Preface

The Synchrotron Radiation Laboratory (SRL) of the Institute for Solid State Physics (ISSP) advances novel materials research by developing soft X-ray spectroscopic techniques using high-brilliance synchrotron radiation sources and soft X-ray lasers at three locations: Harima, Sendai, and Kashiwa.

At the Harima office, the world's highest-performance fast polarization-switching soft X-ray undulator beamline was used for joint research until August 3, 2022, and then transferred to RIKEN. There, a soft X-ray spectroscopic imaging station (including ptychography) has been developed in collaboration with RIKEN SPring-8 since the end of 2022. The novel soft X-ray ptychography system, which uses a total-reflection Wolter mirror, has a resolution of approximately 50 nm, and its long working distance allows for stereo imaging with a high rotation angle. At the X-ray free-electron laser facility, SACLA, nonlinear soft X-ray spectroscopy was developed, exploring its potential as a new spectroscopy method.

To advance measurement techniques in the soft X-ray region, the Sendai Office opened near the new 3 GeV X-ray source facility "NanoTerasu" at the Aobayama new campus of Tohoku University in November 2022. The ambient-pressure photoelectron spectroscopy (APXPS) station, the high-resolution soft X-ray emission spectroscopy (HORNET) station, and the nanoESCA station were relocated from SPring-8 to NanoTerasu, which began commissioning its storage ring in early 2023. On March 25, 2024, the Sendai office relocated to the SRIS (International Center for Synchrotron Radiation Innovation Smart) building of Tohoku University, one of the closest buildings to NanoTerasu. The three endstations resumed commissioning in the summer of 2023 and were realigned to the beamlines BL07U (nanoESCA and HORNET) and BL08U (APXPS) by the end of FY 2023. During commissioning, the APXPS system achieved 10-100 Torr for XPS measurements; the nanoESCA station obtained a spatial resolution of roughly 100-200 nm; and the HORNET station provided spectra with an energy resolution of around 500 meV at 500 eV. While these achievements at NanoTerasu were initially below the standards established at SPring-8, they have since recovered and even exceeded the criteria after the beamlines were aligned following the official operation commencement in April 2024. More details will be reported in subsequent publications.

In addition to the cutting-edge activities using synchrotron radiation and SACLA, the SRL has promoted the scientific use of laser-based high-harmonic generation in the vacuum ultraviolet and soft X-ray regions at the E-building of the Kashiwa campus, in collaboration with Kobayashi and Itatani laboratories of the LASOR laser group. Since 2015, the SRL has operated a joint research program using the high-resolution laser spin- and angle-resolved photoelectron spectroscopy (SARPES) system, designed to provide high energy (1.7 meV) and angular resolutions with high-efficiency spin detectors for various types of solids, such as spin-orbit coupled materials and ferromagnetic materials.

In 2023, an autocollimator and a laser evaluation system, such as FROG, were assembled to improve the stability of the light source (color dispersion and multi-pulse). Additionally, the introduction of a new amplifier (rod fiber) has enabled the use of higher-power light. Currently, the pulse laser and optical system are being adjusted to stably use high-power, high-quality light using the assembled laser evaluation system. This will enable stable operation of pump-probe time-resolved SARPES as well as wavelength conversion of pump light. We have also developed a two-dimensional angle- and time-resolved photoemission spectrometer, which has been available for joint research use since 2022.

Our goal is to provide users with a platform that utilizes both synchrotron radiation and high-harmonic laser generation through strong collaboration with other LASOR group members.

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Yoshihisa Harada
Director of SRL-ISSP