

International Committee for Radionuclide Metrology ICRM

ICRM NEWSLETTER Issue 27

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Editor:

Marie-Martine Bé LNE-Laboratoire National Henri Becquerel (LNE-LNHB) CEA-Saclay 91191 Gif-sur-Yvette Cedex France Tel.: + 33 1 69 08 46 41 Fax: + 33 1 69 08 26 19 E-mail: mmbe@cea.fr

Web Editor: Christophe Dulieu LNE-Laboratoire National Henri Becquerel (LNE-LNHB) CEA-Saclay 91191 Gif-sur-Yvette Cedex France E-mail: <u>christophe.dulieu@cea.fr</u>

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CONTRIBUTIONS

۶	Argentina	 Comisión Nacional de Energía Atómica, CNEA, Buenos Aires
	Austria	 Bundesamt f ür Eich- und Vermessungswesen, BEV, Vienna
۶	Belgium	• Institute for Reference Materials and Measurements, IRMM, Geel
		• SCK•CEN, Mol
۶	BIPM	 Bureau International des Poids et Mesures Sèvres, France
۶	Brazil	• Laboratório Nacional de Metrologia das Radiações Ionizantes, LNMRI/IRD/CNEN, Rio de Janeiro
	Croatia	 Ruđer Bošković Institute, RBI, Zagreb
	France	 Laboratoire National Henri Becquerel, LNE-LNHB, Saclay
۶	Germany	 Physikalisch - Technische Bundesanstalt, PTB, Braunschweig
۶	IAEA	 International Atomic Energy Agency, Vienna, Austria
۶	India	• Bhabha Atomic Research Centre, BARC, Mumbai
۶	Italy	• Istituto Nationale di Metrologia delle Radiazioni Ionizzanti, ENEA, Rome
>	Japan	 National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology, NMIJ/AIST, Tsukuba
۶	Poland	 Laboratory of Radioactive Standards, RC POLATOM, Otwock-Świerk

۶	Romania	• Institutul National de Fizica si Inginerie Nucleara, IFIN-HH, Bucharest
	Slovak Republic	 Slovak Institute of Metrology, SMU, Bratislava
	Slovenia	 Jožef Stefan Institute, Ljubljana
	South Africa	 National Metrology Institute of South Africa, NMISA, Cape Town
۶	Spain	• Laboratorio de Metrología de Radiaciones Ionizantes, CIEMAT Madrid
۶	Taiwan	• Institute of Nuclear Energy Research, NRSL/INER Longtan
۶	Turkey	• Sarayköy Nuclear Research and Training Center, TAEK Ankara
۶	United Kingdom	 National Physical Laboratory, NPL, Teddington
	<i>U.S.A.</i>	 National Institute of Standards and Technology, NIST Gaithersburg

EDITORIAL

This newsletter was established in response to a recommendation of the International Committee for Radionuclide Metrology made during its General Meeting in Grenoble 1985. It is meant to serve as a medium for informal exchange of information between workers active in the field of Radionuclide Metrology.

The scope of the Radionuclide Metrology Newsletter is to describe briefly current activities in the following topics:

- foil and source preparation;
- α -, β and γ -ray spectrometry including spectrum evaluation;
- improvement and development of radionuclide measurement techniques;
- measurement and evaluation of radionuclide data;
- low-level radioactivity measurement techniques;
- life-sciences;
- quality assurance and traceability.

In order to ensure that the Newsletter is as comprehensive and informative as possible, contributions are sought from all laboratories known to be engaged in measurements and data evaluation techniques relevant to Radionuclide Metrology.

All previous contributors will be informed concerning the deadline for the next issue. New contributing Radionuclide Metrology laboratories are welcome. Please contact the editor.

Any comments on this issue or suggestions for improvement will be welcome.

At the ICRM General Meeting in Paris 1995, it was decided that the ICRM Newsletter would also allow for the distribution of Progress/Planning Reports SA1 and SA2.

From the experience of this issue, we have the following situation: laboratories regard their normal Newsletter contribution as the fulfilment of SA1/SA2. In this case this is indicated on the contribution by "SA1/SA2". Or laboratories provide (additionally) the traditional SA1/SA2 reports which should not be longer than 2 pages. In the latter case it should be mentioned in the accompanying letter, that the SA1/SA2 contributions be intended for publication in the Newsletter.

For economy reasons, at the ICRM General Meeting in Dublin 2003, it was agreed that the ICRM Newsletter would be put in the LNE-LNHB (former BNM-LNHB) web site (<u>http://www.nucleide.org/Publications/icrm_newsletter.htm</u>) distributed in hard copy, or CD-rom only to those whom have asked for it.

• Contributions may be sent by E-mail as an attachment in MS Word or as plain text file.

INSTRUCTIONS TO CONTRIBUTORS

This Newsletter is realised with no alterations by the editor. To ensure readability and avoid unnecessary work by the editor, it is suggested that:

- Contributions should be typed on plain white A4 paper (21 cm x 29,7 cm), please use the "contribution.doc" file.
- Contributions should contain **no** page number, date, signature, or any correspondence references typed on this sheet. Correspondence to the editor must be on a separate sheet.
- Contributions should be in English and carefully proofread by the authors.
- References to publications or reprints should be completed as required by the Physical Review.
- Complete mailing address and the name of a person who can be contacted for additional information by those desiring it should be given at the end.
- Please note that only files in "MS Word" format will be accepted.

Contribution Format

LABORATORY	Name of laboratory
NAMES	If more than one laboratory is involved identify affiliation through abbreviations (ORNL, LASL, etc.). Visitors can also be identified with asterisks.
KEYWORDS	Alpha spectrometry, beta spectrometry, calorimetry, (anti) coincidence method, cryogenic detector, data evaluation, data measurement, Euromet, gamma-ray spectrometry, gas proportional counter, ionisation chamber, life sciences, liquid scintillation, low-level, NaI well counter, neutron measurement, radioactive gas, radiochemistry, simulation code, SIR, source preparation, X-ray spectrometry, radionuclide by name (e.g. 55Fe or Fe-55). Choose the good ones
APPARATUS ACTIVITY	Choose one; the former for experiments and the latter for compilations, calculations, or theory.
RESULTS	Use this for experimental results.
PUBLICATIONS	Use Physical Review style. Include only materials published during the referred year.
IN PROGRESS	Use this for description of the current work.
INFORMATION SOURCE	Use this for evaluations or compilations.
IN PREPARATION	Use this to also indicate papers submitted for publication.
OTHER RELATED PUBLICATIONS	Optional.
ADDRESS	Mailing address. Give also telephone, telex, fax numbers and E-mail.
CONTACT	Single contact person.

General information on ICRM (President's Message)

The International Committee for Radionuclide Metrology (ICRM) is an association of radionuclide metrology laboratories whose membership is composed of delegates of these laboratories together with other scientists (associate members) actively engaged in the study and applications of radioactivity. It explicitly aims at being an international forum for the dissemination of information on techniques, applications and data in the field of radionuclide metrology. This discipline provides a range of tools for tackling a wide variety of problems in numerous other fields, for both basic research and industrial applications.

There are 39 institutions now represented by delegates in the ICRM. The ICRM has no membership fee and no paid secretariat or other staff. Its overall direction is determined by the delegates in General Meetings, which convene usually every two years, where organizational guidelines and directions for the working programs are agreed upon. The following officers of ICRM are presently serving on the Executive Board:

President	Pierino De Felice ¹	pierino.defelice@enea.it
Vice-Presidents	Dirk Arnold ³	dirk.arnold@ptb.de
	Marie-Martine Bé ⁴	mmbe@cea.fr
	Eduardo García-Toraño ⁹	E.garciatorano@ciemat.es
Past-President	Yoshio Hino ⁵	<u>y.hino@aist.go.jp</u>
Secretary	Franz Josef Maringer ⁶	Franz-Josef.Maringer@bev.gv.at

The Executive Board relies heavily on the Nominating Committee which has the objective of ensuring the continuity of purpose and vigour of ICRM. It does this by soliciting from the membership, and by itself proposing, the names of eligible candidates to fill vacancies about to occur on the Executive Board and the Nominating Committee. The current membership of this committee is:

Chairperson	Guy Ratel ⁷	gratel@bipm.org
Members	Mike Woods ⁸	mike.woods@blueyonder.co.uk

Plenary meetings of the ICRM are held biennially, and have developed into a successful instrument of communication among various specialists, thus encouraging international cooperation. The most recent series of ICRM meetings was at the 18th International Conference on Radionuclide Metrology and its Applications (ICRM 2011), which took place on 19-23 September 2011 in Tsukuba, Japan organized by the National Metrology Institute of Japan, Advanced Industrial Science and Technology (NMIJ/AIST)

Our appreciation and thanks go to all who contributed to this very successful and busy meeting. In particular we recognize the great contributions made by Dr. Yoshio Hino and his local organizing team, a number of other NMIJ colleagues, the Scientific Programme Committee, the referees and session chairmen and to the authors of papers.

ICRM activities are largely the responsibility of its working groups. Each group is guided by a co-ordinator who acts as a centre for ideas and communications and may organize

conferences and workshops. There are now seven working groups with the following fields of interest:

 (1) Radionuclide Metrology Techniques John Keightley¹⁰ Mike Unterweger¹¹ Divided in four sub-groups: Digital Acquisition and Analysis (C. I - Coincidence Counting (J. Keightley¹⁰ Gaz Counting (M. Unterweger¹¹), Large Area Sources (P. De Felice¹) 	http://users.skynet.be/icrmrmt/ John.Keightley@npl.co.uk, michael.unterweger@nist.gov Bobin ⁴),
(2) Life Sciences Jeffrey T. Cessna ¹¹	jeffrey.cessna@nist.gov
(3) Alpha-Particle Spectrometry Stefaan Pommé ²	stefaan.pomme@ec.europa.eu
(4) Gamma-Ray Spectrometry Octavian Sima ¹²	octavian.sima@partner.kit.edu
(5) Liquid Scintillation Techniques Karsten Kossert ³	karsten.kossert@ptb.de
(6) Low-Level Measurement Techniques Dirk Arnold ³ (till Sept. 2012) Mikael Hult ²	dirk.arnold@ptb.de mikael.hult@ec.europe.eu
(7) Non-Neutron Nuclear Data Marie-Martine Bé ⁴	http://www.nucleide.org/3NDWG.htm mmbe@cea.fr

The next 19th international conference of ICRM 2013 will be held in June, 2013 in Antwerpen, Belgium, organized by the JRC/IRMM. The contact person of the local organizing committee is Dr. Uwe Wätjen² (<u>uwe.waetjen@ec.europa.eu</u>). The conference will include oral and poster presentations and business meetings of the ICRM Working Groups, in plenary format. In addition to these plenary meetings, each WG may have specific meetings in the form of international conferences or more restricted workshops.

All ICRM meetings are announced on the ICRM home page "<u>http://physics.nist.gov/icrm</u>" or in this Newsletter. Anyone wishing to participate in these ICRM's activities or to receive further information is encouraged to contact one of the officers or Working Group co-ordinators, and also to visit the ICRM home page.

Finally, we express our heartfelt thanks to Dr. Marie-Martine Bé and Christophe Dulieu⁴ for compiling and uploading this ICRM Newsletter, and also thanks to Dr. Lisa Karam¹¹ for maintaining our ICRM home page.

January 2013

Pierino De Felice President of ICRM

References

- 1. Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile, C.R. Casaccia, P.O. Box 2400, I-00100 Rome, Italy.
- 2. European Commission, Joint Reseach Centre, Institute for Reference Materials and Measurements, Retiesweg 111, B-2440 Geel, Belgium.
- 3. Physikalisch-Technische Bundesanstalt, Bundesalle 100, D-38116 Braunschweig, Germany.
- 4. Laboratoire National Henri Becquerel, CEA Saclay, PC 111, F-91191 Gif-sur-Yvette Cedex, France.
- 5. National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology, Tsukuba Central 2, 1-1-1, Umezono, Tsukuba, Ibaraki, 305-8568, Japan.
- 6. Bundesamt für Eich- und Vermessungswesen, Arltgasse 35, 1160 Wien, Austria.
- 7. Bureau International des Poids et Mesures, Pavillon de Breteuil (BIPM), F-92312 Sèvres CEDEX, France.
- 8. Ionizing Radiation Metrology Consultants Ltd, 152 Broom Road, Teddington, Middlesex TWll 9PQ, U.K.
- 9. Metrología de Radiaciones Ionizantes, Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Avenida Complutense 22, E-28040 Madrid, Spain.
- 10. National Physical Laboratory (NPL), Hampton Road, Teddington, Middlesex, TW11 0LW, UK.
- 11. National Institute of Standards and Technology (NIST), Gaithersburg, Maryland, 20899-8462, U.S.A.
- 12. Faculty of Physics, University of Bucharest, 425 Atomistilor Str., Bucharest-Magurele, P.O.Box MG-11, RO-077125, Romania

ANNOUNCEMENTS

1) Conferences

ICRM 2013 will take place in Antwerp, Belgium, 17-21 June 2013. <u>http://irmm.jrc.ec.europa.eu/icrm2013</u>

2) Announcements:

1) Ruđer Bošković Institute, Zagreb, Croatia

Within the IAEA regional project RER/0/034 "Enhancing the characterization, preservation and protection of cultural heritage artefacts" we organize "Regional Training Course on Dating of Cultural Heritage Artefacts using Nuclear Analytical Techniques" in Zagreb, Croatia, from 20 May to 24 May 2013. Approximately 35 persons from the countries participating in RER/0/034 (Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Greece, Hungary, Kazakhstan, Latvia, Lithuania, Malta, Montenegro, Poland, Portugal, Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, FYR Macedonia, Tajikistan, Turkey, Ukraine) are expected as well as representative(s) from the IAEA. The main invited lecturers are Dr. Irena Hajdas (ETH, Zurich) covering various topics of ¹⁴C dating, and Prof. Dr. Marco Martini (CUDaM, Milano) covering topic of TL and OSL dating and dendrochronology. Several other topics of interest will be presented by local lecturers.

 9^{th} Symposium of Croatian Radiation Protection Association with international participation will be organized in Krk, Krk Island, Croatia, 10 - 12 April 2013. Various aspects of radiation protection will be covered by approximately 80 oral or poster presentations. Special topic will be devoted to 50 years of organized radiation protection in the region, celebrating 50 years of foundation of the Yugoslav radiation protection Association (in Portorož, Slovenia, in 1963).

2) <u>IFIN</u>

Dr. Aurelian Luca, participant in EURAMET EMRP JRP MetroFission, ENG08, WP8: Creating Impact, is the responsible person for the organization of the:

EURAMET EMRP JRP MetroFission – Nuclear Data Workshop, IRMM-Geel, Belgium, 13 – 14 June 2013.

In this quality, he invites all the participants in this WP and all interested people to attend at this important meeting.

3) <u>SMU</u>

Operates a brand new (commercial) TDCR LSC instrument and prepares it for an intercomparison, maybe 68 Ge – 68 Ga (this year) or 64 Cu (next year?).

We are searching for a more experienced cooperating laboratory willing to join the project and share the organizational effort.



Coordinator's Report Alpha and Beta Spectrometry WG

Alpha-particle spectrometry is a measurement technique that has found many practical applications in such diverse fields as nuclear decay data measurements, geological studies, or the measurement of low levels of activity in the environment. The community working on its development is small, but nevertheless active. Published work in 2012 and previous years reported improvements in source preparation, assessments of energy loss within the source, portable devices, activity determinations without tracers, application of solid angle calculations, spectral deconvolution, and measurements of alpha-emission probabilities, branching factors and half-lives, data for nuclear medicine.

Beta-particle spectrometry is even more particular as an art in radionuclide metrology. Significant progress is made with a novel technique using a cryogenic detector and also the response function of semiconductor a Si detector has been investigated.

The MetroFission EMRP hosts a collaboration on nuclear decay data improvement in the Work Package 5. It involves high precision measurements of ²³⁸U alpha-particle emission probabilities and experimental characterization of the beta spectra shape using cryogenic detectors. The challenges imposed by this work have brought about qualitative improvements in the fields of alpha- and beta-particle spectrometry.

The Working Group meets at the ICRM-2013 conference in Antwerp, Belgium.

Stefaan Pommé

EC-JRC-IRMM Retieseweg 111 B-2440 Geel Belgium <u>stefaan.pomme@ec.europa.eu</u> Phone +32 14 571289

Non-Neutron Nuclear Data Working Group (3NDWG): Report, January 2013

Coordinator: Marie-Martine Bé

Key words: decay data; evaluations; nuclear decay data requirements

- 1. The primary aim of the 3NDWG is to provide the worldwide scientific community with an appropriate environment for communications between specialists in the field of non-neutron nuclear data measurements and evaluations so that they can learn more about each others' work, liaise and combine forces to undertake research programmes of mutual interest, and organize multinational efforts to produce recommended sets of non-neutron nuclear data.
- 2. 3NDWG members continue to be involved in the evaluation efforts of the Decay Data Evaluation Project (DDEP). Communications between decay data evaluators are encouraged through this project (co-ordinator: M.-M. Bé, <u>mmbe@cea.fr</u>). Details of this work and the recommended decay data can be found on the Internet: <u>http://www.nucleide.org/DDEP_WG/DDEPdata.htm</u>. A fourth working meeting of the DDEP was organized on October 8-10, in Paris. This three days meeting was dedicated to new evaluators.
- 3. The IAEA Coordinated Research Project on "Updated decay data library for actinides" (2005-09) is now finished. A status of the CRP was given by M.A. Kellett during the last conference. The evaluators turn now their interest to radio pharmaceutical nuclides.
- 4. 25 new nuclides have been evaluated or updated and published in the last Monographie 5-6 issue (2011). A seventh volume is in preparation.
- 5. A dedicated 3NDWG web site is available on: <u>http://www.nucleide.org/3NDWG.htm</u> Members of the 3NDWG are encouraged to use the Working Group to communicate experimental and theoretical work, relevant evaluation procedures and their decay data problems.
- 6. Six oral communications and five posters have been accepted for presentation to the next conference in Antwerp.
- At the General Meeting (Oxf ord, September 2005) of the International Committee for Radionuclide Metrology (ICRM) the Delegates formally approved the recommendation made by the Nuclear Data Working Group of using the DDEP evaluated decay data in all future nuclear data studies.
 The 2011 ICRM Executive Board has renewed this recommendation, particularly in view of the drafting and refereeing work for the ICRM 2013 Conference.

Marie-Martine Bé CEA/LIST-LNHB, Bât 602 91191 Gif sur Yvette, France Phone: +33 1 69 08 46 41 E-mail: mmbe@cea.fr

10 January 2013

Action report of the ICRM Liquid Scintillation Working Group since September 2011

Scope of the WG

The purpose of the Liquid Scintillation Counting Working Group is to provide a forum for ICRM members to address issues related to liquid scintillation and Čerenkov counting. In particular the CIEMAT/NIST efficiency tracing and the Triple-to-Double-Coincidence Ratio (TDCR) method play major roles in Radionuclide Metrology. In the past decade many new developments were presented by ICRM researchers, e.g. new counter systems, new electronics for signal treatment and data acquisitions, investigations of existing models and extensions of calculation procedures and utilization of the methods for activity standardization of further radionuclides.

Working Group meeting at PTB 26-27 November 2012

Following a proposal from the last ICRM conference in Tsukuba, an interim meeting of the LSC Working Group was organized at the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig, Germany, from 26th to 27th November 2012. Twenty-six participants from South Africa, Canada, US, UK, France, Switzerland, Italy, Spain, Poland, Russia, the EU and Germany attended the meeting.

The purpose of the LSC Working Group meeting was to discuss issues that typically cannot be addressed at the general ICRM meeting due to time limitations. The interim meeting also provided an opportunity for members of the LSC-WG to present results of works in progress or recently completed projects, as well as to discuss and plan future LSC-WG activities. The following topics were presented:

Introduction

• "100 years radionuclide metrology at PTR/PTB" (Karsten Kossert)

Hardware developments and adjustments

- "FPGA TDCR at NIST" (Denis Bergeron)
- "New developments in TDCR and the ENEA portable TDCR system" (Marco Capogni)
- "Digital Pulse Processing for TDCR method" (Giuliano Mini)
- "TDCR systems used at PTB" (Ole Nähle)
- "The Hidex-TDCR counter and a bilateral comparison between ENEA and PTB an update" (Karsten Kossert)
- "Detector based on FPGA Influence of threshold, coincidence time and dead time" (Alex Tarancon)
- "Time difference spectra between PMT pulses in a TDCR counter" (Philippe Cassette)

Models and programmes

- "Usage of the MICELLE programme an introduction" (Karsten Kossert)
- "Micelle size measurements and cocktail stability" (Claude Bailat)
- "Micelle size effects" (Denis Bergeron)
- "Influence of various assumptions in the Birks function on the H-3 activity determination" (Ryszard Broda)
- "Monte-Carlo simulation and TDCR and CIEMAT/NIST methods applied to plastic scintillation microspheres" (Alex Tarancon)

Čerenkov counting

- "The TDCR-Čerenkov method an analytical approach" (Karsten Kossert)
- "On the stochastic dependence between photomultipliers in the TDCR-Čerenkov technique" (Christophe Bobin)

Applications and comparisons

- "Standardization of Tc-99" (Freda van Wyngaardt)
- "Standardisation of Tc-99 and new TDCR-LSC at IRMM" (Timotheos Altzitzoglou)
- "Analysis of the BIPM Ni-63 comparison" (Guy Ratel)
- "Half-life determination of Lu-176" (Karsten Kossert)

Each talk was followed by detailed discussions and the participants found it beneficial to have more time for that than during the general conference.



Liquid Scintillation Working Group Meeting Braunschweig, 26. November 2012



Figure 1: Participants of LSC WG meeting at PTB in November 2012

The event was combined with an interim meeting of the Life Sciences WG which was held from 28th November to 29th November. Thus, the organization was similar as in two previous successful meetings held at LNE in 2007 and NPL in 2008. The participants of both meetings also had the opportunity to visit the laboratory of PTB's "Unit of Activity" working group in the morning of 28th November.

An additional session was dedicated to general discussions about future needs and potential actions of the LSC-WG. The participants agreed that such meetings are very valuable and it was proposed to offer similar events to young radionuclide metrologists since some institutes identified a need to train new staff members. A good example for such training workshops were the events organized as VERMI (Virtual European Metrology Institute) workshops. It was also discussed that there is no funding which

would make an organization rather difficult. The topic will be addressed to the ICRM general meeting.

The WG had also a long discussion about current developments of models and programs to compute counting efficiencies according to the TDCR method or CIEMAT/NIST efficiency tracing. It was emphasized that both methods are based on the same model, and consequently, a consistent model should be used for both techniques. However, at the moment a variety of codes exist and comparisons and/or harmonisations were proposed. Due to the complexity of the problem it was finally proposed to organize a comparison exercise in which the same experimental data set is distributed to several participants. Since such an action was already planned as an action of the Key Comparison Working Group (KCWG) of the CCRI(II), a combined action of KCWG and ICRM was considered as a good approach. The organization of this action is currently prepared and a set of experimental data of ³H measurements can be provided by LNHB (Philippe Cassette).

Alex Tarancon from the University in Barcelona presented some details about the upcoming LSC conference in Barcelona from 18th to 22nd March 2013. The conference also includes a session on radionuclide metrology using LSC techniques.

The coordinator also proposed to make a little survey about standardizations of various radionuclides by means of liquid scintillation counting techniques. Details about this survey are given below.

The participants agreed that it would be useful to organize similar interim meetings in the future and two institutes kindly offered possibilities to host such a meeting: NPL (John Keightley) and ENEA (Marco Capogni). The participants also agreed to have the next meeting again in combination with the LS WG and between the main conferences. A final decision about the date and host should be made at the next WG meeting in Antwerp in June 2013.

Survey on standardization of radionuclides by means of various liquid scintillation counting methods.

During the last interim meeting of the ICRM Liquid Scintillation Counting Working Group in November 2012, the participants discussed the need to get more detailed information about activity standardizations of various radionuclides by means of different LS methods. Such data (including methods, references, comparisons and information on achieved uncertainties) could for example be valuable if a WG member starts to standardize a new isotope. In December 2012 a questionnaire was send to the WG members who are kindly asked to send the completed form to the WG coordinator not later than 30 April 2013.

Of course the participation in this survey is voluntary. The outcome of the survey will be provided to all participating institutes. In addition, some compiled information might be presented at future WG meetings.

On behalf of the LSC Working Group

Karsten Kossert (coordinator) Physikalisch-Technische-Bundesanstalt Department 6.1 Bundesallee 100 38116 Braunschweig, Germany Tel. ++49-531-592-6110 Fax. ++49-531-592-6305 E-mail: Karsten.Kossert@ptb.de

Coordinator's Report - ICRM Life Science Working Group

The purpose of the Life Sciences Working Group is to provide a forum for ICRM members to address radionuclide metrology issues as they relate to the life sciences. Issues may include, but are not limited to: development of methodologies to calibrate short-lived radionuclides of interest in nuclear medicine, measurement of decay properties (half-lives, decay energies and probabilities, etc.) of radionuclides used in nuclear medicine and biological research, and development of measurement methodologies for transferring National Measurement Standards to the clinic and research laboratory. The Working Group will facilitate finding solutions to these problems through workshops, publications, electronic communications (i.e., email), and collaborative work.

The most recent meeting of the Life Sciences Working Group (LSWG) was held in, Braunschweig, Germany on 28-29 November 2012, at the Physikalisch-Technische Bundesanstalt (PTB).

Status of action items:

- ⁶⁸Ge/⁶⁸Ga comparison: Details of the proposed solution were presented at PTB. The comparison has been designated CCRI(II)-K2.Ge-68 by the KCWG(II).
- Investigate Monte Carlo simulation of ionization chamber response to beta-emitters: A session of the interim meeting was devoted to this topic. Two complementary presentations were made. Discussion indicated that better beta spectra were needed as well as understanding of the bremsstrahlung spectrum. The possibility of a comparison of a simple model was discussed. An informal subcommittee was formed to pursue the topic.
- Collecting activity calibrator factors for medical radionuclides in different ionization chambers: Results of this effort will be presented in Antwerp.
- <u>Sharing of software for automation of radionuclide calibrators (new)</u>: Individuals who have developed freely available software for this purpose are requested to provide that software to the coordinator, for distribution to the LSWG.
- <u>Comparison of ⁹⁰Y with portable TDCR (new)</u>: This comparison was proposed in support of the MetroMRT joint research project of the European Metrology Research Programme.
- <u>Compile a list of comparisons in nuclear medicine (new)</u>: The proposed list would serve as a basis for future reviews of similar comparisons. Please forward publication to the coordinator for inclusion in the list.
- <u>Create repository for information on dissolution of microspheres (new)</u>: This action would support MetroMRT. Please submit methods and experience to the coordinator.

The next meeting of the LSWG is planned be held during the next ICRM congress held in Antwerp, Belgium on June 17-20, 2013. A report on the PTB interim meeting will be given. Additional topics of discussion being considered include Monte Carlo simulation of ionization chamber response to beta-emitters. Those laboratories working in this area or having any other work they wish to present are requested to contact the coordinator.

The LSWG web page may be found here: http://physics.nist.gov/ICRM/working_groups.html#LS

J.T. Cessna, Coordinator

National Institute of Standards and Technology 100 Bureau Dr., Stop 8462 Gaithersburg, MD 20899-8462, USA jeffrey.cessna@nist.gov Phone: +1 301 975 5539 Fax: +1 301 926 7416

Coordinator's Report Low Level Measurement Techniques Working Group

There is no clear definition to what we mean by "low-level" and there are different definitions in different fields. Here we mostly mean "activities found naturally in the environment". That means massic activities in the order of Bq/kg or absolute activities below some Bq, generally in the mBq range. However, in recent years there have been more ICRM papers in fields like decommissioning, radioactive waste management and monitoring of metal scrap, where "low level" means at or near the clearance levels. For specific samples, this could mean activities in the kBq range and for certain waste we are talking about MBq levels. This means that in this WG we are dealing with techniques that push the limits in background going down to measure μ Bq levels, but we also deal with developing fast measurement techniques for activities in the Bq to kBq range.

The recent years have seen developments in different low level fields. The underground laboratories pushing for the lowest limits continue to grow in number. The EMRP projects have stimulated developments of e.g. various techniques for better characterising nuclear waste near clearance levels. The Fukushima accident led to new developments of rapid measurement devices as well as radioecological studies world-wide. Furthermore, monitoring networks like CTBTO, which relies to a large extent on low-level techniques have started to make a significant impact world-wide.

