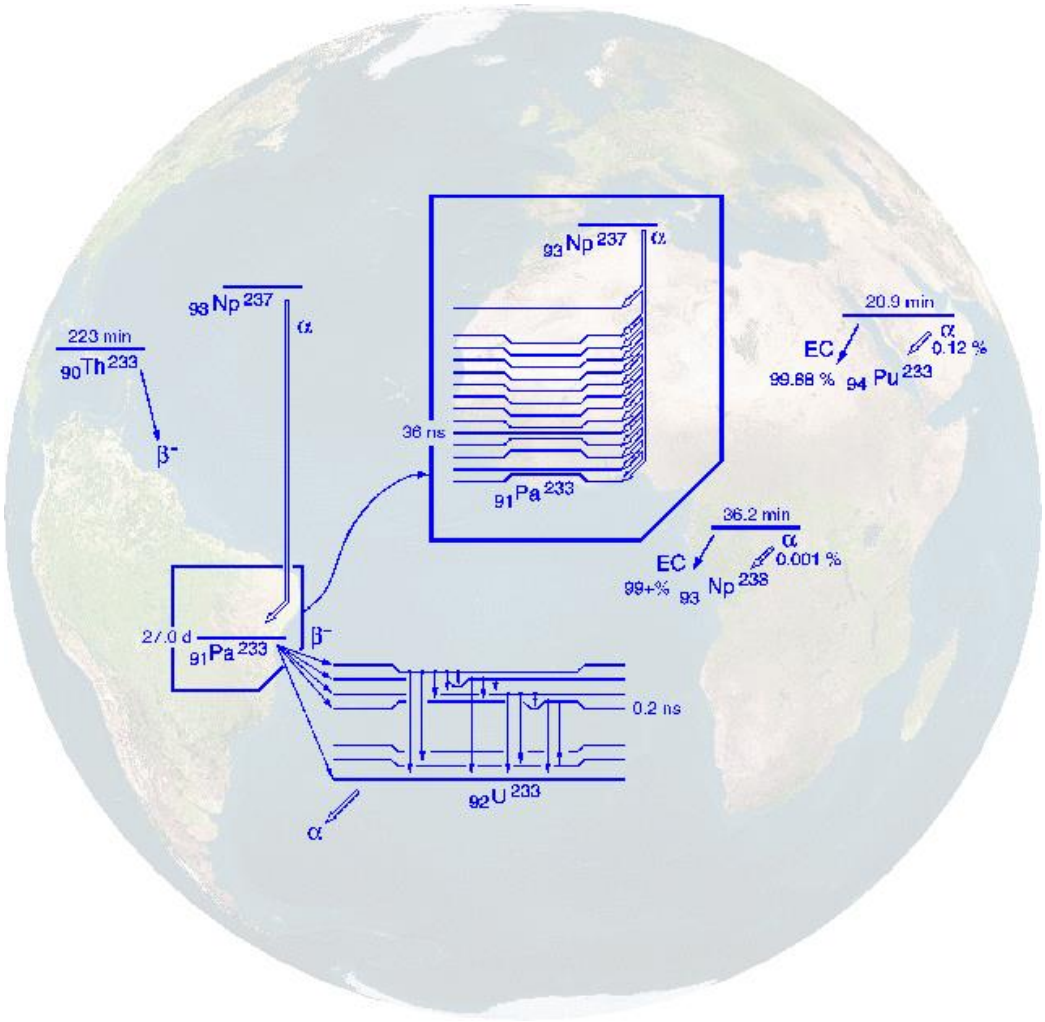
ICRM NEWSLETTER

Issue 32 – September 2020



International Committee for Radionuclide Metrology

Editor: Mark A. Kellett

International Committee for Radionuclide Metrology ICRM

ICRM NEWSLETTER
Issue 32

Foreword

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April 2020

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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 are 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 and previous issues, many laboratories regard their normal Newsletter contribution as a fulfilment of SA1/SA2 and provide no further information.

Laboratories who do wish to provide these SA1/SA2 reports (which should not be longer than 2 pages) should mention in the letter/email accompanying their contribution(s) that the SA1/SA2 contributions are intended for publication in the Newsletter. Any such reports are presented prior to the normal Newsletter contributions for each laboratory and shown as such in the Table of Contents.

For economic reasons, at the ICRM General Meeting in Dublin 2003, it was agreed that the ICRM Newsletter would be available for download from the LNE–LNHB website at (http://www.lnhb.fr/conferences-publications/icrm-newsletter/) and only distributed in hard copy or CD-ROM to those having requested this.

Contributions may be sent by email as an attachment in MS Word (see below) to the Editor.

Instructions to Contributors

This Newsletter is produced with no major 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) **format** inside a box of **15.5 cm x 20 cm** which should be situated **4.5 cm** from the upper and **3 cm** from the left margin. Please use font **Times New Roman** size **11**. The format indicated below should be followed.
- 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 provided in the style 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 use the **"ICRM_NL_form_2019.dotx**" template (shown below) to help ensure your contribution meets the above specifications.
- Please note that only files in MS Word format will be accepted.

Contribution Format

LABORATORY	Name of laboratory, Country
NAMES	If more than one laboratory is involved identify affiliation through abbreviations (ORNL, LASL, etc.). Visitors can also be identified with asterisks.
APPARATUS/ ACTIVITY	Please choose one: APPARARTUS for experiments or ACTIVITY for compilations, calculations or theory.
KEYWORDS	*(Delete/insert as appropriate)* Alpha spectrometry, beta spectrometry, calorimetry, (anti) coincidence method, cryogenic detector, data evaluation, data measurement, defined solid angle (ASD) measurement, environmental control, Euromet, gamma-ray spectrometry, gas proportional counter, ionisation chamber, life sciences, liquid scintillation, low-level, NaI well-type counter, neutron measurement, radioactive gas, radiochemistry, simulation code, SIR, source preparation, traceability, X-ray spectrometry, radionuclide by name (e.g. ^{55}Fe or Fe-55)
RESULTS	Use this for experimental results.
PUBLICATIONS	Use Physical Review style. Include only published material.
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, fax numbers and E-mail address.
CONTACT	Single contact person.

Additional items

You may also add information below. All items given here will be brought together in a specific chapter at the beginning of the Newsletter.

Announcements: *(Only information of interest to the Radionuclide Metrology Community, e.g. conferences, workshops, theses in progress, etc.)*

Proposals: *(Search for PhD or post-doc students, collaboration proposals, etc.)*

General Information on ICRM

INTERNATIONAL COMMITTEE FOR RADIONUCLIDE METROLOGY

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http://physics.nist.gov/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.

The ICRM was founded in Paris in 1974 as a "club" of a few nuclear metrology laboratories and grew rapidly to a worldwide association with at present 47 institutions represented by delegates. 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 organisational guidelines and directions for the working programmes are agreed upon. The following officers of ICRM are presently serving on the Executive Board:

President	Brian Zimmerman[1]	bez@nist.gov
Vice-President	Mikael Hult[2]	mikael.hult@ec.europa.eu
	John Keightley[3]	john.keightley@npl.co.uk
	Akira Yunoki[4]	a.yunoki@aist.go.jp
Past-President	Eduardo García-Toraño[5]	e.garciatorano@ciemat.es
Secretary	Denis Glavič-Cindro[6]	denis.cindro@ijs.si

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	Simon Jerome[7]	simon.mark.jerome@nmbu.no
Members	Pierino de Felice[8]	pierino.defelice@enea.it
	Octavian Sima[9]	octavian.sima@partner.kit.edu

Plenary meetings of the ICRM are held biennially and have developed into a successful instrument of communication among various specialists, truly encouraging international co-operation. The most recent of these was the 22nd International Conference on Radionuclide Metrology and its Applications (ICRM 2019), which took place on 27 – 31 May 2019 in Salamanca, Spain, hosted by the University of Salamanca.

Our appreciation and thanks go to all who contributed to this very successful meeting. In particular, we recognize the great contributions made by Begoña Quintana and her Local Organising Committee, especially Juan Carlos Lozano and Teresa Marcos. Many thanks are also addressed to the Scientific Programme Committee, the referees and session chairs, and the authors of oral and poster presentations.

ICRM activities are largely carried out by its working groups (WGs). Each group is guided by a coordinator who acts as a centre for ideas and communications and may organise conferences and workshops. Currently eight WGs are operating in the following fields of interest:

(1) Radionuclide Metrology Techniques (RMT)
Ryan Fitzgerald[1] ryan.fitzgerald@nist.gov
Christophe Bobin[10] christophe.bobin@cea.fr

sub-groups:
- Digital Coincidence Counting
John Keightley[3] john.keightley@npl.co.uk
- Internal Gas Counting
Steven Bell[3] steven.bell@npl.co.uk
- Large Area Sources
Ole Nähle[11] ole.j.naehle@ptb.de

(2) Life Sciences (LS)
Jeffrey T. Cessna[1] jeffrey.cessna@nist.gov

(3) Alpha-Particle Spectrometry (AS)
Stefaan Pommé[2] stefaan.pomme@ec.europa.eu

(4) Gamma-Ray Spectrometry (GS)
Marie-Christine Lépy[10] marie-christine.lepy@cea.fr

(5) Liquid Scintillation Counting (LSC)
Karsten Kossert[11] karsten.kossert@ptb.de

(6) Low-Level Measurement Techniques (LL)
Mikael Hult[2] mikael.hult@ec.europa.eu

sub-group:
- QA near decision threshold
Matjaz Korun[6] matjaz.korun@ijs.si

(7) Beta-Particle Spectrometry (BS)
Xavier Mougeot[10] xavier.mougeot@cea.fr

(8) Nuclear Decay Data (NDD)
Mark A. Kellett[10] mark.kellett@cea.fr

We thank all the above coordinators for their hard work.

The next plenary conference will be the 23rd International Conference on Radionuclide Metrology and its Applications (ICRM 2021) and will be held on 24-28 May 2021 in Bucharest, Romania, hosted by the Horia Hulubei Institute of Physics and Nuclear Engineering (IFIN-HH). The contact person of the local organizing committee is Aurelian Luca (aluca@nipne.ro); more details will be available on the ICRM 2021 conference website, which is planned to be launched in May 2020. The conference will include oral and poster presentations and business meetings of the ICRM WGs, in plenary format. The organization of ICRM2021 is focusing on providing increased interactions between attendees, including extended poster sessions and the possibility of breakout sessions.

In addition to these plenary meetings at the ICRM conference, each WG may have specific meetings in the form of international conferences or more restricted workshops. The most recent of these types of meetings were held by the LSC and Life Sciences WGs at VNIMM in St. Petersburg, Russia (4-8 June 2018); the Gamma Spectrometry WG at the Headquarters of the Laboratoire national de métrologie et d'essais (LNE) in Paris (14 June 2018); and the Beta Spectrometry, Nuclear Decay Data (in collaboration with the Decay Data Evaluation Project (DDEP)), and Radionuclide Metrology Techniques WGs at NIST, USA (10 – 14 September 2018).

The Low-Level Radionuclide Techniques WG is organizing the ICRM-LLRMT 2020 Conference, to hosted by the National Institute for Nuclear Physics and the Gran Sasso National Laboratory in L'Aquila, Italy. Originally scheduled for 20-24 April 2020, the conference has been tentatively re-scheduled to 21-25 September as a result of the coronavirus outbreak. More information is available at https://icrm2020.lngs.infn.it. Conference proceedings will be published in Applied Radiation and Isotopes.

The LSC and Life Sciences Working Groups will be holding their next meetings 14-18 September 2020 at POLATOM in Otwock, Poland.

Meetings of the Beta Spectrometry, Nuclear Decay Data, and Radionuclide Metrology Techniques WGs are planned for the week of 26 October and will be hosted by the LNHB in Paris.

All relevant information regarding the upcoming Working Group meetings available from the respective coordinators.

All ICRM meetings are announced on the ICRM home page http://physics.nist.gov/icrm or in this Newsletter. Anyone wishing to participate in these ICRM 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.

We express our heartfelt thanks to Dr. Mark A. Kellett[10] for compiling and Christophe Dulieu[10] for uploading this ICRM Newsletter, and also to Dr. Lisa Karam[1] for maintaining our ICRM home page.

February 2020

Brian E. Zimmerman
President of ICRM

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3. National Physical Laboratory (NPL), Hampton Road, Teddington, Middlesex, TW11 0LW, UK.
4. National Metrology Institute of Japan (NMI), National Institute of Advanced Industrial Science and Technology, Tsukuba Central 2, 1-1-q, Umezono, Tsukuba, Ibaraki, 305-8568, Japan.
5. Metrología de Radiaciones Ionizantes, Centro de Investigaciones Energéticas, Medioambientalesy Tecnológicas (CIEMAT), Avenida Complutense 22, E-28040 Madrid, Spain.
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7. Norges miljø- og biovitenskapelige universitet (NMBU), Universitetstunet 3, 1433 Ås, Norway
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11. Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, D-38116 Braunschweig, Germany.

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ICRM

http://physics.nist.gov/ICRM/

In Memory of Walter Bambynek

Ljubljana and Gaithersburg, 26 February 2020
Ref: DGC/ICRM Sec/2020/01

Dear ICRM members,

It is our sad duty to inform you that our dear colleague Walter Bambynek passed away on 24th February 2020. He was one of the leading figures in radionuclide metrology, as one of the founders of the ICRM in 1974 and also building up the radionuclide metrology laboratories at then CBNM, now JRC Geel. For many years, from 1974 until his retirement in 1992, he was head of the Radionuclide Metrology group at CBNM/IRMM. In 2017 he received the "Honorary JRC fellow Award" for his great work.

The former ICRM President Walter Bambynek behind his wife Maria, flanked by ICRM executives at the ICRM conference in Antwerp, 2013.

We are sure that all ICRM members recognize the vast contributions that Walter Bambynek made to the field of radionuclide metrology over the years. Walter Bambynek was one of the founders of ICRM, having been present at the initial Organizational Meeting in Budapest in 1973 and again at the second Organizational Meeting in Paris in 1974, which is generally regarded as the first General Meeting of the ICRM. He served as Working Group Coordinator for Non-neutron nuclear data from 1977 to 1982 and was Secretary from 1980 to 1983. He became President of ICRM in 1983 and served two terms until 1987.

On behalf of the ICRM Executive Board and all ICRM members, we sent a condolence letter to the family of Walter Bambynek and his colleagues at JRC Geel.

Kind regards,

Denis Glavič-Cindro
(ICRM Secretary)

Brian Zimmerman
(ICRM President)

INTERNATIONAL COMMITTEE FOR RADIONUCLIDE METROLOGY

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Summary of the ICRM Executive Board Meeting, Madrid, 24 October 2018

Vienna, 23 March 2020
Ref: FJM/2020/02

Dear ICRM Delegate and Associate Members,

On behalf of the ICRM Executive Board, I would like to give a summary of the Executive Board meeting, held on 24 October 2018 at CIEMAT, Madrid, Spain. The meeting was attended by Eduardo Garcia-Toraño (President), Dirk Arnold (Past President), Akira Yunoki, John Keightley and Mikael Hult (Vice Presidents), Franz Josef Maringer (Secretary), and Simon Jerome (Chair of the Nominating Committee, invited as observer). Begoña Quintana (University of Salamanca) attended the meeting as Scientific Secretary of the ICRM 2019 Local Organising Committee and Uwe Wätjen as invited guest supporting the ICRM 2019 conference preparation.
The half-day EB meeting after the ICRM 2019 Programme Committee Meeting was scheduled to, mainly:

- **Final preparation and organisation of the ICRM 2019 Conference in Salamanca**

- The Conference would be organized by the **Ionizing Radiation Laboratory group at the University of Salamanca** represented by
  - **Prof. Dr. Begoña Quintana and Prof. Dr. Juan Carlos Lozano (USAL)**

  and support will be given by
  - **Dr. Eduardo Garcia-Toraño, CIEMAT.**

- **Conference organisation**
  The Conference will be organized at the **Hospederia Fonseca**. lt is the old Faculty of Medicine of the University of Salamanca, that, for example, has been used for some of the events that took place at the XV Iberoamerican Conference October 2013. The Hospederia Fonseca is located in the centre of the city, two minutes walking from the Plaza Mayor, historic building of the University, or the Cathedral.

  Lodging, transportation, programme and organization, excursions, dates and seasonal weather conditions, conference web site and second announcement arranged by USAL, poster and industrial exhibition, lunches, banquet and social programme, programme for accompanying persons, laboratory visit & ENUSA visit, visa administration has been proposed by the conference local organising team and discussed in the meeting. The conference registration fees has been calculated to cover the total conference costs: EUR 450 early bird, EUR 520 EUR after deadline.

  The Scientific Committee, Program Committee and Referees has been efficiently supported by Uwe Wätjen. The publication of the proceedings was arranged in Applied Radiation and Isotopes

and the ICRM Technical Series. Additionally, the organisational arrangements for the 26th General Meeting has been discussed and defined.

- **Business of ICRM Working Groups**

- The **Radionuclide Metrology Techniques WG** will have a joint workshop at BIPM including the Nuclear Data WG, the Alpha-Particle and Beta-Particle Spectrometry WG and the LNHB Decay Data Evaluation Project.
  Ryan Fitzgerald and Ole Nähle have been asked by RMT WG Coordinator John Keightley for coordination tasks. Decision must be taken by the General Meeting 2019 in Salamanca.
- **Low-Level Measurement Techniques WG**: The ICRM LLRMT 2020 conference is scheduled for 20-24 April 2010 at Gran Sasso Laboratory, Italy, coordinated by the Local Organising Chair Matthias Laubenstein.
  Simon Jerome has been asked by Mikael Hult to take over the LLMT WG coordination (GM decision)
- **Gamma-ray Spectrometry WG**: A WG Meeting planned in Paris, including a Gamma-ray Spectrometry training course.

- **ICRM organisation and business**

- ICRM institutional and associate **membership** has been discussed together with ICRM Liaison with external organisations.
- The next **ICRM Newsletter** is scheduled for spring 2020 coordinated by Mark A. Kellett. EB will prepare a proposal for decision by the General Meeting 2019 to change the ICRM Newsletter period biennially (from 1 year to 2 years).
- The ICRM **web site** will still be hosted by NIST and operated by Lisa Karam.
- The ICRM **Nominations Committee**, chaired by Simon Jerome, will send information on the next Executive Board Members elections at the General Meeting 2019 to ICRM Members in January 2019.
- The next **Executive Board Meeting** is planned for Thursday 30 May 2019 evening for final preparation of the 26th ICRM General Meeting and Friday 31 May 2019 afternoon, after the General Meeting.

With my best regards,

Franz Josef Maringer
(ICRM Secretary until 30 September 2019)

INTERNATIONAL COMMITTEE FOR RADIONUCLIDE METROLOGY

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Summary of the 2019 ICRM General Meeting, Salamanca, 31 May 2019

Vienna, 20 March 2020
Ref: FJM/2020/01

Dear ICRM Delegate and Associate Members,

On behalf of the ICRM Executive Board, I would like to give you a summary of the ICRM General Meeting in Salamanca, 31 May 2019.

- **Introduction:** The 26th General Meeting of the International Committee for Radionuclide Metrology (ICRM) was held on Friday, 31 May 2019, at the Colegio Arzobispo Fonseca, Salamanca, Spain. This was the conclusion of a week of successful meetings hosted by the Laboratorio de Radiaciones Ionizantes, Universidad de Salamanca. The meetings consisted of the four day 22nd International Conference on Radionuclide Metrology and its Applications (**ICRM 2019**), 27 to 30 May 2019, combined with business meetings of the ICRM Working Groups held after the relevant scientific sessions. **138 participants** and **6 accompanying persons** from **32 countries** participated in the conference and **34 orals** and **68 posters** were presented. The technical conference was followed by an ICRM Executive Board Meeting and the General Meeting.

- The General Meeting was **attended** by 31 Delegate Members incl. their temporary representatives.

  - ICRM has **47 Delegate (institutional) Members** at the time of this 26th GM 2019.

  - **New delegates**:
    - Australia, Ms. Freda Wyngaardt, ANSTO (replaces Mark Reinhart)
    - International, Mr. Steven Judge, BIPM (replaces Guy Ratel)
    - UK, Mr. John Keightley, NPL (replaces Simon Jerome)
    - International, Mr. Nikolaus Hermanspahn, CTBTO (replaces Naoko Nakashima)
    - China, Mr. Juncheng Liang, NIM (replaces Yuandi Yang)
    - Ireland, Mr. Luis Leon, UCD (replaces Peter Mitchel)
    - Mexico, Ms. Olga Celia García Díaz, ININ (replaces Victor Tovar Muñoz)
    - Republic Korea, Mr. Kyoung Beom Lee, KRISS (replaces Tae Soon Park)
    - USA, Mr. Brian Zimmerman, NIST (replaces Michael Unterweger)
    - USA, Mr. Craig Aalseth, PNNL (new delegate)
    - Spain, Ms. Begoña Quintana Arnés, University of Salamanca (new delegate)

- **Proxies at this GM**:
  - Brasil, IRD, Carlos da Silva represented by Dr. Andre Quadros
  - International, IAEA, Iolanda Osváth represented by Simon Jerome
  - Poland, RC POLATOM, Ryszard Broda, represented by Tomasz Ziemek
  - Slovenia, IJS, Denis Glavič-Cindro, represented by Mataz Korun

- The meeting started with **Opening remarks** from the ICRM President Eduardo García-Toraño, who welcomed the new delegates, the participating members and guests. He thanked the Scientific Secretary of the ICRM 2019 conference Begoña Quintana Arnés and her conference team for the effective and very successful conference organisation.

- Then the **President** gave his **Report for the 2017 – 2019** period considering these topics:
  - ICRM 2017, Buenos Aires, Argentina:
    - Abstracts submitted: 151
    - Abstracts accepted: 134
    - Oral presentations: 34 + 2 invited lectures
    - Posters: 86
    - Published ARI papers: 90
    - Proceedings had been published in Applied Radiation and Isotopes, 134, pp. 1 - 482, April, 2018
    - Proceedings part II were published online as ICRM Technical Series on Radionuclide Metrology (https://physics.nist.gov/ICRM/ICRM_technicalseries_1.pdf; ISSN 2522-4328) containing 3 additional papers.
  - Executive Board Meetings:
    - Buenos Aires, May 2017, after GM
    - Salamanca, November 2017
    - Madrid, October 2018, after the meeting of the ICRM 2019 SC meeting
  - Working group meetings or workshops:
    - LSC+RMLS at VNIIM, St. Petersburg, June 2018
    - GS at LNE, Paris, June 2018 (following training course)
    - RMT+BS+NDD, at NIST, Gaithersburg, September 2018
  - Preparation of the ICRM 2019 Conference:
    - EB visited Salamanca in November 2017
    - EB prepared a list of SC members which were invited to start abstract evaluation
    - Scientific Secretary contacted ARI for publication
    - Abstracts sent through EasyChair system
    - SC meeting at CIEMAT, Madrid, October 2018
    - Results compiled in the «classical» EXCEL file and communicated to authors
  - ICRM 2019 statistics (preliminary)
    - Abstracts submitted: 166
    - Accepted: 130 (78%)
    - Accepted for publication in ARI: 68 (52 %)
    - Accepted for publication in ICRM Technical Series: 43 (33%)
    - Oral presentations accepted 39, actually presented 34, plus 2 Invited talks
    - Posters accepted 91, actually presented 68

- The certificate for the Best Poster was awarded to Vincent Thomas of CEA/DAM, DIF, France on the "Development of a New Radioactive Gas Detection System".

- Active **ICRM Working Groups**:
  - Alpha-particle spectrometry, S. Pommé
  - Beta-particle spectrometry, X. Mougeot
  - Gamma-ray spectrometry, M.-C. Lépy
  - Life sciences, J. Cessna
  - Liquid scintillation counting, K. Kossert
  - Low-level measurement techniques, M. Hult
    - Subgroup QA near decision threshold, Matjaž Korun
  - Nuclear Decay Data, M.A. Kellett
  - Radionuclide metrology techniques, J. Keightley
    - Subgroup DCC, Christophe Bobin
    - SG Internal gas counting, Mike Unterweger
    - SG Large area sources, Pierino De Felice
  - The participating ICRM Working Group Coordinators gave a short report of activities carried out in their groups.
  - Information on past and future WG activities will be also given in the ICRM Newsletter WG reports.
  - The WG coordinators explicitly expressed their thanks to the reviewers for their quality work in refereeing ICRM 2019 conference papers.

- Confirmation of **existing WGs and new WG coordinators**
  - Unanimously, the GM confirmed the **continuation of all 8 existing WGs**.
  - Changes in the **Radionuclide metrology techniques WG**:
    - New Coordinators: Ryan Fitzgerald (NIST) and Christophe Bobin (LNHB)
    - New WG subgroup coordinators:
      - Digital Coincidence Counting: J. Keightley (NPL)
      - Wide Area reference Sources: O. Naehle (PTB)
      - Gas Counting: Steven Bell (NPL)
  - **Low-level measurement techniques WG**:
    - Simon Jerome, IAEA, was proposed by Mikael Hult as new LLMT Coordinator, confirmed by the GM
  - The other WG coordinators were willing to continue with their tasks, confirmed by the GM.

- **Election of officers**
  - **Nominating Committee** Pierino De Felice (ENEA, Italy), Simon Jerome (NPL, UK – now IAEA, Monaco) and Octavian Sima (University of Bucharest, Romania)
  - **Simon Jerome** became chair of the Nominating Committee
  - First term of office of Vice-President John Keightley (NPL) ended in September 2018. John was willing to stand for a second term. Additional nominations were sought from the ICRM Delegate and Associate members but there were none. John's second term of office was

approved by the ICRM Executive Board in October 2018. The second term of office expires in September 2020 and then a new candidate will be needed.

- Posts due for election at this GM:
  - ICRM President Eduardo García-Toraño (CIEMAT, Spain) decided not to seek a second term of office.
  - ICRM Secretary Franz Josef Maringer (BEV, Austria) decided to step down from this post.
  - ICRM Vice Presidents (two posts) Mikael Hult (JRC, EU) and Akira Yunoki (AIST/NMIJ, Japan) reached the end of their first terms of office and both decided to stand for re-election.

According to the bylaws, nominations were sought

- The present Nominating Committee, after receiving several names of candidates for the vacant positions, proposed at least two names for each of the EB positions and one for the three Nominating Committee members.
- Election results **Executive Board:**

President:	***Brian Zimmerman***, NIST, USA
Vice-President:	***Mikael Hult***, JRC Geel, Belgium
Vice-President:	***Akira Yunoki***, AIST/NMIJ, Japan
Secretary:	***Denis Glavič-Cindro***, IJS, Slovenia

- ***Eduardo García-Toraño***, CIEMAT, Spain, remained member of the Executive Board as immediate Past President.
- No change in the **Nominating Committee** – end of term 30 September 2021**.**
- The General Meeting decided that term in office for all newly elected officers would start on 1 October 2019, ending on 30 September 2021.
- On behalf of the present ICRM Executive Board, the Secretary thanked all ICRM members who were willing to stand for election.

- An offer to **host the ICRM 2021 Conference** and next General Meeting was presented by Aurelian Luca, Horia Hulubei National Institute of R&D for Physics and Nuclear Engineering (IFIN-HH), Department of Radioisotopes and Radiation Metrology, Radionuclide Metrology Laboratory, Bucharest, Romania.

- The IFIN-HH estimated registration fees of about 480 € (early bird, at 120 participants) and proposed end of May 2021 as conference date. The GM voted to organise the **23rd ICRM Conference (ICRM 2021)** and **the next ICRM General Meeting in Bucharest, May 2021**.

- **ICRM and other future meetings** were outlined:
  - The 8th Low-Level Radioactivity Measurement Techniques Conference (**ICRM-LLRMT 2020**) is being planned to be held at LNGS close to L'Aquila, Italy.
  - Information on interim WG meetings planned 2019 – 2021 are given in the ICRM Newsletter, and in the WG reports.

- **Institutional membership:** No changes

- **Associate (personal) membership:**
  - New Associate Members appointed because they are new WG Coordinators (ICRM Bylaws 6.2):
    - **Steven Bell**, NPL, WG RMT
    - **Ryan Fitzgerald**, NIST, WG RMT
    - **Simon Jerome,** IAEA, WG LLMT
    - **Ole Nähle**, PTB, WG RMT
  - **Guy Ratel** (BIPM) was elected as Associate Member in recognition of his special contributions to ICRM and to the science of radionuclide metrology during the many years of his professional career.

- **Newsletter**
  For the future, a biennial publication frequency has been agreed by the GM 2019. The Newsletter is going to be published in the years without an ICRM general conference. The next ICRM Newsletter will be published in 2020.

- **Proceedings:** In view of the recent difficulties encountered with Elsevier on the publication of the proceedings in ARI, briefly touched upon in the President's report, it would be necessary to clarify details of the next conference proceedings before the call for papers. It was mentioned that Elsevier as well as Springer are aiming at smaller proceedings volumes with higher quality papers in order to improve their impact factor. The Executive Board would have to discuss this issue in the preparation of ICRM 2021, keeping in mind the interests of conference participants and authors.

- **ICRM website:** Lisa Karam asked the WG coordinators to generate more visibility for interim WG meetings by announcing and reporting more events on the ICRM website.

- The President **closed the General Meeting** thanking the attending ICRM members for their participation and looking forward to the next ICRM conference and General Meeting 2021 in Bucharest. Being his last General Meeting as President, he thanked the GM members, the Executive Board and in particular the Secretary for their support during the past 2 years.

The **ICRM Executive Board** had met on 30 May 2019 in the evening to prepare the General Meeting and convened again for a second short meeting directly after the GM, in order to mainly discuss with Aurelian Luca, the representative of IFIN-HH, Bucharest and the newly elected EB members the next steps in preparation of the ICRM 2021 conference and to plan the necessary meetings: EB meeting in Bucharest in October 2019, the date of the Scientific Committee meeting was not fixed yet. Since all relevant items were described above in the summary of the General Meeting, a separate summary of the Executive Board meeting of 30/31 May 2019 will not be prepared.

With my best regards,

Franz Josef Maringer
(ICRM Secretary until 30 September 2019)

INTERNATIONAL COMMITTEE FOR RADIONUCLIDE METROLOGY

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ICRM

http://physics.nist.gov/ICRM/

Circular letter to ICRM delegates and associates: Summary of Executive Board meeting of October 2019

Ljubljana, 12 March 2020
Ref: DGC/ICRM Sec/2020/02

Dear ICRM delegate and associate members,

On behalf of the ICRM Executive Board, I would like to give you a summary of our most recent Executive Board meeting, held from 16 to 18 October 2019 at IFIN-HH in Bucharest, Romania. The meeting was attended by Eduardo Garcia-Toraño (President 2017–30 Sep. 2019), Dirk Arnold (Past President 2017–30 Sep. 2019), Akira Yunoki, John Keightley and Mikael Hult (Vice Presidents), Franz Josef Maringer (Secretary 2017–30 Sep. 2019), Denis Glavič-Cindro (Secretary from 30 Sep. 2019), Brian Zimmerman (President from 30 Sep. 2019). Simon Jerome (Chair of the Nominating Committee, invited as observer) was excused. Aurelian Luca, Octavian Sima, Uwe Wätjen and Cristina Wätjen attended the meeting as members of the ICRM 2021 local organising committee / guests.

Handover of business from previous to new President and Secretary took place during this meeting.

The meeting was scheduled to, mainly:

- **Feedback from ICRM 2019 Conference** in Salamanca:
  - 138 participants + 6 accompanying persons from 32 countries, 68 posters and 34 orals were presented.
  - Discussion on review status, ARI and TS, proceedings: submission dates were not seriously accepted; coordinating referees have to speed up the reviewing process which has to be finished at the end of November.

- **Starting the preparation of the next ICRM 2021 Conference** in Bucharest:
  - The conference will take place **24.–28. 5. 2021,** other possible dates are **17.–21. 5.** or **31. 5.–4. 6. 2021**. The Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH) will be hosting the conference. Aurelian Luca is the Scientific Secretary and Chair of the local organising committee.
  - The Local Organising Committee (LOC) comprises Constantin Ivan (Technical-Administrative Director), Alexandra Olteanu (Financial Manager), Ioan Ursu (Scientific Secretary of IFIN-HH), Aurelian Luca (Scientific Secretary ICRM-2021), Nicoleta Mihaela Spanu (Conference Secretary), Webmaster (IT&C Dept.) (probably Laurentiu Serban), Adrian Socolov (conf. designer), Mihail-Razvan Ioan (Deputy Head of dept.), Cornel-Liviu Tugulan with the help of Andrei Antohe, Viorel Fugaru, George Ormenisan and Claudia Olaru (students), Maria Sahagia, Octavian Sima, Doru Stanga, Uwe and Cristina Wätjen.

- The conference itself will take place 24.–28. 5. 2021 (other dates 17.–21. 5. or 31. 5.–4. 6. 2021), on 28 May there will be the ICRM General Meeting and, alternatively, opportunity for laboratory visits at the Laboratory visit ELI-NP. EB discussed about the possibility to extend the conference for half day, morning of Friday for additional WG meetings, in the afternoon GM.
- First announcement is planned to be issued in early May 2020, second announcement early Feb. 2021.
- EB visited 4 candidates for conference venues: Hotel Marriott, Palace of the Patriarchate, Radisson Blu and Athenee Palace Hotel Hilton. Final decision will be taken after complete offers will be gathered.
- Possibilities for conference dinner: Casa Doina (Ion Mincu hall) or Pescarus restaurant, included music and dance performance
- Registration fees will be around 500 EUR.
- The abstract review procedure as with the ICRM 2019 conference allowing for an in-depth abstract evaluation in subgroups of the Scientific Committee will be applied again. Members of the Scientific Committee were proposed.
- Short orals as third option instead of poster were discussed. It depends on the length of the conference. As well longer breaks and coffee and posters in the same place were proposed.
- It is intended to publish the conference proceedings as a special issue of Applied Radiation and Isotopes.

- Discussion on **future symposia of ICRM Working Groups**:
  - The Low-Level Measurement Techniques WG will hold its 8th **ICRM-LLRMT conference** in Assergi – L'Aquila, Italy from 20-24 April 2020, hosted by the Laboratori Nazionali del Gran Sasso (INFN-LNGS). *Due to the steps that Italian Government took to confine the propagation of Coronavirus, the conference was postponed to 21-25 September 2020.*
  - **A week of ICRM Working Group meetings** (ICRM WG Nuclear Decay Data, ICRM WG Beta Spectrometry, ICRM WG Gamma Spectrometry and ICRM WG Radionuclide Measurement Techniques) is planned to be held at the LNE headquarters in Paris in the last week of October, starting Monday 26 October 2020. The meetings will run consecutively during the week, varying in length between ½ day and 1 ½ days, to be decided upon by the working group coordinators. In association with the ICRM Working Group meetings, a DDEP workshop is also planned.
  - The Liquid Scintillation Counting WG and the Life Sciences WG will organise their **interim meetings** in September 2020 at POLATOM (14.-15. 9. LSC, 16. 9. laboratory tours, 17.-18. 9. LS).

- **Membership:**

  Sofia University is proposed as new member by Philippe Cassette.

  J.C. Furnari, T.S. Park and M. Unterweger were proposed to be associate members. If the EB accepts, it should be done at the next General Meeting.

- **ICRM Newsletter, publications and WEB site**
  - Elsevier has changed the process by which it publishes Special Issues. This includes also the ICRM 2019 proceedings. According to the new process, the following steps are taken:
    - Once a manuscript is accepted it goes into production, and it is simultaneously published in the current regular issue and pulled into the online Special Issue.
    - As a consequence, articles from a Special Issue will appear in different regular issues of the journal, though they will be clearly marked and branded as Special Issue articles.
    - The consequence is that the ICRM2019 manuscripts accepted for publication will no longer appear in a single issue, but will rather be allocated to an issue in the order in which they were accepted. They will be collected online on the ARI website as a single Special Issue and will be marked as such, but the citations will be in different issues of the Journal.
    - This also means that attendees will no longer receive a hardcopy of the proceedings.
  - The ICRM Newsletter 31 was published online in September 2018, the EB is grateful to Mark A. Kellett for taking care of the editorship: http://www.lnhb.fr/conferences-publications/icrm-newsletter/
  - The ICRM WEB site still needs to be updated.
  - B. Zimmerman encouraged WG coordinators to update info on web sites.

Please keep me immediately informed about all changes in membership details and contact information to help me keeping the ICRM membership database up-to-date. This is important for sending correctly all ICRM information e.g. circular letters to ICRM Members and Liaison Organisations.

Best regards,

Denis Glavič-Cindro
(ICRM Secretary)

Announcements

Working Groups

A meeting of the Life Sciences Working Group (LSWG) is planned for 17-18 September 2020 at the Radioisotope Center POLATOM in Otwock, Poland. This meeting is planned in coordination with a meeting of the Liquid Scintillation Counting Working Group on 14-15 September. There will be opportunity for a tour of the laboratories at the RC POLATOM on 16 September. For details, contact the coordinator of the LSWG, Jeffrey Cessna (Jeffrey.cessna@nist.gov, +1 301 975 5539).

Available post-doctoral position at LNHB

Development of a new calibration facility for X-ray emitting radionuclides
Application to reactor dosimetry

The activity measurement of X-ray emitting radionuclides in the energy range below 100 keV encounters several difficulties that degrade the accuracy of the quantitative results. These include the difficulty of calibrating the detector efficiency and, in general, the significant uncertainties associated with X-ray emission intensities. In addition, the effect of self-attenuation of X-rays in standard sources or samples induces large corrective factors which must be controlled. Among the important applications of X-ray emitting radionuclides measurement, reactor dosimetry, which makes it possible to determine the neutron fluence received during irradiation and to characterize its spectrum, is based on the analysis of the activity of irradiated dosimeters. These are made of pure metals or alloys of perfectly known compositions, some of which are activated by neutrons. For example, reactions ^{93}Nb(n,n')^{93m}Nb and ^{103}Rh(n,n')^{103m}Rh are of prime importance for reactor dosimetry and are particularly interesting for characterizing neutron fluxes around 1 MeV. The proposed study follows a PhD thesis work that identified several areas for improvement in dosimeter measurement that will need to be implemented; these include:

- implementation of a new method of efficiency calibration of X-ray spectrometers using monochromatic radiation;
- improvement of radionuclide X-ray emission data used as standard for calibration (^{133}Ba, ^{152}Eu, etc.) to establish a consistent set of data;
- validation of corrective coefficients due to the presence of impurities during dosimeter irradiation;
- evaluation and publication of the decay scheme of ^{103}Pd and ^{103m}Rh

Training and experience: The candidate must have a PhD in Physics and Instrumentation or associated subject. He (She) must have a solid knowledge in radiation-material interactions and a strong interest for laboratory experiments. He/she should also have a good critical mind for the detailed analysis of the results. Candidates must be fluent in English and a good level in French is also an advantage.

General conditions: Postdoctoral fixed-term contract of one year (renewable one year).

Starting date: 01/09/2020

Location: Laboratoire National Henri Becquerel – (LNHB) CEA Saclay (France)
(http://www.lnhb.fr/en/)

THESIS SUPERVISOR:

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Available thesis proposal at LNHB

TITLE
Development of uniform surface sources by functionalization for decommissioning & dismantling

RESEARCH FIELD
Chemistry / Condensed matter physics, chemistry & nanosciences

ABSTRACT
The decommissioning of nuclear installations and the management of the radioactive waste produced during this stage are major concerns for the future, especially with the ageing of the European nuclear plants. Improving the qualification of contamination assessment systems would make it possible to analyse more precisely and ideally identify more quickly the appropriate waste management channel to help control the resulting costs. The thesis topic focuses on widespread cases where the activity is present on/in surfaces, flat or curved, as well as in pipes. The objective of the thesis is to realize uniform, traceable, flat or cylindrical surface sources, even deformable, with limited radiation attenuation (case of pure beta or alpha emitters). The added value associated with the traceability of these sources lies in the control of the deposited activity level, whatever the radionuclide considered. The approach adopted is the functionalization of a substrate to immobilise and distribute the radionuclides uniformly without excessive attenuation of the radiation emitted, while ensuring that the surface remains non-contaminating. The formation of strong chemical bonds with the surface will guarantee the stability of the layer formed and the chemical affinity with the grafted complexing molecules aims to permanently immobilize the activity. The choice of the functionalization method depends on the substrate on which the bonding takes place (metallic, polymeric, conductive or non-conductive, flexible or rigid). The other end of these molecules can be functionalized to make them specific to the target radionuclides. The tests of surface sources will be carried out first with Am-241, both alpha and low energy gamma emitter and pure beta or not emitters of interest for the elaboration of typical waste spectra. The problem of large surfaces and especially the criterion of source uniformity (variability of surface activity < 10%, including uncertainties), constrain the method to be used for the functionalization of the surface. The evaluation of the uniformity of the activity distribution over the source surface will be carried out by autoradiography (imaging technique whose signal is proportional to the activity).

LOCATION
Département Métrologie Instrumentation et Information
Laboratoire National Henri Becquerel
Laboratoire de Métrologie de l'Activité
Place: Saclay
Start date of the thesis: 01/10/2020

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PHENIICS

DRT: Thesis SL-DRT-20-1058
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Reports from the Working Group Coordinators

Action report of the ICRM Radionuclide Metrology Techniques Working Group

The ICRM Radionuclide Metrology Techniques Working Group (RMT-WG) met in September 2018 at NIST and during the 2019 ICRM meeting in Salamanca. A key milestone for RMT was the publication of IEC standard 63047 in 2018. This standard regards the data format for list mode digital data acquisition, was a major impetus for reactivating the RMT in 2001. Now that the standard has been published, the RMT-WG is focusing its efforts on this topic on supporting NMIs implementation of IEC 63047 by identifying key parameters for recording coincidence and TDCR counting and developing software to translate among data formats.

Other discussion topics at the 2018 meeting included traceability for large area sources, modelling of dose calibrators, and recent primary standardizations by NMIs. At ICRM 2019, a brief report was given by NIST about their new ampoules being used to contain alpha-emitting SRM solutions, as the traditional “NBS ampoules” used for SIR comparisons have become difficult to clean due to ageing. A new action for the WG was identified as the creation of a checklist for reviewers of ICRM-RMT sessions. An extended breakout session was conducted on gas counting, in which numerous laboratories reported either ongoing or upcoming developments of gas counting capabilities. In addition, recent Xe-133 comparisons and needs for gas standards were discussed.

Outgoing RMT-WG chair John Keightley stepped down and is being succeeded by co-chairs Christophe Bobin (LNE-LNHB) and Ryan Fitzgerald (NIST). John and Christophe will continue to lead the digital coincidence topic. Steven Bell (NPL) and Ole Nähle (PTB) will lead subgroups on gas counting and large area sources, respectively. A 2021 RMT-WG meeting is being coordinated with other ICRM WGs for the last week of October at LNE headquarters in Paris, France. All interested attendees are invited to contact Christophe (christophe.bobin@cea.fr) and Ryan (ryan.fitzgerald@nist.gov) with ideas for contributions or discussions at that meeting.

Coordinator's Report
Life Sciences WG

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 interim meeting of the Life Sciences Working Group (LSWG) was held at The D.I. Mendeleev All-Russian Institute for Metrology (VNIIM) in, St. Petersburg, Russia on 7-8 June 2018. The agenda and participants of the meeting are presented here. Those interested in a topic of discussion are invited to contact the presenter or the coordinator.

Thursday, 7th

Welcome, Introductions, Review of Agenda
Brief descriptions of Life Sciences programs and key personnel (All)
Previous LS-WG Meetings and ongoing actions (A. Fenwick, NPL for J. Cessna, NIST)

Standardizations and New Radionuclides
Measurements of positron emitting radionuclides (E. Tereshchenko, VNIIM)
Discussion Topic: New radionuclides for nuclear medicine applications – all
Primary Standards of ^{155}Tb and ^{161}Tb (A. Fenwick, NPL)
Activity standardization of ^{227}Th (K. Kossert, PTB)
Discussion Topic: ^{224}Ra standardization (All)
^{224}Ra at NPL (A. Fenwick, NPL)
Standardization of ^{166}Ho (European project MRTDosimetry) (C. Bobin, CEA-LNHB)
Measurements of ^{166}Ho (M. Capogni, ENEA)

Ionization Chambers
Ionization chambers at PTB: Hardware, software, analysis. (O. Nähle, PTB)
Bremsstrahlung measurement (F. Juget, IRA)

Friday, 8th

Dissemination of Standards
Calibration of medical instruments for Russian hospitals (G. Zhukov, VNIIM)
Dissemination of ^{18}F standards to Australian users (S. Tobin, ANSTO)
Proposal for ^{67}Cu comparison (F. van Wyngaardt, ANSTO)
Activemeter Calibration Factors for ^{89}Zr and ^{44}Sc (E. García-Toraño, CIEMAT)
Calibrator dial settings for ^{224}Ra and ^{227}Th (A. Fenwick, NPL)
Discussion Topic: Do we need Metrology for very short-lived radionuclides? (All)
Portable system for standardization and why it is important (A. Fenwick, NPL)

Quantitative Imaging
Nuclear medicine imaging and phantom development at NPL (A. Fenwick, NPL)
Reference dosimetric data for diagnostic and therapeutic applications in nuclear medicine (A. Denis-Bacelar, NPL)

EMPIR project funding application: metrology for emerging alpha and Auger emitting radiopharmaceuticals (A. Denis-Bacelar, NPL)

General Topics
Discussion Topic: Comparison needs – ^{124}I pilot?; ^{67}Cu comparison? (All)
Open Discussion (All)
Future actions and meetings of the working group (A. Fenwick, NPL for J. Cessna, NIST)

End of meeting

Participants List

Andrei Antohe, IFIN-HH, Romania
Denis Bergeron, NIST, USA (teleconference)
Christophe Bobin, LNHB, France
Ryszard Broda, POLATOM, Poland
Marco Capogni, ENEA, Italy
Jeffrey Cessna, NIST, USA (teleconference)
Maria Candida Moreira de Almeida, CNEN, Brazil
Antonio Eduardo de Oliveira, LNMRI/IRD, Brazil
Ana Denis-Bacelar, NPL, UK
Tomasz Dziel, POLATOM, Poland
Andrew Fenwick, NPL, UK
Eduardo García-Toraño, CIEMAT, Spain
Frédéric Juget, IRA, Switzerland
Karsten Kossert, PTB, Germany
Matej Krivošík, SMU, Slovakia
Haoran Liu, NIM, China
Ole Nähle, PTB, Germany
Meryem Seferinoğlu, Sinop University, Turkey
Tanya Shilnikova, VNIIM, Russia
Marcell Takacs, PTB, Germany
Evgeny Tereshchenko, VNIIM, Russia
Siobhan Tobin, ANSTO, Australia
Freda van Wyngaardt, ANSTO, Australia
Grigoriy Zhukov, VNIIM, Russia
Tomasz Ziemek, POLATOM, Poland

The most recent meeting of the Life Sciences Working Group (LSWG) was held during the ICRM congress in Salamanca, Spain on May 27, 2019 with 84 participants. The agenda is presented here. Those interested in a topic of discussion are invited to contact the presenter or the coordinator.

