The CCQM, What It Does, What It Has Achieved and Why It is Important to You

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Symposium on Chemistry and the International System of Weights and Measures
Symposium at ACS National Meeting, Boston, MA, August 19, 2015

Bureau
International des
Poids et
Mesures

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- Global need for comparable measurement results through traceability
- Metrological traceability and the Traceability Chain
- The role and deliverables of the NMIs and DIs
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- What are the problems and what goes wrong
- How do the NMIs/DIs and the CCQM work
- CIPM Mutual Recognition Arrangement – CIPM MRA, Quality Chain
- Joint Committee on Traceability in Laboratory Medicine – JCTLM

Need for globally comparable and accepted measurement results for sustainable competitiveness, innovation, better quality of life

- Global trade in commodities ~18 trillon US$ (2012) (WTO Statistics 2013)

  - 80% affected by standards/norms and regulation

  - compliance costs ~10% of production costs

- Industrial, energy, food (>1,2 trillion USD), pharmaceuticals (>461 billion USD), cosmetics, and all other products from everywhere

- Global spread of diseases and global environmental and climate issues

- Global security, forensics and anti doping

- "soft/perceptive" metrology (smell, taste, blends, color, glance, form,etc.) physiological measurements

- **Requires comparable, traceable measurements**

Demanding Metrological Traceability

- Legislators, Regulators (fair trade, carbon trading, food, health, pollution, police)
- Joint Committee on Traceability in Laboratory Medicine - JCTLM (BIPM, IFCC, ILAC, WHO, in-vitro diagnostics industry)
- Codex Alimentarius Commission, HACCP, micro-biology
- Animal health, plant protection, bio-diversity
- WMO Global Atmospheric Watch, climate change
- Pharmacopeia (USP, EDQM, JP, pharmaceutical industry)
- Sports and World Anti Doping Agency – WADA
- Forensics authorities and security authorities
- VAMAS, materials metrology
- And many others, such as of course industry, traders, laboratories

Addressing metrological traceability and measurement uncertainty

CIPM and **BIPM** cooperate with all organizations through workshops and in the CIPM Consultative Committees, such as the **CCQM with all its Working Groups**

“Once measured, everywhere accepted” requires Comparability through <u>Traceability</u>

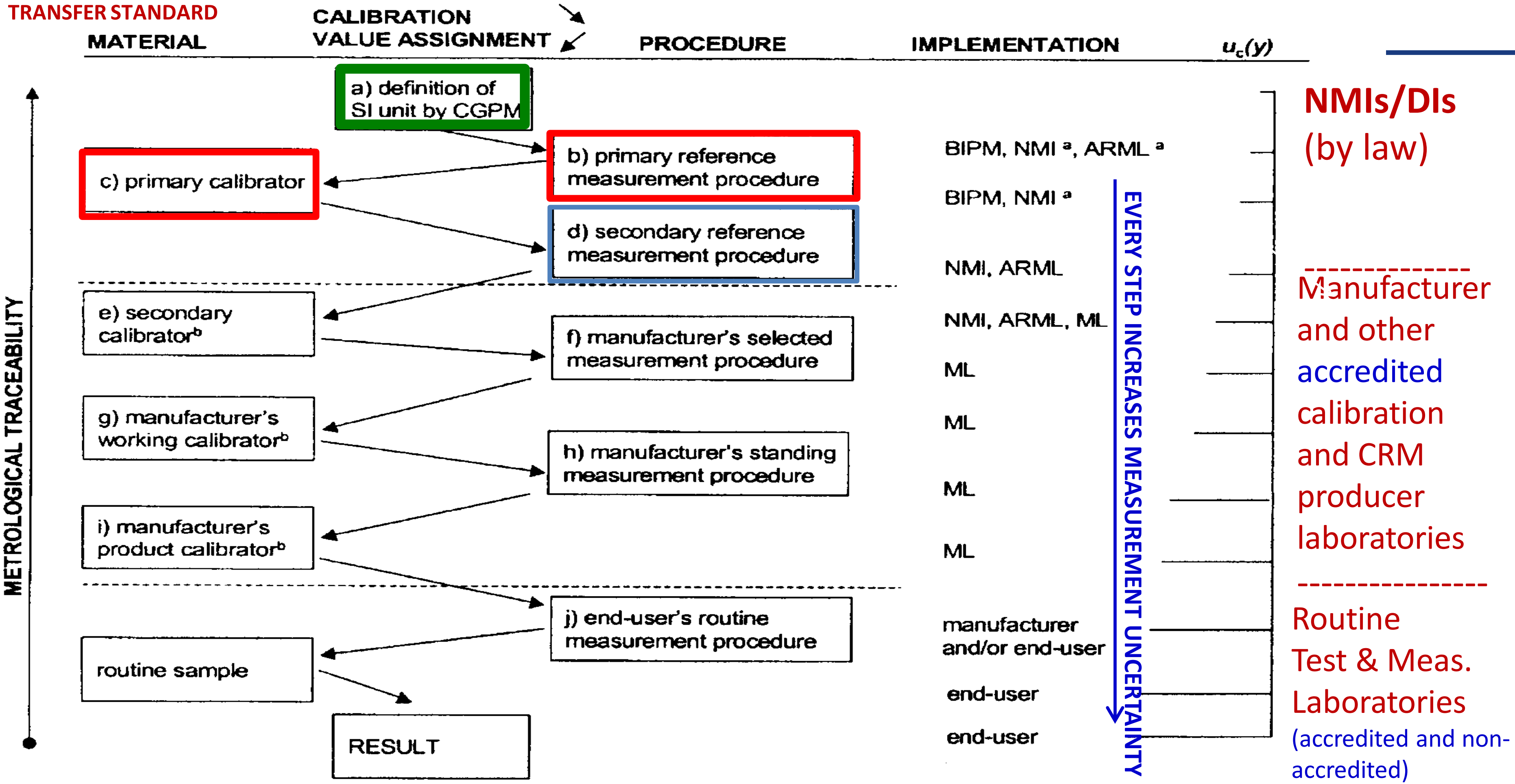
Metrological traceability

Property of a **measurement result** whereby the result can be related to a reference **through an unbroken chain** of calibrations, each contributing to the **measurement uncertainty**
JCGM 200:2008 (VIM 3)

Traceability to the SI, or if not (yet) possible to another internationally agreed reference (e.g. hardness, pH, WHO International Units)

Traceability chain

(by courtesy of ISO (ISO 17511) and BIPM)



Traceability to the SI ((bio-)chemical measurements)

Traceability to the mole or other SI units

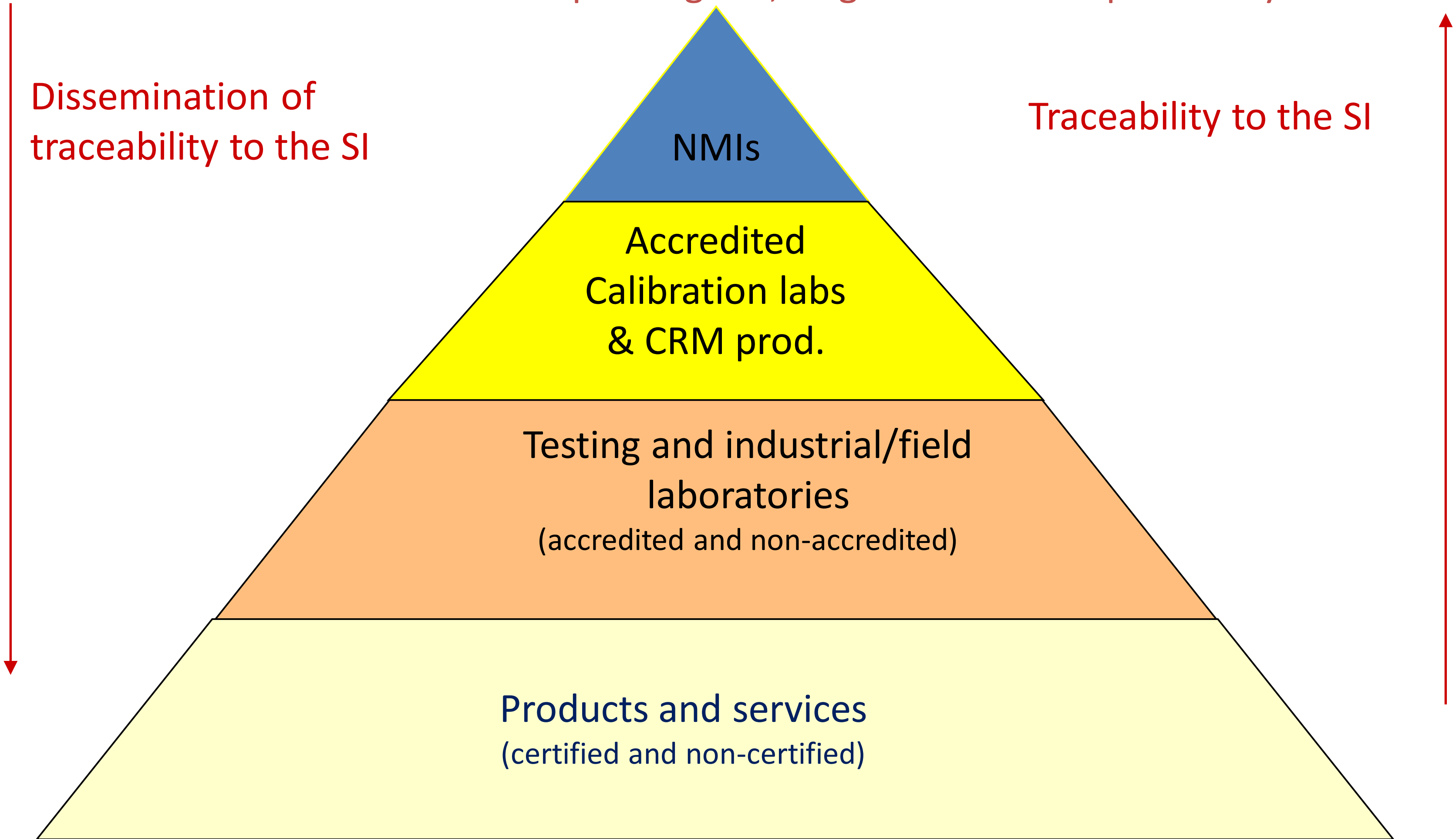
- Amount of substance : mol
- Amount fraction : mol/mol
- Amount concentration : mol/m^3
- Mass concentration : kg/m^3
- Amount content : mol/kg
- Mass fraction : kg/kg
- Surface analysis : nm

(or expressed in multiples or sub-multiples)

In cases of traceability to e.g. WHO International Standards (CRMs) and Units; no traceability to the SI, and no long term stable references

