

# Recent progress on KEK-SCQ magnet

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# Reminder of our status

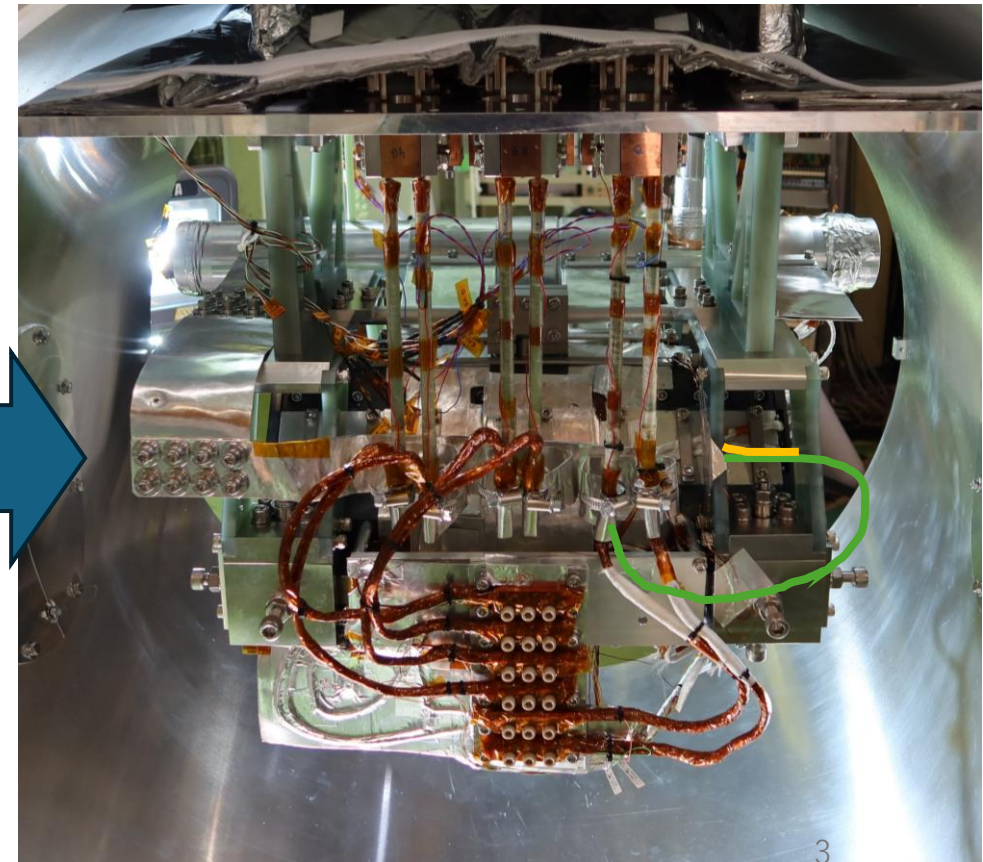
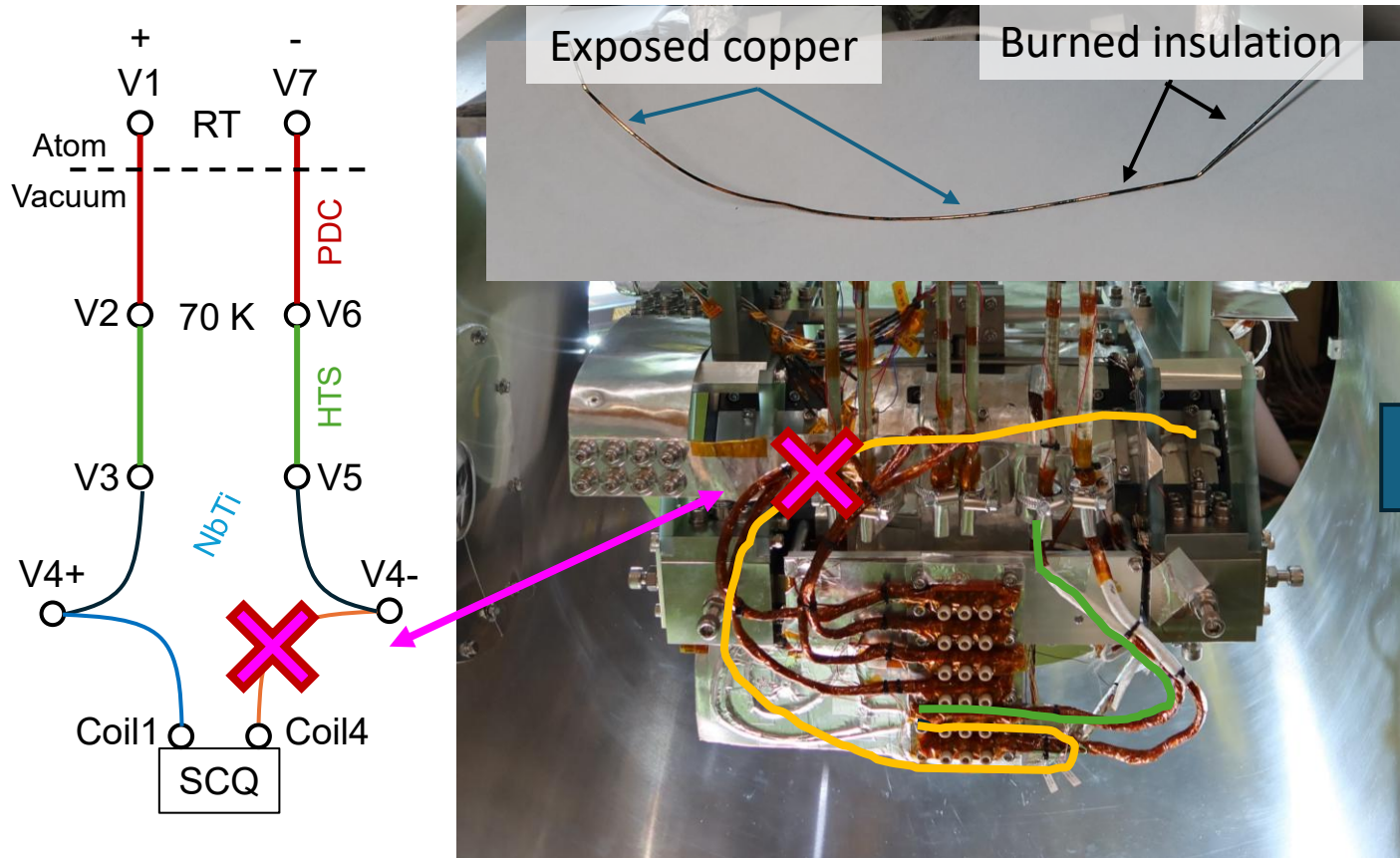
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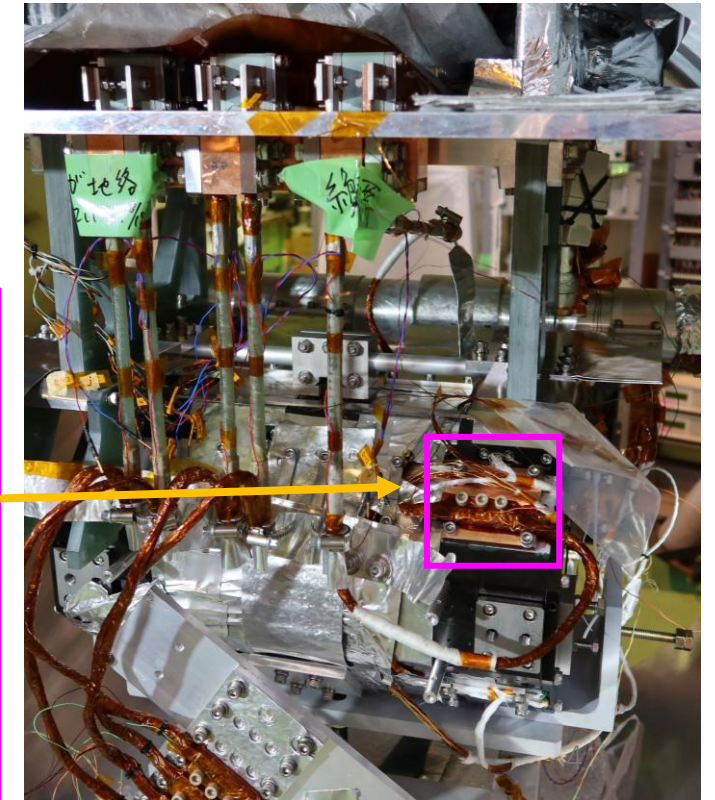
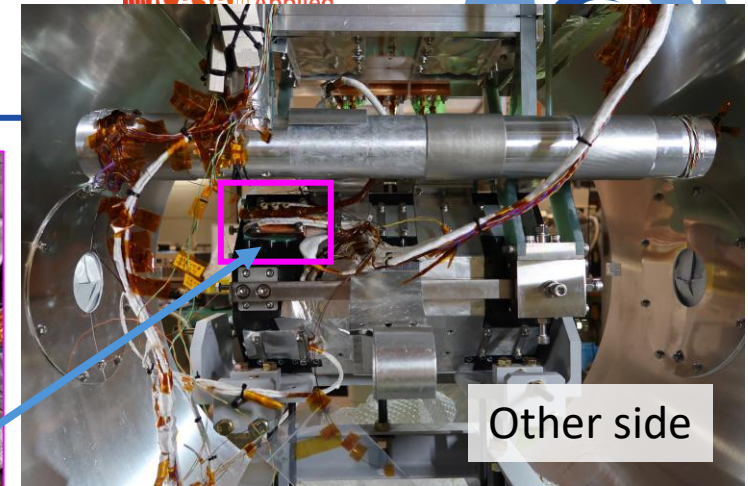
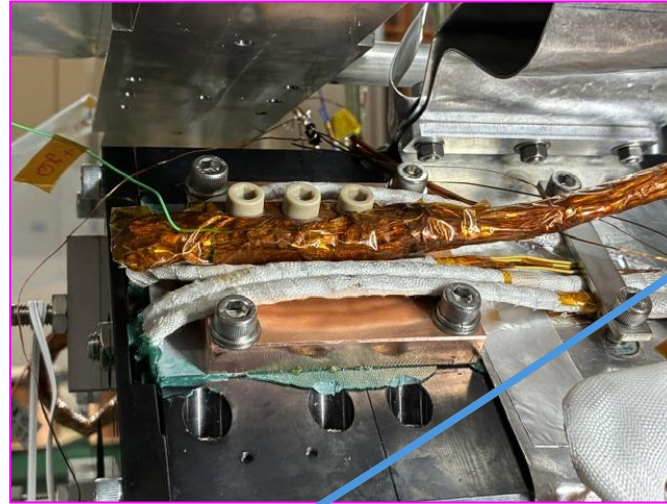
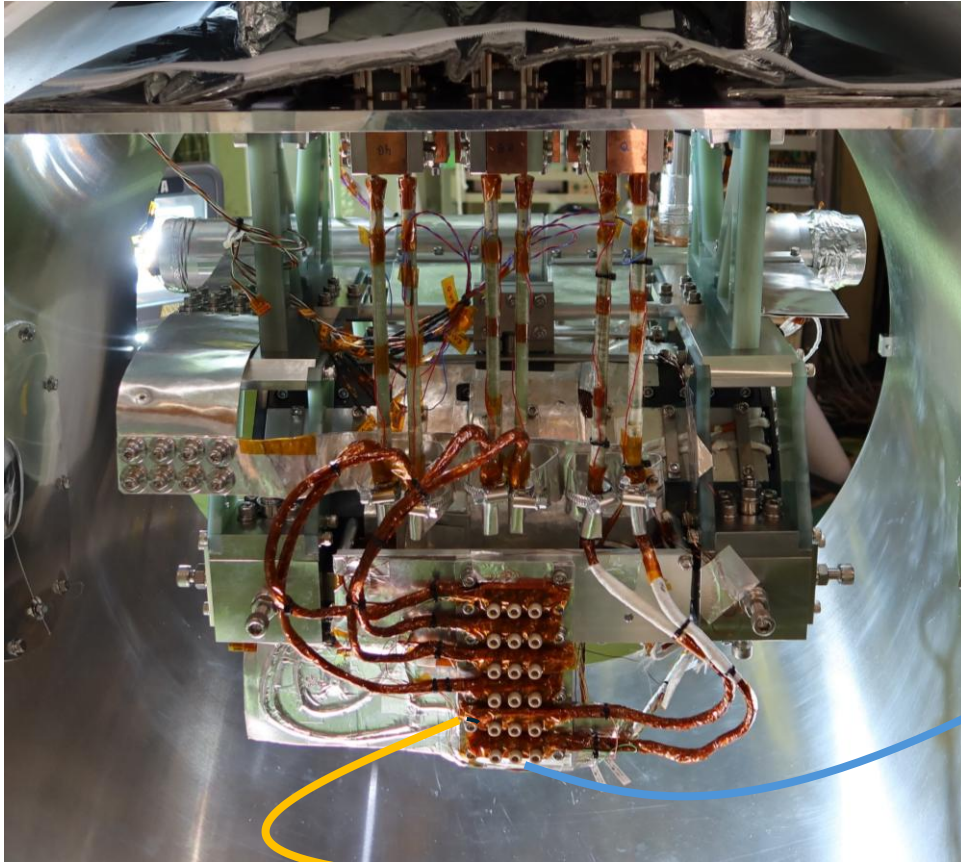
- The SCQ production was completed in the end of March 2026 by Mitsubishi Electric.
- However excitation current has been very limited due to quenching of current lead wires.
  - By July, the maximum current was just **12 A for Quadrupole**. (55 A in design)
- In August, we had an improvement work with MELCO.
- The maximum current was improved to **28 A for Quadrupole**.
- I briefly report on above works and share future schedule.

