

New comparison of alternating current Josephson voltage standards

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Context of this work



The electricity laboratories of the BIPM provide the following services to the NMIs of Member States:

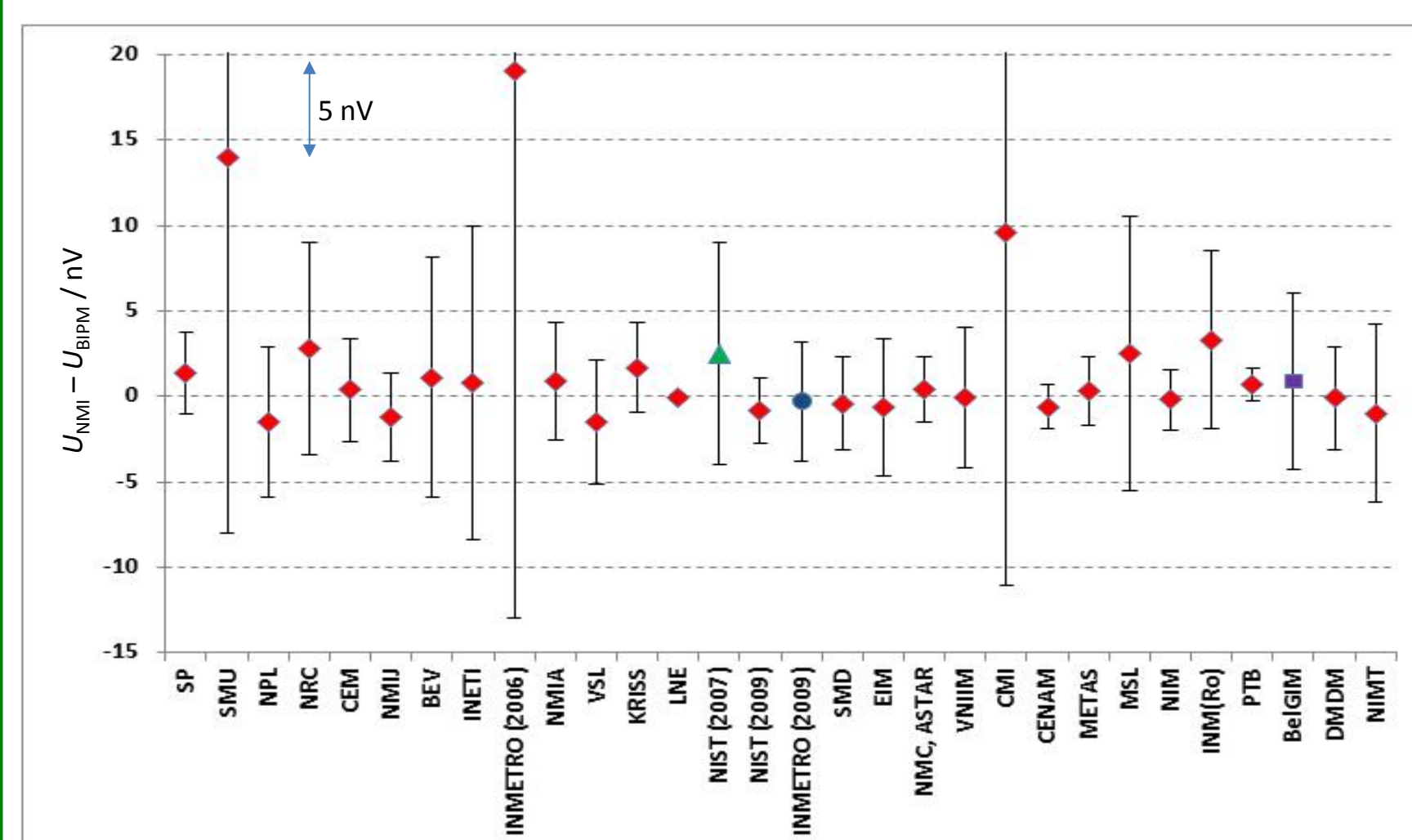
- Organization of comparisons of primary standards to support the CIPM MRA
- Calibrations of secondary standards to support NMIs without quantum standards

In addition, the electricity laboratories are involved in development activities focused on an improved realization of the units.

Organization of comparisons to demonstrate capabilities to the highest level

On-site ongoing Josephson voltage standard comparisons (BIPM.EM-K10)

To verify international coherence of **primary DC (direct current) voltage standards** by comparing Josephson-effect-based standards of the NMIs with that of the BIPM.



