Medical Consultation and Treatment for Overseas Patients

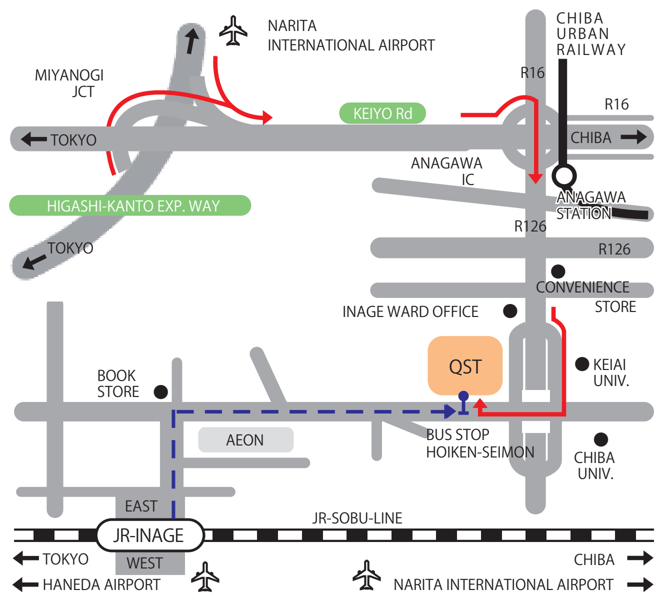
The QST hospital has been a world-leader in carbon ion radiotherapy since 1994 and also accepts patients from overseas. Patients who wish to contact us regarding carbon ion radiotherapy, should enquire below via a registered guarantor (medical coordinator or travel agency).

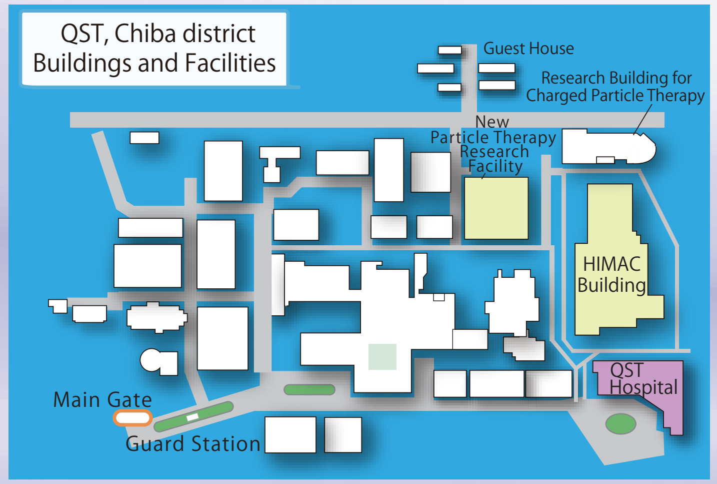
1. Contact for enquiries:
QST Hospital International Particle Therapy Research Center
4-9-1 Anagawa, Inage-ku, Chiba-shi, Chiba 263-8555
Email：kokusaiml@qst.go.jp

2. List of registered guarantors (medical coordinator and travel agency) :

ACCESS

- From central Tokyo, Tokyo-Haneda Airport
  - <by train> Take the JR Sobu line to Inage station. Walk for 10 minutes to QST, or take the bus for Sanno-cho from Inage station to Houiken-mae/QST's main gate.
  - <by car> About 1.8 km to QST from Anagawa IC on Keiyo Highway.
- From Tokyo-Narita Airport
  - <by train> Take the JR Sobu line (rapid service) to Inage station. Walk for 10 minutes to QST, or take the bus for Sanno-cho from Inage station to Houiken-mae/QST's main gate.
  - <by car> About 5.5 km from Chiba-kita IC on Higashi-Kanto Expressway.