## At the July test

- At the July test, we identified the quenching position: between coil 4 and V4-.
- Actually, length of this section was very long, ~1 m.
- In August, we have shorten the length as much as possible.



# August test : Improved points

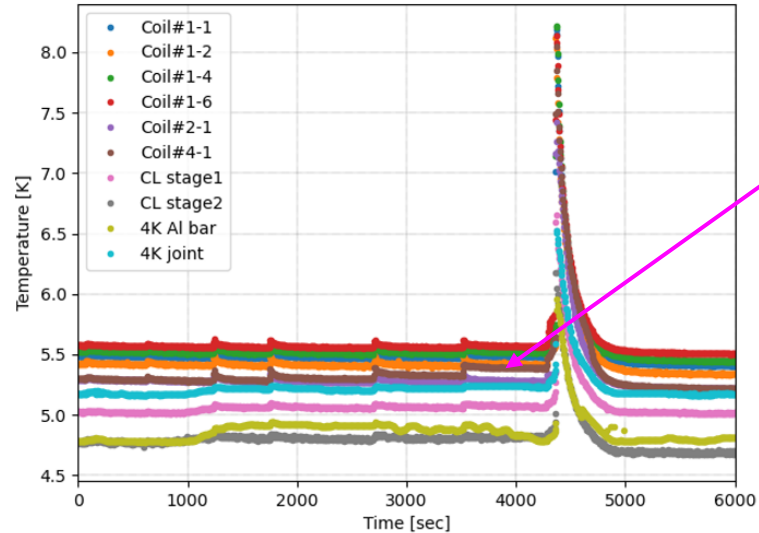
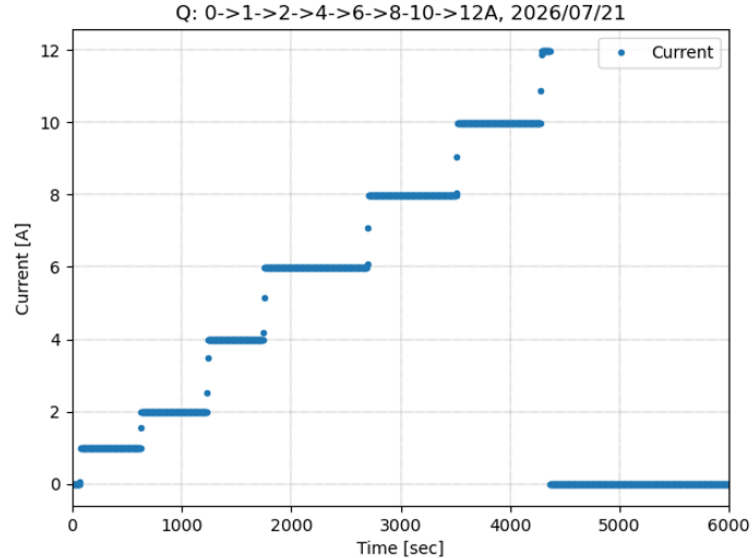


Length of damaged wires  
became about 10cm.

# August test: Current vs. temperature



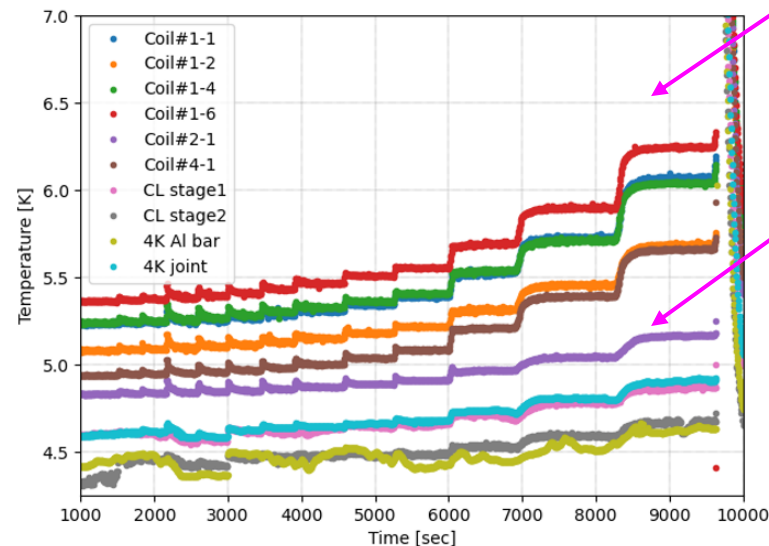
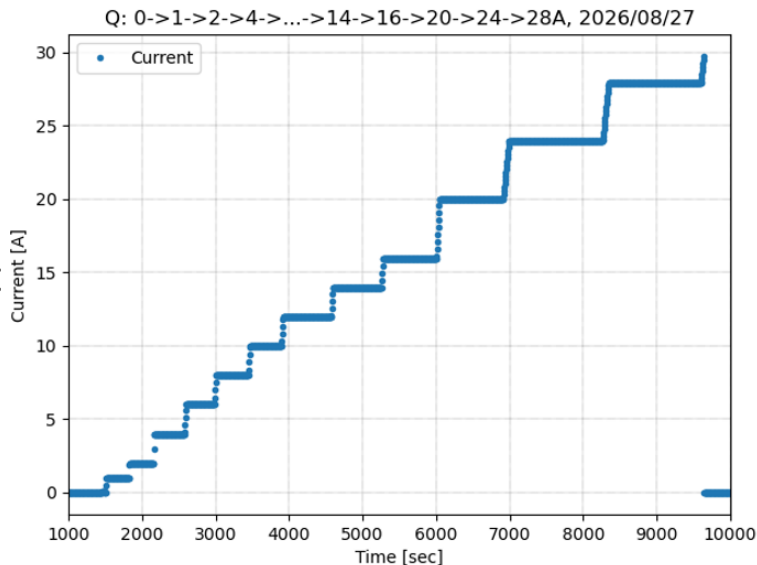
July



## Observation

- Only the temp of Coil 4 rose along with the current. The temps of Coil 1 and 2 returned to their original temps even after inductive warming.
- The temps of Coil 1 and 4 rose along with the current. Coil 2 also rose gradually.
- The temp rise in Coil 2 was delayed after Coil 1 and 4.

