TAKASAKI Institute

Quantum Beam Science Research Directorate

Takasaki Advanced Radiation Research Institute

国立研究開発法人
量子科学技術研究開発機構
National Institutes for
Quantum Science and Technology

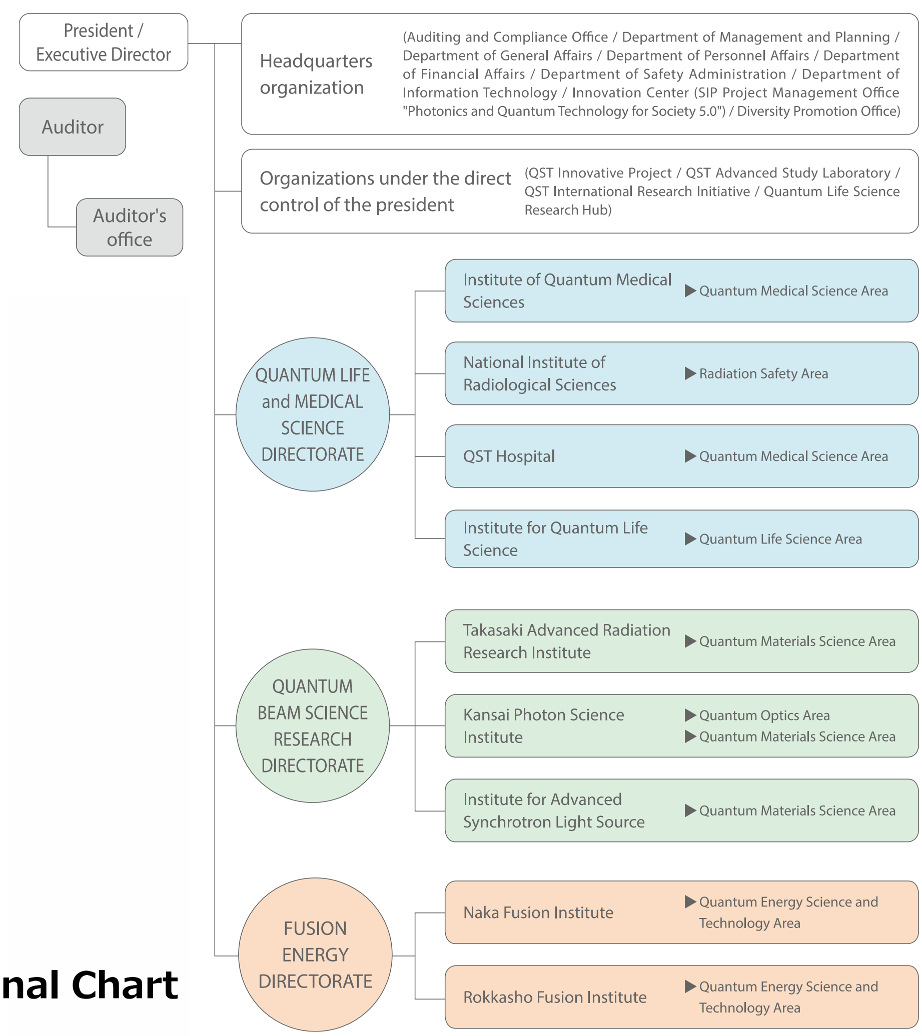
Our ultimate goal is to build a platform for the conduct of world class quantum science and technology research towards the improvement of human health and the overall well being of mankind through the creation of a harmonious diversity.

The National Institutes for Quantum and Radiological Science and Technology (QST) was established on April 1, 2016. The Institute was created by a government decree announced on July 8th, 2015 to merge the National Institute of Radiological Sciences and the Quantum Beam Directorate and the Nuclear Fusion Directorate of the Japan Atomic Energy Agency, resulting in the establishment of QST. The institute is bestowed with the mission to conduct high quality research and development related to quantum science and technologies, nuclear fusion, and radiological science and its application in medicine. QST plays a leadership role in molding the future direction of Japan's radiological science field and is Japan's collaborating partner for international organizations including the ITER and BA projects.

