

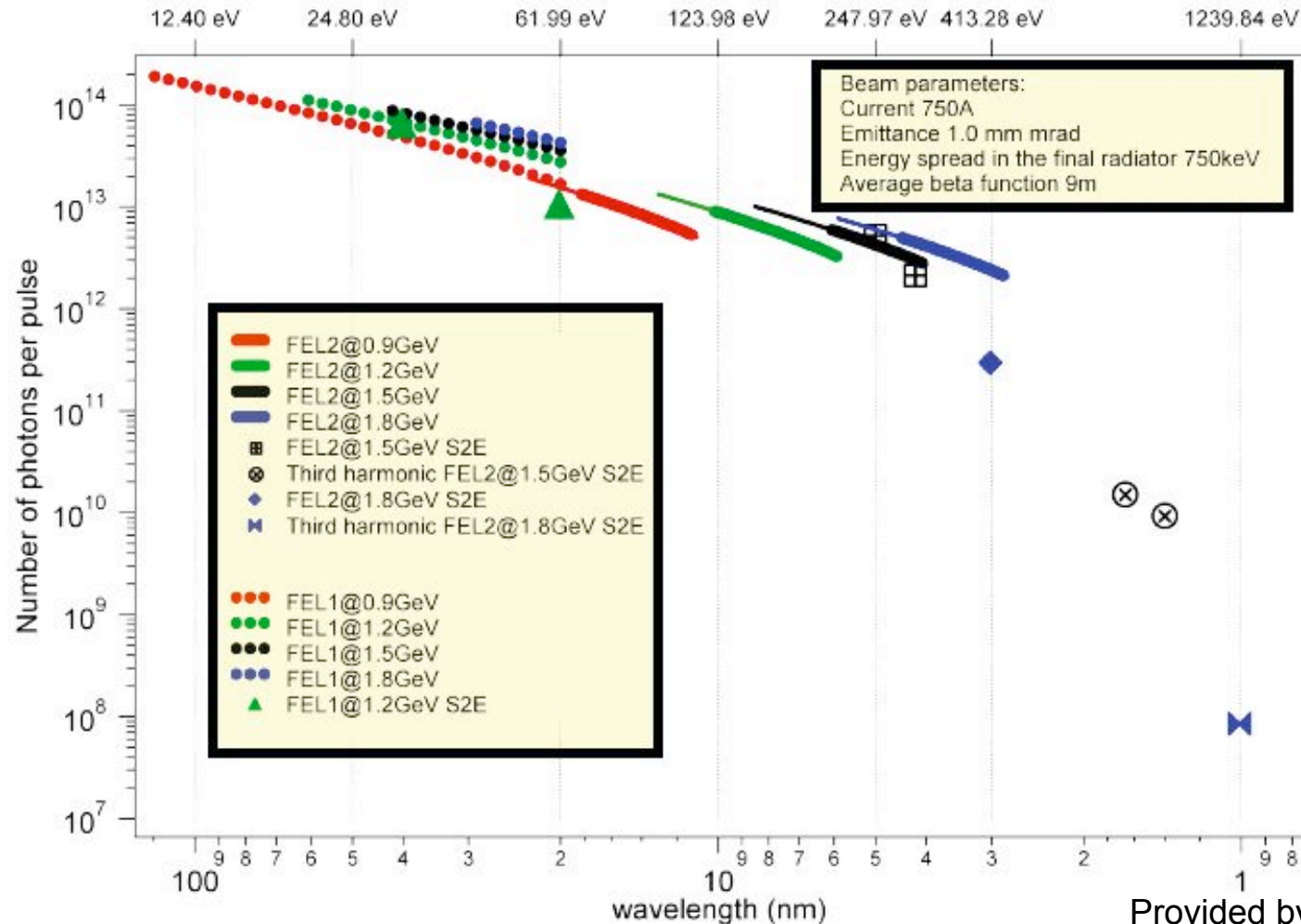


FERMI FEL Update

ESLS 2010: 25, 26 November 2010

S. Milton Representing the FERMI Team

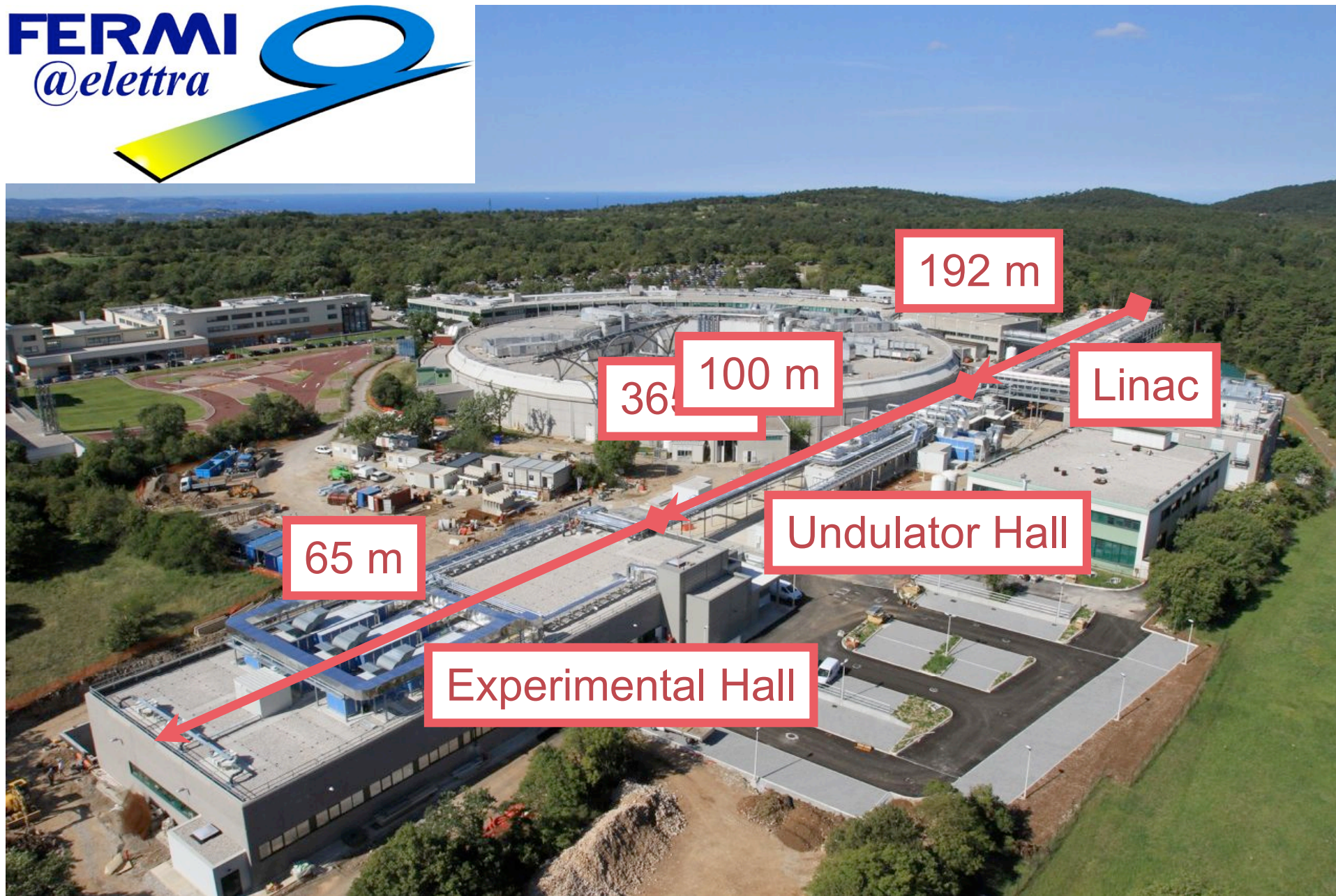
- Seeded FEL User Facility
 - Utilizes the High-gain Harmonic Generation Scheme
 - Two complimentary FEL Lines
 - FEL 1: Single stage HGHG with Ti:S/OPA seed source
 - FEL 2: Cascaded, 2-stage HGHG with Ti:S/OPA seed source
 - Tuneable wavelengths from 100 nm to 4 nm (Fundamental)
 - Variable polarization (APPLE II Undulators)
- 4 Approved and 3 Funded scientific research programs/collaborations
 - Low Density Matter (Funded)
 - Elastic and Inelastic Scattering (Funded)
 - Diffraction and Projection Imaging (Funded)
 - Magnetic Dynamics (Approved)

