RESEARCH FACILITIES

The Institute includes five research facilities, UVSOR Synchrotron Facility, Instrument Center, Equipment Development Center, Research Center for Computational Science (Okazaki Research Facilities), and Okazaki Collaborative Platform (Okazaki Research Facilities).

UVSOR Synchrotron Facility

KERA, Satoshi	Director, Professor
MATSUI, Fumihiko	Professor
KANEYASU, Tatsuo	Professor
KATOH, Masahiro	Project Professor (Hiroshima Univ.)
TANAKA, Kiyohisa	Associate Professor
TAIRA, Yoshitaka	Associate Professor
ARAKI, Tohru	Senior Researcher
IWAYAMA, Hiroshi	Senior Researcher
IZUMI, Yudai	Research Lecturer
SATO, Yusuke	Assistant Professor
KATAYANAGI, Hideki	Research Associate
HAGIWARA, Kenta	IMS Fellow
MATSUDA, Hiroyuki	Post-Doctoral Fellow
HAYASHI, Kenji	Chief Engineer (Unit Leader)
NAKAMURA, Eiken	Chief Engineer
OKANO, Yasuaki	Chief Engineer
MAKITA,Seiji	Engineer
SAKAI, Masahiro	Chief Technician
YANO, Takayuki	Chief Technician
TESHIMA, Fumitsuna	Chief Technician
KONDO, Naonori	Chief Technician
YUZAWA, Hayato	Chief Technician
OTA, Hiroshi	Technician (SPring-8)
SHIMIZU, Kohei	Technician
MINAKUCHI, Aki	Technical Support Staff
MIZUKAWA, Tetsunori	Technical Support Staff
YAMAZAKI, Jun-ichiro	Technical Support Staff
ISHIHARA, Mayumi	Secretary
KAMO, Kyoko	Secretary
YOKOTA, Mitsuyo	Secretary

Outline of the UVSOR Synchrotron Facility

Since the first light in 1983, the UVSOR Synchrotron Facility has been successfully operated as one of the major synchrotron light sources in Japan. After the major upgrade of accelerators in 2003, UVSOR Synchrotron was renamed to UVSOR-II Synchrotron and became one of the world's brightest low energy synchrotron light sources. In 2012, it was upgraded again and has been renamed to be UVSOR-III Synchrotron. The brightness of the electron beam was increased further. The storage ring, *ca.* 53 meters in circumference, is regularly operated in the top-up mode, irrespective of multi bunches or single bunch. We have also been planning Post-UVSOR-III as a long-term strategy for sustainable development to UVSOR-IV.[1)]

The UVSOR accelerator complex consists of a 15 MeV injector LINAC, a 0.75 GeV booster synchrotron, and a 0.75 GeV storage ring. The magnet lattice of the storage ring consists of four extended double-bend cells with distributed dispersion function. The single bunch top-up operation (176 ns, 5.6 MHz) for time-resolved measurements or low current measurements is also conducted for two weeks per year.

Six undulators and eight bending magnets provide synchrotron radiation (SR). The bending magnet, its radius of 2.2 m, produces SR with the critical energy of 425 eV. There are eight bending magnet beamlines (Table. 1). Three of the six undulators are in-vacuum soft X-ray (SX) linear-polarized undulators (BL3U, BL4U, and BL6U) and the other three are vacuum/extreme ultraviolet (VUV/XUV or EUV) circular-polarized undulators (BL1U, BL5U, and BL7U). Two beamlines, BL1U and BL6U, are so-called "in-house beamlines," which are dedicated to strategic projects conducted by internal IMS groups in tight collaboration with domestic and foreign scientists. Other beamlines are so-called "public beamlines," which are open to scientists from universities, governmental research institutes, public and private enterprises, and also to overseas scientists. After each development, the in-house beamline will be opened for use as a public beamline.

From the viewpoint of photon energies, we have one SX station equipped with a double-crystal monochromator, seven SX stations with a grazing incidence monochromator, three VUV stations with a normal incidence monochromator, two IR/THz stations equipped with Fourier transform interferometers and one beamline for light source development without any monochromators.

Table 1. List of beamlines at UVSOR-III Synchrotron.