QST combines the research and development abilities of seven Japanese institutes nationwide in the fields of radiology, quantum beams and nuclear fusion to form a world class institution in quantum science and technologies research. QST takes an unparalleled, pathfinding role in technology research and to promote exploratory studies and translational research that integrate quantum science and technology with medicine and life sciences. QST also serves as a platform to foster collaboration between industry, government, and universities, through activities such as personnel exchanges and joint research. Such efforts repay society on multiple levels that include increase economic output, technological advancement, and education and training opportunities for the next generation of engineers and scientists. Finally, QST actively promotes the creation of harmonious diversity in society by fostering intellectual creativity and understanding and respect for other cultures around the world. This kind of activity contributes to the progress of a peaceful and spiritually rich human society.

We hope to continue to benefit from everyone’s advice, support, and guidance.

President Toshio Hirano
M.D., Ph.D.



Organizational Chart

Greetings | Takasaki Advanced Radiation Research Institute

Yasunari MAEKAWA Ph.D.,
Director General

Takasaki Advanced Radiation Research Institute is a core R&D site for quantum beam science and technology, which are the main missions of the National Institutes for Quantum Science and Technology (QST) established on April 1, 2016. We have been conducting innovative researches on the accumulated basis of radiation/quantum-beam application research for nearly 60 years at our institute including the predecessor institutes, Takasaki Radiation Chemistry Research Establishment of the Japan Atomic Energy Research Institute and Takasaki Advanced Radiation Research Institute of the Japan Atomic Energy Agency.

As for making the most of our facility, one of the world leading ion-beam irradiation facility, TIARA (Takasaki Ion Accelerators for Advanced Radiation Application), as well as electron-beam and gamma-ray irradiation facilities, we are developing leading-edge technologies in generation and control of quantum-beams, such as ions, electrons, positrons, neutrons, and gamma-rays, as well as highly precise material processing and observation technologies using the quantum-beams. Taking advantage of comprehensive utilization of the quantum beam technologies, we are currently challenging the difficulties for realizing "sustainable development goals (SDGs)" proposed by United Nations and a future ideal society "Society 5.0". We focus on R&Ds of quantum functional materials for quantum sensors and spin-photonics devices and energy/environment materials for next-generation batteries, contributing to super smart, zero-emission, and circulating societies, as well as quantum beam/RI technologies, such as cancer-therapy, pharmaceutical, and smart agriculture, in medical, agricultural, and biological fields.

In order to find solutions for important issues in each research field as well as to create innovative outcomes, we are aiming to contribute to the development of science and technology and promotion of industry through the outcomes expected from the above R&Ds of quantum beam science and technology. We would appreciate your support for our activities at Takasaki Advanced Radiation Research Institute.

Solving Critical Issues, Enhancing Science and Technology, and Contributing to the Promotion of Industry

Health and Longevity
Super Smart Society
Safety and Security
Energy, Resources and Food
Manufacturing

Science and Technology Innovation

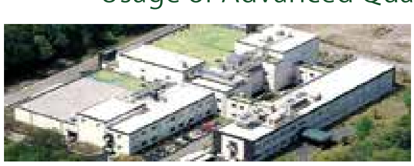
Advance in Scientific fields
Bridge to Practical Use

Takasaki Advanced Radiation Research Institute: Leading Quantum Science and Technology

Utilizing the advantages of various quantum beam facilities, we promote the development of cutting-edge technologies of quantum beam generation and control as well as highly precise material processing and observation using quantum beams. We also perform advanced R&D in the quantum science and technology field by comprehensive use of the excellent functions of quantum beams. In addition, we conduct R&D to solve critical issues in a wide range of fields like medicine, agriculture, and industry via industry-academia collaboration. By the creation of innovative outcomes and their widespread dissemination through this R&D, we aim to contribute to academic and industrial development.

