MCBRDP2 test results at SM18

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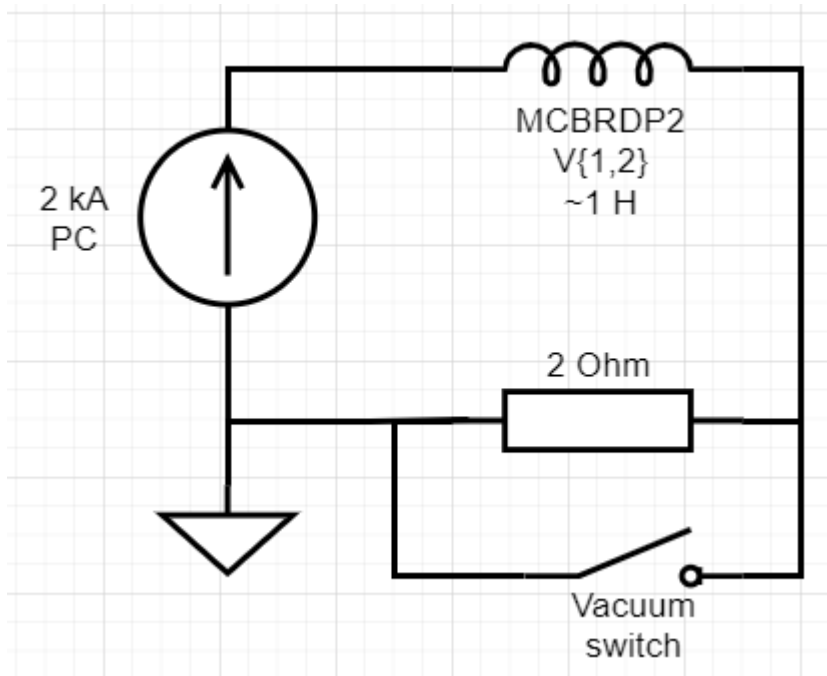
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EDMS: 2436078

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Setup

Circuit diagram

Each aperture has:
- Power converter: 2 kA, 10 V, 4 quadrants
- Energy extraction: 600 A vacuum switch, 2 Ohm dump resistor
  - EE for AP2 changed to 1.4 Ohm after thermal cycle

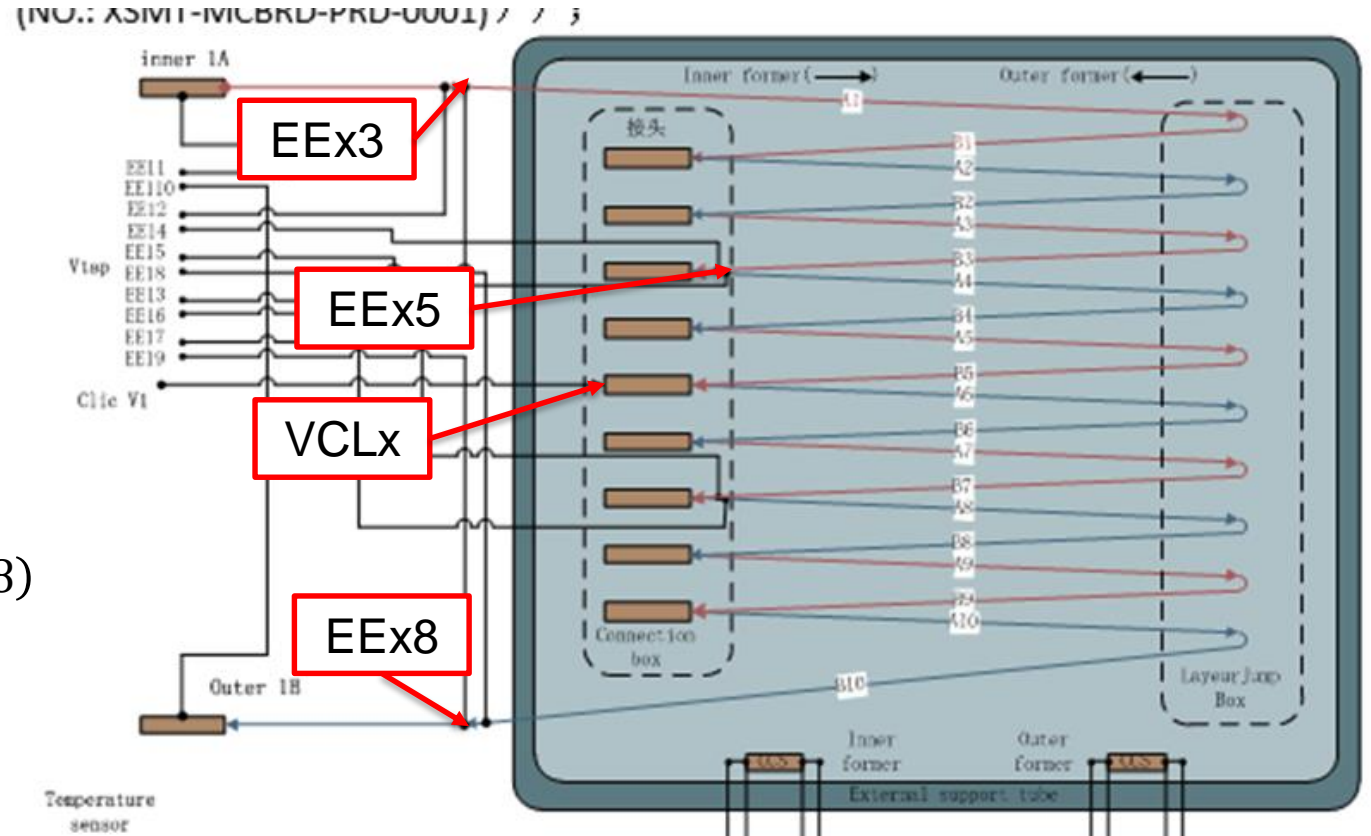# Quench detection

Potaim (symmetric):

