11th International Conference on

Heavy Ion Accelerator Technology

June 8-12, 2009 - Venezia (Italy)

SCIENTIFIC PROGRAM

BOOK OF ABSTRACTS

GENERAL INFORMATION

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List of HIAT09 exhibitors:

We gratefully acknowledge the contribution of:

	Monday June 8, 2009	Tuesday June 9, 2009	Wednesday June 10, 2009	Thursday June 11, 2009	Friday June 12, 2009
9.00	**Opening**	**D. Weisser**: Present and Future of Electrostatic Accelerators	**E. B. Hug**: Medical Application of Hadrontherapy	**R. Laxdal**: Heavy Ion Superconducting Linacs: new machines and new upgrades	**L. Dahl**: The GSI UNILAC Upgrade Program to meet FAIR Requirements
9.10					
9.20					
9.30	**G. Bollen**: Nuclear Physics Perspectives with next-generation RNB Facilities	**S. Dobrescu**: Upgrade of the Bucharest FN Tandem Accelerator	**K. Noda**: Review on HI accelerators for Hadrontherapy	**P. Ostroumov**: Commissioning of the ATLAS Upgrade Cryomodule	**O. Kester**: Status of Construction and Commissioning of the GSI HITRAP Decelerator
9.40					
9.50		**A. K. Gupta**: Development Activities at BARC-TIFR Pelletron Accelerator Facility		**G. Zinkann**: Frequency Tuning and RF Systems for the ATLAS Energy Upgrade SC Cavities	**A. M. Porcellato**: Improved on line performance of the installed ALPI Nb sputtered QWRs
10.00	**J. Nolen**: Complementarity of new RNB Facilities and their Technological Challenges		**H.A. Synal**: New and improved AMS Facilities		
10.10		**L. Beck**: Maier-Leibnitz-Laboratorium - Tandem operation and experiments		**M. Marchetto**: Performances of the ISAC Heavy Ion Linacs	**E. Fagotti**: Operational experience in PIAVE-ALPI complex
10.20					
10.30-11.00	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break
11.00	**A. Osa**: The RI Beams from the Tokai RI Accelerator Complex (TRIAC)	**M. Leitner**: "DIANA" - A new, deep-underground accelerator facility for astrophysics experiments	**A. B. Alpat**: The radiation assurance test facility at INFN-LNS Catania	**M. Pasini**: HIE-Isolde Linac: Status of the R&D activities	**M. Hegelich**: Towards GeV Laser-driven ion acceleration
11.10					
11.20		**K. Sasa**: Progress of an AMS System on the Tsukuba 12UD Pelletron Tandem Accelerator	**T. Watanabe**: Devel. of beam current monitor with HTS SQUID and HTS Current Sensor	**D. Kanjilal**: Development of heavy ion accelerator and associated systems	
11.30	**M. Doleans**: ReA3, the new reaccelerated beam facility at MSU/NSCL				**I. Hofmann**: Laser accelerated ions and their potential use for therapy accelerators
11.40		**F. Chautard**: Operation status of High Intensity Ion Beams at GANIL	**T. Lamy**: Latest developments in ECR Charge Breeders	**V. Nanal**: Operational experience of the superconducting LINAC booster at Mumbai	
11.50	**R. C. Pardo**: First Beam Tests of the ^{252}Cf CARIBU Project				**H. Palancher**: Heavy Ion Irradiation of Nuclear Reactor Fuel
12.00				**J. Tamura**: Multiple Charge State Ion Beam Acceleration with an RFQ Linac	
12.10	**D. Rifuggiato**: Operational experience with the EXCYT facility	**G. Gulbekian**: Status report and future development at FLNR JINR HI accelerator complex	**R. E. Vondrasek**: Initial Results of the ECR CB for the ^{252}Cf Fission Source Proj. (CARIBU) at ATLAS		
12.20				**S. Yaramishev**: Upgrade of the HIT Injector LINAC-Frontend	**A. Roy**: HIAT09 Outlook
12.30	**G. Prete**: The SPES project: an ISOL facility for exotic beams	**K. Hatanaka**: RCNP Cyclotron Facility	**O. Tarvainen**: Ion beam cocktail development and ECRIS plasma physics experiments at JYFL		
12.40				**P. A. Posocco**: Status of linac beam commissioning for the Italian Hadron Therapy Center CNAO	**Closing**
12.50	**M. Manzolaro**: The SPES Project: research and development for the Multi-Foil Direct Target	**N. Sakamoto**: RF system for heavy ion cyclotrons at RIKEN RIBF	**H. Koivisto**: Metal ion beam and beam transmission development at JYFL		
13.00				Lunch	Lunch
13.10-14.40	Lunch	Lunch	Lunch		
14.40	**D. Ene**: Radiological Safety Aspects of the design of RNB Facilities	**J. M. Schippers**: A novel design of a cyclotron based accelerator system for multi-ion-therapy	**D. Leitner**: Superconducting ECR ion source development at LBNL	14.30-23.00: Excursion and Conference Dinner	14.30-19.00: Visit LNL
14.50					
15.00		**M. Maggiore**: Design study of the medical cyclotron SCENT300	**J. Alessi**: A High-performance Electron Beam Ion Sources		
15.10	**K. Yamada**: Progress on the commissioning of RIB Factory at RIKEN Nishina Center				
15.20		**Y. Liu**: HIRFL-CSR Commissioning Status			
15.30	**O. Kamigaito**: Intensity-upgrade plans of RIKEN RI-Beam factory		**R. Becker**: Acceleration of heavy ions generated by ECR and EBIS		
15.40					
15.50	**F. Wenander**: The refinement of REX-ISOLDE	**M. Grieser**: Acceleration, Deceleration and Bunching of Stored and Cooled Ion Beams at TSR, Heidelberg	**G. Zschornack**: Dresden electron beam ion sources: latest developments		
16.00					
16.10	**J. M. Lagniel**: Building Design for High Beam-Power Facilities, the example of SPIRAL 2	**R. Von Hahn**: Status of the Cryogenic Storage Ring	**F. Naab**: Ion sources at the Michigan Ion Beam Lab.: capabilities and performace		
16.20					
16.30-17.00	Coffee break	Coffee break	Coffee break		
17.00	Poster Session	**Free**	Poster Session		
17.10					
17.20					
17.30					
17.40					
17.50					
18.00					
18.10					
18.20					
	19.00-21.00: Welcome reception		19.00-20.30: Visit to St. Mark Basilica		

LEGENDA				
	Session: Radioactive Ion Beams Facilities	Session: Circular Accelerators	Session: Ion Sources	Session: General Topics
	Session: Electrostatic Accelerators	Session: Applications	Session: Linacs	Poster Session

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Scientific Program

SUNDAY 07 June 2009

SALA PALLADIO

17:00 – 19:00 ***Registration***

MONDAY 08 June 2009

AULA MAGNA

Session GENERAL TOPICS
Chair: G. Bisoffi

09:00 – 09:30 ***Opening***

Session RADIOACTIVE ION BEAMS FACILITIES
Chair: G. Bisoffi

10:30 – 11:00 **Coffee break - Sala Vivaldi**

S e s s i o n R A D I O A C T I V E I O N B E A M S F A C I L I T I E S
Chair: R. Laxdal

S e s s i o n R A D I O A C T I V E I O N B E A M S F A C I L I T I E S
Chair: O. Kester

T U E S D A Y 0 9 J u n e 2 0 0 9

A U L A M A G N A

S e s s i o n E L E C T R O S T A T I C A C C E L E R A T O R S
Chair: F. Osswald

10:30 – 11:00 **C o f f e e b r e a k - S a l a V i v a l d i**

S e s s i o n E L E C T R O S T A T I C A C C E L E R A T O R S
Chair: D. Rifuggiato

S e s s i o n C I R C U L A R A C C E L E R A T O R S
Chair: D. Rifuggiato

13:10 – 14:40 **L u n c h - S a n T r o v a s o R e s t a u r a n t**

Session CIRCULAR ACCELERATORS
Chair: A. Noda

WEDNESDAY 10 June 2009

AULA MAGNA

Session APPLICATIONS AND ANCILLARY SYSTEMS
Chair: I. Hofmann

Session APPLICATIONS AND ANCILLARY SYSTEMS
Chair: R. Pardo

S e s s i o n I O N S O U R C E S
Chair: R. Pardo

S e s s i o n I O N S O U R C E S
Chair: R. Repnow

THURSDAY 11 June 2009

AULA MAGNA

Session LINACS
Chair: D. Weisser

FRIDAY 12 June 2009

AULA MAGNA

Session LINACS
Chair: O. Kamigaito

10:30 – 11:00 Coffee break - Sala Vivaldi

Session GENERAL TOPICS
Chair: J.M. Lagniel

12:20 – 12:40 ***HIAT09 Outlook***
A. Roy, *Inter – University Accelerator Centre, India*

12:40 – 13:00 ***Closing***

13:00 – 14:30 Lunch - San Trovaso Restaurant

14:30 – 19:30 Visit to INFN - Laboratori Nazionali di Legnaro

LIST OF POSTER CONTRIBUTIONS

SESSION A: GENERAL TOPICS

SESSION B: ELECTROSTATIC ACCELERATORS

SESSION C: LINACS

SESSION D: CIRCULAR ACCELERATORS

S E S S I O N E : I O N S O U R C E S

SESSION F: RADIOACTIVE ION BEAM FACILITIES

SESSION G: APPLICATIONS

ABSTRACTS

INVITED TALKS
AND
ORAL PRESENTATIONS

MO 1

NUCLEAR PHYSICS PERSPECTIVES WITH NEXT-GENERATION RNB FACILITIES

G. Bollen

Michigan State University, USA

Next-generation rare isotope beam facilities will provide a wide variety of high-quality beams of unstable isotopes at unprecedented intensities, opening exciting research perspectives. New classes of experiments will become possible to explore nuclear structure very far from stability, information will be obtained that is critical for the explanation of element abundances observed in the universe, and special isotopes will become available at high intensities that are important for the study of fundamental symmetries and for societal needs. Worldwide, considerable efforts are underway towards realizing a new generation of rare isotope beam facilities. FRIB, the US's "Facility for Rare Isotope Beams" for which Michigan State University (MSU) was selected as the site, will be based on a 400 kW, 200 MeV/u heavy ion driver linac. Once realized, FRIB will be the world-leading rare isotope beam facility. This talk will present MSU's proposed FRIB concept and discuss science opportunities with such a next-generation facility.

MO 2

COMPLEMENTARITY OF NEW RNB FACILITIES AND THEIR TECHNOLOGICAL CHALLENGES

J. Nolen

Physics Division, Argonne National Laboratory, USA

The scientific case for advanced, high intensity radioactive beam facilities has been made repeatedly by the world-wide nuclear science community. As a result several such facilities of various scopes and based on a wide variety of technologies were proposed and are in various stages of planning and construction. This presentation will compare the capabilities of these next-generation projects and review their technological challenges. These facilities will be based on several types of isotope production accelerators with beam powers from a few kilowatts to megawatts, and will utilize driver beams from protons to uranium. Also, they are generally divided between ISOL-type (light ion drivers) and beam-fragmentation facilities (heavy ion drivers). Secondary, radioactive beams can be available at ion source energy or stopped, as in-flight beams following fragment separators and delivered for research at high energies, or as beams reaccelerated from ISOL-type ion sources or after stopping in gas catchers. The different facility types face a variety of technological challenges that must be overcome to reach their full potential.

This presentation is supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

MO 3

THE RI BEAMS FROM THE TOKAI RADIOACTIVE ION ACCELERATOR COMPLEX (TRIAC)

A. Osa[1], S. Abe[1], T. Asozu[1], S. Hanashima[1], T. Ishii[1], N. Ishizaki[1], H. Kabumoto[1], K. Kutsukake[1], M. Matsuda[1], M. Nakamura[1], T. Nakanoya[1], Y. Otokawa[1], H. Tayama[1], Y. Tsukihashi[1], S. Arai[2], H. Ishiyama[2] , N. Imai[2], M. Okada[2], M. Oyaizu[2], S.C. Jeong[2], K. Niki[2], Y. Hirayama[2], Y. Fuchi[2], H. Miyatake[2] and Y. Watanabe[2]

[1] *Japan Atomic Energy Agency, Japan*
[2] *High Energy Accelerator Research Organization, Japan*

Tokai Radioactive Ion Accelerator Complex (TRIAC) is an ISOL-based radioactive nuclear beam (RNB) facility, connected to the ISOL in the tandem accelerator at Tokai site of Japan Atomic Energy Agency (JAEA). At JAEA-tandem accelerator facility, we can produce radioactive nuclei by means of proton induced uranium fission, heavy ion fusion or transfer reaction. Since TRIAC was opened for use in 2005, we have provided RNBs of fission products and ^{8}Li. For the production of ^{8}Li, we chose ^{13}C (^{7}Li, ^{8}Li) neutron transfer reaction by ^{7}Li primary beam and a 99% enriched ^{13}C sintered disk target. The release time of Li ions from the ^{13}C sintered target/ion source system was measured to be 3.2 s. We are developing the RNB of ^{9}Li ($T_{1/2}$=178 ms) but the long release time caused a significant loss of the beam intensity. A boron nitride target which has fast release of Li is developed for ^{9}Li beam with intensity of 10^{4} pps after separation by JAEA-ISOL.

MO 4

REA3, THE NEW REACCELERATED BEAM FACILITY AT MSU/NSCL

M. Doleans, W. Hartung, O. Kester, F. Marti, X. Wu, R. York and Q. Zhao

National Superconducting Cyclotron Laboratory, MSU, USA

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is currently constructing its new reaccelerated beam facility- ReA3. ReA3 will provide world-unique low energy rare isotope beams by stopping fast, separated rare isotopes in a gas-stopper, and then reaccelerating them in a Linear Accelerator. ReA3 will provide pioneering beams for research in one of the pillars of the next-generation rare isotope facility FRIB that will be hosted at MSU. The main components of ReA3 are a linear cryogenic gas cell to stop the fast beams produced by the existing coupled cyclotron facility, an Electron Beam Ion Trap (EBIT) to boost their charge states, a compact accelerator using a room temperature RFQ and a superconducting linac, and an achromatic beam transport line for delivery to the new experimental area. Beams from ReA3 will range in energy from 0.3 to 6 MeV/u. The maximum energy is 3 MeV/u for heavy nuclei such as uranium, and 6 MeV/u for ions with A<50. The overall design for ReA3 will be presented emphasizing on the ongoing construction and tests of its various components.

MO 5

FIRST BEAM TESTS OF THE ^{252}CF CARIBU PROJECT

R. Pardo, S. I. Baker, C.N. Davids, D. R. Phillips, R.C. Vondrasek and G. P. Zinkann

Argonne National Laboratory, USA

Construction and installation of the Californium Rare Ion Breeder Upgrade (CARIBU) for ATLAS facility is nearly complete. The facility will use fission fragments from a 1 Ci ^{252}Cf source, thermalized and collected into a low-energy particle beam by a helium gas catcher, mass analyzed by an isobar separator, and charge bred to higher charge states for acceleration in ATLAS. In addition, unaccelerated beams will be available for trap and laser probe studies. Expected yields of accelerated beams are up to ~5x10^5 (10^7 to traps) far-from-stability ions per second on target. We expect first beam tests from the project by May 2009. The facility design and first results of beam studies using a weaker 2.2 and 80 mCi sources will be presented in this report. Plans for installation of the 1 Ci source will be discussed.
This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

MO 6

OPERATIONAL EXPERIENCE WITH THE EXCYT FACILITY

D. Rifuggiato, L. Calabretta, L. Celona, F. Chines, L. Cosentino, G. Cuttone, P. Finocchiaro, A. Pappalardo, M. Re and A. Rovelli

INFN/LNS, Italy

The EXCYT project has successfully come to conclusion at the end of 2006. As a consequence, a new facility for production and acceleration of radioactive ion beams is now available at Laboratori Nazionali del Sud, Catania.
This facility is based on the ISOL method: in particular the primary beam is delivered by a Superconducting Cyclotron, while the secondary beam is post-accelerated by a Tandem. A low energy radioactive beam is also available at the exit of the pre-injector. The main features of the commissioning of the facility will be described. Details will be given on the characteristics of the diagnostics devices. Future development activities are related both to operational features of the new facility and to improvements and upgradings that are planned to be introduced in the near future. All of these subjects will be extensively discussed.

