FERMI Project Overview

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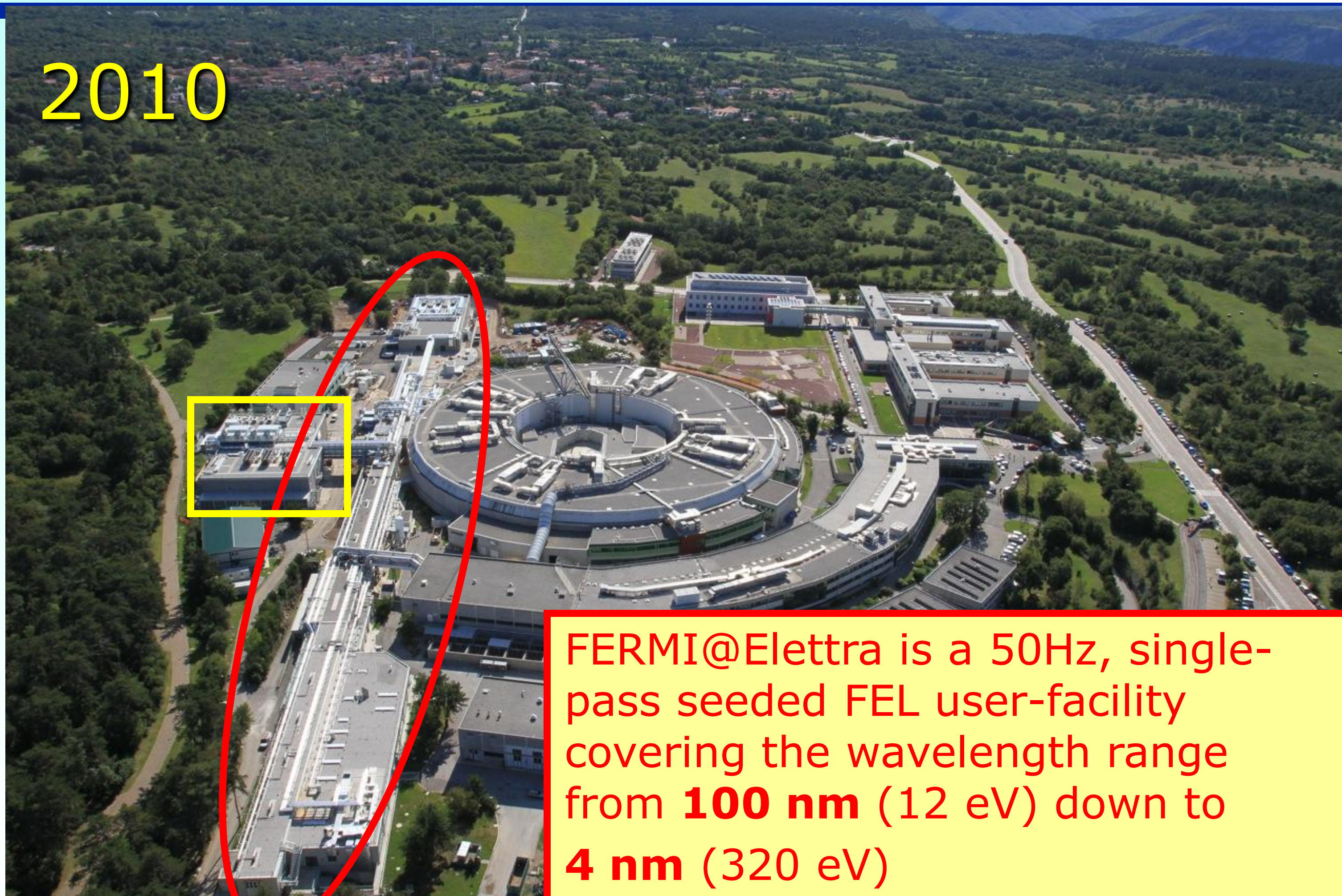
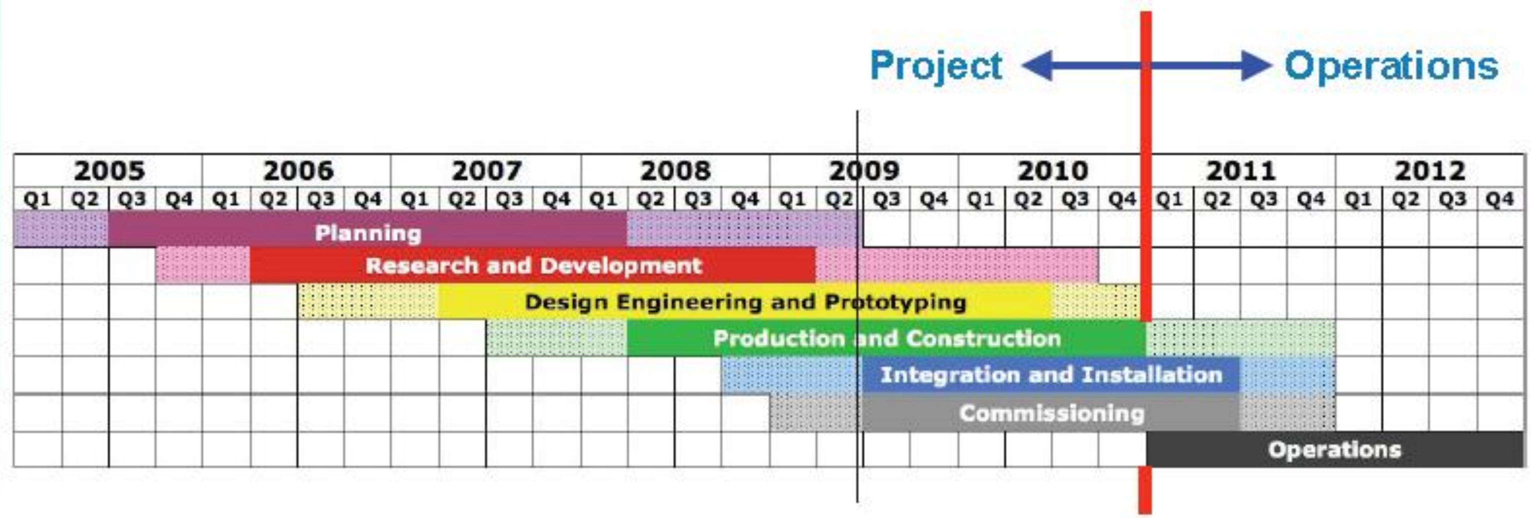
Progress over the last 10 years at Elettra



