Transverse phase-space studies for the electron optics at the direct XUV-seeding experiment at FLASH (DESY)°

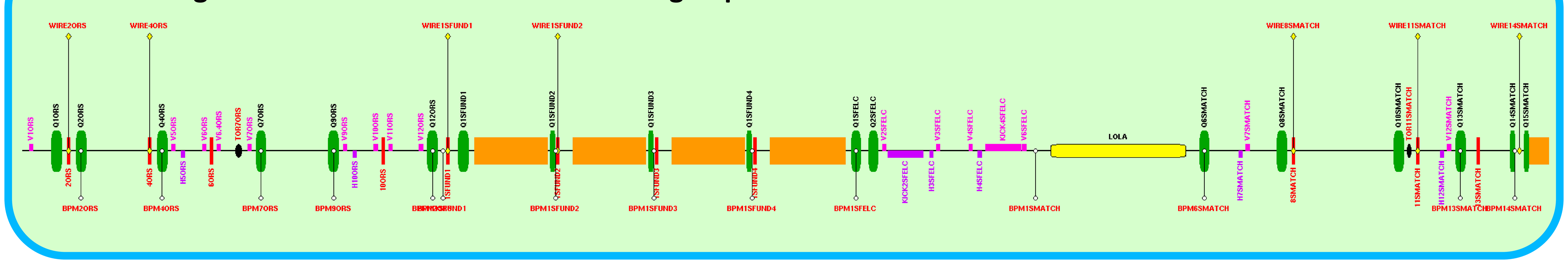
S.Ackermann[1*], A.Azima[1], J.Bödewadt[1], F.Curbis[1], H.Delsim-Hashemi[1], E. Hass[1+], M.Drescher[1], U.Hipp[1], T.Maltezopoulos[1], V.Miltchev[1], M.Mittenzwey[1], M.Rehders[1], J.Rossbach[1], J.Rönsch-Schulenburg[1], R.Tarkeshian[1], M.Wieland[1], S.Bajt[2], S.Düsterer[2], K.Honkavaara[2], T.Laarmann[2], H.Schlarb[2], S.Khan[3], R.Ischebeck[4]

[1]Universität Hamburg - [2]DESY Hamburg - [3]DELTA Dortmund - [4]PSI Villigen

Introduction

In 2010 the FEL-facility FLASH at DESY was upgraded with an experiment to study directly seeded FEL operation in the XUV regime.
For the optimal performance it is necessary to have good coupling between the seed and the electrons and therefore the knowledge on the electron optics parameters is of crucial importance.

