

Work Progress for FLASH2 HGHG Simulation

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S2E Meeting

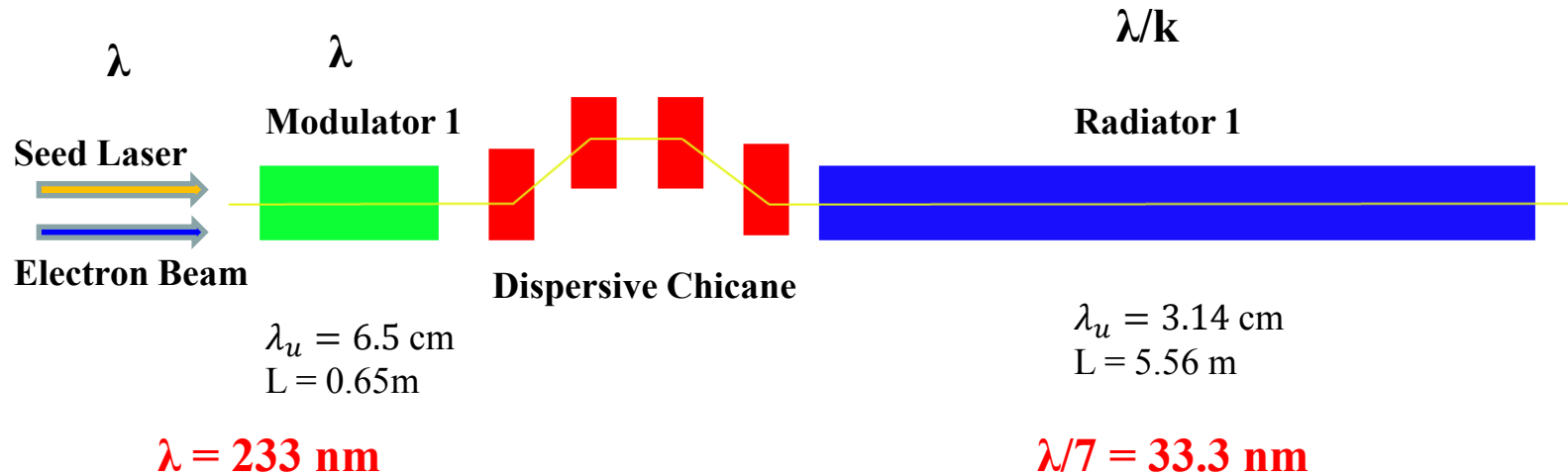
DESY

17.04.2014

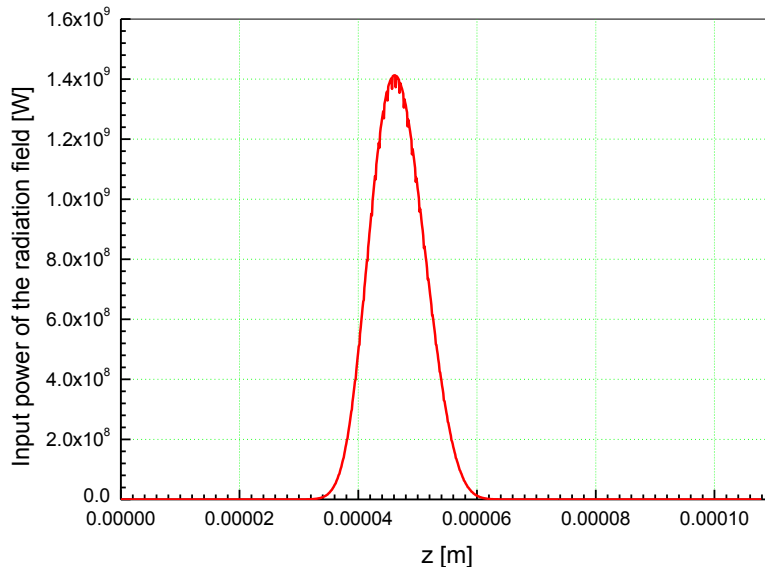
1. Single stage HGHG simulation for FLASH 2 with high peak current using the previous models of undulator, chicane and seeding laser (from Velizar).