Agenda
Summary of interim LS-WG meeting at VNIIM in St Petersburg; Actions of the WG (J. Cessna NIST)
Ra-224 progress at NIST (Elisa Napoli, Oncoinvent, Norway)
Discussion – External Beam Therapy Experience for Radionuclide Therapy Practice (Claude Bailat, IRA)
Establishing traceable nuclear medicine imaging standards for quantitative SPECT (Andrew Robinson, NPL)

Status of action items:

- ^{67}Cu Comparison (new/proposed): The possibility of a ^{67}Cu comparison was proposed by ANSTO at the St. Petersburg interim WG meeting. ^{67}Cu-SARTATE is used as a therapeutic pair with ^{64}Cu PET imaging in the diagnosis and treatment of neuroendocrine tumors. Please contact the coordinator if interested in piloting or participating.

- ^{124}I Comparison (proposed): The possibility of a comparison, through the LS-WG, was discussed at the Rome interim WG meeting and again at the St Petersburg interim WG meeting. A pilot is needed. NIST, IFIN-HH, ENEA, NPL, and PTB (if there is no ^{125}I) initially expressed interest in participation. ANSTO and LNHB have additionally expressed interest. ENEA proposed use of a central supplier. Perkin Elmer was identified as an example supplier of ^{124}I who had successfully distributed sets of vials in the past. A comparison would also provide an opportunity for more half-life determinations.

- ^{227}Th Comparison (proposed): The future need for a comparison of this radionuclide was first discussed at the Rome interim WG meeting. Bayer AS had expressed a willingness to support this comparison. The comparison would, presumably, follow a ^{223}Ra comparison.

- Coordination of efforts for new radionuclides (ongoing): Contact the LS-WG coordinator to transmit requests to other WG members regarding coordination of efforts for new or uncommon radionuclides. There is the opportunity to coordinate with CIEMAT (standardization published; DOI: 10.1016/j.apradiso.2017.10.033), NPL (to be published), and possibly NIST on the standardization of ^{89}Zr. NPL has inquired about cooperation on ^{149}Tb, ^{152}Tb, ^{155}Tb or ^{161}Tb.

- Metrology for short-lived radionuclides? (proposed): Motivation or justification papers for the need of metrology in the case of short-lived radionuclides are requested. Send any information to the LS-WG coordinator. A workshop to bring together stakeholders and produce a position paper has been discussed. A possible solution is to coordinate with the IAEA to produce a document.

- Coordinated collection of Ionization Chamber response curves (ongoing): This action was proposed at the ICRM Congress in 2017. The effort would build upon data collected for radionuclide calibrators by metrology institutes. Curve generation would follow an updated SOLVER method. NIST, IRA, CEA, NPL, PTB, ANSTO, and NRC have expressed interest. A protocol for collection will need to be generated. The collection could aid in the prediction of new calibration factors, especially in complicated parent-daughter situations, such as ^{227}Th. NPL has proposed they could provide a web page to access a collection.

- ^{68}Ge/^{68}Ga comparison (ongoing): The comparison, CCRI(II)-K2.Ge-68, is in Draft B. Results were presented at the ICRM Congress in 2017 and published in the proceedings (DOI: 10.1016/j.apradiso.2017.10.052)

- Formation of an informal subcommittee to investigate simulation of beta emitter response in RC (ongoing/on hold): A detailed study of the influence of various quantities on Monte-Carlo modelling was presented by NRC-Canada at the Rome interim WG meeting. Prior plans for a comparison using a simple geometry have been put on hold. This action has been replaced with the coordinated collection exercise mention above.

- Emphasize importance of measuring nuclear data for nuclear medicine radionuclides (ongoing): Working group members wish to emphasize the importance of measuring nuclear data for nuclear medicine radionuclides. NPL reported they have measured a half-life for ^{223}Ra, now published. NPL identified the ^{161}Tb half-life as being discrepant. A new evaluation for

Ho-166 was reported as being performed, but is not yet published. Substantial measurement efforts as a pert of MRTDosimetry were published in late 2019.

- Collecting activity calibrator factors for medical radionuclides in different ionization chambers (ongoing): The database is updated as needed and is available from the coordinator. An offer has been made by NPL to host the database on their website. Discussions ensued regarding the best form to present information, spreadsheet or database. Appropriate disclaimers are needed for the data. A link from the working group homepage will be provided if this can be established. Many NPL-type chamber calibration figures did not contain reference to publication.

- Sharing of software for automation of radionuclide calibrators (ongoing): Individuals who have developed freely available software for this purpose are requested to provide that software to the coordinator, for distribution to the LSWG.

- Comparison of ^{90}Y with portable TDCR: This comparison was proposed in support of the MetroMRT joint research project of the European Metrology Research Programme. The eventual goal would be direct measurement of ^{90}Y microspheres. An update is needed for this project.

- Compile a list of comparisons in nuclear medicine (ongoing): The proposed list would serve as a basis for future reviews of similar comparisons. A bibliography has been created in support of investigations into radionuclide calibrators. This bibliography is available from the coordinator. Please forward publications to the coordinator for inclusion in the list.

- Create repository for information on dissolution of microspheres (ongoing): This action would support further work resulting from MetroMRT. Please submit methods and experience to the coordinator. The experiences of LNHB and NPL were presented at the recent WG interim meeting and have now been published. ENEA is also working in this area and will report their results in the future.

- Questionnaire – what radionuclide calibrators/ionization chambers are used in your institute to support nuclear medicine? (ongoing): To support interaction between laboratories information is requested regarding what models of radionuclide calibrators or ionization chambers are used in support of nuclear medicine at your institute. Information has still only been provided by ENEA-INMRI. Please provide information to the coordinator for distribution to working group members. A short questionnaire for distribution to members was also suggested at the interim meeting in St. Petersburg.

- Support for measurements of impurities in nuclear medicine radionuclides (ongoing): Members have been requested to provide support or suggest methods for the measurement of impurities in nuclear medicine products. This is of importance when new production methods can introduce different impurities than previously seen for established radionuclides, such as ^{99}Mo and ^{99m}Tc. Two papers that touch on this topic were accepted in the Radionuclide Metrology in the Life Sciences session at the ICRM 2017 congress.

- Comparison of activity of a ^{223}Ra solution (ongoing): A comparison under the auspices of CCRI(II), has been planned, to be piloted by NPL. NPL is soliciting participants and comments on the proposed protocol. They are also still negotiating with the supplier following a change in personnel at the company.

The next interim meeting of the LSWG is planned to be held at the Radioisotope Centre POLATOM, National Centre for Nuclear Research, Otwock, Poland on 17-18 September 2020. Topics of discussion being considered include the current action items. Those laboratories having any work they wish to present or action items to propose are requested to contact the coordinator.

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

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Coordinator's Report
Alpha Spectrometry WG

No report available.

Action report of the ICRM Gamma Spectrometry Working Group

Scope of the GSWG

Gamma-ray spectrometry is a widely used analysis technique, with applications in a large range of fields and expertise. The ICRM Gamma Spectrometry Working Group is devoted to the development of the metrological aspects of gamma-ray spectrometry and its applications. This includes, but is not restricted to:

- Characterization of measurement techniques and instrumentation,
- Determination of photon emission intensities,
- Determination and assessment of corrective factors and uncertainties,
- Determination of activity of gamma-emitting radionuclides for industrial, or safety applications, etc.

The GSWG promotes collaboration between the WG members to improve the analytical techniques and distributes practical information in order to disseminate the knowledge and know-how to various laboratories.

Actions of the GSWG

During the ICRM2017 conference, two actions were proposed: these were actually carried out during the two years and lead to presentations during the ICRM2019 conference and associated publications:

1. Pr. Octavian Sima: Exercise on self-consistency of the methods applied for the evaluation of coincidence-summing corrections in the case of volume source

2. Marie-Christine Lépy: Action to facilitate the use of Monte Carlo simulation software Benchmark for Monte Carlo simulation in gamma-ray spectrometry – Efficiency computation

An intermediate meeting of the GSWG organized by LNHB was held on June 12-14, 2018, in the headquarters of LNE, Paris (France). The meeting brought together about 40 participants and was divided into two parts:

- June 12-13: Course on "advanced" gamma-ray spectrometry. This training was organized for members of the working group, and in particular for new users, to enable them to master this technique as well as possible.

- June 14: The meeting of the working group was mainly dedicated to the two on-going actions of the GSWG:

- Exercise on self-consistency of the methods applied for the evaluation of coincidence-summing corrections in the case of volume sources, leaded by Octavian Sima,
- Action to facilitate the use of Monte Carlo simulation software, leaded by Marie-Christine Lépy.

The agenda allowed the participants to present their software or approaches to these action and to discuss the results.

- June 15: A visit of LNHB laboratories at the CEA Saclay center was proposed and attended by 8 participants.

Picture of the participants to the ICRM GSWG intermediate meeting on June 2018

The meeting material (presentations, report) is made available on the ICRM GSWG web page: http://www.lnhb.fr/icrm_gs_wg

This web page is regularly updated and includes information about the GSWG actions and meetings, as well as practical recommendations.

During the ICRM2019 conference, the Gamma Spectrometry session included 5 oral presentations and 11 posters; unfortunately, this was significantly lower than the expected number of contributions accepted by the Scientific Committee (20) and also there were only eight submitted articles to the reviewing procedure, what is half of what was originally planned (17). In addition to the communications about on-going actions, other new topics of interest were Monte Carlo optimization procedure and spectral unmixing procedures.

During the meeting of the GSWG, Leticia Pibida (NIST) presented the status of standards for gamma-ray spectrometry and encouraged ICRM attendees to participate in the normalization procedures.

Proposal of different actions that were discussed in a dedicated meeting Wednesday afternoon, that gathered about 20 attendees. The topics under discussion were:

- Action to examine the influence of angular correlations on coincidence summing corrections (Pr Octavian Sima proposed a detailed plan);

- Self-absorption corrections in the low-energy range with the specific problem of ^{210}Pb quantification;

- Monte Carlo optimization procedures;

- Continuation of the benchmark for Monte Carlo simulation (Coincidence summing corrections, Marinelli containers and well-type detectors);

- Efficiency calibration (low energy-range, uncertainties) and in the high-energy range (3 MeV – 10 MeV).

It is wished to organize an intermediate meeting in conjunction with the ND-RMT meeting planned in 2020 (probably in France).

Further information and proposals will be distributed to the whole list of interested people on the ICRM GSWG actions (about 120 registered + 30 new names in 2019).

The WG coordinator wishes to thanks all the participants for their active contribution what makes the GSWG alive, with special mention to the reviewers of the ICRM 2019 conference: D. Arnold (PTB), P. De Felice (ENEA), M. Hult (JRC), M. Korun (IJS), F.J. Maringer (BEV), V. Peyres (CIEMAT), O. Sima (U. Bucharest), T. Vidmar (JRC) and J. Keightley (NPL) from the RMT WG. It is hoped that the ICRM GSWG has efficiently contributed to distribute the knowledge towards end-users through the different actions and information uploaded in the webpage. This should continue and be improved within the next two years.

On behalf of the ICRM Gamma Spectrometry WG
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Action report of the ICRM Liquid Scintillation Counting Working Group

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 two decades, many new developments were presented by ICRM researchers, e.g. new counter systems, new electronics for signal processing and data acquisitions, investigations of existing models and extensions of calculation procedures. The methods are used for activity standardization of a growing number of radionuclides as well as for determination and validation of radionuclide decay data.

Working Group meeting at VNIIM 4-5 June 2018

An interim meeting of the LSC Working Group was organized at VNIIM in St. Petersburg from 4th to 5th June 2018. The purpose of the LSC Working Group interim meetings is to discuss issues that typically cannot be addressed at the general ICRM meetings due to time limitations. The interim meeting shall also provide 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 at the meeting in June 2018:

Models and applications

- LSC efficiency calculation at CIEMAT (Eduardo Garcia Toraño Martinez)
- Progress report on micelle effect in liquid scintillation (Frédéric Juget)
- MMC research to support LSC efficiency calculations (Karsten Kossert)
- kB: optimal values for Ultima Gold, Hisafe 3, Instagel Plus and Hionic Fluor (Eduardo Garcia Toraño Martinez)
- Measurements of ^{63}Ni and ^{55}Fe solutions activities by the LS method with single PMT counting system (Sergei Pakhomov)
- ^{55}Fe, ^{3}H and ^{63}Ni measurements at ENEA (Marco Capogni)
- LSC measurements at IFIN-HH (Andrei Antohe)
- Activity determinations of specific isotopes (^{55}Fe and others) by the TDCR-method (Tatiana Shilnokova)
- About the correction for decay during the measurement (Karsten Kossert)
- Software "SpectraDec" and its application in various tasks of liquid scintillation analysis (Sergey Malinovskiy)
- Use of soluble aerosol filters in liquid scintillation spectroscopy (Ivan Buryanenko)
- Activity determination of ^{231}Pa by means of liquid scintillation counting (Hoaran Liu)
- Standardisation of ^{64}Cu by 4π(LS)-γ coincidence counting (Freda van Wyngaardt)

Hardware

- Digitizer approach at PTB (Marcell Takács)
- New developments of LS-techniques in radionuclide metrology (e.g. TDCR and CNET) - Advantages of digitizer for TDCR-method (Ilya Alekseev)
- Implementation of the "pulse-mixing" method in the TDCRG counter (Tomasz Ziemek)

LS-based coincidence counting

- Python code for Coincidence Counting Analysis (Slobhan Tobin)
- The challenge of standardizing ^{99m}Tc by 4π(LS)-γ coincidence counting (Freda van Wyngaardt)

Each talk was followed by very comprehensive and detailed discussions and the participants found it beneficial to have more time for that than during the general conference.
26 participants from 11 countries (including Australia, Brazil and China) attended the meeting.

Figure 1: Participants of LSC WG meeting at VNIIM in June 2018

The event has been combined with a lab tour of the VNIIM laboratories and participants learned a lot about the life and work of the chemist Dmitri Iwanowitsch Mendelejew (1834-1907).
The organization was similar as in 5 previous successful meetings held at LNE in 2007, NPL in 2008, PTB in 2012, NPL in 2014 and ENEA in 2016.
Since such events are good training opportunities, NMIs are encouraged to give young researchers the possibility to participate.

Working Group meeting at ICRM 2019 in Salamanca

The LSC-WG had also a short meeting during the ICRM main conference and discussed recent developments for the extension of the SIR (Romain Coulon, Ryszard Broda), the importance of decay data measurements for LSC when using metallic magnetic calorimeters and improved theory, and list mode data for TDCR (Krasimir Mitev). A comparison on the analysis of the same set of list mode data was proposed and, after the conference, Ole Nähle (PTB) volunteered to coordinate this action as a supplementary KCWG(II) comparison.

Forthcoming meetings

Next interim meeting of the LSC-WG is scheduled for **14-16 September 2020** (followed by an ICRM Life Sciences WG interim meeting) in Warsaw, Poland.

Other meetings

The next international LSC conference will be organized in Chengdu, China. The conference was postponed due the coronavirus and the new dates are 12-16 October 2020.

On behalf of the LSC Working Group

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Coordinator's Report
Low Level Measurement Techniques WG
(ICRM-LLMT WG)

General comments

Measurement of low-level radioactivity continues to be of abiding interest to the scientific community, underscored by 2020 being the 80th anniversary of the discovery of ^{14}C, neptunium and plutonium, although the discovery of the two actinide elements was not announced until 1945; in 2021 we see the 125th anniversary of the discovery of radioactivity.

There are many drivers for the continued measurement of low levels of radioactivity (and one may debate at length what 'low levels' mean), and these include formal legislation, such as the Basic Safety Standard and the Drinking Water Directive in Europe (mirrored in similar legislation around the world), countering illicit use of nuclear material through nuclear forensics as well as decommissioning of nuclear facilities, where the determination of difficult-to-measure and long-lived (> 4 000 a) fission and activation products are among the measurement challenges.

In addition, the large increase in uninformed scepticism of science in general demands that all measurements (whether they appear in the public domain or not) are supported by scientifically and metrologically sound techniques. The ICRM and its members have an important role in promoting these activities.

ICRM 2019 conference, Salamanca

Twelve papers (3 oral, 9 posters) were presented in the 'Low-level Radioactivity Measurement Techniques' session at the conference, including presentations that ranged from the deep oceans to the atmosphere and included radon, γ-ray spectrometry, characteristic limits – topical, as ISO 11929 was revised and updated in 2019 – and novel radiochemical techniques. Thanks to the authors and reviewers for their contributions to this session.

The working group coordinator, Mikael Hult (EC JRC), had previously indicated that pressure of work prevented him from continuing in the coordinator's role; a previous incumbent, Simon Jerome, agreed to take over the coordination of this working group until a new coordinator is found. This was confirmed at the ICRM general meeting on 31st May 2019. I wish to thank Mikael for all of the hard work that he put in during his 7 years as coordinator that has raised awareness of the working group and led it into new areas of science, such as astrophysics and radioecology.

ICRM-LLRMT Conference 2020 (https://icrm2020.lngs.infn.it/news/)

The preparations for the 8th Low-level Radioactivity Measurements Techniques conference were started in the latter half of 2018, and have continued throughout 2019 and into 2020. The conference will be hosted by in Italy by Laboratori Nazionale del Gran Sasso (LNGS); LNGS is one of the laboratories of Istituto Nazionale di Fisica Nucleare, and their support is deeply appreciated. The call for abstracts opened in August 2019 and closed in November 2019.

In all 177 abstracts were submitted for the conference through Indico and reviewed by the guest editors and scientific committee by mid-January 2020. The outcome was that 100 abstracts were accepted as a papers in the conference proceedings to be published by Applied Radiation and Isotopes (77 oral and 23 posters). An additional 69 posters will be presented at the conference, but will not go forward for publication as part of the conference proceedings.

The conference sessions are Applications (Mikael Hult, EC-JRC), Fundamental Physics (Matthias Laubenstein, LNGS), Low level γ spectrometry (Franz-Josef Maringer, BEV), Noble gases (Hardy Simgen, MPIK), Non-radiometric techniques (Lindis Skipperud, NMBU), Quality and Intercomparisons (Michel Bruggeman, SCK CEN), Radiochemistry (Simon Jerome, NMBU), Radon

(TBA) and Techniques for low level α, β and γ (Dirk Arnold, PTB). There will also be three thematic sessions – Climate Change (Iolanda Osvath, IAEA), Emergency Preparedness, (Steven Bell, NPL) and ISO Standards (TBA). Thanks to all of the guest editors and wider scientific committee for their reviews and collation of data.

The conference was originally scheduled for 20-24th April 2020, but has been postponed to 21st-25th September 2020 as a result of the global coronavirus pandemic. This should not affect the delivery of the conference or the publication of papers, although this assumes that current restrictions will be lifted before the beginning of August.

Finally, I would like to record my appreciation to Matthias Laubenstein, Mikael Hult and Brian Zimmerman for all they have done to get the conference to the point where it is ready to run and to be published.

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15th March 2020
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Coordinator's Report
Beta-Particle Spectrometry WG

Background

The Beta Particle Spectrometry Working Group is devoted to the development of the metrological aspects of beta spectrometry and its applications. This includes:

- Theory. Beta ($\beta^{\pm}$) and electron capture (ε) transitions; Theoretical shape factors and influence of the nuclear current; Atomic effects.
- Experiments. Instrumentations used for beta spectrometry; Techniques that need beta information; Confidence on experimental shape factors; Data analysis and unfolding methods.
- Simulations. Confidence on the physical processes: low energies, radioactive decays, atomic rearrangements; Comparison of the results of different codes.
- Evaluations. Confidence and uncertainties on experimental shape factors; Procedure for establishing recommended shape factors; Mean energies, log *ft* values, database.

Interested communities in radionuclide metrology are: nuclear decay data, liquid scintillation counting, ionisation chambers, 4π β-γ counting.

Recent and on-going activities

- A dedicated website was created in 2016 and can be found at the following address: http://www.lnhb.fr/icrm_bs_wg/.

- Theory

  i) Further developments of calculations of electron capture decays. Precise atomic energies and radiative corrections have been demonstrated to be of high importance for accurate theoretical predictions.

  ii) Inclusion of the nuclear structure in beta decay calculation has been conducted through the determination of single particle nuclear matrix elements. Formalism has been explicitly extended to electron captures.

  iii) A new version of the BetaShape code has been released in June 2019. This version includes improvements in the calculation of radiative corrections for beta decays and an update of the database of experimental shape factors. In addition, calculation of electron capture decays is included, with provision of capture probabilities and capture-to-positron probabilities for all subshells, log(ft) values and splitting of the branch between capture and beta plus transitions. This new version is made available for the community at the same address:
  http://www.lnhb.fr/rd-activities/spectrum-processing-software/

- Simulation

  i) A decay module for Geant4 has been developed at LNHB, in the same spirit as the PenNuc module developed by CIEMAT with support from LNHB, but with improvements such as a coupling with the BetaShape code. This module was presented at the ICRM 2019 conference (May 27-31, 2019) and will be made available for the community.

ii) An unfolding algorithm has been developed at PTB based on Monte Carlo simulations (EGSnrc). The purpose is to correct a ^{36}Cl spectrum measured with a metallic magnetic calorimeter for the distortion due to the escape of bremsstrahlung photons. A similar algorithm has been developed at LNHB using Geant4 and Penelope simulations and successfully applied to beta spectra measured with silicon detectors.

- Measurements

  i) Beta spectra of ^{14}C, ^{36}Cl, ^{99}Tc and ^{151}Sm decays have been measured with metallic magnetic calorimeters at LNHB and PTB.

  ii) Beta spectra of ^{87}Rb and ^{176}Lu decays have been measured with solid scintillator crystals at TU Delft (Gonitec).

  iii) A magnetic spectrometer has been developed at IRA (CHUV) dedicated to beta spectrometry and beta spectra of ^{36}Cl, ^{60}Co, ^{99}Tc and ^{134}Cs decays have been measured.

  iv) A detection system based on silicon detectors in a quasi-4π configuration is being developed at LNHB and preliminary beta spectra of ^{14}C, ^{36}Cl and ^{99}Tc decays have been measured.

- Evaluations

  The BetaShape program is the reference code for DDEP evaluations. A database of published experimental shape factors, as comprehensive as possible, is being developed and will be made available on the Working Group website.

Related projects

- European metrology project (EURAMET, EMPIR programme) MetroBeta 15SIB10, 2016-2019. Website: http://metrobeta-empir.eu/. Partners are from Czech Republic, France, Germany, Netherlands, Poland and Switzerland.

Summary. The MetroBeta project is taking both theoretical and experimental approaches to improving the knowledge of beta spectra. On the theoretical side, existing knowledge of the calculation of nuclear wave functions is being used to take into account the nuclear structure effect on these spectra. On the experimental side, beta spectrometry with MMCs is being developed, as well as solid scintillators containing the beta emitters in the structure of the scintillator crystal. Comparison of the newly calculated and measured spectra will validate the quality of the spectra.

- European metrology project (EURAMET, EMPIR programme) MetroMMC 17FUN02, 2018-2021. Website: http://empir.npl.co.uk/metrommc/. Partners are from France, Germany, Portugal, South Korea and United Kingdom.

Summary. The main objective of the MetroMMC project is to improve the knowledge of electron capture decay and subsequent atomic relaxation processes. New theoretical calculation techniques and extensive experiments using MMCs will be developed to determine important decay data which are relevant for primary activity standardisations in radionuclide metrology, in cancer therapy on the DNA level, and when studying the early history of the solar system. The experimental parts will be complemented with a new approach based on microwave coupled resonators.

Recent and future meetings

- Joint radionuclide metrology meetings took place at NIST (September 10-14, 2018):

  i) Decay Data Evaluation Project (September 10-11, 2018)

  ii) Nuclear Decay Data Working Group (September 11, 2018)

  iii) Beta-Particle Spectrometry Working Group (September 11, 2018)

  iv) Radionuclide Metrology Technique Working Group (September 12, 2018)

  v) NIST - BIPM Workshop on low electrical current measurement for radioactivity metrology (September 13, 2018)

  vi) MetroBeta Workshop (September 14, 2018)

  vii) MetroMMC workshop (October 24, 2019)

- A Working Group meeting took place in Salamanca during the ICRM 2019 conference (May 27-31, 2019). Three presentations were given:

  i) M. A. Kellett (LNHB), Overview of the MetroBeta Project

  ii) K. Kossert (PTB), Comparison and validation of beta spectra measurements

  iii) D. Arnold (PTB), Overview of the MetroMMC project

- The next Working Group meeting will take place alongside the next DDEP workshop and the ICRM Nuclear Decay Data Working Group meeting.

On behalf of the Beta-Particle Spectrometry Working Group,

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Coordinator's Report
Nuclear Decay Data WG

Background

The "Nuclear Decay Data" Working Group aims to:

- Create a link between evaluators in the Decay Data Evaluation Project (DDEP) and the measurement community within NMIs, in order to improve the understanding of the evaluation needs within NMIs;
- Encourage NMIs to undertake decay data measurements as part of their normal standardisation work, which it is felt can be achieved with limited extra effort;
- Communicate current/future measurements within NMIs to the DDEP in order to better coordinate future evaluations;
- Ensure that new measurement needs identified during the evaluation process are communicated to the measurement community;
- Interest/recruit new DDEP evaluators at ICRM events.

In particular, the evaluations undertaken by the DDEP are critically reliant on the availability of absolute emission probability measurements, which solely NMIs, with their ability to make absolute activity measurements, are in a position to provide.

Second Working Group Meeting, 11 September 2018, NIST, USA

The second meeting was attended by fifteen or so participants. Presentations and discussions included the feedback from a new DDEP evaluator, recent nuclear data measurements and future possibilities. Although it was a fairly limited attendance, the opportunity for discussion within such a forum was welcomed.

ICRM Conference Session, 27 May 2019, Salamanca, Spain

During the 22nd International Conference on Radionuclide Metrology, a Working Group Session was organised. Presentations from a number of NMIs and other institutes active in measuring nuclear data were made, including PTB, NPL, NIST, LNE-LNHB, who gave an overview of their recent and future measurements.

Forthcoming

The third meeting for this Working Group will be held during the week of nuclear data related meetings to be held at the LNE, Paris during the week (26th – 30th October 2020). The week will include a DDEP workshop, various ICRM Working Group meetings (Nuclear Decay Data, Beta Spectrometry, Gamma Spectrometry and Radionuclide Measurement Techniques). The final schedule will be released in the near future.

I look forward to seeing you in October.

On behalf of the Nuclear Decay Data Working Group,

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Contributions

LABORATORY	Comisión Nacional de Energía Atómica (CNEA), Argentina
NAMES	M. C. FERRARI, M. ROSSI, N. DE MATTEIS, R. AMOR
ACTIVITY	1. Measurement of natural and artificial radionuclides in environmental samples and others. 2. Preparation, quality control, standardisation and issue of radioactive sources. 3. Development of radioactive standards in different matrixes. 4. Monte Carlo simulations applied to efficiency calibration curves in GeHP detectors.
KEYWORDS	Environmental control, gamma-ray spectrometry, liquid scintillation, low-level, radiochemistry, simulation code, Monte Carlo, SIR, source preparation, traceability.
RESULTS	1. Gross alpha and gross determination in samples of milk powder, maize, soyben meal, wheat and fish by liquid scintillation. 2. Radiochemistry separation and 90Sr determination in samples of milk powder, maize, soyben meal, meat, cheese, wheat and fish. 3. Analysis of environmental samples by high resolution gamma spectrometry. 4. Routine measurements and certifications of non radioactive contamination in exported foodstuffs by high resolution gamma spectrometry. 5. Preparation and calibration of radioactive sources in different matrixes.
PUBLICATIONS	*On the equivalence between homogeneously prepared sources and sources prepared by seeding in layers for different geometries, energies and matrix parameters*. M. C. Ferrari *et al*, Applied Radiation and Isotopes (154) December 2019
IN PROGRESS	Monte Carlo simulations of efficiency curves for different gamma sources.
ADDRESS	Comisión Nacional de Energía Atómica, Centro Atómico Ezeiza, Av. del Libertador 8250 (C.P. 1429), Buenos Aires, ARGENTINA Tel.: +54 11 4125 8683 E-mail: mcferrari@cnea.gob.ar
CONTACT	M. C. Ferrari

LABORATORY	Comisión Nacional de Energía Atómica (CNEA), Argentina
NAMES	P. Arenillas, C. Balpardo, S. Consorti, R. Llovera, E. Depaoli, L. Paredes Gramegna
ACTIVITY	1. Absolute activity measurements. 2. Participation in international comparisons. 3. Accelerator Mass Spectrometry (AMS).
KEYWORDS	Alpha spectrometry, beta spectrometry, digital coincidence method, TDCR, data evaluation, data measurement, defined solid angle (ASD), gas proportional counter, ionisation chamber, liquid scintillation, NaI well-type counter, simulation code, SIR, accelerator, AMS, C14.
RESULTS	1. New miniTDCR system based on hybrid PMT. 2. Development of a graphitization line for radiocarbon dating samples. 3. ^{14}C measurements in archaeological samples by AMS technique.
IN PROGRESS	1. Radiocarbon dating by AMS. 2. Radiocarbon analysis for bio based materials. 3. Develop of an acquisition system based on FPGA. 4. Implementation of a detection system for gaseous samples. 5. Installation of two metrological ionizations chambers.
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CONTACT	C. Balpardo

LABORATORY	Comisión Nacional de Energía Atómica (CNEA), Argentina
NAMES	C. GUARDO, M. LOBO
ACTIVITY	Routine metrological assessment of radionuclide activimeters used in Nuclear Medicine.
KEYWORDS	Ionisation chamber, life sciences, activimeters
RESULTS	1. Assessment of 64 Nuclear Medicine Centre calibrators for ^{99m}Tc, ^{131}I, ^{67}Ga, ^{68}Ga, ^{111}In, ^{177}Lu, ^{153}Sm, ^{18}F, ^{90}Y, ^{99}Mo, ^{223}Ra, ^{51}Cr and ^{32}P. 2. Maintenance of the accreditation by the Argentinean Accreditation Body, by ISO 17025.
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LABORATORY	Radionuclide Metrology Laboratory Australian Nuclear Science and Technology Organisation (ANSTO), Australia
NAMES	Freda van Wyngaardt, Michael Smith, Tim Jackson, Bonnie Howe (until June 2018), Christine Keevers (from June 2019) Part time: Samantha Lee, Siobhan Tobin, Adam Sarbutt Nuclear Stewardship Platform Leader: Mark Reinhard (until December 2018), Emmy Hoffmann (from December 2018)
ACTIVITY	Primary standard development, maintenance and calibration of secondary standard ionisation chamber, gamma-ray spectrometry
KEYWORDS	(anti) coincidence method, digital data acquisition, gamma-ray spectrometry, (pressurised) proportional counter, ionisation chamber, life sciences, liquid scintillation, SIR, source preparation, traceability, F-18, Tc-99m, Cu-64, Cu-67, Ga-67, Mo-99/Tc-99m, Co-60
RESULTS	BIPM.RI(II)-K4 SIRTI comparisons for F-18, Tc-99m and Cu-64 (Draft A in preparation)
PUBLICATIONS	W.M. van Wyngaardt, S.M. Tobin, S. Lee, M.L. Smith, T.W. Jackson, J. Ilter, B. Howe, A. Sarbutt. Primary standardisation of technetium-99m by liquid scintillation coincidence counting. Appl. Radiat. Isot. 156 (2020) 108935
IN PROGRESS	Validation of 4π(PPC)-4πγ and 4π(PC)-γ coincidence systems as well as 4π(LS)-γ live-timed-anti-coincidence system by standardisation of Co-60; for BIPM.RI(II)-K1 comparison Development and validation of digital data acquisition system based on CAEN digitisers for application with the 4π(PPC)-4πγ and 4π(LS)-γ detection systems Development and implementation of improved quality assurance and measurement strategy for alternate secondary standard ionisation chamber, transfer of calibration factors from SSIC to alternate TPA ionisation chamber Primary standardisation of Ga-67, Cu-67 and Mo-99/Tc-99m
INFORMATION	https://www.ansto.gov.au/business/products-and-services/radiation/measurement
SOURCE IN PREPARATION	
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CONTACT	Freda van Wyngaardt

LABORATORY	Radionuclide Metrology Metrology Australian Nuclear Science and Technology Organisation (ANSTO), Australia
NAMES	Freda van Wyngaardt, Bonnie Howe (until June 2018), Samantha Lee, Christine Keevers (from June 2019), Tim Jackson, Michael Smith Nuclear Stewardship Platform Leader: Mark Reinhard (until December 2018), Emmy Hoffmann (from December 2018)
ACTIVITY	Standard dissemination
KEYWORDS	Cr-51, Cu-67, F-18, Ga-67, Ga-68, Ge-68/Ga-68, I-123, Lu-177, Mo-99/Tc-99m, P-32, Sm-153, Tc-99m
RESULTS	Australian Nuclear Medicine Traceability Program (ANMTP) offered on-site certification for measurement of Ga-67, Ge-68/Ga-68, I-131 (capsules) and Tc-99m to 23 dose calibrators at 13 Nuclear Medicine facilities during 2018 ANMTP offered on-site certification for measurement of I-131 (capsules), Lu-177 and Tc-99m to 43 dose calibrators at 17 Nuclear Medicine facilities during 2019 Australian Industry Becquerel Traceability Program (AIBTP) provided measurement traceability to the Radiopharmaceutical industry for Cr-51, I-123, I-131, Lu-177, Mo-99/Tc-99m, Sm-153 and Tc-99m AIBTP-PET provided measurement traceability for F-18 to seven cyclotrons Australian Certified Reference Materials (ACRMs) of Tc-99m and I-131 prepared for users from Australia and New Zealand Method development and P-32 measurements that supported OncoSil Medical Ltd with optimising the production of a medical device by neutron activation
PUBLICATIONS	
IN PROGRESS	Collaboration with Clarity Pharmaceuticals to develop a primary standard and provide measurement traceability for a clinical study using Cu-67 SARTATE
INFORMATION	https://www.ansto.gov.au/business/products-and-services/radiation/measurement
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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CONTACT	Freda van Wyngaardt

BEV Radionuclide Metrology
2018-2021 Progress Report and Work Plan
(information for ICRM members)

Bundesamt für Eich- und Vermessungswesen (BEV),
Referat Ionisierende Strahlung und Radioaktivität, Austria, SA1/SA2

The programme at the BEV in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the national standards for activity measurements, radionuclide metrology research and general activities in the field of standardisation and quality-assurance in calibrations and measurements.

The BEV staff in 2019 were:

Scientists	**Function**
Franz Josef Maringer	Head of IR Section, primary activity standards, research, university lectures, environmental studies
Robert Brettner-Messler	Secondary activity standards, type approval, calibration
Hannah Wiedner	Gamma-ray spectrometry, radon standards and research
Michael Stietka	Gamma-ray spectrometry, radon research
Technicians	
Patrick Lobner	Testing, calibration, type approval and verification
Alfred Matzek	Verification

The main specific activities carried out at BEV in this field are summarised below.

Activity line	**BEV Radionuclide Metrology 2018-2019 Progress report**	**BEV Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Improvement of the new Rn-220 activity concentration in air standard (MetroRADON)	• European Project: MetroRADON II: Rn-222, Rn-220 • Rn-222 activity concentration in water
International comparisons	• CCRI(II)-S9: Cs-137 and K-40 in rice • CCRI(II)-S10: Surface emission rate of beta/alpha particles in 2 sr solid angle • CCRI(II)-S13: Cs-134 and Cs-137 in wheat flour • BIPM.RI(II)-K1.Y-88 • CCRI(II)-S15.Rn-222 / EURAMET 1475 • EMPIR 16ENV10 T5.3 Rn-222 • EMPIR 16ENV10 T5.2 Rn-222	• BIPM CCRI(II) SIR Cd-109 • BIPM CCRI(II) SIRTI F-18 • CCRI(II)-S Rn-220 • CCRI(II)-S Co-60 • CCRI(II)-S Cs-137 • EURAMET Rn-220
Standardization of measurement methods	• Rn-222 in water • ICRM WG gamma-ray spectrometry peak locating comparison	• New HPGe detector system (BSI) • New gamma-ray spectrometry software • Rn-220 activity concentr. in air

Activity line	**BEV Radionuclide Metrology 2018-2019 Progress report**	**BEV Radionuclide Metrology 2020-2021 Work plan**

National QA programmes and services	• Standardisation of NORM reference material
	• Testing, calibration, type approval and verification of activity measurement instruments
	  • radioactive intake monitors
	  • whole body counters
	  • radioactivity exhaust air monitors
	  • medical dose calibrators
	  • surface contamination monitors
	  • hand-foot monitors
	  • clearance monitors
		• Standardisation of NORM reference material
		• Rn-220 source preparation
		• Testing, calibration, type approval and verification of activity measurement instruments

Membership in international and national organisations	• BIPM/CCRI • BIPM/CCRI(II) • ICRM committee membership • IAEA • IRPA • IEC • EURAMET • EMPIR • CEN • ASI • ÖVS	• BIPM/CCRI • BIPM/CCRI(II) • ICRM committee membership • IAEA • IRPA • IEC • EURAMET • EMPIR • CEN • ASI • ÖVS
Management and Organisation	European Projects: • EMPIR 15HLT06 MRTDosimetry Metrology for clinical implementation of dosimetry in molecular radiotherapy • EMPIR 16ENV10 MetroRADON Metrology for radon monitoring (JRP co-ordination)	European Projects: • MetroRADON II – Industry, Normative • European Metrology Innovation and Research Program 2021 – 2027 – JRPs in radionuclide metrology

Activity line	**BEV Radionuclide Metrology 2018-2019 Progress report**	**BEV Radionuclide Metrology 2020-2021 Work plan**
Teaching activity	**TU Wien - Technical University of Vienna, BOKU - University of Natural Resources and Life Science Vienna:** • Practical course radiation protection and dosimetry • Project works on applied radiation physics • Research seminar for master- and doctoral studies on radioecology and environmental radiometry • Metrology • Project work metrology • mitdenken.erlaubt@tuwien.ac.at • radioecology • Aspects of Radiation Physical Concepts and Socio-Economic Concepts in Radiation Protection • Project work metrology	**TU Wien – Techn. University of Vienna,** **BOKU - University of Natural Resources and Life Science Vienna:** • Practical course radiation protection and dosimetry • Project works on appl. radiation physics • Research seminar for master- and doctoral studies on radioecology and environmental radiometry • Metrology • Project work metrology • mitdenken.erlaubt@tuwien.ac.at • radioecology • Aspects of Radiation Physical Concepts and Socio-Economic Concepts in Radiation Protection • Project work metrology
Quality system	• Successful QMS internal assessment audit • Installation of the new radionuclide metrology laboratory	• QMS EURAMET peer assessment audit • Installation of the new HPGe detector system and gamma-ray spectr. software

LABORATORY	Bundesamt für Eich- und Vermessungswesen (BEV), Referat Ionisierende Strahlung und Radioaktivität, Austria Federal Office of Metrology and Surveying, Section Ionising Radiation and Radioactivity
NAMES	*Scientists:* Franz Josef MARINGER (Section Head) Robert BRETTNER-MESSLER Hannah WIEDNER Michael STIETKA *Technicians:* Patrick LOBNER, Alfred MATZEK
ACTIVITY	*Development and operation of primary and secondary radionuclide metrology standards:* • Multi-wire proportional chamber for large area sources • $4\pi\gamma$ ionisation chambers • HP-Ge detectors for gamma-ray spectrometry • Radon ionisation chamber *Operation of legal metrology:* • Type approval of medical dose calibrators, 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:* • EMPIR 15HLT06 MRTDosimetry Metrology for clinical implementation of dosimetry in molecular radiotherapy • EMPIR 16ENV10 MetroRADON Metrology for radon monitoring (JRP co-ordination) *Participation in international comparisons:* • SIR BIPM-RI(II)-K1.Y-88 (Draft A) • CCRI(II)-S9: Measurement of the activity concentration of Cs-137 and K-40 in rice material • CCRI(II)-S10: Surface emission rate of beta/alpha particles in 2 sr solid angle for the calibration of surface contamination monitors (Draft B) • CCR(II)-S13: Measurement of an activity per unit mass of Cs-134 and Cs-137 in wheat flour • CCRI(II)-S15.Rn-222 - EURAMET 1475: Activity of radionuclide Rn-222 • EMPIR MetroRADON T5.2: Rn-222 activity concentration in air, range 400 Bq/m³ – 6000 Bq/m³

	• EMPIR MetroRADON T5.3: Rn-222 activity concentration in air, range < 300 Bq/m³ *Applications:* • Coordination of interlaboratory comparison exercises • Quality management services for ionising radiation laboratories (ISO/IEC 17025) • Low-level radionuclide metrology • Gamma-ray spectrometry • Radon and thoron instruments calibration • Radiation protection • Radioecology • Radionuclides in environmental research • Monte Carlo Simulations *New radionuclide metrology laboratory:* • Planning, conception, construction and equipment of a new radioactivity laboratory in Seibersdorf, federal country of Lower Austria, 230 m² laboratory area • 4 laboratory rooms: o Open radioactive sources and materials manipulation laboratory, radiation protection laboratory room type B o Activity measurement instruments calibration, type approval and verification laboratory room, radiation protection laboratory room type C o Austrian national activity standards laboratory room, radiation protection laboratory room type C o Gamma-ray spectrometry and radon laboratory room, radiation protection laboratory room type C
KEYWORDS	National Metrology Institute, radionuclide metrology, low-level radioactivity measurement techniques, environmental monitoring, EURAMET, EMPIR, gamma-ray spectrometry, gas proportional counter, ionisation chamber, low-level, radioactive gas, simulation code, SIR, source preparation, traceability, radionuclide metrology, radiation protection, radioecology, NORM, radon, medical applications, life sciences
RESULTS	• BIPM-RI(II)-K1.Y-88 • Testing, calibration, type approval and verification of activity measurement instruments o radioactive intake monitors o whole body counters o radioactivity exhaust air monitors o medical dose calibrators o surface contamination monitors o hand-foot monitors o clearance monitors
PUBLICATIONS	Franz Josef Maringer, Hannah Wiedner, Francesco Cardellini. **An innovative quick method for traceable measurement of radon 222 in drinking water.** Applied Radiation and Isotopes 155 (2020) https://doi.org/10.1016/j.apradiso.2019.108907.

