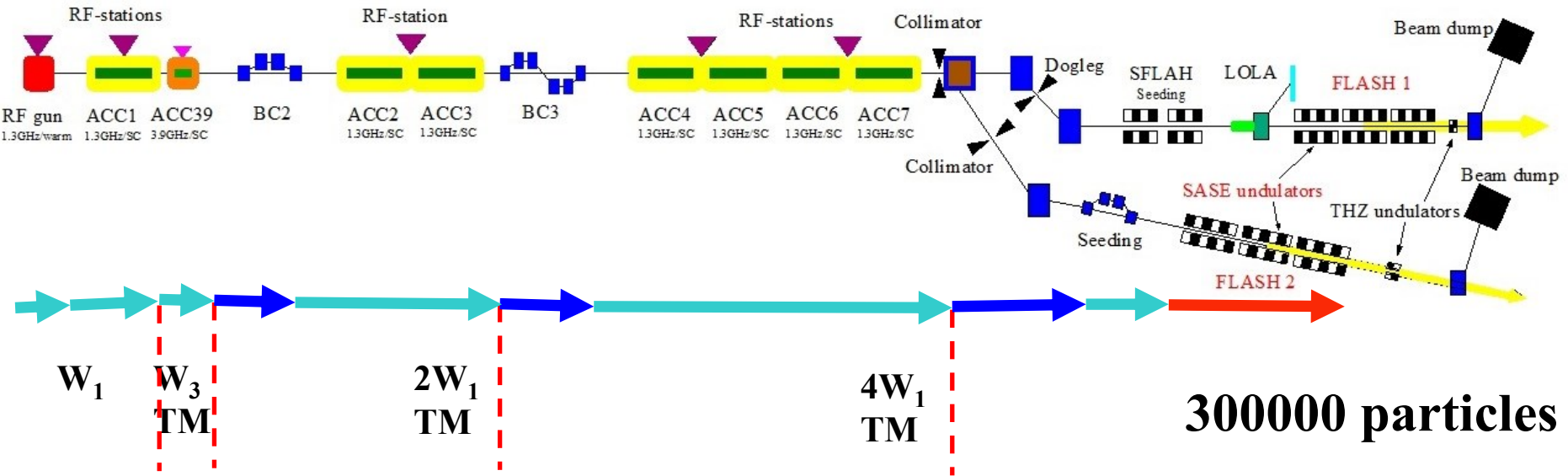


Work Progress for the Simulations for FLASH2

Guangyao Feng
S2E Meeting

DESY
27.03.2014

Beam dynamics simulations for FLASH2 SASE option for different bunch charge cases



ASTRA (tracking with space charge effects, 3D calculation)

CSRtrack (tracking with CSR impact)

Genesis 1.3

W_1 -TESLA cryomodule wake (TESLA Report 2003-19, DESY, 2003)

W_3 - ACC39 wake (TESLA Report 2004-01, DESY, 2004)

TM - transverse matching to the design optics

Beam dynamics simulations for FLASH2 **SASE** option 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]	$V_{\text{acc2,3}}$ [MV]	$\Phi_{\text{acc2,3}}$ [deg]	$V_{\text{acc4,5,6,7}}$ [MV]	$\Phi_{\text{acc4,5,6,7}}$ [deg]
1.0	160.4	-3.2	21.9	153.4	337.3	25.0	550.0	0.0
0.50	159.5	2.4	19.8	162.6	337.3	25.0	550.0	0.0
0.25	159.9	1.9	20.5	160.5	337.3	25.0	550.0	0.0
0.10	160.0	-1.0	21.9	152.6	337.3	25.0	550.0	0.0
0.02	160.4	3.3	21.0	162.0	337.3	25.0	550.0	0.0

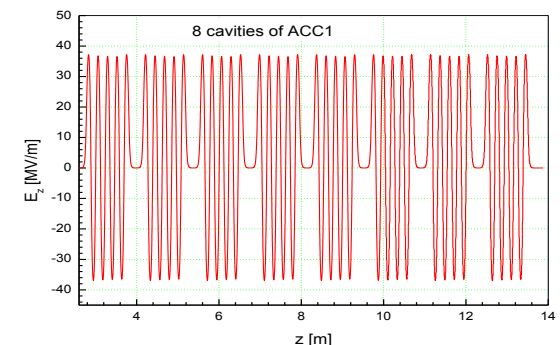
*RF power restrictions:

Maximum energy gain for accelerating modules

ACC1	165 MeV
ACC39	22 MeV
ACC2/3	345 MeV
ACC4/5	320 MeV
ACC6/7	430 MeV

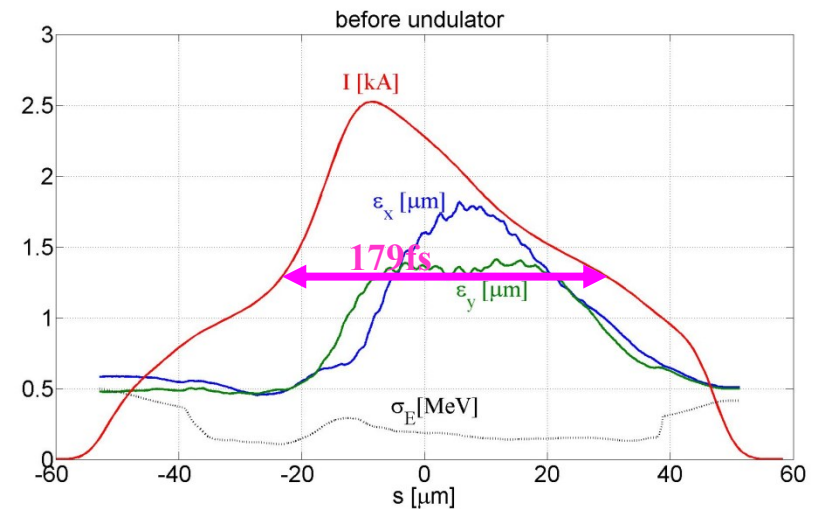
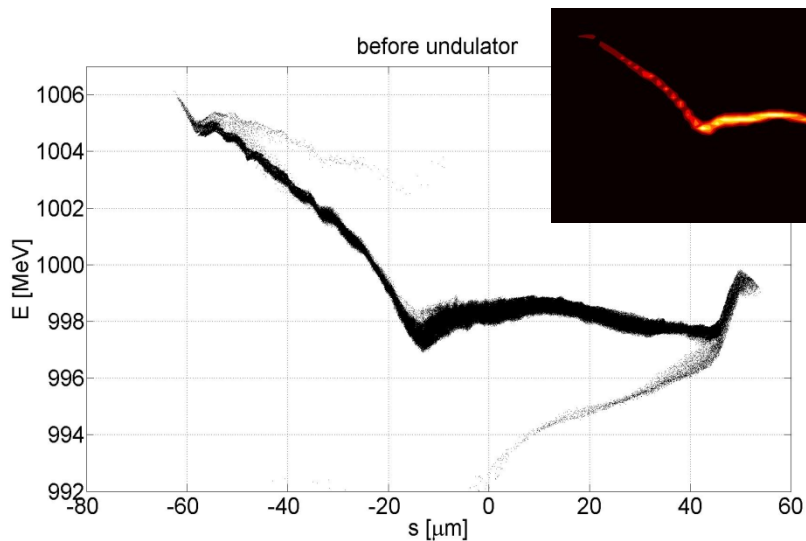
* Same voltage amplitude has been used for the first 4 cavities and the last 4 cavities of ACC1

$$V_{1-4} = V_{5-8}$$



Beam dynamics simulations for FLASH2 **SASE** option for different bunch charge cases

Q=0.5nC



$$\epsilon_x^{proj} = 1.38 \mu\text{m} \cdot \text{rad}, \epsilon_y^{proj} = 1.19 \mu\text{m} \cdot \text{rad}$$