2. Preparing for the new simulation with the models from Joern.

Descriptions for the undulator and the seeding laser



Seeding Laser



Chicane defined in Genesis input file

```
trama= 1
itram11= -0.9924
itram12= -0.0037
itram13= 0.000000D+00
:
:
itram66= 1.000000D+00
```

R56 for full compression and beam current estimation

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

$$P_L = 1.42 \text{ GW}$$

$$E_0 = 1.0 \text{ GeV}$$

$$\Rightarrow E_{mod} = 3.25 \text{ MeV}$$

$$\Rightarrow R_{56} = 11.43 \mu\text{m} \quad \text{For full compression}$$

Bunching factor

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

For getting high radiation power $\Rightarrow b_m \cdot I = \text{Maximal value}$

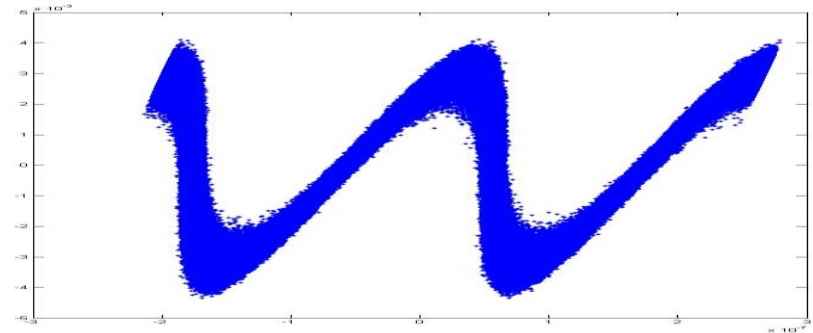
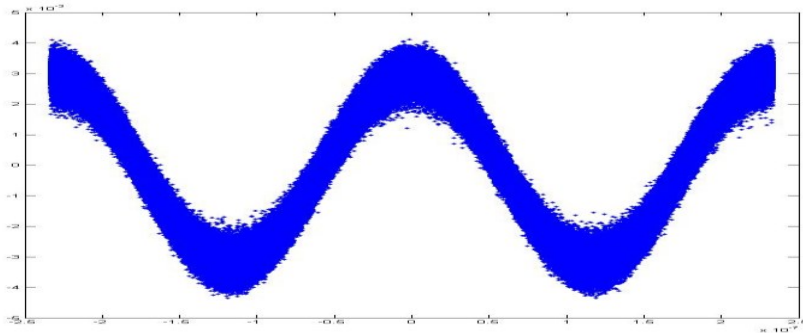
$$\Rightarrow I = \frac{E_0}{m \cdot k \cdot r_{56} \frac{dE_s}{dI}}$$

