# CCM-Working Group on Gravimetry (CCM-WGG)


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# Terms of Reference

- To propose key comparisons to the CCM;
- To maintain contact with international organizations and stakeholders active in gravimetry;
- To support stakeholders to ensure and promote the traceability of gravimetry to the SI;
- To follow the main research activities in gravimetry.

# Present WGG Membership

| | | | |
|---|---|---|---|
| 1. | Dr Henri Baumann | METAS | Switzerland |
| 2. | Dr Mirjam Bilker-Koivula | FGI | Finland |
| 3. | Dr Sylvain Bonvalot | BGI | France |
| 4. | Dr In-Mook Choi | KRISS | Republic of Korea |
| 5. | Prof. James Faller | | USA |
| 6. | Prof. Olivier Francis | LGUL | Luxemburg |
| 7. | Dr Alessandro Germak | INRIM | Italy |
| 8. | Dr Baki Karaboce | UME | Turkey |
| 9. | Prof. Dr Jan Krynski | | Poland |
| 10. | Dr Jacques Liard | NRC | Canada |
| 11. | Dr Shigeki Mizushima | NMIJ/AIST | Japan |
| 12. | Dr. David B. Newell | NIST | USA |
| 13. | Dr Vojtech Palinkas | VUGTK | Czech Republic |
| 14. | Dr Franck Pereira | SYRTE | France |
| 15. | Dr Lennart Robertsson | BIPM | |
| 16. | Dr Ian A. Robinson | NPL | United Kingdom |
| 17. | Dr Diethard Ruess | BEV | Austria |
| 18. | Dr Michel Van Camp | | Belgium |
| 19. | Dr Leonid Vitushkin[2] | VNIIM | Russian Federation |
| 20. | Dr Shuqing Wu | NIM | China |

# next 5 years program of work (1/2)

- organize KCs/Pilot Studies and support those organized by RMOs (discussion on the periodicity)
- support traceability in gravimetry: in the field of gravimetry there is a lack in traceability for those measurements carried out with relative gravimeters, mainly used in calibration laboratories in field of force and derived quantities (torque, pressure, hardness, etc.);

# next 5 years program of work (2/2)

- To promote scientific exchanges on matters relating gravimetry (i.e. workshops, meetings, conferences, etc.);
- To improve CMC declarations on gravimetry, for absolute and relative measurements and calibrations, as well for decreasing the declared uncertainty.

# Proposed Changes to Membership

- **Dr. Cafer KIRBAŞ**, TÜBİTAK UME, Turkey
  *UME is a CCM observer*
  *substitute of Dr. Baki Karaboce*
- **Dr. Homood M. Alotaibi**, Saudi Standards, Metrology and Quality Org. (SASO/NMCC), Kingdom of Saudi Arabia
  *SASO/NMCC is not a CCM member or observer*
- **Dr. Reinhard Falk**, Federal Agency of Cartography and Geodesy (BKG), Germany
  *BKG is not an NMI/DI*
  *personal membership – previously Dr. Herbert Wilmes*

# WGG Meetings held since last CCM

- 23rd – 24th February, 2016
  at ROYAL OBSERVATORY OF BELGIUM
  *in conjunction with the IAG/ SC2.1/JWG 2.1 "Establishment of a global absolute gravity reference system" meeting*

# WGG Meetings planned

At the last meeting, it was decided to have a periodicity of two year for the WGG meetings.

The next will be on 2018 (date and place to be decided, possibly in coincidence of other international events or meeting in the field)

# Major WGG issues handled by correspondence

Final agreement and publication of the following KCs:

- CCM.G-K2
- EURAMET.M.G-K2
- COOMET.M.G-S1

# Liaisons with RMO KCs

| RMO and Name | Quantity | Year | Type | Status |
|---|---|---|---|---|
| **SIM.M.G-K1** | Free-fall acceleration | 2016 | Key comparison | (Draft A finish, Draft B in preparation) |
| **EURAMET.M.G-K2** | Free-fall acceleration | 2015-2017 | Key comparison | Approved for equivalence, Results available |
| **COOMET.M.G-S1** | Free-fall acceleration | 2015-2017 | Supplementary comparison | Approved and published |

