

Length, Angle and Dimensions

The Consultative Committee for Length (CCL)

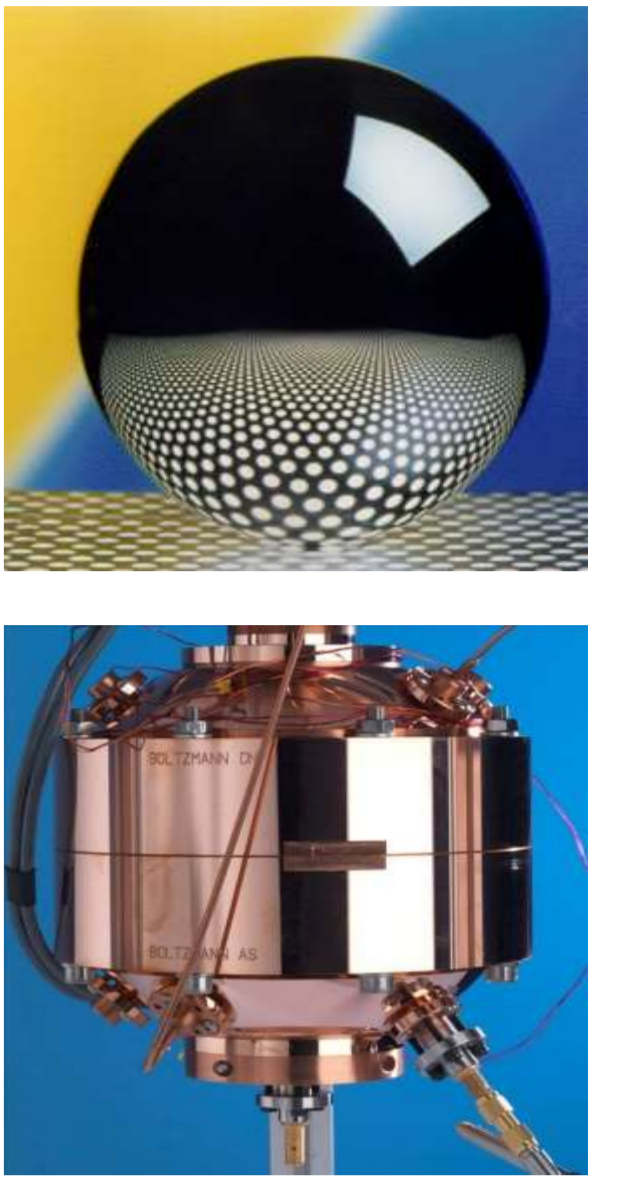
The CCL provides a global forum for NMIs on best practices, state of the art and innovations

Established nine technical discussion groups for new research ideas, opinions, feedback on standards

CONFERENCES:

- **MacroScale conferences** in 2014 and in 2017 – *Dimensional metrology*
- **SPIE Advanced Lithography (AL)** – *Metrology, Inspection, and Process Control*
- **Frontiers of Characterization and Metrology for Nanoelectronics**
- **BAM-PTB Nano Workshop 2018**
- **NanoScale Seminars** in 2013 and 2016 – *Quantitative Microscopy*

Precision engineering and dimensional metrology are key to three **SI re-definitions** based on fundamental constants: form and dimension of **Avogadro** spheres and **Boltzmann** resonators, **Planck** balance interferometry