$$\frac{dE_s}{dI} \approx \frac{3 \text{ keV}}{50 \text{ A}}$$

$$m = 7$$

$$\Rightarrow I = 7728 \text{ A}$$

Energy modulation, microbunching and bunching factor

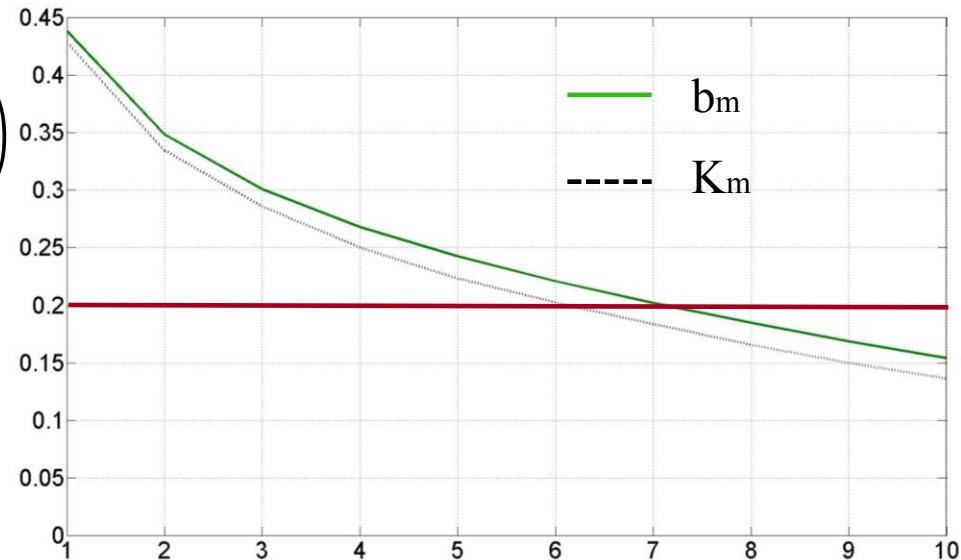


$$b_m = J_m \left(m \cdot k \cdot r_{56} \cdot \frac{E_{mod}}{E_0} \right) \cdot \text{Exp} \left(-0.5 \left(m \cdot k \cdot r_{56} \cdot \frac{E_s}{E_0} \right)^2 \right)$$

$$K_m = \frac{1}{N} \left(\left| \sum_n \text{Exp}(i \cdot m \cdot k \cdot z_n) \right| \right)$$

