

Internationale Zusammenarbeit auf dem Gebiet der Durchflußmessung

Prof. Dr. rer.nat Dr.-Ing.habil. D. Dopheide
Fachbereich Fluidmechanik PTB

PTB-Seminar: Neue Entwicklungen bei der Kalibrierung von Durchflußmeßgeräten

13 - 14 November 2001
Physikalisch-Technische Bundesanstalt (PTB)
Bundesallee 100, 38116 Braunschweig

Vortragsübersicht:

Organisation der Metrologie: BIPM/CIPM, RMOs

- national: EUROMET
- weltweit: SIM, APMP

Mutual Recognition Agreement (MRA)

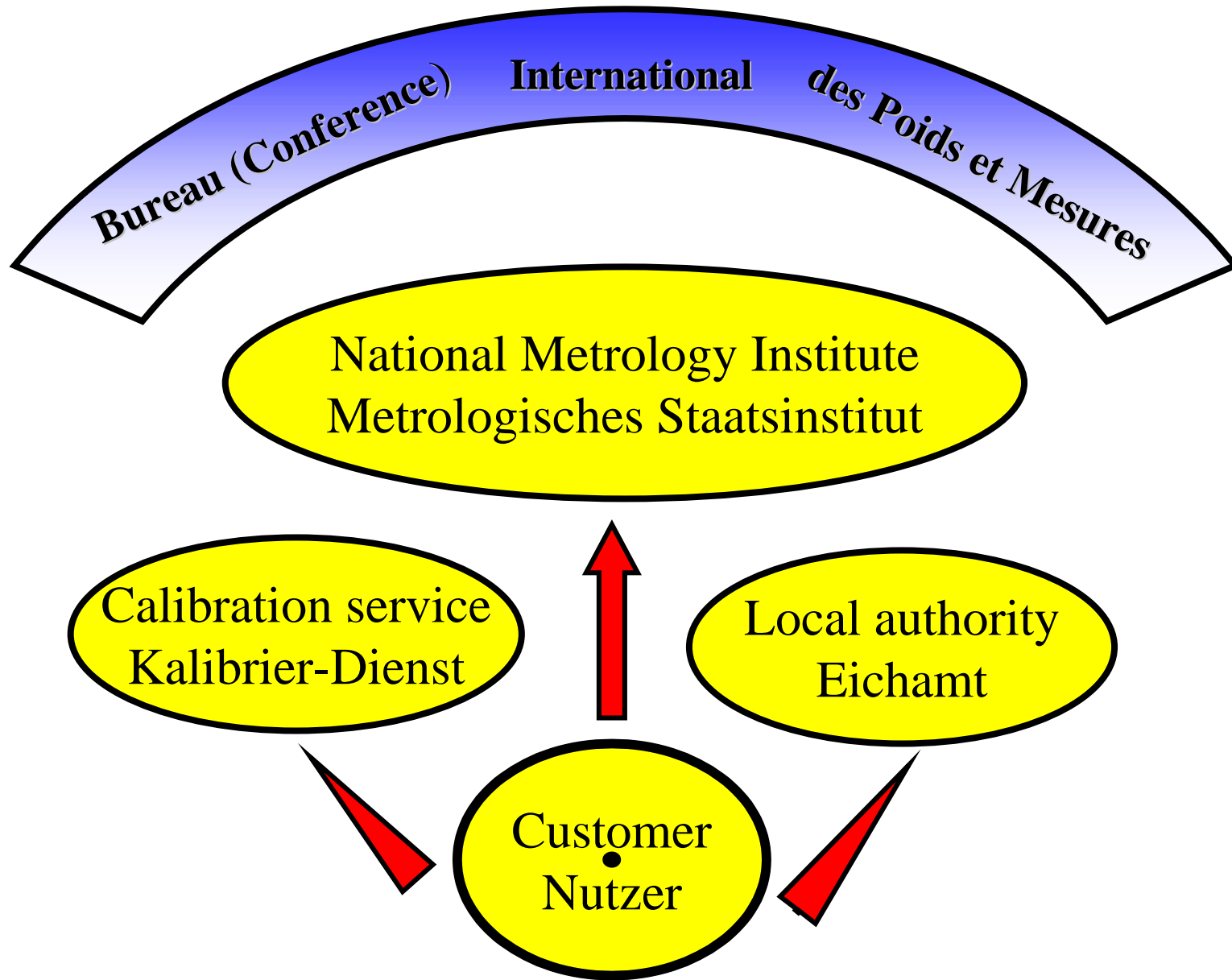
gegenseitige Anerkennung von
Prüfständen und Zertifikaten

Calibration and Measuring Capabilities [CMC]

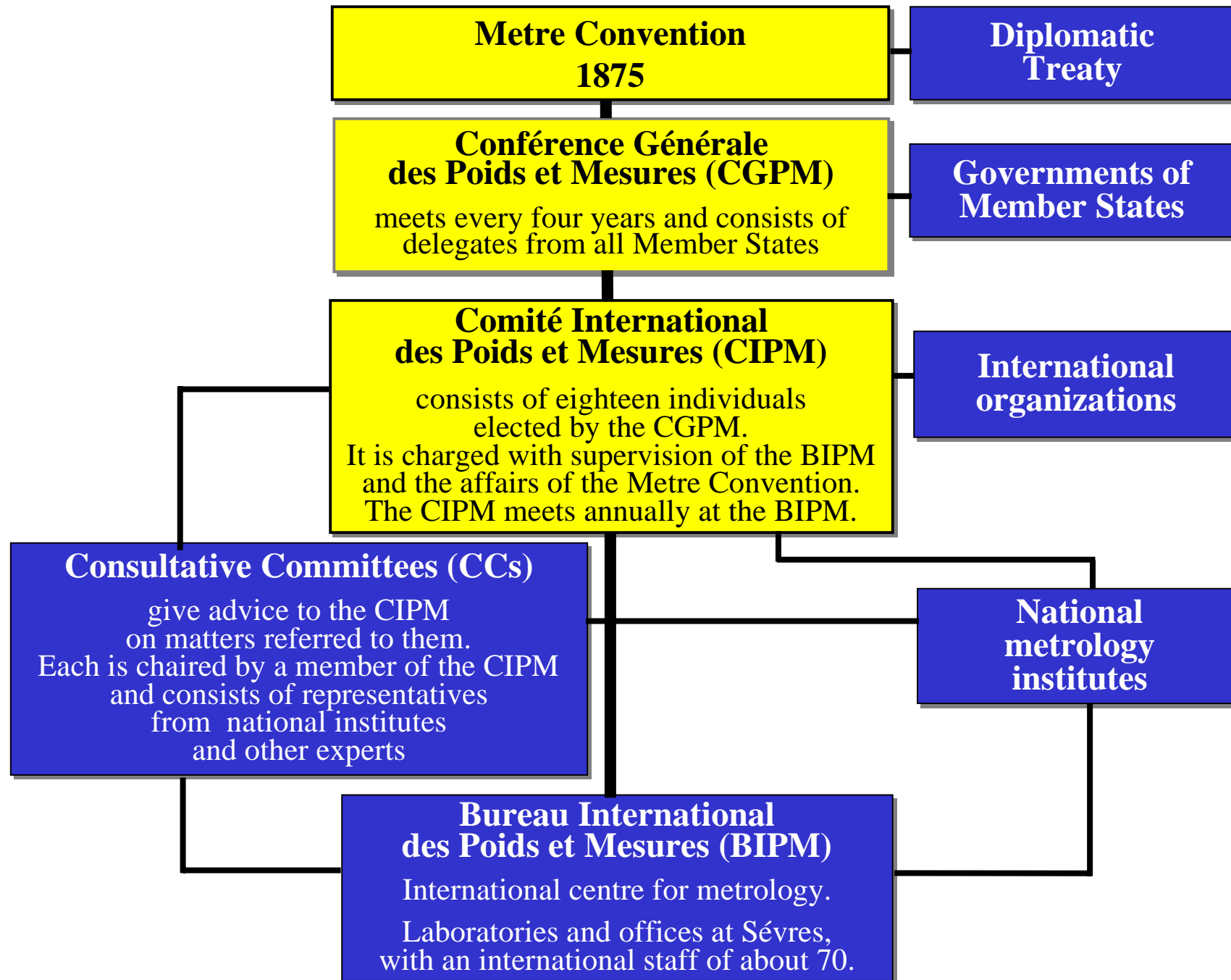
- Übersicht Europa (Flow)
- Rest der Welt

3D-Visualisierung der CMCs für den Fluidbereich:

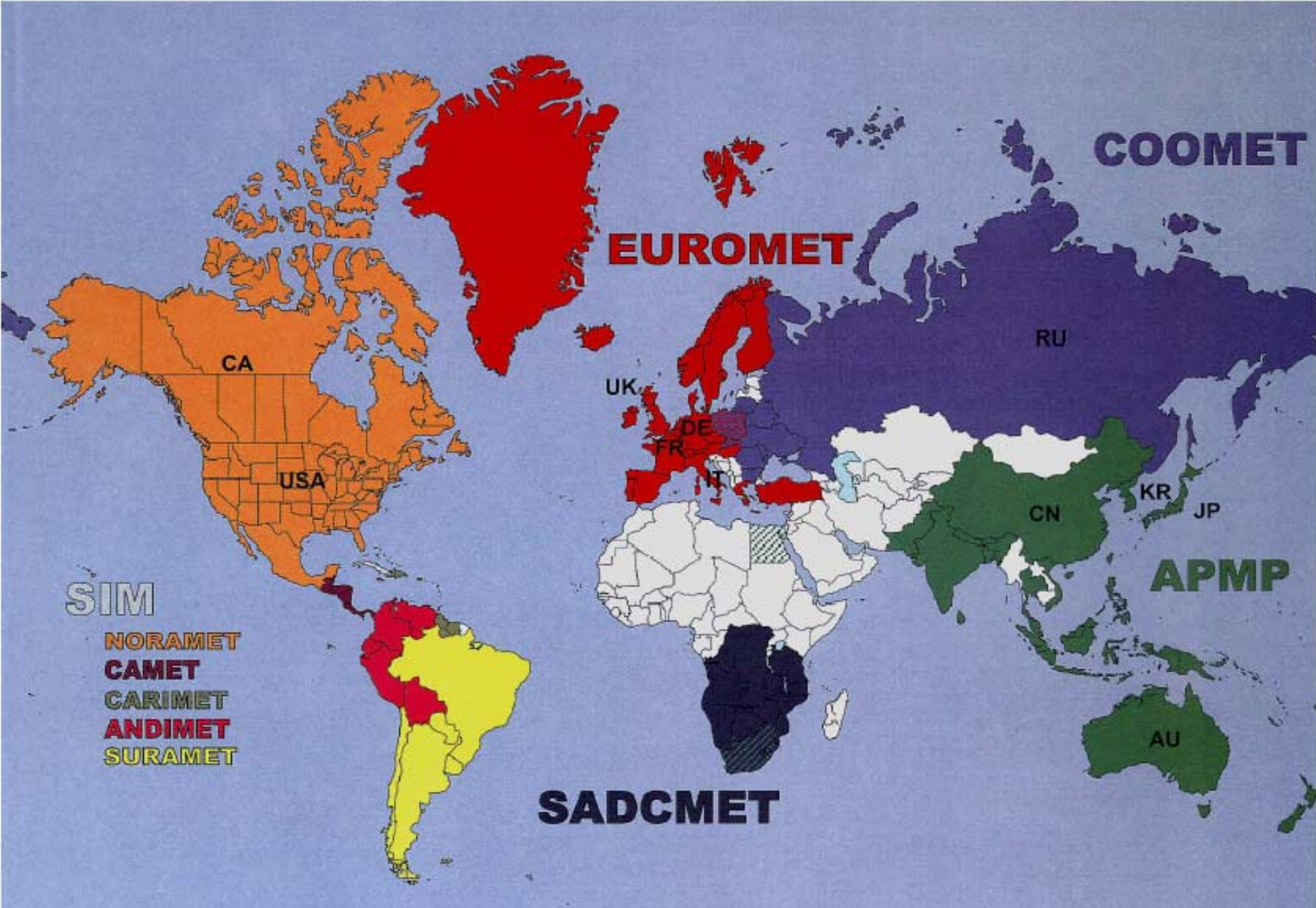
- Flüssigkeiten, Wasser



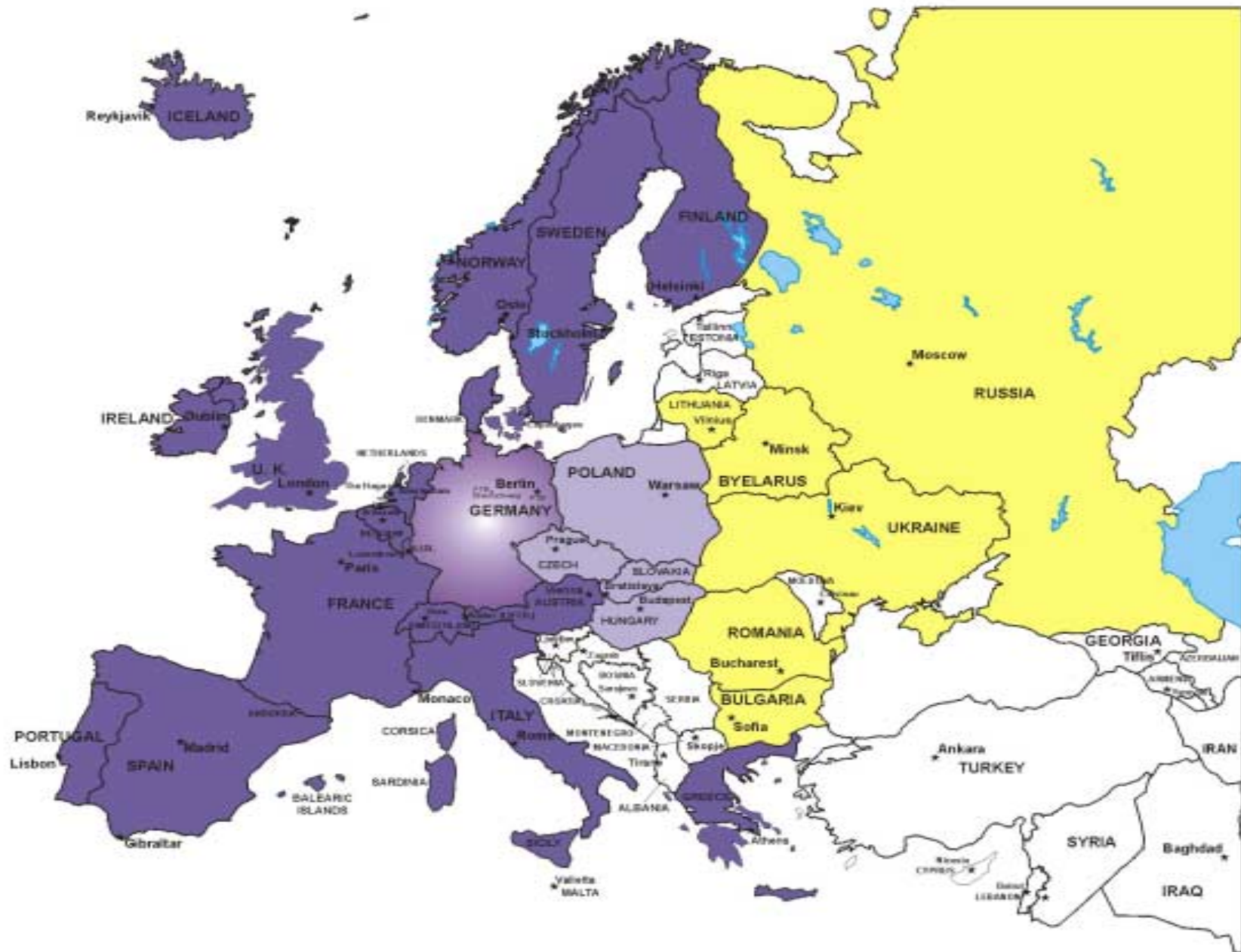
Traceability Chains for Measurements



Regional Metrology Organizations

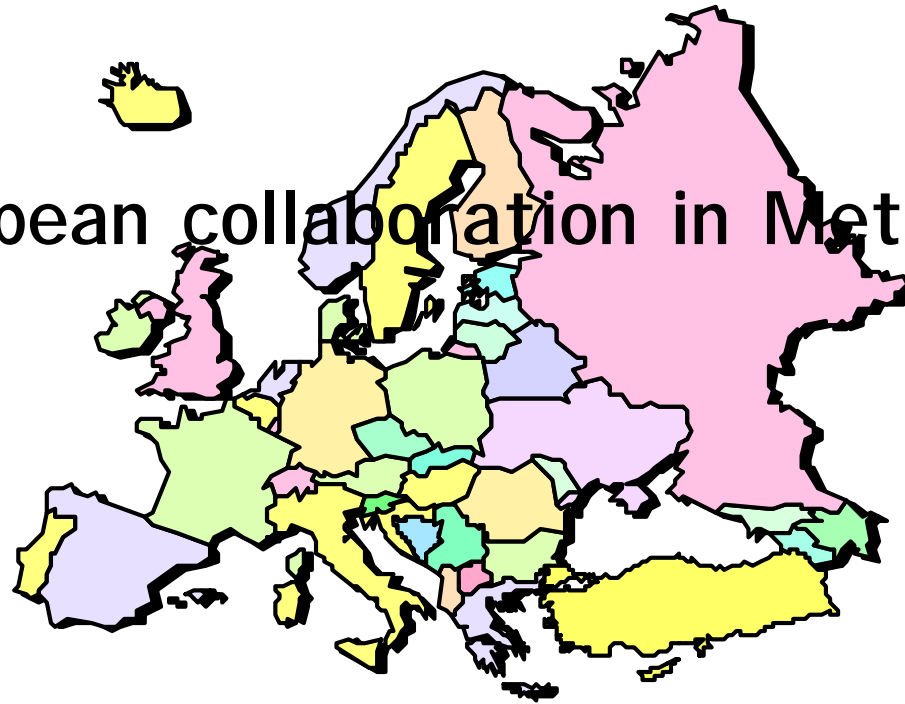


EUROMET + COOMET



EUROMET

European collaboration in Metrology



EUROMET



EUROMET

Collaboration organisation between
the National Metrology Institutes of
European states and the Commission of
the European Communities.
25 members and 15 corresponding
organizations



EUROMET



AIMS

- To develop a closer collaboration between Members in the work of measurement standards within the present metrological structure.

- To optimise the utilisation of resources and services of Members and emphasise the deployment of these towards perceived metrological needs.

- To improve measurement services and make them accessible to all Members.

- To ensure that the national facilities developed in the context of EUROMET collaboration are accessible to all Members.

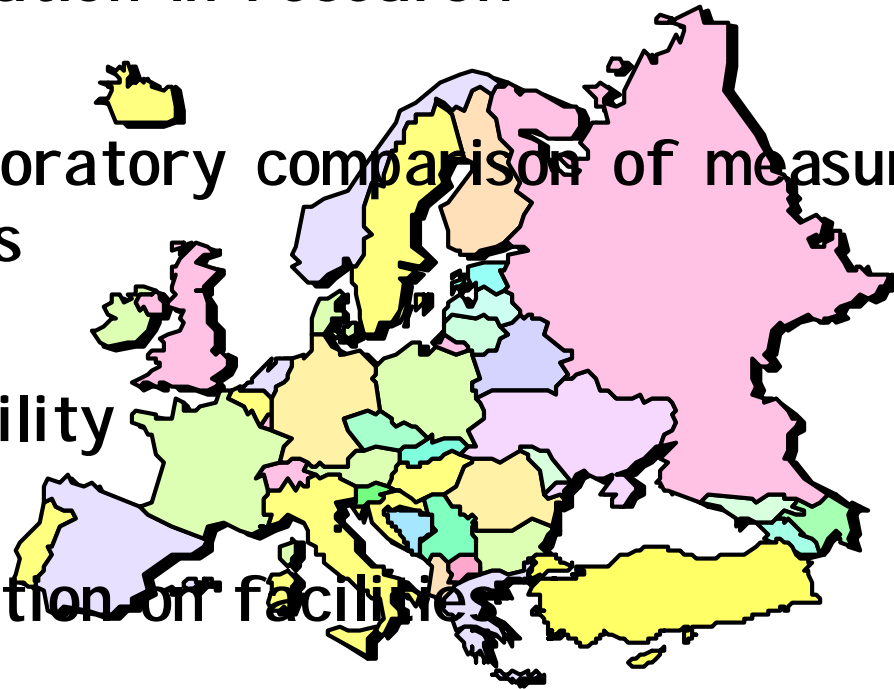


EUROMET



TYPE OF COLLABORATION

- Co-operation in research
- Interlaboratory comparison of measurement standards
- Traceability
- Consultation on facilities



