Xenocs
Reflecting Future Technology

Newsletter

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Table of contents

Xenocs: your x-ray beam delivery on demand!

Since their introduction by Xenocs in 2002, single reflection multilayer coated optics for 2D focusing have become widely used solutions for a broad range of analytical applications.

Xenocs is now proud to introduce two additional major products:

- The GeniX product line combines a micro-focus x-ray source with a high performance X-ray optic to create a state-of-the-art solution for delivering a highly characterized X-ray beam in a turnkey system. The paradigm of using excessively large sources and defining beam size and divergence is coming to a close. Instead you can now use single-reflection x-ray optics to efficiently collect large solid angles from a high brilliance micro-focus source – and the benefits are numerous. You will find in GeniX a high performance solution in terms of beam intensity, spot-size, stability, power consumption and cost of ownership.

Peter Høghøj, President

- Aspher'X is our new product line of EPMA and WD-XRF analysers. The multilayer coated completely aspherical analysers offer an unprecedented flux collection while keeping background signals low, thus allowing for high precision measurements with unsurpassed lower limits of detection.

With GeniX and Aspher'X, Xenocs continues to bring innovative and cost effective solutions to our customers. We are looking forward to working with you, too.

Aspher'X free form optics for EPMA and WDXRF applications

Based on our extensive experience in shaping X-ray beams by controlling the spot size, divergence, and spectral purity, Xenocs has developed a new product range of analyzers for demanding applications. Successful measurements require high signal, low background, effective second order extinction, and excellent energy resolution. Meeting these requirements lowers the detection limit and leads to higher precision analysis.

At a system level as well, Xenocs doubly focusing analyzers lead to improvement. Since the optic creates a small beam spot, the detector entrance can be strongly apertured to limit background noise. Moreover, traditional gasflow detectors can be replaced by more economic small area silicon drift diodes that offer better energy discrimination.

Our multilayer mirrors obviously do not cover the entire periodic table, but for soft X-rays Xenocs analyzers provide superior performance, allowing fast and accurate analysis.

■ Energy	N, B, O, As, C
■ Size	Up to 100x20 mm²
■ Shape	Aspherical

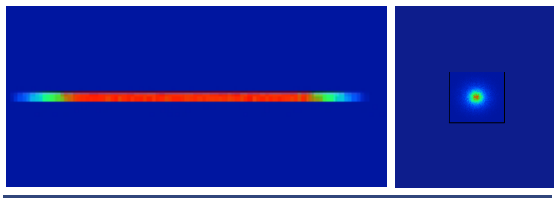


Fig. 1: Comparison of typical spot images (source size Ø 40µm) for traditional and Aspher'X elliptical analyzers with a given geometry.
Left: spot image for a traditional analyzer (size 150µmx22mm²)
Right: spot image for an Aspher'X analyzer (size Ø 150µm)

Fig. 2: Photo of a 2D aspherical analyzer (90x20mm²) with a graded multilayer coating.

Protein crystal analysis: working with smaller crystals

sanofi aventis
L'essentiel c'est la santé.

In order to satisfy our customers striving to analyze ever smaller crystals in the lab, Xenocs introduced a new *FOX2D* optic for protein crystallography in the beginning of 2005. Originally this optic targeted the upgrade market of the widely spread 300 µm rotating anode generators. A detailed application note by Dr. Andrew Leslie of MRC Cambridge discussing the results he collected using this configuration can be found on our web site.

More recently, a similar test was conducted on a 70 µm microfocus rotating anode at Sanofi Aventis in Vitry (France) by Dr. Jean-Pierre Marquette and Dr. Magali Mathieu. In this case the diffractometer was composed of a Rigaku 007HF Cu rotating anode generator operating at 40 kV and 30 mA and a MAR 345 image plate detector.

For this test, a kinase protein crystal of 80 X 30 µm2 large (space group C2), that usually does not diffract in the lab, was chosen. A 200 degree dataset was collected at one image per degree, 5 minutes per frame. The detector was operated in 345 mm scan mode (MAR 2300) and the crystal to detector distance was 200 mm (2.2 Å maximum resolution). Data were processed using the MOSFLM and the SCALA programs.