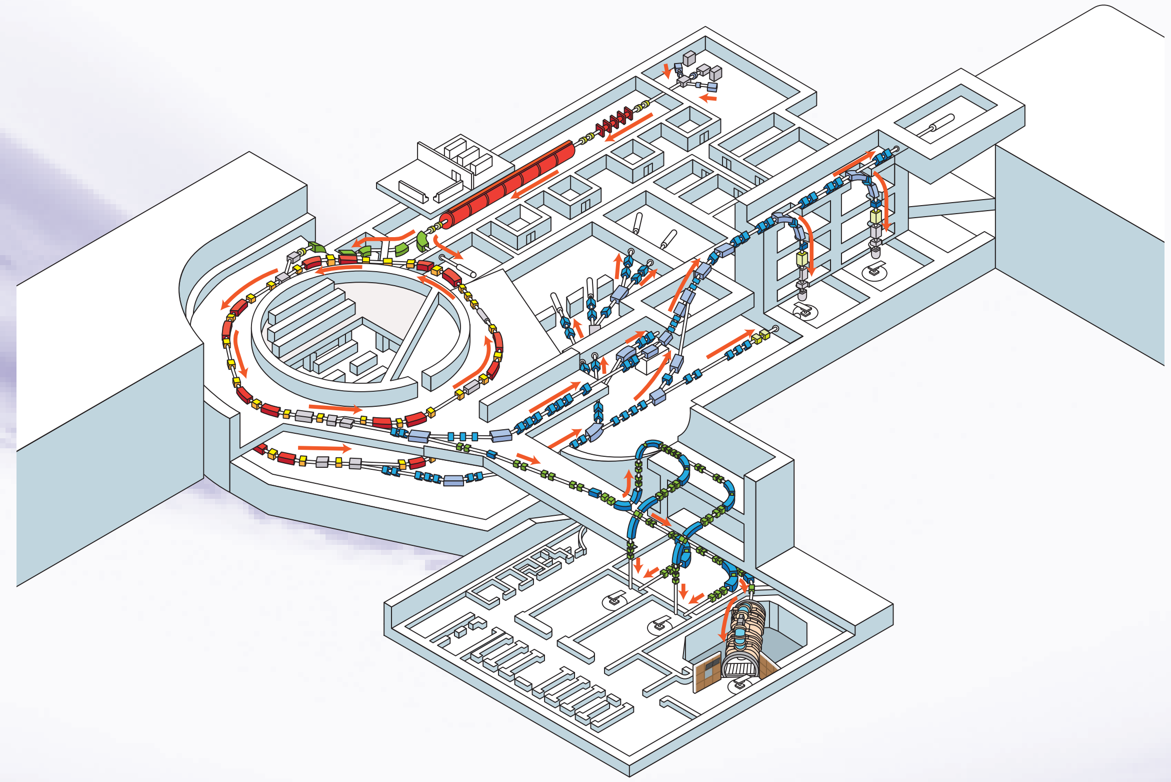
National Institutes for Quantum Science and Technology
4-9-1 Anagawa, Inage-ku, Chiba City 263-8555, Japan

Advanced Radiation Therapy
Leading the World in Solid Cancer Treatment

Carbon Ion Radiotherapy Facility

HIMAC

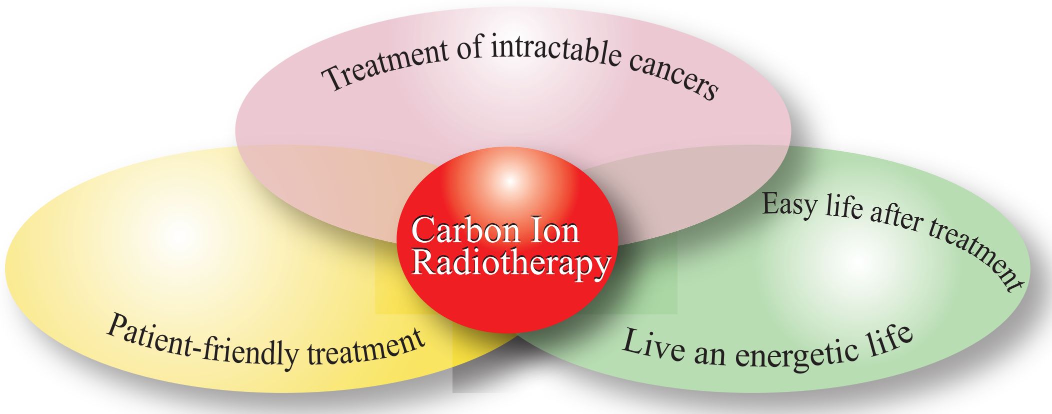
- Heavy Ion Medical Accelerator in Chiba -



