Development of a Persistent Superconducting Joint between Bi-2212/Ag-alloy Multifilamentary Round Wires

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Outline

- **Background and motivation**
  - **Why Bi-2212?**
  - **Why do we need Bi-2212 superconducting joints?**
- **How can we make Bi-2212 superconducting joints?**
- **Choice of matrix for the superconducting joints**
- **Transport properties of the superconducting joints**
- **Microstructure of the superconducting joints**
- **Joint characterization with the field decay method**
- **Summary**

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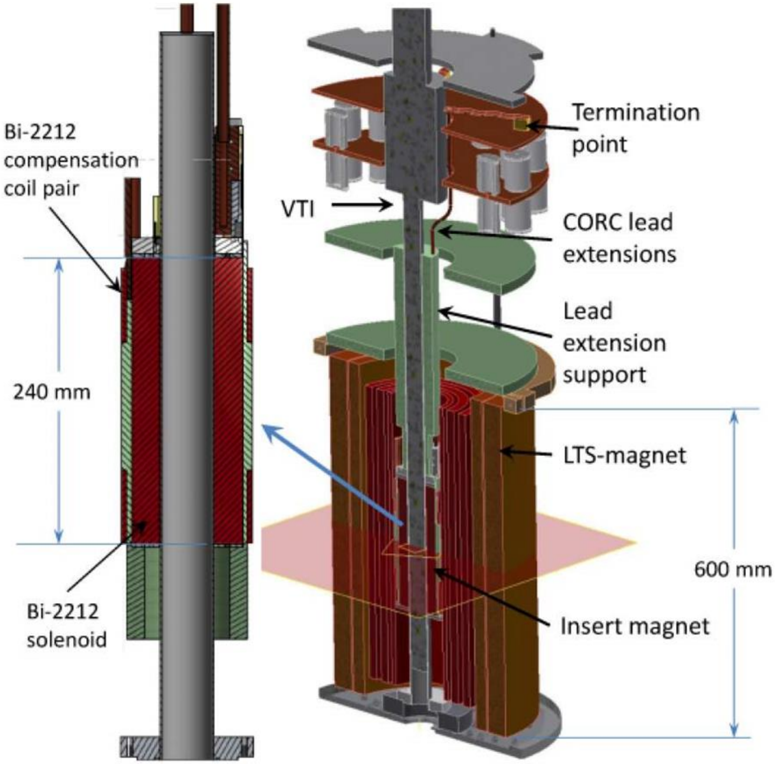
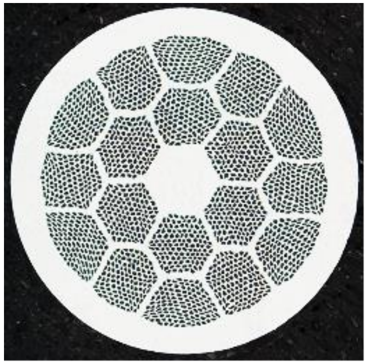
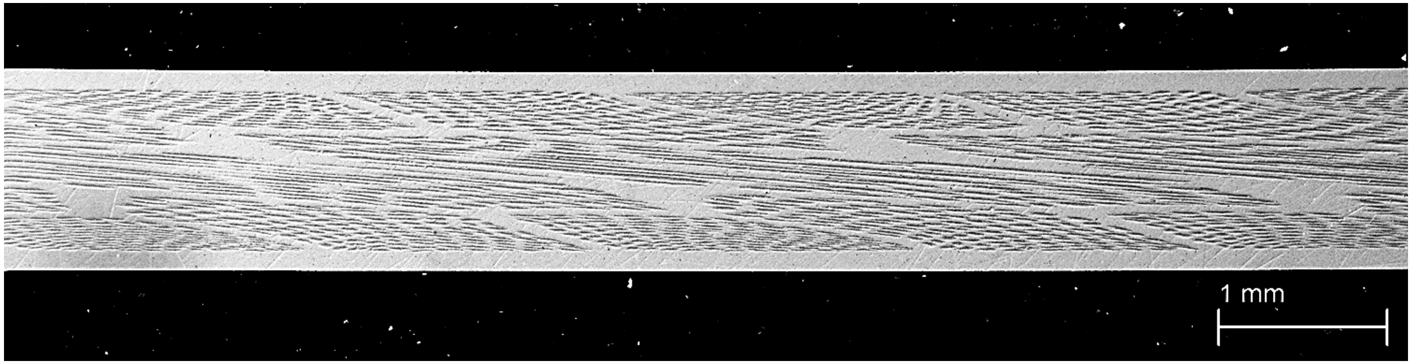
Why Bi-2212?

- **Round, multi-filamentary and without macroscopic electro-magnetic anisotropy.**
- **Twisted wire with significant reduction of hysteretic losses.**
- **A high irreversibility field above 100 T at 4.2 K.**
- **Overpressure (OP) processing makes J_e of Bi-2212 very competitive.**
- **Competitive conductor candidate for high field magnet applications.**



U. P. Trociewitz *et al.*, 2LPo2F-05





Why do we need Bi-2212 superconducting joints?