# KCs / Pilot Studies underway

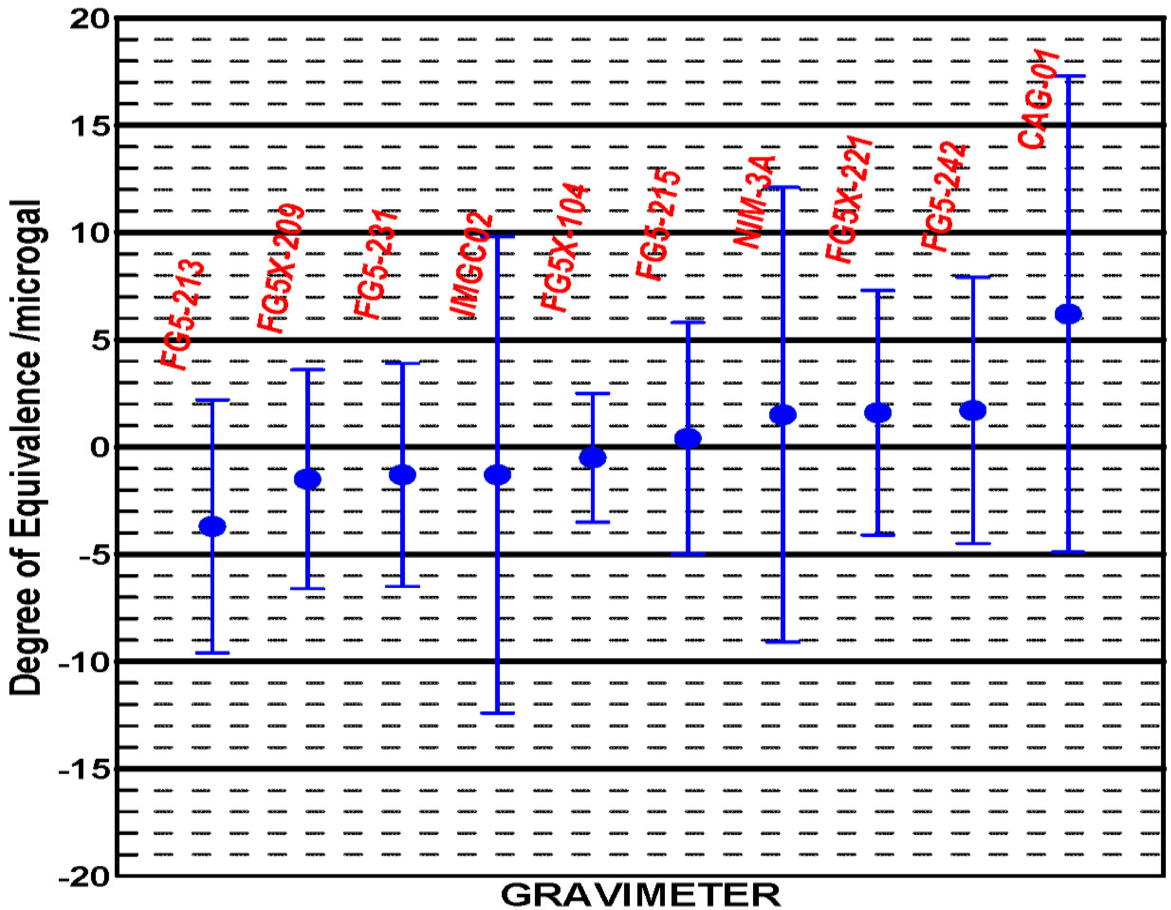
| Name | Quantity | Year | Type | Status |
|---|---|---|---|---|
| **CCM.G-K2.2017** | Free-fall acceleration | 2017 | Key comparison | Planned |

October 16th/31st 2017

Changping Campus (NIM China)