For comparison, the same crystal was also measured with a *FOX2D CU 12_38P*. Radiation damage which can be significant for such a small crystal must be taken into account when comparing the data. For this reason the diffraction pattern was collected first using the *FOX2D CU 12_38P* and then on the *FOX2D CU 25_25P*. The merging statistics for the two datasets are presented below:

	FOX2D CU 25_25P (measured second)	*FOX2D CU 12_38P (measured first)*
Max intensity	684	259
Mosaicity	~2.0	undefined
Resolution	to 2.95 Å	Spots to 3Å, useful only to about 6Å (very noisy diffraction)
R_{sym}	13.8% (31.3%)	-
R_{meas} (all I+ and I-)	16.4% (37%)	-
Mean(I)/sd(I)	5.2 (2.4)	-
Completeness	99.9% (multiplicity 3.4)	-

As one can see, measurements were possible with the *FOX2D CU 25_25P*. With the *FOX2D CU 12_38P* configuration, the diffraction patterns were too noisy and the spots too weak to be properly integrated.

Previous diffraction experiments using traditional home lab sources (300 mm rotating anode generators) highlight the efficiency of the *FOX2D CU 25_25P* for crystals with sizes in the range of about 100 to 150 µm. The present results reveal the exploitable results can be collected even with crystals as small as 30 µm when a *FOX2D CU 25_25P* optic is combined with a microfocus rotating anode generator. This mirror represents a big step forward in the use of laboratory X-ray installations for crystal screening. Experiments can now be performed on small crystals previously thought to diffract only on synchrotron beam-lines.

Fig. 1: Installation at Sanofi Aventis in Vitry, France with a Rigaku Micromax 007HF Cu rotating anode generator, a MAR345 image plate detector and a *FOX2D CU 25_25P* optic.

FOX2D CU 25_25P is the better choice for setups where the crystal size is smaller than 1.5 x the source size. For other configurations *FOX2D CU 12_38P* is the best solution.

Fig. 2: The biggest crystals on this image are about 80x40x5µm³, representative of the crystal we tested.

GeniX beam delivery system

Xenocs expands the range and capabilities of the company's products with the introduction of a complete beam delivery system: GeniX (Generator of intense X-ray beam). The GeniX product platform is based on a compact water cooled microfocus x-ray source and can be configured with a range of *FOX2D* optics. The resulting combination runs at 50 watts and is a very stable, low maintenance system with reduced operational cost. GeniX is very cost competitive compared to rotating anodes or traditional sealed tubes.

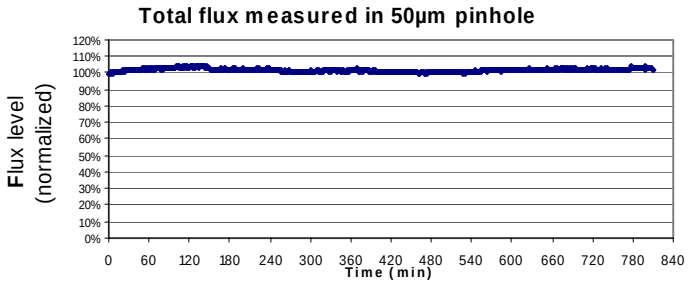


Fig. 1: Flux stability measured with a cold start up in a 50µm pinhole with a pindiode detector. Source is operated at full power (50W - 50kV- 1mA)

The 50 watt micro-focus source with high flux density and the 2D single reflection Xenocs optic combine to allow GeniX to deliver an intense x-ray beam suited to the most demanding applications. Its compact size and the plug and play design ensures easy retrofitting to existing diffraction instruments. The following functionalities are included:

- Security and fast shutter
- Command & control unit with Ethernet interface
- Configurable collimator system
- Configurable manual filter wheel (option)
- Water chiller unit (option)
- Dry pump for primary vacuum (option)

As detailed in the table below, GeniX is already available in several standard focused beam configurations for copper radiation, and is rapidly being extended to other geometries (collimated beam) and to other radiations.