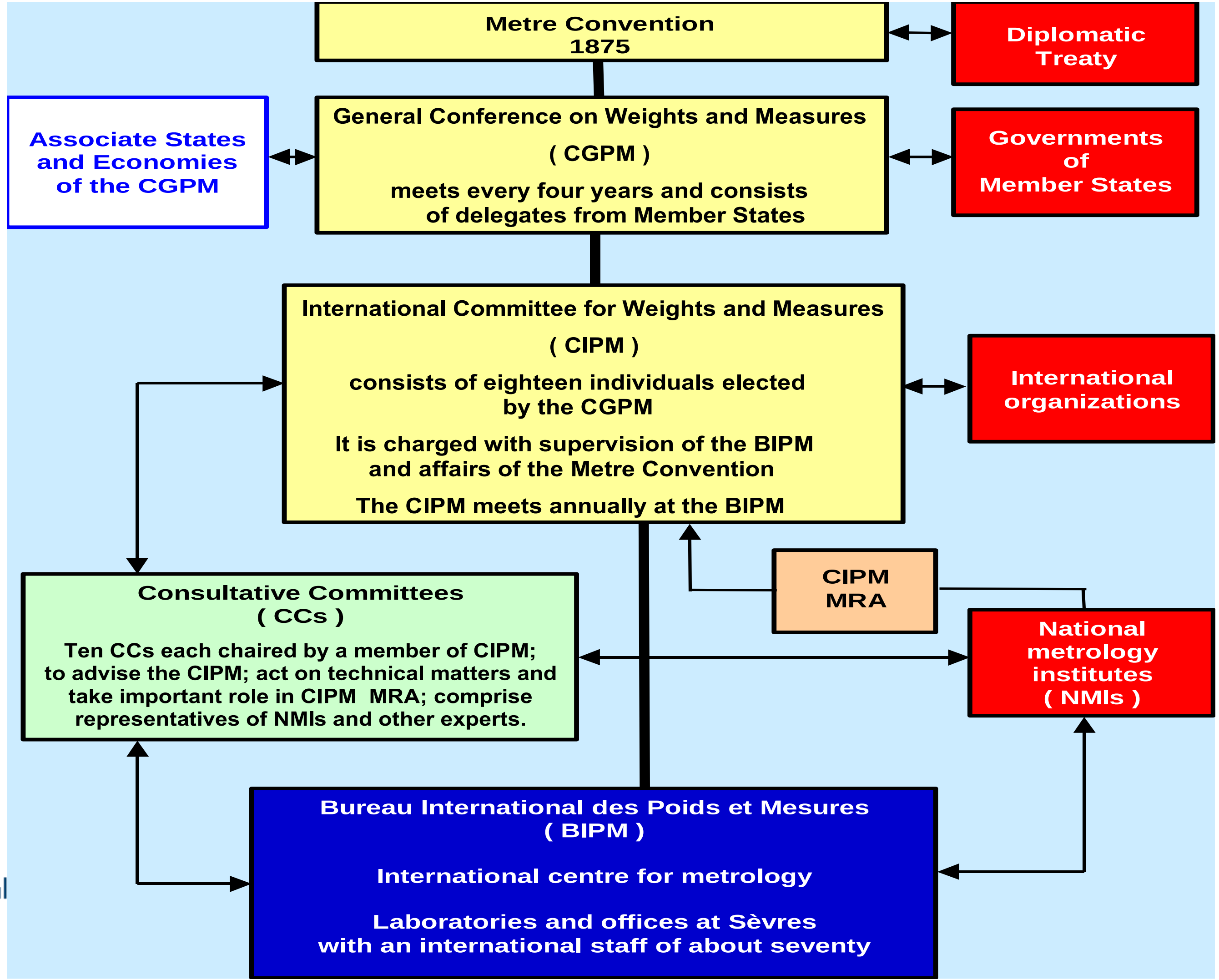
The National Metrological Infrastructure

National measurement standards are a public good; so government responsibility and resources



Services to be delivered by National Metrology Institutes and other Designated Institutes

- **Calibration** of (transfer) measurement standards and capability to assign values to physical, bio and chemical reference samples
- **Certified Reference Materials** (production, certification)
- **Reference value assignment of Proficiency Testing** samples (own PT schemes and/or third party PT schemes)
- **Validation of measurement methods/procedures**
- Delivering traceability to industry and ILAC Arrangement accredited calibration and testing laboratories, CRM producers and PT providers
- Delivering traceability to sector specific reference laboratories (clinical and food reference laboratories, WMO reference laboratories, a.o.)



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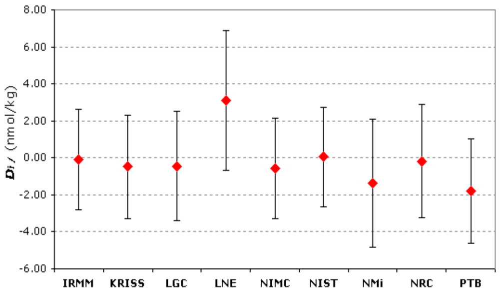
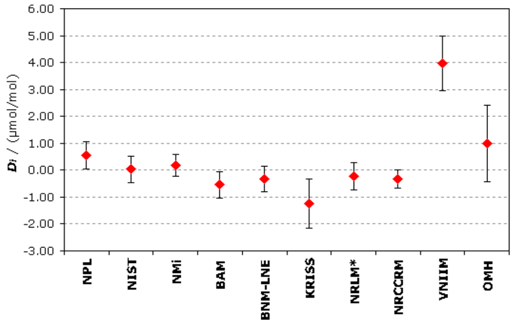
CCQM – the Beginning

- A Working Group on Metrology in Chemistry was established by the CIPM at its 80th meeting in September 1991
  - Study I, metals in solution (coordinated by NIST)
  - lead (and cadmium) in natural water
    - 1st study 1992-1994 not satisfactory
    - 2nd study 1995-1998 acceptable results



  - Study II, measurement of gases (coordinated by VSL)
  - Carbondioxide in nitrogen



- In 1993 CIPM decided to endorse the Working Group's recommendation that a permanent Consultative Committee for Amount of Substance be formed

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How to establish global comparability through traceability ?

The 1st meeting of the CCQM in 1995

Still many scientists outside the CCQM doubting whether it will ever be possible to establish traceability in chemistry

CCQM – Metrology in Chemistry and Biology

President: W. May (Past President: R. Kaarls, 1993-2013)

Executive Secretary: R. Wielgosz (BIPM)

~ 45 Member and Observer Organizations

~ 250 experts active in the CCQM WGs

Some WGs meeting twice per year

CCQM plenary in April 2015

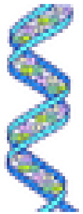
CCQM Working Groups

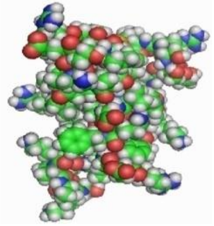
Chairpersons/Strategic Planning	NIST	W. May
Key Comparisons and CMC Quality	GLHK	W.M.(Della) Sin
Organic Analysis	NMIA	L. Mackay
Inorganic Analysis	LGC	M. Sargent
Gas Analysis	KRISS	J.S. Kim
Electro-chemical Analysis	SMU	M. Mariassy
Surface Analysis	BAM	W. Unger

CCQM – Metrology in Chemistry and Biology

CCQM Working Groups (continued)

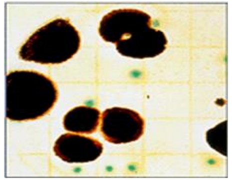
- Nucleic Acids — LGC — H. Parkes
- Proteins — KRISS — S-R. Park
- Cells — NIST — A. Plant





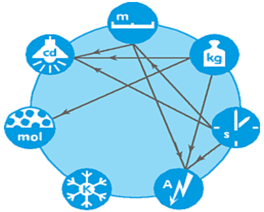
CCQM ad hoc Steering Group

- – Microbiology — NIST — J. Morrow
- – Identity WG — NIST/IRMM — J. Morrow/H. Schimmel
- – Quantity WG — NMIA/NIM — D. Clarke/Wang Jing



CCQM ad hoc Working Group

- Redefinition SI — PTB — B. Güttler
- CIPM MRA and CMC database review — CIPM/CCQM — R. Kaarls

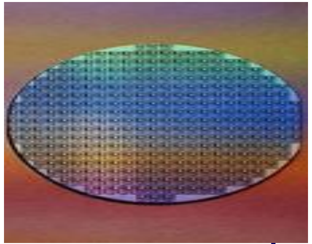


CIPM MRA

CCQM Metrology in (Bio-)Chemistry

- High purity Chemicals (inorganic and organic compounds, **metals**, isotopics, other)
- Inorganic solutions (elemental, anionic, other)
- Organic solutions (PAHs, PCBs, pesticides, other)

- Gases (high purity, environmental, fuel, forensic, medical, other)
- Water (fresh water, contaminated water, sea water, other)
- pH
- Electrolytic conductivity

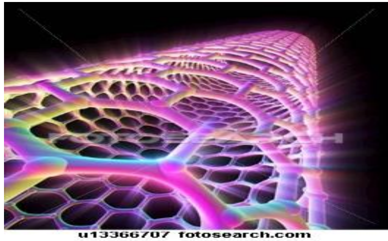


- Metals and Metal alloys (ferrous metals, non-ferrous metals, precious metals, other)
- Advanced materials (semiconductors, superconductors, polymers and plastics, ceramics, other)

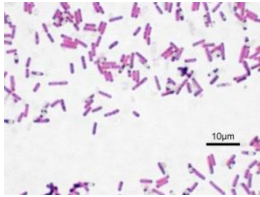
CCQM Metrology in (Bio-)Chemistry

- Biological fluids and materials (blood serum, renal fluids, hair, tissues, bone, botanical materials, other)
- Food (nutrional constituents, contaminants, GMOs, other)

- Fuels (coal and coke, petroleum products, bio-mass, other)
- Sediments, Soils, Ores and Particulates (sediments, soils, ores, particulates, other)



- Other Materials (cements, paints, textiles, glasses, thin films, coatings, insulating materials, rubber, adhesives, other)
- Surfaces, films and engineered nanomaterials (inorganic, organic, biomaterials, other)
- Micro-biological pathogens (bacteria, virusses, fungi, yeast, mould)



Priority areas in the USA (NIST)

- Energy (biofuels, hydrogen fuel, solar, wind) green, renewable

- Environment and climate change (WMO GAW)long term future
- Healthcare better healthcare, cost reduction
  - Diagnostics (EU IVD directive driven)

  - Therapeutic (WHO)

  - Pharmaceuticals (USP, a.o.)
- Food safety and nutritional value (FDA, EU, etc.) better food quality, more healthy people, reducing the economic costs of food borne illnesses and waste of food
- Homeland security/forensics safer society

Priority areas in the EU (EURAMET)

European Metrology Research Programme (FP 7 and art.185) and EMPIR on Innovation and Research (EU Horizon 2020)

•Health care (Virtual human modelling system, Reference measurements and materials (JCTLM), Diagnostic and Therapeutic instrumentation (imaging, microscopy, NMR, ultrasound)
better health care, innovative products

•Energy (New and renewable energy resources, Smart energy networks)
green and renewable energy

•Environment and climate change (Detecting change and monitoring climate, Carbon dioxide sequestration) a cleaner and long term future

•Fundamental metrology (SI, Nanotechnology, Security related metrology)
fundamental measurement standards, and safe nanotechnology and a safer society

CCQM stakeholder and expert cooperation

- BIPM (scientific and industrial metrology), OIML (legal metrology)
- MoU with WHO, WMO, IAEA, ILAC, JCTLM (IFCC and ILAC)
- Codex Alimentarius Commission/IAM, IUPAC, WADA, VAMAS, Pharmacopeia/USP, IAFSI/ENFSI, ISO, a.o.

- Regulators, Industrial Societies, Sector Specific Reference Laboratories, EQAS, PT providers, a.o.
- Addressing the "Grand Challenges" in society and economy (EU, APEC, USA, Japan, a.o. with focus areas on food safety, health care, environmental control/climate change, energy, advanced and nano materials, and security/forensics)

Parameters for Bioethanol to be included in MRC

As presented in the White Paper

Equally for Bio Diesel – FAME, many organic components

- Density
- Sulfate content
- Sulfur content
- Copper content
- Iron content
- Sodium content
- Ethanol content
- Acidity
- Phosphorus content
- pHe
- Chloride content
- Water content

Ocean salinity

- Salinity is one of the most important input quantity of climate models and of Tsunami warning systems.

- Standards are maintained and disseminated on behalf of International Association for the Physical Sciences of the Oceans (IAPSO) by OSIL.

