# High-resolution and Highly Stabilized Beamline BL17SU for Advanced Soft X-ray Spectroscopy

Beamline **BL17SU** was developed with the aim of carrying out spectroscopic studies for solid state physics as well as materials science. A novel insertion device, ID17, called a multi-polarization-mode undulator [1], has been developed to provide an intense soft X-ray (SX) beam. The ID17 consists of electromagnets and permanent magnets applying vertical and horizontal magnetic fields, respectively. By adjusting these magnetic fields to the specific operational mode, the ID17 can be operated as a helical or a pseudo-vertical undulator, and can also have a helicity switching capability that enables us to perform advanced SX spectroscopy. Recently, we have estimated the degree of circular polarization (CP) of the SX beam obtained from ID17 by magnetic circular dichroism in core-level X-ray absorption spectroscopy for a ferrimagnetic Gd-Fe-Co target [2]. The degrees of CP were deduced for all the available operational modes and compared with theoretical calculations, as shown in Fig. 1(c). As can be seen in the figure, the calculated degrees of CP are in reasonable agreement with the measurements. In Fig. 1(a), we also show the measured photon intensities, which are indicated as values of photocurrent (nA) measured using a Au flux monitor, as a function of energy.

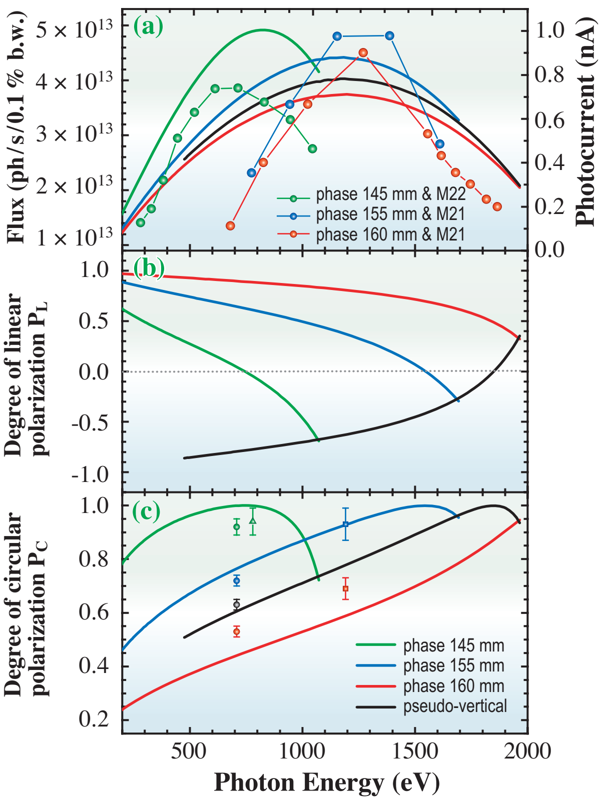


Fig. 1. Calculated and measured characteristic features of the SX beam from ID17.

BL17SU has been designed to have branched beamlines, which can be selected for exclusive use by using two sets of pre-focusing mirrors. Both branches have their own monochromator covering the energy range from 300 to 1800 eV [3]. Both branches have several experimental stations including one allowing high-resolution, angle-resolved photoemission spectrometry combined with laser molecular-beam epitaxy (E1a station) and one with high performance slit-less spectrometer for SX emission spectroscopy (E2a station). To achieve the ultimate performance of these experimental stations, a high-resolution and highly stabilized SX beam with a small spot-size is indispensable. Since the first ignition of ID17, we had been devoting much effort to satisfy such requirements.

We have housed the optical components in a temperature stabilization system (TSS) to improve the stability of a photon energy [4]. The system is composed of a thermal insulation booth and heaters controlled by a proportional-integral-derivative controller. The fluctuations in the photon energy, grating rotation angle, and the temperature of the support frame before the installation of the TSS were measured at 867 eV and are shown in Fig. 2(a). It is recognized that the fluctuation of the temperature difference $\Delta T$ of the support frame between upstream and downstream coincides exactly with that of the photon energy. This implies that the fluctuation of $\Delta T$ (0.15 °C/12 h) induces a slight variation in the angle of the optical element, which results in a corresponding energy drift (30 meV/12 h). Figure 2(b) shows the results measured after the installation of the TSS. By stabilizing the ambient temperature of the optical elements and their support frames to 0.01 °C/12 h, the photon energy stability is successfully improved to 10 meV/12 h as shown in Fig. 2(b).

To accomplish the small spot-size at the sample position, a set of refocusing mirrors with a Kirkpatrick-Baez configuration has been installed in each experimental station. A focal size of less than a few tens of microns was successfully achieved at each station. Figure 3 shows the focused beam profile at the E2a station measured by a two-dimensional scan of the pinhole. The vertical and horizontal focal sizes are 3 and 10 μm, respectively.

Using the high-resolution and highly stabilized SX beam, various advanced spectroscopic studies are being intensively carrying out at BL17SU.