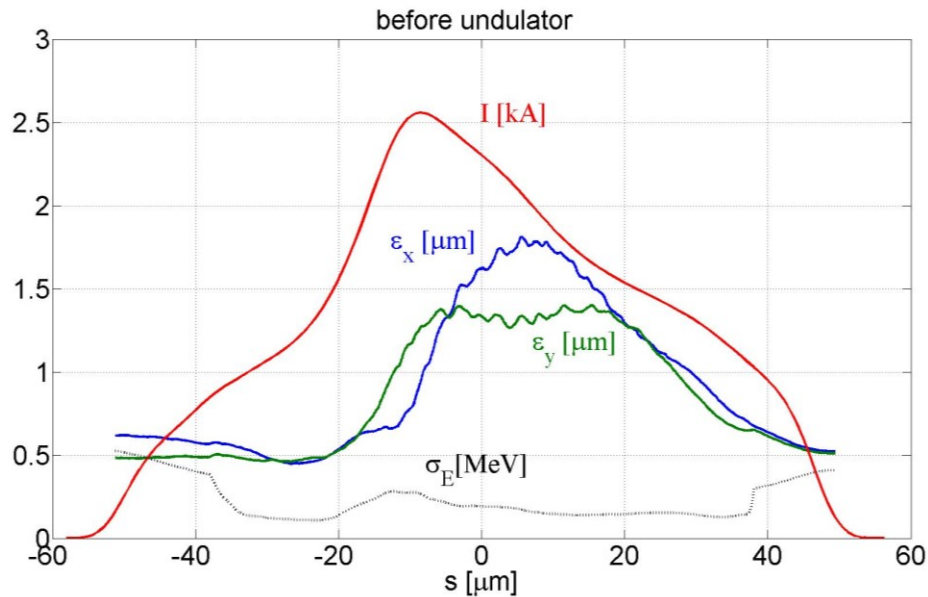
$$E_s = 250 \text{ keV}$$

$$N = 1000000$$

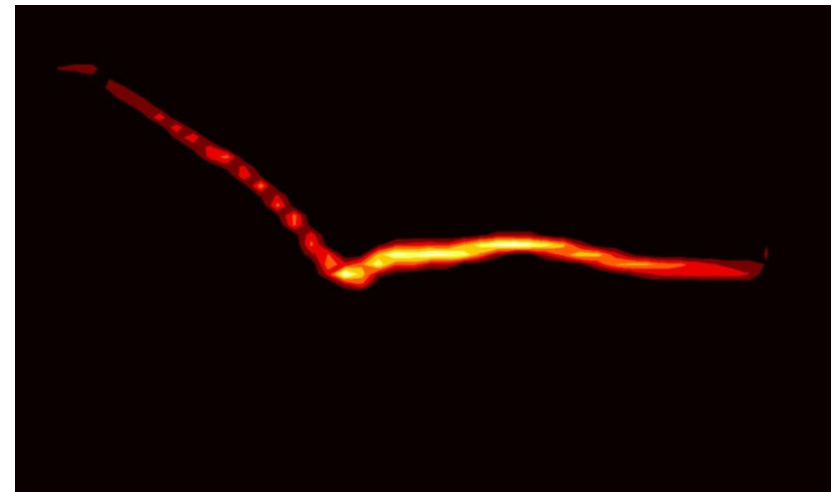
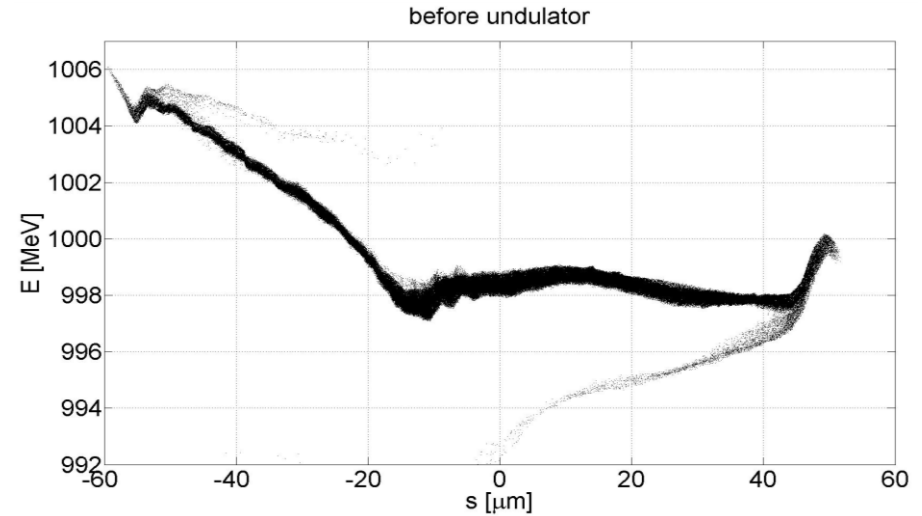


HGHG simulation with high peak current ($Q=0.5\text{nC}$)

