Bureau International des Poids et Mesures

Consultative Committee for Ionizing Radiation (CCRI)

Report of the 29th meeting (8-9 June 2023) to the International Committee for Weights and Measures

Comité international des poids et mesures

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR IONIZING RADIATION
as of 8 JUNE 2023

President

Dr Jan-Theodoor Janssen, National Physical Laboratory [NPL], Teddington

Executive Secretary

Dr Vincent Gressier, International Bureau of Weights and Measures [BIPM], Sèvres

Chair, Section I (X- and gamma rays, charged particles)

Dr Malcolm McEwen, National Research Council of Canada [NRC], Ottawa

Chair, Section II (Measurement of Radionuclides)

Dr Lisa Karam, National Institute of Standards and Technology [NIST], Gaithersburg

Chair, Section III (Neutron Measurements)

Dr Andreas Zimbal, Physikalisch-Technische Bundesanstalt [PTB], Braunschweig

Members

Bundesamt für Eich- und Vermessungswesen [BEV], Vienna

Czech Metrology Institute [CMI], Brno

Federal Agency on Technical Regulating and Metrology [Rosstandart], Moscow

Federal Institute of Metrology METAS [METAS], Bern-Wabern

Korea Research Institute of Standards and Science [KRISS], Daejeon

Laboratoire National de Métrologie et d'Essais [LNE], Paris

National Institute of Metrology [NIM], Beijing

National Institute of Standards and Technology [NIST], Gaithersburg

National Metrology Institute of Japan, AIST [NMIJ/AIST], Tsukuba

National Metrology Institute of South Africa [NMISA], Pretoria

National Physical Laboratory [NPL], Teddington

National Research Council of Canada [NRC], Ottawa

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig

The Director of the International Bureau of Weights and Measures [BIPM], Sèvres

Official observers

Central Office of Measures/Gtówny Urgad Miar [GUM], Warsaw

Centro Español de Metrología [CEM], Madrid

Ente per le Nuove Tecnologie, l'Energia e l'Ambiente -Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti [ENEA-INMRI], Rome

Government Office of the Capital City Budapest [BFKH], Budapest

Instituto Nacional de Metrologia, Qualidade e Tecnologia [INMETRO], Rio de Janeiro

National Institute of Metrology/Institutul National de Metrologie [INM], Bucharest

National Measurement Institute, Australia [NMIA], Lindfield

Slovak Institute of Metrology/Slovenský Metrologický Ústav [SMU], Bratislava National Research

VSL Dutch Metrology Institute [VSL], Delft

Liaisons

European Commission - Joint Research Centre [JRC-Geel], Geel

International Atomic Energy Agency [IAEA], Vienna

International Commission on Radiation Units and Measurements [ICRU]

Comprehensive Nuclear-Test-Ban Treaty Organization [CTBTO], Vienna

Invited to attend as observers

National Institute of Standards [NIS], Giza

National Scientific Centre "Institute of Metrology" [NSC IM], Karkiv

The 29th meeting of the Consultative Committee for Ionizing Radiation (CCRI) was held at the BIPM with online participation allowed from 9 to 10 June 2023.

The following were present:

A. Allaoua (LNE-IRSN), R.-P. Alvarez (IAEA), J.-M. Bordy (ISO), R. Brettner-Messler* (BEV), A. Buffler* (UCT - NMISA), D. Butler* (ARPANSA), M. Carrara (IAEA), C.-H. Chu (INER), M. Embid Segura (CIEMAT), P. De Felice (ENEA-INMRI), J. de Pooter (VSL), K.C. de Souza Patrao* (LNMRI/IRD), R. P. Fitzgerald (NIST), R. Galea (NRC), S. Giblin (NPL), R. Hamdy Bakr* (NIS), N. Hermanspahn (CTBTO), S. H. Hwang (KRISS), S. Jozela (NMISA), M. Kamensky* (SMU), L. Karam (NIST), M. Kato* (NMIJ/AIST), J. Keightley* (NPL), M. Kellett (LNE-LNHB), A. Knyziak* (GUM), M.-R. Ioan* (IFIN-HH), J.-T. Janssen (NPL), J. Liang (NIM), G. Lorusso* (NPL), T. Matsumoto* (NMIJ/AIST), M. McEwen (NRC), M. Milton* (BIPM), S. Mohamed (FANR), N. N. Moiseev* (VNIIM), Z. Msimang* (IAEA), T. Otto* (ICRU), P. Peier (METAS), M. Pinto (ENEA-INMRI), A. Pystovyi* (NSC IM), S. Pommé (JRC-Geel), J. Rangel (LNMRI/IRD), N. Roberts (NPL), J. Rusňák (CMI), Y. Sato (NMIJ/AIST), V. Skliarov (NSC IM), J. Stenger (PTB), A. Steurer* (BEV), A. Subiel* (NPL), L. Szücs (BFKH), M. Szymko* (GUM), A. K. Thompson (NIST), M. van Rooy* (NMISA), F. van Wyngaardt (ANSTO), A. Veres (LNE-LNHB), A. Y. Villevalde* (VNIIM), Z. Yang (NIM), J. Zhang (NIM), A. Zimbal (PTB), B. Zimmerman (NIST).

Also present:

I. Ahmed (next Executive Secretary of the JCRB), D. Burns (BIPM), R. Coulon (BIPM), A. Cypionka (BIPM), V. Gressier (BIPM – Executive Secretary), C. Kessler (BIPM), S. Maniguet (BIPM – KCDB), C. Michotte (BIPM), O. Werhahn (Executive Secretary of the JCRB).

1. Welcome (CCRI President, J.-T. Janssen)

   A welcome greeting was extended to all the participants, including the Technical Committee (TC) chairs, Working Group (WG) members, institute members, observers, liaisons and BIPM staff in attendance.

