

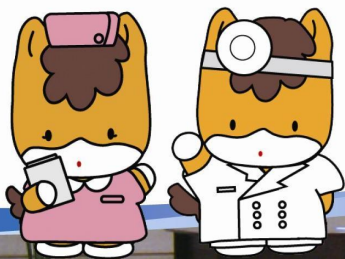


About Heavy Ion Cancer Therapy

Gunma University, Gunma Prefecture

(Information provided by Gunma University)

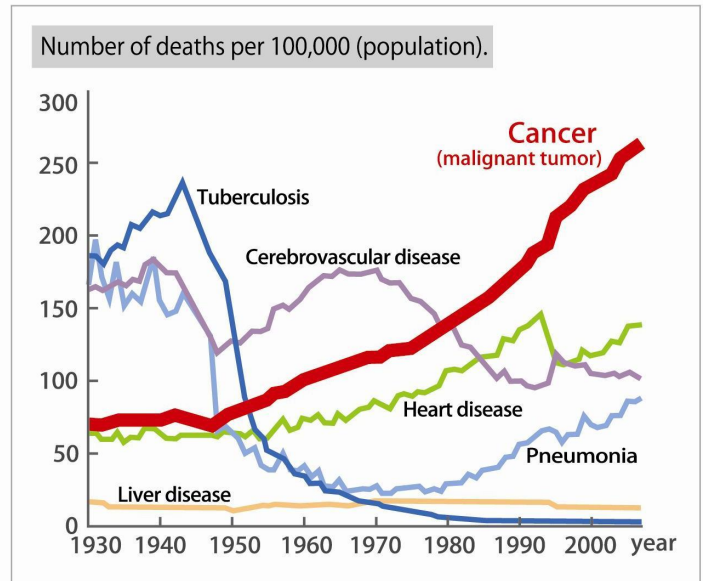
Advanced Cancer Therapy



Cancer : the Leading Cause of Death in Japan

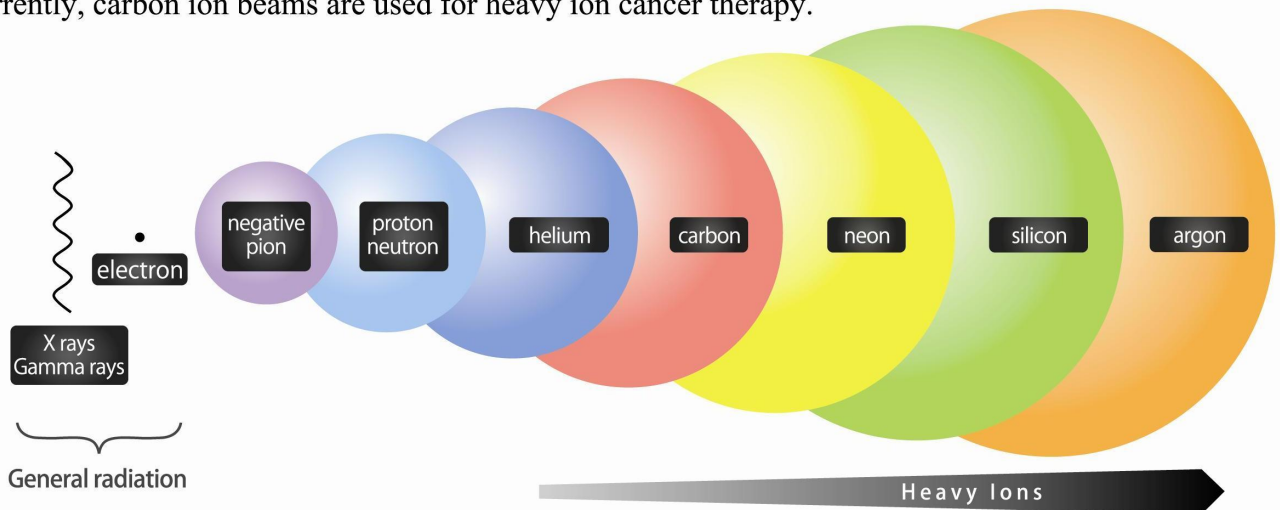


Cancer is the leading cause of death in Japan. Therefore, cancer control is the most important issue in the field of public health. Cancer therapy in the future should provide a high rate of cure and a low incidence of adverse effects for the patients.



