Transport Channel and Optics

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1. Introduction

The fiscal year1996 was a memorable year for the beamline group as well as for the other groups of the SPring-8. At the beginning of April 1996, all the remaining members of the beamline group who had been working at the JAERI Tokai campus and the RIKEN Wako campus joined the advance members of the frontend and insertion device groups at the SPring-8 site. This union facilitated the mutual collaboration between the beamline group and the other groups including the accelerator, building, utility and safety groups, as well as the collaboration among beamline staff members. A large number of serious discussion meetings with equipment vendors took place during the first half of the fiscal year for the finalization of beamline components and pieces of equipment that are to be installed in the experimental stations. The construction of the beamlines in the experimental hall began in August 1996 starting with the radiation shielding hutch. In February 1997, the construction of the first two beamlines (BL47XU and BL02B1) were completed, and these beamlines along with the storage ring underwent the pre-operation tests. At the end of March 1997, we observed the SR from a bending magnet on a screen monitor that was placed in the frontend of 02B1. This was followed by the observation of undulator radiation, the introduction of the monochromatized SR from a bending magnet and an undulator to the experimental hutches in May 1997.

2. Construction of Transport Channels

The first version of the catalogue of the standard component kits for transport channels was published from JASRI. This includes detailed information on the following items:

(a) Downstream Shutters
(b) 4-jaw Slits for Monochromatic X-rays
(c) 4-jaw Slits for White X-rays
(d) Fixed Masks
(e) View Ports
(f) Bellows
(g) Beryllium Windows
(h) Gamma-Ray Stoppers
(i) Helium Chambers
(j) End Stoppers
(k) Exhaustion Units
(l) Vacuum Gauge Units

Detailed construction schedules for transport channels and experimental stations were reviewed during April and May 1996. At that time, we selected a total of seven beamlines for the first phase construction. These included three bending-magnet (BM) (01B1, 02B1, 04B1) and four x-ray undulator (09XU, 41XU, 45XU, 47XU) beamlines. The deadline for these beamlines was set at the end of May 1997. On the other hand, we set the completion date for one wiggler (BL08W), two x-ray undulator (10XU, 39XU) and one soft-x-ray undulator (25SU) beamlines at September 1997, just before the dedication of these units for user operation. This is because most of the construction work for the frontends and insertion devices are to be completed during the summer shutdown of the accelerator operation in 1997.

The first step of the transport channel construction at the SPring-8 site was the geometrical survey in the experimental hall which started in June, although the storage ring building in which beamlines were to be installed had not yet been completed.

The height level of the electron orbit in the storage ring was transferred to the several reference points on the outer surface of the concrete shield wall. For each of the 61 beamlines, two reference points separated by several tens of meters were marked on the projected line of the virtual direct beam axis to the floor of the experimental hall. The real lines were drawn at those beamlines with the divisions for every meter by using two reference points for which the construction plan was made. These lines with divisions were used as scales in aligning the beamline components as well as in building the shielding hutches.

The construction of radiation shield hutches began in late August. The components of transport channels and optics were delivered between October 1996 and May 1997. The setup and alignment of the first phase beamlines began in late October. At first, one x-ray undulator beamline (47XU) was setup and it was aligned by some of the in-house staff members. The setup and alignment of standard BM beamlines (01B1, 02B1) were included in the contract for the inclination/elevation stage, which is a standard component of the BM beamlines. Based on the experience accumulated during the setup and aligning process, we prepared a standard specification for beamline setup and alignment for the standard x-ray undulator beamlines. Setup and alignment of the remaining three x-ray undulator beamlines (09XU, 41XU, 45XU) and one non-standard BM beamline (04B1) were made by an outside company on the basis of this specification.

More detailed information can be obtained from the individual reports in this volume[1-3].

Fig. 1. Radiation shielding hutch at BL02B1

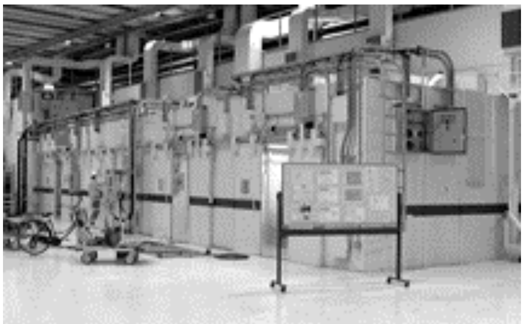

Fig. 2. Radiation shielding hutch at BL47XU

3. Optical Components

3.1 Standard X-Ray Monochromators

Two prototypes of the standard x-ray monochromator, one for the BM beamlines and another for the undulator beamlines, were delivered in May 1996. We prepared a characterization station equipped with a rotation-anode x-ray generator. A control software was developed using these prototypes. One important improvement after testing these prototypes was to change the SR beam duct flanges of the undulator type from ICF70 to ICF152. With this change, the vacuum chambers for the undulator type and for BM type beamlines were made fully compatible.

