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XFEL Simulations with SIMPLEX and GENESIS

(Some preliminary results)

OUTLINE

1. Simulation software.
2. Test with sample input files.
3. Beam parameters.
4. Focusing lattice.
5. Some results of XFEL study with SIMPLEX and GENESIS
6. Questions

SIMULATION SOFTWARE

GENESIS (2001)

S. Reiche, "Numerical Studies for a Single Pass High Gain Free-Electron Laser", DESY print, DESY-THESIS-2000-012 (2000)

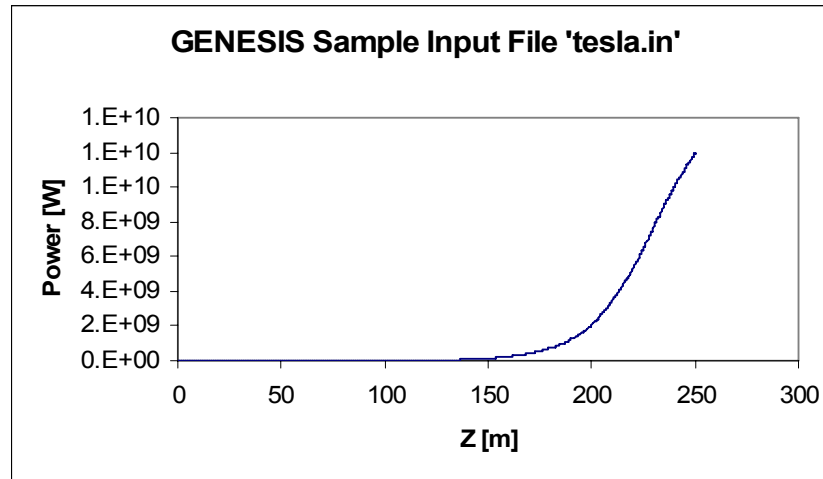
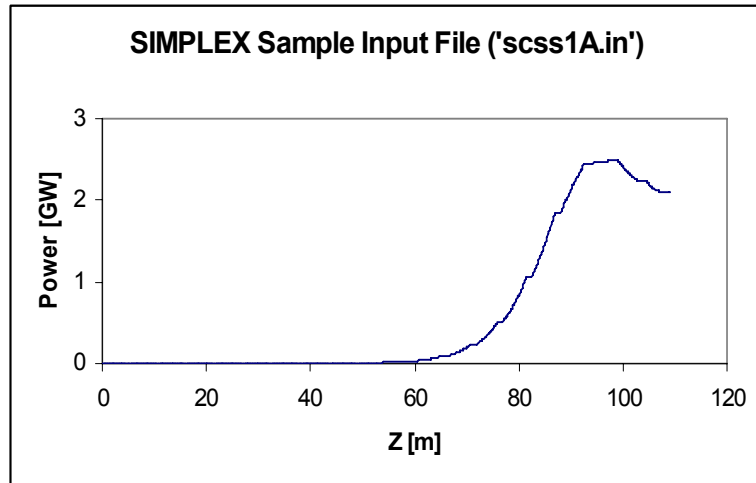
<http://pbpl.physics.ucla.edu/reiche> (official website)

SIMPLEX (2005)

[1] T. Tanaka, "FEL simulation code for undulator performance estimation", Proc. FEL2004, Trieste (2004)

