

In-field evaluation of REBCO superconducting joint

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WED-PO2-613-09

Motivation

HTS coated conductor



REBCO
Piece length limit ~500 m

superconducting joint
 $I_c > 250$ A at 1 T

Precise evaluation

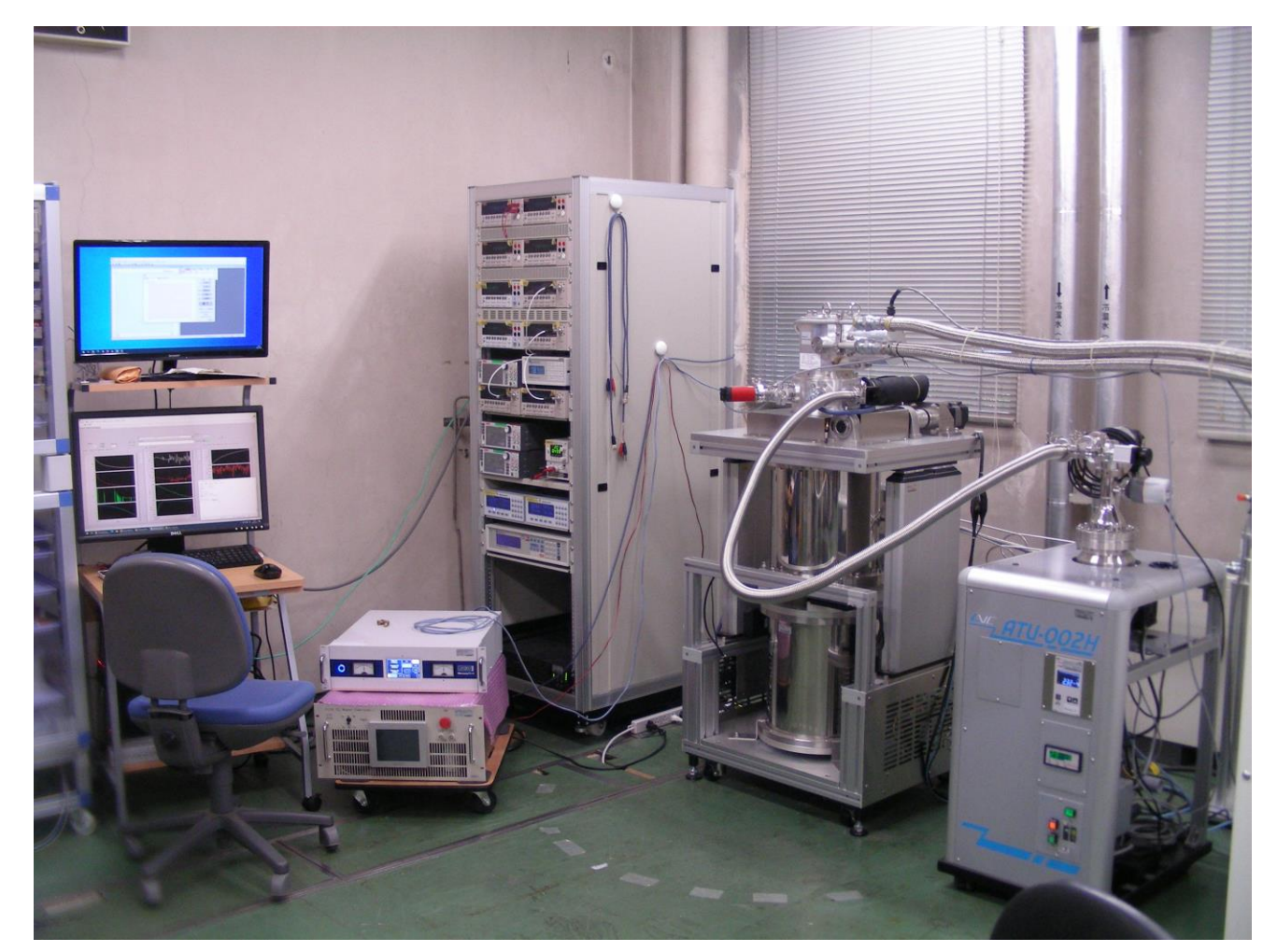
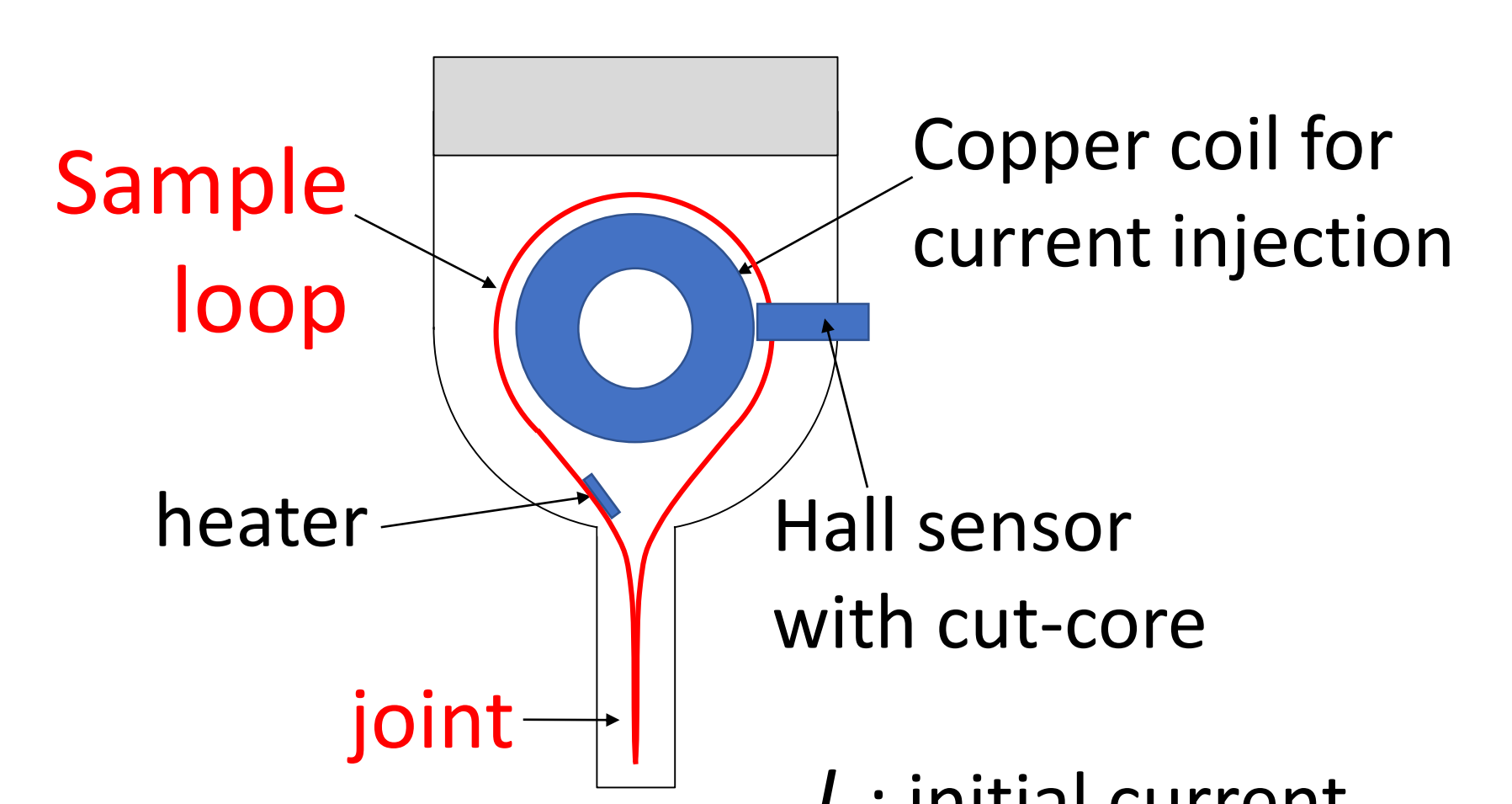
HTS superconducting magnet