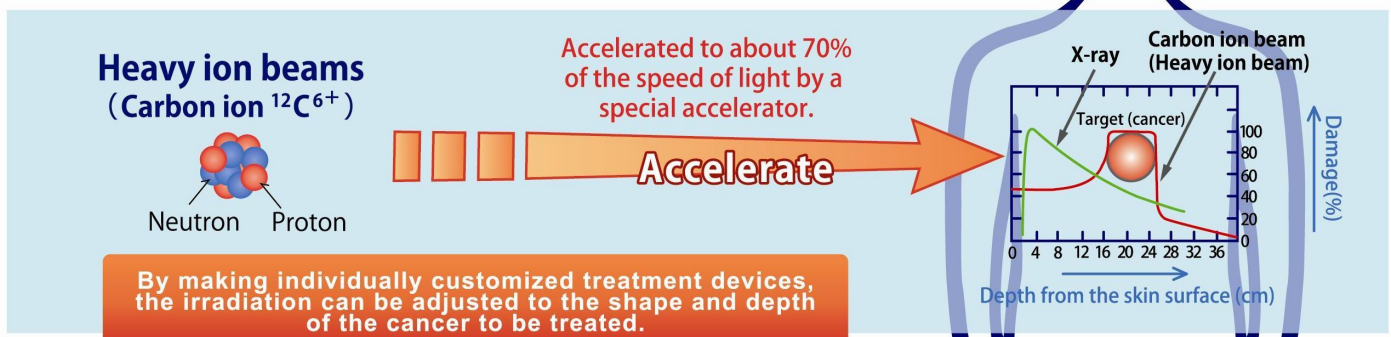
What are Heavy Ions?

Radiation releases energy while traveling through space or matters in the form of waves or particles. Radiation composed of particles heavier than electrons is called a particle beam, and radiation composed of particles heavier than helium is specifically called a “heavy-ion” beam. Currently, carbon ion beams are used for heavy ion cancer therapy.



Heavy Ion Therapy

Heavy ions are accelerated to approximately 70% of the speed of light and applied to patients in order to treat deep-seated cancer within the bodies. Heavy ion cancer therapy allows the tumors to be treated without using invasive procedures such as surgery and without causing pain.





3 Advantages of Heavy Ion Therapy

1 Superior Dose Localization

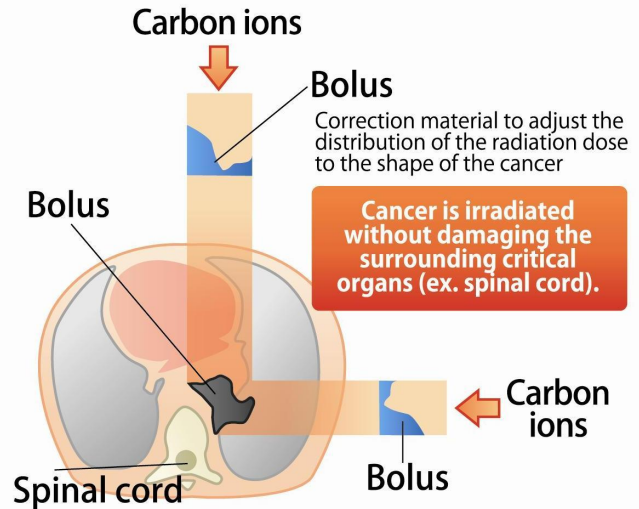
Heavy ion therapy can severely damage the tumor while minimizing damage to surrounding tissues. Heavy ion therapy has less toxicity (adverse effects) than conventional radiotherapy.