1 V level -1991
10 V level -2004

Extended to
AC voltages - 2024

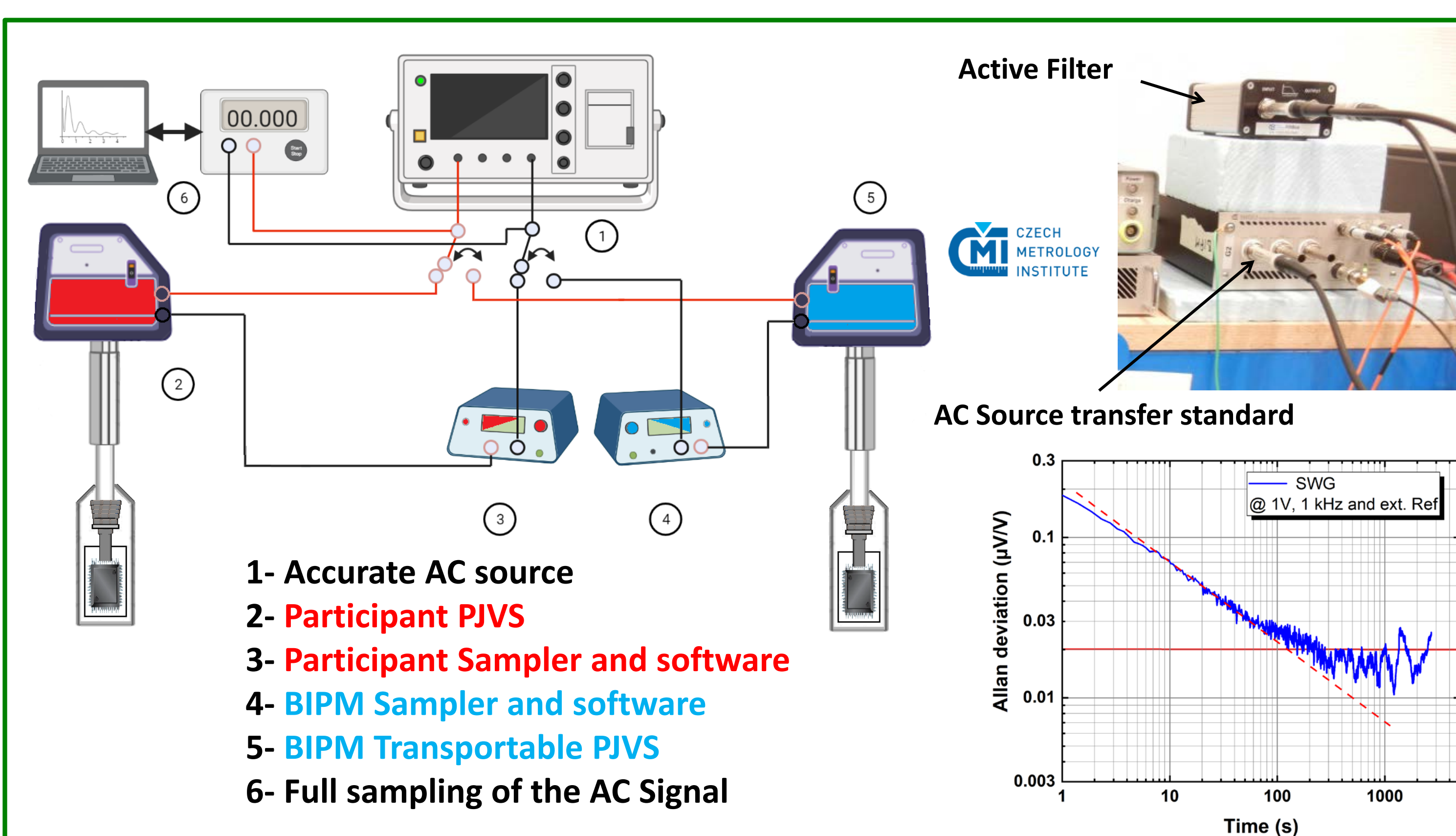
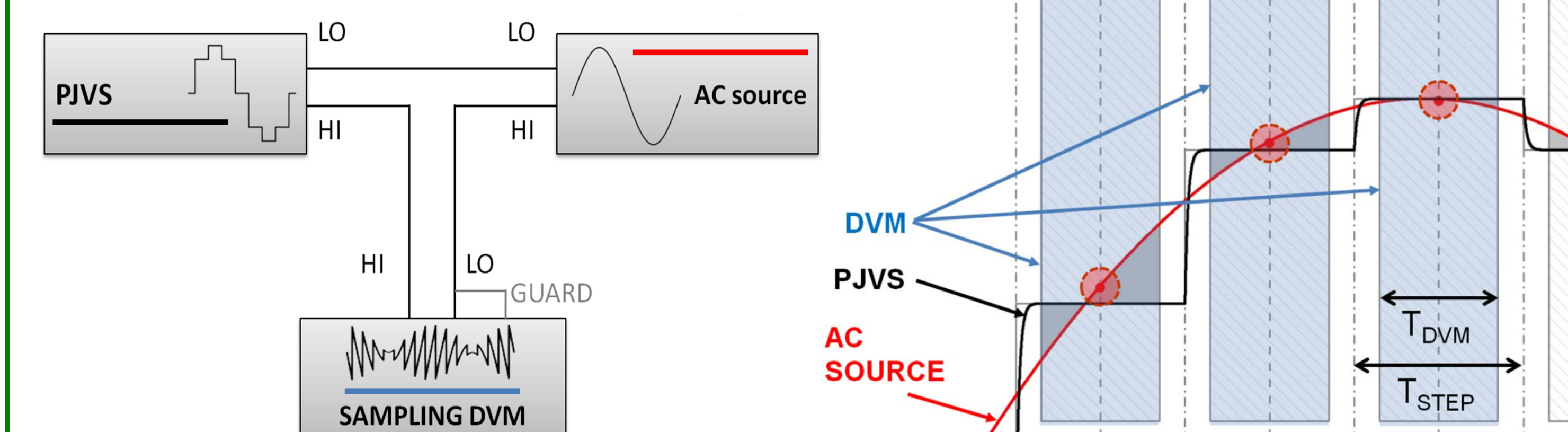


