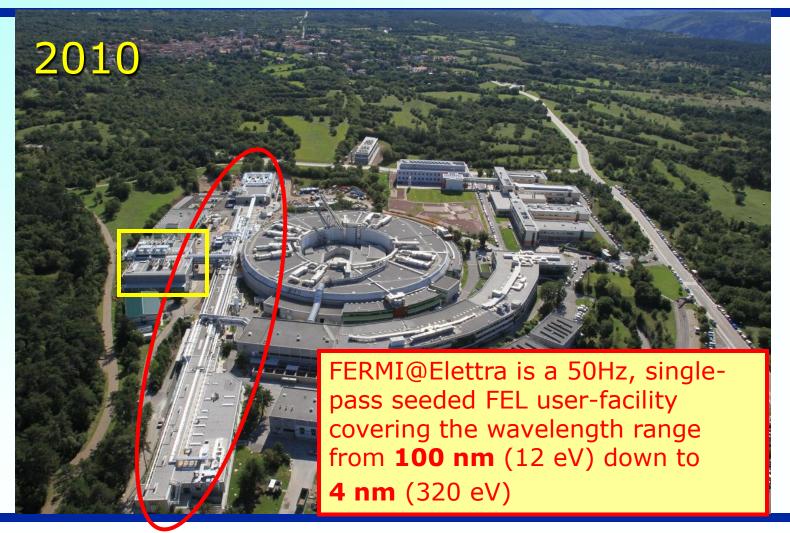


FERMI Project Overview

M. Svandrlik



Progress over the last 10 years at Elettra

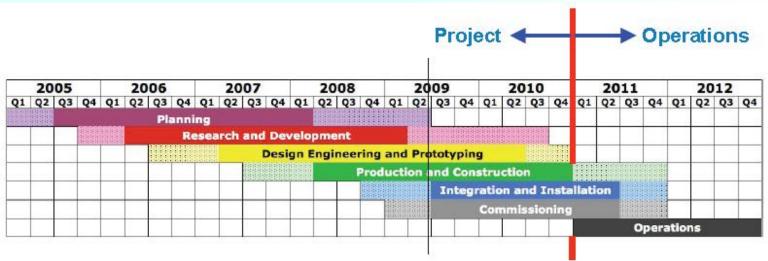






FERMI@Elettra: History and Overall Schedule

- ☐ 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.

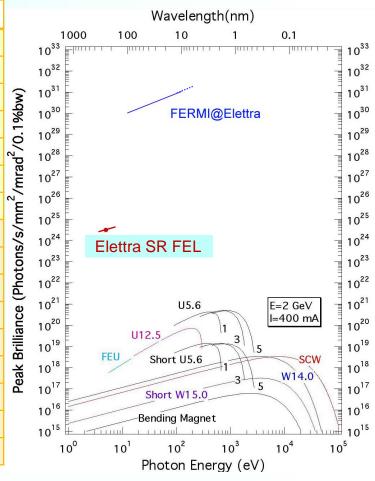






FERMI@Elettra Specifications and Performance

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	<1	e-size		
Repetition Rate	10 – 50	50	Hz	
Energy	1.2	1.5	GeV	
Charge	0.	nC		
Slice Norm. Emittance, rms	1.	mm mrad		
Slice Energy Spread, rms	<0.20	<0.15	MeV	
Total Energy Spread, rms	<1.2	<1.5	MeV	
Peak Current, flat region	80	Α		
Bunch Length, full width	0.	ps		
Energy Jitter, rms	0.	%		
Timing Jitter, rms	<1	fs		

