


33nd Meeting of the CCEM

8 – 9 March 2023

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CCEM President

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CCEM Secretary



Working together to
promote and advance
the global comparability
of measurements

1. Agenda (summary)

2. Actions arising from the minutes of the 32st CCEM meeting
3. News from CIPM and CGPM
4. GT-RF report
5. WGRMO report
6. Cooperation with other Consultative Committees (CCRI, CCM)
7. Membership and observership application presentations (NIS, UTMS)

8. News from the BIPM
9. WGLF report
10. Scientific presentations
11. CCEM strategy (including CCEM webinars)
12. BIPM electricity work programme
13. Update on BIPM digitalization projects
14. Membership review
15. AOB and date of next meeting

2. Actions from the 2021 CCEM meeting

- ◆ Work on new version of Guidelines on CMC submission” with clearer guidance on specification of ranges used in matrices:
⇒ new version 6.2 published in October 2022
- ◆ Work on Guidelines on acceptance of CMCs: further revision, taking into account comments received from CCEM members:
⇒ new version posted as working document
- ◆ Finalize new version of CCEM Strategy:
⇒ done and published in May 2021
- ◆ CCEM to organize webinars, support group created:
⇒ two webinars held

3. News from the CIPM

- ◆ CIPM meetings since March 2021: June 2021, Oct 2021, June 2022

All CIPM decisions and reports are public!

<https://www.bipm.org/en/committees/ci/cipm>

- ◆ Major focus: preparation for the 2022 CGPM

**International Committee
for Weights and Measures**
Proceedings of the 111th meeting
(21-23 June 2022)

Executive summary of last CIPM meeting (June 2022)

Executive Summary

111th meeting of the CIPM (21-23 June 2022)

Digital transformation

The CIPM acknowledged the considerable progress the BIPM is making towards the digital transformation.

CIPM Code of Conduct

The CIPM noted the decision taken by correspondence to approve the first edition of the CIPM Code of Conduct.

Headquarters

The CIPM noted the decision taken by correspondence to recommend the use of the term Headquarters (in French “Siège”) to refer to the scientific and technical staff and facilities at the Pavillon de Breteuil.

Approval of the audited financial statements of the BIPM and the Pension and Provident Fund

The CIPM confirmed its approval of the audited financial statements of the BIPM and of the BIPM Pension and Provident Fund. The CIPM granted the BIPM Director quietus for the 2021 exercise.

Budget 2023

The CIPM decided that the budget for 2023 should follow the expenditure agreed by the CGPM at its 26th meeting (2018) with an updated estimate for the revenue.

Supplementary sums

The CIPM adopted a way of addressing the supplementary sums paid by Member States in the BIPM Financial Report.

Dotation

The CIPM instructed the BIPM Director to prepare a financial plan for the period 2024-2027 based on a 1.5 % increase in the dotation each year, with an associated balanced budget.

By-Laws

The CIPM discussed the first draft of the By-Laws for the BIPM.

Continuous UTC

The CIPM stressed the importance of gaining as much support as possible for Draft Resolution D at the 27th meeting of the CGPM (2022) to ensure the future of UTC.

Renewal of the Director's appointment

The CIPM unanimously decided to re-nominate Dr Milton as BIPM Director and to renew his appointment for a further term from 1 January 2023.


Changes to membership and observership of the Consultative Committees

- CCAUV: SE NDI Systema (Ukraine) as an observer
- CCL: NIS (Egypt) as a member
INTI (Argentina), NIMT (Thailand), NSC IM (Ukraine) as observers
- CCPR: INMETRO (Brazil), JV (Norway) as members
NSC-IM (Ukraine) as an observer.

CGPM: CCEM presentation and poster (1)

- ◆ Summary presentation of the CCEM work in the past 2 years (see working documents for full presentation)

Electrical measurements in daily life




Sustainable society

Telecom

Fair trade

Nanoelectronics



CGPM: CCEM presentation and poster (2)

Electricity and Magnetism

The Consultative Committee for Electricity and Magnetism (CCEM)

The Revised SI: Quantum electrical standards are back into the SI!



