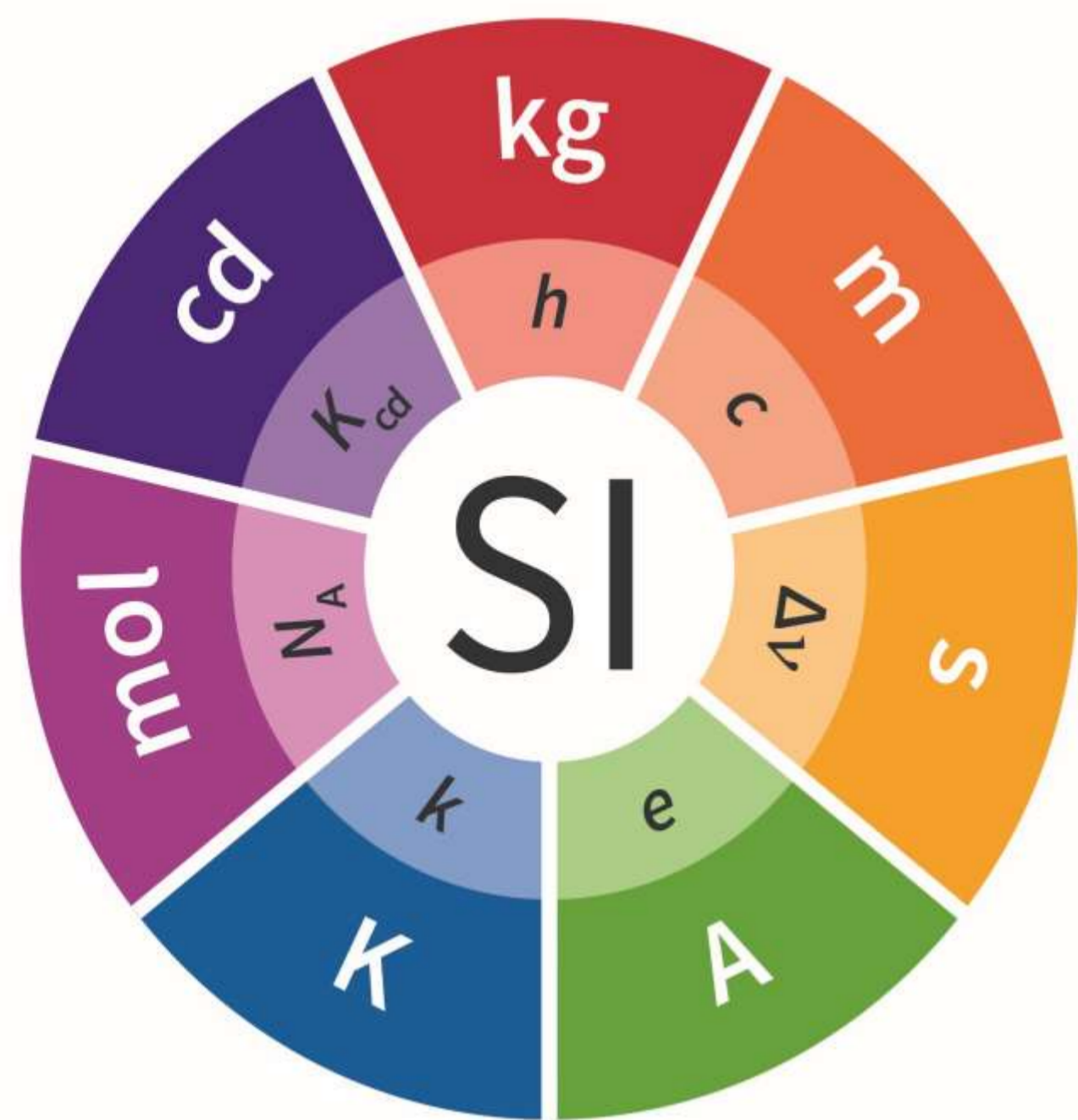


Electricity and Magnetism

The Consultative Committee for Electricity and Magnetism (CCEM)