Usage of Advanced Quantum Beam Facilities

Co-60 Gamma-ray Irradiation Facilities



TIARA, Takasaki Ion Accelerators for Advanced Radiation Application

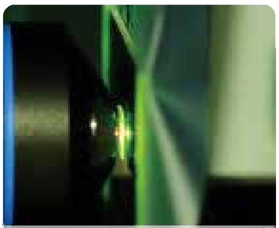
Electron Beam Irradiation Facility

Materials and Life Science Experimental Facility, MLF
Japan Proton Accelerator Research Complex, J-PARC

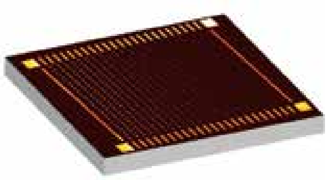
Quantum Materials Science Research

Aiming to lead the super smart society, quantum-functional materials such as quantum sensors, innovative electronic devices, and advanced functional polymer materials have been developed by utilizing quantum beams combined with our understanding of materials at the nano-size level.

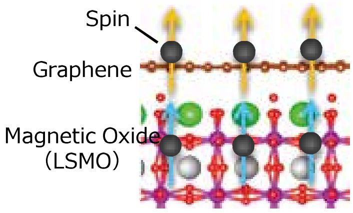
Quantum Sensing and Information Materials



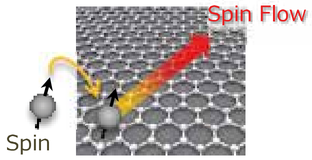
Red Emission from the NV



Emission of V_{si} Formed in SiC



Efficient injection of Spin Flow

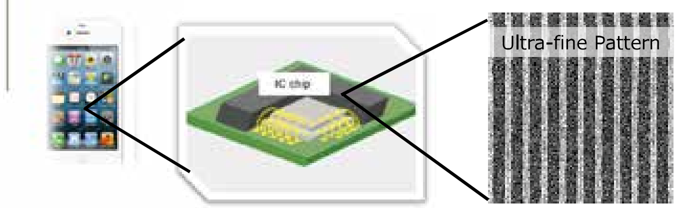


Spin Transport at High Speed and Over Long Distances

Formation of luminescent centers expected to be applied to quantum bits and quantum sensors "Nitrogen-Vacancy (NV) center in diamond" and "Silicon Vacancy (V_{Si}) in silicon carbide (SiC)" by controlling their concentration and position

Development of technology to manipulate the electron spin direction and control the flow of spin current in graphene, which are essential for the realization of high-performance spintronics devices based on graphene

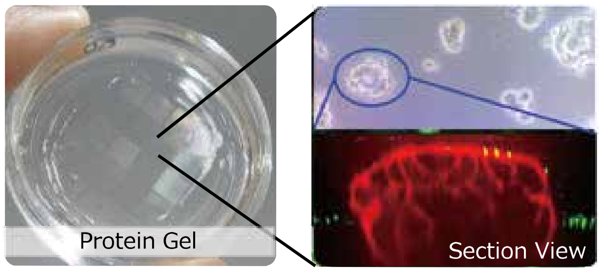
EUV Ultra-Fine Fabrication Technology



High Integration of Semiconductor Devices by Ultrashort Wavelength Lithography

Development of materials and processes for nanofabrication to realize ultra-miniaturization and low power consumption of semiconductors, which are essential for IoT, AI (artificial intelligence), big data, and 5th-generation mobile technologies (5G)

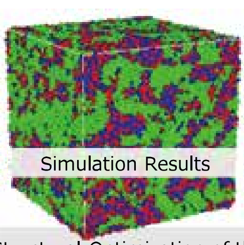
Advanced Biodevices



Development of a high-performance culture substrate that reproduces the *in vivo* environment and controls cell functions through new technology that gels proteins while maintaining their biocompatibility and controls their hardness and shape

