THE IAEA COLLABORATING CENTRE FOR NEUTRON ACTIVATION BASED METHODOLOGIES OF RESEARCH REACTORS

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Abstract

The Reactor Institute Delft was inaugurated in May 2009 as a new IAEA Collaborating Centre for Neutron Activation Based Methodologies of Research Reactors. The collaboration involves education, research and development in (i) Production of reactor-produced, no-carrier added radioisotopes of high specific activity via neutron activation; (ii) Neutron activation analysis with emphasis on automation as well as analysis of large samples, and radiotracer techniques; and, as a cross-cutting activity, (iii) Quality assurance and management in research and application of research reactor based techniques and in research reactor operations.

1. INTRODUCTION

The Reactor Institute Delft of the Delft University of Technology houses the Netherlands' only academic nuclear research reactor, with associated instrumentation and laboratories for scientific education on and research with ionizing radiation [1]. The Institute's swimming pool type research reactor reached first criticality in 1963 and is currently operated at 2 MW thermal power on a 100 h/week basis. The reactor is equipped with neutron mirror guides serving ultra modern neutron beam physics instruments, and with a very bright positron facility. Fully automated gamma-ray spectrometry systems are used by the laboratory for neutron activation analysis, providing large scale services under an ISO/IEC 17025:2005 compliant management system, being (since 1993) the first accredited laboratory of its kind in the world. Already for several years, this laboratory is sustainable by rendering these services to both the public and the private sector.

The prime user of the Institute's facilities is the scientific research Department of Radiation, Radionuclides & Reactors of the University's Faculty of Applied Sciences, housed inside the building [2]. Both the Institute and the Department are specialized and equipped for providing education (e.g., at M.Sc. and Ph.D. level) in all aspects of nuclear science and engineering as well as in (group) training courses. All reactor facilities are also made available for use by, or for services to, external clients (industry, government, private sector, other (inter)national research institutes and universities). For the sake of clarity, the abbreviation "RID" is used from here on to denote the combination of the Institute's facilities and Department's educational and research activities.

On May 11, 2009, Mr. N.Ramamoorthy, Director of the Division of Physical and Chemical Sciences of the IAEA Department of Nuclear Sciences and Applications, officially confirmed the status of the Reactor Institute Delft as an IAEA Collaborating Center for Neutron Activation Based Methodologies of Research Reactors by presenting a plaque to the Delft University of Technology President Mr. D.J. van den Berg. Both Mr. Ramamoorthy and Mr. Van den Berg emphasized the importance of the status of Collaborating Center as a sign of recognition and as an opportunity to expand international co-operation efforts. Mr. H.W.Swarttouw, Safety director at the Ministry of Foreign Affairs, emphasized that the Dutch

government is proud of the institute's new status. It is entirely in line with the Dutch government's ambitions in the area of nuclear technology.

2. NEUTRON ACTIVATION BASED METHODOLOGIES AT THE COLLABORATING CENTER

RID's laboratory for instrumental neutron activation analysis (INAA) has more than 35 years experience in end-user oriented services to archaeologists, geologists, environmental scientists, industry and medical institutions. The laboratory has several gamma-ray spectrometers, most of them with newly designed, fully automated sample changers and normal and well-type semiconductor detectors. A laboratory information management system was developed integrating the various data streams related to spectrum analysis, calibration, data interpretation, customer's information and reporting. Annually approximately 2,500 samples are being analyzed though the system has ample capacity for handling 10,000 samples per year for multi-element analysis. The ISO/IEC 17025 accreditation has proven to be indispensable for maintaining a competitive position to the end-users by demonstrable technical competence, valid results and credibility. The revenues of the services have contributed to the sustainability of this laboratory, keeping its instrumentation at the state-of-the-practice.

RID has been recognized by the European Union as a Facility for Transnational Access through the NMI3 network, offering scientists from the European Community to submit proposals for use of RID's facilities including for NAA.

The laboratory was one of the initiators for getting INAA designated as a primary ratio method of measurement in April 2007 by the BIPM/CCQM [3].

RID's Section Radiation and Isotopes for Health focuses amongst others on innovative neutron activation based radioisotope production routes, serving the Section's research programs in which the radiotracer methodology is applied for assessment of kinetic parameters of targeting compounds. Neutron activation analysis is applied in studies related to the metabolism of elements in man and animal. The Section uses also the neutron beams for innovative applications of neutron activation based depth profiling for characterization of boron containing targeting compounds.

3. COLLABORATION WITH THE AGENCY

Employees of the Reactor Institute Delft have contributed to the Agency's activities since the early 1970s via numerous expert missions, lecturing in IAEA training courses and workshops, by hosting and training Agency's scientific visitors and research fellows and by contributions to IAEA scientific publications such as TECDOC's. RID's staff assisted the Agency in designing (thematic) technical cooperation projects aiming at establishing quality management infrastructures at nuclear analytical (including neutron activation) laboratories in Member States, and at improving the sustainability of research reactor applications. The Agency's Analytical Quality Assurance Services (AQCS) has regularly called upon RID's expertise in neutron activation analysis for the characterization of Agency's reference materials. The Institute has been counterpart in various research agreements with the IAEA, and served as the venue of several IAEA (regional) training courses.

