

Consultative Committee for Length

Ismael Castelazo, CCL President

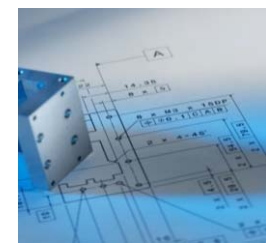
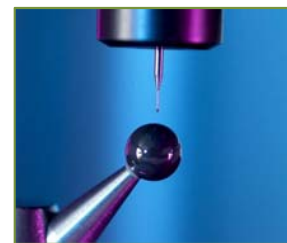
Gianna Panfilo, CCL Executive Secretary



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Global forum for progressing the state-of-the art

- ◆ **Improved description of the practical realization of the metre (mise-en-pratique)**
 - Explicit description of time-of-flight and interferometric techniques plus Si lattice parameter as a secondary representation
- ◆ **Secondary representation of the metre for nano dimensional applications**
 - Traceability via silicon lattice parameter
- ◆ **Improved accuracy of Coordinate Measuring Machines**
 - Increased use for measurements at the NMI level
- ◆ **Non-contact dimensional measurements**
 - Optical scanners, X-ray computed tomography, laser trackers



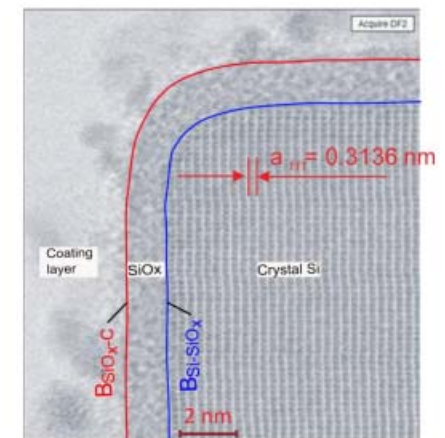
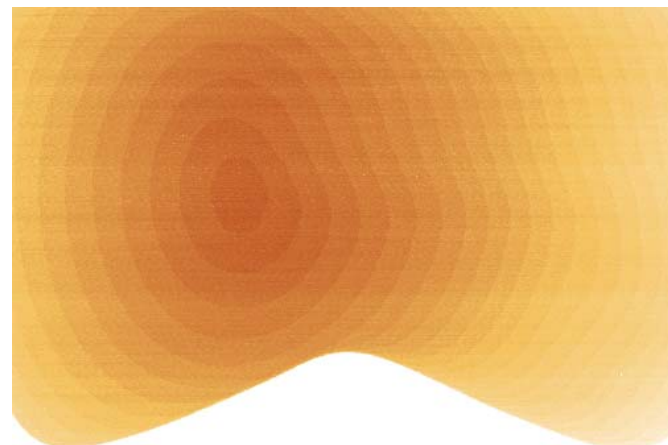
Secondary representation of the metre for nano dimensional applications

- ◆ Need for a nano dimensional length standard not based on optical fringe division identified by CCL via the CCL WG-N
- ◆ Traceability to metre via silicon lattice parameter
- ◆ Si d_{220} lattice parameter measured via x-ray interferometry to support Avogadro project and quoted in CODATA
- ◆ Represents a length scale derived from the bottom up and using nature
- ◆ Currently three routes to realization are being incorporated into the updated MeP for the metre



Use of Si d_{220} lattice parameter

1. Realized via x-ray interferometry which can be used as a 1 dimensional ruler or translation stage with graduations every 192 pm; sub division also possible
2. Silicon monoatomic steps: an amphitheatre of monoatomic steps
3. Counting atoms in pillars of silicon imaged by TEM



Facilitating dialogue between NMIs and stakeholders

- ◆ **National Metrology Institutes**

 - Inter-NMI Research programmes (e.g. EMPIR)

 - Prioritizing of national programmes

- ◆ **Instrument manufacturers and end users**

 - Major industrial stakeholders include **aerospace, automotive and semiconductor manufacturers** but dimensional metrology touches every aspect of manufacturing

 - “MacroScale” and “NanoScale” conference series

 - Presentations from equipment manufacturers, some end-users and other stakeholders