- NMR and MRI magnets require stringent field stability.
- Persistent current mode (PCM) operation is highly desired to achieve very stable magnetic field.
- Superconducting joints ($R < 10^{-11}\ \Omega$) are essential components of magnets to run in PCM.
- **Large HTS magnets typically have multiple electrical joints.**
- **To date, no practical HTS superconducting magnet has been operated in PCM.**
- **Compared to Bi-2223 and REBCO, it might be easier for Bi-2212 to achieve superconducting joints.**

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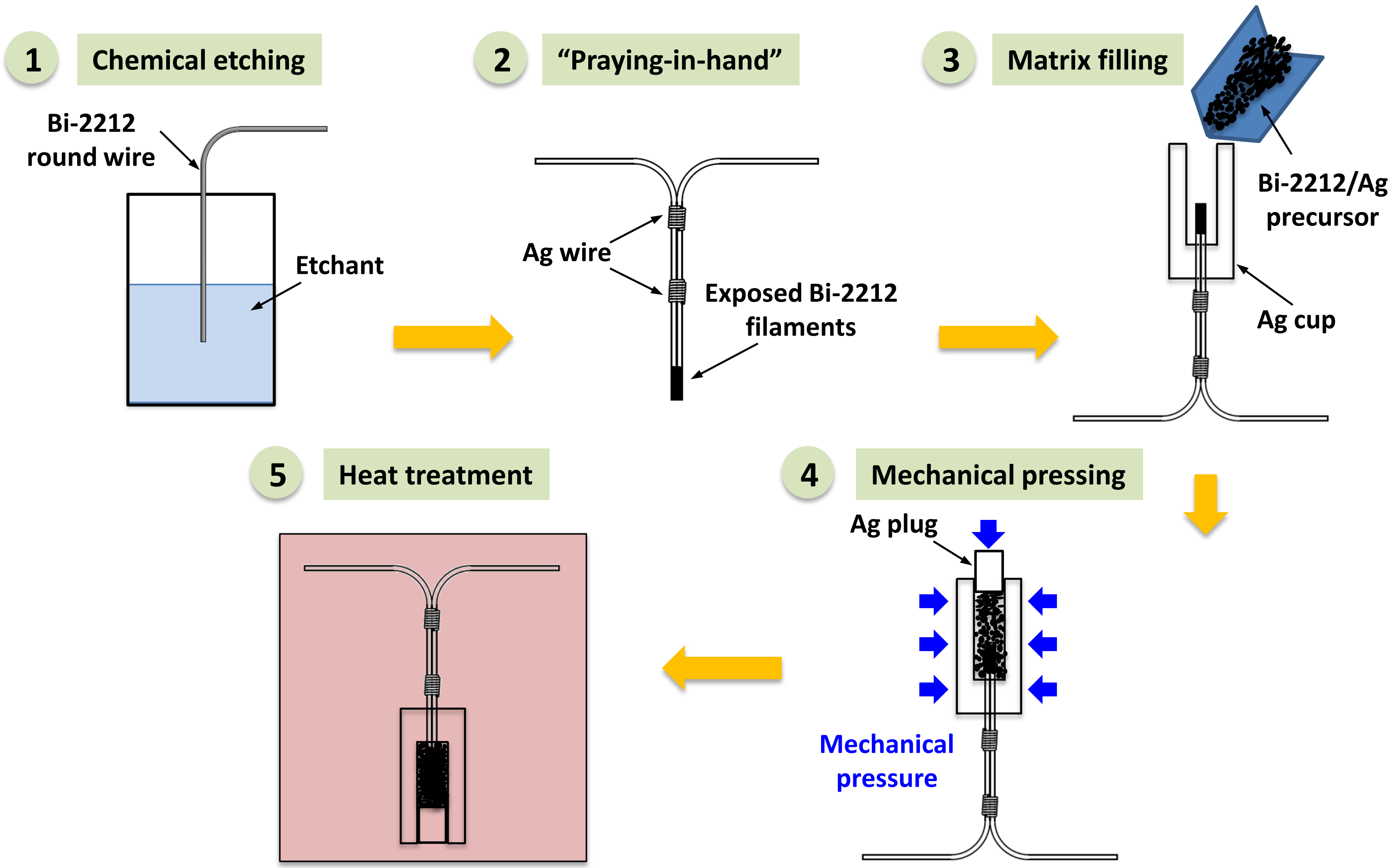
A practical Bi-2212 superconducting joint fabrication approach



1. U. P. Trociewitz, P. Chen *et al.*, US patent pending, FSU Ref.:15-131, March-2015.
2. P. Chen, U. P. Trociewitz *et al.*, manuscript submitted to SUST.

