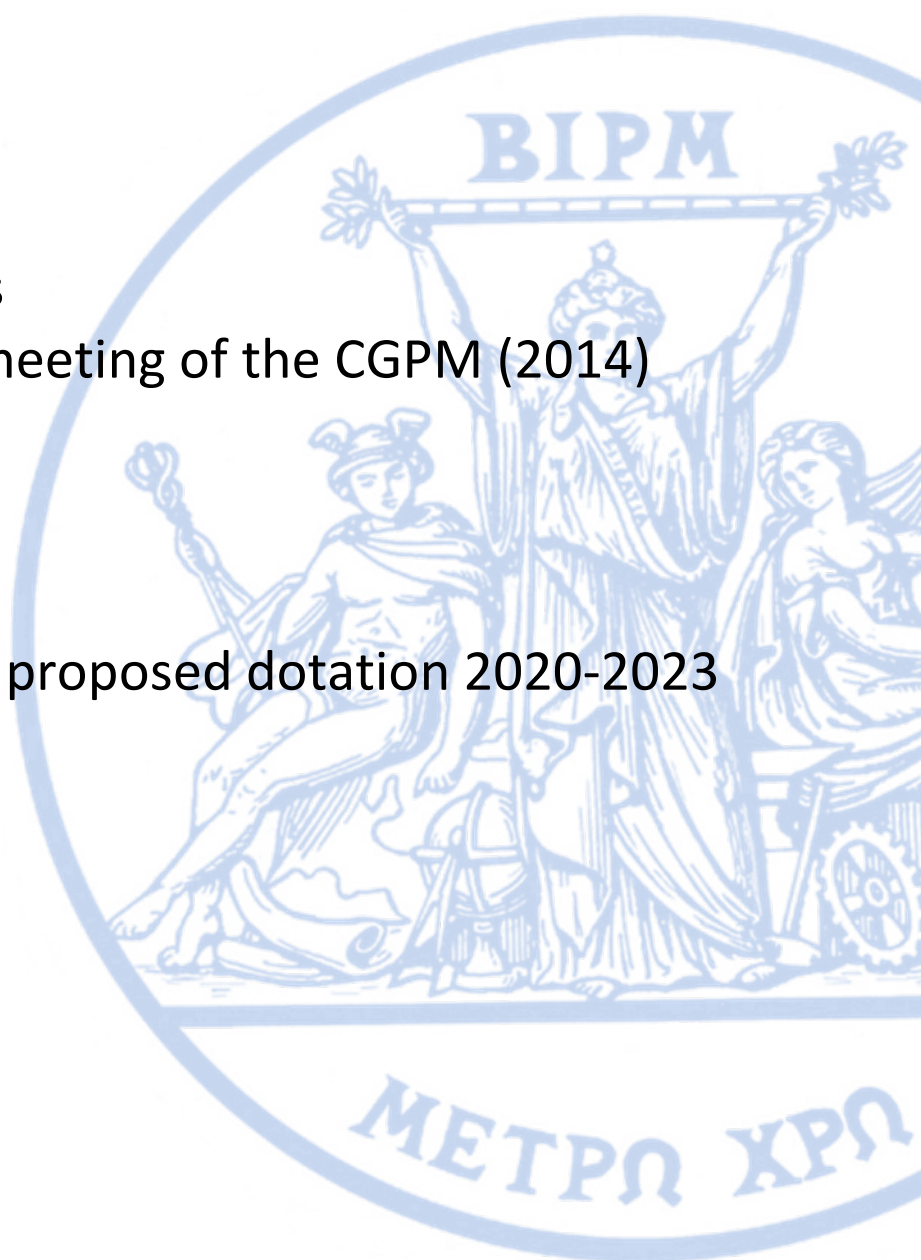


Bureau
↓ **International des**
↓ **Poids et**
↓ **Mesures**

Highlights of progress
made since the 25th meeting of the CGPM (2014)

and

Notes supporting the proposed dotation 2020-2023



This document has been prepared to support discussions at the 26th CGPM and particularly at meetings of the CGPM Working Group on the Dotation of the BIPM. It should be read in conjunction with the following proposal, which is available from the BIPM website:

Work Programme of the BIPM for the four years 2020-2023

Important supporting information is available in the following documents that are also available from the BIPM website:

Convocation of the General Conference on Weights and Measures (26th meeting)

Financial Report 2017

BIPM Strategic Plan (2018)

All of the above documents can be accessed through the dedicated webpage for the 26th CGPM

<http://www.bipm.org/en/cgpm-2018/>

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Executive Summary

This document provides information to support the discussion of the proposed BIPM dotation at the 26th meeting of the CGPM in November 2018.

