HGHG simulation for FLASH2 with new models

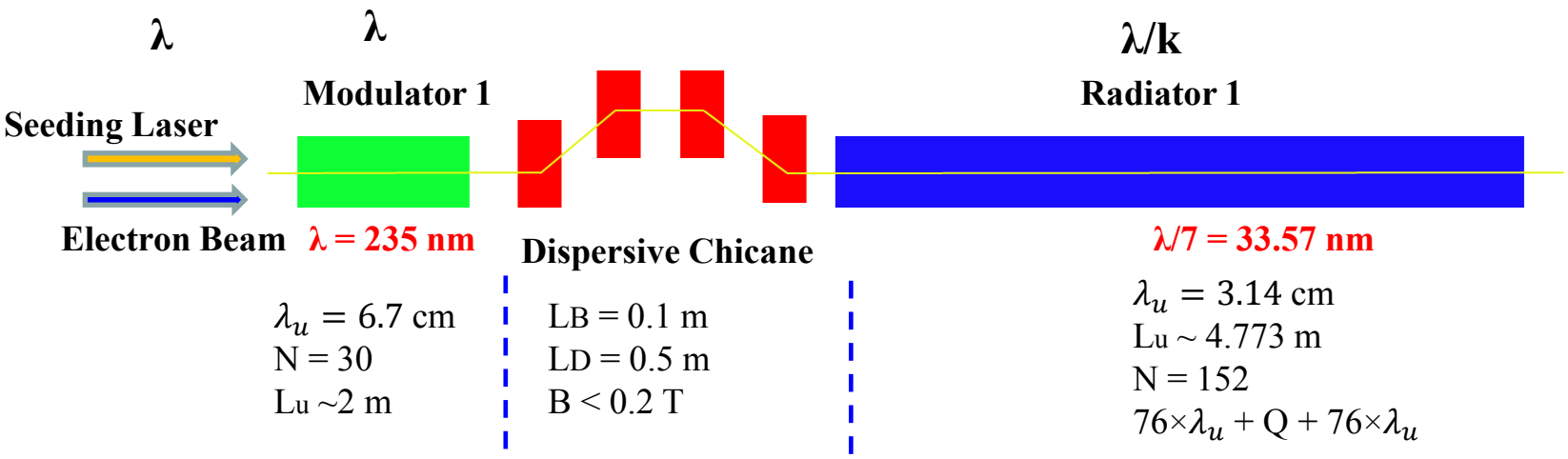
Guangyao Feng

S2E Meeting

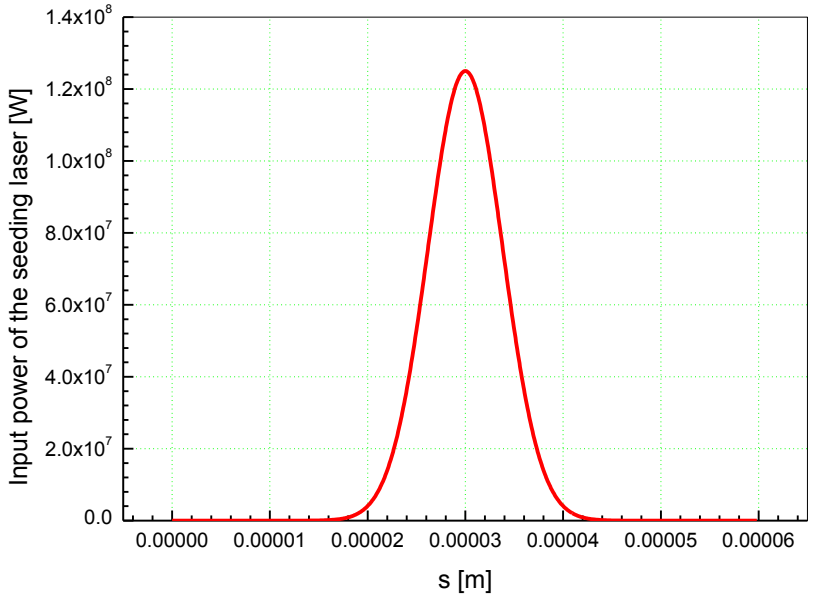
DESY

24.06.2014

Descriptions for the new models of the undulators and the seeding laser



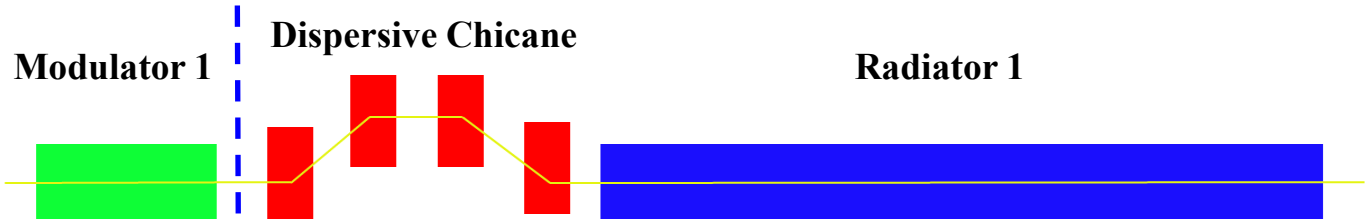
Seeding Laser



Laser peak power P_laser = 125 MW
with Rayleigh length z_R = 4.2 m
laser pulse duration of τ =30 fs (FWHM)
Wavelength λ= 235 nm

Radiation simulation for FLASH2 HGHG

Modulator and Chicane + Radiator are simulated separately with Genesis 1.3



Modulator run

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

Chicane + Radiator run

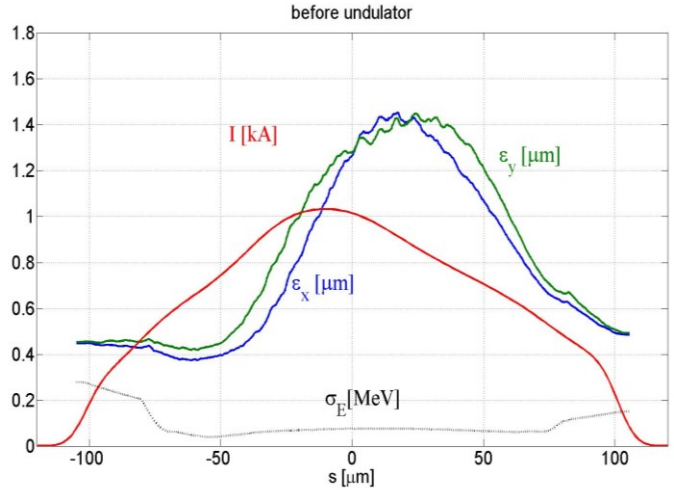
1. Importing particle distribution.
2. Up converting the particle distribution to a higher harmonic.
3. Tracking through the dispersive chicane.
4. Integrating through the radiator.

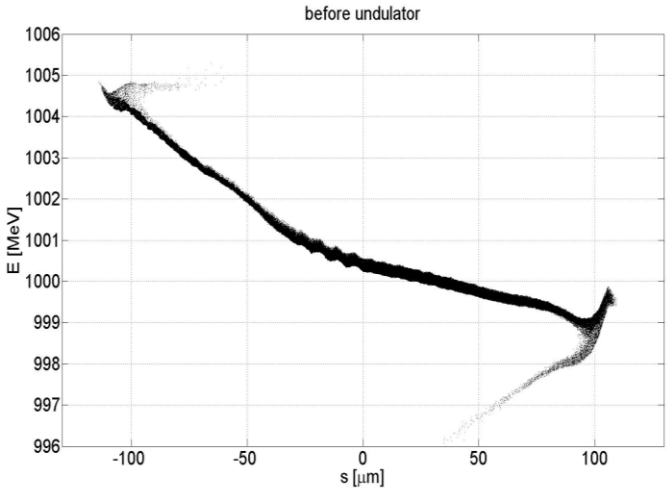
As the first step, space charge, CSR, wakefields of vacuum chamber are not taken into account in the simulation.