2 Effective Against Cancers Which are Resistant to Conventional Radiations

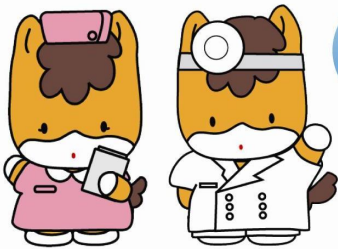
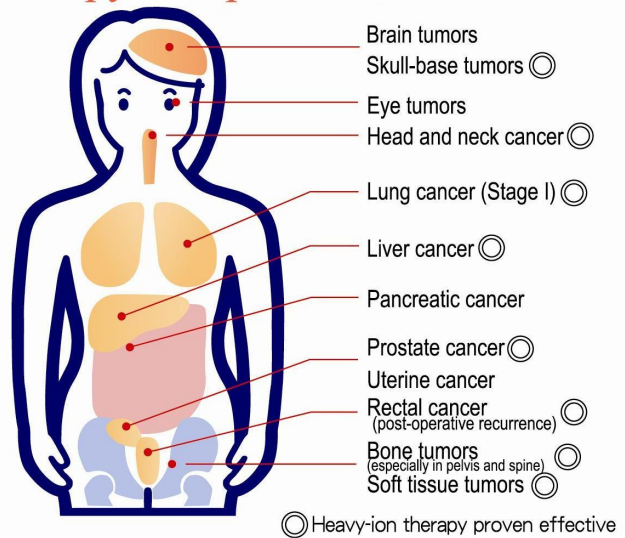
Heavy ion beams have stronger biological effects than X-ray. For example, heavy ion therapy is more effective against tumors such as osteosarcoma, which are difficult to cure with conventional X-ray radiotherapy.

3 Short Treatment Time.

The treatment time for heavy-ion radiotherapy is relatively short (3 weeks on average). Compared to conventional X-ray radiotherapy, which requires 6-7 weeks, the treatment time can be reduced dramatically.



Types of cancers which heavy ion therapy is expected to be effective.



Earlier Return to Daily Life

Comparison with other therapies

	Surgery	Particle/Radiation Therapy	Chemotherapy
Indications	<ul style="list-style-type: none"> Localized Cancer (mainly early-stage diseases) 	<ul style="list-style-type: none"> Localized Cancer (from early-stage to advanced-stage diseases) 	<ul style="list-style-type: none"> Systemic cancer (Cancer with metastasis & hematological cancer such as leukemia) Used in combination with other therapies for localized cancer
Advantage	<ul style="list-style-type: none"> Considered more likely to be curative. 	<ul style="list-style-type: none"> Relatively smaller damage to organ function and morphology. Relatively smaller damage to the patient. The treatment results for early-stage cancer in selected sites are equivalent to those of surgery. 	<ul style="list-style-type: none"> Can sometimes prolong patients' lives by suppressing the progression of cancer.
Disadvantage	<ul style="list-style-type: none"> Relatively large deprivation of organ function and morphology Indication for surgery can be limited due to location of cancer and conditions of patients (age, concomitant diseases, etc) 	<ul style="list-style-type: none"> The financial cost for particle therapy is more expensive compared to other therapies. Adverse effects can occur in organs near the tumors. 	<ul style="list-style-type: none"> Can cause systemic adverse effects.



Processes of Heavy Ion Therapy

This flow chart is an example of heavy ion therapy. The processes can differ depending on facilities and individual circumstances.

Step0 Referral

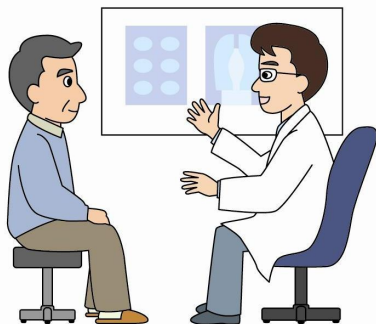
If a patient is diagnosed with cancer by a primary care physician or in a hospital and found that he/she is likely to be indicated for heavy ion therapy, the patient should be referred by the physician to facilities which are offering heavy ion therapy.

Step1 Detailed Diagnosis /Tests

out-patient

About 1-2 weeks

The patient is checked in detail by his/her history, physical examination, and other diagnostic tests, and the treatment method will be discussed. It is possible that the patient is considered not to be indicated for heavy ion therapy at this time.



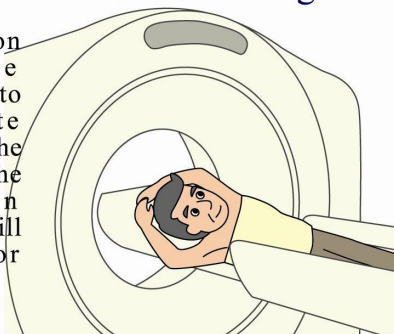
The patient will be informed about the therapy in detail (Informed consent will be obtained before the start of therapy).

Step2 Preparation for Heavy Ion Therapy

In-patient or out-patient

Preparation for Treatment Planning

An immobilization device will be prepared in order to achieve accurate body position for the treatment. Using the immobilization device, CT scan will be performed for treatment planning.