Treatment of Intractable Cancers
Short-term Treatment
High Quality of Life

QST National Institutes for Quantum Science and Technology

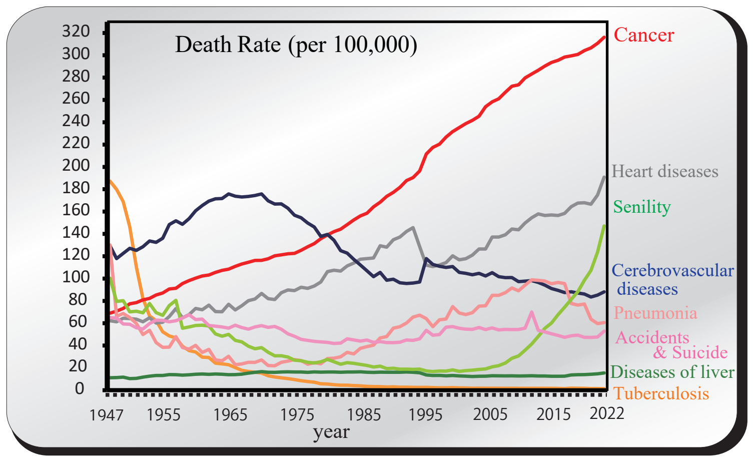
2023.7



QST constructed the first original machine in the world specialized for carbon ion radiotherapy named HIMAC (Heavy Ion Medical Accelerator in Chiba). HIMAC has achieved remarkable results as health insurance treatments, advanced medicine and clinical trials.

Cancer, the No.1 Cause of Death
The key to treatment is radiotherapy.

The numbers of patients with cancer, and of deaths resulting from cancer are increasing. In 2021, the number of people who died of cancer in Japan amounted to 380,000, which is 27% of the total yearly deaths.



Annual death rates from major causes
Cited from the Vital statistics (approximation) by the Ministry of Health, Labour and Welfare (2022)

What is Radiotherapy?

Radiotherapy = Cancer treatment without surgery: neither painful nor hot

Radiotherapy is a sophisticated method of annihilating cancer cells with radiation, by making microscopic damage within the molecules of DNA (deoxyribonucleic acid) in a cell nucleus, and of preventing further cell division.

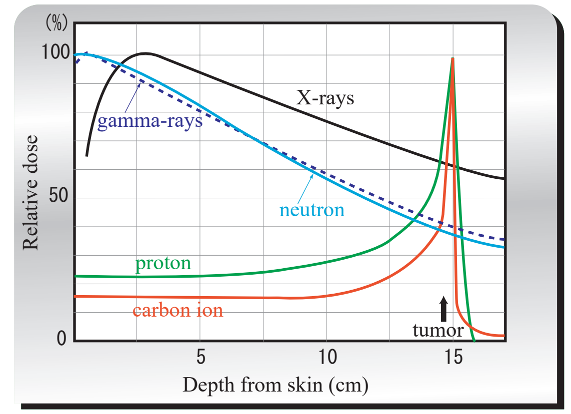
Cancer Treatment Methods

		Advantage	Disadvantage
Local treatment	Surgery	• Highly effective in controlling cancer • If there is no metastasis, the chances of complete recovery are high • The spread of cancer can be confirmed directly with the eye	• Heavy strain on the body • Take a long time to recover • Need to take time off from work
Local treatment	Radiotherapy	• Less strain on the body • Fast recovery • Treatment can be continued while living a normal life	• Less effective than surgery in controlling cancer • Side effects such as skin redness, fatigue, and malaise may occur
Systemic treatment	Drug therapy	• Since it circulates throughout the body, it is effective even for small metastases regardless of the location of the cancer • Helps shrink or prevent cancer	• Damage normal non-cancer tissue • Side effects such as nausea, anorexia, and malaise may occur

Carbon Ion Beam・Physical and Biological Features

Advantages of Carbon Ion Radiotherapy: Treatment of intractable cancers, short-term treatment, high quality of life
Treatment of unresectable cancer and radiation resistant cancer

As you can see in the figure on the right, X-rays become gradually less and less effective as they travel through the body, so in order to treat cancers located in a deep region of the body, the radiation dose is concentrated by irradiating from multiple directions.
In comparison, heavy ions are suitable for the treatment of these cancers because they affect cells only weakly until they reach the tumor, and demonstrate an enormous effect at the moment they stop in the tumor.



