

# FAST DIFFRACTION STUDIES WITH MICROFOCUS SOURCES

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## Beam performance for x-ray diffraction

### Measurement:

- Small areas
- Mapping capability
- High resolution
- Short time

### Beam distribution in:

- Real space
- Angular space
- Wave-length or energy
- Time

### Beam generation:

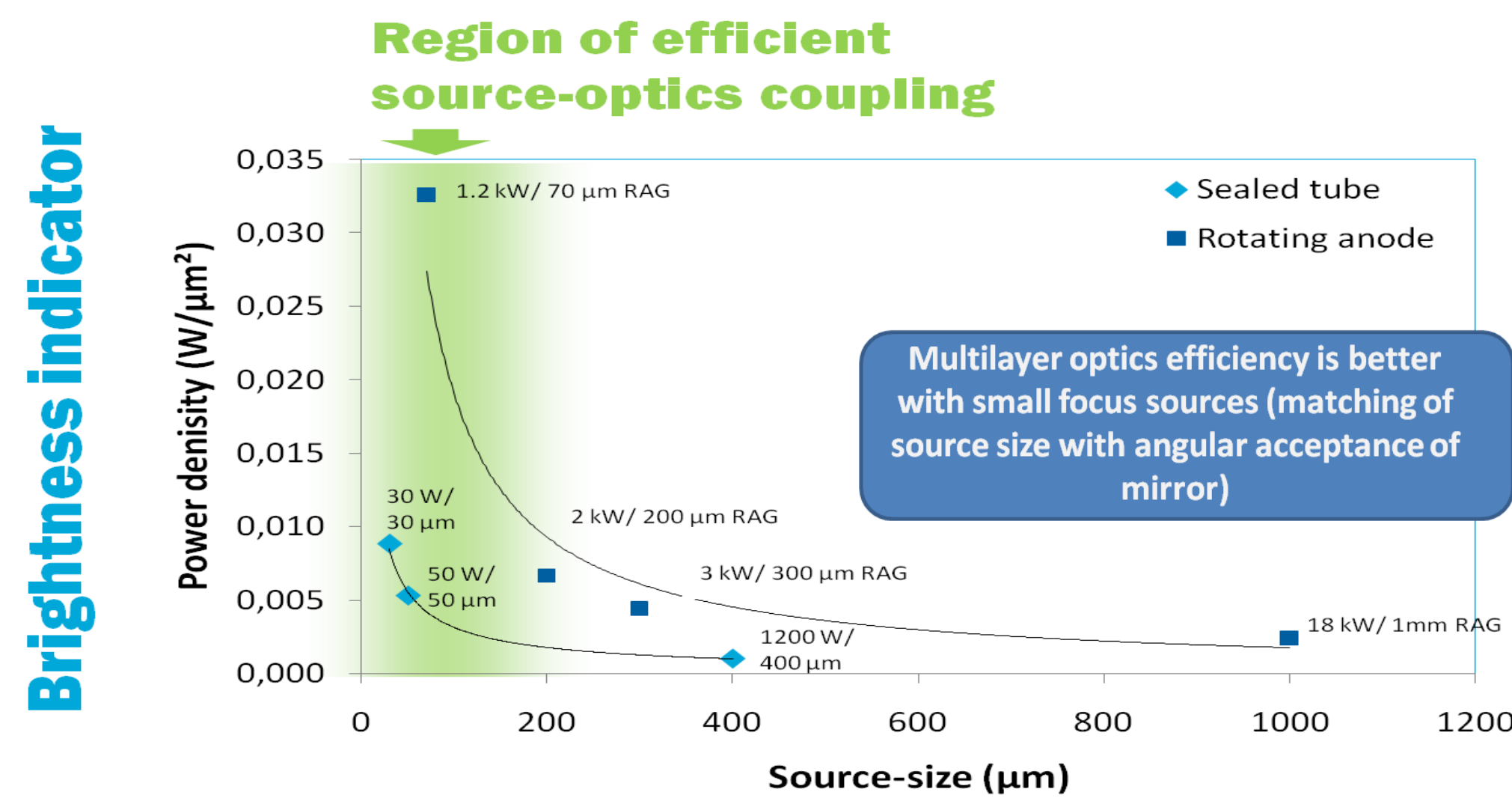
- Source brilliance
- Optics efficiency
- Beam path

