STATUS OF THE WORKING GROUP FOR FLUID FLOW

JOHN WRIGHT

NIST FLUID METROLOGY GROUP

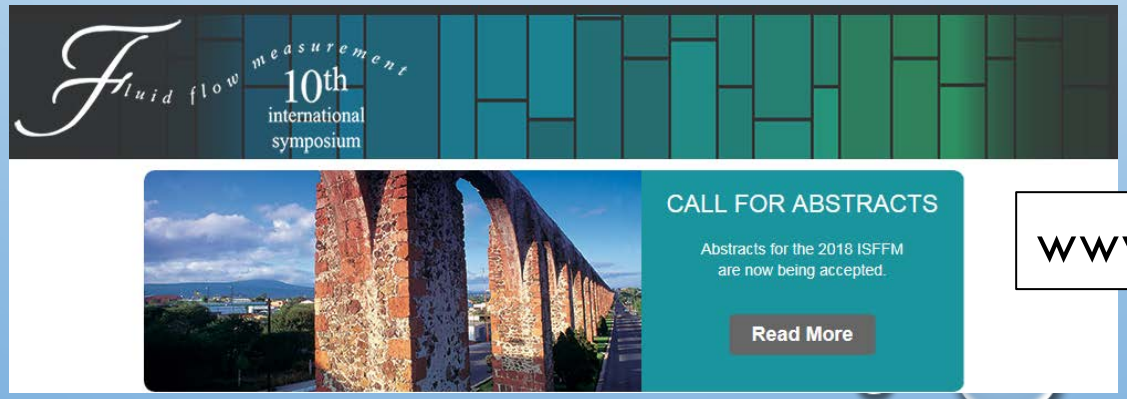
CHAIR WORKING GROUP FOR FLUID FLOW

MAY 18, 2017

WGFF MEETINGS

April 13 and 14, 2015 at ISFFM, Washington D. C., (31 participants)

September 22 and 23, 2016 at FLOMEKO, Sydney, (27 participants)



www.isffm.org/

Next meeting: March 19 and 20, 2018 at ISFFM, Queretaro, Mexico

16TH MEETING OF THE WORKING GROUP FOR FLUID FLOW

SYDNEY, AUSTRALIA

SEPTEMBER 22 AND 23, 2016

WGFF LEADERSHIP

Chair: John Wright, since 2011, reappointed through 2019
Vice-Chair: Bodo Mickan, since 2011

<u>Plan:</u>

- Nominations and vote in 2018
- Transition to new chair at 2019 WGFF meeting

WGFF MEMBERS

Country	Individual	Institute
Austria	Petra Milota (RMO)	BEV
Australia	Khaled Chahine	NMIA
Chile (DI)	Jeny Vargas Angel	CISA
China	Chunhui Li	NIM
Czech Republic	Miroslava Benkova	CMI
France (DI)	Remy Maury	LNE-LADG
Germany	Bodo Mickan	PTB
Italy	Pier Giorgio Spazzini	INRIM
Japan	Takashi Shimada (RMO)	NMIJ
Kenya	Dominic Ondoro	KEBS
Korea	Yong Moon Choi	KRISS
Mexico	Roberto Arias (RMO)	CENAM
Netherlands	Peter Lucas	VSL
Portugal	Elsa Batista	IPQ

Country	Individual	Institute
Russia (DI)	Konstantin Popov	VNIIM
Singapore	Wu Jian	A*STAR
South Africa	Deona Jonker (RMO)	NMISA
Sweden	Olle Penttinen	SP
Switzerland	Hugo Bissig	METAS
Thailand	Theerarak Chinarak	NIMT
Turkey	Bulent Unsal	UME
United Kingdom	Michael Reader-Harris	NEL
United States	John Wright	NIST
	Invited Guests	
Canada	Christian Lachance (MC)	NRC
Chinese Taipei	Chun Min Su	CMS ITRI

APPLYING COMPARISON RESULTS TO CMC REVIEWS

IOP Publishing | Bureau International des Poids et Mesures
Metrologia
Metrologia 53 (2016) 1243–1258
doi:10.1088/0026-1394/53/6/1243

Transfer standard uncertainty can cause inconclusive inter-laboratory comparisons

John Wright[1], Blaza Toman[1], Bodo Mickan[2], Gerd Wübbeler[2], Olha Bodnar[2] and Clemens Elster[2]

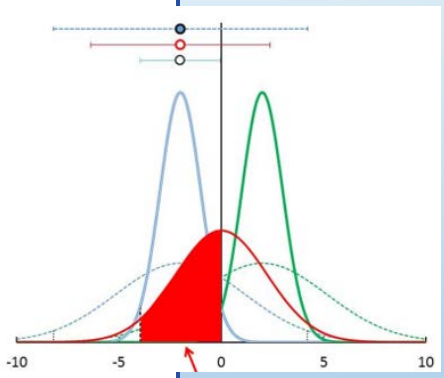
[1] National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA
[2] Physikalisch-Technische Bundesanstalt (PTB), Braunschweig and Berlin, Germany

E-mail: john.wright@nist.gov

Received 11 April 2016, revised 30 July 2016
Accepted for publication 9 August 2016
Published 7 October 2016

Abstract

Inter-laboratory comparisons use the best available transfer standards to check the participants' uncertainty analyses, identify underestimated uncertainty claims or unknown measurement biases, and improve the global measurement system. For some measurands, instability of the transfer standard can lead to an inconclusive comparison result. If the transfer standard uncertainty is large relative to a participating laboratory's uncertainty, the commonly used standardized degree of equivalence $\leqslant 1$ criterion does not always correctly assess whether a participant is working within their uncertainty claims. We show comparison results that demonstrate this issue and propose several criteria for assessing a comparison result as passing, failing, or inconclusive. We investigate the behavior of the standardized degree of equivalence and alternative comparison measures for a range of values of the transfer standard uncertainty relative to the individual laboratory uncertainty values. The proposed alternative criteria successfully discerned between passing, failing, and inconclusive comparison results for the cases we examined.



Considered the effects of large transfer standard uncertainty on comparison results (generally only a problem when transfer standard is poorly evaluated during preliminary testing or is damaged during the KC).