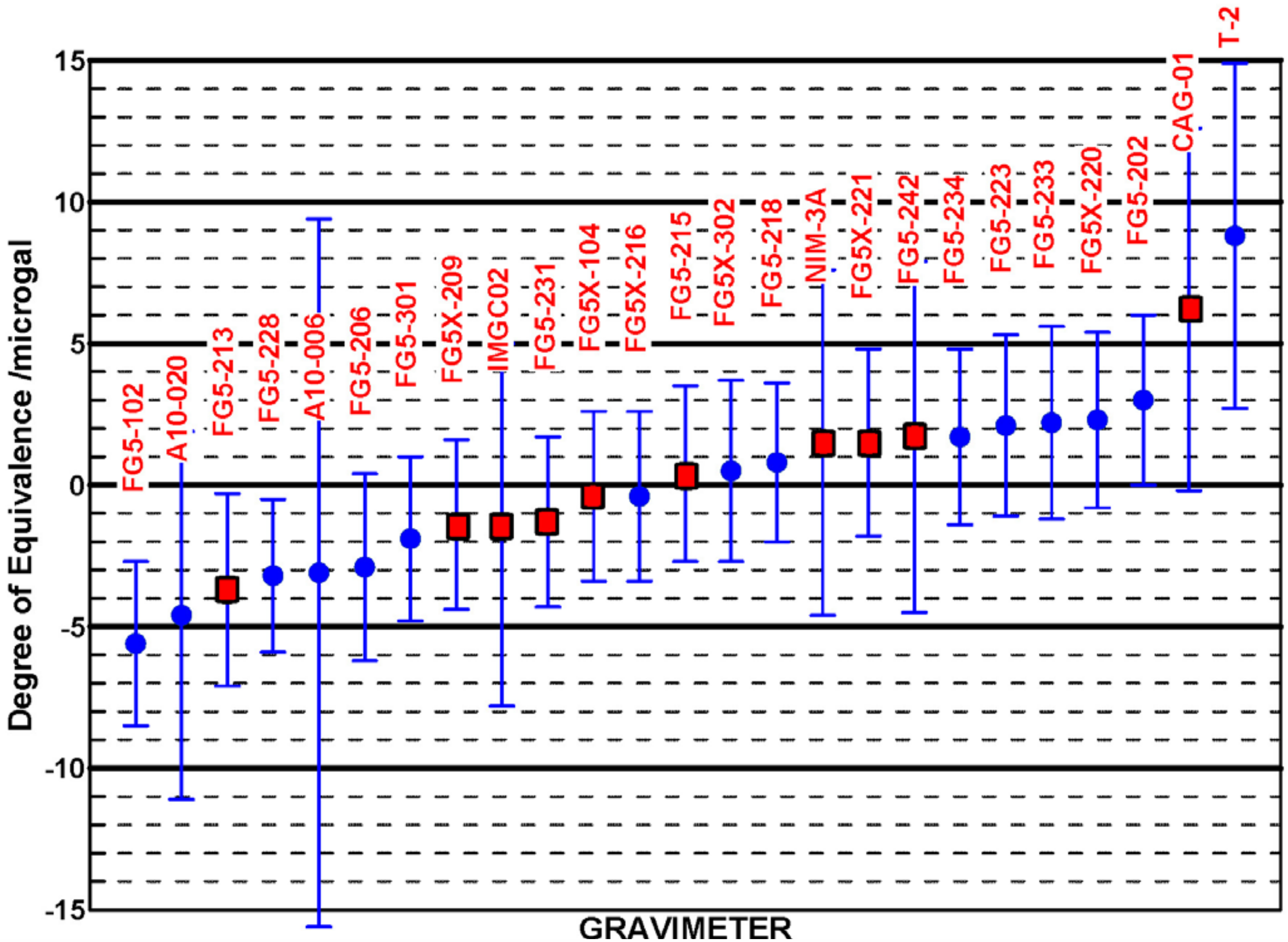
# CCM.G-K2

Participants: **10,** Type: **7** FG5 **(3** type X**) + 1** atomic **+ 2**