In Section 1, we present highlights of achievements made since the previous meeting of the CGPM, these include:

- attracting five new Member States and six Associate States; there are now 60 Member States and 42 Associates States and Economies, representing 98 % of the world GDP (according to World Bank data),
- adopting a new approach to calculating the subscriptions of small Associate States resulting in a reduction for those with a weighting on the UN scale of less than 0.02 % to remove the financial barrier to participation in the global measurement system for the states with the smallest economies,
- implementing plans for a long-term financially-sustainable basis for the BIPM Pension Fund, through increasing staff contributions and introducing a new scheme with higher contributions and reduced benefits for all staff recruited since 2017 (details are presented in Annex 2), and through amending recruitment policy to reduce the long-term liability for Member States,
- introducing a major new focus for our work on capacity building and attracting sponsors to accelerate the development of emerging metrology systems, strengthening the global measurement system, and increasing the pool of NMIs able to contribute to the operation of the CIPM MRA, and
- strengthening the BIPM international liaison activities, most notably with the OECD, raising the awareness of the global measurement system, and enabling cooperation and coordination that increases its impact on global trade and global challenges to the benefit of all Member States.

In Section 2, we present the key elements of a proposed Work Programme for the BIPM for the years 2020-2023¹. It proposes that the foundation of BIPM's activities will continue to be the work of staff in all parts of the organization to carry out liaison, coordination and technical collaboration, with technical activities limited to those where the BIPM has a distinctive role and that provide direct support to many or all Member States. The proposed programme combines new laboratory activities such as:

- the dissemination of the kilogram from the BIPM Kibble balance,
- the introduction of high-accuracy frequency data from optical clocks into the UTC calculation to prepare the way for the redefinition of the second,
- the launch of the next-generation of the International Reference System (SIR) for comparing standards of radionuclides used in nuclear medicine and environmental monitoring, which will reduce the dependence on sealed reference sources at the BIPM (and thus reducing the associated liabilities), and

¹ The full text of the proposed Work programme is available from the BIPM website.

- new projects in chemical metrology that will build capacity amongst NMIs with emerging metrology systems to underpin measurements of contaminants in food and support accurate patient care.

In Section 3, we summarize the information needed for the discussion of the BIPM Dotation for 2020 to 2023. Following an extended period during which operational savings have enabled the programme to be delivered with no increase in contributions from Member States, we present projections of the BIPM finances under a base case and in two alternative scenarios. We include an option for some strategic re-organization of BIPM's staff and operations in response to the retirement of senior staff and changing priorities.

Finally, in Section 4, we indicate some trends in the priorities for the work of the BIPM in the long term.

1. Highlights of progress made with the 2016-2019 work programme, including the new initiative on capacity building and knowledge transfer

The agreed Work Programme for the years 2016 to 2019 has more than one year to run. We are able to report that all the commitments scheduled for completion to date have been completed. We report here on some of the major achievements.

In 2014, the BIPM undertook to develop the new Capacity Building and Knowledge Transfer (CBKT) activities based on external sponsorship. The first projects were launched in 2016. This CBKT initiative has been challenging, but rewarding, the activities are highly rated by the participants, and the value of the activities have been universally recognized. Key achievements include:

- the launch of sixteen projects (twelve have been completed and four are ongoing),
- support from eight NMIs and collaboration with all six of the regional metrology organizations (RMOs), and
- participation by 308 people from 83 countries who have benefited from the contributions of 56 invited lecturers from 27 countries.

Already there is firm evidence that the BIPM CBKT activities have:

- accelerated the integration of states with emerging metrology systems,
- reduced the CIPM MRA review effort for the leading NMIs, and
- increased the number of NMIs able to provide technical committee Chairs, thus balancing the load more fairly amongst the world-wide NMI community.

Highlights of the laboratory activities include the:

- operation of the BIPM Kibble balance reliably under vacuum for unbroken periods of up to one week with an uncertainty of 2 to 3 parts in 10^7 , with further improvements planned,
- first comparisons of primary peptide reference materials have been completed, and are now contributing to the harmonization of C-peptide measurements and diabetes care world-wide,
- provision of improved web access to UTC products from a new data base, and improved stability through the introduction of NMI Software-Defined Radio (SDR) receivers reducing diurnal fluctuations to less than a nanosecond, and
- launch of the first comparisons of ^{11}C and ^{64}Cu isotope standards used for medical imaging, and the launch of a new comparison and calibration service for dosimetry established using the DOSEO facility. (This is situated off-site in Saclay and provides a cost-effective response to the demand for support for radiotherapy across the globe by sharing a local facility and avoiding a very expensive investment at the BIPM).

Highlights of the international liaison activities include:

- contributing significantly to the revision of ISO/IEC 17025, ensuring that best practice in metrology from across Member States is reflected in the key documentary standard, which is used by more than 60 000 laboratories world-wide, and
- agreeing a joint definition of Quality Infrastructure with the ten International Organizations in the DCMAS Network (plus the World Bank) and working to reinvigorate and relaunch the network as the International Network on Quality Infrastructure (INetQI), thus allowing the organizations to work coherently with potential Member States and Associate States.

