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MOXPA — Linear Colliders, Lepton Accelerators and New Acceleration Techniques

The Global Design Initiative for an International Linear Collider

MOXPA01

B.C. Barish (CALTECH)

Two years after the selection of the SC technology and a few months before the release of the ILC Conceptual Design Report, the presentation will review the main issues towards an ILC project and the world-wide collaboration presently set-up to address them. It will especially emphasize the challenges both technical (performances, reliability, machine protection, cost minimisation, industrialisation) and organisational, in a world-wide collaboration for the first time from the very beginning of the project. It will then present the status of the performances already demonstrated, the R&D presently envisaged to improve them or reduce the cost, the test facilities set-up to address them and the effort towards technology transfer to industry and industrialisation. Finally, it will present the plans and schedule for the future as well as the site specific parameters and cost issues.

SCRF Test Facilities toward the ILC

MOXPA02

K. Saito (KEK)

After the ICFA selection of the superconducting linear collider technology in August 2004, many intensive R&D programs are in the planning stage or already underway. Work is proceeding in the three major geographical regions involved in the ILC: Europe(TTF), North America (SMTF) and Asia (STF). In this paper, the global activity represented by these superconducting RF test facilities will be reviewed. Their goals, plans, schedules and possible complementarities will be presented. The performance expected from the different R&D efforts by 2008, and the corresponding contribution to the ILC Technical Design Report, will be especially emphasized.

MOYAPA — Linear Colliders, Lepton Accelerators and New Acceleration Techniques

MOYAPA01

Laser-plasma Wakefield Acceleration: Concepts, Tests and Premises

V. Malka (Ecole Polytechnique) J. Faure (CEA) Y. Glinec, A. Lifschitz (LOA)

The presentation will review all novel methods presently developed to reach high accelerating fields from the concepts, to simulations, feasibility demonstration in real tests and performances presently achieved. It will point out and compare their potential but also their technical challenges and possible limitations. It will also present the necessary R&D and the tests presently envisaged including schedule and milestones not only in terms of fields but also of beam quality preservation and power efficiency. Finally, possible future applications will be suggested.

MOYBPA — Circular Colliders

LHC Progress and Commissioning Plans

MOYBPA01

O.S. Brüning (CERN)

The LHC at CERN is in its final installation phase, and the first tests with beam are planned for part of the machine for the end of 2006. The commissioning of the full machine with beam is planned for summer 2007. The talk summarizes the current status of the LHC installation and the strategy for obtaining an optimum hardware configuration. In a second part the talk outlines the main milestones for the hardware and beam commissioning and presents estimates for the expected performance levels for the commissioning phase with beam.

Operation of High-luminosity Meson Factories and the Challenge to go to the Next Generation

MOYBPA02

K. Akai (KEK)

This talk will present an overview of the operational status of B- and Phi-Factories, and address their present luminosity performance and limitations, such as electron cloud effects. It will also discuss upgrade plans, including motivation and beam dynamics challenges, new ideas, R&D and machine experiments in view of the next generation of meson factories with ~100 times more luminosity. In particular, it will address machine tests with strong RF focusing, crab cavity developments and first operational experience at KEKB.

MOZAPA — Hadron Accelerators

MOZAPA01

Approaches to High Intensities for FAIR

P.J. Spiller, W. Barth, L.A. Dahl, H. Eickhoff, R. Hollinger, P.S. Spaedtke (GSI)

A new accelerator complex is planned to generate highest intensities of heavy ion and proton beams for the Facility for Antiproton and Ion Research (FAIR) at GSI. The two new synchrotrons, SIS100 and SIS300 which deliver the primary beams to the FAIR target stations, will make use of the existing GSI accelerators UNILAC and SIS18 as injectors. In order to reach the desired intensities close to 1012 uranium ions and 2.5 x 1013 protons per pulse, a substantial upgrade program of the existing facility is being prepared. The well defined technical subprojects of these upgrade programs and the concepts for approaching the intensity goals of SIS100/300 will be described.

MOZAPA02

Commissioning Highlights of the Spallation Neutron Source

N. Holtkamp (ORNL)

The Spallation Neutron Source (SNS) is a second generation pulsed neutron source at Oak Ridge National Laboratory. The SNS is funded by the U.S. Department of Energy's Office of Basic Energy Sciences and is dedicated to the study of the structure and dynamics of materials by neutron scattering. A collaboration composed of six national laboratories (ANL, BNL, TJNAF, LANL, LBNL, ORNL) is responsible for the design and construction of the various subsystems. With the official start in October 1998, the operation of the full facility has begun in late spring 2006 delivering a 1.0 GeV proton beam with a pulse length of approximately 700 nanoseconds on a liquid mercury target. Within the next two years a beam power of more than one MW should be achieved. The multi-lab collaboration provided a large variety of expertise in order to enhance the beam power delivered by the accelerator by almost an order of magnitude compared to existing neutron facilities. The SNS linac consists of a room temperature and superconducting (sc) structures and is the first pulsed high power sc linac in the world. The compressor ring and the target are the final subsystems that were commissioned during early 06.

MOZBPA — Synchrotron Light Sources and FELs

Results from the VUV-FEL

MOZBPA01

J. Rossbach (DESY)

The talk will provide the latest results from the VUV-FEL. It will cover the general performance of the machine and comparison to theory. A status will be given of the performance of key systems: the gun, accelerating modules and RF systems, electron and photon beam diagnostics, timing and synchronization and undulator performance. Future developments and implementations will also be discussed (and implications to the XFEL).

A Review of ERL Prototype Experience and Light Source Design Challenges

MOZBPA02

S.L. Smith (CCLRC/DL/ASTeC)

The presentation will review the status of commissioning of ERL light source prototype projects drawing on experience from the JLab IR FEL, UK's ERL prototype ring and the Cornell injector project. State of the art design for future light source based on ERLs and FELs will be illustrated using the concept for the UK's 4GLS project.

MOPCH — Poster Session

MOPCH001

Modeling Coherence Decay in Broad Band Triplet Interaction

M. Frichembruder, R. Pakter, F.B. Rizzato (IF-UFRGS)

In the present analysis we study the transition from coherent to incoherent dynamics in a nonlinear triplet of broad band combs of waves*. We first reduce the original set of equations into a set where all submodes within a comb interact with all pairs of submodes in the remaining combs. We then develop a spectral formalism that in a self-contained way enables: (i) to determine the point of the transition; (ii) to obtain a convenient set of low dimensional equations modeling the full dynamics**. As shall be discussed in connection with accelerator physics, the results can be applied to a variety of parametric or nonlinear wave devices like beat wave accelerators, FELs, etc.

*G. I. Oliveira et al. Physica D 164, 59 (2002).**M. Frichembruder et al. submitted to Physica. D (2005).

MOPCH002

Seeding the FEL of the SCSS Phase 1 Facility with the 13th Laser Harmonic of a Ti: Sa Laser Produced in Gas

G. Lambert, M. Bougeard, W. Boutu, P. Breger, B. Carré, D. Garzella, M. Labat, H. Merdji, P. Monchicourt, P. Salieres (CEA) O.V. Chubar, M.-E. Couprie (SOLEIL) T. Hara, H. Kitamura, T. Shintake (RIKEN Spring-8 Harima) D. Nutarelli (LAC)

A seeding configuration, in which the 13th harmonic (60 nm) of a Ti: Sa laser (50 mJ, 10 Hz, 130 fs) generated in a gas cell is used as the external source, will be tested in 2006 on the SCSS test facility (SPring-8 Compact Sase Source, Japan). This facility is based on a thermionic cathode electron gun (1 nC of bunch charge), a C-band LINAC (5712 MHz, 35 MV/m) and two in-vacuum undulators (15 mm of period). The maximum electron beam energy is 250 MeV and the SASE emission from visible to 60 nm can be obtained. The High order Harmonic Generation (HHG) experiment was mounted off-line at the end of last December. A first chamber is dedicated to harmonic generation. A second one is used for spectral selection and adaptation of the harmonic waist in the modulator. The tests are performed in Saclay with the LUCA (Laser Ultra Court Accordable) laser (15 mJ, 10 Hz, 50 fs) from January to March at 266 nm, 160 nm and 60 nm and its results are presented here. Also, before performing the real tests in SPring-8 FEL presence, final theoretical estimations of the performances relying on 1D simulations using PERSEO code and 3D simulations using GENESIS and SRW codes are given.

MOPCH003

Seeding SPARC Facility with Harmonic Generation in Gases: Preliminary Tests of the Harmonic Generation in Gas Chamber

O. Tcherbakoff, M. Bougeard, P. Breger, B. Carré, D. Garzella, M. Labat, G. Lambert, H. Merdji, P. Monchicourt, P. Salieres (CEA) M.-E. Couprie (SOLEIL) A. Doria, L. Giannessi (ENEA C.R. Frascati)

In High Gain Harmonic Generation Free Electron Laser configuration, an external light source is injected in the first part of an undulator. The electron-photon interaction leads to a coherent light emission in the second part of the undulator. We propose to use the High Order Harmonic Generation in gases process as the seed for SPARC project (Frascati, Italy). With this facility, the electron beam is accelerated to 200 MeV and passes through an undulator of 6 sections. The preliminary tests on the seeding chambers presented in this paper have been realised at the CEA (Saclay, France). The experiment is based on three vacuum chambers. In the first one, a Ti: Sa laser (800 nm, 2.5 mJ, 50 fs, 10 Hz) is focussed in a 10 Hz pulsed gas jet (Argon or Xenon), producing harmonics of the fundamental. Filters in the second chamber enable the selection of the harmonic (3rd or 5th). Finally, a telescope focuses the harmonic beam at a given position. The whole module is to be moved to the SPARC facility. Appropriate tuning of the undulator gaps will amplify the 3rd and 5th harmonics seeded, as well as non-linear harmonics of those wavelengths, allowing the perspective of producing a FEL at 53 nm

Coherent Harmonic Generation Experiment on UVSOR-II Storage Ring

MOPCH004

M. Labat (CEA) M.-E. Couprie (SOLEIL) T. Hara (RIKEN Spring-8 Harima) M. Hosaka, M. Katoh, A. Mochihashi, M. Shimada, J. Yamazaki (UVSOR) G. Lambert (RIKEN Spring-8) D. Nutarelli (LAC) Y. Takashima (Nagoya University)

Harmonic Generation schemes on Free Electron Laser devices are very promising. The injection of a traditional laser source inside the first undulator leads to an efficient energy modulation of the electron bunch, and therefore, its spatial modulation, resulting in a more coherent light emission along the second undulator. Experiments have been performed on the UVSOR-II Storage Ring at Okazaki (Japan) with electrons stored at an energy of 600 MeV, and using a 2.5 mJ Ti:Sa laser at 800 nm wavelength, 1 kHz repetition rate, and 100 fs up to 2 ps pulse duration. The experimental setup is presented, including the transport alignment and synchronisation between the laser and the electron beam. The third harmonic at 266 nm has been characterised versus various parameters: current, RF cavity voltage, undulator gap, magnetic functions of the storage ring, and laser pulse duration. Those results are compared with theory via analytical models and simulations.

The ARC-EN-CIEL FEL Proposal

MOPCH005

M.-E. Couprie, C. Bruni, O.V. Chubar, A. Loulergue, L. Nahon (SOLEIL) B. Carré, D. Garzella, M. Jablonka, M. Labat, G. Lambert, F. Meot, P. Monot, A. Mosnier (CEA) J.-R. Marquès (LULI) D. Nutarelli (LAC) J.-M. Ortega (CLIO/ELYSE/LCP)

ARC-EN-CIEL (Accelerator-Radiation Complex for Enhanced Coherent Intense Extended Light), the French project of a fourth generation light source aims at providing the user community with coherent femtosecond light pulses covering from UV to soft X ray. It is based on a CW 1 GeV superconducting linear accelerator delivering high charge, subpicosecond, low emittance electron bunches with a high repetition rate (1 kHz). Electron beam calculations will be presented. The FEL is based on the injection of High Harmonics Generated in Gases (HHG) in a High Gain Harmonic Generation scheme, leading to a rather compact solution. The produced radiation extending down to 0.8 nm with the Non Linear Harmonics reproduces the good longitudinal and transverse coherence of the harmonics in gas. Calculations are preformed with PERSEO, taking into account the proper transverse overlap between HHG and the electron beam, and with SRW. Optional beam loops are foreseen to increase the beam current or the energy. They will accommodate fs synchrotron infrared Coherent Synchrotron Radiation sources, VUV and X ray ranges and a FEL oscillator in the 10 nm range. An important synergy is expected between accelerat

MOPCH006

Beam Adaptation at the Infrared FEL, CLIO

J.P. Berthet, F. Glotin, J.-M. Ortega (CLIO/ELYSE/LCP) W. Salah (The Hashemite University)

The infrared free-electron laser CLIO is tunable from 3 to 150 5m by operating its driver RF linear accelerator between 50 and 12 MeV. This is the largest spectral range ever obtained with a single optical cavity. We have studied the electron beam transverse adaptation in the FEL undulator throughout the spectral and energy range. Each beam dimension is measured by a moving wire whose temperature dependant resistivity is monitored. The results are compared with simulations computed with the TRANSPORT code.

MOPCH007

Undulators for a Seeded HGHG-FEL Test Bench at MAX-lab

J. Bahrdt, H.-J. Baecker, W.F. Frentrup, A. Gaupp, K. Goldammer, A. Meseck, M. Scheer (BESSY GmbH) S. Werin (MAX-lab)

Undulators for a Seeded HGHG-FEL at MAX-lab Within the European FEL Design Study a seeded HGHG-FEL will be set up at MAX-lab. In the modulator, a planar pure permanent magnet undulator, the 3rd harmonic of a Ti:Sapphire laser (267nm) interacts with the electron beam. In the following dispersive section the energy modulation is converted into a spatial modulation. The radiator emits at the third harmonic (89nm). The radiator has an APPLE II type magnetic structure providing full polarization control. The undulators and the dispersive section are currently built at BESSY. The electron beam height at MAX-lab of 400mm requires a specific design of the undulator carriages. The magnetic and mechanical design of the HGHG stage will be presented.

MOPCH008

Considerations for Double Pulse Lasing from the BESSY-FEL

K. Goldammer, B.C. Kuske, A. Meseck (BESSY GmbH)

BESSY proposes a linac-based High-Gain Harmonic-Generation (HGHG) free electron laser (FEL) facility with three independent FEL lines. Two to four HGHG stages downconvert the initial seed wavelength (230nm to 460nm) to the desired radiation range (1.24nm to 51nm). High FEL gain is ensured as the seed radiation interacts only with unperturbed parts of the electron bunch in every HGHG-stage. This so-called fresh-bunch-technique relies on dipole chicanes that delay the electron bunches relative to the radiation. Fresh-bunch chicanes are incorporated prior to each modulator in the BESSY-FEL allowing the bunch to completely travel through all undulators. However, simulations show that bunch parts that have previously lased generate a noticeable radiation power level in the final amplifiers. This motivated simulation studies on the significance and applicability of such inherent additional pulses. It is revealed that the BESSY-FEL provides the opportunity to deliver double pulses at the FEL exit being of high interest to the user community. Temporal seperation and intensity levels can be controlled by carefully optimising the properties of the magnetic chicanes.

The BESSY 2nd Generation Soft X-ray FEL User Facility

MOPCH009

J. Knobloch (BESSY GmbH)

Future VUV-to-soft-X-ray FEL facilities promise to open fundamentally new frontiers for the synchrotron user community. So-called 2nd generation FELs, which use seeded schemes rather than SASE, can deliver reproducible ultra-short photon pulses at an energy level of mJ/pulse. BESSY has been designing a High-Gain-Harmonic-Generation (HGHG) based FEL with a 2.3 GeV superconducting driver linac that covers photon energies from 24 eV to 1 keV. The design provides full tuneability of photon energy, variable beam polarization and complete synchronization to external lasers—all essential for future femtosecond, time-resolved pump-probe experiments. Also, the CW linac offers great flexibility for the repetition rates and pulse patterns. BESSY-organized User Workshops helped identify the user requirements for such an FEL. This information provided the basis for the Technical Design Report that was submitted to the German Wissenschaftsrat in 2004, which then held an on-site review in 2005. Meanwhile, preparatory studies continue at BESSY. They include start-to-end simulations, tolerance studies, and the development of superconducting RF technology in the HoBiCaT test facility.

High Power Tests of a High Duty Cycle, High Repetition Rate RF Photoinjector Gun for the BESSY FEL

MOPCH010

F. Marhauser (BESSY GmbH)

The proposed BESSY Soft X-ray FEL uses a normal conducting 1.3 GHz photoinjector RF gun cavity at comissioning phase. Due to the challenging RF pulse pattern the cavity has to cope with an average power of 75 kW. A 1.5-cell RF gun prototype has been built with a dedicated cooling layout. Results of the first high power RF tests are detailed in this paper.

Jitter Measurement by Spatial Electro-optical Sampling at the Flash Free Electron Laser

MOPCH011

A. Azima, S. Düsterer, J. Feldhaus, H. Schlarb (DESY) A.L. Cavalieri (MPQ) D. Fritz (Michigan University) K. Sengstock (Uni HH)

For pump-probe experiments carried out at the VUV-FEL at DESY, FEL laser pulses with 32 nm wavelength have to be synchronized with high precision to optical laser pulses generated by a TiSa oscillator. To measure the relative timing variations between the FEL and the optical laser, an electro-optical experiment to determine the electron beam arrival time at the undulator has been installed. Here, the electron beam profile is encoded spatially into the laser pulse and readout by an intensified camera. A similar experimental setup has been successfully used at the sub-picosecond pulsed source (SPPS) at higher charge and shorter rms bunch length. In this paper, we report about the achievements and difficulties of the Timing Electro-Optical (TEO) setup, that allows to post-order experimental user data with a precision of 100 fs rms and better.

FEL Disturbance by Ambient Magnetic Field Changes

MOPCH012

H. Kapitza, P. Göttlicher, N. Heidbrook, H. Schlarb (DESY)

The VUV-FEL at DESY in Hamburg (Germany) is mostly located inside the circular accelerator PETRA which serves as an injector for the electron proton collider HERA. SASE was regularly lost in the VUV-FEL when protons were ramped to the injection energy in PETRA. This effect was mediated by magnetic field changes in the order of 1 microtesla, caused by time-dependent uncompensated magnet currents of more than 800 A which made PETRA act like a large current loop. The resulting beam displacements of several hundred micrometers in the undulators proved to be enough to make SASE fail. This serious disturbance of user runs was eliminated by introducing an improved compensation scheme which further limits residual currents in PETRA during proton injection. The consequences of this observation for the design of the XFEL are briefly discussed.

MOPCH013

Slice Emittance Measurements at FLASH

M. Roehrs, C. Gerth, M. Huening, H. Schlarb (DESY)

The SASE process in Free Electron Lasers mainly depends on time-sliced parameters of charge density, energy spread and transverse emittance. At the VUV-FEL at DESY, electron bunches are compressed longitudinally in two magnetic chicanes in order to achieve high peak currents. The compression causes considerabe variations in slice emittance along the bunches. The vertically deflecting rf-structure LOLA, which is in operation at the VUV-FEL since early 2005, allows to resolve longitudinal variations in horizontal slice width for single bunches. The horizontal slice emittances can be determined by additionally varying the strengths of the quadrupoles upstream of LOLA. Results of slice emittance measurements using different bunch compression schemes are presented.

MOPCH014

Energy-time Correlation Measurements Using a Vertically Deflecting RF Structure

M. Roehrs, C. Gerth, M. Huening, H. Schlarb (DESY)

To initiate the lasing process in SASE-based Free Electron Lasers, electron bunches with high peak currents are necessary. At the VUV-FEL at DESY, high peak currents are produced by bunch shortening in magnetic chicanes induced by a linear energy-time gradient. The residual uncorrelated time-sliced energy width after compression is a crucial parameter for the lasing process. The final energy-time correlation provides important information about the compression process. This paper presents a measurement of slice energy spread and energy-time correlation using a vertically deflecting rf-structure (LOLA). The structure allows to map the time delay of bunch slices to the vertical axis of a screen. After dispersing the bunches horizontally with a dipole, the energy-time correlation can be directly obtained in a single shot measurement. Results for different bunch compression schemes are presented. The measured bunch length in case of a non-compressed beam is compared to streak camera measurements.

MOPCH015

Impact of Undulator Wakefileds and Tapering on European X-ray FEL Performance

I. Zagorodnov, M. Dohlus, T. Limberg (DESY)

The European X-ray Free-Electron Laser (XFEL) based on self-amplified spontaneous emission (SASE) requires an electron beam with a few kA peak current and a small-gap undulator system up to 250 m in length. The interaction between the high-current electron bunch and the undulator vacuum chamber affects the FEL performance. In this paper we estimate the induced wakefields in elliptical pipe geometry, taking into account the main geometrical variations of the chamber. To study the expected performance in the presence of the calculated wakefields, we are doing start-to-end simulations with the tracking codes ASTRA, CSRtrack and GENESIS. To compensate the wakefield impact on the FEL performance, an adiabatic change of undulator parameters is considered.

Bunch Compression Monitor

MOPCH016

H. Delsim-Hashemi, J. Rossbach, P. Schmüser (Uni HH) O. Grimm, H. Schlarb, B. Schmidt (DESY) A.F.G. van der Meer (FOM Rijnhuizen)

An accelerated bunch of electrons radiates coherently at wavelengths longer than or comparable to the bunch length. The first generation Bunch Compression Monitor (BCM) that is installed at the VUV-FEL applies this principle by measuring the total radiation intensity. For a better control on the degree of the compression, the radiated intensity in different bandwidth can be used. Dependent on the changes in the structure of the bunch, its radiation spectrum changes correspondingly. A new generation BCM uses wavelength dependent diffracting devices and multi-channel sensors to measure the signal in different wavelength channels simultaneously. This paper describes the construction of the first prototypes and experimental results in different short wavelength bands measured at the linac of the VUV-FEL at DESY, Hamburg.

Macro-Pulse Generation in a Storage-Ring Free-Electron Laser: A Single-Particle Plus FEL Numerical Approach

MOPCH018

F. Curbis, E. Allaria, G. De Ninno (ELETTRA)

In a storage-ring free-electron laser (FEL), the onset and growth of intra-cavity power at the fundamental resonant wavelength is naturally accompanied by coherent emission at higher harmonics. Contrary to what happens in single-pass linac-based devices, the electron beam is re-circulated in the storage ring and the microbunching becomes thermalized. As a consequence, a correct theoretical understanding of the process requires a proper modelling of the turn-by-turn evolution of the electron-beam phase space, both inside the undulators (where the FEL interaction takes place) and along the ring. To simulate this process we have coupled an ad hoc modified version of the 3D numerical code Ginger (which models the FEL interaction) together with a linear one-turn map (which propagates the electron beam along the ring). We present our results and draw a comparison with previous simplified approaches. We also present the first benchmarking of experiments carried out with the ELETTRA storage-ring FEL.

Baseline Design of the Linac Upgrade for Fermi

MOPCH019

G. D'Auria, P. Craievich, P. Delgiusto, S. Di Mitri, M. Ferianis, M.M. Milloch, G.C. Pappas, G. Penco, M. Trovo (ELETTRA) L.R. Doolittle, A. Ratti (LBNL)

The FERMI FEL requires a major upgrade of the existing linac, which needs to be transformed from being the injector for the ELETTRA light source, to becoming the source for the FERMI FEL. In this work, we present the baseline design, including the integration of the 7 additional systems from the LIL linac, and one X-band station as linearizers. We will present the new layout with the required modifications and additions to the existing infrastructure to meet the more demanding needs of the system. Such modifications include a new RF controller, improvements in the modulator stability and an upgrade to the average power capabilities of the system to operate at 50 Hz. Test results from the characterization of the existing systems will be included, as well as plans for future development.

MOPCH020

Design and Optimization of the FERMI @ Elettra FEL Layout

G. De Ninno, E. Allaria, B. Diviacco (ELETTRA) W.M. Fawley, G. Penn (LBNL) W. Graves (MIT)

The FERMI @ ELETTRA project at Sincotrone Trieste will be comprised of two FEL's, each based on the principle of seeded harmonic generation. The first undulator line, FEL-1, will operate in the 40-100 nm wavelength range and will rely upon one stage of harmonic up-conversion. The second undulator line, FEL-2, extends the output spectral domain to the 10^{-40} nm wavelength range and will use two harmonic stages operating as a cascade. We review the FEL studies that have led to the final design and present results of numerical simulations with GENESIS and GINGER codes including those examining the effects of undulator errors and shot-to-shot fluctuations in multiple input parameters.

MOPCH021

FERMI @ Elettra: Conceptual Design for a Seeded Harmonic Cascade FEL for EUV and Soft X-rays

C.J. Bocchetta, E. Allaria, D. Bulfone, P. Craievich, G. D'Auria, M.B. Danailov, G. De Ninno, S. Di Mitri, B. Diviacco, M. Ferianis, A. Gambitta, A. Gomezel, E. Karantzoulis, G. Penco, M. Trovo (ELETTRA) J.N. Corlett, W.M. Fawley, S.M. Lidia, G. Penn, A. Ratti, J.W. Staples, R.B. Wilcox, A. Zholents (LBNL) M. Cornacchia, P. Emma (SLAC) W. Graves, F.O. Ilday, F.X. Kaertner, D. Wang (MIT) F. Parmigiani (Università Cattolica-Brescia)

We present a summary of the conceptual design for the FERMI FEL project funded for construction at the Sincrotrone Trieste, Italy. The project will be the first user facility based on seeded harmonic cascade FEL's, providing controlled, high peak-power pulses, and complementing the storage ring light source at Sincrotrone Trieste. The facility is to be driven by electron beam from a high-brightness rf photocathode gun, and using the existing 1.2 GeV S-band linac. Designed for an initial complement of two FEL's, providing tunable output over a range from ~100 nm to ~10 nm, FERMI will allow control of pulse duration from less than 100 fs to approximately1 ps, and with polarization control from APPLE undulator radiators. Seeded by tunable UV lasers, FEL-1 is a single-stage of harmonic generation to operate over ~100 nm to ~40 nm, and FEL-2 a two-stage cascade operating from ~40 nm to ~10 nm or shorter wavelength. Photon output is spatially and temporally coherent, with peak power in the 100's MW to GW range. We have designed FEL-2 to minimize the output radiation spectral bandwidth. Major systems and overal facility layout are described, and key performance parameters summarized.

MOPCH022

Time-resolved "Start-to-end" FEL Simulation Results for the FERMI @ Elettra Project

G. De Ninno, E. Allaria (ELETTRA) W.M. Fawley, G. Penn (LBNL) W. Graves (MIT)

The FERMI FEL project* is the first user facility based on seeded harmonic cascade FEL's, providing controlled, high peak-power pulses, and complementing the storage ring light source at Sincrotrone Trieste. FERMI will initial comprise two FEL's, providing tunable output over a wavelength range from ~100- to 40-nm (FEL-1) and ~40-to-10-nm (FEL-2) with control of both polarization and temporal pulse duration. We present results concerning the predicted FEL output based the expected 6D electron beam phase space at the undulator entrance as determined from detailed "start-to-end" simulations**. Both the GENESIS and GINGER codes were applied to this study. We discuss the expected transverse and longitudinal coherence, and also the predicted sensitivity to both undulator errors and accelerator jitter.

*C. J. Bocchetta et al. "FERMI @ Elettra – Conceptual Design for a Seeded Harmonic Cascade FEL for EUV and Soft X-rays", this conference. **S. DiMitri et al. "Start to End Simulations of FERMI@ELETTRA", this conference.

Future Seeding Experiments at SPARC

MOPCH024

L. Giannessi, S. Ambrogio, F. Ciocci, G. Dattoli, A. Doria, G.P. Gallerano, E. Giovenale, M. Quattromini, A. Renieri, C. Ronsivalle, I.P. Spassovsky (ENEA C.R. Frascati) D. Alesini, M.E. Biagini, R. Boni, M. Castellano, A. Clozza, A. Drago, M. Ferrario, V. Fusco, A. Gallo, A. Ghigo, M. Migliorati, L. Palumbo, C. Sanelli, F. Sgamma, B. Spataro, S. Tomassini, C. Vaccarezza, C. Vicario (INFN/LNF) M. Bougeard, B. Carré, D. Garzella, M. Labat, G. Lambert, H. Merdji, P. Salieres, O. Tcherbakoff (CEA) M.-E. Couprie (SOLEIL) A. Dipace, E. Sabia (ENEA Portici) M. Mattioli, P. Musumeci, M. Petrarca (Università di Roma I La Sapienza) M. Nisoli, G. Sansone, S. Stagira, S. de Silvestri (Politecnico/Milano) L. P. Poletto, G. T. Tondello (Univ. degli Studi di Padova) L. Serafini (INFN-Milano)

Sources based on High order Harmonics Generated in gases (HHG) with high power Ti:Sa lasers pulses represent promising candidates as seed for FEL amplifiers for several reasons, as spatial and temporal coherence, wavelength tunability and spectral range, which extends down to the nm wavelength scale. This communication describes the research work plan that is under implementation at the SPARC FEL facility in the framework of the EUROFEL programme. The main goal of the collaboration is to study and test the amplification and the FEL harmonic generation process of an input seed signal obtained as higher order harmonics generated both in crystals (400 nm and 266 nm) and in gases (266 nm, 160 nm, 114 nm). The SPARC FEL can be configured to test several cascaded FEL layouts that will be analysed in this contribution.

Laser Comb: Simulations of Pre-modulated E- Beams at the Photocathode of a High Brightness RF Photoinjector

MOPCH025

M. Boscolo, M. Ferrario, C. Vaccarezza (INFN/LNF) I. Boscolo, F. Castelli, S. Cialdi (INFN-Milano) P. Musumeci (INFN-Roma)

A density modulated beam at the photocathode though the proper modulation of the laser beam pulse does not change substantially emittance and energy spread, properties directly related to FEL. It has been found that bunch density modulation is transformed into energy modulation along the propagation through the injector*. There are some physical arguments that suggest a possibility to use this modulation for the enhancement of the FEL process, or for the production of plasma wakes. Preliminary beam dynamics studies have been carried on to explore the use of electron beam pre-modulation at the cathode to adjust their longitudinal structure at the end of the beamline. Energy modulation at the end of the beamline could eventually be turned into current modulation through a magnetic compressor with R56<0. The feasibility of this experiment has to be investigated carefully, preliminary studies are discussed here. This paper focuses on simulations that explore the properties of the energy modulation at the end of the beamline correlated to the initial characteristics of the train of electron pulses.

*M. Biagini et al. "Beam Dynamics Studies for the SPARC Project", Proc. of PAC03.

MOPCH026

A Biperiodic X-band RF Cavity for SPARC

L. Ficcadenti, M.E. Esposito, A. Mostacci, L. Palumbo (Rome University La Sapienza) D. Alesini, B. Spataro (INFN/LNF) A. Bacci (INFN-Milano)

The Frascati photo-injector SPARC (Pulsed Self Amplified Coherent Radiation Source) will be equipped with an X-band RF cavity for linearizing emittance to enhance bunch compression and for reducing bunch longitudinal energy spread. A biperiodic cavity working on the pi/2-mode offers some advantages in comparison to a conventional (periodic) cavity despite the need of accurate machining. A copper prototype made of 17 separated cells has been built following numerical simulation. In this paper we report on preliminary measurements of its RF properties. The main characteristics of the cooling system for the final device are also addressed.

MOPCH027

Metal Film Photocathodes for High Brightness Electron Injectors

G. Gatti, L. Cultrera, F. Tazzioli, C. Vicario (INFN/LNF) A. Fiori, S. Orlanducci (Università di Roma II Tor Vergata) J. Langner, M. S. Sadowski, P. Strzyzewski (The Andrzej Soltan Institute for Nuclear Studies, Centre Swierk) A. Perrone (INFN-Lecce) C. Ristoscu (INFLPR)

Advanced high brightness injectors require photocathodes with fast response,high quantum efficiency and good surface uniformity. Both Mg films deposited by laser ablation and Pb films deposited by vacuum arc could satisfy these requirements. Their emission and morphology are compared.

MOPCH028

Status of the SPARX FEL Project

C. Vaccarezza, D. Alesini, M. Bellaveglia, S. Bertolucci, M.E. Biagini, R. Boni, M. Boscolo, M. Castellano, A. Clozza, L. Cultrera, G. Di Pirro, A. Drago, A. Esposito, M. Ferrario, D. Filippetto, V. Fusco, A. Gallo, A. Ghigo, S. Guiducci, M. Migliorati, L. Palumbo, L. Pellegrino, M.A. Preger, C. Sanelli, M. Serio, F. Sgamma, B. Spataro, A. Stella, F. Tazzioli, M. Vescovi, C. Vicario (INFN/LNF) F. Alessandria, A. Bacci, F. Broggi, C. De Martinis, D. Giove, M. Mauri (INFN/LASA) L. Catani, E. Chiadroni, A. Cianchi, C. Schaerf (INFN-Roma II) S. Cialdi, C. Maroli, V. Petrillo, M. Rome, L. Serafini (INFN-Milano) F. Ciocci, G. Dattoli, A. Doria, F. Flora, G.P. Gallerano, L. Giannessi, E. Giovenale, G. Messina, P.L. Ottaviani, G. Parisi, L. Picardi, M. Quattromini, A. Renieri, C. Ronsivalle (ENEA C.R. Frascati) P. Emma (SLAC) L. Ficcadenti, A. Mostacci (Rome University La Sapienza) M. Mattioli (Università di Roma I La Sapienza) P. Musumeci (INFN-Roma) S. Reiche, J.B. Rosenzweig (UCLA)

The SPARX project consists in an X-ray-FEL facility jointly supported by MIUR (Research Department of Italian Government), Regione Lazio, CNR, ENEA, INFN and Rome University Tor Vergata. It is the natural extension of the ongoing activities of the SPARC collaboration. The aim is the generation of electron beams characterized by ultra-high peak brightness at the energy of 1 and 2 GeV, for the first and the second phase respectively. The beam is expected to drive a single pass FEL experiment in the range of 13.5-6 nm and 6-1.5 nm, at 1 GeV and 2 GeV respectively, both in SASE and SEEDED FEL configurations. A hybrid scheme of RF and magnetic compression will be adopted, based on the expertise achieved at the SPARC high brightness photoinjector presently under commissioning at Frascati INFN-LNF Laboratories. The use of superconducting and exotic undulator sections will be also exploited. In this paper we report the progress of the collaboration together with start to end simulation results based on a combined scheme of RF compression techniques.

Status of the SPARC Project

MOPCH029

P. Musumeci, D. Levi, M. Mattioli, G. Medici, D. Pelliccia, M. Petrarca (Università di Roma I La Sapienza) D. Alesini, M. Bellaveglia, S. Bertolucci, R. Boni, M. Boscolo, M. Castellano, A. Clozza, L. Cultrera, G. Di Pirro, A. Drago, A. Esposito, M. Ferrario, L. Ficcadenti, D. Filippetto, V. Fusco, A. Gallo, G. Gatti, A. Ghigo, M. Incurvati, C. Ligi, F. Marcellini, M. Migliorati, A. Mostacci, L. Palumbo, L. Pellegrino, M.A. Preger, R. Ricci, C. Sanelli, M. Serio, F. Sgamma, B. Spataro, A. Stecchi, A. Stella, F. Tazzioli, C. Vaccarezza, M. Vescovi, C. Vicario (INFN/LNF) F. Alessandria, A. Bacci, I. Boscolo, F. Broggi, S. Cialdi, C. De Martinis, D. Giove, C. Maroli, M. Mauri, V. Petrillo, M. Rome, A.R. Rossi, L. Serafini (INFN-Milano) L. Catani, E. Chiadroni, A. Cianchi, E. Gabrielli, S. Tazzari (INFN-Roma II) F. Ciocci, G. Dattoli, A. Dipace, A. Doria, G.P. Gallerano, L. Giannessi, E. Giovenale, G. Messina, P.L. Ottaviani, S. Pagnutti, L. Picardi, M. Quattromini, A. Renieri, G. Ronci, C. Ronsivalle, M. Rosetti, E. Sabia, M. Sassi, A. Torre, A. Zucchini (ENEA C.R. Frascati) A. Perrone (INFN-Lecce) S. Reiche, J.B. Rosenzweig, G. Travish (UCLA)

The SPARC Project is starting the commissioning of its photo-injector. RF gun, RF sources, RF network and control, power supplies, emittance meter, beam diagnostics and control to measure the RF gun beam are installed. The photocathode drive laser has been characterized in terms of pulse shape and quality. We expect to conduct beam measurements at RF gun exit in the next future and consequently to start the installation of accelerating sections. The design of the 12 m undulator for the FEL experiment has been completed and the first undulator section out of 6 is under construction: we expect to characterize it at Frascati ENEA laboratory within the next months. SPARC as a facility will host FEL experiments using SASE, seeding and non-linear resonant harmonics. Additional R&D on X-band and S-band structures for velocity bunching are in progress, as well as studies on new photocathode materials and exotic undulator designs. We also present studies on solenoid field defects, beam based alignments, exotic electron bunch production (blow-out of short laser pulses or intensity modulated laser pulses). The possible use of segmented superconducting micro-undulators will be discussed too.

Production of Coherent X-rays with a Free Electron Laser Based on an Optical Wiggler

MOPCH030

V. Petrillo, A. Colzato (Universita' degli Studi di Milano) A. Bacci, C. Maroli, L. Serafini (INFN-Milano) M. Ferrario (INFN/LNF)

The interaction between high-brightness electron beams and counter-propagating laser pulses produces X rays via Thomson scattering. If the laser source is long enough, the electrons bunch on the scale of the emitted X-ray wavelength and a regime of collective effects establishes. In this case, the FEL instability develops and the system behaves like a FEL based on an optical undulator. Coherent X-rays are irradiated, with a bandwidth thinner than that of the incoherent emission. The emittance of the beam and gradients or irregularities in the laser energy distribution are the principal factors that limit the growth of the X-ray signal. We analyse with a 3-D code the transverse effects in the emission produced by a relativistic electron beam when it is under the action of an optical laser pulse and the X-ray spectra obtained. The scalings typical of the optical wiggler, with very short gain lengths and overall time durations of the process make possible considerable emission also in violation of the Pellegrini criterion for static wigglers. A generalized form of this criterion is validated on the basis of the numerical evidence.

MOPCH031

Progress on the Pi-mode X-band RF Cavity for SPARC

L. Ficcadenti, M.E. Esposito, A. Mostacci, L. Palumbo (Rome University La Sapienza) D. Alesini, B. Spataro (INFN/LNF) A. Bacci (INFN-Milano)

The Frascati photo-injector SPARC (Pulsed Self Amplified Coherent Radiation Source) will be equipped with an x-band RF cavity for linearizing emittance to enhance bunch compression and for reducing bunch longitudinal energy spread. The nine cell standing wave cavity prototype made of separated cells has been already built and measured*. In this paper we report on characterization of the first brazed prototype. Heat load studies have been performed as well to design the cooling system for the final device.
*D. Alesini et al. Nucl. Instr. and Meth. A 554 (2005) 1.

MOPCH034

On a Skeleton CASSINI Ovals Current Undulator

A.M. Mihalache, V.I.R. Niculescu (INFLPR) V. Babin (INOE) M.R. Leonovici, C. Stancu (Bucharest University, Faculty of Physics) F. Scarlat (Valahia University, Faculty of Sciences)

A new undulator structure for free electron lasers was presented. Current skeleton CASSINI ovals produced magnetic fields which are spatially periodic. The current structure was in the shape of stacks of modified CASSINI ovals. The current has alternating directions. The magnetic field components for each wire present C2 symmetry. CASSINI undulator transverse cross-section* was approximated by polygons. In cartesian coordinates the Biot-Savart law was analytically evaluated. The magnetic field was mainly transversal and easily adjusted with the current. The versatility of this structure introduces a new type of two beams longitudinal undulator or wiggler design for transverse moments.
*Cassini curve; C. Mihu, I.P. Iambor-1989.

MOPCH036

Photocathode Roughness Impact on Photogun Beam Characteristics

T.V. Gorlov (MEPhI) A.M. Tron (LPI)

Photocathode surface roughness has an impact on photoelectron yield, bunch duration, beam emittance at the exit of femtosecond photogun with an accelerating field that is considered in assumption of quasi-stationary one in the paper. The main problem in investigating the impact is determination of the field near the surface, statistical properties of which are defined through rms values of deviation and slope in profile line of the surface roughness. Developed and created code allows determining the field with relative rms error not worse than 0.001%. The results of the investigation for rms values of roughness and its slope within respectively 500. . .0 nm and 20. . .0 degrees are presented and discussed.

MOPCH038

Predicted Parameters of the Second Stage of High Power Novosibirsk FEL

A.V. Kuzmin, O.A. Shevchenko, N. Vinokurov (BINP SB RAS)

The first stage of Novosibirsk high power terahertz FEL was successfully put into operation in 2003*. The measured parameters of the FEL turned out to be in a good agreement with calculations [2]. The second and the third stages of the FEL are under construction now. The beam energy at the second stage will be about 20 MeV and the wavelength will change

in the range 40-80 μm. In this paper we present the design parameters for the second stage FEL. The simulations were carried out with the help of 1-D code based on macroparticles. This code was previously used for the first stage simulations**.
*E. A. Antokhin et al. NIM A528 (2004) p.15-18.**A. V. Kuzmin et al. NIM A543 (2005) p.114-117.

Simulations for the FEL Test Facility at MAX-lab within EUROFEL

MOPCH040

S. Thorin, M. Brandin, S. Werin (MAX-lab) M. Abo-Bakr, J. Bahrdt, K. Goldammer (BESSY GmbH)

Within the EUROFEL project a High Gain Harmonic Generation Free Electron Laser will be constructed at MAX-lab in collaboration with BESSY. The electron bunches will be created in the existing MAX-lab injector and transported to the inside of the MAX II ring where the FEL undulators will be located. To predict FEL performance and stability, simulations of the photo injector, linac, recirculator, transport and undulator sections as well as start to end simulations have been carried out.

Design of a New Preinjector for the MAX Recirculator to be Used in EUROFEL

MOPCH041

S. Werin, M. Brandin, T. Hansen, D. Kumbaro, L. Malmgren, S. Thorin (MAX-lab) J. Bahrdt (BESSY GmbH)

The MAX-lab recirculator injector will be equipped with a new preinjector system. The aim is to reduce the emittance, increase the charge and achieve a proper timing between accelerator and laser systems. All is aimed at the MAX-lab test facility for HG built in collaboration with BESSY in the EUROFEL program. The preinjector system consists of a photo cathode RF-gun with an emittance compensating solenoid. Special issues regard the injection of the new beam into the beam path of the MAX recirculator and the conservation of beam parameters.

Progress in the Design of a Two-Frequency RF Cavity for an Ultra-Low Emittance Pre-Accelerated Beam

MOPCH042

J.-Y. Raguin, A. Anghel, R.J. Bakker, M. Dehler, R. Ganter, C. Gough, S. Ivkovic, E. Kirk, F. Le Pimpec, S.C. Leemann, K.L. Li, M. Paraliev, M. Pedrozzi, L. Rivkin, V. Schlott, A.F. Wrulich (PSI)

Today most of the X-rays Free-Electron Laser projects are based on state of the art RF guns, which aim at a normalized electron beam emittance close to 1 mm·mrad. In this paper we report on the progress made at PSI towards a hybrid DC + RF Low Emittance Gun (LEG) capable of producing a beam with an emittance below 0.1 mm.mrad. To reduce the intrinsic thermal emittance at the LEG cathode the electrons are extracted from nanostructured field-emitters. A gun test facility is under construction wherein after emission the beam is accelerated up to 500 keV in a diode before being injected and accelerated in a two-frequency 1.5-cell RF cavity. The fast acceleration in the diode configuration allows to minimize the emittance dilution due to the strong space charge forces. The two-frequency RF structure is optimized to limit the emittance blow-up due to the non-linearity of the RF field.

MOPCH043

An Optimization Study for an FEL Oscillator at TAC Test Facility

Ö.M. Mete, Ö. Karsli, O. Yavas (Ankara University, Faculty of Engineering)

Recently, conceptual design of the Turkic Accelerator Center (TAC) proposal was completed. The main goal of this proposal is a charm factory that consists of a linac-ring type electron-positron collider. In addition, synchrotron radiation from the positron ring and free electron laser from the electron linac are proposed. The project related with this proposal has been accepted by the Turkish government. It is planned that the Technical Design Report of TAC will have been written in the next three years. In this period, an infrared oscillator free electron laser (IR FEL) will be constructed as a test facility for TAC. 20 and 50 MeV electron energies will be used to obtain infrared FEL. The main parameters of the electron linacs, the optical cavities and the FEL were determined. The possible use of obtained laser beam in basic and applied research areas such as biotechnology, nanotechnology, semiconductors and photo chemistry were discussed.

MOPCH044

Peculiarities of the Doppler Effect for Moving Radiative Particles in Dispersive Medium at Extreme Conditions

M.V. Vysotskyy, V.I. Vysotskii (National Taras Shevchenko University of Kyiv, Radiophysical Faculty)

The features of Doppler effect for fast moving radiating particles with discrete energy levels spectrum (e.g. radiation at channeling) at parameters close or equal to extreme condition of Cherenkov effect are studied. The formal usage of Cherenkov condition leads in this case to incorrect and unphysical results. The main task of this work was to find maximal radiation frequency and its dependence from the system parameters. This finite frequency was found. It was shown that at correct use of conservation laws the dependence of radiation and absorption frequencies on deviation from exact Cherenkov condition contains one discontinuity. The value of these frequencies on two sides of this discontinuity is different by 2.5 times. It was shown that the positions of these discontinuities depend on deviation value and corresponds to the condition of normal Doppler effect transformation into abnormal. Conditions that correspond to maximal radiation and absorption frequencies are different and are shifted in different directions form the exact Cherenkov condition (in relation to the velocity and dielectric permittivity).

MOPCH045

A Source of Coherent Soft X-ray Radiation Based on High-order Harmonic Generation and Free Electron Lasers

M. Gullans, J.S. Wurtele (UCB) G. Penn, A. Zholents (LBNL)

We examine a scheme for a Free Electron Laser (FEL) harmonic amplifier seeded by a ~30-nm wavelength signal produced using a process of High-order Harmonic Generation (HHG). The seed is first amplified in an optical klystron from ~100 kW to ~30 MW using a 1 GeV electron beam and then is used for an energy modulation of electrons in the downstream undulator. Subsequently, a 100-MW level of radiation at shorter wavelengths down to 4 nm is obtained by bunching the energy modulated electrons and passing the bunched beam through an undulator tuned to the desired harmonic of 30 nm. We also compare this scheme to a more familiar harmonic cascade FEL by replacing the HHG with an additional stage of harmonic generation.

Study of the Electron Beam Dynamics in the FERMI @ ELETTRA Linac

MOPCH047

M. Cornacchia, P. Craievich, S. Di Mitri (ELETTRA) I.V. Pogorelov, J. Qiang, M. Venturini, A. Zholents (LBNL) D. Wang (MIT) R.L. Warnock (SLAC)

A study of the electron beam dynamics in the linac is made within the framework of the design of a free electron laser (FEL) at the Syncrotrone Trieste*. A scope of the work includes analysis of two operational scenarios, one with relatively long electron bunches of the order of 1.5 ps and a moderate peak current of 500 A and one with shorter bunches of the order of 0.7 ps and higher peak current of the order of 800 A. In both cases, care has been taken to preserve the slice and projected emittances formed in the photocathode gun injector and to minimize the slice energy spread. The latter goal is accomplished by balancing the onset of the microbunching instability driven by the longitudinal space charge forces and the emission of coherent synchrotron radiation using Landau damping produced by a so-called laser heater. Various analytical techniques and tracking codes have been employed to obtain the reported results.

*C. Bocchetta, et al., this conference.

Linac Coherent Light Source Electron Beam Collimation

MOPCH048

J. Wu, D. Dowell, P. Emma, C. Limborg-Deprey, J.F. Schmerge (SLAC)

This paper describes the design and preliminary simulations of the electron beam collimation system in the Linac Coherent Light Source (LCLS) linac. Dark current is expected from the gun and some of the accelerating cavities. Particle tracking of the expected dark current through the entire LCLS linac, from L0-linac exit to FEL undulator entrance, is used to estimate final particle extent in the undulator as well as expected beam loss at each collimator or aperture restriction. A table of collimators and aperture restrictions is listed along with halo particle loss results, which includes an estimate of average continuous beam power lost on each individual collimator. In addition, the transverse wakefield alignment tolerances are calculated for each collimator.

Trajectory Stability Modeling and Tolerances in the LCLS

MOPCH049

J. Wu, P. Emma (SLAC)

To maintain stable performance of the Linac Coherent Light Source X-ray Free-electron laser, one has to control undulator trajectory stability to a small fraction of the rms beam size. BPM based feedback loops running at 120 Hz will be effective in controlling jitter at low frequencies less than a few Hz. On the other hand, linac and injector stability tolerances must control jitter at higher frequencies. In this paper, we study the possible sources of such high frequency jitter, including: 1) steering coil current regulation; 2) quadrupole (and solenoid) transverse vibrations; 3) quadrupole (and solenoid) current regulation in presence of typical 200-micron misalignments; 4) charge jitter coupling to RF cavity transverse wakefield due to alignment errors; and 5) bunch length jitter coupling to Coherent Synchrotron Radiation in Chicane. Based on this study, we then set tolerances on each item.

MOPCH051

Operation of the First Undulator-based Femtoslicing Source

S. Khan (Uni HH) K. Holldack, T. Kachel, T. Quast (BESSY GmbH) R. Mitzner (Universität Muenster, Physikalisches Institut)

At the BESSY II storage ring, a source of sub-100-fs x-ray pulses with tunable polarization and excellent signal-to-background ratio has been constructed in 2004, based on laser-induced energy modulation ("femtoslicing"*) and subsequent angular separation of the short-pulse x-rays from an elliptical undulator. After commissioning and characterizing the source, short-pulse radiation is now routinely delivered for pump-probe applications. The paper summarizes the results from commissioning and operational experience as well as possible upgrade options.
*A. Zholents and M. Zoloterev, PRL 76 (1996), 912.

MOPCH053

Towards Sub-picoseconds Electron Bunches: Upgrading Ideas for BESSY II

G. Wuestefeld, J. Feikes, P. Kuske (BESSY GmbH)

Sub-picoseconds bunches were achieved with the BESSY low alpha optics, and their lengths were measured using Fourier Transform spectroscopy*. To avoid the coherent synchrotron radiation instability, the current in these short bunches has to be limited to theμampere level. An upgrade of the BESSY II rf gradient to much larger values is suggested to overcome this low current limitation by two orders of magnitude. Intense, picoseconds long bunches could then be achieved already at the regular user optics. The resulting short and very intense electron bunches are useful for generation of short x-ray pulses and powerful THz-radiation. Expected parameters of bunch length and current are discussed.
*J. Feikes et al. "Sub-Picoseconds Electron Bunches in the BESSY Storage Ring", EPAC'04, Luzerne (Switzerland), July 2004.

MOPCH054

Plans for the Generation of Short Radiation Pulses at the Diamond Storage Ring

R. Bartolini (Diamond) M. Borland, K.C. Harkay (ANL)

Diamond is a third generation light source under commissioning in Oxfordshire UK. In view of the increasing interest in the production of short radiation pulses, we have investigated the possibility to operate with a low-alpha optics, the use of a third harmonic cavity for bunch shortening and the implementation of a crab cavity scheme in the Diamond storage ring. The results of the initial accelerator studies will be described, including the modification of the beam optics, non-linear beam dynamics optimisation and choice of RF parameters for the crab cavity operation. The expected performance of these schemes will be summarised.

MOPCH055

Circulation of a Short, Intense Electron Bunch in the NewSUBARU Storage Ring

Y. Shoji, Y. Hisaoka, T. Matsubara, T. Mitsui (NewSUBARU/SPring-8, Laboratory of Advanced Science and Technology for Industry (LASTI)) T. Asaka, S. Suzuki (JASRI/SPring-8)

One new method is proposed which supplies synchrotron radiation light from a short and intense electron bunch. This method supplies a short and intense x-ray pulse and extremely strong coherent radiation in a long wavelength region to beam lines of a storage ring. SPring-8 linac supplied a short and intense 1.0 GeV electron beam to NewSUBARU storage ring. The electron bunch was compressed to 10ps (full width) from the normal condition (20ps full width) using ECS system. The pulse charge was 0.10nC/bunch and the energy spread was (±) 0.2 % (full width) at the injection point. The ring lattice was adjusted at a quasi-isochronous condition to keep the short bunch for many revolutions. The estimated linear and non-linear momentum compaction factors were $-6\cdot10^{-5}$ (the linear factor), 0.0 (the second order factor) and +0.9 (the third order factor). The bunch length was measured by a streak camera, and the coherent radiation was detected by a Shottky diode detector. The short bunch was successfully circulated for about 50 turns.

Development of High Brightness Soft X-ray Source Based on Inverse Compton Scattering

MOPCH056

R. Moriyama, Y. Hama, K. Hidume, A. Oshima, T. Saito, K. Sakaue, M. Washio (RISE) H. Hayano, J. Urakawa (KEK) S. Kashiwagi (ISIR) R. Kuroda (AIST)

Compact soft X-ray source based on inverse compton scattering have been developed at Waseda University. Using 1047nm laser light from Nd:YLF laser scattered off 4.2MeV electron beam generated from a photo-cathode rf-gun, we have already suceeded to generate the soft X-ray. The energy of this x-ray is included in the part of water window, in which absorption of water is much less than that of moleculars that organize a living body. Furthermore, this x-ray source has other features such as short pulse, proportional mono-energy and energy variableness. Because of these tures, the application to the biological microscope have been expected. However, the flux of x-ray is not satisfied for the biological microscope application. Therefore, to multiply a soft X-ray flux, we utilized multi-pass amplifier for the laser light and improved a collision chamber. In this conference, we will report the experimental results and future plans.

The Design of a 1.8 keV Compton X-ray Generator for a SC RF Linac at KAERI

MOPCH057

A.V. Bondarenko, S.V. Miginsky (BINP SB RAS) Y.H. Han, Y.U. Jeong, B.C. Lee, S. H. Park (KAERI)

A quasi-monochromatic X-ray source based on the KAERI SC linac system has been designed and is being manufactured now. A 10 MeV 10 mA electron beam together with a 20 W 1.06 ?m laser beam will be used for 1.8 keV Compton X-ray generation with a few percentage of energy spread and 107 photons per second. A simple straight beamline was designed to deliver the electron beam with no degradation of its emittance and energy spread and to focus it to a proper size to produce the desired X-rays. We expect the first demonstration of 1.8 keV Compton X-ray generation in autumn 2006.

RF Photogun as Ultra Bright Terahertz Source

MOPCH058

W.P.E.M. Op 't Root, M.J. Loos, O.J. Luiten, M.J. Van der Wiel, T. van Oudheusden, S.B. van der Geer (TUE)

Recently research into new terahertz (0.3 to 30 THz) light sources has gained a lot of interest. Especially compact sources capable of delivering high peak fields (~ 1 MV/cm), in a short pulse. To achieve this, we will use short relativistic electron bunches, created by photoemission and accelerated in an rf-photogun, to create THz light by means of coherent transition radiation. Because wavelengths smaller and comparable to the bunch length add up coherently, the intensity scales with N^2, with N the number of electrons in the bunch. In the first experiments we expect to create THz light pulses with a bandwidth of 1 THz and 1 μJ per pulse. If such a light pulse is focused on a spot of radius 250 μm, this corresponds to peak electrical fields of 1 MV/cm. The eventual goal is to increase the bandwidth of the source, by creating shorter electron bunches. This will be accomplished by choosing a suitable radial laser profile, leading to ellipsoidal electron bunches, which can be focused and compressed very effectively. Eventually this will lead to THz pulses with a bandwidth of 10 THz and energy of 100 μJ. This corresponds to peak electrical fields of 10 MV/cm and higher.

MOPCH059

From Pancake to Waterbag: Creation of High-brightness Electron Bunches

T. van Oudheusden, O.J. Luiten, W.P.E.M. Op 't Root, M.J. Van der Wiel, S.B. van der Geer (TUE)

Our recent insight is that, when creating high-brightness electron bunches, the major problem is not space charge density itself, but its distribution. Non-linear space charge effects lead to a decrease of brightness. We have a novel recipe of creating waterbag bunches (uniformly charged 3D ellipsoids), which have linear space charge fields. Because of these linear fields we have control of the Coulomb explosion of the bunches. Furthermore, using linear charged particle optics, waterbags can be compressed and focussed with conservation of brightness. Our recent simulations prove that it is possible to create such ideal waterbag bunches in practice. The recipe is to create at the cathode a pancake-like electron bunch with a "hemisphere" charge density distribution. During acceleration this pancake will evolve into a waterbag by its own space charge forces, if two conditions on the acceleration field and the surface charge density are fulfilled. These two conditions are leading to a parameter space, which is explored by simulations. We will present numerical simulations and the present status of the experimental realization.

MOPCH062

Centroid, Size, and Emittance of a Slice in a Kicked Bunch

C.-X. Wang, W. Guo (ANL)

A transversely kicked bunch will decohere due to, among other things, chromatic and amplitude-dependent tune shifts. The chromatic tune shift leads to correlation between transverse and longitudinal phase space. Such a correlation can be used for compressing synchrotron radiation of the bunch with adequate optics. In this report, we revise the decoherence calculation to derive the centroid and second moments of a beam slice in a kicked bunch, taking into account chromatic and nonlinear decoherence, but neglecting wakefield and radiation damping, etc. A simple formula for estimating slice bunch length (and potential pulse compression ratio) is given for the ideal situation.

MOPCH064

The Specification, Design and Measurement of Magnets for the Energy Recovery Linac Prototype (ERLP) at Daresbury Laboratory

F. Bødker (Danfysik A/S) N. Marks, N. Thompson (CCLRC/DL/ASTeC)

The Energy Recovery Linac Prototype (ERLP) is currently under construction at Daresbury Laboratory in the UK and will serve as a test bed for the investigation of technologies and beam physics issues necessary for the development of Daresbury Laboratory's Fourth Generation Light Source (4GLS) proposal. A number of new ERLP beam transport system magnets have been procured for the project. The magnets have been designed, manufactured and measured by Danfysik following a stringent magnetic field specification produced by Daresbury Laboratory. In this paper we summarise the magnet specification. We then present details of the magnetic and mechanical design of the magnets and finally discuss the measurement techniques used to demonstrate that the field quality of the magnets satisfied the specification.

Fabrication and Installation of Superconducting Accelerator Modules for the ERL Prototype (ERLP) at Daresbury

MOPCH065

P. vom Stein, S. Bauer, M. Pekeler, H. Vogel (ACCEL) R. Bate, C.D. Beard, D.M. Dykes, P.A. McIntosh, B. Todd (CCLRC/DL/ASTeC)

Installation and commissioning of the superconducting energy recovery linac(ERL) prototype is under way at Daresbury Laboratory. ACCEL have manufactured two superconducting accelerator modules for the injector and the linac, operating at 2K with 1.3 GHz TESLA type cavities. Each module contains two cavities and is designed to provide an accelerating voltage of 25 MV in cw mode. This paper presents details of the module fabrication, cavity preparation and performance results. An overview of the cryogenic installations for the modules is given and status results of the commissioning are discussed.

The Conceptual Design of 4GLS at Daresbury Laboratory

MOPCH066

J.A. Clarke (CCLRC/DL/ASTeC)

GLS is a novel next generation proposal for a UK national light source to be sited at Daresbury Laboratory, based on a superconducting energy recovery linac (ERL) with both high average current photon sources (undulators and bending magnets) and three high peak current free electron lasers. Key features are a high gain, seeded FEL amplifier to generate XUV radiation and the prospect of advanced research arising from unique combinations of sources with femtosecond pulse structure. The conceptual design is now completed and a CDR recently published. The 4GLS concept is summarised, highlighting how the significant design challenges have been addressed, and the project status and plans explained.

Lattice Design for the Fourth Generation Light Source at Daresbury Laboratory

MOPCH069

B.D. Muratori, M.A. Bowler, H.L. Owen, S.L. Smith (CCLRC/DL/ASTeC) S.V. Miginsky (BINP SB RAS)

The proposed Fourth Generation Light Source (4GLS) has three electron transport paths, an energy recovery loop containing the main linac, IDs and a VUV-FEL, a separate branch after the main linac for an XUV-FEL and a transport path for an IR-FEL. The first two present major challenges in lattice design. The energy recovery loop will be fed by a high average current gun, with bunches of charge of about 80 pC. High charge (1nC) bunches from a high brightness gun will be accelerated prior to the main linac and split into the XUV-FEL branch using energy separation after the main linac. We present a lattice design and results from numerical modelling of the electron bunch transport. The requirements of the machine are short bunches, a small emittance for both branches and an overall topology which gives a reasonable dimension for the building. Different transport and compression schemes were assessed to meet these requirements whilst balancing the disruptive effects of longitudinal and transverse space charge, CSR, wakefields and BBU. Investigations into all of these instabilities are summarized together with other transport issues and the resulting requirements on all IDs.

MOPCH070

The Status of the Daresbury Energy Recovery Prototype Project

D.J. Holder, J.A. Clarke, P.A. McIntosh, M.W. Poole, S.L. Smith (CCLRC/DL/ASTeC) N. Bliss (CCLRC/DL) E.A. Seddon (CCLRC/DL/SRD)

The major component of the UK's R&D programme towards an advanced energy recovery linac-based light source facility is a 35 MeV technology demonstrator called the energy recovery linac prototype (ERLP). This is based on a combination of a DC photocathode electron gun, a superconducting linac operated in energy recovery mode and an IR FEL. The current status of the of this project is presented, including the construction and commissioning progress and plans for the future exploitation of this scientific and technical R&D facility.

MOPCH071

Optimization of Optics at 200 MeV KEK-ERL Test Facility for Suppression of Emittance Growth Induced by CSR

M. Shimada, A. Enomoto, T. Suwada, K. Yokoya (KEK)

Energy Recovery Linac (ERL) gets a lot of attention as a next period light source instrument. To produce high-brightness and short pulse synchrotoron lights, it is necessary to pass through high current and short bunch electron beams to the insertion part of ERL with keeping the low emittance and the low energy spread. However, it is challenging because Coherent Synchrotorn Radiation (CSR) generated at bending magnets is potential sources of the emittance growth which is enomous especially for high current, short bunch and a low energy beam. Therefore, it is benefit to a gradual bunch compression in the arc after accelerating the beam up to the full energy. The beam optics and lattice design of 200MeV ERL Test Facility is optimized to suppress the emittance growth caused by CSR at the arc section on two conditions, high-current mode (100mA, 1psec) and short bunch mode (0.1psec) similar to 5GeV ERL facility proposed by Cornell University.

MOPCH072

Adjustable Input Coupler Development for Superconducting Accelerating Cavity

M.V. Lalayan, M.A. Gusarova, V.I. Kaminsky, A.A. Krasnov, V.A. Makarov, N.P. Sobenin (MEPhI) A.A. Zavadtsev, D.A. Zavadtsev (Introscan)

The waveguide and coaxial-type input couplers for Energy Recovery Linac type injector cavity electrodynamical and thermal simulation results are presented. The devices are designed to feed the superconducting cavity with up to 500 kW RF power in continuous wave regime at 1.3 GHz operating frequency. The cavity external quality factor adjustment is provided. The heat load to the cryogenic system was lowered to a tolerable level by coupler design optimization.

MOPCH073

A Project of a High-power FEL Driven by an SC ERL at KAERI

A.V. Bondarenko, S.V. Miginsky (BINP SB RAS) Y.H. Han, Y.U. Jeong, B.C. Lee, S. H. Park (KAERI)

A project of a high-power FEL at Korea Atomic Energy Research Institute is described. The FEL is driven by a superconducting energy recovery linac. The future ERL will be connected to the existing machine without any modification. It consists of two 180-degree bents and two

straight sections: one is for the FEL, another for a Compton X-rays source. One can choose the regime controlling the lenses. The total ERL is isochronous to avoid any problems with longitudinal beam instability. The total relative emittance degradation through the whole machine is ? 1.5. The FEL will be based on a 2 m helical in-vacuum undulator made of permanent magnets. One mirror of the optical cavity is blind and made of copper; the other one, the outcoupler, is semi-transparent and made of CVD diamond. The expected average power is a few kW and the tuning range 35. . .70 ?m.

Layout of an Accumulator and Decelerator Ring for FAIR

MOPCH074

P. Beller, K. Beckert, C. Dimopoulou, A. Dolinskii, F. Nolden, M. Steck, J. Yang (GSI)

Antiproton physics and experiments with rare isotope beams are major research fields at FAIR. Antiproton physics requires the accumulation of high intensity antiproton beams. The accumulation of up to 10^{11} antiprotons at 3 GeV is foreseen. This will be accomplished by the combination of the collector ring CR for stochastic precooling and the specialized accumulator ring RESR. The accumulation scheme in the RESR is based on the usage of a stochastic cooling system. The requirements of this cooling system strongly affect the magnetic structure of the RESR. For experiments with short-lived rare isotope beams the RESR serves the task of fast deceleration. Precooled rare isotope beams will be injected at 740 MeV/u and then decelerated to energies between 100 and 400 MeV/u in less than 1 s. This contribution presents the ring design and lattice studies relevant for both tasks of the ring as well as a description of the antiproton accumulation scheme.

Internal Target Effects in the ESR Storage Ring with Cooling

MOPCH075

V. Gostishchev, K. Beckert, P. Beller, C. Dimopoulou, A. Dolinskii, F. Nolden, M. Steck (GSI) I.N. Meshkov, A.O. Sidorin, A.V. Smirnov, G.V. Trubnikov (JINR)

The accurate description of beam-target effects is important for the prediction of operation conditions in terms of high luminosity and beam quality in the FAIR facility at GSI. Numerical models have been developed to evaluate beam dynamics in ion storage rings, where strong cooling in combination with a dense target is applied. First systematic benchmarking experiments were carried out at the existing ESR storage ring at GSI. The influence of the internal target on the beam parameters is demonstrated. Comparison of experimental results with simple models describing the energy loss of the beam particles in the target as well as with more sophisticated simulations with the BETACOOL code will be given.

Baseline Design for the Facility for Antiproton and Ion Research (FAIR) Finalized

MOPCH076

D. Krämer (GSI)

The baseline design for the future international facility FAIR has been worked out. The unique accelerator complex will provide high intensity ion beams ranging from antiprotons to uranium for nuclear matter and hadron physics studies. Radioactive beams are generated for nuclear structure and astrophysics experiments. Phase space compression utilizing stochastic and electron cooling allow for fundamental tests at highest precision. Centered around two fast ramping superconducting synchrotrons, ions are accelerated to a beam rigidity of up to 100 Tm and 300 Tm, respectively. Two dedicated storage rings serve for beam accumulation and cooling, providing unprecedented beam quality for experiments in the NESR and HESR storage rings. An overview of the layout of the accelerator complex and beam delivery systems is given. Ongoing R&D activities are reported; project status and international participation will be presented.

MOPCH077

The Collector Ring CR of the FAIR Project

F. Nolden, K. Beckert, P. Beller, U. Blell, C. Dimopoulou, A. Dolinskii, U. Laier, G. Moritz, C. Muehle, I. Nesmiyan, C. Peschke, M. Steck (GSI)

The Collector Ring is a storage ring in the framework of the FAIR project. It has the purpose of stochastic precooling of both rare isotope and antiproton beams and of measurung nuclear masses in an isochronous setting. The paper discusses progress in the development of magnet systems, rf systems, injection/extraction strategies and stochastic cooling systems. Finally it is discussed how to confirm the predicted performance of the slotline electrodes developed recently for stochastic cooling.

MOPCH078

Simulation of Dynamic Vacuum Induced Beam Loss

C. Omet, P.J. Spiller, J. Stadlmann (GSI)

In synchrotrons, operated with intermediate charge state, heavy ion beams, intensity dependent beam losses have been observed. The origin of these losses is the change in charge state of the beam ions at collisions with residual gas atoms or molecules. The resulting A/Z deviation from the reference beam ion leads to modified trajectories in dispersive elements, which finally results in beam loss. At the impact positions, secondary particles are produced by ion stimulated desorption and increase the vacuum pressure locally. In turn, this pressure rise will enhance the charge change¯ and particle loss process and finally cause significant beam loss within a very short time (a few turns). A program package has been developed, which links the described beam loss mechanisms to the residual gas status and determines the vacuum dynamics. Core of the program is an ion optics tracking routine, in which the atomic physics and vacuum effects are embedded.

MOPCH079

Ion Optical Design of the Heavy Ion Synchrotron SIS100

J. Stadlmann, K. Blasche, B. Franczak, C. Omet, N. Pyka, P.J. Spiller (GSI) A.D. Kovalenko (JINR)

We present the ion optical design of SIS100, which is the main synchrotron of the FAIR project. The purpose of SIS100 is the acceleration of high intensity heavy ion and proton beams and the generation of short compressed single bunches for the production of secondary beams. Since ionization in the residual gas is the main loss mechanism, a new lattice design concept had to be developed, especially for the operation with intermediate charge state heavy ions. The lattice was optimized to generate a peaked loss distribution in charge separator like lattice cells. Thereby it enables the control of generated desorption gases in special catchers. For bunch compression, the lattice provides dispersion free straight sections and a low dispersion in the arcs. A special difficulty is the optical design for fast and slow extraction, and the emergency dumping of the high rigidity ions within the same short straight section.

Design of the NESR Storage Ring for Operation with Ions and Antiprotons

MOPCH080

M. Steck, K. Beckert, P. Beller, C. Dimopoulou, A. Dolinskii, F. Nolden, J. Yang (GSI)

The New Experimental Storage Ring (NESR) of the FAIR project has two major modes of operation. These are storage of heavy ion beams for internal experiments and deceleration of highly charged ions and antiprotons before transfer into a low energy experimental area. The heavy ion beams can be either stable highly charged ions or rare isotope beams at an energy of 740 MeV/u selected in a magnetic separator. The antiprotons come with an energy of 3 GeV from the production target, they are pre-cooled and accumulated in a storage ring complex. The magnetic structure of the NESR has been optimized for large transverse and longitudinal acceptance by detailed dynamic aperture calculations. This will allow storage of multi-component beams with a large spread of charge to mass ratio, corresponding to a large spread in magnetic rigidity. Highest phase space density of the stored beams is provided by an electron cooling system, which for ions covers the full energy range and for antiprotons allows intermediate cooling during the deceleration process. For experiments with short-lived isotopes the cooling time and the time of deceleration will be optimized to a few seconds.

FLAIR: a Facility for Low-energy Antiproton and Ion Research

MOPCH081

C.P. Welsch, C.P. Welsch (CERN) H. Danared (MSL)

To exploit the unique possibilities that will become available at the Facility for Antiproton and Ion Research (FAIR), a collaboration of about 50 institutes from 15 countries was formed to efficiently enable an innovative research program towards low-energy antimatter-physics. In the Facility for Low-energy Antiproton and Ion Research (FLAIR) antiprotons and heavy ions are slowed down from 30 MeV to energies as low as 20 keV by a magnetic and an electrostatic storage ring. In this contribution, the facility and the research program covered are described with an emphasis on the accelerator chain and the expected particle numbers. An overview of the novel beam handling, cooling and imaging techniques as they will be required across the facility is given.

Design Study for an Antiproton Polarizer Ring (APR)

MOPCH083

A. Garishvili, A. Lehrach, B. Lorentz, S.A. Martin, F. Rathmann (FZJ) P. Lenisa (INFN-Ferrara) E. Steffens (Erlangen University)

In the framework of the FAIR* project, the PAX collaboration has suggested a new experiments using polarized antiprotons**, in particular the study of the transverse spin structure of the proton. To polarize antiprotons the spin filtering method is proposed. The PAX collaboration is going to design the Antiproton Polarizer Ring (APR). In this contribution the design of this storage ring is described. The basic parameters of the APR are antiproton beam energy of 250 MeV and emittance in both planes of 250 pi mm mrad. The APR consists of two 180 degree arcs and two straight sections. One straight section houses the injection/ extraction and the polarized internal target cell, in the other straight section, the electron cooler and a Siberian snake are located. Different optical conditions have to be fulfilled in the straight sections: (1) The target cell requires a beta function of less than 0.3 m. (2) The beam has to be circular and upright in the phase space ellipse at the target, the electron cooler, and the snake. (3) The antiproton beam should have a size of 10 mm for an emittance of 250 pi mm mrad. (4) The momentum dispersion has to be zero in both straight sections.
*Conceptual Design Report for an International Accelerator Facility for Research with Ions and Antiprotons, available from www.gsi.de/GSI-Future/cdr.**PAX Technical Proposal, available from www.fz-juelich.de/IKP/pax.

MOPCH084

From COSY to HESR

D. Prasuhn, J. Dietrich, A. Lehrach, B. Lorentz, R. Maier, H. Stockhorst (FZJ)

The High Energy Storage Ring (HESR) at the proposed Facility for Antiproton and Ion Research (FAIR) puts strong demands on quality and intensity of the stored antiproton beam in the presence of thick internal targets. The existing synchrotron and storage ring COSY in Juelich can be seen as a smaller model of the HESR. In this paper we will discuss possible benchmarking experiments at COSY, involving effects like beam cooling, target heating, intra-beam scattering, etc. The aim of these experiments is to support the design work for the HESR and ensure that the specified beam conditions can be achieved.

MOPCH085

Pickup Structures for the HESR Stochastic Cooling System

R. Stassen, P.B. Brittner, G. Schug, H.S. Singer (FZJ)

The design of the High-Energy Storage Ring (HESR) of the future International Facility for Antiproton and Ion Research (FAIR) at the GSI in Darmstadt includes electron and stochastic cooling. Simulations have shown that the bandwidth of a 2-4 GHz stochastic cooling system is sufficient to achieve the requested beam parameter at the internal target. New 2-4 GHz pickup structures have been developed and tested. First results of the low impedance, printed loop structures will be presented.

MOPCH086

Stochastic Cooling for the HESR at the GSI-FAIR Complex

H. Stockhorst, B. Lorentz, R. Maier, D. Prasuhn (FZJ) T. Katayama (CNS)

The High-Energy Storage Ring (HESR) of the future International Facility for Antiproton and Ion Research (FAIR) at the GSI in Darmstadt is planned as an anti-proton cooler ring in the momentum range from 1.5 to 15 GeV/c. An important and challenging feature of the new facility is the combination of phase space cooled beams with internal targets. The required beam parameters and intensities are prepared in two operation modes: the high luminosity mode with beam intensities up to 10^{11} and the high reso-lution mode with 10^{10} anti-protons cooled down to a relative momentum spread of only a few 10-5. In addition to electron cooling, transverse and longitudinal stochastic cooling are envisaged to accomplish these goals. It is shown how the great benefit of the stochastic cooling system to adjust the cooling force in all phase planes independently is utilized to achieve the requested beam spot and the high momentum resolution at the internal target within reasonable cooling down times for both HESR modes even in the presence of intra-beam scattering. A numerical and analytical approach to the Fokker-Planck equation for longitudinal filter cooling has been carried out.

MOPCH087

Quasi-adiabatic Transition Crossing in the Hybrid Synchrotron

Y. Shimosaki, K. Takayama, K. Torikai (KEK)

Non-adiabatic features around the transition energy are well-known to be one of most important beam physics issues in most of circular hadron accelerators. A novel technique to avoid them by the adiabatic motion, a quasi-adiabatic focusing-free transition crossing (QAFFTC), was proposed. In a longitudinally separated function-type accelerator*, in which

particles are confined by an rf voltage or burrier voltages and accelerated by a step voltage, the confinement voltage can be arbitrarily manipulated as long as the particles do not diffuse, while a strict acceleration voltage is necessary for the orbit of a charged particle to be balanced in the radial direction. The introduction of QAFFTC is most suitable for the longitudinally separated function-type accelerator. This new method was examined in this type of accelerator**, both theoretically and experimentally. This was a first and significant application of the hybrid synchrotron. The results will be presented.
*K. Takayama and J. Kishiro, Nucl. Inst. Meth. A 451, 304 (2000).**K. Takayama et al. Phys. Rev. Lett. 94, 144801 (2005).

Ion Cooler Storage Ring, S-LSR

MOPCH088

A. Noda, S. Fujimoto, M. Ikegami, T. Shirai, H. Souda, M. Tanabe, H. Tongu (Kyoto ICR) H. Fadil, M. Grieser (MPI-K) T. Fujimoto, S.I. Iwata, S. Shibuya (AEC) I.N. Meshkov, I.A. Seleznev, A.V. Smirnov, E. Syresin (JINR) K. Noda (NIRS)

Ion cooler and storage ring, S-LSR has been constructed. Its beam commissioning has been successfully performed since October, 2005 and electron beam cooling for 7 MeV proton beam has been performed with both flat and hollow spatial distributions. Effect of relative velocity sweep between electron and ion beams on the cooling time* has been confirmed. Based on the success to create the peaks in the energy spectrum of laser-produced ions, injection of laser-produced ions into S-LSR after rotation in the longitudinal phase space by an RF cavity synchronized to the pulse laser is under planning in order to apply electron cooling for such real laser produced hot ions. Three dimensional laser cooling satisfying the condition of 'tapered cooling' is also under investigation. 24Mg+ ions are to be laser-cooled only in the 'Wien Filter' in order to be cooled down to the appropriate energy according to their horizontal positions**. In parallel with the computer simulation, construction of the laser cooling system with use of ring dye laser accompanied with the second harmonics generator is now underway.
*H. Fadil et al. Nucl. Instr. & Meth. in Phys. Res. A517, 1-8 (2004).**A. Noda and M. Grieser, Beam Science and Technology, 9, 12-15 (2005).

Basic Aspects of the SIS100 Correction System Design

MOPCH089

V.A. Mikhaylov, A.V. Alfeev, A.V. Butenko, A.V. Eliseev, H.G. Khodzhibagiyan, A.D. Kovalenko, O.S. Kozlov, V.V. Seleznev, A.Y. Starikov, V. Volkov (JINR) E. Fischer, P.J. Spiller, J. Stadlmann (GSI)

The basic concept and the main design features of the superconducting SIS100 correction system are presented. The system comprises 84 steerer magnets consisting of two orthogonal dipole windings each for correction of the beam close orbit in vertical and horizontal planes, 48 normal sextupole windings connected in two families with opposite polarities for chromaticity correction and 12 units containing skew quadrupoles, normal and skew sextupoles and octupoles as well. The correction system should operate in a pulse mode corresponding to the accelerator cycle, i.e., up to 1 Hz. The main magnetic, geometrical and electrical parameters of the corrector magnets were specified. They are based on the beam dynamic analysis within the frames of the DF-type SIS100 lattice at different betatron tune numbers and tolerable alignment and manufacturing errors of the main lattice dipole and quadrupole magnets. The problem of reasonable unification of the corrector modules is discussed also, including their geometrical sizes, maximum supply current and cooling at 4.5 K. The concept of the SIS100 corrector magnets is based on the pulsed correctors designed for the Nuclotron.

MOPCH090

ITEP-TWAC Status Report

N.N. Alexeev, D.G. Koshkarev, B.Y. Sharkov (ITEP)

Three years of successful operation the ITEP-TWAC facility delivers proton and ion beams in several modes of acceleration and accumulation of by using the multiple charge exchange injection technique*. Substantial progress is achieved in output ion beam current intensity of the linear injector I3, in intensity of the buster synchrotron UK, in efficiency increasing of ion beam stacking and longitudinal compression in the storage ring U10. The machine status analysis and current results of activities aiming at subsequent improvement of beam parameters for extending beam technology applications are presented.
*N. Alexeev et al. Laser and Particle Beams (2002) V 20, N3, 385-392.

MOPCH091

An Alternative Nonlinear Collimation System for the LHC

J. Resta-López, R.W. Assmann, S. Redaelli, J. Resta-López, G. Robert-Demolaize, D. Schulte, F. Zimmermann (CERN) A. Faus-Golfe (IFIC)

The optics design of an alternative nonlinear collimation system for the LHC is presented. We discuss an optics scheme based on a single spoiler located in between a pair of skew sextupoles for betatron collimation. The nonlinear system allows opening up the collimator gaps and, thereby reduces the collimator impedance, which presently limits the LHC beam intensity. After placing secondary absorbers at optimum locations behind the spoiler, we analyze the beam losses and calculate the cleaning efficiency from tracking studies. The results are compared with those of the conventional linear collimation system.

MOPCH092

CRYRING Machine Studies for FLAIR

H. Danared, A. Källberg, A. Simonsson (MSL)

At the FLAIR facility (Facility for Low-energy Antiproton and Ion Research) at FAIR, antiprotons and heavy ions will be decelerated to very low energies and ultimately to rest. One step in this deceleration is made in the magnetic storage ring LSR (Low-Energy Storage Ring). CRYRING at the Manne Siegbahn Laboratory in Stockholm will be closed down within the next few years, and since CRYRING has an energy range quite similar to the proposed LSR, is equipped with beam cooling, and has several other features required for a deceleration ring, plans are being made for the transfer of CRYRING to FAIR and for its use as the LSR ring. This paper describes some of the characteristics of CRYRING relevant for its new role, modifications that need to be made, and test that have been performed at CRYRING with, e.g., deceleration of protons from 30 MeV to 300 keV kinetic energy, which is the proposed energy range for antiprotons at LSR.

Design of the Double Electrostatic Storage Ring DESIREE

MOPCH093

P. Löfgren, G. Andler, L. Bagge, M. Blom, H. Danared, A. Källberg, S. Leontein, L. Liljeby, A. Paal, K.-G. Rensfelt, A. Simonsson (MSL) H. Cederquist, M. Larsson, S. Rosén, H.T. Schmidt, K. Schmidt (FYSIKUM, AlbaNova, Stockholm University)

A double electrostatic storage ring named DESIREE is under construction at the Manne Siegbahn Laboratory and Stockholm University. The two rings will have the same circumference, 9.2 m, and a common straight section where merged beam experiments with ions of opposite signs will be performed. The whole structure will be contained in a single vacuum vessel resulting in a very compact design. In addition to its unique double ring structure it will be possible to cool DESIREE down to 10-20K using cryogenerators. This will reduce the internal vibrational and rotational excitations of stored molecules. A cold system will also result in excellent vacuum conditions where longer lifetimes of the stored beams can be expected. While the ion optical calculations have entered a final phase much of the work is now devoted to solve many of the mechanical and cryogenic challenges of DESIREE. In order to test the mechanical and cryogenic properties of for example insulators, vacuum seals, and laser viewports a small test system has been built. The test system is expected to provide valuable information for the final design of DESIREE.

Low-intensity Beams for LHC Commissioning from the CERN PS-booster

MOPCH094

M. Benedikt, J. Tan (CERN)

A variety of low-intensity beams will be required for LHC commissioning. In contrast to the nominal LHC physics beam, these single-bunch beams are produced without longitudinal bunch splitting in the injector chain. Consequently, not only the transverse but also the longitudinal beam characteristics have already to be established in the CERN PS-Booster. The required intensities extend down to four orders of magnitude below the typical PS-Booster working range and the transverse emittances must be adjustable to vary the beam brightness over a large range. The different beam variants are briefly summarized and the specific techniques developed for their production, like low-voltage rf capture, and transverse and longitudinal shaving, are described. In particular, the choice of harmonic number and its consequences for operation and beam reproducibility are discussed. Finally, the performance achieved for the different beams is summarized.

Performance of Nominal and Ultimate LHC Beams in the CERN PS-booster

MOPCH095

M. Benedikt, M. Chanel, K. Hanke (CERN)

The requirements for nominal and ultimate LHC beams in the CERN PS-Booster were specified in 1993 and served as input for the definition of the "PS conversion for LHC" project. Already during the upgrade project and also after its completion in 2000, the beam intensities to be provided from the PS Booster were increased in order to compensate for changes on the LHC machine, the beam production scheme in the PS and for non-anticipated beam losses along the injector chain. In order to improve the beam brightness, to be compatible with the increased requirements, extensive machine studies have taken place on the PS-Booster. The working point was changed to reduce the influence of systematic resonances and the injection line optics was re-matched to improve the injection efficiency. The paper summarizes briefly the evolution of the performance requirements. The various measures undertaken to improve the LHC beam quality are outlined and the present performance achieved in the PS-Booster is presented.

MOPCH096

LEIR Lattice

J. Pasternak, P. Beloshitsky, C. Carli, M. Chanel (CERN)

The Low Energy Ion Ring (LEIR) is a low energy ion cooling and accumulation ring and serves to compress long ion pulses from Linac 3 into high density bunches suitable for LHC ion operation. Issues of the LEIR lattice are to fulfil all constraints with a small number of quadrupoles and compensations of perturbations due to an electron cooler and gradients seen by the beam in the bending magnets during the ramp. Furthermore, experimental investigations via orbit reponse measurements will be reported.

MOPCH097

CERN Proton Synchrotron Working Point Control Using an Improved Version of the Pole-face-windings and Figure-of-eight Loop Powering

R.R. Steerenberg, J.-P. Burnet, M. Giovannozzi, O. Michels, E. Métral, B. Vandorpe (CERN)

The working point of the CERN Proton Synchrotron, which is equipped with combined function magnets, is controlled using pole-face-windings. Each main magnet consists of one focusing and one de-focusing half-unit on which four pole-face-winding plates are mounted containing two separate coils each, called narrow and wide. At present they are connected in series, but can be powered independently. In addition, a winding called the figure-of-eight loop, contours the pole faces and crosses between the two half units, generating opposite fields in each half-unit. The four optical parameters, horizontal and vertical tune and chromaticity, are adjusted by acting on the pole-face-winding currents in both half units and in the figure-of-eight loop, leaving one physical quantity free. The power supply consolidation project opened the opportunity to use five independent power supplies, to adjust the four parameters plus an additional degree of freedom. This paper presents the results of the measurements that have been made in the five-current mode together with the influence of the magnetic nonlinearities, due to the unbalance in the narrow and wide winding currents, on the beam dynamics.

MOPCH098

LHC@FNAL: A Remote Access Center for the LHC at Fermilab

E.S. McCrory, K.B. Biery, E.G. Gottschalk, S.G. Gysin, E.R. Harms, S.K. Kunori, M.J. Lamm, K.M. Maeshima, P.M. McBride, A.J. Slaughter, A.D. Thomas (Fermilab) M. Lamont (CERN)

A facility is being designed at Fermilab to help people contribute to the Large Hadron Collider (LHC) effort at CERN. This facility is called LHC@FNAL. The purpose of LHC@FNAL is to permit members of the LHC community in North America contribute their expertise to LHC activities at CERN, and to assist CERN with the commissioning and operation of the LHC accelerator and CMS experiment. As a facility, LHC@FNAL has three primary functions: 1) To provide access to information in a manner that is similar to what is available in control rooms at CERN, and to enable members of the LHC community to participate remotely in LHC and CMS activities. 2) To serve as a (bidirectional) communications conduit between CERN and members of the LHC community located in North America. 3. To allow visitors to Fermilab to see firsthand how research is progressing at the LHC. Visitors will be able to see current LHC activities, and will be able to see how future international projects in particle physics can benefit from active participation in projects at remote locations. LHC@FNAL is expected to contribute to a wide range of activities for the CMS experiment and for the LHC accelerator.

MOPCH099

Performance and Capabilities of the NASA Space Radiation Laboratory at BNL

K.A. Brown, L. Ahrens, I.-H. Chiang, C.J. Gardner, D.M. Gassner, L. Hammons, M. Harvey, J. Morris, A. Rusek, P. Sampson, M. Sivertz, N. Tsoupas, K. Zeno (BNL)

The NASA Space Radiation Laboratory (NSRL) at BNL has been in operation since 2003. The first commissioning of the facility took place beginning in October 2002 and the facility became operational in July 2003. The facility was constructed in collaboration with NASA for the purpose of performing radiation effect studies for the NASA space program. The NSRL is capable of making use of protons and heavy ions in the range of 0.05 to 3 GeV/n slow extracted from BNL's AGS Booster. It is also capable of making use of protons and heavy ions fast extracted from the AGS Booster. Many different beam conditions have been produced for experiments at NSRL, including very low intensity In this report we will describe the facility and its' performance over the eight experimental run periods that have taken place since it became operational. We will also describe the current and future capabilities of the NSRL.

MOPCH100

Polarized Proton Acceleration in the AGS with Two Helical Partial Snakes

H. Huang, L. Ahrens, M. Bai, A. Bravar, K.A. Brown, E.D. Courant, C.J. Gardner, J. Glenn, A.U. Luccio, W.W. MacKay, V. Ptitsyn, T. Roser, S. Tepikian, N. Tsoupas, J. Wood, K. Yip, A. Zelenski, K. Zeno (BNL) F. Lin (IUCF) M. Okamura, J. Takano (RIKEN)

Acceleration of polarized protons in the energy range of 5 to 25 GeV is particularly difficult: the depolarizing resonances are strong enough to cause significant depolarization but full Siberian snakes cause intolerably large orbit excursions and it is not feasible in the AGS since straight sections are too short. Recently, two helical partial snakes with double pitch design have been built and installed in the AGS. With careful setup of optics at injection and along the ramp, this combination can eliminate intrinsic and imperfection depolarizing resonances encountered during acceleration. This paper presents the accelerator setup and preliminary results. The effect of horizontal intrinsic resonances in the presence of two partial snakes are also discussed.

MOPCH101

On the Feasibility of a Spin Decoherence Measurement

W.W. MacKay (BNL)

In this paper, we study the feasibility of making a turn-by-turn spin measurement to extract the spin tune of a synchrotron from a polarized beam injected perpendicular to the stable spin direction. For the ideal case of a zero-emittance beam with no spin-tune spread, there would be no spin decoherence and a measurement of the spin tune could easily be made by collecting turn-indexed polarization data of several million turns. However, in a real beam there is a momentum spread which provides a tune spread. With a coasting beam the tune spread will cause decoherence of the spins resulting in a fast depolarization of the beam in a thousand turns. With synchrotron oscillations the decoherence time can be greatly increased, so that a measurement becomes feasible with summation of the turn-by-turn data from a reasonable number of bunches (100 or fewer). Both the cases of a single Siberian snake and a pair of Siberian snakes are considered.

MOPCH102

A Straight Section Design in RHIC to Allow Heavy Ion Electron Cooling

D. Trbojevic, J. Kewisch, W.W. MacKay, T. Roser, S. Tepikian (BNL)

The Relativistic Heavy Ion Collider (RHIC) has been continuously producing exciting results. One of the major luminosity limitations of the present collider is the intra beam scattering. A path towards the higher luminosities requires cooling of the heavy ion beams. Two projects in parallel electron and stochastic cooling are progressing very well. To allow interaction between electrons and the RHIC beams it is necessary to redesign one of the existing interaction regions in RHIC to allow for the longer straight section with fixed and large values of the betatron functions. We present a new design of the interaction region for the electron cooling in RHIC.

MOPCH103

SPIRAL2 RFQ Prototype – First Results

R. Ferdinand, R. Beunard, V. Desmezières, M. Di Giacomo, P. Robillard (GANIL) A.C. Caruso (INFN/LNS) S. Cazaux, M. Desmons, A. France, D. Leboeuf, O. Piquet, J.-C. Toussaint (CEA) M. Fruneau, Y. Gómez-Martínez (LPSC)

The SPIRAL2 RFQ has been designed to accelerate a 5 mA deuteron beam (Q/A=1/2) or a 1 mA particle beam with q/A=1/3 up to 0.75 MeV/A at 88MHz. It is a CW machine which has to show stable operation, provide the required availability and reduce losses to a minimum in order to minimize the activation constraints. Extensive modelisation was done to ensure a good vane position under RF. The prototype of this 4-vane RFQ has been built and tested in INFN-LNS Catania and then in IN2P3-LPSC Grenoble. It allowed us to measure the vacuum quality, the RF field by X-ray measurements, the cavity displacement and the real vane displacement during the RF injection. Different techniques were used, including an innovative and effective CCD measurement with a 0.6 μm precision. This paper outlines the different results.

MOPCH105

A New RF Tuning Method for the End Regions of the IPHI 4-vane RFQ

O. Delferriere, M. Desmons, A. France (CEA) R. Ferdinand (GANIL)

The 3-MeV High Intensity Proton Injector (IPHI) RFQ is constituted by the assembly of three 2-m-long segments. The tuning of the end regions of such an accelerator with respect to the quadrupole mode is generally made by machining the thickness of the end plates. The dipole modes are moved away from the accelerator mode frequency by adding dipole rods and adjusting their length. In the case of the last IPHI RFQ segment, the tuning range given by possible plate thickness was not sufficient to adjust the frequency at 352 Mhz without modifying the notch depth, leading to serious engineering problems for the cooling, new thermo-mechanical simulations and drawings. To avoid these difficulties, a new way has been investigated by replacing the end plate thickness adjustment by a "quadrupole rod" length adjustment. These rods are situated between the beam axis and the dipole rods, and the tuning range is largely increased. The paper will describe this method applied to the IPHI RFQ and some experimental results obtained on the cold model.

An Innovative Method to Observe RFQ Vanes Motion with Full-scale RF Power and Water Cooling

MOPCH106

A. France, O. Piquet (CEA) R. Ferdinand (GANIL)

The design of high current RFQs is heavily strained by thermo-mechanical considerations, which eventually have an impact on machining costs, cooling systems, etc. A 1-meter long copper prototype of the SPIRAL2 RFQ has been specifically built to corroborate design options. An innovative method has been developed, allowing real-time observation of mechanical deformations of RFQ vanes, with full-scale RF power and water cooling. Digital images are acquired by a CCD camera, and processed by a dedicated software. Processing includes contrast stretching, low-pass filtering, and block-correlation followed by interpolation. Sub-pixel relative motions of RFQ electrode ends are clearly detected and measured, with RMS errors of the order of 0.6 microns.

Tuning Procedure of the 6 Meter IPHI RFQ

MOPCH107

O. Piquet, M. Desmons, A. France (CEA)

In the framework of the IPHI project (High Intensity Proton Injector), the RFQ cavity is divided into 6 sections of 1 meter each, and assembled in 3 segments separated by coupling plates. We will present the tuning procedure of the aluminium RFQ cold model to set the accelerating mode frequency, a flat voltage profile and to minimize the dipole components of the accelerating voltage. This tuning procedure can be divided in three steps. First, dipole mode frequencies are adjusted with rods for the 3 separated segments. Second, RFQ end cells and coupling cells are tuned by mechanical machining of tuning plates. Third, using a fully automated bead-pull for the measurement of the field distribution inside every RFQ quadrants, the RFQ is tuned with 96 plungers in a small number of iterations. Tuning this 6-meter long cold model is a comprehensive training in view of the future tuning of the copper RFQ with the variable voltage profile.

Error Study of LINAC 4

MOPCH108

M.A. Baylac, J.-M. De Conto, E. Froidefond (LPSC) E.Zh. Sargsyan (CERN)

Within the framework of the Joint Research Activity HIPPI (High Intensity Pulsed Proton Injector) of the CARE program, the conception study of the LINAC 4 accelerator which aims to intensify the proton flux available for the CERN injection line is pursued. The linac, operating in pulsed mode at 352 MHz, is designed to accelerate a 65 mA beam of H^- ions up to an energy of 160 MeV. The requirements on acceptable beam emittance growth and particle loss are extremely tight. In order to determine the Drift Tube Linac tolerances, we examined the sensitivity of the LINAC 4 DTL to errors on the accelerating field and the focusing quadrupoles. Simulations were performed with the transport code TRACEWIN (CEA-Saclay, France). We will present results on individual sensitivities to a single error as well as the global impact of alignment and RF errors on the beam quality. Similarly, accelerating structures following the DTL in the LINAC4 design (CCDTL, SCL) have been studied.

MOPCH109

Design Studies on a Novel Stellarator Type High Current Ion Storage Ring

M. Droba, N.S. Joshi, O. Meusel, P. Nonn, U. Ratzinger (IAP)

A high current storage ring for the accumulation of ion beams provided by a new 150 kV terminal is under consideration at the Frankfurt University. The configuration based on a toroidal magnetic field seems promising for the storage of intense low energy ion beams, especially when concerning the various potential concepts for space charge compensation. The theory of plasma confinement on magnetic surface is transformed to numerical simulations on circulating ion beams. The space charge effects and stability conditions are studied and will be presented. Various injection techniques based on crossed field-drifts are investigated. Accordingly test experiments are prepared based on two 30 degree toroidal sectors at a major radius of 1.3m with a maximum toroidal magnetic field of 0.6T on axis.

MOPCH111

A Fast Beam Chopper for the RAL Front End Test Stand

M.A. Clarke-Gayther (CCLRC/RAL/ASTeC) G. Bellodi, F. Gerigk (CERN)

The FETS project at RAL will test a fast beam chopper, designed to address the requirements of high power proton drivers for next generation pulsed spallation sources and neutrino factories. A description is given of the novel RAL 'Fast - Slow' chopping scheme, and of candidate optical designs for the 3.0 MeV, 60 mA, H^- Medium Energy Beam Transport (MEBT) line.

MOPCH112

The RAL Front End Test Stand

A.P. Letchford, M.A. Clarke-Gayther, D.C. Faircloth, D.C. Plostinar, J.K. Pozimski (CCLRC/RAL) J.J. Back (University of Warwick) Y.A. Cheng, S. Jolly, A. Kurup, P. Savage (Imperial College of Science and Technology, Department of Physics)

High power proton accelerators (HPPAs) with beam powers in the megawatt range have many possible applications including drivers for spallation neutron sources, neutrino factories, waste transmuters and tritium production facilities. These applications typically propose beam powers of 5 MW or more compared to the highest beam power achieved from a pulsed proton accelerator in routine operation of 0.16 MW at ISIS. The UK's commitment to the development of the next generation of HPPAs is demonstrated by a test stand being constructed in collaboration between RAL, Imperial College London and the University of Warwick. The aim of the RAL Front End Test Stand is to demonstrate that chopped low energy beams of high quality can be produced and is intended to allow generic experiments exploring a variety of operational regimes. This paper describes the status of the RAL Front End Test Stand which consists of five main components: a 60 mA H^- ion source, a low energy beam transport, a 324 MHz Radio Frequency Quadrupole accelerator, a high speed beam chopper and a comprehensive suite of diagnostics. The aim is to demonstrate production of a 60 mA, 2 ms, 50 pps, chopped H^- beam at 3 MeV.

MOPCH113

Re-bunching RF Cavities and Hybrid Quadrupoles for the RAL Front-end Test Stand (FETS)

D.C. Plostinar (CCLRC/RAL/ASTeC) M.A. Clarke-Gayther (CCLRC/RAL/ISIS)

The proposed FETS project at RAL will test a fast beam chopper in a 3.0 MeV H^- Medium Energy Beam Transport (MEBT) line. Space restrictions in the MEBT line place constraints on component length and drive the requirement to identify compact component configurations. A description is given of candidate re-bunching RF cavities and hybrid quadrupole designs. The cavity options considered are the space efficient Drift Tube Linac type cavity (DTL) with integrated quadrupoles, and the high shunt impedance Coupled Cavity Linac type cavity (CCL) with external quadrupoles. The advantages and disadvantages of both structures are discussed and a comprehensive comparison between the two is made enabling the best cavity geometry choice. The compact hybrid quadrupole configurations considered are the 'tandem' combination of permanent magnet (PMQ) and electro-magnetic (EMQ) types, and the concentric combination of PMQ and laminar conductor (Lambertson) EMQ types.

MOPCH114

Progress on Dual Harmonic Acceleration on the ISIS Synchrotron

A. Seville, D.J. Adams, D. Bayley, N.E. Farthing, I.S.K. Gardner, M.G. Glover, A. Morris, B.G. Pine, J.W.G. Thomason, C.M. Warsop (CCLRC/RAL/ISIS)

The ISIS facility at the Rutherford Appleton Laboratory in the UK is currently the most intense pulsed, spallation, neutron source. The accelerator consists of a 70 MeV H^- Linac and an 800 MeV, 50 Hz, rapid cycling, proton Synchrotron. The synchrotron beam intensity is $2.5 \cdot 10^{13}$ protons per pulse, corresponding to a mean current of 200 μA. The synchrotron beam is accelerated using six, ferrite loaded, RF cavities with harmonic number 2. Four additional, harmonic number 4, cavities have been installed to increase the beam bunching factor with the potential of raising the operating current to 300 μA. As ISIS has a busy user schedule the time available for dual harmonic work has been limited. However, much progress has been made in the last year and encouraging results have been obtained. This paper reports on the hardware commissioning and beam tests with dual harmonic acceleration.

MOPCH115

Transverse Space Charge Studies for the ISIS Synchrotron

C.M. Warsop (CCLRC/RAL/ISIS)

The ISIS Facility at the Rutherford Appleton Laboratory in the UK produces intense neutron and muon beams for condensed matter research. It is based on a 50 Hz proton synchrotron which, once the commissioning of a new dual harmonic RF system is complete, will accelerate about $3.5 \cdot 10^{13}$ protons per pulse from 70 to 800 MeV, corresponding to mean beam powers of 0.2 MW. Following this upgrade, transverse space charge is expected to be one of the main intensity limitations, and is also a key factor for further machine upgrades. A programme of R&D on transverse space charge is now under way, aiming not only to improve the ISIS ring but also to exploit it as an experimental tool for testing theory and codes. This paper summarises work so far, outlining calculations for coherent envelope modes on ISIS, using numerical solutions of the envelope equation to show the expected behaviour near half integer resonance. Progress on work linking these predictions with more realistic beam models in space charge codes, and extending calculations to images, coupling and non linear resonances will be described. Plans and preparations for experiments, along with initial results, will also be presented.

MOPCH116

Electromagnetic Design of a Radio Frequency Quadrupole for the Front End Test Stand at RAL

A. Kurup (Imperial College of Science and Technology, Department of Physics) A.P. Letchford (CCLRC/RAL/ISIS)

The goal of the RAL front end test stand is to demonstrate cleanly chopped bunches of a 60mA H^- ion beam at 3MeV. The acceleration of the H^- ions from 65keV to 3MeV will be done using a radio frequency quadrupole (RFQ) operating at a resonant frequency of 324MHz. The two types of RFQ considered were a 4-vane and a 4-rod. The 4-vane has a higher Q-value but the post-production adjustment is limited. The 4-rod design is easier to manufacture but requires complicated cooling at 324MHz. The results of electromagnetic simulations using CST Microwave Studio are presented for the 4-vane type and 4-rod type RFQ.

MOPCH117

Mechanical Design and RF Measurement on RFQ for Front-end Test Stand at RAL

P. Savage, Y.A. Cheng (Imperial College of Science and Technology, Department of Physics) A.P. Letchford (CCLRC/RAL/ISIS) J.K. Pozimski (CCLRC/RAL)

This paper will present the mechanical design and preliminary results of a RF measurement system for the cold model of a 324MHz 4-vane RFQ, which is part of the development of a proton driver front end test stand at the Rutherford Appleton Laboratory (RAL) in the UK. The design concepts will be discussed and some issues in manufacturing of the RFQ will be pointed out, and specific modifications will be explained. Furthermore, results of thermal simulations of the RFQ will be presented together with RF simulations of the resonant frequency, the Q-value and the longitudinal field distribution.

MOPCH118

Wideband Low-output-impedance RF System for the Second Harmonic Cavity in the ISIS Synchrotron

Y. Irie (JAEA/J-PARC) D. Bayley, G.M. Cross, I.S.K. Gardner, M.G. Glover, D. Jenkins, A. Morris, A. Seville, S.P. Stoneham, J.W.G. Thomason, T. Western (CCLRC/RAL/ISIS) J.C. Dooling, D. Horan, R. Kustom, M.E. Middendorf, G. Pile (ANL) S. Fukumoto, M. Muto, T. Oki, A. Takagi, S. Takano (KEK)

Wideband low-output-impedance RF system for the second harmonic cavity in the ISIS synchrotron has been developed by the collaboration between Argonne National Laboratory, US, KEK, Japan and Rutherford Appleton Laboratory, UK. Low output impedance is realized by the feedback from plate output to grid input of the final triode amplifier, resulting in less than 30 ohms over the frequency range of 2.7 - 6.2 MHz which is required for the second harmonic cavity. The vacuum tubes in the driver and final stages are both operated in class A, and a grid bias switching system is used on each tube to avoid unnecessary plate dissipations during a non-acceleration cycle. High power test was performed with a ferrite-loaded second harmonic cavity, where the bias current was swept at 50 Hz repetition rate. The maximum voltage of 12kV peak per accelerating gap was obtained stably at earlier period of an acceleration cycle. A beam test with this system is planned at the ISIS synchrotron in order to investigate how the low impedance system works under heavy beam loading conditions, and is capable of mitigating the space charge detuning at the RF trapping stage.

Present Status of the Induction Synchrotron Experiment in the KEK PS

MOPCH119

K. Takayama, Y. Arakida, T. Iwashita, T. Kono, E. Nakamura, Y. Shimosaki, M.J. Shirakata, T. Sueno, K. Torikai (KEK) K. Otsuka (Nippon Advanced Technology Co. Ltd.)

A concept of the induction synchrotron, which was proposed by Takayama and Kishiro in 2000, has been demonstrated by using the KEK PS since 2004. A proton bunch trapped in the RF bucket was accelerated with the induction acceleration devices from 500 MeV to 8 GeV*, which was energized with the newly developed switching power supply. This form of the KEK PS is something like a hybrid synchrotron. In addition, the injected proton bunch was confined by the step barrier-voltages at the injection energy of 500MeV**, which were generated with the same induction acceleration device. Then a concept of the induction synchrotron that a proton bunch was captured by the barrier bucket and accelerated with the induction voltage is to be fully demonstrated.
*K. Takayama et al. "Observation of the Acceleration of a Single Bunch by Using the Induction Device in the KEK Proton Synchrotron", Phys. Rev. Lett., 94, 144801 (2005).**K. Torikai et al. "Acceleration and Confinement of a Proton Bunch with the Induction Acceleration System in the KEK Proton Synchrotron", submitted to Phys. Rev. ST-AB (2005), KEK-Preprint 2005-80 A, December 2005.

Ground Motion Study and the Related Effects on the J-PARC

MOPCH120

S. Takeda, N. Yamamoto, M. Yoshioka (KEK) Y. Nakayama (JPOWER)

The power spectrum density, coherence and cross-spectrum density of the ground motion in the J-PARC site are studied to get the guideline of the beam control systems. J-PARC consists of a 600 MeV linac, a 3 GeV Rapid-cycling synchrotron (RCS) and a 50 GeV synchrotron (MR). MR provides a beam current of 15 micro-A with a period of 3 sec to either the nuclear physics experimental area or the neutrino production target. MR is a very high beam power machine, so its optimum beam loss must be kept fewer than 0.01% of an accelerated beam in order to decrease the radiation damage of accelerator components and to get easy accessibilty to them. From the point of view of beam loss, we give some detailed discussion about the relation between the MR operation and the ground motion using the observed data.

Ground Motion Measurement at J-PARC

MOPCH121

Y. Nakayama, K. Tada (JPOWER) S. Takeda, M. Yoshioka (KEK)

In the next generation accelerator, construction of the machine on the stable ground is preferable for accelerator beam operation. We have measured ground motion at the J-PARC site under construction, where the ground is very close to the Pacific Ocean. In this paper, some of the observed results are shown, comparing the results of the previous observation at some accelerator facilities and next generation accelerator candidate sites in Japan.

MOPCH122

Realistic Beam Loss Estimation from the Nuclear Scattering at the RCS Charge-exchange Foil

P.K. Saha, H. Hotchi, Y. Irie, F. Noda (JAEA/J-PARC) H. Harada (Hiroshima University)

We have developed simulation tools for the realistic beam loss estimation at the RCS(rapid cycling synchrotron) of J-PARC(Japan Proton Accelerator Research Complex). The present simulation concerns an accurate estimation of the beam loss caused by the nuclear scattering at the charge-exchange foil during the multi turn injection period. It can also figure out the loss point in the ring, so would become very useful for the maintenance and optimization as well. The simulation code GEANT together with the SAD(Strategic Accelerator Design) have been used for the present purpose. In this paper, detail simulation method including the result will be discussed.

MOPCH124

Energy Deposition in Adjacent LHC Superconducting Magnets from Beam Loss at LHC Transfer Line Collimators

V. Kain, S. Beavan, Y. Kadi (CERN)

Injection intensities for the LHC are over an order of magnitude above the damage threshold. The collimation system in the two transfer lines is designed to dilute the beam sufficiently to avoid damage in case of accidental beam loss or mis-steered beam. To maximise the protection for the LHC most of the collimators are located in the last 300 m upstream of the injection point where the transfer lines approach the LHC machine. To study the issue of possible quenches following beam loss at the collimators the entire collimation section in one of the lines, TI 8, together with the adjacent part of the LHC has been modeled in FLUKA. The simulated energy deposition in the LHC for worst-case accidental losses as well as for losses expected during a normal filling is presented. The operational implications are discussed.

MOPCH126

Accelerator Research on the Rapid Cycling Synchrotron at IPNS

G.E. McMichael, F.R. Brumwell, L. Donley, J.C. Dooling, W. Guo, K.C. Harkay, Q.B. Hasse, D. Horan, R. Kustom, M.K. Lien, M.E. Middendorf, M.R. Moser, S. Wang (ANL)

The Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory is a national user facility for neutron scattering. Neutrons are produced by 70 ns pulses of protons (~3x 10^{12} protons per pulse) impacting a depleted-uranium target at a pulse repetition rate of 30 Hz. Three accelerators in series (a 750 keV Cockcroft-Walton, 50 MeV Alvarez linac accelerating H^- ions, and a 450 MeV rapid-cycling proton synchrotron) provide the beam that is directed to the target. New diagnostics and a third rf cavity that can be operated at either the fundamental or second harmonic of the ring frequency have recently been installed and an experimental program established to try to gain understanding of an instability that limits the charge-per-bunch in the RCS. This program will be described, and preliminary results presented.

MOPCH127

SNS Warm Linac Commissioning Results

A.V. Aleksandrov, S. Assadi, W. Blokland, P. Chu, S.M. Cousineau, V.V. Danilov, C. Deibele, J. Galambos, S. Henderson, D.-O. Jeon, M.A. Plum, A.P. Shishlo (ORNL)

The Spallation Neutron Source accelerator systems will deliver a 1.0 GeV, 1.4 MW proton beam to a liquid mercury target for neutron scattering research. The accelerator complex consists of an H^- injector, capable of producing one-ms-long pulses at 60Hz repetition rate with 38 mA peak current, a 1 GeV linear accelerator, an accumulator ring and associated transport lines. The 2.5MeV beam from the Front End is accelerated to 86 MeV in the Drift Tube Linac, then to 185 MeV in a Coupled-Cavity Linac and finally to 1 GeV in the Superconducting Linac. The staged beam commissioning of the accelerator complex is proceeding as component installation progresses. Current results of the beam commissioning program of the warm linac will be presented including transverse emittance evolution along the linac, longitudinal bunch profile measurements at the beginning and end of the linac, and beam loss study.

MOPCH129

Status of the SNS Beam Power Upgrade Project

S. Henderson, A.V. Aleksandrov, D.E. Anderson, S. Assadi, I.E. Campisi, F. Casagrande, M.S. Champion, R.I. Cutler, V.V. Danilov, G.W. Dodson, D.A. Everitt, J. Galambos, J.R. Haines, J.A. Holmes, N. Holtkamp, T. Hunter, D.-O. Jeon, S.-H. Kim, D.C. Lousteau, T.L. Mann, M.P. McCarthy, T. McManamy, G.R. Murdoch, M.A. Plum, B.R. Riemer, M.P. Stockli, D. Stout, R.F. Welton (ORNL)

The baseline Spallation Neutron Source (SNS) accelerator complex, consisting of an H^- injector, a 1 GeV linear accelerator, an accumulator ring and associated transport lines, will provide a 1 GeV, 1.44 MW proton beam to a liquid mercury target for neutron production. Upgrades to the SNS accelerator and target systems to increase the beam power to at least 2 MW, with a design goal of 3 MW, are in the planning stages. The increased SNS beam power can be achieved primarily by increasing the peak H^- ion source current from 38 mA to 59 mA, installing additional superconducting cryomodules to increase the final linac beam energy to 1.3 GeV, and modifying injection and extraction hardware in the ring to handle the increased beam energy. The mercury target power handling capability will be increased to 2 MW or greater by i) mitigating cavitation damage to the target container through improved materials/surface treatments, and introducing a fine dispersion of gas bubbles in the mercury, and ii) upgrading the proton beam window, inner reflector plug and moderators. The upgrade beam parameters will be presented and the required hardware modifications will be described.

MOPCH130

Simulations for SNS Ring Commissioning

J.A. Holmes, S.M. Cousineau, S. Henderson, M.A. Plum (ORNL)

In preparation for SNS ring commissioning, a number of operational issues have been studied using ORBIT Code simulations. These include beam injection without the use of time-dependent painting, beam accumulation and transport to the extraction dump and to the target, optimal painting schemes for various beam intensities, detailed tracking through the extraction septum with fully correct geometry, quadrupole current constraints in the ring-to-target transfer line (RTBT), and detailed modeling of H minus carbon foil stripping at injection. All these studies incorporated detailed physics including beam-foil interactions, symplectic single particle tracking, space charge and impedances, and losses due to apertures and collimation.

MOPCH131

SNS Ring Commissioning Results

M.A. Plum, A.V. Aleksandrov, S. Assadi, W. Blokland, I.E. Campisi, P. Chu, S.M. Cousineau, V.V. Danilov, C. Deibele, G.W. Dodson, J. Galambos, M. Giannella, S. Henderson, J.A. Holmes, D.-O. Jeon, S.-H. Kim, C.D. Long, T.A. Pelaia, T.J. Shea, A.P. Shishlo, Y. Zhang (ORNL)

The Spallation Neutron Source (SNS) comprises a 1.5-MW, 60-Hz, 1-GeV linac, an accumulator ring, associated beam lines, and a spallation neutron target. Construction began in 1999 and the project is on track to be completed in June 2006. By September 2005 the facility was commissioned up through the end of the superconducting linac, and in January 2006 commissioning began on the High Energy Beam Transport beam line, the accumulator ring, and the Ring to Target Beam Transport beam line up to the Extraction Beam Dump. In this paper we will discuss early results from ring commissioning including a comparison of achieved vs. design beam machine parameters and the maximum beam intensity achieved to date.

MOPCH132

Coupled Maps for Electron and Ion Clouds

U. Iriso (CELLS) S. Peggs (BNL)

Contemporary electron cloud models and simulations reproduce second order phase transitions, in which electron clouds grow smoothly beyond a threshold from "off" to "on". In contrast, some locations in the Relativistic Heavy Ion Collider (RHIC) exhibit first order phase transition behaviour, in which electron cloud related outgassing rates turn "on" or "off" precipitously. This paper presents a global framework with a high level of abstraction in which additional physics can be introduced in order to reproduce first (and second) order phase transitions. It does so by introducing maps that model the bunch-to-bunch evolution of coupled electron and ion clouds. This results in simulations that run several orders of magnitude faster, reproduce first order phase transitions, and show hysteresis effects. Coupled maps also suggest that additional dynamical phases (like period doubling, or chaos) could be observed.

MOPCH133

An Analytic Calculation of the Electron Cloud Linear Map Coefficient

U. Iriso (CELLS) S. Peggs (BNL)

The evolution of the electron density during multibunch electron cloud formation can often be reproduced using a bunch-to-bunch iterative map formalism. The coefficients that parameterize the map function are readily obtained by fitting to results from compute-intensive electron cloud simulations. This paper derives an analytic expression for the linear map coefficient that governs weak cloud behaviour from first principles. Good agreement is found when analytical results are compared with linear coefficient values obtained from numerical simulations. This analysis is useful in predicting thresholds beyond which electron cloud formation occurs, and thus in determining safety regions in parameter space where an accelerator can be operated without creating electron clouds. The formalism explicitly shows that the multipacting resonance condition is not a sine qua non for electron cloud formation.

Electron-impact Desorption at the RHIC Beam Pipes

MOPCH134

U. Iriso, U. Iriso (CELLS) W. Fischer (BNL)

The electron induced molecular desorption coefficient of a material provides the number of molecules released when an electron hits its surface. This coefficient changes as a function of the material, energy of the electrons, surface status, etc. In this paper, this coefficient is inferred analyzing electron detector and pressure gauge signals during electron clouds at the Relativistic Heavy Ion Collider (RHIC) beam pipes. The evolution of the electron-impact desorption coefficient after weeks of electron bombardment is followed for both baked and unbaked stainless steel chambers, evaluating the feasibility of the scrubbing effect. Measurements of an energy spectrum during multipacting conditions are shown, and the final results are compared with laboratory simulations.

Benchmarking Electron Cloud Data with Computer Simulation Codes

MOPCH135

U. Iriso (CELLS) G. Rumolo (CERN)

Saturated electron flux and time decay of the electron cloud are experimentally inferred using many electron detector datasets at the Relativistic Heavy Ion Collider (RHIC). These results are compared with simulation results using two independent electron cloud computer codes, CSEC and ECLOUD. Simulation results are obtained over a range of different values for 1) the maximum Secondary Electron Yield (SEY), and 2) the electron reflection probability at zero energy. These results are used to validate parameterization models of the SEY as a function of the electron energy.

China Spallation Neutron Source Accelerators: Design, Research, and Development

MOPCH136

J. Wei (BNL) S.X. Fang, S. Fu (IHEP Beijing)

The Beijing Spallation Neutron Source (BSNS) is a newly approved high power accelerator project based on a H^- linear accelerator and a rapid cycling synchrotron. During the past year, several major revisions were made to the design including the type of the front end, linac frequency, transport layout, ring lattice, and type of ring components. Possible upgrade paths were also laid out: based on an extension of the warm linac, the ring injection energy and the beam current could be raised doubling the beam power on target to reach 200 kW; an extension with a superconducting RF linac of similar length could raise the beam power near 0.5 MW. Based on these considerations, research and development activities are started. In this paper, we discuss the rationale of design revisions and summarize the recent work.

An Anti-symmetric Lattice for High Intensity Rapid-cycling Synchrotrons

MOPCH137

J. Wei, Y.Y. Lee, S. Tepikian (BNL) S.X. Fang, Q. Qin, J. Tang, S. Wang (IHEP Beijing) S. Machida, C.R. Prior, G. Rees (CCLRC/RAL/ASTeC)

Rapid cycling synchrotrons are used in many high power facilities like spallation neutron sources and proton drivers. In such accelerators, beam collimation plays a crucial role in reducing the uncontrolled beam loss. Furthermore, the injection and extraction section needs to reside in dispersion-free region to avoid couplings; a significant amount of drift space is needed to house the RF accelerating cavities; orbit, tune, and chromatic corrections are needed;

long, uninterrupted straights are desired to ease injection tuning and to raise collimation efficiency. Finally, the machine circumference needs to be small to reduce construction costs. In this paper, we present a lattice designed to satisfy these needs. The lattice contains a drift created by a missing dipole near the peak dispersion to facilitate longitudinal collimation. The compact FODO arc allows easy orbit, tune, coupling, and chromatic correction. The doublet straight provides long uninterrupted straights. The four-fold lattice symmetry separates injection, extraction, and collimation to different straights. This lattice is chosen for the Beijing Spallation Neutron Source synchrotron.

MOPCH138

Choice of Proton Driver Parameters for a Neutrino Factory

W.-T. Weng, J.S. Berg, R.C. Fernow, J.C. Gallardo, H.G. Kirk, N. Simos (BNL) S.J. Brooks (CCLRC/RAL/ASTeC)

A Neutrino Factory typically comprises the following subsystems: proton driver; target; muon collection and conditioning(bunching, phase rotation, and cooling); muon acceleration; and muon decay ring. It takes great effort to design each subsystem properly, such that it can mesh with all other subsystems to optimize the overall facility performance. This optimization is presently being studied as part of the International Scoping Study of a Future Neutrino Factory and Superbeam Facility. This paper will evaluate the implications of other subsystems on the parameters of a proton driver for a Neutrino Factory. At the desired power of 4 MW, the impacts of the choice of the proton energy, bunch length, bunch intensity, and repetition rate on other subsystems are assessed to identify a proper range of operation for each parameter. A suitable "design phase space" of proton driver parameters is defined. Given possible choices of design parameters for proton driver, we compare the performance of a linac, a synchrotron, and an FFAG accelerator. The relative merits of existing proton driver proposals will also be examined.

MOPCH139

Results and Experience with Single Cavity Tests of Medium Beta Superconducting Quarter Wave Resonators at TRIUMF

V. Zviagintsev, K. Fong, M.P. Laverty, R.E. Laxdal, A.K. Mitra, T.C. Ries, I. Sekachev (TRIUMF)

A heavy ion superconducting linac is being installed at ISAC/TRIUMF. A first stage of the ISAC-II upgrade will see the installation of 20 quarter wave bulk niobium cavities (Beta0=0.057,0.071). The cavities operate CW at 106MHz with design peak fields of Ep=30MV/m, Bp=60mT while delivering an accelerating voltage of 1.08MV at <7W power consumption. All cavities have been tested in a single cavity test stand with twenty of twenty-one meeting ISAC-II specifications. The cavity test results will be presented. In particular we will discuss our experience with BCP vs. EP surface treatments and with Q-disease. In addition the tuning plates of two of the cavities were modified to provide a unique compensation to the resonant frequency.

MOPCH140

Compensation of Lorentz Force Detuning of a TTF 9-cell Cavity with a New Integrated Piezo Tuner

G. Devanz, P. Bosland, M. Desmons, E. Jacques, M. Luong, B. Visentin (CEA)

The high gradient operation of superconducting elliptical multicells in pulsed mode is required for linear colliders or free-electron lasers based on the superconducting technology. Such an operation is limited by dynamic Lorentz force detuning if no compensation for this effect is attempted.

The RF power headroom required for accelerating field amplitude and phase stabilisation by low-level RF control techniques solely would be too costly. A new active tuner with integrated piezo actuators has been developped in the framework of the european CARE/SRF program solve this issue. The design is based on the lever-arm concept of the Saclay tuner already installed on running TTF cavities. We have carried out integrated tests of the 9-cell cavity equipped with the piezo tuner and power coupler in the CryHoLab horizontal test cryostat. Characterisation of the electromechanical system consisting of the cavity and piezo-tuner assembly and full power pulsed tests will be presented.

Fast Argon-Baking Process for Mass Production of Niobium Superconducting RF Cavities

MOPCH141

B. Visentin, J.-P. Charrier, Y. Gasser, S. Regnaud (CEA)

Baking is a necessary stage to reach high gradients with niobium superconducting cavities. In the standard process, so called "in-situ UHV baking", Nb cavity is baked at 110^{o}C, during 2 days. During this treatment the inner part of the cavity is pumped out under Ultra High Vacuum conditions. In order to save time, "fast UHV baking" at 145 ^{o}C during 3 hours, under UHV pumping, has been successfully demonstrated* with similar improvements for cavity performances compare to the standard treatment. With the same simplification concern, we report here about an alternative method to avoid restrictive UHV requirements. Experiments have been carried out to perform "fast baking" in oxygen-free atmosphere, because bad performances have been observed with "fast baking" in air. These degradations are closely connected with a strong oxygen penetration in bulk analysed by Secondary Ion Mass Spectroscopyon on Nb samples .

*Proceedings of SRF Workshop – Ithaca (July 2005) – TuP05.

Commissioning of the SOLEIL RF Systems

MOPCH142

P. Marchand, H.D. Dias, M.D. Diop, M.E. El Ajjouri, J.L. Labelle, R.L. Lopes, M. Louvet, C.M. Monnot, J. Polian, F. Ribeiro, T. Ruan, R.S. Sreedharan, K. Tavakoli, C. Thomas-Madec (SOLEIL) P. Bosland, P. Bredy (CEA)

The 352 MHz RF accelerating systems for the SOLEIL Booster (BO) and Storage Ring (SR) are being commissioned. In the BO a 5-cell copper cavity of the CERN-LEP type is powered with a 35kW solid state amplifier. In the SR the required RF accelerating voltage (up to 4.4MV) will be provided by two cryomodules, each containing a pair of superconducting cavities, specifically designed for SOLEIL. The parasitic impedances of the high order modes are strongly attenuated by means of four coaxial couplers, located on the tube connecting the two cavities. The first cryomodule is already installed in the SR tunnel, while the second one is being constructed by ACCEL (Germany). These cryomodules are supplied in liquid helium from a single 350W liquefier and each cavity is powered with a 190kW solid state amplifier. The RF system commissioning and first operation results are reported.

MOPCH143

Electromechanical Characterization of Piezoelectric Actuators Subjected to a Variable Preloading Force at Cryogenic Temperature

M. Fouaidy, N. Hammoudi, M.S. Saki, H. Saugnac, L. Simonet (IPN)

Piezoelectric actuators are actually used in Fast Active Cold Tuning Systems (FACTS) for SRF cavities. The characteristics, performances and lifetime of these actuators depend on the preloading force applied by the cavity and the FACTS to the piezostacks. Experimental data are needed for reliable and optimum operation of piezostacks in superconducting protons or electrons linacs. In the frame of the CARE project supported by EU, we designed and constructed a dedicated apparatus for studying the electromechanical behavior of prototype piezoelectric actuators subjected to variable preloading force at cryogenic temperatures. This device was successfully used for testing piezoelectric actuators prototypes for T in the range 2K-300K. The dielectric properties as well as dynamic properties were measured including the actuator characteristics when used as force sensor. The corresponding data are reported and discussed.

MOPCH144

Low Temperature Properties of Piezoelectric Actuators Used in SRF Cavities Cold Tuning Systems

G. Martinet, S. Blivet, F. Chatelet, M. Fouaidy, N. Hammoudi, A. Olivier, H. Saugnac (IPN)

High accelerating gradients (10 MV/m for SNS, 33 MV/m for ILC) at which SRF cavities will be operated in pulsed machines induce frequency shift much higher than the resonator bandwidth. This so-called Lorentz detuning should be compensated dynamically by means of an active piezo-tuning system. In the frame of the CARE project activities supported by EU, IPN Orsay participates to the development of a fast cold tuning system based and piezoelectric technology for SRF cavities operating at temperature T=2K. The aim of this study is the full characterization of piezoelectric actuators at low temperature including dielectric properties (capacitance, impedance, dielectric losses), radiation hardness tests (fast neutron tolerance), mechanical measurements (maximum displacement, maximum stroke) and thermal properties (heating, heat capacity). Results obtained in the temperature range from 2K up to 300K will be presented and discussed.

MOPCH145

Tests Results of the Beta 0.07 and Beta 0.12 Quarter Wave Resonators for the SPIRAL2 Superconducting Linac

G. Olry, J.-L. Biarrotte, S. Bousson, C. Joly, T. Junquera, J. Lesrel, G. Martinet, D. Moura, H. Saugnac, P. Szott (IPN) P.-E. Bernaudin, P. Bosland, G. Devanz (CEA)

New developments and tests have been carried out on low beta (0.07) and high beta (0.12) 88 MHz superconducting Quarter Wave Resonators. These resonators will be installed in the LINAC driver, respectively in the low beta section, composed of cryomodules A (developed at CEA-Saclay) and the high beta section composed of cryomodules B (developed at IPN-Orsay). Both resonators' types will be equipped with the same power coupler (developed at LPSC-Grenoble) and designed for a maximum power of 20 kW. RF tests results of the prototype cavities and power couplers are reported. The fabrication of the two cryomodules prototypes, fully equipped, is in progress in order to be ready for high power RF tests at 4.2 K at the beginning of 2007.

Status of the Beta 0.12 Superconducting Cryomodule Development for the Spiral2 Project

MOPCH146

H. Saugnac, J.-L. Biarrotte, S. Blivet, S. Bousson, C. Commeaux, C. Joly, T. Junquera, J. Lesrel, fl. Lutton, G. Martinet, G. Olry, P. Szott (IPN)

SPIRAL2 is a radioactive beams facility, composed of a superconducting linac driver, delivering deuterons with an energy up to 40 MeV (5 mA) and heavy ions with an energy of 14.5 MeV/u (1 mA). This facility is now fully approved by the French government. IPN Orsay is in charge of the study and manufacture of the beta 0.12 cryomodule of the superconducting LINAC. These cryomodule, designed for an overall cryogenic power of 30 W at 4.2 K, is composed of two quarter wave type 88 MHz rf resonator providing a minimum of 6.5 MV/m with a quality factor of 1 10 9, two tuning mechanisms controlling the resonator frequency and an alignment system allowing to adjust the cavity position with a ± 1 mm accuracy. Several tests performed on a first resonator prototype fabricated by the "Ettore Zanon SpA" Company, have validated the cavity and its auxiliary components design. A first cryomodule fully equipped (cavities, cryostat, tuning and alignment systems), planned to be tested at the beginning of 2007, is under manufacturing. The details of the cryomodule design and the resonator tests results are discussed in the paper.

Developments in Conditioning Procedures for the TTF-III Power Couplers

MOPCH147

H. Jenhani, T. Garvey, P. Lepercq, M. Omeich, C.P. Prevost, V. Variola (LAL)

Despite extensive experience in many laboratories on power conditioning of couplers for RF superconducting accelerators, it is still not a well understood procedure and can produce many unpredictable phenomena. There remains considerable interest in reducing the power coupler conditioning time necessary for superconducting linear accelerators. This paper presents studies of optimisation of the conditioning procedure for the couplers intended for use on the European XFEL project.

First RF Tests in the HoBiCaT Superconducting Test Facility at BESSY

MOPCH148

O. Kugeler, W. Anders, J. Borninkhof, H.G. Hoberg, S. Klauke, J. Knobloch, M. Martin, G. Mielczarek, A. Neumann, D. Pflückhahn, S. Rotterdam, M. Schuster, T. Westphal (BESSY GmbH)

In preparation for the construction of the BESSY-FEL User Facility, BESSY recently completed the installation of the HoBiCaT cryogenic test facility for superconducting RF (SRF) TESLA cavity units, including all ancillary devices (helium tank, input coupler, tuner, magnetic shielding). It is designed to house two such units in a configuration similar to that envisaged for the superconducting CW linac of the BESSY FEL. Commissioning of the facility is now complete and the first TTF-III RF coupler and cavity unit have been tested. In particular, the complete production, cleaning and assembly of the cavity unit was carried out by industry. These tests thus serve as a first step at qualifying industrial partners for series production of such systems, which will be essential for the future construction of SRF based light sources. Results will be presented.

MOPCH149

Microphonics Measurements in a CW-driven TESLA-type Cavity

O. Kugeler, W. Anders, J. Knobloch, A. Neumann (BESSY GmbH)

Superconducting cavities with a high quality factor exhibit a very low bandwidth in their resonant frequency, which makes their operation very sensitive to mechanical oscillations. In CW mode of operation, as is intended for the BESSY-FEL Linac, microphonics are therefore the dominant error source for field stability. In order to compensate the detuning, it is necessary to properly characterize amplitude and frequency with respect to all involved mechanical and electrical components. Such measurements have been performed at the HoBiCaT test facility at BESSY and will be described in detail.

MOPCH150

Characterization of a Piezo-based Microphonics Compensation System at HoBiCaT

A. Neumann, W. Anders, S. Klauke, J. Knobloch, O. Kugeler, M. Schuster (BESSY GmbH)

In the superconducting driver linac for the BESSY FEL, piezo actuators will be utilized to rapidly counteract the detuning of the cavity resonance caused by nm mechanical oscillations (microphonics). This is of importance to guarantee field stability and lower the power consumption of the RF system for the superconducting cavities. To design a suitable compensator, mechanical and electro-mechanical transfer functions, as well as the tuning range of the system under operating conditions have been measured and will be presented.

MOPCH151

Pulsed RF System for the ELBE Superconducting Accelerator

A. Buechner, F.G. Gabriel (FZR/FWFE) H. Buettig, U. Lehnert, P. Michel, Ch. Schneider, R. Schurig (FZR)

The RF system for the ELBE accelerator was originally designed for CW mode. Although this works problem-free tests have shown that it is possible to reach higher gradients in the TESLA cavities with a pulsed RF system. The new RF system will be presented together with measurements of the achievable gradients. Roughly 30% higher gradients could now be used in pulsed mode. As positive side effects the radiation by field emission is reduced by the duty cycle and an easy in situ RF conditioning of cavities and coupler windows is possible.

MOPCH152

A Pulsed-RF High-power Processing Effect of Superconducting Niobium Cavities observed at the ELBE Linear Accelerator

U. Lehnert, H. Buettig, P. Michel, Ch. Schneider, R. Schurig (FZR) A. Buechner, F.G. Gabriel (FZR/FWFE)

The driver LINAC of the ELBE radiation source is built for cw operation. However, in some cases a pulsed-mode operation was desired to extend the otherwise stringent gradient limits. The main restriction results from field emission that decreases the Q of the cavities which was evaluated from measurements of the liquid helium consumption. After pulsed-mode operation with gradients exceeding the maximum cw accelerating gradients by 30–40

Peak Field Optimization for the Superconducting CH Structure

MOPCH153

H. Liebermann, H. Podlech, U. Ratzinger (IAP)

The Cross-Bar H-type (CH) cavity is a multi-gap drift tube structure operated in the H-210 mode which has been developed at the IAP Frankfurt and in collaboration with GSI. Based on detailed numerical simulations a 19 cell prototype cavity from massive Nb was realised. For optimization of the magnetic and electric peak fields, detailed numerical simulations with CST MicroWave Studio have been performed. After successful experiments on the superconducting prototype cavity calculations about improved drift tube geometries with respect to field emission took place. Additionally, the stem geometry was further improved by simulations.