Version	Energy	Spot size (µm)	Flux (Ph/s)	Divergence (deg)
GeniX High flux	Cu	230	200 E6	0.15°
GeniX Small spot	Cu	80	40 E6	0.3°
GeniX High convergence	Cu	80	175 E6	3°

Sealed tube and *FOX2D CU 12_INF* - a highly versatile instrument - high brilliance, high reliability and low cost of ownership

Forschungszentrum Rossendorf

A few months ago, our collimating optic was installed together with a compact 4-circle diffractometer from General Electrics IT Seifert at the Forschungszentrum in Rossendorf, Germany. This gives the user the possibility to convert the instrument from a very high resolution instrument (using the collimating mirror in combination with a four-bounce Bartels monochromator) to a high flux instrument using solely the 2D parabolic mirror and the full Kα beam.

Fig. 2: Sealed tube in point focus geometry on a General Electrics IT Seifert diffractometer equipped with a *FOX2D CU 12_INF* mirror and an evacuated telescopic collimation system.

Many applications, such as the study of nanostructures, thin films, or defects in crystals often demand high flexibility from the X-ray diffraction setup. These requirements are fulfilled by the powerful combination of a classic sealed tube in point focus geometry and a high performance optic – the *FOX2D CU 12_INF* double collimating single-reflection mirror.

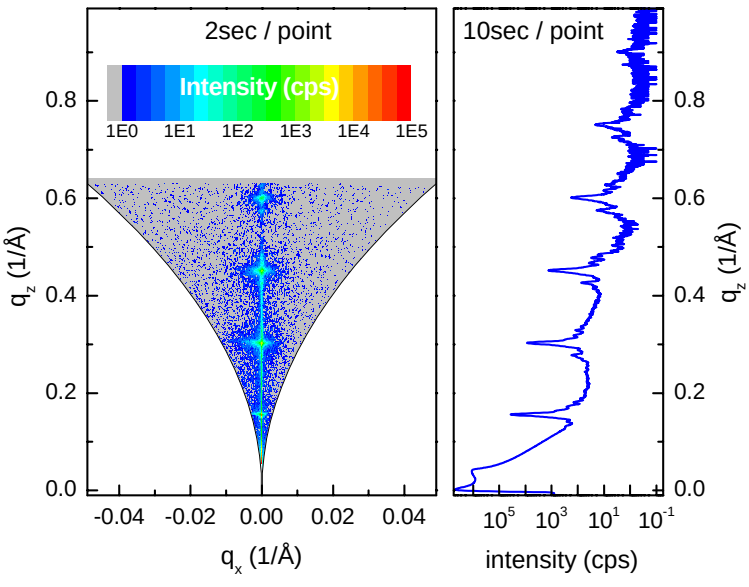


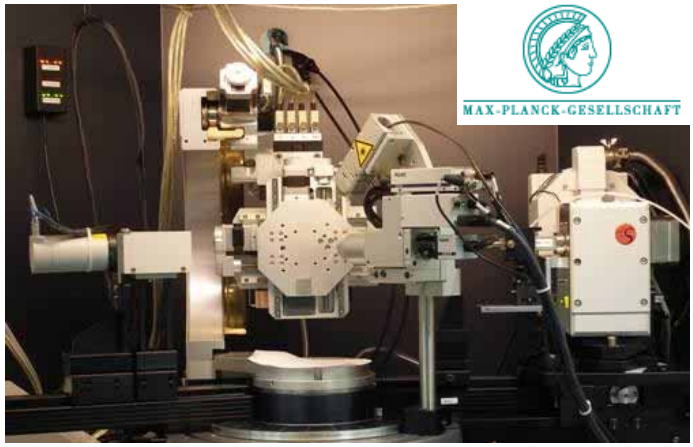
Fig. 3: RSM and reflectivity of an almost perfect AlAs/GaAs superlattice measured over night; 4 nm period 80 times; sample size 5x10mm.; the new device reduces the measurement time by a factor of 4.

