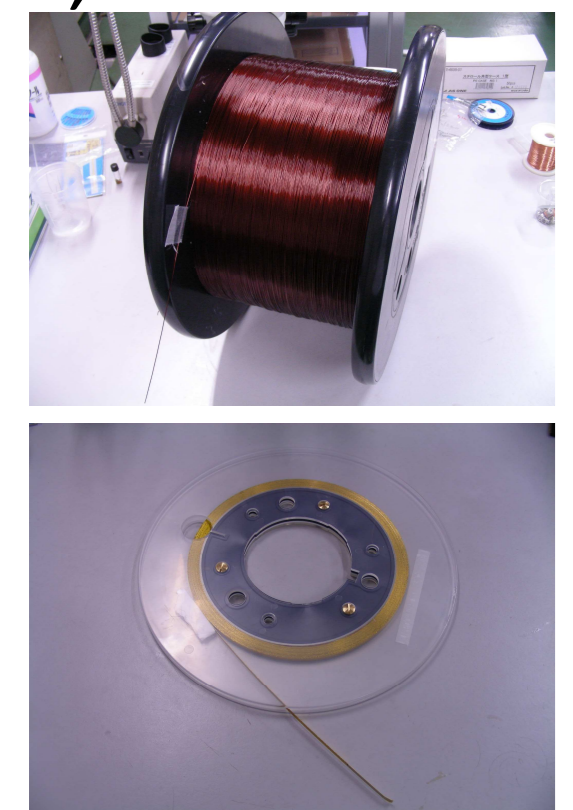


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Motivation

LTS, HTS conductors



SC Joint R&D

R_j I_c T_c B_{c2}
Quick & Precise Evaluation

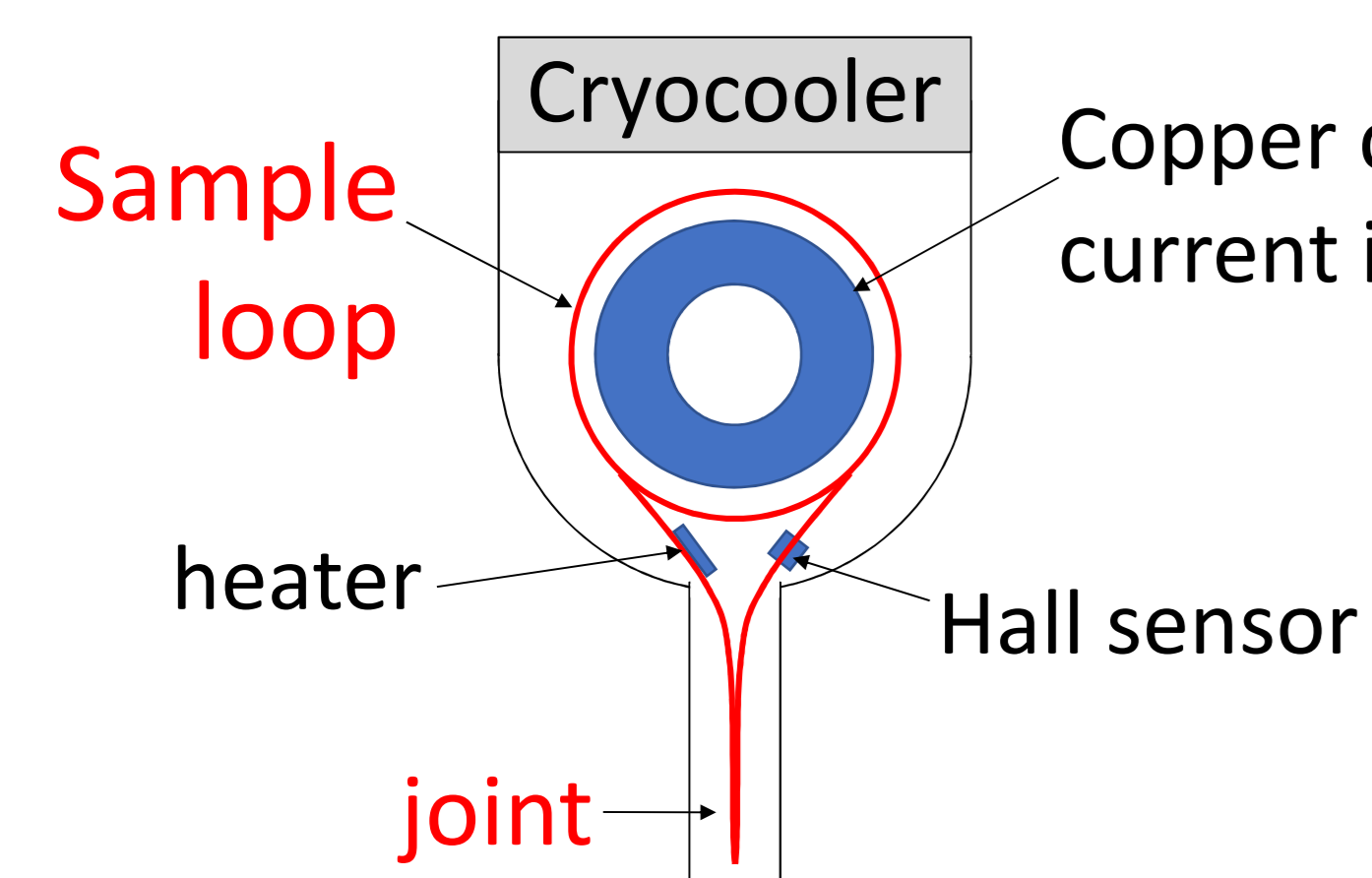
Applications



NMR, MRI, Power cable, etc.