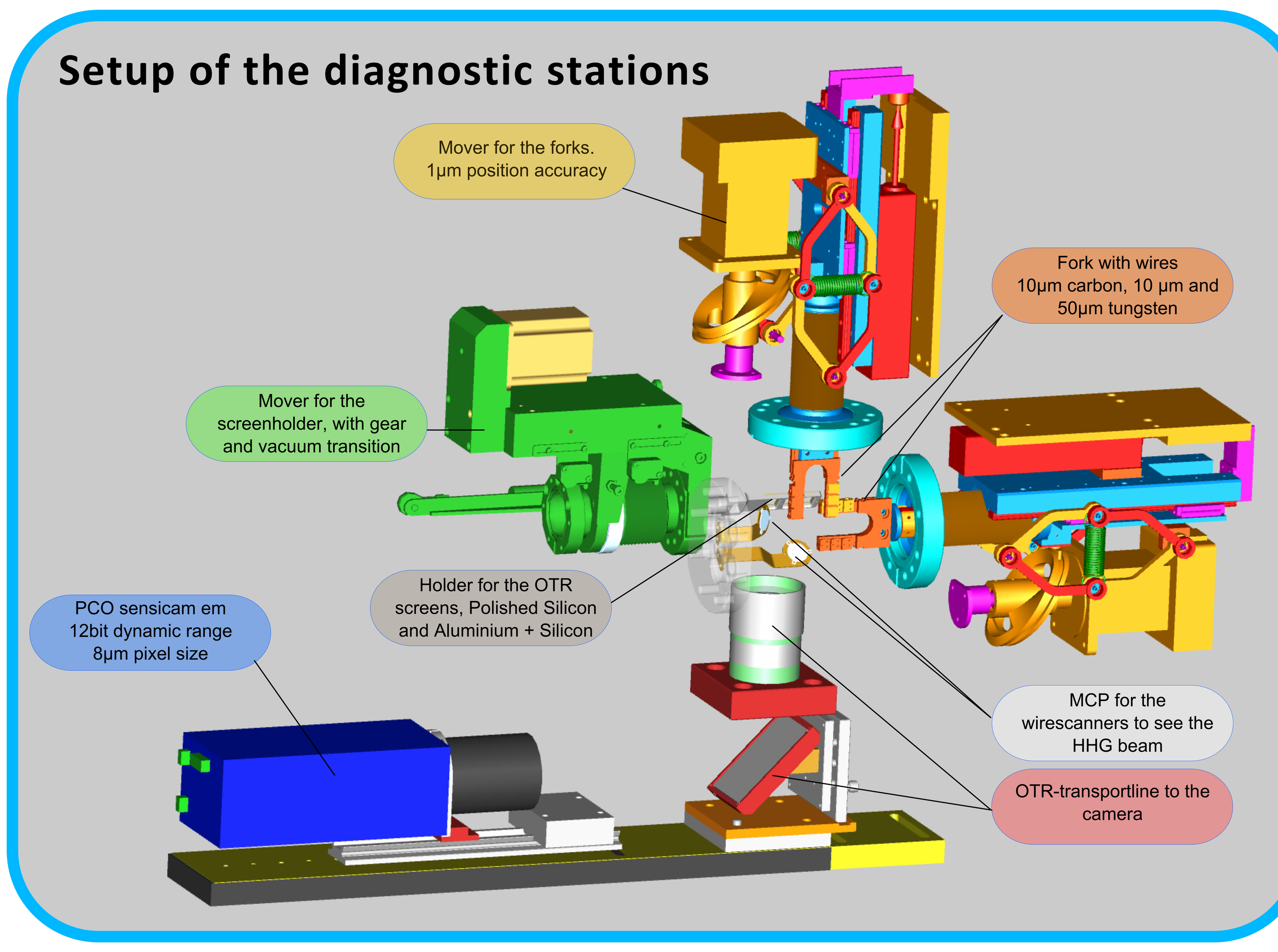
Lattice design of the new installed XUV seeding experiment at FLASH



Motivation

Normally, a high-gain FEL amplifies the spontaneous radiation emitted of the electron bunch going through the undulators. This process is highly statistically distributed and the energy varies from shot to shot. A laser-seeded FEL offers the possibility to drive pump-probe experiments with femtosecond synchronisation.
Seeding can only work if the laser seed propagates colinearly with an intensive electron beam. In order to set up the machine it is necessary to know and control the electron optics parameters.