EUROMET

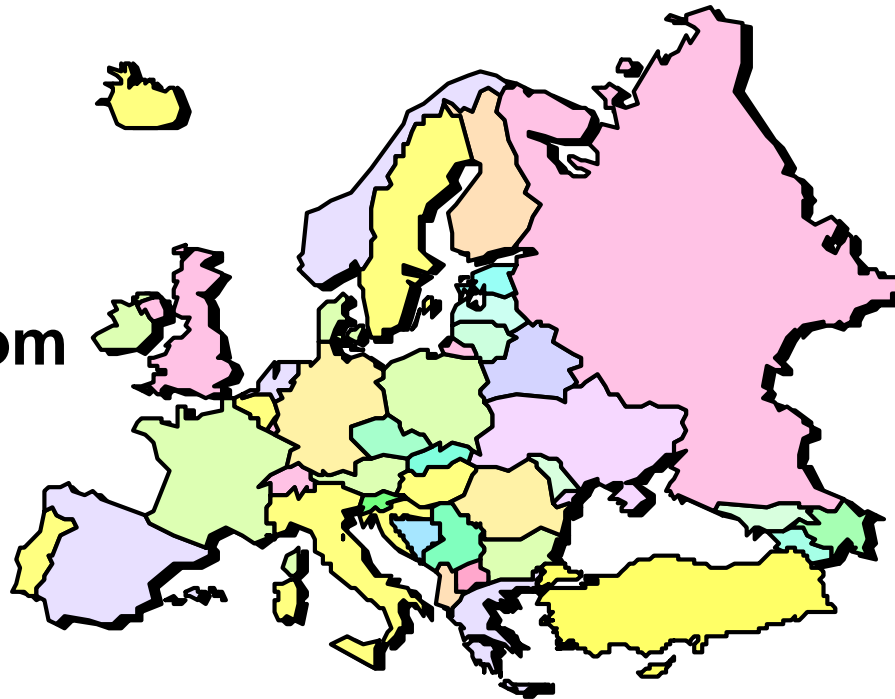


**Austria
Finland
Hungary
Luxembourg
Poland
Slovakia
Spain
Sweden
United Kingdom**

**Belgium
France
Iceland**

**Czech Republic
Germany
Ireland
Netherlands**

**Denmark
Greece
Italy
Norway
Portugal
Slovenia
Switzerland
Turkey
CEU**



Chairman TC Flow: Prof. Dr. D. Dopheide

EUROMET

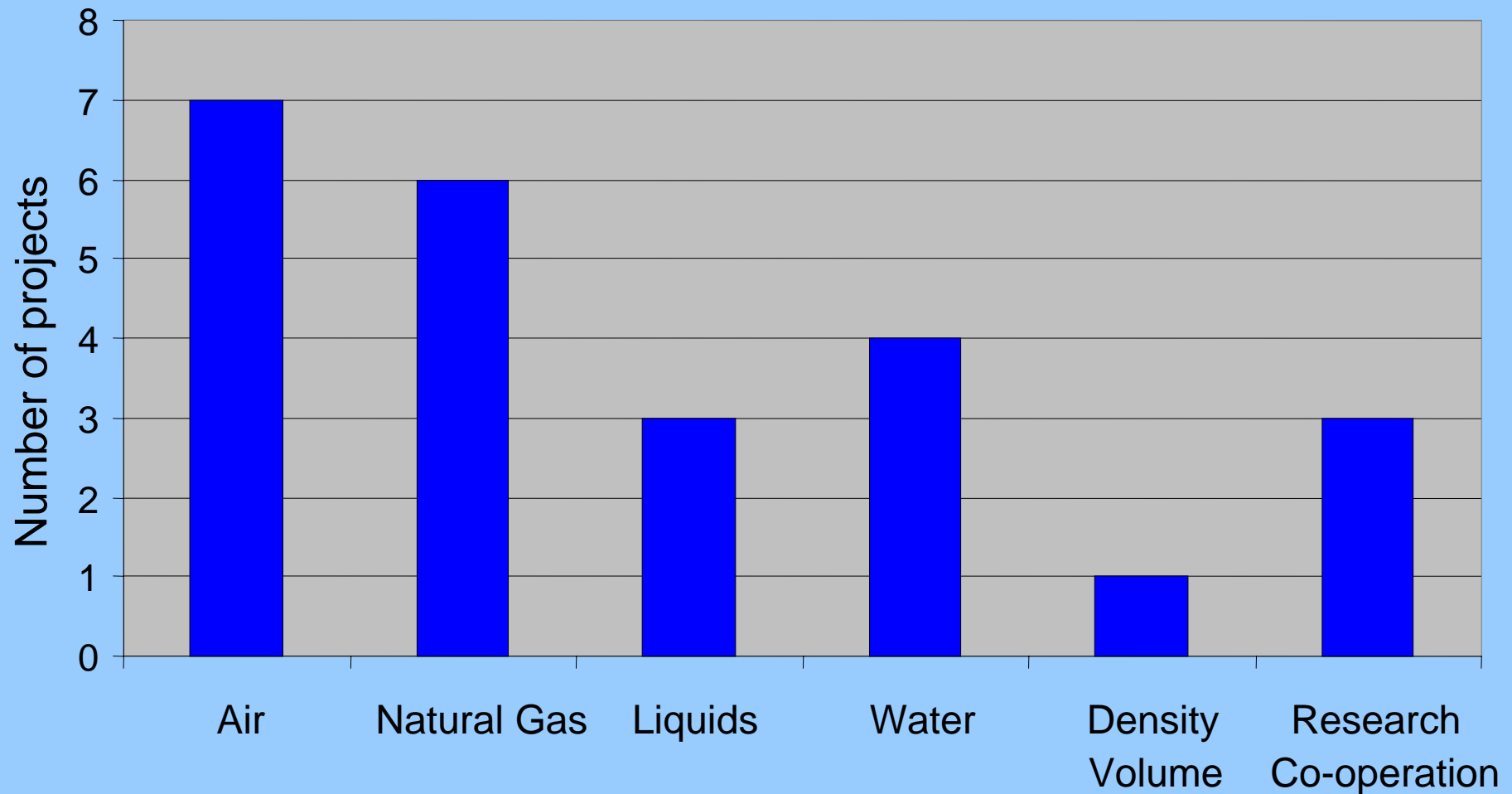




EUROMET-Flow Section: 2000/2001
Chairman TC Flow: Dietrich Dopheide
PTB, Germany



Number of flow projects according to technical section

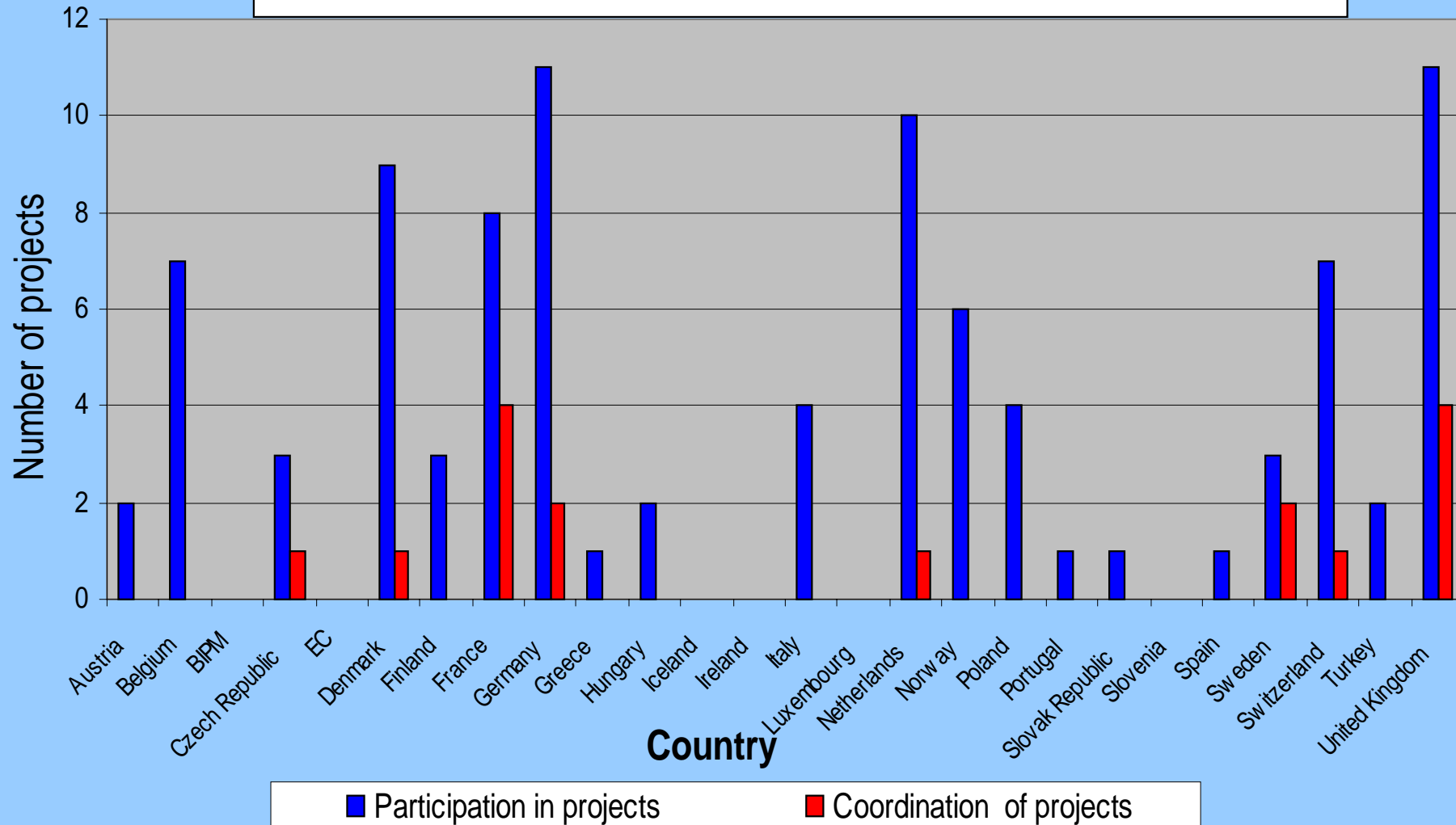




EUROMET-Flow Section: 2000/2001
Chairman TC Flow: Dietrich Dopheide
PTB, Germany



Participation in and coordination of projects



Calibration and Measuring Capabilities der NMIs

- Übersicht über Meß- und Prüfmöglichkeiten der nationalen Metrologie-Institute mit Angabe der Meßunsicherheiten
 - gegenseitige Prüfung der Vertrauenswürdigkeit durch Ringvergleiche innerhalb EUROMET sowie zwischen den RMOs SIM und APMP
 - Prüfung der Angaben durch BIPM
 - Publikation im Internet durch BIPM

