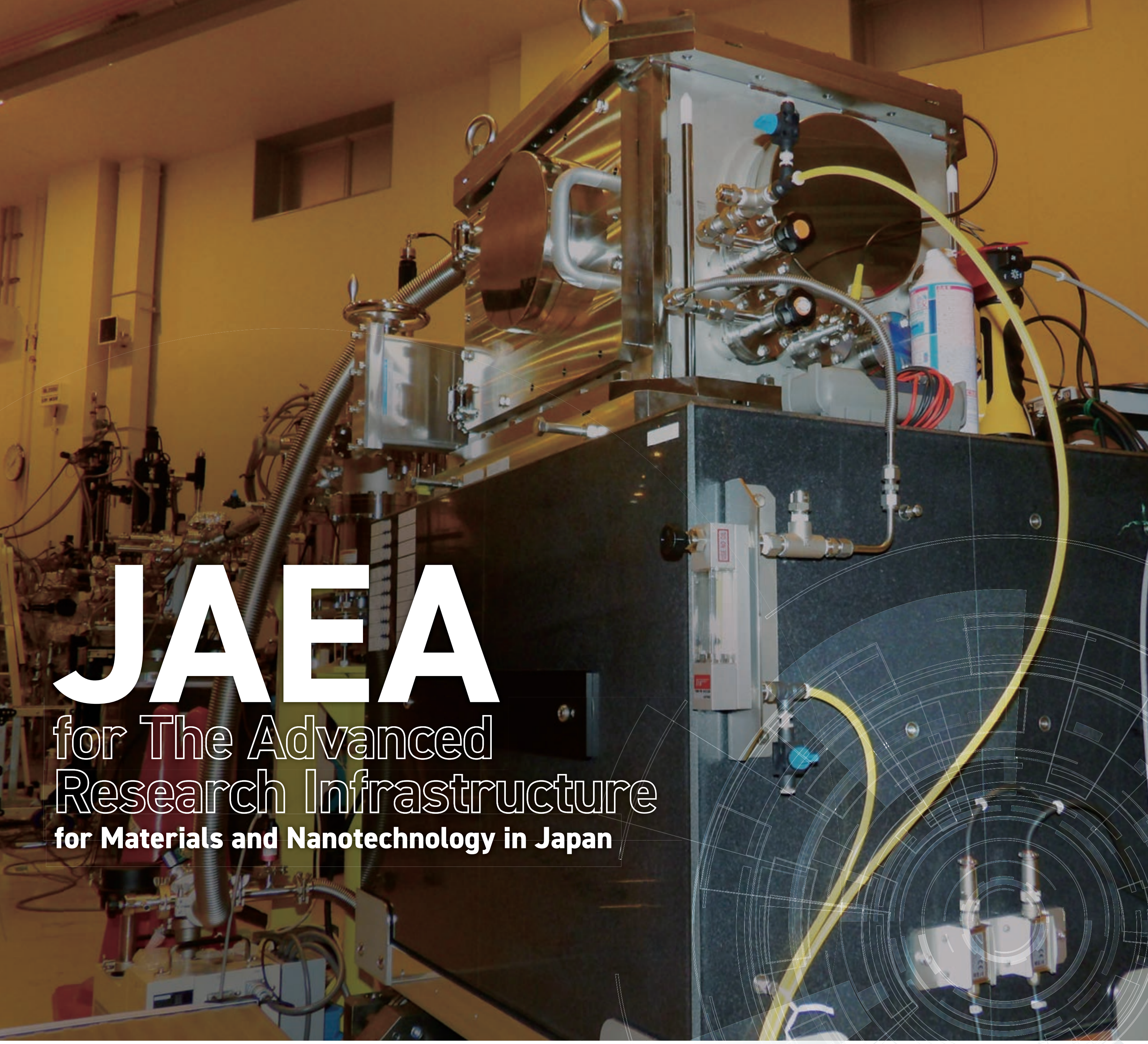


JAEA for The Advanced Research Infrastructure for Materials and Nanotechnology in Japan