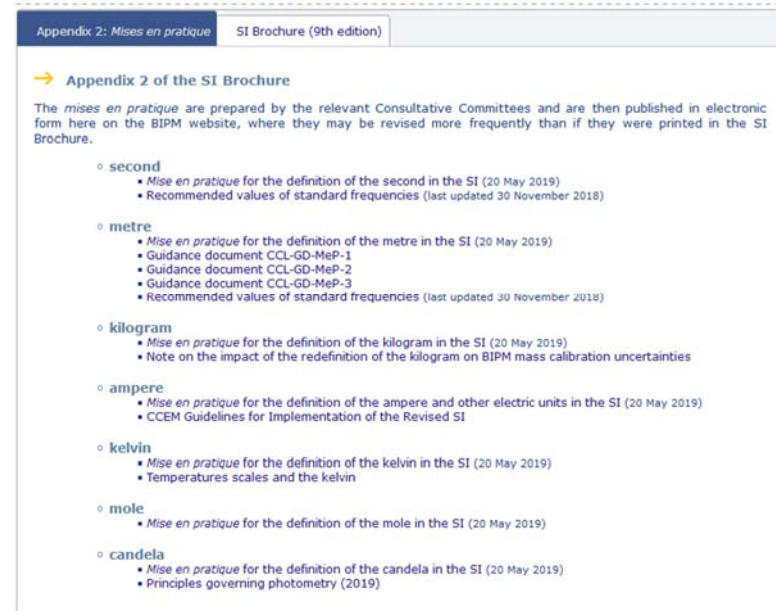
Mise en pratique and Strategy

- **Mise en pratique**

The *Mise en pratique* for the definition of the metre in the SI is now published in the Appendix 2 of the SI Brochure.

Until this publication only the “recommended values of standard frequencies” in common with the CCTF established the “mise en pratique” for the definition of the metre.

Practical realizations of the definitions of some important units



Appendix 2: *Mises en pratique* | SI Brochure (9th edition)

→ Appendix 2 of the SI Brochure

The *mises en pratique* are prepared by the relevant Consultative Committees and are then published in electronic form here on the BIPM website, where they may be revised more frequently than if they were printed in the SI Brochure.

- second
 - *Mise en pratique* for the definition of the second in the SI (20 May 2019)
 - Recommended values of standard frequencies (last updated 30 November 2018)
- metre
 - *Mise en pratique* for the definition of the metre in the SI (20 May 2019)
 - Guidance document CCL-GD-MeP-1
 - Guidance document CCL-GD-MeP-2
 - Guidance document CCL-GD-MeP-3
 - Recommended values of standard frequencies (last updated 30 November 2018)
- kilogram
 - *Mise en pratique* for the definition of the kilogram in the SI (20 May 2019)
 - Note on the impact of the redefinition of the kilogram on BIPM mass calibration uncertainties
- ampere
 - *Mise en pratique* for the definition of the ampere and other electric units in the SI (20 May 2019)
 - CCEM Guidelines for Implementation of the Revised SI
- kelvin
 - *Mise en pratique* for the definition of the kelvin in the SI (20 May 2019)
 - Temperatures scales and the kelvin
- mole
 - *Mise en pratique* for the definition of the mole in the SI (20 May 2019)
- candela
 - *Mise en pratique* for the definition of the candela in the SI (20 May 2019)
 - Principles governing photometry (2019)

- The **strategy document** of CCL and its summary have been published in the BIPM website.

Collaboration between CCL and CCTF

The collaboration between the CCL and CCTF is done by means the CCL and CCTF Working group: **CCL-CCTF-WGFS**.

Main duties:

- the “recommended values of standard frequencies” in common with the CCTF established one part of the “mise en pratique” for the definition of the metre.
- CCL-K11 - **Comparison of optical frequency and wavelength standards**
- the guidance document **CCL-GD-08** concerning alternative arrangements for reviewing CMCs in the laser frequency field.

Standards organizations, accreditors and regulators

- ◆ **Standards organizations**

ISO TC 213 (Dimensional and geometrical product specification and verification) approved the creation of new external liaisons with the CCL and appointed Dr Balsamo (Italy, INRIM) as the Liaison Officer.

A dedicated [BIPM webpage](#) has been created.