**Brilliance:**  $\text{Ph/mm}^2/\text{mrad}^2/\text{s}$  in relevant part of spectrum

- Brilliance starts with the **source**.
- At best, **optics**, beam path preserves brilliance while transforming beam to a useful (optimum) distribution in phase-space.

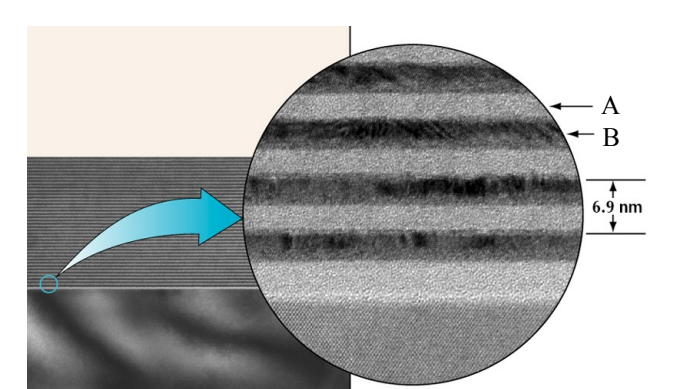
## Source-optic coupling for X-ray beam conditioning

- Microfocus sources provide very high brilliance at low power (better heat dissipation)