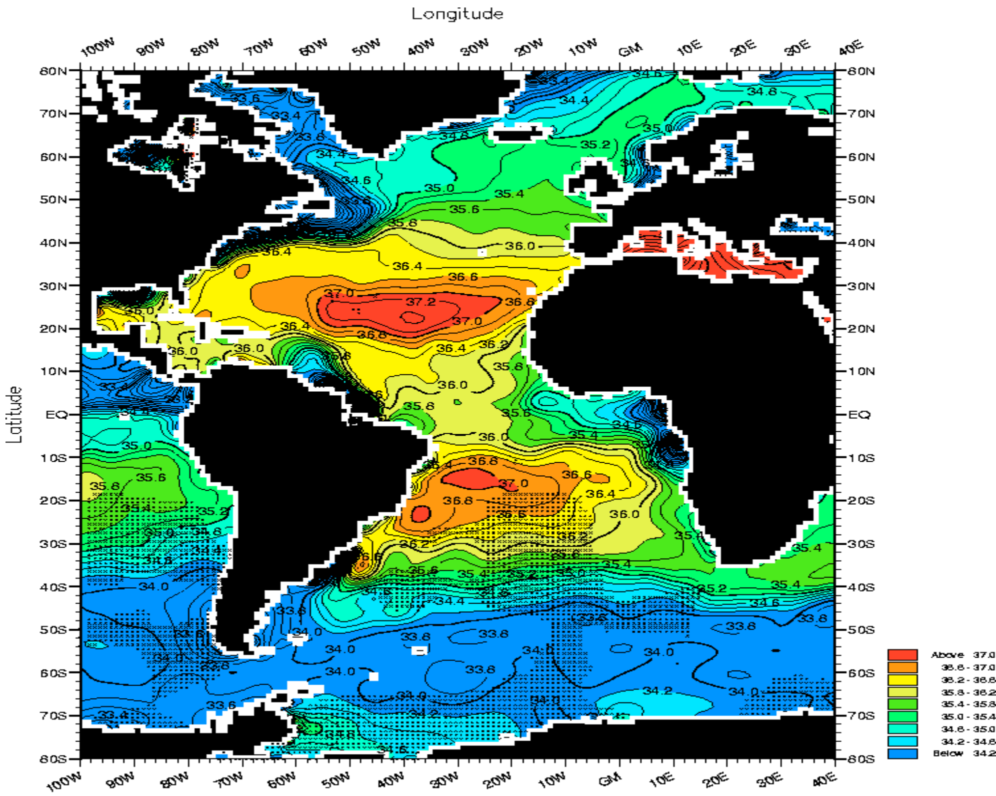
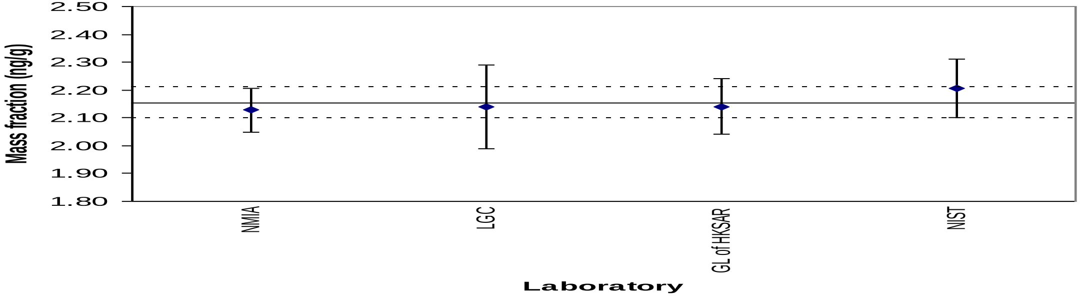


Fig. I2-1. April mean salinity (PSS) at the surface.
Minimum Value= 0.00 Maximum Value= 42.22 Contour Interval: 0.20

Forensics

- Crime Scene Investigations
- **Standards for Drunk Driving Testing**
- **Drugs of Abuse in Urine and Hair**
- **Sports Medicine**
- **DNA-based Human Identification**
- Explosives Detection
- **Estimating Drug use within the Population**

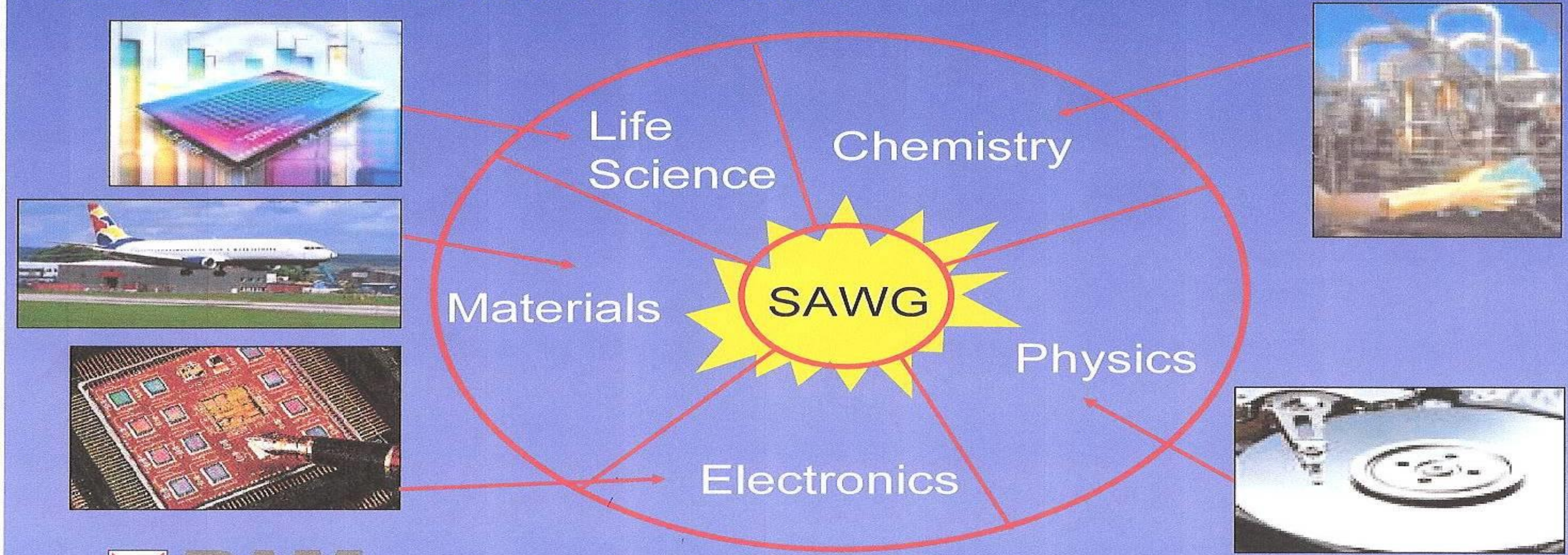
Anabolic Steroids in Urine



Very good results of a comparison of 4 NMIs/DIs, which deliver traceability, carried out in cooperation with the WADA

Surface and Micro/NanoAnalysis (SNMA) at the Interface

SMNA resides in a number of NMIs in one or more different Divisions, depending on local histories – so the light may shine in different directions in the NMIs.



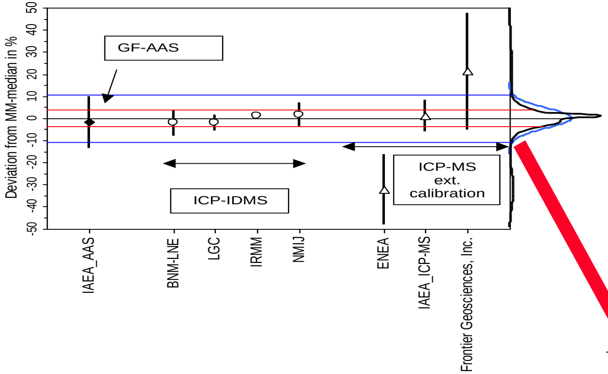
Why need of reliable micro-biological measurements?

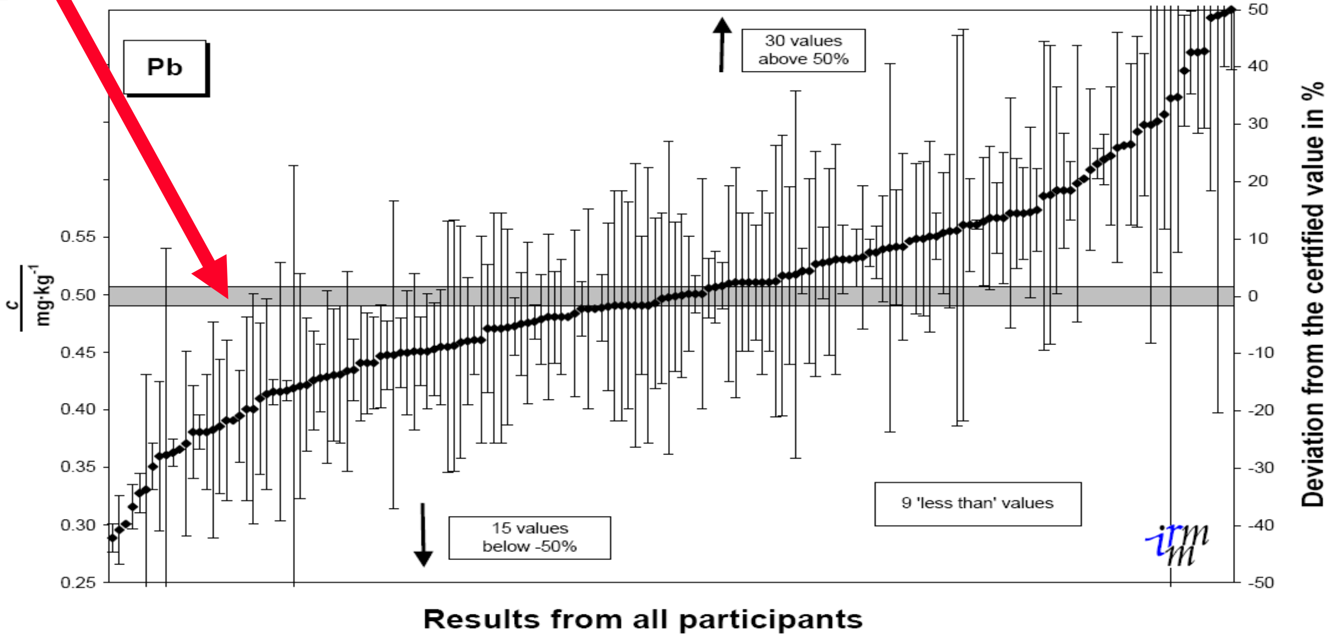
- Already for many years requested by a number of NMIs
- 2013 world export volume of food products > 1200 billion USD
- Estimated that 20% to 30% of total world food production is lost due to microbial spoilage
- USA CDC statistics on food-borne illnesses indicate:
  - 48 million illnesses per year due to food-borne pathogens, of which
  - 128 000 hospitalizations and 3000 deaths
  - It means every year 1 in 6 Americans are affected
- Food poisening in the EU (EFSA 2009 figures)

	EU 2009	USA 2011 estimated
Salmonella	108 614	1 027 561
Campylobacter	198 252	845 024
Listeria	1 645	255 death
VTEC E.coli	3 573	2 100 hospitalized

(sources CDC statistics and Campden BRI)