FERMI@Elettra is a 50Hz, single-pass seeded FEL user-facility covering the wavelength range from **100 nm** (12 eV) down to **4 nm** (320 eV)

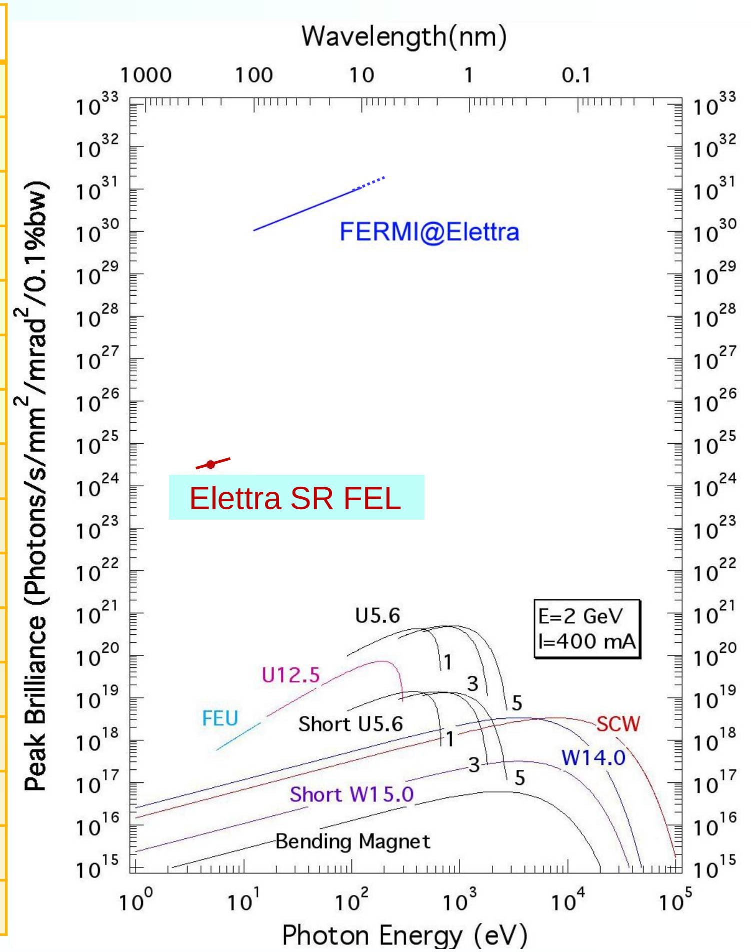
FERMI@Elettra: History and Overall Schedule

- Conceptual and Technical Design Study: 2003 – 2007
- Engineering Design and Production: 2007 - 2011
- Civil Engineering and Installations: 04/2009 – 08/2011
- RF Conditioning and Beam Commissioning: 09/2009 – 12/2011
- Operations start in 2011, first Experiment in February.

