



BUREAU INTERNATIONAL DES POIDS ET MESURES
Comité Consultatif pour les Rayonnements Ionisants
Section III (Neutron Measurements)
27th Meeting (May 9-12, 2023)
BIPM, Sèvres, Petit Pavillon and online

Chair	Dr Andreas Zimbal (PTB)
Co-Chair	Mr Neil Roberts (NPL)
CCRI President	Dr J.T. Janssen (NPL)
CCRI Executive Secretary	Dr Vincent Gressier (BIPM)

Participants

Dr Amokrane Allaoua, LNE-IRSN
Mr Pavol Blahusiak, SMU
Dr Andy Buffler, UCT
Dr Maynard Dewey, NIST
Dr Tingyu Jiao, CIAE
Dr Jungho Kirn, KRISS
Dr Wei U, CIAE
Dr Benjamin Lutz, PTB
Dr Tetsuro Matsumoto, NMIJ/AIST
Dr Roberto Mendez Villafane, CIEMAT
Dr Liviu-Cristian Mihailescu, SCK.CEN/LNK
Dr Cheick Thiam, LNE-LNHB
Dr Zdenek Vykydal, CMI
Dr Young Soo Yoon, KRISS
Dr Hui Zhang, NIM

online

Dr John-Paul Archambault, NRC
Dr Roberto Bedogni, INFN-LNF
Dr Michael Bunce, NPL

Dr Chien-Hau Chu, NRSL/INER
Dr Szymon Domanski, FANR SSDL
Dr Shannon Hoogerheide, NIST
Dr Peane Maleka, iThemba LABS
Dr H. Pieter Mumm, NIST
Dr Jeffrey Nico, NIST
Dr Refuoe Pepenene, NMISA
Dr Walsan Wagner Pereira, LNMRI/IRD
Dr Massimo Pinto, ENEA-INMRI
Dr Ras Bihari Rakesh, BARC
Dr David Thomas, NPL

1. Welcome

The Committee was welcomed by Vincent Gressier, the Executive Secretary of the CCRI and by Andreas Zimbal, Chair of the CCRI(III).

JT Janssen was introduced to the Committee as the new President of the CCRI. He comes from the National Physical Laboratory (NPL) in the UK, where he is the Chief Scientist and International Director, working in the field of quantum electrical metrology.

2. Appointment of the Rapporteur

John Paul Archambault (NRC) was appointed as rapporteur.

3. Approval/Changes to the agenda

Topic 15: there was no presentation on ICRU 95: operational quantities

4. Update on the CCRI Strategy

J.T. Janssen and V. Gressier discussed the need for an update of the CCRI strategy

Part 1: J.T. Janssen

Review of the CC Vision and Mission, along with seven resolutions for the next four years coming from the CGPM meeting in November 2022:

- Evolving needs for metrology
- Global digital transformation of the SI system
- Extension of the SI prefixes (10^{27} , 10^{30})
- Use of future UTC (regarding leap seconds)
- Future redefinition of the SI (seconds redefined using optical instead of microwave)
- Universal adherence to the Metre Convention (150th anniversary in 2025)
- Dotation

An important point is the need to get young scientists involved in the strategic planning.

The CIPM strategy for the years 2030+ was summarized:

- Determine the benefits of the SI redefinition in 2018
- Determine how, what technologies will shape the future
- What are the next grand challenges?
- How will metrology support this?
- How will it shape the community?

The drivers of change were identified to be: well-being, sustainability and enterprise.

The grand challenges in metrology were identified as

- Climate and Environment
- Health and Life Sciences
- Food Safety
- Energy
- Advanced Manufacturing
- Digital Transformation
- 'New' Metrology

Task groups have already been formed for climate and environment and digital transformation. Three priorities for metrology have been identified as digitally enabled global measurement, systems metrology and enabling confidence.

Part 2: V. Gressier

In the CCRI strategy document, the specific points for neutron metrology are:

- BNCT
- Investigation of the impact of the new operational quantities
- Extension of the metrology in both neutron energy and intensity (both low and high)

There is a need to review the current CCRI strategy and have changes ready for June 2024. Andreas Zimbal would like to identify key relationships not only with the other sections of the CCRI, but also with other CCs. J.T. Janssen will contact the members of the CCRI strategy working group (Chairs and Vice-Chairs) to organise the work.

5. Reports from NMI

During the meeting, presentations were given by BARC, CIAE, CIEMAT, CMI, IRSN, KRISS, LNHB, NIM, LNMRI, NMISA, i-TLABS, NRC, NIST, NPL, NMIJ, UAE, PTB, SCK-CEN and SMU.

Copies of the presentations, where available, can be found in the working documents on the section's Sharepoint site.