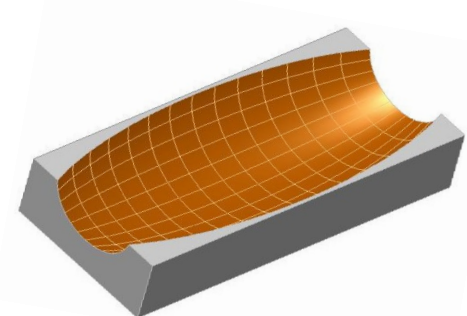


## X-Ray beam delivery system with microfocus source

- X-ray multilayer coatings
- Aspheric substrate
- Advanced X-ray optics



- high reflectivity
- monochromatic beam



- large collection angles
- small spot-size



**FOX3D preserves brilliance and focuses the X-ray beam towards sample or detector**

### Features

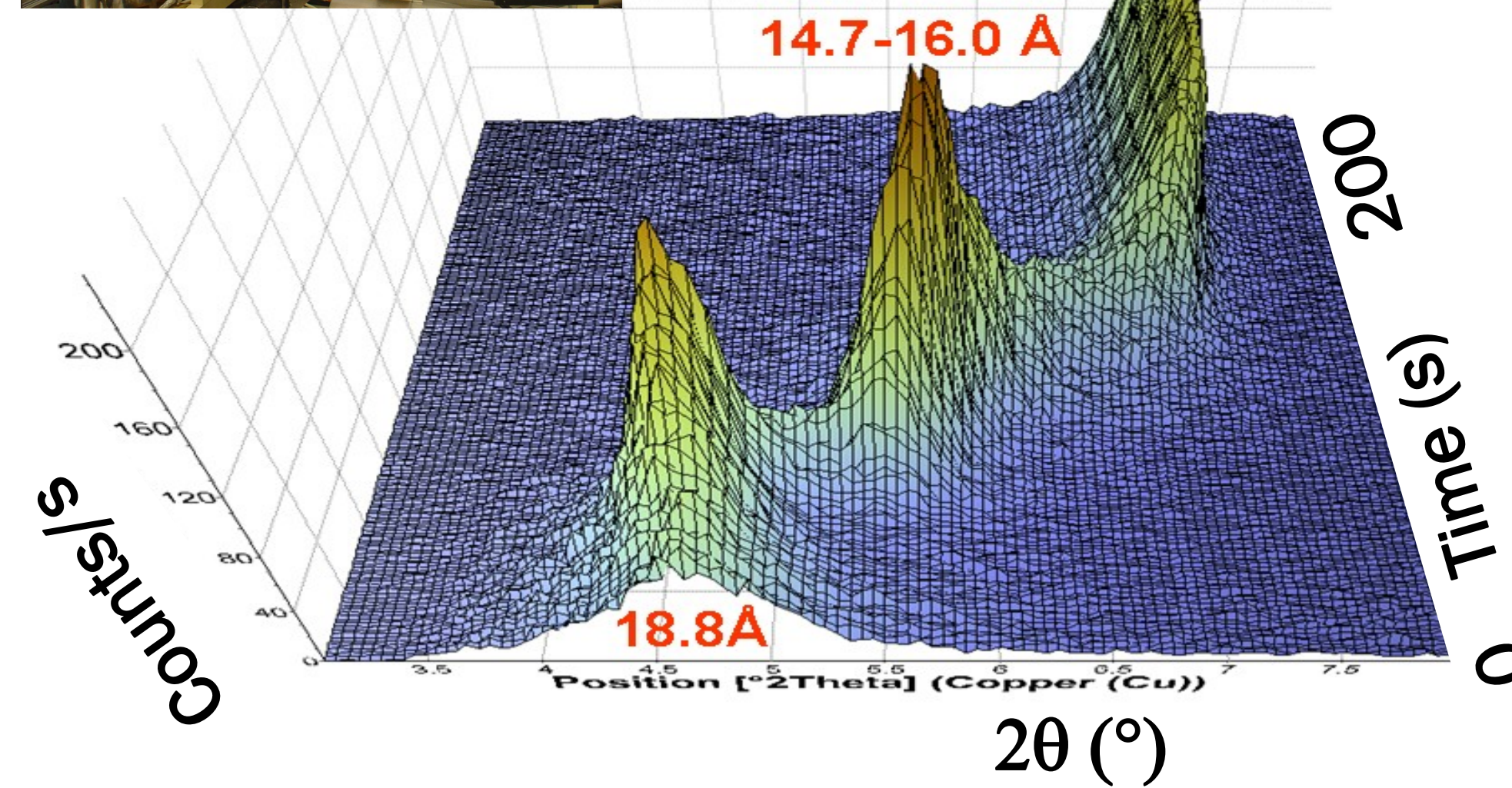
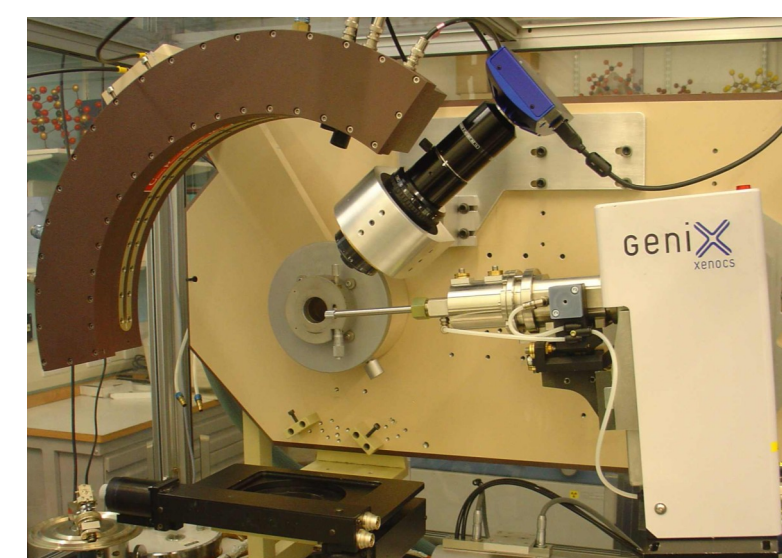
- Low Power Source (30 or 50W)
- High performance optics
- Compact system
- Control & Command unit
- Safety Shutter
- Remote Operation (Ethernet)
- Water cooling (closed loop)

