R&D I (BL47XU)

1. Introduction

An X-ray undulator beamline (BL47XU) is allocated as the first R&D beamline which is to serve both scientific and technical R&D efforts for novel utilization of X-ray undulator beams.

Scientific objectives and the layout of the beamline are summarized in the SPring-8 Annual report of 1995. Here we describe our R&D of a liquid nitrogen cooling system for monochromator crystals. We also describe our new instrument, a pinhole chamber, installed in the optics hutch.

2. R&D of the Liquid Nitrogen Cooling System

One of the scientific objectives of BL47XU is the R&D of imaging techniques in the hard X-ray region. For such purposes, crystal deformation should be minimized. To find a solution to this problem, we have been investigating the liquid nitrogen cooling system of the monochromator. The liquid nitrogen circulator we have installed was manufactured by Oxford Corp., England, and was connected to the monochromator crystals by transfer tubes. The circulating system is located outside of the optics hutch, and the pipes were introduced into the optics hutch through one of the ventillating ducts at the ceiling of the hutch as shown in Fig. 1.

Two SUS pipes were guided to the monochromator as the inlet and outlet of the liquid nitrogen, and each pipe was branched into two for the two monochromator crystals. In such a way, both first and second crystals were cooled to the temperature of liquid nitrogen. Thus the exit beam direction is kept constant over a wide energy range. Two as-grown crystals are cooled through the copper holders by a so-called indirect cooling method. Figure 2 is a photograph showing the first crystal.

As for cooling capability, this system was designed to work with a heat load as large as 400 W. This capability was confirmed by illuminating the X-ray radiation from the undulator under high heat load conditions. Figure 3 shows the rocking curve measurements with a gap of 10 mm (K = 1.91) and 30 mm (K = 0.27) (the minimum being 8 mm), with front end slit aperture of 1 mm square at 29 m downstream of the source point. This measurement was done using 18 keV X-rays and the Si(333) reflection plane with a storage electron beam current of about 70 mA. With the present system, the heat load effect was not perfectly removed when the gap was as small as 10 mm.

3. Installation of Pinhole Chamber

A pinhole chamber was installed in the optics hutch around 40 m from the undulator source. It has two translation stages and two rotation stages for alignment (as shown in Fig.4). Among these stages, a horizontal stage had a stroke as large as 5 cm, which allows switching of three different pinholes and slits. This chamber is planned for use in air as well as in vacuum. Tiny pinholes and slits can be used as the tiny virtual sources, at about 5~12 m upstream of the experimental stages, for microfocus experiments and experiments using a high degree of coherence.

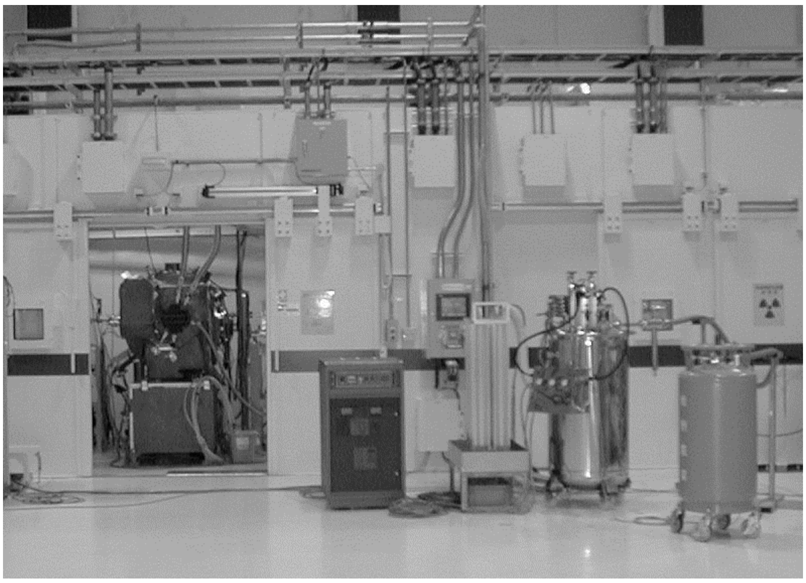

Fig. 1. The liquid nitrogen cooling system for the monochromator of BL47XU. Pipes connect the liquid nitrogen circulator outside the hutch to the monochromator crystals inside the optics hutch. In the figure, only one dewar is connected to the vessel of the circulator, but six dewars are connected and refilling is done automatically at present.

