



Metre Convention: Interaction with Member States and Associates

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14 November 2017

Bureau
♦ **I**nternational des
♦ **P**oids et
♦ **M**esures



Outline

01 – The Metre Convention and the BIPM:

- Liaison work
- Laboratory work
- Coordination work

02 – The SI units – recent progress towards revising the SI.

03 – Participating in the activities of the BIPM:

- Status of a Member State
- Status of an Associate State
- Benefits of participation in the activities of the BIPM

Why was the Metric system of so much interest?



The Metric System was first introduced after the French Revolution:
to allow fair trade by weight and length.



The definitions were:

- **The metre** = one ten millionth of the meridian of the earth (through Paris).
- **The kilogram** = the mass of 1dm^3 of water (at its temperature of maximum density).



But, in 1812 – Napoleon abandoned the Metric System !

Why was the Metric system of so much interest?

In the middle of the 19th century

- **The Metric System was introduced again in France.**

But confusion grew about which were the true definitions of the metre and the kilogram?

- ❖ the old revolutionary standards, or
- ❖ the artefact standards held in the National Archives.

Why was the Metric system of so much interest?



USAGE EXCLUSIF DES MESURES DECIMALES – LOI DU 4 JUILLET 1837.

CONVENTION NATIONALE

– DECRET DU 14 THERMIDOR AN 1 DE LA REPUBLIQUE
Fse – LOUIS PHILIPPE 1. ROI DES Français

– 1. JANVIER 1840 –

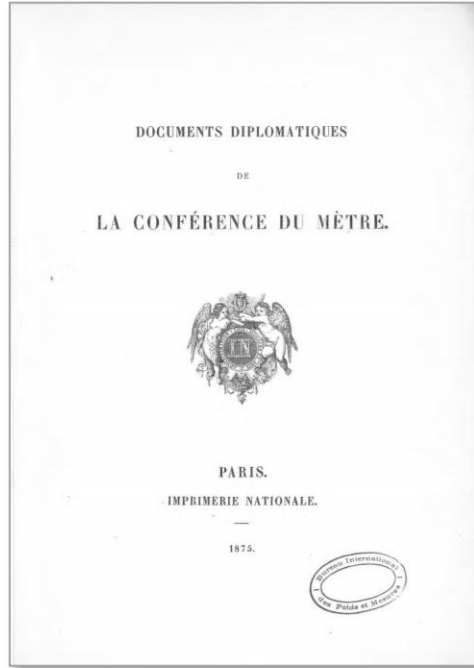


Soon after-
there were new
demands for more
accurate measurements.



Provost, Exposition universelle de 1855, vue de la grande nef du Palais de l'Industrie, 1855.
Lithographie en couleurs, musée d'Orsay

the Metre Convention



20 May 1875 - The Metre Convention was signed in Paris by 17 nations

ARTICLE PREMIER (1875)

Les Hautes Parties contractantes s'engagent à fonder et entretenir, à frais communs, un *Bureau international des poids et mesures*, scientifique et permanent, dont le siège est à Paris⁽¹⁾.

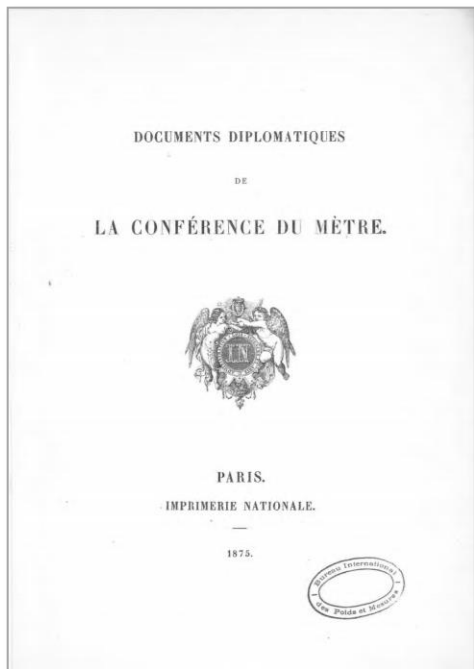
The First Article creates the International Bureau of Weights and Measures (BIPM)

ART. 3 (1875)

Le Bureau international fonctionnera sous la direction et la surveillance exclusives d'un *Comité international des poids et mesures*, placé lui-même sous l'autorité d'une *Conférence générale des poids et mesures*, formée de délégués de tous les Gouvernements contractants.

Article 3 states that the BIPM shall operate under the authority of the General Conference on Weights and Measures (CGPM) and the supervision of the International Committee for Weights and Measures (CIPM)

the Metre Convention



ART. 6 (1.875)

Le Bureau international des poids et mesures est chargé :

- 1° De toutes les comparaisons et vérifications des nouveaux prototypes du mètre et du kilogramme ;
- 2° De la conservation des prototypes internationaux ;
- 3° Des comparaisons périodiques des étalons nationaux avec les prototypes internationaux et avec leurs témoins, ainsi que de celles des thermomètres étalons ;
- 4° De la comparaison des nouveaux prototypes avec les étalons fondamentaux des poids et mesures non métriques employés dans les différents pays et dans les sciences ;
- 5° De l'étalonnage et de la comparaison des règles géodésiques ;
- 6° De la comparaison des étalons et échelles de précision dont la vérification serait demandée, soit par des Gouvernements, soit par des sociétés savantes, soit même par des artistes et des savants.

*Articles 6 (1875)
describes the mission
attributed to the BIPM*

ART. 7 (1921)

Après que le Comité aura procédé au travail de coordination des mesures relatives aux unités électriques, et lorsque la Conférence générale en aura décidé par un vote unanime, le Bureau sera chargé de l'établissement et de la conservation des étalons des unités électriques et de leurs témoins, ainsi que de la comparaison, avec ces étalons, des étalons nationaux ou d'autres étalons de précision.

Le Bureau est chargé, en outre, des déterminations relatives aux constantes physiques dont une connaissance plus exacte peut servir à accroître la précision et à assurer mieux l'uniformité dans les domaines auxquels appartiennent les unités ci-dessus mentionnées (article 6 et 1^{er} alinéa de l'article 7).

Il est chargé, enfin, du travail de coordination des déterminations analogues effectuées dans d'autres instituts.

*Articles 7 (1921)
Expanded the role*

The BIPM – an international organisation

Established in 1875 when 17 States signed the Metre Convention, now with 58 Member States.



CGPM – Conférence Générale des Poids et Mesures

Official representatives of Member States.



CIPM – Comité International des Poids et Mesures

Eighteen individuals of different nationalities elected by the CGPM.



BIPM – Bureau International des Poids and Mesures

- *International coordination and liaison*
- *Technical coordination – laboratories*
- *Capacity building*

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

Member States and Associates

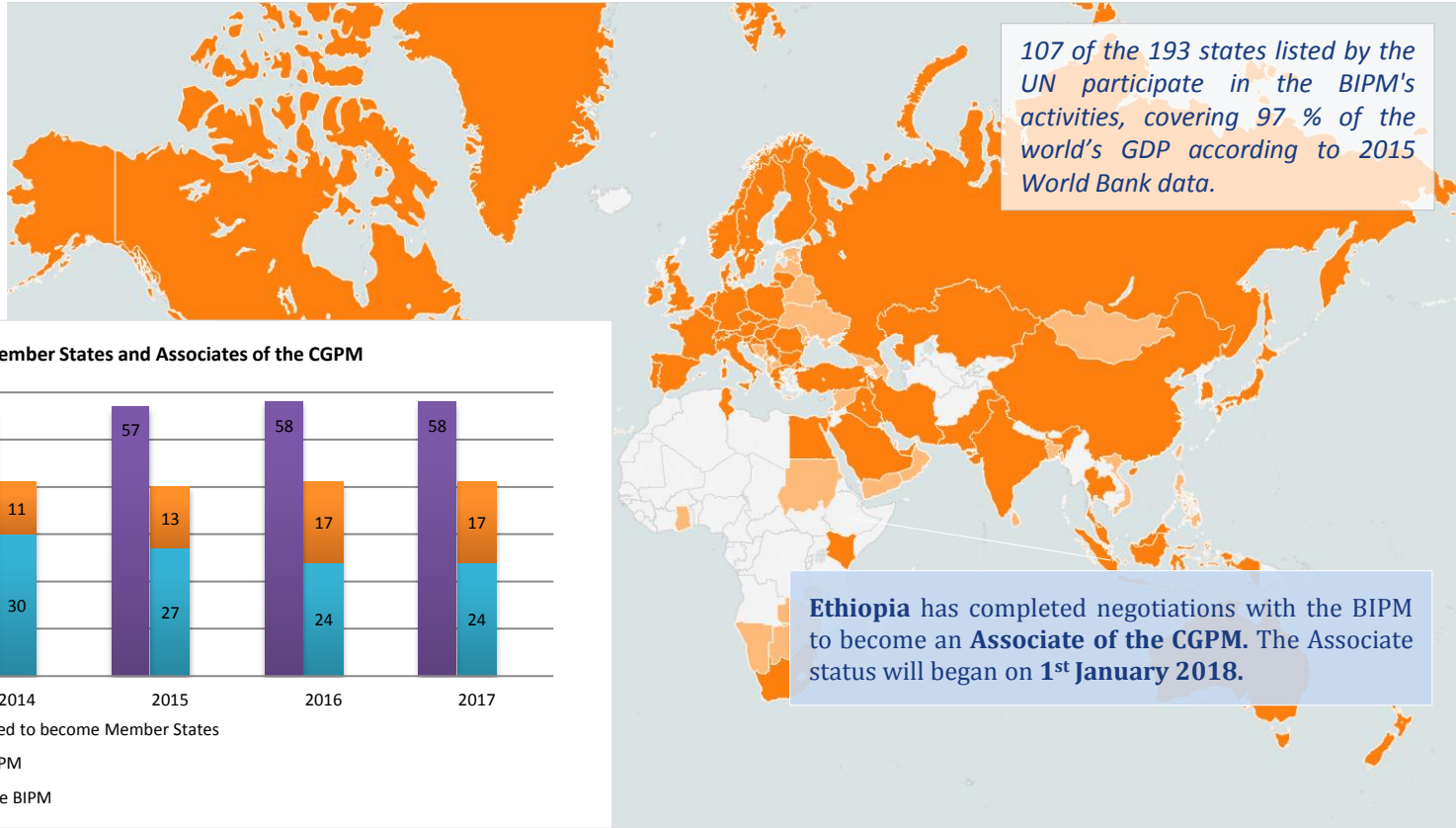
As of today, there are:

- 58 Member States

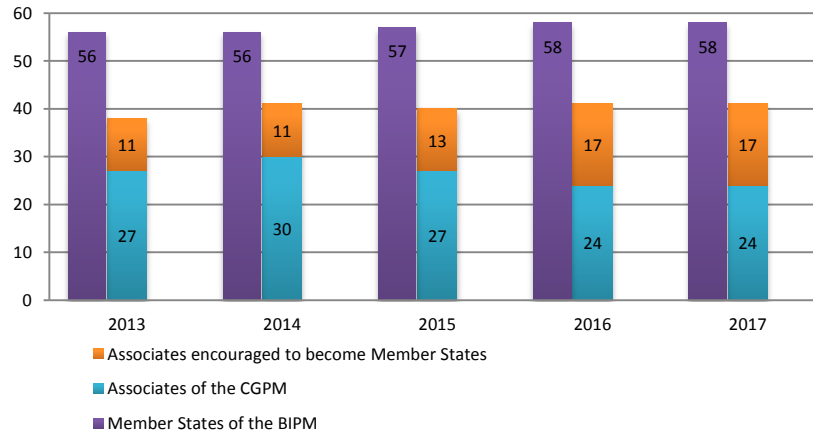
- 41 Associates

(States and Economies) of the
CGPM

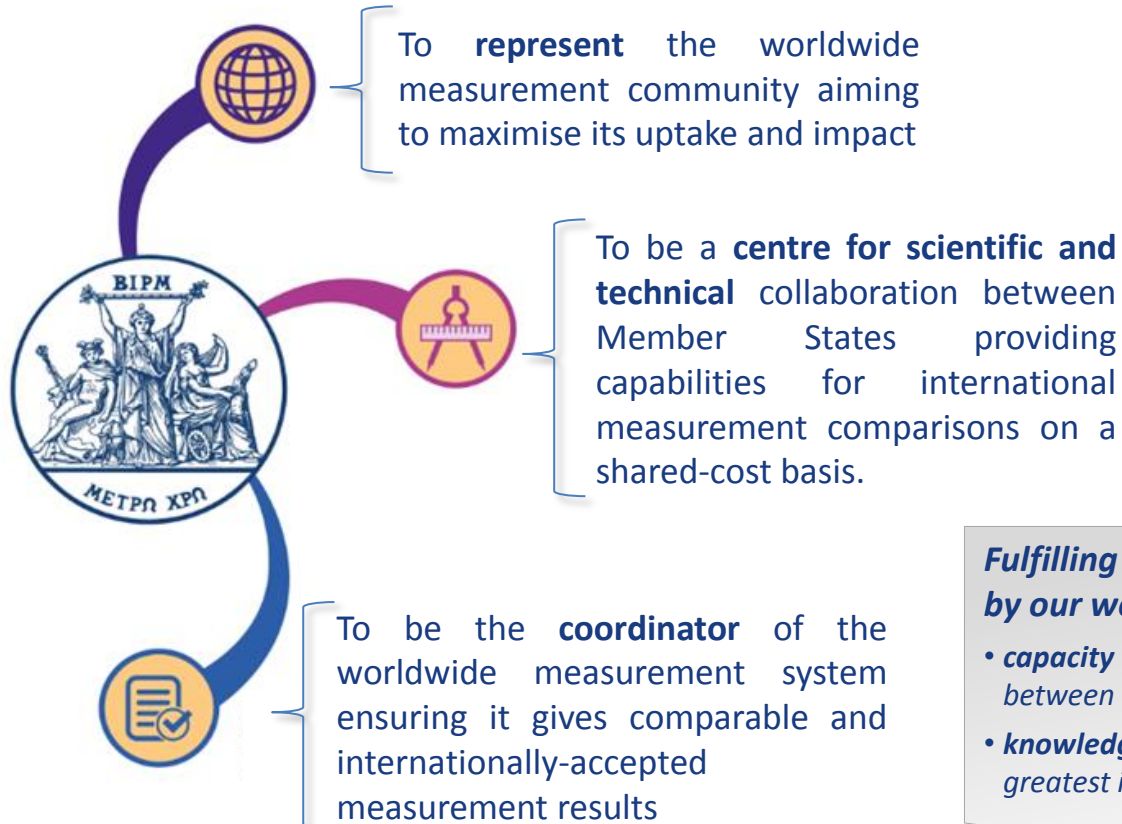
+ Ethiopia on 1st January 2018



Member States and Associates of the CGPM



The objectives of the BIPM

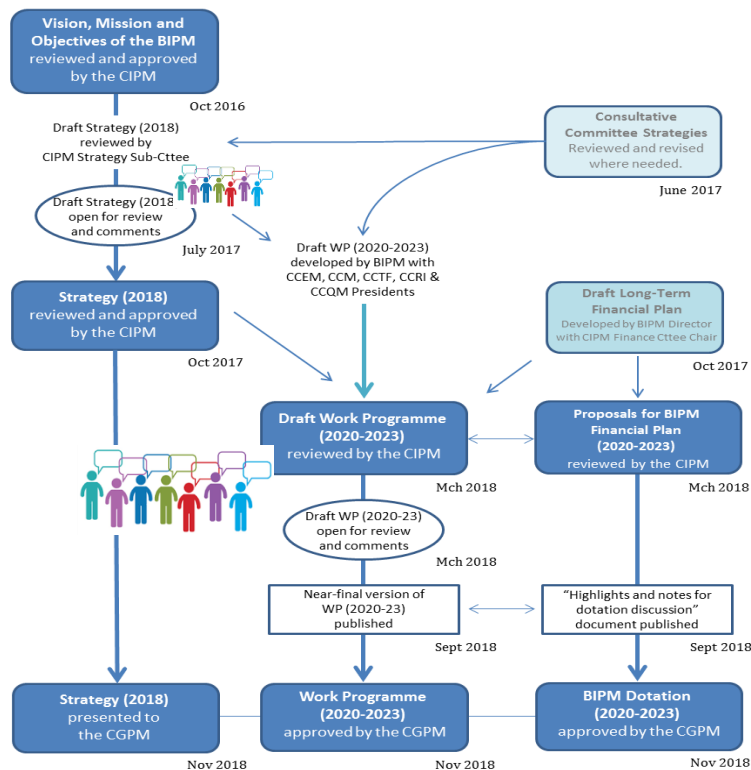


Fulfilling our mission and objectives is underpinned by our work in:

- **capacity building**, which aims to achieve a global balance between the metrology capabilities in Member States.
- **knowledge transfer**, which ensures that our work has the greatest impact.

BIPM Strategy and Work Programme

Timeline for development and agreement of the BIPM Strategy and Work Programme for the 26th CGPM (2018)