### Benefits

- Low power consumption
- High brilliance
- Easy to integrate
- Ease of use
- Space clearance from sample
- Low maintenance
- Extreme beam stability



## Time resolved diffraction in the laboratory



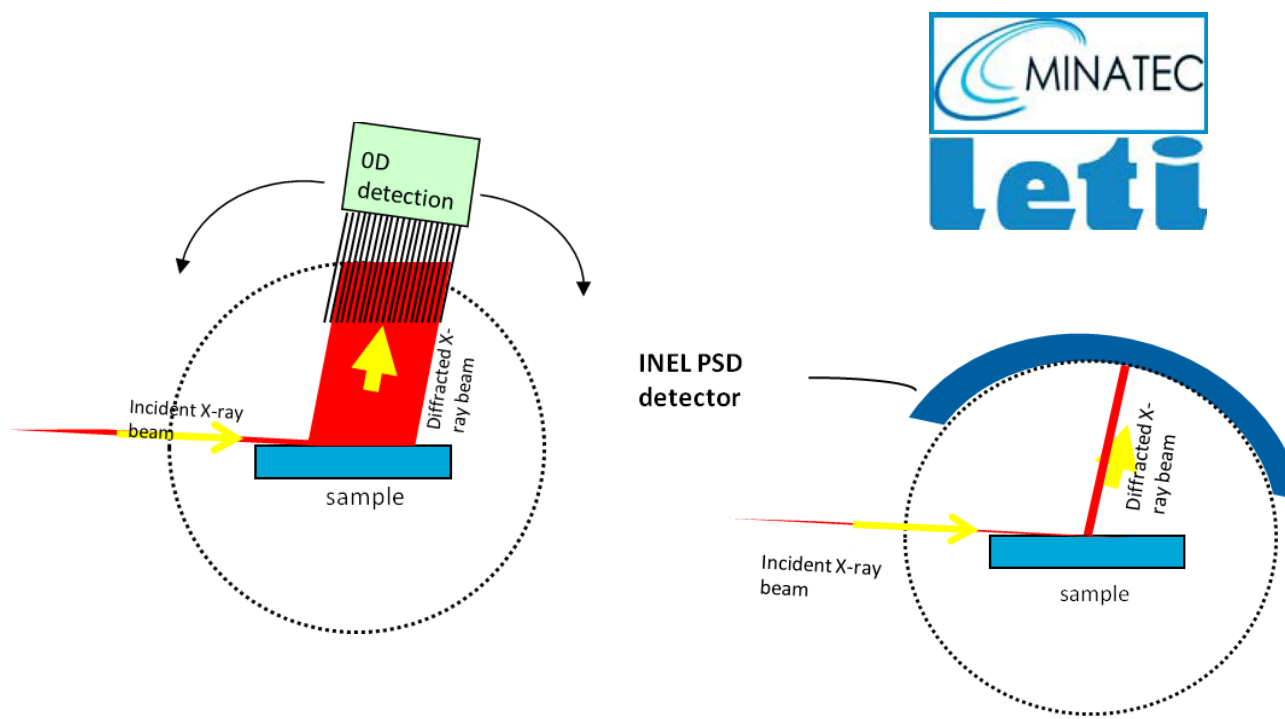
Clay-dehydration study (Na-Montmorillonite)  
 → 100μm area  
 → 200 x 1 second snapshot resolving all three states of dehydration.  
 → Combination of GeniX beam delivery system and curved gas-detector.