Advanced Functional Polymer Materials Alliance

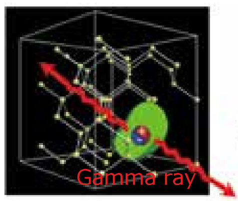
Water Filter for Cesium Removal



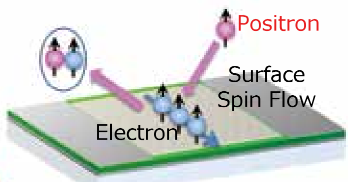
Structural Optimization of the Graft Membrane

Promoting efficient and rapid product development by collaborating with multiple companies in material development using materials informatics

Positron Beam Microstructural Analysis



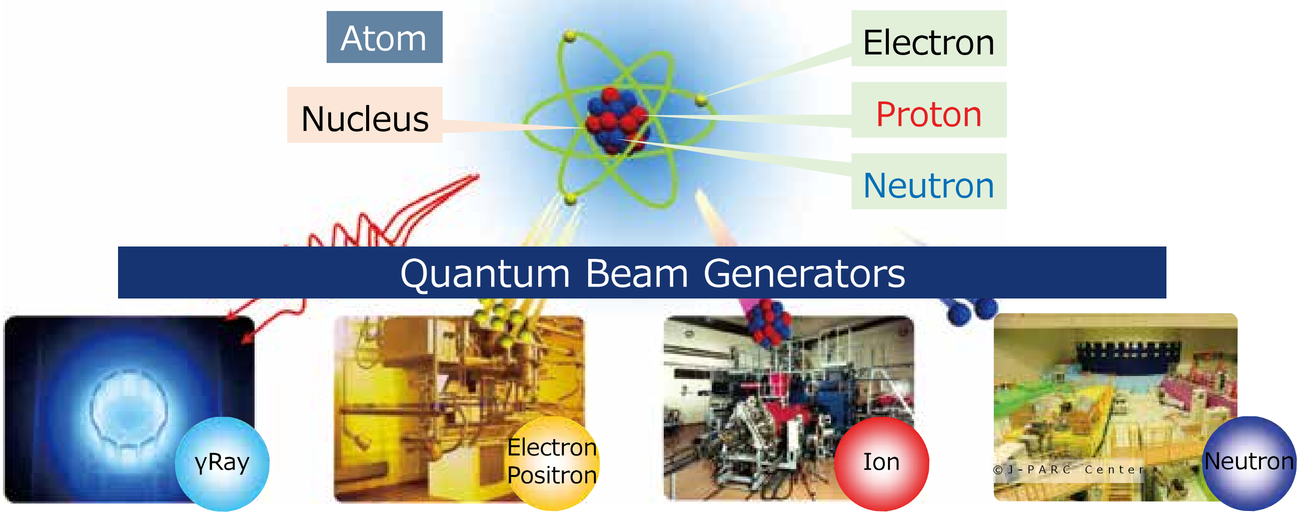
Sensitive Detection of Atomic Vacancies



Detection of Local Electron Spins

Development of technology to analyze atomic vacancies, surface atomic arrangements, and electron spins of materials by using positrons, the antimatter of electrons

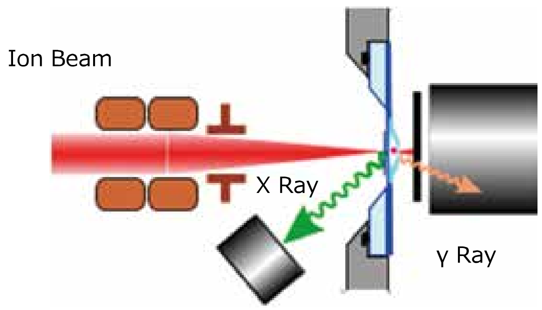
Takasaki Advanced Radiation Research Institute

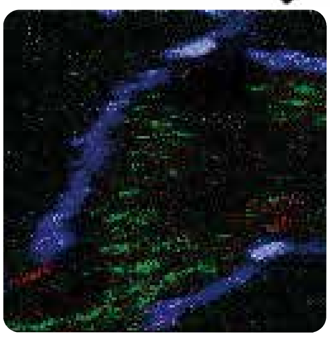


Lead the research and development of "Quantum Science, Quantum Life Science, and Quantum Beam Technology" and aim to build a quantum beam science platform.