The by far biggest event in the past year for this WG was the organisation of the ICRM-LLRMT'12 conference at Jeju island in Korea September 17-21. The conference was excellently organised by KRISS and therefore many thanks to the hard working organiser Tae Soon Park and head of conference secretariat Sang Han Lee and their teams. In spite of the typhoon "Sanba", which struck Jeju island at the start of the conference, 125 participants turned up. The conference held a special session on measurements following the Fukushima accident and also a workshop on matrix radionuclide CRM production, led by Ken Inn from NIST.

During the conference in Korea, I had the honour of taking over as WG coordinator from Dirk Arnold, PTB, who has been leading this WG since 2005. I hope to continue in Dirk's footstep and organise this WG in an impeccable way. I am glad to have been able to receive his support during these first months after taking over.

The next Working Group meeting will take place at the ICRM 2013 conference in Antwerp, Belgium. Looking further ahead, it is foreseen to organise the next ICRM-LLRMT conference in 2016 but it is not yet decided where it will be held.

Mikael Hult

EC-JRC-IRMM Retieseweg 111 B-2440 Geel Belgium <u>Mikael.hult@ec.europa.eu</u> Phone +32 14 571269

CONTRIBUTIONS

LABORATORY	RADIOISOTOPE METROLOGY LABORATORY - CNEA, ARGENTINA		
NAMES	P. ARENILLAS, R. BIANCHINI, C. BALPARDO, S. CONSORTI, M. ROLDAN, R. LLOVERA, M. LOBO		
ACTIVITY	 Absolute activity measurements. Participation in international comparisons. Operation of a Tandem FN accelerator mainly for AMS (in progress). 		
KEYWORDS	Alpha spectrometry, beta spectrometry, coincidence method, data evaluation, data measurement, gas proportional counter, liquid scintillation, NaI well counter, simulation code, TDCR counter, AMS, accelerator.		
RESULTS	 Setup of the detection stage of the accelerator facility. Participation in activity comparison of Tc-99m by SIRTI (instrument transfer). 		
PUBLICATIONS	"Standardization of Ga-68 by Coincidence Measurements, Liquid Scintillation Counting and $4\pi\gamma$ Counting". Miguel Roteta, Virginia Peyres, Leonor Rodríguez Barquero, Eduardo García-Toraño*, Pablo Arenillas, Christian Balpardo, Darío Rodrígues, Roberto Llovera.		
IN PROGRESS	 Application of the Anticoincidence Counting and Correlations Technique. Standardization of several radionuclides. Efficiency Monte – Carlo calculations of a (HP)Ge detector and a 4π- gamma detector. New TDCR system based on hybrid PMT. Implementation of a new 4 channels ULS-TAR module for TDCR and coincidences system. Radionuclides measurements at the accelerator facility. 		
INFORMATION			
SOURCE IN PREPARATION	"Standardization of 18F by Digital beta(LS)-gamma Coincidence Counting" Rodrigues D., Balpardo C., Cassete P., Arenillas P., Capoulat M. E., Cerutti G., García-Toraño E		
OTHER RELATED PUBLICATIONS			
ADDRESS	Comisión Nacional de Energía Atómica, Centro Atómico Ezeiza. Av. del Libertador 8250 (C.P.1429) - Buenos Aires - ARGENTINA Telephone/Fax: (54-11) 6779-8279/8554 e-mail: arenilla@cae.cnea.gov.ar		
CONTACT	P. A. ARENILLAS		

LABORATORY	RADIOISOTOPE METROLOGY LABORATORY - CNEA, ARGENTINA	
NAMES	G.L. CERUTTI, C. GUARDO, E. CIRELLO, L. RAMÍREZ.	
ACTIVITY	Measurement of natural and artificial radionuclides in environmental samples and others.	
KEYWORDS	Gross alpha determination, gross beta determination, liquid scintillation, low-level, radiochemistry, gamma spectrometry	
RESULTS	 Participation in IAEA/ALMERA environmental activity comparison (IAEA-TEL-2011-04). Activity determinations of ⁹⁰Sr in 79 samples of milk powder, maize, soybean meal, wheat, cheese, fish and meat. Activity determinations of ²⁴¹Am and ²³⁹Pu in 79 samples of milk powder, maize, soybean meal, wheat and fish. Analysis of about 215 environmental samples by high resolution gamma spectrometry. Analysis of ⁶⁰Co, Am-241 and ¹³⁷Cs by NaI(Tl) detector for surface contamination testing in about 110 samples. Routine measurements and certifications of non radioactive contamination in exported foodstuffs by high resolution gamma spectrometry (about 2000 samples). 	
PUBLICATIONS		
IN PROGRESS	Implementation of a quality system based on Guide ISO 17025.	
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS		
ADDRESS	Comisión Nacional de Energía Atómica, Centro Atómico Ezeiza. Presbítero Juan González y Aragón N°15 (B1802AYA) - Ezeiza - Buenos Aires – ARGENTINA	
CONTACT	G. L. CERUTTI e-mail: <u>cerutti@cae.cnea.gov.ar</u> Telephone/Fax: (54-11) 6779-8408	

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LABORATORY	RADIOISOTOPE METROLOGY LABORATORY - CNEA, ARGENTINA	
NAMES	G.L. CERUTTI, C.C. GUARDO.	
ACTIVITY	 Preparation, quality control, standardisation and issue of : Standard point gamma sources and solutions of several radionuclides of alpha, beta and gamma emitters. Large area standard sources of alpha, beta and gamma emitters. Development of standard sources. 	
KEYWORDS	Gamma-ray spectrometry, source preparation, radioactive standards.	
RESULTS	 Preparation and calibration of about 90 radioactive sources. Re-accreditation by ISO17025 in "Preparation and calibration of radioactive standards" by the Argentinian Accreditation Body (OAA). Participation in activity comparison of Tc-99m by SIRTI (instrument transfer). 	
PUBLICATIONS		
IN PROGRESS	 Development of simulated water standards. Development of reference materials for gamma emitters. GeHP measurement by Monte Carlo simulation. 	
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS		
ADDRESS	Comisión Nacional de Energía Atómica, Centro Atómico Ezeiza. Presbítero Juan González y Aragón N°15 (B1802AYA) - Ezeiza – Buenos Aires – ARGENTINA	
CONTACT	G. L. CERUTTI e-mail: <u>cerutti@cae.cnea.gov.ar</u> Telephone/Fax: (54-11) 6779-8408	

LABORATORY	RADIOISOTOPE METROLOGY LABORATORY - CNEA, ARGENTINA		
NAMES	C.C. GUARDO, M. ROLDAN, M. LOBO		
ACTIVITY	 Routine metrological assessment of radionuclide activimeters used in Nuclear Medicine. Preparation, quality control and standardisation of standard sources for Nuclear Medicine. Organisation of comparisons for activity measurements among Nuclear Medicine Centres in Argentina. 		
KEYWORDS	Ionisation chamber, life sciences, activimeters.		
RESULTS	 Assessment of 71 Nuclear Medicine Centre calibrators for ¹⁸F, ³²P, ⁶⁷Ga, ⁹⁰Y, ^{99m}Tc, ⁹⁹Mo, ¹¹¹In, ¹³¹I, ¹⁵³Sm.¹⁷⁷Lu. Maintenance of the accreditation of "Activimeters calibration" by the Argentinean Accreditation Body, by ISO 17025. Acquisition of a new activimeter. 		
PUBLICATIONS			
IN PROGRESS	Calibration of the LMR's new Reference Ionization Chamber		
INFORMATION			
SOURCE IN PREPARATION			
OTHER RELATED PUBLICATIONS			
ADDRESS	Comisión Nacional de Energía Atómica, Centro Atómico Ezeiza. Av. del Libertador 8250 (C.P.1429) - Buenos Aires - ARGENTINA Telephone/Fax: (54-11) 6779-8491/8554 e-mail: <u>ccguardo@cae.cnea.gov.ar</u>		
CONTACT	C. C. GUARDO		

LABORATORY	ORY BEV – Bundesamt für Eich- und Vermessungswesen, Austria	
NAMES	Scientists: Franz Josef MARINGER (Head) Robert BRETTNER-MESSLER Technician: Patrick LOBNER	
ACTIVITY	Development and operation of primary and secondary radionuclide metrology standards:	
	 Multi-wire proportional chamber for large area sources 4πγ ionisation chambers HP-Ge detectors for gamma-ray spectrometry Radon ionisation chamber 	
	Legal Metrology:	
	 Type approval of medical activity meter, surface contamination monitors, hand-foot monitors, clearance monitors Verification of medical activity meter, surface contamination monitors, hand-foot monitors, clearance monitors Calibration services for activity measurement instruments 	
	Research and Development:	
	 EMRP ENV09 Metrology for radioactive waste management MetroRWM EMRP IND04 Ionising radiation metrology for the metallurgical industry MetroMETAL 	
	Participation in international comparison:	
	 SIR BIPM-RI(II)-K2.Ba-133 CCRI(II)-S9: Measurement of the activity concentration of Cs-137 and K-40 in rice material CCRI(II)-S10: Measurement of source emission rate for the calibration of surface contamination monitors 	
	Applications:	
	 Quality management services for ionising radiation laboratories (ISO/IEC 17025) Low-level radionuclide metrology Gamma-ray spectrometry Radiation protection Radioecology Radionuclides in environmental research 	
KEYWORDS	National Metrology Institute, Radionuclide metrology, Low-level radioactivity measurement techniques	
RESULTS	 BIPM-RI(II)-K1.Ce-139 BIPM-RI(II)-K2.Ba-133 Calibration and verification of contamination monitors Calibration of thyroid monitors 	
PUBLICATIONS	F.J. Maringer, A. Baumgartner, F. Rechberger, C. Seidel, M. Stietka: Activity	

	measurement and effective dose modelling of natural radionuclides in building material. Appl. Rad Isot. (2013) (accepted)
	F J Maringer, J Šuráň, P Kovář, B Chauvenet, V Peyres, E García-Toraño, M L Cozzella, P De Felice, B Vodenik, M Hult, U Rosengård, M Merimaa, L Szücs, C Jeffery, J C J Dean, Z Tymiński, D Arnold, R Hinca, G Mirescu: Metrology for radioactive waste management: Clearance levels and acceptance criteria legislation, requirements and standards. Appl. Rad Isot. (2013) (accepted)
	M. Stietka, A. Baumgartner, C. Seidel, F.J. Maringer: Development of standard methods for activity measurement of natural radionuclides in waterworks as basis for dose and risk assessment – first results of an Austrian study. Appl. Rad Isot. (2013) (accepted)
	FJ Maringer, A Steurer: International co-operation, basic principles and on- going developments in radiation protection metrology and measurements. 13th International Congress of the International Radiation Protection Association (IRPA 13). Glasgow, 13 – 18 May 2012.
	FJ Maringer, A Baumgartner, F Rechberger, C Seidel, M Stietka: Exposure caused by natural radionuclides in building materials: current practice, regulations and radiation protection standards development. 13th International Congress of the International Radiation Protection Association (IRPA 13). Glasgow, 13 – 18 May 2012.
	C. Michotte, G. Ratel, K. Kossert, FJ Maringer: Update of the BIPM comparison BIPM.RI(II)-K1.Ce-139 of activity measurements of the radionuclide ¹³⁹ Ce to include the 2008 results of the PTB Germany and the BEV, Austria. Metrologia 48 (2011).
	D Stanga, FJ Maringer, E Ionescu. A new method for determining the efficiency of a large-area beta sources constructed from anodized aluminium foils. Appl Rad Isot 69 (2011) 227-230.
	Seidel, C; Baumgartner, A; Ringer, W; Gräser, J; Friedmann, H; Kaineder, H; Maringer, FJ: Soil gas radon measurements in a region of the Bohemian Massif: investigations in the framework of an Austrian pilot study. Radiat Prot Dosimetry. 2011; 145(2-3):329-332.
	Baumgartner, C. Hranitzky, H. Stadtmann, FJ. Maringer: Determination of photon fluence spectra from a ⁶⁰ CO therapy unit based on PENELOPE and MCNP simulations. Rad Measur 46 (2011), 595 -601.
IN PROGRESS	Co-operations in research, applications and university courses:
	 EMRP IND57 Metrology for processing materials with high natural radioactivity MetroNORM EMRP Call 2013
	 IAEA – Radioactive Waste Management, Radon IRPA (Internat. Radiation Protection Association): radiation protection
	 CEN – Natural radioactivity of building materials BOKU (University of Natural Resources and Life Science Vienna): radioecology, natural radiation environment TU VIE (Technical University of Vienna): radiation physics, radiation protection, dosimetry
	 AIT (Austrian Institute of Technology): environmental isotopes SEIB (Seibersdorf Laboratories GmbH): radiation protection ÖVS (Austrian Radiation Protection Association): radiation

	 protection ASI (Austrian Standards Institute): Low-level radioactivity measurements working group
INFORMATION	82 CMCs for radioactivity measurement calibration services
SOURCE IN PREPARATION	Planned radionuclide comparisons in BIPM SIR / CCRI(II).K: Tl-201, Lu-177, Pb-210
OTHER RELATED PUBLICATIONS	Hino, Y, De Felice, P, Wätjen, U, Maringer, FJ (edts.): Proceedings of the 18th International Conference on Radionuclide Metrology and its Applications. Appl Rad Isot 70(9), 2012.
	Andreas Baumgartner, Andreas Steurer, Franz Josef Maringer: Radiation protection of patients: status of primary standard dosimetry of high-energy photon and electron beams in Austria. 13th International Congress of the International Radiation Protection Association (IRPA 13). Glasgow, 13 – 18 May 2012.
	Baumgartner, A; Steurer, A; Tiefenböck, W; Gabris, F; Maringer, FJ; Kapsch, RP; Stucki, G: Reevaluation of correction factors of a primary standard graphite calorimeter in ⁶⁰ Co gamma ray beams as a basis for the appointment of the BEV absorbed dose rate to water reference value. Radiat Prot Dosimetry. 2011; 145(1): 3-12. DOI 10.1016/j.radmeas.2011.04.024.
ADDRESS	BEV – Bundesamt für Eich- und Vermessungswesen Section Ionising Radiation and Radioactivity Arltgasse 35, 1160 Wien, Austria
CONTACT	Prof. Dr. Franz Josef Maringer Tel.: +43 1 21110 6372 Fax: +43 1 21110 6000 E-mail: <u>franz-josef.maringer@bev.gv.at</u> www.bev.gv.at

LABORATORY	European Commission - Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Standards for Nuclear Safety, Security and Safeguards Unit Radionuclide Metrology Sector
NAMES	T. Altzitzoglou, A. Rozkov
ACTIVITY	 * Liquid Scintillation Counting * Gamma-ray spectrometry * Primary and secondary standardization and nuclear decay data measurement
KEYWORDS	Alpha-particle spectrometry, beta-particle spectrometry, gamma-ray spectrometry, coincidence method, data measurement, environmental control, Euromet, life sciences, liquid scintillation, TDCR, CIEMAT/NIST efficiency tracing, low-level, simulation code, SIR, ESIR, (quantitative) source preparation, traceability, X-ray spectrometry
RESULTS	* International comparison for the activity measurement of ¹⁷⁷ Lu
NESOL IS	* Feasibility study for the development of plutonium reference materials for age dating in nuclear forensics.
	* Intercomparison of Methods for Coincidence Summing Corrections in Gamma-Ray Spectrometry; Phase 2: Volume sources.
	* Measurement of the natHf(d,x) ¹⁷⁷ Ta cross section and impact of erroneous gamma-ray intensities
	* Measurement of the ²³⁰ U half-life.
	* Training of Turkish scientists from TAEK.
PUBLICATIONS	 * S. Pommé, J. Paepen, T. Altzitzoglou, R. Van Ammel and E. Yeltepe, Measurement of the ¹⁷⁷Lu half-life, ARI 69 (2011) 1267–1273. * B. E. Zimmerman, T. Altzitzoglou, A. Arinc, E. Bakhshandeiar, D. E. Bergeron, L. Bignell, C. Bobin, M. Capogni, J. T. Cessna, M. L. Cozzella, C. J. da Silva, P. De Felice, M. S. Dias, T. Dziel, A. Fazio, R. Fitzgerald, A. Iwahara, F. Jaubert, L. Johansson, J. Keightley, M. F. Koskinas, K. Kossert, J. Lubbe, L. Mo, O. Nähle, O. Ott, J. Paepen, S. Pommé, M. Sahagia, B. R. S. Simpson, F. F. V. Silva, R. van Ammel, M. J. van Staden, W. M. van Wyngaardt, and I. M. Yamazaki, Results of an international comparison for the activity measurement of ¹⁷⁷Lu, ARI 70 (2012) 1825-1830. * MC. Lépy et al., Intercomparison of methods for coincidence summing corrections in gamma-ray spectrometry – Part II (Volume sources), ARI 70 (2012) 2112-2118.
IN PROGRESS	 * Standardization of ¹²⁹I and ^{166m}Ho (EMRP MetroRWM project). * Development of TDCR Liquid Scintillation Counter.
INFORMATION	http://irmm.jrc.ec.europa.eu/activities/radionuclide_metrology/Pages/index.aspx
ADDRESS	European Commission Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Retieseweg 111, B-2440 Geel, Belgium Tel. +32 14 571 266 - Fax +32 14 584 273 e-mail: <u>timotheos.altzitzoglou@ec.europa.eu</u>
CONTACT	Timos Altzitzoglou

LABORATORY	European Commission - Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Standards for Nuclear Safety, Security and Safeguards Unit Radionuclide Metrology Sector
NAMES	Mikael Hult, Gerd Marissens, Erica Andreotti (2012), Guillaume Lutter, Ayhan Yüksel (2012), Faidra Tzika
ACTIVITY	Ultra low-background gamma-ray spectrometry
APPARATUS	Eleven HPGe-detectors for ultra low level gamma-ray spectrometry in the underground laboratory HADES. Two low-background HPGe-detectors above ground. One low-background NaI well (+plug) for Compton suppression. Two special lead/copper shields enabling multiple detector configurations.
KEYWORDS	Anti-coincidence method, gamma-ray spectrometry, low-level, NaI well-type counter, neutron measurement, EGS4
RESULTS	* Experiment at the TEXTOR Tokamak aiming at quantifying the proton flux
	* Improved half-life limit of (i) double beta decay in ¹¹⁰ Pd and ¹⁰² Pd, (ii) alpha decay in ¹⁵¹ Eu and (iii) the 155 eV β ⁻ decay in ¹¹⁵ In
	* Radiopurity measurements of materials for the GERDA experiment
	* Design of an underground area for measuring deadlayer-thicknesses, pulse- shapes and testing of GERDA Phase II crystals
	* Ultra low-background detector development in HADES; material selection and installation of an HPGe-detector with an inverted arm
	* Characterisation of CeBr ₃ scintillation detectors
	* Underground measurements of Pacific sea water samples following the Fukushima accident
	* Analysis of the ${}^{50}Cr(n,t){}^{48}V$ cross section
PUBLICATIONS	* Gasparro J, Hult M, Marissens G, Hoshi M, Tanaka K, Endo S, Laubenstein M, Dombrowski H, Arnold D. Measurements of 60Co in massive steel samples exposed to the Hiroshima atomic bomb explosion, Health Physics 102 (2012) 400–409; doi:10.1097/HP.0b013e31823a172e
	 * Hult M, Andreotti E, González de Orduña R, Pommé S, Yeltepe E. Quantification of uranium-238 in environmental samples using gamma-ray spectrometry. Proceedings of ER2010 - Environmental Radioactivity New Frontiers and Developments Vol. 104 (2012). Ed. W. Plastino and P.P. Povinec, Rome, p. XXXIII + 464, ISBN 978-88-7438-069-5. Italian Physical Society
	* Lutter G., Hult M, Billnert R, Oberstedt A, Oberstedt S, Andreotti E, Marissens G, Rosengard U and Tzika F. Radiopurity ofaCeBr ₃ crystal used as scintillation detector, NIM A 703 (2013) 158–162
	 * M. Agostini, L. Baudis, E. Bellotti, R. Brugnera, D. Budjáš, C. Cattadori, A. di Vacri, A. Garfagnini, S. Georgi, R. Gonzáles de Orduña, P. Grabmayr, A. Hegai, M. Hult, J. Jochum, V. Kornoukhov, L. Pandola, G. Pivato, S. Schönert, M. Tarka, C. Ur, K. Zuber. Procurement, production and testing of BEGe detectors depleted in 76Ge, Nucl. Phys. B (Proc. Suppl.) 489 (2012) 229–232

	* G. Bonheure et al. First fusion proton measurements in TEXTOR plasmas using activation technique, Rev. Sci. Instrum. 83, 10D318 (2012); http://dx.doi.org/10.1063/1.4739228
	* Danevich F.A., Andreotti E., Hult M., Marissens G., Tretyak V.I. and Yüksel A. Search for the α decay of ¹⁵¹ Eu to the first excited level of ¹⁴⁷ Pm using underground γ -ray spectrometr, Europ. Phys. J. A 48 (2012) 157-162
	* G. Bonheure, M. Hult, R. González de Orduña et al. Experimental investigation of d(³ He,p)α and d(d,p)t fusion reaction products confinement in JET, Nucl. Fusion 52 (2012) 083004; doi:10.1088/0029- 5515/52/8/083004
	* Andreotti E, Hult M, Marissens G, González de Orduña R. Study of the double beta decays of ⁹⁶ Ru and ¹⁰⁴ Ru, ARI 70 (2012) 1985-1989
	 * Andreotti E, Hult M, Marissens G, González de Orduña R, Wieslander E, Misiaszek M. The half-life of the beta decay ¹¹⁵In (9/2+) → ¹¹⁵Sn (3/2+) Phys. Rev. C 84 (2011) 044605 (1-8)
	* Hult M, Marissens G, Sahin N, Hoshi M, Hasai H, Shizuma K, Tanaka K and Endo S. Distribution of ⁶⁰ Co in steel samples from Hiroshima, ARI 70 (2012) 1974–1976
IN PROGRESS	* 1-mm resolution depth distribution of ⁶⁰ Co in Hiroshima steel
	* Certification of post-Fukushima Japanese brown rice CRM
	* EMRP projects: MetroMetal, MetroRWM and metroNORM
	* Post-Fukushima measurements of Pacific Ocean
	* Decay data for long-lived radionuclides like ¹⁷⁶ Lu and ¹¹⁵ In in $InCl_3$
	* Characterisation of HPGe-deadlayers using a source scanner
	* Finalisation of GERDA Phase II crystals enriched to 86% in 76 Ge
INFORMATION	http://irmm.jrc.ec.europa.eu/activities/radionuclide metrology/Pages/index.aspx
ADDRESS	European Commission Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Retieseweg 111, B-2440 Geel, Belgium Tel. +32 14 571 269 - Fax +32 14 584 273
CONTACT	Mikael Hult
LABORATORY	European Commission - Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Standards for Nuclear Safety, Security and Safeguards Unit Radionuclide Metrology Sector
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NAMES	S. Pommé, M. Marouli, G. Suliman, T. Altzitzoglou, R. Van Ammel, J. Paepen, H. Stroh, V. Jobbágy, U. Wätjen
ACTIVITY	Primary standardisation of activity and measurement of nuclear decay data
KEYWORDS	Alpha-particle spectrometry, coincidence counting, 4π CsI(Tl)-sandwich spectrometer, defined solid angle (alpha-particle and X-ray) counting, gamma-ray spectrometry, gas proportional counting (atmospheric, pressurised), ionisation chamber, liquid scintillation counting, NaI well-type counters, X-ray spectrometry, simulation code, SIR, source preparation (quantitative drop deposition, IRMM source drying device, vacuum evaporation and electrodeposition), traceability, data evaluation, data measurement, Euramet projects, life sciences
RESULTS	* Measurement of half-lives of ²³⁰ U decay series and ²²⁵ Ac, ²²¹ Fr, ²¹⁷ At, ²¹³ Bi, ²¹³ Po and ²⁰⁹ Pb
	* High-resolution alpha-particle spectrometry of ²³⁰ U/ ²²⁶ Th decay series, ²²⁵ Ac/ ²¹³ Bi decay series and ²³⁶ U
	* Construction of γ - and n-emitting irradiators for testing of radiation monitors
	* Remediating error in ¹⁷⁷ Ta production cross sections (p and d induced)
	* Construction of magnet system to reduce coincidence effects in ^{238,236} U high-resolution alpha-particle spectrometry
	* Training of Turkish metrologists from TAEK
PUBLICATIONS	S. Pommé, STEFFY – Software for calculation of nuclide-specific total counting efficiency in well-type γ -ray detectors, ARI 70 (2012) 2070-2074
	S. Pommé, G. Suliman, M. Marouli, R. Van Ammel, V. Jobbagy, J. Paepen, H. Stroh, C. Apostolidis, K. Abbas, A. Morgenstern, Measurement of the ²²⁶ Th and ²²² Ra half-lives, ARI 70 (2012) 1913-1918
	S. Pommé, T. Altzitzoglou, R. Van Ammel, G. Suliman, M. Marouli, V. Jobbagy, J. Paepen, H. Stroh, C. Apostolidis, K. Abbas, A. Morgenstern, Measurement of the ²³⁰ U half-life, ARI (2012) 1900-1906
	G. Suliman, S. Pommé, M. Marouli, R. Van Ammel, V. Jobbagy, J. Paepen, H. Stroh, C. Apostolidis, K. Abbas, A. Morgenstern, Measurements of the half-life of ²¹⁴ Po and ²¹⁸ Rn using digital electronics, ARI 70 (2012) 1907-1912
	M. Marouli, S. Pommé, J. Paepen, R. Van Ammel, V. Jobbagy, A. Dirican, G. Suliman, H. Stroh, C. Apostolidis, K. Abbas, A. Morgenstern, High-resolution alpha-particle spectrometry of the ²³⁰ U decay series, ARI 70 (2012) 2270-2274
	A. Dirican, P. E. Erden, M. Seferinoğlu, S. Pommé, Use of solid angle for alpha detector efficiency in ²²⁶ Ra analyses of soil samples, ARI 70 (2012) 2260-2262
	F. Simonelli, K. Abbas, A. Bulgheroni, S. Pommé, T. Altzitzoglou, G. Suliman, Measurement of the $^{nat}Hf(d,x)^{177}Ta$ cross section and impact of erroneous gamma-ray intensities, NIM B 285 (2012) 162-164

	S. Pommé, M. Marouli, G. Suliman, H. Dikmen, R. Van Ammel, V. Jobbágy, A. Dirican, H. Stroh, J. Paepen, F. Bruchertseifer, C. Apostolidis, A. Morgenstern, Measurement of the ²²⁵ Ac half-life, ARI 70 (2012) 2608-2614
	uncertainty and degrees of equivalence – for CCRI(II) key comparison data, JRC Scientific and Policy Reports, EUR 25355 EN, EUR – Scientific and Technical Research series - ISSN 1831-9424 (online), ISSN 1018-5593 (print), ISBN 978-92-79-25104-7, doi:10.2787/61338 2012, 2012
IN PROGRESS	Half-life determination of ²³⁵ U, ²³⁸ U, ²² Na, ¹³⁴ Cs, ⁵⁵ Fe
	Alpha-particle spectrometry of ^{233,238} U (MetroFission)
	Development of a new reference ionisation chamber
	Standardisation/half-life of ¹²⁹ I, ^{166m} Ho (MetroRWM)
	Decay data measurements on ²³⁵ U, ²²⁷ Ac, ²²⁶ Ra (MetroNORM)
	Manuscripts on uncertainty calculation in radionuclide metrology
INFORMATION	http://irmm.jrc.ec.europa.eu/activities/radionuclide_metrology/Pages/index.aspx
SOURCE IN PREPARATION	M. Marouli, G. Suliman, S. Pommé, R. Van Ammel, V. Jobbágy, A. Dirican, H. Stroh, H. Dikmen, J. Paepen, F. Bruchertseifer, C. Apostolidis, A. Morgenstern, Decay data measurements on ²¹³ Bi using recoil atoms, ARI (2013)
	G. Suliman, S. Pommé, M. Marouli, R. Van Ammel, H. Stroh, V. Jobbágy, J. Paepen, A. Dirican, F. Bruchertseifer, C. Apostolidis, A. Morgenstern, Half- lives of ²²¹ Fr, ²¹⁷ At, ²¹³ Bi, ²¹³ Po and ²⁰⁹ Pb from the ²²⁵ Ac decay series, ARI (2013)
	V. Jobbágy, M. T. Crespo, R. Van Ammel, M. Marouli, A. Moens, S. Pommé, E. García-Toraño, Preparation of high-resolution ²³⁸ U α-sources by electrodeposition: a comprehensive study, ARI (2013)
ADDRESS	European Commission Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Retieseweg 111, B-2440 Geel, Belgium Tel. +32 14 571 289 - Fax +32 14 584 273
	e-mail: stefaan.pomme@ec.europa.eu
CONTACT	Stefaan Pommé