   Dr Janssen introduced himself. He is a newly elected member of the CIPM, specializing in Quantum Electrical Metrology. He said how honored he is to be President of the CCRI, that he has the invaluable help of the Section Chairs and the Executive Secretary, and paid tribute to the work of Dr Sené, his predecessor.

   The CCRI president also expressed his special thanks to Dr David Burns and Dr Pierino De Felice for their long and immeasurable contribution to the work of the CCRI, this being the last meeting in which they will both participate.

   Finally, Dr Janssen pointed out that this was the first CCRI meeting to be held in person since the pandemic, but also the first to be held in hybrid mode, with 30 participants taking part online.

   A final note was that all reports received are available on the BIPM website (https://www.bipm.org/en/committees/cc/ccri/28-2021) but due to time constraints, it would not be possible to present all the reports at the meeting.

2. Opening Remarks (BIPM Director, Martin Milton)

   Dr Milton was not able to participate to the first day of the meeting. The opening remarks were then transmitted to Dr Janssen and included in the CCRI president report (see chapter 7)

3. Rapporteur

   Raphael Galea (National Research Council Canada) was appointed, with help of Anna Subiel (NPL).

4. Approval of Agenda

   Approved by all.

5. Minutes of the 28th meeting of the CCRI

   The minutes of the 28th meeting of the CCRI were adopted late 2021 and already posted at the BIPM website. No further remarks or comments.

6. Outcomes of the 2021-2023 meetings of the CIPM (CCRI President, JT Janssen)

Seven resolutions were adopted at *27th Meeting of CGPM (2022)*

1. On the report prepared by the CIPM on the "Evolving Needs in Metrology"
2. On the global digital transformation and the SI
3. On the extension of the range of SI prefixes
4. On the use and future development of UTC
5. On the future redefinition of the second
6. On the universal adherence to the Metre Convention
7. On the dotation of the International Bureau of Weights and Measures for the years 2024 to 2027

The CIPM defined several grand challenges for the 21st century:

1. Climate
2. Health and life sciences
3. Energy
4. Advanced manufacturing
5. CC Cross cutting: digital transformation
6. CC Cross cutting: New metrology: Metrology away from NMI labs or metrology on a chip or networking metrology sensor networks.

The CIPM proposed to create appropriate forums to shape and coordinate the metrology community's response to the identified grand challenges: a forum on metrology of the digital world, a sectorial task group on climate change, and a forum on Quantum Technology.

The CIPM has been renewed with new members elected in 2023 [Georgette Macdonald (NRC), Gustavo Ripper (INMETRO), Gopal Achanta (CSIR-NPL), J-T Janssen (NPL), and Victoria Coleman (NMI)] as well with a new bureau: Wynand Louw (NMISA, President), Takashi Usuda (NMIJ, Secretary), and Philippe Richard (METAS) and James Olthoff (NIST) (Vice presidents).

Dr. JT Janssen followed with Dr. M Milton's presentation:

- The World Metrology Day has been proposed as a UNESCO world day.
- The 2022 workshop on Metrology for climate action was very successful: 100 recommendations and 1000 participants (including several ionizing radiation metrologists).
- The BIPM has been admitted as an observer to the COP27 from 2022 to the United Framework Convention on Climate Change (UNFCCC).
- SI Brochure: Digital transformation: resolution 2 of the 27th CGPM: Digital transformation and new digital services. SI reference point. Beta testing in Oct 2023.
- Joint statement of intent on digital transformation signed by multiple organizations

- The Metre Convention 150 years anniversary will be 20 May 2023. Several celebrations are planned all that week. A question was asked about expected attendance. This is around 1,000, depending on the venue BIPM will be able to secure.
- BIPM personnel changes: Andy Hanson has retired and Anna Cypionka is the new Director of the BIPM International Liaison and Communication Department.

The CCRI president also reminded that, apart from healthcare, the ionizing radiation community plays the key role in allowing safe operation of radiation facilities, commissioning and decommissioning nuclear power plants and in environmental monitoring. A strong presence in the CIPM's 2030 strategy is therefore awaited.

7. Reports from the CCRI Section Chairs

7.1. Section I: x- and gamma-rays, charged particles - Malcolm McEwen (NRC)

The CCRI(I) was held at the IAEA in conjunction with the SSDL network meeting in May 2023. A Joint IAEA SSDL CCRI(I) one day workshop was organized between the two meetings. All these events were organized with a possible online participation. and it was very interesting in hearing as many voices in metrology as possible.

All RMOs were represented, with also representatives from IAEA, ICRU and AAPM, but no one from ATSM or IOMP (the Section will aim to keep inviting these two to future meetings).

It was noted that the training for ionizing radiation metrologists is proposed as an area for development (IAEA TCS-76).

Malcolm McEwen (NRC) is the current chair of CCRI(I) and KCWG(I) and has been renewed till 2027. The following list outlines the recommendations and actions noted from the summary of this meeting.

The BIPM program in Dosimetry has been reviewed. The reestablishment of the K5/C5 capability at the IAEA is in progress, the development on the new medium energy x-ray facility looks impressive and the Work Plan 2024-2027 has been discussed and supported by the Section.

Comparisons:

The comparisons K1-K9 are all under control and are intended to move to more bilateral comparisons, especially with the BIPM, to mitigate transport and

regulatory difficulties. The S3 comparison (traceability for all dosimetry for radiation processing) was completed.

The new comparisons identified for the next 2-5 years are LDR (Low Dose Rate) brachytherapy, MeV electrons and protons.

The strategic plan concerns the increased cost/regulation of Co-60 and the fact that electronic brachytherapy is not a standardized treatment modality meaning that it is challenging to run intercomparisons supporting clinical trials.

Working groups reports:

KCWG(I) is not required to be very active because the system of BIPM bilateral comparisons works very well.

