Since re-organization as an independent administrative institution in April 2001, researchers at the National Institute of Radiological Sciences (NIRS) have been performing studies according to mid-term plans that have been revised every 5 years. The first mid-term plan was started in April 2001; the second, in April 2006; and the third, in April 2011. NIRS has four fields of research activities, heavy charged particle therapy, molecular imaging, radiation protection, and radiation emergency medicine, and a support system for radiation technology. The third mid-term plan was carried out by four research centers and one fundamental technology center. In May 2012, the program for recovery from the Fukushima Daiichi Nuclear Power Plant (NPP) accident was started as a new center. In March 2013, a new department was also established; the Radiation Emergency Medical Assistant Team (REMAT) now plays an important part in medical response to accidents including the after effects of the Fukushima NPP accident. In this report, the research activities at NIRS during the last year of the third mid-term plan (April 2015 to March 2016) are presented.

The Great East Japan Earthquake triggered tsunami with over 10-meter-high waves that damaged facilities of the Fukushima Daiichi NPP of Tokyo Electric Power Company (TEPCO), resulting in the severe nuclear accident. Since NIRS is the national core center for radiation emergency medicine, many NIRS researchers still continue to be involved in response activities to the accident, though 5 years have passed. Besides these activities many others are also being carried out and 251 original papers were published in FY 2015, in both international and domestic journals of high reputation. Furthermore, more than 81 proceedings were published for international and domestic scientific meetings, and 357 oral presentations and 34 patent applications were made. Collaborative studies and exchanges of researchers were also actively carried out: 103 collaborative studies were done, 363 researchers worked as visiting staff members at NIRS, and 136 students were accepted as trainees.

The Research Center for Charged Particle Therapy, as a leading research organization in this field, has been conducting clinical, biological and physics research studies using heavy ions generated from the heavy ion medical accelerator in Chiba (HIMAC). In FY 2015, 794 patients were treated. As well, the clinical trial team treated 7 tumor types of cancers: prostate, lung, head & neck, bone & soft tissue, liver, pancreas, and post-operative pelvic recurrence of rectal cancer. Scanning irradiation became available for the routine treatment of less mobile targets in the head & neck or pelvic region; more than one thousand patients could be treated with scanning at the new treatment research facility. Highlights of research progress are shown in detail in other sections.

The Molecular Imaging Research Center, consisting of four groups, has long experience with medical imaging technologies including positron emission tomography (PET), single photon emission tomography (SPECT), and magnetic resonance imaging (MRI). The Center...
conducted basic science and technology studies 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. Details on these studies are presented later.

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 and/or low-dose rate 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 rational regulations for the safe and secure use of radiation in daily life. Main research programs at this Center are to explore the mechanisms of radiation carcinogenesis, to investigate how lifestyle modifies radiation effects, and to study the effect of low dose-rate radiation exposure.

With the establishment of REMAT in 2010, the Research Center for Radiation Emergency Medicine became responsible for basic research. The Center is focusing its efforts on three projects: developing and modifying the most appropriate methodologies for evaluating radiation exposure, exploring and supplying effective drugs to reduce the radiotoxicity and metallic toxicity of internal contamination with radionuclides, and applying mesenchymal stem cells (MSCs) as regenerative medicine to treat radiation exposure injuries.

NIRS is the national center for radiation emergency medicine in Japan, providing direct or consultative services to local governments and hospitals in the event of a radiation incident. Services provided by REMAT include providing exposed victims (patients) with the most advanced radiation emergency medicine treatments possible and making dose assessments. REMAT especially is playing an important role in medical response to the Fukushima NPP accident. REMAT also carries out activities to maintain and strengthen the emergency preparedness system and has worked to establish the third national-wide network councils for medicine, bio-dosimetry with chromosome analysis, and physical dosimetry. REMAT has also introduced several international or domestic courses at NIRS on radiation emergency medical preparedness for medical professionals of the Asian region. In August 2015, NIRS was designated as an advanced center for radiation emergency medical assistance by the Nuclear Regulation Authority (NRA).

Since its designation as a collaborating Center of the World Health Organization (WHO) in September 2013, NIRS has been contributing to strengthening preparedness to radiation emergencies and Radiation Emergency Medical Preparedness and Assistance Network (REMPAN) activities, providing medical and technical assistance to WHO in response to radiation emergencies, carrying out biodosimetry, analyzing radiation protection for indoor radon exposure, and promoting radioprotection in the field of medical exposure to ionizing radiation, with the focus on risks assessment and risk management. Together, the Research Center for Radiation Protection and REMAT also have acted as a national hub in collaboration with international organizations including the International Atomic Energy Agency (IAEA), International Commission on Radiological Protection (ICRP), and United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

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

The program for recovery from the Fukushima Daiichi NPP accident started in May 2012 has four research projects and a system of cooperation. Research projects are the study for long-term and environmental effects of radiation, the health effect survey for emergency workers at the NPP, and the study of environmental dynamics of radionuclides and radiation in the ecosystems in Fukushima Prefecture. The program contributed to the external dose assessment of residents for 4 months after the accident.

Some other research programs have also been continued or were 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 (MOE), the Ministry of Health, Labour and Welfare (MHLW), and the NRA.

In this report readers will be able to learn about the substantial research that was performed in the 5th year of the third mid-term plan. I would like to conclude with heartfelt thanks for the cooperation and advice generously provided to us by all parties concerned.