

2011 MEXT Program for Leading Graduate Schools



GUNMA UNIVERSITY

**Program for Cultivating Global Leaders
in Heavy Ion Therapeutics and Engineering**



2016



A Message from the
President



President
Hiroshi Hiratsuka

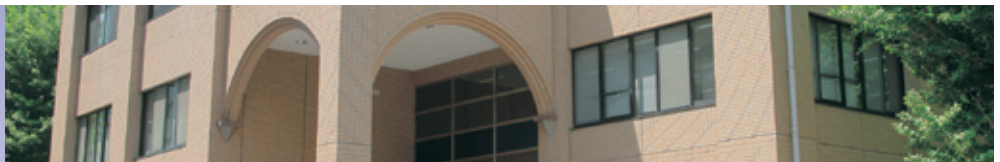
The Gunma University program, titled “Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering,” was adopted in the “Only-one type” category as one of the “Leading Graduate Schools Program” launched by MEXT in 2011. Our program fosters excellent human resources involved in state-of-the-art heavy ion cancer therapy that offers patients a high quality of life and has attracted high expectations from Japan and overseas.

In Japan, heavy ion cancer therapy has been conducted in a total of five institutes including the National Institute of Radiological Sciences (currently, National Institutes for Quantum and Radiological Science and Technology). However, Gunma University is the only institution currently developing human resources through heavy ion education, research, and treatment. Currently, only a few universities throughout the world, such as Hidelbelg University, have heavy ion treatment facilities. The need for heavy ion cancer therapy is growing and we can expect such facilities to increase in the future in Japan and the world, as well as the development of more advanced treatment. Thus, development of globally competent physicians, nurses, medical physicists, and accelerator technicians who can lead heavy ion cancer therapy has become an urgent priority.

At Gunma University, we have been working on state-of-the-art heavy ion cancer therapy and research. These activities have mainly been focused on our Organization for Promotion of Heavy Ion Medicine, Graduate School of Medicine, affiliated hospital, and the Initiative for Advanced Research (GIAR); we have produced valuable results in both treatment and research. I hope that Leading Graduate Schools Program of our university will continue to foster global leaders in the field of heavy ion medical engineering and advance heavy ion cancer therapy in the future.



A Message from the
Executive Director, Research



Vice President
Takashi Izumi

Heavy ion cancer therapy is a cutting-edge technique that was put to practical use in the National Institute of Radiological Sciences. It offers patients a high quality of life. There are high expectations for the method to open new horizons for cancer therapy. Gunma University installed the world’s first miniaturized practical heavy ion device. The university has used it to treat over 2,000 cancer patients since the device began operation in 2010. The operation is highly sophisticated and requires cooperation of a wide range of professionals. In addition to the physician, radiologist, nurse, and others involved in conventional therapy, heavy ion cancer therapy requires several specialists, including a medical physicist to conduct an ion dose distribution simulation, a technician to control the accelerator and ion beam, and a radiation physicist to investigate the biological action of the heavy ions.

At Gunma University, as well as treating cancer patients, we are also conducting education programs to foster highly professional human resources who can lead heavy ion treatment. In our “Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering,” we have focused the full capabilities of the university and we aim to foster global leaders who can lead heavy ion therapy. Our Graduate School of Medicine established the Heavy Ion Medical Engineering Course as a doctoral degree combining medical science and engineering, and started accepting students in April 2012. The program provides education and research in heavy ion, fostering global leaders in research and development of advanced medical equipment and related operation technologies. For this reason, the Graduate School of Engineering and related organizations in Japan and overseas are involved in the course, as well as manufacturers of medical equipment, to offer education that goes beyond the respective specialized fields covered. Graduates of the course are expected to contribute to medical innovation through heavy ion therapeutics and engineering, a field that is expected to see global expansion.



*A Message from the
Program Director*



*Dean of Graduate School of
Medicine, Gunma University*
Takashi Minegishi, M.D., Ph.D.

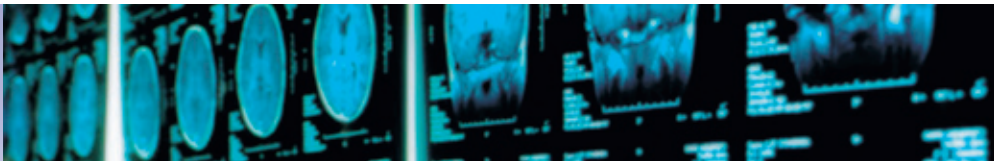
The Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering is one of the Leading Programs in Doctoral Education (Only-One Category: Programs that produce leaders with a clearly defined specialty) supported by the Ministry of Education, Culture, Sports, Science and Technology, which was adopted in 2011. The Gunma University Graduate School of Medicine established the Heavy Ion Medical Engineering Course as a doctoral degree program combining medical science and engineering, and started accepting students in April 2012.