# CCM.G-K2 + Pilot Study

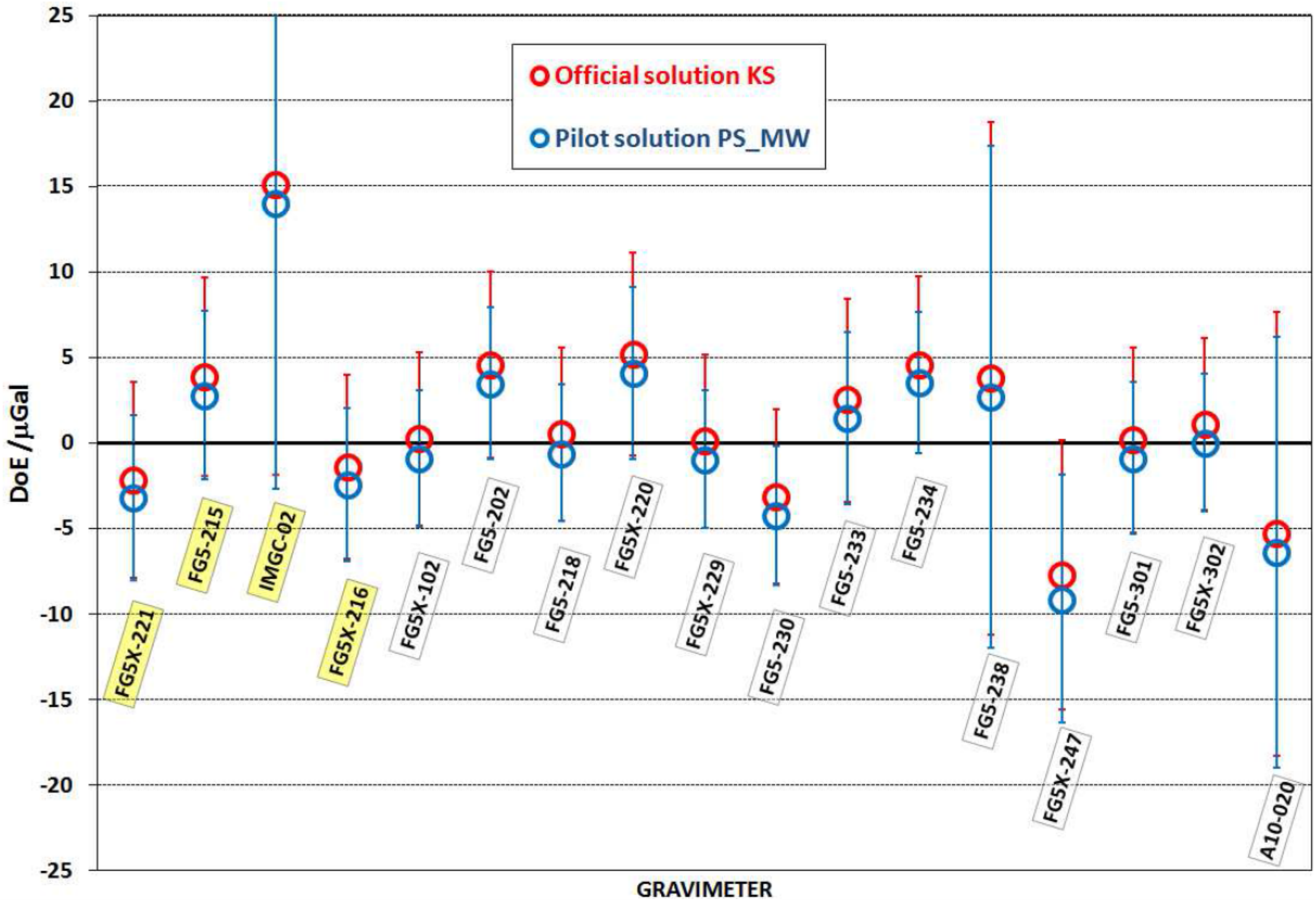
Participants: **25 (10 MNI/DI),** Type: **19** FG5 **(6** type X**) + 2** A10 **+ 1** atomic **+ 3**



