Work progress in July 2013

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MPY, DESY

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The plan for last month

1. The particle distribution file conversion from genesis output to Astra input at the exit of SASE1 for 0.5nC charge case. (60%)

2. Beam dynamics simulation for EXFEL SASE1 for other different bunch charge cases (1.0nC, 0.25nC, 0.1nC, 0.02nC) (80%)

Particle distribution file conversion from genesis output to Astra input

Sven's advice:

1. Getting the newest version of Genesis which supports HDF5 output.
2. Setting IONE4ONE=1 and ZSEP=1.
   The macro particles have the same charges per slice.
   Avoiding artificial spikes generating in the current profile.

Slice number estimation for SASE1 genesis calculation

At the entrance of SASE1,
Peak current : 5kA
Beam energy : 17.5GeV
Total bunch length : ~ 70 μm

For SASE1,
Radiation wavelength: ~ 9.49×10^{-11}m

➡ Nslice=(s1-s0)/(ZSEP×XLAMDs) =737619

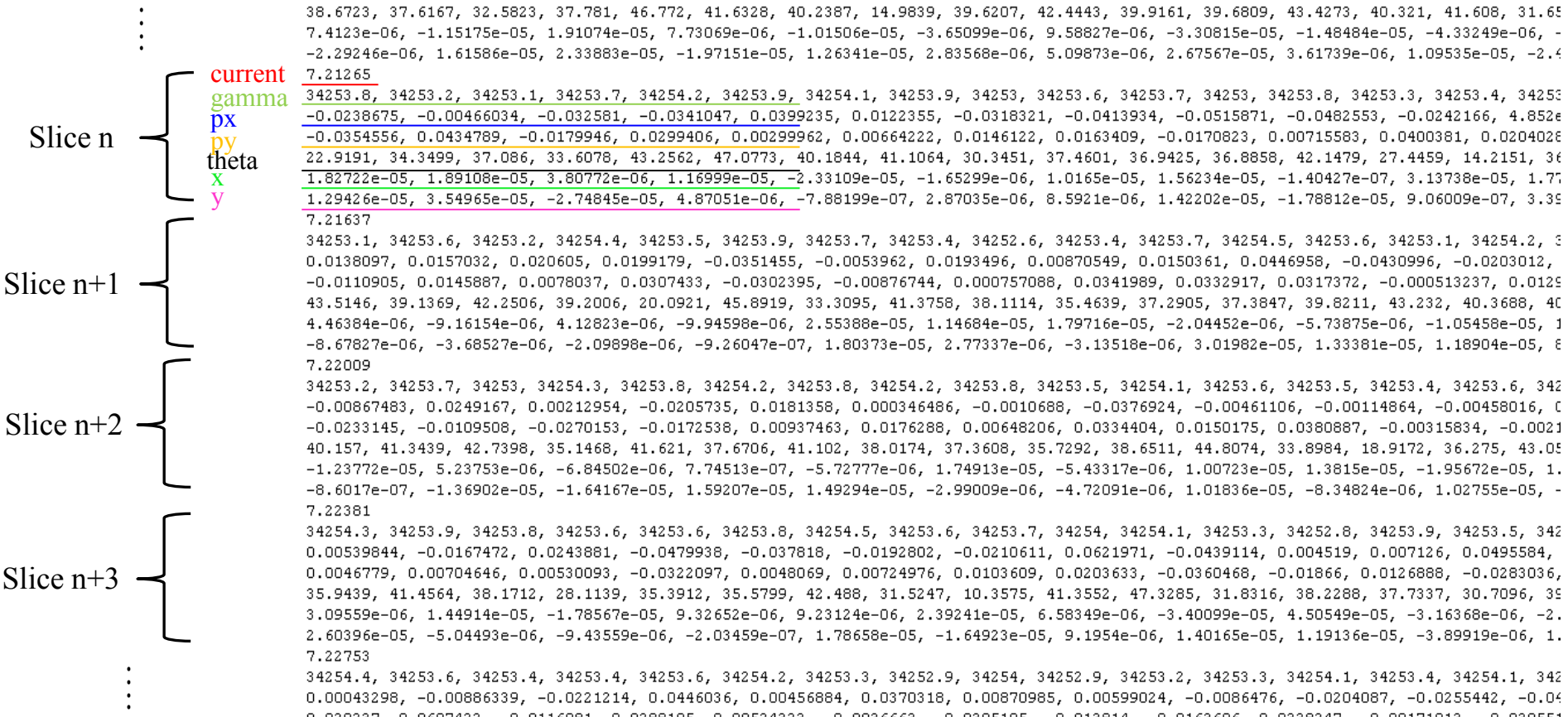
Particle distribution file conversion from genesis output to Astra input

(1)Npar = 8000
(2)Npar = 400, Size of output file ~ 200GBytes

complete it as the following steps:

1. Getting the particle distribution file (HDF5 format) with newest version genesis. (done)
2. Particle distribution file conversion from HDF5 format to ASCII format. (done)
3. Particle distribution file conversion from genesis output file (ASCII format) to a normal 6D phase space file. (wrote a matlab script, doing conversion…)
4. Use a random generator to pick the particles with reasonable number from the 6D particle distribution file and generate a new file. Then convert it to a file with Astra input format.