BIPM.EM-K10.b: comparison of Josephson voltage standards at 10 V



The comparison protocol has been prepared with active support from:

- NIST (USA): programmable Josephson voltage standard
- KRISS (Republic of Korea): guest scientist for 15 months
- CENAM (Mexico), NMJ (Japan), PTB (Germany), NPL (UK): trial comparisons
- VTT (Finland), NMIA (Australia), VNIIM (Russia): instrumentation



Active Filter

AC Source transfer standard

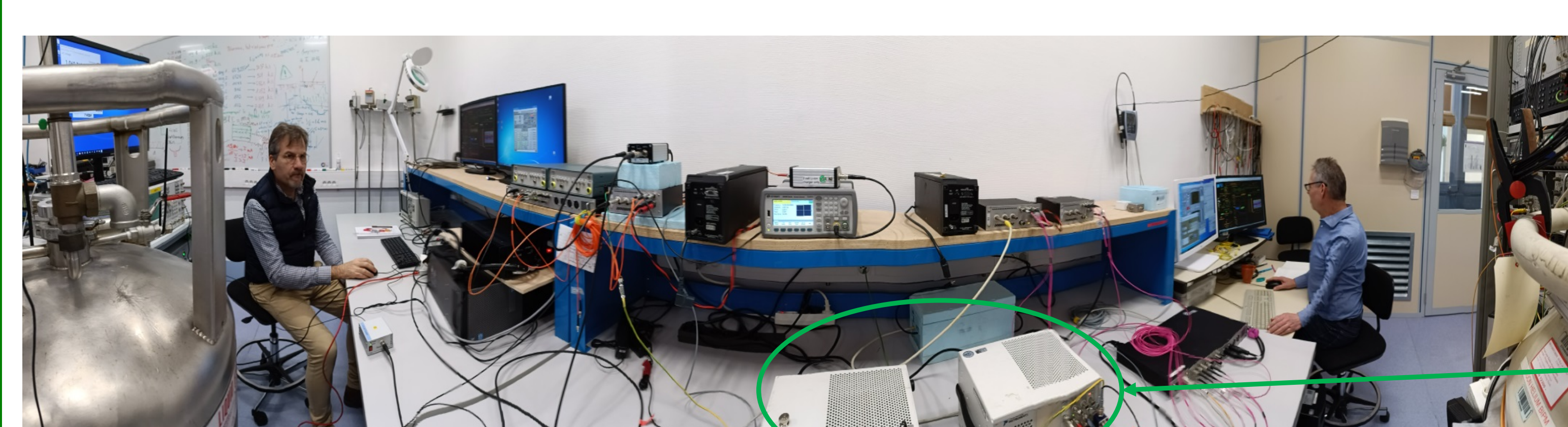
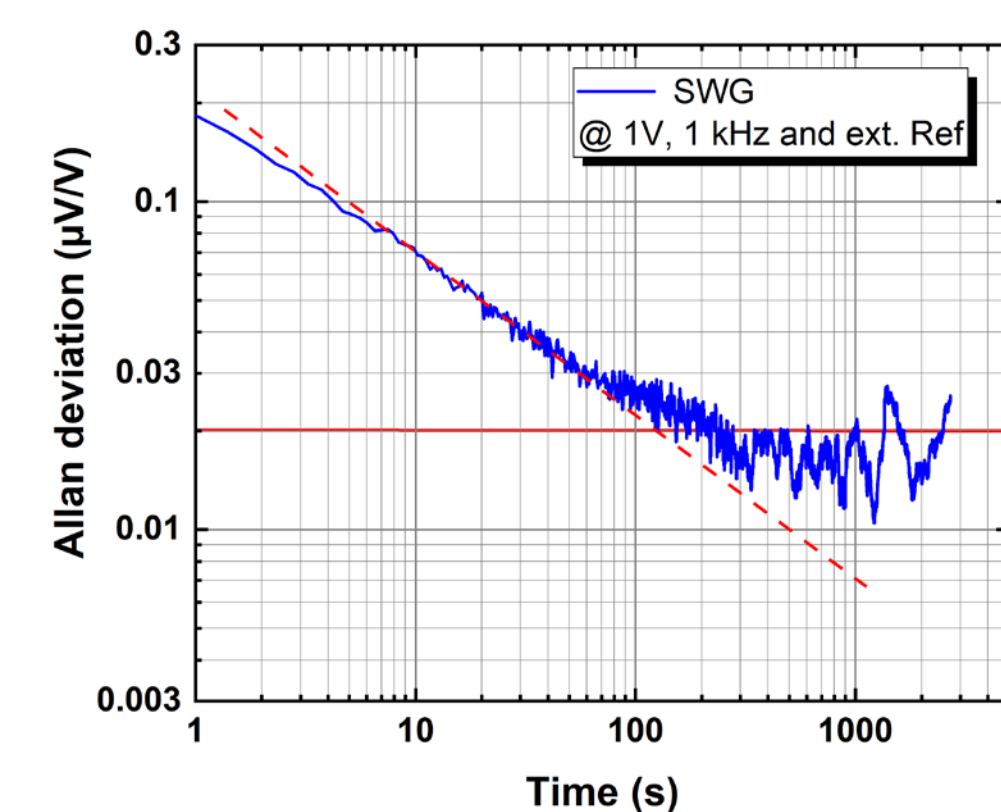
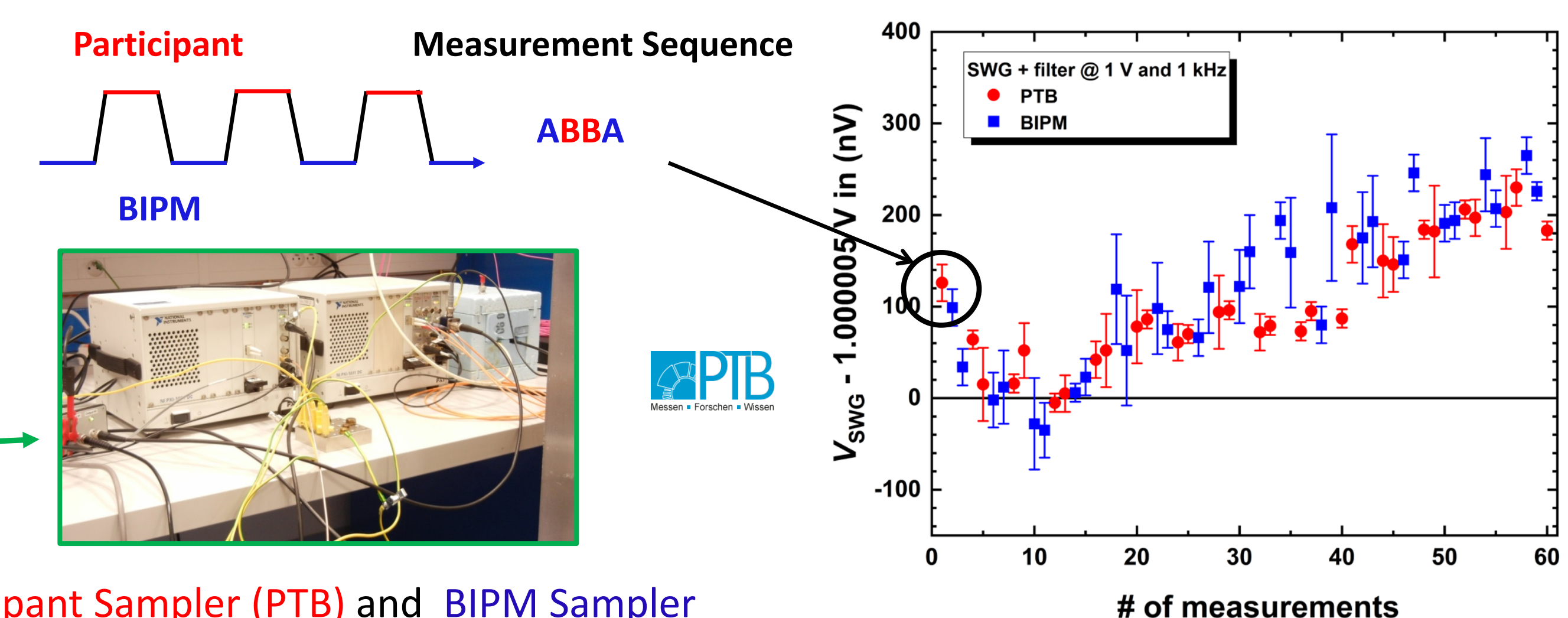
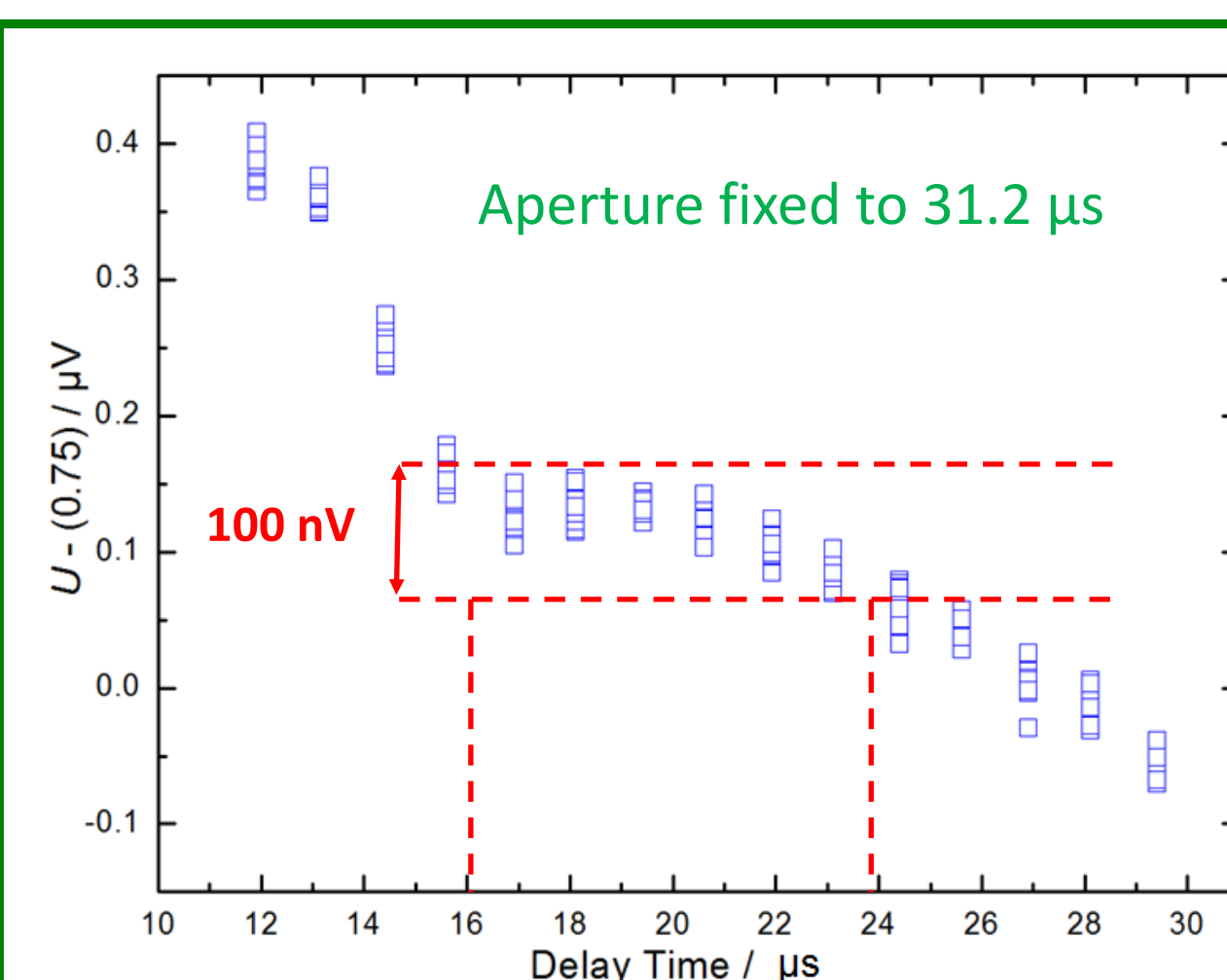


