TECHNISCHE UNIVERSITÄT WIEN

ATOMINSTITUT

PRD-3.HTS.01-T021

Radiation damage in HTS

M. Eisterer, A. Bodenseher, D. Hofmann

Atominstitut, TU Wien
Stadionallee 2, 1020 Vienna, Austria

WPMAG final meeting, January 16th 2025

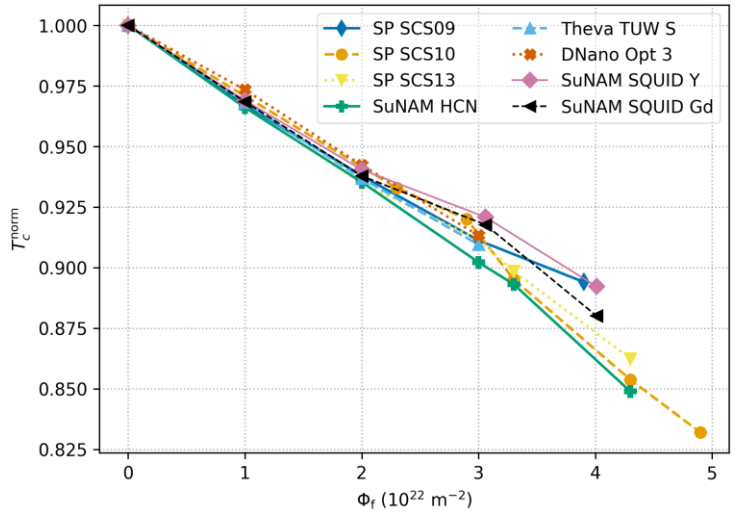
Outline (Task Specifications)

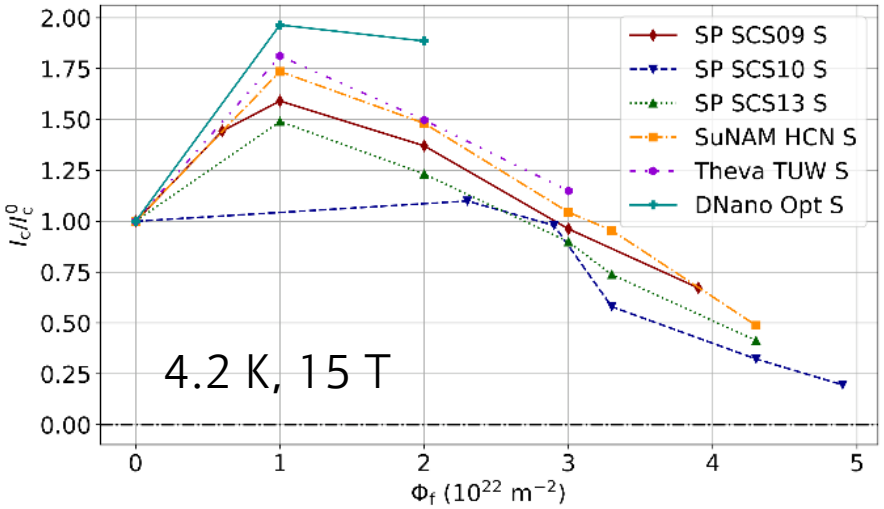
1) **Irradiation and characterization of commercial coated conductors**
2) **Nb_3Sn wires at very high fluences**
3) **Recovery of the superconducting properties via thermal treatment and observing defect mobility via in situ measurements**
4) **Hot spot formation in coated conductors**

1) Irradiation and characterization of commercial coated conductors

Irradiation step: **10^{22} m^{-2}** (E>0.1 MeV)

- Old sample set (SuNAM, SuperPower and Theva)