# EURAMET.M.G-K2

Participants: **17** (**4 MNI/DI**, 2 USA)**,** Link: **4** (CCM.M.G-K2)**,** Type: **15** FG5 (7 type X) **+ 1** A10 **+ 1**

# EURAMET.M.G-K2



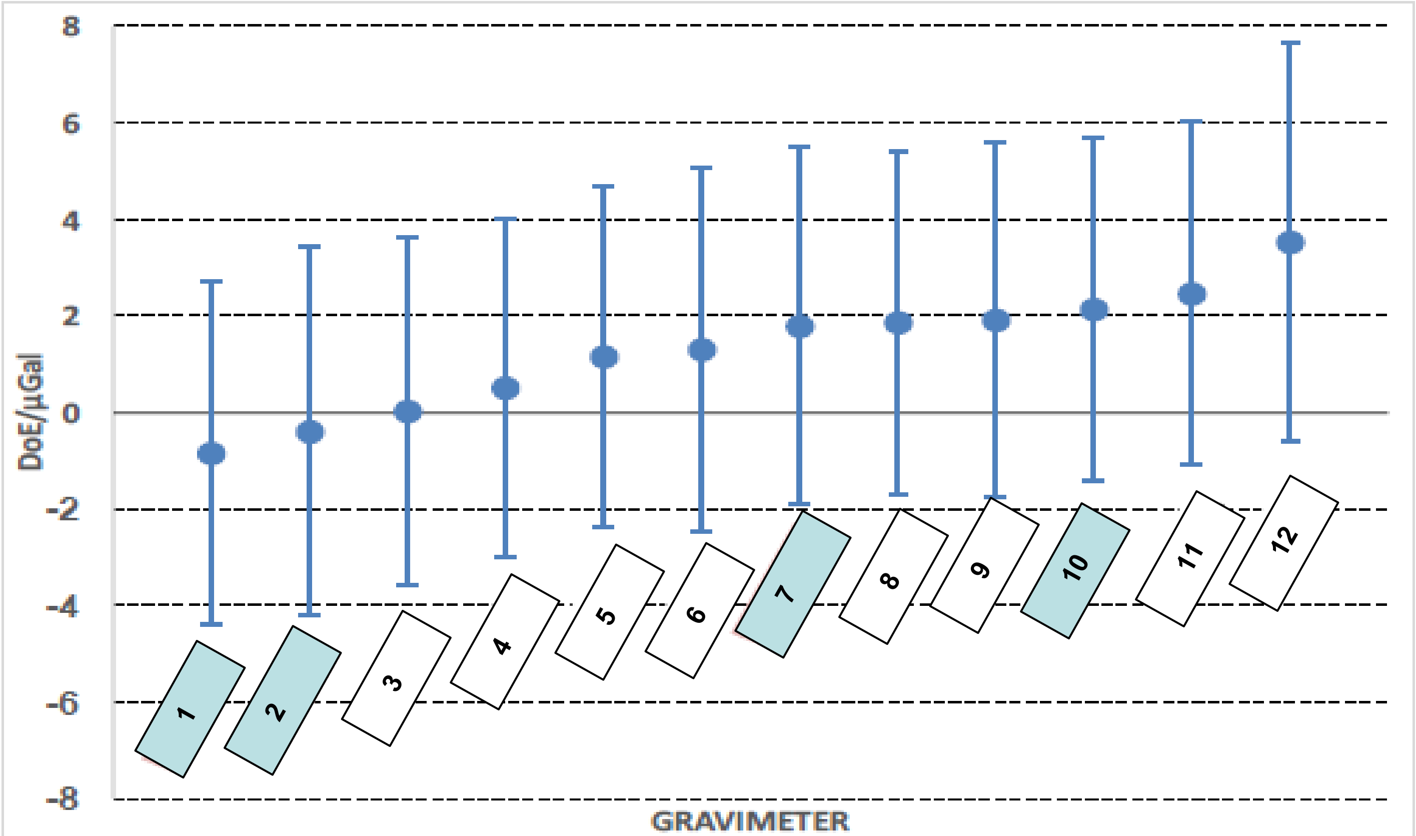
# COOMET.M.G-S1
# Bilateral

Participants: **2 MNIs** (1 EURAMET)**,** Link: **1** (CCM.M.G-K2)**,** Type: prototype