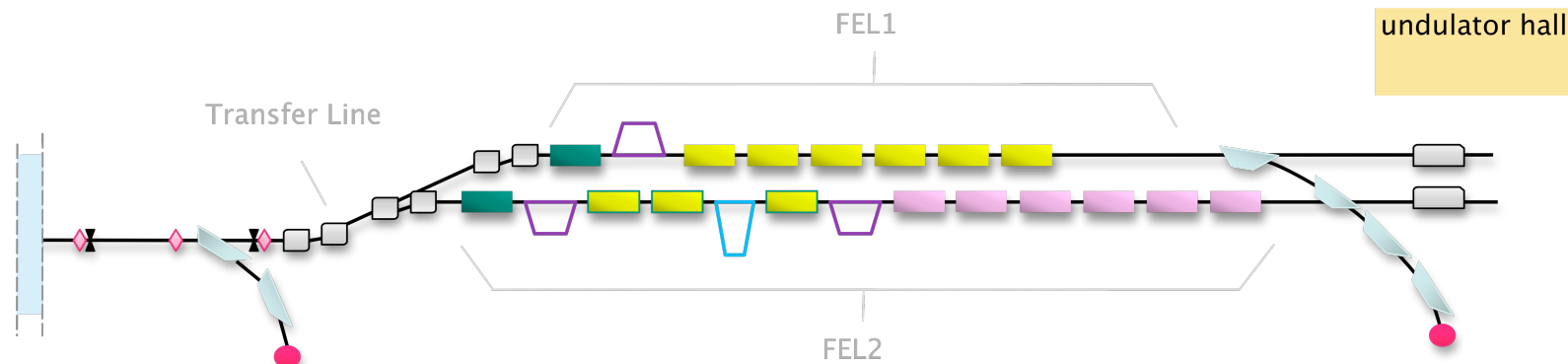
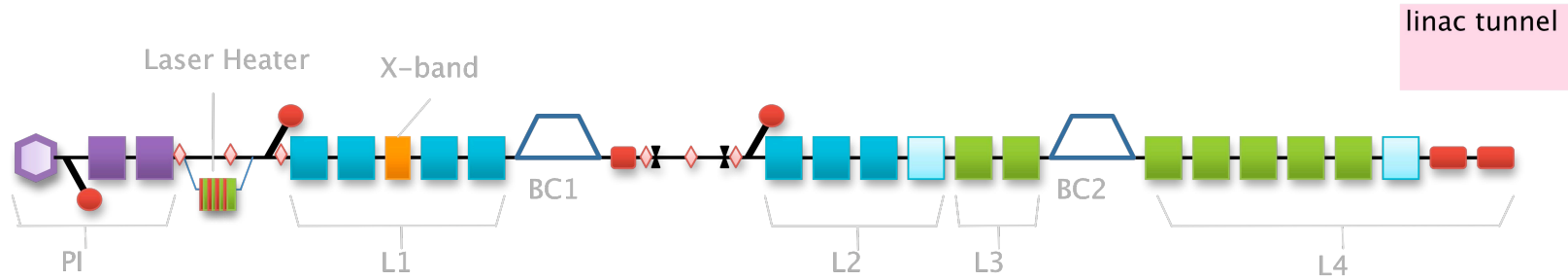