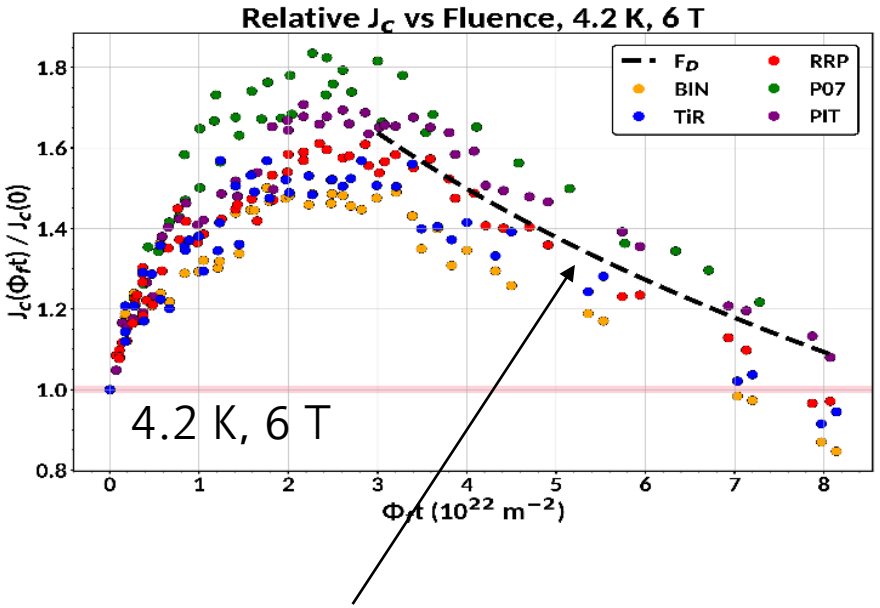


- New samples: Fujikura, Faraday Factory, SuperPower, Shanghai Superconductor (Eu-123)
  6 sets: 0, 10^{22} m^{-2}, 2· 10^{22} m^{-2}, 3· 10^{22} m^{-2}, 4· 10^{22} m^{-2}, 5· 10^{22} m^{-2}, not yet characterized

2) Nb_3Sn wires at very high fluences

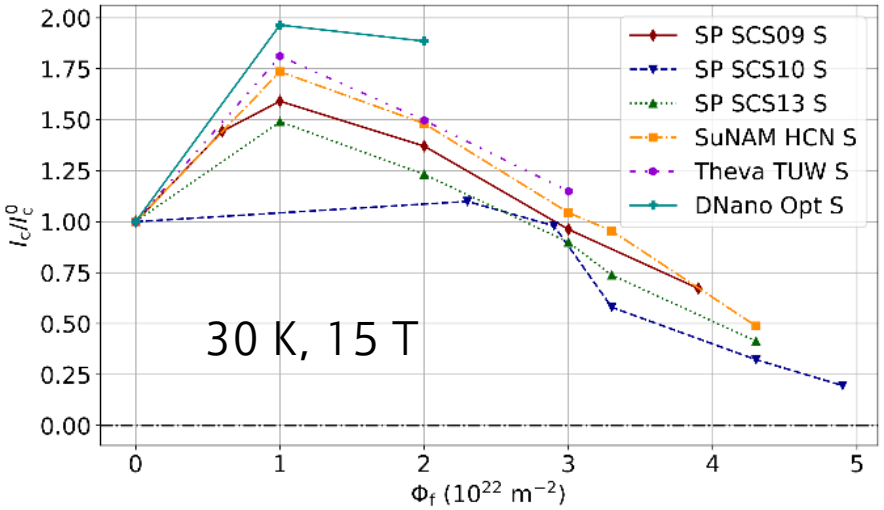
Irradiation step: **10^{22} m^{-2}** (E>0.1 MeV) 2 steps!

Nb_3Sn wires (magnetization)a



Description with degradation model
M. Eisterer et al. SuST **38** (2025) 10LT01

RE-123 tapes (transport)



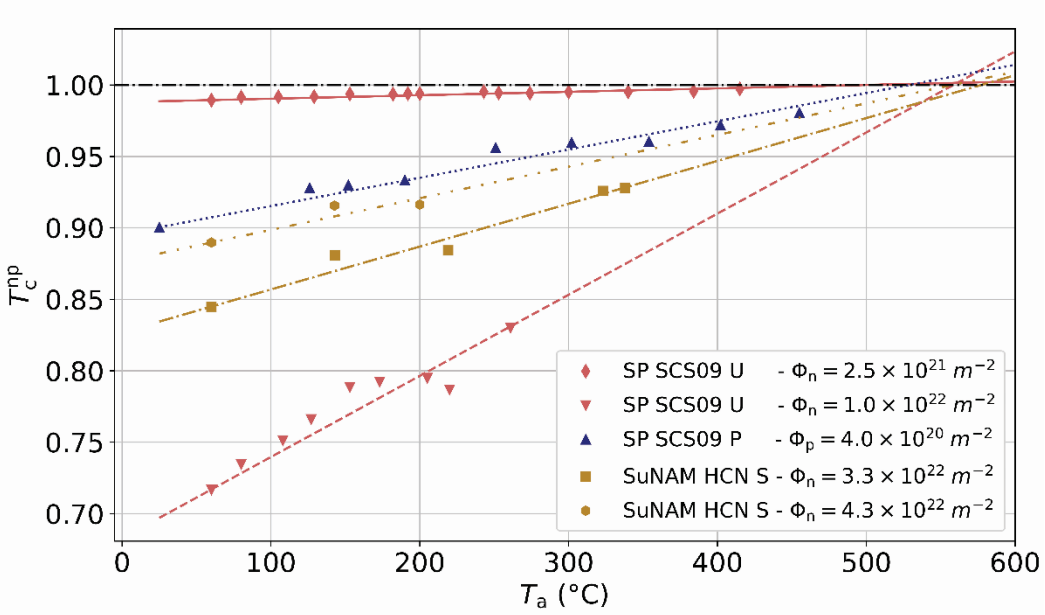
Similar behavior:

- Increase of J_c: improved pinning
- Degradation: Scattering of charge carriers (reduction in superfluid density)

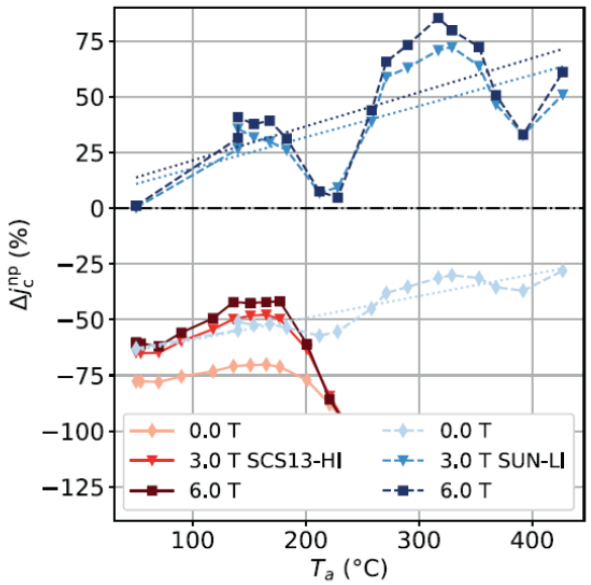
3) Recovery of the superconducting properties via thermal treatment and observing defect mobility via in situ measurements

Annealing in steps: 12 h, pure oxygen

Transition temperature (reduction of scattering)



Critical current (recovery of superfluid density)



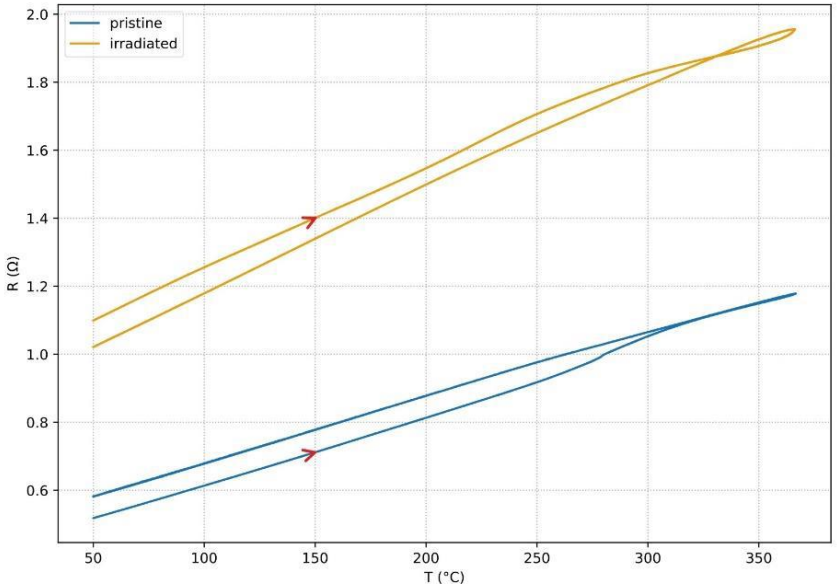
R. Unterrainer et al., SuST 35 (2022) 04LT01

