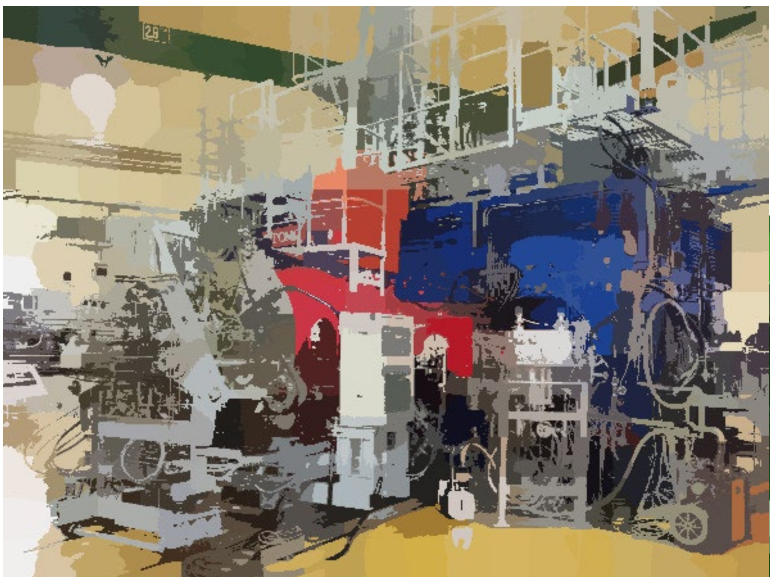
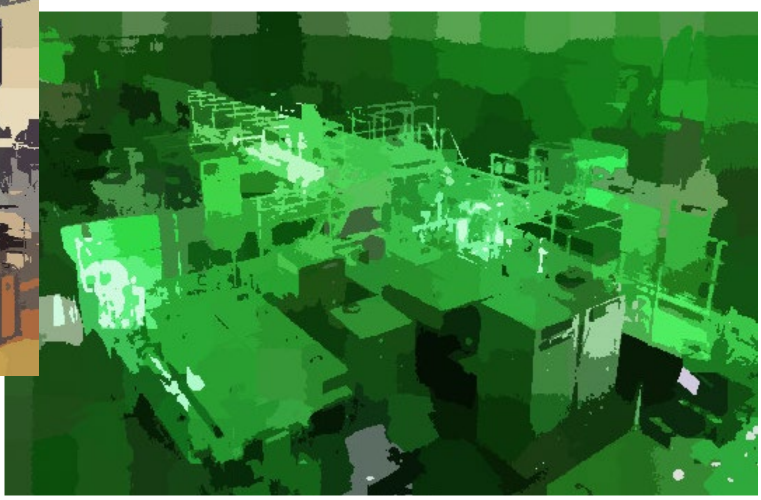
National Institutes for
Quantum and Science and Technology

Quantum Beam Science Research Directorate





Quantum Beam Science Research Directorate

The term “Quantum Beam" covers high-intensity/high-quality ion beams, high-intensity lasers, synchrotron radiation, and neutron beams. These quantum beams are produced using facilities and equipment such as particle accelerators, high-power laser equipment, and synchrotron radiation sources. The technical field that deals with the range of technologies required to generate and control these quantum beams and uses them as tools for observation and processing is called “Quantum Beam Technology", and has immense potential to contribute to revolutionary improvements in science and technology.

In our directorate we aim to produce innovative results in a wide range of fields, including medicine, science, agriculture and engineering. To achieve this we make use of advanced quantum beam technologies, taking full advantage of our strengths in having access to a wide variety of quantum beam facilities and devices, including ion irradiation research facilities, electron and gamma-ray irradiation facilities, high-intensity laser devices, synchrotron radiation beamlines, and neutron utilization devices. For this purpose, the Takasaki Advanced Radiation Research Institute and the Kansai Photon Science Institute serve as bases for promoting “Ion Beam Science", aiming at enhancing the generation and control of various quantum beams, “Quantum Materials Science", comprehensively making use of the unique and forefront properties of quantum beams, and “Quantum Optics", pioneering the world's highest level laser technology. Starting in 2019, we are also responsible for the development of a “Next-Generation Synchrotron Radiation Facility" through a public-private partnership, playing a leading role in the further development of quantum beam technology.