Beamline	Optics	Energy Range	Targets	Techniques
BL1B	Martin-Puplett FT-FIR	0.5-30 meV	Solid	Reflection/Adsorption
BL6B	Michelson FT-IR	4 meV-2.5 eV	Solid	Reflection/Adsorption
BL7B	3-m normal incidence	1.2-25 eV	Solid	Reflection/Adsorption
BL3B	2.5-m off-plane Eagle	1.7-31 eV	Solid	Reflection/Absorption
BL5B	Plane grating	6-600 eV	Solid	Calibration/Absorption
BL4B	Varied-line-spacing plane grating (Monk-Gillieson)	25 eV-1 keV	Gas, Liq. Solid	Photoionization, XAFS Photodissociation, XMCD
BL2A	Double crystal	585 eV-4 keV	Solid	Reflection/XAFS
BL1U	Tandem undulators/ Free electron laser	1.6-13.9 eV	Gas Solid	Laser Compton Scattering Orbital Momentum Light
BL7U	10-m normal incidence (modified Wadsworth)	6-40 eV	Solid	Photoemission
BL5U	Varied-line-spacing plane grating (Monk-Gillieson)	20-200 eV	Solid	ARPES Spin-resolved ARPES
BL6U	Variable-inc.-angle-varied-line-spacing plane grating	40-700 eV	Solid	ARPES XAFS / XPD
BL4U	Varied-line-spacing plane grating (Monk-Gillieson)	50-700 eV	Gas, Liq. Solid	XAFS Microscopy (STXM)
BL3U	Varied-line-spacing plane grating (Monk-Gillieson)	60-800 eV	Gas, Liq. Solid	XAFS / Photoemission Photon-emission

Inter-University and International Collaboration Programs

A variety of molecular science and related subjects have been carried out at UVSOR Synchrotron Facility by IMS and external/overseas researchers. The cumulative total number of visiting researchers (person-days) per year tops > 5000, who come from > 60 different institutes. International collaborations are also pursued actively, and the number of visiting foreign researchers reaches ~70. UVSOR-III Synchrotron invites new/continuing research proposals twice a year. The proposals both for academic and public research (charge-free) and for private enterprises (charged) are acceptable. The fruits of the research activities using UVSOR-III Synchrotron are published as the UVSOR ACTIVITY REPORT annually.

Return of Beam Current Value from 200 mA to 300 mA

Since January 2023, the amount of charge that can be injected into the storage ring has decreased, so from May 2023, the stored beam current value was reduced from 300 mA to 200 mA, and user operations were continued. The cause of the decrease in injection charge was that the electron beam was accelerated under unstable conditions in the booster synchrotron, which is a device that accelerates an electron beam to 750 MeV. In ring-type accelerators, there is a phenomenon that induces instability in the electron beam. It is thought that the operating conditions of the booster synchrotron matched the unstable conditions, causing the spatial spread of the electron beam to increase and resulting in a decrease in the amount of charge injected into the storage ring. To avoid unstable conditions, the excitation waveform of the electromagnets in the booster synchrotron was changed. As a result, it was confirmed that the spatial spread of the electron beam became smaller and the amount of charge that could be incident increased to at least the same level as before 2023. User operation began in June 2025 with a storred beam current value of 300 mA. However, after replacing the vacuum ducts of the booster synchrotron, which had been leaking vacuum, in April 2025, the amount of charge circulating in the booster synchrotron decreased by 50%. The cause is currently unknown. As a result of this impact, operation is being conducted with an increased number of beam injections.

Recent Developments

In line with the ongoing upgrade plan at SPring-8, it was officially decided that the infrared beamline BL43IR will be shut down at the end of FY2025, since the future ring design will no longer allow efficient extraction of infrared radiation. Recognizing the continuing demand for synchrotron-based infrared research, UVSOR has taken the initiative to provide an alternative platform for the BL43IR user community. On September 20, 2023, the "UVSOR/SPring-8 Infrared Beamline Joint Users' Meeting" was held at IMS. In this meeting, the infrared beamline BL6B at UVSOR was introduced to BL43IR users, and discussions were conducted on the transition of research activities from SPring-8 to UVSOR. As an outcome, preparations have been launched to transfer experimental capabilities and to ensure that users can continue advanced infrared studies at UVSOR.