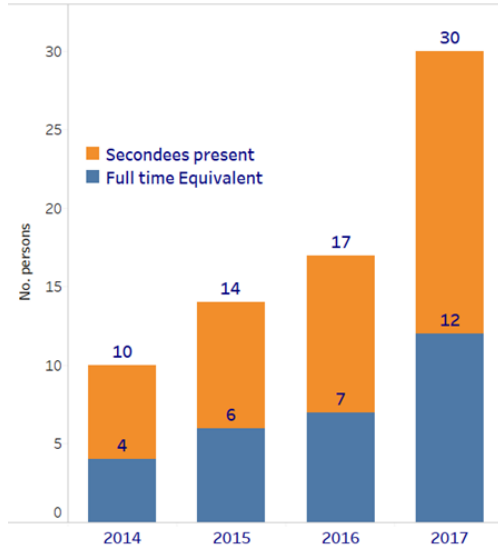


The BIPM work is directed to support its Member States

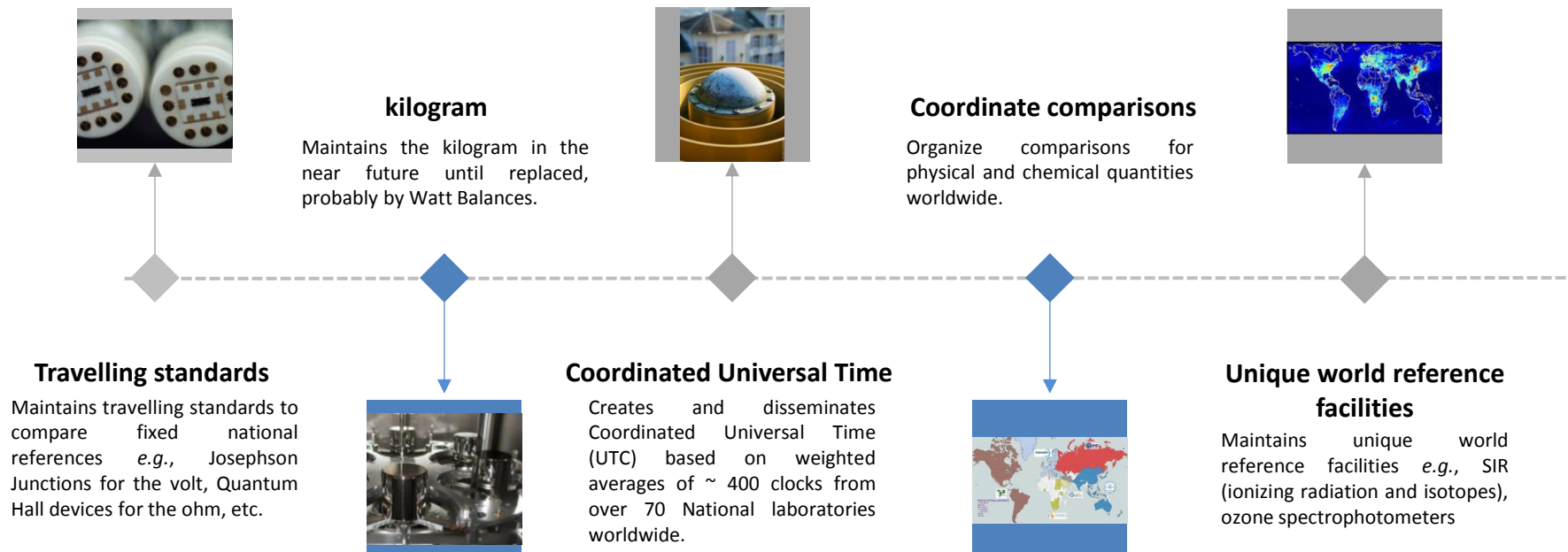
- BIPM Strategic Plan aims to implement the BIPM vision, mission and objectives
- The strategy documents of CCs are subject to review and comment by Member State Representatives and NMI Directors
- BIPM Strategic Plan is complementary to the strategic plans developed the Consultative Committees, and is subject to review and comment by Member State Representatives and NMI Directors
- BIPM Work Programme is built on the interactions with NMI Directors and Member State Representatives, and has been the subject of specific consultation with the Member States
- The BIPM Work Programme is presented to the CGPM alongside the BIPM strategy and requested 'dotation'
- Progress against the Work Programme is reviewed annually by the CIPM

The BIPM Staff

BIPM secondees (2014-2017)



The main technical roles of the BIPM



CCM Pilot Study of future realizations of the kilogram

A pilot comparison of mass calibrations based on methods that will be used to realize the kilogram after its redefinition.

Participants:

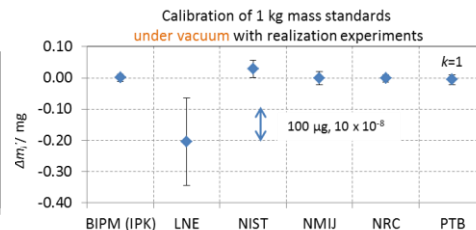
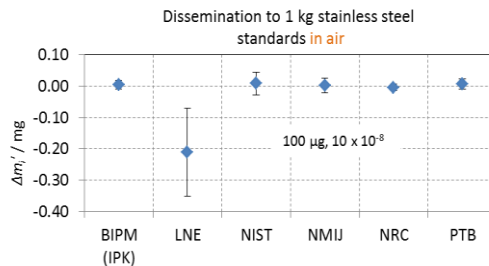
Kibble balances

- LNE, France
- NIST, United States America
- NRC, Canada

^{28}Si spheres from the Avogadro coordination project

- PTB, Germany
- NMIJ AIST, Japan

- The results are in good agreement for both sets of standards.
 - Four of the five participants agree within one standard deviation
 - The fifth agrees at the level of $k = 2$.
- The uncertainty of the weighted mean is $10\text{ }\mu\text{g}$ for both sets.
- The weighted mean agrees with the IPK well within the uncertainty.



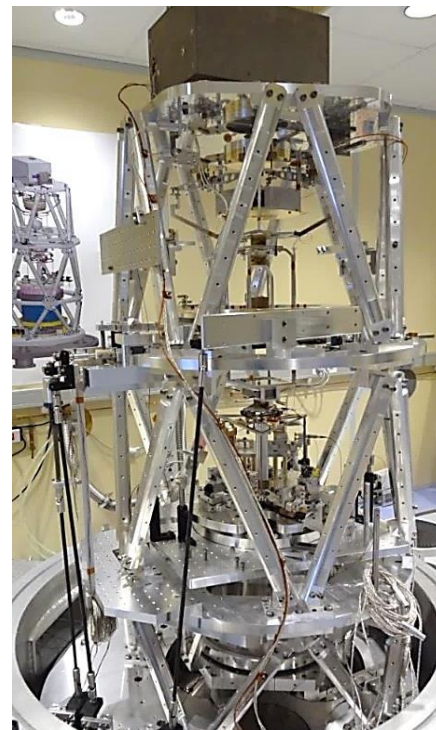
Status of the BIPM Kibble balance (*aka* watt balance)

Progress and achievements

- fully operational in vacuum (and air) with 1 kg mass standard and bifilar coil.
- new suspension & mass loading device
- improved alignment
- noise reduction on force measurement
- completion of 2 PJVS systems
- two papers published, one submitted

Present status and outlook

- day-to-day repeatability of several parts in 10^{-7}
- type B uncertainty of a few parts in 10^{-7}
- expected uncertainty 1×10^{-7} end 2017 and $< 3 \times 10^{-8}$ end 2019



Chemistry: International Liaison



A database of NMI CRMs in support of IVD industry and patient care

Joint Workshop on
“Peptide and Protein
Therapeutics and Diagnostics”



Bureau
International des
Poids et
Mesures

ISO REMCO & ISO TC 212
CRMs and Reference Measurement
Systems for IVDs



Input into the Expert Committee for
Biological Standardisation: Requirements
for Metrological Traceability

BIPM-WADA workshop on
“Metrology and Standards for Anti
Doping Analysis” (2016)



Addressing issues of metrological
traceability and CRMs for stable
isotope ratio measurements



INTERNATIONAL UNION OF
PURE AND APPLIED CHEMISTRY

IUPAC Organic Purity Project
– Project chaired by the BIPM
with participation by 12 NMIs

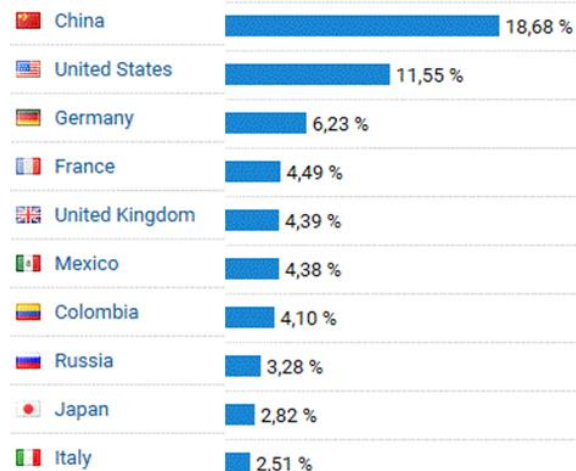
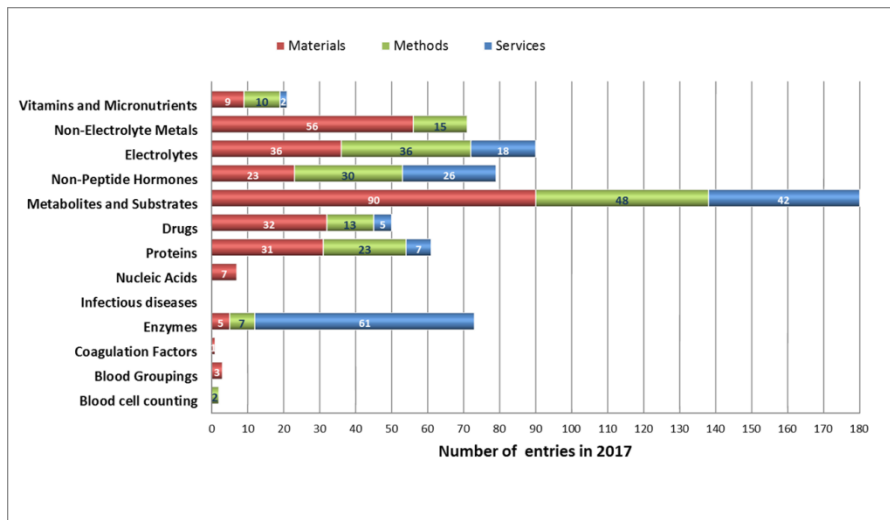
Joint Committee for Traceability in Laboratory Medicine

Database of higher-order reference materials,
measurement methods/procedures and services

- 15 national and regional bodies/NMIs
- 28 stakeholders



Accurate results
for patient care



Time: Improving the uncertainty of [UTC-UTC(k)]

A new algorithm for the calculation of the uncertainties of [UTC-UTC(k)] has been developed.

It correctly takes into account correlations in the uncertainty propagation. Its implementation is planned by November 2017.

