BL45XU RIKEN Structural Biology I

BL45XU consists of two experimental stations, protein crystallography (PX) and small-angle x-ray scattering (SAXS). Both experiments can be carried out simultaneously, with tandem vertical undulators. Only SAXS station is open to the public. For application to PX station, please contact to the office of Division of Bio-Crystallography Technology, RIKEN Harima Institute.
The main characteristic of BL45XU-SAXS is its idealistic optics for scattering experiments from non-crystalline biological samples as well as polymer materials. Two-crystal monochromator (diamond, (111) plane) followed by K-B mirrors (vertical and horizontal) are used in order to reduce parasitic scattering. The change of camera length in limited beamtime is strongly avoided. We contribute 20% of beam time for public use. As for biological sample we also accept extra external users in collaboration base. Before submitting the application to JASRI for the first time, please talk with contact person.

Area of research

Time-resolved structures of non-crystalline biological materials such as protein, nucleic acid solutions, membrane, muscle, and micelle system under various conditions, are studied by using small-angle scattering and diffraction technique.

Keywords

Scientific field

Small-angle X-ray scattering, Macromolecular crystallography (closed for RIKEN use)

Equipment

High-resolution small-angle scattering camera, Stopped-flow mixer, Temperature jump cell, High-pressure cell for protein solutions

Source and optics

Specification of tandem vertical undulators

Type	In vaccum, vertically polarized
Period length	37 mm
Number of period	37 + 37

SAXS optics

The beam is splitted by a transparent double crystal monochromator. The transmitted beam is used for PX. The optics of PX branch is described in the reference (M. Yamamoto *et al.*, *J. Synchrotron Rad.*, **5**, 222-225, (1998)). The SAXS monochromator can tune from 6.5 keV to 14 keV, though it is usually fixed at 13.8 keV. Laue geometry of (100) faced synthetic diamond with 8 × 7 × 0.3 mm^3 (horizontal × vertical × thickness) is used. If one wants to use different energy other than 13.8 keV, please consult to contact person and notify in the application form. The focusing system consists of a vertical and a horizontal mirror, which is located at 40.5 or 41.73 m from the source, respectively. The focus is formed at 57.5 m from the source. Therefore, the focusing ratio of the mirrors is 2.48 to 1. The mirrors are rhodium-coated and have 4 mrad of glancing angle where 82% of reflectivity is expected at 12 keV. In order to reduce parasitic scattering, four slits are installed; down-stream of the monochromator (slit 1), of the mirror (slit 2), 2 m up stream of the sample (slit 3), and immediate up stream of the sample (slit 4). More detailed information is written in the reference (T. Fujisawa *et al.*, *J. Appl. Cryst.*, 33, 797-800 (2000)).

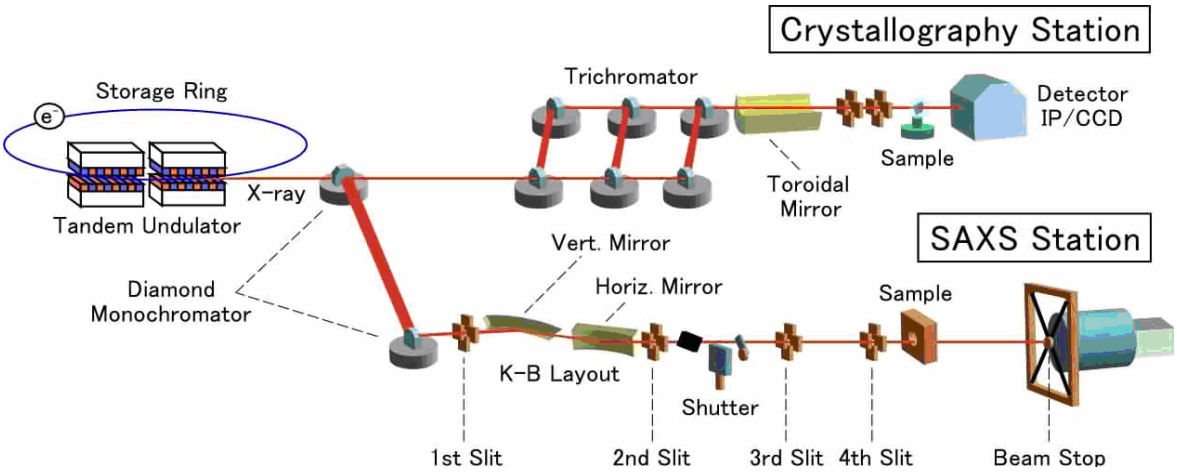
X-rays at sample

(i) SAXS station

Energy range	6.8 ~14.0 keV (tunable) 13.8 keV (fixed)
Energy resolution	$\Delta E/E < 10^{-4}$
Photon flux	$\sim 3 \times 10^{11}$ photons/sec
Beam size (typically)	0.4 mm (horizontal) × 0.2 mm (vertical)

(ii) Crystallography station (closed for RIKEN use)

Energy range	7.5 ~14.0 keV (tunable)
Energy resolution	$\Delta E/E < 10^{-4}$
Photon flux	$\sim 10^{11}$ photons/sec
Beam size (typically)	0.1 mm (horizontal) × 0.1 mm (vertical)



Optics of BL45

Experimental stations

SAXS station

The length of the camera can be changed by sliding a detector wagon on which a vacuum chamber for beam stop and a detector stage are equipped. The choice of camera length is discrete; 0.6 m, 1.0 m 1.8 m, and 2.2 m and 3.6 m. The more short camera lengths are available upon request. Please ask contact person. The table below indicates the relation ship between camera length and S-range. The change of camera length during limited user time should be avoided.

