Consultative Committee on Ionizing Radiation (CCRI)

Report to the 25th CGPM

BIPM Director
on behalf of CCRI Presidents
Dr Kim Carneiro and Dr Wynand Louw
Scope and Impact

Mission

World-wide harmonization and comparability of ionizing radiation measurements

Impact

• Medical applications: radiodiagnostics, radiotherapy, nuclear medicine
• Radiation protection: Environmental survey
• Nuclear energy and fuel cycle
• Main stakeholders:
  - International Atomic Energy Agency (IAEA)
  - International Commission on Radiation Units (ICRU)
  - International Organization for Medical Physics (IOMP)
  - International Committee on Radionuclide Metrology (ICRM)
  - International Commission on Radiological Protection (ICRP)
• All RMOs: AFRIMETS, APMP, COOMET, EURAMET, SIM

Areas of Work

• **Dosimetry**: X- and γ-rays, charged particles (CCRI(I))
• **Radioactivity**: radionuclide measurements (CCRI(II))
• **Neutron fields**: neutron measurements (CCRI(III))

Some statistical data

- 4 billion x-ray examinations per year
- 35 million medical examinations per year using radionuclides
- 11 million radiation workers
- 8 million radiotherapy treatments/year
- 11000 clinical accelerators
- 2300 60Co sources for therapy
- 2500 HDR/LDR brachytherapy facilities
- 1300 industrial electron accelerators
- > 200 industrial gamma-irradiators

Members

• 28 Members:
  - 14 National Metrology Institutes
  - 11 Designated Institutes
  - 2 International Organizations
  - 1 Personal Member
• 11 Observers
Main Achievements (2011 – 2014)

- Evaluation of DoE for absorbed dose to water ($D_w$) in clinical accelerator photon beams
  - Approved and implemented. Five results for equivalence

- Brachytherapy comparisons with high-dose rate $^{192}$Ir sources
  - Revised and re-started

- Thematic special publications on:
  - neutron metrology
  - uncertainties in radionuclide measurements
  - Metrologia 48, 6 (2011)
  - Under peer review stage

- Tools for comparison analysis
  - Power-moderated mean (PMM) method
  - Measurement Methods Matrix
  - Adopted for KCRV evaluation in CCRI(II)
  - Updated for optimal choice and timing of radionuclide comparisons

- New developments:
  - Extension of SIRTI to new short-lived radionuclides
  - Extension of SIR to $\beta$ emitters: started
  - Shared use of a single facility: implemented
  - Implemented for $^{18}$F (110 min half-life)
  - Pilot study with $^3$H, $^{14}$C, $^{55}$Fe and $^{63}$Ni: started

81 BIPM calibrations of national standards in gamma and X-ray beams
59 BIPM Key comparisons
3 CCRI Key comparisons + 4 CCRI Supplementary comparisons
SIRTI EXTENSION TO $^{18}$F (1.8 h half-life)

- **Extension of SIR to short-lived radionuclides:**
  - previously implemented for $^{99m}$Tc (6 h half-life) with the SIR Travelling Instrument (SIRTI)
  - **extended in 2014 to $^{18}$F** (the most frequent radionuclide used for imaging by Positron Emission Tomography-PET)
  - **BIPM.RI(II)-K4.F-18 comparison** registered in the KCDB

- **Comparisons carried out (all in 2014)**
  - VNIIM, NPL and ENEA
  - All reports at Draft A stage:
    * VNIIM and ENEA: pending on their results of primary measurements of activity
    * NPL: Analysis of results in progress
# Stakeholder involvement and Strategic approach

Stakeholders contribute directly to the definition of the CCRI strategic approach:  
**Table of CCRI strategic actions for 2016-2019**

<table>
<thead>
<tr>
<th>ID</th>
<th>Action</th>
<th>Section I</th>
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<th>BIPM</th>
<th>AFRIMETS</th>
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*Only for $^{137}$Cs
# Measurement Methods Matrix (MMM)

| Nr | App. | Nuclide | 40K\textsubscript{AP}\textsubscript{R} | 40K\textsubscript{AP}\textsubscript{P} | 40K\textsubscript{AP}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{S}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{S}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{N}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{N}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{H} | 40K\textsubscript{AP}\textsubscript{H}\textsubscript{E} | 40K\textsubscript{AP}\textsubscript{H}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{H}\textsubscript{E} | 40K\textsubscript{AP}\textsubscript{H}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{K}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{K}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{K}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{K}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{S} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{K}\textsubscript{H/E} | 40K\textsubscript{AP}\textsubscript{K}\textsubscript{S} |
|----|-----|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1  | ENV | H-3    | 3             | 2             | 1             | 0.6           | 6              | 3              | 2              | 1              | 6              | 3              | 2              | 1              | 6              | 3              | 2              | 1              | 6              | 3              | 2              | 1              | 6              | 3              | 2              |
| 2  | RES | Be-7   | 3             | 2             | 1             | 0.6           | 6              | 3              | 2              | 1              | 6              | 3              | 2              | 1              | 6              | 3              | 2              | 1              | 6              | 3              | 2              | 1              | 6              | 3              | 2              |
|    |     | Be-10  |                |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 3  | MDD | O-11   | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 4  | ENV, RES | C-14 | 3             | 1             | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 5  | MDD | P-18   | 2             | 1             | 2             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 6  | DCA | Na-22  | 1             | 1             | 0.6           |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 7  | DCA | Na-24  | 0.6           |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 8  | ENV | Ar-26  | 2             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 9  | MDT, RES | P-32 | 1.5           | 0.7           | 1.5           |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 10 | MDT, RES | P-33 | 1.5           | 1             | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 11 | S-35 | 3             | 1             | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 12 | ENV, MDD, FOF | C-36 | 1.5           | 0.7           | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 13 | ENV | Ar-37  | 1.5           | 1             | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 14 | ENV | K-40   | 0.6           |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 15 | MDD, WAS, FOF | Ar-41 | 1.5           | 1             | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 16 | ENV, WAS, FOF | Ca-41 | 1.5           | 1             | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 17 | ENV | K-42   | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
| 18 | Ca-45 | 1.5        | 1             |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |               |
Future Challenges

**METROLOGICAL CHALLENGES...**

**Short term (2016-2019)**

- Promote the progression from air kerma to absorbed dose to water standards
- Establish a long-term strategy for accelerator dosimetry and brachytherapy
- Extension of the SIRTI to further short-lived isotopes ($^{64}$Cu, $^{11}$C,...)
- Full extension of the SIR to beta- and to alpha-particle emitters
- Revision of neutron CMCs

**Medium/Long term (2020-2023)**

- Work towards new biologically-based quantities
- Evaluate non-reactor based methods of radionuclide production
- Proton (hadron) dosimetry
- Neutron standards for intense pulsed fields
Thank you for your attention