

ELLIPSOIDAL MULTILAYER OPTICS FOR MICRO-XRF

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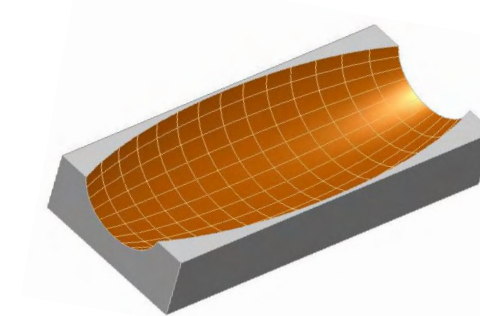
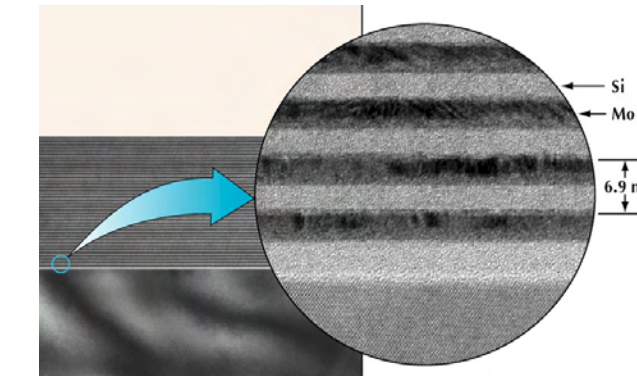
X-ray focusing optics for EDXRF

	Polycapillary	Monocapillary	HOPG	Doubly Curved Crystals
Spatial Resolution	Very small spot (15µm)	Very small spot (15µm for tapered capillaries)	Limited spatial resolution (mosaic crystal)	> 50µm depending on source size
Spectral Property	Polychromatic**	Polychromatic**	Monochromatic (background reduction)	Monochromatic (background reduction)
Efficiency	10-30% depending on energy	~10%	High Reflectivity (over large E spectrum)	Small Reflectivity (typically 10-5%)
Solid Angle	Up to 20°	Lower than polycapillary but imaging capability	High	0,05 sr-0,01 sr
Focal Distances	Small focal distances required for very small spot (few mm)	Small focal distances for very small spot (few mms)	Mosaicity impacts spot size	50-500 mm