1.3 GHz NMR magnet
Persistent current mode

Joint resistance evaluation system

Current decay method using LR closed circuit



System specification

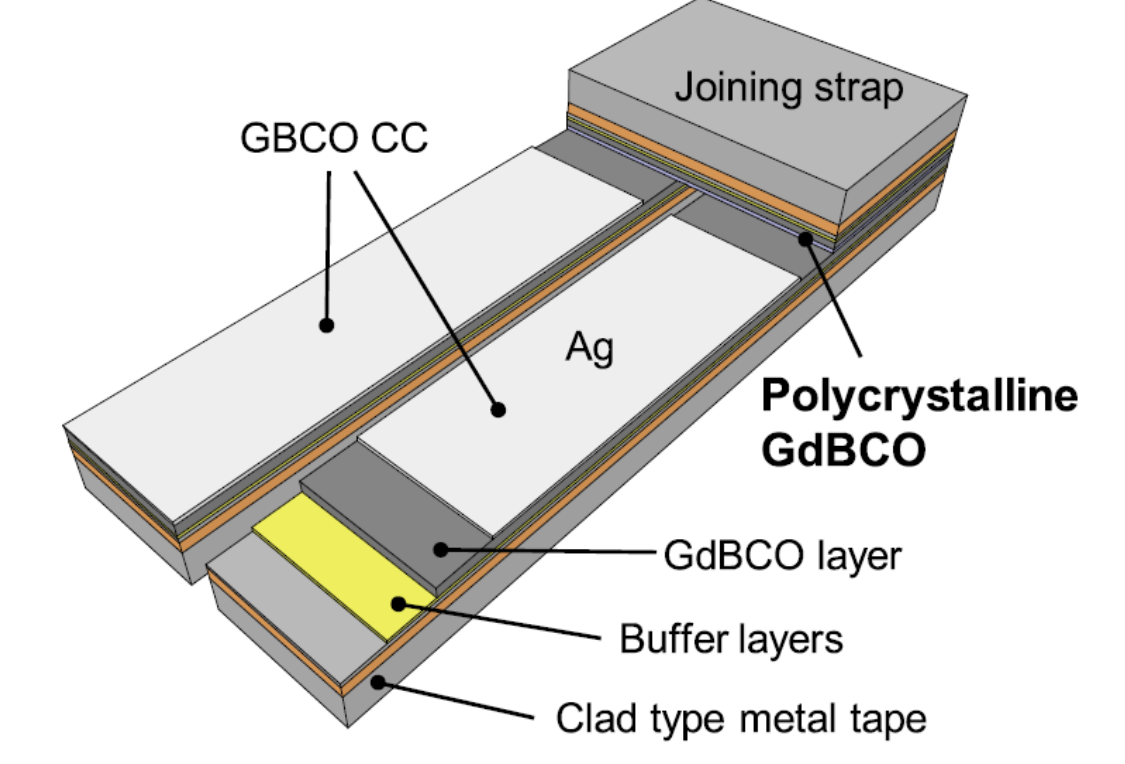
Sample temperature: 2.9 K~120 K
External magnetic field: 0~3 T
Max. Injected current: ~400 A
Resistance evaluation: 10^{-16} ~ 10^{-6} Ω

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

I_0 : initial current
 L : circuit inductance (~0.5 μ H@1-turn)
 R : circuit resistance