August

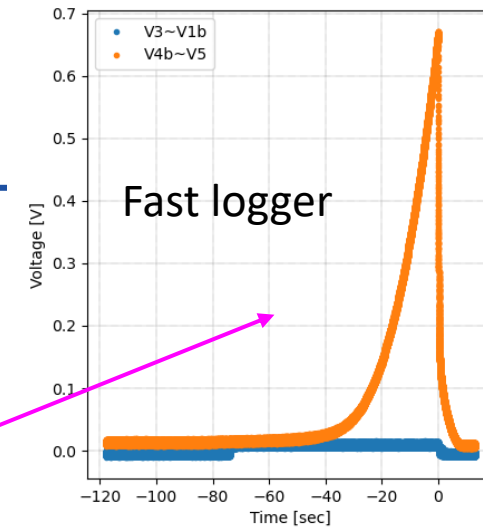
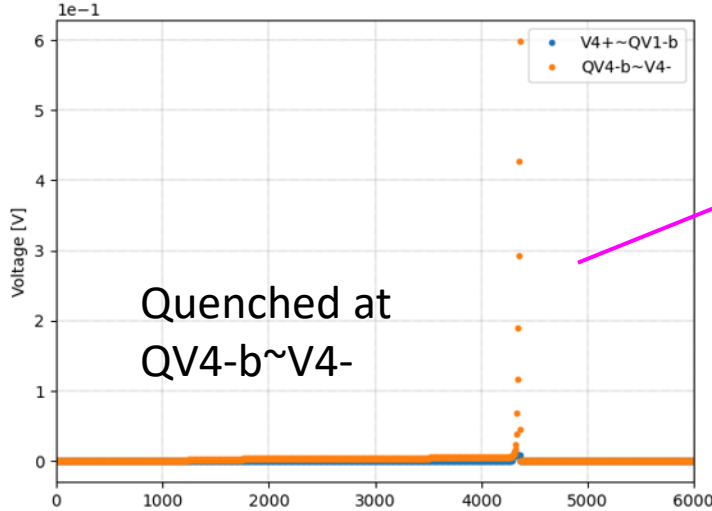
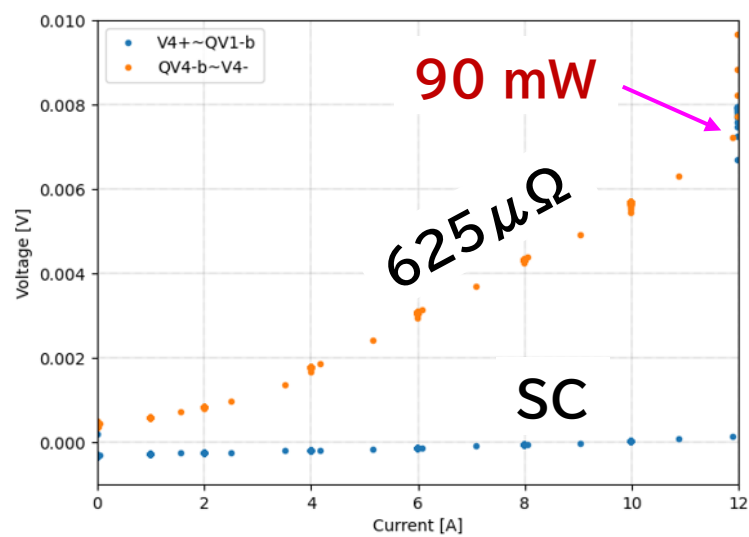


→ Sources of heating are located near Coils 1 and 4. The temp rise in Coil 2 can be explained due to heat transfer from Coils 1 and 4.

# August test: NbTi wire from coil



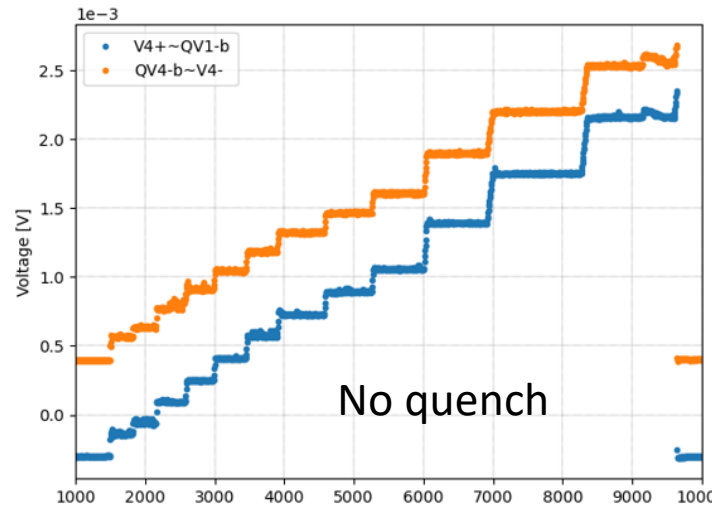
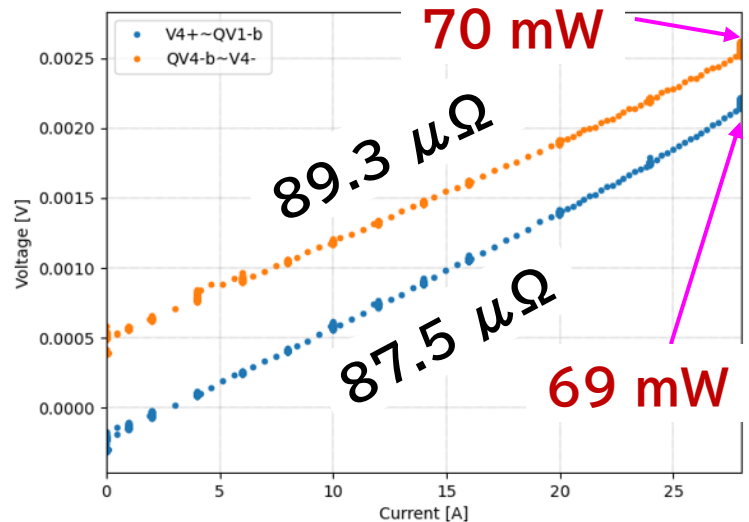
July



## Observation

- A voltage developed on Coil4 side. Coil1 side kept SC in July. Coil4 showed 625 uOhm.

August



- Both of Coil 1 and 4 had voltage development. Coil1 and 4 showed 87.5 uOhm and 89.3 uOhm, respectively.

→ Either the NbTi wires from coils are damaged or joints have resistance.