Beam bunch properties at the entrance of undulator system



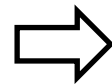
5% bad particles are removed



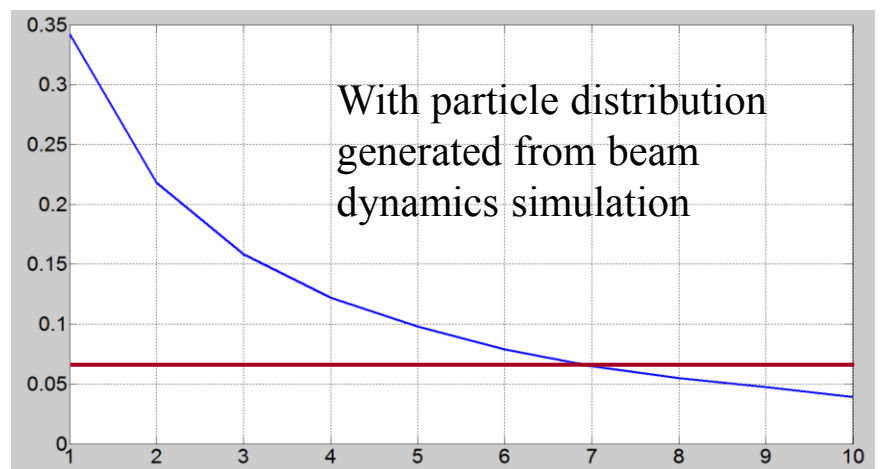
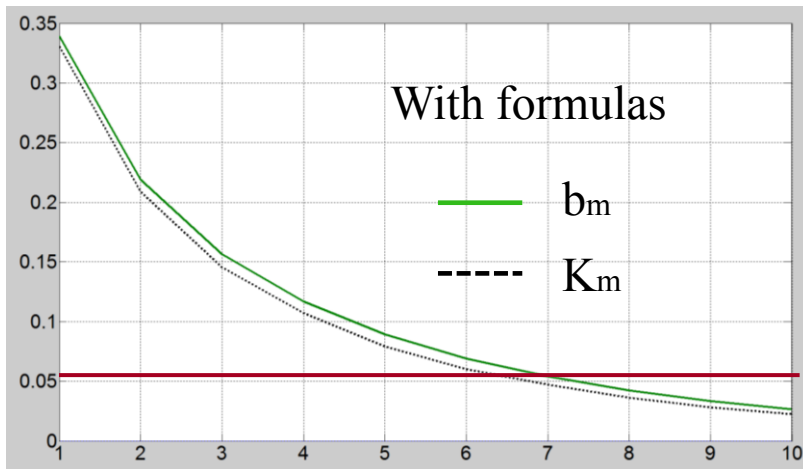
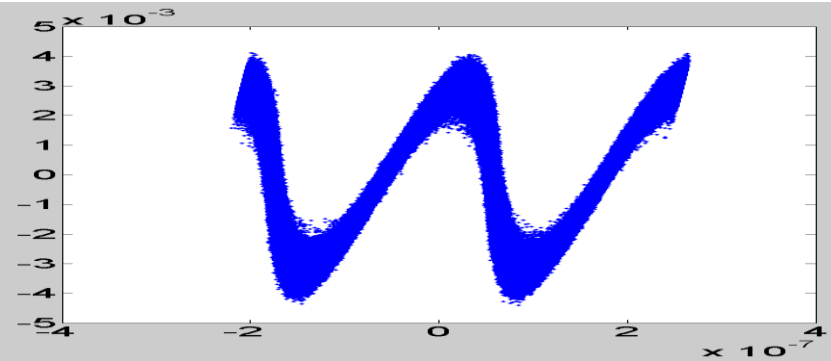
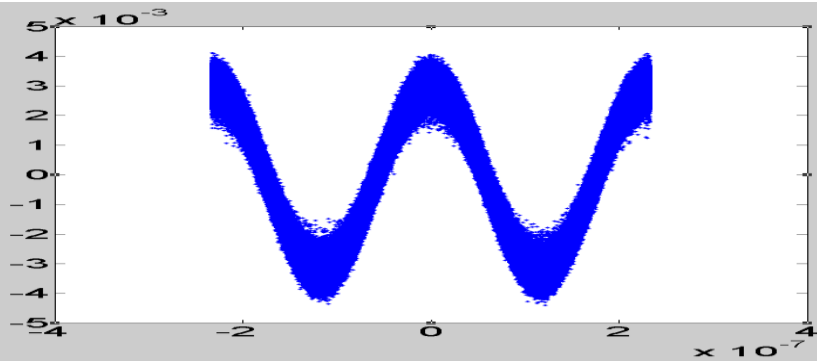
HGHG simulation with high peak current

* R56 of the dispersive chicane has not been adjusted for full compression because of the original transfer matrix description.