Sample settings

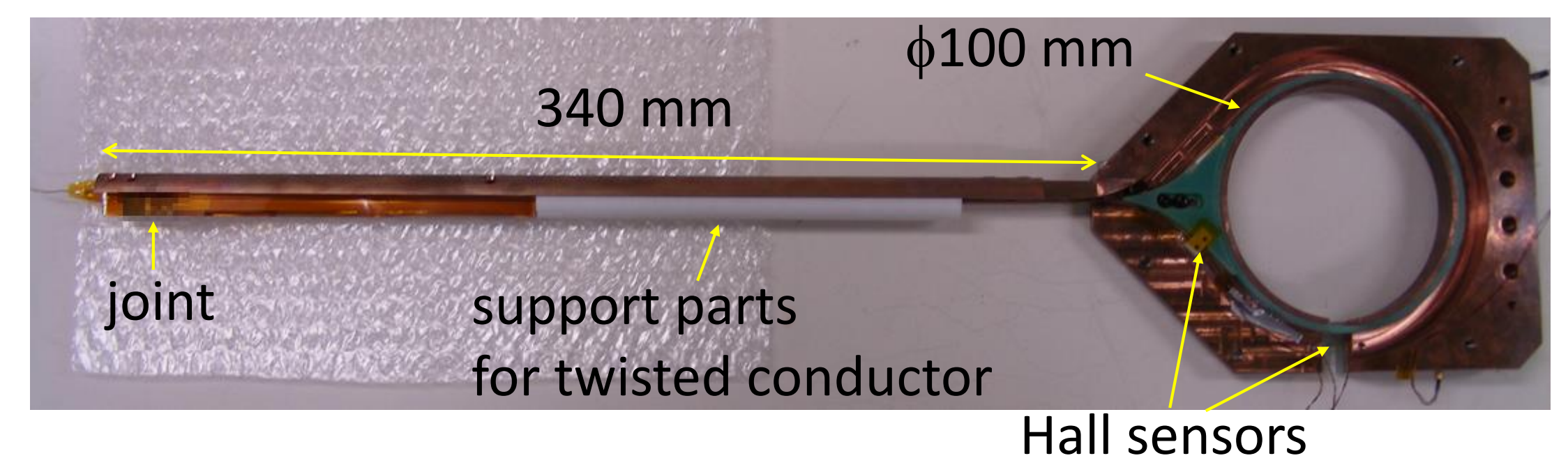
REBCO superconducting(SC) joint



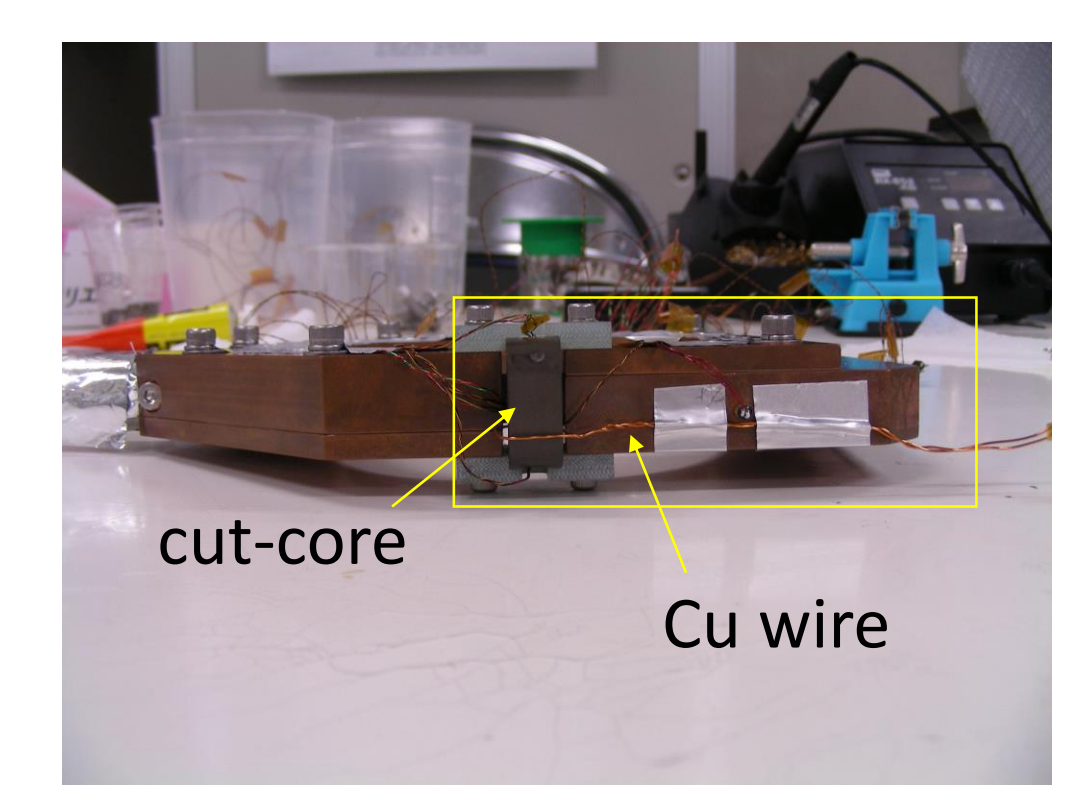
Schematic drawings of iGS joint
K. Ohki et al., Supercond. Sci. Technol. 30, 115017 (2017)

Sample specification

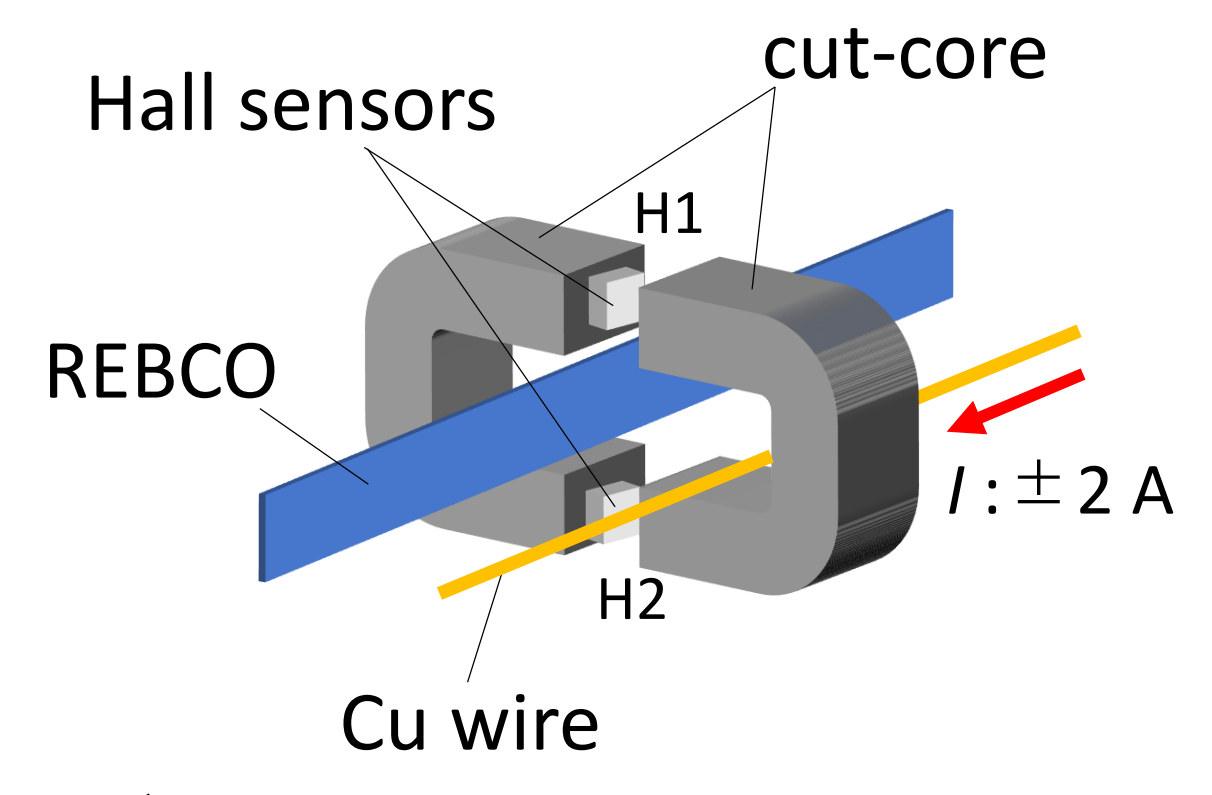
Conductor: REBCO coated conductor
Joint: intermediate grown superconducting (iGS) joint
Total length: ~1000 mm
Turn: 1



