HZB Helmholtz Zentrum Berlin

Präsentation

Author Name

Collaborators

Electron beam optimization and MC-simulations of electron beam:

G. Feng, DESY

FEL-simulations:

A. Meseck, HZB

Helpful discussions on beam properties:

M. Dohlus, DESY

Providing information on experimental set-up:

B. Hacker, Uni. Dortmund

Collaborators

Electron beam optimization and S2E-simulations of the electron beam:

G. Feng, DESY

FEL-simulations:

A. Meseck, HZB

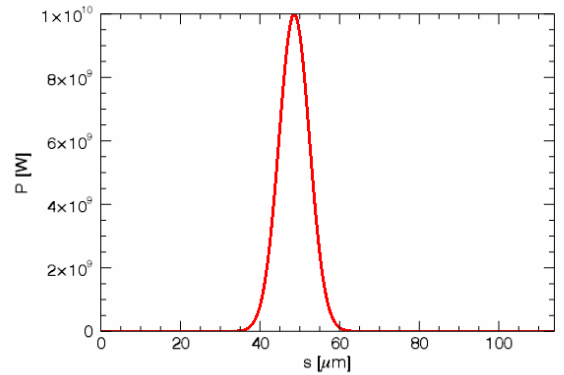
Helpful Discussions on beam properties:

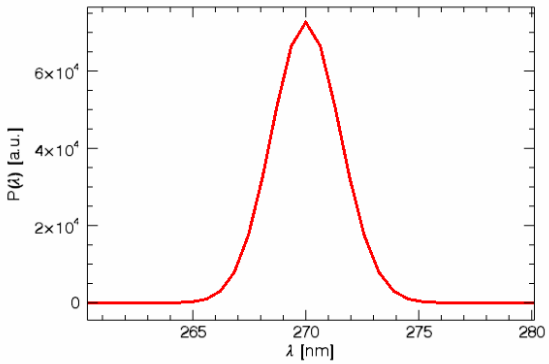
M. Dohlus, DESY

Providing information on experimental set-up:

K. Hacker, University Dortmund

One Stage HGHG at FLASH





Laser

Electron beam

ORS 1

ORS 2

Chicane

Chicane

S-FLASH1

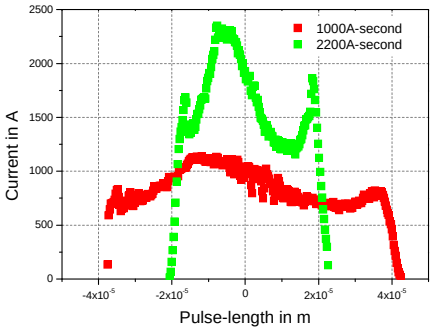
S-FLASH2

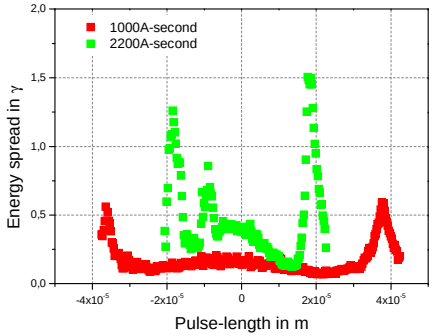
S-FLASH3

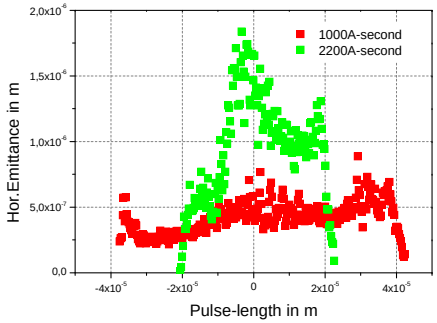
S-FLASH4

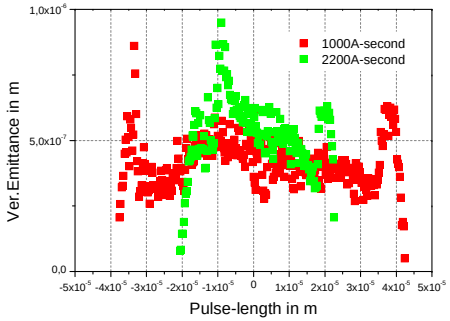
Modulator

Radiator

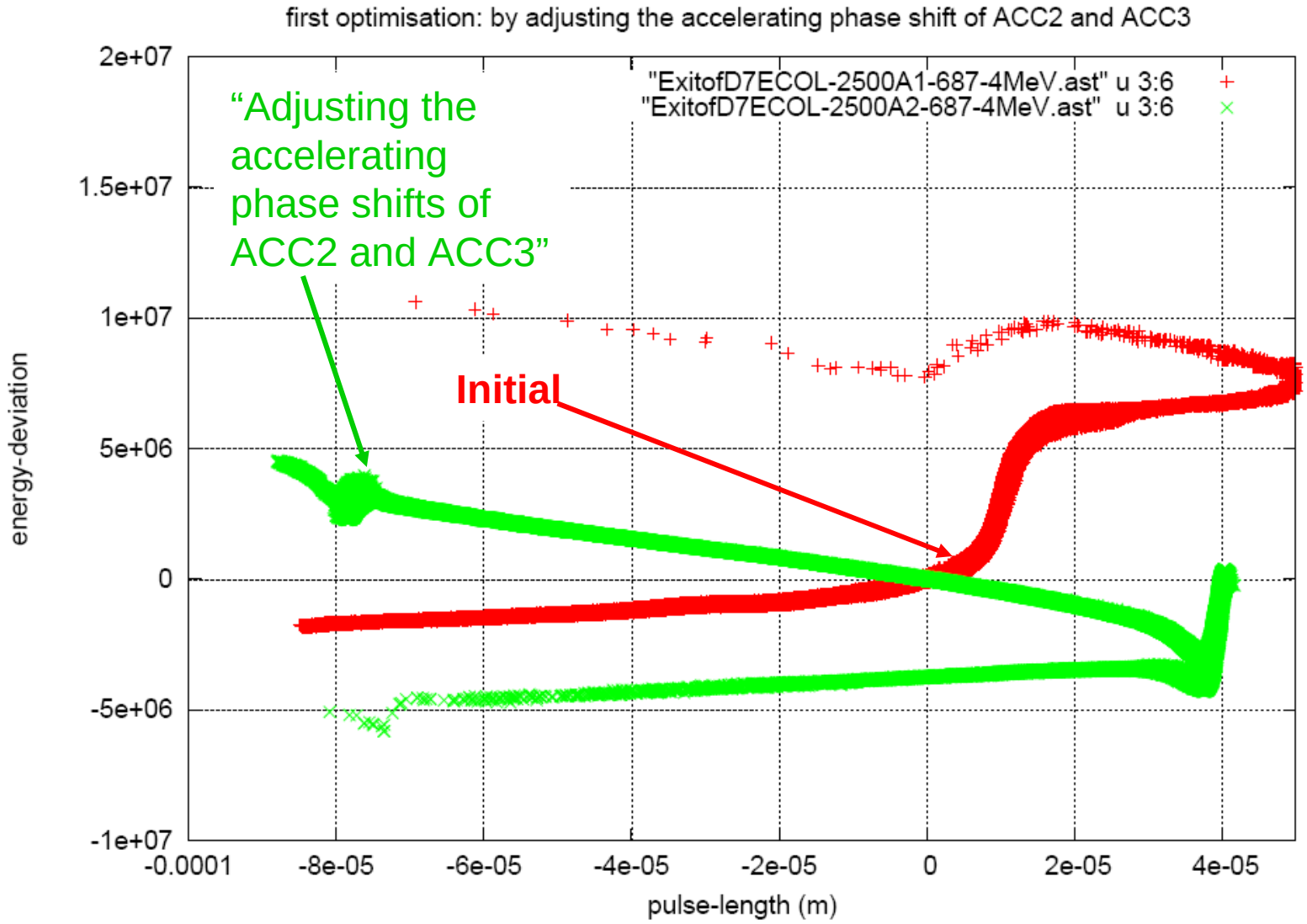




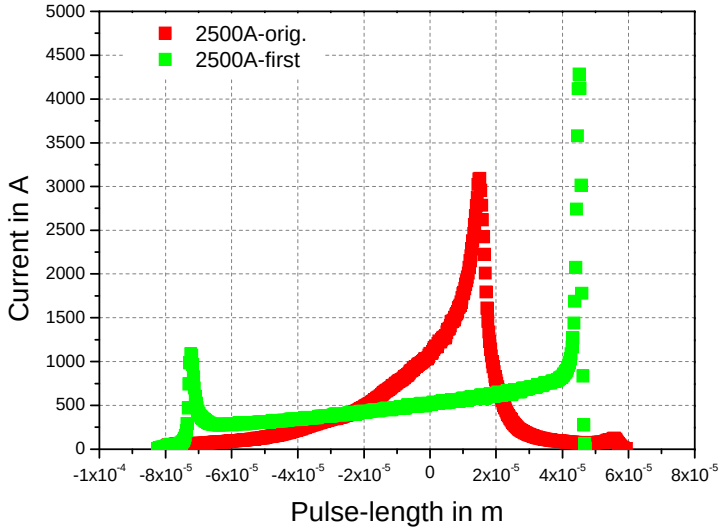


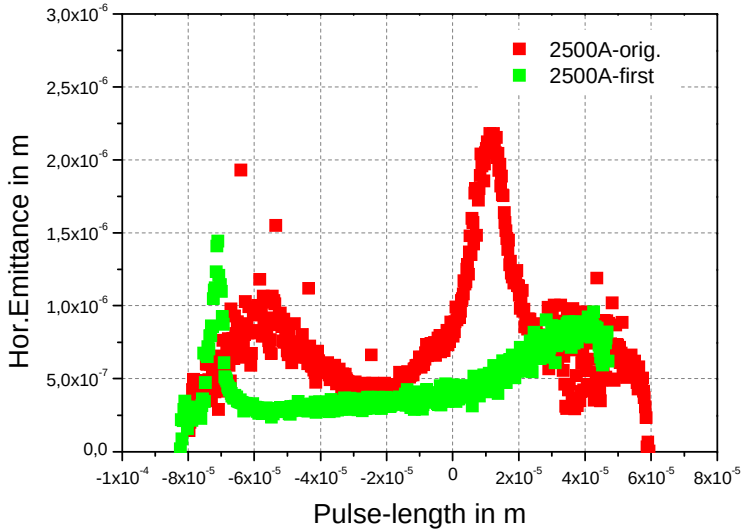


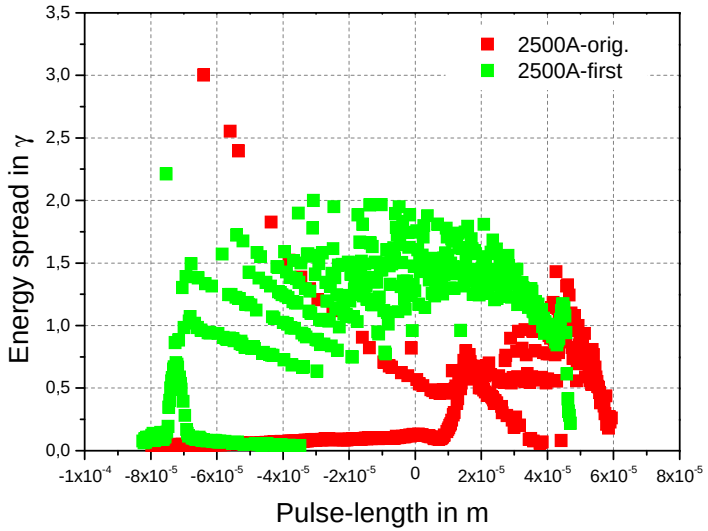
Electron Beam: First Optimization

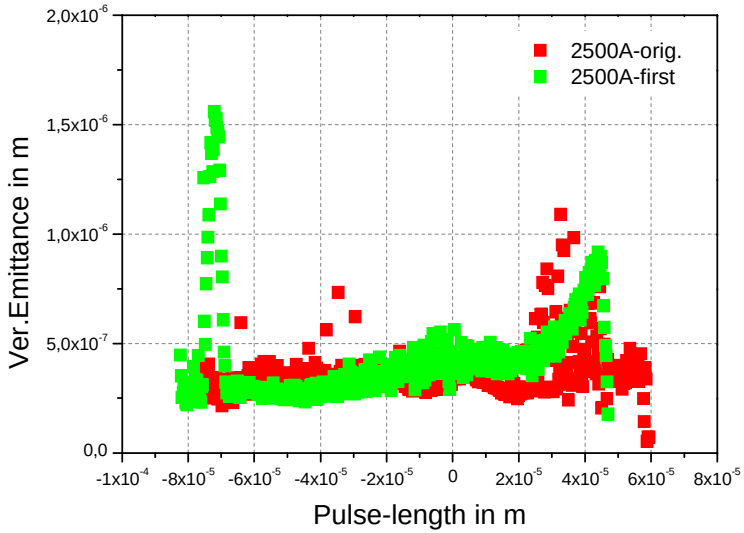


First Optimization

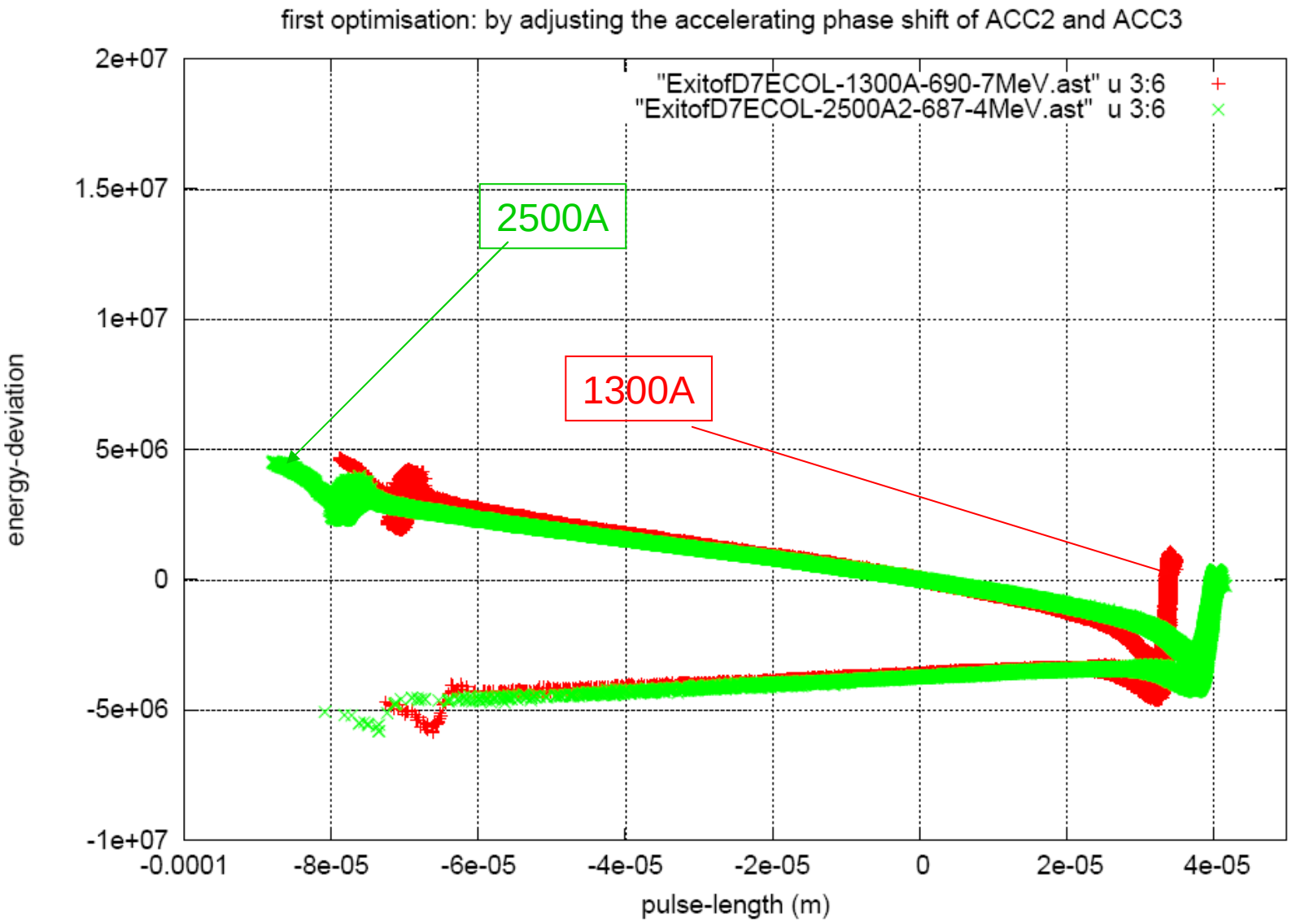




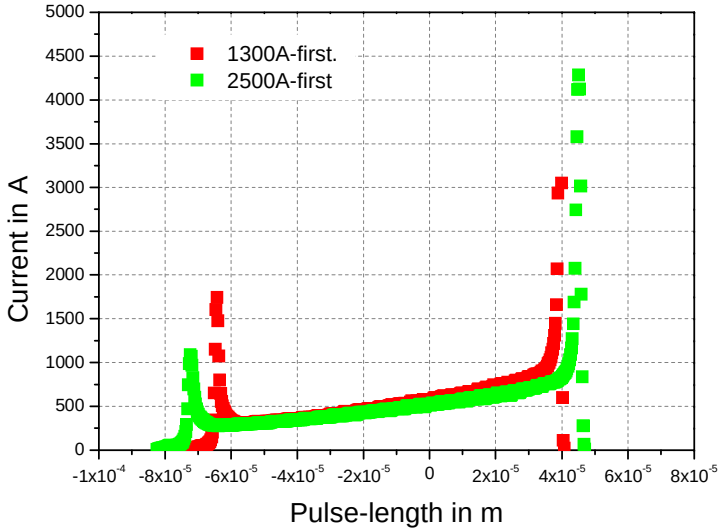


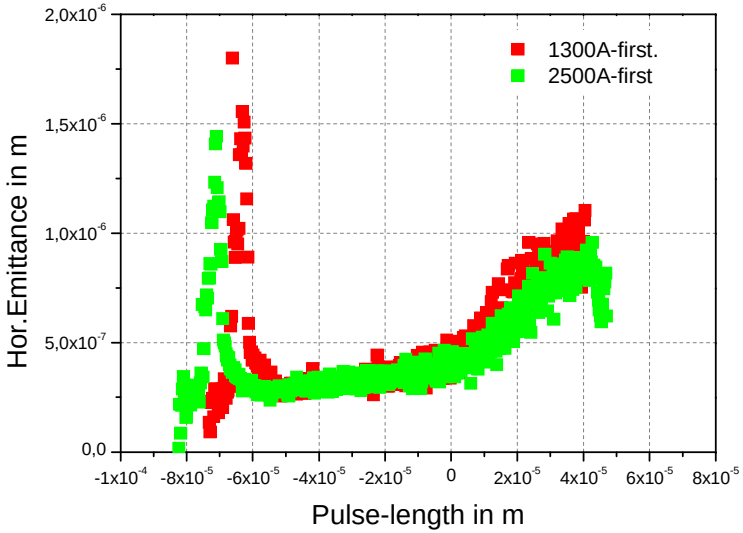


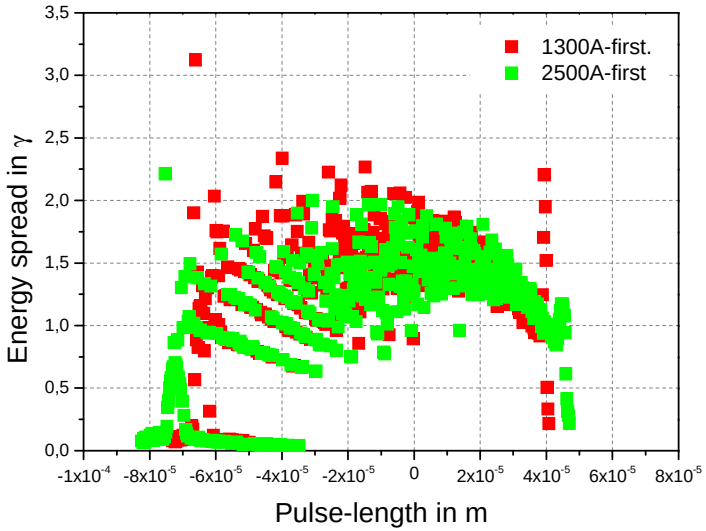
“Adjusting the Phase Shifts for Different Currents”