As a first step of performance evaluation, measurements of human hair samples were carried out at BL6B by Dr. Ikemoto, the beamline scientist of SPring-8 BL43IR.[2] These samples, which have been used as reference specimens at BL43IR, enable assessment of spatial resolution and signal-to-noise characteristics of the microspectroscopy system. The sliced hair samples were prepared with an optimized thickness (~10 µm) and mounted on BaF_2 substrates. Using a JASCO FT/IR-6100, IRT-7000 microscope system, absorption spectra and infrared imaging were obtained under transmission configuration with various optical conditions. The comparison between BL6B and BL43IR clarified both the potential and the current challenges at UVSOR as shown in Figure 1. In particular, mapping of the C–H stretching band (2805–3141 cm^{-1}) revealed the internal cortex structure of hair fibers with sufficient resolution. However, it was also found that when using SR with a linear array detector, the SR spot size is too small to be effectively utilized, resulting in non-uniform images. Based on this observation, a practical measurement strategy has been proposed: To employ the standard internal light source together with a linear array detector for rapid imaging of many samples, and to reserve SR combined with a single-element detector for detailed and high-resolution analysis of selected regions. This dual approach allows both efficient throughput and precise characterization.

These results indicate that UVSOR BL6B can provide a robust platform for continuing infrared microspectroscopy previously performed at BL43IR, while highlighting the need for optimized measurement schemes. Further development of sample environment control devices, including humidity and temperature regulation, is planned to broaden the research scope. UVSOR is committed to supporting the BL43IR user community and to ensuring a smooth and effective transition of their research activities in the coming years.

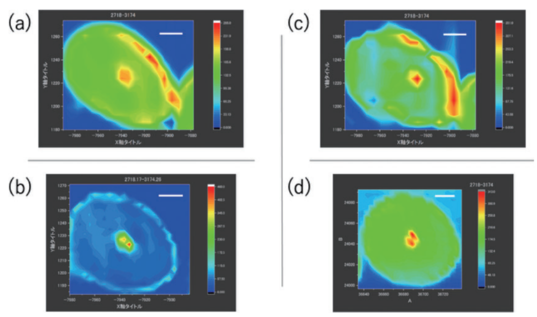

Figure 1. Infrared imaging of sliced human hair samples showing intensity maps of the C–H stretching band: (a) BL6B with standard light and linear array MCT detector; (b) BL6B with SR and single-element MCT detector; (c) BL6B with SR and linear array MCT detector; (d) BL43IR/SPring-8 with SR and single-element MCT detector.

References

1) S. Kera *et. al.*, *Electron. Struct.* **5**, 034001 (2023).
2) *UVSOR Activity Report* **51** (2025), in press.

Instrument Center

YOKOYAMA, Toshihiko	Director, Professor
SUZUKI, Toshiyasu	Team Leader
NAKAMURA, Toshikazu	Team Leader
MINATO, Taketoshi	Senior Researcher
SHIGEMASA, Eiji	Unit Leader
TAKAYAMA, Takashi	Chief Engineer
UEDA, Tadashi	Engineer
FUJIWARA, Motoyasu	Chief Technician
ASADA, Mizue	Chief Technician
OKANO, Yoshinori	Technician
URUICHI, Mikio	Technician
MIYAJIMA, Mizuki	Technician
NAGAO, Haruyo	Technician
HIRANO, Kaho	Technician
MINAMINO, Yu	Technician
MANDAI, Kyoko	Technician
ISHIYAMA, Osamu	Project Manager
NAKAMOTO, Keiichi	Project Manager
OTA, Yasuhito	Project Manager
KAKU, Mie	Project Manager
OHARA, Mika	Research Fellow
IKI, Shinako	Technical Associate
ISHIDA, Himawari	Technical Associate
KUBOTA, Akiko	Technical Support Staff
IMAI, Yumiko	Technical Support Staff
UCHIDA, Mariko	Technical Support Staff
IWASE, Mahiro	Technical Support Staff
FUNAKI, Yumiko	Secretary
HYODO, Yumiko	Secretary
KURITA, Yoshiko	Secretary
TOYAMA, Yu	Secretary

Instrument Center was organized in April of 2007 by integrating the general-purpose and state-of-the-art facilities of Research Center for Molecular Scale Nanoscience and Laser Research Center for Molecular Science. The mission of Instrument Center is to support in-house and external researchers in the field of molecular science, who intend to conduct their researches by utilizing general-purpose and state-of-the-art instruments. The staffs of Instrument Center maintain the best conditions of the measurement apparatuses, and provide consultation for how to use them.