R56=8 μm

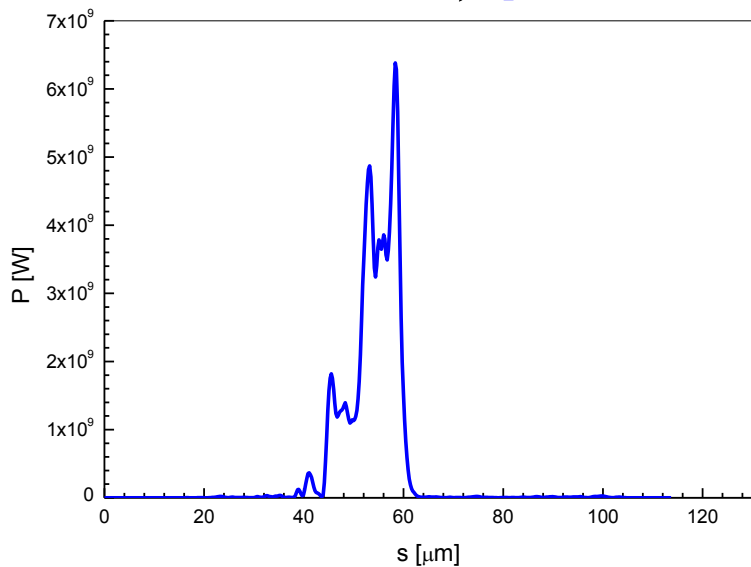


under-compression



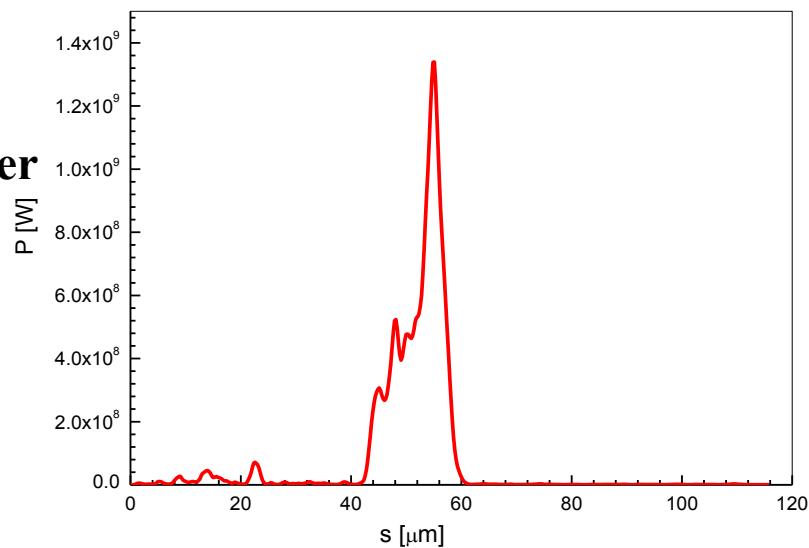
HGHG simulation with high peak current

Radiator, $I_p=2.5\text{kA}$

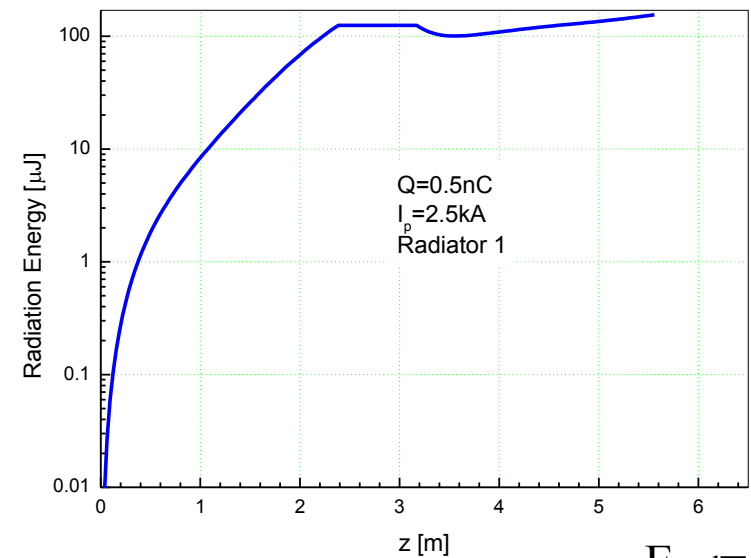


Radiation Power

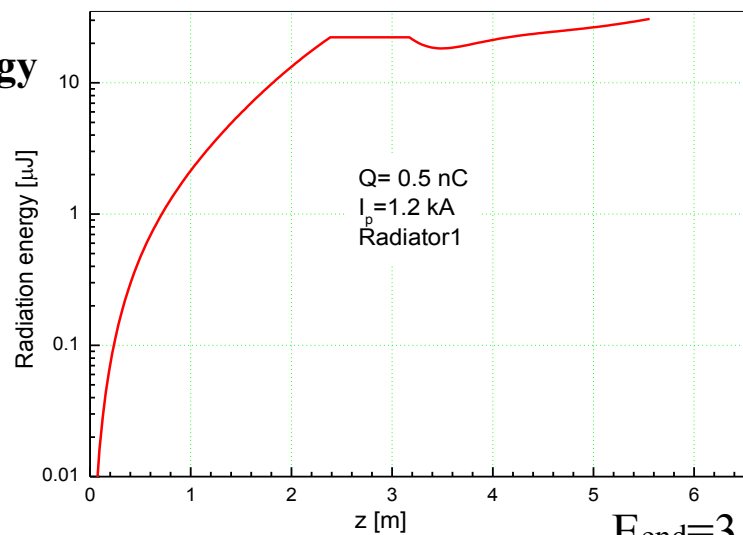
Radiator, $I_p=1.2\text{kA}$



Radiation energy



$E_{\text{end}}=154 \mu\text{J}$

