Bureau International des Poids et Mesures

International Recognition of NMI Calibration and Measurement Capabilities:

The CIPM MRA

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The Metre Convention

The Metre Convention was signed on May 20, 1875 by representatives of 17 states.

From the text:

“Desiring the international uniformity and precision in standards of weight and measure…”

The Metre Convention

THE METRE CONVENTION
International Convention established in 1875 with 55 Member States in 2011. The institutional foundation of the International System of Units (now the SI).

CGPM – Conférence Générale des Poids et Mesures

Composed of Member State representatives. Typically meets every 4 years to decide on matters pertaining to the Metre Convention and the SI

CIPM – Comité International des Poids et Mesures

18 individuals of different nationalities appointed by CGPM. Supervises BIPM and generally supplies chairs to Consultative Committees.

BIPM – Bureau International des Poids and Mesures

Research institute founded by the Metre Convention. Administers interlaboratory comparisons and provides measurement services to member NMIs.

Consultative Committees (CCs)

CCAUV – Acoustics, US & Vibration
CCEM – Electricity & Magnetism
CCL – Length
CCM – Mass and related
CCPR – Photometry & Radiometry
CCQM – Amount of substance
CCRI – Ionizing Radiation
CCT – Thermometry
CCTF – Time & Frequency
CCU - Units

Development of the CIPM MRA

Towards the late 1980's several factors had emerged that led to the idea of forming an agreement among NMIs to formalize a system of mutual recognition of national measurement standards and calibration certificates:

- Pressure from accreditation bodies for demonstration of NMI capabilities to which the laboratories they accredited were expected to be traceable and of equivalence of NMI calibration certificates.

- The development of regional groupings of NMIs to undertake cooperative activities - EUROMET in Europe, APMP in the Asia – Pacific

- The reduction of tariff barriers resulting from GATT Uruguay round of negotiations and the conclusion of the Technical Barriers to Trade Agreement increased attention paid to TBTs among which intergovernmental acceptances of testing methods and standards is of relevance to metrology.

Timeline of the CIPM MRA

October 1992

CIPM decides that BIPM should seek a broad role in international traceability of measurements and standards - first official step to the CIPM MRA

October 1993

CIPM considers a draft scheme for using BIPM and CC comparisons as the basis for formal *worldwide traceability*

October 1994

CIPM adopts a draft resolution for the 20th CGPM: *"Worldwide traceability of measurement standards"*

Timeline of the CIPM MRA

February 1997

First and second drafts of the CIPM MRA

Meeting of 38 NMI directors agree that the principle of an international MRA preferable to bilateral NMI agreements or linked regional arrangements. Revisions to 2nd draft requested.

September 1997

CIPM adopts 7th draft and creates the Joint Committee of the RMOs and the BIPM (JCRB) to be responsible for coordinating implementation of the CIPM MRA

Timeline of the CIPM MRA

1998

Negotiations with NMIs and other interested parties continue over the text of the CIPM MRA and mechanisms for KCs and CMCs

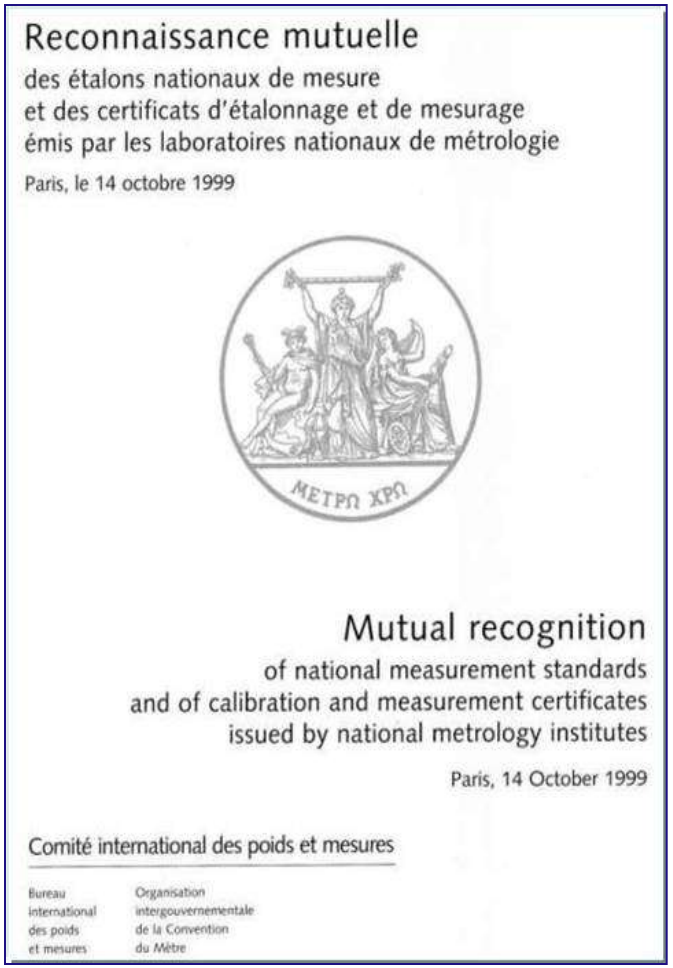
April 1999

Final text sent to printers and to Directors with invitation to sign during 21st CGPM

July 1999

Last minute objections to text! After agreement with objecting party, new final text sent to printers.

The CIPM Mutual Recognition Arrangement



Reconnaissance mutuelle

des étalons nationaux de mesure
et des certificats d'étalonnage et de mesurage
émis par les laboratoires nationaux de métrologie

Paris, le 14 octobre 1999

ΜΕΤΡΩ ΧΡΩ

Mutual recognition

of national measurement standards
and of calibration and measurement certificates
issued by national metrology institutes

Paris, 14 October 1999

Comité international des poids et mesures

Bureau international des poids et mesures

Organisation intergouvernementale de la Convention du Mètre

The CIPM Mutual Recognition Arrangement (CIPM MRA) was signed on 14 October, 1999 by the Directors of the National Metrology Institutes of 38 States signatories to the Metre Convention and two international organizations.

The essence of the CIPM MRA is that it provides the institutional and technical framework (the "what", "who" and "how") for NMIs to recognize each others' measurement standards and calibration certificates.

CIPM MRA

Essential Points: Objectives

The objectives of the CIPM MRA are stated as:

- to establish the degree of equivalence of national measurement standards maintained by NMIs
- to provide for the mutual recognition of calibration and measurement certificates issued by NMIs
- thereby to provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce and regulatory affairs

Essential Points: Process

The objectives of the CIPM MRA are to be achieved through:

- International comparisons of measurements, to be known as key comparisons
- Supplementary international comparisons of measurements
- Quality systems and demonstrations of competence by NMIs

Essential Points: Outcomes

The outcome of the CIPM MRA processes are statements of the measurement capabilities of each NMI (CMCs) published in a database maintained by the BIPM and publicly available online.