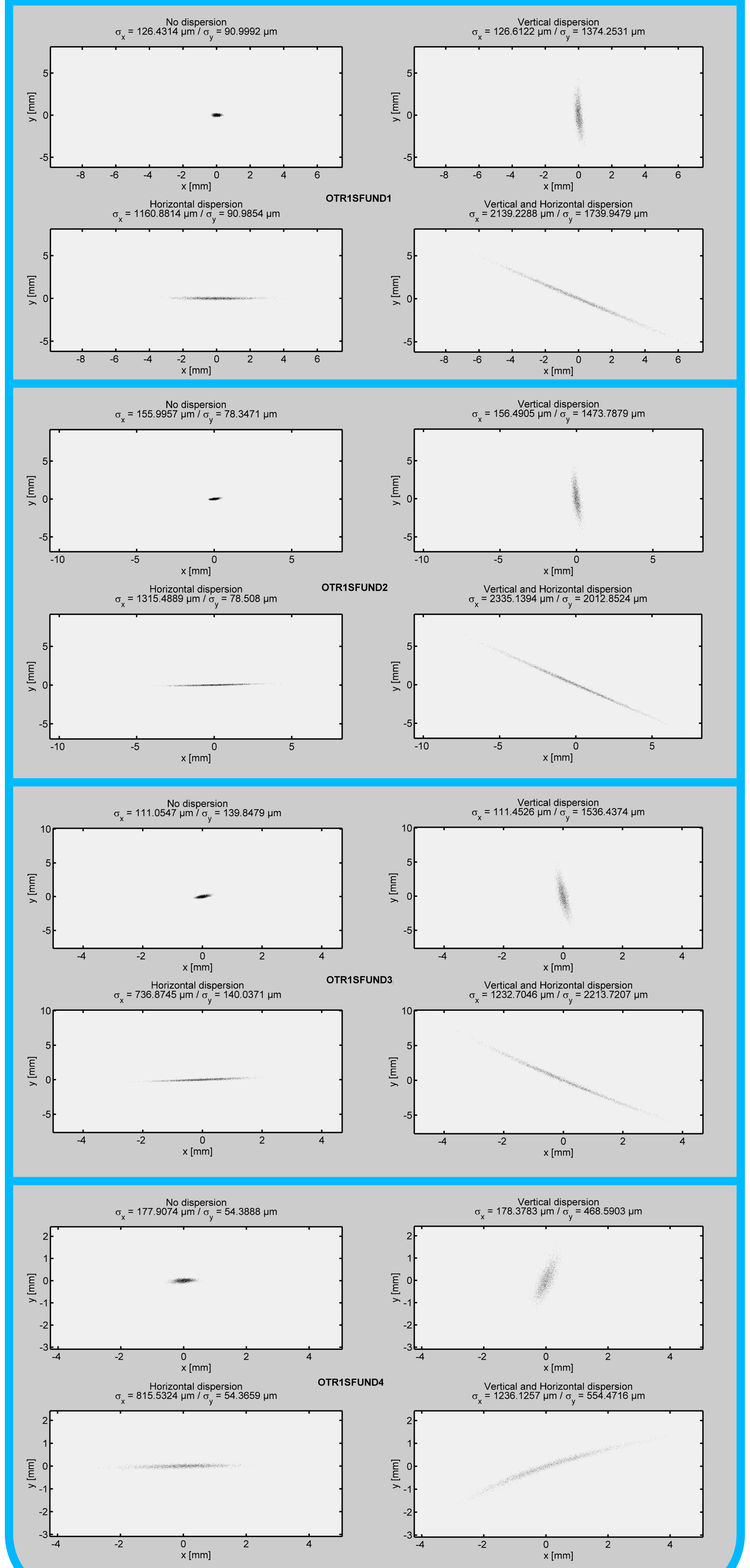
Setup of the diagnostic stations



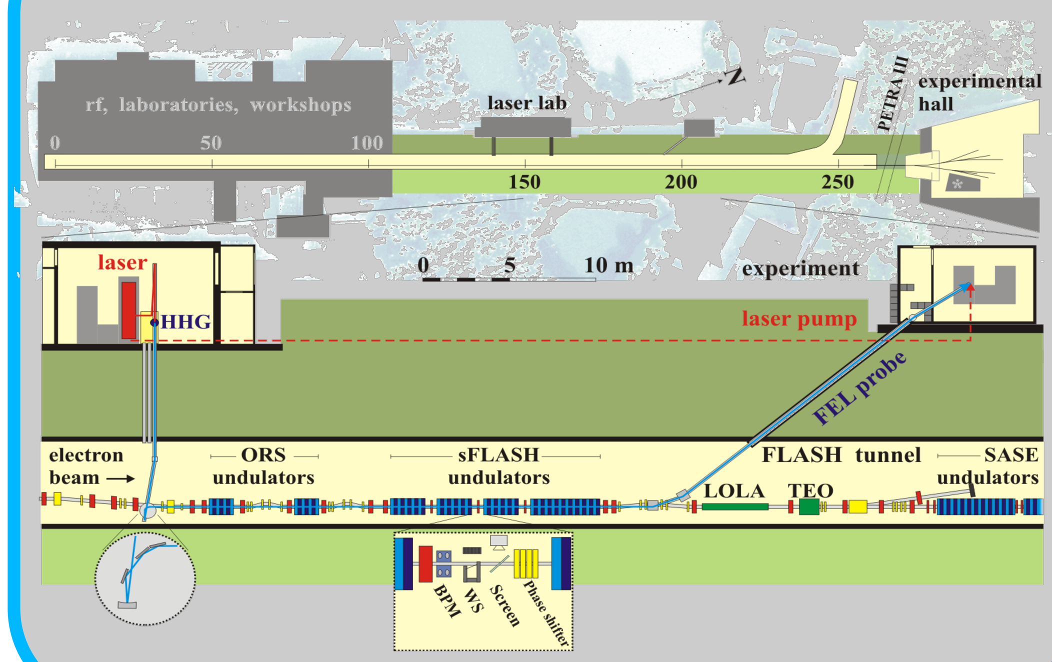
Influence of uncompensated dispersion

A tracking simulation was performed to study the influence of uncompensated dispersion on the beamsizes of the design optics for FLASH.