Dry-ice Cleaning on SRF Cavities

MOPCH154

A. Brinkmann, J.I. Iversen, D. Reschke, J. Ziegler (DESY)

High pressure rinsing with ultra-pure water is the well-proven standard cleaning step after chemical or electrochemical surface treatment of SRF cavities. Dry-ice cleaning (DIC) is a powerful additional cleaning option which depends on the sublimation-impulse method. Particles and film contaminations, especially hydro-carbons, are removed without residues. Furthermore DIC offers the possibility of a final horizontal cleaning of a fully equipped cavity because water is not present in the cleaning process. Horizontal cleaning tests on single-cell cavities showed promising high gradient, high Q-value performances, but field emission is still the limiting effect. On the basis of these tests a new IR-heater module is installed to keep a high temperature gradient between the CO2 jet and the cavity surface. New test results for this optimized cleaning set-up will be presented.

Performance Limitations of Tesla Cavities in the Flash Accelerator and their Relation to the Assembly Process

MOPCH155

L. Lilje (DESY)

Several accelerator modules with superconducting cavities have been assembled for TTF. The paper reviews the performance of these structures and will try to correlate their performance to information about the assembly process. In some cases a performace degradation could be attributed to problems in this process. The introduction of additional quality control steps improved accelerator module performance. For example, the more recently assembled modules have shown the expected acceleration gradients and no vacuum leaks.

Structural Analysis for a Half-reentrant Superconducting Cavity

MOPCH157

E. Zaplatin (FZJ) T.L. Grimm, W. Hartung, M. J. Johnson, M.S. Meidlinger, J. Popielarski (NSCL)

A half-reentrant cavity (1300 MHz, beta=1.0) is being developed at Michigan State University for use in a superconducting linear collider and other applications. The electromagnetic performance of a half-reentrant cell shape is similar to that of a fully reentrant cavity, but a multi-cell half-reentrant cavity can be cleaned using traditional techniques. We present the results of structural analyses of the half-reentrant cavity for the mid-cell, single-cell, and multi-cell cases. The analysis includes the static and dynamic response of the cavity. Stiffening options to minimize the resonant RF frequency shift due to pressure and the Lorentz force are explored.

MOPCH158

HIPPI Triple-spoke Cavity Design

E. Zaplatin, M. Pap, R. Tölle (FZJ)

In the frames of the European project of High Intensity Pulsed Proton Injector (HIPPI) the 352 MHz, beta=0.48 triple-spoke cavity is under development and will be built at the research center FZJ in Juelich. The criteria and results of the cavity RF and structural analyses are presented.

MOPCH159

Coupler Design Considerations for the ILC Crab Cavity

P. Goudket, C.D. Beard (CCLRC/DL/ASTeC) G. Burt (Microwave Research Group, Lancaster University)

Transverse deflecting cavities, such as the ILC crab cavity, commonly operate in the TM110 dipole mode. This means that in addition to the higher order modes (HOMs), that need to be controlled for every cavity, the fundamental TM010 mode and the other polarisation of the dipole mode also need to be damped. As the resonant frequency of the fundamental mode is much lower than the cut-off frequency of the beampipe, this mode becomes trapped in the cavity and difficult to extract using conventional HOM couplers, hence a dedicated coupler is likely to be required. The ILC crab cavities will require excellent damping of all undesirable modes in order to maintain maximum luminosity at the IP.

MOPCH160

A Beam-based High Resolution Phase Imbalance Measurement Method for the ILC Crab Cavities

A. Kalinin, L. Ma, R.J. Smith (CCLRC/DL/ASTeC)

A high resolution method of RF phase adjustment and test is proposed for the Crab Cavity system of the ILC. The method is based on beam as ultimate test instrument. To measure phase imbalance in the pair of crab cavities (<0.02deg at 1.3GHz is required), a low energy (~1GeV) beam is used. A bunch center-of-mass trajectory through the cavities spaced (n+1/2) RF wavelengths and excited as in the case of the ILC, is a straight line for phase-balanced cavities and gets a kick when unbalanced. The kick is measured by two spaced BPMs with reference to the initial trajectory angle measured by two other BPMs. The method is insensitive to a bunch arrival time jitter and RF phase Common Mode jitter. A prototype of the test bench based on the method, is proposed. Using a 10MeV beam, two simple dipole cavities and low RF power, the prototype can be utilized for mastering high resolution measurements, for adjustment and tests of low level electronics of the Crab Cavity system and RF systems of XFEL ERLs as well. The phase resolution of the prototype is estimated as 0.01deg and the amplitude resolution as 0.01%.

Development of a Prototype Superconducting CW Cavity and Cryomodule for Energy Recovery

MOPCH161

P.A. McIntosh, C.D. Beard, D.M. Dykes, B. Todd (CCLRC/DL/ASTeC) S.A. Belomestnykh (Cornell University, Laboratory for Elementary-Particle Physics) A. Buechner, P. Michel, J. Teichert (FZR) J.M. Byrd, J.N. Corlett, D. Li (LBNL) T. Kimura, T.I. Smith (Stanford University) M. Liepe, V. Medjidzade, H. Padamsee, J. Sears, V.D. Shemelin (Cornell University) D. Proch (DESY)

Energy Recovery LINAC (ERL) and LINAC-driven FEL proposals and developments are now widespread around the world. Superconducting RF (SRF) cavity advances made over the last 10 years for TESLA/TTF at 1.3 GHz, in reliably achieving accelerating gradients >20 MV/m, suggest their suitability for these ERL and FEL accelerators. Typically however, photon fluxes are maximised from the associated insertion devices when the electron bunch repetition rate is as high as possible, making CW-mode operation at high average current a fundamental requirement for these light sources. Challenges arise in controlling the substantial HOM power and in minimizing the power dissipated at cryogenic temperatures during acceleration and energy recovery, requiring novel techniques to be employed. This paper details a collaborative development for an advanced high-Qo cavity and cryomodule system, based on a modified TESLA cavity, housed in a Stanford/Rossendorf cryomodule. The cavity incorporates a Cornell developed resistive-wall HOM damping scheme, capable of providing the improved level of HOM damping and reduced thermal load required.

RF Requirements for the 4GLS Linac Systems

MOPCH162

P.A. McIntosh, C.D. Beard, D.M. Dykes, A.J. Moss (CCLRC/DL/ASTeC)

The 4GLS facility at Daresbury will combine energy recovery linac (ERL) and free electron laser (FEL) technologies to deliver a suite of naturally synchronised state-of-the-art sources of synchrotron radiation and FEL radiation covering the terahertz (THz) to soft X-ray regimes. CW-mode operation at high acceleration gradients are needed for the various 4GLS accelerator systems and here is where Superconducting Radio Frequency (SRF) cavities excel. Since resistive losses in the cavity walls increase as the square of the accelerating voltage, conventional copper cavities become uneconomical when the demand for high CW voltage grows with particle energy requirements. After accounting for the refrigeration power needed to provide the liquid helium operating temperature, a net power gain of several hundred remains for SRF over conventional copper cavities. This paper details the RF requirements for each of the SRF accelerating stages of the 4GLS facility, outlining techniques necessary to cope with CW-mode operation and HOM power generation.

Analysis of Wakefields in the ILC Crab Cavity

MOPCH163

G. Burt, A.C. Dexter (Microwave Research Group, Lancaster University) C.D. Beard, P. Goudket (CCLRC/DL/ASTeC) L. Bellantoni (Fermilab) R.M. Jones (UMAN)

The large crossing angle schemes of the ILC need a correction of bunch orientation at the IP in order to recover a luminosity loss of up to 80%. The orientation of bunches can be changed using a transverse deflecting cavity. The location of the crab cavity would be close to the final focus, and small deflections caused by wakefields in the cavities could cause misalignments of the bunches at the IP. Wakefields in the FNAL CKM cavities have been analysed

and their effects studied in view of use as the ILC crab cavity. Numerical simulations have been performed to analyse the transverse wakepotentials of up to quadrupole order modes in this cavity and the effect upon bunches passing through this cavity. Trapped modes within the CKM cavity have been investigated. Perturbation tests of normal conducting models of this cavity have been launched to verify these results. The effect of the final focus quadrupole magnets on the deflection given to the bunch have also been calculated and used to calculate luminosity loss due to wakefields.

MOPCH164

Status of the Diamond Storage Ring Radio Frequency System

M. Jensen, M. Maddock, S.A. Pande, S. Rains, A. F. Rankin, D. Spink, A.V. Watkins (Diamond) J. Alex, M. Mueller (Thomson Broadcast & Multimedia AG) B. A. Aminov (CRE) M. Pekeler (ACCEL)

The installation and commissioning of the Diamond Storage Ring RF system is nearing completion. Diamond will initially operate with two RF high power amplifiers and two cavities. The key components in each RF system are a 300 kW amplifier implemented through the combination of four 80 kW IOTs, a 500 MHz superconducting cavity providing up to 2 MV of accelerating voltage and an advanced analogue IQ Low Level RF (LLRF) system to control the cavity frequency, voltage and phase. We present here an update on the recent installation and early commissioning results of the RF systems.

MOPCH165

Low- and Intermediate-beta, 352 MHz Superconducting Half-wave Resonators for High Power Hadron Acceleration

A. Facco, F. Scarpa, D. Zenere (INFN/LNL) R. Losito (CERN) V. Zviagintsev (TRIUMF)

A beta=0.17, 352 MHz superconducting Half-Wave resonator was designed and constructed at INFN-LNL in the framework of the SPES and EURISOL projects. This cavity, together with the beta=0.31 HWR of similar design that was previously built in the framework of the SPES project, allows acceleration of high power hadron beams in the 5?100 MeV/u energy range, as required in the SPES primary linac and in the first part of the EURISOL proton driver. Main features of this structure, compared to other ones developed elsewhere with different geometries for similar applications, are compactness and mechanical stability. Characteristics and test results will be presented.

MOPCH166

Construction, Tuning and Assembly of the Beta=0.12 SC Ladder Resonator at LNL

G. Bisoffi, E. Bissiato, A. Palmieri (INFN/LNL)

The Ladder resonator is a 4-gap full Nb cavity suitable for the 0.1< beta <0.2 range of high current proton linacs. A beta=0.12 Nb prototype of this cavity has been built by ZANON (Schio, Italy) on the basis of LNL design. In this paper we describe the construction procedure of such cavity, as well as the tuning steps, aimed at the achievement of the target frequency of 352.2 MHz and the desired field uniformity along the four gaps. Related results of RF simulations and room temperature tests are presented. The preparation of the SC test at LNL is at an advanced stage.

MOPCH167

PBG Superconducting Resonant Structures

M.R. Masullo (INFN-Napoli) A. Andreone, E. Di Gennaro, F. Francomacaro, G. Lamura (Naples University Federico II) V. Palmieri, D. Tonini (INFN/LNL) M. Panniello, V.G. Vaccaro (Naples University Federico II and INFN)

We have realized normal conducting and superconducting "open resonators" based on the Photonic Band Gap (PBG) concept. We present the study, the optimisation and the measurements (from room temperature to 1.5 K) of Copper and Niobium PBG accelerating cavities operating at two different frequencies, 6 GHz and 16 GHz. All the structures are realised by extruding a single bulk piece of material, using a new machining method that minimizes the surface losses caused by the contact between different conducting parts. Measurements on the compact (54 mm external diameter) 16 GHz Nb structure are very good, showing in the superconducting state a quality factor Q =1.2x105 at the lowest temperature (1.5 K), limited by radiation losses only. The shunt impedance measured for the 16 GHz prototype is 70 MOhm/m, underlining the applicability of such resonant structures as accelerating cavities.

MOPCH168

Novel Development on Superconducting Niobium Film Deposition for RF Applications

A. Cianchi, L. Catani, D. D. Di Giovenale, J. Lorkiewicz (INFN-Roma II) J. Langner, M. S. Sadowski, P. Strzyzewski (The Andrzej Soltan Institute for Nuclear Studies, Centre Swierk) V. M. Merlo, M. Salvato, S. Tazzari (Università di Roma II Tor Vergata) B.R. Ruggiero, R. Russo (ICIB)

A new deposition technology has been developed, based on a cathodic arc system working under UHV conditions, to produce metallic thin films. The technique presents several advantages compared to standard sputtering, mainly: ionized state of the evaporated material, absence of gases to sustain the discharge, higher energy of atoms reaching the substrate surface, possibility to apply bias to the substrate and to guide the arc plasma using magnetic fields. Recent results on superconducting Niobium films deposited under several conditions and on sapphire substrate are reported. A cavity deposition system has been developed and the plasma transport to the cavity cell studied

MOPCH169

High Pressure Rinsing Water Jet Characterization

D. Sertore, E. Cavaliere, M. Fusetti, P. Michelato, C. Pagani, P. Pierini (INFN/LASA)

High pressure rinsing is widely used as the final wet step in the high field superconducting cavities production. The interaction of an high speed ultra pure water jet with the niobium surface depends on various parameters such as water pressure, water throughput, treatment duration, cavity rotation speed, etc. In this paper we illustrate a simple technique for the characterization of water jet parameters based on the momentum transfer between the water jet and a load cell. The jet profile and its dependence on water pressure as well as the force exerted by the jet on the surface are easily measured. Moreover a portable apparatus has been set up and the information gathered in different laboratories will be used for a quantitative comparison of the different HPR systems. These measurements allow to study the correlation of the jet parameters with the effects (surface status, oxide formation, corrosion, etc) of the water interaction with the niobium surface. Furthermore a new analysis, based on the luminescence induced on transparent dielectric samples, is used for confirmation of the water jet structure.

MOPCH170

Experimental and Theoretical Analysis of the Tesla-like SRF Cavity Flanges

L. Monaco, P. Michelato, C. Pagani, N. Panzeri (INFN/LASA)

In view of the future large SC accelerator, an improvement of the reliability and a cost reduction of the SRF cavities cold flanges is required. In this paper, a critical analysis of the TESLA-like cold connection flanges at room and at cryogenic temperature is presented. This analysis is based on experimental characterization of the mechanical properties of the joint and of the leak rates during the sealing process. A FEM model, that agrees with the experimental data, is also presented. This model is being used for the optimization of the present SRF flanges and the development of new cold connections.

MOPCH171

ILC Coaxial Blade Tuner

C. Pagani, A. Bosotti, P. Michelato, N. Panzeri, R. Paparella, P. Pierini (INFN/LASA)

A coaxial (blade) tuner solution has been developed for the compensation of the Lorentz force detuning of the superconducting cavities under the high gradient pulsed operation foreseen for ILC operation. The device is based on prototypes successfully tested at DESY in 2002 both on CHECHIA and on the superstructures inserted in the TTF string. During both tests the blade tuner performed as expected in terms of stiffness, frequency sensitivity and tuning capabilities. An improvement of the tuner characteristics has been designed by the integration of fast tuning capabilities by means of piezo-ceramic element. Two prototipes of the new INFN coaxial piezo blade tuner have just been manufactured and they will be tested at DESY and BESSY after the cavity integration. In this paper the blade tuner design and main characteristics are presented, together with the early interpretation of the cold test results.

MOPCH174

Optimization of the BCP Processing of Elliptical Nb SRF Cavities

C. Boffo, C. A. Cooper, A.M. Rowe (Fermilab) G. Galasso (University of Udine)

Bulk niobium (Nb) electropolished SRF cavities performing at or above 35 MV/m is an aggressive goal recently put forth by the International Linear Collider (ILC) collaboration. Buffered chemical polishing (BCP) is still the most cost effective and least complex processing technique known today to optimize the surface properties of high gradient single crystal and relatively low gradient polycrystalline SRF cavities. BCP will be the preferred chemical process in the production of the nine-cell third harmonic 3.9 GHz cavities at Fermilab. The internal shape of these cavities will result in uneven material removal rates between iris and equator of the cells. We will describe a thermal-fluid finite element model adopted to simulate the etching process, and thus revealing the issues at hand. Experimental work, such as flow visualization tests performed to verify the simulation, will also be discussed. Finally we are presenting results obtained with a novel device, which allows to homogenize the flow pattern and to resolve the problem.

High Power Testing RF System Components for the Cornell ERL Injector

MOPCH175

S.A. Belomestnykh, R.P.K. Kaplan, M. Liepe, P. Quigley, J.J.R. Reilly, C.K. Sinclair, V. Veshcherevich (Cornell University, Laboratory for Elementary-Particle Physics)

There are two high power 1300 MHz RF systms under development for the Cornell University ERL Injector. The first system, based on a 16 kWCW IOT transmitter, will provide RF power to a buncher cavity. The second system employs five 120 kWCW klystrons to feed 2-cell superconducting cavities of the injector cryomodule. All components of these systems were ordered and some have already been delivered, including the IOT transmitter (manufactured by Thales-BM), 20 kWCW AFT circulator, 170 kWCW circulators (Ferrite Co.) and two prototype input couplers for superconducting cavities. A special LN2 cryostat has been designed and built for testing/processing the input couplers. The results of the first high-power tests are presented.

A Comparison of Large Grain and Fine Grain Cavities Using Thermometry

MOPCH176

G.V. Eremeev, H. Padamsee (Cornell University, Laboratory for Elementary-Particle Physics)

An important limitation for SRF niobium cavities is the "high field Q-slope." To investigate this phenomenon we compare the behavior of large grain and fine grain cavities using thermometry. Thermometry allows us to distinguish between different problems which occur in cavities, and to distinguish between different areas showing high field Q-slope. We looked for the difference in heating between grain boundaries and inside grains. We have found interesting differences between the heating of high field slope regions and the heating of point-like defects.

Status of HOM Load for the Cornell ERL Injector

MOPCH177

V.D. Shemelin, B. Gillett (Cornell University) P. Barnes, M. Liepe, V. Medjidzade, H. Padamsee, G.R. Roy, J. Sears (Cornell University, Laboratory for Elementary-Particle Physics)

The HOM load for the injector of the Energy Recovery Linac at Cornell University is proposed to work at a temperature of 80 K. The anticipated absorbed power of the load is up to 200 W. Versions with inner diameter of 78 and 106 mm are under development. Two different kinds of ferrites and a lossy ceramic are chosen as RF absorbers for the load to cover a wide frequency range. Measurements of electromagnetic properties of absorbing materials have been performed in a frequency range from 1 to 40 GHz. The engineering design of the load is ready and technological issues of brazing the absorbing tiles and cooling have been solved. Brazing quality is controlled by IR thermograms. First warm measurements of a prototype load are expected this summer.

MOPCH178

Tests on MgB2 for Application to SRF Cavities

T. Tajima (LANL) I.E. Campisi (ORNL) A. Canabal-Rey (NMSU) Y. Iwashita (Kyoto ICR) B. Moeckly (STI) C.D. Nantista, S.G. Tantawi (SLAC) H.L. Phillips (Jefferson Lab) A.S. Romanenko (Cornell University, Laboratory for Elementary-Particle Physics) Y. Zhao (University of Wollongong, Institute of Superconducting and Electronic Materials)

Magnesium diboride (MgB2) has a transition temperature (Tc) of ~40 K, i.e., about four times higher than niobium (Nb). The studies in the last three years have shown that it could have about one order of magnitude less RF surface resistance (Rs) than Nb and seems much less power dependent compared to high-Tc materials such as YBCO. In this paper we will present results on the dependence of Rs on surface magnetic fields and possibly the critical RF surface magnetic field.

MOPCH179

Design of a New Electropolishing System for SRF Cavities

T. Tajima (LANL) C. Boffo (Fermilab) M.P. Kelly (ANL) J. Mammosser (Jefferson Lab)

Electropolishing (EP) is considered the baseline surface treatment for Superconducting RF (SRF) cavities to achieve >35 MV/m accelerating gradient for the International Linear Collider (ILC). Based on the lessons learned at the forerunners such as KEK/Nomura, DESY and JLAB and on the recent studies, we have started a new design of the next EP system that will be installed in the US. This paper presents requirements, specifications, and the detail of the system design as well as the path forward towards the future industrialization.

MOPCH181

1.3 GHz Electrically-controlled Fast Ferroelectric Tuner

V.P. Yakovlev (Omega-P, Inc.) J.L. Hirshfield (Yale University, Physics Department) S. Kazakov (KEK)

A fast, electrically-controlled tuner is described with parameters suitable for operation with the 9-cell SC accelerator structure of ILC. The tuner is based on a magic tee and two phase shifters that contain ferroelectric rings. The dielectric constant of the ferroelectric ring is altered by applying a 4.2 kV DC pulse that provides an RF phase shift from 0 deg to 180 deg. This, in turn allows a change of the input signal amplitude from zero to its maximum value, or a change in phase from 0 deg to 360 deg during the RF pulse. It is shown that the possibility of changing the cavity coupling to the input line during the RF pulse allows significant RF power savings, up to 12.5 MW for the 800 GeV ILC option. In addition, fast electrically-tuned amplitude and phase control with a feed-back system should be useful to compensate for possible phase deviations of the input RF fields in each cavity of ILC to match the cavity with the feeding transmission line as the beam load varies.

The JLAB Ampere-class Cryomodule Conceptual Design

MOPCH182

R.A. Rimmer, G. Ciovati, E. Daly, T. Elliott, J. Henry, W.R. Hicks, P. Kneisel, S. Manning, R. Manus, J.P. Preble, K. Smith, M. Stirbet, L. Turlington, L. Vogel, H. Wang, K. Wilson, G. Wu (Jefferson Lab)

For the next generation of compact high-power FELs a new cryomodule is required that is capable of accelerating up to Ampere levels of beam current. Challenges include strong HOM damping, high HOM power and high fundamental-mode power (in operating scenarios without full energy recovery). For efficient use of space a high real-estate gradient is desirable and for economic operation good fundamental-mode efficiency is important. The technology must also be robust and should be based on well-proven and reliable technologies. For Ampere-class levels of beam current both halo interception and beam break-up (BBU) are important considerations. These factors tend to drive the designs to lower frequencies where the apertures are larger and the transverse impedances are lower. To achieve these goals we propose to use a compact waveguide-damped multi-cell cavity packaged in an SNS-style cryomodule.

Plasma Treatment of Bulk Niobium Surfaces for SRF Cavities

MOPCH184

L. Vuskovic, S. Popovic, M. Raskovic (ODU) L. Godet, S.B. Radovanov (VSEA) H.L. Phillips, A-M. Valente-Feliciano (Jefferson Lab)

Cavity surface preparation has been one of the major problems in superconducting radio-frequency (SRF) accelerator technology. Accelerator performance depends directly on the physical and chemical characteristics at the SRF cavity surface. The primary objective of our work is to explore the effects of various types of electric discharge plasmas to minimize surface roughness and eliminate or minimize deterioration of cavity properties by oxygen, hydrogen and other chemical contaminants. To optimize the plasma etching process, samples of bulk Nb are being exposed to three types of electrical discharge in various experimental set-ups. The surface quality obtained by the three methods was compared with samples treated with buffer chemical polishing techniques. Surface comparisons are made using digital imaging (optical) microscopy, scanning electron microscopy, and atomic force microscopy. In preliminary tests, samples compared with those treated conventionally have shown comparable or superior properties. Tests have also shown that surface quality varies with plasma conditions and their optimization to obtain the best SRF cavity surface is a major goal of the ongoing work.

First Cool Down of the Juelich Accelerator Module Based on Superconducting Half-Wave Resonators

MOPCH186

F.M. Esser, B. Laatsch, H.S. Singer, R. Stassen (FZJ) R. Eichhorn (TU Darmstadt)

In the context of upgrading the existing proton and deuteron accelerator facility COSY at the Forschungszentrum Juelich, an accelerator module based on superconducting half wave resonators is prototyped. Due to beam dynamics, the requirements of cavity operation and a top-loading design for mounting, the cryostat had to be designed very compact and with a separate vacuum system for beam and insulation vacuum. These restricted requirements lead to very short cold-warm transitions in beam port region and to an unconventional design regarding to the shape of the cryostat vessel. This paper will review the design constraints, gives an overview of the ancillary parts of the module (cavities, tuner, etc.) and will present the results of the first cool-down experiments. Furthermore the future work will be presented.

MOPCH187

Key Cryogenics Challenges in the Development of the 4GLS

R. Bate, R.K. Buckley, A.R. Goulden, C. Hodgkinson, S.M. Pattalwar (CCLRC/DL/ASTeC)

The fourth generation light source (4GLS) is a uniquely flexible source of ultra-high brightness continuous and pulsed radiation covering the IR to XUV range of the spectrum. It is the first light source in the world that is planned from the outset to be a multi-user, multi-source facility combining ERL (energy recovery LINAC) and FEL (free electron laser) technology. 4GLS will require six different sets of superconducting LINACs. Each of the LINAC modules consists of 2 to 7, 1.3 GHz superconducting RF cavities of the TESLA design operating at 1.8 K. The overall cooling power necessary to cool the cavities is estimated to be around 2.5KW demanding the superfluid liquid helium flow rates in excess of 200g/s. Even though the technology of the superconducting RF cavities is somewhat well understood, the design and subsequent operation of the cryogenic system / Cryo modules is an extremely complex task. In this paper we describe the key cryogenic challenges of the 4GLS project and our approach in identifying solutions to meet them.

MOPCH189

Calculating the Muon Cooling within a MICE Liquid Absorber

M.A. Green, S.P. Virostek (LBNL) S.Q. Yang (OXFORDphysics)

The key elements of the Muon Ionization Cooling Experiment (MICE) cooling channel are the absorbers that are a part of the MICE absorber focus coil modules (AFC modules). The boundaries of room temperature solid absorbers are well defined. The density of most solid absorber materials is also well understood. The properties of solid absorber are most certainly understood to 0.3 percent. The MICE liquid absorbers are different in that their dimensions are a function of the absorber temperature and the fluid pressure within the absorber. The second element in the liquid absorber is the variability of the liquid density with temperature and pressure. While one can determine the absorber boundary within 0.3 percent, the determination of the liquid density within 0.3 percent is more difficult (particularly with liquid helium in the absorber). This report presents a method of calculating absorber boundary and the cooling performance of the MICE absorbers as a function of fluid temperature and pressure.

MOPCH190

Cryomodule Development for Superconducting RF Test Facility (STF) at KEK

K. Tsuchiya, H. Hayano, Y. Higashi, H. Hisamatsu, M. Masuzawa, H. Matsumoto, C. Mitsuda, S. Noguchi, N. Ohuchi, T. Okamura, K. Saito, A. Terashima, N. Toge (KEK)

Current status of the cryomodule development for superconducting RF test facility, STF, at KEK is presented. The objective of the STF construction is to have an experience of 5-m long cryomodule fabrications and to learn an operational method of superconducting RF cavities. The STF consists of two 5-m long cryomodules, each housing four 9-cell cavities (one for 35 MV/m and the other for 45 MV/m). In addition to the cavity type, each cavity has variations in its appendices. Thus, two cryomodules must have different structures for the cavity support and for the port of the RF input coupler. This paper describes the details of the cryomodule design, the development of the bimetallic joint for connecting the titanium helium vessel to the stainless steel cooling pipe, and the studies of the magnetic shielding for high quality cavities.

Copper Heat Exchanger for the External Auxiliary Bus-bars Routing Line in the LHC Insertion Regions

MOPCH191

C. Garion, A. Poncet, F. Seyvet, J.-P.G. Tock (CERN) M. Sitko, B. Skoczen (CUT)

The corrector magnets and the main quadrupoles of the LHC dispersion suppressors are powered by a special superconducting line (called auxiliary bus-bars line N), external to the cold mass and housed in a 50 mm diameter stainless steel tube fixed to the cold mass. As the line is periodically connected to the cold mass, the same gaseous and liquid helium is used for cooling the magnets and the line. The final sub-cooling process (from 4.5 K down to 1.9 K) consists of the phase transformation from liquid to superfluid helium. It is slightly delayed with respect to the magnets. To accelerate the process, a special heat exchanger has been designed. Located in the middle of the dispersion suppressor portion of the line it consists in creating a local sink of heat extraction, providing two additional lambda fronts that propagate in opposite directions towards the line extremities. Both the numerical model and the sub-cooling analysis are presented in the paper for different configurations of the line. Design, manufacturing and integration aspects of the heat exchanger are described. Finally, the results of the qualification tests and the expected performance of the line are given.

Operation of a Helium Cryogenic System for a Superconducting Cavity in an Electron Storage Ring

MOPCH192

F. Z. Hsiao, S.-H. Chang, W.-S. Chiou, H.C. Li (NSRRC)

A 500 MHz superconducting cavity maintaining the energy of electrons in the storage ring of TLS light source started from the year 2005. A helium system dedicated to keep the niobium cavity at 4.5 K has begun its operation since the year 2003. The cryogenic system provides maximum refrigeration of 469 W or liquefaction rate of 134 l/hr. The constraint from the superconducting cavity leads to specific features of the cryogenic system. This paper presents the operation of the cryogenic system as the superconducting cavity at different conditions. The interaction in between the cryogenic system and the superconducting cavity and the constraints on the starting and shutdown of the cryogenic system are indicated.

SNS 2.1K Cold Box Turn-down Studies

MOPCH193

F. Casagrande, P.A. Gurd, D.R. Hatfield, M.P. Howell, W.H. Strong (ORNL) D. Arenius, J. Creel, V. Ganni, P. Knudsen (Jefferson Lab)

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory is nearing completion. The cold section of the Linac consists of 81 superconducting radio frequency cavities cooled to 2.1K by a 2400 watt cryogenic refrigeration system. The 2.1K cold box consists of four stages of centrifugal compressors with LN2-cooled variable speed electric motors and magnetic bearings. The cryogenic system successfully supported the Linac beam commissioning at both 4.2K and 2.1K and has been fully operational since June 2005. This paper describes the control principles utilized and the experimental results obtained for the SNS cold compressors turn-down capability to about 30% of the design flow, and possible limitation of the frequency dependent power factor of the cold compressor electric motors, which was measured for the first time during commissioning. These results helped to support the operation of the Linac over a very broad and stable cold compressor operating flow range (refrigeration capacity) and pressure. This in turn helped to optimise the cryogenic system operating parameters, minimizing the utilities and improving the system reliability and availability.

MOPCH194

Studies of the Alignment Tolerance for the Injector System of the IFUSP Microtron

T.F. Silva, M.N. Martins, P.B. Rios (USP/LAL)

The Instituto de Fmsica da Universidade de Sco Paulo (IFUSP) is building a two-stage 38 MeV continuous-wave racetrack microtron. In this work, we describe the determination of alignment tolerances for the injector system of the IFUSP Microtron. This system consists of a linear accelerator with input energy of 100 keV and output energy of 1.8 MeV. The work presented ere involves analysis of our possibilities of alignment, the beam specifications for the acceleration structures and the strength of the correcting coils. Simulations were made using a method based on rotation matrices that allows for misalignments in the optical elements. It uses a tolerance parameter, given by the user, which is interpreted as a standard deviation of the normal misalignment distribution used to shuffle a configuration. A 5% loss of particles is achieved at a tolerance of 0.25-mm, without the inclusion of correcting coils (steerings) in the simulations.

MOPCH195

The LiCAS-RTRS – A Survey System for the ILC

A. Reichold, C. Perry (OXFORDphysics) M. Dawson, J. Green, Y. Han, M. Jones, G. Moss, B. Ottewell, R. Wastie (JAI) G. Grzelak (Warsaw University) D. Kaemtner, J. Prenting, E. Saemann, M. Schloesser (DESY)

The ILC requires an unprecedented accuracy and speed for the survey and alignment of its components. The Rapid Tunnel Reference Surveyor (RTRS) is a self-propelled train intended to automatically survey a reference network in the ILC tunnels with a design accuracy of 200 microns over distances of 600 m. A prototype RTRS has been built by the LiCAS collaboration. It will shortly commence operation at DESY. The operation principle of the RTRS will be explained. The status of the project's hardware, software and calibrations as well as the principles and performance of the underlying measurement techniques will be described.

MOPCH196

Diamond Storage Ring Remote Alignment System

I.P.S. Martin, A.I. Bell, A. Gonias, N.P. Hammond, J. Kay, D. Wilson (Diamond)

The 24 cell Diamond Storage Ring is 561.6m in circumference and is mounted on 72 support girders, the largest of which are 6m long and weigh 17 Tonnes. Each girder can be remotely positioned in 5 axes using a system of motorised cams. This system has been designed to enable the future remote realignment of the Storage Ring using beam based alignment techniques. The system is described in detail including the mechanical and electrical components of the system as well as a description of the alignment algorithms employed and how these have been incorporated into the control system.

MOPLS — Poster Session

Large Scale Beam-beam Simulations for the CERN LHC using Distributed Computing

MOPLS001

W. Herr, E. McIntosh, F. Schmidt (CERN) D. Kaltchev (TRIUMF)

We report on a large scale simulation of beam-beam effects for the CERN Large Hadron Collider (LHC). The stability of particles which experience head-on and long-range beam-beam effects was investigated for different optical configurations and machine imperfections. To cover the interesting parameter space required computing resources not available at CERN. The necessary resources were available in the LHC@home project, based on the BOINC platform. At present, this project makes more than 40000 hosts available for distributed computing. We shall discuss our experience using this system during a simulation campaign of more than six months and describe the tools and procedures necessary to ensure consistent results. The results from this extended study are presented and future plans are discussed.

The Study of the Machine-induced Background and its Applications at the LHC

MOPLS002

V. Talanov, I. Azhgirey, I. Baishev (IHEP Protvino) D. Macina, K.M. Potter, E. Tsesmelis (CERN)

We present the recent advances in the analysis of the machine-induced background generation and formation at the LHC. Different aspects of the study of the machine background problem at the LHC are reviewed, including the background production at the different stages of the machine operation, the role and influence on the background from the collimators in the experimental insertions and the background shielding. The potential use of the machine background for the purposes of detector testing and alignment is also discussed.

Tertiary Halo and Tertiary Background in the Low Luminosity Experimental Insertion IR8 of the LHC

MOPLS003

V. Talanov (IHEP Protvino) R.W. Assmann, D. Macina, K.M. Potter, S. Redaelli, G. Robert-Demolaize, E. Tsesmelis (CERN)

In our report we present the results for numerical simulation of tertiary halo and tertiary background in the LHC. We study the case of the proton losses in the betatron cleaning insertion IR7 with the subsequent tertiary halo generation in the downstream experimental insertion IR8. We analyze the formation of tertiary background in the experimental area of the IR8 and evaluate the performance of the machine-detector interface shielding with respect to this source of the background. The results obtained are compared with the previous estimates of the machine-induced background in the low luminosity insertions of the LHC, and the balance between different sources of the background is discussed.

MOPLS004

Estimation and Analysis of the Machine-induced Background at the TOTEM Roman Pot Detectors in the IR5 of the LHC

V. Talanov (IHEP Protvino) V. Avati (Helsinki University, Department of Physics) M. Deile, D. Macina (CERN)

The problem of background generation in the experimental insertion IR5 of the LHC during machine operation in the dedicated TOTEM mode with low intensity beams and the specially designed beta* = 1540 m optics is discussed. The sources of the machine-induced background in the IR5 forward physics areas are identified and their relative importance is evaluated. The results of the background simulation in the IR5 are presented, based on the most recent estimates of the residual gas density for TOTEM beam conditions. The methods for background analysis and rejection are explained.

MOPLS005

A Staged Approach to LHC Commissioning

R. Bailey, O.S. Brüning, P. Collier, M. Lamont, R.J. Lauckner, R. Schmidt (CERN)

After a brief reminder of the performance goals of the LHC, the overall strategy proposed for commissioning the machine with protons is presented. A thorough commissioning of the LHC hardware systems, presently ongoing, will lead into a staged approach for the first two years of operation with the beam, allowing both the complexity of the machine operation and the destructive power of the high intensity beams to be introduced in a controlled, incremental manner. The demands on the annual machine schedule are discussed, including the need to incorporate dedicated running for ions and proton-proton total cross section measurements. An important pre-commissioning milestone is the injection of the beam into a sector of the partially completed LHC; the motivation and tests planned are briefly summarised.

MOPLS006

Adaptive RF Transient Reduction for High Intensity Beams with Gaps

J. Tuckmantel, P. Baudrenghien (CERN)

When a high-intensity beam with bunch-trains and gaps passes a cavity with a high-gain vector feedback enforcing a constant voltage, large transients appear, stressing the RF high power hardware and increasing the trip rate. By modulating the cavity voltage with a varying periodic waveform (set-function), the RF power can be made constant while still preserving the high feedback gain. The average cavity voltage is conserved but bunches have to settle at slightly shifted positions. A method is derived to obtain this set-function in practice while making no assumptions or measurements of the beam or RF parameters. Adiabatic iterations are made, including the whole machine as an analog computing device, using all parameters as they are. A computer simulation shows the success of the method.

MOPLS007

Monitoring Heavy-ion Beam Losses in the LHC

R. Bruce, G. Bellodi, H.-H. Braun, S.S. Gilardoni, J.M. Jowett (CERN)

The LHC beam loss monitor (BLM) system, primarily designed for proton operation, will survey particle losses and dump the beam if the loss rate exceeds a threshold expected to induce magnet quenches. Simulations of beam losses in the full magnet geometry allow us to compare the response of the BLMs to ion and proton losses and establish preliminary loss

thresholds for quenches. Further simulations of beam losses caused by collimation and electromagnetic interactions peculiar to heavy ion collisions determine the positions of extra BLMs needed for ion operation in the LHC.

Beam Halo on the LHC TCDQ Diluter System and Thermal Load on the Downstream Superconducting Magnets

MOPLS008

B. Goddard, R.W. Assmann, A. Presland, S. Redaelli, G. Robert-Demolaize, L. Sarchiapone, Th. Weiler, W.J.M. Weterings (CERN)

The moveable single-jawed graphite TCDQ diluter must be positioned very close to the circulating LHC beam in order to prevent damage to downstream components in the event of an unsynchronised beam abort. A two-jawed graphite TCS collimator forms part of the TCDQ system. The requirement to place the TCDQ and TCS jaws close to the beam means that the system can intercept a substantial beam halo load. Initial investigations indicated a worryingly high heat load on the Q4 coils. This paper presents the updated load cases, shielding and simulation geometry, and the results of simulations of the energy deposition in the TCDQ system and in the downstream superconducting Q4 magnet. The implications for the operation of the LHC are discussed.

The LHC as a Proton-nucleus Collider

MOPLS009

J.M. Jowett, C. Carli (CERN)

Following its initial operation as a proton-proton (p-p) and heavy-ion (208Pb^{82+} - 208Pb^{82+}) collider, the LHC is expected to operate as a p-Pb collider. Later it may collide protons with other lighter nuclei such as 40Ar^{18+} or 16O^{8+}. We show how the existing proton and lead-ion injector chains may be efficiently operated in tandem to provide these hybrid collisions. The two-in-one magnet design of the LHC main rings imposes different revolution frequencies for the two beams in part of the magnetic cycle. We discuss and evaluate the consequences for beam dynamics and estimate the potential performance of the LHC as a proton-nucleus collider.

Measurement of Ion Beam Losses Due to Bound-free Pair Production in RHIC

MOPLS010

J.M. Jowett, S.S. Gilardoni (CERN) R. Bruce (MAX-lab) K.A. Drees, W. Fischer, S. Tepikian (BNL) S.R. Klein (LBNL)

When the LHC operates as a Pb^{82+} ion collider, losses of Pb^{81+} ions, created through Bound-free Pair Production (BFPP) at the collision point, and localized in cold magnets, are expected to be a major luminosity limit. With Au^{79+} ions at RHIC, this effect is not a limitation because the Au^{78+} production rate is low, and the Au^{78+} beam produced is inside the momentum aperture. When RHIC collided Cu^{29+} ions, secondary beam production rates were lower still but the Cu^{28+} ions produced were predicted to be lost at a well-defined location, creating the opportunity for the first direct observation of BFPP effects in an ion collider. We report on measurements of localized beam losses due to BFPP with copper beams in RHIC and comparisons to predictions from tracking and Monte Carlo simulation.

MOPLS011

Investigations of the Parameter Space for the LHC Luminosity Upgrade

J.-P. Koutchouk (CERN)

Increasing the LHC luminosity by a factor of ten is a major challenge, not so much for the beam optics but certainly for the beam-beam long-range interactions and even more for the technology and layout: the quadrupole gradient, its physical aperture and tolerance to the energy deposition shall be significantly increased; its distance to the crossing point shall be reduced if the particle detectors can allow it. To help identifying consistent solutions in this multi-dimensional constrained space, a algorithmic model of an LHC insertion was prepared, based on the present LHC layout, i.e., "quadrupole first" and small crossing angle. The model deals with the layout, the beam optics, the beam-beam effect, the superconductor field margins and the peak heat deposition in the coils. The approach is simplified to allow a large gain in the design/computation time for optimization. First results have shown the need to use the Nb3Sn technology (or a material of equivalent performance) to reach the performance goal. In this paper, the model is refined to take into account the quench levels and temperature margins. The optimal insertions within the framework of this approach are identified.

MOPLS012

The LHC Sector Test

M. Lamont, R. Bailey, H. Burkhardt, B. Goddard, L.K. Jensen, O.R. Jones, V. Kain, A. Koschik, R.I. Saban, J.A. Uythoven, J. Wenninger (CERN)

The proposal to inject beam into a sector of the partially completed LHC is presented. The test will provide an important milestone, force preparation of a number of key systems, and allow a number of critical measurements with beam. The motivation for the test is discussed, along with the proposed beam studies, the radiation issues and the potential impact on ongoing installation. The demands on the various accelerator systems implicated are presented along with the scheduling of the preparatory steps, the test itself and the recovery phase.

MOPLS013

The Roman Pot for LHC

M. Oriunno, M. Deile, K. Eggert, J.-M. Lacroix, S.J. Mathot, E.P. Noschis, R. Perret, E.R. Radermacher, G. Ruggiero (CERN)

The LHC machine will be equipped with Roman Pot stations by the TOTEM experiment to measure the pp total cross section and to study the elastic scattering and the diffraction physics processes. TOTEM needs to bring the pots, equipped with cold micro-strip silicon detectors, as a close as possible to the high intensity beam of LHC. Because of the special optics required by TOTEM, the beam has a transversal size of only 80 microns at the Roman pot locations. Safety considerations for the machine protection set the limit to 10 ?, i.e. 800 μm. Such unprecedented parameters, together with the issues of the Ultra High Vacuum and the RF compatibility, and the harsh radiation environment, have requested a design for the Roman Pot system, which is compliant with the LHC requirements and operations. To better meet also the challenging requirements of TOTEM, a technology development of a thin window has been pursued and a flatness of less than 50 μm has been obtained by brazing foil of 150 μm thicknesses. A prototype of the Roman Pot and of the thin window box have been manufactured and tested. We describe the main issues of the final design and the results of the preliminary tests.

Lifetime Limit from Nuclear Intra-bunch Scattering for High-energy Hadron Beams

MOPLS014

F. Zimmermann, H.-H. Braun, F. Ruggiero (CERN)

We derive an approximate expression for the nuclear scattering rate inside a bunched hadron beam. Application to the LHC suggests that the loss rate due to nuclear scattering can be significant in high-energy proton or ion storage rings.

Quality Control Techniques Applied to the Large Scale Production of Superconducting Dipole Magnets for LHC

MOPLS015

F. Savary, M. Bajko, J. Beauquis, G. De Rijk, N. Emelianenko, P. Fessia, P. Hagen, J. Miles, L. Rossi, E. Todesco, J. Vlogaert, C. Vollinger, E.Y. Wildner (CERN)

The LHC accelerator, under construction at CERN, is characterized by the use on a large scale of high field superconducting dipoles: the 27-km ring requires 1232 15-m long dipole magnets designed for a peak field of 9 T. The coils are wound with Rutherford-type cable based on copper-stabilized Nb-Ti superconductors and will be operated at 1.9 K in pressurized superfluid helium. The challenge that had to be faced has been an efficient, cost-effective and reproducible mass production to very tight tolerances: the field quality must be better than 10^{-4} and the geometry of the cold bore tube and magnet controlled to 0.1 mm over the whole length, any deviation being liable to induce delays and significant cost increase. This paper presents the main methods and tools chosen to face successfully this challenge: some methods were foreseen in the technical specification, others were implemented based on the experience gained in several years of fabrication.

LHC IR Upgrade: A Dipole First Option with Local Chromaticity Correction

MOPLS016

R. de Maria, O.S. Brüning (CERN) P. Raimondi (INFN/LNF)

In the framework of the LHC Luminosity Upgrade, we develop a new layout of the interaction region (IR) with betastar equal to 25cm in which the combination-separation dipoles come first with respect to the triplet assembly (dipole first) in opposition of the nominal layout (quadrupole first). The new layout presents several advantages (separate channel for multipole errors, straightforward crossing angle scheme, early separation of the beam). The payoff is a large beta function in the triplet, which enhances the chromaticity and other non-linear effects. We investigate options for local chromaticity correction and their effects on long-term stability.

A Low Gradient Triplet Quadrupole Layout Compatible with NbTi Magnet Technology and Betastar=0.25m

MOPLS017

R. de Maria, O.S. Brüning (CERN)

The paper presents a triplet layout option with long (ca. 100 m total triplet length), low gradient (45 T/m to 70 T/m) quadrupole magnets. Assuming a maximum magnet diameter of 200mm, the peak coil field at the magnet coils still remains below 7 T which is still compatible with conventional NbTi magnet technology. The peak beta function inside the triplet magnets reaches 18 km and the configuration therefore requires an additional chromaticity correction scheme similar to a dipole first layout option. However, at the same time, the presented solution provides an interesting alternative to a high gradient triplet layout which requires the new Nb3Ti magnet technology.

MOPLS018

High-order Effects and Modeling of the Tevatron

P. Snopok, M. Berz (MSU) C. Johnstone (Fermilab)

The role and degree of nonlinear contributions to machine performance is a controversial topic in current collider operations and in the design of future colliders. A high-order model has been developed of the Tevatron in COSY, which includes the strongest sources of nonlinearities. Signatures of nonlinear behavior are studied and compared with performance data. The observed nonlinear effects are compared before and after implemention of nonlinear correction schemes.

MOPLS020

Rad-hard Luminosity Monitoring for the LHC

A. Ratti, J.-F. Beche, J.M. Byrd, K. Chow, S. De Santis, P. Denes, B. Ghiorso, H.S. Matis, M. T. Monroy, W.C. Turner (LBNL) E. Bravin (CERN) P.F. Manfredi (Pavia University, Engineering faculty) W. Vandelli (Pavia University)

Luminosity measurements at the high luminosity points of the LHC are very challenging due to the extremely high radiation levels in excess of 1 GGy/yr. We have designed an ionization chamber that uses a flowing gas mixture and a combination of metals and ceramics. With such a choice, an additonal challenge is achieving the necessary speed to be able to resolve bunch-by-bunch luminosity data. We present the design, analysis and experimental results of the early demonstration tests of this device.

MOPLS021

Beam Pipe Desorption Rate in RHIC

H. Huang, W. Fischer, P. He, H.-C. Hseuh, U. Iriso, V. Ptitsyn, D. Trbojevic, J. Wei, S.Y. Zhang (BNL)

Increase of beam intensity in RHIC has caused several decades of pressure rises in the warm sections during operation. This has been a major factor limiting the RHIC luminosity. About 250 meters of NEG coated beam pipes have been installed in many warm sections to ameliorate this problem. Beam ion induced desorption is one possible cause of pressure rises. A series beam studies in RHIC has been dedicated to estimate the desorption rate of various beam pipes (regular and NEG coated) at various warm sections. Correctors were used to generate local beam losses and consequently local pressure rises. The experiment results are presented and analyzed in this paper.

MOPLS022

On the Feasibility of Polarized Heavy Ions in RHIC

W.W. MacKay (BNL)

Heavy nonspherical ions such as uranium have been proposed for collisions in RHIC. When two such ions collide with their long axes aligned, then the plasma density might be as much as 60% higher. Since the collisions might have any orientation of the two nuclei, the alignment of the nuclei must be inferred from a complicated unfolding of multiplicity distributions. Instead, if it is possible to polarize the ions and control the orientation in RHIC, then a much better

sensitivity could be obtained. This paper investigates the manipulation of such polarized ions with highly distorted shapes in RHIC. Several ion species are considered as possibilities with either full or partial Siberian snakes in RHIC.

Status of Fast IR Orbit Feedback at RHIC

MOPLS023

C. Montag, J. Cupolo, J. Glenn, V. Litvinenko, A. Marusic, W. Meng, R.J. Michnoff, T. Roser, C. Schultheiss, J.E. Tuozzolo (BNL)

To compensate modulated beam-beam offsets caused by mechanical vibrations of IR triplet quadrupoles at frequencies around 10 Hz, a fast IR orbit feedback system has been developed. We report design considerations and recent status of the system.

RHIC Performance as Polarized Proton Collider in Run-6

MOPLS024

V. Ptitsyn, L. Ahrens, M. Bai, D.S. Barton, J. Beebe-Wang, M. Blaskiewicz, A. Bravar, J.M. Brennan, K.A. Brown, D. Bruno, G. Bunce, R. Calaga, P. Cameron, R. Connolly, T. D'Ottavio, J. DeLong, K.A. Drees, A.V. Fedotov, W. Fischer, G. Ganetis, H. Hahn, T. Hayes, H.-C. Hseuh, H. Huang, P. Ingrassia, D. Kayran, J. Kewisch, R.C. Lee, V. Litvinenko, A.U. Luccio, Y. Luo, W.W. MacKay, Y. Makdisi, N. Malitsky, G.J. Marr, A. Marusic, R.J. Michnoff, C. Montag, J. Morris, T. Nicoletti, B. Oerter, F.C. Pilat, P.H. Pile, T. Roser, T. Russo, J. Sandberg, T. Satogata, C. Schultheiss, S. Tepikian, D. Trbojevic, N. Tsoupas, J.E. Tuozzolo, A. Zaltsman, A. Zelenski, K. Zeno, S.Y. Zhang (BNL)

The Relativistic Heavy Ion Collider in Run-6 was operating in polarized proton mode. With two Siberian Snakes per ring, the polarized protons were brought into collisions at 100 Gev and 31.2 Gev energies. The control of polarization orientation at STAR and PHENIX experiments was done using helical spin rotators. Physics studies were conducted with longitudinal, vertical and radial beam polarization at collision points. This paper presents the performance of RHIC as a polarized proton collider in the Run-6 with emphasis on beam polarization and luminosity issues.

Experience in Reducing Electron Cloud and Dynamic Pressure Rise in Warm and Cold Regions in RHIC

MOPLS025

S.Y. Zhang, L. Ahrens, J.G. Alessi, M. Bai, M. Blaskiewicz, P. Cameron, R. Connolly, K.A. Drees, W. Fischer, J. Gullotta, P. He, H.-C. Hseuh, H. Huang, R.C. Lee, V. Litvinenko, W.W. MacKay, C. Montag, T. Nicoletti, B. Oerter, F.C. Pilat, V. Ptitsyn, T. Roser, T. Satogata, L. Smart, L. Snydstrup, S. Tepikian, P. Thieberger, D. Trbojevic, J. Wei, K. Zeno (BNL)

Significant improvement has been achieved for reducing electron cloud and dynamic pressure rise at RHIC over several years; however, there remain to be factors limiting luminosity. The large scale application of non-evaporable getter (NEG) coating in RHIC has been proven effective in reducing electron multipacting and dynamic pressure rise. This will be reported together with the study of the saturated NEG coatings. Since beams with increased intensity and shorter bunch spacing became possible in operation, the electron cloud effects on beam, such as the emittance growth,are an increasing concern. Observations and studies are reported. We also report the study results relevant to the RHIC electron cloud and pressure rise improvement, such as the effect of anti-grazing ridges on electron cloud in warm sections, and the effect of pre-pumping in cryogenic regions.

MOPLS026

Monitoring of Interaction-point Parameters using the 3-dimensional Luminosity Distribution Measured at PEP-II

B.F. Viaud (Montreal University) W. Kozanecki (CEA) C. O'Grady, J.M. Thompson, M. Weaver (SLAC)

The 3-D luminosity distribution at the IP of the SLAC B-Factory is monitored using $e^+ e^-$ -> e^+ e-, mu+ mu- events reconstructed online in the BaBar detector. The transverse centroid and spatial orientation of the luminosity ellipsoid provide a reliable monitor of IP orbit drifts. The longitudinal centroid is sensitive to small variations in the average relative RF phase of the beams and provides a detailed measurement of the phase transient along the bunch train. Relative variations in horizontal luminous size are detectable at the micron level. The longitudinal luminosity distribution depends on the e± overlap bunch length and the vertical IP beta-function beta*y. In addition to continuous online monitoring of all the IP parameters above, we performed detailed studies of their variation along the bunch train to investigate a temporary luminosity degradation. We also used controlled variations in RF voltage and beam current to extract separate measurements of the e^+ and e^- bunch lengths. The time-history of the beta*y measurements, collected over a year of routine high-luminosity operation, are compared with HER & LER phase-advance data periodically recorded in single-bunch mode.

MOPLS027

Beam-beam Simulations for a Single Pass SuperB-factory

M.E. Biagini (INFN/LNF) P. Raimondi, J. Seeman (SLAC) D. Schulte (CERN)

A study of beam-beam collisions for an asymmetric single pass SuperB-Factory is presented*. In this scheme an electron and a positron beam are first stored and damped in two damping rings, then extracted, compressed and focused to the IP. After collision the two beams are re-injected in the DR to be damped and extracted for collision again. The explored beam parameters are similar to those used in the design of the International Linear Collider, except for the beam energies. Very flat beams and round beams were compared in the simulations, with the GuineaPig code**, in order to optimize both luminosity performances and beam blow-up after collision. With such approach, luminosities of the order of 10^{36} /(cm^2 sec) can be achieved. *http://arxiv.org/abs/physics/0512235.**D. Schulte. "Study of electromagnetic and hadronic background in the Interaction Region of the TESLA Collider", PhD Thesis, Hamburg, 1996.

DAFNE Status Report

MOPLS028

A. Gallo, D. Alesini, M.E. Biagini, C. Biscari, R. Boni, M. Boscolo, B. Buonomo, A. Clozza, G.O. Delle Monache, E. Di Pasquale, G. Di Pirro, A. Drago, A. Ghigo, S. Guiducci, M. Incurvati, P. Iorio, C. Ligi, F. Marcellini, C. Marchetti, G. Mazzitelli, C. Milardi, L. Pellegrino, M.A. Preger, L. Quintieri, R. Ricci, U. Rotundo, C. Sanelli, M. Serio, F. Sgamma, B. Spataro, A. Stecchi, A. Stella, S. Tomassini, C. Vaccarezza, M. Vescovi, M. Zobov (INFN/LNF) G. Benedetti (CELLS) L. Falbo (INFN-Pisa) J.D. Fox, P. Raimondi, D. Teytelman (SLAC) E. Levichev, S.A. Nikitin, P.A. Piminov, D.N. Shatilov (BINP SB RAS)

The operation of DAFNE, the 1.02 GeV c.m. e^+e^- collider of the Frascati National Laboratory with the KLOE detector, started in April 2004 has been concluded at the end of March 2006 with a total delivered luminosity of 2 fb-1 on the peak of the Phi resonance, 0.2 fb-1 off peak and a high statistics scan of the resonance. The best performances of the collider during this run have been a peak luminosity of 1.5 1032 cm-2s-1 and a daily delivered luminosity of 10 pb-1. The KLOE detector has been removed from one of the two interaction regions and its low beta section substituted with a standard magnetic structure, allowing for an easy vertical separation of the beams, while the FINUDA detector has been moved onto the second interaction point. Several improvements on the rings have also been implemented and are described together with the results of machine studies aimed at improving the collider efficiency and testing new operating conditions.

Preliminary Study of a Crab Crossing System for DAFNE

MOPLS029

A. Gallo, D. Alesini, F. Marcellini, P. Raimondi, M. Zobov (INFN/LNF)

The implementation of a crab crossing scheme at the Frascati Phi-factory DAFNE is under consideration, together with several other ideas and upgrades to increase the collider luminosity. The crab crossing is beneficial to the luminosity because it is expected to optimize the geometrical superposition of the colliding bunches and to weaken the synchro-betatron beam-beam resonances. The basic specifications of such a system, the expected luminosity increase, a preliminary design of the crab cavities and the architecture of the dedicated RF system are presented.

Recent Progress of KEKB

MOPLS030

Y. Funakoshi (KEK)

We summarize the machine operation of KEKB during the past one year, focusing on progress for this period.

Beam Orbit Control System for the KEKB Crab Cavities

MOPLS031

M. Masuzawa, Y. Funakoshi, T.T. Nakamura, J.-I. Odagiri (KEK)

KEKB is an electron-positron collider with an 8 GeV electron ring (HER) and a 3.5 GeV positron ring (LER). The two beams currently collide at one interaction point with a finite horizontal crossing angle of 11 mrad. The design luminosity of 10 /nb/sec was first reached in May 2003 and the peak luminosity exceeded 16 /nb/sec in December 2005. Simulations predict a luminosity boost if a crab crossing scheme is introduced. The installation of two superconducting crab cavities, one in each ring, is scheduled in March 2006 in order to implement the crab crossing scheme. For stable operation, the horizontal beam position in the crab cavity must be carefully controlled. This is needed to avoid loss of control of the crabbing mode field due to beam loading. A beam position feedback system at the crab cavity has been prepared and tested. Its performance will be discussed in this report.

MOPLS032

Beam-beam Limit and the Degree of Freedom

K. Ohmi, K. Oide (KEK) E. Perevedentsev (BINP SB RAS)

Beam-beam limit is caused by chaotic diffusion due to the strong nonlinear force of beam-beam interaction. Degree of freedom in the colliding system is essential for the diffusion. We discuss the diffusion using several models.

MOPLS033

Beam-beam Limit and Feedback Noise

K. Ohmi, Y. Funakoshi, S. Hiramatsu, K. Oide, M. Tobiyama (KEK)

Beam-beam interaction is strongly nonlinear, therefore particles in the beam experience chaotic motion. A small noise can be enhanced by the chaotic nature, with the result that unexpected emittance growth can be observed. We study the noise of transverse bunch by bunch feedback system and related luminosity degradation. Similar effects caused by crab cavity noise is also discussed.

MOPLS037

Beams Injection System for e^+e^- Collider VEPP-2000

D.E. Berkaev, V.V. Druzhinin, I. Koop, A.P. Lysenko, F.V. Podgorny, V.P. Prosvetov, P.Yu. Shatunov, Y.M. Shatunov, D.B. Shwartz (BINP SB RAS)

Electron-positron collider VEPP-2000 is under commissioning at the Budker Institute of Nuclear Physics. The paper presents the injection system of the collider delivering the beam from the booster storage ring BEP with maximum energy 900 MeV. A matching of the beam injection with the storage ring optics is done with respect to a nonlinear kicker field. Features of beam diagnostic and transfer line magnets including pulse septums (100 mksec; 30 kGs) and fast kickers (20 nsec; 70 kV) are described. Results of the magnetic measurements and their comparison to calculated data are given.

MOPLS038

Beam Energy Calibration in Experiment on Precise Tau Lepton Mass Measurement at VEPP-4M with KEDR Detector

A. Bogomyagkov, V.E. Blinov, S. Karnaev, V. Kiselev, E.V. Kremyanskaya, E. Levichev, O.I. Meshkov, S.I. Mishnev, I. Morozov, N.Yu. Muchnoi, S.A. Nikitin, I.B. Nikolaev, A.G. Shamov, D.N. Shatilov, E.A. Simonov, A.N. Skrinsky, V.V. Smaluk, Yu.A. Tikhonov, G.M. Tumaikin, V.N. Zhilich (BINP SB RAS)

Experiment on mass measurement of tau lepton requires an absolute energy calibration. The resonant depolarization technique is used for most accurate (1 keV) but once at a time energy calibration. The measured energy is used for calibration of the germanium detector for Compton backscattering energy

monitoring. The developed Compton backscattering facility allows continuous energy monitoring with accuracy of 50 keV for 10 minutes of data acquisition. The tau lepton threshold is in the vicinity of integer spin resonance, which minimizes polarization lifetime in the presence of vertical orbit distortions. Therefore, spin matching of the VEPP-4M is required. The achieved lifetime is sufficient for absolute energy calibration.

Magnet Structure of the VEPP-2000 Electron-positron Collider

MOPLS040

P.Yu. Shatunov, D.E. Berkaev, A.A. Borisov, I. Koop, N.A. Mezentsev, E. Perevedentsev, Y.M. Shatunov, D.B. Shwartz (BINP SB RAS) A. Valishev (Fermilab)

Electron-positron collider VEPP-2000 with beam energy up to 1 GeV is under commissioning at Budker Institute. This paper presents magnetic elements of the storage ring including 13T focusing superconducting solenoids in interaction regions. Features of magnet elements design and magnetic measurements results are given together with comparison to previously calculated data.

MAD-X/PTC Lattice Design for DAFNE at Frascati

MOPLS041

F. Schmidt (CERN) E. Forest (KEK) C. Milardi (INFN/LNF)

In absence of a program that takes as an input the desired or known location of the magnets in the tunnel, accelerator designers have been using MAD8/X that looks at a ring as a sequence of magnets without a connection to the tunnel. In many simple examples that is just fine, but once more complicated structures are treated one is bound to play tricks with MAD. Here PTC comes to the rescue. It is shown how pieces of this machine that exist in MAD-X format are used in PTC to create this double ring, as found in the tunnel, with a proper survey in the forward and backward direction. Special elements have been implemented in MAD-X to allow the full PTC description of the machine. It is discussed how this real PTC model differs from the 'fake' MAD-X model and how well PTC describes the real machine.

Longitudinal Beam Stability for CESR-c

MOPLS042

R. Holtzapple, J.S. Kern, P.J.S. Stonaha (Alfred University) B. Cerio (Colgate University) M.A. Palmer (Cornell University, Laboratory for Elementary-Particle Physics)

The Cornell Electron-Positron Storage Ring (CESR) operates at 1.9 GeV per beam for high energy physics collisions. To maintain high luminosity it is essential for the bunch trains to be longitudinally stable. Measurements of longitudinal stability with a single, multiple, and colliding trains have been performed using a dual sweep streak camera and are presented in this paper.

MOPLS043

Studies of the Beam-beam Interaction at CESR

J.A. Crittenden (Cornell University, Department of Physics) M.G. Billing (CESR-LEPP)

The Cornell Electron Storage Ring facility operates 2-GeV multi-bunch electron and positron beams in a single beam-pipe. Electrostatic separators are used to separate the two counter-rotating beams at the parasitic crossings. When the beam energy was lowered from 5 GeV in 2003, the strength of the beam-beam interaction became a more important factor in beam-current limitations, resulting in extensive experimental and calculational studies of their characteristics. The CESR lattice design procedure has been modified recently to account explicitly for their dynamic consequences. We describe our modelling of the beam-beam interaction, experimental validation techniques, and investigations into compensation strategies.

MOPLS044

Luminosity Variations along Bunch Trains in PEP-II

F.-J. Decker, M. Boyes, W.S. Colocho, A. Novokhatski, M.K. Sullivan, J.L. Turner, S.P. Weathersby, U. Wienands, G. Yocky (SLAC)

In spring of 2005 after a long shut-down, the luminosity of the B-Factory PEP-II decreased along the bunch trains by about 25-30%. There were many reasons studied which could have caused this performance degradation, like a bigger phase transient due to an additional RF station in the Low-Energy-Ring (LER), bad initial vacuum, electron cloud, chromaticity, steering, dispersion in cavities, beam optics, etc. The initial specific luminosity of 4.2 sloped down to 3.2 and even 2.8 for a long train (typical: 130 of 144), later in the run with higher currents and shorter trains (65 of 72) the numbers were more like 3.2 down to 2.6. Finally after steering the interaction region for an unrelated reason (overheated BPM buttons) and the consequential lower luminosity for two weeks, the luminosity slope problem was mysteriously gone. Several parameters got changed and there is still some discussion about which one finally fixed the problem. Among others, likely candidates are: the LER betatron function in x at the interaction point got reduced, making the LER x stronger, dispersion reduction in the cavities, and finding and fixing a partially shorted magnet.

MOPLS045

Achieving a Luminosity of 10^{34}/cm^2/s in the PEP-II B-factory

J. Seeman, J. Browne, Y. Cai, W.S. Colocho, F.-J. Decker, M.H. Donald, S. Ecklund, R.A. Erickson, A.S. Fisher, J.D. Fox, S.A. Heifets, R.H. Iverson, A. Kulikov, A. Novokhatski, V. Pacak, M.T.F. Pivi, C.H. Rivetta, M.C. Ross, P. Schuh, K.G. Sonnad, M. Stanek, M.K. Sullivan, P. Tenenbaum, D. Teytelman, J.L. Turner, D. Van Winkle, M. Weaver, U. Wienands, W. Wittmer, M. Woodley, Y.T. Yan, G. Yocky (SLAC) M.E. Biagini (INFN/LNF) W. Kozanecki (CEA)

For the PEP-II Operation Staff: PEP-II is an asymmetric e^+e^- collider operating at the Upsilon 4S and has recently set several performance records. The luminosity has exceeded 1x10^{34}/cm^2/s and has delivered an integrated luminosity of 728/pb in one day. PEP-II operates in continuous injection mode for both beams, boosting the integrated luminosity. The peak positron current has reached 2.94 A and 1.74 A of electrons in 1732 bunches. The total integrated luminosity since turn on in 1999 has reached over 333/fb. This paper reviews the present performance issues of PEP-II and also the planned increase of luminosity in the near future to over 2 x 10^{34}/cm^2/s. Upgrade details and plans are discussed.

Design of an Asymmetric Super-B Factory

MOPLS047

J. Seeman, Y. Cai, A. Novokhatski, A. Seryi, M.K. Sullivan, U. Wienands (SLAC) M.E. Biagini, P. Raimondi (INFN/LNF)

Submitted for the High Luminosity Study Group for an Asymmetric Single-pass Super-B Factory: Parameters are being studied for a high luminosity e^+e^- collider operating at the Upsilon 4S that would deliver a luminosity of over $10^{36}/cm^2/s$. This collider would use a novel combination of linear collider and storage ring techniques. In this scheme an electron beam and a positron beam are first stored in fast-damping and low-emittance damping rings, then extracted, accelerated, compressed and focused to the interaction point. After collision the two beams are decelerated and re-injected in the damping rings to be damped and extracted for collision again. The explored beam parameters are similar to those used in the design of the International Linear Collider, except for the beam energies. Design parameters for very flat beams and round beams have been studied.

Doubling the PEP-II Luminosity in Simulations

MOPLS048

Y. Cai, J. Seeman, K.G. Sonnad, U. Wienands (SLAC)

The PEP-II luminosity reached $1x10^{34}$cm-2s-1 in October 2005. The question of how to increase the luminosity using modest improvements in the PEP-II accelerator in the coming years is the subject of this paper. We found that the parasitic collisions significantly degrade the simulated luminosity as the beam currents are increased from 3A and 1.7A to 4A and 2.2A in the low and high energy rings, respectively. Using the beam-beam code BBI, we systematically optimized the luminosity and showed that a luminosity of over $2x10^{34}$cm-2s-1 is achievable within the limits of machine parameters.

Anomalous High Radiation Beam Aborts in the PEP-II B-factory

MOPLS049

M.K. Sullivan, Y. Cai, S. DeBarger, F.-J. Decker, S. Ecklund, A.S. Fisher, S.M. Gierman, S.A. Heifets, R.H. Iverson, A. Kulikov, N. Kurita, S.J. Metcalfe, A. Novokhatski, J. Seeman, K.G. Sonnad, D. Teytelman, J.L. Turner, U. Wienands, D. Wright, Y.T. Yan, G. Yocky (SLAC)

The PEP-II B-factory at SLAC has recently experienced unexpected beam losses due to anomalously high radiation levels at the BaBar detector. The problem was finally traced to the occurrence of very high pressure (>100 nTorr) spikes that have a very short duration (few seconds). We describe the events and show analysis predicting where in the vacuum system the events originated and describe what was discovered in the vacuum system.

Combined Phase Space Characterization at the PEP-II IP using Single-beam and Luminous-region Measurements

MOPLS050

A.J. Bevan (Queen Mary University of London) Y. Cai, A.S. Fisher, C. O'Grady, J.M. Thompson, M. Weaver (SLAC) W. Kozanecki (CEA) B.F. Viaud (Montreal University)

We present a novel method to characterize the e ± phase space at the IP of the SLAC B-factory, that combines single-beam measurements with a detailed mapping of luminous-region observables. Transverse spot sizes are determined in the two rings with synchrotron-light monitors & extrapolated to the IP using measured lattice functions. The 3-D luminosity distribution, as well as the spatial dependence of the transverse-boost distribution of the colliding beams, are measured using $e^+ e^-$ –> mu+ mu- events reconstructed in the BaBar tracking detectors; they provide information on the luminous spot size, the e^- angular divergence & the vertical emittance. The specific luminosity, which is proportional to the inverse product of the overlap IP beam sizes, is continuously monitored using Bhabha-scattering events. The combination of these measurements provide constraints on the horizontal & vertical spot sizes, angular divergences, emittances & beta functions of both beams at the IP during routine high-luminosity operation. Preliminary results of this combined-spot size analysis are confronted with measurements of IP beta-functions & overlap IP beam sizes at low beam current.

MOPLS051

Tracking Down a Fast Instability in the PEP-II LER

U. Wienands, R. Akre, S.C. Curry, S. DeBarger, F.-J. Decker, S. Ecklund, A.S. Fisher, S.A. Heifets, A. Krasnykh, A. Kulikov, A. Novokhatski, J. Seeman, M.K. Sullivan, D. Teytelman, D. Van Winkle, G. Yocky (SLAC)

During Run 5, the beam in the PEP-II Low Energy Ring (LER) became affected by a predominantly vertical instability with very fast growth rate of 10. . .60/ms - much faster than seen in controlled grow-damp experiments - and varying threshold. The coherent amplitude of the oscillation was limited to approx. 1 mm pk-pk or less and would damp down over a few tens of turns; however, beam loss set in even as the measured amplitude damped, causing a beam abort. This led to the conclusion that the beam was actually blowing up. The presence of a 2 nu_s line in the spectrum suggested a possible head-tail nature of the instability, although chromaticity was not effective in raising the threshold. In this paper we will describe the measurements and data taken to isolate and locate the cause of the instability and, eventually, the discovery and fix of the root cause.

MOPLS052

Luminosity Improvement at PEP-II Based on Optics Model and Beam-beam Simulation

Y. Cai, W.S. Colocho, F.-J. Decker, Y. Nosochkov, P. Raimondi, J. Seeman, K.G. Sonnad, M.K. Sullivan, J.L. Turner, M. Weaver, U. Wienands, W. Wittmer, M. Woodley, Y.T. Yan, G. Yocky (SLAC)

The model independent analysis (MIA) has been successfully used at PEP-II to understand machine optics and improve the luminosity. However, the rate of success was limited because the improvement of optics does not necessarily lead to increase of luminosity. Recently, we were able to reconstruct MIA model in a full optics code, LEGO, and used it to calculate complete lattice and beam parameters. These parameters were fed to the beam-beam code, BBI, to understand the luminosity histories at PEP-II over the past year. Using these tools, we optimized the luminosity by varying the beam parameters such as emittance. Finally, we implemented an optimized solution with a set of asymmetric horizontal orbit bumps into the machines during a delivery shift with a few percentage gain in luminosity. The solution was retained at PEP-II machines along with the luminosity. Later, these asymmetric bumps also played a vital role in reaching $1\text{x}10^{34}$cm-2s-1 as the beam currents increased.

Beta-beat Correction Using Strong Sextupole Bumps in PEP-II

G. Yocky (SLAC)

A method for correcting lattice beta mismatches has been developed for the PEP-II collider using orbit offsets in strong sextupoles. The solution is first predicted in the MAD program by modeling closed orbit bumps in the plane of correction at the sextupoles strongest in that plane. The derived solution is then tested in the machine to confirm the prediction and finally dialed into the machine under high-current conditions.

On Increasing the HERA Luminosity

Y.A. Kot, F.J. Willeke (DESY)

The luminosity of the HERA lepton proton collider is limited in part by the bunch length of the protons of 20cm. This limitation is expected to be removed by the installation of a new damper system which will control longitudinal coupled bunch instabilities of the proton beam and avoid the bunch lengthening of a factor of two. This opens the possibility for increasing the luminosity HERA since the beta functions at IP for both leptons and protons can be lowered by about 20% without noticeable reduction of the corresponding luminosity by the so-called hour-glass effect. The beam spot size can be further reduced if the beam-beam focusing of the leptons (dynamic beta) at IP is increased by softening the rigorous beam beam-beta beat compensation which is accomplished by proper phasing of the two IP's. Unfortunately the non-linear chromaticity compensation would be weakened as well, which will cause an enhancement of the synchro-betatron resonances and may lead to poor lifetime and poor background conditions. Therefore, the non-linear chromaticity needs to be reduced by means of a more complex scheme of chromaticity compensating sextupole magnets.

A Lepton-proton Collider with LHC

F.J. Willeke (DESY) J.B. Dainton (Cockcroft Institute) M. Klein (DESY Zeuthen) P. Newman (Birmingham University) E. Perez (CEA)

The physics, and a design, of a Large Hadron Electron Collider (LHeC) are sketched. With high luminosity, 10^{33}cm-2s-1, and high energy, ?s = 1.4TeV, such a collider can be built in which a 70GeV electron (positron) beam in the LHC tunnel is in collision with one of the LHC hadron beams and which operates simultaneously with the LHC. The LHeC makes possible deep-inelastic lepton-hadron (ep, eD and eA) scattering for momentum transfers Q2 beyond 106GeV2 and for Bjorken x down to the 10-6. New sensitivity to the existence of new states of matter, primarily in the lepton-quark sector and in dense partonic systems, is achieved. The precision possible with an electron-hadron experiment brings in addition crucial accuracy in the determination of hadron structure, as described in Quantum Chromodynamics, and of parton dynamics at the TeV energy scale. The LHeC thus complements the proton-proton and ion programmes, adds substantial new discovery potential to them, and is important for a full understanding of physics in the LHC energy range.
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MOPLS056

QCD Explorer Proposal: E-linac versus E-ring

H. Karadeniz (TAEK) S. Sultansoy (Gazi University, Faculty of Science and Arts)

TeV center of mass energy lepton-hadron collider is necessary both to clarify fundamental aspects of strong interactions and for adequate interpretation of the LHC data. Recently proposed QCD Explorer utilizes the energy advantage of the LHC proton and ion beams, which allows the usage of relatively low energy electron beam. Two options for the LHC based ep collider are possible: construction of a new electron ring in the LHC tunnel or construction of an e-linac tangentially to the LHC. In the latter case, which seems more acceptable for a number of reasons, two options are under consideration for electron linac: the CLIC technology allows shorter linac length, whereas TESLA technology gives higher luminosity.

MOPLS058

eRHIC - Future Machine for Experiments on Electron-ion Collisions

V. Ptitsyn, J. Beebe-Wang, I. Ben-Zvi, A.V. Fedotov, W. Fischer, W. Graves, V. Litvinenko, W.W. MacKay, C. Montag, S. Ozaki, T. Roser, S. Tepikian, D. Trbojevic (BNL) D.P. Barber (DESY) W.A. Franklin, R. Milner, B. Surrow, C. Tschalaer, E. Tsentalovich, D. Wang, F. Wang, A. Zolfaghari, T. Zwart, J. van der Laan (MIT) A.V. Otboev, Y.M. Shatunov (BINP SB RAS)

The paper presents recent developments for the design of the high luminosity electron-ion collider, eRHIC, proposed on the basis of the existing RHIC machine. The goal of eRHIC is to provide collisions of electrons and positrons on ions and protons in the center-of-mass energy range from 30 to 100 GeV. Lepton beams as well as the beam of protons (and, possibly, light ions) should be polarized. Two independent designs are under development, the so-called 'ring-ring' and 'linac-ring' options. The 'ring-ring' option is based on a 10 GeV electron storage ring. The design issues for the 'ring-ring' option are similar to those at existing B-factories. In the 'linac-ring' option, the electron beam is accelerated in a 10 GeV recirculating energy recovery linac. This option may provide higher luminosities ($> 1{\cdot}10^{33}$ cm-2s-1 for e-p collisions), but requires considerable R&D studies for a high current electron polarized source. In order to maximize the collider luminosity, ion ring upgrades, such as electron cooling and ion beam intensity increase, are considered.

MOPLS059

The Probe Beam Linac in CTF3

A. Mosnier, M. Authier, D. Bogard, A. Curtoni, O. Delferriere, G. Dispau, R. Duperrier, W. Farabolini, P. Girardot, M. Jablonka, J.L. Jannin, M. Luong, F. Peauger (CEA) N. Rouvière (IPN) R. Roux (LAL)

The test facility CTF3, presently under construction at CERN within an international collaboration, is aimed at demonstrating the key feasibility issues of the multi-TeV linear collider CLIC. The objective of the probe beam linac is to "mimic" the main beam of CLIC in order to measure precisely the performances of the 30 GHz CLIC accelerating structures. In order to meet the required parameters of this 200 MeV probe beam, in terms of emittance, energy spread and bunch-length, the most advanced techniques have been considered: laser triggered photo-injector, velocity bunching, beam-loading compensation, RF pulse compression . . . The final layout is described, and the selection criteria and the beam dynamics results are reviewed.

Design of an Interaction Region with Head-on Collisions for the ILC

MOPLS060

J. Payet, O. Napoly, C. Rippon, D. Uriot (CEA) M. Alabau Pons, P. Bambade, J. Brossard, X. Dadoun, C. Rimbault (LAL) D.A.-K. Angal-Kalinin, F. Jackson (CCLRC/DL/ASTeC) R. Appleby (UMAN) L. Keller, Y. Nosochkov, A. Seryi (SLAC)

An interaction region with head-on collisions is considered an alternative to the baseline configuration of the International Linear Collider, including two interaction regions with finite crossing-angles (2 and 20 mrad). Although more challenging from the point of view of the beam extraction, the head-on scheme is favoured by the experiments because it allows a more convenient detector configuration, particularly in the forward region. The optics of the head-on extraction is revisited by separating the e^+ and e^- beams horizontally, first by electrostatic separators operated at their LEP nominal field and then using a defocusing quadrupole of the final focus beam line. In this way the septum magnet is protected from the beamstrahlung power. Newly optimized final focus and extraction optics are presented, including a first look at post-collision diagnostics. The influence of parasitic collisions is shown to lead to a region of stable collision parameters. Beam and beamstrahlung photon losses are calculated along the extraction elements. Issues concerning the design of the large bore superconducting final focus magnets, common to both incoming and outgoing beams, are considered.

Optimization of the e-e$^-$ Option for the ILC

MOPLS061

M. Alabau Pons, M. Alabau Pons, A. Faus-Golfe (IFIC) R. Appleby (UMAN) P. Bambade, X. Dadoun (LAL)

The e-e$^-$ running mode is one of the interesting physics options for the International Linear Collider. The luminosity for e-e$^-$ collisions is reduced by mutual defocusing due to the strong electromagnetic fields that the bunches experience during collisions. The resulting beamstrahlung energy loss and beam-beam deflection angles as function of the vertical transverse offset are different compared to the e^+e^- collisions. In this paper, the dependence of these observables with the offset for different beam sizes has been analysed to optimize performances for the e-e$^-$ mode, taking into account the requirements of the beam-beam deflection based intra-train feedback system. A first study of the implications for the final focus and extraction line optics is also presented for the cases of the 2mrad and 20mrad ILC base line crossing angle geometries.

Accelerator Component Vibration Studies and Tools

MOPLS063

R. Amirikas, A. Bertolini, W. Bialowons (DESY)

This talk will cover a research program on accelerator component vibrations. Ground motion and technical noise, such as vacuum and refrigeration systems, couple to the beam, mainly via quadrupoles, making the design of their supports, especially, in the case of the superconducting magnets, critical. This program includes investigation of cold mass vibration of the superconducting quadrupoles inside an accelerating module and sensor performance in the main or fringe field of a linear collider detector. Seismometer accuracy limitations in correlated ground motion measurements are also being investigated.

MOPLS064

Measurement of Ground Motion in Various Sites

W. Bialowons, R. Amirikas, A. Bertolini, D. Kruecker (DESY)

This presentation will be an overview of a study program, initiated in DESY, to measure ground vibration of various sites which can be used for site characterization for the International Linear Collider (ILC) design. Commercial broadband seismometers have been used to measure ground motion, correlation and surface wave velocity. The database of measured ground vibrations is available to the scientific community. A parameterization of the spectra will also be presented.

MOPLS065

An ILC Main Linac Simulation Package Based on Merlin

N.J. Walker, D. Kruecker, F. Poirier (DESY)

The preservation of the ultra-small vertical emittance in the International Linear Collider (ILC) will require the use of beam-based alignment techniques, the expected performance of which relies heavily on the use of simulation tools. In this report, we present the newest release of a purpose-built ILC main linac simulation tool, based on the Merlin* C++ class library. Examples of results from Dispersion Free Steering (DFS) simulations are also be presented.
*http://www.desy.de/~merlin

MOPLS066

Direct Measurement of Geometric and Resistive Wakefields in Tapered Collimators for the International Linear Collider

N.K. Watson, D. Adey, M.C. Stockton (Birmingham University) D.A.-K. Angal-Kalinin, C.D. Beard, J.L. Fernandez-Hernando, F. Jackson (CCLRC/DL/ASTeC) R. Arnold, R.A. Erickson, C. Hast, T.W. Markiewicz, S. Molloy, M.C. Ross, S. Seletskiy, A. Seryi, Z. Szalata, P. Tenenbaum, M. Woodley, M. Woods (SLAC) R.J. Barlow, A. Bungau, R.M. Jones, G.Yu. Kourevlev, A. Mercer (UMAN) D.A. Burton, J.D.A. Smith, A. Sopczak, R. Tucker (Lancaster University) C. Densham, G. Ellwood, R.J.S. Greenhalgh, J. O'Dell (CCLRC/RAL) Y.K. Kolomensky (UCB) M. Kärkkäinen, W.F.O. Müller, T. Weiland (TEMF) N. Shales (Microwave Research Group, Lancaster University) M. Slater (University of Cambridge) I. Zagorodnov (DESY) F. Zimmermann (CERN)

Precise collimation of the beam halo is required in the ILC to prevent beam losses near the interaction region that could cause unacceptable backgrounds for the physics detector. The necessarily small apertures of the collimators lead to transverse wakefields that may result in beam deflections and increased emittance. A set of collimator wakefield measurements has previously been performed in the ASSET region of the SLAC LINAC. We report on the next phase of this programme, which is carried out at the recently commissioned End Station A test facility at SLAC. Measurements of resistive and geometric wakefields using tapered collimators are compared with model predictions from MAFIA and GdfidL and with analytic calculations.

Test Beam Studies at SLAC's End Station A, for the International Linear Collider

MOPLS067

M. Woods, C. Adolphsen, R. Arnold, G.B. Bowden, G.R. Bower, R.A. Erickson, H. Fieguth, J.C. Frisch, C. Hast, R.H. Iverson, Z. Li, T.W. Markiewicz, D.J. McCormick, S. Molloy, J. Nelson, M.T.F. Pivi, M.C. Ross, S. Seletskiy, A. Seryi, S. Smith, Z. Szalata, P. Tenenbaum (SLAC) D. Adey, M.C. Stockton, N.K. Watson (Birmingham University) M. Albrecht, M.H. Hildreth (Notre Dame University) W.W.M. Allison, V. Blackmore, P. Burrows, G.B. Christian, C.C. Clarke, G. Doucas, A.F. Hartin, B. Ottewell, C. Perry, C. Swinson, G.R. White (OXFORDphysics) D.A.-K. Angal-Kalinin, C.D. Beard, J.L. Fernandez-Hernando, F. Jackson, A. Kalinin (CCLRC/DL/ASTeC) R.J. Barlow, A. Bungau, G.Yu. Kourevlev, A. Mercer (UMAN) S.T. Boogert (Royal Holloway, University of London) D.A. Burton, J.D.A. Smith, R. Tucker (Lancaster University) W.E. Chickering, C.T. Hlaing, O.N. Khainovski, Y.K. Kolomensky, T. Orimoto (UCB) C. Densham, R.J.S. Greenhalgh (CCLRC/DL) V. Duginov, S.A. Kostromin, N.A. Morozov (JINR) G. Ellwood, P.G. Huggard, J. O'Dell (CCLRC/RAL) F. Gournaris, A. Lyapin, B. Maiheu, S. Malton, D.J. Miller, M.W. Wing (UCL) M.B. Johnston (University of Oxford, Clarendon Laboratory) M.F. Kimmitt (University of Essex, Physics Centre) H.J. Schriber, M. Viti (DESY Zeuthen) N. Shales, A. Sopczak (Microwave Research Group, Lancaster University) N. Sinev, E.T. Torrence (University of Oregon) M. Slater, M.T. Thomson, D.R. Ward (University of Cambridge) Y. Sugimoto (KEK) S. Walston (LLNL) T. Weiland (TEMF) M. Wendt (Fermilab) I. Zagorodnov (DESY) F. Zimmermann (CERN)

The SLAC Linac can deliver to End Station A a high-energy test beam with similar beam parameters as for the International Linear Collider for bunch charge, bunch length and bunch energy spread. ESA beam tests run parasitically with PEP-II with single damped bunches at 10Hz, beam energy of 28.5 GeV and bunch charge of (1.5-2.0)·1010 electrons. A 5-day commissioning run was performed in January 2006, followed by a 2-week run in April. We describe the beamline configuration and beam setup for these runs, and give an overview of the tests being carried out. These tests include studies of collimator wakefields, prototype energy spectrometers, prototype beam position monitors for the ILC Linac, and characterization of beam-induced electro-magnetic interference along the ESA beamline.

Beam Impact of the ILC Collimators

MOPLS068

G. Ellwood, R.J.S. Greenhalgh (CCLRC/RAL)

Spoilers in the ILC Beam Delivery System are required to survive a minimum of 1-2 direct impacts from each energetic electron or positron bunch of charged particles without failure, in addition to maintaining low geometric and resistive wall wakefields. The transient shock wave resulting from rapid localised beam heating and its implications for spoiler design are studied using ANSYS. The realistic patterns of energy deposition are taken from FLUKA.The results presented quantify uncertainties in the predictions and consider possible options for spoiler jaws for the ILC.

MOPLS069

Development of a Superconducting Helical Undulator for the ILC Positron Source

Y. Ivanyushenkov, E. Baynham, T.W. Bradshaw, A.J. Brummitt, F.S. Carr, J. Rochford (CCLRC/RAL) I.R. Bailey, D.P. Barber, J.A. Clarke, J.B. Dainton, O.B. Malyshev, D.J. Scott, B.J.A. Shepherd (Cockcroft Institute) P. Cooke, L.I. Malysheva (Liverpool University, Science Faculty) G.A. Moortgat-Pick (CERN)

An undulator positron source has been recently selected by the International Linear Collider (ILC) community as a baseline. For the ILC a helical undulator capable of producing 10 MeV photons and with a period as close as possible to 10 mm is required. The HeliCal collaboration in the UK is looking at the merits of both permanent magnet and superconducting technologies for the design of a helical undulator. For the superconducting option, several prototypes have been built and tested. This paper details the design, construction and test results of the first superconducting prototypes.

MOPLS070

Numerical Calculations of Collimator Insertions

C.D. Beard (CCLRC/DL/ASTeC) J.D.A. Smith (Cockcroft Institute)

A series of collimator spoilers have been designed and manufactured for testing in the ESA wakefield tests. The purpose of the tests is a benchmarking exercise to assist with the understanding into the causes of wakefields due to spoiler profile and materials. Simulations of the spoiler designs have been used to understand the likely effects that would be observed with the beam tests. Simulations of these collimator insertions have been carried out in MAFIA and GDFIDL, and a comparison of the results completed. The wake potential has been measured, and the corresponding loss factor and kick factors have been calculated. The results from the simulations are discussed in this report.

MOPLS071

TDR Measurements in support of ILC Collimator Studies

C.D. Beard, P.A. Corlett, A.J. Moss, J.H.P. Rogers (CCLRC/DL/ASTeC) R.M. Jones (Cockcroft Institute)

In this report the outcome of the "wire method" cold test, experimental results and their relevance toward the ILC set-up is considered. A wire is stretched through the centre of a vessel along the axis that the electron beam would take, and a voltage pulse representing the electron bunch is passed along the wire. The parasitic mode loss parameter from this voltage can then be measured. The bunch length for the ILC is 0.3mm, requiring a pulse rise time of ~1ps. The fastest rise time available for a time domain reflectrometry (TDR) scope is ~10ps. Reference vessels have been examined to evaluate the suitability of the test gear at comparable bunch structures to the ILC.

Status of the HeLiCal Contribution to the Polarised Positron Source for the International Linear Collider

MOPLS072

J.A. Clarke, O.B. Malyshev, D.J. Scott (CCLRC/DL/ASTeC) I.R. Bailey, P. Cooke, J.B. Dainton, L.I. Malysheva (Liverpool University, Science Faculty) D.P. Barber (DESY) E. Baynham, T.W. Bradshaw, A.J. Brummitt, F.S. Carr, Y. Ivanyushenkov, J. Rochford (CCLRC/RAL) G.A. Moortgat-Pick (Durham University)

The baseline positron source for the International Linear Collider is a helical undulator-based design, which can generate unprecedented quantities of polarised positrons. A major thrust of the global design in this area is led by the UK-based HeLiCal collaboration. The collaboration takes responsibility for the design and prototyping of the helical undulator itself, which is a highly demanding short period device with very small aperture, and also leads the start to end simulations of the polarised particles to ensure that the high polarisation levels generated are maintained from the source, right through the beam transport systems and up to the interaction point itself. This paper will provide an update on the work of the collaboration, focusing on these two topic areas, and will also discuss future plans.

Shower Simulations, Comparison of Fluka, Geant4 and EGS4

MOPLS073

L. Fernandez-Hernando (CCLRC/DL/ASTeC) R.J. Barlow (UMAN) A. Bungau (Cockcroft Institute) L. Keller (SLAC) N.K. Watson (CCLRC/RAL/ASTeC)

Computer simulations with different packages (Fluka, Geant4 and EGS4) were run in order to determine the energy deposition of an ILC bunch in a spoiler of specified geometry at various depths. The uncertainty in these predictions is estimated by comparison of their results. Various candidate spoiler designs (geometry, material) are studied. These shower simulations can be used as inputs to thermal and mechanical studies using programs such as ANSYS.

Collimation Optimisation in the Beam Delivery System of the International Linear Collider

MOPLS074

F. Jackson (CCLRC/DL/ASTeC)

The collimation systems of the International Linear Collider (ILC) beam delivery system (BDS) must perform efficient removal of halo particles which lie outside the acceptable ranges of energy and spatial spread. An optimisation strategy is developed to improve the performance of the BDS collimation system. Primary considerations are the phase relationships between collimation systems and the final focus, and the overall bandwidth of the system.

Progress towards Crab Cavity Solutions for the ILC

MOPLS075

G. Burt, A.C. Dexter (Cockcroft Institute) C.D. Beard, P. Goudket (CCLRC/DL/ASTeC) L. Bellantoni (Fermilab)

In order to achieve acceptable luminosity for ILC crossing angles greater than a few mrad, RF deflection cavities must be used to rotate electron and position bunches leading up to the IP. A bunch that passes through a deflection cavity at a phase where the deflection averages to zero receives a crab

kick leading to a finite rotation at the IP. For a beam energy of 500GeV and a crossing angle of 20mrad, the required crab kick is about 19.5MV at 1.3GHz and 6.5MV at 3.9GHz. Cavities are needed on both beams and are likely to be positioned about 12m before the IP. Any RF phase error between the bunch and the cavity leads to a deflection of the bunch in addition to a rotation of the bunch. Any differential phase error between the cavities leads to differing deflections and consequential loss in luminosity. Collaborative work with FNAL, being undertaken to develop a variant of their 3.9GHz CKM cavity optimised for an ILC solution, is described. Current analysis favours a solution with four nine-cell cavities on each beam. It is anticipated that the cavities will be run CW and driven from small Klystron/s (< 5kW) or solid state amplifiers.*

*We would like to thank Chris Adolphsen, SLAC, for his help in technical discussions, which were greatly appreciated.

MOPLS076

The Stimulated Breit-Wheeler Process as a Source of Background e^+e^- Pairs at the ILC

A.F. Hartin, A.F. Hartin (OXFORDphysics)

Passage of beamstrahlung photons through the bunch fields at the interaction point of the ILC determines background pair production. The number of background pairs per bunch crossing due to the Breit-Wheeler, Bethe-Heitler and Landau-Lifshitz processes is well known. However the Breit-Wheeler process also takes place in and is modified by the bunch fields. A full QED calculation of this Stimulated Breit-Wheeler process reveals cross section resonances due to the virtual particle reaching the mass shell. The one loop Electron Self energy in the bunch field is also calculated and included as a radiative correction. The bunch field is considered to be a contant crossed electromagnetic field with associated bunch field photons. Resonance is found to occur whenever the energy of contributed bunch field photons is equal to the beamstrahlung photon energy. The Stimulated Breit-Wheeler cross section exceeds the ordinary Breit-Wheeler cross section by several orders of magnitude and a significantly different pair background may result.

MOPLS077

The 2mrad Crossing Angle Interaction Region and Extraction Line

R. Appleby (UMAN) D.A.-K. Angal-Kalinin (CCLRC/DL/ASTeC) P. Bambade, X. Dadoun (LAL) J. Carter (Royal Holloway, University of London) L. Keller, K. C. Moffeit, Y. Nosochkov, A. Seryi, C.M. Spencer (SLAC) O. Napoly (CEA) B. Parker (BNL)

A complete optics design for the 2mrad crossing angle interaction region and extraction line was presented at Snowmass 2005. Since this time, the design task force has been working on developing and improving the performance of the extraction line. The work has focused on optimising the final doublet parameters and on reducing the power losses resulting from the disrupted beam transport. In this paper, the most recent status of the 2mrad layout and the corresponding performance are presented.

MOPLS078

Benchmarking of Tracking Codes (BDSIM/DIMAD) using the ILC Extraction Lines

R. Appleby (UMAN) P. Bambade, X. Dadoun (LAL) A. Ferrari (UU/ISV)

The study of beam transport is of central importance to the design and performance assessment of modern particle accelerators. In this work, we benchmark two contemporary codes - DIMAD and BDSIM, the latter being a relatively new tracking code and built within the framework of GEANT4. We consider both the 20mrad and 2mrad extraction lines of the International Linear Collider and perform disrupted beam tracking studies of heavily disrupted post-collision electron beams. We find that the two codes in most cases give an equivalent description of the beam transport.

The Charged Beam Dumps for the International Linear Collider

MOPLS079

R. Appleby (UMAN) J.R.J. Bennett, T.A. Broome (CCLRC/RAL/ASTeC) C. Densham (CCLRC/DL) H. Vincke (CERN)

The baseline configuration of the International Linear Collider requires 2 beam dumps per interaction region, each rated to 18MW of beam power, together with additional beam dumps for tuning purposes and machine protection. The baseline design uses high pressure moving water dumps, first developed for the SLC and used in the TESLA design, although a gas based dump is also being considered. In this paper we discuss the progress made by the international community on both physics and engineering studies for the beam dumps.

A Laser-wire System at the ATF Extraction Line

MOPLS080

S.T. Boogert, G.A. Blair, G.E. Boorman, A. Bosco, L. Deacon, C. Driouichi (Royal Holloway, University of London) A. Aryshev, H. Hayano, V. Karataev, K. Kubo, N. Terunuma, J. Urakawa (KEK) A. Brachmann, J.C. Frisch, M.C. Ross (SLAC) N. Delerue (JAI) S. Dixit, F.B. Foster, G.F. Gannaway, D.F. Howell, Q.M. Qureshi, A. Reichold, R. Senanayake (OXFORDphysics) L.J. Jenner (Cockcroft Institute) T. Kamps (BESSY GmbH)

A new laser-wire system has been installed at the ATF extraction line at KEK, Tsukuba. The system aims at a micron-scale laser spot size and employs a mode-locked laser system. The purpose-built interaction chamber, light delivery optics, and lens systems are described, and the first results are presented.

A Study of Laser System Requirements for Application in Beam Diagnostics and Polarimetry at the ILC

MOPLS081

S. Dixit, N. Delerue, K.J. Peach (JAI) G.A. Blair, S.T. Boogert, G.E. Boorman, A. Bosco, C. Driouichi (Royal Holloway, University of London) A. Brachmann, J.C. Frisch, M.C. Ross (SLAC) F.B. Foster, D.F. Howell, Q.G. Quelch, Q.M. Qureshi, A. Reichold (OXFORDphysics) G.J. Hirst, I. N. Ross (CCLRC/RAL) V. Soskov, V. Variola, Z.F. Zomer (LAL) J. Urakawa (KEK)

Advanced laser systems will be essential for a range of diagnostics devices at the ILC. High average power, excellent stability and reliability will be crucial in order to deliver the information required to attain the necessary ILC luminosity. The key parameters are listed together with the R&D required to achieve the necessary laser system performance.

MOPLS082

Simulation of the ILC Collimation System Using BDSIM, MARS15 and STRUCT

J. Carter, I.V. Agapov, G.A. Blair, L. Deacon (Royal Holloway, University of London) A.I. Drozhdin, N.V. Mokhov (Fermilab) Y. Nosochkov, A. Seryi (SLAC)

The simulation codes STRUCT, MARS15 and BDSIM are used to simulate in detail the collimation section of the ILC. A comparative study of the collimation system performance is performed, and the key radiation loads are calculated. Results for the latest ILC designs are presented together with their implications for future design iterations.

MOPLS083

Higher Order Mode Study of Superconducting Cavity for ILC Baseline

K. Watanabe (GUAS/AS) H. Hayano, E. Kako, S. Noguchi, T. Shishido (KEK)

The superconducting cavity of ILC baseline shape is being developed at KEK-STF (Superconducting RF Test Facility). The Higher Order Mode (HOM) of the cavity is one study item for the development. The purpose of the HOM study is further optimization of TTF HOM coupler and measurement of the HOM field distribution and the polarization of the main dipole modes. The result will be applied to HOM readings of beam induced signal for the purpose of cavity offset position and angle of axis measurement relative to the beam. We tried to improve of TESLA-type HOM coupler for more small size and relaxation of second stop-band. The cold-model coupler was made, and the RF characteristic was measured. After HOM couplers welded to the KEK Baseline nine-cell SC cavity, Qext of fundamental mode and each HOM, field pattern of each HOM and polarization of dipole modes were measured by the network analyzer. The results of the improved HOM coupler are presented.

MOPLS084

Experimental Comparison at KEK of High Gradient Performance of Different Single Cell Superconducting Cavity Designs

F. Furuta, Y. Higashi, T. Higo, I.H. Inoue, S. Kazakov, Y. Kobayashi, H. Matsumoto, Y. Morozumi, R.S. Orr, T. Saeki, K. Saito, K. Ueno, H. Yamaoka (KEK) J.S. Sekutowicz (DESY)

We have performed a series of vertical tests of three different designs of single cell Niobium superconducting cavities at 2 degrees Kelvin. These tests aimed at establishing that an accelerating gradient of 45 MV/m could be reached in any of the designs, while using the standard KEK surface preparation. The designs tested were the Cornell re-entrant shape (RE), the DESY/KEK low loss shape (LL), and the KEK ICHIRO series. The cavities underwent surface preparation consisting of centrifugal barrel polishing, light chemical polishing, electropolishing, and finally a high pressure water rinse. All three kinds of cavities were used in a series of vertical tests to investigate details of the surface treatment. When using ultra-pure water for the high pressure rinse, the LL cavity reproducibly exceeded a gradient of 45 MV/m, the RE design reproducibly reached a gradient of between 50 MV/m and 52 MV/m, and three of the six ICHIRO cavities reached a gradient of between 45 MV/m and 49 MV/m.

Experience with a Zero Impedance Vacuum Flange at He Super-Leak Temperature for the ILC

MOPLS085

H. Matsumoto, F. Furuta, I.H. Inoue, K. Saito, S.N. Sakamoto, K. Ueno (KEK)

Several tens of thousands of vacuum flanges will be used in the construction of the ILC. So the reliability and large scale reproducibility of these elements are important issue. To arrive at a standardized vacuum flange, a new design of a unisex flange has been developed. This important component has to serve in two roles at He-super-leak temperature; both as an rf seal and as a vacuum seal. We chose the unisex type with a 90-degree sharp edge forming the seal. The design is a modification of the DESY S-band rectangular waveguide flange. The variation in flatness between the flange and gasket along the inside wall is within 50 micrometer. This should present zero impedance for a bunched beam and for rf power. The He-super-leak performance was measured using the "build up method", i.e.the test was carried out for three hours at 2 degrees Kelvin. The measured He leak rate was below $1 \cdot 10^{-13}$ Atm*cc/sec for a test flange after three successive tests. We describe the design concept and the operational experience at various rf frequencies. These span the frequency range corresponding to warm and cold accelerators.

Series Test of High-gradient Single-cell Superconducting Cavity for the Establishment of KEK Recipe

MOPLS087

T. Saeki, F. Furuta, Y. Higashi, T. Higo, S. Kazakov, H. Matsumoto, Y. Morozumi, K. Saito, N. Toge, K. Ueno, H. Yamaoka (KEK) M.Q. Ge (IHEP Beijing) K. Kim (Kyungpook National University) R.S. Orr (University of Toronto)

We have performed a series of vertical tests of single cell Niobium superconducting cavities at 2 degrees Kelvin. These tests aimed at establishing the feasibility of reaching an accelerating gradient of 45 MV/m on a routine basis. The cavity profiles were all of the KEK low loss design and were fabricated from deep drawn Niobium half shells using electron beam welding. The cavity surface preparation followed an established KEK procedure of centrifugal barrel polishing, light chemical polishing, high temperature annealing, electropolishing, and finally a high pressure water rinse. Of the six cavities tested, three exceeded 45 MV/m on the first test. This clearly establishes the feasibility of this gradient. In this paper we describe these tests and our future program for optimising the surface preparation.

Resonant Kicker System for Head-on-collision Option of Linear Collider

MOPLS088

Y. Iwashita (Kyoto ICR)

The separation of incoming and outgoing (electron and positron) beams at the interaction point of a linear collider is investigated using a resonant kicker system. It should enable head-on-collisions at the interaction point with the use of staggered passing times for each bunch at certain locations. Magnetic core materials for such a resonant kicker with a frequency of 6MHz are under investigation. Such a kicker system should minimize the perturbation of the incoming bunch with a finite bunch length, while it kicks the outgoing bunch by more than 1 millirad. Various arrangements of such kickers along the beamlines are discussed.

MOPLS090

Design of a Strip-line Extraction Kicker for CTF3 Combiner Ring

I. Rodriguez, F. Toral (CIEMAT) L. García-Tabarés (CEDEX) A. Ghigo, F. Marcellini (INFN/LNF)

The new CLIC test facility (CTF3) is the latest stage to prove the technical feasibility of the CLIC project. An extraction kicker is necessary for the combiner ring, and it will be a strip-line type device due to lower coupling impedances and straightforward fabrication. The field uniformity together with a correct beam dynamics are the most challenging issues of this design. The main parameters of the kicker are analytically calculated using standard analytic formulae. The numeric modelling and simulation of several possible straight sections are reported, and the characteristic impedance is matched with the 50 Ω load. The field homogeneity, the kick angle and the scattering parameters are calculated in a 3D finite element model. Several manufacturing issues for the first prototype are also outlined.

MOPLS091

First Design of a Post Collision Line for CLIC at 3 TeV

V.G. Ziemann, T. J. C. Ekelof, A. Ferrari (UU/ISV) P. Eliasson (CERN)

As part of the Post collision diagnostic task of the ILPS work-package of EuroTeV we discuss a design of the beam line between the interaction point and the beam dump for CLIC with a center-of-mass energy of 3 TeV. The design is driven by the requirement to transport the beam and all secondaries such as beamstrahlung and coherent pairs to the beam dump with minimal losses. Moreover, we discuss the integration of novel diagnostic methods into the post collision beam line based on the detection of coherent pairs and monitoring the beam profile of the primary beam.

MOPLS092

Efficient Collimation and Machine Protection for the Compact Linear Collider

R.W. Assmann, F. Zimmermann (CERN)

We present a new approach to machine protection and collimation in CLIC, separating these two functions: If emergency dumps in the linac protect the downstream beam line against drive-beam failures, the energy collimation only needs to clean the beam tails and can be compact. Overall, the length of the beam delivery system is significantly reduced.

MOPLS093

Commissioning Status of the CTF3 Delay Loop

R. Corsini, S. Doebert, F. Tecker, P. Urschütz (CERN) D. Alesini, C. Biscari, B. Buonomo, A. Ghigo, F. Marcellini, B. Preger, M. Serio, A. Stella (INFN/LNF)

The CLIC Test Facility CTF3, built at CERN by an international collaboration, aims at demonstrating the feasibility of the CLIC scheme by 2010. In particular, one of the main goals is to study the generation of high-current electron pulses by interleaving bunch trains in delay lines and rings using transverse RF deflectors. This will be done in the 42 m long delay loop, built under the responsibility of INFN/LNF, and in the 84 m long combiner ring that will be installed in 2006. The delay loop installation was completed, and its commissioning started at the end of 2005. In this paper the commissioning results are presented, including the first tests of beam recombination.

Luminosity Tuning at the Interaction Point

MOPLS094

P. Eliasson, M. Korostelev, D. Schulte, R. Tomas, F. Zimmermann (CERN)

Minimisation of the emittance in a linear collider is not enough to achieve optimal performance. For optimisation of the luminosity, tuning of collision parameters such as angle, offset, waist, etc. is needed, and a fast and reliable tuning signal is required. In this paper tuning knobs are presented, and their optimisation using beamstrahlung as a tuning signal is studied.

Investigations of DC Breakdown Fields

MOPLS095

T. Ramsvik, S. Calatroni, A. Reginelli, M. Taborelli (CERN)

The need for high accelerating gradients for the future 30 GHz multi-TeV e^+e^- Compact Linear Collider (CLIC) at CERN has triggered a comprehensive study of DC breakdown fields of metals in UHV. The experimental setup is based on a capacitor discharge across a gap junction. The simple design and fully automated computer control enable breakdown fields and dark current of numerous materials to be measured. The study shows that Mo, W and Ti reach high breakdown fields, and are thus good candidates for the iris material of CLIC structures. For untreated Mo the breakdown field is higher than Cu but the conditioning speed is slower. Ti, on the other hand, shows acceptable conditioning speeds, but material erosion makes this solution problematic. Feasible solutions to increase the spark conditioning speed for the case of Mo are presented together with attempts to prevent Ti erosion. For some of the materials studied a significant reduction in the saturated breakdown field was observed upon gas exposure during intensive spark conditioning. As an example, a 50% decrease of the breakdown field of Mo is recorded when spark conditioning is carried out in an environment of 10^{-5} mbar air.

Effects of Wake Fields in the CLIC BDS

MOPLS096

G. Rumolo, A. Latina, D. Schulte (CERN)

The wake fields due to collimators in the Beam Delivery System of CLIC are modeled using a conventional approach. According to the chosen ranges of parameters, differences in the transverse kicks due to both the geometric and resistive wall components for different regimes are highlighted (inductive or diffractive for the geometric wake fields, short- or long-range, ac or dc for the resistive wall wake fields). A module for particle tracking along the BDS including the effect of wake fields has been introduced in PLACET, and the first tracking results are shown.

Progress on the CTF3 Test Beam Line

MOPLS097

D. Schulte, S. Doebert, G. Rumolo, I. Syratchev (CERN) D. Carrillo (CIEMAT)

In CLIC, the RF power to accelerate the main beam is produced by decelerating a drive beam. The test beamline (TBL) of the CLIC test facility (CTF3) is designed to study and validate the stability of the drive beam during deceleration. This is one of the R&D items required from the International Linear Collider Technical Review Committee to demonstrate feasibility of CLIC. It will produce 30 GHz rf power in the GW range and allow to benchmark computer codes used for the CLIC decelerator design. Different options of this experimental beam line are discussed.

MOPLS098

Study of an ILC Main Linac that Follows the Earth Curvature

D. Schulte, P. Eliasson, A. Latina (CERN) F. Poirier, N.J. Walker (DESY)

In the base line configuration, the tunnel of the ILC will follow the earth curvature. The emittance growth in a curved main linac has been studied, including static and dynamic imperfections. These include effects due to current ripples in the power supplies of the steering coils, the impact of the beam position monitor scale errors.

MOPLS099

A Study of Failure Modes in the ILC Main Linac

D. Schulte, P. Eliasson, A. Latina (CERN) Eckhard. Elsen, D. Kruecker, F. Poirier, N.J. Walker, G.X. Xia (DESY)

Failures in the ILC can lead to beam loss or even damage the machine. Also failures that do not lead to beam loss can affect the luminosity performance, in particular since some time is required to recover from them. In the paper a number of different failures is being investigated and the impact on the machine performance is being studied.

MOPLS100

CLIC Final Focus Studies

R. Tomas, H.-H. Braun, D. Schulte, F. Zimmermann (CERN)

The design of the CLIC final focus system is based on the local compensation scheme proposed by P. Raimondi and A. Seryi. However, there exist important chromatic aberrations that deteriorate the performance of the system. This paper studies the optimization of the final focus based on the computation of the high orders of these aberrations using MAD-X and PTC. The use of octupole doublets to reduce the size of the halo in the locations with aperture limitations is also discussed.

MOPLS101

Beam Dynamics and First Operation of the Sub-harmonic Bunching System in the CTF3 Injector

P. Urschütz, H.-H. Braun, G. Carron, R. Corsini, S. Doebert, T. Lefevre, G. McMonagle, J. Mourier, J.P.H. Sladen, F. Tecker, L. Thorndahl, C.P. Welsch (CERN)

The CLIC Test Facility CTF3, built at CERN by an international collaboration, aims at demonstrating the feasibility of the CLIC scheme by 2010. The CTF3 drive beam generation scheme relies on the use of a fast phase switch of a sub-harmonic bunching system in order to phase-code the bunches. The amount of charge in unwanted satellite bunches is an important quantity, which must be minimized. Beam dynamics simulations have been used to study the problem, showing the limitation of the present CTF3 design and the gain of potential upgrades. In this paper the results are discussed and compared with beam measurements taken during the first operation of the system.

Beam Dynamic Studies and Emittance Optimization in the CTF3 Linac at CERN

MOPLS102

P. Urschütz, H.-H. Braun, R. Corsini, S. Doebert, F. Tecker (CERN) A. Ferrari (UU/ISV)

Small transverse beam emittances and well-known lattice functions are crucial for the 30 GHz power production in the Power Extraction and Transfer Structure (PETS), and for the commissioning of the delay loop of the CLIC Test Facility 3 (CTF3). Following beam-dynamics-simulation results, two additional solenoids were installed in the CTF3 injector in order to improve the emittance. During the runs in 2005 and 2006, an intensive measurement campaign to determine Twiss parameters and beam sizes was launched. The results obtained by means of quadrupole scans for different modes of operation suggest rms emittances well below the nominal (100 pi mm mrad) and a convincing agreement with PARMELA simulations.

A High-gradient Test of a 30 GHz Molybdenum-iris Structure

MOPLS103

W. Wuensch, C. Achard, H.-H. Braun, G. Carron, R. Corsini, S. Doebert, R. Fandos, A. Grudiev, E. Jensen, T. Ramsvik, J.A. Rodriguez, J.P.H. Sladen, I. Syratchev, M. Taborelli, F. Tecker, P. Urschütz, I. Wilson (CERN) H. Aksakal (Ankara University, Faculty of Sciences) Ö.M. Mete (Ankara University, Faculty of Engineering)

The CLIC study is investigating a number of different materials as part of an effort to find ways to increase achievable accelerating gradient. So far, a series of rf tests have been made with a set of identical-geometry structures: a tungsten-iris 30 GHz structure, a molybdenum-iris 30 GHz structure and a scaled molybdenum-iris X-band structure. A second molybdenum-iris 30 GHz structure of the same geometry has now been tested in CTF3 with pulse lengths up to 350 ns. The new results are presented and compared to those of the previous structures to determine dependencies of quantities such as accelerating gradient, material, frequency, pulse length, power flow, conditioning rate and breakdown rate.

The Progress in Developing Superconducting Third Harmonic Cavity

MOPLS104

N. Solyak, H. Edwards, M. Foley, I.G. Gonin, E.R. Harms, T.K. Khabiboulline, D.V. Mitchell, D.O. Olis, A.M. Rowe (Fermilab)

XFEL and TTF facilities are planning to use section with a few third harmonic cavities (3.9GHz) upstream of the bunch compressor to improve beam performances [1-2]. Fermilab is developing superconducting third harmonic section for TTFII upgrade. This section will include four cavities equiped with couplers and blade tuners, installed in cryostat. Up to now, two cavities are complete and one of them is under test. The status of the cavity development and preliminary test results are presented in the paper.

Collimators for ILC

MOPLS105

A.A. Mikhailichenko (Cornell University, Department of Physics)

We considered two types of collimators for usage in undulator conversion system of ILC. In the first, the Pyrolytic graphite is used and it is installed in front of a target; the second one uses InGa alloy in rotating cylinder. The last one installed in front of undulator. Collimators allow absorption single train on bunches in ILC and enhace the photon polarization.

MOPLS106

Independent Operation of Electron/Positron Wings of ILC

A.A. Mikhailichenko (Cornell University, Department of Physics)

We represent a concept of fast feedback system allowing independent operation of electron-positron wings of ILC.

MOPLS107

Test of SC Undulator for ILC

A.A. Mikhailichenko (Cornell University, Department of Physics)

We represent details of design and results of test SC 40cm-long undulator having period 10mm and aperture ~8 mm allowing K=0.7. This undulator can be used in ILC positron conversion system.

MOPLS108

Liquid Metal Target for ILC

A.A. Mikhailichenko (Cornell University, Department of Physics)

We considered the Hg target for gamma/positron conversion suitable for usage in ILC project. Positron scheme generation with undulator allows usage thin Hg jet confined in profiled duct with rectangular cross-section.

MOPLS109

Operational Experience with Undulator for E-166

A.A. Mikhailichenko (Cornell University, Department of Physics)

We represent results of operation of 2.54 mm period, K=0.2, up to 30 Hz undulator used in E-166 experiment for polarized positron production. One peculiarity is in usage of Ferrofluid for cooling.

MOPLS110

ILC Linac R&D at SLAC

C. Adolphsen (SLAC)

Since the ITRP recommendation in 2004 to use superconducting rf technology for a next generation linear collider, the former NLC group at SLAC has been actively pursuing a broad range of R&D for this collider (the ILC). In this paper, we review the progress of those programs relating to linac technology. These include the development of a Marx-style modulator (120 kV, 120 A, 1.5 ms, 5 Hz) and a 10 MW sheet-beam klystron, construction of an L-band (1.3 GHz) rf source using a SNS HVCM modulator and commercial klystrons, fabrication and testing of a five-cell L-band cavity prototype for the ILC positron capture accelerator, high power tests of cavity coupler components, beam tests of prototype S-band linac beam position monitors and measurements of the magnetic center stability of an ILC prototype superconducting quadrupole magnet built by the CIEMAT group in Spain.

Commissioning of the ALTO 50 MeV Electron Linac

MOPLS113

J. Lesrel, J. Arianer, M. Arianer, O. Bajeat, J-M. Buhour, H. Bzyl, F. Carrey, M. Chabot, J.-L. Coacolo, T. Corbin, H. Croizet, J.-M. Curaudeau, F. Doizon, M. Ducourtieux, J.-M. Dufour, S. Essabaa, D. Grialou, C. Joly, M. Kaminski, H. Lefort, B. Lesellier, G. Magneney, L. Mottet, Y. Ollivier, C. Planat, M. Raynaud, Y. Richard, A. Said, A. Semsoum, F. Taquin, C. Vogel (IPN) G. Bienvenu, J-N. Cayla, M. Desmons (LAL)

The ALTO 50 MeV electron linac is dedicated to the production of neutron-rich radioactive nuclei using the photo-fission process and the optimisation of the target-ion source system for SPIRAL 2 and Eurisol projects. A description of the accelerator consisting in 3 Mev injector (old test station of LAL), LIL accelerating structure, RF power plant, beam line, control system and diagnostics will be given. Specified and measured beam parameters will be compared to show the performance for the photo-fission and eventually other applications.

Construction of the Probe Beam Photo-injector of CTF3

MOPLS114

J. Brossard, M. Desmons, B.M. Mercier, C.P. Prevost, R. Roux (LAL)

The paper describes the HF and dynamic beam modelling performed onto the 3 GHz / 2,5 cells photo-injector of the future CTF3 (CLIC Test Facility 3) probe beam linac, whose goal is to demonstrate the feasibility of the 30 GHz accelerating sections in the framework of the CLIC project. The Probe Beam Photo-Injector (PBPI) conception is inspired from the drive beam photo-injector already designed by LAL (Orsay, France) and actually tested in our laboratory. However, the design of PBPI has been simplified with respect to the previous because the charge per bunch is 4 times lower and the number of bunches several orders of magnitude smaller. The internal geometry and the coupling system of the PBPI have been designed with 2D (SUPERFISH) and 3D (HFSS, ANSYS) codes. A detailed analysis of the dissymmetry (induced by the coupling system) of the accelerating field component has been performed. Based on the modified design, PARMELA simulations showed that the technical specifications are fulfilled. The vacuum issue has been also carefully investigated, and NEG (Non Evaporated Getter) technology has been adopted in order to reach the 10^{-10} mbar pressure inside the structure.

A Spin Rotator for the ILC

MOPLS115

P.O. Schmid, N.J. Walker (DESY)

A spin rotator featuring an optic axis with straight vision is presented. This rotator utilizes three bends, two solenoid pairs and two correction devices. These correctors, named reflectors, are mandatory for removing the cross plane coupling introduced by the solenoids. It is shown how the solenoids have to be set up to achieve longitudinal IP polarization taking into account non-zero crossing angles at the interaction region and a linac following the curvature of the earth. Furthermore, the stability requirements for mechanical and electrical imperfections are analyzed.

MOPLS116

Status Report on the Harmonic Double-sided Microtron of MAMI C

A. Jankowiak, K. Aulenbacher, O. Chubarov, M. Dehn, H. Euteneuer, F.F. Fichtner, F. Hagenbuck, R.H. Herr, P. Jennewein, K.-H. Kaiser, W.K. Klag, H.J. Kreidel, U.L. Ludwig-Mertin, J.R. Röthgen, S.S. Schumann, G.S. Stephan, V. Tioukine (IKP)

The Mainz Mikrotron MAMI is a cascade of three racetrack microtrons, delivering since 1991 a high quality 855MeV, 100muA cw electron beam for nuclear and radiation physics experiments. An energy upgrade of this machine to 1.5GeV by adding a Harmonic Double-Sided Microtron (HDSM)* as a fourth stage is well under way. Here we give a review of the experiences gained during fabrication and testing of the main components of the HDSM and report the status of its construction. Initial operation of the machine is expected for the first half of 2006. After a period of commissioning in diagnostic pulse mode with low beam power (10ns, high intensity bunch trains with a repetition rate of max. 10kHz), soon the first nuclear physics experiments will be started.

*A. Jankowiak et al. "Design and Status of the 1.5 GeV-Harmonic Double Sided Microtron for MAMI", Proceedings EPAC2002, Paris, p. 1085.

MOPLS117

Tuning Algorithms for the ILC Beam Delivery System

J.K. Jones (CCLRC/DL/ASTeC)

Emittance preservation is an important aspect in the design and running of the International Linear Collider (ILC) with a direct consequence on the luminosity of the machine. The Beam Delivery System represents a major problem in this respect as it produces emittance dilution effects that are difficult to correct and that have a direct effect on the emittance as seen at the interaction point, and thus upon the luminosity of the machine. Tuning algorithms for this section of the machine rely on the correction of aberrations through the use of linear and higher order knobs, using corrections magnets distributed throughout the system. Alternative systems are also discussed. The design and implementation of these tuning algorithms, and their effectiveness in a variety of cases, are investigated and estimates made for tolerances on a variety of error sources. Simulations results are also presented for models of the ATF-2 accelerator under development at KEK, with comparisons made to the ILC design.

MOPLS118

Magnetic Modelling of a Short-period Superconducting Helical Undulator for the ILC Positron Source

J. Rochford, E. Baynham, T.W. Bradshaw, F.S. Carr (CCLRC/RAL/ASTeC) I.R. Bailey, L.I. Malysheva (Cockcroft Institute) D.P. Barber (DESY) A.J. Brummitt, Y. Ivanyushenkov (CCLRC/RAL) J.A. Clarke, O.B. Malyshev, D.J. Scott (CCLRC/DL/ASTeC) P. Cooke, J.B. Dainton (Liverpool University, Science Faculty) G.A. Moortgat-Pick (Durham University)

A positron source utilising undulators is now defined as the baseline option for the International Linear Collider (ILC). The ILC requires a short period undulator, as close to 10mm as possible, that is capable of producing 10 MeV photons. The HeliCal collaboration in the UK has undertaken a programme to design, develop and produce a prototype undulator. As part of the programme, the group has used the OPERA software package to perform the magnetic design of the undulator. The design has addressed several issues, including the effect of magnetic material for the undulator former, optimal winding geometry, the magnetic flux inside the superconductor and its variation with undulator period and the winding bore. This paper summarizes the results of both the 2d and the 3d magnetic simulations.

Mitigation of Emittance Dilution due to Transverse Mode Coupling in the L-band Linacs of the ILC

MOPLS120

R.M. Jones, R.M. Jones (UMAN) R.H. Miller (SLAC)

The main L-band linacs of the ILC accelerate 2820 bunches from a center of mass of 10 GeV to 500 GeV (and in the proposed later upgrade, to 1 TeV). The emittance of the vertical plane is approximately 400 times less than that of the horizontal plane. Provided the vertical and horizontal mode dipole frequencies are degenerate, then the motion in each plane is not coupled. However, in reality the degeneracy will more than likely be removed with the eigen modes lying in planes rotated from the x and y planes due to inevitable manufacturing errors introduced in fabricating 20,000 cavities. This gives rise to a transverse coupling in the horizontal-vertical motion and can readily lead to a dilution in the emittance in the vertical plane. We investigate means to ameliorate this emittance dilution by splitting the horizontal-vertical tune of the lattice.

The DAFNE Beam Test Facility: from 1 to 10 Milliards of Particles

MOPLS121

G. Mazzitelli, B. Buonomo, L. Quintieri (INFN/LNF) P. Valente (INFN-Roma)

The DAFNE Beam Test Facility is operating since 2002, providing electrons, positrons and photons from the single particle up to 1010 particleS per spill and from 20 to 750 MeV. During these years, the facility has hosted tens of high energy test and experiments coming from all Europe, operating in a wide spread of multiplicity and energy. Operation performance and parameters, tools and diagnostics, as well as the main results obtained, are presented.

Design of the ILC Prototype FONT4 Digital Intra-train Beam-based Feedback System

MOPLS122

P. Burrows (Queen Mary University of London) G.B. Christian, H. Dabiri Khah, A.F. Hartin, G.R. White (JAI) C.C. Clarke, C. Perry (OXFORDphysics) A. Kalinin (CCLRC/DL/ASTeC) D.J. McCormick, S. Molloy, M.C. Ross (SLAC)

We report on the design and initial testing of the 4th generation Feedback on Nanosecond Timescales (FONT) prototype intra-train beam-based feedback system for beam control and luminosity optimisation at the International Linear Collider (ILC). FONT4 comprises a fast-analogue front-end BPM signal processor, with an FPGA-based digital feedback processor and a fast-risetime kicker-driver amplifier. The system is being designed with a total latency budget (including signal propagation delays) of about 140ns. FONT4 will be deployed at the Accelerator Test Facility (ATF) at KEK, where it will be tested with the electron bunchtrain extracted from the ATF damping ring. The bunches will have a spacing of c. 150ns, chosen to match the ILC design. We report the results of initial beam tests of the system components. We aim to demonstrate feedback, with delay-loop operation, on this ILC-like bunchtrain.

MOPLS123

Performance of the FONT3 Fast Analogue Intra-train Beam-based Feedback System at ATF

P. Burrows (Queen Mary University of London) G.B. Christian, A.F. Hartin, H.D. Khah, G.R. White (JAI) C.C. Clarke, C. Perry (OXFORDphysics) A. Kalinin (CCLRC/DL/ASTeC) D.J. McCormick, S. Molloy, M.C. Ross (SLAC)

We report on the design and testing of the 3rd generation Feedback On Nanosecond Timescales (FONT) prototype intra-train beam-based feedback system for beam control and luminosity optimisation at the International Linear Collider (ILC). The all-analogue FONT3 electronics was designed to have an ultra-short latency of c. 10ns. We describe the design of the BPM signal processor, feedback circuit and kicker-driver amplifier. We report on deployment of FONT3 at the Accelerator Test Facility (ATF) at KEK, where it was tested with the 56ns-long electron bunchtrain extracted from the ATF damping ring. Feedback, with delay-loop operation, on the beam was demonstrated with a latency close to design. We comment on the applicability of this technology to ILC, as well as future warm-RF based linear colliders, such as CLIC.

MOPLS124

The KEK Injector Upgrade for the Fast Beam-Mode Switch

M. Satoh (KEK)

The KEK linac is a 600-m-long linear accelerator with maximum energy 8-GeV electron and 3.5-GeV positron, and it is used as an injector for 4-rings (KEKB e-/ e+, PF, PF-AR). To increase the operation efficiency, we have an injector upgrade plan for the quasi-simultaneous injection. In this paper, we will present the operation scheme and the construction of a new beam transport line in detail.

MOPLS128

Status of the Fatigue Studies of the CLIC Accelerating Structures

S.T. Heikkinen, S.T. Heikkinen (HUT) S. Calatroni, H. Neupert, W. Wuensch (CERN)

The need for high accelerating gradients for the future Compact Linear Collider imposes considerable constraints on the materials of the accelerating structures. The surfaces exposed to high pulsed RF currents are subjected to cyclic thermal stresses possibly resulting in surface break up by fatigue. Since no fatigue data exists in the literature up to very large numbers of cycles, a comprehensive study has been initiated. Low cycle fatigue data (up to 10^8 cycles) has been collected by means of a pulsed laser surface heating apparatus. The surface damage has been characterized by SEM observations and roughness measurements. High cycle fatigue data (up to 10^{11} cycles) at various stress ratios have been collected in high frequency bulk fatigue tests using an ultrasonic apparatus. It is found that the appearance of surface fatigue damage in the laser experiments, and of fatigue cracks in the bulk specimen, happen at similar stress levels for similar numbers of cycles. This allows the two experimental techniques to be connected and to predict the surface damage at a high number of cycles. Up-to-date fatigue data for selected high conductivity, high strength Cu alloys are presented.

Integration of the PHIN RF Gun into the CLIC Test Facility

MOPLS129

S. Doebert (CERN)

CERN is a collaborator within the European PHIN project, a joint research activity for Photo injectors within the CARE program. The scope of this project is to build an RF Gun equipped with high quantum efficiency Cs2Te cathodes and a laser to produce the nominal beam for the CLIC Test Facility (CTF3). The nominal beam for CTF3 has an average current of 3.5 A, 1.5 GHz bunch repetition frequency and a pulse length of 1.5 us (2310 bunches) with quite tight stability requirements. In addition a phase shift of 90 deg is needed after each train of 140 ns for the special CLIC combination scheme. This RF Gun will be tested at CERN in fall 2006 and should be integrated as a new injector into the CTF3 linac, replacing the existing injector consisting of a thermionic gun and a subharmonic bunching system. The paper studies the optimal integration into the machine trying to optimize transverse and longitudinal phase space of the beam while respecting the numerous constraints of the existing accelerator. The presented scheme uses emittance compensation and velocity bunching to fulfill the requirements.

Implications of a Curved Tunnel for the Main Linac of CLIC

MOPLS130

A. Latina, D. Schulte (CERN) P. Eliasson (Uppsala University)

Preliminary studies of a linac that follows the earth's curvature are presented for the CLIC main linac. The curvature of the tunnel is modeled in a realistic way by use of geometry changing elements. The emittance preservation is studied for a perfect machine as well as taking into account imperfections. Results for a curved linac are compared with those for a laser-straight machine.

Preliminary Studies of Ion Effects in ILC Damping Rings

MOPLS133

G.X. Xia, Eckhard. Elsen (DESY)

Ion effects are potentially detrimental to the performance of the damping rings for the International Linear Collider (ILC). In this paper, the ion effects in the damping rings of ILC are briefly reviewed. Fast beam-ion instability (FBII) is studied in the linear regime. The growth rates and the beam blowups due to FBII are analytically calculated and compared for two variants of the ILC damping ring designs (OCS and TESLA) and discussed as a function of the vacuum pressure. Finally, some detailed simulation results are also presented.

Minimizing Emittance for the CLIC Damping Ring

MOPLS134

H.-H. Braun, M. Korostelev, D. Schulte, F. Zimmermann (CERN)
E.B. Levitchev, P.A. Piminov, S.V. Sinyatkin, P. Vobly, K. Zolotarev (BINP SB RAS)

The CLIC damping rings aim at unprecedented small normalized equilibrium emittances of 3.3 nm vertical and 550 nm horizontal, for a bunch charge of 2.6 10^9 particles and an energy of 2.4 GeV. In this parameter regime the dominant emittance growth mechanism is intra-beam scattering. Intense synchrotron radiation damping from wigglers is required to counteract its effect. Here the overall optimization of the wiggler parameters is described, taking into account state-of-the-art wiggler technologies, wiggler effects on dynamic aperture, and problems of wiggler radiation absorption. Two technical solutions, one based on superconducting magnet technology and the other on permanent magnets, are presented. Although dynamic aperture and tolerances of this ring design remain challenging, benefits are obtained from the strong damping. Only bunches for a single machine pulse need to be stored, making injection/extraction particularly simple and limiting the synchrotron-radiation power. With a 360 m circumference, the ring remains comparatively small.

MOPLS135

Correction of Vertical Dispersion and Betatron Coupling for the CLIC Damping Ring

M. Korostelev, F. Zimmermann (CERN)

The sensitivity of the CLIC damping ring to various kinds of alignment errors have been studied. Without any correction, fairly small vertical misalignments of the quadrupoles and, in particular, the sextupoles, introduce unacceptable distortions of the closed orbit as well as intolerable spurious vertical dispersion and coupling due to the strong focusing optics of the damping ring. A sophisticated beam-based correction scheme has been developed to bring the design target emittances and the dynamic aperture back to the ideal value. The correction using dipolar correctors and several skew quadrupole correctors allows a minimization of the closed-orbit distortion, the cross-talk between vertical and horizontal closed orbits, the residual vertical dispersion and the betatron coupling.

MOPLS136

Ion Effects in the Damping Rings of ILC and CLIC

F. Zimmermann, W. Bruns, D. Schulte (CERN)

We discuss ion trapping, rise time of the fast beam-ion instability, and ion-induced incoherent tune shift for various incarnations of the ILC damping rings and for CLIC, taking into account the different regions of each ring. Analytical calculations for ion trapping are compared with results from a new simulation code.

MOPLS137

Tracking Studies to Determine the Required Wiggler Aperture for the ILC Damping Rings

I. Reichel (LBNL) A. Wolski (Liverpool University, Science Faculty)

The injection efficiency of an ILC damping ring is closely tied to its acceptance. To maximize both, one wants a physical aperture as large as possible in the wiggler magnets, as these are the limiting physical apertures in the ring. On the other hand, a small aperture in the wiggler magnets is needed to achieve the required field profile, a high magnetic field that is very linear over the whole physical aperture of the magnet. Tracking studies were done for all proposed ILC damping ring lattices to determine their required apertures. Although a half-aperture of 8 or 10 mm had been proposed, our studies showed that, for most lattices, a 16 mm half-aperture is required. (For some lattices a 12 mm half aperture might suffice.) We present here the results of our studies, which led to adopting a 16 mm half-aperture in the current ILC damping ring baseline design.

Space Charge and Equilibrium Emittances in Damping Rings

MOPLS138

M. Venturini (LBNL) K. Oide (KEK) A. Wolski (Liverpool University, Science Faculty)

The unusual combination of small beam size and long ring circumference may cause space charge to have noticeable effects on the beam dynamics of the ILC (International Linear Collider) damping rings. One possible consequence is a modification of the vertical equilibrium emittance resulting from a non-ideal lattice. One simple way to account for this effect is to model space charge in the linear approximation within the framework of Oide's envelope (or Chao's matrix) formalism, whis is commonly used to calculate equilibrium emittances in lepton storage rings. However, this model would likely overestimate the effect as a linear approximation for space charge is accurate only in a small neighborhood of a bunch center. For a more accurate modelling, we propose to make use of Sacherer's envelope equations consisting of a closed set of equations for the second moments of a beam distribution that account for the nonlinear dependence of the space-charge force. Here we will illustrate how Sacherer's equations can be combined with Oide's formalism and apply the result to the ILC damping rings.

Choosing a Baseline Configuration for the ILC Damping Rings

MOPLS139

A. Wolski (Liverpool University, Science Faculty) J. Gao (IHEP Beijing) S. Guiducci (INFN/LNF)

The damping rings for the International Linear Collider must be capable of accepting large beams from the electron and positron sources, and producing highly damped beams meeting demanding stability specifications, at the machine repetition rate of 5 Hz. Between March and November 2005, a program of studies was undertaken by an international collaboration of 50 researchers to compare a number of configuration options, including ring circumferences between 3 and 17 km. Here, we outline the studies and discuss the principal considerations in the choices of the baseline and alternative damping ring configurations.

Tuning Algorithms for the ILC Damping Rings

MOPLS140

J.K. Jones (CCLRC/DL/ASTeC)

Emittance preservation is an important aspect in the design and running of the International Linear Collider with a direct consequence on the luminosity of the machine. One major area of concern is in the damping rings, where the extracted emittances set the effective lower limits for the rest of the machine. Algorithms for tuning this system have been investigated, and simulations have been performed to understand the design and implementation issues. The different algorithms have been applied to the various damping ring designs, and the effectiveness of each algorithm has been assessed. A preliminary recommendation of tuning algorithm, and its effectiveness under various conditions, is given.