Declaration of the impact of a CCM or RMO comparison on the CMC claims

1. Subfield: Air speed	RMO internal identifier
2. KCDB identifier: CCM.FF-K3.2011	

3. Pilot/Coordinating laboratory(ies) (*acronyms and countries*):
PTB (Germany) & LNE-CETIAT (France)

4. Participating institute (*acronym and country*):
NIST (USA)
Person who declares on behalf of the participating laboratory
Name: Iosif Shinder
Tel: (301) 975-5943
e-mail: iosif.shinder@nist.gov

The declarer affirms that the comparison results of his/her NMI have been checked against their CMC claims and states (please add rows as needed in the following table):

measurand	our CMC claims	our comparison results	Yes or No, our claims are supported by our comparison results
K3 Air Speed, 0.5 m/s to 40 m/s	(k = 2, level of confidence 95%) in %: $(0.44 + 0.16/v^2)$, v speed in m/s	LDA: En = 0.06 to 0.65 Ultrasonic: En = 0.04 to 1.02	Yes, the results of K3 support NIST's CMCs for the best existing device (LDA) but En values >1 for the ultrasonic anemometer transfer standard suggest that the uncertainty values given in customer calibration reports for this device under test are underestimated. NIST will investigate possible explanations (such as blockage effects) and either make appropriate corrections or increase the uncertainty for customer calibration reports.

Used CCM "Declaration of Impact" forms for CCM.FF-K3.2011

RECENT FLOW COMPARISONS

Key Comparison	Measurand	Pilot Lab	Status
CCM.FF-K4.2011.2	Liquid volume, 100 μL	IPQ	Complete, 2013
CCM.FF-K6.2011	Low pressure gas flow	SMU / CMI	Complete, 2014
CCM.FF-K4.2011.1	Liquid volume, 20 L and 100 mL	CENAM	Complete, 2015
CCM.FF-K2.2015	Hydrocarbon liquid flow	NMIJ	Complete, 2016
CCM.FF-K3.2011	Air speed	LNE / PTB	Complete, 2017
CCM.FF-K3.2011.1	Air speed	LNE / PTB	In progress
CCM.FF-K1.2015	Water flow	PTB	In progress
CCM.FF-K2.2011.1	Hydrocarbon liquid flow	VSL	Draft A Report
CCM.FF-K5.2016	High pressure gas flow	PTB	Preliminary testing
CCM.FF-K6.2017	Low pressure gas flow	ITRI	Planned, request CCM approval
CCM.FF-K1.2017	Microflow of water	NMIT / METAS	Planned

ON-GOING WGFF KEY COMPARISONS

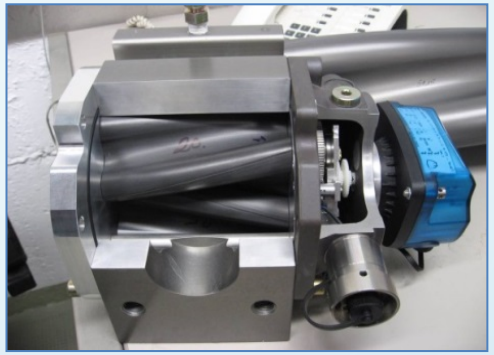
K2.2011: Hydrocarbon Liquid Flow
Smits (VSL)
2 Coriolis meters, Draft A in revision

K1.2015: Water Flow
Frahm & Engel (PTB)
Ultrasonic & turbine, damaged in shipment

K5.2016: High Pressure Gas Flow
Mickan (PTB)
Turbine & critical flow venturi, pressure certification

COMPLETED WGFF KEY COMPARISONS

K4.2: Volume, Batista (IPQ)
Completed 2013



K6: Low Pressure Gas Flow, Benkova (CMI) & Makovnik (SMU)
Completed 2014

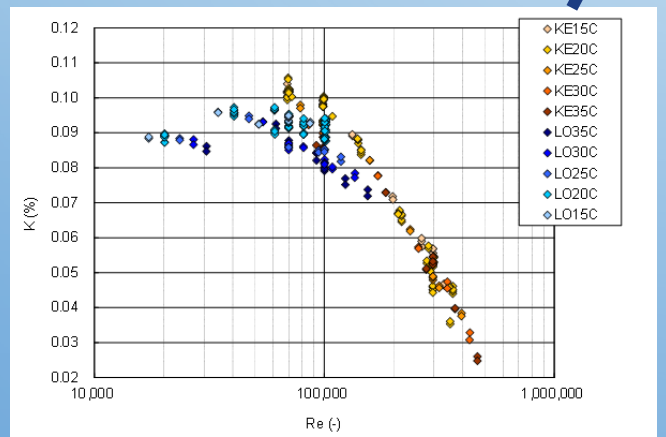
K4.1: Volume, Arias (CENAM)
Completed 2015

K2.2: Hydrocarbon Liquid Flow, Shimada (NMIJ)
Completed 2016

K3: Air Speed, Care (LNE), Mueller (PTB)
Completed 2017

CCM.FF-K2.2015: HYDROCARBON LIQUID FLOW COMPARISON, SHIMADA (NMIJ)

Screw-type positive displacement flow meter



Most thorough preliminary testing!

Uncertainty category	(*k*=2, %)
Reproducibility	0.0035
Temperature and viscosity effects	0.0058
Pressure effects	0.0028
Linearity	0.0009
Root-sum-of-squares	**0.0080**