Treatment Planning

Using the obtained CT scan images, the staff will complete the treatment planning such as defining treatment area and its dose. The treatment plan will be discussed and approved by multiple staff in a conference.



Based on the shapes of the body and the tumor to be treated, devices will be custom-made for each patient to create a desirable irradiation dose.

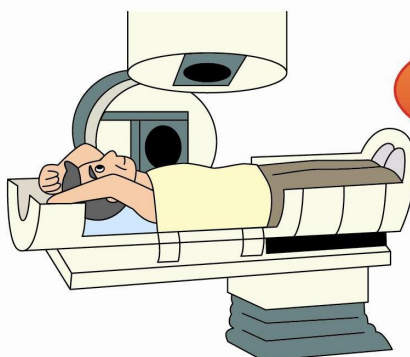
Step3 Heavy Ion Therapy

In-patient or out-patient

About 1 day to 5 weeks

After the area to be treated is precisely positioned using X-ray imaging, and the patient will be irradiated with heavy ion beams.

The treatment will be once a day, and the irradiation will take about a few minutes. The total treatment time will be about 20 minutes to 1 hour including the preparation.



The patient will not feel any pain or heat during the treatment.



Numbers of treatment sessions (examples of Gunma University)

Lung/liver cancer	4 sessions
Prostate cancer	16 sessions (4 weeks)

After the treatment is completed, the patient will be discharged when the treated area has no complication.

Step4 Patient Follow-Up

out-patient

The patient will be followed up after the discharge.

The patient will be followed carefully by continuing regular out-patient visits and scheduled tests.



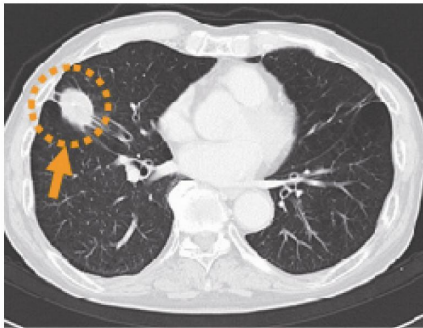


Case Reports of Heavy Ion Therapy

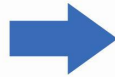
Provided by National Institute of Radiological Sciences
(Carbon ions: total Dose / No. of Fraction / Period of Irradiation)

1 Lung Cancer

Irradiated dose: 28 GyE (in total) Irradiated fractions: 1 fraction
Total treatment duration: 1 day



Before the treatment



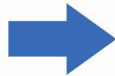
6.5 months after the treatment

2 Malignant Melanoma

Irradiated dose: 57.6 GyE (in total) Irradiated fractions: 16 fractions
Total treatment duration: 4 weeks



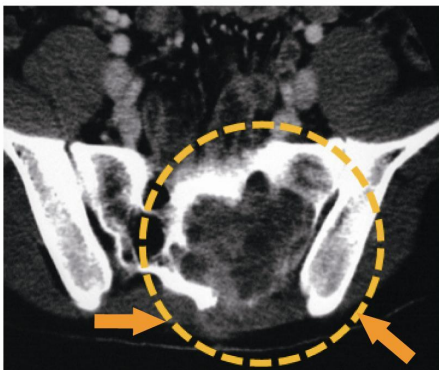
Before the treatment



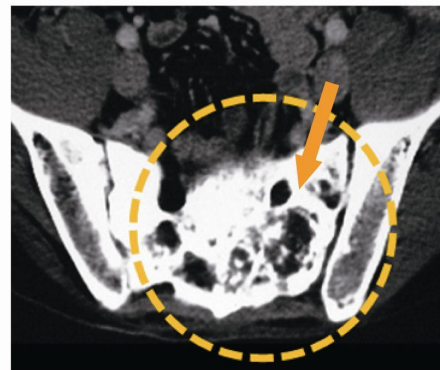
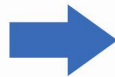
15 months after the treatment

3 Osteosarcoma on Sacrum

Irradiated dose: 52.8 GyE (in total) Irradiated fractions: 16 fractions
Total treatment duration: 4 weeks



Before the treatment



5 years after the treatment

GyE
(Gray Equivalent)