MOPLS141

The Proposed Conversion of CESR to an ILC Damping Ring Test Facility

M.A. Palmer, R.W. Helms, D. L. Rubin, D. Sagan, J.T. Urban (Cornell University, Laboratory for Elementary-Particle Physics) M. Ehrlichman (University of Minnesota)

In 2008 the Cornell Electron Storage Ring (CESR) will end nearly three decades of providing electron-positron collisions for the CLEO experiment. At that time it will be possible to reconfigure CESR as a damping ring test facility, CesrTF, for the International Linear Collider (ILC) project. With its complement of 12 damping wigglers, CesrTF will offer horizontal emittances in the few nanometer range and, ideally, vertical emittances approaching those specified for the ILC damping rings. An important feature of the CesrTF concept is the ability to operate with positrons or electrons. Positron operation will allow detailed testing of electron cloud issues critical for the operation of the ILC positron damping rings. Other key features include operation with wigglers that meet or exceed all ILC damping ring requirements, the ability to operate from 1.5 to 5.5 GeV beam energies, and the provision of a large insertion region for testing damping ring hardware. We discuss in detail the CesrTF machine parameters, critical conversion issues, and experimental reach for damping ring studies.

MOPLS142

Optimization of CESR-c Superferric Wiggler for the International Linear Collider Damping Rings

J.T. Urban, G. Dugan, M.A. Palmer (Cornell University, Laboratory for Elementary-Particle Physics)

We present the results of an optimization of the Cornell Electron Storage Ring (CESR) superferric wiggler for the International Linear Collider (ILC) damping ring. The superferric CESR wiggler has been shown to have excellent beam dynamics properties in the ILC damping ring. We reduced the physical size, and hence cost, of the CESR wiggler with minimal degradation of ILC damping ring beam dynamics. We will provide a description of the optimized superferric wiggler and show the performance of this wiggler in the ILC baseline damping ring.

MOPLS143

Suppression of Secondary Emission in a Magnetic Field using Sawtooth Surface

L. Wang, T.O. Raubenheimer, G.V. Stupakov (SLAC)

The effect of surface roughness on the secondary electron emission from a sawtooth surface in a magnetic field under electron bombardment is investigated using a Monte-Carlo method. Some of the secondary electrons emitted from the sawtooth surface return to the surface within their first few gyrations, resulting in low effective secondary electron yield. A sawtooth surface in magnetic field can significantly reduce the secondary emission yield below the multipacting threshold.

TUXPA — Circular Colliders

Tevatron Operational Status and Possible Lessons for the LHC

TUXPA01

V.A. Lebedev (Fermilab)

This talk will provide an overview of the Tevatron Run II luminosity progress and plans, including SC magnet measurements and modeling of field errors in view of the LHC operation, electron cooling progress and results, slip-stacking and optimized use of the injectors for antiproton production, and improvements in the antiproton source.

RHIC Operational Status and Upgrade Plans

TUXPA02

W. Fischer (BNL)

Since 2000 RHIC has collided, at 8 energies, 4 combinations of ion species, ranging from gold ions to polarized protons, and including the collisions of deuterons with gold ions. During that time the heavy ion luminosity increased by 2 orders of magnitude, and the proton polarization in store reached 46% on average. Planned upgrades include the evolution to the Enhanced Design parameters by 2008, the construction of an Electron Beam Ion Source (EBIS) by 2009, the installation of electron cooling for RHIC II, and the implementation of the electron-ion collider eRHIC. We review the expected operational performance with these upgrades.

LHC Luminosity and Energy Upgrades

TUXPA03

W. Scandale (CERN)

LHC upgrade studies are ongoing as part of the EU CARE-HHH network and in the US-LARP collaboration. The aim is a ten-fold increase of the LHC luminosity by about 2014 and a possible upgrade of the injector complex to inject at 1 TeV and, at a later stage, to raise the collider energy. This talk will provide an overview of the beam dynamics and technological challenges associated with the LHC upgrade, including magnet R&D plans, electron cloud and beam-beam limitations, preferred scenarios to maximize the integrated luminosity, and machine experiments on beam-beam compensation or crystal collimation.

TUYPA — Beam Instrumentation and Feedback

TUYPA01

Femtosecond Bunch Length Measurements

S.P. Jamison (CCLRC/DL/ASTeC) G. Berden (FOM Rijnhuizen) W.A. Gillespie, P.J. Phillips (University of Dundee) A. MacLeod (UAD) B. Steffen (DESY)

The measurement of ultrashort longitudinal bunch profiles is of growing importance to accelerator development and operation. With requirements of ~10fs time resolution, and a desire for non-destructive and real time diagnostics, the challenges for diagnostic development are significant. Alongside more established transverse deflecting cavity and CTR measurement techniques, new approaches arriving from the field of ultrafast lasers offer significant potential; Ultrafast electro-optic detection has now been demonstrated on several accelerators, and in many distinct forms, although challenges remain in getting to the desired time resolution. Proposed schemes combining ultrafast laser diagnostics with FEL interactions, such as the "optical replica" scheme also have considerable potential. Here, an overview of the current status of femtosecond scale longitudinal profile diagnostics will be given, together with an outlook to the future expectations.

TUYPA02

High Precision SC Cavity Alignment Diagnostics with HOM Measurements

J.C. Frisch, L. Hendrickson, J. May, D.J. McCormick, S. Molloy, M.C. Ross, T.J. Smith (SLAC) N. Baboi, O. Hensler, L.M. Petrosyan (DESY) N.E. Eddy, S. Nagaitsev (Fermilab) O. Napoly, R. Paparella, C. Simon (CEA)

Experiments at the TTF at DESY have demonstrated that the Higher Order Modes induced in Superconducting Cavities can be used to provide a variety of beam and cavity diagnostics. The centers of the cavities can be determined from the beam orbit which produces minimum power in the dipole HOM modes. The phase and amplitude of the dipole modes can be used as a high resolution beam position monitor, and the phase of the monopole modes to measure the beam phase relative to the accelerator RF. Beam orbit feedback which minimizes the dipole HOM power in a set of structures has been demonstrated. For most SC accelerators, the existing HOM couplers provide the necessary signals, and the downmix and digitizing electronics are straightforward, similar to those for a conventional BPM.

TUYPA03

Developments in Beam Instrumentation and New Feedback Systems for the ILC

H. Hayano (KEK)

This presentation will review the challenging beam properties that need to be measured and controlled and new diagnostic developments that address these challenges for ILC beam instrumentation.

TUZAPA — Hadron Accelerators

Present Status of the J-PARC Accelerator

TUZAPA01

H. Kobayashi (KEK)

The Japan Proton Accelerator Research Complex (J-PARC) is a joint project of High Energy Accelerator Research Organization (KEK) and Japan Atomic Energy Agency (JAEA), which started on April 1, 2001. The J-PARC accelerator complex is composed of a 400 MeV proton linac, a 3 GeV Rapid-Cycling Synchrotron (RCS), and a 50 GeV Proton Synchrotron (MR). A 180-MeV beam (in the first stage) accelerated by the linac is to be injected into the RCS, and further accelerated there to 3 GeV. The RCS will operate at 25 Hz, and will provide the Materials and Life Science Facility (MLF) with a 1-MW beam (600 kW during 180 MeV injection). There are two extraction sections in the MR: fast extraction for neutrino experiment and slow extraction for the Hadron Facility. A linac beam with a peak current of 30 mA and an energy of 19.7 MeV was successfully accelerated in Sep. 2004 using the first tank of the Drift Tube Linac in KEK. Now three accelerators are under installation. The beam commissioning of the linac will start in this December and those of the RCS and the MR will start in Sep. 2007 and May 2008, respectively. Status of installation and plan for commissioning run will be presented.

ISIS Upgrades – A Status Report

TUZAPA02

D.J.S. Findlay, D.J. Adams, T.A. Broome, M.A. Clarke-Gayther, P. Drumm, D.C. Faircloth, I.S.K. Gardner, P. Gear, M.G. Glover, S. Hughes, H.J. Jones, M. Krendler, A.P. Letchford, E.J. McCarron, S.J. Payne, C.R. Prior, A. Seville, C.M. Warsop (CCLRC/RAL/ISIS)

Since 2002 several accelerator upgrades have been made to the ISIS spallation neutron source at the Rutherford Appleton Laboratory in the UK, and upgrades are currently continuing in the form of the Second Target Station Project. The paper reviews the upgrade programmes: a new extraction straight, replacement of the Cockcroft-Walton by an RFQ, installation of a second harmonic RF system, replacement and upgrading of installed equipment, design and installation of improved diagnostics in conjunction with beam dynamics simulations, the Second Target Station Project, design and construction of a front end test stand, and the MICE programme. The paper also looks forward to possible future schemes at ISIS beyond the Second Target Station Project.

TUZBPA — Hadron Accelerators

TUZBPA01

The ERL High Energy Cooler for RHIC

I. Ben-Zvi (BNL)

This talk will first briefly review high-energy electron cooling, including the recent results from Fermilab. The main empasis will be on describing the proposed electron-cooling device for RHIC, based on an Energy Recovery Linac. Finally, results from the prototype ERL will presented.

TUZBPA02

Crystal Channelling in Accelerators

V.M. Biryukov (IHEP Protvino)

This presentation will begin with a description of the channelling of charged particles through crystals and the use of the channelling effect in accelerators etc. Results from use of crystals for beam deflection and extraction from synchrotrons in Russia, USA and CERN will also be given. Following this the potential advantage of crystals for collimation in high-energy high-intensity machines will be described.

TUXFI — Applications of Accelerators

FFAG Accelerators and their Applications

Y. Mori (KURRI)

This talk will give an introduction to the FFAG concept and review the present development of FFAG accelerators. It will also discuss the use of FFAGs for applications such as hadron therapy, neutron generation, BNCT, ADS, and muon acceleration.

TUOAFI — Applications of Accelerators

TUOAFI01

Development for New Carbon Cancer-therapy Facility and Future Plan of HIMAC

K. Noda, T. Fujisawa, T. Furukawa, Y. Iwata, T. Kanai, M. Kanazawa, N. Kanematsu, A. Kitagawa, Y. Kobayashi, M. Komori, S. Minohara, T. Murakami, M. Muramatsu, S. Sato, E. Takada, M. Torikoshi, S. Yamada, K. Yoshida (NIRS) C. Kobayashi, S. Shibuya, O. Takahashi, H. Tsubuku (AEC) Y. Sato, M. Tashiro, K. Yusa (Gunma University, Heavy-Ion Medical Research Center)

The first clinical trial with carbon beams generated from the HIMAC was conducted in June 1994. The total number of patients treated is now in excess of 2500 as of December 2005. Based on our 10 years of experience with the HIMAC, we have proposed a new carbon-ion therapy facility for wide-spread use in Japan. The key technologies of the accelerator and irradiation systems for the new facility have been developed since April 2004. The new carbon-therapy facility will be constructed at Gunma University from April 2006. As our future plan for the HIMAC, further, a new treatment facility will be constructed at NIRS from April 2006. The design work has already been initiated and will lead to the further development of the therapy with the HIMAC. The facility is connected with the HIMAC accelerator complex and has two treatment rooms with horizontal and a vertical beam-delivery systems and one room with a rotating gantry. We will report the development for new carbon therapy facility and the design study for new treatment facility with the HIMAC.

TUOAFI02

Design of a Treatment Control System for a Proton Therapy Facility

J.E. Katuin, J.C. Collins, C. Hagen, W. Manwaring, P. Zolnierczuk (IUCF)

The IUCF Proton Therapy System (PTS)is designed by Indiana University and operated by the Midwest Proton Radiotherapy Institute (MPRI) to deliver proton radiation treatment to patients with solid tumors or other diseases susceptible to radiation. PTS contains three Treatment Systems, each consisting of four subsystems: Beam Delivery, Dose Delivery, Patient Positioning and Treatments Control. These systems are implemented using different operating systems, control software, and hardware platforms. Therefore, IUCF developed an XML network communication protocol so that subsystems could issue commands to and receive feedback and status from other subsystems over a local area network (LAN). This protocol was also applied to the MPRI clinical database used to access patient treatment plans. The treatment control system was designed so that a single user interface could be used to deliver proton therapy. The use of the XML and the LAN allowed the software of the treatment control system to be designed such that the various systems are treated as objects with properties and methods. This approach not only simplified the overall design of the treatment control system, it also simplified the effort required for software validation, testing, and documentation.

Production of MeV Photons by the Laser Compton Scattering Using a Far Infrared Laser at SPring-8

H. Ohkuma, M. Shoji, S. Suzuki, K. Tamura, T. Yorita (JASRI/SPring-8) Y. Arimoto (Osaka University) M. Fujiwara, K. Kawase (RCNP) K. Nakayama, S. Okajima (Chubu University)

In order to produce MeV gamma-ray by the Laser Compton scattering (LCS), a high power optically pumped Far Infrared (FIR) laser has been developed at SPring-8. In the case of the SPring-8 storage ring, the momentum acceptance is so large (± 200 MeV) that the scattered electron is re-accelerated, then the stored beam is not lost by the LCS process. The beam diagnostics beamline is used to inject a FIR laser beam against 8-GeV stored electron beam and to extract MeV gamma-ray produced by LCS. The FIR laser system, gamma-ray production system, and measured gamma-ray spectrum will be presented. Future plans will also be introduced. In order to produce higher intense gamma-ray, we are constructing new gamma-ray production system at another beamline.

TUYFI — Accelerator Technology

TUYFI01

Gantry Design for Proton and Carbon Hadrontherapy Facilities

U. Weinrich (GSI)

Using an isocentric gantry improves the efficiency and the flexibility of cancer treatments with ion beams (hadrontherapy). After an overview of the constraints imposed to these heavy equipments the gantries constructed for both proton and carbon ion facilities will be described. Finally, the new studies undertaken to decrease the cost of such equipments will presented.

TUYFI02

Latest Developments on Insertion Devices

P. Elleaume, J. Chavanne (ESRF)

A review will be carried out of the developments on Insertion Devices that have taken place world wide in the last few years. These include the development of long period electro-magnet undulators, the operational results of a number of Apple-II undulators, the development of superconducting short period multipole wigglers, as well as the construction and operation of several in-vacuum undulators. The construction of a large number of competitive middle energy synchrotron sources in the hard X-ray range means that the need to increase the photon energy in the fundamental peak of an undulator is becoming a very important issue. Two main development strategies are currently being investigated. One consists of using superconducting undulator technology, the other of a further refinement of the in-vacuum undulator permanent magnet technology with cryogenic cooling of the magnetic assembly. The issues and challenges that are part of each approach will be presented, together with the latest results.

TUOBFI — Accelerator Technology

A Diagnostic Kicker System as a Versatile Tool for Storage Ring Characterisations

O. Dressler, J. Feikes, J. Kolbe (BESSY GmbH)

For the BESSY II Synchrotron Light Source two diagnostic kicker systems including current pulsers were developed, allowing vertical and horizontal deflection of the stored beam. Synchronised with the revolution trigger, simultaneous pulsing of the systems kicks the stored beam in any transverse direction with a repetition rate of up to 10 Hz allowing a wide range of storage ring investigations. Examples are dynamic aperture measurements and frequency map measurements. Special efforts were made to assure the demands of high amplitude and time stability for this kind of experiments. The technical concept of the systems and the controlling of the measurements are described.

TUOCFI — Accelerator Technology

TUOCFI01

Radiation Measurements vs. Predictions for SNS Linac Commissioning

I.I. Popova, F. X. Gallmeier, P. L. Gonzalez, D. C. Gregory (ORNL)

Detailed predictions for radiation fields, induced inside and outside of the accelerator tunnel, were performed for each of the SNS accelerator commissioning stages, from the ion source through the entire LINAC. Analyses were performed for normal commissioning parameters, for worst possible beam accidents, and for beam fault studies, using the Monte Carlo code MCNPX. Proper temporary shielding was developed and installed in local areas near beam termination points (beam stops) and some critical locations, such as penetrations, in order to minimize dose rates in general occupied areas. Areas that are not full-time occupied and have dose rates above a specified limit during beam accident and fault studies were properly restricted. Radiation monitoring was performed using real time radiation measurement devices and TLDs to measure absorbed dose and dose equivalent rates. The measured radiation fields were analyzed and compared with transport simulations. TLD readings vs. calculations are in a good agreement, generally within a factor of two difference. A large inconsistency among instrument readings is observed, and an effort is underway to understand the variations.

TUOCFI02

First Results of SNS Laser Stripping Experiment

V.V. Danilov, A.V. Aleksandrov, S. Assadi, J. Barhen, Y. Braiman, D.L. Brown, W. Grice, S. Henderson, J.A. Holmes, Y. Liu, A.P. Shishlo (ORNL)

Thin carbon foils are used as strippers for charge exchange injection into high intensity proton rings. However, the stripping foils become radioactive and produce uncontrolled beam loss, which is one of the main factors limiting beam power in high intensity proton rings. Recently, we presented a scheme for laser stripping of an H^- beam for the SNS ring. First, H^- atoms are converted to H0 by a magnetic field, then H0 atoms are excited from the ground state to the upper levels by a laser, and the excited states are converted to protons by a magnetic field. This paper presents first results of the SNS laser stripping proof-of-principle experiment. The experimental setup is described, and possible explanations of the data are discussed.

TUOCFI03

RF Cavity with Co-based Amorphous Core

M. Kanazawa, T. Misu, A. Sugiura (NIRS) K. Katsuki (Toshiba)

A compact acceleration cavity has been developed with new Co-based amorphous cores, which will be used in a dedicated synchrotron for cancer therapy. This core has high permeability that makes the cavity length short, and the cavity with no tuning system is possible with low Q-value of about 0.5. An acceleration cavity consists of two units that have a single acceleration gap at the center, and at the both side of the gap there are quarter wave coaxial resonators. Considering the requirements for easy operation, a transistor power supply was used instead of commonly used tetrode in the final stage RF amplifier. Each resonator has maximum impedance about 400? at 3MHz, and has been attached with 1:9 impedance transformer. In the frequency range from 0.4 to 8 MHz, the acceleration voltage of more than 4kV can be obtained with total input RF power of 8kW. With these performances, the cavity length is short as 1.5m. In this paper the structure of the cavity and their tested high power performances are presented.

TUODFI — Circular Colliders

The Final Collimation System for the LHC

TUODFI01

R.W. Assmann, O. Aberle, G. Bellodi, A. Bertarelli, C.B. Bracco, H.-H. Braun, M. Brugger, S. Calatroni, R. Chamizo, A. Dallocchio, B. Dehning, A. Ferrari, P. Gander, A. Grudiev, E.B. Holzer, J.-B. Jeanneret, J.M. Jimenez, M. Jonker, Y. Kadi, K. Kershaw, J. Lendaro, J. Lettry, R. Losito, M. Magistris, A.M. Masi, M. Mayer, E. Métral, R. Perret, C. Rathjen, S. Redaelli, G. Robert-Demolaize, S. Roesler, F. Ruggiero, M. Santana-Leitner, P. Sievers, M. Sobczak, E. Tsoulou, V. Vlachoudis, Th. Weiler (CERN) I. Baishev, I.L. Kurochkin (IHEP Protvino)

The LHC collimation system has been re-designed over the last three years in order to address the unprecedented challenges that are faced with the 360 MJ beams at 7 TeV. The layout of the LHC has now been fixed and a final approach for collimation and cleaning has been adopted. In total 132 collimator locations have been reserved in the two LHC rings and can be installed in a phased approach. Ninety collimators of five different types will be available for initial beam operation. The system has been fully optimized for avoiding quenches of super-conducting magnets during beam losses and for sufficient survival of beamline components against radioactive dose. The phased approach for LHC collimation is described, the various collimators and their functionalities are explained, and the expected system performance is summarized.

DAFNE Experience with Negative Momentum Compaction

TUODFI02

M. Zobov, D. Alesini, M.E. Biagini, A. Drago, A. Gallo, C. Milardi, P. Raimondi, B. Spataro, A. Stella (INFN/LNF)

There are several potential advantages for a collider operation with a lattice having a negative momentum compaction factor (alfa): bunches can be shorter and have a more regular shape; longitudinal beam-beam effects and synchrobetatron resonances are predicted to be less dangerous; requirements on sextupole strengths can be relaxed because there is no head-tail instability with the negative chromaticity. Since the lattice of the Frascati e^+e^- Phi-factory DAFNE is flexible enough to provide collider operation with alfa < 0, we have exploited this possibility to study experimentally the beam dynamics. The negative momentum compaction lattices have been successfully implemented and stable 1 A currents have been stored in both the electron and positron rings without any problem for RF cavities and feedback systems operation. First collisions have been tested at low currents. In this paper we describe the experimental results and compare them with expectations and numerical simulations. Present limitations to DAFNE operation with alfa < 0 are also discussed.

Operational Status of CESR-c

TUODFI03

J.A. Crittenden (Cornell University, Department of Physics)

We summarize recent running experience at the Cornell Electron Storage Ring operating as a high-statistics production-threshold factory for mesons containing charm quarks. Since beginning operation at beam energies near 2 GeV in late 2003, CESR has accumulated world-record samples of D and D_s meson decays and has also operated in an energy-scanning mode, making unique contributions to the presently very active field of charm spectroscopy. CESR lattice design is

characterized by the versatility provided by the variety of beam-line components applied to the challenges imposed by the beam-beam interactions at the parasitic crossing points in the pretzel orbits and the necessity of powerful superconducting wiggler magnets used to tune damping and emittance. We describe the observed tune-plane, beam-current and luminosity limits, as well as our understanding of their sources and near-term plans for operational improvements.

TUPCH — Poster Session

Diagnostics and Timing at the Australian Synchrotron

TUPCH003

M.J. Spencer, S. Banks, M.J. Boland, M. Clift, R.T. Dowd, R. Farnsworth, S. Hunt, G. LeBlanc, M. Mallis, B. Mountford, Y.E. Tan, A. Walsh, K. Zingre (ASP)

The 3GeV Australian Synchrotron will begin operation in March 2007. This paper outlines the storage ring diagnostics systems and the injection timing system. The diagnostics system includes an optical beamline with streak camera, an x-ray beamline with pinhole array, a diagnostic straight with fast feedback kicker, stripline, direct current current transformer, and a four-fingered scraper. Over the 14 sectors there are 98 beam position monitors and 14 movable beam loss monitors. The timing system is based on a static injection system with the storage ring bucket to be filled targeted by delaying the firing of the electron gun.

Commissioning of the LNLS X-ray BPMs

TUPCH004

S.R. Marques, P.F. Tavares (LNLS)

We present experimental results of the commissioning of staggered-pair blade X-Ray beam position monitor (XBPM) recently developed and installed at the diagnostic beamline of the UVX electron storage ring at the Brazilian Synchrotron Light Laboratory (LNLS). The results obtained with a prototype XBPM indicate that the short-term and long-term data are both in agreement with the data from a commercially acquired XBPM installed at the same beamline, as well as with the data of the electron storage ring RF BPMs. In this paper we present the commissioning results of the LNLS XBPM.

A Wideband Intercepting Probe for the TRIUMF Cyclotron

TUPCH006

V.A. Verzilov, D. Cameron, D.T. Gray, S. Kellogg, M. Minato, W.R. Rawnsley (TRIUMF)

An intercepting probe for the TRIUMF cyclotron capable of measuring the phase and time structure of the circulating beam was designed, manufactured, installed into the tank and tested. A model of the probe head in the form of a 50 Ohm parallel plate transmission line was developed and simulated to operate up to 2 GHz. Thermal simulations show that the probe can withstand at least 500 nA of average current for the 500 MeV beam. In laboratory tests the probe demonstrated a bandwidth in excess of 1 GHz. The probe was mounted on a 3 m long drive and is capable of travelling over 0.5 m at an angle of 27 degree w.r.t. the cyclotron radius. The signals extracted from the probe are processed by a pair of diplexers, where low frequency and high frequency components are separated. The low frequency signal is directed to our standard electronics for processing and provides both dc current and a time of flight signal with a rise time of about 100 ns. At the high frequency output a signal-to-noise ratio of about 4 at 250 nA average current and 0.1 % duty cycle was measured in the presence of rf background from the cyclotron resonators. A bunch time structure as short as 1 ns was resolved.

TUPCH007

High Resolution BPM for the Linear Colliders

C. Simon, S. Chel, M. Luong, O. Napoly, J. Novo, D. Roudier (CEA)
N. Rouvière (IPN)

The beam-based alignment and feedback systems which are essential for the operation of the future colliders use some high resolution Beam Position Monitors (BPM). In the framework of CARE/SRF, the task of CEA/DSM/DAPNIA (Saclay) is the design, the fabrication and the beam test of a BPM in collaboration with DESY. This system is composed of a RF re-entrant cavity with a beam pipe radius of 78mm and an analog electronics having several signal processing steps to reject the monopole mode. Thanks to its high position resolution (better than 1μm) and its high time-resolution (around 10ns), it is a candidate for the X-FEL at DESY and the ILC. Indeed the chosen coupling allows the bunch to bunch measurement and the separation between the monopole and dipole modes. Moreover, this BPM is designed to be used in a clean environment, at the cryogenic and room temperatures.

TUPCH008

Behavior of the BPM System During the First Weeks of SOLEIL Commissioning

J.-C. Denard, L. Cassinari, N. Hubert, N.L. Leclercq, D. Pedeau (SOLEIL)

SOLEIL, a new synchrotron light source built near Paris in France, is pioneering a new high resolution electron Beam Position Monitor (BPM) system to achieve stability of the beams at the micron level, as required for the beamlines. The same BPM system allows also measurement of the beam position in turn-by-turn mode for various machine physics studies. The system combines the high stability characteristic of multiplexed input channels and the flexibility of a digital system. Instrumentation Technologies developed the Libera module upon SOLEIL proposals and requirements. The performances of the system evaluated after the Booster and the storage ring commissioning will be presented.

TUPCH009

Beam Measurements and Manipulation of the Electron Beam in the BESSY-II Transferline for Topping Up Studies

T. Kamps, P. Kuske, D. Lipka (BESSY GmbH)

The BESSY-II storage ring based synchrotron radiation source will be upgraded to allow for continuous topping up operation. In order to achieve a high injection efficiency between the booster synchrotron and the storage ring, the transferline will be equipped with novel beam size monitors and collimators. This paper describes the collimator design and first beam measurements of the transverse emittance. The transverse emittance is measured using the quadrupole scan technique. The data taking and the analysis procedure is given together with results and comparision with simulations.

Profile Measurement by Beam Induced Fluorescence for 60 MeV/u to 750 MeV/u Heavy Ion Beams

TUPCH010

P. Forck, C. Andre, F. Becker, H. Iwase (GSI) D. Hoffmann (TU Darmstadt)

At the planned heavy ion facility FAIR very intense beams of heavy ions will be transported between various synchrotrons and focused on targets for secondary ion productions. For the transverse profile determination only non-destructive methods are suited due to the large deposed beam power. We investigated experimentally the Beam Induced Fluorescence (BIF) method. Due to the atomic collision by the beam ions the residual gas N**2 is excited to fluorescence levels. Single photon detection is performed by a double MCP image intensifier coupled to a digital CCD camera. Extensive experimental studies (with the today available lower ion currents) were performed to determine the photon yield and the background contribution for different ion species and beam energies. The measured profiles show a good correspondence to other methods as long as the vacuum pressure by a regulated N**2 inlet is below 10-1 mbar. Based on the experimental results, the layout for a BIF profile determination will be discussed.

Innovative Beam Diagnostics for the Challenging FAIR Project

TUPCH011

P. Forck, A. Peters (GSI)

The planned FAIR facility consists of two heavy ion synchrotrons and four large storage rings. The super-conducting synchrotrons are build for high current operation and secondary ion production. A large variety of low current secondary beams is stored and cooled in the four storage rings. A complex operation scheme with multiple use of transport lines is foreseen. This demands an exceptional high dynamic range for the beam instrumentation. Due to the enormous beam power, non-destructive methods are mandatory for high currents. For the low current secondary beams, non-destructive diagnostics are also preferred due to the low repetition rate. Precise measurements of all beam parameters and automatic steering or feedback capabilities are required due to the necessary exploitation of the full ring acceptances. Moreover, online beam-corrections with short response times are mandatory for the fast ramping super-conducting magnets. Due to the ultra-high vacuum condition and the demanding measurement accuracy, novel technical solution are foreseen. An overview of the challenges and projected innovative solutions for various diagnostic installations will be given.

Digital Techniques in BPM Measurements at GSI-ISI

TUPCH012

A.A. Galatis, P. Kowina, K. Lang, A. Peters (GSI)

In this paper we describe new approaches for BPM measurements in hadron accelerators, which have strongly varying beam parameters such as intensity, accelerating frequency and bunch length. Following signal dynamic adjustment, direct digitalization and treatment of digitized data, we should reach a BPM resolution of 0.1mm. Interchangeability of this method between accelerators should be provided, which results in autonomous data treatment algorithms, free of external status and timing signalling. This should ensure the usability of the system in other bunched accelerator rings. Different operation modes are intended for allowing online storage of beam position data over full acceleration cycles as well as storage of beam waveforms in regions of acceleration that are of special interest e.g. transition, kicking, bunch gymnastics. First results of realised hardware/software combinations will be introduced and discussed.

TUPCH013

Numerical Calculations of Position Sensitivity for Linear-cut Beam Position Monitors

P. Kowina, A.A. Galatis, W. Kaufmann, J. Schoelles (GSI)

In this contribution the results of simulations performed for different geometries of linear-cut Beam Position Monitors (BPMs) are compared for two design types: i)based on metal electrodes and ii)using a metal coated ceramics. The advantage of the ceramic solution is a compact construction allowing easy positioning. Contrary, the construction based on the metal electrodes benefits from its simplicity. The main goals in optimization are the sensitivity and linearity of the position determination. High position sensitivity can be achieved by the reduction of the plate-to-plate cross talks caused by coupling capacities. For instance, the insertion of an additional guard ring into the gap between the active plates leads to an increase of the sensitivity by about 30%. This insertion is necessary in case of ceramic solution: The large ceramics permeability enlarges the coupling capacity by about a factor of four. The careful geometrical arrangement allows to avoid resonances in the interesting frequency range i.e. from 0.2 to 200MHz. The displayed simulations are performed using CST Microwave Studio. The investigated BPMs will be used in the FAIR facility presently under design at GSI.

TUPCH014

Machine Protection by Active Current-transmission Control at GSI-UNILAC

H. Reeg, J. Glatz, N. Schneider (GSI) H. Walter (Ing.-Buero H. Walter)

Toroidal beam current transformers (BCT) are installed at dedicated locations along the UNILAC accelerator. They provide an output signal with a fixed transimpedance. Dedicated signal pairs from consecutive transformers drive differential integrator stations. If preset protection levels are exceeded due to beam charge loss during the macro-pulse, fast interlock signals are generated. The actual beam pulse is instantaneously truncated by a fast beam chopper, avoiding any thermal damage or radio-activation of machine components.
A new BCT macro-pulse selector/display is presently under construction, which will provide time structure observation of multiple UNILAC macro-pulses, as well as long-term data logging. The hardware is set up with PXI components from National Instruments, running a multi-client/server controller software under LabViewRT®. Offline-analysis of the accumulated BCT data is expected to improve the protection system's operation and reliability. An overview of the system layouts, technical details, and relevant operational results will be presented.

TUPCH015

Integrated Beam Diagnostics Systems for HICAT and CNAO

A. Reiter, A. Peters, M. Schwickert (GSI)

An integrated system for beam diagnostics was produced at GSI for the heavy-ion cancer treatment facility HICAT of the Heidelberg university clinics. A set of 92 manifold beam diagnostic devices allows automated measurements of the main beam parameters such as beam current, profile or energy. The beam diagnostic subsystem is completely integrated in the overall accelerator control system and its timing scheme. This paper reports on the underlying design patterns for the abstraction of the beam diagnostic devices towards the control system. Event-counting devices, i.e. scintillating counters and ionization chambers, are presented as examples of the diagnostic devices in the synchrotron and high-energy beam transport section of HICAT. Additionally, it is shown that the well-defined building blocks of the beam instrumentation made it possible to prepare almost identical devices including the manual control software, to be used in the CNAO facility (Centro Nazionale di Adroterapia Oncologica) presently under construction in Pavia, Italy.

Numerical Simulation of Synchrotron Radiation for Bunch Diagnostics

TUPCH016

A. Paech, W. Ackermann, T. Weiland (TEMF) O. Grimm (DESY)

For the operation of the VUV-FEL at DESY, Hamburg, the longitudinal charge distribution of the electron bunches that drive the free electron laser is of high importance. One novel method to measure the bunch shape is to analyze the coherent far-infrared synchrotron radiation generated at the last dipole magnet of the first bunch compressor. For the correct interpretation of the results it is mandatory to know how various parameters, like the bunch shape and path, the vacuum chamber walls, the optical beamline, etc., influence the observed spectrum. The aim of this work is to calculate the generation of synchrotron radiation inside the bunch compressor with the emphasis of including the effects of the vertical and horizontal vacuum chamber walls in the vicinity of the last dipole magnet. Challenging problems for the numerical simulations are the very short wavelength and the broad frequency range of interest. As a first step, it is shown how the radiation leaving the vacuum chamber, that is generated by a single point charge, can be calculated with the help of the uniform theory of diffraction (UTD).

Fast Beam Dynamics Investigation Based on an ADC Filling Pattern Measurement

TUPCH018

J. Kettler, P. Hartmann, R.G. Heine, T. Weis (DELTA)

A diagnostic tool to determine the longitudinal particle filling pattern has been installed at the 1.5 GeV electron storage ring DELTA. The instrument is PC-based using an ADC-conversion at a sampling rate of 2 GS/s and a nominal bandwidth of 1 GHz which is applied to the sumsignal of a single storage ring beam position monitor. By sampling over successive turns the resolution is enhanced by one order of magnitude allowing an easy access to the longitudinal particle distribution inside the ring. The data obtained turn-by-turn over hundreds of revolutions can be further analysed by FFT-techniques allowing a very fast detection (~ 1 s) of longitudinal coupled bunch mode (CBM) instabilities from the phase modulated spectrum. The application of the FFT to the amplitude modulated particle distribution moreover allows a "post mortem"-investigation of CBM induced beam loss. The paper will present the layout of the diagnostic system and will report on filling pattern measurements as well as on investigations of longitudinal CBM-instabilities.

Laser-based Beam Diagnostic for the Front End Test Stand (FETS) at RAL

TUPCH019

C. Gabor (IAP) D.A. Lee (Imperial College of Science and Technology, Department of Physics) A.P. Letchford (CCLRC/RAL/ISIS) J.K. Pozimski (CCLRC/RAL)

High power proton accelerators (HPPA) are required for several future projects like spallation sources or a neutrino factory. Compared with existing machines the beam power therefore has to be increased by a factor of 30. The Front end test stand at RAL is being built to demonstrate that a chopped Hminus beam of 60 mA at 3 MeV with 50 pps and sufficiently high beam quality, as required for all proposed Proton drivers, can be built. For the test stand a comprehensive set of beam diagnostics is also required. Due to the high beam energy and power non destructive diagnostic methods are favorable. Hminus beams offer the possibility to use intense laser light to detach the additional electron and use the produced particles for beam diagnostics. The principle is appropriate to determine the transversal beam density distribution as well as the transversal and longitudinal beam emittance in front and behind the RFQ. A detailed layout of the beam diagnostics including a discussion of the predicted spatial and temporal resolution and the dynamic range of the proposed devices will be presented.

TUPCH021

Principles of longitudinal beam diagnostics with coherent radiation

O. Grimm (DESY)

The Kramers-Kronig dispersion relation connects the real and imaginary part of a response function under very general assumptions. It is used in the context of accelerator physics for longitudinal bunch diagnostics as a phase retrieval technique: the modulus of the complex form factor (the Fourier transform of the charge distribution) is accessible experimentally, and the missing phase then (partially) reconstructed to allow an inversion of the Fourier transform. Contrary to real and imaginary part, the connection between modulus and phase is not unique anymore due to the possibility of zeros of the form factor in the complex frequency plane that cannot be measured. This paper gives a mathematically explicit, step-by-step derivation of the phase reconstruction technique for bunch diagnostics, and it explains the problem of zeros and their practical effect with some examples. The intention is not utmost mathematical rigour, but a clear, accessible explanation of all steps involved.

TUPCH022

Large Horizontal Aperture BPM for use in Dispersive Sections of Magnetic Chicanes

K.E. Hacker, H. Schlarb (DESY) F. Loehl (Uni HH)

A beam position monitor with a large horizontal aperture for use in dispersive sections of FLASH magnetic chicanes will be installed in October 2006. It has a horizontal range of 13 cm and a resolution requirement of better than 10 microns. A stripline design mounted perpendicularly to the the electron beam direction is used to provide broadband electrical pulses traveling in opposite directions, the phases of which give a measure of the beam position. The phase measurement will be accomplished through an optical method developed for a beam arrival time monitor. Results from simulation and recent beam arrival-time measurements will be used to justify expectations for the BPM performance.

TUPCH023

Direct Observation of Beam-beam Induced Dynamical Beta Beating at HERA

G. Kube, F.J. Willeke (DESY)

The Hadron Electron Ring Anlage (HERA) at DESY provides collisions between a 920 GeV proton beam and a 27.5 GeV electron beam in two interaction regions. The strong beam-beam force, which mainly affects the electrons, induces a tune shift together with a dynamical beta beat. The latter leads to a modification of the transverse beam profile, which can be observed in different profile monitors in HERA. The time-like evolution of the electron beam shape during luminosity tuning and before and after dump of the proton beam, averaged over all bunches, could be studied by means of a synchrotron radiation profile monitor. Measurements with a wire scanner allowed to see the beam-beam force's influence on each individual bunch at the expense of resolution. The observations could be explained qualitatively in the frame of linear incoherent beam-beam interaction.

Comparative Study of Bunch Length and Arrival Time Measurements at FLASH

TUPCH024

H. Schlarb, A. Azima, S. Düsterer, M. Huening, E.-A. Knabbe, M. Roehrs, R. Rybnikov, B. Schmidt, B. Steffen (DESY) M.C. Ross (SLAC) P. Schmüser, A. Winter (Uni HH)

Diagnostic devices to precisely measure the longitudinal electron beam profile and the bunch arrival time require elaborate new instrumentation techniques. At the VUV-FEL, two entirely different methods are used. The bunch profile can be determined with high precision by a transverse deflecting RF structure. The method is disruptive and does not allow to monitor multiple bunches in a macro-pulse train. Therefore, it is augmented by two non-disruptive electro-optical devices, called EO and TEO. The EO setup uses a dedicated diagnostic laser synchronized to the machine RF. The longitudinal electron beam profile is encoded in the intensity profile of a chirped laser pulse and analyzed by looking at the spectral composition of the pulse. The second setup, TEO, utilizes the TiSa-based laser system used for pump-probe experiments. Here, the temporal electron shape is encoded into a spatial dimension of laser pulse by an intersection angle between the laser and the electron beam at the EO-crystal. In this paper, we present a comparative study of bunch length and arrival time measurements performed simultaneously with all three experimental techniques.

Precision RF Gun Phase Monitor System for the VUV-FEL

TUPCH025

H. Schlarb, N. Heidbrook, H. Kapitza, F. Ludwig, N. Nagad (DESY)

For RF photo-injectors, the properties of the high brightness beam critically depend on the synchronization between the RF gun acceleration phase and the photo-cathode laser. At the VUV-FEL, the phase stability is determined by operating the RF gun close to zero-crossing RF phase. This allows the conversion of phase variations into charge variations which then is readout by a precision charge measurement system based on toroids. In this paper, we discuss the limitation of this method. Resolution reduction of the charge measurement system due to electro-magnetic-interference is discussed in detail.

Single Shot Longitudinal Bunch Profile Measurements at FLASH using Electro-optic Techniques

TUPCH026

B. Steffen, E.-A. Knabbe, B. Schmidt (DESY) G. Berden, A.F.G. van der Meer (FOM Rijnhuizen) W.A. Gillespie, P.J. Phillips (University of Dundee) S.P. Jamison, A. MacLeod (UAD) P. Schmüser (Uni HH)

For the high-gain operation of a SASE FEL, extremly short electron bunches are essential to generate sufficiently high peak currents. At the superconducting linac of the VUV-FEL at DESY, we have installed an electro-optic experiment with temporal decoding and spectral decoding to probe the time structure of the electric field of single sub 200fs e-bunches. In this technique, the field-induced birefringence in an electro-optic crystal is encoded on a chirped ps laser pulse. The longitudinal electric field profile of the electron bunch is then obtained from the encoded optical pulse by a single-shot cross correlation with a 30 fs laser pulse using a second-harmonic crystal (temporal decoding) or by a single-shot measurement of its spectrum (spectral decoding). In the temporal decoding measurements an electro-optic signal of 230fs FWHM was observed, and is limited by the material properties of the particular electro-optic crystal used. Bunch profile and time jitter measurements were obtained simultaneously with VUV SASE operation.

TUPCH027

Time Resolved Single-shot Measurements of Transition Radiation at the THz Beamline of FLASH using Electro-optic Spectral Decoding

B. Steffen, E.-A. Knabbe, B. Schmidt (DESY) G. Berden, A.F.G. van der Meer (FOM Rijnhuizen) W.A. Gillespie, P.J. Phillips (University of Dundee) S.P. Jamison, A. MacLeod (UAD) P. Schmüser (Uni HH)

Single-shot electro-optic detection was used to measure the temporal profile of coherent transition radiation (CTR) pulses at the VUV-FEL at DESY. The CTR was generated from single bunches kicked to an off-axis screen, with the radiation transported through a 20m long transfer line imaging the CTR from a radiation screen to an experimental station outside the accelerator tunnel. Bipolar pulses with a FWHM less than 1ps have been measured and are consistent with simulations of the propagation of radiation through the transfer line.

TUPCH028

Layout of the Optical Synchronization System for FLASH

A. Winter, P. Schmüser, A. Winter (Uni HH) F. Loehl, F. Ludwig, H. Schlarb, B. Schmidt (DESY)

The present RF synchronization system of the VUV-FEL can typically stabilize the arrival time of the electron bunches at the undulator to about 200 fs on a timescale of minutes and to several picoseconds on a timescale of hours. To improve the machine stability and to ensure optimal performance for the VUV-FEL user facility, a new ultra-precise timing system is mandatory. The optical synchronization system under construction will satisfy three goals: Firstly, it provides a local oscillator frequency with the same stability as the existing low-level RF regulation, secondly, it can synchronize the experimental lasers of the FEL users with a precision in the order of 30 fs, thirdly, it provides an ultra-stable reference for beam arrival time measurements and enables a feedback on the electron beam to compensate residual drifts and timing jitter. The optical synchronization system is based on an optical pulse train from a mode-locked laser with a highly stabilized repetition rate. This paper describes the proposed layout of the optical synchronization system, the integration into the machine layout and the diagnostic experiments to monitor the performance of the system.

TUPCH029

High-precision Laser Master Oscillators for Optical Timing Distribution Systems in Future Light Sources

A. Winter, P. Schmüser, A. Winter (Uni HH) J. Chen, F.X. Kaertner (MIT) F.O. Ilday (Bilkent University) F. Ludwig, H. Schlarb (DESY)

X-ray pulses with a pulse duration in the 10 fs regime or even less are needed for numerous experiments planned at next generation free electron lasers. A synchronization of probe laser pulses to the x-ray pulses with a stability on the order of the pulse width is highly desirable for these experiments. This requirement can be fulfilled by distributing an ultra-stable timing signal to various subsystems of the machine and to the experimental area to provide synchronization at the fs level over distances of several kilometers. Mode-locked fiber lasers serve as laser master oscillators (LMO), generating the frequencies required in the machine. The pulse train is distributed through length-stabilized fiber links. This paper focuses on the LMO, devoting special attention to the phase noise properties of the frequencies to be generated, its reliability to operate in an accelerator environment, and the residual timing jitter and drifts of the RF feedback for the fiber links. A prototype experimental system has been constructed and tested in an accelerator environment and its performance characteristics will be evaluated.

A Beam Diagnostics System for the Heidelberg Cryogenic Storage Ring CSR

TUPCH030

T. Sieber, H. Fadil, M. Grieser, A. Wolf, R. von Hahn (MPI-K)

The storage of rotationally non-excited molecules and highly charged ions requires lowest temperatures and vacuum pressures. At the MPI-K Heidelberg a cryogenic storage ring (CSR) for atomic and molecular physics experiments is under development. The CSR shall allow operation at temperatures of 2 K and pressures down to $1 \cdot 10^{-15}$ mbar. The ring consists of electrostatic elements and has a circumference of ~35 m. It is housed inside a large cryostat, cooled by a (20W @ 2K) Helium refrigerator. To reach low UHV pressures already at room temperature the whole machine has to be bakeable up to 300^{o}C. These boundary conditions, together with the low charge states, low velocities and low intensities (1nA-1muA) of the ions, put strong demands on the beam diagnostics system. Some beam parameters like profile, position and intensity cannot be measured with "standard" beam diagnostics technology. Here new or further developments are required. The paper gives a general view of the beam diagnostics concept for the CSR and shows in more detail possible solutions for measurement of beam position and beam profile.

A New SQUID-based Measurement Tool for Characterization of Superconducting RF Cavities

TUPCH031

K. Knaack, K. Wittenburg (DESY) R. Neubert, S. Nietzsche, W. Vodel (FSU Jena) A. Peters (GSI)

In this contribution a LTS-SQUID based measurement tool for characterization of superconducting RF cavities for the upcoming X-FEL project at DESY will be presented. The device makes use of the Cryogenic Current Comparator (CCC) principle and measures the so-called dark current, generated e.g. by superconducting cavities at high voltage gradients. To achieve the maximum possible energy the gradients should be pushed near to the physical limit of 50 MV/m. The measurement of the undesired field emission of electrons (the so-called dark current) in correlation with the gradient will give a proper value to characterize the performance of the RF cavities. The CCC mainly consists of a high performance LTS-DC SQUID system which is able to measure extremely low magnetic fields, e.g. caused by the extracted dark current of the RF cavities. Therefore, a special designed toroidal niobium pick-up coil for the passing electron beam is superconducting connected across the input coil of the SQUID. The noise limited sensitivity of the CCC as well as new experimental results with the whole measurement device assembled in a special wide-necked LHe cryostat will be presented.

Precise Measurements of the Vertical Beam Size in the ANKA Storage Ring with an In-air X-ray Detector

TUPCH032

A.-S. Müller, I. Birkel, E. Huttel, P. Wesolowski (FZK) K.B. Scheidt (ESRF)

A major part of the X-rays generated in the ANKA dipole magnets is unused by the experimental beamlines and is, on a number of dipoles, absorbed in a conical shaped Copper absorber. The 8 mm thickness that it presents lets a tiny fraction of the hard X-rays above 70KeV enter the free air space behind it. The transmitted power of only a few uW/mrad hor. is sufficient to be detected, with sub-second measurement time, by a novel In-Air X-ray detector. This extremely compact and low-cost device is situated just behind the absorber. The design, developed and in use at the ESRF, is based on a Cadmium Tungstenate ($CdWO_4$) scintillator converting X-rays into visible light that is collected and focused onto a commercial CCD camera. Since the small vertical divergence of the high energy photons and the distance of the detector from the source point are known, it is possible to derive the vertical electron beam size with a high intrinsic precision. This paper presents results of beam size measurements as a function of various ANKA machine parameters, that illustrates the great diagnostic potential of this type of detector for a 2.5GeV medium energy light source like ANKA.

TUPCH033

Automated Beam Optimisation and Diagnostics at MAMI

M. Dehn, H. Euteneuer, F.F. Fichtner, A. Jankowiak, K.-H. Kaiser, W.K. Klag, H.J. Kreidel, S.S. Schumann, G.S. Stephan (IKP)

At the Institut fur Kernphysik (IKPH) of Mainz University the fourth stage of the Mainz Microtron (MAMI), a 855MeV to 1500MeV Harmonic Double Sided Microtron (HDSM), is now on the verge of first operation*. To provide an automated beam optimisation, low-Q-TM010 and TM110 resonators at each linac of the three cascaded RTMs and the two linacs of the new HDSM are used. These monitors deliver position, phase and intensity signals of each recirculation turn when modulating the beam intensity with 12ns-pulses (diagnostic pulses, max. rep. rate 10kHz). For operating the HDSM an extended system for displaying and digitising these signals was developed. High-bandwidth ADCs allow very comfortable to analyse, calibrate and automatically optimise the beam positions and phases during operation. The system is also used to adjust the transversal and longitudinal focussing according to the design parameters. Synchrotron radiation monitors, providing beam sizes and positions out of the bending magnets for each turn and on the entrance and exit of the linac axis, were a very helpful tool for beam-matching between the RTMs. Therefore a similar system was planned and constructed for the HDSM.
*A. Jankowiak et al. "Status Report on the Harmonics Double Sided Microtron of MAMI C", this conference.

TUPCH035

Fine Spatial Beam Loss Monitoring for the ISIS Proton Synchrotron

S.J. Payne, S.A. Whitehead (CCLRC/RAL/ISIS)

Beam loss detection at the ISIS synchrotron is achieved using a series of 3 and 4 metre long argon gas ionisation tubes placed around the inside track of the main ring and along the injector and extraction sections. Even with this level of diagnostics problems have occurred, for example, inside a main dipole within the accelerator ring where small concentrated areas of loss have resulted in severe damage to the RF shield. This type of loss cannot be easily resolved using the conventional argon gas system due to the length of the detectors and their distance from the vacuum vessel (around 2m). We report here the development of a compact beam loss monoitoring system which has been installed inside a dipole between the vacuum vessel and the main body of the dipole. The system comprises of six 150 sq. cm. (BC408) plastic scintillators connected to photo-multiplier tubes via fibre optic bundles. Measurements taken demonstrate that the new system can easily resolve complex beam loss patterns along the dipole while remaining robust to the high radiation environment. We also report here details of our PXI based data collection and display system.

TUPCH036

Modelling of Diagnostics for Space Charge Studies on the ISIS Synchrotron

B.G. Pine, S.J. Payne, C.M. Warsop (CCLRC/RAL/ISIS)

The ISIS Facility at the Rutherford Appleton Laboratory in the UK produces intense neutron and muon beams for condensed matter research. It is based on a 50 Hz proton synchrotron which, once the commissioning of a new dual harmonic RF system is complete, will accelerate about $3.5 \cdot 10^{13}$ protons per pulse from 70 to 800 MeV, corresponding to mean beam powers of 0.2 MW. Transverse space charge is a key issue for both present and proposed upgrades to the machine, and is the focus of current R&D studies. Experiments on the ISIS ring are central to this work, therefore understanding and quantifying limitations in present and proposed diagnostics is essential. This paper presents work studying and modelling the ISIS residual gas profile monitors, including the effects of non-uniformity in sweep fields, space charge and images. Progress on related work looking at other important diagnostics, e.g., position and envelope monitoring, will also be summarised.

Development of Emittance Scanner Software for ISIS

TUPCH037

C.M. Thomas, D.C. Faircloth (CCLRC/RAL/ISIS)

Horizontal and vertical Faraday cup and slit scanners are used on ISIS, the 800MeV pulsed neutron source at the Rutherford Appleton Laboratory, to calculate the emittance of the beam. Software has been written in C++ to control the scanners, acquire and display beam data and compute an emittance value for the beam. The software allows the user more control, and has the ability to scan over a wider range, than was previously available.

Beam Loss Monitoring and Machine Protection Designs for the Daresbury Laboratory Energy Recovery Linac Prototype

TUPCH038

S.R. Buckley, R.J. Smith (CCLRC/DL/ASTeC)

Daresbury Laboratory is currently constructing an energy recovery linac prototype (ERLP). This is to carry out the necessary research and development of the technology of photo-cathode electron guns and superconducting linacs so that a fourth generation light source (4GLS) can be designed and constructed. Beam loss monitoring and machine protection systems are vital areas for the successful operation of the ERLP. These systems are required, both for efficient commissioning and for hardware protection during operation. This paper gives an overview of the system requirements, options available and details of the final design specification.

A Phase Space Tomography Diagnostic for Pitz

TUPCH039

D.J. Holder, B.D. Muratori (CCLRC/DL/ASTeC) F.E. Hannon (Jefferson Lab) S. Khodyachykh, A. Oppelt (DESY Zeuthen)

The Photo Injector Test Facility at DESY in Zeuthen (PITZ) is a European collaboration developing RF photocathode electron guns for light source and linear collider projects. As part of the collaborative work being partially funded by the EU's FP6 programme, CCLRC Daresbury Laboratory and DESY are designing and building a phase space tomography diagnostic based on a set of multiple quadrupoles and view screens. In order to measure the beam emittance, four screens with intermediate quadrupole doublets will be used. The equipment will be installed and tested at PITZ as part of the facility upgrade presently ongoing. Following simulations of the gun using the ASTRA code at a range of energies, simulations of the electron beam parameters through the matching and tomography sections must be undertaken in order to specify the optimum arrangement of magnets and screens.

TUPCH041

Electro-optic Diagnostics on the Daresbury Energy Recovery Linac

P.J. Phillips, W.A. Gillespie (University of Dundee) S.P. Jamison (CCLRC/DL/ASTeC) A. MacLeod (UAD)

An electro-optic longitudinal bunch profile monitor is being implemented on the 4GLS prototype energy recovery linac (ERL/p) at Daresbury Laboratories and will be used both to characterise the electron bunch and to provide a testbed for electro-optic techniques. The electro-optic station is located immediately after the bunch compressor, and within the FEL cavity; its location allows it to draw on nearby beam profile monitors and CTR and CSR diagnostics for calibration and benchmarking. We discuss the implementation and planned studies on electro-optic diagnostics with this diagnostic station.

TUPCH042

The Optical System for a Smith-Purcell Experiment at 45MeV

V. Blackmore, W.W.M. Allison, G. Doucas, C. Perry (OXFORD-physics) P.G. Huggard (CCLRC/RAL) M.B. Johnston (University of Oxford, Clarendon Laboratory) B. Redlich, A.F.G. van der Meer (FOM Rijnhuizen)

Smith-Purcell (SP) radiation has been used to investigate the longitudinal profile of a 45MeV, picosecond long bunched beam at the FELIX facility, FOM Institute. The three important optical elements that made this experiment possible were (i) high quality optical filters, (ii) nonimaging light concentrators, (iii) and a system to rapidly change between gratings.

TUPCH043

Observations of the Longitudinal Electron Bunch Profile at 45MeV Using coherent Smith-Purcell radiation

G. Doucas, V. Blackmore, B. Ottewell, C. Perry (OXFORDphysics) P.G. Huggard (CCLRC/RAL) M.B. Johnston (University of Oxford, Clarendon Laboratory) M.F. Kimmitt (University of Essex, Physics Centre) B. Redlich, A.F.G. van der Meer (FOM Rijnhuizen)

Coherent Smith-Purcell (SP) radiation has been used to determine the longitudinal profile of the electron bunch at the FELIX facility, FOM Institute. Far-infrared radiation was detected using a simple, compact arrangement of 11 pyroelectric detectors. Background radiation was suppressed through the use of high quality optical filters, and an efficient light collection system. The measured bunch profile was most closely in agreement with 90% of the particles contained within 5.5ps, with an approximately triangular temporal profile.

TUPCH044

Turn-by-turn Data Acquisition and Post-processing for the Diamond Booster and Storage Ring

R. Bartolini, M.G. Abbott, I.P.S. Martin, G. Rehm, J.H. Rowland (Diamond)

The Diamond booster and storage ring are equipped with Libera Electron Beam Position Processors with turn-by-turn capabilities. We describe here the turn-by-turn data acquisition system and the software used for post-processing the beam data. The signals from the Libera boxes are acquired and controlled with EPICS and then transferred to the MATLAB environment via the MATLAB Channel

Access. Here they are post-processed using MATLAB capabilities and dedicated software linked to MATLAB. Examples of data acquired and measurements performed during Diamond booster and storage ring commissioning are reported.

First Use of Current and Charge Measurement Systems in the Commissioning of Diamond

TUPCH045

A.F.D. Morgan, M.G. Abbott, G. Rehm (Diamond)

This paper will discuss the results obtained from the charge and current measurement systems installed in Diamond during the commissioning stage of operation. The charge measurements are gathered from integrating current transformers and Faraday cups, while the current is measured using a DC current transformer in each ring. The measured beam parameters will be investigated, as well as how well the devices performed against expectations.

Performance of Global Diagnostics Systems during the Commissioning of Diamond

TUPCH046

G. Rehm, M.G. Abbott (Diamond)

This paper summarises data acquired with beam diagnostics systems distributed globally through Diamond's Linac, transfer paths, booster and storage ring. It shows results from the electron beam position monitors using their capabilities to monitor transient events, the booster ramp as well as stored beam. The performance derived from real beam measurements is compared to measurements obtained in the lab using signal and pulse generators. Other systems of widespread use are screens and synchrotron light monitors. Their performance and control system integration based on IEEE1394 camera technology is presented. Finally, first results from the fast and slow beam loss monitoring systems are described.

Diamond Optical Diagnostics: First Streak Camera Measurements

TUPCH047

C.A. Thomas, G. Rehm (Diamond)

We present in this paper a first set of measurements of the six-dimensional phase-space of the electron beam in the Diamond storage ring. We recall the predicted performance and compare it with our first measurements. The two pinhole cameras measure the beam size, from which we retrieve the energy spread and the emittance of the beam in both horizontal and vertical directions. We have designed a robust and simple UV-visible beamline, to measure the electron bunch profile and length with a streak camera, and to measure the beam quality using a state-of-the-art single photon counting technique.

TUPCH048

A Study of Emittance Measurement at the ILC

G.A. Blair, I.V. Agapov, J. Carter, L. Deacon (Royal Holloway, University of London) D.A.-K. Angal-Kalinin (CCLRC/DL/ASTeC) L.J. Jenner (Cockcroft Institute) M.C. Ross, A. Seryi, M. Woodley (SLAC)

The measurement of the ILC emittance in the ILC beam delivery system and the linac is simulated. Estimates of statistical and machine-related errors are discussed and implications for related diagnostics R&D are inferred.

TUPCH049

Proposal for a Fast Scanning System Based on Electro-optics for Use at the ILC Laser-wire

A. Bosco, G.A. Blair, S.T. Boogert, G.E. Boorman, L. Deacon, C. Driouichi, M.T. Price (Royal Holloway, University of London)

Electro-optic devices open the possibility of ultra-fast scanning systems for use in intra-train scanning at the ILC, where scanning rates in excess of 100 kHz may be required. A first study of the possibilities is presented together with the first results from a prototype system.

TUPCH050

Beam Profile Measurements with the 2-D Laser-wire

G.A. Blair, I.V. Agapov, S.T. Boogert, G.E. Boorman, A. Bosco, J. Carter, C. Driouichi, M.T. Price (Royal Holloway, University of London) K. Balewski, H.-C. Lewin, F. Poirier, S. Schreiber, K. Wittenburg (DESY) N. Delerue, D.F. Howell (OXFORDphysics) T. Kamps (BESSY GmbH)

A new laser-wire system has been installed at the PETRA ring at DESY, Hamburg. The system is set up to scan in two dimensions using piezo-driven mirrors and employs a newly acquired injection seeded Q-switched laser. The system is described and first results are presented.

TUPCH052

Turn by Turn Measurements at DAFNE Based on the Libera Beam Position Processor

A. Stella, M. Serio (INFN/LNF)

The BPM detection electronics developed by Instrumentation Techonologies implements digital receivers technology to measure beam position from the amplitude of pick-up signals. Besides the closed orbit mode, the Libera module can be operated also in the Turn-by-Turn mode. Operational experience with Libera at DAFNE, the Frascati $e^+ e^-$ collider, has been focused on this functionality. Data obtained from DAFNE have been processed with well established extraction algorithms to accurately measure the betatron tunes from a small number of turns, providing instantaneous information on tune variations occurred also in fast damped decays after a kick. Hardware and software implementation together with experimental data are reported.

Bunch Length Characterization Downstream from the Second Bunch Compressor at FLASH DESY, Hamburg

TUPCH053

E. Chiadroni (INFN-Roma II)

The characterization of the longitudinal density profile of picosecond and sub-picosecond relativistic particle bunches is a fundamental requirement in many particle accelerator facilities, since knowledge of the characteristics of the accelerated beams is of utmost importance for the successful development of the next generation light sources and linear colliders. The development of non-intercepting beam diagnostics is thus necessary to produce and control such beams. First experimental evidences of the non-intercepting nature of diffraction radiation diagnostics are given. The longitudinal bunch distribution downstream of the second bunch compressor of the DESY TTF VUV-FEL has been reconstructed using a frequency-domain technique based on the autocorrelation of coherent diffraction radiation. Due to the low and high frequency suppression, introduced by the experimental apparatus, only a portion of the CDR spectrum participates to the reconstruction of the longitudinal bunch profile. The knowledge of the system frequency response is then crucial in order to correct the results and extrapolate a bunch shape as close as possible to the real one.

Upgrade of Signal Processing of the BPM System at the SPring-8 Storage Ring

TUPCH054

T. Fujita, S. Sasaki, M. Shoji, T. Takashima (JASRI/SPring-8)

SPring-8 is a third generation synchrotron light source, which is operated stably with top-up mode and with optics of low emittance mode. Along with stabilization of electron beam orbit in the ring, upgrading of the BPM system has also been required. We have developed a new signal processing circuit for COD measurement with a target of a few microns of position resolution at 1 kHz band-width and a few hundreds per second to take beam position of all BPMs. In the new circuit, a multiplexing method is employed and the IF frequency is directory detected with a 2MSPS 16-bit ADC. The digitized signal is processed with DSP to obtain beam position. Analog components of the circuit are equipped in a temperature controlled cabinet in order not to be affected by fluctuation of ambient temperature. In this paper we report schematics and performance of the new circuit, e.g., dependence of position resolution on measurement band-width and long time stability, etc. In addition, we briefly describe possibility of fast orbit measurement as a further application of the circuit.

Beam Phase Measurement of Stored Bunch

TUPCH055

T. Ohshima, A. Yamashita (JASRI/SPring-8) M. Yoshioka (SES)

We developed a system to measure synchronous phase angles for all bunches stored in the storage ring using an oscilloscope with high sampling rate. Precise phase measurement of specific bunch is required from the synchrotron radiation (SR) users, especially from the time resolved spectroscopy users. In a pump and probe experiment, the trigger timing for pumping laser should be precisely adjusted to the probe SR light. The timing of SR light is affected by the accelerating RF voltages, filling pattern, bunch currents, gap positions of insertion devices and so on. At the SPring-8, the bunch currents and the synchronous phase angles for all stored bunches can be measured within 30seconds using newly developed system. The precision of the phase angle is less than 8ps. We are now preparing to deliver the information of synchronous phase angle to SR users. The detail of the measurement system and achieved performance will be presented.

TUPCH056

A Simpler Method for SR Interferometer Calibration

J.W. Flanagan, H. Fukuma, S. Hiramatsu, H. Ikeda, T. Mitsuhashi (KEK)

Previous methods of performing absolute calibration of the SR interferometer used at KEKB (measuring mirror distortion with a pinhole mask, virtual beam broadening via local bumps, physical beam broadening via dispersion bumps) are very time-consuming, and require dedicated machine time to take the necessary data. We report on a new, simpler method we have developed, wherein we create small local bumps at the SR source point and observe the resulting shifts in the phase of the interference fringes. From these data we can calibrate the total magnification of the system, including the effects of mirror distortion. The calibration data can be taken in a very small amount of time (tens of minutes), and in parallel with physics running, without stopping the beam-size measurement system or interfering with its use for luminosity tuning. By taking the calibration data at different beam currents and correlating the magnification at each current with the appropriate interference pattern fit parameters, we can also obtain the parameters needed for real-time mirror distortion correction.

TUPCH057

A Diagnostic System for Beam Abort at KEKB

H. Ikeda, K. Akai, J.W. Flanagan, T. Furuya, S. Hiramatsu, M. Suetake, Y. Suetsugu, M. Tobiyama, T. Tsuboyama (KEK) S. Stanic (Tsukuba University)

A controlled beam abort system has been installed at KEKB for the protection of the hardware components of the accelerator and detector from damage by ampere-class beam currents. In order to identify the reason for each abort and optimize the abort system to handle each type of problem as well as improve machine operation, a diagnostic system has been developed. Fast signals, such as beam currents, accelerating voltages of the RF cavities and beam loss monitor signals from PIN photo-diodes are recorded and analyzed by a data logger system with a high sampling rate at the moment of each abort. Beam oscillations, radiation dose at the detector and vacuum pressure are also examined to classify the reasons for beam loss and aborts. Statistics and typical examples of these aborts will be discussed.

TUPCH058

Very Small Beam Size Measurement by Reflective SR Interferometer at KEK-ATF

T. Naito, T. Mitsuhashi (KEK)

An SR interferometer with the Herschelian reflective optics has been developed for the measurement of several um beam size. The chromatic aberration of the optical system applied in the SR interferometer limits the resolution of SR interferometer. We used objective lens of the SR interferometer by a focusing mirror. For the convenience of observation of the interferogram, we applied Herschelian arrangement of the optics. The measured vertical beam size was less than 5um and the estimated vertical emittance was 1x10-11m at the KEK-ATF damping ring.

Dual-mode Beam Current Monitor

S. Ninomiya, T. Adachi, S. Fukumoto (KEK) S.H. Hatori, T. Kurita (WERC)

A new type HEREWARD-transformer is developed. The original scheme connects pickup coil to the low impedance input of the amplifier to increase the time constant of the transformer. The new scheme employs negative impedance circuit which realizes perfect cancellation of the coil resistance. Therefore DC component of the beam current can be observed. Since number of winding of the pick up coil is only 100-turns, therefore by using the original scheme with a fast operational amplifier, the transformer can be operated at fast CT mode. Thus the dual mode operation can be realized by single core; the first mode is the slow beam intensity monitor, and the second is a fast response transformer. This operation mode realizes an accurate observation of the beam injection process. In order to make installation easy, the core is divided into two pieces. The magnetic shield from bending field is also installed. This monitor is developed at KEK, and installed into the accelerator at the WAKASA WAN Energy Research Center.

Beam Collimator System in the J-PARC 3-50BT Line

M.J. Shirakata, H. Oki, T. Oogoe, Y. Takeuchi, M. Yoshioka (KEK)

For the J-PARC 50 GeV Main Ring Synchrotron (MR), the design beam emittance is 54 pi mm mrad. On the other hand, the 3 GeV beam from the Rapid Cycling Booster Synchrotron (RCS) may have a large halo component upto 216 pi mm mrad. In order to absorb the halo component, a beam collimator system will be installed in the beam transport line called as the 3-50BT, which connects the RCS and the MR. From the view of the hands-on maintenance, high endurance structure is adopted. The beam collimator design including the beam optics is reported in this paper.

Installation of Beam Monitor Sensors in the LINAC Section of J-PARC

S. Sato, H. Ao, T. Tomisawa, A. Ueno (JAEA/LINAC) H. Akikawa (JAEA) Z. Igarashi, S. Lee (KEK)

In the LINAC section of J-PARC, we have several type of sensors of monitor, i.e, Beam Position Monitor, Beam Profile Monitor, Beam Size Monitor, Current Monitor, Beam Phase Monitor, Beam Loss Monitor. Those sensors are being installed currently. The procedures, remarks during the installation, status are described in this paper. As an examle, the beam postion monitors are one of sensors which are taken cared intensively for their positioning on their housing quadrupole magnet, then our cares during their installation are described .

Synchrotron Radiation Diagnostics for the NSLS Booster

T.V. Shaftan, I. Pinayev (BNL)

We developed an optical diagnostics system for the NSLS booster-synchrotron utilizing the synchrotron radiation from the dipole magnet. MATLAB based software allows to study the electron beam properties along the energy ramp. The trajectory, beam sizes and coupling at the different instants of time are retrieved from the analysis of the electron beam image. In the paper we present the system layout, as well as experimental results and upgrade plans.

TUPCH063

Novel Method for Beam Dynamics using an Alpha Particle Source

A. Sato, M. Aoki, Y. Arimoto, I. Itahashi, Y. Kuno, T. Oki, M. Yoshida (Osaka University)

PRISM is a future muon source which would provide high intense, monochromatic and pure muon beams. In order to achieve such muon beams we use a technique called Phase Rotation using an FFAG ring (PRISM-FFAG). The PRISM-FFAG ring is now under construction in Osaka university. The Commissioning will start in JFY 2007. In order to investigate the dynamical performances of the FFAG before the actual commissioning, we propose a novel experimental method. The principle of the method and its application to PRISM-FFAG will be described in this paper.

TUPCH064

Beam-based Alignment Strategy for the Group Controlled Magnets System

N. Hayashi (JAEA/J-PARC) S. Lee, T. Toyama (KEK)

The beam based alignment of the beam position monitor (BPM) becomes an important tool to reduce the closed orbit distortion (COD) in the recent accelerator. Normally, it requires the independent control of the quadrupole field. Changing the current of a quadrupole magnet, one would find the unperturbed position. However, the J-PARC Rapid-Cycling Synchrotron (RCS) has seven quadrupole families and only group of each family can be controlled simultaneously. There is neither separate power supplies nor auxiliary coil windings on each individual magnet. A similar alignment procedure is applicable for the coupled-controlled magnet system, but it becomes very complicated. For the simplest case, three magnets grouped together, four different beam orbits have to be measured at three different BPM locations. The method and some simulation results for J-PARC/RCS case will be presented in this report.

TUPCH065

A Prototype of Residual Gas Ionization Profile Monitor for J-PARC RCS

K. Satou, N. Hayashi (JAEA/J-PARC) S. Lee, T. Toyama (KEK)

A prototype of a residual gas ionization profile monitor (IPM) for J-PARC RCS has been developed. It consists of electrodes producing electric field to collect ionized ions/electrons, MCP as a signal read-out device, an electron generator to evaluate the gain balance of MCP channels, and a wiggler type magnet producing guiding field. The monitor has been installed in KEK-PS main ring and has been examined using proton beam. At the conference, recent preliminary results of experiments will be reported.

TUPCH067

Time-resolved Beam Emittance Measurement of Dragon-I Linear Induction Accelerator

G.J. Yang, S. Chen, X. Jiang, Z. Zhang (CAEP/IFP)

A beam emittance diagnostic system of an intense pulsed electron beam (20MeV, 2.6kA, 80ns) based on optical transition radiation is developed. A gated CCD camera is used to get time-resolved result. We develop a timing system to avoid the time jitter, an anti-interference system to avoid the electromagnetic interference, and a C++ code to deal with the experimental data. The measured emittance is about 2000¦Đ.mm.mrad, which is agree with the result of three gradient method.

Development of Beam Profile Monitor for Cyclotron

TUPCH070

K.-H. Park, S.-M. Hong, Y.G. Jung, D.E. Kim, H.-G. Lee, W.W. Lee (PAL) D.H. An, J.-S. Chai, Y.S. Kim (KIRAMS) B.-K. Kang (POSTECH)

A beam profile monitor was designed and fabricated to measure the beam shape of the cyclotron MC50 beam line at KIRAMS. The sensor module was made of 13 tungsten wires and they were assembled into an array type. The sensor wires whose diameter is 1 mm were placed in parallel with the incident beam, while they were placed in the perpendicular direction to the incident beam in the conventional method. Thus this monitor has a linear actuator to scan whole beam profile, which moves the sensor module from the dormant to measurement position or vice versa. The current output of each sensor was amplified using a trans-resistance amplifier which can measure input current in the range of 1 pA. The amplifier had a resolution of ~ 20 fA, the temperature drift of ~0.5 pA/^{o}C, and the signal-to-noise ratio greater than 80 dB. Various test results of the amplifier and sensor module assembly are given in this paper. The measured current profiles of cyclotron beam line at KIRAMS are also given.

Testing the Silicon Photomultiplier for Ionization Profile Monitor

TUPCH071

S.V. Barabin, D.A. Liakin, A.Y. Orlov (ITEP) P. Forck, T. Giacomini (GSI)

A new kind of photonic device is proposed to be used in the fast operating mode of the ionization profile monitor. A silicon photomultiplier device combines the advantages of photomultipliers and solid-state photo detectors. It provides high sensitivity, wide optical spectrum response, high bandwidth and absence of 1/f noise component. Those parameters are critical in the IPM with fast readout feature, which is developing in GSI in collaboration with ITEP, COOSY, MSU and CRYRING laboratories. Very first investigations were made to obtain detailed parameters of silicon photomultiplier. A testing layout and resulting performance data are presented in this publication.

New Generation Streak Camera Design and Investigation

TUPCH072

A.M. Tron (LPI) T.V. Gorlov, I.G. Merinov (MEPhI)

The only method for electron bunch duration monitoring with a resolution in the order of 10 fs and less is the method of photochronography of the bunch incoherent radiation in the frequency range, for example, of visible light and at realizing streak camera with new principles of its operation*. In the paper the streak camera design for measuring both the electron bunches and x-ray pulses duration with the mentioned temporal resolution is presented. The results of the camera investigation, with photoelectron dynamics simulation taking into account space-charge effect and impact of the surface roughness of a spherical photocathode of the 20-50 micrometers radius (forming a modulating gap of spherical configuration) on the camera resolution, are presented and discussed.

*A. M. Tron and I. G. Merinov. Method of bunch radiation photochronography with 10 femtosecond and less resolution. http://www.physics.ucla.edu/PAHBEB2005/talks/10**oct**2005/wg**2/a**tron.pdf

TUPCH073

Study of Beam Energy Spread at the VEPP-4M

O.I. Meshkov, V. F. Gurko, A.D. Khilchenko, V. Kiselev, N.Yu. Muchnoi, A.N. Selivanov, V.V. Smaluk, A. N. Zhuravlev (BINP SB RAS)

The knowledge of beam energy spread is necessary for the experimental program of the VEPP-4M collider. In this report we discuss the application of optical diagnostics for measurement of this value. The diagnostics is based on multi-anode photomultiplier and provides information about betatron and betetron frequencies of electron beam*. The beam energy spread is derived from the spectra of synchrotron oscillation. The results, obtained with this method, are compared with data, provided by Compton backscattering technique.

*O. I. Meshkov et al. Application of the beam profile monitor for VEPP-4M tuning. Proc. of DIPAC '05, June 6 - 8, 2005, Lyon, France, POM008.

TUPCH074

Fast and Precise Beam Energy Monitor Based on the Compton Backscattering at the VEPP-4M Collider

N.Yu. Muchnoi, S.A. Nikitin, V.N. Zhilich (BINP SB RAS)

Accurate knowledge of the colliding beam energies is essential for the current experiments with the KEDR detector at the VEPP-4M collider. Now the experimental activity is focused on the new precise measurement of the tau-lepton mass by studying the behavior of the tau production cross-section near the reaction threshold. To achieve the desired quality of the experiment, an on-line beam energy monitoring by the Compton backscattering of laser light was performed. This approach is found to be a very good supplement to rare energy calibrations by the resonant depolarization technique, saving the beam time for luminosity runs. The method itself does not require electron beam polarization and additionally allows one to measure the electron beam energy spread. The achieved accuracy of the method in the beam energy range 1.7–1.9 GeV is 60 keV.

TUPCH075

Dependence of the Electron Beam Polarization Effect in the Intra-beam Scattering Rate on the Vertical Beam Emittance

S.A. Nikitin, I.B. Nikolaev (BINP SB RAS)

Measurement of the Intra-beam scattering rate is applied in the resonant depolarization technique to detect beam polarization in electron/positron storage rings. A depolarization jump in the counting rate of scattering particles occurs at the instant when the beam becomes unpolarized due to fulfillment of the external spin resonance condition. The magnitude of the jump depends on polarization quadratically. It also depends on some other beam parameters as well as the position of counters relative to the beam orbit. A larger jump implies higher accuracy in absolute calibration of particle energy because the latter is proportional to the spin precession frequency. In contrast to an ordinary one-dimensional approach, we calculate the magnitude of jump subject to, among other things, the vertical component of relative velocity in particle collisions inside the beam. For this purpose, the transverse momentum distribution function is properly modified. Calculations performed for the VEPP-4M storage ring-collider show that the jump may depend significantly on the ratio between the vertical and radial beam emittance. We present results of our recent experiments on study of this dependence.

Beam Phase Measurement in a 200 MeV Cyclotron

TUPCH077

J.L. Conradie, A.H. Botha, P.J. Celliers, J.L.G. Delsink, D.T. Fourie, P.T. Mansfield, P.F. Rohwer, M.J. Van Niekerk (iThemba LABS) J. Dietrich, I. Mohos (FZJ)

New phase measuring equipment is being planned for the K 200 variable frequency, separated-sector cyclotron at iThemba LABS near Cape Town. A commercial lock-in amplifier is used to measure the beam phase over the full radial range. Measurements are made at the third and fifth harmonics of the main RF frequency to limit pick-up from the flat-topping and main dees. Computer-generated signals, with phase and amplitude control, at the same harmonics, are used to cancel the signals coupled from the dees to the phase probes. In addition the signals without beam are vectorially subtracted from those with beam to enhance the sensitivity and accuracy. Results of measurements, using these techniques, on existing phase probes in the cyclotron, will be presented.

BPM Design for the ALBA Synchrotron

TUPCH078

F. Pérez, A. Olmos (ALBA) T.F. Günzel (ESRF)

ALBA is a 3 GeV, low emittance, 3rd generation synchrotron light source that is in the construction phase in Cerdanyola, Spain. Vertical beam sizes down to a few microns will require beam stabilities on the submicron level. The BPM has to be designed in order to provide reliable and accurate beam position readings. Simulation and computational codes have been used to optimise, for a given vacuum chamber dimension, the BPM design. The optimisation has taken into account the usual sensitivity and intrinsic resolution parameters, but as well, the wakefield loss factor of the buttons. Due to the small vertical vacuum chamber dimension and the high design current, the beam power deposited in the buttons is becoming a concern due to the thermal deformation effects that can introduce errors at the submicron level. A compromise between a higher intrinsic resolution from one side, and a low power deposited by the beam in the buttons from the other, define the final buttons dimensions.

Characterisation of the MAX-II Electron Beam: Beam Size Measurements

TUPCH079

M. Sjöström, H. Tarawneh, E.J. Wallén (MAX-lab)

Over the last year investigations of the MAX-II electron beam characteristics have been made. Examples of investigated parameters include the beam size, bunch length, vacuum and Touschek lifetimes, and the machine functions. Several upgrades of the MAX II ring have been performed since the commissioning 1995 like a new 100 MHz RF system with a 500 MHz Landau cavity, exchanged injector, and a variety of insertion devices. There is hence a need to systematically characterize the present machine. This systematic characterisation is now underway and this article describes details of the beam size measurements.

Bunched Beam Current Measurements with 100 pA rms Resolution at CRYRING

TUPCH080

A. Paal, A. Simonsson (MSL) J. Dietrich, I. Mohos (FZJ)

In CRYRING molecular beams with currents down to 1 nA are used for experiments. To extend the rms resolution of the bunched beam current measurements down to 100 pA, a BERGOZ Integrating Current Transformer (ICT) and one of the

the capacitive pick-up's sum signal are integrated simultaneously. The absolute calibration of the pick-up integrator signal is carried out at the end of the acceleration stage, during 20-60 ms. The ion beam current can be measured over a pulse width range of 100 ns to 15 us with a 20-60% bunch duty cycle. For both detectors, low noise amplifiers and a differential input double integrator have been designed. A programmable phase shifter allows measurement of the beam current during the acceleration of the ions, generating a gate signal with proper phase for the integrators in the 30 kHz-3 MHz frequency range. The bandwidth of the integrators used is 100 Hz.

TUPCH081

Technical Aspects of the Integration of the Optical Replica Synthesizer for the Diagnostics of Ultra-short Bunches in FLASH at DESY

V.G. Ziemann (UU/ISV) N.X. Javahiraly, P. van der Meulen (FYSIKUM, AlbaNova, Stockholm University) M. Larsson (Stockholm University, Department of Physics) E. Saldin, H. Schlarb, E. Schneidmiller, A. Winter, M.V. Yurkov (DESY)

In this paper we present an overview of current status of the Optical Replica synthesizer at DESY. The method is based on producing an "optical copy" of the electron bunch with its subsequent analysis with optical techniques*. To this end, a near-IR laser beam is superimposed on the electron beam in the first undulator of an optical klystron. In the following dispersive section the laser-induced energy modulation is transformed into a density modulation . The modulated electron bunch then produces a strong optical pulse in the second undulator. Analysis of this near-IR pulse (the optical copy) then provides information about the profile, the slice emittance and the slice energy spread of the electron bunch. We discuss the implementation of such a measurement set-up at the FLASH facility at DESY and investigate the influence of various parameters on the performance of the device. Topics we address include the dispersive chicane, as well as the requirements for the seed laser pulses and the detection and analysis of the near-IR pulse.
*E. Saldin, et al. "A simple method for the determination of the structure of ultrashort relativistic electron bunches," Nucl. Inst. and Methods A 539 (2005) 499.

TUPCH082

The EuroTeV Confocal Resonator Monitor Task

V.G. Ziemann, T. J. C. Ekelof, A. Ferrari, M. A. Johnson, E. A. Ojefors, A. B. Rydberg (UU/ISV) F. Caspers (CERN)

We describe the progress in the analysis of the confocal resonator monitor task which is part of the diagnostics workpackage of EuroTeV. The initial design was analyzed both numerically and experimentally and found limitations. We therefore digressed from strict confocality and report the numerical analysis and S-parameter measurements of a modified design. Furthermore, we discuss the mechanical design needed for planned tests with beam in CTF3 which requires integration of the monitor into the beam pipe, damping of trapped modes, and frequency tunability.

TUPCH083

Time-resolved Spectrometry on the CLIC Test Facility 3

T. Lefevre, C.B. Bal, H.-H. Braun, E. Bravin, S. Burger, R. Corsini, S. Doebert, C.D. Dutriat, F. Tecker, P. Urschütz, C.P. Welsch (CERN)

The high charge (>6microC) electron beam produced in the CLIC Test Facility 3 (CTF3) is accelerated in fully loaded cavities. To be able to measure the resulting strong transient effects, the time evolution of the beam energy and its energy spread must be measured with at least 50MHz bandwidth.

Three spectrometer lines were installed all along the linac in order to control and tune the beam. The electrons are deflected by a dipole magnet onto an Optical Transition Radiation (OTR) screen, which is observed by a CCD camera. The measured beam size is then directly related to the energy spread. In order to provide time-resolved energy spectra, a fraction of the OTR photons is sent onto a multichannel photomultiplier. The overall set-up is described, special focus is given to the design of the OTR screen with its synchrotron radiation shielding. The performance of the time-resolved measurements are discussed in detail. Finally, the limitations of the system, mainly due to radiation problems, are discussed.

Expected Signal for the TBID and the Ionization Chambers Downstream of the CNGS Target Station

TUPCH084

L. Sarchiapone, A. Ferrari, E. Gschwendtner, M. Lorenzo Sentis (CERN)

Downstream the carbon graphite target of the CNGS (CERN Neutrinos to Gran Sasso) facility at CERN it has been decided to install a secondary emission monitor called TBID (Target Beam Instrumentation Downstream) monitor to measure the multiplicities and the left/right as well as up/down asymmetries of secondary particles from target. Calculations show that the titanium windows used to close off the TBID vacuum tank might not withstand the highest beam intensities with small spot sizes expected at CNGS, in case the proton beam accidentally misses the 4-5 mm diameter target rods. Therefore it has been suggested to place two ionisation chambers as a backup for the TBID located left and right of the TBID monitors. Monte Carlo simulations with the particle transport code FLUKA were performed firstly to obtain the fluence of charged particles in the region of interest and secondly to estimate the induced radioactivity (noise) in this area. This allows to assess the actual signal/noise situation and thus to determine the optimal position (lateral displacement with respect to the beamline) of the ionisation chambers. This document presents the results of these calculations.

Precision Beam Timing Measurement System for CLIC Synchronization

TUPCH086

J.P.H. Sladen, A. Andersson (CERN)

Very precise synchronization between main and drive beams is required in CLIC to avoid excessive luminosity loss due to energy variations. One possibility to accomplish this would be to measure and correct the drive beam phase. The timing reference for the correction could be the beam in the transfer line between the injector complex and the main linac. The timing of both main and drive beams will have to be measured to a precision in the region of 10 fs. The aim is to achieve this by means of a beam measurement at 30 GHz with the signal mixed down to an intermediate frequency (IF) for precise phase detection. The RF and IF electronics are being developed and tests will be carried out in CTF3.

Beam Diagnostics with Schottky Noise in LEIR

TUPCH087

J. Tan, G. Tranquille (CERN)

The high density Lead ion beams, needed for LHC, are obtained in the Low Energy Ion Ring (LEIR) at CERN by multi-turn injection followed by electron cooling and stacking. During this injection and stacking phases where the circulating beam is unbunched, diagnostics with Schottky noise are used for probing essential beam parameters, such as tune, momentum spread, emittance and their evolution with time… The hardware facility and first results obtained during the recent commissioning of LEIR are described.

TUPCH088

High Dynamic Range Beam Profile Measurements

C.P. Welsch, E. Bravin, B. Burel, T. Lefevre (CERN) T. Chapman, M.J. Pilon (Thermo)

In future high intensity, high energy accelerators, beam loss has to be minimized to maximize performance and minimize activation of accelerator components. It is imperative to have a clear understanding of the mechanisms that can lead to halo formation and to have the possibility to test available theoretical models with an adequate experimental setup. Measurements based on optical transition radiation (OTR) provide an interesting opportunity for high resolution measurements of the transverse beam profile. In order to be applicable for measurements within the beam halo region, it is of utmost importance that a high dynamic range is covered by the image acquisition system. The existing camera system as it is installed in the CLIC Test Facility (CTF3) is compared to a step-by-step measurement with a photo multiplier tube (PMT) and measurements with a cooled charge injection device (CID) camera. The latter acquisition technique provides an innovative and highly flexible approach to high dynamic range measurements and is presented in some detail.

TUPCH089

Investigations of OTR Screen Surfaces and Shapes

C.P. Welsch, E. Bravin, T. Lefevre (CERN)

Optical transition radiation (OTR) has proven to be a flexible and effective tool for measuring a wide range of beam parameters, in particular the beam divergence and the transverse beam profile. It is today an established and widely used diagnostic method providing linear real-time measurements. Measurements in the CLIC Test Facility (CTF3) showed that the performance of the present profile monitors is limited by the optical acceptance of the imaging system. In this paper, two methods to improve the systems' performance are presented and results from measurements are shown. First, the influence of the surface quality of the OTR screen itself is addressed. Several possible screen materials have been tested to which different surface treatment techniques were applied. Results from the measured optical characteristics are given. Second, a parabolic-shaped screen support was investigated with the aim of providing an initial focusing of the emitted radiation and thus to reduce the problem of aperture limitation. Measured and calculated emission distributions are presented.

TUPCH090

Electron Beam Profile Measurements with Visible and X-ray Synchrotron Radiation at the Swiss Light Source

Å. Andersson, M. Rohrer, V. Schlott, A. Streun (PSI) O.V. Chubar (SOLEIL)

Two different methods of beam profile measurements using a) visible-to-UV range synchrotron radiation b) X-ray synchrotron radiation have been realized in a single diagnostics beam line at the Swiss Light Source. While the visible-to-UV part uses a focusing lens to create an image of the electron beam cross section, the X-ray part makes use of the pinhole camera principle. In the visible-to-UV case the vertically polarized synchrotron radiation renders an image heavily influenced by inherent emission and diffraction effects of synchrotron radiation. This turns out to be an advantageous influence in order to determine

ultra small beam profiles. For each of the two methods practical point-spread function measurements, including all beam line components, and high-precision wave-optics based calculations (SRW code) of the synchrotron light characteristics were performed to ensure correct interpretation of the measured profiles. Results from both monitors will be presented to allow comparison.

Commissioning of a New Digital BPM System for the PSI Proton Accelerators

TUPCH092

B. Keil, P.-A. Duperrex, M. U. Müller (PSI)

A new digital beam position monitor (DBPM) system has been developed and successfully tested at the PSI proton accelerators. The DBPM hardware consists of an analogue RF front-end (RFFE), a VMEbus backplane module (VBM), and the PSI VME PMC Carrier board (VPC). The RFFE combines the 2nd RF harmonic (101.26 MHz) beam signals of pickup coils with a 101.31 MHz pilot signal. The RFFE output signals are undersampled and down-converted to base-band (no analogue mixer) by ADCs and DDCs (Direct Digital Downconverters) on the VBM. The DDCs send the digitised beam and pilot signal amplitudes to a Virtex2Pro FPGA on the VPC board. The FPGA calculates the beam positions at different averaging rates, checks interlock limits, and provides triggered storage of beam position waveforms. Furthermore, the FPGA performs automatic gain control of voltage-controlled amplifiers (VCAs) of RFFE and VBM. By continuous normalisation of beam to pilot signal, nonlinearities and temperature drifts of the electronics are eliminated. Compared to the old analogue BPM electronics, the new DBPMs offer an increased dynamic range (0.2 μA to 2 mA instead of 5 μA to 2 mA) and larger bandwidth (10 kHz instead of 10 Hz).

THz Diagnostic for the Femtosecond Bunch Slicing Project at the Swiss Light Source

TUPCH094

V. Schlott, D. Abramsohn, P. Beaud, G. Ingold, P. Lerch (PSI)

Interaction of electron bunches with a femtosecond Ti:Sa laser beam along a modulator wiggler in the Swiss Light Source (SLS) storage ring results in an energy modulation of the electron beam on the length scale of the laser pulse. While high energy photon pulses (3 18 keV, ~ 100 fs long) are produced by an in-vacuum undulator (radiator) and used for time resolved experiments within the SLS femtosecond bunch slicing project, coherent synchrotron radiation (CSR) emitted by the adjacent bending magnet in the THz-regime is used for longitudinal slicing diagnostics and monitoring of slicing efficiency. This paper describes the simulation and layout of the THz-diagnostic beamline and presents first time and spectrally resolved measurements with the longitudinal slicing diagnostics, which has been set-up for the SLS "femto-slicing" project.

Status of Synchrotron Radiation Monitor at TLS

TUPCH095

C.H. Kuo, J. Chen, K.-T. Hsu, S.Y. Hsu, K.H. Hu, D. Lee, C.-J. Wang (NSRRC)

Synchrotron radiation monitor of the Taiwan Light Source have been upgraded recently. Improvement of optics and modelling was performed to improve accuracy of measurement for small beam size. Synchrotron light interferometer is implemented for complementary measurement. IEEE-1394 digital CCD camera is used to improve image transmission quality, camera remote control and to extend dynamic range. Intensify gated camera are included in this upgrade for dynamic property observation of the stored beam.

Functionality enhancement of image analysis is also supported. Efforts and achievements will be summarized in this report.

TUPCH096

High-intensity Bremsstrahlung Monitoring System for Photonuclear Technologies

V.L. Uvarov, S.P. Karasyov, V.I. Nikiforov, R.I. Pomatsalyuk, V.A. Shevchenko, I.N. Shlyakhov, A.Eh. Tenishev, Yu.V. Zhebrovsky (NSC/KIPT)

The realization of promising photonuclear technologies (a soft technology for medical isotope production, radioactive waste handling, activation analysis, etc) calls for the sources of high-energy (Egamma>10MeV) and high-intensity (>=10E03W/cm2) photons. These sources may by obtained by converting a beam from a high-current electron Linac into bremsstrahlung. The method of combined activation of a set of foils that have different energy thresholds of the (gamma,n) reactions is proposed to determine the space-energy characteristics of such radiation. In each energy range the geometrical characteristics of the bremsstrahlung flux are reconstructed from the foil surface gamma-activity distribution. The last one is determined through one-dimensional scanning of the foils by a specially designed detecting head that includes a linear matrix of 16 collimated semiconductor detectors (CdZnTe; 2x2x2,mm). A preliminary analysis of the system geometry and applicability of the method was performed by computer simulation based on the PENELOPE software. A developed PC based measuring system with CAMAC interface is described.

TUPCH097

Instrumentation and Operation of a Remote Operation Beam Diagnostics Lab at the Cornell Electron-positron Storage Ring

R. Holtzapple, J.S. Kern, P.J.S. Stonaha (Alfred University) B. Cerio (Colgate University) M.A. Palmer (Cornell University, Laboratory for Elementary-Particle Physics)

Accelerator beam diagnostics are being modified at the Laboratory of Elementary Particle Physics (LEPP) at Cornell University for remote operation at nearby Alfred University. Presently, a streak camera used for longitudinal dynamics measurements on the Cornell Electron-Positron Storage Ring (CESR) is operational and measurements have been made from Alfred University [1]. In the near future, photomultiplier tube arrays for electron and positron vertical beam dynamics measurements will be remotely operated as well. In this paper, we describe instrumentation and operation of the remote beam diagnostics.

TUPCH098

Antiproton Momentum Distributions as a Measure of Electron Cooling Force at the Fermilab Recycler

D.R. Broemmelsiek, S. Nagaitsev (Fermilab)

The Fermilab Recycler is a fixed 8GeV kinetic energy storage ring located in the Fermilab Main Injector tunnel near the ceiling. Electron cooling of high-energy antiprotons has recently been demonstrated at the Recycler. Antiproton beam Schottky signals were used to measure the antiproton momentum distribution at equilibrium between a calibrated broadband diffusion source and electron cooling. The large Recycler momentum aperture, the dependence of the electron cooling force as a function of the antiproton momentum deviation and the calibrated diffusion source combine to give a unique spectral measurement of the antiproton momentum beam distribution.

Development of HOM Damped Copper Cavity for the ESRF

TUPCH099

N. Guillotin, J. Jacob, V. Serriere (ESRF)

At the ESRF, HOM driven longitudinal coupled bunch instabilities are currently avoided up to the nominal beam current of 200 mA by precisely controlling the cavity temperatures and thereby the HOM frequencies of the existing five-cell copper cavities. A bunch-by-bunch feedback is presently being commissioned in order to increase the maximum stored current. In parallel, normal conducting strongly HOM damped cavities are under study to possibly replace the five-cell cavities. The design is based on a scaling of the single cell EU cavity*: a pillbox geometry with nose cones and three attached ridged waveguides loaded by ferrites for effective HOM damping. We report on the electromagnetic simulation making use of the 3D codes HFSS and GdfidL. They allowed optimizing the shape of both cavity and dampers, including electromagnetic absorbing material with frequency dependent parameters.

*E. Weihreter et al. A Ridged Circular Waveguide Ferrite Load for Cavity HOM Damping, this conference.

Fiberoptics-based Instrumentation for Storage Ring Longitudinal Diagnostics

TUPCH100

S. De Santis, J.M. Byrd, A. Ratti, M.S. Zolotorev (LBNL) Y. Yin (Y.Y. Labs, Inc.)

Many beam diagnostic devices in today's synchrotron rings make use of the radiation emitted by the circulating particles. Such instruments are placed in close proximity of the accelerator, where in many instances they cannot be easily accessed for safety consideration, or at the end of a beamline, which because of its cost, can only move the light port a few meters away from the ring. We present a study on the coupling of synchrotron light into an optical fiber for all those application where the longitudinal properties of the beam are measured (i.e., bunch length, phase, intensity, etc.). By choosing an appropriate fiber it is possible to keep attenuation and dispersion at negligible values over a large bandwidth, so that this method would allow to have the diagnostic instruments directly in the control room, or wherever convenient, up to several hundred of meters away from the tunnel. This would make maintaining and replacing instruments, or switching between them, possible without any access to restricted areas. Additionally, the few components required to be near the ring (lenses and couplers) in order to couple the light into the fiber are intrinsically radiation-hard.

Modeling of Ultrafast Streak Cameras

TUPCH101

G. Huang, J.M. Byrd, J. Feng, H.A. Padmore, J. Qiang, W. Wan (LBNL)

We present progress on modeling of streak camera with application to measurement of ultrafast phenomena. Our approach is based on treating the streak camera as a photocathode gun and applying modeling tools for beam optics, space charge, and electromagnetic fields. We use these models to compare with experimental results from a streak camera developed at the Advanced Light Source. Furthermore, we explore several ideas for achieving sub-100 fsec resolution.

TUPCH103

New Developments on Single-shot Fiber Scope

Y. Yin, X. Che (Y.Y. Labs, Inc.)

New development has been done to reduce the noise and improve the stability of the single-shot fiber scope, which used an optical fiber recirculating delay line to regenerate the single-shot very short electrical pulse, so a sampling scope can recover the original signal. New measurements have been done and will be reported.

TUPCH105

Performance of a Nanometer Resolution BPM System

S. Walston, C.C. Chung, P. Fitsos, J.G. Gronberg (LLNL) S.T. Boogert (Royal Holloway, University of London) J.C. Frisch, J. May, D.J. McCormick, M.C. Ross, S. Smith, T.J. Smith (SLAC) H. Hayano, Y. Honda, N. Terunuma, J. Urakawa (KEK) Y.K. Kolomensky, T. Orimoto (UCB) A. Lyapin, S. Malton, D.J. Miller (UCL) R. Meller (Cornell University, Department of Physics) M. Slater, M.T. Thomson, D.R. Ward (University of Cambridge) V.V. Vogel (DESY) G.R. White (OXFORDphysics)

International Linear Collider (ILC) interaction region beam sizes and component position stability requirements will be as small as a few nanometers. It is important to the ILC design effort to demonstrate that these tolerances can be achieved – ideally using beam-based stability measurements. It has been estimated that RF cavity beam position monitors (BPMs) could provide position measurement resolutions of less than one nanometer and could form the basis of the desired beam-based stability measurement. We have developed a high resolution RF cavity BPM system. A triplet of these BPMs has been installed in the extraction line of the KEK Accelerator Test Facility (ATF) for testing with its ultra-low emittance beam. The three BPMs are rigidly mounted inside an alignment frame on variable-length struts which allow movement in position and angle. We have developed novel methods for extracting the position and tilt information from the BPM signals including a calibration algorithm which is immune to beam jitter. To date, we have been able to demonstrate a resolution of approximately 20 nm over a dynamic range of ± 20 microns. We report on the progress of these ongoing tests.

TUPCH106

Commissioning the SPEAR3 Diagnostic Beamlines

W.J. Corbett, C. Limborg-Deprey, W.Y. Mok, A. Ringwall (SLAC)

SPEAR 3 has two diagnostic beam lines: an x-ray pinhole camera and a visible/UV laboratory. The pinhole camera images ~8 keV dipole radiation on a phosphor screen with a remote computer to capture digital profile images. The visible/UV beam line features an 8 mm high GlidCop 'cold finger' to remove the x-ray core of the beam. The remaining light is deflected horizontally onto an optical bench where it is focused via reflective (Cassegrain) or refractive optics. The visible beam is then split into branch lines for a variety of experimental applications. This paper describes the experimental arrangement, data processing algorithms and measurements obtained with both systems.

Characterization of the PEP-II Colliding-beam Phase Space by the Boost Method

TUPCH108

M. Weaver (SLAC) W. Kozanecki (CEA) B.F. Viaud (Montreal University)

We present a novel approach to characterize the colliding-beam phase space at the interaction point of the energy-asymmetric PEP-II B-Factory. The method exploits the fact that the transverse-boost distribution of $e^+ e^-$ –> mu+ mu- events reconstructed in the BaBar tracking system, reflects that of the colliding electrons & positrons. The average boost direction, when combined with the measured orientation of the luminous ellipsoid, determines the e^+e^- crossing angles. Varying the horizontal direction of one beam with respect to the other in a controlled fashion allows to estimate the individual e^+ and e^- horizontal IP beam sizes. The angular spread of the transverse boost vector provides an accurate measure of the angular spread of the incoming high-energy beam, confirming the presence of a significant beam-beam induced increase of this angular spread. In addition, the longitudinal dependence of the angular spread of the boost vector in the y-z plane allows to extract from the continuously-monitored boost distributions, a weighted average of the vertical IP beta-functions & emittances of the two beams representative of routine high-luminosity operation.

Ion-related Phenomenon in UVSOR/UVSOR-II Electron Storage Ring

TUPCH109

A. Mochihashi, K. Hayashi, M. Hosaka, M. Katoh, J. Yamazaki (UVSOR) Y. Hori (KEK) Y. Takashima (Nagoya University)

A vertical betatron tune shift depending on beam current under multibunch condition was observed in the UVSOR storage ring. Vertical tune increased as beam current decreased, and the slope of the tune shift depended on the condition of the vacuum in the ring. Such a change in vertical tune was explained by a change in the stability condition of trapped ions*/** with the beam current. Based on a theoretical model*** that gives density of the trapped ions the experimental results were discussed via analytic and tracking calculations. Both the effect from the residual gas ions generated by scattering between high energy electrons and molecules and that from dissociated ions that come from secondary ionization processes have been discussed. In quest of the ion-related phenomenon in single-bunch condition, precise tune measurement has been also performed in the UVSOR-II storage ring. The experimental results in the single-bunch condition have been discussed. Precise measurement of vacuum pressure in the beam duct is a key issue of the ion-related phenomenon. A design of vacuum pressure measurement system via detecting residual gas fluorescence will be introduced in the presentation.
*R. D. Kohaupt. DESY Internal. Bericht No.H1-71/2 (1971). **Y. Baconnier and G. Brianti. CERN Internal Report No.CERN/SPS/80-2(DI) (1980). ***A. Mochihashi et al. Jpn. J. Appl. Phys. 44 (2005) 430.

Upgrade of Main RF Cavity in UVSOR-II Electron Storage Ring

TUPCH110

A. Mochihashi, K. Hayashi, M. Hosaka, M. Katoh, J. Yamazaki (UVSOR) H. Suzuki (Toshiba) Y. Takashima (Nagoya University)

The UVSOR electron storage ring, which is dedicated to a synchrotron radiation (SR) light source especially for VUV and Soft X-ray, has been improved at the beginning of 2003, and transverse emittance in the improved ring (UVSOR-II)* has been decreased from 165nm-rad to 60 and/or 27nm-rad. Users runs have been performed since September 2003 with 60nm-rad mode, and since then high brilliant SR beams have been supplied routinely for users. The 27nm-rad mode, however, was difficult to introduce to daily operation initially because Touschek lifetime was insufficient in such small emittance condition. To improve the beam lifetime and make full use of the SR beams, we have built new main RF cavity. The aim of the improvement was to increase momentum acceptance by increasing RF accelerating voltage; the previous cavity generated the voltage of 55kV, whereas the new one can generate 150kV in maximum without changing RF frequency (90.1MHz) and transmitter (20kW in maximum). The new cavity has been installed in the UVSOR-II in spring of 2005, and high power commissioning went on smoothly. Because of the improvement, from spring 2005 the UVSOR-II has switched the daily users run to 27nm-rad.

*M. Katoh et al., in this conference.

TUPCH111

RF System for the Superconducting Linac Downstream from DEINOS Injector

P. Balleyguier, J.-L. Lemaire (CEA)

The DEINOS injector will be followed by an accelerator consisting of a LEP-like cryomodule including four 4-cell superconducting cavities. Each of these cavities will be fed by a solid-state amplifier delivering 20 kW in CW operation at 352 MHz. We will use the technology developed by the "Synchrotron SOLEIL" RF team, consisting of merging the power of numerous independent 330 W modules. The design of the low level RF system will be based on our experience with the ELSA accelerator.

TUPCH112

Commissioning of the 100 MeV Preinjector HELIOS for the SOLEIL Synchrotron

A.S. Setty, D. Jousse, J.-L. Pastre, F. Rodriguez (THALES) R. Chaput, J.-P. Pollina, B. Pottin, M.-A. Tordeux (SOLEIL) A. Sacharidis (EuroMev)

HELIOS is the 100 MeV electron linac preinjector of SOLEIL the new French SR facility. It has been supplied by THALES, as a turn-key system on the basis of SOLEIL APD design. The linac was commissioned in October 2005. This paper will remind the main features of the linac, especially on beam-loading compensation, and will give results obtained during the commissioning tests where a special care has been taken for emittance measurements. Specified and measured beam parameters will be compared to show the performance of the entire system.

TUPCH113

Construction of the ALPHA-X Photo-injector Cavity

J. Rodier, T. Garvey (LAL) D.A. Jaroszynski, V.M. Pavlov, Y.M. Saveliev, M. Wiggins (USTRAT/SUPA) M.J. de Loos, S.B. van der Geer (PP)

We will describe the construction and low power testing of an RF cavity to be used as a photo-injector for the ALPHA-X project within the Department of Physics at the University of Strathclyde (UK). The gun is a two and a half cell S-band cavity, employing a metallic photo-cathode. RF power is coupled to the gun via a co-axial power coupler. The specification of the gun and the low power measurements made to achieve the correct mode frequency and field flatness will be presented.

A Ridged Circular Waveguide Ferrite Load for Cavity HOM Damping

TUPCH114

E. Weihreter, V. Duerr, F. Marhauser (BESSY GmbH)

A normal conducting HOM damped 500 MHz prototype cavity has been tested with three tapered circular double ridged waveguide to coaxial transitions as HOM couplers, featuring maximum longitudinal and transverse HOM impedances below 5 kOhm and 200 kOhm/m respectively. Numerical simulations indicate that these impedance levels can be further reduced by more than a factor of 3 using homogeneous circular double ridged waveguides for improved coupling to the HOMs. In the present paper the layout of an optimised homogeneous waveguide with "in vacuum" ferrite tiles is presented, including mechanical and thermal design considerations. Low power reflectrometry measurements demonstrate good matching of a prototype load, and high power tests of the ferrite absorber elements indicate that the waveguide load is well suited for the cavity HOM power levels present in state of art 3rd generation SR sources.

Status of the 70 MeV, 70 mA CH Proton-DTL for FAIR

TUPCH115

G. Clemente, H. Podlech, U. Ratzinger, R. Tiede (IAP) L. Groening (GSI) S. Minaev (ITEP)

The CH-type cavity shows promising features in the low and medium beta range: its high accelerator gradient and the high level of shunt impedance together with the compact transverse dimensions make this new cavity a good candidate for proton acceleration up to 100 MeV. That's why GSI has decided to base the new high current proton injector for the new FAIR facility on that structure: the operating frequency will be 352 MHz with an injection energy of 3 MeV. In order to improve the technical experience on this new kind of structure, IAP has built a model consisting of 8 equidistant gaps for a total cavity-length of 60 cm. Several design options with respect to welding, alignement, cooling and RF joints were studied and compared each other. A new concept for the end-cells geometry will result in the desired flatness of the electric field along the cavity axis and, at the same time, allow effective integration of internal quadruple lenses. Finally, the electric quadruple content of CH-structure gaps is listed in dependence on the geometry of the cell.

Waveguide Distribution Systems for the European XFEL

TUPCH116

V.V. Katalev, S. Choroba (DESY)

In the European X-ray FEL 32 superconducting cavities are connected to a 10 MW multibeam klystron through a waveguide distribution system. The basic waveguide system is a linear system. The XFEL tunnel has limited space for the waveguide system and therefore some new compact high power waveguide components like a motor driven phaseshifter, an iris tuner and an asymmetric shunt tee have been developed. Also alternative layouts of the waveguide distribution system which may have certain advantages have been designed. In this report we will present the different layouts and report on the status of the development of the different new waveguide components.

TUPCH117

Experience with the 208MHz and 52MHz RF Systems for the HERA Proton Accelerator

R. Wagner, S. Choroba, A. Gamp, T.G. Grevsmuehl, G.M. Moeller (DESY) A.B. Bienkowski (The Andrzej Soltan Institute for Nuclear Studies, Centre Swierk)

The RF System for the Hera Proton Ring consists of four 208MHz systems and two 52MHz systems. At injection three of the 208MHz systems are at 70 kV and one System is at 190kV with a phase of 180 degree. The 52 MHz Systems are at 70kV each. During ramping the RF voltage of all cavities follows a ramp table. At flat top at 920GeV both 52 MHz systems are at 50kV and three of the 208MHz Systems are at 190kV while the 180 degree phased system is reduced to 30kV. The typical beam current is 100mA in 180 bunches with a bunch separation of 96 ns. About one year before shutdown of HERA this presentation gives an review of about 14 years operation of the Proton RF System. It is also an overview of the hardware including the beam loading compensation (fast feedback) the tuning system and the other components.

TUPCH118

Manufacturing and Testing of 2.45 GHz and 4.90 GHz Biperiodic Accelerating Structures for MAMI C

A. Jankowiak, O. Chubarov, H. Euteneuer (IKP) K. Dunkel, C. Piel, H. Vogel, P. vom Stein (ACCEL)

At the Institut fur Kernphysik (IKPH) of Mainz University the fourth stage of the Mainz Microtron (MAMI), a 855MeV to 1500MeV Harmonic Double Sided Microtron*, is now on the verge of first operation. For this project ACCEL Instruments GmbH manufactured biperiodic, on axis coupled, standing wave accelerating structures at the frequencies of 2.45GHz and 4.90GHz. Four resp. eleven multicell sections were manufactured, low power characterized and after delivery tested at the high power test stand of IKPH. This paper describes the production and characterization of these structures, presents results of the high power tests, and compares these data with results gained at IKPH for an in house built 4.90GHz prototype and the 2.45GHz structures built in the 1980s.

*A. Jankowiak et al. "Design and Status of the 1.5 GeV-Harmonic Double Sided Microtron for MAMI", Proceedings EPAC2002, Paris, p. 1085.

TUPCH120

The Diamond Light Source Booster RF System

C. Christou, V.C. Kempson (Diamond) K. Dunkel (ACCEL) A. Fabris (ELETTRA)

The Diamond Light Source (DLS) accelerator complex can be divided into three major components; a 3 GeV 561 m circumference storage ring, a 158.4 m circumference full-energy booster synchrotron and a 100 MeV pre-injector linac. This paper describes the design and presents commissioning results of the RF system for the booster synchrotron. Booster RF commissioning took place in late 2005 and early 2006 and involved the setting-into-operation of a 60 kW IOT amplifier, supplied by Thales Broadcast and Multimedia, a 5-cell copper cavity, manufactured by Accel Instruments, and a low-level RF system designed and built by Sincrotrone Trieste SCpA.

The IASA Cooling System for the 10 MeV Linac

TUPCH121

A. Karabarbounis, D. Baltadoros, T. Garetsos, C.N. Papanicolas, E. Stiliaris (IASA) A. Zolfaghari (MIT)

A de-ionized water cooling system for the IASA room temperature 10 MeV CW Linac has been constructed and successfully installed. Commissioning is undergoing achieving resistivity larger to 5M?cm with a temperature accuracy of for all three linacs. Three ways mixing valves with a stepping capability of one thousand different mixing steps fulfill independently for each section the required temperature stability and the appropriate resonance frequency to our cavities. The RF requirements for the three linacs is 190kW provided by a single high power klystron tube capable to deliver up to 500 kW CW at 2380 MHz. The klystron is been cooled with a parallel similar cooling system and a third system cools our Aluminum waveguide complex. In this paper we will present the design, specifications and results of our preliminary tests. A sophisticated control and interlock system based on EPICS guarantees the proper functioning of the system.

Dipole Stabilizing Rods System for a Four-vane RFQ: Modeling and Measurement on the TRASCO RFQ Aluminum Model at LNL

TUPCH123

F. Grespan, A. Palmieri, A. Pisent (INFN/LNL)

The Dipole Stabilizing Rods (DSR's) are devices used in order to reduce a priori the effect of perturbation on the operating mode of a four-vane RFQ caused by neighboring dipole modes by increasing the frequency spacing between the TE210 mode and dipole modes, without, in principle, affecting the quadrupole TE210 mode. They have proven to be particularly useful in the case of coupled RFQ's whose overall length is significantly greater than the operating wavelength. In this article we present a circuit model of such DSR's, that, used in combination with a transmission line model of a four vane RFQ, has allowed us to predict the dimensioning of the DSR's in the case of the aluminum model of TRASCO RFQ. The DSR parameters and, in general, the accuracy of the model have been also confirmed by HFSS simulations and by RF measurements on the above-mentioned model.

Improvement of Co-based Amorphous Core for Untuned Broadband RF Cavity

TUPCH124

A. Sugiura, M. Kanazawa, T. Misu, S. Yamada (NIRS) K. Katsuki, T. Kusaka, K. Sato (Toshiba)

We have developed a cobalt-based amorphous core as a new magnetic-alloy (MA) core for the loaded RF cavity. Because of its permeability found to be approximately twice as high as that of FINEMET, this MA core is an excellent candidate for constructing a compact broadband RF cavity with less power consumption. In this report, we present our recent studies of the Co-based amorphous core's physical properties and performance. Improvement of the new core coated by new materials surface of ribbon is also described.

TUPCH126

Outgassing Rate of Highly Pure Copper Electroplating Applied to RF Cavities

T. Abe, T. Kageyama, Y. Saito, H. Sakai, Y. Sato, Y. Takeuchi (KEK) Z. Kabeya, T. Kawasumi (MHI) T. Nakamura, S. Nishihashi, K. Tsujimoto (Asahi Kinzoku Co., Ltd.) K. Tajiri (Churyo Engineering Co., Ltd.)

We plan to apply a new copper electroplating with a high purity and a high electric conductivity to normal-conducting RF cavities for electron or positron storage rings with a high current beam. As reported in 2005 Particle Accelerator Conference, our first test cavity, made of iron, with the electroplated copper surface finished up by electropolishing showed an excellent electric performance compared with the case of cavities made of oxygen free copper. Our next step is to examine the vacuum performance. This paper reports results of the outgassing-rate measurements on our second test cavity together with its fabrication process.

TUPCH127

Fine Grooving of Conductor Surfaces of RF Input Coupler to Suppress Multipactoring

T. Abe, T. Kageyama, H. Sakai, Y. Takeuchi (KEK)

An RF input coupler to feed high power into an accelerating cavity with heavy beam loading undergoes many multipactoring zones due to the wide range of the input RF power. Furthermore, a regular coaxial line is more subject to multipactoring than a rectangular waveguide because of the uniformity of the electromagnetic field. Grooving the conductor surfaces of the coaxial line is a promising method to suppress multipactoring under any conditions expected in the above cases. This paper reports results of our multipactoring simulation study and the high power test of the input coupler with a grooved coaxial line.

TUPCH128

New Cutting Scheme of Magnetic Alloy Cores for J-PARC Synchrotrons

C. Ohmori, S. Anami, E. Ezura, Y. Funahashi, K. Hara, K. Hasegawa, A. Takagi, M. Toda, K. Ueno, M. Yoshii (KEK) Y. Morita, T. Yoshioka (ICEPP) M. Nomura, A. Schnase, F. Tamura, M. Yamamoto (JAEA/ J-PARC)

A new cutting method using a grindstone was developed to manufacture the magnetic alloy cores. The problem of local temperature rise around the cut surfaces was solved. Long-term high-power tests have been performed for both J-PARC RCS and MR RF systems. Mechanism of local heating, new cutting scheme, and manufacturing method are presented.

TUPCH129

Conceptual Design of a 3rd Harmonic Cavity System for the LNLS Electron Storage Ring

N.P. Abreu, O.R. Bagnato, R.H.A. Farias, M.J. Ferreira, C. Pardine, P.F. Tavares (LNLS)

The installation of a second RF cavity in the UVX electron storage ring at the Brazilian Synchrotron Light Laboratory (LNLS) at the end of 2003 brought about longitudinal instabilities driven by one of the HOMs of the new cavity. Even though the operational difficulties related to these unstable modes were successfully overcome by means of a combination of cavity tuning (using temperature and plunger adjustments) with phase modulation of the RF fields at the second harmonic of the synchrotron frequency,

a more appropriate technique to avoid those problems is the use of higher harmonic cavities, which have the important advantage of providing damping of the longitudinal modes without increasing the energy spread, i.e., without compromising the longitudinal emittance. In this work we present the design of a passive higher harmonic cavity system optimized for operation at the LNLS storage ring. The parameters for a set of cavities as well as the analysis of some of the effects that they may introduce in the beam dynamics are presented. An overview of the technical aspects related to the project, construction and installation of the cavities in the storage ring is also presented.

Development of the Feed-forward System for Beam Loading Compensation in the J-PARC RCS

TUPCH130

F. Tamura, M. Nomura, A. Schnase, M. Yamamoto (JAEA/J-PARC) S. Anami, E. Ezura, K. Hara, C. Ohmori, A. Takagi, M. Yoshii (KEK)

In the J-PARC Rapid Cycling Synchrotron (RCS), the heavy beam loading effects due to the high intensity proton beam must be compensated for stable acceleration. The beam feedforward technique is used to compensate the beam loading in the RCS. We present the development of the feedforward system. We designed and built the full-digital system with modern FPGAs to realize high accuracy, stability and predictability of the compensation. Because of the low Q value of each accelerating cavity, the wake voltage consists of not only the accelerating harmonic component but also higher harmonics. Thus, the system is designed to compensate the beam loading at several harmonics. The system has two parts. In the first part, vector components of the selected harmonic are detected from the beam signal picked up by a wall current monitor. The compensation RF signal is generated from the vector components with proper gain and phase in the latter part. The gain and phase are set individually for each harmonic and each cavity of the twelve cavities. We also present the preliminary test results of the newly developed modules.

High Power Test of MA Cavity for J-PARC RCS

TUPCH131

M. Yamamoto, M. Nomura, A. Schnase, F. Tamura (JAEA/J-PARC) S. Anami, E. Ezura, K. Hara, C. Ohmori, A. Takagi, M. Toda, M. Yoshii (KEK) K. Hasegawa (JAEA)

We have been constructing the RF system for the J-PARC RCS. Almost all of the power supplies and the tube amplifiers have been constructed, and the cavities are under construction. All of them are tested at the experimental hall before installing into the J-PARC RCS building. We test the hybrid cavity scheme to realize the optimum cavity Q-value. The results of the test are described.

Higher Order Mode (HOM) Damper of 500 MHz Damped Cavity for ASP Storage Ring

TUPCH132

J. Watanabe, K. Nakayama, K. Sato, H. Suzuki (Toshiba) M. Izawa (KEK) A. Jackson, G. LeBlanc, K. Zingre (ASP) T. Koseki (RIKEN/RARF/CC) N. Nakamura, H. Sakai, H. Takaki (ISSP/SRL)

TOSHIBA has delivered the storage ring RF system for the Australian Synchrotron Project(ASP). Two pairs of the 500MHz Higher Order Mode(HOM) damped cavities were applied for this system. Two on-centered and one off-centered dampers were attached for damping the longitudinal HOM impedance down to less than 20kOhm/GHz. In order to reduce the coupling of off-center damper for accelerating mode and improve cooling power of damper, New HOM damper was designed by optimizing SiC absorber structure and damper antenna length using HFSS code. The design and manufacture of the new HOM damper and the test are described.

TUPCH133

Comparison of Measured and Calculated Coupling between a Waveguide and an RF Cavity Using CST Microwave Studio

J. Shi, H. Chen, S. Zheng (TUB) D. Li (LBNL) R.A. Rimmer, H. Wang (Jefferson Lab)

Accurate predications of RF coupling between an RF cavity and ports attached to it have been an important study subject for years for RF coupler and higher order modes (HOM) damping design. We report recent progress and a method on the RF coupling simulations between waveguide ports and RF cavities using CST Microwave Studio in time domain (Transit Solver). Comparisons of the measured and calculated couplings are presented. The simulated couplings and frequencies agree within ~ 10% and ~ 0.1% with the measurements, respectively. We have simulated couplings with external Qs ranging from ~ 100 to ~ 100, 000, and confirmed with measurements. The method should also work well for higher Qs, and can be easily applied in RF power coupler designs and HOM damping for normal-conducting and superconducting cavities.

TUPCH134

RF Characteristics of the PEFP DTL

H. S. Kim, Y.-S. Cho, H.-J. Kwon, K.T. Seol (KAERI)

A conventional 20 MeV Drift Tube Linac (DTL) for the Proton Engineering Frontier Project (PEFP) has been developed as a low energy section of a 100 MeV accelerator. The 20 MeV DTL consists of 4 tanks with 152 cells. The machine has a unique feature of driving the 4 tanks with a single klystron. Therefore it has several control knobs to compensate the errors of each tank during operation. To develop the RF control scheme, the variations of the RF parameters of each tank were measured under various environmental conditions such as wall temperature, cooling water temperature, and cooling water pressure. In addition, the behaviors of the RF parameters among the tanks were also monitored during high power operation. In this paper, the measurement results are discussed and the control scheme based on the results are proposed.

TUPCH135

Characteristics of the PEFP 3 MeV RFQ

H.-J. Kwon, Y.-S. Cho, J.-H. Jang, H. S. Kim, K.T. Seol (KAERI)

A four-vane type 3 MeV, 350 MHz RFQ (Radiofrequency Quadrupole) has been developed as a front end part of PEFP (Proton Engineering Frontier Project) 100 MeV accelerator. After the completion of field tuning and high power conditioning at reduced duty, the initial operation of the RFQ with beam was carried out. During the initial test period, several parameters related with the RF and beam were measured to characterize the performance of the RFQ. Based on these measurements, several suggestions for further system improvement were proposed. In this paper, the initial test results are discussed and the suggestions for the system improvement are summarized.

Phase Measurement and Compensation System in PLS 2.5 GeV Linac for PAL-XFEL

TUPCH136

W.H. Hwang, J. Choi, Y.J. Han, J.Y. Huang, H.-G. Kim, S.-C. Kim, I.S. Ko, W.W. Lee (PAL)

In PAL, We are preparing the 3.7 GeV PAL**XFEL project by upgrading the present 2.5GeV Linac. In present PLS Linac, the specifications of the beam energy spread and rf phase are 0.6%(peak) and 3.5 degrees(peak) respectively. And the output power of klystron is 80 MW at the pulse width of 4 ? and the repetition rate of 10 Hz. In XFEL, the specifications of the beam energy spread and rf phase are 0.03%(rms) and 0.01 degrees(rms) respectively. We developed an analogue and a digital phase measurement and rf phase compensation system for stable beam quality. This paper describes the microwave system for the PAL**XFEL and the rf phase measurement and phase compensation system.

Design of the RF System for 30 MeV Cyclotron

TUPCH137

I.S. Jung, D.H. An, J.-S. Chai, H.B. Hong, S.S. Hong, M.G. Hur, H.S. Jang, J. Kang, J.H. Kim, Y.-S. Kim, M.Y. Lee, T.K. Yang (KIRAMS) K.H. Kwon (SKKU)

LAD (Lab. of Accelerator Development) in KIRAMS (Korea Institute of Radiological & Medical Sciences) developed 13MeV medical cyclotron, named by KIRAMS-13, for PET (Positron Emission Tomography) in 2001. Now, KIRAMS-13 is widespread in Korea through the national project, "Development of Cyclotron and FDG Synthesis module." But, there is just one cyclotron for SPECT(Single Photon Emission Computed Tomography) in Korea, which is made by IBA, Belgium. If some problems are happened, we should shut off the cyclotron until IBA engineer fixes them. So, we decide to develop a 30MeV cyclotron, named KIRAMS-30, which has high-performance compared with existing commercial cyclotrons and will install this machine to radioactive isotopes production and researches in Advanced Radiation Technology Institute. In this paper, we design RF system, such as cavity, power coupler, and so on. At design of RF components, we consider mechanical stability, RF heating and cooling, arcing and multipacting, low maintenance. We simulate KIRAMS-30 with MWS (MicroWave Studio) and present simulation results.

Studies of Thermal Fatigue Caused by Pulsed RF Heating

TUPCH140

S.V. Kuzikov, Yu. Danilov, N.S. Ginzburg, N.Yu. Peskov, M.I. Petelin, A. Sergeev, A.A. Vikharev, N.I. Zaitsev (IAP/RAS) A.V. Elzhov, A. Kaminsky, O.S. Kozlov, E.A. Perelstein, S. Sedykh, A.P. Sergeev (JINR) I. Syratchev (CERN)

A future linear collider with a multi-TeV level of energies of the collided particles in the center of masses is naturally associated with high frequencies and a high power RF level. One of the interfering factors in this way is an effect of copper damage due to multi-pulse mechanical stress caused by high-power microwaves. In order to get new information about this effect, we started an experiment with the test cavity fed by 30 GHz FEM oscillator (15-30 MW, 100-200 ns, 0.5 - 1 Hz). Now we finished the second phase of this experiment where the test cavity was irradiated by 0.1 millions of RF pulses with temperature rise ~140 C in each pulse. The third phase is the experiment with 1 million pulses. In the next planned experiment with 36 GHz magnetron (0.1-0.15 MW, 1-2 mks, 0.01 - 1 kHz) we are going to investigate the thermal fatigue in most interesting for collider application region of temperatures (30-50 C). It is expected that these two experiments will supply necessary statistical information for the developed theory of the thermal fatigue in order to extrapolate lifetime numbers to other values of the temperature rise and pulse duration.

TUPCH141

New Developments for the RF System of the ALBA Storage Ring

F. Pérez, B. B. Baricevic, D. Einfeld, H. Hassanzadegan, A. Salom, P. Sanchez (ALBA)

ALBA is a 3 GeV, 400 mA, 3rd generation Synchrotron Light Source that is in the construction phase in Cerdanyola, Spain. The RF System will have to provide 3.6 MV of accelerating voltage and restore up to 540 kW of power to the electron beam. For that six RF plants, working at 500 MHz, are foreseen. The RF plants will include several new developments: 1) DAMPY cavity: the normal conducting HOM damped cavity developed by BESSY and based in the EU design; six will be installed. 2) CaCo: A cavity combiner to add the power to two 80 kW IOTs to produce the 160 kW needed for each cavity. 3) WATRAX: A waveguide transition to coaxial, specially designed to feed the DAMPY cavities due to the geometrical and cooling constrains. 4) IQ LLRF: The low level RF will be based on the IQ modulation/demodulation technique, both analogue and digital approach are being pursued. This paper describes the Storage Ring RF System and reports about the status of these new developments.

TUPCH142

Development of a Novel RF Waveguide Vacuum Valve

A. Grudiev (CERN)

The development of a novel rf waveguide vacuum valve is presented. The rf design is based on the use of TE0n modes of circular waveguides. In the device, the $T{\cdot}10^{01}$ mode at the input is converted into a mixture of several TE0n modes which provide low-loss rf power transmission across the vacuum valve gap, these modes are then converted back into the $T{\cdot}10^{01}$ mode at the output. There are a number of advantages associated with the absence of surface fields in the region of the valve: 1)Possibility to use commercially available vacuum valves equipped with two specially designed mode converter sections. 2)No necessity for an rf contact between these two sections. 3)Increased potential for high power rf transmission. This technology can be used for all frequencies for which vacuum waveguides are used. The only drawback is that, in rectangular waveguides, mode converters from the operating mode into the $T{\cdot}10^{01}$ mode and back again are necessary. Experimental results for the 30 GHz valves developed for the CLIC Test Facility 3 (CTF3) are presented showing in particular that the rf power transmission losses are below 1%.

TUPCH143

High Gradient Tests of an 88 MHZ RF Cavity for Muon Cooling

C. Rossi, R. Garoby, F. Gerigk, J. Marques Balula, M. Vretenar (CERN)

The scheme for a Muon Cooling channel developed at CERN in the frame of Neutrino Factory studies foresees the use of 44 and 88 MHz cavities operating at a real-estate gradient as high as 4 MV/m. To assess the feasibility of this scheme, including high-gradient operation at relatively low frequency and the production and handling of high RF peak powers, a test stand was assembled at CERN. It included an 88 MHz resonator reconstructed from a 114 MHz cavity previously used for lepton acceleration in the PS, a 2.5 MW final amplifier made out of an old linac unit improved and down-scaled in frequency, and a PS spare amplifier used as driver stage. After only 160 hours of conditioning the cavity passed the 4 MV/m level, with local peak surface field in the gap exceeding 25 MV/m (2.4 times the Kilpatrick limit). The gradient was limited by the amplifier power, the maximum RF peak output power achieved during the tests being 2.65 MW. This paper presents the results of the tests, including an analysis of field emission from the test cavity, and compares the results with the experience in conditioning ion linac RF cavities at CERN.

Automatic Conditioning of the CTF3 RF System

TUPCH144

J.P.H. Sladen, S. Deghaye, S. Livesley, J. Marques Balula, J. Mourier, J.-M. Nonglaton (CERN) A. Dubrovsky (JINR)

The RF system of CTF3 (CLIC Test Facility 3) includes ten 35 MW to 40 MW 3 GHz klystrons and one 20 MW 1.5 GHz klystron. High power RF conditioning of the waveguide network and cavities connected to each klystron can be extremely time consuming. Because of this, a fully automatic conditioning system has been developed within a CERN JINR (Dubna) collaboration. It involves relatively minor hardware additions, most of the work being in application and front-end software. The system has already been used very successfully.

The MUCOOL RF Program

TUPCH145

J. Norem (ANL) A. Bross, A. Moretti, B. Norris, Z. Qian (Fermilab) D. Li, S.P. Virostek, M.S. Zisman (LBNL) R.A. Rimmer (Jefferson Lab) R. Sandstrom (DPNC) Y. Torun (IIT)

Efficient muon cooling requires high RF gradients in the presence of high (~3T) solenoidal fields. The Muon Ionization Cooling Experiment (MICE) also requires that the x-ray production from these cavities is low, in order to minimize backgrounds in the particle detectors that must be located near the cavities. These cavities require thin Be windows to ensure the highest fields on the beam axis. In order to develop these cavities, the MUCOOL RF Program was started about 6 years ago. Initial measurements were made on a six-cell cavity and a single-cell pillbox, both operating at 805 MHz. We have now begun measurements of a 201 MHz pillbox cavity. This program has led to new techniques to look at dark currents, a new model for breakdown and a general model of cavity performance based on surface damage. The experimental program includes studies of thin Be windows, conditioning, dark current production from different materials, magnetic-field effects and breakdown. We will present results from measurements at both 805 and 201 MHz.

The Interactions of Surface Damage on RF Cavity Operation

TUPCH146

J. Norem, A. Hassanein, Z. Insepov (ANL) A. Bross, A. Moretti, Z. Qian (Fermilab) D. Li, M.S. Zisman (LBNL) R.A. Rimmer (Jefferson Lab) D.N. Seidman, K. Yoon (NU) Y. Torun (IIT)

Studies of low frequency RF systems for muon cooling has led to a variety of new techniques for looking at dark currents, a new model of breakdown, and, ultimately, a model of RF cavity operation based on surface damage. We find that cavity behavior is strongly influenced by the spectrum of enhancement factors on field emission sites. Three different spectra are involved: one defining the initial state of the cavity, the second determined by the breakdown events, and the third defining the equilibrium produced as a cavity operates at its maximum field. We have been able to measure these functions and use them to derive a wide variety of cavity parameters: conditioning behavior, material, pulse length, temperature, vacuum, magnetic field, pressure, gas dependence. In addition we can calculate the dependence of breakdown rate on surface field and pulse length. This work correlates with data from Atom Probe Tomography. We will describe this model and new experimental data.

TUPCH147

High Pressure RF Cavities in Magnetic Fields

P.M. Hanlet, M. Alsharo'a, R. E. Hartline, R.P. Johnson, M. Kuchnir, K. Paul (Muons, Inc) C.M. Ankenbrandt, A. Moretti, M. Popovic (Fermilab) D.M. Kaplan, K. Yonehara (Illinois Institute of Technology)

A study of RF breakdown in pressurized cavities immersed in strong magnetic fields has begun as part of a program to develop RF cavities filled with dense hydrogen gas to be used for muon ionization cooling. A pressurized 805 MHz test cell is being used at Fermilab to compare the conditioning and breakdown behavior of copper, molybdenum, and beryllium electrodes as functions of hydrogen and helium gas densities and magnetic field strength. These results will be compared to the predicted or known RF breakdown behavior of these metals in vacuum with and without external magnetic fields.

TUPCH148

201 MHz Cavity R&D for MUCOOL and MICE

D. Li, S.P. Virostek, M.S. Zisman (LBNL) A. Bross, A. Moretti, B. Norris (Fermilab) J. Norem (ANL) H.L. Phillips, R.A. Rimmer, M. Stirbet (Jefferson Lab) M. Reep, D.J. Summers (UMiss) Y. Torun (IIT)

We describe the design, fabrication and preliminary testing of the prototype 201 MHz copper cavity for a muon ionization cooling channel. Application of the cavity includes the Muon Ionization Cooling Experiment (MICE) as well as cooling channels for a neutrino factory or a muon collider. This cavity was developed by the US MUCOOL collaboration and is being tested in the MUCOOL Test Area (MTA) at Fermilab. In order to achieve a high accelerating gradient, the cavity beam irises are terminated by a pair of curved, thin beryllium windows. Several of the fabrication methods developed for this cavity and the windows are novel and offer significant cost savings compared to conventional construction methods. Cavity thermal and RF performance will be compared to FEA modeling predictions. RF commissioning results will be presented.

TUPCH149

Design of a 10 MHz Heavy Ion RFQ for a RIA Post Accelerator

S.O. Schriber, V. Andreev (NSCL)

Design of a 10 MHz heavy ion RFQ for the RIA post accelerator is described. Main rf and mechanical parameters of the proposed accelerator are given. This 10 MHz RFQ is capable of accelerating beams from an initial energy of 2 keV/u to 8 keV/u covering a charge to mass ratio from 1/10 to 1/240.

TUPCH150

Improved 1.3 GHz Inductive Output Tube for Particle Accelerators

A.E. Wheelhouse (e2v technologies)

There is an increasing requirement for RF power sources in the L-band frequency range for operation in particle accelerators. Previously (at PAC 2005), the design, development and initial testing of a new L-band 16kW cw inductive output tube (IOT) was described. This paper discusses the detailed performance characteristics of the latest EEV IOT116LS embodying the most recent design improvements and presents data demonstrating its suitability for operation at 1.3GHz in the next generation of light sources.