High flux optic for surface scattering and the diffraction analysis of the microstructure of materials

The Xenocs *FOX2D CU 12_INF* parabolic multilayer optic is one of the most versatile products to come out in the recent years. It is ideally suited for Small Angle X-ray Scattering and high resolution applications. In addition to these classical applications for collimating multilayer optics, other applications become interesting. Among these is the analysis of the anisotropy of the microstructure of polycrystalline materials employing parallel-beam geometry (see, for example, Welzel & Mittemeijer (2006) Powder Diffraction 20(4), pp. 376 - 392).

A significant improvement for laboratory sources still equipped with double reflection optics is thus possible by upgrading to the FOX2D double curved single reflection mirror. In the Central Scientific Facility (i.e. a service group) 'X-ray diffraction' at the Max Planck Institute for Metals Research in Stuttgart Prof. E.J. Mittemeijer and Dr U. Welzel upgraded their rotating anode source (100 µm x 100 µm in point focus geometry, 1kW power) and obtained a significant gain in the diffracted intensity (between a factor of 4 and 15 depending on the beam size used) compared to the Kirkpatrick-Baez optic that they previously used. The instrument has a broad range of applications, of which one example is given below: a sample of Ge islands grown on Si(001) by molecular beam epitaxy at the CEA Grenoble. The grazing incidence diffraction signal of these islands in the vicinity of the 220 reflection is plotted in red in Fig. 1. Data from such samples are generally recorded on synchrotron beamlines. To compare, the same measurement taken on BM32 at the ESRF in Grenoble is plotted in black.

Obtaining such a measurement with a laboratory diffractometer has been virtually impossible in the past due to a lack of intensity. Thus, the use of modern x-ray optics is narrowing the gap between laboratory and synchrotron diffraction measurements.



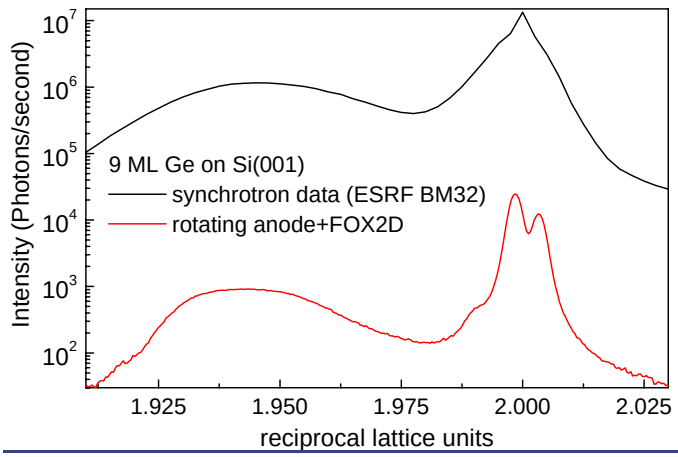


Fig. 1: Radial scan across the 220 reflection of a sample of epitaxial Ge-islands on Si(001). The black line refers to synchrotron data (Bending magnet 32 at the ESRF). The red line has been recorded from the same sample on a rotating anode equipped with *FOX2D CU 12_INF* collimating optics.

Forthcoming Conferences 2006 :

Date	Event	Place
June 1-3	MAMC - 35th Mid-Atlantic Macromolecular Crystallography Meeting	Winston Salem, USA
July 10-13	AFC - Association Française de Cristallographie	Toulouse, France
July 22-27	ACA 2006 - American Crystallographic Association annual meeting	Honolulu, USA
August 06-11	ECM23 - 23rd European Crystallographic Meeting	Leuven, Belgium
August 07-11	DXC 2006 - Denver X-ray Conference	Denver, USA
September 01-04	EPDIC-10 - 10th European Powder Diffraction Conference	Geneva, Switzerland

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