The National Institute of Radiological Sciences (NIRS) was re-organized as an independent administrative institution in April 2001. Since then, NIRS scientists have been performing research studies according to the mid-term plans. Every 5 years, the mid-term plan has been revised: the first mid-term plan was started in April 2001; the second, in April 2006; and the third, in April 2011. Research activities at NIRS are done in five fields: heavy charged particle therapy, molecular imaging, radiation protection, radiation emergency medicine, and radiation technology. These mid-term plans have been carried out by four research centers and one fundamental technology center.

In this report, the research activities at NIRS during the first and second years (FY 2011 and 2012: April 2011 to March 2013) of the third mid-term plan are presented.

The Great East Japan Earthquake measuring 9.0 on the Richter scale struck the northeast coast of Honshu, the main island of Japan, at 14:46 on March 11, 2011, triggering tsunami with over 10 meter-high waves. The earthquake was followed by numerous aftershocks. Although the operating reactors automatically shut down after the initial earthquake, damage primarily from the tsunami resulted in loss of electrical supplies for reactor cooling functions, which led to hydrogen explosions in some reactor units of the Fukushima Daiichi Nuclear Power Plant (NPP) of Tokyo Electric Power Company (TEPCO) that resulted in large amounts of radioactive materials, mainly I-131, Cs-134 and Cs-137, being released into the environment.

In April 2011, 3 weeks after the start of this huge disaster, NIRS began the third mid-term plan. Since NIRS is designated as the national core center for radiation emergency medicine, we first had to respond to the disaster by: sending experts, receiving contaminated emergency workers, providing information on radiation and its effects to the public, and performing dose estimation. The people of Japan are still struggling with the effects of the multiple disasters, even though almost 2 years have passed and many NIRS researchers continue to be involved in response activities to the Fukushima accident.

The numbers of original papers published reached 214 and 251 in FY2011 and 2012, respectively and many of them were published in international journals of high reputation. Furthermore, more than 100 proceedings were presented at international and domestic scientific meetings, 806 oral presentations, and 95 patent applications. Collaborative studies and exchanges of researchers were also actively carried out: 268 collaborative studies were done, 812 researchers worked as visiting staff, and 277 students were accepted as trainees. In short, substantial, high level achievements have been realized by NIRS personnel and recognized by their peers, both domestically and internationally.

The Research Center for Charged Particle Therapy, as a leading research organization in this field, has conducted clinical, biological and physics research studies using heavy ions generated from the heavy ion medical accelerator in Chiba (HIMAC). In FY 2011, more than 650 patients were treated despite the confusion and extra work caused by the East Japan Great Earthquake. The clinical trial for lung cancer (single fraction) was completed in March 2012 and moved to the stage of clinical...
practice in April 2012. In FY 2012, the clinical trial team started work with patients receiving carbon therapy with a newly installed scanning beam delivery system. The highlights of research progress in FY2011 and FY2012 are shown in other parts of this chapter.

The Molecular Imaging Research Center, consisting of four groups, has long experience with medical imaging technologies including positron emission tomography (PET) and magnetic resonance imaging (MRI). The Center conducts basic science and technology for molecular imaging and also application studies for diagnosis and pathophysiology of oncology and psychiatry. Current projects include the development of molecular probes and radiopharmaceutical production techniques and the investigation of measurement techniques for PET and MRI, in addition to preclinical and clinical applications in oncology and psychiatric and neurological diseases.

The Research Center for Radiation Protection has been providing a scientific basis for establishing regulations with global standards for radiation protection, security and safety, focusing on effects of low-dose radiation derived from human activities and from natural environmental radiation. For this purpose, the results of basic radiobiological research have been provided to promote understanding of radiation effects and to encourage enactment of more reasonable regulations for the safe and secure use of radiation in our lives. The Center has renewed its designation by the IAEA as a “Collaborating Centre for Biological Effects of Low Dose Radiation”.

NIRS has been designated as the national center for radiation emergency medicine in Japan, providing direct or consultative services to local governments and hospitals in the event of an actual radiation incident. The Research Center for Radiation Emergency Medicine is responsible for services including providing exposed victims (patients) with the most advanced radiation emergency medicine treatments possible. Therefore, the Center has played important roles in medical response to the Fukushima accident. The Center also carries out activities to maintain and strengthen the emergency preparedness system fulfilling its role by establishing three nation-wide network councils for medicine, bio-dosimetry with chromosome analysis, and physical dosimetry. Furthermore, the Center conducted basic research studies on treatment of radiation exposure and dose estimation. The Center has also introduced several courses at NIRS on radiation emergency medical preparedness for medical professionals of the Asian region.

Research on radiation protection and radiation emergency medicine, an important mission of the institute since its establishment, has been carried out primarily in two centers. These centers played a role as a national hub in collaboration with international organizations including the International Atomic Energy Agency (IAEA), International Commission on Radiological Protection (ICRP), United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), and World Health Organization (WHO).

The Fundamental Technology Center, which was established to support various studies performed in NIRS with advanced fundamental technology, has been carrying out maintenance and quality control of institute accelerators including the single particle irradiation system to cell (SPICE), the PIXE (particle induced X-ray emission) analysis and tandem accelerator (PASTA), and the neutron exposure accelerator system for biological effects experiments (NASBEE), as well as radiation measurement apparatus for cosmic rays. Efforts have also been extended to establish and support experimental animal laboratories for internal and external researchers.

In May 2012, the program for recovery of Fukushima was started. This program includes four research projects and a cooperation system. Research projects are the study for long-term and environmental effects of radiation, the health effect survey for emergency workers at the nuclear power plant, and the study of environmental dynamics of radionuclides and radiation in the ecosystems in the Fukushima region. The cooperation system is for collaboration with the Fukushima Medical University (FMU).

The second-term of the International Open Laboratory (IOL) also began in April 2011, for which four units were approved, including the “Particle Therapy Molecular Target Unit”, the “Particle Beam Quality Unit”, the “Space Radiation Research Unit”, and “Radiation Response Model Unit”. The purpose of the IOL is to conduct top level research by collaborating with distinguished scientists from leading research institutes world-wide and to promote further internationalization at NIRS by active research collaborations with foreign scientists. For the two years of FY 2011 and 2012, the IOL was involved in publication of 12 original articles and held three workshops/seminars.

Some other research programs have also been continued or newly started with the support of funding agencies including the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Ministry of Economy, Trade and Industry (METI), the Ministry of the Environment, and the Nuclear Regulation Agency.

In this report readers will be able to learn about substantial research that was performed in the 1st and 2nd years of the third mid-term plan. I would like to conclude with heartfelt thanks for cooperation and advice provided to us by all parties concerned.