ERLP/4GLS Low Level Radio Frequency System

A.J. Moss, P.A. Corlett, J.F. Orrett, J.H.P. Rogers (CCLRC/DL/ASTeC)

The Energy Recovery Linac Prototype (ERLP) being constructed at Daresbury Laboratory will use an analog-based low level RF (LLRF) control system designed and built at FZR Rossendorf. Once the machine is operational, the testing and development of a digital LLRF feedback system will take place using the ERLP as a testbed.

MICE RF Test Stand

P.A. Corlett, A.J. Moss, J.F. Orrett (CCLRC/DL/ASTeC)

The Muon Ionization Cooling Experiment (MICE) RF test stand is being assembled at Daresbury Laboratory. This will provide a test bed for power amplifiers to produce the 2MW 200MHz RF for the MICE experiment RF cavities. Initial design and proposed layout of the RF system are described.

IOT Testing at the ERLP

J.F. Orrett, S.R. Buckley, P.A. Corlett, A.J. Moss (CCLRC/DL/ASTeC) S. Rains (Diamond)

The testing of Inductive Output Tubes (IOT) at 1.3GHz is underway for use on the Energy Recovery Linac Prototype (ERLP) being constructed at Daresbury Laboratory. A 50KV high voltage power supply (HVPS) has been commissioned and characterised for use as a test RF supply. This will be used to power the ERLP RF system in both continuous and pulse modes of operation. First results are presented of the IOTs and the use of the HVPS system.

RF Amplifier for Next Generation Light Sources

J.S. Przybyla, E. Radcliffe (e2v Technologies)

This paper describes the design concepts and development issues around generating a compact 16kW 1.3GHz RF amplifier for use in the next generation of light sources. These amplifiers need to be operated for extended periods to maximise use of the facility and so high reliability and availability are of key importance. Equally important are the capabilities to have extensive self-monitoring and fault prediction, autonomous operation, low heat dissipation to air, and easy maintenance. The design and development of such an RF amplifier based on the latest e2v technologies 1.3GHz inductive output tube (IOT) will be described. The RF amplifier equipment makes extensive use of commercially available products and industry collaborations to produce an amplifier that meets all the requirements yet can be manufactured and operated in a most cost effective manner. Prototype equipment will be shown at EPAC 06.

TUPCH155

2D and 1D Surface Photonic Band Gap Structures for Accelerator Applications

I.V. Konoplev, A.W. Cross, W. He, P. MacInnes, A. Phelps, C.W. Robertson, K. Ronald, C.G. Whyte (USTRAT/SUPA)

High frequency (26.5GHz to 40GHz), high power (tens of MW) microwave sources are required for cavity testing and conditioning applications in accelerators such as CLIC. The first study of microwave radiation from a co-axial Free-Electron Maser (FEM) based on a two-mirror cavity formed by a 2D Surface Photonic Band Gap (SPBG) structure (input mirror 10.4cm) and 1D SPBG structure (output mirror 10cm) is presented. The electron beam source consisted of a magnetically insulated plasma flare emission carbon cathode. Application of a 450kV voltage pulse of duration ~250ns across the cathode and grounded anode resulted in the production of a 7.0cm diameter annular electron beam of current ~1500A. The output radiation power from the FEM was measured using a Ka-band horn with 60dB of attenuation in front of a microwave detector located at a distance of 1.5m from the output window. By integrating the microwave power measured at the detector over the radiation pattern a total power of 50 (±10) MW corresponding to an efficiency of ~9% was calculated. The location of the operating frequency was found to lie between 35GHz and 39GHz, which agrees with theoretically predicted frequency of 37.2GHz.

TUPCH156

Design and Simulation of a Cusp Gun for Gyro-amplifier Application in High Frequency RF Accelerators

D.H. Rowlands, A.W. Cross, W. He, A. Phelps, E.G. Rafferty, C.W. Robertson, K. Ronald, J. Thomson, C.G. Whyte, A.R. Young (USTRAT/SUPA)

Gyro-amplifiers have potential as the high frequency RF drivers for particle accelerators. They require relativistic electron beams with low velocity spread and with a high fraction of the electron energy associated with the cyclotron motion. For harmonic operation and mode control an axis-encircling beam is desirable. The passage of an electron beam through a non-adiabatic magnetic field reversal (cusp) converts part of the electron beam's axial velocity into axis-encircling transverse velocity. A cusp-based electron beam forming system, yielding a 10MW, 150kV, 70A axis-encircling beam will be presented. This cusp gun is being designed as the electron beam source for a microwave gyro-amplifier that is relevant for high frequency accelerator applications. The latest results from numerical simulations and experiments will be presented and compared.

TUPCH158

High Power, Solid State RF Amplifiers Development for the EURISOL Proton Driver

F. Scarpa, A. Facco, D. Zenere (INFN/LNL)

A 5 kW solid-state RF amplifier for the SPES and EURISOL projects has been built and extensively tested. High reliability and low cost are the main goals for this device, an evolution of a 2.5 kW unit previously developed and presented at EPAC 02. The description of the amplifier, especially designed for superconducting cavities, its characteristics and test results will be illustrated and discussed, as well as the design and construction of two new 10 kW amplifier units that have recently started.

High Power Waveguide Switching System for SPring-8 Linac

TUPCH159

T. Taniuchi, T. Asaka, H. Dewa, H. Hanaki, T. Kobayashi, A. Mizuno, S. Suzuki, H. Tomizawa, K. Yanagida (JASRI/SPring-8) A. Miura (Nihon Koshuha Co., Ltd.)

A vacuum waveguide switch has been developed to build a backup system of an RF source for the electron injector system and the klystron drive line in the SPring-8 linac. A high power test of the waveguide switch was carried out, and the maximum RF power of 62 MW in peak, 1μsecond in pulse width and 10 pps in repetition rate was achieved without serious problems in RF and vacuum characteristics. The backup system utilizing this waveguide switch has been installed in the electron injector system.

Novel Conception of Beam Temperature in Accelerator and Applications

TUPCH160

D. Dong (IHEP Beijing)

In this paper, we will introduce a novel conception of beam temperature in accelerator, discuss the calculation method. And finally the author will show an example on the beam temperature in a klystron.

Operation Results of 1 MW RF Systems for the PEFP 20 MeV Linac

TUPCH162

K.T. Seol, Y.-S. Cho, H. S. Kim, H.-J. Kwon (KAERI) K.R. Kim (PAL)

The PEFP 20 MeV linear accelerator is composed of a 3 MeV RFQ and 20 MeV DTL. Two sets of 1MW, 350MHz RF systems drive the RFQ and DTL. The RF system can perform a 100% duty operation. The TH2089F klystron is used as an RF source. During the test operation, only the driving RF signal of the klystron was operated in pulse mode, while the electron beam was maintained in DC mode. The klystron power supplies and cooling systems were also operated in 100% duty mode. In this paper, the operation results of 1 MW RF systems including klystron power supply and cooling system are discussed and propose possible options to improve the operation conditions based on the results.

Status of 30 GHz High Power RF Pulse Compressor for CTF3

TUPCH163

I. Syratchev (CERN)

A 70 ns 30 GHz pulse compressor with resonant delay lines has been built and installed in the CTF3 test area to obtain the high peak power of 150 MW necessary to demonstrate the full performance of the new CLIC accelerating structure. This pulse compressor will be commissioned at high power in 2006. Different methods to provide fast RF phase switching are discussed. The current status of the CTF3 RF pulse compressor commissioning and first results are presented.

TUPCH164

Ka-band Test Facility for High-gradient Accelerator R&D

M.A. LaPointe, J.L. Hirshfield, E.V. Kozyrev (Yale University, Physics Department) A.A. Bogdashov, A.V. Chirkov, G.G. Denisov, A.S. Fix, D.A. Lukovnikov, V.I. Malygin, Yu.V. Rodin, M.Y. Shmelyov (IAP/RAS) S.V. Kuzikov, A.G. Litvak, O.A. Nezhevenko, M.I. Petelin, A.A. Vikharev, V.P. Yakovlev (Omega-P, Inc.) G.V. Serdobintsev (BINP SB RAS) S.V. Shchelkunov (Columbia University)

Achievement of high acceleration gradients in room-temperature structures requires basic studies of electric and magnetic RF field limits at surfaces of conductors and dielectrics. Facilities for such studies at 11.4 GHz have been in use at KEK and SLAC; facilities for studies at 17.1 GHz are being developed at MIT and UMd; and studies at 30 GHz are being conducted at CERN using the CLIC drive beam to generate short intense RF pulses. Longer pulse studies at 34 GHz are to be carried out at a new test facility being established at the Yale Beam Physics Laboratory, built around the Yale/Omega-P 34-GHz magnicon. This high-power amplifier, together with an available ensemble of components, should enable tests to be carried at up to about 9 MW in 1 mcs wide pulses at up to four output stations or, using a power combiner, at up to about 35 MW in 1 mcs wide pulses at a single station. RF pulse compression is planned to be used to produce 100-200 MW, 100 ns pulses; or GW-level, 1 mcs wide pulses in a resonant ring. A number of experiments have been prepared to utilize multi-MW 34-GHz power for accelerator R&D, and users for future experiments are encouraged to express their interest.

TUPCH165

Compact Single-channel Ka-band SLED-II Pulse Compressor

S.V. Kuzikov, S.V. Kuzikov, M.E. Plotkin, A.A. Vikharev (Omega-P, Inc.) J.L. Hirshfield (Yale University, Physics Department)

Basic studies of factors that limit RF fields in warm accelerator structures require experiments at RF power levels that can only be produced from an intense drive beam, as with CLIC studies, or using pulse compression of output pulses from the RF source. This latter approach is being implemented to compress output pulses from the Yale/Omega-P 34-GHz magnicon to produce ~100-200 MW, 100 ns pulses. A new approach for passive pulse compression is described that uses a SLED-II-type circuit operating with axisymmetrical modes of the TE0n type that requires only a single channel instead of the usual double channel scheme. This allows avoidance of a 3-dB coupler and need for simultaneous fine tuning of two channels. Calculations show that with this device at 34 GHz one can anticipate a power gain of 3.3:1, and an efficiency of 66% for a 100 ns wide output pulse, taking into account losses and a realistic 50-ns long 180 degrees phase flip.

TUPCH166

Multi-megawatt Harmonic Multiplier for Testing High-gradient Accelerator Structures

V.P. Yakovlev (Omega-P, Inc.) J.L. Hirshfield (Yale University, Physics Department)

Basic studies for determining the RF electric and magnetic field limits on surfaces of materials suitable for accelerator structures for a future multi-TeV collider, and for the testing of the accelerator structures and components themselves, require stand-alone high-power RF sources at several frequencies, from 10 to 45 GHz. A relatively simple and inexpensive two-cavity harmonic multiplier at 22.8, 34.3, or 45.7 GHz is suggested to be the stand-alone multi-MW RF power source for this application. The design is based on the use of an existing SLAC electron gun, such as the XP3 gun, plus a beam collector as used on the XP3 klystron. RF drive power would be supplied from an 11.4 GHz, 50 or 75 MW SLAC klystron and modulator, and a second modulator would be used to power the gun in the multiplier. Preliminary computations show that 64, 55, and 47

MW, respectively, can be realized in 2nd, 3rd, and 4th harmonic multipliers at 22.8, 34.3, and 45.7 GHz using 75 MW of X-band drive power.

Modeling and Simulation Results of High-power HOM IOTs

TUPCH167

E.L. Wright, H.P. Bohlen (CPI)

The inductive output tube (IOT) continues to be the device-of-choice for terrestrial UHF broadcast applications due to its high efficiency, linearity, compactness, etc.; the same reasons that make this an attractive choice for scientific users. The IOT is being considered for a growing number of accelerator programs requiring multi-kilowatts of continuous wave power, at UHF and L-band frequencies. A number of vacuum electron device manufacturers are developing IOTs in support of these programs. There are an equal number of accelerator programs that operate pulsed, requiring high peak powers, where the only sources available are klystrons and MBKs. For these applications a higher-order mode IOT (HOM IOT) shows great promise for the same reasons described above. Modeling and simulation results for devices built to operate within the UHF and L-band frequency ranges will be shown, at power levels up to 5 MW.

IOTs: The Next Generation RF Power Sources for Accelerators

TUPCH168

Y. Li, H.P. Bohlen, R.N. Tornoe, E.L. Wright (CPI)

A new generation of Inductive Output Tubes (IOT) have been developed with a focus on cost reduction, robustness, stability, enhanced power, improved gain and efficiency. As demonstrated with our L-band integral cavity IOT, a new family of IOTs can operate as CW or pulse amplifiers with up to 80 kW CW and 120 kW peak output power. Switching between the CW and pulse mode is easy and simple. In this paper, we will present our new compact designs and the latest performance data.

Calculation, Measurement and Analysis of Vacuum Pressure Data and Related Bremsstrahlung Levels on Straight Sections of the ESRF

TUPCH171

R. Kersevan, P. Berkvens, P. Colomp (ESRF)

One of the major personal safety issues of modern synchrotron radiation (SR) light sources is the minimization of the exposure of beamline staff and users to high-energy bremsstrahlung (BS) radiation generated in the straight sections of the storage ring and entering the optics hutches of the beamlines. This is particularly important when insertion device (ID) narrow-gap chambers are installed, nowadays characterized by very low specific conductances. At the ESRF, this has led to the implementation of systematic measurements of BS levels and vacuum conditioning curves, in conjunction with the installation of non-evaporable getter (NEG)-coated ID chambers. A dedicated beamline is used to do on-axis measurements of the BS intensity during the initial conditioning period of newly installed NEG-coated ID chambers. This paper will show results of measurements and calculations performed throughout the years, and comment on the suitability from the radiation safety point of view of the installation of NEG-coated chambers in large numbers around the ring.

TUPCH172

Status Report on the Performance of NEG-coated Chambers at the ESRF

R. Kersevan, M. Hahn, i. Parat (ESRF)

At the ESRF, the use of NEG-coated narrow gap chambers for insertion device (ID) straight sections has become the standard choice for in-air IDs. A total of 25 chambers have been installed at different times in the ring, with 19 being installed as of Jan 2006, for a total length of 82 m. The vacuum performance has been excellent for all but one of them. It has been found that the now standard "10mm" design, i.e. a 5 m-long, 57x8 mm2 ellipse, is compatible with the multi-bunch operation at 200 mA. Runs at higher currents, performed in preparation of current upgrades, have gone smoothly. During 2005, a 3.5 m-long prototype of a chamber suited for installation in the achromat part of the lattice has been installed in the ring. It was characterized by a much smaller cross-section (30x20 mm2, HxV) as compared to a standard chamber (74x33 mm2, HxV), and by the absence of three lumped pumps, replaced by the NEG-coating. The data taken during a full run have been extremely encouraging, to the point of considering the adoption of a similar design for a future upgrade of the storage ring lattice and vacuum system. A status report will be given, alongside with a discussion of future plans.

TUPCH173

Understanding of Ion Induced Desorption Using the ERDA Technique

M. Bender, H. Kollmus (GSI) W.A. Assmann (LMU)

In heavy ion synchrotrons like SIS18 at GSI high energetic ions can impact on the beam pipe and release gas molecules. This so called "ion induced desorption" deteriorates the accelerator vacuum and as a consequence the beam life time and luminosity. To minimize the pressure increase it is necessary to understand the physics of ion induced desorption. The elastic recoil ion detection analysis (ERDA) can give a time resolved element specific depth profile of a probe under ion bombardment. A UHV-ERDA setup has been installed at GSI to investigate correlations between desorption and material properties as well as its dose dependant evolution. Recent experiments have shown the influence of the surface state of a sample such as the oxide layer on steel as well as the importance of a high-purity bulk such as in silicon and OFHC copper. We will present the results of gold coated copper in comparison to stainless steel as applicable materials for accelerators.

TUPCH174

Vacuum Issues and Challenges of SIS18 Upgrade at GSI

H. Kollmus, M.C. Bellachioma, M. Bender, A. Kraemer, J. Kurdal, H.R. Sprenger (GSI)

For the present experiment programm and for the planned FAIR facility the heavy ion synchroton SIS18 at GSI has to reach the space charge limit for highly and intermediate charged heavy ions. For the booster mode of SIS18 the number of $1x10^{12}$ ions per second in 4 Hz operation mode is specified. To achive this requirement a dynamic vacuum in the 10-12 mbar region has to be garanteed. The poster will present the status of recent R & D work concerning the SIS18 vacuum upgrade, with a focus on the new GSI NEG coating facility and on ion-induced desorption measurements using advanced ion beam analysis.

The Vacuum System of FAIR Accelerator Facility

TUPCH175

A. Kraemer, M.C. Bellachioma, H. Kollmus, H.R. Sprenger, St. Wilfert (GSI)

The FAIR accelerator complex consists of two superconducting synchrotrons (SIS100 and SIS300) with a circumference of 1083.6m each, a high energy beam transport system (HEBT) with a total length of about 2.5km and four storage rings (CR, RESR, HESR and NESR). Their length varies between 200m and 550m. For each of the subsystems, different vacuum requirements have to be fulfilled. The vacuum system of SIS100 and SIS300 consists of cryogenic and bakeable room temperature sections, where a pressure in the lower 10-12 mbar range is needed. For HEBT, also a combination of cryogenic and room temperature sections, a vacuum pressure of 10-9 mbar is sufficient. The storage rings will be operated in a pressure range from 10-9 mbar to 10-12 mbar. In the poster a detailed layout of the vacuum systems and technical solutions will be presented.

Measurement of the Sorption Characteristics of NEG Coated Pipes: The Transmission Factor Method

TUPCH177

A. Bonucci, A. Conte, P. Manini, S. Raimondi (SAES Getters S.p.A.)

ZrTiV Non Evaporable Getter (NEG) coatings of vacuum chambers have found application in the particle accelerators to lower the gas pressure, during the operative conditions. For that, the characterization of the actual pumping speed of the NEG coating is a key issue. It is carried out by means of the dynamic sorption method according to ASTM F798-82 standard, conducted "offline" on a sample (coupon), suitably positioned inside the chamber to be coated and recovered after the process. To evaluate in-situ the sorption characteristics of getter coated chambers, a different measurement technique (Trasmission Factor Method) is here described. It is based on the measurement of pressures ratio at the inlet and the outlet of a coated pipe, under a flow of test gas. A calibration curve permits to evaluate sticking probability of the coated surface from the pressure ratio. The use of reference samples to calibrate the method is quite difficult. A better approach is a modellistic one, finding the dependency of pressure ratio on the average sticking probability, the pipe length and the section geometry and dimensions. Preliminary experimental results will be shown.

Deposition of Non Evaporable Getter (NEG) Films on Vacuum Chambers for High Energy Machines and Synchrotron Radiation Sources

TUPCH178

P. Manini, A. Bonucci, A. Conte, S. Raimondi (SAES Getters S.p.A.)

Non Evaporable Getter (NEG) films, sputter deposited onto the internal surfaces of vacuum chambers reduce thermal out-gassing and provide conductance-free distributed pumping ability, allowing the achievement of very low pressure inside narrow and conductance limited chambers, like Insertion Devices. NEG films do show additional interesting features, like low secondary electron yield and low gas de-sorption rates under ions, electrons and photons bombardment. They seem therefore ideal to reduce electron multi-pacting and dynamic gas de-sorption induced beam instabilities in high energy machines. This paper presents SAES getters experience in the NEG coating of chambers of different geometries and sizes for a variety of projects related to high energy machines and synchrotron radiation facilities. Examples of applications, as well as most common issues related to chambers preparation, film deposition, characterization and quality control, are given. Areas where further work is still necessary to fully take advantage of NEG film properties will be also discussed.

TUPCH179

R&D on Copper Beam Ducts with Antechambers and Related Vacuum Components

Y. Suetsugu, H. Hisamatsu, K.-I. Kanazawa, K. Shibata, M. Shimamoto, M. Shirai (KEK)

A beam duct with antechambers is able to reduce the effect of photoelectrons and, as a result, to suppress the electron cloud effect of positron or proton beam. It will be adopted for a future high current positron/proton rings and also a damping ring of a linear collider. Copper beam ducts with one or two antechambers were manufactured for test and the feasibility was studied. The test chambers were then installed into the KEK B-factory positron ring and the performance was investigated with a beam current up to 2000 mA. The temperature, the pressure and the electron density in the beam channel were measured during the beam operation. The photoelectron, for example, was found to be well suppressed as expected compared to that of a simple circular beam duct. The related vacuum components, such as a connection flange, a bellows chamber and a gate valve with the same cross section to the beam duct, were also developed and tested together with the beam duct.

TUPCH182

Radiation Monitors as a Vacuum Diagnostic in the Room Temperature Parts of the LHC Straight Sections

V. Talanov (IHEP Protvino) V. Baglin, T. Wijnands (CERN)

In the absence of collisions, inelastic interactions between protons and residual gas molecules are the main source of radiation in the room temperature parts of the LHC long straight sections. In this case the variations in the radiation levels will reflect the dynamics of the residual pressure distribution. Based on the background simulations for the long straight section of the LHC IP5 and on the current understanding of the residual pressure dynamics, we evaluate the possibility to use the radiation monitors for the purpose of the vacuum diagnostic, and we present the first estimates of the predicted monitor counts for different scenarios of the machine operation.

TUPCH183

H2 Equilibrium Pressure in a NEG-coated Vacuum Chamber as a Function of Temperature and H2 Concentration

A. Rossi (CERN)

Non Evaporable Getter (NEG) coating is used in the LHC room- temperature sections to ensure a low residual gas pressure for its properties of distributed pumping, low outgassing and desorption under particle bombardment; and to limit or cure electron cloud build-up due to its low secondary electron emission. In certain regions of the LHC, and in particular close to the beam collimators, the temperature of the vacuum chamber is expected to rise due to energy deposition from particle losses. Gas molecules are pumped by the NEG via dissociation on the surface, sorption at the superficial sites and diffusion into the NEG bulk. In the case of hydrogen, the sorption is thermally reversible, causing the residual pressure to increase with NEG temperature and amount of H2 pumped. Measurements were carried out on a stainless steel chamber coated with TiZrV NEG as a function of the H2 concentration and the chamber temperature, to estimate the residual gas pressure in the collimator regions for various LHC operation scenarios, corresponding to different particle loss rates and times between NEG regenerations. The results are presented in this paper and discussed.

Low Level RF System Development for SOLEIL

P. Marchand, M.D. Diop, F. Ribeiro, R.S. Sreedharan (SOLEIL) M. Luong, O. Piquet (CEA)

The Low Level RF system that is used in the SOLEIL storage ring consists in fully analog "slow" amplitude, phase and frequency loops, complemented with a direct RF feedback. A fast digital FPGA-based I/Q feedback, currently under development, will be implemented later on. The performance of both systems has been evaluated using a Matlab-Simulink-based simulation tool. The computed and first experimental results are reported.

DSP-based Low Level RF Control as an Integrated Part of DOOCS Control System

V. Ayvazyan, A. Brandt, O. Hensler, G.M. Petrosyan, L.M. Petrosyan, K. Rehlich, S. Simrock, P. Vetrov (DESY)

The Distributed Object Oriented Control System (DOOCS) has been developed at DESY as a control system for TTF/VUV-FEL. The DSP based low level RF control system is one of the main subsystems of the linac. Several DOOCS device servers and client applications have been developed to integrate low level RF control into the TTF/VUV-FEL control system. The DOOCS approach defines each hardware device as a separate object and this object is represented in a network by a device server, which handles all device functions. A client application can have access to the server data using the DOOCS application programming interface. A set of generic and specially devoted programs provide the tools for the operators to control the RF system. The RF operation at the linac is being automated by the implementation of DOOCS finite state machine servers.

Phase Stability of the Next Generation RF Field Control for VUV- and X-ray Free Electron Laser

F. Ludwig, M. Hoffmann, H. Schlarb, S. Simrock (DESY)

For pump and probe experiments at VUV- and X-ray free electron lasers the stability of the electron beam and timing reference must be guaranteed in phase for the injector and bunch compression section within a resolution of 0.01 degree (rms) and in amplitude within 1 10-4 (rms). The performance of the field detection and regulation of the acceleration RF directly influences the phase and amplitude stability. In this paper we present the phase noise budget for a RF-regulation system including the noise characterization of all subcomponents, in detail down-converter, ADC sampling, vector-modulator, master oscillator and klystron. We study the amplitude to phase noise conversion for a detuned cavity. In addition we investigate the beam jitter induced by these noise sources within the regulation and determine the optimal controller gain. We acknowledge financial support by DESY Hamburg and the EUROFEL project.

FPGA-based RF Field Control at the Photocathode RF Gun of the DESY VUV-FEL

E. Vogel, W. Koprek, P. Pucyk (DESY)

At the DESY Vacuum Ultraviolet Free Electron Laser (VUV-FEL) bunch peak current and the SASE effect are (amongst other parameters) sensitive to beam energy and beam phase variations. The electron bunches are created in an rf gun, which does not have field probes. Variations of the gun rf field cause beam energy and phase variations. They have a

significant influence on the overall performance of the facility. DSP based rf field control used previously was only able to stabilize the rf output of the klystron. This was due to the lack of processing power and the over-all loop delay. The controller was not able to provide satisfactory rf field stability in the gun. Replacing the DSP hardware by the new FPGA-based hardware Simulation Controller (SimCon), we are able to reduce the latency within the digital part significantly allowing for higher loop gain. Furthermore SimCon provides sufficient processing power for calculating a probe signal from the forward and reflected power as input for PI and adaptive feed forward (AFF) control. In this paper we describe the algorithms implemented and the gun rf field stability obtained.

TUPCH190

Universal Controller for Digital RF Control

S. Simrock (DESY) W. Cichalewski, M.K. Grecki, G.W. Jablonski (TUL-DMCS) W.J. Jalmuzna (Warsaw University of Technology, Institute of Electronic Systems)

Digital RF control systems allow to change the type of controller by programming of the algorithms executed in FPGAs and/or DSPs. It is even possible to design a universal controller where the controller mode is selected by change of parameters. The concept of a universal controller includes the self-excited-loop (SEL) and generator driven resonator (GDR) concept, the choice of I/Q and amplitude or phase control, and allows for different filters (including Kalman filter and method of optimal controller synthesis) to be applied. Even time-varying mixtures of these modes are possible. Presented is the implementation of such a controller and the operational results with a superconducting cavity.

TUPCH191

Considerations for the Choice of the Intermediate Frequency and Sampling Rate for Digital RF Control

S. Simrock, M. Hoffmann, F. Ludwig (DESY) M.K. Grecki, T. Jezynski (TUL-DMCS)

Modern FPGA-based rf control systems employ digital field detectors where an intermediate frequency (IF) in the range of 10 to more than 100 MHz is sampled with a synchronized clock. Present ADC technology with 14-16 bit resolution allows for maximum sampling rates up to 250 MHz. While higher IF's increase the sensitivity to clock jitter, lower IF frequencies are more susceptible to electromagnetic noise. The choice of intermediate frequency and sampling rate should minimize the overall detector noise, provide high measurement bandwidth and low latency in field detection, and support algorithms for optimal field estimation.

TUPCH193

Low Level RF Control System Modules for J-PARC RCS

A. Schnase, M. Nomura, F. Tamura, M. Yamamoto (JAEA/J-PARC) S. Anami, E. Ezura, K. Hara, C. Ohmori, A. Takagi, M. Yoshii (KEK)

After completing the design phase, the VME modules for the Low Level RF Control (LLRF) of the Rapid Cycling Synchrotron of J-PARC are now in the production and debugging phase. First all modules are tested for basic functionality, for example dual harmonic signal generation. Then sets of modules are connected together to check higher-level functions and feedback. Finally, the LLRF modules are interfaced to high voltage components like amplifiers and cavities. We present the results of these tests, the test

methods and test functions on several levels. This way we simulate beam operation working conditions and gain experience in controlling all parameters.

Analogue and Digital Low Level RF for the ALBA Synchrotron

TUPCH194

F. Pérez, H. Hassanzadegan, A. Salom (ALBA)

ALBA is a 3 GeV, 400 mA, 3rd generation Synchrotron Light Source that is in the construction phase in Cerdanyola, Spain. The RF System will have to provide 3.6 MV of accelerating voltage and restore up to 540 kW of power to the electron beam. Two LLRF prototypes are being developed in parallel, both following the IQ modulation/demodulation technique. One is fully based on analogue technologies; the other is based on digital FPGA processing. The advantages of the IQ technique will be summarised and the control loop logic described. The hardware implementation in analogue as well as in digital format will be presented and first test results shown. The implementation of the same logic with both technologies will give us a perfect bench to compare, and use the better of them, for the final LLRF of the ALBA synchrotron.

The LHC Low Level RF

TUPCH195

P. Baudrenghien, G. Hagmann, J.C. Molendijk, R. Olsen, A. Rohlev, V. Rossi, D. Stellfeld, D. Valuch, U. Wehrle (CERN)

The LHC RF consists in eight 400 MHz superconducting cavities per ring, with each cavity independently powered by a 300 kW klystron, via a circulator. The challenge for the Low Level is to cope with both very high beam current (more than 1A RF component) and excellent beam lifetime (emittance growth time in excess of 25 hours). For each cavity we have a Cavity Controller rack with two VME crates implementing a strong RF Feedback, a Tuner Loop with a new algorithm, a Klystron Ripple Loop and a Conditioning system. In addition each ring has a Beam Control system (four VME crates) including Frequency Program, Phase Loop, Radial Loop and Synchronization Loop. A Longitudinal Damper (dipole and quadrupole mode) acting via the 400 MHz cavities is included to reduce emittance blow-up due to filamentation following phase and energy errors at injection. Finally an RF Synchronization system implements the bunch into bucket transfer from the SPS into each LHC ring. When fully installed in 2007 the whole system will count over three hundreds home-designed VME cards of twenty-three different models installed in fourty-five VME crates.

Digital Design of the LHC Low Level RF: the Tuning System for the Superconducting Cavities

TUPCH196

J.C. Molendijk, P. Baudrenghien, A. Butterworth, E. Ciapala, R. Olsen, F. Weierud (CERN) R. Sorokoletov (JINR)

The low level RF systems for the LHC are based extensively on digital technology, not only to achieve the required performance and stability but also to provide full remote control and diagnostics facilities needed in a machine where most of the RF system is inaccessible during operation. The hardware is based on modular VME but with additional low noise linear power supplies and a specially designed P2 backplane for timing distribution and fast data interchange. Extensive design re-use and the use of graphic FPGA design tools have streamlined the design process. A milestone was the test of the tuning system for the superconducting cavities. The tuning control module is based on a 2M gate FPGA with on-board DSP. Its design and functionality are described, including features such as automatic measurements of cavity characteristics and transient response of the tuning system. The tuner control is used as a test bed for LHC standard software components. A full 'vertical slice' from remote application down to the hardware has been tested. Work is ongoing on the completion of other modules and building up the software and diagnostics facilities needed for RF system commissioning.

TUPCH197

Low level RF System Development for the Superconducting Cavity in NSRRC

M.-S. Yeh, L.-H. Chang, F.-T. Chung, K.-T. Hsu, Y.-H. Lin, C. Wang (NSRRC)

The present low level system in NSRRC is based on analogy feedback control scheme. It provides feedback regulation on EM field, phase, and resonant frequency of the superconducting RF cavity. In order to address the required flexibility and improve diagnostic of the RF control system, a new digital low-level RF system based on Field Programmable Gate Array (FPGA) is proposed to be develop in house. The status of current analogy low level RF system and the specification of new digital FPGA based low level RF system are reposted herein.

TUPCH200

Amplitude Linearizers for PEP-II 1.2 MW Klystrons and LLRF Systems

D. Van Winkle, J. Browne, J.D. Fox, T. Mastorides, C.H. Rivetta, D. Teytelman (SLAC)

The PEP-II B-factory has aggressive current increases planned for luminosity through 2008. At 2.2 A (HER) on 4 A (LER) currents, longitudinal growth rates will exceed the damping rates achievable in the existing low level RF and longitudinal low mode feedback systems. Klystron gain non-linearity has been shown to be a key contributor to these increased growth rates through time domain non-linear modeling and machine measurements. Four prototype klystron amplitude modulation linearizers have been developed to explore improved linearity in the LLRF system. The linearizers operate at 475 MHz with 15 dB dynamic range and 1 MHz linear control bandwidth. Results from lab measurements and high current beam tests are presented. Future development progress and production designs are detailed.

TUPLS — Poster Session

Enhanced Optical Cooling of Ion Beams for LHC

TUPLS001

E.G. Bessonov, M.V. Gorbunkov (LPI) A.A. Mikhailichenko (Cornell University, Department of Physics)

Enhanced optical cooling (EOC) of fully stripped lead ions in LHC is investigated. The method of EOC is based on the usage of pickup and kicker undulators and optical amplifier. External selectivity is arranged by a moving screen located on the image plane of the optical system, projecting the emitted undulator radiation there (see physics/0509196). Nonlinear features of cooling and requirements to the ring lattice, optical and laser systems are discussed. Comparison with classical optical stochastic cooling (OSC) is represented as well.

Dust Macroparticles in HERA and DORIS

TUPLS002

A. Kling (DESY)

Charged dust macroparticles are considered as sources of sudden beam lifetime breakdowns detected in many electron storage rings. This phenomenon is still observed in HERA, although the distributed ion pumps, which were previously identified as dust particle sources, have been removed. We report on the observations of trapped dust during the last period of electron operation and present a detailed model of dust macroparticle dynamics in the HERA e-ring and in DORIS with particular emphasis on stability and possible trapping processes.

A Perfect Electrode to Suppress Secondary Electrons inside the Magnets

TUPLS003

L. Wang, M.T.F. Pivi (SLAC) H. Fukuma, S.-I. Kurokawa (KEK) G.X. Xia (DESY)

Electron cloud due to multipacting in the positron ring of B-factories is one of the limitations on the machine performance. Electron cloud in the drift region can be suppressed by solenoid. However, solenoid doesn't work inside a magnet. Numerical studies show that there is strong multipacting in the dipole magnet of the B-factory positron ring. Electrons also can be trapped inside quadrupole and sextupole magnets. The electron cloud from the dipole magnet and wiggler in the positron damping ring of the ILC is a critical limitation on the choice of damping ring circumference, which directly results in a choice of two 6km rings as the baseline for the positron damping ring. Various electrodes have been studied using the program CLOUDLAND. Our studies show that a wire type of electrode with a few hundred voltages works perfectly to kill the secondary electrons inside various magnets.

TUPLS004

How Einsteinian Tide Force Affects Beam in a Storage Ring

D. Dong (IHEP Beijing)

In this paper, we will introduce Einsteinian tide force into a storage ring, and discuss the beam characteristic in a storage ring, we can see that it is quite different from Newtonian tide force act on beam in a storage ring which we know very well. We also discuss the method to measure the beam instability in storage ring caused by these two different tide forces.

TUPLS005

Preliminary Study of Using "Pipetron"-type Magnets for a Pre-accelerator for the LHC Collider

G. De Rijk, L. Rossi (CERN) H. Piekarz (Fermilab)

One of the luminosity limitations of the LHC is the rather low injection energy (0.45 TeV) with respect to the collision energy (7 TeV). The magnetic multipoles in the main dipoles at low field and their dynamic behaviour are considered to limit the achievable bunch intensity and emittance. We report on a preliminary study to increase the injection energy to 1.5 TeV using a two beam pre-accelerator (LHCI) in the LHC tunnel. The LHCI is based on "Pipetron" magnets as originally proposed for the VLHC. The aim of the study is to assess the feasibility and to identify the critical processes or systems that need to be investigated and developed to render such a machine possible.

TUPLS006

Optics of a 1.5 TeV Injector for the LHC

J.A. Johnstone (Fermilab)

A concept is being developed to install a second ring above the LHC to accelerate protons from 450 GeV to 1.5 TeV prior to injection into the LHC. The arc and dispersion suppressor optics of the LHC would be replicated in the injector using combined function 'transmission line' magnets orginally proposed for the VLHC. To avoid costly civil construction, in the straight sections housing detectors at least, the injector and LHC must share beampipes and some magnets through the detector portion of the straights. Creating the appropriate optics for these injector-LHC transition regions is very challenging: In addition to matching to the nominal LHC lattice functions at these locations, the changes in altitude of 1.1 m between the injector and LHC must be accomplished achromatically to avoid emittance blowup when the beams are transferred to the LHC.

TUPLS008

A new HOM Water Cooled Absorber for the PEP-II B-factory Low Energy Ring

M. Kosovsky, N. Kurita, A. Novokhatski, J. Seeman, S.P. Weathersby (SLAC)

At high currents and small bunch lengths beam line components in the PEP-II B-factory experience RF induced heating from higher order RF modes (HOMs) produced by scattered intense beam fields. A design for a passive HOM water cooled absorber for the PEP-II low energy ring is presented. This device is to be situated near HOM producing beamline components such as collimators and provide HOM damping for dipole and quadrupole modes while minimizing impedance to the beam. We present a method of optimizing the impedance characteristics of such devices through the evaluation of loss factors and absorber effectiveness for specific modes using scattering parameter and wakefield analysis.

Design and Tests of New Fast Kickers for the DAFNE Collider and the ILC Damping Rings

TUPLS009

D. Alesini, S. Guiducci, F. Marcellini, P. Raimondi (INFN/LNF)

In this paper we illustrate the design of new, fast stripline kickers to inject or extract bunches in electron/positron rings. The kickers have been designed for the injection upgrade of the Phi-factory DAFNE and as injection/extraction devices for the International Linear Collider (ILC) damping rings. The design is based on tapering the striplines in order to simultaneously obtain low impedance and an excellent uniformity of the deflecting field. The design has been done using 2D and 3D electromagnetic codes such as Superfish and HFSS. High voltage test results on prototypes are also shown.

New Beam Transport Line from LINAC to Photon Factory in KEK

TUPLS010

N. Iida, K. Furukawa, M. Ikeda, K. Kakihara, T. Kamitani, M. Kikuchi, Y. Kobayashi, T. Mitsuhashi, Y. Ogawa, M. Satoh, T. Suwada, M. Tawada, K. Yokoyama (KEK)

The e+/e$^-$ injector LINAC in KEK usually injects into four rings which are Low Energy Ring (LER) of KEKB (3.5GeV/e+), High Energy Ring (HER) of KEKB(8.0GeV/e-), Photon Factory (PF)(2.5GeV/e-) and Advanced Ring for pulse x-rays (PF-AR)(3.0GeV/e-). While LINAC continuously injects into LER and HER alternately about every five minutes, both of the KEKB rings usually store almost full operating currents. Time for PF or PF-AR, which includes switching time, took about 20 minutes several times a day. During this, the storage currents in KEKB rings decreased, and the optimum points of luminosity tuning had been lost. It had taken more than two hours to recover the luminosity. It is so useful for KEKB to shorten the time for switch LINAC KEKB to/from PF or PF-AR. In summer of 2005, the transport line from LINAC to PF were renewed, in which a DC bending magnet only for PF line apportions electron beam from the end of LINAC to the new line. We succeeded to reduce the occupancy time for PF injection to about five minutes. In this paper design of the new PF beam transport line and the practical performance achieved according to the design are described.

The Beam Screen for the LHC Injection Kicker Magnets

TUPLS011

M.J. Barnes, F. Caspers, L. Ducimetière, N. Garrel, T. Kroyer (CERN)

The two LHC injection kicker magnet systems must each produce a kick of 1.2 T.m with a flattop duration variable up to 7.86 μs, and rise and fall times of less than 0.9 μs and 3 μs, respectively. Each system is composed of four 5 Ω transmission line kicker magnets with matched terminating resistors and pulse forming networks (PFN). The LHC beam has a high intensity, hence a beam screen is required in the aperture of the magnets This screen consists of a ceramic tube with conducting "stripes" on the inner wall. The stripes provide a path for the image current of the beam and screen the magnet ferrites against Wake fields. The stripes initially used gave adequately low beam impedance however stripe discharges occured during pulsing of the magnet: hence further development of the beam screen was undertaken. This paper presents options considered to meet the often conflicting needs for low beam impedance, shielding of the ferrite, fast field rise time and good electrical and vacuum behaviour.

TUPLS012

Dynamic Stresses in the LHC TCDS Diluter from 7 TeV Beam Loading

B. Goddard, A. Presland, W.J.M. Weterings (CERN) L. Massidda (CRS4)

In the event of an unsynchronised beam abort, the MSD extraction septum of the LHC beam dumping system is protected from damage by the TCDS diluter. The simultaneous constraints of obtaining sufficient beam dilution while ensuring the survival of the TCDS make the design difficult, with high thermally induced dynamic stresses occurring in the material needed to attenuate the particle showers induced by the primary beam impact. In this paper, full 3D simulations are described where the worst-case beam loading has been used to generate the local temperature rise and to follow the resulting time evolution of the mechanical stresses. The results and the accompanying design changes for the TCDS, to provide an adequate performance margin, are detailed.

TUPLS013

Protection of the LHC against Unsynchronised Beam Aborts

B. Goddard, R.W. Assmann, E. Carlier, J.A. Uythoven, J. Wenninger, W.J.M. Weterings (CERN)

An unsynchronised beam abort in the LHC could cause major damage to other downstream accelerator components, in particular the extraction septum magnets, the experimental low-beta triplet magnet apertures and the tertiary collimators. Although the LHC beam dumping system includes design features to minimise their frequency, such unsynchronised aborts can arise from several sources and cannot be excluded. A system of protection devices comprising fixed and moveable passive diluters and collimators will be built to safely protect the downstream LHC aperture from the mis-directed bunches in case of such a failure. The sources of unsynchronised abort events are described, together with the requirements and design of the protection devices and their expected performance. The accompanying operational requirements and envisaged solutions are discussed, in particular the problem of ensuring the local orbit at the protection devices.

TUPLS014

Optics Flexibility and Dispersion Matching at Injection into the LHC

A. Koschik, H. Burkhardt, B. Goddard, Y. Kadi, V. Kain, V. Mertens, T. Risselada (CERN)

The LHC requires very precise matching of transfer line and LHC optics to minimise emittance blow-up and tail repopulation at injection. The recent addition of a comprehensive transfer line collimation system to improve the protection against beam loss has created additional matching constraints and consumed a significant part of the flexibility contained in the initial optics design of the transfer lines. Optical errors, different injection configurations and possible future optics changes require however to preserve a certain tuning range. Here we present methods of tuning optics parameters at the injection point by using orbit correctors in the main ring, with the emphasis on dispersion matching. The benefit of alternative measures to enhance the flexibility is briefly discussed.

Calibration Measurements of the LHC Beam Dumping System Extraction Kicker Magnets

TUPLS015

J.A. Uythoven, F. Castronuovo, L. Ducimetière, B. Goddard, G. Gräwer, F. Olivieri, L. Pereira, E. Vossenberg (CERN)

The LHC beam dumping system must protect the LHC machine from damage by reliably and safely extracting and absorbing the circulating beams when requested. Two sets of 15 extraction kicker magnets form the main active part of this system. They have been produced, tested and calibrated by measuring the integrated magnetic field and the magnet current at different beam energies. The calibration data have been analysed, and the critical parameters are compared with the specifications. Implications for the configuration, control and operation of the beam dumping system are discussed.

Characterization of Crystals for Steering of Protons through Channelling in Hadronic Accelerators

TUPLS016

V. Guidi, S. Baricordi, M. Fiorini, G. Martinelli, A. Mazzolari, E. Milan (UNIFE) E. Boscolo Marchi, G. Della Mea, R. Milan, S. Todros, A. Vomiero (INFN/LNL) A. Carnera, D. De Salvador, A. Sambo (Univ. degli Studi di Padova) Y.A. Chesnokov (IHEP Protvino) Yu.M. Ivanov (PNPI) W. Scandale (CERN)

Channeling of relativistic particles through a crystal may be useful for many applications in accelerators, and particularly for collimation in hadronic colliders. Efficiency proved to be dependent on the state of the crystal surface and hence on the method used for preparation. We investigated the morphology and structure of the surface of the samples that have been used in accelerators with high efficiency. We found that crystal fabrication by only mechanical methods (dicing, lapping, and others) leads to a superficial damaged layer, which is correlated to performance limitation in accelerators. A planar chemical etching was studied and applied in order to remove the superficial damaged layer. RBS analysis with low-energy protons highlighted better crystal perfection at surface, as a result of the etching. Finally, measurement with 70-GeV protons at IHEP demonstrated a superior performance of the chemically cleaned crystals with respect to conventional samples. A protocol for preparation and characterization of crystal for channelling has been developed, which may be of interest for reliable operation with crystals in accelerators.

Optics Study for a Possible Crystal-based Collimation System for the LHC

TUPLS017

R.W. Assmann, S. Redaelli, W. Scandale (CERN)

The use of bent crystals as primary collimators has been long proposed as an option to improve the cleaning efficiency of the LHC betatron and momentum collimation systems. These systems are presently based on two-stage collimation with amorphous scatterers and absorbers. Crystals are expected to help by channeling and extracting the halo particles with large angles, resulting in higher cleaning efficiency. Independent of ongoing studies for crystal qualifications (not reported here), it is important to understand the required deflection angles and the possible locations of absorbers for the LHC layout. Optics studies have been performed in order to specify the required angles for various LHC beam energies and possible locations of absorbers for the deflected halo beam. A possible layout for crystal-assisted collimation at the LHC is discussed, aiming for a solution which would not change the LHC layout but would make use of the existing collimator location.

TUPLS018

Collimation Efficiency during Commissioning

C.B. Bracco, R.W. Assmann, A. Ferrari, S. Redaelli, G. Robert-Demolaize, M. Santana-Leitner, V. Vlachoudis, Th. Weiler (CERN)

The design of the LHC collimation system naturally focused on understanding and maximizing the ultimate performance with all collimators in place. However, for the commissioning of the LHC it is important to analyze the collimation efficiency with certain subsets of collimators, with increased collimation gaps and relaxed set-up tolerances. Special studies on halo tracking and energy deposition have been performed in order to address this question. The expected cleaning performance and intensity limits are discussed for various collimation scenarios as they might be used during commissioning and initial operation of the LHC.

TUPLS019

Critical Halo Loss Locations in the LHC

G. Robert-Demolaize, R.W. Assmann, C.B. Bracco, S. Redaelli, Th. Weiler (CERN)

The requirements on cleaning efficiency in the LHC are two to three orders of magnitude beyond the needs at existing super-conducting colliders. The LHC will therefore operate in unknown territory, which can only be assessed by powerful simulation tools. Such tools have been developed at CERN over the last years, making it possible to perform detailed simulations of the LHC cleaning processes and multi-turn loss patterns around the LHC ring. The simulation includes all collimators, diluters and absorbers in the LHC. Proton loss maps are generated with a 10 cm resolution, which allows performing advanced studies for quenches of super-conducting magnets along with the analysis of the deposited energy in the machine elements. The critical locations of beam halo losses are discussed, both for the ideal machine and for various scenarios of closed-orbit distortion and beta-beating. From these results it can be shown that it is sufficient to use a limited number of BLM's for the setup and optimization of the LHC collimation system.

TUPLS021

First Observation of Proton Reflection from Bent Crystals

W. Scandale (CERN) V.T. Baranov, V.N. Chepegin, Y.A. Chesnokov (IHEP Protvino) Yu.A. Gavrikov, Yu.M. Ivanov, L. P. Lapina, A.A. Petrunin, A.I. Schetkovsky, V. Skorobogatov, A. V. Zhelamkov (PNPI) V. Guidi (UNIFE) A. Vomiero (INFN/LNL)

We recently suggested using short bent crystals as primary collimators in a two-stage cleaning system for hadron colliders, with the aim of providing larger impact parameters in the secondary bulk absorber, through coherent beam-halo deflection*. Tests with crystals a few mm long, performed with 70 GeV proton beams at IEHP in Protvino, showed a channeling efficiency exceeding 85%. We also observed disturbing phenomena such as dechanneling at large impact angle, insufficient bending induced by volume capture inside the crystal, multiple scattering of non-channeled protons and, for the first time, a proton flux reflected by the crystalline planes. Indeed, protons with a tangent path to the curved planes somewhere inside the crystal itself are deflected in the opposite direction with respect to the channeled particles, with an angle almost twice as large as the critical angle. This effect, up to now only predicted by computer simulations**, produces a flux of particles in the wrong direction with respect to the absorber, which may hamper the collimation efficiency if neglected.

*A. Afonin et al. PhysRevLett.87.094802(2001).**A. M. Taratin and S.A.Vorobiev, Phys.Lett. A119(1987)425.

Experimental Study of Crystal Channeling at CERN-SPS for Beam-halo Cleaning

TUPLS022

M. Fiorini, P. Dalpiaz, V. Guidi (UNIFE) G. Ambrosi (INFN-PG) R.W. Assmann, I. Efthymiopoulos, L. Gatignon, W. Scandale (CERN) C. Biino (INFN-Torino) Y.A. Chesnokov (IHEP Protvino) Yu.M. Ivanov (PNPI) R. Santacesaria (INFN-Roma) A.M. Taratin (JINR) A. Vomiero (INFN/LNL)

An efficient and robust collimation system is mandatory for any superconducting hadron collider, in particular for the LHC, which will store a beam of unprecedented high intensity and energy. The usage of highly efficient and short primary bent-crystal collimators might be a possibility for reaching nominal and ultimate LHC intensity. Over the last years, groups in Russia (St. Petersburg) and Italy (Ferrara) have developed crystal production methods, which considerably improve the crystal quality. In view of the crystal-collimation experiments at the Tevatron and of the potential improvement compared with the phas$\cdot 10^{-1}$ LHC collimation system, considering the recent progress in crystal technology, we proposed experiments for crystal characterization in the SPS beam lines. Major objectives will be: 1) qualification of the new crystals to be used in the Tevatron; 2) measuring the channeling efficiency of long crystals with 1 mrad and/or 8 mrad bending angle; and 3) comparison of loss patterns around the ring for a crystal with one for amorphous material. In this paper we will report the progress towards the SPS experiment.

FFAGs as Muon Accelerators for a Neutrino Factory

TUPLS024

S. Machida (CCLRC/RAL/ASTeC)

The FFAG accelerator is a solution for rapid acceleration of muons because of its large aperture and no need of magnet ramping. Its particle dynamics is, however, peculiar due to high energy gain per turn and large transverse amplitude, which has not been seen in other types of circular accelerators. One variation of FFAG, called non-scaling FFAG, employs quite new scheme, namely, out of bucket acceleration. We studied emittance distortion, coupled motions among 3-D planes, effects of resonance lines, etc., based on a newly developed tracking code. In this paper, we will emphasize new regime of particle dynamics as well as a modeling technique of FFAG.

Racetrack Non-scaling FFAG for Muon Acceleration

TUPLS025

D. Trbojevic (BNL)

The non-scaling Fixed-Field Alternating Gradient (FFAG) machines have very strong focusing, large momentum acceptance, and small dispersion and betatron functions. This report is a study of using a compact non-scaling FFAG in combination with the superconducting linac to accelerate the muons. The drift space between two kinds of combined function magnets in the previous non-scaling FFAG is removed. The time of flight in the non-scaling FFAG has a parabolic dependence on momentum. The large energy acceptance of the machine requires matching between the linac and the non-scaling FFAG arcs for both the betatron and dispersion functions over the entire energy range.

TUPLS027

A Non-scaling FFAG for Radioactive Beams Acceleration (RIA)

D. Trbojevic, T. Roser, A.G. Ruggiero (BNL)

One of the most expensive components of proposals to accelerate heavy radioactive beams is the superconducting linac. This is an attempt to design a non-scaling Fixed-Field Alternating-Gradient (FFAG) lattice to allow acceleration of heavy radioactive beams in a short time period with an acceptance in momentum of ±50%. As it had been previously reported the non-scaling FFAG has very small orbit offsets, very strong focusing, and large momentum acceptance. The lattice with small combined function magnets would provide substantial savings in the cost of the RF.

TUPLS028

An Irradiation System for Carbon Stripper Foils with 750 keV H^- Beams

A. Takagi, Y. Arakida, Z. Igarashi, K.I. Ikegami, C. Kubota, I. Sugai, Y. Takeda (KEK) S. Dairaku, N. Saito, A. Sato, K. Senzaki (Kyoto University) Y. Irie (JAEA/J-PARC)

Carbon stripper foils of around 300 ug/cm2 will be used as a stripping of H-ion beam of the 3 GeV Rapid Cycling Synchrotron in the J-PARC. The foil should have a long lifetime with mechanically strong against high temperature of 1800K due to high-energy deposition by high intensity H-ion and circulating bunched proton beam irradiations. For this purpose, we have installed a new irradiation system using high intensity pulsed and dc H-beams of the KEK 750keV Cocksfoot-Walton accelerator. By adjusting the peak intensity and the pulse length of the hydrogen beams appropriately, the energy deposition becomes equivalent to that exerted by the incoming H^- and the circulating beams at the injection process of the RCS. The new irradiation system and some preliminary results of the carbon stripper foil will be reported.

TUPLS029

Optical Scheme of an Electrostatic Storage Ring

V. Aleksandrov, Yu. Kazarinov, V. Shevtsov (JINR) R. Doerner, H. Schmidt-Boecking, K.E. Stiebing (IKF) A. Schempp (IAP)

We consider the optical scheme of an electrostatic storage ring for low energy heavy ions/ molecules* with special requirements to type of optical functions. Results of calculation are presented.
*C. P. Welsch et al. Proc. of PAC'03, 12-16 May 2003, Portland, Oregon, USA, p.1622.

TUPLS031

Commissioning of the ISAC-II Heavy Ion Superconducting Linac at TRIUMF

R.E. Laxdal, W. Andersson, K. Fong, M. Marchetto, A.K. Mitra, W.R. Rawnsley, I. Sekachev, G. Stanford, V.A. Verzilov, V. Zviagintsev (TRIUMF)

A new heavy ion superconducting linac at TRIUMF is being installed to boost the final energy of radioactive beams from ISAC from 1.5MeV/u to above the Coulomb barrier. A first stage of 20MV consisting of five medium beta cryomodules each with four quarter wave bulk niobium cavities and a superconducting solenoid is being commissioned in early 2006. The cavities (Beta0=0.057, 0.071) operate cw at 106MHz with design peak fields of Ep=30MV/m, Bp=60mT while delivering an accelerating voltage of 1.08MV at ~4W power consumption. The report will summarize the commissioning results and early operating experience.

Superconducting Driver Linac for the New Spiral 2 Radioactive Ion Beam Facility GANIL

TUPLS032

T. Junquera (IPN)

The new Spiral 2 facility will deliver high intensity rare isotope beams for fundamental research in nuclear physics, and high neutron flux for multidisciplinary applications. Based into the ISOL and in-flight isotope production methods this facility will cover broad areas of the nuclide chart. The driver accelerator must deliver CW beams of deuterons (40 MeV, 5 mA) and heavy ions (q/A=1/3, 15 MeV/A, 1 mA). The injector is composed of two ion sources (deuterons and heavy ions) and a common RFQ cavity (88 MHz). The Superconducting Linac is composed of two sections of Quarter Wave Resonators (beta 0.07 and 0.12, frequency 88 MHz) with room temperature focusing devices. After two years of preliminary study, and following the recent decision to launch the construction phase, a complete design of the Driver Accelerator is presently completed. Important results have been obtained during the initial R&D phase, in particular on ion sources, RFQ and superconducting resonators prototypes. Status report on both the design and the prototype performances will be given in this contribution.

First Stage of a 40 MeV Proton Deuteron Accelerator Commissioning Results

TUPLS033

C. Piel, K. Dunkel, M. Pekeler, H. Vogel, P. vom Stein (ACCEL)

In 2006 the first stage of a 40MeV superconducting linear accelerator for protons and deuterons will be commissioned at SOREQ. This paper will present commissioning of the ECR source after final assembly. First results of the 1.5MeV/u cw RFQ are expected, further test results of the beta=0.09 half wave superconducting resonators are presented, and resonator geometry improvements with respect to electron multipacting behaviour will be discussed. An outlook on the project with respect to achieve the final energy of 40MeV will be given.

UNILAC Upgrade Programme for the Heavy Element Research at GSI-SHIP

TUPLS034

W. Barth, L.A. Dahl, S. Hofmann, K. Tinschert (GSI) U. Ratzinger (IAP)

In the field of heavy-element research using the velocity separator SHIP significant achievements were made at GSI during the last 30 years. The experiences obtained of experiments clearly show that superheavy-element research was always based on efforts to extend the limits of technical possibilities - of these the increase of beam intensity is one of the major contributions. This paper provides for technical information on the already planned upgrades of the present facility, which results in a significant overall increase of the experimental sensitivity. It is foreseen to investigate and to build a sc 28 GHz-ECR ion source, which should increase the primary beam intensities. The beam coming from the new ECR source will be delivered to the GSI-High Charge State Injector by a second LEBT-system. An upgrade program for the rf-amplifiers and the rf-structures is intended to increase the duty factor from 30 % to 50 %. Besides the ECR-source a new RFQ accelerator and the IH structure may alternatively serve as an injector for an new advanced stand alone accelerator providing for 100 % duty factor. Two different linac-layouts will be discussed.

TUPLS035

The HITRAP Decelerator Project at GSI

L.A. Dahl, W. Barth, M. Kaiser, O.K. Kester, H.J. Kluge, W. Vinzenz (GSI) B. Hofmann, U. Ratzinger, A.C. Sauer, A. Schempp (IAP)

The heavy ion trap (HITRAP) at GSI is a funded project since 2004. Highly charged ions up to U^{92+} provided by the GSI accelerator facility will be decelerated and subsequently injected into a Penning trap for further cooling almost to rest. A combination of an IH^{-} and an RFQ-structure decelerates the ions from 4 MeV/u down to 6 keV/u. In front of the decelerator a double-drift-buncher-system provides for phase focusing and a final debuncher integrated in the RFQ-tank reduces the energy spread in order to improve the efficiency for beam capture in the cooler trap. The report gives an overview of the final beam dynamic design of the entire decelerator. Besides the construction status of the cavities, particular beam diagnostic features due to the short pulses of 1 μs and 108 MHz bunch frequency, and the measures for technical and controls integration into the existing GSI accelerator complex are presented. Finally the recent time schedule and considerations for commissioning are shown.

TUPLS036

Status of the Linac-commissioning for the Heavy Ion Cancer Therapy Facility HIT

M.T. Maier, R. Baer, W. Barth, L.A. Dahl, C. Dorn, T.G. Fleck, L. Groening, C.M. Kleffner, C. Müller, A. Peters, B. Schlitt, M. Schwickert, K. Tinschert, H. Vormann (GSI) R. Cee, B. Naas, S. Scheloske, T. Winkelmann (HIT) U. Ratzinger, A. Schempp (IAP)

A clinical facility for cancer therapy using energetic proton and ion beams (C, He and O) is under construction and will be installed at the Radiologische Universitätsklinik in Heidelberg, Germany. It consists of two ECR ion sources, a 7 MeV/u linac injector and a 6.5 Tm synchrotron to accelerate the ions to final energies of 50-430 MeV/u. The linac comprises a 400 keV/u RFQ and a 7 MeV/u IH-DTL operating at 216.8 MHz. In this contribution the current status of the linear accelerator is reported. After first tests with $1H^{+}$ beam of the RFQ at GSI, the commissioning of the accelerator in Heidelberg has already started. The commissioning with beam is performed in three steps for the LEBT, the RFQ and the IH-DTL. For this purpose a versatile beam diagnostic test bench has been designed. It consists of a slit-grid emittance measurement device, transverse pick-ups providing for time of flight energy measurements, SEM-profile grids and different devices for beam current measurements. This paper will provide for a status report of the linac-commissioning.

TUPLS037

The Frankfurt Funneling Experiment

U. Bartz, D. Ficek, N. Mueller, A. Schempp, J. Thibus, M. Vossberg (IAP)

The goal of the Frankfurt Funneling Experiment is to multiply beam currents of RFQ accelerators at low energies to avoid problems with space charge. The two beams from the ion sources are injected into two RFQ channels. The last part of the RFQ electrodes have been replaced to achieve a 3d focus at the crossing point of the two beam axis where the funneling deflector as a central peace of the experiment is located. The newly designed multi-cell deflector is adapted to the optimised funneling section. It is mechanically solid, easy to tune in and ready for operation. First measurements will be presented.

The MAFF IH-RFQ Test Stand at the IAP Frankfurt

TUPLS038

A. Bechtold, D. Habs (LMU) J. Fischbach, U. Ratzinger, J. Rehberg, M. Reichwein, A. Schempp (IAP) J. Haeuser (NTG Neue Technologien GmbH & Co KG) O.K. Kester (GSI)

The IH-type RFQ for the MAFF project at the LMU in Munich is presently under construction and will be integrated into a beam test stand at the IAP in Frankfurt. It is the second RFQ following the IH resonator concept and the first one that can be directly compared to a very similar 4-rod type machine, namely the REX-ISOLDE RFQ at CERN. The MAFF RFQ has been designed to accelerate rare isotope beams (RIBs) with mass to charge ratios up to 6.3 from 3 keV/u to 300 keV/u at an operating frequency of 101.28 MHz with an electrode voltage of 60 kV. First RF-measurements have already been executed and can be compared to appropriate simulation results. Parts of the test stand are currently under construction, such as the volume ion source for He^{+} at an extraction voltage of 12 keV and an electrostatic quadruplet for injection with an integrated steering system. These tests and accompanying theoretical investigations will be done with special respect to the applicability of such normal conducting RFQ accelerators to the EURISOL post accelerator.

Proposal of a Normal Conducting CW-RFQ for the EURISOL Post-accelerator and a Dedicated Beta-beam Linac Concept

TUPLS039

A. Bechtold, H. Podlech (IAP)

A combination of three superconducting RFQs has been proposed for the EURISOL post accelerator layout. At least the first RFQ of this triplet could be replaced by a normal conducting continuous wave (c.w.) device. Efficient cooling systems have already been designed and applied to existing machines at the IAP in Frankfurt. Preliminary electrode and cavity designs can be presented. Since a parallel use for beta-beam applications was intended, we have optimized the design not only for heavy ion applications with negligible beam currents at c.w. but also for lighter ions with currents up to 7.5 mA at pulsed operation. More recent investigations on beta-beams came up with currents around 50 mA, which then would make a separate linac solution for beta-beams necessary. We worked out some preliminary design suggestions for such a dedicated 100 MeV/u machine.

Tuning of a 4-rod CW-mode RFQ Accelerator

TUPLS040

P. Fischer, A. Schempp (IAP)

A four-rod RFQ accelerator has been built which operates in CW mode with a power consumption of 250 kW. The assembly of a high power RFQ structure requires a precise mechanical alignment and field tuning of the electrode field. The field distribution must be very flat to enable a proper operation with few losses. Adjusting of the field distribution is critical in long structures. Simulations and the status of the tuned structure will be discussed.

TUPLS041

The HITRAP RFQ Decelerator at GSI

B. Hofmann, A. Schempp (IAP) O.K. Kester (GSI)

The HITRAP linac at GSI will decelerate ions from 5 MeV/u to 6 keV/u for experiments with the large GSI Penning trap. The ions, provided by the GSI accelerator facility, will be decelerated at first in the existing experimental storage ring (ESR) down to an energy of 5 MeV/u, and injected into a new IH decelerator and decelerated to 5oo keV/u. The following 4- Rod type RFQ will decelerate the ion beam from 5oo keV to 6 keV/u. The RFQ has been designed and will be built at the Institute for Applied Physics in Frankfurt. The properties of the RFQ decelerator and the status of the project will be discussed.

TUPLS042

First Cryogenic Tests of the Superconducting CH-structure

H. Podlech, C. Commenda, H. Klein, H. Liebermann, U. Ratzinger, A.C. Sauer (IAP)

The CH-structure is a new multi-cell drift tube structure operated in the TE21-mode and is well suited for the acceleration of low and medium beta ion and proton beams. Due to the mechanical stiffness room temperature as well as superconducting CH-cavities can be realised. A 19-cell, beta=0.1 superconducting CH-prototype cavity has been developed and built. First cryogenic tests have been performed at 4.5 K in Frankfurt successfully. An effective accelerating voltage of 3.6 MV has been achieved so far. This corresponds to an electric peak field of 23 MV/m. Actual measurements aim on a localisation of possible field emission centers, afterwards further surface preparation will take place.

TUPLS043

Simulations for the Frankfurt Funneling Experiment

J. Thibus, A. Schempp (IAP)

Beam simulations for the Frankfurt Funneling Experiment are done with RFQSim and FUSIONS. RFQSim is responsible for the beam transport through an RFQ accelerator. Behind the accelerator the particle dynamic program FUSIONS calculates the macro bunches of both beam lines through an r.f. funneling deflector. A new space charge routine has now been included. The status of the development of FUSIONS and the results of the simulations will be presented.

TUPLS044

The 3D Beam Dynamics with the Space Charge in the Low and Middle Energy Super-conducting Option of HIPPI

N.E. Vasyukhin, R. Maier, Y. Senichev, R. Tölle (FZJ)

For the low and middle energy of the High Intensity Proton Pulse Injector (HIPPI), a superconducting option is considered.The 3D beam dynamics simulation results in the slot and the finger-slot sections covering the energy range from 3 to 160 MeV are presented. The optimization aim is the increase of beam current together with the reduction of emittance growth, beam losses and costs. The slot structure is compared with the conventional spoke structure.

Completion of the Commissioning of the Superconducting Heavy Ion Injector PIAVE at INFN-LNL

TUPLS045

G. Bisoffi, G. Bassato, A. Battistella, l. Boscagli, A. Calore, S. Canella, D. Carlucci, M. Cavenago, F. Chiurlotto, M. Comunian, M. De Lazzari, A. Facco, E. Fagotti, A. Galatà, P. Modanese, M.F. Moisio, A. Pisent, M. Poggi, A.M. Porcellato, P.A. Posocco, C. Roncolato, E. Sattin, S. Stark (INFN/LNL) N. Schiccheri (CNAO Foundation)

At INFN-LNL the commissioning of the injector PIAVE, based on superconducting RFQs, has been completed. All the superconducting cavities (two RFQs and 8 quarter wave resonators - QWR) have shown very satisfactory stability with respect to changes of the liquid helium pressure and microphonics. Beam parameters are very close to the nominal values. The commissioning was completed by accelerating the pilot beam $16O^{3+}$ with the PIAVE injector and the booster linac ALPI (summer 2005). Since December 2005, a number of test beams were accelerated (mainly noble gas species) with PIAVE and ALPI and delivered to user experimental stations. Regular operation will be scheduled from Fall 2006 onwards.

An Analysis of Lumped Circuit Equation for Side Coupled Linac (SCL)

TUPLS047

V.G. Vaccaro, A. D'Elia (Naples University Federico II and INFN) M.R. Masullo (INFN-Napoli)

The behaviour of a SCL module is generally described by resorting to an equation system borrowed from lumped circuit theories. This description holds for a narrow frequency band (mono-modal cavity behaviour). A milestone in this field is represented by the classical analysis made by Knapp & alii where the equations allow for the resonant frequencies of the cavities and the first and second order coupling constants. Eigenvalues and eigenvectors (resonant frequencies of the system and relevant current amplitudes) are also given. We show that the system is not correct in the second and last but one equations for the case of half cell termination and non zero second order coupling constants. Due to the relevance of this formulation and of the case treated, we pay a particular attention to find the missing terms in the above mentioned equation. We suggest a correction term, having in addition a deep meaning from electromagnetic point of view. By means of this term we may justify the analytical solution given by the authors. Some numerical examples are also given showing that a discrepancy appears comparing the new equations with the results of the non-correct formulation.

Optimization Design of a Side Coupled Linac (SCL) for Protontherapy: a New Feeding Solution

TUPLS048

V.G. Vaccaro, A. D'Elia (Naples University Federico II and INFN) T. Clauser, A.C. Rainò (Bari University, Science Faculty) C. De Martinis, D. Giove, M. Mauri (INFN/LASA) S. Lanzone (CERN) M.R. Masullo (INFN-Napoli) R.J. Rush (e2v technologies) V. Variale (INFN-Bari)

It is proposed to use an SCL, starting at 30MeV, up to 230MeV. The linac consists of 25 modules (two tanks each). Twelve, 3GHz power generators, feed two modules in parallel, with the last power generator feeding the last module. The SCL is designed, assuming a mean accelerating field in the cavities of 16,5MV/m. The longitudinal and transverse beam dynamics has been studied, assuming that the input parameters (emittance, energy spread and mean current) are those of commercial 30MeV cyclotrons. The characteristics of the ejected beam were analysed: the transmittance value is largely sufficient to deliver a correct dose for therapy; the beam line activation is kept largely below allowed levels; the output energy spread is sufficiently small. The first prototype module is under construction and a second one is under design. Contacts with e2v have been established for defining an agreement, which proposes to use magnetrons as feeders for the acceleration tests. Attention was therefore paid to phase locking constraints between feeders. Theoretical studies suggest that transmittance stays constant if de-phasing is kept into values that seem attainable with magnetrons.

TUPLS049

A Rationale to Design Side Coupled Linac (SCL): a Faster and More Reliable Tool

V.G. Vaccaro, A. D'Elia (Naples University Federico II and INFN) M.R. Masullo (INFN-Napoli)

A module of an SCL is formed by a cascade of two or more tanks, connected by a Bridge Couplers (BC) with an RF feeder, which realizes a well defined accelerating field configuration in all the coupled cavities. Even resorting to geometrical scaling for the design of the adjacent tanks in the module it is not possible to reproduce the same e-m parameters. In addition to this the BC's for each tanks have a different geometrical design because of phasing constraints. The standard procedure may leads a very slow convergence of the design to the optimum and it is not in general clear if the optimum is reached. In this paper a rationale for designing a module of an SCL will be described and it will be presented its application to PALME first module (30-3???MeV). From a lumped circuit model one may get useful relations between e-m global response of the system and single cell parameters. Therefore it provides a certain number of tools which are used for the designing steps in connection with the standard electromagnetic CAD's, the results of which were used as "measurements".

TUPLS051

Development of PEFP 20 MeV Proton Accelerator

Y.-S. Cho, H.M. Choi, S.-H. Han, I.-S. Hong, J.-H. Jang, H. S. Kim, K.Y. Kim, Y.-H. Kim, H.-J. Kwon, K.T. Seol, Y.-G. Song (KAERI)

A 20 MeV proton accelerator has been developed as a low energy part of PEFP (Proton Engineering Frontier Project) 100 MeV accelerator. The 20 MeV accelerator consists of ion source, LEBT (Low Energy Beam Transport), 3 MeV RFQ (Radiofrequency Quadrupole) and 20 MeV DTL (Drift Tube Linac). After the field tuning and high power RF conditioning of the accelerating cavities, the first beam test of the 20 MeV accelerator is underway. During the test, the pulsed proton beam was extracted from the ion source by pulsing the high voltage power supply. Two 1.1 MW, 350MHz RF systems were used to drive the 20 MeV accelerator. The current transformers between DTL tanks and Faraday cup at the end of 20 MeV DTL were used to measure the beam current. In this paper, the development of 20MeV accelerator are summarized and the first beam test results are discussed.

TUPLS052

Beam Dynamics of the PEFP Linac

J.-H. Jang, Y.-S. Cho, K.Y. Kim, Y.-H. Kim, H.-J. Kwon (KAERI)

The PEFP Linac consists of a 50 keV ion source, LEBT, 3 MeV RFQ, 20 MeV DTL called DTL1, MEBT, and 100 MeV DTL called DTL2. The MEBT includes two small DTL tanks, which match the 20 MeV proton beams into the DTL2, and a bending magnet, which extracts the 20 MeV proton beams to the experimental hall. We will present the full beam dynamics study from the entrance of the DTL1 to the end of DTL2 with the initial beam parameters obtained from a simulation study of the RFQ. Our study focuses on the longitudinal beam matching in order to compensate the missing RF effect between every neighboring DTL tanks as well as the full beam matching between DTL1 and DTL2.

Beam Dynamics of a High Current IH-DTL Structure for the TWAC Injector

TUPLS053

S. Minaev, T. Kulevoy, B.Y. Sharkov (ITEP) U. Ratzinger, R. Tiede (IAP)

A powerful ion injector based on a laser ion source is needed for an efficient operation of the Tera Watt Accumulator (TWAC) complex including a heavy ion synchrotron and a storage ring, which is under progress now at ITEP, Moscow. The Interdigital H-type drift tube linac (IH-DTL) structure operating at 162 MHz is proposed for the second stage of the injector linac behind of a 81 MHz RFQ. Consisting of independently driven sections with inter-tank quadrupole triplet focusing, this structure will accelerate highly stripped ions with charge-to-mass ratios above 1/3 in the energy range from 1.57 MeV/u at the RFQ exit to 7 MeV/u. Beam currents up to 100 mA are expected for medium ions like Carbon or Aluminum. Since the rf frequency is duplicated at the entrance of the IH-DTL in order to reduce size as well as power consumption, space charge effects are dominant at full current. Beam dynamics and structure parameters are discussed in detail.

The Isochronous Mode of the Collector Ring

TUPLS054

S.A. Litvinov, A. Dolinskii, H. Geissel, F. Nolden, M. Steck, H. Weick (GSI)

The isochronous mode of a storage ring is a special ion-optical setting in which the revolution time of circulating ions of one species does not depend on their velocity spread. In this mode the ring can be used for mass measurement of exotic nuclei. The Collector Ring (CR) [1] of the FAIR project [2] will operate in such mode as time-of-flight spectrometer for short-lived exotic nuclei (T1/2 > 20 μs) produced and selected in flight with the Super-FRS fragment separator [3]. This technique has been developed at the ESR [4]. The dependence of the revolution time in the isochronous ring from its transverse acceptance, the closed orbit distortion, and nonlinear imperfection of the magnet field was investigated analytically and with a Monte-Carlo simulation. The corresponding results will be presented.

References: [1] A. Dolinskii et. al., GSI Annual Report, 2004 [2] W. Henning, Nucl. Phys. A721 (2003)211c [3] H. Geissel, et. al., Nucl. Instr. Meth. B204 (2003)71 [4] M. Hausmann et. al., Nucl. Instr. Meth. A 446 (2000)569

First Section of a 352 MHz Prototype Alvarez DTL Tank for the CERN SPL

TUPLS055

S.V. Plotnikov, A.P. Durkin, D. Kashinskiy, V.A. Koshelev, T. Kulevoy, S. Minaev, V. Pershin, B.Y. Sharkov, V. Skachkov (ITEP) V.F. Basmanov, V.A. Demanov, I.D. Goncharov, E.S. Mikhailov, N.I. Moskvin, S.T. Nazarenko, V.S. Pavlov, V.V. Porkhaev, V.T. Punin, A.V. Telnov, V.N. Yanovsky, N.V. Zavyalov, S.A. Zhelezov (VNIIEF)

In the Linac4/SPL projects at CERN, 352 MHz 30 mA DTL Alvarez accelerating structure will be used to accelerate protons between 3 and 40 MeV. The R&D for the development of a prototype structure for the energy range from 3 to 10 MeV is taking place jointly at ITEP and VNIIEF. The design of this 2.7 m Alvarez tank containing 27 drift tubes is described in this document. Results of calculations of the section parameters are presented. One of the main features of the design is the use of permanent magnets made of SmCo5

alloy as quadrupole focusing lenses (PMQ) inside the drift tubes. Details of the experimental PMQ-equipped drift tube are described.

TUPLS057

Linac4, a New Injector for the CERN PS Booster

R. Garoby, G. Bellodi, F. Gerigk, K. Hanke, A.M. Lombardi, M. Pasini, C. Rossi, E.Zh. Sargsyan, M. Vretenar (CERN)

The first bottle-neck towards higher beam brightness in the LHC injector chain is due to space charge induced tune spread at injection in the CERN PS Booster (PSB). A new injector called Linac4 is proposed to remove this limitation. Using RF cavities at 352 and 704 MHz, it will replace the present 50 MeV proton Linac2, and deliver a 160 MeV, 40 mA H^- beam. The higher injection energy will reduce space charge effects by a factor of 2, and charge exchange will drastically reduce the beam losses at injection. Operation will be simplified and the beam brightness required for the LHC ultimate luminosity should be obtained at PS ejection. Moreover, for the needs of non-LHC physics experiments like ISOLDE, the number of protons per pulse from the PSB will increase by a significant factor. This new linac constitutes an essential component of any of the envisaged LHC upgrade scenarios, which can also become the low energy part of a future 3.5 GeV, multi-megawatt superconducting linac (SPL). The present design has benefited from the support of the French CEA and IN2P3, of the European Union and of the ISTC (Moscow). The proposed machine and its layout on the CERN site are described.

TUPLS058

New Prestripping Section of the MILAC Linear Accelerator Designed for Accelerating a High Current Beam of Light Ions

A.P. Kobets, V.A. Bomko, O.F. Dyachenko, Ye.V. Ivakhno, M.S. Lesnykh, Z.O. Ptukhina, V.N. Reshetnikov, S.S. Tishkin, V.P. Yashin, A.V. Zabotin, B.V. Zajtsev, V.G. Zhuravlev (NSC/KIPT)

In the Kharkov Institute of Physics and Technology, the works on construction of a new prestripping section of the multicharge ion linear accelerator (MILAC) is performed. The task is set to provide acceleration of high current beams of light ions for research works on radiation material engineering and applied investigations. The new prestripping section is designed for accelerating ions with A/q=4 up to the energy of 1 MeV/u; after stripping they will be accelerated in the main section up to the energy of 8.5 MeV/u. Special operational mode will allow to increase noticeably the repetition rate with the same power consumption. The calculation results on beam dynamics in the structure with alternating phase focusing in the version with the stepped change of the synchronous phase, and calculations of electrodynamic characteristics of the accelerating structure of the interdigital type. The peculiarities of the construction of the accelerating structure are described.

TUPLS061

Design of a Low Energy Electron Cooler for the Heidelberg CSR

H. Fadil, M. Grieser, D. Orlov, A. Wolf (MPI-K)

The electrostatic Cryogenic Storage Ring (CSR) is currently being designed at MPI-K in Heidelberg. This ring will utilize electrostatic deflectors and focusing elements, and will store ions with kinetic energies in the range 20~300 keV (E/Q) to be mainly utilized in atomic and molecular physics experiments. The CSR will be equipped with a compact magnetic electron cooler, which will serve the double purpose of phase space compression of the stored ion beam as well as an electron target for recombination experiments. The cryogenic photocathode source, developed for the Heidelberg

TSR, will be used to provide extremely cold magnetically guided electron beams. The maximum cooling electron energy is 165 eV and the usual operation energy for 20 keV protons will be about 10 eV. The cooler will fit in the 2.8 m straight section of the ring. The device will be installed inside the outer vacuum chamber of the CSR, and the magnetic confinement of the electrons will be provided with high temperature superconducting coils. The design of the magnets of the CSR electron cooler will be presented in this paper.

Cooling Rates at Ultra-low Energy Storage Rings

TUPLS062

C.P. Welsch, C.P. Welsch (CERN) A.V. Smirnov (JINR)

Electrostatic low-energy storage rings have proven to be a highly flexible tool, able to cover experiments from a variety of different fields ranging from atomic, nuclear and molecular physics to biology and chemistry. Future machines will decisively rely on efficient electron cooling down to electron energies as low as some eV, posing new challenges to the cooler layout and operation. The BETACOOL code has already been successfully applied for the layout and optimization of a number of different electron coolers around the world. In this contribution, the results from calculations of the cooling rates at future low-energy machines equipped with an internal target like the Ultra-low energy Storage Ring (USR) at the Facility for Low-energy Antiproton and Ion Research (FLAIR) are presented.

Layout of the USR at FLAIR

TUPLS063

C.P. Welsch, C.P. Welsch (CERN) M. Grieser, J. Ullrich, A. Wolf (MPI-K)

The Facility for Low-energy Antiproton and Ion Research (FLAIR) and a large part of the wide physics program decisively rely on new experimental techniques to cool and slow down antiprotons to 20 keV, namely on the development of an ultra-low energy electrostatic storage ring (USR). The whole research program connected with anti-matter/matter interactions is only feasible if such a machine will be realized For the USR to fulfil its key role in the FLAIR project, the development of novel and challenging methods and technologies is necessary: the combination of the electrostatic storage mode with a deceleration of the stored ions from 300 keV to 20 keV, electron cooling at all energies in both longitudinal and transverse phase-space, bunching of the stored beam to ultra-short pulses in the nanosecond regime and the development of an in-ring reaction microscope for antiproton-matter rearrangement experiments. In this contribution, the layout and the expected beam parameters of the USR are presented and its role within FLAIR described. The machine lattice and the cooler parameters are summarized.

Design and Commissioning of a Compact Electron Cooler for the S-LSR

TUPLS064

H. Fadil, S. Fujimoto, A. Noda, T. Shirai, H. Souda, H. Tongu (Kyoto ICR) T. Fujimoto, S.I. Iwata, S. Shibuya (AEC) M. Grieser (MPI-K) K. Noda (NIRS) I.A. Seleznev, E. Syresin (JINR)

The ion cooler ring S-LSR has been constructed and commissioned in October 2005. The ring successfully stored a 7 MeV proton beam. The S-LSR is equipped with a compact-electron cooler which has a cooling solenoid length of 0.8 m, a toroid bending radius of 0.25 m and maximum magnetic field in the cooling section of 0.5 kG. The commissioning of the electron cooler was carried out with successful observation of both longitudinal and horizontal cooling of the proton beam. By varying the electric potential on the Pierce electrode in the gun, we have investigated the possibility of generating a hollow shaped electron beam, and studied its effect on the electron cooling process. Also the effect of the electrostatic deflector, installed in the toroid section in order to compensate the drift motion of the secondary electrons, was investigated. The design and results of the commissioning of the compact electron cooler are presented.

TUPLS065

Beam Commissioning of Ion Cooler Ring, S-LSR

T. Shirai, S. Fujimoto, M. Ikegami, A. Noda, H. Souda, M. Tanabe, H. Tongu (Kyoto ICR) H. Fadil (MPI-K) T. Fujimoto, H. Fujiwara, S.I. Iwata, S. Shibuya (AEC) I.N. Meshkov, I.A. Seleznev, A.V. Smirnov, E. Syresin (JINR) K. Noda (NIRS)

S-LSR is a new ion cooler ring constructed in Kyoto University. The circumference is 22.557 m and the maximum magnetic rigidity is 1 Tm. The constructiion and the vacuum baking had been finished in September, 2005. The beam commissioning was started since October, 2005. The injected beam is 7 MeV proton from the existing linac. The beam circulation test and the electron beam cooling were carried out successfully and the beam information and the characteristics of the ring were measured. One of the subjects of S-LSR is a realization of the crystalline beams using the electron and laser cooling. The lattice of S-LSR was designed to suppress the beam heating as much as possible and we also present such measurement results in this paper.

TUPLS066

Peculiarities of Electron Cooler Operation and Construction at Ultra Low Energy in an Electrostatic Ring

E. Syresin (JINR)

Few projects of electrostatic rings with electron cooler are discussed now. Electron cooling at low electron energy of 10 eV was realized at the KEK electrostatic ring. The electron cooling permits to suppress the ion multi scattering on residual gas atoms and allows increasing the ion lifetime. Peculiarities of an electron cooler operation and construction at ultra low energy in an electrostatic ring are considered. The cooler gun operation regime is cardinally changed at a reduction of the electron energy to a value comparable with a cathode work function. A virtual cathode and ohmic resistance of cathode emitter give an input in beam formation at ultra low energy. Effective electron cooling of heavy atomic and bimolecular ions at mass of 100-1000 is reached at a small photocathode diameter of 1 mm and a high magnetic expansion factor of 10^{-1000}. The electron cooler construction has traditional design in KEK electrostatic ring. The cooler construction can be simplified at a small circumference of electrostatic ring. Straight cooler schemes without toroidal magnets permit to reduce ring space required for electron cooler.

TUPLS067

Status of the HESR Electron Cooler Design Work

D. Reistad, T. Bergmark, O. Byström, B. Gålnander, S. Johnson, T. Johnson, T. Lofnes, G. Norman, T. Peterson, K. Rathsman, L. Westerberg (TSL) H. Danared (MSL)

The electron energy of the HESR electron cooler shall be variable from 450 keV to 4.5 MeV. Furthermore, the design shall not exclude a further upgrade to 8 MeV. Operation of the HESR in a collider mode, which requires electron cooling of both protons and antiprotons traveling in opposite directions, is an interesting option. The status of the technical design of the HESR electron cooling system will be presented.

LEIR Electron Cooler Status

TUPLS068

G. Tranquille, V. Prieto, R. Sautier (CERN) A.V. Bubley, V.V. Parkhomchuk (BINP SB RAS)

The electron cooler for LEIR is the first of a new generation of coolers being commissioned for fast phase space cooling of ion beams in storage rings. It is a state-of-the-art cooler incorporating all the recent developments in electron cooling technology (adiabatic expansion, electrostatic bend, variable density electron beam…) and is designed to deliver up to 600 mA of electron current for the cooling and stacking of Pb^{54+} ions in the frame of the ions for LHC project. In this paper we present our experience with the commissioning of the new device as well as the first results of ion beam cooling with a high-intensity variable-density electron beam.

Performance of Fermilab's 4.3 MeV Electron Cooler

TUPLS069

A.V. Shemyakin, A.V. Burov, K. Carlson, M. Hu, T.K. Kroc, J.R. Leibfritz, S. Nagaitsev, L.R. Prost, S.M. Pruss, G.W. Saewert, C.W. Schmidt, M. Sutherland, V. Tupikov, A. Warner (Fermilab)

A 4.3 MeV DC electron beam is used to cool longitudinally an antiproton beam in the Fermilab's Recycler ring. The cooling rate is regulated either by variation of the electron beam current up to 0.5 A or by a vertical separation of beams in the cooling section. The paper will describe steps that provided a stable operation and present the status of the cooler.

Chromaticity Control in Linear-field Nonscaling FFAGs by Sextapoles

TUPLS070

S.R. Koscielniak (TRIUMF)

Because of their high repetition rate and large apertures, FFAGs are proposed for high-current medical accelerators suitable for cancer therapy. The linear-field nonscaling FFAG is made from repeating cells containing D and F combined function magnets. The betatron tune profiles decrease with momentum; this leads to the crossing of resonances. We examine how sextapole magnets may be used to flatten the tune profile; in particular (i) whether it is better to place them at the D or F; (ii) what strength is required; and (iii) what is their effect on the closed orbits and path length? The orbit geometry is derived from a thin-element model and the tunes from power series in the quadrupole strength. Chromaticity is corrected by coupling focusing strength to dispersion, which is far stronger in the F element. The zeros of the orbit dispersion become the poles of the "sextapole strength to flatten the tune at some particular momentum". We demonstrate that a weak F sextapole can produce a substantial horizontal tune flattening, and has little impact on other optical properties. Contrarily, placing the sextapole at the D element may destroy the dynamic aperture and or vertical focusing.

Minimum Cost Lattices for Nonscaling FFAGs

TUPLS071

S.R. Koscielniak (TRIUMF)

Previously, linear-field FFAG lattices for muon acceleration have been optimized under the condition of minimum path length variation. For non-relativistic particles, as are employed in the hadron therapy of cancer, that constraint is removed allowing a wider range of design choices. We adopt the thin-element kick model for a degenerate F0D0 cell composed of D and F combined function magnets. The dipole field components are parametrised in terms of the bending at the reference momentum and the reverse bend angle. The split between positive and negative bending sets the shape of the closed orbits. The cost function, based on stored magnetic energy, is explored in terms of the split. Two cost minima are found, one corresponding to minimum peak magnet field in the F element, and another to minimum radial aperture in the D element. Analytic formulae are given for the minimization conditions. The minimum field lattice is similar to existing designs based on minimizing the path length variation, but the minimum aperture lattice presents a new direction for future detailed design studies.

TUPLS072

Nonscaling FFAG with Equal Longitudinal and Transverse Reference Momenta

S.R. Koscielniak (TRIUMF)

An unusual feature of linear-field nonscaling FFAG designs is that the radio-frequency is not necessarily synchronous with the reference orbit and momentum chosen for the lattice design. This arises because optics design prefers the reference geometry to be composed of straight lines and arcs of circles - either at the mean momentum, or at high momentum to centre the orbit in the F element. The asynchronous acceleration proposed for rapid acceleration has strong requirements to set the longitudinal reference at 1/4 and 3/4 of the momentum range to minimize phase slip. The usual particle-tracking programs, such as MAD, though sophisticated in the transverse plane, are far cruder in their longitudinal working and do not allow for a longitudinal reference momentum and RF phase independent of the transverse values. In the context of a thin-element lattice model, we show how to make the transverse reference momentum and optic design coincident with the longitudinal reference by adjusting the ratio of positive and negative bending in the D and F elements, respectively, and retaining a lines and arcs composition for the reference orbit. This prepares the way for MAD tracking.

TUPLS073

Formulae for Linear-field Non-scaling FFAG Accelerator Orbits

M.K. Craddock (UBC & TRIUMF) S.R. Koscielniak (TRIUMF)

Non-scaling FFAG accelerators using constant-gradient F and D magnets with their fields decreasing outwards can compact ion orbits for a wide range of momentum (e.g., 1:2) into a narrow radial range. Designs to accelerate protons, ions and muons are currently being studied for proton drivers, cancer therapy facilities and neutrino factories. In this paper, analytic formulae are reported for some basic orbit properties, helping to make clear their dependence on the various design parameters and momentum. For the designs tested so far the numerical results are in excellent agreement with those obtained using lattice codes.

TUPLS075

Design of the Flat-top Acceleration Cavity for the LNS Superconducting Cyclotron

L.A.C. Piazza, D. Battaglia, L. Calabretta, A.C. Caruso, F. Consoli, M.M. Maggiore, D. Rifuggiato, A. Spartà (INFN/LNS)

A 3rd harmonic Flat-top acceleration system for the K800 Superconducting Cyclotron of the Laboratori Nazionali del Sud (LNS) was designed to reduce the energy spread of the accelerated particles and to improve the beam quality and the extraction efficiency. The Flat-top effect is realized by the superposition of the 3rd harmonic to the fundamental acceleration frequency. The 3rd harmonic frequency

is produced by an additional resonator, capacitively coupled to the K 800 cavities. The Flat-top cavity was designed with the 3D electromagnetic codes Ansoft HFSS and CST MicroWaveStudio.

Beam Extraction of 150 MeV FFAG

TUPLS076

M. Aiba, Y. Mori, H. Nakayama, K. Okabe, Y. Sakamoto, A. Takagi (KEK) R. Taki (GUAS/AS) Y. Yonemura (Kyushu University)

A beam extraction from FFAG accelerator was performed for the first time at KEK 150MeV proton FFAG synchrotron. The purpose of 150MeV FFAG project is to establish a working prototype for various applications. The beam extraction is thus one of important goals. The extraction is based on fast extraction methode using kicker and pulse septum working at 100Hz. A rapid cycling is also our focus to take advantages of FFAG accelerator. Beam extraction experiment was successful under 100Hz operating. The details of experiment will be presented in this paper.

Development of FFAG-ERIT Ring

TUPLS077

K. Okabe, M. Muto (KEK) Y. Mori (KURRI)

An intense neutron source with the emittance recovery internal target (ERIT) using the FFAG accelerator is under development. The design of the FFAG storage ring for this purpose will be presented.

Design Studies of the Compact Superconducting Cyclotron for Hadron Therapy

TUPLS078

Y. Jongen, W. Beeckman, W.J.G.M. Kleeven, D. Vandeplassche, S.E. Zaremba (IBA) V. Aleksandrov, G.A. Karamysheva, Yu. Kazarinov, I.N. Kian, S.A. Kostromin, N.A. Morozov, E. Samsonov, V. Shevtsov, G. Shirkov, E. Syresin (JINR)

An overview of the current status of the design of the compact superconducting isochronous cyclotron C400 able to deliver ion beams with a charge to mass ratio of 0.5 is given. This cyclotron is based on the design of the current PT (proton therapy) C230 cyclotron and will be used for radiotherapy with proton, helium or carbon ions. $12C^{6+}$ and $4He^{2+}$ ions will be accelerated to 400 MeV/u energy and extracted by electrostatic deflector, H^{2+} ions will be accelerated to the energy 260MeV and extracted by stripping. Computer modeling results on the axial injection system, magnetic system, inflector and center design are given. Results of simulations of the ion beam injection, acceleration and extraction are presented.

Hadron Cancer Therapy Complex Employing Non-scaling FFAG Accelerator and Fixed Field Gantry Design

TUPLS079

E. Keil (CERN) A. Sessler (LBNL) D. Trbojevic (BNL)

Non-scaling FFAG rings for cancer hadron therapy offer reduced physical aperture and large dynamic aperture as compared with scaling FFAGs. The variation of tune with energy implies the crossing of resonances during acceleration. Our design avoids intrinsic resonances, although imperfection resonances must still be crossed. We consider a system of three non-scaling FFAG rings for cancer therapy with 250 MeV protons and 400 MeV/u carbon ions. Hadrons are accelerated in a common RFQ and linear accelerator, and injected into the FFAG rings at v/c=0.1128. The H^+/C6+ ions are accelerated in the two smaller/larger rings to 31 and 250 MeV/52.5 and 400 MeV/u kinetic energy, respectively. The lattices consist of symmetrical triplet cells with a straight section for RF cavities. The gantry with similar triplet cells accepts the whole required momentum range at fixed field. This unique design uses either High Temperature super-conductors or super-conducting magnets reducing gantry size and weight. Elements with a variable field at the beginning and at the end set the extracted beam at the correct position for the specific energy and adapt the beam to specific requirements during treatment.

TUPLS080

The Proposed 2 MeV Electron Cooler for COSY-Juelich

J. Dietrich (FZJ) V.V. Parkhomchuk (BINP SB RAS)

The design, construction and installation of a 2 MeV electron cooling system for COSY-Juelich is proposed to further boost the luminosity even with strong heating effects of high-density internal targets. In addition the design of the 2 MeV electron cooler for COSY is intended to test some new features of the high energy electron cooler for HESR at FAIR/GSI. The design of the 2 MeV electron cooler will be accomplished in cooperation with the Budker Institute of Nuclear Physics in Novosibirsk, Russia. Starting with the boundary conditions of the existing electron cooler at COSY the requirements and a first general scheme of the 2 MeV electron cooler are described.

TUPLS081

Flat Beams and Application to the Mass Separation of Radioactive Beams

P. Bertrand (GANIL) J.-L. Biarrotte (IPN) D. Uriot (CEA)

The notion of flat beam is now well established and has been proven theoretically and experimentally with applications for linear colliders. In this paper, we propose a new and simple demonstration of the "flat beam theorem", and a possible application in the frame of radioactive ion beams (RIB) production. It consists in using a magnetized multi-specie heavy ion beam extracted from a high frequency ECR source, decoupling the transverse phase planes in such a way to obtain a very small emittance in the horizontal one, and using a dipole to separate the isotopes. A design of such a transport and separation line will be proposed and commented.

TUPLS082

The Frankfurt Neutron Source at the Stern-Gerlach-Zentrum (FRANZ)

L.P. Chau, O. Meusel, U. Ratzinger, A. Schempp, K. Volk (IAP) M. Heil (FZ Karlsruhe)

About 40ns long proton pulses with an energy of 120keV and currents of up to 200mA will be produced at the 150kV high current injector with a rep.rate of up to 250kHz. The main acceleration will be done by a 175MHz-RFQ. After this section the proton bunches will have an energy of about 1.7MeV. A 4-gap cavity will allow for an energy increase up to 2.2MeV.In order to get 1ns short pulses at the Li-7-Target we propose a buncher-system of the Mobley-Type*, whereby periodic deflection at one focus of a dipole-magnet guides the bunche train from the linac on different paths to the other focus, where the n-production traget is located in the time focus.By 7Li(p,n)B$\cdot 10^7$ reactions low-energy neutron bunches will be produced with an averaged integrated flux-density of $4*10^7$/(cm2 s) at a distance of 0.4m. The upper limit for the neutron spectra will be 500keV. The main challange with respect to this buncher is the strong space charge action, which has to be treated by careful

particle simulations. FRANZ is among other duties well suited for (n,gamma)-cross-sectional measurements with astrophysical relevance**/***. It is characterised by high n-intensities and by its pulse-structure.
*Phys. Rev. 88(2), 360-361 (1951). **Phys. Rev. C 71, 025803 (2005).***Phys. Rev. Lett. 94, 092504 (2005).

A Low Energy Accumulation Stage for a Beta-beam Facility

TUPLS083

A. Källberg, A. Simonsson (MSL) M. Lindroos (CERN)

The EU supported EURISOL Design Study encompasses a beta-beam facility for neutrino physics. Intense electron (anti-)neutrino beams are in such a machine generated through the decay of radioactive ions in a high energy storage ring. The two main candidate isotopes for the generation of a neutrino and an anti-neutrino beam are $6He^{2+}$ and $18Ne^{10+}$. The intensities required are hard to reach, in particular for the neon case. A possible solution to increase the intensity is to use an accumulator ring with an electron cooler. Critical parameters such as cooling times and current limitations due to space charge and tune shifts are presently being optimized. We will in this presentation give an overview of the low energy accumulation stage and review recent work on this option.

Estimation of Decay Losses and Dynamic Vacuum for the Beta-beam Accelerator Chain

TUPLS084

M. Benedikt, A. Fabich (CERN) M. Kirk, C. Omet, P.J. Spiller (GSI)

The beta-beam is based on the acceleration and storage of radioactive ions. Due to the large number of ions required and their relatively short lifetime, beam losses are a major concern. This paper estimates the decay losses for the part of the accelerator chain comprising the CERN PS and SPS machines. For illustration purposes, the power deposition in these accelerators is compared to that expected for nominal CNGS proton operation. The beam losses induced vacuum dynamics is simulated and the consequences for machine operation are discussed.

Stacking Simulations in the Beta-beam Decay Ring

TUPLS085

S. Hancock (CERN) A. Chancé (CEA)

The so-called beta-beam concept for accelerator-driven neutrino experiments envisages the production of a pure beam of electron neutrinos (or their antiparticles) through the beta-decay of radioactive ions circulating in a high-energy storage ring. An unprecedented number of ions must be collected in the decay ring and maintained in a few short bunches. Stacking is unavoidable to match the available source rates with this demand. A new stacking method makes use of off-momentum injection into the decay ring to approach the circulating beam without requiring ultra-fast injection elements, rotation in the longitudinal plane to bring the fresh bunches onto the central orbit and asymmetric merging to transport these ions into the centre of the large stack. Simulation results are presented for the complete repetitive stacking process for two candidate ion species of significantly different charge-to-mass ratio.

TUPLS086

Charge Breeding Exploration with the MAXEBIS

H.Z. Zimmermann (LMU) R. Becker, M.K. Kleinod (IAP) O.K. Kester (GSI)

The demand of exotic ions prior to their injection into an accelerator has driven the development of the charge breeding method. Existing facilities like REX-ISOLDE or ISAC at TRIUMF are already using a charge state booster for the post acceleration of radioactive ions. Planned facilities like EURISOL for instance have identified the need of a breeding system. In order to be comparable to the efficiency to a brut force acceleration employing stripper, the efficiency of a charge breeder has to be maximized and the breeding time has to be shortened comparing the existing breeder systems. Therefore the exploration and optimization of the charge state breeding is mandatory and supported by the EU. The Frankfurt MAXEBIS has been modified within the past years towards high current electron beam and external injection of alkaline ions by a surface ionisation source. The electron gun, the inner electrode structure and the collector of the MAXEBIS have been modified. The system has been shipped to GSI and re-assembled. The goals of the following experiments will be systematic studies of the breeding efficiency. The new setup and first experimental results will be presented.

TUPLS087

Recent Gains in Polarized Beam Intensities for the Cooler Synchrotron COSY at Jülich

R. Gebel, O. Felden, R. Maier, P. von Rossen (FZJ)

Since January 1996, the cyclotron JULIC operates as the injector of H(-) or D(-) beams for the cooler synchrotron COSY at the IKP of the Forschungszentrum Juelich. Routinely about 8 microA of unpolarized or 1 microA of polarized H(-) ions are delivered for charge-exchange injection into COSY. A polarization in excess of 90 % was measured for protons inside the synchrotron COSY. Additionally, polarized and unpolarized D(-) ions have been delivered to experiments. A sequence of up to eight different polarization states for deuterons has been provided for experiments. By advancing the components of the polarized ion the number of polarized particles for injection into the cyclotron has been increased by a factor of three to $5{,}5\text{x}10^{12}$ protons, delivered in a 20 ms pulse with a repetition rate of 2 seconds. This report sums up the characteristics of the ion sources and the cyclotron in their present mode of operation and describes the achievements towards higher beam intensities as well as for providing unpolarized and polarized H(-) and D(-) beams with high reliability.

TUPLS088

Energy Distribution of H^- Ions from the ISIS Ion Source

D.C. Faircloth, J.W.G. Thomason (CCLRC/RAL/ISIS) G. Doucas, M. Haigh, I. Ho-ching Yiu, J. Morrison (OXFORDphysics)

We have used a specially designed retarding field energy analyzer with a resolution (Δ E /E) of approximately 2 x 10 -4 in order to measure the energy distribution, under different operating conditions, of the H^- beam of the ISIS ion source. The poster presents the details of the analyzer and the first results obtained on the Ion Source Test Facility at RAL.

Pseudospark-sourced Beams of Electrons and Ions

TUPLS089

A.W. Cross, W. He, A. Phelps, K. Ronald, H. Yin (USTRAT/SUPA)

A pseudospark discharge has undergone intensive studies with regard to its unusual and interesting discharge properties during last fifteen years. The pseudospark attracts significant attention from diverse fields such as pulsed-power switching, electron beam generation, free electron masers, ion beam generation, extreme-ultraviolet radiation sources, microthrusters and pseudospark-triggered wakefield acceleration. This paper will present experiments and measurements of pseudospark-sourced electron and ion beams for accelerators. Pulsed electron beams with current intensity over 108 Am-2, high brightness up to 1012A m-2 rad-2 and emittance of tens of mm mrad were produced from a multi-gap pseudospark discharge. The transportation of the pseudospark electron beams is also investigated in order to produce high peak current, high quality, short (~100 picosecond) or long duration (2~100ns) high-brightness electron beam pulses. Recent results from a high current density pseudospark-produced ion beam experimentally investigated with hydrogen gas will be presented.

LEBT Simulations and Ion Source Beam Measurements for the Front End Test Stand (FETS)

TUPLS090

S. Jolly, P. Savage (Imperial College of Science and Technology, Department of Physics) J.J. Back (University of Warwick) D.C. Faircloth, A.P. Letchford (CCLRC/RAL/ISIS) J.K. Pozimski (CCLRC/RAL)

The Front End Test Stand (FETS) at the Rutherford Appleton Laboratory (RAL) is intended to demonstrate the early stages of acceleration (0-3MeV) and beam chopping required for high power proton accelerators, including proton drivers for pulsed neutron spallation sources and neutrino factories. Optimisation of the beam focussing within the Low Energy Beam Transport (LEBT) is necessary to minimise beam losses upon acceleration within the FETS RadioFrequency Quadrupole (RFQ). Simulations of the LEBT are currently under way using the General Particle Tracer package (GPT). Previous envelope calculations suggest weak and strong focussing solutions for the LEBT solenoids. Definitive beam dynamics simulations in GPT require further measurements of the transverse emittances and beam profile of the ion source beam, due to the sensitivity of the simulations on the initial beam profile and level of space charge compensation. A pepperpot emittance/profile measurement system has been designed for use on the ISIS ion source development rig. Results from this pepperpot system are used to constrain the initial conditions for the GPT simulations.

Implementations on the RF Charge Breeder Device BRIC with Test Measurements

TUPLS092

V. Variale, A. Boggia, T. Clauser, A.C. Rainò, V. Valentino (INFN-Bari) P.A. Bak, G.I. Kuznetsov, B.A. Skarbo, M.A. Tiunov (BINP SB RAS)

The Radioactive Ion Beam (RIB) production with ISOL technique should require a charge breeder device to increase the ion acceleration efficiency and reduce greatly the production cost. The "charge state breeder" BRIC (BReeding Ion Charge) is based on an EBIS source and it is designed to accept RIB with charge state +1 and increase their charge state up to +n. BRIC has been developed at the INFN section of Bari (Italy) during these last 3 years with very limited funds and it has been assembled at the LNL (Italy) laboratory. BRIC could be considered as a solution for the charge state breeder of the SPES project under study also at the LNL. The new feature of BRIC,

with respect to the classical EBIS, is given by the insertion, in the ion drift chamber, of a Radio Frequency (RF) - Quadrupole aiming to filtering the unwanted masses and then making a more efficient containment of the wanted ions. The RF test measurements seem confirm, as foreseen by simulation results* that a selective containment can be obtained. Most accurate measurements, however, are needed and for that implementations of the system have been carried out.
*V. Variale and M. Claudione. "BRICTEST: a code for charge breeding simulations in RF quadrupolar field", NIM in Phys. res. A 543 (2005) 403-414.

TUPLS093

AG Acceleration using DPIS

T. Kanesue, K. Ishibashi (Kyushu University) A. Kondrashev (ITEP) M. Okamura (RIKEN) K. Sakakibara (RLNR)

We are investigating high current and high repetition rate ion production methods for various heavy ions which can be utilized for an injector of an FFAG accelerator. Direct Plasma Injection Scheme (DPIS) is one of the candidates of the ion production methods and to confirm the capability of the DPIS, we are now preparing for accelerating high intensity Ag^{15+} ions. The DPIS uses a combination of Laser Ion Source (LIS) and RFQ linac. The plasma goes into the linac directly without transportation line and the ions are extracted at RFQ entrance. To determine the specifications of new RFQ electrodes, the plasma properties were measured. With the Nd-glass laser (3 J / 30 ns), we could not obtain high charge state ions. A new Nd-YAG laser (2.3 J / 6 ns) enabled us to observe many high charged ions and the most produced ions were Ag^{15+}. We completed the plasma distribution measurements. Based on these results, we designed the new RFQ, which will accommodate Q / M = 1 / 8 particles, supposing Ag^{+}15.

TUPLS094

Development of a Permanent Magnet Microwave Ion Source for Medical Accelerators

S. Hara, T. Iga, M. Tanaka (Hitachi, Ltd., Power & Industrial Systems R&D Laboratory)

A permanent magnet microwave ion source was developed to improve availability of proton accelerator application systems based on industrial microwave ion source technologies. The ion source needs no filament in the discharge chamber, which leads to reliability improvement and less maintenance time. Because the ion source uses a permanent magnet, the ion source needs no coils, no coil power and no coil coolant. The hydrogen beam of over 60 mA has been extracted from a single 5mm diameter aperture with a proton fraction of 85% at a microwave power of 1.3kW. Rise times of the microwave power and beam current to 90 % of the final value were about 30 and 100μseconds respectively at a pulse operation mode with 400μseconds pulse width and 20 Hz repetition rate. These performance parameters are equal to the solenoid coil ion source parameters, making the ion source desirable for accelerator applications like proton therapy systems.

Recent Progress about DPIS

TUPLS095

M. Okamura, R.A. Jameson (RIKEN) T. Kanesue (Kyushu University) H. Kashiwagi (JAEA/ARTC) A. Kondrashev (ITEP) K. Sakakibara (RLNR) A. Schempp (IAP) J. Tamura (TIT)

We have focused on high brightness of induced plasma in Laser Ion Source (LIS) to provide intense highly charged ions efficiently. To take the advantage of the intrinsic density of the laser plasma, Direct Plasma Injection Scheme (DPIS) has been developed. The induced laser plasma has initial expanding velocity and can be delivered directly to the RFQ. Extraction electrodes and focusing devices in LEBT are not needed. Since 2004, a newly designed RFQ has been used to verify the capability of the new ion production scheme. We succeeded to accelerate 60 m A of Carbon beam and 60 mA of Aluminium beam. We have also tried to understand plasma properties of various species by measuring charge states distributions and time structures, and are now ready to accelerate heavier species. Currently Silver 15+ beam is planned to be accelerated. In the conference, design strategies and detailed techniques for the DPIS will be described based on the measured plasma properties of various elements and new findings obtained from recent acceleration experiments. The durability and the reproducibility will be also explained.

Strongly Focused He^+ Beam Source for Alpha Particle Measurement at ITER

TUPLS096

K. Shinto, S. Kitajima, A. O. Okamoto, M. Sasao (Tohoku University) Y. H. Hirano, S. Kiyama, H. S. Sakakita (AIST) O. Kaneko, M. Nishiura (NIFS) M. Wada (Doshisha University, Graduate School of Engineering)

A He^+ beam source for He0 beam probe for measurement of fusion produced alphas due to D-T nuclear reaction in a thermonuclear fusion plasma has been designed and constructed. The ion source consists of a 300 mm diameter and 280 mm length plasma chamber and a beam extraction system which has three concaved electrodes. Helium plasma is confined by line cusp magnetic fields produced by Sm-Co permanent magnets. The magnetic field strength near the extraction region is designed to be less than 20 gauss. Through the 100 mm diameter extraction area of the concaved electrodes 300 beamlets are formed with apertures of 4 mm. The focal length of the concaved electrodes is designed to be 750 mm. The beam quality of the extracted He^+ beam will be measured by several beam diagnostic apparatuses. The total beam current, the beam profile and the beam emittance will be measured to design a proper alkali metal vapor cell for a He^- beam production by a double charge exchange process and a beam transport line to the post accelerator up to MeV region. In the article, the details of the ion source and the beam diagnostic system will be described.

Application of DPIS to IH Linac

TUPLS097

J. Tamura, J. Hasegawa, T. Hattori, N. Hayashizaki, T. Ishibashi, T. Ito (Research Laboratory for Nuclear Reactors, Tokyo Institute of Technology) A. Kondrashev (ITEP) M. Okamura (RIKEN)

We are now designing a Laser Ion Source (LIS), which will be operated with an Interdigital H (IH) structure linac using the Direct Plasma Injection Scheme (DPIS). The DPIS has been applied to RFQ linacs and has successfully achieved very high current with simple structure. The IH structure linac was designed to accept 40 keV proton beam which could be produced by the DPIS. The combination of the DPIS and IH structure linac will realize quite compact accelerator complex with intense proton beam. The detailed design study of a plasma production chamber with a cryogenic cooler is investigated.

TUPLS099

The New 14 GHz Ion Source for the U-400 Heavy Ion Cyclotron

M. Leporis, V.B. Bekhterev, S.L. Bogomolov, A. Efremov, G. Gulbekyan, Yu.K. Kostyukhov, N. Lebedev, V.N. Loginov, Yu. Yazvitsky (JINR)

The new 14 GHz ion source DECRIS-4, to be used as a second injector of heavy multiply charged ions for the U-400 cyclotron and, in the future, also as a "charge breeder" (the "1+ -> n+" method) for the second phase of the DRIBs project, has been designed and constructed at the FLNR. The main feature of the ion source design is the creation of the extended resonance zone in a comparatively compact ECRIS. For this purpose the axial magnetic field is formed with a flat minimum by mounting only one additional solenoid coil to the classical CAPRICE magnetic structure. In this case the superposition of the axial magnetic field and the radial field of the permanent magnet hexapole, made from NdFeB, allows one to create a larger resonance volume. First results of the ion source tests show that in this resonance volume electrons are heated very efficiently which allows to produce intense beams of medium charge state ions with comparatively low level of input microwave power. The basic design features, construction issues and the first results of ion source tests are presented.

TUPLS100

Generation of Highly Charged Ions Using ND-glass Laser

A. Kondrashev (ITEP) T. Kanesue (Kyushu University) M. Okamura (RIKEN) K. Sakakibara (RLNR)

The parameters of ions (charge state distributions, currents and pulse durations) were measured in laser plasma generated by 3 J/ 30 ns Nd-glass laser for wide range of elements from 12C to 181Ta and for different laser power densities at the target surface. It is shown that such a laser can effectively generate highly charged ions for elements from 12C to 56Fe. Registered ion charge states significantly drops for heavier elements because of recombination losses of highly charged ions during laser produced plasma expansion into vacuum. Absolute currents and numbers of ions with different charge states were obtained by normalization of charge state distributions summary on total ion currents measured by Faraday cup for 10^{11} W/cm2 and 10^{12} W/cm2 laser power densities at the target surface. The results obtained are very useful for Laser Ion Source (LIS) development, in particular, for Direct Plasma Injection Scheme (DPIS) study*.
*M. Okamura et al. Laser and Particle Beams, 20, 2002, pp. 451 - 454.

TUPLS103

Further Development of a Low Inductance Metal Vapor Vacuum Arc (LIZ-MeVVA) Ion Source

B.M. Johnson (APS) E. Garate, R. McWilliams, J.P. Sprunck, A. van Drie (University of California IIrvine) A. Hershcovitch (BNL)

A Low Impedance Z-Discharge Metal Vapor Vacuum Arc (LIZ-MeV) ion source* is being explored as an alternate pre-injector for the Brookhaven Relativistic Heavy Ion Collider (RHIC). With the vacuum arc operating at tens of kiloamperes and an aluminum electrode, LIZ-MeV has been run in two regimes: an LC dominated "ringing" arc of period 4.1 microseconds, which decays after about 6 cycles, and a 1-3 microsecond wide "pulsed" arc, where a small series resistance has been added to critically damp ringing. Metal ions are extracted from the plasma using a two-grid system with a triggered, variable-delay voltage of up to 10 kV. Time-of-Flight (TOF) measurements are taken using a Faraday cup located at the end of a 15-76 cm drift tube. TOF measurements from both arc regimes have been obtained suggesting generation of about a billion ions per pulse of charge states +1 and +2, and occasionally +3 states. TOF results are compared with simple theoretical models.

*B. M. Johnson, et al. Two approaches to electron beam enhancement of the metal vapor vacuum arc ion source. Laser and Particle Beams 21, 103 (2003).

Matching of High Intensity Ion Beams to an RFQ: Comparison of PARMTEQ and IGUN Simulations

TUPLS104

R. Becker, R.A. Jameson (IAP)

The classical way of matching an ion source to the low energy accelerator RFQ generally is performed by adjusting the matching optics of the LEBT to provide the rms ellipse twiss parameter requirements of the RFQ shaper section. By matching to the rms parameters (the equivalent rms beam method) the actual shape of the distribution plays a smaller role according to F. Sacherer. In many cases, however, the matching optics are creating not only aberrations to the ion beam but also a very non-elliptical shape of the emittance figure, and a more exact match may be required. As a way out, an ion extraction program (IGUN) has been modified to also take into account the rf-focusing of non-modulated RFQ vanes in the shaper section. This makes it feasible to use this program for the simulation from the ion source plasma until the beginning of modulation inside the RFQ, and it can also handle dc fields in the injection region of the RFQ. In order to demonstrate the differences of both approaches we apply them to well defined experimentally proved designs of RFQ shaper sections.

Sputter Probes and Vapor Sources for ECR Ion Sources

TUPLS105

M. Cavenago, A. Galatà, M. Sattin (INFN/LNL) T. Kulevoy, S. Petrenko (ITEP)

Sputter probes are a promising method for injecting controlled quantities of metallic elements inside ECRIS ion source, provided that sputter rate can be controlled, so that high charge states and low sample consumption rate will be attained. Moreover pressure at the probe and inside source should be different. With a simple differential pumping scheme and a sputter probe at 25 mm from ECRIS plasma, a 200 nA current of $120Sn^{18+}$ was easily obtained. Typical results (for Sn and Ti) of an inductively heated rf oven are discussed for comparison. Improvements of sputter probe concept and geometry are also described.

Pulsed Bending Magnet of the J-PARC MR

TUPLS106

K. Koseki, H. Kobayashi, H. Nakayama, K.O. Okamura, M.J. Shirakata, M. Tawada (KEK)

Japan Proton Accelerator Research Complex (J-PARC) is under construction with a collaboration between Japan Atomic Energy Agency (JAEA) and High Energy Accelerator Research Organization (KEK). The J-PARC consists of a 180 MeV linac, a 3 GeV rapid-cycle synchrotron (RCS) and a 50 GeV synchrotron (MR). The bunch trains, which extracted from the RCS, is delivered both to the "Materials and Life Science Facility" and to the MR, two beam transport lines, 3-NBT and 3-50BT, are constructed. The switching of bunch trains is performed by a pulsed bending magnet. The field strength of 1.21 Tesla with rise and fall time of less than 40 msec is required. It was found that an effect induced by eddy current, which flows at thick end-plates, disturbs the flatness of the magnetic field. A simple compensation circuit has been adopted for a cure. A result from a field measurement, which shows a sufficient flatness, is presented.

TUPLS107

Operation of the Opposite-Field Septum Magnet for the J-PARC Main-Ring Injection

I. Sakai, Y. Arakaki, K. Fan, Y. Saito, M. Tomizawa, M. Uota (KEK) A.K. Kawasaki, H. Mori, A. Tokuchi (NICHICON) Y. Morigaki, A. Nishikawa (IHI/Yokohama)

The opposite field septum magnet system has been applied to the injection system of the J-PARC 50-GeV proton synchrotron. The features of the system are a force-free structure, easy pulse excitation and the possibility of a large-aperture, thin-septum structure. The septum magnet has the structure of an inside-vacuum to eliminate the thickness of the vacuum-chamber walls and electric-insulation layer to make the septum thickness as thin as possible. However the magnet cores and return coils are outside of the vacuum to reduce the out-gassing rate of the vacuum system. Finally, the larger beam aperture than the full acceptance of the ring and larger separation angle can be obtained at the septum magnet for low-loss injection. In this paper we will introduce the methods to eliminate the error fields caused by fabrication errors and eddy current with pulse excitation and stability of high current power supply of 50 kA.

TUPLS108

Realization of Thick Hybrid Type Carbon Stripper Foils with High Durability at 1800K for RCS of J-PARC

I. Sugai, K. Hara, H. Kawakami, M. Oyaizu, A. Takagi, Y. Takeda (KEK) T. Hattori, K.K. Kawasaki (RLNR) Y. Irie, J. Kamiya, M. Kinsho (JAEA/J-PARC)

The J-PARC requires thick carbon stripper foils (250-500 ug/cm^2) to strip electrons from the H-beam supplied by the linac before injection into a 3 GeV Rapid Cycling Synchrotron. The 200 MeV H^- beam from the linac has a pulse length of 0.5 ms with a repetition rate of 25 Hz and an average beam current of 335 uA. By much energy deposition of these high-intensity H^- and circulating bunched beams, commercially available best stripper foils (CM) will break in a very short time and even a diamond foil will rupture at around 1800K by MW class accelerators. We have realized for first time the hybrid boron doped carbon stripper foils with long life time for J-PARC. The foils of 250-500 ug/cm^2 were made by a controlled DC arc-discharge method. The lifetime was tested by using 3.2 MeV Ne^+ DC beam of 2.5 uA and 750 keV H^- DC beam of 500 uA, in which a significant amount of energy was deposited in the foils. The maximum lifetime was extremely long, 120- and 480-times than those of diamond and CM foils. The foils were also free from any shrinkage, and showed low thickness reduction rate even at high temperature of 1800K during long time irradiation of 90h.

TUPLS109

Present Status of the L3BT for J-PARC

T. Ohkawa (JAEA) M. Ikegami (KEK) J. Qiang (LBNL)

L3BT is a beam transport line from J-PARC (Japan Proton Accelerator Research Complex) linac to the succeeding 3-GeV RCS (Rapid Cycling Synchrotron). The construction of the L3BT has been almost finished. The beam commissioning of the L3BT will be started soon. On the other hand we have performed 3D particle simulations with PARMILA and IMPACT to evaluate the performance of the halo scraping, momentum compaction and beam diagnostics. In this paper, results of the beam simulation of the L3BT are presented. The construction status of the L3BT is also presented in brief.

Measurement of the Extraction Kicker System in J-PARC RCS

TUPLS110

J. Kamiya, M. Kinsho, M. Kuramochi, T. Takayanagi, O. Takeda, T. Ueno, M. Watanabe, M. Yoshimoto (JAEA/J-PARC)

Kicker magnet system in the J-PARC RCS is now under construction at JAEA (Japan Atomic Energy Agency). Their role in RCS is to kick the accelerated 3 GeV proton beam to the following extraction line at a repetition rate of 25 Hz. There are three kinds of kicker magnets (S, M, L), distinguished by the difference in the size of their apertures. The specification of 2 % is required on the magnetic field in terms of homogeneity in time and space from the beam optical point of view. The required flatness of the temporal uniformity was accomplished by superposing the waveforms of the two kicker magnet*. The required specification to the special uniformity is also very severe to achieve because our kicker magnet is designed with a large aperture in order to accept a maximum beam power of 1 MW. We established the search coil as a detector and 3-axes stage to perform magnetic field mapping. In order to reduce the signal noises and detect the stable output signals, matching register and integrated circuit were carefully selected. The 3-axes stage was precisely aligned. The distribution of the magnetic field (By) and integrated BL were systematically measured for the three types of kickers.
*J. Kamiya et al. "Magnetic field measurement of the extraction kicker magnet in J-PARC RCS," submitted for publication to the proceedings of the 19th International Conference on Magnet Technology.

Experimental Results of the Shift Bump Magnet in the J-PARC 3-GeV RCS

TUPLS111

T. Takayanagi, Y. Irie, J. Kamiya, M. Kinsho, M. Kuramochi, O. Takeda, T. Ueno, M. Watanabe, Y. Yamazaki, M. Yoshimoto (JAEA/J-PARC)

The shift bump magnet produces a fixed main bump orbit to merge the injection beam into the circulating beam. In order to control the injection beam for the short injection time (500 microseconds) with sufficient accuracy, the shift bump magnet needs a wide uniform magnetic field and the high speed exciting pattern of the high current. The magnetic field design and the structural analysis of the shift bump magnets have been performed using three-dimensional electromagnetic analysis code and mechanical analysis code, respectively. The magnetic field distributions were measured with a long search coil, thus giving a BL product over a magnet gap area. The temperature distributions at the various points of the magnet were measured by thermocouples over 24 hours till they saturated. General trend of these measurements agrees well with calculations.

Present Status of Injection and Extraction System of 3 GeV RCS at J-PARC

TUPLS112

M. Yoshimoto, Y. Irie, J. Kamiya, M. Kinsho, F. Noda, P.K. Saha, T. Takayanagi, O. Takeda, M. Watanabe (JAEA/J-PARC)

The injection and extraction system for 3GeV RCS (Rapid Cycling Synchrotron) at J-PARC (Japan Proton Accelerator Research Complex) have many challenging issues, in order to realize MW beam in the RCS ring. The system is consisted in 3 parts, such as the injection line, the dump line, and the extraction line. And they are constructed from many kinds of components, such as DC and pulse magnets, a charge exchange system, beam monitors, titanium and ceramic vacuum chamber, a beam dump, and so on. Up to now, final designs are accomplished and developments and experiments of some components are carried out. In this presentation, summary of the injection and extraction system, recent status of developments, and beam commissioning scheme for beam injection and extraction are introduced.

TUPLS113

Designs of Septum Magnet at 3 GeV RCS in J-PARC

M. Yoshimoto, Y. Irie, J. Kamiya, M. Kinsho, T. Takayanagi, O. Takeda, M. Watanabe (JAEA/J-PARC) H. Fujimori, S. Igarashi, H. Nakayama (KEK)

GeV RCS (Rapid Cycling Synchrotron) at J-PARC (Japan Proton Accelerator Research Complex) consists in many kinds of septum magnets. There are two septum magnets to inject the beam into the ring, three septum magnets to extract the beam for the users, and two septum magnets to dump the beam which can not be exchanged its charge at the first foil. In order to reduce the magnetic leakage field from the septum magnets at the beam orbit in the ring, the silicon steel sheets are set at the outside of the septum magnets for the magnetic shields. However sufficient spaces to set the thick magnetic shields are not securable at the divergent duct areas. Therefore the vacuum chambers are made by the magnetic stainless steel and the leakage fields in the chambers can be reduced. As results of the 3D field calculations by TOSCA, the magnetic leakage field can be suppressed to a few Gauss or less.

TUPLS114

An Improvement of Matching Circuit of RF Kicker Electrodes

T. Kurita, S. Fukumoto, S.H. Hatori (WERC) S. Ninomiya (KEK)

Beam extraction system at accelerator of The Wakasa Wan Energy Research Center employs RF knockout technology. Narrow band RF noise is applied to the transverse kicker electrodes to increase betatron amplitude of the beam. Recently some improvements of the beam extraction system are introduced: To improve the shape of the spill, a feedback control of noise amplitude is introduced. The feedback control system works as an attenuator, therefore it is necessary to enhance the noise amplitude of the kicker electrodes to obtain agreeable effect on the spill shape. In order to obtain a higher voltage, we revamp the matching circuit at the electrodes. By introducing the resonating characteristic at the matching circuit, we obtained 3 times more amplitude at the electrodes. General shape of the spill is improved by this work, and extraction efficiency at a real operating condition is also improved.

TUPLS115

Transverse Phase Space Painting for the CSNS Injection

J. Qiu, J. Tang, S. Wang (IHEP Beijing) J. Wei (BNL)

The CSNS accelerators consist of an 80 MeV proton Linac, and a 1.6 GeV rapid cycling synchrotron (RCS). The ring accumulates 1.88*1013 protons via H^- stripping injection in the phase CSNS-I. The injected beam is painted into the large transverse phase space to alleviate space-charge effects. The uniformity of beam emittance is important in reducing the tune shift/spread due to space charge effect. The paper introduces two parameters to evaluate the uniformity of a distribution. To satisfy the low-loss design criteria, extensive comparison of different painting scenarios has been carried out by using the simulation code ORBIT. This paper gives detailed studies on painting schemes and the dependence on the lattice tune, the injection peak current, and also chopping rate.

Extraction System Design for the CSNS/RCS

J. Tang, Y. Chen, Y.L. Chi, Y.L. Jiang, W. Kang, J.B. Pang, Q. Qin, S. Wang, W. Wang (IHEP Beijing) J. Wei (BNL)

The CSNS extraction system takes use one of the four dispersion-free straight sections. Five vertical kickers and one Lambertson septum magnet are used for the one-turn extraction. The rise time of less 250 ns and the total kicking angle of 20 mrad are required for the kickers that are grouped into two tanks. The design for the kicker magnets and the PFN is also given. To reduce the low beam loss in the extraction channels due to large halo emittance, large apertures are used for both the kickers and septum. Stray magnetic field inside and at the two ends of the circulating path of the Lambertson magnet and its effect to the beam has been studied.

Beam Transport Lines for the CSNS

J. Tang, G.H. Wei, C. Zhang (IHEP Beijing) J. Wei (BNL)

This paper presents the design of two beam transport lines at the CSNS: one is the injection line from the linac to the RCS and the other is the target line from the RCS to the target station. In the injection beam line, space charge effects, transverse halo collimation, momentum tail collimation and debunching are the main concerned topics. A new method of using triplet cells and stripping foils is used to collimate transverse halo. A long straight section is reserved for the future upgrading linac and debuncher. In the target beam line, large halo emittance, beam stability at the target due to kicker failures and beam jitters, shielding of back-scattering neutrons from the target are main concerned topics. Special bi-gap magnets will be used to reduce beam losses in the collimators in front of the target.

Injection System Design for the CSNS/RCS

J. Tang, Y. Chen, Y.L. Chi, Y.L. Jiang, W. Kang, J.B. Pang, Q. Qin, J. Qiu, L. Shen, S. Wang (IHEP Beijing) J. Wei (BNL)

The CSNS injection system is designed to take one uninterrupted long drift in one of the four dispersion-free straight sections to host all the injection devices. Painting bumper magnets are used for both horizontal and vertical phase space painting. Closed-orbit bumper magnets are used for facilitating the installation of the injection septa and decreasing proton traversal in the stripping foil. Even with large beam emittance of about 300 pmm.mrad used, BSNS/RCS still approaches the space charge limit during the injection/trapping phase for the accumulated particles of $1.9*10^{13}$ and at the low injection energy of 80 MeV. Uniform-like beam distribution by well-designed painting scheme is then obtained to decrease the tune shift/ spread. ORBIT code is used for the 3D simulations. Upgrading to higher injection energy has also been considered.

Design Study of the Axial Injection System of C400 Cyclotron

V. Shevtsov, V. Aleksandrov, Yu. Kazarinov (JINR) Y. Jongen, D. Vandeplassche (IBA)

Computer modeling results on the axial injection system design are given. Results of simulations of the Carbon, Hydrogen and Helium ion beam injection are presented.

TUPLS122

Implementation of the Proposed Multiturn Extraction at the CERN Proton Synchrotron

M. Giovannozzi (CERN)

Following the positive results of the three-year measurement campaign at the CERN Proton Synchrotron concerning beam splitting with stable islands in the transverse phase space, the study of a possible implementation of the proposed multi-turn extraction was undertaken. The novel approach would allow a substantial reduction of beam losses, with respect to the present scheme, when delivering the high-intensity proton beams required for the planned CERN Neutrino to Gran Sasso Project. Major modifications to the ring layout are foreseen, such as a new design of the extraction bumps including also the installation of three additional kickers to create a closed-bump over the five turns used to extract the split beam. The ring aperture was reviewed and improvements are proposed to reduce possible beam losses between beam splitting and extraction. The goal consists of implementing the proposed changes by the end of the 2007/2008 PS shutdown and to commission the novel extraction during the 2008 physics run.

TUPLS123

Design of the LHC Beam Dump Entrance Window

R. Veness, B. Goddard, S.J. Mathot, A. Presland (CERN) L. Massidda (CRS4)

TeV proton beams from the LHC are ejected through a 600 m long beam dump transfer line vacuum chamber to a beam dump block. The dump block is contained within an inert gas-filled vessel to prevent a possible fire risk. The dump vessel and transfer line are separated by a 600 mm diameter window, which must withstand both the static pressure load and thermal shock from the passage of the LHC beam. In a previous paper* the functional requirements and conceptual design of this window were outlined. This paper describes the analysis leading to the final design of the window. The choice of materials is explained and tests performed on the prototype window are summarized.

*A. Presland et al. "A large diameter entrance window for the LHC beam dump line". Proc. PAC 2005, 1698-1700.

TUPLS125

Spin Transport from AGS to RHIC with Two Partial Snakes in AGS

W.W. MacKay, A.U. Luccio, N. Tsoupas (BNL) J. Takano (RIKEN)

The stable spin direction in the RHIC rings is vertical. With one or two strong helical Siberian snakes in the AGS, the stable spin direction at extraction is not vertical. Interleaved vertical and horizontal bends in the transport line between AGS and the RHIC rings also tend to tip the spin away from the vertical. In order to preserve polarization in RHIC, we examine several options to improve the matching of the stable spin direction during beam transfer from the AGS to each of the RHIC rings. While the matching is not perfect, the most economical method appears to be a lowering of the injection energy by one unit of G*gamma to 45.5.

TUPLS126

Interaction of the CERN Large Hadron Collider (LHC) Beam with Carbon Collimators

N.A. Tahir, D. Hoffmann (GSI) Y. Kadi, R. Schmidt (CERN) R. Piriz (Universidad de Castilla-La Mancha) A. Shutov (IPCP)

The LHC will operate at 7 TeV with a luminosity of 10^{34} cm-2s-1. Each beam will have 2808 bunches, with nominal intensity per bunch of 1.1×10^{11} protons. The energy stored in each beam of 362 MJ. In a previous paper the mechanisms causing equipment damage in case of a failure of the machine protection system was discussed, assuming that the entire beam is deflected into a copper target. Another failure scenario is the deflection of beam into carbon material. Carbon collimators and beam absorbers are installed in many locations around the LHC to diffuse or absorb beam losses. Since their jaws are close to the beam, it is very likely that they are hit first when the beam is accidentally deflected. Here we present the results of two-dimensional hydrodynamic simulations of the heating of a solid carbon cylinder irradiated by the LHC beam with nominal parameters, carried out using the BIG-2 computer code* while the energy loss of the 7 TeV protons in carbon is calculated using the well known FLUKA code**. Our calculations suggest that the LHC beam may penetrate up to 10 m in solid carbon, resulting in a substantial damage of collimators and beam absorbers.
*V. E. Fortov et al. Nucl. Sci. Eng. 123 (1996) 169. **A. Fasso et al. The physics models of FLUKA: status and recent development, CHEP 2003, La Jolla, California, 2003.

TUPLS127

Permanent Deformation of the LHC Collimator Jaws Induced by Shock Beam Impact: an Analytical and Numerical Interpretation

A. Bertarelli, O. Aberle, R.W. Assmann, A. Dallocchio, T. Kurtyka, M. Magistris, M. Mayer, M. Santana-Leitner (CERN)

Inspections carried out on jaws of the LHC collimator prototype, which underwent the 450 GeV robustness test in CERN TT40 extraction line, revealed no visible damage, except a permanent deformation of the jaw metal support of ~300 um. An explanation of this phenomenon is proposed in this paper. The temperature increase on the metal support induced by the thermal shock, though limited to ~70^{o}C, led to a sudden expansion of the copper-based support which was partially prevented by the inertia of the material itself, thus generating compressive stresses exceeding the elastic limit of OFE-copper. An analytical assessment of the process, followed by a finite-element transient elasto-plastic analysis, is presented. Numerical results are in good agreement with measured data. In order to confirm this analysis, a special test on series production jaws, where OFE-copper has been replaced by Dispersion Strengthened Copper (Glidcop®), is scheduled for the second half of 2006.

TUPLS128

A New Analytical Method to Evaluate Transient Thermal Stresses in Cylindrical Rods Hit by Proton Beams

A. Dallocchio, A. Bertarelli, T. Kurtyka (CERN)

This paper presents an analytical solution for the thermo-mechanical problem of CNGS target rods rapidly heated by fast extracted high energy proton beams. The method allows the computation of the dynamic transient elastic stresses induced by a proton beam hitting off-axis the target. The studies of such dynamic thermo-mechanical problems are usually made via numerical methods. However, an analytical approach is also needed to quickly provide reference solutions for the numerical results. An exact solution for the temperature field is first obtained, using Fourier-Bessel series expansion. Quasi-static thermal stresses are then computed as a function of the calculated temperature distribution, making use of the thermoelastic displacement potential for the equivalent isothermal two-dimensional stress problem. Finally, the contribution of dynamic stresses due to longitudinal and bending stress waves is determined by means of the modal summation method. This method can be effectively applied to any solid having cylindrical shape, made out of isotropic elastic material.