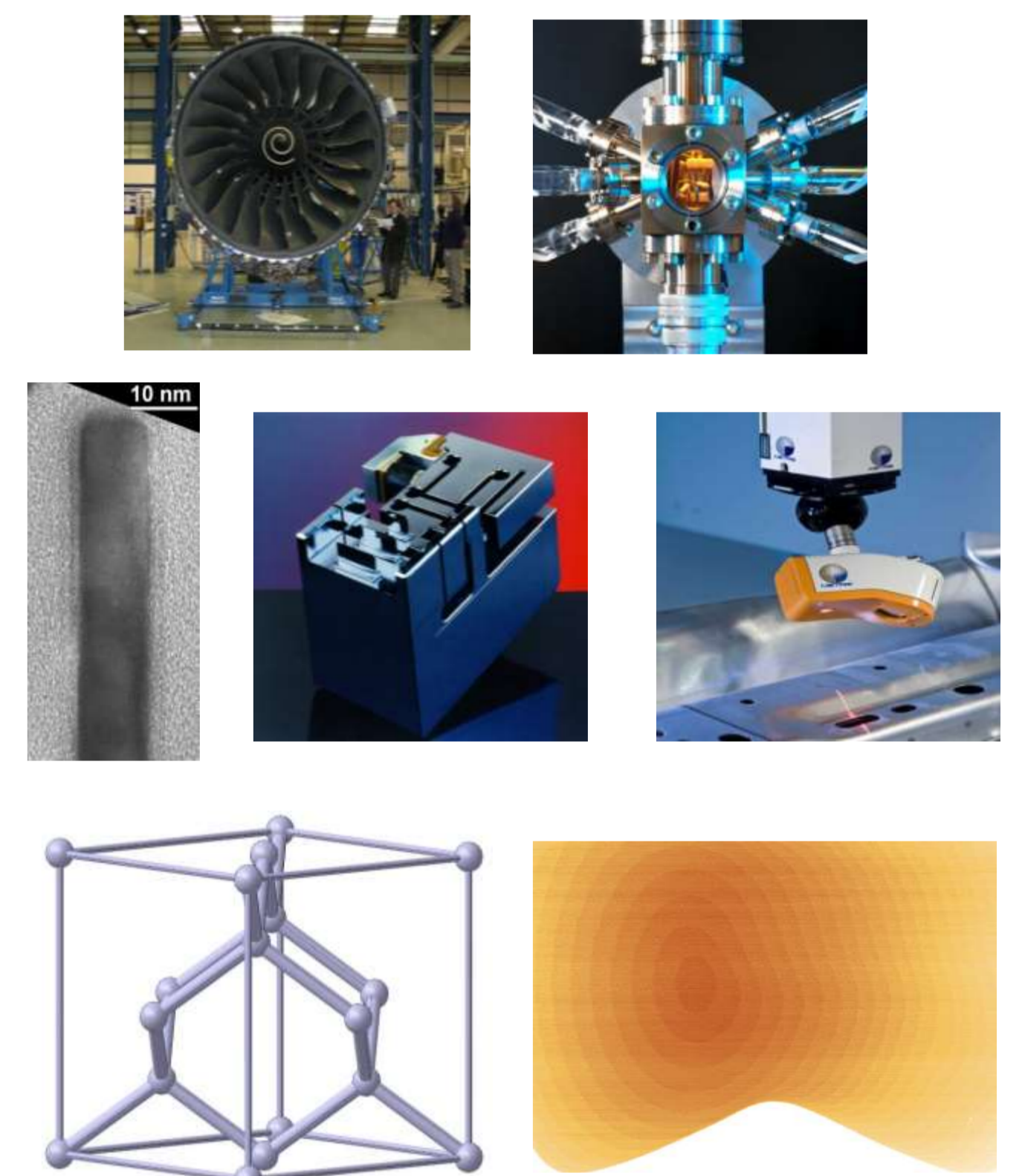
The CCL improves continuously the global comparability of measurements