Essential Points: Engagement

By signing the CIPM MRA, an NMI agrees to:

- accept the process specified in the CIPM MRA for establishing the datab
- recognize the re comparisons a
- recognize the cal other participating NM

Where more than one institute holds national measurement standards in a country, additional institutes may participate in the CIPM MRA with the authorization of the institute that has signed the CIPM MRA. Such institutes are known as "designated Institutes" or "DI"s

Essential Points: Exclusions

The ‘recognition’ offered by the CIPM MRA is not unlimited:

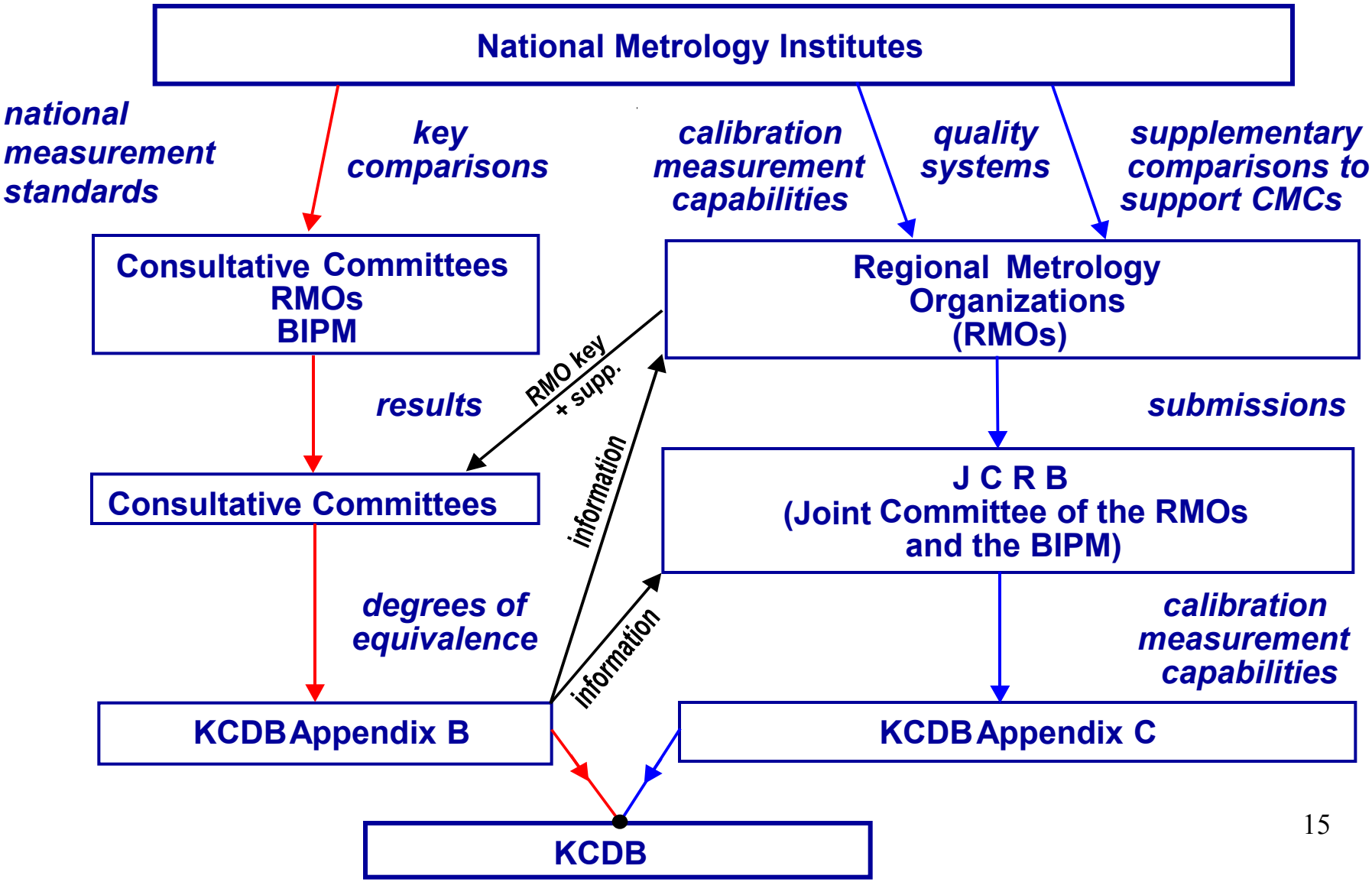
- signature of the CIPM MRA engages NMIs but not necessarily any other agency in their country
- responsibility for the results of calibrations and measurements rests wholly with the NMIs that makes them and is not, through the CIPM MRA, extended to any other participating NMI

Essential Points: Organizational Structure

Roles and responsibilities within the CIPM MRA:

- overall coordination is by the BIPM under the authority of the CIPM
- the CCs of the CIPM, the RMOs and the BIPM are responsible for carrying out the key and supplementary comparisons
- a Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB) is responsible for coordination of the CMC reviews and the discussion of issues pertaining to the implementation of the CIPM MRA

Diagram of the CIPM MRA



Comparisons in the CIPM MRA

- A fundamental mechanism of the CIPM MRA
- Primary function is to establish the degrees of equivalence of national measurement standards which is the technical basis on which NMIs recognize each others national measurement standards
- Key and Supplemental comparisons are also demonstrations of NMI measurement capabilities
- Registered in Appendix B of the KCDB

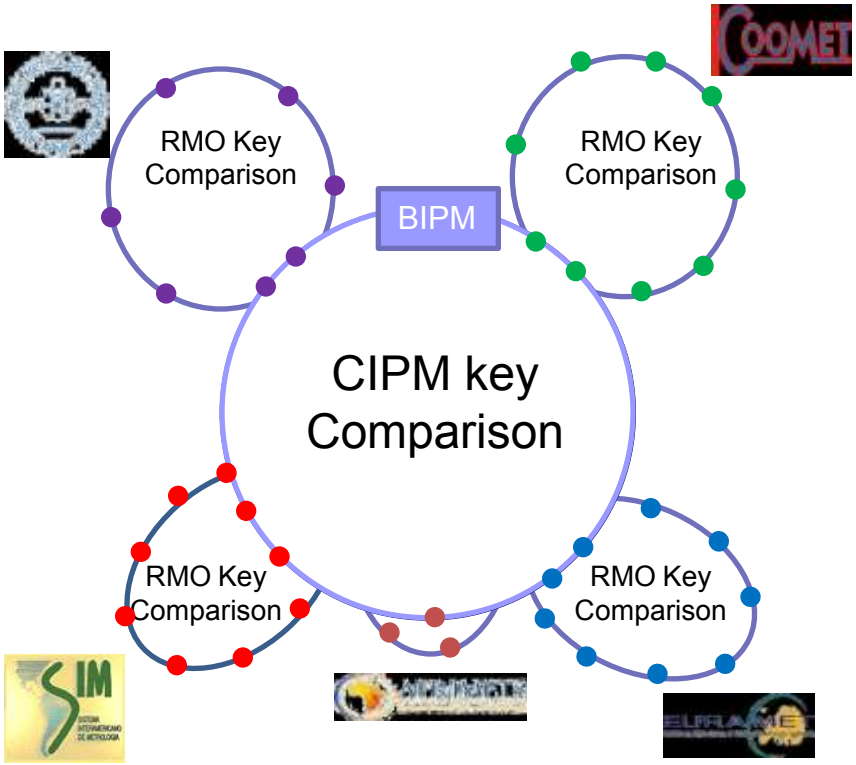
Comparisons in the CIPM MRA

There are 3 basic categories of measurement comparisons:

CIPM key

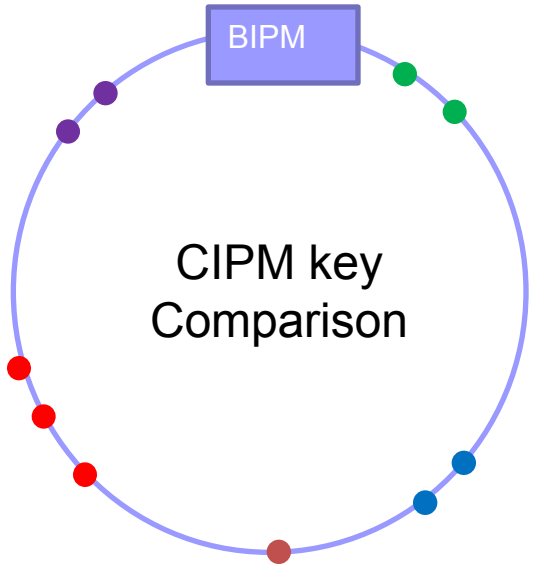
RMO key

Supplementary



Comparisons in the CIPM MRA

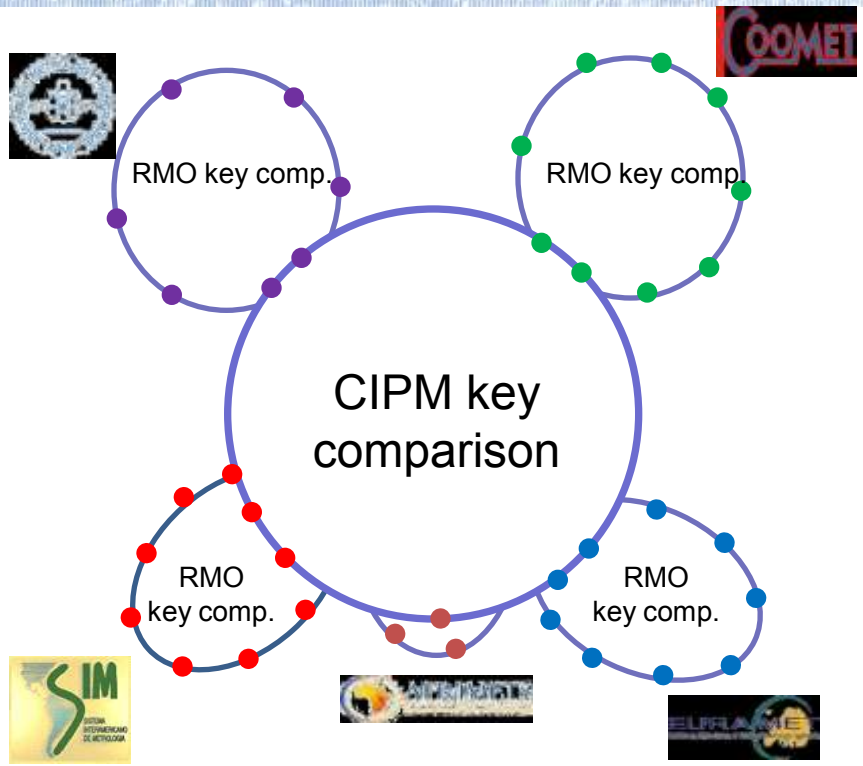
CIPM key
RMO key
Supplementary



- Highest level of accuracy
- Selected by CCs to test the principal techniques in the field
- Participation is limited to members of the Consultative Committees
- Reference value is determined by consensus among the participants

Comparisons in the CIPM MRA

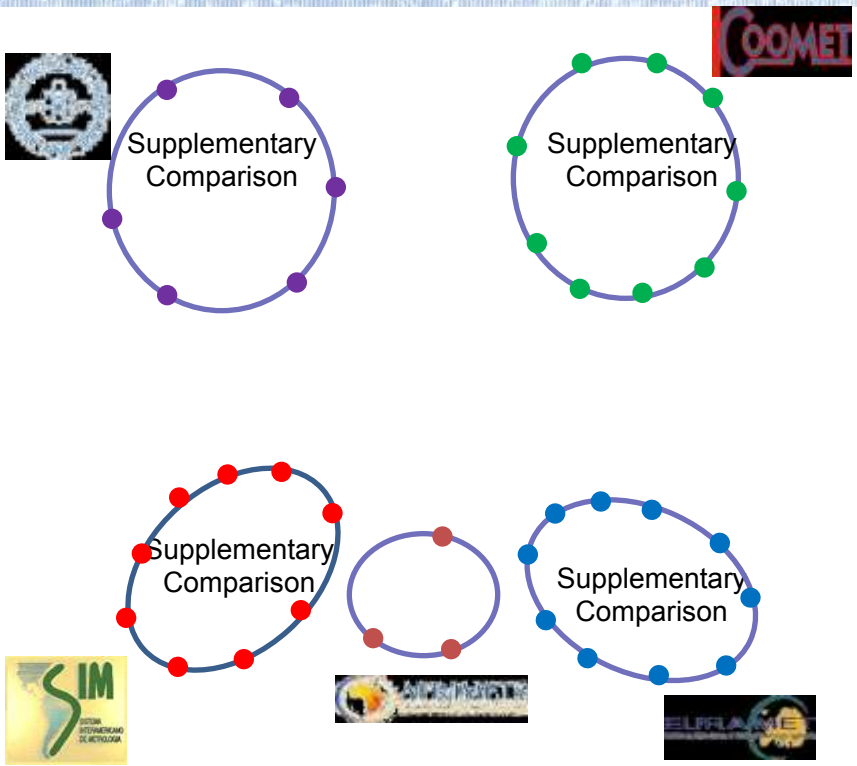
CIPM key
RMO key
Supplementary



- Undertaken by Regional Metrology Organizations
- Follow the same protocol of the CIPM Key Comparisons
- The reference value is linked to the CIPM KC through the NMIs that participate in both comparisons (at least two NMIs)