Provided by E. Allaria

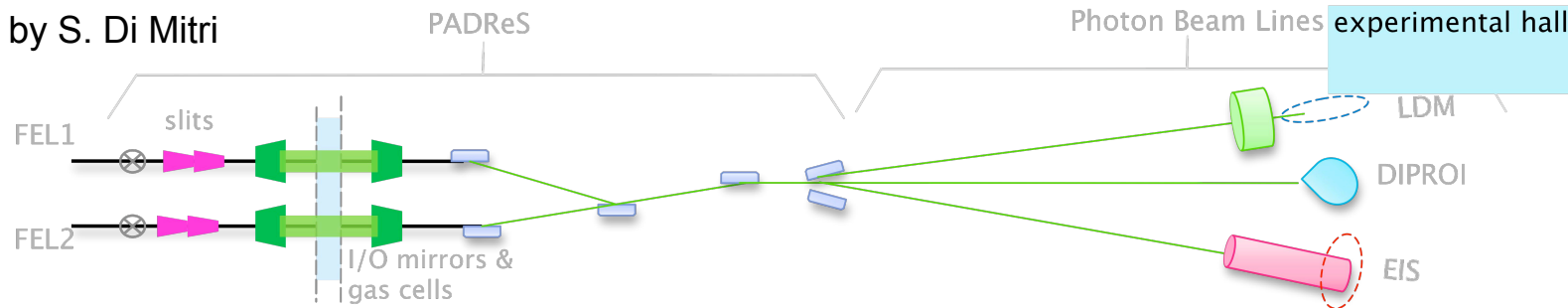
Lines predicted using M.Xie formulae for expected FERMI parameters assuming 40fs pulse length
 Points Ginger and Genesis simulations for S2E files

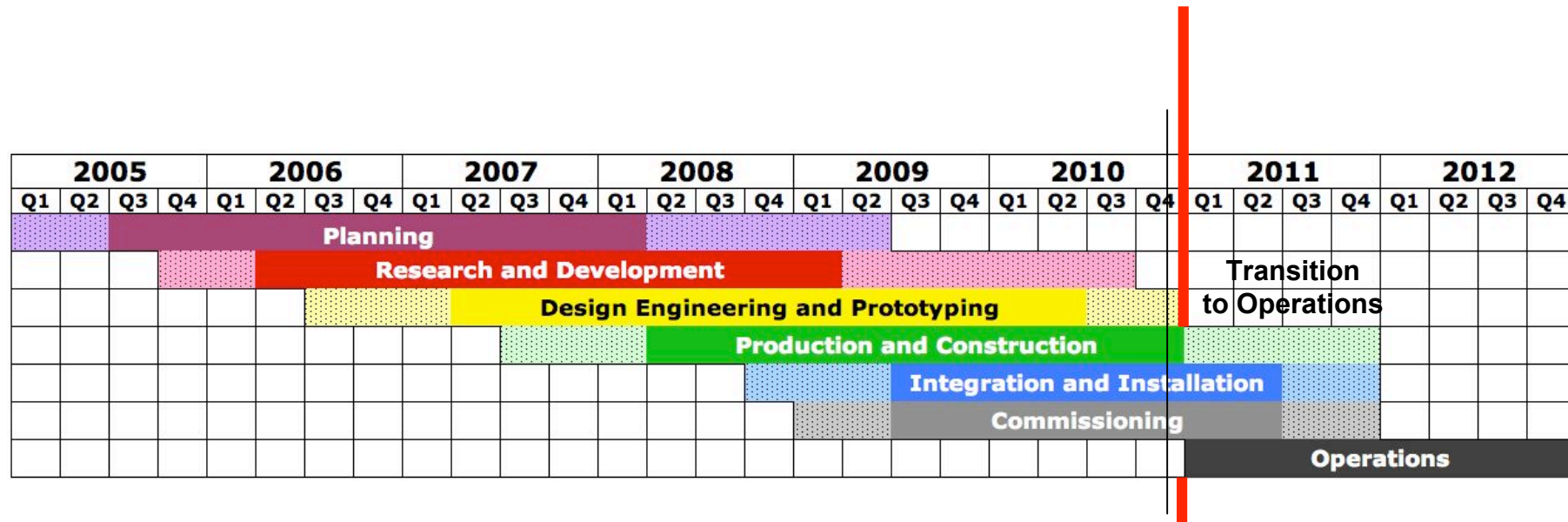
Parameter	FEL-1	FEL-2
HGHG Stages	1	2 ("fresh bunch" in 2nd stage)
Fundamental Wavelength range [nm]	100 to 20	20 to 4.2 (1.4 at 3rd harm.)
Output pulse length (rms) [fs]	< 100	20 – 100 (< 10 future goal)
Bandwidth (rms) [meV]	17 (at 40 nm)	100 (at 4.2 nm)
Polarization	Fully Variable	Fully Variable
Repetition rate [Hz]	50	50
Peak power [GW]	1 to >5	0.5 to 2
Harmonic peak power (% of fundamental)	~2	~0.2 (at 4.2 nm)
Photons per pulse	10^{14} (at 40 nm)	2×10^{12} (at 4.2 nm)
Pulse-to-pulse stability	≤ 30 %	~40 %
Pointing stability [μ rad]	< 20	< 20
Virtual waist size [μ m]	250 (at 40 nm)	120
Divergence (rms, intensity) [μ rad]	50 (at 40 nm)	10 (at 4.2 nm)