$$V_{diff} = (EEx3 - VCLx) - (VCLx - EEx8)$$

Trigger at $|V_{diff}| > 100 \ mV$ during 2 ms

QDS (asymmetric):

$$V_{diff} = 1.67(EEx3 - EEx5) - 0.7(EEx5 - EEx8)$$

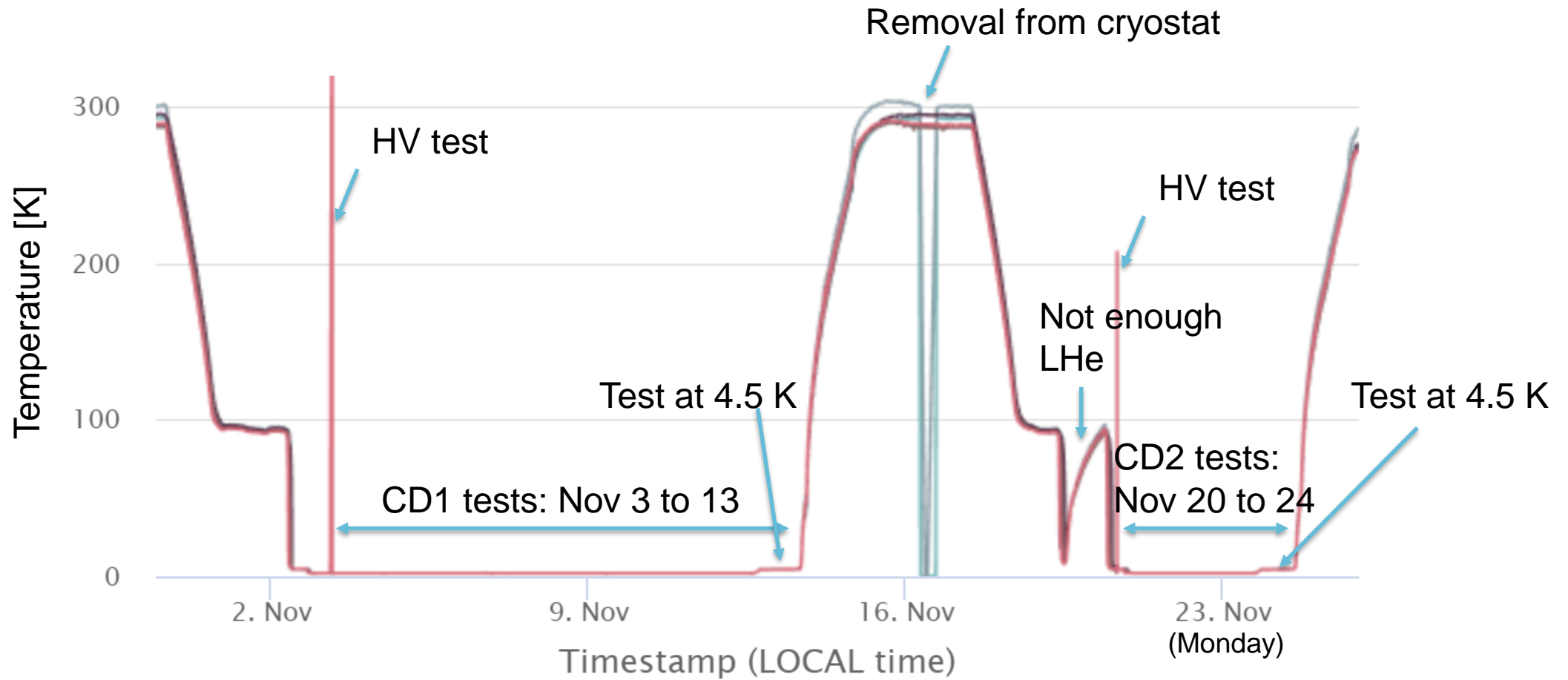Trigger at $|V_{diff}| > 50 \ mV$ during 5 ms