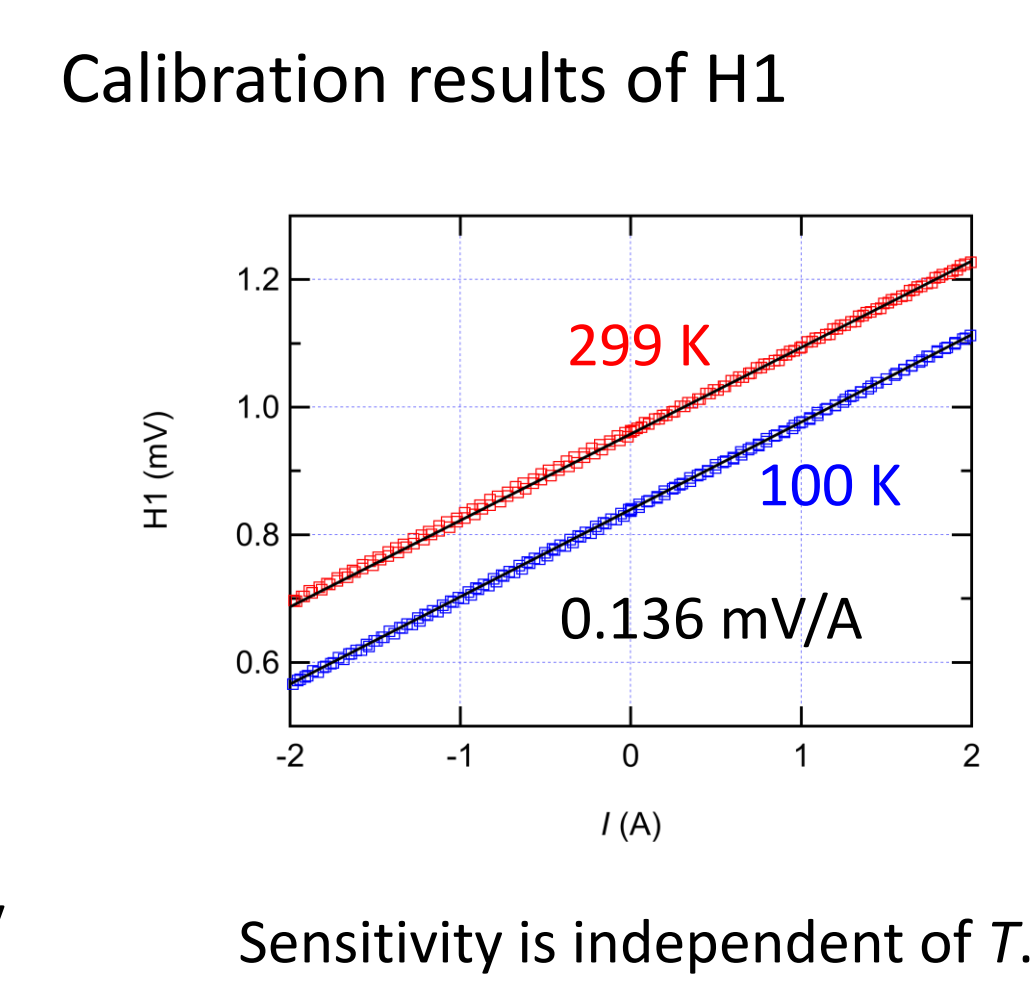
Loop current (I_{loop}) measurement



Side-view of a sample holder

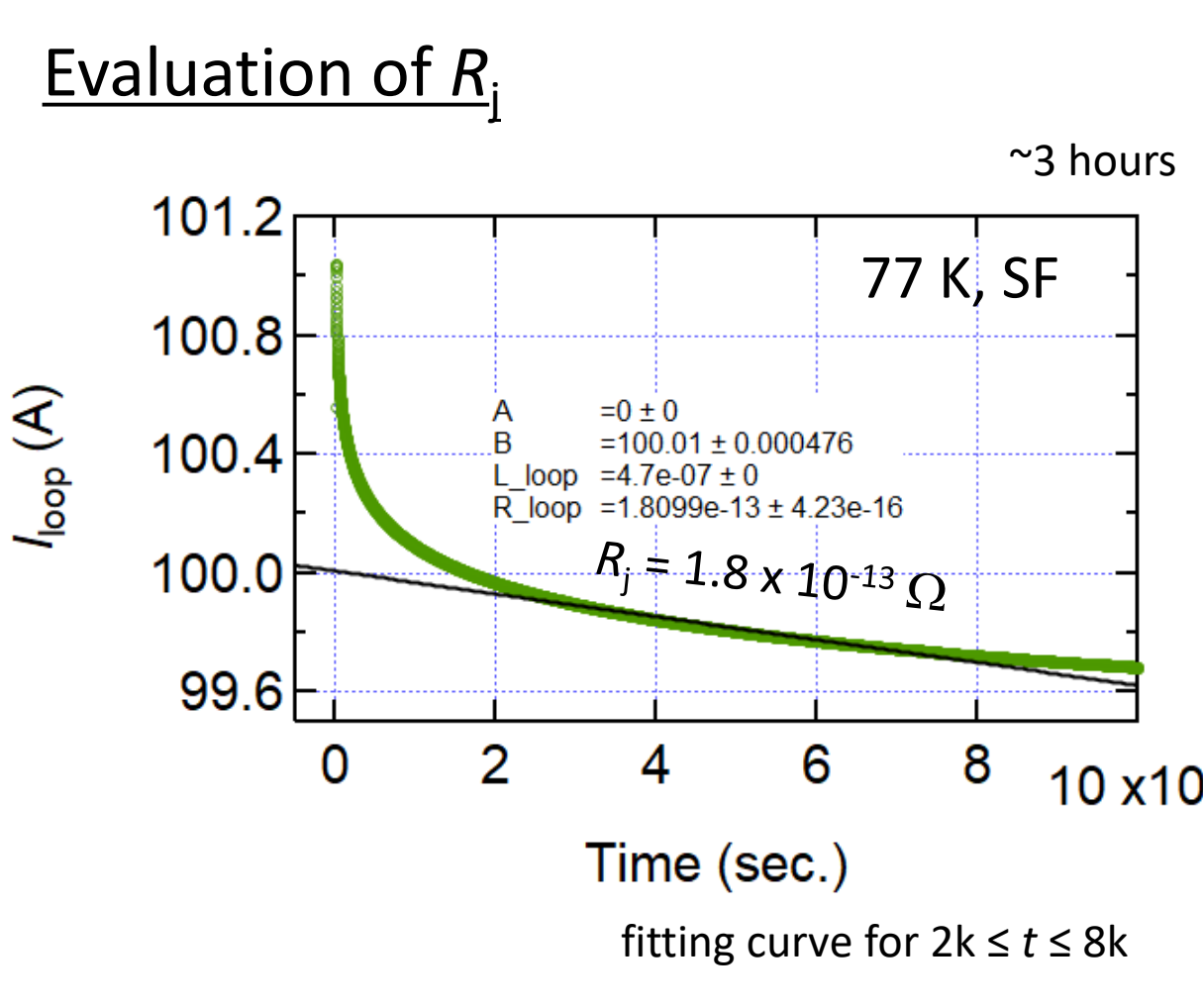
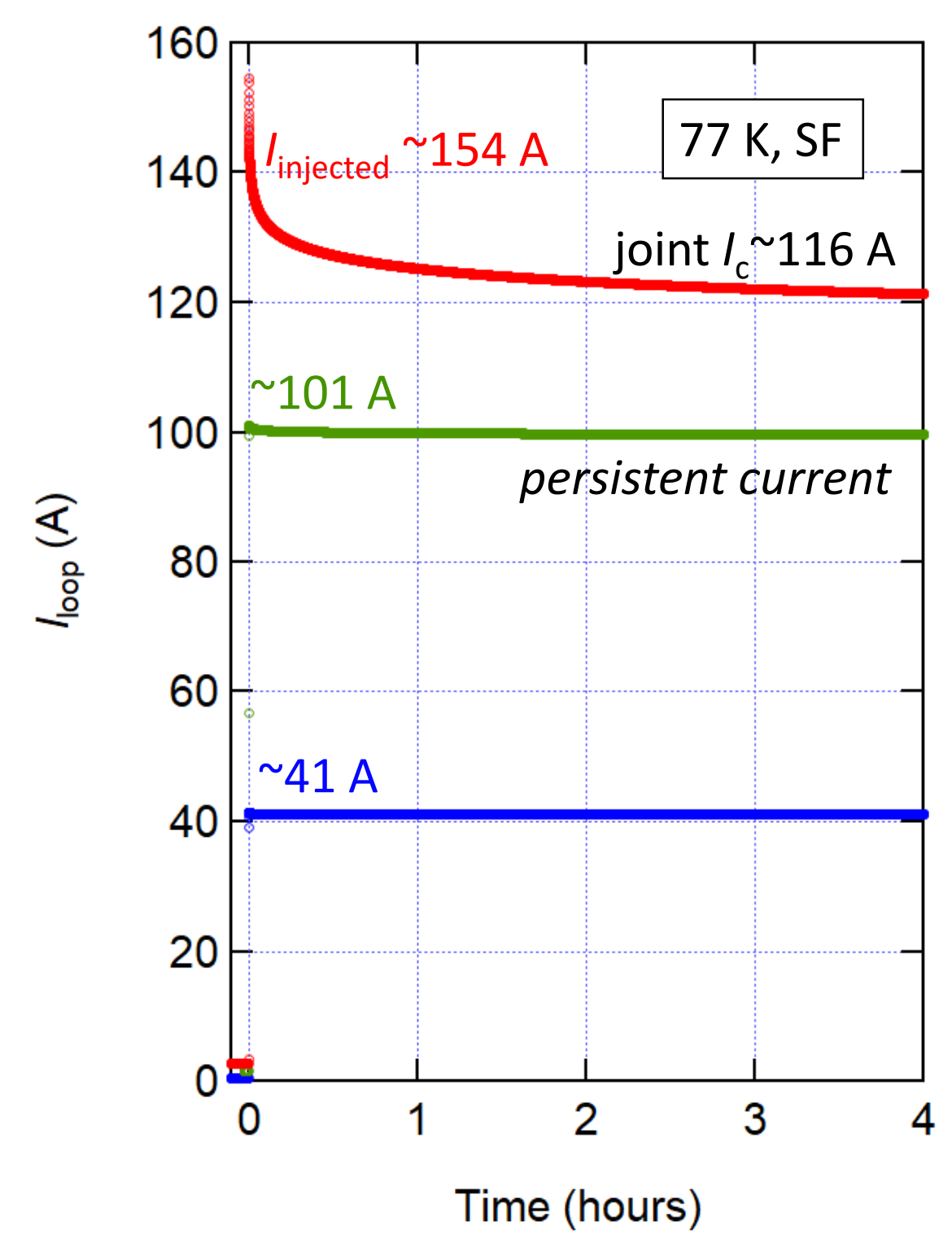


- ✓ Significant improvement in SNR.
- ✓ Injected current can be calibrated by Cu wire current.