	M.C. Ali Santoro, M.J. Anagnostakis, T. Boshkova, A. Camacho, M.C. Fornaciari Iljadica, S.M. Collins, R. Diaz Perez, J.U. Delgado, M. Đurašević, M.A. Duch, V.H. Elvira, R.S. Gomes, A. Gudelis, D. Gurau, S. Hurtado Bermudez, R. Idoeta, A. Jevremović, A. Kandić, H. Wiedner, … B. Zorko. **Determining the probability of locating peaks using computerized peak-location methods in gamma-ray spectra as a function of the relative peak-area uncertainty.** Applied Radiation and Isotopes 155 (2020) https://doi.org/10.1016/j.apradiso.2019.108920 . H. Wiedner, K. Lotter, P. Karner, H. Friedmann, F.J. Maringer. **Radon in drinking water: Comparison and evaluation of two ionization chamber activity measurement methods.** Applied Radiation and Isotopes 134 (2018) 477-481 https://doi.org/10.1016/j.apradiso.2017.06.031 H. Wiedner, J. Riedl, F.J. Maringer, A. Baumgartner, M. Stietka, F. Kabrt. **Production and characterization of a traceable NORM material and its use in proficiency testing of gamma-ray spectrometry laboratories.** Applied Radiation and Isotopes 134 (2018) 45-50 https://doi.org/10.1016/j.apradiso.2017.09.025 Andreas Baumgartner, Michael Stietka, Franz Kabrt, Hannah Wiedner, Franz Josef Maringer. **Study of particular problems appearing in NORM samples and recommendations for best practice gamma-ray spectrometry.** Applied Radiation and Isotopes 126 (2017) 289-292 https://doi.org/10.1016/j.apradiso.2016.12.035 Franz Josef Maringer, Andreas Baumgartner, Francesco Cardellini, Philippe Cassette, Teresa Crespo, Julian Dean, Hannah Wiedner, Jiři Hůlka, Mikael Hult, Simon Jerome, Franz Kabrt, Petr Kovář, Cyrus Larijani, Guillaume Lutter, Maria Marouli, Alexander Mauring, Monika Mazánová, Bogusław Michalik, Nathalie Michielsen, Virginia Peyres, Sylvie Pierre, Roy Pöllänen, Stefaan Pommé, Mário Reis, Michael Stietka, László Szücs, Branko Vodenik. **Advancements in NORM metrology – Results and impact of the European joint research project MetroNORM.** Applied Radiation and Isotopes 126 (2017) 273-278 https://doi.org/10.1016/j.apradiso.2017.02.040 F. Kabrt, A. Baumgartner, M. Stietka, H. Friedmann, V. Gruber, W. Ringer and F. J. Maringer. **A comparison of radon indoor measurements with interpolated radon soil gas values using the inverse weighting method on measured results.** Radiation Protection Dosimetry 177 1-2 (2017) 213–219 https://doi.org/10.1093/rpd/ncx141 M. Stietka, A. Baumgartner, F. Kabrt and F.J. Maringer. **Measurement strategies for radon in indoor air of waterworks – a review.** Radioprotection 52 (2017) 101-107 https://doi.org/10.1051/radiopro/2017004

IN PROGRESS	Co-operations in research, applications and university lectures and laboratory exercises: • IAEA – Radioactive Waste Management, NORM, Radon • IRPA (Internat. Radiation Protection Association) – radiation protection • ICRM – WGs LLRMT, Gamma-ray spectrometry • ISO / CEN – Natural radioactivity of building materials, indoor radon • BOKU (University of Natural Resources and Life Science Vienna) – radioecology, natural radiation environment • TU Wien (Technical University of Vienna) – metrology, radiation physics, radionuclide metrology, radiation protection, dosimetry • AIT (Austrian Institute of Technology) – environmental isotopes • SEIB (Seibersdorf Laboratories GmbH) – radiation protection, dosimetry • ÖVS (Austrian Radiation Protection Association) – radiation protection • ASI (Austrian Standards Institute) – Low-level radioactivity measurements working group
INFORMATION	100 CMCs for radioactivity measurement calibration services
SOURCE IN PREPARATION	Planned radionuclide comparisons in BIPM SIR & SIRTI / CCRI(II).K1: Cd-109, F-18
OTHER RELATED PUBLICATIONS	Franz Josef Maringer, Claudia Ackerl, Andreas Baumgartner, Christopher Burger-Scheidlin, Maria Kocadag, Johannes H. Sterba, Michael Stietka, Jan Matthew Welch. **Long-term environmental radioactive contamination of Europe due to the Chernobyl accident - Results of the Joint Danube Survey 2013.** Applied Radiation and Isotopes 126 (2017) 100-105 https://doi.org/10.1016/j.apradiso.2017.02.035 F. Kabrt, A. Baumgartner, M. Stietka and F.J. Maringer. **Introduction and testing of a simplified method for the evaluation of the radon emanation.** Radiation Protection Dosimetry 77 1-2 (2017) 26–30 https://doi.org/10.1093/rpd/ncx151 M Kocadag, V Exler, C Burger-Scheidlin, A Baumgartner, M Stietka, C Landstetter, M Korner, FJ Maringer. **Environmental radioactivity study of Austrian and Bavarian forest ecosystems: Long-term behaviour of contamination of soil, vegetation and wild boar and its radioecological coherences.** Applied Radiation and Isotopes 126 (2017) 106-111 https://doi.org/10.1016/j.apradiso.2017.03.008 H. Friedmann, A. Baumgartner, V. Gruber, H. Kaineder, F.J. Maringer, W. Ringer, C. Seidel. **The uncertainty in the radon hazard classification of areas as a function of the number of measurements.** Journal of Environmental Radioactivity 173 (2017) 6-10 https://doi.org/10.1016/j.jenvrad.2016.08.011
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LABORATORY	European Commission - Joint Research Centre, Institute for Reference Materials and Measurements (IRMM), Radionuclide Metrology Sector
NAMES	S. Pommé, M. Marouli, H. Stroh, R. Van Ammel, J. Paepen
ACTIVITY	Primary standardisation of activity and measurement of nuclear decay data
KEYWORDS	Alpha-particle spectrometry, coincidence counting, 4πCsI(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, conversion electron spectrometry, simulation code, SIR, source preparation (quantitative drop deposition, JRC source drying device, vacuum evaporation and electrodeposition), traceability, data evaluation, data measurement, method development, nuclear dating, Euramet projects, life sciences, norms and standards
RESULTS	* Set-up for internal conversion electron (ICE) spectrometry with a silicon detector * Deconvolution of ICE spectra and determination of ICE emission probabilities for americium-241 * Improved half-life of ^{55}Fe and ^{99m}Tc * Evidence against solar influence on nuclear decay constants: study of annual and monthly oscillations * Derivation of significance criteria for cyclic modulations in time series * Derivation of uncertainty propagation formula for half-life measurements * Measurement of absolute γ-ray emission probabilities in the decay of ^{235}U and ^{227}Ac * MetroRWM: half-life of ^{129}I * MetroDECOM: provision of radioactive standards * Training for students and metrologists * Intercomparison of short-lived nuclides activity measurements with radionuclide calibrators in Belgian, Dutch, and German hospitals * International standard for list-mode data used in nuclear instrumentation * Standardisation and alpha spectrometry of ^{231}Pa * Automated distance measurements for defined solid angle counting * Certification of ^{243}Am reference material * Chapter on analytical techniques for plutonium
PUBLICATIONS	M. Marouli, G. Lutter, S. Pommé, R. Van Ammel, M. Hult, S. Richter, R. Eykens, V. Peyrés, E. García-Toraño, P. Dryák, M. Mazánová, P. Carconi, Measurement of absolute γ-ray emission probabilities in the decay of ^{235}U, Appl. Rad. Isot. 132 (2018) 72-78. S. Pommé, G. Lutter, M. Marouli, K. Kossert, O. Nähle, On the claim of modulations in radon decay and their association with solar rotation, Astroparticle Physics 97 (2018) 38-45.

	A.H. Tkaczyk, H. Saare, C. Ipbüker, F. Schulte, P. Mastinu, J. Paepen, B. Pedersen, P. Schillebeeckx, G. Varasano, Characterization of EJ-200 plastic scintillators as active background shield for cosmogenic radiation, Nuclear Instr. and Methods in Physics Research, A 882 (2018) 96-104. S. Pommé, H. Stroh, T. Altzitzoglou, J. Paepen, R. Van Ammel, K. Kossert, O. Nähle, J. D. Keightley, K. M. Ferreira, L. Verheyen, M. Bruggeman, Is decay constant?, Appl. Rad. Isot. 134 (2018) 6-12. S. Pommé, M. Marouli, J. Paepen, N. Marković, R. Pöllänen, Deconvolution of ^{238,239,240}Pu conversion electron spectra measured with a silicon drift detector, Appl. Rad. Isot. 134 (2018) 233-239. Raf Van Ammel, Katarzyna Sobiech-Matura, Uwe Wätjen, Tom Vercammen, Pieter Castelein, Roel Wuyts, Johan Paul, Qualification of a precision pattern dispenser, Appl. Rad. Isot. 134 (2018) 117-121. Jiri Suran, et al., Metrology for decommissioning nuclear facilities: partial outcomes of joint research project within the European Metrology Research Program, Appl. Rad. Isot. 134 (2018) 351-357. Philippe Cassette, Timotheos Altzitzoglou, Andrei Antohe, Mario Rossi, Arzu Arinc,Marco Capogni, Raphael Galea, Arunas Gudelis, Karsten Kossert, K.B. Lee, Juncheng Liang, Youcef Nedjadi, Pilar Oropesa Verdecia, Tanya Shilnikova, Winifred van Wyngaardt, Tomasz Ziemek, Brian Zimmerman, Results of the CCRI(II)-S12.H-3 supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated-water source measured using the LSC-TDCR method, Appl. Rad. Isot. 134 (2018) 257-262. C. Saldarriaga Vargas, S. Rodriguez Pérez, K. Baete, S. Pommé, J. Paepen, R. Van Ammel, L. Struelens, Intercomparison of ^{99m}Tc, ^{18}F, and ^{111}In activity measurements with radionuclide calibrators in Belgian hospitals, Physica Medica 45 (2018) 134-142. Eduardo García-Toraño, Timotheos Altzitzoglou, Pavel Auerbach, Marie-Martine Bé, Christophe Bobin, Philippe Cassette, Frédéric Chartier, Rainer Dersch, Marta Fernández, Hélène Isnard, Karsten Kossert,Valérie Lourenço, Ole Nähle, Anthony Nonell, Virginia Peyrés, Stefaan Pommé, Andrej Rozkov, Anabel Sánchez-Cabezudo, Jana Sochorová, The half-life of ^{129}I, Appl. Radiat. Isot. 140 (2018) 157-162 S. Pommé, J. Paepen, R. Van Ammel, Linearity check of an ionisation chamber through ^{99m}Tc half-life measurements, Appl. Radiat. Isot. 140 (2018) 171-178 M. Marouli, G. Lutter, S. Pommé, R. Van Ammel, M. Hult, S. Pierre, P. Dryák, P. Carconi, A. Fazio, F. Bruchterseifer, A. Morgenstern, Measurement of absolute γ-ray emission probabilities in the decay of ^{227}Ac in equilibrium with its progeny, Appl. Radiat. Isot. 144 (2019) 34-46 S. Pommé, G. Lutter, M. Marouli, K. Kossert, O. Nähle, A reply to the rebuttal by Sturrock et al., Astropart. Phys. 107 (2019) 22-25 S. Pommé, Solar influence on radon decay rates: irradiance or neutrinos?, Eur. Phys. J. C 79 (2019) 73 (pp. 9) S. Pommé, H. Stroh, R. Van Ammel, The ^{55}Fe half-life measured with a pressurised proportional counter, Appl. Radiat. Isot. 148 (2019) 27-34 M. Marouli, S. Pommé, Automated optical distance measurements for counting at a defined solid angle, Appl. Radiat. Isot. 153 (2019) 108821

	S. Pommé, J. Paepen, M. Marouli, Conversion electron spectroscopy of the 59.54 keV transition in 241Am alpha decay, Appl. Radiat. Isot. 153 (2019) 108848 E. García-Toraño, T. Crespo, M. Marouli, V. Jobbágy, S. Pommé, P. Ivanov, Alpha-particle emission probabilities of 231Pa derived from first semiconductor spectrometric measurements, Appl. Radiat. Isot. 154 (2019) 108863 K. Lützenkirchen, Y. Aregbe, F. Chartier, O. Dieste, M. Hedberg, H. Isnard, P. Moisy, A. Nonell, S. Pommé, P. Raison, D. Roudil, A. Ruas, P. Steier, M. T. Swinhoe, Pamela Thompson, Paul Thompson, T. Wiss, J. Zsigrai, Analytical science of Plutonium, In: "Plutonium handbook – Volume 4: Chemistry", Eds. D. L. Clark, D. A. Geeson, R. J. Hanraha Jr., American Nuclear Society, 2019, pp. 1808-1978. Simon Jerome, Christophe Bobin, Philippe Cassette, Rainer Dersch, Raphael Galea, Liu Haoran, Anja Honig, John Keightley, Karsten Kossert, Juncheng Liang, Maria Marouli, Carine Michotte, Stefaan Pommé, Stefan Röttger, Ross Williams, Ming Zhang, Half-life determination and comparison of activity standards of ^{231}Pa, Appl. Radiat. Isot. 155 (2020) 108837 S. Pommé, T. De Hauwere, On the significance of modulations in time series, Nucl. Instr. Meth. A 956 (2020) 163377 S. Pommé, T. De Hauwere, Derivation of an uncertainty propagation factor for half-life determinations, Appl. Radiat. Isot. 158 (2020) 109046
IN PROGRESS	Half-life measurements of ^{235}U, ^{238}U, ^{22}Na, ^{134}Cs, ^{243}Am, ^{44}Ti Decay data evaluation using the Power-Moderated Mean Calibration of ionisation chambers for parent-daughter decay Calibration of ionisation chambers for PET nuclides Construction of A-TOF time-of-flight instrument for high-resolution alpha-particle spectrometry Development of a new empirical mode detection method in residuals of time series Precise measurement of the neutron capture cross section of ^{235}U at thermal and sub-thermal energies
INFORMATION	https://ec.europa.eu/jrc/en/research-topic/nuclear-reference-data-materials-and-measurements?search
SOURCE IN PREPARATION	Comparing significance criteria for cyclic modulations in time series
OTHER RELATED PUBLICATIONS	https://online-learning.tudelft.nl/courses/understanding-nuclear-energy/ http://www.ans.org/pubs/handbooks/plutonium/
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CONTACT	Dr. Stefaan Pommé

LABORATORY	European Commission - Joint Research Centre, Institute for Reference Materials and Measurements (IRMM), Radionuclide Metrology Sector – Low-level radioactivity group
NAMES	Mikael Hult, Gerd Marissens, Heiko Stroh, Guillaume Lutter
ACTIVITY	Ultra Low-level and Low-level gamma-ray spectrometry
KEYWORDS	gamma-ray spectrometry, muon shield, underground laboratory, anti-coincidence, low-level, ultra low-level, neutron measurement, simulation code, EGSnrc,
RESULTS	* Measurements in support of the three EMRP projects Preparedness and MetroDecom II. Like e.g. determination of activity distribution inside metal reference standards. Characterisation and certification of reference standards * Enabling the underground facility to become an open access facility via the transnational access programme "EUFRAT" https://ec.europa.eu/jrc/en/eufrat with projects like: (i) Nuclear dating of natural; archives like corals, ice cores and tree rings (ii) deadlayer determination in HPGe-detectors (iii) Measurements of rare decays like double beta decays and rare alpha-decays (iv) baseline study of anthropogenic radioactivity in Antarctic biota and wild-life. * Ultra low-background detector development in HADES. Material selection and installation of a high-resolution HPGe well-detector (Ge-14) based on small contact technology. * Radiopurity measurements and detector testing for the GERDA LEGEND experiment. * Measurements of samples from hydrothermal plumes from the Pacific ocean with the aim to understand their dynamics by performing nuclear dating using different radium isotopes. * Supporting the REM Proficiency Tests with reference measurements https://remon.jrc.ec.europa.eu/Services/Proficiency-Tests * Organisation of a workshop on underground science together with IAEA – JEILORA, Joint EC/IAEA workshop on Low-level Radioactivity Measurements and Applications
PUBLICATIONS (2018-2019)	M. Misiaszek, et al. 2018, “Improving sensitivity of a BEGe-based high-purity germanium spectrometer through pulse shape analysis”, Eur. Phys. J. C78 p.392. A. Domula, et al. 2018, “Pulse shape discrimination performance of Inverted Coaxial Ge detectors”, Nucl. Instr. Meth. A891 p. 106-110. M. Hult, et al. 2018, “Characterisation of an ultra low-background point contact HPGe well-detector for an underground laboratory”, Appl. Radiat. Isot. 134 p. 446-449 G. Lutter, et al. 2018, “A gamma-ray spectrometry analysis software environment”, Appl. Radiat. Isot. 134 p. 200-204 M. Hult, et al. 2019, “Determination of homogeneity of the top surface deadlayer in an old HPGe detector”, Appl. Radiat. Isot. 147 p. 182-188 M. Agostini et al., 2019. Characterization of 30 ^{76}Ge enriched Broad Energy Ge detectors for GERDA Phase II. Europ. Phys. J. C 79 E. Yeltepe, et al. 2018, “A review of the TAEA proficiency test on natural and anthropogenic radionuclides activities in black tea”, Appl. Rad. Isot. 134 p. 40-44.

	F.J. Pavia, et al. 2019, "Timescales of hydrothermal scavenging in the South Pacific Ocean from 234Th, 230Th, and 228Th, Earth and Planetary Science Letters 506 p. 146-156 M. Hult, et al. 2019, "Underground gamma-ray measurements of radium isotopes from hydrothermal plumes in the deep Pacific Ocean", Appl. Radiat. Isot. 153 https://doi.org/10.1016/j.apradiso.2019.108831 M. Marouli et al., 2019, "Measurement of absolute γ-ray emission probabilities in the decay of Ac in equilibrium with its progeny, Appl. Radiat. Isot. 144 p. 34-46 M. Agostini et al., 2019, Probing Majorana neutrinos with double-beta decay, Science 365 (2019) 1445-1448
IN PROGRESS	* Ultra low-background detector development in HADES. Material selection and installation of a high-resolution HPGe well-detector (Ge-16) based on small contact technology. * Radiopurity measurements and detector testing for the LEGEND experiment. * Measurements of new samples from hydrothermal plumes from the Pacific ocean with the aim to understand their dynamics by performing nuclear dating using different radium isotopes. * Supporting the REM Proficiency Tests with reference measurements https://remon.jrc.ec.europa.eu/Services/Proficiency-Tests * Measurement of neutron cross sections and neutron fluence using novel techniques * Open access projects: (i) Nuclear dating of natural; archives like corals, ice cores and tree rings (ii) deadlayer determination in HPGe-detectors (iii) Measurements of rare decays like double beta decays and rare alpha-decays (iv) measurements of meteorites (v) radiopurity measurements for CELLAR partners * Characterisation of reference materials in different matrices for both internal JRC customers as well as external (like IAEA)
INFORMATION	https://ec.europa.eu/jrc/en/research-facility/hades-underground-laboratory?search https://ec.europa.eu/jrc/en/research-facility/open-access
SOURCE IN PREPARATION	
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SCK•CEN
Low-Level Radioactivity Measurements (LRM)
2018-2021 Progress Report and Work Plan

(information for ICRM members)

SCK•CEN, Low-Level Radioactivity Measurements (LRM), Belgium, SA1/SA2

The laboratories of the LRM services group are devoted to routine radioactivity analyses. Striving to high quality measurements and services for our customers we are investing continuously in the quality assurance of our services and in supporting research to apply the best techniques in terms of accuracy, throughput and cost.

Our laboratories provide services to the Federal Agency of Nuclear Control (FANC) who is coordinating the radiological surveillance program of the Belgian territory and to the Federal Agency for the Safety of the Food Chain (FAVV) and to many external parties. Our services consist in the sampling, sample preparation and radiological analysis of food and environmental samples. Our laboratories also have a long history in bio-assay e.g. the radioactivity analysis of excretion samples (urine and faeces).

Scientists	**Function**
Bruggeman	Head LRM
Verrezen Freddy	Technical Group Manager
Vasile Mirela	R&D Task Manager
Sneyers Liesel	Technical Group Manager and Lab Head (Sampling and sample preparations)
Dupuis Edmond	Lab Head (gross alpha/beta counting & Ra-226/Rn-222) analysis
Verheyen Leen	Lab Head (Gamma-ray Spectrometry)
Jacobs Karin	Lab Head (Alpha-spectrometry)
Loots Hilde	Lab Head (Liquid Scintillation Counting and $^{89/90}$Sr and I) counting)
Lab Technicians	**14**

The main specific activities carried out at LRM in this field are summarised below.

Activity line	**SCK•CEN, Low-Level Radioactivity Measurements 2018-2019 Progress report**	**SCK•CEN, Low-Level Radioactivity Measurements 2019-2020 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Determination of 'difficult to measure' radionuclides (Ni-63, Fe-55, Cl-36, I-129) • Implementation of fusion for solids sample preparation • Investigation of mass spectrometry applications	• Validation of low energy gamma-ray emitters in solid samples using transmission based matrix characterization with a modified EFFTRAN version; • alpha/beta global measurements using LSC • Separation methods using plastic scintillators (Tc-99, Cl-36) • Determination of 'difficult to measure' radionuclides (Ca-41, Pm-147, Sm-151, Se-79) • Bioassay of radionuclides used in medical applications (Ac-225, Lu-177)
International comparisons	• ALMERA (IAEA) • NPL • IRSN • PROCORAD • BfS	• ALMERA (IAEA) • NPL • IRSN • PROCORAD • BfS
Membership in international and national organisations	• ICRM (member) • ALMERA (IAEA) • k_0 users group	• ICRM (member) • ALMERA (IAEA) • k_0 users group
Management and Organisation	• Partner in the execution of the Belgian Radiological Surveillance program • Bio-assay analysis of nuclear industry	• Partner in the execution of the Belgian Radiological Surveillance program • Bio-assay analysis of nuclear industry
Teaching activity	• Teaching in the framework of SCK•CEN's Academy • Practical exercises in the framework of BNEN (Belgian Nuclear higher Education Network) • Lecturing at EC-organized gamma-spec courses	• Teaching in the framework of SCK•CEN's Academy • Practical exercises in the framework of BNEN (Belgian Nuclear higher Education Network) • Lecturing at EC-organized gamma-spec courses
Quality system	• Management of Quality System ISO 17025 • Installation of a central sample management system (C-LIMS)	• Continuous Improvement of Quality System • Licensing ISO14001

SCK•CEN

Radiochemical Analyses and Processes (RCA)

2016-2019 Progress Report and Work Plan

(information for ICRM members)

The Radiochemistry expert group (RCA) at SCK•CEN is a multidisciplinary laboratory dedicated to being a center of excellence in radiochemistry and in the destructive chemical and radiochemical analysis of samples and materials originating from the nuclear fuel cycle, from radionuclides production and investigation and from nuclear research in general. Our laboratories provide services to the Federal Agency of Nuclear Control (FANC), NIRAS and many other external as well as internal research projects. Our services consist in sample preparation and separations (both in hot cell as in glove box) and radiochemical analysis using mass spectrometry (HR-ICP-MS, TQ-ICP-MS, TIMS, GMS) as well as spectroscopy (Gamma, alpha, LSC, OES).

Scientists	**Function**
Geuens Ingrid	Head RCA
Adriaensen Lesley	Lab head (alpha and gamma spectrometry; LSC, sample preparation hot cell, glove box and separations)
Dobney Andrew	Lab head (Thermal ionisation mass spectrometry)
Peter Van Bree	Lab Head (ICP-MS)
Lab Technicians	**5**

The main specific activities carried out by SCK•CEN, RCA in this field are summarised below.

Activity line	**SCK•CEN, Radiochemistry 2018-2019 Progress report**	**SCK•CEN, Radiochemical Analyses and Processes 2019-2020 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Optimisation of Labsocs software for different geometries	• Optimisation of analyses of radioactive samples with HR-ICP-MS • Optimisation of the measurement methodology of Ni-63, C-14 and Cl-36 with LSC
International comparisons	• CETAMA • IRMM • IAEA safeguards analytical laboratory	• CETAMA • IRMM • IAEA safeguards analytical laboratory • NWAL (IAEA)
Standardization of measurement methods		
National QA programs and services	• Analyses for BR2 reactor	• Analyses for BR2 reactor
Membership in international and national organisations	• ICRM (member) • EGADSNF (expert group on assay data for spent nuclear fuel - member)	• ICRM (member) • EGADSNF (expert group on assay data for spent nuclear fuel - member)
Management and Organization		
Teaching activity	• Teaching in the framework of SCK•CEN's Academy • Teaching in the framework of BNEN (Belgian Nuclear higher Education Network)	• Teaching in the framework of SCK•CEN's Academy • Teaching in the framework of BNEN (Belgian Nuclear higher Education Network)
Quality system	• Continuous Improvement of Quality System • Management of Quality System ISO 17025	• Continuous Improvement of Quality System • Management of Quality System ISO 17025

LABORATORY	SCK•CEN, Low-Level Radioactivity Measurements (LRM), Belgium SCK·CEN, Policy Support
NAMES	M. Bruggeman, F. Verrezen, M. Vasile, T. Vidmar*, A. Borella*, L. Sneyers, L. Verheyen
ACTIVITY	Gross alpha and beta, ^{3}H, ^{14}C, $^{89-90}$Sr, ^{131}I, ^{210}Po, ^{226}Ra, ^{63}Ni, ^{55}Fe 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, in-situ gamma-ray spectrometry Preparation of Radioactive Standards Determination of the Pu isotopic composition with medium resolution gamma ray detectors
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, in-situ gamma-ray spectrometry, Cadmium Zinc Telluride detectors, CZT detectors, Inspector 1000, measurement, gamma-ray spectrometry, Safeguards, Plutonium, isotopic composition, CZT, LaBr.
RESULTS	
PUBLICATIONS	*Determination of homogeneity of the top surface deadlayer in an old HPGe detector*. MikaelHult, Stef Geelen, Mark Stals, Guillaume Lutter, Gerd Marissens, Heiko Stroh, Sonja Schreurs, Wouter Schroeyers, Michel Bruggeman, Leen Verheyen. Applied Radiation and Isotopes, 147, p 182-188, 2019. *Determination of the lanthanides, uranium and plutonium by means of on-line high-pressure ion chromatography coupled with sector field inductively coupled plasma-mass spectrometry to characterize nuclear samples*. Nancy Nazem Wanna, Karen VanHoecke, Andrew Dobney, Mirela Vasile, Thomas Cardinaels, Frank Vanhaecke, 2019. Journal of Chromatography A, https://doi.org/10.1016/j.chroma.2019.460839, in press. *Negative correlation between the number of sunspots and the occurrence of ^{7}Be and ^{22}Na in the surface air and their contribution to radiation doses*. Brodnik, D., Glavič-Cindro, D., Glavič-Cindro, D., Nečemer, M., Maver-Modec, P., Petrovič, T., Vidmar, T., Vodenik, B. & Zorko, B., 1 Dec 2019, In: Archives of Industrial Hygiene and Toxicology. 70, 4, p. 290-295 6 p. *Consistency test of coincidence-summing calculation methods for extended sources*. Sima, O., de Vismes Ott, A., Dias, M. S., Dryak, P., Ferreux, L., Gurau, D., Hurtado, S., Jodlowski, P., Karfopoulos, K., Koskinas, M. F., Laubenstein, M., Lee, Y. K., Lépy, M-C., Luca, A., Menezes, M. O., Moreira, D., Nikolic, J. K., Peyres, V., Saganowski, P., Savva, M. I. & 7 others, 3 Oct 2019, In: Applied Radiation and Isotopes. 11 p., 108921. *InSiCal – A tool for calculating calibration factors and activity concentrations in in situ gamma spectrometry*. Mauring, A., Vidmar, T., Gäfvert, T., Drefvelin, J. & Fazio, A., 1 Aug 2018, In: Journal of environmental radioactivity. 188, p. 58-66 9 p.
IN PROGRESS	Development of bioassay methods for radionuclides used in nuclear medicine (Ac-225 and Lu-177) Investigation of methods based on plastic scintillators

	Mass-spectrometry investigation to environmental applications PhD topic on development of methods for determination of 'difficult to measure' radionuclides (^{41}Ca, ^{79}Se, ^{36}Cl, ^{129}I, ^{151}Sm, ^{147}Pm, ^{99}Tc) – on going Pb-210 analysis in dense materials with gamma-ray spectrometry using transmission for matrix characterisation; selection of appropriate source, use of EFFTRAN to compute the correction factors. (General method for matrix characterization using un-collimated transmission measurements and EFFTRAN calculations.) Automated optimization of detector models for use with the efficiency transfer method. Contribution to International Workshop on Uranium and Plutonium Isotopic Analysis by Non-Destructive Assay Techniques for Nuclear Safeguards, IAEA 27-29 May 2020; Peak Shape Characterization of a 500 mm^3 Cadmium Zinc Telluride Detector and Analysis of Spectroscopic Measurement Data for Uranium and Plutonium Samples; A. Borella, M. Bruggeman, R. Rossa, P. Schillebeeckx, T. Vidmar
INFORMATION	
SOURCE IN PREPARATION	EC NRM 171 Set of 5 Uranium standards (low enrichment) to be received from JRC-Geel
OTHER RELATED PUBLICATIONS	M. Vasile, F. Verrezen, P. Fouquet-Métivier, M. Bruggeman, K. Jacobs (2019). *DEVELOPMENT OF 'ON-SITE' METHODS FOR ASSAY OF ALPHA - EMITTING RADIONUCLIDES*. 2019 - ICRM, Buenos Aires, Argentina. Loots, H., Verrezen, F., Bruggeman, M., Vasile, M. 2019. *Determination of ^{3}H in environmental samples using a Pyrolyser system - Our challenges.* 8th Organically Bound Tritium Workshop, Constanta, Romania. Vasile, M., Loots, H., Verrezen, F 2019. *Validation of the ISO 13164-4 method for the determination of Rn-222 in water: The LRM approach*. Rn-in-water workshop, JRC-GEEL, Belgium. Boogers, E., Borella, A., & Rossa, R. (2019). *Improved electronics for ^{3}He based neutron counters*. 2019 - ANIMMA - Advancements in Nuclear Instrumentation Measurement Methods and their Applications, Portoroz, Slovenia. https://doi.org/10.1051/epjconf/202022505002 Rossa, R., Borella, A., Boden, S., & Broeckx, W. (2019). *Estimation of fissile material content in irradiated In-Pile Sections using neutron coincidence counters*. 1-5. 2019 - ANIMMA - Advancements in Nuclear Instrumentation Measurement Methods and their Applications, Portoroz, Slovenia. https://doi.org/10.1051/epjconf/202022506001 Borella, A., Boogers, E., Rossa, R., & Schillebeeckx, P. (2018). Characterization and Monte Carlo simulations for a CLYC detector. *International Journal of Modern Physics: Conference Series*, *48*, 1-10. [1860115]. https://doi.org/10.1142/S2010194518601151 Borella, A., & Rossa, R. (2018). Monte Carlo simulations for the determination of the ^{235}U enrichment with the infinite thickness methodology. In L. Bourva, & P. Jansson (Eds.), *International Workshop on Numerical Modelling of NDA Instrumentation and Methods for Nuclear Safeguards: (NM-NDA-IMNS18)* (pp. 66-73). European Safeguard Research and Development Association.

	Rossa, R., Boogers, E., Borella, A., Boden, S., Broeckx, W., Noynaert, L., & van der Meer, K. (2018). Use of neutron coincidence counters for the estimation of fissile content in irradiated material. In *International Workshop on Numerical Modelling of NDA Instrumentation and Methods for Nuclear Safeguards* European Safeguard Research and Development Association.
ADDRESS	Low Level Radioactivity Measurements SCK•CEN Boeretang 200 B-2400 Mol Belgium Telephone: (+32-14) 33 28 86 E-mail:mbruggem@sckcen.be
CONTACT	Michel Bruggeman, Mirela Vasile, Freddy Verrezen

Announcements:

International Workshop on Uranium and Plutonium Isotopic Analysis by Non-Destructive Assay Techniques for Nuclear Safeguards, IAEA 27-29 May 2020

LNMRI/IRD Radionuclide Metrology Group
2018 -2021 Progress Report and work Plan

National Laboratory for Ionizing Radiation Metrology LNMRI/IRD, Brazil, SA1/SA2

The programmes at the National Laboratory for Ionizing Radiation Metrology of Institute of Radiation Protection and Dosimetry (LNMRI/IRD) in the field of Radionuclide Metrology in the period of 2018-2021 were and will be focused in primary standardization and also in the maintenance of the national radiaoctivity standards. We also have three programmes for guarantee the traceability in national level with hospital, radiopharmaceutical producer and low level activity measurements.

The LNMRI-IRD Radionuclide Metrology staff in 2018 was as following:

Researchers	**Function**
Akira Iwahara	Consultant
Andre L. Lopes Quadros	Data Aquisition System
Antônio E. De Oliveira	Traceability of activity measurements programme with hospitals
Carlos J. Da Silva	Primary Radionuclide activity standardization by anticoindence counting, Secondary Radionuclide activity standardization
Alfredo Lopes F. Filho	Primary Radionuclide activity standardsization and gamma spectrometry
Luiz Tauhata	Consultant
Karla Cristina Patrão	Head of Metrology Division
Estela M. de Oliveira	Reference Material and radiochemistry
Paulo A. L. da Cruz	Liquid scintillation counting –CIEMAT/NIST and TDCR
Mônica Aguiar Leobino	Primary Radionuclide activity standardization by anticoindence counting, Secondary Radionuclide activity standardization, Deputy Head of Metrology Services
Roberto Poledna	Consultant
Technicians	
Ronaldo L. da Silva	Secundary Radionuclide activity standards gamma spectrometry
Regio S. Gomes	Data Aqusitiom System and Gamma spetrometry
Eduardo Vieira de Veras	Sources preparation
Otavio L. Trindade	Secundary Radionuclide activity standardization and data Aquisition
Johnny de A. Rangel	Sources preparation and Head of Metrology Services
Anderson A. Leiras	Primary Radionuclide activity standardization by coindence counting

The main specific activities carried out at IRD-LNMRI in this field are summarised below:

Activity	**IRD-LNMRI Radionuclide Metrology 2018-2019 Progress Report**	**IRD-LNMRI Radionuclide Metrology 2020-2021 work plan**
National QA programmes and Services	Calibration service Preparation of radionuclide standards (liquid solutions, point sources and spiked reference materials) for external users.	Calibration service Preparation of radionuclide standards (liquid solutions, point sources and spiked reference materials) for external users.
International comparisons and SIR submission	-	Zn-65, Eu-152
Primary standardization	Sr-90, I-125, I-123, Eu-152, Th-229, Ra-223, U-232	H-3, Ni-63, Co-60, Zn-65, Cd-109, Sr-90, I-123, Cs-137, Eu-152, U-232, Ra-223, Th-232
Membership in international and national organisations	- ICRM, BIPM/CCRI(II) - SBM (Brazilian Metrology Society)	- ICRM, BIPM/CCRI(II) - SBM (Brazilian Metrology Society)
Teaching activity	- Invited lectures - Master and doctor degree courses	- Invited lectures - Master and doctor degree courses
Quality system	Maintenance the quality system based on ISO/IEC 17025	Maintenance the quality system based on ISO/IEC 17025

LABORATORY	National Laboratory for Ionizing Radiation Metrology LNMRI/IRD, Brazil
NAMES	Anderson A. Leiras, A. Iwahara, C. J. da Silva, A. E. de Oliveira, Eduardo V.de Veras, P. A. L. da Cruz, J. U. Delgado, L. Tauhata, Johnny Rangel, Regio dos S. Gomes, R. Poledna, L. Tauhata, A. L.L. Quadros, Mônica L. da Silva
ACTIVITY	1- Participation in international comparisons 2- Absolute activity measurements 3- Sources supply to users 4- Quality assurance programa for activity measurements in nuclear medicine
RESULTS	1- Primary standardization of ^{65}Zn, ^{90}Y, ^{125}I, ^{152}Eu, ^{223}Ra solutions; 2- Comparative performance of 4πβ(LSC)-NaI(Tl) anticoincidence, 4πβ(LSC)-(NaI(Tl) coincidence systems and CIEMAT/NIST Methods.
PUBLICATIONS	1- De Oliveira A. E.; Iwahara, A. Da Cruz P.L.; Da Silva, C.J.; De Araujo E. B.; Mengatti J.; Da Silva R. L.; Trindade O. L.; Rapid and accurate assesement of activity in Brazilian hospital and clinics. Published in Applied Radiation and Isotopes, v. 134, p. 64-67, 2018. 2- Da Silva, C.J; Da Cruz, Paulo A. L.; Iwahara A.; Oliveira E. M.; A.; J. S. Loureiro; Tauhata, L.; Da Silva R. L.;Poledna R.; Lopes, R. T.; ^{68}(Ge + Ga) Activity Standardization by 4πβLS-γ(NaI(Tl)) anticoincidence counting. Published in Applied Radiation and Isotopes, v. 134, p. 307-311, 2018. 3- Da Silva, C.J.; Da Cruz, Paulo A. L.; Iwahara A.; Loureiro J. Dos S.; Gomes, R. Dos Snatos; Araujo M.T.F.; Poledna, R.; Da Silva R. L.; Laranjeira, A. da S.; ^{134}Cs activity standardization by 4πβLS-γ(NaI(Tl)) live-timed anticoincidence counting and submission to International Reference System. Published in Applied Radiation and Isotopes, v. 134, p. 316-320, 2018. 4- Cessna, J.T.; Fitzgerald, R.; Zimmerman, B.E.; Laureano-Pérez; Bergeron, L.; D.E. Van Wyngaardt; Smith, M..; Jackson, T.; Howe, B.; Da Silva, C.J.**;** Iwahara, A.; Da Cruz, P.A.L.; Zang, M.; Liu, H.; Liang, J.; Fréchou, C.; Bobin, C.; Cassette, P.; Kossert, K. Nähle, O.; Marganiec-Galazka, J.; Joseph; L.; Ravindra, A; Kulkarni, D.N.; Yunoki, A.; Sato, Y.; Lee, K.B.; Lee, J.M.; Agung; Dziel,T.; Listkowska, A; Tyminski, Z.; Sahagia, M.; Antohe, A.; Ioan, M. R.; Luca, A.; Krivosek, M.; Ometakova J; Javornik A.; Zalesakova M.; García-Toraño Martinez, E.; Roteta, M.; Mejuto, M.; Nedjadi, Y; Juget, F.; Yuan, M. C.; Yeh, C.Y.; Yeltepe, E.;.; Dirican, A.; Keightley J; Pearce A.; Results of an international comparison of activity measurements of ^{68}Ge. APPLIED RADIATION AND ISOTOPES, v. 134, p. 385-390, 2018. 5- DA CRUZ, P A L; TAUHATA, L; DA SILVA, C J; PRINZIO, M. A. R. R.; Delgado, J.U.; OLIVEIRA, A.E.; Oliveira, E.M.; POLEDNA, R; LOUREIRO, JAMIR S.; ALFREDO, L F F; DA SILVA, R L; TRINDADE FILHO, O L; VERAS, E V; RANGEL, J; Gomes, R.S.; DANTAS, V. B.; QUADROS, A. L. L.; DE ALMEIDA, M C M; SOUZA, P. S.; ARAUJO, M. T. F.; RUZZARIN, A.; CONCEIÇÃO, D A; SANTOS, A.; IWAHARA, A . Radionuclide metrology: traceability and response to a radiological accident. BRAZILIAN JOURNAL OF RADIATION SCIENCES, v. 6, p. 1-14, 2019. 6- CACAIS, FABIO LUDOLF; Delgado, José Ubiratan; LOAYZA, VICTOR MANUEL; RANGEL, JOHNNY ALMEIDA . Bayesian estimation of the relative deviations between activities in the radionuclide standardization. BRAZILIAN JOURNAL OF RADIATION SCIENCES, v. 7, p. 1-14, 2019.

	7- LOUREIRO, JAMIR S.; DA CRUZ, PAULO A. L; IWAHARA, Akira; DELGADO, JOSÉ U; Lopes, Ricardo T. .^{65}Zn and ^{133}Ba standardizing by photon-photon coincidence counting. JOURNAL OF PHYSICS. CONFERENCE SERIES (PRINT), v. 975, p. 012040-1, 2018. 8- RUZZARIN, A; DA CRUZ, P A L; FERREIRA FILHO, A L; IWAHARA, A. Primary Standardization of Eu-152 by 4πβ(LS) - γ (Nal) coincidence counting and CIEMAT-NIST method. JOURNAL OF PHYSICS. CONFERENCE SERIES (PRINT), v. 975, p. 012062, 2018. 9- DA SILVA, C J; DA CRUZ, P A L; IWAHARA, A; LOUREIRO, J S; RUZZARIN, A.; TAUHATA, L. Standardization of Fe-59 by efficiency extrapolation 4πβ-γ anticoincidence method. JOURNAL OF PHYSICS. CONFERENCE SERIES (PRINT), v. 1044, p. 012060-012060, 2018. 10-TRINDADE FILHO, O L; CONCEIÇÃO, D A; Da SILVA, C J; DELGADO, J U; DE OLIVEIRA, A E; IWAHARA, A; TAUHATA, L . A study to assess the long-term stability of the ionization chamber reference system in the LNMRI. JOURNAL OF PHYSICS. CONFERENCE SERIES (ONLINE), v. 975, p. 012059, 2018.
IN PROGRESS	1- Primary activity measurements of ^{223}Ra,^{125}I 2- Standardization of ^{137}Cs
ADDRESS	Instituto de Radioproteção e Dosimetria, Av. Salvador Allende, s/n, Barra da Tijuca, CEP 22783-127, Rio de Janeiro, Brasil.Tel: ++55 21 2173 2874 Tel: ++55 21 2173 2875
CONTACT	E-mail: carlos@ird.gov.br Carlos J. Da Silva

LABORATORY	Laboratório Nacional de Metrologia das Radiações Ionizantes (LNMRI/IRD), Brazil, Instituto de Radioproteção e Dosimetria, Comissão Nacional de Energia Nuclear - CNEN
NAMES	J.U. Delgado, R. Poledna, Ronaldo L. da Silva, Miriam T.F. de Araújo, Octavio L. Trindade, M, L. Da Silva
ACTIVITY	1- Half-life determination. 2- Impurities study by gamma-ray spectrometry. 3- Determination of photon emission probabilities
RESULTS	1- ^{223}Ra. 2- Impurities study of ^{90}Y, ^{125}I, ^{223}Ra, ^{229}Th. 3- ^{229}Th, ^{223}Ra.
PUBLICATIONS	1- FERREIRA FILHO, A.L.; DA SILVA, R.; DA CRUZ, P.A.L.; Da Silva, C.J.; POLEDNA, R.; ARAÚJO, M.T.F.; ARCANJO, C.F.; DELGADO, J.U.; Lopes, R.T. . Application of the sum-peak method to activity standardizations of ^{152}Eu sources in LNMRI (BR). APPLIED RADIATION AND ISOTOPES, v. 134, p. 340-350, 2018. 2- FERREIRA FILHO, ALFREDO LOPES; GOMES, REGIO S.; DA SILVA, RONALDO LINS; DA CRUZ, PAULO ALBERTO LIMA; Delgado, José Ubiratan; LOPES, Ricardo Tadeu . Obtenção das equações de taxa de contagem de pico descrevendo as coincidências-soma de gama e raios-X. BRAZILIAN JOURNAL OF RADIATION SCIENCES, v. 7, p. 1-25, 2019 3- OLIVEIRA, ESTELA MARIA; IWAHARA, Akira; POLEDNA, ROBERTO; DA SILVA, CARLOS JOSÉ; DA CRUZ, PAULO ALBERTO LIMA; GOMES, REGIO DOS SANTOS; DELGADO, JOSÉ UBIRATAN; LOPES, RICARDO TADEU . Sum-peak method with two NaI(Tl) crystals: ^{68}(Ge+Ga) standardization. BRAZILIAN JOURNAL OF RADIATION SCIENCES, v. 7, p. 01, 2019.
IN PROGRESS	1- Application of sum peak method to reference sources for radionuclide metrological calibrations to research in nuclear programmes**.** 2- Study for application coincidence X-γ method for radionuclide metrological calibrations.
ADDRESS	Instituto de Radioproteção e Dosimetria, Av. Salvador Allende, s/n, Barra da Tijuca, CEP 22783-127, Rio de Janeiro, Brasil.Tel: ++55 21 2173 2874 Tel: ++55 21 2173 2875
CONTACT	E-mail: ronaldo@ird.gov.br Ronaldo L. Da Silva

LABORATORY	Laboratório Nacional de Metrologia das Radiações Ionizantes (LNMRI/IRD), Brazil, Instituto de Radioproteção e Dosimetria, Comissão Nacional de Energia Nuclear - CNEN
NAMES	A. C. M. Ferreira, A. E. de Oliveira, Estela M de Oliveira, L. Tauhata, Poliana S. de Souza.
ACTIVITY	1- Preparation of the spiked sources of beta, alpha and multi-gamma emitters in water matrix 2- Quality assurance programme for low level activity measurements
RESULTS	Performance of 28 laboratories for low level measurements.
PUBLICATIONS	1- DE SOUZA, POLIANA SANTOS; CLAIN, ALMIR FARIA; FILHO, OCTÁVIO LUIZ TRINDADE; DE OLIVEIRA, ESTELA MARIA; DELGADO, JOSE UBIRATAN; LOPES, RICARDO TADEU . Production of spiked vegetation samples containing γ-emitting radionuclides for proficiency testing. JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY, v. 321(3), p. 851-856, 2019.
IN PROGRESS	Spike of grass matrix.
ADDRESS	Instituto de Radioproteção e Dosimetria, Av. Salvador Allende, s/n, Barra da Tijuca, CEP 22783-127, Rio de Janeiro, Brasil.Tel: ++55 21 2173 2874 Tel: ++55 21 2173 2875
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NRC Radionuclide Metrology
2018-2021 Progress Report and Work Plan
(information for ICRM members)

National Research Council of Canada (NRC), Canada, SA1/SA2

The programs at the National Research Council (NRC) of Canada Radionuclide Laboratory consist of the development, maintenance and dissemination of activity standards, through primary and secondary standard methods. Canadian stakeholders from the medical physics, radiation protection and nuclear forensic communities in both private and public sectors have requested and received certified reference materials and services in the form of independent testing and calibration services from NRC. NRC has also partnered with the private and public sector in various research projects.

The NRC staff in 2019 were:

Scientists	**Function**
Patrick Saull	Head (of laboratory or group)
Raphael Galea	Primary activity standards
Raphael Galea	Secondary activity standards
Raphael Galea	Liquid scintillation counting
Raphael Galea	Gamma spectrometry
Raphael Galea	Alpha spectrometry
John Paul Archambault	Neutron standards
Raphael Galea	Source preparation/radiochemistry
Technicians	
Kimberly Moore	Source preparation/radiochemistry

The main specific activities carried out at NRC in this field are summarised below.

Activity line	**NRC Radionuclide Metrology 2018-2019 Progress report**	**NRC Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Collaboration with NRC chemical metrology on the production of Uranium Ore Concentrate CRMs. • Revival of Neutron emission rate primary standard and provision of ^{56}Mn primary standardization.	• Production of a ^{99}Ru free ^{99}Tc CRM. • Standardization of ^{89}Zr.
International comparisons	• CCRI(II)-K2.Fe-55. • CCRI(II)-K2.H-3	• SIM.RI(II)-Zn-65. • CCRI(II).K2-Cd-109. • BIPM pilot study ^{60}Co for ESIR. • CCRI(III).K9-Cf Neutron emission rate. • CCRI(III).S1 Ambient dose rate (neutron). • New submissions to SIR
Standardization of measurement methods		• Development of primary radioactive noble gas counting capability.