| | Abbreviation of laboratory | |
|---|---|---|
| | NSC «IM» | INRIM |
| The result of measurements of laboratory $g$, $10^{-8}$ m·s$^{-2}$ | 980533642,1 | 980533663,6 |
| Summary standard uncertainty, applied by laboratory $u_j$, $10^{-8}$ m·s$^{-2}$ | 10,7 | 4,6 |
| Difference between the measured valued $d_{ij}$, $10^{-8}$ m·s$^{-2}$ | 21,5 | |
| Standard uncertainty of equivalence degree $u(d_{ij})$, $10^{-8}$ m·s$^{-2}$ | 11,6 | |
| Expanded uncertainty of equivalence degree $U(d_{ij})$, $10^{-8}$ m·s$^{-2}$ | 23,2 | |

# SIM.M.G-K1

Participants: **12 (4 MNI/DI,** 1 EURAMET, 3 SIM, 4 from America, 5 from Europe, **),**
Link: **1** (EURAMET.M.G-K2) **+ 1** (CCM.M.G-K1)**,** Type: **all FG5 (4 type X)**



# FOREWORD

# Fourth International Comparison of Absolute Gravimeters (ICAG94)

## I. Marson

Metrologia (1995), Volume 32, Number 3

*….*

*The International Gravity Commission, a body of the International Association of Geodesy, has since 1981 recognized the need for **periodic comparisons of absolute gravimeters** in order **to detect possible systematic errors** and to **define the accuracy level of the methodology**. A Working Group (WG6 - Intercomparison of Absolute Gravimeters) is responsible for the organization of these comparisons.*