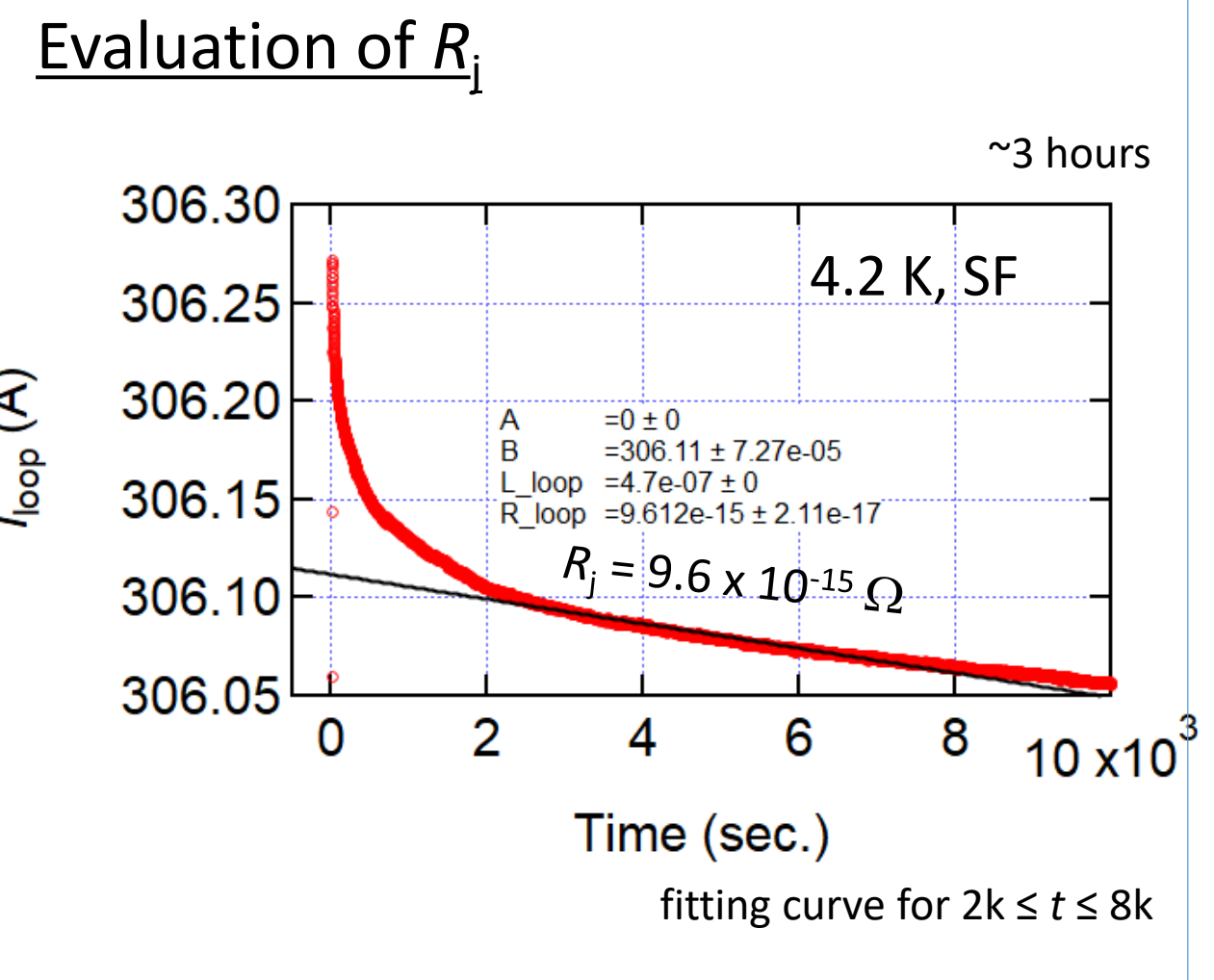
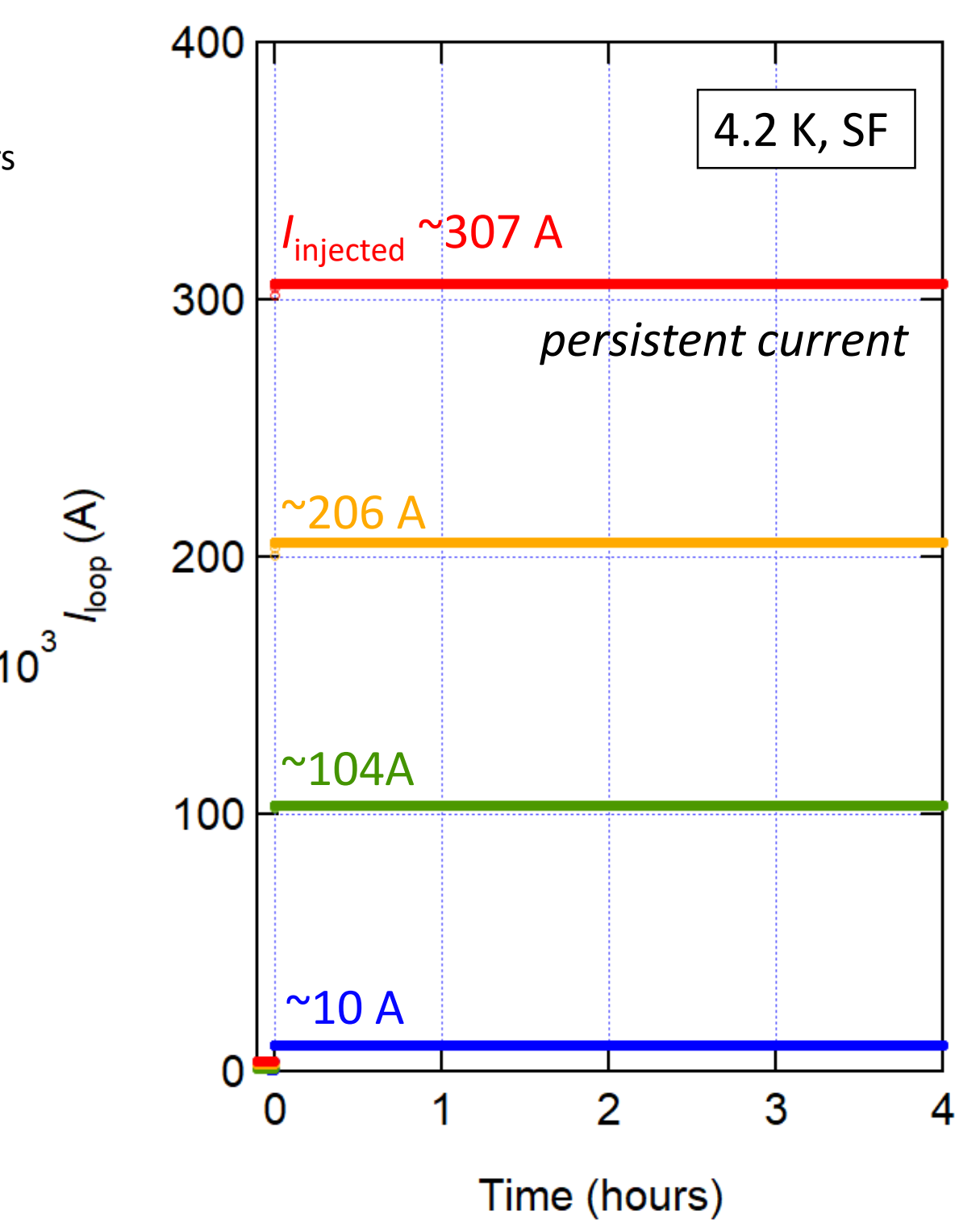
Evaluation Results