HGHG simulation for two cases

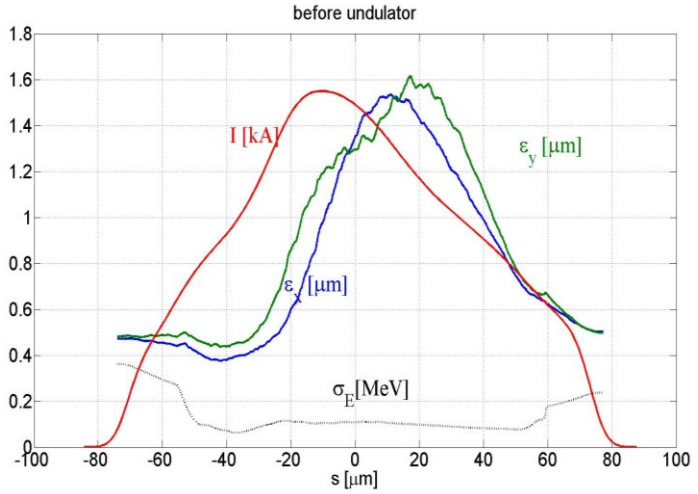
Electron beam bunch descriptions at the entrance of the modulator from beam dynamics simulation (Q=0.5nC) **Np=300000**

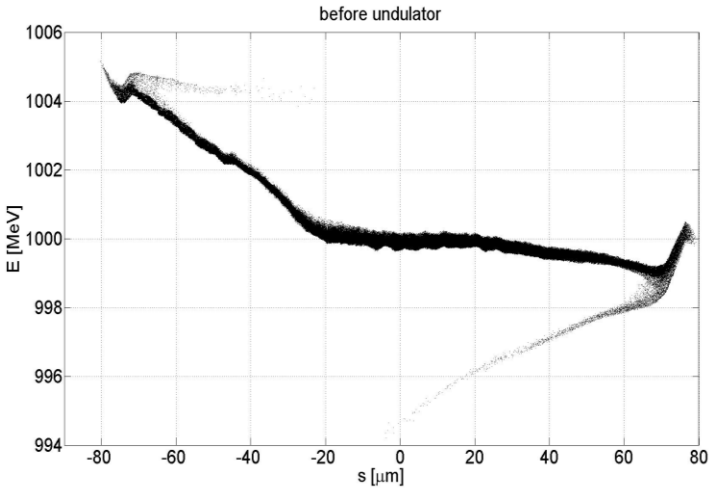
Case 1 (I_{peak}~1.0 kA)





Case 2 (I_{peak}~1.5 kA)





HGHG simulation for two cases

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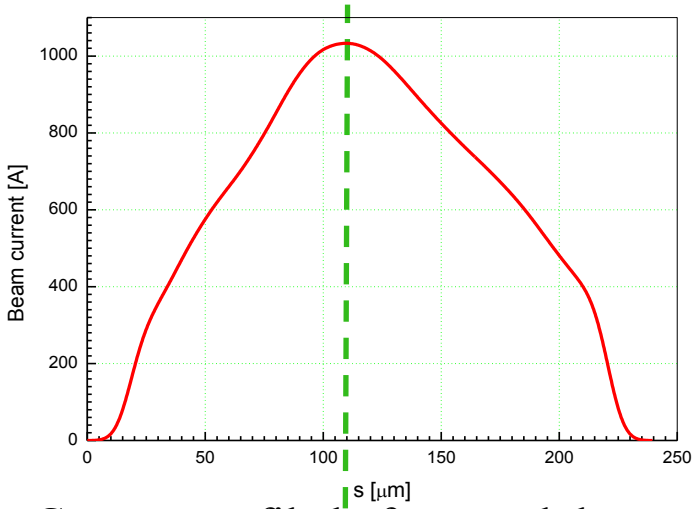
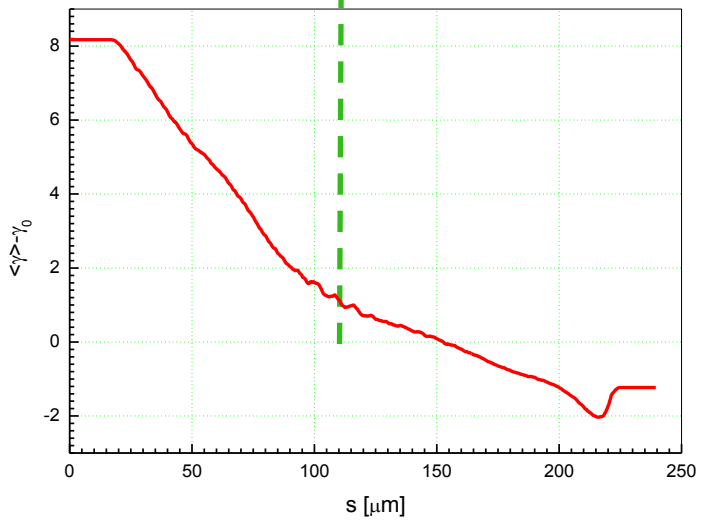
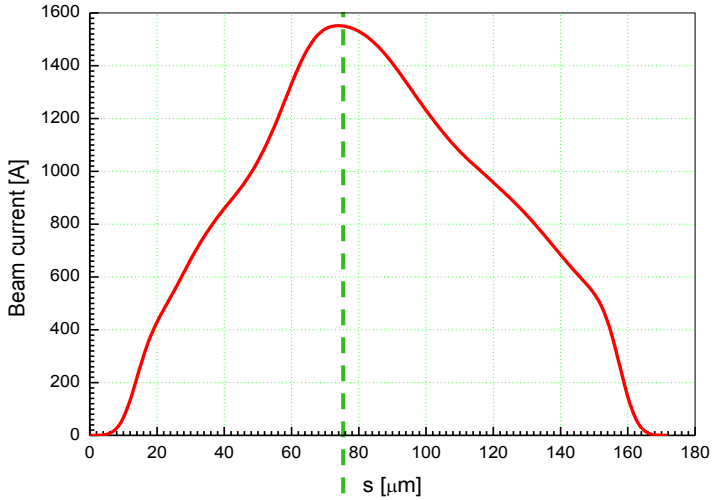


Current profile before modulator

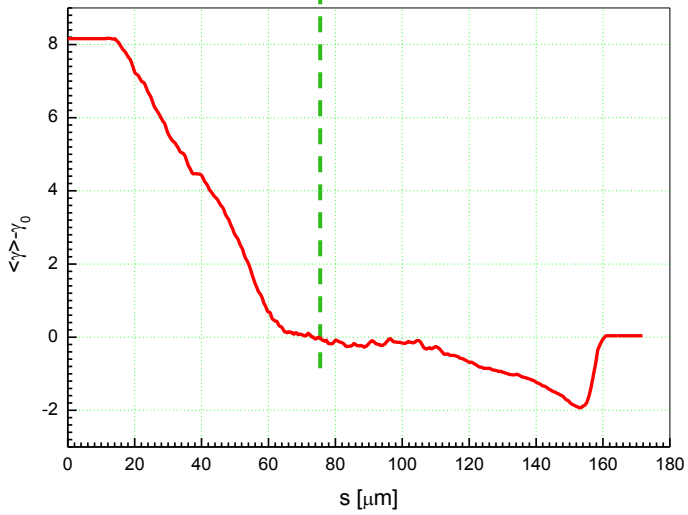


Energy distribution before modulator

Case 2 (I_{peak}~1.5 kA)



