

## Upgrades of a TOF single-crystal neutron diffractometer SENJU for improvement of versatility

T. Ohhara<sup>1</sup>, R. Kiyonagi<sup>1</sup>, A. Nakao<sup>2</sup>, K. Munakata<sup>2</sup>, Y. Ishikawa<sup>2</sup>, K. Moriyama<sup>2</sup>, I. Tamura<sup>1</sup>, K. Kaneko<sup>1</sup>

<sup>1</sup>J-PARC Center, Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan,  
<sup>2</sup> Neutron Science and Technology Center, CROSS, Tokai, Ibaraki 319-1106, Japan

*takashi.ohhara@j-parc.jp*

SENJU at J-PARC is a time-of-flight (TOF) single-crystal neutron diffractometer designed for precise crystal and magnetic structure analyses under multiple extreme environments, such as low-temperature, high-pressure and high-magnetic field, as well as for taking diffraction intensities of small single crystals with a volume of less than 1.0 mm<sup>3</sup> down to 0.1 mm<sup>3</sup> [1]. We have recently upgraded some SENJU components, such as sample environment devices, the detector system, and data processing software. These upgrades of SENJU enhance the possibility and accessibility of SENJU, in other words, improvement of versatility. In this presentation, we will introduce the recent upgrades of SENJU for the improvement of its versatility.

A major advance in the sample environment is installing a radial oscillating collimator (ROC). The ROC can cut the neutron scattering from vacuum vessels of extreme sample environment devices, making low-background measurements with extreme conditions possible. By using the ROC, we can obtain low-background diffraction data with a dilution cryostat ( $T > 50$  mK), a liquid-He free cryostat ( $T > 300$  mK), a cryo-furnace ( $700 \text{ K} > T > 10 \text{ K}$ ), a niobium-furnace ( $T < 1300 \text{ K}$ ), and a superconducting magnet ( $B < 6.8 \text{ T}$ ,  $T > 50 \text{ mK}$ ).

As an upgrade of the detector system, we added four area-detectors to SENJU in the obliquely downward direction of the sample position. The additional detectors can cover the blind region in the reciprocal space when measuring a low-symmetry sample and improve the measurement efficiency of low-symmetric molecular crystals.

A significant part of software upgrades is an improvement of accessibility. We have developed remote-access data processing software installed on a cloud computing system and works on various web browsers. This software will make remotely access to the measured data from users' laboratories easy even in the COVID-19 situation.

[1] Ohhara, T., Kiyonagi, R., Oikawa, K., Kaneko, K., Kawasaki, T., Tamura, I., Nakao, A., Hanashima, T., Munakata, K., Moyoshi, T., Kuroda, T., Kimura, H., Sakakura, T., Lee, C. H., Takahashi, M., Ohshima, K., Kiyotani, T., Noda, Y. & Arai, M. (2016). *J. Appl. Cryst.* **49**, 120.

**Keywords: J-PARC; Single-crystal neutron diffraction; SENJU; Materials science**