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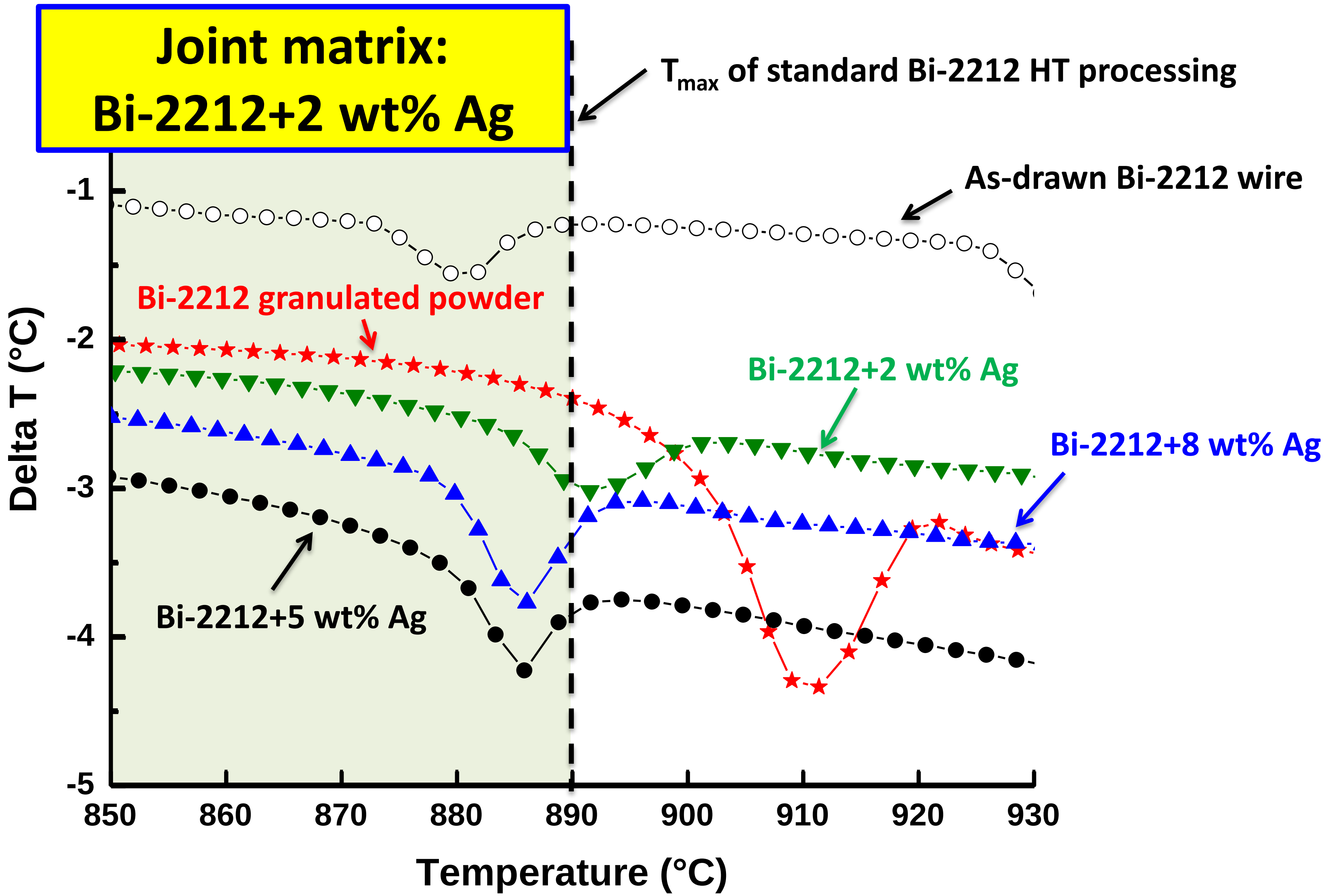
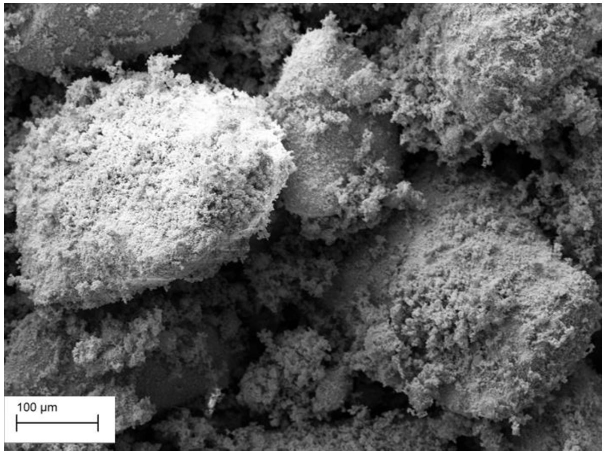
Can we adjust melting point with Ag additions?