Advanced Energy Materials Development by Synchrotron Radiation and Informatics

Implementing Agency JAPAN ATOMIC ENERGY AGENCY

Project Overview

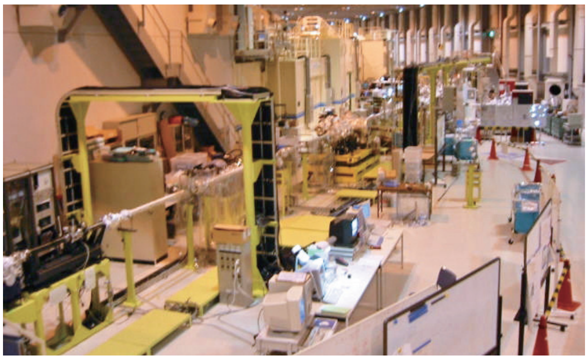
The Ministry of Education, Culture, Sports, Science and Technology`s Advanced Research Infrastructure for Materials and Nanotechnology in Japan (ARIM) project attempts to promote data-driven research and development throughout Japan, which has been garnering significant attention in materials development recently. The Ministry will develop an infrastructure that enables strategic use of experimental data, while developing state-of-the-art equipment and a system that enables efficient data collection.

This project comprises 25 universities and research institutes nationwide, and is divided into seven key technical areas. The Ministry will contribute to the research and development of users by forming a hub-spoke system comprising hub institutions that provide advanced facilities with strengths in each area and institutions with distinctive equipment and technologies.

JAEA Beamlines

In addition to the two dedicated JAEA beamlines listed below, we also have one provision equipment at BL14B1, which is owned by QST.

BL22XU: JAEA Actinoide Science I Beamline



BL23SU: JAEA Actinoide Science II Beamline

EXPERIMENTAL DEVICE

BL14B1: QST Quantum Dynamics II Beamline

Energy-dispersive XAFS measuring system

・Conventional X-ray absorption spectroscopy (XAFS) measurements using a double crystal spectrometer
・Employs a 36-element semiconductor detector in the fluorescence method
・Sample temperature is between 20 and 1073 K
・Atmosphere containing carbon monoxide and nitrogen monoxide can be controlled using a gas control system, and gas component analysis can also be performed using a quadrupole mass spectrometer
*It also enables time-resolved XAFS measurement using a curved analyzing crystal

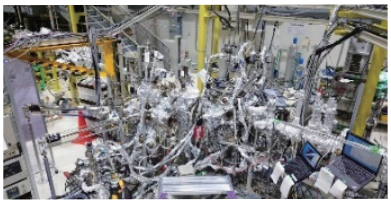
[Examples of application] In-situ XAFS analysis of hydrazine hydrate oxidation catalyst, elucidation of the reaction mechanism of secondary batteries using polyoxometalate compounds as electrode materials, etc.

BL23SU: JAEA Actinoide Science II Beamline

Surface chemistry experiment apparatus

・Enables in-situ observation and real-time measurements of the dynamics of chemical reactions such as adsorption/desorption, oxidation/reduction, etc., on metal and semiconductor surfaces
・Enables surface cleaning in the surface preparation chamber via Ar ion sputtering and heating up to 1450 K
・LEED and AES equipment included for reconstructed surface and chemical composition observations
・Enables supply of gas molecules with different kinetic energies to the sample surface using a gas dozer and supersonic molecular beam apparatus.

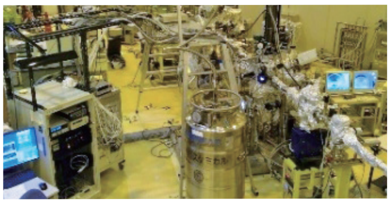
[Examples of application] Elucidation of graphene formation process, study of insulating film formation process on SiC surface, surface interface analysis for GaN-based power electronics development, observation of chemical bonding state of hafnium silicide oxidation process, etc.



Soft X-ray photoelectron spectrometer

・Photoelectron spectrometer that can also determine band structure via angle-resolved photoemission spectroscopy (ARPES) measurements
・Enables detailed electronic structure measurement of rare earth and 3d transition metal compounds

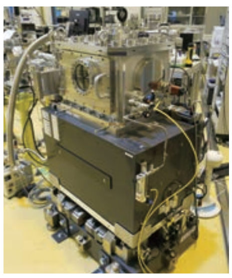
[Examples of application] Uranium compounds, rare earth compounds



*Scanning Transmission X-ray microscope apparatus (STXM)

Newly registered device in 2023

・Element-selective chemical analysis tool with nanoscale spatial resolution
・Enables the two-dimensional mapping of the transmitted light (absorption) intensity by irradiating the sample with soft X-rays focused to several tens of nanometers and scanning the sample
・A powerful method for analyzing fine particle samples and samples with significant heterogeneity
・Enables analysis of elemental distribution, and valence and chemical bonding states for a wide range of elements such as lanthanides, actinides, 3d transition metal elements, and nitrogen and oxygen in organic compounds
・Light energy: 400–1900 eV; best spatial resolution: 30 nm (when using 25nm FZP); sample temperature: 300 K