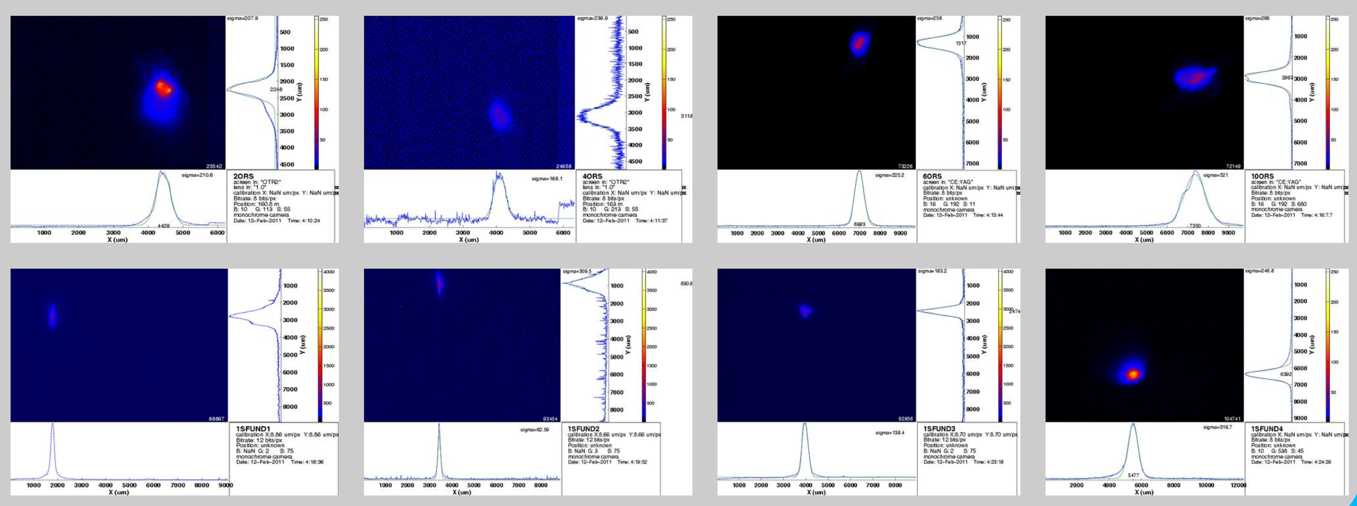
Initial Energy: 700 MeV / Initial energy chirp: 10 MeV / Dispersion: 10 cm