UTC

- Strongly depend on the time link uncertainties
- All the time links connect each contributing laboratory to PTB, which plays a central role. The uncertainty of PTB is underestimated

CIRCULAR T 356
2017 SEPTEMBER 11, 13h UTC
BUREAU INTERNATIONAL DES POIDS ET MESURES
ORGANISATION INTERGOUVERNEMENTALE DE LA CONVENTION DU METRE
PAVILLON DE BRETEUIL F-92312 SEVRES CEDEX TEL. +33 1 45 07 70 70 FAX. +33 1 45 34 20 21 tai@bipm.org

ISSN 1143-1393

The contents of the sections of BIPM Circular T are fully described in the document "Explanatory supplement to BIPM Circular T" available at http://ftp2.bipm.org/pub/tai/publication/notes/explanatory_supplement_v0.1.pdf

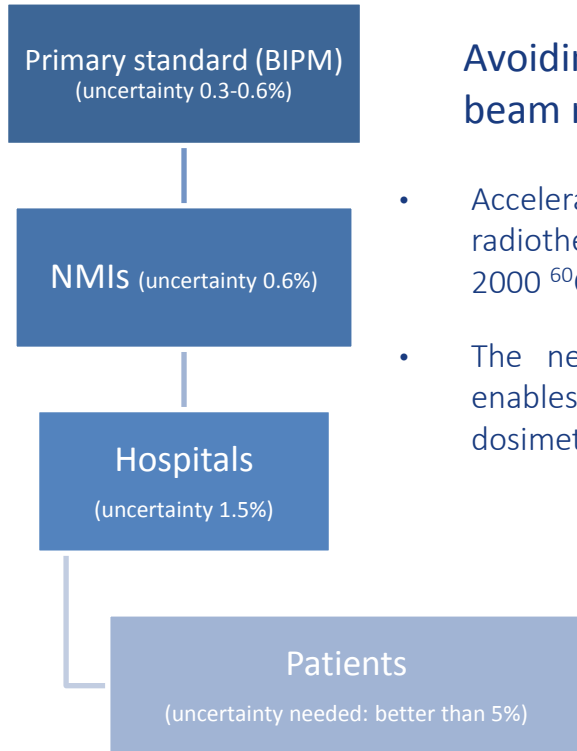
1 - Difference between UTC and its local realizations UTC(k) and corresponding uncertainties.
From 2017 January 1, 0h UTC, TAI-UTC = 37 s.

| Date 2017 | 0h UTC | JUL 30 | AUG 4 | AUG 9 | AUG 14 | AUG 19 | AUG 24 | AUG 29 | Uncertainty/ns | Notes |
|------------------------|---------|---------|---------|---------|-----------------|---------|---------|--------|----------------|-------|
| MD | | 57964 | 57969 | 57974 | 57979 | 57984 | 57989 | 57994 | u _k | u |
| Laboratory k | | | | | [UTC-UTC(k)]/ns | | | | | |
| AOS (Boroddec) | -6.7 | -5.1 | -3.9 | -2.3 | -1.0 | -2.1 | -2.6 | 0.5 | 3.0 | 3.0 |
| APL (Laurel) | 2.0 | 0.8 | 0.7 | 1.4 | -2.0 | 0.5 | 1.6 | 0.4 | 10.9 | 10.9 |
| AUS (Sydney) | 465.1 | 457.8 | 451.5 | 438.6 | 437.9 | 441.3 | 436.8 | 0.4 | 5.9 | 5.9 |
| BEV (Biden) | 55.0 | 51.4 | 50.9 | 44.6 | 45.2 | 39.6 | 36.2 | 0.4 | 2.8 | 2.8 |
| BJR (Sofiya) | 6651.1 | 6698.8 | 6733.2 | 6762.8 | 6802.7 | 6821.6 | 6864.7 | 0.7 | 3.0 | 3.1 |
| BIRN (Beijing) | 10.9 | 24.8 | 36.1 | 37.3 | 36.0 | 42.3 | 37.7 | 0.7 | 2.8 | 2.9 |
| BOM (Skopje) | -840.5 | -832.0 | -827.9 | -829.4 | -831.0 | -829.0 | -839.4 | 0.7 | 7.4 | 7.4 |
| BY (Minsk) | -0.9 | -1.7 | 2.3 | 1.4 | -0.5 | -1.0 | -0.6 | 1.5 | 9.3 | 9.4 |
| CAO (Cagliari) | - | - | - | - | - | - | - | - | - | - |
| CH (Bern-Mabern) | 7.9 | 10.3 | 14.9 | 22.6 | 30.8 | 31.5 | 27.9 | 0.4 | 1.9 | 1.9 |
| CNES (Toulouse) | 9.6 | 16.4 | 19.6 | 23.6 | 25.7 | 27.5 | 27.3 | 0.4 | 4.2 | 4.2 |
| CNH (Quetzaro) | 8.5 | 9.0 | 10.2 | 3.0 | 1.4 | 0.9 | -1.1 | 2.5 | 11.1 | 11.4 |
| CNPP (Panama) | 9.3 | -0.9 | -15.4 | -24.0 | -42.4 | -26.2 | -41.5 | 0.6 | 7.2 | 7.2 |
| DFRT (Tunis) | 18655.6 | 18858.5 | 19069.3 | 19278.8 | 19467.0 | 19674.2 | 19872.3 | 0.7 | 20.0 | 20.1 |
| DLR (Oberpfaffenhofen) | 177.7 | 243.5 | 310.4 | -7.7 | 50.5 | 41.1 | 44.4 | 0.7 | 3.0 | 3.1 |
| DMHM (Belgrade) | 8.2 | 4.5 | 14.5 | 8.3 | 10.1 | -3.6 | -0.8 | 0.4 | 2.8 | 2.8 |
| DTAG (Frankfurt/M) | 49.2 | 46.6 | 45.6 | 45.2 | 42.4 | 38.1 | 29.7 | 0.4 | 7.7 | 7.7 |
| EDH (Thessaloniki) | -7.1 | 22.1 | -1.9 | 16.0 | 27.4 | 9.8 | -77.7 | 4.0 | 11.3 | 12.0 |
| ESTC (Hoordwijk) | -0.4 | 0.5 | 0.4 | -0.4 | -0.4 | 0.5 | -0.8 | 0.4 | 2.8 | 2.8 |
| HKO (Hong Kong) | 999.4 | 1004.5 | 1014.5 | 1018.1 | 1037.8 | 1040.3 | 1054.0 | 0.4 | 7.4 | 7.4 |

Two major changes will be introduced in November 2017

- the pivot for GNSS time links is an “auxiliary time scale” instead of a single NMI (PTB),
- correlations are introduced.

Ionizing Radiation: Effective cancer therapy



Avoiding under- or over-treatment in external beam radiotherapy

- Accelerators are replacing radioactive sources for radiotherapy (there are 11000 accelerators compared to 2000 ^{60}Co facilities).
- The new partnership with the CEA's DOSEO facility enables BIPM to provide comparisons to underpin dosimetry primary standards at NMIs.
- BIPM staff have characterized the beam (intensity profile, energy, stability) & developed a protocol for comparisons – a comparison with KRISS is starting and a comparison with METAS is next.



DOSEO



02 – The SI units: recent progress towards revising the SI

The International System of Units (SI)

Prefixes

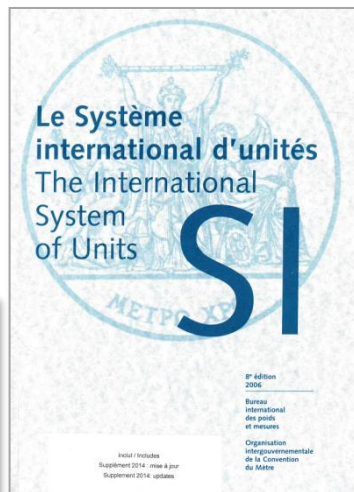
Table 5. SI prefixes

| Factor | Name | Symbol | Factor | Name | Symbol |
|-----------|-------|--------|------------|-------|--------|
| 10^1 | deca | da | 10^{-1} | deci | d |
| 10^2 | hecto | h | 10^{-2} | centi | c |
| 10^3 | kilo | k | 10^{-3} | milli | m |
| 10^6 | mega | M | 10^{-6} | micro | μ |
| 10^9 | giga | G | 10^{-9} | nano | n |
| 10^{12} | tera | T | 10^{-12} | pico | p |
| 10^{15} | peta | P | 10^{-15} | femto | f |
| 10^{18} | exa | E | 10^{-18} | atto | a |
| 10^{21} | zetta | Z | 10^{-21} | zepto | z |
| 10^{24} | yotta | Y | 10^{-24} | yocto | y |

Base units

Table 1. SI base units

| Base quantity | | SI base unit | |
|---------------------------|------------------|--------------|--------|
| Name | Symbol | Name | Symbol |
| length | l, x, r , etc. | metre | m |
| mass | m | kilogram | kg |
| time, duration | t | second | s |
| electric current | I, i | ampere | A |
| thermodynamic temperature | T | kelvin | K |
| amount of substance | n | mole | mol |
| luminous intensity | I_v | candela | cd |



Derived units

Table 3. Coherent derived units in the SI with special names and symbols

| Derived quantity | Name | Symbol | SI coherent derived unit ^(a) | |
|---|-------------------------------|-------------------|---|--|
| | | | Expressed in terms of other SI units | Expressed in terms of SI base units |
| plane angle | radian ^(b) | rad | 1 ^(b) | m/m |
| solid angle | steradian ^(b) | sr ^(c) | 1 ^(b) | m ² /m ² |
| frequency | hertz ^(d) | Hz | | s ⁻¹ |
| force | newton | N | | m kg s ⁻² |
| pressure, stress | pascal | Pa | N/m ² | m ⁻¹ kg s ⁻² |
| energy, work, amount of heat | joule | J | N m | m ² kg s ⁻² |
| power, radiant flux | watt | W | J/s | m ² kg s ⁻³ |
| electric charge, amount of electricity | coulomb | C | | s A |
| electric potential difference, electromotive force | volt | V | W/A | m ² kg s ⁻³ A ⁻¹ |
| capacitance | farad | F | C/V | m ⁻² kg ⁻¹ s ⁴ A ² |
| electric resistance | ohm | Ω | V/A | m ² kg s ⁻³ A ⁻² |
| electric conductance | siemens | S | A/V | m ⁻² kg ⁻¹ s ³ A ² |
| magnetic flux | weber | Wb | V s | m ² kg s ⁻² A ⁻¹ |
| magnetic flux density | tesla | T | Wb/m ² | kg s ⁻² A ⁻¹ |
| inductance | henry | H | Wb/A | m ² kg s ⁻² A ⁻² |
| Celsius temperature | degree Celsius ^(e) | °C | | K |
| luminous flux | lumen | lm | cd sr ^(c) | cd |
| illuminance | lux | lx | lm/m ² | m ⁻² cd |
| activity referred to a radionuclide ^(f) | becquerel ^(d) | Bq | | s ⁻¹ |
| absorbed dose, specific energy (imparted), kerma | gray | Gy | J/kg | m ² s ⁻² |
| dose equivalent, ambient dose equivalent, directional dose equivalent, personal dose equivalent | sievert ^(g) | Sv | J/kg | m ² s ⁻² |
| catalytic activity | katal | kat | | s ⁻¹ mol |

The 8th edition of the SI Brochure is available from the BIPM website.