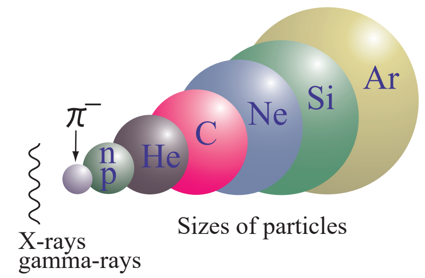
Dose distributions of various therapeutic radiations in the body

What is a carbon beam?*)

Carbon ion beam: Beam of carbon (C ions), flying at extraordinarily high speed. QST is using carbon ion beam for cancer treatment.

Other radiation*)

Proton beam: Beam of protons (nuclei of hydrogen) flying at an extraordinarily high speed.
Photon beam: X-rays and gamma-rays are photon beams at high energy.



*) When these ions are used for treatment, an extremely large number of flying particles make up a bundle (beam) in the same direction for irradiating the tumor.

Physical features of a carbon ion beam

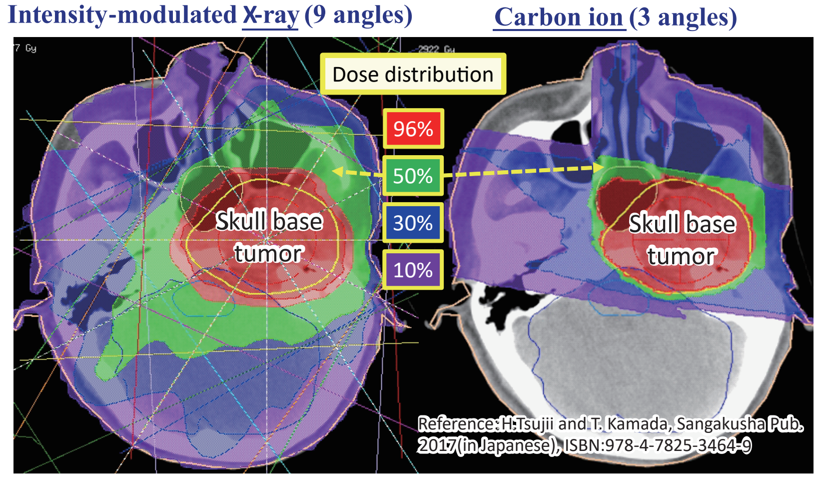
- The depth where the ion stops is exactly predetermined.
- The radiation dose becomes enormous only when the ion stops.

Biological features of a carbon ion beam

- The biological effect is stronger than X-rays for the same dose.

Comparison of X - ray and carbon ion dose distributions

Intensity-modulated X-ray (9 angles) **Carbon ion (3 angles)**

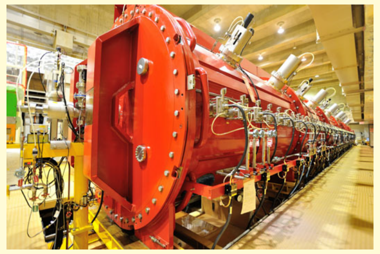


Carbon ions stop at the exact depth given by the injection energy. In addition, they have the advantage that the strongest effect on killing cells is shown at the point where they stop. Therefore, one can concentrate the damage to cancer cells by adjusting the stopping point for them. As a result, the irradiation range and irradiation dose of normal tissue can be reduced.

Instruments for Carbon Ion Radiotherapy

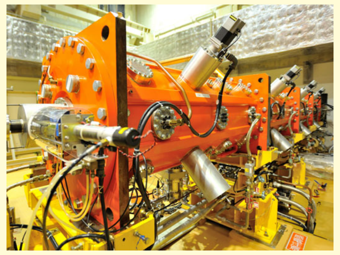
HIMAC, First Machine for Carbon Ion Radiotherapy in the World

HIMAC is the first machine in the world constructed for research on carbon ion radiotherapy. The mission of HIMAC is to verify the effectiveness and safety of carbon ion radiotherapy and to develop new medical technologies. HIMAC consists of various instruments shown below.