Radionuclide Therapy and Quantitative Imaging WG: over 50 % of current clinical trials involve radiopharmaceuticals, inducing a significant need for this activity.

Task Group on Radioactive Sources and Alternative Technologies: the final report is in progress and awaited before the end of the year.

Brachytherapy Standard WG: not very active at present, but some NMIs/DIs suggest pursuing collaborative work on standards for LDR Brachytherapy.

Digital Transformation TG: There has not yet been much user demand but extensive expertise in MC simulations has direct relevance to the topic of digital twins. Also, 3 areas in relation to digitalization were identified: data integrity, multi-lateral comparisons and validation of MC systems.

An interest in spectrometry in dosimetry was raised, with the possibility of the future formation of a dedicated Task/Working group.

Communication WG: The good participation and attendance on topics relevant to Section I was highlighted. The problem of YouTube not being accessible everywhere was pointed out by Chinese members.

Actions and Decisions:

1. Plan to have a virtual follow-up meeting to review the minutes and make decisions due to the lower attendance at the end of a week meeting.
2. BIPM Plan for CCRI(I) 2024-2027 supported.
3. KCWG(I) requested to produce some “how does the light shine” guidance linking comparisons and CMCs.
4. KCWG(I) requested to provide guidance on updating measurement standards (if not at time of a KC).
5. A CCRI(I) WG may be required to take on the recommendations of the Radioactive Sources TG.
6. BSWG(I) should be reformed to discuss options for LDR brachytherapy comparisons.
7. Repository for BIPM webinars should be as platform-neutral as possible to enable access from all countries.

8. A joint SSDL/CCRI(I) meeting should be repeated, likely date is 2029 (due to meeting cycles of the two groups).

Questions:

Were there any issues with hybrid meeting in terms of decision making? Decision making was mostly impacted by the fatigue of the attendees rather than by the hybrid character of the meeting.

7.2. Section II – Measurement of radionuclides - Lisa Karam (NIST)

The CCRI(II) was held at the BIPM headquarters in person, with additional online participation, shortly before the CCRI meeting in June, 2023. Lisa Karam (NIST) is the current chair of CCRI(II) and has been renewed till 2025.

Comparisons

After some discussion, due to new results, it was decided that the KCRV for the Lu-177 comparison remains unchanged. Future comparisons will address Cu-67, Ac-225, radioactive gases and radionuclide calibrators.

The 10-year plan has been updated, substituting Zn-65 with Am-241 for 2026.

Following KCWG(II) recommendations, the CCRI(II) has validated the opening of the BIPM(II)-K5 comparison (the Extended SIR, ESIR) with 11 possible radionuclides in the first quarter of 2024.

RMO SIRTI

RMO-SIRTIs were deemed to be a very good addition to facilitate the comparison of short-lived isotopes for countries geographically very far from the BIPM. For RMOs seeking to develop such a detector (SIM and APMP as of today), the following conditions were adopted:

1. The characteristics of the RMO SIRTI to match those of the BIPM SIRTI .
2. The protocols for the RMO SIRTI comparison to mirror the protocols for the BIPM SIRTI.
3. The link of the RMO SIRTI to the SIR will be made through two steps (via the BIPM SIRTI, with an insignificant increase in uncertainty).
4. The RMO SIRTI results may be considered for inclusion in KCRV, upon recommendation from the KCWG(II).

Organization and strategy

A new Vice-Chair, who is intended to become the Chair following the CCRI(II) 2025 meeting, is solicited for CCRI(II).

The CCRI strategy will be updated responding to the CIPM's Grand Challenges. For Section II, this update seems straightforward and will be done electronically.

Working group updates

- RTQI WG: providing guidance for the nuclear medicine community.
- CCEM-CCRI: considering balance between cost and solution in considering the use of small current measurements to support ionization chamber calibrations; best practices guidance being developed.
- Communications WG: CCRI webinars, workshops, news resources.
- CCU-CCQM: on the metrology of quantities that can be counted (working on seeing how CCRI fits in; e.g., counting of decays).
- CCRI(II)-CCQM: a small community with a huge interest in using mass spectrometry techniques in radionuclide metrology applications as was reflected by the participants in the workshop held earlier in 2023.

Actions and decisions

1. Recommendation to the CCRI: Quick completion and distribution of rules for IR CMCs.
2. KCRV updated for Cu-64 with new SIRTI submissions.
3. Open (March 2024) BIPM(II)-K5 comparison ESIR for 11 possible radionuclides.
4. Substitute Am-241 comparison in 10-year plan with Zn-65 SIM comparison (with world-wide participation) already running.
5. Start work on the RMO SIRTIs at SIM and APMP.
6. Request for a new Vice-Chair for CCRI(II), who would likely become the Chair following the CCRI(II) 2025 meeting.

Questions:

- Any request for digital certificates from the user community? Not at the moment; seems to be a push from the CIPM but this issue will likely come up in the near future from the user side.
- Are there plans to develop a EURAMET SIRTI? Proximity of many laboratories to the BPIM likely do not make this a huge priority at the moment. NPL is considering developing a system.

7.3. Section III – Neutron Measurements - Andreas Zimbal (PTB)

Section III (neutron metrology) of the CCRI held its 27th meeting from 9th to 12th May 2023 at the BIPM in Sèvres. Thirty-three participants, 14 of who were online, discussed the ongoing activities and future needs of neutron metrology during 3 full days.

Comparisons

In the last two years, 2 comparisons have been published (two K9.AmBe) and there are 4 on-going comparisons (K9.Cf, K12, S1-H*(10), S2-Hp(10)). A scheduled future Key Comparison concerns thermal neutron fields (K8.2024). Each comparison, including supplementary ones, will then be repeated on a 10 years basis. To be noted was that no high energy comparison is scheduled despite a clear need.