MO 7

THE SPES PROJECT: AN ISOL FACILITY FOR EXOTIC BEAMS

G. Prete[1], A. Andrighetto[1], G. Bassato[1], P. Benetti[2], L. Biasetto[1], G. Bisoffi[1], L. Calabretta[4], M. Cinausero[1], A. Covello[3], A. Dainelli[1], J. Esposito[1, 5], E. Fagotti[1,5], P. Favaron[1], A. Galatá[1], F. Gramegna[1], A. Lombardi[1], M. Manzolaro[1], P.F. Mastinu[1], A. Pisent[1], M. Poggi[1], P. Posocco[1,5], L. Sarchiapone[1], D. Zafiropoulos[1] and SPES COLLABORATION

[1] *INFN/LNL, Italy*
[2] *INFN/Pavia Section and University of Pavia, Italy*
[3] *INFN/Naples Section and Federico I University, Italy*
[4] *INFN/LNS, Italy*
[5] *Consorzio RFX, Italy*

SPES (Selective Production of Exotic Species) is an INFN project to develop a Radioactive Ion Beam (RIB) facility as an intermediate step toward EURISOL. The SPES project is part of the INFN Road Map for the Nuclear Physics development in Italy and is supported by the whole Italian Nuclear Physics community and mainly by LNL and LNS the INFN National Laboratories of Nuclear Physics in Legnaro and Catania. The Laboratori Nazionali di Legnaro (LNL) was chosen as the site for the facility construction due to the presence of the PIAVE-ALPI accelerator complex, which will be used as re-accelerator for the RIB. The SPES project is based on the ISOL method and makes use of a proton driver of 40 MeV energy and 200 µA current impinging on a Direct Target of UCx. Neutron-rich radioactive beams will be produced by Uranium fission at an expected fission rate in the target in the order of 1013 fissions per second. A detailed study of the target was performed to determine the feasibility of the system to sustain the total beam power of 8 kW. The key feature of SPES is to provide high intensity and high-quality beams of neutron rich nuclei to perform forefront research in nuclear structure, reaction dynamics and interdisciplinary fields like medical, biological and material science. The exotic isotopes will be re-accelerated by the ALPI superconducting linac at energies up to 10 MeV/A for masses in the region of A=130 amu with an expected rate on target of 10^9 pps.

MO 8

THE SPES PROJECT: RESEARCH AND DEVELOPMENT FOR THE MULTI-FOIL DIRECT TARGET

M. Manzolaro[1], A. Andrighetto[1], L. Biasetto[1], G. Meneghetti[2], S. Carturan[1], D. Scarpa[1], P. Colombo[2] and G. Prete[1]

[1] *INFN/LNL, Italy*
[2] *University of Padua, Italy*

SPES is a facility to be built at National Institute of Nuclear Physics (INFN) Laboratory (Legnaro-Italy) intended to provide intense neutron-rich radioactive ion beams. The SPES Production Target is composed of seven UCx co-axial disks spaced in the axial direction in order to dissipate by thermal radiation the power due to the proton beam (E=40 MeV, I=0.2 mA) which, passing through them, induces nuclear reactions. The disks are closed inside a tubular box made of graphite; the box is located inside a water-cooled chamber kept at 50°C under vacuum and has to maintain the average temperature of 2000 °C so as to enhance the radioactive nuclei extraction. Since the proton beam power is not sufficient to heat the box up to the required level, it is contained inside a Tantalum heating and screening device. In this work the Thermal-Electric behaviour of the Target system prototype is analysed by means of FE multiphysics analyses; the numerical results are compared with both potential difference and temperature measurements. The SPES facility should be able to produce 10^{13} fissions/sec; however, the number of isotopes useful for nuclear physic studies in the experimental areas must be reduced taking into account sticking time, half life, cross section, proton flux, diffusion and effusion time, ionization and transport efficiencies. In order to increase the diffusion and effusion efficiency, new materials and new processes for the production of carbides have been developed at LNL.

MO 9

RADIOLOGICAL SAFETY ASPECTS OF THE DESIGN OF THE RNB FACILITIES

D. Ene, J. C. David, D. Doré and D. Ridikas

CEA, IRFU/SPhN, France

The paper summarizes the radiation safety issues related to the strategy to be used for the design of RNB facilities with particular emphasis on the EURISOL project. Problems addressed are:
1. Legislation framework sets-up safety requirements concerning the protection of the environment, public and staff.
2. Identification and estimation of the radioactive sources are essential for deciding the radiation safety features to be accounted.
3. Protection against radiations and confinement of the radioactive materials ensuring safe operation. Both functions need the characterisation of the prompt radiation field for normal and accident conditions. For the first, the design provides the optimum shielding configuration required to protect the public and workers. Second requires a risk analysis to demonstrate that designed equipments are adequate to minimize the risk of the radioactive material dispersion.
4. Radiation protection after beam shut-down. In this concern the assessment of the residual radiation field is important to give specifications on the exposure of the personnel during maintenance and interventions particularly when the machine will be dismantled and decommissioned. Consequently, measures are to be included in the design to limit the exposure and the working procedures.
5. Protection of the public and the environment. Environmental assessment studies are necessary to estimate the impact of the radioactive releases proving the suitability of the facility design.

MO 10

PROGRESS ON THE COMMISSIONING OF RADIOACTIVE ISOTOPE BEAM FACTORY AT RIKEN NISHINA CENTER

K. Yamada, N. Fukunishi, M. Fujimaki, T. Fujinawa, A. Goto, H. Hasebe, Y. Higurashi, E. Ikezawa, O. Kamigaito, M. Kase, M. Komiyama, H. Kuboki, K. Kumagai, T. Maie, M. Nagase, T. Nakagawa, J. Ohnishi, H. Okuno, N. Sakamoto, Y. Satou, K. Suda, M. Wakasugi, H. Watanabe, T. Watanabe, Y. Watanabe, Y. Yano and S. Yokouchi

RIKEN Nishina Center, Japan

The Radioactive Isotope Beam Factory (RIBF) at RIKEN Nishina Center will be a next generation facility which is capable of providing the world's most intense RI beams over the whole range of atomic masses. Three new ring cyclotrons have been constructed as post-accelerators for the existing facility in order to provide the intense heavy-ion beam for the RI beam production by using a in-flight separation method. The beam commissioning of RIBF was started at June 2006 in parallel with constructing other equipments at RIBF. We succeeded in the first beam extraction from the final booster cyclotron, SRC, which is the world's first superconducting ring cyclotron, using 345 MeV/nucleon aluminum beam on December 28th, 2006. The first uranium beam with energy of 345 MeV/nucleon was extracted from the SRC on March 23rd, 2007. Various modifications for equipments and many beam studies were performed in order to improve the transmission efficiency and to gain up the beam intensity. Commissioning of the accelerator complex was successfully completed in December 2008 through the achievement of the world's most intense beams of 0.4 pnA ^{238}U and 200 pnA ^{48}Ca with 345 MeV/nucleon. This talk will present what we have done during the commissioning in order to obtain better performance as well as the current performance of the RIBF accelerator complex, which includes transmission efficiencies, isochronous fields and radial beam patterns, stability of the accelerators, and so on.

MO 11

INTENSITY-UPGRADE PLANS OF RIKEN RI-BEAM FACTORY

O. Kamigaito, M. Fujimaki, T. Fujinawa, N. Fukunishi, A. Goto, Y. Higurashi, E. Ikezawa, M. Kase, M. Kidera, M. Komiyama, H. Kuboki, K. Kumagai, T. Maie, M. Nagase, T. Kageyama, T. Nakagawa, J.I. Ohnishi, H. Okuno, N. Sakamoto, Y. Sato, K. Suda, T. Watanabe, Y. Watanabe, K. Yamada, S. Yokouchi and Y. Yano

RIKEN Nishina Center, Japan

In 2008, the RIKEN RI-Beam Factory (RIBF) succeeded in providing heavy ion beams of ^{48}Ca and ^{238}U with 170 particle-nano-ampere and 0.4 particle-nano-ampere, respectively, at an energy of 345 MeV/u. The beam power of ^{48}Ca was 2.8 kW (CW). The transmission efficiency through the accelerator chain has been significantly improved. From the operational point of view, however, the intensity of the uranium beam should be much increased. Therefore, we have constructed a superconducting ECR ion source which is capable for the microwave power of 28 GHz. The excitation test was performed successfully, and the source was brought to RIKEN recently. In order to reduce the space-charge effects, the ion source was installed on the high-voltage terminal of the Cockcroft-Walton injector, where the beam from the source will be directly injected into the heavy-ion linac by skipping the RFQ pre-injector. The test of the ion source will be started in March 2009. We will show another upgrade plan of constructing an alternative injector for the RIBF, consisting of the superconducting ECR ion source, an RFQ, and three DTLs, which aims at independent operation of the RIBF experiments and super-heavy element synthesis. An RFQ linac, which has been originally developed for the ion-implantation application will be recycled for the new injector. Reconditioning of the RFQ as well as the design study of the DTLs are under progress.

MO 12

THE REFINEMENT OF REX-ISOLDE

F. Wenander, D. Voulot, A. Gustafsson, J. Van De Walle, R. Scrivens and A. Herlert

CERN, Switzerland

Over the last few years the REX-ISOLDE post accelerator has delivered 24 different radioactive elements and over 60 isotopes with masses ranging from 8 to 204 amu and with half-lives down to some 10 ms. The high demand for beam time in combination with the versatility of the machine results in 7-8 experiments per year. The low-energy part of REX, consisting of a Penning trap and Electron beam ion source, has developed from a pure bunching and charge-breeding system to an elaborate set of tools that can be used for different purposes. The mass-selectivity of the Penning trap has been explored and a maintained high transmission for the low-energy stage could be demonstrated by the use of pulsed injection from a newly installed RFQ cooler. As a result isobarically clean beams can in principle be provided to the experiments although complications arise for relatively high beam currents. This year we've also shown that the low energy system, particularly the EBIS, can be used for in-trap decays. That means also elements that are normally difficult to extract from the ISOL target-ion source (e.g. refractory elements such as Fe) can be delivered to the experiments by letting the straightforwardly produced mother-nuclei decay in the EBIS before being accelerated. Finally, recent development projects will be discussed such as the setup for polarization of accelerated radioactive beams, presently under build-up.

MO 13

BUILDING DESIGN FOR HIGH BEAM-POWER FACILITIES, THE EXAMPLE OF SPIRAL 2

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The buildings and their equipments associated to the nuclear engineering play a crucial role for a successful operation of high beam-power facilities. They also represent the biggest part of the facility total investment cost and are frequently the critical path in the construction planning. The management of the building and conventional facility design and construction is a complex task including many aspects: set up of the functional and technical specifications for buildings, radiation shielding, remote handling, electrical power distribution, cooling system…, definition of the interfaces between the accelerator and experimental equipments and the buildings, selection of the building prime contractor, task sharing between the accelerator and physicist teams and the building prime contractor, infrastructures optimization up to the final detailed design… These topics will be discussed taking SPIRAL 2 as example.

TU 1

PRESENT AND FUTURE OF ELECTROSTATIC ACCELERATORS

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Electrostatic accelerator laboratories were the nursery for the heavy ion physics research of today and the accelerators this research needed. The first conference, of what has evolved into the HIAT series, was the "Conference on Electrostatic Accelerator Technology" hosted by the Daresbury Laboratory in 1973. While some of the founding labs of this series have ceased doing accelerator based physics, electrostatic accelerators still inject beams into present day heavy ion boosters. Electrostatic accelerators also continue to provide beams for nuclear and applied physics in laboratories with and without boosters. The development of electrostatic accelerators remains active and will continue in the next few years. The improvements have been spurred by injection beam requirements of boosters as well as the special transmission and stability needs of accelerator mass spectrometry. The survey of the electrostatic accelerator community presented here, has identified a broad range of improvements and uses as well as future technical directions for electrostatic accelerators.

TU 2

UPGRADE OF THE BUCHAREST FN TANDEM ACCELERATOR

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The Bucharest FN Tandem Accelerator was put in operation in 1973 and upgraded a first time in 1983 to 9 MV. In the period 2006-2009 a second program of the tandem upgrade was performed aiming to transform this accelerator in a modern and versatile facility for atomic and nuclear physics studies as well as for different applications using accelerated ion beams. The upgrade was achieved by replacing the main components of the tandem by new ones and by adding new components. The old HVEC belt of the Van de Graaff generator was replaced by a "pelletron" system, the old stainless steel inclined field electrodes accelerator tubes were replaced by titanium spiral field tubes, the old HICONEX 834 sputter negative ion source was replaced by a new SNICS II sputter source and all old electronic equipment including RMN and Hall probe gauss meters as well as low voltage and high voltage power supplies for the magnets, lenses and ion sources were replaced by new ones. The new equipment added to the tandem consists of a helium negative ion source, a new injector based on a multi-cathode ion source 40 MC-SNICS for AMS applications, a new pulsing system in the millisecond range and a new chopper and bunching system for pulsing the ion beam in the nanosecond range. Now the tandem is currently operated in very stable conditions up to 9 MV on a basis of about 4000 hours/year accelerating a broad range of ion species.

TU 3

DEVELOPMENT ACTIVITIES AT BARC-TIFR PELLETRON ACCELERATOR FACILITY

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The 14UD Pelletron Accelerator Facility at Mumbai has recently completed two decades of successful operation. The accelerator is mainly used for basic research in the fields of nuclear, atomic and condensed matter physics as well as material science. The application areas include accelerator mass spectrometry, production of track-etch membranes, radioisotopes production, radiation damage studies and secondary neutron production for cross section measurement etc. Over the years, a number of developmental activities have been carried out in-house that have helped in improving the overall performance and uptime of the accelerator and also made possible to initiate variety of application oriented programmes. Recently, a superconducting LINAC booster has been fully commissioned to provide beams up to A~60 region with E~5 MeV/A. As part of Facility augmentation program, it is planned to have an alternate injector system to the LINAC booster, consisting of 18 GHz superconducting ECR ion source, 75 MHz room temperature RFQ linac and superconducting low-beta resonator cavities. The development of an alternate injector will further enhance the utilization capability of LINAC by covering heavier mass range up to Uranium. The ECR source is being configured jointly with M/s Pantechnik, France, which will deliver a variety of ion beams with high charge states up to $^{238}U^{34+}$. This paper will provide detailed presentation of developments being carried out at this facility.

TU 4

MAIER-LEIBNITZ-LABORATORIUM - TANDEM OPERATION AND EXPERIMENTS

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The Tandem accelerator of the Maier-Leibnitz-Laboratorium (MLL), the former “Beschleunigerlabor der LMU und TU München“ was running very reliable during the last year. The accelerator was running 7000 hours for experiments in the fields of nuclear and applied physics. The status of the Tandem accelerator will be presented and some technical problems of the past years of operation. The MAFF project (Munich Accelerator for Fission Fragments) was suspended due to missing funding. MAFF was planned be the successor of the Tandem accelerator. Now the Tandem accelerator will be useful for experiments in the framework of the two Excellence Clusters “Origin and structure of the Universe” and MAP (Munich Centre for advanced Photonics). The Tandem ion beams are applied for experiments in the field of nuclear astrophysics and AMS with astrophysical implication and for irradiation of cells, tissue and finally animals for tumor therapy with laser accelerated ions. Preliminary studies in this field are performed with ion beams from the tandem accelerator.

TU 5

"DIANA" - A NEW, DEEP – UNDERGROUND ACCELERATOR FACILITY FOR ASTROPHYSICS EXPERIMENTS

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DIANA (Dakota Ion Accelerators for Nuclear Astrophysics) is a collaboration between the University of Notre Dame, University of North Carolina, Western Michigan University, and Lawrence Berkeley National Laboratory to build a nuclear astrophysics accelerator facility 1.4 km below ground. DIANA is part of the US proposal DUSEL (Deep Underground Science and Engineering Laboratory) to establish a cross-disciplinary underground laboratory in the former gold mine of Homestake in South Dakota, USA. DIANA would consist of two high-current accelerators, a 30 to 400 kV high voltage platform, and a second dynamitron accelerator with a voltage range of 350 kV to 3 MV. As a unique feature, both accelerators are planned to be equipped with either high-current microwave ion sources or multi-charged ECR ion sources producing ions from protons to oxygen. Electrostatic quadrupole transport elements will be incorporated in the dynamitron high voltage column. Compared to current astrophysics facilities DIANA could increase the available beam densities on target by magnitudes: up to 100 mA on the low energy accelerator and several mA on the high energy accelerator. An integral part of the DIANA project is the development of a high-density super-sonic gas-jet target which can handle these anticipated beam powers. The paper will explain the main components of the DIANA accelerators and their beam transport lines and will discuss related technical challenges.

TU 6

PROGRESS OF AN ACCELERATOR MASS SPECTROMETRY SYSTEM ON THE TSUKUBA 12UD PELLETRON TANDEM ACCELERATOR

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The 12UD Pelletron tandem accelerator has been installed at the University of Tsukuba, Tandem Accelerator Complex (UTTAC) since 1975. The maximum terminal voltage of 12 MV is available for various ion beam applications. In recent years, the main research field of the 12UD Pelletron tandem accelerator has shifted from nuclear physics to accelerator mass spectrometry (AMS). AMS is an ultra-sensitive technique for the study of long-lived radioisotopes and stable isotopes with very low abundances. It is important to eliminate the isobaric interference for sensitive measurements of heavy isotopes. The high terminal voltage has an advantage for the detection of heavy isotopes because the target isotopes and their isobars are clearly separated by the relative differences in energy losses. The multi-nuclide AMS system at the University of Tsukuba (Tsukuba AMS system) is able to measure long-lived radioisotopes such as ^{14}C, ^{26}Al, ^{36}Cl and ^{129}I by using a molecular pilot beam method that stabilize the terminal voltage within 0.1% accuracy. Much progress has been made in the development of new AMS techniques for the Tsukuba AMS system. As for ^{36}Cl AMS, ^{36}Cl with a charge state 9+ at 100 MeV is used for AMS measurements. The standard deviation of the fluctuation is typically ±2%, and the machine background level of $^{36}Cl/Cl$ has reached lower than 10^{-15}.
This report presents the overview and progress of the Tsukuba AMS system.