The Revised SI: Bringing the quantum electrical standards into the SI



Definition of the kilogram

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

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

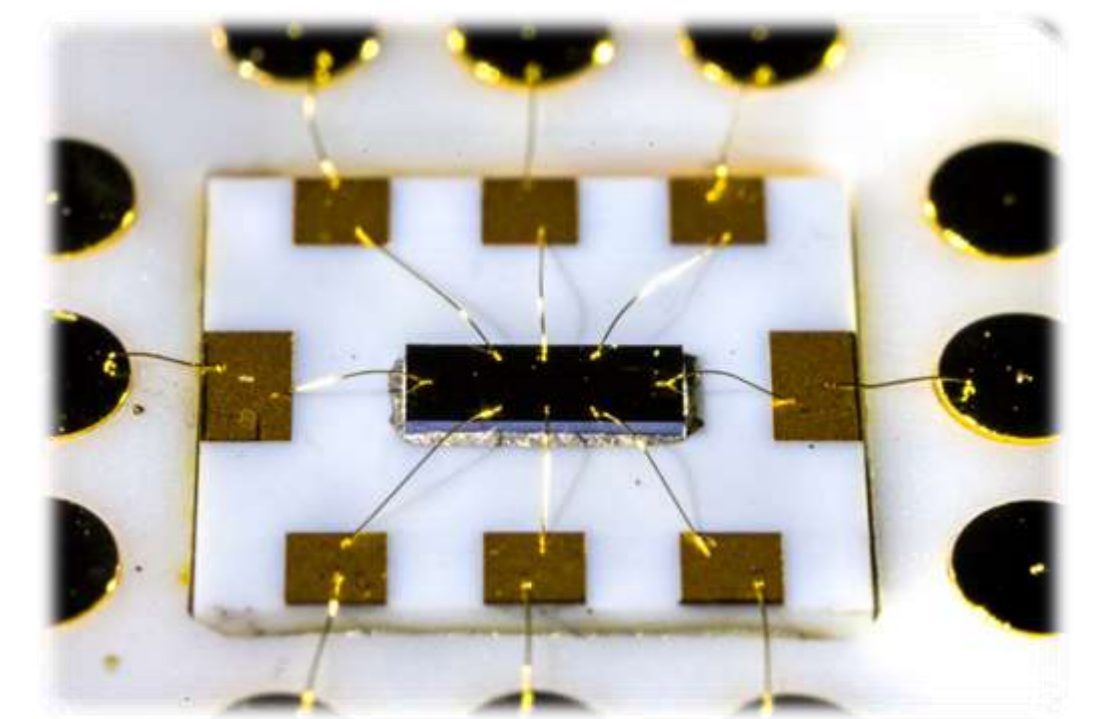
$$R = \frac{1}{n} \frac{h}{e^2}$$

(n : quantum number)