The CCL is the focus for TRACEABILITY in dimensional measurements

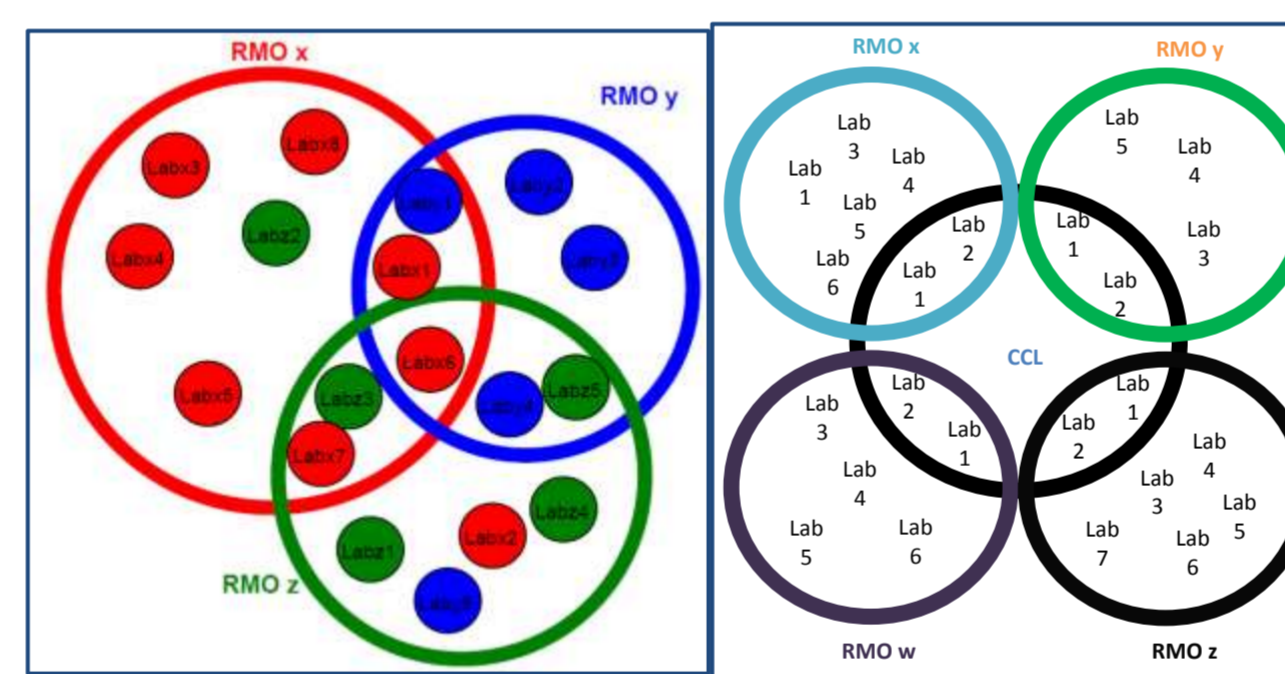
- **Guidance documentation** for comparisons and CMC validation published on the BIPM website for **Open Access**
- Introduction of a new “flexible” **1D CMC**
- Harmonized terminology for dimensional metrology in 13 languages - **DimVim**
- **CMC foresight**: anticipating workload with corrective actions after comparison reports

New routes to traceability

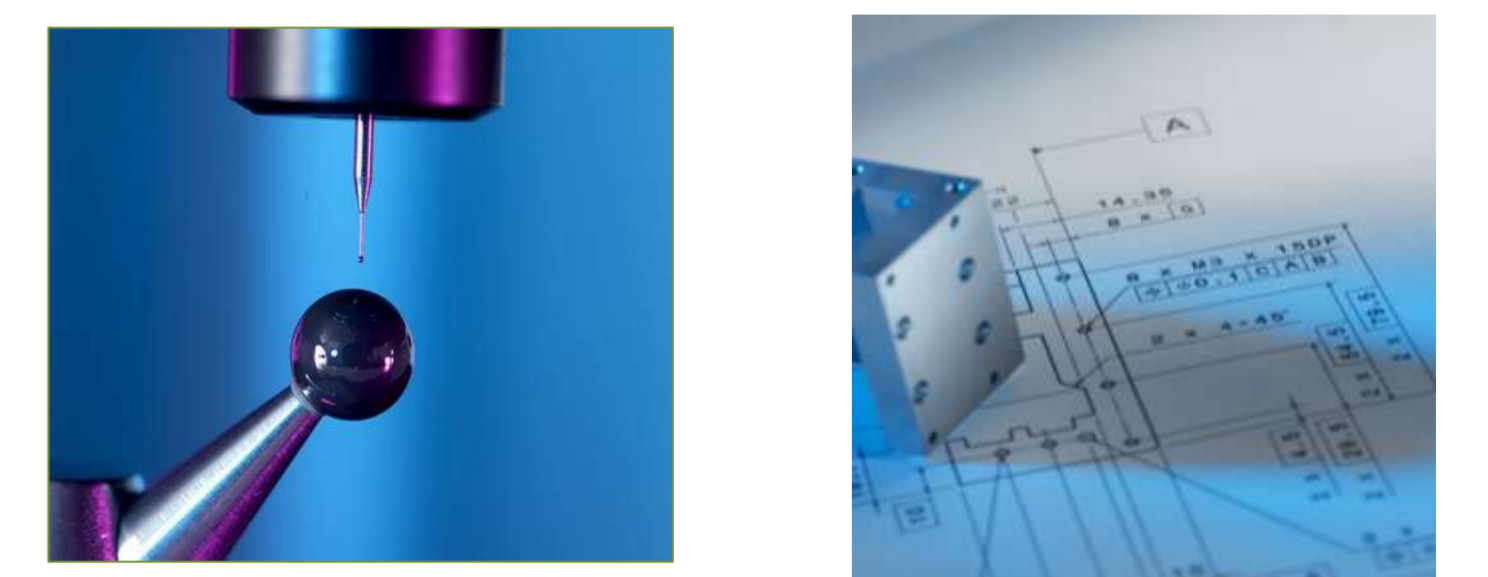
- **Lattice parameter of silicon** included in revision of the **MeP for the metre** to provide **new traceability routes for dimensional nanometrology**: **x-ray interferometry for displacement generation and measurement, mono-atomic silicon steps for SPM calibration and silicon pillars for TEM calibration**
- Develop and validate traceability routes for *in situ* metrology
- Extend the traceability of the **metre** to extreme scales: **sub-nanometre** and geodetic (**kilometre**)
- Update list of **frequency values** for use in **metre realizations** and **secondary realizations of the second**
- Support industry’s transition to **non-contact measurement** to enable faster and cheaper production
- Coordinate pre-normative research into novel **coordinate metrology systems** such as **X-ray CT**, micro **CMMs**