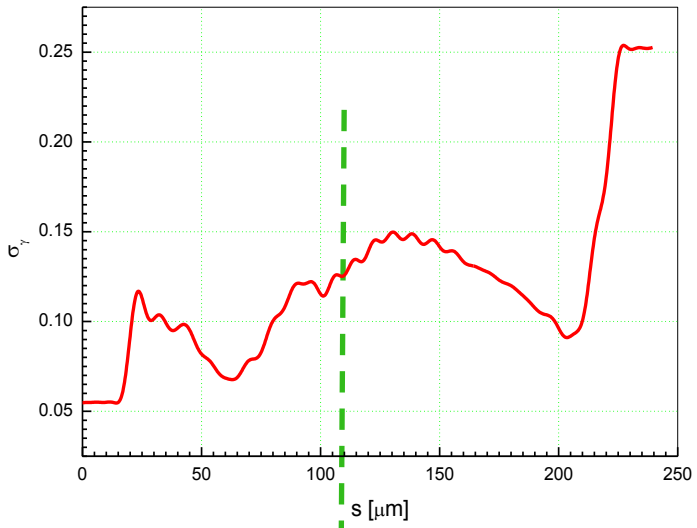
Current profile before modulator



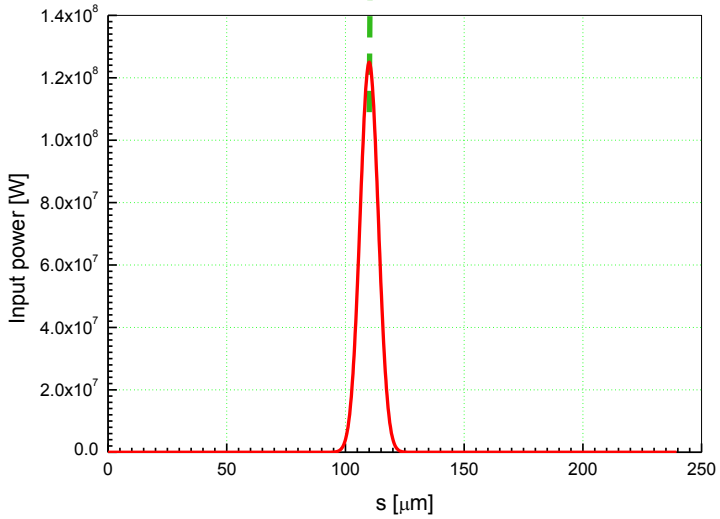
Energy distribution before modulator

HGHG simulation for two cases

Case 1 (I_{peak}~1.0 kA)

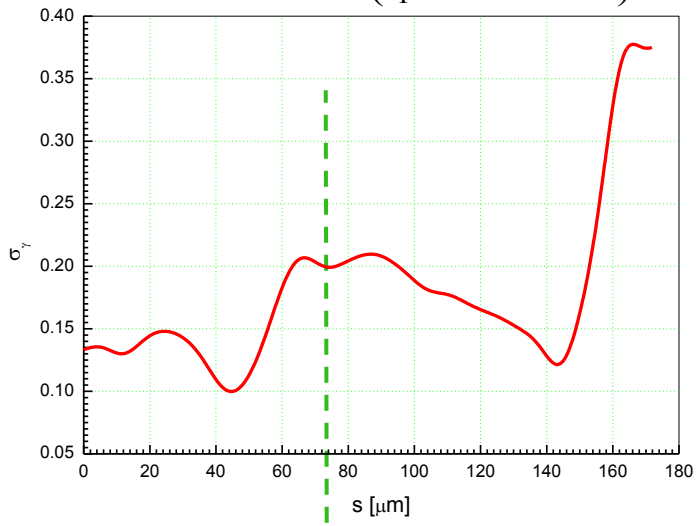


Energy spread before modulator

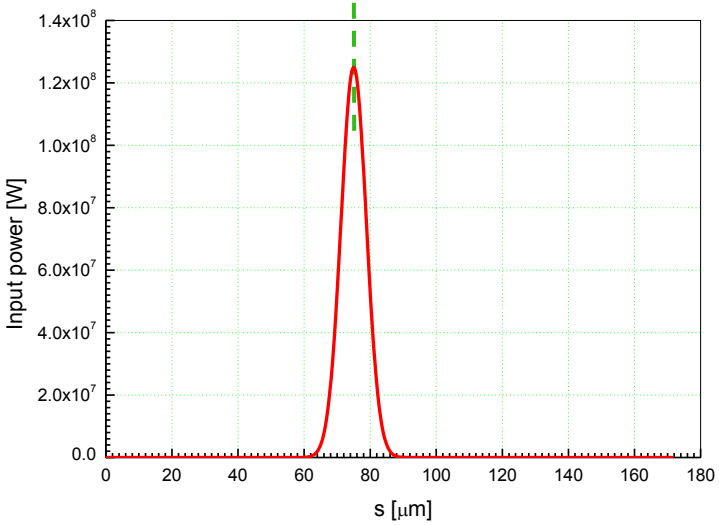


Shift of the laser with respect to electron bunch

Case 2 (I_{peak}~1.5 kA)



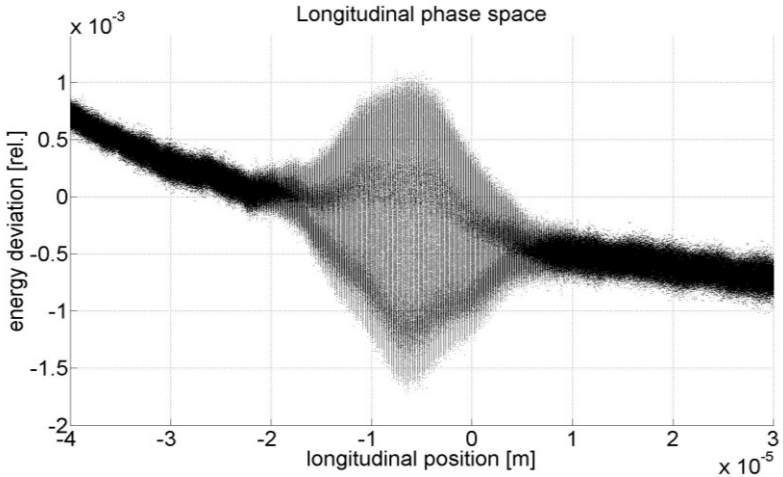
Energy spread before modulator



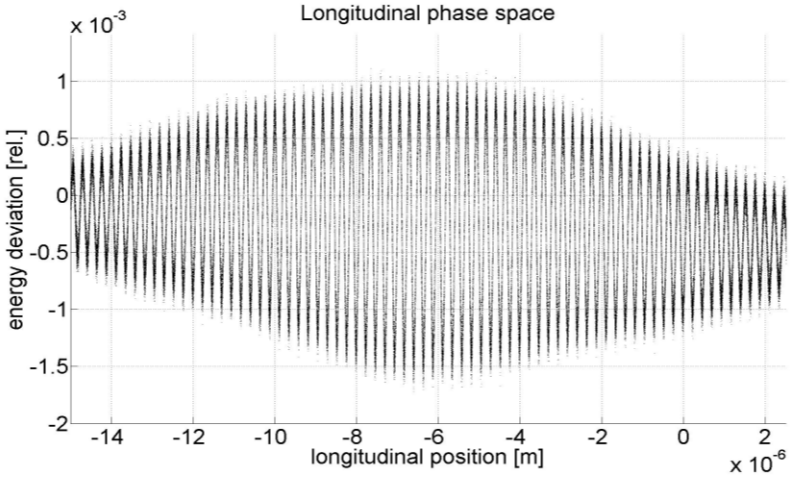
Shift of the laser with respect to electron bunch

