

MULTILAYER OPTICS FOR NANOSTRUCTURE STUDIES IN THE LAB, THE EXAMPLE OF HIGH Z ELEMENTS

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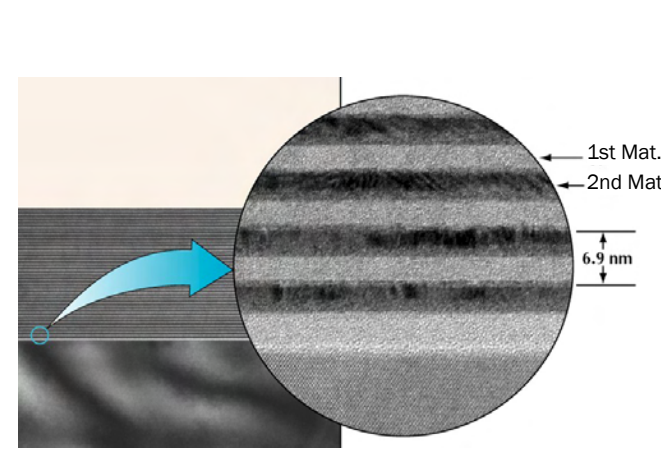
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Aspheric multilayer coated optics preserves source brilliance

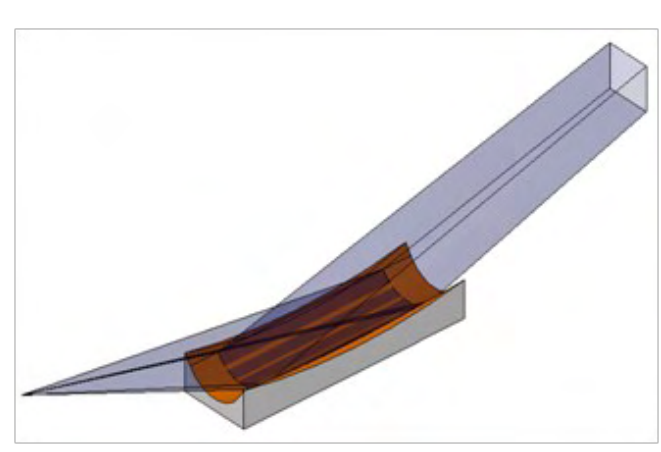
X-ray multilayer coatings

- high reflectivity
- tailored spectral purity



highly curved aspheric substrates

- Single Reflection design for high intensity
- Adapted Spot Size
- Divergence Control
- Easy to align