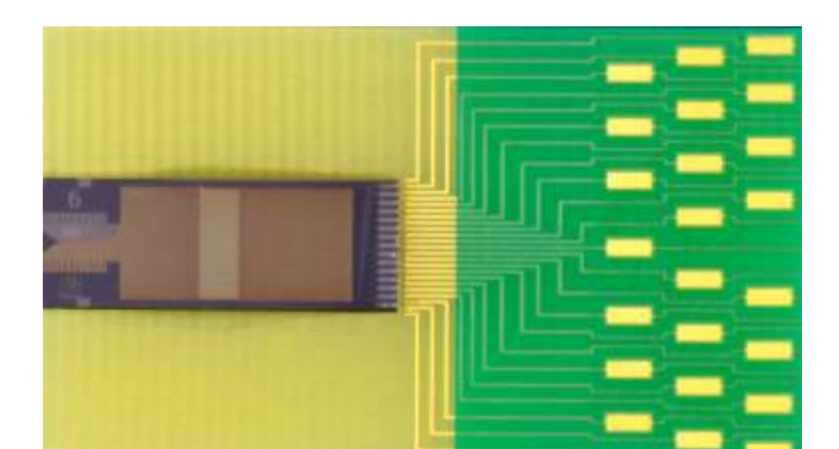
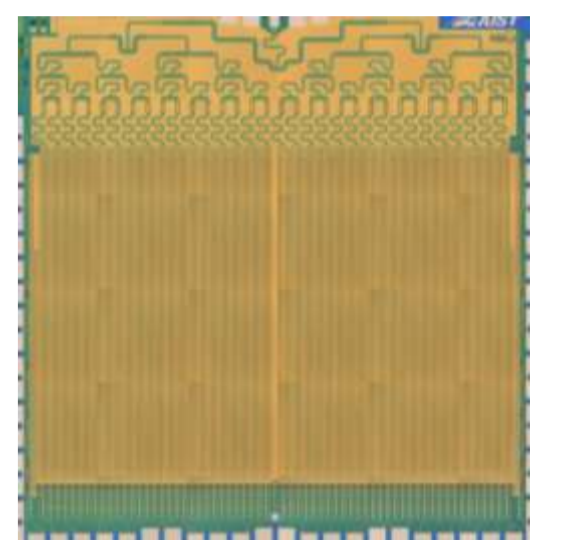
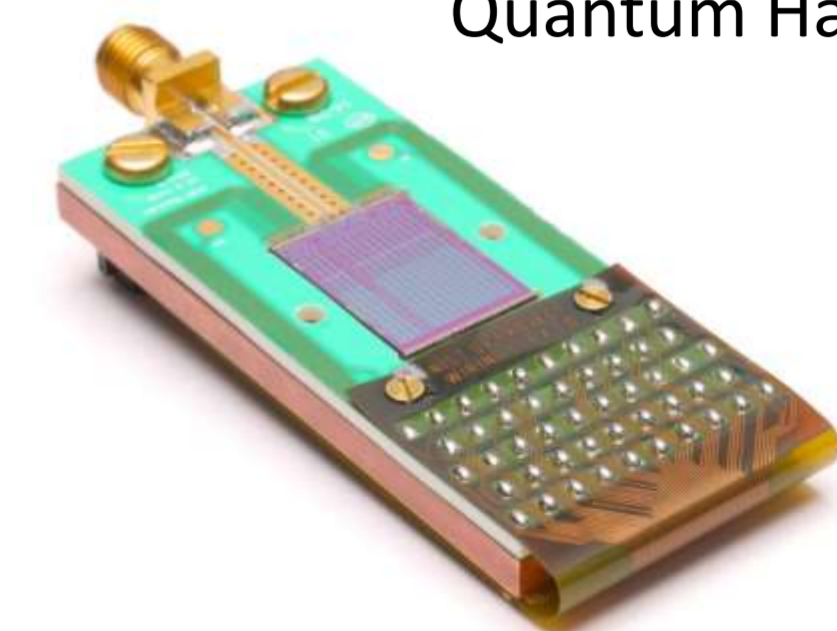
Josephson quantum standard for voltage

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

(n : quantum number, f : frequency)



Quantum Hall bar (BIPM)



programmable Josephson arrays (NIST, NMIJ, PTB)