Structure of Genesis particle output file



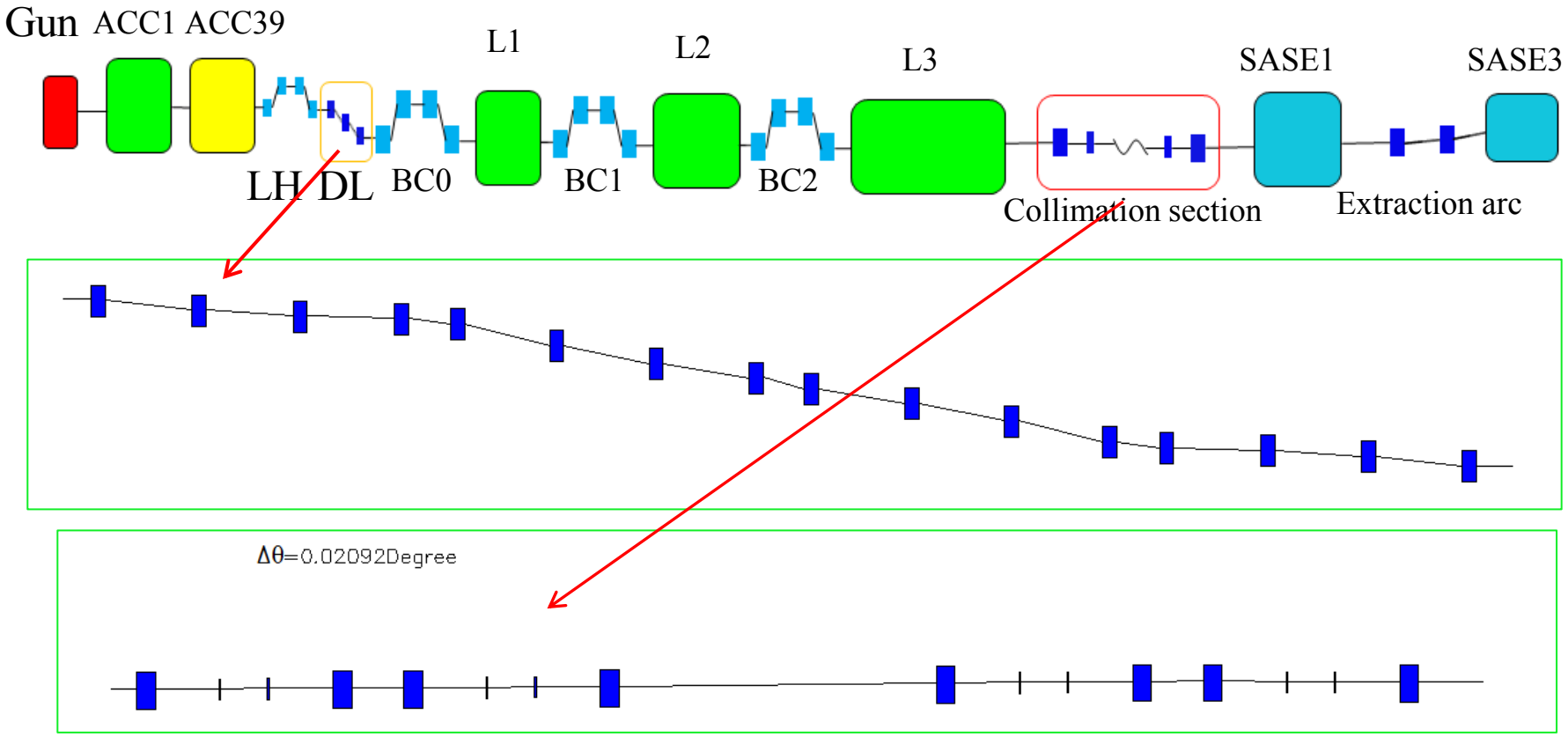
Normal 6D phase space

Number	1	2	3	4	5	6
Parameter	x	y	z	px	py	pz
Unit	m	m	m	eV/c	eV/c	eV/c

Beam dynamics simulation for SASE1 for different bunch charge cases (100%)

- **At the end of the linac**
  E=17.5GeV
  I_{peak}=~5.0kA
- **Beam energy at some key positions**

$E_1 = 130\,\text{MeV}$ $E_2 = 700\,\text{MeV}$ $E_3 = 2400\,\text{MeV}$ E_4=17.5GeV



Beam dynamics simulation for SASE1 for different bunch charge cases

Parameters for the bunch compressors*

Charge Q, nC	Momentum compaction factor in Dogleg $R_{56,dogleg}$ [mm]	Momentum compaction factor in BC_0 $R_{56,0}$ [mm]	Total compr. $C_{dogleg}*C_0$	Momentum compaction factor in BC_1 $R_{56,1}$ [mm]	Compr. in BC_1 C_1	Momentum compaction factor in BC_2, $R_{56,2}$ [mm]	Total compr. C
1.0	-30.1	-62.00	3.5	-54	8	-20	121
0.5	-30.1	-54.80	3.5	-50	8	-20	217
0.25	-30.1	-48.20	3.5	-50	8	-20	385
0.10	-30.1	-43.90	3.5	-50	8	-20	870
0.02	-30.1	-41.40	3.5	-50	8	-20	4237