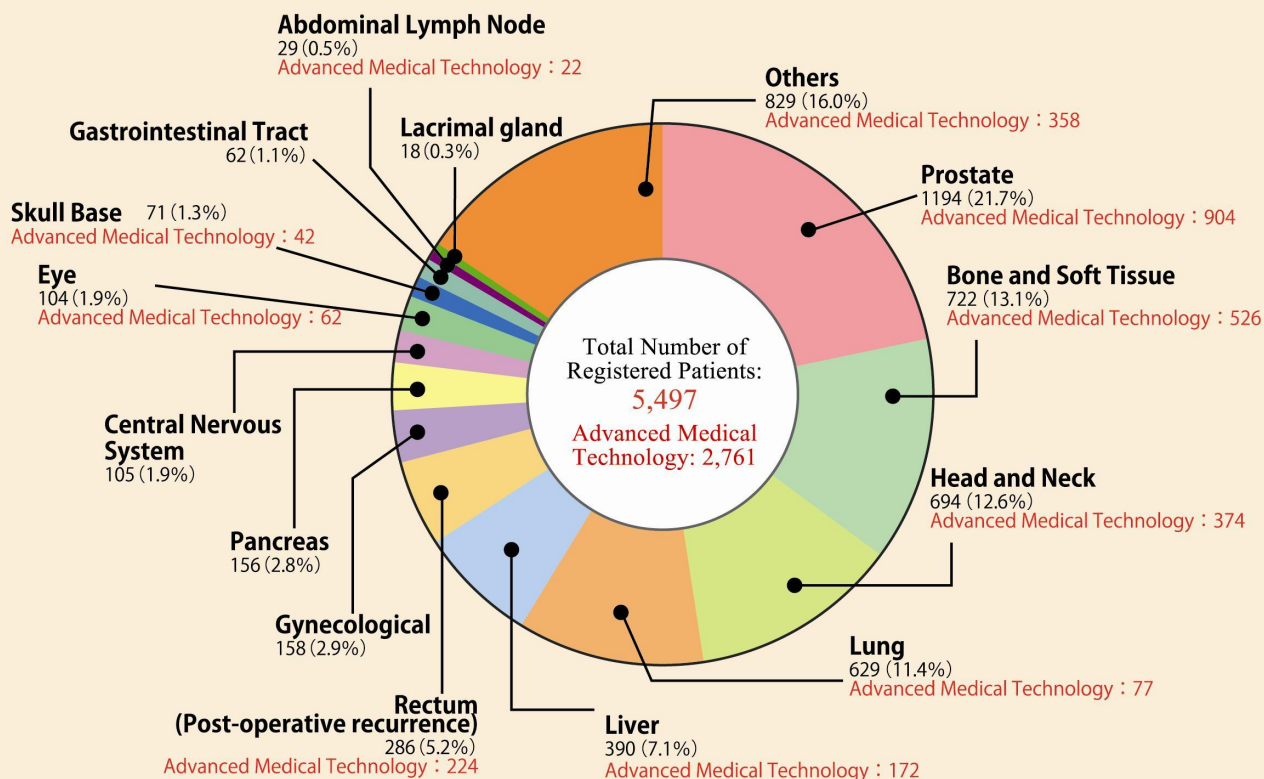
The unit of irradiated dose for heavy ion therapy