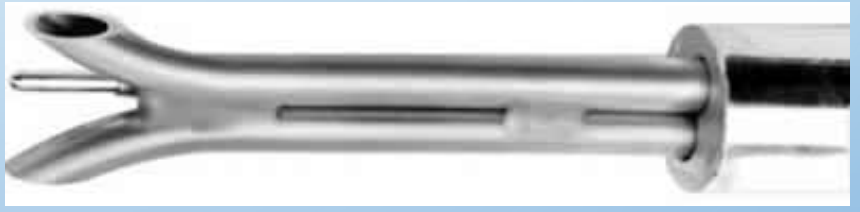
$$U_{TS} / U_{labi} < 1$$

AIR SPEED APPLICATIONS

Wind turbine siting

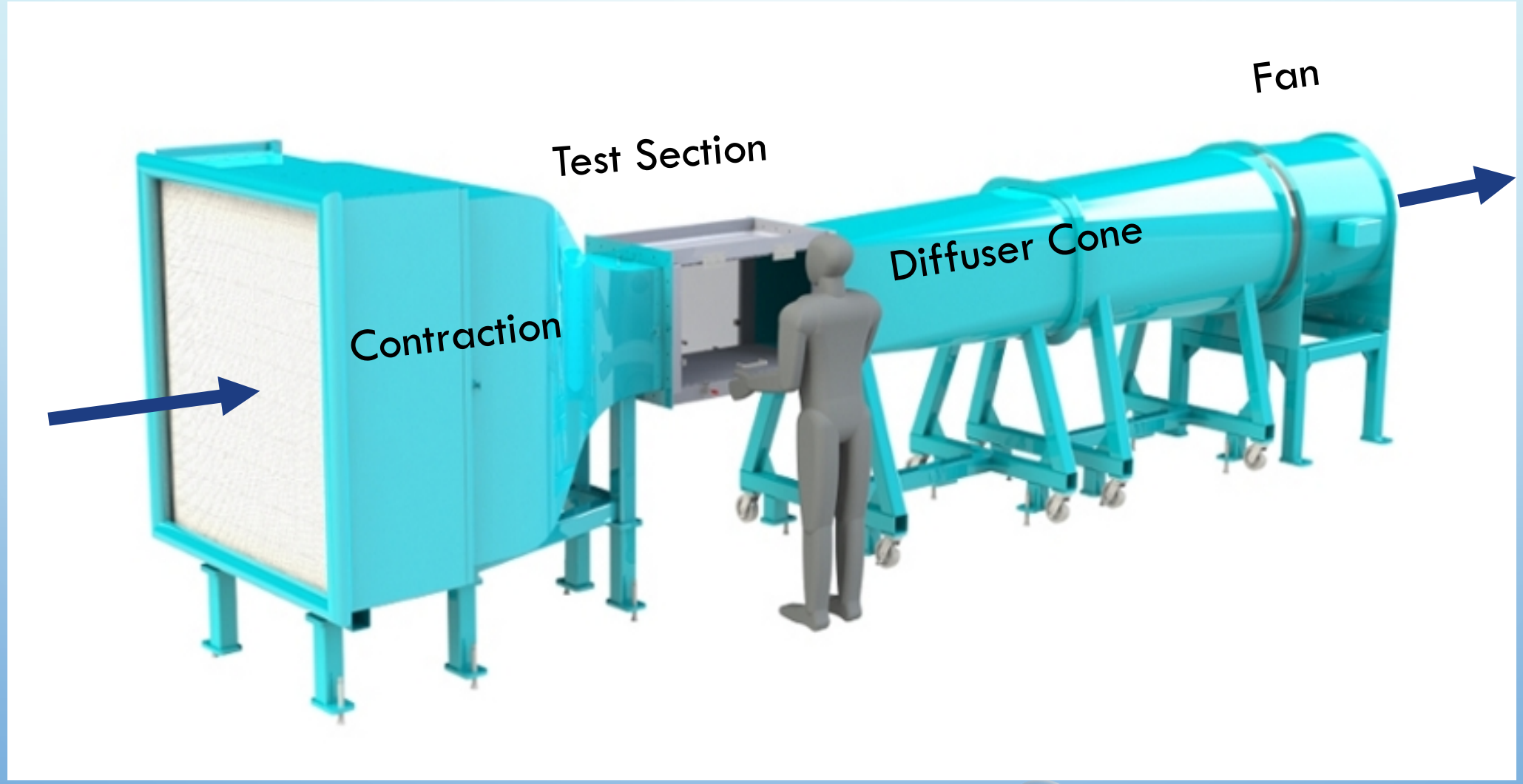
Cup and vane anemometers

Pollution control



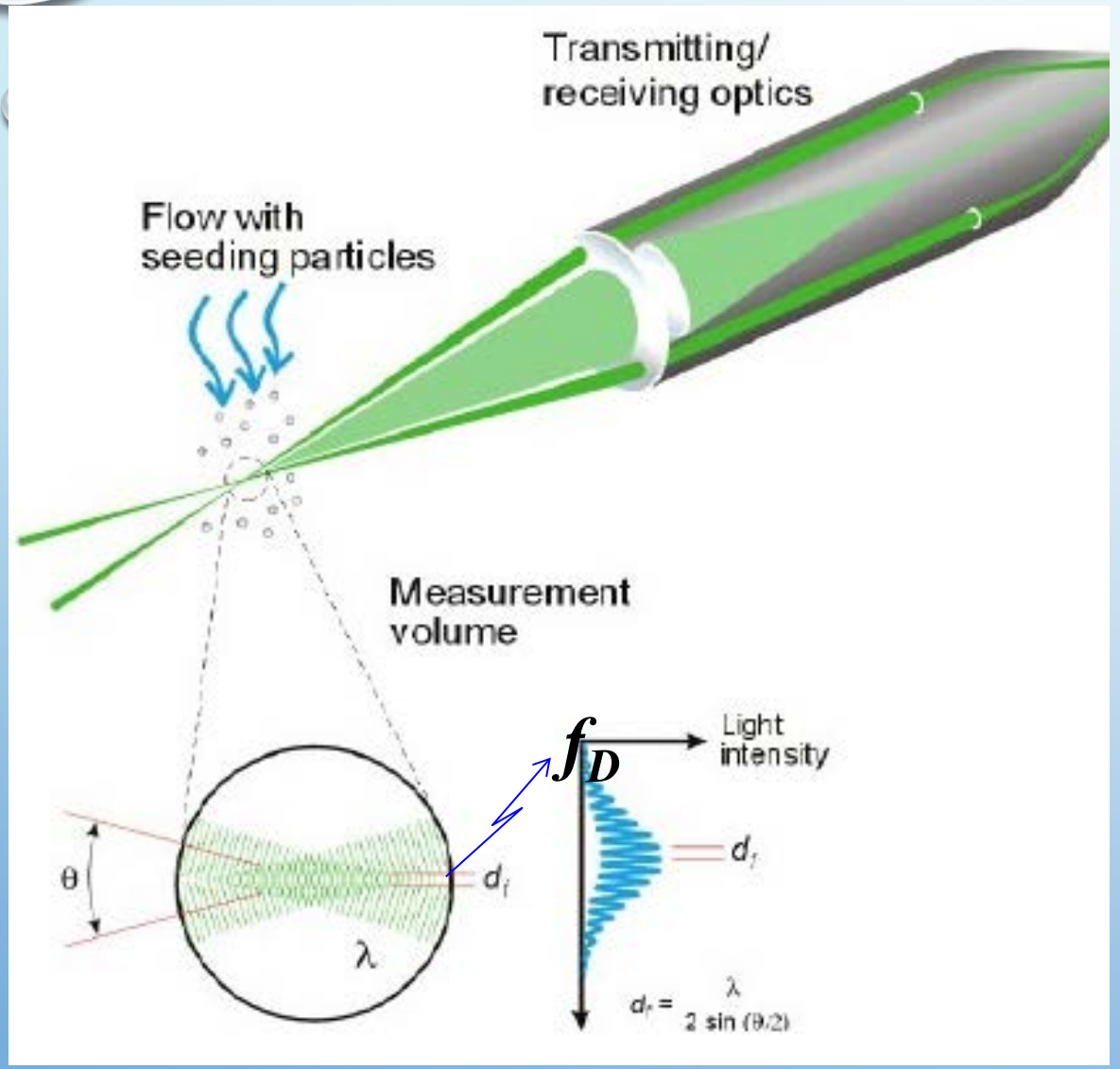