The main instruments the Center now maintains in Yamate campus are: Nuclear magnetic resonance (NMR) spectrometers (JNM-ECA 600, JNM-ECZL 600, and JNM-ECS400 for solutions), matrix assisted laser desorption/ionization time-of-flight (MALDI TOF) mass spectrometer (microflex LRF, Bruker Daltonics), ESI-TOF mass spectrometer (Bruker Daltonics, maXis), double-focusing mass spectrometer (JEOL JMS-777V), powder X-ray diffractometer (Rigaku RINT-Ultima III), molecular structure analysis using crystalline sponge method (Rigaku SuperNova), circular dichroism (CD) spectrometer (JASCO J-1500), differential scanning calorimeter (MicroCal VP-DSC), isothermal titration calorimeter (MicroCal PEAQ-iTC & iTC200), field emission transmission electron microscope (JEOL JEM-2100F), elemental analyzer (J-Science Lab Micro Corder JM10), ICP atomic emission spectroscopy (Agilent 5110 ICP-OES), fluorescence spectrometer (JASCO FP-8650DS), fluorescence lifetime spectrometer (Quantaurus-Tau C16361-01), electron probe microanalyzer (EPMA, JEOL JXA-8230/SS-94000SXES), and automatic organic molecular synthesis (Cole-Parmer reaction station Integrity 10).

In the Myodaiji campus, the following instruments are installed: Electron spin resonance (ESR) spectrometers (Bruker E580, E680, E500, EMX Plus, nanosecond pulsed laser for time resolved experiments), NMR spectrometer (Bruker AVANCE600 for solids), superconducting quantum interference devices (SQUID; Quantum Design MPMS-7, MPMS-XL7, MPMS-3), solid-state calorimeter (Rigaku DSC8231/TG-DTA8122), solution X-ray diffractometer (Rigaku NANO-Viewer), single crystal X-ray diffractometers (Rigaku Mercury CCD-1, CCD2, RAXIS IV, Rigaku HyPix-AFC, and Rigaku XtaLAB Synergy-R/DW), operando multipurpose x-ray diffraction for powder and thin films (Panalytical Empyrean), thermal analysis instruments (Rigaku DSC8231/TG-DTA8122), fluorescence spectrometer (SPEX Fluorolog), UV-VIS-NIR spectrometer (Shimadzu UV-3600Plus), Absolute PL quantum yield measurement (Hamamatsu Photonics Quantaurus-QY C11347-01), Raman microscope (Renishaw INVIA REFLEX 532), picosecond tunable laser system (Spectra Physics Tsunami and Quantronix Titan/Light Conversion TOPAS), low vacuum analytical SEM (Hitachi SU6600), angle resolved ultraviolet photoelectron spectroscopy (ARUPS) for functional band structures (Scienta-Omicron DA30), FTIR spectrometer (Bruker IFS 66v/S), two sets of *operando* scanning probe microscopes

(Bruker Dimension XR Icon Nanoelectrical & Nanoelectrochemical), and electron spectrometers for chemical analysis (ESCA) equipment (Scienta-Omicron, R4000L1).

In the fiscal year of 2024, Instrument Center accepted 148 applications from outside and the total user time amounted 2,598 days for outside and 1,209 days for in-house. Instrument Center also maintains helium liquefiers in the both campus and provides liquid helium to users (52,220 L/year). Liquid nitrogen is also provided as general coolants used in many laboratories in the Institute (41,871 L/year).

Instrument Center also organizes the Inter-University Network for Common Utilization of Research Equipments and the ARIM (Advanced Research Infrastructure for Materials and Nanotechnology in Japan) Program (FY2021–2030) supported by Ministry of Education, Culture, Sports, Science and Technology. These special programs are described in the other chapter of the booklet.

Awards

NAKAMURA, Toshikazu; 2024 Society Award of the Society of Electron Spin Science and Technology (SEST) in Japan (2024).

NAKAMURA, Toshikazu; “Outstanding Achievements” of ARIM Japan, MEXT (2025).