A discussion was held on the need to find and implement ways to limit the duration of key and supplementary comparisons organized within the CCRI(III). It was noted that the long delays, sometimes several years, in the completion of comparisons are mostly due to the increased logistical problems associated with sending around radioactive sources and transfer devices. It was decided for the upcoming CCRI(III).K8 comparison to run two transfer instruments in parallel in two separate groups.

Creation of a task group

There is the need to establish traceable metrology for neutron energies above 20 MeV, especially for dosimetry in mixed high energy radiation fields, which is relevant for aircrews, space missions, and patients treated with modern forms of radiotherapy using protons and heavy ions. Therefore, it was decided to create a CCRI(III) task group, “metrology for high energy neutrons,” with the aim of increasing communication and interaction among metrology institutes, institutes with suitable facilities, and stakeholders interested in this field through a potential workshop to be organized in 2024 or early 2025.

Revision of neutron ISO standards

The entire ISO8529 series is being updated. A presentation on the modifications made and planned had been presented by R. Bedogni from INFN.

Proposals and recommendations

- A proposal was made to establish a CCRI(III) TG on “high energy neutrons”.
- It was recommended to perform supplementary comparisons [$H_p(10)$, H*(10)] on a regular basis.

Questions:

- Is it an issue to transfer sources across borders? Bad and getting worse.
- Is CCRI(III) considering a SIRTI-like detector to facilitate comparisons? Not at the moment, but there are also difficulties with transferring equipment or breaking of equipment that cause delays.

8. Reports from CCRI Working Group and Task Group Chairs

8.1. CCRI Radionuclide Therapy and Quantitative Imaging Working Group (CCRI-RTWG) - Brian Zimmerman (NIST)

The Aims of this WG is to enable the CCRI and its Sections to identify where radionuclide (and dosimetry) metrology can improve the effectiveness of radiopharmaceutical therapy (RT) and to coordinate activities to address this, particularly in the fields of quantitative imaging and patient dosimetry.

The areas of focus are PET, SPECT imaging, beta and alpha emitters.

The activities since 2021 has been several meetings and webinars, and a plan to produce two Good Practice Guides:

- Guidance on Traceability and Establishment of Secondary Standards Laboratories (in progress)
- Guidance on Measurement Issues Associated with Targeted Alpha Therapy (starting mid-2024)

Questions:

- Coordination between Sections I and II? Not for now but recommendations are being made to Section I.
- How to link activity (Bq) with dose (Gy)? Report exists on recommendations for this linking. IAEA has also published a report that is relevant and ICRU Report 96 (2021) on Dosimetry-Guided Radiopharmaceutical Therapy has been published in 2021.

8.2. CCEM-CCRI Task Group - Low Current Measurement (CCEM-CCRI-TG-LCM) - Stephen Giblin (NPL)

The mission of this Task Group is to guide the introduction of new technology for the measurement of low electrical current for ionization chambers used in the measurement of radionuclide standards. The awaited output is a guideline paper traceable measurement of small currents for IR applications.

Currently, a guidelines paper exists in a very rough draft form. CCRI(II) members encourage completion of this very useful document.

To be noted, a new EURAMET SRT (Selected Research Topic) proposal on “small current metrology for industrial applications“ is under development.

Questions:

- Are you looking at pulsed current sources relevant to dosimetry? CCEM is considering this and will address this if funded (the SRT proposal includes this aspect) but currently most work is on DC.
- There will still be a need for long-lived sources? Yes, there always will be.
- Cost of manpower and expertise needed to operate these ULCA devices? A number of radionuclide labs are introducing ULCAs into their laboratories. ULCAs are stable for many years so no calibration is required for long lengths of time. Expertise will become more distributed as experience grows so it is not envisioned that an electrical standards expert will be required.
- How can the ULCA be used to follow the decay of very short-lived isotopes (high currents to low currents)? From the electrical point of view the issue is the linearity of the measurement, but one also needs an instrument which does not exhibit surprising changes in gain when it switches the range. The ULCA will address this concern.

8.3. Task Group on radioactive sources and alternative technologies (CCRI-RS-TG) - Malcolm McEwen (NRC)

This task group is transverse to all CCRI Sections. Its creation in 2021 was motivated by the ORS (Office of Radiological Security) report to remove radioactive sources from end use whereas some of these are clinically critical.

This TG was aimed to look for alternatives with the following questions. How to accept an alternative? (“like-for-like” or “fit for purpose”?) What else is impacted? How do we implement this change?

All possibilities were studied: KV x-ray sources, E-LINACS and proton accelerators, electrically generated irradiation, calculational alternatives, zero-radiation options, lower risk radioactive sources, co-operative managed reduction (sharing a source).

As a conclusion (included in a report still at an early draft stage), alternatives are interesting but ongoing access to radioactive sources are needed. MC simulations will increasingly be used, but barriers remain (fundamental data, absolute accuracy applicability). Once the report published, a WG may be formed to take this forward.

Discussions:

- Need to continue to look at alternatives because sources are very expensive. Ability to demonstrate equivalence with alternatives may be harder.
- Introducing more stability to dosimetry measurements may be help. Perhaps EM standards would consider stability like the ULCA at the mA level. Making the stability better is possible but implementing it and making is cost effective is the challenge.
- Making a change away from Co-60 or other sources will cause a huge change in the published standards requiring a large effort in the ISO documents community.

8.4. CCRI CCQM workshop on the use of Mass Spectrometry in IR Metrology - Lisa Karam (NIST)

Mass Spectrometry (MS) would be an adjunct technique to decay counting methods. Many NMI/DIs already have some MS capability and/or activity. An on-line workshop was held from 14 to 16 February 2023, which was a common initiative between CCRI and CCQM. This has shown that there is a lot of interest and stakeholders driving this interest. The on-going challenges are the cost of facilities and training, potential cross-contamination with radioactive materials, the traceability chain, relating mass to activity, and sample preparation.