Joint resistance evaluation system

Current decay method using LR closed circuit



$$I(t) = I_0 e^{-\frac{R}{L}t}$$

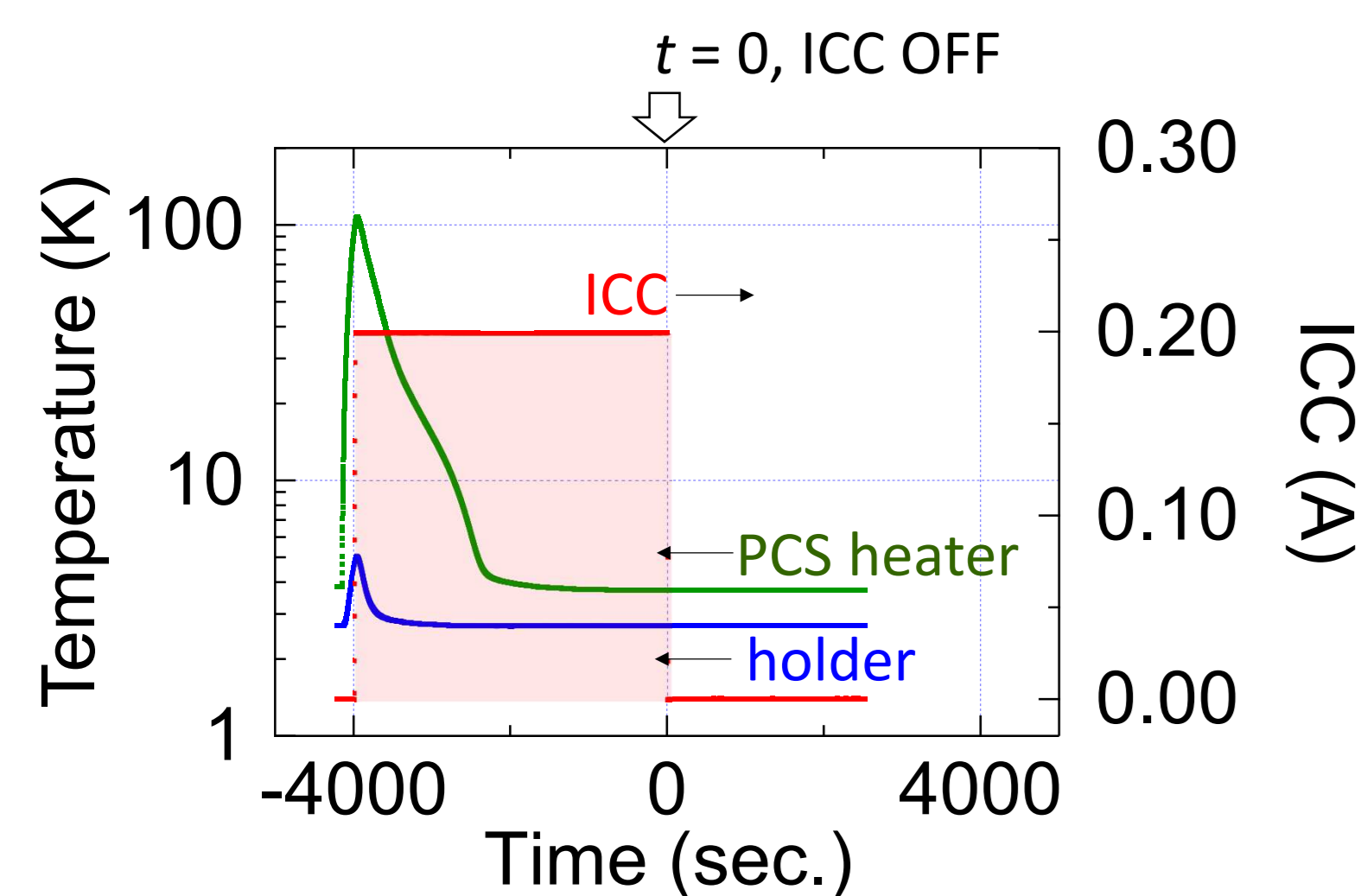
I_0 : initial current

L : circuit inductance ($\sim 0.5 \mu\text{H}$ @1-turn)

R : circuit resistance ($< 10^{-12} \Omega$)

