National Institutes for
Quantum Science and Technology

QST

National Institutes for
Quantum
Science and
Technology

QST *Message*

Success will come where there is hope.

The National Institutes for Quantum Science and Technology (QST) is committed to creating and delivering new value through research and development in quantum science and technology, thereby contributing to the realization of a sustainable future society in which the economy, society, and the environment are in harmony.

QST is unique in that it promotes a wide range of research and development, from energy development to life sciences and medicine, based on quantum science and technology, and has a variety of large-scale R&D facilities and equipment, including quantum beam facilities, fusion energy facilities, and a research hospital. QST's world-class large-scale R&D facilities and equipment are widely used not only for R&D within QST but also by universities, other institutions, and private companies, contributing to the "maximization of research achievements" required of a National Research and Development Agency.

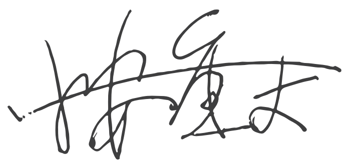
QST has been designated as a “Foundational Quantum Technology Hub” and a “Quantum Life R&D Hub” in the "Quantum Technology Innovation Hubs" established by the national "Quantum Future Society Vision”, “Quantum Future Industry Creation Strategy" and "Quantum Technology Innovation Strategy," and promotes research and development of quantum materials, which are key materials for quantum devices, and the application of quantum life technology, which integrates quantum technology with life science and medicine. In addition, we have been designated as a “Fusion Technology Innovation Hub” under the “Fusion Energy Innovation Strategy” and are conducting research and development toward the realization of fusion energy generation under the slogan "Creating a Sun on Earth!". In the field of life science and medicine, we are responsible for the research topics “Higher Functions of the Human and Macaque Brains” and “New Imaging Techniques and Theranostics for Brain Lesion and Circuit Injury” in the core organization of the "Integrated Program for Neuroscience" of AMED, which is the national neuroscience research program. In addition, we aim to contribute to the realization of a healthy and longevity society through heavy-ion cancer radiotherapy, targeted radionuclide therapy, and imaging technology for the diagnosis of dementia and other diseases. Furthermore, QST has been designated as the “Core Advanced Radiation Emergency Medical Support Center” and is engaged in technical development and human resources training related to radiation exposure medicine and radiation effects. The 3 GeV high-brilliance synchrotron radiation facility "NanoTerasu," was developed using the quantum beam generation technology we have cultivated, began creating innovative materials and devices and applying them to industry in April 2024, and started the operation of public shares beamlines in March 2025.

The second medium- to long-term phase of QST began in April 2023. By further upgrading the world's most advanced and high-performance large-scale R&D facilities and their basic technologies that have been established to date, QST aims to promote innovative research and development through collaborative creation and facility sharing between us and researchers in Japan and overseas, and to lead the world not only in quantum science and technology, but also in a wide range of other fields.

National Institutes for Quantum Science and Technology

President

KOYASU Shigeo



Contents

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QST

QUANTUM INNOVATION

Utilizing our quantum science and technology platform consisting of a variety of world-class, large-scale research and development facilities and equipment, we are conducting a wide range of research and development, from energy development to life science and medicine, centered on quantum science and technology.

Through these research and development efforts, we aim to contribute to Japan's economic growth through a productivity revolution and the creation of new industries, a healthy and longevity society by overcoming cancer and dementia, and a green transformation through carbon neutrality and a circular economy, thereby creating a sustainable future society in which the economy, society, and environment are in harmony.

Research and development for creating the future

- QST promotes advanced and creative research and development in four research areas based on our quantum science and technology platform: quantum technology innovation research, quantum medical science, quantum energy research, and quantum beam science.
- By utilizing the world's most advanced and high-performance large-scale research and development facilities and their fundamental technologies, QST contributes to "maximizing research achievements" through collaborative creation and facility sharing between ourselves and domestic and overseas researchers, and leads the world not only in quantum science and technology but also in a wide range of other fields.
- As a core role in the national strategy, etc., the center will serve as a hub connecting universities and companies, accepting students, professional researchers, and engineers to foster human resources in the field of quantum science and technology, and will also focus on fostering industries by providing testbeds and startup support.

Realization of a Sustainable Future Society through Quantum Science and Technology Research, etc.

Quantum Energy Science and Technology Area

Achieving Sustainable Environment and Energy

- Fusion energy development, etc.

Quantum Beam Science Area

Developing and Upgrading of Technologies for Generation, Control, and Utilization of Cutting-edge Quantum Beams

Research promotion focusing on four areas

Quantum Medical Science Area

Achieving Healthy and Longevity Society through Next-Generation Medical Technologies

- Quantum scalpel (heavy-ion cancer radiotherapy), etc.

Quantum Technology Innovation Research Area

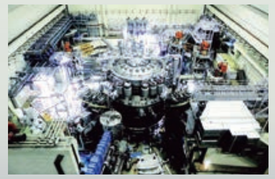
Creating Innovation with Quantum Materials, Quantum Technologies and Life Sciences

- Promotion of research and development for the creation of new quantum functions and their practical application and social implementation
- Research and development of quantum measurement and sensing technologies and for the elucidation of life phenomena from a quantum theoretical perspective

Quantum Science and Technology Platform

Establishment, utilization, and shared use of state-of-the-art large-scale research and development facilities, and human resource development for the next generation through collaboration within QST and with domestic and international universities, research institutes, and industry by utilizing the fundamental technologies of these facilities.

NanoTerasu
3 GeV Synchrotron Radiation Facility



JT-60SA
Tokamak-type Superconducting Plasma Experimental System

TIARA
Ion Irradiation Research Facility

HIMAC
Heavy-Ion Medical Accelerator

SPring-8
QST Contract Beamlines

IFMIF Prototype Accelerator
High Energy Neutron Source

J-KAREN-P
Ultra-short Pulse, Ultra-high Intensity Laser

[Leading R&D facilities and equipment]

R&D Hubs designated by the government

Foundational Quantum Technology Hub
[Vision of Quantum Future Society/Strategy of Quantum Future Industry Development]

Quantum Materials and Applications Research Center Building
(scheduled for completion in 2027)

Quantum Life R&D Hub
[Quantum Technology Innovation Strategy]

Quantum Life Science Research Building

Research and development center for neuropsychiatric disorders diagnosis and treatment technologies
[AMED Large Research Project Aimed at Fundamental Treatment of Dementia]

Exploratory Research Building

Radiation Emergency Medicine Hub
[Designated as Core Advanced Radiation Emergency Medical Support Center by the Nuclear Regulatory Commission]

Dose Assessment Building for Advanced Radiation Emergency Medicine

Fusion Technology Innovation Hub
[Fusion Energy Innovation Strategy]

Blanket Test Facility Building

3 GeV Synchrotron Radiation Facility, NanoTerasu
[The specific advanced large research facility (operation start in FY2024)]

View of NanoTerasu

QST
RESEARCH INSTITUTES

QST research institutes and leading quantum science and technology platform facilities and equipment

Takasaki Institute for Advanced Quantum Science


Ion Irradiation Research Facility TIARA (in service)


Electron-beam Irradiation Facility (in service)

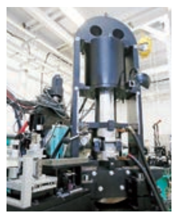

Cobalt 60 Gamma-ray Irradiation Facilities (in service)

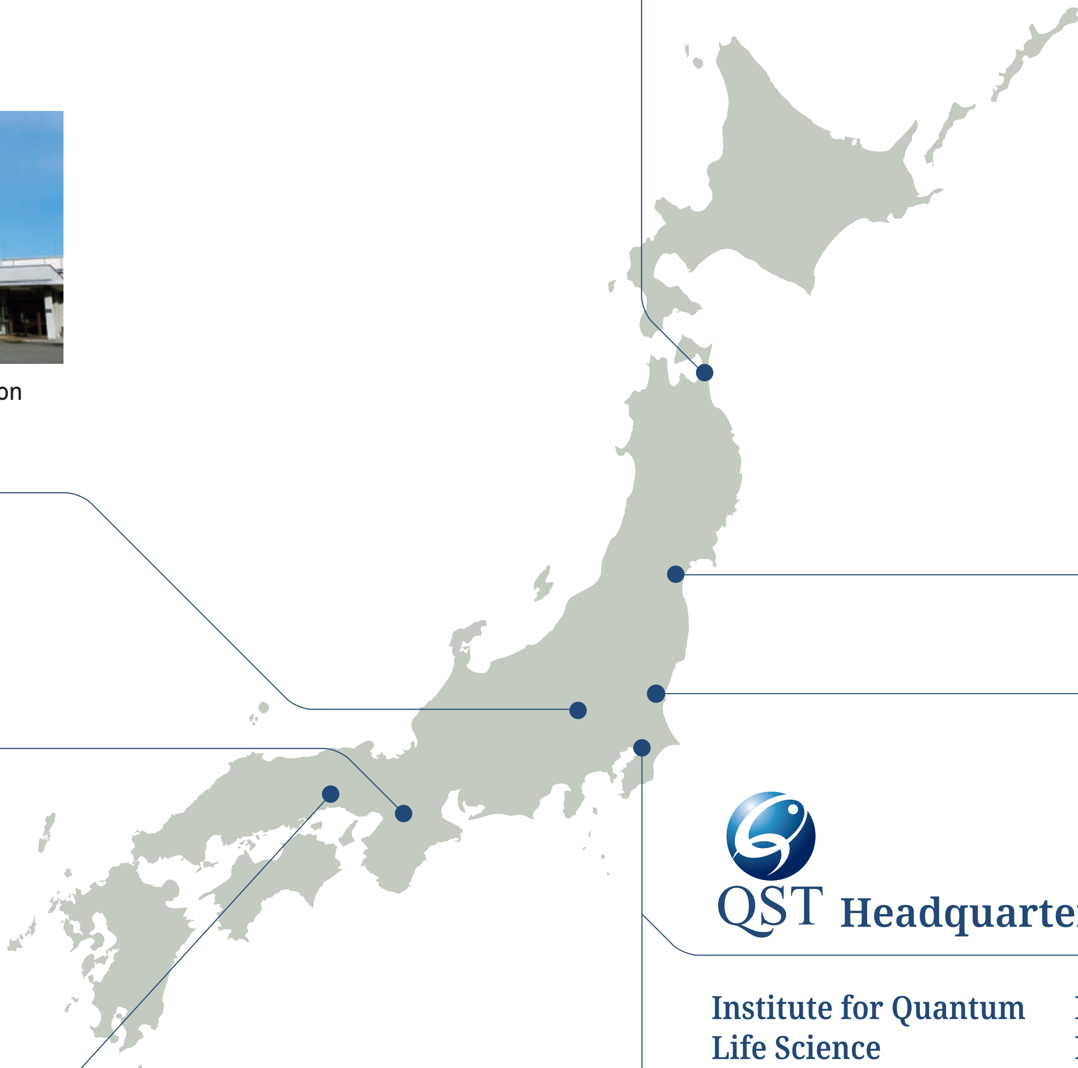
Kansai Institute for Photon Science (Kizu site)