**But enables to analyze a high range of elements

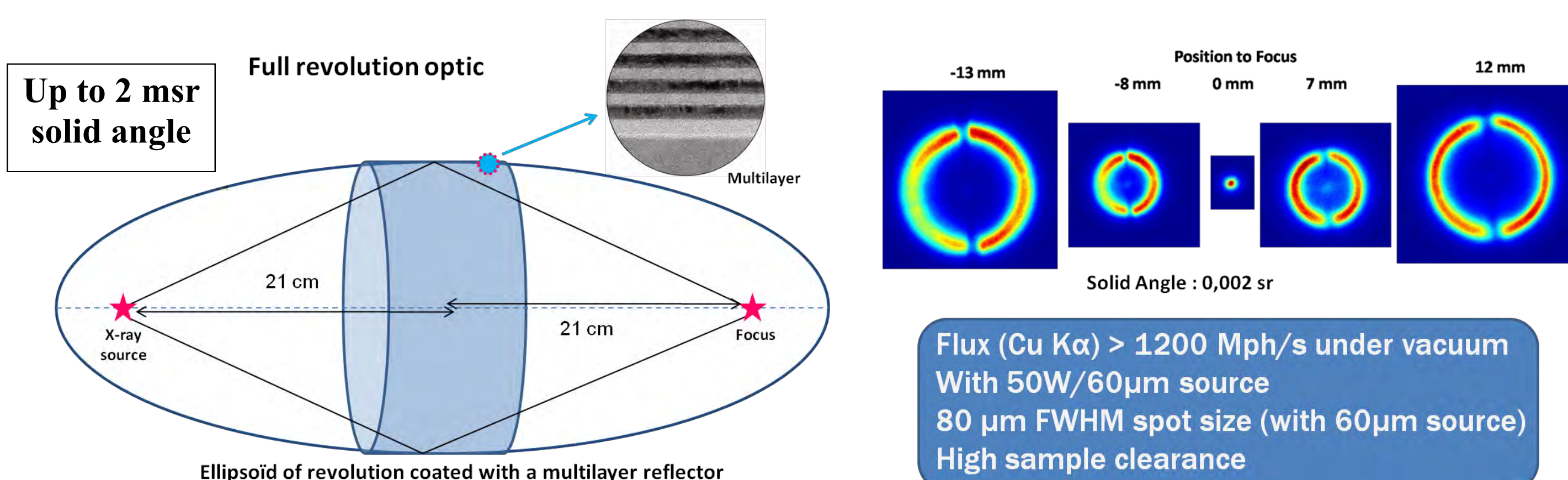
Multilayer optics for EDXRF

- X-ray multilayer coatings
 - High reflectivity
- Highly curved substrates
 - High precision beam shaping
- X-ray multilayer optics provide an intense monochromatic beam with comfortable focal distances (sample clearance)
- But multilayer optics were suffering from reduced capture angle (due to the small Bragg angle)