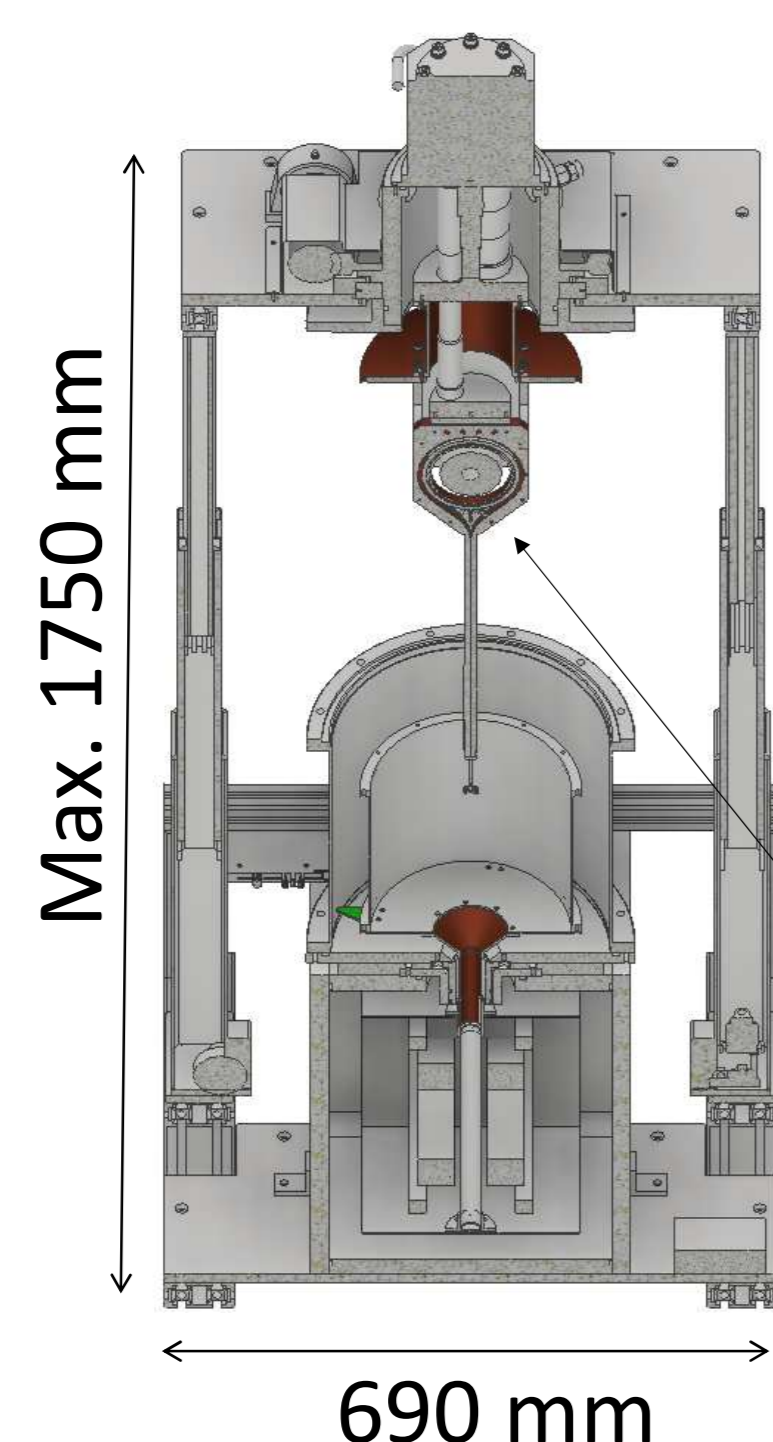
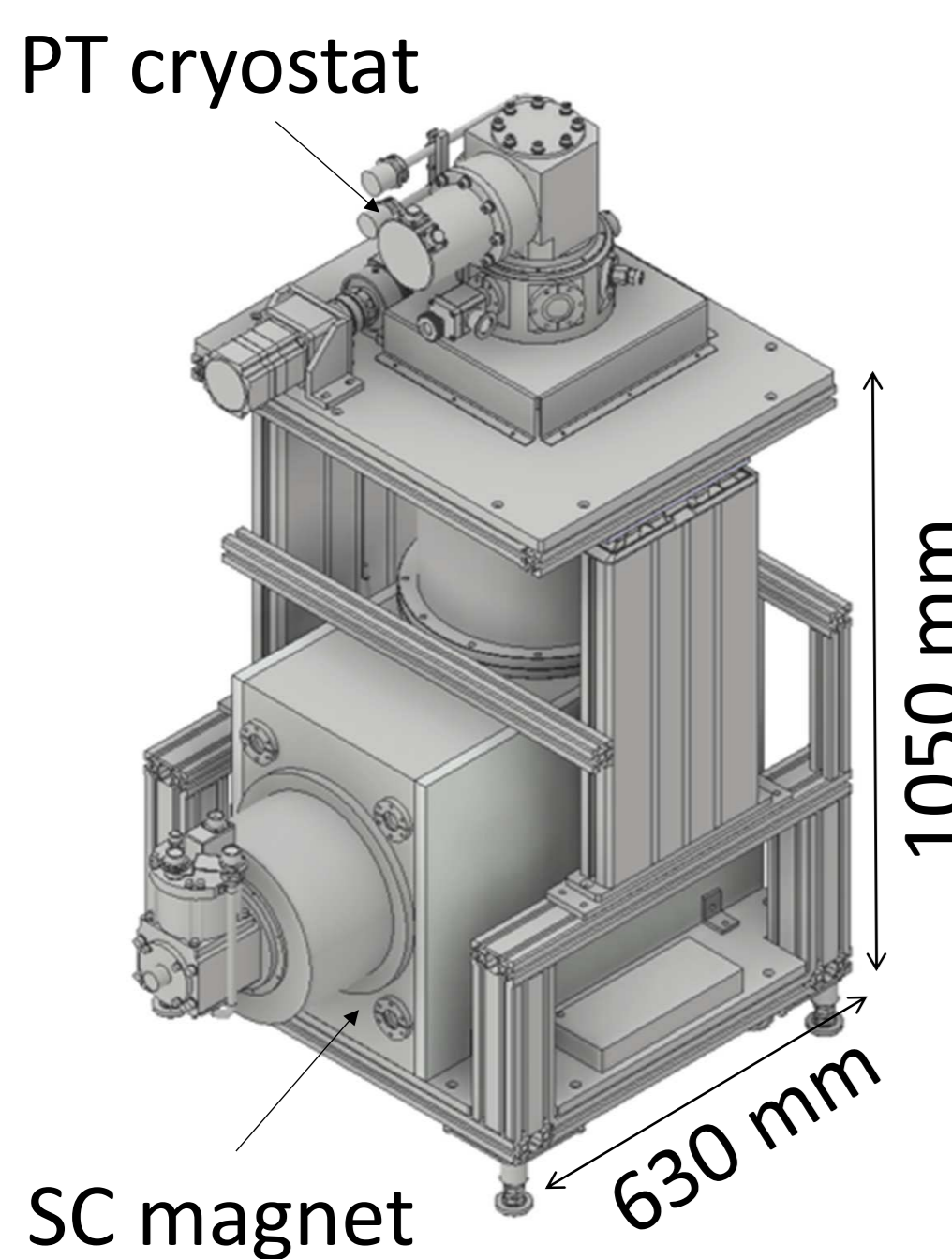