Overview
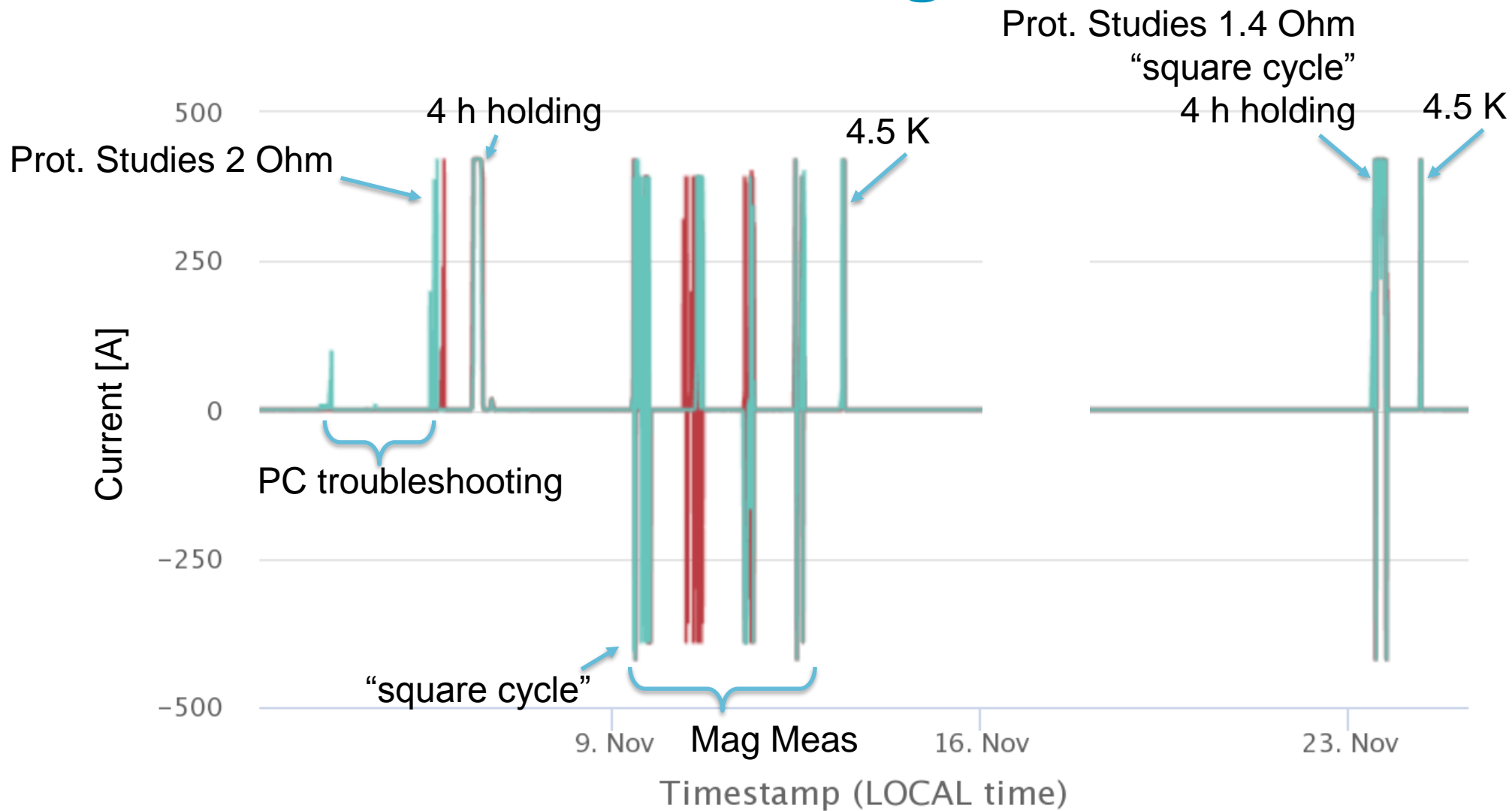
Cool down and warm up

Removal from cryostat

HV test

HV test

Test at 4.5 K

Not enough LHe

Test at 4.5 K

CD1 tests: Nov 3 to 13

CD2 tests: Nov 20 to 24
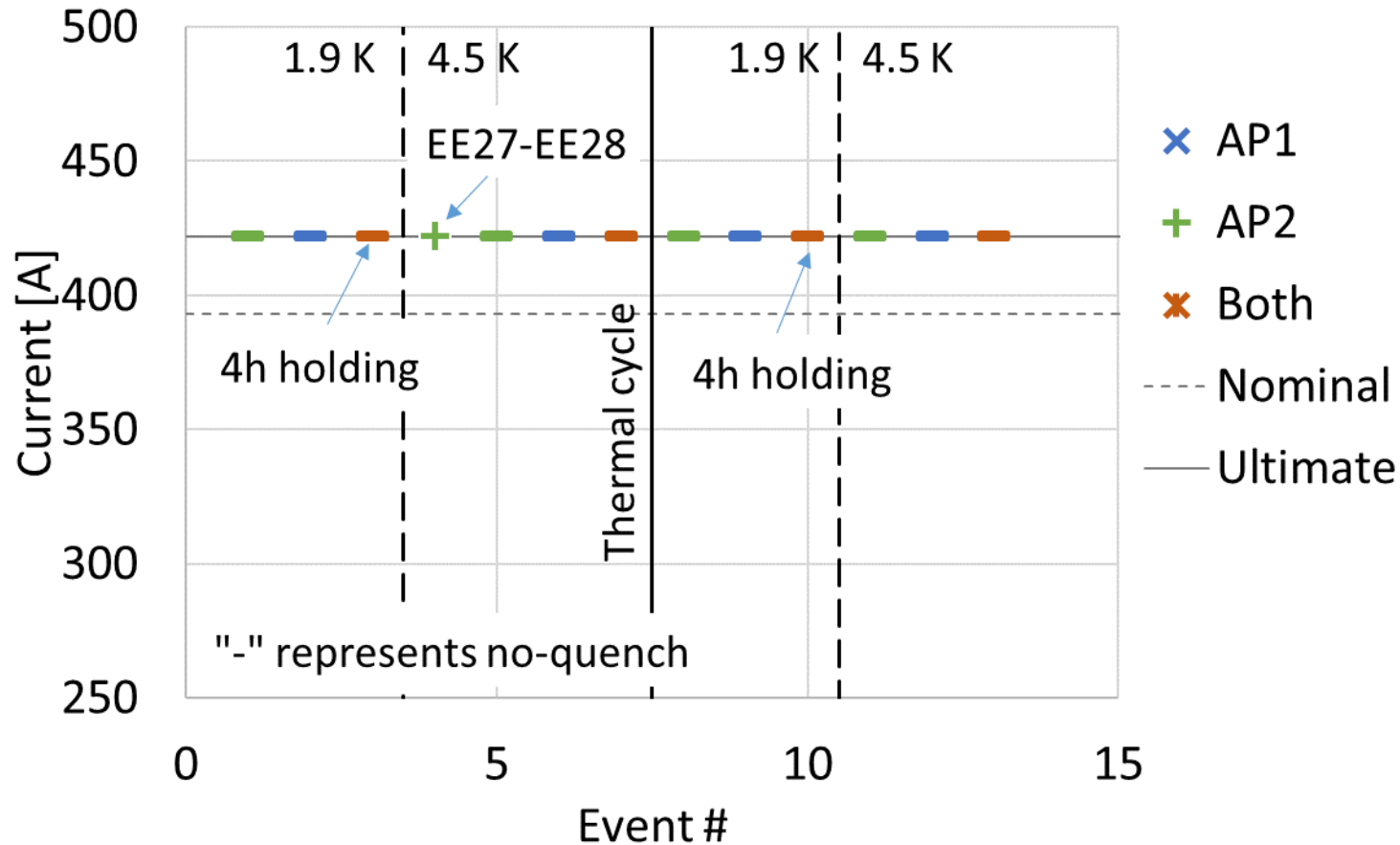
Powering

Test results

Training verification after test at IMP