Energy modulation for two cases

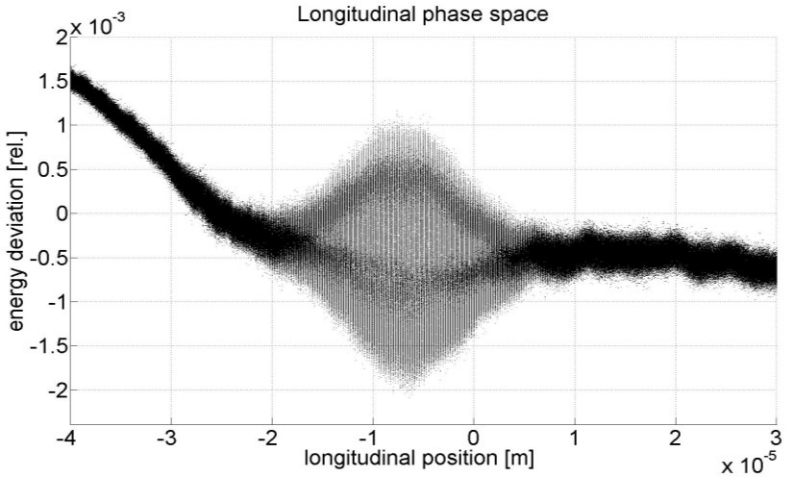
Case 1 (I_{peak}~1.0 kA)



Longitudinal phase space after the modulator (before chicane)



Case 2 (I_{peak}~1.5 kA)



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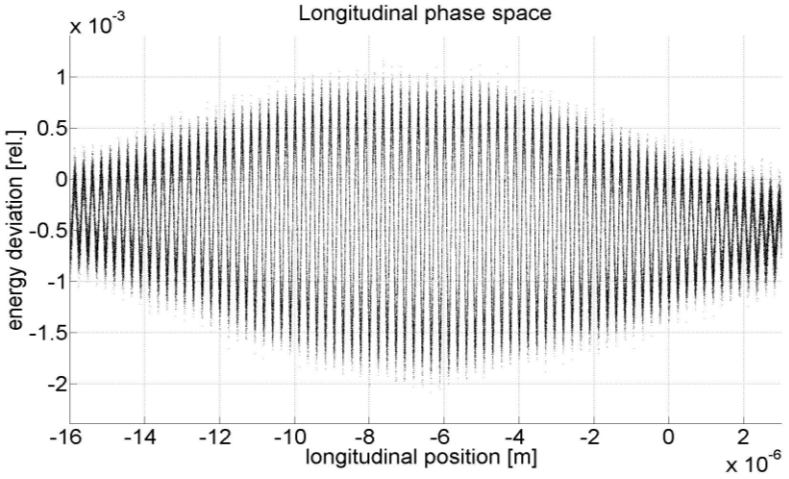
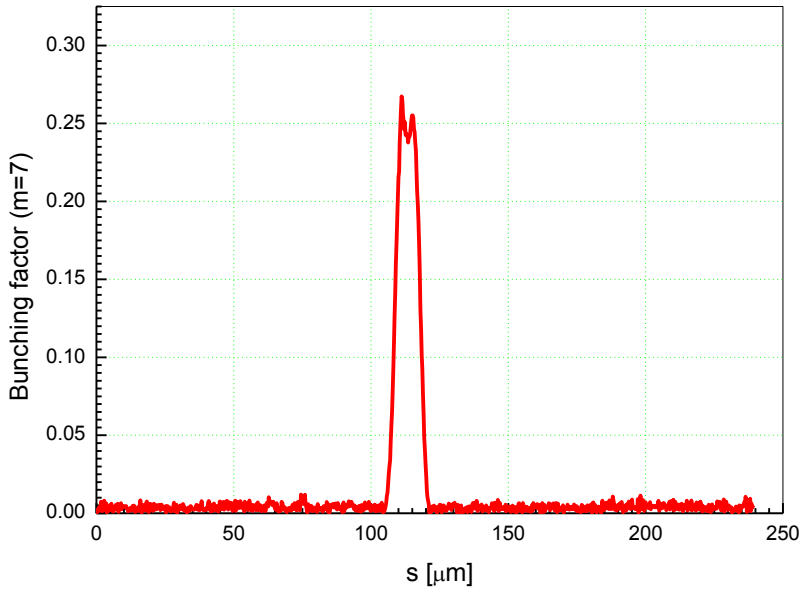


HGHG simulation for two cases

$$P_L = 8.7 \times 10^9 \times \left(\frac{E_0 E_{mod}}{511000^2} \frac{\sigma_{Laser}}{L_u \cdot K_{ut}} \right)^2$$

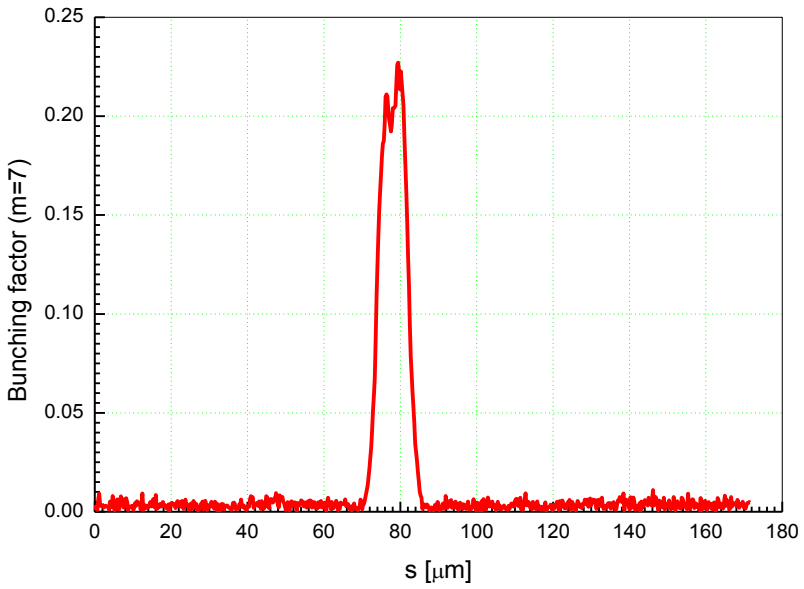
$$b_m = J_m \left(m \cdot k \cdot r_{56} \cdot \frac{E_{mod}}{E_0} \right) \cdot Exp \left(-0.5 \left(m \cdot k \cdot r_{56} \cdot \frac{E_s}{E_0} \right)^2 \right)$$