<http://radiant.harima.riken.go.jp>

TEST WITH SAMPLE INPUT FILES



4. Undulator system

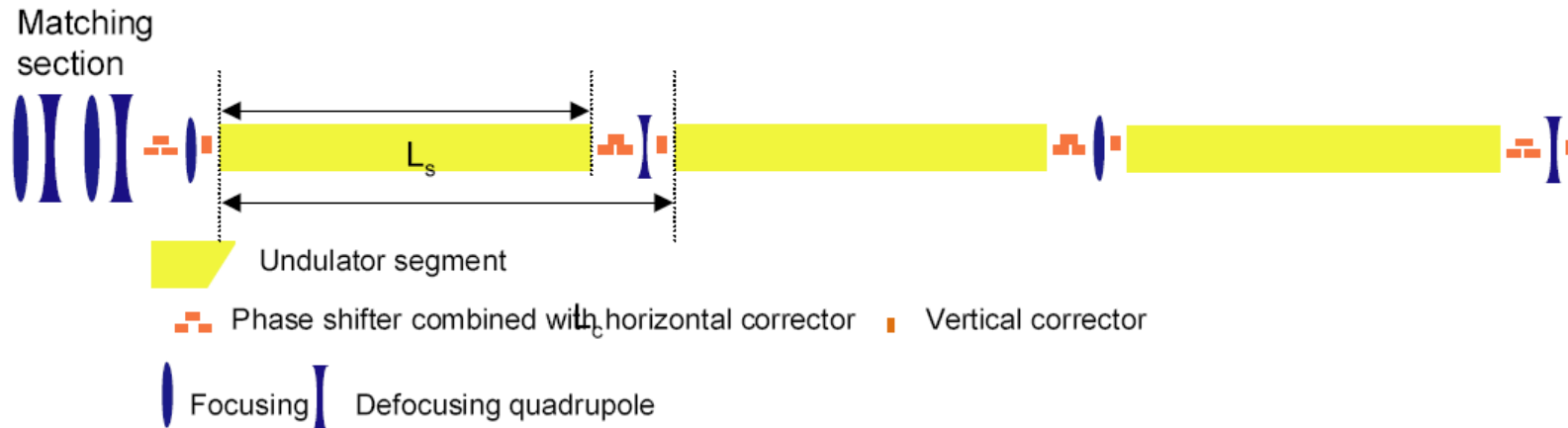
Undulator system parameters are defined in the result of detailed simulation (with actual number of the particles) with the FAST code [TDR]

	λ [nm]	λ_u [mm]	g [mm]	B_{max} [T]	K	β [m]	L_{rat} [m]
SASE1	0.1	35.6	10	1	3.3	32	133
SASE2	0.1	47.9	19	0.63	2.8	45	174
	0.4		10	1.37	6.1	15	72
SASE3	0.4	80.0	23	0.44	3.3	15	81
	1.6		10	0.91	6.8	15	50
	4.9		10	0.91	6.8	15	45

Focusing lattice(SASE1)

Lattice type	Doublet (FODO without dipoles)
Focusing gradient (F) [T/m]	18
Defocusing gradient (D) [T/m]	-18
Focusing lens width [m]	0.2
Defocusing lens width [m]	0.2
F – D distance [m]	6.1
Period length [m]	12.2
Number of periods	17

SASE1 undulator line description (S2E meeting, March 10, 2004)

