

WGLF summary to CCEM

24 March 2017

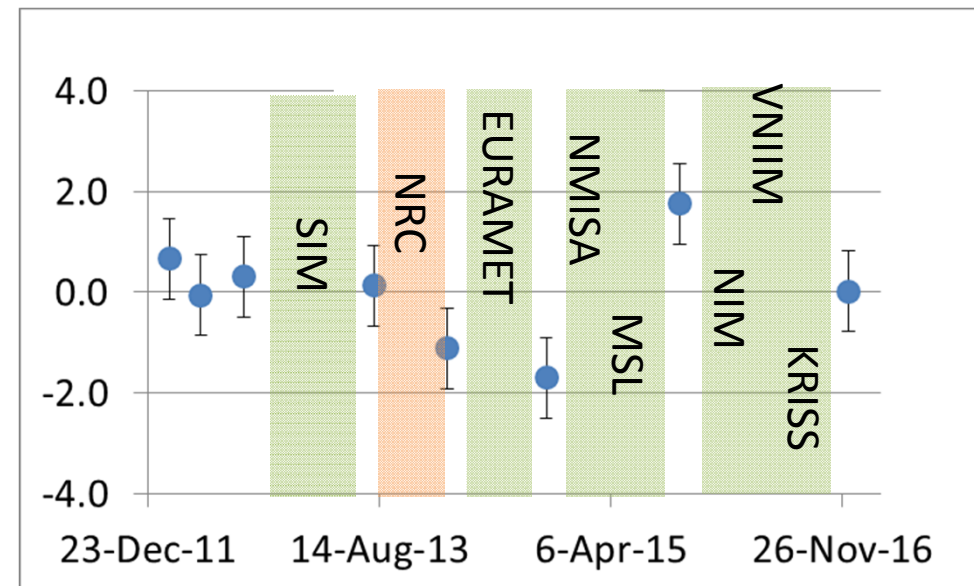
Jonathan Williams
WGLF Chairman

BIPM Comparisons

- * Typically 25 to 30 resistance and capacitance calibrations per year
- * Few Zener calibrations
- * On-site Josephson comparisons continue
- * Following the first on-site QHR comparison in the new series, there have been problems with the next two, a third is planned next for CMI.

Ongoing Key Comparisons

- * K2 – resistance at 10 M Ω and 1 G Ω
 - * Pilot laboratory: NRC
 - * Started September 2012
 - * Taking longer than expected due to problems with the travelling standards
 - * Schedule was re-planned
 - * Measurements are complete
 - * Draft A report planned for June 2017



Ongoing Key Comparisons

- * K5 – primary power at 120 & 240 V, 5 A, 53 Hz; phase 0° , $\pm 60^\circ$, $\pm 90^\circ$, two Radian travelling standards
 - * Aimed uncertainty level $< 20 \mu\text{W}/\text{VA}$
 - * Planned loop:
 - * Pilot measurements: **PTB**
 - * SIM: **NRC, CENAM** and **INMETRO**
 - * EURAMET: **VSL, LNE** and **SP**
 - * APMP: **NIM, NMIA** and **VNIIM**
 - * From Afrimets: **NMISA**
 - * Target of 2.5 years of measurements, 6 months analysis
 - * Organisation by CENAM and report writing by VSL

Ongoing Key Comparisons

- * K13 – power harmonics
 - * Participants agreed: NIST, NRC, SP, PTB, NPL, VNIIM, NIM
 - * Travelling standard Fluke 6105
 - * Technical protocol written by NRC and SP, includes up to 4 sets of waveforms
 - * Support group NIST, NRC, SP, NPL, NIM
 - * The circulation of the travelling standard will be made in three rounds, first to SIM, then to EURAMET and finally to COOMET with measurements at NIM in between
 - * Comparison scheduled to start in summer 2017

Ongoing Key Comparisons

- * K4 – capacitance, 10 pF and 100 pF, 1 kHz and 1.592 kHz
- * Adopted a **star** approach
 - * BIPM, METAS, NIM, NIST, NMIA, NPL, PTB and VNIIM
 - * BIPM will be a participant and will not be the KCRV
 - * Measurements in laboratories have begun and standards will travel to BIPM during April. Aim to have everything completed by the end of 2017