The impact of the international liaison role continues to expand by working with the:

- OECD to promote the role of measurement in international regulation with 50 other International Organizations raising awareness and opening the possibility of future cooperation and coordination to increase its impact on global trade and global challenges to the benefit of all Member States.
- UNIDO to explain the role of metrology in supporting the Sustainable Development Goals defined by the United Nations.
- OIML to coordinate the presentation of metrology in areas of mutual interest, by ensuring the two organizations reflect best practice and consistency to ease adoption and maximize the benefit in global trade and manufacturing.

In the area of coordination, there have been some important achievements such as by:

- increasing the impact and effectiveness of the BIPM's activities by growing participation in the organization by the addition of five new Member States² and six new Associates of the CGPM³,
- the on-going integration of one new RMO, GULFMET, into the processes of the CIPM MRA,
- improving the efficiency of the global mutual recognition arrangement through completion of the review of the CIPM MRA review and implementation of the recommendations, and
- developing new criteria for setting the subscriptions for Associate States with “emerging metrology systems” (micro-CEEMS) to remove the financial barrier to participation in the global measurement system for the states with the smallest economies.

² New Member States: The Republic of Lithuania, The United Arab Emirates, The Republic of Slovenia, Montenegro and Ukraine

³ New Associate States: The Republic of Azerbaijan, The State of Qatar, The Federal Democratic Republic of Ethiopia, The United Republic of Tanzania, The State of Kuwait and The Republic of Uzbekistan.

Alongside delivery of the work programme, some important operational milestones have been met, whilst making organizational cost-savings:

- The main laboratory spaces, offices and ancillary spaces in the main *Observatoire* building have been renovated and the IT infrastructure has undergone a major upgrade.
- The content management system used for the BIPM website, the KCDB database and the JCRB online review platform are all currently being completely renewed, with completion scheduled for 2019.
- An average of 2053 people per year between 2014 and 2017 have participated in meetings at the BIPM.
- Thirty nine secondees (equivalent to approximately 18 person years) have contributed to the delivery of the work programme from 2016 to 2018.
- Operating expenses have been controlled carefully and are below the level of 2013. (See Table 1 below). Total staff costs have been controlled carefully, whilst the cost of secondees has increased as a result of the strategic intent to increase participation by NMI staff in the work of the BIPM.

in k€	2013	2014	2015	2016	2017
Contributions	11 744	11 885	12 121	12 178	12 178
Subscriptions	530	702	790	955	1 116
Other income	598	1 009	823	561	539
Total operating revenue	12 872	13 596	13 734	13 694	13 833
Current staff cost	6 382	6 309	6 256	6 091	6 836
Contribution to the pension fund	2 329	2 251	2 400	2 400	2 800
Operating, laboratory and building expenditure	2 496	2 405	2 027	2 020	2 383
Capital spend	1 411	1 394	1 353	1 458	1 061
Total expenses	12 618	12 359	12 036	11 969	13 080
<i>Result</i>	<i>254</i>	<i>1 237</i>	<i>1 698</i>	<i>1 725</i>	<i>753</i>

Table 1 – Audited spend and income for 2013 to 2017.

2. Summary of the proposals for the BIPM Work Programme 2020-2023

In this section, we summarize the proposals for the BIPM Work Programme for 2020-2023, which is based on the published BIPM Strategic Plan (2018). Both the strategy and the draft Work Programme have been agreed by the CIPM and have been through rounds of consultation with the NMIs and representatives of Member States.

The proposed activities are ambitious and depend on the work of visiting scientists and specialists working alongside BIPM staff for their delivery. The increasing participation of visiting scientists reduces costs, brings in specific expertise when it is needed, injects new ideas, and provides flexibility in staffing. The proposals also includes capacity building and knowledge transfer activities, some of which depend on the BIPM securing sponsorship from NMIs, Member States and RMOs, or other bodies. The Work Programme document gives estimates of the staff resources and expenditure needed for each task.

The programme includes projects in four technical areas that will:

Physical Metrology

- Coordinate the comparison of primary realizations of the kilogram according to the new definition and maintain the consensus value on the BIPM working standards and the BIPM ensemble of mass standards.
- Disseminate the unit of mass by establishing metrological traceability from the BIPM Kibble balance based on the new definition of the kilogram.
- Organize a new comparison of AC voltage standards based on the Josephson effect.
- Develop a new approach to providing traceability for capacitance standards based on the AC quantum Hall effect.

Time Metrology

- Introduce high-accuracy frequency data from optical clocks into the UTC calculation to prepare the way for the redefinition of the second.
- Implement a new optical fibre-based method as an independent technique for inter-laboratory receiver delay validation.
- Automate data handling protocols in order to optimize the monthly calculation of UTC and to pave the way towards more frequent dissemination of UTC.
- Increase the number of laboratories participating each week in Rapid-UTC by 10 %.