Data courtesy of Dr. Jens Najorka, Natural History Museum, London

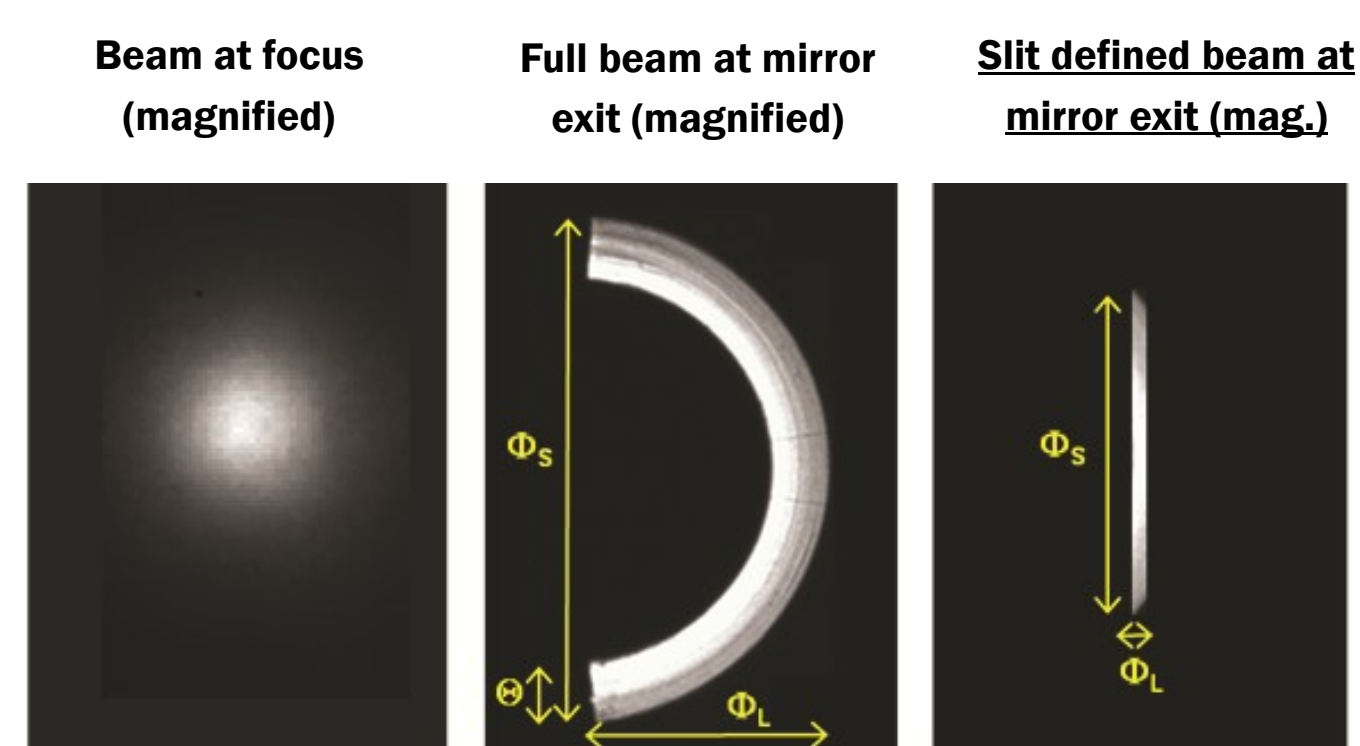
## Grazing incidence x-ray diffraction with microfocus sources

- GeniX Cu High Convergence for GIXRD

- Small spot in incidence plane enables GIXRD with position sensitive detector
- Small spot in perpendicular plane enables mapping
- High solid angle of collection for high flux measurements with excellent angular resolution