* Igor Zagorodnov, M. Dohlus, A semi-Analytical Modelling of Multistage Bunch Compression with Collective Effects, Physical Review STAB 14(2011), 014403
* Igor Zagorodnov, Beam Dynamics Simulations for XFEL, BD meeting, 2011

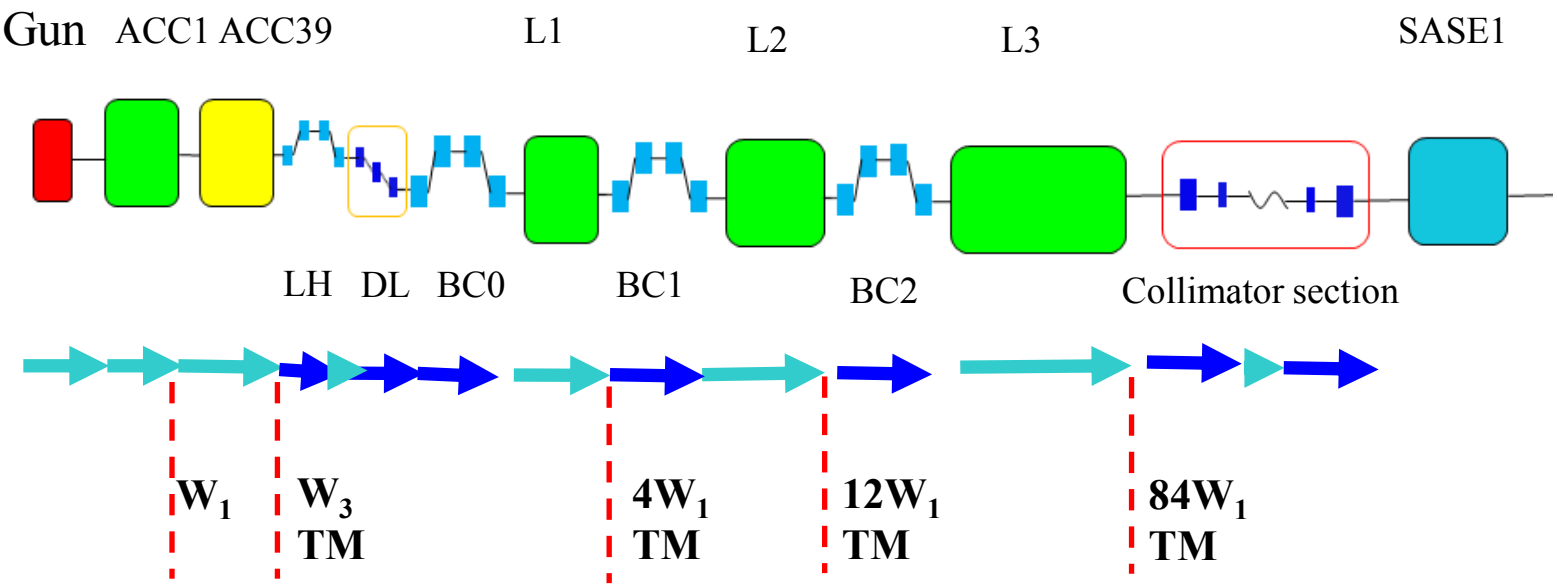
Beam dynamics simulation for SASE1 for different bunch charge cases

RF settings in accelerating modules for different bunch charge cases

Charge nC	V_{acc1} [MV]	φ_{acc1} [deg]	V_{acc39} [MV]	φ_{acc39} [deg]	V_{linac1} [MV]	φ_{linac1} [deg]	V_{linac2} [MV]	Φ_{linac2} [deg]
1.0	144.64	-0.77	24.51	148.68	643.83	27.5	1837.42	22.0
0.5	153.47	16.71	23.49	184.54	651.95	29.0	1864.74	24.0
0.25	156.24	18.73	24.64	187.07	646.70	28.1	1812.60	20.0
0.1	156.72	17.99	25.64	184.13	639.57	27.2	1831.21	21.5
0.02	156.03	16.50	26.16	180.16	637.76	26.7	1833.36	21.8

Linac3: accelerating on crest

Beam dynamics simulation for SASE1 for different bunch charge cases



L1: ACC2
L2: ACC3+ ACC4+ ACC5
L3: ACC6+ …+ ACC26

200000 particles
100CPUs, ~11 hours

ASTRA (tracking with space charge effects, cylindrical symmetric algorithm)

CSRtrack (tracking with CSR effects)

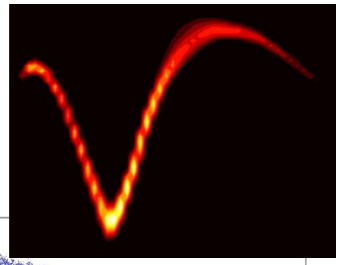
W1 -TESLA cryomodule wake (TESLA Report 2003-19, DESY, 2003)

