



BUREAU INTERNATIONAL DES POIDS ET MESURES
Comité Consultatif pour les Rayonnements Ionisants
Section III (Neutron Measurements)
26th Meeting (Thursday 1 June to Friday 4 June 2021)
Videoconference

Chair	Dr Vincent Gressier (IRSN)
CCRI President	Dr Martyn Sené (NPL)
CCRI Executive Secretary	Dr Steven Judge (BIPM)

Delegates

John-Paul Archambault (NRC)
Luciano Bertalot (ITER)
Pavol Blahušiak (SMU)
Michael Bunce (NPL)
Xandra Campo (CIEMAT)
Marco Capogni (ENEA-INMRI)
Pierino De Felice (ENEA-INMRI)
Scott Dewey (NIST)
Serhii Dushkin (NSC)
Vincent Gressier (LNE-IRSN)
Steven Judge (BIPM)
Jungho Kim (KRISS)
Vitaly Krasilnikov (ITER)
Wei Li (CIAE)
Benjamin Lutz (PTB)
Peane Maleka (iThemba Labs)
Tetsuro Matsumoto (NMIJ/AIST)

Roberto Méndez Villafaña (CIEMAT)
Livi-Cristian Mihailescu (SCK.CEN/LNK)
Pieter Mumm (NIST)
Ralf Nolte (PTB)
Refuoe Donald Pepenene (NMISA)
Neil Roberts (NPL)
Martyn Sené (NPL)
Luca Silvi (ENEA-INMRI)
Sunil Singh (BARC)
Ian Swainson (IAEA)
Cheick Thiam (LNE-LNHB)
David Thomas (NPL)
Sathian Vilippalil (BARC)
Zdenek Vykydal (CMI)
Andreas Zimbal (PTB)

Minutes

1. Welcome by the President of the CCRI, Dr Martyn Sené (NPL) and the Chair of CCRI Section III, Dr Vincent Gressier (IRSN)

Vincent Gressier welcomed delegates to the meeting.

Martyn Sené the president of CCRI gave an overview of the CCRI mission. He emphasized the importance of ionizing radiation metrology. For example, during the pandemic, many IR services remained active in the UK. CCRI webinars were one result of pandemic operating; previous webinars are on the CCRI YouTube channel.

CIPM strategy - post redefinition of SI - 5 themes (questions) for better engagement with the stake holders:

1. What are the evolving needs for metrology?
2. What are key scientific challenges to advance the global measurement system?
3. How can we deepen engagement with other international organizations on measurement science issues?
4. What should be our strategy for the future membership of the organization?
5. How can we modernize the operations of the organization?

Updated CCRI strategy - evolution 2019-2020-2021 50+ topics identified.

Stephen Judge the executive secretary of CCRI and director of Ionizing Radiation at the BIPM is leaving very shortly for retirement. Vincent Gressier will become the new executive secretary of CCRI. The resulting vacancy for the chair of section 3 will be filled by Andreas Zimbal of the PTB.

2. Appointment of the Rapporteur

Scott Dewey (NIST) was appointed rapporteur.

3. Changes to the agenda

There were no changes to the agenda.

4. Approval of minutes from 2019

Vincent Gressier sent around the 2019 minutes and participants we were asked to approve them offline.

5. Status of CCRI comparisons

5.1 - On going comparisons

- a. CCRI(III).K9.AmBe.1 – there is no change in status since 2019. A draft B report has been commented on and it is ready to be turned into a final report. A decision was made to use the value "as reported" to be consistent with K9.AmBe.
- b. CCRI(III).K9.AmBe.2 – The NPL measurements were done in 2019 followed by ENEA. The ENEA submitted revised results. A draft A report was sent out in April 2021. A draft B report is in preparation.
- c. CCRI(III).K9.Cf.2016 – The measurement phase is completed. Participants were asked to decay correct their results using only the Cf-252 decay constant. NPL will determine the Cf-250 correction factor. It will be applied by the evaluator based on date of measurement. To date, 6 out of 10 reports have been received.
- d. CCRI(III).S1-H*(10) – There is a delay in the total schedule, and it will be September 2022 before all participants can complete their measurements. There are 7 (Cf), 7 (Am-Be), 4 (Cf, D2O), 2 (PuBe) source measurements up to the date of the meeting. PTB has been testing the stability of the instruments most recently while it is waiting to send them to Russia. There is an upwards trend in the stability test that is not understood.

