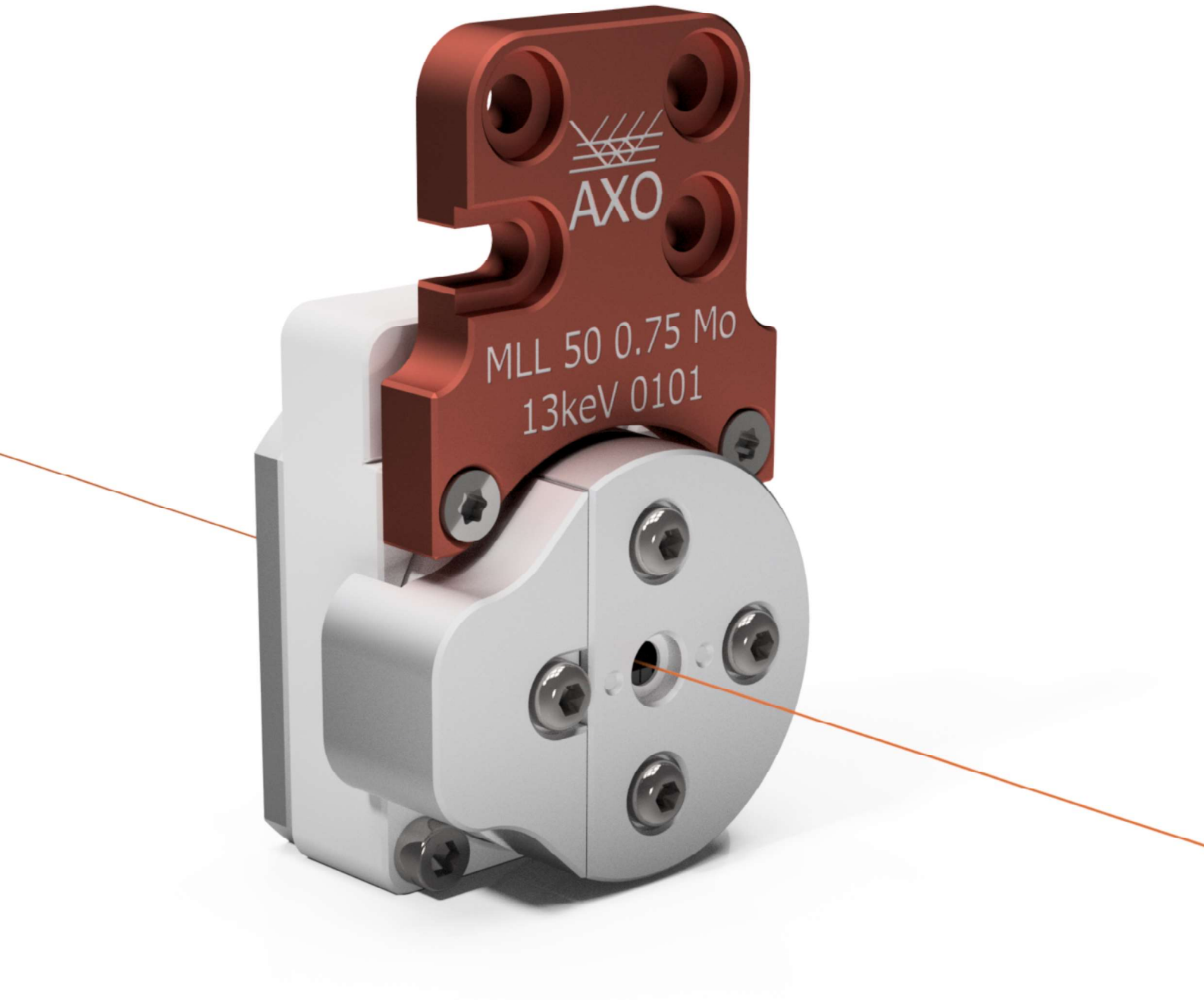
Fraunhofer IWS

AXO
A brand of Anton Paar

Multilayer Laue Lenses (MLLs)



Multilayer Laue Lenses (MLLs)

Focusing X-rays, especially in the high energy regime, down to the nanometer range opens up fascinating new opportunities. X-ray nanodiffraction with a resolution below 30 nm was able to map the crystallographic texture and stress states in TiN-SiOx thin films. X-ray microscopy and nano XRF become possible with such small beam dimensions. Multilayer Laue Lenses, developed and provided by Fraunhofer IWS and AXO DRESDEN, provide large working distances and are as easy to use as Fresnel zone plates, but offer higher diffraction efficiencies for hard X-rays.

Multilayer Laue Lenses (MLLs)

Technology

Multilayer Laue Lenses (MLLs) are made from multi-layers composed of thousands of individual layers each having a different, very precisely adjusted thickness in the nm-range. When cut into thin slices those MLL work as diffractive optics and can be used as focusing optics similar to Fresnel zone plates. Thus, resolutions of few tens of nanometers and high diffraction efficiencies can be achieved particularly for hard X-rays.

Point focusing can be achieved by combining two MLL slices perpendicularly in a dedicated mount. The resulting lens device is internally aligned to ensure low aberrations. It is as easy to use as a Fresnel zone plate.

In order to cope with experimental demands Fraunhofer IWS and AXO DRESDEN have developed MLLs with long working distances. They have been fabricated, tested and used for nano-beam experiments in the framework of long-term proposals at ESRF, Grenoble, and PETRA III, DESY, Hamburg; as well as in other user experiments.