Case 1



Bunching factor after the chicane

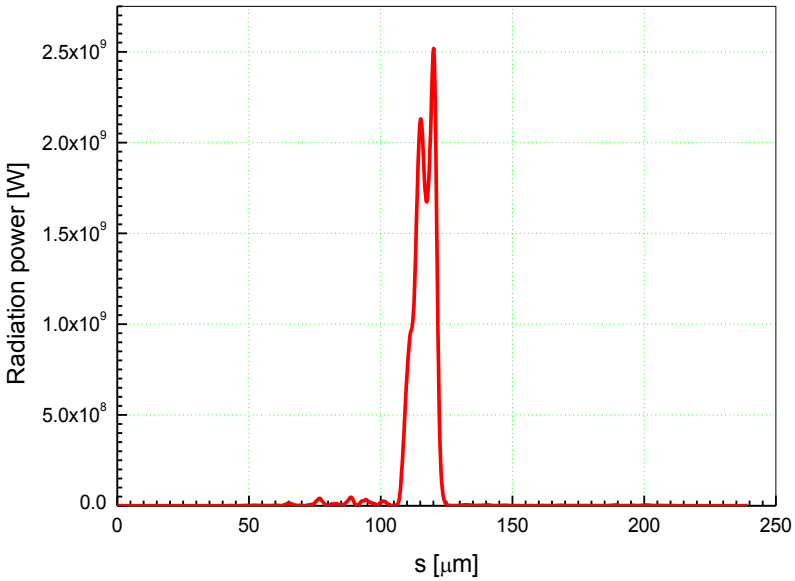
Case 2



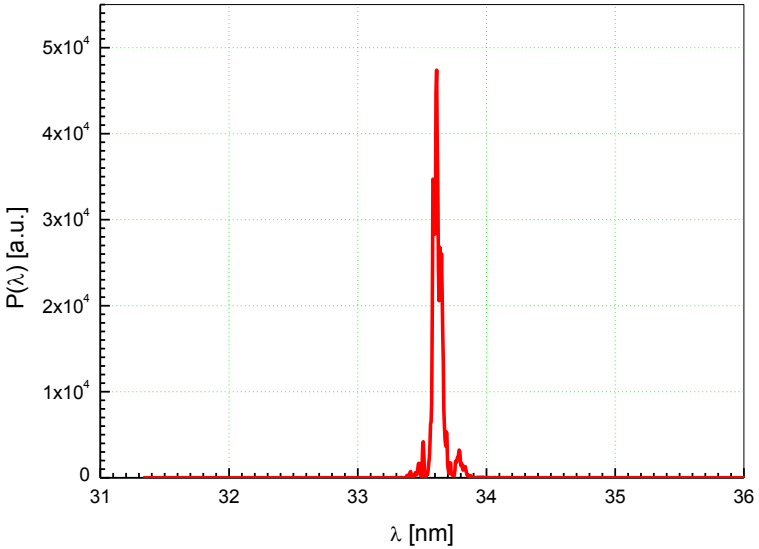
Bunching factor after the chicane

HGHG simulation for two cases

Case 1

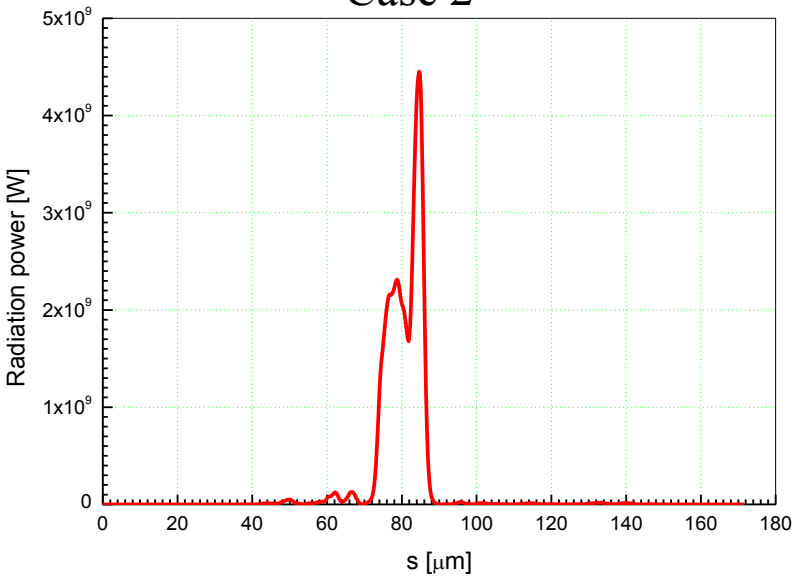


Radiation power after radiator

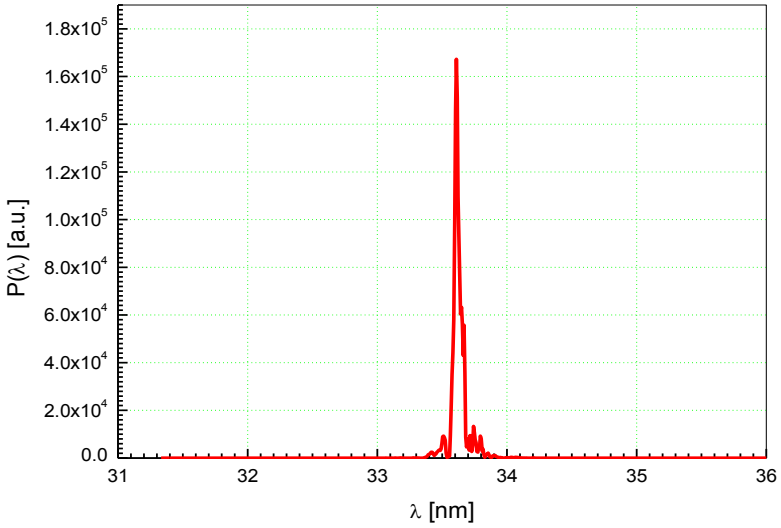


Spectrum

Case 2



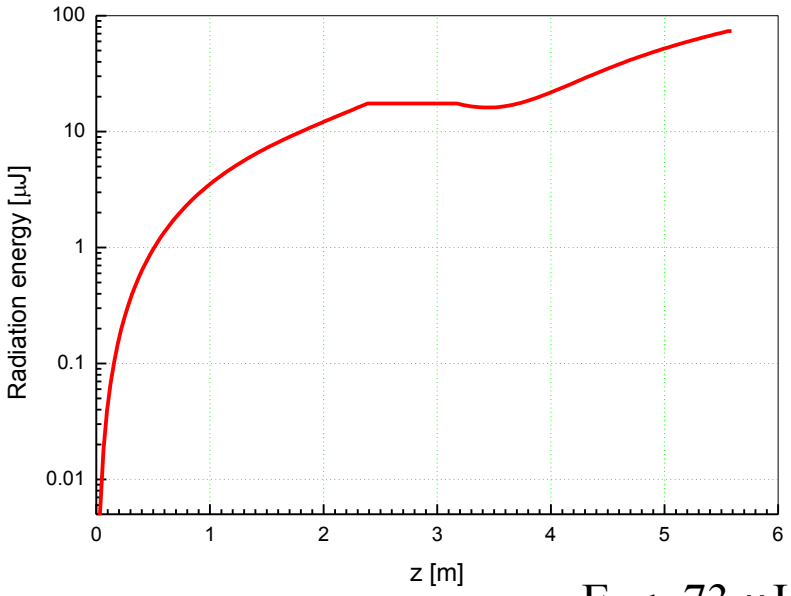
Radiation power after radiator



Spectrum

HGHG simulation for two cases