Experiment procedure

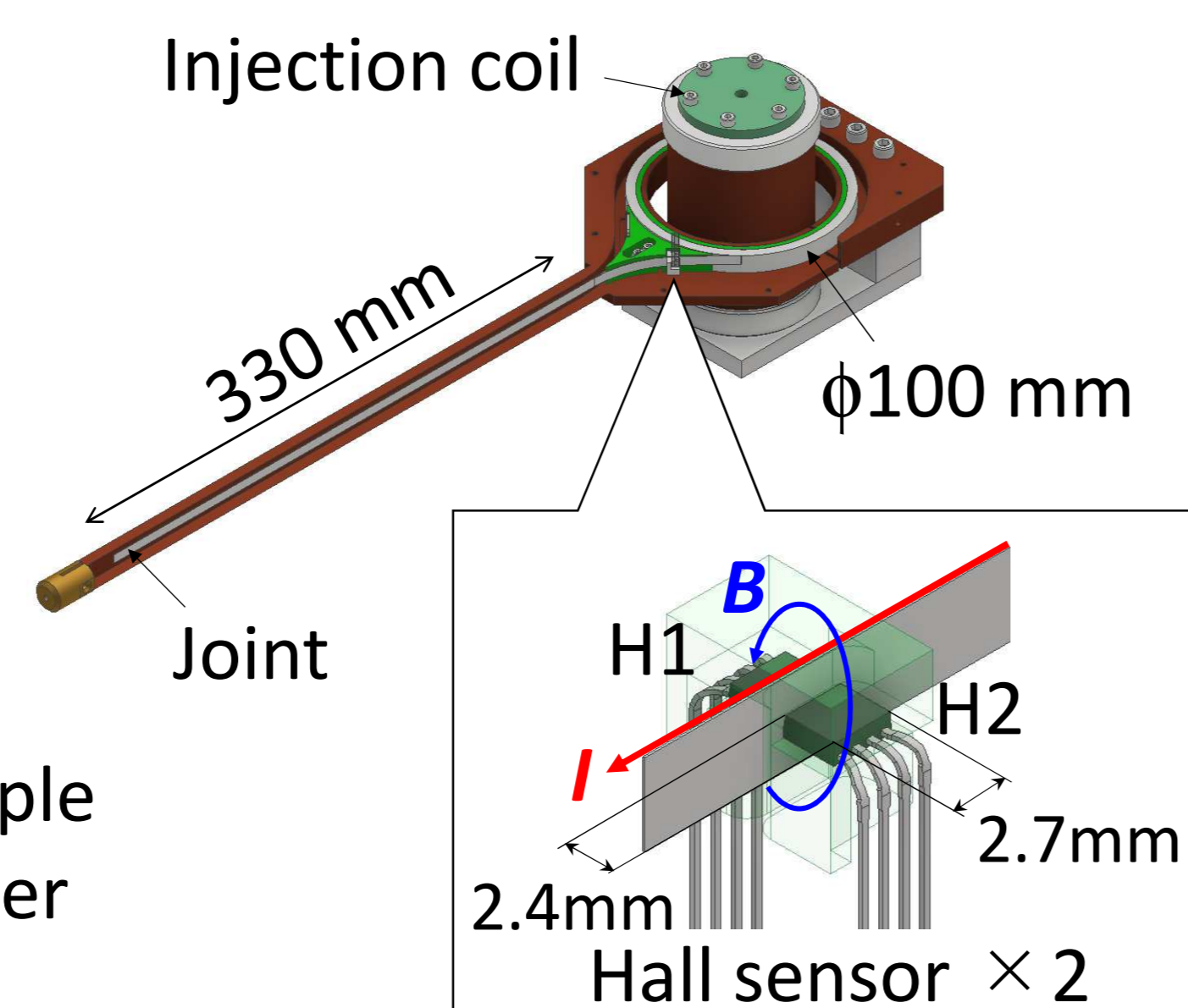


1. Set sample temperature (3~100 K)
2. PCS heater ON (locally up to over T_c)
3. Injection coil current (ICC) ON
4. PCS heater OFF
5. Waiting (sample temperature stabilization)
6. ICC OFF
7. Measurement of Hall sensor output (current of sample loop)

