Modern microfocus X-ray sources define the state-of-the-art for protein crystallography and small angle scattering in the home lab. These sources have anode spot sizes of 100 μm or smaller. To preserve their brilliance, these sources are combined with high-quality Montel multilayer optics as beam shaping devices that image the source spot onto the position of the sample, magnifying the beam to a suitable size. Depending on the shape of the substrate, multilayer optics deliver a parallel or focused monochromatic beam. Below, we present results of three different microfocus X-ray sources: a sealed tube source, a rotating anode generator, and a liquid metal jet X-ray source.

**Incoatec Microfocus Source IμS**

The IμS is a low-maintenance, highly brilliant sealed tube X-ray source. When combined with a dedicated multilayer optic, such as the QUAZAR (FWHM = 0.25 mm, 7.6 mrad) or the QUAZAR MX optics (FWHM = 0.10 mm, 7.6 mrad), the IμS delivers a flux density of more than 2 x 10^10 photons/(s mm²) in a 2D focused beam. The latest version of the IμS, the new IμS **High Brilliance**, has an improved X-ray optical design that leads to a flux density of more than 3 x 10^10 photons/(s mm²). Therefore, the IμS delivers intensities comparable to older microfocus rotating anode generators which are suitable for structural analysis on protein crystals and poorly diffracting small molecule samples. This makes the IμS ideal for screening and structure determination of most protein crystals, including SAD phasing experiments.

**Liquid Metal Jet X-ray Source – The METALIET**

The maximum power load that can be applied to solid metal anodes is limited by the thermal properties of the anode material and by the heat dissipation mechanism. This sets a hard limit for future improvements of X-ray sources based on solid metal targets. In Excillum’s liquid metal jet X-ray source, however, X-rays are generated by an electron beam that is focused on a high-speed jet of a molten Gallium alloy. Such a high-speed liquid metal-jet target allows for power loads of several hundreds of kW/mm² in a spot size of < 20 μm. In order to preserve the extreme brightness of this source, a dedicated synchrotron-class optic of highest quality was designed for Ga-Kα radiation (9.25 keV). With this optic, the METALIET source is the brightest home-lab X-ray source, delivering unprecedented intensities of > 4 x 10^10 photons/(s mm²) for a focused beam (FWHM = 0.07 mm). With a dedicated parallel beam Montel optics, a flux of more than 3 x 10^10 photons/s has been observed, giving a superb performance for small angle scattering experiments.

**Protein Crystallography**

Microfocus rotating anode generators (μRAG) such as the High-Brightness Turbo X-ray Source (HB-TXS), allow significant higher power loads compared to microfocus sealed tube sources. In combination with high performance multilayer optics, this type of μRAG delivers a flux density that is about an order of magnitude higher compared to microfocus sealed tubes, resulting in intensities that are close to those obtained from second generation synchrotron beam lines. This enables diffraction studies on very small and poorly diffraction protein crystals and complete data collections with significantly shorter exposure times, e.g. for high-throughput studies.

**30 sec Lysozyme Data Set**

Data statistics and a typical diffraction pattern of a 30 sec lysozyme data set, measured with a Bruker AXS X8 PROTEUM system equipped with Helios MX optics.

**Microfocus sealed tube IμS (Incoatec, Cu anode, 50 μm focal spot) with QUAZAR multilayer optics.**

**Microfocus rotating anode X-ray generator HB-TXS (Bruker AXS, Cu anode, 100 μm focal spot, 2.5 kW) with HELOIS MX optic.**

**Liquid metal jet X-ray source METALIET (Excillum, 20 μm focal spot, 200 kW) with a dedicated HELOIS MX optic for Ga radiation.**

**Working principle of the METALIET X-ray source.**

**Flux density measurement of the METALIET equipped with a dedicated HELOIS MX optic for protein crystallography. The comparison with a microfocus rotating anode shows that the METALIET is the X-ray source of choice for small and poorly diffracting samples with a size of 0.1 mm or smaller.**

**Small Angle Scattering**

SAXS scattering plot and radial integration of a Ag Behenate sample, measured with a Bruker AXS NANOSTAR equipped with the METALIET X-ray source.

**SAXS scattering plot of a very thin fiber from a rat tail tendon, measured with a Bruker AXS D8 VENTURE equipped with the METALIET X-ray source.**

**Data statistics and a typical diffraction pattern of two small protein crystals, measured with a Bruker AXS D8 VENTURE equipped with the METALIET X-ray source.**