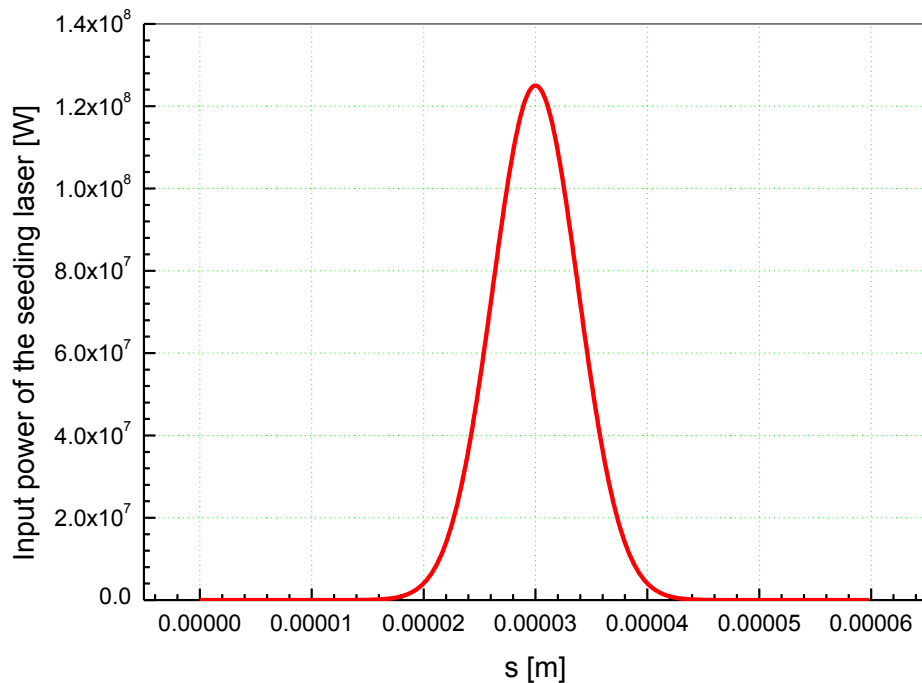


$E_{\text{end}}=31 \mu\text{J}$

Preparation for HGHG simulation with new models of modulator and seeding laser

Modulator length: $L = 2$ m
Number of periods: $N = 30$
Period length: $L_u = 0.067$ m

Laser peak power $P_{\text{laser}} = 125$ MW
with Rayleigh length $z_R = 4.2$ m
laser pulse duration of $\tau = 30$ fs (FWHM)
Wavelength $\lambda = 235$ nm