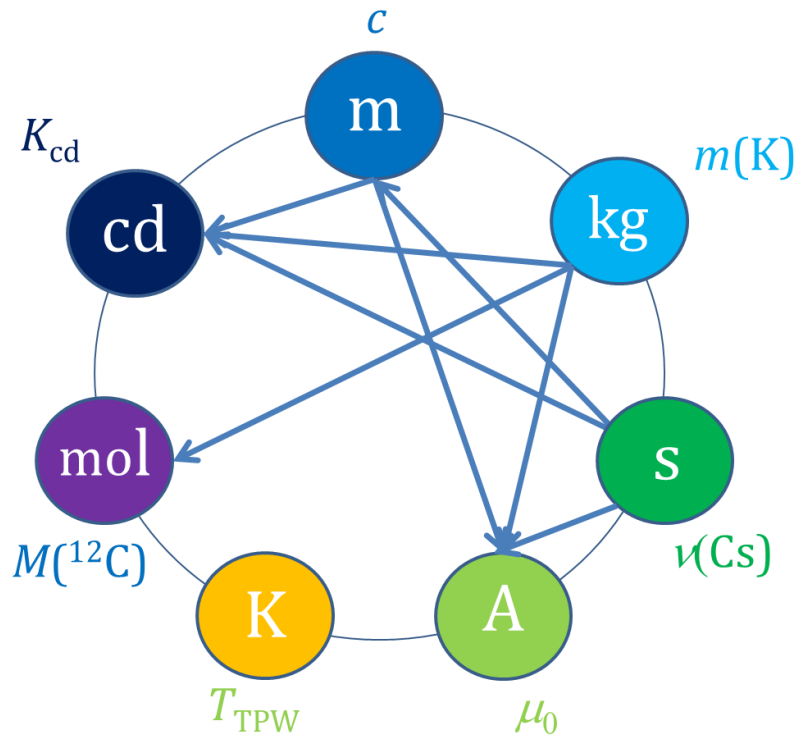
Proposal for 4 new definitions

Definitions based on **fundamental (or conventional) constants**:

- metre (c)
- kilogram (h)
- ampere (e)
- candela (K_{cd})
- mole (N_{A})
- kelvin (k)

Definition based on **material property**:

- second (^{133}Cs)



(I. Mills et al., *Metrologia*, 2006, 43, 227-246)

The definition of the kilogram in the SI

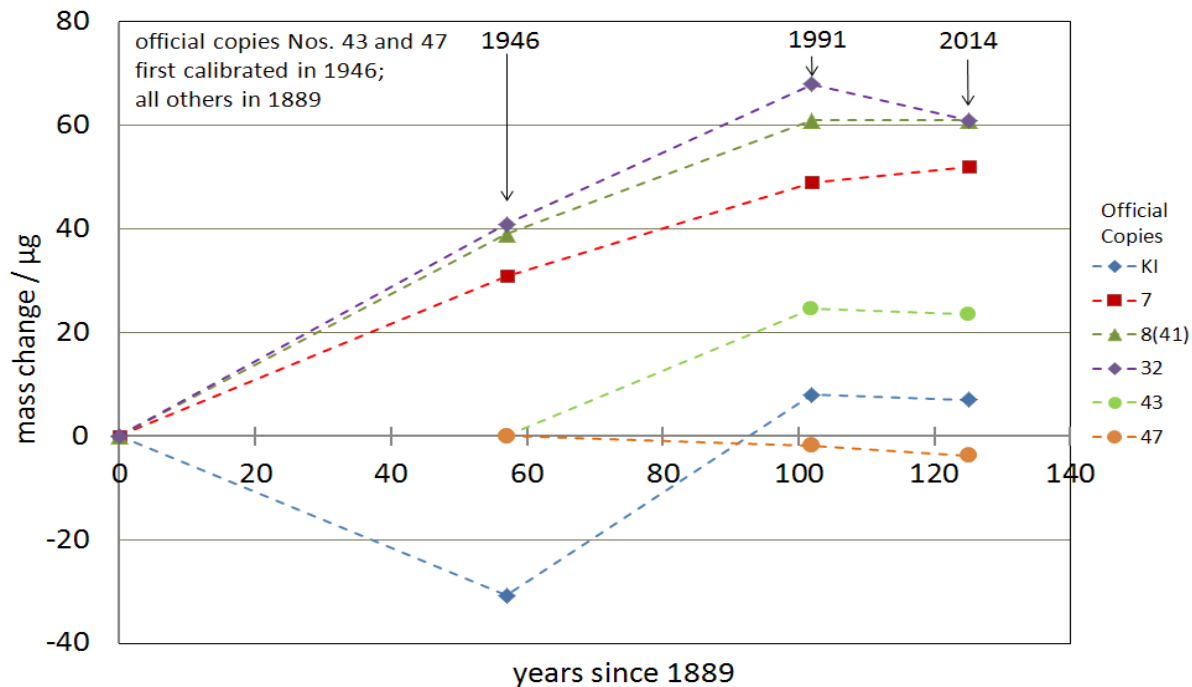
**The kilogram is the unit of mass -
it is equal to the mass of the
international prototype of the kilogram.**

- ❖ manufactured around 1880 and ratified in 1889
- ❖ represents the mass of 1 dm³ of H₂O at its maximum density (4 °C)
- ❖ alloy of 90% Pt and 10% Ir
- ❖ cylindrical shape, $\varnothing = h \sim 39$ mm
- ❖ kept at the BIPM in ambient air

**The kilogram is the last SI base
unit defined by a material artefact.**

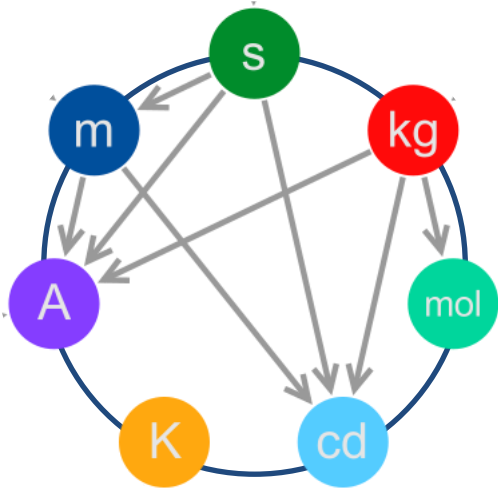


Why make the change ? – the IPK



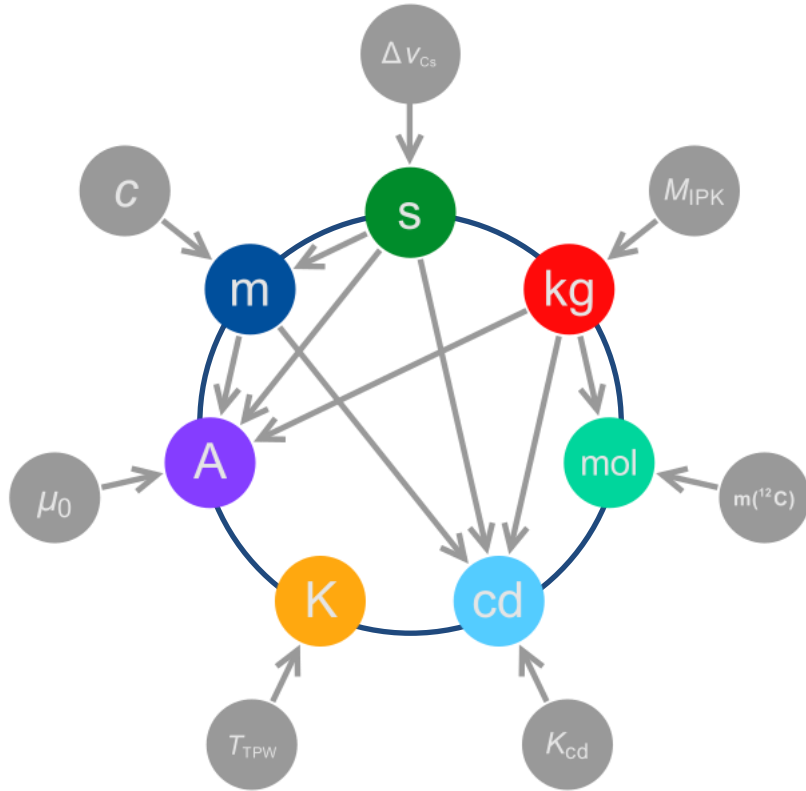
The IPK and the six official copies form a very consistent set of mass standards

The re-definition in diagrams



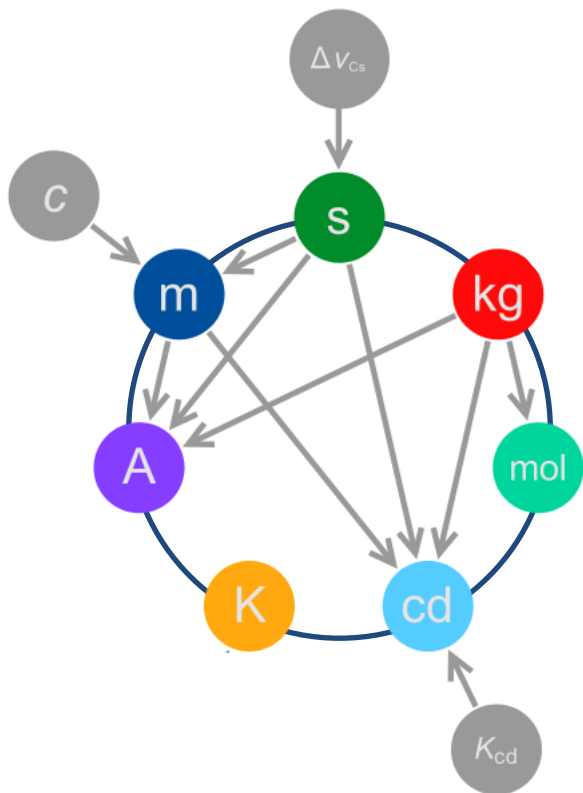
Seven base units –that are linked together.