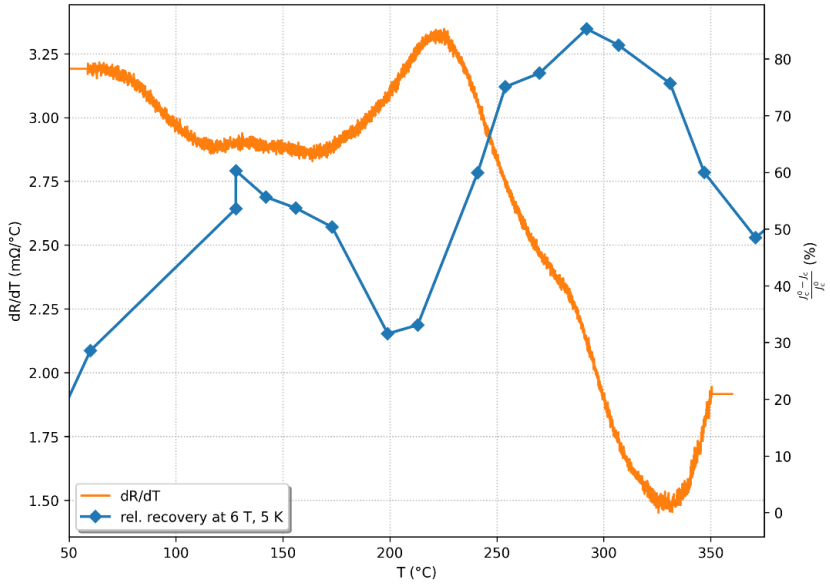
Which defects heal at which temperature? Effect on superconducting properties?

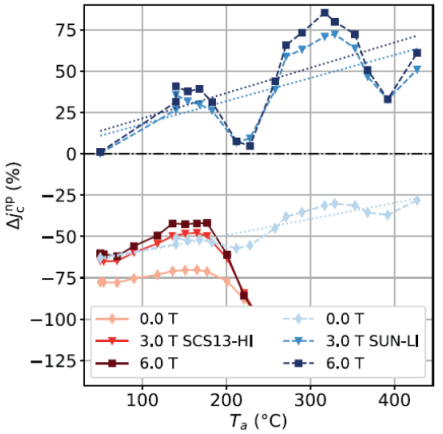
3) Recovery of the superconducting properties via thermal treatment and observing defect mobility via in situ measurements

In situ annealing, 0.8 K/min;

Superpower SPSCS4050-2009:
irradiation → ΔT_c = -9 K, annealing → ΔT_c = -9 K, annealing







Strong correlation between changes in resistivity and critical current.
To be done: comparison with defect mobility (simulations) or microstructure.

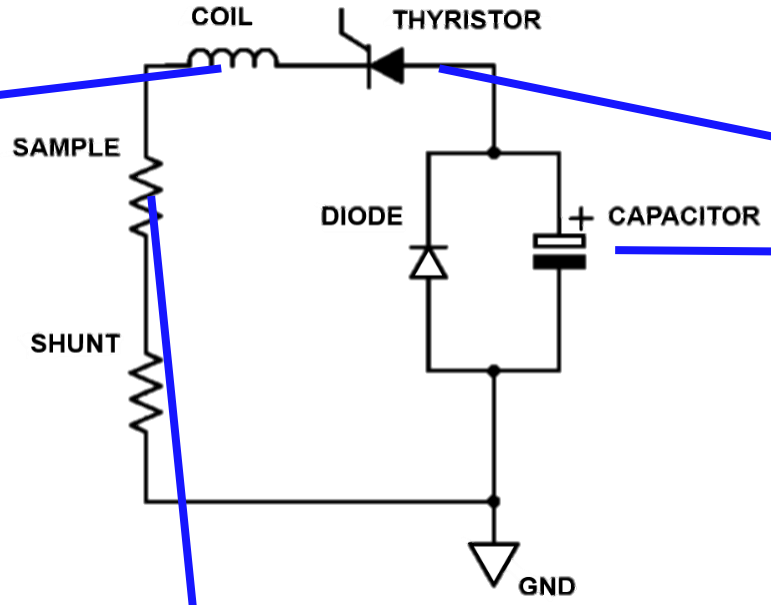
4) Hot spot formation in coated conductors