Your continued support and encouragement in our endeavours are greatly appreciated.

ITOH Hisayoshi, PhD

Managing Director of

Quantum Beam Science Research Directorate

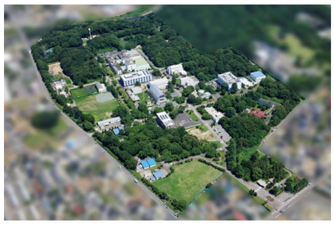
伊藤久義

Organization & Locations

National Institutes for
Quantum and Radiological Science and Technology

- Headquarters organization
- Organization under the direct control of the president
- Quantum Life and Medical Science Directorate
- **Quantum Beam Science Research Directorate**
  - Research Planning and Promotion Office
  - **Takasaki Advanced Radiation Research Institute**
    - Department of Administrative Services
    - Department of Advanced Radiation Technology
    - Quantum materials and applications research center (QUARC)
    - Department of Advanced Functional Materials Research
    - Department of Radiation-Applied Biology Research
    - Tokai Quantum Beam Science Center
      - Advanced Functional Polymer Materials Group
  - **Kansai Photon Science Institute**
    - Department of Administrative Services
    - Department of Advanced Photon Research
      - Applied Quantum Optics Cooperation Group
    - Synchrotron Radiation Research Center
  - **Institute for Advanced Synchrotron Light Source**
    - Department of Administrative Services
    - Department of Advanced Synchrotron Radiation Research and Development
- Fusion Energy Directorate

Takasaki Advanced Radiation Research Institute



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370-1292, Japan

(Tokai site)
2-4 Shirane,Tokai-mura,Naka-gun,Ibaraki
319-1106, Japan
(c/o JAEA Atomic Energy Research Institute)

(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)

Kansai Photon Science Institute

(Kizu site)
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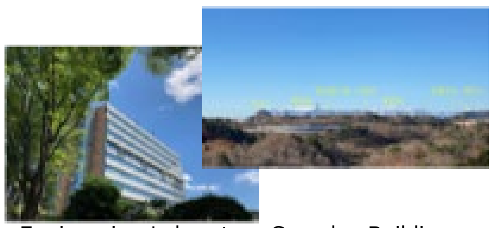
619-0215, Japan

(Harima site)
1-1-1 Kouto, Sayo-cho, Sayo-gun, Hyogo,
679-5148, Japan

Institute for Advanced Synchrotron Light Source



Engineering Laboratory Complex Building,
Tohoku University

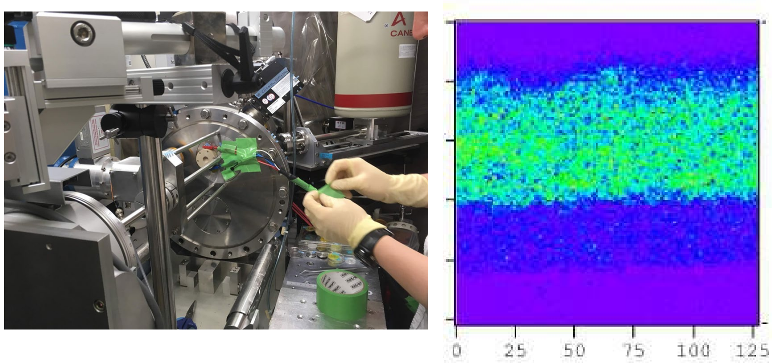
6-6-11-901 Aoba, Aramaki, Aoba-ku, Sendai-shi,
Miyagi 980-8578, Japan