CCL members play a major role in national, international and industry-based standards organizations

- ◆ **Accreditors and regulators**

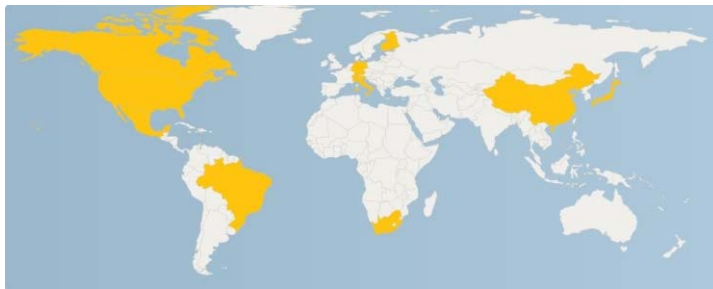
CCL technical decisions are used by members, observers and liaison organizations to support accreditors and regulators

Global comparability of measurements

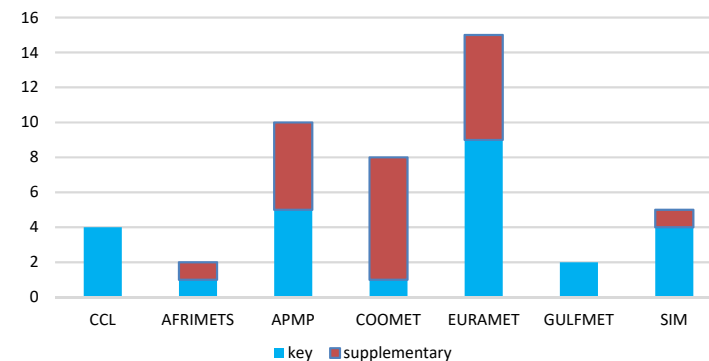
- ◆ **A comparison portfolio based on dimensional metrology techniques**

Nine key comparisons test the principal techniques required by a competent dimensional metrology laboratory

Example of outreach of the CCL-K1 KC



46 Active Comparisons



- ◆ **CCL-RMO comparisons**

Interlinked RMO comparisons improve the efficiency of the process where there are insufficient numbers of laboratories offering a service to make the classical scheme (of CCL and multiple RMO comparisons) worthwhile

17th CCL meeting (14 to 15 June 2018)



- CCL meets every 3 years, 24 members and 4 observers
- 3 Working Groups, 1 joint WG with CCTF and 9 Discussion Groups
- 60 participants at last meeting (experts included)
- The current portfolio of KCs 1 to 11 is complete to fulfil the MRA requirements
- There are 1641 CMC for length published in KCDB

CCL - Meetings

- ◆ In October 2019 CCL WG meetings will take place at PTB.

- 14-15 /10/2019 EURAMET TC-L meeting
- 15-16 /10/2019 Nanoscale conference

NanoScale 2019

12th Seminar on Quantitative Microscopy (QM)
and
8th Seminar on Nanoscale Calibration, Standards and Methods

Dimensional and related measurements
in the micro- and nanometre range
and
2nd Award of NanoKnight
on 15th and 16th October 2019
at
at the site of Braunschweig, Bundesallee 100, Germany.

Physikalisch-Technische Bundesanstalt

The seminar will be organized by
EURAMET Nanometrology group
Physikalisch-Technische Bundesanstalt (PTB)

- 17/10/2019 meeting of CCL Working Group on Dimensional Nanometrology (CCL-WG-N)
- 17-18/10/2019 meeting of CCL Working Group on the CIPM MRA (CCL-WG-MRA)

Guidance on CMCs and comparisons

◆ CCL Length Services Classification scheme (DimVIM)

Has been translated into 14 languages and has served as a template for other CCs, accreditation bodies, and other organizations.

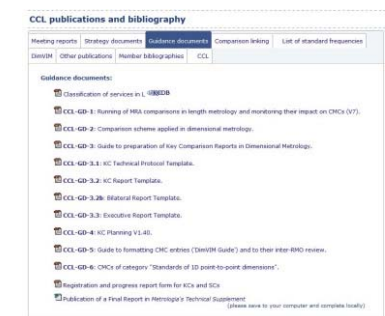
<https://www.bipm.org/en/committees/cc/ccl/dimvim.html>



◆ Guidance documents

Guidance documents and templates have been developed on formatting CMCs, conducting comparisons, model protocols and final reports.

<https://www.bipm.org/en/committees/cc/ccl/publications-cc.html>



Thank you very much for
your attention.

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