Design, construction and test in SULTAN of high-current REBCO racetrack coil

SWISS PLASMA CENTER

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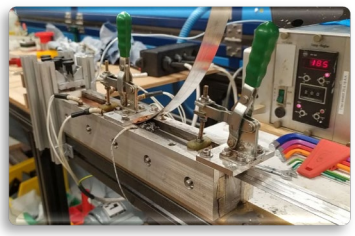
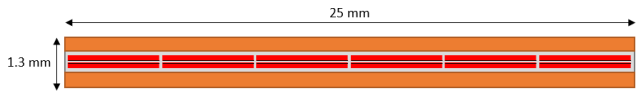
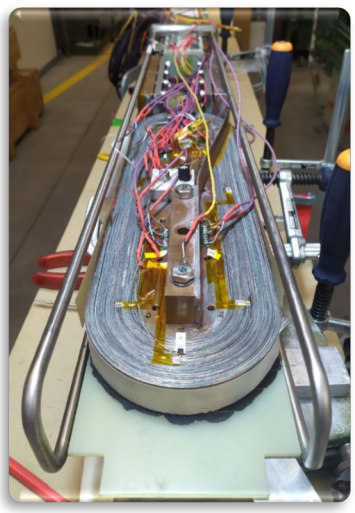
Conductor and coil layout

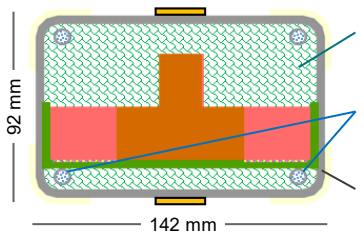


- Laminated stacked-tape soldered conductor (LASSO)





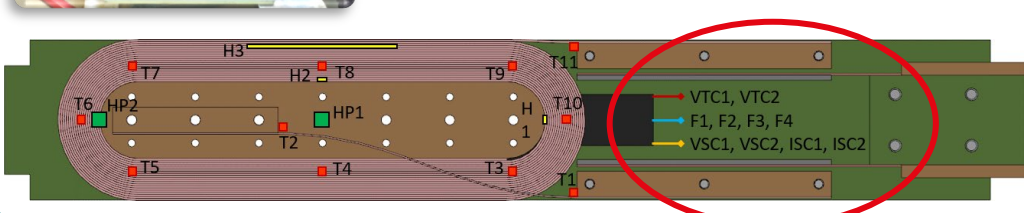
- 20-turn flat racetrack
- Fiberglass turn insulation
- Impregnated and indirectly cooled



~13% DMSO
(common cryoprotective agent)

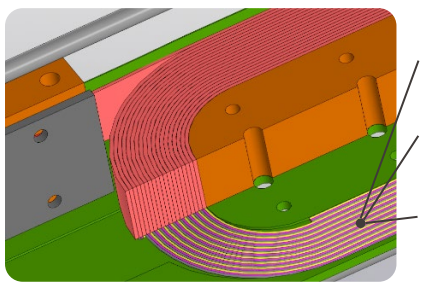
Inlet cooling
(supercritical helium)

Steel casing
(2 welded U-shapes, 4 mm thick)

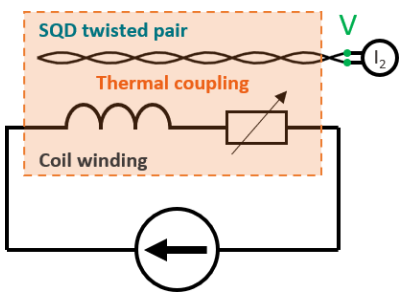


Studied quench detection methods

(aimed at temperature-based response immune to EM noise and mechanical strain)



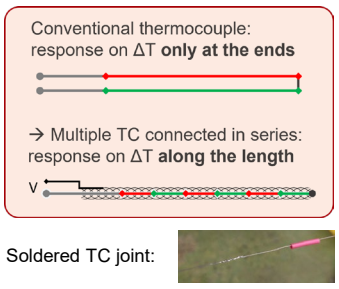
1. **SQD twisted-pair**
   (bronze-route Nb_3Sn, OD 0.2 mm, insulated by acrylate)
2. **Thermocouple chain**
   (type K, OD 0.2 mm, ~60 joints, 6-around-1 copper shield)
3. **FBG optical fibers**
   (48 FBGs in 4 paths, Teflon tubing OD 0.6 mm)



1: measuring resistance of superconducting quench detection (SQD) wire

Pros: distributed spatial sensing, sensitivity controlled by I_2

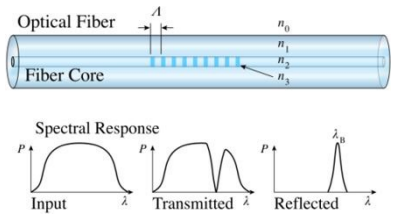
Cons: limited choice for Tc(B) temperature threshold, hot-spot is not localized.



2: measuring voltage over series-connected thermocouples

Pros: continuous response on temperature gradient among joints

Cons: discrete sensing, hot-spot is not localized.