CCQM-P39 and IMEP-20: Pb in tuna fish



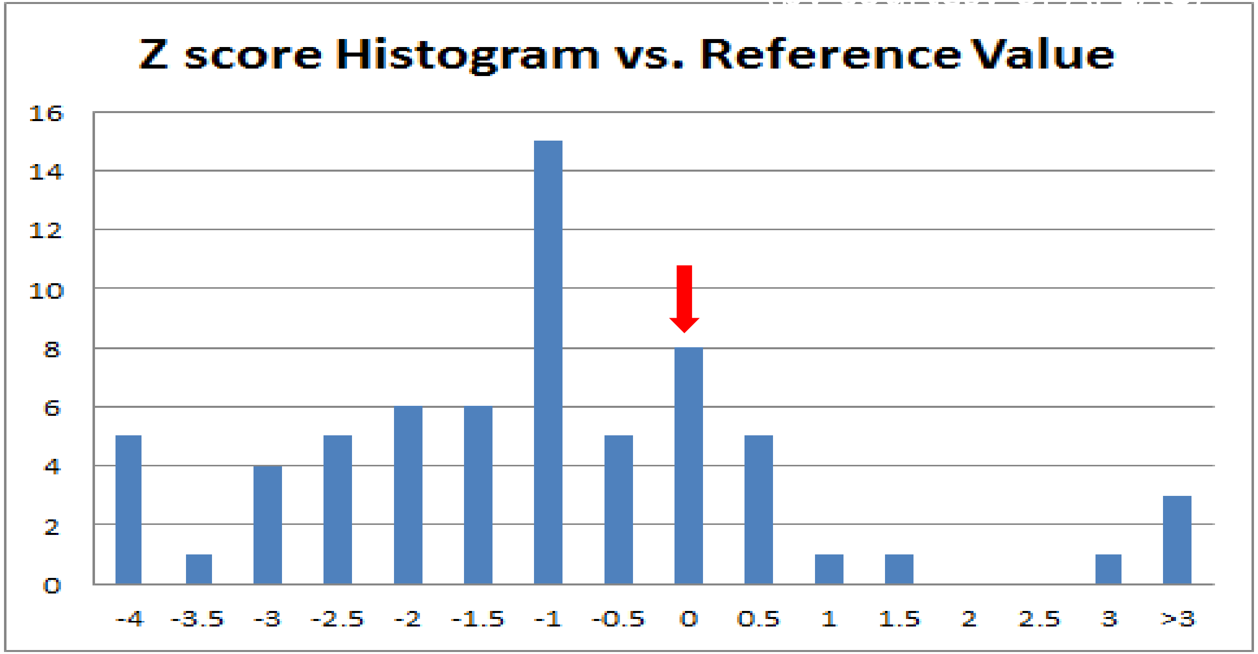


Reference Value or Consensus Value

- A good example of the outcome.
- Apparent bias was found in recent APLAC Accreditation PT program.

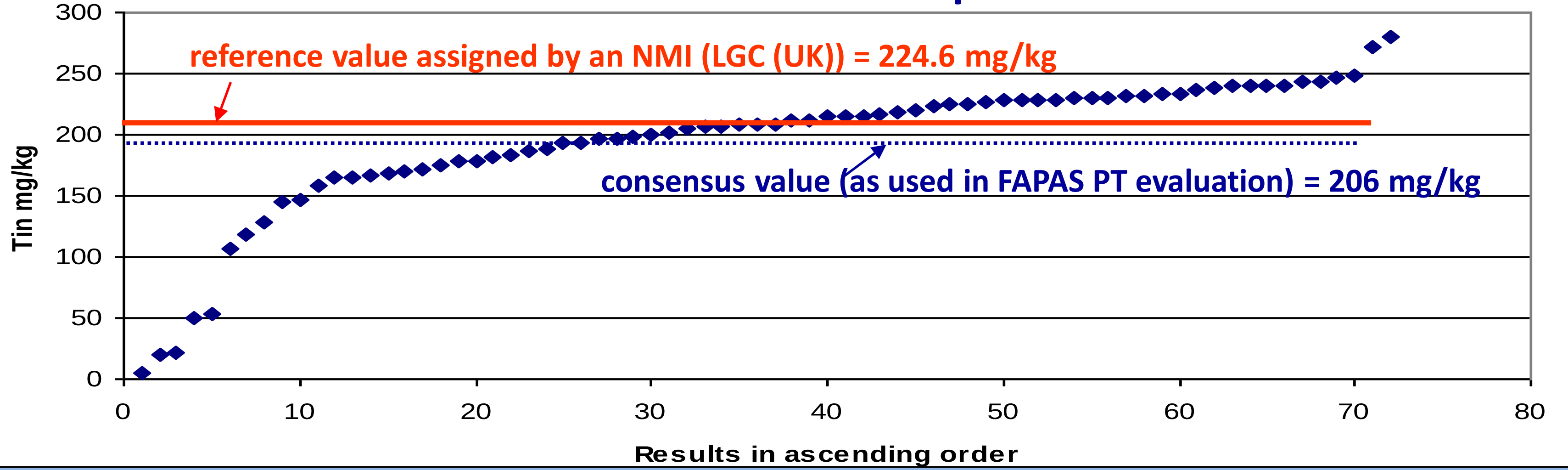
'PAH in Sediment'

- Corrective actions needed
- Demonstrates the advantage of an assigned reference value instead of a consensus value



Food Analysis Performance Assessment Scheme (FAPAS®)
Proficiency Test 0754 Results (>70 food testing laboratories)

Tin in a frozen tomato paste



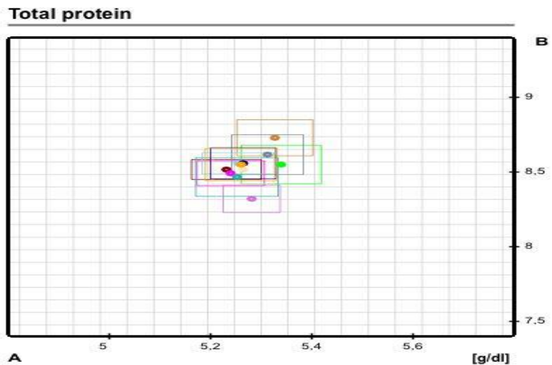
Changes in ratings of laboratories PT performance if use reference value instead of consensus value

Effect on Rating	Number of Labs.	Percent
'Acceptable' >> 'Unacceptable'	17	37
'Unacceptable' >> 'Acceptable'	9	20
No change to rating	20	43

Current major measurement problems in (bio-)chemistry

- Impossibility to address all possible analyte-matrix combinations
- Lack of pure, primary calibrators/reference materials

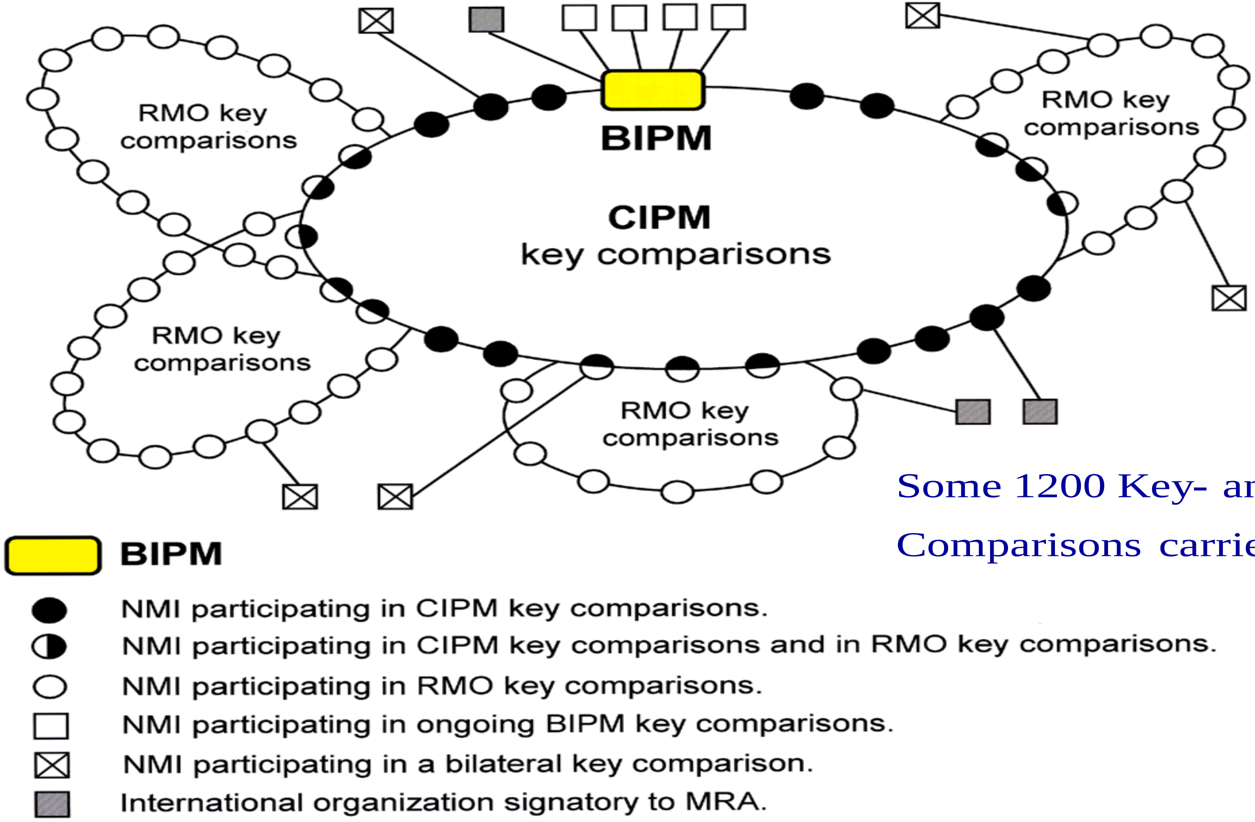
  Quantification and Identification !
- Measurand not understood (insufficient knowledge of what the measurand, intended to be measured, should be, and not sure what is really measured)
- Measurand is method/procedure defined (need global harmonization of procedure)
- “reference” methods/procedures are not metrologically sound
- Insufficient global harmonization of measurement methods (e.g. moisture in grains and cereals; in cooperation with OIML, ISO, Codex Alimentarius, legislators)
- Measurement uncertainty
- No calibration chain/hierarchy
- Lack of CRMs
- Commutability problems



RELA-IFCC
DGKL-RFB
EQAS 2010

CIPM, CCQM, BIPM, RMOs and bilateral comparisons in the scope of the CIPM MRA

Scheme for Key Comparisons



Some 1200 Key- and Supplementary-Comparisons carried out and planned

WGs Conducting Key Comparisons that Interrogate Measurement Competencies that Cover a Broad Range of Application Areas *… including the following examples:*

Health
- clinical diagnostic markers
- electrolytes *(Na, K, Ca),* Pb in blood
- anabolic steroids in urine

Food
- Pesticides, antibiotics hormones
- vitamins and minerals
- drinking water
- ethanol in "Adult Beverages"

Environment
- air, soil, sediments
- biological tissues
- waste water

Advanced Materials
- semiconductors, alloys, polymers

General Studies
- pH and electrolytic conductivity
- purity assessment
- calibration solutions mixtures

Forensics
- drugs, breathalyzer *(ethanol-in-air)*
- explosive residues
- DNA profiling