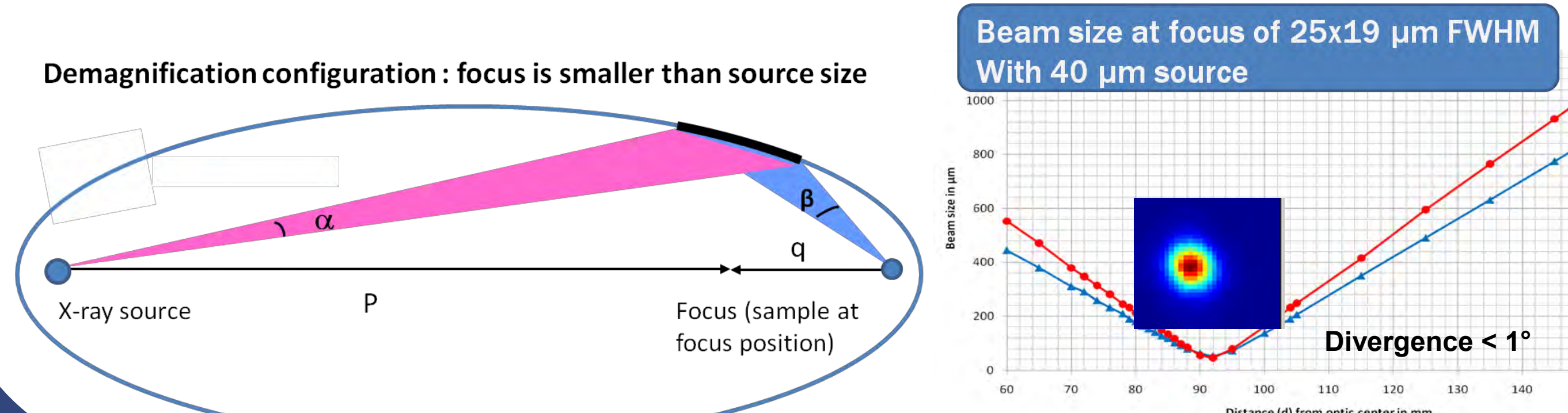


New developments in aspheric multilayer optics

- Very High convergence optic for beam focusing on small spot

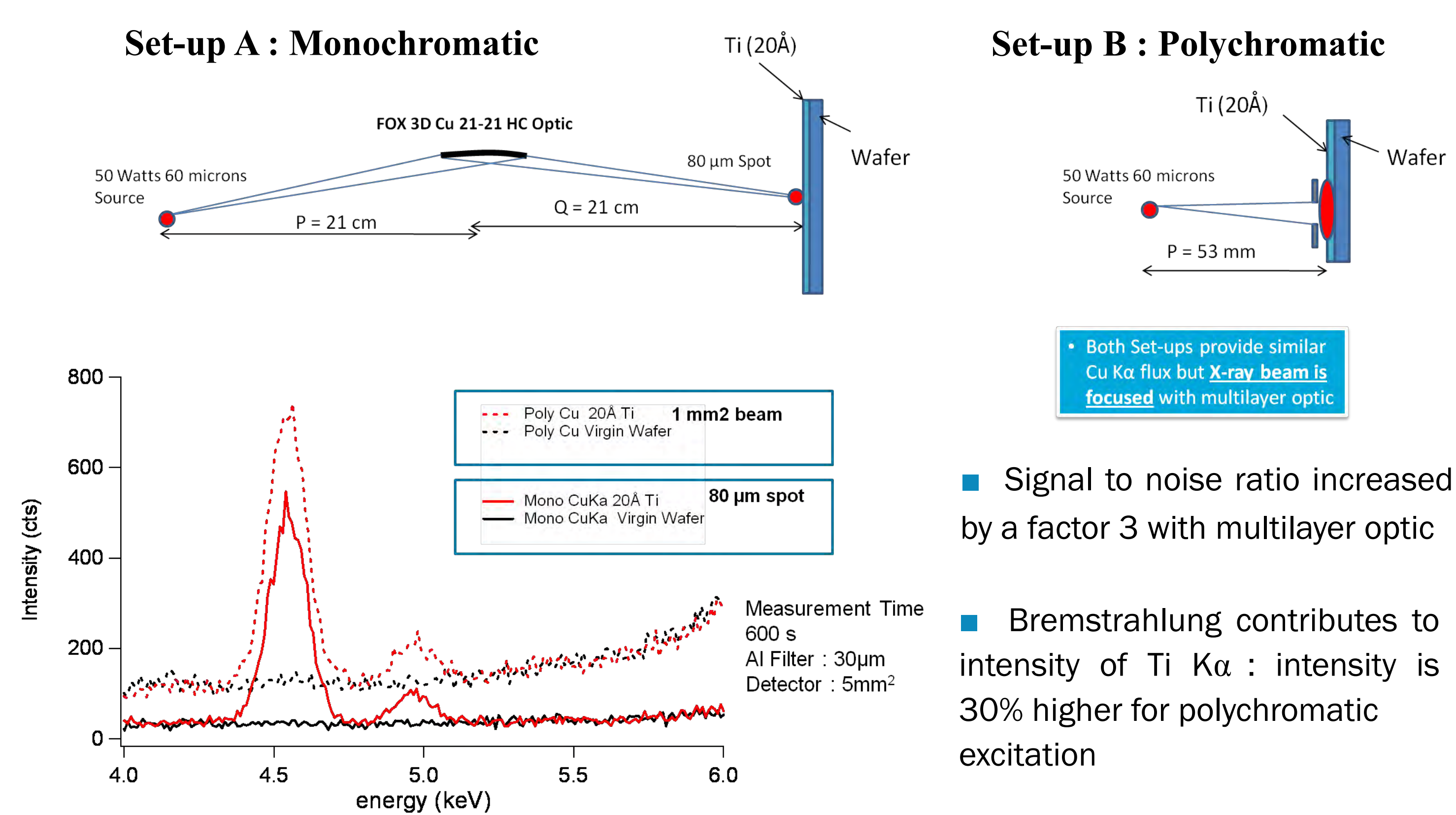