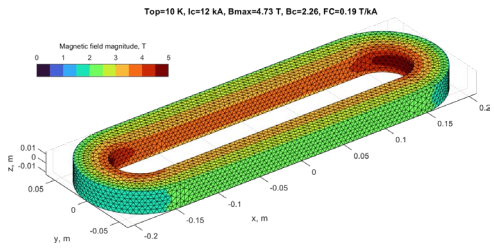
3: measuring spectral shift of light reflected by each FBG

Pros: continuous temperature monitoring at each FBG location

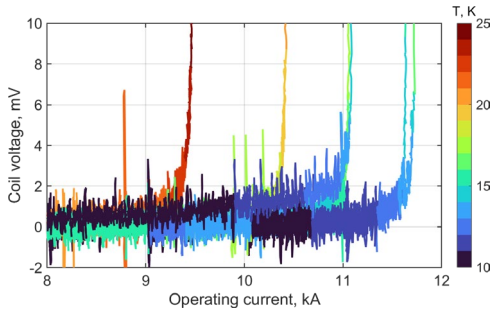
Cons: brittle, high resolution over long length is cumbersome.

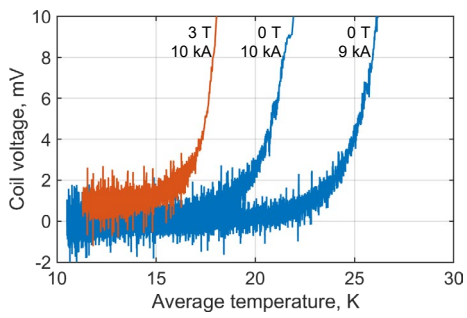
Modelling and test results

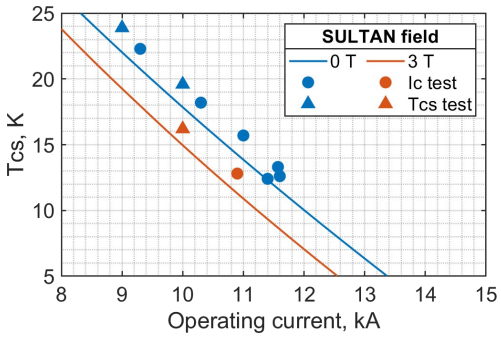
- Coil performance is not limited by the higher field at the coil ends due to favorable orientation of REBCO tapes (i.e. parallel to the ab-plane)

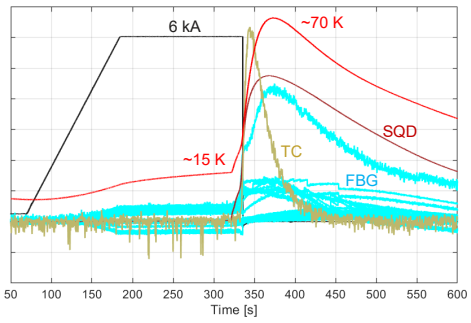


- DC performance in-line with prediction, sharp V-I and V-T transitions (n>50, m>10)

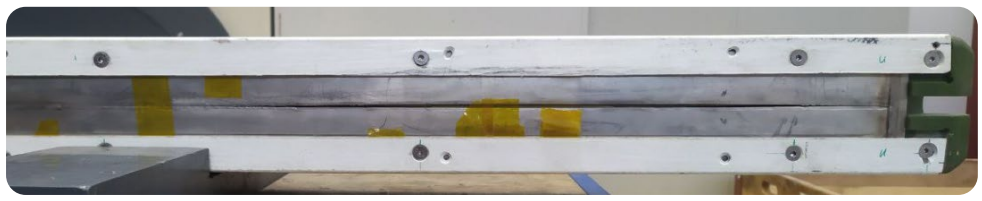






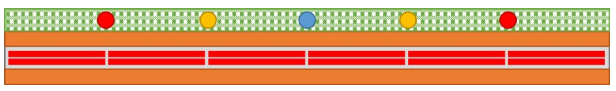


- Steel casing cracked at ~1200 kN/m EM load…

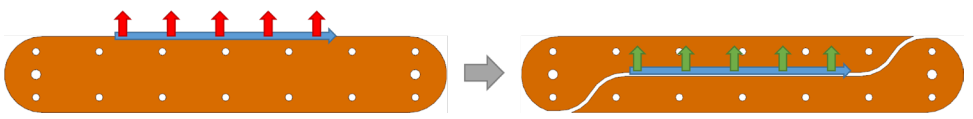


Outlook

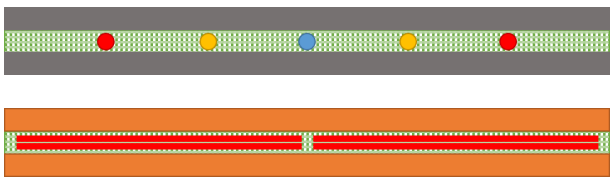
- Co-wound QD instrumentation…



- Inner joint compressed by EM forces (not peeled)…



- Extending LASSO concept…



Reinforcement & QD strip

Switch conductor

EUROfusion

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