Development of Quantum Beam Technology

Ion Microbeam Elemental Analysis





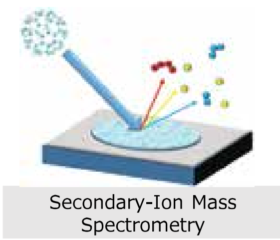
Elemental distribution analysis in rice leaves

Red: Zinc
Blues: Silicon
Green: Calcium

Development of an elemental distribution-analysis technique in micrometer scale using the PIXE/PIGE method with a MeV proton microbeam

Generation and Utilization of Cluster-Ion Beams

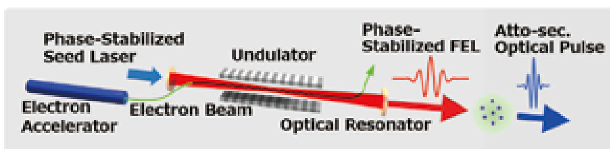
Highly-intense Negative C_{60} Ion Source



Secondary-Ion Mass Spectrometry

Development of a highly-intense ion source as a basis for highly-sensitive mass spectrometry using cluster-ion beams

Generation of X-ray Atto(10^{-18})second Pulses



Development of X-ray attosecond pulse generation technology that makes it possible to stop the movement of electrons for viewing by phase-controlled free-electron laser (FEL) and high harmonic generation technology

Quantum Beam Biological Application Research

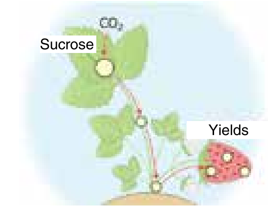
Explore the interaction between radiation/quantum beams and organisms to achieve innovative results by comprehensively utilizing the "watch", "create", and "cure" functions of quantum beams.
Achive a paradigm shift in biology with quantum beam bioscience.

Ion Beam Breeding

Photos Courtesy of Aichi Agricultural Research Center

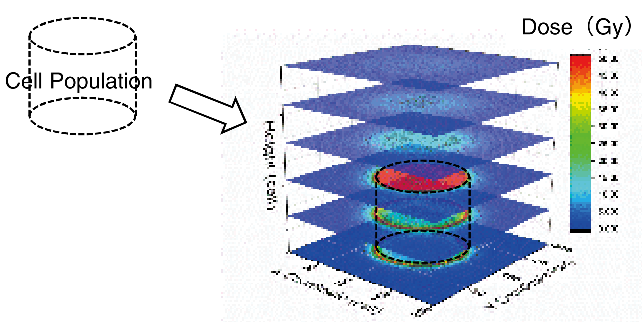
New chrysanthemum cultivars with elegant petals created by ion beams.

Radiotracer Imaging for Agriculture



Movement of photoassimilate into strawberry fruits by RI imaging using ^{11}C produced by our cyclotron accelerator

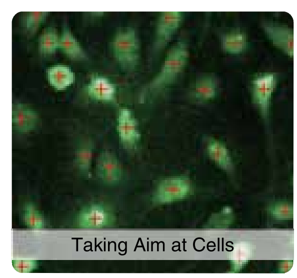
3-Dimensional Visualization of Single-Cell Dose



Development of a technology that can evaluate the radiation dose distribution in one cell, which is important in the targeted alpha therapy

Microbeam Irradiation of Cells

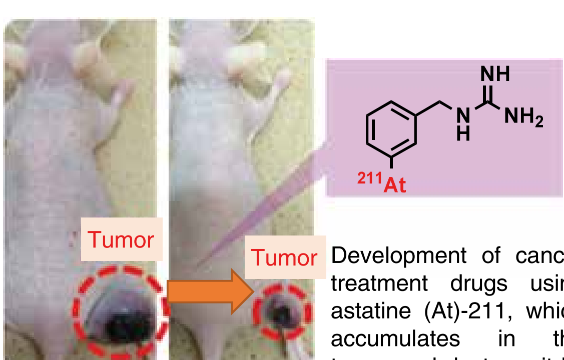
Microbeam Irradiation Device



Taking Aim at Cells

Analysis of the biological effects of heavy ions by target irradiation of the cells. The cells were automatically detected by an irradiation microscope, and irradiated with a heavy-ion microbeam smaller than those cells.