Nähere Angaben unter

www.BIPM.fr

www.Euromet.ch

www.ptb.de/english/org/1/13/hp.htm

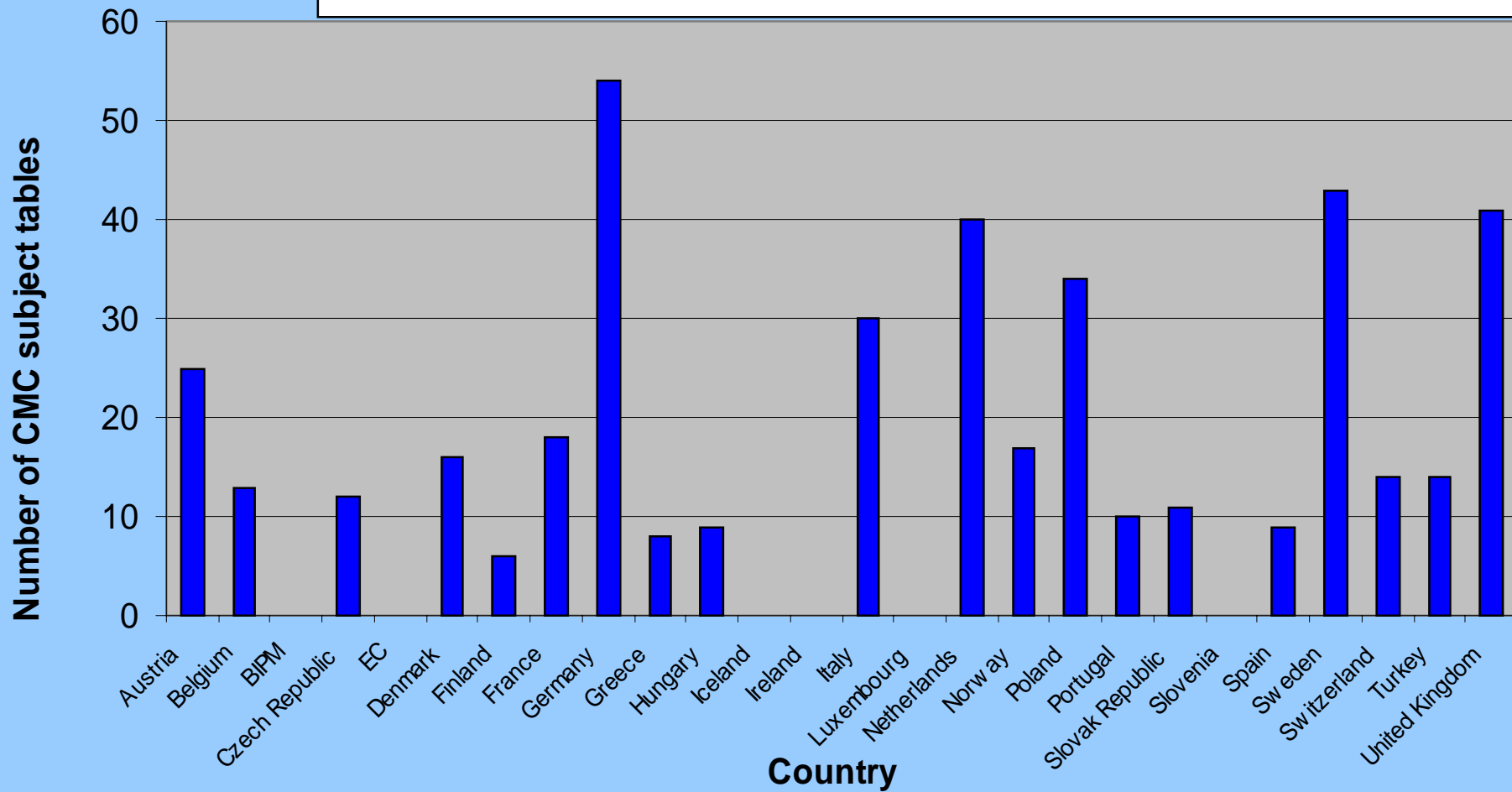
(Fachbereich Fluidmechanik)



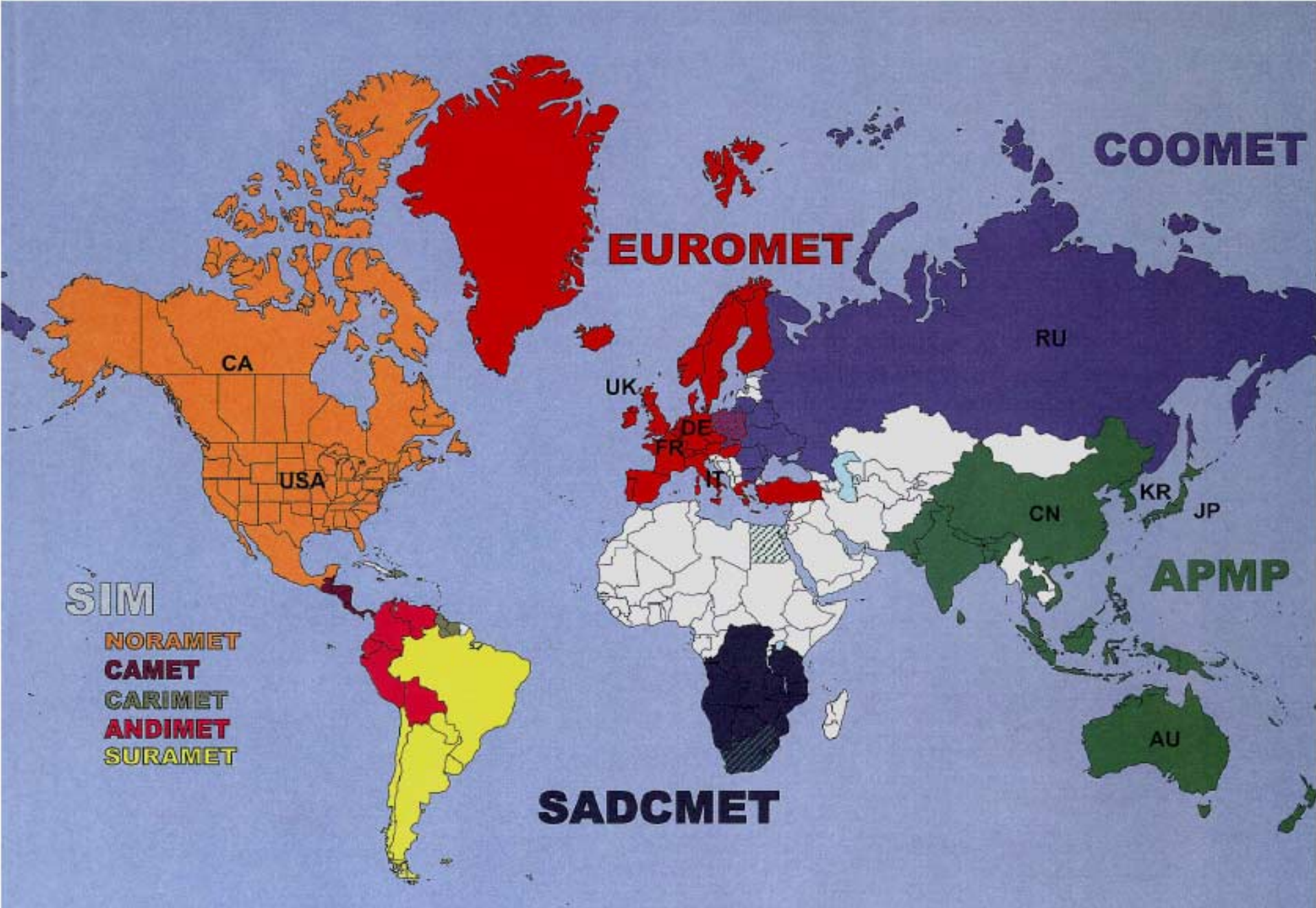
EUROMET-Flow Section: 2001
Chairman TC Flow: Dietrich Dopheide
PTB, Germany



Submission of CMC subject tables per country



Regional Metrology Organizations

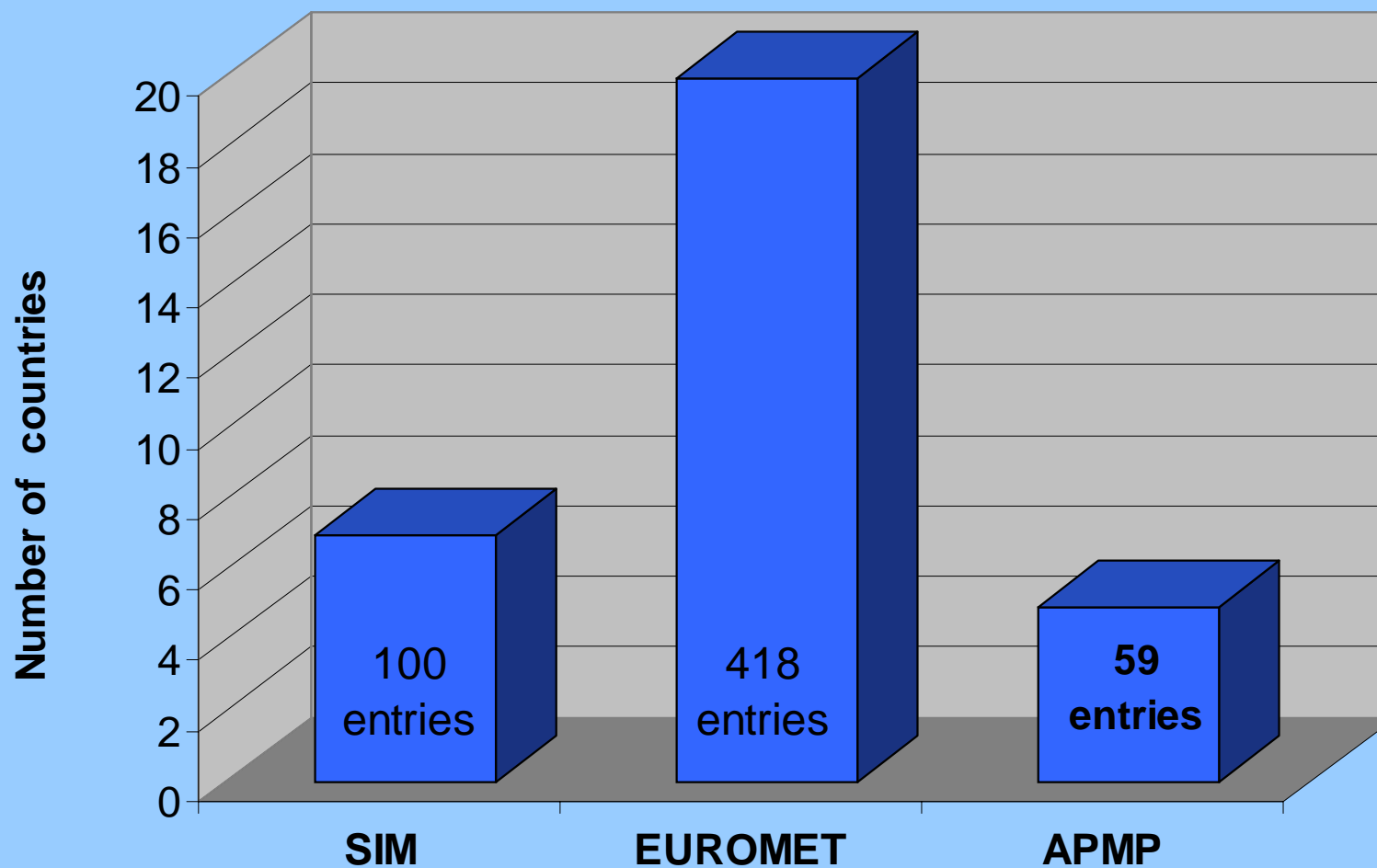




EUROMET-Flow Section: 2001
Chairman TC Flow: Dietrich Dopheide
PTB, Germany



Number of participating countries and CMC flow entries per RMO



Mutual Recognition Arrangement (MRA*)

...produced by CIPM under the authority of the Meter Convention for signature in 1999 by the directors of the NMIs of the Member States of the Convention.