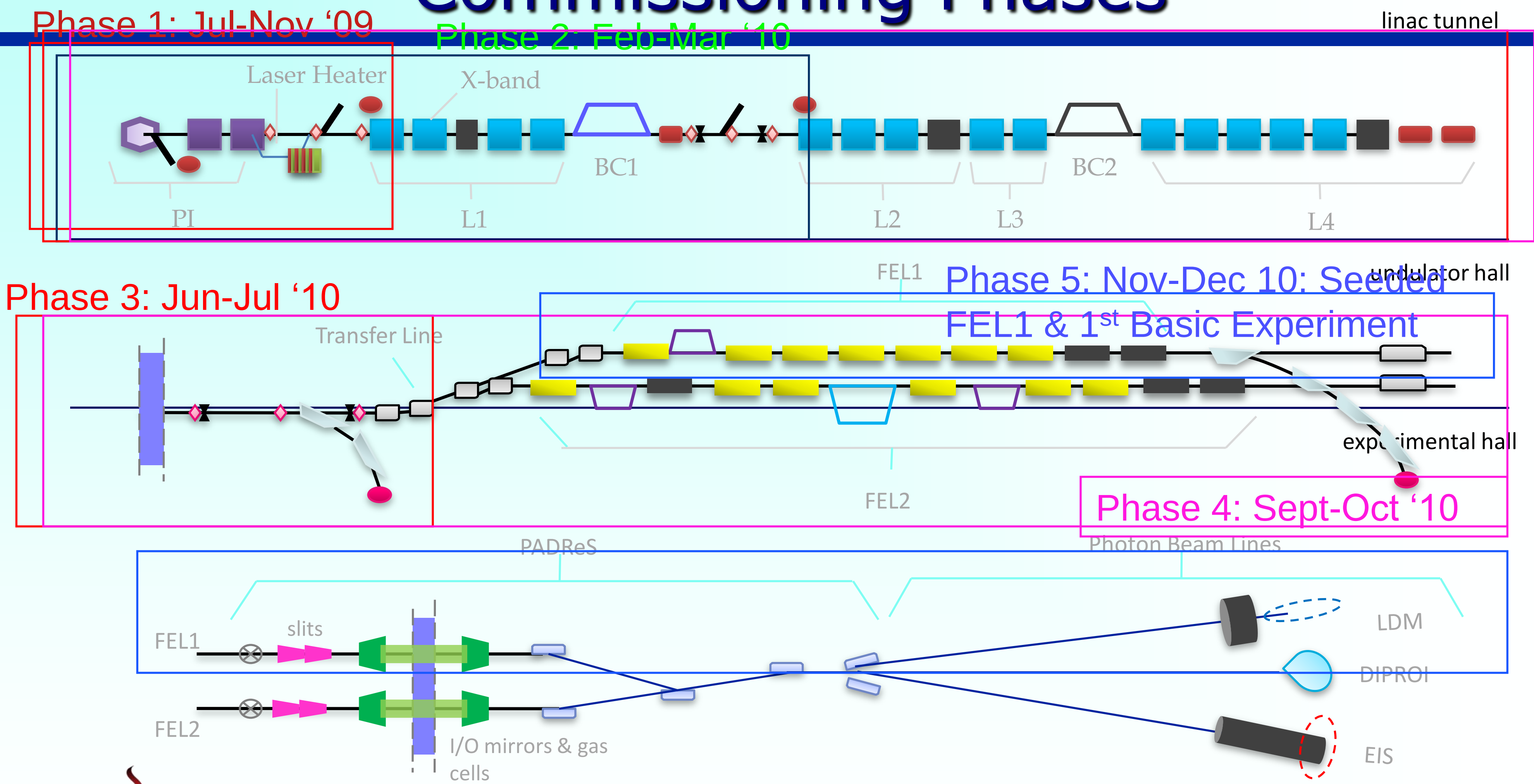


FERMI@Elettra
Specifications and Performance

Parameter	FEL1	FEL2	Units
Output Wavelength (fundam.)	**100 – 20**	**20 – 4**	**nm**
Output Pulse Length, rms	≤50	≤50	fs
Peak Power	**1 – 5**	**> 0.3**	**GW**
Photons per Pulse	> 10^{13}	> 10^{12}	1meV bw
Power Stability	<30	<50	%
Transverse Stability	<10%		e-size
Repetition Rate	**10 – 50**	**50**	**Hz**
Energy	**1.2**	**1.5**	**GeV**
Charge	0.8		nC
Slice Norm. Emittance, rms	**1.0**		**mm mrad**
Slice Energy Spread, rms	**<0.20**	**<0.15**	**MeV**
Total Energy Spread, rms	<1.2	<1.5	MeV
Peak Current, flat region	**800**		**A**
Bunch Length, full width	0.7		ps
Energy Jitter, rms	0.1		%
Timing Jitter, rms	<150		fs