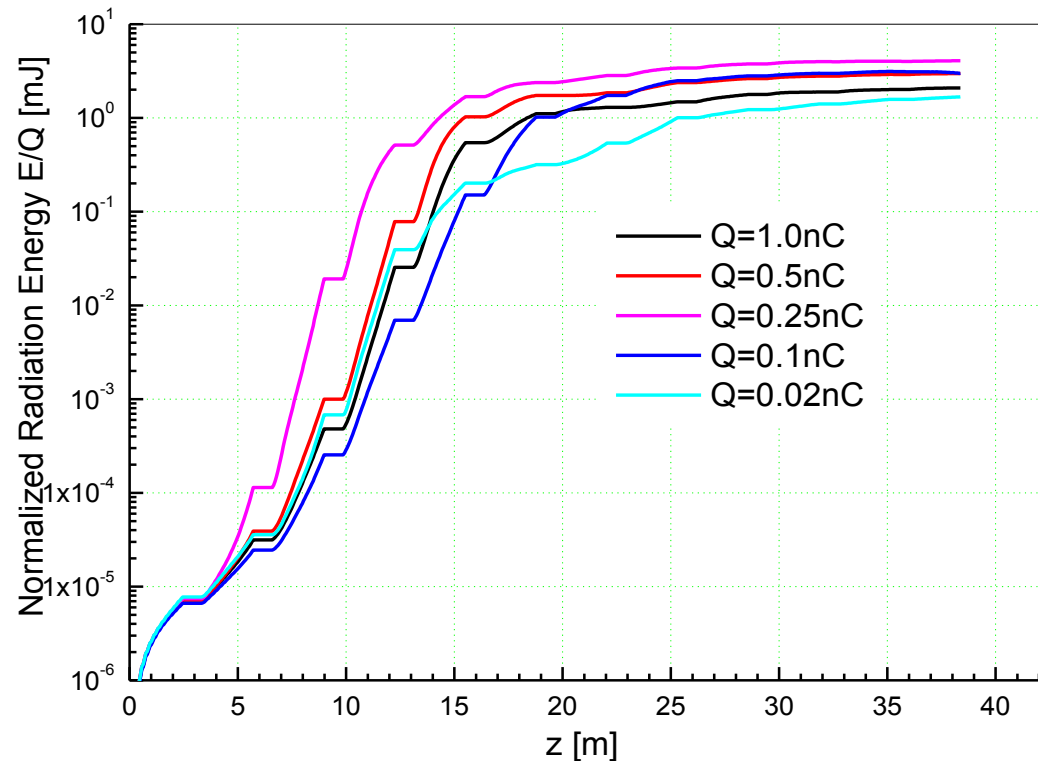
5% bad particles are removed

SASE FEL calculations for FLASH2 with Genesis 1.3

Slice parameters are extracted from beam dynamics simulations for SASE simulation

γ	$\Delta\gamma$	ε_x	ε_y	β_x	β_y	$\langle x \rangle$	$\langle y \rangle$	$\langle x' \rangle$	$\langle y' \rangle$	α_x	α_y	I
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$\lambda_u=31.4\text{mm}$, $K=1.87$, $\lambda=18.4\text{nm}$



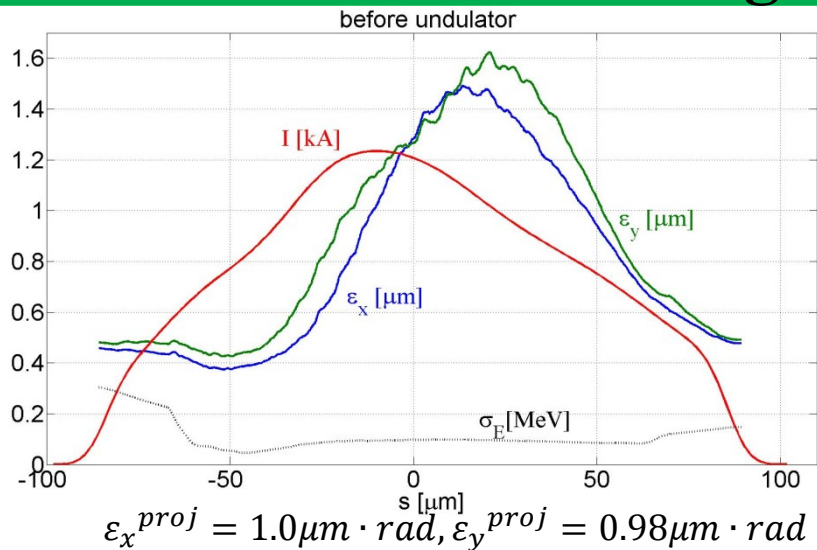
* The undulator description comes from Matthias Scholz.

Beam dynamics simulations for FLASH2 **HGHG** for different bunch charge cases

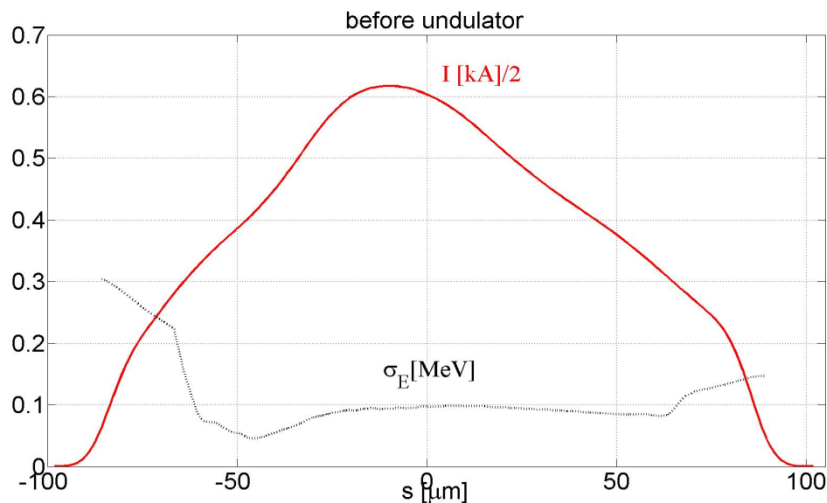
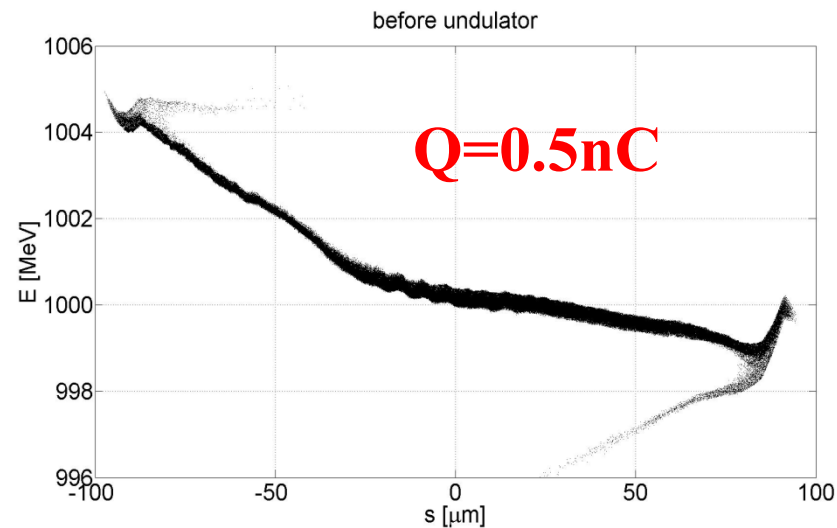
Requirements:

- 1) The global slice length: $\sim 15 \text{ um slice} = 50 \text{ fs}$
Maximal energy chirp (correlated energy spread) along the global slice $\sim 150 \text{ keV}$
- 2) Min current along the global slice: Should exceed at least 0.5 kA
- 3) Maximal local slice emittance along the global slice?: 1.5 um
- 4) Maximal local (uncorrelated) energy spread: $\sim 100 \text{ keV}$

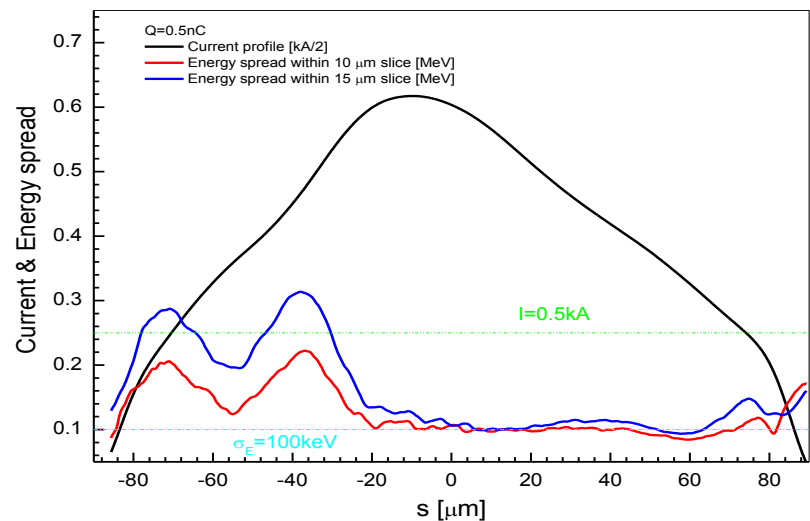
Beam dynamics simulations for FLASH2 **HGHG** for different bunch charge cases