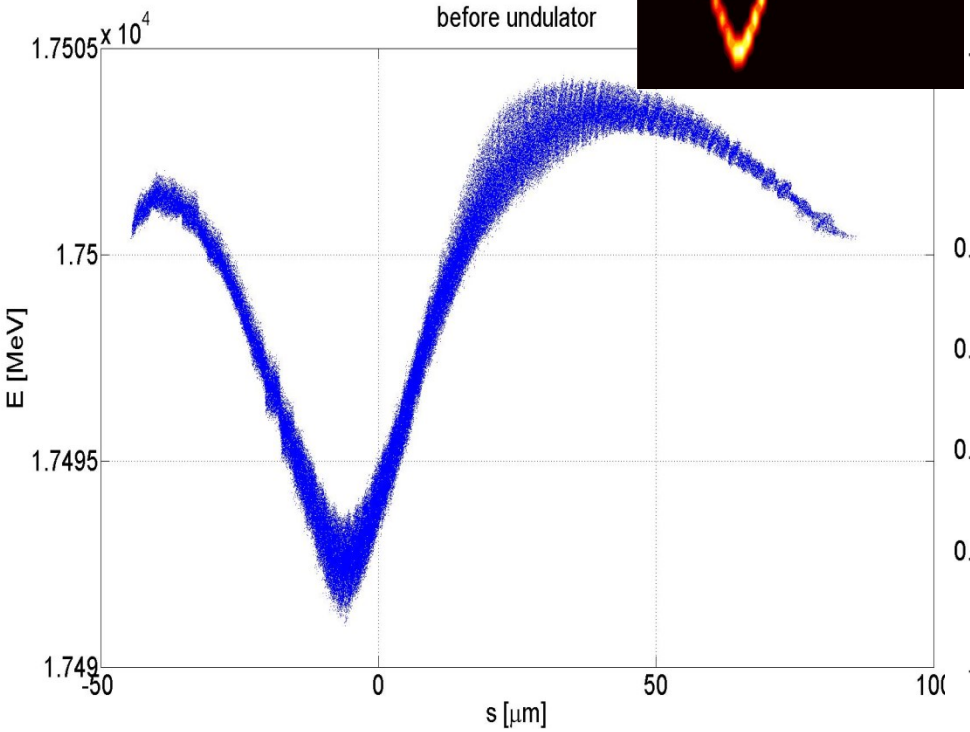
W3 - ACC39 wake (TESLA Report 2004-01, DESY, 2004)

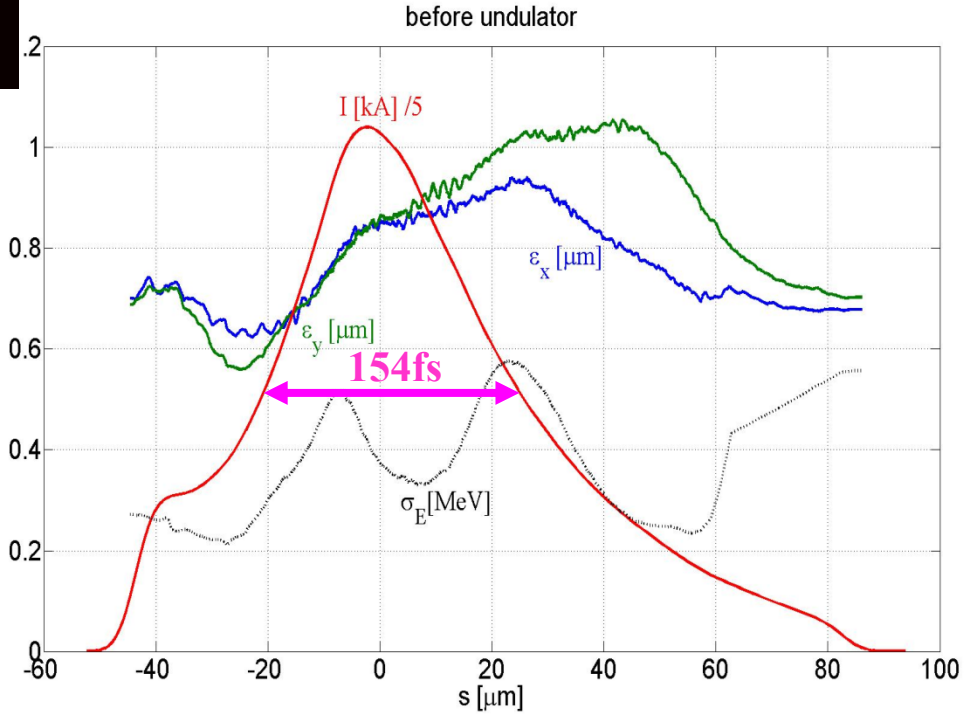
TM - transverse matching to the design optics