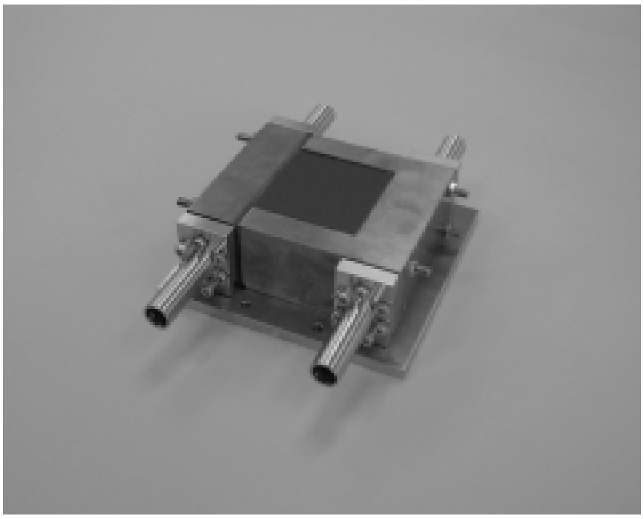

Fig. 2. The first crystal and copper holder of the monochromator. The crystal is indirectly cooled, and there are several thermocouples attached to the holder and the SUS pipes for monitoring temperatures.

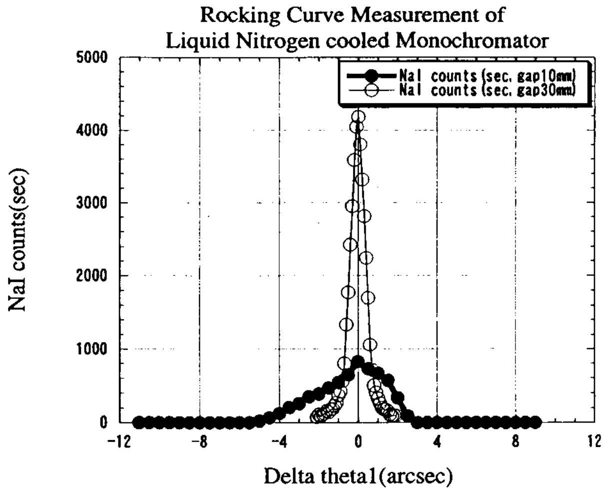

Fig. 3. Results of rocking curve measurements with a gap of 10 mm and 30 mm and a front end slit aperture of 1 mm square. This measurement was done using 18 keV X-rays and Si(333) reflection plane with a storage electron beam current of about 70 mA. The width of the rocking curve (in FWHM) changed from 0.85” (30 mm) to 3.5” (10 mm), which is the effect by the heat load.

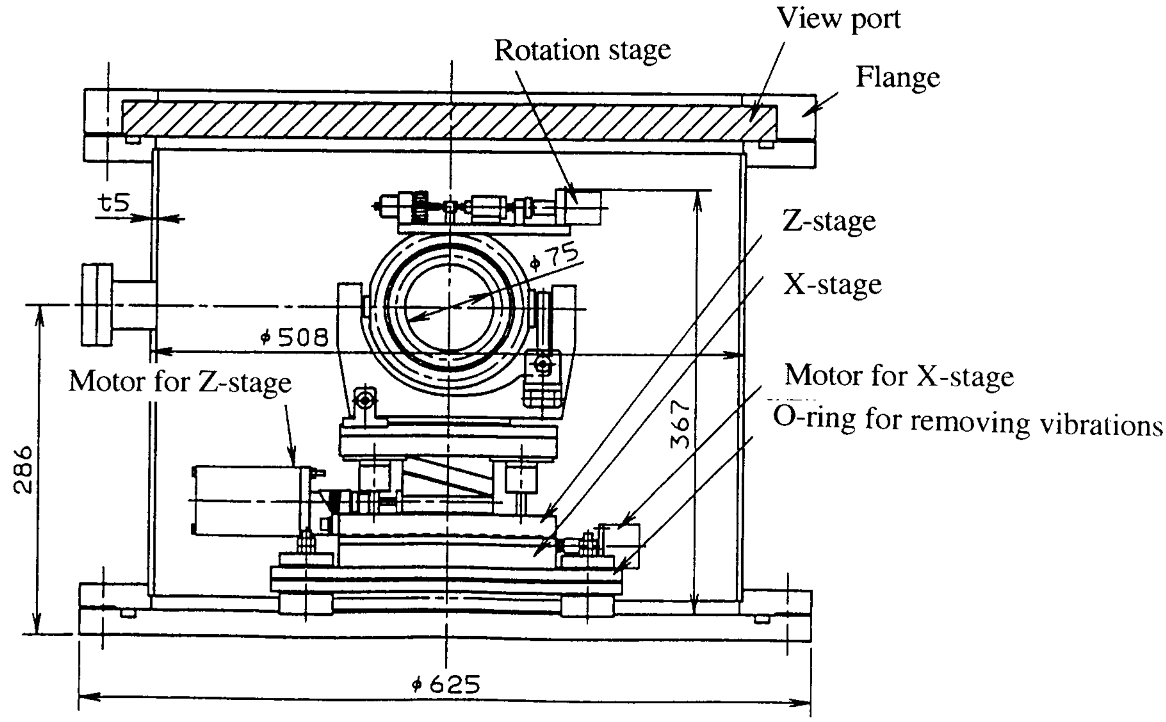

Fig. 4. Stages inside the pinhole chamber manufactured by AYUMI Industry Corp. Two translation stages and two rotation stages are assembled for alignments.