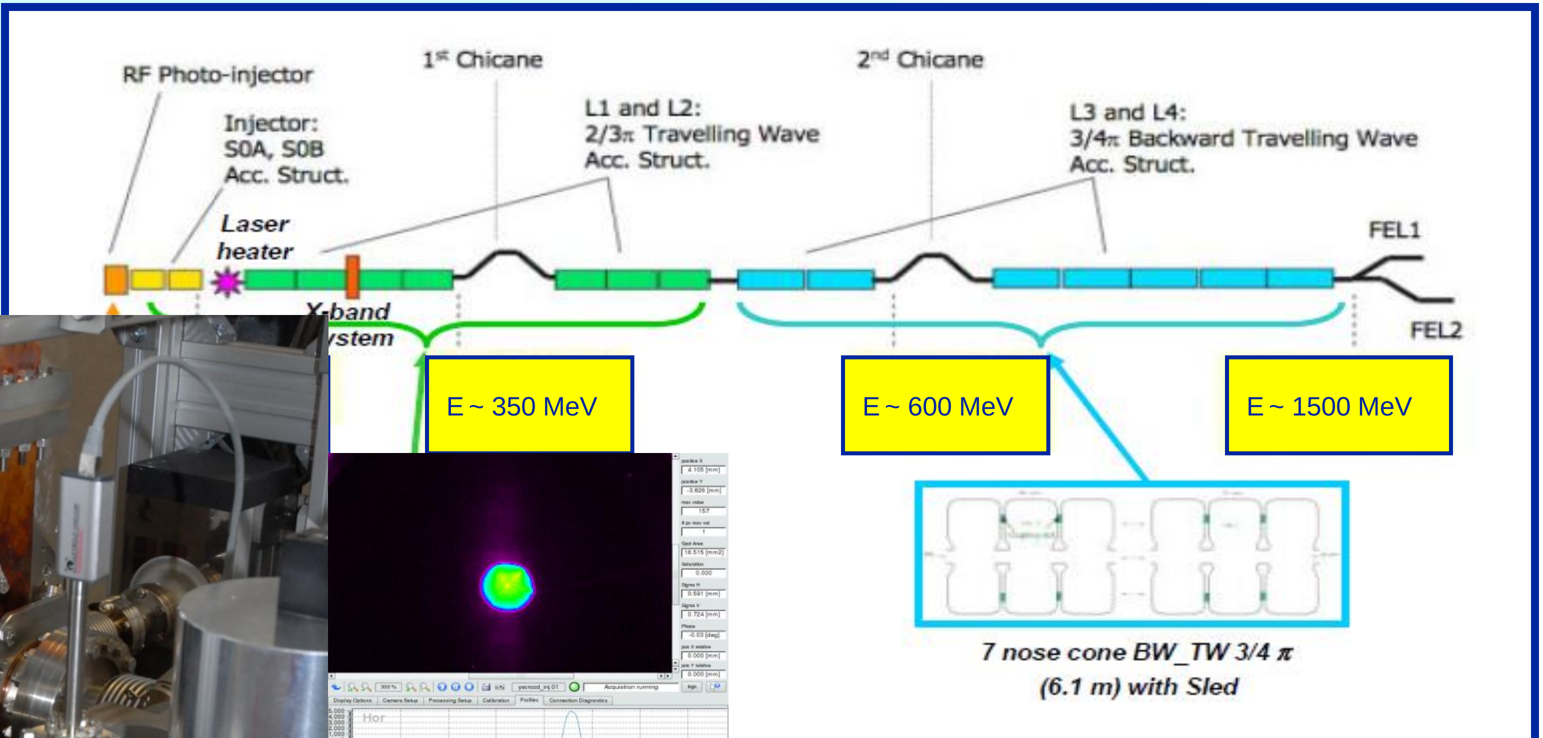


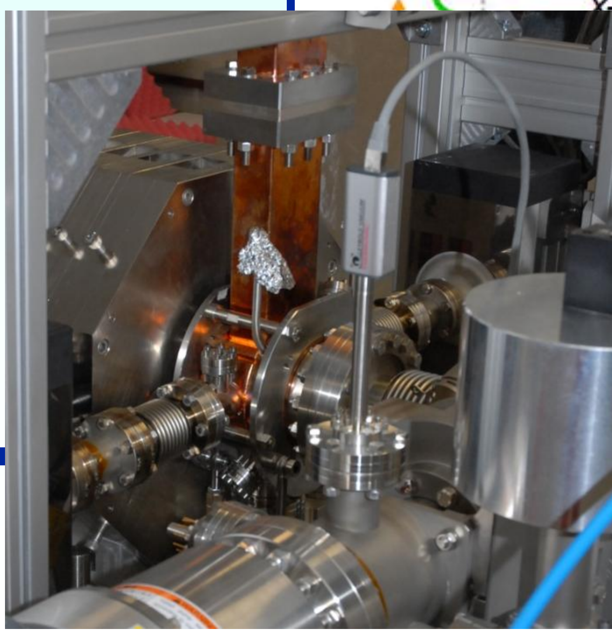
FEL-1 Layout and Commissioning Phases



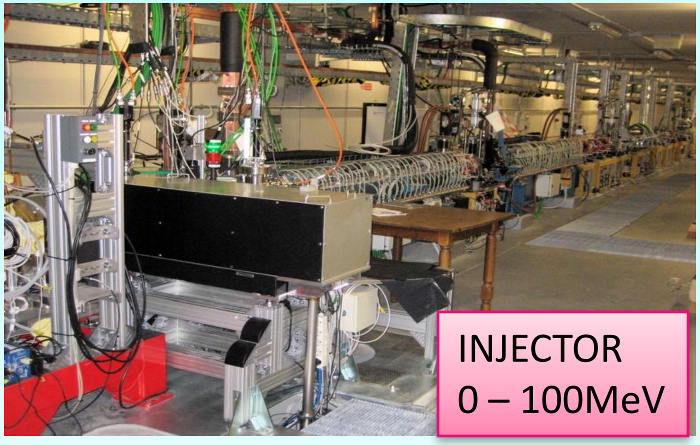
LINAC layout

FERMI is based on a warm 1.5 GeV linac, made up by 16 S-band accelerating cavities
The accelerator consists of a new high-brightness electron source, a laser heater system for the control of uncorrelated energy spread, a 4th harmonic accelerating section to linearize the bunch charge, and two magnetic bunch compressors to increase the delivered peak current.

