

## 17RPT03 DIG-AC

A digital traceability chain for AC voltage and current

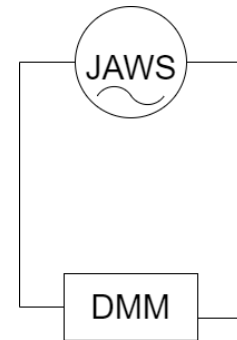
# WP4 – Validation of the new traceability chain

CEM- Final meeting

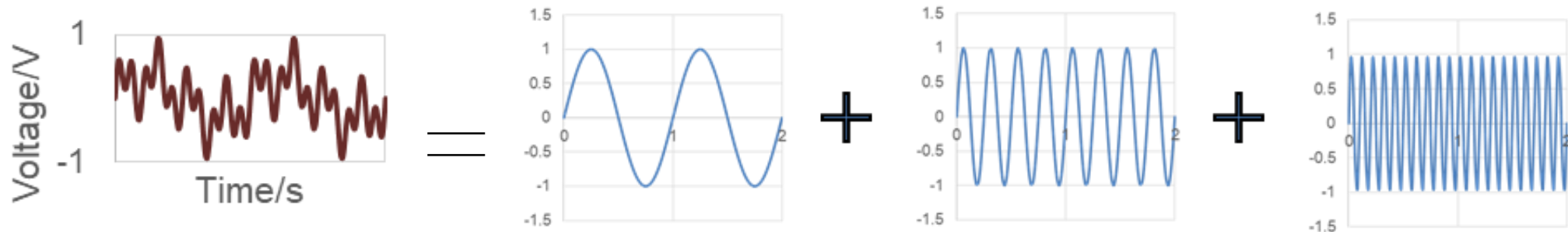
Madrid 19/05/2022

# Task 4.1: Validation against Josephson voltage standards

- Comparison of the response of two digitisers (DMM1 and DMM2) when same multi frequency signal generated by JAWS is inputted in two ways:
  - 1. Frequencies one by one
  - 2. Frequencies at the same time



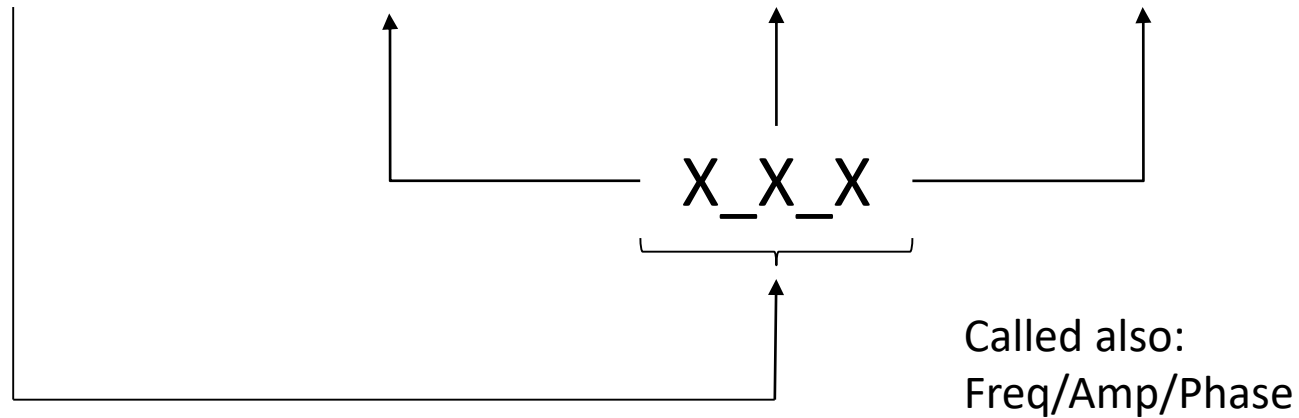
Example:



# Task 4.1: Validation against Josephson voltage standards

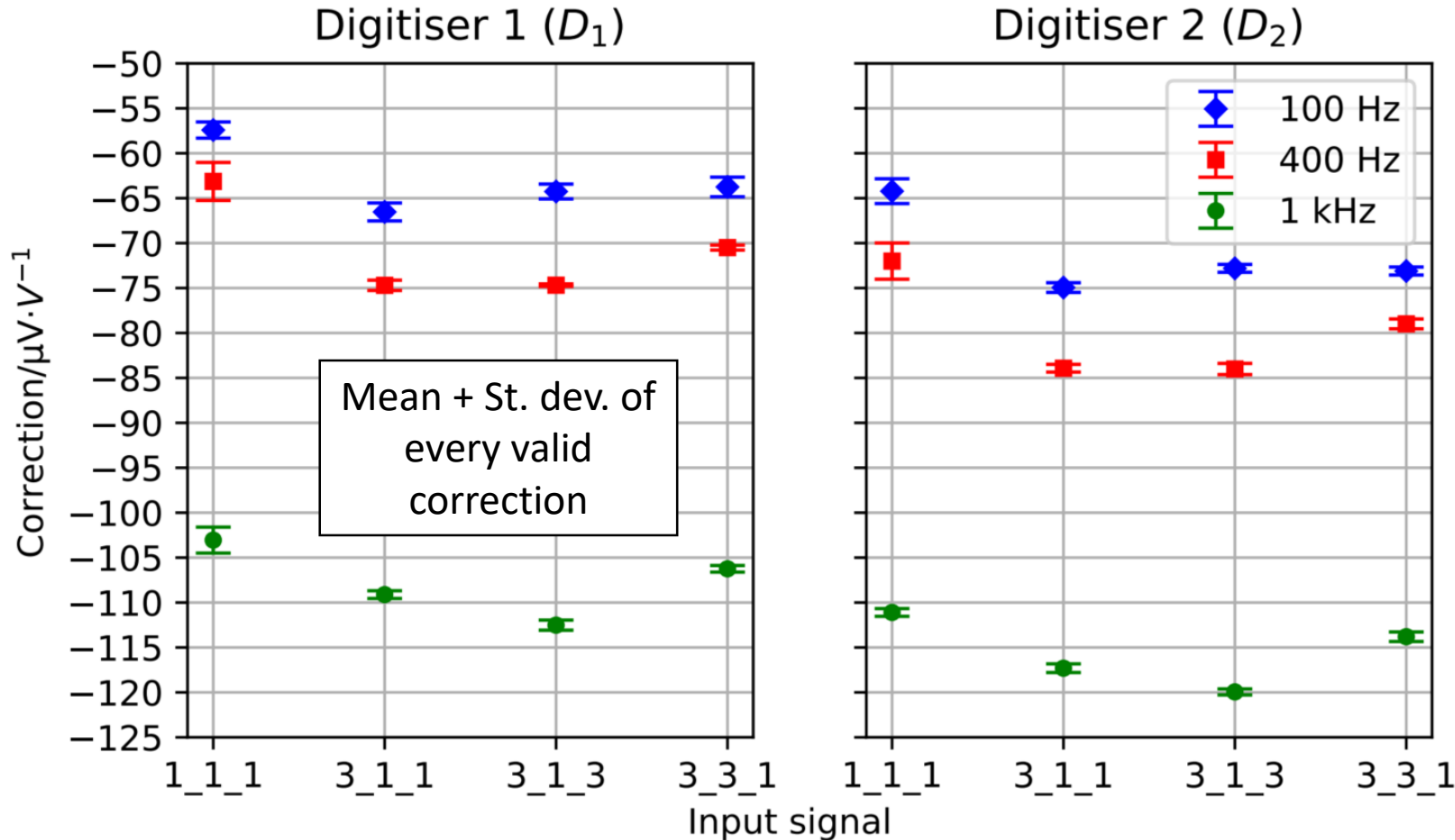
- Nomenclature for input signals, used in the presentation:

Measurement	Signal	Source parameters	
		Voltage RMS (amplitude)	Phase/°
1_1_1	Single	1 → $V_{max}$	1 → -
3_1_1	3 @ same time	1 → $1/3 V_{max}$	1 → $\alpha$
3_3_1	3 @ same time	3 → $1/2 V_{max}, 1/3 V_{max}, 1/6 V_{max}$	1 → $\alpha$
3_1_3	3 @ same time	1 → $1/3 V_{max}$	3 → $\alpha, \alpha + 45, \alpha + 90$



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- These are the corrections calculated for both digitisers:



$$-c = e = \frac{U_{meas} - U_{nom}}{U_{nom}} 10^6$$

Formula to correct measure voltage:

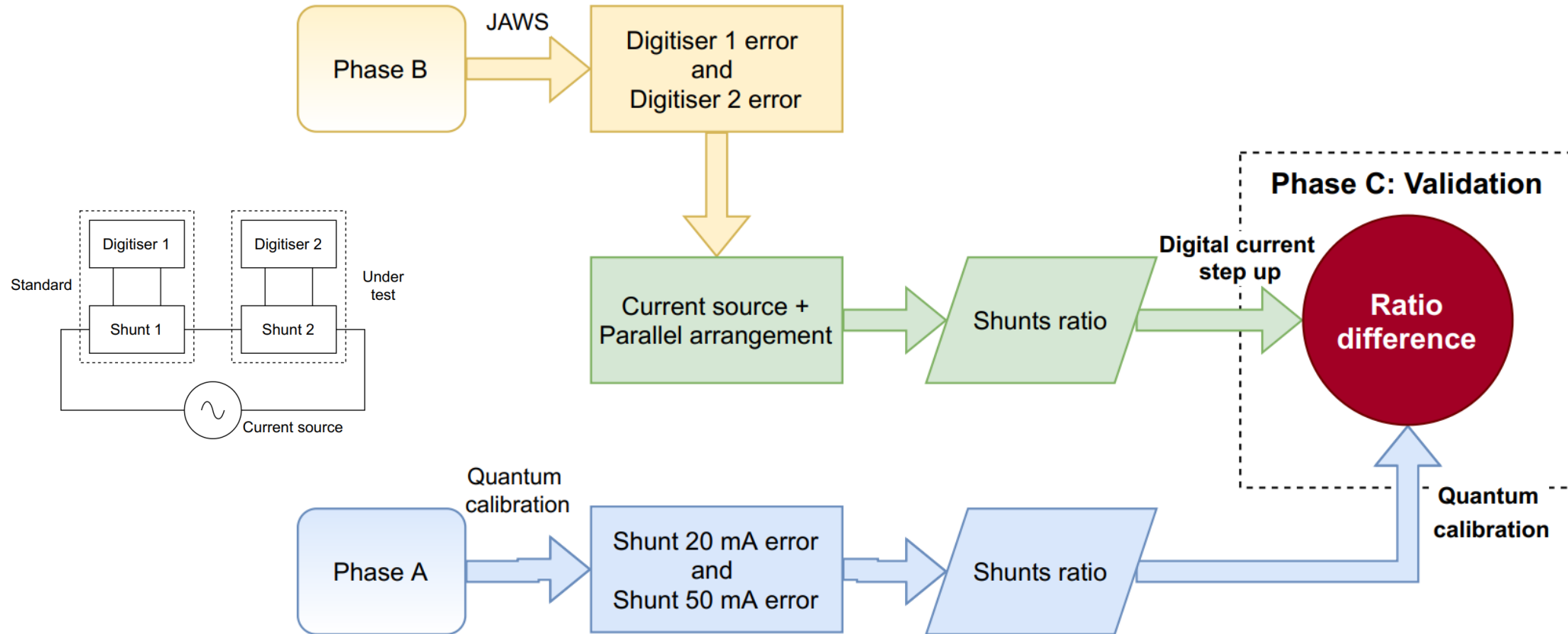
$$V_{Corrected} = V_C = \frac{V_{measured}}{1 + \frac{-c}{10^6}}$$