Velocity profiles with Pitot tubes

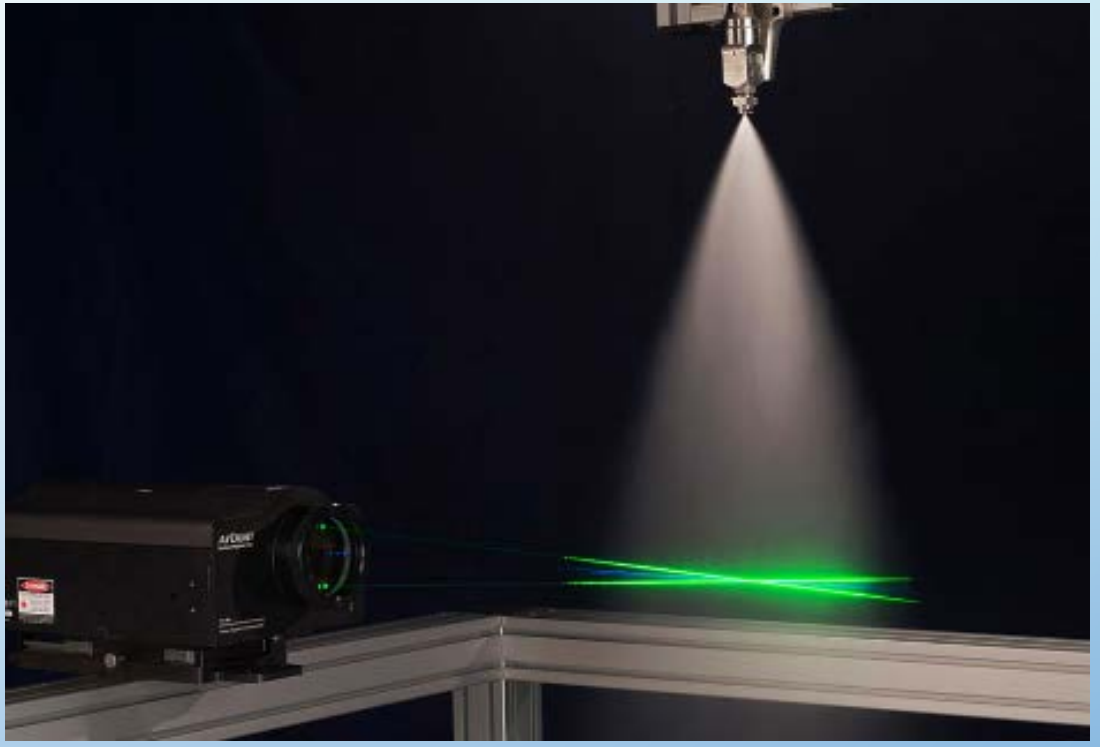
WIND TUNNEL



Small test sections have significant blockage effects

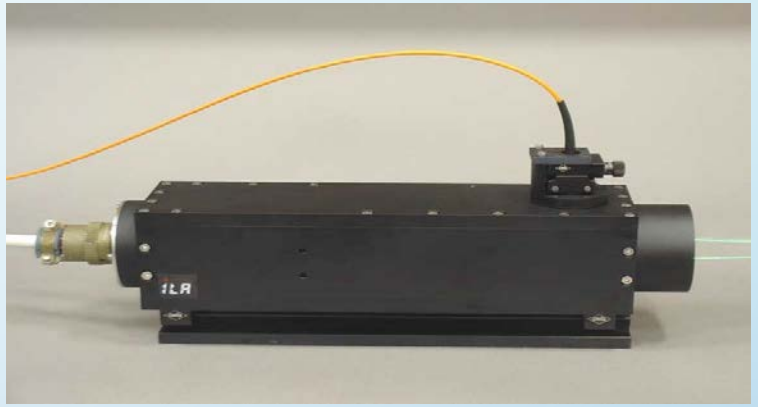
LASER DOPPLER ANEMOMETER (LDA)





