IAEA Collaborating Centre for Neutron Activation Based Methodologies of Research Reactors

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IAEA Collaborating Centres

Concept

• A Collaborating Centre is an institution which assists the Agency in implementing its regular budget programme through research and development and training in a relevant nuclear technology.

• The collaboration is implemented in accordance with a time-limited workplan (3 years maximum).

• The collaboration is at no cost to the Agency, but limited specialist supplies may be provided.
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- Designation as a Collaborating Centre is a public recognition of the work that the institution is doing for the Agency.

  It can be regarded as an acknowledgement of being an internationally recognized player in the specified field, and as an expression of thanks by the Agency.

- Designation does not confer any special status on the institute, nor does it infer any pre-eminence in its field compared with other institutions in the same country or elsewhere.
IAEA Collaborating Centres

20 Collaborating Centres worldwide (2011)

- South Korea: Terrestrial and marine environment
- Burkina Faso: Research and methods relevant to SIT against tsetse
- India: Nuclear techniques in nutrition
- Mexico: Development and Application of the Sterile Insect Technique (SIT) against fruit flies
- Poland: Radiation processing and industrial dosimetry
- Spain: Accelerator based analytical techniques for the study of long-lived radionuclides in marine samples
- Argentina: Human resource development for nuclear technologies and their applications
- Australia: Neutron scattering techniques
- Malaysia: Radiation processing of natural polymers
- Syria: Radioecology of naturally occurring radioactive materials (NORM)
- Japan: Radiobiology, charged particle therapy and molecular imaging
- Costa Rica: Learning and accelerated capacity building for food and environmental protection
- Hungary: Production and characterization of matrix reference materials
- Italy: Capacity building in synchrotron radiation applications
- Brazil: Animal genomics and bioinformatics
- Philippines: Studies on harmful algal blooms
- Korea: Research and education activities in nuclear medicine and molecular imaging
- China: Mutant germplasm enhancement and exploration in plants
IAEA Collaborating Centre for Neutron Activation Based Methodologies of Research Reactors

May 11, 2009
The Dutch knowledge centre for university *radiation-related* research and training with the primary focus on the reactor, radionuclides and ionizing radiation.
Operational power level 2 MW
100 h/week continuous operation
Thermal neutron fluence rate in-core
Thermal neutron fluence rate at core surface
Integral fluence rate at neutron-guide exit
Positron yield

- $4 \times 10^{13} \text{ cm}^{-2}\text{s}^{-1}$
- $1 \times 10^{13} \text{ cm}^{-2}\text{s}^{-1}$
- $3 \times 10^7 \text{ cm}^{-2}\text{s}^{-1}$
- $2 \times 10^8 \text{ s}^{-1}$
Hoger Onderwijs Reactor (HOR) facilities
IAEA Collaborating Centre: What

Neutron activation based methodologies

• Production of carrier-free radioisotopes of high specific activity via neutron activation.

• Neutron activation analysis with emphasis on automation, as well as analysis of large samples, and radiotracer techniques.

• Quality assurance and management in research and application of research reactor based techniques.

Assistance for the Agency’s training programme
IAEA Collaborating Centre: How

• (Regional) training courses in Delft or in Member States
  - Radiotracer methodology
  - Neutron activation analysis
  - Metrology in nuclear analytical techniques
  - Quality assurance and management

• Hosting scientific visitors and providing research fellowship training
  - Radioisotope production
  - Automation in NAA
  - Logistics of large scale projects and sustainability of services
  - Quality assurance and management

• Transfer of technology
  - Large sample neutron activation analysis
  - New facilities in Member States
  - RID as benchmark

• Expert Services to Member States

• Participation of Member States in our research programs
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We offer training and assistance for Nuclear Analytical Techniques:

- Principle of Neutron Activation Analysis (NAA)
- Metrology of NAA (calibration, validation, uncertainty, primary method requirements)
- Quality Control/Quality Assurance in NAA
- Automation and facility design
- Principles of the radiotracer method
- Principles and applications of compartmental studies
- Principles of carrier-free production of radionuclides
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We offer training and assistance for QC/QA/QM:

- Principles and pragmatics of quality control, quality assurance and quality management
- Interpretation and implementation of the requirements of the ISO/IEC 17025:2005
- Training in Internal Auditing in nuclear science related laboratories
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We are available to help you via Expert Services, and national and regional training courses on

- Neutron activation analysis
- Gamma-ray spectrometry
- QC/QA/QM + ISO/IEC 17025 implementation
- Gap analysis of quality management systems
- Automation in NAA, handling of large-scale projects
- Commercial services
- Metrology in nuclear analytical, and chemical measurements
- Radiotracer methodology and applications
IAEA Collaborating Centre

Support to IAEA 1999-2011

135 man-weeks in expert missions and consultant/technical meetings
17 contributions to IAEA scientific publications
35 scientific visitors and fellows hosted for total 156 man-weeks
8 workshops and training courses hosted
2 research agreements
IAEA Collaborating Centre