LABORATORY	European Commission - Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Standards for Nuclear Safety, Security and Safeguards Unit Radionuclide Metrology Sector
NAMES	U. Wätjen, J. Merešová, V. Jobbágy, T. Altzitzoglou
ACTIVITY	* development of reference materials
	* organisation of measurement comparisons for EU member state laboratories monitoring radioactivity in the environment and food (ICS-REM)
	* Training of young researchers from EU Enlargement&Integration countries in radiochemistry and radioactivity measurement methods
	* Training of Turkish scientists from TAEK and universities
APPARATUS	facilities for radiochemical separations; large solid angle α -particle spectrometers; gross α -/ β - proportional counter; primary standardisation equipment when needed; HPGe detector systems and LSC when needed
KEYWORDS	Intercomparisons, proficiency tests, reference materials, traceability, environmental monitoring, life sciences, source preparation, radiochemistry, low-level, liquid scintillation, alpha spectrometry, beta spectrometry, gamma-ray spectrometry
RESULTS	* European Union comparison on the determination of ⁹⁰ Sr, ¹³⁷ Cs and ⁴⁰ K in dried bilberries by monitoring laboratories
	* EU comparison on the determination of gross α -/ β -activity in water by monitoring laboratories
	* Supplementary comparison CCRI(II)-S8 "dried bilberries"
PUBLICATIONS	* J. Merešová, U. Wätjen, T. Altzitzoglou, Determination of natural and anthropogenic radionuclides in soil – results of an European Union comparison, ARI 70 (2012) 1836-1842
	* U. Wätjen, T. Altzitzoglou, A. Ceccatelli, H. Dikmen, H. Emteborg, L. Ferreux, C. Frechou, L. García, J. La Rosa, A. Luca, Y. Moreno, P. Oropesa, Y.Ö. Özkök, S. Pierre, M. Schmiedel, Y. Spasova, Z. Szántó, L. Szücs, K. Trothe, H. Wershofen, Ü. Yücel, Results of an international comparison for the determination of radionuclide activity in bilberry material, ARI 70 (2012) 1843-1849
	* Y. Hino, P. De Felice, U. Wätjen and F.J. Maringer (guest editors), ICRM2011 Proceedings of the 18 th International Conference on Radionuclide Metrology and its Applications (19-23 September 2011, Tsukuba, Japan), ARI 70, issue 9 (2012) 1809-2274
IN PROGRESS	* Evaluation of EU comparison on gross α -/ β -determination in water
	* Supplementary comparison report CCRI(II)-S8
	* Certification report CRM IRMM-426: ⁹⁰ Sr, ¹³⁷ Cs and ⁴⁰ K in dried bilberries
INFORMATION	http://irmm.jrc.ec.europa.eu/activities/radionuclide_metrology/Pages/index.aspx
OTHER RELATED PUBLICATIONS	Y. Spasova, U. Wätjen, L. Benedik, M. Vasile, T. Altzitzoglou, M. Beyermann, Evaluation of EC comparison on the determination of ²²⁶ Ra, ²²⁸ Ra, ²³⁴ U and ²³⁸ U in mineral waters, JRC Scientific and Technical Report EUR 24694 EN (2011), ISSN 1018-5593, ISBN 978-92-79-19069-8

	J. Merešová, U. Wätjen, T. Altzitzoglou, Evaluation of EC interlaboratory comparison on radionuclides in soil, JRC Scientific and Policy Report EUR 25360 EN (2012), ISSN 1831-9424, ISBN 978-92-79-25111-5
	J. Merešová, U. Wätjen, Evaluation of EC interlaboratory comparison on the determination of ⁹⁰ Sr, ¹³⁷ Cs and ⁴⁰ K in dried bilberries, JRC Scientific and Policy Report EUR xxxxx EN (in preparation)
ADDRESS	European Commission Joint Research Centre Institute for Reference Materials and Measurements (IRMM) Retieseweg 111, B-2440 Geel, Belgium Tel. +32 14 571 266 - Fax +32 14 584 273 e-mail: <u>uwe.waetjen@ec.europa.eu</u>
CONTACT	Uwe Wätjen

LABORATORY	SCK·CEN, Low Level Radioactivity Measurements
NAMES	M. Bruggeman, C. Hurtgen, F. Verrezen, P. Vermaercke, T. Vidmar, F. Farina, L. Sneyers, L. Verheyen, K. Smits
ACTIVITY	Gross alpha and beta, ³ H, ¹⁴ C, ⁸⁹⁻⁹⁰ Sr, ¹³¹ I, ²¹⁰ Po, ²²⁶ Ra, actinides and gamma activity measurements in environmental samples
	Assay of actinides (Th, U, Pu, Am) in biological samples (urine, faeces) and environmental samples (water, sediment, soil) by alpha spectrometry and by KPA for U.
	Gamma-spectrometry, Preparation of Radioactive Standards, Neutron activation analysis with relative NAA and k ₀ – method
KEYWORDS	Alpha spectrometry, measurement, environmental control, gas proportional counter, liquid scintillation, low-level, radiochemistry, coincidence counting, gamma-ray spectrometry, ionisation chamber, low-level, NaI well counter, neutron measurement, simulation code, source preparation, X-ray spectrometry.
RESULTS	Upgrading of EFFTRAN with detailed X-X and X-γ coincidence summing corrections for application in extended range and broad energy HPGe detectors;
	γ -ray sample self-shielding correction method based on a multi energy γ -transmission experiment and subsequent determination of an equivalent matrix composition for use in generic efficiency transfer by selecting the matrix.
	Spread sheet application to set up uncertainty budgets for different counting vials in γ -ray spectrometry as a function of energy, resulting in low- and high-energy uncertainty polynomials, to be used in Genie's detection efficiency covariance matrix.
	Determination of k_0 factors for various elements to be used in neutron activation analysis
PUBLICATIONS	Erica Andreotti, Mikael Hult, Gerd Marissens, Raquel Gonzalez de Orduña, Peter Vermaercke: Study of the double beta decays of 96Ru and 104Ru, In: Applied Radiation and Isotopes 70 (2012) 1985–1989
	G. Bonheure, M. Hult, R Gonzalez de Orduña, D. Arnold, H. Dombrowski, M. Laubenstein, E. Wieslander, T. Vidmar, P. Vermaercke, et all: Experimental investigation of the confinement of $d(3He,p)\alpha$ and $d(d,p)t$ fusion reaction products in JET, In : Nucl. Fusion 52 (2012) 083004 (10pp)
	F. Farina Arboccò, P. Vermaercke, L. Sneyers & K. Strijckmans: Experimental validation of some thermal neutron self-shielding calculation methods for cylindrical samples in INAA, In:, J Radioanal Nucl Chem (2012) 291:529-534 DOI 10.1007/s10967-011-1211-y
IN PROGRESS	Study on gelation of water samples to homogenise heterogeneous waters containing particles in suspension.
	Implementation of Rn-222 analysis with LSC for drinking waters and comparison with the Lucas cell method.
	Study the effect of acidification of samples and the use of automated samplers that do not allow the use of acids.

ADDRESS	Low Level Radioactivity Measurements
	SCK•CEN
	Boeretang 200
	B-2400 Mol Belgium
	Telephone: (+32-14) 33 28 86
	E-mail: <u>mbruggem@sckcen.be</u>
	Web: <u>http://www.sckcen.be/lrm</u>
CONTACT	Michel Bruggeman, Freddy Verrezen

LABORATORY	SCK•CEN, Radio-Chemical Analysis laboratories (RCA)
NAMES	L. Adriaensen, M. Gysemans
ACTIVITY	Destructive radiochemical analysis of spent fuels for the determination of burn-up and for spent fuel characterization programs
	Determination of Pu concentration in MOX fuels (accredited according to ISO17025).
	Radiochemical analysis of long-lived and radiotoxic nuclides in various types of radioactive waste such as resins, evaporator concentrates, filters, incinerator ashes
	Study of separation chemistry of actinides and specific radionuclides
	Radiochemical analysis of reactor dosimeters and irradiated reactor materials.
KEYWORDS	Alpha spectrometry, beta spectrometry, gamma-ray spectrometry, low-level, Nal well-type counter, radiochemistry, source preparation
RESULTS	Burn-up determination for the CHIPS program.
	Dissolution, separation and analysis of Cl-36, I-129 and Tc-99 in resin materials
SOURCE IN PREPARATION	Dissolution, separation and analysis of ³⁶ Cl in radioactive concrete or metal samples
	Microwave and high pressure dissolution of different types of waste materials
ADDRESS	Radio-Chemical Analysis SCK•CEN Boeretang 200, B-2400 Mol, Belgium Telephone: (+32-14) 33 32 26 Fax: (+32-14) 32 07 55
	E-mail: <u>ladriaen@sckcen.be</u>
CONTACT	L. Adriaensen

LABORATORY	Bureau International des Poids et Mesures
NAMES	C. Michotte, M. Nonis
ACTIVITY	International comparisons of short-lived radionuclides using the SIR transfer instrument (SIRTI)
KEYWORDS	life sciences, NaI well-type counter, transfer instrument of the SIR, traceability, Tc-99m, F-18, nuclear medicine
RESULTS	In 2012, Tc-99m activity comparisons (BIPM.RI(II)-K4.Tc-99m) were carried out at NIM, China and CNEA, Argentina. The NIM used an IC calibrated by coincidence counting (draft B to be published) and the CNEA used a Ge detector (draft A to be prepared).
PUBLICATIONS	Michotte C., Sato Y., Unno Y., Yunoki A., Activity measurements of the radionuclide ^{99m} Tc for the NMIJ, Japan, in the ongoing comparison BIPM.RI(II)-K4.Tc-99m, <i>Metrologia</i> , 2012, 49 , <i>Tech. Suppl.</i> , 06013.
IN PROGRESS	Extension of the SIRTI for F-18: development of new NI scalers, stability and reproducibility, Monte-Carlo simulation of β^+ particles, calibration against the SIR.
	Preparation for the Tc-99m comparison at LNMRI, Brazil.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	BIPM, Pavillon de Breteuil, 12bis grande rue, F-92 312 Sèvres Cedex
CONTACT	Carine Michotte, <u>cmichotte@bipm.org</u>

LABORATORY	Bureau International des Poids et Mesures
NAMES	G. Ratel, et al.
ACTIVITY	Measurements in view of extending the SIR to beta emitters
KEYWORDS	beta spectrometry, liquid scintillation, extension of the SIR, radionuclide Ni-63
RESULTS	Measurements of Ni-63 sources from ENEA, IRMM, LNE-LNHB, NIST, NMISA, NPL, PTB and RC with commercial LS counters and TDCR spectrometers completed
PUBLICATIONS	In preparation : presentation for the ICRM 2013 conference in Geel
IN PROGRESS	Paper under completion
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	BIPM, Pavillon de Breteuil, 12bis Grande Rue, F- 92312 Sèvres Cedex
CONTACT	Guy Ratel; gratel@bipm.org

LABORATORY	Bureau International des Poids et Mesures
NAMES	G. Ratel and P. Cassette
ACTIVITY	Comparison of several experimental methods to evaluate the quenching level of a solution
KEYWORDS	beta spectrometry, liquid scintillation, extension of the SIR, radionuclide 63Ni
RESULTS	Measurements of Ni-63, Tc-99 and H-3 sources using the BIPM TDCR facility and the LNE-LNHB TDCR with a Compton spectrometer completed
PUBLICATIONS	In preparation: presentation for the LSC 2013 conference in Barcelona
IN PROGRESS	Analysis under completion
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	BIPM, Pavillon de Breteuil, 12bis Grande Rue, F- 92312 Sèvres Cedex
CONTACT	Guy Ratel; gratel@bipm.org

LABORATORY	Bureau International des Poids et Mesures
NAMES	G. Ratel and M. Nonis
ACTIVITY	Realization of a new TDCR facility enabling external Compton spectrometry for determination of the quenching level of solutions
KEYWORDS	beta spectrometry, liquid scintillation, extension of the SIR, Compton spectrometry
RESULTS	
PUBLICATIONS	
IN PROGRESS	Work in progress: facility designed and now being machined at the BIPM workshop
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	BIPM, Pavillon de Breteuil, 12 bis Grande Rue, F- 92312 Sèvres Cedex
CONTACT	Guy Ratel; gratel@bipm.org

LABORATORY	Bureau International des Poids et Mesures
NAMES	C. Michotte, M. Nonis
ACTIVITY	International comparisons of short-lived radionuclides using the SIR transfer instrument (SIRTI)
KEYWORDS	life sciences, NaI well-type counter, transfer instrument of the SIR, traceability, Tc-99m, F-18, nuclear medicine
RESULTS	In 2012, Tc-99m activity comparisons (BIPM.RI(II)-K4.Tc-99m) were carried out at NIM, China and CNEA, Argentina. The NIM used an IC calibrated by coincidence counting (draft B to be published) and the CNEA used a Ge detector (draft A to be prepared).
PUBLICATIONS	Michotte C., Sato Y., Unno Y., Yunoki A., Activity measurements of the radionuclide ^{99m} Tc for the NMIJ, Japan, in the ongoing comparison BIPM.RI(II)-K4.Tc-99m, <i>Metrologia</i> , 2012, 49 , <i>Tech. Suppl.</i> , 06013.
IN PROGRESS	Extension of the SIRTI for F-18: development of new NI scalers, stability and reproducibility, Monte-Carlo simulation of β^+ particles, calibration against the SIR.
	Preparation for the Tc-99m comparison at LNMRI, Brazil.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	BIPM, Pavillon de Breteuil, 12 bis grande rue, F-92 312 Sèvres Cedex
CONTACT	Carine Michotte, <u>cmichotte@bipm.org</u>

Issue 27

LNMRI/IRD radionuclide Metrology Group 2012 -2015 Progress Report and work Plan

The programmes at the National Laboratory for Ionizing Radiation Metrology (LNMRI/IRD) in the field of Radionuclide Metrology Metrology in the period of 2012-2015 were and will be focused in primary and also in the maintenance of the national radioactivity standards. We also have two programmes for guarantee the traceability in national level with hospital and low level activity measurements.

Scientists	Function
Akira Iwahara	Primary Radionuclide activity standars- coindence counting, Secundary
	Radionuclide activity standards
Adelaide Gondim	Reference Material and radiochemistry
Antônio E. De	Traceability programme with hospitals
Oliveira	
Carlos J. Da Silva	LNMRI- Technical Coordinator, Primary Radionuclide activity standars-
	Anticoindence counting, Secundary Radionuclide activity standards
Denise M. Simões	Primary Radionuclide activity standards- coincidence counting,
	Secundary Radionuclide activity standards
Jamir S. Loureiro	Liquid scintillation counting –CIEMAT/NIST and TDCR
José U. Delgado	Head of Metrology Division
Maura J. Bragança	Reference Material and radiochemistry
Paulo A. L. Da Cruz	Liquid scintillation counting –CIEMAT/NIST and TDCR
Roberto Poledna	Gamma spectrometry
Technicians	
Ronaldo L. Da Silva	Secundary Radionuclide activity standards
Regio Gomes	Sources preparation
Eduardo Veras	Sources preparation
Otavio L. Trindade	Secundary Radionuclide activity standards

The LNMRI-IRD Radionuclide Metrology staff in 2013 is the following :

Activity	IRD-LNMRI	IRD-LNMRI
-	Radionuclide Metrology	Radionuclide Metrology
	2012-2013 Progress Report	2014-2015 work plan
National QA	- Calibration service	- Calibration service
programmes and	- Preparation of radionuclide	- Preparation of radionuclide
Services	standards (liquid solutions, point	standards (liquid solutions, point
	source and spiked reference	source and spiked reference
	materials) for external users.	materials) for external users.
International	Tc-99,Ge-68, Co-60, Cs-134	Cs-137, Co-57
comparisons		
Primary	Tc-99,Ge-68, Tc-99m	Eu-152, Ru-106, Sm-153
standardization		
Membership in	-ICRM, BIPM/CCRI(II)	-ICRM, BIPM/CCRI(II)
international and		
national organisations		
Reaching activity	- Invited lectures	- Invited lectures
	- Master degree course	- Master degree course
Quality system	Maintenance the quality system	Maintenance the quality system
	based on ISO/IEC 17025	based on ISO/IEC 17025

LABORATORY	Laboratório Nacional de Metrologia das Radiações Ionizantes LNMRI/IRD/CNEN
NAMES	A. Iwahara, C. J. da Silva, A. E. de Oliveira, E. M. de Oliveira,P. A. L. da Cruz, J. dos S. Loureiro, J. U. Delgado, R. Poledna,L. Tauhata, D. S. Moreira, R. dos S. Gomes
ACTIVITY	 Participation in international comparisons Absolute activity measurements Sources supply to users Quality assurance programa for activity measurements in nuclear medicine
RESULTS	1- Primary standardization of 60 Co, 68 Ge, 99 Tc, solutions; 2-Comparative performance of $4\pi\beta$ (LSC)-(NaI(Tl) anticoincidence and $4\pi\beta$ (PC)-(NaI(Tl) coincidence systems
PUBLICATIONS	1- Rezende, E. A.; Correia, A.R. ; Iwahara, A. ; da Silva, C.J. Tauhata L. ; Poledna R. ; da Silva R.L. ; de Oliveira, E.M. ; de Oliveira, A.E. Radioactivity measurements of ¹⁷⁷ Lu, ¹¹¹¹ n and ¹²³ I by different absolute methods. Applied Radiation and Isotopes,v.70,p.2081-2086,2012.
	2- da Silva C.J.; J. S. LOUREIRO ; Delgado J.U.; Poledna R.; Moreira, D. S. ; Iwahara, A. ; Tauhata, L.; da Silva R. L.; Lopes, R.T. ; Standardization of Ho-166m and ²⁴³ Am/ ²³⁹ Np by live-timed anti-coincidence counting with extending dead time. Applied Radiation and Isotopes, v. 70, p. 2056-2059, 2012.
	3- Oliveira, E. M.; Iwahara, A.; Poledna R., ;Delgado J.U.; da Silva, C.J.; Tauhata,L. ;da Silva, R. L.; Lopes, R.T Standardization of ⁶⁵ Zn by sum-peak method. Applied Radiation and Isotopes, v. 70, p. 2087-2090, 2012.
	4- Zimmerman, B.E. ; Altzitzoglou, T. ; Antohe, A.; Arinc, A. ; Bakhshandeiar, E. ; Bergeron, D.E.; Bignell; L.; Bobin, C. Capogni, M.; Cessna, J.T.; Cozzella, M.L.; da Silva, C.J.; De Felice, P.; Dias, M.S.; Dziel, T.; Fazio, A.; Fitzgerald, R.; Iwahara, A.; Jaubert, F.; Johansson, L.; Keightley, J.; Koskinas, M.F.; Kossert, K.; Lubbe, J.; Luca, A. ;Mo L.; Nähle O.; Ott O.; Paepen J.; Pommé S.; Sahagia M.; Simpson B.R.S.; Silva, F.F.V.; Ammel R. van; staden M.J. Van; Wyngaardt W.M.; and Yamazaki I. M. Results of an international comparison for the activity measurement of ¹⁷⁷ Lu. Applied Radiation and Isotopes, v. 70, p. 1825-1830, 2012.
	5- de Oliveira, E.M. ; Tauhata L. ; Poledna R.; Lopes, R.T. ; Delgado J.U.; da Silva, M.A.L. ; Iwahara, A. Use of sum-peak and coincidence counting methods for activity standardization of ²² Na. Nuclear Instruments & Methods in Physics Research. Section A,

(Print), v. 687, p. 69-74, 2012.

Accelerators, Spectrometers, Detectors and Associated Equipment

(SA1/SA2)

	 6- Chaves, Tainá Olivieria ; Iwahara, Akira ; Tauhata, Luiz ; Rezende, Eduarda Alexandre ; Correia, Amanda Ribeiro ; Oliveira, Estela Maria . Calibration of the LNMRI Secondary Standard Ionization Chamber for ¹³¹I capsules used in nuclear medicine. Journal of Radioanalytical and Nuclear Chemistry (Print), v. 293, p. 211-216, 2012. Correia, Amanda Ribeiro; Iwahara, Akira ; Tauhata, Luiz ; Rezende, Eduarda Alexandre ; Chaves, Tainá Olivieri ; de Oliveira, A.E. ; de Oliveira, E.M. Fatores de correção volumétrica na medição de atividade de ^{99m}Tc e ¹²³I em calibradores de radionuclídeos. RB. Radiologia Brasileira (Print), v. 45, p. 93- 97,2012.
IN PROGRESS	 Primary activity measurements of ¹³⁷Cs C. J. da Silva, Regio dos Santos Gomes, R. Poledna Primary activity measurements of ^{99m}Tc A. Iwahara, C. J. da Silva, Regio dos Santos Gomes, Paulo A. Lima da Cruz, L. tauhata, R. Poledna
ADDRESS	Instituto de Radioproteção e Dosimetria, Av. Salvador Allende, s/n, Recreio, CEP 22780-160, Rio de Janeiro, Brasil.Tel: ++55 21 2173 2879 Fax: ++55 21 2442 1605
CONTACT	A.Iwahara E-maiL: <u>iwahara@ird.gov.br</u>

	(SA1/SA2)
LABORATORY	Laboratório Nacional de Metrologia das Radiações Ionizantes LNMRI/IRD/CNEN
NAMES	E.M. de Oliveira, J.U. Delgado, M. Candida de Almeida, R. Poledna, Ronaldo L. da Silva.
ACTIVITY	 Half-life determination. Impurities study by gamma-ray spectrometry. Determination of photon emission probabilities
RESULTS	Impurities study of ¹²³ I, ¹¹¹ I and ¹⁷⁷ Lu.
PUBLICATIONS	1-da Silva, C.J. ; Iwahara, A.; Moreira, D.S.; Delgado J. U.; Gomes, R.S. ; ⁵⁷ Co half-life determination. Applied Radiation and Isotopes, v. 70, p. 1924-1926, 2012.
IN PROGRESS	 Aplication of sum peak to Reference sources for radionuclide metrological calibrations to research in nuclear programmes, M. R. Poledna, J. U. Delgado , R. L. da Silva, E. M. de Oliveira Study for application coincidence x-g method for radionuclide metrological calibrations, R. Poledna, J.U.Delgado, J. dos Santos Loureiro
ADDRESS	Instituto de Radioproteção e Dosimetria, Av. Salvador Allende, s/n, Recreio, CEP 22780-160, Rio de Janeiro, Brazil.Tel: ++55 21 2173 2873 Fax: ++55 21 2442 1605
CONTACT	J. U. Delgado EmaiL : <u>delgado@ird.gov.br</u>

Issue 27

	(SA1/SA2)
LABORATORY	Laboratório Nacional de Metrologia das Radiações Ionizantes LNMRI/IRD/CNEN
NAMES	A.C.M. Ferreira, A.E. de Oliveira , A. F. Clain, L. Tauhata, M.E.C. Vianna, M. J. C. S. de Bragança and A.M.G.F.Azeredo.
ACTIVITY	1- Preparation of the spiked sources of beta, alpha and multi- gamma emitters in water matrix;
	2-Quality assurance programa for low level activity measurements
RESULTS	1-Participation in interlaboratorial comparison, organized by CNEN / Brazil, to characterize mussel tissue which will be candidate to reference material.
PUBLICATIONS	
IN PROGRESS	Proficiency test applied on 20 years of data of the Brazilian Intercomparison Program. L.Tauhata, M.E.C.M.Vianna, A.E.de Oliveira, M.J.C. S. Bragança, A.C.Ferreira, A.F.Clain, E.M. Oliveira, C. C.Conti.
ADDRESS	Instituto de Radioproteção e Dosimetria, Av. Salvador Allende, s/n, Recreio, CEP 22780-160, Rio de Janeiro, Brazil.Tel: ++55 21 2173 2885 Fax: ++55 21 2442 1605
CONTACT	Maura J. C.S. Bragança E-maiL: <u>maura@ird.gov.br</u>

LABORATORY	Laboratory for Measurements of Low-level Radioactivity Ruđer Bošković Institute, Zagreb, Croatia
NAMES	researchers: Nada Horvatinčić, Ines Krajcar Bronić, Jadranka Barešić assistant: Andreja Sironić, Ph.D. student, technician: Anita Rajtarić
APPARATUS	LSC Quantulus 1220 System for electrolytic enrichment of water with tritium Vacuum line for benzene synthesis (¹⁴ C measurements) Vacuum line for direct absorption of CO2 Vacuum line for graphitization of samples for 14C-AMS measurement Chemistry laboratory
ACTIVITY	 Improvement of measurement techniques for radiocarbon (benzene synthesis and direct absorption, both measured by LSC technique; preparation of graphite targets for AMS ¹⁴C measurement) and tritium measurement (electrolytic enrichment and LSC measurement) Radiocarbon dating of archaeological (Neolithic, Roman period, Middle ages), geological and paleontological samples, geochronology Tritium activity measurements of natural waters (precipitation, surface and ground waters) and modelling Use of stable (²H, ¹³C, ¹⁸O) and natural radioactive isotopes (³H, ¹⁴C) in hydrogeological, paleoclimatological, environmental and ecological studies Physico-chemical and isotopic study of processes in karst environment, particularly in carbonate sediments, and water-sediment interaction Carbon isotopes (¹³C, ¹⁴C) in carbon cycle studies Speleothem formation studied by geochemical and isotopic methods and application in paleoclimatological studies Monitoring of ¹⁴C in biological samples around nuclear power plant Participation in IAEA/WMO project: "Global Network of Isotopes in Precipitation (GNIP) and Isotope Hydrology Information System (ISOHIS)". Data for stations Zagreb and Ljubljana since 1976
KEYWORDS	data evaluation, data measurement, environmental monitoring, liquid scintillation, LSC, accelerator mass spectrometry, dating, low-level, AMS, radionuclides C-14, H-3, stable isotopes H-2, C-13, O-18
RESULTS	¹⁴ C dating of charcoal and bone samples from several archaeological sites was performed. For large samples, containing >2 g of carbon, the liquid scintillation measuring techniques was used, and samples were prepared either as benzene or as CO ₂ that was subsequently absorbed in the absorption-scintillation cocktail. Small samples, containing <1 g of carbon, were prepared as graphites and measured by AMS technique. Monitoring of ³ H in precipitation and in the Sava River, as well as that of ¹⁴ C in atmospheric CO ₂ and recent plants has been continued. Carbon isotope composition (δ^{13} C and a ¹⁴ C) of various types of plants was determined. The study of lake sediments in the karst area was continued by measuring Cs-137 and Pb-210 in lake sediments.