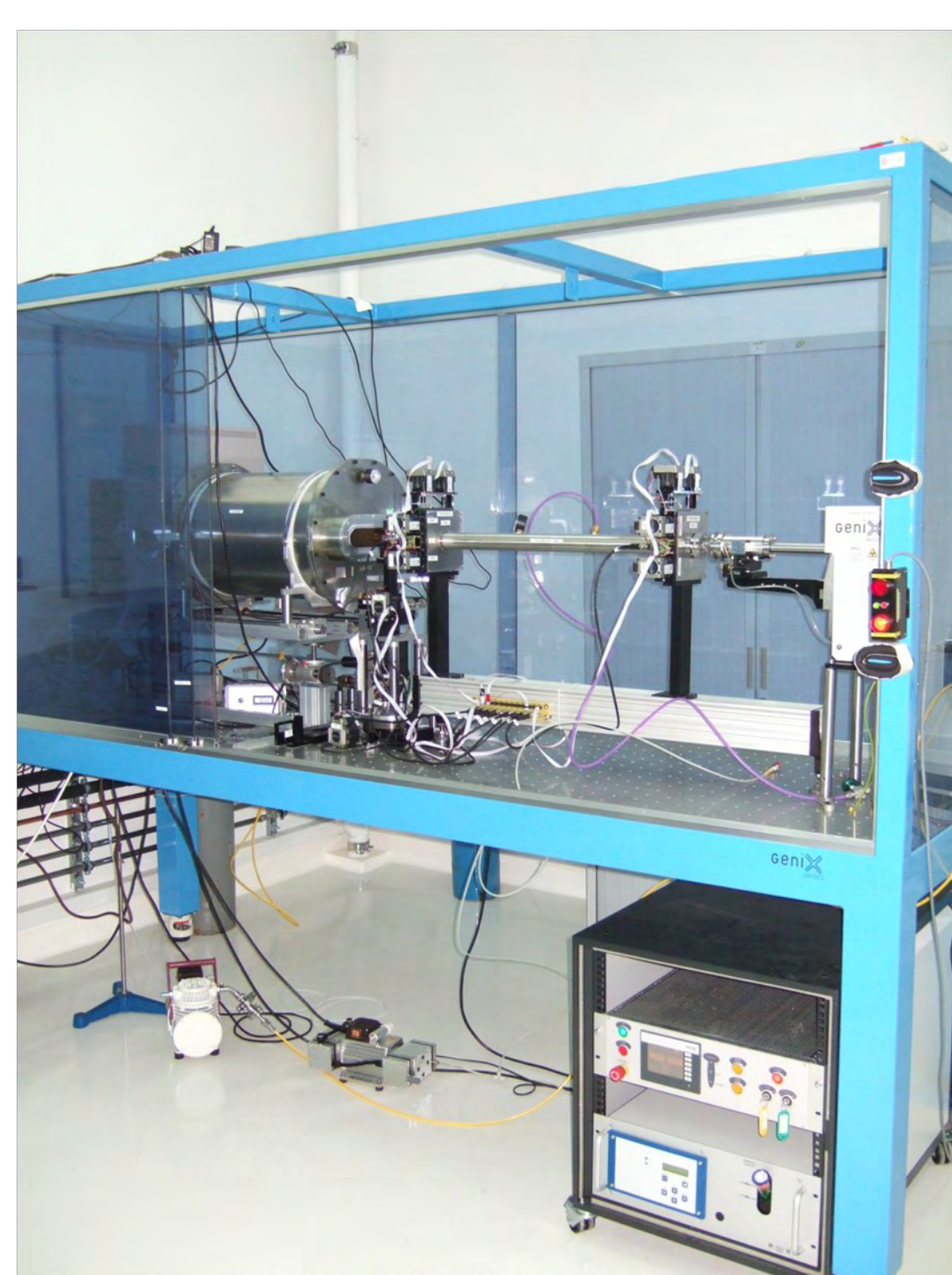


X-ray beam characteristics of Mo GeniX solutions

Source -Optic configuration	Applications	Typical Flux [photons/sec]	FOX 2D p, q [cm]	Focal Spot Size FWHM [μm ²]	Divergence mrad ²
GeniX Mo High Flux	Small Molecule Crystallography	> 30 x 10 ⁶	10,30	250	2.8 x 2.4
GeniX Mo Small spot	Microdiffraction	> 5 x 10 ⁶	25,25	80 x 80	4 x 5.3
GeniX Mo Low divergence	SAXS	> 5 x 10 ⁶	25,INF	0,7 x 1,2 mm	0,4 x 0,4