The program provides education and research in the field of heavy ion medical science and biology, and advanced clinical practice using heavy ion, fostering global leaders in research and development of advanced medical equipment and related operation technologies. For this reason, the Graduate School of Engineering and related organizations in Japan and overseas are involved in the course, as well as manufacturers of medical equipment, to offer education that goes beyond the respective specialized fields covered.

On March 2016, we sent the first graduates of this program out into society. Graduates are expected to play roles as global leaders in the heavy ion therapy facilities and advanced medical equipment development industry in Japan and overseas.



*A Message from the
Program Coordinator*



*Director of the Heavy Ion Medical
Research Center*
*Professor of Department of
Radiation Oncology*
Takashi Nakano, M.D., Ph.D.

While Japan seeks to be a state-builder with science and technology, there is concern that Japan lags behind America and Europe in the development of science and technologies in many medical fields. Against this background, the “Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering” at Gunma University is intended to overcome this international inferiority in the development of medical science and technologies, and to enable Japan to be a presumptive leader in science and technology.

Gunma University is the only university in Japan that has its own heavy ion therapy equipment, and conducts postgraduate education and research related to heavy ion radiotherapy under the auspices of the Heavy Ion Medical Research Center. Furthermore, at the education and research center established through the 21st Century Center of Excellence Program using accelerator technology, we have accumulated technologies and experience in heavy ion radiotherapy engineering, heavy ion microsurgery system, medical Compton cameras, clinical practice using heavy ion radiotherapy, and so on.

In this way, we aim to foster outstanding leaders in heavy ion medical science who can play an active role across various fields of specialization, as globally respected leader scientists who can lead radiation oncology, physical engineering, and medical biology in the field of heavy ion radiotherapy, or as leaders of research and development at companies developing the equipment for heavy ion therapy.



Heavy ion cancer therapy is a minimally invasive cancer treatment with the best QOL after treatment.

Gunma University is the only university in Japan with a graduate school doctoral course that has its own heavy ion therapy equipment, and we conduct postgraduate education and research related to heavy ion radiotherapy.

In the “Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering,” we provide the integrated education environment of physical engineering, biology and medical science related to heavy ion radiotherapy. We aim to foster outstanding leaders in heavy ion radiotherapy who can play an active role across various fields of specialization, as globally respected leader scientists.

Outline and Objective

The overall objective of the Program is to cultivate global leaders of radiation oncologists, physical engineering researchers, medical biologists, and researchers at companies developing the equipment for heavy ion radiation therapy, who can support the promotion and development of the heavy ion radiation therapy.

The Program involves establish a leading cooperative training course of the heavy ion medical engineering course combining medical science in the Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering, which provides education about the basics of the heavy ion medicine and biology, advanced clinical research of heavy ion medicine, and both the development and operation technologies of advanced medical equipment. In this way, we aim to foster globally respected radiation oncologists, leaders in physical engineering and the medical biology field, and leaders of research and development at companies developing the equipment for heavy ion medicine who can support the research and development of the heavy ion radiotherapy field.

