FERMI@elettra Diagnostics

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Abstract

FERMI@elettra is the fourth generation light source currently under construction at the Sincrotrone Trieste Laboratory. It is a seeded FEL based on the existing 1.0GeV Linac which will be fitted with FEL specific sub-systems like a new photoinjector and two bunch compressors to obtain in front of the undulator chain a stable and high quality beam. Due to the challeging beam parameters, the diagnostics play a key role for the successfull commissioning first, and then for a reliable operation of the new faciltiy. In this paper we give an overview on the FERMI diagnostics operating in the 6-D phase space along with some keynotes on the timing system which is an integral part of the longitudinal diagnostics.

Paper not received
(See slides of talk on following pages)

FERMI@elettra DIAGNOSTICS

Mario Ferianis – Elettra
on behalf of the
Beam Instrumentation Group

- FERMI@elettra overview
- Diagnostics
- Current activities and achievements

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FERMI@elettra overview

- **FERMI@elettra** is the 4[th] generation Light Source, currently under construction in Trieste, based on the upgraded Normal Conducting S-band (2998.010 MHz) ELETTRA LINAC.
- Fixed e-beam energy
- single bunch at 50 Hz operation

Spectral range covered by two undulator lines
Seeded Harmonic Generation

FEL 1: 100 – ~40 nm (12-30eV) single stage
Time domain experiments → high stability & intensity
FEL 2: ~40 – 10 nm (30-124eV) two stages
High resolution experiments → frequency domain
Each FEL will *feed two or more* beam lines

- Gap tuning, flexible polarization, Apple Type radiators Variable photon pulse length (narrow bandwidth operation): *50fs to ~1.0ps*
- Need for an excellent timing and Synchronization

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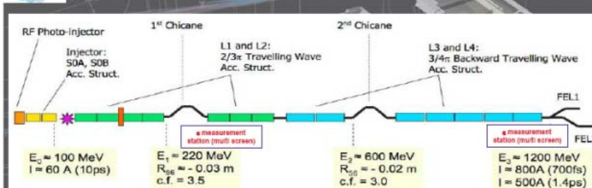
Schematic layout of the accelerator



	"Short" bunch	"Medium" bunch	"Long" bunch
Bunch length	200 fs (flat part)	700 fs (flat part)	1.4 ps (flat part)
Peak current	800 A	800 A	500 A
Emittance(slice)	1.5 μm	1.5 μm	1.5 μm
Energy spread(slice)	<150 keV	<150 keV	<150 keV
Flatness, $\|d^2E/dt^2\|$		<0.8 MeV/ps²	<0.2 MeV/ps²

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FERMI@elettra Diagnostics

- accurate photo-injector characterisation:
  emittance, charge profile, energy spread
- seeded FEL scheme: *whole bunch / fresh bunch (core)*
  calls for **slice measurements**:
  longitudinal charge profile,
  emittance,
  energy spread
  transverse and **longitudinal** overlap e- beam/laser
  - high resolution BPM
  - bunch arrival monitors
  - shot-to-shot feedbacks
- **stability of output** FEL radiation
- ***mm*** **to** ***sub-mm*** **bunch length;**
  currently two options:
  medium bunch: LB= 0.21mm (700fs) short FEL pulse
  long bunch: LB= 0.57mm (1.4ps) long FEL pulse