Comparisons in the CIPM MRA

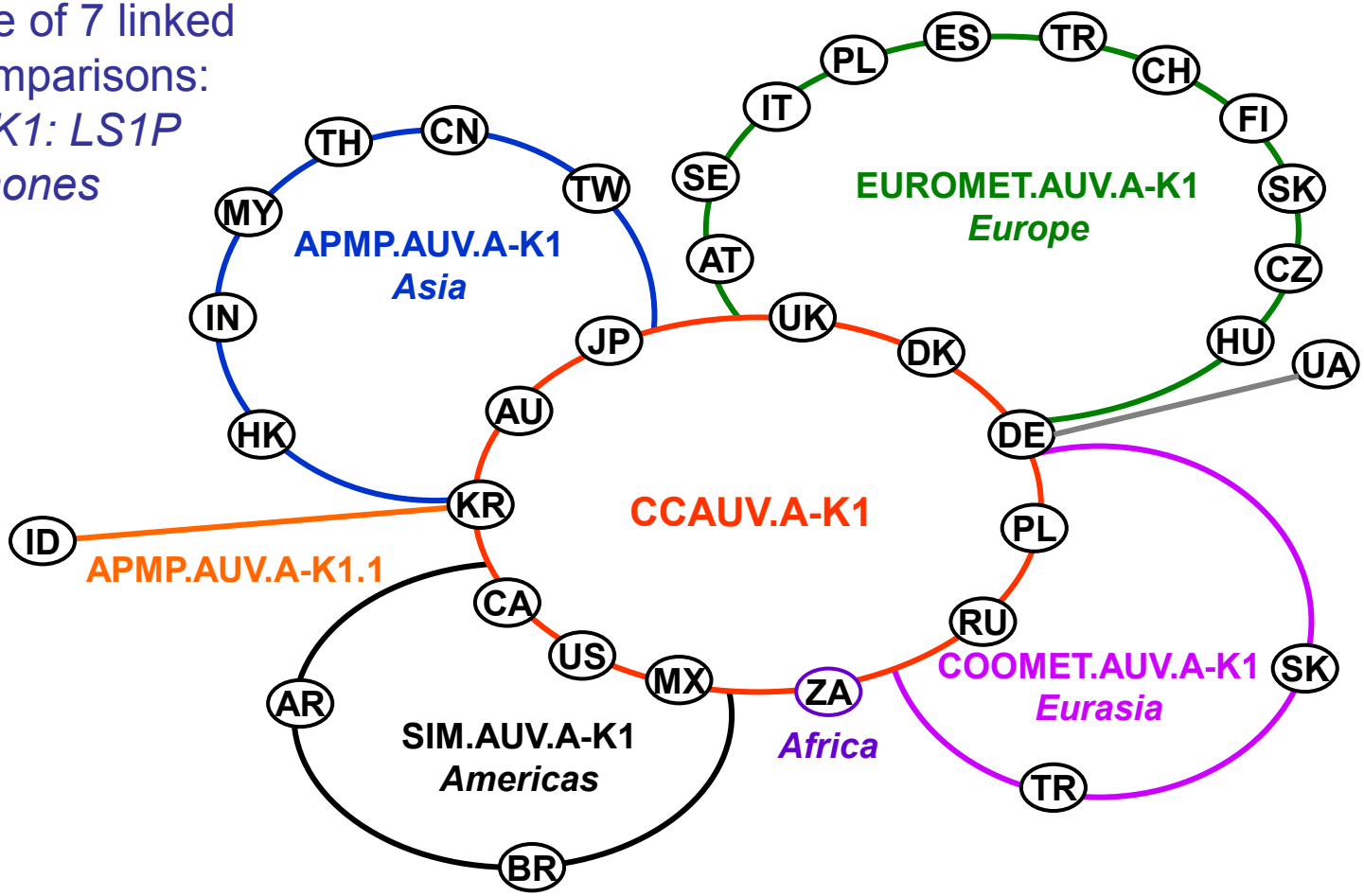
CIPM key
RMO key
Supplementary



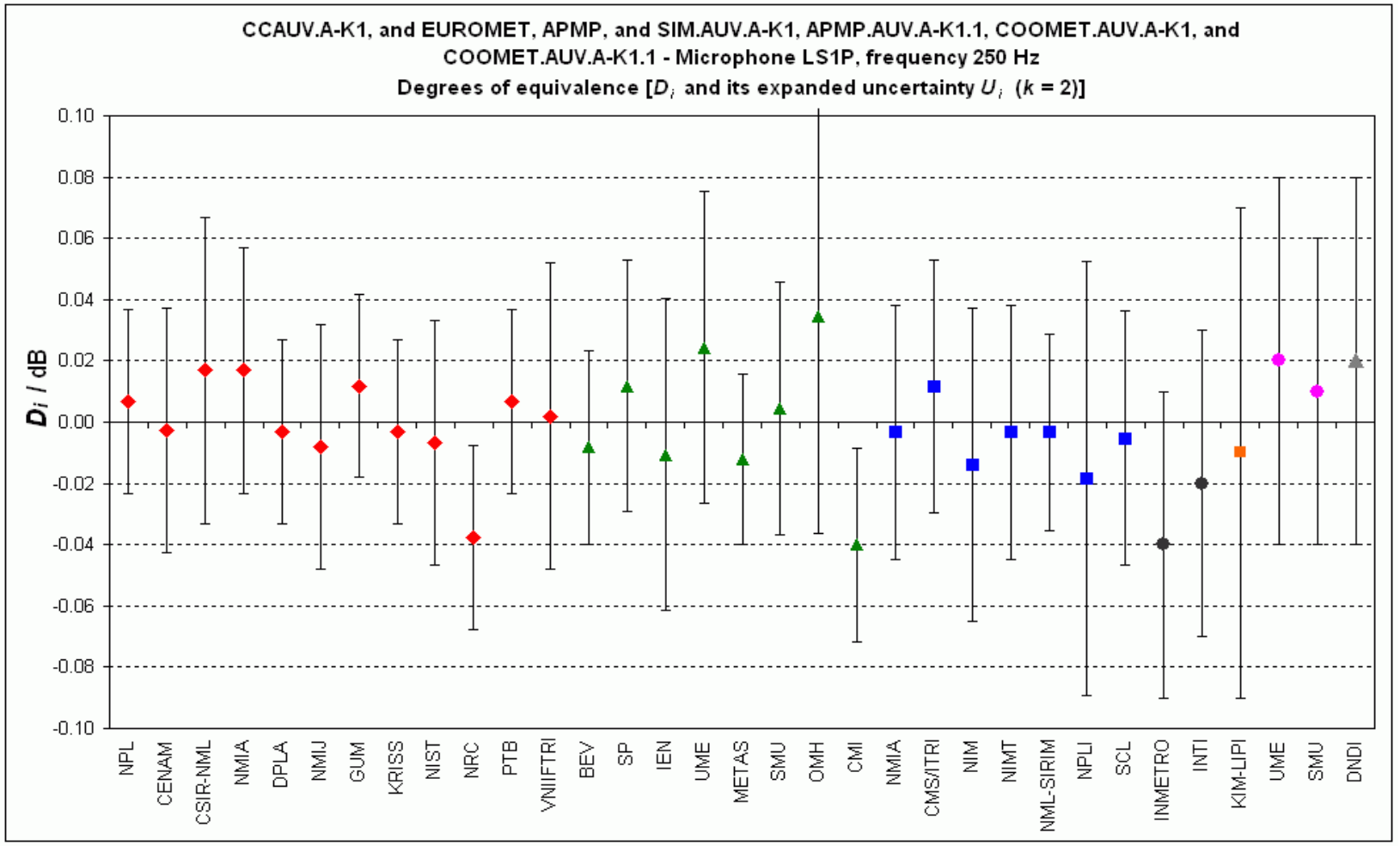
- Usually takes place within RMOs
- Covers areas not covered by Key Comparisons – lower accuracy measurements and different techniques
- Not linked to Key Comparisons