TU 7

OPERATION STATUS OF HIGH INTENSITY ION BEAMS AT GANIL

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The GANIL facility (Caen, France) is dedicated to the acceleration of heavy ion beams for nuclear physics, atomic physics, radiobiology and material irradiation. The production of stable and radioactive ion beams for nuclear physics studies represents the main part of the activity. Two complementary methods are used for exotic beam production: the Isotope Separation On-Line (ISOL, the SPIRAL1 facility) and the In-Flight Separation techniques (IFS). SPIRAL1, the ISOL facility, is running since 2001, producing and post-accelerating radioactive ion beams. The running modes of the accelerators will be recalled as well as a review of the operation from 2001 to 2008. A point will be done on the way we managed the high intensity ion beam transport issues and constraints which allows the exotic beam production improvement.

TU 8

STATUS REPORT AND FUTURE DEVELOPMENT AT FLNR JINR HEAVY IONS ACCELERATOR COMPLEX

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Four heavy ions cyclotrons are in operation at FLNR now. Heavy ions beams used for superheavy elements synthesis, RIB production and application. Plan for seven years accelerator development and operation are presented.

TU 9

RCNP CYCLOTRON FACILITY

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The RCNP accelerator cascade consists of an injector AVF cyclotron (K=140) and a ring cyclotron (K=400). It provides ultra-high quality beams as well as moderately high intensity beams for a wide range of researches in nuclear physics, fundamental physics, applications and interdisciplinary fields. Maximum energy of protons and heavy ions are 400 and 100 MeV/u, respectively. Sophisticated experimental apparatuses are equipped like a pair spectrometer, a neutron time of flight facility with a 100 m long tunnel, a radioactive nuclei separator, a super-thermal Ultra Cold Neutron (UCN) source, a white neutron source and a RI production system for nuclear chemistry. Such ultra high resolution measurements as $\Delta E/E=5x10^{-5}$ are routinely performed with the Grand Raiden spectrometer by utilizing the dispersion matching technique. A flat-topping system and an 18 GHz superconducting ECR ion source were introduced to improve the beam quality and intensity. A new beam line was installed to diagnose the characteristics of the beam to be injected into the ring cyclotron as well as to bypass the ring cyclotron and directly transport low energy beams from AVF cyclotron to experimental halls. Developments have been continued to realize the designed performance of these systems.

TU 10

RF SYTEM FOR HEAVY ION CYCLOTRONS AT RIKEN RIBF

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At RIKEN RIB-factory an accelerator complex which consists of superconducting ring cyclotron (SRC), intermedeiate-stage ring cyclotron (IRC) and Fixed-frequency booster Ring Cyclotron (FRC) provides heavy ion beams with an enegy of 345 MeV/u. The total beam power at the SRC is as high as 3 kW in the case of ^{48}Ca 170 pnA which we achieved last year. Beam loss in the acceleration by cyclotorons mainly occurs at the electric static deflector at extraction and damages the deflector septum. The power loss at the extraction deflector should be less than 300 W. In order to reduce the loss at deflectors, high voltage acceleration with a harmonic flattop field play an important role. For the SRC, four acceleration single-gap cavities and a third harmonic flattop cavity are installed. The maximum voltage is 600 kVp at 36.5 MHz. A long term stability of voltage and phase are ±0.5% and ±0.1 deg. which are obtained with an analogue feedback system. The cavities are normal type and the voltage 600 kVp is obtained with an rf power of 150 kW. The main rf amplifier is based on a tetrode THALES (SIEMENS) RS2042SK coupled with a tetrode THALES (SIEMENS) RS2012CJ with a grounded-grid circuit. The SRC is energy variable machine so that the rf system is frequency tunable whose range of is 18.2 MHz to 38.2 MHz. For the acceleration of 10 kW ^{48}Ca beam in this year, development of rf system is undergoing. In this paper the performance of the rf sytem and a recent development will be reported.

TU 11

A NOVEL DESIGN OF A CYCLOTRON-BASED ACCELERATOR SYSTEM FOR MULTI-ION-THERAPY

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Hospitals considering hadron therapy often desire a phased approach: start with protons and add Carbon ions later. This motivated our concept based on an accelerator system of two coupled cyclotrons. Protons (H_2^+), He, or C-ions of 250 MeV/nucl will be provided by a compact superconducting cyclotron. Protons or He-ions can be used for the full spectrum of treatments and "low energy" C-ions for a subset of tumours, or radiobiological experiments. For treatments at all tumour sites with C-ions, one can subsequently boost the C-ions up to 450 MeV/nucl in a separate sector cyclotron, consisting of six sector magnets with superconducting coils. Our concept has several advantages, typical for cyclotrons: stable DC beam, fast energy change (external degrader), fast (kHz) beam intensity control with an accuracy of a few percent, high extraction efficiency and no intensity problems. By using external ion sources we can quickly switch ion type. First studies indicate a relatively robust design with straight forward beam dynamics issues and that our system is smaller than corresponding synchrotrons. Present efforts to optimize the design of the super conducting sector magnets indicate that the introduction of a steep gradient in the sector would have many advantages. Our concept of two cyclotrons offers an attractive two-phase realization. The booster enabling all treatments can be built later but already during the first phase experience can be obtained with all ions.

TU 12

DESIGN STUDY OF THE MEDICAL CYCLOTRON SCENT300

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The INFN-LNS is designing a medical superconducting cyclotron able to deliver carbon and proton beam at energy of 300 and 260 AMeV respectively, these energies are really appealing for cancer therapy. The design of the C300 cyclotron, already called SCENT, is performed inside a cooperation agreement with the IBA company. The updated design of the C300 cyclotron, in particular of the RF Cavity and of the injection and extraction system will be described. The mean features of the beam dynamics and of the extraction system will be also presented.

TU 13

HIRFL-CSR COMMISSIONING STATUS

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CSR is a new ion cooler-storage-ring system in IMP, China, it consists of a main ring (CSRm) and an experimental ring (CSRe). The two existing cyclotrons SFC (K=69) and SSC (K=450) of the Heavy Ion Research Facility in Lanzhou (HIRFL) will be used as its injector system. The heavy ion beams from the cyclotrons will be injected first into CSRm for the accumulation with e-cooling and acceleration, finally extracted fast to CSRe for internal-target experiments and mass measurements of radioactive ion beams (RIBs), or extracted slowly for external-target experiments or cancer therapy. In 2005 the CSR construction was completed, and the commissioning was finished in the past two years, including the stripping injection (STI), electron-cooling with hollow electron beam, C-beam stacking with the combination of STI and e-cooling, the wide energy-range accelerating from 7 MeV/u to 1000 MeV/u with the RF harmonic-number changing at the mid-energy, the multiple multi-turn injection (MMI) and the beam accumulation with MMI and e-cooling for heavy-ion beams of C, Ar and Xe, the fast and slow extraction from CSRm, the commissioning of CSRe with two lattice modes and the RIBs mass-spectrometer test with the isochronous mode in CSRe by the time-of-flight method.

TU 14

ACCELERATION, DECELERATION AND BUNCHING OF STORED AND COOLED ION BEAMS AT THE TSR, HEIDELBERG

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At present the ion storage ring TSR is mainly used for experiments with beams at the energy provided by accelerators used for the ion injection. Several experiments have demonstrated the feasibility of wide range, efficient acceleration and deceleration. Using only the calculated functions for the power-supply currents, taking into account the saturation effects of the TSR magnets and the rf frequency control, it was possibly to accelerate a $^{12}C^{6+}$ beam from 73.3 MeV to 362 MeV with an efficiency of 98% to the rigidity limit of 1.57 Tm. In a first test devoted to the deceleration highly charged ions with the new control system, a reduction of the beam energy by a factor of > 6, from 73.3 to 11.8 MeV (1 MeV/u), could be achieved readily with an efficiency of 68% (magnetic rigidity from 0.71 to 0.28 Tm). This considerably enlarges the operating range with highly charged ions produced at the MPIK tandem accelerator as motivated by planned stored beam experiments in the TSR. Small longitudinal bunch lengths are demanded by experiments with a reaction microscope in storage rings. Development beam times were performed with 50 MeV $^{12}C^{6+}$ ion beams using the fifth harmonic of the revolution frequency for bunching. The measured bunch lengths are space charge limited, bunch lengths with a standard deviation of 5 ns can be anticipated with beam currents of micro Amperes, realizing conditions suitable for planned experiments with an internal jet target and a reaction microscope in TSR.

TU 15

STATUS OF THE CRYOGENIC STORAGE RING

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A novel next generation electrostatic Cryogenic Storage Ring (CSR) for heavy ions, molecules and clusters up to bio-molecules in the energy range of 20-300 keV is under construction at MPI Heidelberg. A unique feature of this ring is the possibility to operate it at all temperatures between room temperature down to 2 K. Operation at cryogenic temperatures is inevitably necessary to investigate the properties and reaction modes of molecular ions in their ground state as e.g., in interstellar environment. Therefore only cold wall surfaces have to be used to eliminate black body radiation exciting molecular quantum states. In addition, surfaces of 2-10 K will act as a large cryo-pump, expected to achieve a vacuum of better than 10^{-15} mbar (corresponding to 10^{-13} mbar at room temperature), which is mandatory for sufficiently large storage times for slow heavy ions. Considerable progress towards realization of this technologically ambitious project can be reported. The detailed layout of the storage ring CSR has been defined. A 2 K-21 W helium refrigerator system was designed, ordered and successfully commissioned at MPI, where it is now in operation to cool the prototype cryostat with its cryogenic ion trap CTF to 2 K temperature.

WE 1

MEDICAL APPLICATION OF HADRONTHERAPY

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As 3D-conformal treatment has become the clearly accepted goal of radiation oncology, charged particle treatment with protons and heavier ions ascended to the forefront. After three decades of > 50,000 treated patients, proton radiotherapy has established itself as an accepted and often preferred treatment modality for tumors requiring high-dose conformal irradiation. It has continuously demonstrated its ability of dose reduction to normal tissues, thus becoming the RT modality of choice for pediatric malignancies. Simultaneously, heavier ions, notably carbon ion therapy, have been developed at fewer centers, involving approximately 5000 patients worldwide. The rational is primarily based on a comparable dose distribution compared to protons but with the potential benefit of increased biologic effectiveness. Radioresistan tumours are believed to benefit most from carbon ion therapy. The current status of clinical results will be discussed. The majority of clinical data have been obtained on rare, but difficult to treat tumours, for example mesenchymal tumours of the skull base and paraspinal region. Here, an approximate 10-15% tumour control advantage has been observed for particle therapy. Most clinical data are based on Phase I/II protocols. The anticipated future direction of the role of particle therapy in medicine is a complex subject and involves an interplay of radio-biology, accelerator physics and radiation oncology.

WE 2

REVIEW ON HI ACCELERATORS FOR HADRONTHERAPY

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Heavy-ion beams have attractive growing interest for cancer treatment owing to their high dose localization at the Bragg peak as well as high biological effect there. Recently, therefore, heavy-ion cancer treatments have been successfully carried out at various facilities and several construction projects for the facility of the heavy-ion therapy have also been progressing in the world, based on the development of the accelerator technologies. This report will review the development of the accelerator technologies and the accelerator facilities for the heavy-ion cancer therapy.

WE 3

NEW AND IMPROVED AMS FACILITIES

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Accelerator Mass Spectrometry (AMS) provides instrumentation originally developed by nuclear physicists to measure cosmogenic radionuclides at natural levels. In the past years impressive progress in the measurement technique has been made and a new generation of AMS spectrometers became available to the AMS user community. More recently, the technology has been pushed even further and it could be demonstrated that, in particular for radiocarbon, AMS systems can be built which will not use conventional accelerator technology. The new generation AMS systems are introducing in radiocarbon dating and, more recently, into the Life Science applications resulting in a boom of new AMS facilities with more than 20 installations over the last five years. Low energy AMS is not limited to radiocarbon only. Triggered by the advent of very thin extremely homogeneous silicon nitrate detector windows, improvements in the detection of low energetic heavy ions with gas ionisation detectors have been made. The possibilities of high resolution particle identification at low beam energies open up a great potential for ^{10}Be, ^{26}Al, ^{129}I and actinides measurements at compact AMS systems. A brief summary of major development steps for the measurement technique and a review on state-of-the-art AMS instrumentation will be given. Special emphasis will be laid on precision limits of radiocarbon dating and detection limits for heavier radionuclides.

WE 4

THE RADIATION ASSURANCE TEST FACILITY AT INFN-LNS CATANIA

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This paper describes the beam monitoring system that has been developed at the Superconducting Cyclotron at INFN-LNS (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali del Sud, Catania, Italy) in order to monitor the beam parameters such as energy, flux, beam profile for SEE (Single Event Effects) cross-sections determination and DD (Displacement Damage) studies. The relatively high energy of the beams (for this study 20 MeV/nucleon) allows the irradiation of components in air which is used also as a degrader. In order to have an accurate and continuos monitoring of beam parameters we have developed fully automatic dosimetry setup to be used during SEE (with heavy ions) and DD (with protons of 60 MeV/nucleon) tests of electronic devices and systems. The final goal of our activity is to demonstrate the accuracy on controlling the beam profile, energy and fluence delivered onto the DUT (Device Under Test) surface and along with our experience on the easiness of operating in air. The measurement of flux and fluence of a beam impinging on DUT is one of the most important ingredients for the calculation of SEE cross-section. According to the ESA standard ESCC 25100 this measurement should be done with an accuracy of ±10%. We have exposed during the same session, two beam calibration systems, the "Reference SEU monitor" developed by ESA/ESTEC and the beam monitoring and dosimetry setup developed by our group. The results are compared and discussed here.

WE 5

DEVELOPMENT OF BEAM CURRENT MONITOR WITH HTS SQUID AND HTS CURRENT SENSOR

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A highly sensitive beam current monitor with an HTS (High-Temperature Superconducting) SQUID (Superconducting QUantum Interference Device) and current sensor, that is the HTS-SQUID monitor, has been developed for the RIBF (RI beam factory) in RIKEN. Unlike other existing facilities, the HTS-SQUID monitor allows us to measure the DC of high-energy heavy-ion beams nondestructively in such a way that the beams are diagnosed in real time and the beam current extracted from the cyclotron can be recorded without interrupting the beam user's experiments. Both the HTS magnetic shield and the HTS current sensor were dip-coated by thin Bi_2–Sr_2–Ca_2–Cu_3–O_x (Bi-2223) layer on 99.9% MgO ceramic substrates. In the present work, all these HTS fabrications are cooled by a low-vibration pulse-tube refrigerator. These technologies enable us to downsize the system. Prior to the practical use for the RIBF, the HTS-SQUID monitor was installed in the beam transport line of the RIKEN ring cyclotron to demonstrate its performance. As a result, a 20 μA $^{40}Ar^{15+}$ beam intensity (63 MeV/u) was successfully measured with a 500 nA resolution. Despite being performed in an environment with strong gamma ray and neutron flux radiations, RF background and large magnetic stray fields, measurements could be carried out in this study. We will report the present status of the monitor system and the results of the beam measurement.

WE 6

LATEST DEVELOPMENTS IN ECR CHARGE BREEDERS

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The basic principles of the ECR charge breeder are recalled, special attention is paid to the critical parameters allowing the optimization of the ECR charge breeders characteristics (efficiency yield, charge breeding time, capture potential deltaV). Possible means to increase the 1+ ion beam capture for light ions is presented. An overview is given on the present ECR charge breeders situation and results worldwide (ISOLDE, KEK, ANL, SPIRAL2…). In the context of radioactive environment, possible technological improvements and/or simplifications are suggested to facilitate the maintenance and to reduce the human intervention time in case of a subsystem failure.

WE 7

INITIAL RESULTS OF THE ECR CHARGE BREEDER FOR THE ^{252}CF FISSION SOURCE PROJECT (CARIBU) AT ATLAS

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The construction of the Californium Rare Ion Breeder Upgrade (CARIBU), a new radioactive beam facility for the Argonne Tandem Linac Accelerator System (ATLAS), is in progress. The facility will use fission fragments from a 1 Ci ^{252}Cf source; thermalized and collected into a low-energy particle beam by a helium gas catcher. In order to reaccelerate these beams, the existing ATLAS ECR1 ion source has been redesigned to function as a charge breeder source. Both the helium gas catcher system as well as the ECR charge breeder are located on high voltage platforms. An additional high voltage platform has been constructed to accommodate a low charge state stable beam source for charge breeding development work. Thus far the charge breeder has been tested with stable beams of Rubidium and Cesium with charge breeding efficiencies of 3.6 % into $^{85}Rb^{15+}$ and 2.9 % into $^{133}Cs^{20+}$. The design features of this charge breeder and the initial results with multiple frequency heating will be discussed.