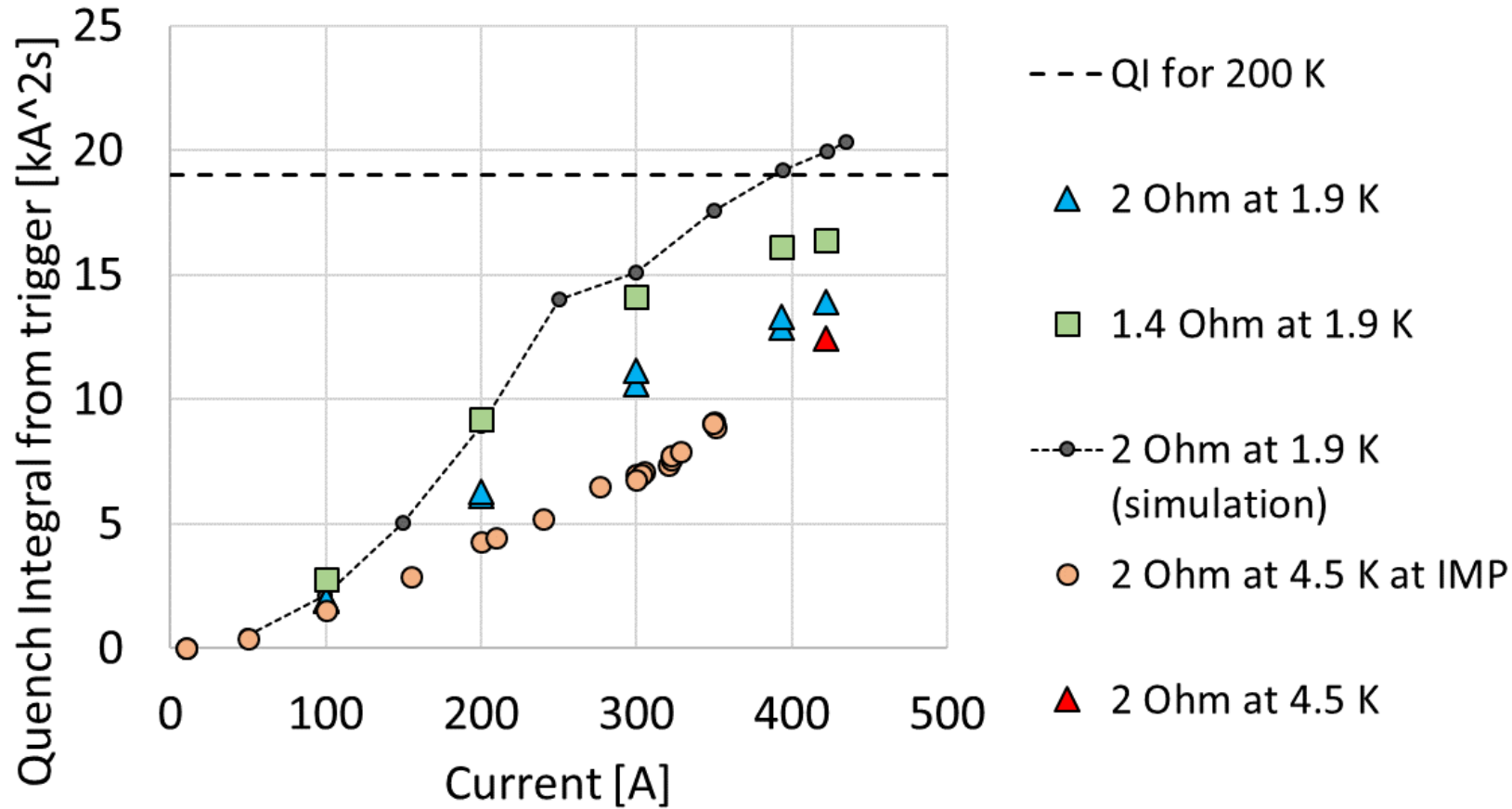MCBRDP2 at SM18, after training at IMP

All ramps at 2 A/s

Perfect training memory after test at IMP: each aperture reached ultimate current at 1.9 K without quench, both individually and combined.

One quench at ultimate current (during deceleration phase) in AP2 at 4.5 K, no further quench afterwards.