Seeding Section at FLASH

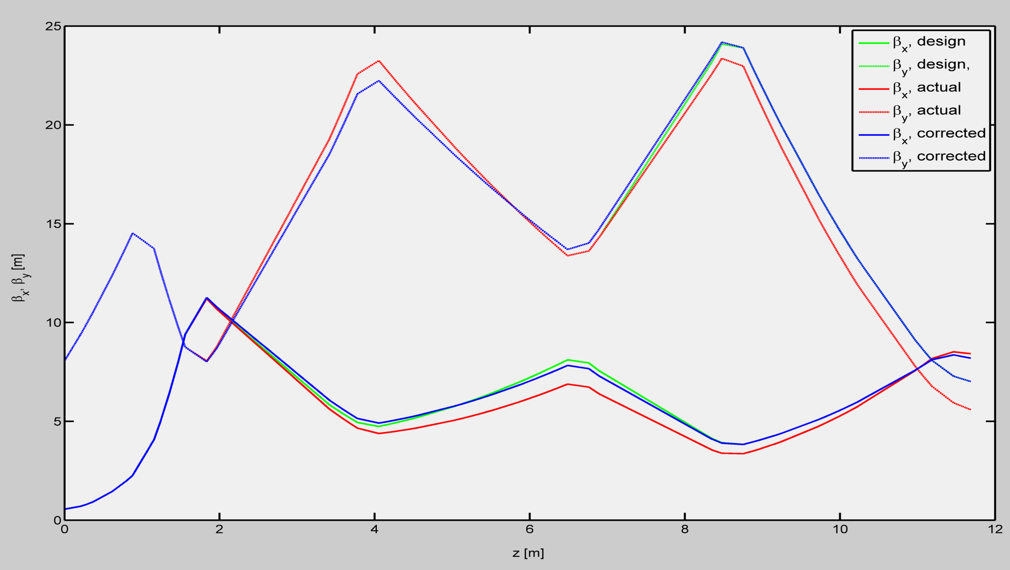


Electron beam profile measurements



Undulator focussing

The undulators in the ORS section are electric ones. If they are switched on, a focussing effect occurs which can be corrected by adjusting the currents in the ORS quadrupoles.



Reconstruction of the twiss parameters and emittances

A Monte Carlo simulation was performed to get the rms errors of the measurement.