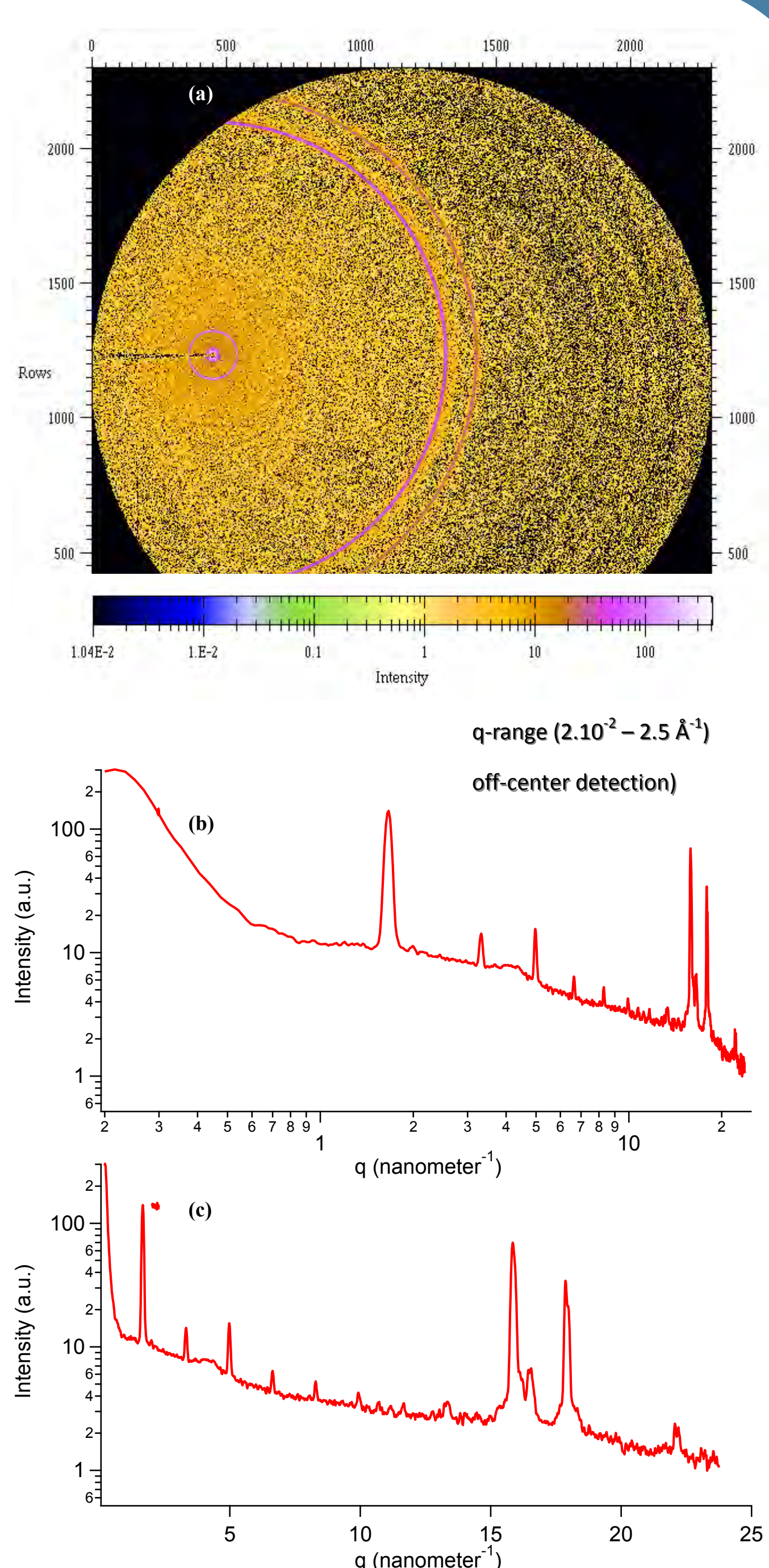


GeniX Mo Low Divergence for SAXS/WAXS Applications



Set-up

- GeniX Mo Low divergence: here the divergence is minimal, focusing is considered at ∞
- Anti-scattering vacuum slits (special mounted edges) and flight tube from FORVIS
- Large (350 mm diameter) detector from MAR Research for small and wide angle regime acquisition
- Motorized sample changer