Chemical Metrology

- Coordinate the implementation of new values for ultra-violet absorption cross-sections for ozone amongst 25 NMIs world-wide that are centrally involved in providing the basis for world surface ozone measurements.
- Triple the number of nuclei covered by the BIPM's qNMR Internal Standard Reference Data, allowing wider application of qNMR techniques at NMIs for chemical standard characterization.

- Apply unique absolute carbon dioxide measurement methods and isotope ratio comparisons to underpin NMI, WMO and IAEA standards for atmospheric monitoring.
- Provide comparisons for the 20 NMIs world-wide that are most involved in delivering organic calibrants for the detection of food contamination.

Ionizing Radiation Metrology

- Double the number of NMIs taking part in key comparisons and calibrations of the primary standards that underpin radiotherapy dosimetry for 11 000 clinical accelerators world-wide by making greater use of the off-site DOSEO facility.
- Provide comparisons and calibrations using an off-site ^{137}Cs facility for radiation protection dosimetry, to support traceability of the calibration of dosimeters used by the 22 million people world-wide exposed to ionizing radiation in the workplace.
- Launch the next-generation International Reference System (SIR) for comparing standards of gamma-emitting radionuclides, for applications in nuclear medicine and environmental monitoring. Exploit new low-current measurement technologies that may have spin-off advantages for their use at NMIs and DIs.
- Introduce new comparisons for long-lived radionuclides, to underpin standards used when decommissioning nuclear plants and for the measurement of naturally-occurring radioactive materials.

Liaison, Coordination, Communication and Promotion

The work programme also describes liaison, coordination and communication activities that will address objectives agreed in the strategy and will thereby respond effectively and in a timely way to opportunities (and threats) arising from the evolving environment.

Highlights amongst the liaison activities will include increased interactions with the most relevant international bodies, in order to promote the benefits of the world-wide metrology infrastructure delivered through the international quality infrastructure. The liaison activities are broad, and the BIPM must remain agile in terms of its activities as liaison partners respond to their changing needs. However, what can be assured is the importance of seamlessly linking scientific and legal metrology, and thus the continued close collaboration with the OIML is crucial to allow both organizations to present ‘one voice’ for metrology to the outside world. Additionally, the BIPM will continue to work closely with the other ‘Quality Infrastructure’ partners, most notably ISO and ILAC, aided by the agreement through the INetQI – International Network of a common definition for Quality Infrastructure.

Capacity Building and Knowledge Transfer (CBKT)

During the 2016-2019 Work Programme, the BIPM launched a series of new activities supported by sponsorship from NMIs in the areas of capacity building and knowledge transfer. Notably, these included two major courses supported by NIST and delivered at the BIPM. These were aimed at ensuring effective participation in the CIPM MRA, with

short versions subsequently ‘rolled out’ at the RMO level with wider participation. These courses were very highly regarded by all parties. Such CIPM MRA support activities have been identified as being core to the BIPM’s mission and consequently are included as funded activities in the base case for the dotation proposed in the following section. The core CBKT activities will:

- Support the next generation of technical leaders (in Consultative Committees, RMO Technical Committees and piloting scientific comparisons) to increase the pool of NMIs that are able to contribute to activities and take leadership responsibility within the CIPM MRA.
- Accelerate the development of emerging metrology systems by effectively integrating staff from new Member States and Associates into the international metrology system, promoting ‘right first time’ engagement in the CIPM MRA and thus reducing the review burden on the leading NMIs.
- Broaden the opportunities for participation in the activities of the organization by supporting candidate Member States and Associates, notably in Africa (where currently, of the 54 African states, only 14 participate, four as Member States and ten as Associate States).

The core CBKT activities will be planned with the RMOs and performed at the BIPM, and where appropriate, in the regions. At least 60 NMI/DI staff are expected to attend courses and workshops held at the BIPM, with a further 360 NMI/DI staff expected to benefit through the participation of BIPM staff in joint activities organized with the RMOs.

During the 2016-2019 Work Programme, support for topic-based capacity building activities at the BIPM and at NMIs was received from NIM, NPL, PTB, UME, METAS, NMISA, COOMET, GULFMET and EURAMET. Achieving similar levels of sponsorship will enable the 2020-2023 programme to:

- Launch a new technical capacity-building activity on protein and peptide analysis to support NMIs developing capability in “Metrology for accurate patient care”.
- Continue the “Safe food and feed” and “Metrology for clean air” capacity building projects, expanding the activities to include additional regions of the world.
- Improve the quality of data submitted to UTC by implementation of new capacity-building opportunities in the BIPM Time Department by the establishment of a “UTC simulator”.
- Provide capacity-building opportunities related to techniques necessary for the comparison of electrical quantum standards and for the dissemination of mass standards.
- Engage with NMIs and DIs working in radiation dosimetry and radionuclide metrology, through joint projects and workshops.

- Implement new activities proposed and funded by stakeholders advancing the work of the wider metrology community and being consistent with the objectives of the BIPM.