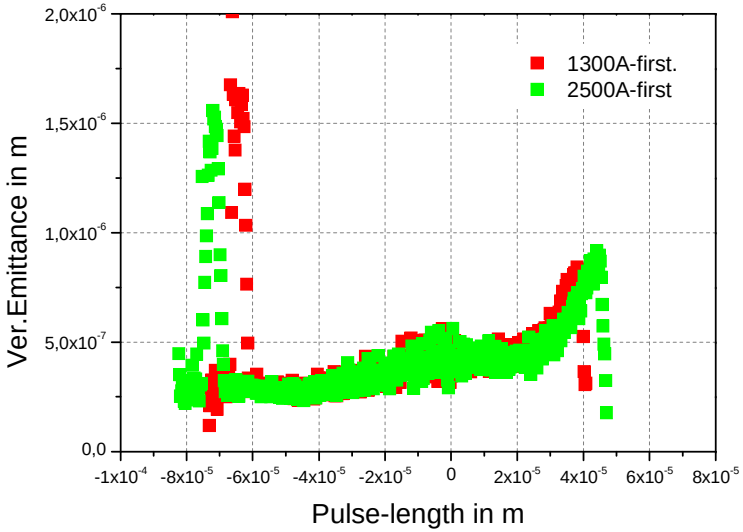


First Optimization; Different Currents

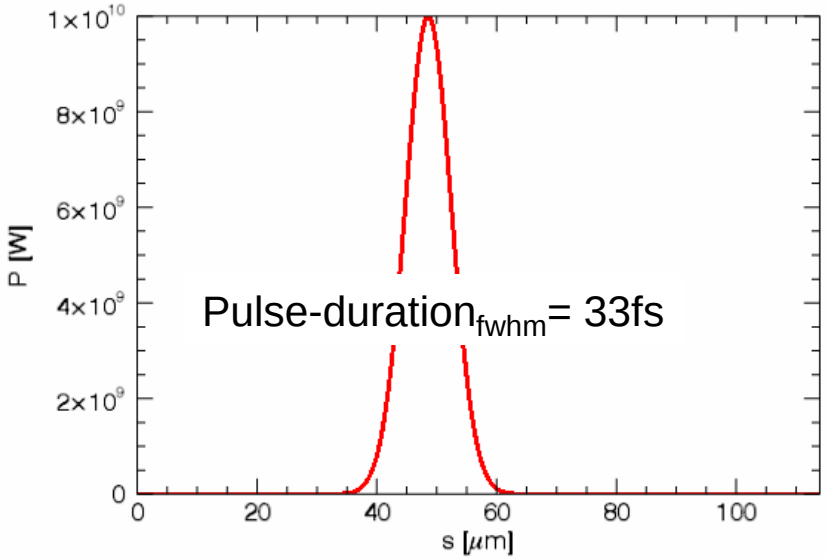


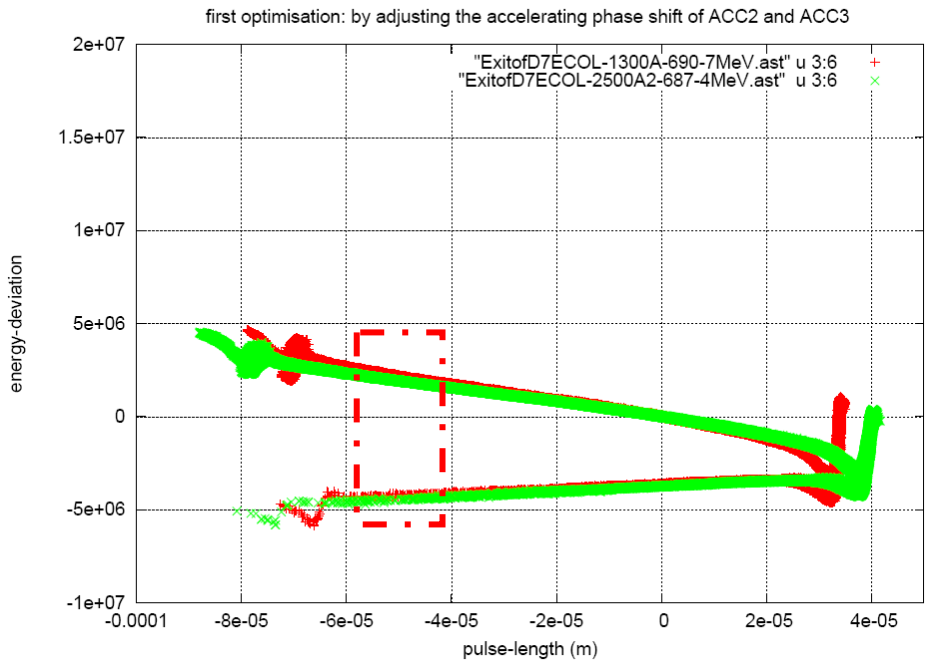


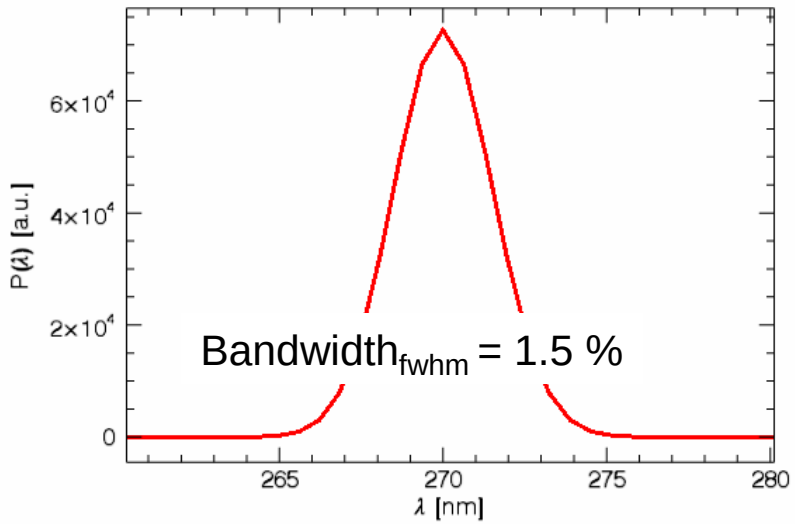




Seeding Pulse and the Two Energy Arms

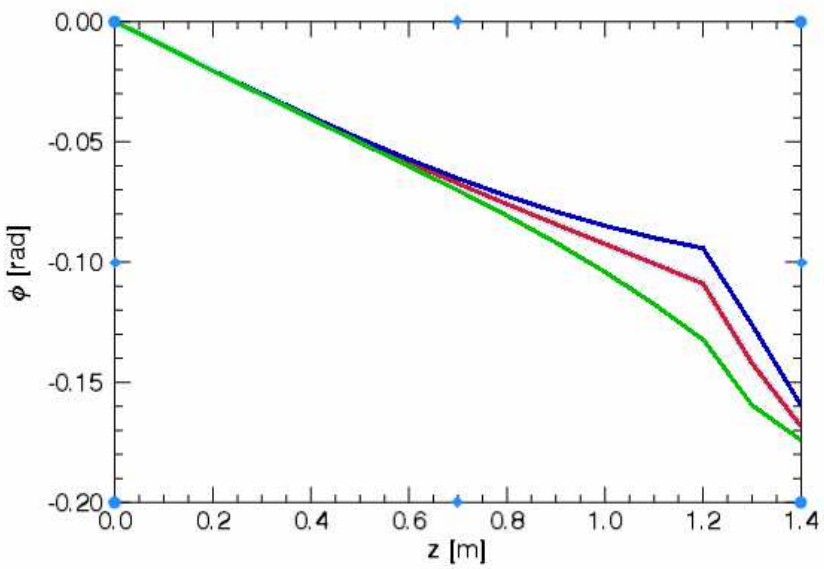


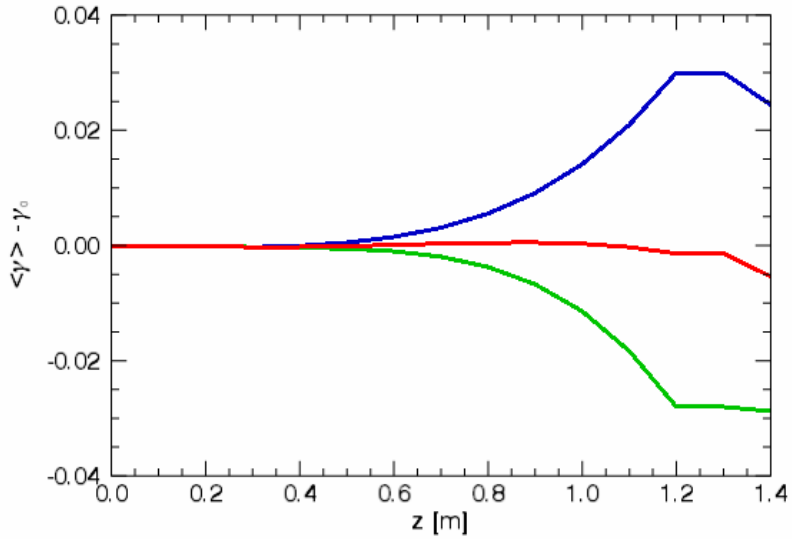


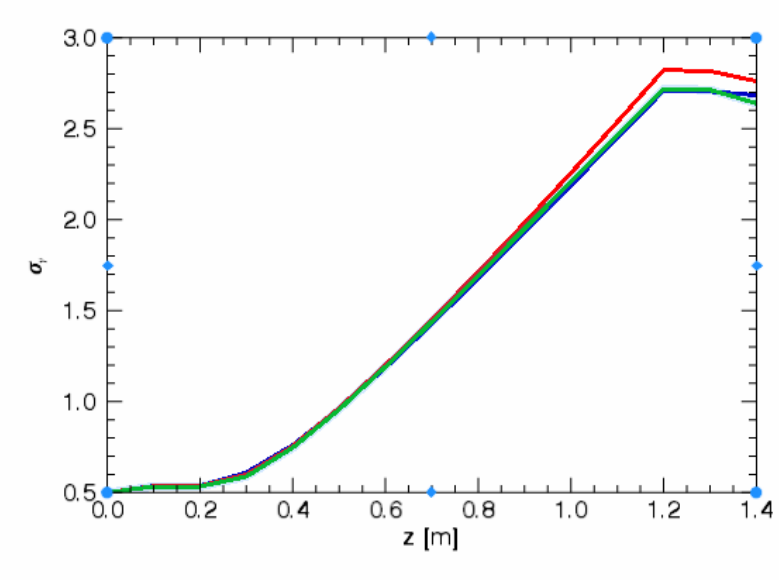


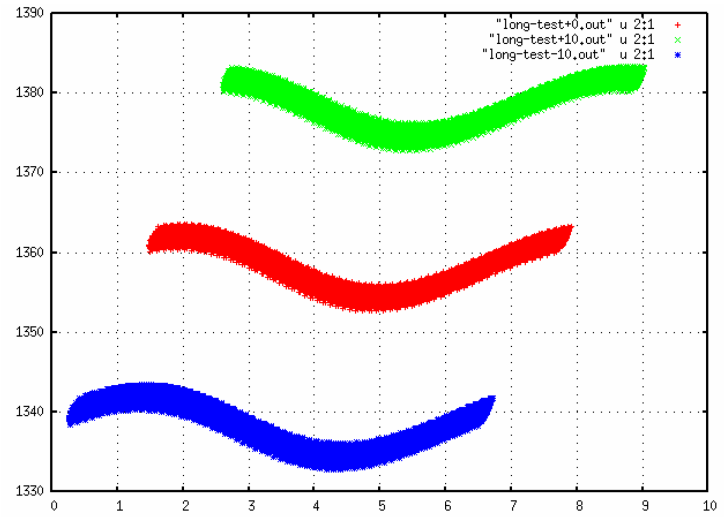
$\Delta\gamma / \gamma_{max} = 10 / 1350 = 0.74\%$