Laser Experiment Facility J-KAREN-P (in service)

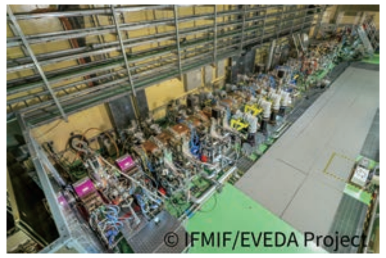

QUADRA-T (in service)

Kansai Institute for Photon Science (Harima site)



QST contract Beamlines at the Large Synchrotron Radiation Facility SPring-8
BL11XU (in service)
BL14B1 (in service)



Rokkasho Institute for Fusion Energy



International Fusion Materials Irradiation Facility (IFMIF) Prototype Accelerator (under development)

Headquarters
4-9-1 Anagawa, Inage-ku, Chiba-shi, Chiba 263-8555; Tel. +81-43-382-8001

Institute for Quantum Life Science, Institute for Quantum Medical Science, QST Hospital, Institute for Radiological Science
4-9-1 Anagawa, Inage-ku, Chiba-shi, Chiba 263-8555; Tel. +81-43-251-2111

Takasaki Institute for Advanced Quantum Science
1233 Watanukimachi, Takasaki-shi, Gunma 370-1292; Tel. +81-27-346-9232

Kansai Institute for Photon Science (Kizu), The Kids' Science Museum of Photons
8-1-7 Umemidai, Kizugawa-shi, Kyoto 619-0215; Tel. 0774-71-3000

Kansai Institute for Photon Science (Harima)
1-1-1 Kouto, Sayo-cho, Sayo-gun, Hyogo 679-5148; Tel. +81-791-27-2111

NanoTerasu Center
6-6-11-901 Aza Aoba, Aramaki, Aoba-ku, Sendai, Miyagi 980-8579; Tel. +81-22-785-9480

Naka Institute for Fusion Science and Technology
801-1 Mukoyama, Naka-shi, Ibaraki 311-0193; Tel. +81-29-270-7213

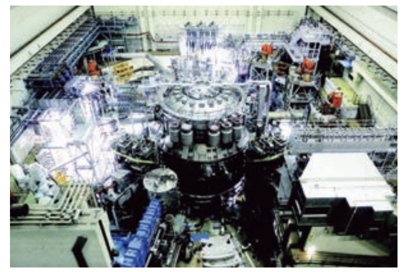
Rokkasho Institute for Fusion Energy
2-166, Oaza-Obuchi-Aza-Omotedate, Rokkasho-mura, Kamikita-gun, Aomori 039-3212; Tel. +81-175-71-6500

Tokyo Office
22nd floor, Fukoku Seimei Building, 2-2-2 Uchisaiwaicho, Chiyoda-ku, Tokyo 100-0011; Tel: +81-3-6852-8165

NanoTerasu Center


3 GeV Synchrotron Radiation Facility
NanoTerasu (for sharing according to the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities)

Naka Institute for Fusion Science and Technology


Tokamak-type Superconducting Plasma Experimental System JT-60SA

QST Headquarters

Institute for Quantum Life Science


Quantum Life Science Research Building

Institute for Quantum Medical Science


Heavy-Ion Cancer Radiotherapy Facility HIMAC (in service)

QST Hospital

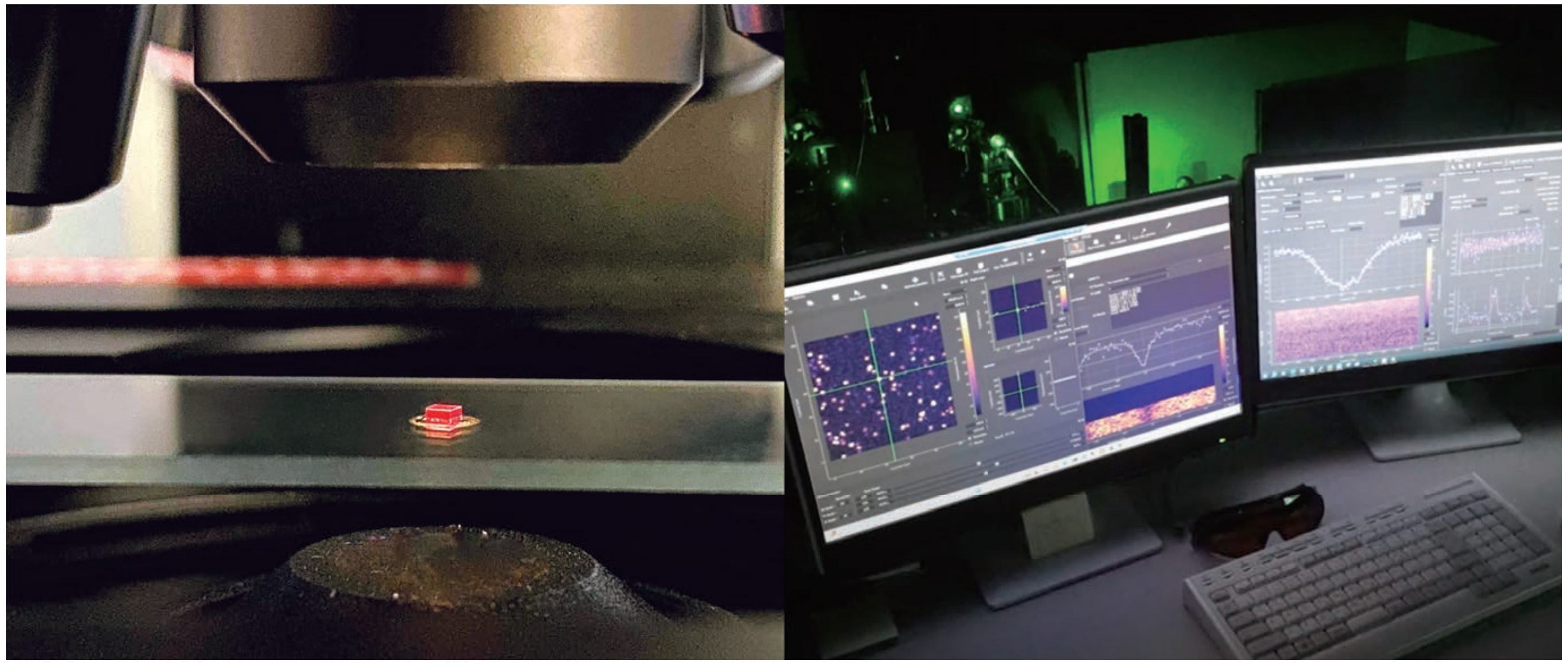

QST Hospital

Institute for Radiological Science


Advanced Radiation Medical Dosimetry Building

Mission

Ultra-smart society developed by quantum technologies



Foundational quantum technology research aims to establish technologies for quantum computing, quantum communication, quantum sensing, etc., and conducts research and development of quantum materials and devices that are indispensable for these technologies, establishing foundational quantum technologies and promoting research and development for the creation of new quantum functions through integration with state-of-the-art optical technologies. We will also build a stable supply base of the world's most advanced quantum materials and promote their practical application and social implementation in a wide range of fields.

Core institutes ▶ Takasaki Institute for Advanced Quantum Science, Kansai Institute for Photon Science

Related institutes ▶ NanoTerasu Center, Institute for Quantum Life Science

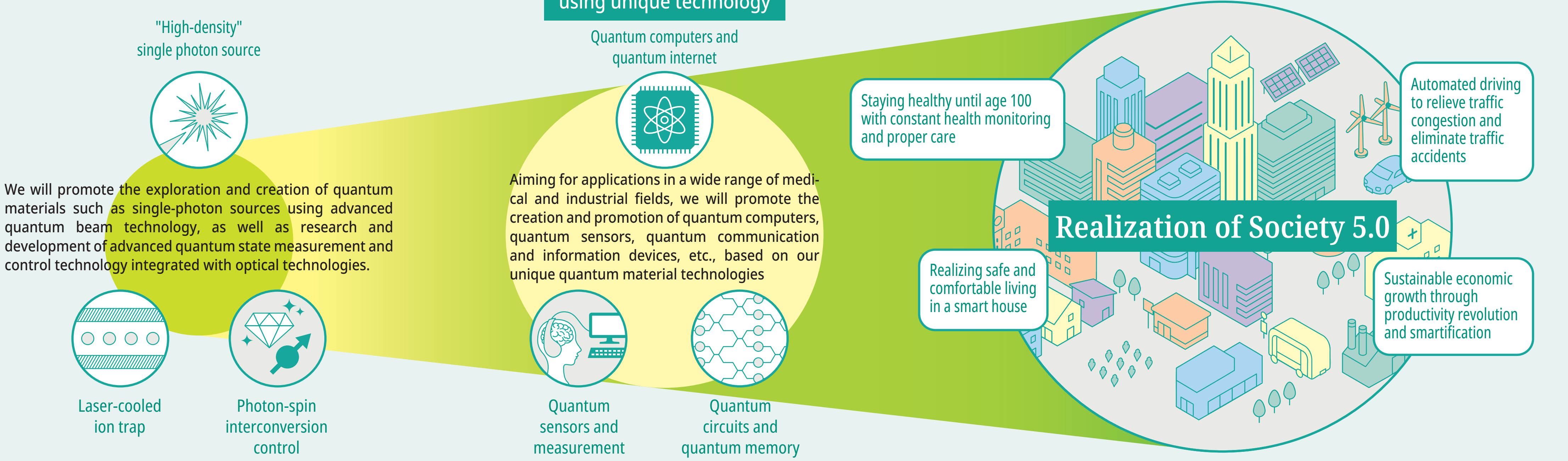
Major Competitive Funds ▶ K Program (JST), SIP (Cabinet Office), Moonshot R&D Program (JST), Q-Leap (JST)

Foundational Quantum Technology Hub

We are engaged in pioneering research and development of quantum materials and devices that exhibit advanced quantum functions, and in the establishment of a stable supply base for such materials and devices, utilizing our strengths in various quantum beam facilities such as ion beams, electron beams, lasers, and synchrotron radiation, and in advanced quantum beam technologies. Based on the quantum material and device technologies created here, we will promote the development and industrial application of quantum computing, quantum sensing, quantum communication and information devices, and link them to the realisation of a sustainable and robust future society through the fusion of cyberspace and physical space, known as Society 5.0.