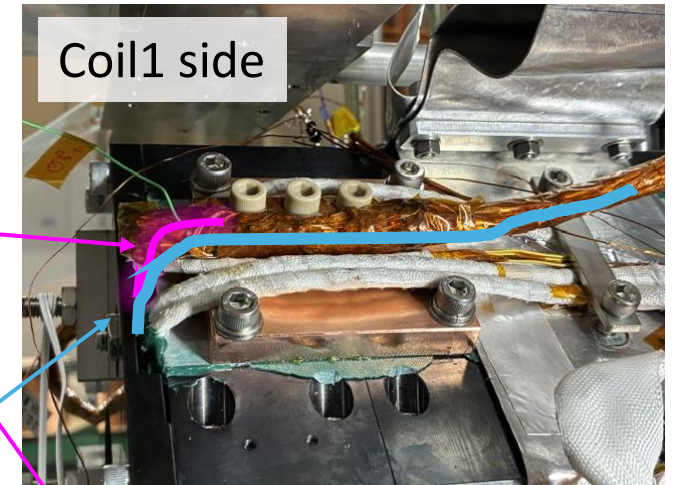
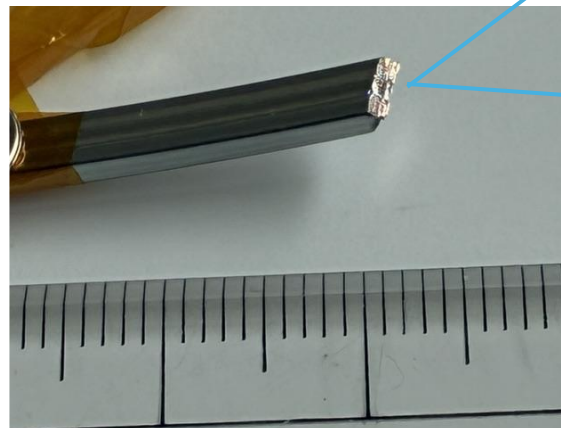
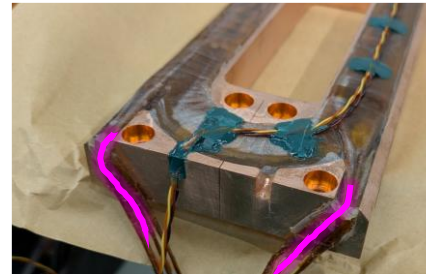
# August test: Consideration and countermeasure

- ***Quenching occurred in the coil1*** but we don't think the coil1 has issue. The correct understanding should be: coil1 and 4 were heated up by heating source near them and the coil1 reached critical current and quenched.
- Heating location is most likely NbTi wires from the coils 1 and 4, meaning they are seriously damaged. They are continuous wires of coils and cannot be repaired.

## Countermeasures

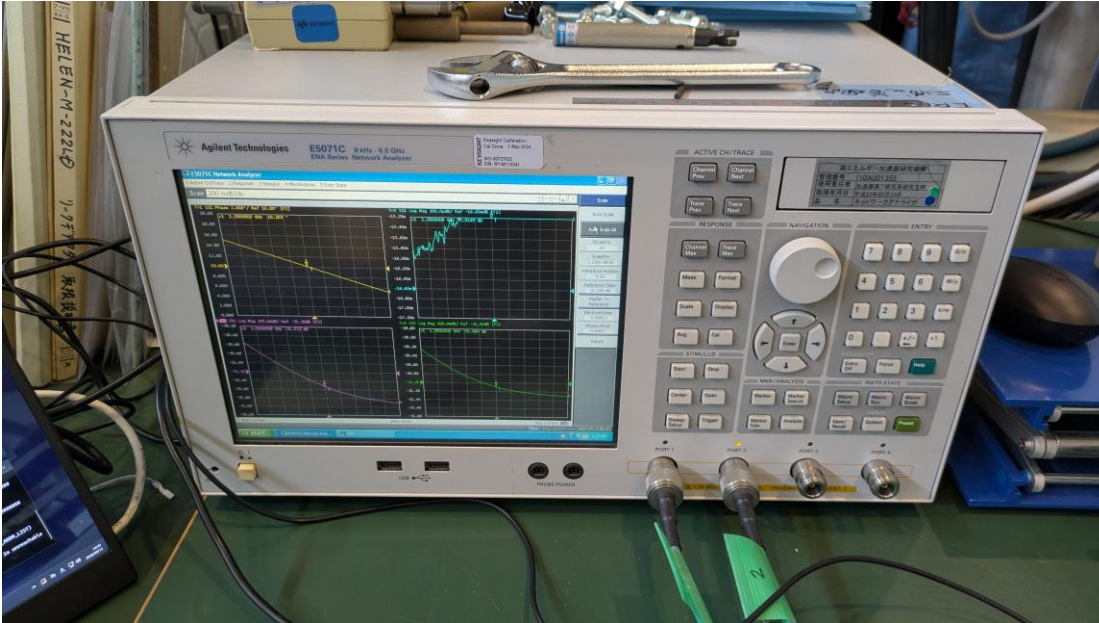
- We are going to solder healthy thick NbTi wire along with the damaged original NbTi wires for efficient thermal conductive cooling.

3.5 mm x 2 mm



# For November experiment

- 4ch Network Analyzer (Agilent Technology, E5071C)



I'm not sure if our RF cables are suitable for your experiment or not. I'd like to ask you to bring them to KEK.

- Ecal kit



# For November experiment



Yesterday's discussion with Laura, Juan-Carlos and Cesar

- Cooling time:
  - 4 days normally. For safe side, 5 days should be assumed for this experiment since BPM+flange (~10kg) is attached.
- Warming time:
  - 3 days. Above 80K, N<sub>2</sub> gas will be injected. Is it OK for your measurement?
- Temperature sensors:
  - There are 5 calibrated Cernox temperature sensors. You can attach where you want to see.
  - Since our building has no air-conditioning system, I recommend you to monitor temperature around VNA during your measurement.
- Excitation
  - If you want, we can excite quadrupole magnet at cryogenic temperature. Please discuss within your group and tell me later your opinion.
- Radiation paperwork
  - Nothing to do for your side. I'll submit a paper for your work.



