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Adaptive Focal Plane Variation Using Alvarez X-ray Lens

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Micro and nano-focusing are essential at beamlines at synchrotron light sources and X-ray free electron laser facilities for various X-ray techniques. The focal plane position of an X-ray optical element can be in error due to mispositioning or misalignment of the optical elements or chromatic aberrations in the case of refractive and diffractive optics. Often for in-situ experiments, the sample cannot be moved along the optical axis to the focal plane. The X-ray focal plane can be moved by Zoom X-ray Optics, but this requires multiple moveable optical elements and is difficult to implement and complicated to align.
We recently developed a varifocal X-ray lens based on the Alvarez lens concept which works in tandem with an X-ray focusing element allowing the focal plane to be adjusted [1]. In this paper, we present the working principle of the Alvarez X-ray lens (AXL) and its application for one and two-dimensional focal plane variations of X-ray focusing elements. Three AXLs were fabricated by 3D printing and were characterised along with an elliptical mirror and a compound refractive lens (CRL) at the B16 Test beamline at the Diamond Light Source. The AXL changed the focal plane of the mirror and CRL by a few mm on either side of the optics'focal plane which is greater than the latter depth of focus. For the elliptical mirror, the coma aberration can be eliminated by combining the variation of focusing power with a small adjustment of the mirror. An AXL can be used to compensate for a CRL focus position change due to its chromatic aberration. AXL is small and easy to adapt to the existing optical layout as it does not deviate beam path, making it a useful device at beamlines where focus size, focal plane or astigmatism, and chromatic corrections are essential.

Reference:
1. Dhamgaye, V., Laundy, D., Khosroabadi, H., Moxham, T., Baldock, S., Fox, O. and Sawhney, K., Alvarez varifocal X-ray lens. Nature Communications, 14(1), 4582 (2023).

I plan to submit also conference proceedings

Yes

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