BL01B1
XAFS I

1. Introduction

BL01B1 is a public beamline dedicated to X-ray absorption fine structure (XAFS) measurements using X-rays over a wide energy range between 3.8 keV and 113 keV. It is widely applied to various research fields in materials science and chemistry. In recent years, the beamline has been continuously improved to support advanced in-situ and operando experiments, including the use of reactive gases and combined measurements with other analytical techniques.

In FY2024, the beamline and its experimental station operated stably for user research. The latest information on beamline specifications, XAFS measurement systems, and user manuals is available on the website at https://bl01b1.spring8.or.jp/.

In this report, we describe the recent upgrades and developments at BL01B1, including the evaluation of the newly introduced 36-pixel detector, the installation of a compact multi-sample exchange system, and the improvement of the projection-type spatially resolved XAFS system.

2. 36-pixel Ge solid state detector (SSD)

Regarding the 36-pixel SSD introduced in FY2023 [1], a stage and collision-prevention sensors enabling the safe adjustment of the detector position and switching between fluorescence and transmission modes were installed (Fig. 1), and a measurement program compatible with high-speed measurements was developed. Test measurements and detector performance evaluations were carried out. The digital signal processor (DSP) used was the APU536 from TechnoAP Co., Ltd. Under the condition of a 1 μs peaking time, the full width at half maximum (FWHM) of the Fe Kα line was 200 eV and that of the Pd Kα line was 150 eV, confirming that all 36 pixels exhibited sufficient energy resolution.

Furthermore, under the conditions of Pd Kα line energy and a DSP peaking time of 300 ns, the dead time was estimated from the output obtained by varying the incident X-ray intensity. The results were 1 μs in the A-mode, 2 μs in the H-mode, and 3 μs in the D-mode. Although there were

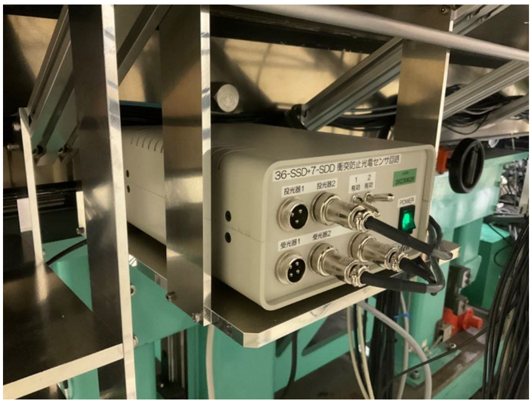

Fig. 1. Collision-prevention sensor and its control circuit box.

differences depending on the storage ring operation mode, the throughput was significantly improved compared with the conventional 19-element SSD.

Thus, the expected performance in terms of throughput, energy resolution, and fast response was achieved. However, background signals that should not have been present in the energy spectra were observed and found to interfere with X-ray absorption spectrum measurements. After consultation with the manufacturer, the detector was returned to the factory for repair. Unfortunately, full-scale user operation could not be achieved in FY2024. In FY2025, fluorescence yield measurements will be conducted using the conventional 19-element SSD, and the 36-pixel detector will be promptly replaced once repairs are completed.

3. Compact automatic sample changer

When conducting measurements with a large number of samples, externally controlled sample exchange using an automated stage is essential to reduce the time and effort required for entering and exiting the experimental hutch. Since the layout on the BL01B1 experimental hutch table is already crowded, it is difficult to install a full-scale multi-sample exchange system such as "HummingBird" at BL14B2. Previously, measurements were carried out sequentially by attaching samples to a plate with 12 holes. To improve efficiency, a new sample exchange system capable of accommodating more samples within a limited space has been introduced (Fig. 2).

Although very compact, the system can hold up to 90 powder samples in acrylic tubes with a diameter of 7 mm (15 tubes × up to 6 rows), which is equivalent to three cartridges of HummingBird. It can also accommodate sheet-type samples, and a dedicated holder has been prepared for standard metal foils that are frequently used at the beamline (Fig. 3). By using this holder, the process of exchanging samples during energy calibration is no longer necessary.

