

2 . Activities at Sendai NanoTerasu

1. Transition to Sendai NanoTerasu and Facility Development

The management of the University of Tokyo high-brilliance, polarization-controlled 25-meter-long soft X-ray undulator beamline BL07LSU was transferred to the RIKEN SPring-8 Center in September 2022, marking the beginning of a new chapter for the organization. Following this transition, the Sendai office was established in November 2022 on the Aobayama campus of Tohoku University under the auspices of a new SRRO launched in April 2022, which includes six departments of the University of Tokyo. This strategic positioning facilitated the organization's involvement in the development of the new 3 GeV synchrotron facility NanoTerasu in Sendai, which began commissioning of its storage ring in early 2023.

At the end of fiscal year 2022, three critical endstations were relocated from SPring-8 to NanoTerasu: the ambient pressure X-ray photoemission spectroscopy (APXPS) station, the 3D-scanning photoelectron microscope (nanoESCA) station, and the high-resolution soft X-ray emission spectroscopy (HORNET) station.

2. Beamline Construction and Commissioning Activities

Throughout 2023, the Sendai office actively participated in establishing endstations at the soft X-ray beamlines BL07U and BL08U of NanoTerasu while collaborating with the Photon Science Innovation Center (PhoSIC) and the National Institutes for Quantum Science and Technology (QST) in the construction of these beamlines. The three endstations resumed commissioning activities during the summer of 2023 and were successfully realigned to their respective beamlines by the end of the fiscal year, with the nanoESCA and HORNET stations positioned at BL07U and the APXPS station at BL08U.

The infrastructure development proceeded smoothly throughout the year, with focusing mirrors and diffraction gratings installed upstream of both BL07U and BL08U beamlines. A significant milestone was achieved on December 7, 2023, when NanoTerasu successfully generated its first beam, marking the first introduction and observation of synchrotron radiation X-rays from insertion devices installed in the storage ring to the experimental hall.

3. Performance Evaluation and Technical Achievements

During the commissioning phase at the end of FY 2023, each endstation demonstrated preliminary operational capabilities. Optical adjustments for guiding synchrotron

radiation commenced in late February 2024, followed by actual delivery of synchrotron radiation to the endstations for equipment calibration, performance evaluation, and energy calibration. At BL08U, the APXPS system successfully achieved pressure ranges of 10-100 Torr for XPS measurements, maintaining its capability for operando observations of catalytic reactions at gas/solid interfaces. Upstream of the APXPS system a soft X-ray nano-focusing absorption spectroscopy apparatus was also installed. At BL07U, the 3DnanoESCA station obtained a spatial resolution of approximately 100-200 nm, enabling sub-microscopic chemical mapping and depth profiling capabilities. The HORNET station provided spectra with energy resolution around 500 meV at 500 eV, supporting high-resolution soft X-ray emission spectroscopy measurements.

4. Future Prospects and Operational Preparation

On March 25, 2024, the Sendai office completed its relocation to the SRIS (International Center for Synchrotron Radiation Innovation Smart) building of Tohoku University from the Agricultural Research Building to the SRIS building within the Aobayama campus of Tohoku University, positioning itself as one of the facilities closest to NanoTerasu. The SOR member at the Sendai office continued working toward the commencement of operations in the beginning of April 2024. Young staff members are actively engaged in developing related technologies to support these advanced capabilities.

While current achievements at NanoTerasu remain considerably below the standards established at SPring-8, significant improvements are anticipated as the beamlines undergo final alignment procedures following the official commencement of operations in April 2024. The foundation established during this transitional year positions the facility to recover and ultimately exceed the performance criteria previously achieved, enabling advanced soft X-ray spectroscopy research and operando experimental capabilities for the broader scientific community.