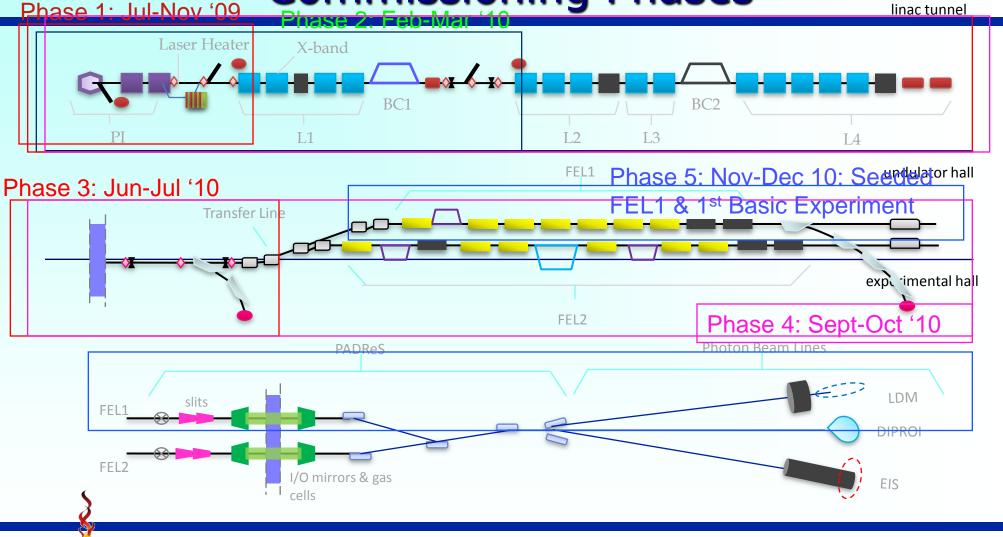




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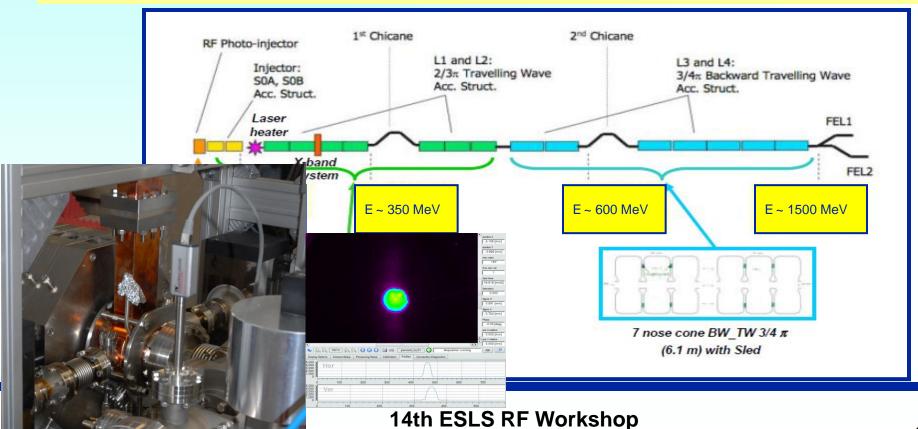
FEL-1 Layout and Commissioning Phases





LINAC layout

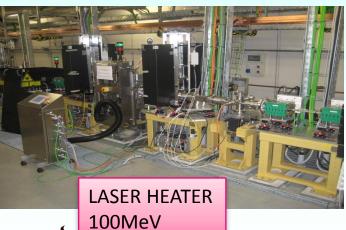
FERMI is based on a warm 1.5 GeV linac, made up by 16 S-band accelerating cavities The accelerator consists of a new high-brightness electron source, a laser heater system for the control of uncorrelated energy spread, a 4th harmonic accelerating section to linearize the bunch charge, and two magnetic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