Beam dynamics simulation for SASE1 for different bunch charge cases

Q=1.0nC





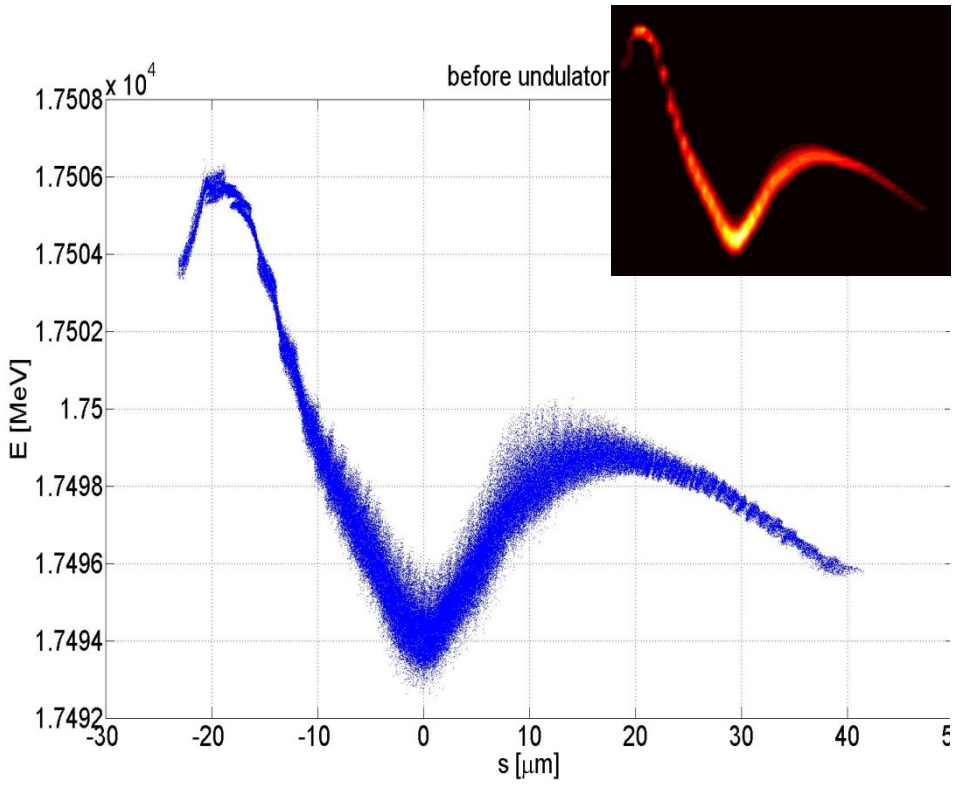


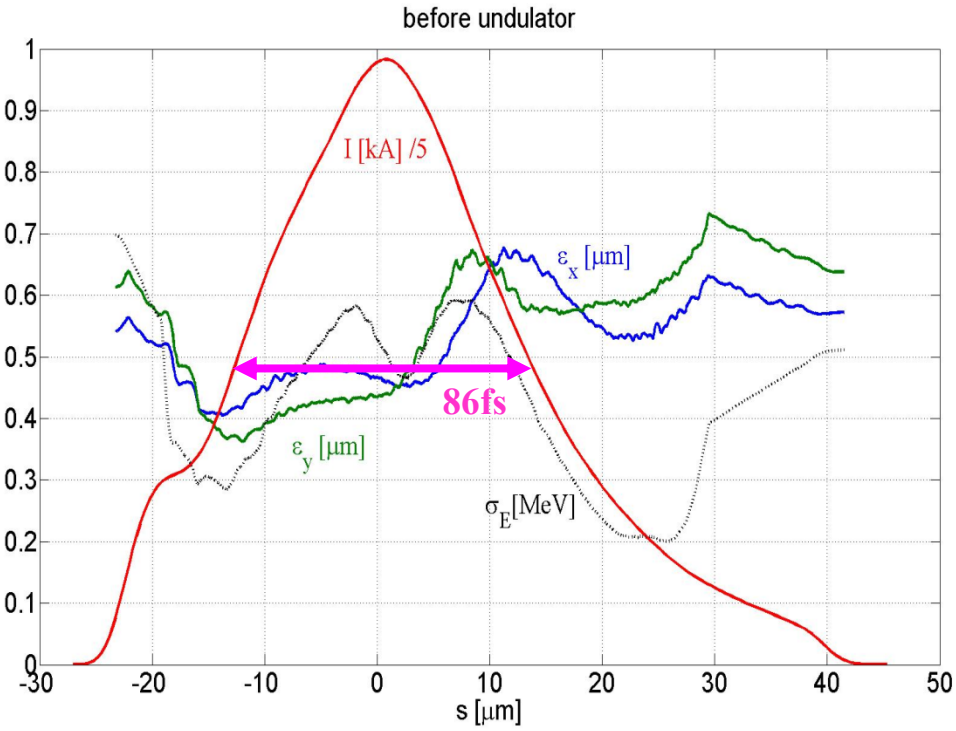
$\varepsilon_x{}^{proj} = 0.9\mu m \cdot rad, \varepsilon_y{}^{proj} = 2.4\mu m \cdot rad$