Comparisons in the CIPM MRA

Example of 7 linked Key Comparisons:
AUV.A-K1: LS1P Microphones



Comparisons in the CIPM MRA



Red diamonds : CCAUV.A-K1 participants
Green triangles : EUROMET.AUV.A-K1 participants only
Blue squares : APMP.AUV.A-K1 participants only
Black circles : SIM.AUV.A-K1 participants only
Orange square : APMP.AUV.A-K1.1 participant only
Pink circles : COOMET.AUV.A-K1 participants only
Grey triangle : COOMET.AUV.A-K1.1 participant only

CMCs in the CIPM MRA

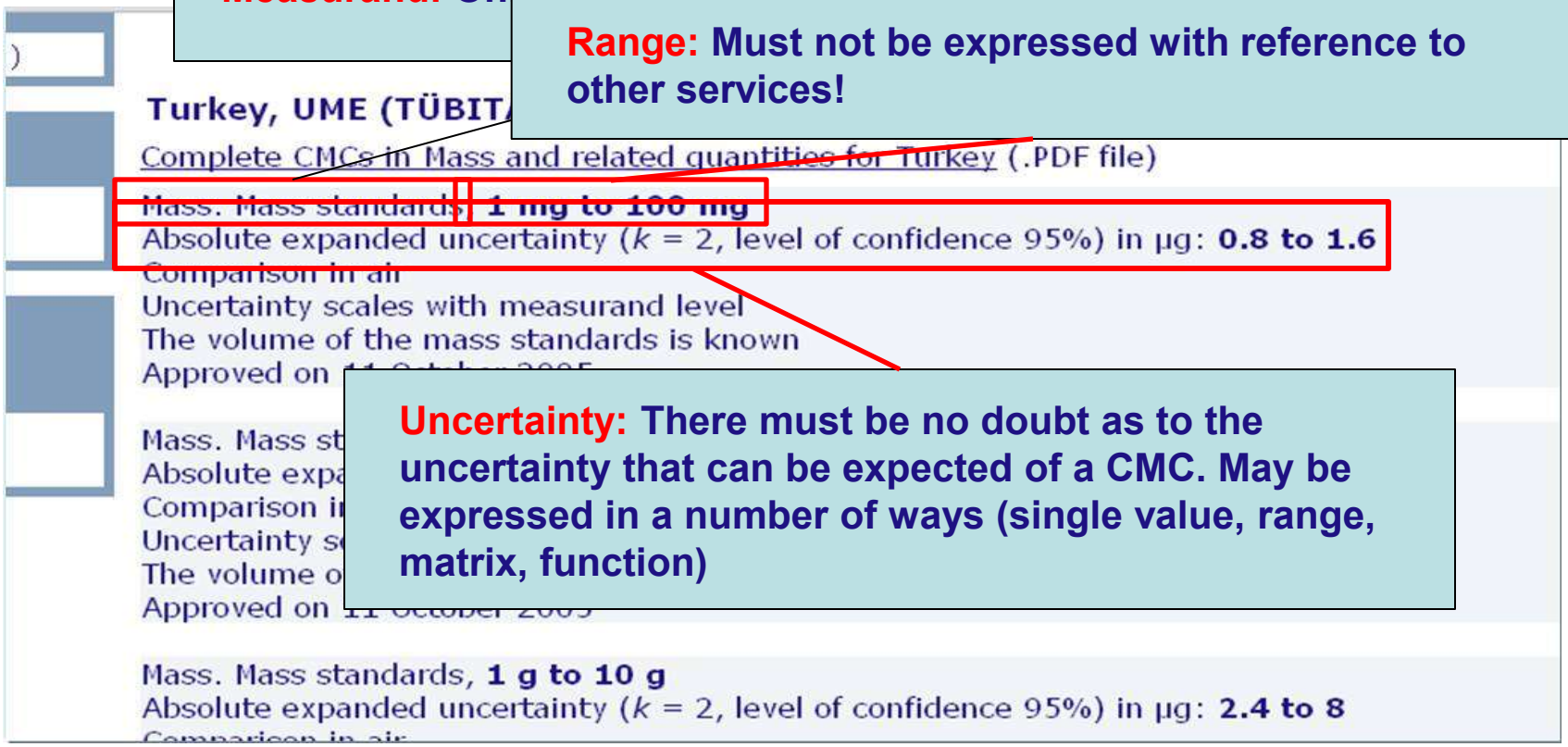
- Under the CIPM MRA, the Calibration and Measurement Capabilities (CMCs) of signatory NMIs are the fundamental object of mutual recognition.
- CMCs are described in terms of measurand, the method used, the range, the uncertainty, and if necessary, the influence parameters.
- CMCs declared by NMIs within the CIPM MRA undergo a review process at RMO and inter-RMO level
- CMCs are published in Appendix C of the KCDB

CMCs in the CIPM MRA

There a

Measurand: Only one measurand per CMC

Range: Must not be expressed with reference to other services!



Uncertainty: There must be no doubt as to the uncertainty that can be expected of a CMC. May be expressed in a number of ways (single value, range, matrix, function)

Traceability

All CMCs must include information on traceability of the measurements to the SI. According to th
are two routes to establish traceability:

1. via a primary realization of the unit o
concerned, in which traceability is declared to its own
demonstrable realization of the SI.

2. via ng relevant CMCs with
ap blished in the KCDB, or through
ca ent services offered by the BIPM

In order for a primary realization or representation of the unit of measurement to be considered valid, it requires the approval of the relevant Consultative Committee.

The NMI or DI must make available a full assessment of the uncertainty budget and the traceability route for its measurement activity when submitting CMCs for intra- and inter-Regional review.

Evidence for CMC declarations

CMC declarations must be backed by evidence. Acceptable evidence includes:

1. Results of key and supplementary comparisons
2. Documented results of past CC, RMO or other comparisons (including bilateral)
3. Knowledge of technical activities by other NMIs, including publications
4. On-site peer-assessment reports
5. Active participation in RMO projects
6. Other available knowledge and experience

CMC Reviews

NMI CMC File

INTRA-REGIONAL CMC REVIEW:

- Lead by the RMO TC Chair of the relevant area
- Checks CMC declarations against required evidence and criteria specified by the JCRB Guidelines
- NMI must respond to comments and questions submitted by reviewers
- Quality System of the NMI must be approved and cover the CMCs under review

INTER-REGIONAL CMC REVIEW:

- Conducted via dedicated JCRB website
- RMOs participate through their TCs
- Checks against technical criteria only
- NMI must respond to comments submitted by reviewers, and if necessary revise the CMC submission

FINAL JCRB APPROVAL

PUBLICATION OF THE CMCs IN KCDB

Quality System Requirements

The CIPM MRA offers two options for NMIs for establishing a QS as a requirement for the recognition of calibration and measurement certificates:

1. Establishment of a quality system that meets the requirements of ISO/IEC 17025 (or ISO Guide 34 for CRM producers) or equivalent for an NMI that is assessed by an accreditation body fulfilling the requirements of ISO/IEC 17011

2. Establishment of a quality system or a different way of assuring quality that meets the requirements of ISO/IEC 17025 (or ISO Guide 34 for CRM producers) or equivalent without third-party assessment

Quality System Requirements

In either case – with or without third-party assessment – all NMIs must have their QS reviewed and approved by the RMO of which they are a member.