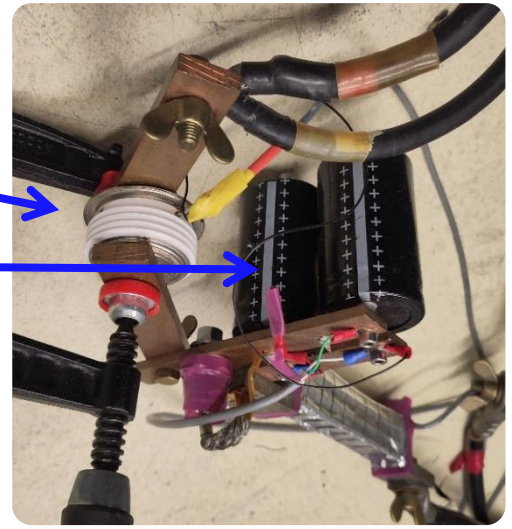
New scanning probe measurement (SPM) setup:

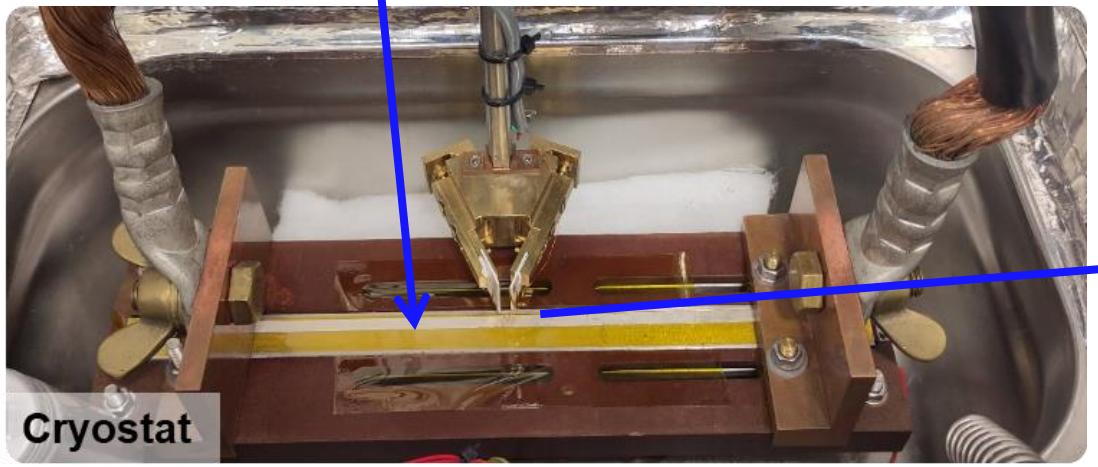
- Mapping space and time resolved hot spot formation
  - Local voltage (voltage taps)
  - Local current from local field (Hall probe)
  - Local power dissipation
  - Comparison with modelling (relevant parameters)
  - Influence of neutron irradiation

D. Kwon et al.
doi: 10.1109/TASC.2020.2976962

Generation of current pulse







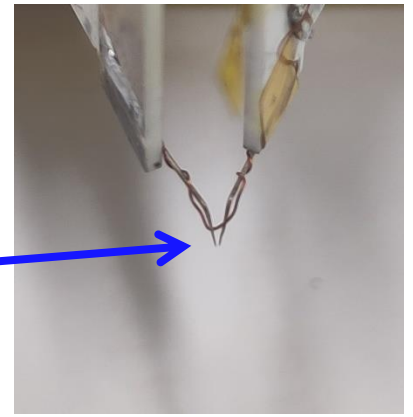
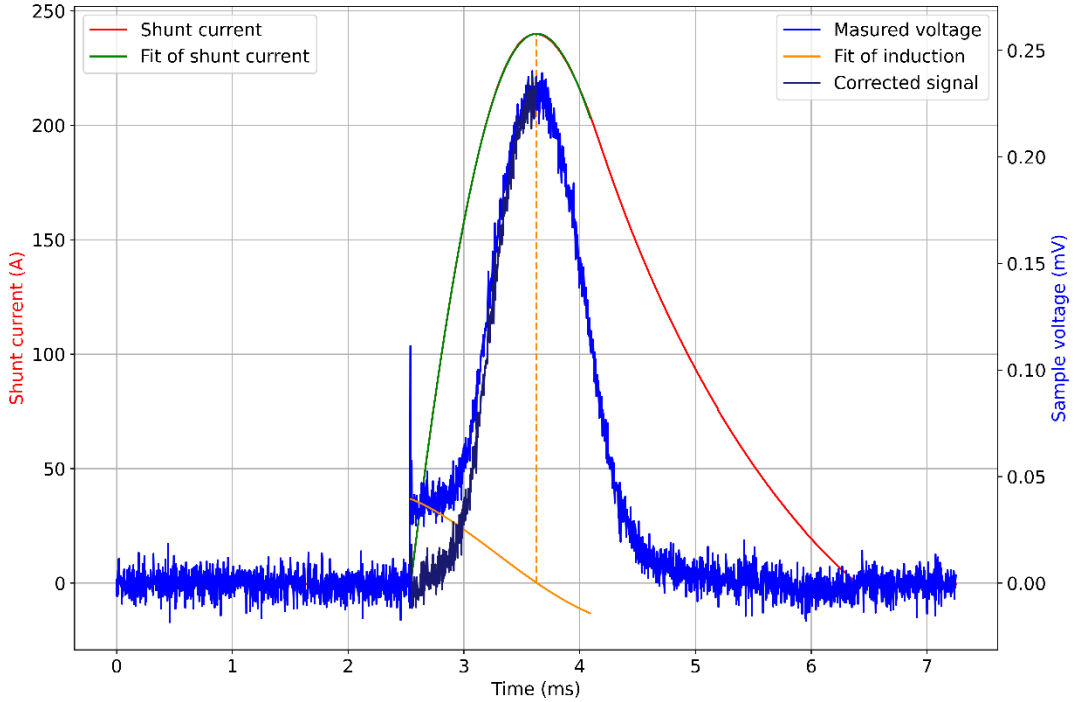


