High numerical aperture EUV wavefront sensor for beamline alignment and optics characterization

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Free-Electron Lasers and diffraction-limited storage rings X-ray beamlines have opened the door to new, exciting experiments in physical, chemical and biological sciences. Many of these experiments require an optimum – or at least a properly defined – beam wavefront (WF) quality. In order to quantify these wavefronts, Hartmann WF sensing provides a number of advantages, such as achromaticity, very large dynamic range, ease of use and alignment.

In this context, Imagine Optic has developed several EUV and X-ray Hartmann based wavefront sensor systems. Our last development is a high numerical aperture (NA=0.15) Hartmann WF sensor for the EUV range (10-45 nm). The system is compact and vacuum compatible, allowing wavefront measurement near a focal spot (fig. 1). We have calibrated this system at 32 nm showing an accuracy of $\lambda/20$ RMS [1]. It has been used at the Free Electron Laser FLASH to characterize an EUV Schwarzschild objective [2]. This sensor is appropriate for applications such as EUV microscopy, metrology of EUV lithography optics, characterization of high-divergence EUV sources.

We will present the results obtained using this wavefront sensor for beamline alignment and optics characterization.

Fig. 1: Picture of the high NA EUV wavefront sensor (left) in front of a EUV Schwarzschild objective.

[1] Li et al, 2020, Optics Letters, **45 (15)**, pp4248-4251 https://doi.org/10.1364/OL.396356

[2] Ruiz-Lopez et al, 2020, Sensors, ***20*(22)**, 6426; https://doi.org/10.3390/s20226426