Commodities
- emissions trading, sulfur in fossil fuels
- natural gas
- cement

Biotechnology
- DNA quantification
- protein quantitation
- GMO

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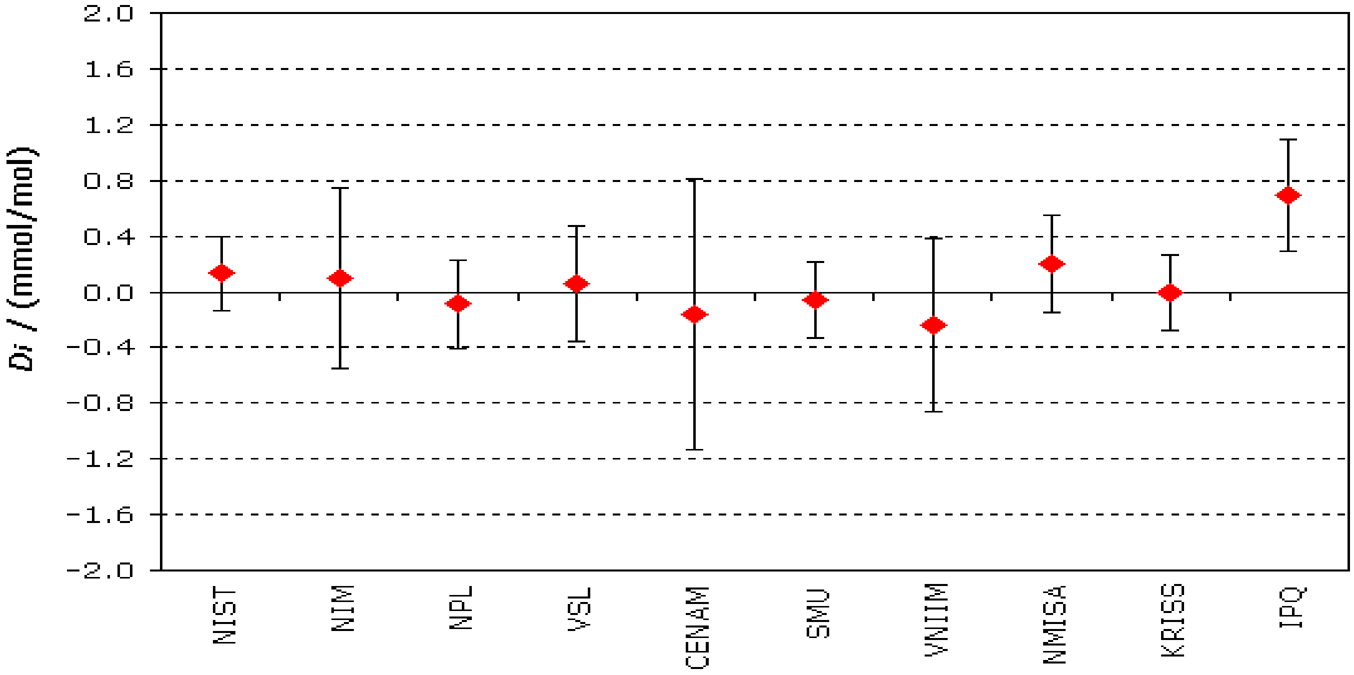
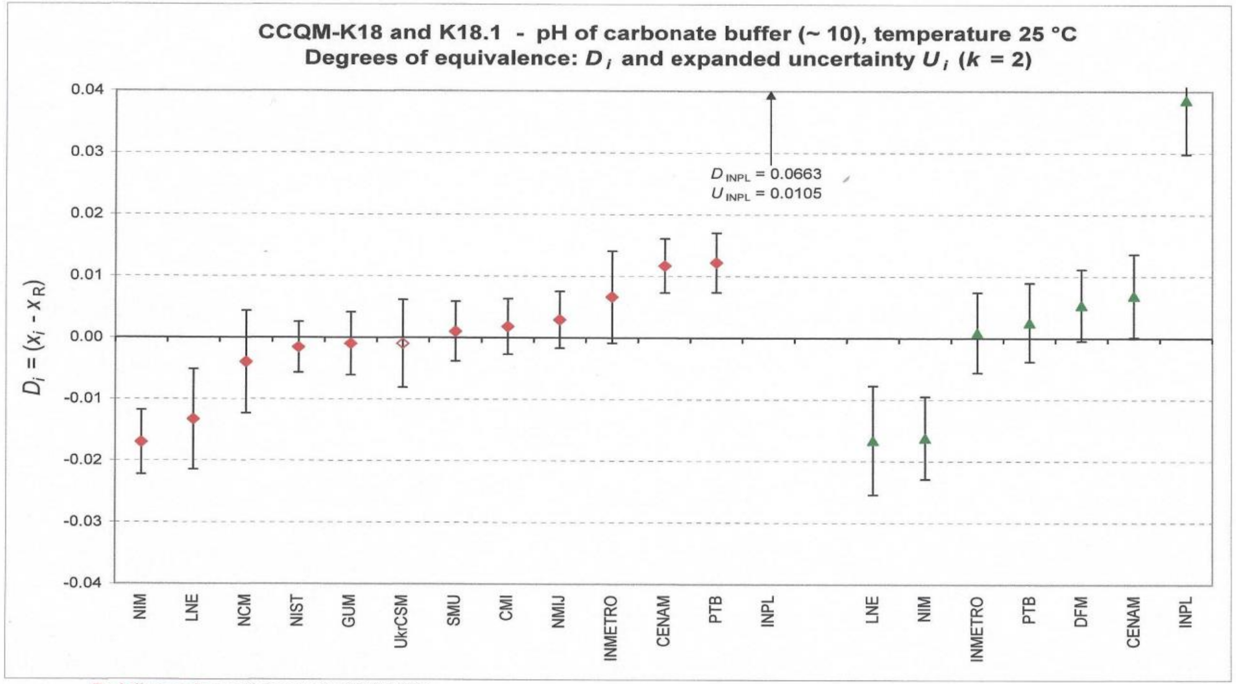
Amount of Substance fraction of CO_2 in Stack gas

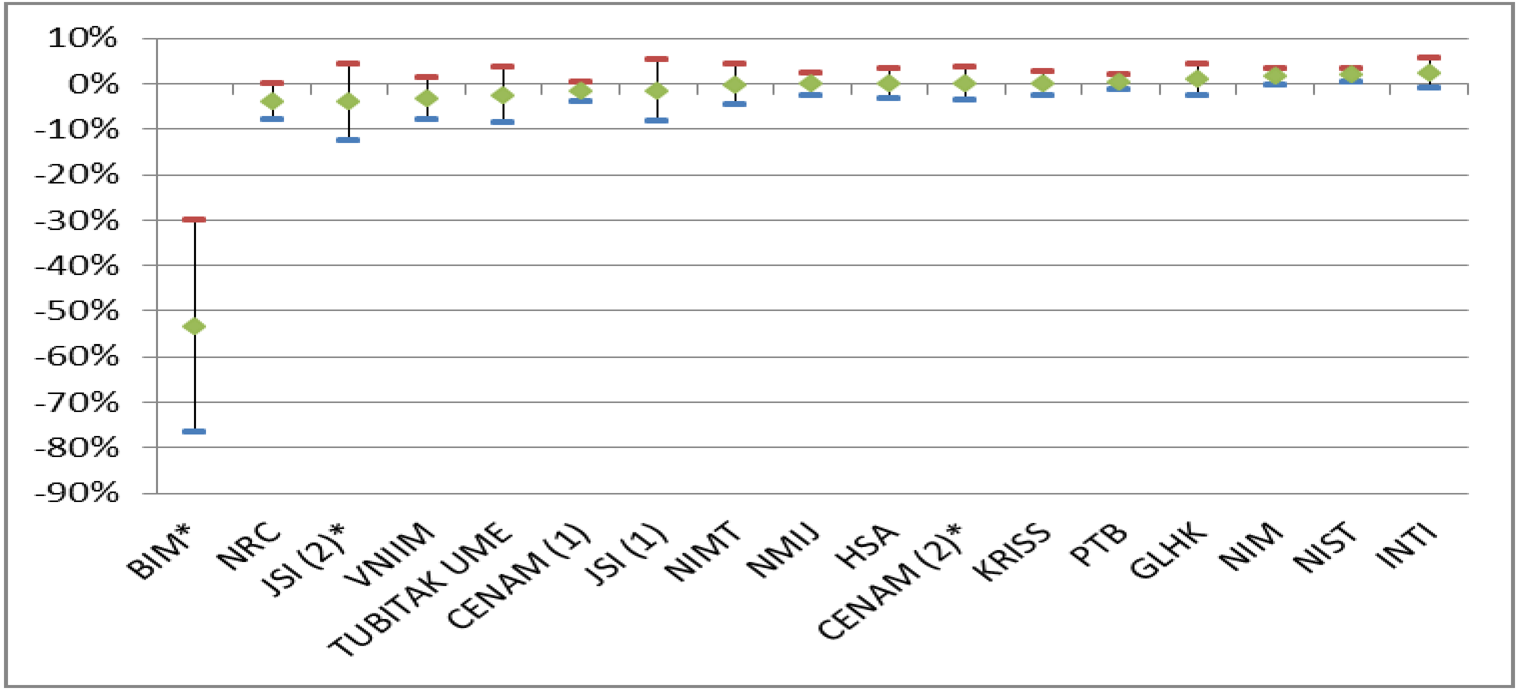
Degrees of equivalence, offset D_i and expanded uncertainty (k=2) U_i expressed in mmol/mol

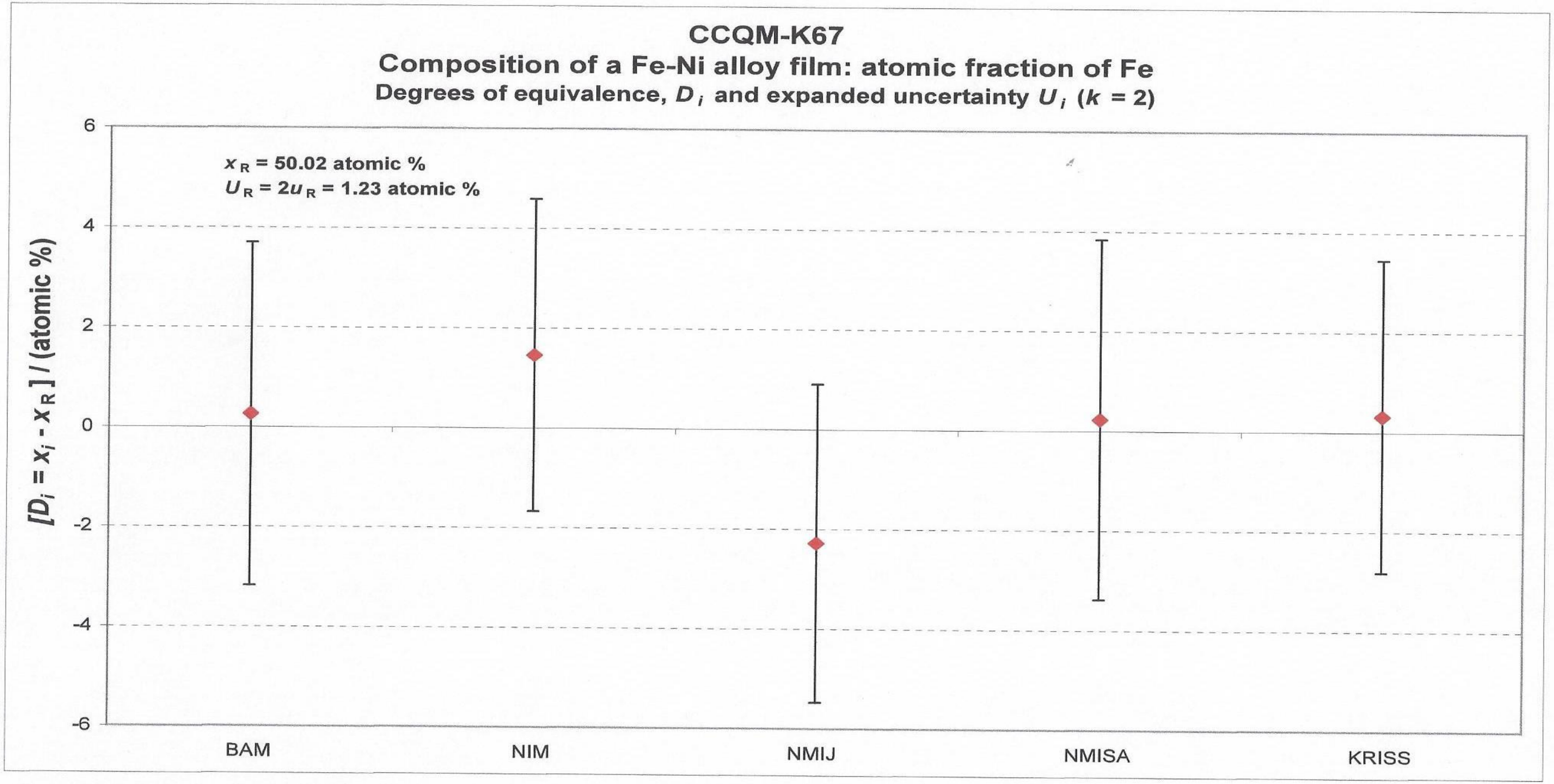




Red diamonds: participants in CCQM-K18
Green triangles: participants in CCQM-K18.1
Open symbols represent values for laboratories in Associate States and Economies of the CGPM