- Very small spot optic with moderate divergence

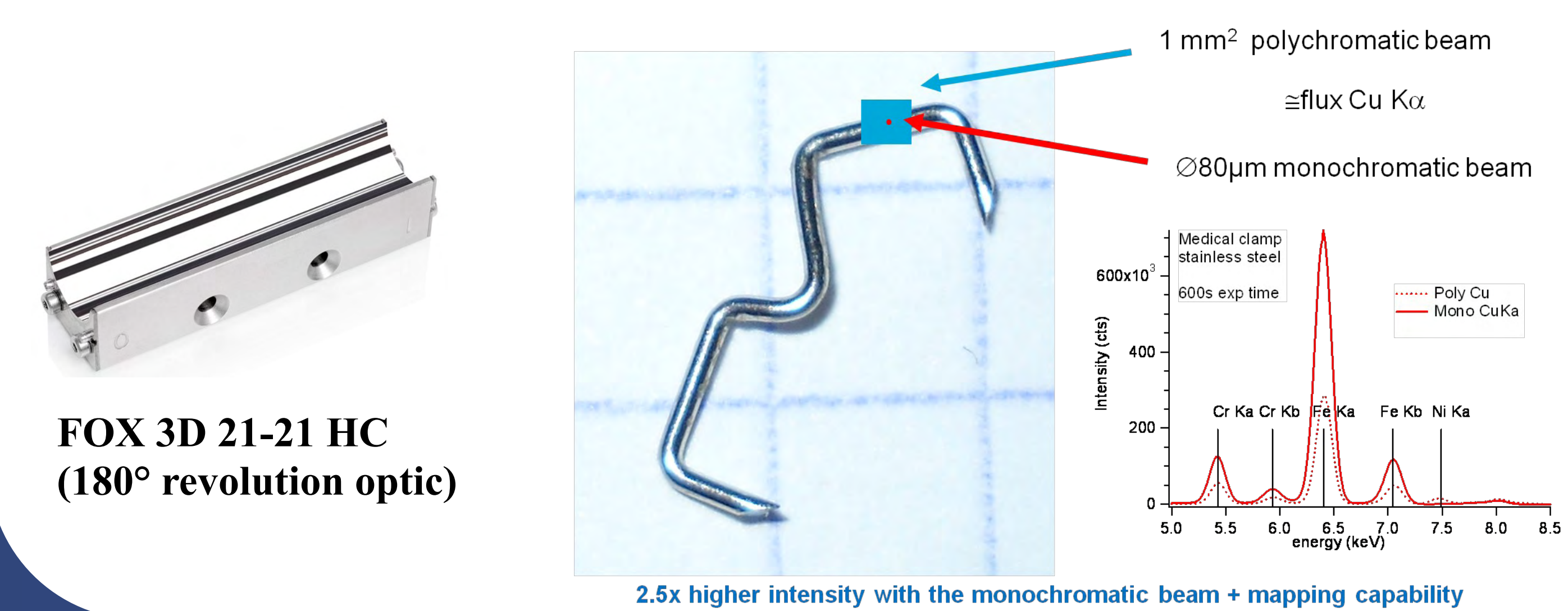


Impact of monochromatic focused beam in EDXRF

Thin film measurement (use of a High Convergence optic-180° revolution)