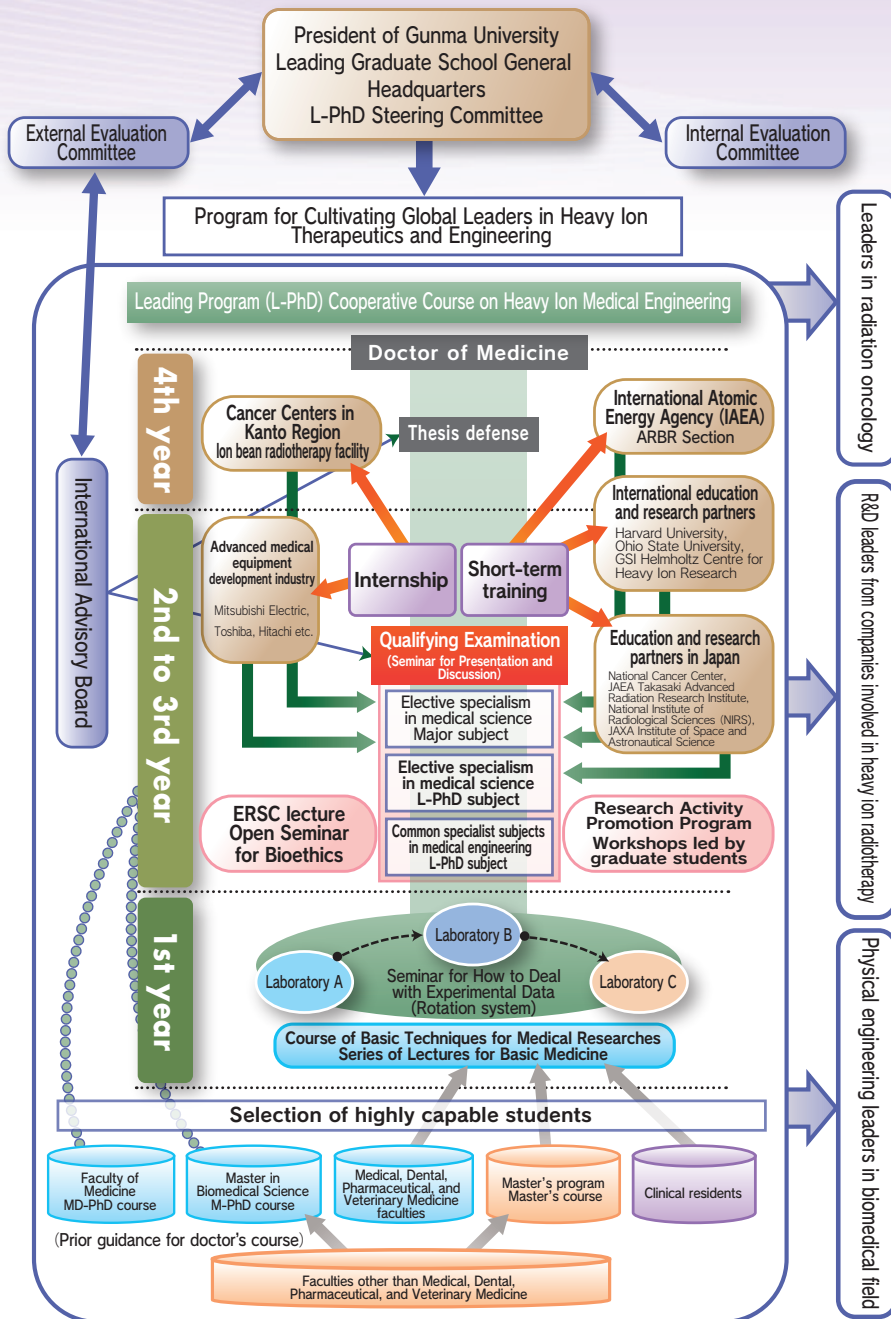
Content of the Degree Program

The Program for Cultivating Global Leaders in Cooperative Course on Heavy Ion Medical Engineering (L-PhD) of the Graduate School of Medicine is a doctoral program aiming to foster leaders in radiation oncology, physical engineering research, medical physics, and medical biology research. Students of the graduate school of medicine are required to study common subjects in lower level and specialized subjects of each major field at a higher level.

In the L-PhD Medical Engineering Course, 10 new subjects were established. Moreover, 11 subjects in the Course of Medical Sciences curriculum were upgraded. These changes were made to provide a substantial graduate school education. Internship in institutes in industry/government/academia, and on-the-job training in associate institutes in Japan and abroad, were introduced as well. Additionally, a rotation system enabling students to take a number of lectures for coursework beyond their specialized field was put in place. Moreover, Common Specialist Subjects in Medical Engineering, lectures beyond the conventional boundaries of each course, was established and made available for students of the Graduate School of Medicine and the Graduate School of Science and Technology. The doctoral program in the graduate school of medicine provides an education system that exceeds the boundaries of the students’ specialized fields. The L-PhD medical engineering cooperative course provides the opportunity to acquire knowledge and methodology of integrated medicine and engineering about heavy ion physical engineering and heavy ion biology as well as heavy ion radiotherapy. The L-PhD Research Fund is provided for outstanding research projects proposed by L-PhD students; thereby, cultivating students’ ability to accomplish their original research goals independently.