Ca in Herba Ecliptae




CCQM-K67
Composition of a Fe-Ni alloy film: atomic fraction of Fe
Degrees of equivalence, D_i and expanded uncertainty U_i (k = 2)
x_R = 50.02 atomic %
$U_R = 2u_R$ = 1.23 atomic %
$[D_i = x_i - x_R]$ / (atomic %)
6
4
2
0
-2
-4
-6
BAM
NIM
NMIJ
NMISA
KRISS

CIPM Mutual Recognition Arrangement – CIPM MRA

- Covering all physical, chemical and biological measurement areas
- In total > 24 000 CMCs published (March 2015), based on on-site peer reviewed capabilities and competences **(ISO/IEC 17025 and ISO Guide 34)**
- ~ 5800 (bio-)chemical **C**alibration and **M**easurement **C**apabilities
- From ~ 249 NMIs/DIs in 93 countries/economies, and IAEA, EU JRC (IRMM and ISPRA), WMO (3 reference labs) and ESA-ESTEC.
- Chemical and biological comparisons
  - 187 CCQM Key Comparisons
  - 178 CCQM Pilot Study comparisons
  - 25 additional comparisons, including Microbial Identity and Cell Counting
  - 47 RMO Key- and Supplementary Comparisons

BIPM and the Mutual Recognition Arrangement

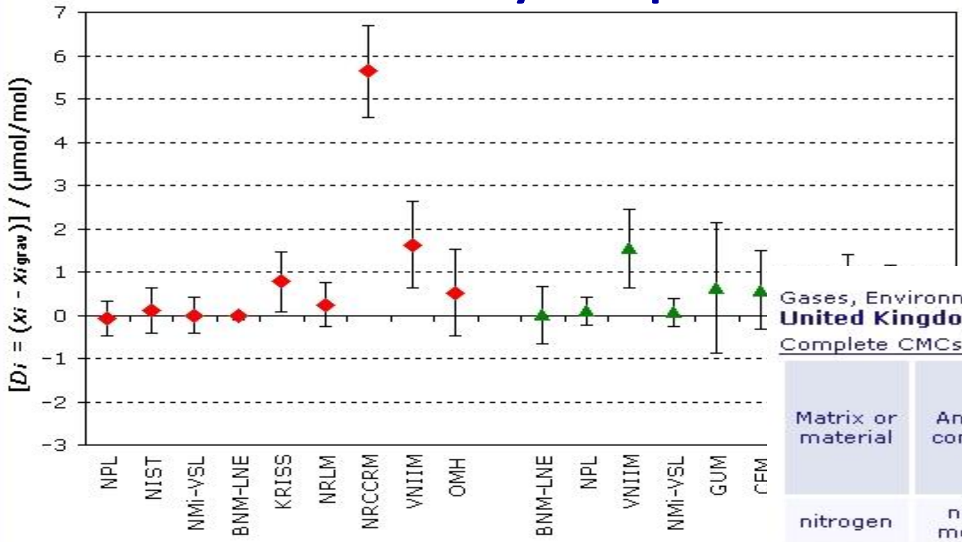
Laboratory individual measurements | Equivalence statements | Degrees of equivalence | **Graph(s) of equivalence**

CCQM-K1.c and EUROMET.QM-K1.c — KCDB

MEASURAND : Amount-of-substance fraction of Nitrogen monoxide in Nitrogen
NOMINAL VALUE : 100 µmol/mol

Degrees of equivalence D_i and expanded uncertainty U_i (k = 2) expressed in µmol/mol

Key Comparisons



Red diamonds: participants in CCQM-K1.c
Green triangles: participants in EUROMET.QM-K1.c

CIPM MRA

Calibration and Measurement Capabilities

Gases, Environmental
United Kingdom, NPL (National Physical Laboratory)
Complete CMCs in Amount of Substance for Gases for United Kingdom (.pdf file)

Matrix or material	Analyte or component	Dissemination range of measurement capability		Range of certified values in reference materials	
		Amount-of-substance fraction in mmol/mol	Relative expanded uncertainty in %	Amount-of-substance fraction in mmol/mol	Relative expanded uncertainty in %
nitrogen	nitrogen monoxide	1 to 10	0.2 to 0.1	1 to 10	0.2 to 0.1

Mechanism(s) for measurement service delivery: PRGM, SGS and calibration
Uncertainty convention 2
Internal NMI service identifier: NPL/15

Mechanisms for measurement service delivery: CRMs

Biological fluids and materials, Blood serum

United States, NIST (National Institute of Standards and Technology)

Complete CMCs in Amount of Substance for Biological fluids and materials for United States (.pdf file)

Matrix or material	Analyte or component	Dissemination range of measurement capability		Range of certified values in reference materials	
		Amount-of-substance concentration in mmol/l	Relative expanded uncertainty in %	Amount-of-substance concentration in mmol/l	Relative expanded uncertainty in %
human serum	cholesterol	3 to 10	0.2 to 1.5	3.453 to 8.61	0.20 to 1.3

Mechanism(s) for measurement service delivery: SRM 1589a, SRM 1951a, SRM 1952a, SRM 909b, SRM 968c

Uncertainty convention 1: The expanded uncertainty for certified values in reference materials is given at a 95% level of confidence, but the coverage factor is not explicitly equal to 2

Internal NMI service identifier: NIST/8392169

High purity chemicals, Organic compounds

United States, NIST (National Institute of Standards and Technology)

Complete CMCs in Amount of Substance for High purity chemicals for United States (.pdf file)

Matrix or material	Analyte or component	Dissemination range of measurement capability		Range of certified values in reference materials	
		Mass fraction in %	Relative expanded uncertainty in %	Mass fraction in %	Absolute expanded uncertainty in %
high purity cholesterol	cholesterol	95 to 100	0.2 to 0.1	99.8	0.1

Mechanism(s) for measurement service delivery: SRM 911c

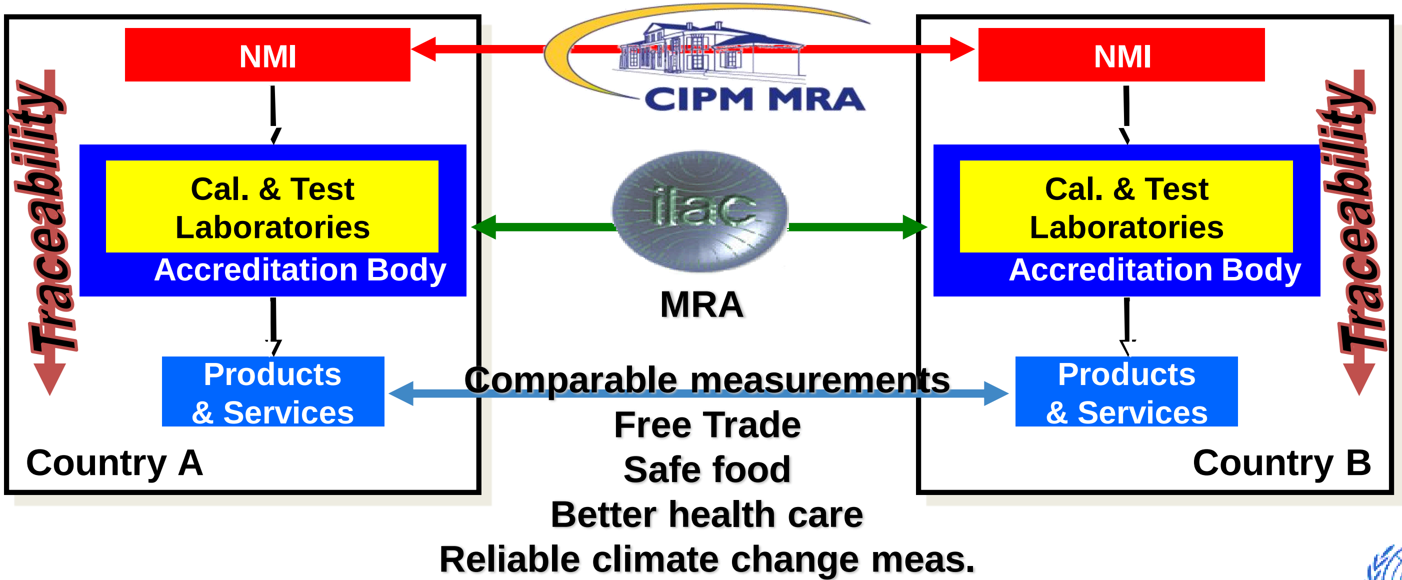
Approved on 24 June 2008.

Uncertainty convention 2

Internal NMI service identifier: NIST/8392005

Quality Chain, the importance of reliable measurements

A sound measurement system is fundamental in fields of science, production of goods and services, health, commerce, communications,…It creates the framework in which suppliers of products and services can demonstrate compliance with specifications within an internationally standardized system.



MSTQ is essential for strengthening export and quality of life

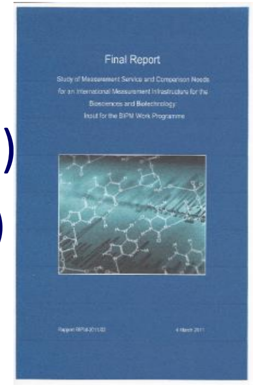
Joint Committee on Traceability in Laboratory Medicine - JCTLM

Principal promotors

- CIPM/BIPM
- IFCC
- ILAC

Supported by

- WHO
- Regulators (FDA, EC, Japan)
- CRM producers (NIST, IRMM, a.o.)
- Reference laboratories (CDC, DGKS, etc.)
- PT and QA organisations (CAP, EQA, etc)
- Written Standards (NCCLS, JCCLS, ISO)
- IVD industry (ADVAMED, EDMA, JARC)



JCTLM triggered by EC IVD Directive

* Implementation of
  - EC-IVD Directive (98/79/EC)
  - prEN ISO 17511
* EC-IVD Directive Annex 1
  - Essential requirements A 3

'...The traceability of values assigned to calibrators
and/or control materials must be assured through
available reference measurement procedures and/or
available reference materials of a higher order.'