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WE 8

ION BEAM COCKTAIL DEVELOPMENT AND ECR ION SOURCE PLASMA PHYSICS EXPERIMENTS AT JYFL

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The accelerator laboratory at JYFL (University of Jyväskylä, Department of Physics) is built around an isochronous K130-cyclotron, which is operated about 7000 hours per year. The experiments conducted at JYFL range from basic research in nuclear physics to industrial applications. The heavy ion beams for the cyclotron are produced with two electron cyclotron resonance ion sources (ECRIS). A substantial share of the beam time hours at JYFL is allocated for heavy ion beam cocktails, used for irradiation tests of electronics. Producing the ion beams for these experiments has required active development of the ion source facilities. This work will be reviewed in detail. The implications of the beam cocktail campaign to the beam time allocation procedure will be discussed. The JYFL ion source group has recently conducted experiments on plasma properties of ECR ion sources. These experiments include plasma potential and time-resolved bremsstrahlung measurements, for example. The results of these experiments will be presented. The obtained information can be helpful for the development of next-generation ECR ions sources. The measured plasma properties can be used as input data for codes simulating beam formation in ECR ion sources. On the other hand the results can be used for benchmarking electron heating simulation codes. The plasma physics experiments and the implications of the results on ECR ion source technology and beam production with different methods will discussed.

WE 9

METAL ION BEAM AND BEAM TRANSMISSION DEVELOPMENT AT JYFL

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The activities of the JYFL ion source group cover the development of metal ion beams, improvement of beam transmission and studies of ECRIS plasma parameters. The plasma studies will be presented by O. Tarvainen. The development of metal ion beams is one of the most important areas in the accelerator technology. Especially work for the ion beams from refractory elements are needed. In this article the inductively heated oven capable of operating up to 2000 ˚C is described. A vigorous work on the enhancement of the low energy beam injection for K-130 cyclotron is done. It has been noticed that the accelerated beam intensity after the cyclotron does not increase with the intensity extracted from the JYFL 14 GHz ECR ion source. This indicates that the beam transmission efficiency decreases remarkably as a function of beam intensity. Three different explanation has been found: 1) the beam divergence in the extraction of the JYFL 14 GHz ECRIS is too high making efficient beam transport difficult, 2) the hollow beam structure is created especially in the case of intensive ion beams and when high solenoid focusing is needed and 3) the first analysing magnet generates elliptical beam structure and consequently the beam emittance can increase due to solenoid focusing. The origin for the hollow beam structure is still unknown but the the work for an accurate beam profiler with the charge state resolving capability is started. The status of the beam transmission project will be given.

WE 10

SUPERCONDUCTING ECR ION SOURCE DEVELOPMENT AT LBNL

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The development of the superconducting 28 GHz ECR ion source VENUS at the Lawrence Berkeley National Laboratory (LBNL) pioneered high field superconducting ECR ion sources and opened a path to a new generation of heavy ion accelerators. Because of the success of the VENUS ECR ion source, superconducting 28 GHz ECR ion sources are now key components for proposed radioactive ion beam facilities. This paper will review the recent ion source development program for the VENUS source with a particular focus on the development of high intensity uranium beams. In addition, the paper will discuss a new R&D program started at LBNL to develop ECR ion sources utilizing frequencies higher than 28 GHz. This program addresses the demand for further increases of ion beam intensities for future radioactive ion beam facilities. The most critical technology for this new generation of sources is the development of the high-field superconducting magnet system. The magnetic field strengths necessary for 56 GHz operation require a peak field in the magnet coils of 12-14 T, requiring new superconductor material such as Nb_3Sn. LBNL has recently concluded a conceptual, comparative design analysis of different coil configurations in terms of magnetic performance and has developed a structural support concept compatible with the preferred magnetic design solution. The results of this study are presented.

WE 11

A HIGH-PERFORMANCE ELECTRON BEAM ION SOURCE

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At Brookhaven National Laboratory, a high current Electron Beam Ion Source (EBIS) has been developed as part of a new preinjector that is under construction to replace the Tandem Van de Graaffs as the heavy ion preinjector for the RHIC and NASA experimental programs. This preinjector will produce milliampere-level currents of essentially any ion species, with q/A ≥ 1/6, in short pulses, for injection into the Booster synchrotron. In order to produce the required intensities, this EBIS uses a 10 A electron gun, and an electron collector designed to handle 300 kW of pulsed electron beam power. The EBIS trap region is 1.5 m long, inside a 5 T, 2 m long, 8” bore superconducting solenoid. The source is designed to switch ion species on a pulse-to-pulse basis, at a 5 Hz repetition rate. Singly-charged ions of the appropriate species, produced external to the EBIS, are injected into the trap and confined until the desired charge state is reached via stepwise ionization by the electron beam. Ions are then extracted and matched into an RFQ, followed by a short IH Linac, for acceleration to 2 V/A, prior to injection into the Booster synchrotron. An overview of the preinjector will be presented, along with experimental results from the prototype EBIS, where all essential requirements have already been demonstrated. Design features and status of construction of the final high intensity EBIS will also be presented.

WE 12

ACCELERATION OF HEAVY IONS GENERATED BY ECR AND EBIS

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ECR and EBIS have become well-known ion sources for most heavy ion accelerator projects. The basic difference arises from the method, how energy is provided to create dense energetic electrons: An ECR uses microwave heating of a magnetically confined plasma, while in an EBIS the energy comes from a power supply to accelerate an electron beam and focus it to high density in a strong solenoidal magnetic field. Basically ECR sources are dc sources of heavy ions but the afterglow extraction also provides intense mA pulses in ms. In contrast to this EBIS sources provide an intense ion pulse in 10 – 100 µs and therefore find application in feeding synchrotrons. This determines most of the accelerator applications: ECR sources have very successfully extended the range (and life) of cyclotrons, while EBIS has found application at high energy facilities. For radioactive beam facilities, both kind of sources are in use. ECR sources in the trapping mode (ECRIT) perform the ionization (charge breeding) of high intensity primary beams, while EBIS can reach higher charge states at lower emittance, which provides an improved signal to noise ratio for rare isotopes.

WE 13

DRESDEN ELECTRON BEAM ION SOURCES: LATEST DEVELOPMENTS

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Electron Beam Ion Sources (EBIS) are powerful tools to produce ions over a wide ion charge spectrum for nearby all elements. A wide spectrum of very different applications of EBIS is known. The EBIS are used in basic research as well as in applications of different fields of technology but also in conjunction with particle accelerators. With the Dresden EBIS ion source family compact ion sources for the production of highly charged ions (HCIs) as platform technology for a wide field of applications are available. The Dresden EBIS-A is a compact, long-term stable room-temperature ion source and the Dresden EBIS-SC a new superconducting high-current EBIS for the production of high currents of HCI /1/. Significant parameters of these ion sources are compared in the present paper. This paper discusses the performance of the presented ion sources for the production of HCIs, compare the sources with other existing machines and discusses the usability of the Dresden EBIS sources in connection with different types of accelerators. It is shown that the sources are particularly suitable for applications in medical particle therapy. The outstanding properties of the EBIS favour them for use with CYCLINACS, Rapid Cycling Medical Synchrotrons and complex synchrotron based medical irradiation facilities.

References:
/1/ see: http://www.dreebit.com

WE 14

ION SOURCES AT THE MICHIGAN ION BEAM LABORATORY: CAPABILITIES AND PERFORMACE

O. Toader and F. Naab

University of Michigan, USA

Michigan Ion Beam Laboratory (MIBL) at the University of Michigan has scientific instruments equipped with ion sources capable of generating a wide variety of ions. The 1.7 MV Tandem particle accelerator can operate with three different sources: a Torvis type (H^+ and D^+ ions), a duoplasmatron (used mainly in the production of alpha particles for surface analysis) and two sputtering sources (for the production of a variety of heavy ions). The Ion Beam Assisted Deposition (IBAD) system has a 1.2 kV, Kaufman type ion source that can produce ions from noble gasses (used during vapour deposition). And finally, the latest acquisition at MIBL, the 400 kV ion implanter is equipped with a versatile ion source that can (theoretically using three different modes of operation) generate ions from any element in the periodic table. The presentation will outline the capabilities and the performance of the ion sources and present the latest applications and projects at MIBL.

TH 1

HEAVY ION SUPERCONDUCTING LINACS: NEW MACHINES AND NEW UPGRADES

R. Laxdal

TRIUMF, Canada

Heavy Ion superconducting cavities and cryomodules have undergone a renaissance in the last ten years as new heavy ion applications are being discussed to support drivers and post-accelerators primarily for radioactive ion beam facilities. The accelerators are characterized by cw operation and the push has been for high Qo at the operating point to get high performance with a reasonable cryogenic load. New features include particulate control in cavity processing and assembly, cryomodules engineered with separated vacuum for beam and thermal isolation volumes, high performance mechanical tuners and rf couplers and layouts with strong periodic focusing to permit high gradient operation. The present state of the art for high gradient operation is the ISAC-II heavy ion linac but many projects are now in preparation or being developed. A survey of the planned projects and facility upgrades will be presented.

TH 2

COMMISSIONING OF THE ATLAS UPGRADE CRYOMODULE

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The ongoing energy upgrade of the heavy-ion linac ATLAS at ANL includes a new cryomodule containing seven 109 MHz β=0.15 quarter-wave superconducting cavities to provide an additional 15 MV voltage. Several new features have been incorporated into both the cavity and cryomodule design. For example, the primary feature of the cryomodule is a separation of the cavity vacuum space from the insulating vacuum. The cavities are designed in order to cancel the beam steering effect due to the RF field. Clean techniques have been applied to achieve low-particulate rf surfaces essential for reliable long-term high-gradient operation. The evacuated and sealed clean subassembly consisting of cavities, spools, beam valves, couplers, vacuum manifold, and support frame is mounted to the top plate of the cryostat for the final assembly outside the clean room. The cryomodule was designed and built as a prototype for the driver linac of the Facility for Rare Isotope Beams (FRIB). Similar design can be effectively used in the front-end of SC proton linacs based on TEM-class SC cavities. The initial beam commissioning results will be reported.

TH 3

FREQUENCY TUNING AND RF SYSTEMS FOR THE ATLAS ENERGY UPGRADE SC CAVITIES*

G. Zinkann[1], J.D. Fuerst[1], S.M. Gerbick[1], M.P. Kelly[1], M. Kedzie[1], S. Macdonald[1], P.N. Ostroumov[1],R.C. Pardo[1], S. Sharamentov[1], K.W. Shepard[2] and Z. Conway[3]

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A new cryomodule with seven low-beta superconducting (srf) quarter wave niobium cavities has been designed and constructed as an energy upgrade project for the ATLAS accelerator at Argonne National Laboratory. The technology developed for this project is the basis for the next generation superconducting heavy ion accelerators. This paper will discuss the methods employed to tune the cavities eigenfrequency to match the accelerator master oscillator frequency and the development of the RF systems used to both drive the cavity and keep the cavity phase locked during operation.
* This work was supported by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

TH 4

PERFORMANCES OF THE ISAC HEAVY ION LINACS

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ISAC is the TRIUMF facility for the production and post acceleration of Rare Isotope Beams (RIBs). The post acceleration section includes two normal conducting linacs, an RFQ injector and a variable energy IH-DTL, and a superconducting linac composed of five cryomodules each containing four quarter wave bulk niobium resonators. All three machines operate CW. The RFQ and DTL deliver beam since 2000 to a medium energy area with energies variable between 150 keV/u and 1.8 MeV/u. The superconducting linac, with an effective voltage of 20 MV started delivering in 2007 with performances exceeding design specifications reaching final energies up to 11 MeV/u for lighter particles. The linac gradient performance shows no average degradation in performance. Well established operational and tuning procedures allow reliable operation. Schemes have been developed to effectively deliver the very low intensity (as low as few hundred particles per second) radioactive ion beams. The superconducting linac will be upgraded with the addition of twenty more cavities (boosting the acceleration voltage to 40 MV) by the end of 2009 making the reliability quest more challenging. In this paper we present past, present and planned operations with the ISAC linacs.

TH 5

HIE – ISOLDE LINAC: STATUS OF THE R&D ACTIVITIES

M. Pasini[1], S. Calatroni[1], A. D'Elia[2, 3], M. Fraser[1,3], C. Maglioni[1,3], V. Parma[1], P. Trilhe[1] and M. Lindroos[1]

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For the post-accelerator of radioactive ion beams at CERN a major upgrade is planned to take place in the next 4-5 years. The upgrade consists in boosting the energy of the machine from 3 MeV/u up to 10 MeV/u with beams of mass-to-charge ratio A/q=4.5 and in replacing part of the existing normal conducting linac. The new accelerator is based on two gap independently phased 101.28 MHz Nb sputtered superconducting Quarter Wave Resonators (QWRs). Two cavity geometries, "low" and "high" β, have been selected for covering the whole energy range. A R&D program has started in 2008 looking at the different aspects of the machine, in particular beam dynamics studies, high β cavity development and cryomodule design. A status report of the different activities is given here.

TH 6

DEVELOPMENT OF HEAVY ION ACCELERATOR AND ASSOCIATED SYSTEMS

D. Kanjilal

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A 15 UD Pelletron electrostatic accelerator using compressed geometry tubes is in regular operation at Inter-University Accelerator Center (IUAC) since 1990. It has been providing various ion beams in the energy range from a few tens of MeV to 250 MeV for scheduled experiments. A superconducting linac booster module having niobium quarter wave resonators has been made operational for experiments. The linac module has been tested and used to accelerate energetic heavy ion beams from 15 UD Pelletron. A new type of high temperature superconducting electron cyclotron resonance ion source (HTS-ECRIS) was designed, fabricated and installed. It is in regular operation as a part of alternate high current injector (HCI) system to inject highly charged ions into the superconducting linac. A radio frequency quadrupole (RFQ) accelerator is being developed to accelerate highly charged particles (A/Q ~ 6) to an energy of 180 keV/A. The beam will then be accelerated further by drift tube Linacs (DTL) to the required velocity to inject the ion beams to the linac booster. Details of various development activities related to the heavy ion accelerator and associated systems will be presented.

TH 7

OPERATIONAL EXPERIENCE OF THE SUPERCONDUCTING LINAC BOOSTER AT MUMBAI

R. Pillay[1], B. Srinivasan[2], V. Nanal[1], J.N. Karande[1], S.S. Jangam[1], S.K. Singh[2], P. Dhumal[1], M.S. Pose[1], C. Rozario[1], S.K. Sarkar[1] , R.D. Deshpande[1] and S.R. Sinha[1]

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The superconducting LINAC booster, indigenously developed to boost the energy of the heavy ion beams from the 14 MV Pelletron accelerator at TIFR, Mumbai, has been fully operational since July 2007. The LINAC consists of seven modular cryostats, each housing four lead plated quarter wave resonators, designed for an optimum velocity (β=0.1) at an operating frequency of 150 MHz. The LINAC phase I (superbuncher +3 modules) and phase II (4 modules) are connected by an achromatic, isochronous mid-bend magnet system. In order to maintain a stable phase and amplitude of the electric field in the cavity, the RF controller cards based on a self-excited loop with phase and amplitude feedback have been developed. The RF power is fed to each resonator using this controller card with a solid state 150 MHz, 150W RF power amplifier. The cryogenic system for the LINAC has been designed for a typical power dissipation of 6 W in each resonator. Initial beam trials have yielded an average energy gain of 0.4 MV/q per cavity corresponding to 80% of the design value. Beam transmission from entry to exit of LINAC was found to be 80%, without using any beam steerers. The beam timing measured at target after collimation was found to be excellent (~ 600 ps). Operational experience of LINAC, namely, empirically devised procedures for the acceleration of different beams and RF settings will be presented.

TH 8

MULTIPLE CHARGE STATE ION BEAM ACCELERATION WITH AN RFQ LINAC

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We are investigating space charge dominated beam dynamics in a Radio Frequency Quadrupole (RFQ) linac. The beam current from recent heavy ion sources are high enough that the self fields cannot be neglected in comparison to the applied fields. Some of the heavy ion sources are being developed to generate highly ionized particles. In these kinds of sources, desired ions with different charge state and contaminating particles are generated and extracted. Then ions which have close charge to mass ratio are simultaneously injected into an RFQ linac with desired species. To describe the evolution of the beam inside the RFQ, we simulated the multiple charge state ion beam acceleration by using particle-in-cell (PIC) method. Here the high-intensity carbon beam from our laser ion source was applied to the simulation. The space charge contributions to the transmissions in transverse and longitudinal directions, the emittance growth and the change in the betatron oscillation frequency are examined.

TH 9

UPGRADE OF THE HIT INJECTOR LINAC-FRONTEND

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The Therapy Linac in Heidelberg (HIT) was successfully commissioned in 2006. Required beam parameters were reached except of the beam intensity. The achieved particle transmission for C^{4+} (design ion) is significantly lower than design. Particle losses are mainly observed in the RFQ. One critical point is the matching section of the RFQ electrodes - Input Radial Matcher (IRM). The original design of the IRM requires too rigid and narrow beam Twiss-parameters at the RFQ entrance. Also the measured emittance is about twice higher compared to the design. Numerically and experimentally it was proved that the solenoid, used for the beam matching to the RFQ, is not able to provide for the necessary beam size and convergence. As it was shown by beam dynamics simulations using the code DYNAMION, a minor modification of the IRM allows for an improvement of the beam transmission (up to 50%). The proposed measure was realized for the new HIT-RFQ, which is recently under test stage. The same modification of the electrodes for the CNAO-RFQ is already proposed.