Conceptual Diagram



System of the Program

Besides the foundations of heavy ion therapeutics and engineering, this Program provides lectures and training related to a wide range of related scientific fields. In addition, the students have opportunities of internships at companies and related medical institutions to establish a career path after graduation. Furthermore, in order to develop a broad perspective on heavy ion medical science, the graduate students attend to international conferences and join research activities in foreign research institutions (international educational training) to develop young researchers internationally playing an active role.

This Program develops international leaders in radiation oncology, physical engineering, and medical biology, and provides high-quality researchers and developers to radiation and heavy ion research centers and heavy ion radiation therapy facilities in Japan and overseas. The curriculum allows highly capable students to complete graduate school in three years.

Enrollment

For this program, we select highly capable students from clinical residency, schools of medicine, dentistry, pharmaceuticals, veterinary, as well as from other master courses.

First Year

Students learn through training in basic medical technologies and basic lecture courses. Additionally, students participate as necessary in the rotation of seminars for discussing research results.

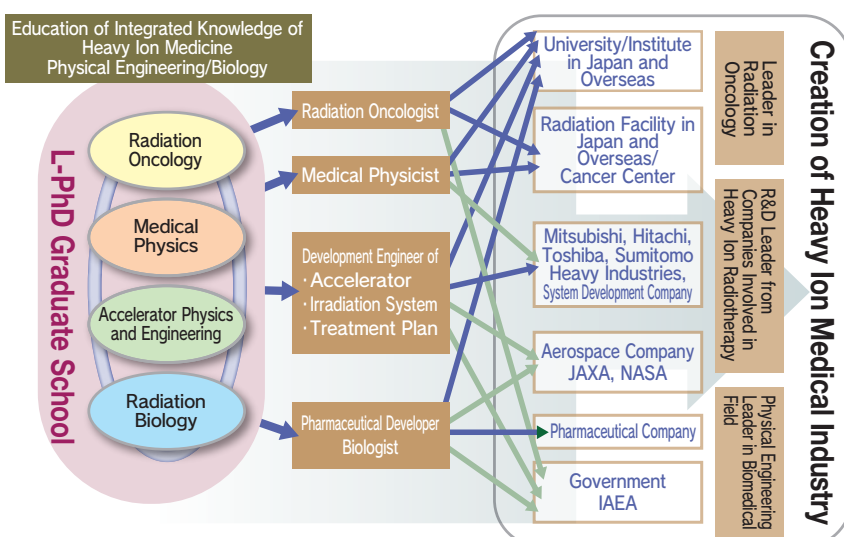
Second and Third Year

Students study major subjects and major specialist subjects in medical science and therapeutics/engineering leading graduate school. In addition, basic research ability is tested through Qualifying Examinations (seminars for the research presentation and discussions). Students also participate in public seminars in bioethics, and workshops led by graduate students as part of the Research Activity Promotion Program. Internships in the advanced medical equipment development industry, Cancer Centers in the Kanto region and particle therapy facilities are also available, as well as short term training at education and research related facilities in Japan and overseas, and at the International Atomic Energy Agency (IAEA).

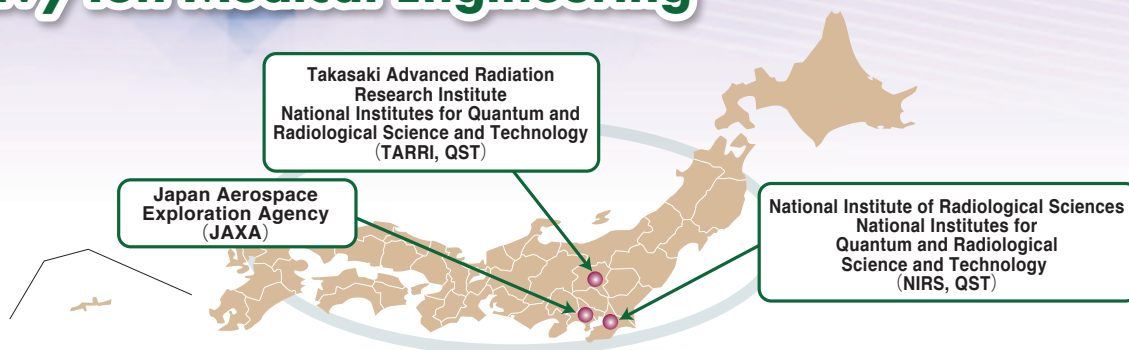
Forth Year (or Third Year)

Students write a thesis of the research results. The Ph.D. degree is given when completing the required credits and passing the thesis defense. Students have possible opportunities to have research supervision from an international advisory board of internationally prominent researchers.