Reviews of NMI QS are done according to CIPM MRA-G-02: "Guidelines for the monitoring and reporting of the operation of quality systems by RMOs"

RMOs have a degree of flexibility in setting the requirements for the QS of their member NMIs and DIs and their review processes.

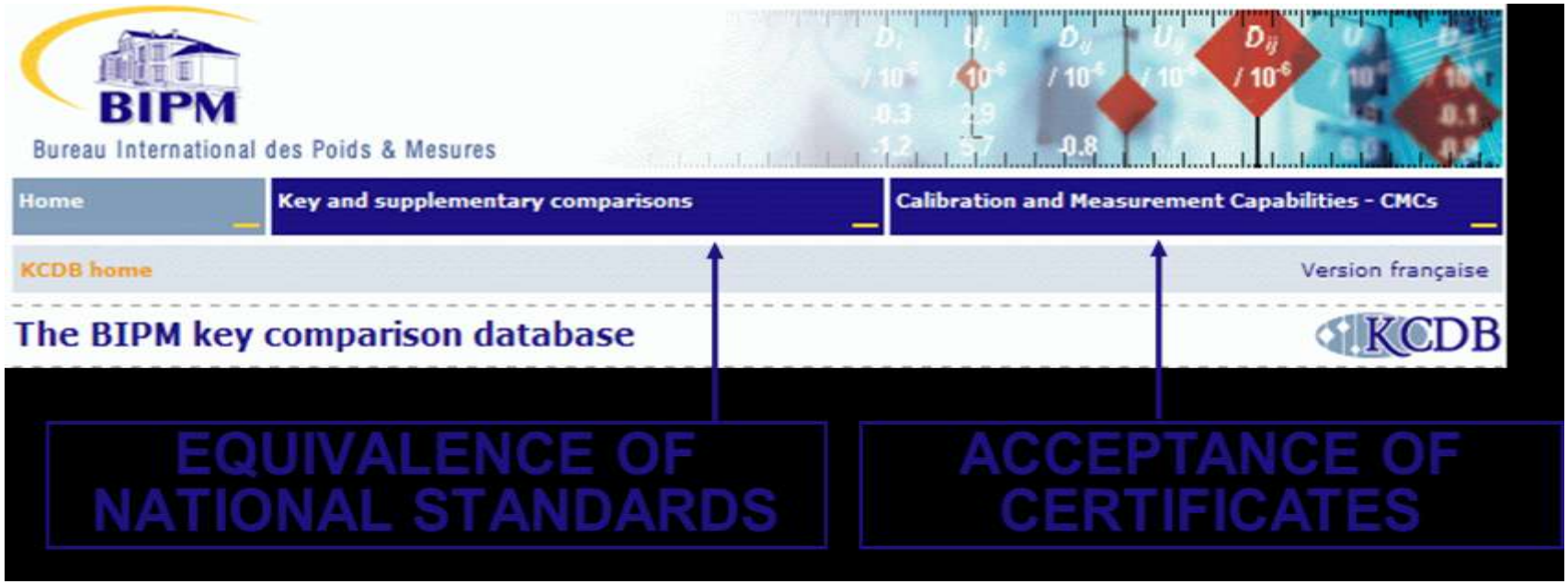
CIPM MRA Logo

Once an NMI has published CMCs, it can apply to the BIPM Director to use the CIPM MRA logo on its calibration and measurement certificates covered by those CMCs.

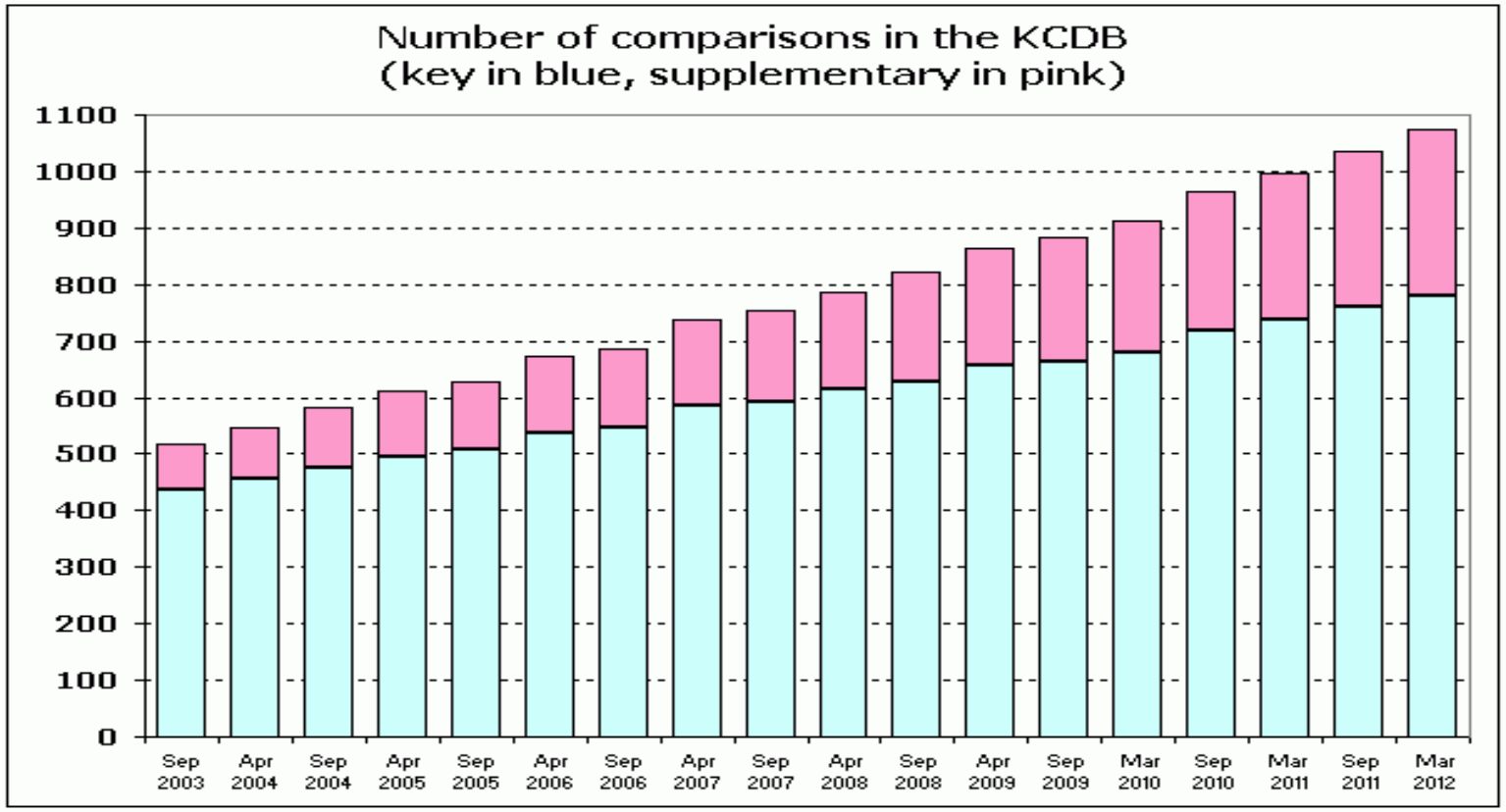
"This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the CIPM.
Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see http://www.bipm.org)"

