FACILITY FOR COHERENT THZ AND FIR RADIATION

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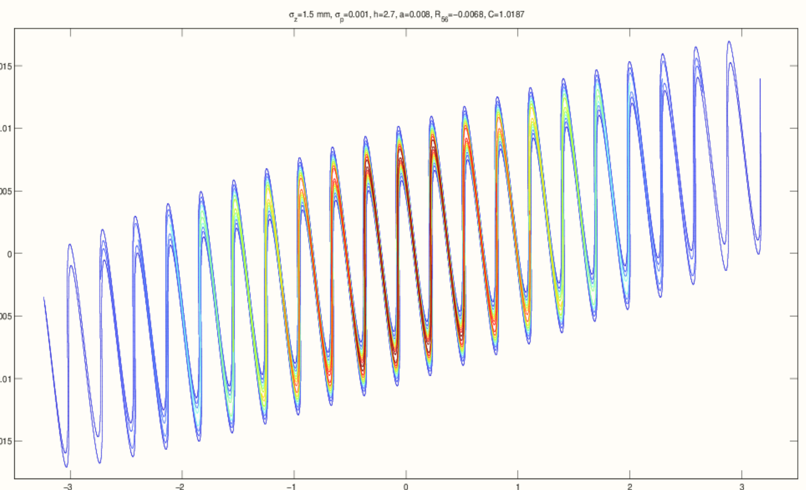
Conceptual:

1. Use THz oscillator FEL to create microbunching
2. Steepen the bunching profile in beam line
3. Which creates a comb-beam
4. Generate harmonics in radiator undulator

Map initial dGaussian distribution to start of second undulator...

$$\Psi_f(z_f,\delta_f) = \frac{1}{2\pi\sigma_z\sigma_\delta}\exp\left[-\frac{1}{2}\left\{\left(\frac{1}{\sigma_z^2}+\frac{h^2}{\sigma_\delta^2}\right)[z_f-R_{56}\delta_f]^2 -2\frac{h}{\sigma_\delta^2}[z_f-R_{56}\delta_f](\delta_f-a\cos(k_t[z_f-R_{56}\delta_f])) +\frac{(\delta_f-a\cos(k_t[z_f-R_{56}\delta_f]))^2}{\sigma_\delta^2}\right\}\right].$$