Career Paths for Postgraduates



Cooperation System for Cultivating Global Leaders in Heavy Ion Medical Engineering

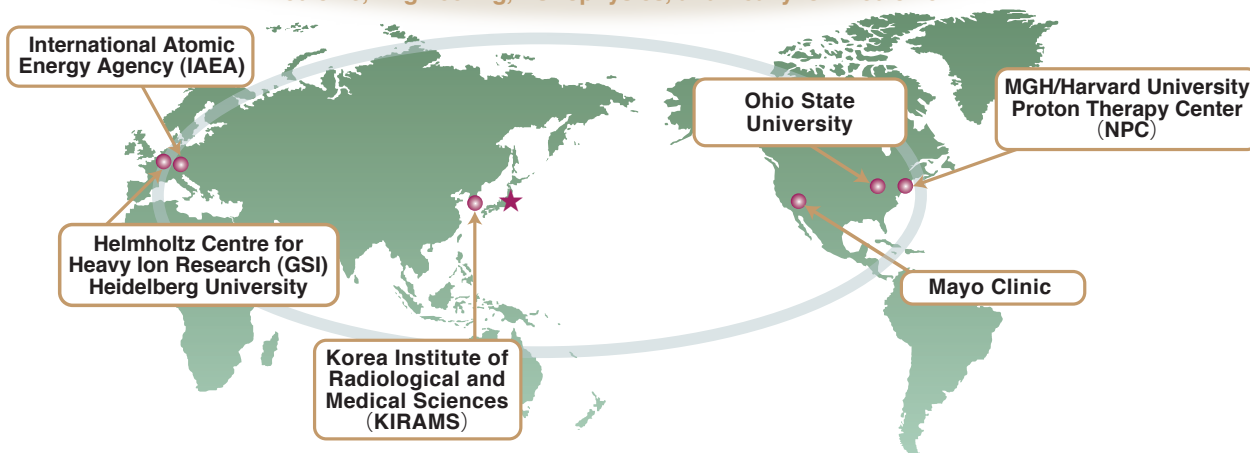


International Education Research Network

Education Outside the Frame of Conventional Major Goes Beyond the Specialized Fields

Establish the International and Interdisciplinary Cooperative Course on Heavy Ion Medical Engineering by Research Organization Consortium in Japan and Abroad

Traverse the Boundaries and Unify Accelerator Physical Engineering, Medicine, Engineering, Astrophysics, and Heavy Ion Medicine



Faculties and Staff

(As of Sep. 2016)

■ Program Director

Takashi Minegishi, M.D., Ph.D.
Dean of Graduate School of Medicine

■ Program Coordinator

Takashi Nakano, M.D., Ph.D.
Professor, Department of Radiation Oncology

Graduate School of Medicine

Junichi Tamura, M.D., Ph.D.	General Medicine	Professor
Yoshihisa Nojima, M.D., Ph.D.	Medicine and Clinical Science	Professor
Takashi Izumi, M.D., Ph.D.	Biochemistry	Professor
Yasuki Ishizaki, M.D., Ph.D.	Molecular and Cellular Neurobiology	Professor
Tomoaki Shirao, M.D., Ph.D.	Neurobiology and Behavior	Professor
Yuchio Yanagawa, M.D., Ph.D.	Genetic and Behavioral Neuroscience	Professor
Masami Murakami, M.D., Ph.D.	Clinical Laboratory Medicine	Professor
Tetsunari Oyama, M.D., Ph.D.	Diagnostic Pathology	Professor
Hiroshi Koyama, M.D., Ph.D.	Public Health	Professor
Yoshihiko Kominato, M.D., Ph.D.	Legal Medicine	Professor
Hideaki Yokoo, M.D., Ph.D.	Human Pathology	Professor
Kazuhiro Suzuki, M.D., Ph.D.	Urology	Professor
Hiroyuki Kuwano, M.D., Ph.D.	General Surgical Science	Professor
Hirokazu Arakawa, M.D., Ph.D.	Pediatrics	Professor
Satoshi Yokoo, M.D., Ph.D.	Stomatology and Maxillofacial Surgery	Professor
Izuhu Hatada, Ph.D.	Laboratory of Genome Science	Professor
Masami Torikoshi, Ph.D.	Heavy Ion Medical Research Center	Professor
Akihisa Takahashi, Ph.D.	Heavy Ion Medical Research Center	Professor
Tatsuaki Kanai, Ph.D.	Heavy Ion Medical Research Center	Professor
Tatsuya Ohno, M.D., Ph.D.	Heavy Ion Medical Center	Professor