It is estimated that around 40 laboratory placements at the BIPM totalling around 170 person months will be offered, with a further 100 participations in laboratory-based workshops organized at the BIPM.

3. Scenarios proposed for the dotation for the period 2020-2023

In this section we propose a base case for the BIPM dotation together with two alternative scenarios. They have all been costed on the basis of the proposed Work Programme (2020-2023) with detailed costings for each component of the programme and for the general operating expenses of the laboratories. (The detailed assumptions underlying the estimated income and expenditure are given in Annex 1).

All cases are based on vacancies amongst the BIPM staff due to retirement and the expiry of fixed-term contracts not being replaced on a strictly like-for-like basis. Hence total staff numbers will reduce from 72 (in 2020) to 67 (in 2023) unless the new recruitments proposed in the base case are supported.

The Base Case – “One percent compound increase”

The base case corresponds to the values for the annual dotation published in the draft of Resolution D in the formal convocation for the meeting of the CGPM. It involves a 1 % increase in the dotation for each year in the period 2020 to 2023. The additional funds that would be provided in this case would be:

Year	2019	2020	2021	2022	2023
Income from dotation in the base case in excess of a “no change” scenario (k€)	-	122	246	371	497
Projected number of staff	73 ⁴	72	72	71	70

This base case will enable the BIPM to respond to the expectations that it should evolve to meet new requirements in response to changes in priorities articulated by the NMIs and RMOs. **The costings presented will enable the BIPM to deliver the proposed Work Programme for 2020 to 2023 (see Section 2), and also:**

1. To support the “core” CBKT activities from the dotation enabling them to be delivered without external sponsorship.
2. To recruit three staff in 2021 (or 2022) to correct for some of the vacancies arising from retirement and the expiry of fixed-term contracts such that total BIPM staff will only reduce from 72 (in 2020) to 70 (in 2023). The three recruitments will be:
 - A staff member on a 5-year contract to lead the communications and publicity activities of the BIPM.
 - A staff member on a 5-year contract to support initiatives launched by the CIPM which are emerging priorities in many Member States and where there is a clear

⁴ The maximum number of staff for 2019 was agreed by the CGPM in 2014.

role for metrology to play in addressing these challenges⁵, and to expand the BIPM's work on providing a portal to data and data-related services held by the international metrology community.

- An experienced scientist to replace a senior principal scientist following retirement.
3. To carry out some re-organization of BIPM's staff and operations in 2022/2023 needed to maintain the organization's effectiveness and to anticipate changing priorities in the long term. This will seek to correct for a number of key retirements. In planning this re-organization, the CIPM will consider a range of options that respond to evolving circumstances such as by: opening joint appointments with Universities or NMIs, hiring staff on short-term contracts, contracting the tasks externally, hosting personnel seconded from NMIs or by the re-prioritization of posts. This review must also anticipate further key retirements in 2024 in the context of trends for the work of the BIPM that can be foreseen. (Some examples are given in Section 4).

We propose that the detailed decisions in establishing the appropriate balance between these alternative activities included in the base case should be decided by the CIPM.

⁵ Examples of such initiatives under discussion are the application of metrology to "big data", the "reproducibility challenge" and Industry 4.0, and the development of new traceability concepts to exploit quantum technologies.

Proposed base case (in k€)	2019 forecast budget	2020	2021	2022	2023
Gross salaries	4 850	5 006	5 233	5 504	5 616
Family and social allowances	1 170	1 190	1 216	1 252	1 296
Social contributions	370	391	409	430	439
Subsistence allowance to seconded staff	360	400	404	408	412
Current staff cost	6 750	6 987	7 262	7 594	7 763
Contribution to the Pension Fund	2 550	2 550	2 600	2 650	2 750
Contract service suppliers	312	344	357	371	385
Site expenses	846	896	900	929	960
Coordination and communication	253	313	322	391	337
Laboratory operating expenses	615	758	786	814	843
Laboratory investment	855	730	635	535	295
Site investment	649	555	482	449	458
Miscellaneous	486	306	260	265	468
TOTAL EXPENSES	13 315	13 439	13 604	13 998	14 259
Contributions: dotation	11 980	12 357	12 480	12 607	12 731
Contributions: projected accessions	311	398	402	577	583
Subscriptions	940	629	635	505	518
Other income	225	225	225	225	225
TOTAL REVENUE	13 456	13 609	13 742	13 914	14 057
<i>DIFFERENCE (excess+ / lack -)</i>	<i>141</i>	<i>170</i>	<i>138</i>	<i>-84</i>	<i>-202</i>

Table 2 – Estimated budget for the base case proposed in draft resolution D.

The figures given for 2019 are the forecast budget. Savings have been identified from the budget approved in 2014 (13 920 k€). (Total revenue includes the dotation, plus other revenue, which is primarily the subscriptions received from Associate States and Economies).

