Test of HTS Demonstrator Coils at High Field and Variable Temperature in the SULTAN Facility

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SULTAN facility

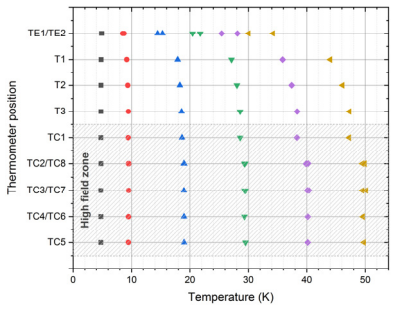
Field generated by 3 pairs of **split solenoids**:

- **B_{max} = 10.905 T** in the test well
- Homogeneity (2%) along ±200 mm

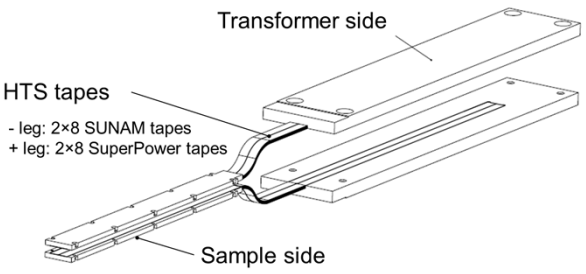
Nb-Ti trafo can supply **100 kA at 4.5 K** to sample.
Typically, samples are **Cable-in-Conduits**.

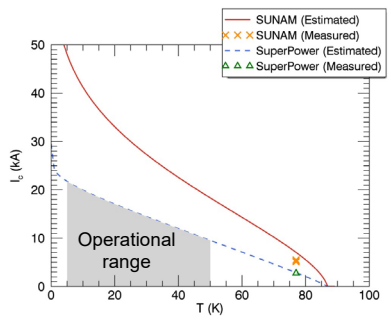
Sample counter cryostat

- Required for the test of the **FeaTHeR coils**
- Confines flow of He gas in a volume where **temperature is regulated**: 4.8 to 50 K
- Helium pressure: p_{He} = 10 bar
- 2880 mm-long cylindrical stainless steel chamber (OD 88.9 mm, ID 83.7 mm)



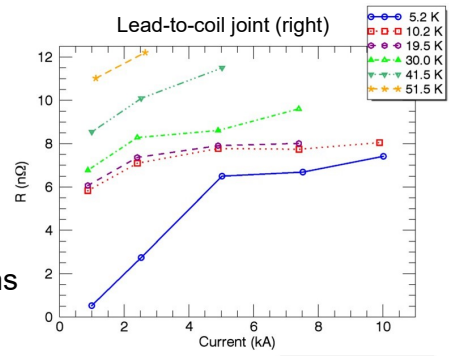
HTS current adapter

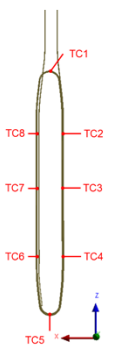


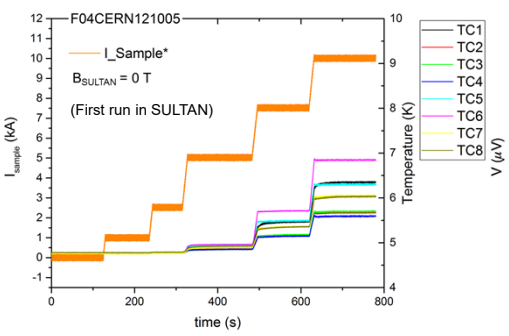


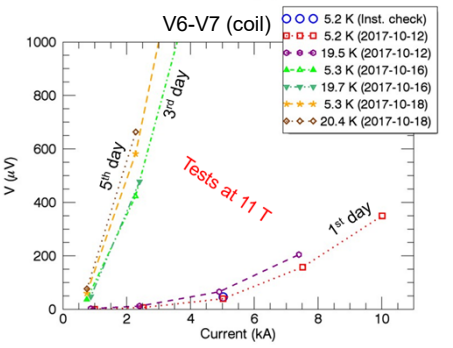
Test of FeaTHeR M0.4 (Oct 2017)