Seeding Multiple Energy Arms

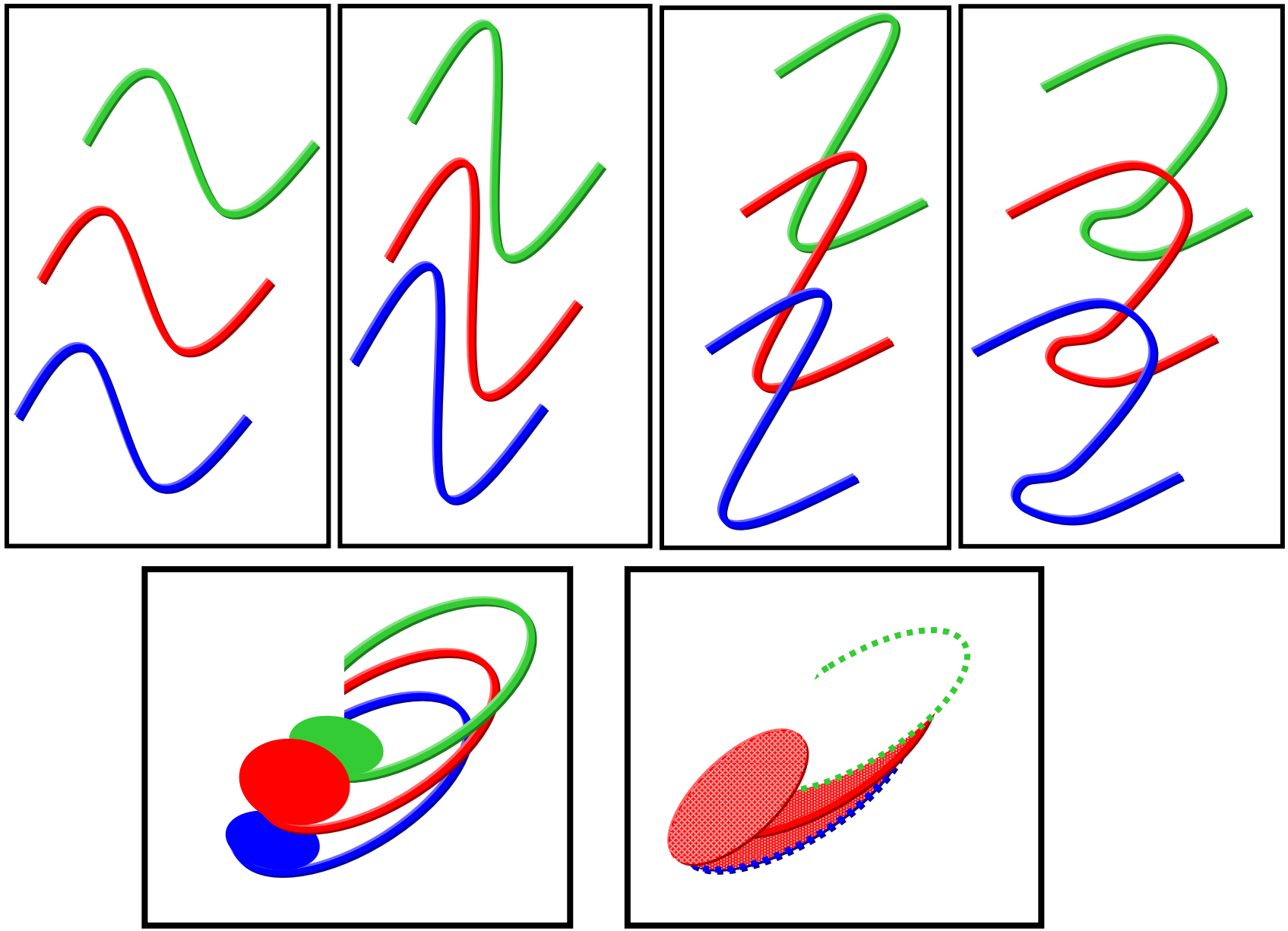




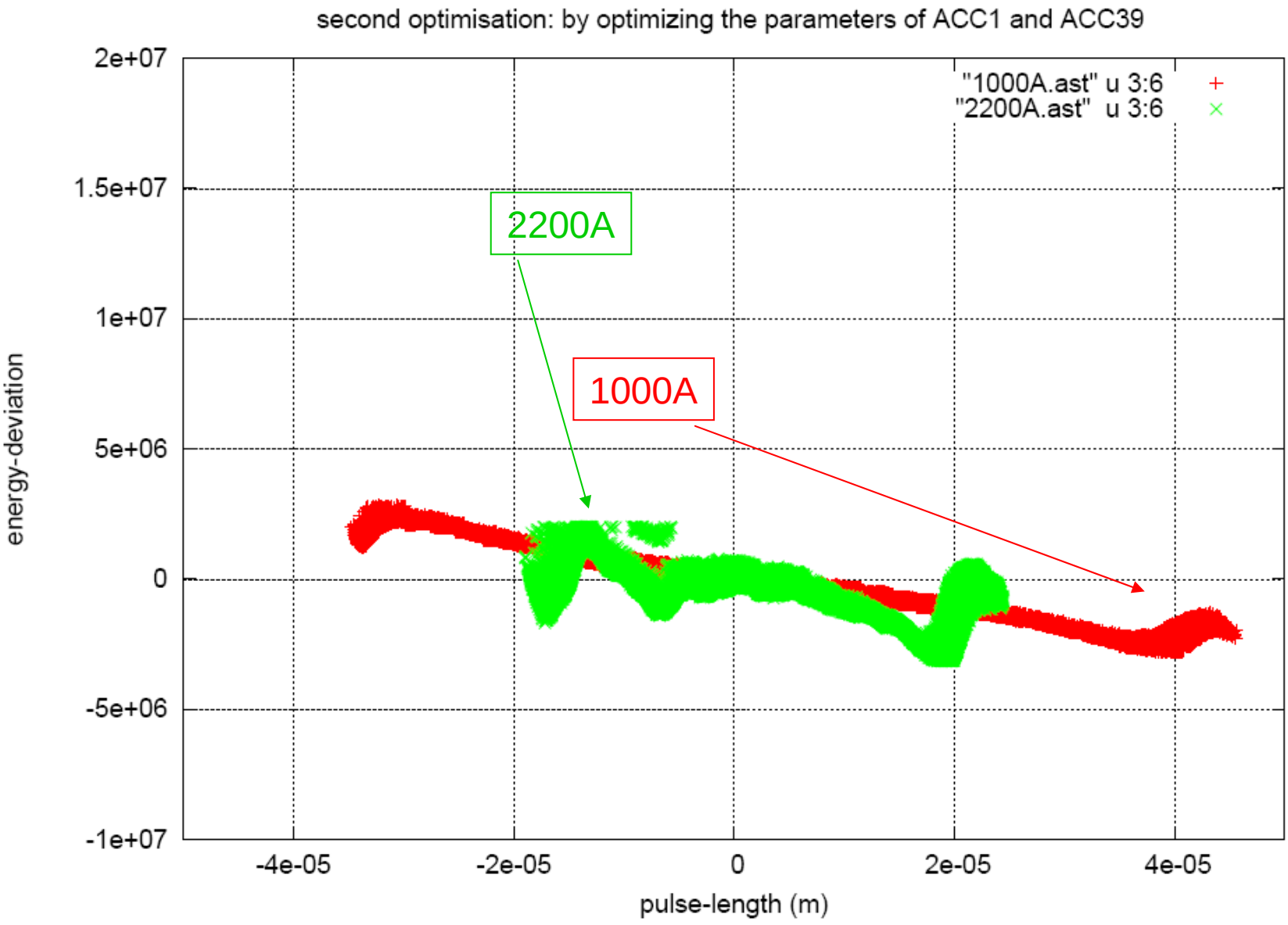




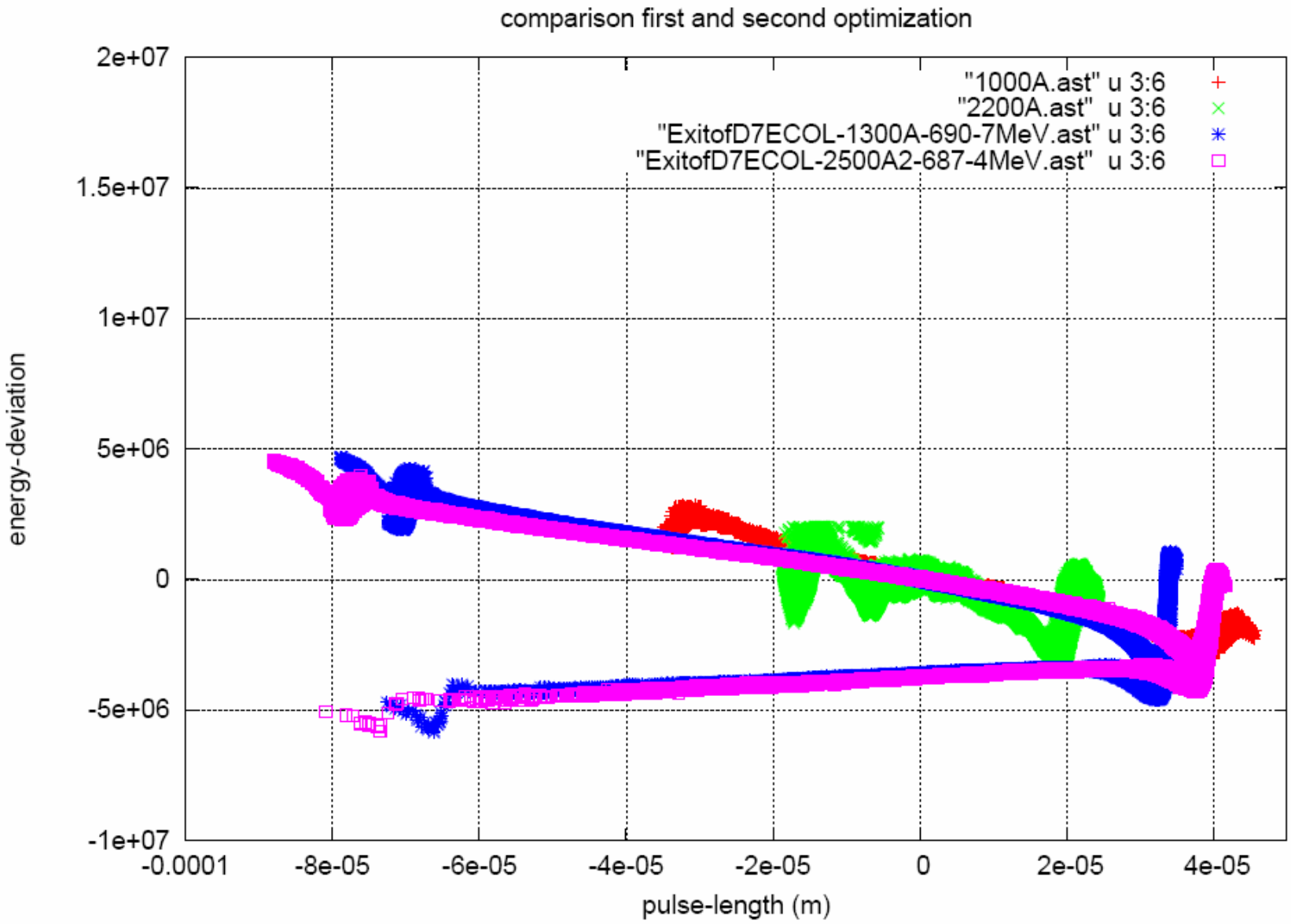
Commingling



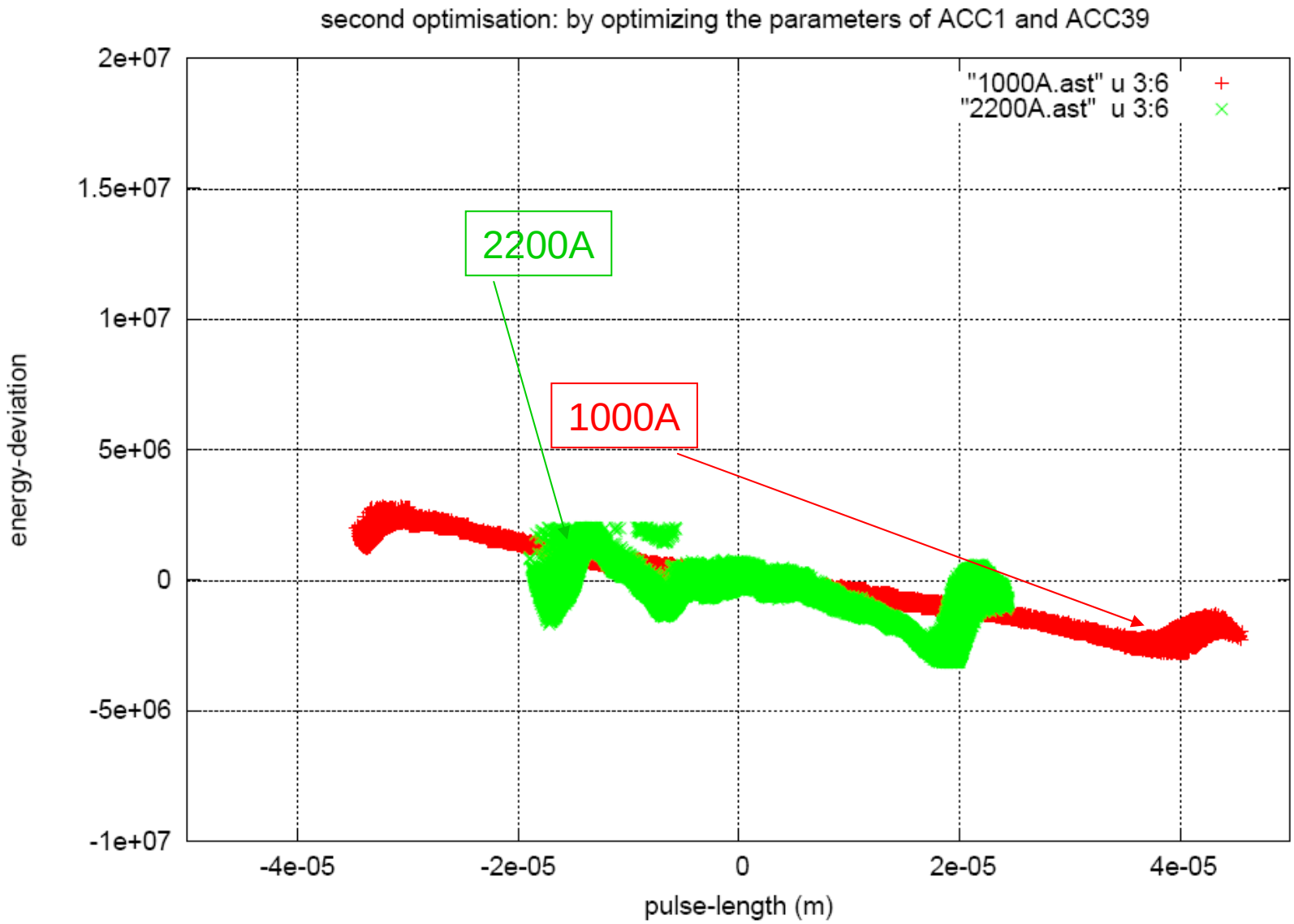
Second optimization: “Optimizing ACC1 and ACC39”