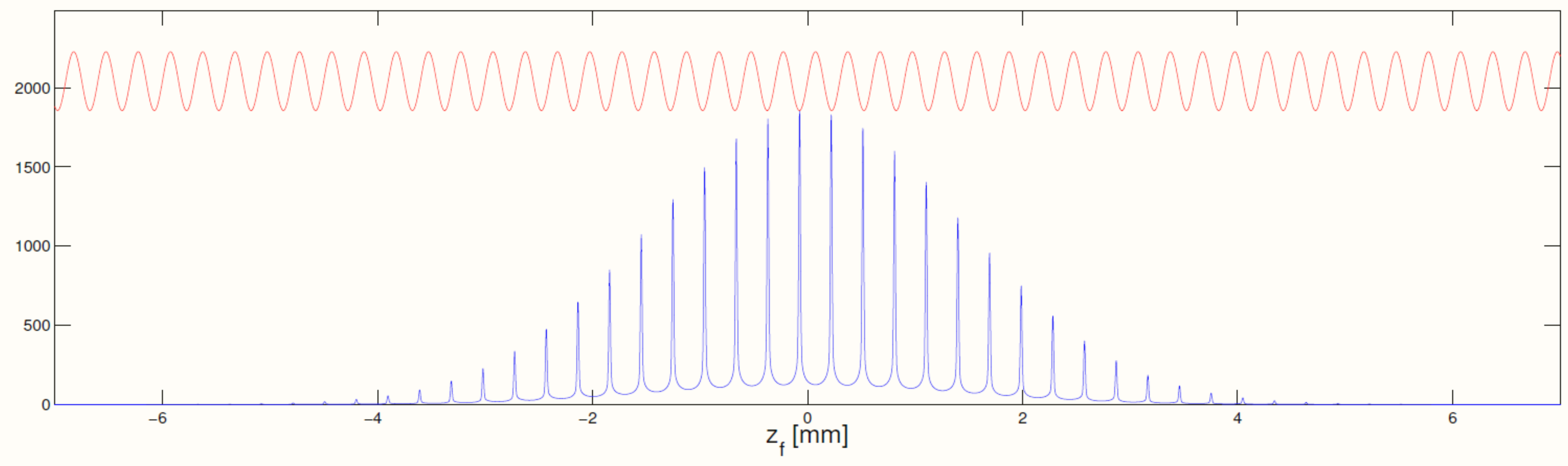


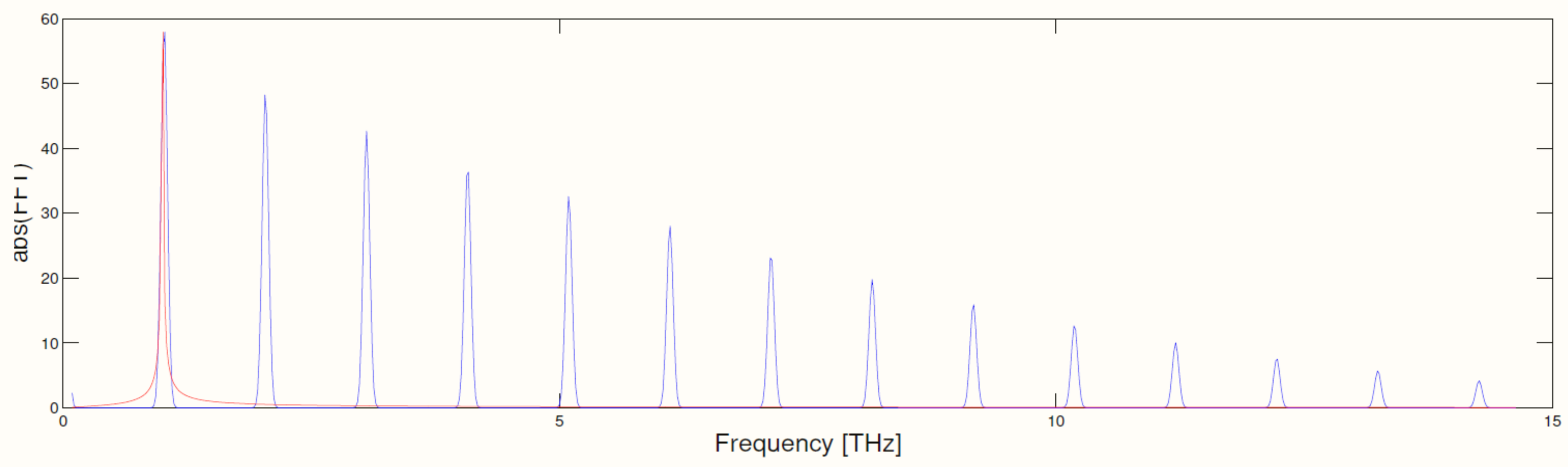
...and map on a grid in Matlab

easy to create projections and spectrum from FFT