Objectives:

- to establish the degree of equivalence of *national measurement standards* maintained by the NMIs;
- to provide for the mutual recognition of *calibration and measurement certificates* issued by the NMIs;
- thereby to provide governments and other parties with a secure technical foundation for wider agreements related to international trade, commerce, and regulatory affairs.

Process:

- international comparisons ~ CIPM KCs,
- supplementary comparisons ~ Regional Metrology Organization (RMO) KCs, etc.
- quality systems and demonstrations of competence by NMIs.

Outcome:

Statements of the measurement capabilities of each NMI in a data base maintained by the BIPM and publicly available on the Web.

* See www.bipm.fr for details on the BIPM, CIPM, and the MRA.



MRA Signatories (43):



Argentina

Australia

Austria

Belgium

Brazil

Bulgaria

Canada

Chile

China

Czech Republic

Denmark

Ecuador*

Egypt

Finland

France

Germany

Hungary

India

Ireland

Italy

Japan

Korea

Mexico

Netherlands

New Zealand

Norway

Poland

Portugal

Romania

Russia

Singapore

Slovak Republic

South Africa

Spain

Sweden

Switzerland

Thailand

Turkey

UK

Uruguay

US

Int'l Orgs:

Int'l Atomic Energy Agency (IAEA)

Inst. for Refr. Matls and Msmts (IRMM)

* Associate Member, as of Jan. '01

CIPM Consultative Committees (CCs):



1. CCAUV-Acoustics, Ultrasound, and Vibration

2. CCEM-Electricity and Magnetism

3. CCL-Length

4. CCM-Mass and Related Quantities

5. CCPR-Photometry and Radiation

6. CCQM-Amount of Substance

7. CCRI-Ionizing Radiation

8. CCT-Thermometry

9. CCTF-Time and Frequency

10. CCU-Units

Working Groups:

1. Density

2. Mass

3. Force (WGF)

4. Pressure

5. Avogadro's Const.

6. Hardness

7. Fluid Flow (WGFF)

a. Water Flow

b. Hydrocarb. Liq. Flow

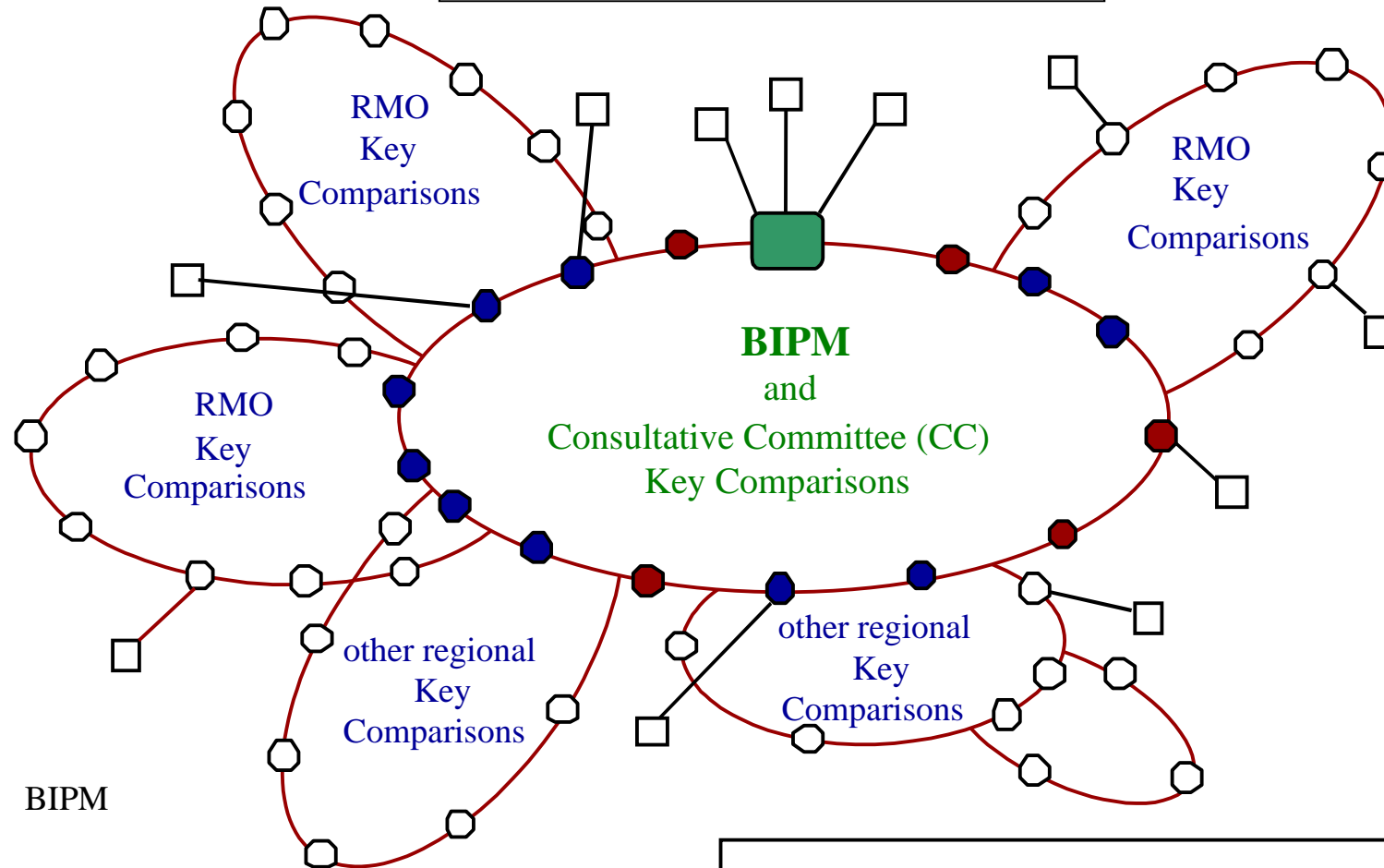
c. Hi-Press Gas Flow

d. Lo-Press Gas Flow








e. Air Speed

f. Liquid Volume

Generic Key Comparison Tests



 BIPM

-  NMI participating in BIPM/CC Key Comparisons
-  NMI participating in BIPM/CC Key Comparisons and in RMO Key Comparisons
-  NMI participating in regional Key Comparisons
-  NMI participating in neither BIPM/CC nor regional Key Comparisons but making bilateral comparisons directly with BIPM or with NMIs in categories , , or 

CCM = BIPM Consultative Committee on Mass and Related Quantities

RMOs = Regional Metrology Organizations

NMI = National Metrology Institution

SIM = Systema Interamericano Metrologia

APMP = Asian-Pacific Metrology Program

EUROMET = Metrology Organization of the European Union



WGFF Responsibilities



Measurand	Initiating Country	Assisting Country	Country
Water Flow	Korea	UK	Mexico
Hydrocarbon Liquid Flow	UK	Japan	US
Air Flow (Low P)	US	UK	Korea
Gas Flow (High P)	Germany Netherlands	US	Korea
Air Speed	Japan	Brazil	Netherlands
Volume	Mexico	Australia	Sweden