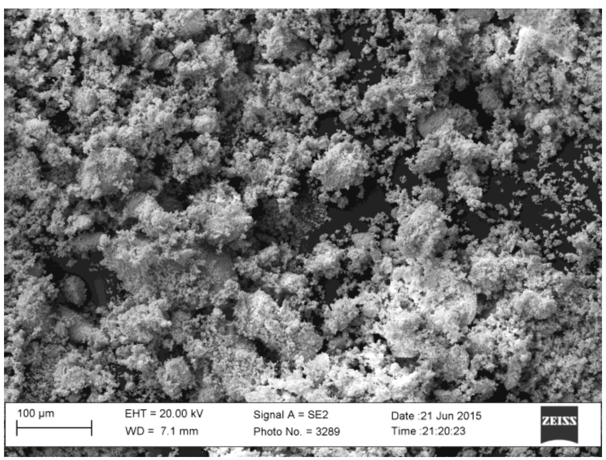


Nexans granulate Bi-2212 powder

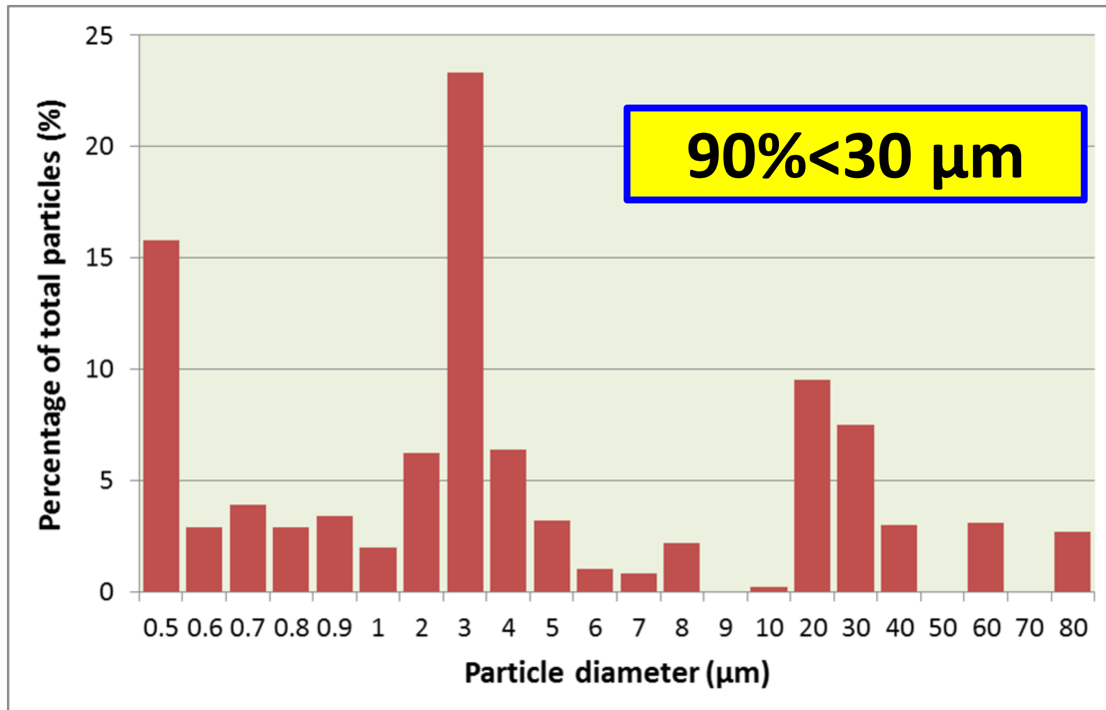


Adding Ag + Milling

Bi-2212 precursor with 2 wt% Ag



Fine particle size is needed for matrix surrounding Bi-2212 filaments