Results of Heavy Ion Therapy

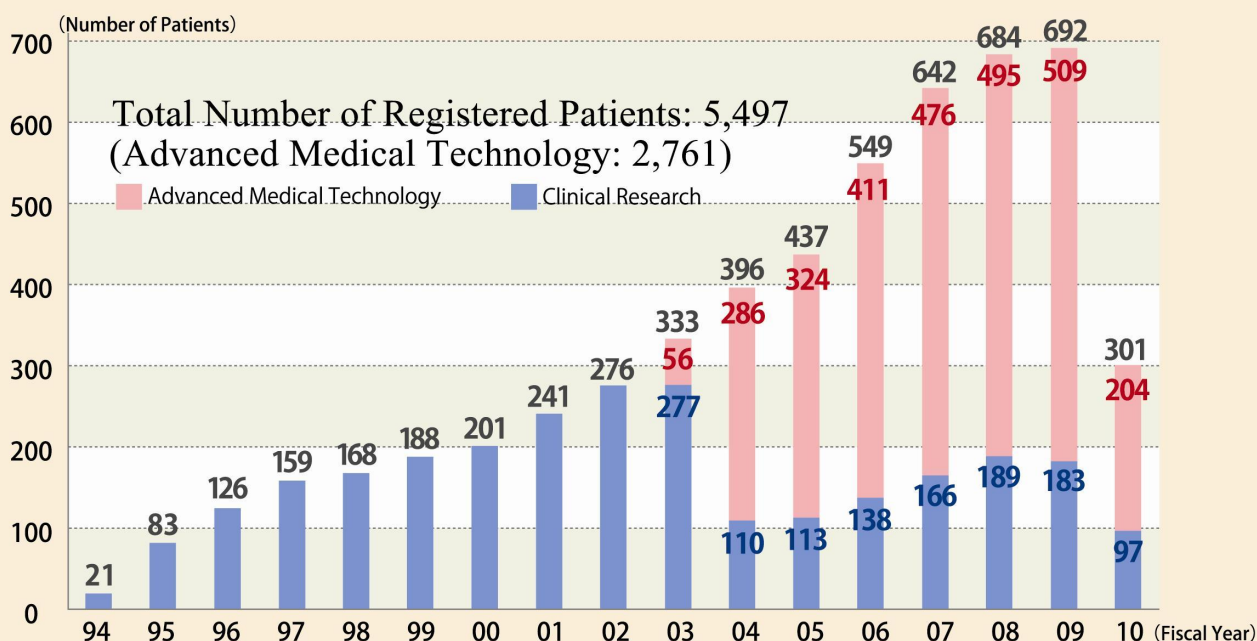
Data from June, 1994.6 to July 2010.7

Registered Patients of Heavy Ion Therapy



Data from June, 1994.6 to July 2010.7

Change in the Number of Registered Patients



Advanced Medical Technology :
 Medical treatment which is above the level of standard medical procedures practiced under the Japanese health insurance system and is approved and performed as an advanced medical technology.

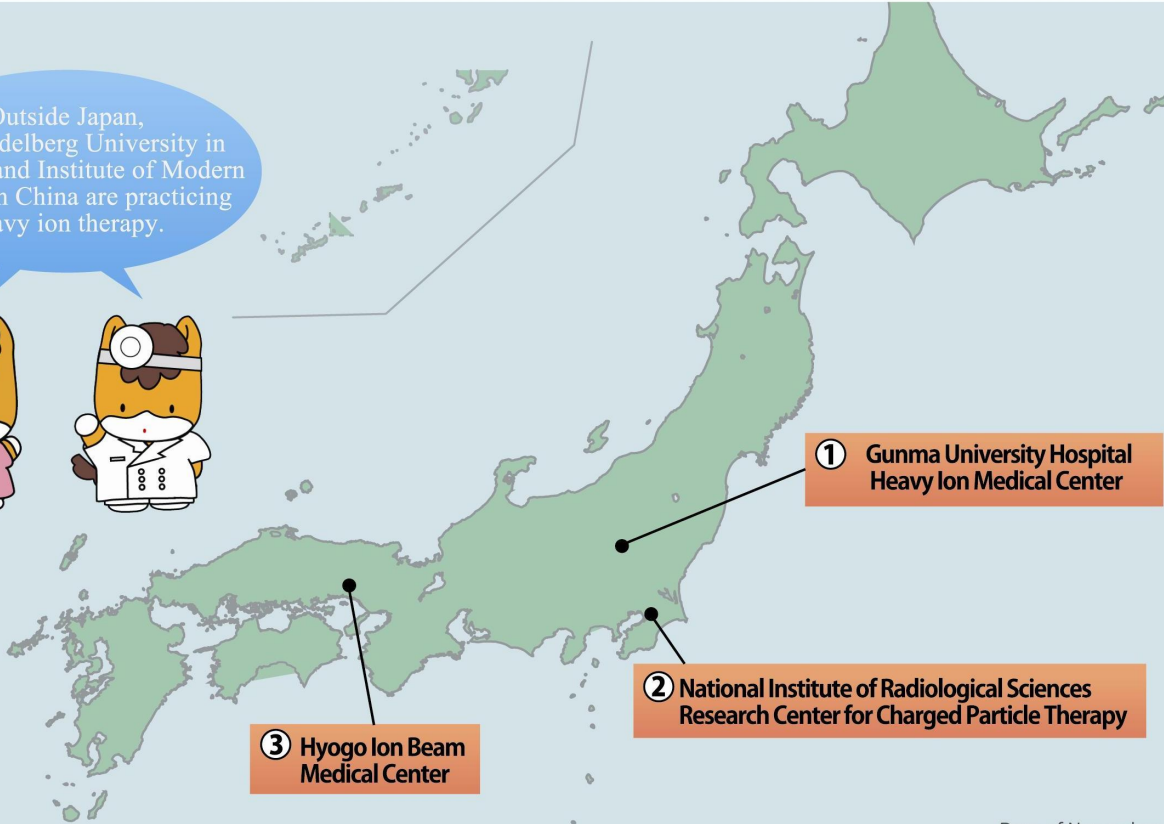
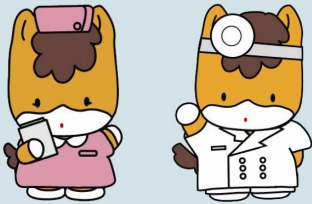
Clinical Research :
 Research conducted in a clinical setting to scientifically evaluate the effects and safety of new treatment methods.