Faculty of Science and Technology

Osamu Hanaizumi, Ph.D.	Division of Electronics and Informatics	Professor
Hiroshi Sakurai, Ph.D.	Division of Electronics and Informatics	Professor
Kou Yamada, Ph.D.	Division of Mechanical Science and Technology	Professor
Yoshiaki Yamakoshi, Ph.D.	Division of Electronics and Informatics	Professor
Hayato Sone, Ph.D.	Division of Electronics and Informatics	Professor

Graduate School of Health Sciences

Kunihiko Hayashi, Ph.D.	Department of Laboratory Sciences	Professor
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Partner Institutions

Hideyuki Sakurai, M.D., Ph.D.	Faculty of Medicine, University of Tsukuba	Professor
Takashi Kohno, M.D., Ph.D.	National Cancer Center Research Institute	Chief
Hiroshi Tsuji, M.D., Ph.D.	Dept. of Charged Particle Therapy Research, Clinical Research Cluster, NIRS	Department Director
Tadayuki Takahashi, Ph.D.	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency	Professor
Yasuhiko Kobayashi, Ph.D.	Dept. of Radiation-Applied Biology, Takasaki Advanced Radiation Research Institute	Department Director
Tomihiko Kamiya, Ph.D.	Dept. of Advanced Functional Materials Research, Takasaki Advanced Radiation Research Institute	Senior Principal Researcher
Yoshio Tamaki, M.D., Ph.D.	Faculty of Medicine, University of Tsukuba	Professor
Takeshi Ebara, M.D., Ph.D.	Dept. of Radiation Oncology, Gunma Prefectural Cancer Center	Department Director
Chihiro Tsukishima, Ph.D.	Power Systems Works, Mitsubishi Electric Corporation	Chief Engineer
Takashi Yazawa, Ph.D.	Toshiba Corporation Energy Systems & Solutions Company	Chief Specialist
Hiroshi Akiyama, Ph.D.	Hitachi, Ltd. Healthcare Business Unit	Technical Director
Jay S. Loeffler, M.D., Ph.D.	Massachusetts General Hospital, USA	Chief
Michael Scholz, Ph.D.	GSI Biophysics Department, Germany	Scientific Head (Acting)
Arnab Chakravarti, M.D., Ph.D.	The Ohio State University, USA	Chair and Professor
Marco Durante, Ph.D.	TIFPA – INFN, Italy	Director
Koji Noda, Ph.D.	Dept. of Accelerator and Medical Physics, National Institute of Radiological Sciences	Department Director

Outline of Courses

Education – Medicine (Radiation Oncology and Heavy Ion Medicine)



Heavy ion beam is characterized by superior biological dose distribution compared with photon beams (X-rays and gamma rays), and in clinical medicine, it is principally used for treatment of malignant tumors. Clinical heavy ion beam medicine is a new academic field comprising radiation oncology, which involves basic radiology including biology, physics, chemistry, and radiation management, as well as tumor pathology, clinical oncology, diagnostic radiology and so on. In this clinical heavy ion beam medicine, the students aim to study the role of heavy ion beam radiotherapy in cancer treatment, in addition to understanding multidisciplinary cancer treatment based on a combination of surgery, chemotherapy, photon beam treatment, and the like.

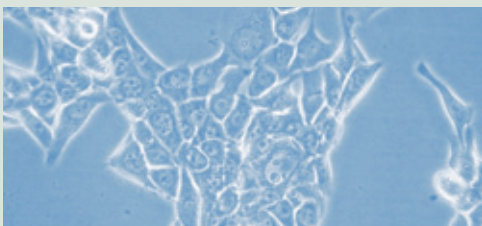
Education – Physics and Engineering (Medical Physics)



Gunma University has been conducting radiation therapy using X-rays and heavy ion beams (carbon ion beams). This course is designed for individuals who seek various knowledge related to accelerators and irradiation systems, patient positioning, biological effects and clinical doses, treatment planning and others required for heavy ion radiation therapy.