5% bad particles are removed

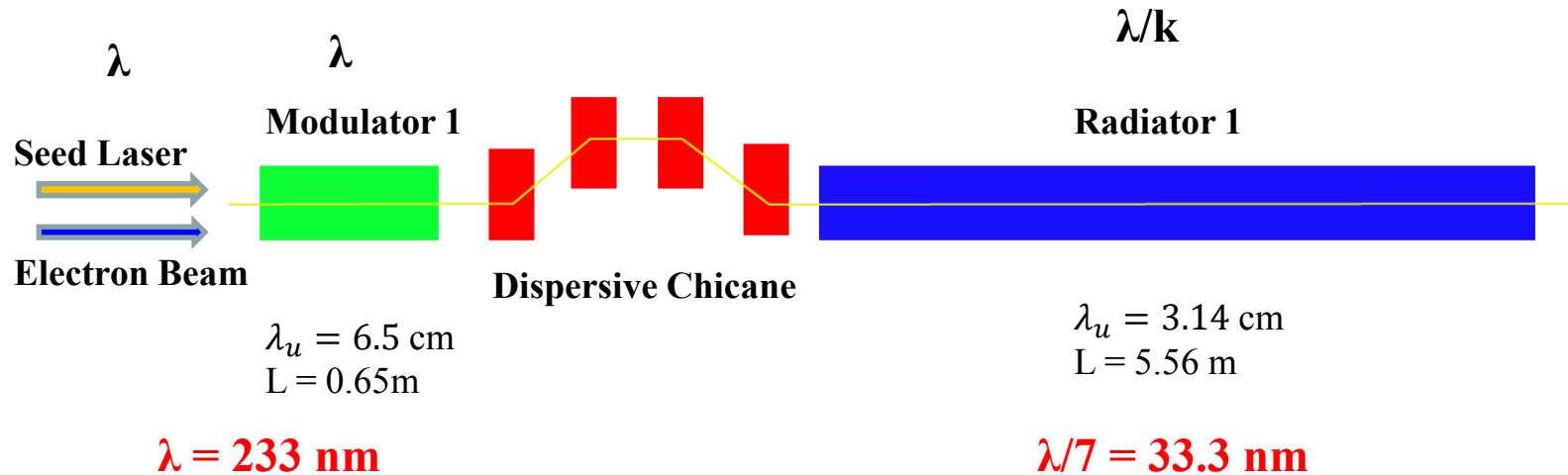


Slice energy spread distribution (uncorrelated)

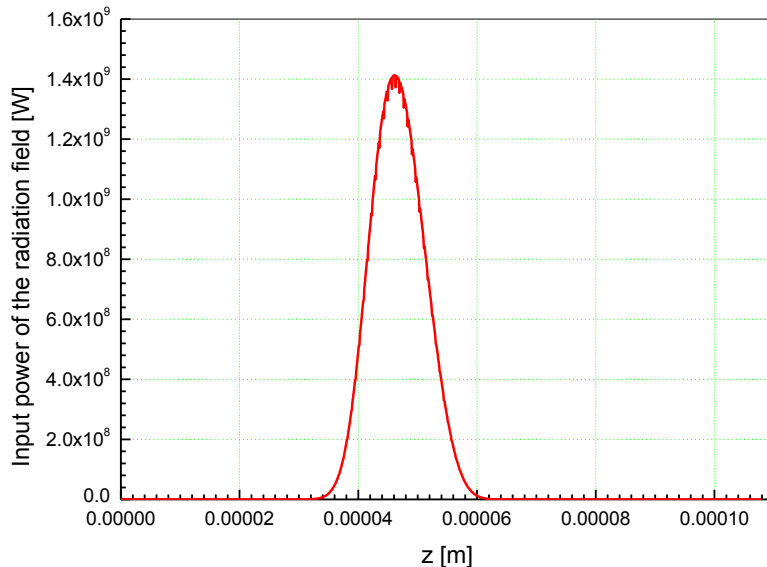


Energy spread within 15 μm and 10 μm slice length

Radiation calculation for FLASH2 HGHG



Seed Laser

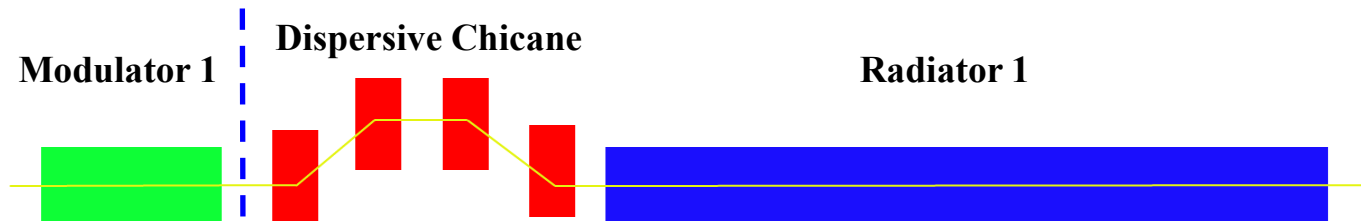


Chicane defined in Genesis input file

```
trama= 1
itram11= -0.9924
itram12= -0.0037
itram13= 0.000000E+00
itram56= 8.000000E-6
itram66= 1.000000E+00
```


Radiation calculation for FLASH2 HGHG

Modulator and **Chicane** + **Radiator** are calculated separately with Genesis 1.3



Modulator run

1. Integrating through modulator with a seed.
2. Dumping particle distribution

```
$newrun  
nharm = 7  
npart = 56448  
beamfile='inputbeam.txt,  
radfile='seeding_pulse.txt'  
outputfile='modulator.out'
```

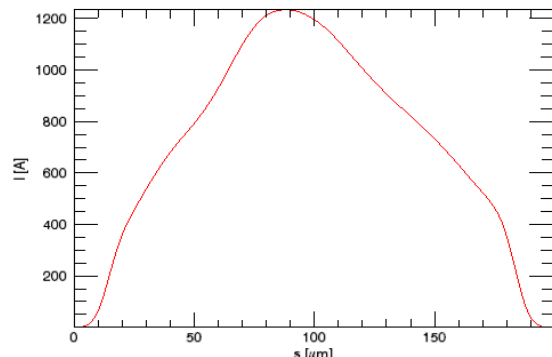
Chicane + **Radiator** run

1. Importing particle distribution.
2. Up converting the particle distribution to a higher harmonic.
3. Tracking through the dispersive chicane.
4. Integrating through the radiator.