Optimum, when left edge of sine is vertical yields

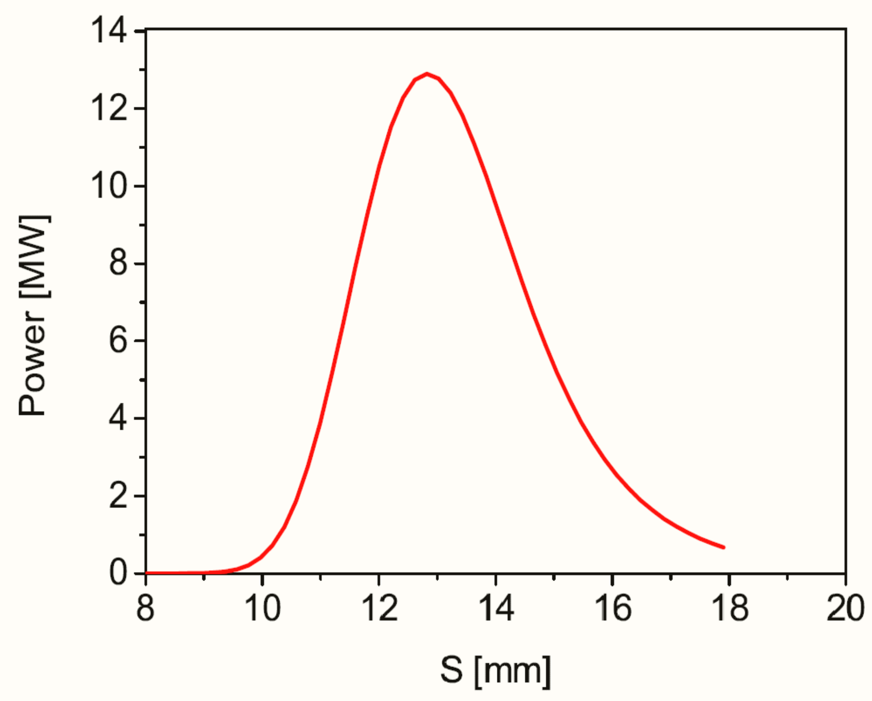
$0 = 1 + R_{56}(h + k_t a)$ with $k_t = 2\pi/\lambda$