As an outcome, a Task Group dedicated to the use of MS in radionuclide metrology will be established under CCRI(II) with the goal to report to the CCRI(II) in 2025.

8.5. Communication Working Group (CCRI-COMWG) and KT activities - Vincent Gressier (BIPM)

This new working group, created in February 2022, aims to help the Executive Secretary to plan and shape communication activities. The WG is made up of 12 members, with representatives from all RMOs, CCRI Sections and the BIPM.

The main actions concern the CCRI Webinars (big success with up to now 20 webinars and 1400 attendees, 40 % being stakeholders), the CCRI “news resources”, the preparation of e-learning, and support for workshops. The CCRI-COMWG requires input from everyone to succeed in the above actions and can help communicate RMO or NMI/DI activities through these methods.

8.6. Digital Transformation Task Group (CCRI-DT-TG) - Romain Coulon (BIPM)

This new Task Group was created in March 2023. The 11 members are from each Section, BIPM, ICRU, IAEA and DDEP (for nuclear data needs input). This TG creation was motivated from the Resolution 2 of the 27th CGPM on the Global digital Transformation and the International System of units. The aim of this TG is therefore to advise the CCRI on the SI Digital Framework and to act as a forum to exchange information on progress.

There are currently two working documents in progress: a user-needs for digital transformation in Ionizing Radiation Metrology (illustrated by user cases) and the “Digital Traceability Chain for Ionizing Radiation Metrology”.

In order to have the best overview possible, and as this activity needs a lot of cross-cutting coordination, the TG host invited presentations from other CCs, the BIPM digital transformation group, the Forum on Metrology and digitalization, NMIs, and technical experts.

Questions:

- Do you discuss new digital technologies (AI, etc.)? Just at the beginning of discussions. This will be discussed but first the efforts are put towards the digital representation of data. The TG would be very interested in experts to give presentations on these fundamentally new topics.
- What is the benefit of a digital key comparison? Good question and it will be addressed in the user document. Offering machine readable key comparison information could help in analyzing the results of the comparison including the meta data. It could in some cases help in the traceability chain.

9. CCRI strategy

9.1. Invited Talk: Nuclear techniques in environmental studies - Roman Padilla Alvarez (IAEA)

This invited talk was intended as an input to the CCRI strategy update. giving some views about the use and needs of ionizing radiation in environmental studies. A focus was made on air pollution and on source attribution of greenhouse gases in the atmosphere.

Roman Padilla Alvarez presented all the nuclear techniques used at IAEA in environmental studies and their applications to the measurement of radionuclides in the environment. They appear to be well-instrumented for measuring radionuclides, including radiometric and MS techniques.

In addition, IAEA provides inspection activities, surveys, Certified Reference Materials, and proficiency testing as well as workshops, working groups, training, capacity building and information exchange.

Questions:

What does the IAEA need from the Metrology community?

The current international recommendations and dose coefficients for non-human biota (ICRP, 2008; ICRP, 2017) address this diversity via systematic use of generic models and data, which serve as a robust and practical framework for environmental dose assessment. Still, some gaps can be identified for terrestrial organisms, for which variability of environments and habitats cannot be comprehensively addressed by the existing generic methods and models. The ongoing CRP pursues to develop a robust probabilistic framework for assessment

of external doses for terrestrial animals and plants, while adequately addressing and quantifying inherent uncertainties due to spatial distribution of radioactivity in the environment, soil structure, water content, types of vegetation, terrain, migration routes of animals. Development of the framework should be supported by field experimental and theoretical Monte Carlo simulation studies, probabilistic modelling and consideration of uncertainties.

In general, what is needed is the improvement of metrological traceability of radioactive measurements. Sometimes difficulty in calibration of dosimeters. Sometimes difficulties are faced in calibration of dosimeters. Proper calibration of dose rate meters and TLD dosimeters for measurement and interpretation of ambient dose rates in the environment is the task which may require development of task-specific techniques and methods (dose assessment and dose reconstruction).

Liaising with the International Commission on Radiation Units and Measurements (ICRU) is envisaged to justify selection of operational quantities for external dosimetry applications (see, e.g., ICRU Report 95 “Operational quantities for external radiation exposure”; https://www.icru.org/report/icru-report-95-operational-quantities-for-external-radiation-exposure/).

9.2. Discussion of CCRI strategy – JT Janssen (CCRI president)

JT Janssen described the need of a draft strategy revision for June 2024. It could be a straightforward rewriting of the existing strategy from 2021 to bring it in line with CIPM priorities, which look to be all included but not in the right order. New additions are also possible to include (up to the year to 2030 and beyond).

Questions:

Everyone can contribute to this document so please communicate anything through your CCRI Section chairs.

The strategy seems to be more like a reflection? The strategy is an international explanation of what we do. It could be used to take back to our governments and possibly influence our work.

Are there documents that can show us how we have performed when we have reached these future dates of the strategy? The strategy documents are living documents but can be utilized to show our governments that we align.

The BIPM is very important to the CCRI. Do other CCs benefit as much as CCRI from the work at the BIPM? No, not as much as does CCRI, but it is something we can exploit.

10. Reports from international organizations in liaison with the CCRI

10.1. IAEA (Mauro Carrara)

Dr Carrara gave a brief summary of work in progress at the IAEA. He reminded that the main objective of his group (Dosimetry and Medical Radiation Physics Section) is to support Member States in enhancing their capacity to implement radiation imaging and treatment modalities safely and effectively through optimized dosimetry and medical physics practice.

Recently, this objective was implemented through calibration and auditing services, developments in radiation dosimetry (new guidelines in nuclear medicine “Dosimetry in Radiopharmaceutical Therapy” and two guidelines to support the medical physicist profession on professional ethics and AI, which is to be published), clinical medical radiation physics, and quality assurance programs.