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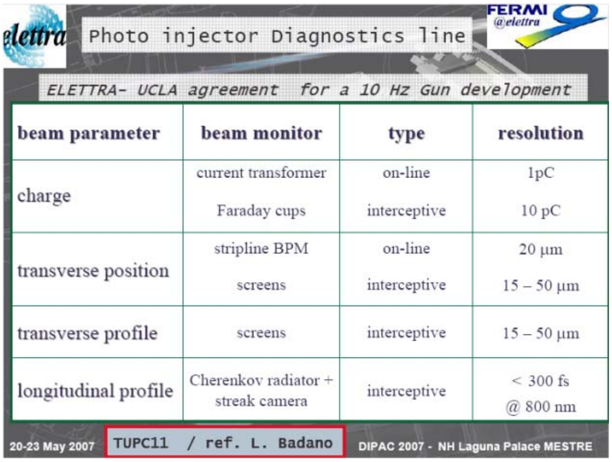
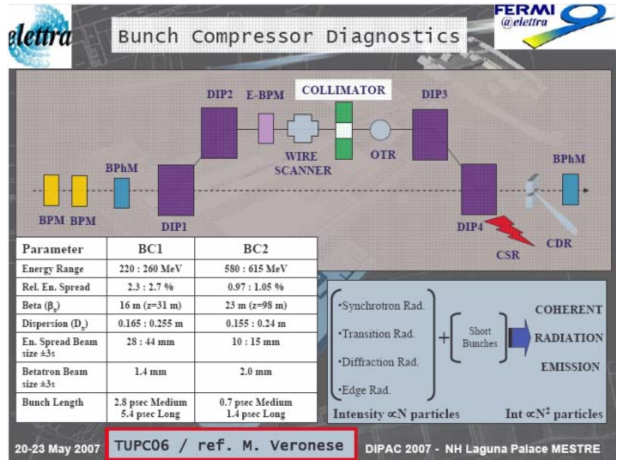
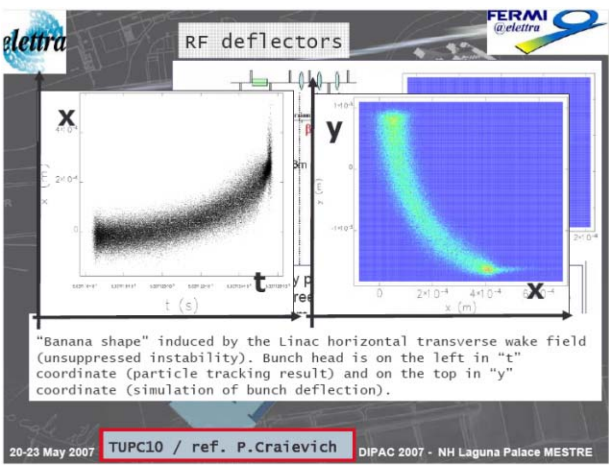
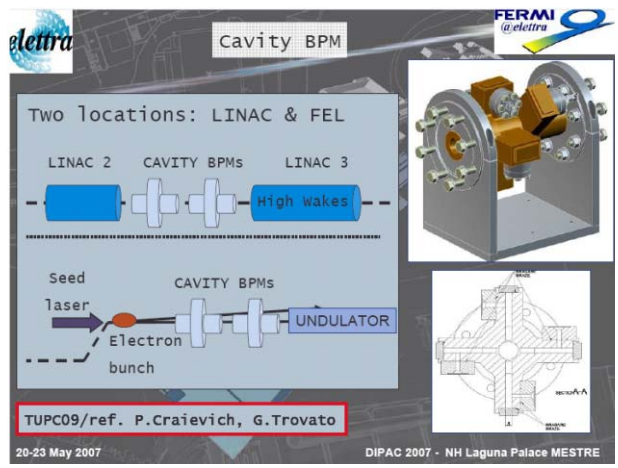


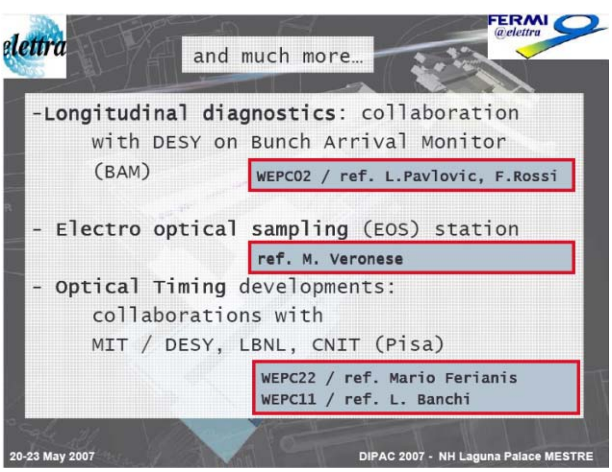
beam parameter	beam monitor	type	resolution
charge	current transformer Faraday cups	on-line interceptive	1pC 10 pC
transverse position	stripline BPM screens	on-line interceptive	20 μm 15 – 50 μm
transverse profile	screens	interceptive	15 – 50 μm
longitudinal profile	Cherenkov radiator + streak camera	interceptive	< 300 fs @ 800 nm