- Beam properties of GeniX Cu High convergence

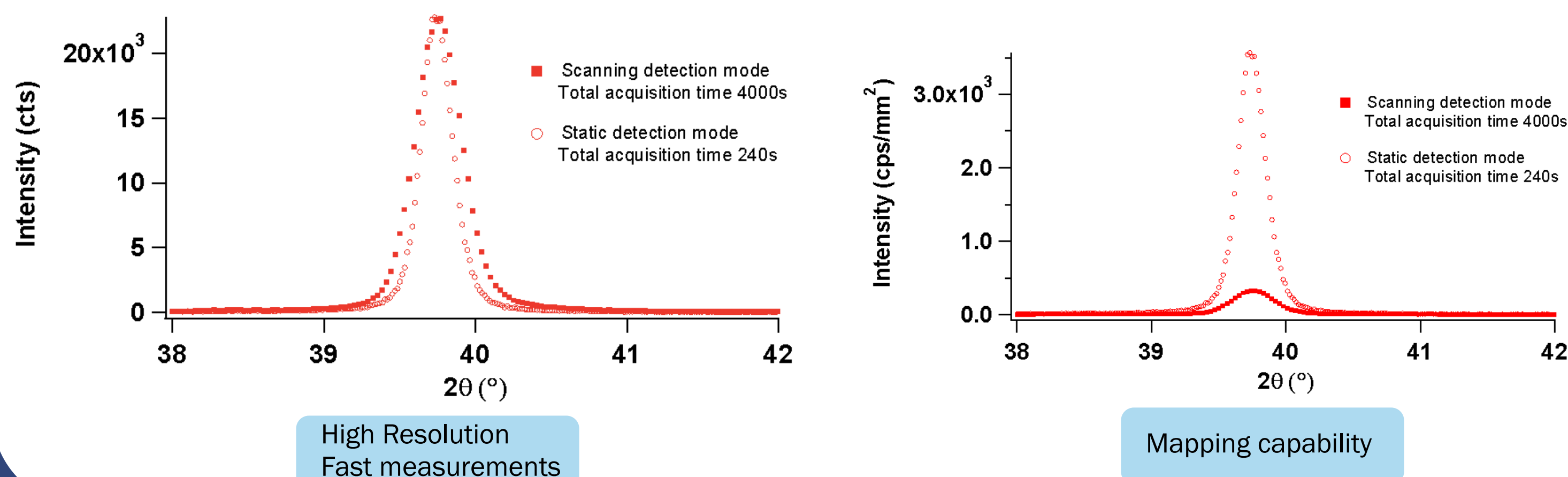


Beam Configuration	Full Beam	Slit-Limited Beam
Typical Flux Cu Kα (vacuum, 50 W/50 μm source)	> 600 x 10 <sup>6</sup> ph/s	> 35 x 10 <sup>6</sup> ph/s
Beam Convergence	Φ <sub>s</sub> ≥ 4°; Φ <sub>L</sub> ≥ 2° θ = 0.54°	Φ <sub>s</sub> = 2.6°; Φ <sub>L</sub> = 0.05°
Spot size at focus FWHM, 50 μm source	~80 μm	~80 μm
Spot size at focus FWHM, 30 μm source	~50 μm	~50 μm

- Installation of GeniX Cu High Convergence at CEA-LETI Minattec (GIXRD, static detection)



- XRD data of Pt film acquired with GeniX Cu HC (slit limited beam), compared with classical diffractometer data