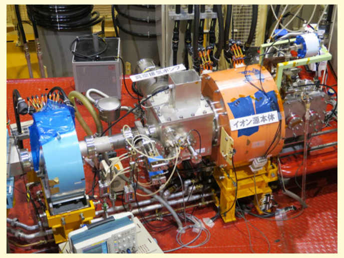
③ Alvarez Linac

Linear accelerator for medium-speed ions. Length:24 m/up to 11% of the speed of light



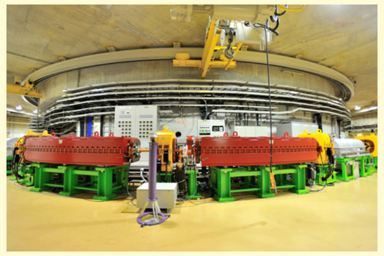
② RFQ Linac

Linear accelerator for low-speed ions. Length:7.3 m /up to 4% of the speed of light



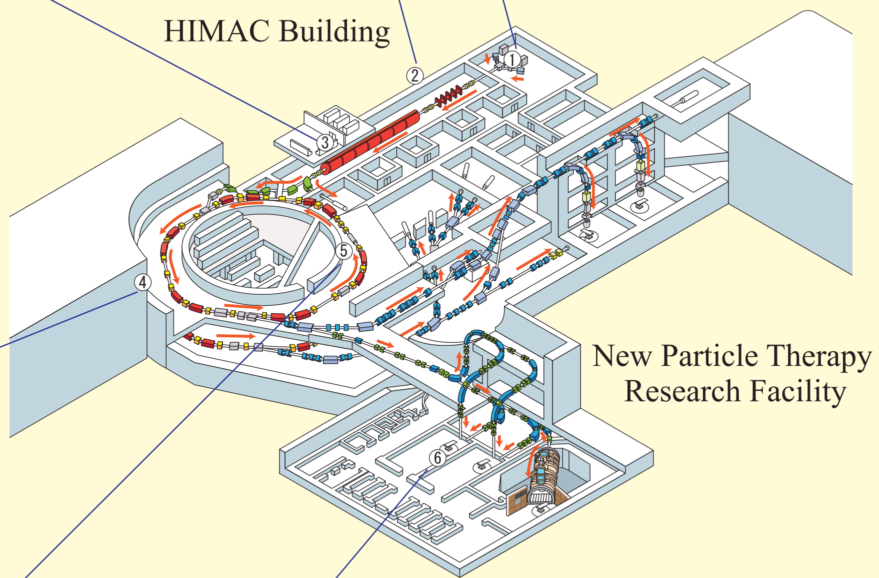
① ECR Ion Source

This type of ion source produces highly charged carbon ions.



④ Bending Magnet of Synchrotron

The AC electromagnets are used to adjust the trajectory of the ions.



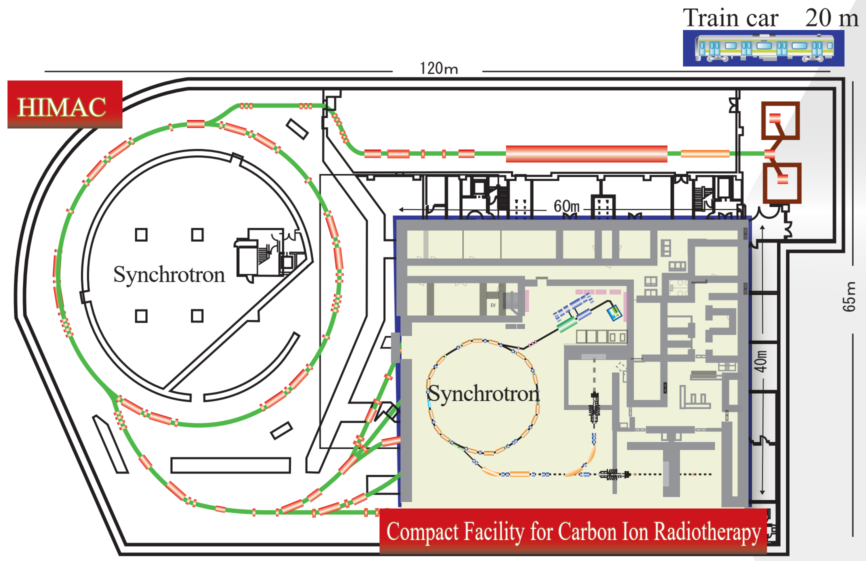
⑤ RF Cavity

By gradually increasing the radiofrequency, the ions are accelerated up to 84% of the speed of light.