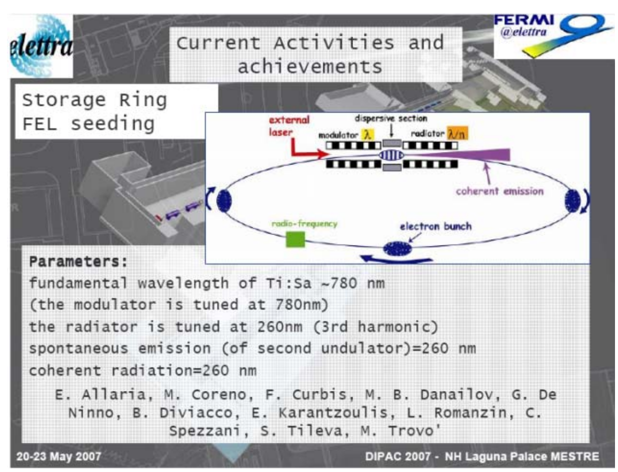


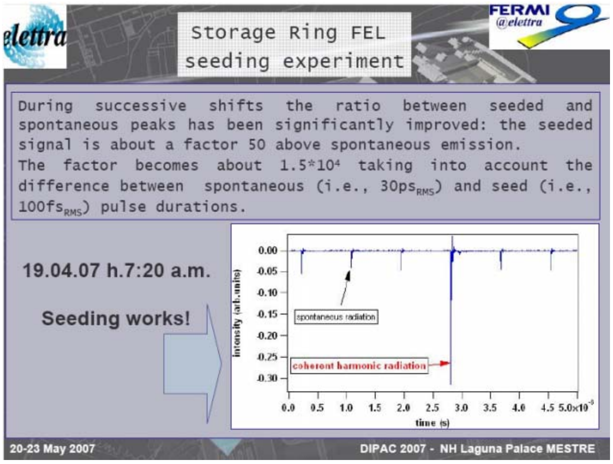
Parameter	BC1	BC2
Energy Range	220 : 260 MeV	580 : 615 MeV
Rel. En. Spread	2.3 : 2.7 %	0.97 : 1.05 %
Beta (β_x)	16 m (z=31 m)	23 m (z=98 m)
Dispersion (D_x)	0.165 : 0.255 m	0.155 : 0.24 m
En. Spread Beam size ±3s	28 : 44 mm	10 : 15 mm
Betatron Beam size ±3s	1.4 mm	2.0 mm
Bunch Length	2.8 psec Medium 5.4 psec Long	0.7 psec Medium 1.4 psec Long










Storage Ring FEL seeding experiment
During successive shifts the ratio between seeded and spontaneous peaks has been significantly improved: the seeded signal is about a factor 50 above spontaneous emission.
The factor becomes about 1.5*10⁴ taking into account the difference between spontaneous (i.e., 30ps_RMS) and seed (i.e., 100fs_RMS) pulse durations.
19.04.07 h.7:20 a.m.
Seeding works!
spontaneous radiation
coherent harmonic radiation
Intensity (arb.units)
time (s)
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Current Activities and achievements
100Mev & 1.0GeV LINAC test bed for FERMI diagnostics
TUPC11 / ref. L. Badano M. Veronese
bunch profile and position
transverse emittance (Q- scan)
current/charge
bunch longitudinal profile
bunch length variations (CTR)
energy / energy spread
182 mm
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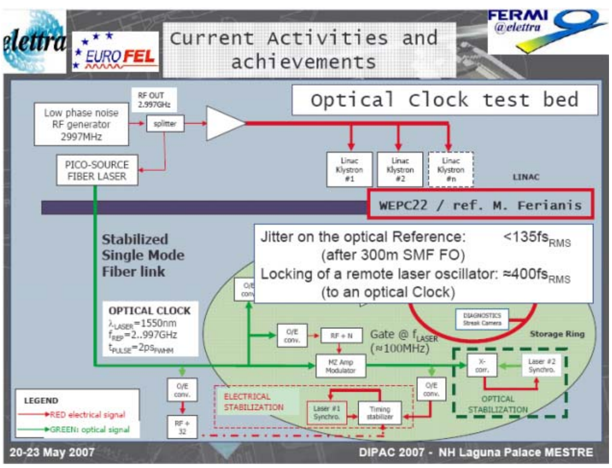
Current Activities and achievements
Optical Clock test bed
Low phase noise RF generator 2997MHz
RF OUT 2.997GHz
splitter
PICO-SOURCE FIBER LASER
Linac Klystron #1
Linac Klystron #2
Linac Klystron #n
LINAC
WEPC22 / ref. M. Ferianis
Stabilized Single Mode Fiber link
Jitter on the optical Reference: <135fs_RMS
(after 300m SMF FO)
Locking of a remote laser oscillator: ≈400fs_RMS
(to an optical Clock)
OPTICAL CLOCK
Gate @ f_LASER (≈100MHz)
Storage Ring
ELECTRICAL STABILIZATION
OPTICAL STABILIZATION
LEGEND
RED electrical signal
GREEN: optical signal
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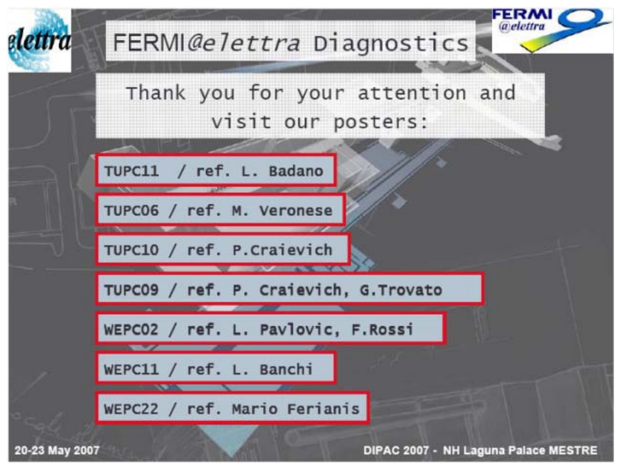
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Thank you for your attention and visit our posters:
TUPC11 / ref. L. Badano
TUPC06 / ref. M. Veronese
TUPC10 / ref. P.Craievich
TUPC09 / ref. P. Craievich, G.Trovato
WEPC02 / ref. L. Pavlovic, F.Rossi
WEPC11 / ref. L. Banchi
WEPC22 / ref. Mario Ferianis
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