Equipment Development Center

YAMAMOTO, Hiroshi	Director
KONDO, Takuhiko	Chief Engineer (Unit Leader)
TOYODA, Tomonori	Chief Engineer
MATSUO, Junichi	Chief Technician
TAKADA, Noriko	Chief Technician
KIMURA, Sachiyo	Technician
KIMURA, Kazunori	Technician
MIYAZAKI, Yoshino	Technician
ISOGAI, Toshifumi	Technician
SAWADA, Toshihiro	Technical Support Staff
ISHIKAWA, Akiko	Technical Support Staff
SUGANUMA, Kouji	Technical Support Staff
INAGAKI, Itsuko	Secretary

Research and development of novel instruments demanded in the forefront of molecular science, including their design and fabrication, are the missions of this center. Technical staffs in the three work sections, mechatronics, electronics and lithography are engaged in developing state-of-the-art experimental instruments in collaboration with scientists. We expanded our service to other universities and research institutes since 2005, to contribute to the molecular science community and to improve the technology level of the center staffs. A few selected examples of our recent developments are described below.

Manufacturing Methods for Soft Materials

When developing original equipment, one of the common challenges is securing materials during machining. This issue became particularly evident in the fabrication of components for the low-temperature goniometer stage we produced last year (Figure 1). The stage is composed of numerous small parts, each requiring precise shaping and surface uniformity.

Typically, a vise is used to fix materials on a milling machine. However, depending on the material and thickness, clamping pressure can cause deformation, leading to uneven surfaces. This problem was especially pronounced with resin parts compared to metal ones. To overcome this, we devised an alternative method based on adhesion rather than clamping.

Specifically, we prepared a centering jig, attached the large surface of the material using double-sided adhesive tape, and constrained three surrounding sides to prevent dislodgement. This approach allowed us to machine the surface uniformly without deformation (Figure 2).

Through such efforts, we continue to refine machining techniques by designing custom jigs and exploring new methods to ensure high-precision fabrication of soft and delicate materials.

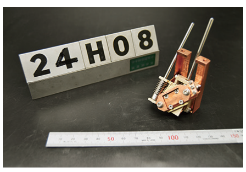

Figure 1. Low-Temperature Goniometer Stage.

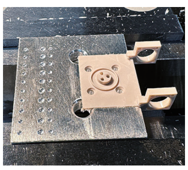

Figure 2. Part attached to original jig.

Development of Network-Compatible 4-Channel AD Converter Module

Many laboratory instruments, such as vacuum gauges, provide analog voltage outputs but lack network connectivity. To enable remote monitoring of such devices, we developed a compact 4-channel AD converter module based on the ESP32 microcontroller and its evaluation board (Figure 3).

The module is powered *via* a USB Type-C connector (5 V, 0.5 A) and can connect either to a 2.4 GHz Wi-Fi station or operate as an access point. An integrated OLED display provides basic information such as the device MAC address, connection status, and real-time voltage readings, making the module suitable for both networked and standalone use.

The system supports simultaneous measurement of four voltage inputs within a ±10 V range, with 16-bit resolution provided by the A/D converter and pre-amplifier circuitry. While the acquisition rate is modest (approximately one second per measurement), the module includes a microSD card slot, enabling continuous long-term operation over several months depending on storage capacity. Data can be retrieved *via* any HTTP or WebSocket client, and a dedicated monitoring dashboard is under development for consolidated observation of multiple units (Figure 4).

Initially, one prototype was produced at the request of a researcher. Following its successful demonstration, ten additional units were manufactured for the UVSOR Synchrotron Facility. These deployments confirm the module's practicality as a flexible solution for extending network capability to analog-output instruments.

Figure 3. Module overview.

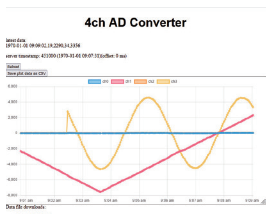

Figure 4. Monitoring web application.