Questions:

- At CCRI(I) there was a debate on how much importance to put on electronic brachytherapy. What is the IAEA perspective from developing countries for these modalities? Based on Iraq as an example, use of iridium afterloaders is decreasing while cobalt afterloaders are on the rise. E-brachtherapy does not seem to hold much interest in the clinical community from these countries.
- CCRI(I) overlaps with IAEA to provide standards.

10.2. ICRU (Thomas Otto)

Dr Otto highlighted the recent publications of ICRU.

- Report 96: Dosimetry-Guided Radiopharmaceutical Therapy.
- Report 97: MRI-Guided radiation therapy using MRI Linear Accelerators

‘Operational Quantities for External Radiation Exposure’.

The forthcoming reports will concern microdosimetry (update of report 36 - 2023), tumor volume definition and treatment planning (2024), and radiation protection dosimetry (2025).

Questions

What is the relationship between ICRU and ISO? ICRU will not replace any other reports from other organizations like ISO. ICRU hopes to have these reports viewed as guidance documents. The purpose of the ICRU report is to have a

"review booklet" of what is up-to-date state-of-the art. No calibration procedures and descriptions of how to equip an SSDL will be outlined in these ICRU reports.

10.3. ICRM (Brian Zimmerman)

Dr Zimmerman described that ICRM (International Committee for radionuclide Metrology) is made up of 50 members/institutions including NMI/DIs from CCRI (II).

In the last two years two very successful meetings were held: ICRM-LLRMT (Low-Level Radioactivity Measurement Techniques) in Gran Sasso in April 2022 and the main ICRM conference in Bucharest in March 2023, which was attended by more than 135 (22 online) colleagues from NMIs/DIs, universities, and international organizations.

The next main conference ICRM in 2025 is tentatively scheduled for the 3rd week of June in Paris, hosted by the LNHB.

The rest of the information contained in the report has been uploaded to the CCRI SharePoint site.

10.4. JRC (Stefan Pommé)

The JRC (Joint Research Centre) is over 60 years old and has operated as an NMI for many years. Their activity in metrology covers multiple primary standard methods for radioactivity, decay data determination, proficiency testing opportunities for European laboratories, method development for half-life measurements, software used by members of CCRI(II) (e.g., Power Moderated Mean for determining the mean of measurements, and visualizing this mean using PommPlot), a lot of fundamental work performed in verification of the exponential decay law due to false claims that this law was violated, and a currently work on SIR parent-progeny calibration factors.

10.5. ISO TC 85 SC2: Radiological Protection (Jean-Marc Bordy)

ISO/TC85/SC2 develops standards in the field of Radiation Protection for individuals (workers, patients, members of the public) and the environment regarding the use of various sources of ionizing radiations in planned, existing, or emergency exposure situations linked to nuclear industry, medical applications, industrial activities, research activities, and natural radiation sources.

ISO/TC85/SC2 has established liaisons with international organizations: BIPM, EANM, EC - European Commission, EURADOS, IAEA, ICRP, ICRU, IEC/SC45B, ISSPA, OIML, WHO, WNA.

120 standards have been published and about 30 standards are in preparation.

Discussion

Observation that spectrometry seems to be a common theme in multiple areas.

10.6. CTBTO - Comprehensive Nuclear-Test-Ban Treaty Organization Preparatory Commission (Nikolaus Hermanspahn)

The Treaty curbs the development of nuclear weapons and the improvement of existing weapons – it bans all nuclear explosions, everywhere by everyone. The Treaty has been signed by 185 states.

The verification is done through monitoring, consultation and clarification, on-site inspection and confidence building measures. The monitoring is made through four technologies: seismic, hydroacoustic, infrasound and radionuclide.

Concerning radionuclides (92 are followed), all is ok for the gamma-ray emitting ones.

Gaseous xenon radionuclides are traceable through gamma-ray spectroscopy but there are no primary standards at the very low activity levels under consideration. With an MDA <1 mBq/m^3 for Xe-133, a comparison would be great.

Questions

Is the CBTBO only sensitive to nuclear bombs or also dirty bombs with other isotopes released? Concerned with nuclear bombs but in principle have sensitivity for radionuclides other than from xenon.

CBTBO installs the monitor on sites but then ownership changes to the nation hosting the station.

What type of containers are used to store the radioxenon? Gas cell with carbon fiber window to be measured in gamma-spec.

11. Report from the BIPM Ionizing Radiation Department (Vincent Gressier)

Dr Gressier gave a brief summary of the recent work of the BIPM Ionizing Radiation Department, made of 8 staff members with 3 in dosimetry, 4 in radionuclides. and the department director (neutron metrologist). This presentation was followed by a visit to the ionizing radiation (IR) department where more technical questions and discussions were exchanged.

The IR department is a hub for bilateral comparisons (80 % of all the comparisons in ionizing radiation metrology) for both Sections I and II. It offers calibration services in dosimetry and provides an administrative support to Section III.

11.1. Radiation Dosimetry:

In the last two years, the dosimetry group has fully opened the calibration services for high energy photons using the DOSEO facility, is re-opening the ^{137}Cs services for radiation protection at the IAEA, and has renewed the BIPM medium energy x-ray facilities with a new generator/tube, a new calibration bench and a new standard (free air chamber)

11.2. Radionuclide metrology:

Recent developments in the radionuclide metrology group include the on-going replacement of the Ra-226 reference sources with Ho-166m sources for the SIR, successful remote comparisons with the SIRTI, and the pilot study of ^{60}Co on the ESIR. Two other points to be highlighted are the RMO SIRTI project and the start of the ESIR comparison (see section 2 of this report).