Provided by S. Di Mitri





□ “Shaded” areas merely underline the fact that there are many areas involved, some of which are phased to start earlier or later than other areas



Photo F. Cianciosi

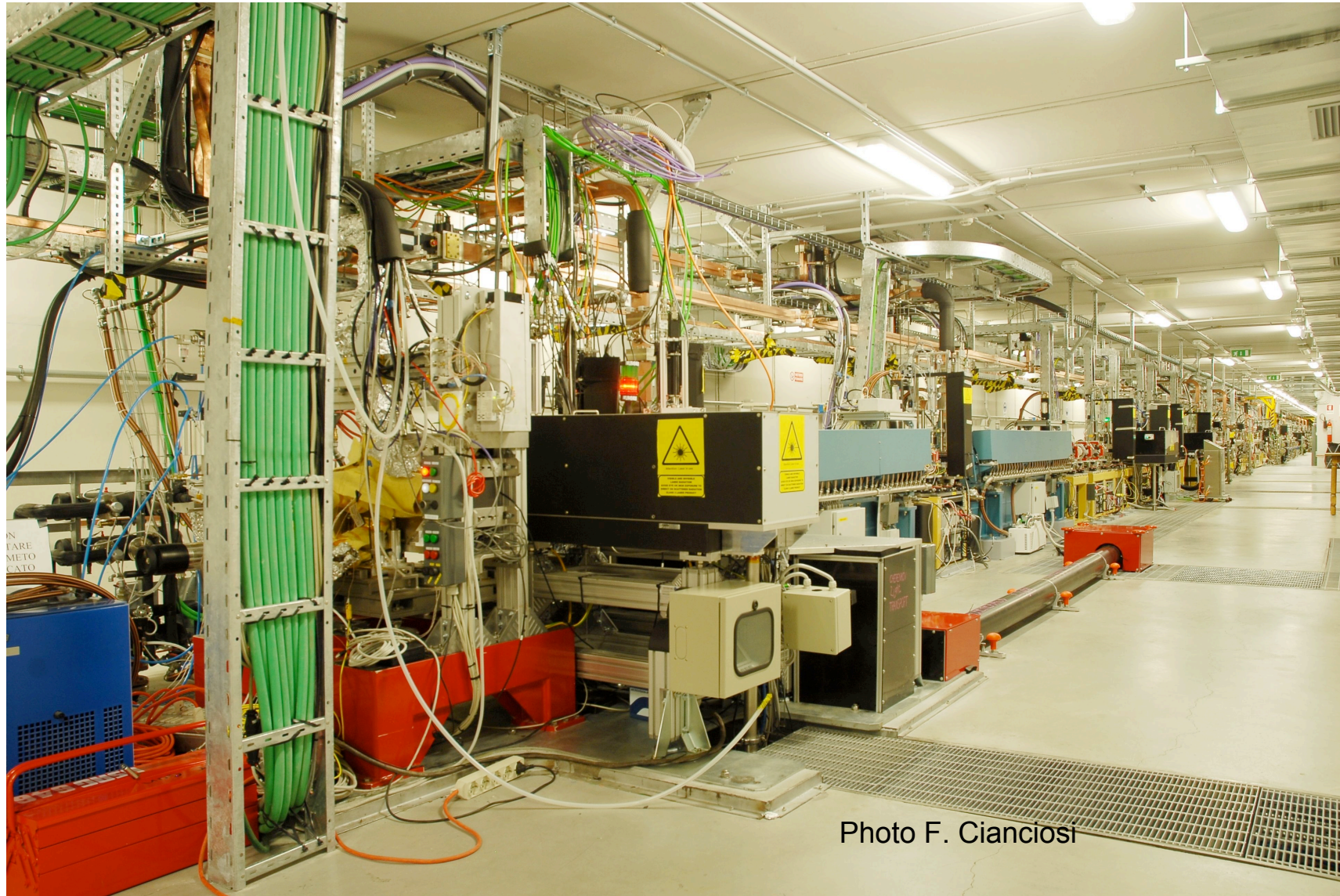


Photo F. Cianciosi



Photo F. Cianciosi

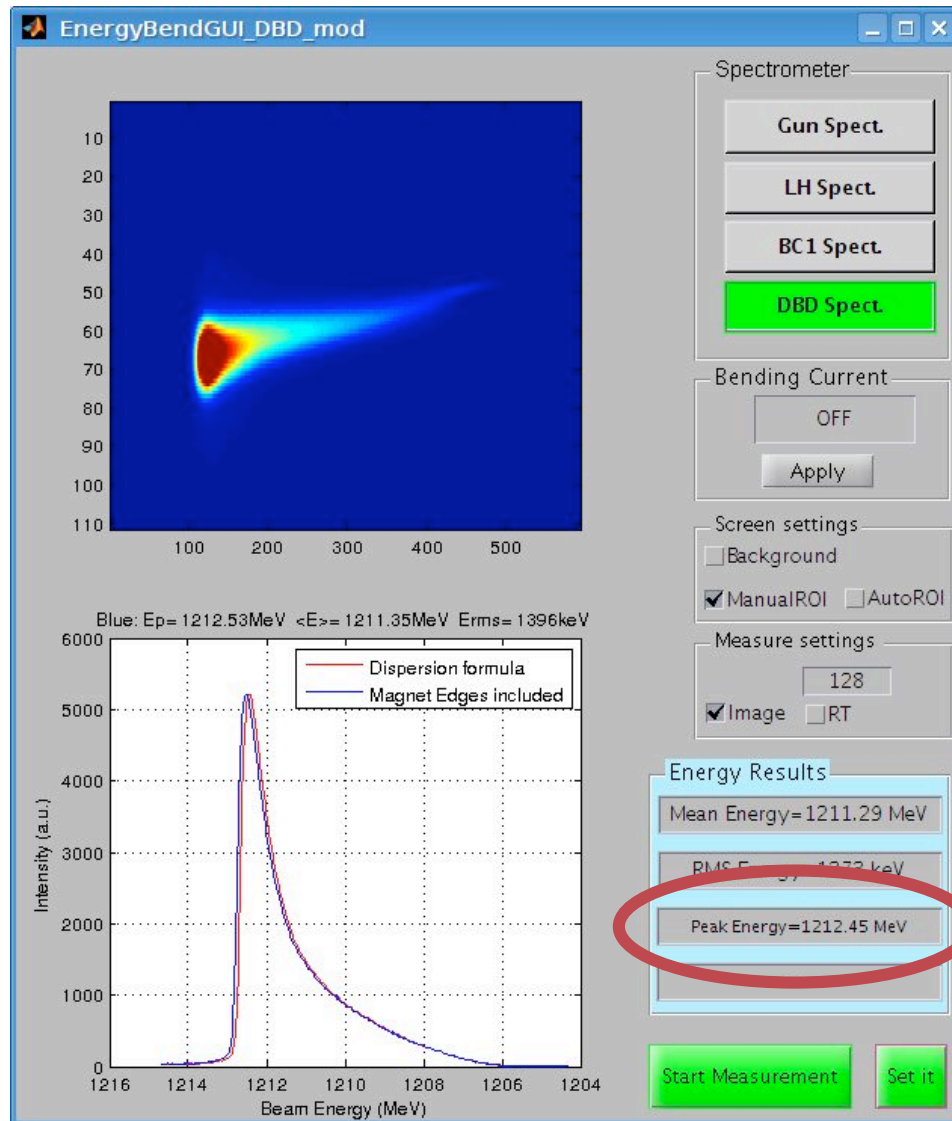


Photo F. Cianciosi