4. WORK PLAN

4.1 Neutron activation based methodologies

RID and the IAEA, in consultation with each other, provide opportunities for education, research and development at the Collaborating Centre in production of reactor-produced, no-carrier added radioisotopes of high specific activity via neutron activation.

This can be accomplished by participation of IAEA Member States in RID's research programs in Delft on innovative production routes in which the radioactive nuclei are separated from the chemically identical target nuclei. This includes projects for the design of dedicated reactor irradiation facilities. The objectives of these programs relate primarily to feasibility and demonstration of new production routes and application on laboratory-scaled research programs, rather than on development and implementation of a commercial service activity. No-carrier added radioisotopes obtained via neutron activation will open entirely new areas of application for the radiotracer methodology.

In addition, RID supports the IAEA via:

— (Regional) training courses on the radiotracer methodology; to be held either at RID or, via RID's staff expert service, in Member States' institutions;
— Hosting scientific visitors and research fellowship training;
— Expert services to assist the Member States

Neutron activation analysis with emphasis on automation as well as analysis of large samples, and radiotracer techniques can be accomplished at RID by:

— Regional thematic training courses such as (but not limited to) neutron activation analysis, and metrology in nuclear analytical methods; to be held either at RID or, via RID's staff expert service, in Member States' institutions;
— Hosting scientific visitors and research fellowship training with emphasis on automation and conduct and logistics of large-scale projects;
— Expert services to assist Member States 'on-the-spot' in improving their facilities;
— Transfer of knowledge and expertise in large sample analysis for realizing new dedicated facilities elsewhere, as well as in providing opportunities for researchers using the Delft facility as a benchmark, and in providing opportunities to use the large sample facility for specific projects in the applied fields.

Quality assurance and management in research and application of research reactor based techniques and in research reactor operations can be accomplished at RID by:

— (Regional) training courses in the basic principles of quality control and quality assurance in neutron activation based methodologies; to be held either at RID or, via RID's staff expert service, in Member States' institutions;
— Hosting scientific visitors and research fellowship trainees for training on practical and pragmatic implementation thereof.

An annual progress report by the Collaborating Centre on the activities in the programme is submitted to the IAEA in January of the following year.

4.2 Assistance for the Agency's training programme

RID hosts individual IAEA supported scientific visitors and fellows for information transfer and training in neutron activation based methodologies, as well as provide related (regional) training courses for IAEA supported participants from its Member States.

Between 1999 and 2011, the Institute hosted 37 scientific visitors and fellows for a total of 157 man-weeks; provided hospitality for 10 workshops, training courses and (regional coordination) meetings; contributed to 17 IAEA scientific publications; participated in 2 co-

ordinated research projects by research agreements and provided 125 man-weeks expertise for IAEA expert missions, and consultants/technical meetings.

IAEA supported researchers may, under supervision of RID's staff also conduct (part of) their own research using RID's facilities, provided that such research activities meet the quality standards of the Delft University of Technology, implying a certain degree of creativity, innovation and demonstration of relevance.

5. PROSPECTS OF THE REACTOR INSTITUTE DELFT

5.1 Human capacity development

The Delft University of Technology provides a M.Sc. specialization 'Nuclear Science and Engineering' for students with a background in chemical engineering as well as in applied physics. Students can select topics related to applications for energy, or related to health. The course has a duration of 2 years, and is accredited for 120 ECTS [4].

In addition, a European master education "Nuclear Security' will start by the year 2012/2013. This education is organized by Delft TOPTECH (TU Delft's School of Executive Education) together with institutions in the United Kingdom, Germany, Austria, Norway and Greece, with the IAEA as an advisory partner. The education has a duration of 1 year (60 ECTS) [5].

5.2 Facility improvements

Given its demonstrated sustainability, the Delft University of Technology approved a plan identified by the acronym OYSTER (Optimized Yield - for Science, Technology and Education - of Radiation) for installing a new compact reactor core with new type of fuel elements which, together with a power increase to 3 MW and a cold neutron source in one of the radial beam-tubes [6]. This project is projected for the year 2013. The neutron beam instruments will gain orders of magnitude in performance, opening new research avenues; the thermal neutron fluence rates in the irradiation facilities for activation will go up by a factor 10-30 and a factor of 7 * higher positron output (~ $1.5.10^9$ s^{-1}) is expected. In addition, an innovative neutron diffractometer is under construction, and plans exist for a multi-purpose neutron polarization instrument and a neutron imaging facility.

OYSTER will also boost the research based on neutron activation and, consequently, the Collaborating Centre will benefit for it too.

5.3 Other expansions

Construction of the Holland Particle Therapy Centre [7] will start in 2012 at the premises of the Reactor Institute Delft. This Centre will, by 2015, operate a 200 MeV cyclotron for proton cancer therapy. The Department Radiation, Radionuclides and Reactors of the Delft University of Technology will add scientific research to its program, e.g. related to dosimetry, imaging aspects and e.g. aspects of induced radioactivity due to proton interaction in the body.

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