	Denous in Contents isournels
PUBLICATIONS	 Papers in Current Contents Journals Bočić, N; Faivre, S; Kovačić, M; Horvatinčić, N. Cave development under the influence of Pleistocene glaciation in the Dinarides – an example from Štirovača Ice Cave (Velebit Mt., Croatia). Zeitschrift für Geomorphologie. 56 (2012) 409-433
	 Borozati, N.; Krajcar Bronić, I; Obelić, B; Barešić, J. Rudjer Bošković Institute radiocarbon measurements XVII. Radiocarbon 54 (2012) 137-154. Šturm, M; Vreča, P; Krajcar Bronić, I. Carbon isotopic composition (δ¹³C and ¹⁴C activity) of plant samples in the vicinity of the Slo-vene nuclear power plant. J. Environmental Radioactivity 110 (2012) 24-29.
	 Invited lectures at conferences published as paper: 1. Krajcar Bronić, I; Topić, N; Radić, I; Peković, Ž; Sironić, A. Radiocarbon dating of St. Stephen's in Pustijerna church in Dubrovnik, Croatia The Unknown Face of the Artwork / Radvan, R; Akzuy, S; Simileanu, M (eds.). Istanbul Kultur University, 2012. 27-34
	 Conference papers 1. Krajcar Bronić, I; Todorović, N; Nikolov, J; Barešić, J. Intercomparison of low-level tritium and radiocarbon measu-rements in environmental samples. RAD2012 - The First International Conference on Radiation and Dosimetry in Various Fields of Research – Proceedings, Ristić, G.(ed.). Niš, Serbia: University of Niš, 2012. 279-282
	 Conference abstracts Barešić, J; Krajcar Bronić, I; Horvatinčić, N; Obelić, B; Sironić, A; Kožar-Logar, J. Interlaboratory comparison of tritium electrolytic enrichment systems at RBI (Zagreb) and JSI (Ljubljana). IRPA13 Abstracts - 13th International Congress of the International Radiation Protection Association Glasgow: IRPA, 2012. 932. Barešić, J; Perez, G; Valiente, M; Horvatinčić, N; Obelić, B. Trace elements distribution in the sediments of the Plitvice Lakes system. Sowaeumed International Workshop: ITS2WAT-2012, Book of Abstracts Marrakech: STE Service Imane Copie, 2012. 13-14. Faivre, S; Bakran-Petricioli, T; Horvatinčić, N. Relative sea-level change in the Central Adriatic during the last 1.5 ka years Programme and abstract book ; SEQS 2012 Meeting, At the edge of the sea: sediments, geomorphology, tectonics, and stratigraphy in quaternary studies. Sassari, Sardinia, Italy, 2012. 28. Horvatinčić, N; Faivre, S; Sironić, A; Krajcar Bronić, I; Bakran-Petricioli, T. ¹⁴C dating of the biogenic littoral rims on the Adriatic islands. Abstracts book, 21 International Radiocarbon Conference. Pariz, 2012. 468. Krajcar Bronić, I; Obelić, B; Horvatinčić, N; Sironić, A; Barešić, J; Rajtarić, A; Breznik, B; Volčanšek, A. ¹⁴C activity monitoring in the vicinity of the Nuclear Power Plant Krško 2006 – 2011. RAD2012 - The First International Conference on Radiation and Dosimetry in Various Fields of Research, Book of Abstracts / Ristić, G. (ed.). Niš, Serbia: University of Niš, 2012. 107. Krajcar Bronić, I; Obelić, B; Horvatinčić, N; Sironić, A; Barešić, J; Rajtarić, A; Breznik, B; Volčanšek, A. Impact of refuelling of the Krško Nuclear Power Plant on the ¹⁴C activity in the atmosphere and plants.
	 Nuclear Power Plant on the ¹⁴C activity in the atmosphere and plants. IRPA13 Abstracts - 13th International Congress of the International Radiation Protection Association. Glasgow: IRPA, 2012. 1331 7. Krajcar Bronić, I; Topić, N; Radić, I; Peković, Ž; Sironić, A. A contribution to the history of Dubrovnik, Croatia - Radiocarbon dating of burial and charcoal samples from church of St. Stephen. Abstracts, 2012 International Symposium on Radiation Physics - ISRP 2012, Rio de Janeiro, Brazil.

	 Mandić, M; Mihevc, A; Leis, A.; Krajcar Bronić, I. Geochemical and stable isotope characterisation of drip water and modern carbonate from Postojna Cave, Slovenia. daphne DFG-Forschergruppe 4th Workshop, Abstract volume (Mangini, A.; Spoetl, Ch.; Scholtz, D.; Immerhauser, A. (eds.). Heidelberg, Germany: daphne, 2012. 65-66. Obelić, B; Krajcar Bronić, I; Horvatinčić, N; Sironić, A; Barešić, J; Rajtarić, A; Breznik, B; Volčanšek, A. Influence of refuelling of the Krško Nuclear Power Plant on environmental ¹⁴C levels. Abstracts, 2012 International Symposium on Radiation Physics - ISRP 2012, Rio de Janeiro, Brazil: IRPS, 2012. Ranogajec-Komor, M; Krajcar Bronić, I; Miljanić, S; Katušin-Ražem, B. Croatian Radiation Protection Association. 37th Annual Meeting on Radiation Protection, T. Bujtas (ed.). Budapest: Roland Eotvos Physical Society, 2012. 48. Sironić, A; Horvatinčić, N; Bikit, I; Todorović, N; Nikolov, J; Mrdja, D; Forkapić, S. Depth profiles of ¹³⁷Cs and ¹⁴C in lake sediments from the Plitvice Lakes. RAD2012 - The First International Conference on Radiation and Dosimetry in Various Fields of Research - Book of Abstracts / Ristić, G. (ed.). Niš, Serbia: University of Niš, 2012. 108. Sironić, A; Horvatinčić, N; Krajcar Bronić, I; Gulliver, P. Carbon isotopes as tracers of processes in the karst waters. Abstracts book, 21st International Radiocarbon Conference. Paris, France 2012. 298.
IN PROGRESS	• Continuous improvement of sample preparation and measurement techniques, participation in international intercomparison exercise TRIC2012 and some inter-laboratory comparisons
	• Continuous monitoring of H-3 and C-14 in environment, study of water and carbon natural cycles, anthropogenic influence on carbon cycle
	• Study of processes in karst by applying stable and radioactive isotopes, study of speleothem formation and their application in paleoclimatic studies
	Project with the National Park Plitvice Lakes: "The impact of climate changes and environmental conditions to the biologically induced precipitation of tufa and sedimentation processes in Plitvice Lakes" (2011-2013) (responsible investigator: N. Horvatinčić)
	Regional project IAEA RER/8/034 "Enhancing the characterization, preservation and protection of cultural heritage artefacts" (2012-2015)
INFORMATION	http://www.irb.hr/eng/Research/Divisions-and-Centers/Division-of- Experimental-Physics/Laboratory-for-Low-level-Radioactivities
	http://ariadne.irb.hr/en/str/zef/z3labs/lna/Projekti/
	<u>http://bib.irb.hr/</u> for project <u>098-0982709-2741</u>
OTHER RELATED PUBLICATIONS	Mandić, Magda. Determination of equilibrium conditions of carbonate precipitation in Postoj na Cave w ith application to paleoclimatology. <i>Ph.D. thesis</i> , Zagreb: Faculty of Science, 31.1. 2013, Mentors: Ines Krajcar Bronić ; Albrecht Leis.
ADDRESS	Laboratoryfor Measurementsof Low-level Radioactivity(Radiocarbon and Tritium Laboratory)Rudjer Bošković Institute, Bijenička 5410000 Zagreb, Croatiaphone: +385 1 4680219, or +385 1 4571 271, fax: +385 1 4680 239,
CONTACT	Ines Krajcar Bronić, <u>krajcar@irb.hr</u> , +385 1 4571 271

LABORATORY	Laboratory for Radioecology
	Ruđer Bošković Institute, Zagreb, Croatia
NAMES	Delko Barišić, Željko Grahek, Martina Rožmarić Mačefat, Ivanka Lovrenčić Mikelić, Marijana Nodilo, Matea Rogić, Gorana Karanović, Tomislav Kardum, Rajko Kušić
ACTIVITY	 Measurement of ³H, ^{89,90}Sr and gamma emitters in natural samples including food and water Measurement of ³H, ⁵⁵Fe, ^{89,90}Sr and gamma emitters in low level liquid waste Measurement of gross alpha and gross beta activity Determination of ²¹⁰Po, ²²⁶Ra and uranium isotopes Participation in intercomparison excercises Monitoring of NPP Laboratory is acredited according to HRN EN ISO/IEC 17025 Participation in CIESM MEDITERRANEAN MUSSEL WATCH (including phase II Po-210 in mussels from the Adriatic sea) Participation in project of radioactivity monitoring of nearshore sea using marine indicator organisms Monitoring of radioactivity in Sava and Danube rivers
KEYWORDS	environmental monitoring, determination of radionuclides ³ H, ⁵⁵ Fe, ^{89,90} Sr alpha (²¹⁰ Po, ²²⁶ Ra, ^{234,238} U) and gamma emitters, low level measurement
RESULTS	Publication (last 5 years)
PUBLICATIONS	 Rožmarić, Martina; Rogić, Matea; Benedik, Ljudmila; Štrok, Marko; Barišić, Delko; Gojmerac Ivšić, Astrid, 210Po and 210Pb activity concentrations in Mytilus galloprovincialis from Croatian Adriatic coast with the related dose assessment to the coastal population. // Chemosphere. 87 (2012), 11;1295-1300. Cukrov, Neven; Frančišković-Bilinski, Stanislav; Barišić, Delko; Hlača, Bojan. A recent history of metal accumulation in the sediments of Rijeka harbor, Adriatic Sea, Croatia. // Marine pollution bulletin. 62 (2011), 1; 154-167. Sofilić, Tahir; Barišić, Delko; Sofilić, Una.Natural Radioactivity in Steel Slag Aggregate. // Archives of metallurgy and materials. 56 (2011), 3; 627-634. Mihelčić, Goran; Barišić, Delko; Vdović, Neda; Legović, Tarzan; Mihelčić, Vladislav. Impact of Tourism on Trace Metal Concentrations (Pb, Cr, Ni, Cu and Zn) in Sediments of Telašćica Bay (East Adriatic – Croatia). // Croatica chemica acta. 83 (2010), 3; 333-339. Sofilić, Tahir; Barišić, Delko; Sofilić, Una.Monitoring of Cs-137 in Electric Arc Furnace Steel Making Process. // Journal of radioanalytical and nuclear chemistry. 284 (2010), 3; 615-622. Cukrov, Neven; Mlakar, Marina; Cuculić, Vlado; Barišić, Delko.Origin and transport of 238U and 226Ra in riverine, estuarine and marine sediments of the Krka River, Croatia. // Journal of environmental radioactivity. 100 (2009), 6; 497-504.

	8 Lovrenčić Ivanka: Volner Matija: Baričić Delko: Ponijač Marina: Kezić Nikola:
	Solotković, Ivanka, Volner, Malija, Bansic, Deiko, Popijac, Malina, Kezić, Nikola,
	tree (Abies albe L) from Corali Kater, Creatia // Journal of Dedicanalytical and
	Iree (Ables alba L.) Ironi Gorski Kolar, Croalia. II Journal of Radioanalytical and
	Nuclear Chemistry. 275 (2008), 1, 71-79.
	9. Thé bault, H.; Rodriguez y Baena, A. M.; Andral, B.; Barišić, Delko; Albaladejo, J.
	B.; Bologa, A. S.; Boudjenoun, R.; Delfanti, R.; Egorov, V. N.; El Khoukhi, T.;
	Florou, H.; Kniewald, Goran; Noureddine, A.; Patrascu, V.; Pham, M. K.; Scarpato,
	A.; Stokozov, N. A.; Topcuoglu, S.; Warnau, M. 137Cs baseline levels in the
	Mediterranean and Black Sea: A cross-basin survey of the CIESM
	Mediterranean Mussel Watch programme // Marine Pollution Bulletin 57 (2008)
	6-12: 801-806
	10. Grahek Želiko: Karanović Gorana, Nodilo Marijana, Continous, sonaration
	of Sr. V and some estimides by mixed solvent anion eveloping and
	of Sr, f and some actinues by mixed solvent amon exchange and $\frac{241}{100}$ and $$
	determination of ""Sr, ""Pu and ""Am in soil and vegetation samples //
	Journal of radioanalytical and nuclear chemistry. 293 (2012), 3; 815-827.
	11. Grahek, Zeljko; Karanović, Gorana, Nodilo, Marijana, Rapid determination of
	89,90Sr in wide range of activity concentration by combination of Y,Sr
	separation and cherenkov counting // Journal of radioanalytical and nuclear
	<i>chemistry</i> . 292 (2012) , 2; 555-569.
	12. Grahek, Željko; Gojmerac Ivšić, Astrid; Krljan, Nikolina; Nodilo, Marijana.
	Separtion of Sr in combination of ion exchange and Sr resin with alcohol-
	nitric acid solution and rapid determination of ⁹⁰ Sr in wine and soil samples.
	Journal of radioanalytical and nuclear chemistry. 289 (2011) . 2: 437-449.
	13. Požmarić Martina: Coimerac Ivčić Astrid: Crahek Želiko
	13. Rozmanc, Martina, Gojmerac Ivsic, Astriu, Granek, Zeijko.
	Determination of unanium and therium in complex complex using
	Determination of uranium and thorium in complex samples using
	Determination of uranium and thorium in complex samples using chromatographic separation, ICP-MS and spectrophotometric detection.
	Determination of uranium and thorium in complex samples using chromatographic separation, ICP-MS and spectrophotometric detection. <i>Talanta</i> . 80 (2009) ; 352-360.
IN PROGRESS	 Determination of uranium and thorium in complex samples using chromatographic separation, ICP-MS and spectrophotometric detection. <i>Talanta.</i> 80 (2009) ; 352-360. Development of methods for the separation of ⁵⁵Fe and ^{89,90}Sr on Sr and Pb resins and their rapid determination
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IN PROGRESS INFORMATION SOURCE IN PREPARATION OTHER RELATED PUBLICATIONS ADDRESS	 Determination of uranium and thorium in complex samples using chromatographic separation, ICP-MS and spectrophotometric detection. <i>Talanta.</i> 80 (2009) ; 352-360. Development of methods for the separation of ⁵⁵Fe and ^{89,90}Sr on Sr and Pb resins and their rapid determination Development of method for the selective preconcentration of Sr by using molecular recognition resins and determination of low level activities of ⁹⁰Sr by Cherenkov counting of resins Development of methods for water and biological sample preparation for alpha-spectrometric measurements www.irb.hr Laboratory for Radioecology Rudjer Bošković Institute Bijenička 54 10000 Zagreb, Croatia phone: 00385 1 4561 060 or 00385 1 4560 931
IN PROGRESS INFORMATION SOURCE IN PREPARATION OTHER RELATED PUBLICATIONS ADDRESS	Determination of uranium and thorium in complex samples using chromatographic separation, ICP-MS and spectrophotometric detection. <i>Talanta.</i> 80 (2009) ; 352-360. • Development of methods for the separation of ⁵⁵ Fe and ^{89,90} Sr on Sr and Pb resins and their rapid determination • Development of method for the selective preconcentration of Sr by using molecular recognition resins and determination of low level activities of ⁹⁰ Sr by Cherenkov counting of resins • Development of methods for water and biological sample preparation for alpha-spectrometric measurements www.irb.hr Laboratory for Radioecology Rudjer Bošković Institute Bijenička 54 10000 Zagreb, Croatia phone: 00385 1 4561 060, or 00385 1 4560 931 fax: 00385 1 4680 205
IN PROGRESS INFORMATION SOURCE IN PREPARATION OTHER RELATED PUBLICATIONS ADDRESS	Determination of uranium and thorium in complex samples using chromatographic separation, ICP-MS and spectrophotometric detection. <i>Talanta.</i> 80 (2009) ; 352-360. • Development of methods for the separation of ⁵⁵ Fe and ^{89,90} Sr on Sr and Pb resins and their rapid determination • Development of method for the selective preconcentration of Sr by using molecular recognition resins and determination of low level activities of ⁹⁰ Sr by Cherenkov counting of resins • Development of methods for water and biological sample preparation for alpha-spectrometric measurements www.irb.hr Laboratory for Radioecology Rudjer Bošković Institute Bijenička 54 10000 Zagreb, Croatia phone: 00385 1 4561 060, or 00385 1 4560 931 fax: 00385 1 4680 205

LABORATORY	Laboratoire National Henri Becquerel (LNHB), France
NAMES	M.M. Bé, C. Dulieu, X. Mougeot, M. Kellett, C. Bisch
ACTIVITY	Evaluation of Radionuclide Decay Data
KEYWORDS	data evaluation, ¹⁴ C, ³⁵ S, ³⁶ Cl, ⁴⁵ Ca, ¹³⁴ Cs, ¹⁹⁵ Au, beta spectra
RESULTS	Evaluation of decay data <u>http://www.nucleide.org/DDEP_WG/DDEPdata.htm</u> Organisation of DDEP meeting, October 2012
PUBLICATIONS	X. Mougeot, MM. Bé, C. Bisch, M. Loidl. Evidence for the exchange effect in the beta decay of ²⁴¹ Pu. Physical Review A86 (2012) 042506
	MM. Bé, P. Cassette, M.C. Lépy, MN. Amiot, K. Kossert, O.J. Nähle, O. Ott, C. Wanke, P. Dryak, G. Ratel, M. Sahagia, A. Luca, A. Antohe, L. Johansson, J. Keightley, A. Pearce. Standardization, decay data measurements and evaluation of ⁶⁴ Cu. Applied Radiation Isotopes 70 (2012) 1894
	MN. Amiot, MM. Bé, T. Branger, P. Cassette, M.C. Lépy, Y. Ménesguen, I.Da Silva. Standardization of ⁶⁴ Cu using an improved decay scheme. Nuclear Instrum. Methods Phys. Res. A 684 (2012) 97
IN PROGRESS	Evaluation of: ⁴¹ Ca, ⁵⁸ Co, ¹⁴⁸ Pm, ^{148m} Pm, 127Xe, ^{108m} Ag, ¹¹⁰ Ag, ^{110m} Ag
INFORMATION	Program to calculate beta spectra with the Gove and Martin formalism done, experimental study in progress.
	Monographie BIPM-5: vol. 7 ready for publication
	Coordination of WP5 in EMRP MetroRWM (waste Management).
	Participation to WP1 in EMRP MetroMRT (Molecular RadioTherapie)
	Coordination of WP4 in MetroNORM (EMRP accepted)
OTHER RELATED PUBLICATIONS	CD Rom NUCLÉIDE, Editor EDP Sciences, ISBN 978 2 7598 0077 3
ADDRESS	CE Saclay LNHB – PC 111 F- 91191 Gif sur Yvette Cedex Tel: +33 1 69 08 46 41 E-mail: <u>mmbe@cea.fr</u>
CONTACT	Marie-Martine Bé

LABORATORY	Laboratoire National Henri Becquerel (LNHB), France
NAMES	V. Lourenço, D. Lacour, I. Le Garrérès, S. Morelli
ACTIVITY	Source preparation for all measurement techniques. Development of reference materials representative of environmental radioactivity either by spiking or by characterized sampling. Organization of proficiency tests for the laboratories of the French nuclear operators (EDF, Areva, etc.) or environmental radioactivity monitoring laboratories. These tests are not limited to French laboratories. The group is also involved in several European Projects.
KEYWORDS	Sources, environmental radioactivity, reference materials, sampling
RESULTS	Several procedures of drying and homogenizing for vegetal matrixes
PUBLICATIONS	An oral communication will be made at ICRM 2013 on the spiking of a vegetal matrix with gamma emitting radionuclides.
IN PROGRESS	Destructive analyses on solid samples containing gamma emitting radionuclides (biological, sediment or soil samples) will be studied. A process to spike a real soil matrix with gamma emitting radionuclides is also considered. LNHB also aims at being COFRAC accredited as a PTE provider against ISO 17043:2010.
INFORMATION	
SOURCE IN PREPARATION	Thin sources (electroprecipitation, microfiltration, etc.)
OTHER RELATED PUBLICATIONS	
ADDRESS	CEA Saclay LNHB Bat. 602, PC 111 F-91191 Gif-sur-Yvette cedex
CONTACT	Valerie.lourenco@cea.fr / Tel: 033169083951

LABORATORY	LNE- Laboratoire National Henri Becquerel
NAMES	Sylvie Pierre
ACTIVITY	Alpha spectrometry and alpha counting
KEYWORDS	²¹⁰ Po, half-life, ²²² Rn, uranium
RESULTS	Measurements of the polonium half-life with and without cooling. Measurement of ²²² Rn activity by defined solid angle alpha counting using cryogenic source: system requalified
PUBLICATIONS	On the variation of the ²¹⁰ Po half-life at low temperature, <i>S. Pierre et al.</i> , Applied Radiation and Isotopes 68 (2010) 1467-1470
IN PROGRESS	Measurement of low level actinide sources for the device dedicated to the direct alpha spectrometry of actinides in solution
INFORMATION	Alpha spectrometry chambers for high and low level activities, defined solid angle (ASD) equipment. All equipment with PIPS detectors.
SOURCE IN PREPARATION	²³⁸ U, ²³⁵ U : measurements in progress for activity and spectrometry
OTHER RELATED PUBLICATIONS	
ADDRESS	LNE/LNHB CEA-Saclay – BC 111 F-91191 Gif-sur-Yvette cedex, FRANCE Tel +33.0.1 69 08 43 75 Fax : +33.1.69.08.26.19 E-mail : <u>sylvie.pierre@cea.fr</u>
CONTACT	Sylvie Pierre

LABORATORY	LNE- Laboratoire National Henri Becquerel
NAMES	Laurent Ferreux, Yves Ménesguen, Sylvie Pierre, Laurine Brondeau, Marie-Christine Lépy
ACTIVITY	Gamma-ray spectrometry
KEYWORDS	Gamma-ray spectrometry, Monte Carlo simulation, Efficiency calibration, decay scheme
RESULTS	Efficiency calibration of HPGe detectors within 0.5 % relative uncertainty for point sources.
	Efficiency calibration for volume sources (liquid in 15 and 50 cm^3) and 100 cm^3 gas geometries
PUBLICATIONS	Coincidence summing corrections applied to volume sources Marie-Christine Lépy, Laurent Ferreux, Sylvie Pierre Applied Radiation and Isotopes, 70 (2012) 2137-2140.
IN PROGRESS	Accurate efficiency calibration for 500 cm ³ volume sources
	Validation of efficiency transfer for Marinelli geometries
	Test of digital signal processing equipments
	Measurement of photon emission intensities of ¹²⁷ Xe, ¹³¹ I, ²³⁵ U
INFORMATION	Coaxial and planar HPGe Detectors
SOURCE IN PREPARATION	"On scattering effects for volume sources in low-energy photon spectrometry", Accepted for publication in Applied Radiation and Isotopes "Validation of efficiency transfer for Marinelli geometries", Accepted for publication in Applied Radiation and Isotopes
OTHER RELATED PUBLICATIONS	Intercomparison of methods for coincidence summing corrections in gamma-ray spectrometry—part II (volume sources) <i>MC. Lépy, T. Altzitzoglou, M.J. Anagnostakis, M. Capogni, A.</i> <i>Ceccatelli, P. De Felice, M. Djurasevicf, P. Dryak, A. Fazio, L. Ferreux,</i> <i>A. Giampaoli, J.B. Han, S. Hurtado, A. Kandic, G. Kanisch, K.L.</i> <i>Karfopoulos, S. Klemola, P. Kovar, M. Laubenstein, J.H. Lee, J.M. Lee,</i> <i>K.B. Lee, S. Pierre, G. Carvalhal, O. Sima, Chau Van Tao, Tran Thien</i> <i>Thanh, T. Vidmar, I. Vukanac, M.J. Yang</i> Applied Radiation and Isotopes <u>70 (2012) 2112-2117</u>
ADDRESS	LNE/LNHB CEA-Saclay – BC 111 F-91191 Gif-sur-Yvette cedex, FRANCE Tel : +33.1.69.08.24.48 Fax : +33.1.69.08.26.19 E-mail : marie-christine.lepy@cea.fr
CONTACT	Marie-Christine Lépy

LABORATORY	LNE- Laboratoire National Henri Becquerel
NAMES	Yves Ménesguen, Marie-Christine Lépy
ACTIVITY	X-ray Spectrometry
KEYWORDS	X-ray Spectrometry, fluorescence yield, attenuation coefficient, synchrotron
RESULTS	Measurement of linear attenuation coefficients and fluorescence yields of different materials
	Characterization of the response of X-ray detectors using a reference proportional counter
PUBLICATIONS	
IN PROGRESS	Characterization of the metrology beamline at the SOLEIL synchrotron facility
INFORMATION	Si(Li), SDD, CdTe and HPGe Detectors
	Tunable monochromatic X-ray source (1-28 keV) (SOLEX), several efficiency calibration of various detectors (CdTe, Si PIN)
	Synchrotron beam line (SOLEIL)
SOURCE IN PREPARATION	« Low Energy characterization of Caliste HD, a CdTe based Imaging Spectrometer », conference IEEE NSS/RTSD 2012 proceeding
OTHER RELATED PUBLICATIONS	
ADDRESS	LNE/LNHB CEA-Saclay – BC 111 E 01101 CIG – N – H – ED ANCE
	F-91191 Gif-sur-Yvette cedex, FRANCE Tel : +33.1.69.08.24.48
	Fax : +33.1.69.08.26.19
	E-mail : <u>yves.menesguen@cea.fr</u>
CONTACT	Yves Ménesguen

LABORATORY	LNE - Laboratoire National Henri Becquerel
NAMES	Laurent Ferreux, Sylvie Pierre, Isabelle Tartès
ACTIVITY	Low-level activity measurements
KEYWORDS	Alpha spectrometry, environmental control, gamma-ray spectrometry, gas proportional counter, liquid scintillation, low-level
RESULTS	Characterisation of a vegetal matrix spiked with mixtures of gamma emitting radionuclides in progress
PUBLICATIONS	ICRM LLT 2012 : Validation of efficiency transfer for Marinelli geometrie
IN PROGRESS	Measurement of the photon emission intensities of ²³⁵ U
	Characterisation of a HPGe detector for low level measurement
INFORMATION	Main equipment: HPGe detector with active anti-cosmic shielding
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	LNE/LNHB CEA-Saclay – BC 111 F-91191 Gif-sur-Yvette cedex, FRANCE Tel. : +33.1.69.08.56.08 Fax. +33.1.69.08.26.19 E-mail : <u>laurent.ferreux@cea.fr</u>
CONTACT	Laurent Ferreux

LABORATORY	LNE - Laboratoire National Henri Becquerel
NAMES	Laurent Ferreux, Isabelle Tartès, Valérie Lourenco
ACTIVITY	Low-level activity measurement
	Organisation of national and international interlaboratory comparisons in the field of activity measurements.
KEYWORDS	Alpha spectrometry, environmental control, gamma-ray spectrometry, gas proportional counter, liquid scintillation, low-level, traceability,
RESULTS	
PUBLICATIONS	Interlaboratory comparison results: LNHB Reports NT 12-37, NT 12-38, NT 12-47,
IN PROGRESS	3 LNHB Reports in progress
INFORMATION	An open intercomparison program is proposed every year by LNE-LNHB.
	The intercomparison program for 2013 is: - Mass activity measurement of mixtures of gamma emitting radionuclides with low activity about 10 to 100 Bq/kg. - Mass activity measurement of mixtures of gamma emitting radionuclides about 10 to 100 kBq/g. - Mass activity measurement of ³ H in an effluent matrix (about 1 to 4 kBq/g)
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	LNE/LNHB CEA-Saclay – BC 111 F-91191 Gif-sur-Yvette cedex, FRANCE Tel. : +33.1.69.08.56.08 Fax. +33.1.69.08.26.19
CONTACT	E-Mail : laurent.ferreux@cea.fr

LABORATORY	Physikalisch-Technische Bundesanstalt
NAMES	Rainer Dersch, Karsten Kossert, Ole Nähle et al.
ACTIVITY	R&D in liquid scintillation counting, Čerenkov counting and activity determination by means of ionization chambers; measurement of nuclear decay data; large area sources
KEYWORDS	data measurement; ionisation chamber; life sciences; liquid scintillation; radionuclides: ⁴¹ Ca, ¹⁷⁶ Lu, ¹²⁹ I, ^{166m} Ho, ²²⁹ Th; comparisons: ⁵⁹ Fe, ⁹⁹ Tc, ⁸⁹ Sr (bilateral with ENEA); EMRP- MetroFission: ³ H, ²⁴¹ Pu, Large Area Source Comparison Exercise (LASCE)
RESULTS	Activity standardization and determination of decay data for various radionuclides, calibration and characterization of ionization chambers
PUBLICATIONS	Jörg, Amelin, Kossert, Lierse v. Gostomski: Precise and direct determination of the half-life of ⁴¹ Ca. Geochimica Cosmochimica Acta 88 (2012) 51.
	Ott, Kossert, Sima: Photon emission probabilities of ¹⁷⁶ Lu. Applied Radiation and Isotopes 70 (2012) 1886.
	Nähle, Kossert: Characterization of photon emitting wide area reference sources. Applied Radiation and Isotopes 70 (2012) 2018.
	Wanke, Kossert, Nähle: Investigations on TDCR measurements with the HIDEX 300 SL using a free parameter model. Applied Radiation and Isotopes 70 (2012) 2176.
	Kossert, Nähle, Ott, Dersch: Activity determination and nuclear decay data of ¹⁷⁷ Lu. Applied Radiation and Isotopes 70 (2012) 2215.
IN PROGRESS	Test of $4\pi(LS)\beta$ - γ coincidence counting, extension of the models for TDCR and CNET, construction of a new automatic sample changer with several ionization chambers, participation in the EMRP projects "MetroFission", "Radioactive Waste Management" and "MetroMetal", measurement of wavelength-dependent refractive index of various liquid scintillation cocktails, revision of ISO 8769
INFORMATION	Works are done with many collaborators;
	Information about activity standards and calibration services:
	http://www.ptb.de/en/org/6/61/611/katalog/allgemeines_en.htm
SOURCE IN PREPARATION	Activity determination of ⁵⁹ Fe (LSC2013) and ²²⁹ Th (ICRM 2013), results of a Mini- TDCR system (ICRM 2013)
OTHER RELATED PUBLICATIONS	Kossert, Jörg, Lierse v. Gostomski: Experimental half-life determination of ¹⁷⁶ Lu. Applied Radiation and Isotopes, proceedings of ICRM LLRMT 2012, accepted.
ADDRESS	РТВ
	Physikalisch-Technische Bundesanstalt
	Bundesallee 100 - 38116 Braunschweig (Germany)
	Phone: +49 531 592 6110
	Fax: +49 531 592 6305
	Karsten.Kossert@ptb.de
CONTACT	Karsten Kossert