12. Reports from Regional Metrology Organizations and Members / Observers

12.1. CCRI-RMO Working Group - Sibusiso Jozela (NMISA)

Dr Jozela reminded the attendees that the CCRI RMO Working Group is made up of RMO representatives, the CCRI(I, II, III) Section chairs, and the CCRI Executive Secretary. The chair of the RMO WG rotates through the RMOs. After AFRIMETS comes APMP; the incoming chair for the next 4 years is Chien-Hau Chu (INER) with the support of a vice-chair (Duncan Butler, ARPANSA).

In the last two years, several documents were reviewed and updated: the Terms of Reference for the RMO-WG, the "Rules for completing CMCs" with a major change being the inclusion of the possibility of declaring batched radionuclide CMCs, the CIPM-MRA-G-11, and the CMC Review Checklist, already in use in SIM, as a tool for reviewers optional for all RMOs.

Other actions concerned the approval of the use of an IAEA report to support a CMC claim and the review of a course on the BIPM e-learning site on "How to enter a CMC claim for ionizing radiation metrology".

The WG also discussed a proposal to request the JCRB to allow multiple revision of a CMC during the JCRB review stage. This will affect all CCs and is announced here to communicate this proposal to all CCs.

Questions:

- Single revision was a decision by design.
- Points to other learning resources for help in using the KCDB.
- Who decides about the acceptance of the IAEA reports? RMO WG has accepted, but now it has been put forward to CCRI for acceptance. CCRI has been working with IAEA to update the reports with the complete uncertainty budgets to make those reports acceptable to the CCRI (with the further evidence with the claim on the uncertainty).

12.2. Reports on JCRB decisions pertaining to the CCRI (Olav Werhahn)

Dr Werhan reported on the work of the JCRB. His mandate as JCRB executive secretary is ending and his successor will be Ibrahim Ahmed from the KEBS.

The documents having been or being revised are:

2022: CIPM MRA-G-13 revised to better align the 'greying-out practice' with the KCDB 2.0 platform.

2023: CIPM MRA-G-11 a revision proposed on the statistical evaluation of comparisons is not supported by all CCs (CCs expressed concerns on the proposed level of details for this type of CIPM guideline documents).

The action JCRB/46-1 (2023) is to ask each RMO to nominate (one or two) RMO coordinators for the "Young metrologists' 2050+ vision" foresighting exercise and to send their names to C. Kuanbayev (BIPM) by 31 March 2023.

A new recommendation, JCRB/46-1 (2023), has been provided. Noting the availability in the KCDB of a unique and persistent identifier for each CMC (and each version of a CMC), the JCRB recommends use of these CMC identifiers by the participating NMIs/DIs (for example in their quality documentation) and asks the BIPM Headquarters to make available appropriate training material to encourage this.

As resolution JCRB/46-1 (2023), the 47th meeting of the JCRB will be held in Costa Rica (Laboratorio Costarricense de Metrología); 12/13 September 2023.

Discussion

CMC review process includes revisions from the submitter. JCRB measures the time for a review includes the time for the entire process, review plus revision.

12.3. RMO Technical Committee / Working Group Chair Reports

The TC-IR Chairs gave brief summaries of progress in their regions; further details are available in the working documents.

- AFRIMETS (Sibusiso Jozela - NMISA): There are currently no ongoing comparisons piloted by AFRIMETS. The group remains very small, with NMISA being currently the only NMI that has measurement capabilities covering dosimetry, radioactivity and neutron metrology. The challenge of changes in personnel in some NMIs impacts continuity in retaining skills. The NMIs under AFRIMETS are currently participating in other RMO organized comparisons and also using IAEA bilateral comparisons. The RMO's focus within the next two years will be building capacity for the region, using available avenues within CCRI and IAEA. The RMO will also have a reach out program to countries where there are no laboratories to get a clear picture on how traceability is received.

- APMP (Chien-Hau Chu - INER): There has been active participation in comparisons. An RMO comparison is planned for high energy electrons as well as a supplementary one for radioactivity. Hybrid comparisons are being used (two underway for NK low and medium energy x rays). The strategy followed for comparisons is to meet requirement of CCRI (bilateral and hybrid comparisons) and carry out collaborative NMI-piloted comparisons. For the RMO-SIRTI project, 3 institutes are developing their own instruments.

Discussion

A hybrid comparison is bilateral but moderated by a 3rd party, typically the RMO Chair. Hybrid comparisons are not entirely new; the IAEA has, in the past, run something similar.

Encourage all 3 APMP-SIRTIs to come together in the same location when making the link to the BIPM-SIRTI.

- COOMET (Nikolay Moiseev - VNIIM)): The Republic of Lithuania and Ukraine have terminated their participation in COOMET. There has been active participation in comparisons RI(II).S3 and RI(I)-S3. New foreseen comparisons are the specific activity of Ba-133 (not yet registered within COOMET, but

discussions with BIPM underway) and a bilateral comparison for Cs-137 and/or x rays.

Discussion

Bilateral comparisons in dosimetry were deemed to be cheaper, quicker and simpler.

- EURAMET (Jacco de Pooter - VSL): EURAMET TC-IR representatives from 15 DIs, 14 NMIs and JRC have been discussing CMCs, the KCDB and preparations for EMP calls, with capacity building being an important aspect.

  There is active participation in comparisons (currently 5 underway), one is planned for interlaboratory comparison of the radionuclide calibrators for short-living radionuclides in nuclear medicine.

  Several existing and future European metrology programs (EMP) involve or could involve ionizing radiation metrology.

  - For health: FLASH radiotherapy, MR guided radiotherapy, radionuclide therapy (alpha-emitters), AI/digitization, radiodiagnostics and radiation protection/regulations
  - For normative standards: contribution to TG-398 (RTNORM) and electronic brachytherapy (PRISM-eBT)
  - For Environment, Energy, Industry and Fundamental: small and hybrid nuclear power, alignment with the European “Green Deal” (pollution free environment and climate change), radon as a tracer.