The re-definition in diagrams

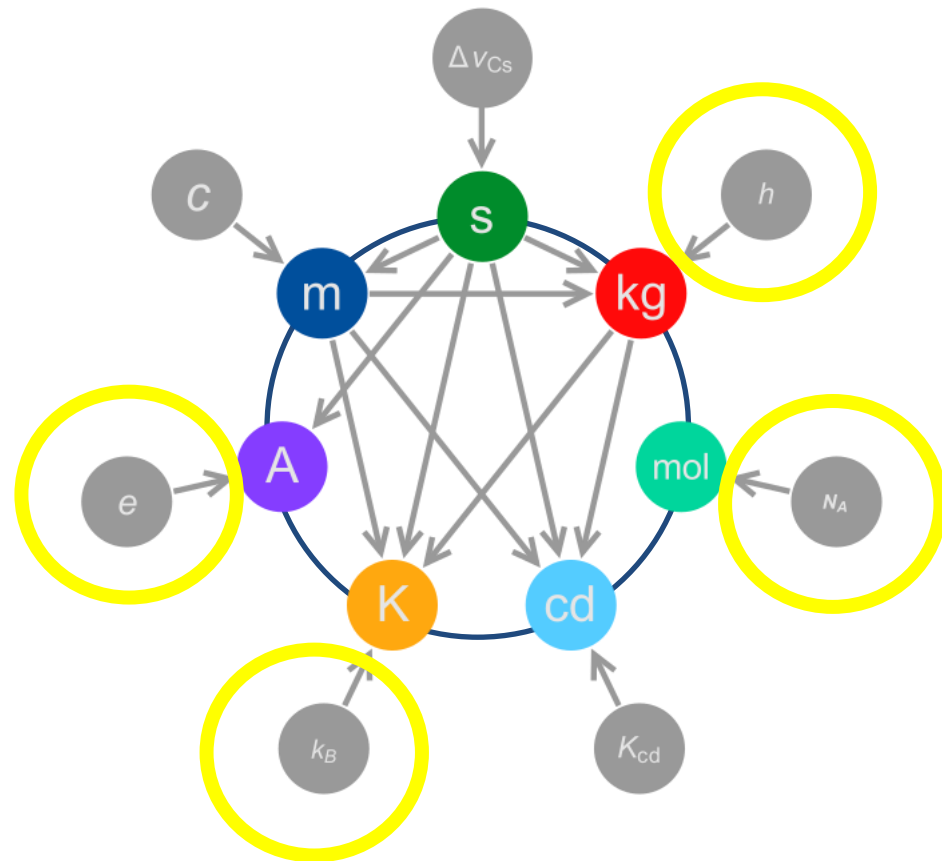
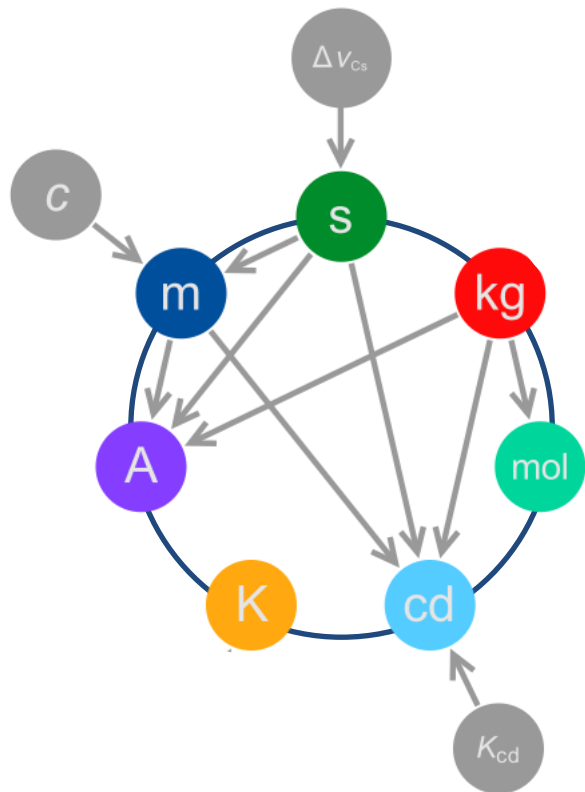


We propose to change the definitions of four of them.

The re-definition in diagrams



The re-definition in diagrams



Final values for the constants have been calculated by the CODATA Task Group on Fundamental Constants

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Metrologia



ACCEPTED MANUSCRIPT • OPEN ACCESS

The CODATA 2017 Values of h , e , k , and N_A for the Revision of the SI

David B Newell¹, Franco Cabiati², Joachim Fischer³, Kenichi Fujii⁴, Saveley G Karshenboim⁵, Helen S Margolis⁶ , Estefania de Mirandes⁷, Peter J Mohr⁸, Francois Nez⁹, Krzysztof Pachucki¹⁰

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RECOMMENDATION U1 (2017)

...recommends

- *that the CIPM undertakes the necessary steps to proceed with the planned redefinition of the kilogram, ampere, kelvin and mole at the 26th CGPM in 2018*

<http://www.bipm.org/en/news/new-si.html>

RECOMMENDATION OF THE CONSULTATIVE COMMITTEE FOR UNITS TO BE SUBMITTED TO THE INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES

RECOMMENDATION U1 (2017)

On the possible redefinition of the kilogram, ampere, kelvin and mole in 2018

The Consultative Committee for Units (CCU), at its 23rd meeting in 2017,

recalling

- Resolution 1 of the 24th General Conference on Weights and Measures (CGPM) in 2011 “*On the possible future revision of the International System of Units, the SI*”, which took note of the intention of the International Committee for Weights and Measures (CIPM) to propose a revision of the SI that would link the definitions of the kilogram, ampere, kelvin and mole to exact numerical values of the Planck constant h , elementary charge e , Boltzmann constant k and Avogadro constant N_A ,
- Resolution 1 of the 25th CGPM in 2014 “*On the future revision of the International System of Units, the SI*”, which noted that despite significant progress the data did not appear to be sufficiently robust for the CGPM to adopt the revised SI at its 25th meeting and therefore encouraged National Metrology Institutes (NMIs) and the International Bureau of Weights and Measures (BIPM) to pursue efforts to obtain data relevant to the determination of h , e , k , and N_A with the requisite uncertainties,

The SI – Redefinition and progress



<http://www.bipm.org/en/si-download-area/graphics-files.html>

- *Redefinition is expected at the CGPM in November 2018*
- *Implementation date 20 May 2019*
- *The Task Group on raising of the public awareness has been created*
- *It has developed a 'brand book' supporting redefinition: is available on the BIPM website.*
- *The awareness campaign will be launched on May 20 (WMD) 2018 and run through to 20 May 2019.*

How can we explain the new definitions?

- ♦ **The new definitions will “facilitate universality of access to the agreed basis for worldwide measurements”.**
 - This has been an ambition for the “metric system” that goes back more than 200 years. The 2018 definitions will make it possible for the first time.
- ♦ **The changes will underpin future requirements for increases in accuracy**
 - As science and technology advances, the demands for the accuracy of measurements will continue to increase accuracy. The 2018 definitions will provide for these needs for many years to come.
- ♦ **The new definitions use “the rules of nature to create the rules of measurement”.**
 - The use of constants in nature enable you to link from the smallest to the largest measurements quantities. It will tie measurements at the atomic (and quantum) scales to those at the macroscopic level. This introduces the appeal of a fundamental (“quantum”) basis for the changes.