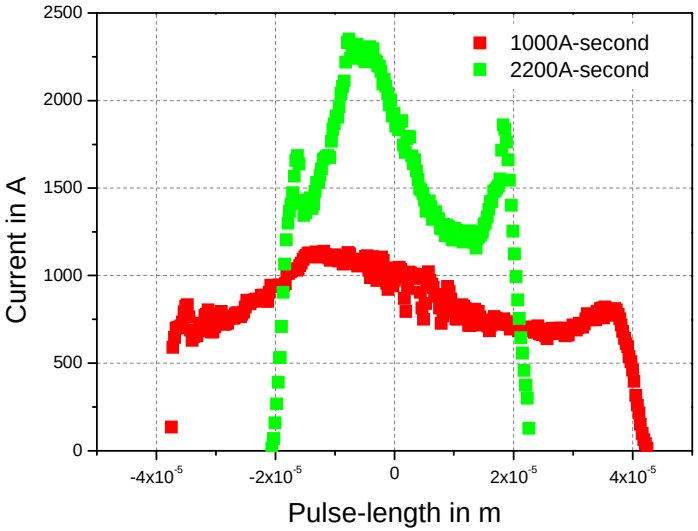
Comparison of the Second and the First Optimization

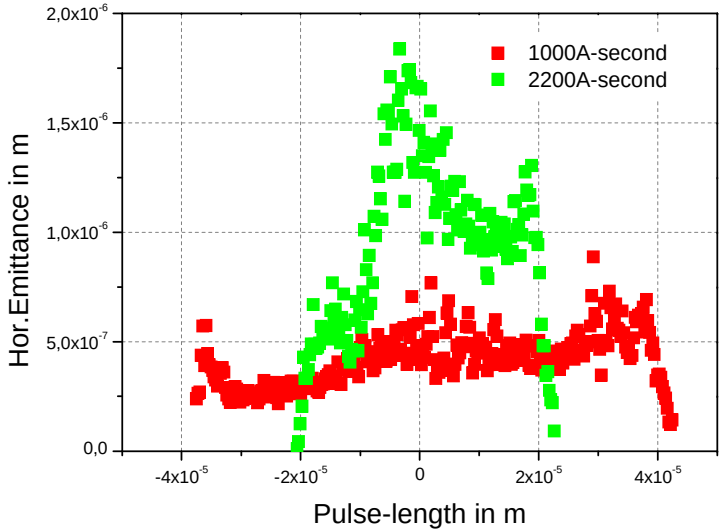


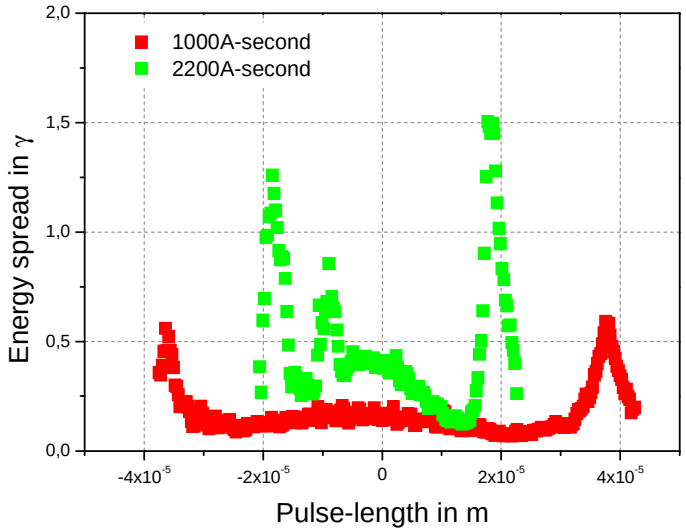
Second Optimization; Different Currents

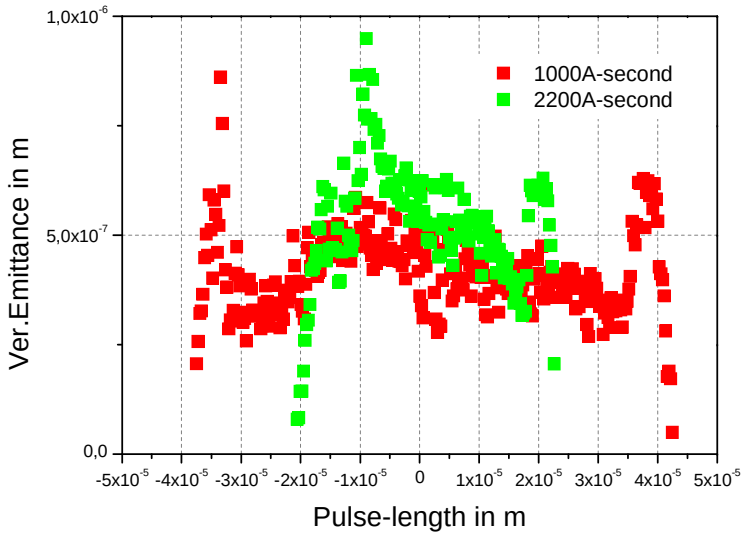


Second Optimization; Different Currents

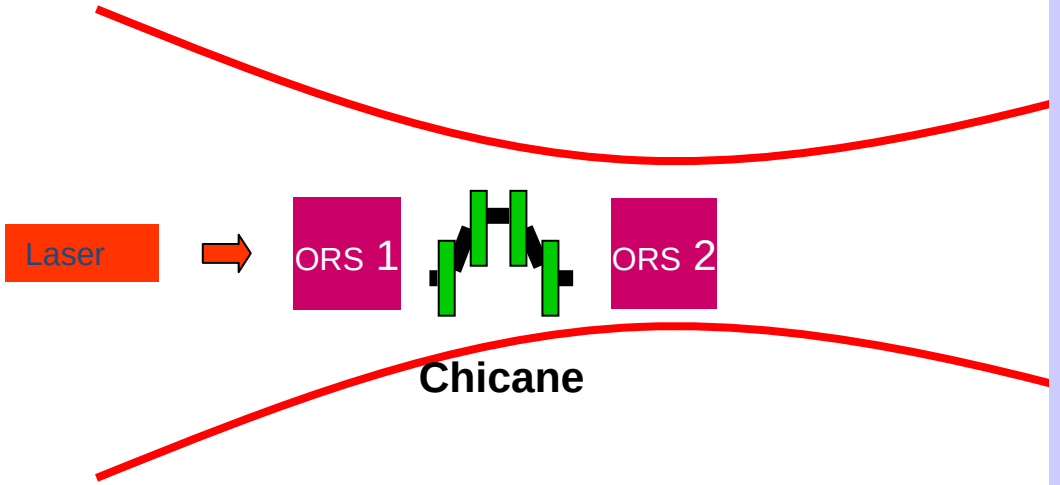




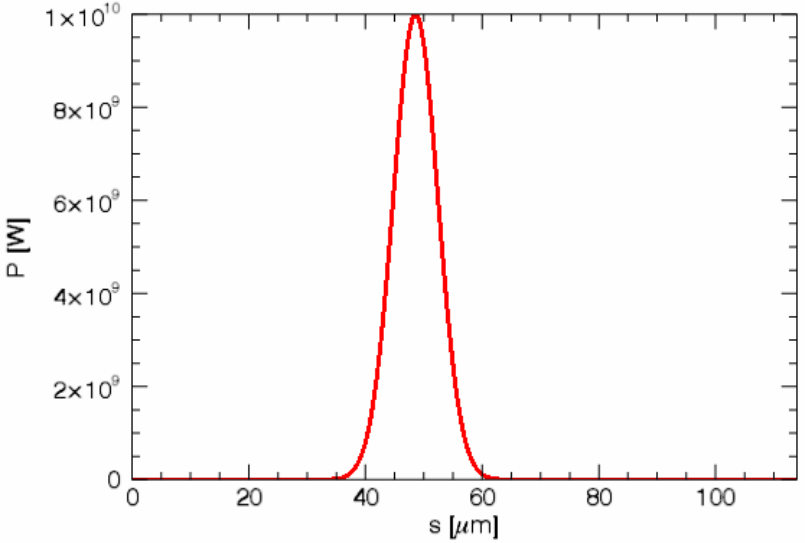


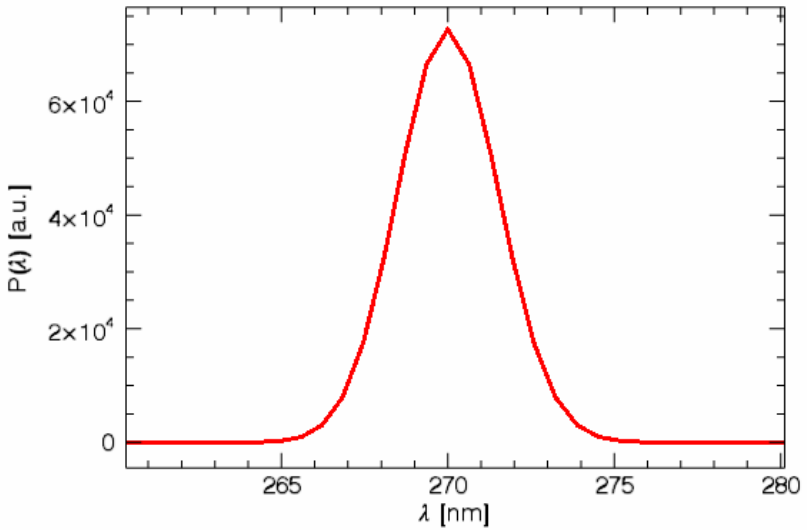


Seeding Pulse



- Wavelength: 270nm
- Pulse-duration$_{fwhm}$: 33fs
- Bandwidthfwhm : 1.5 %
- Rayleigh length: 4m
- Waist position:4.93m behind undulator entrance





Preparation

The maximum achievable K-parameters of s-FLASH-undulators:

WEPD014 Proceedings of IPAC'10, Kyoto, Japan

UNDULATORS OF THE sFLASH EXPERIMENT *

M. Tischer†, U. Englisch, T. Müller, A. Schöps, P. Vagin, DESY, Hamburg, Germany
H. Delsim-Hashemi, J. Roßbach, University of Hamburg, Germany
I. Vasserman, ANL, Argonne, USA

Table 1: Parameters of sFLASH Undulators

	U32	**U33**
Min. gap [mm]	9.0	9.8
Period length [mm]	31.4	33
No. of poles	120	240
Length [m]	2	4
K value	2.72	3.03