LABORATORY	Physikalisch-Technische Bundesanstalt
NAMES	Dr. Annette Röttger, Anja Honig, Diana Linzmaier, Thomas Reich, Matthias Fritsche, Viviane Notzon
ACTIVITY	Radon measuring technique:
	Radon-220 (Thoron) progeny reference chamber and mixed atmosphere reference chamber (Radon-222, Radon-220 and their progenies) of the PTB. Production and measurement of reference atmospheres.
	Online -spectrometry and offline simultaneous -spectrometry.
KEYWORDS	Rn-220, Rn-222, Alpha and Gamma spectrometry, radioactive gas
RESULTS	Reference atmospheres for Rn-220, Rn-222 and their progenies. Calibration service. ICRU Working group.
PUBLICATIONS	Diana Linzmaier and Annette Röttger : Development of a low-level radon reference atmosphere, to be published in ARI in 2013
IN PROGRESS	Development of a transfer standard for low-level radon reference atmosphere, ICRM 2013
INFORMATION	http://www.ptb.de/de/org/6/61/613/index.htm
SOURCE IN	Low-Level radon reference atmospheres (below 1 kBq/m ³).
PREPARATION	Thoron progeny chamber.
	Radon reference chamber.
OTHER RELATED PUBLICATIONS	http://www.ptb.de/de/org/6/61/613/index.htm
ADDRESS	РТВ
	Physikalisch-Technische Bundesanstalt
	Bundesallee 100 - 38116 Braunschweig (Germany)
	Phone: +49 531 592 6104
	Fax: +49 531 592 8525
	annette.roettger@ptb.de
CONTACT	Annette Röttger

^{*}Corresponding author: tel. +49 531 592 6107, fax +49 531 592 8525, email diana.linzmaier@ptb.de

LABORATORY	IAEA Environment Laboratories
NAMES	A. Fajgelj, E. Moedlhammer
ACTIVITY	Establishment of a Quality System at NAEL Certification of Reference Materials Metrological activities
KEYWORDS	Quality Assurance, Reference Materials, Metrology.
RESULTS	 Starting activities for the establishment of a Quality System at NAEL. Organization of the 13thInternational Symposium on Biological and Environmental Reference Materials (BERM 13) (Vienna, 25-29 June 2012). It was attended by 200 representatives of institutions engaged in production of reference materials worldwide. Collaboration with the ICRM on the establishment of a new WG on QA. Collaboration with IUPAC on the use of proficiency test schemes. Collaboration with EURACHEM on uncertainty in analytical measurement.
PUBLICATIONS	IUPAC/CITAC Guide: "Selection and use of proficiency testing schemes for a limited number of participants — chemical analytical laboratories" (IUPAC Technical Report), Pure Appl. Chem., Vol. 82, No. 5, pp. 1099–1135, 2010 (ISSN: 0033-4545).
	EURACHEM/CITAC Guide CG4 "Quantifying Uncertainty in Analytical Measurement", Third Edition, QUAM:2012.P1, EURACHEM, 2012; (ISBN: 978-0-948-926-30-3).
	I. Kuselman, F. Pennecchi, C. Burns, A. Fajgelj, P. De Zorzi: "Investigating out- of-specification test results of chemical composition based on metrological concepts"; Accred. Qual. Assur. (2010) 15:283-288, Springer, Heidelberg (ISSN 0949-1775).
	P. De Bièvre, R. Dybkaer, A. Fajgelj, and D. BrynnHibbert: "Metrological traceability of measurement results in chemistry: Concepts and implementation" (IUPAC Technical Report), Pure Appl. Chem., Vol. 83, No. 10, pp. 1871–1933, 2011(ISSN: 0033-4545).
IN PROGRESS	NAEL accreditation according to ISO 17025:2005 and ISO Guide 34:2009 for reference materials production.
OTHER RELATED PUBLICATIONS	B.M. Dantas, A.L.A. Dantas, M.E.D. Acar, J.C.S. Cardoso, L.M.Q.C. Luliao, M.F. Lima, M.H.T. Taddei, D.R. Arine, T. Alonso, M.A.P. Ramos, A. Fajgelj, "Accreditation and training on internal dosimetry in a laboratory network in Brasil: An increasing demand", Radiation Protection Dosimetry (2011), Vol. 144, No. 1-4, pp. 124-129.
	I. Kuselman, I. Schumacher, F. Pennecchi, C. Burns, A. Fajgelj, P. de Zorzi: "Long-term stability study of drug products and out-of-specification test results"; Accred. Qual. Assur. (2011) 16:615-622, Springer, Heidelberg (ISSN 0949- 1775).
ADDRESS	Vienna International Centre, PO Box 100, 1400 Vienna, Austria
CONTACT	Ales Fajgelj (a.fajgelj@iaea.org)

LABORATORY	Radiometrics Laboratory (RML), IAEA Environment Laboratories
NAMES	H.Nies, O. Blinova, M. Eriksson, A. Harms, I. Levy, I.Osvath, and M.Pham
ACTIVITY	Certification of Reference Materials Organisation of Proficiency Test Exercises Organisation of Training for Capacity Building in Member States
KEYWORDS	Alpha spectrometry, beta spectrometry,gamma-ray spectrometry, liquid scintillation, low-level, radiochemistry, source preparation, traceability, ⁴⁰ K, ¹³⁴ Cs, ¹³⁷ Cs, ²²⁸ Ra, ²³⁴ U and ²³⁹⁺²⁴⁰ Pu
RESULTS	Certification of Reference Material: IAEA-446 Radionuclides in Baltic Seaweed (<i>Fucusvesiculosus</i>) Organisation of Proficiency Test Exercises: IAEA-RCA RAS/7/021 'Proficiency Test for Caesium Determination in Sea Water' and ROPME PTE 'Determination of Radionuclides in Sediment and Biota Sample' Organisation of training in radioanalytical techniques: ALMERA network (in collaboration with IAEA TerrestrialEnvironment Laboratory) and Technical Cooperation Projects (in collaboration with Karlsruhe Institute of Technology)
PUBLICATIONS	 M.A. Charrette, H. Dulaiova, M.E. Gonneea, P.B. Henderson, W.S. Moore, J.C. Scholten, M.K. Pham, 2012. GEOTRACES radium isotopes interlaboratory comparison experiment. Limnology and Oceanography: Methods, 10 451-463. E.Holm, M. Eriksson, B. Lind, I. Levy, G. Kinn, 2012. Source preparation of actinides and polonium using coins. Journal of Radioanalytical and Nuclear Chemistry, DOI 10.1007/s10967-012-1986-5.
IN PROGRESS	Laboratory accreditation according to ISO 17025:2005 and ISO Guide 34:2009 for reference material production Organisation of a follow-up proficiency test exercise for ⁹⁰ Sr, ¹³⁴ Cs and ¹³⁷ Cs determination in sea water Identification of new candidate reference materials
IN PREPARATION	 O.Sima, I.Osvath, 2013. Calibration of a low-level anti-Compton underground gamma-spectrometer by experiment and Monte Carlo. Applied Radiation and Isotopes, in press. R.Suvaila, I.Osvath, O.Sima, 2013. Improving the assessment of activity in samples with non-uniform distribution using the sum peak count rate. Applied Radiation and Isotopes, in press. M.K. Pham, A.V. Harms, H. Nieset al., 2013. Certified Reference Material IAEA-446 for radionuclides in Baltic Sea seaweed. Applied Radiation and Isotopes, submitted.
OTHER RELATED PUBLICATIONS	M.K. Pham, M. Eriksson, I. Levy, H. Nies, I. Osvath, M. Betti, 2012. Detection of Fukushima Daiichi nuclear power plant accident radioactive traces in Monaco. Journal of Environmental Radioactivity 114, 131-137.
ADDRESS	4a Quai Antoine 1er, 98000 Monaco
CONTACT	Hartmut Nies(h.nies@iaea.org)

LABORATORY	Terrestrial Environment Laboratory (TEL), IAEA Environment Laboratories
NAMES	M. Groening, A. Ceccatelli, R. Katona, G. Kis-Benedek, A. Pitois
ACTIVITY	Characterization and certification of terrestrial environment Reference Materials Organisation of Proficiency Tests Development of radioanalytical methods and guidelines for detection of radionuclides in the environment Organisation of Training for Capacity Building in Member States
KEYWORDS	Alpha spectrometry, beta spectrometry, gamma-ray spectrometry, liquid scintillation, ICPMS, low-level, radiochemistry.
RESULTS	 Certification of the following RMs: IAEA-372 (grass), IAEA-444 (soil), IAEA-445 (water), IAEA-434 (phosphogypsum), IAEA-447 (moss soil). Characterization of the following RMs: IAEA-360 (soil), IAEA-448 (soilfromoilfield), IAEA-455 (Koreansoil). Organization of WWPTs (one per year) and ALMERA PTs (one per year) on determination of radionuclides in environmental samples of terrestrial origin. http://nucleus.iaea.org/rpst/ReferenceProducts/Proficiency_Tests/index.htm Organization of one national Japanese proficiency test on determination of radionuclides in soil, grass, water and air filters. Development of rapid methods and monitoring methods. Development of guidelines on sampling techniques and application of corrections in radioanalytical techniques. Organization of the following training courses for ALMERA (activity in collaboration with NAEL-RML): "Coincidence summing and geometry corrections in gamma-ray spectrometry" (Seibersdorf, 2010). "Measurement of natural radionuclides in environmental samples, NORMs and TENORMs by gamma spectrometry: experimental challenges and methodologies"(Monaco, 2011). "Measurement Results Uncertainty Estimation and Method Validation" with specific sessions and group exercises dedicated to radioanalytical techniques (Turkey, 2012). Organization of workshops, implementation of expert missions and provision of equipment to Counterparts involved in the projects. Regional Training Course on "Preparation and Use of In-house Reference Materials for Quality Control of Analytical Results and Method Validation" (Panama, 2011). Advanced Regional Training Course on "Method Validation and Method Validation" (Panama, 2011). Training Course on "Quality Internal Auditing" (Jordan, 2011). Training Course on "Quality Internal Audit

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	 Regional Workshop on "Quality Procedures and Management Practices towards Improved Environmental Radioactivity Monitoring" (Austria, 2012). Regional Training Course on "Managerial and Technical Requirements for Compliance with the ISO17025 standard" (Hungary, 2012). Organization of workshops and meetings for certification of new RMs. Training of fellows and scientific visitors on a regular basis.
PUBLICATIONS	CCRI(II) Comparison Report (http://nucleus.iaea.org/rpst/Documents/sha00343236.pdf)
	Report IAEA/AQ/ 21 (<u>http://nucleus.iaea.org/rpst/Documents/IAEA-AQ-21_web.pdf</u>)
	Report IAEA/AQ/ 21 (<u>http://nucleus.iaea.org/rpst/Documents/IAEA-AQ-21_web.pdf</u>)
	Report IAEA/AQ/17 (<u>http://nucleus.iaea.org/rpst/Documents/IAEA-AQ-17_web.pdf</u>)
	Report IAEA/AQ/22 (<u>http://nucleus.iaea.org/rpst/Documents/IAEA-AQ-22_web.pdf</u>)(Appl. Rad. Isot. 70 (2012) 1632–1643)
IN PROGRESS	Laboratory accreditation according to ISO 17025:2005 and ISO Guide 34:2009 for reference materials production.
	Certification of characterized RMs.
	Identification of new RMs.
	Organization of next cycle WWPT and ALMERA PT.
	Training courses for ALMERA (2013: training course on 'Rapid assessment methods' in USA) (activity in collaboration with NAEL-RML).
	Initiation of the development and validation of rapid methods for the determination of Sr-89+90 in waters (freshwater and seawater) and soil samples (collaboration with KINS, Republic of Korea, in the frame of the ALMERA method development activities).
SOURCE IN	Certification report of IAEA-448 (in press).
PREPARATION	Japanese PT report (in press).
	2011 ALMERA PT report (submitted for publication to the IAEA Publication Committee).
	"Water-content determination using Karl-Fisher method" (submitted for publication to the IAEA Publication Committee).
	"Population representative nationwide and regional surveys of radon concentration in dwellings: review of methodology and measurement techniques" (submitted for publication to the IAEA Publication Committee).
	"A combined procedure for determination of plutonium isotopes, Am-241 and Sr-90 in environmental samples" (draft).
	"A procedure for the sequential determination of Po-210, Pb-210, Ra-226, Th and U isotopes in phosphogypsum by liquid scintillation counting and alpha spectrometry" (draft).

	"Guidelines for the Application of Coincidence Summing and Geometry
	Corrections in Gamma-Ray Spectrometry" (draft).
	Guidance document on "Air sampling techniques and determination of alpha and beta emitters in aerosols" (draft).
	Update of TECDOC 1415 "Soil sampling for environmental contaminants" (draft).
	"Vegetation sampling for monitoring purposes" TECDOC (draft).
	"Measurement and calculation of radon releases from NORM residues" TRS (in press).
	"A procedure for rapid simultaneous determination of 89Sr and 90Sr in milk using Cerenkov and scintillation counting" (draft).
	"A procedure for the rapid determination of Ra-226 and Ra-228 in drinking water by prompt liquid scintillation counting" (draft).
OTHER RELATED PUBLICATIONS	"Intercomparison of methods for coincidence summing corrections in gamma- ray spectrometry – Part II (volume sources)" (Appl. Rad. Isot. 70, 2112-2118).
	"International comparison for the determination of radionuclide activity in bilberry material" (Appl. Rad. Isot. 70, 1843-1849).
ADDRESS	Vienna International Centre, PO Box 100, 1400 Vienna, Austria
CONTACT	Manfred Groening (m.groening@iaea.org)
LABORATORY	Bhabha Atomic Research Centre, India
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NAMES	Leena Joseph, Anuradha Ravindra, D.B. Kulkarni
ACTIVITY	 Participation in international intercomparison programmes Absolute activity measurements Audit programme of activity measurements in nuclear medicine centres Calibration of radionuclide calibrators and sources
KEYWORDS	gas proportional counter, liquid scintillation, SIR, LASCE. F-18
RESULTS	 Tc-99 standardized under international intercomparison programme. F-18 standardized by primary method and sensitivity coefficient for secondary standard determined. Radionuclide calibrators of hospitals and Nuclear Medicine Centres calibrated An automatic liquid scintillator based 4π β-γ coincidence unit is being tested Participated in LASCE
PUBLICATIONS	 Standardization of ⁶⁰Co by CIEMAT/NIST efficiency tracing technique at BARC, India, D.B. Kulkarni, R. Anuradha, Sonali Bhade, and Leena Joseph presented at 30th IARP National Conference (IARPNC-2012) held at Mangalore University, Mangalagangotri during March 15-17, 2012 Development of liquid scintillation based 4πβ(LS)-γ coincidence counting system and demonstration of its performance by standardization of ⁶⁰Co, D.B. Kulkarni^a, R. Anuradha^a, Leena Joseph^a and B.S. Tomar^b, Int. J. Appl. Radiat. Isot. 2013, 72, 68-72
IN PROGRESS	 15th National Audit of I-131 activity measurements in hospitals and nuclear medicine centres in the country. Participate in SIR Establishment of equivalence of activity measurements with the new automatic liquid scintillator based 4π β-γ coincidence system with international standards. Emission rate measurements of large area sources with window less, gas flow multi-wire proportional counting system. Calibration of sources for users Calibration of radionuclide calibrators
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Mr. D A R Babu Head, Radiation Standards Section, Radiation Safety Systems Division, BARC, Mumbai - 400 085, India Telephone: 25592277 Telefax: 0091(22) 5505151,5519613, e-mail: rajubabu@barc.gov.in
CONTACT	Leena Joseph, e-mail: leena@barc.gov.in

ENEA-INMRI, Radionuclide Metrology 2012-2015 Progress Report and Work Plan (information for ICRM members)

The programmes at the National Institute for Ionising Radiation Metrology of ENEA (ENEA-INMRI) in the field of radionuclide metrology in the years 2012-2015 were and will be focused, as in the past, on maintaining and developing the national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

The ENEA-INMRI Radionuclide Metrology staff in 2013 is the following:

Scientists	Function
P. De Felice	ENEA-INMRI Head
M. Capogni	Primary Radionuclide activity standards
G. Cotellessa	Primary Radionuclide activity standards
P. Carconi	Secondary Radionuclide activity standards
A. Petrucci	Secondary Radionuclide activity standards
F. Cardellini	Radon standards
S. Loreti [*]	Neutron standards
M.L. Cozzella	Source preparation and radiochemistry
Technicians	
A. Fazio	Secondary Radionuclide activity standards

(*) Involved in radionuclide metrology only for aspects in common with neutron metrology.

The main specific activities carried out at ENEA-INMRI in this field are summarised below. Highlights are marked in bold with corresponding details reported in separate sheets.

Activity line	ENEA-INMRI Radionuclide Metrology 2011-2012 Progress report	ENEA-INMRI Radionuclide Metrology 2013-2014 Work plan
Development of primary standards, Improvement of measuring methods and instrumentation	 Development of new primary standards (Ni-63, Sr-89, Sr-90, Tc-99, Cu-64) Development of a new radon blank chamber for determination of blank indication of radon active monitors Characterization of climatic parameters in 1 m³ radon chamber Participation in EMRP Projects: MetroFission WP6 (TDCR) MetroFission WP7 (DCC) MetroRWM MetroMRT 	 Development of new primary standards (F-18, Mn-56, Tc-99m, Rn-220, Rn-222) Participation in EMRP Projects: MetroFission MetroMetal MetroRWM MetroNORM Generation of Aerosol atmosphere in radon chamber Application of Cerenkov TDCR counting Beta efficiency for the 4πγ NaI(Tl) system Efficiency curve for the 4πγ ionization chamber Update of radon-in-water standard

International comparisons	 BIPM (Tc-99) SIR (Cu-64, Ni-63) Bilateral ENEA-PTB: (Sr-89) by TDCR method with Hidex 300SL metrological version system 	 BIPM (Y-90 microspheres, Large area sources) BIPM CCRI(II) (Tc-99, Cu-64) SIR (Co-60, Rn-222, I-124, F-18, Tc-99m, Cs-134) Bilateral ENEA-LNHB (H-3 and Pu-241) by Portable TDCR counter Bilateral (Rn-222 atmosphere, radon-in-water)
Standardization of measurement methods	 ICRM GSWG Coincidence summing comparison for volume sources Application of YAP crystals to radon metrology Accurate self-absorption correction in gamma ray spectrometry (Pb-210, Am-241) Methods for radon measurements in caves 	 Nuclear track detection methods Application of YAP crystal detectors to radionuclide metrology Methods for radioactivity measurements in tap waters
National QA programmes and services	 Preparation of radioactive standards (liquid solutions, point sources, paper filters and spiked reference materials) for external users Collaboration with IAEA (Lectures and guideline development) 	 Provision of Calibration service Organisation of Proficiency Tests for national laboratories: radioactivity surveillance network, radon measurement laboratories, nuclear medicine departments Collaboration with the National Accreditation Body (ACCREDIA) for development of Secondary Calibration Laboratories for surface contamination
Membership in international and national organisations	• ICRM, BIPM-CGPM, BIPM/CCRI(II), EA, EURAMET, IEC/TC45, ISO/TC85, UNI-CEI (National Standardisation Organisation)	 ICRM, BIPM-CGPM, BIPM/CCRI(II), BIPM/CCRI(III), EA, EURAMET, IEC/TC45, ISO/TC85, UNI-CEI (National Standardisation Organisation) ICRM Presidency (2012-2013)
Management and Organization	 European Projects: Metrofission WP8 (Impact) EMRP Call 2010 Industry & Env. EMRP Call 2011 Health2 EMRP Call 2012 Industry Completion of reactivation of measuring systems after laboratory restructuration 	 European Projects: Metrofission WP8 (Impact) Submission of new CMCs Completion of reactivation of measuring systems after laboratory restructuration
Teaching activity	• Invited lectures	Invited lectures
Quality system	 Management of Quality System Quality System Peer Review, in the frame of EURAMET Project n.1123 	 Improvement of Quality System Development of working standards for influence quantities (temperature, rel. humidity, mass, volume,) Review of Calibration Certificates

LABORATORY	ENEA - Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI) - Italy.
NAMES	M. Capogni, P. Carconi, M.L. Cozzella, P. De Felice, A. Fazio
APPARATUS	Liquid Scintillation counting systems
	Gamma-ray spectrometry system
	Radiochemistry laboratory
ACTIVITY	Participation of the ENEA in the International Comparison of ⁹⁹ Tc activity measurements
RESULTS	
IN PROGRESS	Absolute activity measurements by liquid scintillation counting techniques (CIEMAT/NIST and TDCR methods) Impurity check by analytical procedure and γ -ray spectrometry.
PUBLICATIONS	
ADDRESS	ENEA Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti Centro Ricerche Casaccia P.O.Box 2400 - Roma (Italy) Phone:+39 06 3048 6628
	Fax: +39 06 3048 4650 marco.capogni@enea.it
CONTACT	M. Capogni

LABORATORY	ENEA - Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI) - Italy.
NAMES	M. Capogni, M.L. Cozzella, P. De Felice, S. Loreti
APPARATUS	TDCR counting systems and DCC unit.
ACTIVITY	Development of a new TDCR portable instrument for <i>in-</i> <i>situ</i> measurements of β -emitters; metrological characterisation of some commercial digitizers for digital coincidence counting applications; measurements tests with the Hidex 300SL metrological version counter.
RESULTS	The new TDCR portable instrument was assembled by using a new kind of PMTs (Hamamatsu R7600) with very high quantum efficiency, relative low voltage supply and good portability. Different DT5720X CAEN modules were used to digitalise signals from different detectors (photomultiplier tubes, proportional counters).
	Implementation of the coincidences counting techniques based on the MAC3 philosophy inside the CERN ROOT analysis code.
IN PROGRESS	Participation to the WP6, WP7 and WP8 of the EMRP Joint Research Project "Metrofission". The new portable TDCR counter is under test with new CAEN digitizers DT5720.
ADDRESS	ENEA Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti Centro Ricerche Casaccia P.O.Box 2400 - Roma (Italy)
	Phone: +39 06 3048 6628 Fax: +39 06 3048 4650 marco.capogni@enea.it
	Phone: +39 06 3048 4950 Fax: +39 06 3048 4650 stefano.loreti@enea.it
	Phone: +39 06 3048 3580 Fax: +39 06 3048 355 pierino defelice@enea.it
CONTACT	M Canogni P De Felice S Loreti

LABORATORY	ENEA - Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI) - Italy.
NAMES	F. Cardellini, P. De Felice
APPARATUS ACTIVITY	Blank radon chamber, Radon chamber with aerosol generation
	Metrological characterization of a new ²²² Rn-free chamber used for radon monitors linearity check at very low radon concentration.
	Development and characterization of aerosol generators for radon chambers.
RESULTS	Paper on the radon blank chamber presented at the ICRM- LLRMT2012 Conference, South Korea.
IN PROGRESS	Aerosol generation with different size distribution and radon decay product in air measurement.
PUBLICATION	
ADDRESS	ENEA Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti Centro Ricerche Casaccia P.O. Box 2400 - Roma (Italy)
	Phone: +39 06 3048 3084 Fax: +39 06 3048 4650 francesco.cardellini@enea.it
	Phone: +39 06 3048 3580 Fax: +39 06 3048 355 pierino.defelice@enea.it
CONTACT	F. Cardellini, P. De Felice

LABORATORY	ENEA - Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI) - Italy.
NAMES	G. Cotellessa, M. Capogni, P. De Felice
APPARATUS	CR-39 solid state nuclear tracks detectors
ACTIVITY	Metrological characterization of alpha particle detection with CR-39 detectors.
RESULTS	A new analysis technique was developed for track counting of alpha particles emitted by a ²²² Rn gas source and alpha emitting plutonium isotopes.
IN PROGRESS	Study of experimental aspects concerning α -particle detection by using CR-39 detectors.
PUBLICATION	A patent request is being submitted for the new analysis technique.
ADDRESS	ENEA Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti Centro Ricerche Casaccia P.O. Box 2400 - Roma (Italy)
	Phone: +39 06 3048 3084
	Fax: +39 06 3048 4650 giuseppe.cotellessa@enea.it
	Phone: +39 06 3048 6628
	Fax: +39 06 3048 4650 marco.capogni@enea.it
	Phone: +39 06 3048 3580
	rax: +39.06.3048.355 pierino.defelice@enea.it
CONTACT	G. Cotellessa

LABORATORY	ENEA - Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI) - Italy.
NAMES	M. Capogni, M. D'Arienzo
APPARATUS ACTIVITY	Cerenkov TDCR counting system Participation in MetroMRT EMRP Project. Application of
	the TDCR technique to the metrology of high-energy beta emitting radionuclides by using the Cerenkov light
RESULTS	New measurements are in progress for the Y-90 activity determination by three ENEA TDCR systems (Hidex 300SL, portable and fixed TDCR systems)
IN PROGRESS	Participation in WP1 and WP2 of the Joint Research Project "MetroMRT".
ADDRESS	ENEA Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti Centro Ricerche Casaccia P.O.Box 2400 - Roma (Italy)
	<u>marco.capogni@enea.it</u> Phone: +39 06 3048 6628 Fax: +39 06 3048 4650
	marco.darienzo@enea.it Phone: +39 06 3048 4118 Fax: +39 06 3048 3580

CONTACT M. Capogni, M. D'Arienzo

LABORATORY	National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology (NMIJ/AIST)
NAMES	Akira YUNOKI, Yasushi SATO and Yasuhiro UNNO
ACTIVITY	Calibrations of activity by using the following apparatus; $4\pi\beta(pc)-\gamma(NaI)$ and $4\pi\beta(ppc)-\gamma(Ge)$ coincidence systems, Calibrated $4\pi\gamma$ ionisation chamber, HP-Ge and Si(Li) detectors, Liquid scintillation system, NaI(Tl) well-type counter, PIPS for α counting and 2π multi wire chamber, Length-compensated internal gas counting system.
KEYWORDS	Alpha spectrometry, beta spectrometry, coincidence method, data evaluation, data measurement, gamma-ray spectrometry, gas proportional counter, ionisation chamber, liquid scintillation, low-level, NaI well-type counter, radioactive gas, SIR, source preparation, traceability, X-ray spectrometry
RESULTS	(1) We have developed a certified reference material of Cs-134 and Cs-137 in brown rice grain.
	(2) We have developed a reference air kerma standard for brachytherapy sources of I-125.
	(3) We participated in CCRI(II).RI(II)-K2.Tc-99, CCRI(II)-S9 and CCRI(II)-S10.
PUBLICATIONS	 Y. Unno, A. Yunoki, T. Kurosawa, T. Yamada, Y. Sato, Y. Hino, "MEASUREMENT OF ANISOTROPIC ANGULAR DISTRIBUTIONS FOR I-125 BRACHYTHERAPY SOURCES", APPLIED RADIATION AND ISOTOPES, Vol. 70, No. 9, pp. 2240-2242 (2012). Y. Sato, et.al., "Remote Calibration of Ionization Chambers for Radioactivity Calibration", JOURNAL OF NUCLEAR SCIENCE AND TECHNOLOGY, Vol.49, No.8, 873-879 (2012).
IN PROGRESS	 (1) Improvement of a radioactive gas standard. (2) Development of reference materials of Cs-134 and Cs-137 in other matrices.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Radioactivity and Neutron Section, Quantum Radiation Division, National Metrology Institute of Japan.
	Central2,1-1-1 Umezono Tsukuba, Ibaraki 305-8568, JAPAN.
CONTACT	Akira Yunoki (e-mail: <u>a.yunoki@aist.go.jp</u>)

LABORATORY	Laboratory of Radioactivity Standards National Centre for Nuclear Research Radioisotope Centre POLATOM
NAMES	R. Broda, D. Cacko, T. Dziel, A. Jeczmieniowski, E. Kolakowska, M. Leszczyńska, A. Listkowska, A. Muklanowicz, A. Patocka, Z. Tymiński, T. Ziemek
ACTIVITY	25 th Annual Congress of the European Association of Nuclear Medicine, October 27-31, 2012, Milan, Italy
	13 th Congress of the Polish Association of Nuclear Medicine, September 19-22, 2012, Kielce, Poland
	LSC Working Group Meeting, November 26-27, 2012, PTB, Braunschweig
	Life Science Working Group Meeting, November 28-29, 2012, PTB, Braunschweig
	CCRI(II)-K2.Tc-99 key comparison of the activity concentration of the same Tc-99 solution
	CCRI(II)-S10 supplementary comparison of measurement of source emission rate for the calibration of surface contamination monitors
	EURAMET Joint Research Project ENV09 MetroRWM "Metrology for radioactive waste management" (13 JRP-Partners; coordinator: CMI Czech Republic)
	EURAMET Joint Research Project IND04 MetroMetal "Ionizing radiation metrology for the metallurgical industry" (14 JRP-Partners; coordinator: CIEMAT Spain)
KEYWORDS	Alpha spectrometry, beta spectrometry, (anti) coincidence method, TDCR method, EURAMET, gamma-ray spectrometry, ionisation chamber, liquid scintillation, NaI well-type counter, proportional counter, radiochemistry, simulation code, SIR, source preparation, traceability, X-ray spectrometry
RESULTS	New computer programs for the TDCR method: TDEMI8 for β - γ emitters and TDCR-C2 (in C++ language) for β -emitters.
	Extending the accreditation scope for X- and γ -spectrometry measurements.
	Development of quality documentation for radiopharmaceutical precursors $^{90}\mathrm{YCl}_3$ and $^{177}\mathrm{LuCl}_3.$
PUBLICATIONS	B.E. Zimmerman, T. Altzitzoglou, A. Antohe, A. Arinc, E. Bakhshandeiar, D.E. Bergeron, L. Bignell, C. Bobin, M. Capogni, J.T. Cessna, M.L. Cozzella, C.J. da Silva, P. De Felice, M.S. Dias, T. Dziel, A. Fazio, R. Fitzgerald, A. Iwahara, F. Jaubert, L. Johansson, et al. "Results of an international comparison for the activity measurement of ¹⁷⁷ Lu", Applied Radiation and Isotopes, Volume 70, Issue 9, September 2012, Pages 1825-1830
	R. Broda, T. Dziel, A. Muklanowicz, "Standardization of a ⁸⁵ Sr solution by three methods", Applied Radiation and Isotopes, Volume 70, Issue 9, September 2012, Pages 2222-2226
IN PROGRESS	Development and construction of a new $4\pi(LS)-\gamma$ coincidence and anticoincidence system (TDKG) with a TDCR detector in LS-channel and NaI(Tl) – in γ -channel with a FPGA-based digital platform.
	Participation in SIR comparison of ¹³⁴ Cs and ⁵⁷ Co.
	Comparison of ⁸⁹ Sr and ⁹⁰ Y activity measurements with Polish hospitals.
	Development of new types of multigamma volume sources with different matrices.