Perfect memory after thermal cycle

Quench integral

MCBRDP2, QI from trigger

Legend:
- – – – QI for 200 K
- ▲ 2 Ohm at 1.9 K
- ▪ 1.4 Ohm at 1.9 K
- – •– 2 Ohm at 1.9 K (simulation)
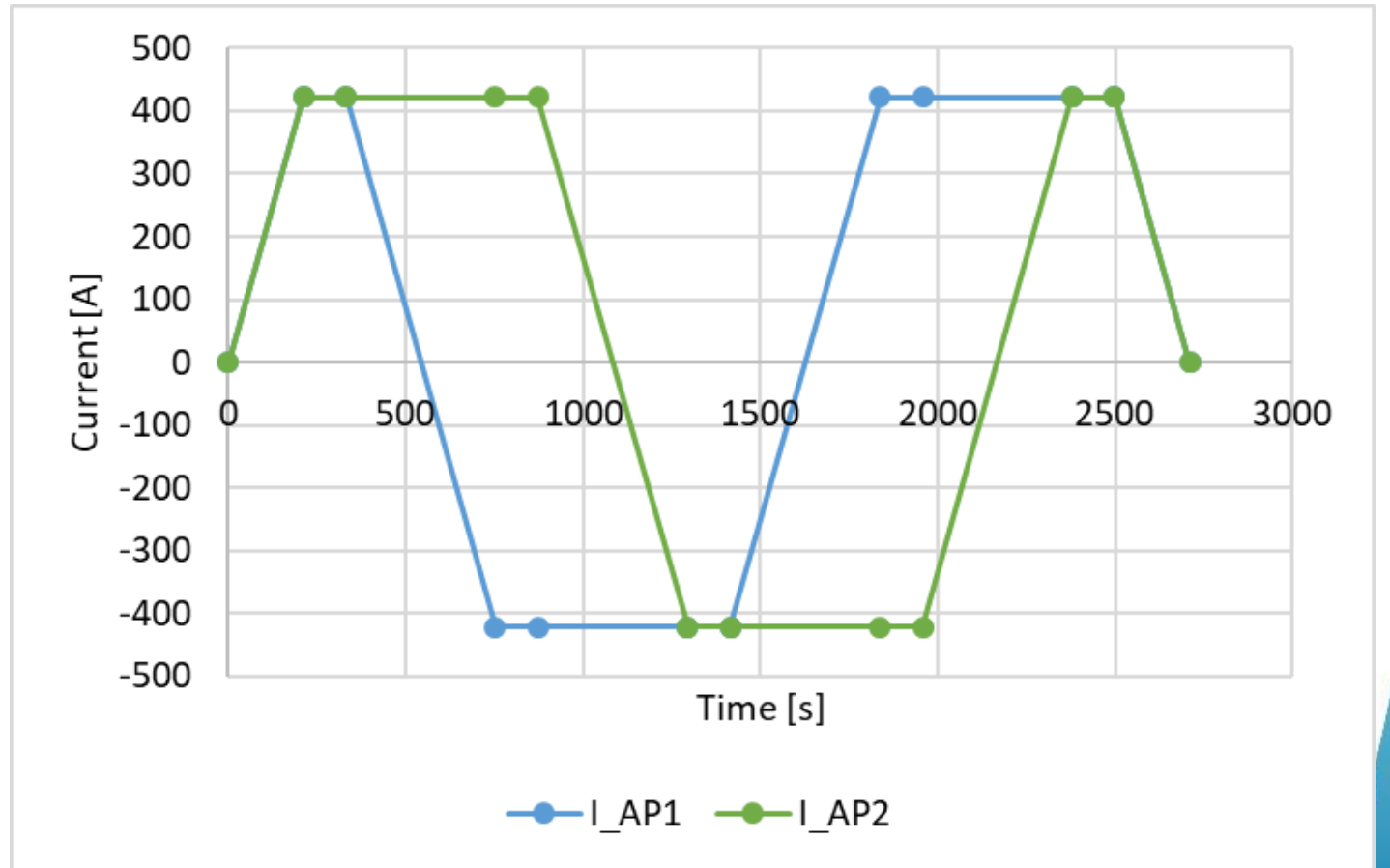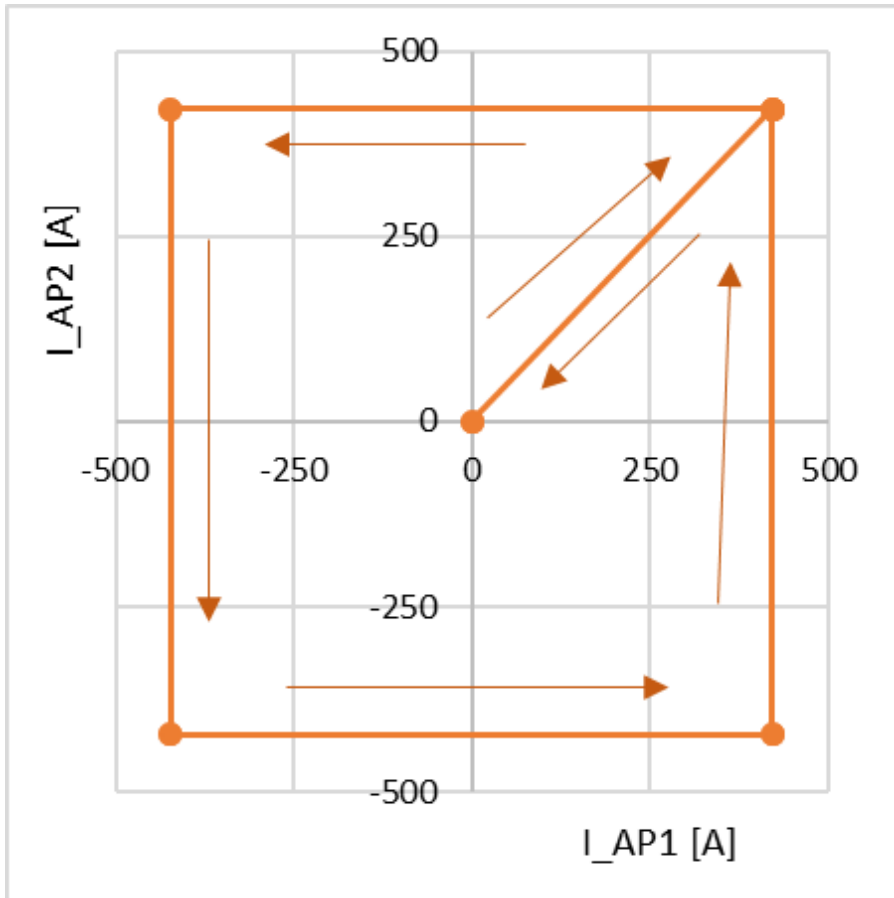- ● 2 Ohm at 4.5 K at IMP
- ▲ 2 Ohm at 4.5 K

Quench integral at 2 Ohm significantly lower than expected

Quench integral at 1.4 Ohm lower than maximum allowed for 200 K hotspot temperature

Point at 4.5 K (red triangle) matches well the trend from IMP (orange circles)

