BL03XU
Advanced Softmaterial

1. Introduction

BL03XU is the first Japanese beamline designed specifically for the polymer field. This beamline is managed and operated by an industrial and academic joint organization (frontier soft-material beamline consortium: FSBL). FSBL consists of 15 research groups from leading Japanese chemical and textile companies and academic researchers from universities. It has been 10 years since the usage installation contract was approved, and after undergoing the final examination, the second phase of FSBL was started. In the second phase, it will be operated as a beamline dedicated to soft-material structure evaluation with an emphasis on the small-angle X-ray scattering method.

2. Labor saving of small-angle camera distance change system

Until FY2018, the camera distance was changed by fixing the detector position and moving the sample position upstream and downstream. However, adjusting the optical system was time consuming when the camera distance needed to be changed due to the numerous devices around the camera. In FY2019, the layout was changed so that the sample position is fixed, and the detector is moved upstream and downstream.

Figure 1 shows a photograph of the layout for a small-angle scattering measurement with a camera distance of 4 m. As the camera distance changes, the length of the vacuum pipe in the blue part is changed, while the sample in the red part remains the same. The detector behind it is moved upstream.

In addition, the sample mount can move

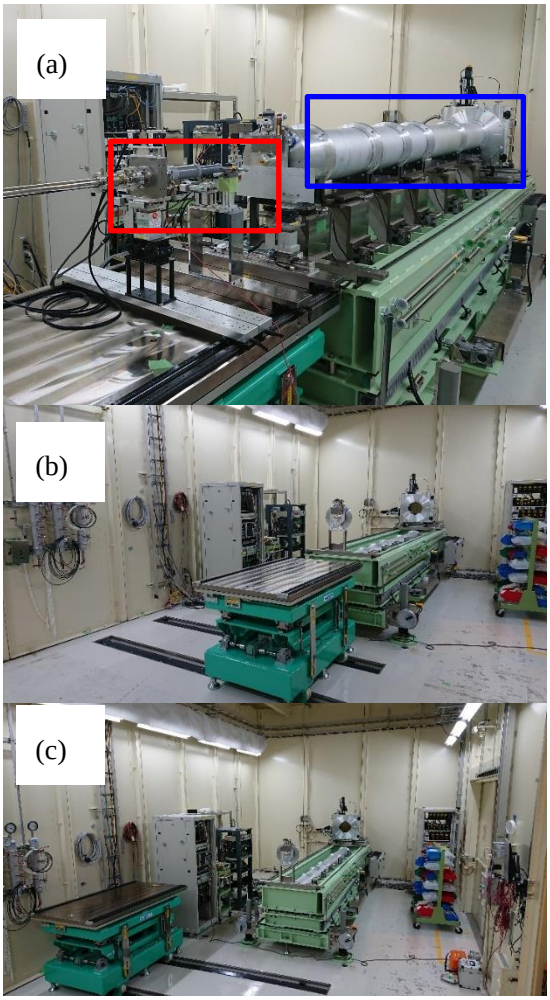

Fig. 1. (a) Small-angle scattering measurement layout with a camera distance of 4 m. Red square contains a guard slit to remove parasitic scattering, a microscope to observe the optical image of the sample, an automatic XZ stage for the sample, a detector for wide-angle scattering measurement, and a device brought in by the user. (b), (c) Photographs before and after evacuation of the sample mount for installation of large equipment, respectively.

significantly on the hutch floor rail. Similar to the old setup, users can bring and install a device as large as 3 m × 3 m × 4 m. It used to take about 1 h to change the layout, but this modification has shortened it to about 10 min. In the future, this process will be fully automated, realizing additional labor savings.

3. Verification of light focusing conditions with mirrors

In the conventional fixed position detector layout, a Kirkpatrick-Baez (KB) mirror is used to focus light on the detector surface to obtain the best angular resolution. In the case of a fixed sample position, the detector moves up and down, making it difficult to change the focusing position of the mirror according to the movement. The bend values of the KB mirror are determined so that the focal spot size does not change significantly in the range of 0.25–4 m.

Figures 2(a) and (b) show the positional dependence of the X-ray size when the Front End slit size is set to 0.3 mm × 0.4 mm and the bend values of the KB mirrors with reflective surfaces horizontally and vertically are changed, respectively. By setting the bend values of the vertical KB mirror to 13,500 pulses and the horizontal to 19,500 pulses, the beam sizes were 30–60 μm and 140–170 μm (FWHM), respectively. Considering that the pixel size of the Pilatus detector is 172 μm × 172 μm, the angular resolution (pixel resolution) in the small-angle scattering measurement can be sufficiently secured.

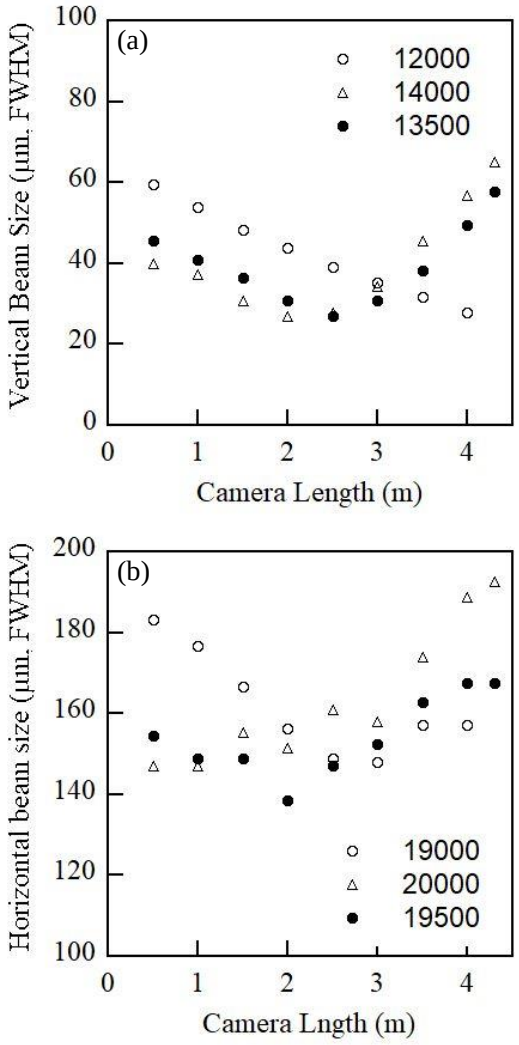

Fig. 2. Beam size at the detector position when the curvature of the mirror (bend value) is changed (a) vertically and (b) horizontally.

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