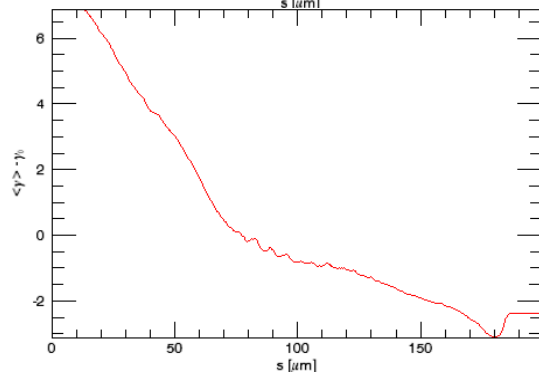
```
$newrun  
partfile='modulator.out.dpa,  
convharm= 7
```

Radiation calculation for FLASH2 HGHG (Q=0.5nC)

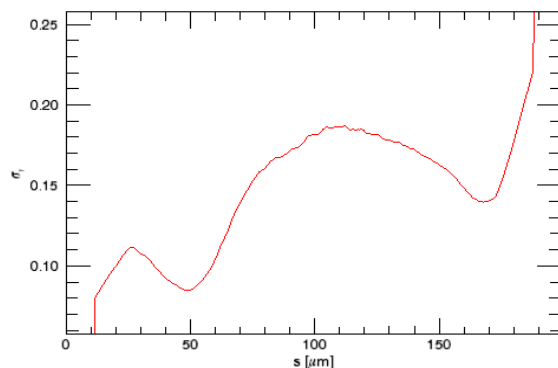
CASE 1: With beam description file generated from ASTRA simulation