Alternative Scenarios

The 25th meeting of the CGPM (2014) did not grant an increase in the dotation paid to the BIPM. Since that time, the effect of inflation on running costs has been controlled partially within the envelope of the small increases in income from new Members States and Associate States and Economies⁶. Additionally, savings have been made in all of the most important categories of expenditure. It is now difficult to foresee significant additional savings through such measures.

In this section, we indicate the challenges of sustaining the BIPM if it is necessary for it to progress with less dotation income than planned in the base case. The information is presented in terms of two alternative scenarios.

Alternative Scenario A - “One percent step increase in 2020”

A dotation increase by a single step of 1 % in 2020 would generate additional dotation funding of 122 k€ in each year of the programme.

Year	<i>2019</i>	2020	2021	2022	2023
Income from dotation in Scenario A in excess of a “no change” scenario (k€)	-	122	122	122	122
Projected number of staff	73	72	71	69	67

This scenario provides sufficient funding to support the activities described in the proposed Work Programme for 2020 to 2023 published on the BIPM website. Additionally there would be sufficient income:

- Firstly, to support the “core” CBKT activities as in bullet point 1 of the base case above.
- Secondly, to carry out some re-organization of the BIPM’s staff and operations in 2022/2023 as in bullet point 3 of the base case above.

In this scenario the recruitment of extra staff described in the base case above would not be possible. We propose that the detailed decisions in establishing these priorities should be determined by the CIPM.

⁶ The increase in subscriptions is due in part to an increase in the number of Associate States and Economies and also due to the increase in subscriptions resulting from the “escalator mechanism”.

Alternative Scenario B - “No increase”

In the second alternative scenario we assume that there will be no increase in the dotation paid by existing Member States for the period 2020-2023.

Staff numbers are those shown in the table below:

Year	<i>2019</i>	2020	2021	2022	2023
No of staff	73	72	71	69	67

This scenario provides sufficient funding to support the activities described in the proposed Work Programme for 2020 to 2023 published on the BIPM website on the basis that sponsorship can be secured for all of the capacity-building activities, including the core CBKT activities.

Under this scenario there would be no resources available for the CIPM to implement a strategic re-organization of BIPM’s staff and operations to prepare for the future.

Whilst the projected net financial results shown in Table 2 will be balanced over the four-year programme as a whole, the projected outcome has a negative trend leading to an estimated loss of around 200 k€ in 2023. This trend of a growing deficit must be addressed ahead of any consideration at the 27th meeting of the CGPM of a Work Programme for 2024-2027.

4. Long-term considerations for the BIPM in 2025 and beyond

The planned BIPM activities for 2020-2023 match the requested dotation (taking due account of other income, which is primarily from the subscriptions of Associates) as the ‘base case’. Consideration has been given to the possibility that the requested increase is not forthcoming by the presentation of two alternative scenarios.

The choice for the BIPM dotation made between the base case and the two alternative funding scenarios described in Section 3 will have an influence on the BIPM staffing in 2024 and hence on the future capability of the BIPM staff to address requirements in 2025 and beyond. To put this staff capability in context, we summarize in this section some trends that we can expect to influence the BIPM in 2025 and beyond.

The BIPM Strategic Plan (2018) was agreed by the CIPM in 2017. It includes the strategy for the period 2018 to 2019, together with aspirations for the long term. It was the basis for the development of the BIPM Work Programme for 2020-2023. The process of developing the strategy involved the identification of some trends in the priorities for the work of the BIPM in the long term, these, together with subsequent informal discussions by the CIPM, suggest that:

- The membership of the organization will continue to broaden and increasingly involve States with emerging metrology systems.
- The demand for increased (and quantifiable) impact from metrology globally will continue.
- The development and implementation of a common vision for Quality Infrastructure shared amongst International Organizations will continue to be a route towards showing the impact of metrology.
- The capabilities of the RMOs will continue to strengthen, but differences in their size and resources will continue.
- The implementation of the new definitions for the SI base units (planned for May 2019) will result in the uptake of “quantum”-based traceability routes for key quantities. Requirements to disseminate many quantities using established methods will continue.
- A high priority will continue to be set on metrology that contributes to addressing societal challenges and underpinning the uptake of disruptive technologies.

These trends have been recognized in the 2020-2023 work programme; they will also have a continuing and significant impact on the strategy for the BIPM beyond this period. It will be a priority for the CIPM elected in 2018 to consider how the function and operations of the BIPM might evolve in the future.

Nevertheless, the following changes can be expected:

- A greater emphasis on the international work of the BIPM, working more closely with the OIML and other IOs to achieve greater impact in the world-wide presentation of the message of quality infrastructure.