Operation range

- Operation range test checked at 1.9 K without quench
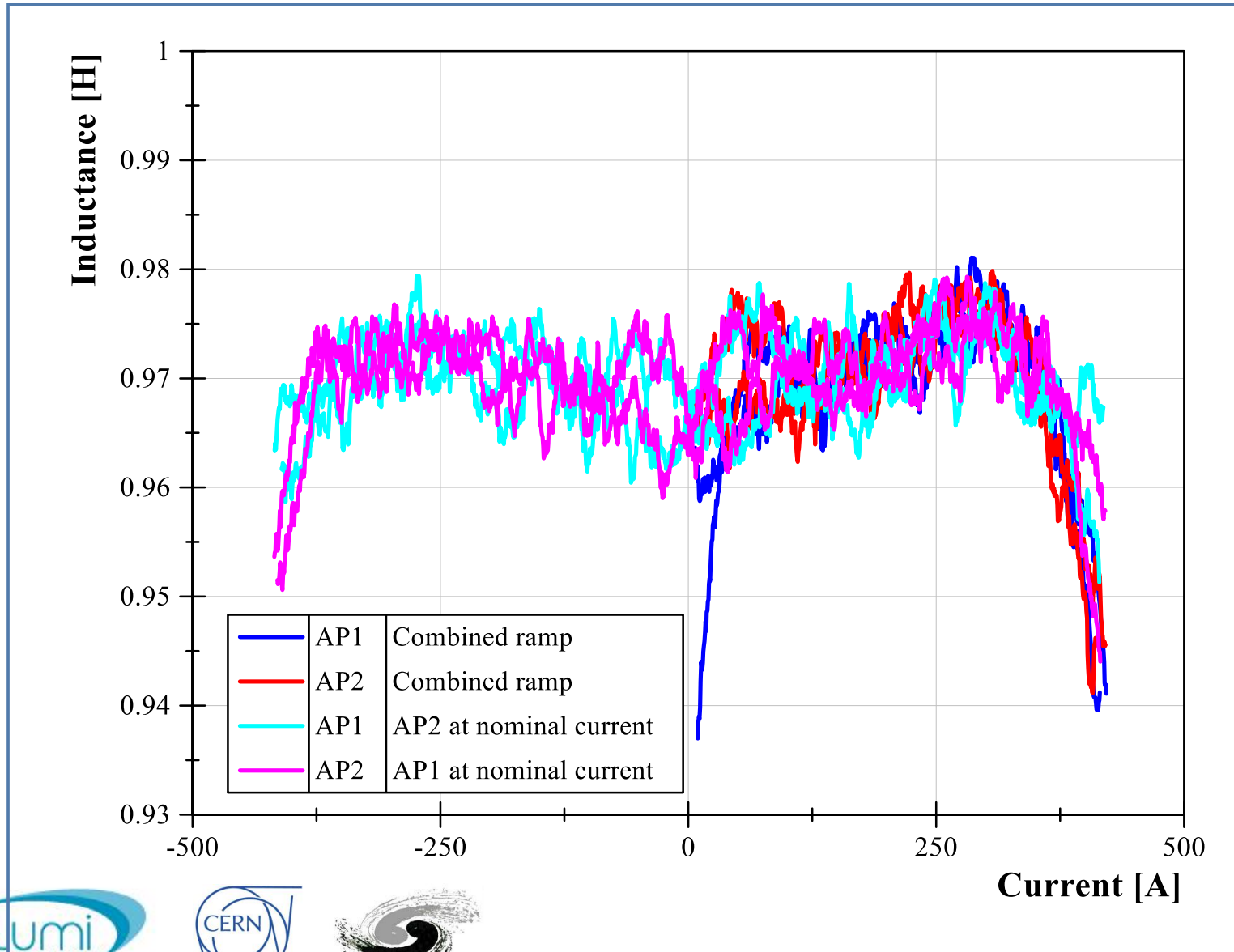
Inductance