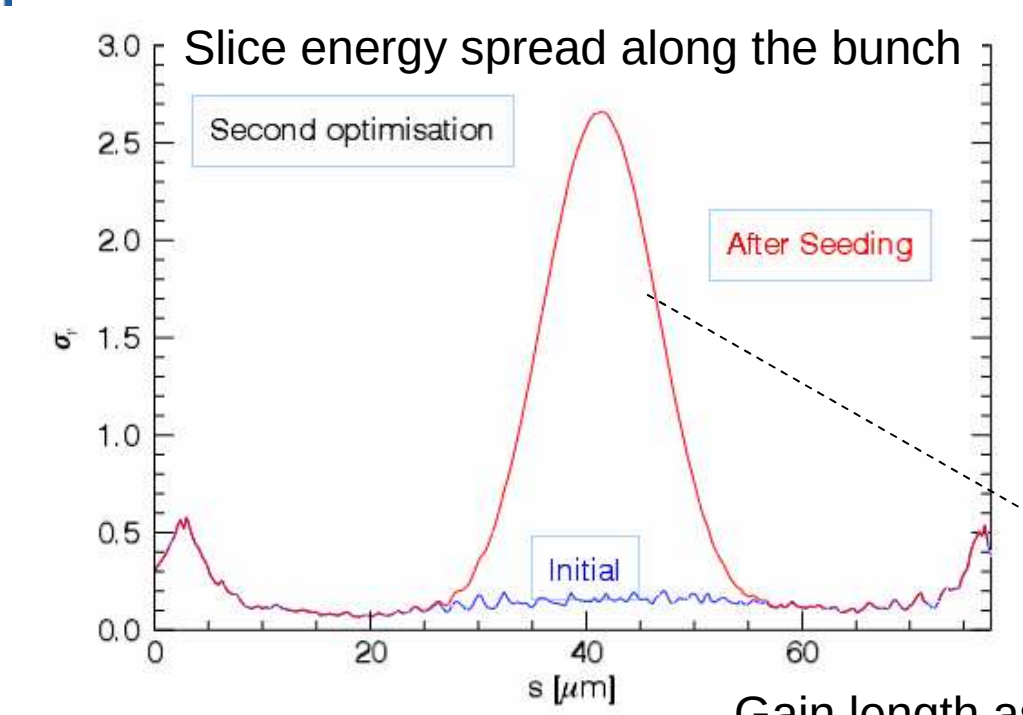
Beam energy: 700 MeV

$K_{max\text{-}rms} = 1.92$ $\lambda_s = 39nm.$

$K_{min\text{-}rms} = 0.8$ $\lambda_s = 14nm$

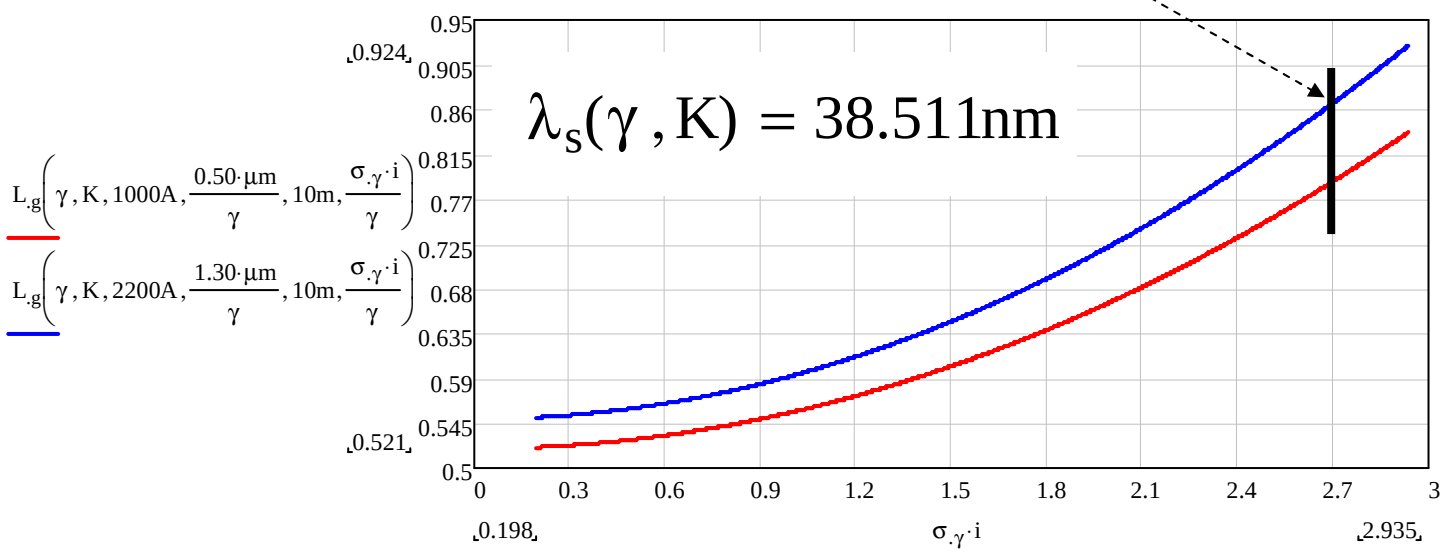
From 7^{th} up to 19^{th} harmonics!

Increased Energyspread



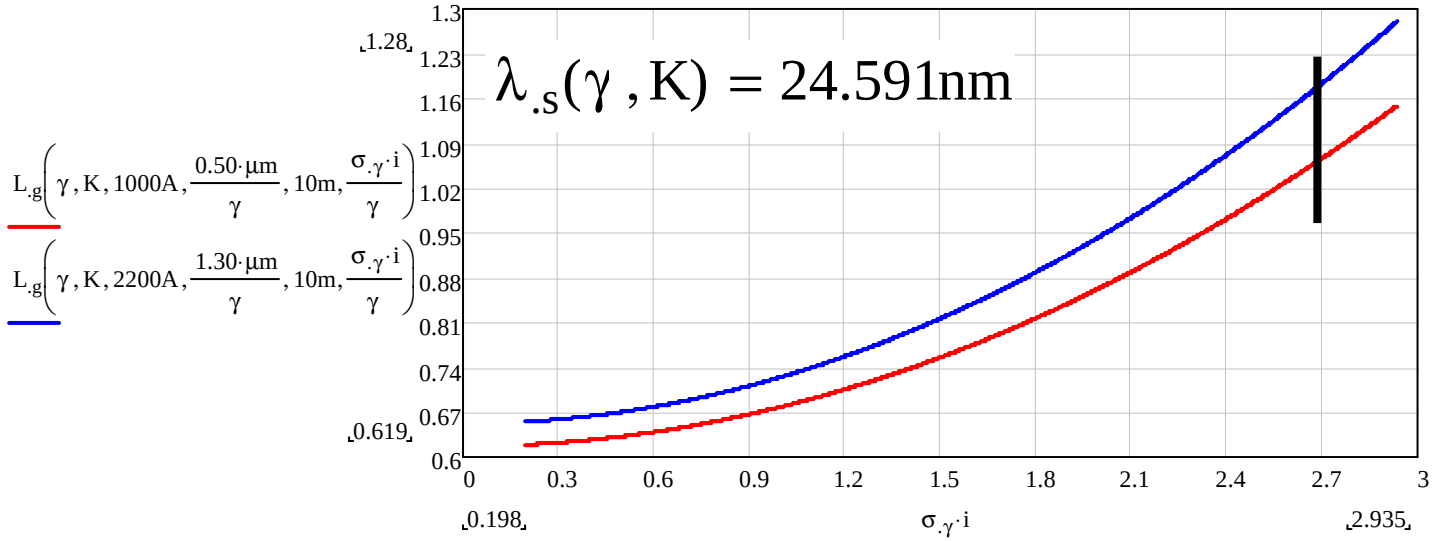
The slice energy spread increases due to the seed degrading the FEL gain length!