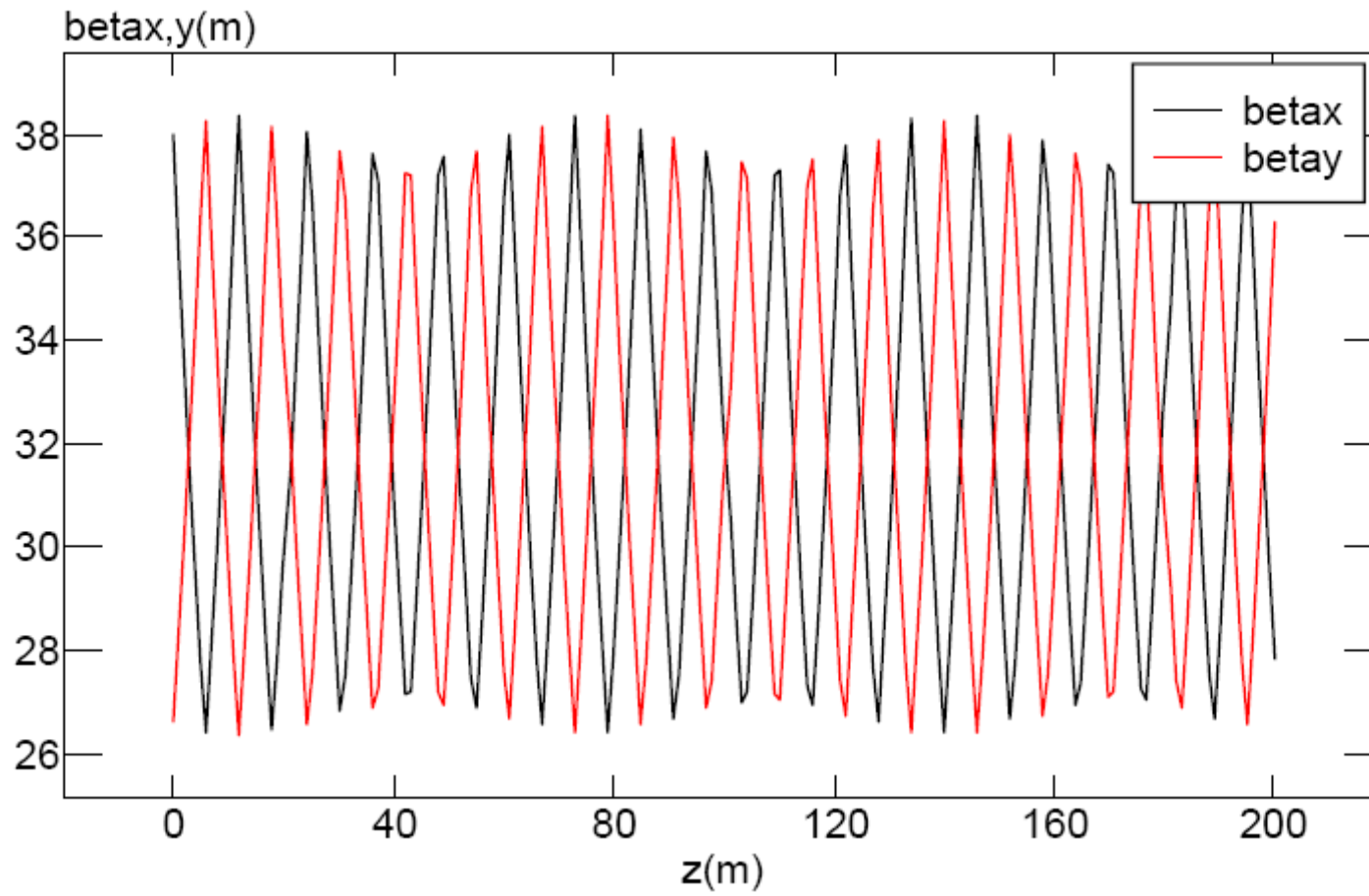


Matching described by Yujong Kim

Phase shifters not included

Quadrupole length/strength adjusted to increase stepsize

Beta function in the SASE1 undulator

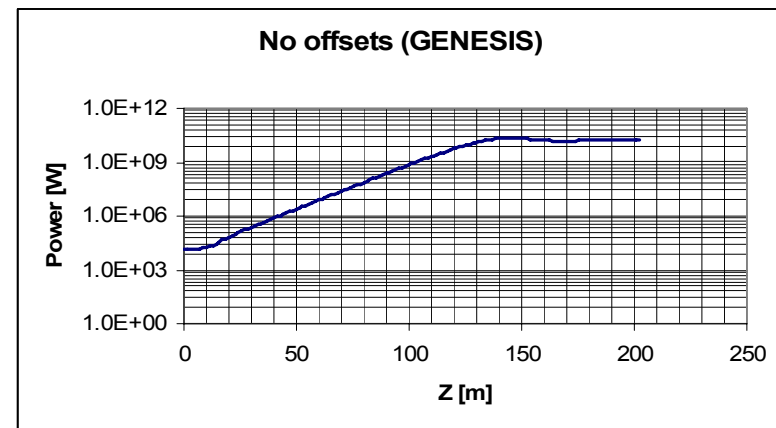
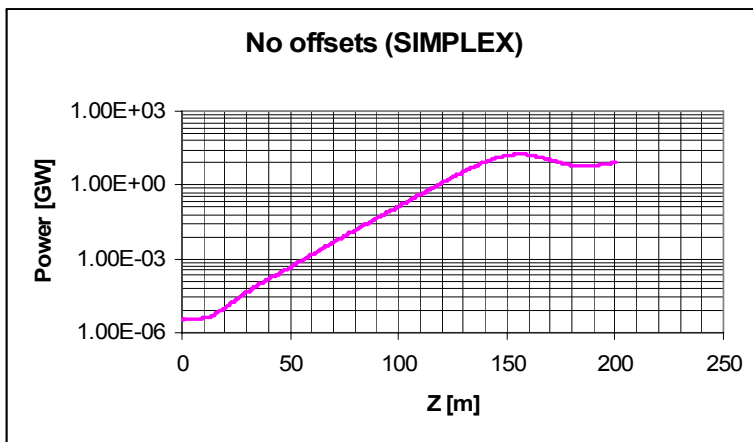
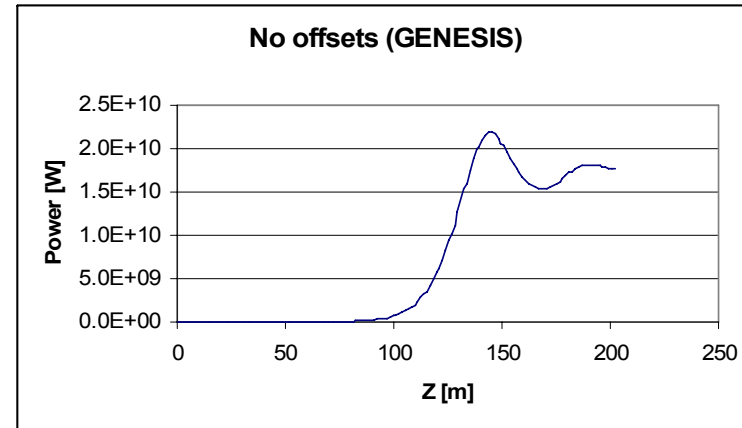
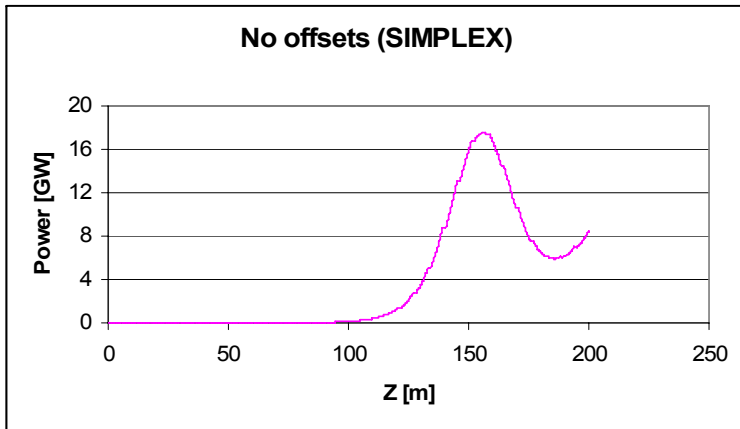


