Transport Channel and Optics

1. Introduction

FY1998 saw the completion of many transport channels, as well as the commencement of construction of many beamlines. A medium length beamline from a bending magnet into the biomedical imaging building (BL20B2) was completed by using Pb-shielded, 400 mm diameter vacuum ducts between two hutches, one of which is located in the storage ring building and the other in the biomedical imaging building. A new branch transport channel with a high-resolution grating monochromator using a variable-spacing grating was completed at BL27SU.

Construction of nine new beamlines started in FY 1998 at SPring-8. These include four X-ray undulator beamlines (BL19XU, BL20XU, BL35XU and BL40XU), 4 bending magnet X-ray beamlines (BL02B2, BL04B2, BL28B2 and BL40B2), and one infrared beamline (BL43IR) from a bending magnet. Although the details of experimental facilities are given in the report of each beamline, we would like to summarize the transport channel and optics features of these beamlines. In addition, the extension of existing BL29XU to a length of 1 km was begun to accommodate the construction of a new building.

Most of the transport channels and optics of these new beamlines, except for the infrared beamline, use the standard components developed during FY 1994~1997 [1].

Following the initial tests of the transport channel and optics components made in FY 1997, various tests of the functions implemented in the initial design were carried out. These include the tests of adjustable-inclined geometry and rotated-inclined geometry for the standard monochromator mechanism and the sagittal focusing test at high energy. Some of the new developments in optics have continued, including cryogenic cooling of silicon crystals and refractive lens/collimators. The optical elements were also improved, especially the pin-post crystals and diamond crystals.

Some upgrade of the crystal fabrication facility was performed to enable the complete fabrication of silicon flat crystal optical elements.

2. New Beamlines

2.1 BL02B2

This Powder Diffraction beamline from a bending magnet was completed in March 1999. Since the beamline user group strongly requested a parallel incident beam to the sample, the beamline optics starts with a parabola mirror followed by a double-crystal monochromator. The parabola mirror is configured by bending a Rh-coated flat mirror of 1 m length. For this, a mirror support with bending and water-cooling mechanisms is installed upstream of the monochromator. A standard adjustable-inclined double-crystal monochromator [2] is used in the beamline.

2.2 BL04B2

This High Energy Diffraction beamline from a bending magnet was completed in March 1999. A single-bounce, constant deflection-angle crystal monochromator is installed in the beamline in a horizontally dispersive geometry. Bragg angle of the monochromator is fixed at 3 degrees. The current monochromator crystal is a 700 mm long Si (111) plate. Horizontal focusing of the beam is achieved by cylindrically bending the crystal. A standard mirror support with bending and indirect cooling mechanisms is used for the monochromator. Utilization of Si (220) and Si (311) is also being considered.

2.3 BL19XU

This Long Straight Section beamline, the fourth beamline of RIKEN, will be completed in FY 2000. It will be the first beamline of SPring-8 which uses 27 m undulator as an X-ray source. The undulator has an in-vacuum, planar magnetic array with a period of 32 mm. In the experimental hall, an optics hutch and three experimental hutches will be constructed. The optics of this beamline is a standard double crystal monochromator to be cooled cryogenically. Initial equipment for the first experimental hutch will be a versatile high precision multi-axis diffractometer, which is used for state-of-the-arts diagonostics of undulator radiation. The second experimental hutch will be an open hutch where users can install their own equipment. An X-ray diffractometer with a 15T superconducting magnet will be temporarily installed in the third experimental hutch.

2.4 BL20XU

This Biomedical Imaging beamline is the second medium length (200 m) beamline into the biomedical building, and will be completed in FY 2000. The undulator is a planar, in-vacuum one with 28 mm magnetic period and 4.5 m total length. An optics hutch is located in the experimental hall of the storage ring building, while an experimental hutch is in the biomedical building. Lead-shielded vacuum ducts connect the two hutches. The optics of this beamline is also a standard double crystal monochromator that will be cooled cryogenically.

2.5 BL28B2

This White Radiation Topography beamline from a bending magnet was completed in March 1999. It has no monochromators or mirrors.

2.6 BL35XU

This High Energy Resolution Inelastic Scattering beamline is equipped with a back-scattering crystal monochromator and analyzer. It is to be completed within FY 1999. The source undulator is a planar, in-vacuum one with 32 mm magnetic period and 4.5 m total length. A cryogenically cooled silicon double-crystal monochromator in the standard mechanism is installed as a pre-monochromator. A back-scattering monochromator of spherically arranged silicon pillars is located at an ~80 m position from the source. A Si 111 double-crystal "beam displacer" is used for the back-scattered beam to separate its beam axis from that of the incident beam. A bent cylindrical mirror is used to focus the beam at the sample position. This is a complicated beamline, and more detail description can be found in aother report in this volume.

2.7 BL40B2

This Strucutral Biology beamline equipped with focussed monochromator was completed in March 1999. It will, for the time being, be used for wide/small angle scattering/diffraction from macromolecules. Its beamline optics are an adjustable-inclined double-crystal monochromator followed by a bent cylindrical mirror coated with Rh. The beamline has non-connected optics and experimental hutches.

2.8 BL40XU

This High Flux beamline from an x-ray undulator will be completed within FY 1999. The undulator is a helical, in-vacuum one with 40 mm magnetic period and 4.5 m total length. The beamline has no crystal monochromator. Two bent flat mirrors in Kirkpatrik-Baez configuration focus the central cone of the undulator radiation at the sample position. The first mirror is made of Si and cooled indirectly by water. The second mirror is made of quartz and uncooled. Two separated standard mirror supports with bending mechanism are used for the KB configuration.

2.9 BL43IR

This is the first Infrared Materials Science beamline at SPring-8 to be completed within FY 1999. A special design is used for the optics and transport channel.

3. Optics Upgrade

3.1 Pin-post Crystals

The first model of the pin-post crystal has distributed water slots for inlet and outlet under the irradiated surface [3]. This crystal, combined with rotated-inclined geometry, was found to provide enough cooling efficiency for the SPring-8 undulators at the ring current of 20 mA (maximum 80W/mm^2 power density at the monochromator position) [4]. Even when the ring current was raised to 70 mA, no thermal degradation was observed. However, an image split due to water-pressure induced strain and/or deformation was observed. There remains much room for improvement to reduce bonding strain.

We made design improvements of the pin-post crystal to remove above-stated defects [5]. Many water-slots were replaced by a single pair of inlet and outlet slots, placed outside of the irradiated area. This eliminated the split of the beam image after reflection. Improvement of the bonding process is still in progress.

3.2 Test of Sagittal Focusing

A crystal bender for fixed-exit sagittal focusing [6], to be installed in the standard monochromator mechanism, was tested between 40 keV and 60 keV [7]. Good focusing efficiency was observed for non-inclined double-crystal geometry. Additional tests are now being conducted to achieve sagittal focusing for the inclined double-crystal geometry as well as the dynamic focusing properties.

3.3 Cryogenic Cooling

Test operation of a cryogenic cooler for undulator monochromators was carried out at BL47XU. The results were good, as reported from ESRF and APS. On the basis of our experience in the test operation, a new cooling system with smaller liquid nitrogen consumption is being designed for installation in BL19XU, BL20XU, and BL35XU.

4. Crystal Fabrication Facility

A new grinding machine and a mechano-chemical lapping machine were introduced in the crystal fabrication laboratory. These machines, in addition to the existing diamond saw and diamond milling machine, enables the complete fabrication of flat crystal optical elements from silicon.

References

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