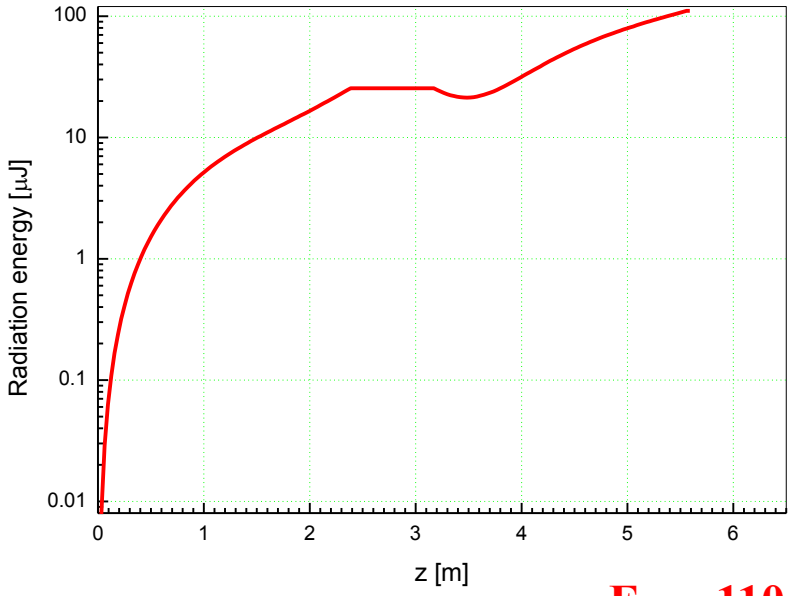
Case 1



E_{end}~73 μJ

Radiation energy along the radiator

Case 2

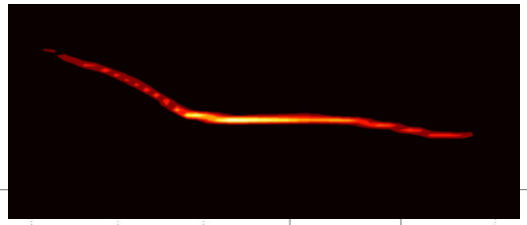


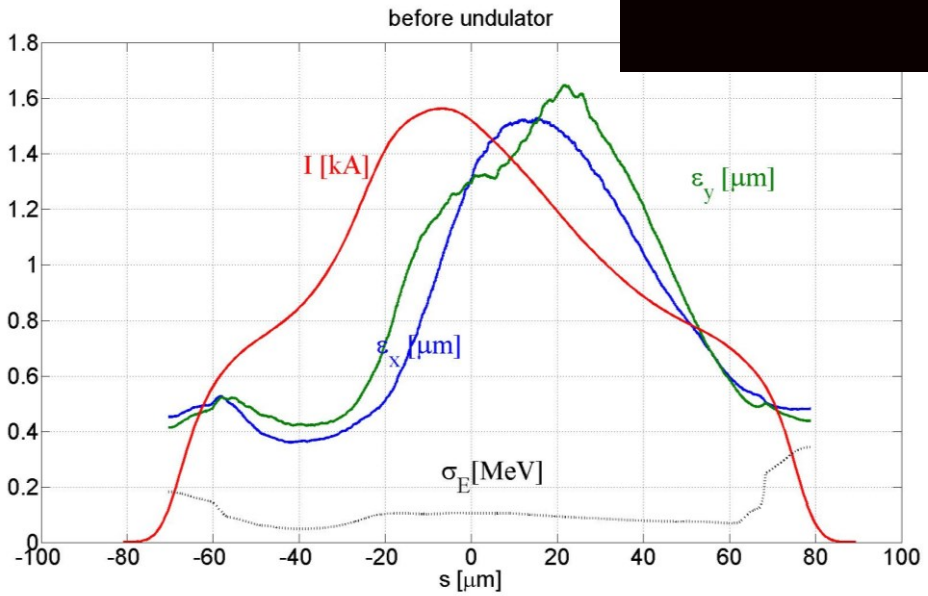
E_{end}~110 μJ

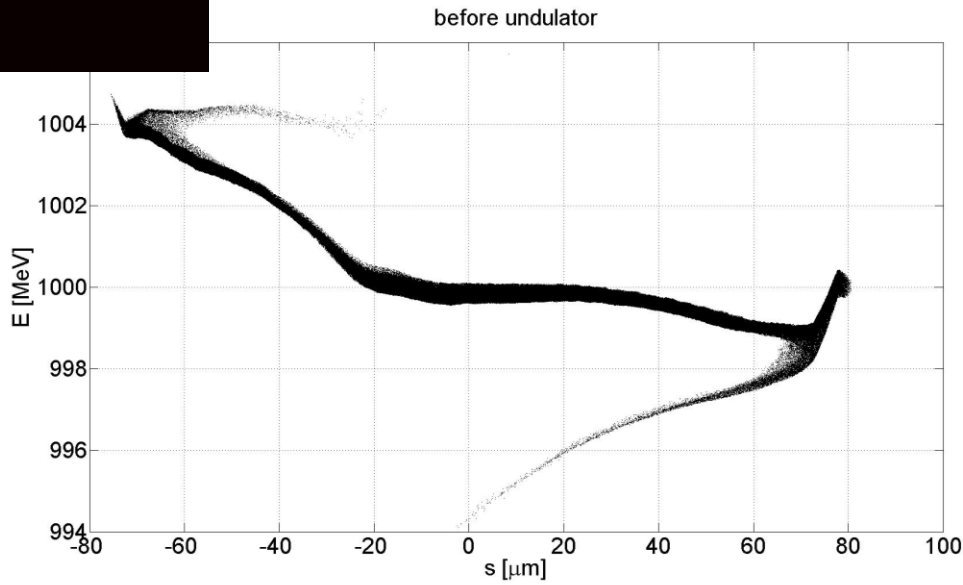
Radiation energy along the radiator

New beam dynamics simulation for case2 for high credibility

Q=0.5 nC , I_{peak} ~ 1.5 kA , **N_p= 1000000**

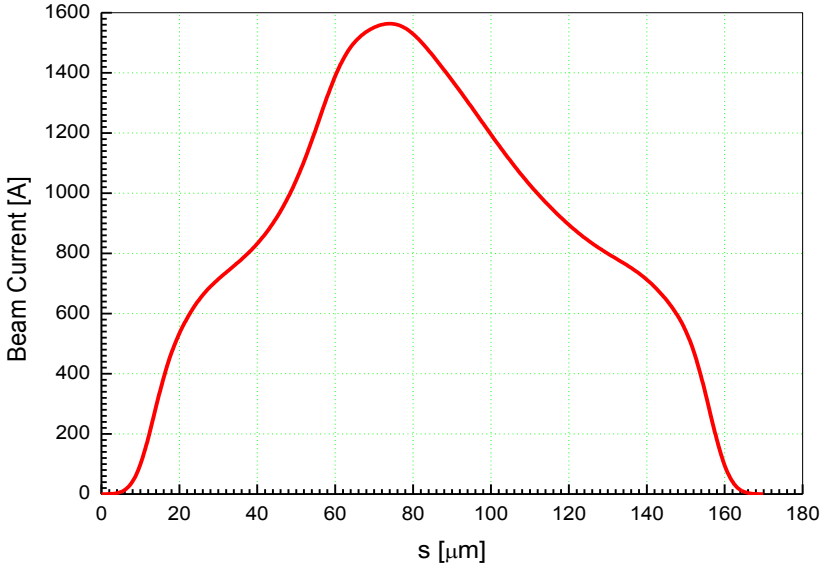




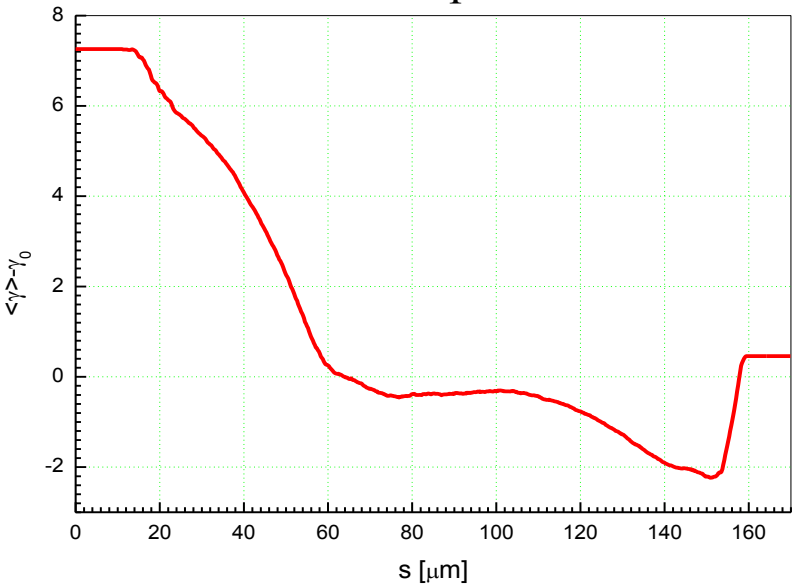