Gain length as a function of slice energy spread

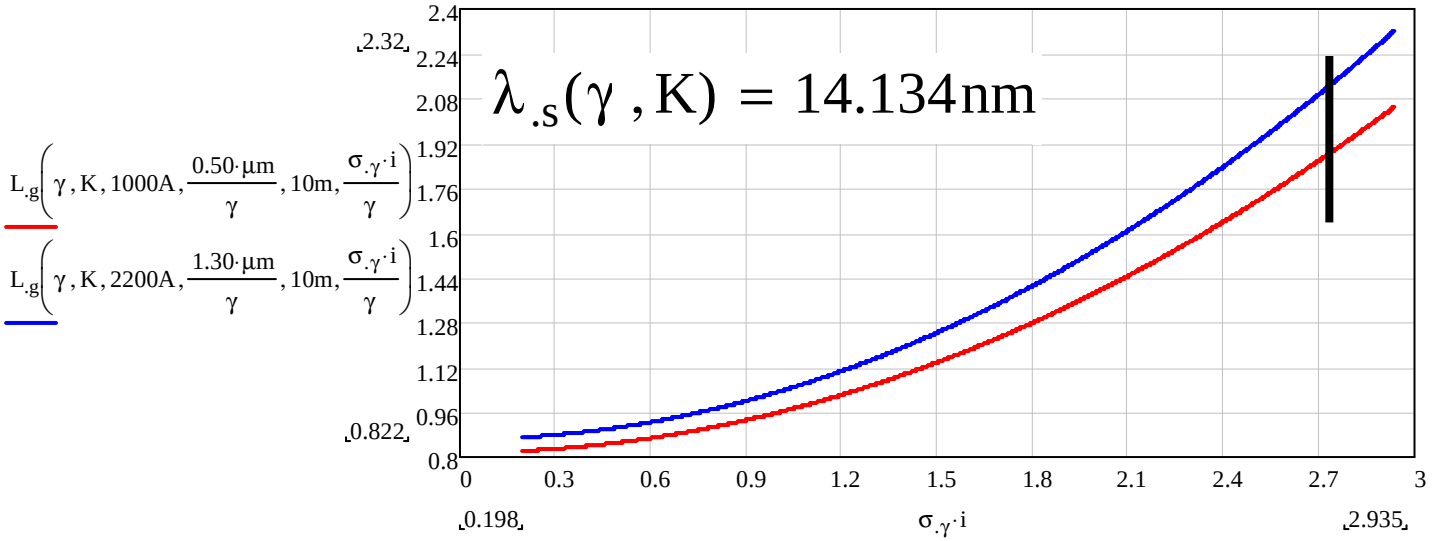


Gainlength for Different Wavelengths

Gain length as a function of slice energy spread



Gain length as a function of slice energy spread

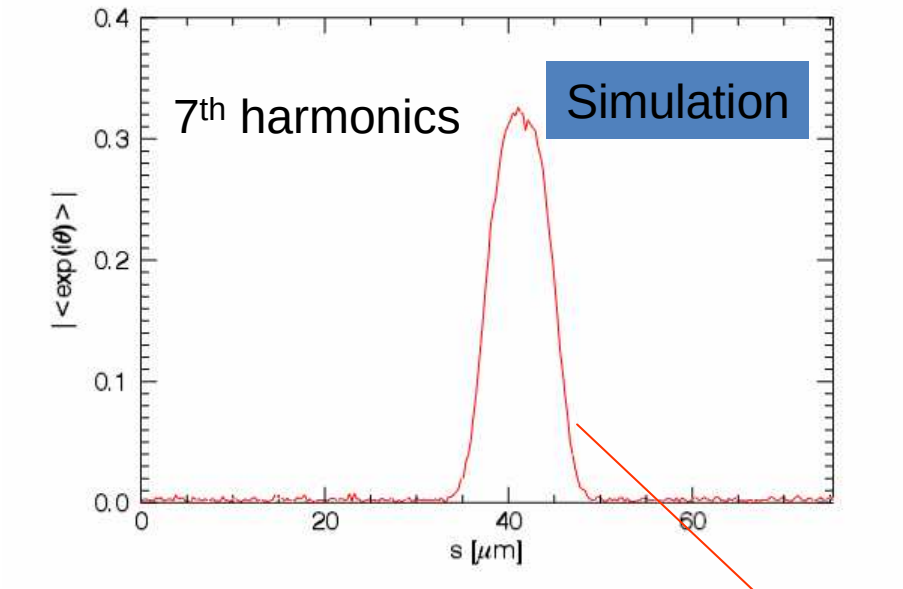


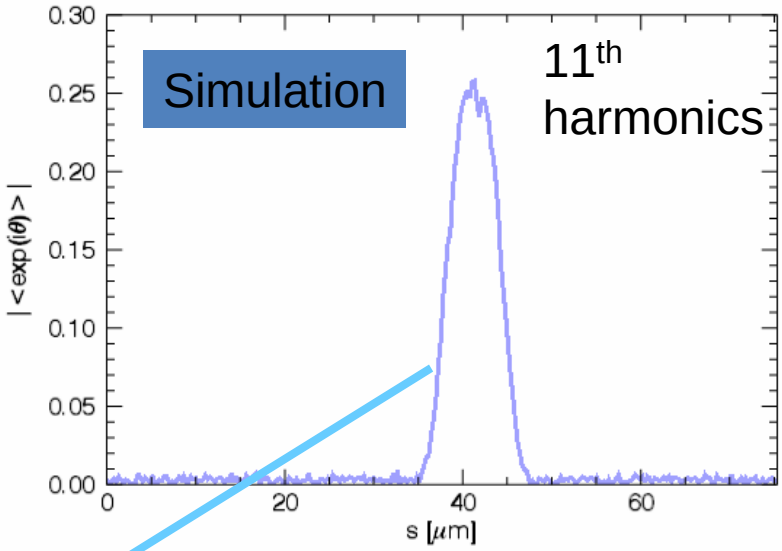
Restricts us to

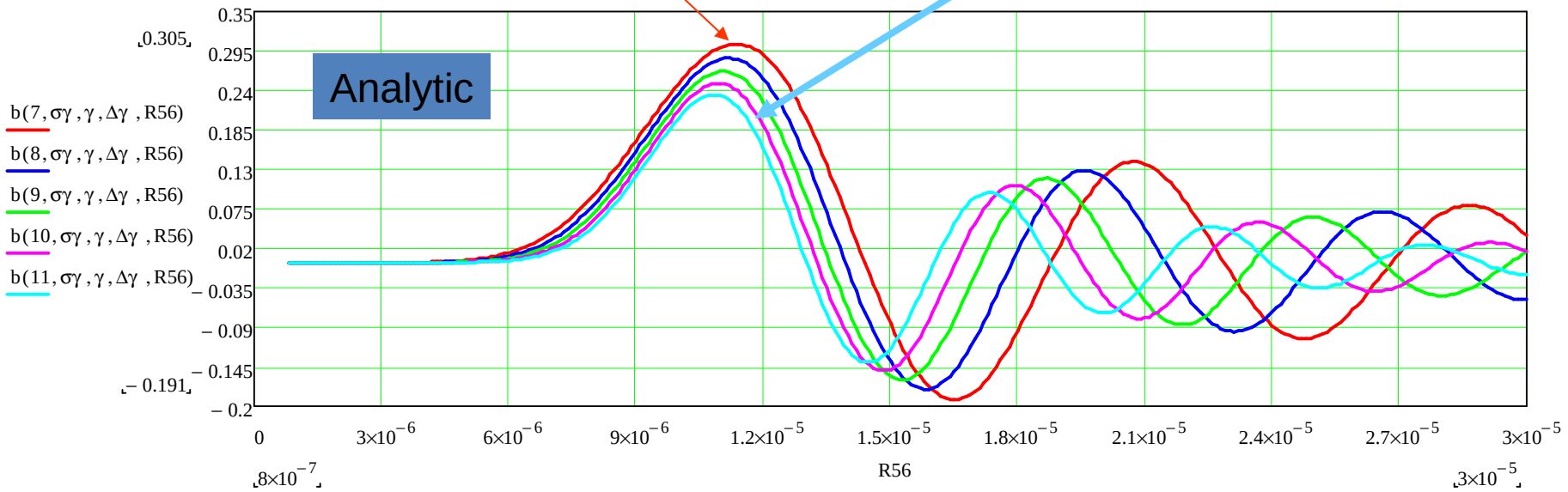
7^{th} up to 11^{th} harmonics for 1000A-case