Instruments overview



Sample holder

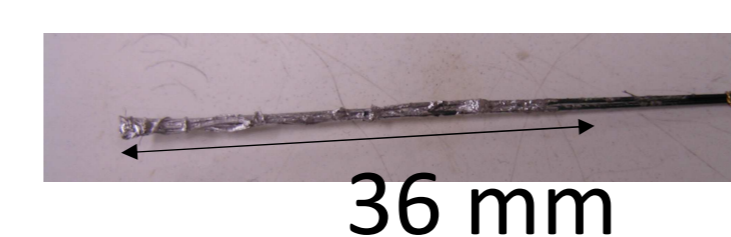


Difference between two Hall sensors \rightarrow Cancelling BKGD field noise

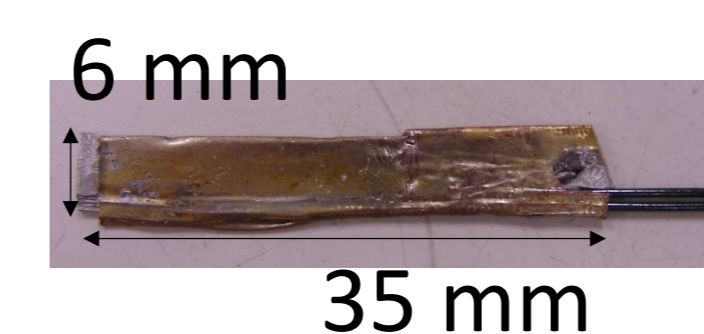
Commissioning results

NbTi superconducting joints

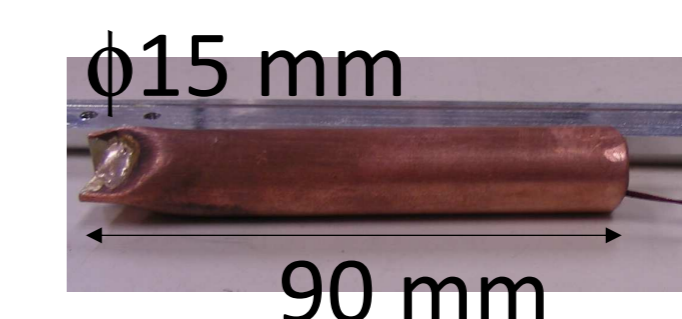
Sample#1, by AIST



Sample#2, by NIMS

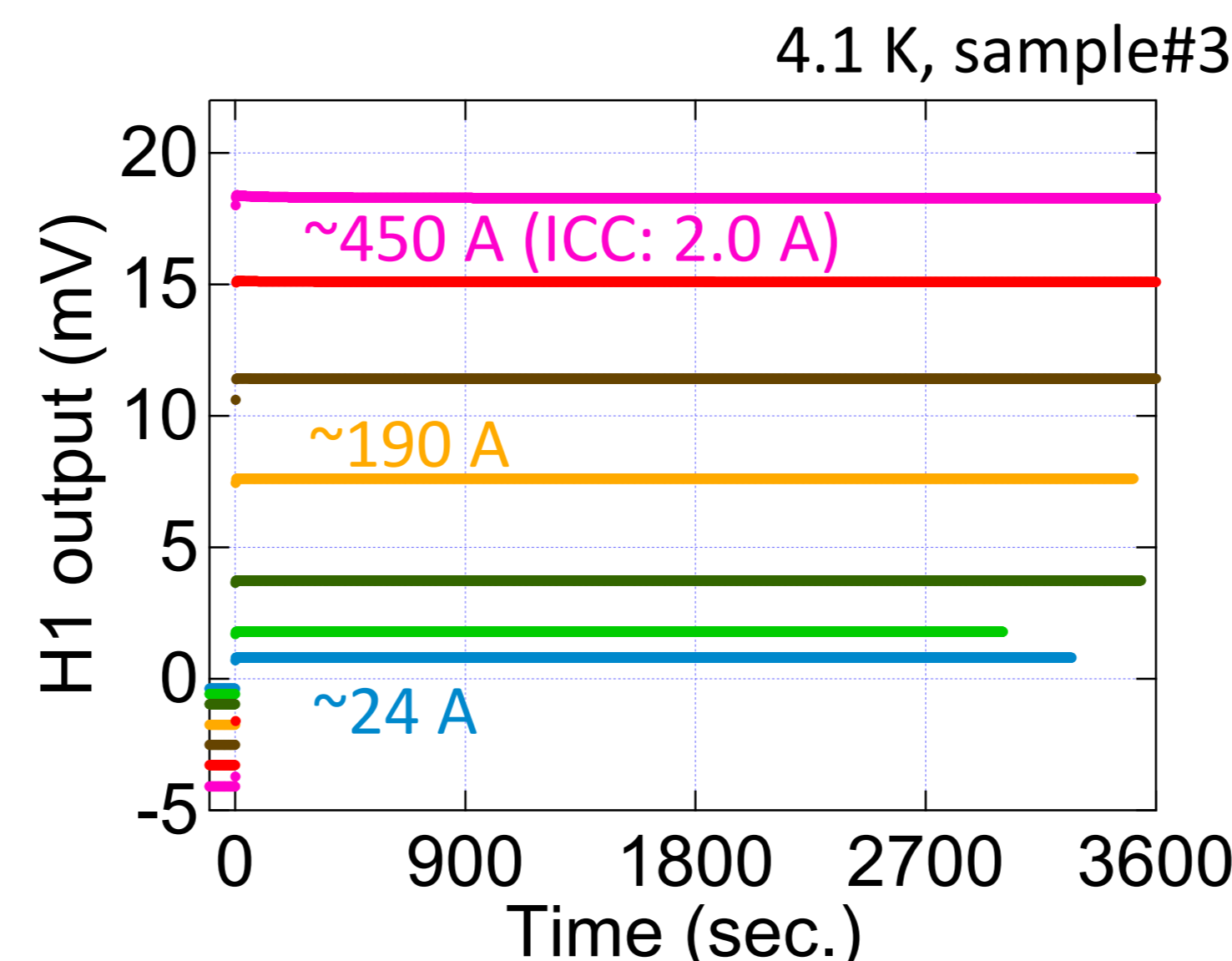


Sample#3, by JASTEC

