



CCU President's Report

27th CGPM (2022)

A large, vibrant graphic consisting of multiple concentric, overlapping arcs in a rainbow color palette (red, orange, yellow, green, blue, purple, magenta). The arcs are arranged in a spiral pattern, creating a sense of movement and unity.

Working together to
promote and advance
the global comparability
of measurement

www.bipm.org

Report by the President of the CCU

Prof. Joachim Ullrich, President of the Consultative Committee for Units (*Comité consultatif des unités*, CCU) gave his report on the activities of the CCU since the 26th meeting of the CGPM (2018).

CCU Executive summary

The CCU is responsible for the further development and improvement of the International System of Units, the SI, and it provides advice to the CIPM about units of measurement in general. To fulfil this task, the CCU seeks advice from its member National Metrology Institutes (NMIs), its liaison organizations and other Consultative Committees. Until 2018, the work of the CCU was focused on the revision of the SI, which was approved by the CGPM in the same year and implemented in the following year. Since then, the strategy of the CCU has been reviewed and the committee now focuses on a number of topics related to the further improvement of the SI. In the short term these include the introduction of new prefixes for SI units and the clarification of the role of units for angles and so-called dimensionless quantities in the SI. In the longer term the planned redefinition of the second will become the dominating topic. The CCU follows the process of increasing digitalization in metrology and explores possible roles of the committee. The development of unambiguous definitions of core metrological terms is expected to become of crucial importance to support the increasing levels of machine-readability and machine-interpretability of metrological information.

Scope of the CCU

The work of the CCU is concerned with matters related to:

- the development and improvement of the International System of Units (SI),
- providing advice to the CIPM about units of measurement in general,
- providing information and advice on units and their use beyond the CIPM to a wide range of international bodies, associations, commissions and committees as well as individuals who approach the BIPM seeking such information.

To fulfil its tasks, the CCU seeks advice from its member NMIs and liaises with stakeholders: international associations, commissions and committees as well as intergovernmental organizations and international bodies. It stays in close collaboration with all related Consultative Committees (CCs) and NMIs. The CCU is responsible for the preparation of successive editions of the SI Brochure, including the “Concise Summary of the SI”. The SI Brochure is the most important and widely used publication of the BIPM. It is now in its 9th edition, which incorporates the revised definitions of the SI. Every care is taken when preparing the text, not only in the accuracy of the meaning but also because it is translated into many other languages as well as being used by people whose first language is neither French nor English. More recently, the CCU has taken steps to support the progress of digitalization in metrology, in particular by providing definitions of core metrological terms which are adequate for increasing levels of machine-readability and -interpretability.

Strategy

Until 2018, the strategy of the CCU was strongly focussed on the preparations for the revision of the SI, which was approved by the CGPM in 2018 and implemented on 20 May 2019. The main task of the CCU remains the further development and improvement of the SI. The CCU Strategy Document was updated in March 2022 and identifies a number of activities in this field: preparing the redefinition of the second (together with the CCTF), clarifying the status of units for angles and dimensionless quantities in the SI, extending the range of SI prefixes as required, clarifying the definitions of core metrological terms and reflecting on the need to maintain the distinction between base units and derived units. The CCU, and in particular its working group on strategy, carefully follow the process towards increasing levels of digitalization in metrology and possible roles therein of the CCU. For such topics, which cannot reasonably be handled by the full committee, the CCU creates dedicated working

groups or task groups, which are dissolved after completion of their task. At present, the CCU has two working groups; for strategy (WG-S) and for the definition of core metrological terms (WG-CMT). It has one task group, on the treatment of angles and dimensionless quantities in the SI Brochure (TG-ADQSIB). The working group on strategy usually meets once a year and prepares the meetings of the full committee, which meets generally every second year.

Due to its cross-cutting nature, the CCU cooperates with many bodies, which have a direct interest and concern in its activities. Representatives of other Consultative Committees are invited as guests to CCU meetings. Relevant international scientific organizations and unions attend CCU meetings as liaison organizations. Although not being members of the CCU, the liaison organizations have in practice the same rights as members to present their opinion on matters of concern.

Activities and achievements since the last meeting of the CGPM

Main activities and achievements

Following the introduction of the revised SI, the CCU arranged a survey among its members, liaison organizations and educational organizations to gather feedback on how the revision was introduced, on the communication strategy, on the implementation as well as on innovations triggered by the revised SI. A separate questionnaire was prepared for each of the three communities. The questionnaires were sent to the NMI Directors of all Member States and to the Presidents of all liaison organizations of the CCU. The NMI Directors were asked to pass on the questionnaire for educational organizations to representative institutions in their country. Replies were received from 18 NMIs, seven liaison organizations, 12 Universities and five schools. In summary, none of the NMIs reported significant difficulties in the implementation of the revised SI and there was no significant impact on the NMIs' customers. A number of innovative approaches were reported. All NMIs used the event to promote the importance of metrology. The liaison organizations were in general well informed of the changes and did not experience any major difficulties. Some of the Universities had already incorporated the revision into their curriculum, but others were not aware of the change.

