

# SmartLab

Automated multipurpose X-ray diffractometer

Rigaku's flagship X-ray diffractometer



**Rigaku**

Leading With Innovation

# Leading-edge hybrid pixel array detector

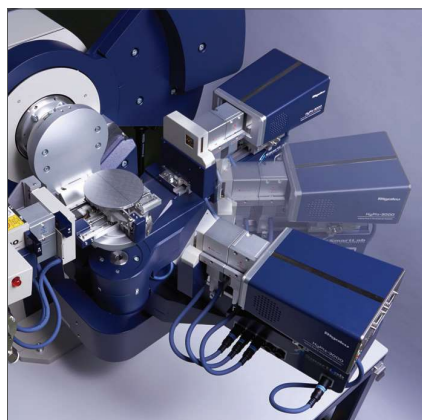
## HyPix-3000\*

Multidimensional semiconductor detector

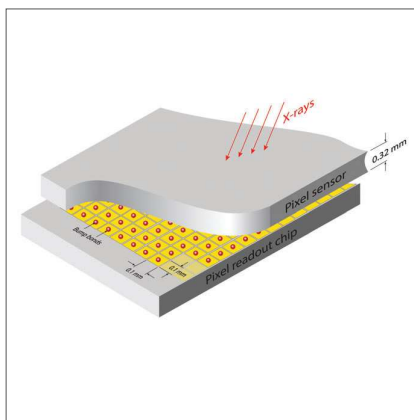


- Supports 0D, 1D and 2D measurement modes
- Excellent energy resolution to suppress XRF
- Keeps background noise to an absolute minimum
- Wide dynamic range
- Shutterless measurement
- Maintenance free

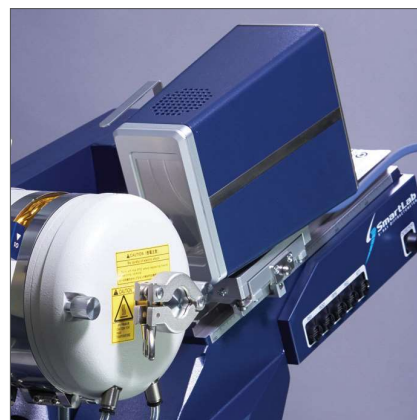
Active area	2,984 mm <sup>2</sup> (77.5×38.5 mm)
Pixel size	100 μm × 100 μm
Number of pixels	775 × 385 = 298,375 pixels
Global count rate	>2.9 × 10 <sup>11</sup> (>1×10 <sup>6</sup> cps/pixel)
Efficiencies	Cr, Co, Cu: ~99% Mo: ~38%
Energy resolution	40% better than previous type



Fully compatible with 5-axis goniometer design



Hybrid pixel array detector (HPAD) design


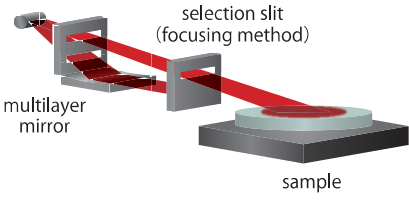
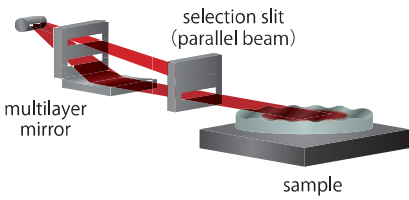

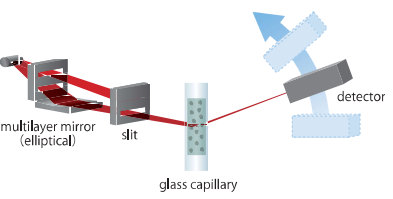

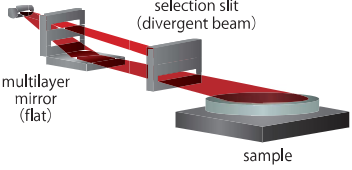

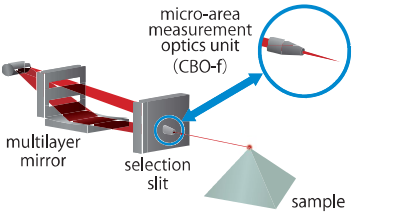

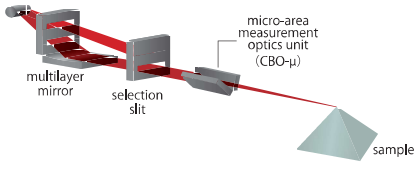


Shutterless high-speed *in-situ* measurement

\*This product was jointly developed by Department of Measurement and Electronics, AGH University of Science and Technology (Poland) and Rigaku Corporation.