Currently, two designs that offer long and very long working distances are available (LWD, VLWD). Although MLLs work over a large photon energy range, each MLL is optimized to a target photon energy in terms of efficiency.

Correction phase plates for MLLs to minimize aberrations can be offered together with our partners of XRnanotech (www.xrnanotech.com).

Applications

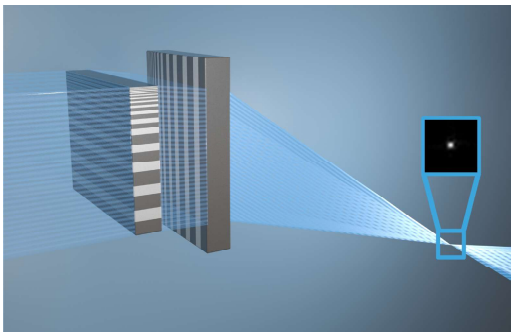
- Nano-XRD e.g. for micro-mechanical studies
- Ptychography
- Nano-XRF
- Holography
- X-ray microscopy

Publications

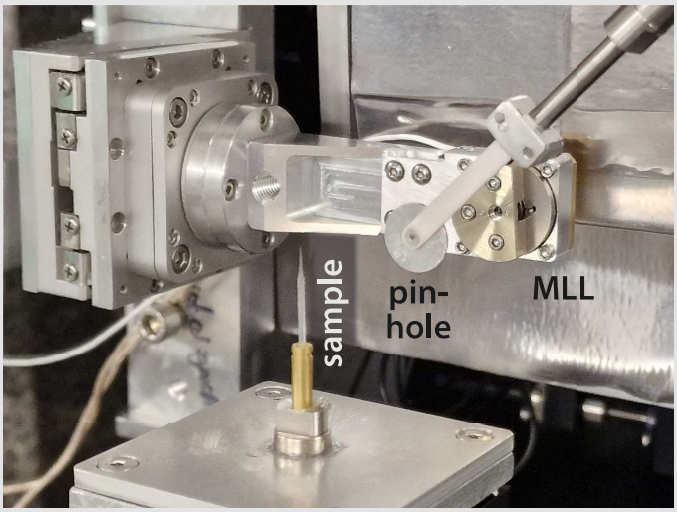
Kubec et al. 2018 JINST 13 C04011. 10.1088/1748-0221/13/04/c04011

Keckes et al. 2018 Acta Mater. 144 862. 10.1016/j.actamat.2017.11.049

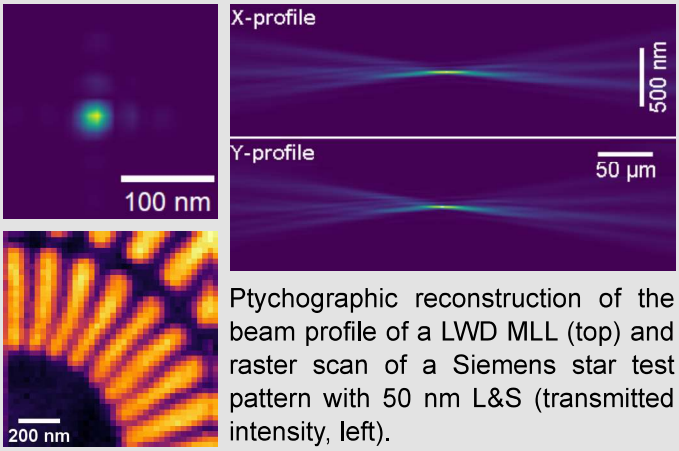
Seiboth et al. 2022 Opt. Express 30 18 31519. 10.1364/OE.454863



Schematic drawing of a 2D focusing crossed MLL.

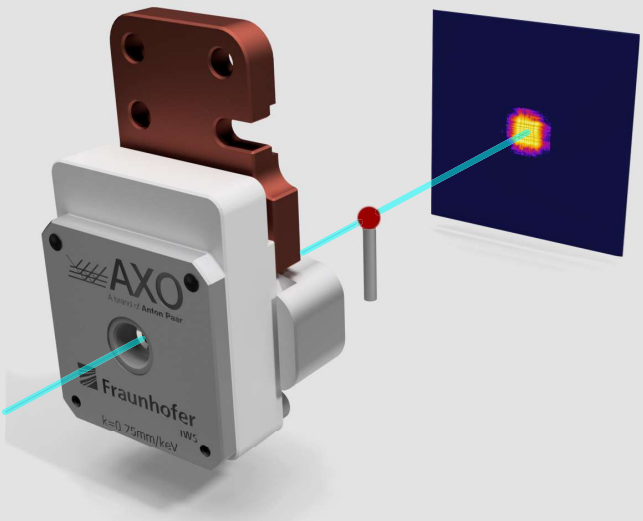


VLWD MLL at 18 keV at ESRF, ID13. The two rotation stages on the left hand side are used to align the MLL.



Ptychographic reconstruction of the beam profile of a LWD MLL (top) and raster scan of a Siemens star test pattern with 50 nm L&S (transmitted intensity, left).

Parameter	LWD	VLWD
Photon energy	e.g. 12 keV	e.g. 12 keV
Focal length	9 mm	45 mm
Working distance	3.1 mm	25 mm
Stack height	50 µm	100 µm
Resolution (typical)	23 nm	80 nm



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