TH 10

STATUS OF LINAC BEAM COMMISSIONING FOR THE ITALIAN HADRON THERAPY CENTER CNAO

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The CNAO (Centro Nazionale di Adroterapia Oncologica) is a dedicated clinical synchrotron facility for cancer therapy using high energy proton (H_3^+) and Carbon (C^{4+}) beams located in Pavia, Italy. The 400 MeV/A synchrotron is injected by a 216.8 MHz, 7 MeV/A linac composed by a low energy beam transport (fed by two ion sources), a 400 keV/A 4-rod type RFQ and a 20 MV IH-DTL.
The commissioning of the two ECRIS ion sources and the low-energy line were successfully completed at the end of January 2009 reaching the proper beam conditions for injection into the RFQ. After installation and conditioning, the RFQ was ready to be commissioned with beam by the GSI-CNAO-INFN team in March 2009.
The beam tests results are presented together with a complete set of simulations.

FR 1

THE GSI UNILAC UPGRADE PROGRAM TO MEET FAIR REQUIREMENTS

L. Dahl

GSI, Germany

The GSI linear accelerator UNILAC and the synchrotron SIS will feed the future accelerator facility FAIR (Facility for Antiproton and Ion Research) with heavy ion beams. Several hardware measures at the UNILAC are performed or planned to meet the FAIR requirement, implicating a beam intensity of $2.7 \cdot 10^{11}$ of U^{28+}-particles within a UNILAC macro pulse of 100 µs length and defined emittance space at SIS injection. The stripper gas jet density in front of the Alvarez section was strongly increased to get the equilibrium charge state even for the heaviest ions. A procedure matching the 6d-phase space for proper Alvarez DTL injection and increase of the phase advance in the Alvarez accelerators reduces emittance growth. A new charge state separator in the beam transfer channel to SIS provides an immediate cut off of particles and reduces undesirable space charge forces. The main particle losses are at the front-end. A compact solenoid channel is planned to inject beams of high current ion sources straight line into the 4-rod-RFQ. The RFQ will be equipped with new designed rods promising the required beam intensity downstream at SIS-injection. The contribution gives an overview of end-to-end simulations, the different upgrade measures, the particular beam investigations, and the status of beam development satisfying FAIR requirements.

FR 2

STATUS OF CONSTRUCTION AND COMMISSIONING OF THE GSI HITRAP DECELERATOR

O. Kester[1], W. Barth[2], P. Gerhard[2], F. Herfurth[2], M. Kaiser[2], H.J. Kluge[2], S. Koszudowski, C. Kozhuharov[2], G. Maero, [2] W. Quint[2], A. Sokolov[2], T. Stöhlker[2], W. Vinzenz[2], G. Vorobjev[2], D. Winters[2], B. Hofmann[3], J. Pfister[3], A. Schempp[3], U. Ratzinger[3] and L. Dahl[2]

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The GSI accelerator facility provides highly charged ion beams up to U^{92+} at the energy of 400 MeV/u. These are cooled and decelerated down to 4 MeV/u in the Experimental Storage Ring. Within the Heavy Ion Trap facility HITRAP the ions are decelerated further down. The linear decelerator comprises a 108/216 MHz double-drift-buncher, a 108 MHz-IH-structure, a spiral-type rebuncher, and an RFQ-decelerator with an integrated debuncher providing energy spread reduction. Finally the beam is injected with the energy of 6 keV/u into a Penning trap for final cooling. The decelerator is completely installed and successfully commissioned since April 2009. For commissioning of the individual sections different ion species, e.g. $^{64}Ni^{28+}$, $^{20}Ne^{10+}$, $^{197}Au^{79+}$, were used. Each section was studied with comprehensive beam diagnostics to measure energy, emittance, intensity, transverse profiles, and bunch structure of the beam. The report gives an overview of the beam dynamics, the decelerator structures, and the results of the different commissioning stages.

FR 3

IMPROVED ON LINE PERFORMANCE OF THE INSTALLED ALPI NB SPUTTERED QWRS

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The average accelerating field of the ALPI 160 MHz sputtered QWRs has been improving with time up to reach, after the last conditioning cycle, the average accelerating field of 4.8 MV/m @ 7 W. Such value can be effectively sustained in operation due to the intrinsic mechanical stability of the sputtered cavity whose frequency is practically not influenced by pressure fluctuations in the He bath. This present average cavity performance approaches the maximum average accelerating field obtainable in the presently installed cavities, most of which were produced by replacement of Pb with Nb in the previously installed substrates. A higher average value can be obtained in ALPI replacing the less performing units, but it is instead necessary to sputter on appropriately built substrates to produce QWRs which can reliably exceed 6 MV/m @7 W. The cavity Q-curves, which were recently measured in ALPI, show a wide range of Q0 and Q-drop, mainly associated with the substrate characteristics, but in some cases also influenced, as discussed in the paper, by cryostat assembling procedure and by cavity production and conditioning.

FR 4

OPERATIONAL EXPERIENCE IN PIAVE-ALPI COMPLEX

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PIAVE-ALPI is the INFN-LNL superconducting heavy ion linac, composed by an SRFQ (superconducting RFQ) section and three QWR sections for a total of 80 cavities installed and an equivalent voltage exceeding 70 MV. In the last years the SRFQ and the bulk niobium QWR came into routine operation, the medium energy QWR section was upgraded with a new Nb sputtered coating, ECR source was firstly improved by using a water cooled plasma chamber and then replaced with a new one. The operation of the accelerator complex allowed acquiring a strong experience on many operational issues related to ECRIS, superconducting cavities and cryogenics, beam control and manipulation (with the new and higher accelerating gradient). The paper reports about operational experience, the present limitations and the future perspectives of the facility in view of the experimental campaign with the EU detector AGATA and of the use of PIAVE ALPI as RIB post-accelerator for SPES radioactive ion beam facility.

FR 5

TOWARDS GeV LASER-DRIVEN ION ACCELERATION

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Particle acceleration with high power lasers has been demonstrated by various mechanisms, accelerating electrons to GeV energies. So far, ion energies were stuck in the MeV range unless one could reach intensities $\geq 10^{24}$ W/cm^2. These parameters are discouraging for advanced accelerator concepts and unacceptable for applications like Ion-driven Fast Ignition (IFI) or hadron therapy. The realization of ultrahigh contrast lasers and free standing nm-thin laser targets however marks a paradigm shift. The combination of these two techniques enables a number of new ion acceleration mechanisms that have been observed in simulations and promise GeV ion energies. Examples are the Break-Out Afterburner (BOA) acceleration and the Phase-Stable Acceleration (PSA) regime, also reported as Radiation Pressure Acceleration (RPA). Here we present the first experimental realization of the BOA acceleration mechanism, achieving 0.5 eV carbon ions out of a single laser acceleration stage at the Los Alamos Trident laser. Full 3D-PIC simulations at full solid density confirm earlier 1- and 2D results, and are in good agreement with the experimental data. Moreover, having been performed before the experiment, they exhibit extraordinary predictive power. We will discuss the requirements this poses on the drive lasers especially concerning the pulse contrast and report first experimental results in realizing those conditions and how to scale to future lasers.

FR 6

LASER ACCELERATED IONS AND THEIR POTENTIAL USE FOR THERAPY ACCELERATORS

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Recent developments in laser acceleration of ions have stimulated ideas for using this concept as innovative and compact option for an ion therapy accelerator. While currently achieved parameters do not allow a detailed conceptual study yet, we study general limitations in transport, space charge, focusing and bunch compression. Of particular importance are the higher order characteristics (second and third order aberrations) of the ion collector following the laser target. The resulting limitations are used to outline a realistic parameter range for practical application to a therapy accelerator. An experimental test stand at the GSI PHELIX laser facility is discussed.

FR 7

HEAVY ION IRRADIATION OF NUCLEAR REACTOR FUEL

H. Palancher

CEA, France

For developing new generations of nuclear fuels, in-pile experiments are required. However considering their price and the delay (a few years) between their design and their analysis, each technological solution can not be tested in nuclear fuel reactors. For that purpose, alternative strategies have to be defined, with the view to identify the best candidate to test in-pile. This talk will be focused on the interest of heavy ion irradiation for the selection of low enriched ^{235}U nuclear fuels. To fulfil the requirements of international non-proliferation treaty, high density UMo alloys appear as the only appropriated fuel material especially for the most powerful research reactors cores (material testing reactors, neutron sources). UMo fuel elements usually consist of fissile particles dispersed in an Al matrix. However their in-pile behaviour is currently not satisfactory because of the growth of a large interaction layer at UMo/Al interfaces under irradiation. Heavy ion irradiations with 80 MeV ^{127}I ions have been successfully used to simulate the damages caused by the fission products at the UMo/Al interface. The growth of an interaction layer has been reproduced thanks to this out-of-pile methodology. This allows to select remedies (silicon addition to the aluminum matrix, UMo particle coating,...) for the growth of this interaction layer.

This work has been performed in collaboration with FRMII (Munich, Germany) at the MLL tandem accelerator.

POSTER PRESENTATIONS

A 1

REFERENCE SIGNAL GENERATION WITH DIRECT DIGITAL SYNTHESIS FOR FAIR

M. Bousonville

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In this paper, an alternative method for the generation of reference signals will be presented. With these reference signals, the RF cavities in the Facility for Antiproton and Ion Research (FAIR) shall be synchronized. Digital frequency generators that work according to the DDS (direct digital synthesis) principle will be used as reference generators. Via an optical network with star topology, these reference generators will be fed with two clock signals that show a certain correlation of frequency and phase. Due to delay measurements, their phases at different end points of the optical network are known. From these clock signals, reference signals with specific frequencies can be derived. The phases of these reference signals can be fine-tuned against the phases of the clock signals, allowing the phases of different reference signals to be synchronized. With the commercially available DDS generators used in the prototype, phase steps of 0.022° are possible. At a reference signal frequency of 50 MHz, this corresponds to 1.22 ps. The presentation describes the functionality of this method for reference signal generation and shows under which conditions the step size of the phase adjustment can be improved further.

A 2

OVERVIEW OF Ar BEAM INDUCED DESORPTION FROM DIFFERENT MATERIALS AT TSL

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Intensity of heavy ion accelerators can be limited by beam induced pressure instability; if pumping is insufficient, pressure will steadily grow reducing the beam lifetime. There is a need of input parameters for vacuum modelling and design of safe UHV systems for updated and new heavy ion accelerators, such as the FAIR facility at GSI, as well as an intention to gain a deeper understanding of the desorption process required an experimental investigation of the ion induced desorption yields (number of released molecules per incident ion) from different materials commonly used in particle accelerators. The experimental data have been obtained with perpendicular incidence beams with an experimental setup based on the throughput method located at the Svedberg laboratory in Uppsala (Sweden). The investigated materials were ^{116}In, Cu, etched Cu, gold coated Cu and Ta and the chosen beams were 5 MeV/u Ar^{8+}, 9.6 MeV/u Ar^{9+} and 17.7 MeV/u Ar^{12+}. The samples can be biased, which means that the amount of secondary outgoing positive and negative particles during ion bombardment could be investigated. A few samples were also bombarded with grazing incident angle. A summary of the results will be reported. This work was performed with support from the EU FP6 Program DIRAC-PHASE-1.

A 3

PREPARATION OF THE IRRADIATION TEST AT CAVE HHD OF GSI DARMSTADT

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In the frame of the FAIR project in spring 2008 an irradiation test of superconducting magnet components has been done at GSI Darmstadt. Cave HHD with the beam dump of SIS synchrotron has been taken for the test area. The beam dump was reequipped to meet the irradiation test requirements. Thereby the first stage of preparation for the irradiation test was to investigate of the radiation field around the reconstructed beam dump from the point of view of the radiation safety. FLUKA simulations were performed to estimate the dose rate inside and immediate outside of the cave during the irradiation. The simulations showed safe level of the radiation field, and it was later confirmed by the measurements provided by the radiation safety group of GSI.

A 4

IRRADIATION OF SUPERCONDUCTING MAGNET COMPONENTS FOR FAIR

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In spring 2008 an irradiation of superconducting magnet components was done at GSI Darmstadt in the frame of the FAIR project. Cave HHD with the beam dump of SIS synchrotron was used for irradiation. The irradiation set-up modeled a scenario of beam loss in a FAIR accelerator: U beam with energy of 1 GeV/u was used to irradiate a thin stainless steel bar at very small angle, so that the test samples situated behind the stainless steel bar were exposed to the beam of secondary particles created in the bar. The total number of U ions dumped on the irradiation set-up was about $2 \cdot 10^{14}$. Presently, in spring 2009 some samples are still radioactive. In the paper we present the estimates of the energy deposition and secondary particle fluences in the test samples and also discuss some results of the irradiation campaign.

A 5

DEPTH-PROFILING OF THE RESIDUAL ACTIVITY INDUCED BY HIGH-ENERGY URANIUM IONS IN THIN STAINLESS STEEL TARGET

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In the frame of the FAIR project irradiation test of superconducting magnet components was performed at GSI Darmstadt in May 2008. As a part of the experiment stainless steel samples were irradiated by 1 GeV/u ^{238}U ions. In contrast to the previous experimental studies performed with thick cylindrical samples, the target was a thin plate irradiated at small angle. The target was constituted as a set of individual foils. This stacked-foil target configuration was foreseen for depth-profiling of residual activity, which has not yet been quantified so far. Gamma-ray spectroscopy was used as the main analytical technique. The isotopes with dominating contribution to the residual activity induced in the samples were identified and their contributions were quantified. Depth profiles of residual activity of all identified isotopes were completed by measurements of the individual target foils. The characteristic shape of the depth-profiles for the products of target activation and projectile fragments was found and described. Monte Carlo code FLUKA was used for simulations of the residual activity and for estimation of the number of ions delivered to the target and their distribution. The measured data are relevant for assessment of radiation situation at high-energy accelerators during the "hands-on" maintenance as well for assessment of the tolerable beam-losses.

B 1

CURRENT STATUS REPORT OF RAPID, THE UNIVERSITY OF TOKYO

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RAPID (Rutherford Backscattering Spectroscopic Analyzer with Particle Induced X-ray Emission and Ion Implantation Devices, The University of Tokyo is dedicated educational and academicals research facility for elemental analysis and ion implantation using tandem accelerator. The 1.7 MV TandetronTM accelerator is charged by Cockcroft Walton type (HVEE: High Voltage Engineering Europe Corp., Netherlands). RAPID has three beam lines: ion implantation line, PIXE (Particle Induced X-ray Emission) line, and RBS (Rutherford Backscattering Spectroscopy) line. Two negative ion sources are installed in RAPID, cesium sputter type and duo plasmatron. Recently, the response of CR-39 track detector with low level radiation was estimated with proton beam. The study of the behavior of hydrogen isotopes implanted into metal oxides is now going. PIXE analysis is applied for environmental and cultural studies, determining the concentration of heavy metal elements in various water samples and gilded frames of art works including one from Florence.

C 1

CONCEPTUAL DESIGN OF A RADIO FREQUENCY QUADRUPOLE FOR THE HEAVY-ION MEDICAL FACILITY

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Design of conventional 4-vane type of RFQ (Radio Frequency Quadrupole) for the heavy-ion medical facility has been studied. The RFQ is capable of accelerating C^{4+} ions from an initial energy of 10 keV/u to 600 keV/u. In this work, all the design parameters have been optimized to achieve stable structure and compactness. The 3D electromagnetic field distribution and RF analysis were obtained by CST Microwave Studio and the field was used in Mathematica for beam simulation. This poster shows the determined physical and mechanical design parameters of RFQ.

C 2

COMMISSIONING OF THE CNAO LEBT AND SOURCES

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The National Center for Oncological Hadrontherapy, CNAO, is the Italian center for deep hadrontherapy. It will deliver treatments with active scanning both with proton and carbon ion beams. The accelerator complex is based on a 25 m diameter synchrotron accelerating carbon ions up to 400 MeV/u kinetic energy and protons up to 250 MeV. The injection chain is made by a 8 keV/u Low Energy Beam Transfer line (LEBT), a RFQ accelerating the beam to 400 keV/u, a LINAC to reach the injection energy of 7 MeV/u and a Medium Energy Beam Transfer line (MEBT) to transport the beam to the synchrotron. The installation of accelerators and lines is very advanced and commissioning has already started in time sharing with installation.
The commissioning of Sources and LEBT is presented.

C 3

BEAM DIAGNOSTICS IN THE CNAO INJECTION LINES COMMISSIONING

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The CNAO, the first Italian centre for deep hadrontherapy, is presently in its final step of installation. It will deliver treatments with active scanning both with proton and carbon ion beams. Commissioning of the low energy injection lines has been successfully concluded in January 2009. CNAO beams are generated by two ECR sources which are both able to produce both particle species. The beam energy in the Low Energy Beam Transfer (LEBT) line is 8 keV/u. A compact and versatile tank containing a complete set of diagnostic tools has been intensively used for the line commissioning: in a length of 390 mm it houses two wire scanners, for vertical and horizontal beam transverse profile, a Faraday Cup, for current measurement, and two vertical and horizontal plates for beam halo suppression, emittance measurements, beam collimation and particles selection. Using one tank devices, phase space distribution reconstruction can be quickly performed as well as synchronous profiles and intensity measurements. Five identical tanks are installed in the LEBT, as consequence of a standardization strategy to improve diagnostic monitor knowledge and make maintenance easier. Commissioning results and measurements are presented.