TUPLS129

EURISOL 100 kW Target Stations Operation and Implications for its Proton Driver Beam

E. Noah, F. Gerigk, J. Lettry, M. Lindroos, T. Stora (CERN)

Targets for the next generation radioactive ion beam (RIB) facilities (RIA, EURISOL) will be subjected to energy deposition levels that call for a specific design of the target and ion source assembly to dissipate the deposited heat and to extract and ionize isotopes of interest efficiently. EURISOL, the next generation European RIB facility, plans to operate four target stations in parallel, three 100 kW direct targets and one 5 MW spallation neutron source with a GeV proton linac driver. The nature of the beam sharing has yet to be defined because in practice it will have a direct impact on target design, operation and lifetime. Splitting the beam in time implies that each target would be subjected to a pulsed beam, whose pulse width and repetition cycle have to be optimized in view of the RIB production. The 100 kW targets are expected to have a goal lifetime of three weeks. Target operation from the moment it is installed on a target station until its exhaustion involves several phases during which the incident proton beam intensity will vary. This paper discusses challenges for high power targetry at EURISOL, with an emphasis on requirements for the proton linac parameters.

TUPLS130

Comparison between Measured and Simulated Beam Loss Patterns in the CERN SPS

S. Redaelli, G. Arduini, R.W. Assmann, G. Robert-Demolaize (CERN)

A prototype of an LHC collimator has been tested with proton beams at the CERN SPS. The interaction of the circulating proton beam with the carbon collimator jaws generated showers that were lost in the downstream SPS aperture. The measured beam loss patterns are compared in detail with the results of dedicated loss simulations. The simulation package includes (1) a 6D particle tracking through the SPS lattice; (2) the scattering interaction of protons with the collimator jaw material; (3) the time-dependent displacement of the collimator jaws with respect to the beam orbit; (4) a detailed aperture model of the full SPS ring. It is shown that the simulation tools can reliably predict the measured location of losses. This provides an important assessment of the simulation tools in view of the LHC beam loss studies.

TUPLS132

Estimation of the Energy Deposited on the CNGS Magnetic Horn and Reflector

L. Sarchiapone, A. Ferrari, M. Lorenzo Sentis (CERN)

In the CNGS installation two magnetic lenses, namely the horn and the reflector, focus the secondary beam generated in the target station. The gap between the horn and reflector is chosen to optimize a wide-band high-energy muon-neutrino beam. These two focusing elements are two coaxial lenses similar in length but different in shape: the outer conductor has a cylindrical shape whereas the inner conductor consists of a sequence of conical shapes to optimize the focusing capacity. The evaluation of the heat load on the support structures is crucial since modifications in the elements around the horn and reflector are under way and the support structures can be adapted to the heat load

found. Furthermore, the heat load in the whole horn area has been evaluated to optimize the cooling-ventilation system. The FLUKA geometry input of the horn and reflector electrical connections has been notably improved in order to accommodate the detailed striplines design to the thermal expansion. The energy deposited on the horn and reflector as well as on their adjacent elements has been estimated using the FLUKA Monte Carlo package and results are presented in this document.

Material Irradiation Damage Studies for High Power Accelerators

TUPLS133

N. Simos, H.G. Kirk, H. Ludewig, L.F. Mausner, J.G. O Conor (BNL) S. Makimura, K. Yoshimura (KEK) K.T. McDonald (PU) L.P. Trung (Stony Brook University)

High-performance targets intercepting multi MW proton beams are the key toward intense muon or neutrino beams. To achieve this goal one must push the envelope of the current knowledge on material science and material endurance and survivability to both short and long proton beam exposure. The demand imposed on the targets of high power accelerators and the limitations of most materials in playing such pivotal roles have led to an extensive search and experimentation with new alloys and composites. These new high-performance materials and composites, which at first glance, appear to possess the right combination of properties satisfying target requirements, are explored under accelerator target conditions where both shock and irradiation damage are at play. Results of the on-going, multi-phased experimental effort under way at BNL involving heavy irradiation of candidate materials using 200 MeV protons at the end of the BNL Linac as well as results on post-irradiation analysis assessing irradiation damage are presented.

Managing the Quality Assurance Documentation of Accelerator Components Using an EDMS

TUPLS134

L. Hagge, J. Buerger, J.A. Dammann, J. Kreutzkamp, K. Lappe (DESY)

Quality assurance (QA) documents are often collected locally on a per-component basis by the manufacturing teams, while project engineers require global evaluations of the QA documents e.g. for production control or during installation and commissioning of the machine. DESY is using an Engineering Data Management System (EDMS) for supporting and unifying the QA documentation of different accelerator components. The EDMS provides dedicated user interfaces which are optimized for the needs of the specific engineering teams which are working on the components (including industrial manufacturers), and at the same time integrates the QA documents into a central database for further overall analysis and applications. The poster introduces the general structure of QA procedures, describes the benefits of using an EDMS for QA documentation and describes examples from different applications at XFEL and PETRA III.

Technical Infrastructure Monitoring at CERN

TUPLS135

J. Stowisek, T.R. Riesco, A.S. Suwalska (CERN)

The Technical Infrastructure Monitoring system (TIM) is used to survey and control CERN's technical services from the CERN Control Centre (CCC). The system's primary function is to provide CCC operators with reliable real-time information about the state of the laboratory's extensive and widely distributed technical infrastructure. TIM is also used to monitor all general services required for the operation of the accelerator complex and the experiments. A flexible data acquisition mechanism allows TIM to interface with a wide range of technically diverse installations, using industry standard protocols wherever possible and custom designed solutions where needed. The complexity of the data processing logic, including persistence, logging, alarm handling, command execution and the evaluation of data-driven business rules is encapsulated in the system's business layer. Users benefit from a suite of advanced graphical applications adapted to operations (synoptic views, alarm consoles, data analysis tools etc.), system maintenance and support. Complementary tools for configuration data management and historical data analysis will be available before the start-up of the LHC in 2007.

TUPLS136

Air Temperature Analysis and Improvement for the Technical Zone at TLS

J.-C. Chang, J.-R. Chen, Z.-D. Tsai (NSRRC) M. Ke (NTUT)

This paper presents the air temperature analysis and control improvement for the technical zone, where many critical instrumentations of power supply, rf, vacuum and control apparatuses are located, at the Taiwan Light Source (TLS). The technical zone with circular shape is located on the core area of the storage ring. The diameter and height of the technical zone are 28.5m and 3m, respectively. Totally 13 temperature sensors are installed in this zone to online record the air temperature history. Because of insufficient cooling capacity and poor air circulation of the air-conditioning (A/C) system, the air temperature may reach to 30 degrees C, and spatial air temperature difference may be more than 7 degrees C. To cope with those problems, a computational fluid dynamics (CFD) code is applied to simulate the spatial temperature distribution. The A/C cooling capacity will be increased, and the air exit and exhaust distribution will be modified according to the simulated results.

TUPLS137

Design of the Utility System for the 3 GeV TPS Electron Storage Ring

J.-C. Chang, J.-R. Chen, Y.-C. Lin, Y.-H. Liu, Z.-D. Tsai (NSRRC)

After 13-year operation of the Taiwan Light Source (TLS), National Synchrotron Radiation Research Center (NSRRC), had proposed to construct a new light sourc, Taiwan Photon Source (TPS) in the near future. TPS is preliminarily designed with 3.0 GeV in energy, 518.4m in circumference and 24 Double-Bend Achromat (DBA). This study designed the utility system, including the electrical power system, grounding system, de-ionized cooling water (DIW) system and air conditioning (AC) system for the TPS. Special considerations are focused on the stability of the electrical power and grounding system and temperature control of the DIW and AC systems. The power and cooling loads had been estimated according to each subsystem of the accelerator. Layouts of main utility equipment and piping system had also been preliminarily designed.

An Overview of the SNS Accelerator Mechanical Engineering

TUPLS140

G.R. Murdoch, J.J. Error, M.P. Hechler, S. Henderson, M. Holding, T. Hunter, P. Ladd, T.L. Mann, R. Savino, J.P. Schubert (ORNL) H.-C. Hseuh, H. Ludewig, G.J. Mahler, C. Pai, C. Pearson, J. Rank, J.E. Tuozzolo, J. Wei (BNL)

The Spallation Neutron Source (SNS) is an accelerator-based neutron source currently nearing completion at Oak Ridge National Laboratory. When completed in 2006, the SNS will provide a 1GeV, 1.44MW proton beam to a liquid mercury target for neutron production. SNS is a collaborative effort between six U.S. Department of Energy national laboratories and offered a unique opportunity for the mechanical engineers to work with their peers from across the country. This paper presents an overview of the overall success of the collaboration concentrating on the accelerator ring mechanical engineering along with some discussion regarding the relative merits of such a collaborative approach. Also presented are a status of the mechanical engineering installation and a review of the associated installation costs.

Measured Residual Radioactivity Induced by U Ions of Energy 500 MeV/u in a Cu Target

TUPLS141

E. Mustafin, H. Iwase, E. Kozlova, D. Schardt (GSI) A. Fertman, A. Golubev (ITEP) R. Hinca, M. Pavlovic, I. Strasik (STU) N. Sobolevskiy (RAS/INR)

Several laboratories in the world have started or plan to build new powerful ion accelerators. These facilities promise to provide very valuable tools for experiments in fundamental nuclear physics, physics of high energy density in matter and for medical applications as well. One of the most important problems that have to be solved during the design stage is the radiation protection of the accelerator. Due to the complexity, it is hardly possible to obtain reliable radionuclide production data for accelerator structure materials from radiation transport codes. Thus, the experimental data which can be measured at the presently existing facilities are necessary for the evaluation of the induced levels of radioactivity around intense heavy ion accelerators. The Uranium beam losses are the most dangerous ones in the FAIR facility. Results of the measurement of activation induced by U beam with energy of E = 500 MeV/u in the copper target are presented in this paper.

WEXPA — Accelerator Technology

WEXPA01

Latest Developments in Superconducting RF Structures for Beta=1 Particle Acceleration

P. Kneisel (Jefferson Lab)

Superconducting RF technology is since nearly a decade routinely applied to different kinds of accelerating devices: linear accelerators, storage rings, synchrotron light sources and FEL's. With the technology recommendation for the International Linear Collider (ILC) a year ago, new emphasis has been placed on improving the performance of accelerating cavities both in Q-value and in accelerating gradients with the goal to achieve performance levels close to the fundamental limits given by the material parameters of the choice material, niobium. This paper will summarize the challenges to SRF technology and will review the latest developments in superconducting structure design. Additionally, it will give an overview of the newest results and will report on the developments in alternative materials and technologies.

WEXPA02

New Developments on RF Power Sources

J. Jacob (ESRF)

The classical generation of RF power with klystrons and tetrodes is evolving and changing to meet the demands of higher efficiency and simpler maintenance. Developments of IOT tubes for FEL, Energy Recovery Linacs and Storage Rings, together with solid state technology approaches and combination techniques for high power generation are opening new alternatives to the classical ones. An overview of the new concepts, designs and solutions applied to the new accelerators will be presented. Advantages and drawbacks of new versus classical technologies as well as strategies for the selection will be discussed.

WEXPA03

Digital Low Level RF

M.-E. Angoletta (CERN)

The demand on high stability and precision on the RF voltage for modern accelerators, as well as better diagnostics, maintenance and flexibility is driving the community to develop Digital Low Level RF systems (DLLRF) for the new linear accelerators, but also for synchrotrons. An overview of the state of the art in digital technologies applied to DLLRF systems and an overview of the different designs developed or in development at the different labs will be presented.

WEYPA — Linear Colliders, Lepton Accelerators and New Acceleration Techniques

Beam Delivery System in ILC

WEYPA01

G.A. Blair (Royal Holloway, University of London)

The presentation will review the challenges of this key ILC sub-system in terms of beam performances, machine protection system, collimation, interaction with the detector and compare them with the achievements in SLC and FFTB. It will then present the world-wide organization to define and make the necessary R&D for the design, beam simulations and benchmarking in tests facilities, especially the ATF2 facility under construction at KEK. It will explore the major issues both from the beam dynamics and the technological point of view, as well as the plans foreseen and the schedule to address them. It will finally analyze the possible upgrade in energy together with the possible limitations and associated issues.

Damping Rings towards Ultra-low Emittances

WEYPA02

S. Guiducci (INFN/LNF)

The presentation will review the various designs of Damping Rings to achieve ultra-low emittance beams in Linear Colliders (ILC and CLIC) pointing out the major issues both from the beam dynamics and the technological point of vue and comparing the required performances with the one achieved in SLC or FFTB. It will then present the design, beam simulations, benchmarking and performances already achieved in test facilities, especially the ATF1 facility developed and operated at KEK. Finally, it will present future R&D plans and schedule in terms of beam performances, beam stability and technological development as well as the world-wide organization to achieve them.

CLIC Feasibility Study in CTF3

WEYPA03

A. Ghigo (INFN/LNF)

After a reminder of the CLIC scheme towards multi-TeV Linear Collider and of the main challenges of this novel technology, the presentation will focus on the CTF3 test facility presently under construction at CERN to address all key issues in a multi-lateral collaboration. It will present the status of the facility and of the technological developments, especially the high field accelerating structures and the RF power production, the performances already achieved as well as the plans and schedule for the future. It will finally compare the CTF3 results with those foreseen by the theory and the corresponding benchmarking of CLIC simulations.

WEOAPA — Linear Colliders, Lepton Accelerators and New Acceleration Techniques

WEOAPA01

Demonstration of Energy Gain Larger than 10GeV in a Plasma Wakefield Accelerator

P. Muggli, S. Deng, T.C. Katsouleas, E. Oz (USC) D. Auerbach, C.E. Clayton, C. Huang, D.K. Johnson, C. Joshi, W. Lu, K.A. Marsh, W.B. Mori, M. Zhou (UCLA) I. Blumenfeld, F.-J. Decker, P. Emma, M.J. Hogan, R. Ischebeck, R.H. Iverson, N.A. Kirby, P. Krejcik, R. Siemann, D.R. Walz (SLAC)

We have recently demonstrating the excitation of accelerating gradients as large as 30 GV/m* using the ultra-short, 28.5 GeV electron bunches now available at the Stanford Linear Accelerator Center. As a result, the electrons in the back of the bunch gained about 3 GeV over the 10 cm-long plasma with a density of ?2.5x1017 e /cm-3. In recent experiments, energy gains in excess of 10 GeV, by far the largest in any plasma accelerators, have been measured over a plasma length of ?30 cm. Moreover, systematic measurements show the scaling of the energy gain with plasma length and density, and show the reproduceability and the stability of the acceleration process. These are key steps toward the application of beam-driven plasma accelerators or plasma wakefield accelerators (PWFA) to doubling the enregy of a future linear collider without doubling its length. We are preparing for experiments to be performed in February-March 2006 aiming at doubling the energy of the 28.5 GeV beam over a plasma length of less than one meter, a distance two thousand times shorter than the accelerator that created the incoming beam. The latest experimental results will be presented.
*M. J. Hogan et al. Phys. Rev. Lett. 95, 054802, 2005.

WEOAPA02

Optimum Frequency and Gradient for the CLIC Main Linac

A. Grudiev, D. Schulte, W. Wuensch (CERN)

A novel procedure for the optimization of the operating frequency, the accelerating gradient, and many other parameters of the CLIC main linac is presented. Based on the new accelerating structure design HDS (Hybrid Damped Structure), the optimization procedure takes into account both beam dynamics (BD) and RF constraints. BD constraints are related to emittance growth due to short- and long-range transverse wakefields. RF constraints are related to RF breakdown and pulsed surface heating limitations of the accelerating structure. Interpolation of beam and structure parameters in a wide range allows hundreds of millions of structures to be analyzed. Only those structures which satisfy BD and RF constraints are evaluated further in terms of ratio of luminosity to main linac input power, which is used as the figure of merit. The frequency and gradient have been varied in the range 12-30 GHz and 90-150 MV/m, respectively. It is shown that the optimum frequency varies in the range from 16 to 20 GHz depending on the accelerating gradient and that the optimum gradient is below 100 MV/m and that changing frequency and gradient can double the luminosity for the same main linac input power.

MICE Overview - Physics Goals and Prospects

M. Yoshida (Osaka University)

Ionization cooling, a technique in which muon beam is passed through a series of absorbers and followed by RF-acceleration, is a proposed method for cooling muon beam, i.e., phase-space reduction. The international Muon Ionisation Cooling Experiment (MICE), which will construct and operate a realistic cooling channel and measure the beam cooling performance, is the first essential step towardsrealization of nutrino factories and eventually muon colliders based on intense muon sources. The MICE have got approved to be constructedin Rutherford Appleton Laboratory (RAL) and the fist beam commissioning is scheduled in 2007. The physics goal and future prospects of the MICE together with the beamline and the instruments which is now being built will be described.

WEOBPA — Hadron Accelerators

WEOBPA01

First Results of the CRFQ Proof of Principle

D. Davino (Universita' degli Studi del Sannio) L. Campajola (Naples University Federico II, Mathematical, Physical and Natural Sciences Faculty) V. Lo Destro, A.G. Ruggiero (BNL) M.R. Masullo (INFN-Napoli) V.G. Vaccaro (Naples University Federico II and INFN)

The Circular Radiofrequency Quadrupole is a new concept of a storage and accelerator ring for intense beams of light and heavy ions, protons and electrons. It is basically a Linear Radiofrequency Quadrupole completely bent on a circle. The advantages, which are expected to be the same performance features of a linear RFQ, would be smaller overall dimension with respect to accelerators with comparable beam intensity and emittance*. A collaboration between BNL and Italian research institute and universities was set up at the end of 2002 with the aim of the proof of the bending principle**. The prototype design is based on a 4-rods scheme and have a linear sector followed by a 45-degree curved sector. The 1mA proton beam, produced by a reconditioned RF source, go through a beam gap diameter of 10mm with circular 10mm diameters rods. Each sector is 700mm long and is placed in a 150mm diameter pipe***. The RF power at 202.56MHz is fed by a CERN "Frank James" 50kW amplifier. In this paper the first power and beam tests of the linear sector are presented.

*A.G. Ruggiero, C-A/AP/65 note, Brookhaven National Laboratory, October 2001. **A.G. Ruggiero et al., Proceedings of the EPAC 2004 conference.***D. Davino et al., Proceedings of the EPAC 2004 conference.

WEOBPA02

LEIR Commissioning

C. Carli, P. Beloshitsky, L. Bojtar, M. Chanel, K. Cornelis, B. Dupuy, J. Duran-Lopez, T. Eriksson, S.S. Gilardoni, D. Manglunki, E. Matli, S. Maury, C. Oliveira, S. Pasinelli, J. Pasternak, F. Roncarolo, G. Tranquille (CERN)

The Low Energy Ion Ring (LEIR) is a central piece of the injector chain for LHC ion operation, transforming long Linac 3 pulses into high density bunches needed for LHC. LEIR commissioning is scheduled to be completed at the time of the conference. A review of LEIR commissioning highlighting expected and unexpected problems and actions to tackle them will be given.

WEOBPA03

1.8 MW Upgrade of the PSI Proton Facility

P.A. Schmelzbach, S.R.A. Adam, A. Adelmann, H. Fitze, G. Heidenreich, J.-Y. Raguin, U. Rohrer, P.K. Sigg (PSI)

The PSI proton accelerator delivers currently a 590 MeV beam with an intensity of 2 mA. The upgrade programme aiming at boosting the beam power from 1.2 to 1.8 MW includes the ongoing installation of new bunchers in the transfer lines to the injector cyclotron and between injector and ring cyclotron, the replacement of the Al-cavities of the ring cyclotron by Cu-cavities operated at 1 MV, and the design and future installation of additional accelerating cavities in the injector cyclotron. Simulation studies are under way to improve our understanding of the space charge effects at the different stages of acceleration. The present status of the project will be presented.

WEXFI — Beam Dynamics and Electromagnetic Fields

Instabilities and Space Charge Effects in High Intensity Ring Accelerators

WEXFI01

O. Boine-Frankenheim, I. Hofmann, V. Kornilov (GSI)

This presentation will review beam dynamics in circular accelerators with high beam intensity and space charge effects. The main focus will be on recent theoretical and experimental results related to collective instabilities and resonance crossing with space charge. In the first part of the presentation, the effect of space charge on collective instability thresholds and impedance budgets will be discussed. In this context the effect of space charge induced mode coupling on the longitudinal microwave instability will be illustrated. The stability of longitudinal bunched beam modes and of transverse dipole modes in the presence of space charge will be discussed. Recent work related to the transverse mode coupling instability (TMCI) with space charge will be reviewed. In the second part of the presentation, "incoherent" space charge effects on transverse nonlinear dynamics issues, like nonlinear resonance crossing, will be reviewed.

Observation and Modeling of Electron Cloud Instability

WEXFI02

K.C. Harkay (ANL)

This presentation will review experimental results and the state of the art in the analysis and simulation of the electron cloud instability in hadron and positron storage rings.

Non-linear Collimation in Linear and Circular Colliders

WEXFI03

A. Faus-Golfe (IFIC) J. Resta-López, F. Zimmermann (CERN)

We describe the concept on nonlinear collimation of beam halo in linear and circular colliders. In particular we present the application of such a concept in two different cases: the energy collimation system for CLIC at 3 TeV c.m. energy and a betatron collimation system for LHC at 14 TeV c.m. energy. For each case, the system properties, like chromatic bandwidth, collimator survival and cleaning efficiency, are evaluated and compared with those of the corresponding linear collimation system.

WEYFI — Beam Dynamics and Electromagnetic Fields

Modelling of Space Charge and CSR Effects in Bunch Compressor Systems

M. Dohlus (DESY)

Bunches with high peak currents of the order of kilo-Amperes are required in linac based X-ray free electron lasers. These bunches cannot be produced directly in guns because space charge forces would destroy the brilliance within a short distance. Therefore bunches with a peak current of a few tens of Amperes are created in laser-driven radio-frequency sources and are compressed in length by two orders of magnitude. In most designs, the compression is achieved in magnet chicanes, where particles with different energies have different path lengths so that a bunch with an energy distribution correlated with longitudinal particle position can shrink in length. The principle problem is that short bunches on curved trajectories will emit coherent synchrotron radiation (CSR). The CSR effects and the space charge fields play an important role in the particle dynamic and the design of a bunch compression system. This presentation will provide an overview of computational methods and simulation tools for space charge and coherent synchrotron radiation effects in magnetic bunch compression systems.

WEOFI — Beam Dynamics and Electromagnetic Fields

Beam Dynamics Measurements in the Vicinity of a Half-integer Resonance

WEOFI01

T. Ieiri, J.W. Flanagan, H. Fukuma, H. Ikeda, Y. Ohnishi, K. Oide, M. Tobiyama (KEK)

The operating point of the betatron tune set near a half-integer is a crucial parameter to make high luminosity in electron/positron ring colliders. Dynamic beam-beam effects would change the optics parameters of the colliders, depending on the betatron tune and the beam-beam parameter. On the other hand, existence of the half-integer stopband makes the beam unstable. Therefore, beam behavior near a half-integer might provide interesting issues from the viewpoint of beam dynamics. We measured a frequency response of the beam across a half-integer for measuring the betatron tune at KEKB. A sharp spike just at a half-integer was observed in the tune spectrum. We believe that the spectrum would be a nonlinear resonance caused by some off-momentum particles in a bunch, not by a coherent motion of a whole bunch. The horizontal beam size measured using a synchrotron radiation monitor indicated a slight increase when the tune approached a half-integer. The variations in the beam size are discussed, considering both dynamic beam-beam effects and a beta beat due to the half-integer stopband.

RF Phase Modulation Studies at the LNLS Electron Storage Ring

WEOFI02

N.P. Abreu, R.H.A. Farias, P.F. Tavares (LNLS)

In this work we present a set of measurements of the effectiveness of RF phase modulation on the second harmonic of the RF frequency as a mechanism to damp longitudinal coupled-bunch instabilities. We also propose a theoretical model of the damping mechanism, in which the increase of the spread in synchrotron frequencies inside the bunches produced by phase modulation is responsible for damping the centroid dipolar coherent motion caused by an external excitation, which could be a Higher Order Mode (HOM) of the RF cavities driving the coupled bunch motion. We measured the coherent synchrotron oscillation damping of a single bunch under two circumstances, with and without phase modulation, and determined the amount of extra damping due to the modulation. With this experiment we could also measure the frequency of small oscillations around the stable islands formed by phase modulation and its behavior when the RF phase modulation amplitude and frequency are changed. We performed measurements of Beam Transfer Function (BTF) to observe the effects of phase modulation over the stable area for coherent oscillations and compared the results with a theoretical model.

Beam Dynamics Simulation in e^- Rings in SRFF Regime

WEOFI03

L. Falbo (INFN-Pisa) D. Alesini (INFN/LNF) M. Migliorati (Rome University La Sapienza)

The concept of strong RF focusing has been recently proposed to obtain locally short bunches in electron/positron colliders, by modulating the longitudinal bunch dimensions along the rings. To study the single bunch dynamics, a macroparticle numerical code has been written which simulates the effects of the objects generating broad band impedance along the ring and the effects of the coherent synchrotron radiation in dipoles and wigglers. The obtained results are shown and discussed.

WEIFI — Session on TT and for Industry

WEIFI01

How to Create a Business out of Manufacturing Linacs

R.W. Hamm, M.E. Hamm (AccSys)

AccSys Technology, Inc. was established in 1985 by the author and several colleagues to sell ion linacs based on the new linac technology that had just been developed at the Los Alamos National Laboratory. The company is now the leading manufacturer of turn-key ion linacs for several markets worldwide. This paper will describe the history of AccSys and how it has survived more than 20 years manufacturing these specialized products. The similarities of AccSys' history to that of a small electron linac manufacturer established in 1970 will also be described to provide a general concept of what is required to create a business out of manufacturing linacs.

WEIFI02

Can the Accelerator Control System be Bought from Industry?

M. Plesko (Cosylab)

This presentation is intended for project leaders and specialists, whose components depend on the control system, which is nearly everybody apart from control experts. The presentation will explain the basic concepts of an accelerator control system, illustrate the similarities and differences among the most popular packages, which are nicely disguised in acronyms such as EPICS, TANGO, TINE, DOOCS, COACK, XAL, CDEV, etc. and compare them to commercial control systems (DCS and SCADA) and LabView. The second part of the presentation will analyse whether a control system is in principle a component as any other and whether therefore in principle it should be bought eventually from a competent supplier like all the other components. It will identify the reasons why many people are reluctant to outsource control systems and illustrate this with some personal experiences and suggestions how to overcome these problems. The talk will conclude by showing how naively we have started a spin-off company* to commercialize the accelerator control system that we have developed, how we have found sustainable sources of business, and how we see the future in this and related markets.
* Cosylab - Control System Laboratory, www.cosylab.com

WEIFI03

Synchrotron Technology for Industrial Research, Development and Quality Assurance - Experience in Commercial Services

T. Baumbach (FZ Karlsruhe)

This presentation will describe the product, the market for it, the industrial environment and future projection or uses for it. It will provide a full scientific description of the development, design and performance of the product, and describe the problems, the challenges, the barriers (if any) and how to overcome them. The presentation will conclude with an analysis of what went right, what went wrong, and give advice to potential newcomers to this field.

WEPCH — Poster Session

Estimation of Transverse Coupling From Pinhole Images

WEPCH004

X.R. Resende, P.F. Tavares (LNLS)

The Brazilian Synchrotron Light Laboratory (LNLS) has recently started filling its storage ring straight sections with insertion devices. Last year a 2-Tesla Wiggler was successfully installed and integrated in the control system. An elliptically polarizing undulator is now under construction and scheduled to be installed in the next shutdown, by the end of the current year. The VUV beamline for the undulator is very demanding with respect to orbit stability and other beam parameters. Considerable reduction of the vertical emittance via reduction of the transverse coupling is a must in order for the undulator beamline to achieve its promised outstanding performance. In this paper we report on recent efforts to better understand the residual coupling in the machine and we describe preliminary proposals of viable solutions that aim at controlling the linear coupling within beamline specifications.

Advances in Beam Orbit Stability at the LNLS Electron Storage Ring

WEPCH005

L. Liu, R.H.A. Farias, M.J. Ferreira, S.R. Marques, F. Rodrigues, P.F. Tavares, R.P.C.C. Tenca (LNLS)

We describe recent efforts made at the Brazilian Synchrotron Light Source (LNLS) to improve beam orbit stability. The main driving force is the high positional stability required by some specific experiments and particularly by a high resolution undulator beamline which is being built at LNLS. Recent steps taken to improve orbit stability include the development of x-ray BPMs to measure the vertical position of the x-ray beam, analysis of RF BPM movement due to thermal load induced by synchrotron radiation after injection, new algorithms to deal with BPM electronics or control board false readings and revision and modification of their installations. In addition a weighted least squares method was developed to account for global correction while simultaneously privileging some local source point position. These upgrades are part of an ongoing work to improve beam orbit stability at LNLS.

Comparison between Simulations and Measurements of Low Charge Electron Bunch in the ELSA Facility

WEPCH006

J.-L. Lemaire, A.B. Binet, A.B. Bloquet, D. Guilhem, V. Le Flanchec, S. Pichon (CEA)

Dedicated focal spot size measurements carried out at the ELSA electron linear accelerator facility have provided detailed data which are suitable for benchmarking of different simulation codes for high charge bunch beam acceleration issued from an RF photo-injector source. We present some characteristic features of bunched electron beam propagation from beam formation at the photo-cathode to acceleration through RF cavities until the final focussing on a target, by using numerical simulations obtained with MAGIC, PARMELA, MAFIA, PARTRAN tool box codes. The challenges for the planned benchmarking are discussed.

WEPCH007

Beam Dynamics Studies for the Spiral-2 Project

J.-L. Biarrotte (IPN) P. Bertrand (GANIL) D. Uriot (CEA)

The SPIRAL-2 superconducting linac driver, which aims to deliver 5 mA, 20 A.MeV deuterons and 1 mA, 14.5 A.MeV q/A=1/3 heavy ions, is now entering the construction phase. It is composed of an injector composed of two ECR sources entering a 88 MHz RFQ, followed by a superconducting section based on independently phased quarter-wave cavities with warm focusing. This paper presents the status of the beam dynamics studies recently performed during this construction phase: consolidation and freezing of the linac design, update of the mass separation system or analysis of the proton capability.

WEPCH008

The Beta-beam Decay Ring Design

A. Chancé, J. Payet (CEA)

The aim of the beta-beams is to produce highly energetic beams of pure electron neutrino and anti-neutrino, coming from beta radioactive decays of the $18Ne^{10+}$ and $6He^{2+}$, both at gamma = 100, directed towards experimental halls situated in the Frejus tunnel. The high intensity ion beams are stored in a ring until the ions decay. Consequently, all the injected particles will be lost anywhere in the ring, generating a high level of losses. The ring circumference has to be a multiple of the SPS circumference. The straight sections must be as long as possible in order to maximize the useful neutrino flux. The straight section length is chosen to be about 35% of the circumference length, which gives 1-km-long arcs. The bend field in the arcs is then reasonable. The arc has been chosen as a 2Pi phase advance insertion, which improves the optical properties (dynamic aperture and momentum acceptance) and allows the easy determination of the working point by the optics of the straight sections.

WEPCH009

Loss Management in the Beta-beam Decay Ring

A. Chancé, J. Payet (CEA)

The aim of the beta-beams is to produce pure electronic neutrino and anti-neutrino highly energetic beams, coming from beta radioactive disintegration of the $18Ne^{10+}$ and $6He^{2+}$, both at gamma = 100, directed towards experimental halls situated in the Frijus tunnel. The high intensity ion beams are stored in a ring, until the ions decay. Consequently, all the injected particles will be lost anywhere around the ring generating a high level of losses. In order to keep a constant neutrino flux, the losses due to the decay of the radioactive ions are compensated with regular injections. The new ion beam is then merged with the stored beam with a specific RF program Two sources of losses have been considered: -The beta-decay products: their magnetic rigidity being different from the reference one, they are bent differently and lost. -The losses during the injection merging process. The first one needs a particular ring design in order to insert appropriate beam stoppers at the right place. The second one needs a specific collimation system which allows beam longitudinal halo cleaning between two successive injections.

Beam-based Alignment for the Storage Ring Multipoles of Synchrotron SOLEIL

A. Madur, P. Brunelle, A. Nadji, L.S. Nadolski (SOLEIL)

First beam-based alignment (BBA) measurements will be carried out during the commissioning of the SOLEIL Storage Ring that will start in April 2006. The results will allow calibrating the zero reading of the 120 Beam Position Monitors (BPMs) with respect to the magnetic centre of the adjacent quadrupoles or sextupoles. BPMs being either adjacent to quadrupoles or sextupoles, we plan to resort to two different BBA methods related to each multipolar magnet. Moreover, as some BPMs are located near both quadrupole and sextupole, the use of both methods will allow us to cross-check the results. We will present here the first results and the comparison with the positions of the magnetic centres as obtained from the magnetic measurements.

Optimisation of a New Lattice for the ESRF Storage Ring

A. Ropert, L. Farvacque (ESRF)

The installation of canted undulators in some of the straight sections of the ESRF storage ring is envisaged in the future. In order to free maximum space in the straight sections and minimise the reduction in length of the undulators, a new lattice, in which the straight section quadrupole triplets are replaced by doublets, is being studied. The paper describes the main features of the lattice and presents the experimental results achieved so far.

Comparison of Betatron Function Measurement Methods and Consideration of Hysteresis Effects

O. Kopitetzki, D. Schirmer, G. Schmidt, K. Wille (DELTA)

Two methods for determining the betatron functions in a storage ring were used to survey the linear optics at Delta. The fast orbit response analysis is used to gain betatron functions at the beam position monitors (BPMs) and dipole correctors. These are compared to betatron functions measured by the tune scan method which gives the beta functions in the quadrupoles. To improve the accuracy of the betatron functions obtained by the tune scan method a measuring procedure is introduced which considers the hysteresis effects in the quadrupole magnets. Systematic deviations in the beta functions measured between the two methods have been observed. The calibration errors of the BPMs can explain the observed deviations. With the orbit response analysis also the betatron phase advances between the measurement points can be calculated. Because these do not depend on the calibration errors, unlike the betatron functions, the differences between measurement and model can be determined more precise. A comparison of both methods with the optics model will be presented.

Electron Transport Line Optimization using Neural Networks and Genetic Algorithms

D. Schirmer, T. Buening, P. Hartmann, D. Mueller (DELTA)

Methods of computational intelligence (CI) were investigated to support the optimization of the electron transfer efficiency from the booster synchrotron BoDo to the electron storage ring DELTA. Neural networks and genetic algorithms were analysed alternatively. At first both types of methods were trained on the basis of a theoretical model of the transport line. After the training various algorithms were used to improve the magnet settings of the real transport line elements with respect to the electron transfer efficiency. The results of different strategies are compared and prospects as well as limitations of CI-methods to the application of typical optimization problems in accelerator operation are discussed.

WEPCH015

Measurement and Correction of Dispersion in the VUV-FEL

E. Prat, W. Decking, T. Limberg (DESY)

Increase in transverse beam size in the undulator caused by dispersive effects is one of the major limitations for the operation of FLASH, the VUV-FEL at DESY. Sources of the (spurious) dispersion are field errors and stray magnet fields in the undulator beam line as well as spurious dispersion created upstream of the undulator by, for instance, rf coupler kicks, magnet misalignments and field errors. The impact of these errors on dispersion generation depends on the actual operating conditions of the accelerator, so the dispersion must be measured and controlled frequently. In this paper we present numerical studies of spurious dispersion generation, first dispersion measurements and correction results.

WEPCH016

Spurious Vertical Dispersion Correction for PETRA III

G.K. Sahoo, K. Balewski, W. Decking (DESY)

Spurious vertical dispersion, arising due to the misalignment and rotational errors of magnets in synchrotron radiation sources with low emittances, are highly undesirable as this contributes to the vertical beam size of the photon beam. This is a matter of concern in PETRA III, a 6GeV light source with a designed horizontal emittance of 1nm.rad and 1% emittance coupling. It has a hybrid lattice of FODO and DBA cells, which will be installed in one-eighth of the existing PETRA II ring. In this paper local and global vertical dispersion corrections are discussed. The global vertical dispersion is corrected using vertical corrector magnets (may also consider 12 skew quadrupole magnets), and the skew quadrupoles are used for local correction as well. Eight of them are placed close to the two damping wiggler sections used for minimizing the horizontal emittance. The remaining four are placed in the new octant with DBA cells where insertion devices are installed.

WEPCH017

Front-to-end Simulation of the Injector Linac for the Heidelberg Ion Beam Therapy Centre

R. Cee (HIT) C.M. Kleffner, M.T. Maier, B. Schlitt (GSI) U. Ratzinger, A. Schempp (IAP)

The injector linac of the Heidelberg ion beam therapy centre is currently in the commissioning phase. Its main components are two electron cyclotron resonance ion sources (ECRIS), a radio-frequency quadrupole accelerator (RFQ) and an interdigital H-type drift tube linac (IH-DTL). It will be able to accelerate beams of hydrogen- helium- carbon- and oxygen-ions up to a specific energy of 7 MeV per nucleon. This contribution focuses on the beam dynamics simulation of the transport lines and the accelerating structures. Three dedicated tools have been employed: Mirko for the beam transport, RFQmed for the particle dynamics through the RFQ and LORASR for the acceleration in the IH-DTL. Between the different beam dynamics codes interfaces have been implemented and a front-to-end simulation has been performed. Comparisons with alternative programmes confirm the results obtained. The work will enable us to investigate the behaviour of the machine in a theoretical model during the forthcoming operating.

Finite Elements Calculations of the Lattice and Ring Acceptance of the Heidelberg CSR

WEPCH018

H. Fadil, M. Grieser, A. Wolf, R. von Hahn (MPI-K)

A new Cryogenic Storage Ring (CSR) is currently being designed at MPI-K in Heidelberg. This electrostatic ring, which will store ions in the 20~300 keV energy range (E/Q), has a total circumference of 35.2 m and a straight section length of 2.8 m. The ring design was at first carried out with the optics code MAD in the first order approximation. Further investigation of the optics was performed with the finite elements electrostatic code TOSCA. The individual elements of the CSR (deflectors and quadrupoles) were calculated then a model of the entire ring was simulated with successful storage (tracking) of 20keV protons for many turns. The lattice parameters thus obtained were compared with the MAD results and show good agreement. The dynamic ring acceptance was also calculated for the standard operating point.

Extending the Linear Least Squares Problem for Orbit Correction in Circular Accelerators

WEPCH020

C. Scafuri (ELETTRA)

A method for extending the linear least squares problem applicable for correcting the orbit of circular accelerators is proposed. The method is based on the definition of a suitable cost function which weighs both orbit deviations and the correction effort, that is steerer kicks. The paper presents the full derivation of the formulas and the results of simulations. The application of this method for the Global Orbit Feedback system of the ELETTRA storage ring is being evaluated.

Generalized Twiss Coefficients Including Transverse Coupling and E-beam Growth

WEPCH021

F. Ciocci, G. Dattoli (ENEA C.R. Frascati) M. Migliorati (Rome University La Sapienza)

We use a generalization of the Twiss coefficients to the fully transverse coupled case. We show that the formalism is particularly useful to treat problems involving the beam optics of electrons propagating in undulators or solenoids. The method allows the treatment in analytical terms, we generalize the method including the effect of spatial charges and higher order multi-polar terms. The method is then applied to a specific example relevant to e-beam emittance dilution in solenoid and exotic undulators.

Study of the Effect of Multipolar Components in the SPARC Emittance Compensation Gun Solenoid

WEPCH022

C. Ronsivalle, G. Dattoli, L. Picardi, M. Quattromini (ENEA C.R. Frascati) G. Bazzano (CNAO Foundation) M. Ferrario, M. Migliorati, L. Palumbo, M.A. Preger, C. Sanelli (INFN/LNF) P. Musumeci (INFN-Roma) J.B. Rosenzweig (UCLA)

The SPARC photoinjector rf gun requires a solenoid immediately downstream for emittance compensation. The analysis of the measured solenoid magnetic maps shows the existence of multipolar components added to the pure solenoid field. The effect of these added fields on beam dynamics and possible correction schemes have been studied from the theoretical point of view and by numerical calculations based on PARMELA/TREDI codes. An accurate 3D numerical modelization by using

CST EM Studio has been done, in order to investigate the source of these multipolar components and to suggest some design modifications aimed to reduce their magnitude. The results of this study are presented here.

WEPCH023

Longitudinal Coherent Oscillation Induced in Quasi-isochronous Ring

Y. Shoji, Y. Hisaoka, T. Matsubara, T. Mitsui (NewSUBARU/SPring-8, Laboratory of Advanced Science and Technology for Industry (LASTI))

Noise sources, which excite longitudinal coherent oscillation is discussed. Especially in a quasi-isochronous electron storage ring an identification of the noise sources is important to obtain an extremely short bunch. One possible source is a well-known rf noise in the acceleration field. The other is a magnetic field ripple, which changes a path-length for a revolution. The analytical formula for the longitudinal coherent oscillation is explained. It contains the path-length oscillation, which had never been considered. The third is a beam itself, probably be a coherent radiation loss. The driving term is not symmetric along the energy axis, then the oscillation amplitude depends on the higher order momentum compaction factor.

WEPCH024

Matrix Formulation for Hamilton Perturbation Theory of Linearly Coupled Betatron Motion

M. Takao (JASRI/SPring-8)

Linear coupled motion in a circular accelerator was successfully parametrized through the transfer matrix approach, where normal mode Twiss and coupling parameters are defined as an extension of Courand and Snyder formulation. However it is not straightforward to assign analytical expressions to the coupling parameters. On the other hand the coupled motion was analytically solved by the Hamilton perturbation theory, which ingeniously describes the resonance phenomena. In the perturbation theory, however, the symplectic structure of the coupled motion is obscure in turn. Hence, for the purpose of combining both the theories with each other with keeping the respective virtues, we develop the matrix formulation based on the Hamilton perturbation theory. Since we have already known the solution of equation of motion, we can construct the transfer matrix in terms of the solution. Thus we formulate the betatron motion with linear coupling resonance in analytic and symplectic manner. As an application of the formulation, we investigate the two-dimensional beam ellipse in an electron storage ring.

WEPCH025

COD Correction at the PF Ring by New Orbit Feedback Scheme

K. Harada, T. Obina (KEK) N. Nakamura, H. Sakai, H. Takaki (ISSP/SRL)

When we correct the global COD (closed orbit distortion), if we use the modified conversion matrix calculated by the eigen vector method with constraint conditions (EVC), the local orbit correction can be simultaneously done to fix the light source point in the insertion device. In the EVC, the local orbit correction is combined to the global orbit correction by the Lagrange's undetermined multiple method. In this paper, we show the machine study results at the PF Ring.

Recent Progress of Optics Measurement and Correction at KEKB

WEPCH026

A. Morita, H. Koiso, Y. Ohnishi, K. Oide (KEK)

We present the progress of the optics measurement and the correction scheme of the KEKB operation for example off-momentum beta correction.

Position Shuffling of the J-PARC Main Ring Magnets

WEPCH028

M. Tomizawa, K. Fan, S. Igarashi, K. Ishii, H. Kobayashi, A.Y. Molodozhentsev, K. Niki, E. Yanaoka (KEK) Y. Irie (JAEA/J-PARC) S. Machida (CCLRC/RAL/ASTeC)

The J-PARC 50GeV main ring has 96 dipole, 216 quadrupole with 11 families and 72 sextupole magnets with 3 families. Magnets installation in the tunnel started last year and will be planed to finish by the end of next fiscal year. Field measurements of all magnets will soon finish by this March. Deviations for BL, B'L, B"L in dipole, quadrupole and sextupole magnets make COD, beta beat and third integer stopband, respectively. They can be reduced by choosing a pair of magnets with similar field deviation and by positioning them so as to cancel each other considering betatron phase (shuffling). In this paper, we will report our shufflling scheme chosen under the given schedule for installation and field measurements and also will show performances expected by the shufflings.

Injection and Extraction Orbit of the J-PARC Main Ring

WEPCH029

M. Tomizawa, Y. Kamiya, H. Kobayashi, I. Sakai, Y. Shirakabe (KEK) S. Machida (CCLRC/RAL/ASTeC)

The J-PARC main ring (MR) accelerates a high intensity proton beam and deliver to the neutrino experimental hall by the fast extraction and to the hadron experimental facility by the slow extraction. The beam from the rapid cycle synchrotron (RCS) is injected by the bunch to bucket transfer into the MR. The MR has two beam dump lines, the first one is used to dump the beam at injection energy and the second one can be used to abort accelerated beam. The beam loss at the injection and extraction is one of the critical issue for high intensity proton accelerators. We report designed injection and extraction orbits and discuss about the beam apertures and the beam loss.

Beam Dynamics of a 175MHz RFQ for an IFMIF Project

WEPCH030

S. Maebara, S. Moriyama, M.S. Sugimoto (JAEA) M.S. Saigusa (Ibaraki University, Electrical and Electronic Eng.)

International Fusion Materials Irradiation Facility (IFMIF) is an accelerator-based neutron irradiation facility employing the D-Li stripping reaction, to produce the neutron field similar to the D-T Fusion reactor (2MW/m2, 20 dpa/year for Fe). The required beam current of 250 mA is realized by two beam lines of 125mA, and the output energies at injector, RFQ and DTL were designed to be 0.1, 5 and 40 MeV, respectively. The operation frequency of 175MHz was selected to accelerate the large current of 125mA. After an intensive beam simulation, the RFQ with a total length of 12.6 m was designed to keep the minimum emittance growth with the RF injection power of 2.3MW CW. For such a 12m-long RFQ, two coupling plates are indispensable in order to suppress higher modes in a longitudinal direction at least. From beam dynamics point views, the transmission co-efficient has been evaluated by TOUTATIS code, and it is found that the transmission decay within 0.5% can be achieved by employing a gap width of less than 4mm for a coupling plate design.

WEPCH032

Orbit Correction System for S-LSR Dispersion-free Mode

H. Souda, S. Fujimoto, M. Ikegami, A. Noda, T. Shirai, M. Tanabe (Kyoto ICR) H. Fadil (MPI-K)

An ion storage ring S-LSR has been constructed at ICR, Kyoto Univ. It is a small ring with 22.557m circumference, and has an electron cooler and laser cooling section to achieve crystalline beam. In the commissioning process, closed orbit correction of a 7MeV proton beam has been successfully realized by means of Simplex Method. Responses to the correctors are linear only within narrow limits because of the space-charge effect in the electron cooler. Therefore, the correction must be repetition of small corrections. Under such condition, measured COD has been reduced less than 0.1mm. Orbit correction is necessary for 35keV Mg+ dispersion-free mode* using both bending magnets and electrostatic deflectors. Since electrostatic deflectors have relatively large field errors, it needs a special process to inject the beam into the dispersion-free mode ring. First circulation is under only the magnetic field, then, the electric field will be added little by little applying continuous COD correction. In this way the dispersion gradually diminishes with keeping stable orbit. In this paper we present the correction scheme and the trial to the dispersion-free circulation.
*M. Ikegami et al. Phys. Rev. ST-AB, 7, 120101-1 (2004).

WEPCH033

Single Particle Beam Dynamics Design of CSNS/RCS

S. Wang, S.X. Fang, Q. Qin, J. Tang (IHEP Beijing) J. Wei (BNL)

Rapid Cycling Synchrotron (RCS) is a key component of Beijing Spallation Neutron Source (BSNS). It accumulates and accelerates protons to design energy of 1.6 GeV and extracts high energy beam to the target. As a high beam density and high beam power machine, low beam loss is also a basic requirement. An optimal lattice design is essential for the cost and the future operation. The lattice design of BSNS is presented, and the related dynamics issues are discussed. The injection/extraction scheme and the beam collimation system design are introduced.

WEPCH036

Design of Short Bunch Compressors for the International Linear Collider

E.-S. Kim (PAL)

We present a two-stage bunch compressor system that was selected as alternative design in the ILC BCD (baseline configuration design). Initial beam with bunch length of 6 mm rms can be compressed to 150 micron rms in the bunch compressor, but the system uses a single chicane for each stage of compression, rather than the 12 chicanes used in the baseline design. We present the design scheme and performances of the system in detail, including scheme for emittance tuning in the system.

Nonlinear Characteristics of the TME Cell

WEPCH038

V.A. Kvardakov, E. Levichev (BINP SB RAS)

The TME (Theoretical Minimum Emittance) cell is being used now for designing the lattice of different storage rings (SR sources, damping rings, FFAG accelerators, etc.). Strong sextupoles required to correct the natural chromaticity of the lattice reduce the dynamic aperture. In the paper we consider the main features of the nonlinear perturbation strength and its connection with the essential lattice parameters: horizontal emittance, betatron tunes, and natural chromaticity. The analytical results are compared with the computer simulation.

Further Development of Irradiation Field Forming Systems of Industrial Electron Accelerators

WEPCH040

N.G. Tolstun, A.S. Ivanov, V.P. Ovchinnikov, M.P. Svinin (NIIEFA)

Electron beam irradiation field forming systems where accelerated electron beam is scanned in a constant field of the elongated bending magnets were developed in our institute more than 15 years ago and they have a number of advantages in comparison with traditional ones. Since than they have been applied in two accelerators with energies 300 and 400 keV; version of the similar system with two electromagnets for two-side irradiation of flexible materials – in a number of 750 keV high voltage accelerators ("Electron-10") successfully operating now in several industrial lines. Systems of forming of electron beam irradiation field based on the same principle have been used in several projects, some of them are already put into operation. Electron optic characteristics of such systems and their various modifications as well as aspects of their possible usage are discussed in the paper.

Analytic Study of Longitudinal Dynamics in Race-track Microtrons

WEPCH041

Yu.A. Kubyshin (UPC) A.V. Poseryaev, V.I. Shvedunov (MSU)

Implementation of low energy injection schemes in the race-track microtron (RTM) design requires a better understanding of the longitudinal beam dynamics. Differently to the high energy case a low-energy beam will slip in phase relative to the accelerating structure phase. We generalize the concept of equilibrium or synchronous particle for the case of non-relativistic energies and introduce the notion of transition energy for RTMs. An analytical approach for the description of the synchronous phase slip is developed and explicit, though approximate, formulas which allow to define the equilibrium injection phase and fix the parameters of the accelerator are derived. The approximation can be improved in a systematic way by calculating higher order corrections. The precision of the analytical approach is checked by direct numerical computations using the RTMTrace code and was shown to be quite satisfactory. Explicit examples of injection schemes and fixing of RTM global parameters are presented.

On the Implementation of Experimental Solenoids in MAD-X and their Effect on Coupling in the LHC

WEPCH043

A. Koschik, H. Burkhardt, T. Risselada, F. Schmidt (CERN)

The betatron coupling introduced by the experimental solenoids in the LHC is small at

injection and negligible at collision energy.
We present a study of these effects and look at possible corrections. Additionally we report about the implementation of solenoids in the MAD-X program. A thin solenoid version is also made available for tracking purposes.

WEPCH044

Interaction Region with Slim Quadrupoles

E. Laface, R. Ostojic, W. Scandale, D. Tommasini (CERN) C. Santoni (Université Blaise Pascal)

An optical performance's improvement of the interaction region can be obtained with the addition of new quadrupoles in the forward detectors area. Such scenario would allow decreasing the β^* below the nominal value. The basic concept consists in using quadrupoles to break the quadratic behavior of β in the free space between the IP and the IR triplets. In this new configuration we present the performance improvements and the hardware requirements.

WEPCH045

Sorting Strategies for the Arc Quadrupoles of the LHC

Y. Papaphilippou, A.M. Lombardi (CERN)

The variation in the field gradient of the LHC arc quadrupoles can not be corrected independently by the dedicated trim quadrupole circuits. This may result to a beta function beating larger than the one accepted by the machine budget. In this respect, sorting strategies for the installation of these magnets were implemented in order to eliminate this effect, as locally as possible. Special care was taken for quadrupoles whose warm measurements showed large gradient errors due to an excessive magnetic permeability. The figures of merit used in the sorting and the results obtained for all 8 sectors of the LHC are detailed. The global optics function beating foreseen, as computed by both analytical estimates and simulations with MAD-X are finally presented.

WEPCH046

Design and Validation with Measurements of the LEIR Injection Line

F. Roncarolo, C. Carli, M. Chanel, L.D. Dumas, R. Scrivens (CERN)

The CERN Low Energy Ion Ring (LEIR) commissioning started in the year 2005. O^{4+} and Pb^{54+} 4.2 MeV/nucleon ion beams are transferred from Linac 3 to LEIR through a low energy transfer line, for which the constraints and the resulting optics design are presented. First trajectory and dispersion measurements agreed only poorly with the theoretical model. Iterations of a refined optics model and further measurements improved the agreement between experimental observations and expectations. In particular, the effect of quadrupolar errors in the line dipole magnets is discussed.

Procedures and Accuracy Estimates for Beta-beat Correction in the LHC

WEPCH047

R. Tomas, O.S. Brüning, S.D. Fartoukh, M. Giovannozzi, Y. Papaphilippou, F. Zimmermann (CERN) R. Calaga, S. Peggs (BNL) F. Franchi (GSI)

The LHC aperture imposes a tight tolerance of 20% on the maximum acceptable beta-beat in the machine. An accurate knowledge of the transfer functions for the individually powered insertion quadrupoles and techniques to compensate beta-beat are key prerequisites for successful operation with high intensity beams. We perform realistic simulations to predict quadrupole errors in LHC and explore possible ways of correction to minimize beta-beat below the 20% level.

Measurement and Modeling of Magnetic Hysteresis in the LHC Superconducting Correctors

WEPCH048

W. Venturini Delsolaro, L. Bottura, Y. C. Chaudhari, M. Karppinen (CERN) N.J. Sammut (University of Malta, Faculty of Engineering)

The Large Hadron Collider, now under construction at CERN, relies heavily on superconducting magnets for its optics layout: besides the main magnets, almost all the correcting magnets are superconducting. Along with clear advantages, this brings about complications due to the effects of persistent currents in the superconducting filaments. Correcting magnets that trim key beam parameters or compensate field errors of the main magnets (among others those due to hysteresis), are in their turn hysteretic. The measured magnetic hysteresis and its possible influence on accelerator operation will be presented, in particular the real-time compensation of decay and snapback in the main magnets, and the reproducibility between runs. A detailed characterization of minor hysteresis loops is given, as well as degaussing cycles and modeling work.

Closed Orbit Correction of TPS Storage Ring

WEPCH049

H.-J. Tsai, H.-P. Chang, P.J. Chou, C.-C. Kuo, G.-H. Luo, M.-H. Wang (NSRRC)

A 3 GeV synchrotron storage ring is proposed in Taiwan to serve the synchrotron light users, especially for the x-ray community. The ring consists of 24 double-bend cells with 6-fold symmetry and the circumference is 518.4 m. The designed natural emittance with slightly positive dispersion in the straight sections is less than 2 nm-rad. This low emittance lattice structure needs strong quadrupoles and sextupoles and the closed orbit distortions are sensitive to the alignment errors in the quadrupoles and sextupoles as well. The closed orbit distortions due to tolerable magnetic errors are simulated and the correction scheme is proposed. Using singular value decomposition method, the closed orbit distortions are corrected and corrector strengths as well as the residual closed orbit distortions are obtained.

WEPCH050

Correction of Vertical Dispersion and Betatron Coupling for the TPS Storage Ring

H.-J. Tsai, H.-P. Chang, P.J. Chou, C.-C. Kuo, G.-H. Luo, M.-H. Wang (NSRRC)

A proposed 3 GeV Taiwan Photon Source (TPS) is a low emittance (1.7 nm-rad) medium energy storage ring with 24 DBA cells. The vertical emittance due to betatron coupling and spurious vertical dispersion generated by the magnet errors and off-center orbits in sextupoles and quadrupoles are analyzed. The sensitivities due to magnetic alignment errors are estimated. Using the SVD method, the result of global vertical dispersion and betatron coupling correction is presented.

WEPCH051

Isochronous Magneto-optical Structure of the Recirculator SALO

I.S. Guk, A. Dovbnya, S.G. Kononenko, F.A. Peev, A.S. Tarasenko (NSC/KIPT) J.I.M. Botman, M.J. Van der Wiel (TUE)

With the goal to provide low energy spread of electron beam, the magneto-optical structure of the recirculator SALO has been modified. All of its parts (an injection tract and arcs) were made isochronous and achromatic. Besides, with the purpose of the accelerating structure arrangement, the length of straight sections was enlarged. The amplitude and dispersion functions on various recirculator sections and design characteristics of the beam are submitted.

WEPCH052

Injection System for Kharkov X-ray Source NESTOR

A.Y. Zelinsky, P. Gladkikh, I.M. Karnaukhov, A. Mytsykov (NSC/KIPT)

During the last three years a Kharkov X-ray generator NESTOR is under design and construction in NSC KIPT. According to the design report, electrons are injected in the storage ring at 100 MeV and ramped up to final energy 225 MeV. Due to compact design of the ring the injection trajectory of the beam will pass through fringe field of a NESTOR bending magnet. It brings additional difficulties on design of an injection channel. In the paper the layout, results of design and calculations of NESTOR injector channel are presented. The channel consists of two bending magnets, five-lens, asymmetrical, objective and two-lens matching cell to compensate dispersion and focusing effects of a dipole magnet fringe field and injection system elements (inflector). Presented results shows that designed lattice provides matching of injected beam parameters with the storage ring acceptance, is stable to element alignment errors and is easy controlled. The final values of the channel lens gradients can be defined only after measurements of inflector field profile.

WEPCH053

Peculiarities of Influence of Coherency Processes at Charged Particles Channeling on Particle Beams Characteristics

V.I. Vysotskii, M.V. Vysotskyy (National Taras Shevchenko University of Kyiv, Radiophysical Faculty)

In the work the length of reciprocal coherency existence and peculiarities of coherency of different states of channeled particles wave functions are discussed. It was shown that the length of coherent channeling depends on the monochromaticity of initial particle beam as well as on the interaction of channeled particles with thermal oscillations of the crystal lattice. Peculiarities of influence of coherency processes at relativistic and nonrelativistic charged particles channeling on spatial and angular characteristics of particle beam that has passed through a thin crystal are discussed. In was shown, that the influence of different particle states interference within the area of coherent channeling leads to very strong periodic dependence of final beam angular width from the crystal length. This effect allows to control beam parameters (e.g., to form narrower beam, that it was before falling on the crystal). Influence of coherency of particle states in a single channel and several channels on the angular distribution and the possibility of quasicharacteristic short-wave spontaneous and stimulated radiation is also studied.

Matrix Formalism for Current-independent Optics Design

WEPCH054

C.-X. Wang, K.-J. Kim (ANL)

Matrix formalism has been a powerful tool for beam optics designs. It not only facilitates computations but also plays an important role in formulating various design concepts. Here we extend the standard matrix formalism for the purpose of designing an optics that transports space-charge-dominated intense beam. Furthermore, we explore the concept of current-independent optics, which can be useful for systems such as high-brightness injectors and space-charge-dominated rings. Our discussion here is preliminary and limited to axisymmetric systems.

A New Algorithm for the Correction of the Linear Coupling at TEVATRON

WEPCH055

Y. Alexahin, E. Gianfelice-Wendt (Fermilab)

The Fourier analysis of TBT data provides valuable information about the machine linear and non-linear optics. The recent upgrade of the Beam Position Monitors system made it possible to exploit this technique also at Tevatron. A program for the measurement and correction of the linear coupling based on this approach has been integrated in the TEVATRON control system. With respect to the method based on the empirical adjustment of the strength of the skew quadrupoles, the new method has the advantage of being faster and of allowing the measurement of the coupling also during the acceleration. Moreover it offers also information about the sum coupling coefficient and about the location of the sources of coupling.

Measurement and Optimization of the Lattice Functions in the Debuncher Ring at Fermilab

WEPCH057

V.P. Nagaslaev, K. Gollwitzer, V.A. Lebedev, A. Valishev (Fermilab)
V. Sajaev (ANL)

A goal of the Tevatron Run-II upgrade requires substantial increase of antiproton production. The central step towards this goal is increasing the Debuncher ring admittance. Detailed understanding of the Debuncher's optics, aperture limitations and lattice functions is necessary. The method of the response matrix optimization has been used to determine quadrupole errors and corrections to the design functions. The measurement accuracy is about 5% due to the Beam Position Monitor system resolution and the small number of steering elements in the machine. We have used these accurate measurements to redesign the machine optics to maximize the acceptance of the Debuncher where the main limiting apertures are the stochastic cooling pickups and kickers. Accuracy of the measurements and the limitations are discussed as well as details of the optics modification.

WEPCH058

Progress with Collision Optics of the Fermilab Tevatron Collider

A. Valishev, Y. Alexahin, G. Annala, V.A. Lebedev, V.P. Nagaslaev (Fermilab) V. Sajaev (ANL)

Recent advances in the measurement and modeling of the machine parameters and lattice functions at the Tevatron allowed modifications of the collision optics to be performed in order to increase the collider luminosity. As the result, beta functions in the two collision points were decreased from 35cm to 29cm which resulted in ~10% increase of the peak luminosity. In this report we describe the results of optics measurements and corrections. We also discuss planned improvements, including the new betatron tune working point and correction of the beta function chromaticity.

WEPCH059

Linear Lattice Modeling of the Recycler Ring at Fermilab

M. Xiao, V.P. Nagaslaev, A. Valishev (Fermilab) V. Sajaev (ANL)

The Recycler Ring at Fermilab is a fixed 8 GeV kinetic energy storage ring, by the use of permanent magnets in the ring lattice. It is a strong focusing FODO lattice made up of either two gradient magnets or two quadrupoles(in dispersion free straight sections). The magnetic properties of all magnets used were measured before installation and surveyed in place to minimize possible errors. Nevertheless, substantial differences are found in tunes and beta functions between the existing linear model and the real storage ring. It results in difficulties when tuning the machine to new lattice conditions. We are trying to correct the errors by matching the model into the real machine using Orbit Response Matrix(ORM) method. The challenge with ORM particular in this ring and the results are presented in this paper.

WEPCH060

Linear and Nonlinear Coupling Using Decoupling Transformations

A. Wolski, A. Sessler (LBNL)

Linear coupling in a storage ring is conveniently analyzed in terms of transformations that put the single-turn map into block-diagonal form. Such a transformation allows us to define new variables, in which the dynamics are uncoupled. Thus, for example, the symplectic conditions are simply that the phase area in each of the uncoupled variables is preserved. In principle, a similar approach may be taken to nonlinear coupling; we discuss such an approach in this paper, giving some simple illustrations of the ideas, based on the well-known techniques of normal form analysis. We also discuss some obstacles to finding a nonlinear decoupling transformation in the general case.

WEPCH061

SABER Optical Design

R.A. Erickson, K.L.F. Bane, P. Emma, Y. Nosochkov (SLAC)

SABER, the South Arc Beam Experimental Region, is a proposed new beam line facility designed to replace the Final Focus Test Beam at SLAC. In this paper, we outline the optical design features and beam parameters now envisioned for SABER. A magnetic chicane to compress positron bunches for SABER and a bypass line that could transport electrons or positrons from the two-thirds point of the linac to SABER, bypassing the LCLS systems, are also discussed.

Precision Measurement and Improvement of Optics for e+, e^- Storage Rings

WEPCH062

Y.T. Yan, Y. Cai, W.S. Colocho, F.-J. Decker, J. Seeman, M.K. Sullivan, J.L. Turner, U. Wienands, M. Woodley, G. Yocky (SLAC)

Through horizontal and vertical excitations, we have been able to make a precision measurement of linear geometric optics parameters with a Model-Independent Analysis (MIA). We have also been able to build up a computer model that matches the real accelerator in linear geometric optics with an SVD-enhanced Least-square fitting process. Recently, with the addition of longitudinal excitation, we are able to build up a computer virtual machine that matches the real accelerators in linear optics including dispersion without additional fitting variables. With this optics-matched virtual machine, we are able to find solutions that make changes of many normal and skew quadrupoles for machine optics improvement. It has made major contributions to improve PEP-II optics and luminosity. Examples from application to PEP-II machines will be presented.

Measurements and Modeling of Eddy Current Effects in BNL's AGS Booster

WEPCH063

K.A. Brown, L. Ahrens, C.J. Gardner, J. Glenn, M. Harvey, W. Meng, K. Zeno (BNL)

Recent beam experiments at BNL's AGS Booster have enabled us to study in more detail the effects of eddy currents on the lattice structure and our control over the basic lattice parameters of betatron tune and chromaticity. The Booster is capable of operating at ramp rates as high as 8 T/sec. At these ramp rates eddy currents in the vacuum chambers have significant effects on the fields and gradients seen by the beam as it is accelerated. The Booster was designed with these effects in mind and to help control the field uniformity and linearity in the Booster Dipoles special vacuum chambers were designed with current windings to negate the effect of the induced eddy currents. In this report results from measurements of these effects will be presented. Results from modeling and comparisons to the measurements will also be presented.

Fast Compensation of Global Linear Coupling in RHIC using AC Dipoles

WEPCH064

F. Franchi (GSI) R. Calaga (BNL) R. Tomas (CERN)

Global linear coupling has been extensively studied in accelerators and several methods have been developed to compensate the coupling vector C using skew quadrupole families scans. However, scanning techniques can become very time consuming especially during the commissioning of an energy ramp. In this paper we illustrate a new technique to measure and compensate, in a single machine cycle, global linear coupling from turn-by-turn BPM data without the need of a skew quadrupole scan. The algorithm is applied to RHIC BPM data using AC dipoles and compared with traditional methods.

Lattices for High-power Proton Beam Acceleration and Secondary Beam Collection, Cooling, and Deceleration

WEPCH065

S. Wang (IHEP Beijing) K.A. Brown, C.J. Gardner, Y.Y. Lee, D.I. Lowenstein, S. Peggs, N. Simos, J. Wei (BNL)

Rapid-cycling synchrotrons are used to accelerate high-intensity proton beams to energies of tens of GeV for secondary beam production. After primary beam collision with a target, the secondary beam can be collected, cooled, accelerated or decelerated by ancillary synchrotrons for various applications. In this paper, we first present a lattice for the main synchrotron. This lattice has: a) flexible momentum compaction to avoid transition and to facilitate RF gymnastics b) long straight sections for low-loss injection, extraction, and high-efficiency collimation c) dispersion-free straights to avoid longitudinal-transverse coupling, and d) momentum cleaning at locations of large dispersion with missing dipoles. Then, we present a lattice for a cooler ring for the secondary beam. The momentum compaction across half of this ring is near zero, while for the other half it is normal. Thus, bad mixing is minimized while good mixing is maintained for stochastic beam cooling.

WEPCH067

Implementation of TPSA in the Mathematica Code LieMath

D. Kaltchev (TRIUMF)

The Lie Algebra package LieMath written in the Mathematica language constructs the beamline map in a single-exponent Lie generator form. The algorithm (BCH-based map concatenation) has been recently enhanced with Truncated Power Series Algebra (TPSA) techniques.The polynomials produced by the series expansion of the Hamiltonian are replaced with arrays of coefficients (derivative structures) and the Poisson bracket and BCH are defined as operations on such structures. We have confirmed the statement that using automatic differentiation instead of symbolic operations increases the speed by least an order of magnitude. The code is equipped with a MAD parser and a normal form block allowing it to extract nonlinear chromaticity and amplitude detuning. The notebook was applied in FFAG studies and may be useful for the linear collider final focus or collimation systems.

WEPCH068

6-D Beam Dynamics Studies in EMMA FFAG

F. Meot (CEA)

Extensive simulations of 6-D transmission simulations in linear, non-scaling FFAGs, based on gutter rapid acceleration, are reported. They concern two different on-going projects: the 20~GeV muon accelerators in the Neutrino Factory (NuFact) with ISS parameters* and a 20~MeV electron model of these machines, EMMA**.
*http://www.hep.ph.ic.ac.uk/iss/**http://hepunx.rl.ac.uk/uknf/wp1/emodel/

WEPCH072

The High Order Non-linear Beam Dynamics in High Energy Storage Ring of FAIR

A.N. Chechenin, R. Maier, Y. Senichev, E. Senicheva (FZJ)

The High Energy Storage Ring (HESR) is part of the international project FAIR for antiproton physics with beam in the momentum range from 1.5 to 15 GeV/c to explore the research areas of hadron structure and quark-gluon dynamics. An important feature of the project is the combination of phase space cooled beams with thick internal targets. Therefore there are two obvious reasons of beam heating: the target-beam interaction and the intra-beam scattering. Another source of the beam size growth is the higher order resonances. In the paper we investigate the non-linear beam dynamics together with different correction schemes minimizing this effect and compare with other sources of beam heating. Since the tune working point has a spread dependent on the chromaticity correction scheme and space charge, we include in our consideration both effects as well. All beam dynamics calculations are carried out with the SIMBAD code from the Unified Accelerator Library (UAL). We use 10000 macro particles, grid sizes 64x64 and 1000 turns per run.

Asymptotic Analysis of Ultra-relativistic Charge

WEPCH073

D.A. Burton, J. Gratus, R. Tucker (Lancaster University)

A new approach is developed for analysing the dynamic behaviour of distributions of charged particles in an electromagnetic field. Noting the limitations inherent in the Lorentz-Dirac equation for a single point particle, a simple model is proposed for a charged continuum interacting self-consistently with the Maxwell field in vacuo. The model is developed using intrinsic tensor field theory and exploits to the full the symmetry and light-cone structure of Minkowski spacetime. This permits the construction of a regular stress-energy tensor whose vanishing divergence determines a system of non-linear partial differential equations for the velocity and self-fields of accelerated charge. Within this covariant framework a particular perturbation scheme is motivated by an exact class of solutions to this system describing the evolution of a charged fluid under the combined effects of both self and external electromagnetic fields. The scheme yields an asymptotic approximation in terms of inhomogeneous linear equations for the self-consistent Maxwell field, charge current and time-like velocity field of the charged fluid and is defined as an ultra-relativistic configuration.

Progress with Non-linear Beam Dynamic Studies of the Diamond Storage Ring

WEPCH074

R. Bartolini, I.P.S. Martin, B. Singh (Diamond) J.K. Jones (CCLRC/DL/ASTeC)

The conflicting requirements of high-brightness photon beams combined with adequate beam lifetime and high injection efficiency mean careful control of the non-linear lattice is crucial to achieving optimum performance. As part of the optimisation of the Diamond storage ring, studies have been made of both the Touschek lifetime and storage ring injection process, with the help of on-momentum and off-momentum frequency maps. The effect of chromaticity on Touschek lifetime has also been investigated and several new sextupole settings were identified achieving good Touschek lifetime and injection efficiency.

Effect of Insertion Devices on Beam Dynamics of the Diamond Storage Ring Using Kick Maps

WEPCH075

B. Singh, A.I. Baldwin, R. Bartolini, I.P.S. Martin (Diamond)

The effect of the all Phase-I Insertion Devices (IDs) on the beam dynamic of the Diamond storage ring has been investigated using the kick map modelisation of the IDs. Kick maps have been produced with high accuracy using the computer code RADIA, considering many longitudinal harmonics. The effect of IDs on the dynamic aperture, Touschek lifetime and injection efficiency in the low emittance lattice, was investigated considering both coupling errors and physical engineering apertures. Harmful resonances have been identified using Frequency Map Analysis (FMA) and full 6D tracking was performed to estimate the Touschek lifetime and the injection efficiency. Additionally, the kick maps have been used to generate feed-forward tables for compensation of linear optics distortion.

WEPCH076

Renormalization Group Reduction of the Frobenius-Perron Operator

S.I. Tzenov (Universita' degli Studi di Salerno, Dipartimento di Fisica E.R. Caianiello)

The Renormalization Group (RG) method is adopted as a tool for a constructive analysis of the properties of the Frobenius-Perron Operator. The renormalization group reduction of a generic symplectic map in the case, where the unperturbed rotation frequency of the map is far from structural resonances driven by the kick perturbation has been performed in detail. It is further shown that if the unperturbed rotation frequency is close to a resonance, the reduced RG map of the Frobenius-Perron operator (or phase-space density propagator) is equivalent to a discrete Fokker-Planck equation for the renormalized distribution function. The RG method has been also applied to study the stochastic properties of the standard Chirikov-Taylor map.

WEPCH077

Particle Tracking in a Sextupole Field using the Euler Method Approximation

S. Di Mitri, E. Karantzoulis (ELETTRA)

The purpose of this paper is to evaluate any differences in the single particle tracking through a magnetic lattice when sextupoles are treated either like sliced or single-kick elements. Only on-energy transverse motion is considered. Convergence and symplecticity of the method of sliced sextupoles are discussed. Dynamic apertures and transverse phase spaces applied to the Elettra synchrotron lattice are compared for the two cases.

WEPCH078

Measurement of Wake Effects by Means of Tune Shift in the KEKB Low-Energy Ring

T. Ieiri, H. Fukuma, Y. Ohnishi, M. Tobiyama (KEK)

The electron cloud produced by the positron beam induces single-bunch and coupled-bunch wakes, in addition to a tune shift. Effects of the dipole wake-field including the electron cloud were tried to measure in the KEKB Low Energy Ring. A test bunch was placed behind a bunch-train of the positron beam, even though a test bunch itself might interact with the remaining electron cloud. We measured a current-dependent tune-shift of a test bunch under constant train-current, while changing the bucket position of a test bunch. The tune shift indicated a strong defocusing field, however, tended to a focusing field when a test bunch approached a train with high train-current. The results are discussed, considering variations of the electron cloud density.

WEPCH079

Effects of Intrinsic Nonlinear Fields in the J-PARC RCS

H. Hotchi, Y. Irie, F. Noda (JAEA/J-PARC) S. Machida (CCLRC/RAL/ASTeC) A.Y. Molodozhentsev (KEK)

In order to accelerate a high intense proton beam with small particle losses, the J-PARC RCS, which is being constructed at JAEA, has a large acceptance. In such synchrotrons, the nonlinear motion of the beam particles, especially moving away from the axis of the elements, is a common issue, and it becomes essential to consider intrinsic field nonlinearities. The main sources of nonlinear magnetic fields in the RCS are as follows: fringes of the main dipole and quadrupole magnets, sextupole fields used for the chromatic correction, leak fields from the injection and extraction beam lines, etc. In this paper, we will discuss influences of

the intrinsic field nonlinearities and a cure for the induced betatron resonances, based on single-particle and multi-particle tracking simulations.

Beam Simulation of SQQ Injection System in KIRAMS-30 Cyclotron

WEPCH080

D.H. An, J.-S. Chai, H.B. Hong, S.S. Hong, M.G. Hur, W.T. Hwang, H.S. Jang, I.S. Jung, J. Kang, J.H. Kim, Y.S. Kim, M.Y. Lee, T.K. Yang (KIRAMS)

The injection system of KIRAMS-30 cyclotron consists of a double gap buncher, an SQQ, and a spiral inflector. Initial beam with 100 mmmrad has been generated by random Gaussian function in the transverse plane and random uniform function in the longitudinal direction. Using the 3D electric and magnetic fields of a buncher, SQQ, inflector, and return-yoke bore, the characteristics of the beam injected into the KIRAMS-30 cyclotron's central region has been obtained. This paper presents the results of its beam characteristics and parameters of each beam element.

Injection of The Proton Beam Into The Compact Cyclotron with Solenoid

WEPCH081

L.M. Onischenko, E. Samsonov (JINR)

The proton (H-) low (100 mkA) intensity beam injected by means of the solenoid comes to the first cyclotron orbit without the beam emittance deterioration. This is demonstrated by computer simulation.

Simulation of Ions Acceleration and Extraction in Cyclotron C400

WEPCH082

Y. Jongen, W.J.G.M. Kleeven (IBA) G.A. Karamysheva, S.A. Kostromin, N.A. Morozov, E. Samsonov (JINR)

The Belgian company IBA, together with scientists of the JINR in Dubna is designing a superconducting isochronous cyclotron for therapy by Carbon beams. The new cyclotron C400 has to deliver carbon ions with energy 400 MeV/amu and protons with energy close to 250 MeV. The cyclotron has a compact type superconducting magnet, with a pole radius of 187 cm. The axial focusing is provided by four sectors, with a spiral angle increasing to a maximum value close to 70^o at maximum energy. With this design, an axial betatron frequency is maintained during most of the acceleration. The beam acceleration is provided by two spiral dees located in opposite valleys. The dee voltage increases from 100 kV at the center to 200 kV at extraction. The paper presents the analysis of the beam acceleration in the proposed new cyclotron. During the acceleration, several resonance lines are crossed, but the paper demonstrates that this resonance crossing is done without damaging the beam properties. Extraction of the Carbon ions is done by an electrostatic deflector, followed by magnetic correctors. Protons are extracted at lower energy by stripping $2H^{+}1$ ions.

WEPCH085

Algorithms for Chromatic Sextupole Optimization and Dynamic Aperture Increase

E. Levichev, P.A. Piminov (BINP SB RAS)

Strong chromatic sextupoles compensating natural chromaticity of a storage ring may reduce dynamic aperture drastically. In the case of several sextupole families, one can find a lot of ways to correct chromaticity, which provides different sizes of the dynamic aperture. Finding a solution that gives the largest dynamic aperture is an important task for the storage ring design and operation. The paper discusses several approaches to sextupole arrangement optimization in order to obtain a large dynamic aperture.

WEPCH086

Adiabatic Theory of Slow Extraction of Particles from a Synchrotron

S.A. Nikitin (BINP SB RAS)

An analytical approach is developed to describe the process of slow extraction of particles from a synchrotron based on adiabatic crossing of the betatron resonance of the third order. An exact expression for the phase integral is found to analyze the conditions of oscillation amplitude growth near the resonance band. It allows one to directly define the interval of adiabatic motion from the start of decreasing the resonant tune to the beginning of fast increase of the oscillation amplitude. The interval distribution function is constructed for the cases of zero momentum spread and zero machine chromaticity as well as for the general case, taking into account non-zero momentum spread, non-zero chromaticity and synchrotron oscillations. Some numeric calculations of the time dependence of the extracted particle current are presented. It is shown that the momentum spread in the extracted beam can be minimized with the use of additional RF acceleration of particles during the slow extraction procedure.

WEPCH087

Normal Form for Beam Physics in Matrix Representation

S.N. Andrianov (St. Petersburg State University, Applied Mathematics & Control Processes Faculty) A.N. Chechenin (FZJ)

The modeling of long beam evolution dynamics in nonlinear accelerator structures has raised new interest in the effective methods of nonlinear effects calculation. Moreover, it is preferably to use both analytical tools and numerical methods for evolution modeling. Usually the standard numerical methods and computer codes are based on the concept of symplectic transfer maps, whereas the analytical tool is the theory of normal forms. The method of normal forms can be realized in symbolic and numerical modes easily enough. In this paper, we discuss the normal form theory based on the matrix formalism for Lie algebraic tools. This approach allows using well known methods of matrix algebra. This permits to compute necessary matrices step-by-step up to desired order of approximation. This procedure leads to more simple structure of matrix representation for very complicated structure of this map does not allow using this map for practical computing. Therefore, it is necessary to transform this map in more appropriate form. In another words the new matrix representation for the map is particularly simple and has explicit invariants and symmetries.

High Order Aberration Correction

S.N. Andrianov (St. Petersburg State University, Applied Mathematics & Control Processes Faculty) A.N. Chechenin (FZJ)

It is known that modern accelerators fall under nonlinear aberrations influence. The most of these aberrations have harmful character, and their effect must be maximally decreased. There are a set of approaches and codes to solving this problem. In this paper, we consider an approach for solving this problem using the matrix formalism for Lie algebraic tools. This formalism allows reducing the starting problem to linear algebraic equations for aberration coefficients, which are elements of corresponding matrices. There are discussed results evaluated using suggested approach and nonlinear programming tools. Some examples of corresponding results are given.

Dynamical Aperture Studies for the CERN LHC: Comparison between Statistical Assignment of Magnetic Field Errors and Actual Measured Field Errors

M. Giovannozzi, S.D. Fartoukh, S.S. Gilardoni, J.-B. Jeanneret, A.M. Lombardi, Y. Papaphilippou, T. Risselada, R. de Maria (CERN)

It is customary to evaluate the performance of a circular particle accelerator by computing the dynamical aperture, i.e., the domain in phase space where bounded single-particle motion occurs. In the case of the LHC the dynamical aperture computation is performed by assuming a statistical distribution of the magnetic field errors of various magnets' classes: the numerical computations are repeated for a given set of realisations of the LHC ring. With the progress in the magnet production and allocation of the available positions in the ring, the statistical approach has to be replaced by the computation of one single configuration, namely the actual realisation of the machine. Comparisons between the two approaches are presented and discussed in details.

Parameter Scans and Accuracy Estimates of the Dynamic Aperture of the CERN LHC

M. Giovannozzi, E. McIntosh (CERN)

Techniques to make use of large distributed computing facilities allow for denser parameter scans of the dynamical aperture, i.e., the domain in phase space where bounded single-particle motion prevails. Moreover, one can also increase the number of 'seeds' each of which represents a possible realisation of multipolar components around the machine. In this paper the dependence of the dynamical aperture on the step size of the grid of initial conditions and on the number of seeds is studied. Estimates on the accuracy of the dynamic aperture are derived and the definition of an improved protocol for numerical simulations is presented.

An Early Beam Separation Scheme for the LHC

J.-P. Koutchouk, G. Sterbini (CERN)

The high nominal luminosity of the LHC requires a large number of bunches spaced by about 7.5 m. To prevent more than one head-on collision in each interaction region, a crossing angle of 0.285 mrad is necessary. A side effect of this crossing angle is the increase of the effective transverse beam cross-section, thereby decreasing the luminosity by some 16%.

For the LHC upgrade, depending on the focusing scenarios, this loss significantly increases and largely offsets the potential gain of a stronger focusing. In this paper we analyze a strategy to circumvent this difficulty, based an early beam separation using small dipoles placed at a few meters from the interaction point, deep inside the detectors. This allows quasi co-linear head-on collisions at the crossing point only. From the beam dynamics point of view, the essential constraint is to control the long-range beam-beam interactions in a scenario where the normalized beam separation is not constant. In this paper the criteria of the analysis and the performance improvement obtained with the scheme are discussed. The strength of the dipoles is estimated as well as the impact on the detectors structure.

WEPCH095

Models to Study Multi-bunch Coupling through Head-on and Long-range Beam-beam Interactions

T. Pieloni, W. Herr (CERN)

In the LHC almost 6000 bunches will collide in four interaction points where they experience head-on as well as clustered long range interactions. These lead to a coupling between all bunches and coherent beam-beam effects. For two colliding bunches this is well understood. However, for a large number of bunches colliding with different collision patterns, it results in a complex spectrum of oscillation frequencies with consequences for beam measurements and Landau damping. To study the coherent beam-beam modes, three complementary models have been developped and will be described in this report. Two of these methods rely on self-consistent multi-bunch and multi-particle tracking while the third is a semi-analytic model based on a complex matrix algorithm. The three methods together provide useful information about the beam-beam coupling of multi bunch beams and together provide a deeper insight into the underlying physics.

WEPCH096

Measurement and Correction of the 3rd Order Resonance in the Tevatron

F. Schmidt (CERN) Y. Alexahin, V.A. Lebedev, D. Still, A. Valishev (Fermilab)

At Fermilab Tevatron BPM system has been recently upgraded resulting much better accuracy of beam position measurements and improvements of data acquisition for turn-by-turn measurements. That allows one to record the beam position at each turn for 8000 turns for all BPMs (118 in each plane) with accuracy of about 10^{-20} μm. In the last decade a harmonic analysis tool has been developed at CERN that allows relating each FFT line derived from the BPM data with a particular non-linear resonance in the machine. In fact, one can even detect the longitudinal position of the sources of these resonances. Experiments have been performed at the Tevatron in which beams have been kicked to various amplitudes to analyze the 3rd order resonance. It was possible to address this rather large resonance to some purposely powered sextupoles. An alternative sextupole scheme allowed the suppression of this resonance by a good factor of 2. Lastly, the experimental data are compared with model calculations.

Beam Dynamics in Compton-ring Gamma Sources

WEPCH097

E.V. Bulyak, P. Gladkikh, V. Skomorokhov (NSC/KIPT) K. Moenig (DESY Zeuthen) T. Omori, J. Urakawa (KEK) F. Zimmermann (CERN)

Electron storage rings with a laser cavity are promising intensive sources of polarized hard photons to generate polarized positron beams. The dynamics of electron bunches circulating in a storage ring and interacting with high-power laser pulses is studied both analytically and by simulation. Common features and difference in the bunch behavior interacting with an extremely high power laser pulse (polarized positron source for the ILC project) and a moderate pulse (source for CLIC) are shown. Also considerations on particular lattice designs for both rings are presented.

Application of the Lie-transform Perturbation Theory for the Turn-by-turn Data Analysis

WEPCH100

Y. Alexahin (Fermilab)

Harmonic analysis of turn-by-turn BPM data is a rich source of information on linear and nonlinear optics in circular machines. In the present report the normal form approach first introduced by R. Bartolini and F. Schmidt is extended on the basis of the Lie-transform perturbation theory to provide direct relation between the sources of perturbation and observable spectra of betatron oscillations. The goal is to localize strong perturbing elements, find the resonance driving terms - both absolute value and phase - that are necessary for calculation of the required adjustments in correction magnet circuits: e.g. skew-quadrupoles for linear coupling correction. The theory is nonlinear and permits to analyze higher order effects, such as coupling contribution to beta-beating and nonlinear sum resonances.

Ion Motion in the Adiabatic Focuser

WEPCH101

A. Sessler, E. Henestroza, S. Yu (LBNL)

The Adiabatic Focuser* works by having a focusing channel whose strength increases with distance down the channel. In this situation electrons of various energies and various transverse oscillation phase all are transversely focused. The concept works with external focusing, but would be very effective in a plasma ion focusing channel where the density of ions is simply increased as one goes down the channel. In the original work (Ref 1) motion of the ions was not included (as it was assumed to be a small effect). Recently, it has been suggested that ion motion in an adiabatic focuser would be significant and, even, preclude operation of the focuser as previously envisioned**. In this paper we numerically study the ion motion in the focuser. The ions clearly influence each other and, most importantly, are influenced by the electric field of the electrons being focused. It is shown that parameters can be selected such that the adiabatic focuser works as well as originally envisioned.
*P. Chen et al. Phys. Rev. Lett. 64, 1231 (1990).**J. R. Rosenzweig, et al. Phys. Rev. Lett. 95, 195002 (2005).

WEPCH102

Studies of the Nonlinear Dynamics Effects of APPLE-II Type EPUs at the ALS

C. Steier, S. Marks, S. Prestemon, D. Robin, D. Schlueter, W. Wan, W. Wittmer (LBNL)

Elliptically Polarizing Undulators (EPUs) have become more and more popular at synchrotron radiation sources, providing full polarization control of the photon beam. The fields of the most commonly used APPLE-II type EPUs have a very fast, intrinsic field roll-off, creating significant nonlinearities of the beam motion with in some cases large impact on the dynamic (momentum) aperture. In general, the nonlinear effects get stronger with longer periods and higher undulator magnetic fields. One of the planned future beamlines at the ALS (MERLIN) will use a quasiperiodic EPU with 9 cm period and maximum B fields of about 1.3 T. We will present simulation studies for the proposed shimming schemes for this future device to reduce the nonlinear effects to acceptable values, as well as experimental studies for the existing 5 cm period EPUs already installed in the ALS.

WEPCH103

Ion Effects in the Electron Damping Ring of the International Linear Collider

L. Wang, T.O. Raubenheimer (SLAC) A. Wolski (Liverpool University, Science Faculty)

Ion-induced beam instabilities and tune shifts are critical issues for the electron damping ring of the International Linear Collider (ILC). To avoid conventional ion trapping (multi-turn trapping), a long gap is introduced in the electron beam by omitting a number of successive bunches out of a long train. However, the beam can still suffer from the fast ion instability (FII), driven by ions that last only for a single passage of the electron bunches. Our study shows that the ion effects can be significantly mitigated by using multiple gaps, so that the stored beam consists of a number of relatively short bunch trains. The ion effects in the ILC damping rings are investigated using both analytical and numerical methods.

WEPCH104

Observation of the Long-range Beam-beam Effect in RHIC and Plans for Compensation

W. Fischer, R. Calaga (BNL) U. Dorda, J.-P. Koutchouk, F. Zimmermann (CERN) A.C. Kabel (SLAC) J. Qiang (LBNL) V.H. Ranjibar, T. Sen (Fermilab) J. Shi (KU)

At large distances the electromagnetic field of a wire is the same as the field produced by a bunch. Such a long-range beam-beam wire compensator was proposed for the LHC, and single beam tests with wire compensators were successfully done in the SPS. RHIC offers the possibility to test the compensation scheme with colliding beams. We report on measurements of beam loss measurements as a function of transverse separation in RHIC at injection, and comparisons with simulations. We present a design for a long-range wire compensator in RHIC.

WEPCH106

Stationary Beam Electron Transport in AIRIX for the TRAJENV Code

O. Mouton (CEA)

In the framework of the AIRIX program, the electron beam propagation between the injector and the X-conversion target is routinely simulated with the 2D TRAJENV code. We describe the physical models implemented in the code for a intense stationary beam. We present both the modeling of applied electromagnetic forces in induction cells and self generated ones. To avoid the cell damage due to target debris generated by the electron beam impact, a thin debris shield has been tested upstream the X-ray converter. Such a thin foil located in the beam pass, is taken into account in TRAJENV. We describe the modeling and the influence of the foil on the beam.

Contributors to AIRIX Focal Spot Size

WEPCH107

N. Pichoff, M. Caron, F. Cartier, D.C. Collignon, A. Compant La Fontaine, G. Grandpierre, L.H. Hourdin, M. Mouillet, D.P. Paradis (CEA)

High intensity electron beam focusing is a key issue for the successful development of flash radiography at hydro test facilities. AIRIX is a 2 kA, 19 MeV, 60 ns, single shot linear accelerator that produces X-rays from the interaction between relativistic electrons and a Tantalum solid target (Ta). A simulation tool has been developed to model the pulsed-beam dynamics through the accelerator from the cathode to the target. This simulator has allowed to estimate the contribution to the beam size on the target (focal spot) of beam emittance, pulse energy dispersion, pulse rising and falling fronts and the ion production on the target. The quantified contributions of these phenomena are reviewed here.

Comprehensive Benchmark of Electromagnetic 3D Codes in Time and Frequency Domain

WEPCH109

V. Serriere, N. Guillotin, J. Jacob (ESRF) F. Marhauser, E. Weihreter (BESSY GmbH)

A comprehensive benchmark of todays most powerful numerical 3D Eigenmode and Time Domain Solvers has been performed using the input geometry of a HOM-damped cavity and a highly lossy waveguide load developed at BESSY. The paper details the simulations results together with existing experimental data.

Calculation of Wake Potentials in General 3D Structures

WEPCH110

H. Henke (TET) W. Bruns (CERN)

The wake potential is defined as an integration along an axis of a structure. It includes the infinitely long beam pipe regions and in case of numerical evaluation leads to pipe wake artefacts. If the structure is cavity like one can position the integration path on the pipe wall and only the integration over the cavity gap remains. In case of axis-symmetric protruding structures it was proposed by O. Napoly et al. to deform the path such that the integration in the pipe regions is again on the wall. The present paper generalizes this method of path deformation to 3D structures with incoming and outgoing beam pipes. Its usefulness is verified with the code GdfidL and no artifacts were observed.

Time Domain Radiation of a Gaussian Charge Sheet Passing a Slit in a Conducting Screen

WEPCH111

M. Filtz, H. Henke (TET)

A semi-analytical method is proposed to calculate in time-domain the radiation of a relativistic Gaussian charge sheet travelling parallel to a slotted conducting screen. The method is based on transient line current elements as basis functions which have a triangular time dependence. Making use of duality magnetic current elements are used in the slot region.

Radiation fields are shown and the transverse kick received by a test charge is given. The dual problem, the scattering of the fields at a conducting strip, is also treated. The main purpose of the paper is to present an effective algorithm which is easy to implement for computing and visualising plane scattering and diffraction problems in time domain.

WEPCH112

Database Extension for the Beam Dynamics Simulation Tool V-code

W. Ackermann, W.F.O. Müller, B. Steiner, T. Weiland (TEMF) J. Enders, H.-D. Gräf, A. Richter (TU Darmstadt)

The beam dynamics simulation tool V-Code has been proved to be very useful in re-designing the injector layout at the super-conducting linear accelerator in Darmstadt (S-DALINAC). Modifications in the beam optics are necessary because a new source of polarized electrons should be installed in addition to the existing thermionic gun. The calculations are performed with V-Code which is designed to handle a large amount of individual beam line elements and can therefore be used for extensive accelerator studies. The available database includes all the necessary components like solenoids, quadrupoles and rf cavities, but as a result of their consecutive treatment overlapping external fields are not allowed. Due to geometrical restrictions in the assembly of the new source a space-saving candidate of a quadrupole triplet violates this software-related condition if it is regarded as three distinct quadrupoles. Consequently, a more general beam line element has to be created which treats the lenses as a single unit without interference of their fields to attached cells. The indispensable data base extension together with simulation results and implementation verifications will be presented.

WEPCH113

Numerical Impedance Calculations for the GSI SIS-100/300 Kickers

B. Doliwa, H. De Gersem, T. Weiland (TEMF)

Fast kicker modules represent a potential source for beam instabilities in the planned Facility for Antiproton and Ion Research (FAIR) at the Gesellschaft für Schwerionenforschung (GSI), Darmstadt. In particular, the more than fifty kicker modules to be installed in the SIS-100 and SIS-300 synchrotrons are expected to have a considerable parasitic influence on the high-current beam dynamics. Here we present our numerical investigations of the longitudinal and transverse kicker coupling impedances using a specialized electromagnetic field software. Besides the coupling to the external network, particular attention is paid to the question whether a resistively-coated ceramic beam pipe is able to reduce coupling impedances and ferrite heating significantly.

WEPCH114

On the Development of a Self-consistent Particle-in-cell (PIC) Code Using a Time-adaptive Mesh Technique

S. Schnepp, E. Gjonaj, T. Weiland (TEMF)

For a large class of problems the self-consistent simulation of charged particle beams in linear accelerators is necessary. Especially, in all low-energetic sections such as injectors the self-consistent interaction of particles and fields has to be taken into account. Well-known programs like the MAFIA TS Modules typically use the Particle-in-cell (PIC) method for beam dynamics simulations. Since they use a fixed computational grid which has to resolve the bunch adequately, they suffer from enormous memory consumption. Therefore and especially in the 3D case, only rather short sections can be simulated. A remedy to this limitation is the usage of a grid which refines itself in the vicinity of particles. For this purpose, a new code called SMOVE based on a time-adaptive grid is being developed. First promising results will be presented at the conference.

Numerical Simulation and Optimization of a 3-GHz Chopper/Prebuncher System for the S-DALINAC

WEPCH115

N. Somjit, W.F.O. Müller, T. Weiland (TEMF) R. Eichhorn, J. Enders, H.-D. Gräf, C. Heßler, Y. Poltoratska, A. Richter (TU Darmstadt)

A new source of polarized electrons with an energy of 100 keV is presently being developed at the superconducting Darmstadt electron linear accelerator S-DALINAC for future nuclear- and radiation-physics experiments. The pulsed electron beam emitted by the photocathode will be cut to 50 ps by a chopper operated at 3 GHz, and further bunch compression down to 5 ps will be achieved by a two-stage prebuncher section. The chopper-prebuncher system is based on similar devices used at the Mainz Mikrotron (MAMI) where the accelerator frequency is slightly smaller (2.4 GHz). For the chopper, a cylindrical resonator operating at TM110 mode is selected to deflect the electron beam onto an ellipse, i.e., both horizontally and vertically. This is simply achieved by particular slits on both ends of the resonator. The prebunching system consists of two cavities. For increasing the longitudinal capture efficiency, the first cavity will be operated at the fundamental accelerator frequency of the S-DALINAC of 3 GHz, and the second cavity at 6 GHz. The cavities are designed to work at the TM010 mode and TM020 mode for the fundamental and first harmonic, respectively.

Recent Simulation Results of the Polarized Electron Injector (SPIN) of the S-DALINAC

WEPCH116

B. Steiner, W.F.O. Müller, T. Weiland (TEMF) J. Enders, H.-D. Gräf, C. Heßler, G. Iancu, A. Richter, M. Roth (TU Darmstadt)

Recent design and development for a polarized electron source (SPIN) for the recirculating superconducting electron linear accelerator S-DALINAC will be presented. The polarized electron beam will be produced by photoemission from an InAlGaAs/GaAs superlattice cathode and will be accelerated to 100 kV electrostatically. The results of the beam dynamics simulation will be shown in detail. The start phase space of the electron bunch behind the gun has been approximated. The transverse focusing system consists of very short quadrupoles. Further main components of the new injector are a Wien filter, a Mott polarimeter, a chopper-prebuncher system (based on devices used at the Mainz Mikrotron MAMI), and diverse beam diagnostic tools. For the approximation of the start phase space CST MAFIA is used, and for the beam dynamic simulation VCode is used.

Beam Dynamics of an Integrated RFQ-drifttube-combination

WEPCH117

A. Bechtold, M. Otto, A. Schempp (IAP)

In the frame of a collaboration with the GSI in Darmstadt an RFQ-Drifttube-Combination for the Heidelberg cancer therapy center HICAT has been designed, built and successfully beam tested at the IAP Frankfurt. The integration and combination of both an RFQ and a rebunching drifttube unit inside a common cavity forming one single resonant RF-structure has been realized for the first time with this machine. The results of the beam measurements and questions about the beam dynamics simulations of such a combination have been investigated in detail with the code RFQSIM.

WEPCH118

LORASR Code Development

R. Tiede, G. Clemente, H. Podlech, U. Ratzinger, A.C. Sauer (IAP) S. Minaev (ITEP)

LORASR is specialized on the beam dynamics design of Separate Function DTL's based on the 'Combined 0 Degree Structure (KONUS)' beam dynamics concept. The code has been used for the beam dynamics design of several linacs already in operation (GSI-HLI, GSI-HSI, CERN Linac 3, TRIUMF ISAC-I) or scheduled for the near future (Heidelberg Therapy Injector, GSI Proton Linac). Recent code development was focused on the implementation of a new PIC 3D FFT space charge routine, facilitating time-efficient simulations with up to 1 million macro particles routinely, as well as of tools for error study and loss profile investigations. The LORASR code was successfully validated within the European HIPPI Project activities: It is the Poisson solver benchmarking and the GSI UNILAC Alvarez section tracking comparison programme. The error study tools are a stringent necessity for the design of future high intensity linacs. The new LORASR release will have a strong impact on the design of the GSI FAIR Facility Proton Linac, as well as the transmission investigations on the IFMIF Accelerator. This paper presents the status of the LORASR code development and the benchmarking results.

WEPCH119

Beam Performance with Internal Targets in the High-energy Storage Ring (HESR)

A. Lehrach, R. Maier, D. Prasuhn (FZJ) O. Boine-Frankenheim, R.W. Hasse (GSI) F. Hinterberger (Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik)

The High-energy Storage Ring of the future International Facility for Antiproton and Ion Research (FAIR) at GSI in Darmstadt is planned as an antiproton synchrotron storage ring in the momentum range of 1.5 to 15 GeV/c. An important feature of HESR is the combination of phase space cooled beams and dense internal targets (e.g., pellet targets), which results in demanding beam parameter requirements for two operation modes: high luminosity mode with peak luminosities of up to $2{\cdot}10^{32}$ cm-2 s-1, and high resolution mode with a momentum spread down to 10-5, respectively. The beam cooling equilibrium and beam loss with internal target interaction is analyzed. Rate equations are used to predict the rms equilibrium beam parameters. The cooling and intra-beam scattering rate coefficients are obtained from simplified models. Energy loss straggling in the target and the associated beam loss are analyzed analytically assuming a thin target. A longitudinal kinetic simulation code is used to study the evolution of the momentum distribution in coasting and bunched beam. The analytic expressions for the target induced momentum tail are found in good agreement with the simulation results.

*A. Lehrach et al. Beam Performance and Luminosity Limitations in the High-Energy Storage Ring (HESR), Nuclear Inst. and Methods in Physics Research, A44704 (2006).

WEPCH120

Simulation of 3D Space-charge Fields of Bunches in a Beam Pipe of Elliptical Shape

A. Markovik, G. Pöplau, U. van Rienen (Rostock University, Faculty of Computer Science and Electrical Engineering) K. Floettmann (DESY)

Recent applications in accelerator design require precise 3D calculations of space-charge fields of bunches of charged particles additionally taking into account the shape of the beam pipe. An actual problem of this kind is the simulation of e-clouds in damping rings. In this paper a simulation tool for 3D space-charge fields is presented where a beam pipe with an arbitrary elliptical shape is assumed. The discretization of the Poisson equation by the method of finite differences on a Cartesian grid is performed having the space charge field solved only in the points inside the elliptical cross-section of the beam pipe taking care of the conducting boundaries of the pipe. The new routine will be implemented in the tracking code ASTRA. Numerical examples demonstrate the performance of the solution strategy underling the new routine. Further tracking results with the new method are compared to established space-charge algorithms such as the FFT-approach.

3D Space-charge Calculations for Bunches in the Tracking Code ASTRA

WEPCH121

G. Pöplau, U. van Rienen (Rostock University, Faculty of Computer Science and Electrical Engineering) K. Floettmann (DESY)

Precise and fast 3D space-charge calculations for bunches of charged particles are of growing importance in recent accelerator designs. One of the possible approaches is the particle-mesh method computing the potential of the bunch in the rest frame by means of Poisson's equation. In that, the charge of the particles are distributed on a mesh. Fast methods for solving Poisson's equation are the direct solution applying Fast Fourier Methods (FFT) and a finite difference discretization combined with a multigrid method for solving the resulting linear system of equations. Both approaches have been implemented in the tracking code ASTRA. In this paper the properties of these two algorithms are discussed. Numerical examples will demonstrate the advantages and disadvantages of each method, respectively.

2D Wake Field Calculations of Tapered Structures with Different FDTD Discretization Schemes

WEPCH122

C. Schmidt (Rostock University, Institute for General Electrical Engn.) H.-W. Glock, U. van Rienen (Rostock University, Faculty of Engineering)

The continual performance improvement of particle accelerators requires advanced prediction of parasitic wake field effects, even in structures of comparatively weak influence like tapers. In the case of smooth tapered components, even well established codes like MAFIA* demonstrate strong discretization dependency of the results or solver instabilities, making them not reliable in such applications. Grid dispersion is assumed to generate this failure. In Ref.** an alternative discretization scheme is described, using a homogeneous rotated mesh intended to eliminate such grid dispersion effects. In order to study the dependence on the discretization applied, we use this scheme to calculate wake fields in prototype taper structures of rotational symmetry. Furthermore a comparison is provided with the results of a non-rotated mesh, MAFIA runs and - so far applicable - analytical approaches.

*MAFIA V4.107: CST GmbH, Bad Nauheimer Str. 19, D-64289 Darmstadt**R. Hampel et al. New discretization scheme for wake field computation in cylindrically symmetric structure. Proc. EPAC'04, pp 2559

Large Simulation of High Order Short Range Wakefields

WEPCH123

A. Bungau (Cockcroft Institute) R.J. Barlow (UMAN)

We present a formalism for incorporating intra-bunch wake fields into particle-by-particle tracking codes, such as MERLIN and BDSIM. Higher order wake field effects are incorporated in a manner which is computationally efficient. Standard formulae for geometric, resistive and dielectric wake fields are included for various apertures, particularly those relevant for ILC collimators. Numerous examples are given.

WEPCH124

BDSIM - Beamline Simulation Toolkit Based on Geant4

I.V. Agapov, G.A. Blair, J. Carter (Royal Holloway, University of London) X. Dadoun (LAL)

BDSIM is a code that combines accelerator-style particle tracking with traditional Geant-style tracking based on Runge-Kutta techniques. This approach means that particle beams can be tracked efficiently when inside the beampipe, while also enabling full Geant4 processes when beam-particles interact with beamline apertures. Tracking of the resulting secondary particles is automatic. The code is described, including a new MAD-style interface and new geometry description, and key performance parameters are listed.

WEPCH125

New Design Tools for a Cyclotron Central Region

D. Battaglia, L. Calabretta, D. Campo, M.M. Maggiore, L.A.C. Piazza, D. Rifuggiato (INFN/LNS)

A code that allows us to design the spiral inflector and the central region of the SCENT cyclotron was implemented. The code integrates the main equations of motion of a particle in an electromagnetic field and provides an useful interface to describe the geometry and the physical constraints of the inflector and the central region to be simulated. The mechanical drawings of the inflector and the central region is made using a standard CAD. These drawings are then imported in OPERA 3D to produce the maps of the electric and magnetic field. An application interface allows us to enter the emittance and the particles' distributions to be transported through the inflector. An iterative process to design the central region was also developed and tested.

WEPCH126

Issues in Modelling of Negative Ion Extraction

M. Cavenago (INFN/LNL) V. Antoni, F. Sattin (CNR/RFX)

In the context of negative ion sources proposed for neutral beam injectors for tokamaks, halo of the extracted beam is typically large (about 10 %) and optimum shape of the multiaperture extraction electrode is a matter of research. Present designs range from an aperture angle of 45 degree (low current, convergent beam) to 90 degrees (flat electrode, high current, large divergence and halo). Two major difficulties of the beam extraction modelling are here discussed. First, the generation processes of negative ion show some shortcomings: volume production seems low; wall production is large, but ions have wrong directions and/or large nonuniformity in current density; elastic scattering of wall generated ions into the extraction direction must compete with mutual neutralization. Second, the plasma sheath charge has to be negative on the extraction hole surface and positive on the nearby wall surface, which enhances beam aberration near hole edge. After discussing limitation of existing codes and model, result from an ad hoc code are discussed. Also 2D equation for the selfconsistent electrostatic field can be written and implemented into a multiphysics general purpose program.

Analysis of Radiative Effects in the Electron Emission from the Photocathode and in the Acceleration inside the RF Cavity of a Photoinjector using the 3D Numerical Code RETAR

WEPCH127

V. Petrillo, C. Maroli (Universita' degli Studi di Milano) G. Alberti (Università degli Studi di Milano) A. Bacci, A.R. Rossi, L. Serafini (INFN-Milano) M. Ferrario (INFN/LNF)

The three-dimensional fully relativistic and self-consistent code RETAR has been developed to model the dynamics of high-brightness electron beams and in particular to assess the importance of the retarded radiative part of the emitted electromagnetic fields in all conditions where the electrons experience strong accelerations. In this analysis we evaluate the radiative energy losses in the electron emission process from the photocathode of an injector, during the successive acceleration of the electron beam in the RF cavity and the focalization due to the magnetic field of the solenoid, taking also into account the e.m. field of the laser illuminating the cathode. The analysis is specifically carried out with parameters of importance in the framework of the SPARC and PLASMONX projects.

Virtual Accelerator as an Operation Tool at J-PARC 3 GeV Rapid Cycling Synchrotron (RCS)

WEPCH128

H. Harada, K. Shigaki (Hiroshima University) K. Furukawa (KEK) H. Hotchi, F. Noda, H. Sako, H. Suzuki (JAEA/J-PARC) S. Machida (CCLRC/RAL/ASTeC)

We developed a virtual accelerator based on EPICS for 3 GeV Rapid-Cycle Synchrotron (RCS) in J-PARC. It is important to have an on-line model of optics parameters, such as tunes, Twiss parameters, dispersion function, at the commissioning stage in a high intensity proton machine. It gives a strong feedback for the RCS operation as a commissioning tool as well as for the studies of beam dynamics issues. Beam position monitors with finite resolutions, a transverse exciter to measure the betatron frequency, and a RF system with variable frequency to simulate off-momentum optics have been implemented into the system. The virtual accelerator system itself and some results of beam dynamics studies will be presented.

Analysis of Symmetry in Accelerating Structures with Group Theory

WEPCH130

S. Sakanaka (KEK)

Many rf cavities for modern accelerators have a variety of symmetry. There is a question as to what is the connection between the symmetry of a cavity and of its eigenmodes. This can be clarified* using the representation theory of groups. The geometric symmetry of a cavity can be expressed by a group of symmetry operations. The structure of this group can be represented by a set of matrices called representation. The group is associated with several irreducible representations which can express possible patterns of transformations under the symmetry operations. The irreducible representations are very suitable to express the symmetry of each eigenmode. This method can be used to improve the understanding of non-axially symmetric structures. In this paper, this method is first explained, and then, it is extended to the application of symmetric periodic structures.

*S. Sakanaka, Phys. Rev. ST Accel. Beams 8, 072002 (2005).

WEPCH131

Development of Numerical Code for Self-consistent Wake Field Analysis with Curved Trajectory Electron Bunches

H. Kawaguchi (Muroran Institute of Technology, Department of Electrical and Electronic Engineering) K. Fujita (Hokkaido University)

Strongly interacting phenomena of electromagnetic radiation fields and ultra-relativistic electron is one of great interests in accelerator science such as in electron beam dynamics at the bunch compressor. The phenomena are described by time domain boundary value problem for the Lienard-Wiechert solutions. Authors develop a time domain boundary element method for self-consistent wake fields analysis of electromagnetic fields and charged particles. To use boundary integral equation for describing the electromagnetic fields, the time domain boundary value problems for the Lienard-Wiechert solution can be naturally formulated and we can simulate the wake fields phenomena with electron beam dynamics. In this paper, beam dynamics of curved trajectory electron bunches inside uniform beam tube are numerically simulated by using 2.5 dimension time domain boundary element technique. Various effects of closed beam tube for ultra-relativistic electron dynamics are considered comparing with the Lienard-Wiechert solutions in free space.

WEPCH132

Design Study of Dedicated Computer System for Wake Field Analysis with Time Domain Boundary Element Method

K. Fujita, T. Enoto (Hokkaido University) H. Kawaguchi (Muroran Institute of Technology, Department of Electrical and Electronic Engineering)

Time domain boundary element method (TDBEM) has advantages of dispersion free calculations and modeling of curved beam trajectories in wake field analysis compared to conventional methods. These advantages give us powerful possibilities for analysis of beam dynamics due to CSR in bunch compressors of next-generation accelerators. On the other hand, the TDBEM also has a serious difficulty of large computational costs. In this paper, a dedicated computer system for wake field analysis with the TDBEM is proposed as one of solutions for high performance computing (HPC) technologies. Recent remarkable progress of LSI hardware design environments such as HDL compiler tools and large scale FPGAs enables us to make up computer hardware systems with very low cost in a short development period. The authors have been working in design studies of the TDBEM dedicated computer system on such LSI design environments. This paper presents a system design and VHDL simulations of a wake field analysis machine based on the TDBEM.

WEPCH134

Development of Code for Simulation of Acceleration of Ions from Internal Source to End of Extraction System in Cyclotrons and Preliminary Design Study of 8MeV Cyclotron for Production of Radioisotopes

S.A. Kostromin (JINR)

From the users' point of view modern cyclotrons must be compact, energy-saving, low-radiation and very reliable facilities. To provide all these characteristics, a very detailed design study of all systems of an accelerator under development is required. Thus, particle tracking from the "beginning" to the "end" in modern cyclotrons with small gaps in the main acceleration region and with efficient extraction systems becomes a very important task for designers. Codes for beam

dynamics simulation at the center, main acceleration region and through the extraction system of the cyclotron have been developed. It is possible to monitor all main beam parameters at the different stages of acceleration, radial, axial and phase motion of the beam and the energy increase. During tracking particles through the extraction system it is possible to calculate rms envelopes of radial and vertical motion of the beam and beam losses at the aperture of the extraction system elements. A preliminary design of a compact 8-MeV proton cyclotron was studied using created codes. The accelerator is supposed to have a four sector compact magnet system with the pole 64 cm in diameter.

Monte Carlo Simulation Model of Internal Pellet Targets

WEPCH136

O.A. Bezshyyko, K.A. Bezshyyko, I.M. Kadenko, R.V. Yermolenko (National Taras Shevchenko University of Kyiv, The Faculty of Physics) A. Dolinskii (NASU/INR) V.G. Ziemann (UU/ISV)

We develop a numerical model of a pellet target and use it for Monte Carlo simulations of the interaction of a circulating beam with a pellet target. Real geometry details of the pellet beam and the beam are taken into account. We emphasize the role of tails of non-Gaussian distributions for transverse scattering and energy loss. These effects are especially important for simultaneous calculations of electron cooling, intrabeam scattering and target influence. Black-box algorithms for the generation of automatic nonuniform random variate distributions are used for the effective time averaging of scattering angle and energy loss distributions.

FAKTOR2: A Code to Simulate the Collective Effects of Electrons and Ions

WEPCH137

W. Bruns, D. Schulte, F. Zimmermann (CERN)

A new code for computing the multiple effects of slowly moving charges is being developed. The basic method is electrostatic particle in cell. The underlying grid is rectangular and locally homogeneous. At regions of interest, e.g., where the beam is, or near material boundaries, the mesh is refined recursively. The motion of the macroparticles is integrated with an adapted timestep. Fast particles are treated with a smaller timestep, and particles in regions of fine grids are also treated with a fine timestep. The position of collision of particles with material boundaries is accurately resolved. Secondary particles are then created according to user-specified yield functions.

Simulations of Long-range Beam-beam Interaction and Wire Compensation with BB-TRACK

WEPCH138

U. Dorda, F. Zimmermann (CERN)

We present weak-strong simulation results for the effect of long-range beam-beam collisions in LHC, SPS, RHIC and DAFNE, as well as for proposed wire compensation schemes or wire experiments, respectively. In particular, we discuss details of the simulation model, instability indicators, the effectiveness of compensation, the difference between nominal and PACMAN bunches for the LHC, beam experiments, and wire tolerances. The simulations are performed with the new code BBTRACK.

WEPCH139

WISE: An Adaptative Simulation of the LHC Optics

P. Hagen, M. Giovannozzi, J.-P. Koutchouk, T. Risselada, S. Sanfilippo, E. Todesco, E.Y. Wildner (CERN)

The LHC beam dynamics requires a tight control of the magnet field quality and geometry. As the production of the magnets advances, decisions have to be made on the acceptance of possible imperfections. To ease decision making, an adaptative model of the LHC optics has been built, based on the current information available (e.g. magnetic measurements at warm or cold, magnet allocation to machine slots) as well as on statistical evaluations for the missing information (e.g. magnets yet to be built, measured, or for non-allocated slots). The uncertainties are included: relative and absolute measurement errors, warm-to-cold correlations for the fraction of magnets not measured at cold, hysteresis and power supply accuracy. A pre-processor generates instances of the LHC ring for the MADX program, with the possibility of selecting various error sources. A post-processor computes ranges for relevant beam optics parameters and distributions. This approach has been applied to the expected beta-beating, to the possible impact of permeability issues in some quadrupole collars, to the geometrical displacements of the multipolar correctors and to prioritize the magnetic measurement programme.

WEPCH140

Recent Improvements of PLACET

A. Latina, H. Burkhardt, L. Neukermans, G. Rumolo, D. Schulte, R. Tomas (CERN) P. Eliasson (Uppsala University) J. Resta-López (IFIC)

The tracking code PLACET is used to simulate the beam transport in linear colliders from the damping ring to the interaction point and beyond. Recent improvements of the code are presented. They include the possibility to simulate bunch compressors and to use parallel computer systems.

WEPCH141

Accelerator Physics Code Web Repository

F. Zimmermann, R. Basset, E. Benedetto, U. Dorda, M. Giovannozzi, Y. Papaphilippou, T. Pieloni, F. Ruggiero, G. Rumolo, F. Schmidt, E. Todesco (CERN) D.T. Abell (Tech-X) R. Bartolini (Diamond) O. Boine-Frankenheim, G. Franchetti, I. Hofmann (GSI) Y. Cai, M.T.F. Pivi (SLAC) Y.H. Chin, K. Ohmi, K. Oide (KEK) S.M. Cousineau, V.V. Danilov, J.A. Holmes, A.P. Shishlo (ORNL) L. Farvacque (ESRF) A. Friedman (LLNL) M.A. Furman, D.P. Grote, J. Qiang, G.L. Sabbi, P.A. Seidl, J.-L. Vay (LBNL) D. Kaltchev (TRIUMF) T.C. Katsouleas (USC) E.-S. Kim (PAL) S. Machida (CCLRC/RAL/ASTeC) J. Payet (CEA) T. Sen (Fermilab) J. Wei (BNL) B. Zotter (Honorary CERN Staff Member)

In the framework of the CARE HHH European Network, we have developed a web-based dynamic accelerator-physics code repository. We describe the design, structure and contents of this web repository, illustrate its usage, and discuss our future plans.

WEPCH143

Electron Linac Based e,X-radiation Facility

V.I. Nikiforov, A. Dovbnya, N.A. Dovbnya, V.L. Uvarov (NSC/KIPT)

In a number of technologies based on high-current electron accelerators bremsstrahlung is generated in the interaction of the beam with the irradiated object. Thus, in addition to the electron radiation, the bremsstahlung may be used for carring out of different technolodgical programs (e,X-facility). A method for the numerical analysis and optimization of the radiation characteristics of such installation is proposed. The accelerator beam track, starting from the electron source and up to output devices is considered as a single multicomponent target consisting of the layers of different materials. The thickness of each layer is measured in the generalized units of the "stopping length". Using the method of simulation based on the PENELOPE/2001 system the characteristics of the mixed e,gamma-radiation field (energy yield of electrons, photons and their ratio) as function of the stopping length for actual or anticipated version of output equipment can be calculated. To illustrate the method, the parameters of the beam path of the NSC KIPT Linacs used as e,X-facilities was analyzed.

CSR Effects in a Bunch Compressor: Influence of the Transverse Force and Shielding

WEPCH144

G. Bassi, J.A. Ellison, K.A. Heinemann (UNM)

We study the influence of CSR on particle bunches traveling on arbitrary planar orbits between parallel conducting plates with a fixed "vertical" charge distribution. Our goal is a numerical solution of the 2 degree-of-freedom Vlasov-Maxwell equations. This provides simulations with lower numerical noise than the macroparticle method and allows the study of emittance degradation and microbunching. As reported*, we calculate the fields excited by the bunch in the lab frame using a new formula that leads to a simplification. The Vlasov equation is integrated in the beam frame interaction picture using the method of local characteristics. The transformation between traditional beam frame and lab frame coordinates is carefully treated. Here we report on our implementation of the algorithm in the context of a chicane bunch compressor**, where the strong correlation between phase space variables requires an adaptive grid. In particular, we present a complete analysis (moments + reduced densities) of the bunch evolution under the fields produced by the unperturbed bunch density. Finally, our progress on the fully self-consistent case is discussed.
* Vlasov treatment of coherent synchrotron radiation from arbitrary planar orbits, Nucl. Instr. Meth. Phys. Res. A, in press.** ICFA Beam Dynamics Mini-Workshop on CSR, Berlin-Zeuthen, 2002. See http://www.desy.de/csr.

Particle Tracking and Simulation on the .NET Framework

WEPCH145

H. Nishimura, T. Scarvie (LBNL)

Particle tracking and simulation studies are becoming complex. In addition to the sophisticated graphics, interactive scripting is becoming popular. A compatibility with the control system requires network and database capabilities. It is not a trivial task to fulfill various requirements without sacrificing the runtime performance. We evaluate the use of .NET to solve this issue by converting a C++ code Goemon* that is an object-oriented version of Tracy developed at ALS. The portability to other platforms will be mentioned in terms of Mono.
*H. Nishimura, PAC'01, Chicago, July 2001, p.3066.

WEPCH146

Intrabeam Scattering Studies for the ILC Damping Rings Using a New Matlab Code

I. Reichel, A. Wolski (LBNL)

A new code to calculate the effects of intrabeam scattering (IBS)has been developed in Matlab based on the approximation suggested by K. Bane*. It interfaces with the Accelerator Toolbox** but can also read in lattice functions from other codes. The code has been benchmarked against results from other codes for the ATF*** that use this approximation or do the calculation in a different way. The new code has been used to calculate the emittance growth due to intrabeam scattering for the lattices currently proposed for the ILC Damping Rings, as IBS is a concern, especially for the electron ring. A description of the code and its user interface, as well as results for the Damping Rings, will be presented.
*K. Bane, in Proceedings of EPAC2002, p.1443. **A. Terebilo, Accelerator Toolbox for MATLAB, SLAC-PUB-8732 and www-ssrl.slac.stanford.edu/at/. ***K. Kubo et al. PhysRevST AB.8.081001 (2005).

WEPCH147

Simulations of Electron Effects in Superconducting Cavities with the VORPAL Code

C. Nieter, J.R. Cary, P. Messmer, D.S. Smithe, P. Stoltz (Tech-X) G.R. Werner (CIPS)

Modeling the complex boundaries of superconducting radio frequency (SRF) accelerating cavities on a Cartesian grid is a challenge for many Finite Difference Time Domain (FDTD) electromagnetic PIC codes. The simulation of such cavities require conformal (curve fitting) boundaries. Modeling the full cavity including couplers and ports is fundamentally a three dimensional problem requiring capability to run in parallel on large numbers of processors. We have recently added conformal boundaries using the method of Zagorodnov* to the plasma simulation code VORPAL. Using this higher order boundary algorithm and the surface physics package TxPhysics, we have begun studies of self-consistent electron effects in SRF cavities. We have modeled the beam excitation of cavity modes and the effects of electron multipacting. Results from these studies will be presented using the new user friendly visualization tool that now ships with VORPAL.
*I. A. Zagorodnov et al. "A uniformly stable conformal FDTD-method in Cartesian grids," International Journal of Numerical Modeling 16, 127 (2003).

WEPCH148

Computing TRANSPORT/TURTLE Transfer Matrices from MARYLIE/MAD Lie Maps

G.H. Gillespie (G.H. Gillespie Associates, Inc.)

Modern optics codes often utilize a Lie algebraic formulation of single particle dynamics. Lie algebra codes such as MARYLIE and MAD offer a number of advantages that makes them particularly suitable for certain applications, such as the study of higher order optics and for particle tracking. Many of the older more traditional optics codes use a matrix formulation of the equations of motion. Matrix codes such as TRANSPORT and TURTLE continue to find useful applications in many areas where the power of the Lie algebra approach is not necessary. Arguably the majority of practical optics applications can be addressed successfully with either Lie algebra or matrix codes, but it is often a tedious exercise to compare results from the two types of codes in any detail. Differences in the choice of dynamic variables, between Lie algebra and matrix codes, compounds the comparison difficulties already inherent in the different formulations of the equations of motion. This paper summarizes key relationships and methods that permit that direct numerical comparison of results from MARYLIE and MAD with those from TRANSPORT and TURTLE.

PBO LAB (tm) Tools for Comparing MARYLIE/MAD Lie Maps and TRANSPORT/TURTLE Transfer Matrices

WEPCH149

G.H. Gillespie, W. Hill (G.H. Gillespie Associates, Inc.)

Particle optics codes frequently utilize either a Lie algebraic formulation or a matrix formulation of the equations of motion. Examples of codes utilizing the Lie algebra approach include MARYLIE and MAD, whereas TRANSPORT and TURTLE use the matrix formulation. Both types of codes have common application to many particle optics problems. However, it is often a very tedious exercise to compare results from the two types of codes in any great detail. As described in a companion paper in these proceedings, differences in the choice of phase space variables, as well as the inherent differences between the Lie algebraic and matrix formulations, make for unwieldy and complex relations between results from the two types of codes. Computational capabilities have been added to the PBO Lab software that automates the calculation of transfer matrices from Lie maps, and that converts phase space distributions between the different representations used by the codes considered here. Graphical and quantitative comparison tools have been developed for quick and easy visual comparisons of transfer maps and matrices.

The Accelerator Markup Language and the Universal Accelerator Parser

WEPCH150

D. Sagan, M. Forster (Cornell University, Laboratory for Elementary-Particle Physics) D.A. Bates, A. Wolski (LBNL) T. Larrieu, Y. Roblin (Jefferson Lab) T.A. Pelaia (ORNL) S. Reiche (UCLA) F. Schmidt (CERN) P. Tenenbaum, M. Woodley (SLAC) N.J. Walker (DESY)

A major obstacle to collaboration on accelerator projects has been the sharing of lattice description files between modeling codes. To address this problem, a lattice description format called Accelerator Markup Language (AML) has been created. AML is based upon the standard eXtensible Markup Language (XML) format; this provides the flexibility for AML to be easily extended to satisfy changing requirements. In conjunction with AML, a software library, called the Universal Accelerator Parser (UAP), is being developed to speed the integration of AML into any program. The UAP is structured to make it relatively straightforward (by giving appropriate specifications) to read and write lattice files in any format. This will allow programs that use the UAP code to read a variety of different file formats. Additionally this will greatly simplify conversion of files from one format to another. Currently, besides AML, the UAP supports the MAD lattice format.

Comment on Healy's Symplectification Algorithm

WEPCH152

W.W. MacKay (BNL)

For long-term tracking, it is important to have symplectic maps for the various electromagnetic elements in an accelerator ring. While many standard elements are handled well by modern tracking programs, new magnet configurations (e.g., a helical dipole with a superimposed solenoid) are being used in real accelerators. Transport matrices and higher terms may be calculated by numerical integration through model-generated or measured field maps. The resulting matrices are most likely not quite symplectic due to numerical errors in the integrators as well as the field maps. In his thesis*, Healy presented a simple algorithm to symplectify a matrix. This paper presents a discussion of limitations of this method.

*L. M. Healy, "Lie Algebraic Methods for Treating Parameter Errors in Particle Accelerators", Doctoral Thesis. University of Maryland, unpublished (1986).

WEPCH153

Symplectic Interpolation

W.W. MacKay, A.U. Luccio (BNL)

It is important to have symplectic maps for the various electromagnetic elements in an accelerator ring. For some tracking problems we must consider elements which evolve during a ramp. Rather than performing a complicated numerical integration for every turn, it should be possible to integrate the trajectory for a few sets of parameters, and then interpolate the transport map as a function of one or more parameters, such as energy. We present two methods for interpolation of symplectic matrices as a function of parameters: one method is based on the logarithm of the matrix, and the other is based on the related but simpler Healy symplectification method.

WEPCH154

SPS Access System Upgrade

E. Manola-Poggioli, PL. Lienard, T. Pettersson (CERN)

The present SPS access system is not entirely compatible with the formal requirements of the French Radioprotection Authorities, and a project has been launched to remedy this situation. The upgrade project is split into three phases that will be implemented, in the present planning, in the shutdowns 2006, 2007 and after the first physics run of the LHC, respectively. This paper presents the results of the safety study, the upgrade strategy and the architecture of the upgraded system.

WEPCH155

Tune-stabilized Linear-field FFAG for Carbon Therapy

C. Johnstone (Fermilab) S.R. Koscielniak (TRIUMF)

The simplicity, smaller aperture, and reduced ring size associated with linear-field, nonscaling FFAGs have made them attractive to investigate for a broad range of applications. Significant progress has recently been made towards understanding and modeling this new type of accelerator. The merits, drawbacks and challenges of the linear-field FFAG are discussed here, in particular its suitability for proton and carbon cancer therapy as compared with conventional synchrotrons and cyclotrons. Specifically, tune stabilization and dynamic aperture, a problem with both scaling and non-scaling FFAGs, will be addressed in detail.

WEPCH156

CERN Safety Alarms Monitoring System (CSAM)

E. Manola-Poggioli, L. Scibile (CERN)

The CERN Safety Alarms Monitoring (CSAM) system is designed to aquire and transmit reliably to the CERN Fire Brigade all the alarms generated by a large number of safety alarm equipment distributed around the sites and in the underground. The quality and accuracy of the information provided by CSAM is crucial to permit a quick and efficient intervention by the Fire Brigade. The CSAM projet was launched in 1999 to replace the previous alarm system which used obsolete technology and operator devices. The new system is in operation since 2005 and 2/3 of all alarm equipement on the CERN sites are now handled by the new system. The migration/installation process is is expected to terminate in May 2006. This paper presents the system architecture, the deployment process and the return of experience in the accelerator environment.

Design and Beam Dynamics Simulation for the Ion-injector of the Austrian Hadron Therapy Accelerator

Th. Strodl (ATI)

MedAustron is an initiative for the construction of the Austrian Hadron Therapy Centre. In 2004 the design study was presented. The basic design consists of two ion sources, an ion-injector, a synchrotron and a beam transfer line with five possible beam exits. The synchrotron is based on the proton ion medical machine study (PIMMS) design with some modifications. The injector is based on the GSI design of the Heidelberg ion therapy cancer accelerator with the original radio frequency quadrupole and IH-Linac. Modifications have been done in the design of the low energy beam transport and the medium energy beam transport lines. The impact of these modifications has been investigated, and several other beam scenarios have bean simulated with different simulation codes.

Status of the Hadrontherapy ETOILE-Project in Lyon

M.J. Bajard (UCBL)

The ETOILE project is the French program for carbon ion beams in cancer treatment. It is now in the final phase. However its development is not only aiming at the building of a medical facility, around the project a broad set of medical and scientific programs have been initiated. The project has been supported by the University of Lyon and extended to the Rhône-Alpes Region and then gained a national visibility with governmental recognition. Many studies have been financed by ETOILE: in beam PET with new solutions, organ motion modelization, tumor cell radioresistance, medico-economical simulation and epidemiological previsions. The facility will be able to produce carbon ion beams and protons. Three treatment rooms are planned, two with horizontal beams and one with an isocentric gantry. The facility will be build in Lyon, through a process using as much as possible well established technology with the other facilities in Europe. The cost will be around 105 MŁ afforded by loans and subventions. The subventions are funded from the Rhône-Alpes Region, the city of Lyon and the ministries of Health and Research. The running cost of the centre, for one thousand patients per year, is estimated to be 21 MŁ.

Accelerator Systems for Particle Therapy

S.P. Møller, F.S. Albrechtsen, T. Andersen, A. Elkjaer, N. Hauge, T. Holst, I. Jensen, S.M. Madsen (Danfysik A/S) K. Blasche, B. Franczak (GSI) S. Emhofer, H.K. Kerscher, V.L. Lazarev, H. Rohdjess (Siemens AG, Medical Solutions)

Danfysik and Siemens have entered a cooperation to market and build Particle Therapy* systems for cancer therapy. The systems are based on the experience from GSI together with a novel design of a synchrotron and Siemens experience in oncology. The accelerator systems will include an injector system (7 MeV/u proton and light ions), a synchrotron and a choice of fixed-angle horizontal and semi-vertical beamlines together with gantry systems. The slowly extracted beam will cover the energy ranges of 48-250 MeV for protons and 88-430 MeV/u for carbon ions. The extraction time will be up to 10s with intensities well beyond the needs of scanning beam applications. We will describe the layout of such a system and present details on some of the subsystems.

*Particle Therapy is a work in progress and requires country-specific regulatory approval prior to clinical use.

WEPCH160

A Novel Proton and Light Ion Synchrotron for Particle Therapy

S.P. Møller, F.S. Albrechtsen, T. Andersen, A. Elkjaer, N. Hauge, T. Holst, I. Jensen, S.M. Madsen (Danfysik A/S) K. Blasche, B. Franczak (GSI)

A compact and simple synchrotron for a cancer particle therapy system has been designed and is presently under construction. A lattice with six regular superperiods, twelve dipole and twelve quadrupole magnets, is used. The optimized lattice configuration, including the design of injection and extraction systems, provides large transverse phase space acceptance with minimum magnet apertures. The result is a synchrotron for PT with light magnets (5t dipoles), low values of peak power for pulsed operation and minimum dc power consumption. In addition, industrial production principles are used, keeping ease of construction, installation, and operation in mind. The beam, injected at 7 MeV/amu, can be accelerated to the maximum magnetic rigidity of 6.6 Tm in less than 1 s. A beam of 48-250 MeV protons and 88-430 MeV/u carbon ions can be slowly extracted during up to 10s. The intensity for protons and carbon ions will be well beyond the needs of scanning beam applications. The design and performance specifications of the synchrotron will be described in detail.

WEPCH161

The FFAG R&D and Medical Application Project RACCAM

F. Meot (CEA) B. Autin, J. Collot, J.F. Fourrier, E. Froidefond, F. Martinache (LPSC) J.L. Lancelot, D. Neuveglise (SIGMAPHI)

The RACCAM project (Recherche en ACCelerateurs et Applications Medicales) has recently obtained fundings, extending over three years (2006-2008), from the French National Research Agency (ANR). RACCAM is a tripartite collaboration, involving (i) the CNRS Laboratory IN2P3/ LPSC, (ii) the French magnet industrial SIGMAPHI, and (iii) the nuclear medecine Departement of Grenoble Hospital. The project concerns fixed field alternating gradient accelerator (FFAG) research on the one hand, and on the other hand their application as hadrontherapy and biology research machines. RACCAM's goal is three-fold, (i) participate to the on-going international collaborations in the field of FFAGs and recent concepts of "non-scaling" FFAGs, with frames for instance, the Neutrino Factory (NuFact) and the EMMA project of an electron model of a muon FFAG accelerator, (ii) design, build and experiment a prototype of an FFAG magnet proper to fulfil the requirements of rapid cycling acceleration, (iii) develop the concepts, and show the feasibility, of the application of such FFAG beams to hadrontherapy and to biology research.
*CEA/DAPNIA and IN2P3/LPSC **IN2P3/LPSC ***Grenoble University Hospital ****SIGMAPHI

WEPCH162

Magnet Simulations for Medical FFAG

E. Froidefond (LPSC) B. Autin (CERN)

Studies have been undertaken concerning magnet design in the frame of the RACCAM FFAG project (this conference). This contribution reports on the objectives of the project in that matter, on the working methods and calculation tools developments, magnetic field modeling and simulations, and on the present status of this work.