Multilayer optics for Mo radiation

Multilayer optics coupling efficiency

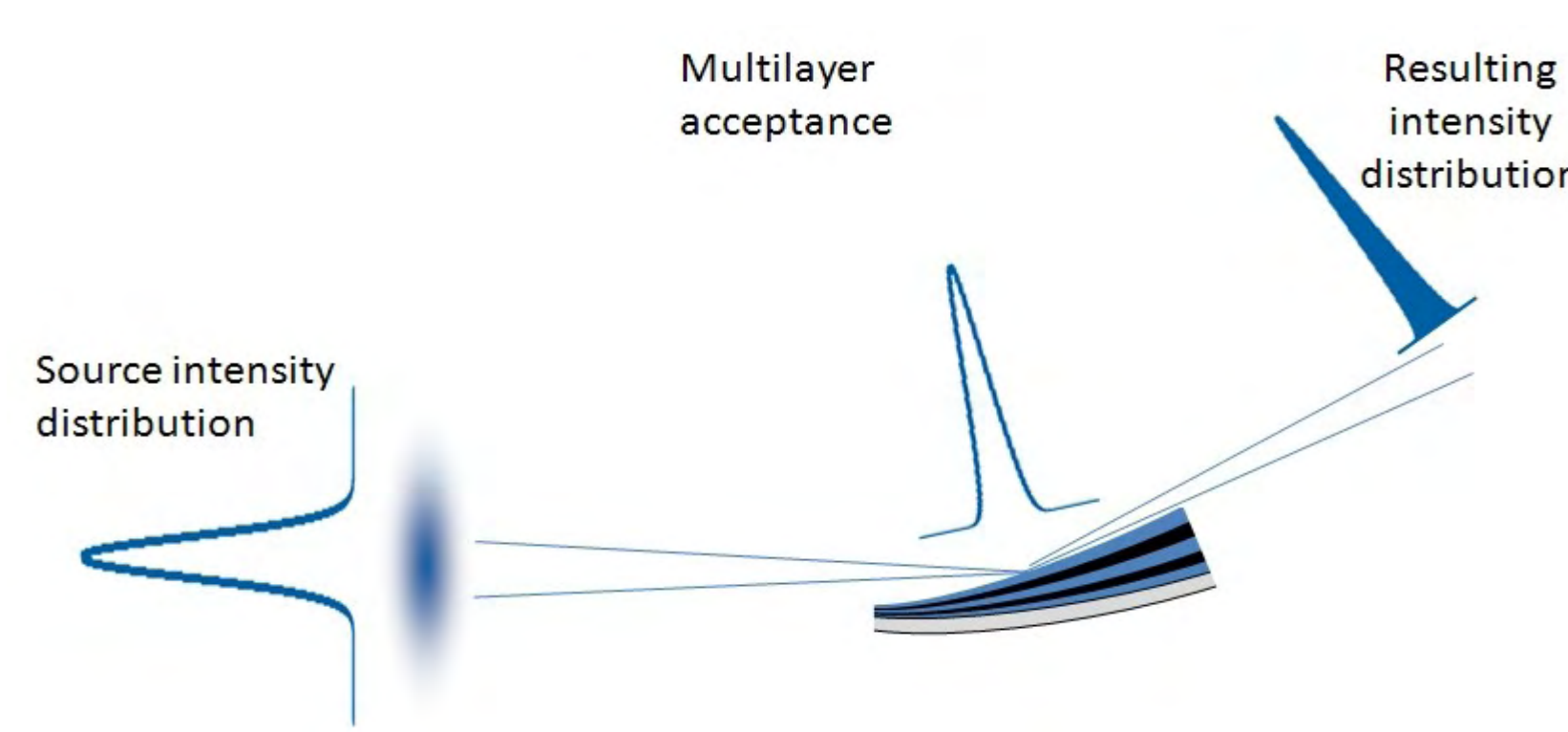
Resulting flux outcome from the optic is a convolution of Source intensity distribution (S_s) and acceptance size (S_m) by the multilayer optic