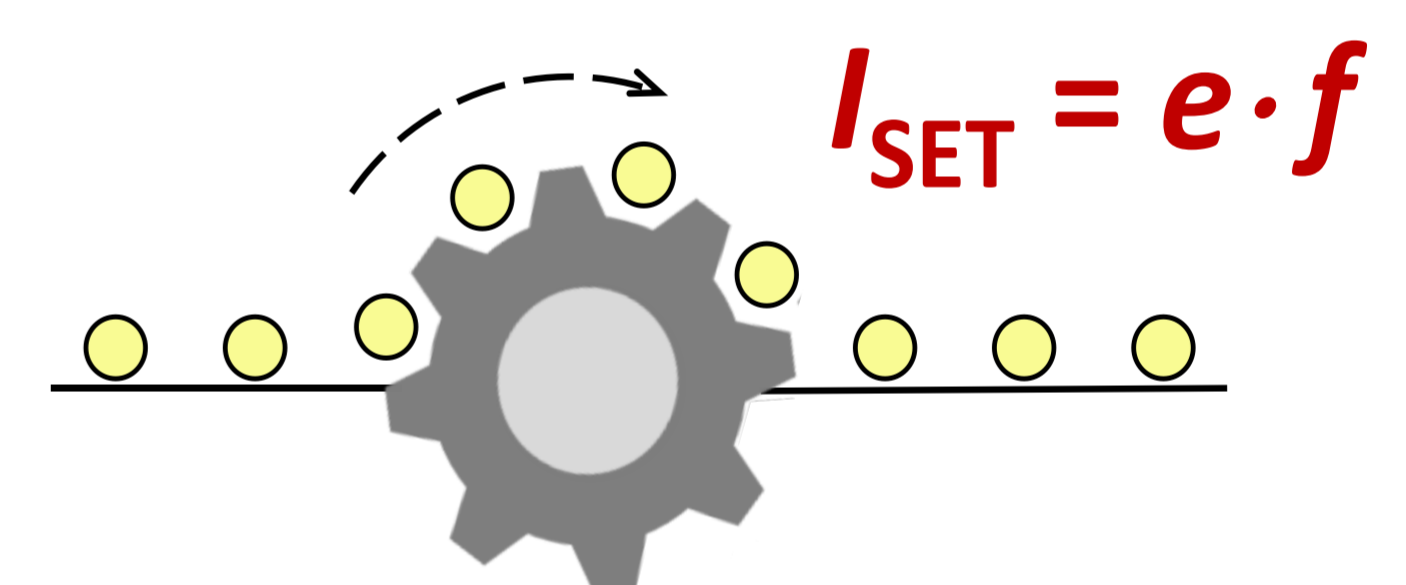
Global forum for progressing the state of the art

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 tunnelling for quantum standard for electrical current
- High-frequency metrology for communications
- Nanomagnetism and spintronics for future electronic devices



Renewable energy sources



Schematic of single electron tunnelling as a quantum standard for current

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

Electrical Units in the New SI: Saying Goodbye to the 1990 Values

Nick Fletcher, Gert Rietveld, James Olthoff, Ilya Budovsky, and Martin Milton

NCSLI Measure Vol. 9, 2014

CCEM Guidelines for Implementation of the 'Revised SI'

Consultative Committee for Electricity and Magnetism

Focus on Metrology in Electricity and Magnetism

Guest Editors

François Piquemal, Laboratoire national de métrologie et d'essais, France
Gert Rietveld, Van Swinderen Laboratorium, The Netherlands (CCEM president).

Metrologia Focus Issue



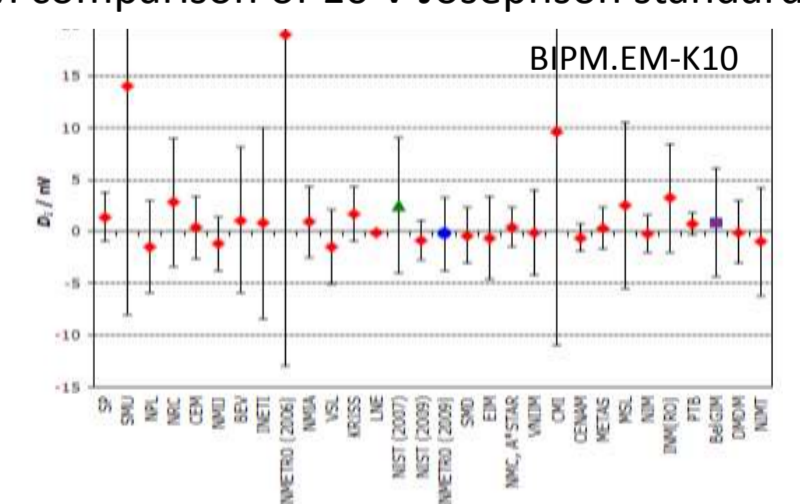
Supporting the CCRI in the development of a technique for measuring ultra-low ionization currents

<https://www.bipm.org/en/measurement-units/rev-si/>

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
- CCEM covers many quantities: not all 198 calibration service categories can be covered by a comparison, so comparisons are strategically planned
- CCEM developed a CMC review process with improved efficiency

BIPM comparison of 10 V Josephson standards



CCEM comparison of 10 pF capacitance calibrations

