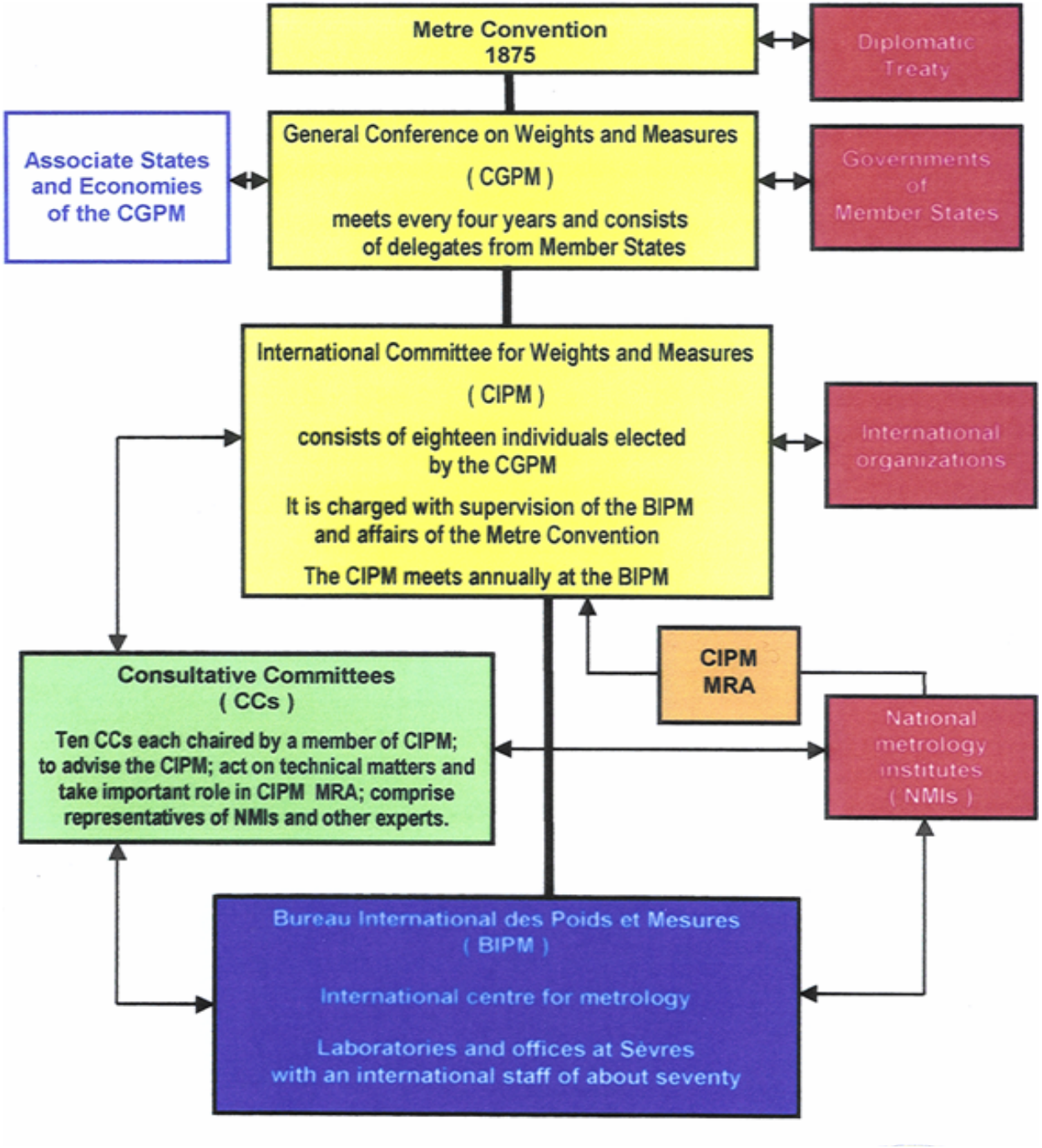
ESTABLISHING INTERNATIONAL TRACEABILITY and COMPARABILITY

Robert Kaarls
Secretary CIPM
President CCQM
Formerly Director NMi – The Netherlands

Workshop on Measurement Traceability
And Uncertainty in Analytical Chemistry
Luzern, 17-18 June 2002

Inter-governmental Treaty “Metre Convention”

- General Conference of Weights and Measures - CGPM
- International Committee of Weights and Measures - CIPM
- 10 Consultative Committees, a.o. CCQM
- International Bureau of Weights and Measures - BIPM at Sevres, France


Metre Convention
1875
Diplomatic Treaty
Associate States and Economies of the CGPM
General Conference on Weights and Measures
(CGPM)
meets every four years and consists of delegates from Member States
Governments of Member States
International Committee for Weights and Measures
(CIPM)
consists of eighteen individuals elected by the CGPM
It is charged with supervision of the BIPM and affairs of the Metre Convention
The CIPM meets annually at the BIPM
International organizations
CIPM MRA
Consultative Committees
(CCs)
Ten CCs each chaired by a member of CIPM; to advise the CIPM; act on technical matters and take important role in CIPM MRA; comprise representatives of NMIs and other experts.
National metrology institutes
(NMIs)
Bureau International des Poids et Mesures
(BIPM)
International centre for metrology
Laboratories and offices at Sèvres
with an international staff of about seventy

