3 A Superconducting Magnet for X-Ray Scattering Measurements

In order to study the effects of magnetic fields on the structure of materials, we installed at BL-16A1 a liquid-He-cooled superconducting magnet and a horizontal two-circle diffractometer. The magnet can be used to produce vertical magnetic fields with strength of up to 8 T. The sample temperature can be varied over a range of 1.5 K to 300 K. The effective opening solid angle of the Be window is ± 3 degrees in the χ-direction, 186 degrees in the 2θ-direction, and uses two 8-degree-width pillars. The magnet is equipped with a 35-liter liquid-He-Dewar vessel, requiring a He transfer to the magnet only every three days (Fig. 1). To avoid magnetic-field dependence of detector efficiency a solid-state detector is employed.

The magnet has been designed for X-ray scattering experiments for materials science. It is applicable to studies of, for example, multi-ferroic materials, strongly correlated materials, and *f*-electron systems. Knowledge of the magnetic-field dependence of material properties including lattice distortions is very important. For example, the colossal magnetoresistance (CMR) effect in perovskite manganese oxides is still a hot topic in materials science, and to study it requires magnetic field strength of several teslas. The new magnet has been used for studies of such CMR thin films, providing important information in clarifying the mechanism of the CMR in the thin films [1].

BL-16A has been shut down, with its components and equipment including the superconducting magnet being moved to a new beamline BL-3A. The new beamline is equipped with a diamond phase retarder, which can be used to rotate the linear polarization direction of the incident X-rays. Higher performance can be obtained with vertically linearly polarized X-rays since the scattering plane of the diffractometer is horizontal, producing low intensity around 2θ~90^{o} with a horizontally polarized beam. Moreover, the phase retarder with this magnet allows us to measure X-ray directional dichroism [2]. The combination of the magnet and the polarization controller has high potential for measurements on magnetic-field dependent properties and their changes in materials.

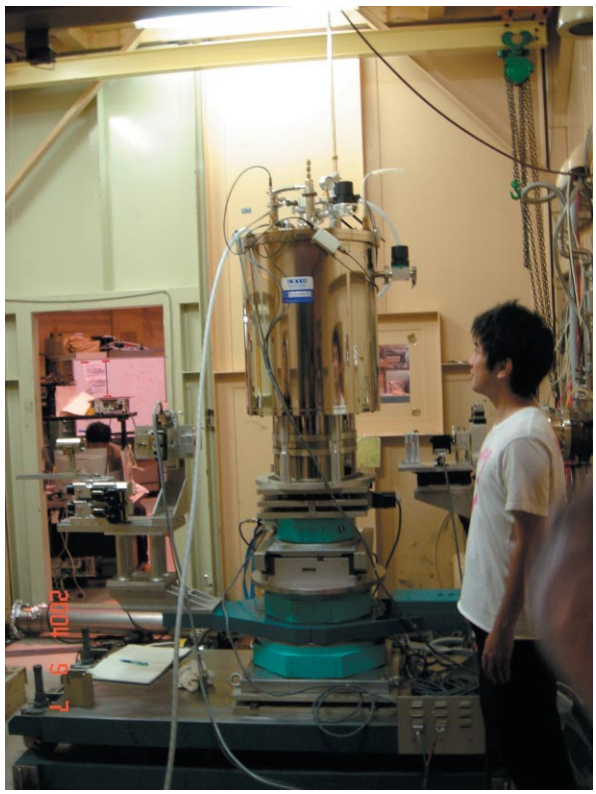

Figure 1
The liquid-He-cooled superconducting magnet mounted on the horizontal two-circle diffractometer.

Reference

[1] Y. Uozu, Y. Wakabayashi, Y. Ogimoto, N. Takubo, H. Tamaru, N. Nagaosa and K. Miyano, *Phys. Rev. Lett.* **97** (2006) 037202 .

[2] M.Kubota, T. Arima, Y. Kaneko, J. P. He, X.Z. Yu and Y. Tokura, *Phys. Rev. Lett.* **92** (2004) 137401 .