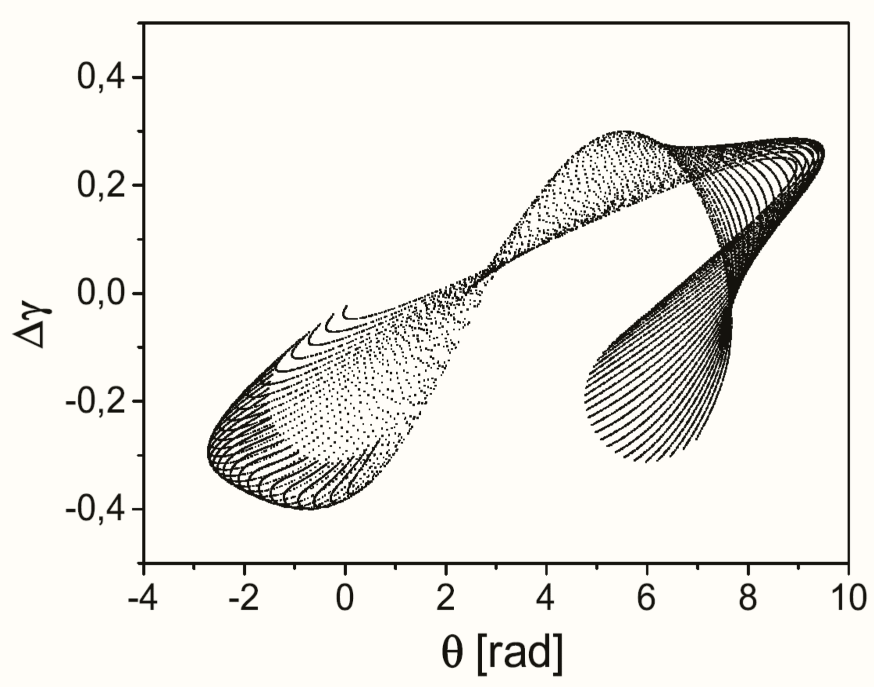


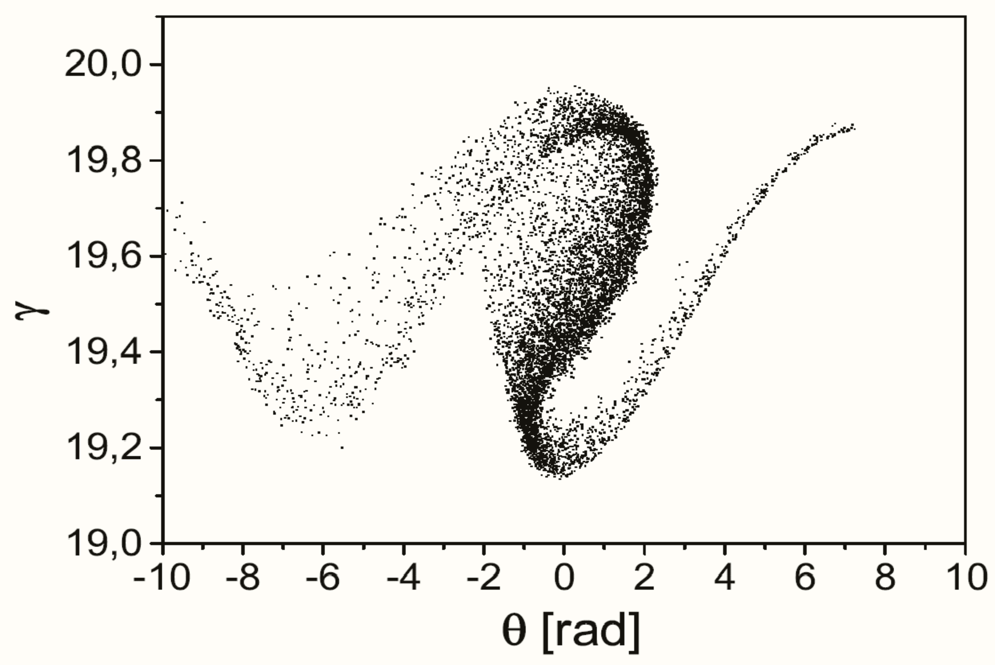


Numerical:

Time-dependent simulations with