# Optical configurations for various applications

## CBO (Cross Beam Optics)

 <p>CBO</p>	 <p>selection slit (focusing method) multilayer mirror sample</p> <p>Divergent beam</p>	 <p>selection slit (parallel beam) multilayer mirror sample</p> <p>Parallel beam</p>
 <p>CBO-E</p>	 <p>multilayer mirror (elliptical) slit glass capillary detector</p> <p>Divergent beam/convergent beam</p>	  <p>selection slit (divergent beam) multilayer mirror (flat) sample</p> <p>Divergent beam (High intensity, low background noise)</p>
 <p>CBO-f</p>	 <p>micro-area measurement optics unit (CBO-f) multilayer mirror selection slit sample</p> <p>Converges line beams to a minute point of <math>\approx 400 \mu\text{m}</math>. No need to change the X-ray tube focus.</p>	  <p>micro-area measurement optics unit (CBO-μ) multilayer mirror selection slit sample</p> <p>Converges line beams to a high-intensity and parallel beam of <math>\approx 100 \mu\text{m}</math>. No need to change the X-ray tube focus.</p>

## Detectors



1D semiconductor detector D/tex Ultra250/250HE	
Active area	384 mm <sup>2</sup> (19.2×20 mm)
Spatial resolution	75 μm
Global count rate	$2.5 \times 10^8$ ( $1 \times 10^6$ cps/pixel)
Efficiencies	Cr, Co, Cu: ~99% Mo: ~40%, ~70% (250 HE)



Multidimensional semiconductor detector HyPix-400*	
Active area	369 mm <sup>2</sup> (9.6×38.5 mm)
Pixel size	100 μm × 100 μm
Global count rate	$>3.7 \times 10^{10}$ cps ( $>1 \times 10^6$ cps/pixel)
Efficiencies	Cr, Co, Cu: ~99% Mo: ~38%

\*This product was jointly developed by Department of Measurement and Electronics, AGH University of Science and Technology (Poland) and Rigaku Corporation.

## CBO-Auto: Fully automatic switch between reflection and transmission optics and geometries



Reflection mode

The optimal measurement method depends on the type of sample or the application.

The Bragg-Brentano focusing (reflection mode) is the standard measurement method for generic powder samples. For samples with specific orientation or large grains (i.e., powder, solid, or films), the transmission method is the optimal approach.

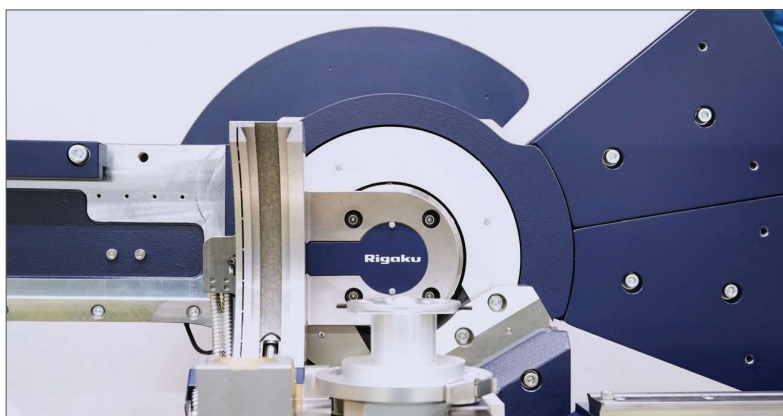
SmartLab provides fully automatic switching between the reflection and transmission methods.

CBO-Auto	
Ts axis	Automatic control
Optics	CBO-Auto (Cu) / CBO-Auto (Mo)
Sample stage	Reflection/transmission ASC-6



Transmission mode

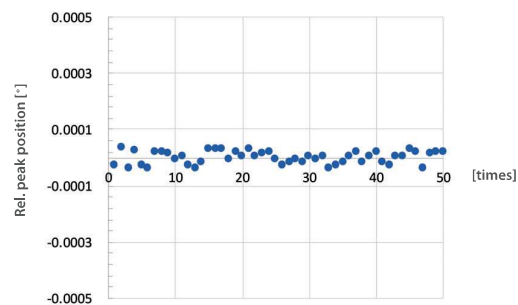
## High-precision goniometer with optical encoders



Encoder controlled high-precision goniometer

Type	Vertical goniometer with sample horizontal mount
Goniometer radius	300 mm (0D, 1D), 150 - 300 mm (2D)
Minimum step size	0.0001°

Reproducibility of the peak positions



Peak position stability after 50 times repeat of  $2\theta$  scan or  $004$  diffraction of silicon single crystal substrate. Distribution is within the range of reference accuracy  $\pm 0.00004^\circ$ .

# SmartLab Studio II software suite

SmartLab Studio II is an integrated software platform with all functions from measurement to analysis.



Selection of sample type, Auto selection of measurement program

Optics change guidance/ (Auto optics adjustment)

## Typical applications

Powder		<ul style="list-style-type: none"> <li>Phase identification</li> <li>Quantification</li> <li>Crystallite size and distortion</li> <li>Precise lattice parameter determination</li> <li>Percent crystallinity</li> <li>Indexing</li> <li>Structural determination</li> <li>Precise crystalline structure determination</li> </ul>	
Stress		<ul style="list-style-type: none"> <li><math>\text{Sin}^2\psi</math> method</li> <li>2D method</li> <li>Multiple-HKL method</li> </ul>	
Small Angle Scattering (SAXS)		<ul style="list-style-type: none"> <li>Grain size distribution</li> <li>Pore size distribution</li> <li>Long period</li> </ul>	

## Micro area measurement

	<b>Specifications of beam size</b>	
Collimator optics	50 $\mu\text{m}$ to 1 mm	
CBO-f	400 $\mu\text{m}$	
CBO- $\mu$	100 $\mu\text{m}$	
No need to change X-ray tube focus		