CCQM Metrology in Chemistry

- Established by CIPM in 1993
- After hypothesis on traceability and comparability had been proven
- Members and observers representing more than 40 institutes from 30 countries/economies
- Including (designated) NMI's and other international organisations (JRC-IRMM, IUPAC, IAEA, IFCC, ISO-REMCO, CITAC, a.o.)

CCQM Metrology in Chemistry

- **Activities**
- **Studies**
- **Primary methods (traceability)**
- **Key comparisons (comparability)**
- **How far does the light shine?**
- **Measurement uncertainty (ISO GUM, EURACHEM-CITAC Guide)**
- **Vocabulary (ISO VIM)**

CCQM Metrology in Chemistry

- **Areas defined in overall framework (1)**
- **Health (clinical diagnostic markers)**
- **Food (pesticides, toxins, drinking water)**
- **Environment (water, air, global warming, contaminants in soil)**
- **Advanced materials (semiconductors, alloys, plastics)**
- **Commodities (oil, cement, precious metals, alcohol content)**

CCQM Metrology in Chemistry

- **Areas defined in overall framework (2)**
- **Forensics (drugs, explosives, breath analysis, DNA)**
- **Pharmaceuticals**
- **Bio-technology (GMO's, DNA profiling, diagnostics)**
- **General analytical applications (purity, pH, isotopic standards)**

- CCQM
- CCQM Working Groups
- Key comparisons NIST
- Organic Analysis NIST
- Inorganic Analysis LGC
- Gas Analysis NMi
- Electro-chemical Analysis SMU
- Surface Analysis NPL
- Bio-technology LGC/NIST

Traceability

- Property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties
- To SI, whenever possible; mol, kg, m, etc. or any combination (multiple, sub-multiple)
- To “next best” internationally agreed reference if SI is not possible

Primary method

- A primary method of measurement is a method having the highest metrological qualities, whose operation can be completely described and understood, for which a complete uncertainty statement can be written down in terms of SI units
- A primary direct method measures the value of an unknown without reference to a standard of the same quantity

Primary ratio method

- A primary ratio method measures the value of an unknown to a standard of the same quantity; its operation must be completely described by a measurement equation
- In this case almost always use is made of a high purity material (a “primary reference material”)
- Thus, high purity analysis are crucial

Definition and study of primary methods

- IDMS
- Coulometry
- Gravimetry
- Titrimetry
- Calorimetry (DSC)
- INAA
- Cavity Ring Down Spectroscopy
- ID-ICP-MS

Certified Reference Materials

- Calibration
- Validation - Recovery factor (calibration)
- In general NOT the top of the chain
- Importance of pure reference materials
- Role when traceability to SI can not be realized
- Limited availability
- Matrix problems

CCQM

- Studies
- Key Comparisons
- Supplementary and bilateral comparisons
- How far does the light shine?
- Review of calibration and measurement capabilities, including traceability delivered via CRM’s, based on own characterizations and value assignment
- Reviewed Quality Assurance Systems