Current decay measurement at 77 K, SF



$I_{injected} \sim 100$ A@77 K, SF
 $R_j = 1.8 \times 10^{-13} \Omega$
joint $I_c \sim 116$ A

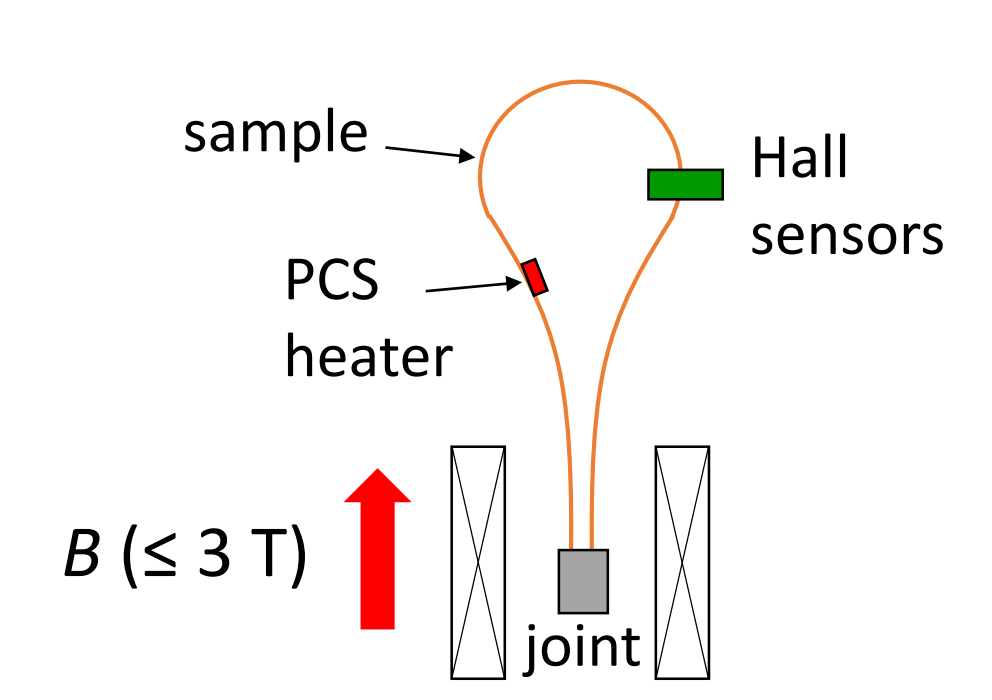
Current decay measurement at 4.2 K, SF



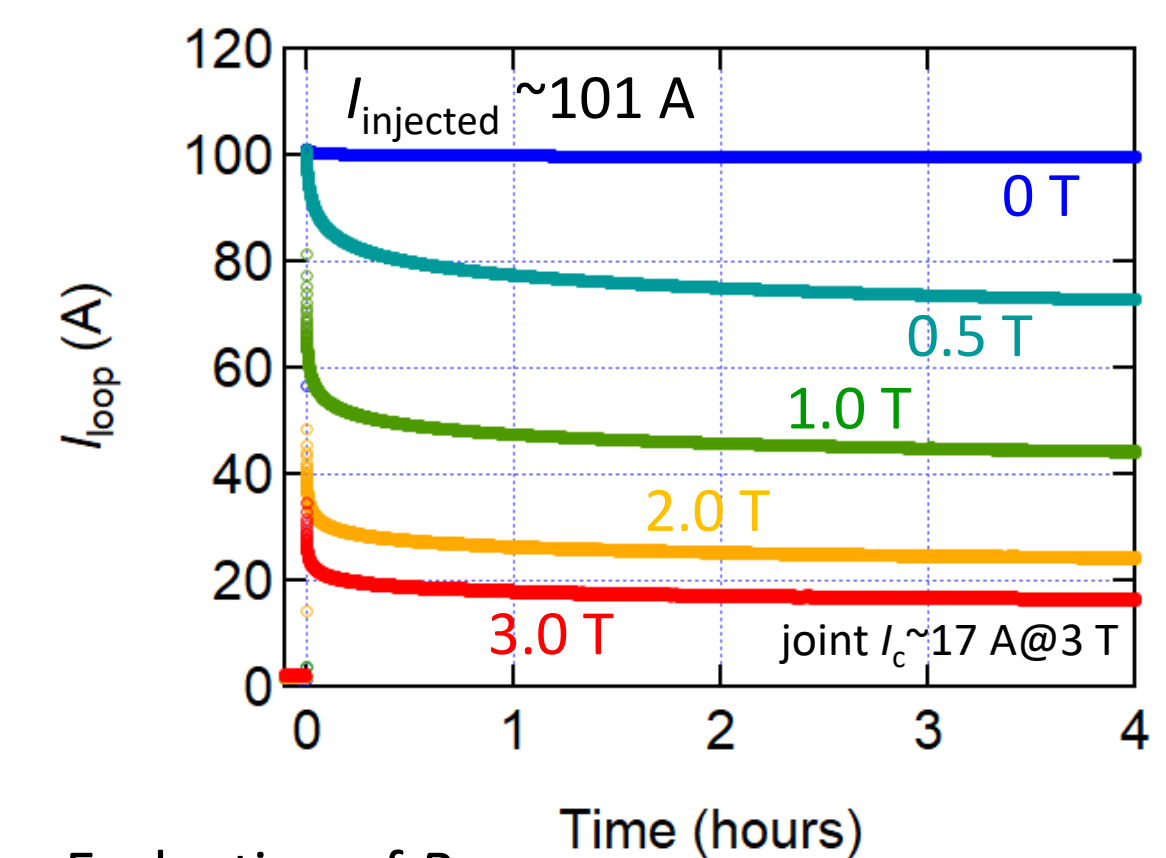
$I_{injected} \sim 300$ A@4.2 K, SF
 $R_j = 9.6 \times 10^{-15} \Omega$
joint $I_c \gg 307$ A