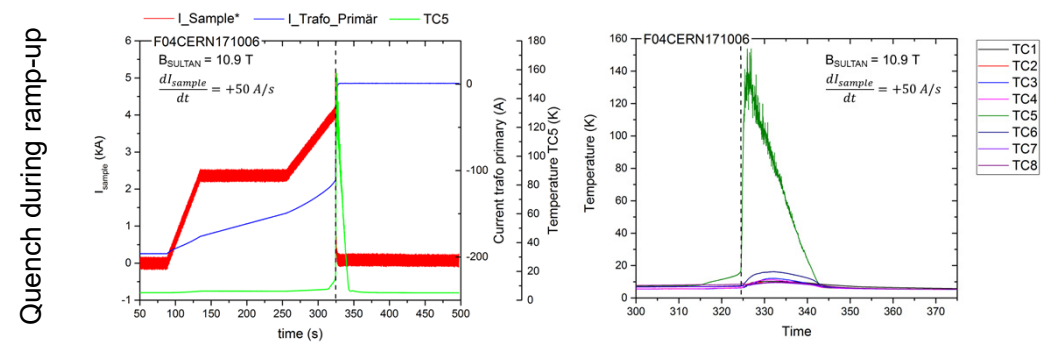
- Lead-to-adapter joints (indium): **R < 6 nΩ**
- Coil-to-lead joints (soldered): **R < 12 nΩ**
- **Largest contribution** to the overall sample resistance comes from the **coil:**
  - **R_{coil} = 35 nΩ** (at 5.2 K and 10 kA)
  - R_{coil} grows dramatically after high field runs
- **Heat generation** observed **inside the coil**.







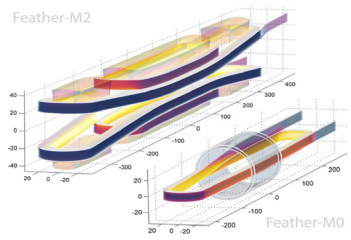




FeaTHeR coils

- **FeaTHeR-M0** are **sub-scale racetrack coils** wound with **REBCO-Roebel cable**.

Coil	Tape supplier	# tapes	tape width	cable width
FM0.4	Bruker	15	5.5 mm	12 mm
FM0.5	SuNAM	15	5.5 mm	12 mm

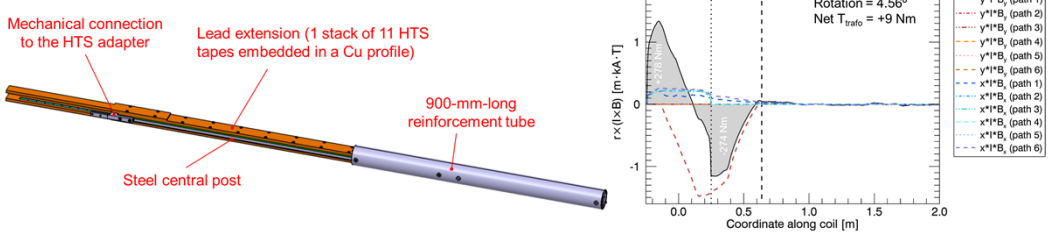


Lead extensions

- The lead extensions of the FeaTHeR coils have to be **unsoldered** and **replaced** by ~1.6-m-long leads for the test in the high field region.
- Each lead extension is made of 11×12-mm-wide tapes in a Cu profile.