Ongoing Key Comparisons

- * K6a/9K6a, ac/dc voltage transfer:
 - * 1 - 4 V, 10 Hz - 1 MHz & 500 - 1000 V, 10 Hz – 100 kHz
- * Two travelling standards will be circulated, combining both activities into one exercise to save on transport and reporting costs
- * **SP**, INTI, PTB, NMIA, **NRC**, JV, NMIJ, NIM, LNE, NMISA, also INMETRO, **Astar** (bold = 1000 V)
- * Coordinator to reconfirm participants with WGLF chair
- * Support group: SP (protocol), INTI (reporting), PTB (pilot measurements)
- * Expected start date 2017-8

Ongoing Key Comparisons

- * K3 – inductance 10 mH and 1 kHz
- * Two temperature-controlled standards made available by PTB
- * **Proposed participants:** PTB, NIST, NPL, VSL, NMIA, NRC, NMISA, INMETRO, CENAM, KRISS, VNIIM
- * PTB willing to be the pilot laboratory if supported by two further NMIs to coordinate and write up the report
- * Coordinator to reconfirm participants with WGLF chair
- * Target start date 2018-19

WGLF strategy for comparisons

- * 10 Key quantities, 1 -4 values in each quantity
- * Discipline of NOT increasing the number of quantities without a strong case
- * Review the values within a quantity
- * Interval between comparisons typically 10 years, based on evolution in laboratories, some quantities longer or even no future comparison scheduled
- * Choices also strongly influenced by the activities in the RMOs

Comparison overview

Quantity	<1998	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
DC Voltage																								
1.1 Sources	BIPM.K10, K11																							
1.3 Ratios					K8, 8.1																			
DC Resistance																								
2.1.2 1 ohm to 1 Mohm	K1, 1 & 10 k	BIPM.K12 QHR,		K10, 100				K13a/b, 1 / 10 k																
2.1.3 above 1 Mohm		K2, 10 M & 1 G														K2.2012 10 Mohm & 1 Gohm								
DC current to 100 A																								
Impedance																								
4.1 Resistance																								
4.2 Capacitance	K4, 10 pF						BIPM.K14a/b, 10 pF / 100 pF														K4, 10 pF / 100 pF			
4.3 Inductance	K3, 10 mH										K3.1, 10 mH													
AC Voltage																								
5.1.1 AC/DC <0.5V					K11, 10 mV, 100 mV			K11.1 10 / 100 mV																
5.1.2 AC/DC 0.5 to 5V	K6.a, 3 V																					K6.a, 3 V		
5.1.3 AC/DC >5V	K6.b, 500 / 1000 V		K9, 1000 V																			K9, 1000 V		
5.3.1 AC ratio		K7, 1 kHz																						
AC Current																								
									K12, 10 mA / 5A															
AC Power																								
	K5, 50 / 60 Hz																					K5, 50 / 60 Hz		
																						K13, power harmonics		
High voltage & current																								
Other DCLF																								

Further comparisons

- * Reviewed the case for DC voltage
 - * 1 V and 10 V are sufficiently covered by Josephson effect standards and comparisons – quantum standard maintains equivalence
 - * DC voltage ratio comparison – considering a comparison with a more simple transfer standard with just two or three ratios up to 1000 V
- * Reviewed the case for DC resistance
 - * 100 ohm resistance is sufficiently covered by the quantum Hall effect standards and comparisons. Another example of a quantum standard maintaining equivalence

Further comparisons

- * Reviewed the case for AC voltage ratio, K7
 - * Inductive voltage dividers are very stable. Previous comparison meets the present needs
- * Reviewed the case for AC/DC current, K12
 - * The previous comparison carried out 2005-06 is sufficient for now, revisit the requirements in 5 years' time
- * Reviewed the case for AC/DC transfer at 10, 100 mV, K11
 - * AC quantum standards based on the Josephson effect are rapidly developing in this area, review the landscape when the technology has stabilised ready for intercomparison

Other matters

- * Proposal to update CMC classifications for categories 8 (high voltage) and 9 (other DCLF quantities)
 - * Received an update from the WGLF task group who are working with the KCDB office on the most efficient approach
- * Any other business
 - * Euramet are working on best practice documents for intercomparison planning and reporting – WGLF chair to work with TC-EM chair to see how this work can be shared across the CCEM membership
 - * Demand is emerging for traceability for DC power relating to charging of electric vehicles