Current Situation of Heavy Ion Therapy Facilities

Heavy Ion Therapy Facilities in Japan (operating facilities)

Outside Japan, only Heidelberg University in Germany and Institute of Modern Physics in China are practicing heavy ion therapy.



Data of November, 2010.



Treatment Fees (for patients under the Japanese health insurance system)

Heavy ion therapy is approved by the Japanese health insurance system as an “advanced medical technology,” and patients covered by the Japanese health insurance can receive heavy ion therapy treatment at the same time with other regular medical services. The treatment fee for heavy ion therapy is at present 3,140,000 Japanese yen. The other medical procedures, tests, in-patient services, and prescriptions can be partly covered by the Japanese health insurance system.

Advanced Medical Technology (Heavy Ion Therapy)

Other Regular Health Services (medical procedures, in-patient services, tests, prescriptions, etc)

①

Covered by the patient
(about 3 million yen)

②

Covered by the patient
(for example, 30%)
Fees which exceeded the specified limit can be reimbursed.

③

Covered by the Japanese health insurance
(for example, 70%)

Fees to be paid by the patient = ① + ② for example, 30%

The present system is available only for Japanese patients.





Inside the heavy ion irradiation facility.

In order to accelerate heavy ions (carbon ions) up to about 70% of the speed of light and irradiate a cancer which is deep inside a body, the facility has the following equipments.



