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High-resolution hard X-ray Hartmann wavefront sensor

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Wavefront sensing is a powerful tool enabling a variety of applications ranging from characterization and alignment of passive or active optical systems to non-destructive testing and phase imaging. Indeed, in the recent past, high-resolution Hartmann sensors have facilitated translating the applications of wavefront sensing to the extreme ultraviolet and X-ray spectral range.

In this work, we report on the performances of a high-resolution hard X-ray Hartmann wavefront sensor (HASO HXR) compatible with a broad photon energy range (5 - 25 KeV). The given sensor exhibits a spatial sampling of 20 µm, offering 100×100 sampling points over a field of view of 2×2 mm^2. To assess the performance of the hard X-ray wavefront sensor, we utilize Instrumentation Facility BM05 at European Synchrotron Radiation Facility (ESRF), Grenoble, France. The calibration performed at 14 KeV (88.57 pm) indicates at-energy root-mean-square (RMS) wavefront measurement accuracy and repeatability of 112 pm and 6 pm, respectively. Moreover, post-calibration, we utilize the HASO HXR to perform phase imaging of different polymeric wires at 14 KeV. Through relative wavefront measurement, i.e., detecting the wavefront with and without the sample, the Hartmann-based approach offers the possibility of extracting absorption, deflection, and phase images in X-ray spectral range.

On the one hand, the high-resolution hard X-ray Hartmann wavefront sensor can be a critical tool for easing the characterization and alignment of optical systems in the stated energy range. On the other hand, as a potential application, the presented results demonstrate HASO-HXR-enabled wavefront sensing for hard X-ray phase imaging.

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no

Primary authors: DOVILLAIRE, Guillaume; Dr PIPONNIER, Martin (Imagine Optic); Dr KUMAR PANDEY, alok (Imagine Optic)

Co-authors: Dr IDIR, Mourad (NSLS II); Dr HUANG, Lei (NSLS II); LEVECQ, Xavier (Imagine Optic)

Presenter: DOVILLAIRE, Guillaume

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