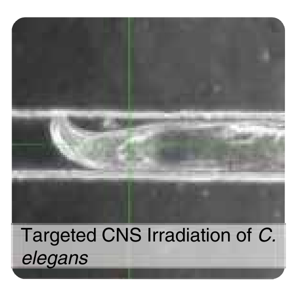
Cancer Therapy with Accelerator-Made RI



Development of cancer treatment drugs using astatine (At)-211, which accumulates in the tumor and destroys it by alpha-irradiation

Microfluidic Chip for Biological Samples

Microfluidic Chip



Targeted CNS Irradiation of *C. elegans*

Heavy-ion microbeam irradiation targeted to the central nervous system (CNS) of the nematode *C. elegans* enclosed in a PDMS microfluidic chip (Worm Sheet), which we have developed for immobilization of biological samples without the use of anesthesia.

Sites & Locations

Fusion Energy Directorate

Rokkasho Fusion Institute

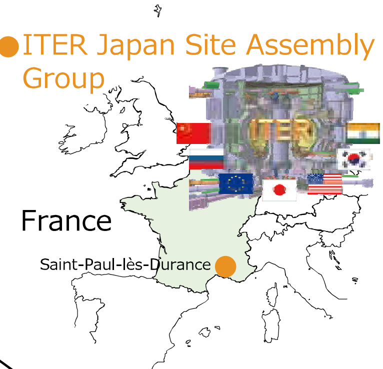
2-166 Oaza-Omotedate, Rokkasho-mura, Kamikita-gun, Aomori 039-3212, Japan
TEL. +81-(0)175-71-6500

2-4 Shirakata, Tokai-mura, Naka-gun, Ibaraki 319-1106, Japan
(c/o Nuclear Science Research Institute, Japan Atomic Energy Agency)
TEL. +81-(0)70-3943-3400

Naka Fusion Institute

801-1 Mukoyama, Naka-shi, Ibaraki 311-0193, Japan
TEL. +81-(0)29-270-7213

ITER Japan Site Assembly Group



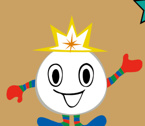
Quantum Life and Medical Science Directorate

Institute for Quantum Medical Science
National Institute of Radiological Sciences
QST Hospital
Institute for Quantum Life Science

4-9-1 Anagawa, Inage-ku, Chiba-shi 263-8555, Japan
TEL. +81-(0)43-206-3025

1 Hikarigaoka, Fukushima-shi, Fukushima 960-1295, Japan
TEL. +81-(0)24-581-5150

The Kids' Science Museum of Photons



8-1-6 Umemidai, Kizugawa-shi, Kyoto, 619-0215, Japan
TEL. +81-(0)774-71-3180

Headquarters

National Institutes for Quantum Science and Technology

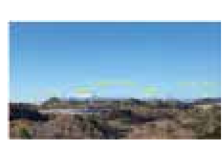
4-9-1 Anagawa, Inage-ku, Chiba-shi 263-8555, Japan
TEL. +81-(0)43-206-3025

Quantum Beam Science Research Directorate

Kansai Photon Science Institute

Kizu Site
8-1-7 Umemidai, Kizugawa-shi, Kyoto, 619-0215, Japan
TEL. +81-(0)774-71-3000

Harima Site
1-1-1 Kouto, Sayo-cho, Sayo-gun, Hyogo, 679-5148, Japan
TEL. +81-(0)791-58-0922