4% bad particles are removed

HGHG simulation for case2

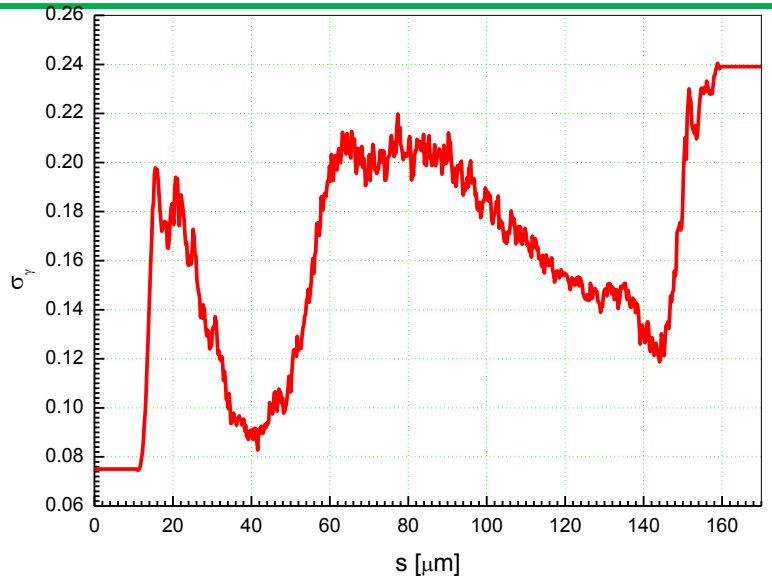


Current profile

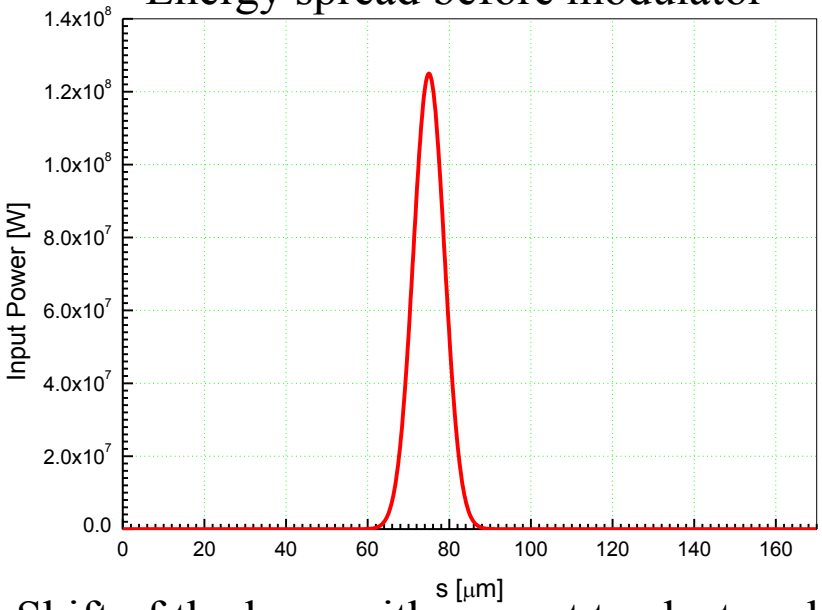


Energy distribution before modulator

HGHG simulation for low peak current case

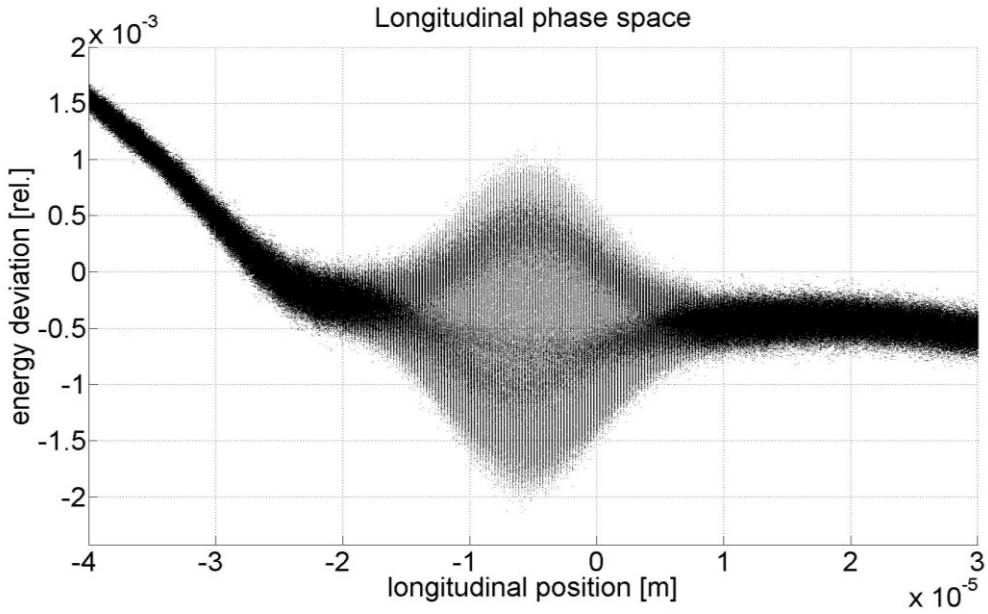


Energy spread before modulator

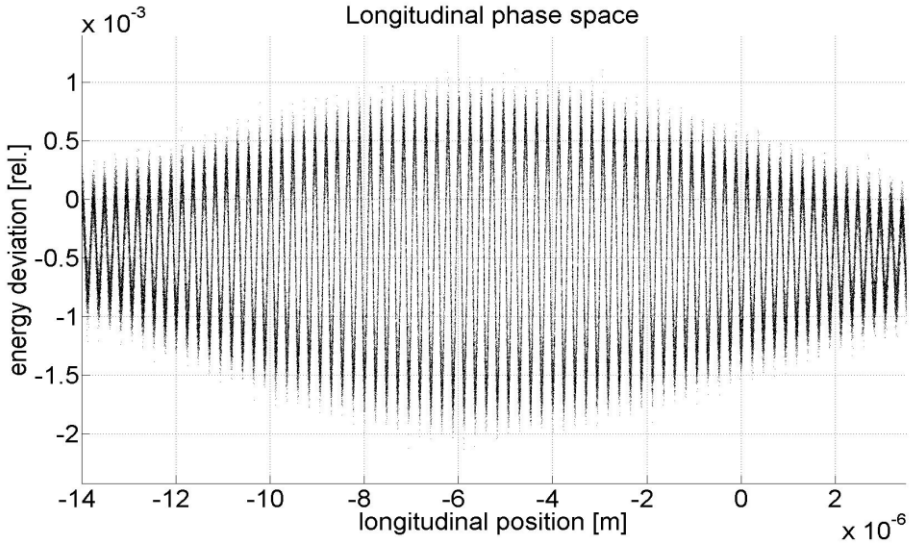


Shift of the laser with respect to electron bunch

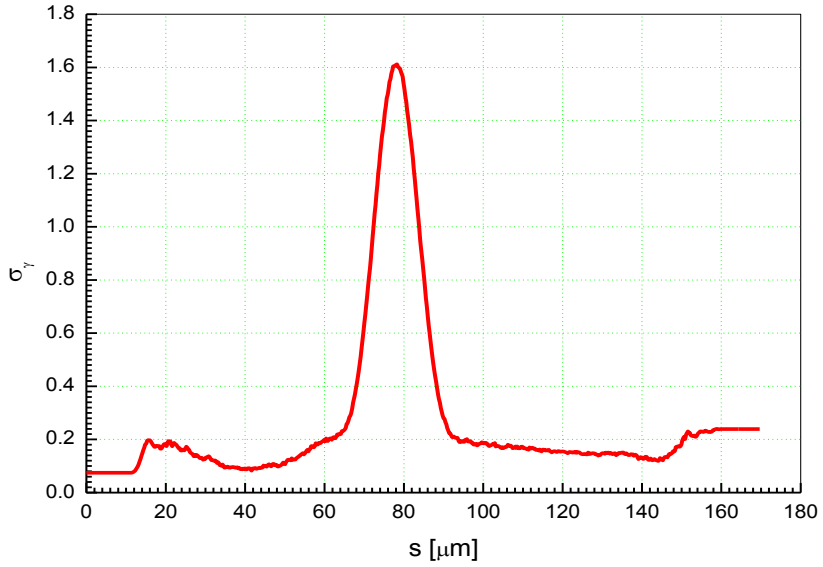
HGHG simulation for low peak current case