CALIBRATION AND MEASUREMENT CAPABILITIES FOR FLOW AT PTB GERMANY

NMI: PTB-Berlin, Germany (Section "Measurement of Thermal Energy")																				
Date: 15 October 2001																				
Liquid Flow / Heat Flow																				
Calibration or Measurement Service				Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty			Reference Standards used in calibration		List of Comparisons supporting this measurement/ calibration service		Administration Service				
internal numbering	Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Level of Confidence	Standard	Source of traceability	Comments pipe sizes	NMI Service Identifier	Service Category (*)	NMI	Review Status	Review Comments	
1	liquid flowing quantity: volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	50	2800	L	water	Temperature 20 °C to 80 °C	0,2	%	95%	gravimetric type, weighing system, temperature sensor	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK); ÖFZS (A), Publ.: J.-F. March et al. Flomeko '98, Lund, p.523	DN 50 - 200	DE1	9.7 and 9.3	PTB	+	ok
2	liquid flowing quantity: mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	50	2800	kg	water	Temperature 20 °C to 80 °C	0,2	%	95%	gravimetric type, weighing system, temperature sensor	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK); ÖFZS (A), Publ.: J.-F. March et al. Flomeko '98, Lund, p.523	DN 50 - 200	DE2	9.7 and 9.4	PTB	+	ok
3	liquid flowrate volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	20	180	m³/h	water	Temperature 20 °C to 80 °C	0,2	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK); ÖFZS (A), Publ.: J.-F. March et al. Flomeko '98, Lund, p.523	DN 50 - 200	DE3	9.7 and 9.2.2	PTB	+	ok
4	liquid flowrate mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	20 000	180 000	kg/h	water	Temperature 20 °C to 80 °C	0,2	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK); ÖFZS (A), Publ.: J.-F. March et al. Flomeko '98, Lund, p.523	DN 50 - 200	DE4	9.7 and 9.1.2	PTB	+	ok
5	liquid flowrate volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	1	20	m³/h	water	Temperature 25 °C to 65 °C	0,4	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	internat. intercomparison with NMI (BUL), ASMW, Publ. J.-F. March et al. Flomeko '98, Lund, p. 105; W. Pöschel et al. Jahresber. 1990 ASMW Berlin, p.48	DN 15 - 50	DE5	9.7 and 9.2.2	PTB	+	ok
6	liquid flowrate mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	1 000	20 000	kg/h	water	Temperature 25 °C to 65 °C	0,4	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK); ÖFZS (A), Publ.: J.-F. March et al. Flomeko '98, Lund, p.523	DN 15 - 50	DE6	9.7 and 9.1.2	PTB	+	ok
7	liquid flowrate volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	0,01	1	m³/h	water	Temperature 20 °C to 80 °C	0,4	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK), SP (SE), BEV (A), Publ.: M. Thrane et al., Flomeko '98, Lund, p.101	DN 10 - 32	DE7	9.7 and 9.2.2	PTB	+	ok
8	liquid flowrate mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	10	1 000	kg/h	water	Temperature 20 °C to 80 °C	0,4	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	internat. intercomparisons with DTI (DK), SP (SE), BEV (A), Publ.: M. Thrane et al., Flomeko '98, Lund, p.101	DN 10 - 32	DE8	9.7 and 9.1.2	PTB	+	ok
9	liquid flowing quantity: volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	50		L	water	Temperature 80 °C to 180 °C	0,4	%	95%	laser doppler veloc., prim. stand. calibration bench, turbine flow-meter as second. stand.	Mass, time, temperat. PTB	Publ. J.-F. March, Meas. Sci. Techn. 9, 1998, p. 128 and Flow Meas. Instr. 7, 1996, p. 211	DN 40 - 150 PN 25	DE9	9.7 and 9.3	PTB	+	ok
10	liquid flowing quantity: mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	50		kg	water	Temperature 80 °C to 180 °C	0,4	%	95%	laser doppler veloc., prim. stand. calibration bench, turbine flow-meter as second. stand.	Mass, time, temperat. PTB	Publ. J.-F. March, Meas. Sci. Techn. 9, 1998, p. 128 and Flow Meas. Instr. 7, 1996, p. 211	DN 40 - 150 PN 25	DE10	9.7 and 9.4	PTB	+	ok
11	liquid flowrate volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	50	120	m³/h	water	Temperature 80 °C to 180 °C	0,4	%	95%	laser doppler veloc., prim. stand. calibration bench, turbine flow-meter as second. stand.	Mass, time, temperat. PTB	Publ. J.-F. March, Meas. Sci. Techn. 9, 1998, p. 128 and Flow Meas. Instr. 7, 1996, p.211	DN 40 - 150 PN 25	DE11	9.7 and 9.2.2	PTB	+	ok
12	liquid flowrate mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	50 000	120 000	kg/h	water	Temperature 80 °C to 180 °C	0,4	%	95%	laser doppler veloc., prim. stand. calibration bench, turbine flow-meter as second. stand.	Mass, time, temperat. PTB	Publ. J.-F. March, Meas. Sci. Techn. 9, 1998, p. 128 and Flow Meas. Instr. 7, 1996, p. 211	DN 40 - 150 PN 25	DE12	9.7 and 9.1.2	PTB	+	ok
13	liquid flowing quantity: volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	5	250	L	glycol-water solutions	Temperature - 15 °C to 80 °C	0,5	%	95%	gravimetric type, weighing system, temperature sensor	Mass, time, temperat. PTB	Publ. J.-F. March, Der Einfluss von Glykol-Wasser-Gemischen auf die Messrichtigkeit von Wärmehähern für thermische Solaranlagen, PTB-Bericht ThEx-14, Oktober 2000	DN 10 - 32	DE13	9.7 and 9.3	PTB	+	ok
14	liquid flowing quantity: mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	5	250	kg	glycol-water solutions	Temperature - 15 °C to 80 °C	0,3	%	95%	gravimetric type, weighing system, temperature sensor	Mass, time, temperat. PTB	Publ. J.-F. March, Der Einfluss von Glykol-Wasser-Gemischen auf die Messrichtigkeit von Wärmehähern für thermische Solaranlagen, PTB-Bericht ThEx-14, Oktober 2000	DN 10 - 32	DE14	9.7 and 9.4	PTB	+	ok
15	liquid flowrate volume	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical output - various methods	0,005	2,5	m³/h	glycol-water solutions	Temperature - 15 °C to 80 °C	0,5	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	Publ. J.-F. March, Der Einfluss von Glykol-Wasser-Gemischen auf die Messrichtigkeit von Wärmehähern für thermische Solaranlagen, PTB-Bericht ThEx-14, Oktober 2000	DN 10 - 32	DE15	9.7 and 9.2.2	PTB	+	ok
16	liquid flowrate mass	Any Flow Measurement Instrument or Flow Device	Pulsed, electrical, digital & optical outputs - various methods	5	2500	kg/h	glycol-water solutions	Temperature - 15 °C to 80 °C	0,3	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	Publ. J.-F. March, Der Einfluss von Glykol-Wasser-Gemischen auf die Messrichtigkeit von Wärmehähern für thermische Solaranlagen, PTB-Bericht ThEx-14, Oktober 2000	DN 10 - 32	DE16	9.7 and 9.1.2	PTB	+	ok

17	Volume of heat conveying flowing liquid (for thermal energy measurements)	Any Flow Measurement Instrument or Flow Device (see lines 1 to 16)	Pulsed, electrical, digital & optical output - various methods				water; glycol-water-solutions respectively	(see lines 1 to 16)	as above	%	95%	gravimetric type, weighing system, temperature sensor, clock	Mass, time, temperat. PTB	Publ. see (lines 1 to 16)	DN 10 -200, up to PN 25	DE17	9.7	PTB	+	ok
18	Thermal energy (as a function of liquid flowrate volume and temperature difference)	Any Type of Calculator	Pulsed, electrical, digital & optical output - various methods	3	200	K	water; glycol-water-solutions respectively	Power 20 W to 10 MW	< 0,2	%	95%	standard resistors, pulse-, frequency- and / or current generators, counters	resistance, current, time, PTB	Publ. H. Fenske et al., Automatisierte Prüfung von Wärmezähler-Rechenwerken durch bildverarbeitungsgestützte Displayerkennung, Euroheat & Power 11/1998, p. 32. Bilateral Intercomparison PTB - DTI, Oct. 1995		DE18	9.7	PTB	+	ok
19	Temperature difference (for thermal energy measurements)	Any Type of Temperature Sensor Pairs	Electrical, digital output - various methods	3	200	K	water; glycol-water-solutions respectively	Temperature - 15 °C to 200 °C	< 0,02	K	95%	resistance measuring devices, standard thermometers, temperature controlled baths	resistance, temperat. PTB	Bilateral Intercomparison PTB - DTI, Oct. 1995		DE19	9.7	PTB	+	ok
20	Thermal energy	Any Type of Heat Meter	Pulsed, electrical, digital & optical output - various methods	20	10 000 000	W	water; glycol-water-solutions respectively	Temperature - 15 °C to 200 °C	< 1,0	%	95%	gravimetric type, weighing system, temperature sensor, clock, temperature controlled baths	Mass, time, temperat. PTB	Bilateral Intercomparison PTB - DTI, Oct. 1995	DN 10 - 200, up to PN 25	DE20	9.7	PTB	+	ok

NMI: PTB Braunschweig, Germany				Date: 15 October 2001																	
Section Liquid Flows				Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty			Reference Standard used in calibration		List of Comparisons supporting this measurement/ calibration		Administration Service		
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Level of Confidence	Standard	Source of traceability	Comments Pipe sizes (mm)	NMI Service Identification	Service Category (*)	NMI	Review Status	Review Comments			
21	Volume flowrate	Flow sensors	e. g. electromagnetic, ultrasonic meters	0,3	100	m³/h	Water	Ambient conditions	± 0,1	%	95%	Balance/diverter + clock + density	PTB	Intercomparisons 1995/1997(BCR-Project 1997:	DN 20 - 150	DE21	9.2.2	PTB	+	ok	
22	Mass flowrate	Flow sensors	e. g. Coriolis-type flowmeters	0,3	100	t/h	Water	Ambient conditions	± 0,1	%	95%	Balance/diverter + clock	PTB	See above	DN 20 - 150	DE22	9.1.2	PTB	+	ok	
23	Volume	Flowmeters	e. g. mechanical, electromagnetic, ultrasonic meters	5	1 500	L	Water	Ambient conditions	± 0,05	%	95%	Balance/diverter + density	PTB	See above	DN 20 - 150	DE23	9.3	PTB	+	ok	
24	Mass	Flowmeters	e. g. Coriolis-type flowmeters	5	1 500	kg	Water	Ambient conditions	± 0,05	%	95%	Balance/diverter	PTB	See above	DN 20 - 150	DE24	9.4	PTB	+	ok	
25	Volume flowrate	Flow sensors	e. g. mechanical, electromagnetic, ultrasonic meters	0,3	≥ 100	t/h	Water	Ambient temperature, pmax = 6 bars	± 0,04	%	95%	Balance/diverter + clock + density meter	PTB	Publications: FLOMEKO 1998 4th ISF M 1999 FLOMEKO 2000	DN 20 - 400	DE25	9.2.2	PTB	0	ok	
26	Mass flowrate	Flow sensors	e. g. Coriolis-type flowmeters	0,3	≥ 100	t/h	Water	Ambient temperature, pmax = 6 bars	± 0,04	%	95%	Balance/diverter + clock	PTB	See above	DN 20 - 400	DE26	9.1.2	PTB	0	ok	
27	Volume	Flowmeters	e. g. mechanical, electromagnetic, ultrasonic meters	30	30 000	L	Water	Ambient temperature, pmax = 6 bars	± 0,02	%	95%	Balance/diverter + density meter	PTB	See above	DN 20 - 400	DE27	9.3	PTB	0	ok	
28	Mass	Flowmeters	e. g. Coriolis-type flowmeters	30	30 000	kg	Water	Ambient temperature, pmax = 6 bars	± 0,02	%	95%	Balance/diverter	PTB	See above	DN 20 - 400	DE28	9.4	PTB	0	ok	
29	Volume	Flowmeters	e. g. mechanical, electromagnetic, ultrasonic meters		250	L	Water	Ambient temperature, flowrate = 1 ... 600 m³/h, pmax = 6 bars	± 0,02	%	95%	Pipe prover	PTB	See above	DN 20 - 400	DE29	9.3	PTB	0	ok	
30	Volume flowrate (average)	Flow sensors	e. g. turbine, ultrasonic, positive-displacement meters	0.6	250	m³/h	White spirit: [density = 770 kg/m³, viscosity = 0,77 mPa*s]	Ambient temperature, pmax = 3,5 bars	± 0,1	%	95%	Calibrated tanks, Standing start / stop	PTB	Intercomparisons 1995/1997(BCR-Project 1997: EU Ref. MAT1-CT 940018)	DN 25 - 150	DE30	9.2.2	PTB	+	ok	
31	Mass flowrate (average)	Flow sensors	e. g. turbine, ultrasonic, positive-displacement meters	0.08	46	t/h	White spirit: [density = 770 kg/m³, viscosity = 0,77 mPa*s]	Ambient temperature, flowrate = 0,2 ... 60 m³/h, pmax = 3,5 bars	± 0,1	%	95%	Balance, Standing start / stop	PTB	See above	DN 25 - 80	DE31	9.1.2	PTB	+	ok	
32	Volume	Flowmeters	e. g. turbine, ultrasonic, positive-displacement meters	5	5 000	L	White spirit: [density = 770 kg/m³, viscosity = 0,77 mPa*s]	Ambient temperature, flowrate = 0,6 ... 250 m³/h, pmax = 3,5 bars	± 0,05	%	95%	Calibrated tanks, Standing start / stop	PTB	See above	DN 25 - 150	DE32	9.3	PTB	+	ok	
33	Mass	Flowmeters	e. g. Coriolis-type flowmeters	50	900	kg	White spirit: [density = 770 kg/m³, viscosity = 0,77 mPa*s]	Ambient temperature, flowrate = 0,2 ... 60 m³/h, pmax = 3,5 bars	± 0,05	%	95%	Balance, Standing start / stop	PTB	See above	DN 25 - 80	DE33	9.4	PTB	+	ok	
34	Volume (liquid)	Glassware	Pipettes	1	100	L	Water contents	Room temperature	± 0,002	%	0,95	Balance + density	PTB	BCR-Project 1996: MAT1-CT 92-0015	DN 25 - 80	DE34	9.3	PTB	+	ok	
NMI: PTB-Braunschweig, Germany				Date: 15 October 2001																	
Section Gas Flow				Calibration or Measurement Service PTB Germany Braunschweig			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty			Reference Standard used in calibration		List of Comparisons supporting this measurement/ calibration		Administration Service		
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Level of Confidence	Standard	Source of traceability	Comments pipe sizes	NMI Service Identification	Service Category (*)	NMI	Review Status	Review Comments			
35	Flowrate or volume (gas)	flowmeters, gasmeters	LFE, MFC, nozzles, orifice meter, soap film devices	0,2	200	L/h	Inert gas	pressure < 3 bar ambient conditions t	0,25	%	95%	piston systems	PTB	Wendt, G.: PTB-Bericht MM-7, S. 41-51	< DN 25	DE35	9.2.1	PTB	+	ok	
36	Mass flowrate or mass (gas)	flowmeters, gasmeters	LFE, MFC, nozzles, orifice meter, soap film devices	0,24	240	g/h	Inert gas	pressure < 3 bar ambient conditions t	0,25	%	95%	piston systems	PTB	Wendt, G.: PTB-Bericht MM-7, S. 41-51	< DN 25	DE36	9.1.1	PTB	+	ok	
37	Flowrate or volume (gas)	flowmeters, gasmeters	LFE, wet gas meters	15	3500	L/h	air	ambient conditions p,t	0,05	%	95%	forced piston devices	PTB	Aschenbrenner, A.: DVGW-Schriftenreihe Nr. 12 (1987) S. 113-134	< DN 50	DE37	9.2.1	PTB	+	ok	
38	Mass flowrate or mass (gas)	flowmeters, gasmeters	LFE, wet gas meters	18	4200	g/h	air	ambient conditions p,t	0,05	%	95%	forced piston devices	PTB	Aschenbrenner, A.: DVGW-Schriftenreihe Nr. 12 (1987) S. 113-134	< DN 50	DE38	9.1.1	PTB	+	ok	
39	Flowrate (gas)	flowmeters	critical nozzles	0,015	15	m³/h	air	ambient conditions p,t	0,10	%	95%	wet gas meter	PTB		< DN 50	DE39	9.2.1	PTB	0	ok	
40	Mass flowrate (gas)	flowmeters	critical nozzles	0,018	18	kg/h	air	ambient conditions p,t	0,10	%	95%	wet gas meter	PTB		< DN 50	DE40	9.1.1	PTB	0	ok	