WEPCH164

High Power RF Tests of the First Module of the TOP Linac SCDTL Structure

L. Picardi, C. Cianfarani, G. Messina, G.L. Orlandi, C. Ronsivalle (ENEA C.R. Frascati) E. Cisbani, S.F. Frullani (ISS)

The TOP Linac (Oncological Therapy with Protons), under development by ENEA and ISS, is a sequence of three pulsed (5 microseconds, 300 Hz) linear accelerators: a 7 MeV, 425 MHz RFQ+DTL (AccSys Model PL-7), a 7-65 MeV, 2998 MHz Side Coupled Drift Tube Linac (SCDTL), and a 65-200 MeV, variable energy 2998 MHz Side Coupled Linac (SCL). The first SCDTL module structure, composed by nine DTL tanks coupled by eight side cavities, has been built. Low power RF measurements have shown good field uniformity and stability along the axis. The structure has been tested with a 1 - 4 MW power RF. Results of low and high power tests are reported and discussed.

WEPCH165

A Nonlinear Transport Line for the Optimization of F18 Production by the TOP Linac Injector

C. Ronsivalle, C. Cianfarani, G. Messina, G.L. Orlandi, L. Picardi (ENEA C.R. Frascati) E. Cisbani, S.F. Frullani (ISS)

The injector of the TOP Linac (Oncological Therapy with Protons), under development by ENEA and ISS, consists of a 7 MeV, 425 MHz RFQ+DTL (AccSys Model PL-7). It is actually in operation at ENEA-Frascati Laboratories for the production of the positron-emitting radionuclide F18 for PET analyses by an intense proton beam (8 - 10 mA, 50 - 100 μs, 30 - 100 Hz). At the exit of the injector, the beam is guided through a magnetic channel to a target composed by a thin chamber (0.5 mm thick and 1-inch diameter) containing water enriched with O18. Recently, to the original quadrupole transport channel, a non-linear magnet system using octupoles has been added in order to flatten the proton beam distribution and optimize the radioisotope production. In the paper the details of the octupole design and beam dynamic study and the first measurements results are presented.

WEPCH166

Beam Test of Thermionic Cathode X-band RF-gun and Linac for Monochromatic Hard X-ray Source

K. Dobashi, A. Fukasawa, M. D. Meng, T. Natsui, F. Sakamoto, M. Uesaka, T. Yamamoto (UTNL) M. Akemoto, H. Hayano, T. Higo, J. Urakawa (KEK)

A compact hard X-ray source based on laser-electron collision is proposed. The X-band linac is introduced to realize a very compact system. 2MeV electron beam with average current 2μampere at 10 pps, 200 ns of RF pulse is generated by a thermionic cathode X-band RF-gun. Beam acceleration and X-ray generation experiment by the X-band beam line are under way.

WEPCH167

Study of Scatterer Method to Compensate Asymmetric Distribution of Slowly Extracted Beam at HIMAC Synchrotron

T. Furukawa, K. Noda, S. Sato, S. Shibuya, E. Takada, M. Torikoshi, S. Yamada (NIRS)

In the medical use of the ion beam, the following characteristics of the beam are preferred: 1) Symmetric Gaussian beam profile is convenient for the scanning irradiation. 2) In the rotating gantry system, the symmetric beam condition can realize no-correlation between the beam profiles and the rotation angles of the gantry. However, the slowly extracted beam has asymmetric distribution in the phase-space and a difference between the horizontal emittance and vertical one. Thus, we have proposed the thin scatterer method to compensate the phase-space distribution of the slowly extracted beam, although the emittance is enlarged by scattering. As a result of particle tracking and experiment, it was verified that the asymmetric distribution was compensated by very small scattering angle. It was also simulated that this scatterer method can realize the symmetric beam condition for the rotating gantry. In this paper, these results of asymmetry compensation for the slow-extraction at HIMAC is presented.

WEPCH168

Development toward Turn-key Beam Delivery for Therapeutic Operation at HIMAC

T. Furukawa, T. Kanai, K. Noda, S. Sato, E. Takada, M. Torikoshi, S. Yamada (NIRS) M. Katsumata, T. Shimojyu, T. Shiraishi (AEC)

Since 1994, more than 2500 cancer patients have been treated by carbon ion beam at HIMAC. To increase the number of patients per day, we have studied the reproducibility of the beam quality, such as the position, profile and intensity, during the operation. For this purpose, the accelerator needs high reproducibility to minimize the beam tuning time with more flexible scheme. Further, the irradiation system and the accelerator need to ensure dose uniformity. As a result of this study, it was found that a slight change of the magnetic field in the transport line would not affect the beam quality. However, a slight change of the horizontal tune strongly affects the beam quality because of a resonant slow-extraction. In this paper, we report about our investigation and present result of the development.

WEPCH169

Alternating Phase Focused IH-DTL for Heavy-ion Medical Accelerators

Y. Iwata, T. Fujisawa, T. Furukawa, S. H. Hojo, M. Kanazawa, N. M. Miyahara, T. Murakami, M. Muramatsu, K. Noda, H. Ogawa, Y. S. Sakamoto, S. Yamada, K. Yamamoto (NIRS) T. Fujimoto, T. Takeuchi (AEC) T. Mitsumoto, H. Tsutsui, T. Ueda, T. Watanabe (SHI)

Tumor therapy using HIMAC has been performed at NIRS since June 1994. With the successful clinical results over more than ten years, a number of projects to construct these complexes have been proposed over the world. Since existing heavy-ion linacs are large in size, the development of compact linacs would play a key role in designing compact and cost-effective complexes. Therefore, we developed an injector system consisting of RFQ and Interdigital H-mode (IH) DTL having the frequency of 200 MHz. The injector system can accelerate carbon ions up to 4.0 AMeV. For the beam focusing of IH-DTL, the method of Alternating Phase Focusing (APF) was employed. With the IH structure and rather high frequency, the cavity size is compact; the radius is 0.4 m, and lengths of RFQ and IH-DTL are 2.5m and 3.5m respectively. The fabrication of RFQ was completed, and we succeeded to accelerate carbon ions with satisfactory performances. For IH-DTL, the full-scale model was first fabricated. With the encouraging result* of its electric field

measurement, we constructed IH-DTL and beam acceleration tests will be performed in March 2006. We will present the performances of the entire injector system.
*Y. Iwata et al., Nucl Instr. & Meth in Phys. Res. A (submitted).

Development of Intensity Control System with RF-knockout Extraction at the HIMAC Synchrotron

WEPCH170

S. Sato, T. Furukawa, K. Noda (NIRS)

We have developed a dynamic intensity control system toward scanning irradiation at the HIMAC Synchrotron. In this system, for controlling the spill structure and intensities of the beams extracted from the synchrotron, the amplitude of the RF-knockout is controlled with the response of 10 kHz. Its amplitude modulation (AM) function is generated based on an analytical one-dimensional model of the RF-knockout slow-extraction. In this paper, we describe the system for controlling amplitude modulation including feedback and the experimental result.

Electron Beam Pulse Processing toward the Intensity Modified Radiation Therapy (IMRT)

WEPCH172

T. Kondoh, S. Tagawa, J. Yang, Y. Yoshida (ISIR)

Radiation therapy attracts attention as one of the cancer therapies nowadays. Toward the next generation of the intensity modified radiation therapy (IMRT), the processing of electron beam pulse is studied using a photo cathode RF gun linac. Accelerated electron pulses will be converted to x-ray pulses by a metal target bremsstrahlung method or by a laser inverse Compton scattering method. Recently, the radiation therapy of cancer is developing to un-uniform irradiation as IMRT. A photo cathode RF gun is able to generate a low emittance electron beam pulse using a laser light pulse. We thought that a photo cathode RF gun can generate intensity and shape modified electron beam by processing of incident laser light. Because of a low emittance, an electron pulse is able to accelerate keeping shape. Electron beam processing by photo masks in incident optical system and generated beams are reported here. Images on photo masks were transported to a cathode surface by optical relay imaging. Beams were monitored by Desmarquest (Cr:Al2O3) luminescence. Spatially separation of a spot to a spot is about 0.3mm. Modified electron beam has fine spatial resolution.

The Performance of Double-grid O-18 Water Target for FDG Production

WEPCH173

H.B. Hong, J.-S. Chai, M.G. Hur, H.S. Jang, J. Kang (KIRAMS) H.H. Cho, K.M. Kim (Yonsei University)

The main stream of our study about the target is increasing the lifetime of the target windows. Mainly we conduct our study to increase the cooling performance and secondly about the structural design of the targets and target window foils. We already had developed and had published the results of our research about O-18 double-grid water target, which had installed on our 13 MeV cyclotron KIRAMS-13. The beam size of the accelerated proton was 9 mm*18 mm (0.35 in * 0.7 in). The double-grid target shows relatively low pressure during irradiation and good yield of F-18. The average yield of F-18 after irradiation was more than 1 Ci at 12.5 MeV , around 26 μA. Additionally, we are conducting new research for new techniques to increase the performance of low energy double-grid target and a new state-of-the-art pleated double foil target.

WEPCH175

Design of 12 MEV RTM for Multiple Applications

A.V. Poseryaev, V.I. Shvedunov (MSU) M.F. Ballester, Yu.A. Kubyshin (UPC)

Design of a compact 12 MeV race-track microtron (RTM) is described. The results of operating wavelength choice, accelerating structure and end magnets optimization and beam dynamics simulation are represented. Use of a C-band linac and rare earth permanent magnet end magnets permit to design RTM, which is more compact and more effective as compared with the same energy circular microtron or linac. Electron beam with energy 4-12 MeV in 2 MeV step can be extracted from RTM. The estimated pulsed RF power required for feeding the linac is about 800 kW, total mass of accelerator is less than 40 kg and its dimensions are about 500x200x110 mm3.

WEPCH177

Conception of Medical Isotope Production at Electron Accelerator

V.L. Uvarov, N.P. Dikiy, A. Dovbnya, V.I. Nikiforov (NSC/KIPT)

A photonuclear method with the use of high-energy bremsstrahlung (Eg>8 MeV) of high intensity (>= 10^{04} W/cm2) provides a possibility of the ecologically safe production of a number of isotopes for nuclear medicine. The conditions of generation of the radiation field having such characteristics as well as the features of photonuclear production of W-181,Pd-103, Cu-67 and other radionuclides are considered in the report. At the initial stage the study of the isotope production is performed by means of the computer simulation in a simplified 2D geometry of the Linac output devices. The code on the base of the PENELOPE/2001 program system supplemented with the data on the excitation functions of the corresponding reactions was developed. The dependences of the isotope yield (gross and specific activity) on the electron energy (30. . .45 MeV), as well as, the data on absorbed energy of radiation in the targets of natural composition are represented. The experimental results confirm the data of modelling. Main trends of realization of the photonuclear method for isotope production and the necessary conditions of the increase of its yield are analysed.

WEPCH178

Simulation Study of Compact Hard X-ray Source via Laser Compton Scattering

R. Kuroda, M.K. Koike, H. Ogawa, N. Sei, H. Toyokawa, K. Y. Yamada, M.Y. Yasumoto (AIST) N. Nakajyo, F. Sakai, T. Yanagida (SHI)

The compact hard X-ray source via laser Compton scattering between high intensity electron beam and high power laser beam was developed at FESTA (The Femtosecond Technology Research Association) project in collaboration between AIST and SHI. According to completion of the project in March 2005, the compact hard X-ray source is being transferred from FESTA to AIST to upgrade and to apply the system to biological and medical uses. Our system consists of a laser-driven photocathode rf gun, two 1.5m-long S-band accelerator structures and a high power Ti:Sa Laser system. This system can generate a hard X-ray pulse which has variable energy of 12 keV – 33 keV with narrow bandwidth by changing electron energy and collision angle. Maximum X-ray photon yield at FESTA was accomplished about 10^7photons/s (@10Hz, MAX 33keV) in case of 165 degree collision angle. In the next phase, we are planning to make the total system much compact using X-band or C-band accelerator structures with permanent magnets. We have carried out the numerical simulations to investigate the possibility of these compact systems. In this conference, we will talk about results of the simulations and future plans.

The Indiana University Proton Therapy System

WEPCH179

D. Friesel, V. Anferov, J.C. Collins, J.E. Katuin, S. Klein, D. Nichiporov, M. Wedeikind (IUCF)

The Midwest Proton Radiotherapy Institute (MPRI)was designed by the Indiana University Cyclotron Facility (IUCF)to deliver proton radiation treatment to patients with solid tumors or other diseases susceptible to radiation. The IUCF Proton Therapy System (PTS)has five unigue subsystems to perform the radiation treatment; Beam Delivery, Dose Delivery, Patient Positioning and Treatment Control systems. The MPRI Clinic began operations in 2003 with a single Fixed Horizontal Beam Line (FHBL)treatment room and is being expanded to include two additional treatment rooms utilizing modified IBA* 360 degree rotating gantry systems. The Gantry nozzles use a beam wobbling and energy stacking system to produce the lateral and longitudinal beam distributions required for patient treatment. A treatment control system** provides a single user interface to deliver and monitor Proton Therapy treatment. This paper will present an brief overview of the Proton Therapy Facility, the properties and examples of the beam performance of the unique Nozzle design, and a summary of the facility beam operations.

* Ion Beam Applications, Inc, Belgium ** Design of a Treatment Control System for a Proton Therapy Facility, Joe Katuin, these proceedings

A Dramatically Reduced Size in the Gantry design for the Proton-Carbon Therapy

WEPCH180

D. Trbojevic, R.C. Gupta, B. Parker (BNL) E. Keil (CERN) A. Sessler (LBNL)

Gantries in the proton/carbon cancer therapy machines represent the major cost and are usually very large. This report explains a new way for the gantry design. The size and cost of the gantries are reduced, and their use is simplified by using the fixed magnetic field. The "new" gantry is made of a very large momentum acceptance non-scaling Fixed Field Alternating Gradient (FFAG) quarter and half arc beam lines. The gantry is made of combined function magnets with a very strong focusing and small dispersion function. Additional magnets with a fast response are required to allow adjustments of the beam position for different energies at the beginning of the gantry. The strong focusing magnets following the gantry have to be adjustable as well to provide the required spot size. The adjustable dipoles provide the radial scanning. The fixed field combined function magnets could be made of small permanent magnets for the proton machine, or of the high temperature superconductors or superconductors for the carbon machine, reducing dramatically the size.

Ion Implantation Via Laser Ion Source

WEPCH181

F. Belloni, D. Doria, A. Lorusso, V. Nassisi (INFN-Lecce)

We report on the development of a new implantation technique via laser ion source. By applying a high voltage on the accelerating gap, this compact device was able to accelerate towards a substrate ions from ablation plasma. The occurrence of arcs during the extraction phase was a major problem to overcome. A pulsed KrF laser was utilized to produce plasma by ablation of solid targets. Radiation wavelength and pulse duration were 248 nm and 20 ns, respectively. The laser beam, 70 mJ per pulse, was focused onto different targets in a spot of about 1 mm^2 in surface, obtaining an irradiance value of about 3.5×10^8 W/cm^2. The implanted samples were characterized by energy dispersive x-ray spectroscopy, Rutherford backscattering spectrometry and x-ray photoelectron spectrometry. Implantations of Al, Cu and Ge on Si substrates were carried out up to 80 nm in depth, operating at 40 kV acceleration voltage. Ion dose was estimated by Faraday cup diagnostics. It was of the order of 10^{10} ions/cm^2 per pulse.

WEPCH182

Design of 9.4 GHz 950 keV X-band Linac for Nondestructive Testing

T. Yamamoto, T. Natsui, M. Uesaka (UTNL) M. Akemoto, S. Fukuda, T. Higo, M. Yoshida (KEK) K. Dobashi (The University of Tokyo, Nuclear Professional School) E. Tanabe (AET Japan, Inc.)

Mobile "suit-case-sized" x-band (9.4GHz) 950 keV linac is designed for applications of non-destructive testing (NDT). Conventional device for the purpose is the S-band linac, but its drawback is a rather large device-size, large electron beam spot size of about 3 mm and lack of spatial resolution. We aim to realize the smaller spot size about 500 micro-m by a low emittance beam. The proposed system consists of the 9.4 GHz magnetron, modulator, thermionic RF electron gun and 9.4 GHz x-band linac and metal target for x-ray generation. The energy at the gun is 20 keV, and the final energy becomes 950 keV. Now, we are designing the linac structure of the pai/2 mode and analyzing the electromagnetic field (EMF) by SUPERFISH. At this time, we finish analyzing EMF of regular cavity cells and we are analyzing EMF of total accelerating tube. We have finished the detailed RF design. Further, we are also performing the design of the pai mode and going to discuss the advantages and drawbacks between them. Construction of the RF supplying system is underway. The detailed design parameters and updated status of the construction are presented at the spot.

WEPCH183

Enhancement of Mechanical Properties of High Chromium Steel by Nitrogen Ion Implantation

B.S. Kim, S.-Y. Lee (Hankuk Aviation University) K. R. Kim, J.S. Lee (KAERI)

This article reports the study of mechanical properties of high chromium steel after N-ion implantation. The samples are implanted with 120keV N-ion at doses ranging from 1x10^{17}ions/square cm to 4x10^{18}ions/square cm. Mechanical properties of implanted samples are compared with those of Cr-plated samples. The compositions of the N-ion implanted layer were measured by Auger electrons spectroscopy(AES). Their mechanical properties as a function of N-ion doses were characterized by nano-indentation, sliding and impact wear tests. The results reveal that the hardness and mechanical properties of ion implanted samples were found to depend strongly on the ion doses. The hardness of the N-ion implanted sample with 2x1018ions/? was measured to be approximately 9 GPa, which is approximately 2.3 times higher than that of un-implanted sample (H=3.8 GPa). Also wear properties of N-ion implanted samples with 2x1018ions/? were largely improved ;compared to the Cr-plated samples, the width of wear track and friction coefficient developed on the N-ion implanted samples are about 60% and 40% smaller, respectively.

WEPCH184

Mechanical Properties of WC-Co by Nitrogen Ion Implantation: Improvement of Industrial Tools

Y. Noh, B.Y. Kim, K. R. Kim, J.S. Lee (KAERI)

Ion implantation of WC-Co has been widely investigated for the improvement of wear resistance, but rarely for friction behavior. Although friction is closely associated with wear, more factors influence friction than wear, and low wear does not generally lead to low friction w6x. Therefore, we focus our study on the effects of ion implantation on the mechanical properties in WC-Co cermets, with particular interest in tool industry applications.

Present Status of FFAG Accelerators in KURRI for ADS Study

WEPCH186

M. Tanigaki, M. Inoue, K. Mishima, S. Shiroya (KURRI) S. Fukumoto, Y. Ishi (Mitsubishi Electric Corp, Energy & Public Infrastructure Systems Center) S. Machida (CCLRC/RAL/ASTeC) Y. Mori (KEK)

KART (Kumatori Accelerator driven Reactor Test) project is in progress at the Kyoto University Research Reactor Institute (KURRI) since fiscal year 2002. We are now constructing a 150 MeV proton FFAG accelerator complex as a neutron production driver for this project. The whole of this FFAG complex is expected to be in the test operation around the spring in 2006. The developments and the current status of this accelerator complex, including the current status of this project, will be presented.

A Compact 5 MeV, S-band, Electron Linac Based X-ray Tomography System

WEPCH187

L. Auditore, L. Auditore, R.C. Barnà, D. De Pasquale, D. Loria, A. Trifirò, M. Trimarchi (INFN & Messina University) U. Emanuele, A. Italiano (INFN - Gruppo Messina)

The availability of commercial X-ray tubes made of radiography and tomography two of the most used non-destructive testing techniques both in industrial and cultural heritage fields. Nevertheless, the inspection of heavy materials or thick objects requires X-ray energies larger than the maximum energy provided by commercial X-ray tubes (600 kV). For this reason, and owing to the long experience of the INFN-Gruppo Collegato di Messina in designing and assembling low energy electron linacs, at the Dipartimento di Fisica, Universita di Messina, a 5 MeV electron linac based X-ray tomographic system has been developed. The X-ray source, properly designed by means of the MCNP-4C2 code, provides a 16 cm diameter X-ray spot at the sample position and a beam opening angle of about 3.6 degree. The image acquisition system consists of a CCD camera (Alta Apogee E1, 768x512 pixel) and a GOS scintillating screen. Preliminary radiographies and tomographies showing the high quality performances of the tomographic system have been acquired. Finally, the compactness of the linac, is one of the advantages of this system that could be used for in situ inspections when huge structures have to be tested

Compact Picosecond Pulse Radiolysis System Using Photo-cathode RF Gun

WEPCH188

M. Washio, Y. Hama, Y. Kamiya, M. Kawaguchi, R. Moriyama, H. Nagai, K. Sakaue (RISE) H. Hayano, J. Urakawa (KEK) S. Kashiwagi (ISIR) R. Kuroda (AIST) K.U. Ushida (RIKEN)

A very compact picosecond pulse radiolysis system has been installed and operated at Waseda University. The system is composed of a laser photo-cathode RF gun as the pump source and stable Nd:YLF laser as the white light source to probe the reaction in the picosecond region. The white light generation is performed by the non-linear effect of intense laser light with the wavelength of 1047 nm into the water cell. The experimental results with the time resolution of 18 ps by examining the time profile of hydrated electron have been obtained. The system configuration will be also presented at the conference.

WEPCH189

Design of the 20 MeV User Facilities of Proton Engineering Frontier Project

K. R. Kim, Jae-Keun Kil. Kil, C.-Y. Lee, J.S. Lee, B.-S. Park (KAERI)

The user facilities of PEFP (Proton Engineering Frontier Project) was designed. It is composed of two beamlines at the first stage and has possibility of expansion to five beamlines. One is low flux beamline for the technology developments in the fields of biological and space sciences and the other is high flux beamline for the utilization in the fields of nano and material sciences. The flux density is 1E+8~1E+10 protons/cm2-sec and 1E+10~1E+13 protons/cm2-sec each. The available energy range is 5~20MeV and the irradiation area is larger than 10cm in diameter with uniformity more than 90% for both. The specifications of these beamlines mentioned above were decided on the basis of result of user demand survey and operation experience of 45MeV proton beam test beamline installed at the MC-50 cyclotron of KIRAMS (Korea Institute of Radiological and Medical Science). The key components of these beamlines are bending magnets, magnetic quadrupole doublet or triplet, collimators, scanning magnets, target stage with water cooling system, degrader for energy control, scattering foils for flux control, etc. The beam optics was calculated using TRANSPORT and TRACE 3D simulation code.

WEPCH190

A Ridge Filter for 36 MeV Proton Beam Applied to BT and ST

Y.K. Lim, K. R. Kim (KAERI)

We designed a ridge filter to obtain a uniform depth-dose distribution as well as to deliver high linear energy transfer along the depth of a target for 36MeV proton beam. Aluminum was chosen as the material of the filter to reduce the radioactivity induced by proton irradiation. The designed ridge filter has a continuous cross-sectional line shape of ridges so that the smoothly varying depth-dose distribution can be maintained before the distal fall-off for lower proton energy than 36MeV. The height of the ridge is 6 mm, its period is also 6 mm and the minimum thickness is 0.3 mm. A Monte Carlo simulation code, MCNPX 2.5.0., was used to calculate the dose distributions. The width of the calculated uniform dose region was 11 mm for 36MeV proton beam in a water-equivalent sample.

WEPCH191

The Design and Manufacture of a 300 keV Heavy Ion Implanter for Surface Modification of Materials

J.S. Lee, Jae-Keun Kil. Kil, C.-Y. Lee (KAERI)

A 300keV ion implanter has been designed for studies of surface modification of several materials by ion beam. The purpose of design is domestic development of the basic technology for the high energy ion implanter. The main point of design is production, acceleration and transportation of high nitrogen ion beam current up to 5mA and ion energy up to 300keV. 300keV ion implanter consists of Duo-PIGatron ion source, einzel lens, mass separation magnet, acceleration tube, magnetic quadrupole doublet, electrostatic scanner and target. Beam optics design carried out where space charge effect in the acceleration tube and second order aberrations in the mass separation magnet were considered. The mass numbers range from 1 to 140 and the resolving power $M/\Delta M$ is 131. Implanter control system includes fiber optics links for the monitoring and control of the ion source parameters in the high voltage zone and computer system for the characterization of the ion beam and whole control of an implantation process.

Compact Electron Linear Accelerator RELUS-5 for Radiation Technology Application

WEPCH192

D.A. Zavadtsev, A.I. Fadin, A.A. Krasnov, N.P. Sobenin (MEPhI) A.A. Zavadtsev (Introscan)

The electron linear accelerator for radiation technology application is designed to meet the following main requirements: 3-5 MeV energy, 3-6 microsecond pulse width, and 1 kW average beam power. The accelerating system is a 0.5 m long S-band standing wave on-axis coupled biperiodic structure. A 35-40 kV electron gun with spherical cathode is used as the injector. The RF generator is a 2.5 MW peak power 4 kW average power magnetron. The generated frequency is stabilized by a high Q-factor accelerating system connected into feed-back of the magnetron. The magnetron is fed by a compact 45-55 kV IGBT based modulator. The accelerator is controlled through a PLC-based control system.

Complex for X-ray Inspection of Large Containers

WEPCH194

V.M. Pirozhenko, V.M. Belugin, V.V. Elyan, A.V. Mischenko, N.E. Rozanov, B.S. Sychev, V.V. Vetrov (MRTI RAS) Yu.Ya. Kokorovets, V.D. Ryzhikov, N.A. Shumeiko, S.Ya. Yatsenko (Communar) A.N. Korolev, K.G. Simonov (ISTOK)

The X-ray inspection complex is intended for non-intrusive inspection of large containers in the seaport. The complex has been developed, manufactured, and tested. To provide two projections of irradiated container and ensure reliable inspection, the complex includes two sets each containing self-shielded X-ray source and L-shaped detector array. The X-ray source includes electron linear accelerator with 7.3 MeV energy, conversion target, local radiation shielding, and alignment means. The accelerator uses standing wave bi-periodic structure fed by magnetron generator with 2.8 GHz frequency. It provides intensive electron beam without application of external magnetic field for the beam focusing. This feature makes it possible to use massive local radiation shielding made from iron. The radiation shielding provides large attenuation of scattered X-rays and ensures the radiation safety for personnel as well as high sensitivity of detecting system and good penetrability of the complex.

Status of the Russian Accelerator Mass Spectrometer Project

WEPCH195

M. Petrichenkov, N. Alinovsky, A.D. Goncharov, V. Klyuev, A. Kozhemyakin, A. Kryuchkov, V.V. Parkhomchuk, S. Rastigeev, V.B. Reva (BINP SB RAS)

The status of the first Russian accelerator mass spectrometer being developed at BINP is described. The scheme of the spectrometer includes two types of ion sources (sputter and gaseous ones), electrostatic tandem accelerator with accelerating voltage up to 2 MV and magnesium vapors stripper and also includes the high-energy and low-energy beam lines with analyzers. The results of the experiments with the ion beams will be given.

WEPLS — Poster Session

WEPLS001

Secondary Particle Production and Capture for Muon Accelerator Applications

S.J. Brooks (CCLRC/RAL/ASTeC)

Intense pulsed muon beams are required for projects such as the Neutrino Factory and Muon Collider. It is currently proposed to produce these from a high-Z target using a multi-megawatt proton driver. This paper examines the effect of proton energy on the yield and distribution of particles produced from tantalum and mercury, with further analysis using a tracking code to determine how these distributions will behave downstream, including a breakdown of loss mechanisms. Example 'muon front end' lattices are used from the UK Neutrino Factory design.

WEPLS002

Design and Expected Performance of the Muon Beamline for the Muon Ionisation Cooling Experiment

K. Tilley, D.J. Adams, P. Drumm (CCLRC/RAL/ISIS) T.J. Roberts (Muons, Inc) K.a. Walaron (University of Glasgow)

It is proposed to install a Muon Ionisation Cooling Experiment (MICE) at the ISIS facility, at Rutherford Appleton Laboratory (RAL). This experiment will be the first demonstration of ionisation cooling as a means to reduce the large transverse emittance of the muon beam, produced during the early stages of a Neutrino Factory. In order to permit a realistic demonstration of cooling, a beam of muons must be produced, possessing particular qualities, notably in emittance and momenta. This paper describes the current design for the muon beamline, outlining issues particular to the needs of the MICE experiment, and discusses its expected performance.

WEPLS003

Simulation of MICE Using G4MICE

C.T. Rogers (Imperial College of Science and Technology, Department of Physics) R. Sandstrom (DPNC)

In the Muon Ionisation Cooling Experiment (MICE), muons will be fired one by one through one or two cooling cells. The experiment will be used to optimise simulation of an ionisation cooling channel for a future Neutrino Factory. This is achieved by measuring the position of each muon in six-dimensional phase space and examining the behaviour of muons collected into bunches offline. The experiment will be run with a number of different input beams, magnet configurations, RF configurations and absorber types. We present the simulated detector and cooling performance of the MICE cooling channel using the G4MICE simulation code for a range of configurations. We detail the simulation of engineering, field and detector models and examine the implications for the cooling efficacy and measurement.

The Target Drive for the MICE Experiment

WEPLS005

C.N. Booth, L.C. Howlett, P.J. Smith (Sheffield University) N. Schofield (University of Manchester, School of Electrical and Electronic Engineering)

The MICE experiment requires a beam of low energy muons to test muon cooling. This beam will be derived parasitically from the ISIS accelerator. A novel target mechanism is being developed which will allow the insertion of a small titanium target into the proton beam halo on demand. The target must remain outside the beam envelope during acceleration, and then overtake the shrinking beam envelope to enter up to 5 mm into the beam during the last 2 ms before extraction. The technical specifications are demanding, requiring large accelerations and precise and reproducible location of the target each cycle. The mechanism must operate in a high radiation environment, and the moving parts must be compatible with the stringent requirements of the accelerator's vacuum system. A prototype linear electromagnetic drive has been built, and the performance is being measured and improved to meet the design specifications. Details of the drive, position readout and control systems will be presented, together with the performance achieved to date.

Requirements for Accelerator-based Neutrino Facilities

WEPLS006

A.P. Blondel (DPNC)

Classification: 1-A18, 3-A09, 4-A15, 6-T03 (non exhaustive). The study of neutrino oscillations offers promises of great discoveries including leptonic CP violation. The experimental programs that are under discussion pose considerable challenges to accelerator builders. Extremely high intensities are needed for classical on- and off-axis pion decay beams; novel ideas such as beta-beams and muon decay beams have been invented and are being studied. The experiments to be performed require outstanding predictability and monitoring of the neutrino flux. The challenges will be reviewed and a list of requirements will be proposed.

A Six-dimensional Muon Beam Cooling Experiment

WEPLS007

R.P. Johnson, M. Alsharo'a, M.A.C. Cummings, M. Kuchnir, K. Paul, T.J. Roberts (Muons, Inc) D.M. Kaplan (Illinois Institute of Technology) V.S. Kashikhin, V. Yarba, K. Yonehara (Fermilab)

Ionization cooling, a method for shrinking the size of a particle beam, is an essential technique for the use of muons in future particle accelerators. Muon colliders and neutrino factories, examples of such future accelerators, depend on the development of robust and affordable ionization cooling technologies. A 6D cooling experiment has been proposed, incorporating a novel configuration of helical and solenoidal magnets in a prototype cooling channel. This Helical Cooling Channel (HCC) experiment is being designed with simulations and prototypes to provide an affordable and striking demonstration that 6D muon beam cooling is understood well enough to enable intense neutrino factories and high-luminosity muon colliders. Because of the large amount of expected beam cooling, helium instead of hydrogen can be used for the initial experiment, avoiding the safety complications of hydrogen. Cryostats are currently being developed using internal heat exchangers for simple, effective and safe hydrogen absorber systems to use in later cooling experiments and real cooling channels. The experimental design choices and corresponding numerical simulations are reviewed.

WEPLS009

Summary of the Low Emittance Muon Collider Workshop (February 6-10, 2006)

R.P. Johnson, K. Paul (Muons, Inc) V. Yarba (Fermilab)

The Low Emittance Muon Collider workshop, held at Fermilab February 6-10, 2006 focused on the development of high-luminosity muon colliders using extreme muon beam cooling, where many constraints on muon collider designs are alleviated with beams of smaller emittance and lower intensity. The workshop covered topics related to proton drivers, targetry, muon capture, bunching, cooling, cooling demonstration experiments, bunch recombination, muon acceleration, collider lattices, interaction-point design, site boundary radiation, and detector concepts for energy frontier and Higgs particle studies. Lower emittance allows for a reduction in the required muon current for a given luminosity and also allows high energy to be attained by recirculating the beam through high frequency ILC RF cavities. The highlights of the workshop and the prospects for such colliders will be discussed.

WEPLS010

20 - 50 GeV Muon Storage Rings for a Neutrino Factory

G. Rees (CCLRC/RAL/ASTeC) C. Johnstone (Fermilab) F. Meot (CEA)

Muon decay ring studies are being undertaken as part of the International Scoping Study (ISS) for a Neutrino Factory. A racetrack and an isosceles triangle shaped ring are under design, initially for a muon energy of 20 GeV, but with an upgrade potential for 50 GeV. Both rings are designed with long straights to optimize directional muon decay. The neutrinos from the muon decays pass to one or two distant detectors; the racetrack ring has one very long production straight, aligned with one detector, while the triangular ring has two straights, each half as long, which can be aligned with two detectors. Lattice studies, injection, collimation, and RF system design for the large acceptance, high intensity rings are discussed and the performance of the two rings compared.

WEPLS011

General Design Considerations for a High-intensity Muon Storage Ring for a Neutrino Factory

C. Johnstone (Fermilab) F. Meot (CEA) G. Rees (CCLRC/RAL/ASTeC)

Muon decay ring design, shielding, and compatibility with potential neutrino detector sites are a critical part of the International Scoping Study (ISS) for a neutrino factory. Two rings are under development: a racetrack and an isosceles-triangle ring initially for muon energy of 20 GeV, but upgradable to 50 GeV. Neutrinos from the muon decays in specially designed production straights can be directed to one or two distant detectors; the racetrack ring has one very long production straight, aligned with one detector, while the triangular ring has two straights, each half as long, aligned with two detectors. An initial site survey of accelerators and distant detectors has been made, along with the required tilt angles from the horizontal will be discussed here. (Lattice studies, injection, collimation, and RF system design are covered in a separate contribution to these proceedings.) Heating and activation effects of beam loss in the chamber walls and components will also be presented.

Use of Gas-filled Cavities in Muon Capture for a Muon Collider or Neutrino Factory

D.V. Neuffer (Fermilab) K. Paul (Muons, Inc)

Recent studies indicate that gas-filled cavities can provide high-gradient acceleration and simultaneous cooling for muons. In this paper we explore using these cavities in the front-end of the capture and cooling systems for muon colliders and neutrino factories. For a muon collider scenario we consider capturing the beam in a low-frequency cavity (~50 MHz) and cooling immediate after capture. For a neutrino factory, we consider capturing beam in high-frequency buckets and phase-energy rotating and cooling them using gas-filled rf cavities. Scenario variants are described and studied.

Studies of a Gas-filled Helical Muon Beam Cooling Channel

R.P. Johnson, K. Paul, T.J. Roberts (Muons, Inc) Y.S. Derbenev (Jefferson Lab) K. Yonehara (Fermilab)

A helical cooling channel (HCC) can quickly reduce the six dimensional phase space of muon beams for muon colliders, neutrino factories, and intense muon sources. The HCC is composed of solenoidal, helical dipole, and helical quadrupole magnetic fields to provide the focusing and dispersion needed for emittance exchange as the beam follows an equilibrium helical orbit through a continuous homogeneous absorber. We consider liquid helium and liquid hydrogen absorbers in HCC segments that alternate with RF accelerating sections and we also consider gaseous hydrogen absorber in pressurized RF cavities imbedded in HCC segments. In the case of liquid absorber, the possibility of using superconducting RF in low magnetic field regions between the HCC segments may provide a cost effective solution to the high repetition rate needed for an intense neutrino factory or high average luminosity muon collider. In the gaseous hydrogen absorber case, the pressurized RF cavities can be operated at low temperature to improve their efficiency for higher repetition rates. Numerical simulations are used to optimize and compare the liquid and gaseous HCC techniques.

International Scoping Study of a Future Accelerator Neutrino Complex

M.S. Zisman (LBNL)

The ISS, launched at NuFact05 to evaluate the physics case for a facility, along with options for the accelerator complex and detectors, is laying the foundations for a subsequent conceptual-design study. It is hosted by RAL and organized by the international community, with participants from Europe, Japan, and the U.S. Here we cover work of the Accelerator Group. For the 4 MW proton driver, we consider linacs, synchrotrons, and FFAG rings. For targets, issues of both liquid-metal and solid materials are examined. For beam conditioning (phase rotation, bunching, and ionization cooling), we evaluate schemes with and without cooling, the latter based on scaling FFAG rings. For acceleration, we examine scaling FFAGs and hybrid systems comprising linacs, dogbone RLAs, and non-scaling FFAGs. For the decay ring we consider racetrack and triangular shapes, the latter capable of simultaneously illuminating two different detectors at different baselines. Comparisons are made between various technical approaches to identify optimum design choices for the facility.

WEPLS018

Optics for Phase Ionization Cooling of Muon Beams

R.P. Johnson (Muons, Inc) S.A. Bogacz, Y.S. Derbenev (Jefferson Lab)

The realization of a muon collider requires a reduction of the 6D normalized emittance of an initially generated muon beam by a factor of more than 10^6. Analytical and simulation studies of 6D muon beam ionization cooling in a helical channel filled with pressurized gas or liquid hydrogen absorber indicate that a factor of 10^6 is possible. Further reduction of the normalized 4D transverse emittance by an additional two orders of magnitude is envisioned using Parametric-resonance Ionization Cooling (PIC). To realize the phase shrinkage effect in the parametric resonance method, one needs to design a focusing channel free of chromatic and spherical aberrations. We report results of our study of a concept of an aberration-free wiggler transport line with an alternating dispersion function. Resonant beam focusing at thin beryllium wedge absorber plates positioned near zero dispersion points then provides the predicted PIC effect.

WEPLS019

Parameters for Absorber-based Reverse Emittance Exchange of Muon Beams

R.P. Johnson (Muons, Inc) Y.S. Derbenev (Jefferson Lab)

The normalized longitudinal emittance of a muon beam after six-dimensional ionization cooling appears very small compared to the value that could be utilized or maintained after acceleration to muon collider energy. This circumstance offers the possibility for further reduction of the transverse emittance by introducing absorber-based reverse emittance exchange (REMEX) between longitudinal and transverse degrees of freedom before acceleration to high energy. REMEX follows Parametric-resonance Ionization Cooling and is accomplished in two stages. In the first stage the beam is stretched to fill the RF bucket at the initial cooling energy. In the second stage the beam is accelerated to about 2.5 GeV, where energy straggling begins to limit the absorber technique, and stretched again. The potential transverse emittance reduction and the intrinsic limitations of the REMEX technique have been analyzed earlier. In this report, we describe the required beam transport and RF parameters needed to achieve the maximum REMEX effect.

WEPLS020

The RF Deflector for the CTF3 Delay Loop

F. Marcellini, D. Alesini (INFN/LNF)

In the CLIC Test Facility 3 (CTF3) a 42 m long ring, called delay loop, is used to halve the distance between bunches in the drive beam. The compression is obtained by merging two adjacent bunch trains from the linac deflected in opposite directions by an RF device, in such a way that the first train is forced to perform a full revolution in the delay loop, while the second one passes through. The length of the ring is an odd multiple of half the distance between bunches in the beam from the linac. The RF deflector consists of two identical cavities connected to the RF power source through a hybrid junction that equally splits the power and isolates the klystron from reflections. Its innovative design, the results of electromagnetic simulations and expected performances are described, together with low level RF measurements for test and characterization of the device before installation. Preliminary recombination results with the CTF3 beam are also shown. The RF deflector has also been used to measure the length of the accelerated bunches.

The PLASMONX Project for Advanced Beam Physics Experiments

WEPLS021

L. Serafini, A. Bacci, R. Bonifacio, M. Cola, C. Maroli, V. Petrillo, N. Piovella, R. Pozzoli, M. Rome, A.R. Rossi, L. Volpe (INFN-Milano) D. Alesini, M. Bellaveglia, S. Bertolucci, R. Boni, M. Boscolo, M. Castellano, A. Clozza, G. Di Pirro, A. Drago, A. Esposito, M. Ferrario, L. Ficcadenti, D. Filippetto, V. Fusco, A. Gallo, G. Gatti, A. Ghigo, M. Incurvati, C. Ligi, F. Marcellini, M. Migliorati, A. Mostacci, L. Palumbo, L. Pellegrino, M.A. Preger, R. Ricci, C. Sanelli, M. Serio, F. Sgamma, B. Spataro, A. Stecchi, A. Stella, F. Tazzioli, C. Vaccarezza, M. Vescovi, C. Vicario (INFN/LNF) F. Alessandria, F. Broggi, C. De Martinis, D. Giove, M. Mauri (INFN/LASA) W. Baldeschi, A. Barbini, M. Galimberti, A. Giulietti, A. Gizzi, P. Koester, L. Labate, S. Laville, A. Rossi, P. Tomassini (CNR/IPP) U. Bottigli, B. Golosio, P.N. Oliva, A. Poggiu, S. Stumbo (INFN-Cagliari) C.A. Cecchetti, D. Giulietti (UNIPI) D. Levi, M. Mattioli, G. Medici, D. Pelliccia, M. Petrarca (Università di Roma I La Sapienza) P. Musumeci (INFN-Roma)

The Project PLASMONX is well progressing into its design phase and has entered as well its second phase of procurements for main components. The project foresees the installation at LNF of a Ti:Sa laser system (peak power > 170 TW), synchronized to the high brightness electron beam produced by the SPARC photo-injector. The advancement of the procurement of such a laser system is reported, as well as the construction plans of a new building at LNF to host a dedicated laboratory for high intensity photon beam experiments (High Intensity Laser Laboratory). Several experiments are foreseen using this complex facility, mainly in the high gradient plasma acceleration field and in the field of mono-chromatic ultra-fast X-ray pulse generation via Thomson back-scattering. We present an innovative scheme of external injection of the SPARC beam into laser wake-field driven plasma waves. Detailed numerical simulations have been carried out to study the generation of short electron bunches, to be injected into plasma waves driven with adiabatically variable density in order to compress the bunch at injection and further accelerate it by preserving a small energy spread and good beam quality.

ILC Beam Energy Measurement based on Synchrotron Radiation from a Magnetic Spectrometer

WEPLS022

E. Syresin, B.Zh. Zalikhanov (JINR) K.H. Hiller, H.J. Schriber (DESY Zeuthen) R.S. Makarov (MSU)

The magnetic spectrometer with a relative energy resolution of $5 \cdot 10^{-5}$ was proposed for ILC beam energy measurements. The beam energy measurement is based on precise definition of the beam position at a resolution of 100 nm and B-field integral at an accuracy of 2E-5. A complementary method of the beam energy measurement is proposed at registration of synchrotron radiation (SR) from the energy spectrometer dipole magnets. The measurements of both edge horizontal positions for SR fan on a distance of 50-70 m downstream of the spectrometer magnets permit to determine the beam energy with required resolution. The main principles of the beam energy measurements based on SR, the numerical simulations of SR performed by the GEANT code and proposal of SR monitors with submicron resolution are discussed.

WEPLS023

The Two-beam Test-stand in CTF3

V.G. Ziemann, T. J. C. Ekelof, M. A. Johnson (UU/ISV) H.-H. Braun, S. Doebert, G. Geschonke, J.P.H. Sladen, W. Wuensch (CERN)

The acceleration concept for CLIC, based on the two-beam acceleration scheme, where the 30 GHz RF power needed to accelerate the high energy beam is generated by a high-intensity but rather low energy drive beam, will be tested in the two-beam test-stand in CTF3. There RF-structures will be tested at full pulse length. The extreme power levels of up to 640 MW warrant a careful diagnostic system to analyze RF breakdown by observing the effect on both probe¯ and drive-beam but also the RF signals and secondary effects such as emitted light, vibrations, vacuum, temperatures. We describe the experimental setup and the diagnostic system planned to be installed in CTF3 for 2007.

WEPLS024

Linear Laser Wakefield Acceleration with External Injection

W. van Dijk, G.J.H. Brussaard, W.H. Urbanus, M.J. Van der Wiel, S.B. van der Geer (TUE)

The Laser Wakefield project at Eindhoven University seeks to separate three processes needed for controlled LWFA: Creation of a plasma channel, injection of electrons and acceleration of these electrons. This enables control over and optimization of the individual components of the accelerator. It also removes the need to operate in the non-linear wakefield regime. This allows the use of lower density plasma regimes without requiring enormous laser intensities. Using front-to-end particle tracking simulations, a setup has been designed consisting of a RF-photogun, a 'modest' 2 TW tabletop laser and a pulsed capillary discharge plasma. Together, these enable the creation of 100 MeV, 1pC bunches with a duration of 10fs. The capabilities of the setup under construction will be presented. Also the outlook of laser wakefield acceleration with external injection will be discussed.

WEPLS025

Multi-bunch Plasma Wakefield Experiments at the Brookhaven National Laboratory Accelerator Test Facility

P. Muggli, E.K. Kallos, T.C. Katsouleas (USC) M. Babzien, I. Ben-Zvi, K. Kusche, P.I. Pavlishin, I. Pogorelsky, D. Stolyarov, V. Yakimenko (BNL) W.D. Kimura (STI) F. Zhou (UCLA)

In the plasma wakefield accelerator (PWFA), a short particle bunch or train of bunches drives a large amplitude relativistic plasma wave or wake. The wake has both transverse, focusing fields, and longitudinal fields that can accelerate trailing particles or a trailing bunch. In this experiment conducted at BNL-ATF, a CO2 laser driven IFEL modulates the energy of the 65 MeV, 1.5 ps electron bunch, which after a drift creates a train of bunches approximately 3 fs long, separated by the laser wavelength (10.6 μm or about 30 fs). The largest wake amplitude is reached when the plasma wavelength is equal to the bunch spacing: $n=1\cdot 10^{19}$ e-/cc. In this case, the bunch train drives a wake with an amplitude of approximately 7 GV/m in an ablative capillary discharge plasma. This wake amplitude is much larger than that previously observed with the un-bunched beam*. With this multi-bunch PWFA scheme, the energy of an appropriately phased trailing bunch could be multiplied by a large factor, of the order of the number of drive bunches. Experimental results including plasma density diagnostic using Stark broadening, beam bunching using CTR and energy gain and loss measurements will be presented.

*V. Yakimenko et al., Phys. Rev. Lett. 91, 014802 (2003).

WEPLS028

Improvement of Electron Generation from a Laser Plasma Cathode through Modified Preplasma Conditions Using an Artificial Prepulse

K. Kinoshita, T. Hosokai, K. Kobayashi, A. Maekawa, T. Ohkubo, T. Tsujii, M. Uesaka (UTNL) A. Yamazaki (KURRI) A.G. Zhidkov (NIRS)

We have been studying the effects of laser prepulses, plasma cavity formation, wave breaking processes in the laser plasma acceleration. It is important to control the preplasma conditions, so as to stabilize the laser plasma acceleration. The modification of the conditions of the laser plasma interaction through an artificial prepulse, magnetic fields, and/or gas density modulation will affect on the characteristics of accelerated electron beams. As the first step, we carry out experiments with an artificial prepulse. If a shockwave driven by the artificial prepulse matches the main pulse foccal position, localized wave breaking may occur effectively, and consequent electron generation will be enhanced. We use a pulse with 10% energy of the main pulse and 300 ps duration to be focused on the interaction point of the gas jet, to change the plasma distribution there. Using the single-shot diagnosis, we investigate the mechanism and technique to improve the properties of electron beams. We observed a strong correlation between the generation of monoenergetic electrons and optical guiding of the main pulse, during the interaction of 11 TW 37 fs laser pulse and He gas jet.

WEPLS029

Monoenergetic 200fs (FWHM) Electron Bunch Measurement from the Laser Plasma Cathode

A. Maekawa, T. Hosokai, K. Kinoshita, K. Kobayashi, T. Ohkubo, T. Tsujii, M. Uesaka (UTNL) Y. Kondo, Y. Shibata (Tohoku University) T. Takahashi, A. Yamazaki (KURRI) A.G. Zhidkov (NIRS)

A laser plasma accelerator is the most promising approach to compact accelerators that can generate femtosecond electron bunches. It is expected that the electron bunch duration less than 100fs can be achieved owing to the high frequency of plasma waves. Since the time-resolution of the fastest streak camera is only 200fs, we have to use the coherent transition radiation (CTR) measurement or E/O (electro-optical) method. We plan to perform a single-shot measurement by getting the whole CTR spectrum by a IR polychromator in near future. As the first step forward it, we used a IR bolometer with different filters and obtained the average spectrum. We can generate monoenergetic electron bunches in the condition of laser intensity 3x1019W/cm2 and electron density 6x1019cm-3. The charge is estimated to be about 10pC using ICT (Integrated Current Transformer). The electron bunch accelerated by plasma waves penetrates 300um Ti-foil, and transition radiation is emitted. We measure CTR spectrum using a bolometer. Spectrum distribution of CTR depends on the electron bunch distribution, therefore we can evaluate the bunch duration from it. In the experiment, bunch duration can be estimated.

WEPLS032

Spin Tracking at the ILC

G.A. Moortgat-Pick, I.R. Bailey, D.P. Barber, J.A. Clarke, J.B. Dainton, O.B. Malyshev, G.A. Moortgat-Pick, D.J. Scott (Cockcroft Institute) E. Baynham, T.W. Bradshaw, A.J. Brummitt, F.S. Carr, Y. Ivanyushenkov, J. Rochford (CCLRC/RAL) P. Cooke, L.I. Malysheva (Liverpool University, Science Faculty)

Polarized beams will play a key role in the physics programme at the International Linear Collider (ILC). It is expected that the electron and positron sources will be able to produce beams with polarizations of about 90% and 60% respectively. However, to obtain accurate measurements it is essential to have precise knowledge and control of the polarization at the interaction point itself. It follows that the theoretical calculations used for spin tracking must be guaranteed to match the anticipated 0.1% relative measurement uncertainty of the polarimeters. To meet this need, the heLiCal collaboration is developing a computer simulation to track the evolution of the polarization of bunches of electrons and positrons from the sources to the interaction point. We have studied the beam spin dynamics throughout the ILC including spin precession and radiative spin-flip processes in the positron source, damping rings, beam delivery system and the interaction region. We present the result of these studies with special emphasis on the impact of new theoretical calculations for the CAIN bunch-bunch simulation including full spin correlations and higher-order contributions.

WEPLS033

Cold Atom Electron Sources

O.J. Luiten, M.P. Reijnders, G. Taban, E.J.D. Vredenbregt, S.B. van der Geer (TUE)

We are developing a completely new method of producing high-brightness electron bunches, based on extraction of electrons from an ultra-cold plasma, created by photo-ionization of a cloud of laser-cooled atoms*. In this way extremely low thermal emittances (<0.1 micron) can be reached at bunch charges of several pC. In addition, pulsed extraction leads to fs bunch lengths and tens of A peak currents without the use of ultra-fast lasers or magnetic compression. GPT simulations in realistic settings show that orders of magnitude in beam brightness may be gained compared to state-of-the-art rf photoguns. Experiments are underway, whose status will be reported.
*B. J. Claessens et al. Phys. Rev. Lett. 95, 164801 (2005).

WEPLS038

Design of Diamond-lined Accelerator Structure Test Cavity

C. Wang, V.P. Yakovlev (Omega-P, Inc.) J.L. Hirshfield, M.A. LaPointe (Yale University, Physics Department)

For a high-gradient normal-conducting accelerator structure for a future multi-TeV linear collider, the main limitation to achievement of high acceleration gradient is RF breakdown. In an attempt to increase the gradient beyond limits that are acceptable for metallic structures, a diamond-lined structure is suggested. The published DC breakdown limit for CVD diamond is ~2 GV/m, but the limit has never been determined for RF fields. Here we present a design for a 34-GHz diamond-lined rectangular test cavity, operating in the symmetric LSM-1,1,6 mode with symmetric side input couplers. The goal is to produce as high electric fields as possible (approaching 1 GV/m) at the diamond surfaces with ~10 MW of input power supplied by the Omega-P/Yale 34-GHz magnicon for experiment test of dielectric strength.

Developments on a Diamond-based Cylindrical Dielectric Accelerating Structure

WEPLS039

A. Kanareykin, C.-J. Jing (Euclid TechLabs, LLC) M.E. Conde, W. Gai, J.G. Power (ANL) P. Schoessow (Tech-X)

Developments on a high gradient diamond-based cylindrical dielectric loaded accelerator (DLA) is presented. A diamond-loaded DLA can potentially sustain accelerating gradients far in excess of the limits experimentally observed for conventional metallic accelerating structures. The electrical and mechanical properties of diamond make it an ideal candidate material for use in dielectric accelerators: high RF breakdown level, extremely low dielectric losses and the highest available thermoconductive coefficient. We used the hot-filament Chemical Vapor Deposition (CVD) process to produce high quality 5-10 cm long cylindrical diamond layers. Our collaboration has also been developing a new method of CVD diamond surface preparation that reduces the secondary electron emission coefficient below unity. Special attention was paid to the numerical optimization of the coupling section, where the surface magnetic and electric fields were minimized relative to the accelerating gradient and within known metal surface breakdown limits.

Progress towards an Experimental Test of an Active Microwave Medium Based Accelerator

WEPLS040

A. Kanareykin (Euclid TechLabs, LLC) P. Schoessow (Tech-X) L. Schächter (Technion)

We have been working on an experimental test of the PASER concept, where an active medium is used to provide the energy for accelerating charged particles. Initial theoretical work in this area focused on acceleration at optical frequencies; however we have identified a candidate active material operating in the X-band: a solution of fullerene (C60) in a nematic liquid crystal has been found to exhibit a maser transition* in this frequency range. The ability to employ a microwave frequency material simplifies the construction of test structures and allows beam experiments to be performed with relatively large beam emittances. We will report results on synthesis and testing of the active material using EPR spectroscopy, design and numerical simulations of bench test structures and plans for future beam experiments.

*A. Blank et al. IEEE Trans. Microwave Theory and Techniques 46 (2137) 1998.

Design and Experimental Investigation of an X-band Multilayer Dielectric Accelerating Structure

WEPLS042

A. Kanareykin, C.-J. Jing, P. Schoessow (Euclid TechLabs, LLC) W. Gai, J.G. Power (ANL)

A new project to significantly improve the efficiency of high gradient DLA structures is presented. A multilayer DLA where the single dielectric layer is replaced by a multiple coaxial layers of differing permittivity have been developed. The power attenuation in the multilayer structure is reduced by the Bragg Fiber principle where the dielectric layers are used to create multiple reflections in order to confine the accelerating mode fields for the most part in the dielectric, reducing the axial current on the conducting outer boundary. A design for an X-band multilayer structure operating in the TM03 mode using alternating dielectric layers with permittivities of 38 and 9.7 is discussed. In order to transfer the RF from the rectangular waveguide to the cylindrical one at TM03 mode, a special coupling and mode conversion scheme was developed. A prototype structure has been constructed and bench test results of the multilayer 11.424 GHz accelerator is presented.

WEPLS043

Progress of the Rossendorf SRF Gun Project

D. Janssen, A. Arnold, H. Buettig, R. Hempel, U. Lehnert, P. Michel, K. Moeller, P. Murcek, Ch. Schneider, R. Schurig, F. Staufenbiel, J. Teichert, R. Xiang (FZR) T. Kamps, D. Lipka, F. Marhauser (BESSY GmbH) W.-D. Lehmann (IfE) J. Stephan (IKST) V. Volkov (BINP SB RAS) I. Will (MBI)

In this paper we report the status and the progress of the superconducting RF gun project in Rossendorf. The gun is designed for cw operation mode with 1 mA current and 10 MeV electron energy. The cavity consists of three cells with TESLA geometry, a special designed half-cell in which the photo cathode will be inserted and a choke filter, which prevents the leakage of RF power by the coaxial line between the cathode and the cavity cell. A double tuner allows the tuning of the half-cell and the TESLA cells separately. In 2005 the fabrication of two cavities with RRR300 and RRR40 was finished. We present the results of the field measurement and the warm tuning of the cavity cells as well as the tuning and performance measurement of the choke filter. The fabrication of the double tuner has been also finished. In a test bench we measured the properties of the tuner (tuning range, resolution) at LN2 temperature. Further activities concern the diagnostic beam line of the gun, the new cathode preparation and cathode transfer system, the driver laser and the LHe transfer line.

WEPLS044

Design of a Superconducting Cavity for a SRF Injector

D. Janssen (FZR) V. Volkov (BINP SB RAS)

In a collaboration between BESSY, DESY, FZR, MBI and BINP a 3-1/2 cell superconducting RF electron gun is under development at the FZ - Rossendorf. The status of the project and the progress obtained in the last year is reported on this conference. The motivation for the design of a new gun cavity, presented in this paper, is the new FEL project at BESSY. This FEL is designed for a bunch charge of 2.5 nC and the transverse emittance should be comparable with that of the current SRF gun project. In order to compensate the high bunch charge a high electric field on the cavity axis is necessary. In the present paper we will present the design of a 1-1/2 cell cavity for a superconducting RF gun. The active length of the cavity (without beam tube) is 14.4 cm. For the magnetic peak field the conservative value of 130 mT is assumed. The obtained particle energy is 6.6 MeV, corresponding to an accelerating field strength of 45.6 MV/m . In the TESLA cavity the same magnetic peak field is connected with an accelerating field strength of approximately 31 MV/m. Tracking calculation of electron bunches are in progress and will be also reported.

WEPLS045

Study on Low-energy Positron Polarimetry

A. Schaelicke, K. Laihem, S. Riemann, A. Ushakov (DESY Zeuthen) R. Dollan, Th. Lohse (Humboldt University Berlin, Institut für Physik)

For the design of the International Linear Collider (ILC) a polarised positron source based on a helical undulator system has been proposed. In order to optimise the positron beam, i.e., to ensure high intensity as well as high degree of polarisation, a measurement of the polarisation close to the positron creation point is envisaged. In this contribution methods to determine the positron polarisation at low energies are investigated. These studies are based on simulations with an extended version of Geant4, which allows the tracking of polarised particles taking into account the spin effects.

Radiation Levels and Activation at the ILC Positron Source

WEPLS046

A. Ushakov, S. Riemann (DESY Zeuthen) Eckhard. Elsen, K. Floettmann (DESY) K.N. Sanosyan (CANDLE)

An undulator-based positron source is recommended as baseline design for the International Linear Collider (ILC). Photons generated by electrons passing an undulator hit a rotating target and create electron-positron pairs. The positrons are captured and accelerated. An advantage of this source is the significantly lower radiation level in comparison to a conventional positron source which uses the electron beam directly to produce electron-positron pairs. The fluxes of neutrons and photons have been calculated with the particle transport code FLUKA. The activation of the positron source components has been estimated depending on the parameters of the source. The results for undulator-based and conventional positron sources are compared and presented.

3-1/2 Cell Superconducting RF Gun Simulations

WEPLS047

C.D. Beard, J.H.P. Rogers (CCLRC/DL/ASTeC) F. Staufenbiel, J. Teichert (FZR)

A 3-1/2 cell superconducting RF photocathode gun is being developed at Forschungszentrum Rossendorf to produce a high peak current, low emittance electron beam. This technology is essential to the realisation of many large scale facilities. The gun is designed for CW operation mode with 1 mA current and 9.5 MeV electron energy, and it will be installed at the ELBE superconducting electron linear accelerator. The gun will have a 3-1/2 cell niobium cavity operating at 1.3 GHz. The cavity consists of three cells with TESLA geometry and a specially designed half-cell in which the photocathode will be placed. Typical ERL-based projects require ~100 mA average current, and therefore suitable upgrade paths are required. Simulations have been carried out to evaluate the design and to determine suitable upgrades for higher current operation. Simulations of alternative cathode surface shapes are presented. Several couplers have been identified that can provide higher power to the cavity, whose integration and suitability has been verified. All the investigations that have identified possible solutions to higher current operation are discussed in this report.

Development of a Positron Production Target for the ILC Positron Source

WEPLS048

I.R. Bailey, I.R. Bailey, J.B. Dainton, D.J. Scott (Cockcroft Institute) V. Bharadwaj, J. Sheppard (SLAC) P. Cooke, P. Sutcliffe (Liverpool University, Science Faculty) J.G. Gronberg, D.J. Mayhall, W.T. Piggott, W. Stein (LLNL)

The future International Linear Collider (ILC) will require of order 10^{14} positrons per second to fulfil its luminosity requirements. The current baseline design produces this unprecedented flux of positrons using an undulator-based source. In this concept, a collimated beam of 10MeV photons produced from the action of an undulator on the main electron beam of the ILC is incident on a conversion target. Positrons produced in the resulting electromagnetic shower can then be captured, accelerated and injected into a damping ring. The international community is pursuing several alternative technologies to develop a target capable of long-term operation in the intense photon beam. In the design being developed jointly by the Cockcroft Institute, LLNL and SLAC, a thin (0.4 radiation length) water-cooled Titanium alloy target wheel of diameter 4m is rotated at approximately 1000rpm to spread the incident power of each pulse over a wide area. We present the latest target design, report on the status of the target prototypes and computer models, and review the interplay between the target technology, capture optics, photon collimator and remote-handling systems.

WEPLS049

The Design of a Hybrid Photoinjector for High Brightness Beam Applications

D. Alesini, M. Ferrario, V. Fusco, B. Spataro (INFN/LNF) L. Ficcadenti, A. Mostacci, L. Palumbo (Rome University La Sapienza) B. O'Shea, J.B. Rosenzweig, G. Travish (UCLA)

In this paper, we illustrate the electromagnetic and beam dynamics design procedure of a new class of photoinjector, a hybrid standing/traveling wave structure. In this device a standing wave RF gun section is integrated with a downstream traveling wave structure through a coupling cell that feeds simultaneously the two sections. We discuss the advantages in RF and beam performance of the hybrid photoinjector compared to conventional systems. The electromagnetic design has been performed using the 2D and 3D electromagnetic codes Superfish and HFSS. Results of beam dynamics simulations in different operating conditions are also discussed.

WEPLS050

Experiments with Electron Cloud and Sources

M. Cavenago (INFN/LNL) G. Bettega, F. Cavaliere, D. Ghezzi, A. Illiberi, R. Pozzoli, M. Rome (INFN-Milano)

The Penning-Malmberg trap ELTRAP installed at University of Milano can provide electron clouds of several sizes for study of non-linear physics: length ranges from 0.15 to 1 m, while diameter is varied between 25 mm and 70 mm by changing the electron source: filament or planar spiral. Vortices develop both in trapped and flowing electron beams. Slow instabilities, due to the accumulation of ions inside the trap are observed and cured by clearing fields. Results as a function of plasma size are described. Plan to install a third laser modulated electron source and additional diagnostic are also summarized.

WEPLS051

Dark Current Investigation of TTF and PITZ RF Guns

L. Monaco, P. Michelato, C. Pagani, P. Pierini, D. Sertore (INFN/LASA) J.H. Han, S. Schreiber (DESY) M. Krasilnikov, F. Stephan (DESY Zeuthen)

The dark current is one of the limiting factor in the operation of RF guns at high gradient. The continuous request of higher brilliance sources and further emittance minimization, leads to apply higher gradients in the RF gun cavity, with the consequence of a significant dark current production. In this context we set up a collaborative effort to identify the dark current sources in the gun, in order to discriminate between the gun and cathode contribution. A critical analysis and organization of dark current measurements, taken during the operation of TTF and PITZ guns, with several cathodes operated at different accelerating fields and solenoids focusing, is presented. Potential areas of improvement are also discussed, together with a possible associated program.

WEPLS052

High QE Photocathode at FLASH

D. Sertore, P. Michelato, L. Monaco, C. Pagani (INFN/LASA) J.H. Han, S. Schreiber (DESY)

The RF gun-based photoinjector of the VUV-FEL/TTF at DESY continues to use high quantum efficiency (QE) photocathodes produced at LASA, Milano. To study the photocathode behavior during beam operation, an online QE monitoring tool has been installed. In this paper, we present the hardware and software setup for the online QE measurement and the results so far obtained. The measured QEs

are usually higher than at TTF phase 1. We compare the QE values taken in the RF gun with data measured just after production with a continuous UV light source.

RF Design of a Cartridge-type Photocathode RF Gun in S-band Linac

WEPLS053

H. Moritani, Y. Muroya, A. Sakumi, T. Ueda, M. Uesaka (UTNL) H. Hanaki, N. Kumagai, S. Suzuki, H. Tomizawa (JASRI/SPring-8) J. Sasabe (Hamamatsu Photonics K.K.) J. Urakawa (KEK)

A cartridge-type photocathode RF gun is under development in collaboration with SPring-8 and Hamamatsu Photonics. Each type of cathode (Cs2Te, Mg, diamond, Ag-Cs-O) is sealed in a cartridge-type vacuum tube. Several tubes can be installed in a vacuum chamber. The cathode in the tube is inserted into a center hole in the back plate of the RF gun by a vacuum manipulator. These cartridge-type photocathodes with high QE or sensitivity for visible lights, which are prepared in a factory, can be used for a long time without vacuum breaking. Since a load-lock system for forming a new high QE film is not needed, the cartridge-type RF gun becomes compact. We are going to introduce this cartridge-type system to our linac with the BNL-GUN-IV RF gun this summer. Now, we are calculating the gun parameters of the transmission cavity which has a back plate with a center hole 8mm in diameter with SUPERFISH and simulating the beam dynamics after modifying the beam line to install the system with PARMELA. We aim to use reliable Mg and high-QE Cs2Te and try diamond and Ag-Cs-O for radiation chemistry applications. The detailed numerical design and construction will be presented.

Higher-order Effect Compensation in Magnetic Compressor for < 50 fs Electron Bunch Generation

WEPLS054

K. Kan, T. Kondoh, J. Yang, Y. Yoshida (ISIR)

An ultrashort electron bunch is essential for pulse radiolysis, which is a pump-probe measurement based on an ultrashort electron beam and an ultrashort light. In Osaka University, a laser photocathode electron linear accelerator with a magnetic compressor has been constructed for the femtosecond electron bunch generation. An electron beam with bunch length of 98 fs was successfully generated and used in pulse radiolysis. However, an electron beam with bunch length of < 50 fs is required for development of pulse radiolysis with time resolution of 100 fs. To generate such a short bunch, higher order disadvantage effects, which are caused by the fringing fields of the magnets in the compressor, should be compensated. In this paper, a compensation technique of higher-order effects was proposed by using a nonlinear energy modulation in the bunch produced in the linear accelerator by re-phasing the linac away from the zero-crossing of the rf (i.e., away from the linear slope). In the simulation, we compressed the electron bunch into 48 fs at bunch charge of 0.1 nC.

Development of Double-decker Electron Beam Accelerator for Femto/attosecond Pulse Radiolysis

WEPLS055

Y.K. Kuroda, T. Kondoh, J. Yang, Y. Yoshida (ISIR)

The study of electron-induced reactions in femto/attosecond time region is very important for the next electron beam nanofabrication. Pulse radiolysis with time resolution of sub-picosecond, as a powerful method to study such reactions in materials, has been developed by using radio-frequency electron accelerators and ultrashort lasers. In Osaka University, a new concept of double-decker electron beam accelerator is proposed for opening next pulse radiolysis on femto/attosecond time scale. The double electron beams with time delay of 1.4ns (350ps x 4) and bunch charge of 0.5-0.6 nC were generated in a photocathode electron accelerator by injecting two laser pulses into the photocathode. The beam energy of the two beams was 31.7MeV. The transverse normalized emittance was 3~6 mm-mrad for both the beams. The front of them is converted to Cherenkov light and used as a probe light source, and the back is used as a pump source. Both electron pulses are generated by one accelerator, resulting in no time jitter between the pump electron bunch and the probe laser pulse.

WEPLS056

R&D Status of the High-intense Monochromatic Low-energy Muon Source: PRISM

A. Sato, M. Aoki, Y. Arimoto, I. Itahashi, Y. Kuno, K. Kuriyama, T. Oki, T. Takayanagi, M. Yoshida (Osaka University) M. Aiba, C. Ohmori, T. Yokoi, K. Yoshimura (KEK) Y. Iwashita (Kyoto ICR) S. Machida (CCLRC/RAL/ASTeC) Y. Mori (KURRI)

PRISM is a project of a future intense low-energy muon source, which combines monochromaticity and high purity. Its aimed intensity is about $10^{11}-10^{12}$ muons per second. The muon beams will have a low kinetic energy of 20MeV so that it would be optimized for the stopped muon experiments such as searching the muon lepton flavor violating processes. PRISM consists of a pion capture section, a pion/muon transfer section and a phase rotation ssection. An FFAG is used as the phase rotator to achieve the monochromatic muon beams. This paper will describe design status of these sections as well as construction status of PRISM-FFAG.

WEPLS057

Equivalent Velocity Spectroscopy Based on Femtosecond Electron Beam Accelerator

S. Takemoto, T. Kondoh, J. Yang, Y. Yoshida (ISIR)

A new femtosecond pulse radiolysis system, which is called as "Equivalent Velocity Spectroscopy (EVS)" based on a photocathode rf linear accelerator and a femtosecond laser, is developed in ISIR for the study of primly process and ultrafast electron-induced reactions for the nanofabrication. In order to achieve a high time resolution on femtosecond scale, a femtosecond electron beam bunch produced by a photocathode accelerator and a synchronized femtosecond laser were used. The electron bunch and laser pulse were injected with an angle determined by the refractive index of the sample. The electron bunch was also rotated with a same angle, resulting in the time resolution degradation due to the velocity difference between light and the electron in the sample is thus avoided. A jitter compensation technique with a femtosecond streak camera was used to reduce the time jitter between the electron bunch and laser pulse. Moreover, in EVS, a technique of double laser pulse injection was used to improve the signal to noise ratio due to the fluctuation of the laser intensity during the measurement.

WEPLS058

Femtosecond Single-bunch Electron Linear Accelerator Based on a Photocathode RF Gun

J. Yang, K. Kan, T. Kondoh, A. Yoshida, Y. Yoshida (ISIR)

A femtosecond single-bunch electron linear accelerator based on a photocathode rf gun was developed in Osaka University for the study of radiation-induced ultrafast physical and chemical reactions. A 32 MeV single electron bunch with a bunch length of 98 fs in rms was generated successfully in the linear accelerator with a magnet bunch compressor. The dependences of the bunch length and the transverse emittance on the bunch charge were investigated experimentally and theoretically. The higher-order effects in the magnetic field were studied and compensated successfully by using a nonlinear energy-phase correlation in the bunch produced in the linear accelerator. By using the femtosecond electron bunch, an equivalent velocity spectroscopy with a synchronized femtosecond laser, as a new method with femtosecond time-resolution, was developed for study of the ultrafast reactions or phenomena on the femtosecond time scale.

The PHIN Photoinjector for the CTF3 Drive Beam

WEPLS059

R. Losito, H.-H. Braun, N. Champault, E. Chevallay, V. Fedosseev, A. Kumar, A.M. Masi, G. Suberlucq (CERN) G. Bienvenu, B.M. Mercier, C.P. Prevost, R. Roux (LAL) M. Divall, G.J. Hirst, G. Kurdi, W. E. Martin, I. O. Musgrave, I. N. Ross, E. L. Springate (CCLRC/ RAL)

A new photoinjector for the CTF3 drive beam has been designed and is now being constructed by a collaboration among LAL, CCLRC and CERN within PHIN, the second Joint Research Activity of CARE. The photoinjector will provide a train of 2332 pulses at 1.5 GHz with a complex timing structure (sub-trains of 212 pulses spaced from one another by 333 ps or 999 ps) to allow the frequency multiplication scheme, which is one of the features of CLIC, to be tested in CTF3. Each pulse of 2.33 nC will be emitted by a Cs2Te photocathode deposited by a co-evaporation process to allow high quantum efficiency in operation (>3% for a minimum of 40 h). The 3 GHz, 2 1/2 cell RF gun has a 2 port coupler to minimize emittance growth due to asymmetric fields, racetrack profile of the irises and two solenoids to keep the emittance at the output below 20 pi.mm.mrad. The laser has to survive very high average powers both within the pulse train (15 kW) and overall (200 W before pulse slicing). Challenging targets are also for amplitude stability (<0.25% rms) and time jitter from pulse to pulse (<1ps rms). An offline test in a dedicated line is foreseen at CERN in 2007.

CLIC Polarized Positron Source Based on Laser Compton Scattering

WEPLS060

F. Zimmermann, H.-H. Braun, M. Korostelev, L. Rinolfi, D. Schulte (CERN) S. Araki, Y. Higashi, Y. Honda, Y. Kurihara, M. Kuriki, T. Okugi, T. Omori, T. Taniguchi, N. Terunuma, J. Urakawa (KEK) X. Artru, R. Chehab, M. Chevallier (IN2P3 IPNL) E.V. Bulyak, P. Gladkikh (NSC/KIPT) M.K. Fukuda, K. Hirano, M. Takano (NIRS) J. Gao (IHEP Beijing) S. Guiducci, P. Raimondi (INFN/LNF) T. Hirose, K. Sakaue, M. Washio (RISE) K. Moenig (DESY Zeuthen) H.D. Sato (HU/AdSM) V. Soskov (LPI) V.M. Strakhovenko (BINP SB RAS) T. Takahashi (Hiroshima University) A. Tsunemi (SHI) V. Variola, Z.F. Zomer (LAL)

We describe the possible layout and parameters of a polarized positron source for CLIC, where the positrons are produced from polarized gamma rays created by Compton scattering of a 1.3-GeV electron beam off a YAG laser. This scheme is very energy effective using high finesse laser cavities in conjunction with an electron storage ring. We point out the differences with respect to a similar system proposed for the ILC.

Laser Driven Linear Collider

WEPLS063

A.A. Mikhailichenko (Cornell University, Department of Physics)

We represent the details of scheme allowing long term acceleration with >10GeV/m. The basis of the scheme is a fast sweeping device for laser bunch. After sweeping the laser bunch has a slope with respect to the direction of propagation. So the every cell of accelerating structure becomes illuminated locally only for the moment, when the particle is there. Self consistent parameters allow considering this type of collider as a candidate for post-ILC era.

WEPLS064

Wiggler for ILC Cooler

A.A. Mikhailichenko (Cornell University, Department of Physics)

We represented the concept of a wiggler with linear piecewise field dependence. This eliminates nonlinearities in wiggler. This type of wiggler can be recommended for usage in ILC cooler.

WEPLS065

The Effect of Vaccum Vessel Permeability on the Field Quality within Dipole and Quadrupole Magnets at the Energy Recovery Linac Prototype (ERLP) at Daresbury Laboratory

N. Thompson (CCLRC/DL/ASTeC)

The Energy Recovery Linac Prototype (ERLP) is currently under construction at Daresbury Laboratory in the UK and will serve as a test bed for the investigation of technologies and beam physics issues necessary for the development of Daresbury Laboratory's Fourth Generation Light Source (4GLS) proposal. To assist with the material specification of the vacuum vessels, analyses have been done on the effect of vessel permeability on the magnetic field quality within quadrupole and dipole magnets. It is found that for dipoles where the specified maximum relative dipole field variation over the good field region is ± $1x\ 10^{-4}$ or for quadrupoles where the specified maximum relative gradient variation is ±1 1x10-3, the transverse size of the good field region decays unacceptably for relative permeability > 1.006. However, for the dipoles where the specified maximum relative dipole field variation is ± 1x10-3, the decay of the good field region is more gradual and would safely permit a material with relative permeability >1.006 to be used for the vacuum vessel within these dipoles.

WEPLS066

Harmonic Measurement and Adjustment of Diamond Quadrupoles

C.P. Bailey, N. Marks (Diamond) F. Goldie, B. Leigh (Tesla Engineering Limited)

The 254 quadrupole magnets for Diamond, manufactured by Tesla Engineering Ltd, were measured for harmonic content to a level around 1 part in 104. In order to meet the demanding requirements on field quality, procedures were then developed to adjust the relative positions of the magnet quadrants such that the desired harmonic levels were achieved. This process was integrated into the analysis software so that the needed changes were specified. The measurements were performed on a seven-coil rotating coil rig, which also enabled the alignment of the magnet in five spatial degrees of freedom to the specified accuracy. In this report we describe the measurement and correction procedures and present a summary of the results that were obtained.

Magnets for the 3 GeV Booster Synchrotron for the Diamond Light Source

WEPLS067

S.P. Mhaskar, C.P. Bailey, G.M.A. Duller, V.C. Kempson, N. Marks (Diamond) F. Bødker, N. Hauge, L.H. Helmersen (Danfysik A/S)

The Diamond Booster is a full energy injector for the Diamond Storage Ring. It is designed to accelerate electrons from 100 MeV to 3 GeV at a 5 Hz repetition rate. The lattice is a missing dipole FODO lattice consisting of 22 unit cells with 36 dipoles, 44 quadrupoles, 28 sextupoles and 44 correctors, distributed around a circumference of 158.4 m. The dipole field will be ramped from 0.026 T at injection to 0.809 T at 3 GeV; the quadrupoles will have a maximum operating gradient of 15T/m. The initial design of pole tip profiles was carried at Diamond, with the magnets then manufactured by DANFYSIK A/S as part of preassembled girder units (44 in total), complete with vacuum vessels. High quality was required to meet the accelerator physics requirements of alignment, positioning accuracies and field tolerances over the required good field apertures. Materials, ramp rates and field range have been selected to obtain almost linear response during magnet ramping. This paper describes the main features of the magnetic designs and measurement results; the magnets have now been delivered and installed at Diamond.

The IASA Magnetic Field Mapping (MFM) Project

WEPLS068

E.P. Pournaras, A. Karabarbounis, C.N. Papanicolas, E. Stiliaris (IASA)

The design and development of an automatic magnetic field mapping device as supporting equipment for the 10 MeV CW-Linac and its transport system at the Institute of Accelerating Systems and Applications (IASA) is presented. The MFM project aims to totally automate the operation of mapping room temperature magnetic field sources, reconstruct the 3D-field shape and reveal nonlinearities in the fridge field regions. The positioning system covers an area of 50x50 cm2 with an accuracy of less than 20 ?m in both axes; magnetic field measurements, mainly based on a Hall probe, can reach in precision the 1x 10^{-4} value. Several software tools for the visualization of the measured fields and for a direct comparison with theoretical estimates are also presented.

The Elettra Booster Magnets Construction Status

WEPLS070

D. Zangrando, D. Castronovo, F. Iazzourene, M. Svandrlik (ELETTRA)

The third generation light source ELETTRA has been in operation since 1993. A new 2.5 GeV full energy booster injector has been approved and founded last year. It will replace the existing linear injector limited to a maximum energy of 1.2 GeV. During last year, after having completed the specifications and the preliminary magnetic and mechanical design, the orders for all the magnets were assigned to two European firms. The paper reports on the magnets' construction status and the requested specifications.

WEPLS071

Design Method for a Large Aperture Opposite-field Septum Magnet

K. Fan, Y. Arakaki, I. Sugai (KEK)

A novel design septum for Japan Proton Accelerator Research Center (J-PARC) delivers high intensity 3GeV proton beam to the 50GeV main ring is presented. The project requires the construction of the large aperture septum to accommodate the large size and high intensity injection beam. As there limitations due to the lattice size and restricted installation space, the septum must provide a large kick angle to the injection beam. Sufficient clearance between the circulating beam and the injection beam is also needed to reduce the beam loss to an acceptable level to avoid the serious radiation problem. To meet these challenging requirements, a large aperture, thin septum, opposite-field septum magnet has been developed. In this paper, we present the detail studies done for the optimization of the magnet, including DC and pulse magnet.

WEPLS072

Results of Field Measurements for J-PARC Main Ring Magnets

K. Niki, K. Ishii, Y. Nemoto, E. Yanaoka (KEK) M. Muto (New Affiliation Request Pending)

The mass production of J-PARC main ring magnets had been completed till the end of fiscal year 2004. Those magnets consists of 97 bending magnets with 6-m in length, 216 quadrupole magnets with 11 families and 72 sextupole magnets. We have been measured the magnetic field for all of these magnets and we will finish it in March, 2006. The obtained distributions for the BL products of bending magnets and the GL products of quadrupole magnets are within the required tolerance limits, values of which are estimated by the beam optics for COD correction, etc. The measured multi-pole components for these magnets, and so on, will be also reported.

WEPLS073

A Super Strong Adjustable Permanent Magnet Quadrupole for the Final Focus in a Linear Collider

Y. Iwashita, T. Mihara (Kyoto ICR) M. Kumada (NIRS) C.M. Spencer (SLAC)

An adjustable permanent magnet quadrupole has been fabricated to demonstrate its feasibility for use in the final focus of a linear collider. The supposed requirements for such a final focus lens are the tight stabilities of its integrated field gradient and magnetic center, plus it must have adjustable strength. The high temperature coefficient of the permanent magnet material NEOMAX is compensated by use of the MS-1 Fe-Ni alloy. The magnet has two concentric rings of NEOMAX. The replacement of the inner ring with a smaller diameter one is planned in order to reach the highest gradient with the current configuration of the quadrupole system; the system has to be scaled down in size to fit in a real linear collider final focus system. A precise magnetic field measurement system is also under fabrication that will be able to measure the magnetic center to a fraction of a micron.

SESAME Magnets System

WEPLS074

S. Varnasseri (SESAME)

In this paper the SESAME storage ring magnet system is described. The storage ring consists of 16 bending magnets with a maximum field of 1.455 T and vertical gradient of 2.79 T/m, 32 focusing quadrupoles with a maximum gradient of 16.92 T/m, 32 defocusing quadrupoles with a maximum gradient of 10.23 T/m, 32 focusing sextupoles with a maximum differential gradient of 200 T/m2 and 32 defocusing sextupoles with the maximum differential gradient of 300 T/m2. The horizontal/vertical correctors will be embedded inside focusing/defocusing sextupoles. For the quadrupole and sextupole, a design similar to ANKA has been adopted. The magnetic and electrical design of dipoles and correctors, field profile and higher order multipoles optimization will be presented.

Considerations on the Design of the Bending Magnet for Beam Extraction System of PEFP

WEPLS077

Y.-H. Kim, Y.-S. Cho, J.-H. Jang (KAERI)

The PEFP is designed to have two beam extraction lines at the 20 MeV end and 100MeV end for beam utilization. So, the bending magnet to extract the beam from the beam line is located among the MEBT. This implies that there is a long drift space between the focusing structures, while, from the beam dynamics study, it is recommended to make the drift space shorter. In this study, we design and compare some bending magnets to satisfy the beam dynamics requirements.

Design Study of the 30 MeV Cyclotron Magnet

WEPLS078

J. Kang, D.H. An, J.-S. Chai, H.S. Chang, H.B. Hong, M.G. Hur, I.S. Jung, Y.-S. Kim, T.K. Yang (KIRAMS)

Korea Institute of RAdiological & Medical Sciences (KIRAMS) has been developing a 30 MeV cyclotron that is planned to be installed at Advanced Radiation Technology Institute, Jeongeup in late 2006. The AVF (Azimuthally Varying Field) magnet of the cyclotron was designed to produce 15-30 MeV proton beam with movable stripper foil. Four directions of extractions are available with two switching magnets. The overall shape of the magnet is cylindrical. The magnet has three kinds of holes for beam injection, vacuum pumps and RF system. The valley and hill gap ratio is about 20 for higher axial focusing. The designed magnet model and its magnetic properties of the KIRAMS-30 are presented.

Magnets for the Storage Ring ALBA

WEPLS080

M. Pont (ALBA) E. Boter, M.L. Lopes (CELLS)

The Storage Ring ALBA is a 3.0 GeV synchrotron light source under construction in Barcelona (Spain). The Storage Ring, has a circumference of 268.8 m and comprises 32 combined magnets, 112 quadrupoles, and 120 sextupoles. This paper will describe the design and the present state of these magnets. The combined magnet has a central field of 1.42 T and a large gradient of 5.65 T/m, since most of the vertical focusing happens at these combined magnets. The 112 quadrupoles have been designed for a maximum gradient of 22 T/m. The bore diameter will be 61 mm and the lengths range from 200 to 500 mm. Each quadrupole will be individually powered. The 120 sextupoles are divided in 9 families. There are two lengths of sextupoles 150 and 220 mm and the maximum sextupole gradient is 600 T/m2.

The bore diameter is 76 mm. The sextupole magnets will also be equipped with additional coils for vertical steering, horizontal steering and quadrupolar skew correction.

WEPLS081

Modifications to the SPS LSS6 Septa for LHC and the SPS Septa Diluters

J. Borburgh, B. Balhan, B. Goddard, Y. Kadi (CERN)

The Large Hadron Collider required the modification of the existing extraction channel in the long straight section (LSS) 6 of the CERN Super Proton Synchrotron (SPS), including the suppression of the electrostatic wire septa. The newly set up fast extraction will be used to transfer protons at 450 GeV/c as well as ions via the 2.9 km long transfer line TI 2 to Ring 1 of the LHC. The girder of the existing SPS DC septa was modified to accommodate a new septum protection element. Changes were also applied to the septum diluter in the fast extraction channel in SPS LSS4, leading to the other LHC ring and the CNGS facility. The requirements and the layout of the new LSS6 extraction channel will be described including a discussion of the design and performance of the installed septum diluters.

WEPLS082

The Septa for LEIR Extraction and PS Injection

J. Borburgh, M. Hourican, T. Masson, A. Prost (CERN)

The Low Energy Ion Ring (LEIR) is part of the CERN LHC injector chain for ions. The LEIR extraction uses a pulsed magnetic septum, clamped around a metallic vacuum chamber. Apart from separating the ultra high vacuum in the LEIR ring from the less good vacuum in the transfer line to the PS this chamber also serves as magnetic screen and retains the septum conductor in place. The PS ion injection septum consists of a pulsed laminated magnet under vacuum, featuring a single-turn water cooled coil and a remote positioning system. The design, the construction and the commissioning of both septa are described.

WEPLS083

Consolidation of the 45-year-old CERN PS Main Magnet System

Th. Zickler, D. Bodart, W. Kalbreier, K.H. Mess, A. Newborough (CERN)

After a major coil insulation breakdown on two of the 45-year-old CERN PS main magnets in 2003, an extensive magnet consolidation program has been launched. This article reviews the analysis of the magnet state before the repair and the applied major improvements. An overview is given of the production of the new components, the actual refurbishment and the commissioning of the main magnet system after 18 months shut down.

AC Field Measurements of Fermilab Booster Correctors Using a Rotating Coil System

WEPLS084

G. Velev, J. DiMarco, D.J. Harding, V.S. Kashikhin, M.J. Lamm, A. Makulski, D.F. Orris, P. Schlabach, C. Sylvester, M. Tartaglia, J. Tompkins (Fermilab)

The first prototype of a new corrector package for the Fermilab Booster Synchrotron is presently in production. This water-cooled package includes normal and skew dipole, quadrupole and sextupole magnets to control orbit, tune and chromaticity of the beam over the full range of Booster energies (400 MeV-8 GeV). These correctors must make rapid excursions from the 15 Hz excitation cycle of the main synchrotron magnets, in some cases even switching polarity in approximately 1 ms at transition crossing. To measure the dynamic changes in the field during operation, a new method based on a relatively slow rotating coil system is proposed. The method pieces together the measured flux from successive current cycles to reconstruct the field harmonics. This paper describes the method and presents initial field quality measurements from the corrector prototype.

Study of RF Breakdown in Normal Conducting Structures with Various Geometries and Materials

WEPLS085

V.A. Dolgashev, S.G. Tantawi (SLAC)

RF breakdown is one of the major factors determining performance of high power rf components, rf sources and accelerating structures. We study the breakdown in 11 GHz high gradient waveguides at rf powers reaching 300 MW. We tested rectangular waveguides of two geometries which have increased surface electric and magnetic fields in comparison with a standard WR90 waveguide. We used copper, gold, molybdenum, and stainless steel as material for the waveguides. We observe rf parameters, X-rays and visible light from breakdown events. We report the results of the conditioning of these waveguides and compare these results.

Status of the Development of the FAIR Superconducting Magnets

WEPLS087

G. Moritz (GSI)

For the planned 'Facility for Antiprotons and Ion Research' (FAIR), a variety of superconducting magnets is foreseen. The synchrotrons SIS 100 and SIS 300 will use fast-pulsed superferric and superconducting cos (theta) magnets. The storage ring CR and the SuperFRS will be equipped with large-scale superferric magnets, while in the storage ring HESR RHIC-type magnets are foreseen. The status of the R&D activities will be presented.

Feasibility Study of a Permanent Magnet Made from High-Tc Bulk Superconductor

WEPLS089

M. Masuzawa, K. Egawa, K. Tsuchiya (KEK)

A field trapping experiment using a magnetic field up to ~1.5 T was performed using high-Tc bulk superconductors. Applications of bulk high-Tc superconductors have been investigated in various fields. High-Tc superconductors are attractive since they can trap higher magnetic fields than conventional permanent magnets. The trapping experiment was done with a field of above 1 T, which can be easily produced by conventional magnets. However, achieving the desired field distribution and understanding the characteristics of the trapped field and its decay process would open up

the possibility of high-Tc bulk superconductor applications in the design of magnets for particle accelerators The distribution of the trapped field and its decay process was monitored by an array of Hall sensors for different shapes of the bulk superconductors. The observations are reported on in this paper.

WEPLS090

Full Length Superferric Dipole and Quadrupole Prototype Magnets for the SIS100 at GSI: Status of the Design and Manufacturing

A.D. Kovalenko, N.N. Agapov, A.V. Alfeev, H.G. Khodzhibagiyan, G.L. Kuznetsov, V.V. Seleznev, A.Y. Starikov (JINR) E. Fischer, G. Moritz, C. Muehle, P.J. Spiller (GSI) A.K. Kalimov (St. Petersburg State Polytechnic University) A.V. Shabunov (JINR/LHE)

The SIS100, one of the two basic accelerators of the future Facility for Antiproton and Ion Research FAIR at GSI, should provide acceleration of U^{28+} and proton beams for 0.5 s with a pulse repetition rate of 1 Hz. In the accelerator magnetic system superferric 2 T dipoles of about 3 m length and 35 T/m quadrupoles of about 1 m length will be used. The magnet coils are made from hollow NbTi composite cable cooled with two-phase helium flow at 4.5 K. The maximum operating current of 7500 A is supposed. The lattice comprises 108 dipoles and 168 quadrupoles. The elliptic beam pipe inner sizes have been fixed to 130x60 mm2 for the dipole and 135x65 mm2 for the quadrupole The design approach is based on the improved versions of the Nuclotron fast-cycling magnets that provide significant less AC loss at 4.5 K, better quality of the magnetic field and a higher long-term mechanical stability of the magnet coils. The AC losses in the magnets for the strongest SIS100 operating cycle at 4.5 K are expected to be about 13 W/m and 17 W/m in the full length prototype dipole and quadrupole magnets respectively.

WEPLS091

Analysis of the Superferric Quadrupole Magnet Design for the SIS100 Accelerator of the FAIR Project

E. Fischer, G. Moritz (GSI) H.G. Khodzhibagiyan, A.D. Kovalenko (JINR) R.V. Kurnyshov, P.A. Shcherbakov (IHEP Protvino)

The heavy ion fast-cycling synchrotron SIS100 is the "workhorse", of the future Facility for Antiproton and Ion Research FAIR at GSI in Darmstadt. The main lattice parameters of the accelerator are defined now so the main engineering problems of the new superferric magnets should be analyzed and solved too. We present the results of finite element calculations and compare them with the experimental data from investigation of the model magnets to characterize the expected AC loss properties of the full length prototype quadrupole. We discuss the appropriate new coil structure aimed at minimizing the heat releases at 4.5 K, but providing the requested long-term mechanical stability against dynamic Lorentz forces and thermal cooling cycles as well.

WEPLS092

Computer Modeling of Magnetic System for C400 Superconducting Cyclotron

Y. Jongen, D. Vandeplassche, S.E. Zaremba (IBA) G.A. Karamysheva, N.A. Morozov, E. Samsonov (JINR)

The superconducting cyclotron (C400) is designed at IBA (Belgium) able to accelerate carbon ions at 400 MeV/nucleon. By computer simulation with 3D TOSCA code, the cyclotron magnetic system principal parameters were estimated (pole radius 187 cm, outer diameter 606 cm, valley depth 60 cm, height 276 cm). The required isochronous magnetic field was shaped with an accuracy of ± 2 mT.

Four-fold symmetry and spiralized sectors with elliptical gap (minimal 12 mm at extraction) provide the stable beam acceleration till 15 mm from the pole edge.

3D Field Computation for the Main Prototype Magnets of the SIS100 Accelerator of the FAIR Project

WEPLS093

P.A. Shcherbakov (IHEP Protvino) E. Fischer (GSI) R.V. Kurnyshov (Electroplant)

Fast cycling superferric magnets are planned for use in the new international accelerator Facility for Antiprotons and Ion Research (FAIR) at GSI, Darmstadt. The dipoles and quadrupoles have to provide the required field quality from the injection field of 0.25T and 4.3T/m up to the maximum values of 2.1T and 35T/m respectively. The complex 3D magnetic field distribution due to the longitudinal component Bz near the yoke end regions and the presence of eddy currents also in the bulk construction elements as well as in a mechanical stable beam pipe design can create unacceptable static and dynamic nonlinearities. The detailed knowledge of these effects is necessary to control the field quality for all operating cycles to be provided by the SIS100 accelerator. We discuss the methodical problems of 3D finite element calculations (ANSYS) of the local and the integral nonlinearities, considering also the problems caused by the various nonlinear and anisotropic material properties and by the structure elements of the yoke and beam pipe. The calculated integral static and the affected by eddy currents harmonic coefficients are presented.

3D Magnetic Field and Eddy Current Loss Calculations for Iron Dominated Accelerator Magnets using ANSYS Compared with Results of Noncommercial Codes

WEPLS094

P.A. Shcherbakov (IHEP Protvino) E. Fischer (GSI) R.V. Kurnyshov (Electroplant)

The design of fast ramped superferric magnets with repetition rates in the order of 1Hz requires reliable software tools to calculate the complex 3D magnetic field quality as well as the impact of eddy current and hysteresis loss. Various technological construction details should be taken into account to obtain a high field quality. We present a methodical study of these questions based on ANSYS calculations for simplified dipole models. The details of these analysis are compared with recently published results obtained by different special codes, i.e. an integral and the FIT method. The time dependences of eddy current power due to longitudinal magnetic field component at the yoke ends, the transient field distribution in the yoke volume and the total eddy current loss are investigated, choosing the identical geometry with the same magnetic and electric properties of the lamination steel used by the other codes. The conclusions for the application potential of the different methods are discussed.

Design and Calculation of a Superferric Combined Magnet for XFEL

WEPLS096

F. Toral, P. Abramian, J.L. Gutierrez, E. Rodriguez, I. Rodriguez, S. Sanz, C. Vazquez (CIEMAT) R. Bandelmann, H. Brueck (DESY) J. Calero, L. García-Tabarés (CEDEX) J. Lucas (Elytt Energy)

A planned European X-ray Free Electron Laser so-called XFEL is being developed within the framework of an international collaboration. The design and fabrication of a prototype of a combined magnet is part of the Spanish contribution to this project. This magnet consists of a superferric quadrupole for focusing and two dipoles (horizontal and vertical) for steering, glued around the beam tube. The magnet will be operated in a superfluid helium bath. The aperture is 78 mm. The quadrupole gradient is 35 T/m whereas each dipole field is about 0.04 T. The magnetic saturation is limited to 5% at nominal current, which is quite a challenging specification for such aperture and gradient. As the overall length of the helium vessel is just 300 mm, the calculation of the magnetic field is a pure 3-D problem which has been solved and optimized using two different FEM codes to cross-check the results. This paper also gives some guidelines about the fabrication techniques most suitable for the first prototype, which is now under construction.

WEPLS097

Random Errors in Superconducting Dipoles

B. Bellesia, E. Todesco (CERN) C. Santoni (Université Blaise Pascal)

The magnetic field in a superconducting magnet is mainly determined by the position of the conductors. Hence, the main contribution to the random field errors comes from random displacement of the coil with respect to its nominal position. Using a Monte-Carlo method, we analyze the measured random field errors of the main dipoles of the LHC, Tevatron, RHIC and HERA projects in order to estimate the precision of the conductor positioning reached during the production. The method can be used to obtain more refined estimates of the random components for future projects.

WEPLS098

Experience with the Quality Assurance of the Superconducting Electrical Circuits of the LHC Machine

D. Bozzini, V. Chareyre, K.H. Mess, S. Russenschuck (CERN) A. Kotarba, S. Olek (HNINP)

The coherence between the powering reference database and the Electrical Quality Assurance (ELQA) is guaranteed on the procedural level. However, a challenge remains the coherence between the database, the magnet test and assembly procedures, and the connection of all superconducting circuits of the LHC. In this paper, the methods, tooling, and procedures for the ELQA during the assembly phase of the LHC will be presented in view of the practical experience gained in the LHC tunnel. The parameters measured at ambient temperature such as the dielectric insulation and the impedance transfer function of assembled circuits will be discussed. Some examples of detected polarity errors and the treatment of non-conformities will be presented.

WEPLS099

Fault Detection and Identification Methods Used for the LHC Cryomagnets and Related Cabling

D. Bozzini, F. Caspers, V. Chareyre, Y. Duse, T. Kroyer, R. Lopez, A. Poncet, S. Russenschuck (CERN)

Several non-standard methods for electrical fault location have been successfully developed and tested. As part of the electrical quality assurance program, certain wires have to be subjected to a (high) DC voltage for the testing of the insulation. With the time difference of spark-induced electromagnetic signals measured with an oscilloscope, fault localization within a ± 10 cm range has been achieved. Another method used and adapted for the particular needs, was the synthetic pulse time-domain reflectometry (TDR) by means of a vector network analyzer. This instrument has also been applied as a low frequency sweep impedance analyzer in order to measure fractional capacities of cable assemblies where TDR was not applicable.

Performance of LHC Main Dipoles for Beam Operation

WEPLS100

G. De Rijk, M. Bajko, L. Bottura, M.C.L. Buzio, V. Chohan, L. Deniau, P. Fessia, J. Garcia Perez, P. Hagen, J.-P. Koutchouk, J. Kozak, J. Miles, M. Missiaen, M. Modena, P. Pugnat, V. Remondino, L. Rossi, S. Sanfilippo, F. Savary, A.P. Siemko, N. Smirnov, A. Stafiniak, E. Todesco, D. Tommasini, J. Vlogaert, C. Vollinger, L. Walckiers, E.Y. Wildner (CERN)

At present about 75% of the main dipoles for the LHC have been manufactured and one of the three cold mass assemblers has already completed the production. More than two third of the 1232 dipoles needed for the tunnel have been tested and accepted. In this paper we mainly deal with the performance results: the quench behavior, the magnetic field quality, the electrical integrity quality and the geometry features will be summarized. The variations in performance associated with different cold mass assemblers and superconducting cable origins will be discussed.

First Computation of Parasitic Fields in LHC Dipole Magnet Interconnects

WEPLS101

A. Devred, B. Auchmann, Y. Boncompagni, V. Ferapontov, J.-P. Koutchouk, S. Russenschuck, T. Sahner, C. Vollinger (CERN)

The Large Hadron Collider (LHC), now under construction at CERN, will rely on about 1600 main superconducting dipole and quadrupole magnets and over 7400 superconducting corrector magnets distributed around the eight sectors of the machine. Each type of magnets is powered by dedicated superconducting busbars running along each sector and passing through the iron yokes of the main dipole and quadruple magnets. In the numerous magnet interconnects, the busbars are not magnetically shielded from the beam pipes and produce parasitic fields that can affect beam optics. We review the 3D models which have been built with the ROXIE software package to evaluate these parasitic fields and we discuss the computation results and their potential impacts on machine performance.

The Construction of the Superconducting Matching Quadrupoles for the LHC Insertions

WEPLS102

R. Ostojic, P. Canard, N. Catalan-Lasheras, G. Kirby, J.C. Perez, H. Prin, W. Venturini Delsolaro (CERN)

After several years of intensive effort, the construction of the superconducting matching quadrupoles for the LHC insertions is nearing completion. We retrace the main events of the project from the initial development of quadrupole magnets of several types to the series production of over 100 complex cryo-magnets, and report on the techniques developed for steering of the production. The main performance parameters for the full series, such as quench training, field quality and magnet geometry are presented. The experience gained in the production of these special superconducting magnets is of considerable value for further development of the LHC insertions.

WEPLS103

The Field Description Model for the LHC Quadrupole Superconducting Magnets

N.J. Sammut, L. Bottura, S. Sanfilippo (CERN) J. Micallef (University of Malta, Faculty of Engineering)

The LHC control system requires an accurate forecast of the magnetic field and the multipole field errors to reduce the burden on the beam-based feed-back. The Field Description for the LHC (FIDEL) is the core of this forecast system and is based on the identification and physical decomposition of the effects that contribute to the total field in the magnet apertures. The effects are quantified using the data obtained from series magnetic measurements at CERN and they are consequently modelled empirically or theoretically depending on the complexity of the physical phenomena. This paper presents a description of the methodology used to model the field of the LHC magnets particularly focusing on the results obtained for the LHC Quadrupoles (MQ, MQM and MQY).

WEPLS104

The Dependence of the Field Decay on the Powering History of the LHC Superconducting Dipole Magnets

N.J. Sammut, L. Bottura, S. Sanfilippo (CERN) J. Micallef (University of Malta, Faculty of Engineering)

The decay amplitude of the allowed multipoles in the LHC dipoles is expected to perturb the beam stability during the injection phase and is strongly dependent on the powering history of the magnet. The effect is particularly large for the pre-cycle nominal flat-top current and duration. With possible prospects of having different genres of cycles during the LHC operation, the powering history effect must be taken into account in the Field Description Model for the LHC (FIDEL) and must hence be corrected for during machine operation. This paper presents the results of the modelling of this phenomenon. We also discuss the statistic of magnetic measurements required to guarantee that the current history effect is predicted within the specified accuracy.

WEPLS105

Performance of the LHC Arc Superconducting Quadrupoles towards the End of their Series Fabrication

T. Tortschanoff, P. Hagen, M. Modena, L. Rossi, S. Sanfilippo, K. M. Schirm, E. Todesco, E.Y. Wildner (CERN) R. Burgmer, H.-U. Klein, D. Krischel, B. Schellong, P. Schmidt (ACCEL) M. Durante, A. Payn, F. Simon (CEA)

The fabrication of the 408 main arc quadrupole magnets and their cold masses will come to an end in summer 2006. A rich collection of measurement and test data has been accumulated and their analysis is presented in this paper. These data cover the fabrication and the efficiency in the use of the main components, the geometrical measurements and the achieved dimensional precision, the warm magnetic measurements in the factory and the performance at cold conditions, especially the training behaviour. The scrap rate of the NbTi/Cu conductor as well as that of other components turned out to be acceptably low and the quench performance measured was in general very good. Most quadrupoles measured so far exceeded the operating field gradient with one or no quench. The multipole content at cold was measured for a limited numbers of quadrupoles as far as needed for verifying the warm-to-cold correlation. From the point of view of field quality, all quadrupoles could be accepted for the machine and the measures taken to overcome the problem of a too high permeability of a batch of collars are discussed.

Design, Performance and Series Production of Superconducting Trim Quadrupoles for the Large Hadron Collider

WEPLS106

M. Karppinen, C. Boyer, J.-M. Castro, H.A. Garcia de Sousa Lopes, C. Giloux, J. Mazet, G. Mugnai, V. Remondino, D. Rodrigues, W. Venturini Delsolaro, R. Wolf (CERN) G. Gaggero, L. Loche, M. Tassisto (ANSALDO Energia, Magnet & Special Product Division) P. Khare, A. Puntambekar (RRCAT)

The Large Hadron Collider (LHC) will be equipped with several thousands of superconducting corrector magnets. Among the largest ones are the superconducting trim quadrupoles (MQTL). These twin-aperture magnets with a total mass of up to 1700 kg have a nominal gradient of 129 T/m at 1.9 K and a magnetic length of 1.3 m. Sixty MQTL are required for the LHC, 36 operating at 1.9 K in and 24 operating at 4.5 K. The paper describes the design features, and reports the measured quench performance and magnetic field quality of the production magnets. The MQTL magnet production is shared between CERN and industry. This sharing is simplified due to the modular construction, common to all twin-aperture correctors.

Comparative Study of Inter-strand Coupling Current Models for Accelerator Magnets

WEPLS107

R. de Maria, B. Auchmann, S. Russenschuck (CERN)

"Inter-Strand Coupling Currents" (ISCCs) contribute to field errors and losses in Rutherford-type superconducting cables in the time¯ transient regime. The field change induces eddy currents in loops formed by the superconducting twisted strands and the resistive matrix. In the ROXIE program two models are implemented to simulate ISCCs in a magnet cross-section: A network model uses an electric circuit to represent the geometry of the twisted strands and their resistive contacts; an analytical model simplifies the network equations to determine an equivalent cable magnetization from an average field sweep over the cable. The implementation of the models in ROXIE allows to combine them with models for "Persistent Currents" and "Inter-Filament Coupling Currents". The non-linear iron yoke can be taken into account as well. The predictions of different ISCC models with regard to losses and field errors are compared for two design versions of the LHC main dipole. We find that as far as field quality is concerned, the models perform equally well. As for losses, however, the analytical model cannot capture the complexity of the problem and computes lower losses than the network model.

High Field Solenoid Magnets for Muon Cooling

WEPLS108

S.A. Kahn, M. Alsharo'a, P.M. Hanlet, R.P. Johnson, M. Kuchnir, D.J. Newsham (Muons, Inc) R.C. Gupta, R. Palmer, E. Willen (BNL)

Magnets made with high-temperature superconducting (HTS) coils operating at low temperatures have the potential to produce extremely high fields for use in beam lines and accelerators. The specific application of interest that we are proposing is to use a very high field (of the order of 50 Tesla) solenoid to provide a very small beta region for the final stages of cooling for a muon collider. With the commercial availability of HTS tape based on BSCCO technology with high current carrying capacity at 4.2 K, very high field solenoid magnets should be possible. In this paper we will evaluate the technical issues associated with building this magnet. In particular we will address how to mitigate the high Lorentz stresses associated with this high field magnet.

WEPLS109

Test Results of Fermilab-built Quadrupoles for the LHC Interaction Regions

M.J. Lamm, R. Bossert, J. DiMarco, SF. Feher, A. Hocker, J.S. Kerby, A. Nobrega, I. Novitski, R. Rabehl, P. Schlabach, J. Strait, C. Sylvester, M. Tartaglia, J. Tompkins, G. Velev, A.V. Zlobin (Fermilab)

The US-LHC Accelerator Project has recently completed the manufacturing and testing of the Q2 optical elements for the LHC interaction region final focus. Each Q2 element consists of two identical quadrupoles (MQXB) with a dipole orbit corrector (MQXB). The Fermilab designed MQXB has a 70 mm aperture and a peak operating gradient of 215 T/m. This paper summarizes the test results for the MQXB program with emphasis on quench performance and alignment studies.

WEPLS110

New Measurements of Sextupole Field Decay and Snapback Effect on Tevatron Dipole Magnets

G. Velev, P. Bauer, R.H. Carcagno, J. DiMarco, M.J. Lamm, D.F. Orris, P. Schlabach, C. Sylvester, M. Tartaglia, J. Tompkins (Fermilab)

To perform detailed studies of the dynamic effects in superconducting accelerator magnets, a fast continuous harmonics measurement system based on the application of a digital signal processor (DSP) has been built at Fermilab. Using this new system the dynamic effects in the sextupole field, such as the field decay during the dwell at injection and the rapid subsequent "snapback" during the first few seconds of the energy ramp, are evaluated for more than ten Tevatron dipoles from the spares pool. The results confirm the previously observed fast drift in the first several seconds of the sextupole decay and provided additional information on a scaling law for predicting snapback duration. The presented information can be used for an optimization of the Tevatron and for future LHC operations.

WEPLS112

Study of 2-in-1 Large-aperture Nb3Sn IR Quadrupoles for the LHC Luminosity Upgrade

A.V. Zlobin, V. Kashikhin (Fermilab)

After LHC operates for several years at nominal parameters, it will be necessary to upgrade it to higher luminosity. Replacement of the low-beta insertions with higher performance design based on advanced superconducting magnets is one of the most straightforward steps in this direction. An interesting option for a new IR design is a double bore inner triplet with separation dipoles placed in front of the focusing quadrupoles. This approach reduces the number of parasitic collisions by more than a factor of three with respect to the quadrupoles-first option and allows independent field error correction for each beam. Several designs of the 2-in-1 Nb3Sn quadrupole magnets suitable for the LHC IR upgrade have been studied, including magnets with "cold" and "warm" iron yokes based on symmetric or asymmetric coils. This paper describes the design concepts of 2-in-1 large-aperture IR quadrupoles and compares their major performance parameters, including aperture, field gradient, field quality, electromagnetic stresses in the coils, and discuss some technological aspects of magnet fabrication.

Progress on the MICE Tracker Solenoid

M.A. Green, S.P. Virostek (LBNL) W. Lau, S.Q. Yang (OXFORD-physics)

This report describes the 400 mm warm bore tracker solenoid for the Muon Ionization Cooling Experiment (MICE). The 2.923 m long tracker solenoid module includes the radiation shutter between the end absorber focus coil modules and the tracker as well as the 2.780 meter long magnet cryostat vacuum vessel. The 2.554 m long tracker solenoid consists of two sections, a three-coil spectrometer magnet and a two-coil matching section that matches the uniform field 4 T spectrometer solenoid into the MICE cooling channel. The two tracker magnets are used to provide a uniform magnetic field for the fiber detectors that are used to measure the muon beam emittance at the two ends of the cooling channel. This paper describes the design for the tracker magnet coils and the 4.2 K cryogenic coolers that are used to cool the superconducting magnet. Interfaces between the magnet and the detectors are discussed.

Impedances in Slotted-Pipe Kicker Magnets

F. Marhauser, O. Dressler, V. Duerr, J. Feikes (BESSY GmbH)

Storage ring slotted-pipe kicker magnets based on the DELTA design are foreseen for the Metrology Light Source (MLS) of the Physikalisch-Technische Bundesanstalt currently under construction near the BESSY site. Although the slotted pipe maintains the cross-section of the storage ring vacuum chamber, image currents have to bypass the slots generating wakefields. Actually modes with substantial impedances have been revealed by simulations and verified by measurements of a kicker model for the MLS.

The Australian Synchrotron Storage Ring Dipole Power Supply

N.J. Meadowcroft, R. Farnsworth (ASP) P. Bellomo (SLAC) S. Cohen (LANL) R. Rumrill (Alpha Scientific Electronics)

The Australian Synchrotron storage ring consists of 28 dipoles, 56 focusing quadrupoles, 28 defocusing quadrupoles, 98 sextupoles, 42 horizontal correctors, 56 vertical correctors and 28 skew quadrupole correctors. The 28 dipole magnets are series connected and powered by a single 1100V, 850A, 24 pulse power supply with an output stability better than 100ppm. The paper will discuss the design, testing, commissioning and control interfaces for the storage ring dipole power supply.

The 3Hz Power Supplies of the SOLEIL Booster

P. Gros, S. Bobault, A. Loulergue (SOLEIL)

SOLEIL is a 2.75 GeV new third generation synchrotron radiation facility under construction near Paris. The injector system is composed of a 100 MeV electron Linac pre-accelerator followed by a full energy (2.75 GeV) booster synchrotron. A repetition rate of 3Hz is required for the booster for the filling of the Storage Ring together with the need for discontinuous operation for top-up filling mode. Based on digital regulation loop, the four power supplies (2 for the dipoles 600 A x 1000 V and 2 for the quadrupoles 250 A x 450 V) reach the current tracking tolerance specification of 10^{-3}. The aim of this paper is to describe the main issues from the loads to the mains network through the power converters that are essential to reach the required performances.

WEPLS119

Power Converters for the ISIS Second Target Station Project (TS-2)

S.L. Birch, A. Morris, S.P. Stoneham (CCLRC/RAL/ISIS)

The Extract Proton Beamline to the ISIS second target station will require magnets to be powered by ac/dc power converters. A total of 50 magnets, quadrupole and dipole, require high stability dc current converters over a large dynamic range from several kW to 600kW. There is also a requirement for two 10Hz pulsed magnets to extract the proton beam from the present 50Hz target beamline, and hence specially designed power supplies are necessary. This paper describes the selection process, types of topology considerations and final selections.

WEPLS122

Multiphase Resonant Power Converter for High Energy Physics Applications

M.J. Bland, J. Clare, P. W. Wheeler (University of Nottingham)

Accelerators used for experiments in high-energy physics require very high power radio frequency sources to provide the energy needed to accelerate the particles. The RF power needs to be stable and predictable such that any variation in the supplied RF power has a limited and acceptable impact on the accelerated beam quality. This paper considers the design of a "long-pulse" modulator supply rated at 25kV, 10A (250kW peak power, duty ratio 10%, 25kW average power, pulse length ~ 1 – 2ms). The supply is based on direct modulation of a multi-phase resonant power supply, fed by an active rectifier. The objectives of the development are to produce a compact power supply, with low stored energy and with high power quality at the utility supply. The paper provides a brief overview of the technology, followed by a discussion of the design choices. Initial results from the laboratory prototype will be included.

WEPLS123

Initial Experimental Results of a New Direct Converter for High Energy Physics Applications

D. Cook, M. Catucci, J. Clare, P. W. Wheeler (University of Nottingham) C. Oates (Areva T&D) J.S. Przybyla, R. Richardson (e2v Technologies)

This paper presents practical results for a new type of power supply for high energy physics CW applications. The converter is a direct topology operating with a high frequency (resonant) link. Losses are minimised by switching at zero current. High operating frequency reduces the filter and transformer size. The transformer uses the latest nano-crystalline materials to further reduce losses. Where possible, circuit elements are incorporated into the transformer to reduce the physical size of the converter. Design of this transformer to accommodate the insulation, VA rating and circuit elements is non-trivial. The Radio Frequency power generated is stable and predictable, whilst the reduced energy storage in filter components removes the need for crowbar circuits. Potential benefits of this converter when compared to conventional approaches are discussed. These include reduced energy storage, reduced turn-on time and enhanced energy density when compared with existing topologies. Preliminary practical results are promising and are presented along with simulation results.

Diamond Booster Magnet Power Converters

WEPLS124

J.A. Dobbing, C.A. Abraham, R.J. Rushton (Diamond) F. Cagnolati, M.P.C. Pretelli, L. Sita (O.C.E.M. S.p.A.) G. Facchini (CERN) C. Rossi (CASY)

This paper will describe the design, factory tests, commissioning and early operation of the Diamond Booster Power Converters. The Power Converters covered are the Dipole, Quadrupole with two outputs, two bi-polar Sextupoles and 44 Steerers. The actual achieved performance will be compared with the specification and the extensive modelling that was carried out during the design phase. The design includes measures to enhance the reliability of the power converters, such as redundancy, plug-in modularity, component de-rating and component standardisation. All the Diamond power converters use the same digital controller, manufactured under licence from the Paul Scherrer Institute.

Diamond Storage Ring Magnet Power Converters

WEPLS125

R.J. Rushton, C.A. Abraham, J.A. Dobbing (Diamond) F. Cagnolati, G. Facchini, M.P.C. Pretelli, V.R. Rossi, L. Sita (O.C.E.M. S.p.A.) C. Rossi (CASY)

The DC Magnet Power Converter requirements for the Storage Ring of the Diamond Project are described together with performance, commissioning and initial operating experience. In addition to meeting the required performance, emphasis during the design phase was placed on reliability and minimising the mean time to repair a power converter. A modular design, built-in redundancy, EMC filtering and testing, component de-rating and standardisation have all been adopted. The power modules for the 200A supplies were subject to highly accelerated stress screening. All converters are switched mode with full digital control and a common control interface. Every power converter appears identical to the Controls Network, from the lowest power corrector up to the 800 kW Storage Ring Dipole Converter.

CNAO Resonance Sextupole Magnet Power Converters

WEPLS126

M.F. Farioli, F. Burini, S. Carrozza, M. Cavazza, S. Minisgallo, M.P.C. Pretelli, G. Taddia (O.C.E.M. S.p.A.) D. Bagnara, M. Spera, A. Tilli, M. Toniato (CASY) I. De Cesaris (CNAO Foundation) M. Incurvati, C. Sanelli (INFN/LNF)

The CNAO Resonance Sextupole Magnet Power Converter requirements for the Storage Ring of the CNAO Project are described together with performance and initial operating experience. In particular the achieved performances will be compared with the specification and the extensive modelling that was done during the design phase. Not only the tight required performances were emphasized during the design phase but also particular attention was put on reliability and minimization of the repairing time (MTTR). Some fundamental criteria, like component de-rating and standardisation, have also been taken into account during the component choice phase. All converters adopt the switching technology with full digital control and a common control interface, that, as for the other CNAO power converters, uses the same digital controller, under licence from the Diamond Light Source.

WEPLS127

CNAO Storage Ring Dipole Magnet Power Converter 3000A / ±1600V

M.P.C. Pretelli, F. Burini, S. Carrozza, M. Cavazza, M.F. Farioli, S. Minisgallo, G. Taddia (O.C.E.M. S.p.A.) I. De Cesaris (CNAO Foundation) M. Incurvati, C. Sanelli (INFN/LNF) F. Ronchi, C. Rossi, M. Spera, M. Toniato (CASY)

This paper will describe the design and simulations of the CNAO Dipole Power Converter rated 3000A / ±1600V. The Power Converter will feed the 16+1 synchrotron bending dipole magnets of the CNAO Storage Ring. The actual design confirms how the choice of a 24-pulses, 4 bridges series-parallel connected, active filter, bipolar voltage, meets the stringent requested technical specification (10^{-5} of maximum current for the output current residual ripple and setting resolution). The extensive modelling will also be presented. The design includes the strength of the topology design, component de-rating and component standardisation. As the other CNAO power converters, the Storage Ring Dipole Power Converter uses the same digital controller, under licence from the Diamond Light Source.

WEPLS128

The Italian Hadrontherapy Center (CNAO): A Review of the Power Supply System for Conventional Magnets

M. Incurvati, C. Sanelli (INFN/LNF) L. Balbo, N. Balbo, A. Tescari (EEI) F. Burini, S. Carrozza, M. Cavazza, M.F. Farioli, S. Minisgallo, M.P.C. Pretelli, G. Taddia (O.C.E.M. S.p.A.) I. De Cesaris (CNAO Foundation)

A hadron (Carbon/Proton) medical centre based on a synchrotron accelerator dedicated to the cure of deep tumours is under construction in Pavia (Italy) under the joint responsibility of CNAO (Centro Nazionale di Adroterapia Oncologica) and INFN (Istituto Nazionale di Fisica Nucleare). This paper describes the power supply system, made up of about 200 units designed by LNF, and whose converters for the synchrotron ring and related low, medium and high energy transfer lines are now under construction by the major Italian companies. The power supplies requirements and electrical characteristics will be reported describing the most interesting topologies that fulfill the requested performances together with the main features of each power supply topology. Synchrotron dipoles, quadrupoles, sextupoles and resonance sextupole power supplies have tight characteristics with respect to precision class (current resolution, residual ripple, short-long term stability, etc.) that range from 5 ppm to 500 ppm, fast dynamical response with bandwidth up to some hundreds hertz, high power from tens of kW to many MW and output current ranging from hundreds of A to 3 kA.

WEPLS129

Upgrade Scheme for the J-PARC Main Ring Magnet Power Supply

H. Sato, K. Koseki, K.O. Okamura, t.s. Shintomi (KEK)

Japan Proton Accelerator Research Complex (J-PARC) is under construction at the Tokai campus of Japan Atomic Energy Agency (JAEA) as a joint project between KEK and JAEA. The accelerator complex, which is constructed as a 200 MeV linac, a 3 GeV RCS synchrotron, and a main ring in phase I. The main ring magnet power supply is constructing as the energy of 40 GeV in phase I and will upgrade up to 50 GeV in phase II. A large amount of pulse electric power, which is + 115 MW and -55 MW peak-to-peak, is required for 50 GeV operation and this large pulse power will give unallowable disturbances to a power network. In order to compensate the disturbances to allowable level, we need some energy storage system. A SMES system will be one of the promising means for the purposes as well as the fly-wheel system. We will describe some energy storage system and also the increasing of repetition rate without energy storage system.

Programmable Power Supply for Distribution Magnet for 20-MeV PEFP Proton Linac

S.-H. Jeong, J. Choi, H.-S. Kang, D.E. Kim, K.-H. Park (PAL)

The distribution magnet is powered by bipolar switching-mode converter that is employed IGBT module and has controlled by a DSP (Digital Signal Process). This power supply is operated at ?350A, 5 Hz programmable stair output for beam distribution to 5 beamlines of 20-MeV PEFP proton linac. Various applications for the different power supply are made simple by software. This paper describes the design and test results of the power supply.

New Magnet Power Supply for PAL Linac

S.-C. Kim, J. Choi, K.M. Ha, J.Y. Huang, J.H. Kim, S.H. Kim, I.S. Ko, S.S. Park (PAL)

Since the completion of PLS in 1994, PLS Linac magnet power supply(MPS) has been operated for 12 years with 12-bit resolution and 0.1% stability. Improvement in the resolution and the reliability of the Linac MPS is highly required now for the stable beam injection and 4th generation light source research. To improve MPS, we developed new compact MPS of 16-bit resolution and 20ppm stability using four-quadrant switching scheme with 50kHz MOSFET switching device. Bipolar MPS for corrector magnet consists of main power board, control power board, regulator board and CPU board. Size of each board is only 100mm width and 240mm depth. Unipolar MPS for quadrupoles and solenoid magnets is composed by parallel-operation of two main power boards, doubling the current output. Output of MPS is 10V, ±10A for the bipolar and 50V, 50A for the unipolar magnet. In this paper, we report on the development and characteristics of the new MPS for PAL linac.

Stability Study of Superconductor Magnet Power Supplies at TLS

Y.-C. Chien, K.-T. Hsu, C.-S. Hwang, C.-Y. Liu, K.-B. Liu (NSRRC)

In this paper, performance of three power supplies schemes driving the newly-developed Superconducting Wave Length Shifter Magnet at TLS is investigated. Due to the inherent structure of the Superconducting Magnet, the main and two accessory trimming power supplies are physically correlated with each others. Due to the inherent structure, in order to achieve high performance control of the magnet, slew rate control of the main power supply and the proper operation sequence have to be properly managed, otherwise, small current disturbance can occurs, which may disgrade the stability of the performance of Superconducting Magnet.

Design and Modeling of the Step Down Piezo Transformer

C.-Y. Liu, Y.-C. Chien, K.-B. Liu (NSRRC)

The energy conversion and the step down voltage waveform of the piezo transformer are required to achieve optimal working condition of the resonate frequency. To meet this requirement, a reliable and precise instrument is needed to scan the resonated point of the piezo transformer such that the piezo transformer's output performance can meet required specification. In this paper, design and modeling of a new step down piezo transformer deployed in NSRRC is described. This step down piezo transformer is capable of delivering energy conversion with high efficiency performance, which is better than traditional transformer, and the voltage transfer ratio is correct. The simulation circuit model used to develop driver circuit of the piezo transformer is also included in the design of this new step down transformer. It has been tested and proven to be working well in power conversion with excellent efficiency and reliability.

WEPLS135

Piezoelectric Transformer Based Continuous-conduction-mode Voltage Source Charge-pump Power Factor Correction Electronic Ballast

R.L. Lin, H.-M. Shih (NCKU) C.-Y. Liu, K.-B. Liu (NSRRC)

This paper presents the piezoelectric transformer (PT) based continuous-conduction-mode (CCM) voltage source (VS) charge-pump (CP) power factor correction (PFC) electronic ballast. By replacing L-C resonant tank and transformer in the conventional CCM VS CP PFC electronic ballast with PT, the cost and volume can be reduced. The main drawback of conventional electronic ballast is that the input current has a narrow conduction angle, which causes rich harmonic that pollute the power system. However, the conventional CCM VS CP PFC electronic ballast is able to solve this problem but still require larger volume. Since the equivalent circuit of PT is identical to the conventional L-C resonant tank used in CCM VS CP PFC electronic ballast, the L-C resonant tank can be replaced by the PT to reduce the cost and volume. In addition, the inherent input capacitance of the PT works as a turn-off snubber for the power switches to decrease the turn-off voltage spikes and thus reduces the turn-off losses of the switches. The results show that the electronic ballast using PT achieved high power factor and the switches can be operated under ZVS condition.

WEPLS136

Pulsed Magnet Power Supplies for Improved Beam Trajectory Stability at the APS

B. Deriy, L. Emery, A.L. Hillman, G.S. Sprau, J. Wang (ANL)

New power circuit and control electronics have been implemented in the septum power supplies at the Advanced Photon Source (APS). The goal was to meet a low pulse-to-pulse relative amplitude jitter of about $\pm 5\cdot10^{-4}$ for trajectory stability in the booster-to-storage ring transport line. The original power supply design produced a jitter of ± 15e-4, which made injection tuning difficult. The jitter for the two new booster pulsed magnet supplies is now 1.1e-4, as inferred by a beam-based statistical analysis. A common design was made for all of the septum magnet power supplies at the APS. The system, regulation algorithms, the results achieved, and the current regulation stability issues will be discussed.

WEPLS138

Operation Status and Statistics of the KEK Electron/Positron Linac

Y. Ogawa, A. Enomoto, K. Furukawa, T. Kamitani, M. Satoh, T. Sugimura, T. Suwada, Y. Yano, K. Yokoyama, M. Yoshida (KEK) Y. Imai, T. Kudou, S. Kusano, K. Suzuki, T. Toufuku (MELCO SC)

The KEK electron/positron linac has been operated since 1982, surpassing the total operation time of more than 100,000 hours. It delivers four different beams to four different rings quite stably, even frequently switching beam modes. The operation time per year has reached 7,000 hours since 1999 when the KEKB entered a normal operation mode. Operation status and statistics will be reported with the emphasis on continuing efforts in various kinds of machine improvements, which have ensured the stable operation.

Operational Status of Klystron-modulator System for PAL 2.5-GeV Electron Linac

WEPLS139

S.S. Park, J. Choi, J.Y. Huang, S.H. Kim, S.-C. Kim (PAL)

The klystron-modulator(K&M) system of the Pohang Accelerator Laboratory (PAL) generates high power microwaves for the acceleration of 2.5 GeV electron beams. There are 12 modules of K&M system to accelerate electron beams up to 2.5 GeV nominal beam energy. One module of the K&M system consists of the 200 MW modulator and an 80 MW S-band (2856 MHZ) klystron tube. The total accumulated high-voltage run-time of the oldest unit among the 12 K&M systems has reached nearly 88,000 hours as of December 2005. The overall system availability is well over 95%. In this paper, we review the overall system performance of the high-power K&M system and the operational status of the klystrons and thyratron lifetimes, and the overall system's availability will be analyzed for the period of 1994 to December 2005.

Update and Summary of the Dependability Assessment of the LHC Beam Dumping System

WEPLS140

R. Filippini, J.A. Uythoven (CERN)

The LHC Beam Dumping System (LBDS) must be able to remove the high intensity beams from the LHC accelerator on demand, at any moment during the operation. As the consequences of a major failure can be very severe, stringent safety requirements were imposed on the design. The final results of an in-depth dependability analysis on the LBDS are summarised, for one year of operation and different operational scenarios. The trade-off between safety and availability is discussed, along with the benefit from built-in features like redundancy, on-line surveillance and post-mortem diagnostics.

Operational Experience with the LHC Waveguide Mode Reflectometer

WEPLS141

T. Kroyer, P. Borowiec, F. Caspers, Z. Sulek, L.R. Williams (CERN)

The LHC microwave mode reflectometer (assembly version) reached operational status by the end of 2005. It is now routinely used in the LHC tunnel to take data on the beam-screen of the individual LHC magnets and also groups of magnets with lengths up to 200 meter. The reflectometer operates in the frequency range from about 4GHz to 8 GHz and employs mode selective launchers. Data traces of typically 16000 data points are taken in the frequency domain with subsequent Fourier transformation into the time domain and numerical waveguide mode dispersion compensation. This paper discusses the operational aspects of the system as well as methods for clutter (fake reflection) elimination and procedures for cross-checks in case of a suspected obstacle or other fault.

The Importance of Layout and Configuration Data for Flexibility during Commissioning and Operation of the LHC Machine Protection Systems

WEPLS142

J. Mariethoz, F.B. Bernard, R.H. Harrison, P. Le Roux, M.P. Peryt, M. Zerlauth (CERN)

Due to the large stored energies in both magnets and particle beams, the LHC requires a large inventory of machine protection systems, as e.g. powering interlock systems,

based on a series of distributed industrial controllers for the protection of the more than 10,000 normal and superconducting magnets. Such systems are required to be at the same time fast, reliable and secure but also flexible and configurable to allow for automated commissioning, remote monitoring and optimization during later operation. Based on the generic hardware architecture of the LHC machine protection systems presented at EPAC 2002 and ICALEPS 2003, the use of configuration data for protection systems in view of the required reliability and safety is discussed. To achieve the very high level of reliability, it is required to use a coherent description of the layout of the accelerator components and of the associated machine protection architecture and their logical interconnections. Mechanisms to guarantee coherency of data and repositories and secure configuration of safety critical systems are presented. This paper focuses on the first system being commissioned, the complex magnet powering system.

WEPLS143

SLS Operation Management: Methods and Tools

A. Lüdeke (PSI)

Users of 3rd generation synchrotron light sources desire not only a high flux on their samples and sub-micron beam stability, they expect at the same time a beam availability close to 100 percent. To reach and maintain a very high availability put special demands on the operation management of a light source. We will illustrate the procedures used at the Swiss Light Source (SLS) to deal with beam interruptions and explain the tools used for operation management.

WEPLS144

ES&H Issues for Design and Operation of Linear Colliders

J.E. Spencer (SLAC)

We consider optimization of the generalized luminosity per unit cost of a linear collider in the current ES&H era. Several specific examples, running over the length of the LC, beginning at the source and ending at the dump suggest that both costs (capital and operating) and the environmental issues can be improved in a mutually compatible way. Thus, a RoHS by any other name such as WEES or OSHA need not present thorny problems requiring unexpected technology R&D but rather a push to leverage the many recent advances that might otherwise be avoided. While not mainstream, the physics is challenging and the true amortized cost may be seriously underestimated by ignoring such issues. As example, the entire, interior surface of a laser driven RF gun involves interesting materials science where the space requires continuous UHV to sustain stable and acceptable quantum efficiency as well as avoid RF breakdown damage in an environment that is also subject to radiation damage that can reduce output from window damage. Rad hard systems can be like bug-proof software. They don’t have to be overly slow, large or heavy and provide opportunities to innovate and justify the cost of such systems.

THXPA — Synchrotron Light Sources and FELs

Overview of the Status of the Diamond Project

THXPA01

R.P. Walker (Diamond)

The presentation will outline the status of the Diamond project including an overview of the major areas of technical challenge including reference to the physics issues and their impact on design and performance. The majority of the talk will present the status and challenges of first commissioning, outlining the current performance and the challenges in achieving operational status.

Overview of the Status of the SOLEIL Project

THXPA02

J.-M. Filhol, J.C. Besson, P. Brunelle, M.-E. Couprie, J.-C. Denard, J.M. Godefroy, C. Herbeaux, V. Le Roux, P. Lebasque, A. Lestrade, M.-P. Level, A. Loulergue, P. Marchand, J.L. Marlats, A. Nadji, L.S. Nadolski, R. Nagaoka, B. Pottin, M.-A. Tordeux (SOLEIL)

SOLEIL is a third generation synchrotron radiation source, under construction in France near Paris. The storage ring consists of a 357 m circumference ring, with 16 cells and 24 straight sections, out of which up to 21 will house insertion devices (ID). The optics features a low 3.7 nm.rad emittance at the 2.75 GeV operating energy, so as to provide high brilliance, from the VUV up to the hard x-ray domain. To reach a long lifetime, and beam position stabilities in the micron range, significant attention was paid at each design stage (optics, magnets, beam position monitors, vacuum and RF systems…), including on the design of the building, the construction of which is now complete. This resulted in some unprecedented approaches such as the intensive use of NEG coating vessels, or the development of a dedicated SC RF cavity and of 200 kW solid state RF amplifiers. The injector system (100 MeV Linac) and the 3 Hz full energy booster synchrotron have reached nominal operating conditions by fall 2005, while the ring commissioning should start by April 2006. Innovative ID's were designed and built so as to provide the best possible performances in a wide energy range (5 eV to 50 keV).

Laser Systems and Accelerators

THXPA03

H. Schlarb (DESY)

The presentation will cover the use of laser systems in accelerators. Topics covered will be the use of lasers for the production of electron beam from photocathodes, timing and diagnostics, laser heater systems to control space charge effects, as seed systems. Challenges in terms of stability, pulse shaping, power and pulse lengths, wavelength range and tuning will be covered for the various aspects.

THYPA — Synchrotron Light Sources and FELs

THYPA01

Overview of FEL Injectors

M. Ferrario (INFN/LNF)

Future light sources based on high gain free electron lasers, require the production, acceleration and transport up to the undulator entrance of high brightness (low emittance, high peak current) electron bunches. Wake fields effects in accelerating sections and in magnetic bunch compressors typically contribute to emittance degradation, hence the photo-injector design and its operation is the leading edge for high quality beam production and for the success of the future light sources. RF guns, photo-cathode materials, laser pulse shaping and synchronization systems are evolving towards a mature technology to produce high quality and stable beams. Nevertheless reduction of thermal emittance, damping of emittance oscillations and bunch compression are still the main issues and challenges for injector designs. With the advent of Energy Recovery Linacs, superconducting RF guns have been also considered in many new projects as a possible electron source operating in CW mode. An overview of recent advancements and future perspectives in FEL injectors will be illustrated in this talk, including a comparison of merits and issues of RF compression versus magnetic compression techniques.

