Performance of RC6, a sister racetrack coil of the record performance RC5

Tengming Shen[1], Daniel Davis[1,2,*]

1. **Lawrence Berkeley National Laboratory**
2. **National High Magnetic Field Laboratory**

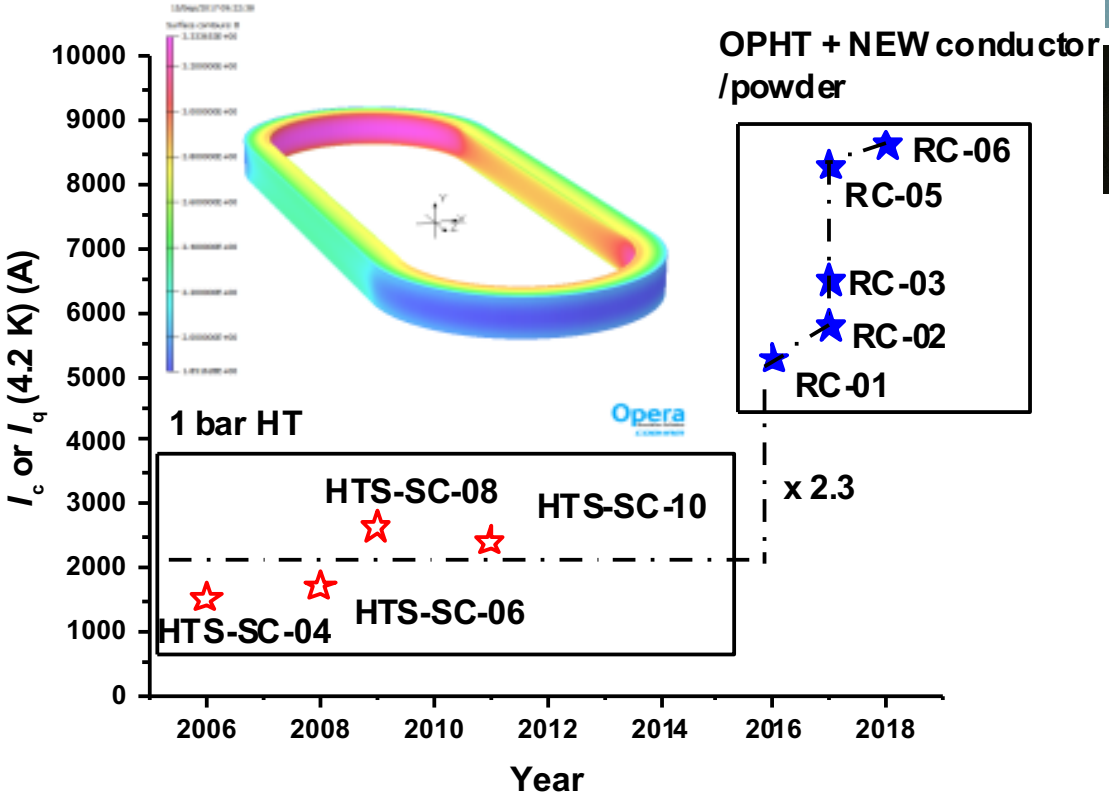
May 30, 2018

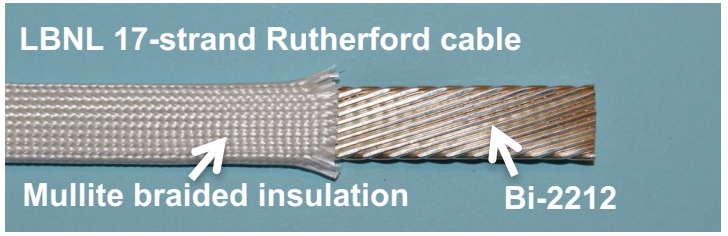
Test: Daniel Davis[1,2,*], Marcos Tuerqueti[1], Hugh Higley[1]
Fabrication: Hugh Higley[1], Jim Swanson[1], Daniel Davis[1,2,*]
Reaction: Ernesto Bosque[2], Lamar English[2]
Conductor qualification: Jianyi Jiang[2]
Lead: Tengming Shen[1]

Work supported by U.S. DOE OHEP through the U.S. Magnet Development Program.

LBNL HTS (2212) subscale magnet program topped with new RC-06 result

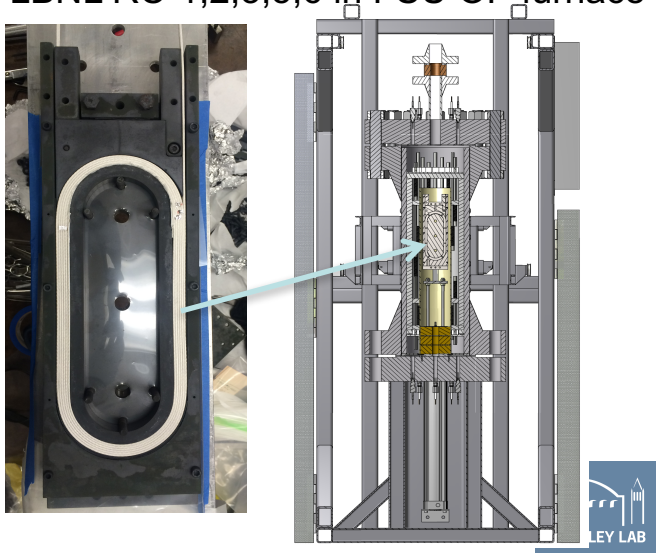
Subscale coils allow fast-turnaround test of cable and magnet-relevant technologies.