# Future plan

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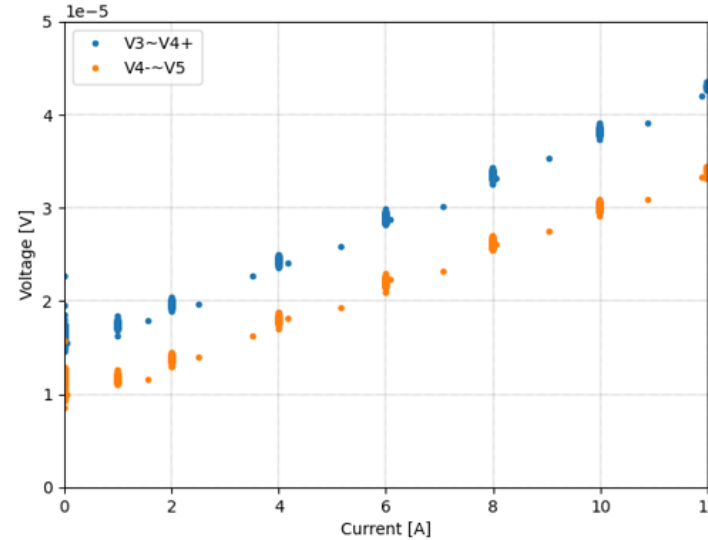
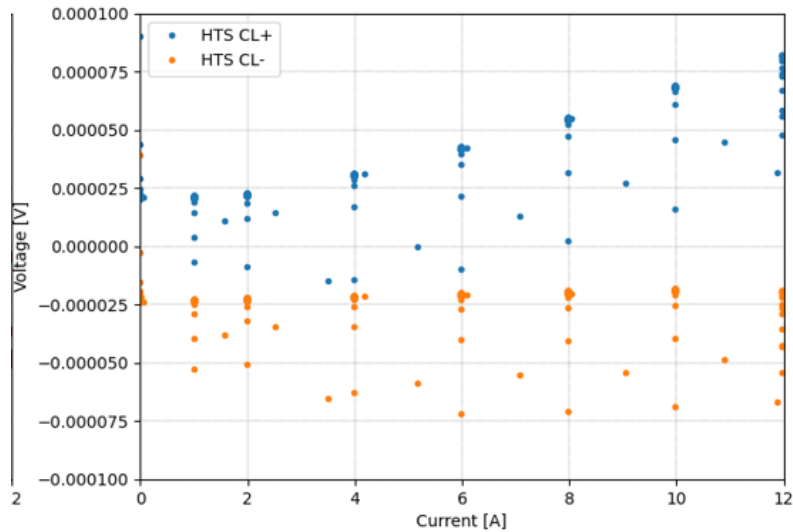


- The company is finalizing the design.
- The company procures necessary parts.
- Repairment schedule is still unclear.
- Excitation tests will be anyway carried out by the end of October.
- There is a request from IFIC, Spain.
- They want to cool their cavity BPM in the cryostat with the SCQ in November.
- Cavity resonant frequency and Q factor will be measured during cooling down.
- All the necessary components/jigs/cables/etc will be prepared by IFIC side.
- We are going to accept their request. I'll discuss details in Valencia on 5<sup>th</sup> and 6<sup>th</sup> October.

# August test: Current vs. CLs



July

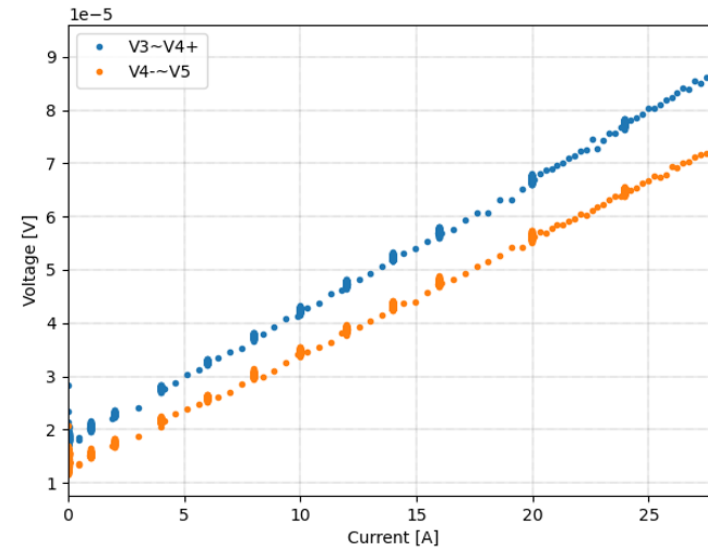
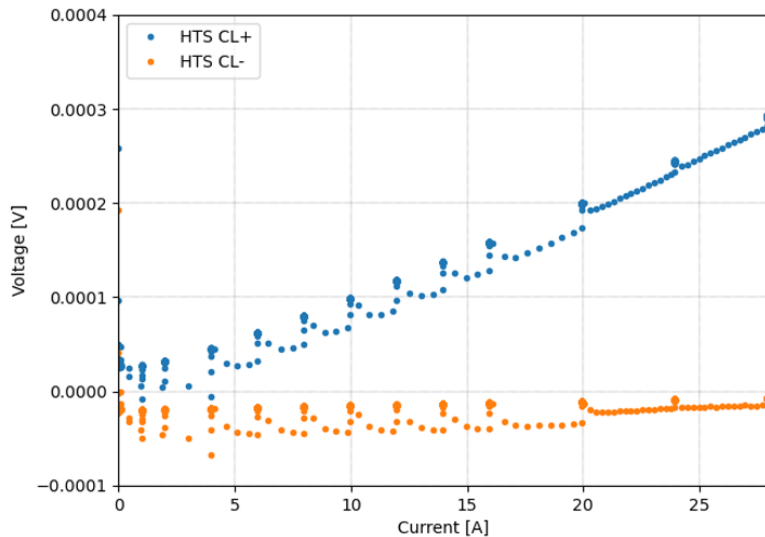


Observation

- No major difference

→ No influence by the work in August.