Activities 2009-2011

- ICTP- IAEA-RID Advanced Workshop on “Neutron probing for compositional and structural characterization of materials and biological samples”
- IAEA Regional Training Course on “Physical Protection of Nuclear Materials and Facilities”
- Second Research Coordinating Meeting of the IAEA CRP-1499 "Application of Large Sample Neutron Activation Analysis Techniques for Inhomogeneous Bulk Archaeological Samples and Large Objects”
- 5 Weeks Scientific Visitors (5 persons)
- 16 Weeks Fellowship Training (3 persons)
- 3 Expert missions
- Participation in IAEA Technical- and Consultants’ meetings
- Serving as help desk for $k_0$-IAEA software
IAEA Collaborating Centre

Activities for 2012

- IAEA 1\textsuperscript{st} RCM on new CRP “Routine Automation in NAA”
- IAEA Feedback meeting on evaluation of laboratory intercomparison results of European NAA laboratories
- Hosting scientific visitors (2 visits already planned)
- Providing fellowship training
- Availability for Expert missions, and for participation in IAEA Technical and Consultants’ meetings
- Continuing the help desk for $k_0$-IAEA software
- At sufficient interest: Summer school (2 weeks) on NAA
IAEA Collaborating Centre: Related research activities

Innovative Ways of Carrier-Free Radioisotope Production

- Use of Szilard-Chalmers chemistry
  1 patent registered ($^{99}$Mo)
  2 patents submitted
  1 patent in preparation

- Dedicated Irradiation Facilities

- New Radioisotope Generators
IAEA Collaborating Centre: Related research activities

Radiotracer Methodology

- Radiolabeling
  Lipid-based nanomaterials with tumor-specific peptides

- Kinetic and stability constants
  Free Ion Selective Radiotracer Extraction

- Absorption of tracers to surfaces
  Thin Gap method and neutron reflectometry

- Non-invasive chemical speciation
  Perturbed Angular Correlation Spectrometry

- Toxicity of metal mixtures
  Cell cultures

- Behavior, distribution and site effects of (nano)elements

- Human and Animal Metabolism Studies
  Compartmental analysis
IAEA Collaborating Centre: Status

Neutron Activation Analysis

- Leading developments in detectors, software, automation, methodologies and applications
- In-house developed software, based on $k_{zn}$ method since 1970
- 3 well type detectors, 3 coaxial detectors (all with sample changers)
- 2 fast rabbit systems (1 with sample changer)
- Typical throughput 2,500 samples/year (capacity ~ 10,000)
- Large sample NAA facility (max. 50 kg)
- 2 George Hevesy Medal Award winners (2003 and 2011)
- From 2012 onwards: No scientific research anymore, only commercial applications
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Neutron Activation Analysis
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Neutron Activation Analysis

Large sample NAA facility
Neutron Activation Analysis: a Primary Method of Measurement

Chapter 1 – Neutron Activation Analysis: Principles and Analytical Characteristics

Chapter 2 - Evaluation of Uncertainties for NAA Measurements Using the Comparator Method of Standardization

Chapter 3 - Performance of NAA Laboratories in CCQM Key Comparisons and Pilot Studies
Other opportunities for capacity building in Delft

M.Sc. Specialization
Nuclear Science and Engineering

Both for
Chemical Engineering
Applied Physics

Focus on Energy or Health, e.g.
Nuclear reactors
Chemistry of the nuclear fuel cycle
Radiation and isotopes for health
Medical imaging

2 years, 120 ECTS
Other opportunities for capacity building in Delft

European Master course “Nuclear Security”

1 year, 60 ECTS
Starting 2012/2013

Coordinated by Delft University of Technology,
in partnership with
United Kingdom
Germany
Norway
Greece
Austria

and aligned with the IAEA
Optimistic developments in Delft

1. 2009: Start Nuclear Science and Engineering MSc specialization

2. 2009: New (young) full professors at all sections:
   - Radiation Detection and Measurement techniques
   - Neutron Beam physics
   - Radiochemistry
   - Defects in materials (positron research)
   - Reactor physics

3. 2009: IAEA Collaborating Center

4. 2010: Grant for innovative neutron diffractometer

5. 2011: Proposal submitted for multi-purpose neutron polarization instrument

6. 2012: Proposal to be submitted for neutron imaging facility

7. 2012: Approval for upgrade reactor and (beam) facilities: OYSTER

8. 2012: Start building Proton Cancer Therapy Clinic (operational 2016)

9. 2012/2013: Start MSc education Nuclear Security

10. 2013: 50 years’ operation of reactor
Outcome of Upgrade

- Neutron fluence rate: factor 40 ↑
- Positron intensity: factor 5 ↑
- Neutron/gamma ratio: factor 400 ↑
- Neutron instruments gain: factor 150 ↑
- Positron instruments gain: factor 60 ↑
End (of this presentation)