6. Status of CCRI comparisons

6.1 - On going comparisons

- a. CCRI(III).K9.AmBe.1 – Final report published 14 January 2022 (Metrologia 2022 59 Tech. Suppl. 06006)
- b. CCRI(III).K9.AmBe.2 – Final report published 23 November 2021 (Metrologia 2021 58 Tech. Suppl. 06025)
- c. CCRI(III).K9.Cf.2016 – Draft A released in April 2023, the results of all participants are in agreement. On-line meeting later in the year to speed up the process of releasing the Draft B and the final report.
- d. CCRI(III).S1-H*(10) – Several delays with Covid-19 and shipping problems. Two participants are still scheduled to make measurements. The duration of comparisons is becoming an issue for neutron metrology, both the circulation of sources and equipment are causing issues.
- e. CCRI(III).S2-H_p(10) – 3 participants completed measurements, one transfer device failed, but could be repaired. Correct operation was verified by the manufacturer. A third dosimeter was obtained for the comparison and is now being circulated as a back-up. There was discussion about the source-detector distance as specified in the protocol, as well as about the minimum dose. To ensure comparability of results, participants should follow the procedures given in the protocol, even if they differ from their own procedures used during customer calibrations. It was decided that the protocol could not be modified.
- f. CCRI(III).K12 - Two changes were made to the protocol: a dead-time module was added to provide a more well-defined interval distribution and data can be provided (on request) to correct for the finite radius of the Long Counter in beams with steep angular variations (notably 2.5 and 5 MeV beams from D(d, n) reactions). The protocol has been accepted and the Long Counter is being shipped to the first participant. BARC has asked to participate in the comparison.

6.2 - Future comparisons and pilot studies

- a. K8.2024 (originally K8.2018): Thermal neutron fields – there is a need to establish a more robust KCRV and to allow more thermal fields to obtain degrees of equivalence. IRSN has to withdraw as the pilot. NIM will act as the pilot, CMI as the co-pilot, BIPM will support both institutes. Principle of the comparison: circulation of transfer instruments (low pressure He-3 counters) and determination of the experimental response in each field. The transfer instruments will be circulated in parallel to 2 subsets of participants, the 2 pilot laboratories will perform measurements for all instruments and allow both “loops” to be linked. This should significantly reduce the duration of the comparison. Next step: NIM and CMI will prepare a draft of the protocol to be validated by the participants.
- b. Pilot Study on Au-foil measurements to investigate potential discrepancies in thermal neutron fluence characterisation: It was decided that the focus should be on the K8 comparison for now, and that CCRI(III) could return to gold foil studies in the future.

7. Strategy for key and supplementary comparisons in CCRI(III) and RMO Comparisons

At the 2019 CCRI(III) meeting, a 10-year cycle for comparison validity was decided (with 15 years being used in exceptional circumstances, with the date of the last measurement being the reference date). This means that after 13 years since a comparison has been performed, the laboratory would receive notification that their DOEs will be removed from the KCDB two years later.

This is of concern as many neutron comparisons are taking longer and longer to complete. One observation is that there are many participants in the CCRI(III) key comparisons but very little activity at the RMO level. Instead of shifting the comparison work to the RMO level, one suggestion is to split the comparisons and to run them in parallel, e.g. with 2 subgroups, as proposed for the K8 comparison.

From this discussion, it follows that the following scheme could be established for future comparisons:

— Key comparisons

- Emission rate comparisons:

CCRI(III)-K9.AmBe: Measurements were completed in 2005

CCRI(III)-K9.Cf: Measurements were completed in 2020

It follows that the next emission rate comparison should start in 2030.

During the next CCRI(III) meetings it has to be discussed and decided whether this comparison should be done with AmBe or Cf sources (depending on the availability of a suitable neutron source) or if there is a need/wish among the potential participants to start earlier.

- Thermal field comparison: CCRI(III)-K8.2024, then **2035** or later depending on the date of the last measurement.
- Monoenergetic field comparison: CCRI(III)-K12 started in 2023, then **2035** or later (depending of the date of the last measurement).
- High energy neutron fields: no comparison at all up to now, to be discussed within the TG “high energies”

— Supplementary comparisons

- $H_p(10)$: Started 2022 – 2025
- $H^*(10)$: Started 2017 – 2023
- Although there is no need to repeat the supplementary comparisons every 10 years, it is recommended that such comparisons be carried out on a regular basis as they allow a large number of members of Section 3 to participate.

8. Status of RMO comparisons

none reported

9. Review Process and Status for Neutrons

The IRSN submitted several new CMCs two years ago, but nothing has come of it so far.

10. Reports from CCRI working groups and task groups

- **Communication WG (V. Gressier)**
 - WG was created in 2022
 - Actions: webinars, ‘news resources’, e-learning, workshops
 - Webinars are a big success (both live and on the YouTube channel), but so far only one webinar with a specific neutron topic (A. Buffler: High energy neutrons) has been presented. It would be good to have more webinars on neutron physics (send ideas on topics, possible speakers, etc. to A. Zimbal)
- **Sources TG (N. Roberts)**
 - Security around sources is increasing since several years
 - In 2014, Cs-Cl blood irradiators were identified as particular risk and US NNSA-ORS looking to eliminate them by 2027
 - No immediate threat to eliminate radionuclide neutron sources, but CCRI(III) concerns will be communicated to CCRI (prices of sources, availability of sources, few alternatives that are stable, long-lived)
- **Digitalization TG (A. Zimbal)**
 - Two on-line meetings in 2023
 - A. Zimbal (PTB) and T. Matsumoto (NMIJ) are representing CCRI(III)
 - Goal: to have all links in calibration chain digitized
 - Mission: to advise CCRI on the SI Digital Transformation framework and to act as a forum for information exchange
- **RMO WG (A. Zimbal)**
 - One meeting in June 2022 and one in May 2023
 - Document on “Rules for Ionising Radiation CMCs” was discussed, proposal to approve this document at the CCRI meeting in June 2023
 - Measurement uncertainties in CMC claims should not be ambiguous and rules for providing upper and lower limits will be provided