- Greater requirements to support capacity-building activities in each of the regions and in their language of choice.
- Demands for enhanced support for the work of the CCs (and the CC Presidents).
- Greater support for specific strategic initiatives defined by the CIPM (current examples include raising the impact of metrology on emerging science and technology challenges such as data “reproducibility”, “digitization” and Industry 4.0, and the development of new traceability concepts to exploit quantum technologies).
- A strategic reduction in the number of comparisons carried out under the auspices of the CIPM MRA generally and specifically coordinated by the BIPM, focusing only on those at the highest level and with the largest participation, or where there is some special reason for coordination by the BIPM laboratories.
- The need to contribute to the dialogue and associated shifts in the concepts of metrological traceability that arise as a result of the expected proliferation of zero-chain quantum-based standards, including working with key international partners such as ILAC to ensure a smooth transition of the world metrological system.
- An increasing demand for meetings to be hosted at the BIPM.

Responding effectively to these trends will require some re-focusing of the BIPM’s capabilities that will require some re-organization of staff and operations. This will be achieved in part by greater flexibility in the deployment of staff and an approach to planning facility investment that responds to changing requirements. For example, the recently-adopted policy of preferring the use of external facilities for the BIPM’s comparison activities, where possible, will continue to provide cost-efficiency and flexibility.

The age profile of existing BIPM staff is such that the number of retirements will peak between 2022 and 2024. These peaks provide an opportunity for the CIPM to re-consider the staffing that is necessary and affordable. In order to best prepare the BIPM to meet the challenges beyond 2025, we have proposed as part of the base case, that the CIPM be given access to resources in the period 2022/2023 to start to address this.

Annex 1 - Assumptions underlying the costings of the Work Programme

Estimation of staff costs

The calculations of staff costs are all based on the implementation of a policy of preferring recruitment to fixed-term contracts (except when an exception is agreed by the CIPM). It is proposed in the base case and the alternative scenarios that the effects of this policy in the effectiveness of the BIPM staff to meet requirements will be mitigated by some actions to re-organize staff and operations, which are described in Section 3.

(Note, the number of staff agreed for the 2016-2019 work programme was 73, but the number projected to be in place at the end of 2019 will be 72).

Calculation of the dotation

Details of the methods used to calculate national contributions⁷ to the dotation and subscriptions⁸ are available from the BIPM website.

The CGPM at its 16th meeting (1979) established the principle addressing accession of new Member States (embodied in Resolution 7) that has been followed since that time:

- a) Since new Member States bring additional work to the BIPM, in order to ensure that support/services to existing Member States are not degraded, and the overall budget of the BIPM should rise accordingly when a new Member State accedes, but
- b) the contribution of existing Member States should not rise as a result of a new Member State acceding.

In this way, the CGPM agrees a dotation that has increased when a new Member State accedes, but it is distributed between an increased number of Member States such that there will be no increase in the contribution for all existing Member States (and adjustments are made to ensure that the maximum and minimum contributors are not affected).

At the time of issuing the Convocation (in February 2018) for the 26th meeting of the CGPM, four states had acceded and become Member States since the 25th meeting of the CGPM, resulting in an uplift in the 2020 - 2023 dotation (before the application of the 1% compound) of an additional 254 k€per annum. These figures form the basis of draft Resolution D.

Since the issue of the Convocation there has been an additional accession of a Member State (Ukraine in August 2018) which further uplifts the dotation. However as this increase is approximately offset by downwards adjustment of the dotation from the expected exclusion of Venezuela, it is not proposed to amend the draft Resolution D figures as a consequence of these two post Convocation changes.

It should be noted that four of the five acceding states were previously Associate States of the CGPM, so whilst the dotation is uplifted by approximately 254 k€per annum, in terms of the overall budget, this is offset by a reduction of approximately 187 k€per annum from the loss of subscriptions that these four states would have paid had they remained Associate States.

⁷ <https://www.bipm.org/utls/common/documents/official/calculating-contributions-EN.pdf>

⁸ <https://www.bipm.org/utls/common/documents/official/calculating-subscriptions-EN.pdf>

Detailed assumptions underlying the estimated costs shown in Table 2.

Annual increase in salary mass	1.8 %
Annual inflation applied to salaries and allowances	2 %
Annual inflation applied to healthcare, contract services and utility costs	4 %
Annual laboratory operating expenditure (average)	3.7 %
Annual Building maintenance expenditure	4 %
Annual laboratory investment	declines by 100 k€
Building investment	follows estimated costs of projects

Detailed assumptions underlying the estimated income shown in Table 2.

In estimating the income from Member States, the following assumptions have been made:

- Note that the total income from dotation contributions is not uplifted for accession of Ukraine because it acceded after the Convocation was issued.
- A “downlift” is anticipated in the case of the expected exclusion of a Member State.
- The above two bullet points taken together are considered to have no net effect on the dotation income.
- All Associate States that have been encouraged to accede and reach the fifth step of the ‘escalator’ accede two years after reaching the 5th step (10 accessions during the 2020-2023 period).
- The exclusion of one Member States is anticipated.
- Any loss of Associate States will be balanced by new Associates.

Detailed list of costs included under the headings within Table 2.