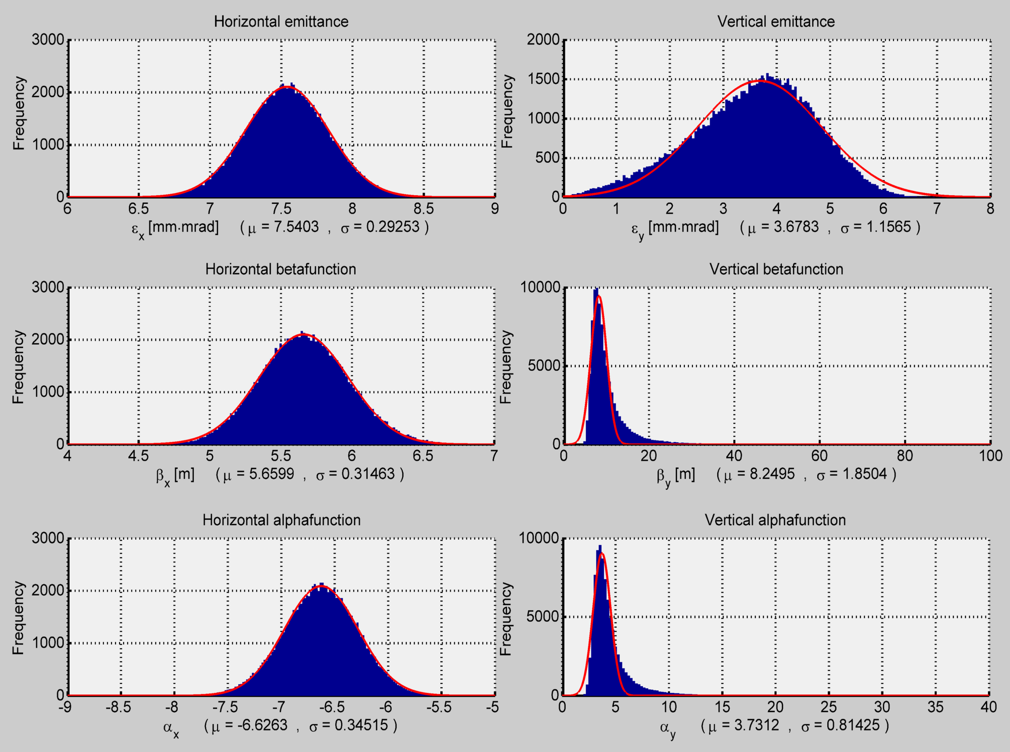
Assumed Energy: 636.725 MeV

Energy error: 0.01

Error on the k-values of the quadrupoles: 0.01

Error of the OTR screens: 10 µm

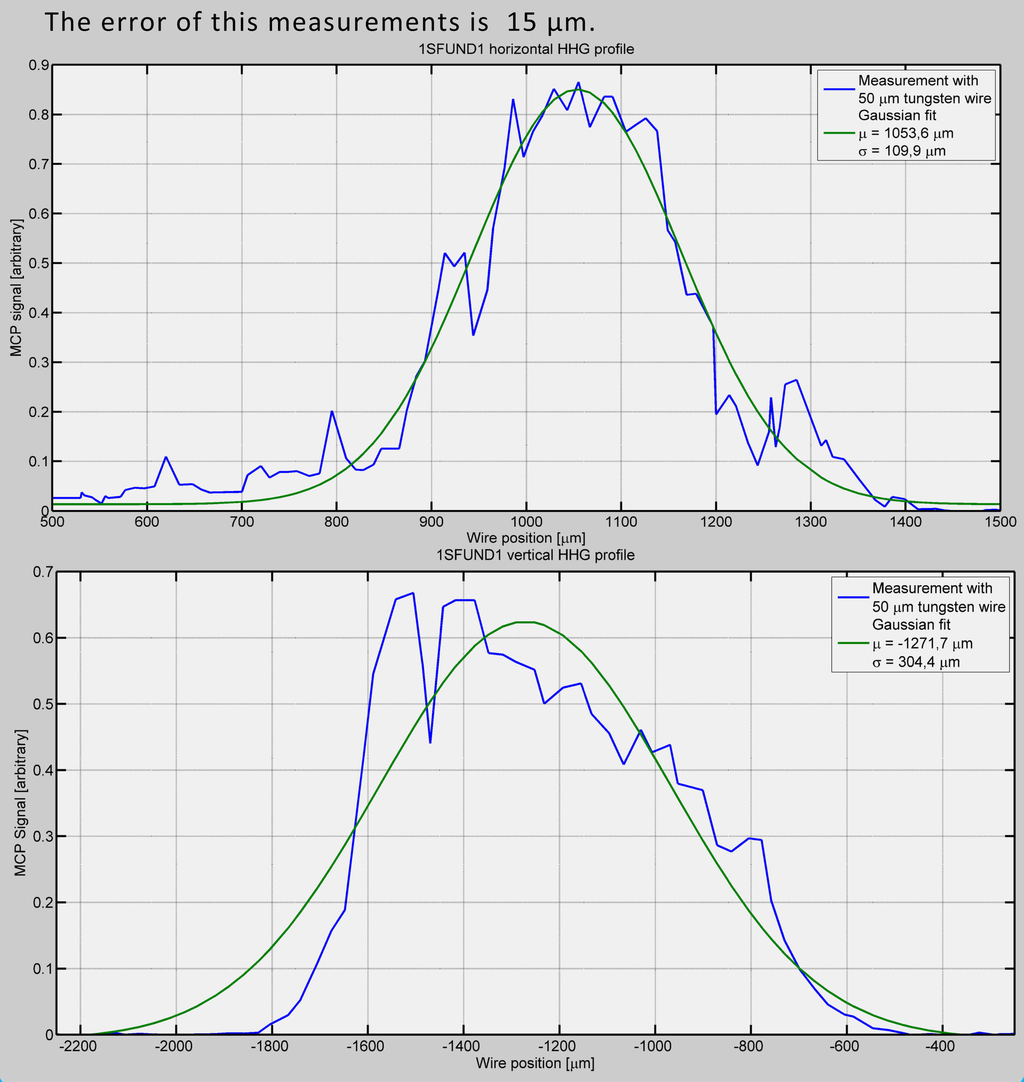
Number of seeds: 100 000



Profiles and positions of our high harmonic photon beam measured by wire scanners+