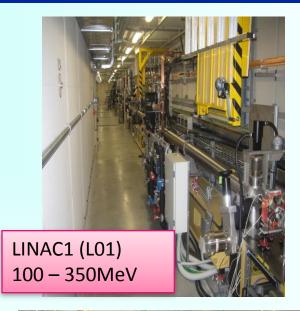




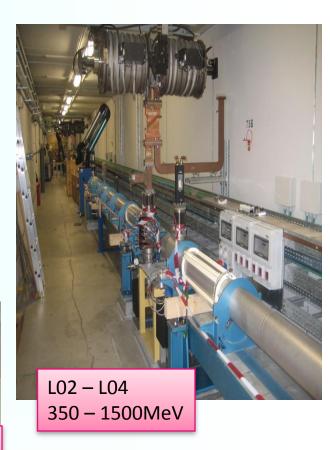
LINAC Sections







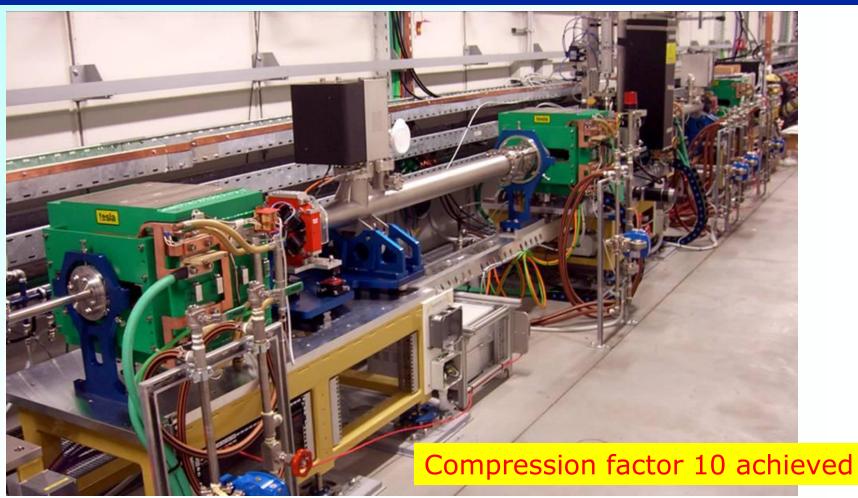








Bunch Compressor 1



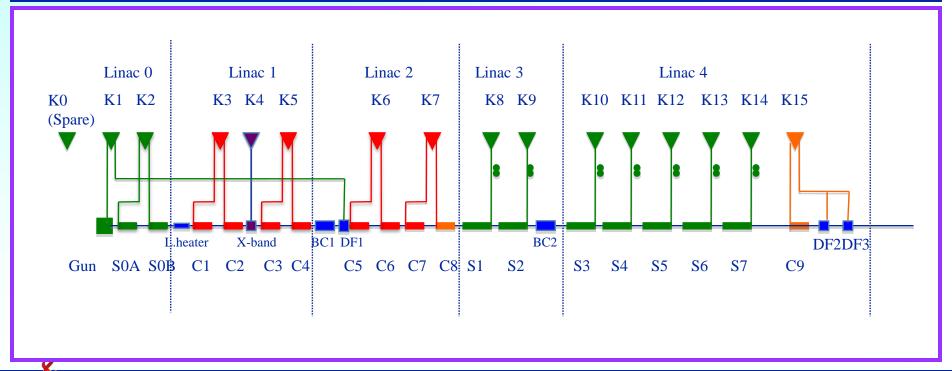






LINAC, High Power System

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.







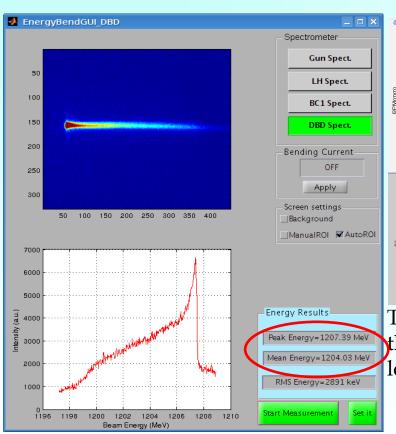
LINAC, 3 GHz RF Power Plant (14 are installed)







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





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FERMI Calendar 2010

2010 FERMI@Elettra Beam and Shutdown schedule												
Mo		Febbraio February	Marzo March	Aprile April	Maggio May	Giugno June	Luglio July	Agosto August	Settembre September	Ottobre October	Novembre November	Dicembre Mese December Month
giorr ITA	o date Shift K	date Shift K	date Shift M L N	K date Shift K	date Shift K	date Shift K	date Shift K	date Shift K	date Shift K	ate Shift K	date Shift K	date Shift K week day W ENG
L Installation with beam possible from Installation with beam possible in EH: PADRES and Beamlines M Installation with beam												
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L	4 Instal.	1 2	1	5	3	7	5	2 Install		4	1	5 S
M	6 through	3 CoOcc UH	3	6 CoOcc SG	4 5	8 9 10 23	6 7	3 Sprea- 4 der	8	5 6	2 3	7 T W
V	8 Spectro	4 5 5 2 nd	5	9 8 14 9 Install	7	11	9 27	⁵ FEL-1; ³	10	7 40 8	4 44	9 49 T 10 F
S D	10	6 phase 7 Comm.	7	10 BC1 11 chicane	8 9	12 13	10 11	8	12 1	9 10	6 7	11 S 12 S
M		8 L1 9 through	8 9 10	12 and C5; 13 temp	10 CoOcc EH 11 12	14 15 16	12 13	9 10 11	14 1	11 12 13	8 RUN 5 Comm.	13 M 14 T 15 W
G	14 2		10 11 12	14 wall 10 15 <mark>removal</mark> 15 16			14 15 28 16	12 13	2 16 37 1	14 41 15 Cons.ant.	10 FEL-1 45	15 W 16 50 T 17 F
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L	18	15 16	15 16	19 20	17 18	21 RUN 3	19	16 17	20 RUN 4 1	18	15 16	20 M 21 T
M	20	17 18	17 18	21	19	23 Comm.		18		20 FEL-1	17 18 46	22 W 23 51 T
V		19	19	23	21 22	25 beam 26 through	23 24	20	24 FEL-1 2	22 Install PEL-1	19 20	24 F
D	24	21 22	21 22	25 26	23	27 DBD	25 26	23	26 MBD 2	24 Undul- 25 ators	21 22	26 S
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M			31									W



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