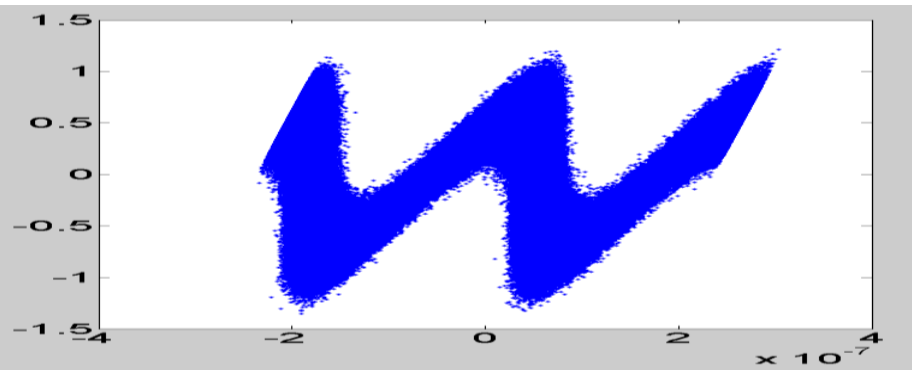
$E_0 = 1.0$ GeV
 $\lambda = 235$ nm
 $P_L = 125$ MW
 $K_{\text{eff}} = 5.0858$

Preparation for HGHG simulation with new models of modulator and seeding laser

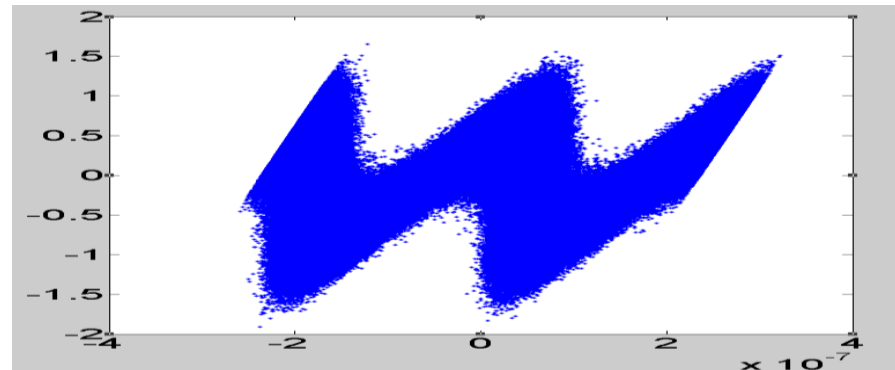
$R_{56} = 58.28\mu\text{m}$

For full compression

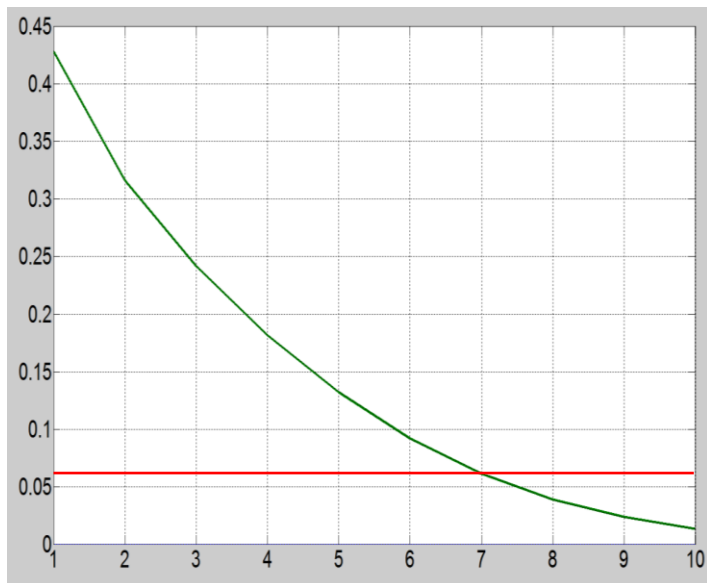
uncorrelated energy spread: 150keV (1.2 kA)



uncorrelated energy spread: 250keV (2.5kA)



Bunching factor



Bunching factor