Institute for Advanced Synchrotron Light Source

6-6 Aramaki Aoba, Aoba-ku, Sendai-shi, Miyagi 980-8579, Japan
TEL. +81-(0)70-3943-3419

Takasaki Advanced Radiation Research Institute

Takasaki site
1233 Watanuki-machi, Takasaki-shi, Gunma 370-1292, Japan
TEL. +81-(0)27-346-9232

Tokai site
2-4 Shirakata, Tokai-mura, Naka-gun, Ibaraki 319-1106, Japan
(c/o Nuclear Science Research Institute, Japan Atomic Energy Agency)
TEL. +81-(0)70-3943-3400

QST Quantum Function Material Industry/Academia Collaboration Meguro Laboratory
2-10, Ookayama, Meguro-ku, Tokyo 152-0033, Japan
(c/o Tokyo Institute of Technology Ookayama North site)
TEL. +81-(0)70-3943-3398

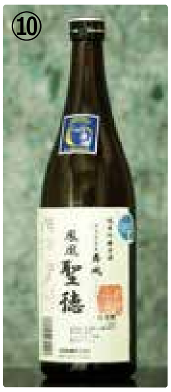
Promotion and Dissemination of Our Quantum Beam Technologies

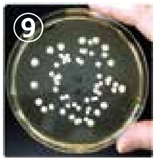
Technology Transfer

You can use our intellectual property rights and technologies in various fields such as medicine, industry, agriculture and energy. Examples of products developed in collaboration with private companies/public institutes are shown below.

Creating Technology of Functional Materials with Quantum Beams

Quantum Beam Breeding Technology





① Continuous Silicon Carbide Fiber "Hi-Nicalon®"
② Air Cleaning Filter
③ Radioactive Cesium Adsorbent "KranCsair®"
④ Hydrogels for Wound Dressing "Viewgel®, Gel Protector®"
⑤ Polymer Electrolyte Membrane for Next Generation Fuel Cells
⑥ "Ryujin", a chrysanthemum cultivar blooming earlier in low temperature
⑦ "Uruwashi-no-Kaori", a new color variety of fragrant Cyclamen
⑧ "KNOX", green wall plants with high NO_2 absorption
⑨ Novel sake yeast "Gunma227" with high ethyl caproate production
⑩ Sake "Hoō Seitoku Maikaze" brewed using the yeast "Gunma227"
⑪ Low cadmium rice "Koshihikari Kan No.1" (right); parent rice "Koshihikari" (left)

Facilities Sharing

You can use our quantum beam facilities and equipment.

Main Facilities, Equipment and Devices	Examples of Usage
・AVF Cyclotron ・Tandem Accelerator ・Single-ended Accelerator ・Ion Implanter	It is possible to supply heavy ions and light ions with a wide range of energy and to use them in combination. Research and development on space environment, biotechnology and medical applications, creation of functional materials, synthesis and utilization of short-lived isotopes.
・Electron Beam Irradiation Facility ・Co-60 Irradiation Facilities	Development of polymer processing technology, irradiation effects of semiconductor-related materials, radiation resistance evaluation of materials and equipment.

Food Irradiation Database

http://foodirra.taka.qst.go.jp/

Food irradiation is a technology for controlling spoilage and eliminating foodborne pathogens. In Japan, gamma-ray irradiation had been used for sprout inhibition of potatoes since 1974.

Irradiated

Non-Irradiated

Outreach Activities

Open House

Science and Technology Education and Support for Workplace Experience

We focus on activities that make our research activities widely known to local residents, junior and senior high school students, and university students.

Research Exchange

Collaborations with Universities

International Cooperation

We strengthen our network through collaboration with universities and overseas research institutions.

Takasaki Advanced Radiation Research Institute, Quantum Beam Science Research Directorate

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Our Website

QST

National Institutes for Quantum Science and Technology

4-9-1 Anagawa, Inage-ku, Chiba-shi 263-8555 Japan
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URL : https://www.qst.go.jp/site/qst-english/