Beam parameters

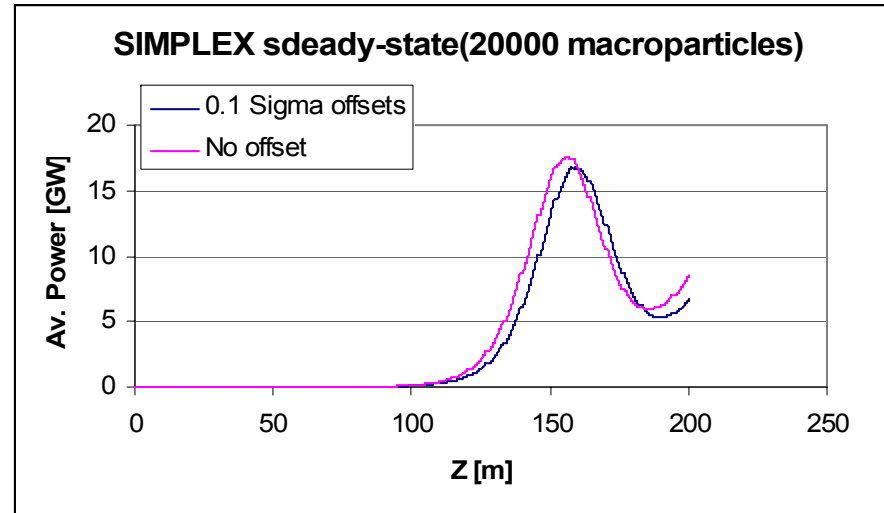
Bunch parameters at the entrance of the undulator system SASE1

Electron energy [GeV]	17.5
Bunch length [m]	2.5×10^{-05}
Bunch charge [nC]	1
Emittance, ε_x [mm-mrad]	1.4
Emittance, ε_y [mm-mrad]	1.4
Energy spread [MeV]	1.5 (8.57×10^{-05})
Peak current [kA]	5
Bunch shape	Nearly Gaussian
γ	34246.6
σ_x [mm]	0.03620
σ_y [mm]	0.03620
$\sigma_{x'}$ [mrad]	1.13×10^{-3}
$\sigma_{y'}$ [mrad]	1.13×10^{-3}

POWER PLOTS (SASE1)



BEAM OFFSET AT THE ENTRANCE OF THE UNDULATOR (SASE1)



Peak Power [GW]

	GENESIS	SIMPLEX
No offsets	21.17	17.4
0.1 Sigma offsets	20.67	16.3
1.0 Sigma offsets	0.0173	0.004

QUESTIONS

- If given arrangement of undulator system is adequate, is 8 cm space enough for vertical corrector?
- What is the most appropriate criterion to define FEL performance (brilliance, saturation length, # of photons)?