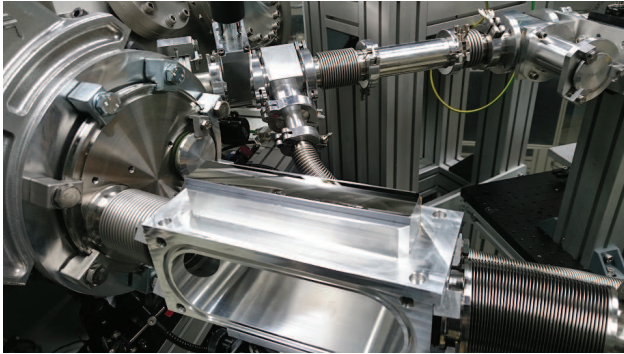


# Tender X-ray optics



Toroidal multilayer mirror at a laser plasma X-ray source (LPS) at the Technical University of Berlin.

### Optics for tender X-ray region

The energy range from 1 keV to a few keV is called tender X-ray region, lying between the hard and soft X-ray regimes. In this energy region are many fluorescence lines of elements from the 3rd row in the periodic system of elements interesting in steel and ceramics production as well as oil analysis.

Multilayer X-ray optics can improve excitation and detection of those elements in XRF analysis.

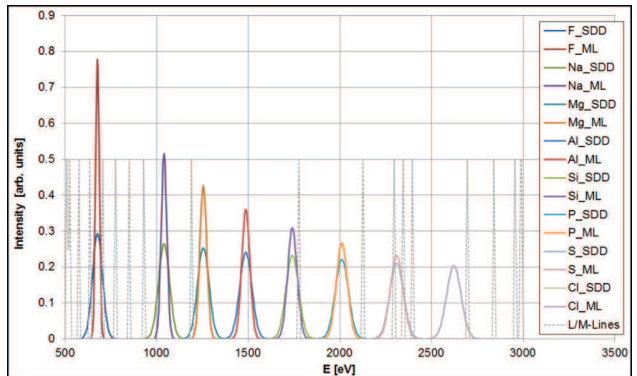
Due to the low energy optics geometries and Bragg angles can become rather large and precise mirror fabrication and coating is challenging. Various mirror shapes and multilayer systems are available at AXO DRESDEN to achieve the best results for each application.

CCD image of a 1078 eV (1.15 nm) X-ray beam emitted from laser plasma source (spot size ~70 μm) focussed to ~75 μm FWHM using a multilayer coated toroid segment mirror. (Image courtesy of BLiX, Berlin, Germany)

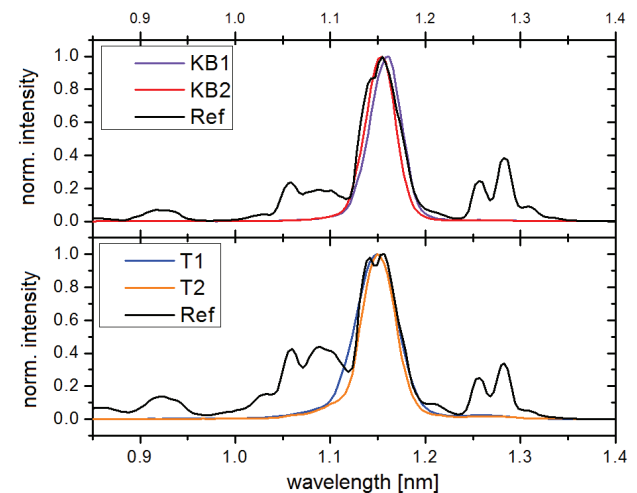


### Energy resolution

Even though energy bandwidth of silicon drift detectors (SDDs) decreases with lower photon energy, the so-called Fano noise has an opposing effect. Here, multilayer monochromators can provide better resolution to separate X-ray fluorescence lines.



Calculated silicon drift detector and multilayer energy resolutions for K emission lines from F to Cl. Several L- and M-lines of heavier elements are shown, too.



Spectrum emitted from a laser plasma source (LPS) before ("Ref") and after reflection from different multilayer mirrors such as a 1-dimensionally focussing mirrors in a KB arrangement and single toroid segments.