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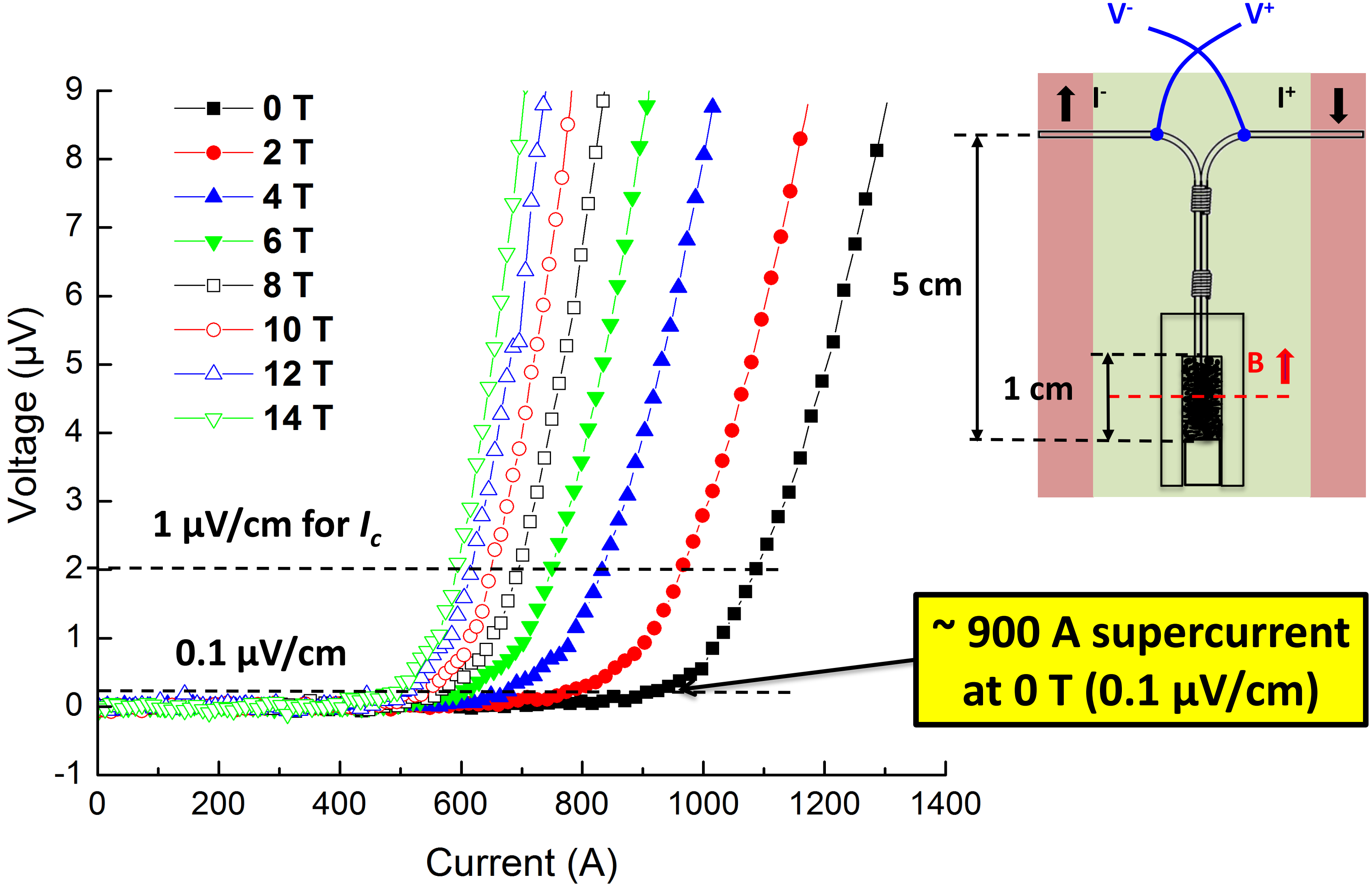
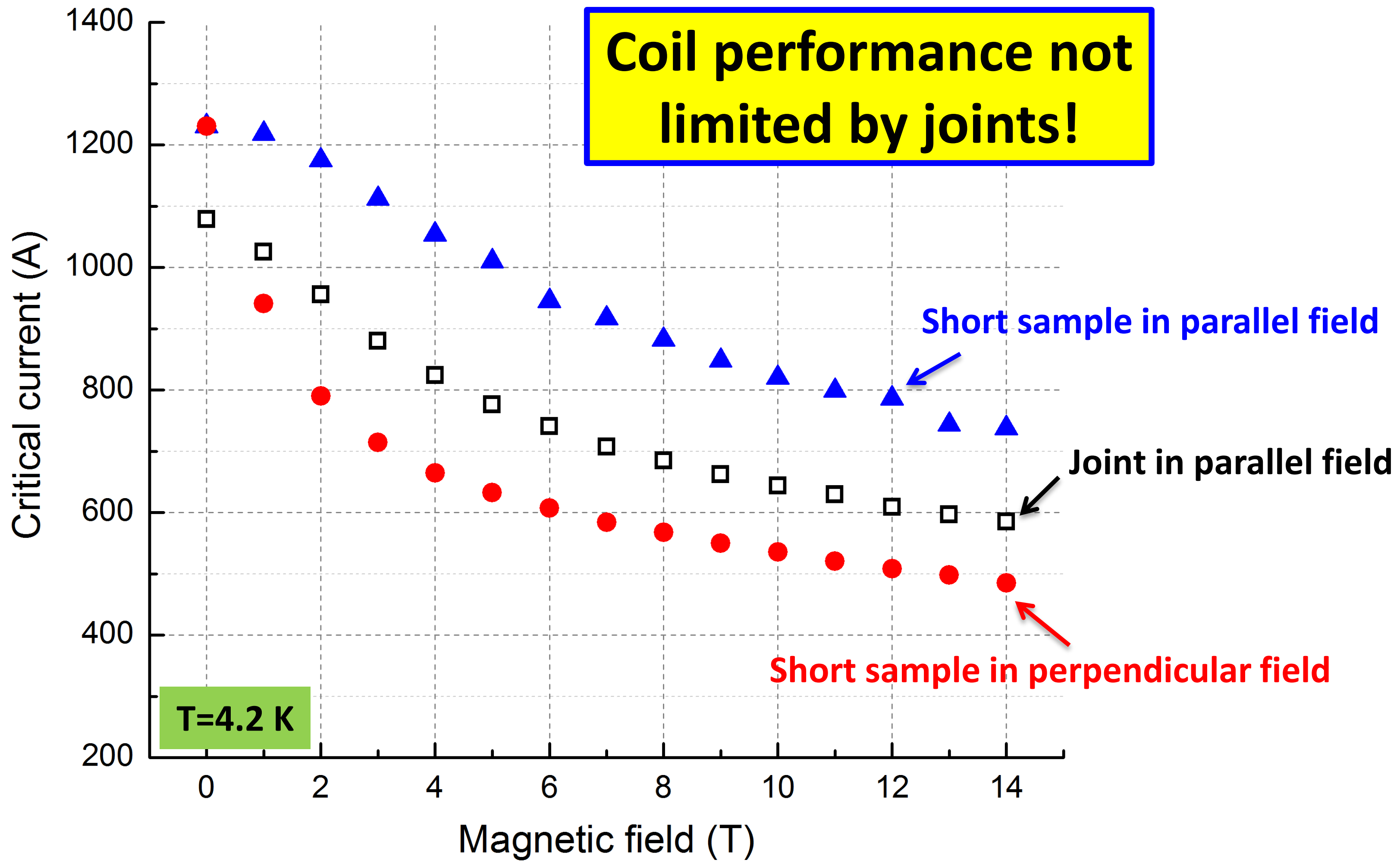
Bi-2212 superconducting joints present good superconducting in-field properties at 4.2 K