INFORMATION	$4\pi(LS)-\gamma$ coincidence and anticoincidence system
	V v apinaidanaa sustam
	A-Y confictuence system Multivire windowless proportional counter
	Welles 1411 liquid scintillation sounter
	Wallac 1411 liquid scintillation counter
	The Card 2910 TK liquid scintillation counter
	X- and γ -ray spectrometry systems with HPGe detectors
	Ionization chamber systems
	Capintec CRC-15β dose calibrator
	MAD2000 dose rate meter
	Scintillation counters with NaI(Tl) detectors
SOURCE IN	Standardization of ¹⁵³ Sm solution by absolute methods.
PREPARATION	Comparison of ⁹⁰ Y and ⁸⁹ Sr activity measurements in Polish hospitals.
	Development of method for ⁹⁹ Mo purification.
OTHER RELATED	
PUBLICATIONS	
	National Centre for Nuclear Research
ADDRESS	Radioisotope Centre POLATOM
	Andrzeja Soltana 7
	05-400 Otwock, Poland
	tel: +48 22 718 0718
	fax: +48 22 718 0350
	e-mail: t.dziel@polatom.pl, <u>r.broda@polatom.pl</u>
	T. Dziel – laboratory manager
CUNTACT	R. Broda

IFIN-HH, Radionuclide Metrology Laboratory 2012 – 2015 Progress Report and Work Plan (information for ICRM members)

The Radionuclide Metrology Laboratory (RML) from IFIN-HH has the following objectives:

- development of radioactivity standards (installations and methods for standardization), their validation through comparisons, participation at international projects, support for Romanian laboratories involved in activity (becquerel) measurement.

Scientists	Function	
Maria Sahagia, PhD	RML head, Primary Radionuclide Activity Standards	
Aurelian Luca, PhD	RML deputy head, Primary and Secondary Radionuclide Activity	
	Standards	
Constantin Ivan, PhD	IFIN-HH Technical Director, Primary Radionuclide Activity	
	Standards	
Andrei Antohe, PhD	Primary and Secondary Radionuclide Activity Standards	
student		
Razvan Mihail Ioan, PhD	Primary and Secondary Radionuclide Activity Standards	
student		
Neacsu Beatris, PhD	Secondary Radionuclide Activity Standards	
student		
Technician		
Constantin Teodorescu	Sources Preparation, Radon Installation	

IFIN-HH, RML staff in 2011

Main activities in the field

Activity line	IFIN-HH, RML	IFIN-HH, RML
	2012 Progress Report	2013-2015 Work Plan
Development of	- Development of ⁶⁸ Ga and ¹⁸ F,	Development of primary standards
primary	primary standards and study of the	and study of decay scheme for PET:
standards:	decay scheme	¹²⁴ I and for targeted therapy: ⁶⁷ Cu,
installation and		186 Re, 82 Sr- 82 Rb, 177 Lu, 90 Y.
method		
Decay Data	- Participation at the DDEP	Evaluation of the radionuclide ⁵² Fe
Evaluation	Workshop at LNE, Paris, France	
Program (DDEP)		
Development of	- Start of the work for the	Development of a Radon chamber,
secondary	Development of a Radon chamber,	secondary standard for the calibration
standards	secondary standard for the	of the radon measurement
	calibration of the radon	instruments: design, construction,
	measurement instruments	calibration, validation
International	- CCRI(II)-S9 comparison on the	- BIPM.RI(II)-K4.Tc-99m
comparisons	"Determination of radionuclide	comparison using the SIR
	content in a matrix of rice"	Transfer Instrument.
		- CCRI(II)-K2.Rn-222 comparison
	- Large Area Sources Comparison	
	Exercise	
	(ICRM - CCRI(II)-S10_LASCE)	
	- CCRI(II)-K2.Tc-99 comparison	

Accreditation	 National Commission for Attestation of the National Standards Annual accredited laboratory survey, by the national body, RENAR. Extension of accreditation for equipment calibration in users' laboratories QS Management reconfirmed by EURAMET TC-Q 	 National Standard for Radionuclide Activity Unit, Becquerel, in 2013 In 2013 RENAR re accreditation; In 2014 and 2015 RENAR annual surveys Annual QS M report at EURAMET TC-Q and reconfirmation
National QA programmes and services	 Preparation of radioactive standards (liquid solutions, point, surface and volume sources) Calibration of sources and medical radionuclide calibrators; first PET calibrators calibrations Calibration of activity measurement installations, like: gross alpha-beta activity counters , liquid scintillation counters, gamma- ray spectrometers [HPGe and NaI(TI)] 	Preparation of radioactive standards (liquid solutions, point, surface and volume sources) Calibration of sources and radionuclide calibrators Calibration of activity measurement installations, like: gross alpha-beta activity counters, liquid scintillation counters, gamma-ray spectrometers [HPGe and NaI(Tl)]
Membership in international and national organizations	 ICRM, BIPM/CCRI(II), DDEP Scientific Committee, First East European Radon Symposium, FERAS 2012, Cluj-Napoca, Romania, 2-5 Sept.2012 Member editorial scientific board, Romanian journal "Metrologie", published by NMI European Physical Society, Romanian Physical Society Romanian Society for Radiological Protection, IRPA associated society 	 ICRM, BIPM/CCRI(II), DDEP Scientific Committee, 4-st International PT Conf. Brasov, 2013 Member editorial scientific board, Romanian journal "Metrologie", published by NMI Romanian Society for Radiological Protection European Physical Society, Romanian Physical Society Romanian Society for Radiological Protection, IRPA associated society
International projects	 ENG 08 –Metrofission, WP8 IND 04– MetroMetal, WP2;3;5;6;7 Bilateral IFA (Romania) - CEA (France) accord IAEA Research Contract 17442/2012 (Improved nuclear decay data for some new emerging medical isotopes). 	 ENG 08–Metrofission, WP8, organization of a workshop; finalization 2013 IND 04– MetroMetal, WP2;3;5;6;7, 2013 and 2014 Bilateral IFA (Romania) - CEA (France) accord, 2013 – 2015 IAEA Research Contract 17442/2012 (2012-2015)
PhD activities and teaching	- 2 PhD theses (A.Antohe and B.Neacsu), under supervision of M. Sahagia, were presented at the	 4 PhD students, supervision Lectures for specialists in nuclear techniques applications

- Lectures for the National Network

of Environmental Radioactivity

Survey

Bucharest University

techniques applications

- 4 PhD students supervision

- Lectures for specialists in nuclear

LABORATORY	Institutul National de C&D pentru Fizica si Inginerie Nucleara "Horia Hulubei" ("Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering) IFIN-HH; Radionuclide Metrology Laboratory
NAMES	M. Sahagia, C. Ivan
ACTIVITY	 Measurement of ⁹⁹Tc by efficiency tracer method, within the CCRI(II)-K2.Tc-99 comparison Development of ⁶⁸Ga and ¹⁸F primary standard and study of the decay scheme Annual RENAR Accreditation Survey and Extension of accreditation, Certificate: LE/013/2009; Notification, CNCAN Designation LE 05/2009
KEYWORDS	Coincidence method, Efficiency extrapolation, Efficiency tracer, Uncertainty budget, Key comparison; Radionuclides by name (⁹⁹ Tc, ¹⁸ F, ⁶⁸ Ga)
RESULTS	Measurement by using the efficiency extrapolation method. Participation at key comparison and obtaining of standard solutions
PUBLICATIONS	 M. Sahagia, A. Luca, A. Antohe, C. Ivan. Standardization of ⁶⁴Cu and ⁶⁸Ga by the 4πPC-γ coincidence method and calibration of the ionization chamber . Appl. Radiat. Isot. 70, 9 (2012)2025-2030 A. Luca, M. Sahagia, A. Antohe. Measurements of ⁶⁴Cu and ⁶⁸Ga half- lives and gamma-ray emission intensities. Appl. Radiat. Isot. 70, 9(2012)1876-1880 C. Michotte, G. Ratel, S. Courte, R. Fitzgerald, M. Sahagia . Activity measurements of the radionuclide Co-57 for the NIST, USA and the IFIN- HH, Romania in the ongoing comparison BIPM.RI(II)-K1.Co-57 Metrologia 49 (2012) Technical Supplement 06005 B.E.Zimmerman,, A.Antohe,, A.Luca, M.Sahagia, Results of an international comparison for the activity measurement of Lu-177 Appl. Radiat. Isot. 70, 9(2012)1825-1830 E.L. Grigorescu, M. Sahagia, A.C. Wätjen, C. Ivan, A. Luca, A. Antohe. Contribution of the radionuclide metrology laboratory to the improvement of the methods for absolute standardization. 2-nd European Nuclear Physics Conference, Bucharest, Romania, 17-21 Sept.2012
IN PROGRESS	Preparation for the measurement of ⁶⁷ Cu, ¹⁷⁷ Lu, ¹⁸⁶ Re
INFORMATION	
SOURCE IN PREPARATION	 Papers accepted at the ICRM 2013 Conference: M. Sahagia, R. Ioan, A. Luca, A. Antohe, C. Ivan, B. Neacsu, C.Ghioca Standardization of ¹⁸F and its use for the Romanian PET metrological traceability chain assurance M. Sahagia, A. Antohe, R. Ioan, A. Luca, C. Ivan. Standardization of Tc-99 by two methods and participation at the CCRI(II)-K2, Tc-99 comparison

OTHER RELATED PUBLICATIONS	A.Stochioiu, A.Luca, M.Sahagia, R.M.Margineanu, I.Tudor Quality assurance for measuremrents of the radioactivity in the area of the "Horia Hulubei" National Institute for Physics and Nuclear Engineering, IFIN-HH. Journal of Environmental Radioactivity 112(2012)4-7
ADDRESS	IFIN-HH, PO Box MG-6, RO-077125, 30 Reactorului Str., Magurele, Jud. Ilfov, Romania; tel: +4021 4046163, fax: +4021 4574440, +4021 4574945; e-mail: <u>msahagia@nipne.ro</u>
CONTACT	Dr. Maria Sahagia, Razvan Ioan

LABORATORY	Institutul National de C&D pentru Fizica si Inginerie Nucleara		
	"Horia Hulubei" ("Horia Hulubei" National Institute of R&D for Physics		
	and Nuclear Engineering), IFIN-HH. Radionuclide Metrology Laboratory		
	Radionuclide Metrology Laboratory		
NAMES	A. Luca, B. Neacsu		
ACTIVITY	-Calibration of HPGe and Nal(TI) gamma-ray spectrometers for the		
	-Radioactivity analysis for various samples		
	-Extension of RENAR accreditation for equipment calibration in users'		
	laboratories; Accreditation survey, Certificate: LE/013/2009 and		
	LI/804/2009 Notification, CNCAN Designation LE 05/2009.		
KEYWORDS	Gamma-ray spectrometry		
DECITITS	- Doctoral thesis of Beatris Luminita Neacsu. Contribuții la		
KESUL 15	implementarea spectrometriei gama în unele aplicații ale medicinei		
	nucleare și ale metrologiei radionuclizilor (Contributions to the gamma-		
	medicine and radionuclide metrology) Supervisor M Sahagia Bucharest		
	University, Physics Faculty		
	- Participation at the CCRI-(II)-S9 supplementary comparison (2011-2012)		
PUBLICATIONS	<i>1.</i> A. Luca, M. Sahagia, A. Antohe. Measurements of ⁶⁴ Cu and ⁶⁸ Ga		
TODEICATIONS	half-lives and gamma-ray emission intensities, Appl.Radiat.Isot.		
	Isot. 70, 9(2012)1876-1880		
	2. A. Luca, MC. Lepy, "Weasurements of relative photon emission intensities and nuclear decay data evaluation of ¹¹³ Sn".		
	Appl.Radiat.Isot. 70, 9 (2012) 1881-1885.		
	3. U. Wätjen et al., "Results of an international comparison for the		
	determination of radionuclide activity in bilberry material",		
	4. A. Luca, B. Neacsu, A. Antohe, M. Sahagia, "Calibration of the		
	high and low resolution gamma-ray spectrometers". IRPA 13		
	Congress, Glasgow, UK, 13 -18.05.2012. Romanian Reports in		
	Physics 64, 4 (2012) 968-976		
IN PROGRESS	comparison of samples and of Monte Carlo spectrometry programs		
	Measurements on radionuclides: ⁶⁷ Cu, ¹⁷⁷ Lu, ¹⁸⁶ Re		
	Calibration of a new low energy γ - and X-rays spectrometer at IFIN-HH.		
SOURCE IN	Papers submitted to the PT-Conf 4rd International Proficiency Testing		
PREPARATION	Conference, Brasov, Romania, 18-20 September 2013		
	powder reference material.		
	-M. Sahagia, A. Luca, R. Mărgineanu, E. Garcia Toraño, V. Peyrés, M.		
	Mejuto, T. Crespo. Comparison of analysis methods for the		
	characterization of radioactive content of metallurgical slag used within the EURAMET-EMRP IRP IND04 MetroMetal		
	IFIN-HH, PO Box MG-6, RO-077125, 30 Reactorului Str., Magurele.		
ADDKESS	Jud. Ilfov, Romania; tel.: +4021 4046163, fax: +4021 4574440, +4021		
	4574945; e-mail: <u>aluca@nipne.ro</u>		
CONTACT	Dr. Aurelian Luca		

LABORATORY	Institutul National de C&D pentru Fizica si Inginerie Nucleara "Horia Hulubei" ("Horia Hulubei" National Institute of R&D for Physics and Nuclear Engineering), IFIN-HH. Radionuclide Metrology Laboratory
NAMES	M. Sahagia, R.Ioan, A. Antohe, A. Luca
ACTIVITY	 Calibration of the chamber for ⁶⁸Ga and ¹⁸F; Calibration of radioiosotope calibrators of end users with ¹³¹I, ^{99m}Tc, ⁶⁸Ga and ¹⁸F standard solutions Calibration of various sources and solutions. Radionuclide Metrology Laboratory (RML), Ionisation chamber measurement: Annual RENAR accreditation survey, Certificate: LE/013/2009 Notification, CNCAN Designation LE 05/2009
KEYWORDS	Ionisation chamber, Radionuclide by name: ¹³¹ I, ^{99m} Tc, ⁶⁸ Ga and ¹⁸ F
RESULTS	A list of 21 radionuclides calibration factors was obtained.
PUBLICATIONS	1. M. Sahagia, A. Antohe, A.Luca, A. C. Watjen, C. Ivan. "The support offered by the Romanian primary activity standard laboratory to the nuclear medicine field". IRPA 13 Congress, Glasgow, UK, 13 -18.05.2012. In press Romania Journal of Physics, Vol. 58, nos.1-2 (2013)
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	Paper accepted at the ICRM 2013 Conference: - M. Sahagia, R. Ioan, A. Luca, A. Antohe, C. Ivan, B. Neacsu, C.Ghioca Standardization of ¹⁸ F and its use for the Romanian PET metrological traceability chain assurance
OTHER RELATED PUBLICATIONS	
ADDRESS	IFIN-HH, PO Box MG-6, RO-077125, 30 Reactorului Str., Magurele, Jud. Ilfov, Romania; tel.: +4021 4046163, fax: +4021 4574440, +4021 4574945; e-mail: <u>msahagia@nipne.ro</u>
CONTACT	Dr. Maria Sahagia, Razvan Ioan, Antohe Andrei

LABORATORY	Institutul National de C&D pentru Fizica si Inginerie Nucleara "Horia Hulubei" ("Horia Hulubei" National Institute of R&D for Physics and Nuclear Engineering), IFIN-HH. Radionuclide Metrology Laboratory
NAMES	A. Luca
ACTIVITY	-Evaluation of nuclear decay data -Experimental determination of nuclear decay data -Reviewer of the Decay Data Evaluation Project (DDEP) evaluations -Participation at the DDEP 2012 Workshop at LNE, Paris, France, 8-10 October 2012.
KEYWORDS	Nuclear decay data, ⁶⁴ Cu, ⁶⁸ Ga, ¹¹³ Sn, ⁵² Fe
RESULTS	-Experimental determination of half-life and gamma-ray emission intensities for ⁶⁴ Cu and ⁶⁸ Ga; experimental determination of X- and gamma-rays emission intensities and preliminary nuclear decay data evaluation of ¹¹³ Sn (cooperation with CEA, LNE-LNHB)
PUBLICATIONS	 A. Luca, M. Sahagia, A. Antohe. Measurements of ⁶⁴Cu and ⁶⁸Ga half-lives and γ-ray emission intensities, Appl.Radiat.Isot. 70, 9(2012)1876-1880 A. Luca, MC. Lépy, "Measurements of relative photon emission intensities and nuclear decay data evaluation of ¹¹³Sn", Appl.Radiat.Isot. 70, 9 (2012) 1881-1885 MM. Bé et al., "Standardization, decay data measurements and evaluation of ⁶⁴Cu", Appl. Radiat. Isot. 70 9(2012), 1894-1899 A. Luca et al., The European Metrology Research Programme JRP ENG08-MetroFission project and its expected impact in nuclear data improvement, paper presented at the European Nuclear Physics Conference (EuNPC2012), Bucharest, Romania, 17-21 September 2012.
IN PROGRESS	 -Evaluation of nuclear decay data of ⁵²Fe (IAEA, Research Contract 17442/2012) and ¹¹³Sn (DDEP). -IFA Romania – CEA France Joint research project C2-05/2012 NASTEPRAD, <u>http://proiecte.nipne.ro/ifa-cea/3-projects.html</u> -Participation at the ND2013 international conference, 4-8 March 2013, New York, USA
INFORMATION	
SOURCE IN PREPARATION	EURAMET EMRP JRP MetroFission – Nuclear Data Workshop, IRMM, Belgium, June 2013.
OTHER RELATED PUBLICATIONS	
ADDRESS	IFIN-HH, PO Box MG-6, RO-077125, 30 Reactorului Str., Magurele, Jud. Ilfov, Romania; tel: +4021 4046163, fax: +4021 4574440, +4021 4574945; e-mail: <u>aluca@nipne.ro</u>
CONTACT	Dr. Aurelian Luca

LABORATORY	Institutul National de C&D pentru Fizica si Inginerie Nucleara "Horia Hulubei" ("Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering) IFIN-HH Radionuclide Metrology Laboratory
NAMES	
	M. Sahagia, A. Antohe, C. Ivan, P.Cassette
ACTIVITY	- Standardization of TC by the LSC-TDCR method within the key comparison CCRI(II)-K2.Tc-99; the TDCR07c program, offered by P.Cassette, was used
	- Measurement of H-3 and C-14 solutions for applications
	- Calibration of commercial LS Counters
	- Minual KEINAK Accreditation Survey, Certificate. LE/015/2009
	supervision of Marco Capogni within the RMG EURAMET -EMRP-
	ENG08 on development of a fixed LSC-TDCR and on the measurement
	of Rn-222 in water by LSC.
KEYWORDS	LSC-TDCR, Traceability, Radionuclides: Tc-99, H-3, C-14
RESULTS	Doctoral thesis of Andrei Antohe. Contributions at the elaboration of the absolute and relative methods for radon standardization and at the realisation of radon standards (Contributii la elaborarea metodelor absolute si relative de etalonare a radonului si la realizarea de etaloane de radon). Supervisor: M.Sahagia. Bucharest University, Physics Faculty
DUDUCATIONS	- M. Sahagia, A.Luca, A.Antohe, C.Ivan, R.Ioan, B.Neacsu. Realization
PUBLICATIONS	of the metrological traceability chain of Rn-222. First East European Radon Symposium, FERAS 2012, Cluj-Napoca, Romania, 2-5 Sept.2012. In press : ROMANIAN JOURNAL OF PHYSICS. Volume 58, Supplement, 2013, <u>www.nipne.ro/rjp</u> - E.L. Grigorescu, M. Sahagia, A.C. Wätjen, C. Ivan, A. Luca, A. Antohe. Contribution of the radionuclide metrology laboratory to the improvement
	of the methods for absolute standardization. 2-nd European Nuclear Physics Conference, Bucharest, Romania, 17-21 Sept.2012, www.nipne.ro/eunpc2012
IN PROGRESS	The realisation of the Radon chamber for the calibration of the equipment used in its measurement, Contract no. 741/2012, national Research Project: CARSTEAM <u>http://proiecte.nipne.ro/pn2/141-proiecte.html</u> Measurement of ²²² Rn vials for Radon chamber project
SOURCE IN PREPARATION	 Papers accepted at ICRM 2013 Conference : M. Sahagia, A. Antohe, R. Ioan, A. Luca, C. Ivan. Standardization of Tc-99 by two methods and participation at the CCRI(II)-K2,Tc-99 comparison Andrei Antohe, Marco Capogni, Francesco Cardellini Radon in water
	activity measurements by new ENEA fixed TDCR system
ADDRESS	IFIN-HH, 30 Reactorului Str., Magurele, Ilfov County, POB. MG 6, Code 077125, Romania
	Tel.: +40214046163, Fax: +40214574432, +40214574440;
	E-mail: msahagia@nipne.ro; antohe@nipne.ro; aluca@nipne.ro
CONTACT	Dr. Maria Sahagia, Andrei Antohe, A.Luca

LABORATORY	Slovak Institute of Metrology (SMU), Department of Ionizing Radiations, Laboratory of Activity of Radionuclides
NAMES	Robert Hinca, Andrej Javorník, Matej Krivošík, Anton Švec
ACTIVITY	 National standard of radionuclide activities maintenance and development Type testing, calibration and instrument verification services Research and development of instrumentation and measuring procedures
KEYWORDS	environmental control, Euromet, gamma-ray spectrometry, ionisation chamber, life sciences, liquid scintillation, NaI well-type counter, SIR
RESULTS	Participation in the CCRI(II) intercomparison LASCE
PUBLICATIONS	Švec A., Photon energy conversion efficiency in gamma-ray spectrometry. Appl. Radiat. Isot., waiting for printing
IN PROGRESS	Participation in EMRP projects (ENG08, ENV09 and IND04), LSC TDCR instrument and method implementation, area source activity measurements, gamma-ray spectrometry
INFORMATION	
SOURCE IN PREPARATION	Švec A., Javorník A.: An advanced method of determining the activity of beta emitting large area sources. A contribution prepared for the ICRM 2013 conf.
OTHER RELATED PUBLICATIONS	
ADDRESS	Slovak Institute of Metrology, Center for Ionizing Radiations, Karloveská 63, 842 55 Bratislava, Slovak Republic
	Tel.: +421 2 60294 657, Fax.: +421 2 60294 670
	e-mail: dobrovodsky@smu.gov.sk, svec@smu.gov.sk
CONTACT	Jozef Dobrovodský, Head of the Department

Proposals : SMU operates a brand new (commercial) TDCR LSC instrument and prepares it for an intercomparison, maybe 68 Ge – 68 Ga (this year) or 64 Cu (next year?). We are searching for a more experienced cooperating laboratory willing to join the project and share the organizational effort.

JOŽEF STEFAN INSTITUTE, Laboratory for Radiological Measuring Systems and Radioactivity Measurements (LMR), Laboratory for Liquid Scintillation Spectrometry (LSC)

2011-2013 Progress Report and Work Plan

(information for ICRM members)

The programmes at the Jožef Stefan Institute, Laboratory for Radiological Measuring Systems and Radioactivity Measurements and Laboratory for Liquid Scintillation Spectrometry in the field of radionuclide metrology in the years 2011-2013 were and will be focused, as in the past, on maintaining and developing gamma-ray spectrometry method and liquid scintillation spectrometry, participation in characterisation of reference material (i.e. intercomparison samples) and quality-assurance in radioactivity measurements.

