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Consultative committee on ionizing radiation: Impact on radionuclide metrology

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HIGHLIGHTS

- Influence of CIPM MRA on radionuclide metrology at laboratories around the world.
- CCRI strategy: to be the "undisputed hub for ionizing radiation global metrology."
- CCRI Strategic Plan stresses importance of measurement confidence for stakeholder.
- NMIs increasing role in radionuclide metrology by designating institutions (DIs).
- NMIs and DIs establish quality systems; validate capabilities through comparisons.

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ABSTRACT

In response to the CIPM MRA, and to improve radioactivity measurements in the face of advancing technologies, the CIPM's consultative committee on ionizing radiation developed a strategic approach to the realization and validation of measurement traceability for radionuclide metrology. As a consequence, measurement institutions throughout the world have devoted no small effort to establish radionuclide metrology capabilities, supported by active quality management systems and validated through prioritized participation in international comparisons, providing a varied stakeholder community with measurement confidence.

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1. Introduction

Since the creation of the Bureau International des Poids et Mesures (BIPM) and the Comité International des Poids et Mesures (CIPM) in 1875 by the Conférence Diplomatique du Mètre (which resulted in the Meter Convention), the performance of metrology has evolved from an activity focused inward (at the single laboratory level) to outward as an interactive activity among laboratories around the world. In 1959, and in the context of the need to compare national radium standards with international standards, the Comité Consultatif pour les Étalons de Mesure des Rayonnements Ionisants (CCEMRI, which would become the Comité Consultatif pour les Rayonnements Ionisants, CCRI, in 1999) met for the first time (CCEMRI, 1960). At this meeting, the importance of interlaboratory cooperation in the difficult task of measurement and standardization of ionizing radiations, including radioactivity, and the role of BIPM in the verification of those measurements and standards, was discussed. The establishment, also during that first meeting, of a permanent subcommittee to concentrate specifically on radioactivity measurements, was within the rules of the CIPM (CIPM, 1952). This permanent subcommittee, eventually to be called the CCRI Section Two or CCRI(II) (CCRI Section II, 2015), was tasked with not only focusing on the emission of various particles and energies from unstable atoms, but also facilitating interactions among the various member institutions representing ionizing radiation measurement laboratories from around the world. The BIPM (tasked, also at that first CCEMRI meeting, with establishing "international standards for measurement of [*radio*]activity…taking into account the results of national, international, and other laboratories and institutions") and the Radium Institute were included among those first member institutions, as was the International Commission on Radiation Units and Measurements (ICRU), as major a stakeholder at the time as it is today. The role of the CIPM and the CCRI in the creation of the ionizing radiation section of the BIPM has been described by Terry Quinn, previous Director of the BIPM (Quinn, 2011).

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As international metrology became better defined, and as governments began to use the results of metrology to enable trade and commerce, the parent organization for which the CCRI operates, the CIPM, adopted a "Mutual Recognition Arrangement" (CIPM MRA) under which the consultative committees in all fields currently operate (CIPM, 2015). Under the auspices of the CIPM MRA, which was intended to enable the recognition of measurements across borders to facilitate trade, individual laboratories [National Metrology Institutes (NMIs) and Designated Institutes (DIs)] began to publish their calibration and measurement capabilities (CMCs) to document their capabilities, including in radionuclide metrology (Karam, 2007). Under this new structure, the preexisting structure of the CCEMRI (becoming the CCRI with the adoption of the CIPM MRA) permitted a logical extension to a strategic model (with the CCRI defining the *goals* of ionizing radiation metrology; the Sections, including CCRI(II), defining the *technical deliverables* needed to support those goals; and the various working groups and individual laboratories performing the actual *tasks* to achieve the needed deliverables). Such a structure allows the CCRI to work efficiently while remaining responsive to stakeholder needs in a timely fashion.

With the signing of the CIPM MRA in 1999, the function of the CCRI(II) as facilitator of international radionuclide metrology expanded to serve as the strategic coordinator between the NMIs and the BIPM, with input and insights from wide stakeholder (user) communities (CIPM MRA, 2015a). At the same time, growing interest among existing laboratories (academic and government) to play a greater role in international trade and commerce led them to more widely demonstrate and perform their radionuclide metrology capabilities, leading to their eventual designation by official National Metrology Institutes (many of which do not have ionizing radiation measurement capabilities) to provide the national radioactivity measurements and standards needed to support environmental monitoring, nuclear energy, industrial, and medical applications of radioactivity.