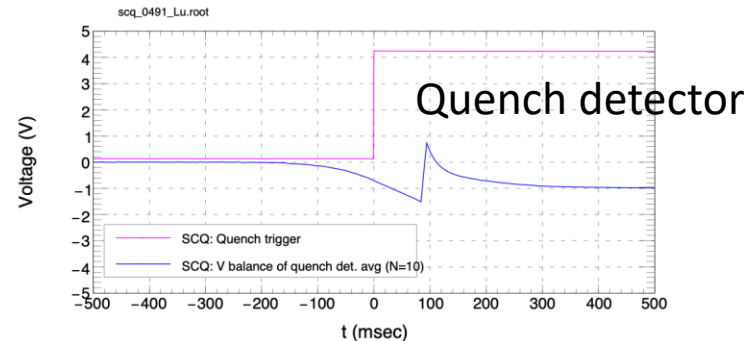
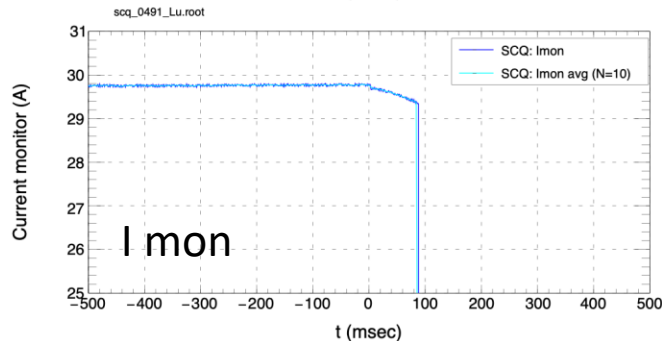
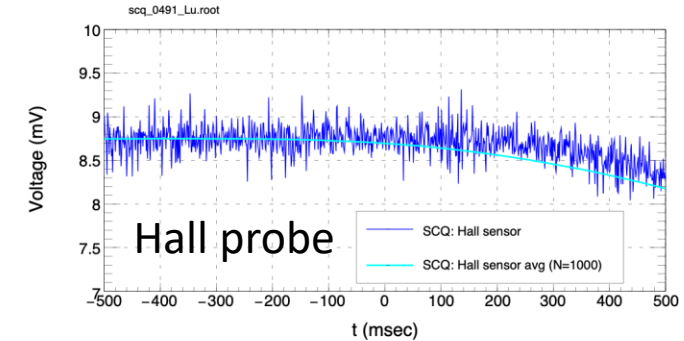
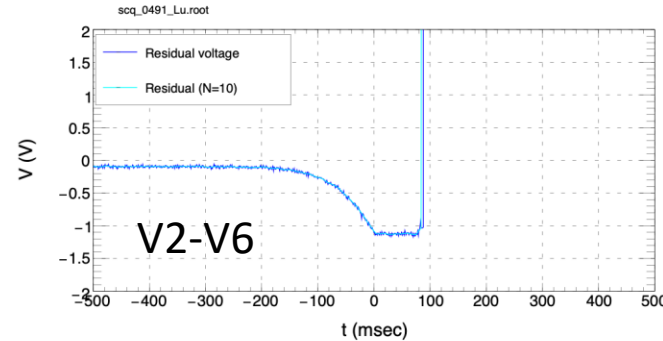
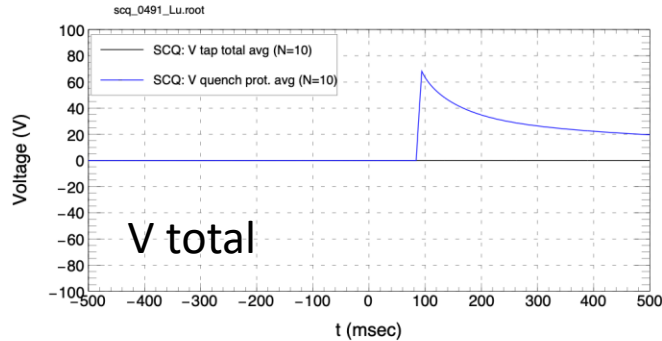
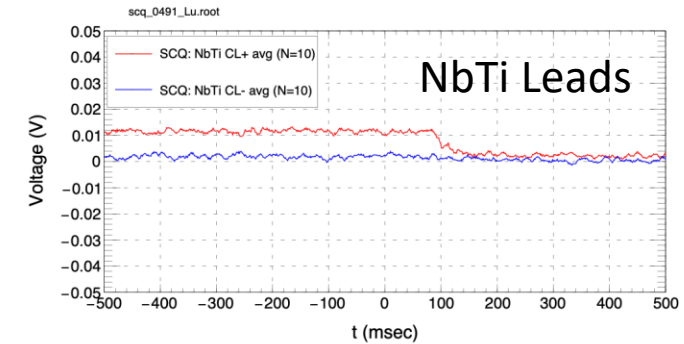
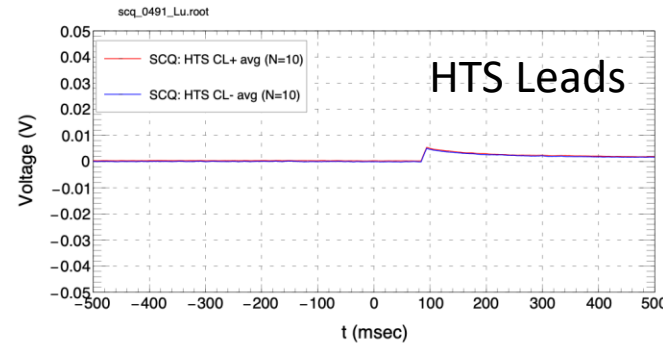
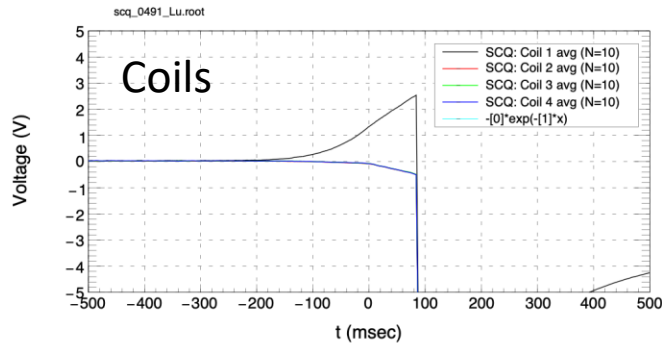
August