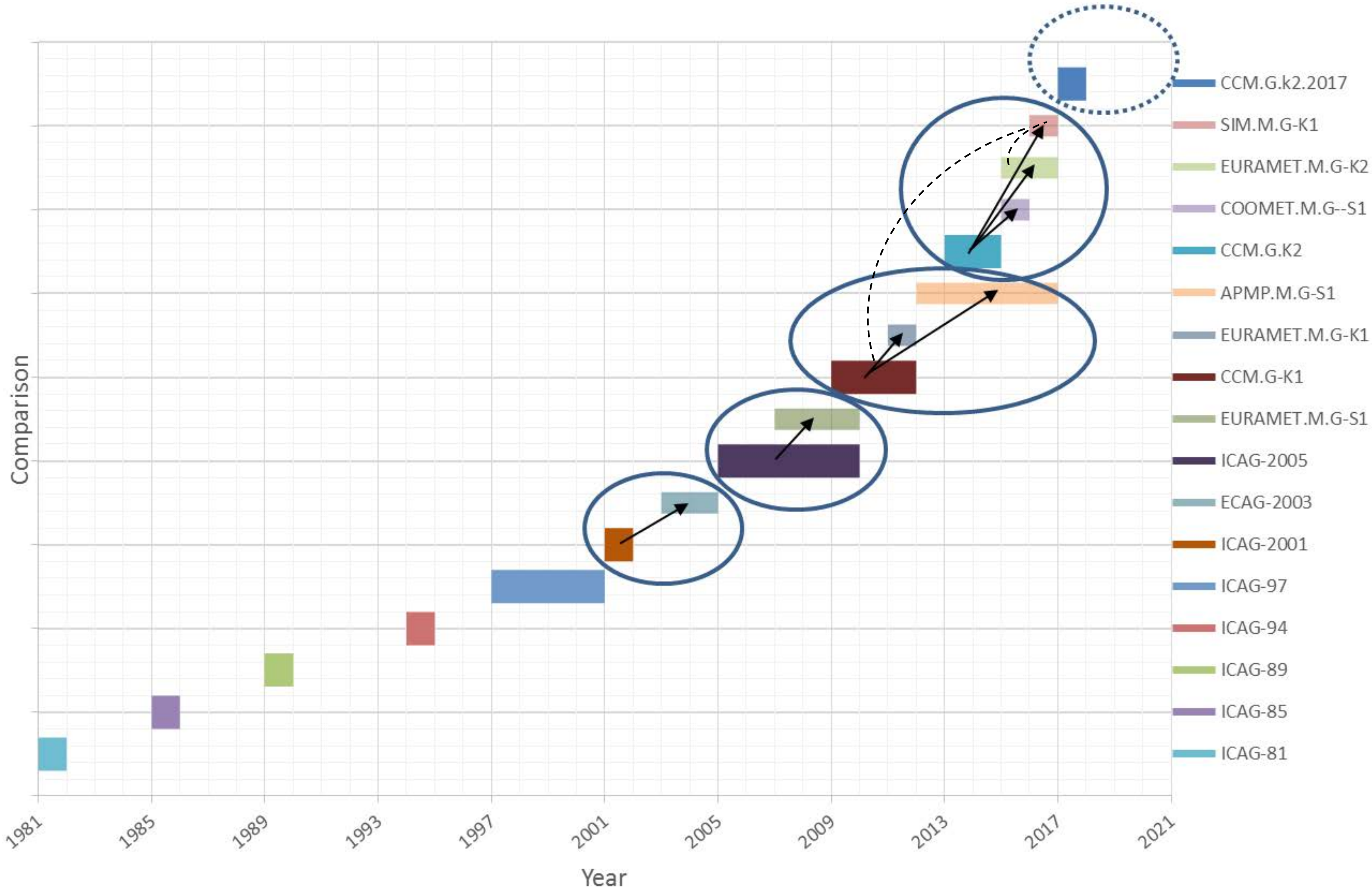
*….*

*Following the 1994 series of measurements, WG6 has decided to **continue the comparisons at the BIPM on a four-yearly basis**, supplemented by **secondary comparisons to be organized on a continental scale** (North America, Europe and Asia) to allow for an easier and possibly wider participation.*

*…*

***Technological progress** and the development of new devices for ballistic gravimetry **call for a constant effort to be made in the comparison and validation of the gravimeters**, both absolute and relative, **used in scientific research and services to third parties**.*

# Evolution of ICAGs



# Are the current and planned KCs sufficient for CMCs in gravimetry?

They are sufficient for supporting the present CMCs for the absolute gravity measurements.

At the light of new possible CMCs (absolute gravimeters calibration and relative gravimeters calibration), probably different type of KCs could be necessary.

# Highlight any major successes (since the last CCM)

- Final results of CCM.G-K2
- Organization of the CCM.G-K2.2017
- Liaison with IAG/ SC2.1 “*Gravimetry and gravity networks*”/JWG 2.1 "*Establishment of a global absolute gravity reference system*" (main challenge for the next four years)

# Highlight any major problems (since the last CCM)

- link in the RMO key comparisons (present rules seem to be not adequate due to the stability of the absolute gravimeters)
- traceability for the calibration laboratories in the field of force and derived quantities (torque, pressure, hardness, etc.). At the present only four NMIs/DIs have CMCs for absolute gravity measurements.
- At the present no CMCs are declared for the calibration of relative gravimeters, as well for the relative gravity measurements.

# Highlight technology trends and challenges in your area (according to the strategy)

- Watt balance experiments need accurate g measurements.
- In the field of absolute gravimetry, we have worldwide registered in recent years, interesting developments of new instruments based on very different technologies.
- Thanks to these studies and achievements, the number of researchers involved in this field is getting bigger. Many of the common problems are studied in several laboratories by increasing the opportunity for discussion of these issues.
- Several of these laboratories are equipped, or are gearing up to better address these researches, including also the possibility of hosting international comparisons.
- Thus, remains a fundamental need for a periodic comparison of the primary instruments, which is always very useful and important for the detection of possible systematic errors; in fact, with increasing independent technologies that realize primary measurements, it is possible to compare uncorrelated measurements.

# Thank you for your attention!