

## BL 38B1

### RIKEN Structural Biology I

#### 1. Introduction

BL38B1, whose light source is a bending magnet, is a small-angle X-ray scattering (SAXS) beamline dedicated to the structural analysis of biological macromolecules, such as proteins, nucleic acids, and their complexes in solution. In FY2020, a SAXS measurement system was installed, making BL38B1 available to RIKEN researchers and Basis for Supporting Innovative Drug Discovery and Life Science Research by AMED (BINDS) project users. Since 2021B, BL38B1 has been open to public use, focusing on biological SAXS (BioSAXS), particularly size-exclusion chromatography-coupled SAXS (SEC-SAXS).

#### 2. Recent activities

A new microfluidic substrate-type cell for time-resolved SAXS (TR-SAXS) experiments has been installed at BL38B1. This substrate incorporates channels directly milled into the material, enabling solutions introduced through two or three separate channels to mix at a single junction before flowing into a common downstream channel [Fig. 1(a)]. Two types of junction structure are available: one includes a baffle that promotes rapid mixing, while the other lacks such a feature, resulting in laminar flow where mixing proceeds more gradually through diffusion. In this downstream region, the adequate reaction time is determined by both the distance from the mixing point and the total pump flow rate. SAXS measurements are conducted by shifting the X-ray beam irradiation point along the channel at fixed intervals. In practice, this is achieved by scanning the sample stage at fixed

intervals during measurement without moving the X-ray beam axis. The substrate, 1 mm thick, is fabricated from cycloolefin polymer (COP, Zeon). Channels are 1.0 mm wide with depths of either 0.7 mm or 0.5 mm. A 0.1 mm COP film, bonded via silane coupling, seals the milled channels [Fig. 1(b)].

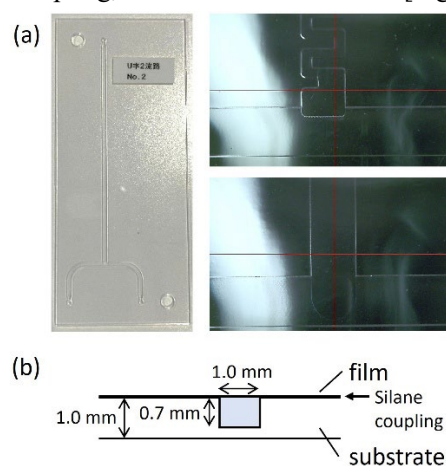


Fig. 1. Microfluidic substrate-type cell.

Solution delivery is regulated using a YSP201 syringe pump (YMC), with software enabling synchronized control of up to four pumps (Fig. 2). This device has already been successfully applied to TR-SAXS measurements of solution-mixing reactions, and further applications are anticipated.

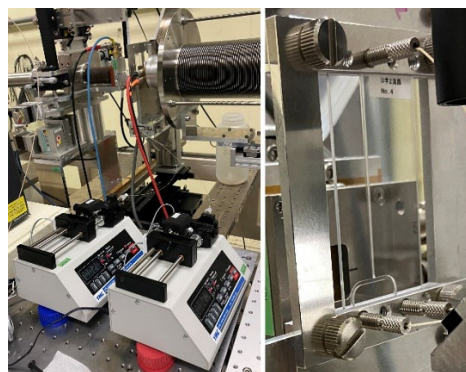


Fig. 2. Whole TR-SAXS system with the microfluidic cell.

The X-ray shutter, which operates in synchronization with the detector, has been upgraded. While the previous system was designed for use in air, the new shutter is compatible with vacuum operation. It can be controlled via either TTL signals or serial communication, with a dedicated control box provided to switch between these modes. Through integration with a device server (NPort 5110A, MOXA), which converts RS-232C to Ethernet, remote control via LAN is also possible.

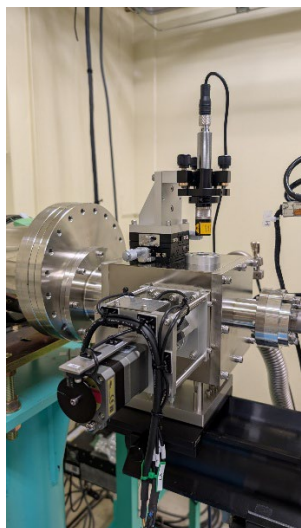


Fig. 3. X-ray beam shutter with the laser system for virtual tracing of the X-ray optical axis (Rigaku Aihara Seiki).

The vacuum chamber housing the shutter is equipped with additional alignment and diagnostic tools. These include a laser system for the virtual tracing of the X-ray optical axis, as well as a dedicated unit for its position and angle adjustment. The Class 2 IEC-certified laser is introduced into the vacuum chamber through a sapphire window and redirected toward the X-ray optical axis using a 90° prism. During laser alignment, the prism blocks the X-ray path; when X-rays are in use, the prism is automatically retracted by a motorized rotation

stage to avoid obstruction. Furthermore, a silicon pin photodiode is mounted on the prism's X-ray receiving surface. When the prism is engaged, this setup enables the direct measurement of the X-ray intensity.

The X-ray detector PILATUS3X 2M (Dectris), installed in FY2014, has now been in operation for over a decade, during which time, signs of aging have begun to appear. In FY2024, the hard disk system of the Disc Control Unit failed, preventing RAID configuration. To resolve this issue and ensure stable operation, the unit was replaced in March 2025.

SEKIGUCHI Hiroshi<sup>1,2</sup>, MASUNAGA Hiroyasu<sup>1,2</sup>, NAGAO Satoshi<sup>1</sup>, MAHMOUD Neimatallah<sup>2</sup>, YAMAMOTO Masaki<sup>2</sup>, and SHIMIZU Nobutaka<sup>2</sup>

<sup>1</sup>Scattering and Imaging Division, JASRI

<sup>2</sup>Life Science Research Infrastructure Group, R&D of technology and systems for synchrotron radiation applications Division, RIKEN SPring-8 Center