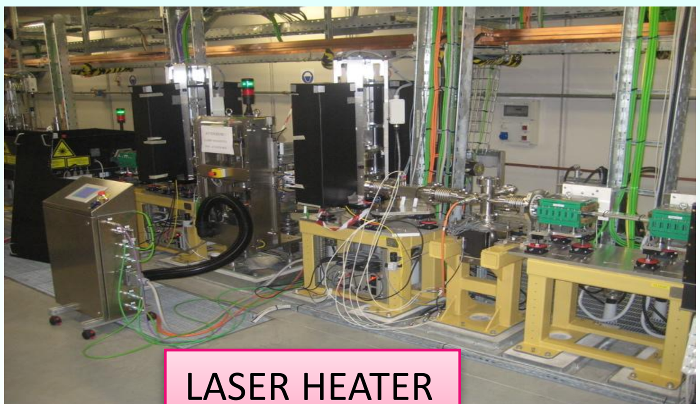




LINAC Sections



INJECTOR
0 – 100MeV



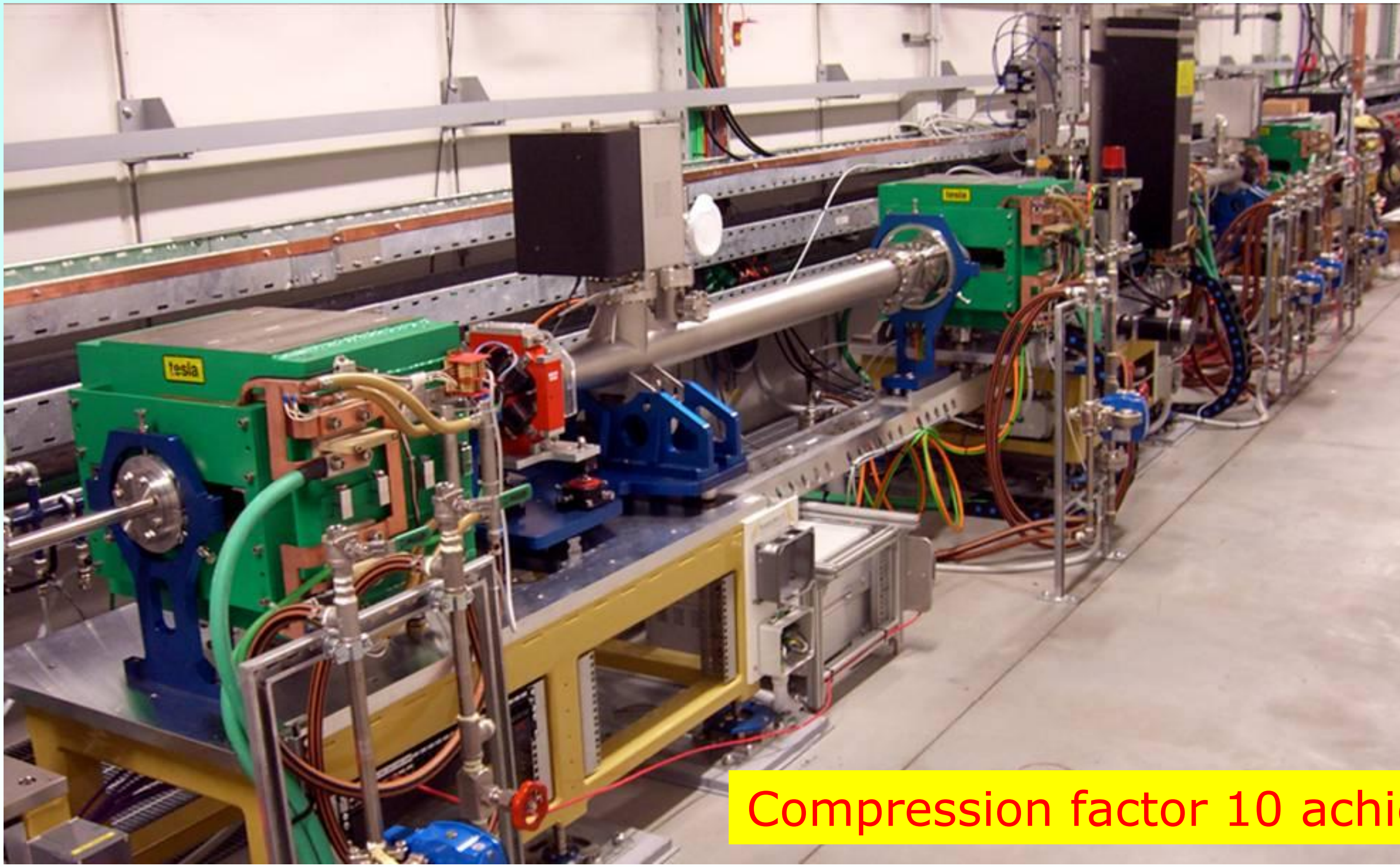
LASER HEATER
100MeV

LINAC1 (L01)
100 – 350MeV

BC1 DIAGS
350MeV

L02 – L04
350 – 1500MeV

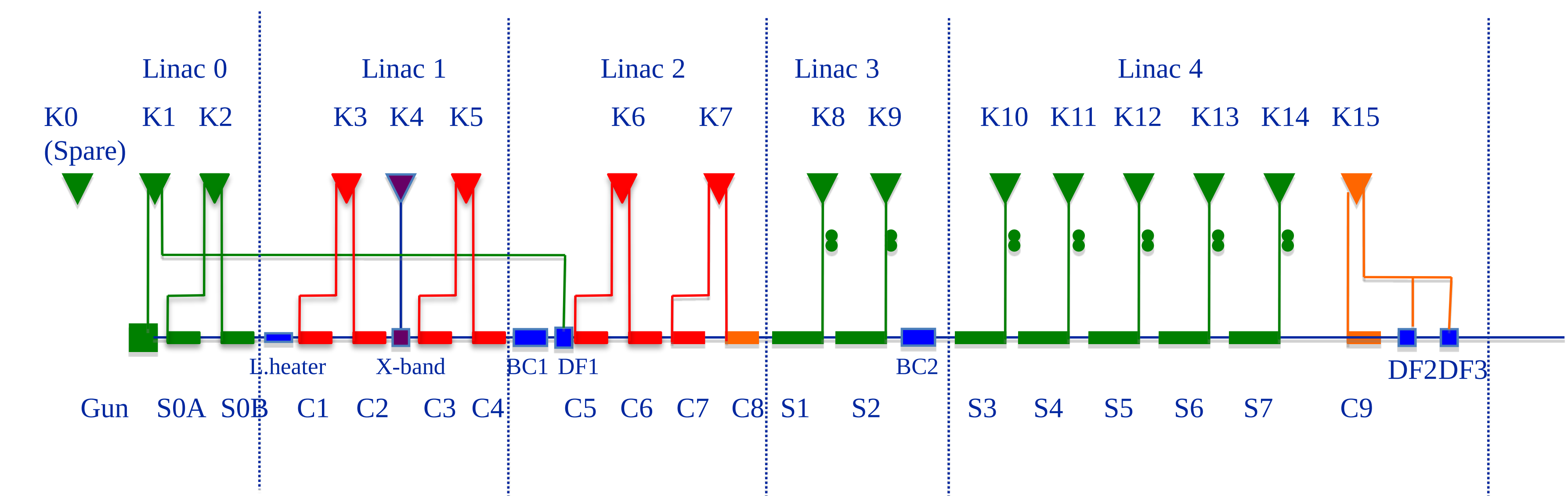
Bunch Compressor 1



Compression factor 10 achieved

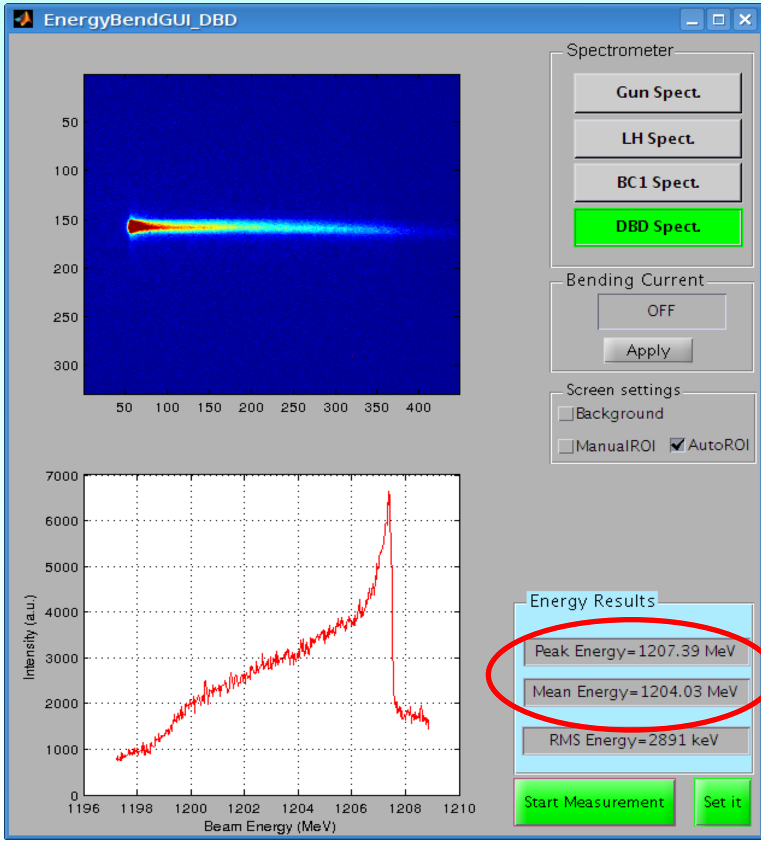