The Jožef Stefan Institute, Laboratory for Radiological Measuring Systems and Radioactivity Measurements (LMR) and Laboratory for Liquid Scintillation Spectrometry (LSC) staff in 2012 is the following:

Scientists	Function	
Branko Vodenik	Head of Laboratory for Radiological Measuring Systems	
	and Radioactivity Measurements, gamma-ray	
	spectrometrist	
Jasmina Kožar Logar	Head of Laboratory for Liquid Scintillation Spectrometry	
Denis Glavič-Cindro	Quality manager and gamma-ray spectrometrist	
Benjamin Zorko	Gamma-ray spectrometrist	
Marijan Nečemer	Gamma-ray spectrometrist and sample preparation	
	(radiochemist)	
Boštjan Črnič	Gamma-ray spectrometrist	
Matjaž Korun	Consultant (retired)	
Technicians		
Drago Brodnik	Sampling, equipment maintaining	
Sandi Gobec	Sampling	

The main specific activities carried out at IJS (LMR and LSC) in this field are summarised below

Activity line	IJS, LMR and LSC 2011-2012 Progress report	IJS, LMR and LSC 2013 Work plan
Improvement of measuring methods and instrumentation	 Traceability in gamma-ray spectrometry Measurements of ¹⁰⁶Ru in thin samples Interpretation of measurement results near the detection limit in gamma-ray and liquid scintillation spectrometry Coincidence summing between X-rays and conversion electrons in ¹³⁷Cs 	 Determination of tritium and members of the uranium and thorium decay in ground- water samples using gamma- ray spectrometry and liquid scintillation spectrometry Implementation of methods for quantitative interpretation of gamma-ray spectrometric measurement results near the natural limit (zero activity)

	 Characterisation of the background in high-resolution gamma-ray spectrometers for the contributions of the members of the uranium and thorium decay series Improvement of the sensitivity of gamma-ray spectrometric measurements of water samples 	 Development of activity measurements of bulk samples on the basis of self-attenuation of gamma-rays Validation of a method for a radon tight sample preparation for gamma-ray spectrometry
International comparisons	 Participation in supplementary comparison on measurement of the activity concentration of Cs-137 and K-40 in rice material CCRI(II)-S9 Characterization of the IAEA-455 Korean soil and IAEA-377 Soil (Feb. 2012) 	 Participation in other available interlaboratory comparison
National QA programmes and services	 Collaboration with IAEA (characterisation of reference materials – phosphogypsum, Korean soil) 	 Collaboration with IAEA (characterisation of other reference materials)
Membership in international and national organisations	 ICRM EURAMET TC-IR SIST/TC UGA (National Standardisation Organisation) 	 ICRM EURAMET TC-IR SIST/TC UGA (National Standardisation Organisation)
Management and Organization	 European Projects: (EMRP Call 2010 Industry and Environment) European Projects: (EMRP Call 2012 Industry) 	 European Projects (EMRP 2010): MetroRWM and MetroMetal European Project (EMRP 2012): MetroNORM
Teaching activity	 Lectures for national users given at IJS Invited lectures (IAEA) 	 Lectures for national users given at IJS Invited lectures
Quality system	 Management of Quality System 	 Improvement of Quality System

LABORATORY	Laboratory for Radiological Measuring Systems and Radioactivity Measurements, Laboratory for Liquid Scintillation Spectrometry	
NAMES	Denis Glavič-Cindro, Branko Vodenik, Jasmina Kožar Logar, Benjamin Zorko, Marijan Nečemer, Boštjan Črnič, Matjaž Korun, Drago Brodnik, Sandi Gobec	
KEYWORDS	gamma-ray spectrometry, liquid scintillation, beta spectrometry, X-ray spectrometry, EURAMET, environmental control	
ACTIVITY	Participation in supplementary comparison on measurement of the activity concentration of Cs-137 and K-40 in rice material CCRI(II)-S9	
RESULTS	-	
PUBLICATIONS	KORUN, Matjaž, MAVER, Petra, <i>Coincidence summing between X-rays and conversion electrons in</i> ¹³⁷ Cs, Appl. Radiat. Isot. (2011)	
	KORUN, Matjaž, KOVAČIČ, Katarina, <i>Determination of the</i> ²³⁸ U in ground- water samples using gamma-ray spectrometry, Appl. Radiat. Isot. 69 (2011) 636-640	
	MAVER, Petra, KORUN, Matjaž, MARTELANC, Matej, VODENIK, Branko, <i>A comparative study of the radon-induced background in low-level</i> <i>gamma-ray spectrometers</i> . Appl. Radiat. Isot. 70 (2012) 324-331	
	KORUN, Matjaž, MAVER MODEC, Petra, VODENIK, Branko, ZORKO, Benjamin, <i>Uranium-induced background of germanium gamma-ray</i> <i>spectrometers</i> , Applied Radiation and Isotopes, 70 (2012) 1480 – 1484	
	KORUN, Matjaž, VODENIK, Branko, Zorko Benjamin, <i>Evaluation of</i> gamma-ray spectrometric results near the decision threshold, Applied Radiation and Isotopes, 73 (2013) 1–8	
	KORUN, Matjaž, VODENIK, Branko, ZORKO Benjamin, <i>Probability of Type-I errors in the peak analyses of gamma-ray spectra</i> , Appl. Radiat. Isotopes, 72 (2013) 58–63	
	KORUN, Matjaž, KOVAČIČ, Katarina, KOŽAR LOGAR, Jasmina. Concentration of tritium and members of the uranium and thorium decay chains in ground water in Slovenia and their implications for managing ground water resources.In: International Symposium on Isotopes in Hydrology, Marine Ecosystems, and Climate Change Studies, Monaco, 27 March-1 April 2011, Abstracts, Vienna: International Atomic Energy Agency, 2011	
	MALI, Nina, KOŽAR LOGAR, Jasmina, LEIS, Albrecht. <i>Isotope</i> <i>investigations of groundwater movement in a coarse gravel unsaturated zone</i> . V: International Symposium on Isotopes in Hydrology, Marine Ecosystems, and Climate Change Studies, Monaco, 27 March-1 April 2011, Abstracts, Vienna: International Atomic Energy Agency, 2011	
	KRIŠTOF, Romana, KOŽAR LOGAR, Jasmina. <i>Quenching parameter in the measurement of biodiesel by liquid scintillation counting</i> . V: CASSETTE, Philippe (editor). LSC 2010, advances in liquid scintillation spectrometry : proceedings of the 2010 International Liquid Scintillation Conference, Paris, France, 6-10 September 2010, Radiocarbon, 35-39 (2011)	

	ZORKO, Benjamin, FAJFAR, Helena, BRODNIK, Drago, NEČEMER, Marijan, ČRNIČ, Boštjan, VODENIK, Branko. <i>Upgrade of low-temperature</i> <i>evaporator for sample preparation</i> , The 7th International Conference on Instrumental Methods of Analysis Modern Trends and Applications, 18-22 September 2011, Chania, Crete, Greece. IMA 2011
	BUČAR, Klemen, KORUN, Matjaž, VODENIK, Branko. Influence of the thorium decay series on the background of high-resolution gamma-ray spectrometers, Applied Radiations and isotopes, 70 (2012) 1005 – 1009
	KORUN, Matjaž, MAVER MODEC, Petra, VODENIK, Branko. Interpretation of the peak areas in gamma-ray spectra that have a large relative uncertainty, Applied Radiations and Isotopes, 70 (2012) 999 – 1004
	KORUN, Matjaž, ZORKO, Benjamin, Reporting measurement results of activities near the natural limit: ote and extension of the article "Interpretation of measurement results near the detection limit in gamma-tay spectrometry using Bayesian statistics", DOI information: 10.1007/s00769-013-0963-1
IN PROGRESS	Participation in the European Projects (EMRP 2010): MetroRWM and MetroMetal.
	In MetroMetal project IJS is engaged at WP3, WP5, WP6 and WP7 and is leader of working package WP5 which includes evaluation of the prototype spectrometric devices produced in WP4 and the methods developed in WP1 at end-user facilities.
	In MetroRWM project IJS is engaged at WP1, WP6 and WP7, WP1 includes Development of standardised traceable measurement methods for solid radioactive waste clearance (free release) and disposal.
	Participation in preparation of the MetroNORM (EMRP Call 2012 Industry) aimed at developing standardized and traceable measurement methods for NORM industry.
	Continuation of work on empirical evaluation of the probability of Type I and Type II errors in gamma-ray spectrometry, censoring in gamma-ray spectrometry, estimation of shielding factors for description of the influence of the sample material on the spectrometer background, statistical methods for analysis of measurement results.
	Evaluation and optimisation of electrolytic enrichment, statistical methods of measurement results, estimation of seasonal variation of radon on spectrometer background, optimisation of measurement conditions in LSC counter, influence of temperature on LSC measurements.
INFORMATION	-
SOURCE IN PREPARATION	GLAVIČ-CINDRO, Denis, KOŽAR LOGAR, Jasmina, BENEDIK Ljudmila, VODENIK, Branko, ZORKO, Benjamin. <i>Detection of Fukushima plume</i> <i>within regular Slovenian environmental radioactivity surveillance</i> , presented at ICRM.LLRMT 2012 in Jeju, Korea
	GLAVIČ-CINDRO, Denis, KOŽAR LOGAR, Jasmina, VARLAM Carmen, FAURESCU Ionut, VAGNER Irina, <i>Slovenian – Romanian bilateral</i> <i>intercomparison on tritium samples</i> , will be presented at ICRM 2013 conference in Antwerpen, Belgium
	KORUN, Matjaž, VODENIK Branko, ZORKO Benjamin, <i>Determination of</i> <i>shielding factors for gamma-ray spectrometers</i> , will be presented at ICRM 2013 conference in Antwerpen, Belgium

	KOŽAR LOGAR, Jasmina, Slovenian alarm and monitoring networks. V: Chernobyl 25 anni dopo: studi, riflessioni e attualità, 21-22-23 giugno 2011, Udine = 25 years after the Chernobyl accident: studies, remarks and recent finding, June 21-22-23, 2011, Udine, Italy. Abstracts. [S. l.: s. n.], 2011, str. 30
	KOŽAR LOGAR, Jasmina, NEČEMER, Marijan, VOGEL-MIKUŠ, Katarina, VODENIK, Branko, GLAVIČ-CINDRO, Denis. <i>Fukushima accident through Slovenian monitoring</i> . V: Chernobyl 25 anni dopo: studi, riflessioni e attualità, 21-22-23 giugno 2011, Udine = 25 years after the Chernobyl accident: studies, remarks and recent finding, June 21-22-23, 2011, Udine, Italy. Abstracts. [S. l.: s. n.], 2011, str. 48
	KORUN, Matjaž, VODENIK, Branko, ZORKO, Benjamin, <i>Reporting gamma-ray spectrometric results near the natural limit</i> , Submitted for publication in Journal of Environmental radioactivity
OTHER RELATED PUBLICATIONS	_
ADDRESS	Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia Tel. +386 1 4773900, Fax +386 1 251 93 85 E-mail: <u>denis.cindro@ijs.si</u>
CONTACT	Denis Glavič-Cindro

LABORATORY	National Metrology Institute of South Africa (NMISA)	
NAMES	M.J. van Staden, W.M. van Wyngaardt, J. Lubbe, B.R.S. Simpson	
ACTIVITY	Absolute standardization of radionuclides by liquid scintillation counting (TDCR, CNET and 4π (LS) β - γ coincidence counting). Participated in CCRI(II)-K2.Tc-99.	
	Established capability for low-level measurements by HPGe. Participated in CCRI(II)-S9 supplementary comparison of the measurement of the activity concentration of ¹³⁷ Cs and ⁴⁰ K in rice material.	
KEYWORDS	Liquid scintillation counting, TDCR, CNET, $4\pi(LS)\beta-\gamma$ coincidence counting, Low-level counting, HPGe	
RESULTS	CCRI(II)-K2.Pu-241, BIPM.RI(II)-K1.Cs-134, BIPM.RI(II)-K1.Cs-137	
PUBLICATIONS	van Wyngaardt, van Staden, Lubbe, First participation by the NMISA in a low- level comparison: CCRI(II)-S9 exercise. Appl. Radiat. Isot. (2013), http://dx.doi.org/10.1016/j.apradiso.2013.03.005i	
	van Wyngaardt, Simpson, van Staden, Lubbe, Absolute standardization of Pu- 241 by the TDCR technique and effect of the beta spectral shape. Appl. Radiat. Isot. 70 (2012) 2188.	
	Simpson, van Staden, Lubbe, van Wyngaardt, Accurate activity measurement of Lu-177 by the liquid scintillation $4\pi\beta$ - γ coincidence counting method. Appl. Radiat. Isot. 70 (2012) 2209.	
	Zimmerman, et al., Results of an international comparison for the activity measurement of ¹⁷⁷ Lu. Appl. Radiat. Isot. 70 (2012) 1825.	
	van Wyngaardt, van Staden, Simpson, Lubbe, 2011. Absolute standardization of ¹³⁷ Cs and ¹³⁴ Cs. In: Cassette, P. (Ed.), LSC 2010. Advances in Liquid Scintillation Spectrometry. Radiocarbon, Tucson, AZ, 181.	
IN PROGRESS	Measurement of I-125	
INFORMATION		
SOURCE IN PREPARATION	Standardization of Tc-99 by three liquid scintillation counting methods and confirmation of the beta spectral shape (ICRM 2013)	
OTHER RELATED PUBLICATIONS		
ADDRESS	NMISA Radioactivity Standards Laboratory, 15 Lower Hope Road, Rosebank 7700 Cape Town, SOUTH AFRICA	
CONTACT	Freda van Wyngaardt Tel. 0027 21 685 7776, fax 0027 21 686 2759 E-mail : fvwyngaardt@nmisa.org	

LABORATORY	CIEMAT - Laboratorio de Metrología de Radiaciones Ionizantes	
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta	
ACTIVITY	Standardization and nuclear data measurement of radionuclides with PET applications.	
KEYWORDS	Coincidence method, gamma-ray spectrometry, gas proportional counter, ionisation chamber, NaI well-type counter, liquid scintillation, PET nuclides.	
RESULTS	Standardization of Ga-68 in cooperation with LMRI (CNEA, Argentina)	
PUBLICATIONS	Miguel Roteta, Virginia Peyres, Leonor Rodríguez Barquero, Eduardo García- Toraño, Pablo Arenillas, Christian Balpardo, Darío Rodrígues, Roberto Llovera, 2012. Standardization of Ga-68 by coincidence measurements, liquid scintillation counting and $4\pi\gamma$ counting. Applied Radiation and Isotopes (70 (9) 2006.	
IN PROGRESS	Measurement of the half-life of Ga-68 (To be presented at the next ICRM conference in Antwerp, Belgium)	
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS	Eduardo García-Toraño, Virginia Peyrés Medina, Miguel Roteta Ibarra. 2010. The half-life of ¹⁸ F. Applied Radiation and Isotopes, 68 (7–8) 1561.	
	Miguel Roteta , Eduardo García-Toraño , Leonor Rodríguez Barquero. 2006. Standardization of ¹⁸ F by coincidence and LSC methods. Applied Radiation and Isotopes, 64 (10–11) 1199.	
	Virginia Peyres, Eduardo García-Toraño. 2011. On the measurement of positron emitters with Ge detectors. Nuclear Instruments and Methods in Physics Research Section A: 637 (1)100.	
ADDRESS	CIEMAT – Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain	
	e.garciatorano@ciemat.es tel: +34 91 346 6225	
	Virginia.peyres@ciemat.estel: +34 91 346 6225	
	Miguel.roteta@ciemat.es tel: +34 91 346 6244	
CONTACT	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta	

LABORATORY	CIEMAT - Laboratorio de Metrología de Radiaciones Ionizantes	
NAMES	M. Teresa Crespo	
ACTIVITY	Standardization of alpha emitters by 2π counting with ionization chambers and defined solid angle counting.	
	Improvements in source preparation for alpha spectrometry.	
	Environmental and geological applications of alpha spectrometry.	
KEYWORDS	Alpha spectrometry, low-level, radiochemistry, source preparation, traceability,	
RESULTS	Dissemination of standards to external laboratories.	
	Optimization of an electrodeposition procedure for the production of ²³⁸ U sources for high-resolution alpha-particle spectrometry.	
PUBLICATIONS	 Evolution of chemical species during electrodeposition of uranium for alpha spectrometry by the Hallstadius method. A.M. Beesley, M.T. Crespo, N. Weiher, N. Tsapatsaris, J.S. Cózar, H. Esparza, C. G. Méndez, P. Hill, S.L.M. Schroeder, M.E. Montero-Cabrera. Applied Radiat. Isot. 67 (2009) 1559-1569. Synchrotron radiation study of the uranium chemical species electrodeposited for alpha spectrometry sources. D. C. Burciaga-Valencia, C. G. Méndez, H. Esparza-Ponce, A. M. Beesley, M. T. Crespo, L. Fuentes-Cobas, L. Fuentes-Montero, M. E. Montero-Cabrera. Revista Mexicana de Física "S" (2011) 57(1) 21-29. 	
	A review of electrodeposition methods for the preparation of alpha-radiation sources. M.T. Crespo. Applied Radiat. Isot. 70 (2012) 210-215.	
IN PROGRESS	Optimization of the parameters affecting electrodeposition of actinides.	
	Alpha spectrometry U/Th dating of carbonate samples.	
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS		
ADDRESS	CIEMAT – Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain	
	<u>teresa.crespo@ciemat.es</u> tel: +34 91 346 6553/6765	
CONTACT	M. Teresa Crespo	

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LABORATORY	CIEMAT - Laboratorio de Metrología de Radiaciones Ionizantes		
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta, Teresa Crespo, Marcos Mejuto		
ACTIVITY	Coordination of the EMRP project "IND04 MetroMetal: Ionising radiation metrology for the metallurgical industry" and participation in two others: "MetroFission" (coordinated by NPL) and "MetroRWM" (coordinated by CMI)		
KEYWORDS	Alpha spectrometry, beta spectrometry, coincidence method, data measurement, gamma-ray spectrometry, gas proportional counter, ionisation chamber, liquid scintillation, low-level, NaI well-type counter, radiochemistry, source preparation		
RESULTS			
PUBLICATIONS	F.J. Maringer at al., Radioactive waste management: review on clearance levels and acceptance criteria legislation, requirements and standards. Accepted for publication in ARI.		
	Viktor Jobbágy, M. Teresa Crespo, Raf Van Ammel, Maria Marouli, André Moens, Stefaan Pommé, Eduardo García-Toraño. Preparation of high-resolution 238U α -sources by electrodeposition: a comprehensive study, accepted for publication in Journal of Radioanalytical and Nuclear Chemistry.		
IN PROGRESS	Preparation of slag sources contaminated with Ra-226 and design of new instruments for measuring contaminated material at steel factories (MetroMetal); detailed simulation of measuring facilities, Half-life determination of I-129 and Ho-166m (Metro RWM); Measurement of P α of U-238, digital acquisition systems for coincidence measurements (MetroFission)		
INFORMATION			
OTHER RELATED PUBLICATIONS	M. Mejuto, T. Crespo, V. Peyres, E. García-Toraño, L. Pérez del Villar, "Metodología para la caracterización y trazado radiactivo de un material de referencia para el control radiactivo en acerías", submitted to the annual meeting of the Sociedad Española de Física Médica / Sociedad Española de Protección Radiológica.		
ADDRESS	CIEMAT – Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain		
	e.garciatorano@ciemat.es	tel: +34 91 346 6225	
	Virginia.peyres@ciemat.es	tel: +34 91 346 6225	
	Miguel.roteta@ciemat.es	tel: +34 91 346 6244	
	teresa.crespo@ciemat.es	tel: +34 91 346 6553/6765	
	marcos.mejuto@ciemat.es	tel: +34 91 346 6244	
CONTACT	Eduardo García-Toraño		

LABORATORY	CIEMAT - Laboratorio de Metrología de Radiaciones Ionizantes	
NAMES	Eduardo García-Toraño, Virginia Peyrés (in cooperation with LNHB and University of Barcelona)	
ACTIVITY	Building an interface between the simulation code "PENELOPE" and the data base "NUCLEIDE"	
KEYWORDS	Simulation code, nuclear data, PENELOPE, NUCLEIDE	
RESULTS	The first version of a routine that allows direct implementation of NUCLEIDE data into the simulation code PENELOPE is running	
PUBLICATIONS		
IN PROGRESS	Testing the package for a number of input data files from NUCLEIDE	
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS		
ADDRESS	CIEMAT – Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain	
	e.garciatorano@ciemat.es tel: +34 91 346 6225	
	Virginia.peyres@ciemat.es tel: +34 91 346 6225	
CONTACT	Eduardo García-Toraño	

LABORATORY	CIEMAT - Laboratorio de Metrología de Radiaciones Ionizantes	
NAMES	Giuseppe Lacerenza, Eduardo García-Toraño	
ACTIVITY	Design and construction of an absolute proportional counter for X-rays of low energy	
KEYWORDS	X-ray spectrometry, defined solid angle counting.	
RESULTS		
PUBLICATIONS		
IN PROGRESS	Feasibility tests and preliminary design finished. Instrument under construction	
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS		
ADDRESS	CIEMAT – Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain	
	Giuseppe.Lacerenza@ciemat.es tel : +34 91 346 6226	
	e.garciatorano@ciemat.es tel :+34 91 346 6225	
CONTACT	Giuseppe Lacerenza	

LABORATORY	CIEMAT - Laboratorio de Metrología de Radiaciones Ionizantes	
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta, Teresa Crespo, Marcos Mejuto, Anabel Sánchez-Cabezudo	
ACTIVITY	Standardization of alpha-, beta- and gamma-emitting sources for external clients	
	Calibration of surface contamination	monitors
KEYWORDS	Alpha spectrometry, beta spectrometry, coincidence method, data measurement, gamma-ray spectrometry, gas proportional counter, ionisation chamber, liquid scintillation, low-level, NaI well-type counter, radiochemistry, source preparation	
RESULTS		
PUBLICATIONS		
IN PROGRESS		
INFORMATION		
SOURCE IN PREPARATION		
OTHER RELATED PUBLICATIONS		
ADDRESS	CIEMAT – Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain	
	e.garciatorano@ciemat.es	tel: +34 91 346 6225
	Virginia.peyres@ciemat.es	tel: +34 91 346 6225
	Miguel.roteta@ciemat.es	tel: +34 91 346 6244
	teresa.crespo@ciemat.es	tel: +34 91 346 6553/6765
	anaisabel.sanchez@ciemat.es	tel: +34 91 346 6566
	marcos.mejuto@ciemat.es	tel: +34 91 346 6244
CONTACT	Virginia Peyrés (gamma measurem (calibration of contamination monito Anabel Sanchez-Cabezudo (LSC Medicine, LSC)	ents), Miguel Roteta and Marcos Mejuto ors), Teresa Crespo (alpha measurements), C), Eduardo García-Toraño (Nuclear

NRSL/INER, Radionuclide Metrology 2011-2014 Progress Report and Work Plan

The radionuclide metrology programmes at the National Radiation Standard Laboratory (NRSL/INER) in the years 2011-2014 were and will be focused, as in the past, on maintaining and developing the national standards for activity measurements.

The NRSL/INER Radionuclide Metrology staff members in 2012 were as the following:

Scientist	Function
Bor-Jing Chang	NRSL/INER Head
Jeng-Jong Wang	Programmes Leader, Environment-level
	Radionuclides Standards
Ming-Chen Yuan	Programmes Leader, Primary Standards
Chien-Yung Yeh	Primary Standards, Secondary Standards
Chin-Hsien Yeh	Gamma spectroscopy
Technicians	

The main specific activities carried out at NRSL/INER in the field are summarised below.

Activity line	NRSL/INER Radionuclide Metrology 2011-2012 Progress report	NRSL/INER Radionuclide Metrology 2013-2014 Work plan
Development of primary standards, improvement of measurement methods and instrumentation	 Development of 4πγ[NaI(Tl)] integral counting system for complex gamma radionuclides Eu-152 Standardization 	 Am-241 Standardization NaI well counter's total efficiencies study by Monte-Carlo simulations. 4πγ IC response study by Monte-Carlo simulations.
National QA programmes and services	 Preparation of radioactive standards(liquid source, point source) for internal users Dose calibrator calibration services Annual environment-level and medium- or low-level radionuclides analysis proficiency testing programs 	 Annual environment-level and medium- or low-level radionuclides analysis proficiency testing programs
Membership in International and national organization	• ICRM	• ICRM
Teaching activity		
Quality system	• ISO-17025	• ISO-17025

LABORATORY	National Radiation Standard Laboratory, Institute of Nuclear Energy Research (NRSL/INER TAIWAN)	
NAMES	Ming-Chen Yuan, Chien-Yung Yeh, Chin-Hsien Yeh, Bor-Jing Chang	
ACTIVITY	 Eu-152 standardizations and ionization chamber recalibration. Held the annual environment-level and medium- or low-level radionuclides analysis proficiency testing programs in Taiwan. 	
KEYWORDS	coincidence method, NaI well-type counter, Eu-152	
RESULTS	1. The Eu-152 solution was standardized to the uncertainty 0.53 % by the $4\pi\beta(PC)$ - γ coincidence counting system with one dimensional and two-dimensional extrapolation techniques for the γ gates at 344 keV peak, 1408 keV peak and energy range between 900 to 1520 keV, This result was consistent with the result of the $4\pi\gamma[NaI(TI)]$ integral counting. According to the $4\pi\beta(PC)$ - γ coincidence counting result, a $4\pi\gamma$ pressurised ion chamber was re-calibrated and the calibration figure was 0.5% lower than the original data supplied by NPL.	
	2. 7 labs participated in the environment-level radionuclides analysis proficiency testing program and measured the solution, filters, soil, plants, milk, meat, rice and mushrooms samples. All participants passed the proficiency testing.	
	3. 6 labs joined in the medium- or low-level radionuclides analysis proficiency testing program and H-3 solution samples were measured. All participants passed the proficiency testing with the maximum discrepancy around 10 %.	
IN PROGRESS	 NaI well counter's total efficiencies study by Monte-Carlo simulations. 	
	2. $4\pi\gamma$ IC response study by Monte-Carlo simulations.	
	3. Am-241 radioactivity Standardization and $4\pi\gamma$ IC re-calibration.	
OTHER RELATED PUBLICATIONS	Chien-Yung Yeh, Ming-Chien Yuan, "Calculating Point Sources Gamma Efficiencies for Well-Type NaI(Tl) Detectors", INER REPORT, INER-9652, 2012. (in Chinese)	
	Hui-Mei Peng, Jeng-Jong Wang, A Study of Production of Radioactive Environmental Reference Materials Used for the Proficiency Testing Program in Taiwan, 6th ICRM LLRMT, Jeju, Korea	
	Hsin-Fa Fanga, Chu-Fang Wangb, and Jeng-Jong Wang, An innovative distillation device for tritiated water analysis with high decontamination factor, 6th ICRM LLRMT, Sep. 17-21, Jeju, Korea	
	Huang-Sheng Chiu, Ping-Ji Huang , Jyi-Lan Wuu, Jeng-Jong Wang, Radioactivity Inspection of Taiwan for Food Products Imported from Japan after the Fukushima Nuclear Accident, 6th ICRM LLRMT, Sep. 17-21, Jeju, Korea.	

	Jeng-Jong Wang, A quick liquid scintillation counting technique for analysis of Sr-90 in environment sample, 6th ICRM LLRMT, Sep. 17- 21, Jeju, Korea.
ADDRESS	Heath Physics Division, Institute of Nuclear Energy research, No.1000, Wuuhua Rd., Jiaan Village, Longtan Township, Taoyuan County, 325, Taiwan.
CONTACT	Ming-Chen Yuan (<u>mcyuan@iner.gov.tw</u>)

TAEK-SANAEM, Radionuclide Metrology 2009-2012 Progress Report and Work Plan (information for ICRM members)

The programmes at the Turkish Atomic Energy Authority, Sarayköy Nuclear Research and Training Center, Ionising Radiation Metrology Division (TAEK SANAEM-RMB) in the field of radionuclide metrology in the years 2009-2012 were and will be focused, as in the past, on maintaining and developing the national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

The TAEK-SANAEM Radionuclide Metrology staff in 2012 is the following:

Scientists	Function
Ü. Yücel	TAEK-SANAEM Radiation Metrology Division Head
E. Yeltepe	Radionuclide standardization by gamma spectrometry
N. K. Şahin	Radionuclide standardization by gamma spectrometry
A. Dirican	Radionuclide standardization by alpha spectrometry
M. Seferinoğlu	Radionuclide standardization by alpha spectrometry
N. Aslan	Radionuclide standardization by liquid scintillation
G. Kahraman	Radionuclide standardization by liquid scintillation

The main specific activities carried out at TAEK-SANAEM in this field are summarised below.