S_m is a function of Δθ (width of Bragg reflection of the multilayer optic) and p (source-optic distance) and is expressed as S_m=p.Δθ

S_r is resulting from the convolution of both size distribution

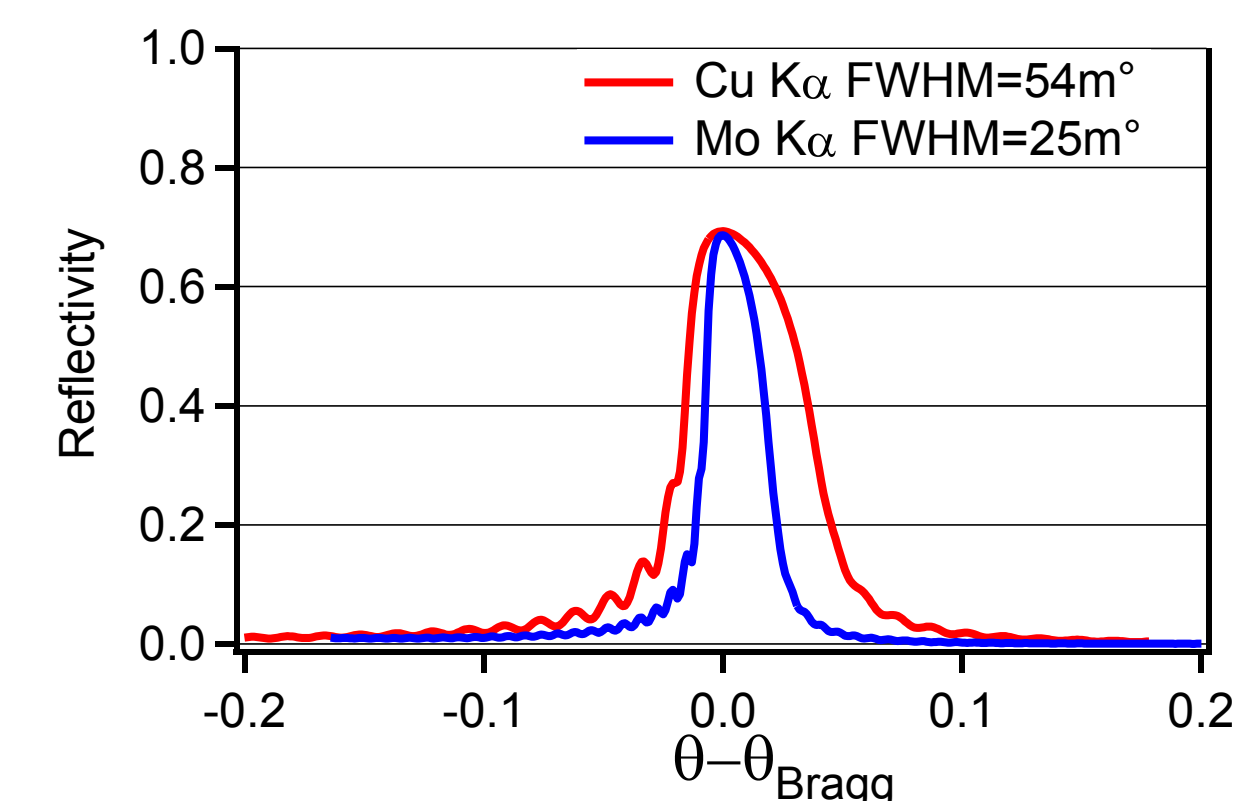
Efficiency of the coupling is therefore expressed as (gaussian hypothesis)