A new style of efficient inter-RMO comparison has been devised and is operational. It is intended to reduce the comparison workload

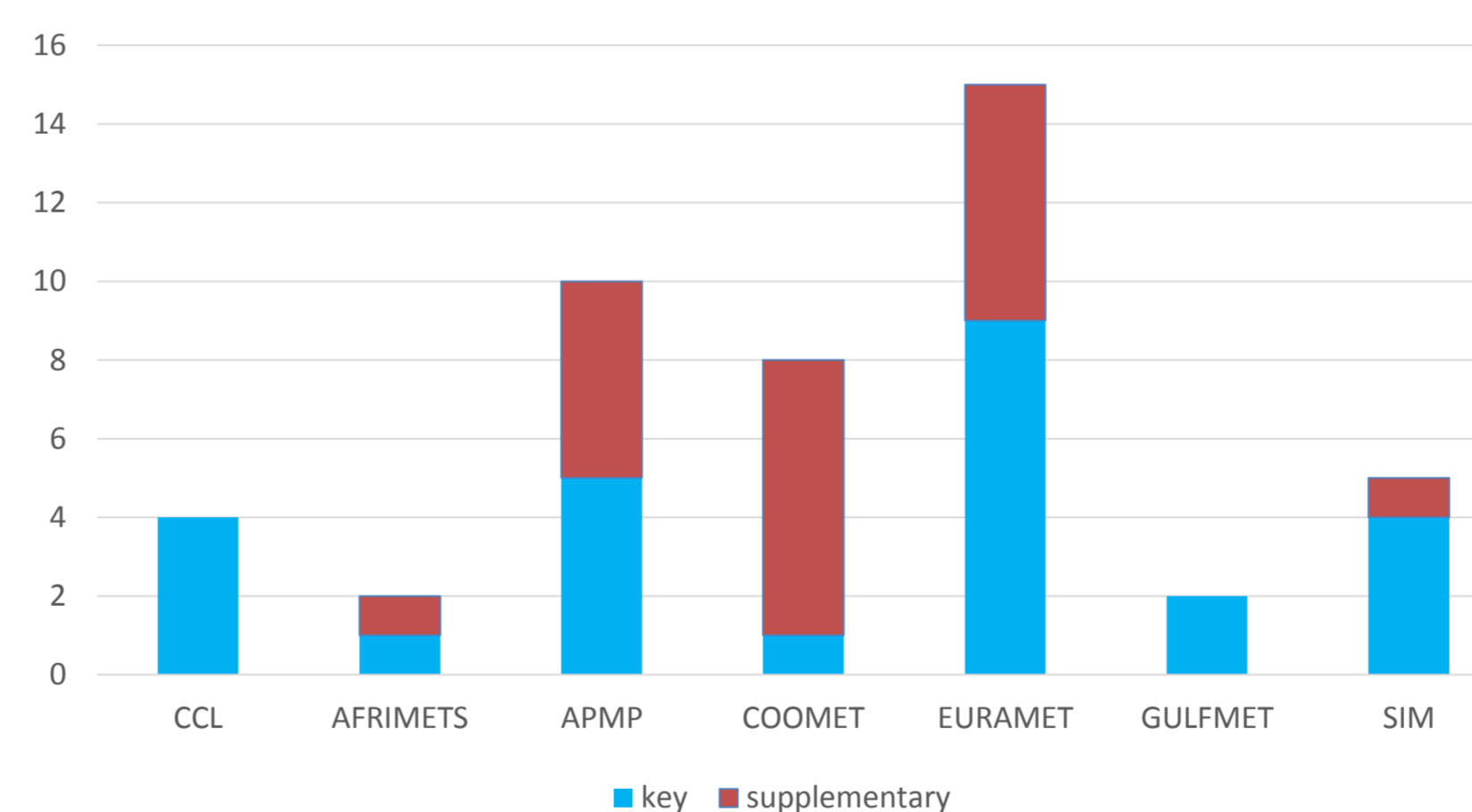


Traceability in dimensional measurements underpins **all manufacturing, engineering and assembly industries world-wide**, ensuring compatibility and interchangeability of parts.