JCTLM WG 1 Measurand/Analyte-Based Review Teams
Co-chaired: K. Phinney (NIST) an H. Schimmel (IRMM)

Blood cell counting	**Lili Wang, NIST,** United States
Blood Groupings	**Susan Thorpe**, **NIBSC,** United Kingdom
Coagulation Factors	**Elaine Gray**, **NIBSC,** United Kingdom
Drugs	**Andre Henrion,**, **PTB**, Germany
Electrolytes/Blood Gases	**Brigitte Toussaint, IRMM,** European Union
Enzymes	**Mauro Panteghini**, **University of Milan**, Italy
Metabolites/Substrates	**Xu Bei**, **NIM**, China
Microbial Serology	**Claude Giroud, Bio-Rad,**
Non-electrolyte Metals	**Lee Yu, NIST,** United States
Non-Peptide Hormones	**Heinz Schimmel**, **IRMM,** European Union
Nucleic Acids	**Helen Parkes, LGC,**, United Kingdom
Proteins	**David Bunk, NIST**, United States
Vitamins	**Donald Wiebe, Univ. of Wisconsin,** United States
Quality System	**Robert Wielgosz**, **BIPM**

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Review Teams established with worldwide representation from Laboratory Accreditation Organizations, National Metrology Institutes, Professional Societies, and IVD Industry in order to facilitate a fair and transparent review process.

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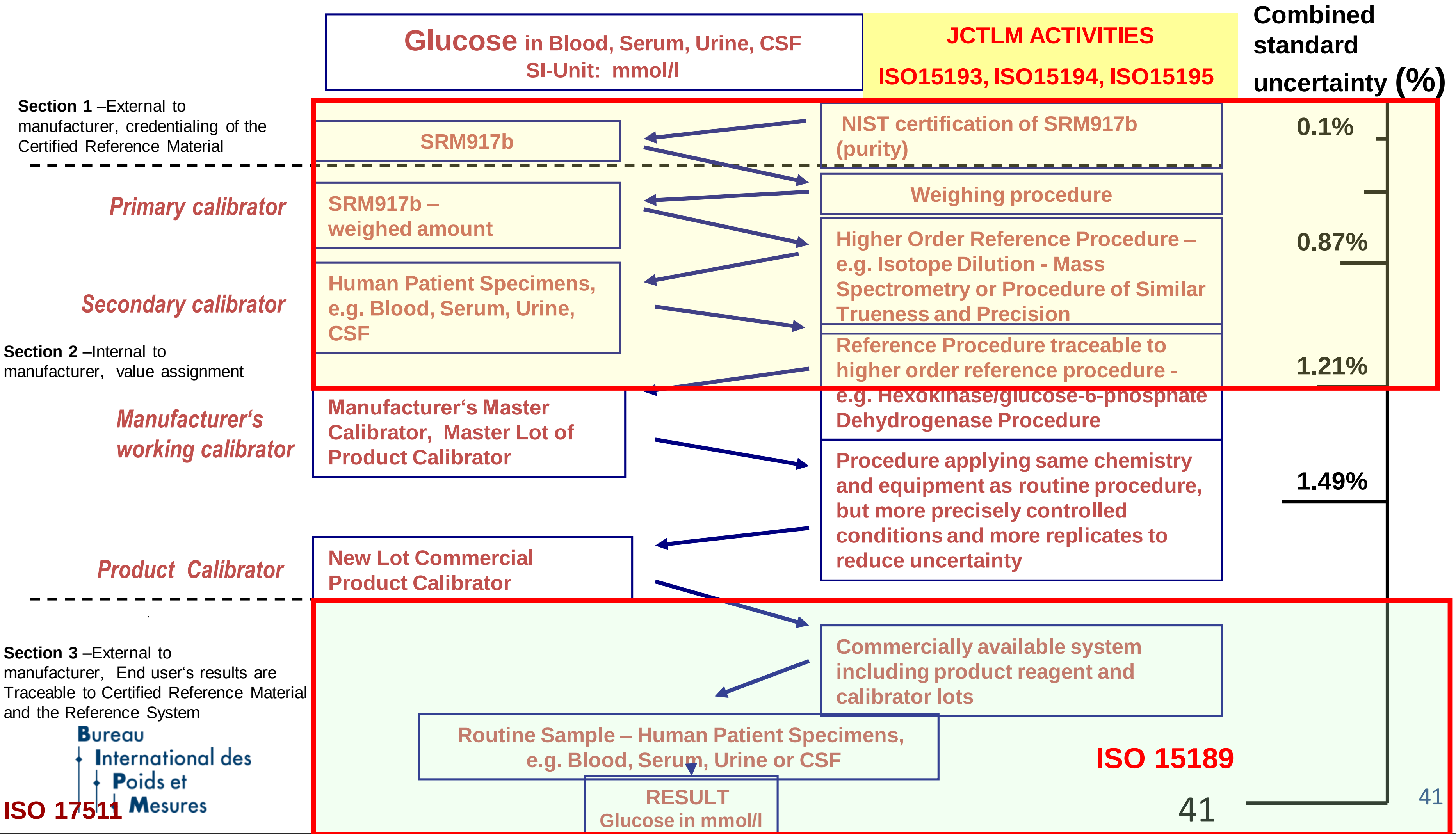
Glucose in Blood, Serum, Urine, CSF
SI-Unit: mmol/l
JCTLM ACTIVITIES
ISO15193, ISO15194, ISO15195
Combined standard uncertainty (%)
Section 1 –External to manufacturer, credentialing of the Certified Reference Material
SRM917b
NIST certification of SRM917b (purity)
0.1%
Primary calibrator
SRM917b – weighed amount
Weighing procedure
Higher Order Reference Procedure – e.g. Isotope Dilution - Mass Spectrometry or Procedure of Similar Trueness and Precision
0.87%
Secondary calibrator
Human Patient Specimens, e.g. Blood, Serum, Urine, CSF
Reference Procedure traceable to higher order reference procedure - e.g. Hexokinase/glucose-6-phosphate Dehydrogenase Procedure
1.21%
Section 2 –Internal to manufacturer, value assignment
Manufacturer's working calibrator
Manufacturer's Master Calibrator, Master Lot of Product Calibrator
Procedure applying same chemistry and equipment as routine procedure, but more precisely controlled conditions and more replicates to reduce uncertainty
1.49%
Product Calibrator
New Lot Commercial Product Calibrator
Section 3 –External to manufacturer, End user's results are Traceable to Certified Reference Material and the Reference System
Commercially available system including product reagent and calibrator lots
Routine Sample – Human Patient Specimens, e.g. Blood, Serum, Urine or CSF
RESULT
Glucose in mmol/l
ISO 15189
ISO 17511
Bureau International des Poids et Mesures
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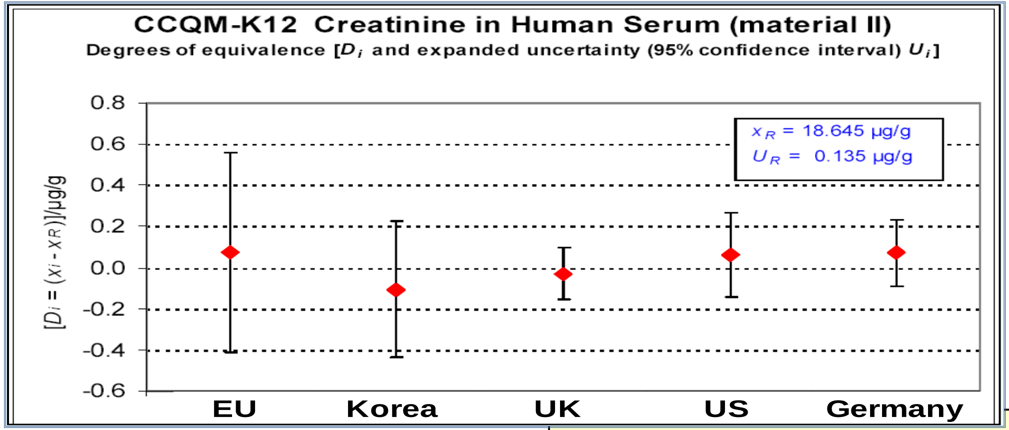
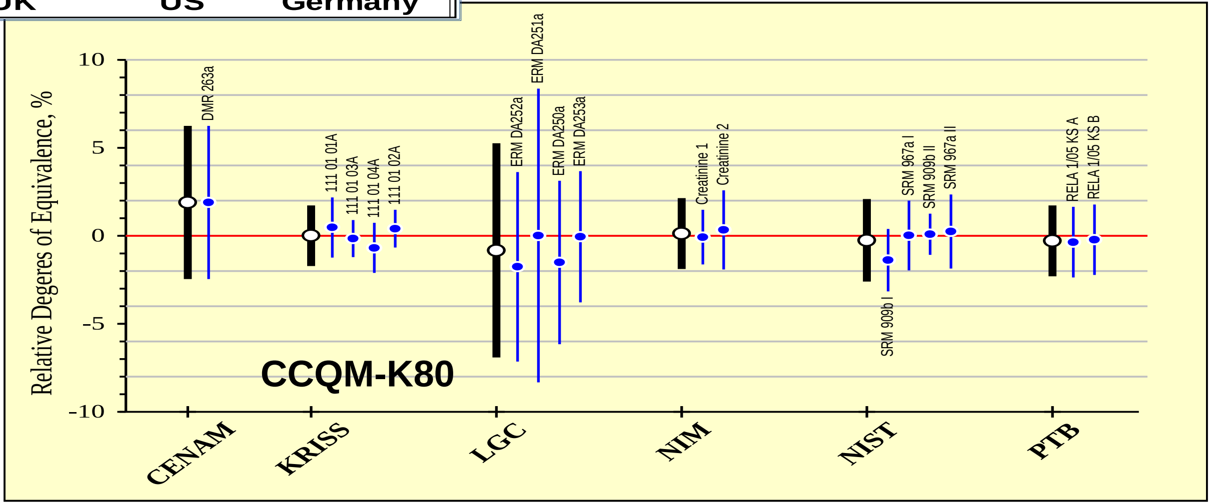
Comparison of Capabilities and Certified Reference Materials for Creatinine in Human Serum



Documented degree of equivalence of measurement capabilities

Comparison of value-assigned CRMs for Creatinine in Serum



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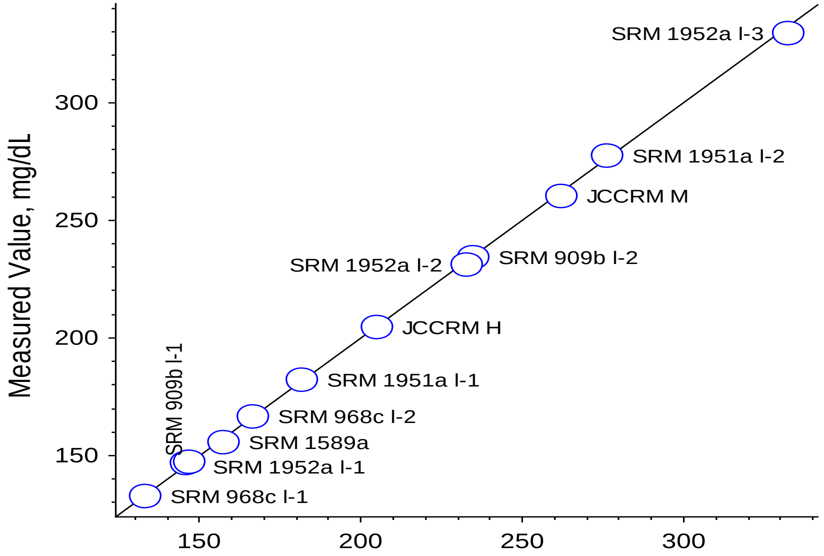
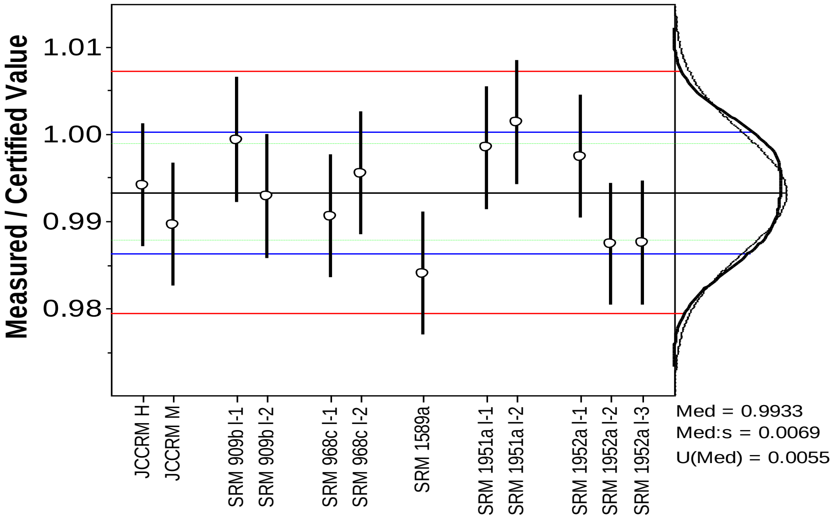
Comparison of CRMs for Cholesterol