7^{th} up to 9^{th} harmonics for 2200A-case

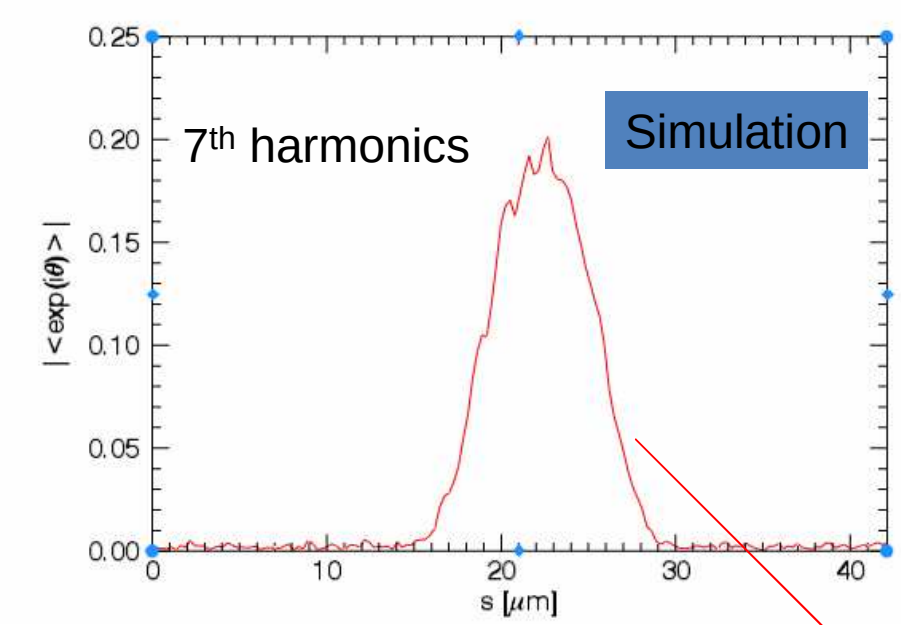
Bunching; 1000A-Case

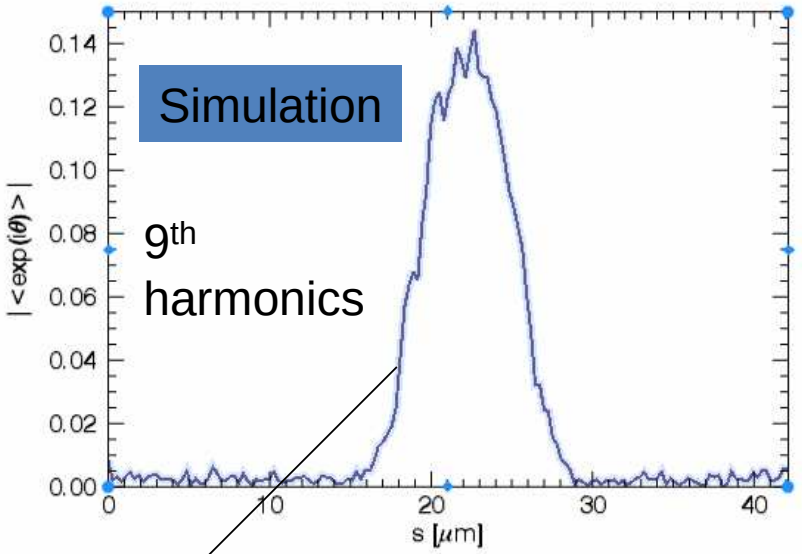


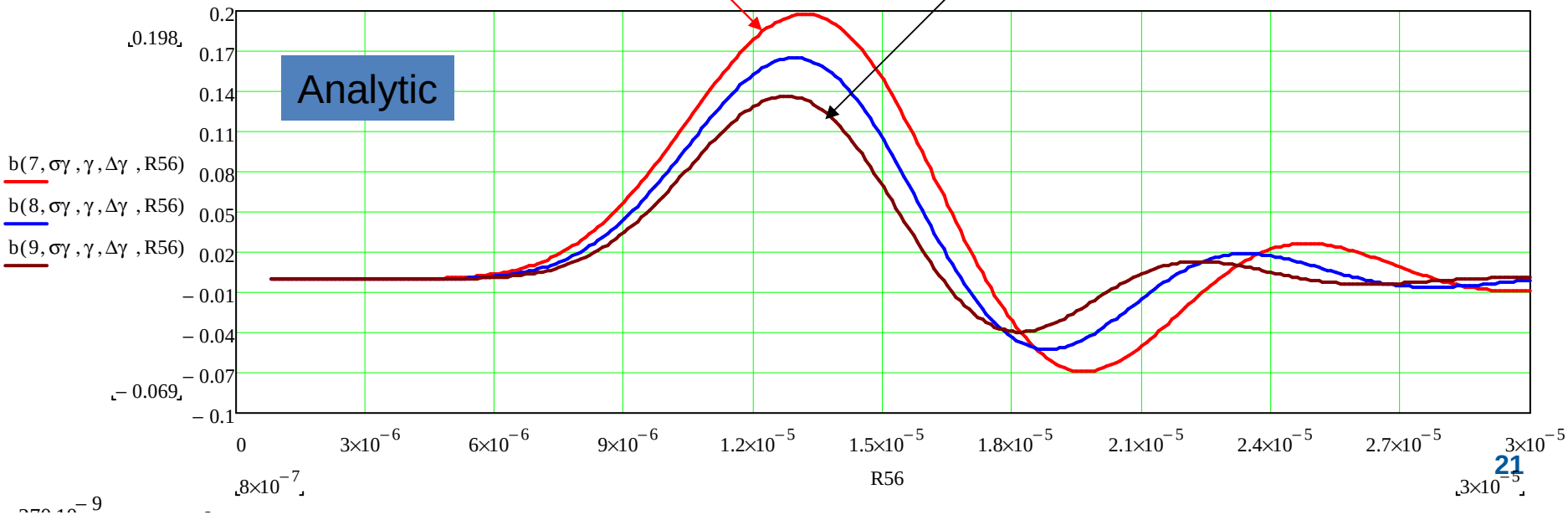




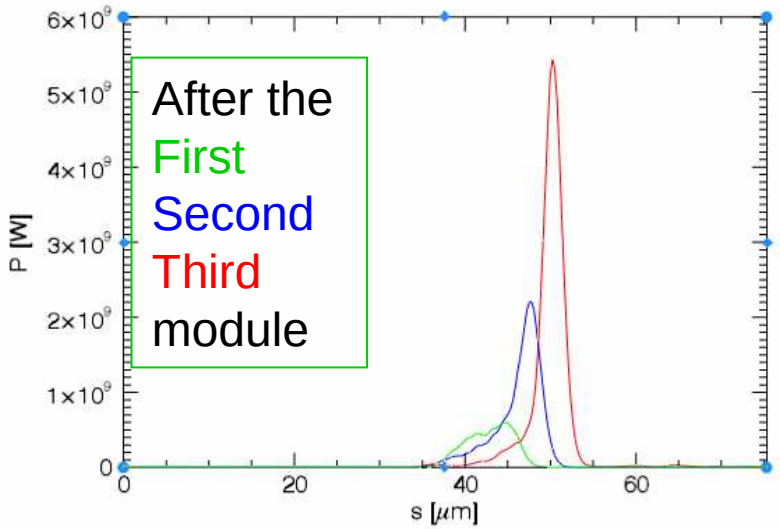
Bunching; 2200A-Case

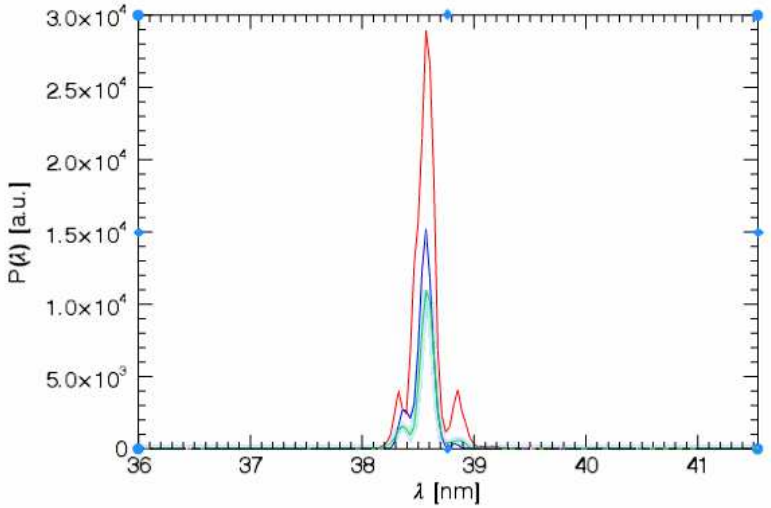




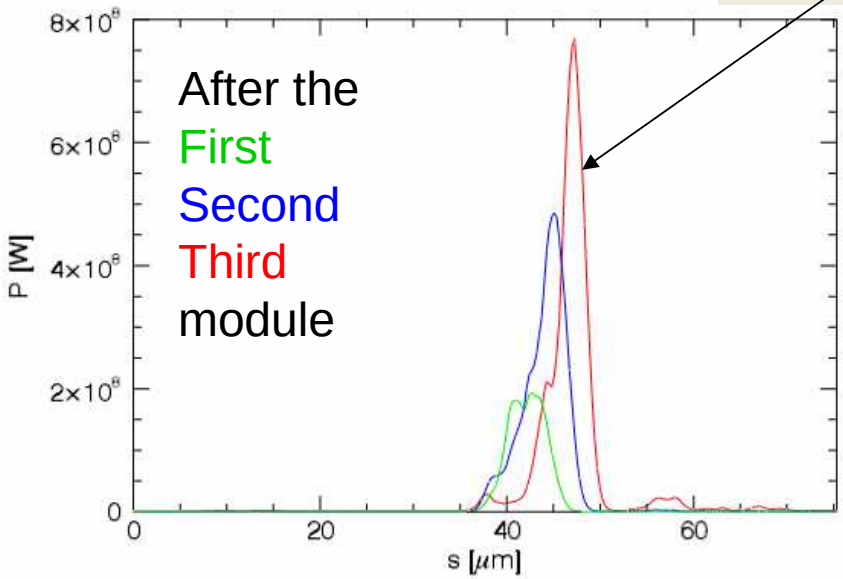


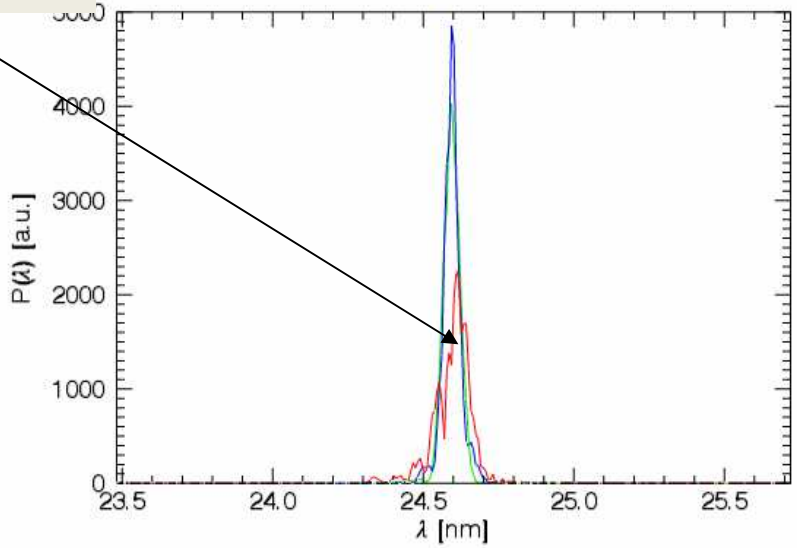
Radiation in the First 3 Undulator-Modules; 1000A-Case





Superradiance





Superradiance

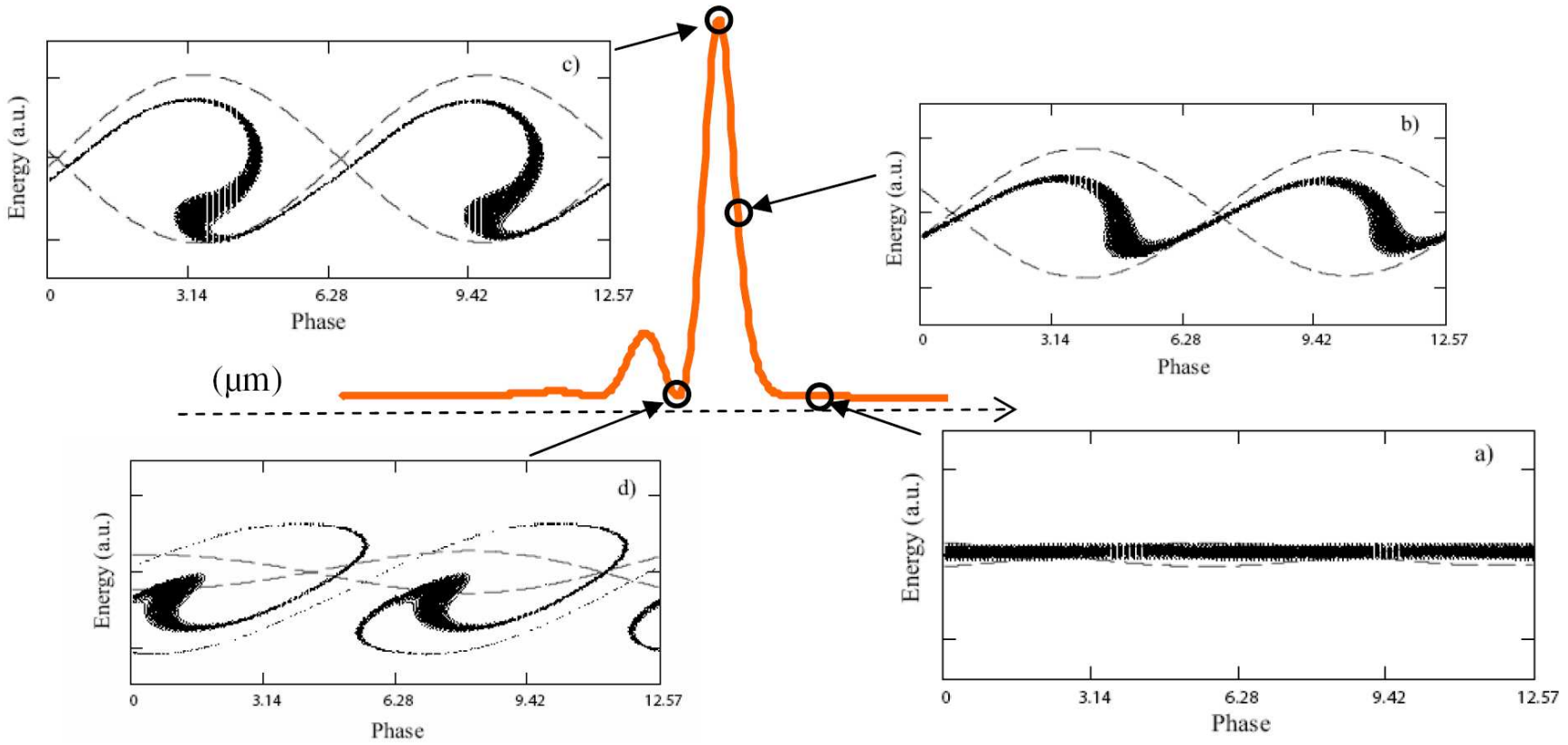
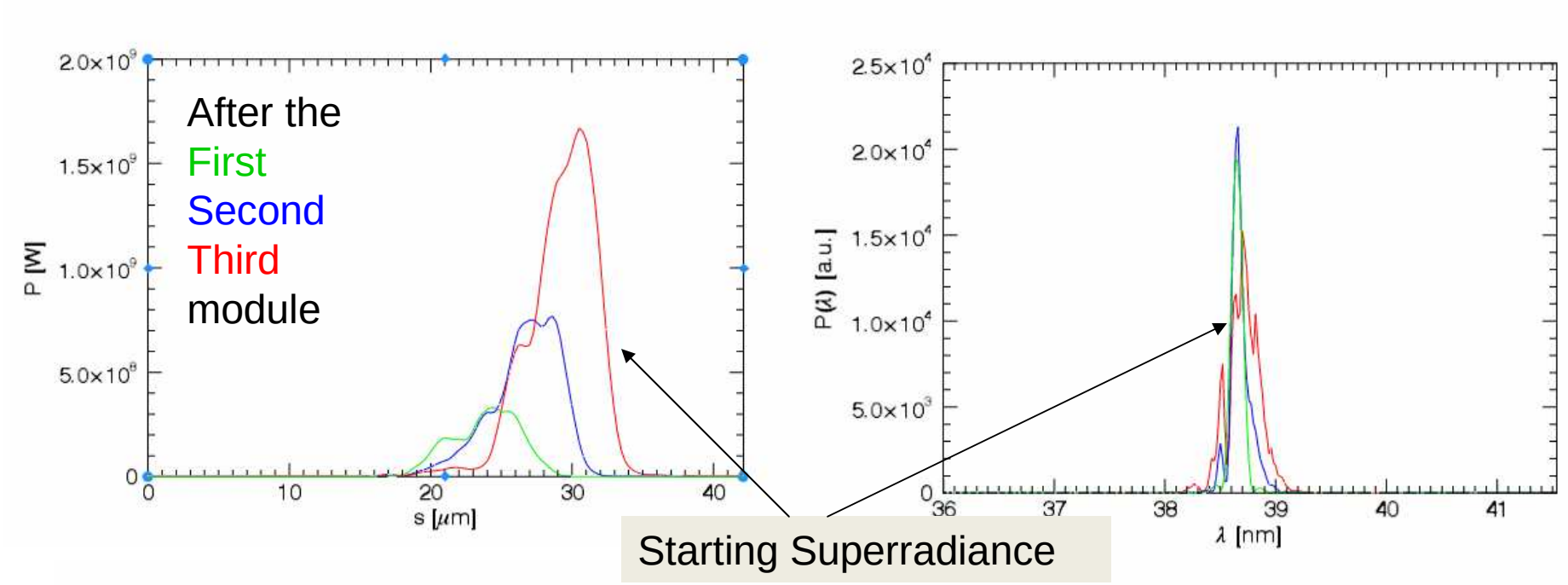


Figure 3: Phase space evolution along the optical pulse

Giannessi FEL2005

Radiation in the First 3 Undulator-Modules; 2200A-case



Summary

Adjusting the Phase Shifts of ACC2 and ACC3 is not enough. A careful optimization of all accelerator modules is mandatory!

For a beam energy of 700 MeV and the sFLASH-undulators, the resonant wavelength ranges from $\lambda s = 39nm$ to $\lambda s = 14nm$, corresponding to 7^{th} -19^{th} harmonics of the Seeding wavelength of $\lambda s = 270nm$.

Due to the increase of the energyspread only a wavelength range from 7^{th} up to 11^{th} harmonics is accessible.

For the low energyspread indicated in the simulations and the high seeding power aimed, the required R56 is small and almost the same for all wavelengths. Thus “the undulator modules pick the wavelength”!

Generally it seems as if the saturation of the SASE process takes place within the first three undulator-modules so that we can expect superradiance after the third undulator.