11. Report from BIPM

BIPM provides on-demand bi-lateral comparisons, and calibrations in dosimetry and radioactivity. The main equipment at the BIPM are three international reference systems for radionuclides and nine international reference systems for dosimetry, including off-site facilities. The BIPM has no neutron facilities (for history, see CCRI reports on the BIPM website), but offers support to the neutron community by:

- Hosting and organising meetings at the BIPM
- Providing the executive secretary
- Chairing the Communication and Digital Transformation WG/TG
- Organising webinars and workshops
- Co-piloting comparisons
- Reviewing comparison protocols and reports

12. Reports from RMO

Presentations were given by AFRIMET, APMP, EURAMET, GULFMET and SIM. Copies of the presentations, where available, can be found in the working documents on the section's Sharepoint site.

13. New Standards and Consequences for CCRI(III)

Presentation given by Roberto Bedogni (INFN-LNF) on the revision of the ISO 8529 series:

8529-1:2021

- published in November 2021
- changes to standard fields (Cf-252, Cf-252 (D₂O-moderated), AmBe, AmB removed, some mono-energetic fields added)

8529-3:1998

- last reviewed and confirmed in 2016
- revision started in 2022
- changes to fluence-to-dose conversion coefficients following changes to recommended spectra (part 1)
- currently in FDIS ballot for approval

8529-2:2000

- currently in first version
- last reviewed and confirmed in 2021
- pre-review technical discussions are in progress
- email Roberto Bedogni if interested in technical studies

Further discussion on the reference calibration point for personal dosimeters occurred. Roberto will bring the discussion to the ISO-8529 Working Group.

14. Proposal for a workshop/task group on high energy accelerator facilities

Presentation by Andy Buffler (University of Cape Town) on high energy neutrons:

- there is a growing need for improved reference standards for high energy neutrons for radiation protection, dosimetry and physics and biology
- instrumentation and analysis are well established and will continue to evolve
- cross-section reference standards are not sufficient
- status data on high energy neutron facilities are limited
- Recommendations by A. Buffler
 - stronger international coordination and collaboration are needed, including a database on the current status of facilities
 - plans to guide key comparisons between participating facilities
 - ISO-17025 guidelines for facilities

- Efforts by the nuclear data community to review the extension of cross-sections to high energies

Massimo Pinto (Vice-chair of CCRI(I)) joined the discussion to indicate the interest of the CCRI(I) in high energy facilities, mainly for proton therapy and high energy ions.

It was decided to form a task group with interested members of the CCRI(III) to guide the development of metrology for high energy neutrons. The working group will start by organising a workshop bringing together members of the metrology community, of the accelerator facilities and the end-users to discuss and educate each other on the needs going forward.

Interested members from CCRI(III): PTB, NMIJ, CIAE, i-TLABS, IRSN, NPL

Task: Define “Terms of Reference” for a possible Task Group that can be presented to the CCRI(I) in June 2023 and to the CCRI meeting in June 2023.

15. Membership changes

Document CIPM-D-01 defines the rules of membership for the CCs. Since 2017, the CCRI(III) operates according to the rules of a Working Group, consisting of members and guests only, i.e. without observers. Currently, the names of both laboratories and individuals are listed as members on the BIPM website, and it has been recommended that only laboratories should be listed.

The CCRI President supports keeping the current structure of three working groups (CCRI(I), (II), (III)), but encourages exploring cross-CCRI Task Groups, etc. This process has already started with the existing CCRI Working Groups.

16. Date of next meeting

It was recommended to hold an on-line meeting in May 2024 to discuss the ongoing key comparisons.
Next CCRI(III) meeting: To be determined for 2025.

17. Summary of action items

- All members participating in CCRI(III).K9.Cf.2016 should send comments about Draft A to Neil Roberts as soon as possible in order to speed up the preparation of Draft B.
- Vincent Gressier to send all current information about CCRI(III).K8 to NIM and CMI (VG. will check if two pilots can be named for a comparison)
- Andreas Zimbal – regarding the Sources TG, discuss CCRI(III) concerns about neutron sources (cost, availability, possible elimination) at the CCRI
- Any member of CCRI(III) interested in being added on an internal CCRI(III) email list, please send an email to Andreas Zimbal
- Any member interested in participating in technical studies for ISO 8529-2, please send an email to Roberto Bedogni
- Roberto Bedogni will discuss the issue of reference points for personal dosimeters with the ISO 8529 Working Group
- Andreas Zimbal will prepare a “Terms of Reference” for the newly formed High Energy Neutron Task Group to be presented at the CCRI(I) meeting and discussed at the CCRI meeting in June 2023