Science Drivers for
Hard X-Ray Upgrades
to LCLS

SLAC NATIONAL ACCELERATOR LABORATORY

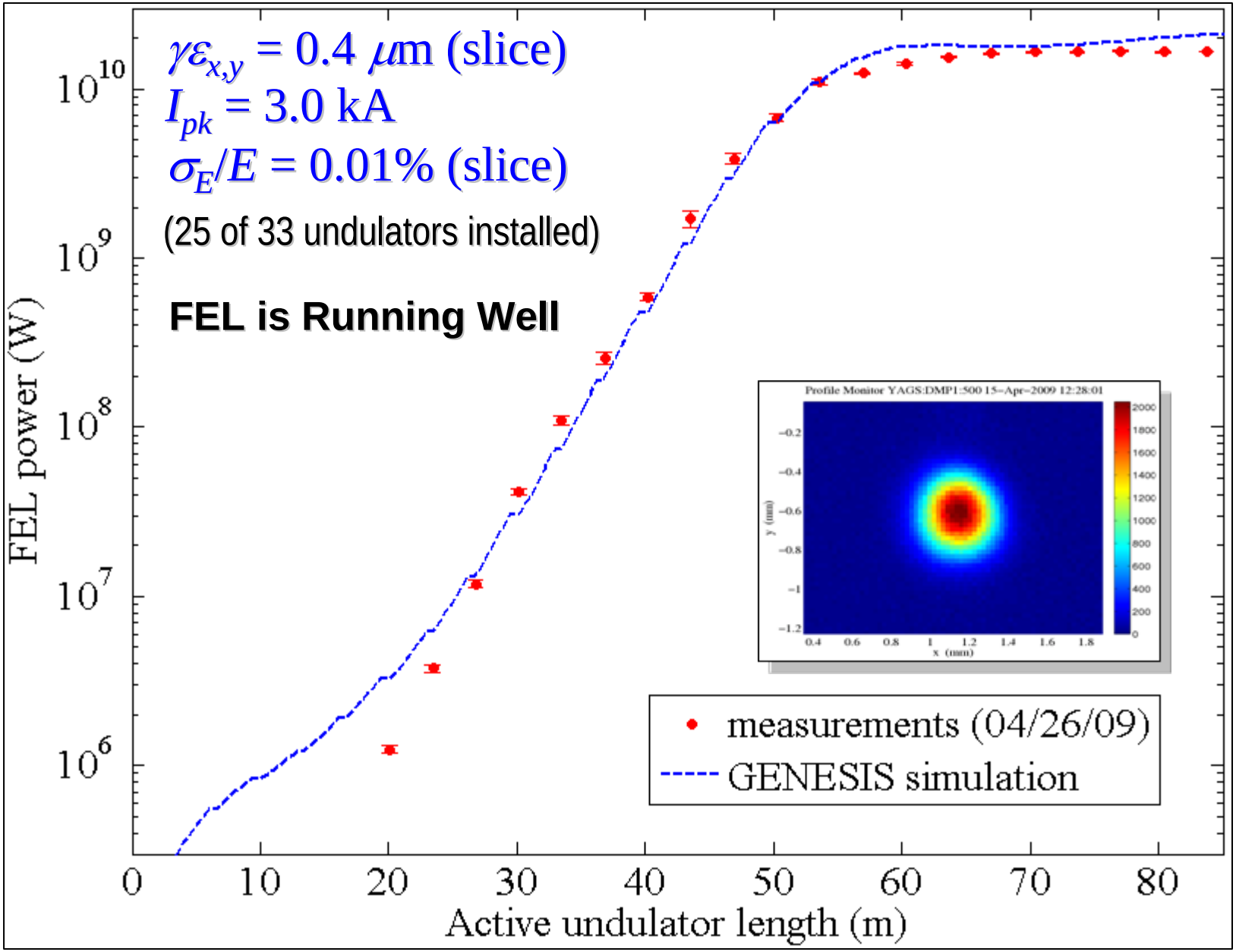
LCLS Upgrade Opportunities Overview

P. Emma

July 29, 2009

132 meters of FEL Undulator Installed

Undulator Gain Length Measurement at 1.5 Å: 3.3 m



Design and Typical Measured *LCLS* Parameters at 1.5 Å

Table 1: Design and typical measured parameters. Stability values are taken over a few minutes and measured at 13.6 GeV.

Parameter	sym.	design	meas.	unit
Accelerator Parameters				
Bunch charge	Q	1	0.25	nC
Final linac e^- energy	γmc^2	13.6	13.6	GeV
Init. bunch length (fwhm)	Δt_0	10	6.5	ps
Final peak current	I_{pk}	3.4	3.0	kA
Proj. emittance (injector)	$\gamma\varepsilon_{x,y}$	1.2	0.4-0.7	μm
Slice emittance (injector)	$\gamma\varepsilon^s_{x,y}$	1.0	0.4	μm
Proj. emittance (14 GeV)	$\gamma\varepsilon^L_{x,y}$	1.5	0.5-1.6	μm
Single bunch rep. rate	f	**120**	**10-30**	**Hz**
RF gun field at cathode	E_g	120	115	MV/m
UV laser energy on cath.	u_l	250	12	μJ
UV laser diam. on cath.	$2R$	1.5	1.2	mm
Cathode quantum eff.	QE	6	10	10^{-5}
FEL Parameters				
Photon wavelength	λ_γ	**1.5-15**	**1.4-15**	**Å**
FEL 3-D gain length	L_G	**4.5**	**~3.3**	**m**
Photons per pulse	N_γ	**1.5**	**1.1-1.9**	**10^{12}**
X-ray energy per pulse	E_γ	**2**	**1.5-2.5**	**mJ**
X-ray peak power	P_{FEL}	**10**	**17-36**	**GW**
Final pulse length (fwhm)	Δt_f	**230**	**70-90**	**fs**
Photon bandwidth (fwhm)	$\Delta\upsilon$	**0.05**	**~0.15**	**%**
Stability Parameters				
e^- energy stability (rms)	$\Delta E/E$	0.1	0.04	%
e^- x,y stability (rms)	x/σ_x	10,10	15,10	%
e^- timing stability (rms)	Δt	120	50	fs
Peak current stab. (rms)	$\Delta I/I$	12	10	%
Charge stability (rms)	$\Delta Q/Q$	2	2.5	%
FEL power stability (rms)	$\Delta P/P$	**30**	**10-15**	**%**

Workshop Program - Proposals

- Polarization Control (Y. Ding)
  - **Can combine with the 2nd harmonic after-burner scheme**
- Short Wavelength Options (Z. Huang)
  - **2nd Harmonic After-Burner**
  - **New Adjustable Gap Undulators**
  - **28-GeV FEL at SLAC**
- Tera-Hertz Pump (H. Loos)
  - **Tera-Hertz generation, timing, and transport**
- Short Pulse Length Options (J. Frisch)
  - **20-pC Bunch Charge**
  - **Slotted Spoiler**
- Self-Seeding and Harmonic Generation (J. Wu)
  - **Possibly self seeded AND 2nd harmonics?**
- Laser Manipulation of the e- Beam (A. Zholents)
  - **ESASE & synchronization**
  - **few-cycle modulation and attosecond pulses**