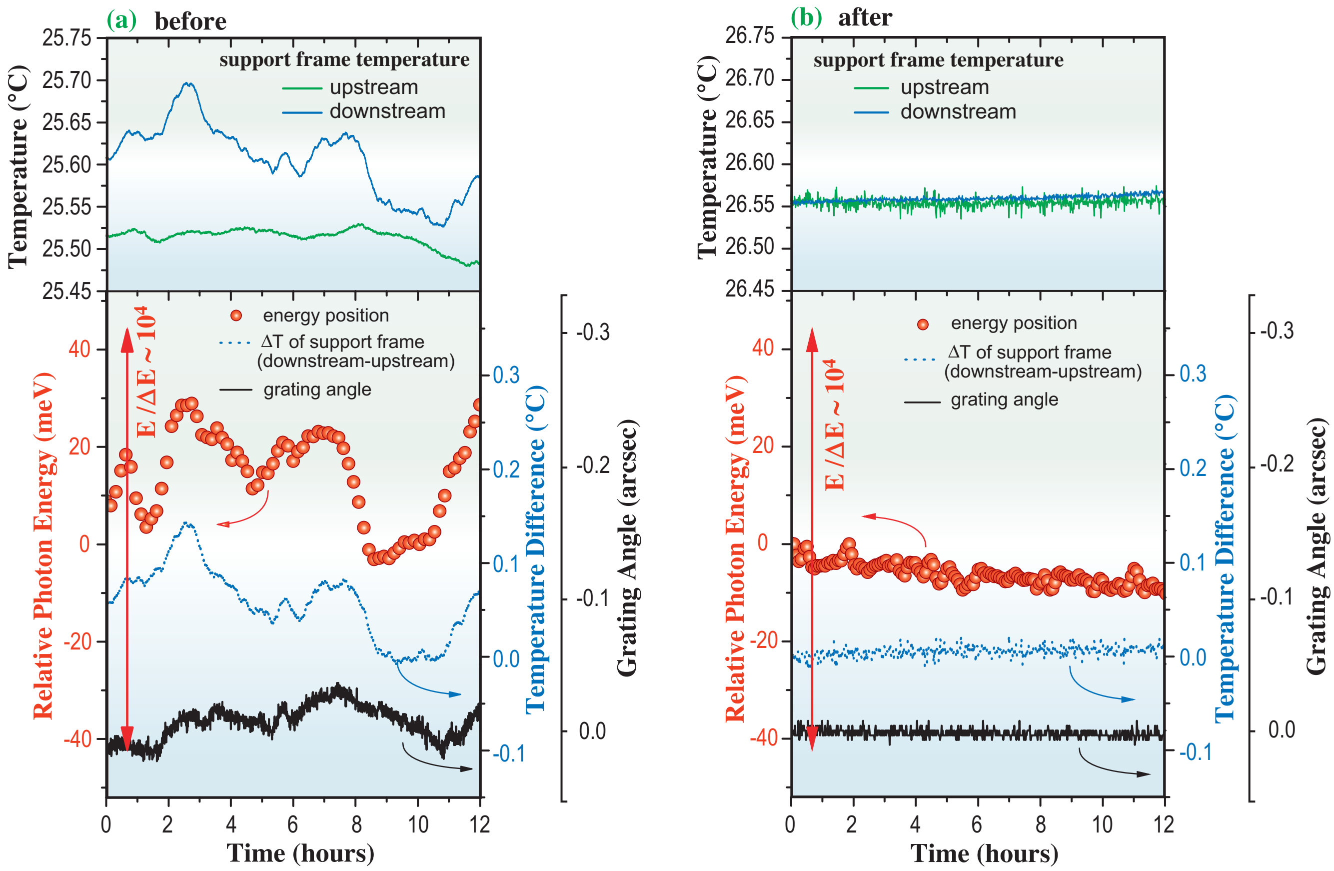


Fig. 2. Relative photon energy (red circles), grating rotation angle (black line), support frame temperature of the upstream (green line) and downstream (blue line), and the temperature difference of the support frame (blue dotted line) measured at 867 eV before **(a)** and after **(b)** installation of the TSS.

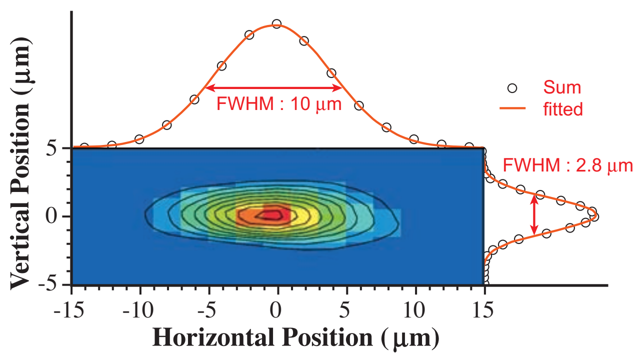


Fig. 3. Measured beam profile at E2a station.

Yasunori Senba [a], Haruhiko Ohashi [a,b] and Masaki Oura [b,*]

[a] SPring-8 / JASRI
[b] SPring-8 / RIKEN

*E-mail: oura@spring8.or.jp

**References**

[1] K. Shirasawa *et al.*: AIP Proc. **705** (2004) 203.
[2] *M. Oura, T. Nakamura, T. Takeuchi, Y. Senba, H. Ohashi, K. Shirasawa, T. Tanaka, M. Takeuchi, Y. Furukawa, T. Hirono, T. Ohata, H. Kitamura and S. Shin: J. Synchrotron Rad.* ***14*** *(2007) 483.*
[3] H. Ohashi *et al.*: AIP Proc. **879** (2006) 523.
[4] Y. Senba *et al.*: AIP Proc. **879** (2006) 718.