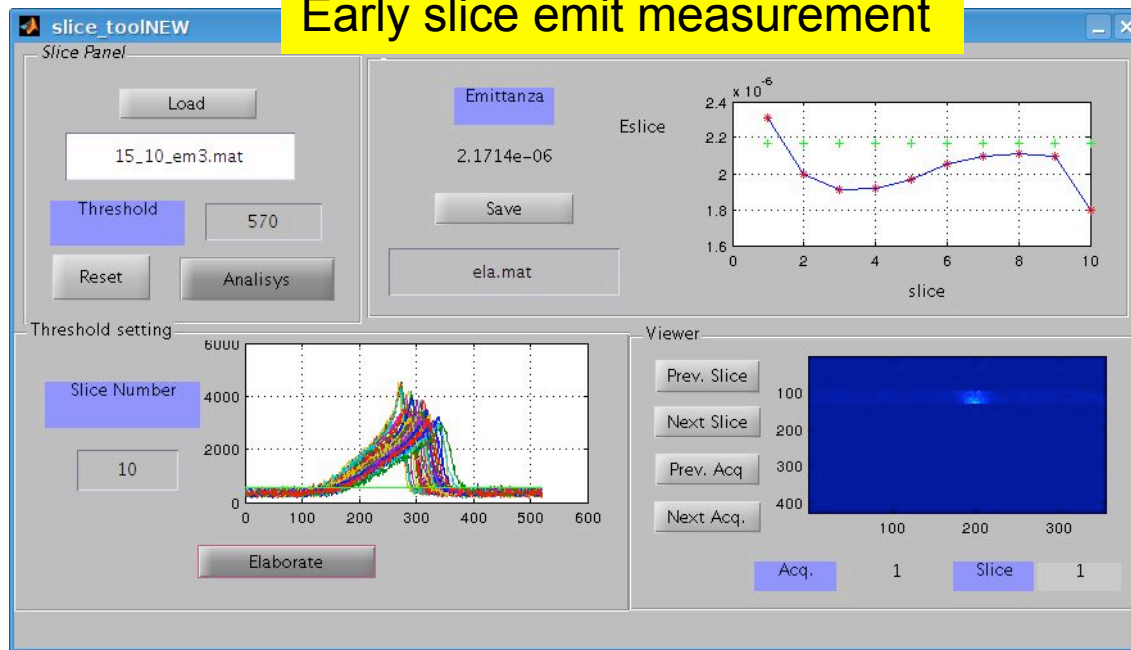
Photo F. Cianciosi



- 1.212 GeV (on crest)
- Some notes:
 - 7 High Impedance Cavities hooked to SLED (SLAC Linac Energy Doubling) cavities)
 - All SLED cavities were detuned for this measurement
 - We have not started using the SLED cavities
 - Expect > 1.5 GeV once we start to use the SLED system

Where	ϵ_X (mm-mrad)	ϵ_Y (mm-mrad)
Laser heater (optimum)	0.75	1.10
Laser heater (matched)	1.25	1.15
Bunch compressor 1 (Comp. Factor = 1, matched)	1.30	1.60

Early slice emit measurement



□ Caveat

- We are seeing emittance growth following the bunch compression and following the high impedance accelerating structures.
- This growth is currently a hot topic of study.