At its 24th and 25th meetings the CCU discussed the necessity to expand the current range of SI prefixes from 10^{24} up to 10^{30} and from 10^{-24} down to 10^{-30} . Pressure for change was brought to bear on the SI by data science and the exponential growth of the global datasphere. Unofficial names for new prefixes were already suggested by this community and applied in the popular science media. A roadmap was developed with the objective of presenting a draft resolution to the 27th meeting of the CGPM in 2022. Draft Resolution C presents four new prefixes to cover the additional ranges.

The CCU has taken up again the long-standing question about the status of the radian and steradian in the SI, and the status of other so-called dimensionless quantities. At the 24th meeting all members and liaison organizations of the CCU were asked to develop an institutional view on the status of units for angles and dimensionless quantities and to present it at the next meeting. The result was a majority leaning towards the status quo in defining units for angles as derived units, but there was also some support for the SI Brochure to be improved to prevent, as far as possible, misunderstanding and error. The CCU Task Group on angle and dimensionless quantities in the SI Brochure (CCU-TG-ADQSIB) was created with the objective to suggest clarifications of the text of the SI Brochure related to these topics. The task group has started its work and will make recommendations at the next meeting of the CCU. It was also decided to hold a joint CCU/CCQM workshop on quantities which are counted in early 2023, with participation from other Consultative Committees. The aim of the workshop is to trigger a discussion on counting across the metrological community so that a common understanding of counting within the SI is achieved.

As a consequence of the revision of the SI, which based the whole unit system on a set of seven defining constants, the question arose on the definitions of terms like “unit”, “quantity” and “quantity value”. The CCU set up a new Working Group on Core Metrological Terms (WG-CMT), which should identify core metrological terms that enter CGPM Resolutions and national legislation, and which are therefore in the interest of Member States, and propose definitions for these terms, taking into account upcoming needs in digitalization. During several meetings the WG could not achieve a consensus and digitalization expertise

was missing. Thus, it was decided the requirements concerning machine readability of these terms should be better taken into account. Additional experts with relevant background in digitalization, mathematics and linguistics have been invited to attend further meetings of the WG.

The CCU strategy document, which had been in force since February 2014, has been revised by the CCU Strategy Working group to clarify the mission of the CCU once the revision of the SI was approved and implemented. One of the main tasks for the future is the monitoring of advances towards a future redefinition of the second. This work will be led by the CCTF and the stages of the process have been defined in a CCTF roadmap, which foresees at present a possible adoption of the redefinition of the second by the CGPM in 2030.

Challenges and difficulties

A major challenge will be to come to a metrologically and mathematically sound definition of core metrological terms such that machines are able to unambiguously “understand”, interpret and finally, even act on that basis. This is of decisive importance for the international quality infrastructure (QI) of the future that builds on these definitions. It is expected that this activity will be the foundation of a “digital VIM” (Vocabulary of Metrology) that by itself has huge practical implications in standardization, for example the ISO 80000 series, and as a result, for many metrological services in the future, such as “digital calibration certificates”.

An ongoing challenge is to come to an agreement on the status of the radian and steradian in the SI. This is a long-standing debate between two opposing views: should angle units remain derived units, or should the radian be given the status of an eighth base unit. If the latter alternative were to be chosen, this would lead to changes in many familiar equations, where the unit radian would need to be explicitly introduced. A third alternative consists in reviving the class of supplementary units, to which the angle units belonged until 1995, when this class was abrogated by a decision of the 20th meeting of the CGPM (1995). To deepen the scientific discussion, the International Mathematical Union (IMU) became an official liaison of the CCU.

Outlook in the short and long term

Following the expected approval of the new SI prefixes at the 27th CGPM (2022), a new version of the 9th edition of the SI Brochure will be published, which will also include a number of editorial improvements. In the short term the work of the CCU will be focused on clarifying the status of units for angles and dimensionless quantities and on supporting digitalization in metrology by providing machine-readable and machine-interpretable definitions of core metrological terms.

In the longer term the focus will be on the planned redefinition of the second, which is being prepared by the Consultative Committee for Time and Frequency (CCTF). A roadmap has been developed by the CCTF to specify the timeline and the necessary milestones. The most likely scenario leads to a redefinition in 2030. The CCU will provide input into this process and will also review the impact of proposals for the redefinition of the second on other fields of metrology.

CCU Data

CCU set up in 1964

President: J. Ullrich

Executive secretary: M. Stock

Membership (since 2018):

Thirteen members, eleven liaisons, no observers

List of CCU members:

<https://www.bipm.org/en/committees/cc/ccu/members>

Meetings since the 26th CGPM
meeting:

8-9 October 2019, 21-23 September 2021

Full reports of the CCU
meetings:

<https://www.bipm.org/en/committees/cc/ccu/publications>

Two Working Groups:

<https://www.bipm.org/en/committees/cc/ccu>

- Core Metrological Terms (WG-CMT)
- Strategy (WG-S)

One Task Group:

- Angle and dimensionless quantities in the SI Brochure (TG-ADQSIB)