Activity line	**NRC Radionuclide Metrology 2018-2019 Progress report**	**NRC Radionuclide Metrology 2020-2021 Work plan**
National QA programmes and services	• Radionuclide calibrator calibration service. • Organization of external independent tests. • Custom CRM preparation • Maintain national inventory for the Canadian Nuclear Forensics Lab network.	• Radionuclide calibrator calibration service. • Organization of external independent tests. • Custom CRM preparation • Maintain national inventory for the Canadian Nuclear Forensics Lab network.
Membership in international and national organisations	• ICRM, BIPM/CCRI(II), SIM-MWG6, ISO/TC85/WG2, ISO/TC85/WG22 • Raphael Galea became chair of the SIM-MWG6 in 2017.	• ICRM, BIPM/CCRI(II), SIM-MWG6, ISO/TC85/WG2, ISO/TC85/WG22
Management and Organisation		
Teaching activity	• Undergraduate Coop students • PhD student in radionuclide metrology	• Undergraduate Coop students • PhD student in radionuclide metrology
Quality system	• Publication of first CMCs in radioactivity for NRC in the KCDB. • External peer review compliant with ISO17034:2016 and internal review compliant with ISO17025:2017.	• Annual internal review of the radioactivity QMS. • Publication of additional CMCs for ^{3}H, ^{11}C, ^{18}F, ^{64}Cu and ^{99m}Tc.

LABORATORY	National Research Council of Canada (NRC), Canada
NAMES	Dr. Raphael Galea and Ms. Kimberly Moore
ACTIVITY	Primary and secondary standardization of radioactivity.
KEYWORDS	Alpha spectrometry, beta spectrometry, (anti) coincidence method, data measurement, SIM, gamma-ray spectrometry, gas proportional counter, ionisation chamber, life sciences, liquid scintillation, NaI well-type counter, neutron measurement, radiochemistry, simulation code, SIR, source preparation, traceability, X-ray spectrometry.
RESULTS	Participation in the CCRI(II) comparison of Fe-55. Participation in the CCRI(II) comparison of H-3. Participation in the CCRI(II) Supplementary comparison on uncertainties in the TDCR-LSC method. Performed accuracy check service for radionuclide calibrators in Manitoba and Nova Scotia. Performed independent testing of radioactivity measurement service for external clients. Participation in the Nuclear Forensics Canadian Advancement Project Network and supply of reference material to participating laboratories.
PUBLICATIONS	1. Simon Jerome, Christophe Bobin, Philippe Cassette, Rainer Dersch, Raphael Galea, Haoran Liu, Anja Honig, John Keightley, Karsten Kossert, Juncheng Liang, et al. *Half-life determination and comparison of activity standards of ^{231}Pa*. Applied Radiation and Isotopes, 155:108837, 2020 2. R Galea, C Michotte, M Nonis, K Moore, I El Gamal, J Keightley, and A Fenwick. *The first official measurement of ^{11}C in the SIRTI*. Applied Radiation and Isotopes, 154:108834, 2019 3. Philippe Cassette, Timotheos Altzitzoglou, Andrei Antohe, Mario Rossi, Arzu Arinc, Marco Capogni, Pierino de Felice, Raphael Galea, Arunas Gudelis, Karsten Kossert, et al. *Results of the CCRI(II)-S12. H-3 supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated-water source measured using the LSC-TDCR method*. Metrologia, 56(1A):06005, 2019 4. Marie-Christine Lépy, Cheick Thiam, M Anagnostakis, R Galea, D Gurau,S Hurtado, K Karfopoulos, J Liang, H Liu, A Luca, et al. *A benchmark for monte carlo simulation in gamma-ray spectrometry*. Applied Radiation and Isotopes, 154:108850, 2019 5. Richard M Essex, Ross W Williams, Kerri C Treinen, Ronald Collé, Ryan Fitzgerald, Raphael Galea, John Keightley, Jerome LaRosa, Lizbeth Laureano-Pérez, Svetlana Nour, et al. *Preparation and calibration of a ^{231}Pa reference material*. Journal of Radioanalytical and Nuclear Chemistry,322(3):1593–1604, 2019 6. R Galea and K Moore. *Production of a carrier-free standard ^{56}Mn source for the NRC manganese salt bath*. Applied Radiation and Isotopes, 154:108896, 2019 7. R Townson, F Tessier, and R Galea. *EGSnrc calculation of activity calibration factors for the vinten ionization chamber*. Applied Radiation and Isotopes, 134:100–104, 2018

	8. Zoya Naperstkow, Kimberly Moore, Daniel Szames, Cassis Varlow, Andrea F Armstrong, and Raphael Galea. *Production and standardization of an on-demand protactinium-233 tracer*. Journal of Radioanalytical and Nuclear Chemistry, 318(1):703–709, 2018
IN PROGRESS	BIPM ^{60}Co pilot study for the Extension to the SIR. Development of radioactive noble gas primary counting capability. Uranium radiochronometry. Monte Carlo methods in radionuclide metrology.
INFORMATION	http://www.nrc-cnrc.gc.ca
SOURCE IN PREPARATION	Monograph on Nuclear Forensics in Canada.
OTHER RELATED PUBLICATIONS	
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CONTACT	Raphael Galea: raphael.galea@nrc-cnrc.gc.ca

NIM Radionuclide Metrology
2018-2021 Progress Report and Work Plan
(information for ICRM members)

National Institute of Metrology (NIM), China, SA1/SA2

The programme at the National Institute of Metrology (NIM, China) in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the primary and secondary national standards for activity measurements and on the more general activities in the field of standardization and quality-assurance in radioactivity measurements.

The NIM staff in 2019 were:

Scientists	**Function**
Juncheng LIANG	Head (of laboratory or group), radon standards and low level measurements
Ming ZHANG	Primary standards (gas counting and surface emission rate counting)
Haoran LIU	Primary and secondary standards (liquid scintillation counting and gamma spectrometry)
Qing ZHAO	Radioactive reference materials
Fuyou FAN	Radiochemistry and radioactive reference materials
Technicians	
Zhijie YANG	Radon standards and electronics
Yang XIAO	Source preparation
Hao YANG	Electronics
Xiangzhuang MA	Calibration services
Yan WANG	Radioactive reference materials and secretary

The main specific activities carried out at NIM in this field are summarized below.

Activity line	**NIM Radionuclide Metrology 2018-2019 Progress report**	**NIM Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Development of a length-compensated proportional counting system for noble gas standardization, and measurement of Kr-85; • Developments of a low-level gamma ray spectrometry for environmental sample measurements • Development of a portable TDCR • Development of a code for uncertainty calculation in gamma-ray spectrometry • Development of a method for rapid separation of Po-210 from Pb-210 • Measurement of activity concentrition of radon progenies by LSC method	• Development of new primary standards: Xe-133 • Development of a new reference chamber for multi-gases calibration. • Development of Po-210, Kr-85 reference material • Development of a code for pulse signal processing to implement pulse-mixing method • Develope on-site metrology apparatuses for nuclear medicine and radon radiation protection.
International comparisons	• CCRI(II)-K2.Pa-231 • CCRI(II)-K2.Fe-55 • Bilateral comparison with NMISA on surface emission rate measurement • CCRI(II)-K3. H-3 piloted by LNHB • CCRI(II)-S14-Rn-222 piloted by LNHB	• Bilateral comparison with LNHB on Kr-85 gas • Pilot an APMP comparison on surface emission rate measurement • Paticipate in CCRI(II)-P1.60Co compariosn • SIRTI comparison
National QA programmes and services	• Preparation of radioactive standards (liquid solutions, point sources, reference materials) for external users. • Organisation of proficiency tests for nuclear power plants and monitoring labs.	• Calibration services continued • Organisation of Proficiency Tests continued
Membership in international and national organisations	• APMP • ICRM • BIPM/CCRI(II), CCRI(II) KCWG，CCRI(II) ESIR	Continued membership of all groups
Quality system	• Management of Quality System 17025 - 2017	• Management of Quality System 17025 - 2017

LABORATORY	National Institute of Metrology (NIM), China
NAMES	Juncheng LIANG, Qing ZHAO, Ming ZHANG, Haoran LIU, Fuyou FAN, Zhijie YANG, Yang XIAO, Hao YANG, XiangZhuang MA and Yan WANG
ACTIVITY	(1) Participated in CCRI.RI-K1.Pa-231 comparison (2) Participated in CCRI(II)-K2.Fe-55.2019 comparison (3) Participated in ICRM GSWG exercise on Monte Carlo simulation in gamma-ray spectrometry (4) Development of a length-compensated proportional counting system for noble gas standardization (5) Development of a low-level gamma ray spectrometry for environmental sample measurements (6) Development of a portable TDCR system at NIM (7) Development of a code for implementing two TDCR counting algorithm: common dead-time TDCR counting algorithm and the individual dead-time TDCR counting algorithm (8) Development of a code for uncertainty calculation in gamma-ray spectrometry (9) Development of a method for rapid separation of Po-210 from Pb-210 based on the usage of a commercial Sr-Specific chromatographic resin (10) Measurement of activity concentration of radon decay products by LSC method
KEYWORDS	Coincidence method, gamma-ray spectrometry, gas proportional counter, life sciences, liquid scintillation, low-level, radioactive gas, radon gas, radiochemistry, simulation code, source preparation, traceability, radionuclide by Pa-231,Fe-55, Po-210, Kr-85
RESULTS	(1) The comparison of Pa-231 was completed, and two articles related to this comparison had been published. (2) The measurement of Fe-55 was completed and the result of NIM was submitted to BIPM. (3) The exercise was completed and result in a co-published article. (4) The length-compensated proportional counting system has been established and carried out a measurement of Kr-85. (5) The low-level gamma ray spectrometry is basically completed and is being tested. (6) A portable TDCR system had been developed at NIM. And the CEAN digitizer DT 5730 was used for implementing the TDCR count model and coincidence logic. (7) The two TDCR counting algorithms had been developed, and a very good agreement between the two algorithms was observed. (8) A code for uncertainty calculation in gamma-ray spectrometry had been developed at NIM. (9) The method for rapid separation of Po-210 from Pb-210 was developed at NIM (10) The measurement of activity concentrition of radon decay products by LSC method was done at NIM.
PUBLICATIONS	Haoran Liu, Qianqian Zhou, Fuyou Fan, Juncheng Liang, Ming Zhang. *Activity determination of ^{231}Pa by means of liquid scintillation counting*. Applied Radiation and Isotopes.2020,155: 108944.

	Fuyou Fan, Haoran Liu, Juncheng Liang, Haowen Sun, Jian Zhang, Duoqiang Pan, Yu Zou. *Rapid separation of Po-210 from Pb-210 based on the usage of a commercial Sr-Specific chromatographic resin*. Journal of Environmental Radioactivity. 2020, 211:106083. Simon Jerome, Christophe Bobin, Philippe Cassette, Rainer Dersch, Raphael Galea, Haoran Liu, Anja Honig, John Keightley, Karsten Kossert, Juncheng Liang, Maria Marouli, Carine Michotte, Stefaan Pommé, Stefan Röttger, Ross Williams, Ming Zhang. *Half-life determination and comparison of activity standards of ^{231}Pa*, Applied Radiation and Isotopes. 2020, 155: 108837. M.C. Lépy, C. Thiam, M. Anagnostakis, R. Galea, D. Gurau, S. Hurtado, K. Karfopoulos, J. Liang, H. Liu, A. Luca, I. Mitsios, C. Potiriadis, M.I. Savva, T.T. Thanh, V. Thomas, R.W. Townson, T. Vasilopoulou, M. Zhang. *A benchmark for Monte Carlo simulation in gamma-ray spectrometry*. Applied Radiation and Isotopes 2019, 154: 108850. WANG Zilu, LI Yuqi, ZHANG Ming, TUO Fei, YANG Zhijie, LI Zeshu, LIANG Juncheng. *Radioactivity Concentration Measurement of ^{85}Kr Using Length compensated Internal Gas Proportional Counting Method*. Atomic Energy Science and Technology, 2019, 53(12): 2465-2470. (In Chinese) YANG Zhi-jie, LIU Hao-ran, LIANG Jun-cheng, ZHU Da-bin, WANG Nan-ping. *A Comparison of Activity Analysis of γ Radionuclides in Water*. Acta Metrologica Sinica, 2019, 40(5): 914-919. (In Chinese)
IN PROGRESS	(1) Development of a new primary standards: Xe-133 (2) Development of a new reference chamber for multi-gases calibration. (3) Bilateral comparison with LNHB on Kr-85 gas (4) Pilot an APMP comparison on surface emission rate measurement (5) Development of Po-210, Kr-85 reference materials (6) Development of a code for pulse signal processing to implement pulse-mixing method (7) Development of on-site metrology apparatuses for nuclear medicine and radon radiation protection. (8) Organisation of Proficiency Tests for nuclear power plants and monitoring labs.
SOURCE IN PREPARATION	(1) Large area plant source (2) Point sources, volume sources (3) LSC Sources
OTHER RELATED PUBLICATIONS	XuFang Li, CongZhan Liu, Zhi Chang, YiFei Zhang, XiaoBo Li, He Gao, ZhengWei Li, XueFeng Lu, Xu Zhou, AiMei Zhang, Tong Zhang, FangJun Lu, YuPeng Xu, ShuangNan Zhanga, TiPei Li, Mei Wu, Shu Zhang, HongWei Liu, Fan Zhang, LiMing Song, YongJie Jin, HuiMing Yu, Zhao Zhang, MinXue Fu, YiBao Chen, JingKang Deng, RenCheng Shang, GuoQing Liu, JinJie Wu, HaoRan Liu, JunCheng Liang, XiangPing Qiu. *Ground-based calibration and characterization of the HE detectors for Insight-HXMT*. Journal of High Energy Astrophysics, 2019, 24: 6-14.
ADDRESS	National Institute of Metrology, ChinaNo.18, Bei San Huan Dong Lu, Chao Yang Dist, Beijing, P. R. China, 100029
CONTACT	Juncheng LIANG, liangjc@nim.ac.cn

LABORATORY	Ruđer Bošković Institute (RBI), Laboratory for Low-level Radioactivities, Croatia
NAMES	Researchers: Jadranka Barešić, Ines Krajcar Bronić (Head), Ivanka Lovrenčić Mikelić (quality manager), Andreja Sironić Assistant: Damir Borković; technician: Anita Rajtarić
ACTIVITY	• Improvement of measurement techniques for radiocarbon (benzene synthesis and direct absorption of CO_2, LSC technique; preparation of graphite targets for AMS ^{14}C measurement) and tritium measurement (electrolytic enrichment and LSC measurement, direct LSC measurement) • Optimization of a simple method for determination of biogenic fraction in liquid fuels by direct measurement using LSC Quantulus and comparison with the AMS method, especially for highly quenched liquids • Radiocarbon dating of archaeological, geological and paleontological samples, geochronology, dating of cultural heritage and art objects • Tritium activity measurements of natural waters (precipitation, surface and ground waters) and modelling • Use of stable (H-2, C-13, O-18) and natural radioactive isotopes (H-3, C-14) 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 (C-13, C-14) in carbon cycle studies • C-14 monitoring in biological samples around nuclear power plant (npp), C-14 monitoring in atmospheric CO_2 around the npp and in the clean areas, C-14 monitoring in npp waste water, C-14 monitoring in river water and biota • Participation in IAEA/WMO project: *"Global Network of Isotopes in Precipitation (GNIP) and Isotope Hydrology Information System (ISOHIS)"*. Data on H-3, H-2 and O-18 in precipitation for station Zagreb since 1976 • Croatian Science Foundation Project **Reconstruction of the Quaternary environment in Croatia using isotope methods** – REQUENCRIM, successfully finished • Regional project IAEA CRO/7/001: **Isotope investigation of the groundwater-surface water interaction at the well field Kosnica in the area of the city of Zagreb**, 2016-2017 – - successfully finished • Research contract **Dating of tufa, sediments and rocks**, financed by National Park Plitvice, 2019, J. Barešić responsible person (https://www.irb.hr/sedra)
KEYWORDS	data evaluation, data measurement, environmental monitoring, liquid scintillation, low-level, LSC, accelerator mass spectrometry, AMS, dating, radionuclides C-14, H-3, stable isotopes H-2, C-13, O-18
RESULTS	^{14}C dating of various types of samples was performed. For large samples, containing >2 g of carbon, the liquid scintillation measuring techniques were used. Small samples, containing <1 g of carbon, were prepared as graphites and measured by AMS technique. Altogether in 2018 and 2019, 190 samples were measured by the LSC technique after benzene synthesis, 253 samples after CO_2 absorption, and 464 samples by the AMS. H-3 and stable isotopes H-2 and O-18 monitoring in precipitation, in the Sava River, and in well-field Kosnica near Zagreb continued. Tritium activity concentration was determined in about 300 samples. C-14 monitoring in atmospheric CO_2 and recent plants around nuclear power plant has been continued. As expected, slightly higher ^{14}C activities were observed in

	atmospheric CO_2 collected close to the ventilation output for short period during and immediately after the refuelling. The comprehensive multi-proxy study of lake sediments from two karst lakes of different sizes, Lake Prošće (0.68 km²) and Lake Kaluđerovac (0.02 km²), the Plitvice Lakes system, Croatia, involved mineralogical, chemical (C/N and TOC) and carbon isotope analyses ($a^{14}C$ and $\delta^{13}C$ of carbonate and organic fractions) of 6 sediment cores. The response of the lake sediment to the environmental conditions did not depend particularly on the size of the lake, but the surrounding environmental conditions had great influence on the sediment composition. To study regional and long-term paleoclimatic records in lake sediments, the sampling location should be far from local-scale influences. Sediment locations closer to the shore and influenced by local water inputs that may occasionally bring terrigenic material to the lake are more appropriate for the determination of local short-term paleoenvironmental events. C-14 dating was expanded to dating of mortar and the method was applied for dating the Aqueduct near Skopje, North Macedonia. Combined radiocarbon (C-14) analysis and sclerochronology was applied to bivalves (Glycymeris sp.) from the North Adriatic Sea. Growth increment time series indicate the potential for creating longer chronologies from live and dead-collected specimens. The C-14 record obtained from G. pilosa correlated well with the modelled surface ocean (mixed-layer) bomb pulse curve. We took part in several **intercomparison** studies: • 5th OBT (organically bound tritium) intercomparison 2018 (fish sample) and 6th OBT intercomparison 2019 (quince sample); • tritium intercomparison IAEA-TRIC2018 (water samples with and without electrolytic enrichment); • ILC/2018/2 Content of bio-component in liquid fuel samples. All participations were successful and showed the quality of laboratory results and indicated possibilities of further improvement of analytical techniques. **Expert missions:** • J. Barešić and I. Krajcar Bronić - experts IAEA in Bulgaria, Bulgarian Academy of Sciences (BAS), Sofia, January 2019, lectures at the National Workshop "Implementing radiocarbon method for dating archaeological finds" and Establishment of quality assurance procedure for radiocarbon dating of archaeological finds in the BAS radiocarbon laboratory • I. Krajcar Bronić - expert IAEA in Columbia, Servicio Geologico Colombiano, Bogota, February 2019, Expert mission on C-14 measurements by liquid scintillation counting and benzene synthesis • I. Krajcar Bronić expert EC JRC Ispra at workshop "Sustainability of Biofuels - Focus on Life Cycle Analysis", Ispra, Italy, May 2019
PUBLICATIONS	**Papers in journals** Faivre, S., Bakran-Petricioli, T., Barešić, J., Horvatić, D., Macario, K. (2019) Relative sea-level change and climate change in the Northeastern Adriatic during the last 1.5 ka (Istria, Croatia). *Quaternary science reviews* 222: 1-17. Faivre, S., Bakran-Petricioli, T., Barešić, J., Morhange, C., Borković, D. (2019) Marine radiocarbon reservoir age of the coralline intertidal alga Lithophyllum byssoides in the Mediterranean. *Quaternary geochronology* 51: 15-23. Horvatinčić, N., Sironić, A., Barešić, J., Sondi, I., Krajcar Bronić, I., Borković, D. (2018) Mineralogical, organic and isotopic composition as palaeoenvironmental records in the lake sediments of two lakes, the Plitvice Lakes, Croatia. *Quaternary international* 494: 300-313 doi:10.1016/j.quaint.2017.01.022.

Kovač, Z., Nakić, Z., Barešić, J., Parlov, J. (2018) Nitrate Origin in the Zagreb Aquifer System. *Geofluids*, 2018 (1), 2789691, 15 doi:10.1155/2018/2789691.

Nikolov, J., Krajcar Bronić, I., Todorović, N., Barešić, J., Petrović Pantić, T., Marković, T., Bikit-Schroeder, K., Stojković, I., Tomić, M. (2019) A survey of isotopic composition (2H, 3H, 18O) of groundwater from Vojvodina. *J. Radioanal. Nucl. Chem*. 320 (5): 385-394 doi:10.1007/s10967-019-06469-x.

Orescanin, V., Durgo, K., Lovrencic Mikelic, I., Halkijevic, I., Kuspilic, M. (2018) Toxicity assessment of untreated/treated electroplating sludge using human and plant bioassay. *Journal of environmental science and health. Part A* 53 (10), 925-930 doi:10.1080/10934529.2018.1462911.

Parlov, J., Kovač, Z., Nakić, Z., Barešić, J. (2019) Using Water Stable Isotopes for Identifying Groundwater Recharge Sources of the Unconfined Alluvial Zagreb Aquifer (Croatia). *Water* 11 (10): 2177, 15 doi:10.3390/w11102177

Peharda, M., Sironić, A., Markulin, K., Jozić, S., Borković, D., Andersson, C. (2019) The bivalve Glycymeris pilosa as an archive of 14C in the Mediterranean Sea. *Radiocarbon* 61 (2): 599-613 doi:10.1017/RDC.2018.146

Sironić, A., Borković, D., Barešić, J., Krajcar Bronić, I., Cherkinsky, A., Kitanovska, L., Štrukil, V., Robeva Čukovska, L. (2019) Radiocarbon dating of mortar from the Aqueduct in Skopje. *Radiocarbon* 61: 1239-1251 doi:10.1017/RDC.2019.66

Stojković, I., Todorović, N., Nikolov, J., Krajcar Bronić, I., Bátor, G, Kovács, T. (2019) Investigation of fast screening LSC method for monitoring 14C activity in wastewater samples. *Radiation measurements*, 121 (1):1-9 doi:10.1016/j.radmeas.2018.12.004.

Topić, N., Krajcar Bronić, I, Sironić, A. (2018) Rezultati arheološkog nadzora i određivanje starosti drvenih pilota iz atrija Kneževa dvora u Dubrovniku. *Portal* 9 (1): 31-48 doi:10.17018/portal.2018.3.

Chapter in book

Nikolov, J., Krajcar Bronić, I., Todorović, N., Stojković, I., Barešić, J., Petrović-Pantić, T. (2018) Tritium in Water: Hydrology and Health Implications. In: Janković, M. (ed.) Tritium - Advances in Research and Applications. New York, NOVA Science Publishers, p. 157-211.

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Kazakis, N., Krajcar Bronić, I., Barešić, J., Philippou, K., Paschalidis, I., Kalaitzidou, K., Mitrakas, M., Ioannidou, A. (2019) Seasonal variations of tritium, uranium and stable isotopes in groundwater and spring waters in the Anthemountas Basin, Northern Greece. In: *International Symposium on Isotope Hydrology: Advancing the Understanding of Water Cycle Processes, CN-271*. IAEA, 14-2.

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Krajcar Bronić, I. (2019) Challenges in radiation protection – the point of view of a small radiation protection society. In: *Proceedings of the XXX Symposium of Radiation Protection Society of Serbia and Montenegro,* Belgrade, p. 12-17.

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IN PROGRESS	• Continuous improvement of preparation and measurement techniques, especially C-14 dating of mortar samples and other types of small samples for AMS C-14 dating • Continuous monitoring of H-3 and C-14 in environment, study of water and carbon natural cycles, anthropogenic influence on carbon cycle – comparison of different types of locations (urban and rural "clean-air" sites) • comparison of different (static and dynamic) sampling techniques of atmospheric CO_2 • Study of processes in karst by applying stable and radioactive isotopes • Study of carbonates formed in marine environment – Adriatic Sea (shells, algal rims, coral), marine reservoir effect in C-14 • optimization of sample combustion for OBT determination • analysis of long-term tritium-in-precipitation data and possibility of influence of solar cycle on cosmogenic tritium production • optimization of direct LSC determination of biogenic component in highly-quenched liquids • We took part in the international intercomparison of mortar samples MODIS2, the results are being processed Improvement of Quality Management System in progress, various forms and documents have been prepared and implemented in the laboratory. IAEA TC National project CRO/7/002 "Using Nitrogen and Oxygen Stable Isotopes in the Determination of Nitrate Origin in the Unsaturated and Saturated Zone of the Velika Gorica Wellfield" (2020-2021) in co-operation with Faculty of mining, geology and oil engineering; University of Zagreb, J. Barešić co-leader, started January 2020, financed by IAEA

	New Croatian Science Foundation project SEALevel – relative change of sea level and climate change along the eastern Adriatic coast, started 2020, J. Barešić team member, Sanja Faivre principal investigator New Croatian Science Foundation project NECEM – Last Neandertals at the Crossroads of the central Europe and the Mediterranean, started 2000, I. Krajcar Bronić team member, Ivor Karavanić principal investigator
INFORMATION	http://www.irb.hr/eng/Research/Divisions/Division-of-Experimental-Physics/Laboratory-for-Low-level-Radioactivities http://www.irb.hr/REQUENCRIM http://www.irb.hr/sedra
SOURCE IN PREPARATION	• long-term isotope composition of precipitation in Zagreb – paper accepted • is there periodicity in cosmogenic production of tritium? – in preparation • C-14: properties, behaviour and risks – book chapter, accepted • radiocarbon dating of paper and parchment – book chapter, accepted • radiocarbon dating of bones, emphasis on AMS, intercomparison - submitted • stable isotopes in study of surface waters in the Plitvice Lakes area • how can dating tufa help in reconstructing karst paleoenvironment?
OTHER RELATED PUBLICATIONS	https://www.bib.irb.hr/pretraga/?q=Krajcar-Broni%C4%87%2C+Ines+%28112976%29&by=author https://www.bib.irb.hr/pretraga/?q=Bare%C5%A1i%C4%87%2C+Jadranka+%28237472%29&by=author https://www.bib.irb.hr/pretraga/?q=Lovren%C4%8Di%C4%87+Mikeli%C4%87%2C+Ivanka+%28260532%29&by=author https://www.bib.irb.hr/pretraga/?q=Sironi%C4%87%2C+Andreja+%28268342%29&by=author
ADDRESS	Laboratory for Low-level Radioactivities (Radiocarbon and Tritium Laboratory) Ruđer Bošković Institute, Bijenička cesta 54, 10000 Zagreb, Croatia phone: +385 1 4680219, or +385 1 4571 271, fax: +385 1 4680 239
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CMI Radionuclide Metrology
2018-2021 Progress Report and Work Plan
(information for ICRM members)

Czech Metrology Institute (CMI), Radionuclide Metrology, Czech Republic, SA1/SA2

The programme at the CMI in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the primary and secondary national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

The CMI staff in 2019 were:

Scientists	**Function**
Vladimír Sochor	Head of Primary standards group
Pavel Dryák	Gamma spectrometry
Petr Kovář	Gamma spectrometry
Jana Sochorová	Primary activity standards
Pavel Auerbach	Electronics specialist
Miroslav Havelka	Liquid scintillation counting, Radon in water standard

The main specific activities carried out at CMI in this field are summarised below.

Activity line	**CMI Radionuclide Metrology 2018-2019 Progress report**	**CMI Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Revision of primary standards: Sn-113, Cd-109 • 4π(LS)-γ coincidence system - comparison of different ways of efficiency changes for extrapolation measurement • Measurement of the intensity of the branching ratio related to the internal pair production of Y-90 • Development of new method for measurement of emanation power of Rn-220 source • Measurement of the decay scheme of Ho-166 • New procedure for the separation of Th-228 daughter radionuclides •	• Development of new primary standards: Sm-153 • Development of the new separation and standardisation method – Ra-226 • Ensuring of metrological traceability for short-lived radionuclides used for imaging methods in nuclear medicine • Development of the new 4πNaI(Tl) detector • Revision of the primary standard – Fe-55
International comparisons	• EURAMET.RI(II)-K2.Ho-166 • EURAMET Project 1437 The follow-up interlaboratory comparison of the radionuclide calibrators	• CCRI(II)-K2.Fe-55 • CCRI(II)-K2. Cd-109

Activity line	**CMI Radionuclide Metrology 2018-2019 Progress report**	**CMI Radionuclide Metrology 2020-2021 Work plan**
National QA programmes and services	• Preparation of radioactive standards (liquid solutions, point sources, reference materials) for external users.	• Preparation of radioactive standards (liquid solutions, point sources, reference materials) for external users.
Membership in international and national organisations	• ICRM, BIPM/CCRI(II), EURAMET	• ICRM, BIPM/CCRI(II), EURAMET
Management and Organisation	• European projects: • 15SIB10, Radionuclide beta spectra metrology‘,WP leadership • 15HLT06, Metrology for clinical implementation of dosimetry in molecular radiotherapy‘‘ • 16ENV09 MetroDecomII, In situ metrology for decommissioning nuclear facilities, WP leadership • 16ENV04 Metrology for mobile detection of ionising radiation in the aftermath of a nuclear or radiological incident , WP leadership • 16ENV10 MetroRADON , Metrology for radon monitoring, WP leadership •	• European Projects: • 16ENV09 MetroDecomII, In situ metrology for decommissioning nuclear facilities, WP leadership • 16ENV04 Metrology for mobile detection of ionising radiation in the aftermath of a nuclear or radiological incident , WP leadership • 16ENV10 MetroRADON , Metrology for radon monitoring, WP leadership • 18HLT04 UHDPulse Metrology for advanced radiotherapy using particle beams with ultra-high pulse dose rates WP leadership • 18NRM02 PRISM-eBT Primary standards and traceable measurement methods for X-ray emitting electronic brachytherapy device, WP leadership
Teaching activity	• Cooperation with Faculty of Nuclear Sciences and Physical Engineering, Prague	• Cooperation with Faculty of Nuclear Sciences and Physical Engineering, Prague
Quality system	• Maintaining of Quality Management System according to ISO17025	• Maintaining of Quality Management System according to ISO17025 • On site peer review FTMC

LABORATORY	Czech Metrology Institute (CMI), Radionuclide Metrology, Czech Republic
NAMES	Petr Kovář, Jana Sochorová, Pavel Dryýk, Pavel Auerbach,
ACTIVITY	Maintaining of the National Standard of Activity of Radionuclides in Czech Republic Maintaining and improving of the management system according to ISO 17025 Production of standard solutions and sources Development of new measurement methods for activity standardisation Nuclear decay data evaluation
KEYWORDS	Alpha spectrometry, beta spectrometry,coincidence method, data evaluation, data measurement, environmental control, Euramet, gamma-ray spectrometry, gas proportional counter, ionisation chamber, life sciences, liquid scintillation, low-level, 4πNaI counter, neutron measurement, radioactive gas, radiochemistry, simulation code, SIR, source preparation, traceability, X-ray spectrometry,
RESULTS	4π(LS)-γ coincidence system - comparison of different ways of efficiency changes for extrapolation measurement Measurement of the branching ratio related to the internal pair production of Y-90 Development of new method for measurement of emanation power of Rn-220 source Measurement of the decay scheme of Ho-166 New procedure for the separation of Th-228 daughter radionuclides
PUBLICATIONS	Dryák, P. & Šolc, J. 2020, "Measurement of the branching ratio related to the internal pair production of Y-90", Applied Radiation and Isotopes, vol. 156, pp. 108942. Bobin, C., Bouchard, J., Chisté, V., Collins, S.M., Dryák, P., Fenwick, A., Keightley, J., Lépy, M.-., Lourenço, V., Robinson, A.P., Sochorová, J., Šolc, J. & Thiam, C. 2019, "Activity measurements and determination of nuclear decay data of ^{166}Ho in the MRTDosimetry project", Applied Radiation and Isotopes, vol. 153, pp. 108826 Marouli, M., Lutter, G., Pommé, S., Van Ammel, R., Hult, M., Pierre, S., Dryák, P., Carconi, P., Fazio, A., Bruchertseifer, F. & Morgenstern, A. 2019, "Measurement of absolute γ-ray emission probabilities in the decay of ^{227}Ac in equilibrium with its progeny", Applied Radiation and Isotopes, vol. 144, pp. 34-46. Sima, O., De Vismes Ott, A., Dias, M.S., Dryak, P., Ferreux, L., Gurau, D., Hurtado, S., Jodlowski, P., Karfopoulos, K., Koskinas, M.F., Laubenstein, M., Lee, Y.K., Lépy, M.C., Luca, A., Menezes, M.O., Moreira, D.S., Nikolič, J., Peyres, V., Saganowski, P., Savva, M.I., Semmler, R., Solc, J., Thanh, T.T., Tyminska, K., Tyminski, Z., Vidmar, T., Vukanac, I. & Yucel, H. 2020, "Consistency test of coincidence-summing calculation methods for extended sources", Applied Radiation and Isotopes, vol. 155, pp. 108921 Šolc, J. 2019, "Comparison of proton interaction physics models and cross section libraries for proton therapy Monte Carlo simulations by MCNP6.2 code", Radiation Measurements, vol. 125, pp. 57-68 Novotny, P., Dryak, P., Solc, J., Kovar, P. & Vykydal, Z. 2018, "Characterization of the Si(Li) detector for Monte Carlo calculations of beta spectra", Journal of Instrumentation, vol. 13, no. 1, pp. P01021-P01021

IN PROGRESS	Development of the new separation and standardisation method – Ra-226 Ensuring of metrological traceability for short-lived radionuclides used for imaging methods in nuclear medicine Development of the new 4πNaI(Tl) detector
INFORMATION	4πβ-γ coincidence system with gas flow proportional counter 4πβ,X-γ coincidence system with pressurized proportional counter 4π(LS)-γ coincidence system TDCR system 4π windowless NaI(Tl) detector X and γ ray spectrometry systems MC based efficiency calculation for spectrometry detectors Radon in water standard
ADDRESS	Headquarters: Czech Metrology Institute, Okružní 31 638 00 Brno Czech Republic Laboratory: Czech Metrology Institute – Regional Branch Prague Radiová 1a 10200 Prague Czech Republic Tel: +420266020407 Email: pkovar@cmi.cz, jsochorova2@cmi.cz
CONTACT	Petr Kovář

Radiation and Nuclear Safety Authority (STUK),
Environmental Surveillance and Measurement, Finland
2018-2021 Progress Report and Work Plan
(information for ICRM members)

Radiation and Nuclear Safety Authority (STUK),
Department of Environmental Surveillance and Measurement, Finland, SA1/SA2

The programme at the department of Environmental Surveillance and Measurement (STUK) in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing gamma-ray spectrometry methods for activity measurements from environmental samples. A new laboratory for calibrating instruments measuring Rn-222 and Rn-220 in air was taken in use.

STUK's staff in the gamma-ray spectrometry team and in radon measurement metrology in 2019 were:

Scientists	**Function**
R.Pöllänen	Gamma-ray spectrometry calibrations, efficiency determination, uncertainty budget, quality management, spectrum analysis, environmental surveillance, activity measurement services, upkeep of accreditation, development of comprehensive laboratory information management system.
V-P.Vartti	
J.Turunen	
A.Vainonen	
T.Karhunen	
T.Torvela	
A.Kallio	
A-P.Leppänen	
T.Turtiainen	Rn-222 and Rn-220 in air calibrations, quality management, equipment maintenance, research
Technicians	
R.Simola	Equipment maintenance, measurements from environmental samples
M.Teräväinen	

The main specific activities carried out at STUK in the abovementioned fields are summarised below.

Activity line	**STUK Radionuclide Metrology 2018-2019 Progress report**	**STUK Radionuclide Metrology 2020-2021 Work plan**
Improvement of measuring methods and instrumentation	• Development of alpha/beta-gamma coincidence measurements with list mode data acquisition • Development of Compton suppression equipment • Environmental parameters control in Rn-222 calibrations • Rn-220 reference atmosphere • A new cross-interference test between radon isotopes	• Alpha/beta-gamma coincidence equipment in operation with list mode data acquisition • Compton suppression equipment with list mode data acquisition in operation • Reducing humidity fluctuations in Rn-222 atmosphere • Validating test for determination of response time by Rn-222 measuring instruments

Activity line	**STUK** **Radionuclide Metrology 2018-2019 Progress report**	**STUK** **Radionuclide Metrology 2020-2021 Work plan**
International comparisons	• IAEA-RML (seawater, 2018) • CTBTO PTE intercomparisons (air filter, 2018 and 2019) • NKS-intercomparison (sediment and drinking water, 2018) • Reactor water intercomparisons (2018 and 2019) • Intercomparison (Rn-222) in 2018 in MetroRadon Project (Euramet/EMPIR) • Intercomparison (Rn-222) in 2019 in MetroRadon Project (Euramet/EMPIR)	• Participation in 4-5 intercomparisons per year. • Intercomparison (Rn-222) in the Nordic Countries (Nordic-Nat WG)
Standardization of measurement methods	• Development of methods for efficiency calibration • Cross-interference between Rn isotopes testing	• New EFFTRAN-based calibration method for environmental samples • Response time testing
National QA programmes and services	• Upkeep of FINAS accreditation • Calibration services	• Upkeep of FINAS accreditation
Membership in international and national organisations	• ICRM committee membership • Membership in MIRA and SupportBSS projects	• Strengthening the ICRM committee membership
Management and Organisation	• New chapters for in-house guide (Radon reference atmosphere manual)	• New chapters for in-house guide (Radon reference atmosphere manual)
Teaching activity		• Lecture courses given • Invited lectures • Course for radon measurers
Quality system	• Improvements of quality system according to ISO 17025:2017	• Continuation of improvements of the quality system according ISO 17025

LABORATORY	Radiation and Nuclear Safety Authority (STUK), Department of Environmental Surveillance and Measurement, Finland
NAMES	R.Pöllänen, V-P.Vartti, J.Turunen, A.Vainonen, T.Karhunen, T.Torvela, A.Kallio, A-P.Leppänen, T.Turtiainen
ACTIVITY	Gamma-ray spectrometry from environmental samples. Rn-222 and Rn-220 activity concentration in air.
KEYWORDS	gamma-ray spectrometry, (anti) coincidence method, cryogenic detector, data evaluation, data measurement, defined solid angle (ASD) measurement, environmental control, life sciences, low-level, well-type counter, simulation code, source preparation, traceability, radionuclide by name. Rn-222 in air, Rn-220 in air.
RESULTS	A well-type HPGe detector was taken into operation. Thorough efficiency calibration performed. Reference ionization chamber for measuring Rn-220 in air was calibrated against the primary standard (LNHB) and Rn-220 atmosphere was validated for its homogeneity.
PUBLICATIONS	-
IN PROGRESS	Development of alpha/beta-gamma coincidence measurements with list mode data acquisition and development of Compton suppression equipment with list mode data acquisition. New method for sample height and density corrections are under development. Developing and validating a test for determination of response time by instruments measuring Rn-222 in air.
INFORMATION	-
SOURCE IN PREPARATION	-
OTHER RELATED PUBLICATIONS	-
ADDRESS	Radiation and Nuclear Safety Authority, Laippatie 4, P.O.Box 14, FI-00881 Helsinki, Finland e-mail: roy.pollanen@stuk.fi
CONTACT	Roy Pöllänen

Announcements:
Upcoming seminar:
NKS seminar on gamma-ray spectrometry will be held in STUK at 8-10 September 2020.

LNE-LNHB Radionuclide Metrology
2018-2021 Progress Report and Work Plan
(information for ICRM members)

LNE – Laboratoire National Henri Becquerel (LNHB), France, SA1/SA2

The programme at the Laboratoire National Henri Becquerel (LNE-LNHB) in the field of radionuclide metrology in the years 2017-2019 was on maintaining and developing the primary and secondary national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

The LNE-LNHB staff in 2018-2019 were:

Scientists	**Function**
I. Aubineau-Lanièce	Head of LNE-LNHB
M.A. Kellett	Head of the Radioactivity Metrology Laboratory
C. Bobin, C. Thiam	Primary activity standards
V. Chisté	Secondary activity standards (dose calibrators)
B. Sabot	Environmental studies, low-level measurements
P. Cassette*, C. Bobin, Y. Kergadallan, B. Sabot	Liquid scintillation counting
M.-C. Lépy, B. Sabot	Gamma spectrometry
S. Pierre, M. Loidl	Alpha spectrometry
S. Pierre, B. Sabot	Radon standards
C. Thiam, P. Cassette*	Neutron standards
V. Lourenço, M. Corbel	Source preparation/radiochemistry
M. Rodrigues	Proportional gas counters
X. Mougeot, A. Singh (PhD student)	Beta spectrometry and theory, Data evaluation
M.A. Kellett	Data evaluation
C. Dulieu	Data dissemination, web development
M. Loidl, M. Rodrigues	Metallic Magnetic Calorimeters for beta, X, electron capture and Q spectrometry
Y. Ménesguen	X-ray spectrometry and analysis techniques
Technicians	
L. Brondeau, M. Cardot-Martin	Secondary activity standards (dose calibrators)
S. Morelli, D. Lacour	Source preparation/radiochemistry

* P. Cassette retired at the end of 2019 after more than 30 years at the LNE-LNHB

The main specific activities carried out at LNE-LNHB in this field are summarised below.

Activity line	**LNE-LNHB** **Radionuclide Metrology 2018 - 2019 Progress report**	**LNE-LNHB** **Radionuclide Metrology 2020 - 2021 Work plan**

Development of primary standards, Improvement of measuring	• Development of new primary standards: *At-211*
	• Interface for digital counting systems
	• Nuclear Data measurements: *Nd-147, Pd-103*
		• Participation in EMPIR Projects :
		  • AeroMet2
		  • MetroMMC
		  • AeroMet, HyMet,

Activity line	**LNE-LNHB** **Radionuclide Metrology 2018 - 2019 Progress report**	**LNE-LNHB** **Radionuclide Metrology 2020 - 2021 Work plan**
methods and instrumentation	• Participation in EMPIR Projects : • MetroMMC • AeroMet, HyMet, MetroDecomII, MetroRadon • MetroBeta, MRTDosimetry	MetroDecomII, MetroRadon
International comparisons	• CCRI(II) comparison on Fe-55 • EURAMET comparison on Rn-222 • EURAMET comparison on Ho-166 • CCRI(II) comparison on AmBe	• BIPM comparison Zn-65 • CCRI(II) comparison on Sn-113 • CCRI(II) comparison on Cf-252 • BIPM comparison Cd-109
Standardization of measurement methods	• Portable TDCR system • Accurate self-absorption correction in gamma-ray spectrometry • New use of digital electronics or detectors	• Portable TDCR system – measurements *in situ* • Radon gas standard
National QA programmes and services	• Preparation of radioactive standards (liquid solutions, point sources) for external users • Calibration services for external users • Calibration of the activity in samples used for comparisons • Organisation of 8 Proficiency Tests for activity measurements	• Preparation of radioactive standards (liquid solutions, point sources) for external users • Calibration services for external users • Calibration of the activity in samples used for comparisons • Organisation of Proficiency Tests for activity measurements
Membership in international and national organisations	• ICRM committee membership • BIPM/CCRI(II), BIPM/CCRI(III), EURAMET TC-IR, IAEA, ISO • BNEN/AFNOR, COFRAC, CETAMA, SFPM • DDEP, JEFF	• ICRM committee membership • BIPM/CCRI(II), BIPM/CCRI(III), EURAMET TC-IR, IAEA, ISO • BNEN/AFNOR, COFRAC, CETAMA, SFPM • DDEP, JEFF
Management and Organisation	• European Projects: • MetroBeta (project coordinator, leader 2 WPs) • MRTDosimetry (leader 1 WP) • HyMet (leader 1 WP) • MetroMMC (leader 2 WPs)	• European Projects: • MetroMMC (leader 2 WPs)
Teaching activity	• Lecture courses given (~100 h) • Invited lectures	• Lecture courses to be given (~100 h) • Invited lectures
Quality system	• Update of the Quality System according to the new ISO 17025:2017 and external audit	• Internal and external audits planned

LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Martin Loidl, Matias Rodrigues
ACTIVITY	Cryogenic detectors: Metallic Magnetic Calorimeters (MMCs)
KEYWORDS	Cryogenic detectors; Metallic Magnetic Calorimeters; High energy resolution; Beta spectrometry; Electron capture probabilities; X-ray spectrometry, Total decay energy spectrometry
RESULTS	High energy resolution beta spectra of ^{14}C, ^{151}Sm, ^{99}Tc High energy resolution X-ray spectra of ^{238}Pu, ^{239}Pu, ^{244}Cm, ^{233}U, ^{237}Np and ^{233}Pa
PUBLICATIONS	M. Loidl *et al*., *MetroBeta: Beta Spectrometry with Metallic Magnetic Calorimeters in the Framework of the European Program of Ionizing Radiation Metrology*, J. Low Temp. Phys. 193 (2018) 1251-1256, https://doi.org/10.1007/s10909-018-1933-0 M. Loidl *et al*., *Beta Spectrometry with Metallic Magnetic Calorimeters in the Framework of the European EMPIR project MetroBeta*, Appl. Rad. Isot. 153 (2019) 108830; https://doi.org/10.1016/j.apradiso.2019.108830 M. Loidl *et al*., *Precision Measurements of Beta Spectra using Metallic Magnetic Calorimeters within the European Metrology Research Project MetroBeta*, J. Low Temp. Phys. (2019); https://doi.org/10.1007/s10909-020-02398-2 Mariam, R., Rodrigues, M. & Loidl, M. *Full-Energy Peak Efficiency Calibration of a Metallic Magnetic Calorimeter Detector for Photon Spectrometry Below 100 keV*. J Low Temp Phys 193, 1269–1275 (2018). https://doi.org/10.1007/s10909-018-2001-5 Mariam, R., Rodrigues, M., Loidl, M. *Determination of L-X-ray line emission intensities in the decay of Cm-244 with a metallic magnetic calorimeter*. Nucl. Instrum. Methods Phys. Res. A 954,162066. (2020) https://doi.org/10.1016/j.nima.2019.04.020 Rodrigues, M., Laarraj, M., Loidl, M. et al. *Development of Total Decay Energy Spectrometry of α-Emitting Radionuclides Using Metallic Magnetic Calorimeters*. J Low Temp Phys 193, 1263–1268 (2018). https://doi.org/10.1007/s10909-018-2008-y
IN PROGRESS	MMC measurements of: - High energy resolution beta spectrum of ^{36}Cl - Fractional electron capture probabilities of ^{54}Mn, ^{59}Ni, ^{109}Cd, ^{125}I - X-ray emission probabilities of ^{54}Mn, ^{59}Ni, ^{65}Zn, ^{109}Cd, ^{125}I
INFORMATION	Measurements of electron capture and beta decaying radionuclides (Results + In progress) have been / are being performed in the framework of the EMPIR projects 15SIB10 MetroBeta (2016-2019); 17FUN02 MetroMMC (2018-2021) Measurements of X-ray spectra emitted by actinides were performed during the PhD thesis of Riham Mariam.