Coil transport performance is not limited by joints



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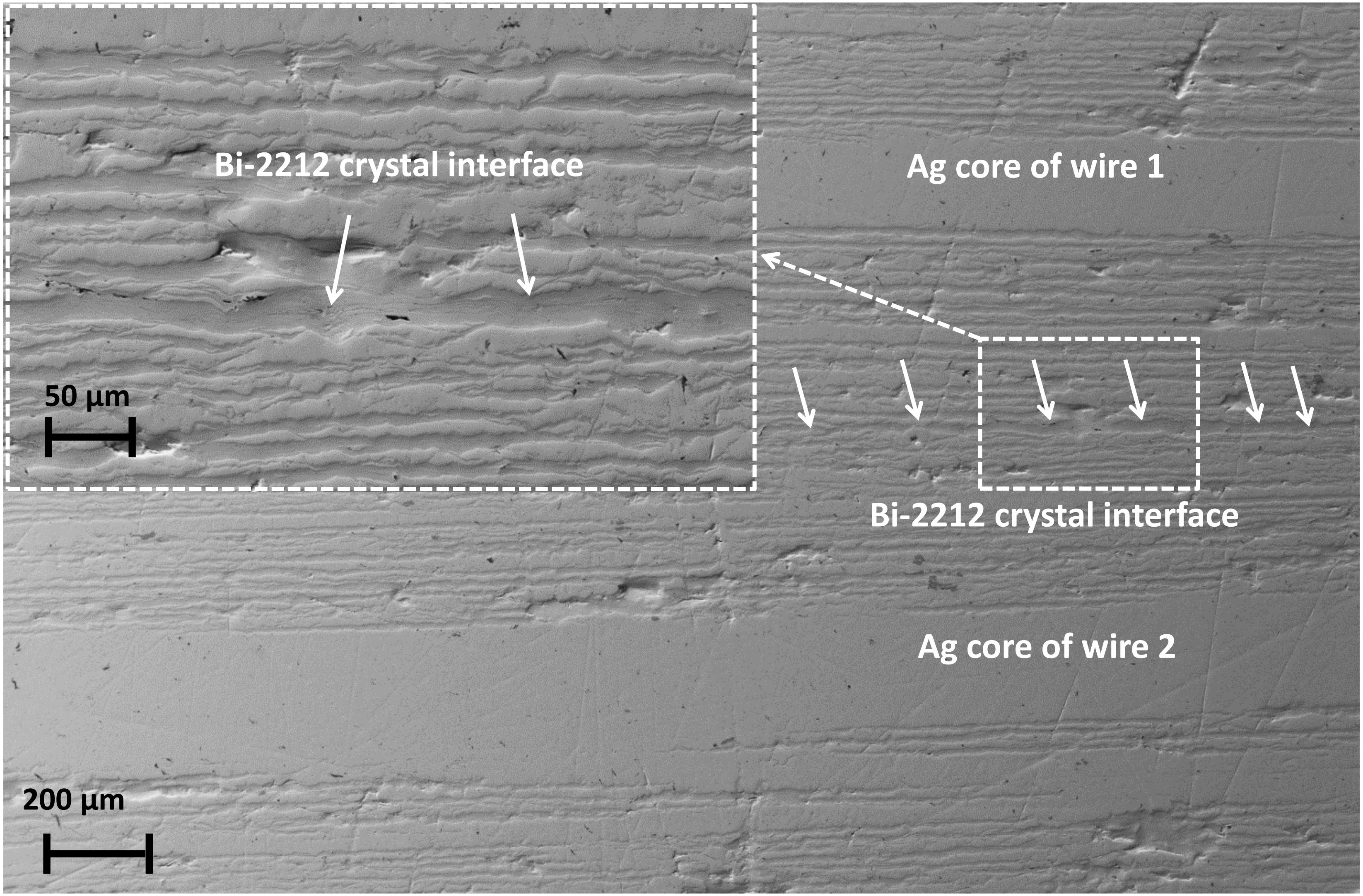
A continuous Bi-2212 superconducting interface is built up between the two wires