LINAC, High Power System

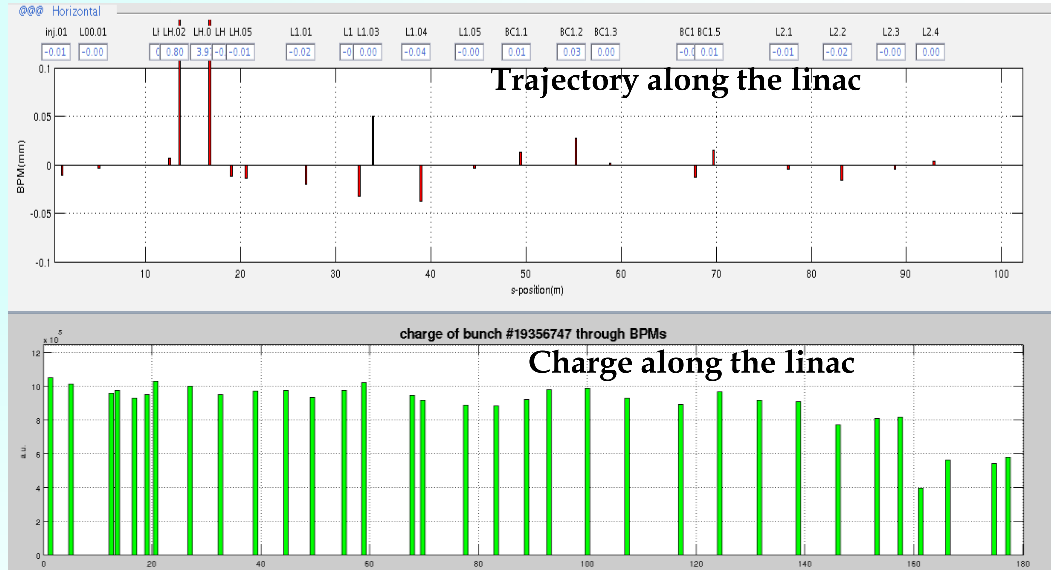
The needed RF power for the S-Band plants is provided by 14 Thales TH2132A klystrons (3 GHz, 45 MW peak power in a 4.5 µsec pulse width) plus a spare klystron that is meant to replace the first two tubes in case of failure. The 12 GHz high power RF source is a scaled version (XL5) of the SLAC XL4 klystron.