SOURCE IN PREPARATION	- ^{54}Mn by electroplating - ^{109}Cd and ^{125}I sources for X-ray spectrometry - source preparation for Q-spectrometry using a nanodrop dispenser
OTHER RELATED PUBLICATIONS	M. Paulsen *et al., Development of a Beta Spectrometry Setup using Metallic Magnetic Calorimeters*, Journal of Instrumentation 14 (2019) P08012, https://doi.org/10.1088/1748-0221/14/08/P08012 L. Bockhorn *et al., Improved source/absorber preparation for radionuclide spectrometry based on low-temperature calorimetric detectors*, J. Low Temp. Phys. (2019), https://doi.org/10.1007/s10909-019-02274-8 P. C.-O. Ranitzsch *et al., MetroMMC: Electron-capture spectrometry with cryogenic calorimeters for science and technology*, J. Low Temp. Phys. (2019), https://doi.org/10.1007/s10909-019-02278-4 R. Mariam, PhD Thesis (in French). *Détermination des intensités absolues d'émission XL d'actinides à l'aide d'un calorimètre métallique magnétique de haute résolution.* Instrumentations et Détecteurs [physics.ins-det]. Université Paris-Saclay, 2019. ⟨NNT : 2019SACLS091⟩. ⟨tel-02168031⟩
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Benoit Sabot, Matias Rodrigues, Sylvie Pierre
ACTIVITY	Noble gases
KEYWORDS	Krypton; Metrology; Radioactive gas; Radon; Tritium; Xenon
RESULTS	New setup for the production of reference atmospheres.
PUBLICATIONS	Sabot B., Rodrigues M., Pierre S., Experimental facility for the production of reference atmosphere of radioactive gases (Rn, Xe, Kr, and H isotopes). Appl Radiat Isot. 2020 Jan;155:108934. doi: 10.1016/j.apradiso.2019.108934. Epub 2019 Oct 10.
IN PROGRESS	Participation in: MetroRADON EMPIRE project, SPARTE FET projects, CDTX, DORN, FOCUS Dem
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	B. Sabot, Calibration of Thoron (^{220}Rn) Activity Concentration Monitors, PhD thesis NNT: 2015SACLS122 (2015), http://www.theses.fr/2015SACLS122 B. Sabot, S. Pierre, P. Cassette, An absolute radon 222 activity measurement system at LNE-LNHB Appl. Radiat. Isot., 118 (2016), pp. 167-174, 10.1016/j.apradiso.2016.09.009 B. Sabot, S. Pierre, N. Michielsen, S. Bondiguel, P. Cassette, A new thoron atmosphere reference measurement system Appl. Radiat. Isot., 109 (2016), pp. 205-209, 10.1016/j.apradiso.2015.11.055
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	X. Mougeot
ACTIVITY	Beta spectrometry
KEYWORDS	Beta spectrometry, Nuclear decay data, Theoretical calculations of weak interaction decays.
RESULTS	The first version of BetaShape, a new code for improved calculations of beta spectra, was released during 2016. The main features of this code include improved theoretical modelling of beta decays, a database of experimental shape factors, the provision of mean energies and logft-values, as well as beta and neutrino spectra, the ability to interface with ENSDF files, and the propagation of the uncertainties from the input data. It is already being used by the DDEP (Decay Data Evaluation Project) international collaboration for decay data evaluations. The developments since then have been implemented in a new version of the code. The radiative corrections have been modified from the previous modelling developed in the 1970s to an accurate and modern model developed in the context of the high-precision study of super-allowed beta decays. In addition, the treatment of the uncertainty propagation has been modified in the case of a lack of uncertainty information in the input file since the previous treatment led to unrealistic values. The database of experimental shape factors has been updated for the ^{36}Cl and ^{138}La beta minus transitions, and the ground-state-to-ground-state beta plus transition occurring in ^{14}O decay has been added. The calculation of electron capture transitions has also been included in the BetaShape code. An improved modelling of electron captures for allowed and forbidden unique transitions has been developed starting from scratch, based on Behrens and Bühring formalism. Relativistic wave functions of the atomic electrons are calculated using an iterative procedure with a convergence to precise atomic orbital energies, taken from a modelling based on the Relativistic Local Density Approximation that includes electron correlations. These energies have been interpolated from Z=92 to Z=120 and parameters have been tabulated to drastically speed up the calculation of the wave functions. These wave functions are used to calculate every overlap needed for additional corrections. The two common approaches from Bahcall and Vatai to correct for the atomic overlap and exchange effects have been extended to every subshell in a unified formulation, with the electron occupation precisely taken into account. The shake-up and shake-off effects, which create secondary vacancies, and the influence of the hole due to the capture process, have been considered. Radiative corrections based on Coulomb-free theory have been included. Uncertainties are also estimated. The BetaShape code then provides relative capture probabilities and their ratios, including capture-to-positron ratios, for every subshell. The splitting of the branch between electron capture and beta plus decays and the logft-value are also given. A comparison with different precise measurements available in the literature has highlighted good agreement and consistent results, validating this modelling. Another ongoing work is related the treatment of forbidden non-unique weak interaction decays, for which the inclusion of the nuclear structure component in the calculations is mandatory. A preliminary code has been validated using simple nucleon wave functions determined from a naive shell model considering both non-relativistic and relativistic harmonic oscillator solutions. Theoretical shape factors and partial half-lives of about twenty beta transitions, allowed and forbidden, have been calculated and compared to measurements. This work has to be considered as the very first step as only single particle nuclear matrix elements are calculated in spherical symmetry. However, it lays the foundations of future

	work for accurate calculations with nuclear wave functions from precise nuclear structure models.
PUBLICATIONS	X. Mougeot, *Towards high-precision calculation of electron capture decays*, Applied Radiation and Isotopes 154, 108884 (2019).
IN PROGRESS	1. Inclusion of many-particle configuration mixing in the calculation of the nuclear matrix elements. 2. High-precision calculations of electron capture decays and atomic parameters within the EMPIR project MetroMMC (2018-2021).
INFORMATION	1. The second version of the BetaShape program is available on the LNHB website through executables for Windows and Linux. 2. This new version was presented at the IAEA to the NSDD network in April 2019 and at BNL to the USNDP network during the Nuclear Data Week in November 2019. Discussions are ongoing for substituting the LogFT code by BetaShape for ENSDF decay data evaluations.
OTHER RELATED PUBLICATIONS	1. L. Hayen, N. Severijns, K. Bodek, D. Rozpedzik, X. Mougeot, *High precision analytical description of the allowed β spectrum shape*, Reviews of Modern Physics 90 (1), 015008 (2018). 2. R. Sandler, G. Bollen, J. Dissanayake, M. Eibach, K. Gulyuz, A. Hamaker, C. Izzo, X. Mougeot, D. Puentes, F.G.A. Quarati, M. Redshaw, R. Ringle, I. Yandow, *Direct determination of ^{138}La β–decay Q value using Penning trap mass spectrometry*, Physical Review C 100, 014308 (2019).
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CONTACT	Xavier Mougeot

LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	C. Dulieu, M.A. Kellett, Y. Kergadallan, X. Mougeot
ACTIVITY	Evaluation and Dissemination of Radionuclide Decay Data
KEYWORDS	Data evaluation, DDEP
RESULTS	Coordination of the Decay Data Evaluation Project (DDEP) and review of evaluations Maintenance of the website and decay data evaluation distribution page, including the addition of beta spectra calculated with the BetaShape code: http://www.lnhb.fr/nuclear-data/nuclear-data-table/ Continual improvements to the α/γ spectrometry website (Laraweb): http://www.lnhb.fr/nuclear-data/module-lara/
PUBLICATIONS	A. Luca, M. A. Kellett, "A new evaluation of the nuclear decay data of 223Ra". Proceedings of International Conference on Nuclear Data for Science and Technology (ND 2019; Beijing, China; 19-24 May 2019). In EPJ Web of Conferences 239, 23002 (2020). [DOI:10.1051/epjconf/202023923002] F. T. Tárkányi, A. V. Ignatyuk, A. Hermanne, R. Capote, B. V. Carlson, J. W. Engle, M. A. Kellett, T. Kibedi, G. N. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takács, M. Verpelli, "Recommended nuclear data for medical radioisotope production: diagnostic gamma emitter", Journal of Radioanalytical and Nuclear Chemistry 319, 487-531 (2019) [DOI:10.1007/s10967-018-6142-4] J. W. Engle, A. V. Ignatyuk, R. Capote, B. V. Carlson, A. Hermanne, M. A. Kellett, T. Kibedi, G. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takacs, F. T. Tarkanyi, M. Verpelli, "Recommended nuclear data for the production of selected therapeutic radionuclides", Nuclear Data Sheets 155, 56-74 (2019) [DOI:10.1016/j.nds.2019.01.003] F. T. Tárkányi, . V. Ignatyuk, A. Hermanne, R. Capote, B. V. Carlson, J. W. Engle, M. A. Kellett, T. Kibédi, G. N. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takács, M. Verpelli, "Recommended nuclear data for medical radioisotope production: diagnostic positron emitters", Journal of Radioanalytical and Nuclear Chemistry 319, 533-666 (2019) [DOI:10.1007/s10967-018-6380-5] A. Hermanne, A. V. Ignatyuk, R. Capote, B. V. Carlson, J. Engle, M. A. Kellett, T. Kibédi, G. Kim, F. G. Kondev, M. Hussain, O. Lebeda, A. Luca, Y. Nagai, H. Naik, A. L. Nichols, F. M. Nortier, S. V. Suryanarayana, S. Takács, F. T. Tárkányi, M. Verpelli, "Reference cross sections for charged-particle monitor reactions", Nuclear Data Sheets 148, 338-382 (2018). [DOI:10.1016/j.nds.2018.02.009] E. García-Toraño, T. Altzitzoglou, P. Auerbach, M.-M. Bé, C. Bobin, P. Cassette, F. Chartier, R. Dersch, M. Fernández, H. Isnard, K. Kossert, V. Lourenço, O. Nähle, A. Nonell, V. Peyrés, S. Pommé, A. Rozkov, A. Sánchez-Cabezudo, J. Sochorová, "The half-life of 129I", Applied Radiation and Isotopes 140, 157-162 (2018). [DOI:10.1016/j.apradiso.2018.06.007]
IN PROGRESS	Training of our new evaluator Yann Kergadallan Recruitment of a second evaluator, expected arrival September 2020

	C. Thiam, C. Dulieu, X. Mougeot, A. Nair, C. Bobin, M. Kellett, "Nuclide++: A C++ module to include DDEP recommended radioactive decay Data in Geant4", accepted in Applied Radiation and Isotopes M.A. Kellett, L. Vio, C. Bobin, L. Brondeau, M. Cardot-Martin, H. Isnard, D. Lacour, M.-C. Lépy, V. Lourenço, M. Marie, C. Thiam, "Measurement of the absolute gamma-ray emission intensities from the decay of 147Nd", accepted in Applied Radiation and Isotopes J. Riffaud, P. Cassette, M. Corbel, M.-C. Lépy, V. Lourenço, M. Kellett, "Measurement of the absolute gamma-ray emission intensities from the decay of 103Pd", accepted in Applied Radiation and Isotopes A. J. M. Plompen, O. Cabellos, C. De Saint Jean, M. Fleming, A. Algora, M. Angelone, P. Archier, E. Bauge, O. Bersillon, A. Blokhin, F. Cantargi, A. Chebboubi, C. Diez, H. Duarte, E. Dupont, J. Dyrda, B. Erasmus, L. Fiorito, U. Fischer, D. Flammini, D. Foligno, M. R. Gilbert, J. R. Granada, W. Haeck, F.-J. Hambsch, P. Helgesson, S. Hilaire, I. Hill, M. Hursin, R. Ichou, R. Jacqmin, B. Jansky, C. Jouanne, M. A. Kellett, D. H. Kim, H. I. Kim, I. Kodeli, A. J. Koning, A. Y. Konobeyev, S. Kopecky, B. Kos, A. Krása, L. C. Leal, N. Leclaire, P. Leconte, Y. O. Lee, H. Leeb, O. Litaize, M. Majerle, J. I. Márquez Damián, F. Michel-Sendis, R. W. Mills, B. Morillon, G. Noguère, M. Pecchia, S. Pelloni, P. Pereslavtsev, R. J. Perry, D. Rochman, A. Röhrmoser, P. Romain, P. Romojaro, D. Roubtsov, P. Sauvan, P. Schillebeeckx, K. H. Schmidt, O. Serot, S. Simakov, I. Sirakov, H. Sjöstrand, A. Stankovskiy, J. C. Sublet, P. Tamagno, A. Trkov, S. van der Marck, F. Álvarez-Velarde, R. Villari, T. C. Ware, K. Yokoyama, G. Žerovnik, "The joint evaluated fission and fusion nuclear data library, JEFF-3.3", accepted in European Physical Journal A
INFORMATION	Coordination and production of the final reporting for the EMPIR project MetroBeta (Radionuclide beta spectra metrology) and WP1 leader – project ended June 2019 Visit of Xiaolong Huang (CNDC, China), July 2019
OTHER RELATED PUBLICATIONS	"Monographie BIPM-5 – Table of Radionuclides, Volume 8 (2016)", Marie-Martine Bé, Vanessa Chisté, Christophe Dulieu, Mark A. Kellett, Xavier Mougeot, Valery Chechev, Xiaolong Huang, Baosong Wang, Aurelian Luca, Alan L. Nichols, CEA/LNE-LNHB, 91191 Gif-sur-Yvette, France and BIPM, Pavillon de Breteuil, 92312 Sèvres, France. "Mini Table de radionucléides – Mini Table of Radionuclides 2015", EDP Sciences, ISBN: 978-2-7598-1186-1 For further information, see: http://www.lnhb.fr/conferences-publications/lnhb-publications/ or http://laboutique.edpsciences.fr/produit/781/9782759811861/Mini%20Table%20de%20radionucleides%202015
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Sylvie Pierre, Cheick Thiam, Philippe Cassette, Xavier Mougeot, Abhilasha Singh.
ACTIVITY	Radon, Thoron
KEYWORDS	Ionization chamber, Monte Carlo simulation, PENELOPE, Radionuclide metrology, Radon.
RESULTS	
PUBLICATIONS	Pierre S., et al., 2019. Simulation of the response of an ionization chamber to ^{214}Bi emission and its application to the measurement of ^{222}Rn. Appl. Radiat. Isot. 154, 108886.
IN PROGRESS	Participation in MetroRADON project
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Christophe Bobin, Cheick Thiam
ACTIVITY	Primary activity standards, nuclear instrumentation, digital instrumentation
KEYWORDS	(anti) coincidence, liquid scintillation counting, well-type NaI(Tl) counting, nuclear and digital instrumentation, Monte Carlo simulation code, automatic γ-spectrum analysis
RESULTS	
PUBLICATIONS	C. Bobin, J. Bouchard, V. Chisté, S.M. Collins, P. Dryák, A. Fenwick, J. Keightley, M.-C. Lépy, V. Lourenço, A.P. Robinson, J. Sochorová, J. Šolc, C. Thiam, "Activity measurements and determination of nuclear decay data of ^{166}Ho in the MRTDosimetry project", Applied Radiation and Isotopes 153 (2019). S. Jerome, C. Bobin, P. Cassette, R. Dersch, R. Galea, H. Liu, A. Honig, J. Keightley, K. Kossert, J. Liang, M. Marouli, C. Michotte, S. Pommé, S. Röttger, R. Williams, M. Zhang, "Half-life determination and comparison of activity standards of Pa-231", Applied Radiation and Isotopes 155 (2020). J. Xu, A. de Vismes Ott, J. Bobin, C. Bobin, "Sparse spectral unmixing for activity estimation in γ-RAY spectrometry applied to environmental measurements", Applied Radiation and Isotopes 156 (2020). H. Paradis, C. Bobin, J. Bobin, J. Bouchard, V. Lourenço, C. Thiam, R. André, L. Ferreux, A. de Vismes Ott, M. Thevenin, 2019. Spectral unmixing applied to fast identification of gamma-emitting radionuclides using NaI(Tl) detectors. Applied Radiation and Isotopes 158 (2020). C. Thiam, C. Dulieu, X. Mougeot, A. Nair, C. Bobin, M.A. Kellett, 2019. Nuclide++: A C++ module to include DDEP recommended radioactive decay Data in Geant4. Applied Radiation and Isotopes 154 (2019). M.A. Kellett, L. Vio, C. Bobin, L. Brondeau, M. Cardot-Martin, H. Isnard, D. Lacour, M.-C. Lépy, V. Lourenço, M. Marie, C. Thiam, "Measurement of the absolute gamma-ray emission intensities from the decay of ^{147}Nd", In press Applied Radiation and Isotopes (2020). S. PIERRE, C. THIAM, P. CASSETTE, X. MOUGEOT, A. SINGH "SIMULATION OF THE RESPONSE OF AN IONIZATION CHAMBER TO ^{214}BI EMISSION. APPLICATION TO THE MEASUREMENT OF ^{220}RN", APPLIED RADIATION AND ISOTOPES 154 (2019). M. LÉPY, C. THIAM, M. ANAGNOSTAKIS, R. GALEA, D. GURAU, S. HURTADO, K. KARFOPOULOS, J. LIANG, H. LIU, A. LUCA, I. MITSIOS, C. POTIRIADIS, M. SAVVA, T. THANH, V. THOMAS, R. TOWNSON, D. VASILOPOULOU, M. ZANG, "A BENCHMARK FOR MONTE CARLO SIMULATION IN GAMMA-RAY SPECTROMETRY", APPLIED RADIATION AND ISOTOPES 154 (2019).
OTHER RELATED PUBLICATIONS	A. Sari, C. Thiam, K. Boudergui, F. Carrel, R. Coulon, J. Dumazert, C. Frangville, H. Hamrita, F. Lainé, M. Trocmé, B. Krausz, R. Pissarello, R. Delalez, 2020. Investigation of fission chamber response in the frame of fuel debris localization measurements at Fukushima Daiichi. Radiation Measurements. Radiation Measurements 130 (2020).

	J. Dumazert, R. Coulon, F. Carrel, A.Sari, C. Thiam, M. Trocmé, Q. Lecomte, H. Hamrita, R. Woo, F. Lainé, C. Frangville, M. Bakkali, K. Boudergui, B. Krausz, R. Pissarello, R. Delalez, 2019. Inverse Problem Approach for the underwater localization of Fukushima Daiichi fuel debris with fission chambers. Nuclear Inst. and Methods in Physics Research, A 954 (2020).
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Valérie Lourenço, Margot Corbel, Sophie Morelli, Didier Lacour
ACTIVITY	Source preparation for all measurement techniques. Teaching activities on source preparation. Radiochemical separations or dissolution. Organisation of national and international proficiency tests in the field of activity measurements (from low-level to high-level activity measurements), http://www.lnhb.fr/services/pti/ The group is involved in EMPIR & H2020 Projects:
KEYWORDS	Sources preparation, radiochemistry, proficiency tests
RESULTS	Preparation of standard solutions of beta/gamma emitters for validation of radiochemical separation process in national measurement laboratories. Development of reference materials representative of dismantling samples either by spiking or by characterized sampling. Development of traceable radioactive surrogate sealed resin test sources with ^{133}Ba or ^{68}Ge/Ga to be used for quality control for SPECT and PET-CT systems. Fabrication of emanation sources of ^{220}Rn and ^{222}Rn by coprecipitation. Preparation of thin sources of beta emitters (^{14}C, ^{36}Cl, ^{60}Co, ^{63}Ni, ^{99}Tc, ^{109}Cd, ^{151}Sm, ^{204}Tl and ^{207}Bi) to improve beta spectra, in the framework of a PhD. Preparation of electrodeposited sources of alpha emitters (^{233}U, ^{237}Np) for MMC measurements.
PUBLICATIONS	Metrological characterization of the GAMPIX gamma camera (DOI: 10.1016/j.nima.2019.162568) Weighing uncertainties in quantitative source preparation for radionuclide metrology (DOI: 10.1088/0026-1394/52/3/S18) Primary standardization of SIR-Spheres based on the dissolution of the Y-90-labeled resin microspheres (DOI: 10.1016/j.apradiso.2014.12.024)
IN PROGRESS	Postdoctoral position (12 months) to develop a representative test surface of one cubic meter to characterize the performances of surface contamination detectors
INFORMATION	The proficiency tests programme is available at: http://www.lnhb.fr/services/pti/
SOURCE IN PREPARATION	Fabrication of surface sources relevant for decommissioning and dismantling of nuclear facilities.
OTHER RELATED PUBLICATIONS	Measurement of absolute K X-ray emission intensities in the decay of Rh-103m (DOI: 10.1016/j.apradiso.2017.10.003) Determination of X- and gamma-ray emission intensities in the decay of I-131 (DOI: 10.1016/j.apradiso.2015.11.091)
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Laurine Brondeau, Sylvie Pierre, Benoît Sabot, Marie-Christine Lépy
ACTIVITY	Gamma-ray and X-ray spectrometry
KEYWORDS	Gamma-ray spectrometry, simulation code, X-ray spectrometry
RESULTS	Efficiency calibration of HPGe detectors with about 0.5% uncertainties for point sources and 1% for volume sources in different activity ranges Calibration for gas measurements in volume geometries Measurement of absolute photon emission intensities for different radionuclides
PUBLICATIONS	Measurement of the absolute gamma-ray emission intensities from the decay of ^{103}Pd, J. Riffaud, P. Cassette, M. Corbel, M.-C. Lépy, V. Lourenço, M.A. Kellett (presented at ICRM2019 – to be published in ARI)
IN PROGRESS	Calibration of HPGe detector in the low-energy range – Consistency of the calibration database Self-fluorescence correction for X-ray low-energy emitters in metallic samples (reactor dosimetry)
INFORMATION	PUFI: software to prepare geometry files for PENELOPE
SOURCE IN PREPARATION	Evaluation of the decay scheme of ^{103}Pd
OTHER RELATED PUBLICATIONS	
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LABORATORY	LNE – Laboratoire National Henri Becquerel (LNHB), France
NAMES	Yves Ménesguen, Marie-Christine Lépy
ACTIVITY	X-ray spectrometry
KEYWORDS	X-ray spectrometry, Atomic data
RESULTS	Measurement of linear attenuation coefficients and fluorescence yields of several elements Development of a grazing incidence X-ray fluorescence setup for reference-free X-ray analysis
PUBLICATIONS	Experimental and theoretical determination of the L-fluorescence yields of bismuth, *Y. Ménesguen, M.-C. Lépy et al*., Metrologia 55 (2018), 621-630 A combined experimental and theoretical approach to determine X-ray atomic fundamental quantities of tin, *Y. Ménesguen, M.-C. Lépy et al*., X-Ray Spectrometry, 2018, 1-11 Advances in the measurements of the mass attenuation coefficients, *Y. Ménesguen, C. Dulieu, M.-C. Lépy*, X-Ray Spectrometry 2018; 0:1-6 Grazing incident X-ray fluorescence combined with X-ray reflectometry metrology protocol of telluride-based films using in-lab and synchrotron instruments, *W. Pessoa, Y. Ménesguen, M.-C. Lépy et al*., Spectrochimica Acta Part B 149 (2018), 143-149 Precise x-ray energies of gadolinium determined by a combined experimental and theoretical approach, *Y. Ménesguen, M.-C. Lépy et al*., Journal of Quantitative Spectroscopy & Radiative Transfer, Vol. 236 (2019), 106585
IN PROGRESS	Update of the COLEGRAM peak processing software Quantification of material traces by X-ray Fluorescence
INFORMATION	Silicon Drift (SDD) X-ray tube (20-88 keV) In-lab tunable monochromatic X-ray source (0.6-28 keV) (SOLEX) Synchrotron beam line (0.05-35 keV) (SOLEIL)
SOURCE IN PREPARATION	Measurement of mass attenuation coefficients, fluorescence yields Development of wavelength-dispersive spectrometer (Ph D thesis work)
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CONTACT	Yves Ménesguen

LABORATORY	Physikalisch-Technische Bundesanstalt (PTB), Germany
NAMES	Karsten Kossert, Ole Nähle, Nataša Lalović, Lina Bockhorn, Dirk Arnold, Marcell Takács, Philipp Ranitzsch et al.
ACTIVITY	R&D in liquid scintillation counting; activity determination by means of ionization chambers; R&D in coincidence counting, measurement of nuclear decay data
KEYWORDS	Decay data measurement; ionisation chambers; life sciences; liquid scintillation; several comparisons, metallic magnetic calorimeters (MMCs), coincidence counting, anti-coincidence counting
RESULTS	Activity standardization and determination of decay data for various radionuclides
PUBLICATIONS	1. *Kossert, K., Marganiec-Gałązka, J., Mougeot, X., Nähle, O.J.*: **Activity determination of ^{60}Co and the importance of its beta spectrum,** Applied Radiation and Isotopes 134 (2018) 212-218. 2. *Marganiec-Gałązka, J., Nähle, O.J., Kossert, K.*: **Activity determination of ^{68}Ge/^{68}Ga by means of 4π(Č)β-γ coincidence counting,** Applied Radiation and Isotopes 134 (2018) 240-244. 3. *Nähle, O.*: **Activity determination of ^{67}Ga using 4πβ–γ coincidence counting,** Applied Radiation and Isotopes 134 (2018) 286-289. 4. *Cassette, Ph., Altzitzoglou, T., Antohe, A., Rossi, M., Arinc, A., Capogni, M., Galea, R., Gudelis, A., Kossert, K., Lee, K.B., Liang1, J., Nedjadi, Y., Oropesa Verdecia, P., Shilnikova, T., van Wyngaardt, F., Ziemek, T., Zimmerman, B.:* **Results of the CCRI(II)-S12.H-3 supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated-water source measured using the LSC-TDCR method.** Applied Radiation and Isotopes 134 (2018) 257-262. 5. *Cessna, J.T., Fitzgerald, R., Zimmerman, B.E., Laureano-Pérez, L., Bergeron, D.E., van Wyngaardt, F., Smith, M., Jackson, T., Howe, B., da Silva, C.J., Iwahara, A., da Cruz, P.A.L., Zhang, M., Liu, H., Liang, J., Frechou, C., Bobin, C., Cassette, P., Kossert, K., Nähle, O., Marganiec-Gałązka, J., Joseph, L., Ravindra, A., Kulkarni, D.N., Yunoki, A., Sato, Y., Lee, K.B., Lee, J.M., Agung, Dziel, T., Listkowska, A., Tymiński, Z., Sahagia, M., Antohe, A., Ioan, M.-H., Luca, A., Krivosek, M., Ometakova, J., Javornik, A., Zalesakova, M., Garcia-Toraño Martinez, E., Roteta, M., Mejuto, M., Nedjadi, Y., Juget, F., Yuan, M.-C., Yeh, C.Y., Yeltepe, E., Dirican, A., Keightley, J., Pearce, A.*: **Results of an International Comparison of Activity Measurements of ^{68}Ge.** Applied Radiation and Isotopes 134 (2018) 385-390. 6. *García-Toraño, E., Altzitzoglou, T., Auerbach, P., Bé, M.M., Bobin, C., Cassette, P., Chartier, F., Dersch, R., Fernández, M., Isnard, H., Kossert, K., Lourenço, V., Nähle, O., Nonell, A., Peyrés, V., Pommé, S., Rozkov, A., Sanchez-Cabezudo, A., Sochorová, J.*: **The half-life of ^{129}I**, Applied Radiation and Isotopes 140 (2018) 157-162. 7. *Loidl, M., Beyer, J., Bockhorn, L., Enss, C., Györi, D, Kempf, S., Kossert, K., Mariam, R., Nähle, O., Paulsen, M., Rodrigues, M., Schmidt, M.*: **MetroBeta: Beta Spectrometry with Metallic Magnetic Calorimeters in the Framework of the European Program of Ionizing Radiation Metrology**. Proceedings of the 17th International Workshop on Low Temperature Detectors in Journal of Low Temperature Physics 193 (2018) 1251-1256. https://doi.org/10.1007/s10909-018-1933-0, 1-6.

8. *Kossert, K., Nähle, O.J.:* **Determination of the activity and half-life of ^{227}Th**. Applied Radiation and Isotopes 145 (2019) 12-18.
9. *Takács, M. P., Kossert, K., Nähle, O. J.:* **Standardization of ^{85}Sr with digital anticoincidence counting and half-life determination of the 514 keV level of ^{85}Rb**. Applied Radiation and Isotopes 153 (2019) 108799.
10. *Paulsen, M., Beyer, J., Bockhorn, L., Enss, C., Kempf, S., Kossert, K., Loidl, M., Mariam, R., Nähle, O., Ranitzsch, P. and Rodrigues, M.:* **Development of a Beta Spectrometry Setup using Metallic Magnetic Calorimeters**. Journal of Instrumentation 14 (2019) P08012.
11. *Loidl, M., Beyer, J., Bockhorn, L., Enss, C., Kempf, S., Kossert, K., Mariam, R., Nähle, O., Paulsen, M., Ranitzsch, P., Rodrigues, M., Schmidt, M.:* **Beta Spectrometry with Metallic Magnetic Calorimeters in the Framework of the European EMPIR project MetroBeta.** Applied Radiation and Isotopes 153 (2019) 108830.
12. *Cassette, Ph., Altzitzoglou, T., Antohe, A., Rossi, M., Arinc, A., Capogni, de Felice, P., M., Galea, R., Gudelis, A., Kossert, K., Lee, K.B., Liang1, J., Nedjadi, Y., Oropesa Verdecia, P., Shilnikova, T., van Wyngaardt, F., Ziemek, T., Zimmerman, B.:* **Results of the CCRI(II)-S12.H-3 supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated-water source measured using the LSC-TDCR method.** Metrologia Techn. Suppl., Volume 56 (2019) 1A, 06005.
13. *Bockhorn, L., Paulsen, M., Beyer, J., Kossert, K., Loidl, M., Nähle, O., Ranitzsch, P.C.-O., Rodrigues, M.:* **Beta Spectrometry with Metallic Magnetic Calorimeters in the Framework of the European EMPIR project MetroBeta.** Journal of Low Temperature Physics (2019) https://doi.org/10.1007/s10909-019-02274-8.
14. *Ranitzsch, P.C.-O., Arnold, D., Beyer, J., Bockhorn, L., Bonaparte, J.J., Enss, C., Kossert, K., Kempf, S., Loidl, M., Mariam, R., Nähle, O.J., Paulsen, M., Rodrigues, M., Wegnder, M.:* **MetroMMC: Electron-capture spectrometry with cryogenic calorimeters for science and technology.** Journal of Low Temperature Physics (2019) https://doi.org/10.1007/s10909-019-02278-4.
15. *Jerome, S., Bobin, C., Cassette, P., Dersch, R., Galea, R., Haoran, L., Honig, A., Keightley, J., Kossert, K., Liang, J., Marouli, M., Michotte, C., Pommé, S., Röttger, S., Williams, R., Zhang, M.:* **Half-life determination and comparison of activity standards of ^{231}Pa.** Applied Radiation and Isotopes 155 (2020) 108837.
16. *Kossert, K.:* **TDCR measurements to determine the half-life of ^{55}Fe.** Applied Radiation and Isotopes (2020) 108931
17. *Kossert, K., Takács, M.P., Nähle, O.:* **Determination of the activity of ^{225}Ac and the half-lives of ^{213}Po and ^{225}Ac**. Applied Radiation and Isotopes 156 (2020) 109020.
18. *Michotte, C. , Ratel, G., Courte, S., Kossert, K., Nähle, O., Dersch, R., Branger, T., Bobin, C., Yunoki, A. and Sato, Y.:* **BIPM comparison BIPM.RI(II)-K1.Fe-59 of activity measurements of the radionuclide ^{59}Fe for the PTB (Germany), LNE-LNHB (France) and the NMIJ (Japan), with linked results for the APMP.RI(II)-K2.Fe-59 comparison**. Metrologia 57 (2020) Techn. Suppl., 06003.
19. *Arnold, D., Kossert, K., Nähle, O.J.:* **Calibration of Radioactive Sources**. Book chapter published in: Fleck, Titov, Grupen, Buvat (eds) "Handbook of Particle Detection and Imaging" 2nd Edition (2020), Springer Cham.
20. *Paulsen, M., Kossert, K., Beyer, J.:* **An unfolding algorithm for high resolution microcalorimetric beta spectrometry**. Nuclear Instruments and Methods in Physics Research A 953 (2020) 163128.

	21. *Cassette, Ph., Arinc, A., Capogni, M., Dutsov, Ch., Galea, R., García-Toraño, E, Kossert, K., Liang, J., Mitev, K., Nähle, O., Nedjadi, Y., Oropesa Verdecia, P., Takács, M., Ziemek, T.:* **Results of the CCRI(II)-K2. H-3 Key Comparison 2018: Measurement of the activity concentration of a tritiated-water source.** Metrologia 57 (2020) 1A, Techn. Suppl. 06004, DOI: 10.1088/0026-1394/57/1a/06004.
IN PROGRESS	Determination of long half-lives (e.g. ^{32}Si, ^{53}Mn, ^{93}Mo), determination of the half-lives of ^{213}Bi and ^{209}Pb, establishing a new extended SIR, developments of a method to allow for PMT asymmetries in TDCR system for any radionuclides, restarting measurement facilities for large-area source calibrations according to ISO 8769 (new service started already), establishing full digital data acquisition for coincidence counting with LS and PC in the beta channel, improvement of low current measurements for ionization chambers using the ULCA with considerably improved linearity
INFORMATION	Works are done with many collaborators from ICRM and outside ICRM; information about activity standards and calibration services: https://www.ptb.de/cms/en/ptb/fachabteilungen/abt6/fb-61/611-unit-of-activity.html
SOURCE IN PREPARATION	22. *Coulon, R., Broda, R., Cassette, P., Courte, S., Jerome, S., S., Judge, S., Kossert, K., Liu, H., Michotte, C., Nonis, M.:* **The international reference system for pure β-emitting radionuclides: an investigation of the long-term reproducibility of the results.** Metrologia, submitted. 23. *Kossert, K., Sabot, B., Cassette, P., Coulon, R., Liu, H.:* **On the photomultiplier-tube asymmetry in TDCR systems.** in preparation. 24. *Ziemek, T., Nähle, O. J., Kossert, K., Leschitzki, S., Takács, M. P., Broda, R., Listkowska, A., Tymiński, Z., Dziel:* **Comparison of coincidence modules for TDCR and 4π(LS)-γ coincidence counters used in POLATOM and PTB**. ICRM 2019, submitted.
OTHER RELATED PUBLICATIONS	25. *Pommé, S., Lutter, G., Marouli, M., Kossert, K., Nähle, O.*: **On the claim of modulations in radon decay and their association with solar rotation**. Astroparticle Physics 97 (2018) 38-45. 26. *Pommé, S., Stroh, H., Altzitzoglou, T., Paepen, J., Van Ammel, Kossert, K., Nähle, O., Keightley, J. D., Ferreira, Verheyen, L., Bruggemann:* **Is decay constant?** Applied Radiation and Isotopes 134 (2018) 6-12. 27. *Pommé, S., Lutter, G., Marouli, M., Kossert, K., Nähle, O.:* **A reply to the rebuttal by Sturrock et al.** Astroparticle Physics, 107 (2019) 22-25.
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LABORATORY	Physikalisch-Technische Bundesanstalt (PTB), Germany
NAMES	Dr. Janine Noordmann, Dr. Herbert Wershofen
ACTIVITY	Radionuclide determination in environmental reference materials with multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS)
KEYWORDS	Traceability of isotope ratios, environmental matrices, radiochemistry, rapid determination, reference materials, radionuclide by name (e.g. ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu), multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS)
RESULTS	
PUBLICATIONS	
IN PROGRESS	Measurements started on pure uranium reference solutions and one pure plutonium sample, which was originally an unirradiated mixed oxide fuel. The sample was delivered as a pure plutonium solution, as the laboratory has been under construction for the last ten months.
INFORMATION	Establishment of SI traceable isotope ratio measurements of uranium and plutonium is planned to implement a much faster method with a much lower relative expanded uncertainty compared to alpha spectrometry measurements.
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	*Flierl, L., Pramann, A., Noordmann, J., Roethke, A., Rienitz, O.:* **UncorK – A Monte Carlo simulation tool for calculating combined uncertainties associated with mass bias calibration factors for isotope ratio measurements**, Spectrochimica Acta Part B: Atomic Spectroscopy, 2020, submitted *Vogl, J., Brandt, B., Noordmann, J., Rienitz, O., Malinovskiy, D.:* **Characterization of a series of absolute isotope reference materials for magnesium: ab initio calibration of the mass spectrometers, and determination of isotopic compositions and relative atomic weights**, Journal of Analytical Atomic Spectrometry, 31 (2016) 1440-1458 *Noordmann, J., Weyer, S., Montoya-Pino, C., Dellwig, O., Neubert, N., Eckert, S., Paetzel, M., Böttcher, M. E.:* **Uranium and molybdenum isotope systematics in modern euxinic basins: Case studies from the central Baltic Sea and the Kyllaren fjord (Norway)**, Chemical Geology, 396 (2015) 182-195
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CONTACT	Dr. Janine Noordmann

LABORATORY	Bhabha Atomic Research Centre (BARC), India
NAMES	Leena Joseph, Anuradha Ravindra, D.B. Kulkarni
ACTIVITY	1. Absolute activity measurements 2. Participation in international intercomparison programmes 3. Audit programme of activity measurements in nuclear medicine centres 4. Calibration of radionuclide calibrators and sources 5. Dissemination of various radioactive standards to users
KEYWORDS	coincidence method, gas proportional counter, ionisation chamber, liquid scintillation, plastic scintillation detector, source preparation, traceability, Co-60, Pm-147, Tl-204 and Sr-90/Y-90
RESULTS	1. A Plastic Scintillator based 4πβ-γ coincidence system has been developed and established as a primary standard. Its performance was demonstrated by standardising Co-60 radioactive solution 2. Pm-147, Tl-204 and Sr-90/Y-90 solutions were standardised by CIEMAT/NIST method 3. Conducted national audit of I-131 activity measurements for 285 nuclear medicine centres in the country. 4. Standardisation of Ru-106. Determination of sensitivity coefficients of secondary standard and radionuclide calibrator for Ru-106 plaque eye applicator and calibration of plaque sources.
PUBLICATIONS	1. Standardisation of Rhenium-188 and determination of calibration factors for secondary standard and radionuclide calibrator; R. Anuradha, D. B. Kulkarni, Leena Joseph, M. S. Kulkarni; Applied Radiation and Isotopes, 152 (2019), Pages 52-56. 2. ^{63}Ni activity measurements a bilateral intercomparison; D. B. Kulkarni, Y. Sato, R. Anuradha, Leena Joseph, M. S. Kulkarni; Applied Radiation and Isotopes, 148, (2019), Pages 60-63. 3. Preliminary measurements with recently developed Plastic Scintillator based 4π β-γ coincidence system, Anuradha Ravindra, D.B. Kulkarni, Leena Joseph, S.S. Dahiwale, Sanjay Dhole, V.Sathian, 22nd National Symposium on radiation physics (NSRP-22) on Radiation physics Research at Advanced Radiation Facilities , JNU, New Delhi, Nov 8-10, 2019 4. Standardization of ^{106}Ru Eye plaques Leena Joseph, D.B. Kulkarni, Anuradha Ravindra, V.Sathian. 22nd National Symposium on radiation physics (NSRP-22) on Radiation Physics Research at Advanced Radiation Facilities, JNU, New Delhi, Nov 8-10, 2019. 5. Quality Audit of ^{131}I activity measurements at Nuclear Medicine Centers in India D.B. Kulkarni. Anuradha Ravindra, Leena Joseph. 22nd National Symposium on radiation physics (NSRP-22) on Radiation Physics Research at Advanced Radiation Facilities, JNU, New Delhi, Nov 8-10, 2019.
IN PROGRESS	1. Primary and secondary standardisation of radioisotopes used in Nuclear Medicine 2. Pilot Study of CCRI(II)-P1. ^{60}Co by BIPM 3. Dissemination of radioactivity standards to hospitals, industry and DAE units 4. Standardisation of Ba-133 for SIR 5. Establish new GIC with ion chamber of make (Centronix IG12) and PTW reference class electrometer as a secondary standard for activity measurements.
INFORMATION	

SOURCE IN PREPARATION	Development of plastic scintillator based primary standard for activity measurements and its performance evaluation. Anuradha Ravindra, D.B. Kulkarni, A.P. Das, Leena Joseph, V. Sathian, S.S. Dahiwale, Sanjay D. Dhole
OTHER RELATED PUBLICATIONS	
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CONTACT	Anuradha Ravindra, email: anur@barc.gov.in

ENEA – Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI), Italy, SA1/SA2
2018-2021 Progress Report and Work Plan
(information for ICRM members)

The programme at the Italian National Institute of Ionizing Radiation Metrology (INMRI) belonging to ENEA (ENEA-INMRI) in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the primary and secondary 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 2019 was:

Scientists	**Function**
P. De Felice	ENEA-INMRI Head
M. Capogni	Primary activity standards
A. Petrucci / M. Capogni	Secondary activity standards
P. Carconi / P. De Felice	Environmental studies
M. Capogni / P. Carconi	Liquid scintillation counting
A. Petrucci	Gamma spectrometry
F. Cardellini / M. Capogni	Radon standards
L. Silvi / M. Capogni	Neutron standards
M. Capone / P. De Felice	Source preparation/radiochemistry
G. Cotellessa / M. Capogni	Nuclear tracks laboratory
Technicians	
A. Fazio	Secondary gamma-emitters activity standards

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 separated sheets.

Activity line	**ENEA-INMRI Radionuclide Metrology 2018-2019 Progress report**	**ENEA-INMRI Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Development of new primary standards: ^{3}H, ^{56}Mn, ^{166}Ho, ^{55}Fe. • Metrological characterization of a ^{64}Cu solution produced at ENEA by 14 MeV neutrons from D-T fusion reactions. • Participation in the EMPIR MRTDosimetry and MetroDECOM-II projects. • Participation in the LSC, LS and γ-ray ICRM WGs.	• Development of new primary standards: **^{11}C**, ^{123}I. • **Thoron standard.** • European Projects: **EMPIR *traceRadon.*** • **MICADO project** funded by EC in collaboration with CAEN.
International comparisons	• EURAMET.RI(II)-K2.Ho-166 . • BIPM CCRI(II).Fe-55.	• **SIR ^{60}Co, ^{134}Cs.** • CCRI(II)-K2.Cd-109

Activity line	**ENEA-INMRI Radionuclide Metrology 2018-2019 Progress report**	**ENEA-INMRI Radionuclide Metrology 2020-2021 Work plan**
Standardization of measurement methods	• New detectors for Medical Imaging. • Metrology for PET and SPECT system. • Monte Carlo code for γ-ray spectrometry.	• **Nuclear tracks detection methods.** • New digital electronics for β-γ coincidence systems. • **Development of new portable β-γ coincidence detector.** • Monte Carlo code for IG11 ionization chamber.
National QA programmes and services	• Preparation of radioactive standards (liquid solutions, point sources, reference materials) for external users. • Organization of Proficiency Tests for national laboratories: radioactive surveillance network, radon measurements laboratories, nuclear medicine departments. • Collaboration with IAEA (Lectures and guideline development).	• Provision of calibration services. • Collaboration with SOGIN and NUCLECO (Italian nuclear operators). • 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), BIPM/CCRI(III), 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)
Management and Organisation	• Completion of reactivation of measuring systems after restructuration work in the laboratory	• Submission of new CMCs. • **Upgrading of measuring systems.**
Teaching activity	• Invited lectures.	• Invited lectures.
Quality system	• Management of Quality System. • Quality System Peer Review.	• Improvements of Quality System. • Review of calibration certificates.