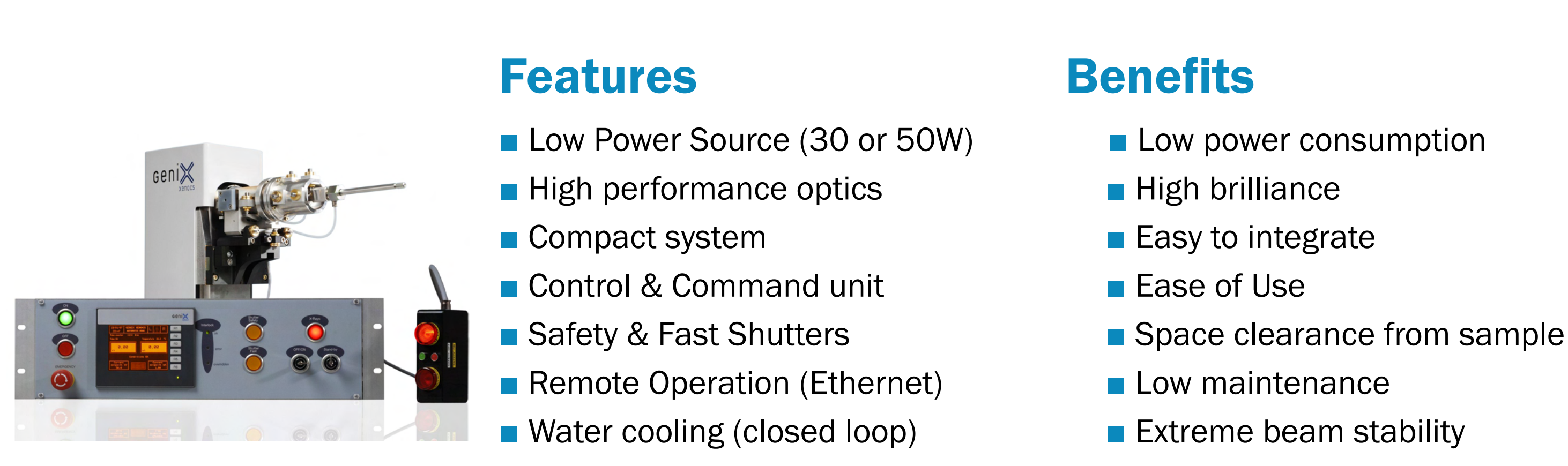


Beam focusing: study of a medical clamp

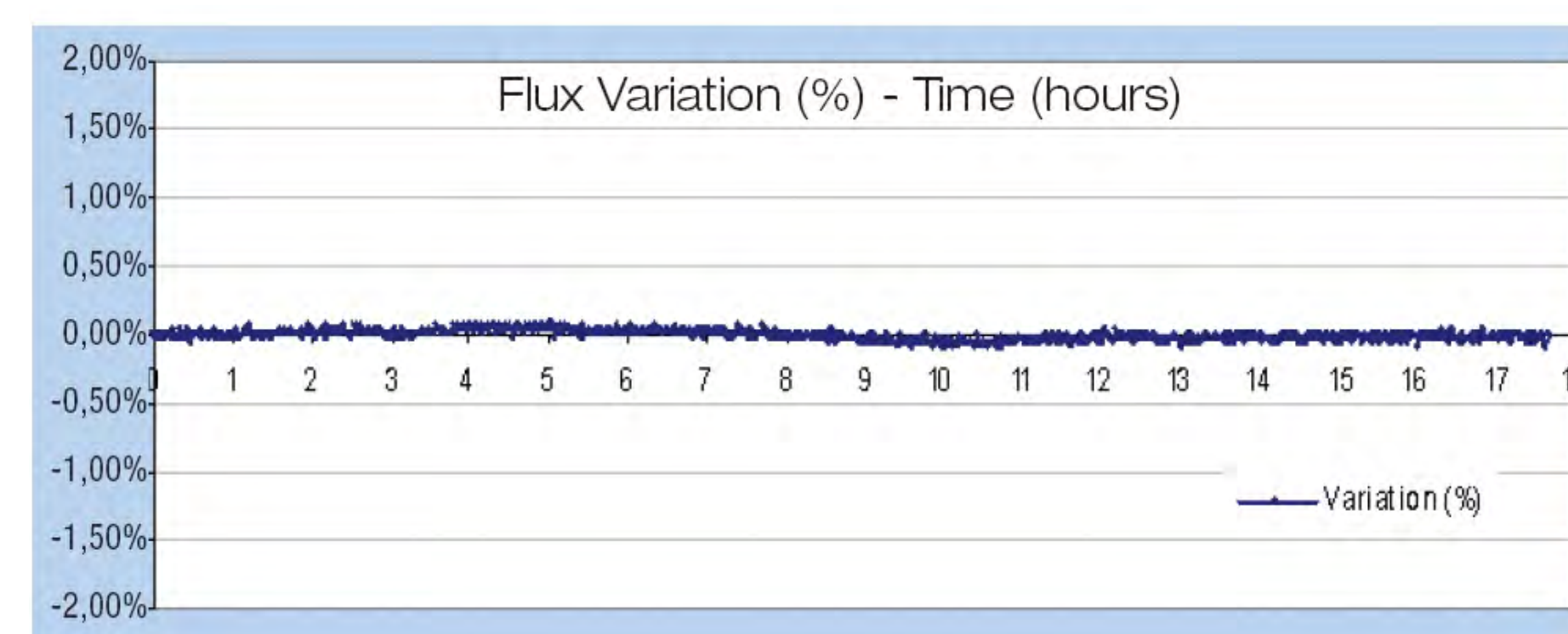


GeniX: The x-ray beam delivery concept

- Integrated system for optimized source optic coupling



- High X-ray beam stability



Comparative study with a polycapillary optic

Set-up tested	Distance source to sample (mm)	Detector area (mm ²)	Distance Sample-to-detector (mm)	Distance exit of optic to sample (mm)
Polycapillary (10 cm length, He filled)	171	5	22 (minimum at 90-45) 19 (minimum at 45-45)	9
Multilayer (Full Revolution 21-21 Optic) All set-up in air	420	5	22 and 14 (minimum at 90-45) 12 (minimum at 45-45)	180

Polycapillary setup
Minimum sample to detector distance of 22mm for 90-45° configuration
40 µm spot size; focusing gain > 7000