Current profile

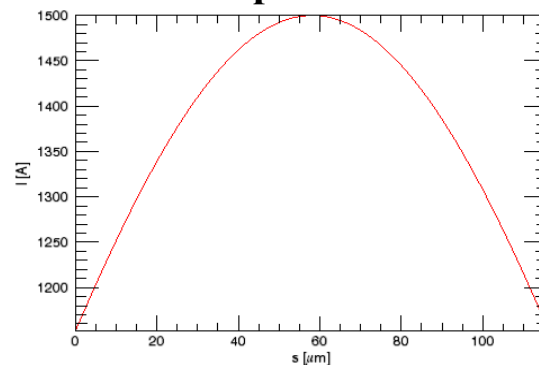


Initial energy distribution



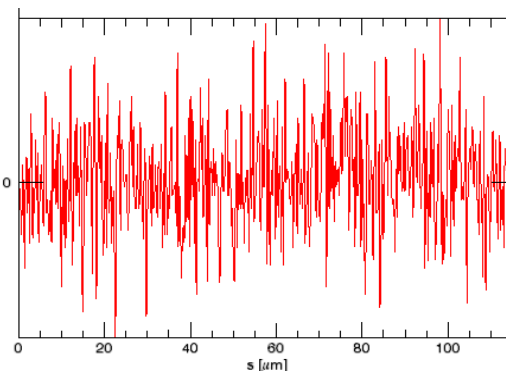
Initial slice energy spread

CASE 2: Using beam parameters definition in Genesis main input file

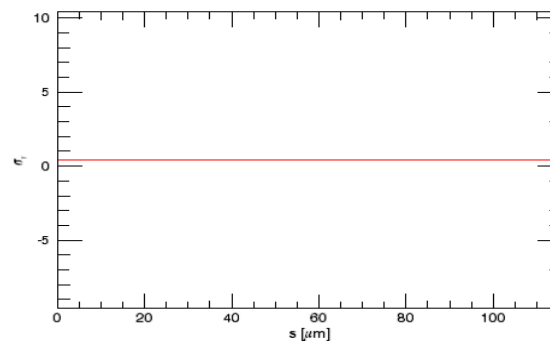


Gaussian distribution

$$\sigma_s = 80 \mu\text{m}$$



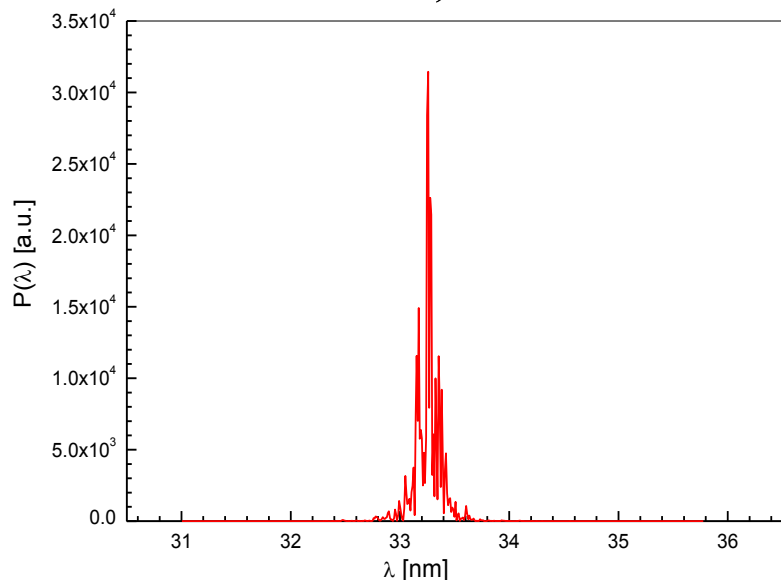
no energy chirp



$$\sigma_\gamma = 0.4$$

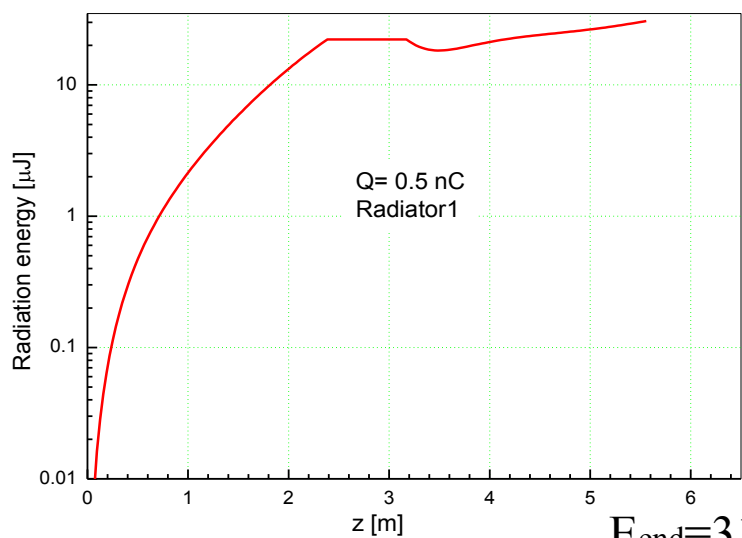
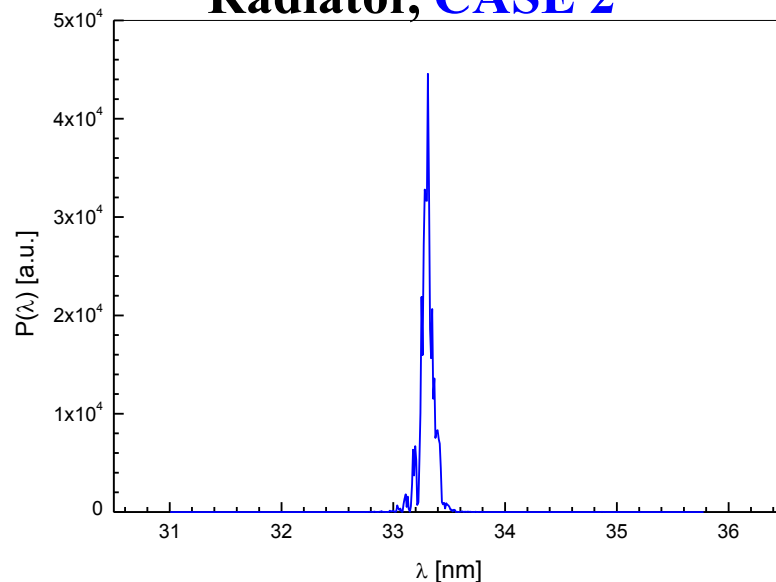
Radiation calculation for FLASH2 HGHG ($Q=0.5\text{nC}$)