5.2 - Planned comparisons

- a. CCRI(III).S2-H_p(10) – The starting date should be Oct 2021 or 2022 with an expected duration of 3–4 years. A draft protocol is ready and will be sent out next week. The protocol should be validated by the end of August. The comparison will use a DMC3000 N transfer instrument (DMC 3000 + neutron module made by Mirion Technologies). It was noted that relatively high doses (~10 mSv) are needed to get accurate measurements

because low doses give high variability. This may make the shadow cone method difficult because dose levels with the cone in place will be low. Participants can follow their own methods for nominal calibration service for the correction of scattered neutrons (no guidance in ISO 8529).

- b. CCRI(III).K12 - This comparison will include the following energies: 250 keV, 2.5 MeV, 5 MeV, 14.8 MeV, 19 MeV. It was noted that the 19 MeV field will be a challenge. The transfer device is an extended-range long counter supplied by IRSN together with NIM modules. PTB is the pilot laboratory. The PTB ion accelerator facility PIAF is available for those participants without access to a facility able to produce monoenergetic neutrons. Participants are requested to go through the distributed protocol and comment so that it can be finalized (deadline: one month from now--beginning of July).
- c. CCRI(III)-K8.2024 Thermal neutron fields – The active transfer instrument response should be about 0.01 cm². Very low pressure SP9 counters from Centronics have been selected as transfer instrument with pressures of 0.01 atm ³He + 1.2 atm krypton. Electronics will be the AIOSAP module from the former K8 comparison. Several tasks remain: buy the counters (IRSN), design and manufacture a Cd shell; calculate the response function with and without Cd shell; design a stability test and then test the stability over a few months. The protocol was discussed. IRSN is not able to pilot this comparison before the middle of next year. It was suggested that the BIPM could be a co-pilot (especially since Vincent Gressier will be there).

5.3 - Future comparisons and pilot studies

- a. Au foils measurements pilot study: These are important for thermal neutron field standardization. Au-198 is used to measure thermal neutron fluence. D. Thomas presented a report. He's proposing a new comparison for which he plans to send out a questionnaire. All agreed with this. He requested that people return it in a couple of months. The results should tell us which comparison going forward would be most useful, namely a repeat of the former one or an Au activation comparison.
- b. High energy comparison: There are three facilities possible for such a comparison: Japan, South Africa, and China. It doesn't appear that any will be available before about 2024. This should be a topic for next section 3 meeting.
- c. AmBe energy distribution: V. Gressier proposed that CCRI(III) carry out a pilot study to quantify the uncertainty induced by the energy distribution on the fluence to dose equivalent conversion coefficient. A spectrometer will be circulated to measure the energy distribution at all the relevant AmBe sources at NMIs. There were debates about the difficulty of such comparison, especially concerning a suitable neutron spectrometer. A questionnaire will then first be sent to NMI's having Am-Be sources requesting their size, date, and origin of manufacture. This will guide whether such a comparison is practical.

6. RMO Comparisons

The RMOs have no planned comparisons.

7. CMC review status

Each institute's CMCs can/should be made consistent with the new categories. Some NMI's are already modifying their CMCs to be consistent with the new system.

8. Reports from NMI (and ITER)

Presentations were given by NPL, PTB, CMI, ENEA, VNIIM, CMI, NIST, NRC, NIM, CIAE, NMII/AIST, KRIS, BARC, NMISA, i-Themba Labs, LNE-LNHB, LNE-IRSN, CIEMAT, SMU, SCK-CEN, ITER. Copies of the presentations, where available, are available in the working documents section for this meeting of the BIPM website.