THOPA — Synchrotron Light Sources and FELs

Formation of Electron Bunches for Harmonic Cascade X-ray Free Electron Lasers

THOPA01

M. Cornacchia, S. Di Mitri, G. Penco (ELETTRA) A. Zholents (LBNL)

A relatively long electron bunch is required for an operation of harmonic cascade free electron lasers (FELs). This is because they repeatedly employ a principle when the radiation produced in one cascade by one group of electrons proceeds ahead and interacts with other electrons from the same electron bunch in the next cascade. An optical laser is used to seed the radiation in the first cascade. Understandably the length of the electron bunch in this situation must accommodate the length of the x-ray pulse multiplied by a number of cascades plus a time jitter between the arrival time of the electron bunch and a seed laser pulse. Thus a variation of the peak current along the electron bunch as well as slice energy spread and emittance may affect the performance of the FEL. In this paper we analyze all possible sources affecting the distributions and interplay between them and show how desirable distributions can be produced. Results are illustrated with simulations using particle tracking codes.

Status of the SCSS Test Accelerator and XFEL Project in Japan

THOPA02

T. Shintake (RIKEN Spring-8 Harima)

Construction of the SCSS* 250 MeV test accelerator was completed in October 2005, and the beam commissioning was started in November 2005. The first light at visible wavelength, which is the spontaneous radiation from undulator, was observed right after machine commissioning. We expect the first SASE beam around 60 nm in 2006. The purpose of the test accelerator is to assemble all hardware components in a real machine, and check their performance, reliability and stability. It is also very important to build all control software and link to the main frame to see system performance. All experience will provide feedback to 8 GeV XFEL design, whose construction will start in April 2006.
*http://www-xfel.spring8.or.jp

An Integrated Femtosecond Timing Distribution System for XFELs

THOPA03

J. Kim, J. Burnham, dc. Cheever, J. Chen, F.X. Kaertner (MIT) M. Ferianis (ELETTRA) F.O. Ilday (Bilkent University) F. Ludwig, H. Schlarb, A. Winter (DESY)

Tightly synchronized lasers and rf-systems with timing jitter in the few femtoseconds range are an important component of future x-ray free electron laser facilities. In this paper, we present an optical-rf phase detector that is capable of extracting an rf-signal from an optical pulse stream without amplitude-to-phase conversion. Extraction of a microwave signal with less than 10 fs timing jitter (from 1 Hz to 10 MHz) from an optical pulse stream is demonstrated. Scaling of this component to sub-femtosecond resolution is discussed. Together with low noise mode-locked lasers, timing-stabilized optical fiber links and compact optical cross-correlators, a flexible femtosecond timing distribution system with potentially sub-10 fs precision over distances of a few kilometres can be constructed. Experimental results on both synchronized rf and laser sources will be presented.
*A. Winter et al. "Synchronization of Femtosecond Pulses", Proceedings of FEL 2005.**J. Kim et al. "Large-Scale Timing Distribution and RF-Synchronization for FEL Facilities", Proc. of FEL 2004.

THPPA — Prize Presentations

THPPA01

High-precision Laser Master Oscillators for Optical Timing Distribution Systems in Future Light Sources

A. Winter, P. Schmüser, A. Winter (Uni HH) J. Chen, F.X. Kaertner (MIT) F.O. Ilday (Bilkent University) F. Ludwig, H. Schlarb (DESY)

Abstract to be supplied

THPPA02

High-Gradient Superconducting Radiofrequency Cavities for Particle Acceleration

L. Lilje (DESY)

The development of radiofrequency superconductivity for particle acceleration has reached a level where many projects consider its use. One of the many attractive features of these accelerating structures is to achieve very high accelerating fields efficiently. The technology has been developped to a stage where accelerating gradients of more than 25 MV/m are being implemented in accelerator modules. In single-cell test resonators even higher gradients were already achieved. To operate cavities at these gradients efficiently their frequency needs to be kept stable to reduce the need for an overhead in radiofrequency power. Introducing active elements like piezoelectric actuators allows to achieve these goals.

THPPA03

The First CW Accelerator in USSR and a Birth of Accelerating Field Focussing

V.A. Teplyakov (IHEP Protvino)

In the absence of Professor Teplyakov, Robert Jameson will present the work for which Professor Teplyakov is awarded the 2006 EPS-AG Prize for Achievement. The abstract of Professor Teplyakov's presentation follows: As CW linear accelerators became required, it appeared an absolute necessity to change the initial part of the accelerator. The initial part should prepare bunches of charged particles for the further acceleration in the main part. The CW accelerator should also be economic and reliable. The problem was solved using the principles of adiabatic capture of particles and low energy injection with focusing by means of the RF field. The acceleration of bunches with non-increasing charge density was the basic idea. It allowed reduction of the injection energy without reducing the current. By 1972, initial testing in IHEP Protvino was accomplished, and the first accelerated beam was obtained in an RFQ. The URAL-30 proton linac was commissioned in 1977 in IHEP. It applies RFQ-focusing from injection up to the top energy of 30 MeV. From 1985 until the present, this facility routinely operates as an injector to a booster proton synchrotron, this feeding the entire accelerator complex of ITEP. Development of the first RFQ in the Western world was started at Los Alamos in 1978 and performed a proof-of-principle test in 1980. After that there were many articles and reports and the RFQ became widely known in the world.

THESPA — Special Invited Presentation

Before the Big Bang: An Outrageous New Perspective and its Implications for Particle Physics

R. Penrose (Mathematical Institute)

The second law of thermodynaics implies that big bang must have been an extraordinarily precisely organized state. What was the geometrical nature of this state? How can we resolve, in any scientific way, the mystery of how such precision came about? In this talk, a novel (and perhaps outrageous) solution is suggested, which involves an examination of what is to be expected of the very remote future of our universe, with its observed accelerated expansion. Some possible observational consequences of the proposal will be indicated, together with some apparent implications for particle physics, some of which are non-standard.

THXFI — Beam Dynamics and Electromagnetic Fields

THXFI01

State of the Art in EM Field Computation

C.-K. Ng, V. Akcelik, A.E. Candel, S. Chen, N.T. Folwell, L. Ge, A. Guetz, H. Jiang, A.C. Kabel, K. Ko, L. Lee, Z. Li, E. Prudencio, G.L. Schussman, R. Uplenchwar, L. Xiao (SLAC)

This presentation will provide an up-to-date survey of the methods and tools for the computation of electromagnetic fields in accelerator systems and components.

THOAFI — Beam Dynamics and Electromagnetic Fields

The Development of Computational Tools for Halo Analysis and Study of Halo Growth in the Spallation Neutron Source Linear Accelerator

THOAFI01

D.A. Bartkoski, A.V. Aleksandrov, S.M. Cousineau, S. Henderson, J.A. Holmes (ORNL)

Computational tools have been developed to quantify the halo in a beam by analyzing beam profiles and identifying the halo particles using the Gaussian area ratio and kurtosis methods. Simulations of various injection quadrupole magnet configurations using three types of initial simulated distributions, along with an analysis of their phase space and rms properties, provides insight into the development of halo in the Spallation Neurton Source linear accelerator. Finally, comparisons with machine beam profile data, taken at the same conditions as that of the simulated data, show how accurately the simulations model the beam and its halo development and provide a better understanding of the best machine configuration with which to minimize beam halo and losses.

Ion Instability Observed in PLS Revolver In-vacuum Undulator

THOAFI02

H.-S. Kang, J. Choi, M. Kim, T.-Y. Koo, T.-Y. Lee, P.C.D. Park (PAL)

Revolver In-Vacuum X-ray Undulator which was designed and fabricated at Spring-8 is under commissioning at PLS. This planar undulator whose permanent magnet array structure is a revolving type with 90-degree step provides 4 different undulator wavelengths of 10, 15, 20, and 24 mm. The minimum gap of the undulator is as small as 5 mm. It was observed that the trailing part of a long bunch train was scraped due to ion instability when the undulator gap was closed below 6 mm. At that time the vacuum pressure in the undulator, which is estimated to be about one order of magnitude lower than that of the undulator gap, increased from 1.4×10^{-10} (gap 20 mm) to 7.9×10^{-10} Torr (gap 6 mm) at the stored beam current of 100 mA. This high vacuum pressure causes fast beam-ion instability: trailing part of a long bunch train oscillates vertically. It was also confirmed that adjusting the orbit along the undulator has improved the situation to some extent. The ion instability measured with a pico-second streak camera and a one-turn BPM as well as the result of orbit adjustment and chromaticity control will be described in this paper.

Global and Local Coupling Compensation in RHIC using AC Dipoles

THOAFI03

R. Calaga (BNL) F. Franchi (GSI) R. Tomas (CERN)

Compensation of transverse coupling during the RHIC energy ramp has been proven to be non-trivial and tedious. The lack of accurate knowledge of the coupling sources has initiated several efforts to develop fast techique using turn-by-turn BPM data to identify and compensate these sources. This paper aims to summarize the beam experiments performed to measure the coupling matrix and resonance driving terms with the aid of RHIC ac dipoles.

THYFI — Beam Instrumentation and Feedback

Tevatron Ionization Profile Monitoring

A. Jansson, K. Bowie, T. Fitzpatrick, R. Kwarciany, C. Lundberg, D. Slimmer, L. Valerio, J.R. Zagel (Fermilab)

Ionization Profile monitors have been used in almost all machines at Fermilab. However, the Tevatron presents some particular challenges with its two counter-rotating, small beams, and stringent vacuum requirements. In order to obtain adequate beam size accuracy with the small signals available, custom made electronics from particle physics experiments was employed. This provides a fast (single bunch) and dead-timeless charge integration with a sensitivity in the femto-Coulomb range, bringing the system close to the single ionization electron detection threshold. The detector itself is based on a previous Main Injector prototype, albeit with many modifications and improvements. The first detector was installed at the end of 2005, with a second detector to follow during the spring shutdown. The ultimate is to continuously monitor beam size oscillations at injection, as well as the beam size evolution during ramp and squeeze.

THOBFI — Beam Instrumentation and Feedback

A Sub 100 fs Electron Bunch Arrival-time Monitor System for FLASH

THOBFI01

F. Loehl, K.E. Hacker, F. Ludwig, H. Schlarb, B. Schmidt (DESY) A. Winter (Uni HH)

The stability of free-electron lasers and experiments carried out in pump-probe configurations depends sensitively on precise synchronization between the photo-injector laser, low-level RF-systems, probe lasers, and other components in the FEL. A measurement of the jitter in the arrival-time of the electron bunch with respect to the clock signal of a master oscillator is, therefore, of special importance. For this task, we propose an arrival-time monitor based on a beam pick-up with more than 10GHz bandwidth which permits measurements in the sub 100 fs regime. The RF-signal from the beam pick-up is sampled by an ultra-short laser pulse using a broad-band electro-optical modulator. The modulator converts the electron bunch arrival-time jitter into an amplitude modulation of the laser pulse. This modulation is detected by a photo detector and sampled by a fast ADC. By directly using the laser pulses from the master laser oscillator of the machine, any additional timing jitter is avoided. In this paper we present the layout of the system and first experimental results.

Measurement of the Beam Profiles with the Improved Fresnel Zone Plate Monitor

THOBFI02

H. Sakai, N. Nakamura (ISSP/SRL) H. Hayano, T. Muto (KEK)

We present the recent progress of the FZP (Fresnel Zone Plate) beam profile monitor constructed at KEK-ATF damping ring. This monitor based on an X-ray imaging optics with two FZPs*. In this monitor, the transverse electron beam image at bending magnet is twenty-times magnified by the two FZPs and detected on an X-ray CCD camera. Then the real-time and 2-dimentional transverse beam profiles can be obtained with non-destructive manner by using this monitor. The expected spatial resolution is less than 1 micro-meter. Recently, we install the new mechanical shutter to improve time resolution of the monitor and avoid the effects of the short-term movement of the beam or the monitor itself. By applying this shutter, the shutter opening time was reduced less than 1ms and the beam profile could be measured more accurately. In this paper, we report the new shutter performance and the measurement results of beam profiles by the improved FZP beam profile monitor.

*K. Iida, et al. Nucl. Instrum. Meth. A 506 (2003) 41-49.

Record-high Resolution Experiments on Comparison of Spin Precession Frequencies of Electron Bunches Using the Resonant Depolarization Technique in the Storage Ring

THOBFI03

S.A. Nikitin, O. Anchugov, V.E. Blinov, A. Bogomyagkov, V.P. Cherepanov, G.V. Karpov, V. Kiselev, E. Levichev, I.B. Nikolaev, A.A. Polunin, E. Shubin, E.A. Simonov, V.V. Smaluk, M.V. Struchalin, G.M. Tumaikin (BINP SB RAS)

The opportunity of performing an experiment on high precision comparison of the electron and positron anomalous magnetic moments following the VEPP-2M experiment is under study at the VEPP-4M storage ring. The record accuracy of 2x10-8 was obtained for comparison of spin precession frequencies in the experiment on resonant depolarization with simultaneously circulating electron bunches, two of them polarized and one unpolarized. It is the first time when the spreading of the spin precession frequency line (~5x10-7,) due to scattering of particle trajectories about the equilibrium orbit in a non-linear field of the storage ring, was presumably observed in experiments. We proposed and realized an RF scheme for controlled separation of the spin precession frequencies of two electron bunches; the first measurements using this scheme were made.

THPCH — Poster Session

Nonlinear Stability in the Transport of Mismatched Beams in a Uniform Focusing Field

THPCH001

R. Pakter, F.B. Rizzato, W. Simeoni (IF-UFRGS)

A nonlinear stability analysis of mismatched breathing beams considering nonaxysymmetric perturbations is performed. It is shown that breathing oscillations of an initially quasi-round beam may nonlinearly induce quadrupole-like oscillations, with a possible increase of the beam size along one direction. A simple model for the nonlinear coupling is developed to clarify the instability mechanism. Growth rates are determined and compared to that of other instabilities that affect mismatched beams, such as halo formation. Self-consistent simulations with different beam loading distributions are used to verify the findings.

Combined Centroid-envelope Dynamics of Intense, Magnetically Focused Charged Beams Surrounded by Conducting Walls

THPCH002

F.B. Rizzato, K. Fiuza, R. Pakter (IF-UFRGS)

This paper analyses the combined envelope-centroid dynamics of magnetically focused high-intensity charged beams surrounded by conducting walls. Similarly to the case were conducting walls are absent*, we show that the envelope and centroid dynamics decouples from each other. Mismatched envelopes still decay into equilibrium with simultaneous emittance growth, but the centroid keeps oscillating with no appreciable energy loss. Some estimates are performed to analytically obtain some characteristics of halo formation seen in the full simulations.
*Moraes et al. Phys. Rev. Lett. 93, 244801 (2004).

Influence of Beam-Breakup Instabilities on Electron Focusing

THPCH003

M. Caron, F. Cartier, D.C. Collignon, L.H. Hourdin, M. Mouillet, D.P. Paradis, N. Pichoff (CEA)

High intensity electron beam focusing is a key issue for the successful development of flash radiography at hydro test facilities. AIRIX is a 2 kA, 19 MeV, 60 ns, single shot linear accelerator that produces X-rays from the interaction between relativistic electrons and a Tantalum solid target (Ta). In that emittance dominated process, different physical mechanisms can limit the end focusing of the intense electron beam on Ta. In the present paper, the role of the beam break-up (BBU) instabilities is pointed out. The theory of BBU for induction linacs has been developed for quite some time. For an accelerating beam with steady state radial oscillations at the accelerator entrance, the theoretical prediction regarding the amplitude growth after n successive cavities agrees with the experimental observations. Therefore, as a result of the subsequent emittance growth a spot size enlargement would be expected. As a matter of fact, we found out experimentally that no direct correlation can be drawn up between BBU growth and focal spot dimensions over the range of transverse beam motion investigated. This finding gives now new orientations on the way to reduce the spot size.

THPCH004

Space Charge Induced Resonance Trapping in High-intensity Synchrotrons

G. Franchetti, I. Hofmann (GSI)

With the recent development of high-intensity circular accelerators, the simultaneous presence of space charge and lattice nonlinearities has gained special attention as possible source of beam loss. In this paper we present our understanding of the role of space charge and synchrotron motion as well as chromaticity for trapping of particles into the islands of nonlinear reonances. We show that the three effects combined can lead to significant beam loss, where each individual effect leads to small or negligible loss. We apply our findings to the SIS100 of the FAIR project, where the main source of field nonlinearities stems from the pulsed super-conducting dipoles, and the beam dynamics challenge is an extended storage at the injection flat-bottom, over almost one second, together with a relatively large space charge tune shift.

THPCH005

Considerations for the High-intensity Working Point of the SIS100

G. Franchetti, O. Boine-Frankenheim, I. Hofmann, V. Kornilov, P.J. Spiller, J. Stadlmann (GSI)

In the FAIR project the SIS100 synchrotron is foreseen to provide high-intensity beams of U 28+, including slow extraction to the radioactive beam experimental area, as well as high-intensity p beams for the production of antiprotons. In this paper we discuss the proposal of three different working points, which should serve the different needs: (1) a high intensity working point for U^{28+}; (2) a slow extraction working point (also U^{28+}); (3) a proton operation working point to avoid transition crossing. The challenging beam loss control for all three applications requires a careful account of the effects of space charge, lattice nonlinearities and chromaticity, which will be discussed in detail in this paper. Since tunes are not split by an integer and the injected emittances are different, the Montague stop-band needs to be avoided. Moreover, final bunch compression for the U beam requires a sufficiently small momentum spread, and the risk of transverse resisitive wall instabilities poses further limitations on our choice of working points.

THPCH006

Scaling Laws for the Montague Resonance

I. Hofmann, G. Franchetti (GSI)

The space-charge-driven Montague resonance is a source of emittance coupling in high-intensity accelerators with un-split tunes. Here we present scaling laws for the stop-band widths, growth rates and crossing behavior of this fourth order resonance. Our results on the coupling can be applied to circular machines as well as to linear accelerators. Based on self-consistent coasting beam simulation we show that for slow crossing of the stop-bands a strong directional dependence exists: in one direction the exchange is smooth and reversible, in the other direction it is discontinuous. We also discuss the combined effect of the Montague resonance and linear coupling by skew quadrupoles.

Development of a High Current Proton Linac for FRANZ

THPCH007

C. Zhang, A. Schempp (IAP)

The FRANZ Facility, a planned worldwide unique pulsed neutron source, will be built at Frankfurt University. A single RFQ or an RFQ-IH combination working at 175MHz will be used to accelerate a 200mA proton beam to the energy which can meet the demands of required neutron production. The beam dynamics study has been performed to design a flexible, short-structure and low-beam-loss RFQ accelerator. The design results and relative analyses are presented.

The Non-linear Space Charge Field Compensation of the Electron Beam in the High Energy Storage Ring of FAIR

THPCH008

A.N. Chechenin, R. Maier, Y. Senichev (FZJ)

In the High Energy Storage Ring, a part of the FAIR project at GSI in Darmstadt, the internal target is used. To compensate the interaction of the beam with the target, the electron beam cooling is needed. However, together with the cooling, the non-linear space charge field of electron beam modifies the dynamic aperture. We investigate the possible schemes of this effect compensation using the multi-pole correctors on the HESR.

Electron Beam-laser Interaction near the Cathode in a High Brightness Photoinjector

THPCH010

M. Ferrario, G. Gatti (INFN/LNF) J.B. Rosenzweig (UCLA) L. Serafini (INFN-Milano)

The production of high charge short bunches in a high brightness photoinjector requires laser pulses driving the cathode with GW range peak power on a mm spot size. The resulting transverse electric field experienced by the electron beam near the cathode is of the order of 200-500 MV/m, well in excess of a typical RF accelerating field of 50-100 MV/m. We present here an analytical and computational study of the resultant beam dynamics. Simulations including the electron beam-laser interaction have been performed with the code HOMDYN taking into account the superposition of incident and reflected laser pulses as well as space charge fields. Under this conditions the emittance degradation is negligible, as predicted by analytical methods, but a longitudinal charge modulation occurs on the scale of the laser wavelength, in case of oblique incidence, driven by the longitudinal component of the laser field. Preliminary simulations up to the photoinjector exit show that charge modulation is transformed into energy modulation via the space charge field, which may produce enhanced microbunching effects when the beam is further compressed in a magnetic chicane.

Wire Compensation of Parasitic Crossings in DAFNE

THPCH011

M. Zobov, D. Alesini, C. Milardi, M.A. Preger, P. Raimondi (INFN/LNF) D.N. Shatilov (BINP SB RAS)

Long-range beam-beam interactions (parasitic crossings) are one of the main luminosity performance limitations for the Frascati e^+e^- Phi-factory DAFNE. In particular, the parasitic crossings (PC) lead to a substantial lifetime reduction of both beams in collision. This puts a limit on the maximum storable current and, as a consequence, on achievable peak and integrated luminosity. In order to alleviate the problem numerical and experimental studies of the PC compensation with current-carrying wires have been performed at DAFNE. Two such wires have been installed at both ends of the KLOE interaction region. Switching on the wires in accordance with the numerical predictions, improvement in the lifetime of the "weak" beam (positrons) has been obtained at the maximum current of the "strong" one (electrons) without luminosity loss. In this paper we describe the PC effects in DAFNE, summarize the results of numerical simulations on the PC compensation with the wires and discuss the experimental measurements and observations.

THPCH013

Study of Particle Losses Mechanism for J-PARC Main Ring

A.Y. Molodozhentsev, M. Tomizawa (KEK)

Detailed understanding as well as confidence in simulation modeling of long-term effects (~ 100'000 turns) of high intensity proton beam is crucial for Main Ring (MR) of the J-PARC project, where it is necessary to hold the high-intensity beam over typically ~ 2 sec with a loss level less than 1%. The major focus of such study is the combined effect of space charge and nonlinear resonances and its impact on halo formation and/or beam loss. In frame of this report, the tracking results for the injection process including realistic representation of the ring's focusing structure are discussed. Optimization of the working point during the injection process is presented. The halo formation and particle losses during the injection and acceleration for MR have been estimated for realistic magnetic field errors.

THPCH015

Matched and Equipartitioned Method for High-intensity RFQ Accelerators

X.Q. Yan, J.-E. Chen, J.X. Fang, Z.Y. Guo, Y.R. Lu (PKU/IHIP) R.A. Jameson (LANL)

Maintaining beam envelope match, avoiding structure resonances, and using an equilibrium (equipartitioned) energy balance within the beam are the primary methods for preventing emittance growth and halo formation in high current linacs. A design strategy that requires the RFQ accelerator to be matched and equipartitioned over most of its length will produces very robust designs under a wide variety of conditions, the beam with proper energy balance is also inherently stable against resonances near the operation point. Based on this strategy, a new dynamics method is proposed to avoid the envelope mismatch and energy imbalance between different degrees of freedom. The beam sizes are well confined to match the accelerating channel in this method, to minimize the emittance growth and the related beam loss. Following the method, a RFQ design code named MATCHDESIGN has been written at Peking University. A test design of 50mA proton RFQ operating at 350 MHz was given to prove this method and it resulted in a good dynamics design.

THPCH016

Transfer Matrix of Linear Focusing System in the Presence of Self-field of Intense Charged Particle Beam

Yu. Kazarinov (JINR)

Within the framework of moments method, the computation algorithm of the transfer matrix in the presence of self-field of the intense charged particle beam is given. The transfer matrix depends on both the linear external electromagnetic field parameters and the initial value of the second order moments of the beam distribution function. In the case of coupled degrees of freedom, the independent 2D subspaces of the whole phase space are found by means of the linear transformation of the phase space variables. The matrix of this transformation connects with second order moments of the beam distribution function. The momentum spread of the beam is taken into account also.

Resonance Trapping, Halo Formation and Incoherent Emittance Growth due to Electron Cloud

THPCH018

E. Benedetto, E. Benedetto (Politecnico di Torino) G. Franchetti (GSI) G. Rumolo, F. Zimmermann (CERN)

The pinched electron cloud introduces a tune shift along the bunch, which together with synchrotron motion, leads to a periodic crossing of resonances. The resonances are excited by the longitudinal distribution of the electron cloud around the storage ring. We benchmark the PIC code HEADTAIL against a simplified weak-strong tracking code based on an analytical field model, obtaining an excellent agreement. The simplified code is then used for exploring the long term evolution of the beam emittance, and for studying more realistic lattice models. Results are presented for the CERN SPS and the LHC.

Halo and Tail Generation Studies for Linear Colliders

THPCH019

L. Neukermans, H. Burkhardt (CERN) J. Resta-López (IFIC)

Halo particles in linear colliders can result in significant losses and serious background which may reduce the overall performances. We present a study of various halo generation processes with numerical estimates. The aim is to allow to predict and minimize the halo throughout the accelerator chain including the final focus up to the experimental detectors. We include estimates for the planned CLIC beam line.

Vlasov Equilibrium of a Periodically Twisted Ellipse-shaped Charged-particle Beam in a Non-axisymmetric Periodic Magnetic Focusing Field

THPCH023

J.Z. Zhou, C. Chen (MIT/PSFC)

A new Vlasov equilibrium is obtained for a periodically twisted ellipse-shaped charged-particle beam in a non-axisymmetric periodic permanent magnetic focusing field. The equilibrium distribution function is derived, and the statistical properties of the beam equilibrium are studied. The generalized envelope equations derived from the kinetic theory recovers the generalized envelope equations obtained in the cold-fluid theory when the temperature is taken to be zero*. Examples of periodically twisted elliptic beam equilibrium are presented and applications are explored.
*J. Zhou et al. “Exact Paraxial Cold-Fluid Equilibrium of a High-Intensity Periodically Twisted Ellipse-Shaped Charged-Particle Beam,” Phys. Rev. ST Accel. Beams, submitted for publication (2005).

An Efficient Formalism for Simulating the Longitudinal Kick from Coherent Synchrotron Radiation

THPCH024

D. Sagan (Cornell University, Laboratory for Elementary-Particle Physics)

Coherent Synchrotron Radiation (CSR) can severely limit the performance of planned light sources and storage rings which push the envelope to ever higher bunch densities. In order to better simulate CSR, the formalism of Saldin is extended to work at lower energies and shorter length scales. The formalism is also generalized to cover the case of an arbitrary configuration of multiple bends.

*E. L. Saldin et al. Nucl. Instrum. Methods Phys. Res., Sect. A 398, 373 (1997).

THPCH025

Electron Cloud Self-consistent Simulations for the SNS Ring

A.P. Shishlo, S.M. Cousineau, V.V. Danilov, S. Henderson, J.A. Holmes, M.A. Plum (ORNL)

The electron cloud dynamics is simulated for the Spallation Neutron Source ring using the self-consistent electron-cloud model for long-bunched proton beams implemented in the ORBIT code. These simulations feature simultaneous calculations of the dynamics of the proton bunch and of the electron cloud, including electron multipacting using a realistic secondary emission surface model. The frequency spectra and growth rates of the proton bunch transverse instability are studied as functions of the RF cavity voltage. The effectiveness of an electron-cloud instability suppression system is also studied using an ORBIT model of the real feedback system. SNS is a collaboration of six US National Laboratories: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Thomas Jefferson National Accelerator Facility (TJNAF), Los Alamos National Laboratory (LANL), Lawrence Berkeley National Laboratory (LBNL), and Oak Ridge National Laboratory (ORNL).

THPCH026

Parallel 3-D Space Charge Calculations in the Unified Accelerator Library

N.L. D'Imperio, A.U. Luccio, N. Malitsky (BNL) O. Boine-Frankenheim (GSI)

The paper presents the integration of the SIMBAD space charge module in the UAL framework. SIMBAD is a Particle-in-Cell (PIC) code. Its 3-D parallel approach features an optimized load balancing scheme based on a genetic algorithm. The UAL framework enhances the SIMBAD standalone version with the interactive ROOT-based analysis environment and an open catalog of accelerator algorithms. The composite package addresses complex high intensity beam dynamics studies and has been developed as a part of the FAIR SIS 100 project.

THPCH027

An Experimental Proposal to Study Heavy-ion Cooling in the AGS due to Beam Gas or the Intrabeam Scattering

D. Trbojevic, L. Ahrens, J. Beebe-Wang, M. Blaskiewicz, J.M. Brennan, W.W. MacKay, G. Parzen, T. Roser (BNL)

Low emittance of not-fully-stripped gold(Z=79) Au+77 Helium-like ion beams from the AGS (Alternating Gradient Synchrotron) could be attributed to the cooling phenomenon due to inelastic intrabeam scattering [1]. The low emittance gold beams have always been observed at injection in the Relativistic Heavy Ion Collider (RHIC). There have been previous attempts to attribute the low emittance to a cooling due to the exchange of energy between ions during the inelastic intrabeam scattering. The Fano-Lichten theory[2] of electron promotion might be applied during inelastic collisions between helium like gold ions in the AGS. During collisions if the ion energy is large enough, a quasi-molecule could be formed, and electron excitation could occur. During de-excitation of electrons, photons are emitted and a loss of total bunch energy could occur. This would lead to smaller beam size. We propose to inject gold ions with two missing electrons into RHIC at injection energy and study the beam behavior with bunched and de-bunched beam, varying the RF voltage and the beam intensity. If the "cooling" is observed additional.

Crystalline Beams at High Energies

THPCH028

J. Wei (BNL) S. Machida (CCLRC/RAL/ASTeC) S. Ochi, H. Okamoto (HU/AdSM) A. Sessler (LBNL) Y. Yuri (JAEA, Takasaki)

Previously it was shown that by crystallizing each of the two counter-circulating beams, a much larger beam-beam tune shift can be tolerated during the beam-beam collisions; thus a higher luminosity can be reached for colliding beams*. On the other hand, crystalline beams can only be formed at energies below the transition energy of the circular accelerators**. In this paper, we investigate the formation of crystals in two types of high-transition-energy lattices, one realized by three-cell missing dipole modules and the other with negative bends. The latter type satisfies the maintenance condition for a crystalline beam***.
*J. Wei and A.M. Sessler, "Colliding crystalline beams", EPAC98, p. 862. **J. Wei et al. Physical Review Letters, 73 (1994) p. 3089.***J. Wei et al. Physical Review Letters, 80 (1998) p. 2606.

Impedance and Beam Stability Study at the Australian Synchrotron

THPCH031

R.T. Dowd, M.J. Boland, G. LeBlanc, M.J. Spencer, Y.E. Tan (ASP)

We present the preliminary results of an impedance study of the Australian Synchrotron storage ring. Beam stability thresholds have been determined and an overall impedance budget set. Broad-band impedance has been evaluted for various components of the vacuum chamber, using both analytical formulae and results from MAFIA simulations. Narrow band resonances have also been investigated, with particular attention paid to higher order modes in the RF cavities and their effect on multi-bunch instabilities.

Instability Studies Using Evaluated Wake Fields and Comparison with Observations at SOLEIL

THPCH032

R. Nagaoka (SOLEIL)

Beam instability is predicted for SOLEIL using the impedance data obtained through component-wise numerical evaluations. The paper also attempts to make the first comparison with measurements. A key issue for SOLEIL has been to acquire precise knowledge of impedance up to a few tens of GHz, due to short bunches, of chambers which are essentially 3D and additionally NEG coated to a large part, which is expected to enhance the reactive part of the resistive-wall impedance. The predictability of instabilities with the data attained thus becomes a large concern. Wake potentials computed with a 3D code are transformed to impedances and decomposed into a series of resonators, inductive and resistive components, to deduce the wake functions, while for NEG coated chambers, they are numerically Fourier transformed from analytically derived impedances. Both time and frequency domain simulations are performed to predict the longitudinal and transverse instabilities in single bunch, as well as resistive-wall instabilities in multibunch as a function of chromaticity. A multibunch tracking is also performed to investigate the filling pattern dependence of the latter.

THPCH033

Recent Studies of Geometric and Resistive-wall Impedance at SOLEIL

R. Nagaoka, J.-C. Denard, M.-P. Level (SOLEIL)

Coupling impedance studies are of great importance for SOLEIL not only to avoid beam instability, but also to ensure protection of a concerned chamber from EM fields excited by the beam. This paper deals with components that required particularly such efforts, which include BPMs, ceramic chambers, and a vertical scraper. The heat deposited in the BPM buttons is investigated as a function of the gap between a button and an electrode, button diameter and thickness. High temperatures on a vacuum tight feed-through would be a problem, affecting the measurement stability at high currents. Coupling of a trapped mode among successively passing bunches is also investigated. To evaluate the heat deposited in a titanium coated ceramic chamber, its impedance is analytically solved using the field matching technique. The solution obtained justifies the image current model that assumes a constant image current density across the coating when the skin depth is greater than the coating thickness. The azimuthal image current distribution is pursued with Piwinski's formalism for flat chambers. The paper also deals with components not treated earlier such as a stripline.

THPCH034

Transverse Coupling Impedances From Field Matching in a Smooth Resistive Cylindrical Pipe for Arbitrary Beam Energies

A.M. Al-Khateeb, A.M. Al-Khateeb, W.M. Daqa (Yarmouk) O. Boine-Frankenheim, R.W. Hasse, I. Hofmann (GSI)

The transverse coupling impedance is investigated analytically. For an off-axis motion of the beam, the perturbed charge distribution of the beam becomes a function of the azimuthal angle, resulting to first order in the beam displacement in a dipole term which is the source of the transverse impedance. All six components of the electromagnetic field are different from zero and, therefore, both TM and TE modes will be excited in the beam-pipe and coupled to the beam at the inner surface of the resistive wall. Using the dipole source term, a linear combination of TM and TE modes is used to get closed form expressions for the transverse electromagnetic field components excited in the beam-pipe, and a generalized analytic expression for the corresponding transverse coupling impedance. It has been found that the contributions of the TM and the TE modes to the real part of the transverse resistive-wall impedance have similar dependence on the relativistic parameter but with opposite signs, the sum of both always being positive. Some approximate simple formulas for three important regions corresponding to small, intermediate and large frequencies in the ultrarelativistic limit were also obtained analytically.

THPCH035

Characterisation of the EU-HOM-damped Normal Conducting 500 MHz Cavity from the Beam Power Spectrum at DELTA

R.G. Heine, P. Hartmann, T. Weis (DELTA)

A HOM-damped prototype cavity developed in the framework of an EC collaboration has been installed into the Dortmund synchrotron light source DELTA. This paper reports on beam studies performed at beam energies of 1.5 GeV and 542 MeV in an attempt to get information on coupled bunch instability thresholds. In addition an evaluation of the longitudinal cavity impedance is presented, based on beam power spectra up to 3 GHz for different filling patterns of the storage ring by analysing the RF signal from the HOM-dampers.

Wakefield Calculations for 3D Collimators

THPCH036

I. Zagorodnov (DESY) K.L.F. Bane (SLAC)

The wakefield effects of the collimators is of concern for future projects. To relax the wakefield effects a gradual transition from a large to a small aperture is used. The impedance of a smooth round collimator is understood well and a good agreement between measurements, theory and simulations is achieved. However, for rectangular flat collimators there is noticeable difference between theory and experiment. Using recently developed time domain numerical approach, which is able to model curved boundaries and does not suffer from dispersion in longitudinal direction, we calculate the short-range geometric wakefields of 3D collimators. This method together with developed by us recently indirect 3D integration algorithm allows to obtain accurate numerical estimations, which are compared to measurements and to analytical results. The applicability range for the analytical formulas is highlighted.

Wakefields Effects of New ILC Cavity Shapes

THPCH037

I. Zagorodnov (DESY) N. Solyak (Fermilab)

The operation of International Linear Collider (ILC) requires high gradients and quality factors in accelerating structure. One way to reach it is to modify the cavity shape to reduce the ratio of peak surface magnetic to accelerating field. Two candidate shapes are suggested recently: the Re-entrant shape and the Low-Loss shape. In this paper we estimate numerically longitudinal and transverse short range wake functions for the new shapes. The obtained analytical expressions are used in beam dynamic simulations for ILC lattice. We show that ILC will tolerate the cavities with the new shape and the smaller iris diameter.

The PANDA Insertion Impedance in High Energy Storage Ring of FAIR

THPCH038

E. Senicheva, A. Lehrach, D. Prasuhn (FZJ)

The PANDA insertion due to the special shape of the vacuum pipe creates a discontinuity. This was expected to be the main contribution in the impedance of the vacuum chamber. In this paper we present the results of computations dealing with this problem. From many published articles it is known that the reliability of the results depends on many factors and some time they differ from each other significantly. Therefore we have investigated the impedance of the PANDA insertion using different codes and methods, in particular, MAFIA, ABCI and the analytical estimation with the formula Yakoya recognized as a most successful theoretical estimation of the tapers. Besides, PANDA has two symmetrical T-shape insertions, which have been calculated by 3D MAFIA and compared with the results given by the diffraction theory. We have analysed the longitudinal and the transverse impedance.

Beam Studies with Coherent Synchrotron Radiation from Short Bunches in the ANKA Storage Ring

THPCH039

A.-S. Müller, I. Birkel, S. Casalbuoni, B. Gasharova, E. Huttel, Y.-L. Mathis, D.A. Moss, P. Wesolowski (FZK) C. J. Hirschmugl (UWM)

In the ANKA storage ring it is possible to store bunches with RMS lengths of the order of 1 ps using a dedicated optics with reduced momentum compaction factor. For short bunch operation a beam energy of 1.3 GeV is chosen as a trade-off between low energy longitudinal instabilities and the increase in natural bunch length with energy. At this medium energy (the energy range of the ANKA storage ring is 0.5 to 2.5 GeV) steady state emission of coherent synchrotron radiation is observed by the ANKA-IR beamline below the threshold current defined by the micro-bunching instability. At lower beam energies where the natural bunch length is significantly shorter, bursts of coherent synchrotron radiation are detected in spite of the longitudinal oscillation. The far infrared spectrum is sensitive to the dynamics of the charge distribution generating the radiation. Measurements of the frequency spectrum of the infrared detector signal add information on bunch dynamics. This paper gives an overview of the studies performed at the ANKA storage ring.

THPCH040

Linac Focusing and Beam Break Up for 4GLS

E. Wooldridge, B.D. Muratori (CCLRC/DL/ASTeC)

As part of the design for 4GLS the linac focusing and its effect on the beam break up (BBU) threshold have been studied. The choice of graded gradient focusing scheme is discussed and initial models of the focusing, using a triplet of quadrupoles between each of the modules within the linac, are presented. The quadrupoles were set-up in a defocusing - focusing - defocusing format with strengths of -1/2k, k, -1/2k. Using these models the BBU threshold was computed using available codes assuming a 9-cell TESLA cavity within the linac and a 7-cell design with HOM dampers. A sweep of the magnet strength with respect to the BBU threshold showed that there is an optimum setting.

THPCH041

Alternate Cavity Designs to Reduce BBU

E. Wooldridge (CCLRC/DL/ASTeC)

An investigation was carried out on alternate cavity designs to decrease the effect of the higher order modes (HOMs) whilst maintaining the cavity accelerating gradient. The cavities were modelled in Microwave Studio and the number of cells per cavity and the number of cells per unit length were examined. HOM data from these models was used in beam break up (BBU) codes to calculate the threshold and the results are presented here. The cells of each cavity were slightly deformed alternately in the x and y planes so that the fundamental frequency of the cavity remained unperturbed, whilst minimising the HOM coupling between consecutive cells. Other patterns, such as alternating each deformed cell by several degrees, were also investigated. The data from these e-m models was also used in BBU calculations and their thresholds calculated.

THPCH042

Numerical Estimations of Wakefields and Impedances for Diamond Collimators

S.A. Pande, R. Bartolini, R. T. Fielder, M. Jensen (Diamond)

The storage ring of the Diamond light source will use two collimators, one in horizontal and one in the vertical planes in the injection straight to protect the IDs from the injection and Touschek losses. These collimators, in the form of tapered metallic intrusions in to the vacuum chamber, will generate considerable wake fields and will contribute to the overall machine impedance. In this paper we present the results of ABCI and MAFIA numerical simulations to estimate these effects.

Jitter Studies for the FERMI@ELETTRA Linac

THPCH043

P. Craievich, S. Di Mitri (ELETTRA) A. Zholents (LBNL)

The FEL project FERMI@ELETTRA* will use the existing linac upgraded to 1.2GeV to produce photon pulses in the wavelength range between 100-10 nm by means of harmonic generation in a seeded scheme. FEL operations foresee stringent requirements for the stability of the global linac output parameters, such as the electron bunch arrival time, peak current, average energy and the slice electron bunch parameters, such as the slice peak current and slice average energy. In order to understand the sensitivity of these parameters to jitters of various error sources along the linac an elaborate study using tracking codes has been performed. As a result, we created a tolerance budget to be used as guidance in the design of the linac upgrade. In this paper we give a detailed description of the applied procedures and present the obtained results.
*C. Bocchetta et al. "FERMI@ELETTRA - Conceptual Design for a Seeded Harmonic Cascade FEL for EUV and Soft X-rays", this conference.

Beam Break-up Instability in the FERMI@ELETTRA Linac

THPCH044

S. Di Mitri, P. Craievich (ELETTRA)

The beam break-up instability is studied for the 1.2 GeV linac of FERMI @ ELETTRA FEL*. This instability is driven by transverse wake fields acting on an electron beam travelling off-axis in the accelerating structures due to the launching errors in positions, angles, energy and misalignment of various lattice elements. Two operational scenarios are considered: one with a relatively long electron bunch of 1.5 ps and a moderate peak current of 500 A and one with a shorter bunch of 0.7 ps and a higher peak current of 800 A. Attention is given to the correction of the "banana" shape of the electron bunch caused by the instability. The simulation results are compared with the analytical predictions.
*C. Bocchetta et al. “FERMI@Elettra – Conceptual Design for a Seeded Harmonic Cascade FEL for EUV and Soft X-rays”, this conference.

Transverse Head-tail Modes Elimination with Negative Chromaticity and the Transverse Multi-bunch Feedback System at ELETTRA

THPCH045

E. Karantzoulis, M. Lonza (ELETTRA)

The rigid dipole head-tail mode threshold at ELETTRA is by now quite low and increasing positively the chromaticity does not bring a much overall advantage in the machine performance. Using the bunch-by-bunch transverse feedback (TMFB), a threshold increase has been observed until the onset of the higher modes, which being bunch shape modes cannot be detected and therefore eliminated by the feedback system. To overcome this problem the machine has been set to a small but negative chromaticity. In this case the m=0 mode is unstable with a very low (<1 mA/bunch) threshold but the higher modes should be stable, especially when the main source of the transverse impedance comes from the resistive wall as in our case. Indeed when activating the TMFB no onset of any modes was observed within reasonable current limits (15 mA/bunch) that we plan to further investigate. In the paper after a theoretical discussion on the role of chromaticity and various types of impedances in the head-tail onset mechanism, the experimental results are presented and discussed.

THPCH047

Maps for Electron Clouds: Application to LHC

T. Demma, S. Petracca (U. Sannio) F. Ruggiero, G. Rumolo, F. Zimmermann (CERN)

Electron Cloud studies performed so far were based on very heavy computer simulations taking into account photoelectron production, secondary electron emission, electron dynamics, and space charge effects providing a very detailed description of the electron cloud evolution. In a recent paper* it has been shown that, for the typical parameters of RHIC, the bunch-to-bunch evolution of the electron cloud density can be represented by a cubic map. Simulations based on this map formalism are orders of magnitude faster than those based on usual codes. In this communication we show that the map formalism is also reliable in the range of typical LHC parameters, and discuss the dependence of the polynomial map coefficients on the physical parameters affecting the electron cloud (SEY, chamber dimensions, bunch spacing, bunch charge, etc.).

*U. Iriso and S. Peggs. "Maps for Electron Clouds", Phys. Rev. ST-AB 8, 024403, 2005.

THPCH048

Transverse Coupled Bunch Instability Driven by 792-MHz Cavity HOM in NewSUBARU Electron Storage Ring

S.H. Hisao, A. Ando, S. Hashimoto, T. Matsubara, Y. Miyahara, Y. Shoji (NewSUBARU/SPring-8, Laboratory of Advanced Science and Technology for Industry (LASTI))

The 792-MHz HOM of the RF cavity can drive horizontal coupled bunch instability in the NewSUBARU electron storage ring. This instability is now avoided by tuning the HOM frequency with an additional tuner (HOM tuner). Detailed characteristics of this instability were investigated by changing the HOM frequency, betatron tune, chromaticity and magnitude of the stored current at the energy of 1 GeV. The experiments were performed with 6-bunch equi-space filling to clarify the mode number. Bunch oscillations show saw-tooth patterns when the stored current is not so large. The measured results are compared with an analytical calculation using a rigid bunch model and Sacherer's formalism. The fundamental aspects can be well explained by the calculation, but there exist many problems that cannot be explained by the rigid bunch model.

THPCH049

Simulation Study of Transverse Coupled-bunch Instabilities due to Electron Cloud in KEKB LER

X.W. Dong, S.-I. Kurokawa, K. Ohmi (KEK)

In this paper we report simulation results on the transverse coupled-bunch instabilities (TCBI) due to electron cloud at the KEKB Low Energy Ring (LER). The formation of electron cloud and related TCBI is investigated based on realistic solenoid field model. Studies on electron cloud in Quadrupole which could induce TCBI are also presented in this paper.

Further Studies on Betatron Sidebands due to Electron Clouds

J.W. Flanagan, H. Fukuma, Y. Funakoshi, S. Hiramatsu, T. Ieiri, H. Ikeda, K. Ohmi, K. Oide, M. Tobiyama (KEK)

We have observed vertical betatron sidebands in the transverse beam spectra of positron bunches at the KEKB LER which are associated with the presence of electron clouds in single-beam studies*, and which are also associated with a loss of luminosity when the KEKB beams are in collision**. The sidebands may be signals of a fast head-tail instability due to short-range wakes within the electron cloud, providing a diagnostic for exploring the mechanism for transverse beam blow-up due to electron clouds. We report here on further studies on the behavior of the sidebands under varying beam conditions, including varying initial beam size below the beam blow-up threshold, chromaticity, RF voltage and fill pattern.
*J. W. Flanagan et al. PRL 94, 054801 (2005).**J. W. Flanagan et al. Proc. PAC05, p. 680 (2005).

The Effect of the Solenoid Field in Quadrupole Magnets on the Electron Cloud Instability in the KEKB LER

H. Fukuma, J.W. Flanagan, T. Kawamoto, T. Morimoto, K. Oide, M. Tobiyama (KEK) F. Zimmermann (CERN)

The electron cloud instability which causes vertical beam blowup in the KEKB LER is largely suppressed by applying a weak solenoid field to vacuum chambers in the drift region. However the blowup is still observed when the bunch spacing is reduced to 3.27 rf buckets or shorter. A question is where the remaining electron clouds are. To investigate the electron clouds in the quadrupole magnets, solenoids made of flat cables were developed and installed in 88 quadrupole magnets. The field strength of the solenoid is 17 Gauss. The effect of the solenoid field on the blowup is now under beam study. So far no clear effect of the solenoids on the luminosity and the sideband accompanied by the blowup is found. We report on the solenoid system, the results of the experiments and comparison of the experimental results with simulations.

Dependence of Transverse Instabilities on Amplitude Dependent Tune Shifts

T. Miyajima, K. Harada, Y. Kobayashi, S. Nagahashi (KEK)

In the Photon Factory electron storage ring, transverse instabilities have been observed in multi-bunch operation mode. The instabilities can be suppressed by amplitude dependent tune shifts, which are induced by the sextupole, octupole and higher order magnetic field. Since four octupole magnets have been installed in the PF ring, we can control the tune shifts, which is caused by the octupole magnetic field, independently of chromaticities, which is caused by sextupole magnetic field. In order to research the suppression mechanism of the instabilities, we measured the dependence of the instabilities on the tune shifts, which are induced by the octupole field. The threshold of the tune shifts, which suppress the instabilities, were observed in the measurement, and it depended on the filling pattern of the bunch train and the beam current per bunch. In addition, we will present the results of the measurement before and after the reconstruction for the straight-sections upgrade at the PF ring, which was carried out in 2005.

THPCH053

Numerical and Experimental Study of Cooling-stacking Injection in HIMAC Synchrotron

E. Syresin (JINR) K. Noda (NIRS) S. Shibuya (AEC) T. Uesugi (KEK)

The cooling-stacking injection at the HIMAC synchrotron was used to increase the intensity of Ar^{18+} ion beam. The beam stacking was realized in a horizontal free phase-space, which was created by the HIMAC electron cooler. The stack intensity of $(1.5\sim2.5)\cdot10^9$ ppp was accumulated at an injection intensity of (0.3~1.0)e9. The stack intensity was limited by the ion lifetime. A peculiarity of present cooling-stacking experiments is related to lifetime difference by a factor of 2~3 of the stack and injected ions. The lifetime of stack ions is determined by vacuum pressure. The new injected ions were slowly lost at multiple scattering on residual gas atoms at diffusion heating in the vertical direction caused by the acceptance of 30pi-mm-mrad and a reduction of cooling force at large betatron amplitudes. The results of numerical simulations and experimental study of cooling-stacking injection on the HIMAC synchrotron are presented.

THPCH054

SIMPSONS with Wake Field Effects

Y. Shobuda, F. Noda (JAEA/J-PARC) Y.H. Chin, K. Takata, T. Toyama (KEK) S. Machida (CCLRC/RAL/ASTeC)

Simpsons, which is originally developed by S. Machida, is the program which calculates the space charge effect to the beam in the ring. The wake field effect to the beam is also installed in this program, because the emittance growth not only due to the space charge effect, but also due to the wake field effect is the important issue. The results of the simulation in J-PARC case are also represented.

THPCH057

The Fast Vertical Single-bunch Instability after Injection into the CERN Super Proton Synchrotron

E. Métral, G. Arduini, T. Bohl, H. Burkhardt, G. Rumolo (CERN) B. Spataro (INFN/LNF)

Since 2003, high-intensity single-bunch proton beams with low longitudinal emittance have been affected by heavy losses after less than one synchrotron period after injection. The effects of the resonance frequency of the responsible impedance, longitudinal emittance and chromaticity on the intensity threshold were already discussed in detail in 2004, comparing analytical predictions with simulation results. In this paper the evolution of the instability between injection and the time of beam loss is our main concern. Measurements are compared with HEADTAIL simulations. A travelling-wave pattern propagating along the bunch, which is the signature of a Beam Break-Up or Transverse Mode Coupling Instability (TMCI), is clearly identified. The oscillating frequency, near ~1 GHz, is in good agreement with the usual broad-band impedance model deduced from beam-based measurements like the head-tail growth rate vs. chromaticity.

THPCH058

Simulation Study on the Beneficial Effect of Linear Coupling for the Transverse Mode Coupling Instability in the CERN Super Proton Synchrotron

E. Métral, G. Rumolo (CERN)

The intensity threshold of the transverse mode coupling instability in a flat vertical chamber, as in the CERN Super Proton Synchrotron, is much higher in the horizontal plane than in the vertical one. This asymmetry between the transverse planes led us to the idea that linear coupling from skew quadrupoles could be used to increase the intensity threshold. This technique is already applied, for instance, in the CERN Proton Synchrotron, where a slow head-tail horizontal instability due to the resistive-wall impedance is stabilized by linear coupling only, i.e. with neither octupoles nor feedbacks. This paper presents the results of the study of the effect of linear coupling on the transverse mode coupling instability, using the HEADTAIL simulation code.

Kicker Impedance Measurements for the Future Multi-turn Extraction of the CERN Proton Synchrotron

THPCH059

E. Métral, F. Caspers, M. Giovannozzi, A. Grudiev, T. Kroyer, L. Sermeus (CERN)

In the context of the novel multi-turn extraction, where charged particles are trapped into stable islands in transverse phase space, the ejection of five beamlets will be performed by means of a set of three new kickers. Before installing them into the machine, a measurement campaign has been launched to evaluate the impedance of such devices. Two measurement techniques were used to try to disentangle the driving and detuning impedances. The first consists in measuring the longitudinal impedance for different transverse offsets using a single displaced wire. The sum of the transverse driving and detuning impedances is then deduced applying Panofsky-Wenzel theorem. The second uses two wires excited in opposite phase and yields the driving transverse impedance only. Finally, the consequences on the beam dynamics are also analyzed.

Simulation Study on the Energy Dependence of the TMCI Threshold in the CERN-SPS

THPCH060

G. Rumolo, E. Métral, E.N. Shaposhnikova (CERN)

This paper concentrates on theoretical studies of Transverse Mode Coupling Instability at the SPS. It shows the expected thresholds based on a HEADTAIL tracking model and on impedance values estimated from previous measurements. First, the effect of space charge is addressed as an important ingredient at the low energies. Subsequently, the change of TMCI threshold possibly induced by a higher injection energy into the SPS (plausible according to the upgrade studies) is investigated and a scaling law with energy is derived.

Tune Shift Induced by Nonlinear Resistive Wall Wake Field of Flat Collimator

THPCH061

F. Zimmermann, G. Arduini, R.W. Assmann, H. Burkhardt, F. Caspers, M. Gasior, O.R. Jones, T. Kroyer, E. Métral, S. Redaelli, G. Robert-Demolaize, F. Roncarolo, G. Rumolo, R.J. Steinhagen, J. Wenninger (CERN)

We present formulae for the coherent and incoherent tune shifts due to the nonlinear resistive wall wake field for a single beam traveling between two parallel plates. In particular, we demonstrate that the nonlinear terms of the resistive wall wake field become important if the gap between the plates is comparable to the transverse rms beam size. We also compare the theoretically predicted tune shift as a function of gap size with measurements for an LHC prototype graphite collimator in the CERN SPS and with simulations.

THPCH062

Collective Effects in the Storage Ring of Taiwan Photon Source

P.J. Chou, C.H. Kuo, C.-C. Kuo, M.-H. Wang (NSRRC)

A new 3- 3.3 GeV synchrotron light source is proposed and named the Taiwan Photon Source (TPS). The TPS design has a natural horizontal emittance less than 2 nm-rad and low emittance coupling, which results in small beam size. The nominal bunch length in TPS storage ring is much shorter compared to the existing Taiwan Light Source, that makes the issue of parasitic heating more significant. Several small-gap insertion devices are planned to provide extremely bright x-ray photon beam. Those design features have impacts on collective beam instabilities. A preliminary study of collective effects in the TPS storage ring is presented.

THPCH064

Comparison of Three CSR Radiation Powers for Particle Bunches and Line Charges

K.A. Heinemann, G. Bassi, J.A. Ellison (UNM)

We are studying coherent synchrotron radiation (CSR) from arbitrary planar orbits as discussed in another abstract we submitted to EPAC06. It is important to have one-dimensional approximations. Here we report on work constructing and validating such approximations. As part of our work two well known papers by Saldin, Schneidmiller and Yurkov (SSY* are considered which deal with the CSR via a one-dimensional approximation whereby the electron bunch is modelled by a line density. Their one-dimensional approach is important because it is used in various CSR codes and since it serves to some extent as a role model for higher-dimensional models. The present report deals with some general aspects of the work of SSY. In particular, care is taken of the renormalization procedure and of the statistical description in terms of the line density. SSY use a renormalized retarded field whereas the present work uses the radiation field which is defined as half the difference of the retarded and advanced fields. The radiation field came into prominence when Dirac** introduced the Lorentz-Dirac equation.
*E. L. Saldin, et al. Nucl. Instr. Meth. Phys. Res. A 398, 373 (1997) and 417, 158 (1998).**P.A.M. Dirac, Proc. Roy. Soc. (London) A167, 148 (1938).

THPCH065

Suppression of Transverse Instability by a Digital Damper

A.V. Burov, V.A. Lebedev (Fermilab)

When a beam phase space density increases, it makes its motion intrinsically unstable. To suppress the instabilities, dampers are required. With a progress of digital technology, digital dampers are getting to be more and more preferable, compared with analog ones. Conversion of an analog signal into digital one is described by a linear operator with explicit time dependence. Thus, the analog-digital converter (ADC) does not preserve a signal frequency. Instead, a monochromatic input signal is transformed into a mixture of all possible frequencies, combining the input one with multiples of the sampling frequency. Stability analysis has to include a cross-talk between all these combined frequencies. In this paper, we are analyzing a problem of stability for beam transverse microwave oscillations in a presence of digital damper; the impedance and the space charge are taken into account. The developed formalism is applied for antiproton beam in the Recycler Ring at Fermilab.

Transient Beam Loading in the DIAMOND Storage Ring

THPCH066

S. De Santis, J.M. Byrd (LBNL) R. Bartolini (Diamond)

Harmonic cavity systems have been installed on several 3rd generation light sources to lengthen the bunches and increase the Touschek lifetime. Apart from this beneficial effect, harmonic cavities are known to increase the transient beam loading in high-current machines, due to the presence of gaps in the fill pattern. The amplitude of this effect, which is substantially larger than that caused by the main RF system, can in turn produce considerable variations in bunch length and phase along the train, which result in a significant reduction of the lifetime increase. We have developed a tracking simulation, which we have applied to the analysis of the beam loading transients in Diamond, for the case of passive superconducting harmonic cavities. The influence of beam current, gap amplitude and harmonic cavity tuning on the final lifetime have been studied, as well as the effects of higher-order modes.

Coherent Synchrotron Radiation Studies at the Accelerator Test Facility

THPCH067

S. De Santis, J.M. Byrd (LBNL) A. Aryshev, T. Naito, J. Urakawa (KEK) M.C. Ross (SLAC)

Coherent Synchrotron Radiation (CSR) has been the object of recent experiments and is a topic of great importance for several accelerator currently in their design phase (LCLS, ILC, CIRCE). We present the results of several experimental sessions performed at the Advanced Test Facility - KEK (ATF). An infrared bolometer was used to detect the emitted infrared radiation in the 1-0.05 mm wavelength range as a function of several beam parameters (beam current, RF power, extraction timing, photoinjector laser phase). The beam energy spread was also recorded. We found that the mismatch between injected and equilibrium beam is the source of the coherent signal detected concurrently with the bunch injection.

BBU Calculations for Beam Stability Experiments on DARHT-2

THPCH069

Y. Tang (ATK-MR) K.C.D. Chan, C. Ekdahl (LANL) T.P. Hughes (Voss Scientific)

The DARHT-2 (Dual-Axis Radiographic Hydrodynamics Test) facility is expected to produce a 2-kA, 20-MeV, 2-microsecond flattop electron beam pulse. Normal operation requires that the beam exit the accelerator with a normalized transverse emittance of less than 0.15-cm-rad. The beam break up (BBU) instability is a potentially serious effect for a high current linear accelerator. It arises from the interaction between the beam and the cavity modes of the accelerating cells. In support of the beam stability experiments, simulations of BBU for DARHT-2 using the Lamda code have been carried out. The simulations used experimental data for the transverse impedance of the cells. Lamda was benchmarked against results calculated with the LLNL code BREAKUP. For nominal transport parameters, simulation results showed that the BBU growth was not significant in changing the beam spot. For a magnetic field reduced by a factor of 5, BBU growth was over a factor of 100, and the image displacement effect was significant.

THPCH070

Long-pulse Beam Stability in the DARHT-II Linear-induction Accelerator

C. Ekdahl, E.O. Abeyta, P.A. Aragon, R. Archuleta, R. Bartsch, K.C.D. Chan, D. Dalmas, S. Eversole, R.J. Gallegos, J. Harrison, E. Jacquez, J. Johnson, B.T. McCuistian, N. Montoya, S. Nath, D. Oro, L.J. Rowton, M. Sanchez, R.D. Scarpetti, M. Schauer (LANL) H. Bender, W. Broste, C. Carlson, D. Frayer, D. Johnson, A. Tipton, C.-Y. Tom (Bechtel Nevada) R.J. Briggs (SAIC) T.P. Hughes, C. Mostrom, Y. Tang (ATK-MR) M.E. Schulze (GA)

The beam breakup instability has long been a problem for linear induction accelerators (LIAs). Although it is predicted to saturate in the strong focus regime relevant to LIAs most, if not all, LIAs have had pulse-widths too short to observe this effect. We recently completed BBU experiments on a 1.2 kA, 6.7-MeV configuration of the DARHT-II LIA having a 1600-ns pulse length much longer than the saturation time. The saturated growth observed in these experiments when we reduced the magnetic guide-field strength was in agreement with theory. We used these results to deduce that BBU growth will be insignificant in the final 2-kA, 17-MeV DARHT-II configuration with the tunes that will be used. Another problematic instability for long-pulse LIAs such as DARHT-II is the ion-hose. We also performed experiments with the 6.7-MeV long-pulse configuration of DARHT-II in which we deliberately induced ion-hose by raising the background pressure far above its normal value. The results of these experiments were used to show that ion-hose will not be a problem for to the final DARHT-II configuration.

THPCH071

Coupling Impedances of Small Discontinuities for Non-ultrarelativistic Beams

S.S. Kurennoy (LANL)

The beam coupling impedances of small discontinuities of an accelerator vacuum chamber have been calculated (e.g., * and references therein) for ultrarelativistic beams using Bethe's diffraction theory. Here we extend the results for an arbitrary beam velocity. The vacuum chamber is assumed to have an arbitrary, but fixed, cross section. The longitudinal and transverse coupling impedances are derived in terms of series over cross-section eigenfunctions, while the discontinuity shape enters via its polarizabilities. Simple explicit formulas for the circular and rectangular cross sections are presented. The impedance dependence on the beam velocity exhibits some unusual features. For example, the reactive impedance, which dominates in the ultrarelativistic limit, can vanish at a certain beam velocity, or its magnitude can exceed the ultrarelativistic value many times.

*S. S. Kurennoy et al. Phys. Rev. $\cdot 10^{52}$ (1995) 4354.

THPCH072

Wakefields in the LCLS Undulator Transitions

K.L.F. Bane (SLAC) I. Zagorodnov (DESY)

We have studied longitudinal wakefields of very short bunches in non-cylindrically symmetric (3D) vacuum chamber transitions using analytical models and the computer program ECHO. The wake (for pairs of well-separated, non-smooth transitions) invariably is resistive, with its shape proportional to the bunch distribution. For the example of an elliptical collimator in a round beam pipe we have demonstrated that—as in the cylindrically symmetric (2D) case—the wake can be obtained from the static primary field of the beam alone. We have obtained the wakes of the LCLS rectangular-to-round transitions using indirect (numerical) field integration combined with a primary beam field calculation. For the LCLS 1 nC bunch charge configuration we find that the total variation in wake-induced energy change is small

(0.03% in the core of the beam, 0.15% in the horns of the distribution) compared to that due to the resistive wall wakes of the undulator beam pipe (0.6%).

Reflectivity Measurements for Copper and Aluminum in the Far Infrared and the Resistive Wall Impedance in the LCLS Undulator

THPCH073

K.L.F. Bane, G.V. Stupakov (SLAC) J. Tu (City College of The City University of New York)

Reflectivity measurements in the far infrared, performed on aluminum and copper samples, are presented and analyzed. Over a frequency range of interest for the LCLS bunch, the data is fit to the free-electron model, and to one including the anomalous skin effect. The models fit well, yielding parameters dc conductivity and relaxation times that are within 30-40

Simulation of the Electron Cloud for Various Configurations of a Damping Ring for the ILC

THPCH075

M.T.F. Pivi, T.O. Raubenheimer, L. Wang (SLAC) K. Ohmi (KEK) R. Wanzenberg (DESY) A. Wolski (Liverpool University, Science Faculty) F. Zimmermann (CERN)

In the beam pipe of the Damping Ring (DR) of the International Linear Collider (ILC), an electron cloud may be first produced by photoelectrons and ionization of residual gasses and then increased by the secondary emission process. This paper reports about the work that has been done by the electron cloud assessment international task force group for the recommendation of the ILC Damping Rings baseline design, made in November 2005. We have carefully estimated the secondary electron yield (SEY) threshold for electron cloud build-up and estimated the related single¯ and coupled-bunch instabilities that can be caused by the presence of electron cloud as a function of beam current and surface properties, for a variety of optics designs. The result of these studies was an important consideration in the choice of a 6-km design for the ILC damping rings. On the basis of the theoretical and experimental work, the baseline configuration specifies a pair of damping rings for the positron beam to mitigate the effects of the electron cloud.

Resistive Wall Wake Effect of a Grooved Vacuum Chamber

THPCH076

G.V. Stupakov, K.L.F. Bane (SLAC)

To suppress the emission of secondary electrons in accelerators with positively charged beams (ions or positrons) it has been proposed to use a vacuum chamber that is longitudinally grooved (or, equivalently, one can say finned)*/**. One consequence of having such a chamber in an accelerator is an increased resistive wall impedance. In this paper, we calculate the resistive wall impedance of one such finned chamber, planned to be used in experimental studies of secondary emission suppression at SLAC. For rectangular fins, we use an analytical method based on a conformal mapping approach; we compare the results with a numerical solution of the field equation. We also numerically compute the impedance for rounded fins (as will be used in the SLAC experiment) and analyse how the impedance depends on geometric properties of the fins.

*A. A. Krasnov. Vaccum, vol. 73, p. 195, (2004).**G. Stupakov and M. Pivi. Preprint SLAC-TN-04-045, (2004).

THPCH077

Resistive-wall Instability in the Damping Rings of the ILC

L. Wang, K.L.F. Bane, T.O. Raubenheimer, M.C. Ross (SLAC)

In the damping rings of the International Linear Collider (ILC), the resistive-wall instability is one of the dominant transverse instabilities. This instability directly influences the choice of material and aperture of the vacuum pipe, and the parameters of the transverse feedback system. This paper investigates the resistive-wall instabilities in an ILC damping ring under various conditions of beam pipe material, aperture, and fill pattern.

THPCH078

Successful Bunched-Beam Stochastic Cooling in RHIC

J.M. Brennan, M. Blaskiewicz, F. Severino (BNL)

Stochastic Cooling of high energy and high frequency bunched beam has been demonstrated in RHIC at 100 GeV. Narrowing of the Schottky spectrum and shorting of the bunch length resulted from cooling the beam for 90 minutes. The purpose of the stochastic cooling is to counteract the fundamental limit of the luminosity lifetime of heavy ions in RHIC which is Intra-Beam Scattering. IBS drives transverse emittance growth and longitudinal de-bunching. The major components of the system have been tested with heavy ion and proton beams in previous runs in RHIC, demonstrating that the difficult challenges of high frequency bunched beam stochastic cooling can be overcome. The vexing problem of pollution of the Schottky spectrum by coherent components is solved with optimized filtering and high dynamic range low noise electronics. A set of 16 high-Q cavities is used to achieve adequate kicker voltage in the 5 to 8 GHz band. This technique exploits the bunched beam time structure to level the microwave power requirement and enables the use of solid state amplifiers to drive the kickers. Because RHIC did not operate with heavy ions in the FY06 run, the system was tested with specially prepared low intensity protons bunches of $2{\cdot}10^9$ particles.

THPCH080

Transverse Impedance of Small-gap Undulators for NSLS-II

A. Blednykh, S. Krinsky, B. Podobedov, J.-M. Wang (BNL)

We discuss the transverse impedance resulting from the use of small-gap undulators in the proposed NSLS-II storage ring. For superconducting undulators, the impedance arises due to the tapered elliptical vacuum chamber. For in-vacuum permanent magnet devices, the impedance results from a more complex geometry. We consider both cases and report results obtained using the electromagnetic simulation program GdfidL.

THPCH081

Transverse Impedance of Elliptical Cross-section Tapers

B. Podobedov, S. Krinsky (BNL)

We investigate the transverse impedance of elliptical cross-section tapers. Analytical estimates for the dipole and quadrupolar components of the impedance at low frequency are obtained by extending a perturbation approach introduced by Stupakov. The perturbation theory results are compared to EM code GdfidL and are found to be in excellent agreement.

Broadband Bunch by Bunch Feedback for the ESRF using a Single High Resolution and Fast Sampling FPGA DSP

THPCH082

E. Plouviez, P. Arnoux, F. Epaud, J. Jacob, J.M. Koch, N. Michel, G.A. Naylor, J.-L. Revol, V. Serriere, D. Vial (ESRF)

In order to increase the current in the ESRF storage ring we have developed a set of multi-bunch feedback systems aimed at fighting longitudinal and transverse coupled bunch instabilities. The longitudinal feedback (LFB) has been the first system installed and tested. It was designed using the scheme developed at SLAC, ALS and INFN Frascati: bunch by bunch processing of a beam phase error signal and correction using a low Q kicker driven by a QPSK modulator. However, we took advantage for this development of the latest available technology for the signal processing electronics with high resolution, high sampling rate ADC and DAC, and FPGA DSP, as well as for the FPGA programming environment. It allowed us to substantially reduce the complexity: the algorithm runs on a single processor, the kicker requires only 200W of RF power to control a 6GeV beam, and the implementation took only about one year. We will describe the main features of our LFB and present the results already achieved in the damping of instabilities driven by our RF cavity HOM. We will also report on the status of the transverse feedback, which is being built up using the same FPGA system as the longitudinal one.

A Tune Feedback System for the HERA Proton Storge Ring

THPCH083

S.G. Brinker, S.W. Herb, F.J. Willeke (DESY) Th. Lohse (Humboldt University Berlin, Institut für Physik)

The transverse tunes of an accelerator or storage ring are important parameters which have to be controlled and adjusted continuously during beam operation in order to assure good experimental background conditions. For the HERA proton storage ring, persistent current effects of the superconducting magnets are the main source for the inadequate repeatability of the tunes without a feedback while the proton beam is accelerated. A tune feedback has been developed, implemented and tested during beam acceleration and luminosity operation. Considering the different conditions during energy ramps and luminosity runs two versions of this feedback system have been established based on different correction and peak-finding algorithms (e.g. wavelet analysis). No additional excitation is needed on top of the standard tune indication system in HERA. The tunes could be kept constant during beam accceleration with a standard deviation of delta Q = 0.003. In luminosity runs where the tune control is more critical, first tests resulted in a standard deviation which was a factor of ten smaller. The feedback system is implemented as a standard tool for beam acceleration.

Control Path of Longitudinal Multibunch-feedback System at HERA-p

THPCH084

F.E. Eints, S. Choroba, M.G. Hoffmann, U. Hurdelbrink, P.M. Morozov, J. Randhahn, S. Ruzin, S. Simrock (DESY)

A longitudinal broadband damper system to control coupled bunch instabilities has been developed and installed in the proton accelerator HERA-p at the DESY. The control system consists of a control path and a Fast Diagnostic System (FDS) for oscillation diagnostic. The control path consists of FPGA-based digital controller, vector modulator, 1kW power amplifier, kicker-cavity and beam. In the FDS, the bunch phase signals are sampled by a digital FPGA board with 14Bit ADC (controller) with a sampling frequency of 10.4MHz. Phase calculation for all bunches and offset correction will be done by FPGA software which includes a digital filter. The filter has to be able to deal with a slowly changing synchrotron frequency. Here we consider a filter design which treats each of maximum 220 bunches as an independent oscillator which has to be damped. More sophisticated mode filter algorithms may be required to get better noise performance. The FPGA-board output signal modulates a 104 MHz sine-wave. The resulting logitudinal correction kick signal is provided by the kicker-cavity. Beside the technical details we present first operational experience and the actual system performance.

THPCH085

The Longitudinal Coupled Bunch Feedback for HERA-p

M.G. Hoffmann, S. Choroba, F.E. Eints, U. Hurdelbrink, P.M. Morozov, J. Randhahn, S. Ruzin, S. Simrock, E. Vogel, R. Wagner (DESY)

A longitudinal broadband damper system to control coupled bunch instabilities has recently been constructed and installed in the 920~GeV proton accelereator HERA-p at the Deutsches Elektronen-Synchrotron DESY. This represents one of the attempts to increase the specific luminosity at HERA by reducing the bunch length. The final bunch length is defined by the initial emittance after injection and by the acceleration process where multiply occuring coupled bunch instabilities provoke bunch length blow up at discrete energies during the ramp. The actual feedback design consists of a fast, high precision bunch centroid phase detector, a 1~kW feedback cavity with 104~MHz centre frequency and 8~MHz bandwidth (FWHM), a I/Q-vector modulator, the low level digital FPGA-board with 14 Bit ADCs and DACs and a cavity transient diagnostics. The system measures the phases of all bunches and calculates corrections in real time (bunch spacing: 96~ns) which are then applied to the beam via a longitudinal kicker. The filter deals with a slowly changing synchrotron frequency (20-80 Hz).

THPCH086

Design of a Local IP Orbit Feedback at HERA-e

J. Keil, O. Kaul, E. Negodin, R. Neumann (DESY)

At the electron-proton collider HERA it is often observed that the proton emittance growth rate of colliding bunches is larger compared to non-colliding proton bunches. In addition the proton background rates are increasing when the two beams are brought into collision. There are indications that a contribution comes from closed orbit oscillations of the electron beam at the two IPs. In the arcs of HERA-e oscillation amplitudes of 100-200 micrometer with frequencies of 2-15 Hz and harmonics of 50 Hz are observed. In order to stabilize the orbit at the IPs in both planes a local digital orbit feedback system with a bandwidth of more than 20 Hz has been developed. The beam position at the IPs is measured with BPMs using dedicated electronics. The four local orbit bumps are produced by air-coil steerer magnets. The data are transmitted using SEDAC field bus lines to a central PC, which is used for the computation of the correction.

THPCH087

Design and Operation of a Ferrite Loaded Kicker Cavity for the Longitudinal Coupled Bunch Feedback for HERA-p

J. Randhahn, S. Choroba, M. Dohlus, M. Ebert, F.E. Eints, M.G. Hoffmann, R. Wagner (DESY)

A longitudinal broadband damper system to control coupled bunch instabilities has recently been constructed and installed in the 920 GeV proton accelereator HERA-p at the Deutsches Elektronen-Synchrotron DESY. The goal of this system is to reduce the bunch length and thus increase specific luminosity at HERA-p. Within the control system a kicker cavity is used as an actuator. The original aspect of this cavity lies in the simple geometry with no need for vacuum inside the cavity and high shunt impedance despite an internal ferrite load. The ferrite load is succesfully used to dampen higher order modes down to Q < 50 while the fundamental mode is damped by less than 2 dB. While nominal input power is rated at 60 dBm the cavity is prepared to handle beam loading. In spite of power requirements and ferrite load the cavity needs no active cooling. It can be tuned in center frequency and bandwidth over a range of 96..105 MHz and 4..7 MHz respectively and in consequence provides an optimal actuator for the particle beam control system. Presented will be the design details, all relevant parameters, the design of the internal ferrite load and operational experience.

A Possibility of Constant Energy Extraction at the KEK ATF2

THPCH088

A. Kalinin (CCLRC/DL/ASTeC)

Beam energy oscillations of the order of 0.02% take place at the KEK ATF. With extractions, the synchrotron oscillation amplitude and phase at the extraction turn randomly fluctuates. The energy jitter causes a position/angle jitter in the Diagnostic section of the Extraction Line. To reduce it, a feed forward energy stabilisation can be used done by extraction of the beam at the turn next to that turn at which the energy passes the equilibrium value. For this, the synchrotron oscillation is measured by a turn-by-turn BPM as a horizontal position oscillation. A fast turn-by-turn processor detects the turn where the oscillation passes zero, and generates an extraction permission signal that triggers the existing ATF Extraction system. Stability improvement by factor of 10 can be obtained even when the extraction is done with uncertainty up to three turns after the trigger.

The Electromagnetic Background Environment for the Interaction-point Beam Feedback System at the International Linear Collider

THPCH089

G.B. Christian, P. Burrows, G.B. Christian, C.C. Clarke, A.F. Hartin, C. Swinson, G.R. White (OXFORDphysics) R. Arnold, C. Hast, S. Smith, M. Woods (SLAC) A. Kalinin (CCLRC/DL/ASTeC)

The Interaction Point (IP) feedback system is essential for maintaining the luminosity at the International Linear Collider (ILC). It is necessary to demonstrate the performance of the feedback beam position monitor (BPM) in an electron-positron pair background similar to that expected in the ILC interaction region (IR). We have simulated the ILC beam-beam interactions and used a GEANT model of the IR to evaluate the pair and photon flux incident on the BPM, for both the 2 mrad and 20 mrad crossing angle geometries. We present results as a function of the proposed machine parameter schemes, as well as for various system layouts within the IR. We plan to study the degradation of BPM resolution, and the long term survivability, in beam tests at End Station A at SLAC. To simulate the background environment of the ILC a 'spray beam' will be produced, which will scatter from a mechanical mock-up of the forward region of the IR, and irradiate the BPM with realistic flux of secondary pairs. We present the proposed experimental layout and planned beam tests.

Stabilization of the ILC Final Focus Using Interferometers

THPCH090

D. Urner, P.A. Coe, A. Reichold (OXFORDphysics)

We are developing a system of interferometers that can measure the relative motion between two objects (such as the two final focus quadrupoles) to a few nanometers using interferometric methods. Two instruments are developed at the John

Adams Institute at University of Oxford: A distance meter to measure length changes and a straightness monitor to measure perpendicular shifts. We will present technique, results and resolutions of our distance meter prototype. We will also examine their applications at the ILC.

THPCH091

Status of the ELETTRA Global Orbit Feedback Project

M. Lonza, D. Bulfone, R. De Monte, V. Forchi', G. Gaio (ELETTRA)

A fast digital feedback system is under development to stabilize the electron beam closed orbit at the ELETTRA storage ring in the band up to 300 Hz. In view of the implementation of the feedback, the existing orbit measurement system will be upgraded to allow for better accuracy in the beam position measurement and higher acquisition rate. A global correction algorithm running on a number of distributed processing units will correct the orbit using all of the storage ring steerer magnets. The status of the project development is given in this article.

THPCH092

Single-loop Two-dimensional Transverse Feedback for Photon Factory

T. Nakamura, K. Kobayashi (JASRI/SPring-8) W.X. Cheng, T. Honda, M. Izawa, T. Obina, M. Tadano (KEK)

We installed a 500MS/s single-loop two-dimensional transverse bunch-by-bunch feedback system in the Photon Factory ring at KEK and the system is in operation at its user mode. The system composed of a single feedback loop; one skewed pair of BPM electrodes and one kicker stripline at skewed position to detect position and kick horizontally and vertically with a single signal line, and a SPring-8 feedback processor. Consequently, this system is easy to tune and cost effective. SPring-8 feedback processor employs FPGA that has enough computing power for processing more than 20-tap FIR filter required for newly developed two-dimensional feedback signal processing. We report the principle of the system, the result of test and the experience.

THPCH093

Bunch-by-bunch Feedback for the Photon Factory Storage Ring

W.X. Cheng, T. Honda, M. Izawa, T. Obina, M.T. Tadano, M. Tobiyama (KEK) K. Kobayashi, T. Nakamura (JASRI/SPring-8)

After the straight-section upgrade in 2005, the PF (Photon Factory) ring will start the top-up operation or the continuous mode in 2006. Previously the octupole magnets were used to suppress the transverse coupled bunch instability and RF modulation method to enhance the bunch length has been effectively used to suppress the longitudinal instabilities. However, such kind of methods are not suitable for the top-up operation, we are preparing active bunch-by-bunch feedback systems for both transverse and longitudinal plane. The transverse feedback system has been installed along with the straight-section upgrade, this system uses a FPGA based feedback processor board developed at the SPring-8, both horizontal and vertical signals are processed in a single control loop. For the longitudinal feedback, a two-port DAFNE type wide-band cavity has been designed and is now manufacturing, a digital signal processing part is under design, the whole system will start commissioning in autumn 2006.

Fully Digitized Synchronizing and Orbit Feed-back Control System in the KEK Induction Synchrotron

THPCH094

K. Torikai, Y. Arakida, Y. Shimosaki, K. Takayama (KEK)

A concept of "Induction Synchrotron", where an extremely long bunch captured by the step barrier-voltages is accelerated with the induction accelerating voltage, is being to be fully demonstrated in the KEK 12GeV-PS for the first time*. Attractive applications of the induction synchrotron are such as higher intensity proton drivers, future high luminosity hadron colliders with superbunch, and arbitral-ion accelerators. Synchronization between the voltage-pulse generation and the beam circulation, accelerating voltage control, and beam-orbit control without beam-rf phase, which is analogous to Delta-R feedback in an RF synchrotron, are indispensable in the induction synchrotron. A fully digitized real-time pulse density and discrete timing control system with 1GHz DSPs has been newly developed. Notable characteristics of the control system, some of which are synchronization at 1MHz revolution frequency with 8ns timing accuracy, are explained in detail. Experimental results of the induction acceleration with the digital orbit controller are also presented in this paper.

*K. Torikai et al. "Acceleration and Confinement of a Proton Bunch with the Induction Acceleration System in the KEK Proton Synchrotron", submitted to Phys.Rev.ST-AB(2005), KEK-Preprint 2005-80.

Transverse Damping System at SIS100

THPCH095

V. Zhabitsky, E. Gorbachev, N.I. Lebedev (JINR) U. Blell, P.J. Spiller (GSI)

The basic concept and main design features of the transverse damping system at the SIS100 synchrotron are presented. SIS100 with five times the circumference of the current SIS18 accelerator is a part of the Facility for Antiproton and Ion Research (FAIR) which is the next accelerator complex being constructed on the GSI site. The existing GSI accelerators serve as injector for SIS100. The SIS100 synchrotron will provide ion beams of high intensities which can lead to transversal and longitudinal beam instabilities. In order to damp the coherent transverse beam oscillations, a transverse feedback system (TFS) is going to be implemented in SIS100. The TFS presented is a feedback with a real-time digital signal processing for damping of transverse injection oscillations, feedback curing transverse coupled bunch instabilities, and excitation of transverse oscillations for beam measurements and other applications. The data on the bandwidth and gain of the TFS as well as the general description of the central processing unit are presented.

Intra Bunch Train Feedback System for the European X-FEL

THPCH096

V. Schlott, M. Dehler, B. Keil, R. Kramert, A. Lounine, G. Marinkovic, P. Pollet, M. Roggli, T. Schilcher, P. Spuhler, D.M. Treyer (PSI)

After joining the preparatory phase of the European X-FEL project, the Paul Scherrer Institut (PSI) agreed in taking over responsibility for electron beam stabilization by developing a fast intra bunch train feedback (IBFB) system, which will be tested in its prototype version at the VUV-FEL facility at DESY. The IBFB will make use of the long bunch trains provided by the superconducting drive accelerators of the VUV- as well as the European X-FEL allowing to damp beam motions in a frequency range of a few kHz up to several hundreds of kHz applying modern control algorithms in a feedback loop. The FPGA-based, digital data processing and the low latency time (preferably < 200

ns) permit the elimination of long range (from bunch train to bunch train) and ultra fast (bunch by bunch) repetitive beam movements by adaptive feed forwards. In this paper, we will introduce the IBFB design concept and report on first test measurements with newly designed stripline beam position monitors for the VUV-FEL.

THPCH097

Commissioning of the Digital Transverse Bunch-by-bunch Feedback System for the TLS

K.H. Hu, J. Chen, P.J. Chou, K.-T. Hsu, S.Y. Hsu, C.H. Kuo, D. Lee, C.-J. Wang (NSRRC) A. Chao (SLAC) K. Kobayashi, T. Nakamura (JASRI/SPring-8) W.-T. Weng (BNL)

Multi-bunch instabilities degrade the beam quality leading to increased beam emittance, energy spread or even to beam loss. The feedback system is used to suppress multi-bunch instabilities due to resistive wall of the beam ducts, cavity-like structures and trapped ions. A new digital transverse bunch-by-bunch feedback system was commissioned at the Taiwan Light Source recently, and has replaced the previous analog system. The new system has the advantages that it enlarges the tune acceptance compared with the old system, enhances damping for transverse instability at high current, and as a result, top-up operation was achieved. In this new system, a single feedback loop simultaneously suppresses both the horizontal and vertical multi-bunch instabilities. The feedback system employs the latest generation FPGA feedback processor to process bunch signals. Memory installed to capture up to 250 msec bunch oscillation signal has included the considerations for system diagnostic and should be able to support various beam physics study.

THPCH098

FPGA-based Longitudinal Bunch-by-bunch Feedback System for TLS

C.H. Kuo, J. Chen, P.J. Chou, K.-T. Hsu, S.Y. Hsu, K.H. Hu, W.K. Lau, D. Lee, C.-J. Wang, M.-H. Wang, M.-S. Yeh (NSRRC) M. Dehler (PSI) K. Kobayashi, T. Nakamura (JASRI/SPring-8)

A FPGA Based Longitudinal Bunch-by-Bunch Feedback System for TLS is commissioning recently to suppress strong longitudinal oscillation. The system consists of pickup, Bunch oscillation detector, FPGA based feedback processor borrow form the design of Spring8. Modulator converts the correction signal to the carrier frequency and longitudinal kicker which was re-designed form SLS' and working at 1374 MHz. The feedback processor is based upon latest generation FPGA feedback processor to process bunch signals. The memory capture is up to 250 msec bunch oscillation signal. The software and hardware design are also included for system diagnostic and support various beam physics study. Preliminary commission result will be summaried in this report.

THPCH099

A Turn-by-turn, Bunch-by-bunch Diagnostics System for the PEP-II Transverse Feedback Systems

R. Akre, W.S. Colocho, A. Krasnykh, V. Pacak, R. Steele, U. Wienands (SLAC)

A diagnostics system centered around commercial fast 8-bit digitizer boards has been implemented for the transverse feedback systems at PEP-II. The boards can accumulate bunch-by-bunch position data for 4800 turns (35 ms) in the x plane and the y plane. A dedicated trigger chassis allows to trigger the data acquisition on demand, or on an injection shot to diagnose injection problems, and provides gating signals for grow-damp measurements. Usually, the boards constantly acquire data and a beam abort stops data acquitision, thus preserving the last 4800 turns of position information before a beam abort. Software in a local

PC reads out the boards and transfers data to a fileserver. Matlab-based data analysis software allows to present the raw data but also higher-level functions like spectra, modal analysis, spectrograms and other functions. The system has been instrumental in diagnosing beam instabilities in PEP. This paper will describe the architecture of the system and its applications.

New Fast Dither System for PEP-II

THPCH100

S.M. Gierman, S. Ecklund, R.C. Field, A.S. Fisher, P. Grossberg, K.E. Krauter, E.S. Miller, M. Petree, K.G. Sonnad, N. Spencer, M.K. Sullivan, K.K. Underwood, U. Wienands (SLAC)

The PEP-II B-Factory uses multiple feedback systems to stabilize the orbits of its stored beams and to optimize their performance in collision [1]. This paper describes an upgrade to the feedback system responsible for optimizing the overlap of colliding beams at the interaction point (IP). The effort was motivated by a desire to shorten the response time of the feedback, particularly in the context of machine-tuning tasks. We describe the original feedback system, the design for the new one, and give a status report on the installation.

Modeling and Simulation of Longitudinal Dynamics for LER-HER PEP II Rings

THPCH101

C.H. Rivetta, J.D. Fox, T. Mastorides, D. Teytelman, D. Van Winkle (SLAC)

A time domain dynamic model and simulation tool for beam-cavity interactions in LER and HER rings at PEP II is presented. The motivation for this tool is to explore the stability margins and performance limits of PEP II LLRF systems at higher currents and upgraded RF configurations. It also serves as test bed for new control algorithms and to define the ultimate limits of the architecture. The tool captures the dynamical behavior of the beam-cavity interaction based on a reduced model. It includes nonlinear elements in the klystron and signal processing. The beam current is represented by macro-bunches. Multiple RF stations in the ring are represented via one or two single macro-cavities. Each macro-cavity captures the overall behavior of all the 2 or 4 cavity RF stations. This allows modeling the longitudinal impedance control loops interacting with the longitudinal beam model. Validation of simulation tool is in progress by comparing the measured growth rates for both LER and HER rings with simulation results. The simulated behavior of both machines at high currents are presented comparing different control strategies and the effect of non-linear klystrons and the linearizer.

Fast Global Orbit Feedback System in SPEAR3

THPCH102

A. Terebilo, T. Straumann (SLAC)

New digital global orbit feedback system is under commissioning in SPEAR3 light source. The system has 4kHz sampling rate and 200Hz bandwidth. Correction algorithm is based on Singular Value Decomposition (SVD) of the orbit response matrix. For performance tuning and additional flexibility when adding or removing correctors and BPMs, we implemented an independent PID control loop for every orbit eigenvector used. This paper discusses performance of the new system and some advantages of multiple PID loops in the eigenvector space versus a single PID loop working on the raw orbit error.

THPCH103

Design and Testing of Gproto Bunch-by-bunch Signal Processor

D. Teytelman, R. Akre, J.D. Fox, A. Krasnykh, C.H. Rivetta, D. Van Winkle (SLAC) A. Drago (INFN/LNF) J.W. Flanagan, T. Naito, M. Tobiyama (KEK)

A prototype programmable bunch-by-bunch signal acquisition and processing channel with multiple applications in storage rings has been developed at SLAC. The processing channel supports up to 5120 bunches with bunch spacings as close as 1.9 ns. The prototype has been tested and operated in five storage rings: SPEAR-3, DAFNE, PEP-II, KEKB, and ATF damping ring. The testing included such applications as transverse and longitudinal coupled-bunch instability control, bunch-by-bunch luminosity monitoring, and injection diagnostic. In this contribution the prototype design will be described and its operation will be illustrated with the data measured at the abovementioned accelerators.

THPCH104

Design and Simulation of the ILC Intra-train Orbit and Luminosity Feedback Systems

G.R. White, G.R. White (JAI) D. Schulte (CERN) N.J. Walker (DESY)

To maintain luminosity to within a few per-cent of the design at the International Linear Collider (ILC), beam stability at the IP needs to be maintained at the sub-nanometre level. To achieve the beam stability required in the presence of ground motion, multiple feedback systems are required. The baseline design calls for a 5-Hz system to control the orbit in the Linac and Beam Delivery System (BDS) and an intra-train system to address high-frequency ground motion and mechanical disturbances which cause orbit distortions at the IP between pulses enough to completely destroy the luminosity. Details of the slower feedback systems have been addressed elsewhere*. The detailed design and simulation of the intra-train feedback systems are described here. This system controls the vertical position and angle at the IP such that luminosity is maximised. The system brings the beams into collision based on BPM-derived information from the initial bunches of the train. It then tunes the IP collision parameters (both position and angle) based on a fast (bunch-by-bunch) luminosity signal from the BeamCal. The system is implemented in fast digital FPGA logic, designed using Matlab's Simulink.
*A. Seryi et al. "Issues of Stability and Ground Motion in ILC", Nanobeam 2005.**G. White et al. "Multi-Bunch Simulations of the ILC for Luminosity Performance Studies", PAC2005.

THPCH105

Summary of Coupling and Tune Feedback Results during RHIC Run 6, and Possible Implications for LHC Commissioning

P. Cameron, A. Della Penna, L.T. Hoff, Y. Luo, A. Marusic, V. Ptitsyn, C. Schultheiss (BNL) M. Gasior, O.R. Jones (CERN) C.-Y. Tan (Fermilab)

Efforts to implement tune feedback during the acceleration ramp in RHIC have been hampered by the effect of large betatron coupling, as well as by the large dynamic range required by transition crossing with ion beams. Both problems have been addressed, the first by implementation of continuous measurement of coupling using the phase-locked tune meter, and the second by the development of the direct diode detection analog front end. Performance with these improvements will be evaluated during the first days of RHIC Run 6 beam commissioning. With positive results, the possibility of implementing operational feedback control of tune and coupling during beam commissioning will be considered. After beam commissioning, chromaticity feedback will be explored as a part of

the accelerator physics experimental program. We will summarize the results of these investigations, and discuss possible implications of these results for LHC commissioning.

ISAC II RF Controls - Status and Commissioning

THPCH106

M.P. Laverty, S.F. Fang, K. Fong, Q. Zheng (TRIUMF)

The rf control system for the 20 ISAC II superconducting cavities is a hybrid analogue/ digital design which has undergone several iterations in the course of its development. In the current design, the cavity operates in a self-excited feedback loop, while phase locked loops are used to achieve frequency and phase stability. One digital signal processor provides amplitude and phase regulation, while a second is used for mechanical cavity tuning control. The most recent version has been updated to incorporate newer hardware and software technology, as well as to allow for improved manufacturability and diagnostics. Operating firmware and software can be updated remotely, if the need arises and system security permits. This paper describes the RF control system, outlines the status of the system, and details the commissioning experience gained in operating this system with the first four-cavity cryomodule.

Upgrade of TRIUMF's 2C STF Control System

THPCH107

M. Mouat, I.A. Aguilar, E. Klassen, K.S. Lee, J.J. Pon, T.M. Tateyama, P.J. Yogendran (TRIUMF)

One of TRIUMF's isotope production facilities, the 2C Solid Target Facility (STF), is being upgraded. This installation is located on a primary beamline of TRIUMF's 500 MeV Cyclotron. As a part of this upgrade project, the STF Control System is also being revised. Changes to the STF are meant to enhance reliability and maintainability. The existing STF controls have run very reliably and have provided the required functionality but were implemented in part using different technology to that used for the majority of the cyclotron's Central Control System. The new hardware and software controls should provide a simpler, more easily maintained configuration. Additional goals are to modify the user interface to more closely resemble the interface used for running the 500 MeV Cyclotron, to enhance the event annunciation, and to increase the number of parameters logged.

Status of SOLEIL Control Systems

THPCH108

A. Buteau, P. Betinelli, L.S. Nadolski (SOLEIL)

The SOLEIL light source is a 2.75 GeV third generation synchrotron radiation facility under construction near Paris Storage ring commissioning is scheduled for April 2006 and 10 BL operation for the end of 2006. This paper will describe the technical solution choosen for the control systems of accelerators and beamlines, and will give the status of the deployment. On the hardware side, the SOLEIL Controls team has implemented an industrial approach using PLCs, standard Motion Controlers and CPCI Systems. The details of our technical choices and architectures will be described in this paper. On the software side, the SOLEIL Controls team has worked closely with ESRF's one on the TANGO framework since 2002. A quick tour on the TANGO software components used for SOLEIL Controls will be detailed. On the supervision layer, SOLEIL has choosen Java as the core technology, using javabeans components provided by the TANGO toolkit within an industrial SCADA (GlobalScreen). These tools and components for Graphical User

Interface development will be presented. At last, an overview of the deployment of these systems on our installation will conclude this document.

THPCH109

Control Applications for SOLEIL Commissioning and Operation

L.S. Nadolski, A. Buteau, J. Chinkumo, R.C. Cuoq, X. Deletoille, M.O. Ounsy, S. Petit, K.S. Saintin (SOLEIL)

Synchrotron SOLEIL, the French third generation light source being commissioned in 2006, is the first facility using TANGO as a full control system. Control applications for operation and Beam Physics Dynamics have being developed using two major tools: the Matlab Middle Layer adapted from ALS and Spear3, and GlobalSCREEN, commercial SCADA software. Both tools are fully interfaced with the TANGO control system. In this paper, a sketch of the software architecture is shown. Then Storage Ring applications developed in house are presented. Finally configuration and database related applications (archiving, snapshot) are briefly described.

THPCH110

The New Control System for the Future Low-emittance Light Source PETRA 3 at DESY

R. Bacher (DESY)

At DESY, the existing high-energy physics booster synchrotron PETRA 2 will be transformed into a 3rd-generation light source (PETRA 3) after the final shutdowm of HERA operation mid 2007. In addition, the technical systems and components of the pre-accelerators LINAC 2 and DESY 2 will be improved. Within the scope of this project, the control system and the front-end electronics will be upgraded. Key elements of the conceptual design are TINE (Threefold Integrated Network Environment) as integrating software bus to provide efficient data communication mechanisms and support services, control room applications based on the thick-client model for optimum visualization and performance and Java as programming language to ensure platform independence, server-side control APIs in various languages to allow choice of the language that is best suited for the control task to be done, a common device interface for generic access to various field buses, and CANopen as interface standard for device electronics to ensure long-term maintenance. The complete conceptual design and the current project status will be presented.

THPCH111

Digital Master Oscillator for the ISIS Synchrotron

C.W. Appelbee, M.G. Glover (CCLRC/RAL/ISIS)

Rutherford Appleton Laboratories in Oxfordshire is home to an 800MeV synchrotron particle accelerator called ISIS. Its main function is to direct a beam of protons into a heavy metal target to produce neutrons for scientists to analyse condensed matter. A second harmonic system is being developed to upgrade the beam current from 200uA to 300uA in order to drive a second target station. This is being achieved by the inclusion of four second harmonic cavities to increase the width of the RF bucket. In the past the six fundamental cavities were driven by an analogue master oscillator but the extra cavities will bring more difficultly in the phasing of the system. This could be more easily and precisely controlled by embedding a Direct Digital Synthesis core into an FPGA chip as the heart of a new digital Master Oscillator. This paper describes the initial research and feasibility of such a system for the setting up, phasing and synchronisation of the ten cavities in the ring. It also describes how more of the controls to the oscillator can be encompassed by digital means.

High-level Software for Diamond Commissioning and Operation

THPCH112

R. Bartolini, C. Christou, I.P.S. Martin, J.H. Rowland, B. Singh (Diamond)

The Diamond accelerator complex is controlled with EPICS. While generic applications are provided by the EPICS toolkit, accelerator physics application for the commissioning and operation of the Diamond booster, storage ring and transfer line are mainly developed with MATLAB. The MATLAB Middle Layer tools developed at ALS and SPEAR3 have been extensively used and extended with many new applications. Experience using these tools during the commissioning of the Diamond booster, transfer lines and storage ring are reported.

The Diamond Light Source Control System

THPCH113

M.T. Heron, M.G. Abbott, P.H. Amos, K.A.R. Baker, Y.S. Chernousko, T.M. Cobb, C.A. Colborne, P.N. Denison, I.J. Gillingham, A. Gonias, P. Hamadyk, S.C. Lay, M.A. Leech, P.J. Leicester, M. McClory, U.K. Pedersen, N.P. Rees, A.J. Rose, J.H. Rowland, E.L. Shepherd, S.J. Singleton, I. Uzun, K. Vijayan (Diamond) S. Hunt (PSI) P.H. Owens (CCLRC/DL)

Diamond is a new 3rd generation synchrotron light source currently being commissioned in the UK. The control system for Diamond will be a site-wide monitoring and control system for the accelerators, beamlines and conventional facilities. This paper presents the design and implementation of the Diamond control system, which is based on the EPICS control system toolkit. It will present the detailed choice of hardware and software, the solutions realised for interfacing and control of the major technical systems of Diamond, together with progress on installation and commissioning.

Timing System Upgrade for Top-up Injection at KEK Linac

THPCH115

K. Furukawa, E. Kadokura, A. Kazakov, M. Satoh, T. Suwada (KEK)

KEK Linac provides electrons and positrons to Photon Factory (PF) and B-Factory (KEKB). Because of the nature of those factory machines both quantity and quality of the beams are required. In order to improve the injections, quasi top-up injections of electrons to PF and KEKB rings have been planned and a new beam transport line was built. Fast beam switching mechanisms are being developed and installed. The timing and control system is also reinforced to realize fast (50Hz) switching of rf timing pulses, low-level rf, beam instrumentation parameters, and beam feedback parameters. The present timing system provides precise (jitters down to 5ps) timing pulses to 150 devices. Many of the signals will be upgraded to enable the fast switching scheme with an event system. At the same time a double-fold synchronization between asynchronous Linac and PF rf signals was developed to achieve precise injection timing mainly because both rings have independent circumference correction systems.

THPCH116

Continuous Circumference Control and Timing System for Simultaneous Electron-positron Injection at the KEKB

M. Suetake, H. Koiso, Y. Ohnishi, K. Oide (KEK)

We have continuously controlled ring circumference with a new method of synthesizer control at the KEKB. The new method stands for continuous controlling of reference frequency of synthesizers. Due to the new circumference control, we stabilized the KEKB circumference within about 6 micrometers. In Fall 2006, KEKB will introduce simultaneous electron-positron injection scheme. We have to change the timing system of KEKB to control the injection phase with pulse-to-pulse injection. We show the plan of the new timing system due to the simultaneous injection scheme.

THPCH117

Synchronized Data Monitoring and Acquisition System for J-PARC RCS

H. Takahashi, Y. Ito, Y. Kato, M. Kawase, H. Sakaki, T.S. Suzuki (JAEA) M. Sugimoto (Mitsubishi Electric Control Software Corp)

J-PARC RCS* is a proton synchrotron with an extreme high power of 1MW, and delicate care must be taken to suppress radiation due to beam loss. The RCS injects each beam pulse of 25 Hz into the MLF** and the MR*** in a predefined order. Furthermore, the different beam control parameters are required for the MLF and the MR. Therefore, in order to reduce beam loss, synchronicity of data is indispensable. For this reason, control data monitoring and acquisition must be made separately for each beam pulse, distinguishing the destination in the control system. The data, which require synchronicity monitoring and acquisition, are such as beam position data (BPM**** data). We select mainly these data, and we are developing the synchronized data monitoring and acquisition system based on RM*****, WER******. The status of development and some test results for this system will be presented in this report.
*Rapid-cycling Synchrotron **Materials and Life Science Facility ***50 GeV Main Ring ****Beam Position Monitor *****Reflective Memory ******Wave Endless Recorder

THPCH118

Development of the Event Notice Function for PLC

M. Kawase, H. Takahashi (JAEA/J-PARC) T. Ishiyama (MELCO SC)

A lot of equipment which controls in J-PARC accelerator composition machinery using PLC (Programmable Logic Controller) exists. The transmitting method to upper control systems, such as interlock information on accelerator composition apparatus, state changes information, and information on the right of control operation, is not performed by polling. The event notice function is used and it transmits to the upper control system. In the case of polling, information is transmitted to the upper control system to a number "msec" order. In the case where the event notice function is used, an event can be interrupted at the time of event generating, and information can be transmitted to a target to the upper control system at it. By the J-PARC control system, it makes it possible to transmit the information on state change (event) to the upper control system immediately from PLC by using the rudder sequence program which the rudder sequence program for apparatus control detected change of a state, and mounted the event notice by using this event notice function. The J-PARC control system which mounted the event notice function is reported.

Development of a General Purpose Power System Control Board

THPCH120

S.H. Nam, S.-H. Jeong, S.H. Kim, S.-C. Kim, S.S. Park, J.-H. Suh (PAL) P. Bellomo, R. Cassel, R. Larsen, M.N. Nguyen (SLAC)

As high frequency switching solid state devices are replacing tube devices and linear devices, power systems become more compact and modular. In those systems, it is desirable to have a high quality and multi-function control board per each power system module. In order to maintain reliable operation of the power system module, the control board requires having multiple and complex functions. Moreover, the control board needs to be compact and low power consuming. It also needs to have a fast communication with the main control station. However, there is no such control board available commercially. Therefore, a general purpose power system control board (PSCB) has been under development since 2005 as a collaboration effort between PAL and SLAC. The PSCB is an embedded, interlock supervisory, diagnostic, timing, and set-point control board. It is designed to use in various power systems such as sequenced kicker pulsers, solid state RF modulators, simple DC magnet power supplies, etc. The PSCB has the Ethernet communication with the TCP/IP Modbus protocol. This paper will describe detail functions and preliminary test results of the PSCB.

Development of Machine Interlock System HMI for PLS

THPCH121

B.R. Park, J. Choi, H.-S. Kang, J.-W. Lee, J.C. Yoon (PAL)

The Machine Interlock System (MIS) for the Pohang Light Source (PLS) is used for the monitoring and control of machine devices and equipments for operation and maintenance, and protects machine devices and equipments by interlock chain program at fault status. The MIS consists of one central system unit and seven remote local system units, and is implemented mainly using GE-FANUC's Programmable Logic Controller (PLC). Using information and data in the MIS, a human-machine interface (HMI) for the MIS is developed for the operator and system manager to efficiently control and monitor the MIS and also to log various event, trip, fault data automatically. Wonder's FactorySuite is used for the HMI development software. The HMI is developed under PC environments, which communicates with the MIS through RS-485 serial link.

New Control System for Nuclotron Main Power Supplies

THPCH123

V. Volkov, V. Andreev, E. Frolov, V. Gorchenko, V. Karpinsky, A. Kirichenko, A.D. Kovalenko, S. Romanov, A. Tsarenkov, B. Vasilishin (JINR) D. Krusinsky, L. Ondris (IMS SAS)

New control and monitoring system for Nuclotron main power supplies was designed in order to substantially extend functionality of the existing equipment and software. The lattice bending (BM), focusing (QF) and defocusing (QD) magnets are powered by two supplies. The BM magnetic field shape is set by pulse function generator that produces a reference burst (Bo-train) with 0.1 Gs resolution. This train controls pattern analog function generator based on a 18-bit DAC. A real B-train from the reference magnet and corresponding analog function are used for feedback loop. The current magnetic field of BM is used as reference function for the focusing and defocusing magnets. A scaling 16-bit multiplied DAC is used to set required ratio IBM/IQFD during accelerator cycle. A 16-bit data acquisition card provides measurement of all analog signals. Digital I/O boards are applied to set and read status of the power supplies, accompanying subsystems and interlocks. Timing modules provide the trigger pulses both for the system internal needs and for synchronizing of the accelerator subsystems and experimental setups.

THPCH125

Inter-laboratory Synchronization for the CNGS Project

J. Serrano, P. Alvarez, J. Lewis (CERN) D. Autiero (IN2P3 IPNL)

CERN will start sending a neutrino beam to Gran Sasso National Laboratory in Italy in May 2006. This beam will cover a distance of around 730 km through the crust of the earth from an extraction line in CERN's SPS to dedicated detectors in Gran Sasso. This paper describes the technological choices made to fulfill the specification of inter-laboratory synchronization in the region of 100 ns, as well as some preliminary results. The common time standard is UTC as disseminated by the GPS system, and the techniques are similar to those used by national metrology laboratories for the manufacturing of UTC itself. In addition, real-time messages sent through the Internet allow the detectors in Gran Sasso to go into calibration mode when no beam is being sent. Data concerning the delay and determinism of this international network link is also presented.

THPCH126

System Development of a Time-of-flight Spectrometer for Surface Analysis of Materials

P. Junphong, Mr. Ano, S. Rattanarin, Dr. Suwannakachorn, T. Vilaithong (FNRF) A. Takahashi (Osaka University)

To study on design the time-of-flight Rutherford backscattering spectrometry (TOF-RBS) technique for nano-material surface analysis with high resolution. At Fast Neutron Research Facility, FNRF, upgrading of the existing pulsed-beam accelerator from 150-keV of D^+ to 280 keV of He^+ was proposed to use for the most powerful method of a near-surface characterization of materials utilizing TOF-RBS. The beam transport was redesigned based on the multicusp ion source which was designed the extraction and focusing system for optimization by the computer program KOBRA, and the existing beam pulsing system to provide He^+ ion beam with a few nano-second width and 280-keV acceleration energy. Simulation was done by the computer program Beam Optics, resulting in the beam size at the target position of 1 mm in diameter. The measured beam size was 6 mm in diameter. The optimization of the target position was done by the PARMELA program, to be at 3.14 m from the middle point of the buncher. Components, beam transport characteristics, beam optic simulation, and role of quadrupole magnet were explained. Design and test of the scattering chamber for TOF-RBS were shown and measured by the MCP detector. The quadrupole triplet was designed and constructed at FNRF. Development of TOF-RBS system was implemented in this study. Designing component, fabrication and installation to the accelerator system were completed. Beam extraction and He-scattering tests were done.

THPCH127

Development of MATLAB-based Data Logging System at Siam Photon Source

P. Klysubun, C. Netsai (NSRC)

New data logging and retrieval systems are currently under development at Siam Photon Source. The systems are written entirely with MATLAB language and utilize two MATLAB toolboxes to handle data communications. The two toolboxes are Open Process Control Toolbox, which is used to carry out communications with Programmable Logic Controllers (PLCs) via Open Process Control Data Access (OPCDA), and Data Acquisition Toolbox, which handles communications with other systems via RS-232 and IEEE-488 interconnections. The interface with the database is handled by the MATLAB Database Toolbox. These MATLAB-based logging and retrieval systems enable accelerator physicists to easily import the logged data to accelerator modeling tools for studies of the accelerator optics. Beamline researchers and users can also write their own retrieval programs to access only the data they need. In this paper we describe the concept, the current status of the systems, and the planned improvements to be carried out in the future.

Portable SDA (Sequenced Data Acquisition) with a Native XML Database

THPCH128

T.B. Bolshakov, E.S. McCrory (Fermilab)

SDA is a general logging system for a repeated, complex process. It has been used as one of the main logging facility for the Tevatron Collider during Run II. It creates a time abstraction in terms understood by everyone and allows for common time tick across different subsystems. In this article we discuss a plan to re-implement this highly successful FNAL system in a more general way so it can be used elsewhere. Latest technologies, namely a native XML database and AJAX, are used in the project and discussed in the article.

Design and Implementation of Analog Feedback Damper System for an Electron-proton Instability at the Los Alamos Proton Storage Ring

THPCH130

C. Deibele, S. Assadi, V.V. Danilov, S. Henderson, M.A. Plum, C. Sibley III (ORNL) S. Breitzmann, S.-Y. Lee (IUCF) J.M. Byrd (LBNL) J.D. Gilpatrick, R.J. Macek, R.C. McCrady, J.F. Power, J. Zaugg (LANL)

The PSR (Proton Storage Ring) at LANSCE has observed an E-P (electron-proton) instability. A wideband analog feedback damper system was designed and implemented that has shown it is possible to correct this instability. The damper system consists of two 180 degree hybrids, low level amplifiers, a delay line, comb filter, power amplifiers, and adjustable delay lines. The system bandwidth is about between 10^{-300} MHz, and was developed and implemented in stages showing improvement in the e-p threshold of the buncher voltage. The system takes advantage of fiber optic technology for delays as well as for the comb filter. A system description and some measurement results are presented.

EPU Assembly Based on Sub-cassettes Magnetic Characterization

THPCH132

G. Tosin, R. Basilio, J.F. Citadini, M. Potye (LNLS)

A procedure to speed up the magnetic field correction of an EPU type undulator is proposed and its results are shown. Such procedure consists in segmenting each one of the four magnetic blocks linear arrays (cassettes) in seven sub-cassettes and making their individual magnetic and mechanical characterization. One theoretical perfect sub-cassette, which is composed of four segments per period in Halbach configuration, is taken as the standard field profile. The peak fields and the fields integrated in each semi-period of one sub-cassette are chosen to be the optimization parameters. The magnetic blocks are displaced (virtual shims) to minimize the difference of the optimization parameters between the sub-cassette magnetic measurement and the standard profile. The sub-cassette magnetic measurements are performed with Hall probes, using the same bench employed in insertion devices characterization.

Conceptual Design of an EPU for VUV Radiation Production at LNLS

THPCH133

G. Tosin, R. Basilio, J.F. Citadini, R.T. Neuenschwander, M. Potye, X.R. Resende, M. Rocha, P.F. Tavares (LNLS)

We describe the magnetic and mechanical design of an elliptically polarizing undulator (EPU) currently under construction at the (Brazilian Synchrotron Light Source - LNLS). The device is designed to cover the photon flux in the range from 100eV to 1000eV (124Å a 12.4 Å), allowing linear, elliptical and circular polarizations. With this device it is possible to reach absorption edges of several elements such as Si, S, Br, C, N, O, Fe, F, Cl and to measure magnetic dichroism. The EPU's magnetic design is conventional, and field corrections are done by means of virtual shims, with horizontal and vertical displacements. Each one of the four magnetic blocks linear arrays (cassettes) is segmented in seven sub-cassettes. The separate magnetic measurement of each sub-cassette allows corrections of the magnetic field profile to be made before final assembly and makes the verification of mechanical tolerances easier and faster, decreasing the expected time that will be spent in the magnetic tuning of the device. The mechanical structure is composed of a C-Frame, gap and phase actuators. The gaps actuators and phase actuators use absolute encoders and bias with springs to eliminate backlash.

THPCH134

Development of Insertion Device Magnetic Characterization Systems at LNLS

G. Tosin, R. Basilio, J.F. Citadini, M. Potye (LNLS)

This paper describes a set of magnetic measurement systems employed in the development of insertion devices at LNLS (Brazilian Synchrotron Light Source). They are: rotating coil (which can also operate as a flip-coil), spatial field mapping using Hall probes and parallel coils (Helmholtz configuration) for magnetic blocks characterization. Although such techniques are well established, strict specifications imposed by the beam dynamics on the magnetic field quality, led to a detailed analysis of their sources of error and their minimization. All three systems have already been tested and showed excellent accuracy and repeatability when compared to typical values found in the literature.

THPCH135

65 MEV Neutron Irradiation of ND-FE-B Permanent Magnets

X.-M. Maréchal, T. Bizen (JASRI/SPring-8) Y. Asano (JAEA/SPring-8) H. Kitamura (RIKEN Spring-8 Harima)

Rare-earth permanent magnets are now playing a major role in accelerator technology, from the development of beam transport systems magnets to their extensive use in synchrotron radiation sources and free electron lasers. Unfortunately, operating in a high radiation environment, rare-earth permanent magnets are subject to demagnetization caused by direct and scattered radiation. The lifetime of these components is therefore a major issue: as a result, the number of studies to clarify the demagnetization mechanism or to test materials of interest for a particular application under specific conditions of irradiation has increased in recent years. However, so far, neutron irradiation experiments have been mainly carried out with reactors, were neutrons have a wide, but mainly low, energy spectrum. We present here the results obtained at the TIARA facility of the Japan Atomic Energy Research Institute, a spalliation source of mono highly energetic neutrons. Four types of Nd-Fe-B permanent magnets (Neomax^{TM} 35EH, 32AH, 27VH and 44H) representing a wide range of characteristics (remanence and coervicity) have been studied.

THPCH139

Development of an Ion Source via Laser Ablation Plasma

F. Belloni, D. Doria, A. Lorusso, V. Nassisi (INFN-Lecce) L. Torrisi (INFN/LNS)

Experimental results on the development of a laser ion source (LIS) are reported. LISs are particularly useful in ion accelerators, ion implanters and devices for electromagnetic isotope separation. A focused UV laser beam (0.1 - 1 GW/cm^2 power density) was used to produce a plasma plume from a Cu target. Several aspects were investigated: ion angular distribution, energy distribution, ion extraction and

charge loss due to ion recombination. Particular attention was devoted to avoid arcs during the extraction phase; it was accomplished by allowing the proper plasma expansion in a suitable chamber before the extraction gap. Diagnostics on free expanding plasma and extracted ions was carried out mainly by time-of-flight measurements, performed by means of Faraday cups and electrostatic spectrometers. At 18kV acceleration voltage, the ion beam current, measured along a drift tube at 147cm from the target, resulted modulated on ion mass-to-charge ratio and its maximum value was 220uA. The Cu+1 ion bunch charge was estimated to be 4.2nC. Ion implantation tests were successfully performed at high acceleration voltage (several tens kV), by using a simple experimental arrangement.

New Pulsed Current and Voltage Circuits Based on Transmission Lines

THPCH140

V. Nassisi, F. Belloni, D. Doria, A. Lorusso, M.V. Siciliano, L. Velardi (INFN-Lecce)

We present two novel circuits able to compress current or voltage pulse named current compressor circuit (CCC) and voltage compressor circuit (VCC), and two novel amplifier circuits able to double the current or voltage pulse. The compressing circuits were composed by a transmission line, l long and a storage line, l/2 long. The CCC compressed the current pulse by a factor of 2 doubling its intensity, while the VCC compressed the voltage pulse by a factor of 2 doubling its amplitude. The amplifying circuits were composed by a R0 transmission line closed on a set of two parallel or series storage lines which doubled the intensity of the pulses. The current pulse amplifier (CPA) had two R0/2 storage lines in parallel, while the voltage pulse amplifier (VPA) had two 2R0 storage lines in series. The storage line was half long with respect to the input-pulse. In both circuits, one storage line was characterized by an open extremity and the other line by a closed extremity. Connecting the storage lines to suitable load resistors, R0/4, and 4R0 for the CPA and VPA, respectively, a twice of the pulse intensity was obtained. The circuits were studied by computer simulations.

The Fast Extraction Kicker System in SPS LSS6

THPCH143

E.H.R. Gaxiola, F. Caspers, L. Ducimetière, P. Faure, T. Kroyer, B. Versolatto, E. Vossenberg (CERN)

A new fast extraction has been set up in SPS LSS6 to transfer 450 GeV/c protons as well as ions to Ring 1 of the LHC, via the transfer line TI 2. The system includes four travelling wave kicker magnets, recuperated from earlier installations and upgraded to fit the new application. All four magnets are powered in series, energised by a single PFN generator and terminated by a short circuit. The layout and the modifications to the magnets and the high voltage circuit are described along with the impact of design choices on the performance of the system. Results from laboratory tests and first machine experience are reported on approaches to overcome the effects of the beam induced kicker heating observed earlier, including a beam screen in form of metallic stripes printed directly onto the ferrites and the use of ferrite blocks with high Curie temperature. Prospects for further improvements are briefly discussed.

THPCH144

The Upgrading of the TLS Injector Bumper and Septum Power Supplies for Top-up Operation

C.-S. Fann, K.-T. Hsu, S.Y. Hsu, J.-Y. Hwang, K.-K. Lin, K.-B. Liu, Y.-C. Liu (NSRRC)

Due to the inevitable requirement of routine top-up mode operation at TLS (Taiwan Light Source), the reliability of all components in TLS injector has been reevaluated in the past several months. Among all possible subsystems to be reinforced, the bumper and septum power supplies revealed urgent need of upgrading while operated continuously in the user shifts. In this report, the modification of the charging mechanism of the pulsed power supplies is described. The modular feature of the newly built units provides fast replacement capability in case of components failure. The unified specifications for all components have greatly reduced the effort in preparing spare parts. The test results of these units are presented in this report.

THPCH146

Solid State Modulators for the International Linear Collider (ILC)

M.A. Kempkes, N. Butler, J.A. Casey, M.P.J. Gaudreau, I. Roth (Diversified Technologies, Inc.)

Diversified Technologies, Inc. (DTI) is developing two solid-state modulator designs for the International Linear Collider with SBIR funding from the U.S. Department of Energy. This paper will discuss design tradeoffs, energy storage requirements and alternatives, and the construction and test status of both ILC designs. The first design is a 150 kV hard switch, employing an innovative energy storage system, which must provide 25 kJ per pulse at very tight voltage regulation over the 1.5 millisecond pulse. DTI's design uses a quasi-resonant bouncer (with a small auxiliary power supply and switch) to maintain the voltage flattop, eliminating the need for massive capacitor banks. The second design builds upon earlier DTI work for the 500 kV, 500 A NLC modulators. It uses a solid-state Marx bank, with ~10 kV stages, to drive the ILC klystron. Staggered turn-on of the Marx stages provides voltage regulation without the need for large capacitor banks.

THPCH147

Solid-state High Voltage Pulse Power in the 10^{-100} Nanosecond Regime

M.A. Kempkes, F.O. Arntz, N. Butler, J.A. Casey, M.P.J. Gaudreau (Diversified Technologies, Inc.)

New particle accelerators, with voltages exceeding 50 kV and currents exceeding 1,000 A, require kicker magnet drivers to deliver pulsed power with durations in the 10^{-100} ns range. Similar levels of pulse performance are needed for state-of-the-art eximer laser systems, impulse radar transmitters, and particle accelerators for medical therapy. In addition, the processing of food using pulsed electric fields (PEF processing) has similar requirements. In this paper, DTI will review solid-state pulse power technologies capable of delivering high-voltage, high-current pulses with 10-to-100 nanosecond pulse duration. IGBTs, MOSFETs, snap-off diodes, and magnetic pulse compression will be discussed. Current research at Diversified Technologies, Inc. is exploring the impact of these switching devices and circuits on pulse wave shape, pulse repeatability, adjustability of pulse voltage, current and timing, maximum pulse rate (PRF), jitter, and robustness.

THPCH148

Tests of a High Voltage Pulser for ILC Damping Ring Kickers

M.A. Palmer, G. Dugan, D. L. Rubin (Cornell University, Laboratory for Elementary-Particle Physics) R. Meller (Cornell University, Department of Physics)

The baseline configuration for the International Linear Collider (ILC) damping rings specifies a single 6 km damping ring for electrons and two 6 km rings for positrons. Kicker requirements are determined by the damping ring circumference and the train structure in the main linac. The nominal bunch train parameters in the ILC main linac are trains of 2820 bunches with 308 ns spacing and a train repetition rate of 5 Hz. This means that the pulsers for the damping ring kickers must have rise and fall times suitable for bunch spacings of ~6 ns, must be able to operate with 3.25 Mhz bursts, and must support an average pulse rate of 14.1 kHz. We describe bench and beam tests of a pulser based on fast ionization dynistor technology whose specifications roughly meet these requirements. We then discuss the implications of our results for the ILC damping ring kickers.

THPCH149

Active RF Pulse Compression using Electrically Controlled Semiconductor Switches

J. Guo, S.G. Tantawi (SLAC)

In this paper, we present the recent results of our research on the ultra-high power fast silicon RF switch and its application on active X-Band RF pulse compression systems. This switch is composed of a group of PIN diodes on a high purity silicon wafer. The wafer is inserted into a cylindrical waveguide operating in the $T{\cdot}10^{01}$ mode. Switching is performed by injecting carriers into the bulk silicon through a high current pulse. Our current design uses a CMOS compatible process and the fabrication is accomplished at SNF (Stanford Nanofabrication Facility). The RF energy is stored in a room-temperature, high-Q 400 ns delay line; it is then extracted out of the line in a short time using the switch. The pulse compression system has achieved a gain of 11, which is the ratio between output and input power. Power handling capability of the switch is estimated at the level of 10MW.

THPCH150

Double-pulse Generation with the FLASH Injector Laser for Pump/Probe Experiments

O. Grimm, K. Klose, S. Schreiber (DESY)

The injector laser of the VUV-FEL at DESY, Hamburg, was modified to allow the generation of double-pulses, separated by a few cycles of the 1.3 GHz radio-frequency. Such double pulses are needed for driving the planned infrared/VUV pump/probe facility. Construction constraints of the facility will result in an optical path length about 80 cm longer for the infrared. Although the VUV can be delayed using normal-incidence multilayer mirrors at selected wavelengths, a fully flexible scheme is achieved by accelerating two electron bunches separated by more than the path length difference and then combine the infrared radiation from the first with the VUV from the second. This paper explains schemes for the generation of double-pulses with the laser system. It summarizes experimental studies of the effect on the operation of diagnostic instrumentation and on the tunability of the machine. Of special concern is the effect of wakefields on the quality of the second bunch, critical for achieving lasing.

THPCH151

Commissioning of the Laser System for SPARC Photoinjector

C. Vicario, M. Bellaveglia, D. Filippetto, A. Gallo, G. Gatti, A. Ghigo (INFN/LNF) P. Musumeci, M. Petrarca (INFN-Roma)

In this paper we report the commissioning of the SPARC photoinjector laser system. In the high brightness photoinjector the quality of the electron beam is directly related to the features of the laser pulse. In fact the temporal pulse shape, the temporization and the transverse distribution of the electron beam is determined by the incoming laser pulse. The SPARC laser system is based on an amplified Ti:Sapphire active medium and the pulse shape is imposed by a programmable acousto-optics dispersive filter. The transfer-line has been designed to reduce the angular jitter and to preserve to the cathode the temporal and spatial features of the laser pulse. The laser system has been integrated with the accelerator apparatus. The diagnostics and the control system has been completed. We present the measured performances and the simulations we carried out.

THPCH152

Temporal Quantum Efficiency of a Micro-structured Cathode

V. Nassisi, F. Belloni, G. Caretto, D. Doria, A. Lorusso, L. Martina, M.V. Siciliano (INFN-Lecce)

In this work the experimental and simulation results of photoemission studies for photoelectrons are presented*. The cathode used was a Zn disc having the emitting surface morphologically modified. Two different excimer lasers were employed like energy source to apply the photoelectron process: XeCl (308nm, 10ns) and KrF (248nm, 20ns). Experimental parameters were the laser fluence (up to 70 mJ/cm2) and the anode-cathode voltage (up to 20 kV). The output current was detected by a resistive shunt with the same value of the characteristic impedance of the sistem, about 100 ?. In this way, our device was able to record fast current signals. The best values of global quantum efficiency were approximately 5x 10^{-6} for XeCl and 1x 10^{-4} for KrF laser, while the peaks of the temporal quantum efficiency were 8x 10^{-6} and 1.4x10-4, respectively. The higher efficiency for KrF is ascribed to higher photon energy and to Schottky effect. Several electron-beam simulations using OPERA 3-D were carried out to analyze the influence of the geometrical characteristics of the diode. Simulating the photoemission by cathodes with micro-structures the output current was dependent on cathode roughness.

*L. Martina et al. Rev. Sci. Instrum., 73, 2552 (2002).

THPCH153

Production of Temporally Flat Top UV Laser Pulses for SPARC Photoinjector

M. Petrarca, P. Musumeci (INFN-Roma) I. Boscolo, S. Cialdi (INFN-Milano) G. Gatti, A. Ghigo, C. Vicario (INFN/LNF) M. Mattioli (Università di Roma I La Sapienza)

In the SPARC photoinjector, the amplified Ti:Sa laser system is conceived to produce an UV flat top pulse profile required to reduce the beam emittance by minimizing the non-linear space charge effects in the photoelectrons pulse. Beam dynamic simulations indicate that the optimal pulse distribution must be flat top in space and time with 10 ps FWHM duration, 1 ps of rise and fall time and a limited ripple on the plateau. In a previous work it was demonstrated the possibility to use a programmable dispersive acousto-optics (AO) filter to achieve pulse profile close to the optimal one. In this paper we report the characterization of the effects of harmonics conversion on the pulse temporal profile. A technique to overcome the harmonics conversion distortions on the laser pulses at the fundamental wavelength in order to obtain the target pulse profile is explained too. Measurements and simulations in the temporal and spectral domain at the fundamental laser wavelength and at the second and third harmonics are presented in order to validate our work. It is also described a time diagnostic device for the UV pulses.

*H. Loos et al. "Temporal E-Beam Shaping in an S-Band Accelerator", Proc. Particle Accelerator Conference, p.642, 2005, Knoxville, TN, USA.

Development of Pulsed Laser Super-cavity for Compact High Flux X-ray Sources

THPCH154

K. Sakaue, M. Washio (RISE) S. Araki, Y. Higashi, Y. Honda, T. Taniguchi, J. Urakawa (KEK) M.K. Fukuda, M. Takano (NIRS) H. Sakai (ISSP/SRL) N. Sasao (Kyoto University)

Pulsed-laser super-cavity is being developed at KEK-ATF for the application of a compact high brightness x-ray source based on Laser Compton Scattering. We use a Fabry-Perot optical cavity with a pulsed laser. The cavity increases a laser effective power, and at the same time, stably makes a small laser spot in side the cavity. In addition, the pulsed-laser gives much higher peak power. Thus, this scheme will open up a new possibility for building a compact high-brightness x-ray source, when collided with an intense bunched electron beam. We are now planning to build such an x-ray source with a 50MeV multi-bunch linac and a 42cm Fabry-Perot cavity using pulse stacking technology. We actually finished construction of the 50MeV linac and will start its operation in the spring, 2006. Development of the pulsed-laser super-cavity and future plan of our compact x-ray source will be presented at the conference.

High-quality Proton Beam Obtained by Combination of Phase Rotation and the Irradiation of the Intense Short-pulse Laser

THPCH155

S. Nakamura, Y. Iwashita, A. Noda, T. Shirai, H. Souda, H. Tongu (Kyoto ICR) S. Bulanov, T. Esirkepov, Y. Hayashi, M. Kado, T. Kimura, M. Mori, A. Nagashima, M. Nishiuchi, K. Ogura, S. Orimo, A. Pirozhkov, A. Sagisaka, A. Yogo (JAEA) H. Daido, A. Fukumi (JAEA/Kansai) Z. Li (NIRS) A. Ogata, Y. Wada (HU/AdSM) T. Tajima (JAEA/FEL) T. Takeuchi (AEC)

Ion production from laser-induced plasma has been paid attention because of its high acceleration gradient (>100GeV/m) compared with conventional RF accelerator. Its energy spectrum is Maxwell-Boltzmann distribution with high-energy cut-off, which limited its application. The phase rotation scheme, which rotates laser produced ions by an RF electric field synchronous to the pulse laser in the longitudinal phase space, was applied to proton beam up to 0.9MeV emitted from Ti foil with 3mm thickness irradiated by focused laser-pulse with peak intensity of 9 ´ 1017W/cm2. Multi-peaks with ~6% width (FWHM) were created and intensity multiplication up to 5 was attained around 0.6MeV region. The proton production process by the intense short-pulse laser has been optimized with use of time of flight measurement of proton beam detected by a plastic scintillation counter, which is specially shielded from the heavy background of electrons and X-rays induced by the intense laser. We have succeeded in on-line measurement of such a proton signal by the detector for the first time, which played an essential role for the investigation of phase rotation scheme.

SNS Transverse and Longitudinal Laser Profile Monitors Design, Implementation and Results

THPCH156

S. Assadi (ORNL)

SNS is using a Nd:YAG laser to measure transverse profiles at nine-stations in the 186-1000 MeV Super-Conducting LINAC (SCL) and a Ti:Sapphire mode-locked laser to measure longitudinal profiles in the 2.5 MeV Medium Energy Beam Transport (MEBT). The laser beam is scanned across the H^- beam to photo-neutralize narrow slices. The liberated electrons are directly collected to measure the transverse or longitudinal beam profiles. We have successfully measured the transverse and longitudinal profiles at all stations. The SCL laser system uses an optical transport line that is installed alongside the 300 meter super-conducting LINAC to deliver laser light at nine locations. Movement of the laser light in the optical transport system can lead to problems with the profile measurement. We are using telescopes to minimize the oscillations and active feedback system on mirrors to correct the drifts and movements. In this paper we present our implementation and beam profiles measured during SCL commissioning. We also discuss future improvements, drift/vibration cancellation system, as well as plan to automate subsystems for both the transverse and the longitudinal profiles.

THPCH158

A Phased-locked S.A.M. Mode-locked Laser for the ELSA Photoinjector

V. Le Flanchec, P. Balleyguier (CEA)

A new laser oscillator has been developed for the ELSA photoinjector. It is a fibered-diode-pumped mode-locked Nd:YVO4 laser, with a completely passive cooling design. Mode-locking is achieved by a saturable absorber mirror. Such a passive laser oscillator must be synchronized with the ELSA electron bunches. A phased-locked loop has been developed for that purpose. We present the main design aspects resulting from the high stability requirement of ELSA. The first electron spectra measurements show the high level of energy stability achieved. We also present improvements in the laser injection system leading to a higher transverse stability, a more uniform cathode illumination, and a better transmission of the whole system.

THPCH159

Analysis of Microphonic Disturbances and Simulation for Feedback Compensation

M. Luong, P. Bosland, G. Devanz, E. Jacques (CEA)

For FEL projects based on a superconducting linac operating in CW mode, the RF power optimization finally comes up against the microphonics disturbances, which result in an unpredictable detuning of the cavities. A new piezoelectric tuner was developed and mounted on a TTF 9-cell cavity with an appropriate instrumentation. This system enables a full characterization of the disturbances and the tuner behavior. First measurements were made in a horizontal cryomodule at 4.2 K. They set a basis for simulations to assess the possibility of a feedback compensation, which is usually credited as impracticable. The outcome of such a compensation is also shown in terms of acceleration voltage amplitude and phase residual errors.

THPCH160

Theoretical Study and Experimental Result of the RF Coupler Prototypes of Spiral 2

Y. Gómez-Martínez, D. Bondoux, JM. Carretta, J.-M. De Conto, M. Fruneau, A. Garrigue, D. Marchand, R. Micoud, E. Vernay, F. Vezzu (LPSC) P. Balleyguier (CEA) M. Di Giacomo (GANIL)

Spiral 2 is a 40 MeV superconducting linac under construction at GANIL. The RF couplers have to provide a 12 kW CW power to the cavities at 88 MHz. Two solutions corresponding to 2 different technologies have been designed and 2 prototypes have been built. We present the technical proposals and issues as well as the results (manufacturing, test at low and high power, multipacting. . .) leading to the final choice.

Status of the Polarized Electron Gun at the S-DALINAC

THPCH161

C. Heßler, M. Brunken, J. Enders, H.-D. Gräf, G. Iancu, Y. Poltoratska, M. Roth (TU Darmstadt) W. Ackermann, W.F.O. Müller, N. Somjit, B. Steiner, T. Weiland (TEMF) K. Aulenbacher (IKP)

Aiming at an extension of the experimenting capabilities for nuclear structure physics at low momentum transfer at the superconducting Darmstadt electron linear accelerator S-DALINAC, a polarized electron gun is being constructed. The new injector will be able to supply the S-DALINAC with 100 keV polarized electrons and should complement the present, unpolarized thermionic source. The design requirements are a degree of polarization of at least 80%, a mean current intensity of 0.06 mA and a 3 GHz cw structure. The basic design of the gun was adapted from the source of polarized electrons at MAMI, Mainz*, and optimized in various simulations. The active material is a strained layer GaAs crystal which is exposed to an 830 nm pulsed laser beam. We report on the status of the polarized source, the preparation setup and a test beam line.
*K. Aulenbacher et al., Nucl. Instrum. Meth. A 391, 498 (1997).