CCQM

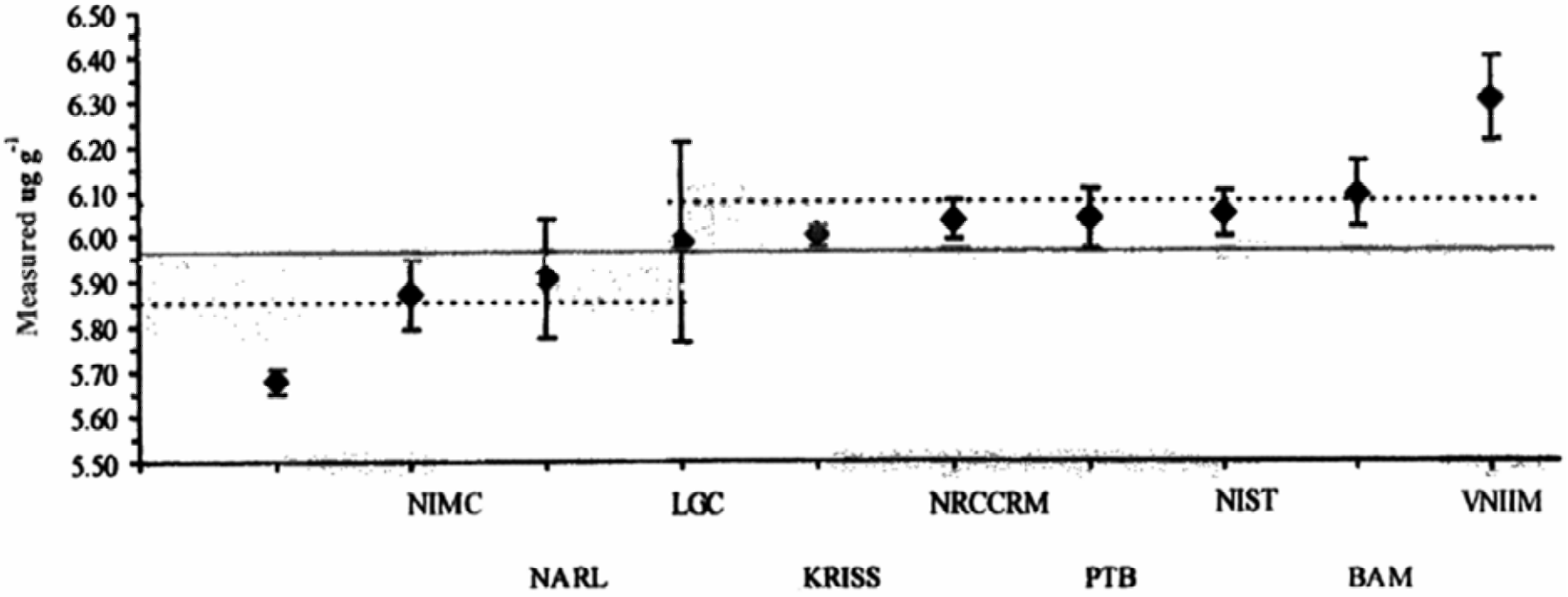
- Studies
- Development primary methods, procedures
- Try out comparisons
- How well can we do it ?
- How far does the light shine ?
- TRACEABILITY * primary method
  * through “calibrated” artifact
  measuring instrument, CRM

CCQM

- Key comparisons
- Key Comparison Reference Value (KCRV)
- Assessing competence
- Assessing capabilities
- Verifying equivalence
- Comparability

- Comparability through Traceability

Figure 2 Sample B Results showing Mean and Upper and Lower Limits of the 95% C. I. of the KCRV (NARL and VNIIM excluded)



pp DDE in Fish Oil

New areas

- Environment
- Food
- Laboratory medicine (in-vitro diagnostics)
- Forensics, drugs, doping
- Bio analysis
- Surface analysis

New networks

- WMO/Global Atmospheric Watch
- WHO/IFCC
- Codex Alimentarius/Global Harmonization Task Force
- EU Reference Laboratories
- Anti-doping Laboratories
- Intensified co-operation with ISO/IEC, WTO, OIML, IMEKO, IUPAC, IUPAP, etc

New networks in metrology

- Covering environmental area, laboratory medicine, food safety, anti-doping, forensics, etc.
- EU is creating EU reference laboratories (should be connected to the NMI's!)
- BIPM establishes networks with ISO/IEC, WTO, ILAC, WMO, WHO/IFCC, Codex Alimentarius, apart from existing contacts with OIML, IMEKO, IUPAP, IUPAC, a.o.

New networks in metrology

- Society requires metrology in much more areas, like environment, health-care, food
- Most NMI's have no wide capabilities and competence in chemistry and biotechnology
- Virtual/decentralized NMI's have to be established, by designating other key institutes as an NMI with responsibilities in a certain field (for specified quantities and measurement ranges)
- These NMI's must join in international activities under the RMO's and the Metre Convention

Role and tasks of the BIPM

- International measurement system
- Traceability, comparability, recognition
- International co-ordination in metrology
- Promotion, stimulation
- Unique international and unique transfer standards (e.g. ozone standard, may be some essential pure materials)

CIPM - MRA

- Signed in October 1999
- By NMI's of Metre Convention Member States
- Internatl. Organizations (IAEA, IRMM)
- Possibilities for Associates to the CGPM
- Appendix B (key and supplementary comparisons)
- Appendix C (best calibration and measurement capabilities, underpinned by results of comparisons and reviewed quality systems)

CIPM – MRA www.bipm.org

- International recognition of national measurement standards and of calibration and measurement certificates issued by national metrology organizations
- Based on key- and supplementary comparisons Appendix B
- Quality assurance (ISO 17025, 34, 35)
- (Peer-) assessments (accreditation)
- NMI capabilities Appendix C

CCQM
Problems in metrology in chemistry

- Matrix structure
- Instabilities and differences in composition of artifacts (reference materials) used in comparisons
- Lack of precise definition of measurand
- Need for precise prescription for treatment and measurement of artifact (sample, CRM)
- Measurement uncertainty calculations
- How far does the light shine?

Why comparability through Traceability ?

- Need for reliable measurements
- Take away Technical Barriers to Trade
- Trade, Accreditation, Metrology agreements, incl. internal markets
- Environment (long term stable reference points)
- Health care
- Food safety
- Forensics, Customs, Anti-Doping, etc.