FELO [1] and final verification of steady state with Genesis [2]







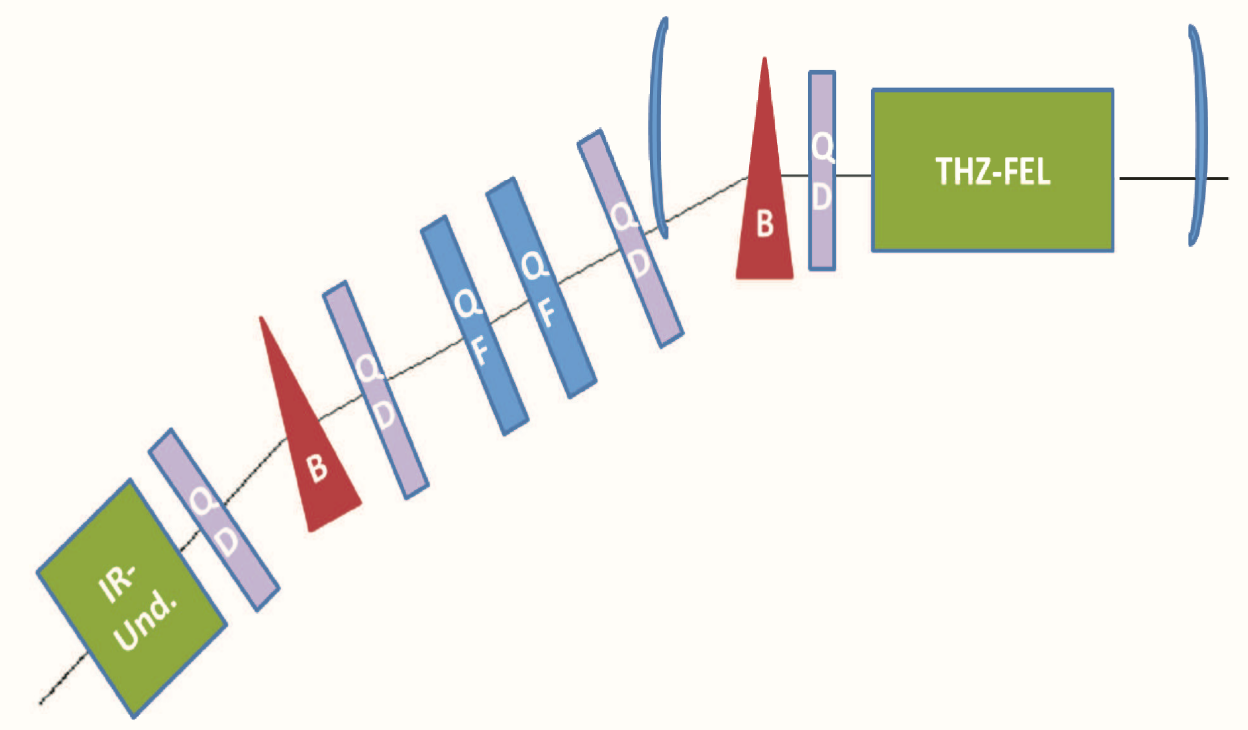
Parameters:

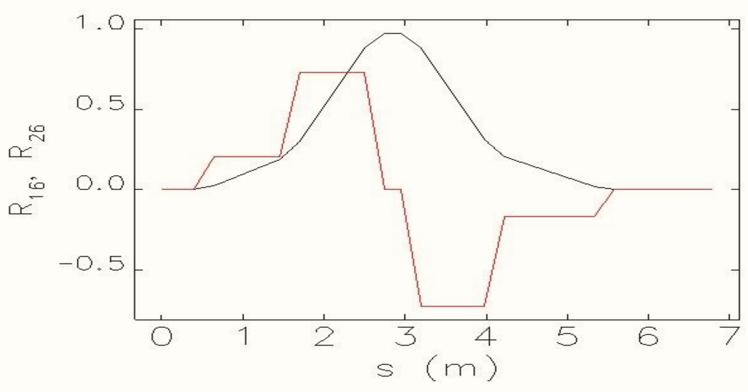
Bunch current:	300 pC
Bunch length (rms):	1.5 mm
Incoh. energy spread:	10^{-3}
Number of periods:	30
K-value (rms):	1.14
Period length:	10 cm
Cavity length:	8.04 m

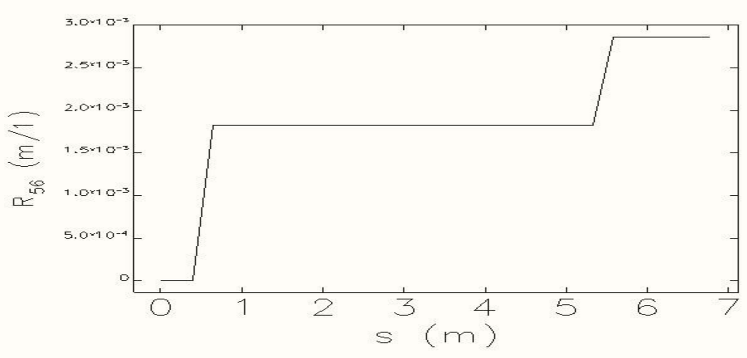
Output:

Wavelength:	300 µm
Peak power:	13 MW
Modulation depth:	2.6 %

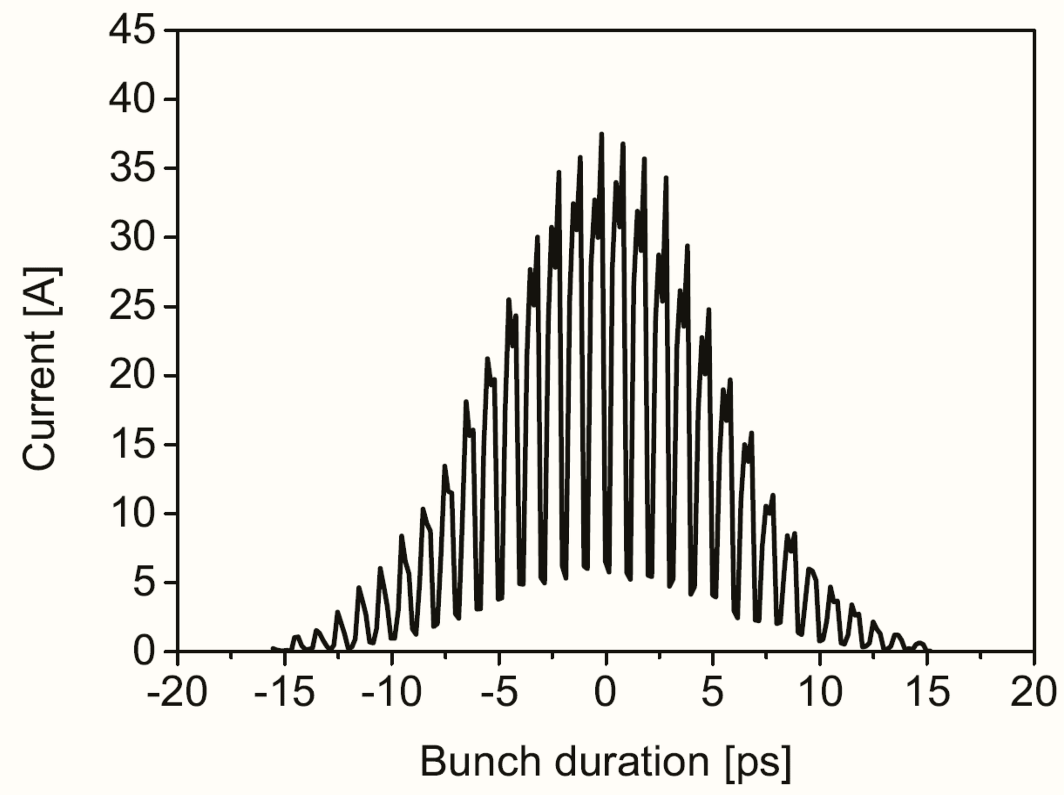
With elegant [3] propagate the modulated beam through the beam line with R_{56}=3 mm

