# Multilayer based x-ray optics at the ESRF

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Multilayer (ML) based x-ray optics have gained considerable interest at $3^{rd}$ generation synchrotron light sources. Over the last 20 years, more than 200 devices have been fabricated at the ESRF ML Laboratory and deployed on ESRF beamlines, mainly in two configurations: as Kirkpatrick-Baez (KB) focusing devices and as double-bounce high-flux monochromators.

The KB mirrors are either bent or polished to their elliptical figure. The ML coatings require steep meridional thickness gradients to account for the variable angle of reflection along the beam footprint. The increased incident angles as compared to total reflection mirrors provide larger numerical apertures and therefore smaller diffraction limited focal spots. At present, ESRF KB optics reach spot sizes down to about 12 nm and are being operated up to photon energies of 65 keV.

Double ML monochromators (DMM) are an interesting alternative to double crystal monochromators (DCM) whenever high flux rather than high spectral resolution is required. On many new ESRF beamlines, monochromators with bandwidths between 0.1% and 0.5% are part of the optics layout. The production of efficient DMMs with such narrow bandwidths is challenging since it implies a large number of bi-layers and low d-spacings. Possible thickness variations in depth and along the beam footprint must remain within these tolerances in order not to spoil their performance. Recently installed DMMs achieve a spectral resolution better than 0.4% and a total transmission above 50%.

This paper will recall some fundamental design aspects for ML x-ray optics and show examples of applications on ESRF beamlines. It will address present limitations and discuss possible approaches to improve the ML performance.