⑥ Treatment rooms

There are three treatment rooms. In particular, Treatment Room G is equipped with a rotating gantry that can irradiate patients with the carbon ion beam from any direction at 360 degrees.

Research on Compact Facility for Carbon Ion Radiotherapy



Since HIMAC was constructed for research, it has a scale of football court. The compact facility for carbon ion radiotherapy is one-third the scale and cost of HIMAC through the optimization of ion species and energy. They are at work at Gunma University, in Saga Prefecture, in Kanagawa Prefecture, in Osaka Prefecture, and at Yamagata University.

Gunma University Heavy Ion Medical Center

Kanagawa Cancer Center

Osaka Heavy Ion Therapy Center

SAGA Heavy Ion Medical Accelerator in Tosu

East Japan Heavy Ion Center Yamagata University

Research and Development of Next-generation Irradiation System

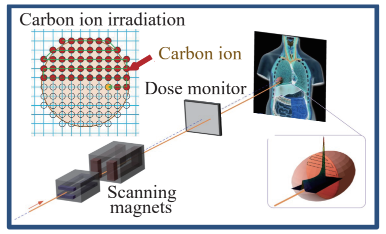
New Particle Therapy Research Facility

[Development of Three-dimensional Scanning Irradiation system]

- We have developed a respiratory gated three-dimensional scanning irradiation system to further concentrate the effects of the carbon ion beam on the cancer, thereby reducing side effects and enhancing therapeutic effect.

[Development of Rotating Gantry]

- We have developed a rotating gantry that can irradiate the carbon ion beam from any direction at 360 degrees so that patients can receive treatment in a comfortable posture.
- By using superconducting technology for the first time in the world, it has achieved a compact size of 13 m in length and 300 tons in weight, despite being designed for carbon ion beams.



Respiratory Gated Three-dimensional Scanning Irradiation System

Rotating Gantry

History of Carbon Ion Radiotherapy

1957	1984	1986	1988	1993	1994	2001	2003	2004	2006	2010	2011	2016	2017	2018	2019	2022
· NIRS was established	· National HIMAC project started under the first 10-year comprehensive strategy against cancer by the Japanese government.	· Basic design of HIMAC started.	· Construction of HIMAC started.	· Construction of HIMAC was accomplished. · Research Center of Charged Particle Therapy was established.	· Clinical trial of carbon ion radiotherapy started. · Research on upgrading of HIMAC started.	· Total number of treated patients exceeded 1000. · Research Center for Charged Particle Therapy was established.	· Carbon ion radiotherapy was approved as advanced medicine by the Minister of Health, Japan.	· Total number of treated patients exceeded 2000. · Research on compact facility for carbon ion radiotherapy was started.	· Research and development of Next Generation Irradiation System started.	·First compact facility for carbon ion radiotherapy started the treatment at Gunma University.	·Clinical trials of the next-generation scanning system were started.	·Insurance coverage started for unresectable bone and soft tissue tumors	·Clinical trials of a Rotating Gantry were started.	·Insurance coverage extended to head and neck cancer and prostate cancer	·The incidence of secondary cancers after treatment of prostate cancer with carbon ion beams was found to be significantly lower than with X-ray therapy.	·Insurance coverage extended to hepatocellular carcinoma, intrahepatic bile duct cancer, pancreatic cancer, colorectal cancer (postoperative recurrence), and cervical adenocarcinoma

Quantum Scalpel Project

The Quantum Scalpel: A compact and high-performance carbon ion radiotherapy system

In order to realize "zero cancer deaths and a healthy, long-lived society," it is necessary to popularize patientfriendly treatments that can maintain a high QOL during and after cancer treatment, such as carbon ion cancer therapy.

Enables treatment while working for almost all cancers that are indicated

Multi-ion irradiation combining neon, oxygen, and helium in addition to carbon ions enhances treatment effects, reduces side effects, and decreases the number of irradiations, making it possible to treat many cancers while working and realizing medical treatment that enables individuals to live their own way of life.