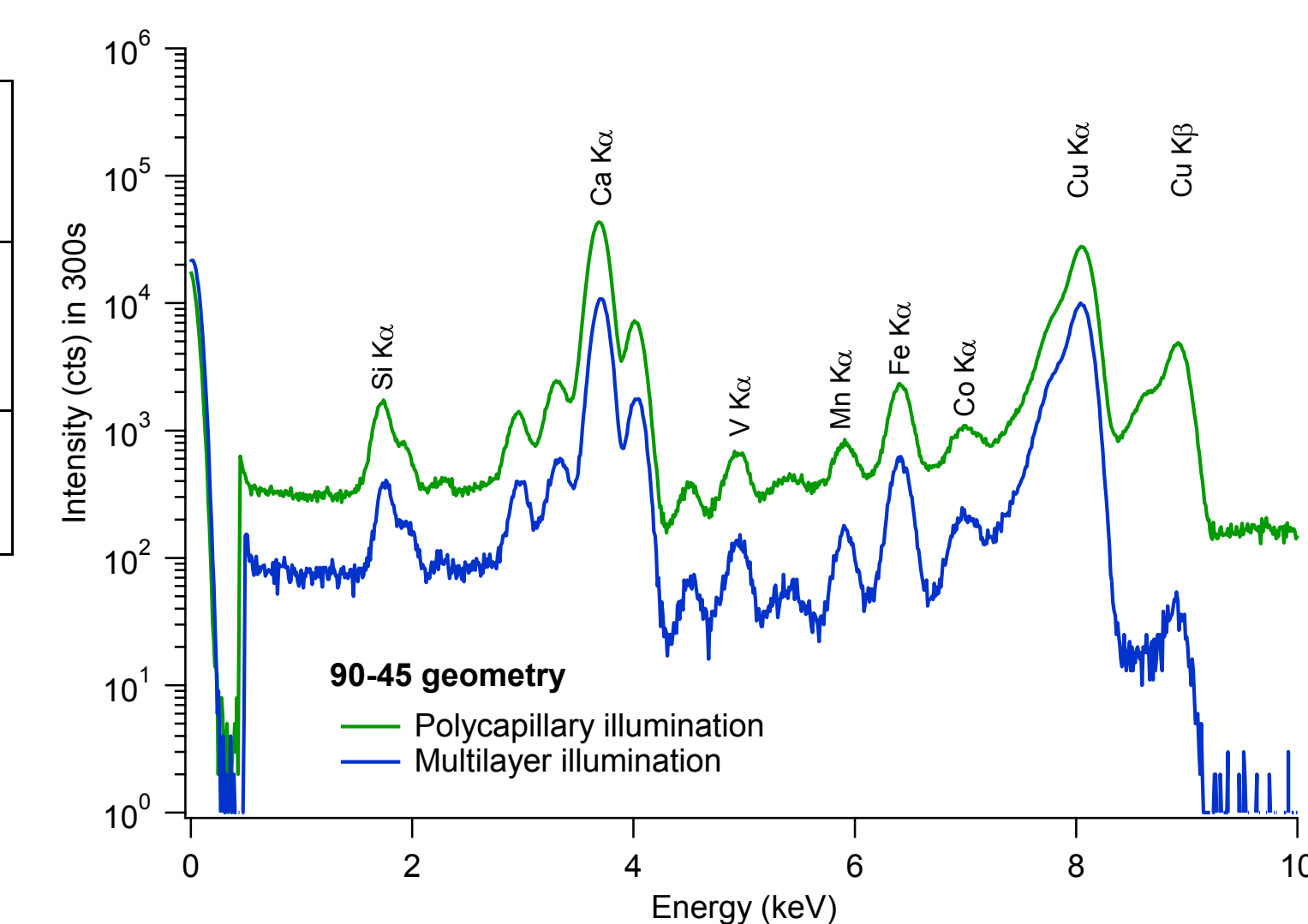
Multilayer setup
Minimum sample to detector distance of 14mm for 90-45° configuration
60 µm spot size