$$C_e = \frac{S_m}{\sqrt{S_s^2 + S_m^2}} \quad \text{Eq.1}$$

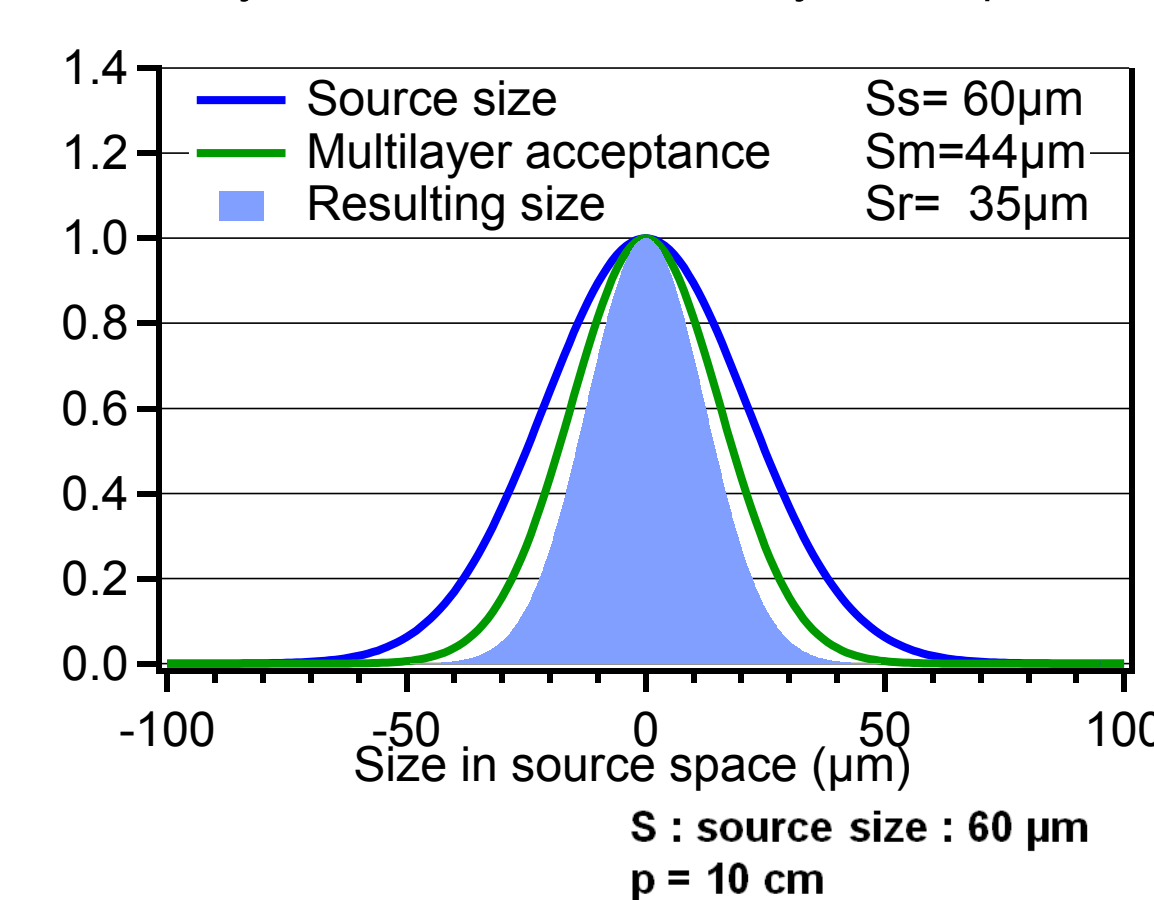


Comparison of Cu VS Mo rocking curve width

→ Reduced FWHM for shorter radiation



Intensity after optic depends on source intensity distribution and multilayer acceptance



Comparative coupling efficiency: Montel VS FOX 2D

(simulation for source 60μm, source to optic p= 10cm)

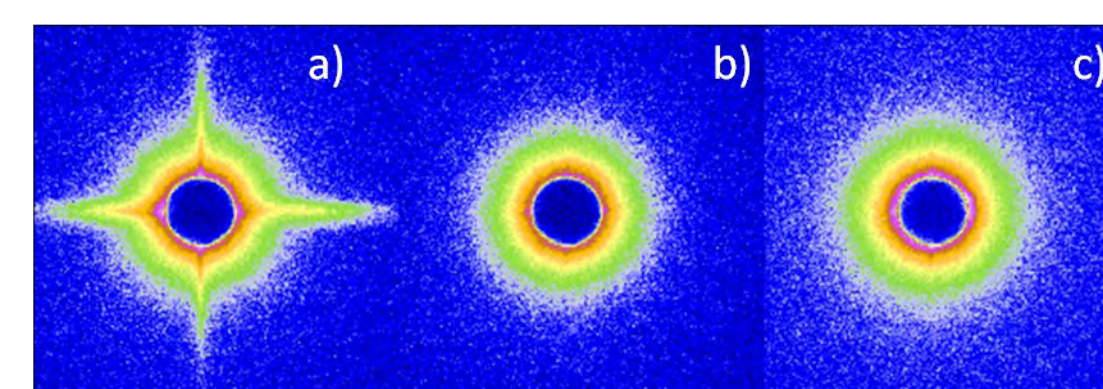
Mirror Type	Montel Mirrors	FOX 2D Mirrors
Optic Efficiency	Eff = 15 %	Eff = 32 %

(Calculated over mirror length)

Single Reflection multilayer optics provide higher flux compared to Montel mirrors

Scatterless slits optimized for Mo radiation

- Modified blades by FORVIS allows for background free collimation, even at intense beams



Images of empty SAXS camera of the D2AM beamline at ESRF, France. Collected on a 1.67m SAXS camera and 3mm beamstop, energy set to 17.48keV.