In-field R_j evaluation

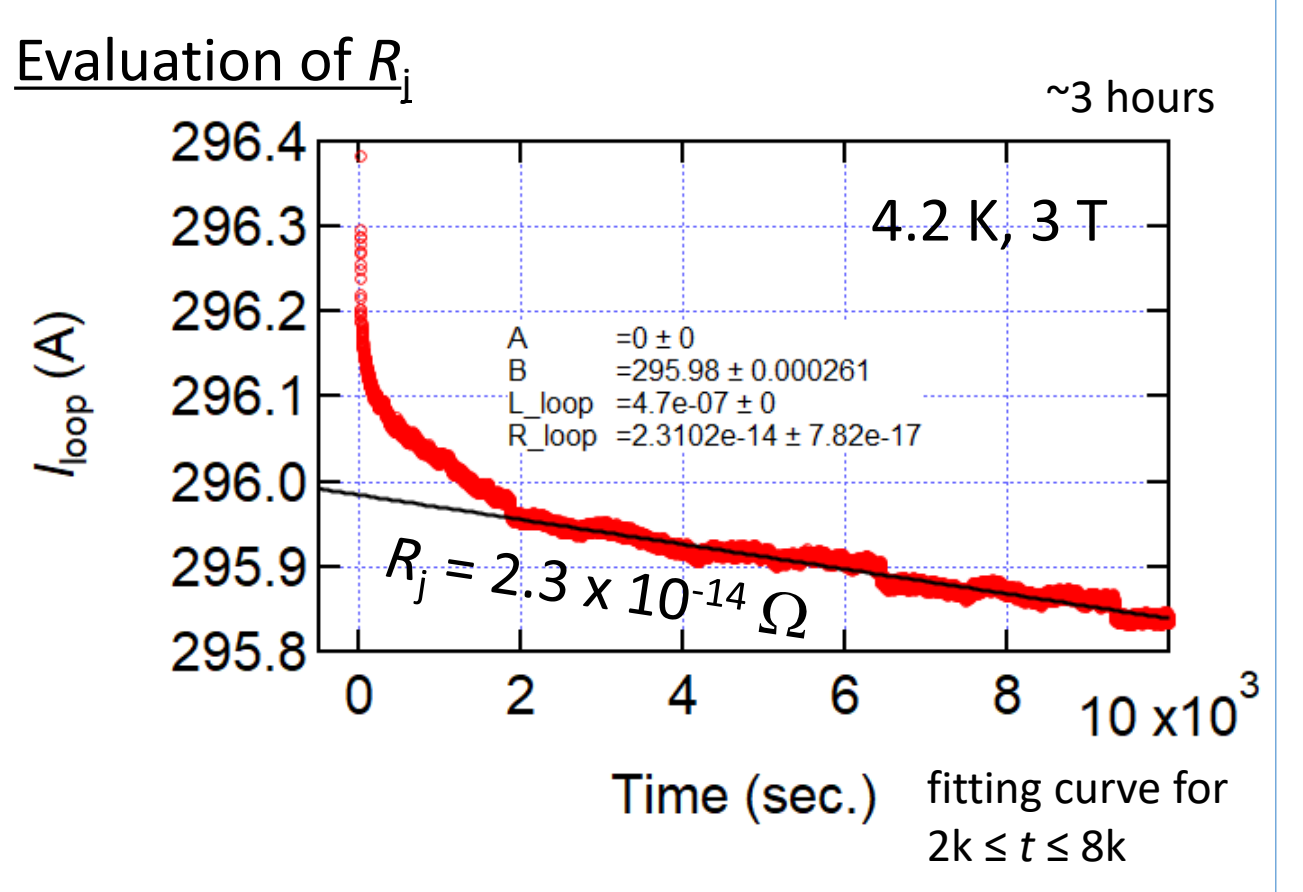
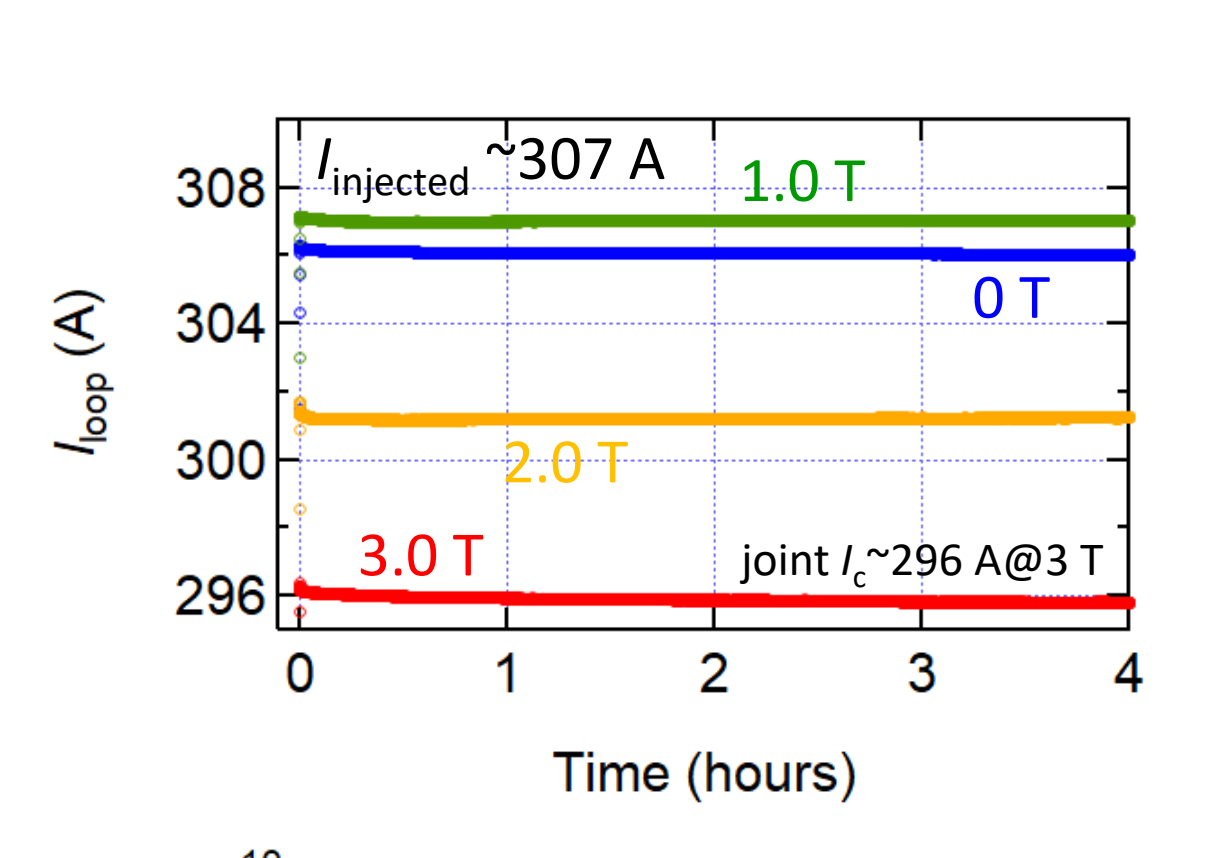
Sample settings