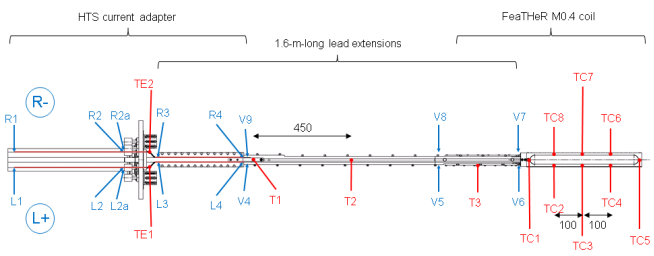
Reinforced structure

- Coil rotated ~4° to cancel net torque



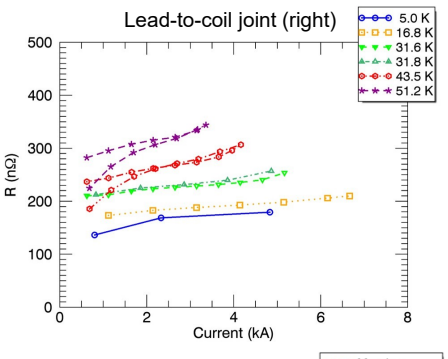
Instrumentation

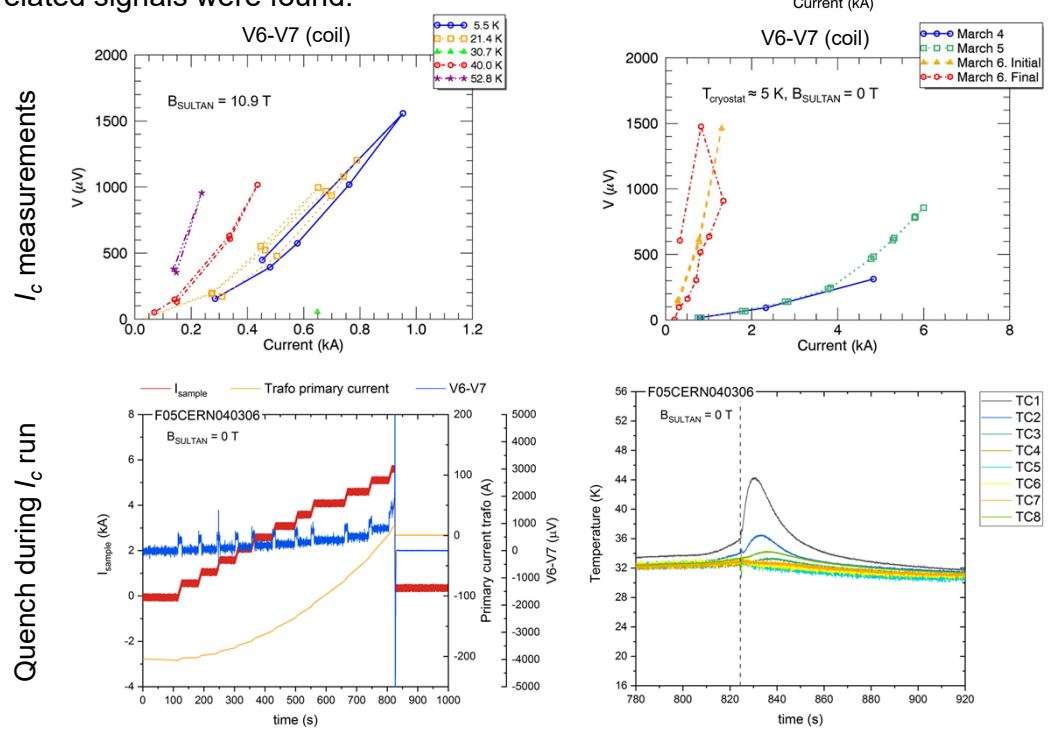
- Cernox temperature sensors
  - 8 coil sensors + 5 infrastructure
- Voltage taps:
  - Paired consecutive V taps
  - Additionally: V6-V7 (coil), V4-V9 (coil+ext) & L^+-R^- (overall)



Test of FeaTHeR M0.5 (Mar 2019)

- **FM05** is also **resistive** since the first run.
- **R_{coil} = 39 nΩ** (at 5.0 K and 5.0 kA), but also **grows** dramatically after **high field** runs.
- Largest contribution to **R_{sample}** comes from **coil-to-lead joints** (indium): R > 100 nΩ
- Pickup coils were installed, but no quench-related signals were found.





Summary

- **Two HTS** demonstrator **coils** have been **tested** at **variable temperature** and **high magnetic field** in SULTAN.
- Both tests were **limited** by the apparent **resistance across the coil**, which **increased** dramatically after the tests at **high field**.
- **Coil-to-lead resistance** was also **a few hundred nΩ** in the coil **FM0.5**:
  - No definite explanation is found
- **Heat generation** is observed inside both coils since the very first runs.

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