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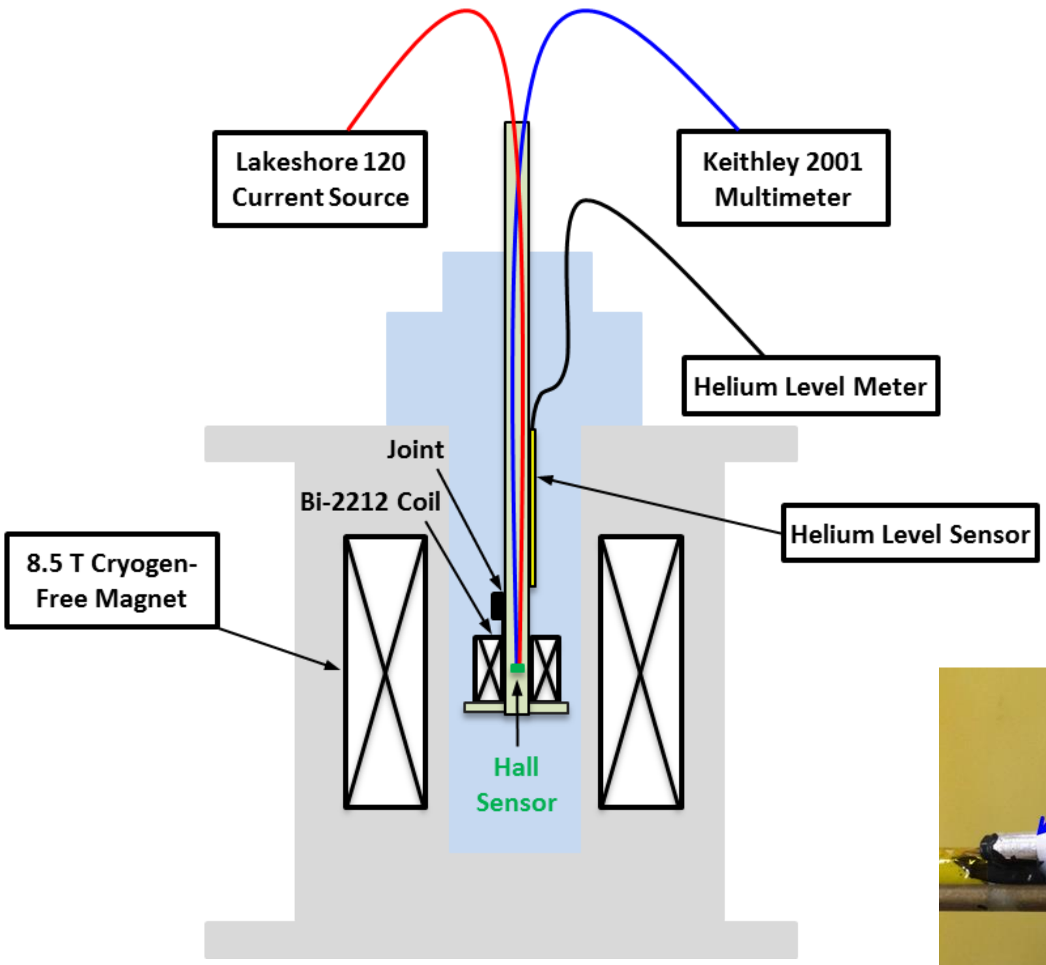
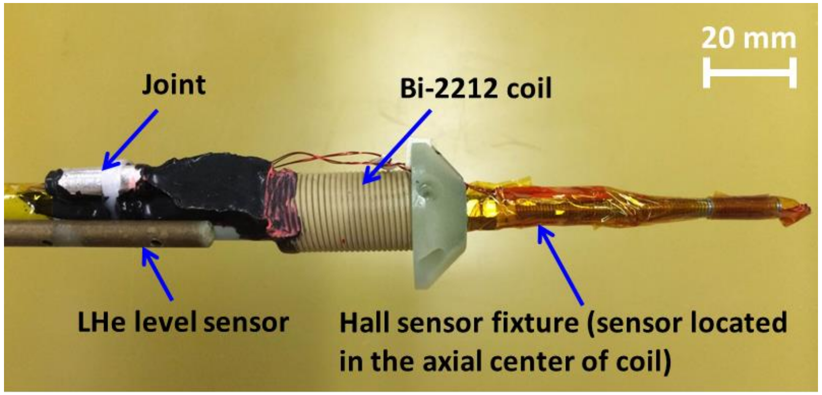
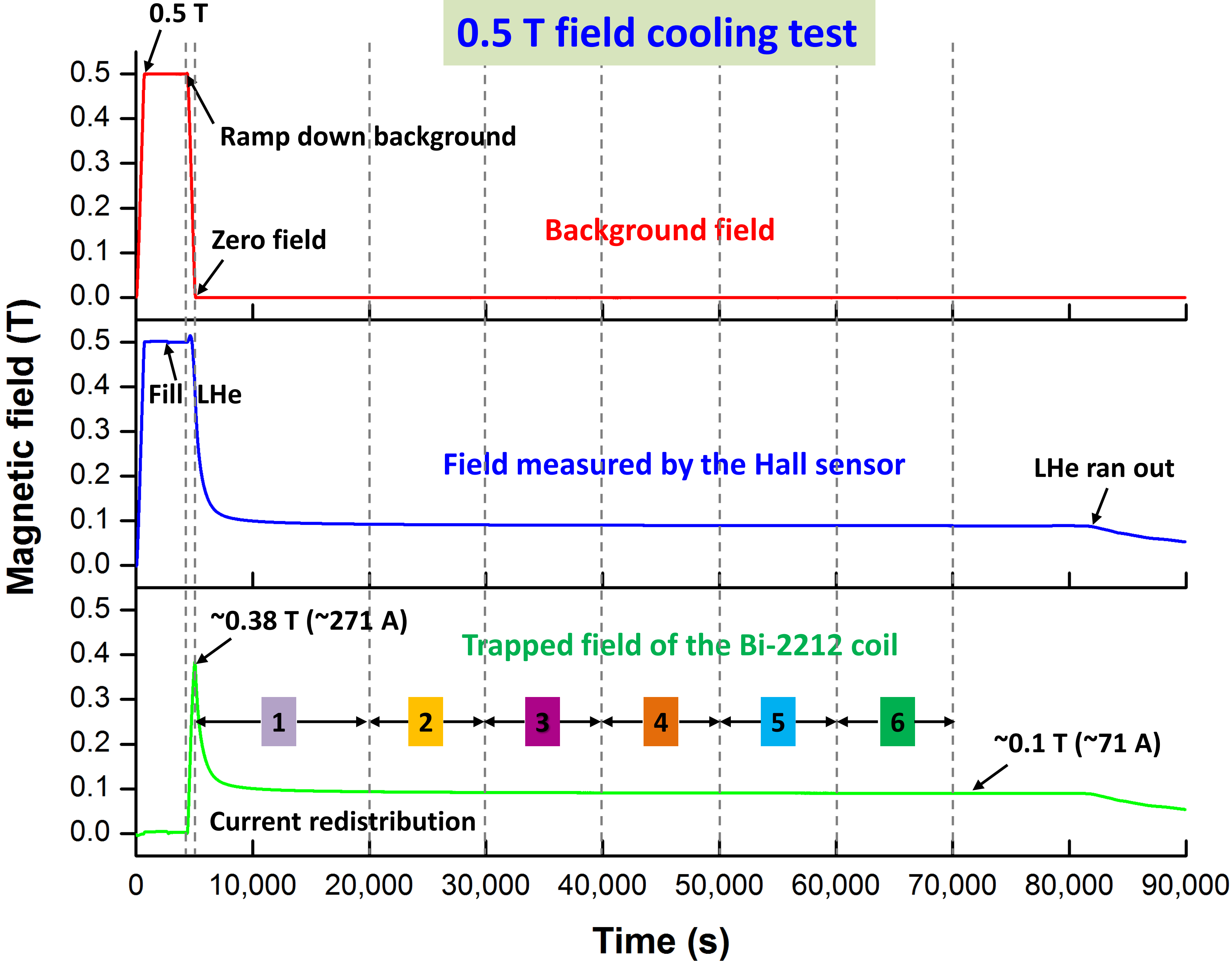
Characterization of joint resistance by the field decay method