B-dependence at 77 K



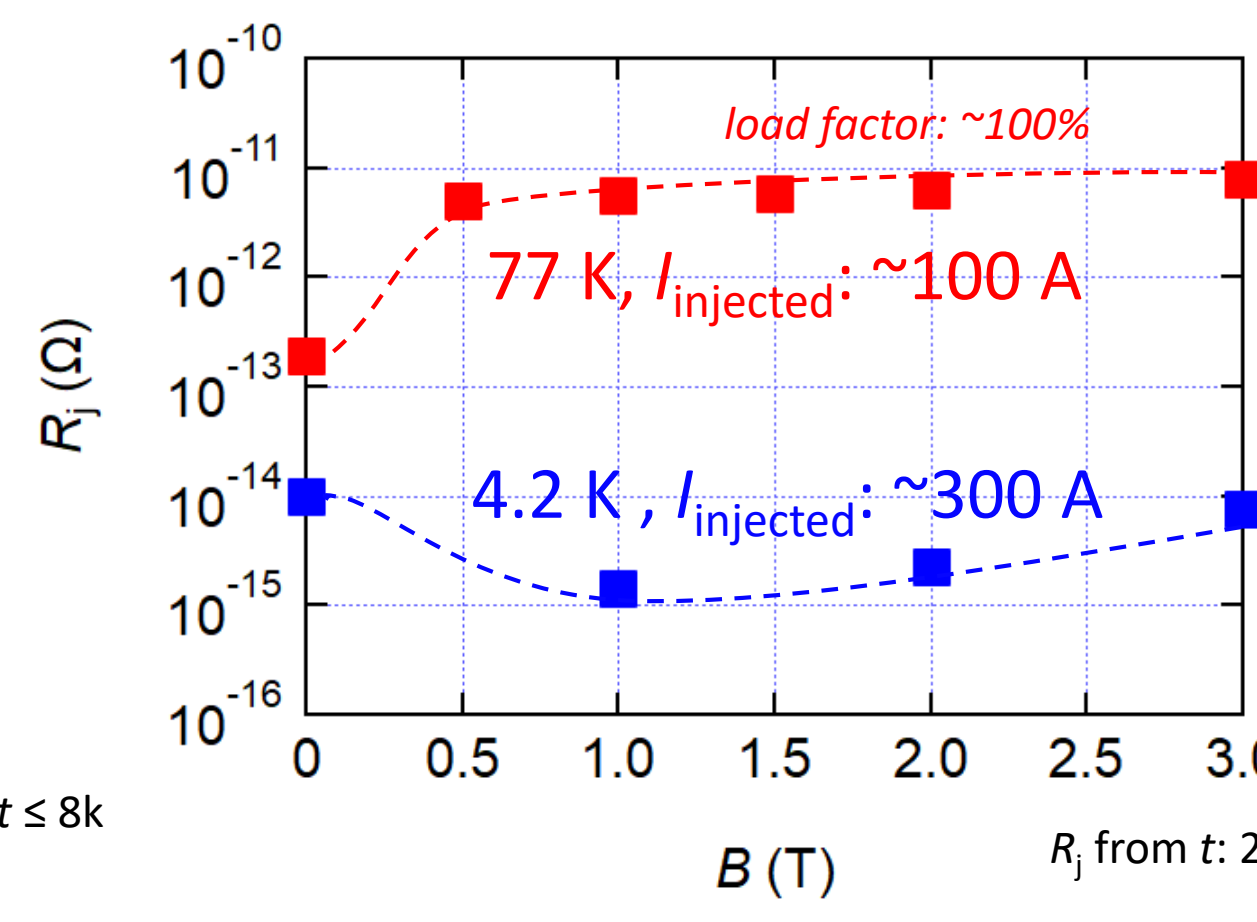
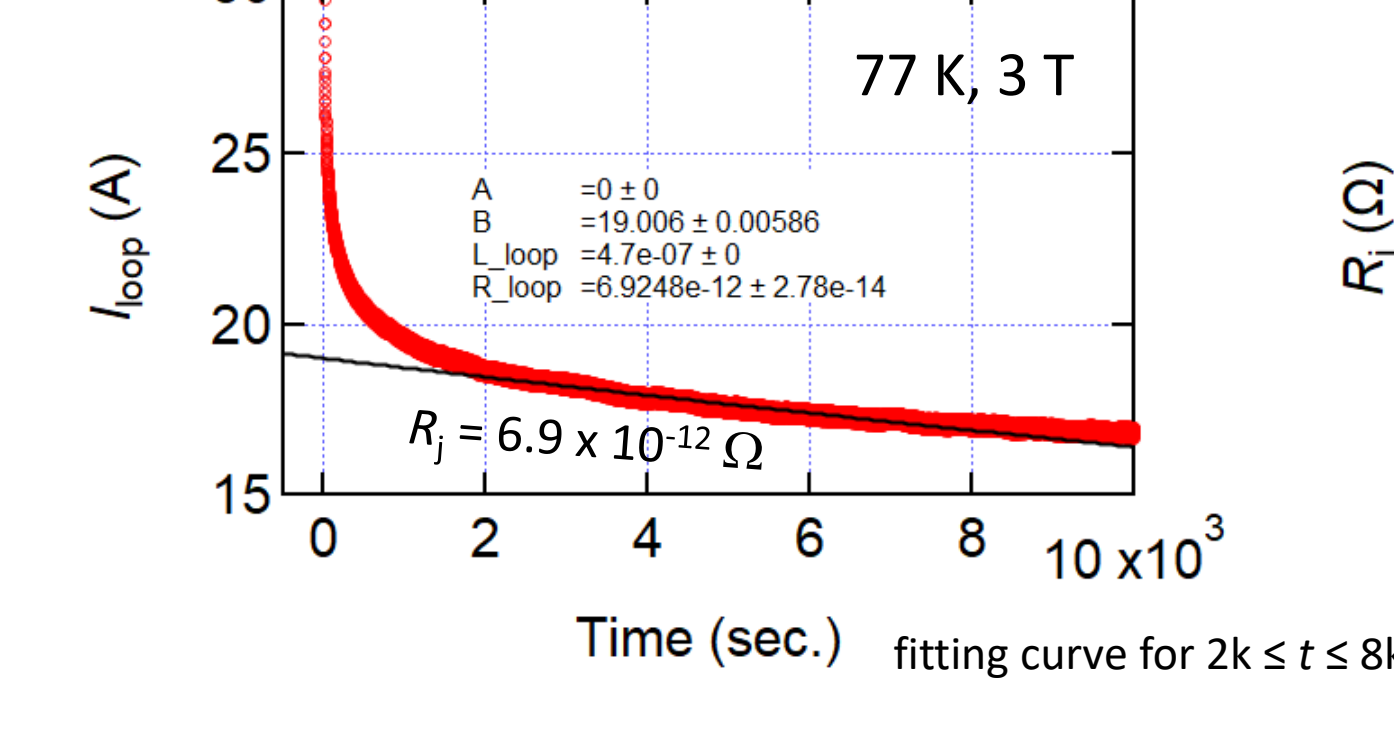
B-dependence at 4.2 K



77 K, $B \leq 3$ T, $R_j < 10^{-11} \Omega$

4.2 K, $B \leq 3$ T, $R_j \sim 10^{-14} \Omega$

Evaluation of R_j



Summary

- Evaluation of REBCO SC joint at $B \leq 3$ T**
- $I_{injected} \sim 100$ A, R_j of 10^{-13} Ω order successfully evaluated at 77 K.
 - At 4.2 K and 3.0 T, joint $I_c \sim 296$ A and $R_j = 2.3 \times 10^{-14}$ Ω were evaluated.

Joint I_c, R_j	77 K	4.2 K
I_c @SF	~ 116 A	$\gg 307$ A
R_j @SF	$1.8 \times 10^{-13} \Omega$	$9.6 \times 10^{-15} \Omega$
I_c @3 T	~ 17 A	~ 296 A
R_j @3 T	$6.9 \times 10^{-12} \Omega$	$2.3 \times 10^{-14} \Omega$

Acknowledgement

This work is based on results obtained from a project commissioned by JST-MIRAI Program Grant Number JPMJMI17A2, Japan.