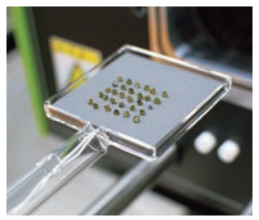
Quantum Technology

Quantum technology is a technology that uses quantum behaviour, which combines the properties of particles and waves in extremely small worlds such as atoms and electrons. Quantum technology is expected to be applied to quantum computers, highly sensitive quantum measurement and sensing, and high-security quantum networks, and to be developed in various fields such as medicine, materials manufacturing, finance, energy, and transportation.



Creation of quantum materials and devices and establishment of supply base

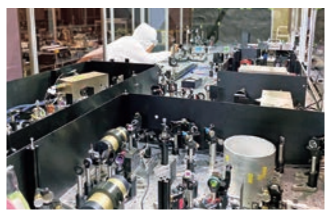
Using advanced quantum beam technology, we will develop technologies for the creation of solid-state spin qubits such as diamond nitrogen-vacancy (NV) centers, quantum materials that can be used as single-photon sources, and quantum devices such as quantum sensors and quantum repeaters using these materials. Furthermore, we will promote the utilization and practical application of quantum technology in industry, academia, and government by providing a stable supply of high-quality, high-performance quantum materials and devices and developing an environment for their use.



Diamond NV center is fabricated by electron irradiation and heat treatment.

Development of cutting-edge laser technology and its integration with quantum material and device technology

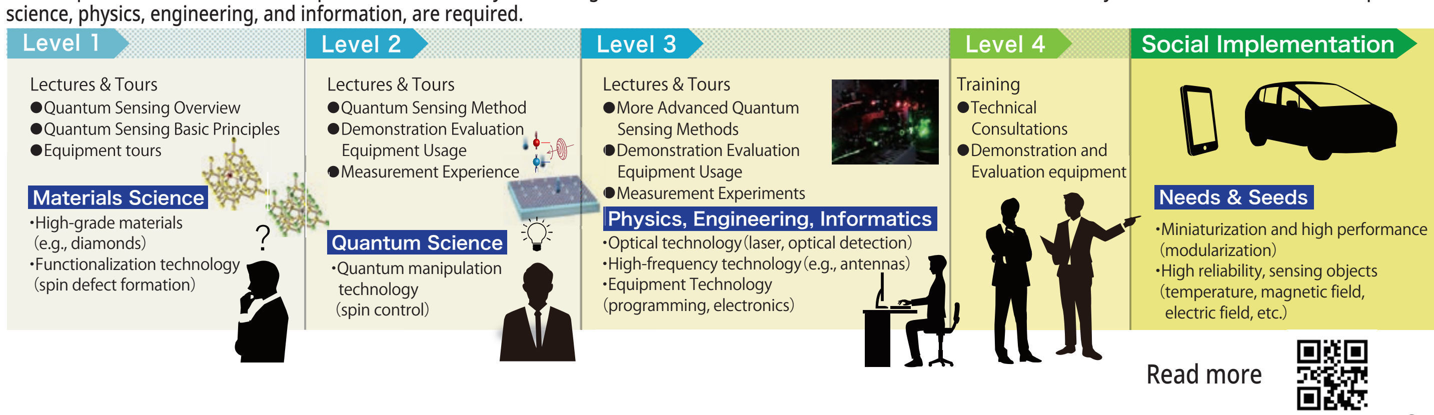
We will promote the combination of optical technologies such as ultra-short pulse lasers with quantum material and device technologies, and carry out research and development of ultra-short pulse lasers and quantum state measurement and control technologies, aiming to realize ultra-fast and low-loss spin-photonic devices by optical control. In ultra-fast dynamics research, which is important in the manipulation of quantum functions by light, we use theory and simulation techniques to understand ultra-fast phenomena and clarify their physical mechanisms, and apply this knowledge to the creation of innovative quantum materials and devices and to the academic exploration of quantum life science.



Ultra-short pulse laser equipment

Develop and secure quantum technology human resources for the next generation

Before quantum sensors can be implemented in society, knowledge of the needs and seeds as well as various fields of study, such as materials science, quantum science, physics, engineering, and information, are required.



Read more

Mission

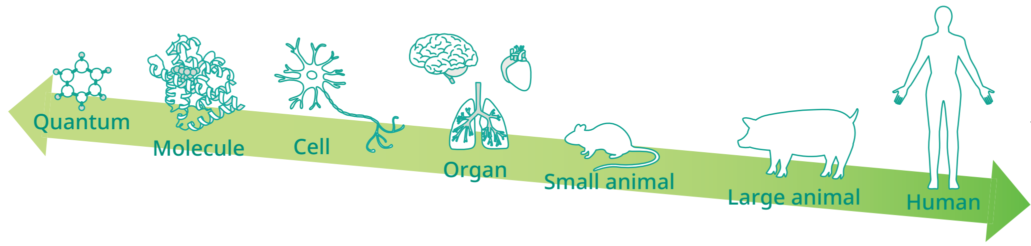
Confronting the question "What is life?" with quantum eyes and hands

Quantum life science research promotes research and development to utilize quantum measurement technology and elucidate life phenomena from a quantum theoretical perspective. In addition to promoting applied research in the fields of medicine and drug discovery, we will develop a new academic field that will lead to the elucidation of the ultimate question for humankind, "What is life?"

Core institutes ▶ Institute for Quantum Life Science

Related institutes ▶ NanoTerasu Center, Takasaki Institute for Advanced Quantum Science, Kansai Institute for Photon Science, Institute for Quantum MedicalScience, Institute for Radiological Science

Major Competitive Funds ▶ Q-Leap (JST), Moonshot R&D Program (JST), SIP (Cabinet Office)



Extending life science from the conventional molecular level to the quantum level, understanding and integrating its hierarchical system.

Institute for Quantum Life Science, the center of research activities. It combines experimental facilities for state-of-the-art quantum measurement and sensing technology with those for life sciences.

As a Quantum Life R&D Hub open to a wide range of companies, universities, and external research institutions, industry, academia, and government will work together in a unified manner to conduct everything from basic research to technology demonstration, open innovation, intellectual property management, and human resource development.

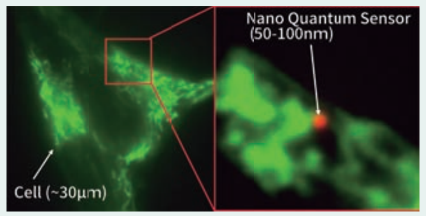
Quantum Life R&D Hub

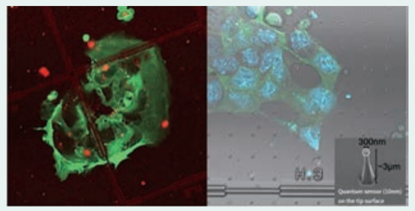
Quantum Measurement and Sensing Technologies

We are developing advanced quantum coherence measurement technologies to explore quantum effects in biological processes such as photosynthesis and magnetoreception. By analyzing the quantum-level structure of biomolecules, we aim to deepen our understanding of their functions and apply this knowledge to drug discovery and bioproduction. Our research also promotes the development of biomimetic technologies inspired by nature. Through these efforts, we contribute to the advancement of life and medical sciences, ultimately supporting the realization of a healthy and longevity society.

Research and development of nanoscale quantum biosensors

Real-time measurement of minute intracellular changes

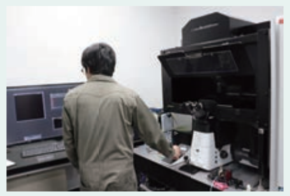




By introducing quantum sensors into living cells, physical conditions such as temperature, electric field, magnetic field, pH, etc. inside the cell can be detected in minute detail and in real time. From this new indicator, we are elucidating disease mechanisms and developing treatments.

As cells transform into tissues, they are accompanied by structural changes in the plasma membrane and changes in the size of the nucleus. We are developing a method to fabricate nanopillars with quantum sensors placed at the tip of nano-sized pillars to quantitatively evaluate changes in cellular states by quantum measurement.

Quantum Sensing for Ultra-Early Disease Detection



The development of a technology that eliminates background noise through quantum manipulation and selects only quantum sensors has made it possible to detect molecules with 100,000 times the sensitivity of conventional technology. By applying this technology, ultra-early diagnosis of cancer and infectious diseases can be achieved with only a small amount of body fluid.

Ultra-sensitive MRI / NMR R&D

Quantum-enhanced imaging for ultra-early disease detection and treatment monitoring

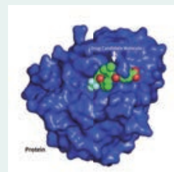
We are developing "hyperpolarization" technology that temporarily increases the signal of test drugs by tens of thousands of times through special quantum manipulation. MRI systems equipped with hyperpolarization technology can observe a set of chemical changes and distribution of substances in the body, enabling imaging of drug metabolism and migration, as well as enzyme activity specific to cancer cells. QST, in collaboration with the University of Tokyo, has succeeded in developing a drug that uses hyperpolarized MRI to image how enzymes deeply related to cancer metastasis and malignancy are activated in vivo.