Detector
Rontec XFlash detector 2001
Active area 5mm²
Peltier cooled to -10°C

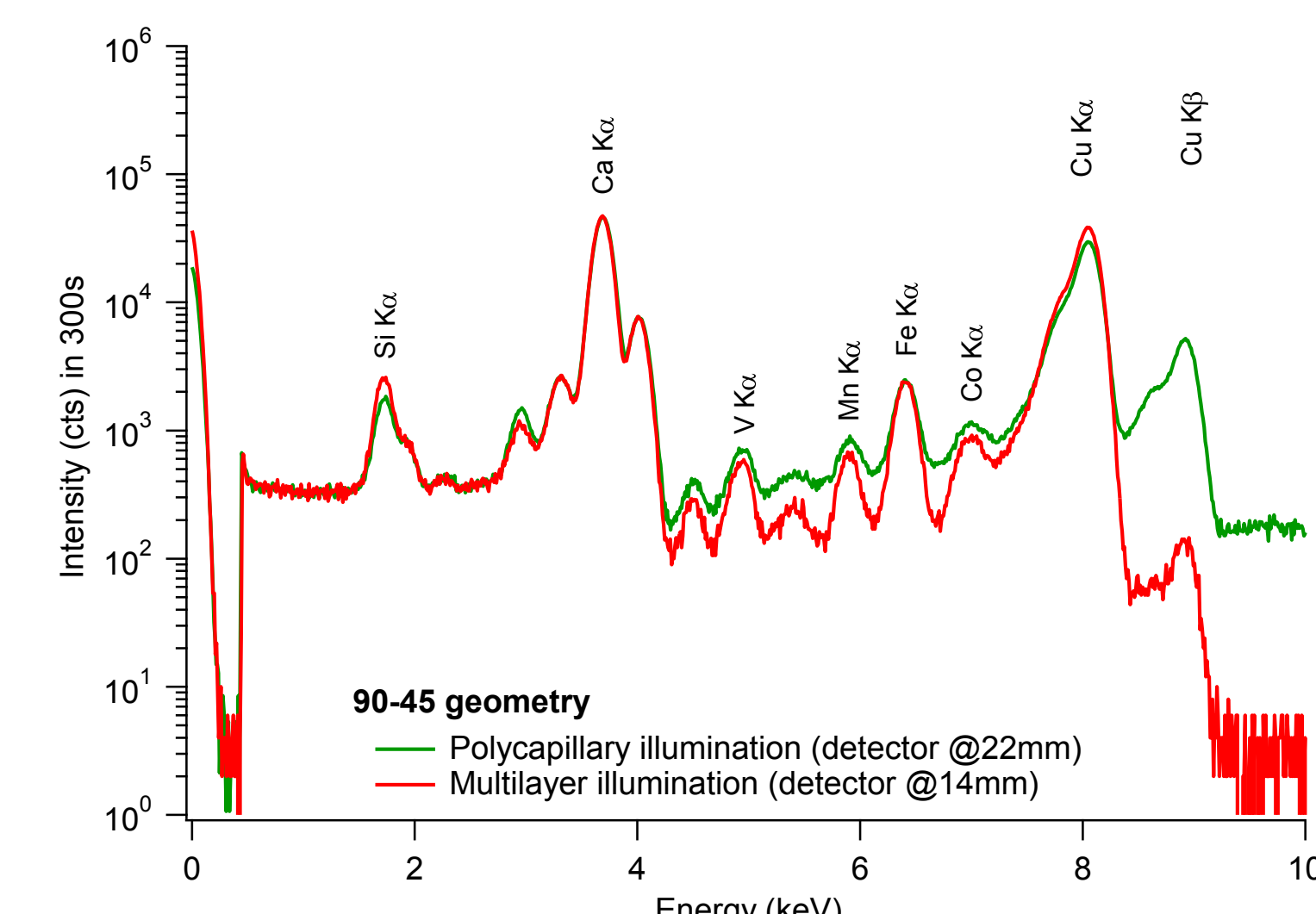
X-ray Source
40µm 30Watts Cu source

	Fluo lines	Si Kα	Ca Kα	V Kα	Mn Kα	Fe Kα
	E (keV)	1.74	3.69	4.95	5.9	6.4
Ratio of the SNR Multilayer VS Polycapillary	90-45, both setups with detector at 22mm	1.2	2.3	3.0	3.0	3.3
	90-45, both at minimum distance	1.5	1.9	1.7	2.5	3.2
	45-45, both setups with detector at 19mm	0.98	2.0	1.6	2.1	3.3

- The setup with polycapillary gives a higher flux intensity (ph/mm²) and higher fluorescence signals
- The monochromaticity of the multilayer setup improves the SNR of polycapillary set-up
- The long focal distance of multilayer optic allows to design new detection schemes with significant collection area increase very close to direct beam



X-ray fluorescence spectrum of certified reference glass sample S005-type B from BAM, Germany. The geometry used was 90° for the angle between the x-ray beam and the surface of the sample. Both curve was collected with minimum achievable sample to detector distance of 22mm for the polycapillary and 14mm for the multilayer setups. Data was also rescaled to simulate an evacuated beam path from source to sample.



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- Aspheric multilayer optics (FOX 3D) provide increased solid angle and high reflectivity compared to traditional multilayer optics and large working distance
- Coupled to small focus sources FOX 3D optics produce a high intensity monochromatic beam providing improved signal to noise in XRF measurements
- New focusing designs and detection scheme can be used with FOX 3D optics

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