RIKEN Coherent X-ray Optics (BL29XU)

1. Introduction

BL29XU has been constructed as the third RIKEN beamline for coherent x-ray optics. It is one of three long beamlines and measures 1 km. The shorter beamline in the storage ring building was constructed by Dec.1998. This part is the SPring-8 standard x-ray undulator beamline [1-4]. After inspection and radiation survey, the commissioning of the beamline, the experimental station [5], and a picosecond laser system [5,6] was carried out by the summer shutdown of 1999. The 1-km-building was completed in Dec. 1999. The extension of beamline to the 1-km-building was started, and was approaching completion in Mar. 2000.

2. Beamline

The energy range of 5.6-18.7 keV is covered by the fundamental radiation from a planar in-vacuum undulator, tuning its gap from 9.6 to 50 mm. To protect the Be window, the maximum aperture size of the front end slit is currently limited to 1×1 mm^2, which is sufficient to transmit the central cone of the undulator radiation. The SPring-8 standard double crystal monochromator scans from 3 to 27 degrees corresponding to 37.8-4.4 keV by Si 111. The monochromator is operated in the rotated inclined geometry with a direct-water-cooled pin-post crystal [7]. The maximum power incident on the first crystal is estimated to be about 490 W (100 mA, 9.6 mm gap) owing to the front end, though the maximum radiation power reaches 9.6 kW. No thermal problem was observed up to a ring current of 100 mA. As there was a threat of the possible disturbance to the beam coherence due to pin-post bonding, we are planning to install a cryogenic cooling system.

A new design was introduced to the extended transport channel to the 1-km-building (Fig. 1). Most of the vacuum duct of the 1-km section is constructed in the open-air, so that Pb shielding cannot be used. An aperture of lead with a diameter of 8.3 mm will be inserted in front of the 1 km section to prevent x-rays hitting the duct wall with a large glancing angle. The scattered x-rays from the aperture will be stopped by an additional Pb shield on the vacuum duct of the first several meters.

3. Experimental Station

The temperature of the experimental hutch is controlled within 0.1 K by an air conditioner. Further stability can be achieved by an optional cover on the instruments. The basis of the station control system is the same as the SPring-8 control system. The stepping motor controllers, counters, DIOs, ADCs and GPIB devices are accessible from user computers via the VME based system. Original GUIs have been prepared for versatile x-ray diffraction experiments, and a LabVIEW based GUI can be used for routine measurements, such as XMCD and XAFS. SPEC is also available.

A multi-axis versatile diffractometer is installed for the x-ray diffraction experiments. The diffractometer is composed of precision goniometers, such as θ, ω-θ, χ-ϕ, 2axis-θ, and coaxis-θ goniometers [8], and various stages, *e.g.*, linear translation, swivel, and rotation stages. The coaxis-θ goniometer has the finest resolution of 1/400 arcsec. The resolution of the θ- and 2axis-θ goniometer is 1/200 arcsec. The optical bench for the diffractometer has a size of 2×1 m^2. It has six XY-carriers to mount the goniometers and five Y-carriers for the detectors and the small stages (Fig. 2). The x-ray beam is supposed to pass near one side of the table (above the smaller carriers) in order to access the goniometers without touching the bench.

The picosecond laser system is installed in a laser booth. The laser of 0.6 mJ/pulse, 2 ps pulse width, and 1 kHz repetition is guided into the experimental hutch

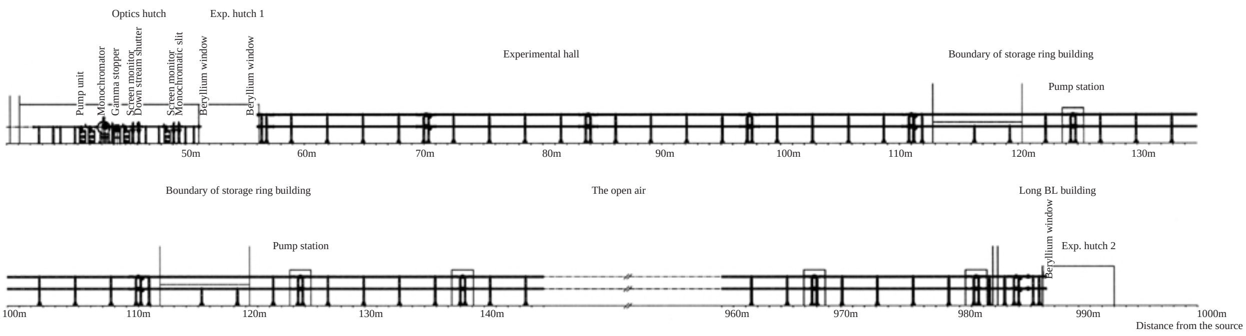

Fig. 1. Schematic side view of the transport channel of BL29XU. The shorter beamline to the experimental hutch 1 (52 m from the source) has been already constructed, and the extension of the beamline to the experimental hutch 2 (987 m from the source) has just been started.

through a laser duct. To enable the laser pulse to coincide with the specific x-ray pulse, the reference signal of the rf cavity is provided. The synchronization between the laser and the x-ray pulse is monitored by an x-ray streak camera [6].

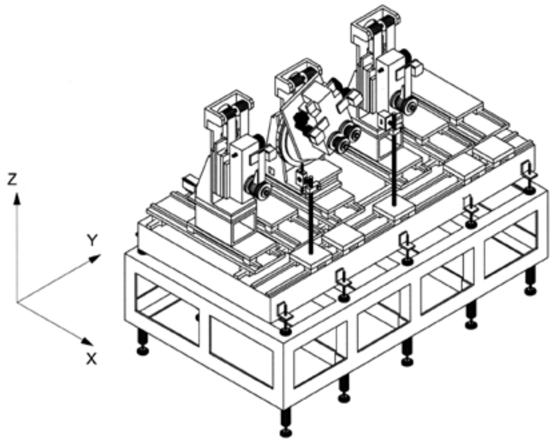

Fig. 2. Schematic view of the multi-axis precision diffractometer. Two θ-goniometers and one 2axis-θ goniometer are mounted on the XY-carriers and a slit and a detector are set on the Y-carriers.

References

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Light Source
SPring-8 standard in-vacuum undulator
32 mm period 140 repetition
Energy range 5.6-18.7 keV (fundamental radiation)

X-rays at Sample
more than 1×10^{13}photons/s for 7-30 keV
6×10^{13}photons/s@ 10 keV

Facilities in Experimental Station
multi-axis precision diffractometer
picosecond laser system
x-ray streak camera