LINAC, 3 GHz RF Power Plant
(14 are installed)

LINAC Commissioning: on 21.09.2010 attained 1.2 GeV (FEL-1 energy)





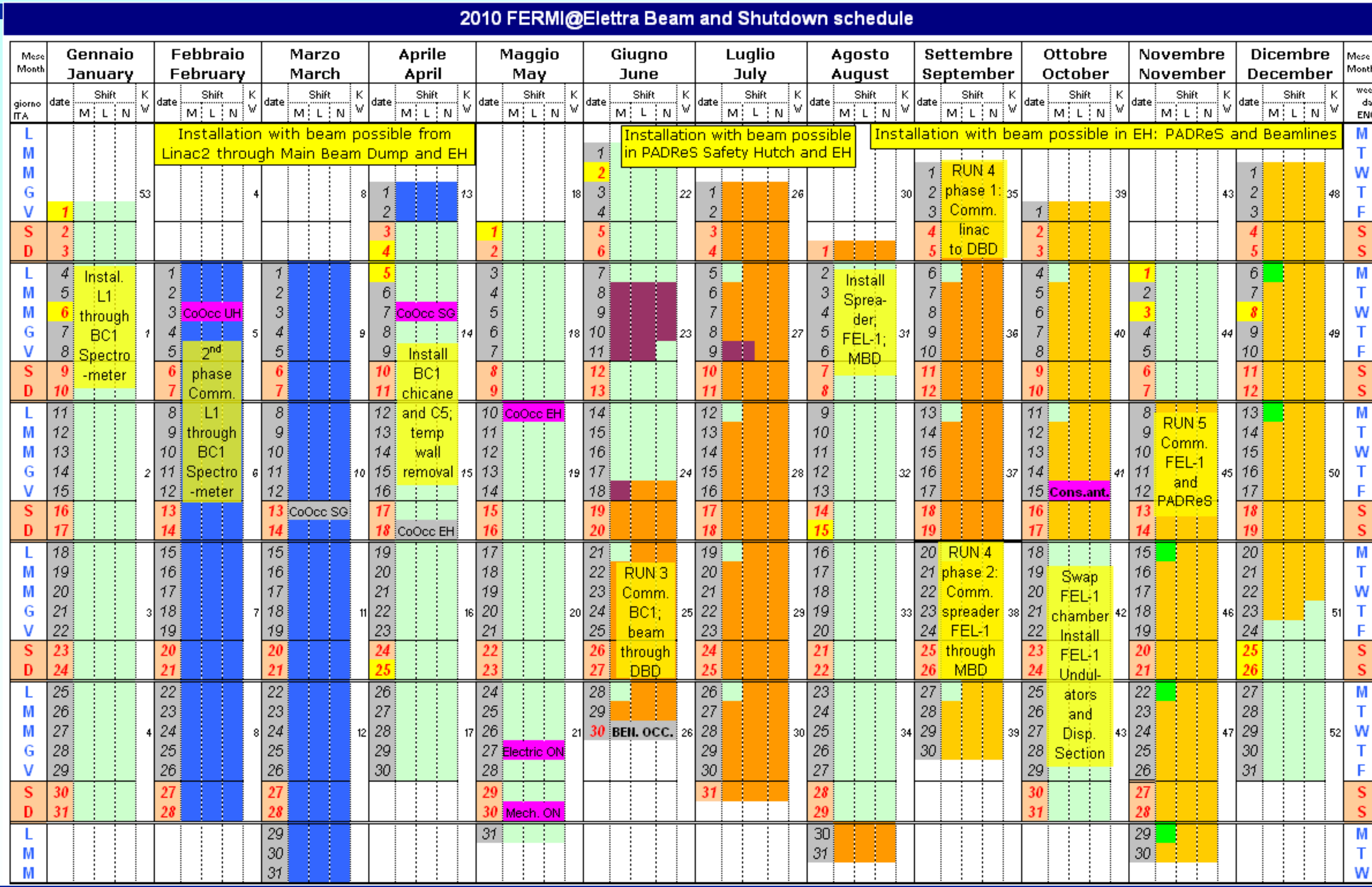
Trajectory control and RF phasing are used to maximize the transport efficiency and compensate for the energy loss induced by the linac wake fields.