- Lase at 65 nm
 - Configuration
 - HGHG (i.e. SASE is only the fallback position)
 - No wavelength tuning
 - Horizontal polarization
 - Requires
 - Transverse and longitudinal overlap of electron beam and seed laser pulse
 - Laser wavelength (260 nm), beam energy (1.15 GeV), and modulator undulator gap settings all commensurate with one another
 - Plausible slice emittance ($< 2 \mu\text{m}$) and peak current ($> 200 \text{ A}$)
 - Suitable, functional diagnostics and controls
 - Additional Hope
 - Perform 1st rudimentary experiment (Young's Slit: transverse coherence)

2011 Draft FERMI Operations Schedule

5 November 2010

Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec														
Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts			Date	Shifts										
	N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E		N	D	E
1				1				1				1				1				1				1				1				1															
2				2				2				2				2				2				2				2				2															
3				3				3				3				3				3				3				3				3															
4				4				4				4				4				4				4				4				4															
5				5				5				5				5				5				5				5				5															
6				6				6				6				6				6				6				6				6															
7				7				7				7				7				7				7				7				7															
8				8				8				8				8				8				8				8				8															
9				9				9				9				9				9				9				9				9															
10				10				10				10				10				10				10				10				10															
11				11				11				11				11				11				11				11				11															
12				12				12				12				12				12				12				12				12															
13				13				13				13				13				13				13				13				13															
14				14				14				14				14				14				14				14				14															
15				15				15				15				15				15				15				15				15															
16				16				16				16				16				16				16				16				16															
17				17				17				17				17				17				17				17				17															
18				18				18				18				18				18				18				18				18															
19				19				19				19				19				19				19				19				19															
20				20				20				20				20				20				20				20				20															
21				21				21				21				21				21				21				21				21															
22				22				22				22				22				22				22				22				22															
23				23				23				23				23				23				23				23				23															
24				24				24				24				24				24				24				24				24															
25				25				25				25				25				25				25				25				25															
26				26				26				26				26				26				26				26				26															
27				27				27				27				27				27				27				27				27															
28				28				28				28				28				28				28				28				28															
29				29				29				29				29				29				29				29				29															
30				30				30				30				30				30				30				30				30															
31				31				31				31				31				31				31				31				31															

Legend

- Operation Training and Machine Studies
- Machine Studies
- Experimental Systems Beam Time
- Maintenance and Installation
- Still under negotiation

svm

- ❑ Second Bunch Compressor
 - Install in April/May 2011
- ❑ LLRF System Completion
 - August 2011
- ❑ X-Band
 - Install April/May 2011
- ❑ 50 Hz Operations
 - By end of 2011
- ❑ High Energy RF Deflectors
 - Installation date undetermined
- ❑ FEL II
 - Complete installation August 2011
- ❑ Photon Transport and Beam Lines
 - Complete installation April/May 2011
- ❑ Experimental Stations
 - All initial stations (LDM, DiProI, EIS) in final locations by Aug. 2011
 - But will be used in temporary location prior to that

- FEL III
 - Convert FEL I to use an HHG source provided through a collaboration with the University of Twente (Netherlands)
 - Time frame: roughly 2 years
- FEL IV (?)
 - Convert FEL II to use the echo-enabled harmonic generation scheme
 - Present configuration is compatible with this
 - Would require FEL III to be able to fully replace FEL II and service the scientific program
- Increase Beam (Photon) Energy (?)
 - Install high-gradient x-band systems at the end of the linac and even replace some of the high impedance s-band structures with x-band systems
 - 2.5 GeV certainly possible in present building



If it were only this easy...



If it were only this easy...