Coil specification	
Conductor	Bi-2212 (1.3 mm dia.)
Insulation	TiO_2 (20 µm)
ID/OD	15/20.4 mm
Layer	2
Turns/Layer	25
Self inductance	15.3 µH
Conductor length	2.7 m
Heat treatment	1 bar

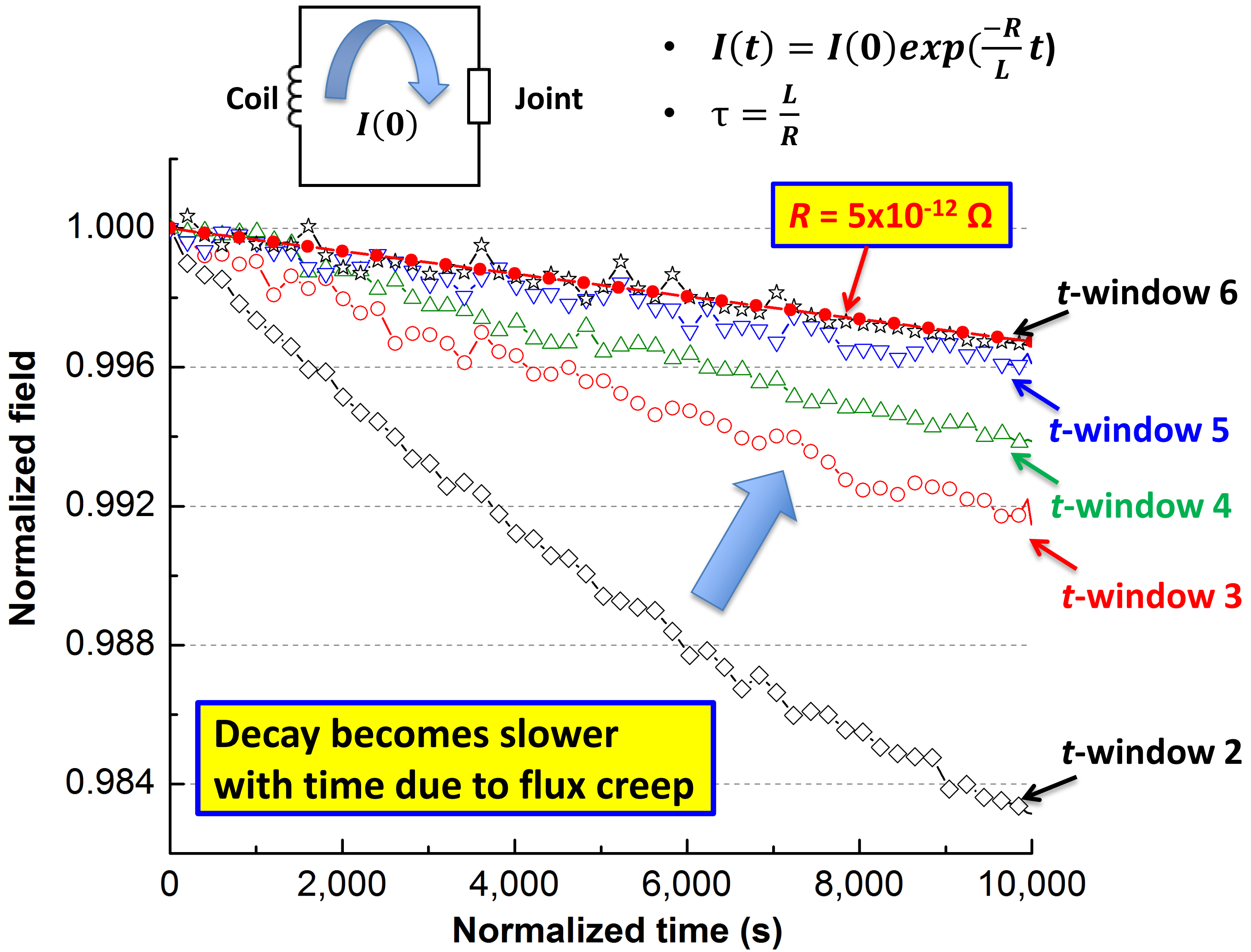


0.5 T field cooling test



R < 5×10^{-12} Ω in self-field at 4.2 K

- $I(t) = I(0)exp(\frac{-R}{L}t)$
- $\tau = \frac{L}{R}$



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1. **A superconducting joint between Bi-2212 round wires was developed for potential persistent operation of Bi-2212 coils.**
2. **Superconducting joints possessed good superconducting properties, *e.g.*, a critical supercurrent of ~900 A at 4.2 K and self-field (0.1 μV/cm).**
3. **The joint resistance was estimated to be below 5×10^{-12} Ω at 4.2 K and self-field.**
4. **Further developments include tests on overpressure (OP) processed joints/coils, design and test of Bi-2212 persistent current switch (PCS) and potential persistent operation of Bi-2212 coils.**

Thank you for your attention!

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