Research Center for Computational Science (Okazaki Research Facilities)

EHARA, Masahiro	Director, Professor
SAITO, Shinji	Professor
OKUMURA, Hisashi	Associate Professor
OKAZAKI, Kei-ichi	Associate Professor
OONO, Hitoshi	Associate Professor
UCHIYAMA, Ikuo	Associate Professor
OHNUKI, Jun	Assistant Professor
SHIRAOGAWA, Takafumi	Assistant Professor
ISHIDA, Tateki	Research Associate
IWAHASHI, Kensuke	Chief Engineer (Unit Leader)
MIZUTANI, Fumiyasu	Engineer
KAMIYA, Motoshi	Engineer
NAITO, Shigeki	Chief Technician
SAWA, Masataka	Chief Technician
NAGAYA, Takakazu	Chief Technician
KINOSHITA, Takamasa	Technician
SUZUKI, Kazuma	Technician
KANESHIRO, Ikuma	Technician
YAZAKI, Toshiko	Technical Associate
UNO, Akiko	Technical Support Staff
KONDO, Noriko	Secretary
URANO, Hiroko	Secretary
IIDA, Kaoru	Secretary

Research Center for Computational Science provides state-of-the-art computational resources to academic researchers in molecular science and related fields, e.g. solid state physics, biophysics, basic biology, and physiology. Our systems consist of HPE Apollo 2000 and Apollo 6500 (since Feb. 2023). The combined system, named "Molecular Simulator," is ranked 196th position in the TOP500 supercomputer list in June 2023. These massive computer resources have been used for various kinds of large-scale calculations, for example accurate electronic structure calculations of molecular systems and conformation searches using generalized ensemble methods. We also provide about 30 application programs to the users: Gaussian, ORCA GAMESS, AMBER, Gromacs, and so on. In particular, we have implemented some original programs developed by researchers in Japan to provide them to the users. From the fiscal year 2024, supercomputer of NIBB was also integrated to the system. The supercomputer systems had been used by 1,737 researchers from 429 groups in the fiscal year 2024. Some of the computational resources are provided to the national projects, Program for Promoting Research on the Supercomputer Fugaku and Program for Data-Driven Material Research and Development.

For fostering young generation, we organize the schools of quantum chemistry and molecular dynamics simulation every year. In the fiscal year 2024, the numbers of registered attendants of these schools were 348 and 365, respectively. We also organize the RCCS supercomputer workshop focusing on the new trends of computational chemistry for the purpose of the research exchange and human resource development. In the fiscal year 2024, we organized the workshop under the title, "Materials Design and Development based on AI/ML: Interplay between Theory and Experiment," which was attended by about 200 researchers.

In cooperation with Institute for Solid State Physics, University of Tokyo, Institute for Materials Research, Tohoku University and R^3 Institute of Newly-Emerging Science Design, University of Osaka, we established the Computational Materials Science Forum (CMSF) to promote the cutting-edge computational materials science technology of Japan, to create world-class results, and to realize the social implementation of simulation technology and materials information science technology.

The center is jointly managed with National Institute for Physiological Sciences and National Institute for Basic Biology (both in the same campus).

Figure 1. HPE Apollo 2000 and Apollo 6500.

Okazaki Collaborative Platform (Okazaki Research Facilities)

Core for Spin Life Sciences

YAMAMOTO, Hiroshi	Professor
NISHIMURA, Katsuyuki	Associate Professor
MOMIYAMA, Norie	Associate Professor
INOMATA, Kohsuke	Research Associate Professor
SUZUKI, Toshiyasu	Team Leader
NAKAMURA, Toshikazu	Team Leader
MINATO, Taketoshi	Senior Researcher

The Okazaki Collaboration Platform was established in July 2024 as an organization to promote interdisciplinary research that transcends the boundaries of the three Okazaki institutions (National Institute for Basic Biology, National Institute for Physiological Sciences, and Institute for Molecular Science). In the field of molecular science, the platform aims to elucidate the diverse structures, properties, reactivity, catalytic activity, energy conversion, and other higher-order functions and dynamic structures exhibited by atoms, molecules, and life systems through the development and application of computational science methods, the development of advanced research techniques and light sources using light, and the design and high-density integration of new molecules and materials. Furthermore, it endeavors to conceptualize and regulate novel phenomena and functionalities. Additionally, the platform will enhance its efforts to foster internationally distinguished young researchers by collaborating with universities and research institutions both domestically and internationally.

As of November 2024, the “Core for Spin Life Science” and “Open Mix Lab [OML OKAZAKI]” have been established under this platform.