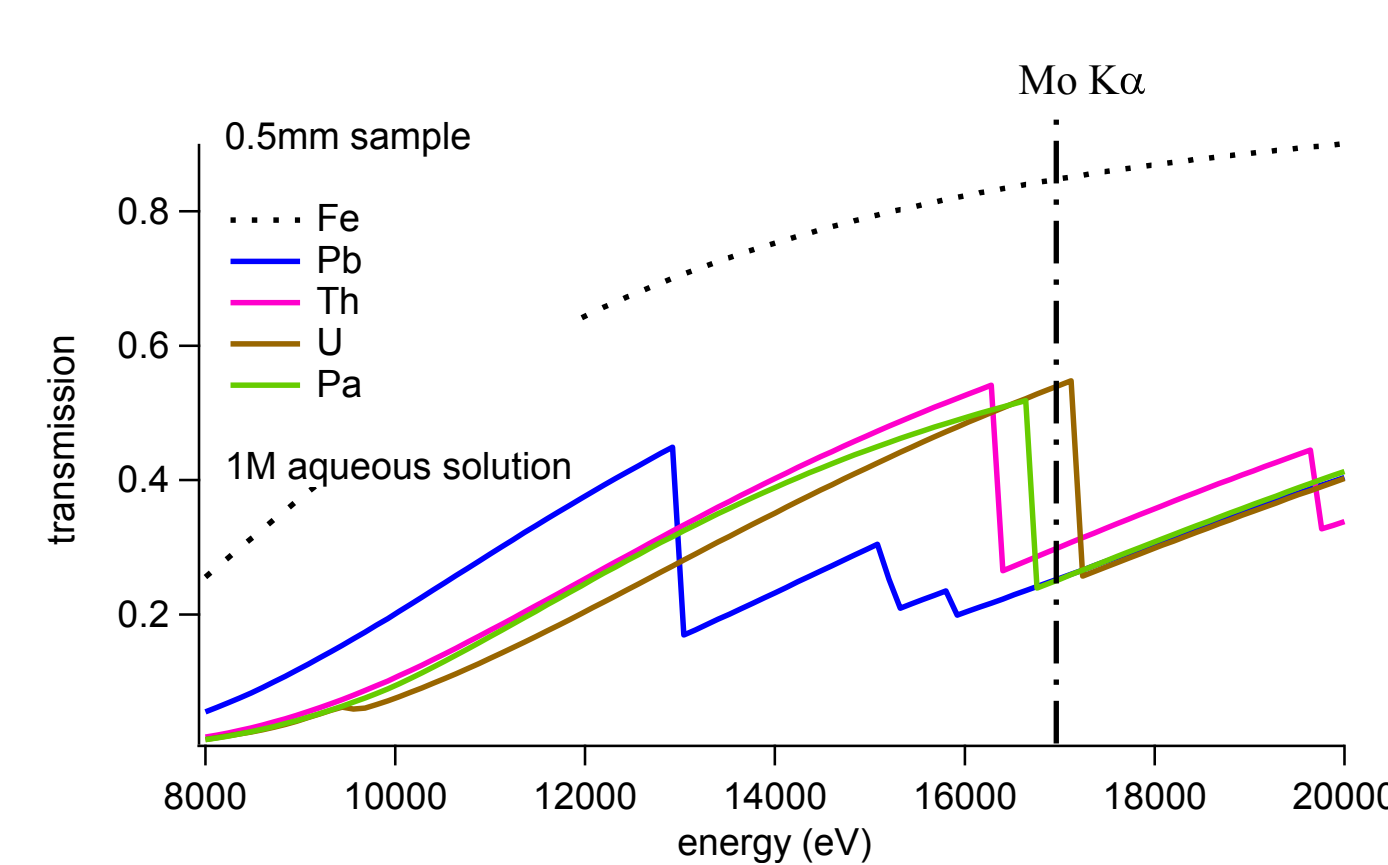
- (a) Standard collimation, flux maximized to 3.4e10 ph/s @17.48keV on sample
- (b) Same collimation, last anti scatter slits replaced by Xenocs' scatterless slits, same flux
- (c) Collimation scheme simplified including Xenocs' scatterless slits allows to increase the flux up to 9.6e10ph/s with same beam focus on detector

- Modified blades by FORVIS allows increased useful flux on sample and offers a potential to further decrease the minimum q reachable by a reduction of beamstop size and/or increase of camera length (work in progress)

Optimization of thickness/concentration/radiation

The case of highly absorbing elements

- Best compromise to be found between radiation used, scattering domain and sample studied
- Optimum thickness for SAXS sample of non multiple scattering systems is obtained for a transmission of 1/e



Transmission is expressed as: $I/I_0 = \exp(-\mu \cdot t)$
with μ the lineic absorption coefficient

- Mo Kα radiation is chosen since the transmission of typical 1M concentrated samples appears to be close to ideal value, while keeping adapted resolution to the WAXS regime with a thickness of 0.5mm.
- Mo Kα radiation appears to be also very useful for known-to-be multiple scattering system @ 8keV i.e. iron-based suspensions. The classical solution is to lower the thickness of the sample, here 0.5mm of sample remains still within easy and practical conditions.



- is a stable, high brilliance, low power microfocus beam delivery system.
- is proven to outperform standard sealed tubes and to provide performance equivalent to traditional rotating anode generator in a number of applications.
- is an affordable solution metrology with reduced maintenance, facilities requirements and running cost.
- is validated by a number of equipment makers and academics

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