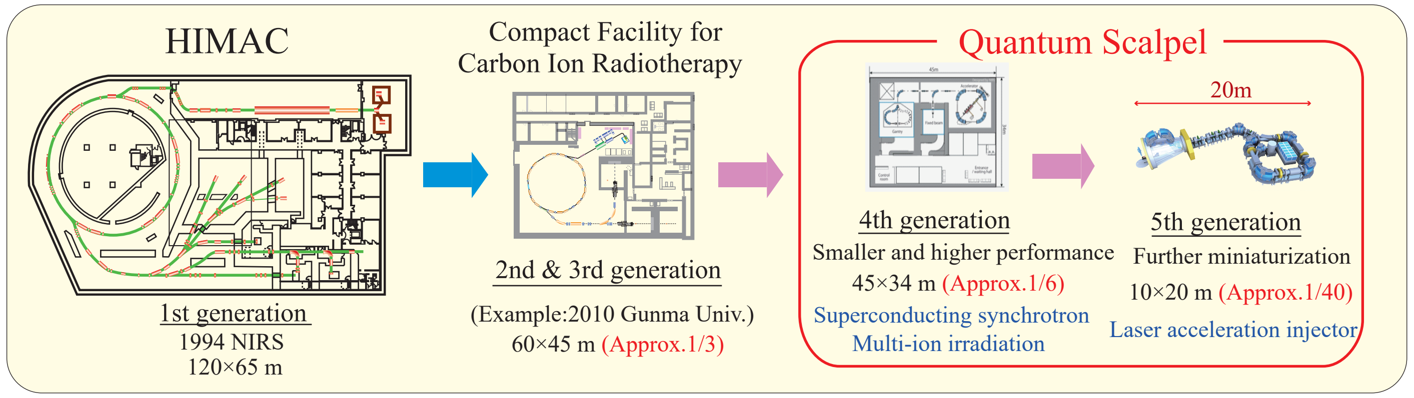
Achieves size compact enough to be installed in an existing hospital building

Intense laser and superconducting electromagnet technology will enable downsizing of the injector, synchrotron, and rotating gantry. Through the widespread use of the "quantum scalpel," which reduces the size and cost of the device, we aim to create a society in which carbon ion radiotherapy is available in more hospitals.

Expanding indications to diseases other than cancer

The Quantum Scalpel Project will also promote research and development for the treatment of cardiac diseases such as arrhythmia as well as cancer. We are also working on the development of microsurgery technology that can reduce the beam diameter to 1–3 mm to irradiate microscopic lesions such as neurological diseases with high precision.

Research and Development for Quantum Scalpel

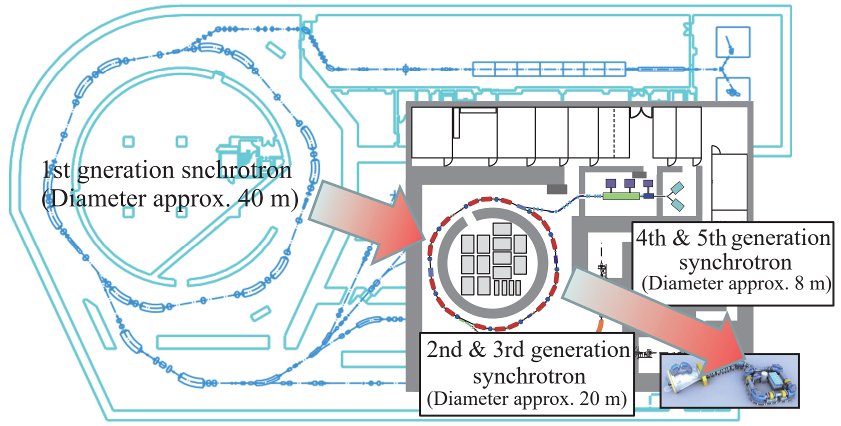


Devices \ Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
Superconducting synchrotron	Element technology development				Design		Production and testing of treatment demonstrator				Approval and dissemination of a 4th-generation machine for pharmaceutical equipment
Multi-ion irradiation	Element technology development				Clinical trials						
Laser acceleration injector	Construction of technology demonstrator				Technology demonstrator upgrading						Construction of a 5th-generation demonstration machine

