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Microchannel Plate (MCP) Optical Device Characterization Using Synchrotron Radiation in the Soft X-Ray Domain

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Compact, efficient, and high-quality plasma wakefield-accelerated free electron lasers (FELs), betatron sources, and novel synchrotron radiation (SR) coherent sources are under development to meet the latest experimental and technological demands [1, 2]. All new sources need small, low-loss optical parts that can focus, condense, monochromatize, filter, and/or focus radiation, as well as change its polarization and phase [3]. Microchannel plates (MCPs) are compact diffractive optics capable of shaping intense beams of radiation and particles for a variety of applications in the UV and soft X-ray domains.
At these wavelengths, MCPs experience grazing incidence and total reflection from the surface, similar to capillary optics. An ordered array of typically cylindrical or rectangular channels is the typical pattern of these compact and thin optics, which have a flat or bent surface made of lead silicate glasses. A couple of MCPs, identical or different, rigidly linked in such a way that the incident radiation on the second MCP surface is the result of the diffracted radiation at the exit of the first MCP [4], represent a new type of metalens whose properties can be properly engineered.
We recently proposed a new soft-x-ray/UV microscopy layout based on a confocal geometry using these types of meta-lenses suitable to be used with SR, FELs, betatrons and also conventional sources. Tests have been performed with synchrotron radiation at Elettra demonstrating the feasibility to image objects/samples placed inside the focal spot of bent MCPs.
In this contribution, we will present diffraction patterns generated by two MCPs assembled in a unique device in the transmission mode using radiation in the UV-soft X-ray domain at the CiPo beamline at Elettra [5]. Patterns collected at 92 eV and 480 eV, with the insertion device of the CiPo beamline working both in the wiggler and undulator modes, are presented. Working with the SR light at 480 eV, a condensed gaussian intensity distribution with a FWHM of 95 μm was observed, confirming the possibility of using this device as a SR condenser in this energy domain [6]. The analysis revealed that beam parameters and MCP configurations can be tuned to generate different patterns for different applications.
The results achieved also confirm that, similar to a multi-slit experiment, a MCP based device may provide fundamental information to probe the coherence degree of the SR source. Tests with different MCPs represent simple soft X-ray microscopy and imaging experiments in the framework of a full field transmission layout based on two compact, thin, and low-cost, low-weight MCPs.

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