Activity line	TAEK-SANAEM	TAEK-SANAEM
	Radionuclide Metrology	Radionuclide Metrology
	2009-2012 Progress report	2013-2014 Work plan
Development of primary standards, Improvement of measuring methods and instrumentation	Completion of the building infrastructure of the metrology laboratories (renovation, air conditioning etc.) Design and installation of alpha particle counting system at defined solid angle, Setting up Compton suppression system	Setting up TDCR Setting up 4-pi –gamma counting system (well type NaI(Tl) detector) Setting up 4-pi –beta (PC)-gamma counting system
International comparisons	Supplementary Comparison Test CCRI(II)-S8 on radionuclide activity measurements in reference materials – Bilberry (Radionuclides: K-40, Cs-137 and Sr-90)	Participation in the SIR (well type ionization chambers at BIPM)
Standardization of measurement methods	Standardization with the ionization chamber Standardization with HPGe detectors Standardization with CIEMAT-NIST method	Standardization with the ionization chamber Standardization with HPGe detectors Standardization with CIEMAT- NIST method Standardization with TDCR method
National QA programmes and services	Collaboration with IAEA (ALMERA Network proficiency tests)	Preparation of radioactive standards for external users, Calibration of radionuclide calibrators with a reference ionization chamber, Organisation of proficiency tests for national laboratories
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Membership in international and national organisations	EURAMET TC IR	ICRM, EURAMET TC IR, CCRI(II)
Teaching activity	Workshops for national laboratories Invited lectures	Workshops for national laboratories Invited lectures
Quality system	Management of Quality System	Improvement of Quality System

LABORATORY	TAEK SANAEM, Radiation Metrology Laboratories
NAMES	Ü. Yücel, E. Yeltepe, N.K. Şahin, A. Dirican, N. Aslan, M. Seferinoğlu, G. Kahraman
ACTIVITY	The staff was trained at IRMM on the standardisation of radionuclides by liquid scintillation, gamma and alpha spectrometry in the scope of the EU project "Improving chemical and ionising radiation metrology in Turkey".
KEYWORDS	Alpha spectrometry, gamma-ray spectrometry, gas proportional counter, liquid scintillation, low-level, radiochemistry, traceability
RESULTS	2009-2012 program: New Radionuclide Metrology Laboratories at SANAEM have been designed and infrastructure works have been completed. Alpha particle counting system at defined solid angle has been designed and installed; Compton suppression system has been set up. The Radiation Metrology Division was established in 2012 at SANAEM. The establishment of a second secondary standard dosimetry laboratory in SANAEM started in 2012 and the laboratory is expected to be in operation by the end of 2014.
PUBLICATIONS	 S. Pommé, E. Yeltepe, et al., "Measurement of the ¹⁷⁷Lu half-life", Appl. Radiat. Isotopes, 69(2011), 1267–1273. M. Hult, E. Andreotti, R. González de Orduña, S. Pommé and E. Yeltepe, "Quantification of Uranium-238 in environmental samples using gamma-ray spectrometry", The European Physical Journal, Web of Conferences, 2012, 24, 7005, M. Marouli, S. Pommé, J. Paepen, R. Van Ammel, V. Jobbágy, A. Dirican, G. Suliman, H. Stroh, C. Apostolidis, K. Abbas, A. Morgenstern, "High-resolution alpha-particle spectrometry of the ²³⁰U decay series", Applied Radiation and Isotopes, 70 (2012), 2270-2274 A. Dirican, P. E. Erden, M. Seferinoğlu, S. Pommé, "The use of solid angle for alpha detector efficiency in ²²⁶Ra analyses of soil samples". Applied Radiation and Isotopes, 70 (2012), 2260-2262. S. Pommé, M. Marouli, G. Suliman, H. Dikmen, R. Van Ammel, V. Jobbágy, A. Dirican, H. Stroh, J. Paepen, F. Bruchertseifer, C. Apostolidis, A. Morgenstern, "Measurement of the 225Ac half-life", Applied Radiation and Isotopes, 70(2012), 2608-2614 U. Wätjen, T. Altzitzoglou, A. Ceccatelli, H. Dikmen, H. Emteborg, L. Ferreux, C. Frechou, J. La Rosa, A. Luca, Y. Moreno, P. Oropesa, S. Pierre, M. Schmiedel, Y. Spasova, Z. Szántó, L. Szücs, H. Wershofen, Ü. Yücel "Results of an international comparison for the determination of radionuclide activity in bilberry material" Applied Radiation and Isotopes, 70 (2012) 1974–1976 L. Karam, M. J.Anagnostakis, A. Gudelis, P. Marsoem, A. Mauring, G. Wurdiyanto, Ü. Yücel "Laboratories new to the ICRM". Applied Radiation and Isotopes, 70 (2012) 1812–1819

	 NI. Seterinogiu "Design of Alpha-Particle Counting System at A Defined Solid Angle for Radionuclide Metrology Laboratory in SANAEM-TURKEY"13th International Symposium on Biological and Environmental Reference Materials (BERM 13), Poster Number: EI-CN-195/161Vienna, Austria, 25-29/06/2012 M.Hult, T. Vidmar, N. Sahin, U.Rosengård, "Measurement of the Lu-176 half-life using the sum-peak method" in preparation N. Aslan, A. Kurt, Ü. Yücel, S. Özvatan, G. Kahraman, N. Kaya, G. Gündoğdu, H. Mert, "Determination of ⁹⁰Sr in Bilberry by Liquid Scintillation Spectrometric Method", International Conference on Nuclear Science and its Applications, Samarkand, Uzbekistan, 25-28/09/2012. M. Seferinoğlu, N. Aslan, A. Kurt, P. E. Erden, H. Mert "Determination of Pu Isotopes in Bilberry By Liquid Scintillation 	
	Spectrometric Method and Alpha Spectrometry, "International	
	Conference on Nuclear Science and its Applications Samarkand	
	Uzbekistan, 25-28/09/ 2012.	
	- Marouli, G. Suliman, S. Pommé, R.Van Ammel, V. Jobbágy, H. Stroh.	
	H. Dikmen, J. Paepen, A. Dirican, F. Bruchertseifer, C. Apostolidis, A.	
	Morgenstern, "Decay data measurements on ²¹³ Bi using recoil atoms",	
	Applied Radiation and Isotopes, Available online 4 January 2013	
IN PROGRESS	2013-2014 work plan:	
INTROUKLSS	Standardization with the ionization chamber,	
	Standardization with HPGe detectors,	
	Standardization with CIEMAT-NIST method,	
	Standardization with TDCR method,	
	Standardization with 4-pi-gamma counting system,	
	Preparation of radioactive standards for external users,	
	Calibration of radionuclide calibrators with a reference ionization	
	chamber,	
	Organization of proficiency tests for national laboratories,	
	Organization of workshops for national laboratories.	
ADDRESS	Sarayköy Nuclear Research and Training Center	
	Saray Mah. Atom Cad. No. 27 Kazan	
	06983 Ankara / TURKEY	
CONTACT	U. Yücel	
	<u>ulku.yucel(a)taek.gov.tr</u>	

LABORATORY	TAEK SANAEM, Radioactivity and Analytical Measurement Laboratories
NAMES	H. Dikmen, S. Yüksek, Y. Ö. Özkök, Y. Ağuş, M. Kaplan, A.T. Bakioğlu, R. Acar, P.E. Erden, M.F. Çınar, A. Kurt, G. Gündoğdu, M. Şengör, H.İ. Kaya, N. Kaya, A. Zararsız, Y. Kalaycı, R. Kırmaz, N.B. Öztaş, E. Çantay
ACTIVITY	 Gross alpha and beta measurements in water, air and other environmental samples by gas proportional counting systems. ³H measurements in water, ⁹⁰Sr measurements in water, food and environmental samples, ¹⁴C measurements in total diet samples by Liquid Scintillation Spectrometry (LSS). ²³⁴U, ²³⁸U, and ²²⁶Ra measurements in environmental samples by alpha spectrometry. Gamma activity measurements in food and environmental samples. Radiocarbon dating of archaeological and geological samples (¹⁴C measurement). Elemental analysis of soil, liquid, powder, bulk form samples by using different types of XRF spectrometer Analysis of uranium isotopes by HR-ICP-MS Participation in international/national comparisons
KEYWORDS	Alpha spectrometry, gamma-ray spectrometry, gas proportional counting system, liquid scintillation spectrometry, low-level, radiochemistry, traceability, x-ray spectrometry
RESULTS	- EPA 900.0 Standard Method "Gross Alpha and Gross Beta in Drinking Water".
	- ASTM D 4107-08 "Standard Test Method for Tritium in Drinking Water".
	- "Determination of Radium Isotopes by BaSO ₄ Coprecipitation for the Preparation of Alpha Spectrometric Sources" method for ²²⁶ Ra radioisotope in water samples.
	- Eichrom ACW02 Coded "Uranium in Water" method for ²³⁴ U, ²³⁸ U radioisotopes in water samples.
	- ASTM E-181 Standard test method for measurement of the activities of gamma-ray emitting ¹³⁴ Cs and ¹³⁷ Cs radionuclides in foodstuffs and K-40, ¹³⁷ Cs, ²²⁶ Ra and ²³² Th radionuclides in building materials and soil samples with high purity Germanium detectors.
	- Experiment Instruction of Na, Mg, Al, Si, K, Ca, Ti, Mn, Fe, P, Sc, V, Cr, Co, Ni, Cu, Zn, As, Rb, Sr, Y, Zr, Nb, Pb, La, Th And U Elements Analysis By WDXRF Spectrometry Experiment methods
	The methods mentioned above were accredited by TURKAK (Turkish Accreditation Agency) on May 2009 according to ISO 17025.
PUBLICATIONS	-Ü. Yücel, N. Aslan, N. Kaya, A. Kurt, E. Yeltepe, H. Mert, "Determination of ⁹⁰ Sr, ¹⁴ C, ¹³⁴ Cs and ¹³⁷ Cs Activities in Total Diet", International Conference on Nuclear Science and its Applications, Samarkand Uzbekistan, 25-28/09/ 2012.

	- F. Oztürk a,*, A. Zararsız b, V.A. Dutkıewicz c, L. Husain c,d, P.K.
	Hopke e, G. Tuncel, "A Temporal variations and sources of Eastern
	Mediterranean aerosols based on a 9-year observation", Atmospheric
	Environment, V.61 (463-475) (2012).
	- S. Yüksek, M. Şengör, R. Acar, H. İ. Kaya, "Determination of Gross
	Alpha/Beta Radioactivity in Drinking Waters in Turkey", 26. National
	Chemistry Congress, Muğla-Turkey, 1-6 October 2012.
	- M. Şengör, S. Yüksek, A. Dirican, N. Şahin, Ü. Yücel, "228 Ra Analysis
	Methods in Water", 26. National Chemistry Congress, Muğla-Turkey, 1-6
	October 2012.
IN PROGRESS	- Validating a procedure for routine measurement of ²¹⁰ Pb in water by
INTROOKESS	LSS and Gross alpha and beta counting,
	- Validating a procedure for routine measurement of ⁹⁰ Sr in water by
	LSS and Gross alpha and beta counting,
	- Gross alpha and beta analysis in water by LSS
	- Analysis of U, Th, and Pu isotopes by HR-ICP-MS
ADDRESS	Sarayköy Nuclear Research and Training Center
	Saray Mah. Atom Cad. No. 27 Kazan
	06983 Ankara / TURKEY
CONTACT	H. Dikmen
	hasan.dikmen@taek.gov.tr

NIST, Radioactivity Group 2012 Progress Report and 2013 Plan

The programs at the National Institute of Standards and Technology, Physical Measurements Laboratory, Radiation and Biomolecular Physics Division, Radioactivity Group in the field of Radionuclide Metrology and its application are focused on the development of primary and secondary activity standards; dissemination of those standards through Standard Reference Materials, Calibration Services, and Measurement Assurance Programs; development of instrumentation; and Quality Assurance.

Scientists	Function
M. Unterweger	Leader, Radioactivity Group
D. Bergeron	Primary and Secondary activity standards, Nuclear Medicine
J.T. Cessna	Primary and Secondary activity standards, Calibrations, Nuclear Medicine
H. Chen-Mayer	CT Dosimetry, Homeland Security
R. Collé	Primary Radionuclide activity standards, Standard Reference Materials
E. Crawford	Environmental Radioactivity standards
R. Fitzgerald	Primary and Secondary Radionuclide activity standards
K.G.W. Inn	Environmental Radioactivity standards
L. King	Primary and Secondary activity standards
J. LaRosa	Environmental Radioactivity standards
L. Laureano-Pérez	Primary Radionuclide activity standards, Standard Reference Materials
L. Lucas	Primary Radionuclide activity standards, Homeland Security
J. Mann	Environmental Radioactivity standards
B. Norman	Homeland Security
L. Pibida	Secondary activity standards, Homeland Security
P. Volkyvitsky	Secondary activity standards, Radon
B. Zimmerman	Primary and Secondary activity standards, Nuclear Medicine
Associates	
D. Golas	Measurement Assurance Program
R. Hutchinson	Primary Radionuclide activity standards
M. Mille	Nuclear Medicine
S. Nour	Environmental Radioactivity standards
R. Young	Measurement Assurance Program
Technicians	
J. Stann	Shipping

The NIST Radioactivity Group staff in 2012 was the following.

The main specific activities carried out at NIST in this field are discussed below.

Activity line	Results from 2012	Plan for 2013
Development of	• Cross-platform calibration of Ge-	• Development of primary
primary standards,	68 cylindrical phantom inserts for	standards: ¹⁸ F, ⁹⁹ Mo, ¹¹¹ In, ¹²⁴ I
Improvement of	PET-CT, radionuclide calibrators,	• Standards for nuclear forensics
measuring methods	and gamma well counter	• Develop digital $\beta - \gamma$ coincidence
and instrumentation	• Development of primary	
	standards: ¹⁸ F, ⁹⁹ Mo, ¹²⁴ I	

International Comparisons	 NPL-piloted ¹⁷⁷Lu radionuclide calibrators comparison SIR submission: ¹³¹I CCRI(II) ⁹⁹Tc 	 SIR submission: ⁹⁹Mo Pilot CCRI(II)-K2.Ge-68
Membership in International and national organizations	• ICRM, BIPM/CCRI(II), SIM, ANSI N42	• ICRM, BIPM/CCRI(II), SIM, ANSI N42

The following is a summary of completed and in-progress Standard Reference Materials.

Nuclide	Completion Date
¹³¹ I	yearly January
⁹⁹ Mo	yearly February
⁶⁷ Ga	yearly April
^{99m} Tc	yearly May
²⁰¹ Tl	yearly August
¹¹¹ In	yearly June
¹³³ Xe	yearly September
⁹⁰ Y	yearly October
¹²⁵ I	yearly December
²²⁹ Th	January 2009
²⁴³ Am	August 2009
²³⁹ Pu	August 2009
²⁴² Pu	July 2010
⁹⁹ Tc	December 2010
⁶³ Ni	March 2011
²⁴⁴ Cm	April 2012
²²⁸ Ra	November 2012
²³⁷ Np	January 2013
²⁰⁹ Po	2013

Additional details are given for selected activities below.

LABORATORY	National Institute of Standards and Technology
NAMES	Denis E. Bergeron, Brian E. Zimmerman, Jeffrey T. Cessna
ACTIVITY	Automated Gamma Well Counter
KEYWORDS	Gamma-ray spectrometry, NaI well-type counter, X-ray spectrometry, F-18, Ge-68, I-124, I-125, Ba-133
RESULTS	Secondary standards for PET nuclides: F-18 and Ge-68
PUBLICATIONS	
IN PROGRESS	Standardization of I-125 and development of secondary standards for I-124
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Institute of Standards and Technology
	Radiation and Biomolecular Physics Division
	100 Bureau Drive, Stop 8462
	Gaithersburg, MD 20899-8462
	denis.bergeron@nist.gov
CONTACT	Dr. Denis E. Bergeron

LABORATORY	National Institute of Standards and Technology
NAMES	Denis E. Bergeron, Brian E. Zimmerman, Jeffrey T. Cessna, Ryan P. Fitzgerald, Denise Simoes Moreira
ACTIVITY	Triple-to-double Coincidence Ratio liquid Scintillation Spectrometer
KEYWORDS	Coincidence method, liquid scintillation, F-18, I-124
RESULTS	Standardization of F-18
PUBLICATIONS	
IN PROGRESS	Refinement of Field Programmable Gate Array-based data acquisition system, standardization of I-124
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Institute of Standards and Technlology
	Radiation and Biomolecular Physics Division
	100 Bureau Drive, Stop 8462
	Gaithersburg, MD 20899-8462
	denis.bergeron@nist.gov, bez@nist.gov
CONTACT	Dr. Denis E. Bergeron, Dr. Brian E. Zimmerman

CONTACT

LABORATORY	National Institute of Standards and Technology
NAMES	Denis E. Bergeron, Brian E. Zimmerman, Jeffrey T. Cessna
ACTIVITY	Radionuclide Calibrators
KEYWORDS	Ionisation chamber, F-18, In-111, I-123, I-124, Lu-177
RESULTS	Dial setting determinations for F-18, In-111, I-123, Lu-177
PUBLICATIONS	
IN PROGRESS	Dial setting determinations, secondary standards for I-124; Refinement of Shewhart Control Chart methodologies for QC
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Institute of Standards and Technology Radiation and Biomolecular Physics Division 100 Bureau Drive, Stop 8462

Gaithersburg, MD 20899-8462

denis.bergeron@nist.gov

Dr. Denis E. Bergeron

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	R. Fitzgerald
ACTIVITY	Anticoincidence measurements (LS-NaI) for primary standards
KEYWORDS	anti-coincidence, ¹³¹ I, ⁹⁹ Tc, ⁹⁹ Mo, ²⁴¹ Np, ¹⁸ F, ¹²⁴ I
RESULTS	primary standards for ¹³¹ I, ⁹⁹ Tc, ²⁴¹ Np
PUBLICATIONS	CCRI (II) comparison reports in progress for ²⁴¹ Pu and ⁹⁹ Tc.
IN PROGRESS	¹²⁴ I, ⁹⁹ Mo, ¹⁸ F, digital coincidence counting.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	NIST, 100 Bureau Drive, Gaithersburg, MD, USA
CONTACT	Ryan Fitzgerald, ryan.fitzgerald@nist.gov, 1-301-975-5597

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	R. Fitzgerald, M. Unterweger
ACTIVITY	Ionization chambers for maintaining standards
KEYWORDS	ionization chamber
RESULTS	New calibration factors for ¹²⁴ I
PUBLICATIONS	Unterweger, M.P. and Fitzgerald R.P., 2012, Unexpected bias in NIST 4-pi- gamma ionization chamber measurements, Appl. Rad. Isot. 70, 1892-1893.
IN PROGRESS	New calibration factors for ionization chambers. Upgrading and validation of electrometers. Implementation of new quality assurance measures.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	Fitzgerald, R., 2012. NIST Ionization Chamber "A" Sample-Height Corrections, Journal of Research of the National Institute of Standards and Technology, 17, 80-95
ADDRESS	NIST, 100 Bureau Drive, Gaithersburg, MD, USA
CONTACT	Ryan Fitzgerald, ryan.fitzgerald@nist.gov, 1-301-975-5597

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	B. E. Zimmerman, R. Fitzgerald, D. E. Bergeron, D. S. Moreira (IRD, Brazil), L. Pibida, and J. T. Cessna
ACTIVITY	Standardization of I-124
KEYWORDS	Standardization, I-124, positrons, TDCR, anticoincidence counting, CIEMAT- NIST method, high-efficiency photon counting
RESULTS	
PUBLICATIONS	
IN PROGRESS	The first standardization of I-124 at NIST is being carried out using $4\pi \beta - \gamma$ live-timed anticoincidence counting, the Triple-to-Double Coincidence Ratio (TDCR) and CIEMAT-NIST efficiency tracing methods, and high-efficiency photon counting. At the same time, calibration factors for the NIST " 4π " γ secondary standard ionization chamber and various NIST-maintained activity calibrators are also being developed.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	100 Bureau Dr., Stop 8462 Gaithersburg, MD 20899-8462
CONTACT	Dr. B. E. Zimmerman, <u>bez@nist.gov</u>

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	B. E. Zimmerman, R. Fitzgerald, D. E. Bergeron, D. S. Moreira (IRD, Brazil), L. Pibida, and J. T. Cessna
ACTIVITY	Re-standardization and evaluation of previous standards for F-18
KEYWORDS	Standardization, F-18, positrons, TDCR, anticoincidence counting, CIEMAT- NIST method, high-efficiency photon counting
RESULTS	
PUBLICATIONS	
IN PROGRESS	An increased interest in standards for positron emitting radionuclides used for medical imaging has prompted a review of past and current standards for F- 18. As a result, new standardization experiments are being carried out to provide updated values. The work is being carried out using $4\pi \beta - \gamma$ live-timed anticoincidence counting, the Triple-to-Double Coincidence Ratio (TDCR) and CIEMAT-NIST efficiency tracing methods, and high-efficiency photon counting. At the same time, calibration factors for the NIST " 4π " γ secondary standard ionization chamber and various NIST-maintained activity calibrators are also being developed and compared to previous results.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	100 Bureau Dr., Stop 8462 Gaithersburg, MD 20899-8462
CONTACT	Dr. B. E. Zimmerman, <u>bez@nist.gov</u>

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	B. E. Zimmerman, L. Pibida, M. Mille, D. E. Bergeron, and J. T. Cessna
ACTIVITY	Construction and calibration of traceable radioactive phantom sources for PET and SPECT imaging
KEYWORDS	Life sciences, calibration, phantoms, medical imaging, Ge-68, Ba-133
RESULTS	A series of Ba-133 sources to be used as I-131 surrogates in an IAEA-sponsored image quantification comparison were prepared by a commercial laboratory and calibrated for activity content by NIST. The comparison exercise is still on-going.
	A methodology to calibrate large-volume (20 cm diameter x 30 cm length) solid epoxy cylinder phantoms containing Ge-68 has also been developed and applied to two prototype sources. The relative combined standard uncertainty on the activity concentration of the Ge-68 in the phantoms was about 0.9 %. One of the phantoms is currently in use as part of a clinical trial. Refinements to the present phantom design are underway and it is expected that this methodology will be used to calibrate the activity content of those new prototypes when they become available.
PUBLICATIONS	
IN PROGRESS	Development of traceable phantoms to investigate partial volume correction of non-spherical objects using Positron Emission Tomography is underway.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	100 Bureau Dr., Stop 8462 Gaithersburg, MD 20899-8462
CONTACT	Dr. B. E. Zimmerman, <u>bez@nist.gov</u>

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	L. Laureano-Pérez, R. Fitzgerald, D. Bergeron, R.Collé
ACTIVITY	International Comparison of ⁹⁹ Tc
KEYWORDS	LTAC, liquid scintillation, TDCR, Tc-99, comparison
RESULTS	An international measurement comparison for a ⁹⁹ Tc solution hosted by National Physical Laboratory (NPL) of the UK, (CCRI(II)K-2. ⁹⁹ Tc comparison) was completed. Measurements by NIST on the solution were performed by three methods: <i>viz.</i> , liquid scintillation (LS) standardizations (with ³ H-standard efficiency tracing); with triple-to-double-coincidence ratio (TDCR) method; and with by $4\pi\beta$ (LS)- γ (NaI) live-timed anticoincidence (LTAC) measurements. Impurities determination was performed by HPGe γ -ray spectrometry and $2\pi\alpha$ spectrometry using Si surface barrier detector (α -SPECT). The determination of the ⁹⁹ Tc massic activity for the NPL solution was performed by live-timed $4\pi\beta$ (LS)- γ (NaI) anti-coincidence counting (LTAC) with ⁶⁰ Co efficiency tracing. LS hemisphere sources were prepared containing different ⁶⁰ Co to ⁹⁹ Tc activity ratios. Also, ⁶⁰ Co-only sources, sources containing no ⁹⁹ Tc and a blank were prepared. The β - γ anti-coincidence data from each mixed-nuclide source and ⁶⁰ Co-only was fit with a linear fit and with a quadratic fit over an efficiency range of 0.58 to 0.93. The ⁶⁰ Co tracer activity was standardized (within 0.04 % agreement with previous standardization) and was subtracted from intercepts of the mixed sources was 0.18 % and 0.32 % for linear and quadratic fits, respectively. The difference between the average activity determined by linear and quadratic fits was 0.02%. Therefore, the final massic activity was obtained by direct measurements of the NPL solution by CNET and TDCR within the respective method's uncertainty. The previously standardized ⁹⁹ Tc (SRM 4288B) was measured at the same time as the NPL ⁹⁹ Tc by LTAC, TDCR and CNET. The result obtained agreed with the previous standardization to within 0.6 %, 0.4 % and 0.01% for each method, respectively.
PUBLICATIONS	
IN PROGRESS	Publication
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	NIST, 100 Bureau Dr MS 8462, Gaithersburg, MD 20899-8462, USA
CONTACT	L.Laureano-Pérez, <u>lizbeth.laureano-perez@nist.gov</u>

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	L. Laureano-Pérez, R.Fitzgerald, R.Collé
ACTIVITY	New Standardization of ²³⁷ Np
KEYWORDS	liquid scintillation, live-timed anticoincidence (LTAC) gamma-ray spectrometry, HPGe, Np-237
RESULTS	Neptunium-237 is produced as a long-lived waste product in nuclear reactors. Hence, accurate standardization is necessary for environmental monitoring of nuclear waste. The standardization of ²³⁷ Np by several primary methods was investigated. This was performed to support a new ²³⁷ Np transfer standard that was developed and which will be disseminated by the National Institute of Standards and Technology (NIST) as Standard Reference Material SRM 4341a. A EUROMET comparison hosted by NPL in 1998 identified ²³⁷ Np- ²³³ Pa equilibrium/stability issues. As a result of this study our master solution was diluted in steps and stability tested at every step. Data suggested that the equilibrium was disturbed when aliquots were removed from the ampoule; hence sufficient time elapsed before standardization measurements were performed. The certified massic activity of SRM 4341a as obtained from the $4\pi\alpha\beta$ liquid scintillation based standardization could be directly compared to the results obtained from the weighted mean of 9 primary standardizations by 5 laboratories and performed in 1998-99 as part of the EUROMET ²³⁷ Np measurement comparison (-0.07 %). NIST confirmatory standardizations of the ²³⁷ Np massic activity for SRM 4341a were performed by live-timed anticoincidence (LTAC) $4\pi\beta(LS) - \gamma(NaI)$ measurements and by high-resolution HPGe gamma-ray spectrometry (γ -spec) with a comparison difference of -0.13 % and 3.8 %, respectively. The uncertainty in the (γ -spec measurement was 6.5 % ($k = 1$). SRM 4341a was in agreement with the previous issue of ²³⁷ Np (SRM 4341), first disseminated in 1993, to within 0.03 %. The ²³⁷ Np SRM solution standards are contained in 5 mL flame-sealed borosilicate glass ampoules, and consist of (5.3196 \pm 0.0003) g of a carrier-free nominal 2 mol·L ⁻¹ nitric acid solution, having a density of (1.067 \pm 0.002) g·mL ⁻¹ at 16.3 °C. The combined standard uncertainty ($k = 2$) on the standardization is 0.92 %.
PUBLICATIONS	
IN PROGRESS	Certification and publication
INFORMATION	
SOURCE IN PREPARATION	SRM 4341a
OTHER RELATED PUBLICATIONS	
ADDRESS	NIST, 100 Bureau Dr MS 8462, Gaithersburg, MD 20899-8462, USA
CONTACT	L.Laureano-Pérez, <u>lizbeth.laureano-perez@nist.gov</u>

LABORATORY	National Institute of Standards and Technology (NIST)
NAMES	R.Collé L. Laureano-Pérez,
ACTIVITY	New Standardization of ²⁰⁹ Po
KEYWORDS	liquid scintillation, α spectrometry, Po-209, SRM
RESULTS	A new primary standardization of ²⁰⁹ Po will be initiated to support the production and dissemination of a new series of carrier-free solution standards (SRM 4326a), as well as to provide a linkage to the previous SRM 4326. The ²⁰⁹ Po certified massic α -emission rate for SRM 4326a will be obtained with three commercial LS counters and with varying cocktail compositions. The new SRM, as the previous issue, will be prepared carrier-free in 2 mol/L HCl. Corrections for the electron capture branch to ²⁰⁹ Bi and for the 2-keV delayed isomeric state in ²⁰⁵ Pb will be made. Confirmatory measurements will be performed by α spectrometry with high resolution Si surface-barrier junction detectors. The linkage to the previous SRM 4326 standardization will obtain a third value for a 19-year decay curve, following those obtained from previous ²⁰⁹ Po standardizations performed in March 1994 and November 2005. The measurement procedures and analyses for the three determinations will be as identical as possible. The new result may confirm or refute the serious 25 % half-life discrepancy that we identified in 2006.
PUBLICATIONS	
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	SRM 4326a
OTHER RELATED PUBLICATIONS	 R.Collé, Long Term Stability of Carrier-Free Polonium Solution Standards, <i>Radioact. Radiochem.</i> 4, no. 2, 20-35 (1993) R. Collé, et al., Delayed Isomeric State in ²⁰⁵Pb and Its Implications for 4πα Liquid Scintillation Spectrometry, of ²⁰⁹Po, <i>Appl. Radiat. Isot.</i> 45, 1165-1175 (1994). R. Collé, et al., Preparation and Calibration of Carrier-Free ²⁰⁹Po Solution Standards, <i>J. Res. NIST</i> 100, 1-36 (1995). R. Collé, L. Laureano-Perez, I. Outola, A Note on the Half-Life of ²⁰⁹Po, <i>Appl. Radiat. Isot.</i> 65, 728-730 (2007). L. Laureano-Perez, R. Collé, R. Fitzgerald, et al. A Liquid-Scintillation Based Primary Standardization of ²¹⁰Pb, <i>Appl. Radiat. Isot.</i> 65, 1328-1380 (2007). R. Collé, L. Laureano-Perez, On the Standardization of ²⁰⁹Po and ²¹⁰Pb, in LSC 2008, Advances in Liquid Scintillation Spectrometry, Radiocarbon, Tucson, Arizona, USA, 2009, pp. 77-85. F.J.Schima, R.Collé. Alpha-Particle and Electron Capture Decay of ²⁰⁹Po, Nucl. Instrum. Meth. Phys. Res. A 369, 498-502 (1996).
ADDRESS	NIST, 100 Bureau Dr MS 8462, Gaithersburg, MD 20899-8462, USA
CONTACT	L.Laureano-Pérez, <u>lizbeth.laureano-perez@nist.gov</u>