Measured during operation range cycle

Inductance ~970 mH as expected

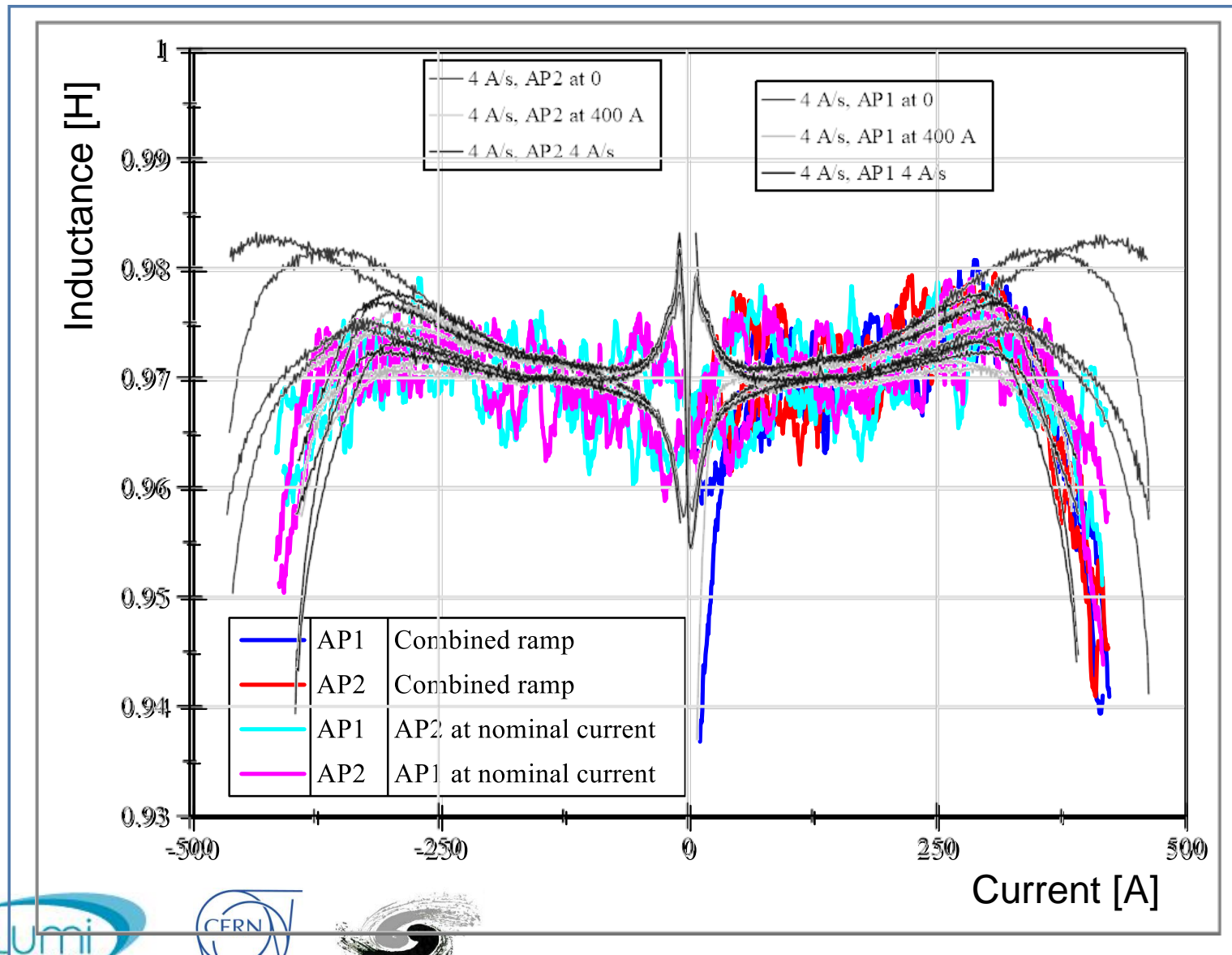Noisy signal due to power converter regulation
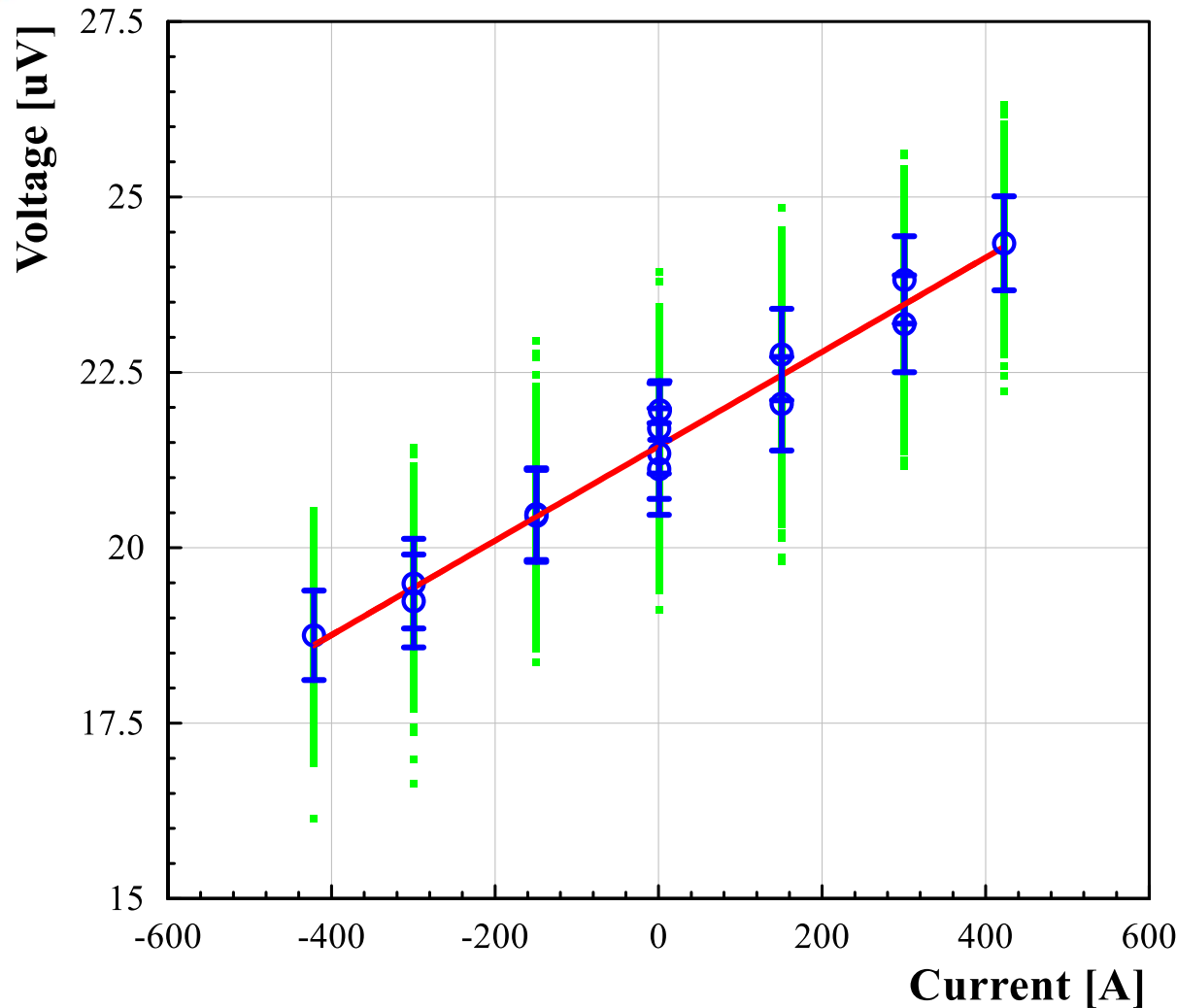
Inductance – comparison with MCBRDP1

Overlayed in grayscale: MCBRDP1 AP1 and AP2 measurements (three curves each)

Similar general features

MCBRDP1 measurement less noisy due to different power converter

Splice resistance

Splice resistance:
6.73 ± 0.0264 nΩ
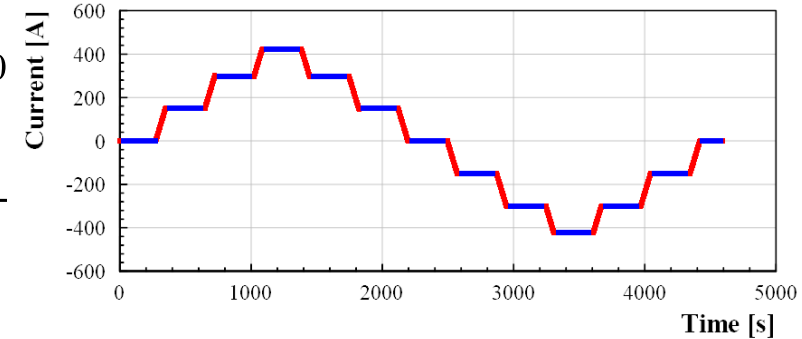
Splice	Meas. at IMP (394 A)	Meas. at SM18
EE14-EE15	6.77 nΩ	7.35 nΩ
EE16-EE17	5.49 nΩ	4.50 nΩ
EE24-EE25	5.36 nΩ	4.84 nΩ
EE26-EE27	6.36 nΩ	6.73 nΩ