4% bad particles are removed

Beam dynamics simulation for SASE1 for different bunch charge cases

Q=0.5nC



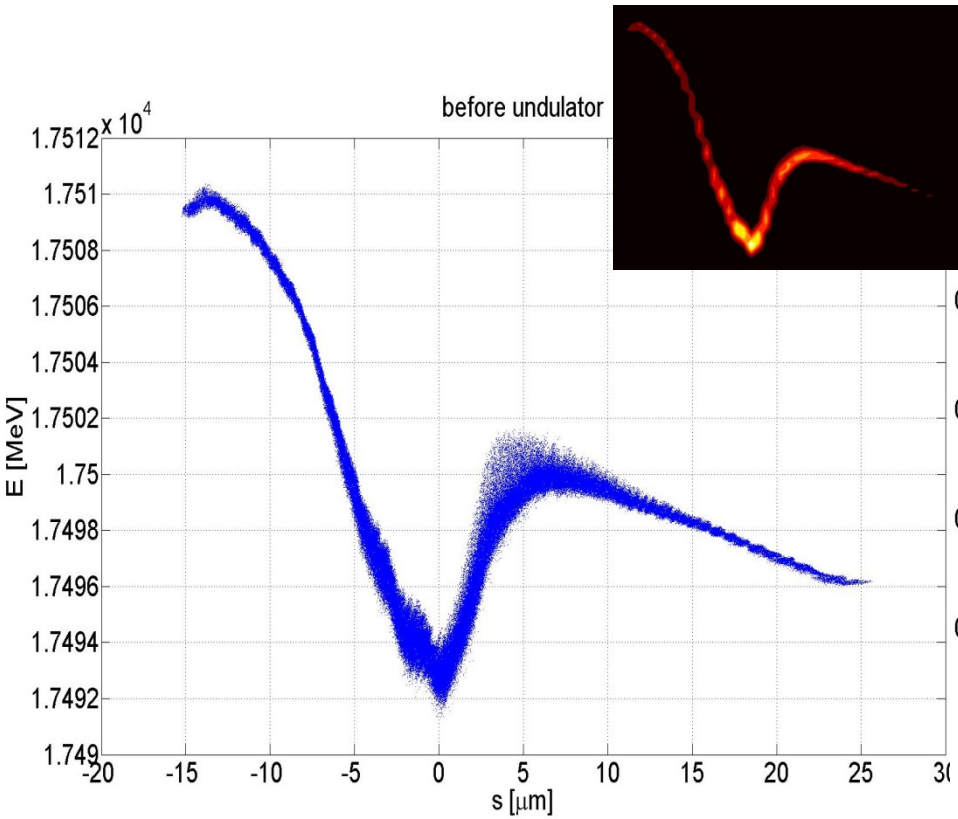


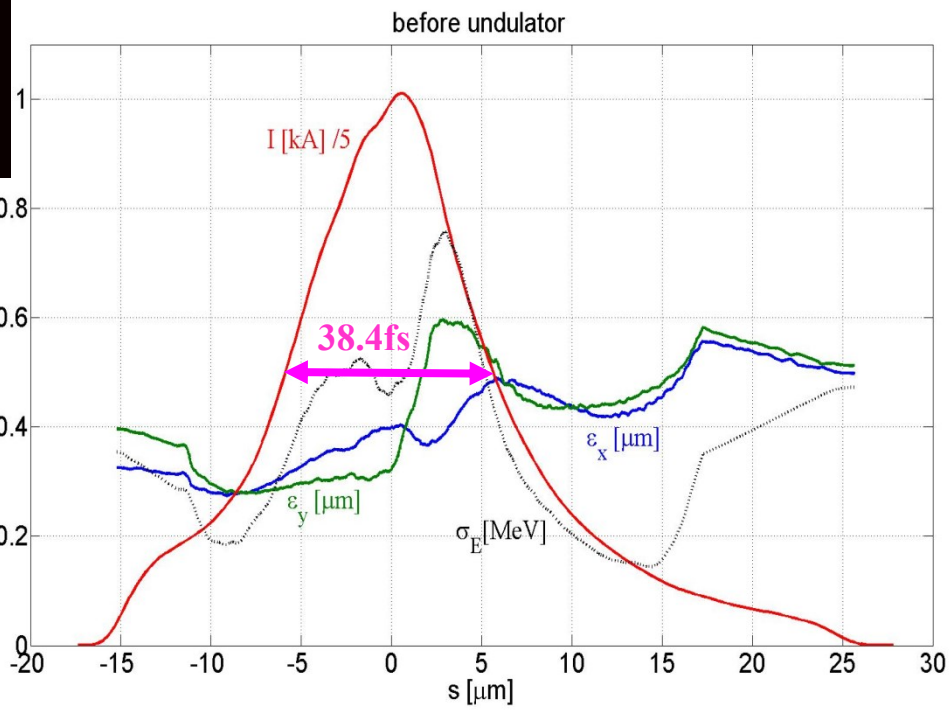
$\varepsilon_x{}^{proj} = 0.65\mu m \cdot rad, \varepsilon_y{}^{proj} = 1.8\mu m \cdot rad$