- Contract service suppliers = Cleaning + reception + security + gardening + others
- Site expenses = Utilities + insurance + office costs + library + IT operation expenses + building maintenance
- Coordination and communications = Publications + cost of meetings + core capacity building expenses + travel (Liaison and Director only).
- Laboratory operating expenses = All laboratory expenses + facility rental + workshop + site supplies + travel for comparisons + travel (staff in laboratory departments)
- Laboratory investment, includes workshop
- Site investment = Building investment + IT (network) investment
- Miscellaneous = Accounting, audit, actuarial and legal costs, exceptional staff costs + expenses of the CIPM bureau

Annex 2 - Reform of the BIPM Pension Fund to ensure its long-term financial stability

At the time of the 24th and 25th meetings of the CGPM in 2011 and 2014, the Member States asked the CIPM to continue to examine the longer term liability associated with the BIPM Pension Fund.

At the 25th meeting of the CGPM, the CIPM re-iterated its commitment to continue to operate the fund on a “pay as you go” basis and to find ways to ensure its long-term financial sustainability. The criterion agreed for its long-term financial sustainability was that the reserves of the Fund should not diminish over a period of 40 years. A number of independent actuarial studies have been commissioned to consider different ways to achieve this.

In 2015, the CIPM transformed its Sub-Committee for the Pension Fund and Health Insurance (PF&HI) into the Pension Fund Advisory Board (PFAB). In order to broaden involvement, it now includes three elected representatives of staff and one elected representative of pensioners (and deferred pensioners) as well as three CIPM Members, the BIPM Director and an external expert⁹.

In January 2017, and after discussions at open discussion meetings and consultation with elected staff representatives and the PFAB, the CIPM implemented some changes to the terms of the Pension Fund. The principal elements of these changes were:

- to increase the annual contributions by the BIPM to the Pension Fund by 400 k€ in 2017 and 150 k€ in every year thereafter,
- to increase the contribution rates for active staff:
 - in the “Pre-2010” section by 1.5 % and then by 1 % each year to reach 19.8 %
 - in the “Post-2010” section by 1.5 % and then by 1 % each year to reach 18.8 %
- to open a new section of the Fund for staff joining BIPM after 1 January 2017 with reduced benefits and a contribution rate of 15 %, and
- to increase retirement ages for staff joining after 1 January 2017 from 65 to 67.

In October 2017 the CIPM unanimously agreed another change to the Fund as part of these measures to ensure its long-term financial sustainability. This was that pensions in payment should not be adjusted for changes in the cost of living for the period 2018-2019. Since the beginning of 2018, the long-term liability is being further limited by a policy of preferring the recruitment of staff to 5-year fixed-term rather than indefinite contracts whenever possible.

The CIPM will commission a full actuarial review of the Fund in 2019 and will share the results with staff. This will enable an independent evaluation of the success of the measures introduced in 2017 and 2018.

⁹ <https://www.bipm.org/en/committees/cc/wg/cipm-pfab.html>

Acronyms used in the present volume

AC	Alternating current
BIPM	International Bureau of Weights and Measures
CBKT	Capacity Building and Knowledge Transfer
CC	Consultative Committee of the CIPM
CEEMS	Countries and Economies with Emerging Metrology Systems
CGPM	General Conference on Weights and Measures
CIPM	International Committee for Weights and Measures
CIPM MRA	CIPM Mutual Recognition Arrangement
DCMAS	Developing Countries Metrology Accreditation and Standards Network
DI	Designated Institute
DOSEO	Doseo technology platform CEA SACLAY
EURAMET	European Association of National Metrology Institutes
GDP	Gross Domestic Product
GULFMET	Gulf Association for Metrology
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
ILAC	International laboratory Accreditation Cooperation
INetQI	International Network for Quality Infrastructure
IO	International Organization
ISO	International Organization for Standardization
JCRB	Joint Committee of the Regional Metrology Organizations and the BIPM
KCDB	BIPM key comparison database
METAS	Federal Institute of Metrology (Switzerland)
NIM	National Institute of Metrology (China)
NIST	National Institute of Standards and Technology (USA)
NMI	National Metrology Institute
NMISA	National Metrology Institute of South Africa (South Africa)
NPL	National Physical Laboratory (UK)
OECD	Organisation for Economic Co-operation and Development
OIML	International Organization for Legal Metrology
PFAB	Pension Fund Advisory Board
PF&HI	Pension Fund and Health Insurance
PTB	Physikalisch-Technische Bundesanstalt (Germany)
qNMR	quantitative Nuclear Magnetic Resonance
RMO	Regional Metrology Organization
SDR	Software-Defined Radio
SIR	International Reference System for gamma-ray emitting radionuclides
UME	National Metrology Institute / TÜBITAK Ulusal Metroloji Enstitüsü (Turkey)
UN	United Nations
UNIDO	United Nations Industrial Development Organization
UTC	Coordinated Universal Time
WMO	World Meteorological Organization