Quantum Theoretical Elucidation and Mimicking of Life Phenomena

We aim to understand the most fundamental levels of life and to elucidate the basic principles underlying life phenomena. Our research also promotes the development of biomimetic technologies, contributing to drug discovery and bioproduction by harnessing the functions of biomolecules.

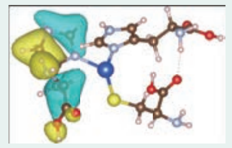
Developing of technologies for analyzing life phenomena

Structure Analysis by Neutrons



Neutrons can be used to observe hydrogen atoms, isotope effects, and electronic states of atoms. Structure-based computer simulations allow us to understand the detailed mechanisms of enzymatic reactions and drug binding.

Observation by Synchrotron Radiation



Synchrotron radiation, which is one billion times brighter than the sun, is used to observe the electronic properties of biomolecules. By analyzing the correlation between molecular structure and electronic state, the relationship between molecular function and motion can be investigated.

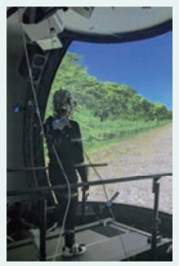
Single molecule measurement of DNA structure using optical tweezers

Optical tweezers manipulate microparticles using the momentum of light, enabling the measurement of proteins and nucleic acids at the single-molecule level. We aim to observe conformational changes and molecular motions, as well as quantify intermolecular forces at the piconewton scale, to uncover the intricate mechanisms of molecular function.

Applications of Quantum Computers to Life Science

We are developing algorithms that utilize quantum computers to analyze high-dimensional bio-data at high speed. Through its implementation, we aim to identify neural activity that causes brain diseases, identify cancer cells, optimize treatment plans and predict recovery with high accuracy and in real time.

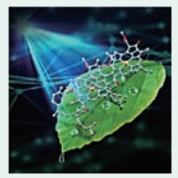
Elucidation of the fundamental principles of life phenomena



Quantum Probability Theory of Cognitive Neural Mechanisms in the Brain

We aim to quantitatively capture the "true state of mind" by analyzing data obtained from a group of devices that simultaneously capture the movements of the brain and body, using a model of quantum probability theory.

Explore the extraordinary abilities of living organisms and develop technologies inspired by them



Plants convert sunlight into electrochemical energy and transfer it to the reaction center through an optimal pathway, resulting in highly efficient energy conversion. Using ultrafast two-dimensional electron spectrometers and other instruments, we aim to measure this sequence of phenomena and uncover the underlying mechanisms.

Some animals, such as the rock dove, can sense the Earth's weak magnetic field and determine direction. This remarkable ability is believed to involve the quantum spin of specific proteins. By identifying these proteins and probing their quantum states, we aim to reveal the underlying mechanisms.

Mission

Healthy and longevity society achieved through overcoming cancer and dementia

In order to realize a healthy and longevity society, we will promote research and development toward the standardization of heavy-ion cancer radiotherapy and social implementation of the next-generation heavy- ion cancer radiotherapy system "quantum scalpel", as well as research and development of diagnostic and therapeutic technologies for neuropsychiatric diseases, solid tumors, multiple and micro cancers, etc. We will promote research and development from basic to clinical research and actual medical treatment by utilizing the strengths of the QST Hospital in addition to our knowledge of quantum life science and radiation effects research.

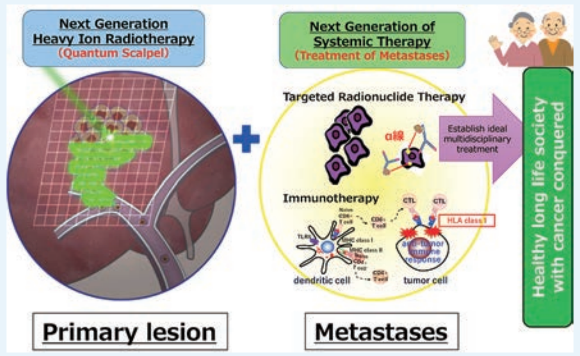
Core institutes ▶ Institute for Quantum Medical Science, QST Hospital

Related institutes ▶ Institute for Quantum Life Science, Institute for Radiological Science, Takasaki Institute for Advanced Quantum Science, Kansai Institute for Photon Science

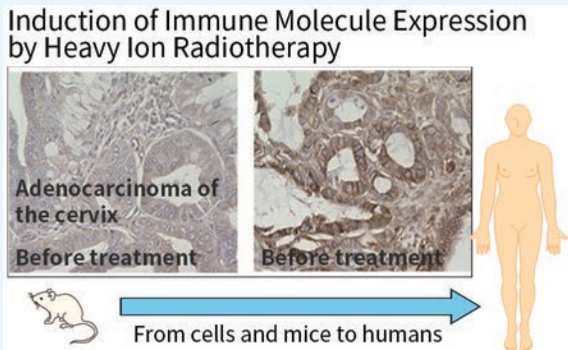
Major Competitive Funds ▶ JST-Mirai Program (JST), Brain/MINDS 2.0 (AMED), Moonshot R&D Program (AMED)

Heavy-ion cancer radiotherapy research

With the aim of expanding insurance coverage of heavy-ion cancer radiotherapy and establishing it as a standard treatment for cancer, we will promote clinical and translational research, including combinatorial therapies effective in improving treatment efficacy, and lead joint clinical research with other treatment facilities.



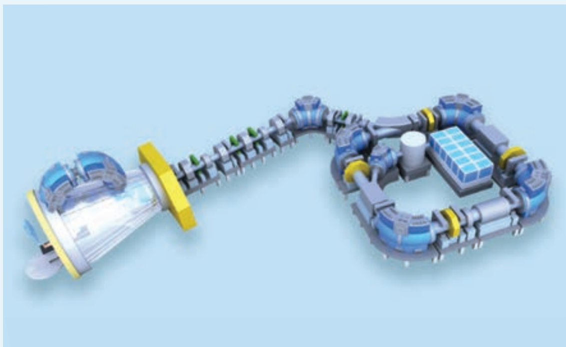
Establishment of treatment strategies to overcome cancer and achieve a society of health and longevity



Elucidating the Mechanism of Biological Effects of Heavy Ion Beams in Cells and Mice for Clinical Application

Development of next-generation heavy-ion cancer radiotherapy system

In addition to research and development of a compact next-generation heavy-ion cancer radiotherapy system (Quantum Scalpel) and its social implementation, we will promote research and development of high-precision treatment technologies such as multi-ion irradiation, which combines beams of multiple ion species according to the nature of the tumor to enhance the therapeutic effect..

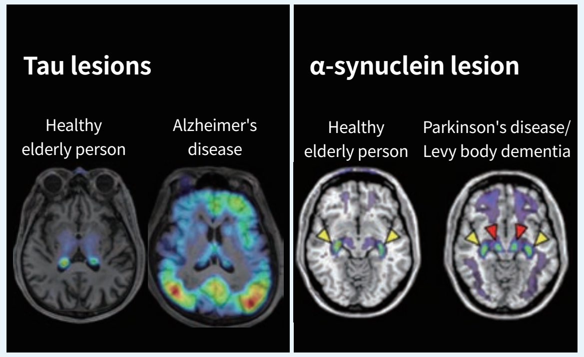


Quantum Scalpel (image)

Multi-ion source for more advanced treatment

Diagnostic and therapeutic research on neuropsychiatric disorders

We conduct research and development of technologies for high-accuracy diagnosis and objective assessments of neuropsychiatric disorders represented by dementia and depression. Based on these accomplishments, we promote the drug development to suppress the disease onset and progression and the manipulation of neural circuits for understanding brain functions toward therapeutic controls.

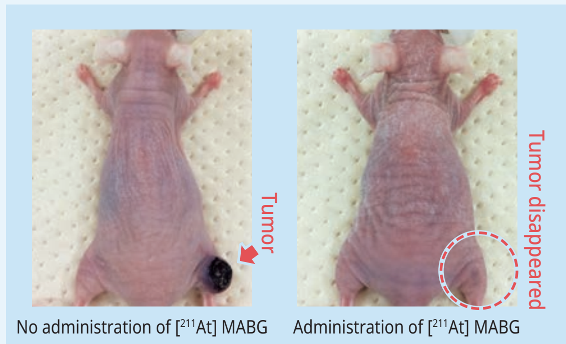


Technology to Visualize Lesions in the Brain for Highly Accurate Diagnosis of Various Types of Dementia

Vrain™, a high-performance, compact PET scanner dedicated for the head

Research on radiopharmaceutical cancer diagnosis and treatment

Using the innovative medical technology of "theranostics" (combination of treatment and diagnosis) utilizing radiopharmaceuticals, we will promote targeted radionuclide therapy (TRT) research, develop radiopharmaceuticals that are effective against multiple and micro cancers, as well as promoting clinical research.



TRT for model mouse with malignant pheochromocytoma

World's first mobile TRT treatment facility

Mission

Social system to protect the public from radiation exposure

As part of research and development to protect the public from radiation exposure, we will contribute to the development of a society that is resilient to various radiation accidents by working on the development and practical application of radiation emergency medicine and dosimetry technologies.

Core institutes ▶ Institute for Radiological Science

Related institutes ▶ QST Hospital, Institute for Quantum Life Science, Institute for Quantum Medical Science

Major Competitive Funds ▶ Radiation Health Management and Health Concerns Project (MOE)

Radiation emergency medical research and improvement of national nuclear disaster countermeasures

As the Core Advanced Radiation Emergency Medical Support Center and a designated national public institution, we will work on technical development, technical support, and training of experts in radiation emergency medicine to enhance nuclear disaster medicine.

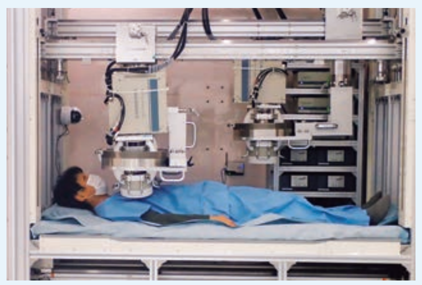
Dose Assessment Building for Advanced Radiation Emergency Medicine

This is one of the best internal exposure assessment facilities in Japan, capable of comprehensive dose assessment of internal exposure to actinide nuclides and pre-clinical testing of internal decontamination agents. It is also effectively used for research and human resource development for nuclear disaster medicine.