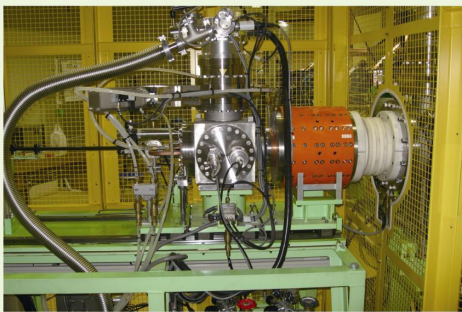
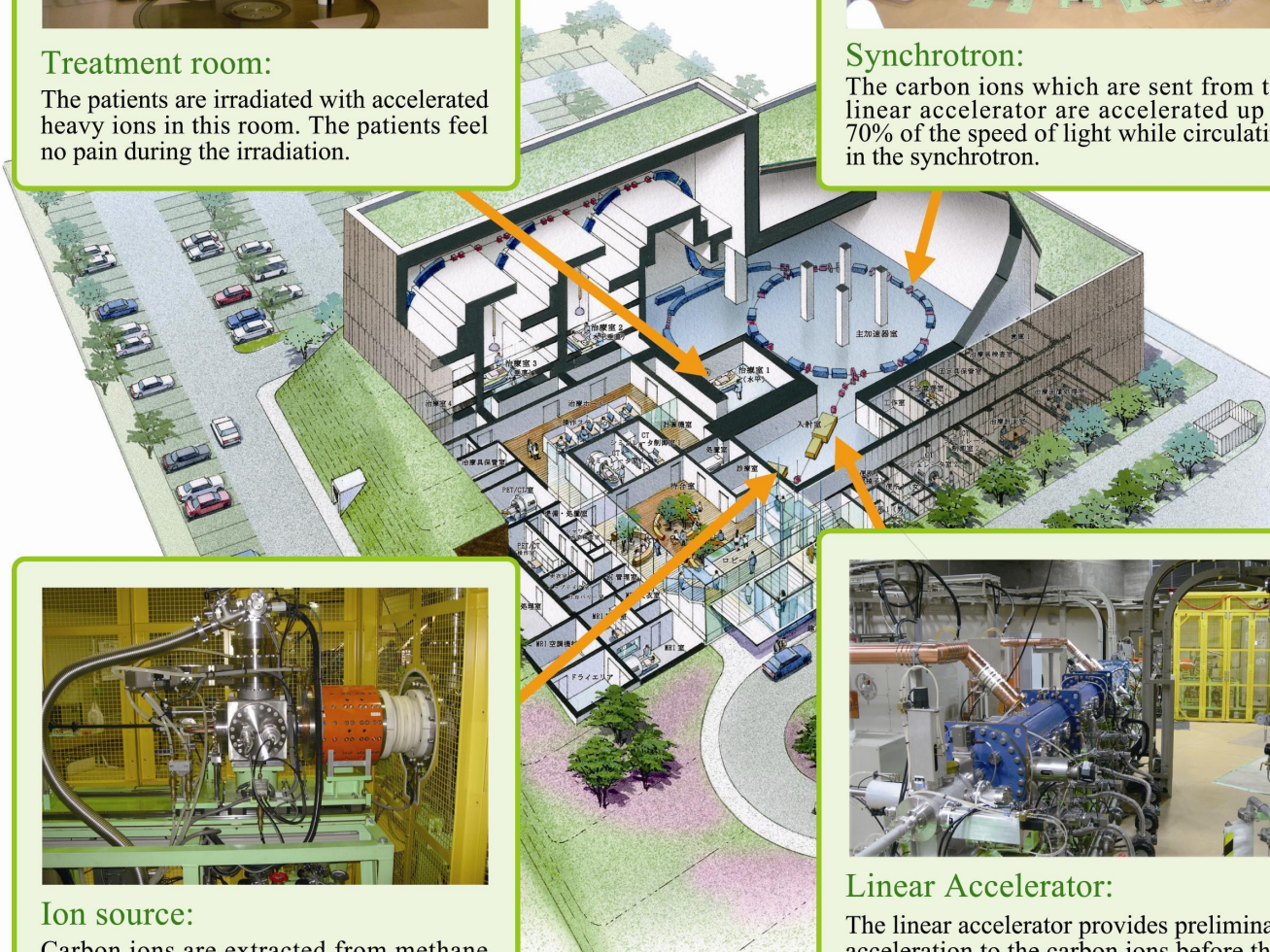
Treatment room:

The patients are irradiated with accelerated heavy ions in this room. The patients feel no pain during the irradiation.



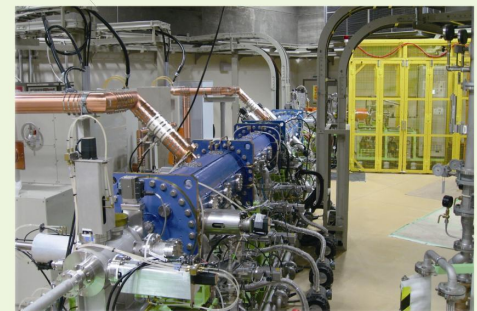
Synchrotron:

The carbon ions which are sent from the linear accelerator are accelerated up to 70% of the speed of light while circulating in the synchrotron.



Ion source:

Carbon ions are extracted from methane gas.



Linear Accelerator:

The linear accelerator provides preliminary acceleration to the carbon ions before they are sent into the synchrotron.

Information provided by Gunma University

For information:

Gunma University Heavy Ion Medical Research Center Heavy Ion Medicine Promotion Office

Address: 3-39-22 Showa-machi, Maebashi, Gunma,
371-8511 JAPAN

Phone +81 27-220-7895 Fax +81 27-220-7720

Webpage <http://heavy-ion.showa.gunma-u.ac.jp/>

Gunma Prefecture Department of Health and Welfare Medical Management Division

Address: 1-1-1, Ote-machi, Maebashi, Gunma,
371-8570 JAPAN

Phone +81 27-226-2535 Fax +81 27-223-0531

E-mail imuka@pref.gunma.jp