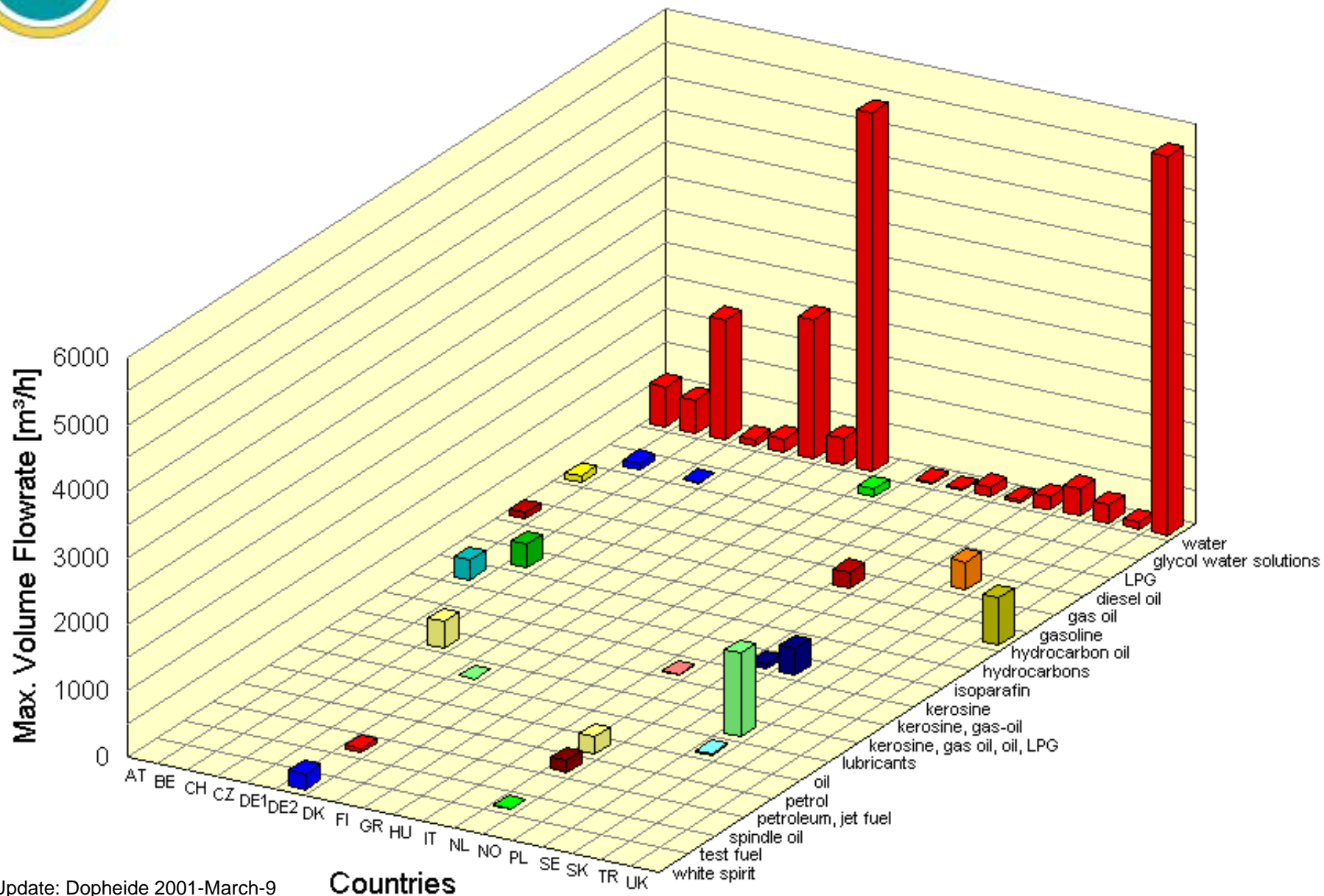
41	Flowrate or volume (gas)	flowmeters, gasmeters	LFE, wet gas meters, critical nozzles	1	60	m ³ /h	air	ambient conditions p,t	0,06	%	95%	bell prover	PTB	NRLM Japan: 1992, 1998; NMI NL: 1995, 1997; IPT Brasilien: 1996; EUROMET 238: 1991-1993; EUROMET 425: 1998; Publ.: Takamoto, M.; Ishibashi, M.; Watanabe, N.; Aschenbrenner, A.; Caldwell, S.: FLOMEKO'93, pp. 75-82;	DN 10 - 100	DE41	9.2.1	PTB	+	ok
42	Mass flowrate or mass (gas)	flowmeters, gasmeters	LFE, wet gas meters, critical nozzles	1,2	72	kg/h	air	ambient conditions p,t	0,06	%	95%	bell prover	PTB	NRLM Japan: 1992, 1998; NMI NL: 1995, 1997; IPT Brasilien: 1996; EUROMET 238: 1991-1993; EUROMET 425: 1998; Publ.: Takamoto, M.; Ishibashi, M.; Watanabe, N.; Aschenbrenner, A.; Caldwell, S.: FLOMEKO'93, pp. 75-82;	DN 10 - 100	DE42	9.1.1	PTB	+	ok
43	Flowrate or volume (gas)	flowmeters, gasmeters	rotary piston meters, turbine meters, ultrasonic meters, vortex meters, LFE, orifice meters	200	5600	m ³ /h	air	ambient conditions p,t	0,08	%	95%	test rig with critical nozzels	PTB	NMI NL: 1989, 1997; NRLM Japan: 1992, 1994; EAM CH: 1995; EUROMET 277: 1994; EUROMET 307: 1996; EUROMET 419: 1999; Publ.: Wendt, G.; Hartlep, A.: PTB-Mitteilungen 102 (1992), S. 371-3375; Wendt, G.: PTB-Bericht MM-7, S. 41-51	DN 50 - 400	DE43	9.2.1	PTB	+	ok
44	Mass flowrate or mass (gas)	flowmeters, gasmeters	rotary piston meters, turbine meters, ultrasonic meters, vortex meters, LFE, orifice meters	240	6720	kg/h	air	ambient conditions p,t	0,08	%	95%	test rig with critical nozzels	PTB	NMI NL: 1989, 1997; NRLM Japan: 1992, 1994; EAM CH: 1995; EUROMET 277: 1994; EUROMET 307: 1996; EUROMET 419: 1999; Publ.: Wendt, G.; Hartlep, A.: PTB-Mitteilungen 102 (1992), S. 371-3375; Wendt, G.: PTB-Bericht MM-7, S. 41-51	DN 50 - 400	DE44	9.1.1	PTB	+	ok
45	Flowrate (gas)	flowmeters	critical nozzles	15	2000	m ³ /h	air	ambient conditions p,t	0,12	%	95%	dou-rotary piston transfer turbine meter	PTB		DN 50 - 200	DE45	9.2.1	PTB	0	ok
46	Mass flowrate (gas)	flowmeters	critical nozzles	18	2400	kg/h	air	ambient conditions p,t	0,12	%	95%	dou-rotary piston transfer turbine meter	PTB		DN 50 - 250	DE46	9.1.1	PTB	0	ok
47	Volume (gas)	gasmeters	turbine meters, rotary piston meters	200	24000	m ³ /h	air	ambient conditions p,t	0,12	%	95%	test rig with turbine meters	PTB	Wendt, G.: PTB-Bericht MM-7, S. 41-51	DN 100 - 600	DE47	9.2.1	PTB	+	ok
48	Mass (gas)	gasmeters	turbine meters, rotary piston meters	240	28800	kg/h	air	ambient conditions p,t	0,12	%	95%	test rig with turbine meters	PTB	Wendt, G.: PTB-Bericht MM-7, S. 41-51	DN 100 - 600	DE48	9.1.1	PTB	+	ok
49	Volume (gas)	gasmeters	turbine meters	100	6000	m ³ /h	air	ambient conditions p,t	0,10	%	95%	LDA test rig for flowrate	PTB	NMI NL: 1991; Publ.: Metrologia 1993; pp. 453 - 469	DN 10 - 300	DE49	9.2.1	PTB	+	ok
50	Mass (gas)	gasmeters	turbine meters	120	7200	kg/h	air	ambient conditions p,t	0,10	%	95%	LDA test rig for flowrate	PTB	NMI NL: 1991; Publ.: Metrologia 1993; pp. 453 - 469	DN 100 - 300	DE50	9.1.1	PTB	+	ok
51	Volume, (high pressure gas)	gasmeters	turbine meters, ultrasonic meters, vortex meters, Coriolis meters	8	6500	m ³ /h	high pressure natural gas	ambient temperature 15° C to 20° C; pressure 15 bar to 50 bar	0,15	%	95%	test rig with turbine meters	common reference value PTB/NMI	GERG 1998-2000; EUROMET 474: 1999/2000; NMI NL: 1997, 1999; Publ.: Kurschat, T.; Brandt, O.; Bremser, W.; Häßelbarth, W.: 4th ISFFM, Denver 1999, paper 14.4, 12 pages	DN 80 - 400, ANSI 600 Pressure 15 - 50 bar	DE51	9.2.1	PTB	+	ok
52	Mass flow-rate (high pressure gas)	flowmeters	turbine meters, ultrasonic meters, vortex meters, Coriolis meters	100	300.000	kg/h	high pressure natural gas	ambient temperature 15° C to 20° C; pressure 15 bar to 50 bar	0,15	%	95%	test rig with turbine meters	common reference value PTB/NMI	GERG 1998-2000; EUROMET 474: 1999/2000; NMI NL: 1997, 1999; Publ.: Kurschat, T.; Brandt, O.; Bremser, W.; Häßelbarth, W.: 4th ISFFM, Denver 1999, paper 14.4, 12 pages	DN 80 - 400, ANSI600 Pressure 15 - 50 bar	DE52	9.1.1	PTB	+	ok
53	flow speed	Laser Doppler Velocimeter (LDV)	LDV	0,1	15	m/s	particel speed on surface (rotating gals wheel)	fringe calibration	0,1	%	95%	rotating glas wheel	PTB	INTA (Spain) 1999 NRLM Japan, 1999	back scatt. mode	DE53	9.5.1	PTB	+	ok
54	flow speed	air speed anemometers	prandtl tubes, fan type anem., hot film anem.	0,2	60	m/s	flow in open wind tunnel	ambient conditions p,t	0,01 ~ 0,05	m/s	95%	LDV+windtunnel	PTB	EUROMET 388: 1998	ø < 60 mm	DE54	9.5.1	PTB	+	ok
55	flow speed	air speed anemometers	prandtl tubes, fan type anem. <25mm	0,5	60	m/s	pipe flow	ambient conditions p,t	0,5	%	95%	LDV	PTB	EUROMET 388: 1998	ø < 40 mm	DE55	9.5.1	PTB	+	ok