Furthermore, the objective of the course is to develop medical physics researchers who are essential for ensuring the reliability of the radiation therapy, through research for upgrading and improving the reliability of heavy ion and X-ray therapy.

Education – Biology (Radiation Biology)



In order to correctly understand the sensitivity and reactivity of cancer and the acute and chronic effects of normal tissue with heavy ion radiotherapy, it is necessary to have a spatiotemporal and integrated perspective based on knowledge of biological phenomena related to biochemistry, molecular biology, cell biology, physiology, anatomy, immunology, oncology, and so on. This course aims to foster researchers who can contribute to the development of heavy ion radiotherapy based on an understanding of the various biological effects of heavy ion beams.

Introducing carbon ion radiotherapy to the world



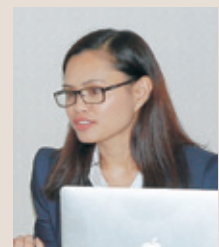
D2 **Daijiro Kobayashi** Major - Radiation Oncology

While particle radiotherapy institutions are focused on the US, recently many hospitals in Japan have also introduced such facilities. I entered the L-PhD program to study carbon ion radiotherapy, which is expected to contribute to cancer therapy in the future.

At the moment, I work in a hospital during the day, and after that I perform biological research. The other day, I had the opportunity to give a presentation at an international meeting about particle therapy for the first time. Most presentation subjects were for proton beam therapy, which meant I had a great chance to progress my research. Moreover, aggressively presenting both in the fundamental and clinical aspects of carbon ion radiotherapy is meaningful in indicating its presence. I feel a strong attraction to this program as I can attend international meetings and take part in an internship at IAEA. I plan to continue with my research and keep working hard so that I can have vigorous and fruitful discussions at international meetings overseas and contribute to future cancer therapy .

Study under the LPhD, become an expert in Carbon ion therapy

D3 **Athena Evalour Simbahon Paz** Major - Heavy Ion Beam Medical Physics and Biology



The first time I came to know about heavy ion therapy it instantly captured my interest. I was amazed by how well many different fields such as physics, engineering, radiobiology and medicine could come together to establish such a powerful treatment modality. Naturally I decided to pursue a PhD in this field. After reading several journals, I found that the National Institute of Radiological Sciences (NIRS) has been successfully performing treatments with carbon ion therapy since 1993 and that there are 5 facilities in operation in Japan. I was convinced that Japan is the best place to do research in this field. I then searched for a PhD program specializing on carbon ion therapy and immediately found the Leading program from Gunma University. The program offers a good balance between providing a strong background through lectures on basic techniques and hands-on training through laboratory rotations. The possibility for internships in companies and research facilities in Japan and abroad also gives an opportunity for students to apply what they learned and improve upon it.

Now after 2 years into my PhD, I can say that I have learned tremendously. We attended the JSMP 2016 conference where we presented our research results. And just recently, I was given the chance to participate in a summer school in Italy on modeling radiation effects from initial physical events. These events not only help us learn and grow as a researcher but also give us a chance to meet renowned experts in the field. With the Leading program, the opportunities are endless! It is my hope to be able to contribute in this research area and in the process promote the L-PhD program of Gunma University. I believe that producing more experts in this field is a vital step in the fight against cancer.

Love Science, Enjoy Life



D3 **Shuchuan Miao** Major - Neurobiology and Behavior

Many patients are suffered from brain tumors. Irradiation therapy is widely used to cure these tumors. However, one of severe side effects is cognitive impairment, which is still unclear. As a neurological doctor, I am interested in this problem. Leading program in Gunma University owns advanced condition and has world-famous professors in neuroscience, so it provides a precious opportunity to study irradiation induced memory damage.

During the last two years, I analyzed the effect of 10 Gy X-ray on the accumulation of drebrin in dendrite of mice hippocampal culture neuron. I found that 10 Gy X-irradiation can decrease the cluster of drebrin and NMDA receptor antagonist can inhibit this decrease. Leading program not only teaches me advanced technique and idea, but also lets me pay attention to the importance of basic methods and techniques. I received strict basic training during my study.

To become future global leaders, communication is very important. During the past time, I attended many international conferences where I communicated with famous experts and young researchers from different counties. The communication helps me to improve my research .The leading program always invites many experts to come to Gunma University and give us excellent lecture. For neuroscience, Professor Shirao also invited many famous scientists in the world to increase our knowledge of neuroscience and improve the ability of study.