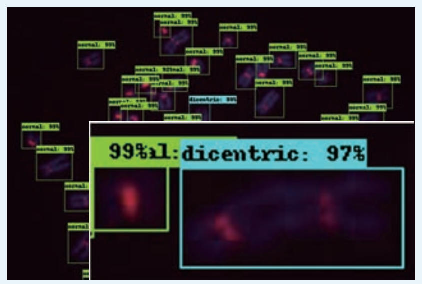
Seminar

Seminars and practical training on the initial response to terrorist incidents involving radiation, chemicals, and explosives are held.

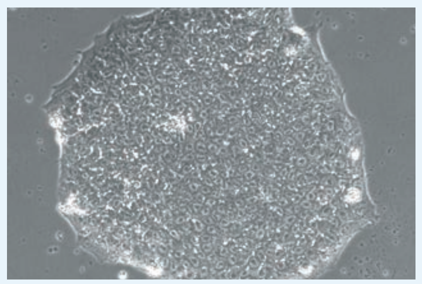
REMAT vehicle



Integrated in-vivo counter system (lung monitor)



Biodosimetry research



Basic research for application of regenerative medicine to radiation emergency medicine

We have the Radiation Emergency Medical Assistance Team (REMAT), which provides initial medical support on site in the event of radiation exposure or radioactive contamination accidents. REMAT consists of physicians specializing in radiation emergency medicine and experts in radiation protection and dosimetry. In addition, we conduct bioassays for diagnosis and treatment of exposed patients, biological dosimetry, development of techniques for trace analysis of nuclides in environmental samples, and basic research for application of regenerative medicine.

Research on radiation effects and contribution to Fukushima reconstruction assistance

As a technical support organization of the Nuclear Regulation Authority, we will conduct research and development on radiation exposure assessment and radiation health effects based on Japan's experience with the accident at TEPCO Fukushima Daiichi NPS and other incidents, and contribute to support the reconstruction of Fukushima while maintaining an international presence through collaboration with related organizations.

Low Dose Radiation Effects Research Building

Environmental Radiation Research Building

Mission

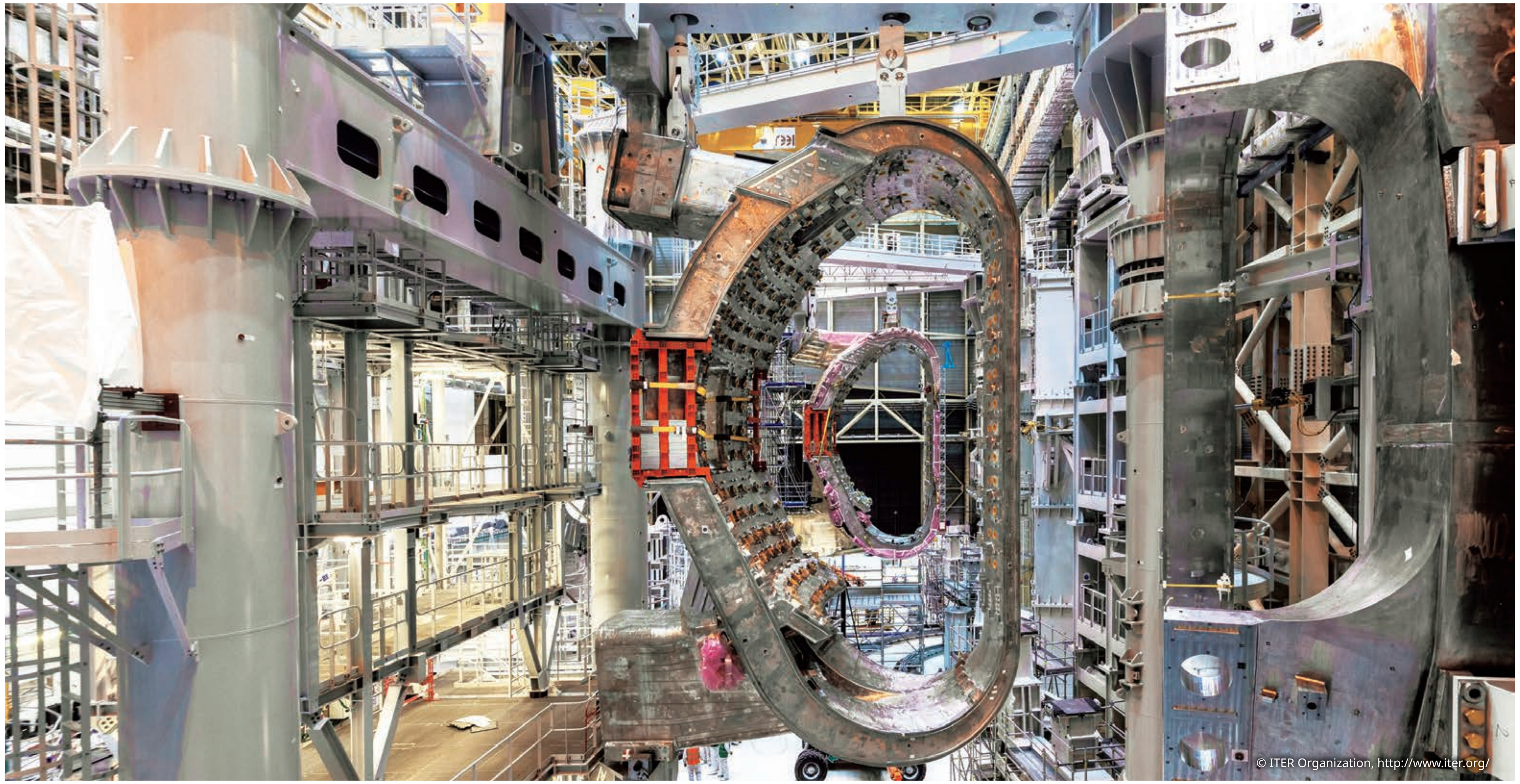
Realization of fusion energy to support Green Transformation (GX)

We will promote comprehensive research and development, including the construction of the experimental reactor ITER in France and the start of operation of the tokamak-type superconducting plasma experimental system JT-60SA at the Naka Institute for Fusion Science and Technology prior to the construction of ITER, with the three major themes: "Promotion of the ITER Project" to demonstrate the scientific and technological feasibility of fusion energy through international cooperation, "Advanced Plasma Research and Development" to study the continuous burning of fuel in a reactor, and "Research and Development of Nuclear Fusion Science and Technology" to support the realization of high-performance plasma.

Core institutes ▶ Naka Institute for Fusion Science and Technology, Rokkasho Institute for Fusion Energy

Related institutes ▶ Takasaki Institute for Advanced Quantum Science

Major Competitive Funds ▶ Small/Startup Business Innovation Research (Cabinet Office), Moonshot R&D Program (JST)



Creating a Sun on Earth!

QST's Role in Realizing Fusion Energy

In order to bridge the technological gap between ITER and DEMO to realize fusion energy, which is expected to fundamentally solve energy and environmental problems, in addition to the ITER Project and Broader Approach activities, the Naka Institute for Fusion Science and Technology and the Rokkasho Institute for Fusion Energy have been designated as the Fusion Technology Innovation Hub, and various research and development activities for the realization of DEMO are being conducted in cooperation with industry and academia.

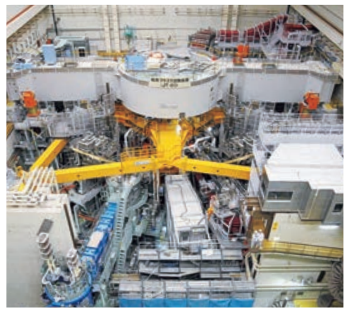
Pathway to fusion energy realization

The roadmap to the DEMO reactor first involves demonstrating fusion energy in ITER, which is under construction, followed by demonstrating power generation from fusion energy in the DEMO reactor. What ITER cannot do for the DEMO reactor will be carried out through Broader Approach (BA) activities.

Test equipment — Scientific feasibility

[Naka, Ibaraki]

JT-60



Realization of ultra-high temperature plasma

World's highest ion temperature of 520 million degrees Celsius achieved

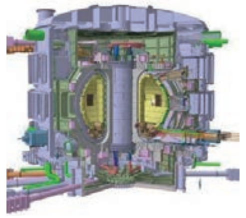
Experimental reactor — Current — Demonstration of fusion energy

[Saint-Paul-lez-Durance, France]

ITER

- Development of remote handling system, divertors, heating systems, etc.
- Support for installation and assembly
- Technical support for integrated test operations, etc.
- Development of test blanket system

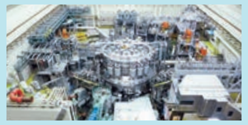
Fusion Power of 500 MW



QST is responsible for procurement of key components

Support ITER / **Complement to ITER**

[Naka, Ibaraki]



Tokamak-type Superconducting Plasma Experimental System JT-60SA

Advanced plasma research and development

- Experimental operation, maintenance, and machine enhancement of JT-60SA
- Burning plasma research, steady- state high-beta research, etc.