Ion Beam Science

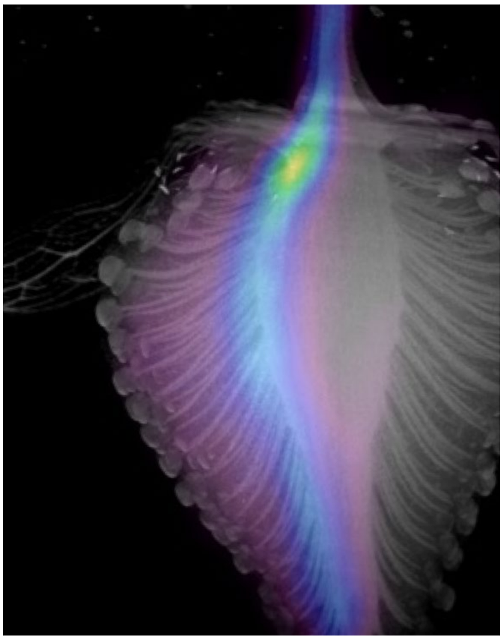
“Life and Living” bred by Ion Beams

Development of Innovative Technologies

We develop state-of-the-art technologies using ion beams that contribute to medicine, the environment, and energy, including the in-air micro-PIXE analysis technique that can measure the elemental distribution with a spatial resolution of 1 micron.



Lithium distribution (right) in an electrode (35 μm thin) of lithium ion battery was measured by micro-PIXE/PIGE analyzer (left).



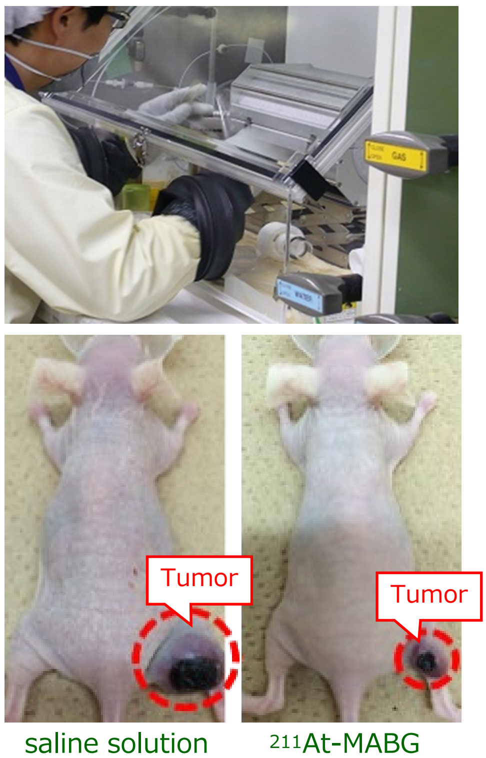
Movement of photosynthates in a strawberry by RI imaging using C-11

Contribution to Food and Agriculture

In order to realize a sustainable society, we use ion beam mutagenesis and RI imaging to help secure food resources through genome design.

Underpinnings of Medical Innovation

With the aim of innovating cancer therapies, we develop novel anti-cancer drugs with radioisotopes produced by accelerators, and clarify the mechanism of cancer cell killing.



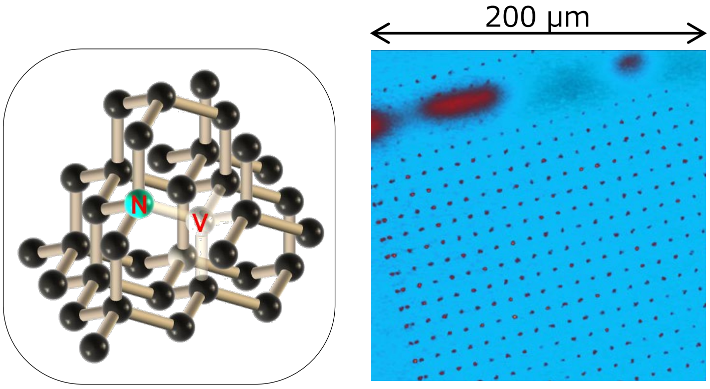
Synthesis of astatin-211 labeled anti-cancer drug (above) and therapeutic effect on pheochromocytoma model (below)

Quantum Materials Science

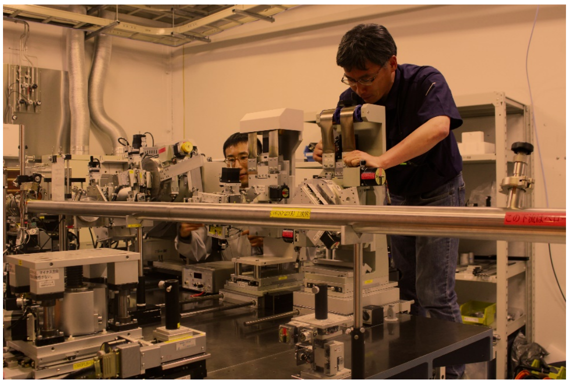
Observe on a Quantum Scale and Create Innovative Quantum Materials and Devices

Creation of Innovative Quantum Devices

Using quantum beams, we create single-photon sources and spin-carrier materials that can be applied to quantum technologies. These innovative quantum devices will enable ultra-sensitive sensing, ultra-low energy consumption, and ultra-high-speed processing.