**Corrections for digitisers obtained**

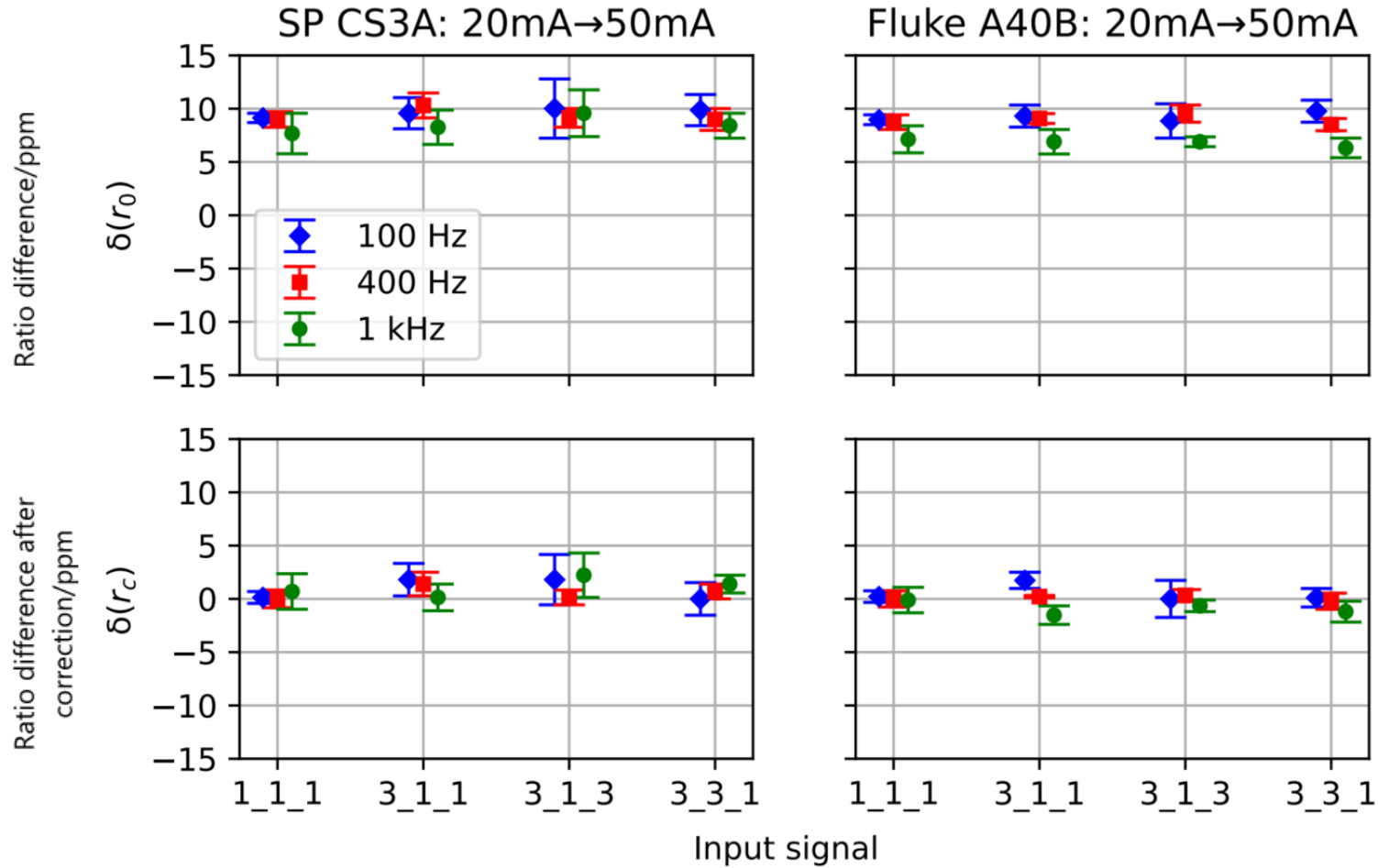
# Task 4.1: Validation against Josephson voltage standards

**Shunts calibrated successfully with very low uncertainty**

- Quantum calibration of 20 mA and 50 mA shunts



# Task 4.1: Validation against Josephson voltage standards



**Differences after correction are very small**

- Travel standard:



- Quantities to be measured:

Input #	Testing point	Current source		
		Current RMS/mA	Frequency/Hz	Phase/°
1	1.1	11.00	100	-
2	2.1	11.00	400	-
3	3.1	11.00	1000	-
4	4.1	3.70	100	$\alpha$
	4.2	3.70	400	$\alpha$
	4.3	3.70	1000	$\alpha$
5	5.1	5.55	100	$\alpha$
	5.2	3.70	400	$\alpha$
	5.3	1.85	1000	$\alpha$
6	6.1	3.70	100	$\alpha$
	6.2	3.70	400	$\alpha + 45$
	6.3	3.70	1000	$\alpha + 90$

Input #	Testing point	Voltage source		
		Voltage RMS/V	Frequency/Hz	Phase/°
1	1.1	4.000	100	-
2	2.1	4.000	400	-
3	3.1	4.000	1000	-
4	4.1	1.330	100	$\alpha$
	4.2	1.330	400	$\alpha$
	4.3	1.330	1000	$\alpha$
5	5.1	1.995	100	$\alpha$
	5.2	1.330	400	$\alpha$
	5.3	0.665	1000	$\alpha$
6	6.1	1.330	100	$\alpha$
	6.2	1.330	400	$\alpha + 45$
	6.3	1.330	1000	$\alpha + 90$

- Calibration error: difference between the measured quantity calculated by the reference standard and the quantity applied to it, and divided by the applied quantity ( $\mu\text{A}/\text{A}$  or  $\mu\text{V}/\text{V}$ ).