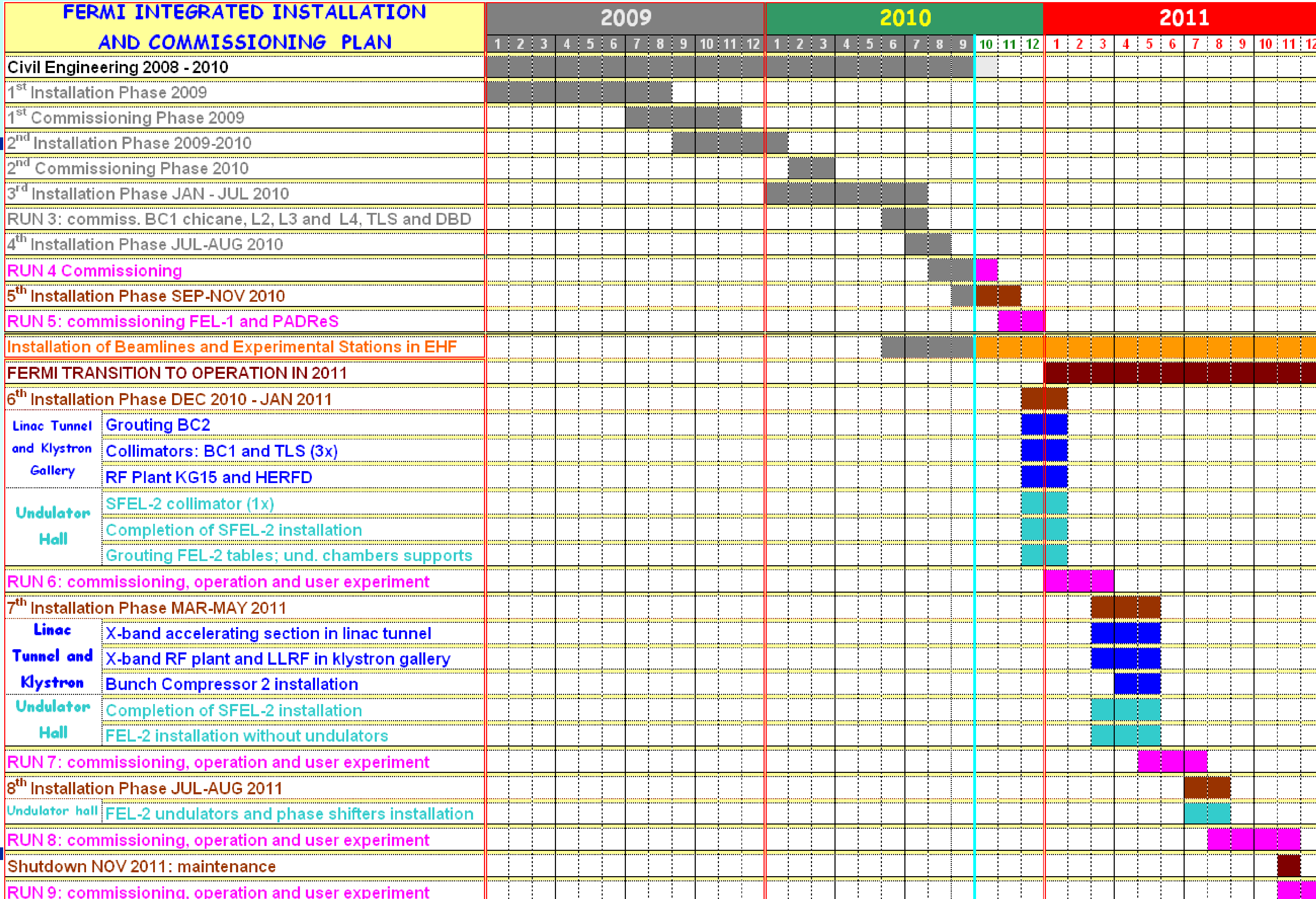
FEL-1

FEL1 beamline

APPLE-II type undulators allow variable polarization and tunable output wavelength

FERMI Calendar 2010




FERMI INTEGRATED INSTALLATION AND COMMISSIONING PLAN
2009
2010
2011
1 2 3 4 5 6 7 8 9 10 11 12
Civil Engineering 2008 - 2010
1st Installation Phase 2009
1st Commissioning Phase 2009
2nd Installation Phase 2009-2010
2nd Commissioning Phase 2010
3rd Installation Phase JAN - JUL 2010
RUN 3: commiss. BC1 chicane, L2, L3 and L4, TLS and DBD
4th Installation Phase JUL-AUG 2010
RUN 4 Commissioning
5th Installation Phase SEP-NOV 2010
RUN 5: commissioning FEL-1 and PADReS
Installation of Beamlines and Experimental Stations in EHF
FERMI TRANSITION TO OPERATION IN 2011
6th Installation Phase DEC 2010 - JAN 2011
Linac Tunnel and Klystron Gallery
Grouting BC2
Collimators: BC1 and TLS (3x)
RF Plant KG15 and HERFD
Undulator Hall
SFEL-2 collimator (1x)
Completion of SFEL-2 installation
Grouting FEL-2 tables; und. chambers supports
RUN 6: commissioning, operation and user experiment
7th Installation Phase MAR-MAY 2011
Linac Tunnel and Klystron
X-band accelerating section in linac tunnel
X-band RF plant and LLRF in klystron gallery
Bunch Compressor 2 installation
Undulator Hall
Completion of SFEL-2 installation
FEL-2 installation without undulators
RUN 7: commissioning, operation and user experiment
8th Installation Phase JUL-AUG 2011
Undulator hall
FEL-2 undulators and phase shifters installation
RUN 8: commissioning, operation and user experiment
Shutdown NOV 2011: maintenance
RUN 9: commissioning, operation and user experiment

Conclusion and Outlook

- FEL-1 installation is almost completed, undulators will come in October.
- Linac Commissioning is progressing well, **1.2 GeV** energy achieved.
- Bunch compression factors up to **10** achieved with **BC1**, as expected.
- Preliminary slice emittance and projected emittance measurements are close to expectations (~ **1.5 mm mrad** and up to **3 mm mrad** respectively, with a c. f. 6.5).
- The electron beam has been transported up to the spreader region in the Undulator Hall.
- Next week beam will be further transported to **FEL-1** and to the **Main Beam Dump** in the Undulator Hall.
- By end of 2010 we expect the **first lasing with FEL-1** at λ about **60 nm**.
- During 2011 FEL-2 will be installed, along with FEL-1 optimization and first user experiments.

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