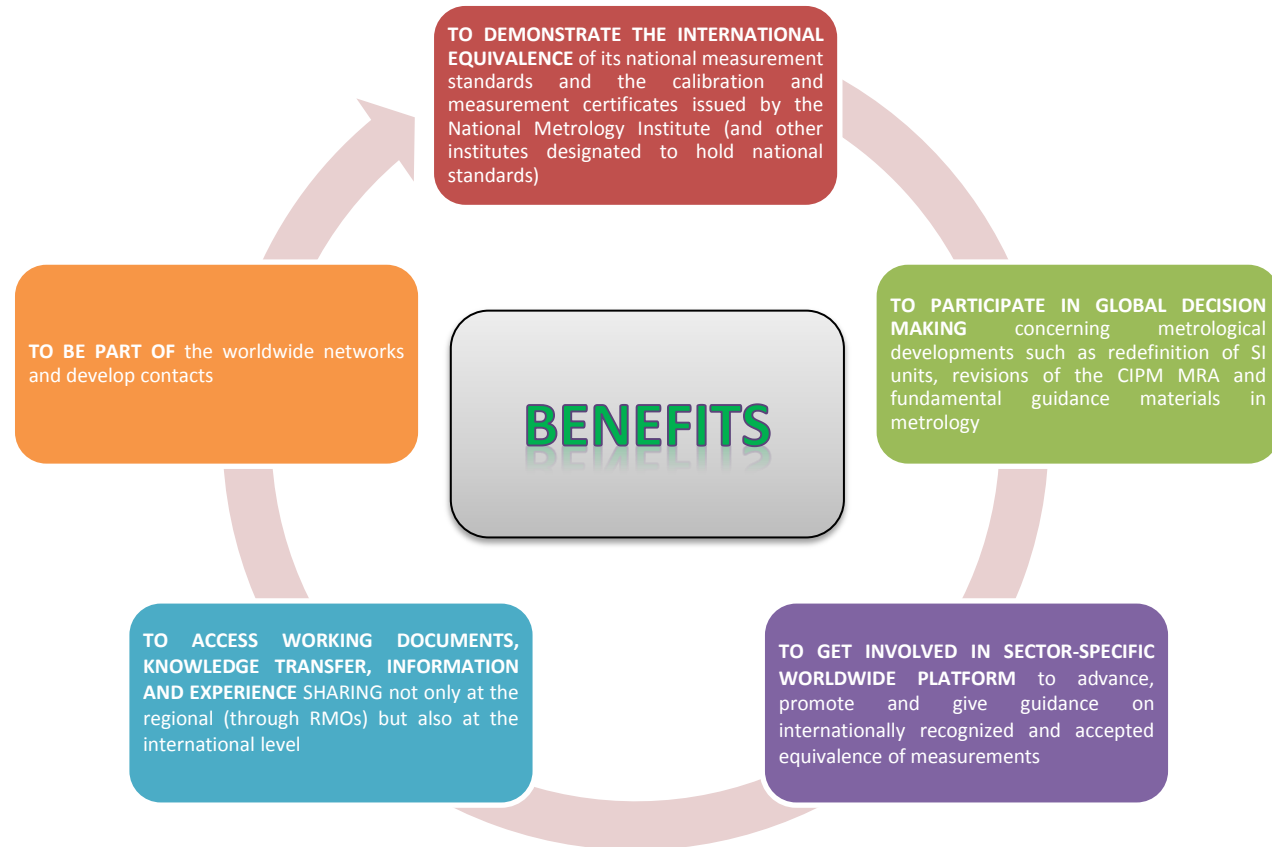
03 – Participating in the activities of the BIPM

Member State of the BIPM or Associate State of the CGPM?

- ◆ **Choice of state to become either:**

- ***Member State of the BIPM*** and have a significant engagement in, and influence on, the world metrology system
- ***Associate State of the CGPM*** and participate in the CIPM MRA, be part of the world metrology system at lower costs
 - Generally speaking, «Associate State» status is seen as the first step to becoming a Member State

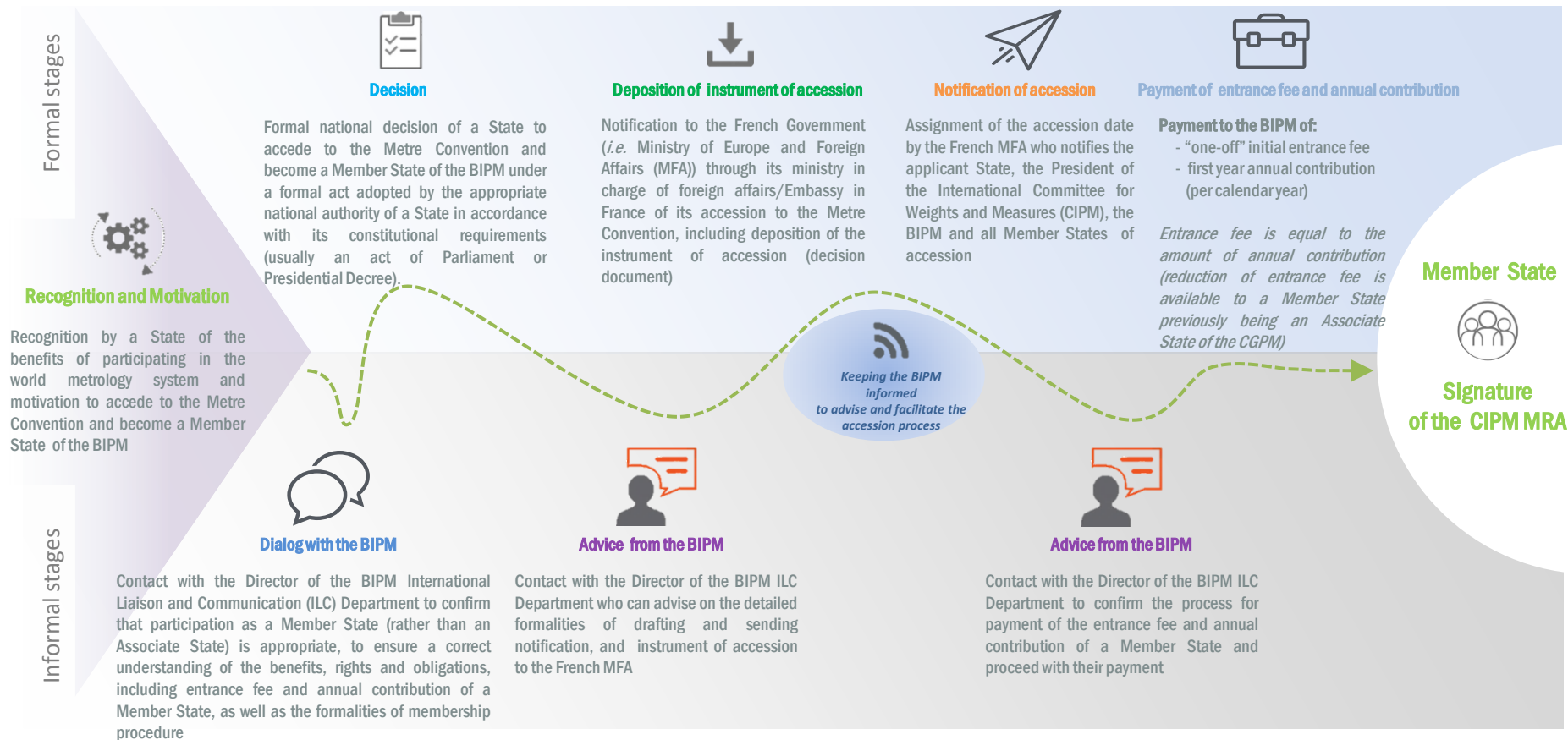
Benefits of participation in the activities of the BIPM



Obligations of a Member State

- ◆ To execute the Metre Convention in a good faith
- ◆ To execute the Resolutions of the CGPM in a good faith
- ◆ To fulfil financial obligations by timely and consistently payment its annual contribution (at the beginning of each year)
 - and in addition on accession - payment of “one-off” initial entrance fee
- ◆ To pay any supplementary sums (advances) to make up the BIPM dotation due to the default of Member States which advantages and prerogatives are suspended
 - *These are reimbursed in the event that defaulting Member State repays its arrears of contributions*

Becoming a Member State (Accession to the Metre Convention)



Exclusive rights of a Member State

- ♦ to attend and vote at the meetings of the CGPM
- ♦ to propose candidates for election to the CIPM
- ♦ If applicable, to have its scientists to participate in various research programmes run by the BIPM
- ♦ If applicable, to second staff to the BIPM
- ♦ to obtain internationally recognized measurement traceability through the BIPM calibration services, at no additional cost (for a complete list of the BIPM calibration services, please see <http://www.bipm.org/en/bipm/calibrations/>)
- ♦ to purchase, at cost, a calibrated platinum-iridium kilogram, known as a national prototype, which is only available from the BIPM
- ♦ If applicable, to participate in the CIPM Consultative Committee meetings (as Member for those NMIs with appropriate expertise, or as Observer for those NMIs who are active in the field, but not at the highest level), and their Working Groups

Other rights of a Member State

- ◆ to participate in the CIPM MRA, specially:
 - to participate in international scientific comparisons of national measurement standards
 - to have the comparison results published in Appendix B of the CIPM MRA, *i.e.* which is also part of publically available KCDB, see http://kcdb.bipm.org/AppendixB/KCDB_ApB_search.asp
 - to submit its national Calibration and Measurement Capabilities (CMCs) into the CIPM MRA review process
 - to have its national CMCs internationally recognized following successful peer review
 - to have its internationally recognized CMCs listed in Appendix C of the CIPM MRA, which is also part of publicly available KCDB, see <http://kcdb.bipm.org/AppendixC/default.asp>
 - to designate additional metrology laboratories such that there are able to participate in the CIPM MRA (when national measurement standards are held by more than one institute)

Member States also:

- ◆ attend the meetings of Member State Representatives and of NMI Directors, organized by the BIPM
- ◆ participate in the BIPM Capacity Building and Knowledge Transfer (CBKT) Program