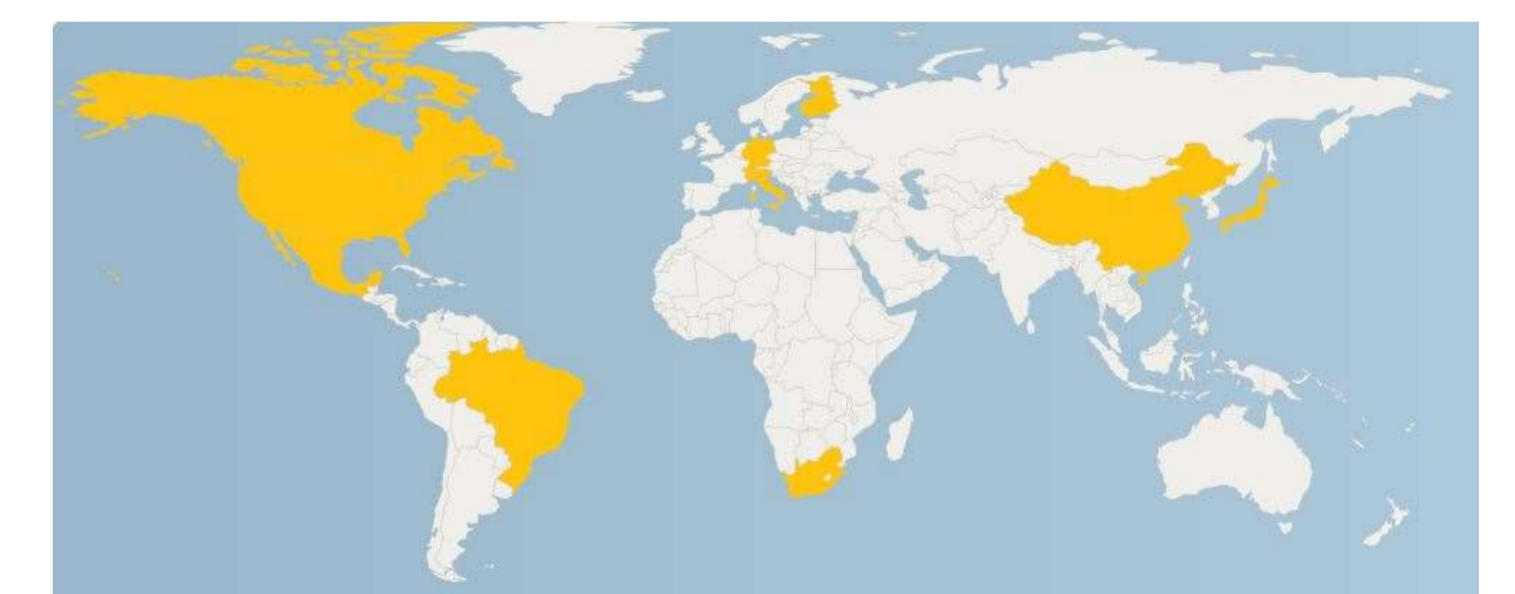


Seven CCL Key Comparisons - 46 comparisons ‘active’

- CCL-K1 (short gauge blocks)
- CCL-K2 (long gauge blocks)
- CCL-K3 (angle)
- CCL-K4 (diameter)
- CCL-K5 (step gauge)
- CCL-K6 (ball plate)
- CCL-K11 (laser frequency/vacuum wavelength)



Example of outreach of the CCL-K1 KC



Total Number of CMCs - 1641

- **187 Laser**
- **1454 Dimensional metrology**

The CCL facilitates dialogue between NMIs and established stakeholders

- **Standards organizations** (for example **ISO**) - **Significant CCL member presence**
- Semiconductor manufacture, Military, Automotive industry
- **Aerospace industry** – **key needs are accuracy and traceability for parts up to 40 m in size.**



Science (geodetic measurement for particle accelerators, interferometry for satellite missions, etc.) **Energy generation** (wind, civil nuclear) - The key requirements for better accuracy and *in situ* calibration are speeding up **Manufacturing**.