European NMIs' Calibration Facilities

Water and liquids other than water

EUROMET Chairman TC Flow



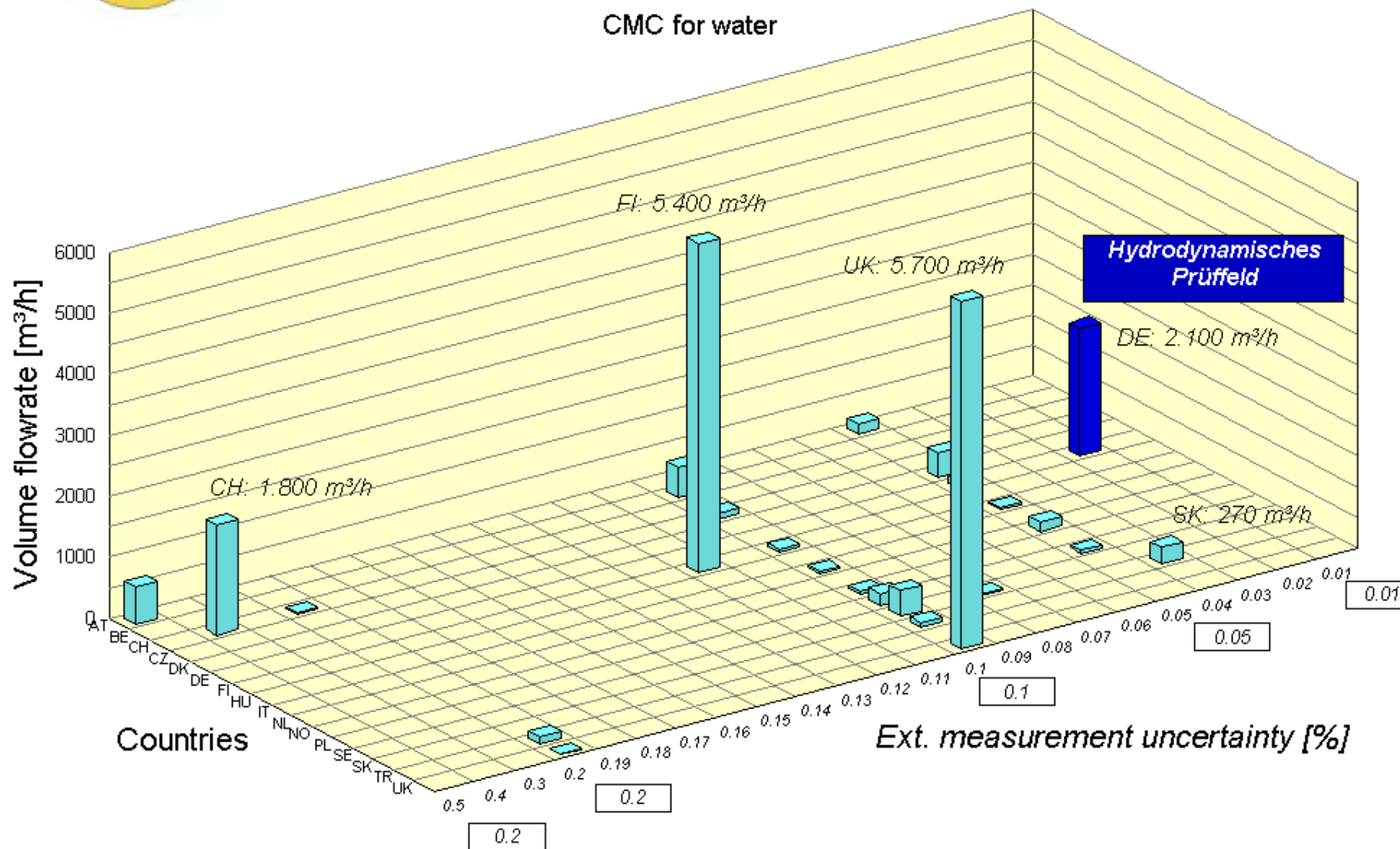
Update: Dopheide 2001-March-9

Countries



EUROMET
CMC for water

Chairman TC Flow

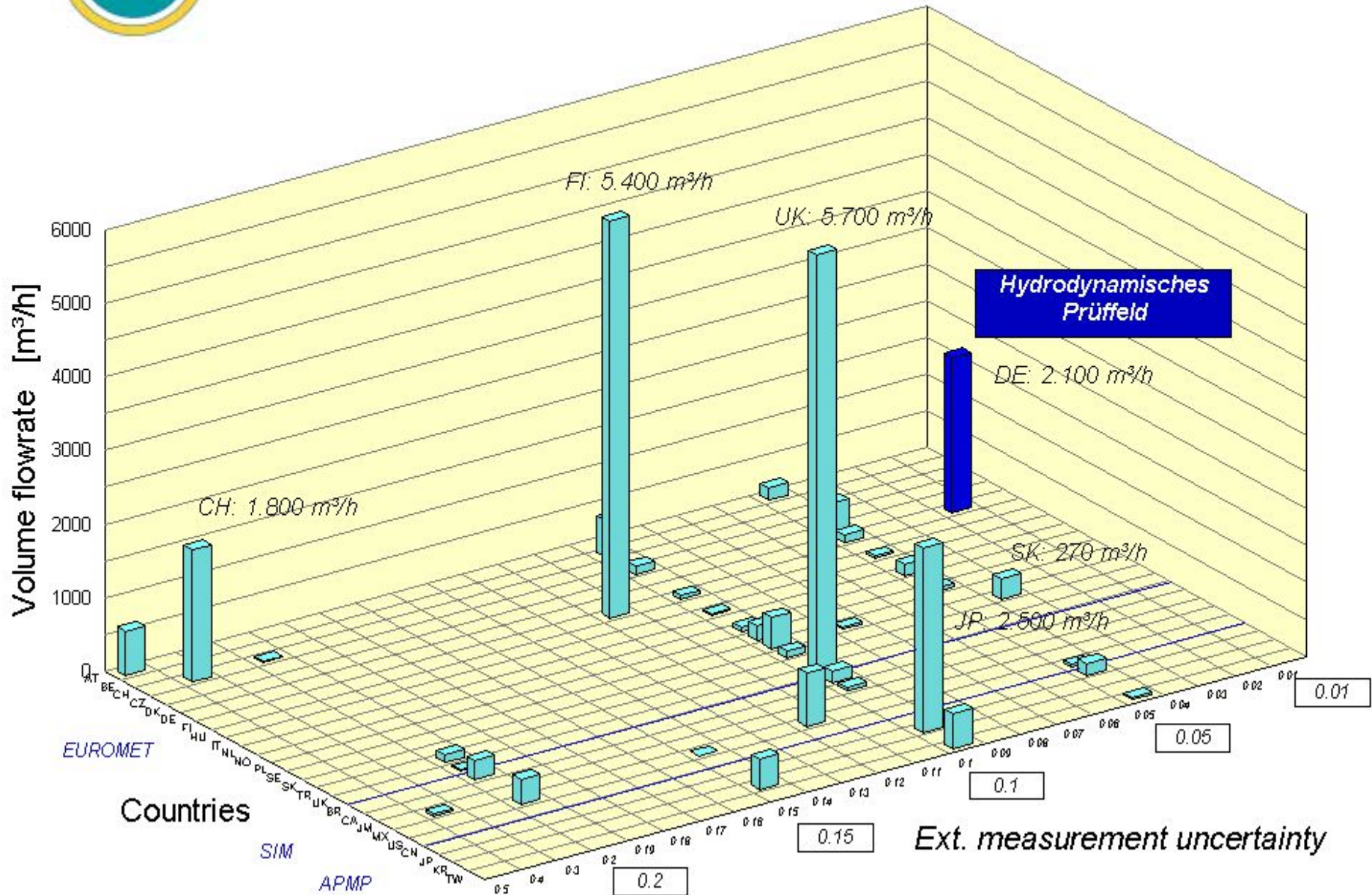




EUROMET, SIM, APMP

CMC for water

EUROMET Chairman TC Flow



Vielen Dank für Ihre Aufmerksamkeit