C 4

NDCX-II, A NEW INDUCTION LINEAR ACCELERATOR PROJECT FOR WARM DENSE MATTER RESEARCH

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The Heavy Ion Fusion Virtual National Laboratory, a collaboration between Lawrence Berkeley National Laboratory (LBNL), Lawrence Livermore National Laboratory (LLNL), and Princeton Plasma Physics Laboratory (PPPL), is currently constructing a new induction linear accelerator, called Neutralized Drift Compression Experiment NDCX-II. The accelerator design makes highly effective use of existing components from LLNL's decommissioned ATA accelerator (induction cells and blumlein voltage sources) that have been transferred to LBNL. We have developed an aggressive acceleration "schedule" that compresses the emitted ion pulse from 500 ns to 1 ns in just 15 meters. In the nominal design concept, 30 nC of Li^{1+} are accelerated to 3.5 MeV and allowed to drift-compress to a peak current of about 30 A. That beam will be utilized for warm dense matter experiments investigating the interaction of ion beams with matter at high temperature and pressure. Construction of the accelerator will be complete within a time frame of approximately two years and will provide a world-wide unique opportunity for ion-driven warm dense matter experiments as well as research related to novel beam manipulations for heavy ion fusion drivers. This paper will discuss the accelerator engineering design and will describe the main components of NDCX-II.

C 5

DECELERATING HEAVY ION BEAMS USING THE ISAC DTL

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TRIUMF, Canada

At the ISAC facility in TRIUMF radioactive ion beams (RIB) are produced using the ISOL method and post accelerated. The post accelerator chain consists of a radio frequency quadrupole (RFQ) injector followed by a drift tube linac (DTL) that accelerates the ions from 150 keV/u up to 1.8 MeV/u. A further stage of acceleration is achieved using a superconducting linac where the beam is injected using the DTL and the energy boosted with 20 MV of acceleration voltage (increased to 40 MV by the end of 2009). The possibility of decelerating the beam maintaining good beam quality using the DTL is investigated based on experimenters request to reach energies lower than 150 keV/u. The beam dynamics simulation using the LANA code are compared with online measurements. In this paper we will report the results of the investigation that aims to establish the lowest energy we can deliver in the post accelerator section of the ISAC facility.

C 6

FABRICATION OF SUPERCONDUCTING NIOBIUM RESONATORS AT IUAC

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Inter-University Accelerator Centre, India

The facility for constructing superconducting niobium resonators indigenously was commissioned at the Inter-University Accelerator Centre (IUAC), New Delhi, in 2002. It includes an electron beam welding machine, surface preparation laboratory and a high vacuum furnace, besides a test cryostat for cold testing of the resonators. The facility was primarily setup to fabricate niobium quarter wave resonators (QWR) for the booster linac, and subsequently for future projects. Starting with a single quarter wave resonator, two completely indigenously built QWRs were initially constructed using this facility. After the successful cold testing of one of the resonators, production of fifteen more QWRs for the second and third linac modules began. The production is presently nearing its completion and twelve QWRs are almost ready. Apart from fabricating new resonators several existing QWRs which needed extensive rework/repair have been successfully restored. In addition to the in-house programmes we are also constructing resonators for other projects. Fabrication of two niobium single spoke resonators for Project-X at Fermi National Accelerator Laboratory, USA, has begun. More recently fabrication of a Tesla-type single cell cavity in collaboration with Raja Ramanna Centre for Advanced Technology, Indore, has also started.

C 7

UPGRADE OF THE CONTROL SYSTEM FOR THE ALPI CRYOGENIC DISTRIBUTION PLANT

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In the LNL Heavy Ion Accelerator Complex, ALPI is a superconducting linear accelerator (Linac) whose first runs date back to 1993. In more than 15 years the LNL Linac evolved from an initial small configuration of 5 cryostats and 16 resonators to the actual size of 19 cryostats and 76 resonators. One more low-energy cryostat with 4 low-beta resonators will be installed in the next months. The superconducting character of the ALPI linac implies the availability of a large cryogenic plant and distribution system to supply the liquid helium necessary to keep at 4.2 K the resonators. While the Linac structure has grown in the years and, in the mean time, the related cryogenic plant and distribution system were enlarged and upgraded twice, the related control system remained largely unchanged in its main parts and it is now the first sub-system that urgently needs a deep renewing. The challenge to renovate a working control system with limited shutdowns is the subject of this presentation.

C 8

WIDE BANDWIDTH, LOW COST SYSTEM FOR CAVITY MEASUREMENTS

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A novel measurement apparatus which simplify the tests of superconducting cavities has been developed at Legnaro. A few commercial electronic boards, mounted in a devoted chassis and controlled by a P.C., operate most of the functions usually carried out by standard rf instrumentation. The set up allows the measurements of resonators in the 80÷700 MHz frequency range and has been used to characterize resonators both in the ALPI vault and in off-line tests. All the typical procedures, related to the cavity measurements in classical VCO-PLL system, are carried out by a devoted control program that allows to adjust and to measure the rf forward power, to find and update the cavity resonant frequency, to calibrate the pick-up signal, to monitor the transmitted power, to adjust the coupler position. Automatic procedures are implemented to measure the cavity decay time, to trace the Q-curve, to perform CW and pulse rf conditioning, to calibrate cables and measurement instruments. The same software is used also to control other two measurement systems routinely used ad Legnaro to test resonators up to 6 GHz frequency.

C 9

DESIGN OF THE MEBT REBUNCHERS FOR THE SPIRAL 2 DRIVER

M. Lechartier

GANIL, France

The SPIRAL 2 project uses normal conducting rebunchers to accelerate high intensity beams of protons, deuterons and heavier ions. All cavities work at 88 Mhz , the beta is 0,04 and 3 rebunchers are located in the MEBT line, which accepts ions with A/q up to 6. The paper describes the RF design and the technological solutions proposed for an original 3 gap cavity, characterised by very large beam holes (60mm) and providing up to 120 kV of effective voltage

D 1

DESIGN OF THE CENTRAL REGION OF THE NEW MULTI-PURPOSE CYCLOTRON U400R

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At the present time, the activities on creation of the new multi-purpose isochronous cyclotron U400R are carried out at the FLNR, JINR. The isochronous cyclotron U400R is intended for obtaining the beams of the accelerated ions from $^{4}He^{1+}$ (A/Z = 4, W = 27 MeV/u) up to $^{132}Xe^{11+}$ (A/Z = 12, W = 3.5 MeV/u). The cyclotron magnetic field can be changed from 0.8 T to 1.8 T and allow the smoothly variation of the ion beam energy at the range ±35% from nominal. The cyclotron RF system keeps up 2÷6 harmonic modes. The aim of the present work is to investigate the optimal geometry of cyclotron center for the wide range of acceleration regimes. The computation of the beams acceleration is carried out by means of the computer code CENTR.

D 2

EXTRACTION OF THE HEAVY ION BEAM FROM THE CYCLOTRONS BY STRIPPING

O. Borisov

JINR, Russia

Heavy ion beam extraction from the AVF cyclotrons by stripping in thin targets is based on loss of the radial stability of the accelerated beam after its magnetic rigidity change. An analysis of possibilities to extract heavy ion beams by stripping is made. Numerical simulation results of the beam extraction by stripping from the cyclotrons are presented. Experience of using heavy ion beam extraction from the cyclotrons of the Flerov Laboratory of the Nuclear Reactions (Dubna) by stripping is considered.

D 3

DESIGN STUDY OF THE INJECTION SYSTEM OF K120 SUPERCONDUCTING CYCLOTRON

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This paper concentrates on the design of the low energy beam transport line between an ECR ion source and the spiral inflector of K120 cyclotron. The K120 superconducting cyclotron is under design at KIRAMS, Korea. The cyclotron has about 3.13 Tesla at the cyclotron center and accelerates the C^{6+} ions up to 30 MeV/amu. The magnetic field distributions for all magnetic elements and the electric field distributions for all electrostatic elements have been obtained by OPERA3D, TOSCA. The integration of the equation of motion for beam simulation with the calculated field distributions has been carried out with Mathematica. This paper includes the resultant specifications of all elements and the results of beam simulation of the injection system of K120 superconducting cyclotron.

D 4

GANIL HIGH INTENSITY TRANSPORT SAFETY SYSTEM

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GANIL, France

For several years, GANIL has been allowed to reach a maximum beam power of six kilowatts (400 W in normal mode) thanks to the THI system (High Intensity Transport System). Three modes of running are necessary to accelerate a THI beam ("Injector" mode, "tuning" mode and "surveillance" mode). The "surveillance" mode requires a safety system to protect equipments against beam losses. Inside cyclotrons, diagnostics measure beam losses current at the injection and extraction devices. Along beam lines, diaphragms measure beam losses current at the input and output of dipoles. Current transformers are used for the beam transmission measurements through beam lines and cyclotrons. The safety system controls beam losses and quickly reduces the beam intensity with a chopper if some losses overshoot thresholds. These thresholds can be monitored by software.

D 5

ELECTRON COOLING OF Pb^{54+} IONS IN LEIR

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Electron cooling is central in the preparation of dense bunches of lead beams for the LHC. Ion beam pulses from the LINAC3 are transformed into short high-brightness bunches using multi-turn injection, cooling and accumulation in the Low Energy Ion Ring, LEIR. The LEIR cooler was the first of a new generation of coolers utilizing high-perveance variable-density electron beams for the cooling and accumulation of heavy ion beams. It was commissioned in 2006 at the same time as the LEIR ring and has since been used to provide lead ions for the commissioning of the LHC injector chain. We report briefly on the status of the LHC ion injector chain and present results of measurements made to check and to better understand the influence of the electron beam size, intensity and density profile on the cooling performance. Future plans to improve the performance of the device will also be presented.

D 6

APPROACH TO 2 DIMENSIONAL LASER COOLING AND ITS OPTICAL OBSERVATION SYSTEM

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Laser cooling for bunched Mg ion beam with the kinetic energy of 40 keV has been applied in S-LSR at ICR. Kyoto University. Up to now, clear peaking of equilibrium momentum spread after laser cooling has been observed at such a synchrotron tune as resonates with the horizontal betatron tune, which is expected to be due to heat transfer from the horizontal degree of freedom to the longitudinal one. In order to demonstrate transverse cooling by laser induced excitation, observation of the horizontal beam size has been pursuit with the use of CCD camera, which detects spontaneously emitted light from the Mg ions. In the present paper, the optical observation system utilized is to be presented with the experimental results so far obtained indicating the transverse laser cooling effects. Consideration of improvement for total laser cooling system required for attainment of 3 dimensional crystalline beam will be also to be presented.

D 7

LATTICE STUDY OF A COMPACT SYNCHROTRON FOR CARBON THERAPY

H. Yim

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A magnet lattice of the carbon-ion synchrotron was studied for cancer therapy, which requires maximum 400 MeV/u carbon beam, at KIRAMS. In the study, we optimized the magnet lattice configuration to fit into the therapy purpose. Major requirements for the purpose are (1) long extraction time (about 1 second), (2) compact size, and (3) low cost. For the purpose (1), a slow extraction scheme was adopted by the use of third integer resonance. For (2) and (3), we minimized the circumference and a number of the magnet elements as much as possible. The study was carried out by the use of simulation codes for beam particle dynamics and optics. A conceptual lattice design of the carbon-ion synchrotron will be presented in this conference.

D 8

BEAM STABILITY IN SYNCHROTRONS WITH DIGITAL FILTERS IN THE FEEDBACK LOOP OF A TRANSVERSE DAMPER

V. Zhabitsky

JINR, Russia

The stability of an ion beam in synchrotrons with digital filters in the feedback loop of a transverse damper is treated. Solving the characteristic equation allows to calculate the achievable damping rates as a function of instability growth rate, feedback gain and parameters of the signal processing. A transverse feedback system (TFS) is required in synchrotrons to stabilize the high intensity ion beams against transverse instabilities and to damp the beam injection errors. The TFS damper kicker (DK) corrects the transverse momentum of a bunch in proportion to its displacement from the closed orbit at the location of the beam position monitor (BPM). The digital signal processing unit in the feedback loop between BPM and DK ensures a condition to achieve optimal damping. Transverse Feedback Systems commonly use digital FIR (finite impulse response) and IIR (infinite impulse response) filters for the signal processing. A notch filter is required to remove the closed orbit content of the signal and correct for the imperfect electric centre of the BPM. Further processing is required to adjust for the betatron phase advance between beam pick-up (BPM) and the damper kicker (DK). Damping rates of the feedback system with digital notch, Hilbert and all-pass filters are analyzed in comparison with those in an ideal feedback system.

D 9

SIMULATION AND DESIGN OF THE COMPACT SUPERCONDUCTING CYCLOTRON C400 FOR HADRON THERAPY

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Carbon therapy is most effective method to treat the resistant tumors. A compact superconducting isochronous cyclotron C400 has been designed by IBA-JINR collaboration. This cyclotron will be used for radiotherapy with proton, helium and carbon ions. The $^{12}C^{6+}$ and $^{4}He^{2+}$ ions will be accelerated to the energy of 400 MeV/amu and will be extracted by electrostatic deflector, H_2^+ ions will be accelerated to the energy 265 MeV/amu and protons will be extracted by stripping. The magnet yoke has a diameter of 6.6 m, the total weight of the magnet is about 650 t. The designed magnetic field corresponds to 4.5 T in the hills and 2.45 T in the valleys. Superconducting coils will be enclosed in a cryostat; all other parts will be warm. Three external ion sources will be mounted on the switching magnet on the injection line located bellow of the cyclotron. The main parameters of the cyclotron, its design, the current status of development work on the cyclotron systems and simulations of beam dynamic will be presented.

E 1

FORMATION OF HIGH INTENSIVE RADIOACTIVE CARBON ION BEAMS IN THE ELECTRON STRING ION SOURCE

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JINR, Russia

The carbon accelerated ion beams are efficiently used for cancer treatment at various medical centres, in particular for patients with radioresistant tumours. On the other hand, the positron–emission tomography is a most effective way of tumor diagnostics. The intensive ^{11}C ion beam could allow both these advantages to be combined it could be used both for cancer treatment and for the on-line positron emission tomography. Formation of a primary radioactive $^{11}C^{6+}$ ion beam with the intensity of 10^{10}÷10^{11} pps from the ion source allows cancer treatment and on-line dose verification. The 11 C isotopes are produced at the nuclear reaction ^{14}N (p,He) ^{11}C in the gas target chamber irradiated by a proton beam. If the target chamber contains N_2 and 5% of H_2, about 10^{14} $^{11}CH_4$ molecules are produced at each 20 minutes. The radioactive methane is loaded into the ion source. The method and technique applied for formation of high intensive radioactive carbon beam was tested in JINR electron string ion source (ESIS) Krion-2. The measured conversion efficiencies of methane molecules to carbon ions is rather high, 15% for C^{6+} ions and 25% for C^{4+} ions. The experimentally obtained conversion efficiency and developed technique of pulse methane loading permits obtaining the primary radioactive $^{11}C^{6+}$ beams at intensity of 10^{10}÷10^{11} pps and performing cancer treatment and on-line dose verification. The research was supported by ISTC, grant № 3454.

E 2

SIMULATION AND DESIGN OF TUBULAR ELECTRON STRING ION SOURCE

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The so-called reflex mode of Electron Beam Ion Source (ESIS) operation has been under intense studies, both experimental and theoretical at JINR during the last decade. The idea of using a tubular electron string ion source (TESIS) has been put forward recently to obtain 1-2 orders of magnitude increase in the ion output as compared with ESIS. The project is aimed at creating a TESIS and to studying an electron string in the tubular geometry. The new tubular source with a superconducting solenoid up to 5 T should be constructed in 2010.
The method of the off–axis TESIS ion extraction will be used to get TESIS beam emittance comparable with ESIS emittance. It is expected that this new TESIS (Krion T1) will meet all rigid conceptual and technological requirements and should provide an ion output approaching 10 mA of Ar^{16+} ions in the pulse mode and about 10 μA of Ar^{16+} ions in the average current mode. Analytical, numerical study of the tubular electron strings and design of the TESIS construction will be given in this report. The experiments with quasi tubular electron beams performed on the modified ESIS Krion 2 also will be discussed there. The TESIS research was supported by ISTC, grant № 3454.

E 3

LARGE BORE ECR ION SOURCE WITH CYLINDRICALLY COMB-SHAPED MAGNETIC FIELDS CONFIGURATION

Y. Kato, F. Sato and T. Iida

Osaka University, Japan

An electron cyclotron resonance ion source (ECRIS) has been developing long time and their performance is still extending at present. Recently, they are not only used in producing multi-charged ions, but also molecules and cluster ions. A new type of ion source with a wide operation window is expected for various uses. We developed a novel magnetic field configuration ECRIS. The magnetic field configuration is constructed by a pair of comb-shaped magnetic field by all permanent magnets and has opposite polarity each other with ring-magnets. This magnetic configuration suppresses the loss due to E×B drift, and then plasma confinement is enhanced. We conduct preliminary extracting and forming large bore ion beam from this source. We will make this source a part of tandem type ion source for the first stage. Broad ion beams extracted from the first stage and transfer like a shower to plasma generated by the second stage. We hope to realize a device which has a very wide range operation window in a single device to produce many kinds of ion beams. We try to control plasma parameters by multiply frequency microwaves for broad ion beam extraction. It is found that plasma and beam can be controllable on spatial profiles beyond wide operation window of plasma parameters. We investigated feasibility and hope to realize the device which has wide range operation window in a single device to produce many kinds of ion beams as like to universal source based on ECRIS.