## Grazing incidence XRD for PV thin films control

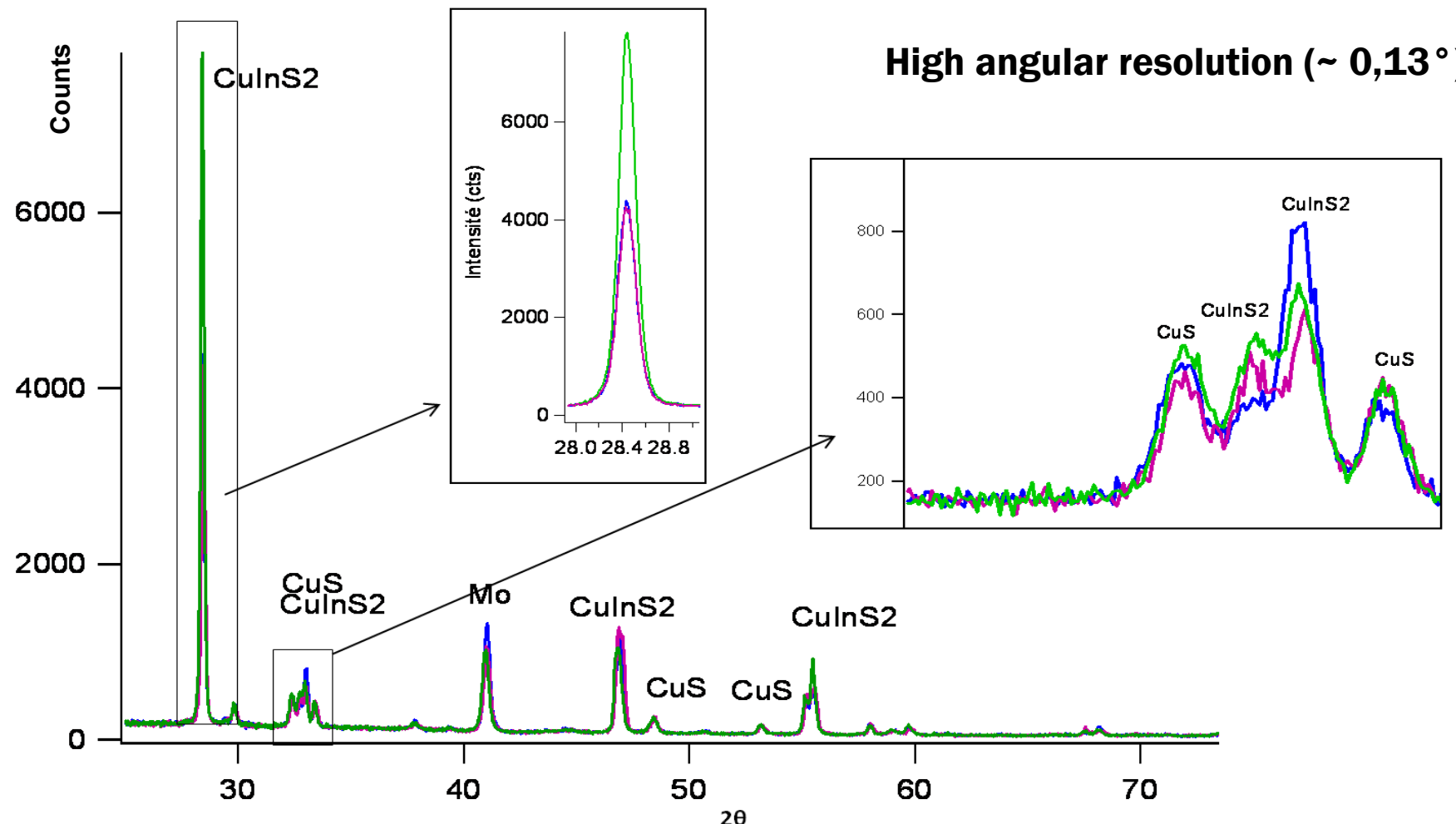
- GIXRD with microfocus sources for annealing process control of CIGS films

### Benefits

- Static Detection Configuration
- Fast measurements (possible to use higher magnification optics with less angular resolution)
- Mapping Capability
- Stable and low maintenance X-ray source system compatible with industrial process control

Diffractogram of various CIGS absorber thin films with different annealing conditions (GIXRD with PSD detector, 5° incidence)

Measurement in 600 seconds with GeniX Cu HC with slit limited configuration



## New beam delivery system: GeniX3D



**High brightness low power x-ray tube**  
 with closed loop water cooling for ultrahigh stability

**Fixed, referenced output x-ray beam**  
 Mechanically defined. Remains unchanged during maintenance

**Aspheric FOX 3D multilayer optics**  
 Single reflection optics with close source-optic coupling

**Compact, robust optical block**  
 Motion free with high clearance.

**X/Y stage for straightforward alignment**  
 Source is aligned towards a fixed optical block

**Smart and intuitive control unit**  
 User friendly touch screen, automatic ramp up and shutdown to extend tube lifetime

- Microfocus sources with advanced X-ray optics can be coupled efficiently to PSD detectors for fast diffraction measurements
- It provide sample mapping capability and integration flexibility
- It is an excellent low cost of ownership alternative to high power RAGs with very low maintenance levels