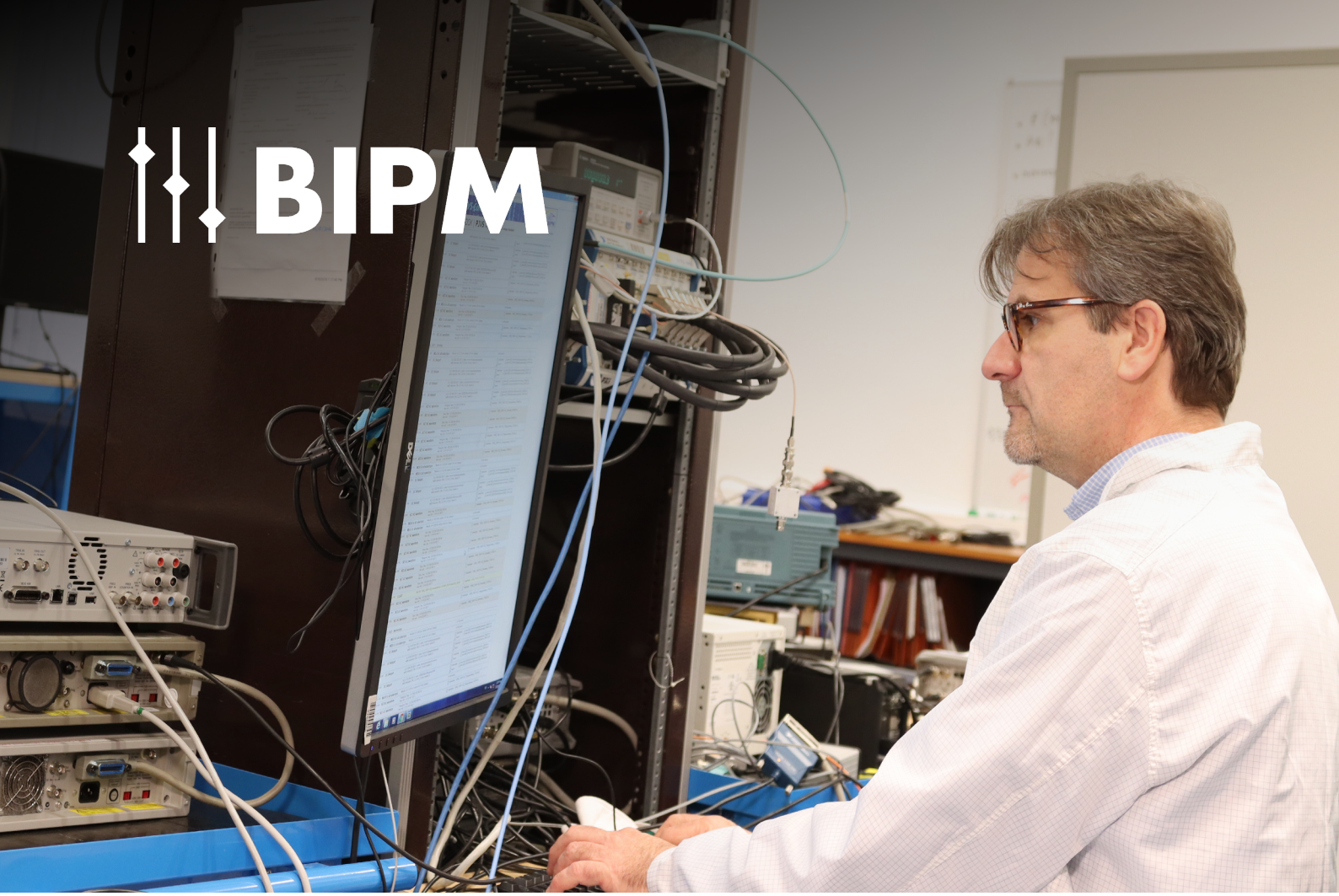

Measurement Comparisons

The technical evidence supporting the CIPM MRA

Signatories of the CIPM MRA participate in scientific measurement comparisons to provide the objective, peer-reviewed technical basis which supports all aspects of the CIPM MRA. Measurement comparisons involve multiple NMIs/DIs[1] measuring the same quantity over the same range (commonly by measuring an attribute of a physical artefact), and then comparing the results using accepted statistical tools.

How do the results of a measurement comparison support the CIPM MRA?

By measuring a common metrological quantity over the same range and set of conditions, NMIs can demonstrate the agreement or *equivalence* of their national standards, verifying the measurement method and its uncertainty. For a selected number of high-level comparisons, the results determine the reference value of the quantity to be used throughout the metrology community. The comparison results can also validate the declared CMCs for an institute. The results and accompanying reports are published in the KCDB, where they form an open, permanent record of the capabilities of the participants and the entire international measurement system.

What types of comparisons are there?

The three types of comparisons are key, supplementary, and pilot studies. All types of comparisons can be organized by the CIPM, the BIPM, and the Regional Metrology Organizations (RMOs). CIPM comparisons are organized by its Consultative Committees. *CIPM key comparisons* test the principal techniques and methods in a particular field, and in most cases are restricted to NMIs who are members of the Consultative Committees. They deliver a key comparison reference value (KCRV) for the quantity chosen. *RMO key comparisons* match the conditions of the CIPM key comparisons and extend the coverage regionally to the RMO members; they are open to all members of the organizing RMO Technical Committee/Working Group. Key comparisons deliver degrees of equivalence between each participant's result and the KCRV, and it is this degree of equivalence which determines whether a participant succeeded or failed when compared to the KCRV. If the difference of the participant's result to the KCRV is smaller than the expanded uncertainty of that difference, equivalence to the KCRV is demonstrated.

Supplementary comparisons are organized by RMOs, and in exceptional cases by the Consultative Committees or the BIPM. Their objective is to meet specific needs not covered by a key comparison. In certain circumstances pilot studies can be organized to establish measurement parameters for a new field or instrument, or as a training exercise; however, they are not registered or published in the KCDB.

How do key comparisons interconnect?

A critical feature of key comparisons is that the results of each RMO key comparisons can be linked to the related CIPM key comparison and therefore all other RMO key comparisons (at the common quantity and range). This establishes the degrees of equivalence of all participants to each other. This is accomplished by using the same technical protocol and conditions for all related comparisons and including at least one participant from each RMO in the linked CIPM key comparison.

How is the quality of the comparison results assured?

Open peer-review is crucial to assuring the quality of the comparison results. One or more participants serve as the pilot institute. Measurement results from each participant are submitted to the pilot institute and must be accompanied by an uncertainty. Once the data analysis has been completed and disclosed to all participants, a participant cannot change or withdraw its results. Rigorously validated statistical methods are used for the data analysis. All participants review the results and draft the report. The final report is approved by the appropriate Consultative Committee working group on key comparisons. All key comparisons (both CIPM and RMO) must be approved by the Consultative Committee of the related measurement field. Supplementary comparisons are approved by the organizing body (CIPM, BIPM, or RMO). The results of both key and supplementary comparisons can be used to support CMCs.

[1] *Throughout this document National Metrology Institutes (NMIs) and Designated Institutes (DIs) are considered to be similar; the acronym NMI is therefore used for both.*

For more information:

BIPM website: https://www.bipm.org/en/

CIPM MRA documents: https://www.bipm.org/en/cipm-mra/cipm-mra-documents

CIPM MRA-G-11 *'Measurement comparisons in the CIPM MRA: Guidelines for organizing, participating and reporting'*

KCDB: https://www.bipm.org/kcdb/