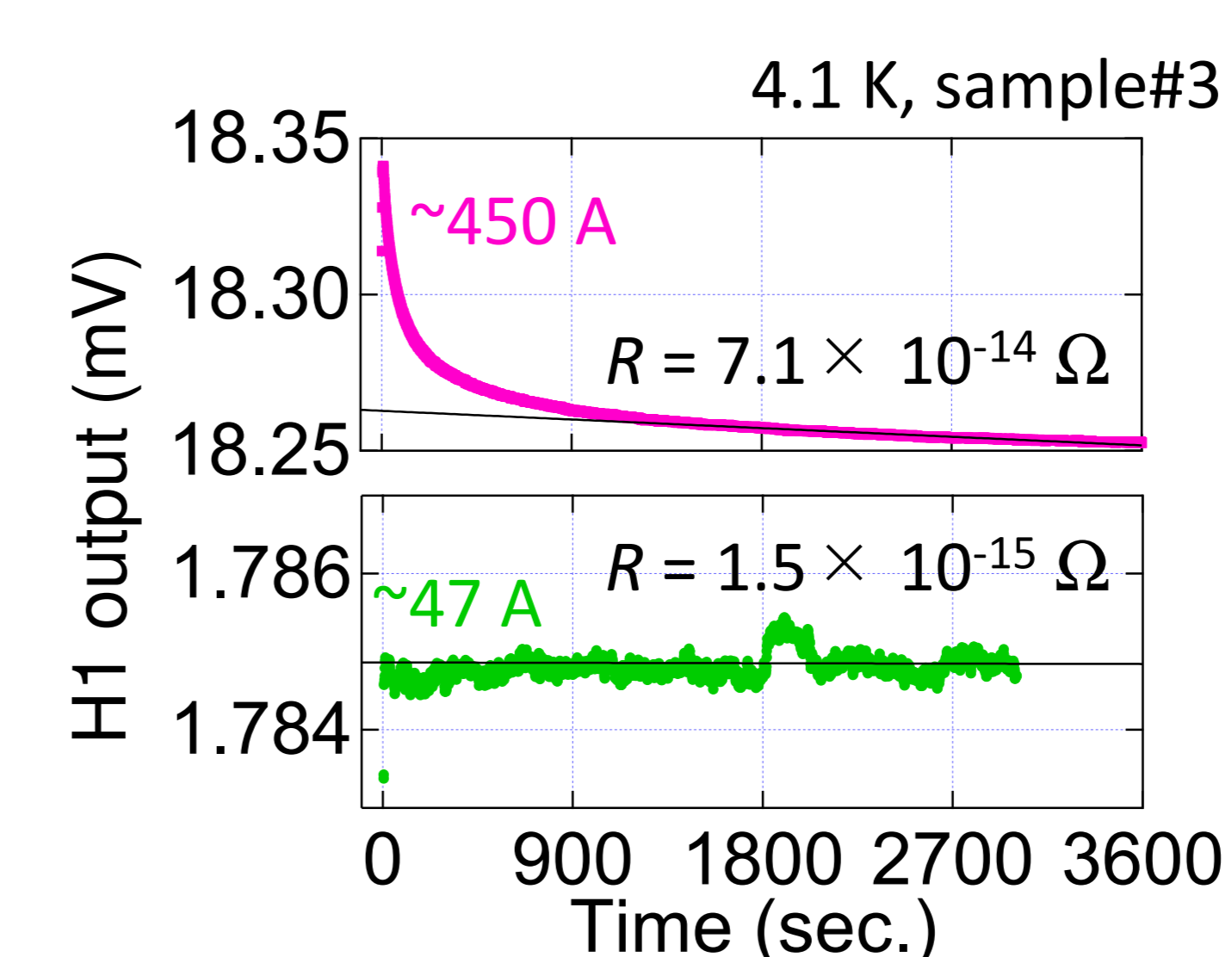


| Sample | Conductor | Joint |
|----------|---------------------------|-------|
| Sample#1 | JASTEC NbTi $\phi 0.6$ mm | Pb-Bi |
| Sample#2 | JASTEC NbTi $\phi 0.6$ mm | Pb-Bi |
| Sample#3 | JASTEC NbTi $\phi 0.6$ mm | Pb-Bi |

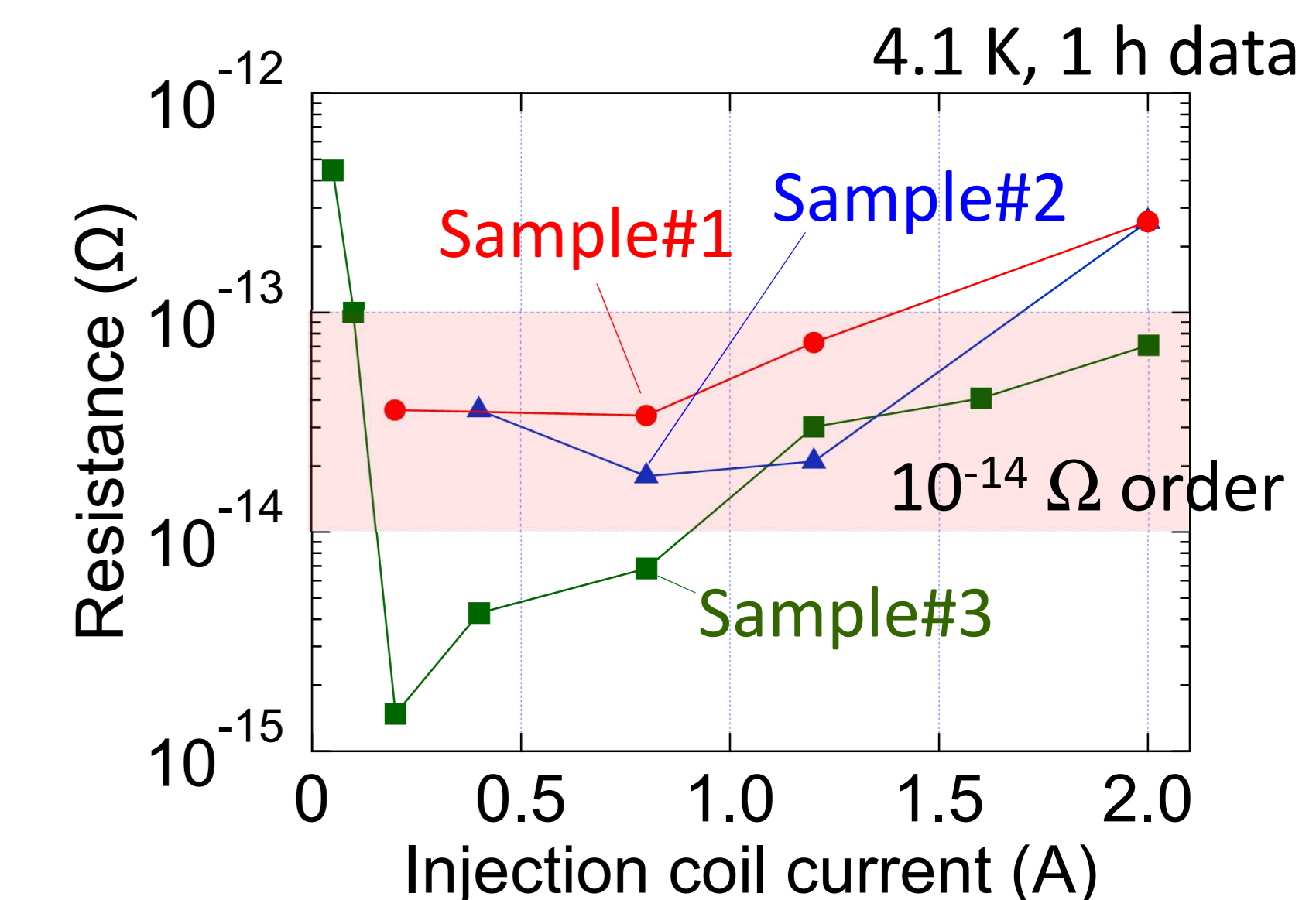
Joint resistance evaluation



Decay curves of various injection currents at 4.1 K. Injection currents are reference values.