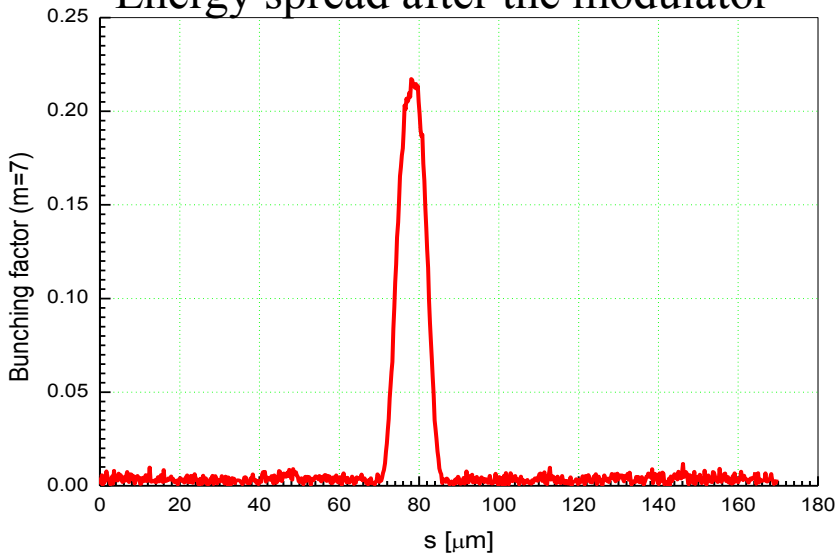
Longitudinal phase space after the modulator (before chicane)



HGHG simulation for low peak current case

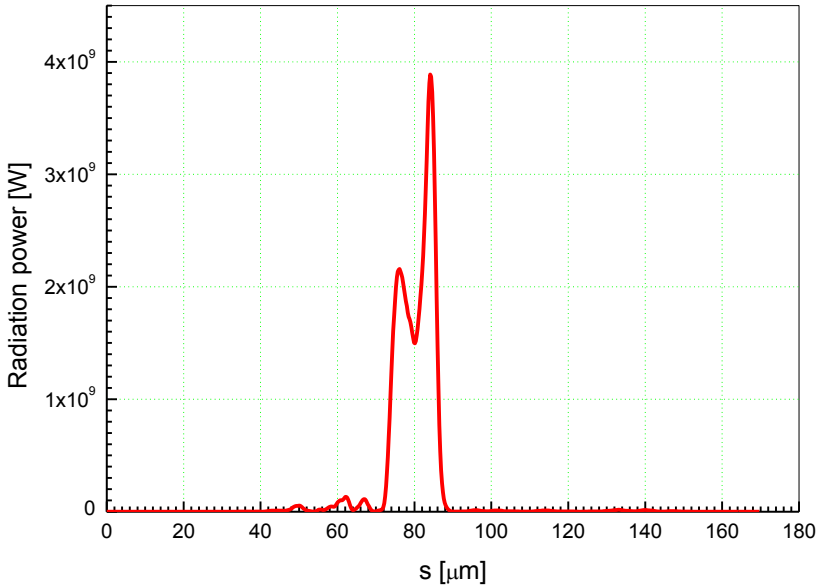


Energy spread after the modulator

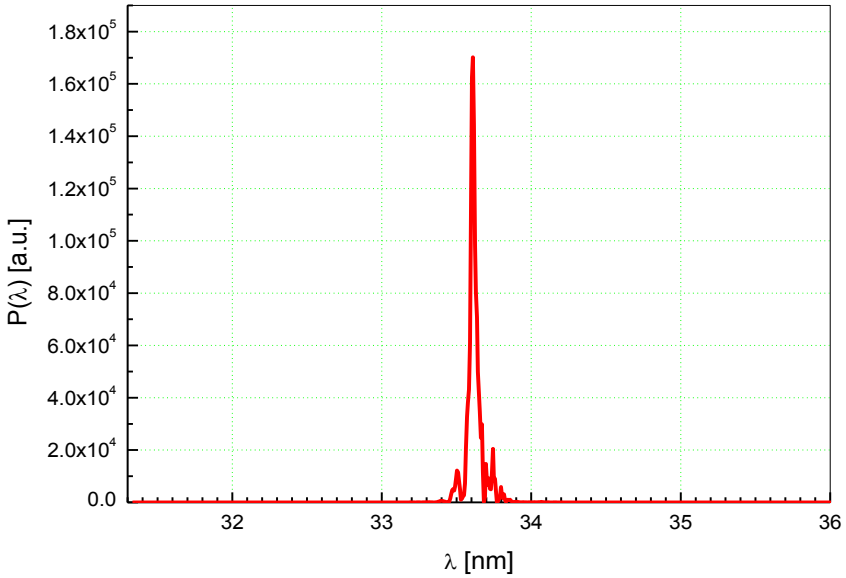


Bunching factor after the chicane (m=7)

HGHG simulation for low peak current case

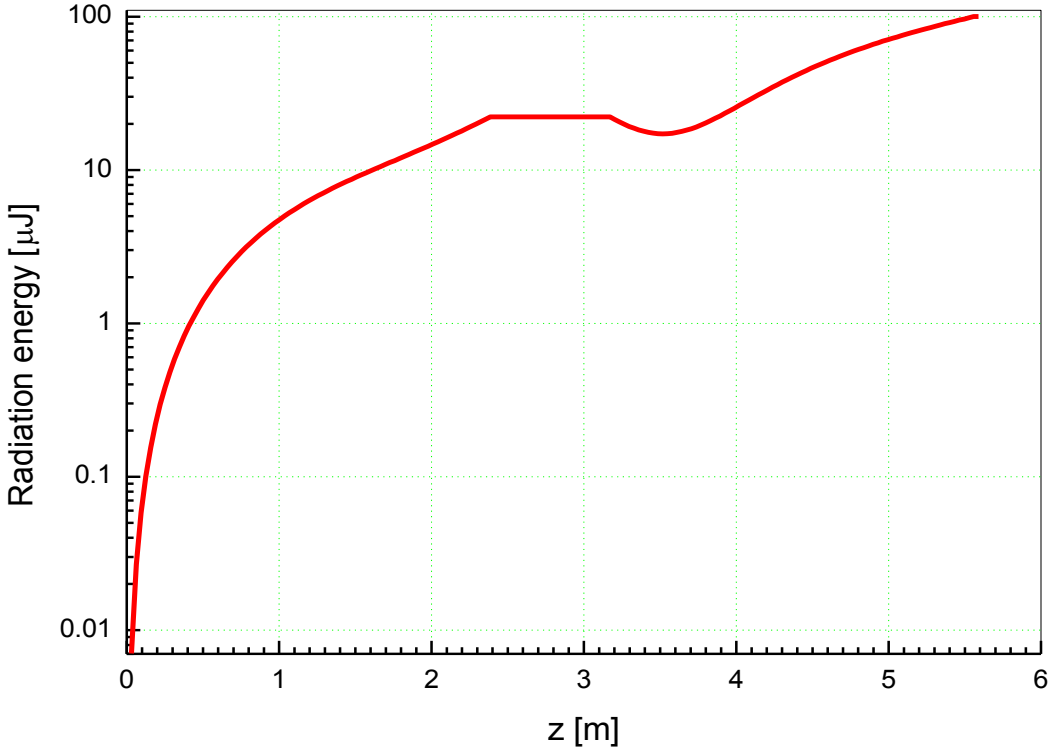


Radiation power after radiator



Spectrum

HGHG simulation for low peak current case



Radiation energy along the radiator E_{end}~100 μJ

Plan

(1) Beam dynamics simulation for the beamline between the modulator and the radiator with ASTRA and CSRTrack codes taking into account the space charge and CSR effects.

(2) Particle distribution conversion from ASTRA to Genesis (HDF5 format), then new Genesis simulation for the radiator.