Prospects for laboratory-based low-Z spectroscopy with a polycapillary optic and a curved reflection zone plate

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We propose a compact, wavelength-dispersive instrument for XUV and soft X-ray fluorescence spectroscopy. Equipped with a halved polycapillary lens (PCL) and an adapted reflection zone plate (RZP) on a curved substrate, the system combines high transmission efficiency near 8.4×10^{-2} % with a resolution around 1.9 eV at the K_α line of Li with an energy of 54.3 eV. As investigated by detailed measurements at a photon energy of 36 eV and associated calculations [1], the PCL collimates the point-like emission (5 µm) from the electron-excited (4.4 keV) Li target to an almost parallel beam with an angular divergence of ≈ 7.8 mrad. An optimized RZP is designed to disperse the XUV radiation at a deflection angle of 37.6° onto a 2-D CCD camera in an overall distance of 850 mm from the source. Within an area of (1024 × 1024) pixels à 13.5 µm, an energy range of at least ± 6 eV around the design energy (Li K_α) can be displayed (Figure 1).

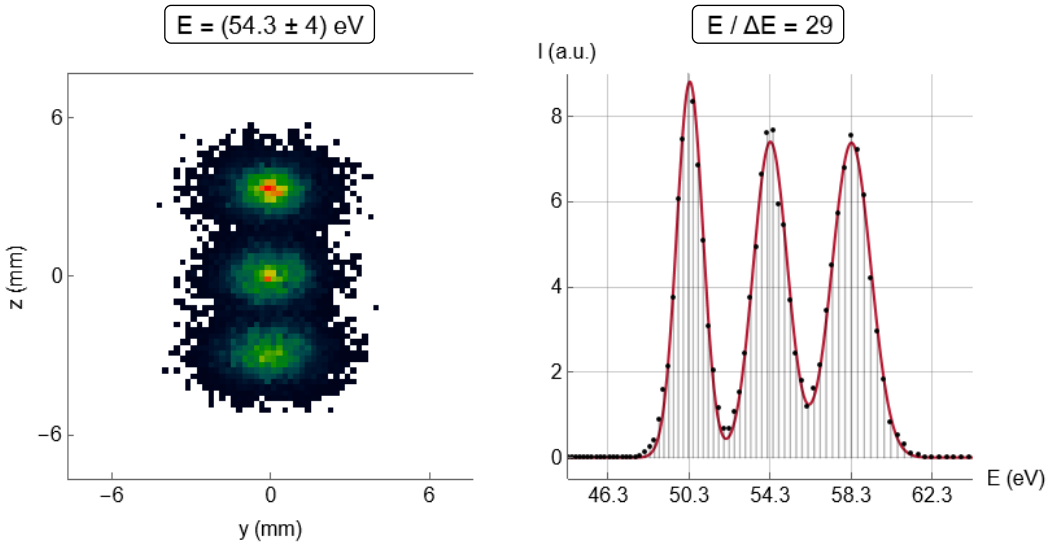

Figure 1: Ray tracing results of a test spectrum around the Li K_α fluorescence line, at an assumed intrinsic bandwidth of 0.1 eV for each photon energy. The CCD image (left) is integrated across the pixel lines (right).

The RZP is inscribed as a laminar profile on a spherical substrate with a radius of curvature of 2.9 m and a size of (100 × 30 × 10) mm^2. At a central line density of 2050 mm^{-1}, holographic shaping of the grating grooves provides aberration-corrected 2-D focusing over the entire spectral range of ≈ (48.3 – 60.3) eV [2].

[1] C. Braig, A. Sokolov, R. G. Wilks, X. Kozina, T. Kunze, S. Bjeoumikhova, M. Thiel, A. Erko, and M. Bär, Opt. Express **25**, 31840 – 31852 (2017); erratum in Opt. Express **30**, 34935 – 34937 (2022).

[2] J. Probst, C. Braig, and A. Erko, Appl. Sci. **10**, 7210 (2020).