Definition of the kilogram

$$h = 6.626\,070\,15 \times 10^{-34} \text{ Js}$$

Planck constant

Definition of the ampere

$$e = 1.602\,176\,634 \times 10^{-19} \text{ C}$$

Charge of the electron

Quantum Hall standard for resistance

$$R = \frac{1}{n} \frac{h}{e^2}$$

(n : quantum number)

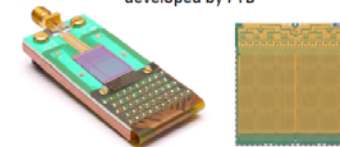
Josephson quantum standard for voltage

$$U = n f \frac{h}{2e}$$

(n : quantum number, f : frequency)



graphene QHR sample, developed by PTB



programmable Josephson arrays (NIST, NMIJ, PTB)

Global forum for progressing the state of the art

Scientific presentations at CCEM meetings (2019, 2021) and workshop on metrology for radiofrequencies and microwaves (2019):

- Low current measurements for ionization chambers
- S-Parameter measurements in coaxial systems
- Industrial metrology challenges induced by 5G
- Plasmonic and photonic technologies for mm-wave wireless communications
- Towards a quantum standard for radio-frequency electric fields
- HF characterization at sub-micrometer scales using on-wafer and SPM techniques
- Quasi-Optical Design and Manufacturing Techniques for mm-wave Remote Sensing Applications



2D-materials
HF measurements to improve knowledge of low dimensional devices



Optical distribution of microwave signals on satellites

CGPM: CCEM presentation and poster (3)

Facilitating dialogue between NMIs and stakeholders

Mise en pratique for the definition of the ampere and other electric units in the SI

Consultative Committee for Electricity and Magnetism

CCEM Guidelines for Implementation of the 'Revised SI'

Consultative Committee for Electricity and Magnetism

<https://www.bipm.org/en/publications/mises-en-pratique>

- Implementation of the revised SI – with small changes in the magnitude of the volt and the ohm - has not led to any problem in the stakeholder community!
- Series of CCEM webinars launched, recordings available on the YouTube channel 'The BIPM'

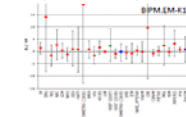


Supporting the CCRI in the development of a technique for measuring ultra-low ionization currents, eliminating the need of sealed radioactive sources

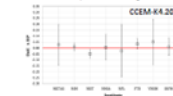
Global comparability of measurements

- Quantum standards have greatly increased comparability of EM measurements world-wide
- BIPM runs on-site comparisons of quantum standards at Member State NMIs
- Successful completion of CCEM-K4 (capacitance at 10 pF), coordinated by BIPM: first CCEM comparison in 'star' configuration, completed in 20 months
- CCEM covers many quantities: not all 198 calibration service categories can be covered by a comparison, so comparisons are strategically planned, preferably in 'star' configuration for improved efficiency
- New CMC review process with improved efficiency runs successfully under KCDB 2.0

BIPM comparison of 10 V Josephson standards



CCEM comparison of 10 pF capacitance calibrations (the first CCEM comparison using star-scheme)



Bureau
International des
Poids et
Mesures

27th meeting of the CGPM (2022)

www.bipm.org

CGPM: resolutions

Seven resolutions were adopted by the Member States:

- ◆ On the report prepared by the International Committee for Weights and Measures on the “Evolving Needs in Metrology”
- ◆ On the global digital transformation and the International System of Units
- ◆ On the extension of the range of SI prefixes
- ◆ On the use and future development of UTC
- ◆ On the future redefinition of the second
- ◆ On universal adherence to the Metre Convention
- ◆ On the dotation of the International Bureau of Weights and Measures for the years 2024 to 2027

21st Century Metrology Grand Challenges

The CIPM identified five “Metrology Grand Challenges”:

- Climate change and environment
- Health & life sciences
- Food safety
- Energy
- Advanced manufacturing



Next to cross-cutting challenges related to *how* we make measurements:

- Digital Transformation
- “New” metrology (e.g. sensor networks, NMI-on-a-chip)



How to move forward?

The CIPM proposes

to create appropriate forums to shape and coordinate the metrology community's response to the identified grand challenges with the objective to coordinate new possibilities for metrology to have an impact on global cross-cutting challenges.

and

to start to develop a new vision for the work of the BIPM that builds on this report, that should be consulted upon with the global metrology community before the 150th anniversary of the BIPM in 2025 and for publication before the 28th meeting of the CGPM, expected to be in 2026

CIPM 2022-2026

CIPM consults with Member States and the community on popular **new vision/mission**, ...

Concludes and presents **Strategy 2030+** to the community in 2025