"Oligo-crystalin" Niobium / Large Grain Niobium Discs, Directly Cut from Ingot

THPCH163

B. Spaniol (W.C. Heraeus GmbH, Materials Technology Dept.)

"Oligo-crystalin" Niobium ingots with very large grains (diameter more than 200 mm) can be perfectly used as start material to cut Niobium discs to form half-cells for SCRF cavities. Caused by the minimum of remaining grain boundaries, the properties of these discs are very promising for the use in SCRF cavities. In addition to the technical properties of such material also the cost benefit is promising. The new production way to cut the discs directly from the ingot is less expensive than the "traditional" sheet rolling process. As a positive side effect, the risk of contaminations is minimized due to the reduced number of production steps.

Progress and Status of the MICE Project

THPCH164

A.P. Blondel (DPNC) P. Drumm (CCLRC/RAL/ISIS)

The design of a Neutrino Factory (NF) has been the subject of several physics studies. For a NF based on a stored high energy muon beam, a potential key technology that has a significant impact on its cost and practicality is the ability to cool rapidly the muon beam prior to acceleration. The muon ionisation cooling experiment (MICE), currently being constructed at the Rutherford Appleton Laboratory (UK), is a demonstration of emittance cooling in a linear cooling channel. A new muon beam line and the basic infrastructure for MICE are funded, and a muon beam is under construction with an expected availability in spring 2007. The experiment will be methodically assembled over the following few years to bring the beam through RF accelerating cavities and liquid hydrogen absorbers and confined by a solenoidal magnetic field. The emittance of the beam before and after the cooling channel is measured in tracking spectrometers. The current status of the beam line and infrastructure build and of the components of MICE is presented.

ERLP Quantum Efficiency Scanner

THPCH165

P.A. Corlett, J.H.P. Rogers (CCLRC/DL/ASTeC)

The Energy Recovery Linac Prototype (ERLP) under construction at Daresbury Laboratory will utilise a photoinjector as its

electron source. In order to characterise the performance of the photo-cathode wafer, a low power laser is scanned across its surface and the resultant current measured to build up a map of the quantum efficiency of the wafer.

THPCH166

The Timing System for Diamond Light Source

Y.S. Chernousko, A. Gonias, M.T. Heron (Diamond) T. Korhonen (PSI) E. Pietarinen, J. Pietarinen (MRF)

The Diamond timing system is the latest generation development of the design, principles and technologies currently implemented in the Advanced Photon Source and Swiss Light Source timing systems. It provides the ability to generate reference events, distribute them over a fibre-optic network, and decode and process them at the equipment to be controlled. The timing system is closely integrated within the Diamond distributed control system, which is based on EPICS. The Diamond timing system functionality and performance, and first operational experiences in using the timing system during the commissioning of the accelerators, are presented in this paper.

THPCH167

Commissioning of the Diamond Pre-injector Linac

C. Christou, V.C. Kempson (Diamond) K. Dunkel, C. Piel (ACCEL)

Commissioning of the linac for the Diamond Light Source (DLS) was completed in October 2005. The linac was supplied by Accel Instruments as a complete system, with DLS providing beam diagnostics, beam analysis software, control system hardware and standard vacuum components. Much of the beam analysis was carried out using the first part of the Linac to Booster transfer line (LTB), which was designed and built by DLS. Operation of the linac and LTB at 100 MeV in long-pulse and short-pulse modes of operation was demonstrated, and all operational parameters were measured to be within specification.

THPCH168

RF Distribution System of the Diamond Master Oscillator

A.V. Watkins, M. Jensen, M. Maddock, S.A. Pande, S. Rains, D. Spink (Diamond)

A modular RF distribution system has been designed and built at Diamond Light Source to distribute the master oscillator (MO) signal. The system will deliver a low noise, phase stable 500 MHz signal to multiple points of use around the synchrotron facility. Providing phase stability and preserving noise performance over the distances required (up to 300m) have been the main design challenges. A modular approach provides future flexibility, and this paper describes each component, outlining design choices, components used, construction details and test results.

Design, Manufacturing and Integration of LHC Cryostat Components: an Example of a Collaboration between CERN and Industry

THPCH169

M. Canetti, F.G. Gangini (RIAL VACUUM S.p.A) N. Bourcey, T. Colombet, V. Parma, I. Slits, J.-P.G. Tock (CERN)

The components for the LHC cryostats and interconnections are supplied by the European industry. The manufacturing, assembly and testing of these components in accordance with CERN technical specifications require a close collaboration and dedicated approach from the suppliers. This paper presents the different phases of design, manufacturing, testing and integration of four LHC cryostat components supplied by RIAL Vacuum (Parma, Italy), including 108 insulation vacuum barriers, 482 cold-mass extension tubes, 115 cryostat vacuum vessel jumper elbows and 10800 interconnection sleeves. The Quality Assurance Plan, which the four projects have in common, is outlined. The components are all leak-tight thin stainless steel assemblies ($< 10^{-8}$ mbar l/s), most of them operating at cryogenic temperature (2 K), however each having specific requirements. Therefore the peculiarities of each component are presented with respect to manufacturing, assembly and testing. These components are being integrated at CERN into the LHC cryostats and interconnections, which allowed validating the design and production quality. The major improvements and difficulties will be discussed.

Reduction of Dark Current in SPring-8 Linac

THPCH170

T. Kobayashi, T. Asaka, H. Dewa, H. Hanaki, A. Mizuno, S. Suzuki, T. Taniuchi, H. Tomizawa, K. Yanagida (JASRI/SPring-8)

In the SPring-8 linac, removal of dark currents generated from an injector part has been studied to enhance the bunch purity of stored beam in the SPring-8 storage ring. We already succeeded in reduction of the dark currents from a thermionic electron gun by a beam deflector of parallel plate electrodes. However, dark currents are also generated in accelerating structures due to the high electric fields. We have been studying removal of the dark currents generated from the first accelerating structure by solenoid coils covering it.

Control System of the Superconducting Insertion Device at TLS

THPCH171

J. Chen, K.-T. Hsu, S.Y. Hsu, K.H. Hu, C.H. Kuo, D. Lee, C.-J. Wang (NSRRC)

There are three superconducting insertion devices installed at Taiwan Light Source. Two is under construction. These insertions enhance hard X-ray production to satisfy the research requirement of X-ray community. The control system is implemented to support the operation of all these superconducting insertion devices. The control system coordinate the operation of the main power supply and the trimming power supply to charge/discharge the magnets and provide essential interlock protection for the coils and vacuum ducts. Friendly user interface supports routine operation. Various applications are also developed to aid the operation of these insertion devices. Design consideration and details of the implementation will be summary in this report.

THPCH172

Present Status of Beam Collimation System of J-PARC RCS

K. Yamamoto (JAEA/J-PARC) M. Abe, H. Hanaue, A. Nakamura, Y. Takeuchi (VIC International Co., Ltd.) Y. Hirooka, M. Okazaki (Mitsui Engineering & Shipbuilding Co., Ltd.)

The precedence manufacture of the two beam collimator was carried out. In these two sets, we tested the heat transfer capacity of cooling fins and remote clamp handling system. The vertical collimator was able to keep temperature under 120 degrees C by the design heat 400W, but in case of the horizontal collimator, it went over 200 degrees C by the design heat 700W. The design was changed towards adding an air duct. About remote clamp handling system, it checked that it could attach by the He leak below 5.*10-10Pa m3/sec as a result of the helium leak examination.

THPCH174

Multipactor Electron Gun with CVD Diamond Cathodes

J.Y. Zhai, C.-X. Tang, S. Zheng (TUB)

A Multipactor Electron Gun (MEG) is developed for the high power microwave generation in the Accelerator Lab of Tsinghua University. This paper presents the recent experimental results of the S-band MEG using hydrogen-terminated and CsI-terminated CVD diamond cathodes. The gun design, cathode preparation and high power experiment are described. An electron beam with 5 μs macro-pulse, 10 Hz repetition rate, greater than 900 mA beam current was obtained.calculation and computer simulation. The properties of the secondary electron emission cathodes are also discussed.

THPCH175

Automatic Resonant Excitation Based System for Lorentz Force Compensation for Flash

P.M. Sekalski, A. Napieralski (TUL-DMCS) S. Simrock (DESY)

The cavity is the key element of each linear accelerator used for high-energy physics purpose. The resonant frequency of cavities depends on its shape. Due to the pulse operation, they are deformed by dynamic Lorentz force (LF) caused by accelerating electromechanical field. As a consequence, the cavities are not working on resonance but they are detuned from master oscillator frequency by few hundreds of Hertz depending on accelerating field gradient. The paper presents an automatic control system for LF compensation applied to fast tuning mechanism CTS. The active element is multilayer low-voltage piezoelectric stack (EPCOS). The resonant excitation with adaptive feed forward algorithm is used to drive the actuator. Test performed at FLASH (former name VUV-FEL) on cav5/ACC1 showed that detuning during flat-top period (800us) might remain below 10Hz for accelerating field gradient of 20MV/m.

Deposition of Lead Thin Films Used as Photo-cathodes by Means of Cathodic Arc under UHV Conditions

THPCH176

P. Strzyzewski, J. Langner, M. S. Sadowski, J. Witkowski (The Andrzej Soltan Institute for Nuclear Studies, Centre Swierk) T. Rao, J. Smedley (BNL) R. Russo, S. Tazzari (Università di Roma II Tor Vergata) J.S. Sekutowicz (DESY)

The cathodic arc technology has been used for various technical purposes for many years. Recently, it has been demonstrated that the cathodic arc can be operated under ultra-high vacuum (UHV) conditions and it might solve the problem of the oxygen contamination coming from water remnants. It opens a new road to many applications where very pure metallic and/or superconducting films are needed. The paper reports on recent experimental studies aimed on the deposition of superconducting films of pure lead (Pb) by means of the UHV cathodic arc. Such layers can be used as photocathodes needed for modern accelerator injectors. The system configuration, used for thin film deposition inside the RF Gun designed at DESY, is also described and the main results and characteristics of thin superconducting Pb-films are presented.

Design and Construction of the PEFP Timing System for a 20 MeV Proton Beam

THPCH177

Y.-G. Song, Y.-S. Cho, H.M. Choi, I.-S. Hong (KAERI) K.M. Ha, J.H. Kim (PAL)

The timing system of the PEFP requires synchronization for the accelerator and for the multipurpose beam line. The system is based on an event distribution system that broadcasts the timing information globally to all the equipment. Fast I/O hardware of the timing system is to distribute appropriate timing signals to accelerator systems, including the Injector, RFQ, DTL, and user's facilities. Signals to be distributed include the synchronized pulse triggers and event information of RF system and switching magnet power supplies for the 20MeV proton beam extraction.

High Power Cavity Combiner for RF Amplifiers

THPCH179

F. Pérez, B. B. Baricevic, D. Einfeld, P. Sanchez (ALBA) J.P. Buge, M.L. Langlois, G. Peillex-Delphe (TED)

A new approach of RF power combination has been developed for the ALBA Storage Ring RF system: a three-port high power Cavity Combiner (CaCo). A prototype has been successfully built and tested in Thales Electron Devices, Thonon, France. The final goal is to combine the power of two 80 kW IOTs at 500 MHz in order to provide a total output power of 160 kW. In this paper, a summary of the analytical and simulation analysis of the expected behaviour is given. In basis of that, the decided geometric constraints and the final design configuration chosen for the prototype production are explained. Low power test results and matching, and finally the high power test performances, are shown. As a conclusion, the RF system of the ALBA Storage Ring will incorporate the CaCo concept to obtain the needed power per cavity from the combination of two IOTs.

THPCH180

Equipment for Tunnel Installation of Main and Insertion LHC Cryo-magnets

K. Artoos, S. Bartolome-Jimenez, O. Capatina, T. Feniet, J.L. Grenard, M. Guinchard, K. Kershaw (CERN)

The installation of about 1700 superconducting dipoles and quadrupoles in the Large Hadron Collider (LHC) is now well underway. The transport and installation of the LHC cryo-magnets in the LEP tunnels originally designed for smaller, lighter LEP magnets have required development of completely new handling solutions. The severe space constraints combined with the long, heavy loads have meant that solutions had to be very sophisticated. The paper describes the procedure of the installation of the main cryo-magnets in the arc as well as the more specific insertion cryo-magnets. The logistics for the handling and transport are monitored with tri-axial acceleration monitoring devices that are installed on each cryo-magnet to ensure their mechanical and geometric integrity. These dynamic results are commented. The paper includes conclusions and some lessons learned.

THPCH181

Overview of the Large Hadron Collider Cryo-magnets Logistics

O. Capatina, K. Artoos, R. Bihery, P. Brunero, J.M. Chevalley, L.P. Dauvergne, T. Feniet, K. Foraz, J. Francey, J.L. Grenard, M. Guinchard, C. Hauviller, K. Kershaw, S. Pelletier, S. Prodon, I. Ruehl, J. Uwumarogie, R. V. Valbuena, G. Vellut, S. Weisz (CERN)

More than 1700 superconducting cryo-magnets have to be installed in the Large Hadron Collider tunnel. The long, heavy and fragile LHC cryo-magnets are difficult to handle and transport in particular in the LEP tunnel environment originally designed for smaller, lighter LEP magnets. An installation rate of more than 20 cryo-magnets per week is needed to cope with the foreseen LHC installation end date. The paper gives an overview of the transport and installation sequence complexity, from the storage area at the surface to the cryo-magnet final position in the tunnel. The success of this task depends on a series of independent factors that have to be considered at the same time. The equipment needed for the transport and tunnel installation of the LHC cryo-magnets is briefly described. The manpower and equipment organisation as well as the challenges of logistics are then detailed. The paper includes conclusions and some of the lessons learned during the first phase of the LHC cryo-magnets installation.

THPCH182

Control of the Geometrical Conformity of the LHC Installation with a Single Laser Source

J.-P. Corso, M. Jones, Y. Muttoni (CERN)

A large and complex accelerator like LHC machine needs to integrate several thousand different components in a relatively limited space. During the installation, those components are installed in successive phases, always aiming to leave the necessary space available for the equipment which will follow. To help ensure the correct conditions for the installation, the survey team uses a laser scanner to measure specific areas and provides this data, merged together in a known reference system, to the integration team who compares the results with the 3D CAD models. This paper describes the tools and software used to rebuild underground zones in the CATIA environment, to check interferences or geometrical non-conformities, as well as the procedures defined to solve the identified problems.

Installation and Quality Assurance of the Interconnections between Cryo-assemblies of the LHC Long Straight Sections

THPCH183

C. Garion, I. Slits, J.-P.G. Tock (CERN)

The interconnections between the cryomagnets and cryogenic utilities in the LHC long straight sections constitute the last machine installation activity. They are ensuring continuity of the beam and insulation vacuum systems, cryogenic fluid and electrical circuits and thermal insulation. The assembly is carried out in a constraining tunnel environment with restricted space. Therefore, the assembly sequence has to be well defined, and specific tests have to be performed during the interconnection work to secure the reliability of the system and thus to ensure the global accelerator availability. The LHC has eight long straight insertion zones composed of special cryomagnets involving specific interconnection procedures and QA plans. The aim of this paper is to present the installation and quality assurance procedures implemented for the LHC LSS interconnections. Technologies such as manual and automatic welding and resistive soldering will be described as well as the different quality controls such as visual and radiographic inspection of welds, electrical and leak testing. An evaluation and statistical analysis of the results of the interconnection work will be presented.

Handling and Transport of Oversized Accelerator Components and Physics Detectors

THPCH184

S. Prodon, C. Bertone, M. Guinchard, P. Minginette (CERN)

For cost, planning and organisational reasons, it is often decided to install large prebuilt accelerators components and physics detectors. As a result, on surface, exceptional transports are required from the construction to the installation sites. Such heavy transports have been numerous during the LHC installation phase. This paper will describe the different types of transport techniques used to fit the particularities of accelerators and detectors components (weight, height, acceleration, planarity) as well as the measurement techniques for monitoring and the logistical aspects (organisation with the police, obstacles on the roads, etc). As far as oversized equipment is concerned, the lowering into the pit is challenging, as well as the transport in tunnel galleries in a very scare space and without handling means attached to the structure like overhead travelling cranes. From the PS accelerator to the LHC, handling systems have been developed at CERN to fit with these particular working conditions. This paper will expose the operating conditions of the main transport equipments used at CERN in PS, SPS and LHC tunnels.

Planning and Logistics Issues Raised by the Individual System Tests during the Installation of the LHC

THPCH185

S. Weisz, E. Barbero-Soto, K. Foraz, F. Rodriguez-Mateos (CERN)

The running of individual system tests has to fit within tight constraints of the LHC installation planning and of CERN's accelerator activity in general. For instance, the short circuit tests of the power converters that are performed in situ restrict the possibility to work in neighbouring areas; much in the same way, the cold tests of the cryogenic distribution line involve safety access restrictions that are not compatible with the transport and installation of cryo-magnets or interconnect activities in the sector considered. Still, these individual system tests correspond to milestones that are required to ensure that we can continue with the installation of machine elements. This paper reviews the conditions required to perform the individual system tests and describe how the general LHC installation planning is organised to allocate periods for these tests.

THPCH186

Magnetic Field Measurement and Fine-tuning of Kickers

T.-C. Fan, C.-H. Chang, C.-S. Fann, C.-S. Hwang, F.-Y. Lin (NSRRC)

We have demonstrated an algorithm which promisingly can tune the pulse shape of current and magnetic field of kicker systems in-situ. This algorithm includes gap shimming of the ferrite magnets to adjust the pulse width of the excitation current and changing the resistance of the secondary coils to modify the pulse curvatures of each kicker. With the empirical formula derived from the systematic measurement on the magnetic field and the pulse current in laboratory, we can reduce the pulse-shape difference among the kicker magnets in the injection section of the storage ring, with no need to do anything on the pulsers and high voltage power suppliers. This approach can efficiently increase the injection efficiency which is demanding in the top-up injection mode adopted by many new facilities of synchrotron radiation.

THPCH187

Analysis and Reduction Electromagnetic Interference to ICTs Caused by Pulsed Power Supply Excitation in NSRRC

Y.-H. Liu, J.-C. Chang, J.-R. Chen, Y.-C. Lin (NSRRC)

The purpose of this paper is to eliminate the Electromagnetic Interference (EMI) from kicker power supply. Analyses of the EMI source and the propagation path are the beginning missions. The radiated and conducted EMI both affected the Integral Current Transformer (ICT) normal operation because of the space limitation for TLS in NSRRC. The ICT is to measure injection efficiency, thus, ICT located just behind the kickers and using the common girder. The EMI signals therefore are much higher than the electron beam currents, and the integral values of the sensor are not correct. For reducing and eliminating the interference of electromagnetic waves, a hybrid segregation and grounding method was used. The EMI wrapper was enclosed the ICT and its high frequency amplifier separately to prevent the radiated EMI from the space. The grounding paths provided the possible stray current dredge to the ground loop. It reduced the stray current spread to the subsystems next to the kickers. The EMI therefore reduced 99%, and the injection efficiency could be calculated successfully. The elimination of the EMI from kicker itself will be the next step in the future.

THPCH192

Experimental, Test and Research Beamlines at Fermilab

C. Johnstone (Fermilab)

Three new external beamlines are in operation or under development at Fermilab: 1) the Main Injector Particle Production (MIPP) beamline, 2) the Mucool Test Area (MTA) beamline, and 3) a new MTEST beamline for advanced detector work for high energy experiments and the ILC. The MIPP beamline is a secondary production beamline capable of producing well-characterized beams of protons, pions, and kaons from 5-120 GeV/c using 120 GeV/c protons from the Fermilab Main Injector. The second line is a new primary 400-MeV proton beamline derived from the 400 MeV proton Linac which will provide for precision measurements of Linac beam parameters in addition to a high-intensity primary test beam for development and verification of muon ionization cooling apparatus. A dual mode operation will also provide accurate, dispersion-free measurements of the Fermilab Linac beam properties with potential for diagnostic development. Installation is planned in 2007. Finally, a third beam is also under design to provide secondary beams at ultra-low - high energies, from ~1 GeV/c to 90 GeV/c in addition to a primary 120-GeV proton mode of operation. It is anticipated that this last line will be installed in fall of 2006.

Comparison between H-ion and Heat Cleaning of Cu-metal Cathodes

THPCH193

D. Dowell, F. King, R.E. Kirby, J.F. Schmerge (SLAC)

Understanding the quantum efficiency (qe) of a metal photocathode in an s-band RF gun is important to limit the drive laser energy requirement and provide the best quality electron beam. Systematic measurements of the qe vs. wavelength for varying surface contamination have been performed on copper samples using x-ray photoelectron spectroscopy (XPS). The sample is first cleaned to the theoretical limit of qe using a 1 keV hydrogen ion beam. The H-ion beam cleans an area approximately 1cm in diameter and has no effect on the surface roughness while removing essentially all contaminants and lowering the work function to 4.3eV. The sample is then exposed to atmospheric contaminants (nitrogen and oxygen) and measured again with XPS to determine the degree of contamination and the effect on the qe. The goal is to determine the best procedure for transferring and installing cathodes in an s-band gun. These results and comparison with a heat cleaned cathode are presented.

Investigation of Using Ferroelectric Materials in High Power Fast RF Phase Shifters for RF Vector Modulation

THPCH194

J.L. Wilson, Y.W. Kang (ORNL) A.E. Fathy (University of Tennessee)

A fast ferroelectric phase shifter controlled by an electric field bias is being investigated for high-power RF phase shifters in vector modulation. Such a device could be used in charged particle accelerators, allowing vector control of the RF power delivered to accelerating RF cavities. Bulk ferroelectric materials, particularly those based on barium-strontium titanate (BST) compounds, have shown promise in high-power applications because of their low loss tangent and high dielectric strength. Such materials have already been investigated for use in fast phase shifters at X-Band frequencies*. Several different compositions of BST compounds are investigated in phase shifter prototypes at 402.5 MHz and 805 MHz that could be easily adapted for future large-scale accelerator projects. The ratio of barium versus strontium in the composition is varied from sample to sample. This allows an investigation of the tradeoffs involved between dielectric strength, loss tangent, tunability, and relative permittivity. Since ferroelectrics are by nature nonlinear dielectric compounds, preliminary study on the nonlinear propagation effects is conducted through computer simulation.

*V. P. Yakovlev et al. Fast X-Band Phase Shifter, Advanced Accelerator Concepts: Eleventh Workshop, 2004.

New Developments on Low-loss Ferroelectrics for Accelerator Applications

THPCH195

A. Kanareykin, P. Schoessow (Euclid TechLabs, LLC) A. Dedyk, S.F. Karmanenko (Eltech University) E. Nenasheva (Ceramics Ltd.) V.P. Yakovlev (Omega-P, Inc.)

Recent results on development of BST (barium strontium titanium oxide composition) ferroelectric materials are presented to be used as the basis for new advanced technology components suitable for high-gradient accelerators. Ferroelectric materials offer significant benefits for linear collider applications, in particular, for switching and control elements where a very short response time of 10 ns can be potentially achieved. The applications include: fast active X-band and Ka-band high-power ferroelectric switches, high-power X-band, and L-band ferroelectric-based phase-shifters. The recently developed large diameter (11 cm) BST-based ferroelectric rings will be used at high pulse power (tens of megawatts) for the X-band components as well as at high average power (in the range of a few kilowatts) for the L-band phase-shifters, which are suitable for ILC applications.

THPCH196

A Proof-of-Principle Experiment for a High-Power Target System

H.G. Kirk, V. Samulyak, N. Simos, T. Tsang (BNL) J.R.J. Bennett (CCLRC/RAL/ASTeC) T.R. Edgecock (CCLRC/RAL) I. Efthymiopoulos, A. Fabich, H. Haseroth, F. Haug, J. Lettry (CERN) V.B. Graves, P.T. Spampinato (ORNL) K.T. McDonald (PU) H.J. Park (PAL)

The MERIT experiment, to be run at CERN in 2007, is a proof-of-principle test for a target system that converts a 4-MW proton beam into a high-intensity muon beam for either a neutrino factory complex or a muon collider. The target system is based on a free mercury jet that intercepts an intense proton beam inside a 15-T solenoidal magnetic field.

THPCH197

Analysis of Availability and Reliability in RHIC Operations

F.C. Pilat, P. Ingrassia, R.J. Michnoff (BNL)

RHIC has been successfully operated for five years as a collider for different species, ranging from heavy ions including gold and copper, to polarized protons. We present a critical analysis of reliability data for RHIC that not only identifies the principal factors limiting availability but also evaluates critical choices at design times and assess their impact on present machine performance. RHIC availability data are compared to similar high-energy colliders and synchrotron light sources. The critical analysis of operations data is the basis for studies and plans to improve RHIC machine availability beyond the 60% typical of high-energy collider.

THPLS — Poster Session

The Strict Solution of a Radiation Problem in Toroidal Cavity

THPLS001

T.H. Harutunyan (YSU) E.D. Gazazyan, M.K. Khojoyan (YerPhI)

The radiation of charged particles bunch which is moving along the axes of toroidal cavity cross section is considered. The toroidal cavity has a finite value of the quality factor and is filled with special symmetry inhomogeneous dielectric medium. The problem's solution is based on the complete set of the toroidal cavity's own modes being defined strictly for the mentioned dielectric medium the cavity is filled with. The charged particles bunch exists in the cavity during a finite time period and the charged bunch's arising and vanishing effects are examined and are taken into account as well. The toroidal cavity is considered as a convenient model to investigate the electromagnetic properties of the tokamak system, using the defined modes.

X-ray and Optical Diagnostic Beamlines at the Australian Synchrotron Storage Ring

THPLS002

M.J. Boland, R.T. Dowd, G. LeBlanc, M.J. Spencer, Y.E. Tan, A. Walsh (ASP)

Two diagnostic beamlines have been designed and constructed for the Australian Synchrotron Storage Ring. One diagnostic beamline is a simple x-ray pinhole camera system, with a BESSY II style pinhole array, designed to measure the beam divergence, size and stability. The second diagnostic beamline uses an optical chicane to extract the visible light from the photon beam and transports it to various instruments. The end-station of the optical diagnostic beamline is equipped with a streak camera, a fast ICCD camera, a CCD camera and a fill pattern monitor. The beamline design and some commissioning measurements are presented.

When Less is More - Construction of the Australian Synchrotron

THPLS003

D. Morris (ASP)

The Australian Synchrotron is a 3 GeV facility under construction next to Monash University in Melbourne. The project was launched in January 2003 and is scheduled for completion in March 2007. The funding of Aus$206M (about 125 MEuros) covers all costs associated with the site, building, accelerators and the first nine beamlines. The building contract was placed in July 2003 and completed in February 2005. Installation of the accelerators began in April 2005 and should be complete by May 2006. Commissioning of the injection system began in October 2005, and storage ring commissioning will begin mid-2006, with beamline commissioning beginning January 2007 and facility handover in March 2007. The project is being delivered with a staff of less than 50, which has meant that much of the detailed design work and project management for major systems (e.g., the injection system, RF system, support girders, vacuum vessels and front ends) has been performed by commercial suppliers under turn-key contracts. The presentation will discuss the main technical challenges, and results will be presented of the commissioning of the linac, booster and storage ring.

THPLS004

Canadian Light Source Update

L. O. Dallin, M.J. Sigrist, T. Summers (CLS)

The Canadian Light Source (CLS) storage ring has been operating routinely since commissioning was completed in the spring of 2004. Beam currents up to 230 mA have been achieved with the single superconducting RF cavity. With steady improvement beam lifetimes (1/e) of 10 hours at 170 mA and 0.25% coupling are now possible. In the last year the vertical tune was increased by 1 integer to produce a smaller vertical beam size in the ID straight sections. This year the horizontal tune will be increased to reduce the beam emittance. The vertical coupling has been reduced both globally and locally using a skew quadrupole response technique. A wide range of photons energies are provided by an initial complement of five insertion devices (IDs) and and two infrared (IR) ports. The 5 m straights have room for two IDs. The light cones from these IDs are separated by about 1.5 mrad by "chicaning" the electron beam in the straights. To date two IDs have been installed in one straight using the chicaning technique. As well, a superconducting wiggler and a in-vacuum undulator have been installed and commissioned. An AppleII type elliptically polarizing undulator will be installed in April 2006.

THPLS005

Commissioning Results from the Injection System for the Australian Synchrotron Project

S. Friis-Nielsen, H. Bach, F. Bødker, A. Elkjaer, N. Hauge, J. Kristensen, L.K. Kruse, S.M. Madsen, S.P. Møller (Danfysik A/S) M.J. Boland, R.T. Dowd, G. LeBlanc, M.J. Spencer, Y.E. Tan (ASP) N.H. Hertel, J.S. Nielsen (ISA)

Danfysik has built a full-energy turnkey injection system for the Australian Synchrotron. The system consists of a 100 MeV LINAC, a low-energy transfer beamline, a full-energy booster and a high energy transfer beamline. The booster synchrotron will deliver a 3-GeV beam with an emittance of 33 nm. The lattice is designed to have many cells with combined-function magnets (dipole, quadrupole and sextupole fields) in order to reach this very small emittance. The current in single¯ and multi-bunch mode will be in excess of 0.5 and 5 mA, respectively. The repetition frequency will be 1 Hz. At the time of writing this abstract, the LINAC beam has been injected into the low-energy transfer beamline. The project is on schedule for delivery in April 2006. Results from the commissioning of the system will be presented together with its performance.

THPLS006

The Machine Installation at SOLEIL

J.C. Besson, X. Deletoille, J.-F. Lamarre, D. Lefebvre, H. Rozelot (SOLEIL)

SOLEIL is a third generation Synchrotron radiation Source, under construction in France near Paris. The 357 m circumference storage ring is mainly composed of (32 +1) dipoles, 160 quadrupoles, 120 sextupoles, 2 RF cryomodules, ~ 200 vacuum chambers, 6 injection equipment; 12 beamline front-ends and 4 insertion devices (initially). The 157 m circumference Booster comprises 36 dipoles, 44 quadrupoles, 28 sextupoles, 1 RF cavity and 8 injection/extraction equipment. Before the beginning of the Process installation, a general planning was established detailing the various stages of the equipment installation and their assembly protocols before their on-site installation. In reality, many unknown factors, delays on the buildings, delays on the equipment deliveries, technical problems encountered during the construction, have constrained us to significantly and frequently amend and adapt this initial planning. Due to the various delays, it was also necessary to manage the

cohabitation with the various building trades. However, the work made on the initial planning paid off as without its detailed protocols, we could not have carried out the Process installation within correct deadline.

Magnetic Measurements Results of the Dipoles, Quadrupoles and Sextupoles of the SOLEIL Storage Ring

THPLS007

P. Brunelle, C. Benabderrahmane, P. Berteaud, F. Briquez, A. Dael, L. Dubois, M. Girault, A. Madur, F. Marteau, A. Nadji, F. Paulin, J. Vétéran (SOLEIL)

During the magnetic measurement campaign, from May 2004 to August 2005, the 326 electro-magnets of the SOLEIL Storage Ring have been characterized in terms of magnetic axis centering and field properties. For the dipoles, two types of measurements have been performed at SOLEIL: field mapping in the mid plan using a Hall probes bench, and field integral comparison with a reference magnet using a stretched wire bench. For the quadrupoles, a rotating coil bench has been built and optimized at SOLEIL in order to reach magnetic center and tilt angle adjustments within ± 25 μm and ± 0.1 mrad respectively. For the sextupoles, magnetic measurements have been performed by the SIGMAPHI Company. This paper will present the main features of the SOLEIL benches, the results of magnetic measurements in terms of reproducibility, field identity between magnets, magnetic axis centering, and harmonic content versus current. Moreover, the origin of some unexpected harmonic field components will be discussed, as well as the magnetic compensation scheme used to minimize some of them.

Commissioning of the SOLEIL Booster

THPLS008

A. Loulergue (SOLEIL)

SOLEIL is a 2.75 GeV new third generation synchrotron radiation facility under construction near Paris. The injector system is composed of a 100 MeV electron Linac pre-accelerator followed by a full energy (2.75 GeV) booster synchrotron. The booster lattice is based on a FODO structure with missing magnet. With a circumference of 157 m and low field magnets (0.74 T), the emittance is in the range of 110 to 150 nm.rad at 2.75 GeV. The magnets are excited at 3 Hz, using switched mode power supplies, with digital regulation. The LEP type RF cavity is powered by a 35 kW-352 MHz solid state amplifier. Closed orbits are measured turn by turn, using the BPM Libera digital electronics. The commissioning took place in October 2005, and an acceleration efficiency of 75% was obtained at the maximum energy. The main results achieved during that commissioning will be reported.

First Results of the Commissioning of SOLEIL Storage Rings

THPLS009

A. Nadji, J.C. Besson, P. Betinelli, P. Brunelle, A. Buteau, L. Cassinari, M.-E. Couprie, J.-C. Denard, J.-M. Filhol, P. Gros, C. Herbeaux, J.-F. Lamarre, P. Lebasque, M.-P. Level, A. Loulergue, A. Madur, P. Marchand, L.S. Nadolski, R. Nagaoka, B. Pottin, M.-A. Tordeux (SOLEIL)

The commissioning of SOLEIL's storage ring will start in April 2006. The objective is to reach, within a first phase of two months, stable beam conditions at 100 mA in the multi-bunch mode that can be used for the commissioning of the beamlines. This is a challenging objective, especially because the SOLEIL's ring is incorporating some innovative techniques such as the use of a superconducting RF cavity, NEG coating for all straight parts of the machine and new BPM electronics. Prior to the start of the commissioning, some insertion devices and most of the insertion devices low gap vacuum vessels, including 10 mm inner vertical aperture vessels for the Apple-II type, will be installed on the ring. This paper will review the performances of all these equipment in presence of the beam. The results of the first commissioning runs will be presented.

THPLS010

Metrology for the Beam Emittance Measurement of the SOLEIL Injector

M.-A. Tordeux, Y.-M. Abiven, N.L. Leclercq, D. Pedeau (SOLEIL)

The injector system of SOLEIL is composed of a 100 MeV electron linac pre-accelerator followed by a full energy 2.75 GeV booster synchrotron, operating at 3 Hz. Dedicated diagnostics such as emittance monitors are installed on the two transfer lines between the linac and the booster and between the booster and the storage ring. The measurement is performed using the gradient method, relying on YAG screens and high resolution CCD cameras. This paper will show the metrology of the emittance measurements which were made for the HELIOS (THALES) iinac beam (total emittance in the range of 1 μm.rad) and for the booster beam (rms emittance ~ 150 nm.rad): error sources are identified and specific corrections are shown. Additional analysis of the dynamics of the injection into the booster and into the storage ring is made for a deeper characterization.

THPLS011

Operation and Recent Development at the ESRF

J.-L. Revol, J.C. Biasci, J-F. B. Bouteille, J. Chavanne, P. Elleaume, L. Farvacque, L. Hardy, J. Jacob, G.A. Naylor, E. Plouviez, A. Ropert, K.B. Scheidt (ESRF)

We report on the achieved performance of the ESRF storage ring as well as developments accomplished or underway. A new hybrid filling mode based on groups of bunches and a 4-bunch filling pattern are now delivered to the users. Following the increasing demand of users for beam stability, the fast orbit feedback has been upgraded. The installation of 5 m-long, 8 mm vertical aperture NEG coated aluminum chambers is progressing at a rate of one chamber per shutdown. The increase in current from 200 to 300 mA is being prepared; however, operation in this mode is still impaired by HOM driven longitudinal instabilities. To overcome this difficulty, a longitudinal feedback is being commissioned. HOM damped cavities are also under study to possibly replace the existing five-cell cavities. The policy of preventive maintenance has been continued. However, in 2005 the machine availability was affected by water leaks occurring on front-end absorbers and on one dipole crotch absorber. The crotch absorbers suffer all from the same erosion process that could be delayed by a systematic vertical realignment, leaving time for procurement and replacement of the entire pool.

THPLS012

Commissioning of the Australian Synchrotron Injector RF Systems

C. Piel, K. Dunkel, J. Manolitsas, D. Trompetter, H. Vogel (ACCEL) M.J. Boland, R.T. Dowd, G. LeBlanc, M.J. Spencer, Y.E. Tan (ASP)

On December 16, 2003 the contract for the design, manufacture, installation and commissioning of the turnkey injector system for the Australian Synchrotron Project was awarded to industry. ACCEL Instruments is delivering the turnkey 100MeV linac and the booster RF system. Commissioning of the linac for ASP was performed in December 2005, right after successful commissioning of the Diamond Light Source injection linac*. The 500MHz booster cavity and related low level RF system will be commissioned after

installation of the booster is finalised in early 2006. The paper will present design and layout information, as well as commissioning results.
*Commissioning of the Diamond Pre-Injector Linac (this conference).

The Magnets of the Metrology Light Source in Berlin-Adlershof

THPLS013

P. Budz, M. Abo-Bakr, K. Buerkmann-Gehrlein, V. Duerr, J. Kolbe, D. Krämer, J. Rahn, G. Wüstefeld (BESSY GmbH) I.N. Churkin, E.R. Rouvinsky, E.P. Semenov, S.V. Sinyatkin, A.G. Steshov (BINP SB RAS) R. Klein, G. Ulm (PTB)

PTB, the German National Metrology Institute in close cooperation with BESSY II, is currently carrying out the project of constructing the low-energy "Metrology Light Source" (MLS) as a synchrotron radiation facility situated in the close vicinity of BESSY II. Construction of the MLS housing is in progress and nearly finished. The user operation is scheduled to begin in 2008. Dedicated to metrology and technology development in the UV and EUV spectral range, the MLS will bridge the gap that is existent since the shutdown of BESSY I. A 100 MeV microtron delivered by Danfysik A/S will provide the electrons for the MLS with a structure of asymmetric double bend achromat. The total circumference of the MLS is 48 m. The electron energy is ramped to the desired value between 200 MeV and 600 MeV. The MLS magnetic lattice, consisting of 8 bending magnets, 24 quadrupole magnets, 24 sextupole magnets and 4 octupole magnets, is laid out to facilitate this operation. The contract for the MLS magnets is awarded to the Budker Institute for Nuclear Physics. A description of the MLS magnets based on the results of the factory acceptance tests should be presented.

Status of the Metrology Light Source

THPLS014

K. Buerkmann-Gehrlein, M. Abo-Bakr, W. Anders, P. Budz, O. Dressler, V. Duerr, J. Feikes, H.G. Hoberg, D. Krämer, P. Kuske, R. Lange, J. Rahn, T. Schneegans, D. Schueler, E. Weihreter, G. Wuestefeld (BESSY GmbH) R. Klein, G. Ulm (PTB)

For more than 25 years, the Physikalisch-Technische-Bundesanstalt (PTB) uses synchrotron radiation at the storage rings BESSY I and II for photon metrology in the spectral range of UV to x-rays. Since decommissioning of BESSY I (1999), there is a gap in the spectral range of UV and EUV wavelength due to the higher electron energy of BESSY II. Thus, in 2003, the Metrology Light Source (MLS), a low energy electron storage ring, was approved, as central instrument in the future Willy Wien Laboratory (WWL). Design, construction and operation of the MLS are realized by BESSY, based on the PTB requirements for a permanent accessible radiometry source, optimized for the spectral range between UV up to VUV. The MLS is tuneable in energy between 200 MeV and 600 MeV, designed for currents between 1pA up to 200mA. Civil construction of WWL in the close vicinity to BESSY is nearing completion. The first MLS components will be installed in spring 2006, commissioning of the 100MeV Microtron is scheduled for summer 2006, while commissioning of the storage ring will start in spring 2007. Regular user operation will begin in January 2008. A status and an overview on the construction of the MLS are

THPLS015

Spectral Fingerprints of Femtoslicing in the THz Regime

K. Holldack, S. Khan, T. Quast (BESSY GmbH) R. Mitzner (Universität Muenster, Physikalisches Institut)

Femtosecond (fs) THz pulses are observed as a consequence of laser-induced energy modulation of electrons in the BESSY II storage ring in order to generate fs x-ray pulses via femtoslicing*. The THz pulses are spectrally characterized by step-scan and rapid scan FTIR spectroscopy. The temporal shape of the laser-induced density modulation is reconstructed from the THz spectra. It is studied as a function of laser and storage ring parameters and monitored over several revolutions. The results are compared with numerical simulations. The THz spectra acquired over a few seconds are used to optimize the laser parameters for achieving minimum x-ray pulse lengths in femtoslicing experiments.
*A. Zholents and M. Zoloterev, PRL 76 (1996), 912.

THPLS016

Bunch Shape Diagnostics Using Femtoslicing

K. Holldack, T. Quast (BESSY GmbH) S. Khan (Uni HH) R. Mitzner (Universität Muenster, Physikalisches Institut)

Laser-energy modulation of relativistic electron bunches as needed for the BESSY femtosecond (fs) x-ray source is accompanied by the emission of fs THz pulses*. The total THz intensity probes the square of the longitudinal particle density within a slice of ~50 fs length (fwhm). The bunch shape can be directly monitored while sweeping the time delay between laser and bunch clock. The method is demonstrated for bunch lengths between 3 and 30 ps (rms) in different operation modes of BESSY II. The use of THz signals from successive turns and the influence of periodic bursts of coherent synchrotron radiation, which lock to the laser pulse under certain conditions, are discussed. The method is used for setting up and stabilizing the temporal overlap between a fs-laser and a relativistic electron bunch.
*K. Holldack et al., Phys. Rev. Lett. (2006), accepted Dec. 2005.

THPLS017

Orbit Stability in the 'Low Alpha' Optics of the BESSY Light Source

R. Müller, J. Feikes, P. Kuske, G. Wuestefeld (BESSY GmbH)

Running the light source during dedicated shifts in the so-called 'low alpha' mode, BESSY serves two major user groups: THz experiments take advantage of intense, coherent synchrotron radiation (CSR) generated by the short bunches. Time resolved experiments appreciate the very short, high intensity VUV and x-ray pulses in the ps range that help, e.g., prepare the high resolution, low intensity fs-slicing experiments. In the 'low alpha' mode, the sensitivity of the storage ring with respect to energy and horizontal orbit is increased by orders of magnitude while the user experiments require the same beam stability as in 'normal' mode. In this paper an overview of the operational conditions of this specific user mode, the stabilization measures taken, observations and available diagnostic results as well as the achievements and shortcomings of the adapted slow orbit feedback are given.

FLUKA Calculations of Neutron Spectra at BESSY

K. Ott (BESSY GmbH)

The synchrotron light source BESSY consists of a 50 MeV microtron, a full energy synchrotron and a 1.9 GeV storage ring. The electron losses during injection causes electromagnetic cascades within the stainless steel of the vacuum system and the aluminum chambers of the undulators. The cascade-produced neutrons result from giant resonances, quasi-deuteron fissions and photo-pion productions. The cross sections of the evaporation reactions of neutrons are an order of magnitude higher than the cross sections of the latter two reaction channels. The energy distribution of the giant resonance neutrons has a maximum at about 1 MeV in comparison with 100 - 200 MeV of the high energy neutrons. At electron accelerators outside the shielding wall, half of the neutron dose is often determined by the more penetrating high energy part of the neutron fluence. We used the particle interaction and transport code FLUKA for the calculations of the energy distribution of both the fluence and the dose inside and outside the shielding wall for different realistic scenarios. From the integrated spectra we get the calibration factor to determine the total neutron dose from the measurements directly.

The Metrology Light Source: an Electron Storage Ring Dedicated to Metrology

R. Klein, G. Ulm (PTB) P. Budz, K. Buerkmann-Gehrlein, J. Rahn, G. Wuestefeld (BESSY GmbH)

PTB, the German National Metrology Institute, in close cooperation with BESSY, is currently setting up a low-energy electron storage ring (200 MeV up to 600 MeV electron energy), the Metrology Light Source MLS, which will be dedicated to metrology and technology development in the UV and EUV spectral range which synchrotron radiation. The MLS has been designed by BESSY according to PTB specifications. User operation is scheduled to begin in 2008. Currently, the building, housing the storage ring, is nearly completed, and all major parts of the storage ring and the injection system have been ordered or have already been delivered. The MLS will be equipped with all the instrumentation necessary to measure the storage ring parameters needed for the calculation of the spectral photon flux according to the Schwinger theory with low uncertainty, enabling PTB to operate the MLS as a primary source standard. Moreover, calculations show, that the MLS is ideally suited for the production of coherent synchrotron radiation in the far IR and THz region. We give a status update on the construction, the instrumentation for the measurement of the storage ring parameters and calculations for a low-

Progress Report on PETRA III

K. Balewski (DESY)

Starting from the middle of 2007, the existing storage ring PETRA II at DESY will be converted into the hard x-ray light source PETRA III. The project was launched in 2002, and in preparation of the conversion a technical design report was published in 2004. Since then detailed design and construction of technical components have begun. Prototypes have been built and tested and the procurement of major parts of the machine components such as magnets and vacuum chambers has started. The project is well underway and in line with the goal of starting the rebuilding in 2007 and the commissioning in 2009. In addition to an overall status report, the development of components and measurement results of prototypes will be presented.

THPLS021

Dynamic Aperture Studies for PETRA III

Y.J. Li, K. Balewski, W. Decking (DESY)

PETRA III is a low-emittance storage ring dedicated to synchrotron radiation. For efficient injection in the top-up mode, the dynamic aperture has to be larger than 30 mm-mrad in the horizontal plane. This paper presents the choice of tunes and the optimization of the sextupole configuration. Tracking simulations have been performed, including the non-linear effects of 20 four-meters-long damping wigglers and a representative set of undulators. Misalignment and multipole errors are considered as well, leading to specifications for the magnet design and alignment procedure.

THPLS022

Radiation Dose Related to ANKA Operation Mode

I. Birkel, MH. Hagelstein, E. Huttel, A.-S. Müller, P. Wesolowski (FZK)

Radiation doses in the ANKA hall are measured by area monitoring and Albedo dosimeters. In August 2004 the machine optics was replaced by a new optics with reduced emittance and higher brightness. Measurements of the beam lifetime and the related radiation doses show a strong correlation between the operation mode of the machine and the dose distribution in the hall.

THPLS023

Wake Computations for the Beam Positioning Monitors of PETRA III

A.K. Bandyopadhyay, A. Joestingmeier, A.S. Omar (Otto-Von-Guericke University) K. Balewski, R. Wanzenberg (DESY)

At DESY it is planned to convert the PETRA ring into a synchrotron radiation facility, called PETRA III, in 2007. For proper design of PETRA III it is very important to estimate the wakes due to various discontinuities along the beam pipe. This article is on the wake computations for the beam positioning monitors (BPMs) in the PETRA III beam pipe. Two computer codes, namely MAFIA and Microwave Studio, were used for the electromagnetic field computations. Convergence tests and the agreement between the results of both softwares were taken as criteria in order to validate the results.

THPLS024

Controlling the Vertical Emittance Coupling in CAMD

V.P. Suller (CCLRC/DL/ASTeC) M.G. Fedurin, P. Jines, D.J. Launey, T.A. Miller, Y. Wang (LSU/CAMD)

The vertical beam size in the CAMD Light Source, as measured with an x-ray pinhole camera, indicates an emittance coupling ratio of 3%. This is consistent with the coupling ratio as measured by the betatron tune split when the coupling resonance is fully engaged. It has been shown that the coupling is mainly produced in the 7T wiggler, which is known to produce non-linear fields. To correct this coupling, it is proposed to install up to four skew quadrupoles. The results of testing a prototype skew quadrupole in the lattice are presented. It is shown that the coupling will be substantially corrected by suitably distributing and powering the four skew quadrupoles.

THPLS025

Diamond Light Source Vacuum Systems Commissioning Status

M.P. Cox, B. Boussier, S. Bryan, B.F. Macdonald, H.S. Shiers (Diamond)

Diamond Light Source is a new 3 GeV light source currently being commissioned in the UK. The main vacuum systems are a 561.6 m circumference electron storage ring and a 158.4 m circumference booster ring. The storage ring target operating pressure is $1 \cdot 10^{-9}$ mbar with 300 mA of stored beam after 100 A.h of beam conditioning. The booster ring target operating pressure is up to an order of a magnitude higher. Pumping is provided by discrete noble diode ion pumps, supplemented by titanium sublimation pumps and NEG cartridge pumps. Vacuum vessel construction is mainly from 316LN stainless steel. There is no in situ bakeout except for the 24 storage ring straights and the front ends. An ex situ bakeout process is used for the storage ring arcs followed by installation under vacuum. This paper reports results and experience from the construction and commissioning of the diamond vacuum systems.

THPLS026

Front Ends at Diamond

J. Strachan, D.G. Clarke (CCLRC/DL) H.C. Huang, J. Kay (Diamond)

This paper describes the three different types of Front End that have been designed to transmit the intense synchrotron radiation generated by the undulator, multi-pole wiggler and bending magnet sources in the Diamond storage ring to the experiments. The functions of the main components and their location in the layout are described. The Finite Element Analysis that has been carried out to verify the performance under the high heat loads generated by Diamond is also described along with the limits on temperature and stress that have been employed in the design.

THPLS027

Vibration Measurement at Diamond and the Storage Ring Response

H.C. Huang, J. Kay (Diamond)

Controlling and minimising the sources and transmission of vibration in Synchrotron Light Sources is an important factor in achieving the stability needed to generate the very brightest beams. This paper describes the equipment that has been used at Diamond to measure vibration and reports the results of measurements taken on the accelerator floor and on the girder structures carrying the Storage Ring. A description is given of the intensively piled foundations and a comparison is made between the measured response and the modelled response. The contribution to vibration from water and ventilation services is also discussed.

THPLS028

Pulsed Magnets and Pulser Units for the Booster and Storage Ring of the Diamond Light Source

V.C. Kempson, J.A. Dobbing (Diamond) C.E. Hansen, N. Hauge, G. Hilleke (Danfysik A/S)

The Diamond booster and storage ring complex require ten pulsed magnet systems, five for the booster (injection and extraction) and five for the storage ring injection. Each has its own specific design criteria, although commonality of approach has been applied wherever possible. This paper describes the design principles and construction method for the various systems and presents the results of power supply tests and magnetic measurements. Finally, initial experience during the Diamond beam commissioning is discussed.

THPLS029

Commissioning of the Booster Synchrotron for the Diamond Light Source

V.C. Kempson, R. Bartolini, C. Christou, J.A. Dobbing, G.M.A. Duller, M.T. Heron, I.P.S. Martin, G. Rehm, J.H. Rowland, B. Singh (Diamond)

The Diamond booster is a 158 m circumference, 5 Hz synchrotron which accelerates the 100 MeV electron beam from a linac to 3 GeV for full-energy injection into the Diamond storage ring. The booster has been commissioned in the first few months of 2006, following successful initial 100 MeV trials at the very end of 2005. The injection and ramping process, orbit correction and essential beam physics measurements are discussed as are extraction and beam transport to the storage ring.

THPLS030

Beam Optic Measurements for the Booster Synchrotron of the Diamond Light Source

B. Singh, R. Bartolini, C. Christou, V.C. Kempson, I.P.S. Martin (Diamond) J.K. Jones (CCLRC/DL/ASTeC)

The booster synchrotron of the Diamond Light Source is a full energy injector ramping from 100 MeV to 3 GeV with a repetition rate of 5 Hz. As part of the booster commissioning, beam optic measurements were performed to characterize the booster performance. Through the use of the beam position monitors, orbit corrections, tune and chromaticity measurements were performed at injection energy and during the ramp. A first comparison with the booster model is also discussed.

THPLS031

Elettra Top-up Requirements and Design Status

F. Iazzourene, S. Bassanese, A. Carniel, K. Casarin, R. De Monte, M. Ferianis, F. Giacuzzo, M. Lonza, G. Tromba, A. Vascotto (ELETTRA)

Elettra is a 2.5 GeV third generation light source in operation since 1993. To provide more stable beams to the users, we plan to operate in the so-called top-up injection mode. The first step is the substitution of the present 1GeV linac by a 100 MeV pre-injector linac and a fast cycling 2.5 GeV synchrotron booster foreseen to be in operation in 2007*. The present paper will report on the requirements for the top-up operation in terms of radiation safety, diagnostics H/S, timing, modality, etc. and the design status. In particular, a new BPM system, based on the log-ratio detectors, has been successfully commissioned on the present transfer line and linac and is ready to be deployed on the new injector and to be used by the new foreseen shot to shot transfer line booster to storage trajectory feedback system. Furthermore, in order to flatten the storage ring filling, the top-up charge will be integrated where needed. Preliminary measurements on the bunch by bunch measurement methods of the storage ring bunch charge are reported.

*"Elettra New Full Energy Injector Status Report", these proceedings.

ELETTRA New Full Energy Injector High Level Software

THPLS032

C. Scafuri, F. Iazzourene (ELETTRA)

The control system for the new full energy injector* will be entirely based on Tango with an object oriented distributed architecture. The availability of the new and modern software platform led us to design and develop a new high level software framework which allows a model-based accelerator control. The new design is fully object oriented and follows a layered approach. The main layers provide a set of different views or abstractions of the underlying accelerator: field layer, machine layer, and optics layer. The field layer handles all the access and communications with the actual devices of the accelerator, e.g., power supplies, instrumentation, etc. The machine layer handles the machine layout description, functional constraints like the association of a string of magnets with one power supply, and the conversion from actual values acquired from the field into values meaningful to beam dynamics problems. The optics layer performs all the actual calculations concerning the beam like beta functions, damping times, etc. An important characteristic of the new library is the unified management of all the needed calibrations and configurations by means of a relational database.
*"Elettra New Full Energy Injector Status Report", these proceedings.

Elettra New Full Energy Injector Status Report

THPLS033

M. Svandrlik, S. Bassanese, F.C. Cargnello, A. Carniel, K. Casarin, D. Castronovo, P. Craievich, G. D'Auria, R. De Monte, S. Di Mitri, A. Fabris, R. Fabris, M. Ferianis, A. Gambitta, F. Giacuzzo, M. Giannini, F. Iazzourene, G.L. Loda, M. Lonza, F.M. Mazzolini, D.M. Morelli, G. Pangon, C. Pasotti, G. Penco, L.P. Pivetta, L. Rumiz, C. Scafuri, G. Tromba, A. Vascotto, R. Visintini, D. Zangrando (ELETTRA)

The Elettra new full energy injector will be based on a 100 MeV linac pre-injector, a 2.5 GeV booster synchrotron and two new beam transfer lines. It will replace the existing 1.2 GeV linac injector and transfer line. Full funding was finally available in 2005, which allowed to start, or in some cases to re-start, the construction activities. The status of the project will be presented in this paper, in particular the progress of the fabrication of various components, like magnets, power supplies, vacuum chambers; also the status of the construction of the building and technical plants will be given. Results of recent optimization studies will also be outlined. The commissioning of the new injector is scheduled to start in Spring 2007, while the first ELETTRA operation for user's with the new full energy injector is expected for the last quarter of 2007.

Top-up Operation of SPring-8 Storage Ring with Low Emittance Optics

THPLS034

H. Tanaka, N. Kumagai, M. Masaki, S. Matsui, H. Ohkuma, T. Ohshima, M. Oishi, J. Schimizu, K. Soutome, S. Takano, M. Takao, H. Takebe, K. Tsumaki, H. Yonehara, T. Yorita, C. Zhang (JASRI/ SPring-8)

We have succeeded in providing stable and three-times more brilliant x-ray to users by combining top-up operation with low emittance optics. The optics with the low emittance of 3nmrad was first applied to the user operation in November 2002. Although the low emittance provided the brilliant x-ray, the extremely short beam lifetime much disturbed the precise experiments. Moreover, the aborted electron beam damaged the part of vacuum chamber at the beam injection section. The low emittance operation was thus suspended in October 2003. By improving design of the vacuum chamber and introducing the top-up injection, the problems for the stable operation were resolved, and then the top-up operation with the low emittance optics has been first achieved at SPring-8. This paper illustrates how we achieved this sophisticated operation by explaining the following three essential investigations: (1) reduction of natural emittance for a storage ring with four magnet-free long straight sections, (2) protection of vacuum chamber from aborted electron beam, and (3) consistency to the top-up operation. The obtained performance is also described in the paper.

THPLS035

Next Generation Light Source Storage Ring at SPring-8

K. Tsumaki, N. Kumagai (JASRI/SPring-8)

A linac-based XFEL and an ERL are widely accepted as next-generation light sources. But they still have many technologically difficult problems to overcome. In contrast, electron beams in a storage ring are very stable. Thus, we examined the possibility of the storage ring as a next-generation light source. We designed a storage ring with an energy of 6 GeV and a circumference of 1436 m. The ring consists of 24 ten-bend achromat cells and has a natural emittance of 83 pm·rad. The circumference is equal to that of SPring-8 storage ring and the cell length is two times, which enables us to replace the existing storage ring with this new one in the SPring-8 tunnel and use the photon beam-lines without constructing new ones. Particle tracking simulation showed that the horizontal dynamic aperture at the center of a straight section is -3.7 mm and +3.4 mm and that it can be increased to -6.6 mm and +10.0 mm by changing the sextupole strength for chromaticity correction while keeping zero chromaticity. In this paper, we describe the design and the dynamic aperture of the extremely low emittance storage ring at SPring-8.

THPLS036

Results of the Straight-sections Upgrade of the Photon Factory Storage Ring

T. Honda, S. Asaoka, W.X. Cheng, K. Haga, K. Harada, Y. Hori, M. Izawa, T. Kasuga, Y. Kobayashi, H. Maezawa, A. Mishina, T. Mitsuhashi, T. Miyajima, H. Miyauchi, S. Nagahashi, T. Nogami, T. Obina, C.O. Pak, S. Sakanaka, H. Sasaki, Y. Sato, T. Shioya, M. Tadano, T. Takahashi, Y. Tanimoto, K. Tsuchiya, T. Uchiyama, A. Ueda, K. Umemori, S. Yamamoto (KEK)

At the 2.5-GeV ring of the Photon Factory (PF), a large reconstruction of the lattice around the straight sections* has been accomplished in 2005. As a result, four short straight sections of 1.5 m have been newly created, and the lengths of the existing straight sections have been much improved. For example, the length of the longest straight section has been extended to 9 m from 5 m. The optics has been optimized for installing short-period narrow-gap (in-vacuum) undulators at the new straight sections. The reconstruction work on the ring was held from March to September 2005. In the range over two-thirds of the storage ring, all the quadrupole magnets and all the beam ducts have been renewed and rearranged. Commissioning of the storage ring was started from the end of September 2005 and continued for one month. The operation for the user experiment was resumed from the end of October on schedule. Though we made no in-situ baking after the installation for the beam ducts, the vacuum scrubbing by the synchrotron radiation is running very well. The product of the beam lifetime and the beam current exceeded 700 A min for the operation current 450 mA at the end of December 2005.
*S. Asaoka et al. "New Upgrade Project for the Photon Factory Storage Ring", AIP Conf. Proc. 705, p161 (2004).

Beam Position and Angular Monitor for Undulator by Using SR Monitor Technique

THPLS037

T. Mitsuhashi, M. Tadano (KEK)

We presented a beam position monitor by using SR monitor technique in the last PAC05. In this monitor, a visible SR in far tail of the undulator spectrum is extracted by a water-cooled beryllium mirror. We applied a focusing system to observe a beam position in the undulator through an optical image of beam. We continue further study of this monitor, and this time, we add the afocal system like a Kepler type telescope to measure the angular deviation of the beam. This system converts the angular deviation of optical axis of input ray into position deviation, and we can measure an angular deviation of the beam through its position deviation on the CCD. The results show us this method is applicable to monitor an angular deviation of beam in the undulator independent from position deviation, and gap change of undulator has no effect for the beam position monitoring.

Upgrade and Current Status of the PF Ring Vacuum System

THPLS039

Y. Tanimoto, Y. Hori, T. Nogami, T. Uchiyama (KEK)

The vacuum system for the KEK Photon Factory (PF) was extensively modified in 2005 as part of the PF ring straight-sections upgrade project. This project required replacements of the quad magnets in both northern and southern straight-sections that account for nearly two-thirds of the whole circumference. Therefore, the vacuum ducts in these new quad magnets (Q-ducts), as well as the vacuum ducts in their related bend magnets (B-ducts), needed to be replaced. The new Q-ducts have a narrower cross-section and are equipped with new 4-electrode beam position monitors, and the new B-ducts are furnished with new distributed ion pumps. After the installation of these vacuum chambers, we omitted the thermal in-situ baking, anticipating that beam scrubbing would provide more efficient cleaning. Furthermore, even pre-baking before installation was not performed for the chambers in the northern half in order to evaluate the effect of the pre-baking during the early period of the commissioning. Details of these modifications, as well as the current status of the new vacuum system, will be presented.

Present Status of the UVSOR-II

THPLS040

M. Katoh, K. Hayashi, M. Hosaka, A. Mochihashi, J. Yamazaki (UVSOR) T. Hara (RIKEN Spring-8 Harima) M. Shimada (KEK)

UVSOR electron storage ring, which was a 2nd-generation synchrotron radiation (SR) light source for VUV and soft x-ray region, has been renewed as UVSOR-II at the beginning of 2003. Because of the improvement, the beam emittance has been reduced from 165nm-rad to 27nm-rad, and longer straight sections with smaller vertical betatron functions have been provided. In addition to a helical/linear undulator, two in-vacuum undulators have been installed in the long straight sections at the improvement. New variably polarized undulator will be also installed in summer 2006. Improvement of booster synchrotron will be also performed in summer 2006 with aiming to top-up operation in the future. Now UVSOR-II has been operated in 750MeV with the emittance of 27nm-rad in daily users runs. Not only the development of high quality SR beams but also basic investigations for new light source have been performed; development of storage ring FEL and investigation of intense THz burst SR. Bunch slicing experiment with a Ti:Sa laser (800nm) has also been started since 2005, and experiments for coherent harmonic generation and coherent SR generation with the laser-beam interaction have been performed.

THPLS041

Observation of Intense Terahertz Synchrotron Radiation produced by Laser Bunch Slicing at UVSOR-II

M. Katoh, M. Hosaka, K. Kimura, A. Mochihashi, M. Shimada (UVSOR) T. Hara (RIKEN Spring-8 Harima) T. Takahashi (KURRI) Y. Takashima (Nagoya University)

We have performed electron bunch slicing experiments using a femto-second high power pulse laser in the UVSOR-II electron storage ring. As the pulse laser system we have used a Ti:Sa laser whose wavelength is 800 nm, typical pulse duration is 100 fs, pulse repetition is 1 kHz and typical average power is 2W. The laser is operated in mode-locked condition and synchronized with the electron beam revolution. The laser pulse is injected into an undulator section and it goes along with the electron bunch. By adjusting the radiation wavelength of the undulator to the laser wavelength, the electron beam energy can be partially modulated in the electron bunch. We have observed THz synchrotron radiation (SR) light from a bending magnet that is downstream of the interaction region. The SR light contains extremely intense THz pulse radiation that is synchronized with the laser injection. The extremely high intensity strongly suggests that the THz pulses are coherent synchrotron radiation from the electron bunch with a hole because of the laser-beam interaction.

THPLS042

Observation of THz Synchrotron Radiation Burst in UVSOR-II Electron Storage Ring

A. Mochihashi, M. Hosaka, M. Katoh, K. Kimura, M. Shimada (UVSOR) T. Takahashi (KURRI) Y. Takashima (Nagoya University)

Very intense THz synchrotron radiation bursts have been observed in single-bunch operation in the UVSOR-II electron storage ring*. The observation was performed in an infrared beam line in UVSOR-II by using a liquid-He-cooled In-Sb hot-electron bolometer that has a good response time of several microseconds. Thanks both to the beam line and the detector, it is clearly observed that the intense bursts have typical macroscopic and microscopic temporal structure. Macroscopically, it is clearly observed that the bursts tend to be generated with quasi-periodic structure in which the period tends to depend on the beam intensity. From a microscopic point of view, each burst has also quasi-periodic structure in itself, and the period almost corresponds to the half value of the inverse of the synchrotron oscillation frequency. The peak intensity of the bursts was about 10000 times larger than that of ordinary synchrotron radiation in the same wavelength region. The extremely high intensity strongly suggests that the bursts are coherent synchrotron radiation, although the radiation wavelength was much shorter than the electron bunch length.

*Y. Takashima et al., Jpn. J. Appl. Phys. 44, No.35 (2005) L1131.

THPLS043

Status of SESAME

G. Vignola, A. Amro, M. Attal, H. Azizi, A. Kaftoosian, F. Makahleh, M.M. Shehab, H. Tarawneh, S. Varnasseri (SESAME)

An overview of the status of SESAME is presented. SESAME is a third generation light source facility, with an e-beam energy of 2.5 GeV, located in Allan, Jordan. The emittance is 26 nm.rad and 12 straights are available for insertion devices. The injector consists of a 22.5 MeV microtron and 800 MeV booster synchrotron, with a repetition rate of 1 Hz. The conceptual design of the accelerator complex has been frozen, and the engineering design is in progress. The phase I scientific program for SESAME has also been finalized, and it foresees 6 beam lines, including 2 IR ports. The construction of the SESAME building is in progress,

and the beneficial occupancy is expected by the end of 2006. The completion of the accelerators complex construction is scheduled for the end of 2009.

Preliminary Experiment of the Thomson Scattering X-ray Source at Tsinghua University

THPLS044

Y.-C. Du, Cheng. Cheng. Cheng, Q. Du, Du.Taibin. Du, W.-H. Huang, Y. Lin, C.-X. Tang, S. Zheng (TUB)

A preliminary experiment of the Thomson scattering x-ray source is being planned and constructed to generate short-pulsed, tunable x-rays in the range of ~4.5 kev by Thomson scattering of laser photons from a relativistic electron beam. Laser photons of ? = 1064 nm are Thomson backscattered by a 16MeV electron beam from a 16MeV Backward Travelling Wave (BTW) electron linac. The laser is derived from a 2J,10ns Nd:YAG laser. The parameters of electron beam and laser have been measured. The simulated and experiment results are described in this paper.

Construction Status of the SSRF Project

THPLS045

Z. Zhao (SINR) H. Ding, H. Xu (SINAP)

The Shanghai Synchrotron Radiation Facility (SSRF), an intermediate energy third generation light source, is under construction at Zhang-Jiang Hi-Tech Park in Shanghai. Its main and auxiliary buildings are scheduled to be completed in October 2006, and this will be followed by the SSRF accelerator installations from October 2006 to March 2008. This paper presents the final design and the current construction status of the SSRF project.

The Status of Instrumentation and Control for SSRF

THPLS046

D.K. Liu (SINAP)

The SSRF (Shanghai Synchrotron Radiation Facility) was started in December 25, 2004, and is located in the Zhang Jiang Hi-Teck park in Shanghai. During the past one year, the main structure is under construction and will be completed in the middle of next year on schedule. Various equipment is being processed and tested. The preliminary design of the control system, including various hardware and software, are completed, and some prototype of IOC with EPICS such as LINAC rf station, magnet station and beam diagnosis station, etc. have been already tested successfully. The digital power supply control will be adopted. Various beam instrumentation have been designed for diagnostics of the LINAC, booster and storage ring. The performance of the design, progress of the subsystem and preliminary test results of the prototype will be described in this paper in detail.

Beam-optics Analysis and Periodicity Restoration in the Storage Ring of the Pohang Light Source

THPLS048

S.H. Shin, M. Yoon (POSTECH) E.-S. Kim (PAL)

The PLS is a third-generation synchrotron radiation source, which provides intense light from ultraviolet to soft x-rays. Similar to other light sources, the PLS is characterized by a small emittance in order to achieve a very high spectral brightness and stably circulating electron beam. To guarantee these characteristics, a thorough understanding of the linear optics has to be carried out, and many storage rings employ LOCO (Linear Optics from Closed Orbits) to analyse the linear optics. This paper will describe the LOCO implementation at PLS and the results.

THPLS052

The Vacuum System for the Spanish Synchrotron Light Source (ALBA)

E. Al-Dmour, D. Einfeld, M. Q. Quispe, L. Ribó (ALBA)

ALBA will be a 3GeV, third generation synchrotron light facility to be built near Barcelona (Spain). The design phase of ALBA is almost completed and the main components have been ordered, which includes the vacuum chambers for the storage ring. Commissioning of the storage ring is foreseen to start at the end of 2008. The circumference of the storage ring of ALBA is 268.8 m, and it will be divided into 16 vacuum sections by ultra high vacuum (UHV) gate valves. The vacuum chamber will be made of stainless steel with an internal vertical aperture of 28 mm and 72 mm width. The vacuum chamber will be connected to an antechamber with a slot of 10 mm height and 20 mm width. The antechamber will have the discrete absorbers, which will absorb the unwanted synchrotron radiation. The pumping will be by sputter ion pumps (SIP) and NEG pumps, with an overall pumping speed from SIP of 57400 l/s. This will maintain an average dynamic pressure of around $1.0{\cdot}10^{-9}$ mbar to achieve a beam lifetime > 15 hours at the designed current. No in-situ bakeout is foreseen, as the vacuum section will be conditioned ex-situ and installed under vacuum to the storage ring.

THPLS053

Status of the ALBA Project

D. Einfeld (ALBA)

ALBA is a 3 GeV light source being built near Barcelona, Spain. ALBA is optimized for high flux density and a large number of available straight sections for insertion devices (3x8 m, 12x4.2 m) in a relatively small circumference of 268.8 m. The light source should be operational in 2010, including the operation of seven beamlines, including six insertion devices. The design of the lattice and of the major components of the accelerator complex (linac and booster, magnets, RF system, vacuum system) is finish and the procurement procedure has started for the large majority of them. The construction of the building will start in the first half of 2006. This report offers an overview of the status of the project, with special emphasis in the new developments.

THPLS054

Closed Orbit Correction and Beam Dynamics Issues at ALBA

M. Muñoz, D. Einfeld, T.F. Günzel (ALBA)

ALBA is a 3 GeV light source being built in Spain. The light source should be operational in 2010.The lattice for the storage ring is now finalized. The basic cells is an extended DBA-like structure with finite dispersion in the straight sections, providing low emittance (under 5nmrad) , small beam cross sections at the source points (less than 150 micro-m horizontal and 10micro-m vertical), and a large number of straight sections (4 times 8m, 12 times 4.2m and 8 times 2.6m). In this paper we review the properties of the lattice with special emphasis in the closed orbit correction system and the lifetime limits.

Effects of Phase 1 Insertion Devices at the ALBA Project

THPLS055

M. Belgroune, M. Muñoz (CELLS)

The ALBA new third generation light source offers a large number of straight sections to its community of users. Three types of straights will be available, 4 of 8 m, 12 of 4.2 m and 8 of 2.6 m. The compact lattice of a 268 m circumference ring is now mature and its main components are already fixed. We discuss here the beam dynamics studies performed for Phase 1 Insertion Devices (IDs) where two helical devices HU71, two in-vacuum undulators U21 and a multipole wiggler have been modeled using the kick map approach. This allowed defining the suitable compensation scheme in a machine where the vertical focusing is mainly controlled by the gradients in the dipole magnets. In addition, the Touschek lifetime computations and the identification of the limiting resonances using Frequency Map Analysis showed how strong the working point is in the presence of these IDs. Tolerances on the multipolar components due to the fields' roll-off have also been defined and allowed the progress in the IDs design.

Synchrotron Radiation Monitors at ALBA

THPLS056

U. Iriso (CELLS) F. Pérez (ALBA)

ALBA is a 3 GeV, low emittance third generation synchrotron light source that is in the construction phase in Cerdanyola, Spain. Synchrotron Radiation Monitors (SRM) are one of the most useful, non-destructive tools to easily obtain information of three important parameters for a synchrotron user: beam position, beam dimensions and beam stability. These monitors diagnose beam performance using the radiation produced when the beam traverses a bending magnet. An extensive usage of SRM, based on the visible part of the spectrum, is planned in the ALBA synchrotron: Linac, Booster, Transfer Lines and the Storage Ring. The latter will be equipped as well with an SRM based on the x-ray part of the spectrum, using the PinHole technique in order to accurately measure the low beam size and emittance. This paper describes the different SRM designs for the ALBA light source.

Injector Design for ALBA

THPLS057

M. Pont, G. Benedetti, D. Einfeld, A. Falone, U. Iriso, M.L. Lopes, M. Muñoz (CELLS) E. Al-Dmour, F. Pérez (ALBA) W. Joho (PSI)

The storage ring ALBA is a 3rd generation synchrotron light source under construction in Barcelona (Spain). The facility is based on a 3.0 GeV storage ring of 268.8 m circumference with a beam emittance under 5 nm.rad. Top-up operation is foreseen from the start. The injector complex for ALBA will consist of a 100 MeV linac and a full energy booster. The linac will be a turn-key system which has already been ordered to the industry and delivery is expected in the second half of 2007. The full energy booster will be placed in the same tunnel as the storage ring and will have a circumference of 249.6 m. The lattice of the booster is a modified FODO lattice providing an emittance as low as 9 nm.rad. The magnet system comprises 40 combined magnets and 60 quadrupoles. Chromaticity correction relies on the sextupole component built-in the combined magnets and the quadrupoles. In this paper a description of the booster design including the present status of the different components will be given.

THPLS058

MAX III Commissioning

M. Eriksson, M. Bergqvist, M. Brandin, L.-J. Lindgren, M. Sjöström, S. Thorin (MAX-lab)

Some of the features of the 700 MeV MAX III synchrotron radiation storage ring are presented, and the commissioning of this ring is described.

THPLS059

Status of the MAX IV Light Source Project

M. Eriksson, M. Berglund, K.I. Blomqvist, M. Brandin, T. Hansen, D. Kumbaro, L.-J. Lindgren, L. Malmgren, M. Sjöström, H. Svensson, H. Tarawneh, S. Thorin, E.J. Wallén, S. Werin (MAX-lab) B. Anderberg (AMACC)

The present development of the accelerator part of the MAX IV synchrotron radiation project is presented. The main features of the 3 GeV injector linac and the two storage rings operated at different electron energies to cover a broad spectral range of high brilliance undulator radiation are described in some detail. A third ring, the existing MAX III ring, is planned to be transferred to the new facility. The preparation of the injector linac to serve as a free electron laser source and the major sub-systems of the facility are also presented.

THPLS060

Lifetime and Acceptance at the SLS

A. Streun, Å. Andersson (PSI)

Beam lifetime at the storage ring of the Swiss Light Source (SLS) is limited by Touschek effect and elastic gas scattering. Both mechanism are affected by narrow gaps in the machine, elastic scattering directly by the vertical acceptance limitation, Touschek scattering via a possible restriction of lattice momentum acceptance due to coupling. The particle loss mechanism was explored by evaluations of lifetime as function of scraper position, chromaticity and emittance coupling.

THPLS061

Status of the Swiss Light Source

A. Lüdeke, Å. Andersson, M. Böge, B. Kalantari, B. Keil, M. Pedrozzi, T. Schilcher, V. Schlott, A. Streun (PSI)

The Swiss Light Source (SLS) is a 3rd generation synchrotron light source in operation since 2001. The paper will point out the recent activities to enhance machine operation and provides an overview about the new beamlines currently under construction at the SLS.

Sub-picosecond X-ray Source FEMTO at SLS

THPLS062

A. Streun, A. Al-Adwan, P. Beaud, M. Böge, G. Ingold, S. Johnson, A. Keller, T. Schilcher, V. Schlott, T. Schmidt, L. Schulz, D. Zimoch (PSI)

The FEMTO source at the SLS (Swiss Light Source) employs laser/e-beam 'slicing' to produce sub-picosecond x-ray pulses for time resolved pump/probe experiments. The final design of the source, the status of construction and commissioning as well as the first experimental results will be presented.

Nonlinear Beam Dynamics of TPS

THPLS063

H.-P. Chang, P.J. Chou, C.-C. Kuo, G.-H. Luo, H.-J. Tsai, M.-H. Wang (NSRRC)

A design study of 3.0 GeV high performance low emittance storage ring Taiwan Photon Source has been conducted recently The natural emittance of the storage ring can be as low as 1.7 nm-rad in our design and its lattice structure is a 24-cell double bend achromat type with circumference of 518.4 m, which will be located in the existing NSRRC site in Hsinchu. The strong focusing requires strong aberration correction with nonlinear sextupole magnets. The distribution of the sextupoles and number of families are studied to ensure a good dynamic aperture. The nonlinear effects in both betatron and synchrotron motions are investigated. Nonlinear beam dynamics effects in the presence of magnetic field imperfections as well as the insertion devices are simulated. The physical aperture limitations are included in the study too, and the Touschek lifetime is calculated. The tracking data are analyzed using frequency map analysis method and corresponding beam dynamics behavior can be revealed more precisely.

Design Concept of the Vacuum System for the 3 GeV Taiwan Photon Source

THPLS064

G.-Y. Hsiung, C.K. Chan, C.-H. Chang, H.P. Hsueh, T.L. Yang (NSRRC) J.-R. Chen (NTHU)

The design concept of the vacuum system for the electron storage ring of the Taiwan Photon Source (TPS), 518.4 m in circumference, is described. The vacuum system for the synchrotron light source not only meets the specifications of an electron beam energy of 3 GeV and a beam current at 400 mA but also provides a safety factor of 1.7 (~ 500 mA) at 3.3 GeV at the upper bound. The vacuum system for the storage ring is built with consideration of the following features: (1) Large aluminum bending chambers to simplify the ultra-high vacuum (UHV) structure; (2) Absorbers located as far from the source as possible to reduce the heat load and associated yield of photon stimulated desorption (PSD) as well as the photoelectron; (3) Vacuum pumps located in the antechamber and closed to the absorbers to increase the localized pumping efficiency and to minimize the impedance of beam ducts; (4) Quantity of flanges and bellows is significantly reduced. Configuration of the pumps, results of the simulation for the pressure and thermal stress, and the criteria of the design will be discussed.

THPLS065

Optimization for Taiwan Photon Source Electron Beam Position Monitors through Numerical Simulation

H.P. Hsueh, C.-H. Chang, G.-Y. Hsiung, C.-K. Kuan, T.-S. Ueng (NSRRC) J.-R. Chen (NTHU)

One of the key steps toward successfully building the newly proposed 3rd generation synchrotron radiation research facility, Taiwan Photon Source (TPS), is to optimize the design of the high resolution electron beam position monitors through numerical simulation. With more advanced electromagnetic simulation tool like MAFIA tailored specifically for particle accelerator, the design for the high resolution electron beam position monitors can be tested in such environment before actually fabricated and physically tested. The design goal of our high resolution electron beam position monitors is to achieve 0.1 micron resolution if allowed by engineering limitations. The design consideration to achieve this 0.1 micron resolution goal will also be discussed. The first design has been carried out and the correlated simulations were also carried out with MAFIA. The results are presented and discussed here. Sensitivity as high as 200 has been achieved at 500 MHz. Further study will also be described.

THPLS066

Improvement on the Single Bunch Operation of the TLS Injector

J.-Y. Hwang, C.-S. Fann, K.-T. Hsu, S.Y. Hsu, K.H. Hu, S.H. Lee, K.-K. Lin, K.-B. Liu, Y.-C. Liu (NSRRC)

The improvement of the TLS (Taiwan Light Source) injector on single bunch operation is presented in this study. Limited by the existing design of the TLS injector, the single bunch operation was not optimized in terms of bunch purity for specific users of TLS. A high voltage pulser was implemented to improve the situation. This pulser has been integrated into the high-voltage-deck electronics of electron gun for single bunch generation. Both high-voltage pulses and the associated electron bunches are monitored with a wideband digital oscilloscope. The result shows that the bunch purity can be greatly improved by using the newly installed pulser. It also greatly eliminates the beam losses while injected into the booster ring.

THPLS067

Vertical Beam Size Control in TLS and TPS

C.-C. Kuo, H.-P. Chang, J.-R. Chen, P.J. Chou, K.-T. Hsu, G.-H. Luo, H.-J. Tsai, D.-J. Wang, M.-H. Wang (NSRRC) A. Chao (SLAC) W.-T. Weng (BNL)

Vertical beam size control is an important issue in the light source operations. The horizontal-vertical betatron coupling and vertical dispersion were measured and corrected to small values in the TLS 1.5 GeV storage ring. Estimated beam sizes are compared with the measured values. By employing an effective transverse damping system, the vertical beam blow-up due to transverse coherent instabilities such as the fast-ion beam instability was suppressed and as a result, the light source is very stable. In NSRRC we are designing an ultra low emittance 3-GeV storage ring and its designed vertical beam size could be as small as a few microns. The ground and mechanic vibration effects, and coherent instabilities could spoil the expected photon brightness due to blow-up of the vertical beam size if not well taken care of. The contributions of these effects to vertical beam size increase will be evaluated and the counter measures to minimize them will be proposed and reported in this paper.

Design of Taiwan Future Synchrotron Light Source

C.-C. Kuo, H.-P. Chang, C.-T. Chen, P.J. Chou, H.J. Jhao, G.-H. Luo, H.-J. Tsai, M.-H. Wang (NSRRC)

We report updated design works for a new 3-3.3 GeV synchrotron light source with a high performance and low emittance storage ring, called Taiwan Photon Source (TPS). With its natural horizontal emittance less than 2 nm-rad and low emittance coupling, TPS will be able to provide an extremely bright photon beam to the demanding users, especially the x-ray community. The lattice type of the TPS is a 24-cell DBA structure and the circumference is 518.4 m. We present the lattice design, the accelerator physics issues and its performances.

Preliminary Design of the TPS Linac to Booster Transfer Line

Y.-C. Liu, H.-P. Chang, C.-S. Fann, K.-T. Hsu, S.Y. Hsu, K.-K. Lin, K.-B. Liu, G.-H. Luo (NSRRC)

The preliminary design of the LTB (linac to booster) transfer line of the proposed TPS (Taiwan Photon Source) project is considered in this study. The layout presented in this report is based on the booster lattice and the choice of linac parameters. These parameters are adopted from previous report of booster design and typical commercial available products of linac. The simulation result indicates that the desired optical functions at a given location can be readily obtained by varying the appropriate focusing strength of quadrupoles. It provides tuning capability to match various possible options of optical functions at injection location. This report is presented together with design consideration of a set of beam diagnostics instruments.

Effect of Nonlinear Synchrotron Motion on TPS Energy Acceptance

M.-H. Wang, H.-P. Chang, C.-C. Kuo, G.-H. Luo (NSRRC)

For design of new generation synchrotron light source the first order momentum compaction factor is usually small. The contribution of second order momentum compaction factor can't be neglected. The longitudinal phase space changes significantly due to the nonlinear effect. This will affect the energy acceptance of the particles and reduce the Touschek beam life time. In this paper we analyze the effect of the nonlinear synchrotron motion of TPS lattice design*. The reduction of energy acceptance is estimated. The contribution to second order momentum compaction factor is discussed. Efforts to minimize this nonlinear effect will also be addressed.
*C. C. Kuo et al., "Design of Taiwan Future Synchrotron Light Source", these proceedings.

Ground Vibration Measurement at NSRRC Site

D.-J. Wang, H.-P. Chang, J.-R. Chen, J.P. Wang, J. Wang (NSRRC)

For the future 3GeV TPS project in the NSRRC, ground vibration would be important for this low emittance machine. We have monitored the ground vibration under various experimental conditions at the NSRRC site. Sensors were installed in the bare site, underground 35 meters deep and ground of TLS storage ring, including an electricity shutdown in the NSRRC. From the collected data, we compare the effect about day and night, traffic effect, internal machine vibration propagation. Specific vibration sources and their propagations are also discussed.

THPLS075

Progress in Development of Kharkov X-Ray Generator

A.Y. Zelinsky, V.P. Androsov, E.V. Bulyak, A. Dovbnya, I.V. Drebot, P. Gladkikh, V.A. Grevtsev, Yu.N. Grigor'ev, A. Gvozd, V.E. Ivashchenko, I.M. Karnaukhov, N. Kovalyova, V.P. Kozin, V. Lapshin, V.P. Lyashchenko, V. Markov, N.I. Mocheshnikov, V.B. Molodkin, A. Mytsykov, I.M. Necklyudov, F.A. Peev, O.V. Ryezayev, A.A. Shcherbakov, A. Shpak, V.L. Skirda, V.A. Skomorokhov, Y.N. Telegin, V.I. Trotsenko, O.D. Zvonarjova (NSC/KIPT) A. Agafonov, A.N. Lebedev (LPI) J.I.M. Botman (TUE) R. Tatchyn (SLAC)

Over the past year the design, development and construction of NSC KIPT X-ray generator NESTOR has been in progress. NESTOR is a new type radiation source on the base of Compton scattering and a 40 - 225 MeV electron storage ring. Electrons are injected in the storage ring at 100 MeV and ramped up to final energy 225 MeV. It is supposed that stored electron beam current will be of about 200 mA. Along with use of Nd:Yag laser of 10 W average power which was developed by High-Q laser firm and optical resonator with accumulation gain of about 1000 it allows to provide X-ray radiation flux up to 1011 phot/s. NESTOR is the cooperative facility and is supported both as well Ukrainian government as NATO SfP project #977982. It is supposed that NESTOR will be in operation in the middle of 2007 year. The status of the project and main facility systems are described in the report.

THPLS076

Status of RF Deflecting Cavity Design for the Generation of Short X-Ray Pulses in the Advanced Photon Source Storage Ring

G.J. Waldschmidt, M. Borland, Y.-C. Chae, K.C. Harkay, D. Horan, A. Nassiri (ANL)

The Advanced Photon Source (APS) at Argonne National Laboratory is exploring the possibility of using radio frequency deflection to generate x-ray radiation pulses on the order of 1 pico-second (Delta t - 70%) or less*. This scheme is based on a proposal by A. Zholents et al.** that relies on manipulating the transverse momenta of the electrons in a bunch by using an rf deflecting cavity to induce a longitudinally dependent vertical deflection of the beam. The beam will then travel through a number of undulators before arriving at a second set of deflecting cavities where the deflection is reversed such that the remainder of the storage ring is largely unperturbed***. Considerable effort has been expended on the design of a superconducting rf deflecting cavity operating in the S-Band at 2.8 GHz to address fundamental design issues including cavity geometry, deflecting voltage, rf power coupling, tuning, and damping of higher-order and lower-order modes. In this paper we present simulation results and analysis of an optimized superconducting rf deflecting cavity design for the APS storage ring.
*K. Harkay et al. Proceedings of 2005 PAC, Knoxville, TN, May 2005, p. 668. **A. Zholents et al. Nucl. Instrum. Methods, A425, 385 (1999). ***M. Borland and V. Sajaev. Proceedings of 2005 PAC, Knoxville, TN, May 2005, p. 3886.

THPLS078

Tests of a New Bunch Cleaning Technique for the Advanced Light Source

F. Sannibale, W. Barry, M.J. Chin (LBNL)

A new bunch cleaning technique is being tested at the Advanced Light Source (ALS) of the Lawrence Berkeley National Laboratory. The new procedure allows for high purity, arbitrary filling patterns and is potentially compatible with standard user operation and with the incoming top-off injection mode. The description of the new system and the results of the first tests at the ALS are presented.

Bunch Diffusion Measurements at the Advanced Light Source

THPLS079

F. Sannibale, W.E. Byrne, C.-W. Chiu, J. Guo (LBNL) J.S. Hull, O.H.W. Siegmund, A.S. Tremsin, J. Vallerga (UCB)

In storage ring based synchrotron light sources, a long beam lifetime is usually a fundamental requirement for a high integrated brightness. The dynamic aperture and the momentum acceptance of lattices are carefully studied and maximized as much as possible for a long lifetime performance. On the other hand, large momentum acceptance and dynamic aperture increase the probability that a particle diffuses from one bunch to another. Diffusion can represent a severe limitation for those experiments where the samples have long relaxation times requiring empty buckets between bunches. At the Advanced Light Source (ALS) of the Lawrence Berkeley National Laboratory we have characterized the particle diffusion for the present lattice in order to evaluate its impact on a special user operation dedicated to these long relaxation time experiments and on the incoming top-off injection mode for the ALS.

Status of the Top-off Upgrade of the ALS

THPLS082

C. Steier, D. Robin, T. Scarvie (LBNL)

In order to provide higher brightness and better stability, the ALS is being upgraded to top-off injection. One main part of the top-off modifications is an upgrade of the booster as well as extraction and injection elements and the transfer line for full energy. Further upgrades include new diagnostics, improved controls and timing system, and new radiation safety systems (monitors and interlocks).

Implementation of the Double-waist Chicane Optics in SPEAR 3

THPLS083

W.J. Corbett, M. Cornacchia, T. Dao, D. Dell'Orco, D. Harrington, R.O. Hettel, X. Huang, Y. Nosochkov, T. Rabedeau, F.S. Rafael, H. Rarback, A. Ringwall, J.A. Safranek, B. Scott, J.J. Sebek, J. Tanabe, A. Terebilo, C. Wermelskirchen, M. Widmeyer (SLAC) M. Yoon (POSTECH)

The SPEAR 3 upgrade produced two new 7.6 m racetrack straight sections in the 18 cell, 234 m magnet lattice. One of these straights houses four PEP-II style mode-damped RF cavities. The other straight will accommodate two new small-gap insertion devices separated by 10mrad in a magnetic chicane configuration. A quadrupole triplet has been installed at the midpoint of the chicane and the vertical tune has been raised by an integer to create a 'double waist' optics with betay = 1.6m in the center of each ID. Furthermore, as part of the optics upgrade, betay in the four straights adjacent to the racetrack sections was reduced from 5m to 2.5m. In this paper, we describe the physical implementation of the double-waist chicane optics and initial operational results.

Nonlinear Dynamics in the SPEAR 3 Double-waist Chicane

THPLS085

J.A. Safranek, X. Huang, A. Terebilo (SLAC)

A quadrupole triplet has been included in the center of a 7.6 m long chicane in SPEAR 3 to create a novel and technically challenging 'double waist' optics with betay=1.6m at the center of each of two future small-gap insertion devices. The new optics also reduces betay to 2.5m in the four adjacent 4.8m straight sections. In this paper, we discuss key issues associated with design of the machine optics, insertion device compatibility issues, optimization of dynamic aperture and initial measurements of machine performance in the new configuration.

THPLS087

A Control Theory Approach for Dynamic Aperture

J. Bengtsson (BNL)

The dynamic aperture problem dates back to the design of the first synchrotrons. Over time, both analytical and numerical methods have been pursued. In the former case mainly by applying techniques developed for celestial mechanics to rather simplified equations of motion. Over the last decade, analysis of the Poincare map has become the method of choice. In particular, application of symplectic integrators, truncated power series algebra, and Lie series techniques has led to a complete set of tools for self-consistent numerical simulations and analytic treatment of realistic models. Nevertheless, a control theory for the general nonlinear case remains elusive. We summarize how to apply this framework to the design of modern synchrotron light sources. Moreover, we also outline how a control theory can be formulated based on the Lie generators for the nonlinear terms.

THPLS088

Optimizing the Dynamic Aperture for Triple Bend Achromatic Lattices

S.L. Kramer, J. Bengtsson (BNL)

The Triple Bend Achromatic (TBA) lattice has the potential for lower natural emittance per period than the Double Bend Achromatic (DBA) lattice for high brightness light sources. However, the DBA has been chosen for 3rd generation light sources more often due to the higher number of undulator straight section available for a comparable emittance. The TBA has considerable flexibility in linear optics tuning while maintaining this emittance advantage. We have used the tune and chromaticity flexibility of a TBA lattice to minimize the lowest order nonlinearities using a high order achromatic tune condition, while maintaining a constant emittance. This frees the geometric sextupoles to counter the higher order nonlinearities. This procedure is being used to improve the nonlinear dynamics of the TBA as a proposed lattice for the NSLS-II facility. The flexibility of the TBA lattice will also provide for future upgrade capabilities of the beam parameters.

THPLS089

Comparison of Double Bend and Triple Bend Achromatic Lattice Structures for NSLS-II

S.L. Kramer, J. Bengtsson, S. Krinsky (BNL)

The Double Bend Achromatic (DBA) and the Triple Bend Achromatic (TBA) lattice have been studied rather extensively for use for the NSLS-II storage ring. The well known advantage of the TBA compared to the DBA is that the emittance per period has the potential to be considerably lower. However, the DBA has been chosen more often due to the greater number of ID straight sections for the users for a desired emittance. We present a comparison of these lattice structures based on the optimization of the non-linear driving terms from the chromatic sextupole and the ease of compensation of these terms using the higher order achromatic cancellation.

Consideration of the Double Bend Achromatic Lattice for NSLS-II

THPLS090

S. Krinsky, J. Bengtsson, S.L. Kramer (BNL)

We present the results of a study of the Double Bend Achromatic (DBA) lattice as a possible choice for the NSLS-II storage ring. The DBA possesses a large number of straight sections with easily tunable beta functions which can be used for insertion device sources and for damping wigglers to reduce emittance. The dispersive regions can be designed to minimize the strength of the chromatic correction sextupoles. A key constraint is the imposition of a limit on circumference which is closely tied to cost. We discuss optimization of the dynamic aperture by minimizing the non-linear driving terms using high-order achromatic cancellation in the non-linear lattice.

Control of Dynamic Aperture with Insertion Devices

THPLS091

T.V. Shaftan, J. Bengtsson, S.L. Kramer (BNL)

It is well known that insertion devices (IDs) perturb the linear optics in the vertical plane. In particular, that the effect can be corrected locally by a symmetric arrangement of four quadrupoles on each side of the IDs. We show how to control an arbitrary set of IDs in this configuration with the response matrix for the beta-beat and perturbation of the phase advance and SVD, i.e., to maintain the dynamic aperture. We also evaluate the residual impact on the dynamic aperture from the nonlinear terms and outline how to control these. As an example, we discuss an impact of some ID models on the NSLS-2 dynamic aperture. Results for a single ID and a set of 20 IDs with random field strengths are presented.

Nb-Pb Superconducting RF-Gun

THPLS092

J.S. Sekutowicz, J.I. Iversen, D. Klinke, D. Kostin, W.-D. Möller (DESY) I. Ben-Zvi, A. Burrill, T. Rao, J. Smedley (BNL) M. Ferrario (INFN/LNF) P. Kneisel (Jefferson Lab) K. Ko, L. Xiao (SLAC) J. Langner, P. Strzyzewski (The Andrzej Soltan Institute for Nuclear Studies, Centre Swierk) R.S. Lefferts, A.R. Lipski (SBUNSL) J.B. Rosenzweig (UCLA) K. Szalowski (University of Lodz)

We report on the status of an electron RF-gun made of two superconductors: niobium and lead. The presented design combines the advantages of the RF performance of bulk niobium superconducting cavities and the reasonably high quantum efficiency of lead, as compared to other superconducting metals. The concept, mentioned in a previous paper, follows the attractive approach of all niobium superconducting RF-gun as it has been proposed by the BNL group. Measured values of quantum efficiency for lead at various photon energies, analysis of recombination time of photon-broken Cooper pairs for lead and niobium, and preliminary cold test results are discussed in this paper.

Status of the Photocathode RF Gun System at Tsinghua University

THPLS093

X. He, Cheng. Cheng. Cheng, Q. Du, Du.Taibin. Du, Y.-C. Du, W.-H. Huang, Y. Lin, C.-X. Tang, S. Zheng (TUB)

An S-band high gradient photocathode RF gun test stand is in construction process at Tsinghua University. The photocathode RF gun test stand is a primary step of a femtosecond hard x-ray source based on Thomson scattering. The photocathode RF gun system adopts Ti:Sap laser, BNL IV type 1.6 cell RF gun, compact compensation solenoid. We foresee to conduct investigations on the thermal emittance contribution of surface roughness, the emittance compensation technique under various laser shape and its application to Thomson scattering x-ray source. Except for the transportation of laser, correction of laser front for glazing incidence and laser pulse shaping system, other parts of the photocathode RF gun test stand have been constructed, and we can start very primary experiment on the RF gun test stand, such as measurements of dark current, QE and energy of the beam. The experimental results are reported.

THPLS094

First Measurement Results at the LEG Project's 100 keV DC Gun Test Stand

S.C. Leemann, Å. Andersson, R. Ganter, V. Schlott, A. Streun, A.F. Wrulich (PSI)

The Low Emittance Gun Project (LEG) at PSI aims at developing a high-brightness, high-current electron source: a 20-fold improved brightness compared to present state-of-the-art electron guns. The source is intended to form the basis for a cost-efficient implementation of a high-power X-ray FEL light-source for scientific research at PSI. A field emitter array (FEA) cathode is being considered a source candidate. In order to study pulsed field emission from such a cathode and to investigate space charge compensation techniques as well as to develop diagnostic procedures to characterize the beam resulting from an FEA cathode, a 100 keV DC gun test stand has been built. The test stand gun and diagnostics have been modeled with the codes MAFIA and GPT. From extensive parameter studies an optimized design has been derived and construction of the gun and diagnostics have recently been completed. We report on the commissioning of the test stand and present first measurement results.

THPLS097

Model of the CSR Induced Bursts in Slicing Experiments

G.V. Stupakov, S.A. Heifets (SLAC)

In a recent experiment on 'femtoslicing' at the Advanced Light Source in LBNL, it has been observed that the beam slicing initiates correlated bursts of coherent synchrotron radiation (CSR) of the beam. In this paper, we suggest a model describing such bursts. The model is based on the linear theory of the CSR instability in electron rings. We describe how an initial perturbation of the beam generated by the laser pulse evolves in time when the beam is unstable due to the CSR wakefield. Although this model does not give quantitative predictions, it qualitatively explains the evolution of the induced CSR bursts.

THPLS098

Optimum Beam Creation in Photoinjectors Using Space-charge Expansion

J.B. Rosenzweig, A.M. Cook, M.P. Dunning, C. Pellegrini (UCLA) M. Boscolo, M. Ferrario, D. Filippetto, L. Palumbo, C. Vicario (INFN/LNF) P. Musumeci (INFN-Roma)

It has recently been shown by Luiten* that by illuminating a photocathode with an ultra-short laser pulse of appropriate transverse profile, a uniform density, ellipsoidally shaped bunch is dynamically formed, which then has linear space-charge fields in all dimensions inside of the bunch. We study here this process, and its marriage to the standard emittance compensation scenario that is implemented in most modern photoinjectors. It is seen that the two processes are compatible, with simulations indicating that a very high brightness beam can be obtained. The scheme has produced stimulus for an experiment at the SPARC injector at Frascati in 2006. We review preparations for this experiment, and discuss the measurable quantities and their appropriate diagnosis, including the time-resolved observation of ellipsoidal beam shape at low energy. A scheme based on gating of Cerenkov radiation produced at

an Aerogel for time-resolved measurements is proposed. Future measurements at high energy based on fs resolution RF sweepers are discussed. The prospects for using the very low longitudinal emittance beam in a future bunch compressor for producing 10 micron long beams are evaluated.
*O. J. Luiten et al. Physical Review Letters, 93, 094802-1 (2004).

Fast Kicker Systems for the SOLEIL Booster Injection and Extraction, with Full Solid-state Pulsed Power Supplies

THPLS099

P. Lebasque, M. Bol, C. Herbeaux, J.-P. Lavieville, J.L. Marlats (SOLEIL)

The Booster of SOLEIL needs injection and extraction kicker systems with fast transition times, good flat top and low jitter, to allow a satisfactory injection efficiency of the Storage Ring injection. So all the kicker systems have been optimised, to fulfil specifications and to permit the use of solid state switching electronics. This contribution presents the ceramic vacuum chambers and magnets design, the specific pulse forming scheme and the realisation of the pulsed power supplies working up to 20 kV. Electrical and magnetic measurements results of kickers systems are given, and also its operation status from the first SOLEIL Booster injection in July 2005.

Four Matched Kicker Systems for the SOLEIL Storage Ring Injection, a Full Solid State Solution of Pulsed Power Supplies Working at High Current

THPLS100

P. Lebasque, R. Ben El Fekih, C. Herbeaux, J.-P. Lavieville, J.L. Marlats (SOLEIL)

The Top Up injection mode of the SOLEIL Storage Ring needs a very good matching of the four kicker magnet fields. But their implantation inside the straight section dedicated to SR injection imposed high level forces on each of the four kickers. This contribution describes the ceramic vacuum chambers and magnets design optimised to provide a very good identity of the four magnets. The pulsed power supplies, based on IGBT high voltage modules, designed to work at high current (5250 A-9000 V) could be located outside the SR tunnel. We highlight the specific development on all components specification and electrical scheme that permits to reach such a challenge. The electrical and magnetic measurement results are reported.

Eddy Current Septum Magnets for Booster Injection and Extraction and Storage Ring Injection at Synchrotron SOLEIL

THPLS101

P. Lebasque, J. Da Silva, P. Gros, J.-P. Lavieville, A. Mary, D. Muller (SOLEIL)

Eddy current thin septum magnets are used to inject or extract the electron beam to/from the Booster and to the Storage Ring of SOLEIL. Good transverse homogeneity in the gap for injected beam, and low leakage field on circulating beam is needed, as well as pulse stability. The Top Up injection mode of the Storage Ring needs a very low level of leakage field on the stored beam path. Operating currents are from 2000 A and 3000 A for Booster injection and extraction, to 5100 A for SR injection. This contribution will describe the magnets and the pulsed power supplies design. The electrical and magnetic measurement results will be presented, with a specific emphasis on the improvements needed to reduce the level of leakage field of the SR septum magnet.

THPLS102

Optimisation of the Coating Thickness on the Ceramic Chambers of the SOLEIL Storage Ring

P. Lebasque, L. Cassinari, J.P. Daguerre, C. Herbeaux, M.-P. Level, C. Mariette, R. Nagaoka (SOLEIL)

The SOLEIL storage ring injection section integrates four matched injection kicker magnets, two diagnostics kicker magnets and a beam shaker, which need ceramic vacuum chambers with an inner titanium coating. For each utilisation (according with its field amplitude and its time or frequency domain), the coating thickness has been evaluated from the different points of view: field attenuation, beam deposited power, magnet excitation deposited power, and cooling efficiency. So we could determine the different coating thicknesses and tolerances needed according to the different magnetic field shapes. The realised ceramic chambers have adequate coating resistances, with in particular a low non-uniformity among the matched injection kicker magnets chambers.

THPLS103

Investigations of the Longitudinal Phase Space at PITZ

J.R. Roensch, J. Rossbach (Uni HH) K. Abrahamyan, G. Asova, J.W. Baehr, G. Dimitrov, H.-J. Grabosch, J.H. Han, O. Kalekin, S. Khodyachykh, S.A. Korepanov, M. Krasilnikov, V. Miltchev, A. Oppelt, B. Petrosyan, S. Riemann, L. Staykov, F. Stephan (DESY Zeuthen) D. Lipka, R. Richter (BESSY GmbH)

The correlation between the positions of the particles in the bunch and their longitudinal momenta has to be analysed in order to optimize photo injectors for Free-Electron Lasers (FELs). Longitudinal phase space measurements at the upgraded PITZ facility* will be presented in this paper. Measurements of the complete longitudinal phase space and its projections behind the gun are compared with simulations. Momentum measurements after a booster cavity will be discussed.
*A.Oppelt et al. "Status and first results from the upgraded PITZ facility", FEL Conf. 2005.

THPLS104

Optimization Studies of the FERMI@ELETTRA Photoinjector

G. Penco, M. Trovo (ELETTRA) S.M. Lidia (LBNL)

In the framework of the FERMI@ELETTRA project the electron beam characteristics strongly depend from the two operating modes: FEL1 (100nm-40nm) with a photon pulse around 100fs and FEL2 (40nm-10nm) with a long photon pulse (~1ps) having a high resolution spectral bandwidth. We present the multi-particles tracking code results concerning the photoinjector, which includes the RF gun and the first two accelerating sections, describing two possible electron bunch lengths, satisfying the two FEL operation modes. The injector optimization relative to the two options, aimed to produce a very low projected emittance (around 1 mm mrad) with a uniform behavior of the slice parameters (emittance and energy spread) along the bunch, is described in this paper. Moreover sensitivity studies, time and energy jitters estimations are presented for both cases.

Characterization of the SPARC Photo-injector with the Movable Emittance Meter

THPLS105

A. Cianchi, L. Catani, E. Chiadroni (INFN-Roma II) M. Boscolo, M. Castellano, G. Di Pirro, M. Ferrario, D. Filippetto, V. Fusco, L. Palumbo, C. Vaccarezza (INFN/LNF) P. Musumeci (INFN-Roma)

As a first stage of the commissioning of SPARC accelerator a complete characterization of the photo-injector is planned. The objective is the optimization of the RF-gun setting that best matches the design working point and, generally, a detailed study of the emittance compensation process providing the optimal value of emittance at the end of the linac. For this purpose a novel beam diagnostic, the emittance-meter, consisting of a movable emittance measurement system, was conceived and built. This paper presents the results of the first measurements with the emittance-meter showing the characteristics and the performance at the SPARC photo-injector.

Possibility of the Beam Injection Using a Single Pulsed Sextupole Magnet in Electron Storage Rings

THPLS107

Y. Kobayashi, K. Harada (KEK)

Recently, we succeeded in the beam injection using a single pulsed quadrupole magnet (PQM) at the Photon Factory Advanced Ring (PF-AR). The PQM enables us to inject the beam into the storage ring without the local bump by several pulsed dipole magnets. In addition, since the stored beam is not kicked when the beam passes through the magnetic center of the PQM, we can avoid the coherent beam oscillation, which is often produced by the unclosed local bump. It is important for the top-up injection in electron storage rings as synchrotron radiation sources. However, in the case of the PQM, we have the problem that the beam profile slightly changes turn-by-turn after the excitation of the PQM. In order to solve it, we investigated the possibility of the beam injection using a single pulsed sextupole magnet (PSM) instead of the PQM. Here, we will present the simulation of the beam injection using the PSM.

Performance Test of RF Photo-Cathode Gun at the PAL

THPLS108

J.H. Park, J.Y. Huang, C. Kim, I.S. Ko, Y.W. Parc, S.J. Park (PAL) X.J. Wang (BNL)

A RF photo-cathode (RF PC) gun with 1.6 cell cavity is installed for the fs-FIR (Femtosecond Far Infrared Radiation) facility being built at the Pohang Accelerator Laboratory (PAL). A short, intense, and low emittance electron beams are produced by the RF PC gun. Performance test of the gun is done include the measurement of RF chraterizations such as a resonant frequency, a mode separation, and etcs. The diagnostics of the beam according to the beam parameters such as phase, charge, and energy, and emittance are done. In this article, we present the measurement results of the RF charaterizations and the beam parameter diagnostics of the RF PC gun at the PAL.

Measurements and Diagnostics on the MAX Recirculator

THPLS109

M. Brandin, B. Nelander, S. Werin (MAX-lab)

The MAX Recirculator is a unique accelerator, a two-pass linac at 500 MeV, that operates as injector for three storage rings. Here are presented some discussions on measurments of beam parameters such as emittance, energy spread, and bunch length.

We describe what measurements are done, by wich methods, results, and how they can be improved. Also, we make an analysis of What methods and hardware are needed to perform the measurements that can't be done with the equipment in place today.

THPLS110

Injection Scheme for TPS Storage Ring

M.-H. Wang, H.-P. Chang, C.-C. Kuo, G.-H. Luo (NSRRC)

Taiwan Photon Source(TPS), a 3~3.3 GeV synchrotron light source with full energy injection is proposed to be built at NSRRC in Taiwan. In this paper we report the design of injection scheme for TPS. The space allocation of the injection components, the bumper design, the aperture consideration and the injection dynamics of injected and stored beam will all be discussed. The particle tracking of first few turns of injection is performed to evaluate the injection efficiency with the errors caused by the time jitter and amplitude stability of injection kickers. The issue of constant current operation will be also addressed.

THPLS111

Beam Loading Measurement and its Application to the Harmonic RF Control of the APS PAR

C. Yao, E.E. Cherbak, N.P. Di Monte, A. Grelick, T. Smith, B.X. Yang (ANL)

The particle accumulator ring (PAR) has dual rf systems: a CW mode fundamental rf system (RF1) operating at 9.77 MHz that accumulates multiple linac pulses into a 0.8-ns bunch, and a 12th harmonic rf (RF12) that compresses the bunch length further to 0.34 ns for injection into the booster. The RF12 capture process is critical for optimal performance of the PAR. We investigated the effects of beam loading during the RF12 capture and bunch length compression process with both spectrum analysis and streak camera imaging. Based on these observations, a new timing scheme for the RF12 tuner and power control was implemented, which has substantially improved the performance of the PAR. We report our observation, the new timing scheme, and beam parameters after optimization.

THPLS112

Electron Multipacting Observation and Simulation in the APS PAR

C. Yao, Y.-C. Chae (ANL)

The particle accumulator ring (PAR) has both fundamental and 12th harmonic rf systems. Gap voltage fluctuations were experienced after vacuum work was performed on the PAR during a maintenance period. This has caused intermittent beam instability and prevented us from running the PAR fundamental rf system at normal power level. Our investigation has concluded that the problem was caused by electron multipacting in the center vacuum chamber of the cavity. We were able to suppress the multipacting by applying a solenoid field in the suspected region. Computer simulation is underway in order to find the location and the parameter range of the multipacting. In this paper we report the experimental observations and results of the simulation relevant to the phenomena.

Design of a Fast Extraction Kicker for the Accelerator Test Facility

THPLS113

S. De Santis, A. Wolski (LBNL) M.C. Ross (SLAC)

We present a study for the design of a fast extraction kicker to be installed in the Advanced Test Facility ring. The purpose of the project is to test the technologies to be used in the design of the extraction kickers for the ILC damping rings. The kicker's rise and fall times are important parameters in the design of the damping rings, as they limit the minimum distance between bunches and ultimately define a lower boundary for the ring length. We propose a stripline kicker composed of several 20-cm long sections, grouped in two locations in the ATF damping ring. An analytical study of the kicker's parameters and computer simulations using Microwave Studio* point out the strict requirements on the pulsers, in order to be able to satisfy the design parameters.
*http://www.cst.com

"CAMSHAFT" Bunch Kicker Design for the ALS Storage Ring

THPLS114

S. Kwiatkowski, K.M. Baptiste, W. Barry, J. Julian, L. Low, D.W. Plate, G.J. Portmann, D. Robin (LBNL)

ALS is a 1.9 GeV third generation synchrotron light source that has been operating since 1992 at Lawrence Berkeley National Laboratory. There are two typical modes of operation of the ALS storage ring. In multibunch mode, the ring is filled to a current of 400 mA in 276 consecutive bunches with a single "camshaft" bunch located in the middle of the 52 bucket gap (h=328). Twice each year, ALS operates in "two-bunch" mode for periods of two weeks delivering 20 mA of average beam current in two diametrically opposite bunches to a small group of users requiring light pulses at lower rates. We plan to build a fast kicker system that will supply single bunch light to users during multibunch operation by displacing the orbit of the camshaft bunch at a prescribed frequency (every N turns). Realization of this project will increase ALS beam availability to multibunch users by at least 10%. This paper will describe the hardware design (pulse generator and beam deflection device) and the test results of the prototype kicker unit.

Simulation and Optimisation of a 100 mA DC Photo-Injector

THPLS115

F.E. Hannon, C. Hernandez-Garcia (Jefferson Lab)

A prototype 100mA injector is presently being designed and manufactured jointly between Thomas Jefferson National Accelerator Facility (J-Lab) and Advanced Energy Systems (AES). This paper discusses the physics optimisation and performance of the injector, which has been studied using the space-charge tracking code ASTRA. The objective is to operate the 7MeV injector with 135pC electron bunches at 748.5MHz repetition rate. We show that the longitudinal and transverse electron bunch properties can be realised within the constraints of the design.

THPLS117

In-vacuum and FEL Undulators at Danfysik

F. Bødker, H. Bach, E.B. Christensen, E. Juul, C.W.O. Ostenfeld, M. Pedersen, T.L. Svendsen (Danfysik A/S)

Danfysik has recently designed and produced two in-vacuum insertion devices. The first device is a 19 mm period device made for the Swiss Light Source and the second is a 20 mm period device for SOLEIL. Both are hybrid undulators with Samarium Cobalt magnets where the SLS device is made with steel poles while the SOLEIL undulator is optimized for high peak field using Vanadium Permendur poles and relative large magnet blocks. A quasi-periodic undulator has been built for FEL applications at the FOM-Institute for Plasma Physics. The device is based on a standard pure permanent undulator design but then converted into a quasi-periodic device. The magnetic performance of the device was in excellent agreement with theoretical calculations with high suppression of the 3. and 5. harmonics. A conventional undulator has also been built for FEL applications at FZR Rossendorf. A high degree of software assistance and automation has been developed for the magnet mounting, shimming and magnetic testing of the insertion devices. This technique reduces the shimming time significantly, reduces the need for highly trained personnel and results in superior magnetic performance.

THPLS118

Status of the SOLEIL Insertion Devices

F. Briquez, C. Benabderrahmane, P. Berteaud, O.V. Chubar, M.-E. Couprie, L. Dubois, J.-M. Filhol, M. Girault, O. Marcouillé, F. Marteau, M. Massal, F. Paulin, M.V. Valleau, J. Vétéran (SOLEIL) A. Dael (CEA)

SOLEIL is the French 2.75 GeV synchrotron radiation light source of low emittance under construction near Paris. It will provide high intensity photons covering a wide spectral range from the IR to the hard x-rays. The storage ring commissioning will start in April 2006, and the first photons in the beam lines are expected during summer 2006. The first set of Insertion Devices (ID) will be installed before the commissioning or within the first year of operation of the machine. They consist of one 640 mm period and three 256 mm period electromagnetic helical undulators, three 80 mm period Apple II type undulators, and three 20 mm period in-vacuum undulators. All these ID's make use of a wide panoply of technical solutions for generating various types of magnetic fields. Magnetic and conceptual designs were performed by SOLEIL, and the technical realisation was carried out together with the different manufacturers. The design specificities of the different types of ID's and the magnetic field characterisation and optimisation will be reported. The first commissioning on the beam of these undulators will be described.

THPLS119

Development of a Cryogenic Permanent Magnet In-vacuum Undulator at the ESRF

C.A. Kitegi, J. Chavanne, D. Cognie, P. Elleaume, C. Penel, B. Plan, F. Revol, M. Rossat (ESRF)

Lowering the temperature of NdFeB materials increases their field remanence and intrinsic coercivity*. This property is potentially interesting for the construction of cryogenic permanent in-vacuum undulators (CPMU)**. Around 150K, the coercivity is increased to such an extent that the NdFeB material is comparable to the Sm2Co17 as far as resistance to radiation damages is concerned. The improvement in field remanence is less remarkable (15% at 150K) and is dominated by a reversible Spin Reorientation Transition (SRT) occurring around 135K. Below this temperature, the remanence decreases. The complete magnetization curves of NdFeB material measured at different cryogenic temperatures are presented. Non-linear models have been constructed and used in the RADIA code in order to compute the field performance of a hybrid NdFeB in-vacuum

undulator. A prototype CPMU is presently under construction at the ESRF. It has a period of 18mm and a magnetic length of 2m. The field integral and local field measurements of the cryogenic device require new systems operated in vacuum. A stretched wire bench and a hall probe bench are under construction; their main characteristics will be presented.
*D. Givord et al. Analysis of hysteresis loops in NdFeB sintered magnets, J. Appl. Phys. 60(9) (3263-3265).**T. Hara et al. Cryogenic permanent undulator, Phys.rev. ST AB volume 7 050702 (2004).

Tracking Simulations and Dynamic Multipole Shimming for Helical Undulators

THPLS120

G. Wuestefeld, J. Bahrdt, M. Scheer (BESSY GmbH)

Symplectic and fast tracking simulations of an APPLE type undulator for the BESSY II storage ring are presented. The simulation is based on a multiple harmonic decomposition of the magnetic field and on a generating function approach. Because of the relatively large undulator period length of 112 mm, corrections of the dynamic multipoles are required to achieve a good dynamical aperture.

Status of the PETRA III Damping Wigglers

THPLS121

M. Tischer, K. Balewski, M. Seidel, L. Yongjun (DESY) A.A. Krasnov, V. Kuzminykh, E. Levichev, P. Vobly, K. Zolotarev (BINP SB RAS)

After mid-2007, the present PETRA storage ring at DESY will be reconstructed towards a dedicated third generation light source operating at 6 GeV. An emittance reduction down to 1 nm can be achieved by means of damping wigglers. 20 permanent magnet wigglers will be installed in two of the long straights of the machine. The wiggler segments are compact fixed gap devices surrounded by iron enclosures to reduce the leakage flux. Each device will provide a damping integral of 4 T2m per segment and generate a synchrotron radiation power of 42 kW. Every wiggler segment will be followed by an SR-absorber to protect all downstream components, the accumulated on-axis power of about 200 kW will be taken up by a final absorber at the damping section end. The wiggler's magnetic design, field properties and correction schemes have previously been proven by a one period long prototype. At present, the first full length (4m) prototype wiggler has been assembled and characterized magnetically.

Investigations of the Thermal Beam Load of a Superconducting In-vacuum Undulator

THPLS122

S. Casalbuoni, MH. Hagelstein, B.K. Kostka, R. Rossmanith (FZK) T. Baumbach, A. Bernhard, D. Wollmann (University of Karlsruhe) E. Steffens, M. Weisser (Erlangen University)

Both the resistive wall effect and the synchrotron radiation can warm up the cold bore of a superconductive in-vacuum undulator. For the in ANKA installed superconducting undulator measurements showed that the dominant heat load contribution comes from the synchrotron radiation generated in the upstream bending magnet: 1 W per 100 mA stored current at a beam energy of 2.5 GeV and an undulator gap of 8 mm.

THPLS123

A Year's Experience with a Superconducting Undulator in the Storage Ring ANKA

R. Rossmanith, S. Casalbuoni, MH. Hagelstein, B.K. Kostka, A.-S. Müller (FZK) T. Baumbach, A. Bernhard, D. Wollmann (University of Karlsruhe) R. Frahm, B. Griesebock, U. Haake (BUW) F. Schoeck, E. Steffens, M. Weisser (University of Erlangen-Nürnberg, Physikalisches Institut II)

In ANKA the worldwide first superconducting undulator demonstrator designed for a storage ring was operated during the last year. The undulator has 100 periods and a period length of 14 mm. During the first year the heat transfer from the beam to the cold bore was investigated and the spectra and the electrical tunability together with a monochromator was measured. The results are so encouraging that plans exist to equip ANKA with two more undulators, one with the opportunity to double electrically the period length and one with electrically variable polarization direction.

THPLS124

The Second Generation of Superconductive Insertion Devices for ANKA

A. Bernhard, T. Baumbach, D. Wollmann (University of Karlsruhe) S. Casalbuoni, MH. Hagelstein, R. Rossmanith (FZK) T. Schneider (FZ Karlsruhe) F. Schoeck, E. Steffens, M. Weisser (University of Erlangen-Nürnberg, Physikalisches Institut II)

After the superconducting undulator SCU14 was installed and successfully started operation at ANKA in spring 2005, a second generation of superconducting insertion devices for ANKA is under development. The ANKA soft x-ray analytics beamline WERA is planned to be equipped with a superconducting elliptically polarising undulator (SCEPU) with electrically tunable polarisation, and a superconducting combined undulator/wiggler (SCUW) capable of period tripling will serve as the source for the planned ANKA imaging beamline. In this paper the studies on the ANKA superconducting EPU and the status of the SCUW-project will be reviewed.

THPLS125

A Concept on Electric Field Error Compensation for the ANKA Superconductive Undulator

D. Wollmann, T. Baumbach, A. Bernhard (University of Karlsruhe) S. Casalbuoni, MH. Hagelstein, B.K. Kostka, R. Rossmanith (FZK) G. Gerlach (University of Dresden, Institute for Solid-State Electronics) F. Schoeck, E. Steffens, M. Weisser (University of Erlangen-Nürnberg, Physikalisches Institut II)

In April 2005 a superconductive undulator test device, the so-called SCU14 (period length 14 mm, 100 periods) was installed at ANKA. Before installation, the magnetic field was measured and documented. This was the first test of a superconductive undulator in a storage ring and the dominating questions to be answered were related to the interaction of the undulator with the beam. The field quality was of lower importance and will be improved by a modified mechanical fabrication technique at the next superconductive undulators. Nevertheless, after finishing the fundamental beam tests the question was discussed how one would improve the field quality (minimize the phase error) of the existing undulator by local correction devices. The concepts could be used later in a weaker form for local field corrections at future undulators, if necessary.

Construction and Testing of a Pair of Focusing Undulators for ALPHA-X

THPLS126

B.J.A. Shepherd, J.A. Clarke (CCLRC/DL/ASTeC)

ALPHA-X is a four-year project shared between several research groups in the UK to build a laser-plasma accelerator and produce coherent short-wavelength radiation in an FEL. A pair of undulators for the project have been designed and built by ASTeC at Daresbury Laboratory. The undulators are 1.5m long, 100 period permanent magnet devices with a minimum gap of 3.5mm, a peak field of 0.7T and a two-plane focusing design. The devices were modelled using RADIA, and data from the magnet block manufacturer was used to sort the blocks. To optimise the trajectory in the real devices, magnetic testing (using Hall probe and flipping coil techniques) and block swapping has been performed in Daresbury's dedicated insertion device test facility. The measurements agree well with the models, and the undulators will perform well within specification.

Plans for a 2nd Insertion Device in CAMD

THPLS127

V.P. Suller (CCLRC/DL/ASTeC) M.G. Fedurin, P. Jines, D.J. Launey, T.A. Miller, Y. Wang (LSU/CAMD)

To allow the possible installation of a 2nd Insertion Device in the CAMD Light Source the lattice optic needs to be changed. The present configuration has a small vertical beta function in the long straight containing the 7T wiggler. The new optic will give small vertical beta at two long straights which are diametrically opposite. Test results with the new optic are presented together with the measured beam parameters. These are used to predict the photon beam performance for several types of Insertion Device which could be installed.

Overview of Diamond IDs for Phase 1

THPLS128

E.C. Longhi, A.I. Baldwin, S.P. Mhaskar, J.C. Schouten, C.W. Thompson (Diamond)

Diamond Light Source is a 3GeV synchrotron currently under construction in the UK, which will be operational in early 2007. It is a third generation light source comprising 22 usable straight sections for insertion devices. Phase 1 of beamline construction will include eight Insertion Devices: five PPM in-vacuum undulators, two APPL$\cdot 10^{-2}$ devices to be installed in the same straight, and one 3.5T superconducting wiggler. This paper describes the current status of construction and magnetic measurements for each of the Phase 1 devices.

Thermal Neutron Demagnetization of NdFeB Magnets

THPLS130

R.W. Klaffky (DOE/OFES) R.M. Lindstrom (NIST) B. Maranville, R. Shull (National Institute of Standards and Technology) B.J. Micklich, J.H. Vacca (ANL)

At the Advanced Photon Source at Argonne National Laboratory, NdFeB insertion device magnets have shown losses of magnetization on a few straight sections where the largest electron beam losses occur due to limiting vacuum chamber apertures. In the worst case, these magnetization losses were evident after a three month operational period. To isolate the effect that thermal neutrons have on these magnets, the magnetization and coercivity were

studied for two NdFeB grades as a function of dose from 7.5 x 10(12) to 6 x 10(13) neutrons/cm2. After saturation, the remanent magnetization was found to decrease linearly with the logarithm of the dose. At a dose of 7.5 x 10(12) neutrons/cm2.sec, there was already a 43 percent magnetization loss for the N45 grade and a 15 percent loss for the N48 grade. There was no apparent change in coercivity with dose. The change in remanent magnetization is a consequence of boron thermal neutron capture through the 10B(n,alpha)7Li reaction, which generates MeV energy alpha particles and lithium ions.

THPLS132

Physics Requirement of a PLS-XFEL Undulator

D.E. Kim, C.W. Chung, I.S. Ko, J.-S. Oh, K.-H. Park (PAL)

Pohang Accelerator Laboratory(PAL)is planning a 0.3nm SASE (Self Amplification of Spontaneous Emission) XFEL based on a 3.7GeV linear accelerator. For short saturation length, application of the SPring8 type in the vacuum undulator is needed. This reflects the experiences from the Spring8 SCSS project. The end structures were designed to be asymmetric along the beam direction to ensure systematic zero 1st field integral. The thickness of the last magnets was adjusted to minimize the transition distance to the fully developed periodic field. This approach is more convenient to control than adjusting the strength of the end magnets. The final design features 4mm minimum pole gap, 15mm period, and peak effective field of 1.09 Tesla. In this article, the physical design of the undulator, the design of the end structure, and the physics requirements of the undulator system will be presented.

THPLS133

Simulations of Electromagnetic Undulator for Far Infrared Coherent Source of TTF at DESY

E. Syresin, V.V. Borisov, E.A. Matushevsky, N.A. Morozov (JINR) O. Grimm, M.V. Yurkov (DESY) J. Rossbach (Uni HH)

A perspective extension of the VUV FEL user facility at DESY is infrared coherent source on the base of electromagnetic undulator. The undulator consists of 9 periods, period length is 40 cm long, and peak magnetic field is up to 1.2 T. With the energy of electron beam of 500 MeV maximum radiation wavelength is about 200 mkm. An important feature of the beam formation system of the VUV FEL is the possibility to produce ultra-short, down to 50 mkm rms electron bunches. Such short bunches produce powerful coherent radiation with multi-megawatt power level. FIR coherent source operates in a parasitic mode utilizing electron beam passed VUV undulator. Generation of two-colors by a single electron bunch reveals unique possibility to perform pump-probe experiments with VUV and FIR radiation pulses. In this report we present simulations of the undulator magnetic system and beam dynamics.

THPLS134

A General View of IDs to be Installed at ALBA on Day One

J. Campmany, F. Becheri, D. Bertwistle, D. Einfeld, J. Marcos, V. Massana (ALBA) Z. Martí (LLS)

The new 3rd generation synchrotron radiation source ALBA to be built nearby Barcelona is planned to start operation in 2009 with several different insertion devices installed in the storage ring either from "day one" or within the first year of operation. The list of high-priority insertion devices includes: 2 planar PPM SmCo in-vacuum undulators with the period of 21.3 mm; 2 Apple-II type PPM NdFeB undulators with the period of 71 mm; 1 superconducting planar wiggler with the period of 30 mm and a maximum field of 2 T, and a 1 conventional wiggler with the period of 65 mm and a maximum field of 1.55 T. The emission of these undulators covers wide spectral range extending from hard X-rays to UV. Pre-design of the IDs was done by ALBA. The construction will be done by industrial companies and institutions with production capabilities. ALBA will set up a magnetic measurement laboratory for the acceptance tests. The paper will present peculiarities of the magnetic design, calculated maximum-flux spectra and associated heat load in various modes of operation.

The Study of Errors of ALBA Fixed Stretched Wire Bench

THPLS135

J. Marcos, J. Campmany, D. Einfeld (ALBA)

The new synchrotron radiation source ALBA to be built nearby Barcelona is planned to start operation in 2009. The facility includes a laboratory for magnetic measurements laboratory devoted to IDs. The stretched wire measurement technique is widely used to obtain magnetic field integrals. This technique is based upon the displacement of a stretched wire relative to the magnetic structure to be measured. In the most usual configuration, the magnets are kept fixed while the wire is moved. This arrangement is especially well suited for measuring big structures such as full undulators or its jaws. In contrast, in the fixed stretched wire configuration the magnetic structure is moved relative to a stationary pick-up coil with a straight segment. This layout is convenient for the measurement of small units, such as individual magnet blocks or magnetic modules. These measurements allow characterising the inhomogeneities of the building blocks of an undulator. In this paper we present an exhaustive analysis of error sources and tolerance requirements for a particular design of a fixed stretched wire bench made at ALBA, based both in the ESRF, SOLEIL and BESSY previous existing designs.

Magnetic Field Multipole Measurement with Hall Probe

THPLS136

Z. Martí (LLS) J. Campmany (ALBA)

When assembling an insertion device before shimming, sorting algorithms are used to reduce the field errors by choosing the best arrangement of magnetic blocks. In order to carry it out, magnets to be placed in the array are measured with the Helmholtz coil. This yields the magnetic dipolar moment of each one. In fact, Helmholtz coil measurements assume a dipolar filed for each block. The development of narrow gap insertion devices yields a growing interest in the effect of magnetic inhomogeneities. Magnetic inhomogeneities introduce multipolar terms that are added to those corresponding to the multipole development of an ideal magnetic source. However, magnetic inhomogeneities are not measured so far with the Helmholtz coil, because it evaluates the magnetic field far from the magnet, and the multipolar terms decay faster than the dipolar with distance. In order to take into account inhomogeneities, a new approach could be used, based on the measurement of multipoles corresponding to each block. In this paper we propose a method for the fast measurement of the multipoles corresponding to an arbitrary magnetic block, using a Hall probe scanning along a single straight line.

Insertion Devices for the MAX IV Light Source

THPLS137

E.J. Wallén, K.I. Blomqvist, B. N. Jensen, U. Johansson (MAX-lab)

The foreseen insertion devices and expected brilliance for the MAX IV light source are presented. The planned MAX IV light source consists of three low emittance storage rings and a 3 GeV linac. The linac is used as a full energy injector. The three storage rings will be operated at 700 MeV, 1.5 GeV, and 3.0 GeV, which makes it possible to cover a large spectral range from IR to hard X-rays with insertion devices optimised for each storage ring.

THPLS138

Fast Polarization Switching at the SLS Microspectroscopy Beamline POLLUX

M. Böge, U. Flechsig, J. Raabe, T. Schilcher (PSI)

POLLUX is a new microspectroscopy facility which will be operated at a bending magnet at the Swiss Light Source (SLS). It offers spectroscopy with sub-micrometer spatial resolution for polymer science and magnetism. First user operation is scheduled for summer 2006. One of the novel envisaged options of the beamline is the usage of circular polarized light. The circular polarization will be generated by a localized angular steering of the electron beam within the bending magnet. This is accomplished by means of the global fast orbit feedback system of the SLS which allows to stabilize the electron beam to the sub-micrometer level up to frequencies of ~100 Hz. Due to the adapting coupling compensation involving dedicated adjacent skew quadrupoles, this steering becomes practically transparent to the other beamlines. Polarization switching rates of a few Hz are within reach.

THPLS139

In-Achromatic Superconducting Wiggler in Taiwan Light Source: Installation and Test Results

C.-H. Chang, C.-C. Chang, H.-P. Chang, H.-H. Chen, J.-R. Chen, T.-C. Fan, G.-Y. Hsiung, M.-H. Huang, C.-S. Hwang, J.C. Jan, F.-Y. Lin (NSRRC)

In order to increase more high flux x-ray photon beams for the Taiwan Light Source, the achromatic superconducting wiggler has been installed and tested in a 1.5 GeV storage ring. The 3.1 Tesla superconducting wiggler will be operated in a 4.5 K liquid helium cryogenic system. In this work, the operation experience and test results of the achromatic superconducting wiggler are described.

FRXAPA — Linear Colliders, Lepton Accelerators and New Acceleration Techniques

Neutrino Factories and Beta Beams

M.S. Zisman (LBNL)

The presentation will review the various concepts of Neutrino Factories and Beta Beams and indicate the main challenges in terms of beam performance and technological developments. It will also present the world-wide organization to define and carry out the necessary R&D for component design, beam simulations of facility performance, and benchmarking of key subsystems via actual beam tests. Currently approved subsystem tests include the Muon Ionization Cooling Experiment (MICE), under construction at Rutherford Appleton Laboratory, and the Mercury Intense Target (MERIT) experiment, to be carried out at CERN. The major issues being examined by MICE and MERIT will be described as well as the plans and schedule to address them.

FRXBPA — Circular Colliders

FRXBPA01

HERA and the Next Generation of Lepton-ion Colliders

F.J. Willeke (DESY)

This talk will present a summary of the physics insights gained from the lepton-hadron collider HERA and review major beam dynamics issues and lessons learned in view of LHC operation, including technical aspects related to the large number of superconducting magnets or the influence of various design choices on the overall machine performance. It will also address future plans for lepton-ion colliders, including eRHIC at BNL and the CEBAF-based ELIC, with emphasis on their luminosity reach and challenges. The talk will also mention possible high energy lepton-ion collisions, for example colliding a 1 TeV proton (or ion) beam from the Tevatron or Super-SPS with a 20-75 GeV electron beam from the ILC or CLIC (first stage).

FRXCPA — Accelerator Technology

Design, Construction, Installation and First Commissioning Results of the LHC Cryogenic System

S.D. Claudet (CERN)

The cryogenic system of the Large Hadron Collider (LHC) will be, upon its completion in 2006, the largest in the world in terms of refrigeration capacity with 140 kW at 4.5 K, distributed superfluid helium with 25 km of superconducting magnets below 2 K and cryogen inventory with 100 tons of Helium. The challenges involved in the design, construction and installation, as well as the first commissioning results will be addressed in this talk. Particular mention will be made of the problems encountered and how they were or are being solved. Perspectives for LHC will be presented. General considerations for future large cryogenic systems will be briefly proposed.

FRYAPA — Applications of Accelerators

FRYAPA01

Developments in Proton and Light-ion Therapy

S. Rossi (CNAO Foundation)

The talk will provide an overview of recent developments in hadrontherapy. It will give a background on cancer therapy with protons and ions, discussing the relative merits of protons and ions versus conventional radiotherapy. It will include status and plans for the development of hadrontherapy facilities, in particular in Europe. It will also describe the status of the Italian hadrontherapy project (CNAO).

FRYBPA — Synchrotron Light Sources and FELs

Overview of Single Pass Free Electron Lasers

C. Pellegrini (UCLA)

The presentation will cover world wide status of single pass free electron lasers. A general status will be given of the projects. Common themes will be discussed, as will the challenges of these themes. Unique characteristics of individual projects will also be covered. Here the emphasis will be on a description of novel and challenging techniques: for example examples seeding of the FEL, different types of guns for high brightness electron beam production, very short or very long pulse production, etc.

FRYCPA — Beam Instrumentation and Feedback

FRYCPA01

ITER and International Scientific Collaboration

S. Chiocchio (MPI/IPP)

The presentation will describe the status and perspectives of the ITER Project. It will also explore the possible connection between the accelerator and the fusion worlds. The talk will cover experience in the managerial and sociological aspects of the worldwide collaboration of which ITER is the end result, very similar to the issues facing the accelerator community, which also faces projects of similar scope from the point of view of time span, technical complexity and sociological impact.

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