Application Note — *FOX2D* optics on GE diffractometer

Compact point focus diffractometer for high-resolution diffraction, grazing incidence diffraction and small angle scattering applications

In high-resolution diffraction, the most commonly used solution consists of a sealed tube in line focus and 1D Göbel Mirror+channel-cut monochromator. This conventional system based on an economical low maintenance x-ray source delivers a highly parallel beam in one dimension.

A **more versatile** solution for this instrument type is achieved by turning the tube to point focus geometry and combining it with a XENOCS *FOX2D* collimating mirror. Delivering lower integrated flux together with a crystal monochromator, this system preserves the very high resolution in one dimension, and additionally delivers a collimated beam in the second dimension. As soon as small beam sizes and angular resolution are the figure of merit, this geometry is favorable. Besides the traditional use in high **resolution diffraction and reflectivity**, this setup can also be utilized in a variety of applications that require angular resolution or small beam cross-sections in two dimensions with high brilliance such as:

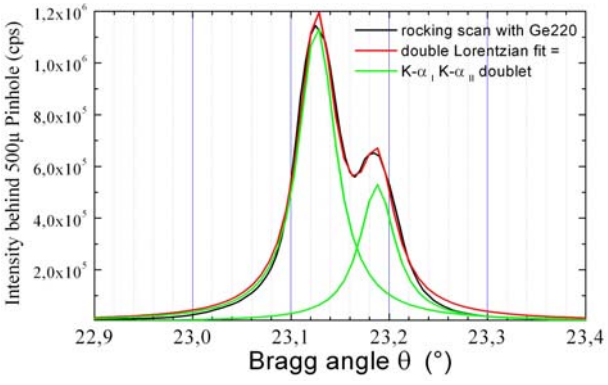
-**Small angle X-ray scattering (SAXS)**
-**Grazing incidence small angle X-ray scattering (GISAXS).**
-**Grazing incidence X-ray diffraction**

Beyond these grazing incidence applications, this setup based on a *FOX2D* mirror is also useful for applications in four-circle mode.

On FZ Rossendorf's request, a *FOX2D* collimating mirror was recently integrated in a GE Inspection Technology XRD 3003 PTS diffractometer. Combined with a sealed tube in point focus geometry, the 2D mirror delivers a collimated Cu K_α beam. The beam path between mirror and sample is evacuated. Beam size can be tuned with two exchangeable apertures along the beam path and a platinum exit pinhole positioned in front of the sample.
With little alignment, the vacuum tube can be replaced with a four-bounce Ge 220 Bartels monochromator suppressing the $K_{\alpha II}$ contribution and further improving the beam collimation.

GE Inspection Technologies X-Ray Diffraction System Seifert XRD 3003 PTS

Source	Type:	Sealed tube long fine focus
	Working power:	1600W (40 KV, 40 mA)
	Filament:	0.4x1.2 mm point focus mode
Optics	Model :	*FOX2D CU 12_INF* collimating optics



Graph 1: Rocking scan characterisation of the mirror beam (500 µm exit) with a Ge220 crystal on the sample goniometer.

In Table I, are given the beam intensities for various beam sizes together with the horizontal and vertical beam divergences. For 500 µm beam diameter at the sample position, the horizontal divergence of the beam is about 0.04° as shown in Graph 1 where the $K_{\alpha I}/K_{\alpha II}$ doublet can be separated by analyzing the primary beam from the mirror with a Ge 220 crystal at the sample position.

Table 1: Experimental results

	Flux at sample position	Beam size FWHM	Horizontal Divergence	Vertical Divergence
With a Ø 2 mm exit pinhole	$5x10^8$ photons/s	Ø 2 mm	1.3 mrad	3 mrad
With a Ø 500 µm exit pinhole	$5x10^7$ photons/s	Ø 500 µm	0.7 mrad	1.5 mrad
After a 4-bounce Ge 220 Bartels monochromator	$5x10^5$ photons/s	1.5 x2 mm^2	0.05 mrad	3 mrad

Conclusion: **The *FOX2D* collimating mirror presents a solution that does not only improve the resolution in both dimensions for standard sealed tube applications, but also extends the field of applications for these compact diffractometers. Beyond tradition high resolution measurements, this simple upgrade of your GE IT equipment with a Xenocs optic enables grazing incidence diffraction as well as small angle scattering experiments.**

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