[Rokkasho, Aomori]

International Fusion Energy Research Centre

Engineering validation and engineering design of the International Fusion Materials Irradiation Facility

Research and development for fusion science and technology

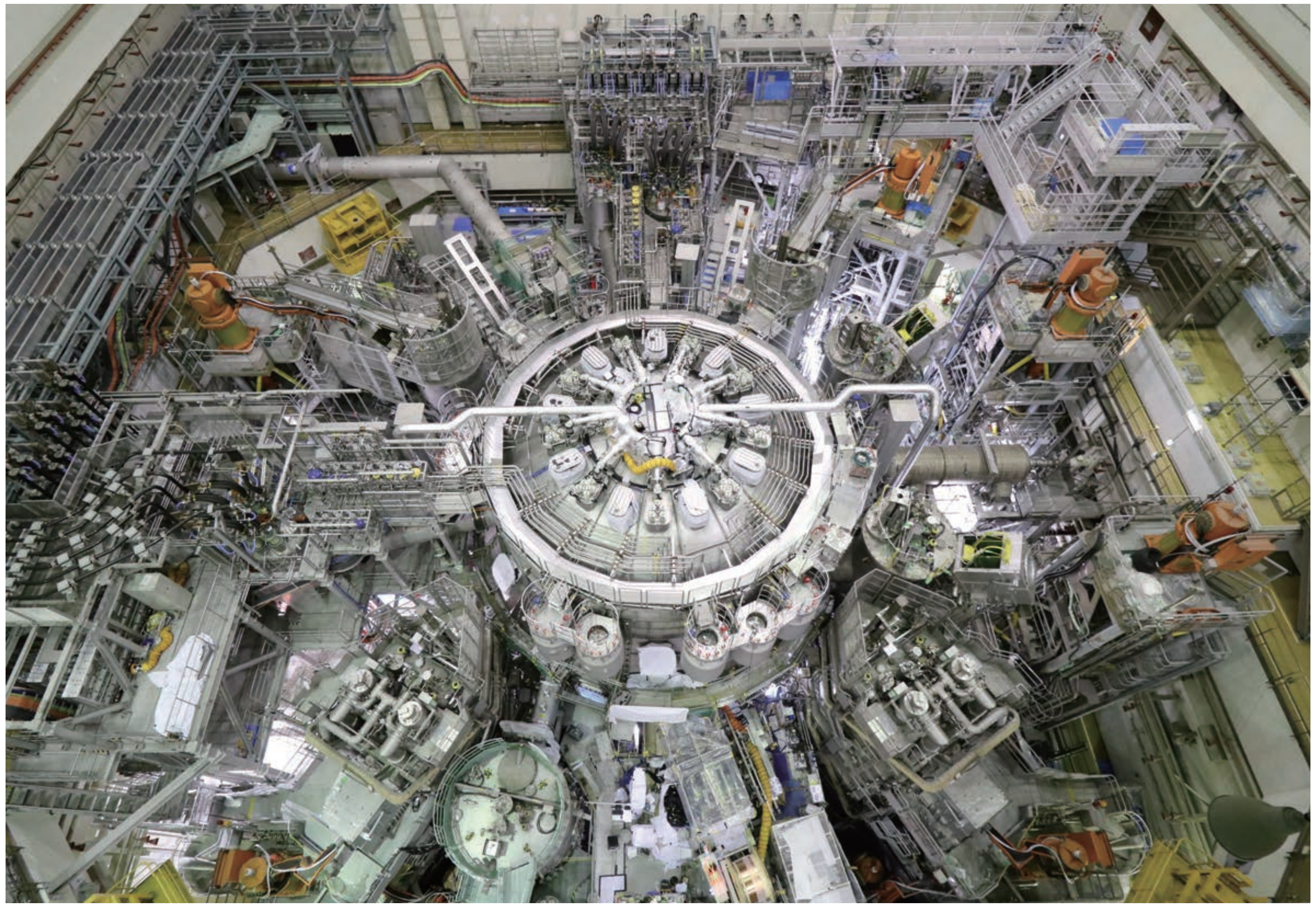
- DEMO reactor design and R&D, theory and simulation research, and fusion informatics center activities
- Operation and performance improvement of IFMIF prototype accelerator, engineering design of fusion neutron source, etc.

Broader Approach (BA) activities in the field of fusion energy research

DEMO reactor — Mid-21st century

Fusion technology to support GX

Earth-friendly DEMO reactor for fusion energy



Tokamak-type Superconducting Plasma Experimental System

JT-60SA

JT-60SA is a tokamak-type superconducting plasma experimental device constructed at Naka Institute for Fusion Science and Technology. It has been developed as a joint project between the Japan-Europe Satellite Tokamak Programme and Japan's National Centralized Tokamak Project. In October 2023, we achieved the long-awaited first plasma, along with the world's largest plasma volume and the world's largest-level plasma currents in a superconducting tokamak, demonstrating fundamental plasma control capabilities using superconducting coils. We are currently working to enhance the plasma heating devices and other equipment in preparation for plasma heating experiments.

Purpose of JT-60SA

Support research to achieve ITER's technical goals

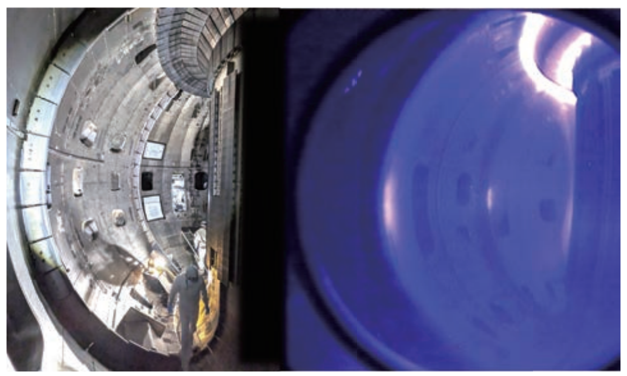
Plasma operation with high performance in the same shape as ITER is performed to reflect the results to ITER.

Supplement ITER toward DEMO reactor

For realization of a high power fusion reactor, we aim to establish an operation method to sustain high pressure plasma for sustainment time (about 100 seconds).

Human resource development

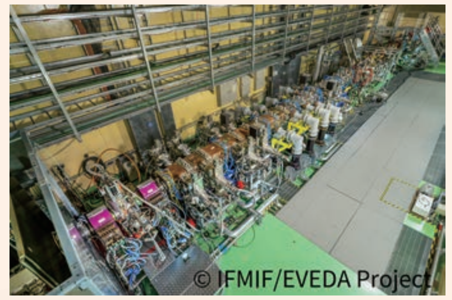
We train researchers and engineers who can lead fusion research and development, including the ITER project.



International Fusion Materials Irradiation Facility (IFMIF) prototype accelerator; LIPAc

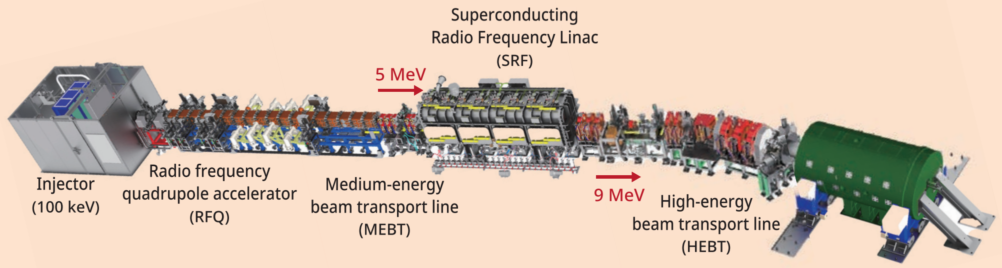
Prototype accelerator for the IFMIF, an accelerator-driven neutron source, to evaluate the integrity of reactor materials against the 14 MeV*1 high-energy neutrons generated in a fusion reactor. It is installed and tested at the Rokkasho Institute for Fusion Energy through a Broader Approach (BA) activities for the early realization of fusion energy. As an international cooperation, Japan and European countries (Italy, Spain, France, and Belgium) cooperate in the design and production, and bring them to the Rokkasho Institute for Fusion Energy for assembly and testing. The total length is 36 m. The first beam was extracted from the injector in 2014 and the first beam acceleration test was conducted in the RF quadrupole accelerator in 2018. The superconducting linear accelerator is being upgraded to achieve the project's goal of 9 MeV/125 mA*2/continuous operation in the integrated beam test using deuterons.

***1** MeV: mega electron-volt, ***2** mA: milliampere



IFMIF/EVEDA projects

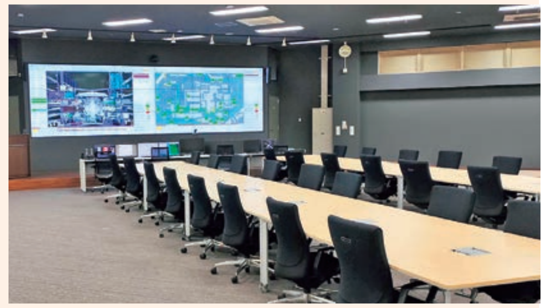
In an international collaboration between Japan and Europe, we are performing the engineering design of the International Fusion Materials Irradiation Facility (IFMIF, consisting of two accelerators with deuteron beam energy of 40 MeV and beam current of 125 mA), and developing Underlying technologies for the devices.



Research and development for DEMO reactor

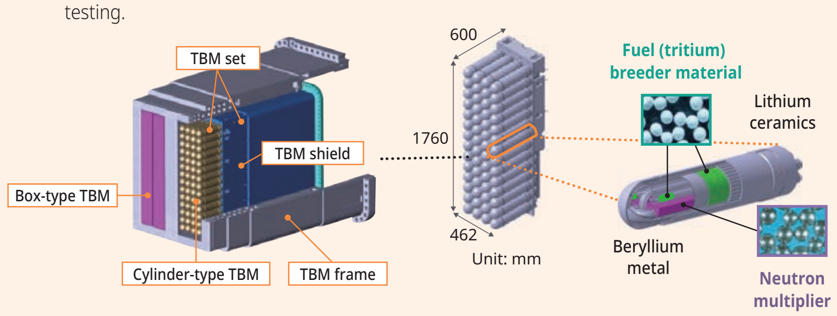
International fusion energy research centre (IFERC)

- DEMO design studies are being conducted in Japan and Europe at the DEMO Design and R&D Coordination Center to examine common issues for fusion DEMO reactors. R&D items on physical and engineering issues necessary for early realization of the DEMO reactor have been identified to carry out R&D activities.
- The ITER Remote Experimentation Center (REC) is building an IT-based REC in Japan and Europe to enable Japanese domestic researchers to participate in experimental and analytical research using ITER. In a demonstration test of ultra-high speed transfer technology, we succeeded in transferring 1 TB of data every 30 minutes, or 105 TB of data in 50 hours. In order to utilize the transferred ITER data for the construction of a fusion DEMO reactor, research and development of machine learning and AI techniques in cooperation with the Computational Simulation Center is also underway.