LABORATORY	ENEA - Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI), Italy
NAMES	M. Capogni, P. De Felice, P. Carconi, M. Capone, A. Fazio
ACTIVITY	Development of a new ^{11}C activity standard
KEYWORDS	liquid scintillation, coincidence method, gamma-ray spectrometer, ionisation chamber, source preparation, life sciences, BIPM SIR
RESULTS	Contact with Gemelli Hospital (Rome) in progress
PUBLICATIONS	-
IN PROGRESS	work in progress
INFORMATION	Gemelli Hospital will provide a ^{11}C liquid solution directly produced by the own cyclotron. The new standard will be linked to the BIPM SIR by the BIPM SIRTI system.
SOURCE IN PREPARATION	-
OTHER RELATED PUBLICATIONS	-
ADDRESS	marco.capogni@enea.it, tel.: +39 06 3048 6628
CONTACT	M. Capogni

LABORATORY	ENEA – Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI), Italy
NAMES	F. Cardellini, M. Capogni, P. De Felice
ACTIVITY	EMPIR traceRadon project
KEYWORDS	Radon measurements, radioactive gas standardisation, greenhouse gas, radioactivity in the environment
RESULTS	Project selected and approved for funding by EMPIR. Start date 1st June 2020. Duration 36 months.
PUBLICATIONS	-
IN PROGRESS	work in progress
INFORMATION	The project is focused on the implementation of radon metrology for the analysis of the atmospheric budget of greenhouse gases and radiation protection in the environment. The consortium is made by 7 Internal Funded Partners, 10 External Funded Partners and 1 External Unfunded Partner. EU Contribution of 2.25 M€ about.
SOURCE IN PREPARATION	-
OTHER RELATED PUBLICATIONS	-
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LABORATORY	ENEA – Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI), Italy
NAMES	P. De Felice, P. Carconi, M. Capogni, A. Fazio
ACTIVITY	MICADO project funded by EU Horizon 2020
KEYWORDS	Standardization and management of radioactive waste, nuclear techniques, digital electronics
RESULTS	Contact established between the EU partners and CAEN Company
PUBLICATIONS	https://www.caen.it/micado-european-project-for-the-monitoring-of-radioactive-waste-kicks-off/
IN PROGRESS	The project started in June 2019 and will end in May 2022.
INFORMATION	MICADO consortium consists of 8 partners from 5 European countries counting Research Institutes, SMES and Large Companies. Budget of the project of about 5 M€ (EU contribution: 4.5 M€)
SOURCE IN PREPARATION	-
OTHER RELATED PUBLICATIONS	-
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CONTACT	P. De Felice

LABORATORY	ENEA – Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI), Italy
NAMES	M. Capogni
ACTIVITY	new 4πβ(LS)-γ detector for activity standardisation
KEYWORDS	TDCR, liquid scintillation, beta-gamma coincidence
RESULTS	Contact with the University of Catane (Prof. Bellini) and INFN of Catane (Dr. C. Sutera). The project was selected for an Industrial PhD.
PUBLICATIONS	
IN PROGRESS	work in progress
INFORMATION	Implementation of the gamma channel on the TDCR portable detector. A PhD student of the University of Catane is working on the project.
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	ENEA – Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti (INMRI), Italy
NAMES	G. Cotellessa, M. Capogni, F. Cardellini, L. Silvi
ACTIVITY	CR-39 solid state nuclear track detectors
KEYWORDS	alpha-particle detector, radon measurement systems, hot-spot detection
RESULTS	Radon tracks reading system implemented. Characterization of the CR-39 in radon standard environmental condition.
PUBLICATIONS	Zorri V., Remetti R., Capogni M., Cotellessa G., Falcone R., 2017. *Feasibility study of the applications of the solid state detectors for fast survey of residual alpha contamination in decommissioning activities. Radiation Measurements* 107, 111-114
IN PROGRESS	work in progress
INFORMATION	CR-39 detectors used for radon measurements and neutron albedo characterisation in neutron facility
SOURCE IN PREPARATION	-
OTHER RELATED PUBLICATIONS	-
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CONTACT	G. Cotellessa, M. Capogni

NMIJ Radionuclide Metrology
2018-2021 Progress Report and Work Plan

(information for ICRM members)

National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology (NMIJ/AIST), Japan, SA1/SA2

The programme at the NMIJ in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the primary and secondary national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

The NMIJ staff in 2019 were:

Scientists	**Function**
Yasushi Sato	Calibrations of activity by using the following apparatus; $4\pi\beta$-γ coincidence counter, $4\pi\gamma$ ionisation chamber, HP-Ge, Si detectors, Liquid scintillation counter, TDCR, NaI(Tl) well-type counter, 2π multi-wire proportional counter,
Akira Yunoki	
Yasuhiro Unno	
Rio Furukawa	
Technicians	
Aki Naganuma	Secondary activity standards

The main specific activities carried out at NMIJ in this field are summarised below.

Activity line	**NMIJ Radionuclide Metrology 2018-2019 Progress report**	**NMIJ Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Continued to develop a proportional counter for the primary standard of Rn-222. • Continued to develop a TDCR system for beta and EC nuclides	• Launch calibration service of a radon-222 monitoring instrument. • Continue to develop a TDCR system for beta and EC nuclides.
International comparisons	• CCRI(II) (Ge-68, Fe-55) • SIR (Eu-152) • Bilateral (Ni-63 BARC-NMIJ)	• CCRI(II) (Xe-133) • APMP large area source • EURAMET (Cu-64)
National QA programmes and services	• Calibrate standard instruments of registered calibration institutes in Japan. (IC, HPGe, MWPC, LS, Well-type NaI)	• Calibrate standard instruments of registered calibration institutes in Japan. (MWPC, LS)
Membership in international and national organisations	• ICRM committee membership • BIPM/CCRI(II) • IEC/TC45	• ICRM committee membership • BIPM/CCRI(II) • IEC/TC45
Teaching activity	• Introduction of activity measurement and uncertainty evaluation to personnel of Fukushima prefecture.	• Introduction of activity measurement and uncertainty evaluation to personnel of Fukushima prefecture.
Quality system	• Peer reviewed • ISO/IEC 17025: 2017	•

LABORATORY	National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology (NMIJ/AIST), Japan
NAMES	Yasushi SATO, Akira YUNOKI, Rio FURUKAWA, Yasuhiro UNNO and Aki NAGANUMA
ACTIVITY	Calibrations of activity by using the following apparatus; 4πβ-γ coincidence counter, 4πγ ionisation chamber, HP-Ge, Si detectors, Liquid scintillation counter, TDCR, NaI(Tl) well-type counter, 2π multi-wire proportional counter, Length-compensated internal gas counting system.
KEYWORDS	Alpha spectrometry, beta spectrometry, coincidence method, data evaluation, data measurement, defined solid angle measurement, gamma-ray spectrometry, gas proportional counter, ionisation chamber, liquid scintillation, low-level, NaI(Tl) well-type counter, neutron measurement, radioactive gas, simulation code, SIR, source preparation, traceability, X-ray spectrometry.
RESULTS	The code for calculation of Fe-55 activity using asymmetrical TDCR data was developed.
PUBLICATIONS	- Y. Sato, Standardization of ^{147}Pm by TDCR Liquid Scintillation Counting using Printed Optical Filters, Radioisotopes, 67, 221-224 (2018) . - R. Furukawa, et. al., "Homogeneity of wheat flour in 5 ml containers for certified reference materials", Applied Radiation and Isotopes 134 (2018) 32-34. - Y. Unno, et. al., "Evaluation of absolute measurement using a 4π plastic scintillator for the 4πβ−γ coincidence counting method", Applied Radiation and Isotopes 134 (2018) 302-306.
IN PROGRESS	NMIJ is developing a proportional counter for standardization of ^{222}Rn. NMIJ is improving its TDCR system to achieve smaller uncertainties.
INFORMATION	--
SOURCE IN PREPARATION	Ar-41, Xe-133, Zr-89, Ac-225
OTHER RELATED PUBLICATIONS	- A. Yunoki, Uncertainty of Measurement in the Response Test of a Thyroid Monitor, Radiation Protection Dosimetry, 184 (2019), 531–534.
ADDRESS	Radioactivity and Neutron Standards Group, Research Institute for Measurement and Analytical Instrumentation, National Metrology Institute of Japan, Central2, 1-1-1 Umezono Tsukuba, Ibaraki 305-8568, JAPAN.
CONTACT	Akira Yunoki (e-mail: a.yunoki@aist.go.jp)

Laboratory of Radioactivity Standards
National Centre for Nuclear Research Radioisotope Centre POLATOM, Poland
2018-2021 Progress Report and Work Plan

(information for ICRM members)

National Centre for Nuclear Research Radioisotope Centre (POLATOM), Poland, SA1/SA2

The programme at the Laboratory of Radioactivity Standards RC POLATOM in the field of radionuclide metrology in the years 2018-2019 was focused on maintaining and developing the national standard for activity measurements and on the more general activities in the field of standardization and quality assurance in radioactivity measurements.

The Laboratory of Radioactivity Standards RC POLATOM staff in 2019 were:

Scientists	**Function**	**Function changes in the latter part of 2019**
T. Dziel	Laboratory Manager, primary and secondary standards	Director of RC POLATOM
A. Listkowska	Quality Manager, source preparation and radiochemistry	Laboratory Manager
R. Broda	primary radionuclides activity standards	
D. Cacko	electronics specialist	
A. Jęczmieniowski	electronics specialist	
E. Lech	source preparation and radiochemistry	Quality Manager
M. Nowicka	source preparation and radiochemistry	Left her job
P. Saganowski	secondary radionuclide activity standards	
Z. Tymiński	secondary radionuclide activity standards	
T. Ziemek	primary radionuclides activity standards	
Technicians		
E. Kołakowska	secondary radionuclide activity standards	
Trainee		
M. Czudek	secondary radionuclide activity standards	New-employed
J. Marganiec-Gałązka	secondary radionuclide activity standards	New-employed (since 2020)

The main specific activities carried out at RC POLATOM in this field are summarized below.

Activity line	**RC POLATOM** **Radionuclide Metrology** **2018-2019 Progress report**	**RC POLATOM** **Radionuclide Metrology** **2020-2021 Work plan**
Improvement of measuring methods and instrumentation	• Validation of measurement methods used in new TDCRG system (TDCR detector in LS-channel and NaI(Tl) – in γ-channel). • Preliminary works with standardization of ^{213}Bi and ^{225}Ac. • New low-background shielding for HPGe detectors. • Implementation of the pulse-mixing method in the TDCRG system • Investigation of the reproducibility of the results of the International Reference System to beta emitters (ESIR). • Conclusions for the ESIR system learned from the ESIR3H exercise. • Comparative studies of the RC POLATOM and PTB coincidence modules. Exchange of experiences concerning data analysis and models.	• New measuring systems with ionization chambers (stationery and portable) as secondary standards for radionuclides used in nuclear medicine. • Modernization of equipment based on modular electronics. • Ionization quenching model in the LS-counter efficiency calculation. • The TDCR system with an improved optical chamber and digitizer.
International comparisons	• CCRI(II)-K2.H-3 key comparison (piloted by LNHB, 2018) • ESIR3H exercise of H-3 measurements for ESIR (piloted by LNHB, 2018) • Comparison of home-made coincidence modules in POLATOM and PTB (2018) • CCRI(II)-K2.Fe-55 key comparison (piloted by NCBJ RC POLATOM)	• SIR: ^{85}Sr • BIPM: Ni-63 comparison for ESIR • Other long-lived gamma emitting radionuclides for SIR to be specified • Comparison of surface emission rate measurements.
National QA programs and services	• Preparation of radioactive standards (solutions, point sources, volume sources) for external users. • Calibration of dose (radionuclide) calibrators. • Organization of proficiency tests for measurements of emission rate from surface sources for accredited laboratories.	• Preparation of radioactive standards (solutions, point sources, volume sources) for users in Poland and abroad. • Calibration of dose (radionuclide) calibrators. • Organization of proficiency tests for activity measurements of diagnostic and therapeutic radionuclides in nuclear medicine departments in Polish hospitals. • Organization of proficiency tests for measurements of emission rate from surface sources for accredited laboratories.
Membership in international and national organizations	• ICRM, BIPM/CCRI(II), EURAMET, Polish Physical Society, Committee for Metrology and Scientific Instrumentation of the Polish Academy of Science, Scientific Council of the National Centre for Nuclear Research, Metrology Council of the Central Office of Measures, Meteoritical Society, Polish Fireball Network	• ICRM, BIPM/CCRI(II), EURAMET, Polish Physical Society, Committee for Metrology and Scientific Instrumentation of the Polish Academy of Science, Scientific Council of the National Centre for Nuclear Research, Metrology Council of the Central Office of Measures

Activity line	**RC POLATOM** **Radionuclide Metrology** **2018-2019 Progress report**	**RC POLATOM** **Radionuclide Metrology** **2020-2021 Work plan**
International cooperation	• Development of TDCRG measurement system (TDCR detector in LS-channel and NaI(Tl) – in γ-channel) with a FPGA-based digital platform for SMU (Slovakia). • Participation in BIPM project RI-A2-2 "Extension of SIR to pure beta and pure alpha emitters: ongoing comparisons, developments and maintenance" (BIPM, LNHB, POLATOM, PTB; 2018-20121) • Scientific visits (PTB, ENEA, SMU) related to improvement of absolute measurements systems and development of new primary standards.	• Improvement of the collaboration between RC POLATOM and PTB in the field of radionuclide metrology. • Scientific cooperation with ENEA-INMRI (Italy). • Participation in EMPIR projects. • Organization of Liquid Scintillation Counting and Life Sciences Working Groups interim meetings in Otwock, Poland (2020). • Scientific visits related to improvement of absolute measurements systems (PTB, LNHB) and development of new primary standards.
Teaching activity	• Lectures on quality assurance in activity measurements of radiopharmaceuticals. • Training course for dose (radionuclide) calibrators' users. • Popularization lectures for students at Primary School on space research, meteors and meteorites, including research isotopic.	• Lectures on radionuclide activity measurements and quality assurance in activity measurements of radiopharmaceuticals within the framework of RadFarm doctoral study in NCBJ • Training course for dose (radionuclide) calibrators' users.
Quality system	• Maintaining of Quality Management System according to ISO/IEC 17025:2005. • Annual audits from Polish Centre for Accreditation (2018 and 2019). • Annual reports to EURAMET TC-Q.	• Modification of Quality Management System according to ISO/IEC 17025:2017. (2019) • Renewal audit from Polish Centre for Accreditation (2020 and 2021).

LABORATORY	National Centre for Nuclear Research Radioisotope Centre (POLATOM), Poland
NAMES	Ryszard Broda, Daniel Cacko, Marek Czudek, Tomasz Dziel, Adam Jęczmieniowski, Ewa Kołakowska, Edyta Lech, Anna Listkowska, Marlena Nowicka, Paweł Saganowski, Zbigniew Tymiński, Tomasz Ziemek
ACTIVITY	Maintaining of the National Standard of Radionuclides Activity in Poland. Maintaining and improving of management system according to ISO 17025. Services for domestic and international customers: • Calibration/production of standard solutions and sources • Calibration of dose calibrators Participation in conferences and scientific meetings: • X Meteorite Conference of Polish Meteoritical Society. Pułtusk, Poland, 20-22.04.2018 – **Z. Tymiński**, et al. PFN - Polish Fireball Network (in Polish). – A. Burakowska, **Z. Tymiński**, et al. Isotope ^{26}Al in fragments of the Pułtusk meteorite (in Polish). • XVI Congress of the Polish Society of Nuclear Medicine. Szczecin, Poland, 23-26.05.2018 – D. Pawlak, W. Wojdowska, I. Cieszykowska, M. Zółtowska, **Z. Tymiński**, J.L. Parus, R. Mikołajczak. Obtaining ^{47}Sc in a nuclear reactor (in Polish). • Meeting of the ICRM Liquid Scintillation Counting Working Group and Life Science WG meeting. St. Petersburg, Russia, 04-05.06.2018. – **R. Broda**. Let's look at the proposed ESIR idea. – **T. Ziemek.** Implementation of the pulse-mixing method in the TDCRG counter. – **T. Ziemek**, O.J. Nähle, K. Kossert, S. Leschitzki, M. Takács. Comparison of coincidence modules for TDCR and 4π(LS)-γ coincidence counting as used in POLATOM and PTB. • Annual Congress of the European Association of Nuclear Medicine, EANM 2018. Dusseldorf, Germany, 13-17.10.2018 – D. Pawlak, W. Wojdowska, I. Cieszykowska, M. Zółtowska, **Z. Tymiński**, J.L. Parus, R. Mikołajczak. Production of ^{47}Sc in Maria Reactor in POLATOM. • ICRM2019 - the 22nd International Conference on Radionuclide Metrology and its Applications, Salamanca , Spain, 27-31.05.2019 – **T. Ziemek**, **R. Broda**, **T. Dziel**, **A. Listkowska**, **Z. Tyminski.** A new coincidence module using pulse-mixing method applied in the 4π(LS)-γ coincidence system with TDCR detector. – **R. Broda**, P. Cassette. Lessons learned from the ESIR3H exercise results. – R. Coulon, S. Judge, M. Nonis, S. Courte, C. Michotte, **R. Broda**, P. Cassette, K. Kossert. Extension of SIR to pure beta and pure alpha emitters. – **T. Ziemek**, O.J. Nähle, K. Kossert, S. Leschitzki, M.P. Takács, **R. Broda, A. Listkowska, Z. Tyminski, T. Dziel**. Comparison of coincidence modules for TDCR and 4π(LS)-γ coincidence counters used in POLATOM and PTB. – **A. Listkowska**, **T. Ziemek**, **P. Saganowski**, **E. Lech**, **Z. Tyminski**, **D. Cacko**, **M. Nowicka**, **E. Kołakowska**, **R. Broda**, **A. Jeczmieniowski**, **T. Dziel**. Study of the influence of the scintillator and the counter on the universal cross-efficiency LSC curves.

	– O. Sima, A. DeVismes-Ott, M.S. Dias, P. Dryak, P. Jodłowski, **P. Saganowski**, K. Tyminska, **Z. Tymiński** et al. Consistency test of coincidence-summing calculation methods for extended sources. • VIII Congress of Metrology, Augustów, Poland, 09-12.06.2019 – **R. Broda**, K. Pochwalski, **T. Ziemek**. 40 years of the absolute TDCR method developed in Poland for measuring radionuclide activity (in Polish). • RAD 2019 - 7th International Conference on Radiation in Various Fields of Research, Herceg Novi, Montenegro, 10-14.06.2019 – **Z. Tymiński**, **P. Saganowski**, **T. Dziel**, **A. Listkowska**, **E. Lech**, **E. Kołakowska**, **M. Nowicka**, **T. Ziemek**, **D. Cacko**, **G. Birnbaum**, **R. Broda**, **A. Jęczmieniowski.** Quality assurance of gamma ray measurements with HPGe detectors used in radiopharmaceutical production. • 45th Congress of Polish Physicists, Kraków, Poland, 13-18.09.2019 – **T. Ziemek.** Application of the pulse-mixing method for absolute measurements of radionuclide activity using liquid scintillator technique (in Polish). Participation in international projects: • SMU Project DE/34/2017 "Construction of a new TDCRG measuring system for the Slovak Institute of Metrology (SMU)" - performed by the Laboratory of Radioactivity Standards NCBJ RC POLATOM • BIPM Project RI-A2-2 "Construction, validation and documentation a sustainable international reference system (ESIR) for pure beta, alpha emitters and selected E.C. radionuclides at BIPM". (support from consortium: LNE-LNHB, NPL, POLATOM, PTB) • ESIR3H exercise to test the ESIR procedure using the ready-to-use ^{3}H sources (piloted by LNE-LNHB) • CCRI(II)-K2.Fe-55 key comparison (piloted by NCBJ RC POLATOM)
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	• Finished validation of methods for measuring the activity and purity of radionuclides of radiochemical preparations. • Comparative measurements of ^{137}Cs radioactivity by specialized centres conducting measurements of radioactive contaminations as part of radiation monitoring of Poland. • Comparative measurements of ^{241}Am and ^{226}Ra radioactivity (piloted by Institute of Nuclear Chemistry and Technology, Poland) • National comparison in determination of ^{3}H, ^{226}Ra, ^{239}Pu and ^{241}Am isotopes in water, ^{239}Pu and ^{241}Am in flour and ^{239}Pu in sand (piloted by Institute of Nuclear Chemistry and Technology, Poland) • Development of absolute methods for measuring the activity of short-lived radionuclides (^{225}Ac) used in nuclear medicine.
PUBLICATIONS	• **Z. Tymiński**, **P. Saganowski**, **E. Kołakowska**, **A. Listkowska**, **T. Ziemek**, **D. Cacko**, **T. Dziel.** Impurities in Tc-99m radiopharmaceutical solution obtained from Mo-100 in cyclotron. *Appl. Radiat. Isot*., 134 (2018) 85-88. • **T. Ziemek**, M. Capogni, G. Ratel, **R. Broda, T. Dziel**, A. Fazio, A**. Listkowska.** Comparison of I-131 activity measurements at the NCBJ RC POLATOM and the ENEA-INMRI linked to the BIPM SIR system. *Appl. Radiat. Isot*., 134, (2018) 380-384

	• **A. Listkowska, E. Lech, P. Saganowski, Z. Tymiński, T. Dziel, D. Cacko, T. Ziemek, E. Kołakowska, R. Broda**. Preparation method and quality control of multigamma volume sources with different matrices. *Appl. Radiat. Isot*., 134, (2018) 126-130 • J.T. Cessna, …, **T. Dziel, A. Listkowska, Z. Tymiński**, … et al. Results of an International Comparison of Activity Measurements of ^{68}Ge. *Appl. Radiat. Isot*., 134, (2018) 385-390 • P. Cassette, …, **T. Ziemek**, …, et al. Results of the CCRI(II)-S12.H-3 supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated water source measured using the LSC-TDCR method. *Appl. Radiat. Isot*., 134, (2018) 257-262 • P. Cassette, …, **T. Ziemek**., et al. Results of the CCRI(II)-K2. H-3 key comparison 2018: measurement of the activity concentration of a tritiated-water source. *Metrologia*, 57, No 1A (2020) 06004. • P. DeFelice, …, **T. Ziemek**, et al. Supplementary comparison of the measurement of the alpha and beta particle surface emission rates from large area sources (CCRI(II)-S10 LASCE). Raport BIPM, Sevres, (2018). • O. Sima, A. DeVismes-Ott, M.S. Dias, P. Dryak, P. Jodłowski, **P. Saganowski**, K. Tyminska, **Z. Tymiński** et al. Consistency test of coincidence-summing calculation methods for extended sources. *Appl. Radiat. Isot.*, 155 (2020) 108921. • **T. Ziemek**, **R. Broda**, **T. Dziel**, **A. Listkowska**, **Z. Tyminski.** A new coincidence module using pulse-mixing method applied in the 4π(LS)-γ coincidence system with TDCR detector. *Appl. Radiat. Isot.*, 159 (2020) 109081
IN PROGRESS	• The use of Monte Carlo simulation in improving metrological methods of measuring gamma spectrometry. • Participation in research projects organized as a part of EURAMET regarding nuclear data (nuclear data evaluation). • Cooperation with BIPM in developing a new scintillator for ESIR measurements based on easily available components. • Preparation of documentation in accordance with the requirements of PN-EN ISO 17034:2017-03 necessary for the Laboratory accreditation as a manufacturer of reference materials. • Launch of a new measuring station with an ionization chamber for comparative measurements of the activity of various radionuclides.
INFORMATION	• 4π(LS)-γ coincidence and anticoincidence system • 4π(LS)-γ coincidence system (TDCRG) with TDCR detector in beta channel • TDCR system • X-γ coincidence system • multiwire windowless proportional counter • Wallac 1411 liquid scintillation counter • Tri-Carb 2910 TR 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 PREPARATION	• R. Coulon, **R. Broda**, P. Cassette, S. Courte, S. Jerome, S. Judge, K. Kossert, H. Liu, C. Michotte, M. Nonis. The international reference system for pure β-particle emitting radionuclides: an investigation of the reproducibility of the results. (accepted for publication in *Metrologia*). • **T. Ziemek**, O.J. Nähle, K. Kossert, S. Leschitzki, M.P. Takács, **R. Broda**, **A. Listkowska**, **Z. Tyminski**, **T. Dziel.** Comparison of coincidence modules for TDCR and 4π(LS)-γ coincidence counters used in POLATOM and PTB. (accepted for publication in *Appl. Radiat. Isot*.).
OTHER RELATED PUBLICATIONS	• **Z. Tymiński,** A. Kotowiecki, A. Burakowska, K. Tymińska, **E. Kołakowska, P. Saganowski, T. Ziemek, T. Dziel**. Pomiary izotopów gamma promieniotwórczych w trynitytach. *Acta Socie. Metheori. Polonorum,* [7] Vol. 9 (2018) 150-157 • **Z. Tymiński**, P. Żołądek, M. Wiśniewski, M. Stolarz, A. Jaśkiewicz, M. Myszkiewicz, M.P. Gawroński, T. Suchodolski, K. Polakowski, P. Zaręba, A. Olech. Report on meteorite field search within PFN in 2016/2017 season. *Acta Soci Metheor Polonorum,* [7] Vol. 9 (2018) 158-163. • M. Wiśniewski, ..., **Z. Tymiński**, ..., et al.. History and current state of the Polish Fireball Network (in Polish). *Acta Socie. Metheori. Polonorum,* [7] Vol. 9 (2018) 177-186. • **Z. Tymiński**, A. Krzesińska, A. Burakowska, M. Stepisiewicz, K. Tymińska, T. Dziel, A. Olech, P. Żołądek. Al-26 Isotope in Pułtusk Meteorite Fragments. *Meteoritics and Planetary Science,* [0] Vol. SI 52 (2018) A357. • **Z. Tymiński**, et al. 15 years of observation – selected meteorite falls registered in the PFN in 2004–2019. *Acta Soci. Metheor. Polonorum,* Vol. 10 (2019) 160-167. • K. Piasecki, …, **Z. Tymiński** et al. Wide acceptance measurement of K-/K+ ratio from Ni+Ni collisions at 1.91A GeV. *Phys. Rev. C,* Vol. 99 (2019) 014904 • P. Żołądek, A. Olech, M. Wiśniewski, **Z. Tymiński**, M. Stolarz. Large Taurids observed by US government sensors. *Proceedings of the IMC,* Vol. 1 (2019) 218. • A. Olech, P. Żołądek, M. Wiśniewski, **Z. Tymiński** et al. PF061018 Bukienka – meteorite dropping fireball. *WGN, the Journal of the IMO,* Vol. 47 No 3 (2019) 75-106
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IFIN-HH - Radionuclide Metrology Laboratory (LMR)
2018-2021 Progress Report and Work Plan

(information for ICRM members)

IFIN-HH, Radionuclide Metrology Laboratory, Romania, SA1/SA2

The programme at the IFIN-HH – Radionuclide Metrology Laboratory (LMR) in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the primary and secondary national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

In 2019, LMR and CMRID (the dose metrology laboratory from IFIN-HH) joined to form the Laboratory of Ionizing Radiation Metrology (LMRI).

The IFIN-HH – LMR staff in 2019 were:

Scientists	**Function**
Aurelian Luca, PhD	LMR Head: Primary and secondary activity standards; Radon; Gamma-ray spectrometry; Nuclear decay data.
Andrei Antohe, PhD	Primary (LSC) and secondary standards; sources preparation
Mihail-Razvan Ioan, PhD	Primary (Coincidence) and Secondary activity standards; Alpha and Gamma-ray spectrometry, Monte Carlo simulation codes
Cornel Liviu Tugulan, PhD	Alpha and Gamma-ray spectrometry, Monte Carlo simulation codes, Radon measurements
Constantin Ivan, PhD	Primary (Electronics) activity standards
Doru Stanga, PhD*	Primary (Large area) and secondary activity standards, Gamma-ray spectrometry
Maria Sahagia, PhD**	Primary and secondary activity standards; Radon standards
George Ormenisan, Master's student	Monte Carlo simulation codes; Radon studies
Claudia Olaru, student	Monte Carlo simulation codes; Radon studies
Technicians	
Constantin Teodorescu	Source preparation/radiochemistry; Radon standards

*) Employee of the Nuclear Reactor Decommissioning Department;
**) Retired, part time employee

The main specific activities carried out at IFIN-HH – LMR in this field are summarised below.

Activity line	**IFIN-HH – LMR Radionuclide Metrology 2018-2019 Progress report**	**IFIN-HH – LMRI (former LMR) Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Development of new primary standards: ^{89}Zr (IFIN-HH) and ^{223}Ra (LNE-LNHB), in the frame of the joint project IFA-CEA no. C5-09/2016 • Evaluation of nuclear decay data for radionuclides: ^{230}U, ^{226}Th, ^{223}Ra • Development of the radon chamber: new types of radon recipients and standards • Calibration of an X-ray spectrometer with Si(Li) detector • Participation to the EURAMET EMPIR 16ENV10 MetroRADON project	• Development of the radon chamber: stable reference atmospheres of low radon (^{222}Rn) activity concentrations to be used for calibrations • Use of Monte Carlo codes for radionuclide metrology applications • European Projects: EURAMET EMPIR: 16ENV10 MetroRADON (until May 31st, 2020), and new projects: 19ENV01 traceRadon (2020-2023), 19ENV02 RemoteALPHA (2020-2023), 19NET03 supportBSS (2020-2024), 19NET04 MIRA (2020-2024)
International comparisons	• CCRI(II)-S13 Cs-134 and Cs-137 in wheat flour (pilot NMIJ-AIST, Japan), in 2018 • EURAMET project no. 1475, EURAMET.RI(II)-S8.Rn-222N (2019)	• BIPM (CCRI(II)-K2.Cd-109) • SIR (Eu-152) • Bilateral: ILC in IFIN-HH labs, with a radioactive sample for γ-ray spectrometry
Standardization of measurement methods	• ICRM Gamma-ray spectrometry WG (participation in two actions, in 2018) • New 3D printer and XRF analyser to be used for radionuclide metrology applications	• Construction of a new 4πβ(LS)-γ coincidence system, using the new optical chamber, three Burle PMs and a NaI(Tl) crystal • Calibration of an alpha-particle spectrometry system • Improvement of the 4π gamma ionization chamber calibration, with application for the PET radionuclides
National QA programmes and services	• Preparation of radioactive standards (liquid solutions, point, surface and volume sources) • Calibration of radioactive sources • Calibration of activity measurement installations: gross alpha-beta activity counters, liquid scintillation counters, gamma-ray spectrometers [HPGe, NaI(Tl)], radionuclide calibrators	• Preparation of radioactive standards (liquid solutions, point, surface and volume sources) • Calibration of radioactive sources • Calibration of activity measurement installations: gross alpha-beta activity counters, liquid scintillation counters, gamma-ray spectrometers [HPGe and NaI(Tl)], radionuclide calibrators • Calibration of radon monitors for activity concentration in air (Bq/m^3)
Membership in international and national organisations	• ICRM committee membership • BIPM/CCRI(II) member, IFIN-HH – LMR report sent in 2019 • EURAMET Associated member (DI), TC-IR (report sent in 2019)	• ICRM committee membership • BIPM/CCRI(II) member, • EURAMET Associated member (DI), TC-IR

Activity line	IFIN-HH – LMR Radionuclide Metrology 2018-2019 Progress report	IFIN-HH – LMRI (former LMR) Radionuclide Metrology 2020-2021 Work plan
Management and Organisation	• Bilateral IFA (Romania) - CEA (France) accord, 2015–2020, contract C5-09/2016-2019. • **EURAMET-EMPIR**: Environment: 16ENV10, Metrology for radon monitoring (MetroRADON), 2017-2020 (funded partner)	• **EURAMET-EMPIR:** Environment: 16ENV10, Metrology for radon monitoring (MetroRADON), 2017-2020; funded partner in: 19ENV01 traceRadon (2020-2023); 19ENV02 RemoteALPHA (2020-2023); 19NET03 supportBSS (2020-2024); 19NET04 MIRA (2020-2024)
Teaching activity	• 3 PhD students supervision • Lectures for specialists in nuclear techniques applications – Centre for Specialization in Nuclear Field (CPSDN), IFIN-HH	• 1 PhD thesis (Vocheci Florin) on γ-ray spectrometry applied in detection of radioactive dispersing devices (RDD), to be presented at the Bucharest University • 1 PhD thesis (Cosar Ciprian) on γ-rays and neutrons metrology • 1 PhD student supervision, in cooperation at the Polytechnical University of Bucharest • Lectures for specialists in nuclear techniques applications – Centre for Specialization in Nuclear Field (CPSDN), IFIN-HH
Quality system	• Annual survey for maintaining of the RENAR national accreditation (2018, 2019) • In 2019: major revision and improvement of the Quality Management System for the LMRI extension (to include LMR) and for the transition to the SR EN ISO/IEC 17025:2018 standard • New technical manager and quality assurance responsible for LMRI (2019)	• Annual survey for maintaining of the RENAR national accreditation for calibration services

Announcements:

1. **During the period May 24-28, 2021, in Bucharest, Romania, the International Committee for Radionuclide Metrology (ICRM) and IFIN-HH will organize the 23rd International Conference on Radionuclide Metrology and its Applications (ICRM 2021).** The organizers are looking forward to welcoming you next year in Bucharest!

2. We are seeking for a motivated collaborator (for part time / full time employment at IFIN-HH), radiochemist with a minimum 5 years experience; he/she will work in the preparation of radioactive standard solutions and sources.

LABORATORY	IFIN-HH, Radionuclide Metrology Laboratory, Romania
NAMES	Maria Sahagia, Mihail Razvan Ioan, Andrei Antohe, Aurelian Luca
ACTIVITY	Measurement of activity of ^{89}Zr
KEYWORDS	Coincidence method, Gas proportional counter, Radionuclide: ^{89}Zr, ^{54}Mn
RESULTS	(i) Absolute standardization of ^{89}Zr by the 4πβ(PC)-γ coincidence method: a new equivalent decay scheme, writing coincidence equations and choice of the optimal measurement conditions. (ii) Measurements by HPGe gamma-ray spectrometry, to determine the possible impurities, to measure the activity and the relative intensities of the emitted gamma rays. (iii) Calibration of the CENTRONIC IG12/20A ionization chamber, by direct measurement using standard solution and linear least squares modelling; their comparison. (iv) Comparisons of results of all measurement methods
PUBLICATIONS	1. M. Sahagia*, A. Luca, A. Antohe, M.-R. Ioan, « Standardization of the emerging medical positron emitter ^{89}Zr », J. Radioanal. Nucl. Chem. 322 (2019) 1683-1689 (*paper presented at the 2nd International Conference on Radioanalytical and Nuclear Chemistry / RANC 2019, May 5–10, 2019, Budapest, Hungary); 2. M. Sahagia, A. Luca, « Absolute standardisation of the radionuclide ^{54}Mn and participation at international comparisons », The 7th International Proficiency Testing Conference (Ptconf 2019), Oradea, Romania, 10-13 September, 2019, Proceedings, ISSN 2066-737X, 187-193, Smart Publishing house, Romania, 2019
INFORMATION	http://proiecte.nipne.ro/ifa-cea/10-projects.html
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	M. Sahagia*, G. Stanescu, A. Luca, A. Antohe, M. R. Calin, I. Radulescu, « Education and training tradition at IFIN-HH in radon measurement and evaluation of radiological impact », Romanian Reports in Physics 71, 4 (2019) art.no. 906 (*paper presented at the "International Symposium on Natural Radiation Sources – Challenges, Approaches and Opportunities", organized by the Romanian Nuclear Authority (CNCAN), Bucharest, Romania, 21-24 May 2019).
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: msahagia@nipne.ro, razvan.ioan@nipne.ro
CONTACT	Maria Sahagia, Mihail-Razvan Ioan

LABORATORY	IFIN-HH, Radionuclide Metrology Laboratory, Romania
NAMES	Aurelian Luca, Mihail Razvan Ioan, Cornel Liviu Tugulan, Catalina Barna, Doru Stanga, Daniela Gurau
ACTIVITY	Measurement of ^{89}Zr activity and nuclear decay data; Participation to the EURAMET project no. 1475 – EURAMET.RI(II)-S8.Rn-222N comparison and to two ICRM GSWG actions; Radioactivity analysis for various samples.
KEYWORDS	Gamma-ray spectrometry, Data measurement, Simulation code, Radionuclide: ^{89}Zr, ^{222}Rn, ^{214}Pb, ^{214}Bi
RESULTS	(i) Relative activity standardization of ^{89}Zr and measurement of the photon emission intensities from the decay of ^{89}Zr; (ii) Measurements of the ^{222}Rn activity in secular equilibrium with its daughters ^{214}Pb and ^{214}Bi, in the frame of the EURAMET project no. 1475; (iii) Participation in two ICRM GSWG actions consisting in the determination of the detection efficiency and true coincidence summing corrections, using Monte Carlo simulation codes.
PUBLICATIONS	1. M. Bruggeman, S.M. Collins, L. Done, M. Durasevic, M.A. Duch, A. Gudelis, M. Hyza, A. Jevremovic, A. Kandic, M. Korun, S. Ilie, J.M. Lee, K.B. Lee, A. Luca, R.M. Margineanu, A. Pantelica, I. Serrano, B. Seslak, L.C. Tugulan, L. Verheyen, B. Vodenik, I. Vukanac, Z. Zeng, B. Zorko, "Systematic influences on the areas of peaks in gamma-ray spectra that have a large statistical uncertainty", Appl. Radiat. Isot. 134 (2018) 51-55; 2. D. Gurau, S. Boden, O. Sima, D. Stanga, "Determination of the neutron activation profile of core drill samples by gamma-ray spectrometry", Appl. Radiat. Isot. 134 (2018) 194-199; 3. M. Sahagia, A. Luca, M.-R. Ioan, A. Antohe, C. Ivan, "Standardization of ^{67}Cu and calibration of the ionization chamber. Impurities and decay scheme problems", Appl. Radiat. Isot. 134 (2018) 297-301
IN PROGRESS	1. M.-C. Lépy et al., "A benchmark for Monte Carlo simulation in gamma-ray spectrometry", proceedings of the ICRM-2019 conference (Appl. Radiat. Isot.); 2. O. Sima et al., "Consistency test of coincidence-summing calculation methods for extended sources", proceedings of the ICRM-2019 conference.
SOURCE IN PREPARATION	New calibrations of the two spectrometry systems with HPGe and Si(Li) detectors, using standard radioactive sources and Monte Carlo simulation codes
ADDRESS	IFIN-HH, PO Box MG-6, RO-077125, 30 Reactorului St., Magurele, Ilfov county, Romania; tel.: +4021 4046163, fax: +4021 4574440, +4021 4574945; e-mail: aluca@nipne.ro
CONTACT	Aurelian Luca

LABORATORY	IFIN-HH, Radionuclide Metrology Laboratory, Romania
NAMES	A. Antohe, M. Sahagia, C. Ivan, M.-R. Ioan, Ph. Cassette
ACTIVITY	Measurement of activity of ^{222}Rn and daughters
KEYWORDS	Liquid scintillation, Triple-to-Double-Coincidence-Ratio, Radionuclide: ^{222}Rn
RESULTS	Absolute activity standardization of ^{222}Rn in secular equilibrium with its daughters, dissolved in liquid scintillator, participation to the comparison EURAMET project no. 1475 – EURAMET.RI(II)-S8.Rn-222N; Calibration of commercial Liquid Scintillation Counters.
PUBLICATIONS	A. Antohe, M. Sahagia, Ph. Cassette, A. Luca, M. R. Ioan, « Tritium standardization by the LSC-TDCR method and participation at international comparisons », Rom. Rep. Phys. 71, no. 3, 209, 2019
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	A new installation for absolute activity standardization 4πβ(LS)-γ is under construction.
OTHER RELATED PUBLICATIONS	M. Sahagia, G. Stanescu, A. Luca, A. Antohe, M. R. Calin, I. Radulescu, « Education and training tradition at IFIN-HH in radon measurement and evaluation of radiological impact »*, Romanian Reports in Physics 71, 4 (2019) art.no. 906 (*paper presented at the "International Symposium on Natural Radiation Sources – Challenges, Approaches and Opportunities", organized by the Romanian Nuclear Authority (CNCAN), Bucharest, Romania, 21-24 May 2019).
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: antohe@nipne.ro
CONTACT	Andrei Antohe

LABORATORY	IFIN-HH, Radionuclide Metrology Laboratory, Romania
NAMES	Aurelian Luca, Mihail Razvan Ioan
ACTIVITY	Nuclear decay data evaluation
KEYWORDS	Data evaluation, Gamma-ray spectrometry, Data measurement, Radionuclide: ^{89}Zr, ^{226}Th, ^{223}Ra, ^{230}U
RESULTS	Participation in the IAEA CRP F41029: Nuclear Data for Charged-particle Monitor Reactions and Medical Isotope Production: nuclear decay data evaluation of ^{226}Th; Nuclear decay data for ^{89}Zr (determination) and ^{223}Ra (evaluation), project IFA Romania – CEA France no. C5-09/2016: Metrology research for the standardization of some pharmaceutical and public health interest radionuclides, to ensure radioprotection in hospitals, homes and working places (2016-2019)
PUBLICATIONS	1. A. Hermanne et al., « Reference Cross Sections for Charged-particle Monitor Reactions », Nucl. Data Sheets 148, 338-382, 2018; 2. A. Luca, M.-R. Ioan, « U-230 nuclear decay data evaluation », Appl. Radiat. Isot. 134, 426-428, 2018; 3. F.T. Tarkanyi et al., « Recommended nuclear data for medical radioisotope production: diagnostic gamma emitters », J. Radioanal. Nucl. Chem., vol. 319, issue 2, 487-531, 2019; 4. F.T. Tarkanyi et al., « Recommended nuclear data for medical radioisotope production: diagnostic positron emitters », J. Radioanal. Nucl. Chem., vol. 319, issue 2, 533-666, 2019; 5. J.W. Engle et al., « Recommended Nuclear Data for the Production of Selected Therapeutic Radionuclides », Nucl. Data Sheets 155, 56-74, 2019.
IN PROGRESS	1. A. Luca, « ^{226}Th nuclear decay data evaluation », proceedings of the ICRM-2019 conference, Salamanca, Spain, 27-31 May 2019 (in press, Appl. Radiat. Isot.); 2. A. Luca, M.A. Kellett, « A new evaluation of the nuclear decay data of ^{223}Ra », oral paper presented at ND-2019 conference, Beijing, China, 19-24 May 2019.
INFORMATION	https://www.iaea.org/projects/crp/f41029
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	IFIN-HH, PO Box MG-6, RO-077125, 30 Reactorului St., Magurele, Ilfov county, Romania; tel.: +4021 4046163, fax: +4021 4574440, +4021 4574945; e-mail: aluca@nipne.ro
CONTACT	Aurelian Luca

LABORATORY	Physics Department, University of Bucharest, Romania
NAMES	Octavian SIMA (Professor Emeritus)
ACTIVITY	Simulation of gamma-spectrometry measurements for inhomogeneous sources; Measurement of ^{210}Pb by gamma-spectrometry, improved self-attenuation corrections; Evaluation of methods applied for the computation of coincidence-summing effects in the case of extended sources
KEYWORDS	Gamma-ray spectrometry; Monte Carlo simulation, data evaluation; data measurement
RESULTS	Observation of the effect of matrix inhomogeneity on the best estimate and uncertainty of the efficiency in the case of extended sources. Improved ^{210}Pb assessment in sediment samples measured in well-type detector configuration. Self-consistency test of methods applied for the computation of the coincidence-summing corrections – 33 sets of results were evaluated
PUBLICATIONS	O. Sima, On homogeneity approximation in calibration of gamma-spectrometry assessment of bulk samples, APPL RADIAT ISOTOPES, 134 (2018) 137-141 D. Gurau et al., D, Determination of the neutron activation profile of core drill samples by gamma-ray spectrometry, APPL RADIAT ISOTOPES, 134 (2018) 194-199 A. R. Iurian et al., Self-attenuation corrections for Pb-210 in gamma-ray spectrometry using well and coaxial HPGe detectors, APPL RADIAT ISOTOPES, 134 (2018) 151-156 O. Sima et al., Consistency test of coincidence-summing calculation methods for extended sources, APPL RADIAT ISOTOPES, 155 (2020) art. 108921 S. Ilie et al., Determination of the Co-60 source activity by using the sum-peak method, ROM REP PHYS, 71 (2019) art. 211
IN PROGRESS	Action of the GSWG: angular correlation effects on coincidence-summing corrections
INFORMATION	Member of the Nominating Committee of the ICRM
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Physics Department, University of Bucharest, RO-077125, Magurele, Romania 405 Atomistilor Str., P.O.Box MG-11 Phone: +0040724692554; e-mail: OctavianAlexandru.Sima@g.unibuc.ro
CONTACT	Octavian Sima

Jožef Stefan Institute, Laboratory for Radioactivity Measurements (LMR), Laboratory for Liquid Scintillation Spectrometry (LSC), Slovenia, SA1/SA2

2018-2021 Progress Report and Work Plan
(information for ICRM members)

The programmes at the Jožef Stefan Institute, Laboratory for Radioactivity Measurements and Laboratory for Liquid Scintillation Spectrometry in the field of radionuclide metrology in the years 2018–2021 were and will be focused, as in the past, on maintaining and developing gamma-ray spectrometry method and liquid scintillation spectrometry, participation in characterisation and preparation of reference material (i.e. intercomparison samples) and quality-assurance in radioactivity measurements.