- Status of an Associate State

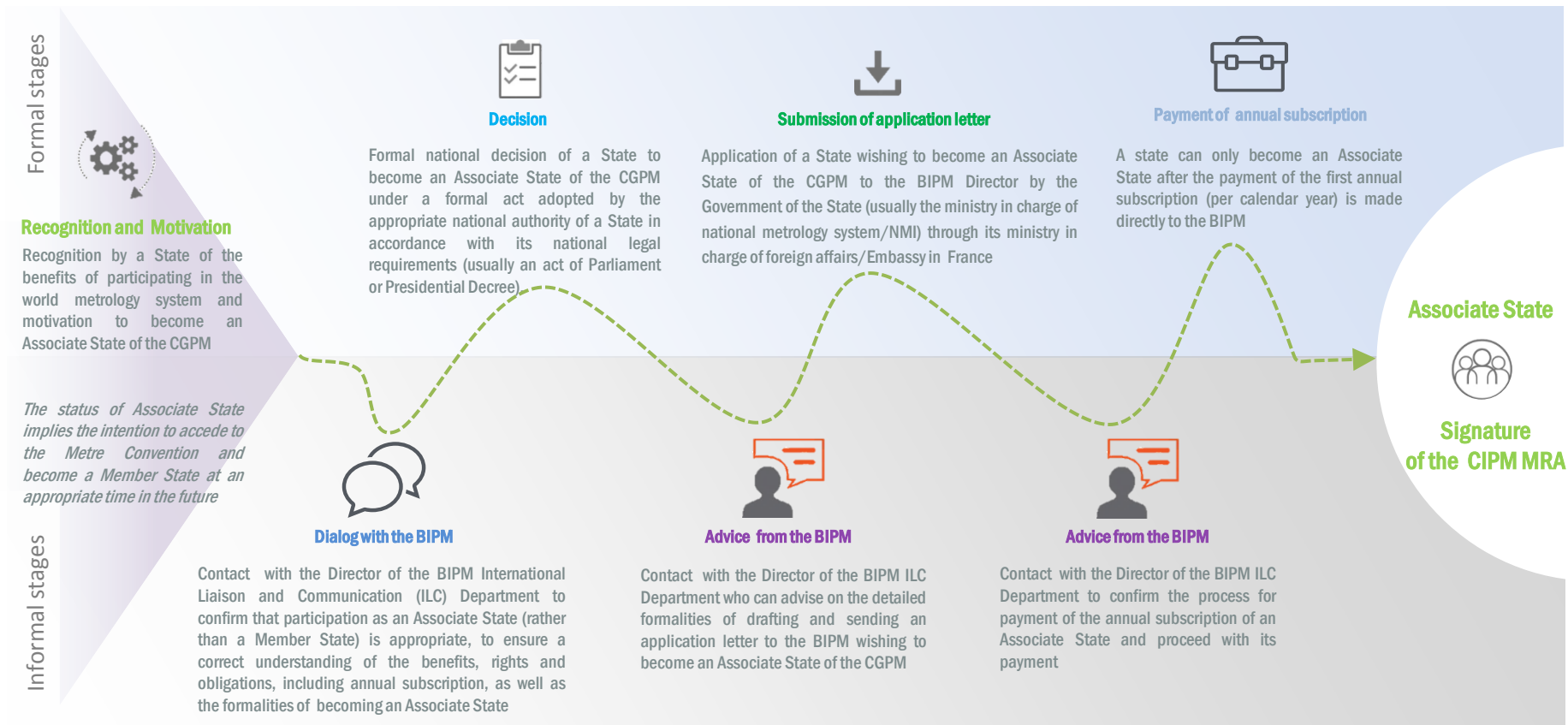
Resolution 3 of the 21st CGPM (1999) created «Associate» status in parallel to the introduction of the CIPM MRA and in consultation with the World Trade Organization (WTO).

Establishment of «Associate» status by the CGPM in 1999

- ◆ This status recognized that *‘many smaller States would have difficulty in allocating funds sufficient to meet the cost of membership of the Metre Convention’.*
- ◆ The Conference decided *‘to assume a responsibility for providing those States **not** yet members of the Metre Convention with the means to establish links to the world's measurement system so as to provide recognition of the traceability of their measurements to the SI’.*
- ◆ The subscription for Associate States was calculated on the same basis as the Member States (*i.e.* based on an adjusted UN coefficient) except that the minimum subscription for an Associate was set at 0.05 % of the BIPM dotation,* one tenth of the minimum contribution for a Member State.

**Resolution 4 of the 24th meeting of the CGPM (2011) doubled the minimum subscription for Associate State was from 0.05 % to 0.1 % of the BIPM annual dotation.*

Becoming an Associate State of the CGPM*



Rights and obligations of an Associate State

- ♦ to participate in the activities associated with the CIPM MRA, especially:
 - to participate, if applicable, in international scientific comparisons of national measurement standards
 - to have comparison results published in Appendix B of CIPM MRA, *i.e.* which is also part of publicly available KCDB, see http://kcdb.bipm.org/AppendixB/KCDB_ApB_search.asp
 - to submit its CMCs into the CIPM MRA review process
 - to have its CMCs internationally recognized following successful peer review
 - to have its internationally recognized CMCs listed in Appendix C of the CIPM MRA, which is also part of publicly available KCDB, see <http://kcdb.bipm.org/AppendixC/default.asp>
 - to designate additional metrology laboratories such that they are able to participate in the CIPM MRA (when national measurement standards are held by more than one institute)
- ♦ Associate States may also:
 - accede to the Metre Convention and thus become a Member State of the BIPM
 - attend the meetings of the CGPM as observers through the appointment of non-voting delegates
 - attend the meetings of Member State Representatives and of NMI Directors, organized by the BIPM
 - under certain circumstances participate in the BIPM Capacity Building and Knowledge Transfer (CBKT) Programme
- ♦ The **obligation** of Associate States is:
 - To fulfil financial obligations by timely and consistently payment of their annual subscription

Status of Associate State of the CGPM – ‘*encouragement*’ criteria and ‘*escalator*’ mechanism

RESOLUTION 3 of the 23rd CGPM (2007)

- *Criteria requested*

CIPM Decision of the 98th meeting (2009) and 99th meeting (2010)

- ✓ *Criteria adopted*

The review by the CIPM of the situation of States which have been Associates for at least 5 years would be based on the fulfilment of the following three criteria:

- Signature of the CIPM MRA by the Associate State’s National Metrology Institute,
- Publication of comparison results in the key comparison database (KCDB),
- Having one or more Calibration and Measurement Capability (CMC) listed in the KCDB.

RESOLUTION 4 of the 24th CGPM (2011)

- ✓ *Criteria implemented*

The 'encouragement' criteria in practice

RESOLUTION 4 of the 24th CGPM (2011):
Associates who have been encouraged to become a Member States

| Associate | Date meeting criteria | Period of increasing subscription | |
|-------------------------|-----------------------|-----------------------------------|--------|
| | | Start | 90% MS |
| Belarus | in 2011 | 2013 | 2017 |
| Costa Rica | in 2011 | 2013 | 2017 |
| Cuba | in 2011 | 2013 | 2017 |
| Ecuador | in 2011 | 2013 | 2017 |
| Jamaica | in 2011 | 2013 | 2017 |
| Latvia | in 2011 | 2013 | 2017 |
| Panama | in 2011 | 2013 | 2017 |
| Ukraine | in 2011 | 2013 | 2017 |
| Viet Nam | in 2011 | 2013 | 2017 |
| Albania | April 2013 | 2015 | 2019 |
| Macedonia, the FYR of | July 2013 | 2015 | 2019 |
| Moldova, Republic of | September 2013 | 2015 | 2019 |
| Estonia | May 2014 | 2016 | 2020 |
| Georgia | May 2014 | 2016 | 2020 |
| Paraguay | May 2014 | 2016 | 2020 |
| Peru | May 2014 | 2016 | 2020 |
| Republic of Philippines | December 2013 | 2016 | 2020 |
| Bolivia | July 2016 | 2018 | 2022 |
| Bosnia Herzegovina | May 2016 | 2018 | 2022 |
| Montenegro | August 2016 | 2018 | 2022 |

Step on ladder:




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CIPM Decisions on Micro-CEEMS *(Countries with Emerging Metrology Systems)*

| Decision CIPM/106-20 | October 2017 |
|---|--------------|
| <p>The CIPM decided that when considering whether it is appropriate for an Associate State of the General Conference on Weights and Measures (CGPM) to be encouraged to accede to the Metre Convention and hence become a Member State, it will take into account whether it has:</p> <ul style="list-style-type: none"> • been an Associate State of the CGPM for at least 5 years, • a National Metrology Institute (NMI) that has signed the CIPM MRA, • published comparison results in the key comparison database (KCDB), • one or more Calibration and Measurement Capability (CMC) listed in the KCDB, • a percentage higher than 0.02 on the "Scale of assessments for the apportionment of the expenses of the United Nations". <p>The above criteria will be applied in the implementation of Resolution 4 of the CGPM (2011) "On the status of Associate State of the General Conference".</p> <p>This decision revises the criteria adopted by the CIPM at its 98th (2009) and 99th (2010) meetings.</p> <p>The above notwithstanding, the CIPM reaffirmed that an Associate State of the CGPM may choose to accede to the Metre Convention and become a Member State at any time should it so wish.</p> <p> [Decisions]</p> | |
| Decision CIPM/106-21 | October 2017 |
| <p>The CIPM decided that an Associate State of the CGPM that does not meet the criteria set in Decision CIPM/106-20 and that has already been encouraged to accede to the Metre Convention, and as a result is paying an increased subscription, shall have its subscription reduced to the minimum for an Associate State. The reduction will come into force in 2018 and will not be retroactive.</p> <p> [Decisions]</p> | |
| Decision CIPM/106-22 | October 2017 |
| <p>The CIPM asked the BIPM to work with any Associate State included in Decision CIPM/106-21 and that is in arrears in order to establish a rescheduling agreement.</p> <p> [Decisions]</p> | |

Conclusion

The BIPM

- The intergovernmental organization through which Member States act together on matters related to measurement science and measurement standards.
- Established in 1875 when 17 Nations signed the Metre Convention; now with 58 Member States and 41 Associate States and Economies.
- Financed jointly by the Member States and Associates; operates under the exclusive supervision of the CIPM. Has an international staff of around 70.
- Pilots comparisons (particularly those that are difficult) and carries out calibrations in selected areas for NMIs of the Member States.
- Runs technical programmes to support Member States in mass, time, electricity, ionizing radiation, and chemistry.
- Generates international reference time scales UTC, UTCr and TT for different applications.
- Maintains JCTLM database for traceability in Laboratory medicine.
- Operates the CIPM MRA & maintains the KCDB.
 - Publishes SI Brochure and the leading international journal in pure and applied metrology – *Metrologia*.
 - Runs Capacity Building & Knowledge Transfer Programme.



Thank you

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Bureau
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♦ **P**oids et
♦ **M**esures



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