Role of Japan Atomic Energy Agency

The Japan Atomic Energy Agency (JAEA), a national research and development agency, owns two dedicated beamlines at the large synchrotron radiation facility SPring-8 and is developing synchrotron radiation utilization technology. Together with the hub institution, the University of Tokyo, and the spoke institution, Hiroshima University, it forms a technical research called "Materials that enable innovative energy conversion." To contribute to solving environmental problems such as carbon neutrality, JAEA provides and supports microstructure analysis and microfabrication technology, as well as an environment for utilizing data.

Using eight analyzers installed at the two dedicated beamlines and a beamline owned by the National Institutes for Quantum Science and Technology, JAEA contributes to the creation of materials such as novel solar cells and power devices via measurement methods such as the composition, electronic state, crystal structure, interface structure, and local structure of materials. By employing high-intensity synchrotron radiation, it can also obtain information of microsamples, uppermost surfaces, interfaces, etc.

Technical consultation

Even if you have no experience with synchrotron radiation experiments, please feel free to contact us for the possibility of using it. Consultation is free. For details, please visit JAEA's ARIM in-charge desk or the dedicated website.

In-charge desk JAEA Innovation Hub Open Innovation Promotion Division
renkei.shisetsu@jaea.go.jp
〈Entire JAEA facility use system〉
https://tenkai.jaea.go.jp/facility/
〈JAEA equipment use〉
https://tenkai.jaea.go.jp/facility/3-facility/05-support/index-141.html
〈JAEA ARIM〉
https://arim.jaea.go.jp

Obtained data and results

As a general rule, for the proposals supported by this project, the obtained experimental data will be provided and also the results will be published. If you would like to keep your results undisclosed, JAEA's independent project can support you with that. For details, please contact the in-charge desk.

*Registered device for the fiscal year 2023. The photo on the cover presents STXM introduced from the fiscal year 2023. There may be additions in the future. Please check the website (https://arim.jaea.go.jp) for the latest registered device.

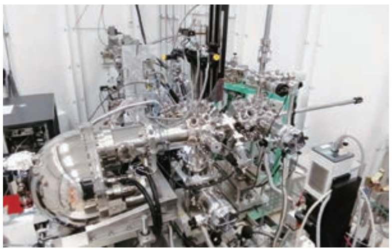
BL22XU: JAEA Actinide Science I Beamline

Hard X-ray photoelectron spectrometer

Newly registered device in 2022

- Enables acquisition of bulk information by reducing the effect of surface contamination
- Effective for the electronic structure analysis of samples for which surface cleaning treatment is difficult and for devices with internal nanoscale multi-layer structures
- Excitation light energy (6, 8, and 10 keV) can be selected, and it is possible to select the detection depth according to a specific purpose

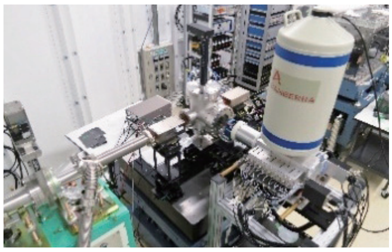
[Example of application] Damage analysis of radiation-resistant spin-driven thermoelectric devices



XAFS measuring system

- Enables XAFS measurement using high luminance and high energy X-rays from an undulator
- Handles time-resolved quick measurements (Quick-XAFS)
- Detectors are of various types such as ion chambers, NaI scintillation, and Ge semiconductors
- Preparation of cryostat for low-temperature measurements

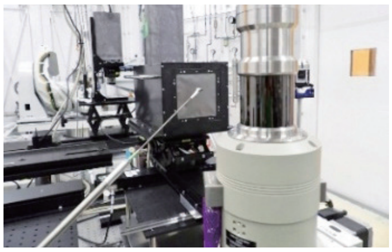
[Examples of application] Structural and electronic-state analyses for functional molecular design, structural analysis, and electronic-state analysis for Rh (III) inducer development



The apparatus for imaging and measureing material stress

- Enables internal strain and stress distribution primarily in metallic materials and imaging measurement
- Enables actual environment in-situ measurement using a high-temperature (maximum 900 ℃) and load (maximum 5 kN) device
- Enables time-resolved measurement at a maximum speed of 200 Hz for strain and stress and 2000 Hz for imaging by utilizing multiple two-dimensional detectors simultaneously

[Examples of application] Evaluation of stress, strain, and dislocation density during deformation in metallic materials, observation of melting solidification phenomenon during laser processing, etc.