9. Reports from RMO

Presentations were given by SIM and AFRIMETS. Copies of the presentations, where available, are available in the working documents section for this meeting of the BIPM website.

There was no report from APMP and no neutron activity to report at COOMET. A. Zimbal informed that European Metrology Networks (EMN) are founded under EURAMET which has a broader and cross-disciplinary scope compared to the technical committees. A new EMN dealing with radiation protection issues is planned.

10. Seminar: IAEA interests in neutron metrology

Part I: IAEA nuclear data activities related to neutron metrology given by Roberto Capote, deputy head, nuclear data section, International Atomic Energy Agency, Department for Nuclear Sciences and Applications: R. Capote spoke about neutron data standards including evaluation of neutron data standards. He called out Cf-252 nu-bar which is a "gold standard". Previously it had been assigned a relative uncertainty of 0.12 %, but now it has been assigned an uncertainty of 0.42 %. He mentioned IRDFF (International Reactor Dosimetry and Fusion File) and TENDL-2019 which are two large databases. The community is worried about unrecognized sources of uncertainties in experimental nuclear data. This problem is fairly well known in radioactivity (see "*When the model doesn't cover reality: examples from radionuclide metrology*" by S. Pommé). V. Gressier suggested that a report informing CCRI(III) how they could help would be useful. It should be addressed to A. Zimbal.

Part II: Community Input to Neutron Metrology by Ian Swainson, Physics Section of IAEA: Firstly, support is needed with boron neutron capture therapy (BNCT). This work is now mostly done with accelerators built in or near hospitals rather than reactors making the technique easier to implement. The requests include support for measuring neutrons in mixed neutron and photon radiation fields near the neutron source; and specifying a standard field for $10^9 \text{ cm}^{-2}\text{s}^{-1}$ epithermal neutrons that would be similar to BCNT irradiation fields. Secondly, support is needed for neutron detectors in laser-produced neutrons which typically consist of intense pulses of high energy neutrons. This is a technology that has progressed rapidly. Finally, support is desired by the diverse fusion energy community where calibrating instruments in harsh radiation conditions is a large challenge. I. Swainson wondered what the European Spallation Source's needs might be.

11. CCRI Strategy document

This can be found on the BIPM website under CCRI publications at the bottom. V. Gressier went over the document with neutron activities. From the seminar and activities report of several NMIs, BNCT should appear more clearly. Some interesting applications include next generation nuclear power, ITER (10% uncertainty), material testing, high energy dosimetry, ionizing radiation due to cosmic rays (photons, neutrons), and outer space travel. There are issues with Cf-252 availability, difficulty of nuclear material shipping, cost/regulations; and these can affect emission rate comparisons. Neutron and alpha damage of miniaturized electronic devices is important with the evolution of CMOS technology. There are 15 NMIs/DIs working in neutron metrology and this is inconsistent with the need for large facilities to deal with neutron needs, requiring that these large facilities should be shared. Determining neutron quantities for high energy neutron and high-intensity pulsed fields are perhaps today's biggest challenges.

12. Membership changes

Today all NMIs working in neutrons are members of section 3 of the CCRI, and other organizations are guests. India likes online meetings because traveling is difficult for them. The BIPM will discuss the nature of future meetings. Mixed meetings could be possible. A. Zimbal feels that comparisons are the most important thing we do, and we should try to enlarge this activity more than any other thing. V. Gressier desires to enlarge the group of institutes having neutron CMCs.

13. Conclusion

A. Zimbal will take over section 3 chair as V. Gressier becomes the executive secretary of CCRI. Some introductory remarks were made by Andreas Zimbal. There is a proposal from the CCRI president (Martyn Sene) that CCRI(I) to (III) should have a vice-chair. Andreas Zimbal supports this idea. He believes more balancing and sharing of work could be very helpful for section 3 to allow small laboratories to contribute more than in the past. To help with this, modern communication technology can be of advantage to allow for more communication and information exchange in section 3 in addition to the biannual meetings.