# PRESENTATION

The *Instituto de Engenharia Nuclear* (IEN), Nuclear Engineering Institute in English, is a research and development unit of the *Comissão Nacional de Energia Nuclear* (CNEN), the Brazilian Nuclear Energy Commission, of the Ministry of Science, Technology and Innovation (MCTI).

The Institute has recently celebrated its 50th year of existence, time during which it contributed significantly to the development of Nuclear Science and Technology in Brazil.

Indeed, Nuclear Science and Technology can offer a variety of solutions for economical, social and environmental problems, ranging from electricity generation to nuclear medicine, with applications of nearly all imaginable human activity.

In particular, nuclear energy is a carbon-free electricity generation technology which, according to the Intergovernmental Panel on Climate Change (IPCC), is expected to play an important role in the mitigation of the Green House Gases (GHG) emissions associated to global warming.

Besides energy generation, nuclear technology applications of health sciences have relevant contributions to improving the quality of life of patients. Moreover, this reduces public expending through the availability of early diagnostic of diseases, which results in less expensive treatments.

**Research in Nuclear Engineering**

IEN's Nuclear Engineering Division (DENN) encompasses most of IEN's research activities.

The Reactor Engineering and Thermo-hydraulics Service (SETER) develops theoretical and applied research in nuclear reactor physics and thermo-hydraulics for both power and research reactors (including the Multipurpose Brazilian Reactor - RMB), research in ADS systems, in probabilistic safety assessment, structural analysis, and in safety and environmental aspects of nuclear energy applications. Most of the research developed in SETER is resulted from M.Sc. degrees on IEN's Nuclear Science and Technology Graduate Program.

The activities developed within the Argonauta Reactor Service (SEREA) provide major contributions to training and formation in the nuclear domain. There are also a number of ongoing research activities regarding radiographic imaging using the reactor neutron flux, the non-destructive testing of mechanical components, and the development of a new subcritical assembly for the Argonauta reactor.

The Instrumentation Service (SEINS), besides performing its traditional role on nuclear instrumentation development, development of radiation protection and nuclear medicine equipment and electronic maintenance, has implemented new research activities to support the RMB project, such as the Field Programmable Gate Array - FPGA based on the instrumentation for nuclear reactors.

The Nuclear Materials Service (SEMAT) develops research on ultrasonic techniques for stress analysis, ultrasonic characterization of nuclear fuels, development of polymeric membranes for nanofiltration and ultrafiltration, and on radioactive waste treatment using membrane separation processes.

The Chemical and Radioactive Waste Service (SEQNR), in addition to performing activities regarding storage and management of radioactive waste and chemical analysis, develops several research activities in areas such as material processing by alkaline fusion and lixiviation, extraction of tungsten from mine waste, chemical characterization based on X-ray fluorescence and nanotracers for industrial applications.

The Complex System Engineering service (SEESC) aims at the deployment of technology for complex systems, considering that complex systems are inextricable combinations of people and technology. There is ongoing research on human-system interfaces, human reliability, artificial intelligence and fuzzy controllers for nuclear processes, safety and resilience engineering, the development of mobile devices for emergencies; and virtual reality applied to control room designing, nuclear power plant security and nuclear knowledge dissemination.

**Radiopharmaceuticals**

Molecular imaging permits visualizing detailed molecular processes in living organisms, and serves as an essential tool for the accurate diagnosis of cancer. Beyond oncology, this technique covers many other fields

such as the characterization of cardiovascular diseases, neurology and neuro-psychiatric diseases. It is also expected to make a significant contribution in the development of new drugs.

The history of nuclear medicine, over the past 40 years, highlights the strong link between chemistry and the development of radionuclides and radiolabeled compounds. Many advances have been reached, and most of them with a major impact on the practice of health care.

As anywhere else in the world, diagnoses and several medical procedures, that use radiopharmaceuticals, are currently being used in many Brazilian hospitals. These techniques are being adopted by basic and clinical scientists for diagnoses and therapies.

The Radiopharmaceuticals Division – DIRA, at IEN, is proud of being an important part of the history of Brazilian nuclear medicine. Moreover, the routine production of 18-FDG, 123-MIBG and Ultra-pure 123-I, the research at DIRA is focused on the development of new radiopharmaceuticals and labeled molecules. The existing facility, which has been augmented in the past few years, includes two cyclotrons (a CV-28 and RDS Eclipse), and a radiochemistry laboratory. These facilities also have the support of a multidisciplinary team and of another group with expertise in radiochemical processing.

The recent successful collaboration with IAEA, which has established the routine production of 18-FDG, illustrates the importance of taking a comprehensive approach to radiological sciences.

With the emergence of new challenges and opportunities, the Radiopharmaceuticals Division (DIRA) continues its efforts to establish itself as a solid contributor to the comprehensive scientific research in nuclear sciences focused on medical applications.

**Knowledge Transfer to Brazilian Society**

The research and development at IEN addresses existing and emergent needs of Brazilian Society; either the Brazilian nuclear sector or the public at large.

The Coordination of Technology and Innovation (CTIN) and the Coordination of Education (CENS) are the vectors for promoting knowledge transfer and social equity**.**

The Coordination of Technology and Innovation (CTIN) is responsible for identifying opportunities for technology transfer, with special emphasis on the needs of the Brazilian nuclear sector.

The Coordination of Education is responsible for promoting various courses at different levels and for integrating students in the research and development activities performed at IEN. In particular, since 2003, IEN has been engaged in preparing a new generation of nuclear engineers to meet the Brazilian demand on human resources for nuclear activities through a post-graduate master (M.Sc.) program.

This Progress Report highlights the research and development accomplished by IEN in the period 2011-2012.

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