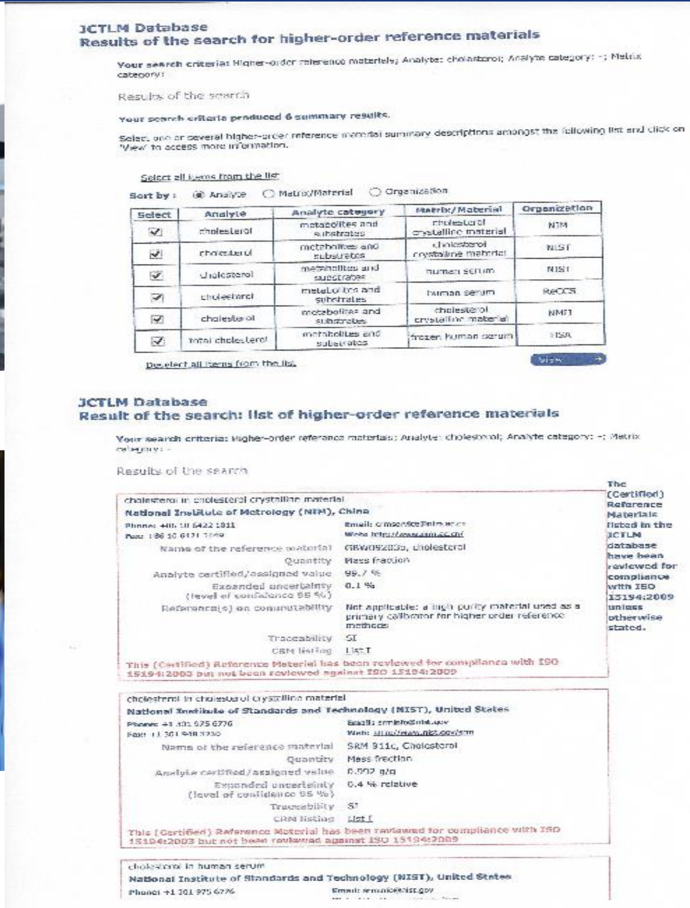
Comparability of Cholesterol in Serum
CRMs on JCTLM LIST

⇨

The measured/certified ratios for this set of CRMs are:

- ~ normally distributed
- with a standard deviation of ~0.7%

JCTLM Database of Reference Materials for IVD measurements



JCTLM Database
Results of the search for higher-order reference materials

Your search criteria: Higher-order reference materials; Analyte: cholesterol; Analyte category: -; Matrix category:

Results of the search

Your search criteria produced 6 summary results.

Select one or several higher-order reference material summary descriptions amongst the following list and click on 'View' to access more information.

Select all items from the list

Sort by : Analyte / Matrix/Material / Organization

Select	Analyte	Analyte category	Matrix/Material	Organization
☑	cholesterol	metabolites and substrates	cholesterol crystalline material	NIM
☑	cholesterol	metabolites and substrates	cholesterol crystalline material	NIST
☑	cholesterol	metabolites and substrates	human serum	NIST
☑	cholesterol	metabolites and substrates	human serum	ReCCS
☑	cholesterol	metabolites and substrates	cholesterol crystalline material	NMIJ
☑	total cholesterol	metabolites and substrates	frozen human serum	HSA

Deselect all items from the list.

View

JCTLM Database
Result of the search: list of higher-order reference materials

Your search criteria: Higher-order reference materials; Analyte: cholesterol; Analyte category: -; Matrix category: -

Results of the search

The (Certified) Reference Materials listed in the JCTLM database have been reviewed for compliance with ISO 15194:2009 unless otherwise stated.

cholesterol in cholesterol crystalline material
National Institute of Metrology (NIM), China

Name of the reference material	GBW09203b, cholesterol
Quantity	Mass fraction
Analyte certified/assigned value	99.7 %
Expanded uncertainty (level of confidence 95 %)	0.1 %
Reference(s) on commutability	Not applicable: a high purity material used as a primary calibrator for higher order reference methods
Traceability	SI
CRM listing	List I

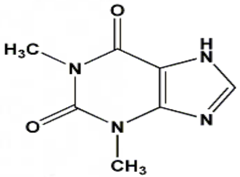
This (Certified) Reference Material has been reviewed for compliance with ISO 15194:2003 but not been reviewed against ISO 15194:2009

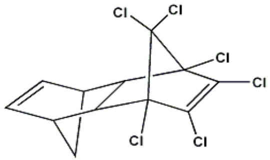
cholesterol in cholesterol crystalline material
National Institute of Standards and Technology (NIST), United States

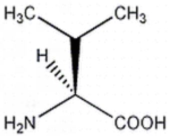
Name of the reference material	SRM 911c, Cholesterol
Quantity	Mass fraction
Analyte certified/assigned value	0.992 g/g
Expanded uncertainty (level of confidence 95 %)	0.4 % relative
Traceability	SI
CRM listing	List I

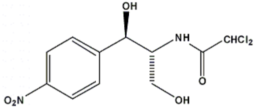
This (Certified) Reference Material has been reviewed for compliance with ISO 15194:2003 but not been reviewed against ISO 15194:2009

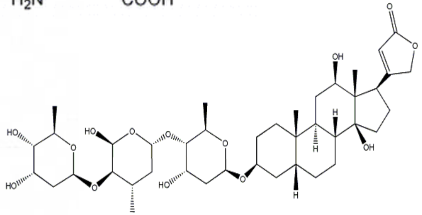
cholesterol in human serum
National Institute of Standards and Technology (NIST), United States











Reference Materials					
Information about Material				Contact Information	
Analyte	Matrix	Material Name and/or ID #	Estimated * Availability (months, as of Jan 2004)	- Producer - Country - Website - Email Address - Phone Number - Fax Number	Commutability Study Information and/or Citations
cholesterol	**cholesterol**	**GBW09203b**	**60**	**NRCCRM, China Tel: 086-10-64221811 Fax: 086-10-64213149 Email: crmservice@nrccrm.com.cn**	**Primary calibrator for higher order reference methods**
cholesterol	**cholesterol**	**SRM 911b**	**21**	**NIST, USA http://ts.nist.gov/ts/htdocs/230/232/232.htm Email:srminfo@nist.gov Tel:(301)975-6776 Fax: (301)948-3730**	**Primary calibrator for higher order reference methods**
cholesterol	**human serum**	**JCCRM 211**	**12**	**HECTEF, Japan http://www.in8.co.jp/hectef/starte.htm Tel: 81-44-813-0055 Fax: 81-44-813-0224**	
cholesterol	**human serum (frozen)**	**SRM 1951b**	**60**	**NIST , USA http://ts.nist.gov/ts/htdocs/230/232/232.htm Email:srminfo@nist.gov Tel:(301)975-6776 Fax: (301)948-3730**	**Material prepared following NCCLS Document C37-A "Preparation and Validation of Commutable Frozen Human Serum Pools as Secondary Reference Materials for Cholesterol Measurement Procedures; Approved Guideline" Method used for certification: Anal Chem 61, 1718-1723 (1989)**
cholesterol	**human serum (lyophilized)**	**SRM 1952a**	**60**	**NIST, USA http://ts.nist.gov/ts/htdocs/230/232/232.htm Email:srminfo@nist.gov Tel:(301)975-6776 Fax: (301)948-3730**	
cholesterol	**human serum (lyophilized)**	**SRM 968c**	**38**	**NIST , USA http://ts.nist.gov/ts/htdocs/230/232/232.htm Email:srminfo@nist.gov Tel:(301)975-6776 Fax: (301)948-3730**	
cholesterol	**human serum (lyophilized)**	**SRM909b**	**60**	**NIST,USA http://ts.nist.gov/ts/htdocs/230/232/232.htm Email:srminfo@nist.gov Tel:(301)975-6776 Fax: (301)948-3730**	

Reference Measurement Procedure					
Procedure Name and/or ID #	Analyte Name	Applicable Matrices	Measurement Principle	Reference Procedure Citation(s) or Document(s)	Reference Procedure Comparability Assessment Studies
NIST definitive method for serum cholesterol	**cholesterol**	**lyophilized, fresh, or frozen serum**	**ID/GC/MS**	**Anal Chem 61, 1718-1723 (1989)**	**CCQM-K6; http://kcdb.bipm.org/appendixB/appbresults/ccqm-k6/ccqm-k6_final_report.pdf; Clin Chem 36, 370-375 (1990)**
U. Of Ghent reference method for cholesterol	**cholesterol**	**lyphilized, fresh, or frozen serum**	**ID/GC/MS**	**Clin Chem 39,1001-6 (1993) [=part II of Clin Chem 39,993-1000 (1993)]; Eur J Clin Chem Clin Biochem 34, 853-60 (1996); Clin Chem 42, 531-5 (1996)**	**EUROMET 563**
DGKC definitive Method for Serum Cholesterol	**cholesterol**	**lyophilized, fresh, or frozen human serum or plasma**	**ID/GC/MS**	**Siekmann et al., Z. anal. Chem. 279, 145-146 (1976)**	**PTB - National Key Comparison for Accredtation**
CDCAbell-Kendall method for cholesterol	**cholesterol**	**lyophillized, fresh or frozen human serum**	**Spectrophotometry**	**Cooper, GR, et al, Clin Chem 32: 921-929, 1986**	**Clin Chem 36, 370-375 (1990)**

UGent, Belgium

Phone: +32 (0)9 264 81 04 **Contact person:** Prof. Dr. L. Thienpont

Fax: +32 (0)9 264 81 98 **Email:** linda.thienpont@Ugent.be

Analyte	glucose
Material or matrix	blood serum, blood plasma
Quantity	Amount-of-substance concentration
Service measurement range	1 mmol/L to 25 mmol/L
Expanded uncertainty (level of confidence 95%)	1.5 % The expanded uncertainty is calculated for measurement protocol n = 6
Interlaboratory comparison results	RELA - IFCC External Quality assessment scheme for Reference Laboratories in Laboratory Medicine at http://www.dgkl-rfb.de:81/index.shtml
Measurement principle	Isotope dilution gas chromatography mass spectrometry (ID/GC/MS)
JCTLM reference measurement method/procedure	University of Ghent reference method for glucose

CCQM charged with establishing the system for global comparability of bio and chemical measurement results through traceability to the SI, or if not (yet) possible, to other internationally agreed references, by that being the basis for international recognition and acceptance of **your** bio and chemical measurement and test results, taking away Technical Barriers to Trade and contributing to a sustainable economy and competitiveness, innovation and a better environment and quality of life

Thank you!

Questions?

Bureau International des Poids et Mesures