A single photon source (left) consisting of a nitrogen-vacancy (NV) pair in diamond. Photoluminescence from NVs formed at the desired position on the diamond substrate (right).



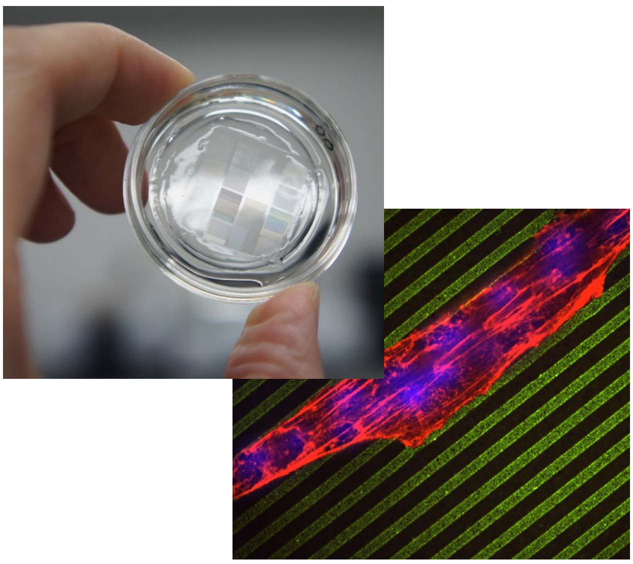
Ultra-high vacuum synchrotron Moessbauer system that enables observation of atomic scale magnetic and spin states

Observation with Advanced Quantum Beam Measurement

Advanced measurement technologies utilizing various quantum beams, such as synchrotron radiation and positron beams, accelerate researches of quantum materials science by observing the state of atoms and electrons constituting matter with high precision and by clarifying the nature of matter.

Creating New Functional Materials through Quantum Beam Molecular Processing

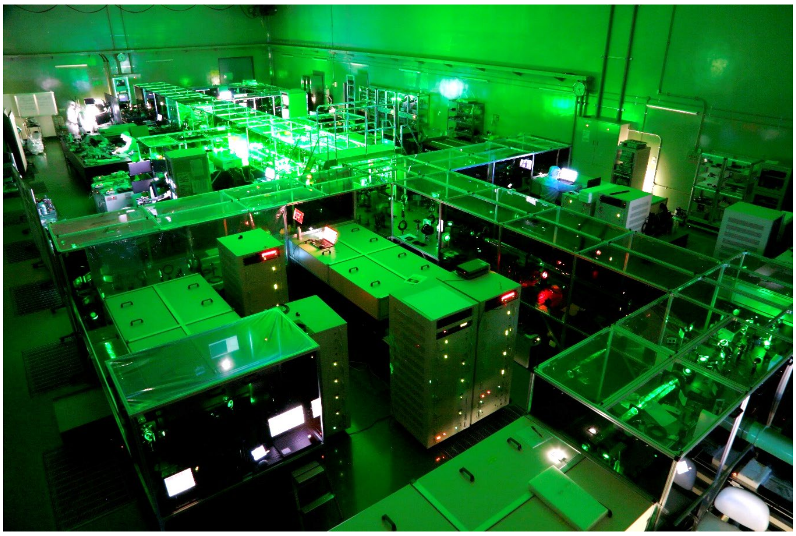
Through close collaboration with the industrial community, we enhance the quantum beam technologies, which we have developed over many decades, such as graft polymerization and crosslinking, to create new polymer materials that can be applied to advanced medical care and industrial development.



Medical polymer material (left) which formed the micro pattern on the surface by the crosslinking technique. A mass of cells (right) grown in a fixed direction on the material.