Though sometimes study is a little tired, my life in Gunma University is wonderful. In our laboratory, we usually hold some enjoyable parties to welcome new members, celebrate birthday or congratulate the graduation of students. Besides, We also have chance to learn colorful culture from students in different countries in this program.

In future, I hope I can learn the mechanism of the memory damage induced by irradiation and conduct more young persons in China to love science.

Voice from Alumni

Opportunities and experiences lead me to an expertise in **Neuro-Radiation**.

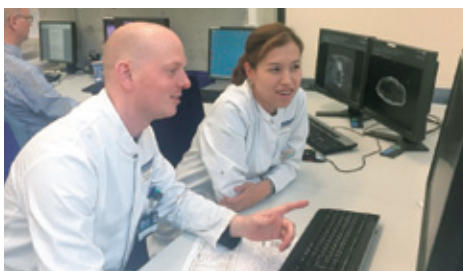
Anggraeini Puspitasari (Completed in 2016 Major - Neurobiology and Behavior)
Assistant Professor, Gunma University Initiative for Advanced Research International Open Lab
(Harvard Medical School, Massachusetts General Hospital)



Entering leading Ph.D. program at Gunma University brings me a lot of experiences. This program introduces me to the new sciences and technologies that I never knew before. They provide the students to have an internship in Japan and overseas. They open the path for the students to establish national and international networkings with the experts, lead me to a position as an assistant professor in the laboratory belongs to Gunma University and Harvard Universities, the place where I was doing the internship.

The studies that I am working now are about the effect of radiation on higher brain functions. I am working with various experts from, Gunma University, MGH/Harvard Medical School and the experts from The Japan Aerospace Exploration Agency. My goals are to reveal the mechanisms underlie the effect of irradiation on the higher brain function. So we can have better protection from radiation for our healthy brain function. I am very grateful to this program. Without this program, I will never reach the dream I had, and I wish I can be a blessing to others.

Activity Report



Internship at the GSI Helmholtz Center for Heavy Ion Research



Attended International Training Course on Carbon-ion Radiotherapy



International Seminar for L-PhD Students



The 3rd International Symposium for the Gunma University Program for Leading Graduate Schools

Student Support

● Financial Support

The expenses listed below will be provided based on university regulations. The amount is subject to change in the future.

- **Stipend:** Although there are conditions, such as not receiving any regular income, there is a stipend for supporting a student's academic research. There are conditions and screening. (100,000-200,000 yen/month) FY 2016: 150,000 yen/month
- **L-PhD Research Funding**
If you do not receive funding from other institutions, L-PhD research funding for L-PhD student's original research activity is available. There are conditions and screening. (Maximum 1,000,000 yen/year)
FY 2016: 600,000 to 1,000,000 yen/year

● Research Result Presentation Support

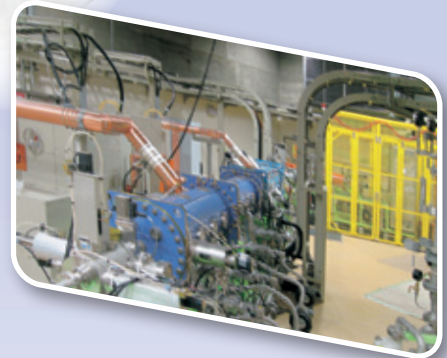
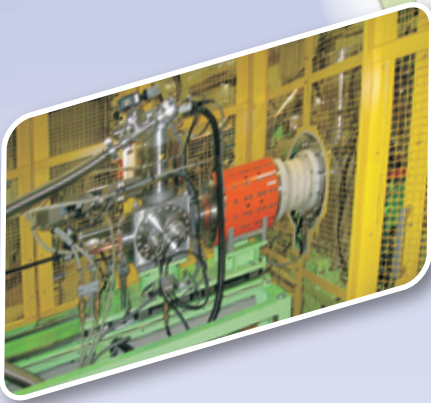
There is financial support for your research presentation at academic conferences. (Registration fee and travel expenses)

● Career Path Support

The course curriculum includes short-term training and internships in Japan and overseas.

● Admission Information

Enrollment is available for spring and fall semesters. For details, please check the following URL for admission procedures:
<http://www.med.gunma-u.ac.jp/admissions/grad/ikagaku/bosyu.html>



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Program for Cultivating Global Leaders in Heavy Ion Therapeutics and Engineering



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群馬大学
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