  Euramet has introduced European Metrology Networks (EMN) which is an additional structure that addresses more directly the needs of stakeholders on a specific horizontal theme. For IR the following EMNs (or are in the process of becoming an EMN) are relevant: Radiation Protection, POLMON (Pollution monitoring) and MIRA (the medical use of ionizing radiation).EURAMET developed a number of capacity building instruments including training courses, mentoring schemes, research mobility grants, e-learning, small collaborative projects, research potential projectsQuestions

  Is there something specific that is needed for SMRs other than what is already done for power reactors? No answer

- GULFMET (Samia Mohamed - FANR): GULMET is fast developing as an RMO and involved in many training sessions. Two RMO comparisons are ongoing (RI(I)-K5 and RI(I)-S1) and a third one, RI(I)-S2, is planned.

  FANR (from United Arab Emirates) is the only DI in GULFMET so far, waiting for two other labs from Saudi Arabia to be nominated as DIs.

  Upcoming projects include the submission of CMCs in dosimetry from the UAE in 2023, the establishment of neutron dosimetry soon (hope to be ready for

CCRI(III)-S2 in 2024), and of surface contamination capabilities in the near future.

Questions

Is there a lot of participation from your observers? They are learning.

- SIM (Raphael Galea - NRC): SIM also noted active participation in comparisons. A SIM-SIRTI is currently developed and will be hosted by LNMRI/IRD (Brazil).

There is a work on Transition Radiation Sensors at NIST, as well as a development of radioactive gas counting ongoing at NRC and NIST.

Discussion

It was acknowledged that the SIM comparison of Zn-65 piloted by LMNRI/IRD had over 60 % participation from non-SIM members, including those from EURAMET and APMP.

12.4. Reports from Members / Observers

Many reports were sent to all three Sections. Two NMIs provided a report to CCRI. BEV (Robert Brettner-Messler) submitted a report for the record without a presentation and ENEA.

- ENEA (Massimo Pinto): Dr Pinto informed CCRI that the reinstatement of greyed out CMCs after funding was provided to maintain and improve facilities and capabilities at ENEA. Not all 97 CMCs are likely to be reinstated, as a review of these may indicate.

Questions

When do you expect to have your peer review? We are negotiating this at the moment but are aiming for the end of 2023 or January 2024 to be ready for the deadline of May 2024.

13. Membership and other CCRI committee issues

13.1. Membership rules to the CCRI and its Sections

Following decisions made at the 26th meeting of CCRI, small changes to membership rules to the CCRI are proposed. As a reminder, membership is decided by the CIPM and is open to Institutions of Member States that are recognized internationally as the most expert in the field.

Institutes which are member of at least 2 CCRI Sections can be members of CCRI, and institutes that are member in 1 CCRI Section can become official observers of CCRI.

Institutes meeting these requirements are invited to apply for member/observer status sending a letter to the BIPM director.

Regarding membership in the Sections, only institutes will be kept (not individuals) on the BIPM webpages. Only two statuses will remain in Sections: member or guest; observer status will no longer exist.

Number of participants from each institution to Sections meetings will be limited as follows (with only one of whom represents the institution):

- Section I: 2 participants (3, when including online),
- Section II: 2 participants (4, when including online),
- Section III: 3 participants (+online on request).

Questions

Are the selection criteria for the CCRI same as Sections? Yes, membership to Sections being a prerequisite. The number of guests can be as great as needed.

13.2. Proposals for new members/observers, liaison organizations

None received.

13.3. Appointment of Section and Working Group Chairs and deputies

The changes are the following.

- Malcolm McEwen NRC chair of CCRI(I) and KCWG(I) is renewed to 2027.
- Lisa Karam (NIST) chair of CCRI(II) is renewed to 2025. A new vice-chair will be soon nominated.
- The BSWG(I) is being restarted; Cecilia Kessler (BIPM) is nominated chair till 2027.

13.4. CCRI resolutions

The resolutions and key points from this meeting are summarized in the table below.

Summary of Resolutions from the 28th CCRI Meeting (* denotes priorities identified by CCRI Section Chairs)

Session / Section	Resolutions / Key points	Date Completed
12.2	• Recommendation JCRB/46-1 (2023): Noting the availability in the KCDB of a unique and persistent identifier for each CMC (and each version of a CMC), the JCRB recommends use of these CMC identifiers by the participating NMIs/DIs (for example in their quality documentation) and asks the BIPM Headquarters to make available appropriate training material to encourage this.	
13.1	• Institutes being member of 1/at least 2 Section(s) are invited to apply for, respectively, official observer/member status of CCRI by sending a letter to the BIPM director • About Sections, institutes (not individuals) will be kept on the BIPM webpages. Only two statuses will remain in Sections: member or guest (observer status no longer exists). • Number of participants to Sections meetings will be limited as follows: o Section I: 2 participants (3 when including online) o Section II: 2 participants (4 when including online) o Section III: 3 participants (+online on request)	

14. Any other business

- CCRI(I) is concerned that 3 staff members at the BIPM is insufficient and would like to see more support (an additional person) in this area for the BIPM.

Martin Milton (BIPM): comments from CCRI(I, II, III) have consistently been sent to the CIPM and then to the CPGM. The response is that we should encourage the secondment of individuals in order to help with the level of effort needed to maintain the BIPM work. Secondments are in two streams: help in delivery of the BIPM program and the capacity building.

- Acknowledgement to D. Burns (BIPM) for his immense contribution to CCRI.

15. Dates of next meetings

2025 is the 150th anniversary of the Metre Convention. Week of 20th May 2025 is booked. As a consequence, CCRI meetings to be proposed for a later date than usual if at BIPM.

M. Kellet (LNE-LNHB) announced that ICRM conference is scheduled tentatively for the week of 15 June 2025.

16. Closure of meeting

Dr Janssen thanked attendees for taking the time to join the meeting and for their contributions to the meeting and, more broadly, to the work of CCRI.