BL40B2
SAXS BM

1. Introduction

The BL40B2 beamline is used for small-angle X-ray scattering (SAXS) experiments of soft materials such as proteins, synthetic polymers, and lipids. In FY2024, we developed a beamstop with an embedded photodiode and a drive mechanism for the wide-angle X-ray scattering (WAXS) chamber, and performed updates to the beamline instrumentation.

2. Evaluation of effect of beamstop wiring on scattering images

At BL40B2, X-ray scattering measurements are normally performed by placing an ion chamber downstream of the sample to measure transmitted intensity. When an ion chamber cannot be installed, a beamstop with an embedded photodiode is used instead. Because the beamstop is positioned in front of the detector, we investigated how its wiring might affect the scattering image.

The beamstop consists of a 3-mm-diameter tantalum disc embedded with a photodiode (S7481, Hamamatsu Photonics) and centered on a 300-mm-diameter film. Its linearity with respect to X-ray intensity was examined at 12.4 keV, confirming that it operates without problems.

BL40B2 employs a large-area detector, so the distance between the beamstop and its frame is 150 mm. Soldering a fine wire over this span proved difficult; however, using a manual wedge bonder [1] allowed us to join 25-µm-diameter aluminum wires successfully (Fig. 1). To assess the impact of these wires, we recorded scattering images from a glassy carbon. The absorption by the aluminum wire

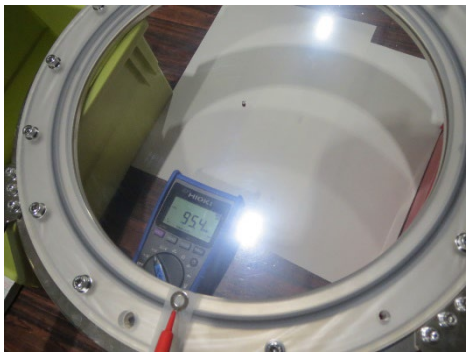

Fig. 1. Beamstop with embedded photodiode soldering 25-µm-diameter aluminum wires.

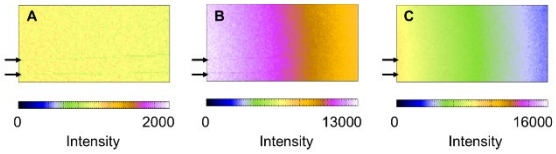

Fig. 2. Glassy carbon scattering images with absorption by 25-µm-diameter aluminum wires (arrows). (a) 6.5 keV. (b) 12.4 keV. (c) 17.5 keV.

appears as a weak line on the image (Fig. 2), and the analysis of this line yields an absorption coefficient that matches the known value for aluminum.

Because the absorption of the 25-µm-diameter aluminum wire is less than 1% at energies above 12.4 keV, it does not cause problems in a line-profile analysis; therefore, we believe that the beamstop with the embedded photodiode can be effectively employed even in SAXS experiments where an ion chamber cannot be installed.

3. Slit-slide mechanism in experimental hutch

At BL40B2, X-ray beam tuning is sometimes carried out without utilizing the mirror in the optical hutch. The unreflected X-rays rise to a height of about 65 mm at the slit position in the upstream of

the experimental hutch, which requires the removal of the 15 kg slits together with the surrounding equipment. The removal process was neither safe nor rapid, and the reproducibility of the slit's position proved problematic.

To address this issue, we deployed a 100 mm slide mechanism for the slits (Fig. 3). This device allows the slits to be retracted quickly and safely, and we have confirmed that it provides sufficient positional reproducibility.

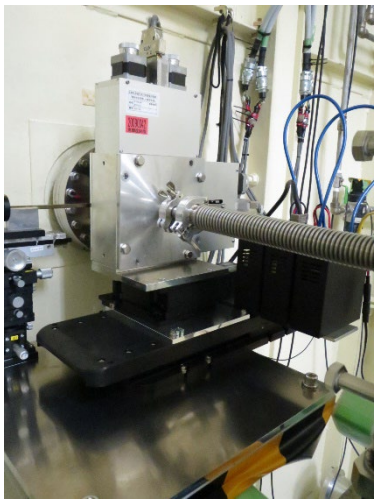

Fig. 3. Slits on the 100 mm slide mechanism.

4. Development of WAXS vacuum chamber system with a beamstop drive mechanism

BL40B2 is equipped with the WAXS vacuum chamber that can be used in either the simultaneous SAXS ($\theta \leq 5°$, θ is the scattering angle) and WAXS ($5< \theta <20°$) mode or in the SAXS/WAXS switched-mode configuration.

When operating in the switched mode, a beamstop is required to absorb the X-ray beam in front of the WAXS detector (an area photon-counting detector). In simultaneous-mode operation, however, a fixed beamstop would block part of the scattered X-rays and create an unmeasurable scattering region; therefore, the beamstop must be removed.

To implement these two modes without incurring the ~2 h of downtime required for venting the WAXS chamber and attaching/detaching the beamstop from the WAXS detector, we added a beamstop rotation drive mechanism to the WAXS vacuum chamber (Fig. 4). The beamstop can be moved into a retracted position when not needed. In the retracted state, we confirmed that neither the beamstop nor its support material appears in the detector image. Beamstop positioning reproducibility is excellent, allowing quick and simple switching between simultaneous and switched measurement modes.

This development is expected to enhance user convenience, provide rapid access to WAXS data, and broaden the scope of analytical information available.

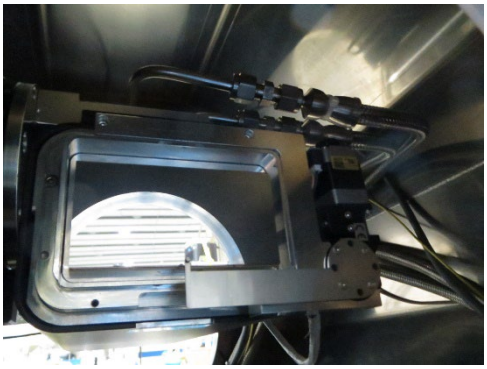

Fig. 4. Beamstop rotation drive mechanism in front of the WAXS detector.

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Reference:

[1] Ohta, N. & Sekiguchi, H. (2023). *SPring-8/SACLA Annual Report FY2023*, 78.