31th Meeting of the CCEM

28 – 29 March 2019

Gerrit Rietveld
CCEM President

Michael Stock
CCEM Secretary
Prof. Dr-Ing. Dieter Kind, 1929 - 2018

- Electrical engineer by training, HV measurement techniques
- PTB president 1975 – 1995
  - DKD, Bessy, 100 year PTB, clean room, Unification of PTB and ASMW
- Great stimulator of international cooperation: Euromet, WELMEC, ...
- CIPM: 1978 – 1996, last 12 years as President
- CCEM: 1992 – 1996 President
1. Agenda (summary)

3. News from CIPM, CGPM and BIPM
4. Matters related to fundamental constants and the SI
5. GT-RF report
6. WGRMO report
7. WGLF report
8. CCEM strategy
9. BIPM electricity work programme
10. CCRI challenge in low current measurements
11. Membership review
12. Miscellaneous
2. Actions from previous meeting

Five actions agreed at CCEM 2017 meeting:

1. Propose suitable note regarding the ‘var’ for the SI brochure
2. Revised SI: final comments to mise en pratique, implementations guidelines and ‘100-word’ paragraph
3. Update CCEM strategy document
4. Possible IEC representation at the CCEM
5. Review news bulletins published by other CC’s

Propose NIS as CCEM observer to CIPM

The International Electrotechnical Commission (IEC) has introduced the var (symbol: var) as a special name for the unit of reactive power. In terms of SI coherent units, the var is identical to the volt ampere.
3. News from the CIPM

- CIPM meetings since March 2017: Oct 2017, June 2018
- CC presidents meeting: June 2017, June 2018

All CIPM decisions and reports are public!

3. News from the CIPM

CIPM 2017 and 2018 discussions and decisions on:

- **Revised SI**
  - Agreed CCM – CCU conditions for revision are met ⇒ Resolution A
  - Support publication of defining constants by TGFC CODATA
  - Final draft SI brochure
  - Updates of CC *mises en pratique*, and common CC statement
  - CCM to define ‘consensus value’ for dissemination of the kg

- **BIPM finances, pension fund**

- **Finish CIPM WG MRA review; start WG on data reproducibility**

- **Agree on new members & observers for CC’s (NIS)**

- **BIPM Mission, Vision, Objectives; 2020-2023 work programme**
Decision CIPM/106-16

The CIPM decided the following text for inclusion in CIPM-D-01:

In order to be informed of technical developments and evolving stakeholder needs in different areas of metrology, the CIPM has Consultative Committees with agreed scopes and the following three objectives:

- to progress the state-of-the-art by providing a global forum for NMIs to exchange information about the state of the art and best practices,
- to define new possibilities for metrology to have impact on global measurement challenges by facilitating dialogue between the NMIs and new and established stakeholders, and
- to demonstrate and improve the global comparability of measurements. Particularly by working with the RMOs in the context of the CIPM MRA to:
  - plan, execute and monitor KCs, and to
  - support the process of CMC review.

No voting in CCs, consensus-based decision-making
News from the CIPM: CC presidents meetings

CC presidents meeting 13-14 June 2017 and 19-20 June 2018:

- Review of the CIPM MRA – status CC actions & RMO actions
  - Exchange experiences
  - Interaction between CCs and RMOs / JCRB
- CC matters
  - Definition of key and supplementary comparisons
  - CC web pages on BIPM site; open access of CC documents
  - CC strategies
- CGPM planning – CC presentations, posters and reports
- Update CIPM-D-01 “Rules of procedures for CCs”
**CGPM news: CCEM poster & report**

**Electricity and Magnetism**

The Consultative Committee for Electricity and Magnetism (CCEM)

- **The Revised SI: Bringing the quantum electrical standards into the SI**
  - Definition of the kilogram: $\hbar = 6.626 077 15 \times 10^{-34}\, \text{J}\cdot\text{s}$
  - 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**: $R = \frac{h}{4\pi e^2}$
- **Josephson quantum standard for voltage**: $U = n \frac{h}{2e}$