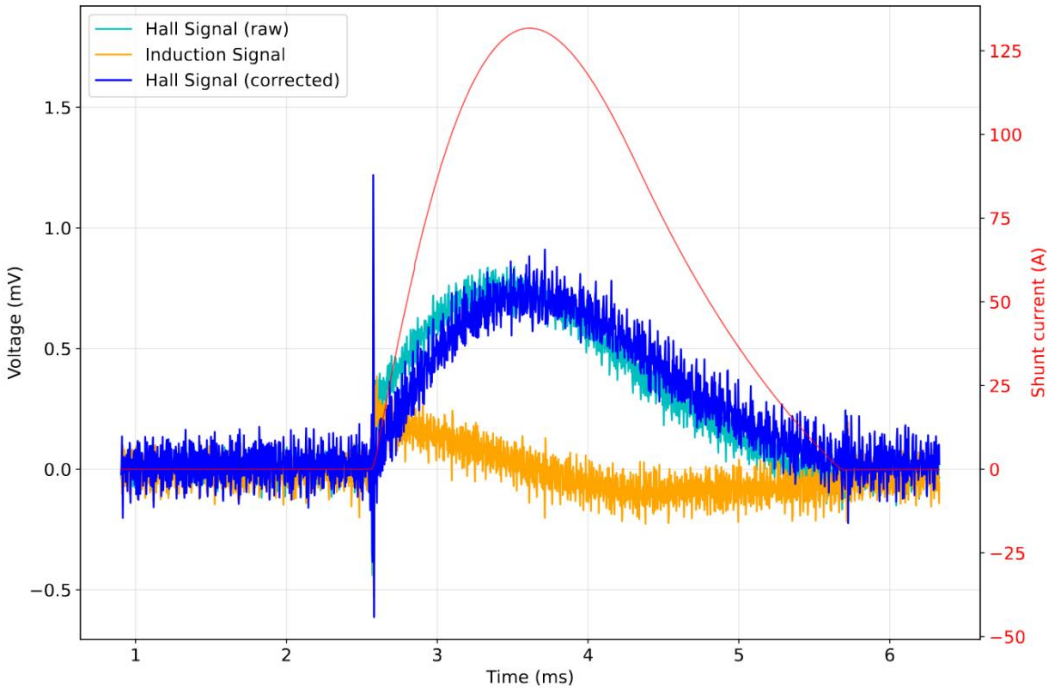
Figure 3: EFS-Probe tips with

4) Hot spot formation in coated conductors

Resistitve voltage



Hall voltage



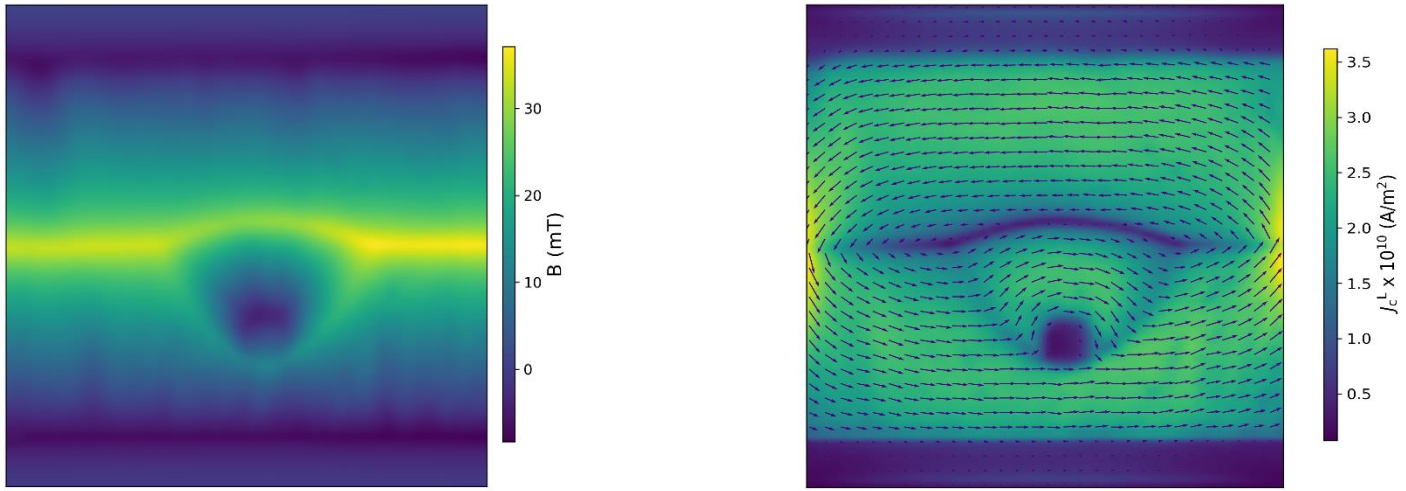
Correction of induction voltage is important!

First results

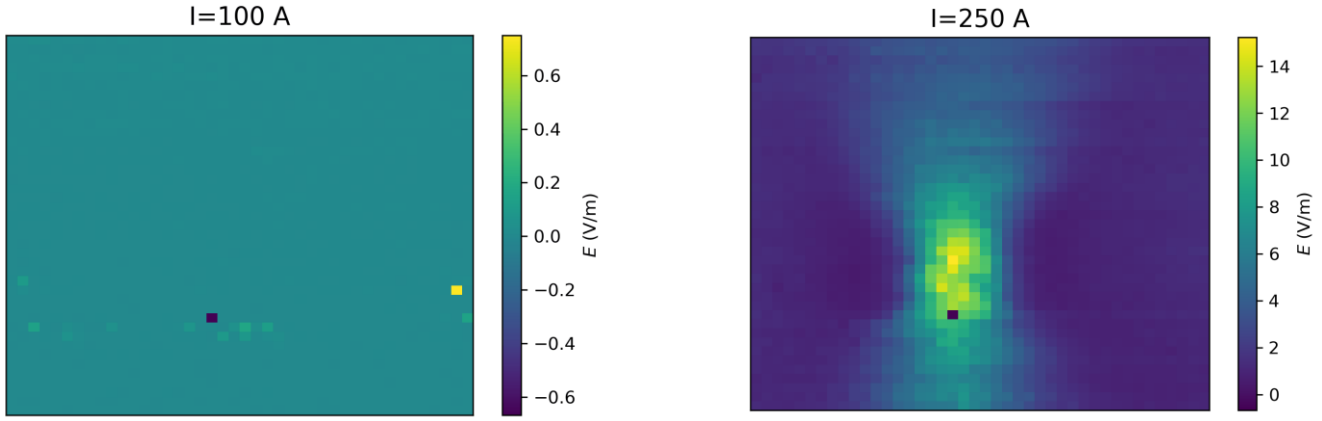
Magnetic field

Currents

SHPM



Electric field
2ms pulse
50x50 µm^2



Coming soon

- Angular resolved measurements of the critical current
  - Torque magnetometry
  - 4.2 K ≤ T ≤ 50 K
  - I_c ≤ 1000 A
- Irradiaton data on state-of-the-art conductors (new sample sets)
  - First results on Eu-123
- Better and more comprehensive data from in-situ annealing