4% bad particles are removed

Beam dynamics simulation for SASE1 for different bunch charge cases

Q=0.25nC



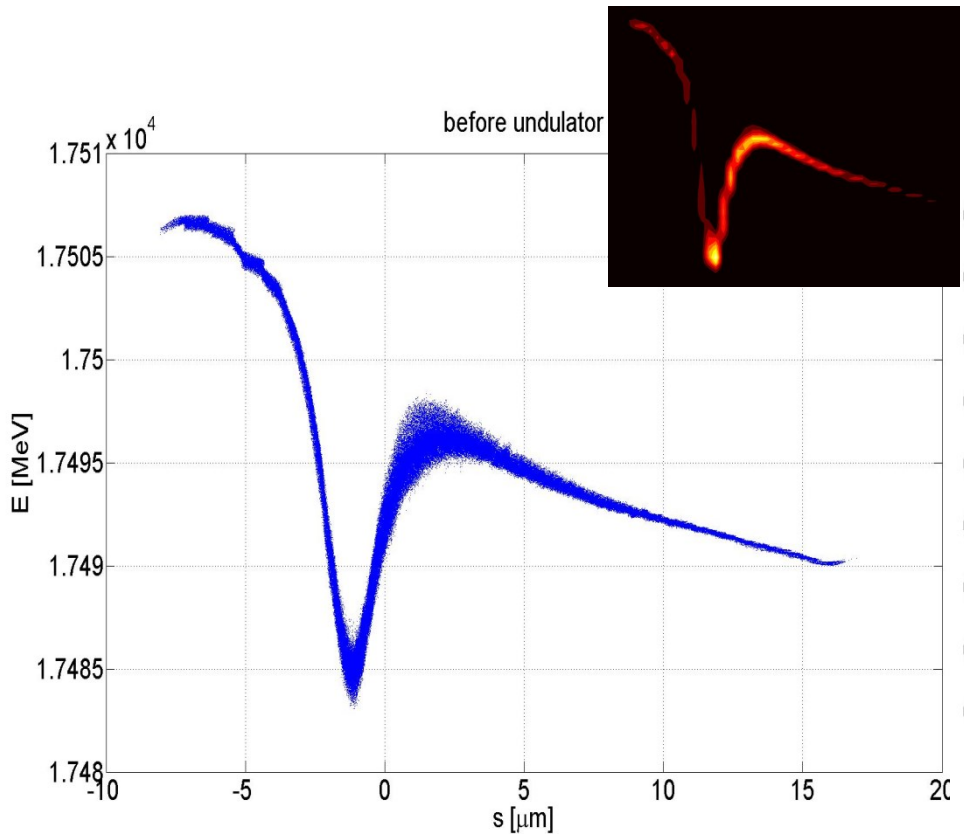


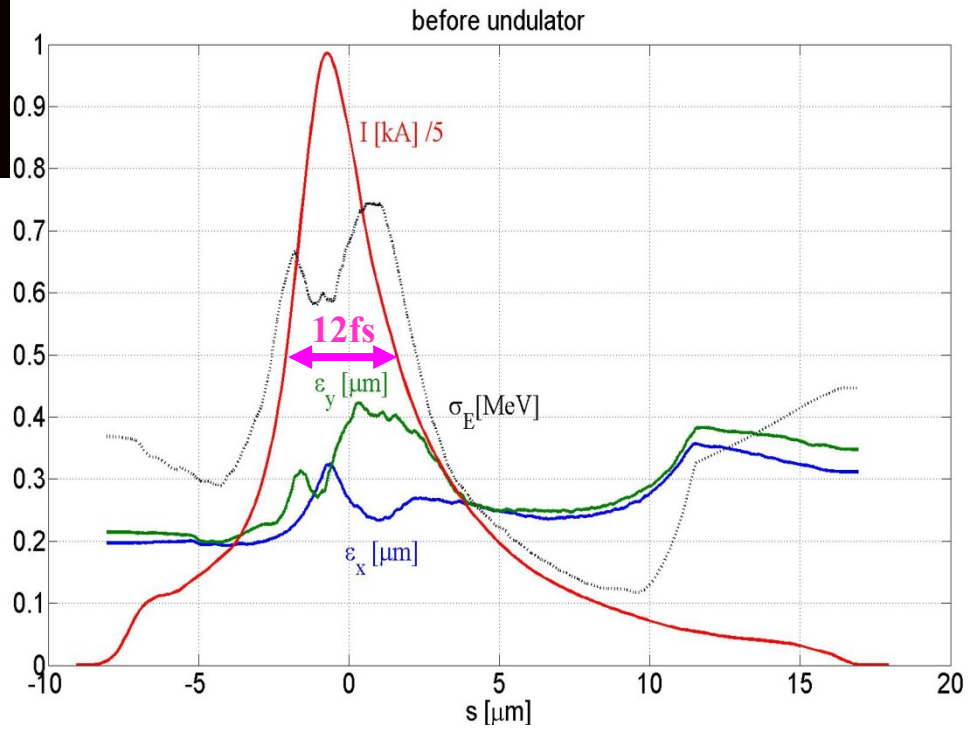
$\varepsilon_x{}^{proj} = 0.5\mu m \cdot rad, \varepsilon_y{}^{proj} = 1.6\mu m \cdot rad$