E 4

NOVEL MODES OF VACUUM DISCHARGE IN MAGNETIC FIELD AS THE BASE FOR EFFECTIVE ION GENERATION

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Institute of High Energy Physics and Nuclear Physics of National Science Center
"Kharkov Institute of Physics and Technology", Ukraine

New properties of vacuum discharges in magnetic field with novel gap geometries at low pressure up high vacuum is brief described. In base of the discharge novel modes may be created ion sources including multicharged ion sources. The ion sources can have advantages in comparison with more conventional ones. The main advantages are: long life time due to absence of heated filaments and arc spots; high energy and mass efficiency due to high electron temperature of plasma. Development of the discharge research and recent results of the author are discussed.

E 5

UPGRADE AND COMMISSIONING OF THE PIAVE-ALPI ECR INJECTOR AT LNL

A. Galatà, M. Sattin, L. Bertazzo, S. Contran, A. Dainese, A. Lombardi, D. Maniero, M. Poggi, F. Scarpa and A. Facco

INFN/LNL, Italy

The positive ion injector for the PIAVE-ALPI complex consists of an ECR ion source placed on a high voltage platform. A 14.4 GHz ECRIS named Alice, designed and constructed at LNL in the early '90, reliably delivered gaseous beams to the Superconducting RFQ PIAVE for nuclear physics experiments until 2008. The requests for heavy ion beams of increased current and energy, needed to perform the experiments planned for the next years with the AGATA demonstrator, prompted us to upgrade our injector with a new ECR source capable of higher output beam currents and higher charge states. This activity started in 2008 and was completed at the beginning of 2009. A 14.5 GHz, SUPERNANOGAN type ECRIS built by Pantechnik, was installed in our refurbished high voltage platform in July 2008. The space available for maintenance in the platform was increased and a new lead shielding for X-rays has been set up. The water cooling circuits have been redesigned to deliver different fluxes and inlet pressures to the equipment mounted on the platform (plasma chamber, extraction electrodes, bending dipole and power supply). A new safety system has been implemented in order to cope with new and more demanding safety rules. A lot of attention has been paid to the optimisation of the injection line with new diagnostic devices for beam characterisation (movable slits, emittance measurement tools). Commissioning of the new source and injector with beams has started and first results will be reported.

E 6

HIGH CURRENT ION SOURCES, BEAM DIAGNOSTICS AND EMITTANCE MEASUREMENT

M. Cavenago[1], M. Comunian[1], E. Fagotti[1,3], T. Kulevoy[1, 2], S. Petrenko[1, 2] and M. Poggi[1]

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[2] *ITEP, Russia*
[3] *Consorzio RFX, Italy*

Singly charged ion sources can easily surpass the 1 kW beam power, as in positive ion source TRIPS (H^+, 60 mA, 80 kV, installed at LNL) or in negative ion source NIO1 (H^-, 130 mA distributed into 9 beamlets, 60 kV, a project of RFX and INFN-LNL). Both calorimetric and optical beam profile monitors become possible, while the traditional two slit beam emittance meter requires extensive cooling to operate. Preliminary calculation of slit deformation and tolerances show possible problem. On the other side, the Allison scanner concept is suited to a much faster measure, which reduces slit deformation errors (still cooling is needed). A design of a compact Allison scanner head is discussed in detail, showing: 1) the fast sweeping electronics; 2) the inbuilt getter pumping capabilites; 3) the segmented construction of electrodes. Effect of space charge neutralization is discussed. Status of prototype construction and of test facilities are reported. Experimental commissioning at lower power seems advisable.

F 1

A SECONDARY RADIOACTIVE BEAM LINE SECTION FOR THE SPIRAL 2 PROJECT: FIRST STEP, THE DESIGN STUDY

F. Osswald and A. Khouaja

CNRS/IN2P3, Uni. Strasbourg, France

This second generation radioactive beam facility will be constructed at GANIL and be operational in 2012 with stable beams and 2013 with RIB. The aim of the installation is to produce high-intensity, high-quality radioactive ion beams of isotopes from large regions of the chart of nuclei in the range of 3 to 240 u. In order to transport radioactive beams from the ion source to the user special attention has to be taken concerning containment of radioactive materials and protection against ionizing radiations. Material activation should be kept as low as possible. Equipment activation during beam processing and matching is difficult to control. Therefore discrete modules are designed with quick coupling, reduced and standard operations, and remote handling in order to mitigate the doses during maintenance. Following project description corresponds to the beginning phase of the technical design of the process and infrastructure equipments and concerning a low energy RIB transport line. Different modelling and simulation technologies are employed to reduce development cycles and to lower costs instead of with time- consuming, costly and some times less precise physical testing which remain nevertheless indispensable.

F 2

HOLLOW CATHODE E-GUN FOR EBIS IN CHARGE BREEDING EXPERIMENT

V. Variale[1], V. Valentino[1], M. Batasova[2], G. Kusnetsov[2], T. Clauser[3] and A. Rainò[3]

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[2] *BINP-Novosibirsk, Russia*
[3] *University of Bari, Italy*

The charge breeding technique is used for Radioactive Ion Beam (RIB) production in the Isotope Separation On Line (ISOL) method in order of optimizing the reacceleration of the radioactive elements produced by a primary beam in a thick target. In some experiments a continuous RIB of a certain energy could be required. The EBIS based charge breeding device cannot reach a real CW operation because the high charge state ions produced are extracted by the same part where the 1+ ions are injected, that is, from the electron collector. In this paper, an hollow cathode e-gun for an EBIS in charge breeding operation has been presented. Furthermore, a preliminary system design to inject the 1+ ions from the cathode part will be also shown. In this way, the ions extraction system, placed in the electron beam collector, can be left only to extract the n+ ions, and then the CW operation, at least in principle, could be reached.

F 3

STUDY AND TEST ON THE 1+ ION SOURCE OF THE SPES PROJECT

M. Libralato[1], M. Manzolaro[1], A. Andrighetto[1], L. Biasetto[1], G. Meneghetti[2], S. Carturan[1], D. Scarpa[1], P. Colombo[2] and G. Prete[1]

[1] *INFN/LNL, Italy*
[2] *University of Padua, Italy*

The production target of the SPES project is going to produce neutron rich isotopes (Z > 40) by directly impinging a 40 MeV proton beam of I = 200 µA on 7 coaxial UCx porous thin disks. In order to produce a very intense exotic beam, a strong effort on target–ion source development is necessary. In the SPES facility the standard ISOLDE MK1 surface ion-source is used for 1+ ions production; in this kind of source a high temperature cavity of Tungsten (also Tantalum or Rhenium) is able to ionize efficiently the alkalis, rare-earth elements and low ionization potential molecules. In this way the ions are ready to be extracted and accelerated by means of an extraction electrode kept at 60 kV. In this work the Structural - Thermal - Electric behaviour of the MK1 ion source is studied, considering a full 3-D Coupled Structural - Thermal - Electric ANSYS® Finite Element model; FE results are compared with both potential difference and temperature measurements. To study the Electrostatic field of the extraction zone close to the ion source an ANSYS® FE Electrostatic model was developed.

F 4

THE LIGHT ION GUIDE CB-ECRIS PROJECT AT THE TEXAS A&M UNIVERSITY CYCLOTRON INSTITUTE

G. Tabacaru[1], H. L. Clark[1], G. Kim[1], D.P. May[1], F. Abegglen[1] , G. Chubaryan[1], G. Souliotis[1], J. Arje[2]

[1] *Cyclotron Institute, Texas A&M University*
[2] *JYFL, Jyväskylä, Finland*

Texas AM is currently configuring a scheme for the production of radioactive-ion beams that incorporates a light-ion guide (LIG) coupled with an ECRIS constructed for charge-boosting (CB-ECRIS). This scheme is part of an upgrade to the Cyclotron Institute and is intended to produce radioactive beams suitable for injection into the K500 superconducting cyclotron. The principle of operation is the following: the primary beam interacts with a production target placed in the gas cell. A continuous flow of helium gas maintains a constant pressure of 500 mbar maximum in the cell. Recoils are thermalized in the helium buffer gas and ejected from the cell within the gas flow through a small exit hole. The positively charged recoil ions (1+) are guided into a 2.5 m long rf-only hexapole and will be transported in this manner on-axis into the CB-ECRIS. The CB-ECRIS will operate at 14.5 GHz and has been specially constructed by Scientific Solutions of San Diego, California for charge-boosting. An overall image of the entire project will be presented with details on different construction phases. Specific measurements and results will be presented as well as future developments.

F 5

IRRADIATION CONTROL OF THE "SPIRAL1" TARGET BY MEASURING THE ION BEAM INTENSITY: "CICS" PROJECT

P. Anger, J.L. Baelde, C. Doutressoulles, M. Ozille, J.F. Rozé, J.C. Deroy, B. Jacquot, M. Dubois, S. Faure, F. Bucaille and C. Mauger

GANIL, France

In order to obtain a more precise control on the irradiation of the targets of the "SPIRAL1" installation and to optimize the experiments schedule as well as the exploitation costs, a new criterion of safety is respected. This new safety criterion is the maximum dose (maximum number of ions stopped in the Spiral1 Target). To control this, an AQ system has been put in operation and more specifically a new device has been set up in order to measure the ion beam intensity and to calculate the number of particles per second. This value can then be integrated over time. This device mainly consists of two redundant instrumentations, which are acquired via a real time industrial controller. The accuracy of measurement is estimated taking into account the variation of beam, of the environment and of the installation. This system obtained the agreement of the French nuclear safety authorities and is operational since September 2007.

G 1

A NEW ACCESS CONTROL UNIT FOR GANIL AND SPIRAL 2

J.L. Baelde, C. Berthe and J.F. Rozé

GANIL, France

In the frame of the GANIL safety revaluation and the new project of accelerator SPIRAL2, it was decided to replace the existing and aging access control system for radiological controlled areas. All machine areas and experimental rooms are concerned. The existing system is centralized around VME cards which makes a simple update very problematic. Therefore a new access control unit as been designed around a pair of PLC (Programmable Logic Controller). It will be supplemented by a radiological control unit that will make the radiological monitoring control of the area concerned. The access conditions to fulfill are to prohibit access to a room when the radiological conditions are above safety level and if there is the possibility of beam presence in the room. The poster presents an overview of the ongoing GANIL Project from the design requirements to technical choice. The foreseen schedule for the in site installation and exploitation is 2011.

G 2

STATUS OF THE CAVIAR DETECTOR AT LISE-GANIL

L. Perrot[1], S. Grévy[2], C. Houarner[2], R. Hue[2], C. Marry[2], S.M. Lukyanov[3] and R. Astabatyan[3]

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[2] *GANIL-IN2P3-CNRS, France*
[3] *JINR, Russia*

Physics that motivated the building of the LISE magnetic spectrometer, main ideas exposed in the scientific council of GANIL June 4th 1981 by M. Brian and M. Fleury, were: atomic physics studies with stripped ions and the study of new isotopes produced by the fragmentation of beams. The LISE line is a doubly-achromatic spectrometer (angle and position), with a resolution better than 10^{-3}. Since the first experiment performed in 1984, several improvements of the spectrometer were made: use of an achromatic degrader (1987, used for the first time in the world), building of the achromatic deviation and the Wien Filter (1990), building of a new selection dipole and associated vertical platform (1994), building of the new LISE2000 line (2001), use of the Caviar detector (2002), building of the CLIM target (2007). Despite an extreme international competition, the LISE spectrometer remains a world-leader equipment using more than 50 % and up to 90 % of the beam time available at GANIL. This paper presents the status of CAVIAR detector which consist of a MPWC dedicated to in flight particle position at the first dispersive plane of LISE. Since two years, intensive efforts were done with the objective to propose a 'plug and play' detector for nuclear physic experiments. We will describe the motivations and the system from MPWC up to the acquisition system. As example few experimental results will be presented.

G 3

HEBT LINES FOR THE SPIRAL2 FACILITY

L. Perrot[1], P. Bertrand[2], J.L. Biarrotte[1] and D. Uriot[3]

[1]*IPN-IN2P3-CNRS, France*
[2] *GANIL-IN2P3-CNRS, France*
[3] *SACM/IRFU/DSM/CEA, France*

The SPIRAL2 facility at GANIL-Caen is now in its construction phase, with a project group including the participation of many French laboratories (CNRS, CEA) and international partners. The SPIRAL2 facility will be able to produce various accelerated beams at high intensities: 40 MeV Deuterons, 33 MeV Protons with intensity up to 5 mA and heavy ions with q/A = 1/3 up to 14.5 MeV/u up to 1 mA current. We will present the status of the beam dynamics studies recently performed for the high energy beam transport lines of the facility. Various studies were performed on beam-dump concerning beam dynamics, safety and thermo-mechanicals aspects. New experimental areas using stable beams and the cave dedicated to radioactive ion production will be presented according the scientific program.

G 4

DEVELOPMENT OF RASTER SCANNING SYSTEM AT NIRS-HIMAC

T. Furukawa, T. Inaniwa, S. Sato, N. Saotome, T. Shirai, Y. Takei, S. Fukuda, S. Mori, A. Nagano, Y. Iwata, S. Minohara and K. Noda

National Institute of Radiological Sciences, Japan

A new treatment facility project, as an extension of the existing HIMAC facility, has been initiated for the further development of carbon-ion therapy. This new treatment facility will be equipped with a three-dimensional irradiation system with pencil beam scanning. The challenge of this project is to realize treatment of a moving target by scanning irradiation, because pencil beam scanning is more sensitive to organ motions compared with the conventional broad-beam irradiation. To accomplish practical moving target irradiation and to fix the final design, a prototype of the scanning irradiation system was constructed and installed into existing HIMAC physics experiment course. One of the most important features of the system is fast scanning to realize moving target irradiation with a relatively large number of rescannings within an acceptable irradiation time. Commissioning of the prototype started in December 2008. Cooperating with highly stabilized beam provided by HIMAC, the commissioning is successfully in progress. We will report the design of the system and the status of the beam study.

G 5

STATUS OF ELECTRON BEAM ION SOURCES FOR PARTICLE THERAPY

G. Zschornack[1] , V. Ovsyannikov[2], F. Grossmann[2], F. Ullmann[2], A. Schwan[2], E. Tanke[3] and P. Urschuetz[3]

[1] *Technische Universitaet Dresden, Institute of Applied Physics, Germany*
[2] *DREEBIT GmbH Dresden, Germany*
[3] *Siemens AG Erlangen, Germany*

Siemens and DREEBIT have entered collaboration with the objective of developing a superconducting electron beam ion source for particle therapy. The so-called Dresden EBIS-SC is a compact and cryogen-free superconducting high B-field EBIS able to produce the required amount of light ions within specified beam parameters. Investigations at the Dresden EBIS-A, a compact room-temperature EBIS, have been performed to demonstrate the ability of EBIS sources to be used in particle therapy. Amongst others, flat carbon ion beams with a pulse duration ranging from 2 to 100 µs have been successfully produced. Final results from the EBIS-A measurement campaign will be presented together with the status of EBIS-SC Prototype development and testing. In the present paper we show that the Dresden EBIS-SC can fulfil the requirements for particle-therapy facilities that are based on a medical synchrotron. The application of the Dresden EBIS-SC ion source can contribute to further optimize medical accelerator facilities.

G 6

DEVELOPMENT OF TREATMENT PLANNING SOFTWARE FOR CARBON-ION SCANNING AT HIMAC

T. Inaniwa, T. Furukawa, S. Sato, S. Mori, N. Kanematsu, K. Noda and T. Kanai

National Institute of Radiological Sciences, Japan

In order to use an intensity-controlled raster scan method at the new treatment facility in HIMAC, we have developed a novel code system dedicated to the planning of radiotherapy with the scanned ^{12}C beam. The variation of beam-spread in the direction lateral to the beam axis and non-collinearity of the beam by scanning magnets in the horizontal and vertical directions are considered in the beam model. Inverse planning techniques are implemented in the software in order to obtain the uniform biological dose distribution within the planned target volume (PTV) as well as reduce the dose delivered to the organ at risks (OARs) delineated on clinical CT images. The scan trajectory is determined so that the path length will be minimized by applying a fast simulated annealing algorithm for scan trajectory optimisation. Furthermore, the extra dose inevitably delivered to the irradiated site is integrated into the inverse planning process to shorten the treatment time. The code also copes with the planning for intensity modulated ion therapy (IMIT). Treatment plans were produced for several CT images of the patients treated at HIMAC. The beam steering file is produced with the software in which the position and particle fluence for each raster point is written following the optimised scan trajectory. The reliability of the developed code has been confirmed through the irradiation experiments according to the beam steering file at the secondary beam line in HIMAC.