As a consequence of the CIPM MRA, and to improve radioactivity measurements in the face of advancing technologies, the CCRI(II) and its working groups continue in a strategic approach to the realization and validation of measurement traceability for radionuclide metrology. As is described in the short, medium and long-term Action Plans in the *CCRI Strategic Plan for the Period 2013–2023*, the importance of increased dialogue among all stakeholders (including between NMIs and their associated DIs) as well as increased efficiencies in all aspects of radionuclide metrology (quicker publication of comparisons reports, improvements in radionuclide decay schemes, expansion of capabilities at the BIPM to accommodate a wider range of submitted radioactive sources, harmonization of uncertainties, etc.) are balanced with the need to address immediate applications (such as post-Fukushima monitoring) as well as establishing the infrastructure required to address un-anticipated needs in the user community and arising from improved technologies and knowledge (Table 1) (Carneiro et al., 2013). The ultimate goal of the *CCRI Strategic Plan* to enable the CCRI to become the "undisputed hub for ionizing radiation global metrology" is dependent on close collaborations with its institutional stakeholders and in direct dialogue with end-users.

In responding to the CIPM MRA and the resulting strategic planning of CCRI(II), measurement institutions throughout the world have devoted significant effort to the establishment and maintenance of quality systems, organized their priorities in participation in international comparisons, and encouraged dialogue with each other and with users. This has allowed the community to better address the needs of not only international metrology but also those of the stakeholders for whom the metrology forms a solid foundation for their own requirements in meeting regulations and assuring quality to their customers.

Table 1
Actions planned in radionuclide metrology to support the strategy for the CCRI.

ID	Action plan for 2013–2015 (short/current term)
a	Harmonize stringency in uncertainties
c	Increase meaningful dialogue between NMIs and DIs
d	Dosimetry for diagnostic imaging – identify metrology needs
f	Evaluation and improvements of the CIPM MRA
g	Stakeholder workshop (both institutional and end-user)
i	New challenges for radiation protection dosimetry (operational quantities)
k	Activity (SIRTI) comparisons
m	Consistent radionuclide decay schemes
n	New needs in public security, health, and industry
p	Extend SIR to pure α and pure β emitters
q	SIRTI for more short-lived radionuclides
t	Standards for contaminated environment or foodstuffs (e.g., postFukushima)
u	Standards for nuclear forensics
v	Shorten the time to publication of comparisons reports
ID	**Action plan for 2016–2019 (medium term)**
g	Extension of the SIR to α-emitters
h	Molecular imaging measurement needs
j	Brachytherapy – LDR comparisons
k	Climate change needs for low-level measurements standards and tracers
l	Anthropogenic and natural radionuclides standards for the environment and the industry (NORM, wastes,…)
m	Single atom counting techniques for activity-mass connection
ID	**Action plan for 2020–2023 (long term)**
a	Standardization methods for new radionuclides
b	Introduction of new biologically related quantities
d	Evaluate non-reactor based methods of radionuclide production

2. Expanding the international radionuclide metrology infrastructure: increased dialogue and awareness

Among the four strategic initiatives of the CCRI Strategic Plan, the "focus on stakeholders" is a key driver for many of the activities of the CCRI(II) and its members. Fundamental to such a focus is the establishment of a metrology infrastructure for radioactivity at measurement laboratories. Although radioactivity measurements have been done since the early part of the 20th century, and the recognition of the importance of its metrology led to creation of the CCEMRI in the mid-20th century, the regulatory and safety considerations of handling radioactive materials are not always within the capacity of a National Metrology Institute. In fact, the number of countries choosing to designate a laboratory for ionizing radiation measurements is significant (see "CIPM MRA: List of Participants") (CIPM MRA, 2015b). Although these designated institutions may have been performing radioactivity measurements for decades, the concept of "metrology" – the science of measurement along with all its aspects – may not have been a consideration in the past.

For more than forty years (since 1974), the International Committee on Radionuclide Metrology (ICRM) has provided an opportunity for laboratories "new" to the concept of metrology of radionuclides to interact directly with members of the CCRI(II) (all of which also have delegates to, and form the foundational "backbone" of, the ICRM) in a wider, scientifically-focused forum. The biennial conferences of the ICRM present a unique opportunity to present the results of CCRI(II) international comparisons and the development of new primary and secondary measurement methods and instrumentation to this wider community. Recognizing that a growing number of these "new" laboratories were taking on increasing roles in providing measurements to support users in achieving measurement-quality assurance, the 2011 meeting of the ICRM in Tsukuba, Japan, presented the work of several laboratories new to the ICRM. The National Technical University of Athens, Greece (NTUA), the Center for Physical Sciences and Technology, Lithuania (CPST), the Center for Technology