Development of energy-extracting blankets

In the DEMO reactors, equipment called a "blanket" is installed surrounding the plasma to extract heat generated by neutrons. The extracted heat is transferred as steam to the generator. The blanket also serves to protect external equipment from neutrons and to use neutrons to produce tritium, the fuel for fusion. We are preparing to bring a Test Blanket Module (TBM) to ITER for demonstration testing. Lithium and beryllium are also essential resources for breeding tritium, but new technologies are needed to secure the necessary quantities for fusion reactors. We have developed the advanced technology that will serve as the foundation for this project, and have established two QST-certified ventures to support their commercialization.



Computational Simulation Centre (CSC)

Since July 2025, QST has been jointly operating a supercomputer procured jointly with the National Institute for Fusion Science. Using a supercomputer with CPU-GPU integrated processors as well as conventional CPUs, simulation studies to support DEMO reactor development, the ITER project and BA projects are being conducted.

Mission

Creation and provision of new value through the use of a large group of research and development facilities

We promote the development and advancement of technologies for generating, controlling, and utilizing quantum beams such as ion beams, electron beams, lasers, and hard and soft X-ray synchrotron radiation, and promote the use of our unparalleled high-performance quantum beam facilities for researchers and engineers in Japan and overseas, as well as their utilization through joint research. Through these efforts, we will promote leading research and development in a wide range of fields, including engineering, biotechnology, and medical science, and create new collaborative activities. The 3 GeV Synchrotron Radiation Facility, NanoTerasu, will be maintained and operated in cooperation and collaboration with regional partners based on a public-private regional partnership, and will be shared in accordance with the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities.

Core institutes ▶ NanoTerasu Center, Takasaki Institute for Advanced Quantum Science, Kansai Institute for Photon Science, Institute for Quantum Medical Science

Related institutes ▶ QST Hospital, Institute for Quantum Life Science, Institute for Radiological Science, Naka Institute for Fusion Science and Technology, Rokkasho Institute for Fusion Energy

NanoTerasu Center — 3 GeV Synchrotron Radiation Facility, NanoTerasu

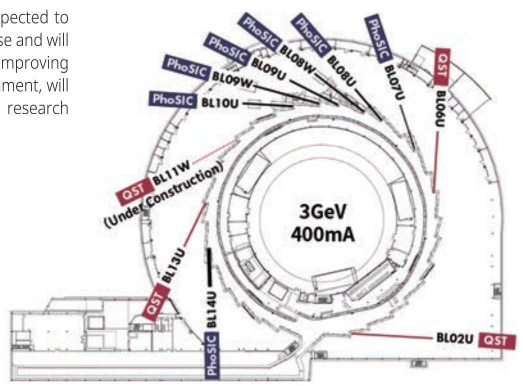
Construction began in 2019 under a 5 year plan, and operations began as scheduled in April 2024. Despite its compact design, it has the world's top-level light source performance, making it a powerful tool for research and development in various fields ranging from cutting-edge scientific research to industrial applications and solutions to social issues. From March 2025, three beamlines, including a soft X-ray resonant inelastic x scattering beamline with the world's highest resolution, are available for public use, and researchers from Japan and abroad are conducting cutting-edge research using these beamlines on a daily basis. A maximum of 28 beamlines can be installed at NanoTerasu. In order to meet the ever-expanding and diversifying needs of research, the lineup of public beamlines is planned to be expanded in the future, and a new X-ray diffraction beamline has already started to be constructed in advance. At the same time, we are also developing a state-of-the-art research environment, including automation and remote control, and NanoTerasu will continue to develop into the world's leading research facility for synchrotron radiation science.

Development and shared-use promotion of the 3 GeV Synchrotron Radiation Facility

The 3 GeV Synchrotron Radiation Facility, which is expected to be in high demand for both academic and industrial use and will contribute to strengthening research capabilities and improving productivity in Japan's industry, academia, and government, will be a leading case of a state-of-the-art large-scale research facility based on public-private regional partnerships.

[National Entity]
National Research and Development Agency: National Institutes for Quantum Science and Technology

[Partners]
General Incorporated Foundations
Photon Science Innovation Center (PhoSIC), Miyagi Prefecture, Sendai City, National University Corporation Tohoku University, General Incorporated Association Tohoku Economic Federation



National Leading natural science with the world's highest performance
- BL-02U: Resonant Inelastic X-ray Scattering (RIXS)
- BL-06U: Angle-Resolved Photoemission Spectroscopy (ARPES)
- BL-11W: X-ray diffraction (under construction)
- BL-13U: Soft X-ray Magnetic Circular Dichroism

Coalition Visualizing various material functions
- BL-07U: Soft X-ray Electronic Structure Analysis
- BL-08U: Soft X-ray Operando Spectroscopy
- BL-08W: Integrated Analysis of Chemical State and Nano/Local Structure
- BL-09U: X-ray Operando Spectroscopy
- BL-09W: X-ray Multiscale Structure Analysis
- BL-10U: X-ray Coherent Imaging
- BL-14U: Soft X-ray Imaging

Quantum beam facilities
open to the public inside and outside QST

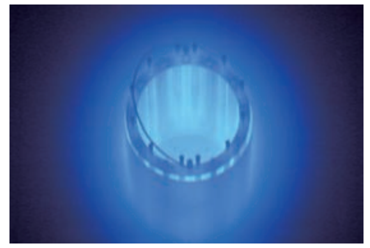
Takasaki Institute for Advanced Quantum Science

Ion Irradiation Research Facility TIARA

Four types of ion accelerators (AVF cyclotron, tandem accelerator, single-ended accelerator, and ion implanter) provide a range of ion types and energies for diverse research and development from creation of quantum materials, environment materials and energy materials to RI production and ion beam breeding. It is also used as an ion beam irradiation facility, which is important for establishing fundamental technologies such as single-photon source formation for quantum sensing and quantum computing.

Electron-beam Irradiation Facility

Capable of electron irradiation over a wide dose range from low to high doses (several kGy to MGy). The facility is used for research into the creation of quantum materials and is the center of fundamental quantum technology for the creation of solid-state quantum sensors and the creation of quantum bits (NV centers) for the development of elemental devices.



Cobalt 60 Gamma-ray Irradiation Facilities

The facility covers a wide dose rate range from radiation resistance tests requiring high dose rates for environmental and energy material development and radiation resistance tests for space, nuclear reactor and fusion reactor materials to low dose rates required for biological mutation breeding research, and has six irradiation chambers capable of permanent and long-term irradiation of large irradiation vessels.

Kansai Institute for Photon Science (Kizu)

Ultra-high Intensity Laser Experimental system (J-KAREN-P)

This is the highest-power ultra-short pulse (femtosecond) petawatt laser system in Japan, which enables irradiation experiments at the world's top level of focused laser intensity. Used for research on laser-driven ion acceleration, development of quantum beam sources such as high-brilliant and high-energy X-ray generation, and high-intensity field science research through international joint experiments to elucidate high-energy astrophysics.

Laser experimental system (QUADRA-T)

The world's most advanced 100W-class picosecond laser pumped ultra-short infrared pulse light source with high repetition rate and high average power. Ultra-fast measurements using ultra-short pulsed lasers and attosecond soft X-ray sources are expected to be applied to the creation and control of quantum materials and quantum life science.

Kansai Institute for Photon Science (Harima)

QST Contract Beamlines at the large synchrotron radiation facility SPring-8

This is a group of advanced measurement devices for nondestructive operand nanostructure observation and precise magnetic and electronic state analysis using hard X-rays of high-brilliant synchrotron radiation. Research on quantum materials and environmental energy materials (hydrogen storage materials) by realizing magnetic measurement of individual atomic layers using advanced analysis technology with synchrotron radiation is being promoted.

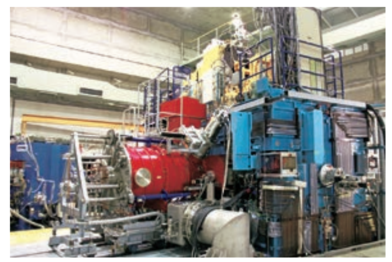
Institute for Quantum Medical Science

Heavy Ion Accelerator Facility

The Heavy-Ion Medical Accelerator for Cancer Therapy (HIMAC) at the Institute for Quantum Medical Science supports heavy-ion cancer radiotherapy and clinical research, and provides high-energy heavy-ion beams of various nuclei to universities, research institutes, and private users in Japan and abroad.

Cyclotron accelerator facility

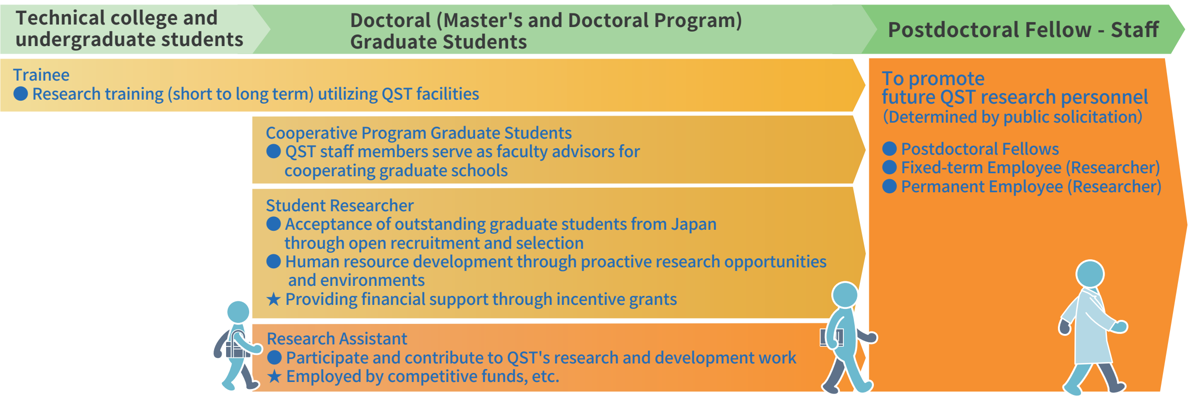
Cyclotron accelerator facility is the foundation for the development and production of radiopharmaceuticals. It contributes to cutting-edge research and development at research institutes, universities, and private companies in Japan and overseas.