G 7

RESEARCH ON MEASUREMENT OF THE FISSION PRODUCT NUCLIDE ^{126}SN BY AMS

H. Shen[1], S. Jiang[1], M. He[1], K.J. Dong[1], X. Wang[1], C. Li[1], G. He[1], D. Zhang[2], G. Shi[2], C. Huang[2], S. Wu[1], J. Gong[1], L. Lu[1], S. Li[2] and S. Wu[1]

[1] *China Institute of Atomic Energy, China*

[2] *College of Physical Science and Engineering Technology , Guangxi university, China*

^{126}Sn is a long-lived beta emitting radionuclide with a half-life of (2.30±0.14)×10^5 years. Artificially produced ^{126}Sn has entered our environment through nuclear weapons testing and releases from reprocessing plants and may locally lead to strongly enhanced ^{126}Sn concentrations. So the long lived ^{126}Sn may have implications on the nuclear pollution in our environment. But the primary difficulty in the determination of the ^{126}Sn concentration is the interference of the stable isobar ^{126}Te. In this paper, a new method was developed for the determination of ^{126}Sn by AMS. Major features of the method include the use of SnF_2 as target material, the selection of SnF_3^- molecular ions for extraction from the target, and the quantitative calibration of our Beijing HI-13 AMS system by using samples with ^{126}Sn determined γ-ray spectrometry. The combination of SnF_2/SnF_3^- (target sample/extraction ions) gives a beam current of SnF_3^- up to 400 nA, while that of TeF_3^- interference can be reduced by 2-3 orders of magnitude. SnF_3^- ions from the negative ion source were injected into the accelerator whose terminal voltage is 8.7 MV. Sn^{10+} ions were selected by an analyzing magnet and finally counted selectively using a ΔE-E gas ionization detector. A perfect linearity (R^2=0.99975) was obtained by using three standard samples with ^{126}Sn/Sn ratios of 1.033×10^{-8}, 4.54×10^{-9}, 6.43×10^{-10}, respectively. A sensitivity of (1.92±1.13)×10^{-10} has been reached by measuring a blank sample.

G 8

ACCELERATOR MASS SPECTROMETRY FOR LONG-LIVED HEAVY ION ^{236}U AT CIAE

X. Wang, H. Shen, S. Wu, S. Jiang, M. He, Y. Bao, X. Guan, Y. Hu, Q. You, C. Li, W. Wang

China Institute of Atomic Energy, China

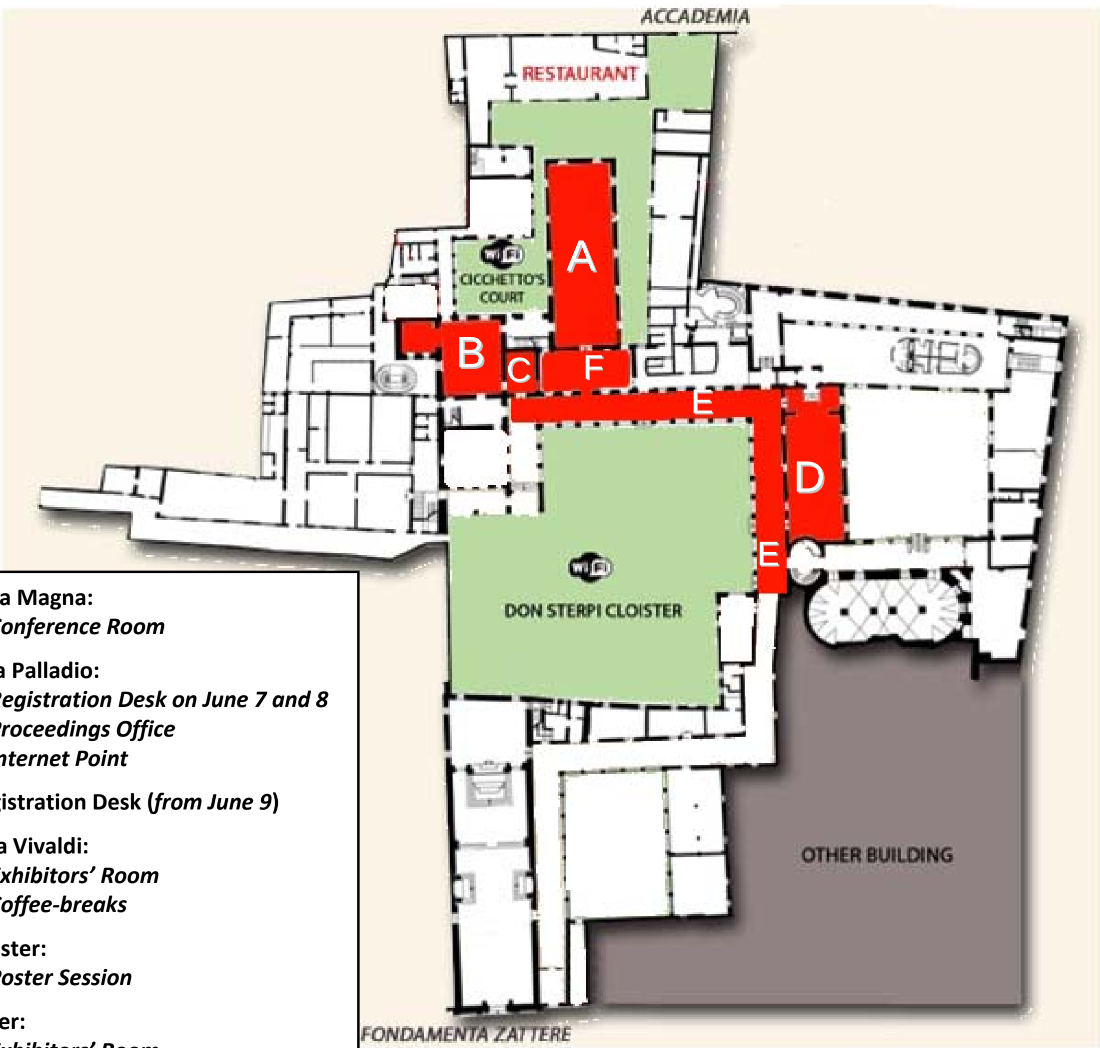
The mass resolution of the original injector at HI-13 AMS systems was 220, could not satisfy the requirement for AMS measurement of heavy isotopes (e.g., ^{236}U, ^{182}Hf). Therefore, to suppress neighboring masses, a high resolution achromatic beam line that consists of a spherical 90º electrostatic analyzer (ESA, 75 cm radius, 4 kV/cm) and a 112º double-focusing analyzing magnet (MA, 80 cm radius, 1.3 T) was installed for AMS. When the ESA's slits is opened up, the object and image point slits (X) of MA are respectively set at 5 and 2mm, the mass resolution can be up to 700, beam current just lost only 5%. Long-lived heavy ion ^{236}U is potentially useful as a legal medical expert for neutron-irradiated uranium usually originated from nuclear activity. By extracting UO^-, simulating the beam transport with the newly proposed $^{208}Pb^{16}O_2^-$, identifying interference isotopes by high resolution injector, electrostatic analyzer and TOF, a method for AMS measurement of ^{236}U has been firstly established on the HI-13 Accelerator at CIAE. After establishing the new injector, the isotopic ^{238}U (^{235}U) background was lower than 1×10^{-11} (1×10^{-9}) after passing through the AMS system. The sensitivity is ~10^{-10} for $^{236}U/^{238}U$ in present work.

GENERAL INFORMATION

Conference Venue

Centro Culturale Don Orione Artigianelli
Zattere Dorsoduro 909/A - 30123 Venezia
ph +39 041 5224077 - fax +39 041 5286214
e-mail: congress@donorione-venezia.it
www.donorione-venezia.it

The Don Orione Artigianelli Cultural Center, facing the Giudecca Canal, is a former ancient monastery, now restored and endowed with the most advanced technology. It is the ideal place for conventions and job meetings. The structure has 10 meeting rooms for 250 places total. The guest house of the centre offers comfortable and low-cost rooms, while lunches will be served at the adjacent Restaurant San Trovaso with garden.



A – Aula Magna:
Conference Room

B – Sala Palladio:
Registration Desk on June 7 and 8
Proceedings Office
Internet Point

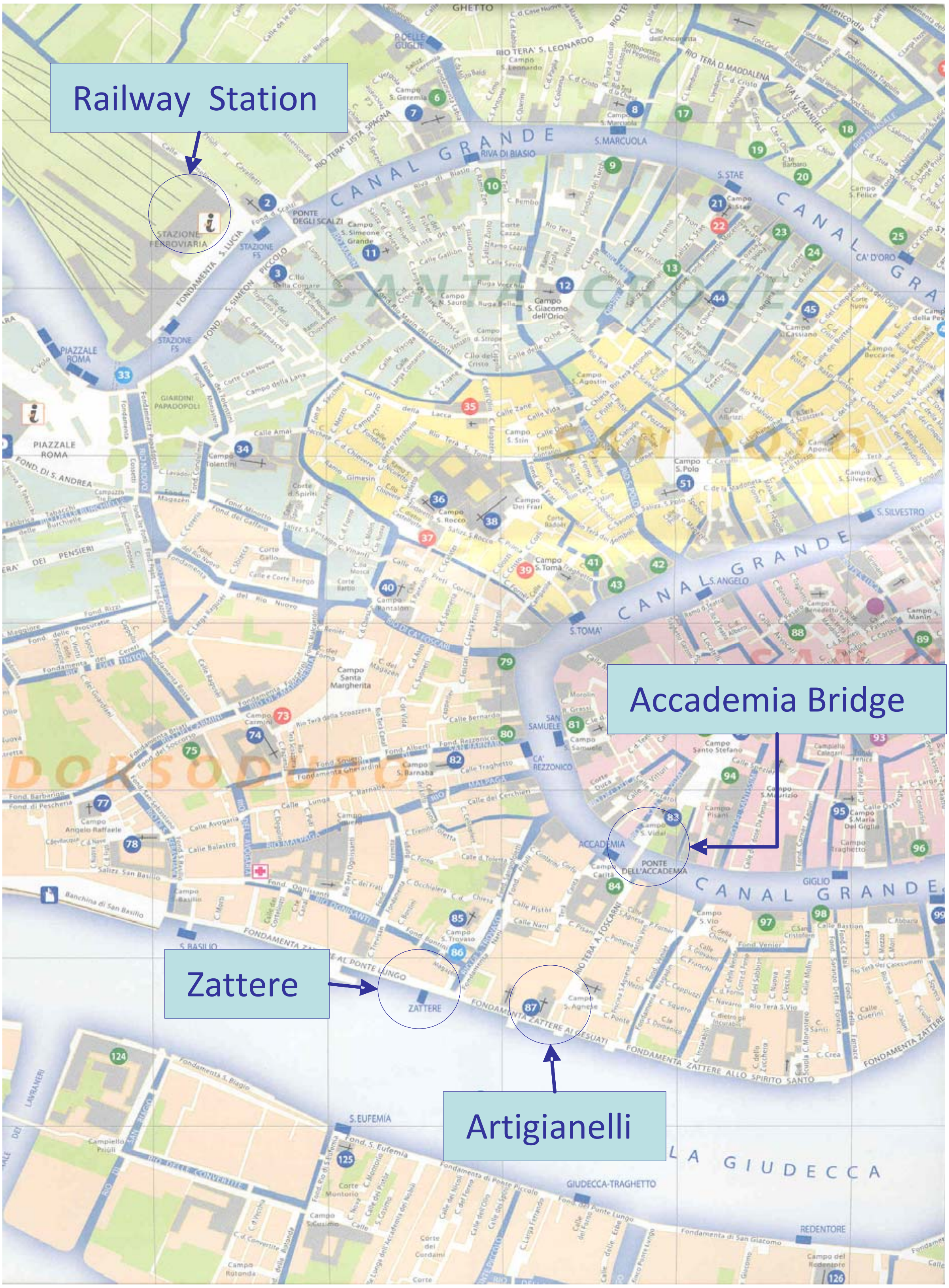
C – Registration Desk (*from June 9*)

D – Sala Vivaldi:
Exhibitors' Room
Coffee-breaks

E – Cloister:
Poster Session

F – Foyer:
Exhibitors' Room

RESTAURANT
San Trovaso Restaurant (*lunches*)



Railway Station
Accademia Bridge
Zattere
Artigianelli

Visit to St. Mark's Basilica

Wednesday, June 10, 2009

19:00 Meeting point at Conference Centre Don Orione Artigianelli

19:30-20:30 Guided tour inside St. Mark's Basilica with English speaking guide

Piazza S.Marco, 1 - 30124 Venezia
Phone: (+39)0412708311
E-mail: biblioteca.proc@patriarcato.venezia.it
Web: www.basilicasanmarco.it

St Mark's Basilica, a superb example of the Romanesque-Byzantine style with five cupolas, was built (10thC) to house the body of the St Mark the Evangelist. The facade features five portals decorated in splendid marbles and mosaics, and with a terrace dividing it into two halves. On the terrace stand Four Horses of gilded copper (copies - the originals are now preserved inside) that were sent from Constantinople to Doge Enrico Dandolo in 1204. Splendid mosaics in the atrium relate the stories of the Bible. The imposing interior in the form of a Greek cross contains a wealth of paintings and sculptures. Of particular interest are mosaics of Veneto-Byzantine origin, some of them reconstructed from drawings by Titian, Tintoretto and Veronese. The Bell Tower adjacent to the basilica was once a lighthouse for ships. At the foot of the tower is a 16th century loggia by J. Sansovino.

Conference Tour

Thursday, June 11, 2009

14:30	Meeting point at Conference Centre Don Orione Artigianelli
15:00	Embarkation at Zattere
15:00- 19:30	Tour by boat to the Venetian Islands of Murano, Burano and Torcello with English speaking guide

Murano

Divided into nine islets crossed by a wide canal, Murano is the island of glass blowing. A long and still-thriving tradition, this magic art has involved whole generations of Murano residents. The Museum of Glass is a must for anyone wishing to bone up on the art of glass-making in Venice. Located in Palazzo Giustiniani - in past times the prestigious seat of the Bishops of Torcello - the museum has an extraordinarily rich collection of decorated articles and glass produced between the 15th century and the present - showing how tastes and styles have changed, and how experiments and new techniques have affected a tradition that brings the island wealth and fame. A short distance from the museum is the Basilica dei Santi Maria e Donato, which is one of the best examples of the Veneto-Byzantine style. The decorations on the exterior of the apse are curious while, in the interior, the mosaics in the paving with ornamental motifs date from the period of the construction of the basilica (1140). Of the original decorations inside there remains a Byzantine mosaic while the lunette above the Baptistery door frames a painting by L. Bastian (1484).

Burano

It lies South-East of Mazzorbo, among Torcello, S. Erasmo, and San Francesco del Deserto. It's the most important center of the Northern Lagoon and has 5 thousands of inhabitants. It's linked to Venice by public water buses. Burano, or *la Boreana*, derives its name from one of the doors of Altino from which it was founded. When Torcello was a town Burano was a village. The bright colours of its popular houses are a peculiarity and its principal economical activities are productin of laces and fishing. There were many important examples of sacred architecture, but nowadays only few remain. Four religious constructions lasted till Napoleonic period as property of Diocesi of Torcello: Santa Maria delle Grazie, now desacrated, San Mauro, San Vito and San Martino Vescovo, parish church still existing. To see: School and Museum of Lace.

Torcello

A small, very old and deeply fascinating island, once a bishopric, today it is an absolute must for anyone wishing to enjoy the beauty of the lagoon. Strolling along the canal-side you come to the centre of the island, a small square where important monuments bear witness to the historic importance of the site. The Cathedral of Santa Maria Assunta is the lagoon's oldest building: founded in 639, it's a splendid example of the Veneto-Byzantine style. The portico and the ornamental motifs on the facade are of particular interest, as is the marble cladding and the splendid mosaics in the interior. Opposite the Basilica are the remains of its ancient Baptistery (7^{th}C) and, nearby, the 13^{th} century Church of Santa Fosca. The Palaces of the Council and of the Archives that stand in the same square, today are the premises of the Estuary Museum: the former offers examples of Veneto-Byzantine art (paintings, codices and illuminated manuscripts) while the latter has sculptures, bas-reliefs and important archaeological findings. From the bell tower there is a splendid view of the lagoon and the Venetian hinterland.

Conference Banquet

Thursday, June 11, 2009

19:30 Conference Banquet at Locanda Cipriani

23:00 Embarkation at Torcello to Venice (Zattere)

Locanda Cipriani
Piazza S. Fosca, 29-30142 Torcello Venezia
Ph .(+39) 041 730150 Fax (+39) 041 735433
info@locandacipriani.com

The lagoon isolates but at the same time protects the island of Torcello, acting as a magic filter that guards its wonderful charm. Here in 1935 Giuseppe Cipriani, captivated by the beauty of the place, opened an Inn which soon became famous, so that today, saying "Torcello" is the same thing as saying Locanda Cipriani (Cipriani's Inn). After Giuseppe, the management of the Inn was taken over by his daughter Carla, then subsequently by her son, Bonifacio Brass. The passing centuries have not lessened the fascination of the island; the successive generations have not altered the inimitable style and class of the Inn, as it is attested by the many illustrious guests attracted yesterday as today by the unique hospitality: from Ernest Hemingway to Charlie Chaplin, from Paul Newman to the entire Royal Family of England.