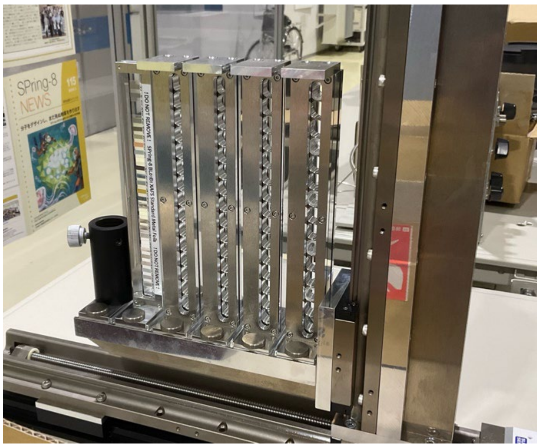

Fig. 2. Overview of the new compact multi-sample exchange system.

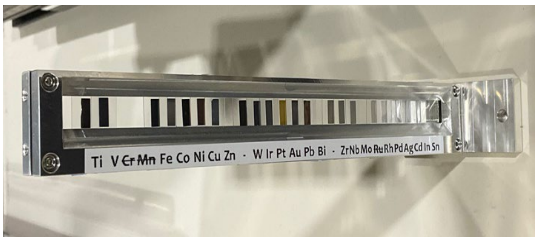

Fig. 3. Dedicated holder for standard metal foils frequently used in energy calibration.

4. Full-field projection QXAFS

Spatially resolved XAFS has been widely used for the analysis of heterogeneous samples or systems that become nonuniform during operation. At BL01B1, projection-type XAFS experiments with a wide field of view are available, complementing the high-spatial-resolution analyses conducted at BL37XU. By utilizing the permanently installed beam monitor for transmission imaging (Fig. 4), imaging XAFS measurements can be conveniently performed, for example, when it becomes necessary during in-situ experiments to promptly evaluate sample inhomogeneity.

In FY2024, improvements were made to this system (Fig. 5). It is now possible to perform seamless two-dimensional detector measurements during routine Quick XAFS scans. Furthermore, adjacent absorption edges can be scanned together, enabling correlated discussions of chemical state mappings of multiple elements based on edge-by-edge analysis [2].

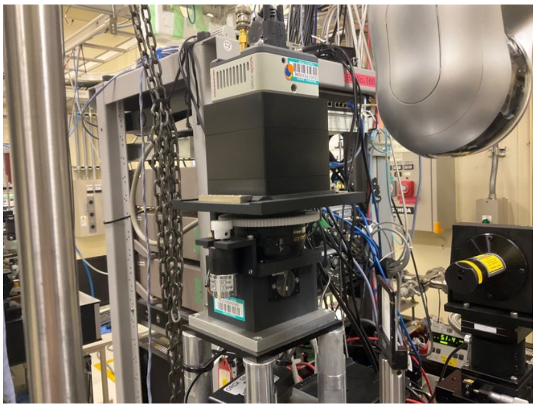

Fig. 4. Photograph of the permanently installed beam monitor for transmission imaging.

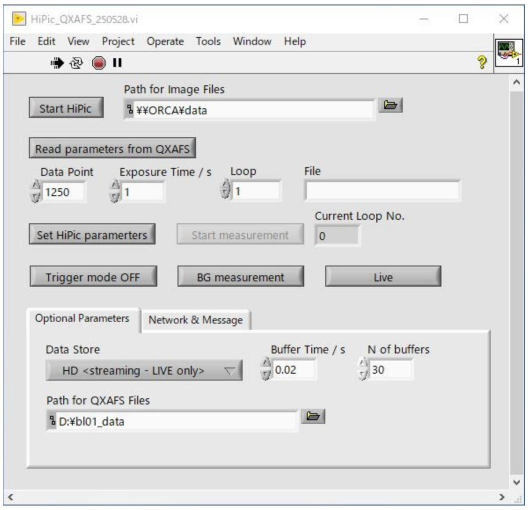

Fig. 5. Measurement software interface for XAFS with two-dimensional detector.

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References:

[1] Kato, K. Katayama, M. Ina, T. & Kudo, T. (2024). *SPring-8/SACLA Annual Report FY2023*, 15–17.

[2] Katayama, M. & Kato, K. (2025). *J. Electrochem. Soc.* **172**, 030511.