Human resource development program for students

QST has established a system to accept and train students from technical colleges to graduate students, according to their skills and needs, in an environment with world-class research and development facilities. Students of graduate schools with which QST has a cooperative graduate school agreement can receive research guidance as a "Cooperative Program Graduate Student" by utilizing QST's research environment with a QST researcher as their advisor. Furthermore, in order to develop human resources for young researchers in the field of quantum science and technology, the "Student Researcher" program for outstanding graduate students in Japan provides them with opportunities to devote themselves to research independently and offers incentive grants to assist them in their research and studies. We also employ domestic graduate students as a "Research Assistant" to participate in QST's research and development work, which is funded by competitive grants and other sources.

Through these programs, we are working to develop human resources to support the career development of talented people who will lead the next generation in industry, government, and academia.



Read more

※ Consistent support for students aspiring to become researchers, from technical college and undergraduate students to graduate students

Industry-University Collaboration Activities

Quantum Technology Innovation Hub Promotion Project

"Foundational Quantum Technology Hub" and "Quantum Life R&D Hub" are promoting the integration of quantum technology and life science and the social implementation of quantum technology with high-functional and high-performance quantum materials at its core, and we support these activities. In addition, we focus on human resource development in industry and activities to promote the spread of quantum technology in order to raise awareness of quantum technology in companies and promote its practical application, aiming to realize social implementation of quantum technology as soon as possible.

QST Certified Venture Support Program

QST supports the establishment of venture companies that utilize the results of QST's research and development in order to promote the dissemination of research and development results through venture companies, return them to society through practical application in industry, and establish a positive cycle. Some QST-certified ventures have been selected for government support programs such as SBIR (Subsidy for Small and Medium Business Innovation) and D T S U (Deep Tech Startup Support Fund/ Deep Tech Startup Support Program), and are accelerating their growth.

One-Stop Contact for Industry-Academia Collaboration

In order to promote the social implementation of R&D results through industry, academia, and government collaboration, QST conducts joint research with external organizations by making maximum use of research facilities and research networks operated and owned by QST. In addition, QST provides one-stop services for consultation on the use of the facilities and technical consultation.
Please feel free to contact us at the following consultation desk.
q-consult@qst.go.jp

QST is promoting the SIP 3rd period project

SIP Cross-ministerial Strategic Innovation Promotion Program

The 3rd period of Cross-ministerial Strategic Innovation Promotion Program (SIP)

The SIP is a national project that promotes research and development from basic research to social implementation in a comprehensive manner.
The 3rd period of the SIP has newly started in FY2023, and QST is in charge of the research promotion corporation for one of its topics, promoting the application of advanced quantum technology platforms to social issues.

This topic aims to accelerate progress toward Society 5.0 through cutting-edge research and development in the fields of (i) quantum computing, (ii) quantum security networks, (iii) quantum sensing, and (iv) innovation creation foundations, as well as their social implementation. The role of QST in this program is to manage the progress of the research and development themes, conduct technical and project evaluations from a professional perspective, and perform management tasks, including public solicitation and contracting. Through these tasks, we will promote the use of quantum technology, expand the range of users, and contribute to the social implementation and practical use of quantum technology in Japan.

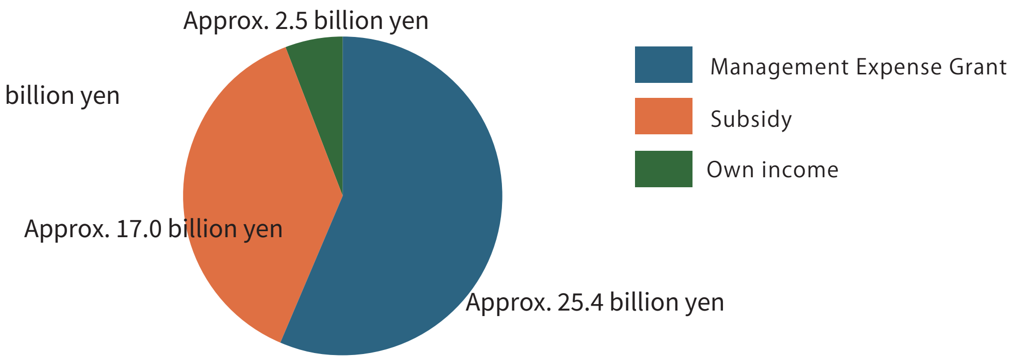
Diversity activity

QST is promoting efforts to realize a diverse environment in which employees with diverse ideas and experiences, regardless of nationality, gender, age, or disability, can work independently and continuously produce excellent research results. In July 2021, we achieved the numerical targets in our general business owner action plan based on the Act on Advancement of Measures to Support Raising Next-Generation Children, and received the "Kurumin Mark" certification from the Minister of Health, Labor and Welfare as a "Company Supporting Child-Rearing. We are still working on an action plan to go even further. In addition, we support the balance between work and childcare/nursing care by introducing a staggered work schedule, flextime system, and telecommuting system as part of our leave and leave system for childcare and nursing care and flexible work styles. Furthermore, to support staff in improving their skills and work-life balance, etc., we have introduced a "mentor system" and hold various seminars and social events.

Childcare and Nursing Support Booklet
Various support systems and procedures are listed.

Budget

Fiscal Year 2024
Budget：Approx. 44.9 billion yen



Subsidy for facility improvement：Approx. 4.0 billion yen
Competitive research funds and other external funds：Approx. 5.4 billion yen

Personnel

Fiscal Year 2024
Number of full-time staff：Approx. 1300
(Percentage of foreigners：3.6%,Percentage of women：27.2%)

Collaboration with overseas institutions and universities

Fiscal Year 2024
Number of International Agreements:
64 (United States: 4, Europe: 25, Asia: 22, Others: 2, International Organizations: 11)
Number of joint research agreements with overseas institutions:
7 (with compensation: 1, without compensation: 6)
Number of joint research agreements with universities:
194 (with compensation: 7, without compensation: 187)

National Institutes for Quantum Science and Technology

International Affairs and Public Relations Section, Department of International Affairs and Public Relations

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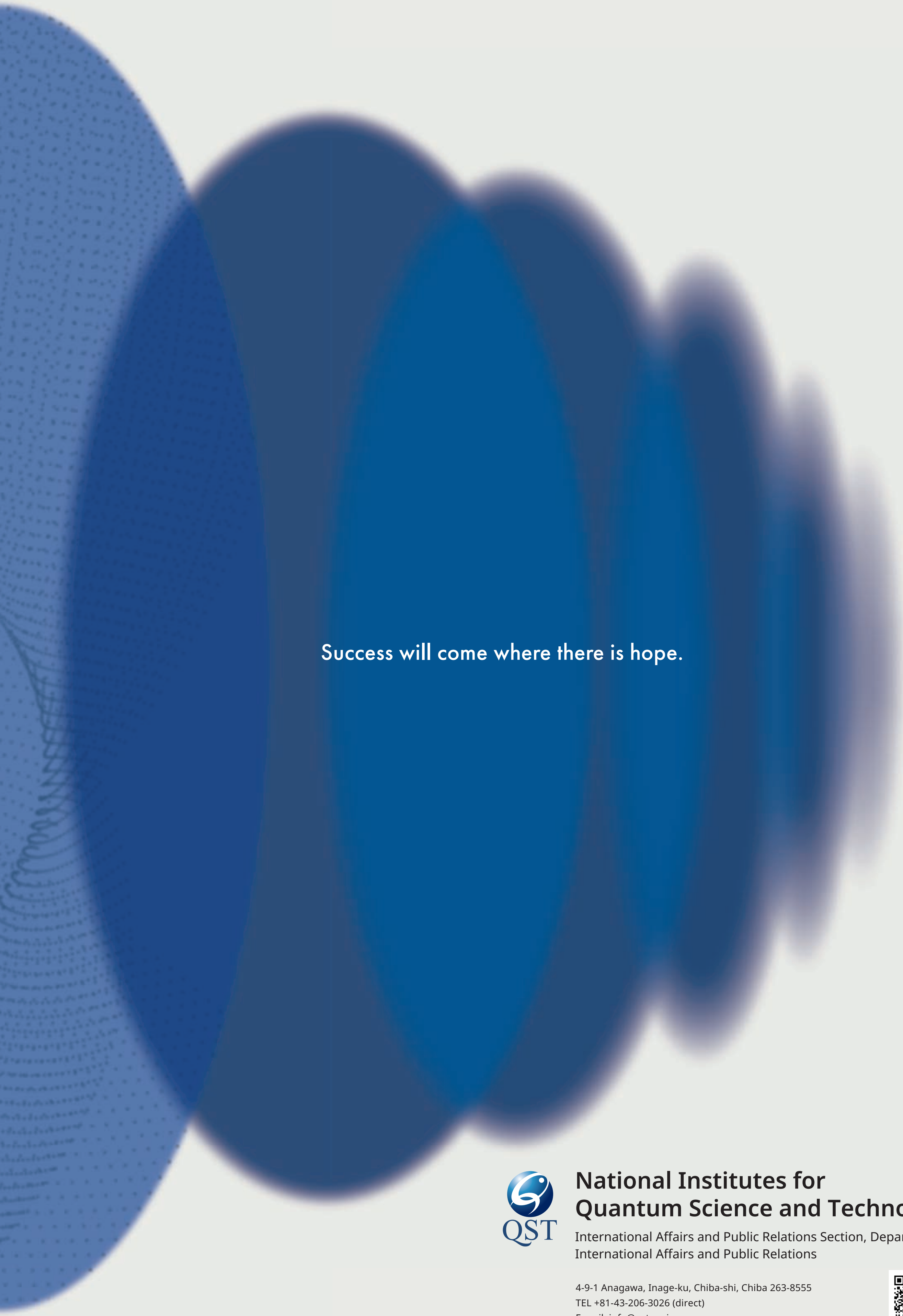
Edited by QST Pamphlet Production Team

Supported by iWAT Co., Ltd.



National Institutes for Quantum Science and Technology

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