The Jožef Stefan Institute, Laboratory for Radioactivity Measurements (LMR) and Laboratory for Liquid Scintillation Spectrometry (LSC) staff in 2019 was the following:

Scientists	**Function**
Toni Petrovič	Head of Laboratory for Radioactivity Measurements from November 2017, gamma-ray spectrometrist
Jasmina Kožar Logar	Head of Laboratory for Liquid Scintillation Spectrometry, liquid scintillation spectrometrist, C-14, total α/β and H-3
Branko Vodenik	Gamma-ray spectrometrist
Denis Glavič-Cindro	Quality manager and gamma-ray spectrometrist
Benjamin Zorko	Gamma-ray spectrometrist
Marijan Nečemer	Gamma-ray spectrometrist (radiochemist)
Boštjan Črnič	Gamma-ray spectrometrist
Romana Krištof	Liquid scintillation spectrometrist, C-14, total α/β and H-3
Matjaž Korun	Consultant (retired)
Technicians	
Mitja Centrih	Sampling; sample preparation for liquid scintillation
Diana Marguč	Sampling; sample preparation for liquid scintillation
Drago Brodnik	Sampling, equipment maintenance
Sandi Gobec	Sampling
Petra Osterman	Sampling and sample preparation

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

Activity line	**IJS, LMR and LSC 2018-2019 Progress report**	**IJS, LMR and LSC 2020-2021 Work plan**
Improvement of measuring methods and instrumentation	– Traceability in gamma-ray spectrometry and liquid scintillation spectrometry – Interpretation of measurement results near the detection limit and decision threshold in gamma-ray and liquid scintillation spectrometry – Implementation of methods for quantitative interpretation of gamma-ray spectrometric measurement results near the natural limit (zero activity)	– Traceability in gamma-ray and liquid scintillation spectrometry – Improvement of the robustness of gamma-ray spectrometric measurements of water samples – Development of generalized method for determination of H-3 in water samples by electrolytic enrichment – Improvement of the sensitivity of total alpha / beta ray spectrometric measurements of water samples

Activity line	**IJS, LMR and LSC 2018-2019 Progress report**	**IJS, LMR and LSC 2020-2021 Work plan**
	– Determination and interpretation of tritium, total alpha / beta activity and members of the uranium and thorium decay in ground-water samples using gamma-ray spectrometry and liquid scintillation spectrometry – Determination and evaluation of uncertainty arising from sampling of environmental samples – Validation and on-site testing of a complex portable aerosol sampling device with an on-line capability for monitoring of airborne radioactivity – Technical development of detector systems mounted on UAV and used for localisation of radiation hot-spots in contaminated areas – Development and optimization of direct method for determination of bio-components in fuels – Accreditation of method for determination of C-14 in different samples – Implementation of the method for determination of OBT (sample preparation, development and introduction of the new equipment)	– Further evaluation of uncertainty arising from sampling of environmental samples – Optimisation and further development of the method for determination of OBT (sample preparation, development and introduction of the new equipment) – Optimisation and further development of the method for determination of C-14 in different materials (sample preparation, development and introduction of the new equipment) – Further development of detector systems mounted on UAV and used for localisation of radiation hot-spots in contaminated areas – Further development and upgrade of the transportable air-sampling system for in-field use with real time gamma spectrometry, including calibration, validation and operation of such systems – Development of a new gamma-ray spectrometry acquisition and analysis platform
International comparisons	– Participation in supplementary comparison on measurement of the activity concentration of Cs-137 and K-40 in rice material CCRI(II)-S9 (pilot KRISS) – Participation in supplementary comparison on measurement of an activity per unit mass of Cs-134 and Cs-137 in wheat flour CCRI(II)-S13 (pilot NMIJ, 2018) – ETRIT intercomparison on H-3 in water, IARMA (2018, 2019) – EGROSS intercomparisons on the determination of gross alpha and beta in water, IARMA (2018, 2019) – ERAD intercomparisons on determination of radionuclides	– Participation in supplementary comparison on measurement of Cs–137 and K-40 in the mushroom CCRI(II)-S15 (pilot KRISS) – NPL Environmental Radioactivity Proficiency Test Exercise 2021 (GL and solid sample) – PROCORAD intercomparison; different radionuclides in urine (gamma ray emitters, H-3, total alpha / beta, C-14) (2020 or 2021) – Interlaboratory comparison on gamma-ray radionuclides in different samples, total alpha / beta and tritium in water samples (IAEA ALMERA 2020 and 2021)

Activity line	**IJS, LMR and LSC 2018-2019 Progress report**	**IJS, LMR and LSC 2020-2021 Work plan**
	in water and solid samples, IARMA (2018, 2019) – Interlaboratory comparison on gamma-ray radionuclides and gross alpha/beta activity measurement in water, soil sediments, vegetation, simulated aerosol filters, IAEA ALMERA (2018, 2019) – Proficiency test for radionuclides in seawater, IAEA RML (2018, 2019) – TRIC 2018, IAEA – MRI, Radionuclides in raw milk and soil (2018, 2019) – International OBT workshop (Montreal, Canada): OBT 2018 – International OBT workshop (Constanta, Romania): OBT 2019 – Instiytut Ceramiki I Materialow Budowlancych, Poland, C-14, Diesel, HVO, FAME (2018)	– ETRIT, EGROSS, ERAD intercomparisons (IARMA, 2020 and 2021) – Participation in other suitable interlaboratory comparisons
Standardization of measurement methods	– Homogeneity tests of water and hay samples IARMA, UK (2018) – Homogeneity tests of water and seaweed samples IARMA, UK (2019) – Characterisation of stainless steel disks EURM 800 and 801 for their massic ^{60}Co content JRC Geel	– Characterization of samples for ALMERA IAEA and IARMA, UK (2020, 2021) – Development of a new Digital Signal Analyzer for gamma ray spectrometry – Preparation steps for standardization of the direct LSC method for determination of biocomponents in fuels
National QA programmes and services	– Collaboration with IAEA (characterisation of different reference materials) – Collaboration with IARMA UK (characterisation and preparation of different reference materials)	– Collaboration with IAEA (characterisation of other reference materials) – Collaboration with IARMA UK (preparation of reference materials in different types of water and their characterization)
Membership in international and national organisations	– ICRM – EURAMET TC-IR – EURADOS – CONCERT – SIST/TC UGA (National Standardisation Organisation) – ALMERA (IAEA) – MODARIA (IAEA) – NERIS – International group for OBT	– ICRM – EURAMET TC-IR – EURADOS – CONCERT – SIST/TC UGA (National Standardisation Organisation) – ALMERA (IAEA) – MODARIA (IAEA) – NERIS – International group for OBT

Activity line	**IJS, LMR and LSC 2018-2019 Progress report**	**IJS, LMR and LSC 2020-2021 Work plan**
Management and Organization	– European Project (EMPIR 2016) Preparedness	– Europen Project (EMPIR 2016) Preparedness – European Project (EMPIR 2019) supportBSS, Support for a European Metrology Network on reliable radiation protection regulation
Teaching activity	– Lectures for national users given at IJS – Invited lectures (IAEA) – Mentorship on BSc, MSc, PhD thesis – Hosting of foreign academic stuff on their sabbatical year	– Lectures for national users given at IJS – Invited lectures – Mentorship on BSc, MSc, PhD thesis – International fellows on trainings
Quality system	– Management of Quality System, harmonisation with ISO/IEC 17025:2017	– Improvement of Quality System

LABORATORY	Jožef Stefan Institute, Laboratory for Radioactivity Measurements (LMR), Laboratory for Liquid Scintillation Spectrometry (LSC), Slovenia
NAMES	Denis Glavič-Cindro, Branko Vodenik, Toni Petrovič, Jasmina Kožar Logar, Benjamin Zorko, Marijan Nečemer, Boštjan Črnič, Matjaž Korun, Romana Krištof, Drago Brodnik, Sandi Gobec, Petra Osterman, Mitja Centrih, Diana Marguč
ACTIVITY	Laboratory for Radioactivity Measurements develops gamma-ray spectrometry measurement methods with the emphasis on the metrological point of view and performs routine measurements of the samples belonging to the regular environmental monitoring programs
KEYWORDS	gamma-ray spectrometry, beta spectrometry, liquid scintillation spectrometry, X-ray spectrometry, EURAMET, environmental control, data evaluation, data measurement, low level, traceability
RESULTS	–
PUBLICATIONS	BRUGGEMAN, M., KORUN, Matjaž, VODENIK, Branko, ZORKO, Benjamin, et al. *Systematic influences on the areas of peaks in gamma-ray spectra that have a large statistical uncertainty*. Applied Radiation and Isotopes, 134 (2018) 51–55 KORUN, Matjaž, VODENIK, Branko, ZORKO, Benjamin. *An alternative approach to the decision threshold*. Applied radiation and isotopes, 134 (2018) 56–58 GLAVIČ-CINDRO, Denis. *Comparison of intercomparison results of gamma ray spectrometry of spiked and real samples*. Applied Radiation and Isotopes, 134 (2018) 59–63 GLAVIČ-CINDRO, Denis, BRODNIK, Drago, CARDELLINI, Francesco, DE FELICE, Pierino, PONIKVAR, Dušan, VENCELJ, Matjaž, PETROVIČ, Toni. *Evaluation of the radon interference on the performance of the portable monitoring air pump for radioactive aerosols (MARE)*. Applied Radiation and Isotopes, 134 (2018) 439–445 KORUN, Matjaž, VODENIK, Branko, ZORKO, Benjamin. *Calculation of the detection limits for radionuclides identified in gamma-ray spectra based on post-processing peak analysis results*. Applied Radiation and Isotopes, 133 (2018) 22–30 MASSON, Oliver, ZORKO, Benjamin, et al. *Potential source apportionment and meteorological conditions involved in airborne ^{131}I detections in January/February 2017 in Europe*. Environmental science & technology, 53 (2018) 8488–8500 BRODNIK, Drago, GLAVIČ-CINDRO, Denis, KORUN, Matjaž, NEČEMER, Marijan, MAVER, Petra, PETROVIČ, Toni, VIDMAR, Tim, VODENIK, Branko, ZORKO, Benjamin. *Negative correlation between the number of sunspots and the occurrence of ^{7}Be and ^{22}Na in the surface air and their contribution to radiation doses*. Arhiv za higijenu rada i toksikologiju, ISSN 0004-1254. 70 (2019) 290–295 MORA, Juan C., ZORKO, Benjamin, et al. *On the use of reference areas for prospective dose assessments on populations 1 of wildlife for planned atmospheric discharges around nuclear installations*. Environmental research: multidisciplinary journal of environmental sciences, ecology, and public health, ISSN 0013-9351, 2019, 28 pages ČERNE, Marko, PALČIĆ, Igor, PASKOVIĆ, Igor, MAJOR, Nikola, ROMIĆ, Marija, FILIPOVIĆ, Vilim, IGRC, Marina Diana, PERČIN, Aleksander, GORETA BAN, Smiljana, ZORKO, Benjamin, VODENIK, Branko, GLAVIČ-CINDRO, Denis, MILAČIČ, Radmila, HEATH, David John, BAN, Dean. *The effect of stabilization on the utilization of municipal sewage sludge as a soil amendment*. Waste management, (2019) 94 27–38

	CHARRASSE, Benoit, ZORKO, Benjamin, et al. *Does the use of reference organisms in radiological impact assessments provide adequate protection of all the species within an environment?*. Science of the total environment, 658 (2019) 189–198 MASSON, O., ZORKO, Benjamin. *Airborne concentrations and chemical considerations of radioactive ruthenium from an undeclared major nuclear release in 2017*. Proceedings of the National Academy of Sciences of the United States of America, ISSN 0027-8424, 2019, 10 pages GLAVIČ-CINDRO, Denis, HAZOU, Eyakifama, KORUN, Matjaž, KRIŠTOF, Romana, OSTERMAN, Petra, PETROVIČ, Toni, VODENIK, Branko, ZORKO, Benjamin. *Measurement uncertainty arising from sampling of environmental samples*. Applied Radiation and Isotopes, 5 (2020) 108978-1–108978-5 ALI SANTORO, M. C., KORUN, Matjaž, VODENIK, Branko, ZORKO, Benjamin, et al. *Determining the probability of locating peaks using computerized peak-location methods in gamma-ray spectra as a function of the relative peak-area uncertainty*. Applied Radiation and Isotopes, 155 (2020) 108920-1–108920-6 KORUN, Matjaž, PETROVIČ, Toni, VODENIK, Branko, ZORKO, Benjamin. *Empirical determination of the correlation coefficient between the number of counts in a peak in a gamma-ray spectrum and the number of counts in the continuum where the peak is superimposed*. Applied Radiation and Isotopes, 158 (2020) 109063-1–109063-4
IN PROGRESS	**Participation in the European Projects: Preparedness (EMPIR 2016) and supportBSS (EMPIR 2019)** **PREPAREDNESS** (EMPIR Call 2016 Environment), the overall objective of this project is the establishment of a metrological basis to support adequate protective measures in the aftermath of nuclear and radiological emergencies. JSI is engaged in development of unmanned aerial detection systems installed on drones for the remote measurement of dose rates and radioactivity concentrations and in development of transportable air-sampling systems. IJS is engaged at WP1, WP2, WP4 and WP5. **supportBSS** (EMPIR 2019), the overall aim of this project is to develop a long-term ongoing dialogue between the metrology community and relevant stakeholders. This dialogue should support the take-up of research outputs from the metrology community and the collection of needs from stakeholders to inform future research. Continuation of work on calculation of decision thresholds and detection limits in gamma-ray spectrometry, and reporting 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, testing of new approach of raw spectral data evaluation on LSC. Further evaluation of the uncertainty arising from the sampling of environmental samples.
INFORMATION	In 2019 we organised regular Annual meeting of EURAMET TC-IR at Jožef Stefan Institute, Ljubljana, Slovenia , January 28–31, 2019
SOURCE IN PREPARATION	KRAJCAR-BRONIĆ Ines, BAREŠIĆ Jadranka, HROVATINČIĆ Nada, KRIŠTOF Romana, KOŽAR LOGAR Jasmina, *New techniques of determination of biogenic fraction in liquid fuels by the C-14 method*

	KRIŠTOF Romana, KOŽAR LOGAR Jasmina, *New approach to general calibration curves for all types of biocomponents in diesel*, working title KRIŠTOF Romana, BAEZA JIMENEZ Ramiro, KOŽAR LOGAR Jasmina OTERO Cristina, *Acid-catalysed biodiesel preparation and characterization of biodiesels from various feedstocks*, working title VODOPIVEC Tina, KOŽAR LOGAR Jasmina, *Total Activity of alpha / beta emitters in drinking waters: validation and optimization of the method,* working title KRIŠTOF Romana, KOŽAR LOGAR Jasmina, VARLAM Carmen, WAGNER Irina, *Intercomparison of samples and methods for determination of biocomponents in fuels by LSC,* working title
OTHER RELATED PUBLICATIONS	–
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CONTACT	Denis Glavič-Cindro

LABORATORY	National Metrology Institute of South Africa (NMISA), Radioactivity Standards Laboratory, South Africa
NAMES	M.J. van Staden, J. Lubbe, M.W. van Rooy
ACTIVITY	On-going project: Upgrade and verification of the NMISA Primary Measurement Data Acquisition System from analogue to digital coincidence counting. Participation in BIPM K1 comparisons of Ba-133 and Ce-139 in 2019. Participation in CCRI(II) K2 comparison of Fe-55 in 2019/2020. Participation in IAEA-TEL-2018-03 and IAEA-TEL-2019-03 low-level PT schemes. NMISA provided radioactivity measurement services to the South African user community and the National Nuclear Regulator (NNR). These services included: - calibration verification checks performed on various activity (dose) calibrators/ ionization chambers at production facilities and nuclear medicine departments; - standardization of various radionuclides (liquids) & I-131 therapy capsules (subsequently used by production facilities and nuclear medicine departments for calibration of dose calibrators); - supply of H-3 standards to the NNR, for low-level LSC measurements; - radio-analysis of various food- & environmental samples using HPGe gamma-ray spectrometry.
KEYWORDS	gamma-ray spectrometry, ionisation chamber, liquid scintillation, low-level, SIR, source preparation, traceability, Ho-166m, Ba-133, Ce-139, Fe-55
RESULTS	Draft B reports were received for BIPM K1 comparisons of Co-57, I-131, Ho-166m, Ba-133, Ce-139, all results showed agreement with the respective KCRVs. Participation in IAEA-TEL-2018-03 and IAEA-TEL-2019-03 low-level PT schemes, all results were deemed acceptable.
PUBLICATIONS	M.W. van Rooy, M.J. van Staden, B.R.S. Simpson, J. Lubbe. *Absolute standardizations of ^{99m}Tc and ^{57}Co by 4π electron-gamma liquid scintillation coincidence counting for SIRTI and SIR comparisons*. Appl. Radiat. Isot. 134 (2018) 245-251. A.Yunoki et al, *Report on APMP comparison of the activity measurements of Fe-59 (APMP.RI(II)-K2.Fe-59)*. Metrologia 57 (2020) Tech. Suppl. 06002. M.W. van Rooy, M.J. van Staden, B.R.S. Simpson, J. Lubbe. *Activity determination of ^{18}F using liquid scintillation beta-efficiency extrapolation and non-extrapolation methods.* Applied Radiation and Isotopes, in press, available on-line: https://www.sciencedirect.com/science/article/pii/S0969804319307328?via%3Dihub#

IN PROGRESS	Completed the method development and validation of LSC low-level H-3 measurements for water samples with a PerkinElmer Tri-Carb 3180 TR/SL. Completed method development and validation of low-level activity measurements for environmental samples with an HPGe detector. Application for ISO 17025 accreditation is planned for 2020. Ongoing method development and validation of LSC low-level Sr-90 measurements with a PerkinElmer Tri-Carb 3180 TR/SL.
INFORMATION	M.W. van Rooy: Presented a poster at the ICRM 2019 conference titled "First absolute standardization of F-18 at NMISA using liquid scintillation beta-efficiency extrapolation and non-extrapolation methods for SIRTI comparison". Presented a poster at the SAIP 2019 conference titled "NMISA quality assurance through international comparisons of radioactivity measurements". Presented a talk at the ANSTT1(2018) workshop at iThemba LABS Cape Town titled "Primary and secondary radioactivity measurement capabilities at NMISA". Attended ANSTT2 (2019) workshop at iThemba LABS Cape Town. Presented a training course on radionuclide metrology and related uncertainties at SAINTS student training programme at iThemba LABS Cape Town in 2019. Attended CCRI(II) meetings at BIPM in 2019. Presented colloquium titled "Ensuring the quality of life of South Africans through radioactivity measurements" at iThemba LABS Cape Town in 2018. J. Lubbe: Presented a talk at the SAAPMB 2018 congress titled "NMISA's Quality of Life Program supports nuclear medicine". Presented a talk at the NLA Test & Measurement 2018 conference titled "NMISA Radioactivity Standards section participation in proficiency testing schemes". Presented a talk at the SAAPMB 2019 congress titled "Technology upgrades at the NMISA Radioactivity Standards section".
SOURCE IN PREPARATION	H-3 Bilateral comparison with LNHB IAEA-TEL-2020-03
OTHER RELATED PUBLICATIONS	None
ADDRESS	NMISA Radioactivity Standards Laboratory 15 Lower Hope Road Rosebank 7700 Cape Town South Africa
CONTACT	Martin van Staden Tel. +27 21 685 0337, fax +27 21 686 2759 E-mail : mvstaden@nmisa.org or radioactivity@nmisa.org

(CIEMAT) Radionuclide Metrology
2018-2021 Progress Report and Work Plan

(information for ICRM members)

Laboratorio de Metrología de Radiaciones Ionizantes (CIEMAT), Spain, SA1/SA2

The programme at the CIEMAT in the field of radionuclide metrology in the years 2018-2019 was on maintaining and developing the primary and secondary national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

The CIEMAT staff in 2019 were:

Scientists	**Function**
Miguel Embid	Head (of laboratory or group)
Miguel Roteta	Primary activity standards
Virginia Peyrés	Secondary activity standards
	Environmental studies
Nuria Navarro	Liquid scintillation counting
	Gamma spectrometry
Teresa Crespo	Alpha spectrometry
	Radon standards
Roberto Méndez	Neutron standards
Teresa Crespo	Source preparation/radiochemistry
Technicians	
Marcos Mejuto	Primary activity standards
Daniel Muñoz	Secondary activity standards
Oscar Oller	Source preparation/radiochemistry
	Radon standards

The main specific activities carried out at CIEMAT in this field are summarised below.

Activity line	**CIEMAT Radionuclide Metrology 2018-2019 Progress report**	**CIEMAT Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Development of new primary standards • Developments • ...	• Setup of the absolute X-ray counter • Interface for digital acquisition systems (Gamma-ray, TDCR, coincidence setups) • Measurements of Tc-99,Ca-41 and Cl-36 by TDCR,CIEMAT-NIST methods and coincidence with tracers. • Standardization of new PET nuclides •

Activity line	**CIEMAT Radionuclide Metrology 2018-2019 Progress report**	**CIEMAT Radionuclide Metrology 2020-2021 Work plan**
International comparisons	• BIPM (Fe-55) • Bilateral • ...	• BIPM CCRI(II) (Cd-109, Zn-65)) • SIR (Tc- 99m, etc.) • Bilateral • ...
Standardization of measurement methods	• New LSC efficiency counting calculation based on PENNUC-NUCLEIDE interface • TDCR setup • Interface for digital acquisition systems • Standardization of PET nuclides (Sc-44, Zr-89) • …	• Setup of the absolute X-ray counter • Interface for digital acquisition systems (Gamma-ray, TDCR, coincidence setups) • Measurements of Th-229 • Standardization of new PET nuclides •
National QA programmes and services	• Preparation of radioactive standards for external users, solid and liquid, alpha-, beta- and gamma-emitters. • Reference mixed standards (liquid) for NPP's and cocktails of gamma emitters for other clients. • Calibration of surface contamination monitors • Calibration of activimeters (mainly Tc-99m and F-18) ...	• Preparation of radioactive standards for external users. • Preparation of reference mixed standards • Calibration of surface contamination monitors • Calibration of activimeters • Preparation of national intercomparison of NPP laboratories (CSN-CIEMAT)
Membership in international and national organisations	• ICRM committee membership • BIPM/CCRI(II), IAEA, IEC, ISO, ...	• ICRM committee membership • BIPM/CCRI(II), IAEA, IEC, ISO, ...
Management and Organisation	• European Projects: MetroDecom • …	• European Projects...
Teaching activity	• Master and other courses at IEE (Institute for Energy Studies) at CIEMAT.	• Master and other courses at IEE (Institute for Energy Studies) at CIEMAT.
Quality system	• Management of Quality System • Improvements • Developments	• Management of Quality System • Improvements • Developments

LABORATORY	Laboratorio de Metrología de Radiaciones Ionizantes (CIEMAT), Spain
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta, Teresa Crespo, Nuria Navarro
ACTIVITY	Standardization of alpha-beta and gamma emitting nuclides. European projects and SIR contributions
KEYWORDS	Coincidence method, gamma-ray spectrometry, ionisation chamber, liquid scintillation, NaI well-type counter
RESULTS	Measurements of Fe-55. Preparation of the gamma cocktail (Am-241, Mn-54, Zn-65, Co-57, Co-60, Cs-137, Sn-113, Y-88) A new coincidence system (LSC-gamma) has been designed and built
PUBLICATIONS	
IN PROGRESS	Measurements of Ca-41, Cl-36, Tc-99 and other PET nuclides.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain
CONTACT	miguel.roteta@ciemat.es +34 91 346 6244 virginia.peyres@ciemat.es +34 91 346 6225 e.garciatorano@ciemat.es +34 91 346 6225 nuria.navarro@ciemat.es +34 91 346 6566 teresa.crespo@ciemat.es +34 91 346 6553

LABORATORY	Laboratorio de Metrología de Radiaciones Ionizantes (CIEMAT), Spain
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta, Nuria Navarro, Teresa Crespo
ACTIVITY	Standardization and Nuclear data Measurements of PET Radionuclides
KEYWORDS	Nuclear data, PET nuclides, coincidence method, gamma-ray spectrometry, ionisation chamber, life sciences, liquid scintillation, NaI well-type counter
RESULTS	Representativeness of volume samples spiked in layers versus those homogeneously spiked was evaluated.
PUBLICATIONS	M. C. Ferrari, V. Peyres, N. Navarro, M. P. Rossi, G. Cerutti, M. Mejuto, T. Crespo. On the equivalence between homogeneously prepared sources and sources prepared by seeding in layers for different geometries, energies and matrix parameters. Applied Radiation and Isotopes 154 (2019) 108894. https://doi.org/10.1016/j.apradiso.2019.108894.
IN PROGRESS	Measurements of NORM materials.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain
CONTACT	e.garciatorano@ciemat.es +34 91 346 6225 virginia.peyres@ciemat.es +34 91 346 6225 miguel.roteta@ciemat.es +34 91 346 6244 nuria.navarro@ciemat.es +34 91 346 6566 marcos.mejuto@ciemat.es +34 91 346 6244 daniel.munoz@ciemat.es +34 91 346 6566

LABORATORY	Laboratorio de Metrología de Radiaciones Ionizantes (CIEMAT), Spain
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta, Ana Isabel Sánchez-Cabezudo, Teresa Crespo
ACTIVITY	Standardization and Nuclear data Measurements of PET Radionuclides
KEYWORDS	Nuclear data, PET nuclides, coincidence method, gamma-ray spectrometry, ionisation chamber, life sciences, liquid scintillation, NaI well-type counter
RESULTS	Measurement of X-ray emission of Fe-55, Mn-54 and fluorescence sources.
PUBLICATIONS	Absolute determination of low-energy X-ray emission rates with a proportional counter lV.H.Elvira,V.Peyrés,M.Roteta,A.Fernández-Sotill,E.García-Torañoa https://doi.org/10.1016/j.apradiso.2020.109113
IN PROGRESS	Measurements of Fe-55 and other nuclides.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Laboratorio de Metrología de Radiaciones Ionizantes, Avenida Complutense 40, 28040 Madrid, Spain
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LABORATORY	Laboratorio de Metrología de Radiaciones Ionizantes (CIEMAT), Spain
NAMES	Eduardo García-Toraño, Virginia Peyrés, Miguel Roteta, Teresa Crespo, Marcos Mejuto, Nuria Navarro
ACTIVITY	Standardization of alpha-, beta- and gamma-emitting sources for external clients Calibration of surface contamination monitors. Calibration of Activimeters (Radionuclide Calibrators)
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	Liquid and solid reference sources for environmental laboratories; interlaboratory comparisons; calibration certificates for equipment. More than 130 technical services completed.
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 anaisabel.sanchez@ciemat.es tel: +34 91 346 6566 marcos.mejuto@ciemat.es tel :+34 91 346 6244
CONTACT	Virginia Peyrés (gamma measurements), Miguel Roteta and Marcos Mejuto (calibration of contamination monitors), Teresa Crespo (alpha measurements), Nuria Navarro (LSC), Eduardo García-Toraño (Nuclear Medicine, LSC)

LABORATORY	Institut de Radiophysique (IRA), Switzerland
NAMES	Claude Bailat, Frédéric Juget, Youcef Nedjadi, Maria Teresa Durán
ACTIVITY	Source preparation, coincidence method, NaI well counter, liquid and solid scintillation, gamma-ray spectrometry, ionization chamber, beta spectrometry, Monte Carlo simulation, Radon measurement, digitalization, proportional counter
KEYWORDS	beta spectrometry, (anti) coincidence method, cryogenic detector, data evaluation, data measurement, defined solid angle (ASD) measurement, environmental control, gamma-ray spectrometry, ionisation chamber, life sciences, liquid scintillation, low-level, NaI well-type counter, neutron measurement, radioactive gas, radiochemistry, simulation code, SIR, source preparation, traceability, solid sample reference
RESULTS	Standardization of Tb-161, Yb-175 and Er-169.
PUBLICATIONS	Frédéric Juget, Giuseppe Lorusso, Guido Haefeli, Youcef Nedjadi, François Bochud, Claude Bailat, Development and validation of a double focalizing magnetic spectrometer for beta spectrum measurements, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 942, 21 October 2019, 162384
IN PROGRESS	Standardization of Tb-161, Yb-175 and Er-169. Building a new reference ionization chamber Digitalization of the data acquisition and processing system Rn-222 comparison and development of a new gas container Purification of Ho-166m solution Measurement of half-life (Tb-161, Yb-175, Si-32)
INFORMATION	www.chuv.ch
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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CONTACT	Claude.bailat@chuv.ch

LABORATORY	National Radiation Standard Laboratory, Institute of Nuclear Energy Research (NRSL/INER), Taiwan
NAMES	Ming-Chen Yuan, Wei-Han Chu, Chien-Hau Chu
ACTIVITY	Standardization of Cr-51. Handled 2018 Proficiency Testing for Low and Intermediate Level Radio-assay Laboratories in Taiwan. Handled 2018 Proficiency Testing for Environmental Level Radio-assay Laboratories in Taiwan. Held 2019 Inter-Laboratory test for radionuclides in foods.
KEYWORDS	Standardization, absolute counting method, Cr-51, proficiency testing.
RESULTS	Cr-51 was standardized by $4\pi e(x) - \gamma$ coincidence counting method, and the measurement uncertainty was around 0.5%. A similar bilateral comparison with CMI(Czech Republic) was used to verify our results and showed good agreement. Six laboratories participated in the Low and Intermediate Level Radio-assay proficiency testing program. All of their results met the requirements of Taiwan Accreditation Foundation. Ten laboratories participated in the Environmental Level Radio-assay proficiency testing program. All of their results met the requirements of Taiwan Accreditation Foundation. Six laboratories participated in this Inter-laboratory test program of radionuclides in foods. Different amounts of mixed sources of Ba-133, Cs-134 and Cs-137 were spiked in water, milk powder and rice powder. Measurement results showed that the errors were around 0.83% to 30%.
PUBLICATIONS	
IN PROGRESS	Na-22 Standardization
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	Health Physics Division, Institute of Nuclear Energy Research, 1000 Wenhua Rd. Jiaan Village, Longtan District, Taoyuan City 32546, Taiwan (ROC)
CONTACT	Ming-Chen Yuan (mcyuan@iner.gov.tw), Wei-Han Chu (weihan@iner.gov.tw)

TAEK-RHTD, Radionuclide Metrology
2018-2021 Progress Report and Work Plan
(information for ICRM members)

TAEK RHTD, Radionuclide Metrology Laboratories, Turkey, SA1/SA2

The programmes at the Turkish Atomic Energy Authority, Department of Radiation and Accelerator Technologies, Radiation Metrology Division (TAEK RHTD-RMB) in the field of radionuclide metrology in the years 2018-2021 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-RHTD Radionuclide Metrology staff in 2019 were:

Scientists	**Function**
Ü. Yücel	Radionuclide standardization by liquid scintillation counting
E. Yeltepe	Radionuclide standardization by gamma spectrometry
N. K. Şahin	Radionuclide standardization by gamma spectrometry
G. Özçayan	Radionuclide standardization by liquid scintillation counting
A. Dirican	Radionuclide standardization by alpha spectrometry
M. Vural	Radionuclide standardization by gamma spectrometry

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

Activity line	**TAEK-RHTD Radionuclide Metrology 2018-2019 Progress report**	**TAEK-RHTD Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	Optimization of alpha particle counting system at defined solid angle Validation of TDCR method 4πβ-γ digital coincidence counting system	Improvement of the some parts of the hardware and software of the 4πβ-γ digital coincidence counting system. Validation of TDCR method.
International comparisons	Supplementary Comparison BIPM CCRI(II)-S13	

Standardization of measurement methods	Standardization with ionization chamber Standardization with HPGe detectors Standardization with CIEMAT-NIST method Standardization with TDCR method Standardization with 4πβ-γ digital coincidence counting method	Standardization with the ionization chamber Standardization with HPGe detectors Standardization with CIEMAT-NIST method Standardization with TDCR method Standardization with 4πγ counting system Standardization with 4πβ-γ digital coincidence counting method Standardization with DSA system
National QA programmes and services	Collaboration with IAEA (ALMERA Network proficiency tests) Organization of proficiency tests on national and international scale Preparation of radioactive standard reference materials	Preparation of radioactive standard reference materials for external users, Preparation of standard point sources for calibration Calibration of radionuclide calibrators with a reference ionization chamber, Organization of proficiency tests on national and international scale
Membership in international and national organisations	IAEA ALMERA Membership EURAMET TC IR ICRM committee membership	IAEA ALMERA Membership ICRM committee membership EURAMET TC IR, BIPM CCRI(II)
Management and Organisation		Participation in EMPIR projects
Teaching activity	Training course in Turkey on radioactivity measurement.	Workshops for national laboratories Invited lectures
Quality system	Improvement of Quality System	Improvement of Quality System

LABORATORY	TAEK RHTD, Radionuclide Metrology Laboratories, Turkey
NAMES	Ü. Yücel, E. Yeltepe, N.K. Şahin, G. Özçayan, M. Vural, A.Dirican
ACTIVITY	Organization of proficiency tests on national and international scale Method development Liquid scintillation counting Gamma-ray spectrometry Alpha particle counting and alpha spectrometry Preparation of reference materials
KEYWORDS	Alpha spectrometry, gamma-ray spectrometry, 4πβ-γ digital coincidence counting, Compton suppression system, liquid scintillation counting, TDCR, CIEMAT/NIST, low-level counting, radiochemistry, proficiency test, traceability, reference material
RESULTS	A primary method 4πβ-γ digital coincidence counting system has been setup in radionuclide metrology laboratories of TAEK. The system with its home-made calculation software is now ready to use. The validation of the system and the software has been performed. A defined solid angle alpha spectrometric system with accurate dimensions was designed and installed for primary standardisation. The design and construction of alpha source preparation systems were completed. Validation and uncertainty budget studies were completed. The improving studies of the failing components of this system have been performed. Activities of some beta particle emitters such as H-3, Ni-63 and Sr-90/Y-90 were measured by TDCR method and by conventional LSC method to test the performance of the TDCR system and to be more familiar with it in our laboratory. Efficiency calibration, verification and validation of secondary standard radionuclide calibrator was completed and ready for use as radioactivity standardization method. Activity concentrations of Ba-133, Co-60, Cs-137, Ge-68 and Eu-152 standard solutions prepared from the PTB standards in our own ampoules were determined and transferred into BIPM ampoules. They were sent BIPM for measurement and be used as CMC claims for these radionuclides. The report of the BIPM is now waited to be published. TAEK participated in the Supplementary International Comparison CCRI(II)-S13 organized by BIPM named as “Measurement of an activity per unit mass of Cs-134 and Cs-137 in wheat flour”. The activity concentrations of Cs-134 and Cs-137 in the wheat flour samples from Japan were measured and sent to BIPM. The results of the test are waited to be announced. An international proficiency test named as “TAEK-RMB-2018-01 Proficiency test on determination of activity concentrations of the natural and anthropogenic radionuclides in thermal water samples” was organized in 2018. The evaluation of the reported results was completed in 2019. The individual reports including the test results of the participants were prepared and sent to the participant laboratories. Reference Material Report” and “Reference Material Information Sheet” have been issued and first reference material, TAEK-RM-1 Black Tea Powder was offered as a product. In the context of the preparation of the radioactive reference sources, a mixed point source and three isotopic point sources were prepared.

PUBLICATIONS	D. Zapata-Garcia, H. Wershofen, M. Seferinoğlu, A. Dirican, N. Aslan, G. Özçayan, Ü. Yücel "Comparison of two methods for the rapid radiochemical analysis of air dust samples in emergency situations", *Applied Radiation and Isotopes,* 150 (2019), 120-126 E. Yeltepe, N.K. Şahin, N. Aslan, M. Hult, G. Özçayan, H. Wershofen, Ü. Yücel, "A review of the TAEA proficiency test on natural and anthropogenic radionuclides activities in black tea", *Applied Radiation and Isotopes,* 134 (2018), 40-44. E. Yeltepe, H. Yücel "Standardization of ^{142}Pr activity concentration", *Applied Radiation and Isotopes,* 134 (2018) 263–268. J.T. Cessna, R. Fitzgerald, B.E. Zimmerman, L. Laureano-Pérez, E. Yeltepe, A. Dirican et al "Results of an international comparison of activity measurements of ^{68}Ge", *Applied Radiation and Isotopes,* 134 (2018), 385-390
IN PROGRESS	Standardization with the ionization chamber Standardization with HPGe detectors Standardization with CIEMAT-NIST method Standardization with TDCR method Standardization with 4πγ counting system Standardization with defined solid angle alpha spectrometer Standardization with 4πβ-γ coincidence counting system Organisation of a proficiency test and studying on choosing a test matrix Preparation of the proficiency test final report Preparation of radioactive standards for external users Preparation of radioactive standard point sources
INFORMATION	-
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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CONTACT	Ülkü Yücel, ulku.yucel@taek.gov.tr

LABORATORY	TAEK-RHTD, Radioactivity and Analytical Measurement Laboratories, Turkey
NAMES	Hülya Mert, Dr. Aylin KURT, Dr. Demet ERÇİN, Dr. Nihal KAYA, Dr. Mihriban ŞAHİN, Abdullah DİRİCAN, Hasan DİKMEN, Yusuf CAN, Dr. Sümer ÖZVATAN, Mine ÖZGÜR, Dr. Yusuf AĞUŞ, Yücel ÖZER ÖZKÖK, Ahmet ÇORAK, Dr. Mehmet KAPLAN, Ahmet Tayfur BAKIOĞLU, Gamze ÖZFIRAT, Eren ÇANTAY, Dr. Abdullah ZARARSIZ, Rıdvan KIRMAZ, Dr. Ece ERGUN, Dr. Yüksel MERT, Nurettin EFE, Dr. Okan OKTAR, Dr. Ömer KANTOĞLU, Dr. Yakup KALAYCI, Dr. Filiz KARACAN, Dr. Nuray AKSU ŞAN, Sedat SEVERCAN, Burhanettin ERDEM, Kadri Furkan NAZIR, Elif KARAARDIÇ, Büşra AYDIN
ACTIVITY	Alpha spectrometry Gross alpha/beta counting Liquid scintillation counting Gamma spectrometry XRF spectrometry High resolution mass spectrometry Participation to international proficiency and comparison tests Providing training courses within the context of IAEA fellowship
KEYWORDS	Alpha spectrometry, beta spectrometry, gamma-ray spectrometry, gas proportional counter, liquid scintillation, low-level, radiochemistry, simulation code, source preparation, traceability, X-ray spectrometry, ICPMS
RESULTS	Measurement of radioactivity concentrations in environmental samples and in various other samples such as milk/milk products, meat, vegetables and fruits by gamma spectrometry. Measurement of Sr-90 in various samples such as water, milk/milk products, meat, vegetables and fruits, and also H-3 in water samples by liquid scintillation counting (LSC) technique. Activity measurements of natural isotopes, Pu-239+240 and Po-210 by alpha spectrometry in various samples. Gross alpha/beta activity measurements in various types of water samples by using proportional counters. In addition, new methods have been developed for Ra-228, Sr-90, Po-210, and Pb-210 activity measurements. For the gamma, alpha, beta and gross alpha/beta measurements, we have participated to the proficiency test organized by International Atomic Energy Agency, IAEA-TEL-2019-04 ALMERA. We have got 100% success for our accredited measurements and more than 90% success for the all measurements. In the context of a comparison test organized by IAEA, IAEA-RML-2019-01, the measurements of Cs-137, Cs-134, K-40 and H-3 activities in sea water samples have been performed and reported. The results of the test are now waited. Within the context of environmental monitoring, radioactivity measurements air filters and in rain/snow waters are routinely performed. Within the context of an IAEA fellowship programme, a training course of 2 months including alpha spectrometric analyses for uranium radioisotopes in water and soil samples, and Po-210 analyses in soil, sediment and plant samples was performed in our laboratories. The calibration procedure studies of in situ gamma spectrometric system have been completed and the results were presented in an international conference. Elemental analysis of soil, liquid, powder, bulk form samples by using different types of XRF spectrometer

	Analysis of uranium and thorium isotopes by HR-ICP-MS Participation in international/national comparisons
PUBLICATIONS	Mihriban ŞAHİN, Abdullah DİRİCAN, Simay YÜKSEK " Determination of gross alpha and gross beta radioactivity levels of bottled mineral water samples in Turkey", Turkish Journal of Nuclear Science, Cilt (30), No:2 (2018)
IN PROGRESS	The measurements of the samples of an international proficiency test are now being performed. The routine activity measurements in the samples of the ongoing environmental monitoring. All types of measurements mentioned in the "activity" part above. Improving studies of the newly developed measurement methods mentioned above. Method development and improving studies for the elemental and isotopic analyses by HR-ICPMS.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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CONTACT	Abdullah Dirican, abdullah.dirican@taek.gov.tr

LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	John Keightley, Andy Pearce, Sean Collins, Rob Shearman
ACTIVITY	Primary measurements: 4π(HPPC)-γ coincidence counting 4π(LS)-γ coincidence counting 4π(APPC)-γ coincidence counting
KEYWORDS	beta spectrometry, coincidence method, cryogenic detector, data measurement, gas proportional counter, liquid scintillation, low-level, SIR
RESULTS	Primary standardisation of: ^{123m}Te, ^{161}Tb
PUBLICATIONS	"The potential radio-immunotherapeutic α-emitter ^{227}Th – part I: Standardisation via primary liquid scintillation techniques and decay progeny ingrowth measurements", S.M. Collins et al, *Applied Radiation and Isotopes, volume 145, March 2019, Pages 240-250* "The potential radio-immunotherapeutic α-emitter ^{227}Th – part II: Absolute γ-ray emission intensities from the excited levels of ^{223}Ra", S.M. Collins et al, *Applied Radiation and Isotopes, volume 145, March 2019, Pages 251-257* "Standardisation of ^{231}Pa by defined solid angle and liquid scintillation methods at NPL", *A. Arinc, J.D. Keightley, Applied Radiation and Isotopes, In Press (2020)*
IN PROGRESS	Standardisation of ^{155}Tb, ^{152}Tb and ^{89}Zr Renovation/Digitisation of High Pressure Proportional Counter (HPPC)
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom
CONTACT	John Keightley +44 20 8943 6398 John.Keightley@npl.co.uk

LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Andrew Fenwick, Natasha Ramirez, Giuseppe Lorusso
ACTIVITY	Ionisation Chambers
KEYWORDS	ionisation chamber, life sciences
RESULTS	Development of a new ionisation chamber electronic system utilising the Keithley 6514 electrometer and an external feedback capacitor. Development of LabView software to run new electronic system. Investigation into the possible use of an ammeter (ULCA) and DVM based system to run ionisation chamber measurements. Precision of this ammeter-based system was found to be inferior to the Keithley 6514 electrometer system.
PUBLICATIONS	
IN PROGRESS	Implementation of a trigger and timestamping ethernet-based synchronised method (IEEE 1588) to achieve sub-millisecond time resolution of the IC readings. Development of an electronic system for the PA782 ionisation chamber which will use an off-the-rack DVM alongside an in-house built electrometer. Implementation of a new IG11-based back-to-back ionisation chamber system with a custom shield. Feasibility study of low-background IC measurement for nuclear data at the Boulby Underground Laboratory, UK.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom
CONTACT	Natasha Ramirez (natasha.ramirez@npl.co.uk)

LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Arzu Arinc, Marc Abilama, John Keightley
ACTIVITY	Primary standardisation of alpha emitters
KEYWORDS	Defined solid angle (DSA) alpha counting, primary standardisation, autoradiography
RESULTS	Standardisations of ^{231}Pa, ^{243}Am
PUBLICATIONS	"Standardisation of ^{231}Pa by defined solid angle and liquid scintillation methods at NPL", A. Arinc, J.D. Keightley, Applied Radiation and Isotopes, In Press (2020).
IN PROGRESS	A GE Amersham Typhoon IP Imager was recently purchased and installed to be used as an autoradiograph with the DSA system. Sources can be exposed to the compatible imaging plates for a suitable period of time; subsequently scanning the plates in the Typhoon system will then produce an activity distribution map of the source. The autoradiograph will be used with future DSA measurements. Extending the Monte Carlo simulation software capability to incorporate the autoradiography results.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom
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LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Steven Bell, Marc Abilama, Rob Shearman, Sean Collins
ACTIVITY	Absolute gas counting
KEYWORDS	Beta spectrometry, Euramet, gamma-ray spectrometry, gas proportional counter, radioactive gas
RESULTS	Standardisation of ^{87}Kr, ^{88}Kr and ^{135}Xe in mixed fission-product gas sample
PUBLICATIONS	
IN PROGRESS	Upgrade of absolute gas counting system with new proportional counters, amplifiers and digitisers, and installation of in-line HPGe gamma-ray spectrometer. Development of cryogenic noble gas separator. Inter-comparison of ^{133}Xe. Development of beta-gamma coincidence counting system for measurement of low-levels of radioxenon (University of Surrey / AWE PhD project).
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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CONTACT	Steven Bell +44 20 8943 6837 steven.bell@npl.co.uk

LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Andy Pearce, Arzu Arinc, Rob Shearman
ACTIVITY	Liquid scintillation counting
KEYWORDS	liquid scintillation, TDCR
RESULTS	Standardisation of Organically bound Tritium, ^{227}Th, ^{231}Pa, ^{232}U, ^{234}U Validated use of Hidex 300SL in secondary standardisation of tritiated water and organically bound tritium Participation in CCRI(II)-S12.H-3 Supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated-water source measured using the LSC-TDCR method Participation in CCRI(II)-K2.Pa231 Supplementary comparison: International comparison of activity measurements of a solution of ^{231}Pa
PUBLICATIONS	"Results of the CCRI(II)-S12.H-3 supplementary comparison: Comparison of methods for the calculation of the activity and standard uncertainty of a tritiated-water source measured using the LSC-TDCR method, P. Cassette et al., Applied Radiation and Isotopes, volume 134, April 2018, Pages 257-262 "The potential radio-immunotherapeutic α-emitter ^{227}Th – part I: Standardisation via primary liquid scintillation techniques and decay progeny ingrowth measurements", S.M. Collins et al., Applied Radiation and Isotopes, volume 145, March 2019, Pages 240-250 "Half-life determination and comparison of activity standards of ^{231}Pa, S. Jerome et al., Applied Radiation and Isotopes, In Press (2020). "Standardisation of ^{231}Pa by defined solid angle and liquid scintillation methods at NPL", A. Arinc, J.D. Keightley, Applied Radiation and Isotopes, In Press (2020).
IN PROGRESS	Development of TDCR analysis software and methods New data acquisition system for TDCR Standardisation of Sn-113 by CIEMAT/NIST and TDCR Investigating use of extractive LSC to improve efficiency and energy/timing resolution in radionuclide metrology
INFORMATION	
SOURCE IN PREPARATION	
ADDRESS	National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom
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LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Ben Russell, Heather Thompkins, Hibaaq Mohamud, Elsje van Es, Emma Braysher, Ben Webster
ACTIVITY	Inductively coupled plasma mass spectrometry (ICP-MS)
KEYWORDS	data evaluation, data measurement, environmental control, Euromet, radiochemistry, traceability
RESULTS	• Ca-41 in concrete following borate fusion and chemical separation- the first known measurement of this radionuclide using any ICP-MS design • Zr-93 in dissolved stainless steel and aqueous waste samples without prior treatment using ICP-MS/MS • The first reaction-cell separation of ^{99}Tc from interfering Mo and Ru, combined with characterisation of novel extraction chromatography resins developed by Triskem International • Measuring different nanoparticle types in various cell streams to assess the performance of nanoparticles as radiosensitisers for cancer treatment • Assessing the purity of rare earth materials prior to irradiation using ICP-MS/MS, with reaction cell separation of lanthanide hydride interferences offering improved purity information. Irradiated target materials have also been measured to assess long-lived impurities • Ni-63, Sr-90, Tc-99, Np-237, Pu-239 in aqueous waste samples without prior treatment using ICP-MS/MS
PUBLICATIONS	• Direct Analysis of Zirconium-93 in Nuclear Site Decommissioning Samples by ICP-QQQ. H.Thompkins, B.Russell, S.Goddard. Sgilent Application Note, 2020. https://www.agilent.com/cs/library/applications/application_zr-93_icp-qqq_8800_8900_5994-1532en_us-agilent.pdf • Chemical Purification of Terbium-155 from Pseudo-Isobaric Impurities in a Mass Separated Source Produced at CERN. B.Webster, P.Ivanov, B.Russell, S.Collins, T.Stora, J.Pedro Ramos, U.Köster, A.Robinson, D.Read. Nature Scientific Reports. 2019, 9, 10884 • Radiobiological Implications of Nanoparticles Following Radiation Treatment. R.Ahmad, G.Schettino, G.Royle, M.Barry, Q.A.Pankhurst, O.Tillement, B.Russell, K.Ricketts. Particle and Particle System Characterisation. 2020, accepted for publication • Production and Characterisation of Reference Materials in Support of Naturally Occurring Radioactive Materials (NORM) industries. E.Braysher, B.Russell, F.Del Molin, D.Read. Environmental Radiochemical Analysis VI, 10-19 • Application of plasma mass spectrometry for half-life measurement of medium and long-lived radionuclides. E.Braysher, B.Russell, D.Read. International Nuclear Physics Conference Proceedings. 2020, accepted for publication. • Evaluation of inductively coupled plasma tandem mass spectrometry for radionuclide assay in nuclear waste characterisation. P.Warwick, B.Russell, I.Croudace, Z.Zacharauskas. J. Anal. Atom. Spectrom. 2019, 34, 1810-1821

	• Atomic spectrometry update: review of advances in the analysis of metals, chemical and materials. S.Carter, R.Clough, A.Fisher, B.Gibson, B.Russell, J.Waack. J. Anal. Atom. Spectrom. 2019, 34, 2159-2216 • Complete dissolution of solid matrices using automated borate fusion in support of nuclear decommissioning and production of reference materials. E.Braysher, B.Russell, S.Woods, M.Garcia-Miranda, P.Ivanov, B.Bouchard, D.Read. J. Radioanal. Nucl. Chem. 2019, 321, 183-196
IN PROGRESS	• Development of standards relevant to mass spectrometry measurement as part of measurement services • UKAS accreditation of the lab • Development of a single procedure for measurement of ~15 radionuclides in a single run • Single nanoparticle measurement for material characterisation and assessing performance of nanoparticles for chemical separation
INFORMATION	The Nuclear Metrology Group at NPL has a tandem inductively coupled plasma mass spectrometer (Agilent 8800 ICP-MS/MS), consisting of a collision-reaction cell positioned between two quadrupole mass filters. This configuration reduces the reliance on offline chemical separation prior to measurement by offering online instrumental separation of the radionuclide of interest from interferences.
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Additional items

Announcements

1) Upcoming conferences: ICRM LLRMT conference (September 2020) - 4 papers submitted on mass spectrometry measurement of radionuclides.