Key Comparison Database (KCDB)

The BIPM Key Comparison Database (KCDB) is a public website containing all results of the principal mechanisms of the CIPM MRA – measurement comparisons and CMC declarations

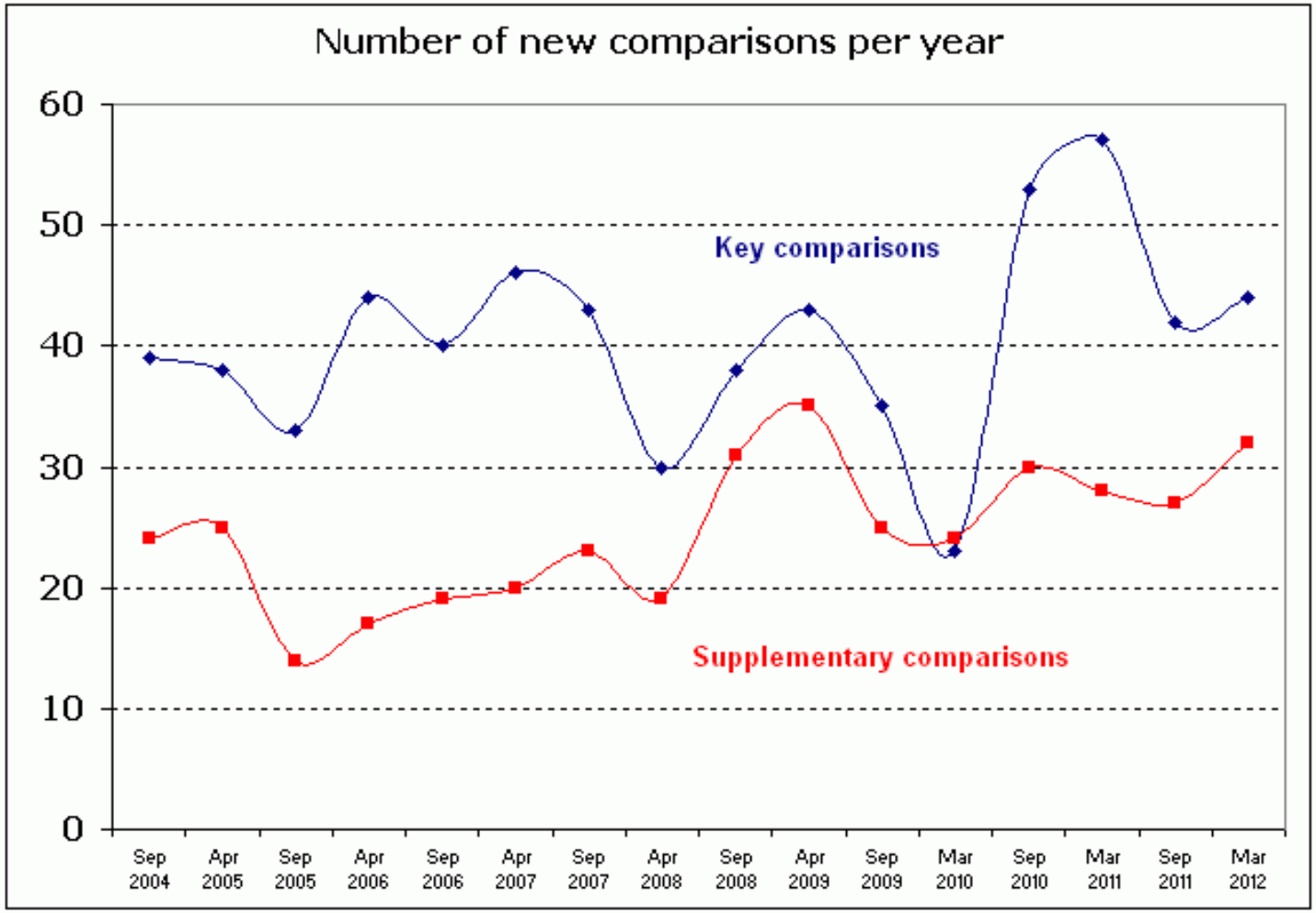


KCDB: Key Comparisons

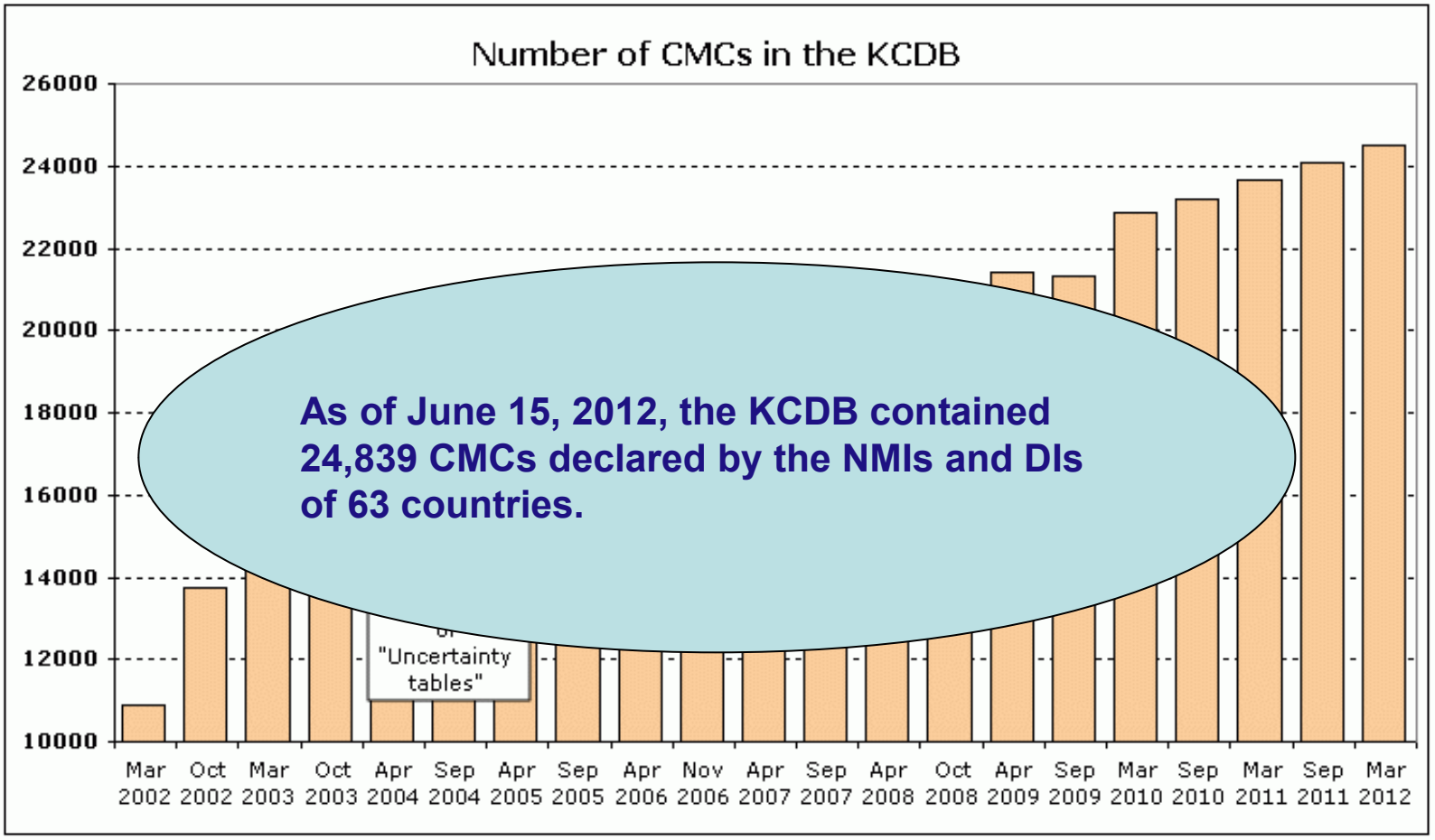


As of June 2012, the KCDB contained data on 793 Key comparisons and 310 supplementary comparisons.

KCDB: Key Comparisons



KCDB: CMCs



As of June 15, 2012, the KCDB contained 24,839 CMCs declared by the NMIs and DIs of 63 countries.

Who benefits from CIPM MRA?

Participating NMIs and Designated Institutes
- Benefit from coordination, greater rigour and increased acceptance of capabilities

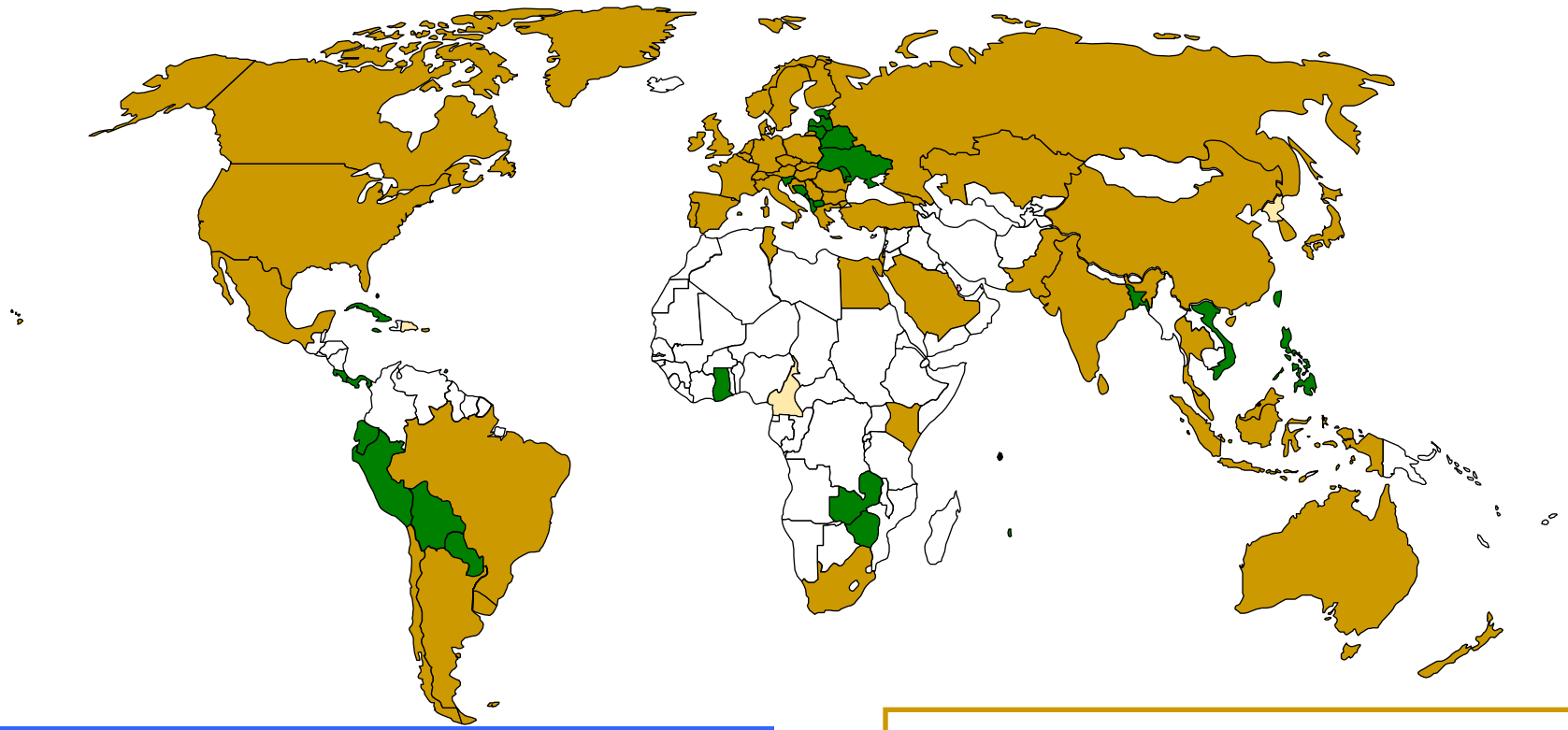
Those NMIs wanting to hold a national standard that is not primary
- able to identify which NMIs can provide the traceability to the SI

The accredited laboratory community
- able to identify which NMIs can provide the traceability to the SI
- easily able to demonstrate valid traceability route to accreditors

Industry
- able to source top level measurement capability

Regulators
- who need a technical basis to underpin acceptance of non national calibrations

CIPM MRA Participation in 2012



87 NMIs plus a further 138 designated institutes from
51 Member States
33 Associates of the CGPM
3 international organizations

Member participating in the CIPM MRA
Associate participating in the CIPM MRA

CIPM MRA Documents

After the signing of the CIPM MRA, the CIPM approved a number of policy and guidance documents concerning implementation of the CIPM MRA.

These detail the requirements, procedures and processes pertaining to all aspects of the implementation of the CIPM MRA.

The documents are available at:

http://www.bipm.org/en/cipm-mra/documents/

Conclusion

International recognition of national measurement standards and capabilities

Publicly available free resource: KCDB

Peer-reviewed measurement comparisons, CMC declarations, quality management systems

Value for accredited laboratories, accreditors. regulators, industry…