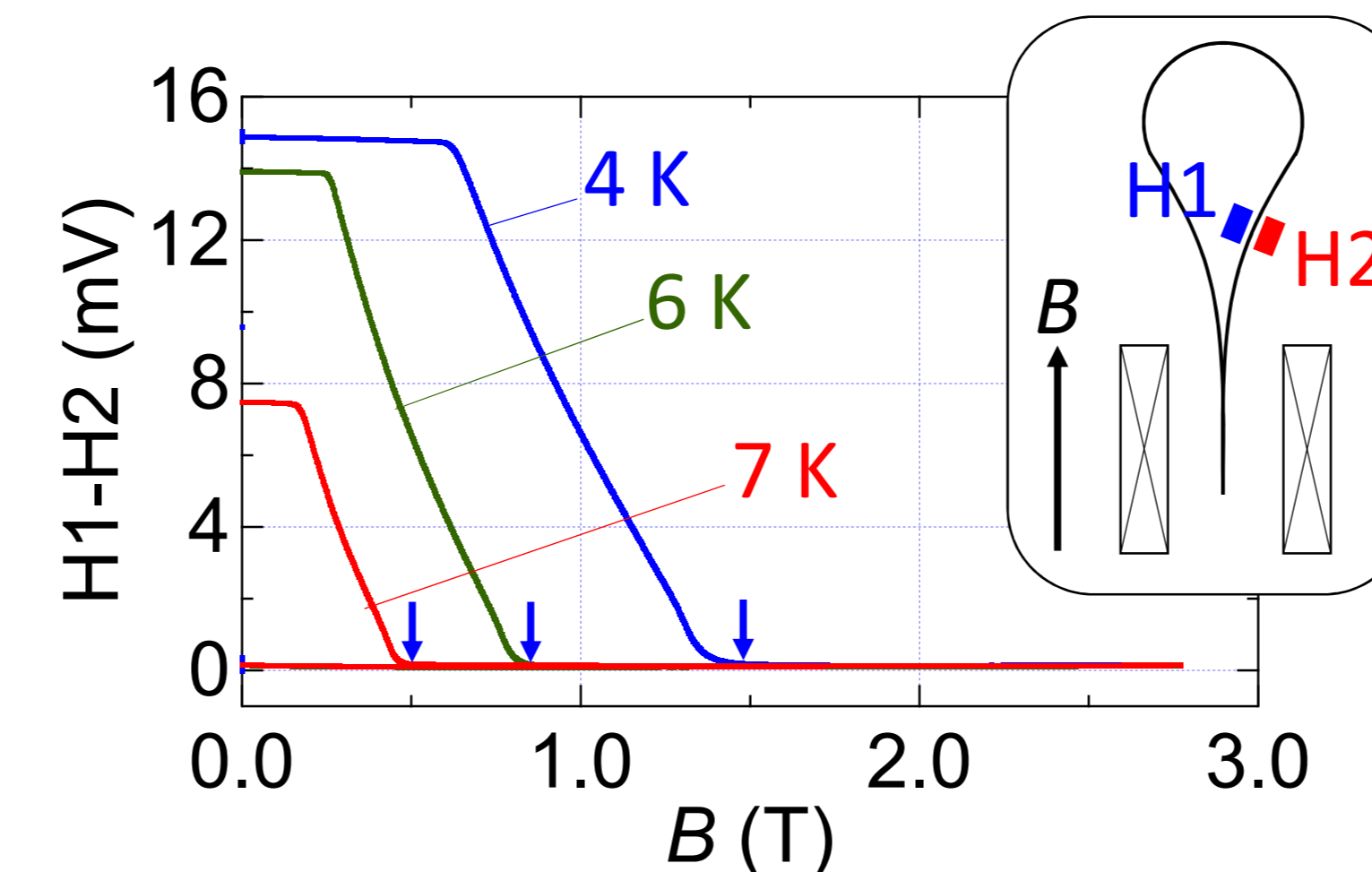
Fitting results of current decay. Black lines indicate $V = V_0 \exp\{-R/Lt\}$.



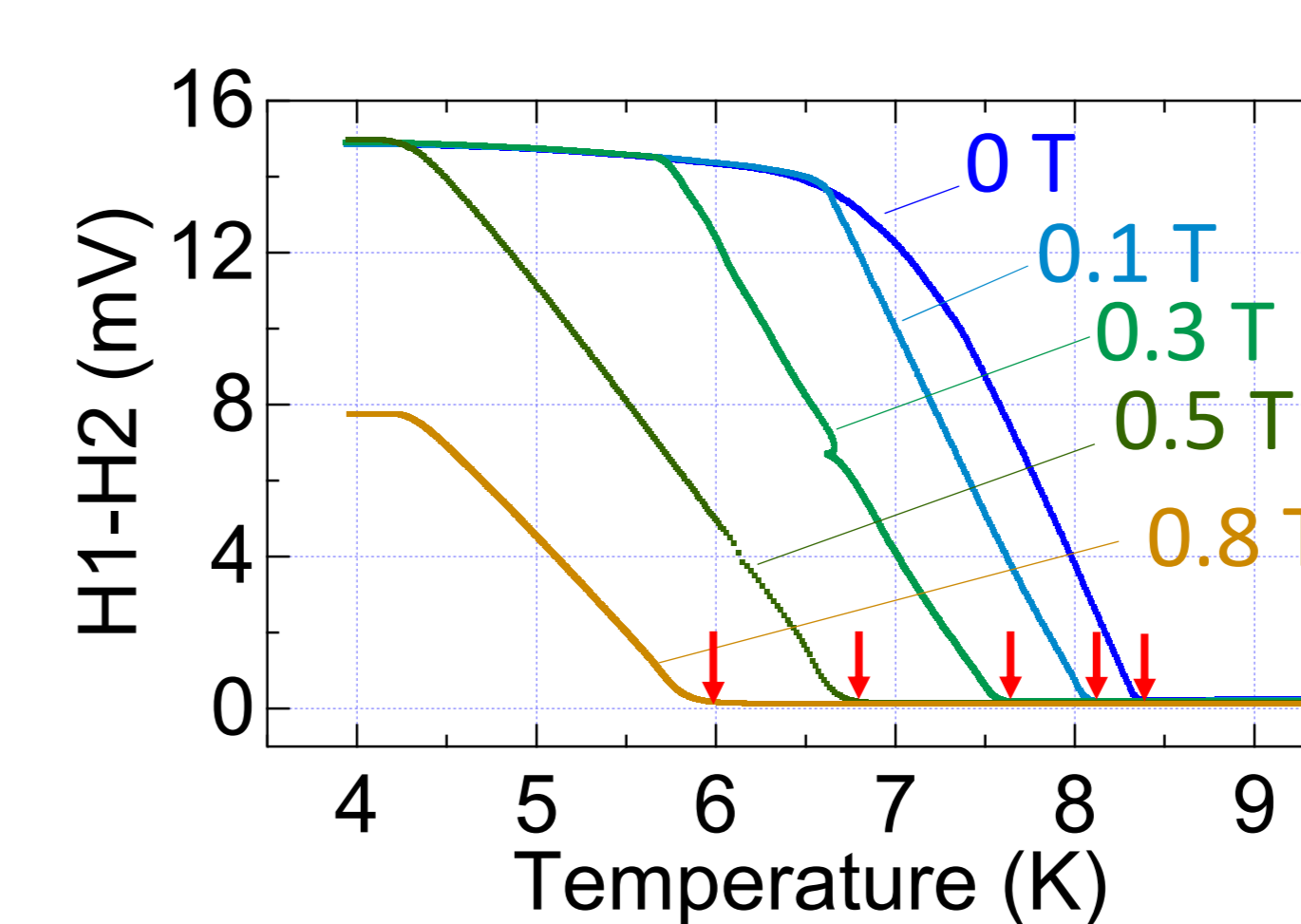
Injection current dependences of resistance for sample#1, #2 and #3. All samples were on the order of $\sim 10^{-14} \Omega$.

