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 DIRECTORATE GENERAL JRC  
 JOINT RESEARCH CENTRE  
 Institute for Reference Materials and Measurements  
 IRMM  
 JRC Reference Laboratory for Radionuclide Metrology

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## Laboratory Report 2007-2009 of IRMM

The reporting period covers approximately the first half of the EC-JRC's framework programme VII for research and technical development. Within this framework, the laboratory's tasks are comprised of five work areas:

1. Primary standardisation of radionuclide activity and determination of decay data;
2. Characterisation of Reference Materials (RMs) for their radioactive components;
3. Ultra-low level radioactivity measurements (mainly in the underground laboratory HADES);
4. Support to international metrology organisations (BIPM/CCRI and its working groups, EURAMET);
5. Development and co-ordination of an international comparison scheme in the frame of the Commission's Radioactivity Environmental Monitoring programme (under Articles 35 and 36 of the Euratom Treaty).

Since the end of 2007, five of the eight temporary staff (PhD students and post-docs) of the laboratory left IRMM due to the impossibility to prolong their contract or a permanent recruitment elsewhere before contract end. During the year 2008, only two of these could be replaced. Moreover, at the beginning of 2009, a very experienced permanent staff member left the group; a replacement in this position is expected for the second half of 2009. At present the laboratory counts 6 permanent and 5 non-permanent staff and an additional stagiaire.

**Highlights of work** done during the past two years since May 2007:

- Primary standardisation of  $^{124}\text{Sb}$  in the frame of a EURAMET project with four independent methods; no evidence for the claimed bias between coincidence and sum counting techniques. Primary standardisation of  $^{177}\text{Lu}$  and  $^3\text{H}$  ongoing in the frame of the CCRI(II) Key Comparisons.
- Detailed study of cascade effects of pulse pile-up with extending and non-extending dead-time.
- Decay data: New half-life values for  $^{124}\text{Sb}$  and  $^{54}\text{Mn}$  determined. Accurate measurement of the half-life of  $^{233}\text{U}$  by a combination of mass spectrometry and primary standardisation of activity (collaboration with PTB, CIEMAT and LNE-LNHB). Lower bound for the half-life of  $^{180\text{m}}\text{Ta}$  now raised to  $2 \cdot 10^{16}$  years. Investigation of uncertainty claims for half-life values in literature and new propagation formula suggested. In the frame of the mentioned EURAMET project, photon emission probabilities of about 100 gamma- and x-ray transitions of  $^{124}\text{Sb}$

determined. In another EURAMET project, coordinated by IRMM, new emission probabilities  $P_\alpha$  and  $P_\gamma$  of  $^{240}\text{Pu}$  were determined. Measurement of the  $\beta^-$ -decay of  $^{115}\text{In}$  with the lowest known decay energy to the first excited state of  $^{115}\text{Sn}$  (Q value < 300 eV).

- Development of a NaI well detector system for  $4\pi\gamma$  counting; study of the total efficiency with an analytical model and comparison with simulations.
- Development of a TDCR system based on fast logic units and a modular multiparameter multiplexer, previously developed at IRMM. Evaluation of the system performance by measuring samples of a variety of radio-nuclides is ongoing. Participation in the TDCR uncertainty assessment project of the ICRM Liquid Scintillation Counting WG.
- Source dryer: Another unit of this prototype model for the preparation of thin, uniform deposits of small crystal size was delivered to NPL.
- The homogeneity and stability of a batch of dried wild berries material suitable as reference material has been established. A CCRI(II) supplementary comparison for  $^{90}\text{Sr}$ ,  $^{40}\text{K}$  and  $^{137}\text{Cs}$  in this material is in preparation (more participants are welcome).
- For the first time, charged particle leakage from a plasma was directly detected in the Joint European Torus (JET) Tokamak with a technique of charged particle flux monitors developed in collaboration between IRMM and researchers of EFDA (European Fusion Development Association). The subsequent low-level  $\gamma$ -ray measurements of the activated metal plates were performed in HADES and other European underground laboratories of the CELLAR network.
- Low-level  $\gamma$ -ray spectrometry in HADES contributed repeatedly to the certification of reference materials (KRISS rice, IAEA-MEL marine sediment), to the selection of radiation-free components for the construction of the neutrinoless double beta-decay experiment GERDA in Gran Sasso, and to reference measurements of air filters for CTBTO (Comprehensive Test Ban Treaty Organisation) in order to study the feasibility of lowering detection limits by the use of underground laboratories.
- In the course of PhD studies, a new underground sandwich detector system consisting of two HPGe detectors and two active anti-muon shields was developed and applied in several projects. Thesis defended in February 2009.
- In the December 2007 meeting of the CCRI(II) WG "Realization of the becquerel" (BqWG), experimental results with the IRMM prototype of a reference ionisation chamber were discussed. Whereas further details of the design were decided based on the experiments and Monte Carlo simulations that had been performed at IRMM and LNE-LNHB, other features such as the proposed alternative of an electrode-free inner wall need to be studied yet.
- Contributions to the CCRI(II) Activity Uncertainties and Comparisons Workshop, held at BIPM in September 2008.
- Evaluation and completion of the intercomparison with  $^{40}\text{K}$ ,  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$  in milk powder among European monitoring laboratories for radioactivity.
- Organisation of the comparison for  $^{226,228}\text{Ra}$  and  $^{234,238}\text{U}$  in bottled mineral waters and preliminary evaluation of comparison with widely spread results of the 45 participating labs. The comparison reference values for

all four radionuclides were established from partly SIR-traceable measurement results of IRMM ( $^{228}\text{Ra}$  in the course of PhD studies) and Bundesamt für Strahlenschutz (BfS), Berlin, using different methods.

- A workshop was organised for the participants in the first three comparisons (air filter, milk powder, water) organised by IRMM for monitoring laboratories, where all aspects (sample preparation, SI-traceable reference values, evaluation of laboratory performance and challenges for future harmonisation in measurement) were vividly discussed.
- A radiochemical method for the sequential determination of low activities of polonium and uranium in water was developed and published.
- Contributions to VERMI (Virtual European Radionuclide Metrology Institute) specialists' workshop on source preparation held at PTB in December 2007 with about 12 participants.
- 38 peer-reviewed publications, a PhD thesis as well as 5 EUR reports published during the past two years.
- Passed first and second surveillance audits of BELAC for accreditation (ISO 17025 and ISO Guide 43) with the scope to primary standardisation of radioactivity (coincidence counting) and organisation of interlaboratory comparisons for radioactivity among monitoring laboratories.

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