κ-type X-ray diffractometer

- κ-type diffractometer suitable for surface structure analysis
- In addition to the standard six axes, it has a rotation axis in the horizontal plane for the entire system
- Enables the simultaneous measurement of electrochemical properties using a potentiostat
- Sample temperature is up to 10 K using a He circulation-type refrigerator and up to 1000 K utilizing an electric furnace

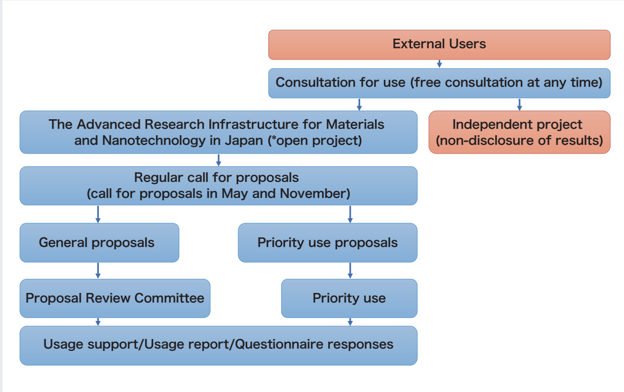
[Examples of application] Synthesis and microstructure analysis of barium titanate nanocubes

Usage flow

Only an outline is introduced below.
For details, please visit our website or contact the below-mentioned office.

1. Call for proposals

To use the equipment registered with ARIM, please submit a proposal application form. Every year, periodic calls for proposals for usage will be made around May for the second half of the relevant fiscal year (B term), and around November for the first half of the next fiscal year (A term). Kindly consult with the person in charge of the equipment beforehand before applying for the proposal. The person in charge will be introduced to you at the inquiry desk. There are also proposals based on competitive funding for priority use. Proposals that have results published will be reviewed by the JAEA-QST joint proposal review committee, and the acceptance or rejection and usage time will be decided.



2. Submission of report

After implementing the proposal, please submit a usage report with the implementation content by the specified date.
The SPring-8 report for each term will be published on the UI site two weeks after the 60th day following the end of that term.
*The usage report will be published in the next fiscal year.

3. Publication of results

Within 3 years after the end of the implementation term (March 31, 2027 for experiments in the 2023B term), please specify the SPring-8 and ARIM proposal numbers, publish the results of any of the following, and register online in the research results database (refer to SPring-8 User Information on the website).

① Peer-reviewed papers (including peer-reviewed proceedings and doctoral dissertations)

② SPring-8/SACLA Research Reports

③ Published technical reports approved by SPring-8/SACLA Results Review Committee

Please submit the "Contact Form for Publication of Results„ with a reprint of the results published in paper presentations, etc., within two years after the end of the implementation fiscal year (JAEA).

Usage fees and others

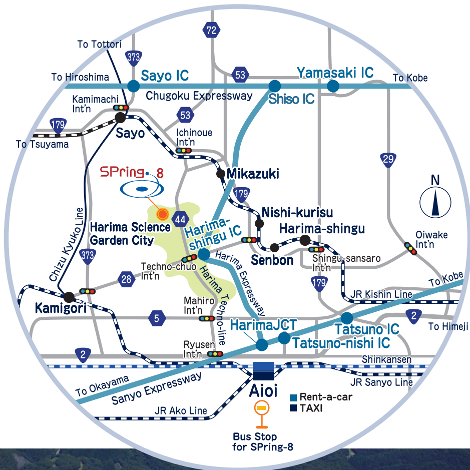
1.Handling fees (tax included): 13,300 yen per proposal

2.Usage fees (tax included, per 8 h-shift)

No data provided - Basic fees: 19,082 yen; priority fees: 52,265 yen

Data submitted - Basic fees: 13,357 yen; priority fees: 36,585 yen

*Prices may be revised depending on future circumstances.
For the latest information, please visit the dedicated website.
https://arim.jaea.go.jp



Access to SPring-8

Access by JR line and bus

・ Approximately 40 min by bus from Aioi Station on the Sanyo Shinkansen/Sanyo Main Line

・ About 130 min by bus from Kobe Sannomiya Bus Terminal
*For bus schedule,
please refer to the QR code on the right.

Access by car

・ Approximately 5 min from Harima-Shingu IC on the Harima Expressway

Panoramic view of SPring-8/SACLA
Courtesy of RIKEN

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