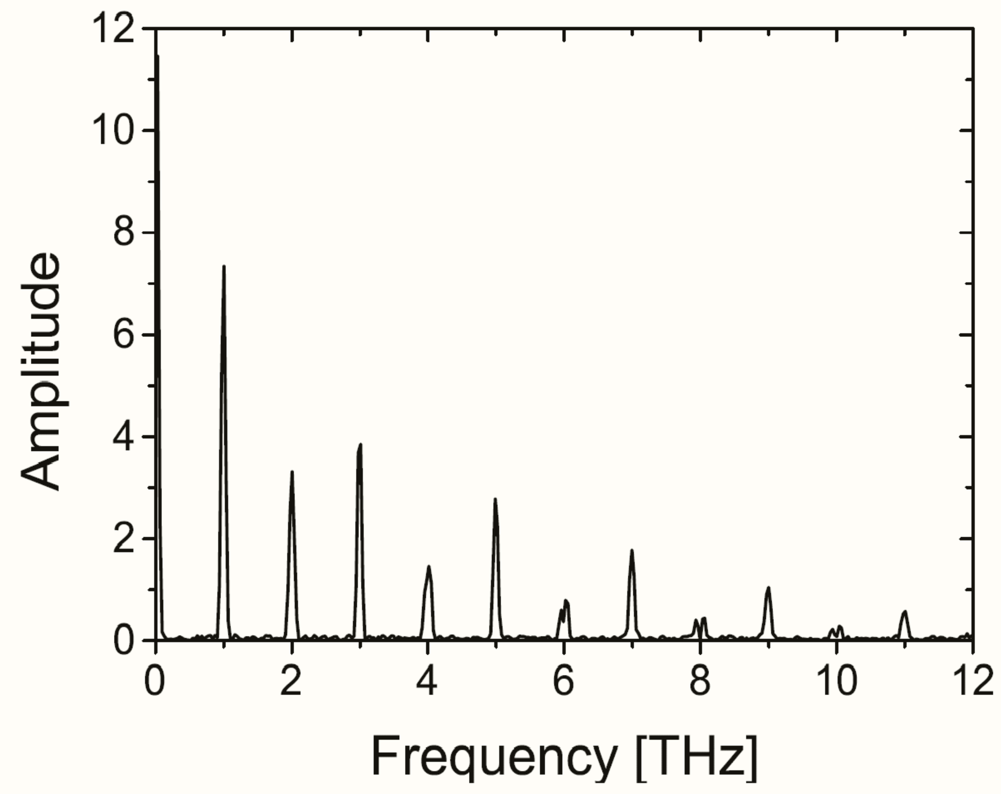




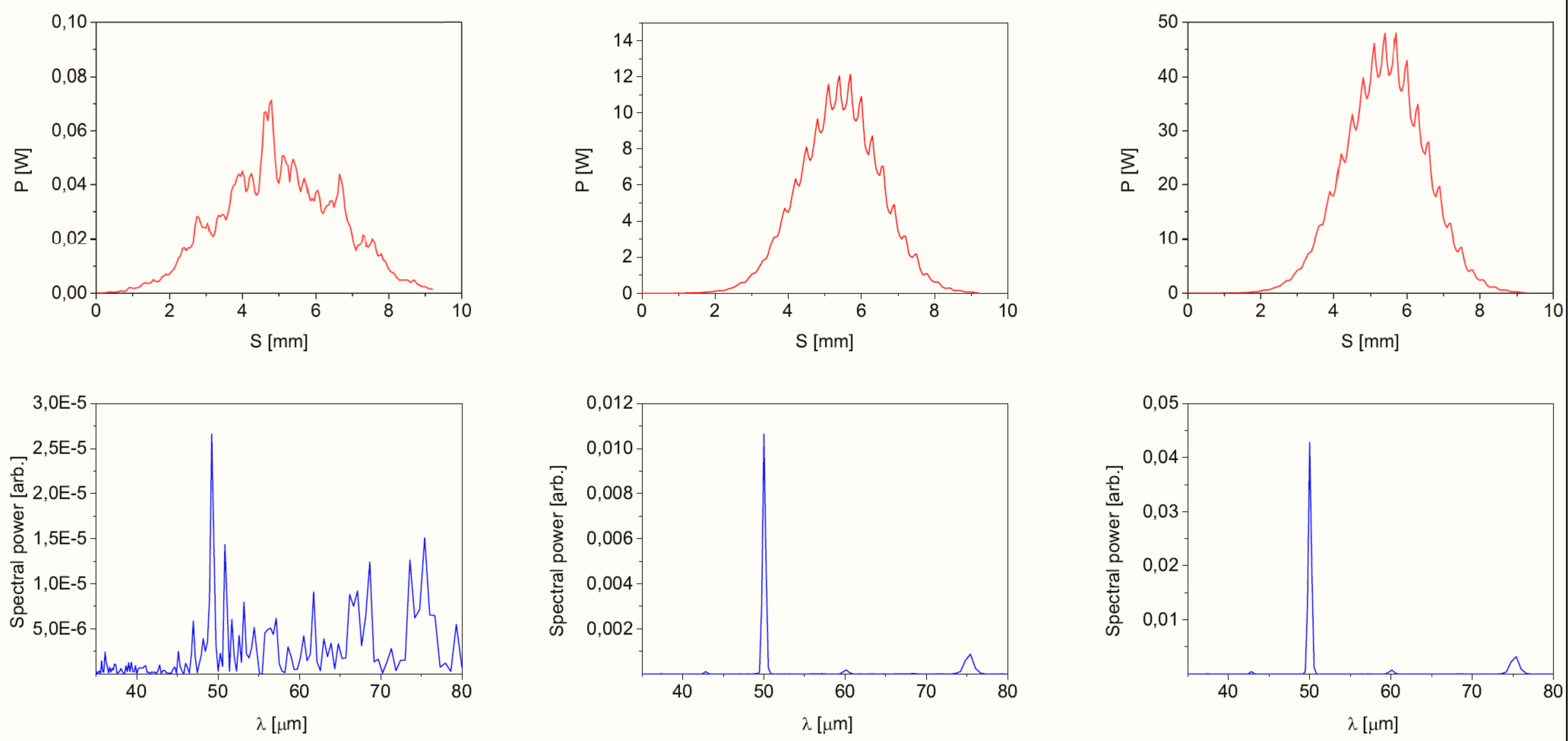


Longitudinal comb-like beam distribution and spectrum at entrance to second undulator





Output power profile and spectrum of 6th harmonic with zero, 0.5 % and 1 % bunching



REFERENCES

[1] B. McNeill et al., *FELO: A one-dimensional time-dependent FEL oscillator code*, Proceedings of the 28th FEL conference in Berlin p.59, 2006.

[2] S. Reiche, *GENESIS 1.3: A fully 3-D time dependent FEL simulation code*, Nucl.Instrum.Meth. A429 (1999) 243.

[3] M. Borland, *elegant: A Flexible SDDS-Compliant Code for Accelerator Simulation*, Advanced Photon Source LS-287, 2000.