The sample table can be movable, which offers great freedom in applying a various sample cell holder.

The details of experimental information can be seen in beamline web page.

(http://www.riken.go.jp/lab-www/biochemi/Beamline/index.html)

Detectors

For most purposes we use XR-II + CCD detectors are used (Amemiya *et al.*, *Rev. Sci. Instrum.* 2290, 2 (1995)).

We have R-AXIS IV^{++} for data collection with wide dynamic range.

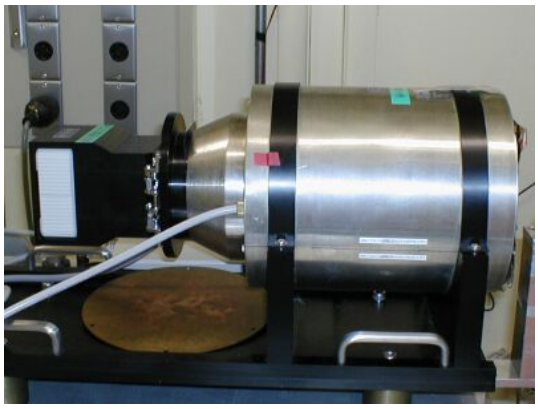
Description of Rigaku R-Axis IV++

Manufacture	Rigaku R-Axis IV+++
IP material	BAS-MS
IP size	300 mm × 300 mm
Pixel size	50 / 100 / 200 μm
Pixel depth	
Type	double photomultiplier
ADC	14 bit+12 bit (× 256)
Total	10^6 counts
Exposure time	1 sec or more
Readout time	ca. 180 sec
Erase time	60 sec (recommended)

Camera Legnth	S-range (A^{-1})		q-range (A^{-1})		spacing (Å)		angle (deg.)	
Normal setup with II+CCD								
600 mm	0.0044	0.132	0.0276	0.829	7.6	227	0.23	6.77
1000 mm	0.0026	0.079	0.0166	0.498	12.6	379	0.14	4.08
1800 mm	0.0011	0.044	0.0069	0.276	22.7	909	0.06	2.23
2300 mm	0.0009	0.033	0.0055	0.207	30.3	1136	0.05	1.70
3600 mm	0.0007	0.022	0.0042	0.142	44.2	1400	0.04	1.14
Mediun Camera wtih IP								
Long part (1 m)	0.0015	0.088	0.0099	0.553	11.4	649	0.08	4.53
Short part (150 mm)	0.33	0.825	2.0735	5.183	1.2	3	16.53	36.5
Very short camera with IP. w/o vacuum path or sample in vacuum. N/A VMIC								
300 mm	0.0143	0.605	0.0902	3.802	1.7	70	0.73	28.52

Feature of available CCD

Feature	Slow CCD		Fast CCD		Full controled CCD	
Manufacture	Hamamatsu C4880-10-14A		Hamamatsu C4880-80-14A		Hamamatsu C7300-12-NR	
Type	Cooled CCD (-50°C)		Cooled CCD (-10°C)		Interline cooled CCD (-10°C)	
Mode	Slow read	Fast read	Slow read	Fast read	Full frame	Binning 2 × 2
Pixel size	0.15 mm		0.25 mm		0.125 mm	0.25 mm
Image size	1000 ×1028		655 × 493		1280 × 1024	640 × 512
Area	150 mm × 150 mm		160 mm × 120 mm		150 mm × 140 mm	
Pixel depth	14 bit		14 bit	10 bit	12 bit	
Saturation charge	60000 electrons		30000 electrons		60000 electrons	
Exposure time	150 msec ~ 60 sec		1 sec ~ 20 sec	30 msec ~ 1 sec	75 msec ~ 5 sec	35 msec ~
Minimum time slice	6 sec	1 sec	3 sec	30 msec	75 msec	35 msec
CCD shutter control	Mechanical		Optical		Optical	
X-ray shutter control	Via software		Manual or external trig.		Client mode. Full-controled via software	
External Trigger	No supported		Supported (start of sequential read)		Full supported	
Recomended aperture size (without defocusing)	# 5 or more		# 4 or more		# 5 or more	# 4 or more



Side view of XR-II+CCD

The references on characteristics of these detectors for the use of synchrotron solution x-ray scattering are;

XR-II + CCD : T. Fujisawa *et al., J. Synchrtron Rad.*, 6, 1106-1114 (1999).

R-AXIS IV++ : T. Fujisawa *et al., J. Appl. Cryst.*, 36, 535-539, (2003).

The detailed information for the practical usage of these detectors is also available in our web page. (http://www.riken.go.jp/lab-www/biochemi/Beamline/BeamlineInformation.html)

PX station

PX station is closed only for RIEN use. More information on PX station is available in the web page of Division of Bio-Crystallography Technology. (http://bioxtal.harima.riken.jp.)

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