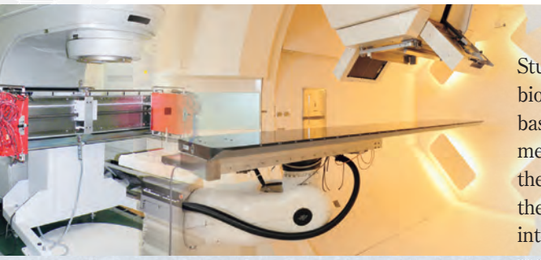
Quantum Biomedical Science and Engineering Course



Students are expected to acquire a thorough knowledge of quantum biomedical science and engineering, which is necessary to be able to apply basic radiation physics knowledge developed from quantum mechanics to medical science, as well as specialized knowledge and skills in radiation therapy, particle therapy, and novel medical equipment related to these therapies. The training in this course will enable students to conduct international research, and play leading roles in the development of novel medical equipment and technology related to radiation and particle therapies.

Particle Beams for Biomedical Science and Engineering

Radiation Oncology

SHIRATO Hiroki,
Professor

HASHIMOTO Takayuki,
Associate Professor

KOBASHI Keiji,
Specially Appointed Associate Professor

NISHIOKA Kentaro,
Assistant Professor

Radiotherapy is characterized by the possibility of preserving the original functions of the living body and by maintaining the patient's ability to function through the induction of the disappearance of neoplasms/tumors, unlike surgery which treats cancer by the removal of organs/tissues from the body. X-ray radiotherapies and particle beam therapies with charged particles achieve treatment by utilizing the physical characteristics of these rays by means of state-of-the-art scientific/engineering technology. The development of more practically useful and effective devices and therapeutic techniques will be enabled if we view and discuss the frontier technology of engineering and science on the basis of a deep understanding of human body structure/function and medical/physiological viewpoints, focusing for example on dose concentration for the purpose of tumor control, dose reduction to normal tissues/organs to minimize adverse reactions and how to deal with body and organ movements that result from respiration, cardiac beating, peristalsis, etc. This laboratory aims to cultivate talented students who are capable of contributing to improvements in disease cure rates and quality of life (QOL) for patients with cancer and other diseases through research on technologies dealing with the motion of organs during radiotherapy, research on particle beam therapies and the development of new medical technology, as well as cultivating globally active researchers and educators on these topics.

Highlighted Keywords: innovative radiation therapy, medical physics for radiation therapy, image-guided, real-time tumor monitoring system

Radiation Medical Physics

TAKAO Seishin,
Associate Professor

YOKOKAWA Kohei,
Assistant Professor

Following recent improvement in the outcome of treatment, thanks to advances in medical/scientific/engineering technology, the need to radiotherapy has been increasing remarkably. Among others, particle beam therapy, which applies accelerators to healthcare, is receiving much expectation as a means of minimizing the patient's physical stress through achieving dose concentration on the target cancer. Recently, the use of image guiding technology has made it possible to provide treatment in a way tailored to the patient's motions during treatment, morphological changes of the tumor, bioreactions and other factors. This laboratory is aimed at utilization of the technology of science/engineering (radiation physics, quantum beam applied engineering, image engineering, etc.) to healthcare. Specifically, in collaboration with the Hokkaido University Hospital Proton Beam Therapy Center, this laboratory will engage in development of irradiation technology/devices capable of reducing adverse events and improving therapeutic efficacy, development of image guiding technology incorporating detailed information about patient's motions and tumor's morphological changes, development of dose calculation/optimization techniques for realization of high precision treatment, and comprehensive education/research through links of medicine, science and engineering (verification of therapeutic efficacy, taking into account also the cellular level reactions, etc.). Through these activities, this laboratory will cultivate researchers of medical physics and engineers for medical device development.

Hokkaido University Hospital Proton Beam Therapy Center

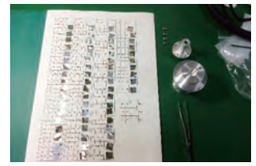
Highlighted Keywords: particle therapy, real-time tumor-tracking technique, image guidance technique

Radiation for Biomedical Science and Engineering

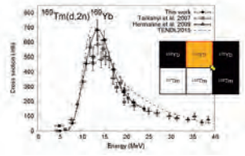
Medical Applied Basic Physics

AIKAWA Masayuki,
Professor

In medical fields, such as radiation therapy and particle therapy, a deep understanding of natural science, especially physics, can play an important role to solve problems and to develop new technologies. For example, the systematic study of nuclear reaction probabilities (cross sections) is required to accurately estimate necessary amounts of medical radioactive isotopes (RI) while minimizing unnecessary by-products.
We focus particularly on charged-particle induced reactions using accelerators, and experimentally measure production cross sections of such RI. We train specialists to conduct research for the public from the physics point of view and to obtain new knowledge required for medical fields.



Metal foil used as target in experiments



Cross section of ^{169}Tm(d, 2n) ^{169}Yb

Highlighted Keywords: radioisotope, nuclear reaction, activation cross section

Medical Physics and Engineering

ISHIKAWA Masayori,
Professor

NAKAMOTO Takahiro,
Assistant Professor

Although medical physics is an indispensable element for radiotherapy, it seems to be less mature in Japan than in other countries. In the United States, leading the world in terms of radiotherapy, each facility providing radiotherapy has medical physicists, who is in charge of quality control of radiotherapy and development of new radiotherapy techniques. In Japan, there is no sufficient environment for such active roles of medical physicists. Radiation measurement is a core technology not only for radiotherapy, but also diagnostic radiology and nuclear medicine. Expertise education on these topics is an element indispensable for cultivation of researchers in the field of medical physics and engineers engaged in development of radiotherapy devices. This laboratory will cultivate researchers and engineers capable of contributing to healthcare through development of clinically useful technologies, in collaboration with the Hokkaido University Hospital.

Radiation therapy system,
real-time tumor monitoring system

Highlighted Keywords: dosimetry, radiation treatment planning devices, research and development of new algorithm, quality assurance technology

Clinical Medical Physics

SUZUKI Ryusuke,
Assistant Professor

TAMURA Masaya,
Assistant Professor

KANEHIRA Takahiro,
Assistant Professor

New discovery for the next generation can be achieved if problems with clinical practice are viewed as research seeds and attempts are made to find solution to such problems through utilization of the knowledge/skills of science and engineering. To this end, students will carry out research in areas closer to a hospital, and confirm the ideas arising from such research through experiments, simulation, etc. at our laboratory, towards the goal of acquiring research capabilities leading to future radiotherapy and development of medical devices. During the course of such activities, students acquire the capabilities needed for medical physicists. In this way, talents capable of contributing to the society will be cultivated.

Radiation therapy device and medical physics staff,
Hokkaido University Hospital

Highlighted Keywords: clinical medical physics, intensity modulated radiation therapy, proton therapy, real-time tumor tracking, radiation treatment planning