Optical and x-ray tests showed that the deviation from the parallel position between the first and the second crystals, while scanning the Bragg angle from 3 degree to 25 degree, was within 20 arcsecs.

The total of eight monochromators for the beamline installation was delivered between January and May 1997. Some of these were aligned at each beamline, and were tested using SR at 47XU and 02B1.

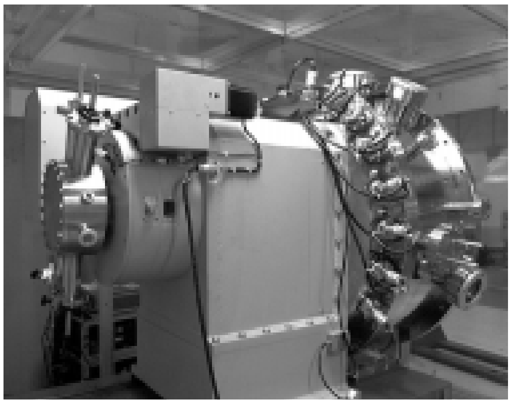

Fig. 3. Standard x-ray monochromator for undulator beamline

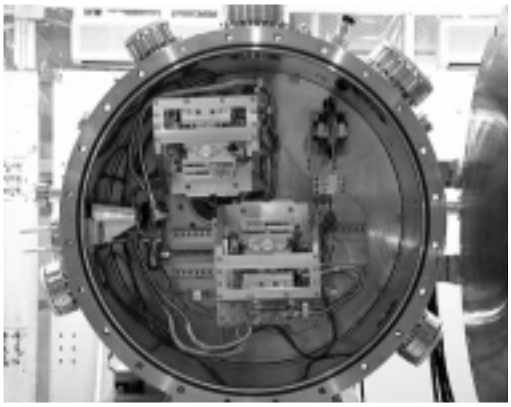

Fig. 4. Monochromator mechanism

3.2 Standard Mirror Supports/Benders

Twelve mirror supports, the procurement order for which had been placed in 1995 FY were delivered between January and May 1997. These included (i) three upward-deflecting 1 m mirror benders with the water cooling capability, (ii) two downward-deflecting 1 m mirror benders without water cooling, (iii) two rightward-deflecting 70 cm mirror benders, (iv) one rightward-deflecting 70 cm mirror support, (v) one upward-deflecting 40 cm mirror bender, (vi) one downward-deflecting 40 cm mirror bender, (vii) one downward-deflecting 33 cm mirror bender and (viii) one parallel 40 cm double mirror support. Some of these units have already been installed in the respective transport channels.

4. Optical Elements

4.1 Pin-Post Water Cooling of Si

Following the test of the pin-post structure fabrication by the sand blasting technique and Au-diffusive bonding of two silicon wafer made in 1995 FY, several sets of crystals to be installed in the monochromators were fabricated in 1996 FY.

Fig. 5. Si single crystal plate with fabricated pin-post structure

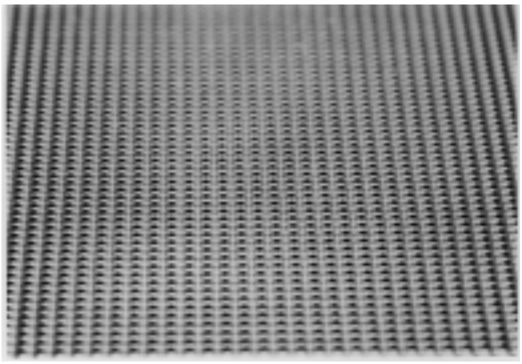

Fig. 6. Enlarged image of pin-post structure

Fig. 7. Water distributor made of Si single crystal

A copper manifold with water paths was designed and fabricated to mount the crystal to the standard monochromator. An x-ray test showed that the performance of the crystal was not quite perfect presumably because of a bonding strain. We are continuing to seek a better bonding condition to minimize the bonding strain.

4.2 Diamond Crystals

Since 1994, Sumitomo Electric Industries (SEI) and the SPring-8 started a joint R&D program aiming to synthesize large and highly perfect crystals. Our tentative target at that time was to obtain highly-perfect crystals with less than 1 arcsec diffraction broadening caused by imperfections. These crystals are to be larger than 10×10 mm^2 in size, if possible, and in the (111) orientation.

The crystal perfection to meet that target was performed in FY 1995. The R&D for synthesizing larger crystals proceeded in this fiscal year, and finally we have achieved a (111) crystal plate of 10×7 mm^2 size. In order to obtain a higher throughput, we continued to develop a larger volume high pressure cell for synthesizing crystals .

References

[1] S. Goto et al; in this report.
[2] S. Goto et al.; in this report.
[3] H. Yamaoka et al.; in this report.