2) Current PhD thesis topics in progress: Joint funded NPL/University of Southampton PhD investigating the capabilities of tandem ICP-MS/MS for nuclear decommissioning (completed December 2019)
Joint-funded NPL/University of Surrey PhD (3rd year) for developing of radiological characterisation techniques and reference materials for naturally occurring radioactive materials
Nuclear Decommissioning Authority (NDA) funded student with NPL/University of Birmingham (2nd year) developing long-lived tracers for measurement of long-lived radionuclides relevant to nuclear decommissioning

LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Andrew Robinson, Andrew Fenwick, Daniel Deidda, Kelley Ferreira, Warda Heetun, Ana Denis-Bacelar, James Scuffham.
ACTIVITY	Nuclear Medicine
KEYWORDS	Life Sciences, Source Preparation, SPECT, PET, Dosimetry
RESULTS	Supported the development of a dosimetry software prototype for molecular radiotherapy for ^{177}Lu-radiolabeled therapies with Mirada Medical (Innovate UK A4I funded-project).
PUBLICATIONS	Chauvin M, Borys D, Botta F, Bzowski P, Dabin J, Denis-Bacelar AM, Desbrée A, Falzone N, Lee BQ, Mairiani A, Malaroda A, Mathieu G, McKay E, Mora-Ramirez E, Robinson AP, Sarrut D, Struelens L, Vergara Gil A, Bardiès M. OpenDose: open access resources for nuclear medicine dosimetry J Nucl Med 2020 Mar 13. https://doi.org/10.2967/jnumed.119.240366 Gillen R, Denis-Bacelar AM, McQuaid SJ, Erlandsson K, Thielemans K, Hutton BF. Can SPECT Resolution Be Considered Invariant in Partial Volume Correction? Annual Congress of the European Association of Nuclear Medicine October 12 – 16, 2019 Barcelona, Spain. Eur J Nucl Med Mol Imaging 46, 1–952 (2019). https://doi.org/10.1007/s00259-019-04486-2 Daniel Deidda, B. Thomas, K. Ferreira, W. Heetun, A. Forgács, B. F. Hutton, K. Thielemans, A. Robinson. Validation of SPECT-CT image reconstruction for the Mediso AnyScan SCP scanner in STIR, Nuclear Science Symposium and Medical Imaging Conference, Manchester, 2019. Daniel Deidda, B. Thomas, K. Thieleman. Implementation of SPECT functionalities in the STIR library, Nuclear Science Symposium and Medical Imaging Conference, Manchester, 2019. Price, E., Robinson, A. P., Cullen, D. M., Tipping, J., Calvert, N., Hamilton, D., … Smith, A. (2019). Improving molecular radiotherapy dosimetry using anthropomorphic calibration. Physica Medica, 58 (January), 40–46. https://doi.org/10.1016/j.ejmp.2019.01.013 Bobin, C., Bouchard, J., Chisté, V., Collins, S. M., Dryák, P., Fenwick, A., … Thiam, C. (2019). Activity measurements and determination of nuclear decay data of ^{166}Ho in the MRTDosimetry project. Applied Radiation and Isotopes, 108826. https://doi.org/10.1016/j.apradiso.2019.108826 Webster, B., Ivanov, P., Russell, B., Collins, S., Stora, T., Ramos, J. P., … Read, D. (2019). Chemical Purification of Terbium-155 from Pseudo-Isobaric Impurities in a Mass Separated Source Produced at CERN, (April), 1–9. https://doi.org/10.1038/s41598-019-47463-3 Price, E., Tipping, J., Cullen, D. M., Calvert, N., Hamilton, D., Page, E., … Robinson, A. P. (2019). Positional dependence of activity determination in single photon emission computed tomography. Nuclear Medicine Communications, 30, 1. https://doi.org/10.1097/MNM.0000000000001034 Wrzosek-Lipska, K., Rezynkina, K., Bree, N., Zielińska, M., Gaffney, L. P., Petts, A., … Wood, J. L. (2019). Electromagnetic properties of low-lying states in neutron-deficient Hg isotopes: Coulomb excitation of ^{182}Hg, ^{184}Hg, ^{186}Hg and ^{188}Hg. The European Physical Journal A, 55(8), 130. https://doi.org/10.1140/epja/i2019-12815-2

IN PROGRESS	Identification of uncertainty components in SPECT imaging Creation of tools to calculate uncertainties on SPECT QA procedures (Linearity, Homogeneity, Gain, Activity calibration) Adaptation of open source software (STIR) to incorporate SPECT imaging and uncertainty propagation Identification of uncertainty components in PET imaging Adaptation of open source software (STIR) to incorporate PET uncertainty propagation Development of good practice guides for the accurate preparation of phantoms used for calibration and QA purposes in SPECT and PET imaging. Imaging studies using ^{166}Ho, ^{155}Tb, ^{152}Tb, ^{161}Tb, ^{89}Zr Production of reference dosimetric data and dosimetry methods with uncertainties for nuclear medicine dosimetry applications which incorporates traceable decay data, through the OpenDose collaboration. Support to establish a new dosimetry service for radioiodine therapies at the Royal Surrey County Hospital. Provision of dosimetry support to study the impact of radiobiologically informed dose prescription on maximising the clinical benefit of ^{90}Y SIRT in colorectal cancer patients (publication under revision in JNM). Contribution to establishing consensus recommendations on the use of ^{18}F-FDG PET/CT in diffuse lung diseases (invitation to submit a State of the Art paper to JNM received, submission in April). Submission of a Statement of Research Intent to ELI-NP on cross-section measurement of the ^{226}Ra(γ, n)^{225}Ra reaction relevant for the production of the medical isotope ^{225}Ac. Support the investigation of the potential for dosimetry-based personalised treatment planning for primary and secondary liver tumours treated with ^{90}Y-microspheres. Investigation of partial volume corrections methods for SPECT imaging in oncology.
INFORMATION	
SOURCE IN PREPARATION	See ‘In progress’ section
OTHER RELATED PUBLICATIONS	N/A
ADDRESS	National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom
CONTACT	Andrew Fenwick (Andrew.fenwick@npl.co.uk) Andrew Robinson (Andrew.robinson@npl.co.uk)

Announcements:
Conference on Applied Radionuclide Metrology has dedicated Nuclear Medicine day, currently scheduled for mid-November

1) Current PhD thesis topics in progress:
   Traceability and quantification of patient dose in molecular radiotherapy (Zr-89 imaging studies and primary standards) – Andrew Fenwick (Cardiff University)

   Establishing the traceability of novel theranostic isotopes: from production to imaging (Tb isotopes) – Sophia Pells (University of Manchester)

   A Novel Dead Time Correction for I-131 SPECT Imaging – Nick Bates (University of Surrey)

   "Harmonisation and Quantification of PET Imaging for Lung Disease" – Francesca Leek (University College London)

   "Delivering improved clinical SPECT quantification through Partial Volume correction" – Rebecca Gillen (University College London)

2) Recently completed PhDs:

   "Metrology for Quantitative Nuclear Imaging and Molecular Radiotherapy" - Jill Wevrett (University of Surrey)

   "Validation of clinical image quantification and dosimetry using 3D printed anthropomorphic phantoms" – Emlyn Price (University of Manchester)

   "Preventing haematological toxicity in radionuclide therapy by optimisation of the fractionation schedules based on dosimetry measurements" – Emma Page (University of Manchester)

LABORATORY	National Physical Laboratory (NPL), United Kingdom
NAMES	Andrew Bennett, Alberto Boso, Matt Birch, Michael Bunce, Sarb Cheema, Nicola Horwood, Neil Roberts, Graeme Taylor, David Thomas, Kim Ward
ACTIVITY	Neutron metrology
KEYWORDS	Neutron measurements
RESULTS	• Developed and validated portable digital electronics for Bonner Sphere spectrometers • Measured photon spectra in standard neutron fields (radionuclide and accelerator-based) using a HPGe • Further characterisation of thermal pile facility using Monte Carlo codes • Performed ^{117m}Sn spectrum-averaged cross section measurement • Performed measurements of secondary neutrons in proton therapy facilities (Krakow, Maastricht) • New data acquisition systems for Mn bath and accelerator services.
PUBLICATIONS	N. J. Roberts, A. Boso *Investigation of digital electronics for the NPL Bonner Sphere spectrometer*, Nuclear Instrument and Methods A, Submitted (2020). M. Licata, M. D. Aspinall, M. Bandala, F. D. Cave, S. Conway, D. Gerta, H. M. O. Parker, N. J. Roberts, G. C. Taylor & M. J. Joyce, *Depicting corrosion-born defects in pipelines with combined neutron/γ ray backscatter: a biomimetic approach*, Scientific Reports **10**, Article number: 1486 (2020) https://doi.org/10.1038/s41598-020-58122-3 Z Ghani, S Popovichev, P Batistoni, L W Packer, A Milocco, A Cufar, D J Thomas, N J Roberts, L Snoj, S Jednorog, E Laszynska and JET Contributors, *Characterisation of neutron generators and monitoring detectors for the in-vessel calibration of JET*, Fusion Engineering and Design **136** (2018) 233-238 https://doi.org/10.1016/j.fusengdes.2018.01.071 D Rigamonti, L Giacomelli, G Gorini, M Nocente, M Rebai, M Tardocchi, M Angelone, P Batistoni, A Cufar, Z Ghani, S Jednorog, A Klix, E Laszynska, S Loreti, M Pillon, S Popovichev, N Roberts, D Thomas and JET Contributors, *Neutron spectroscopy measurements of 14 MeV neutrons at unprecedented energy resolution and implications for deuterium–tritium fusion plasma diagnostics*, Meas. Sci. Technol. **29** (2018) 045502 (9pp) https://doi.org/10.1088/1361-6501/aaa675. R. Bedogni, A. Pola, M. Costa, V. Monti, D.J. Thomas, *A Bonner Sphere Spectrometer based on a large ^{6}LiI(Eu) scintillator: Calibration in reference monoenergetic fields*, Nuclear Inst. and Methods in Physics Research, A 897 (2018) 18–21. https://doi.org/10.1016/j.nima.2018.04.040. J.M. Gómez-Ros, R. Bedogni, C. Domingo, J.S. Eakins, N. Roberts, R.J. Tanner, *International comparison exercise on neutron spectra unfolding in Bonner Spheres Spectrometry: problem description and preliminary analysis*, Radiation Protection Dosimetry **180** (2018) 70-74, https://doi.org/10.1093/rpd/ncy002 David Thomas, Roberto Bedogni, Roberto Méndez, Alan Thompson and Andreas Zimbal, *Revision of ISO 8529—Reference Neutron Radiations*, Radiat. Prot. Dosim. **180** (2018) 21-24, https://doi.org/10.1093/rpd/ncx176.

	N.P. Hawkes, P. Kolkowski, N.J. Roberts, P. Salvador-Castiñeira, G.C. Taylor and D.J. Thomas, *Additional characterisation of the thermal neutron pile at the national physical laboratory, UK*, Radiation Protection Dosimetry**180** (2018) 25-28, 10.1093/rpd/ncx191. N.J. Roberts, *Photon spectra in NPL standard radionuclide neutron fields*, Radiation Protection Dosimetry **180** (2018) 62-65, 10.1093/rpd/ncx172
IN PROGRESS	• Piloting and participating in CCRI(III).K9.Cf.2016 neutron source emission rate comparison exercise. • Replacing the Van de Graaff accelerator. • Development of neutron spectrometer system for highly pulsed beams, in collaboration with Politecnico di Milano within the framework of the UHDPulse EMPIR project. • Development of high energy neutron beamline at iThemba, South Africa, in collaboration with iThemba, IRSN, PTB, University of Cape Town and NMISA. • Use of Sb-Be monoenergetic neutron source to absolutely determine the efficiency of large arrays of neutron detectors used in Nuclear structure research (ELI-NP, RIKEN). • Development of Personnel Tracking system for Dose Assessments • Design of a Total Absorption Spectrometer system for primary standardisation of neutron activated foils. • Development of absolute counting system for Mn bath
INFORMATION	The Nuclear Metrology Group at NPL operates world-leading facilities for measuring neutron source emission rates and providing an extensive range of accelerator- and source-based calibration fields. In particular, a Mn bath is used to precisely measure neutron sources emission rates. A 3.5 MV Van de Graaff accelerator provides proton and deuteron beams that allow to produce monoenergetic neutron beams in the range ~1-20 MeV. Accelerator-based thermal neutron fields up to 10^7 n/cm^{2}s can be achieved, thanks to the use of a graphite thermal pile. A wide range of neutron sources is available as well.
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	National Physical Laboratory, Hampton Road, Teddington, TW11 0LW, United Kingdom neil.roberts@npl.co.uk; alberto.boso@npl.co.uk
CONTACT	Neil Roberts & Alberto Boso

NIST, Radioactivity Group
2019 Progress Report and 2020 Plan

National Institute of Standards and Technology (NIST), USA, SA1/SA2

The programs at the National Institute of Standards and Technology (NIST), Physical Measurement Laboratory, Radiation Physics Division, Radioactivity Group in the field of Radionuclide Metrology and its applications 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.

The Radiation Physics Division at NIST continues to undergo a major renovation of the building housing its facilities, including new radiochemistry laboratories, Class 100 and Class 10000 Clean Rooms, new mass spectrometry facilities, and enhanced counting rooms. Completion of the project is expected in late 2023.

The NIST Radioactivity Group staff at the end of 2019 was the following:

Scientists	**Function**
B. Zimmerman	Leader, Radioactivity Group; primary and secondary activity standards, standards for Nuclear Medicine, Monte Carlo modelling, data evaluations
D. Bergeron	primary and secondary activity standards, standards for Nuclear Medicine
J. Cessna	primary and secondary activity standards, calibrations, standards for Nuclear Medicine
R. Collé	primary activity standards, Standard Reference Materials
R. Essex	Homeland Security reference standards
R. Fitzgerald	Primary radioactivity standards, ionization chambers, Monte Carlo modelling
L. King	primary and secondary activity standards, calibrations
J. LaRosa	environmental radioactivity standards, proficiency testing programs
L. Laureano-Pérez	primary activity standards, Standard Reference Materials
K. Lavelle	Homeland Security standards, mass spectrometry
L. Lucas	Primary and secondary activity standards, Homeland Security standards
M. McCord	measurements for Homeland Security
S. Nour	environmental radioactivity standards, proficiency testing programs
L. Pibida	secondary activity standards, Homeland Security standards and measurements, gamma-ray spectrometry, documentary standards
M. Tyra	environmental radioactivity standards, mass spectrometry
Associates	
Y. Ardalan	Measurement Assurance Program
W. Regits	Measurement Assurance Program
M. Unterweger	primary and secondary activity standards
Technicians	
J. Stann	shipping
Secretary	
L. Chase	

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

Activity line	**NIST Radionuclide Metrology 2018-2019 Progress report**	**NIST Radionuclide Metrology 2020-2021 Work plan**
Development of primary standards, Improvement of measuring methods and instrumentation	• Development of new primary standards: Ra-224 • Ongoing standards for nuclear forensics • Primary standardization of Ba-133	• Development of new primary standards: Pb-212, Zr-89 • Surrogate Urban Debris Reference Material • Peruvian Soil II • Ongoing standards for nuclear medicine imaging (e.g., phantoms) • Primary standardization of Co-60, Zn-65, Gd-153
International comparisons	• CCRI(II)-K2.Ge-68 Draft A • Bilateral comparison with NPL on Ra-224 activity, half-life, and gamma emission probability.	• Pilot Study CCRI(II)-P1.60Co • SIM Zn-65 comparison • CCRI(II) S15 comparison of Cs-137 and K-40 in mushrooms, being prepared by KRISS
Nuclear Data	• Half-life: I-124, Pa-231, Ra-224 • P-gamma: I-124, Pa-233, Ra-224 • DDEP Evaluations: Tb-155	• Half-life: Pb-212, Zr-89, I-129 • P-gamma: Pb-212, Zr-89 • DDEP Evaluations: Tb-155
Standardization of measurement methods	• Installation and commissioning of mass spectrometry system • SI traceable current measurements for ionization chambers (Research) • 2π proportional counting of large area sources with a lip • Live-timed 2π proportional counting of high-activity sources	• Gas counting standards • Mass spectrometry development • SI traceable current measurements for ionization chambers (Deployment) • Cryogenic decay-energy spectrometry
National QA programmes and services	• NIST Radioactivity Measurement Assurance Program (NRMAP) for the Radiopharmaceutical and Power Plant Industries • NIST Radiochemistry Intercomparison Program (NRIP) • Radiological Traceability Program (RTP) • Calibration services	• NIST Radioactivity Measurement Assurance Program (NRMAP) for the Radiopharmaceutical and Power Plant Industries • NIST Radiochemistry Intercomparison Program (NRIP) • Radiological Traceability Program (RTP) • Calibration services
Membership in international and national organisations	• ICRM, BIPM/CCRI(II), SIM, ANSI N42, IEC TC45	• ICRM, BIPM/CCRI(II), SIM, ANSI N42, IEC TC45

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
^{90}Y	yearly October
^{125}I	yearly December
^{152}Eu	January 2020
^{241}Am	January 2020
^{133}Ba	February 2020
^{137}Cs	March 2020
^{243}Cm	March 2020
^{90}Sr	In progress
^{240}Pu	In progress
^{232}U	Planned

Please note that due to uncertainties in the timeline for completion of construction of new laboratory facilities, the timing for the “yearly” and “In Progress/Planned” SRMs is only approximate.

Additional details are given for selected activities below.

LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	D.E. Bergeron, J.T. Cessna, R. Fitzgerald
ACTIVITY	SI traceable current measurements for ionization chambers
KEYWORDS	Ionisation chambers
RESULTS	A system using a 1 GΩ standard resistor in series with a stable voltage source generates currents from 1 pA to 20 nA for traceable calibration of an electrometer used for ionization chamber measurements. The system has been tested, achieving calibration of the ionization chamber electrometer with relative uncertainty better than 0.1% over the range 10^{-12} A to 10^{-8} A.
PUBLICATIONS	"The next generation of current measurements for ionization chambers" S.M. Judge, D.E. Bergeron, R. Fitzgerald, S.P. Giblin, D.G. Jarrett, C. Michotte, H. Scherer, Neil M. Zimmerman, Appl. Radiat. Isotop., submitted. "Ohm's law low-current calibration system for ionization chambers" D. G. Jarrett, S.U. Payagala, R. Fitzgerald, D.E. Bergeron, J.T. Cessna, C.J. Waduwarage Perera, N.M. Zimmerman, IEEEXplore CPEM 2020, *submitted.*
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	NIST, 100 Bureau Drive, Gaithersburg, MD, USA
CONTACT	Denis Bergeron, denis.bergeron@nist.gov, 1-301-975-2282

LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	D.E. Bergeron, J.T. Cessna, B.E. Zimmerman
ACTIVITY	Secondary standards for medically important radionuclides
KEYWORDS	Ionisation chamber, life sciences, NaI well-type counter, I-124, Ra-224
RESULTS	Radionuclide calibrators and a NaI(Tl) well-type counter were calibrated for medically important radionuclides. Solutions in 5 mL ampoules with activities directly linked to NIST primary activity standards were measured on several commercial re-entrant ionization chambers (radionuclide calibrators or dose calibrators) and on the Vinten 671 ionization chamber. Mass links were also used to establish calibrations for (pre)clinically relevant geometries or sample compositions.
PUBLICATIONS	"Standardization of I-124 by three liquid scintillation-based methods" D.E. Bergeron, J.T. Cessna, R. Fitzgerald, L. Pibida, B.E. Zimmerman, ***Appl. Radiat. Isotop.*, 154**, 108849 (2019). "Primary standardization of ^{224}Ra activity by liquid scintillation counting" E. Napoli, J.T. Cessna, R. Fitzgerald, L. Pibida, R. Collé, L. Laureano-Pérez, B.E. Zimmerman, D.E. Bergeron, ***Appl. Radiat. Isotop.*, 155**, 108933 (2020). "Radionuclide calibrator responses for ^{224}Ra in solution and adsorbed on calcium carbonate microparticles" E. Napoli, J.T. Cessna, L. Pibida, R. Fitzgerald, G.E. Hjellum, D.E. Bergeron, ***Appl. Radiat. Isotop.***, *submitted.*
IN PROGRESS	Confirmation of a syringe-specific calibration setting and traceable calibration of a positron emission tomography (PET) scanner for I-124.
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	NIST, 100 Bureau Drive, Gaithersburg, MD, USA
CONTACT	Denis Bergeron, denis.bergeron@nist.gov, 1-301-975-2282

LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	R. Fitzgerald, D. E. Bergeron
ACTIVITY	Anticoincidence measurements (LS-NaI) for primary standards
KEYWORDS	anti-coincidence, ^{124}I, ^{224}Ra, ^{133}Ba
RESULTS	primary standards for ^{224}Ra, ^{133}Ba
PUBLICATIONS	"Standardization of I-124 by three liquid scintillation-based methods" D.E. Bergeron, J.T. Cessna, R. Fitzgerald, L. Pibida, B.E. Zimmerman, Appl. Radiat. Isotop., 154, 108849 (2019). "Primary standardization of 224Ra activity by liquid scintillation counting" E. Napoli, J.T. Cessna, R. Fitzgerald, L. Pibida, R. Collé, L. Laureano-Pérez, B.E. Zimmerman, D.E. Bergeron, Appl. Radiat. Isotop., 155, 108933 (2020). "Standardization of Ba-133" L. Laureano-Pérez, R. Collé, R. Fitzgerald, L. Pibida, D.E. Bergeron, ***Appl. Radiat. Isotop.***, *submitted.*
IN PROGRESS	Planning ^{60}Co, ^{65}Zn, ^{153}Gd, Monte Carlo upgrades
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), USA
NAMES	B. E. Zimmerman, J. T. Cessna, L. Laureano-Perez
ACTIVITY	Clinical comparison study for Pb-203 activity measurement
KEYWORDS	Activity calibrators, Pb-203, clinical study
RESULTS	
PUBLICATIONS	In progress.
IN PROGRESS	
INFORMATION	A comparison of the same solution of Pb-203 was carried out between NIST and 6 laboratories that included one manufacturing site and 5 clinical radiopharmacies. The clinical sites performed the measurements in a 20 mL dose vial geometry, while measurements at NIST were based on an ionization chamber calibrated against a source that was standardized by anticoincidence counting. Initial results indicate a systematic reporting bias of -5% by the participants, which has been tentatively attributed to geometry effects.
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
ADDRESS	NIST, 100 Bureau Drive, Gaithersburg, MD, USA
CONTACT	Brian Zimmerman, bez@nist.gov

LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	R. Fitzgerald
ACTIVITY	Inertial Confinement Fusion to study low-energy nuclear reactions.
KEYWORDS	Nuclear fusion, Monte Carlo
RESULTS	
PUBLICATIONS	
IN PROGRESS	Monte Carlo-based determination of efficiency for beta-decay detector used to study neutral gas atoms released after IFC shot, in collaboration with Houghton College, SUNY Geneseo and the Laboratory for Laser Energetics (LLE).
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	R. Fitzgerald, B. E. Zimmerman
ACTIVITY	Monte Carlo modelling of ionization chambers
KEYWORDS	Ionization chambers, Monte Carlo, EGSnrc, PENELOPE,
RESULTS	
PUBLICATIONS	
IN PROGRESS	We have modelled NIST-owned IG11, TPA MK2 and Vinten ionization chambers using the EGSnrc user code DOSRZnrc and the PENELOPE user code PENCYL. Models have been improved recently to include response to beta particles and positron decay. Studies are underway to include effects of 3-photon positron annihilation. Models are used for confirming primary standards, making impurity corrections, identifying decay data anomalies and predicting geometric and materials effects, e.g. for microsphere suspensions. Modelling is also underway for commercial activity calibrators ("dose calibrators").
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. Pibida
ACTIVITY	Leading the revision of IEC 61452 standard - Measurement of gamma-ray emission rates of nuclides – Calibration and use of germanium spectrometers
KEYWORDS	IEC 61452, HPGe detectors, gamma-ray emission rates
RESULTS	Committee document draft was circulated within the IEC for comments
PUBLICATIONS	IEC WD 61452 Ed.2 IEC:2018. Nuclear Instrumentation – Measurement of gamma-ray emission rates of nuclides – Calibration and use of germanium spectrometers
IN PROGRESS	Continue review process for expected publication in 2021
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	B. E. Zimmerman, D. E. Bergeron, J. T. Cessna, R. Fitzgerald, and L. Pibida
ACTIVITY	Experimental Nuclear Data
KEYWORDS	Nuclear data, half-lives, gamma-ray emission probabilities
RESULTS	Measurements of half-lives, gamma-ray emission probabilities for Ra-224; DDEP data evaluation for Tb-155
PUBLICATIONS	
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	S. Nour, J. La Rosa
ACTIVITY	CCRI(II) supplementary international comparison (CCRI(II)-S13) - Measurement of an activity per unit mass of Cs-134 and Cs-137 in wheat flour
KEYWORDS	gamma-ray spectrometry, cesium-134, cesium-137
RESULTS	Submitted in March 2018 to intercomparison coordinator
PUBLICATIONS	
IN PROGRESS	
INFORMATION	The National Metrology Institute of Japan (NMIJ) and National Food Research Institute (NFRI) jointly developed a certified reference material (CRM) of Cesium-134 and Cesium-137 in wheat flour. The material was harvested just after the accident of the Fukushima Daiichi nuclear power plant. The CCRI(II) supplementary international comparison of activity measurements of Cesium-134 and Cesium-137 in wheat flour will be used to determine the certified values of the CRM. The analyses of the material were done by non-destructive gamma spectrometry measurements of three samples containing about 70 g of undried wheat flour in plastic sample jars levelled at 100 mL. The wheat flour sample bulk density was measured to be about 0.7 g/mL. Comparator standards of similar geometry and density were prepared by spiking 80 mL, 90 mL and 100 mL of pure ethanol (density = 0.789 g/mL at 20 °C) with 0.24 g of a 1 M HCl calibrated solution containing ^{134}Cs and ^{137}Cs. The gamma ray photopeak efficiencies were determined for the 604.7 keV and 795.9 keV γ-emissions of ^{134}Cs and for the 661.7 keV γ-emission of ^{137}Cs (^{137m}Ba) as a function of sample volume. The 604.7 keV and 795.9 keV photopeaks of ^{134}Cs were used with equal statistical weights in calculating the final result. Three methods of peak area integration were used to obtain the net photopeak rates in each spectrum: one was based on the Canberra Genie® software and two were based on the EG&G Ortec Maestro® software. The moisture determination was based on an average of three 3-gram samples. The results for the radioactivity content of ^{134}Cs and ^{137}Cs of the contaminated wheat flour were reported with their associated (k = 2) uncertainties in March 2018.
SOURCE IN PREPARATION	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	S. Nour, J. La Rosa
ACTIVITY	Participation in KRISS mineral CRM intercomparison exercise
KEYWORDS	alpha spectrometry, phosphogypsum, zirconium silicate, bauxite, U, Th
RESULTS	Activity concentrations of ^{230}Th, ^{232}Th, ^{234}U, ^{235}U and ^{238}U on a dry weight basis as well as activity ratios ^{232}Th/^{230}Th, ^{234}U/^{238}U and ^{235}U/^{238}U on reference date 1 December reported to KRISS August 2018
PUBLICATIONS	
IN PROGRESS	
INFORMATION	An invitation from the Korea Research Institute of Standards and Science (KRISS) in January 2018 to take part in an intercomparison exercise for development of mineral CRMs was accepted. Samples of phosphogypsum (PG), bauxite (BX) and zirconium silicate (ZS) mineral powders prepared by KRISS were analyzed for their content of naturally-occurring thorium and uranium. Three 1-gram replicates of PG and BX and four 0.5-gram replicates of zirconium silicate were spiked with ^{229}Th and ^{232}U tracers, fused with 2 grams of lithium metaborate in platinum dishes at ≥ 1100 °C to decompose the mineral matrix, and dissolved in 4.5 – 9M HCl. After removal of insoluble matter (e.g., hydrated silica), uranium and thorium were separated and purified from the mineral matrix components and from each other by application of reliable anion exchange resin and supported liquid extraction chromatography techniques from HCl and HNO_3 media. Sources for U alpha spectrometry were made by electrodeposition of U onto stainless steel disks. Sources for Th alpha spectrometry were prepared by co-precipitation of Th(IV) with 50 µg of Nd(III) as NdF_3 , filtration onto a 0.1 µm-porosity membrane filter, and mounting on a 1-inch diameter plastic disk. Alpha spectrometry measurements were carried out with 450 mm^2, ion-implanted planar silicon detectors under vacuum conditions. Activity concentrations of ^{230}Th, ^{232}Th, ^{234}U, ^{235}U and ^{238}U on a dry weight basis as well as activity ratios ^{232}Th/^{230}Th, ^{234}U/^{238}U and ^{235}U/^{238}U corrected to the reference date (1 December 2016) were reported to KRISS in August 2018 together with their associated total expanded (k = 2) uncertainties.
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OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	R. Essex, M. Tyra, K. Lavelle
ACTIVITY	Surrogate Urban Debris Reference Material
KEYWORDS	mass spectrometry, uranium-235, microXRF, INAA, reference material
RESULTS	
PUBLICATIONS	
IN PROGRESS	Assessment of elemental homogeneity by microXRF and INAA of the material is underway. We have completed all the INAA measurements for both surrogate materials and data analysis is underway. microXRF analysis of the blank (natural U doped material) surrogate is complete and data analysis is in progress. Our next steps are to perform the microXRF analysis of the U-235 doped material to complete the elemental homogeneity analysis.
INFORMATION	Currently, no well documented measurement traceable post nuclear detonation reference materials (RMs) exist to support post-detonation nuclear forensics sample analysis. Nuclear detonation RMs allow for analytical method development, measurement performance assessment, and serve as quality control materials to achieve metrological traceability and measurement accuracy. Furthermore, these RMs insure confidence in data quality that provide legal defensibility for forensic results, attribution and response. As a part of NIST's mission addressing critical national needs, including "improving the accuracy of forensics measurements and ensuring the reliability of protective technologies and materials, in ways that foster homeland security and effective law enforcement," the delivery of a well-characterized Uranium (U) doped urban surrogate glass RMs that mimic the rubble collected after a nuclear detonation event will enable the user community to not only validate their nuclear forensic and attribution abilities but also establish measurement accuracy and traceability.
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. King, R. Fitzgerald
ACTIVITY	2π alpha and beta measurements
KEYWORDS	2π, alpha, beta, emission rate, activity, MCA
RESULTS	Calibrations, correction factors for MCA live-time inaccuracies at high count rates, new method of data handling for sources or certain geometries
PUBLICATIONS	King, L., R. Fitzgerald and R. E. Tosh (2018). "Large area alpha sources with a lip: Integral counting and spectral distortions." Applied Radiation and Isotopes **134**: 376-379. Fitzgerald, R., King, L., "Accurate Integral Counting Using Multi-Channel Analyzers", Appl. Radiat. Isotop., accepted (2020)
IN PROGRESS	Testing of new MCA, acquiring a set of beta standards
INFORMATION	To ensure the counter(s) is operating correctly, beta-emitting sources that are submitted for calibration are measured with a Sr-90 standard (0.1958 MeV), H-3 being the only exception. The sources received have a wide range of energies; 0.0057 MeV to 0.6259 MeV. Identifying, obtaining, and measuring a set of beta-emitting standards with multiple energies would better represent the sources received for calibration. Once obtained these standards will be measured to determine a voltage plateau for each and then added to the measurements when calibrations are performed.
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. Lucas, R. Collé, L. Laureano-Perez
ACTIVITY	Re-standardization ^{152}Eu
KEYWORDS	ionization chamber, Eu-152, SRM
RESULTS	Europium-152 is used in reactor control rods. It is also suggested as a nuclide of choice in hard-gamma brachytherapy. Europium oxide (Eu_2O_3) is widely used as a red phosphor in television sets, and as an activator for yttrium-based phosphors. It is also being used as an agent for the manufacture of fluorescent glass. A re-standardization of ^{152}Eu was performed and will be disseminated by the NIST as SRM 4370d. This ^{152}Eu solution standard is contained in standard NIST 5 mL flame-sealed borosilicate glass ampoules; consists of (5.0338 ± 0.0019) g of a nominal 1 mol·L^{-1} hydrochloric acid solution; has carrier ion concentrations of about 277 μg Eu^{+3} per gram of solution; and is certified to contain a massic activity (18.70 ± 0.22) kBq·g^{-1} as of the reference time 19 July 2018 1200 EST. All the uncertainties cited above correspond to standard uncertainties multiplied by a coverage factor, k = 2. The certified massic activity for ^{152}Eu was determined by 4πγ ionization chamber measurements in February 1987 using NIST chamber "A" and decay corrected to the 2018 reference time. Confirmatory measurements in July 2018 with NIST chamber "A" agreed with the decay-corrected certified value to 0.04%.
PUBLICATIONS	SRM 4370d Certificate, NIST 2020
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	R. Collé, L. Laureano-Perez
ACTIVITY	Standardization of ^{241}Am
KEYWORDS	liquid scintillation, SRM, Am-241
RESULTS	A new primary standardization of ^{241}Am by 4πα LS spectrometry was performed for the production, certification, and dissemination of a new issue of a ^{241}Am solution standard, as SRM 4322d. The radionuclide ^{241}Am, a transuranic isotope of americium with a half-life of (432.6 ± 0.6) a was discovered in 1944 and is produced primarily by neutron irradiation of plutonium. Radioactivity solution standards of ^{241}Am are needed for a variety of purposes by many users, including those for industrial and commercial products, within the nuclear power industry, by the worldwide environmental measurement community, and for nuclear forensic laboratories. The certified massic activity for ^{241}Am at a Reference Time of 1200 EST, 01 March 2019, is: (133.7 ± 0.4) Bq•g^{-1}. It was obtained by 4πα liquid scintillation (LS) counting using two different LS measurement systems. The relative standard deviation of the mean on the set of 108 values was 0.021%, with a 95% confidence interval about the mean of ± 0.041%. This solution is gravimetrically linked to a ^{241}Am stock solution used to prepare several previous NIST ^{241}Am standards, including a primary live-timed anticoincidence standardization in 2007, two proficiency testing standards issued for a nuclear power plant measurement assurance program and for the Integrated Consortium of Laboratory Networks, as well as to SRM 4322c. A remeasurement of SRM 4322c at the time of this work in 2019 agreed with the 2007 certified value to within 0.05%.
PUBLICATIONS	SRM 4322d Certificate, NIST 2020
IN PROGRESS	
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. Laureano-Perez, R. Collé
ACTIVITY	Standardization of ^{133}Ba
KEYWORDS	LTAC, liquid scintillation, SIR, ionization chamber, gamma-ray spectrometry, TDCR, Ba-133, SRM
RESULTS	Barium-133 decays by electron capture mainly to two ^{133}Cs excited levels. Standards of ^{133}Ba are intended primarily for the calibration of ionization chambers and solid-state gamma ray spectrometry systems. A new radioactivity solution standard of ^{133}Ba has been developed and will be disseminated by the NIST as SRM 4251d. This new ^{133}Ba solution standard is contained in standard NIST 5 mL flame-sealed borosilicate glass ampoules; consists of (5.063 ± 0.003) g of a nominal 1 mol·L^{-1} hydrochloric acid solution; has a density of (1.015 ± 0.002) g·mL^{-1} at 22.6 °C; has carrier ion concentrations of about 88 μg Ba^{+2} per gram of solution; and is certified to contain a massic activity (382.6 ± 4.6) kBq·g^{-1} as of the reference time 13 July 2018 1200 EST. All the uncertainties cited above correspond to standard uncertainties multiplied by a coverage factor, k = 2. The standardization for the ^{133}Ba content of the solution was based on 4πe(LS)-γ(NaI) live-timed anticoincidence counting (LTAC). Confirmatory determinations were also performed by High Purity Germanium (HPGe) γ-ray spectrometry, by CIEMAT/NIST efficiency tracing (CNET) using two efficiency monitors (^{3}H and ^{55}Fe), by ionization chamber (IC) measurements, and by triple-to-double-coincidence ratio (TDCR). All the results agree within their respective uncertainties. The homogeneity of the solution amongst 47 ampoules was verified in the AutoIC, and was demonstrated, with a relative median absolute deviation of 0.034% A new K-value for ^{133}Ba was calculated to be (6525 ± 40) kBq (k = 1) for IC "A" using radium reference source 50 (RRS 50) based on the LTAC-determined massic activity. This new value agreed to within +0.2% with the previous value or K_{new}/K_{old} = 1.002. No calibration factor had been previously determined for the AutoIC. As a result of this standardization an empirical K-value for ^{133}Ba was determined in the same way as the one for IC "A". For the AutoIC using RRS 50 the obtained K-value is (6105 ± 38) kBq (k = 1).
PUBLICATIONS	SRM 4251d Certificate, NIST 2020
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. Lucas, R. Collé, L. Laureano-Perez,
ACTIVITY	Re-standardization ^{137}Cs
KEYWORDS	ionization chamber, Cs-137, SRM
RESULTS	Cesium-137 is used in small amounts for calibration of radiation detection equipment, such as Geiger-Mueller counters. In larger amounts, Cs-137 is used in medical radiation therapy devices for treating cancer, and in industrial gauges that detect the flow of liquid through pipes A re-standardization of ^{137}Cs was performed and will be disseminated by the NIST as SRM 4233f. This ^{137}Cs solution standard is contained in standard NIST 5 mL flame-sealed borosilicate glass ampoules; consists of (5.0668 ± 0.0009) g of a nominal 1 mol·L^{-1} hydrochloric acid solution; has carrier concentrations of about 26 μg CsCl per gram of solution; and is certified to contain a massic activity (221.1 ± 1.7) kBq·g^{-1} as of the reference time 4 August 2018 1200 EST. All the uncertainties cited above correspond to standard uncertainties multiplied by a coverage factor, $k = 2$. The certified massic activity for ^{137}Cs was obtained by decay and ionization chamber positioning corrections to an original 2005 calibration using NIST pressurized 4πγ ionization chamber "A" that was calibrated using a ^{137}Cs solution whose activity was determined by a 4π (e + X) - γ coincidence efficiency extrapolation technique. Confirmatory measurements with chamber "A" in August 2018 were in agreement to –0.12%.
PUBLICATIONS	
IN PROGRESS	Certification
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	R. Collé, L. Laureano-Perez
ACTIVITY	Re-standardization ^{243}Cm
KEYWORDS	ionization chamber, Cm-243, SRM
RESULTS	A re-standardization of ^{243}Cm was performed and will be disseminated by the NIST as SRM 4329a. This ^{243}Cm solution standard is contained in standard NIST 5 mL flame-sealed borosilicate glass ampoules; consists of (5.156 ± 0.011) g of a nominal 1 mol·L^{-1} nitric acid solution, It is certified to contain a massic activity (30.53 ± 0.17) Bq·g^{-1} as of the reference time 15 May 2019 1200 EST. All the uncertainties cited above correspond to standard uncertainties multiplied by a coverage factor of k = 2. The certified massic activity for ^{243}Cm was obtained by 4πα liquid scintillation (LS) counting using three different LS measurement systems (with widely varying operating characteristics). For the determination, two different LS cocktail compositions (with 4 counting sources for each) were measured 5 or 6 times on each of the three instruments. Confirmatory measurement of the ^{243}Cm massic activity was performed by gamma-ray spectrometry. This solution is a re-standardization and recertification of SRM 4329, which was originally standardized by defined solid angle alpha counting in 1984. The current liquid scintillation-based standardization differs from the decay corrected original standardization by +1.5%. However, due to the large uncertainty in the ^{243}Cm half-life and the nearly 35 years decay correction, the k = 2 uncertainty in the massic activity of the solution based on the decay corrected original standardization is ± 2.5%. Assay of ^{243}Cm in this SRM by gamma-ray spectrometry agrees with the certified value by – 0.90%.
PUBLICATIONS	
IN PROGRESS	Certification
INFORMATION	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. Laureano-Perez, R. Collé
ACTIVITY	Standardization of ^{90}Sr
KEYWORDS	liquid scintillation, CNET, Sr-90, SRM
RESULTS	A new standardization of ^{90}Sr was performed and will be disseminated by the NIST as SRM 4239a. This new ^{90}Sr solution standard is contained in a generic 5-mL flame-sealed borosilicate glass ampoules; consists of (5.084 ± 0.003) g of a nominal 1 mol·L^{-1} hydrochloric acid solution; has carrier ion concentrations of about 25 μg•g^{-1} Sr^{+2} and 34 μg•g^{-1} Y^{+3} per gram of solution; and is certified to contain a massic activity (24.492 ± 0.088) kBq·g^{-1} as of the reference time 25 December 2019 1200 EST. All the uncertainties cited above correspond to standard uncertainties multiplied by a coverage factor, $k = 2$. The certified massic activity for ^{90}Sr in radioactive equilibrium with ^{90}Y was obtained by 4πβ liquid scintillation (LS) spectrometry with two commercial LS counters. The LS detection efficiency was calculated using the MICELLE2 code for the CIEMAT/NIST method with composition matched LS cocktails of a ^{3}H standard as the efficiency detection monitor and two different LS cocktail compositions. This solution is gravimetrically linked to a ^{90}Sr stock solution (SRM 4234a) used to prepare the previous NIST ^{90}Sr standard SRM 4239. A remeasurement of SRM 4239 at the time of this work in 2020 agreed with the 2008 certified value to within 0.2%. This determination agrees to the decay corrected SRM 4234a certified value to within 0.002%.
PUBLICATIONS	
IN PROGRESS	Certification
INFORMATION	
SOURCE IN PREPARATION	
OTHER RELATED PUBLICATIONS	
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LABORATORY	National Institute of Standards and Technology (NIST), USA
NAMES	L. Laureano-Perez, R. Collé
ACTIVITY	Standardization of ^{240}Pu
KEYWORDS	liquid scintillation, Pu-240, SRM
RESULTS	A new standardization of ^{240}Pu was performed and will be disseminated by the NIST as SRM 4338b. This new ^{240}Pu solution standard is contained in a generic 5-mL flame-sealed borosilicate glass ampoules; consists of (5.49 ± 0.01) g of a nominal 1 mol·L^{-1} nitric acid solution, and is certified to contain a massic activity (40.81 ± 0.45) Bq·g^{-1} as of the reference time 27 August 2019 1200 EST. All the uncertainties cited above correspond to standard uncertainties multiplied by a coverage factor, k = 2. The certified massic activity for ^{240}Pu was obtained by 4πα liquid scintillation (LS) counting using three different LS measurement systems (with widely varying operating systems). For the determination two different LS cocktails compositions (with 5 counting sources each) were measured 5 times on each of the three instruments. This solution is gravimetrically linked to a ^{240}Pu stock solution obtained from Oak Ridge National Laboratory in February 1980 and was used to prepare the previous NIST ^{240}Pu standard SRM 4338a, which was certified using NIST "0.1 π"α defined-solid-angle counter with scintillation detector and a reference time of 1 May 1996. A remeasurement of SRM 4338a at the time of this work in 2019 agreed with the decay corrected 1996 certified value to within 0.26%.
PUBLICATIONS	
IN PROGRESS	Certification
INFORMATION	
SOURCE IN PREPARATION	
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End of Contributions