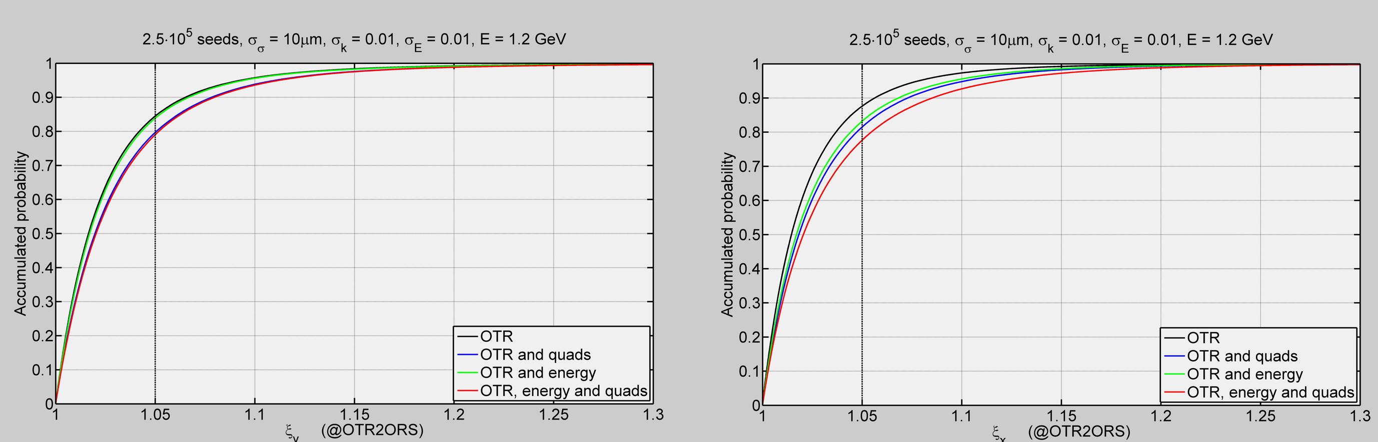
In order to measure the HHG beam in the sFLASH undulators, the wire scanners have been equipped with one MCPs each, which detects the photoelectrons from the wire.

The error of this measurements is 15 µm.



Mismatch parameters

A simulation using the estimated errors above was used in order to get the expected distribution of mismatch parameters. The different lines stand for different errors, so that we can see how big the errors of the energy, the quads and the OTR really are.



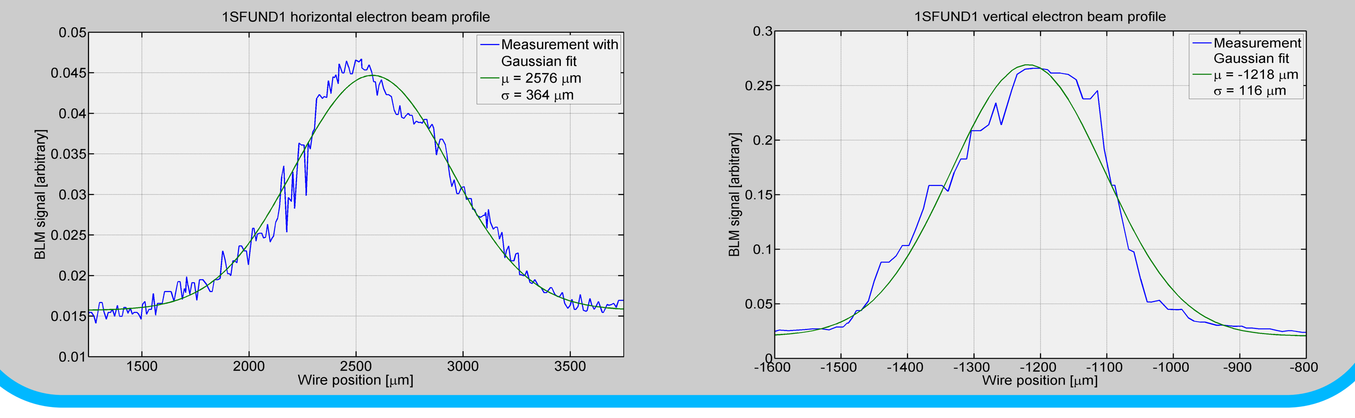
Summary & Outlook

First results show that the twiss parameters and the emittances can be reconstructed in most of the cases. The vertical parameters have a larger error than the horizontal ones. For seeding the dispersion has to be carefully corrected, as otherwise the beamsizes will blow up. The ORS undulators have just a small influence on the betafunction. The wire scanners show signal and could be adjusted during our last shifts.

In the next measurement shift, we will try to match the optics, so that the machine will be well prepared for seeding.

Electron beam profiles using wire scanners

Electrons interact with the wires and produce particle showers. The flux of secondary particles is proportional to the number of electrons that interact with the wire. For the following measurements the 10 µm tungsten wire was used, therefore the error is as small as 3 µm.



Acknowledgements

The simulations were performed using elegant 24.0.1 [1]
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References

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

*Contact: Sven.Ackermann@desy.de +Contact: Eugen.Hass@desy.de

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