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Wavefront metrology and beam propagation in the EUV/X-ray spectral range

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Proper in-situ fine-adjustment of the optical elements is crucial for an optimal performance of beam lines at synchrotron or free-electron laser facilities, considering that even slight misalignments of the grazing incidence mirrors can already deteriorate the focal spot. Real-time wavefront monitoring represents a valuable tool for reduction of these aberrations. In particular, wavefront sensors based on the Hartmann technique are well suited for this purpose as they afford rather compact setups and can be employed for both coherent and partially coherent radiation.
A Hartmann-type wavefront sensor was developed for the EUV and soft X-ray range in cooperation with DESY / Hamburg. From the simultaneous recording of wavefront and beam profile, prediction of the propagation behaviour of the beam is possible. In particular, focal intensity distributions can be computed, considering also the spatial coherence properties of the FEL beam. The latter were accessed experimentally for FLASH, using caustic scans and a subsequent evaluation of the Wigner distribution function. The improved Hartmann sensors are now routinely applied for fine-tuning of grazing incidence focusing mirrors of the free electron lasers FLASH and European XFEL / Hamburg.
Nevertheless, due to the many non-orthogonal degrees of freedom of these focusing optics, an optimal adjustment using wavefront metrology can be still very time-consuming. Within the new project "FEL Focus"fast machine learning algorithms based on wavefront data are developed in order to automate the fine-adjustment of FEL optics. Such an automated system control will greatly reduce the workload of the measuring station staff.

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no

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