**Global forum for progressing the state of the art**

- **Scientific presentations at CCEM meetings** (2013, 2015, 2017) and workshop on future measurement challenges (2017), covering:
  - Watt/Kibble balances, paving the way to the revised SI
  - Graphene for wider uptake of quantum Hall resistance standards
  - Josephson standards for arbitrary waveform generation
  - Metrology for smart electrical grids to integrate renewables into electricity systems
  - Single-electron tunneling for quantum standard for electrical current
  - High-frequency metrology for communications
  - Nanomagnetism and spintronics for future electronic devices

- **Schematic of single-electron tunneling as a quantum standard for current**

**Consultative Committee for Electricity and Magnetism (CCEM)**

**President**: Dr.ir Gerrit Rietveld  
**Executive Secretary**: Dr Michael Stock

**Executive summary**

The Consultative Committee for Electricity and Magnetism covers a very broad field of metrology which is based on a large number of measurement standards, realizing many derived units and ratios over a wide frequency range. Since the 25th CGPM, significant steps have been taken to increase the impact and the efficiency of the CIPM MRA in the EM area, most notably via more strategic planning of comparisons, full implementation of matrices in the presentation of CMCs, and the introduction of a more efficient CMC review process. The BIPM has provided continued support to the worldwide comparability of EM measurements amongst others via its ongoing key comparison programme.

Based on the outcomes of the 2017 CCEM workshop on “Future Challenges in Electrical Metrology”, a first discussion was held on revision of the existing CCEM strategy, setting new priorities for the future. At the next CCEM meeting in March 2019 a new CCEM strategy, based on the workshop outcomes, will be discussed.

Major scientific efforts in the past four years were devoted to progressing electrical methods to realize the kilogram, in preparation of the proposed revision of the SI. A draft *mise en pratique* has been developed for the base SI electrical unit, the ampere, and for derived electrical units in the revised SI. Since the introduction of the revised SI will introduce a small step change in voltage and resistance measurements and related derived quantities, CCEM Guidelines for Implementation of the ‘Revised SI’ have been prepared to support the electrical stakeholder community in handling this step change.
CGPM news: CCEM presentation – revised SI

Achievements in the quantum electrical effects
- CCEM report

Dr.ir. Gert Rietveld
CCEM President

Dr. Michael Stock
CCEM Executive Secretary

Please: say to the revised SI...
CGPM election CIPM & CIPM appointment CC presidents

Decision CIPM/108-07

The CIPM appointed Dr S.-R. Park as the President of the Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM) for a four-year term.

Decision CIPM/108-08

The CIPM appointed Dr N. Dimarcq as the President of the Consultative Committee for Time and Frequency (CCTF) for a four-year term.

Decision CIPM/108-09

The CIPM thanked the Presidents of the Consultative Committees for their work and their excellent reports to the 26th meeting of the CGPM. It decided to reappoint the Presidents of the following Consultative Committees for four-year terms:

- Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV): Dr T. Usuda.
- Consultative Committee for Electricity and Magnetism (CCEM): Dr G. Rietveld.
- Consultative Committee for Length (CCL): Dr I. Castelazo.
- Consultative Committee for Mass and Related Quantities (CCM): Dr P. Richard.
- Consultative Committee for Photometry and Radiometry (CCPR): Dr M.L. Rastello.
- Consultative Committee for Ionizing Radiation (CCRI): Dr W. Louw.
- Consultative Committee for Thermometry (CCT): Dr Y. Duan.
- Consultative Committee for Units (CCU): Prof. J. Ullrich.

Other CIPM members:

Dr F. Bulygin (Russian Federation)
Dr I. Castelazo (Mexico)
Dr D. del Campo Maldonado (Spain)
Dr Y. Duan (People’s Republic of China)
Dr N. Dimarcq (France)
Dr H. Leiz (Argentina)
Dr T. Liew (Singapore)
Prof. P. Navezhmakov (Ukraine)
Dr S.-R. Park (Republic of Korea)
Dr M.L. Rastello (Italy)
Dr P. Richard (Switzerland)
Dr G. Rietveld (Netherlands)
Dr M. Sené (United Kingdom)
Dr A. Steele (Canada)

ex officio Dr M.J.T. Milton (United Kingdom), Director of the BIPM