Photo credit - Luis Palafox



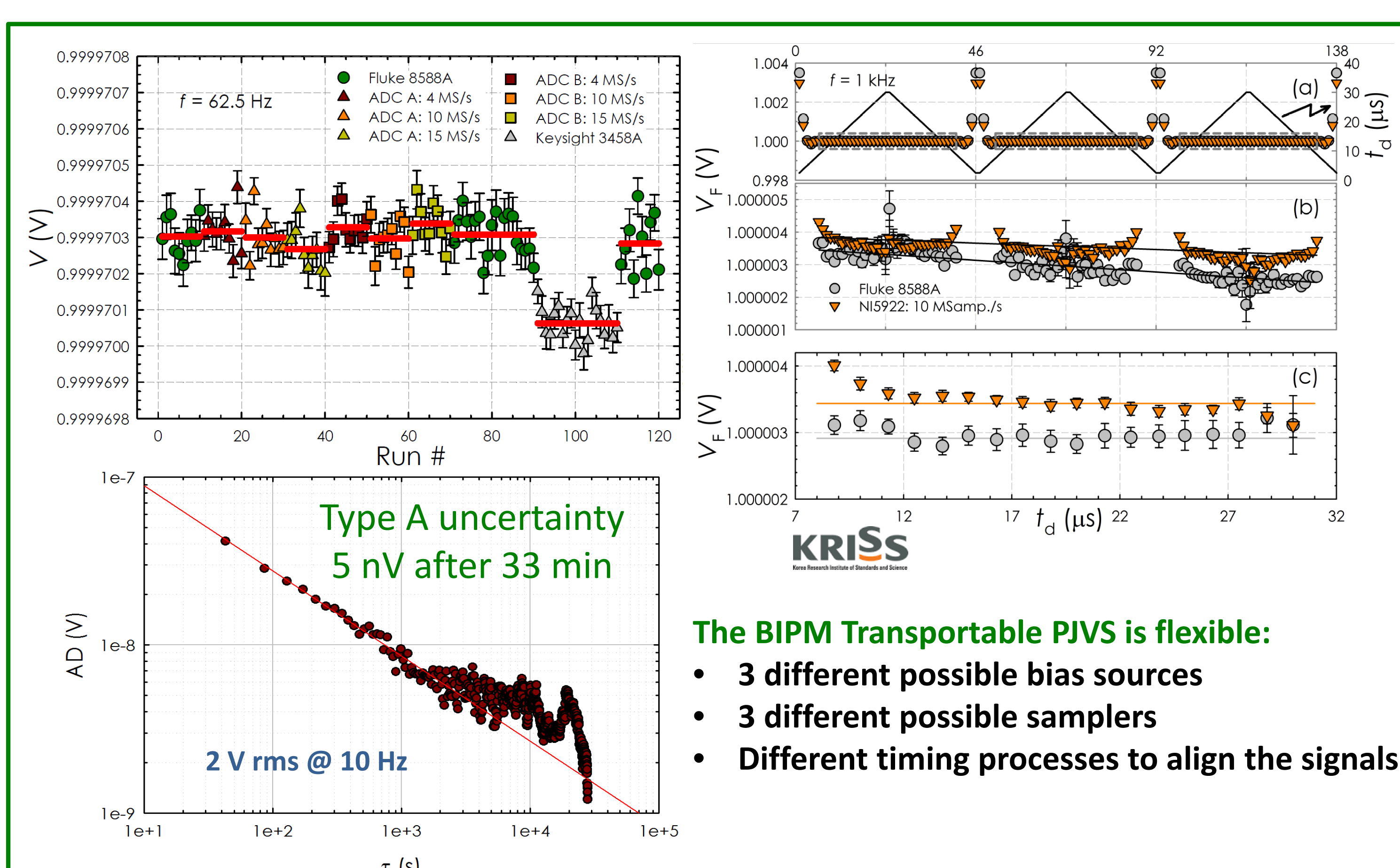
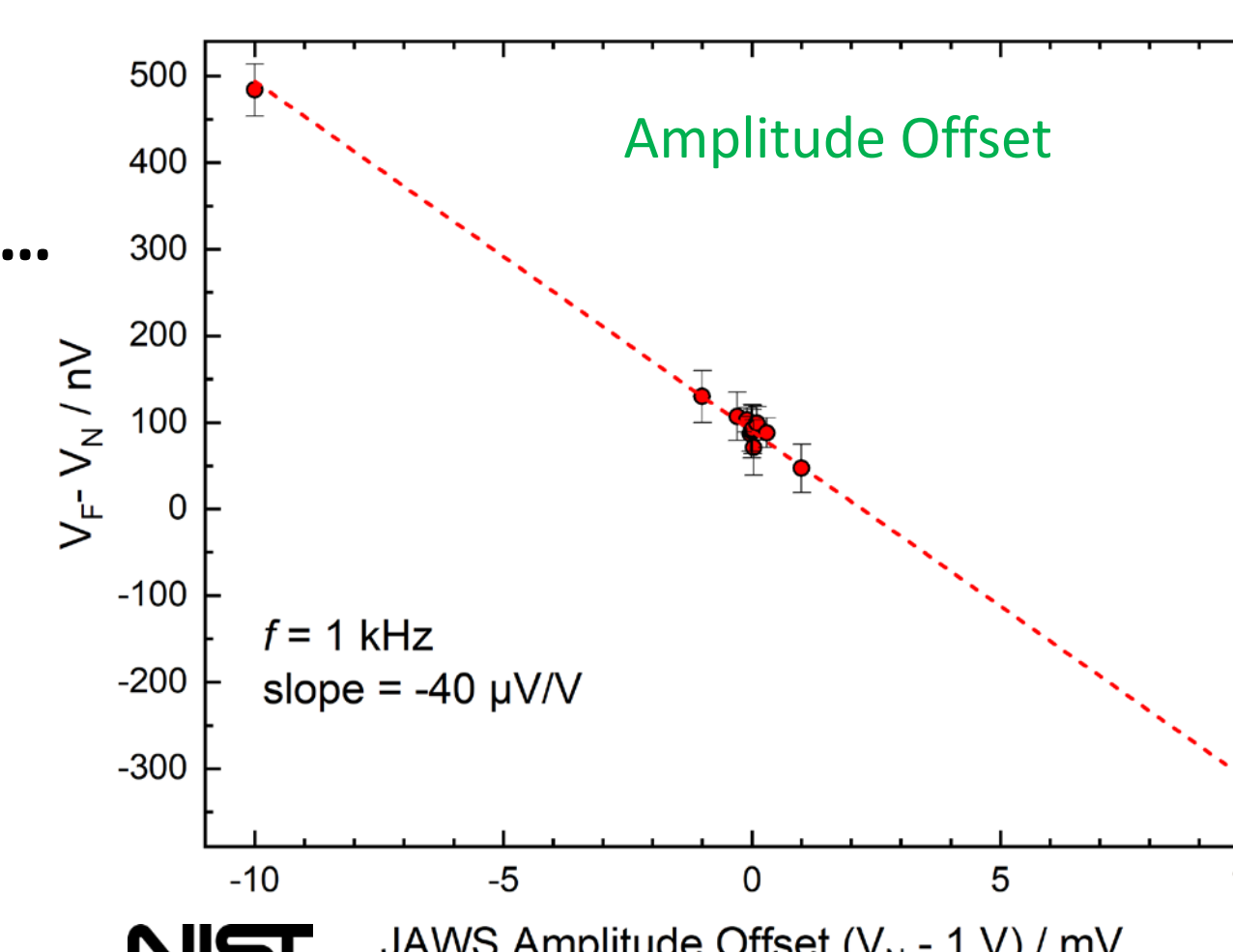
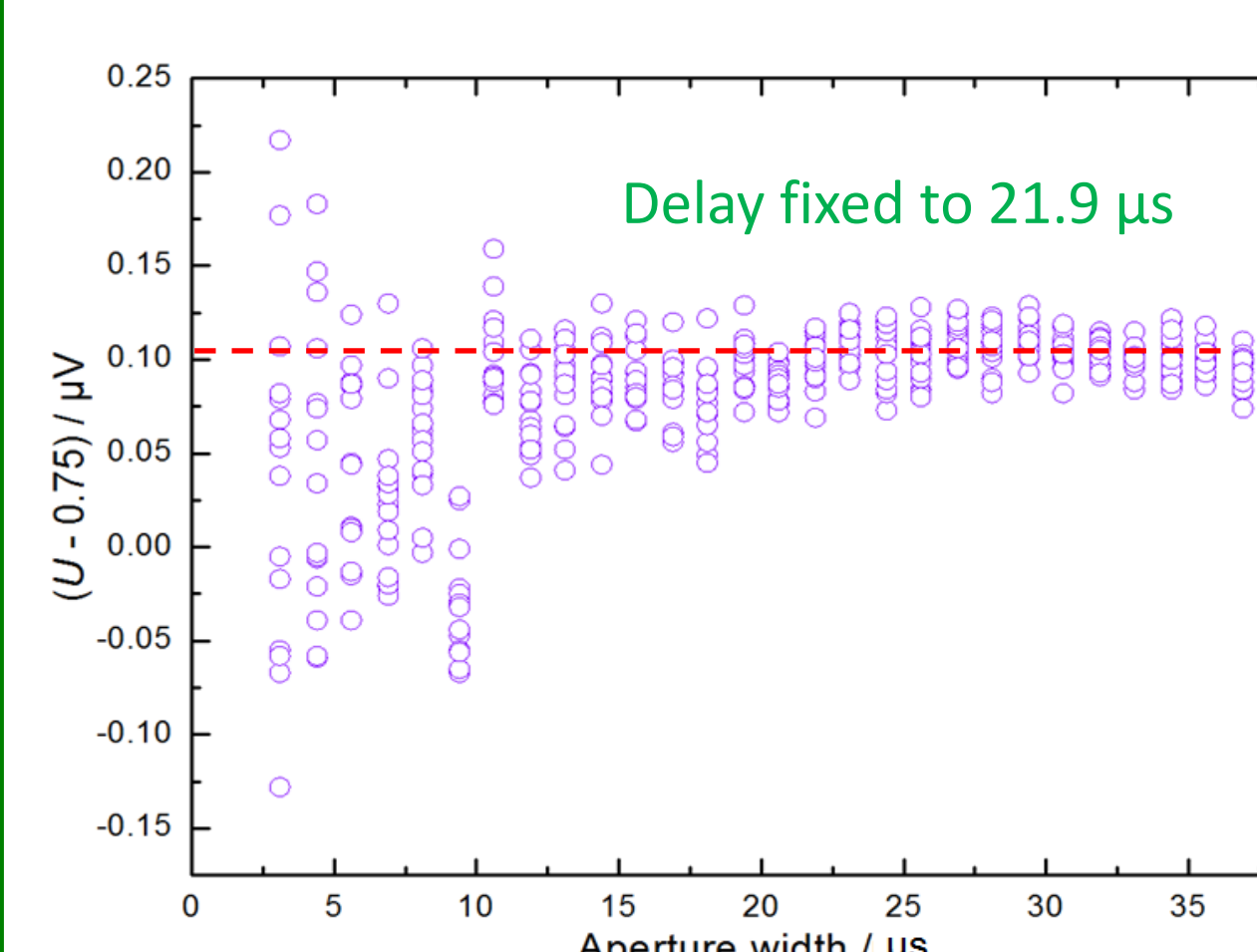
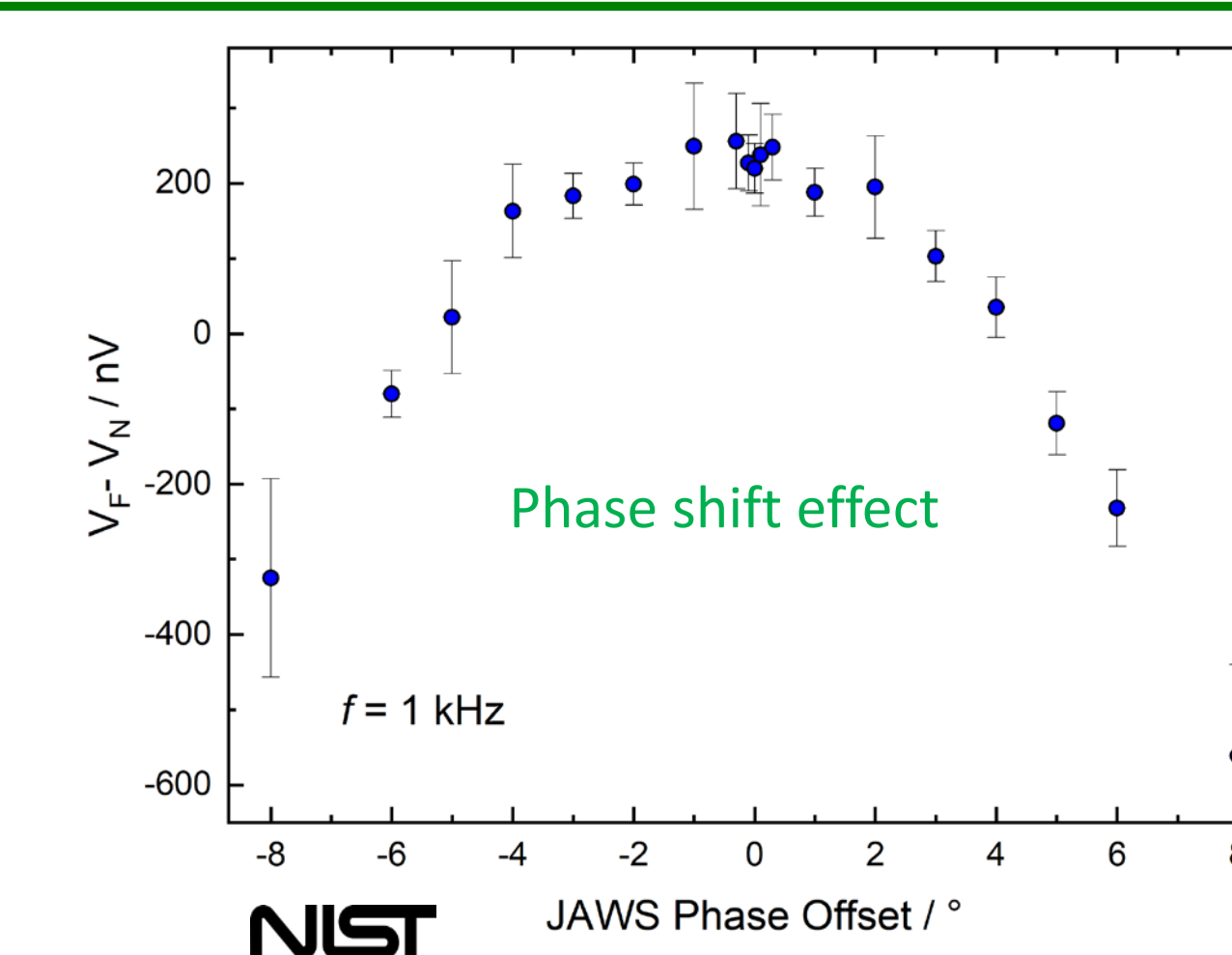
Participant Sampler (PTB) and BIPM Sampler



Investigations on Type B uncertainties

0.75 V rms @ 1 kHz

- Leakage resistance to ground
- Sampler input filter
- Grounding of the measurement setup
- Electromagnetic interferences
- Capacitive coupling (increases with f)
- Aperture of the windows (PIVS)
- Delay time (PIVS)
- Phase shift (AC Source)
- Amplitude changes (AC source)...



The BIPM Transportable PIVS is flexible:

- 3 different possible bias sources
- 3 different possible samplers
- Different timing processes to align the signals

Freq./Hz	N	Difference/nV	typ. Type A unc./nV
62.5	64	5	30
125	64	7	20
250	32	44	20
625	32	100	20
1250	16	200	30

Type A: 2 to 5 parts in 10^8 demonstrated for 0.75 V - 1 kHz

Fulfillment of the BIPM scientific objectives

1. Extension of an existing successful ongoing comparison program
2. Program of pilot studies to achieve the state of the art measurement process
3. Achievement of a full uncertainty budget
4. New protocol drafted with the support of the CCEM
5. NMIs survey to identify the interest: 29 replies

21 Future Participants in the DC comparison option
and
16 Future Participants in the AC comparison option