4% bad particles are removed

Beam dynamics simulation for SASE1 for different bunch charge cases

Q=0.1nC



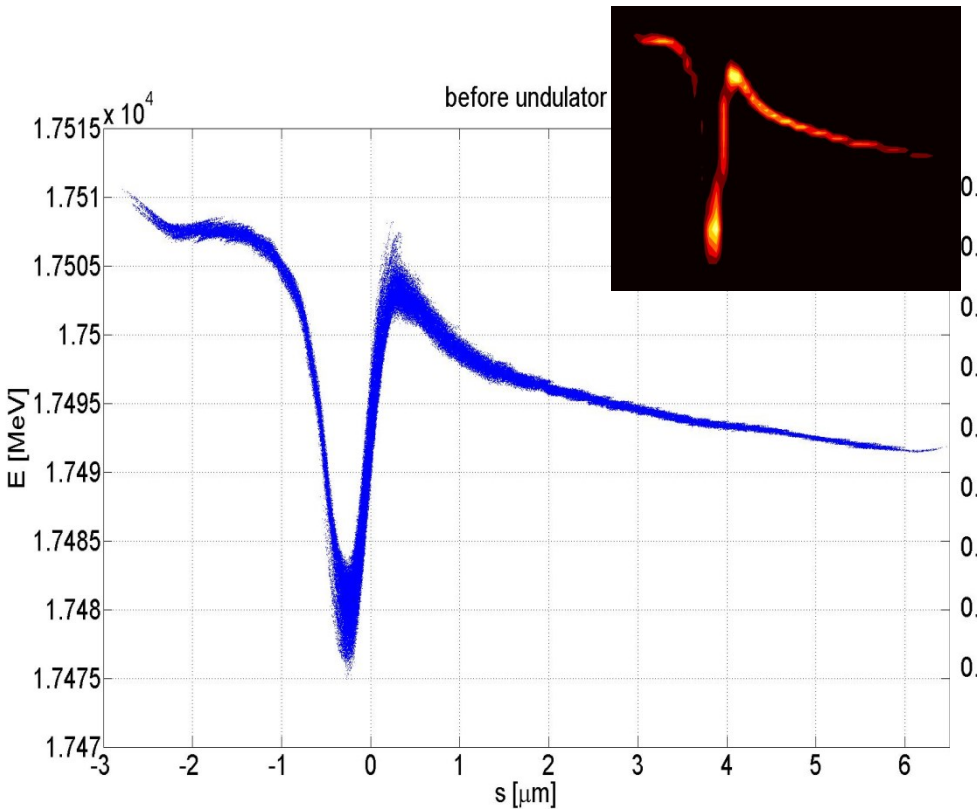


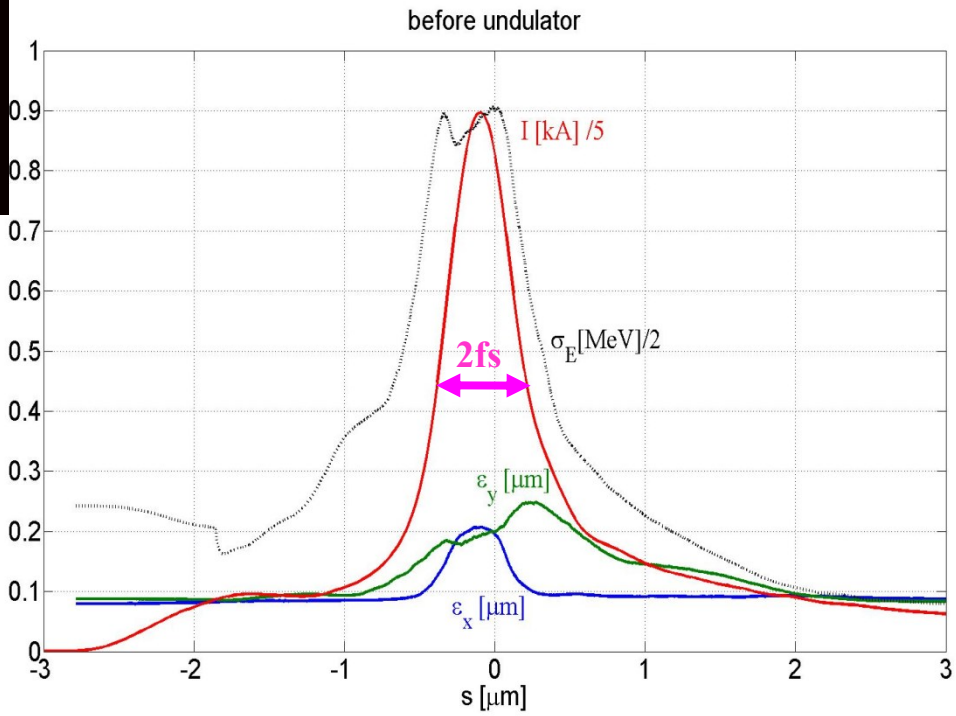
$\varepsilon_x{}^{proj} = 0.36\mu m \cdot rad, \varepsilon_y{}^{proj} = 0.64\mu m \cdot rad$

4% bad particles are removed

Beam dynamics simulation for SASE1 for different bunch charge cases

Q=0.02nC





$$\varepsilon_x{}^{proj} = 0.15\mu m \cdot rad, \varepsilon_y{}^{proj} = 0.38\mu m \cdot rad$$

4% bad particles are removed

The plan for this month

1. The particle distribution file conversion from genesis output to Astra input at the exit of SASE1 for 0.5nC charge case. (100%)

2. Beam dynamics simulation between SASE1 and SASE3 for 0.5nC charge case. (50%)