Good agreement between IMP and SM18 results
Similar to measurements in MCBRDP1 (5-6.6 nΩ)

RRR
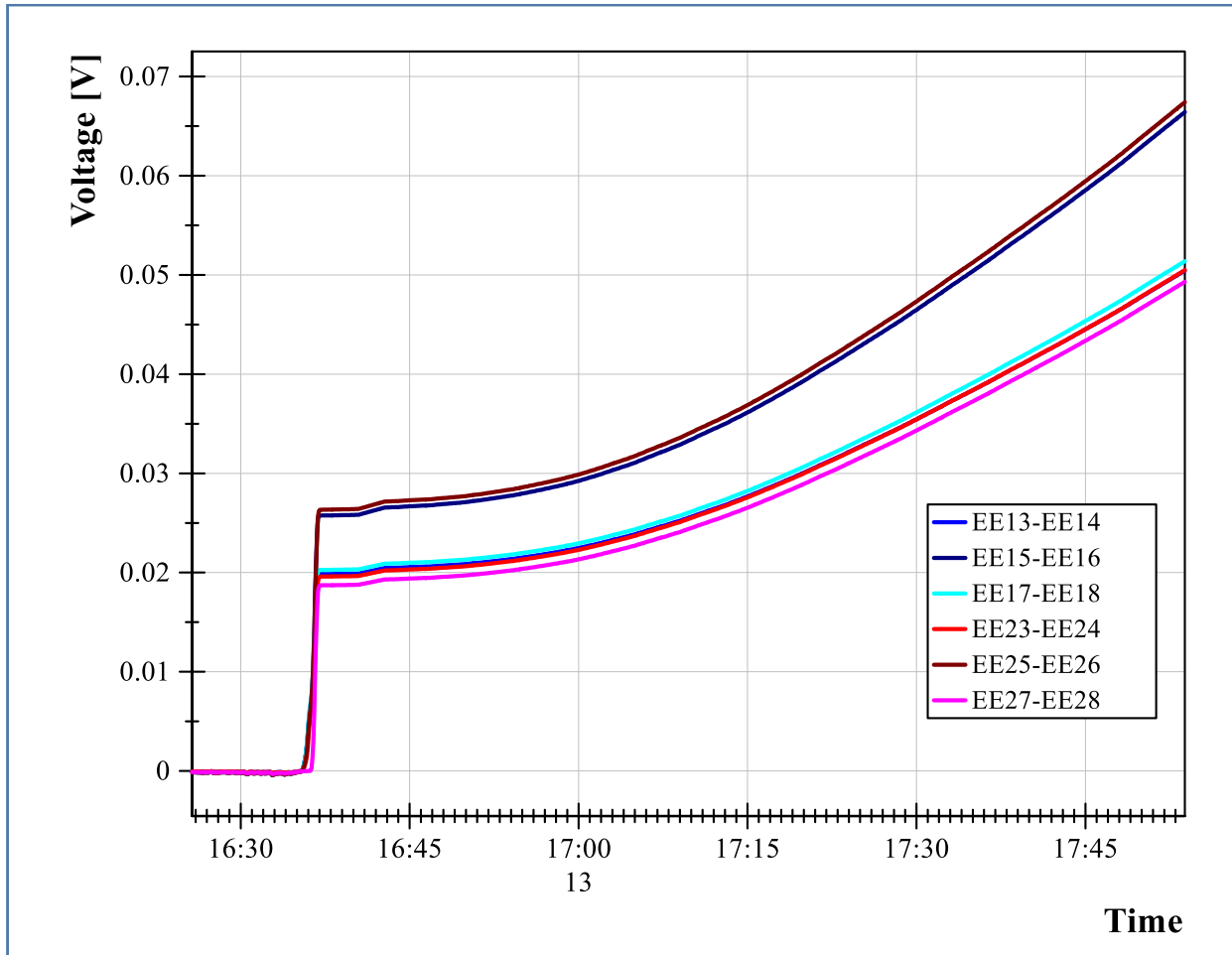
Segment	RRR
EE13-EE14	178
EE15-EE16	182
EE17-EE18	176
EE23-EE24	179
EE25-EE26	178
EE27-EE28	188

Electrical insulation tests

Step	Connection	Temp [K]	Voltage [V]	Duration [s]	Resistance [GΩ]
Reception	AP1 vs gnd	293	429	60	59
	AP2 vs gnd	293	432	60	20
After box removal	AP1 vs gnd	293	430	60	131
	AP2 vs gnd	293	429	60	134
CD1 before test	AP1 vs gnd	1.9	2146	60	2.5
	AP2 vs gnd	1.9	2147	60	8
CD1 after test	AP1 vs gnd	4.5	2121	60	25
	AP2 vs gnd	4.5	2122	60	23
Warm in GHe	AP1 vs gnd	300	431	60	214
	AP2 vs gnd	300	429	60	207
CD2 before test	AP1 vs gnd	4.5	2148	60	17
	AP2 vs gnd	4.5	2149	60	18
CD2 after test	AP1 vs gnd	4.5	2147	60	31
	AP2 vs gnd	4.5	2149	60	28

All electrical insulation tests passed OK

Summary

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- MCBRDP2 shows perfect training memory after test at IMP
  - Including: warm up, tilting to horizontal, boxing, transport by ship, typhoon, customs, unboxing, tilting to vertical, and cool down
- Quench integral lower than expected from simulations, and acceptable with 1.4 Ohm dump
- Inductance, splice resistance, HV tests as expected