Magnetic field dependence

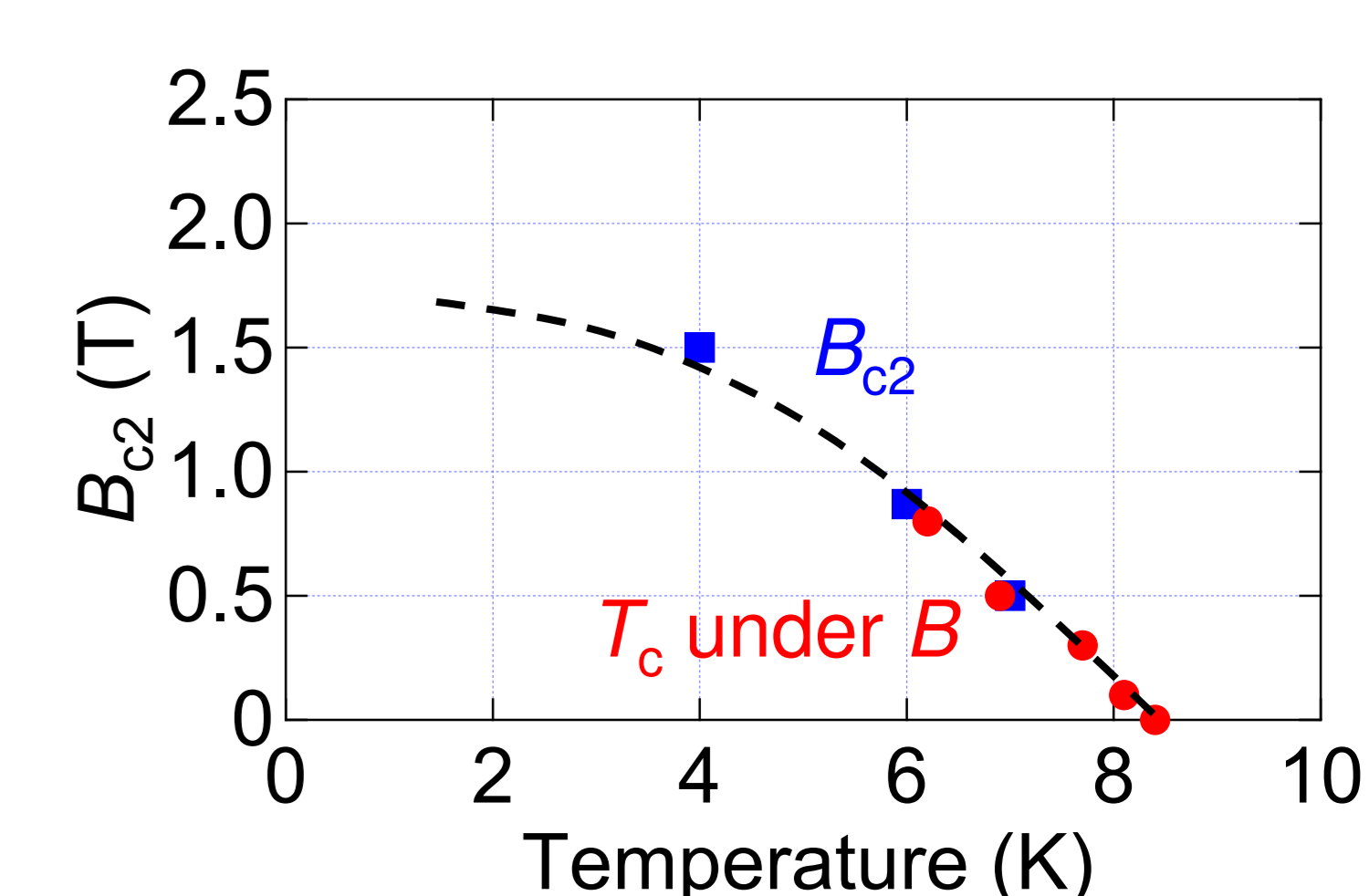
sample#4: NbTi, Pb-Bi solder joint



Magnetic field dependences of injected current at several temperatures. Blue arrows indicate B_{c2} .



Temperature dependences of injected current under various magnetic fields. Red arrows indicate T_c under B .



B_{c2} (■) and T_c under B (●) plotted as a function of temperature. Dotted line is a guide to the eyes.

Summary

Evaluation of superconducting joints

- $\triangleright R_j$ of $10^{-14} \Omega$ order successfully evaluated in 1 hour.
- $\triangleright I_c, B_{c2}$ vs T could be measured.

Future work

- ✓ Precise quantification of injected current.
- ✓ Angular dependence measurement in B .

Acknowledgement

This work is based on results obtained from a project commissioned by the New Energy and Industrial Technology Development Organization (NEDO) [No.16100555-0] and JST-MIRAI Program Grant Number JPMJMI17A2, Japan.

Achievement

| | |
|-----------------------|--------------------------------|
| Joint resistance: | $10^{-8} \sim 10^{-15} \Omega$ |
| Sample temperature: | 3 ~ 120 K |
| RT to 4.2 K: | ~ 3 hours |
| Max. sample current : | ~ 450 A (1 turn) |
| Magnetic field: | 0 ~ 3 T |