# Multilens X-ray Interferometry Based on Si Planar Compound Refractive Lenses

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We report the development and experimental demonstration of a new class of high-energy X-ray interferometers based on silicon planar compound refractive lenses (CRLs). The proposed bilens and multilens systems use coherent X-ray illumination to generate diffraction-limited secondary sources whose overlapping wavefields produce stable and controllable interference patterns. The observed fringe spacings range from the nanometer to micrometer scale, enabling applications in coherence characterization, phase-sensitive imaging, beam shaping, and nanoscale analysis.

The bilens interferometer, consisting of two parallel CRLs, was tested with 12 keV X-rays and produced submicron interference fringes detected using scanning and moiré imaging techniques. The far-field interference patterns were used for characterization of X-ray beam coherence, demonstrating the potential of the method for advanced beam diagnostics at modern synchrotron facilities.

The interferometer was further applied to phase-sensitive imaging of weakly absorbing samples in the hard X-ray regime. Experimental studies performed at ESRF beamlines showed that the technique enables accurate reconstruction of phase-shift profiles with high spatial and phase sensitivity. The experimental observations were in good agreement with theoretical predictions and numerical simulations, confirming the validity of the proposed approach.

To extend the concept, multilens interferometers containing multiple parallel arrays of planar CRLs were developed and tested in the 10–65 keV energy range. The generated interference patterns exhibited strong longitudinal dependence and were successfully described within the Talbot imaging framework. Experimental results obtained at ESRF beamlines demonstrated good agreement with simulations and confirmed the capability of the multilens interferometer as a high-resolution tool for beam diagnostics and coherent X-ray manipulation.

In addition, a coherent X-ray beam expander based on the multilens interferometer concept was experimentally demonstrated. The device enabled efficient generation of highly divergent coherent beams with controllable angular size and photon flux density in both coherent and incoherent operating modes.

These developments establish multilens X-ray interferometry as a promising technique for diffraction-limited synchrotron sources and next-generation X-ray free-electron lasers, opening new opportunities for advanced X-ray imaging and beam control applications.