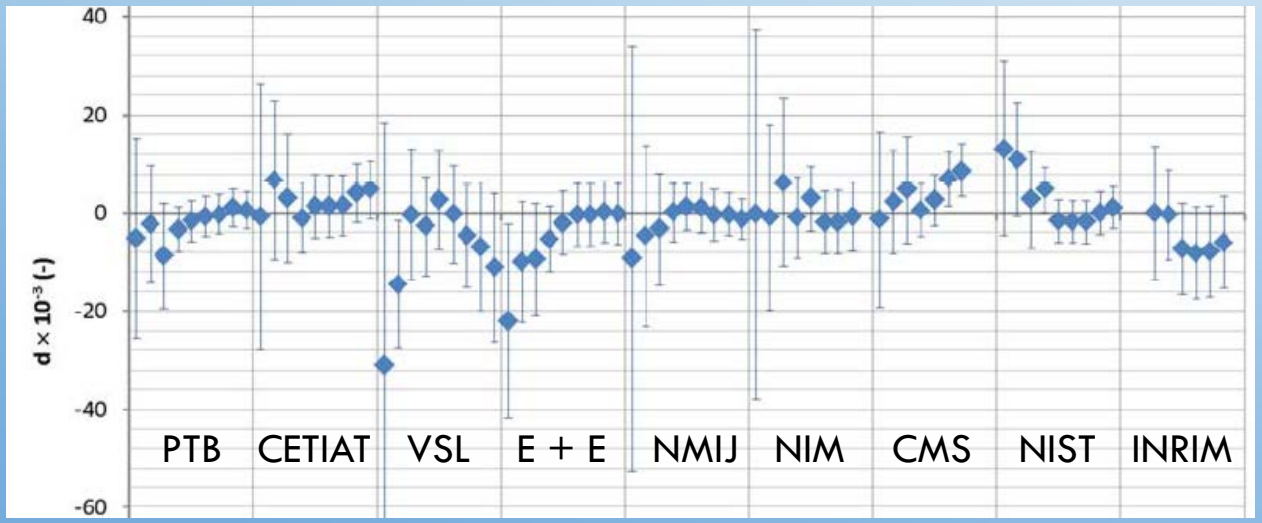
Non-intrusive! No blockage!

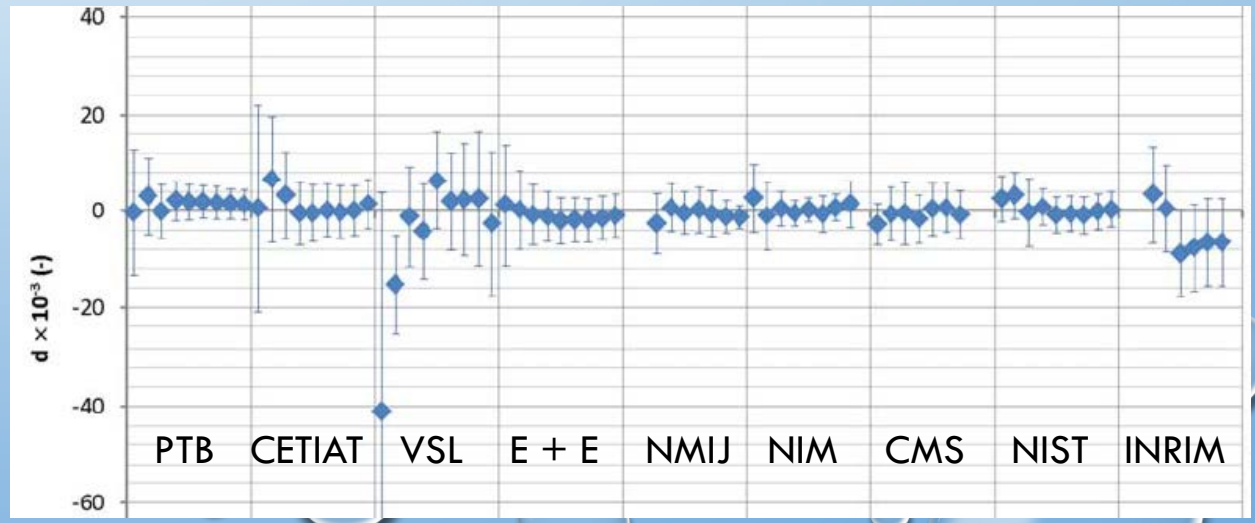
CCM.FF-K3.2011AIR SPEED: CARE (LNE) AND MUELLER (PTB)



Ultrasonic anemometer

Laser Doppler anemometer (LDA)





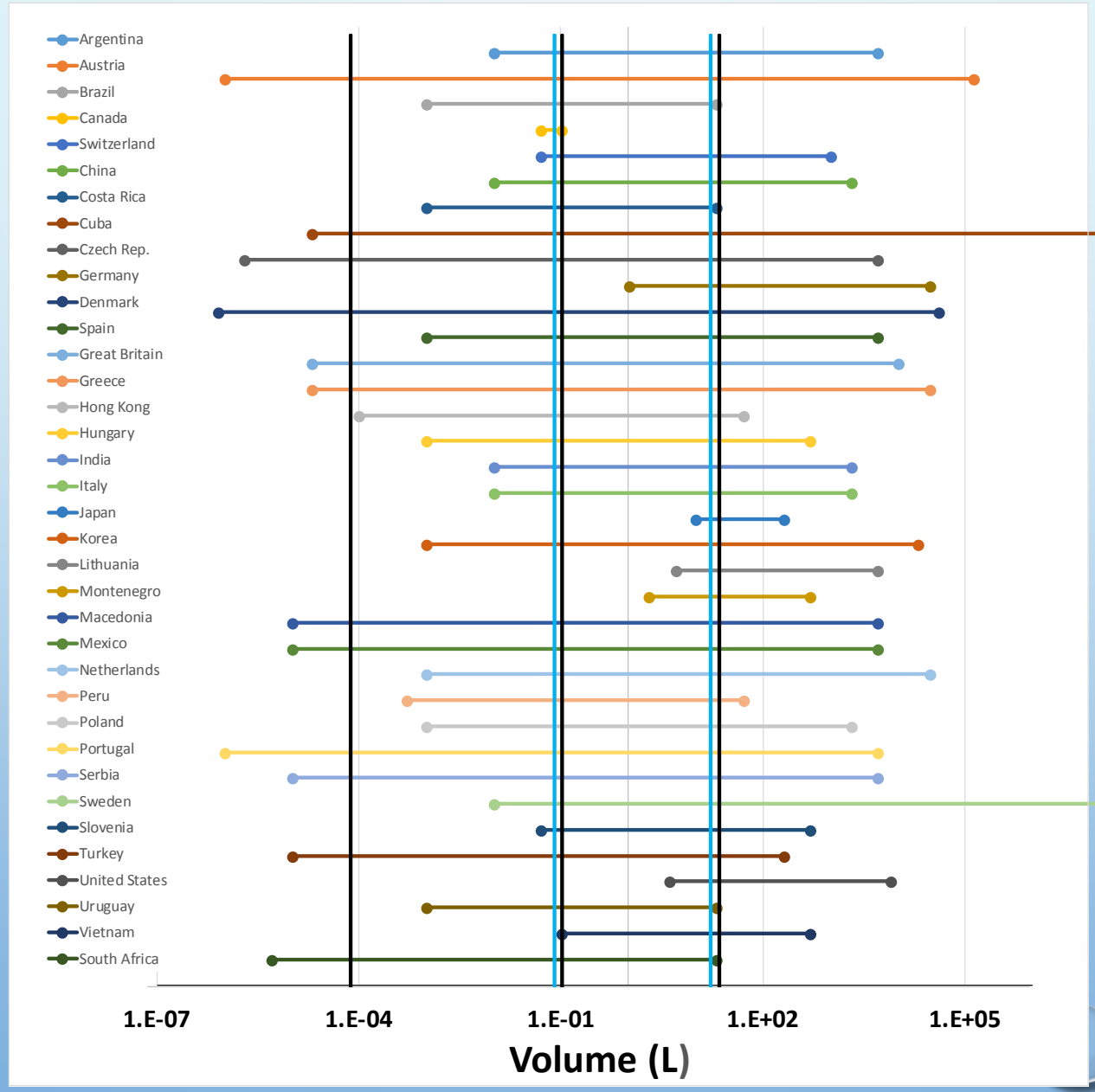
“GAP ANALYSIS”