Radiator, CASE 1

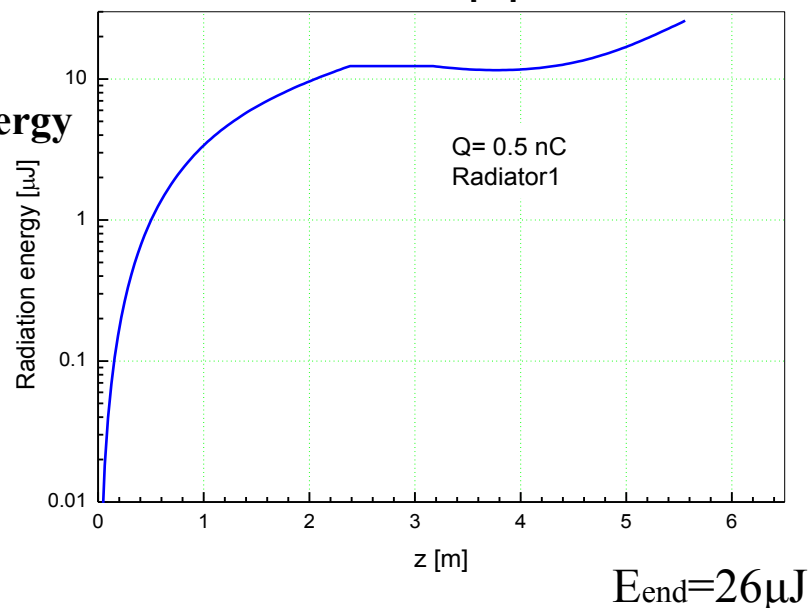


Spectrum

Radiator, CASE 2



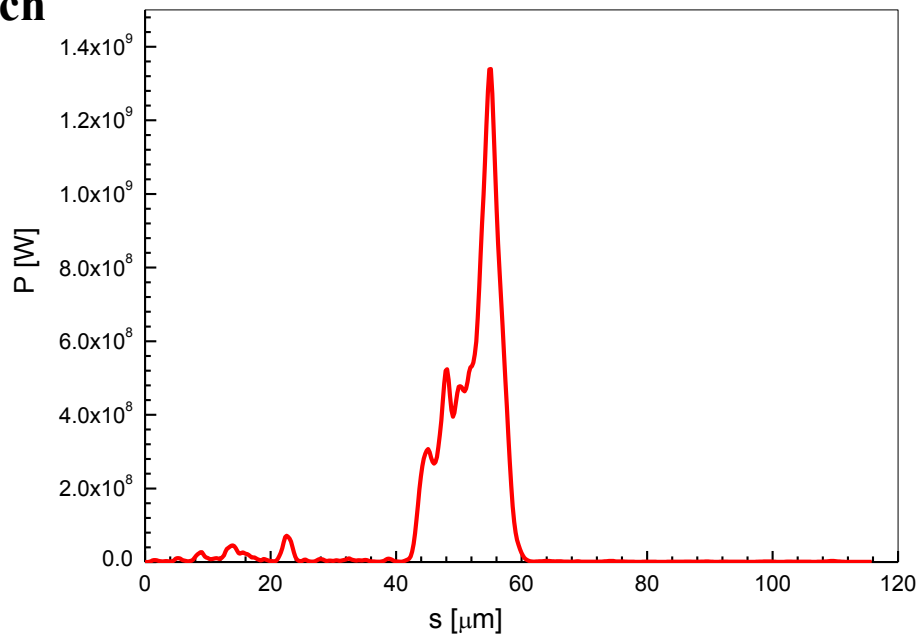
Radiation energy



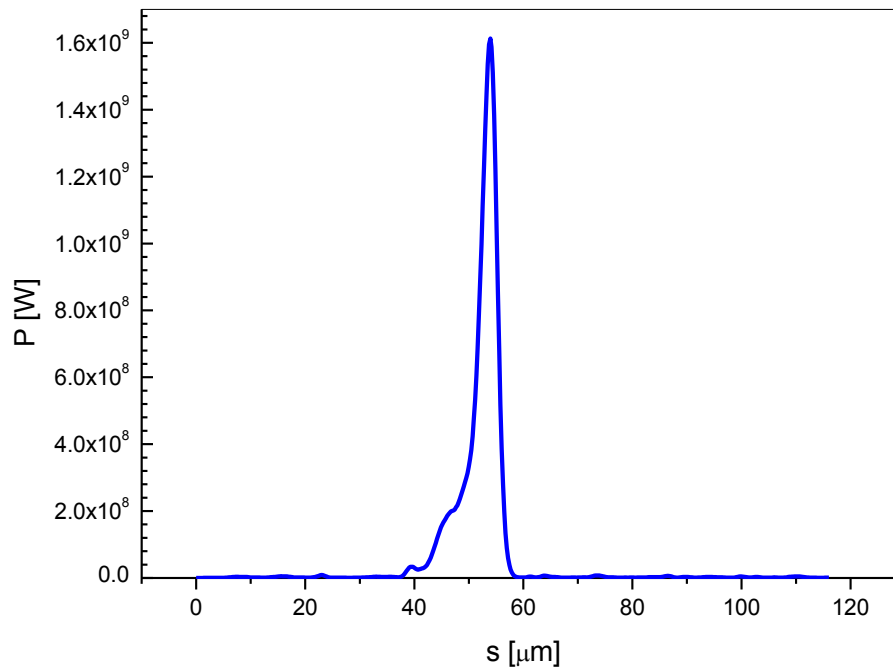
Power distribution along the bunch

At the exit of radiator

CASE 1



CASE 2



The plan

- 1. Modifying the internal report of beam dynamics simulations for FLASH2.**
- 2. Further work for beam dynamics simulations of FLASH2 for low bunch charge cases.**
- 3. Preparing for cascaded HGHG calculation.**