Quantum Optics

The Quest for Future by Lasers



The world's leading high-intensity laser, J-KAREN. By confining 30 J of laser energy in a time of 30 femtoseconds (1 femto is 1/(1000 trillion)), an ultra-high intensity of 1 petawatt (=1000 trillion watts) can be achieved.

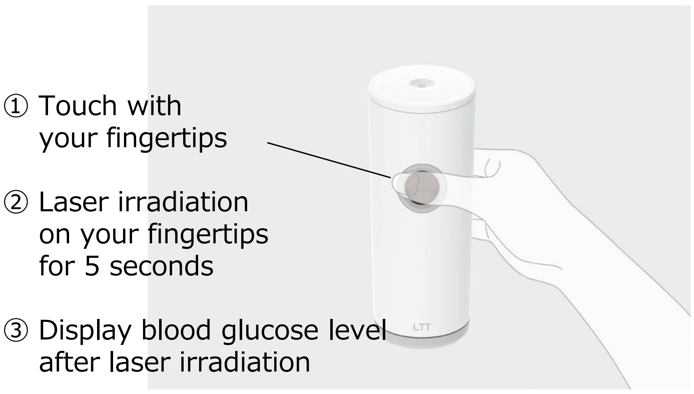
Challenge to Ultra-High Field Science

We attempt to elucidate relativistic phenomena in ultra-high fields that can only be created by high-intensity lasers, observe ultra-high speed phenomena using ultra-short pulse lasers, and perform cutting-edge science such as material control.

Creating a Safe and Prosperous Future

We contribute to the realization of a prosperous and safe future through the development of medical and industrial application technologies with lasers that support everyday life and the social implementation of the results of QST-certified venture companies.

Development and practical application of non-invasive blood glucose sensor using infrared laser technology



© Light Touch Technology Inc.

Light Touch Technology Inc., a QST-certified venture company (Approved in July 2018).

Development of automatic, remote, and high-speed diagnostic technology for internal defects in concrete by laser hammering method

PhotonLabo co., Ltd., a QST-certified venture company (Approved in June 2019).

Next-Generation Synchrotron Radiation Facility

Synchrotron Radiation facility for Cutting-Edge Academic Research and Diverse Industrial Applications

Construction through a "Public-Private Partnership"

As the national body for the development and operation of the Next-Generation Synchrotron Radiation Facility, we promote the development of the facility in cooperation with regional and industrial partners.

Partners: Photon Science Innovation Center (Representative body, abbreviated as PhoSIC), Miyagi Prefecture, Sendai City, Tohoku University, Tohoku Economic Federation

It can measure the light elements with high sensitivity and can meet various needs from basic science to industrial application, such as research and development of magnets and spintronics elements, drug discovery and development of new highly active catalysts.

Convenient Location at Tohoku University's Aobayama New Campus

New Aobayama campus map of Tohoku University and the construction site

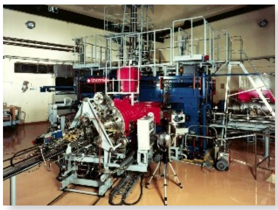
It is planned to be built on the Aobayama new campus of Tohoku University, a nine-minute subway ride from Sendai Station. We will establish a new scheme for industry-university collaboration and aim to build a research complex at one of the best locations in the world.

Establishment of the 3GeV-Class Synchrotron Radiation Source

We are promoting the development of the latest accelerator technologies for the next-generation synchrotron radiation facilities such as high brightness 3 GeV class synchrotron radiation sources.

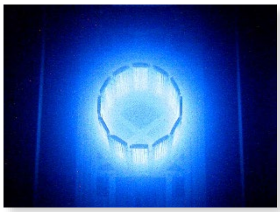
In order to design and build the storage ring, a half of the minimum unit of magnet arrangement was built as a trial. We established the alignment method for the magnet arrangement with an accuracy of several micrometers.

Facilities and Equipment for Quantum Beam Science Research



Ion Irradiation Research Facility Cyclotron

Electron Beam Irradiation Facility



Gamma-Ray Irradiation Facility

J-KAREN

Quadra-T

QST Quantum Dynamics Ⅰ
Beamline of SPring-8
BL 11 XU

QST Quantum Dynamics Ⅱ
Beamline of SPring-8
BL14B1

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