# August test: Fast logger analysis by YA



- 28 → 32 A @ 0.05 A/s, enlarged horizontal axis around quenching

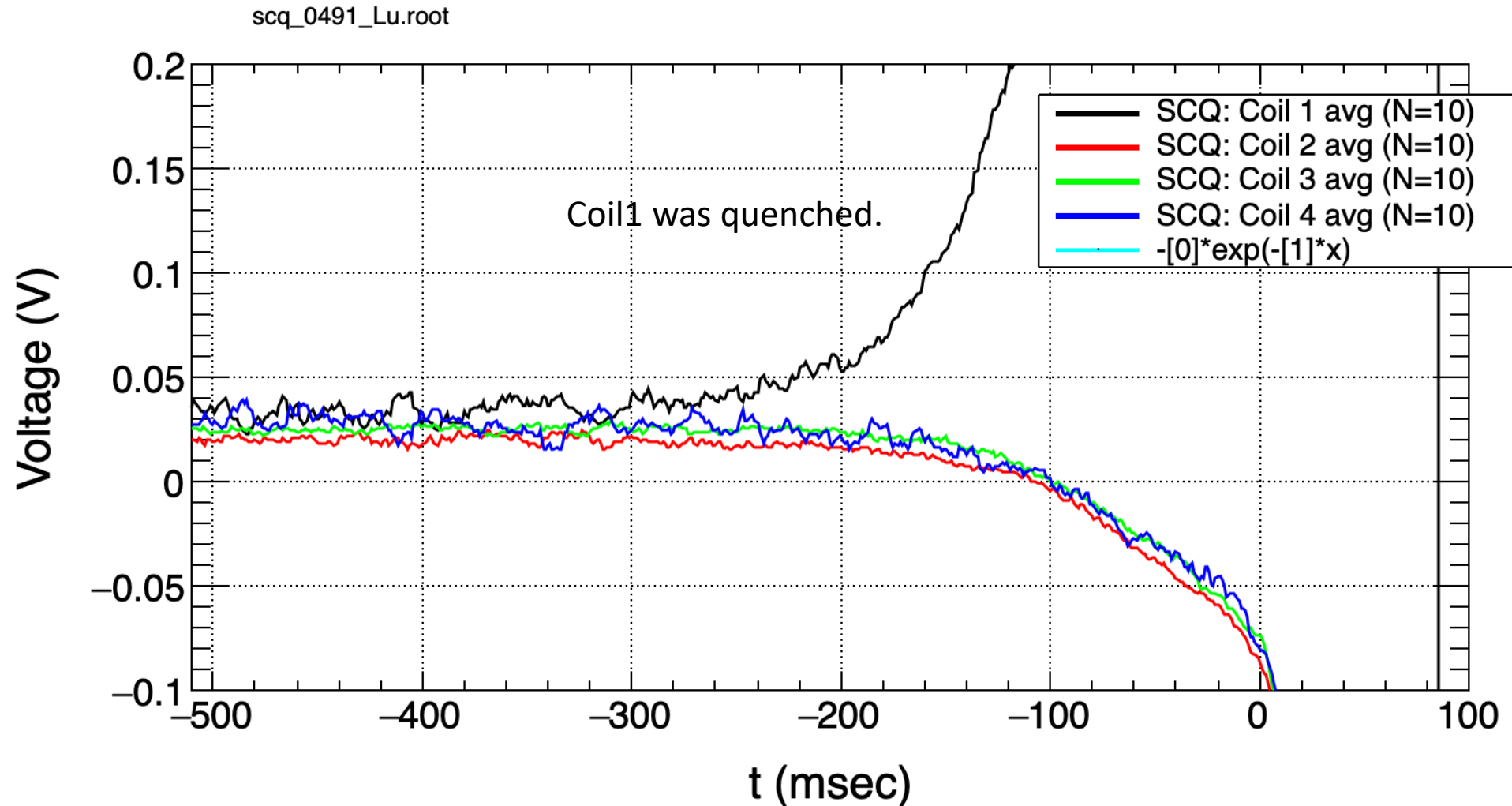


Coil1 was quenched.

# August test: Fast logger analysis by YA



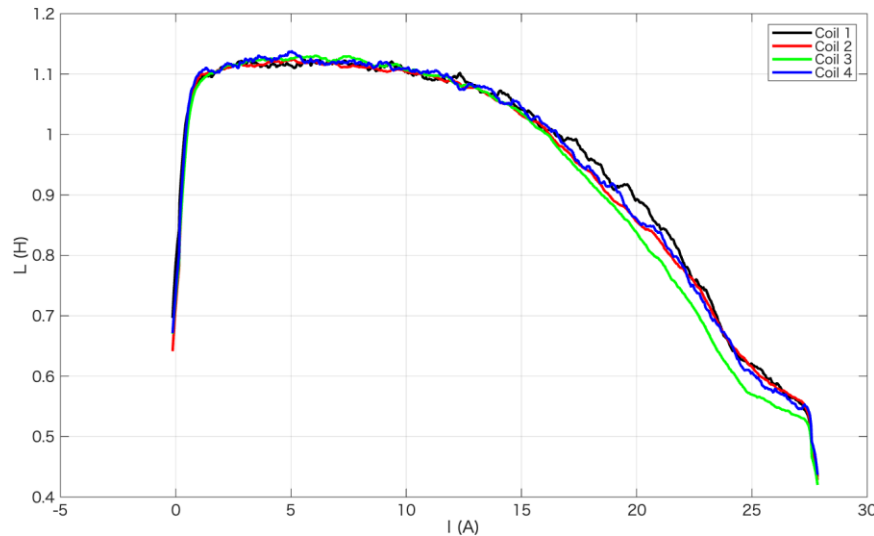
- Enlarged graph for coils



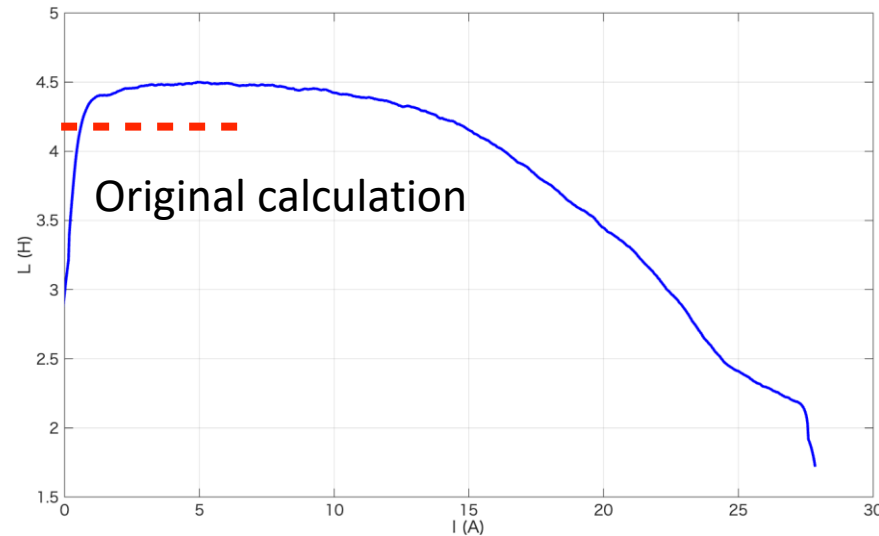
# August test: Inductance analysis by YA



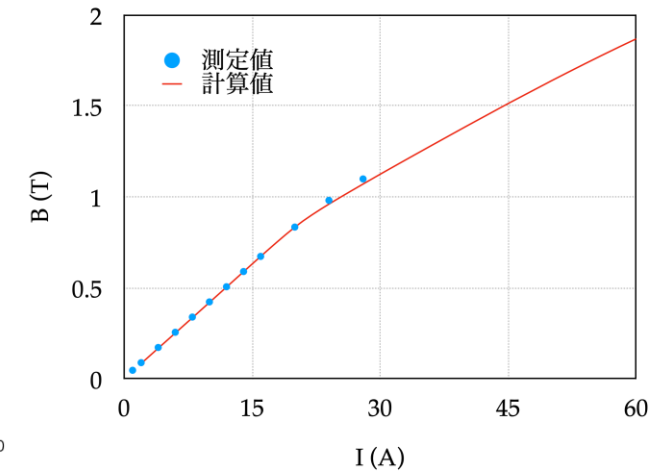
4 coils



Sum of 4 coils



Hall probeの測定値と計算値



- Measured inductance was higher than the original design calculation.
- Measured magnetic flux density matched calculation results below 24A, but discrepancies became apparent at 24A or higher.
- Causes of the difference are:
  - Measured magnetic permeability was not implemented in the calculation
  - Difference between the final magnet design and the original Yasushi's calculation.