How well do our comparisons cover our CMCs?

(How far does the light shine?)

VOLUME

36 countries



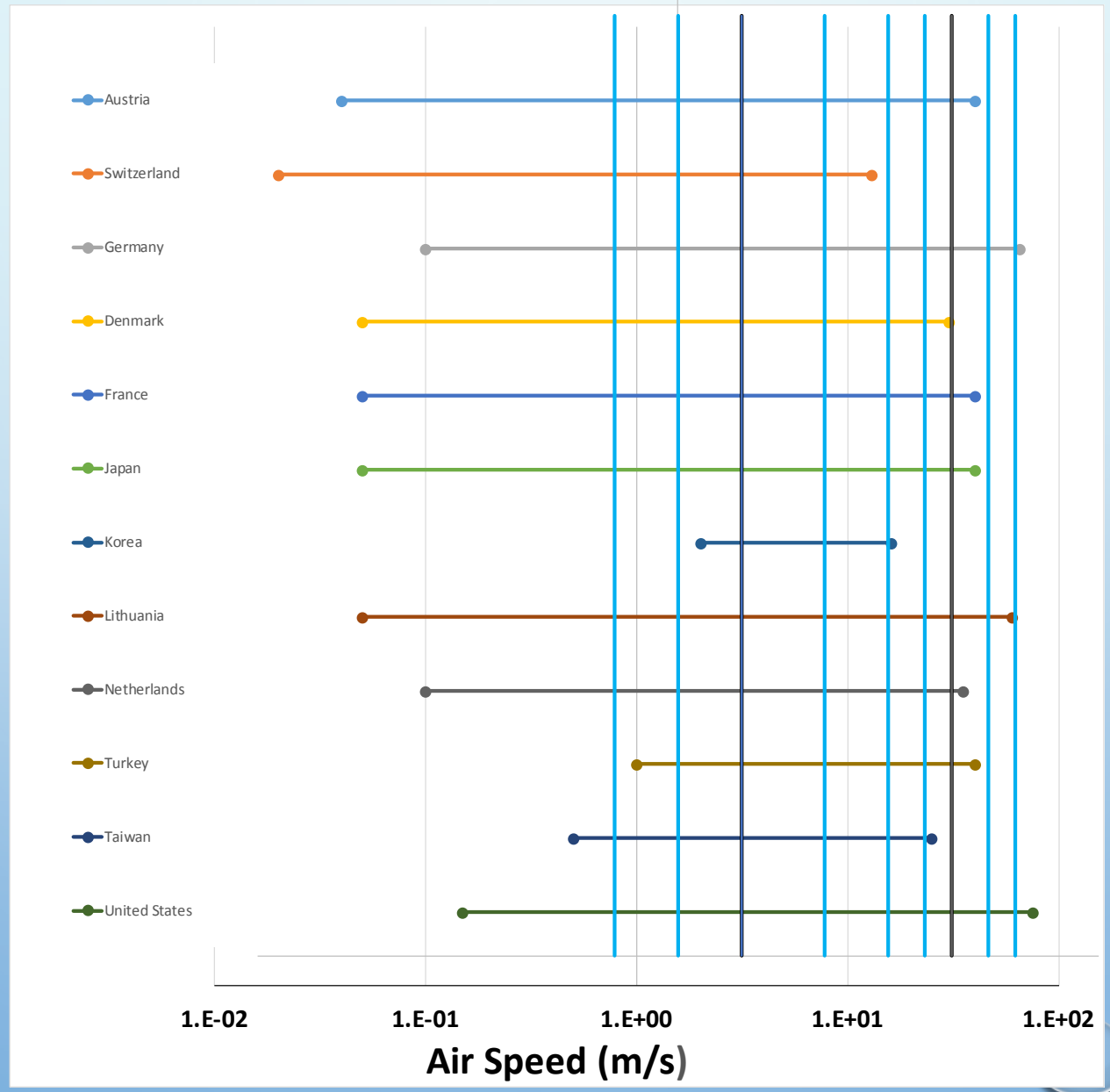
K4-2003

K4.1-2011

K4.2-2011

AIR SPEED

12 countries

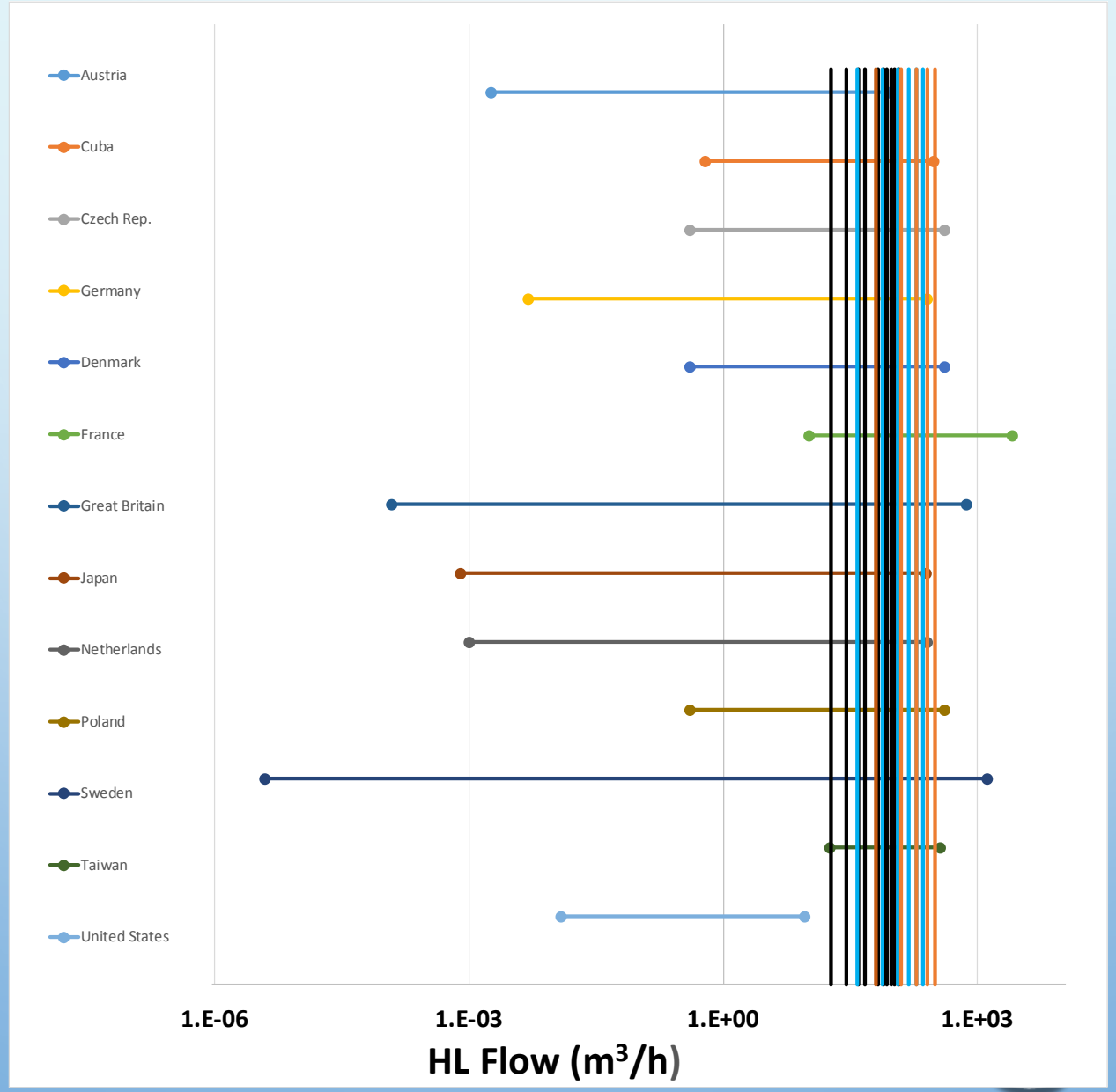


K3-2005

K3-2011

HYDROCARBON LIQUID FLOW

13 countries



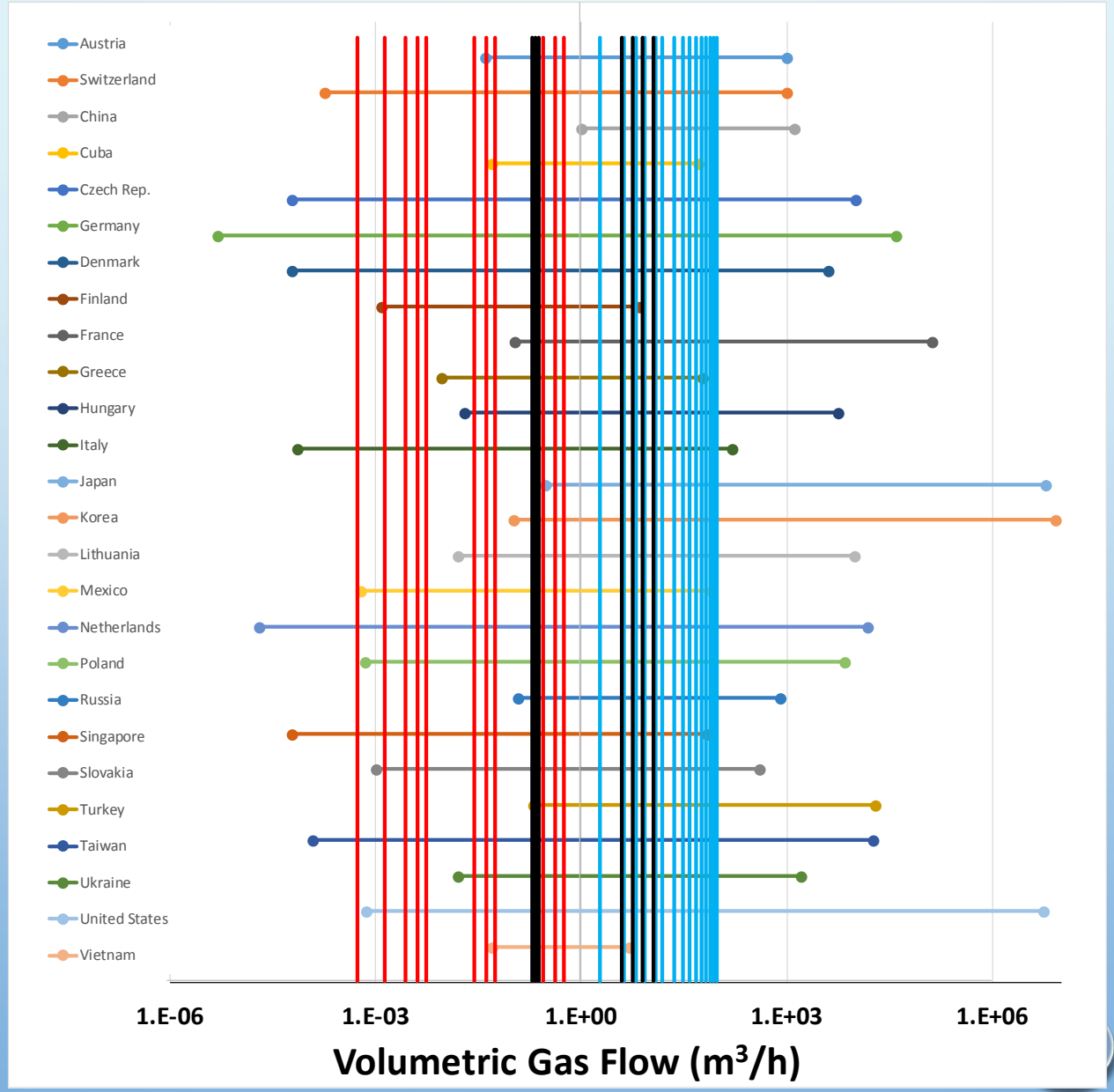
K2-2005

K2.1-2011

K2.2-2011

LOW PRESSURE GAS FLOW

26 countries



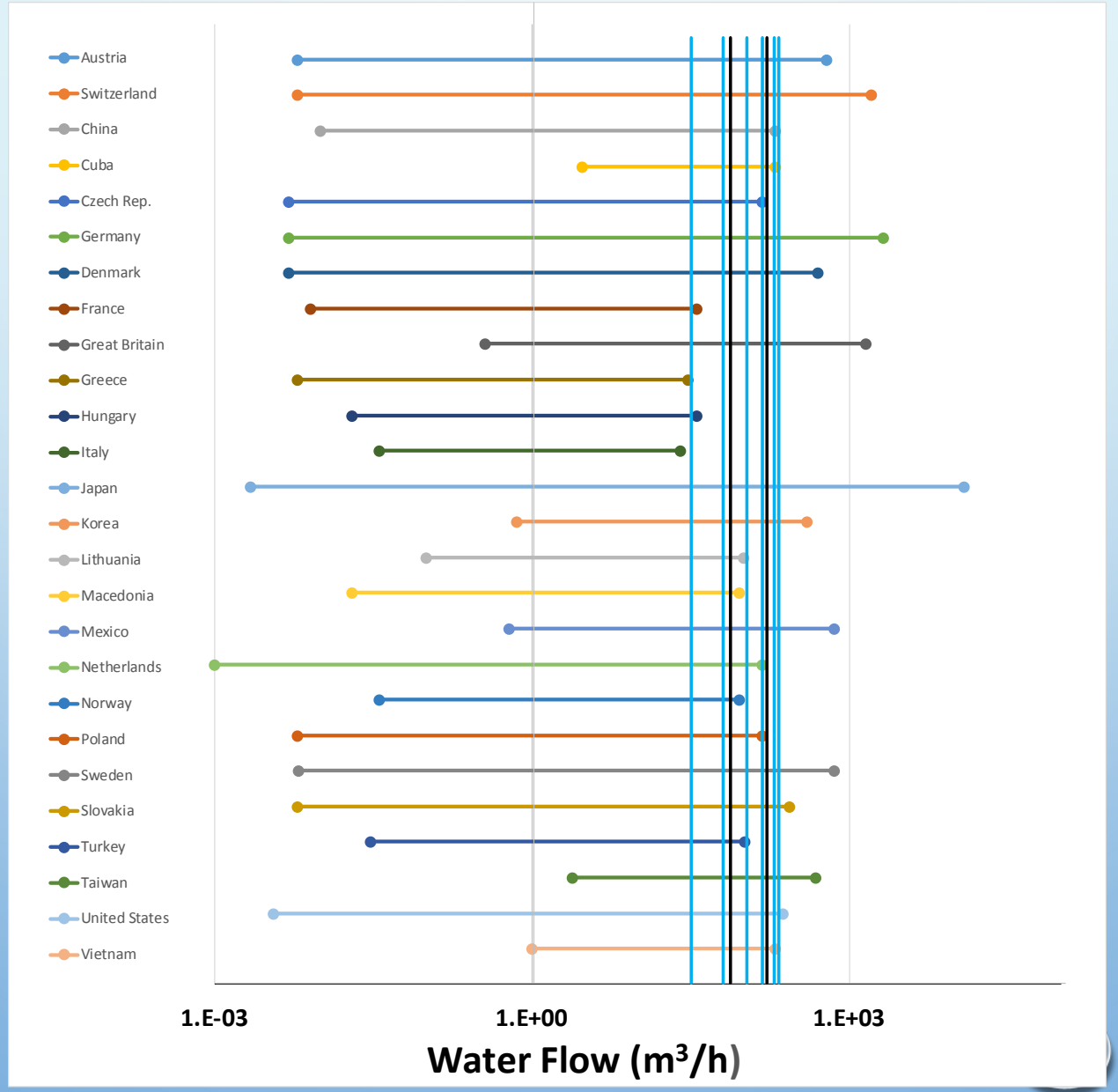
K6-2005

K6-2011

K6-2017?

WATER FLOW

26 countries



K1-2005

K1-2015

REQUEST CCM APPROVAL FOR:

CCM.FF-K6.2017 Low pressure gas flow

- Pilot: Chinese Taipei (CMS/ITRI)
- Participants: Australia, Chinese Taipei, Czech Republic, France, Germany, Italy, Japan, South Korea, Switzerland, USA
- Set points: 0.01 L/min to 10 L/min

PLANNED COMPARISON

CCM.FF-K1.2017 Water micro-flow

- Pilots: NIMT/Thailand & METAS/Switzerland
- Participants: Chinese Taipei, France, Germany, Japan, Netherlands, Portugal, Switzerland, USA
- Set points: 10 µL/min to 1 mL/min ?

PROGRAM OF WORK FOR NEXT 5 YEARS

- How to objectively apply KC results to CMC reviews
- Reorganize flow service categories
- Increase participation by developing economies, strengthen coordination with RMOs, encourage different labs to serve as Pilots of key comparisons
- Guidelines on linkage and how to handle multiple artifacts
- Guidelines on allowed changes between Draft A and Draft B
- Solve transport and cost sharing problems

IN MEMORY OF JEAN-PIERRE VALLET

GREAT PERSON, GREAT FRIEND!!