Quantum Scalpel Technology Development

Superconducting synchrotron

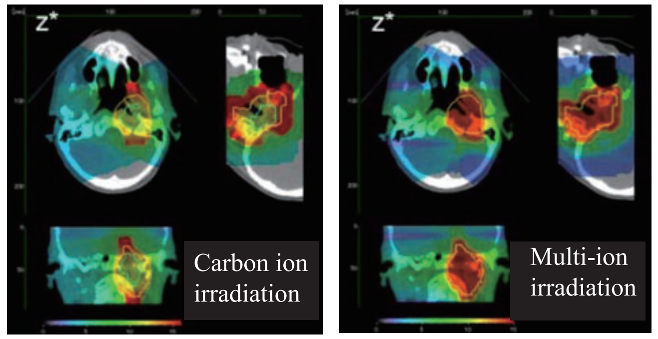
By using superconducting magnets, which can create a high magnetic field, the electromagnets that occupy a large space in the circular accelerators (diameter reduced to 20 m) of existing carbon ion radiotherapy system can be made much smaller, requiring only 1/10th of the installation area.



Multi-ion irradiation

Irradiation with ions heavier than carbon, such as oxygen and neon ions, further improves the treatment outcome of radiation resistant intractable cancers, while irradiating areas adjacent to normal organs with helium ions, which is lighter than carbon ions, reduces side effects and the number of irradiation sessions.

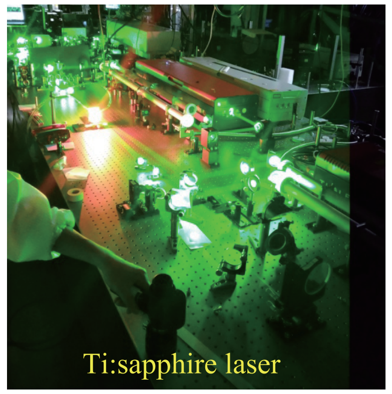
Distribution of the relative biological effects in the body

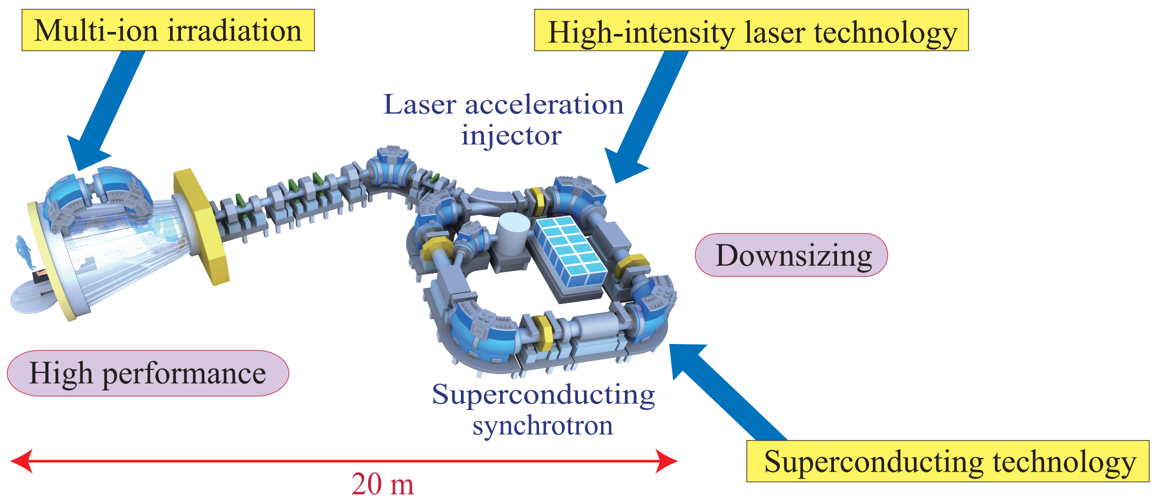


In the case of multi-ion irradiation (right), the biological effect becomes uniformly high within the target area (contoured by yellow line).

Laser acceleration injector

Using laser-driven ion acceleration technology, the length of the injector (ion source + linear accelerator) is reduced to around 5m from around 15 m, which is the length of conventional linear accelerators.
Kansai Institute for Photon Science, QST, with support by the JST-Mirai Program, is conducting demonstration experiments of this laser acceleration injector (see figure on the right).





Quantum scalpel 5th-generation system