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 the novel utilization of x-ray undulator beams.

The scientific objectives and the layout of the beamline are summarized in the SPring-8 Annual report of 1995. To handle the high heat-load of the undulator beamline, R&D for the liquid-nitrogen (LN_2) cooling system for monochromator crystals is being carried out at this beamline (previously reported on the SPring-8 Annual report of 1998). Small modifications were made to this cooling system this year.

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 LN_2 cooling of the monochromator. The LN_2 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 ventilating ducts at the ceiling of the hutch (see SPring-8 Annual report of 1998).

This year, a coupler for six dewars was manufactured with twelve manual valves (for LN_2 & air) so that LN_2 can be supplied from six dewars one after another. The consumption of the LN_2 is more than the content of a 250-litter-dewar and the valve operation of the dewars needs to be manually performed at least once a day. Automatic refilling is planned by introducing balances for the dewar and a controller for the valve operations.

The heat transfer into the pipes from the environment is prevented by the vacuum of the monochromator chamber and by the aluminum sheet covering the pipes. Moreover a coil was placed inside the passage in the crystals so that the cooling efficiency of the crystals is improved by the turbulance. The LN_2 circulator has a motor to keep the flow rate of the LN_2 constant. The rotation frequency of this motor is usually set between 30 and 50 Hz and the flow rate of the LN_2 is typically 10~14 liter/min.

There is a possibility of the vibration from the LN_2 flow affecting the imaging experiments severely. This effect was carefully investigated by placing a phase edge (e.g. edge of a Kapton 25 μmt film) about 4 m upstream of the 2D detector inside the experimental hutch. Any vibration of the monochromator crystals blurs the Becke lines (interference pattern observed downstream of the phase edge). This blurring was clearly observed when the rotation frequency of the motor was raised above 35 Hz or so. On the other hand, it is better to set this frequency to around 50 HZ to avoid drifting when the heat load is relatively large (e.g. higher than 340 W). The maximum heat load tolerable was shown to be ≥ 600 W, and considerations are needed on the flow rate of LN_2 for high flux experiments.

In principle, the LN_2 cooling system is working properly, and the coherence of the undulator beam has been extensively investigated using various techniques (μ-beam focusing experiment, X-ray microscopy and X-ray speckle measurement and so on).

Light Source	
Type	In-vacuum undulator
Undulator period, λ_u	32mm
Number of period, N_{period}	140
Tunable range	≥ 5.1keV
Peak brilliance	3×10^{19}ph/s/mrad^2/mm^2/0.1% b.w. (E=9keV, @100mA)
Total power	4.5kW(E=9keV, @100mA)
Power density	300kW/mrad^2 (E=9keV, @100mA)

X-rays at Sample	
Energy range	9-18keV(1st harmonics) 27-54keV(3rd harmonics)
Energy resolution	$\Delta E/E \sim 2\times10^{-4}$
Photon flux	2×10^{14}ph/s/mrad^2/mm^2/0.1% b.w.(E=9keV, @100mA)
Beam size	2mm(H)×0.7mm(V) (E=9keV, @40m from source)

Facilities in Experimental Stations

- Optics R&D Diffractometer (experimental table (1m×2m), Exp. Hutch 1)
- Imaging R&D Diffractometer (experimental table (2m×3m), Exp. Hutch 2)
- Pinhole Chamber (switchable in vacuum, @40m from the source, Opt. Hutch)