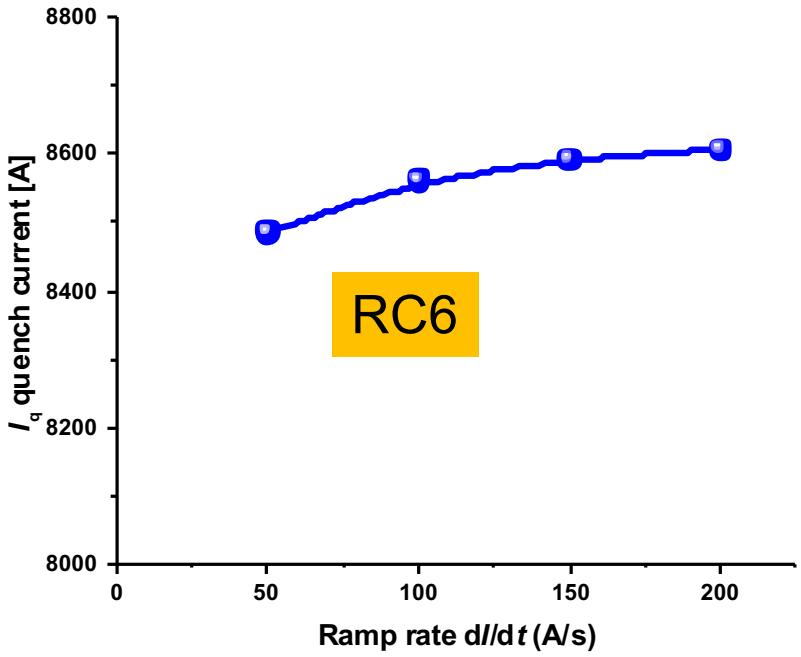
BERKELEY LAB · ASC · NATIONAL MAGLAB

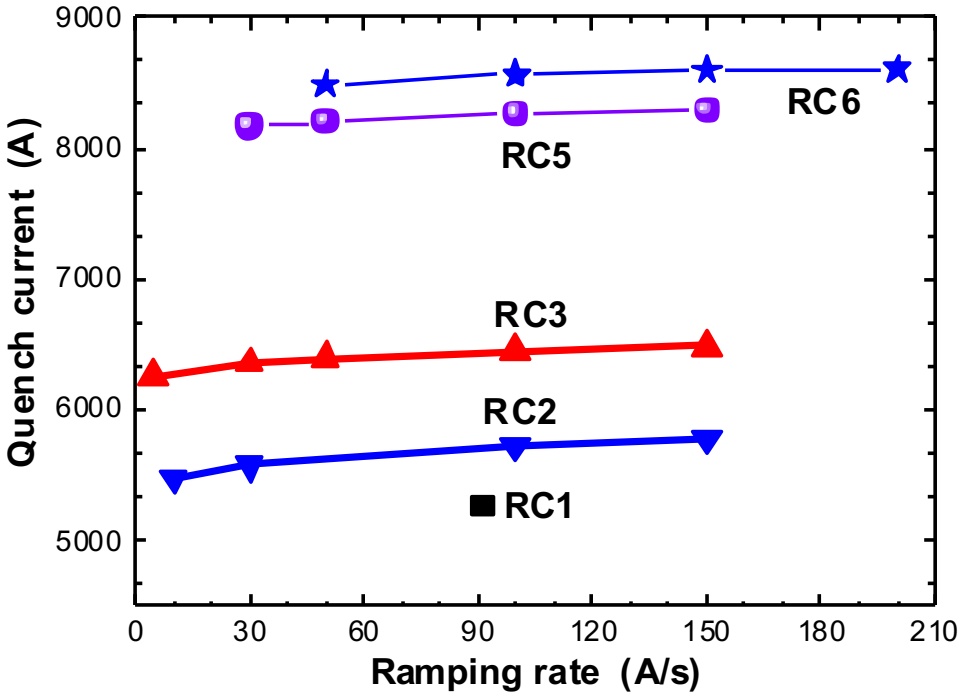
LBNL RC-1,2,3,5,6 in FSU OP furnace



RC5 and RC6 conductor, the wire PMM170123, was fabricated by Bruker OST with nGimat LLC using a new, Nanospray powder developed with support from DOE SBIR/STTR grants and donated to LBNL.

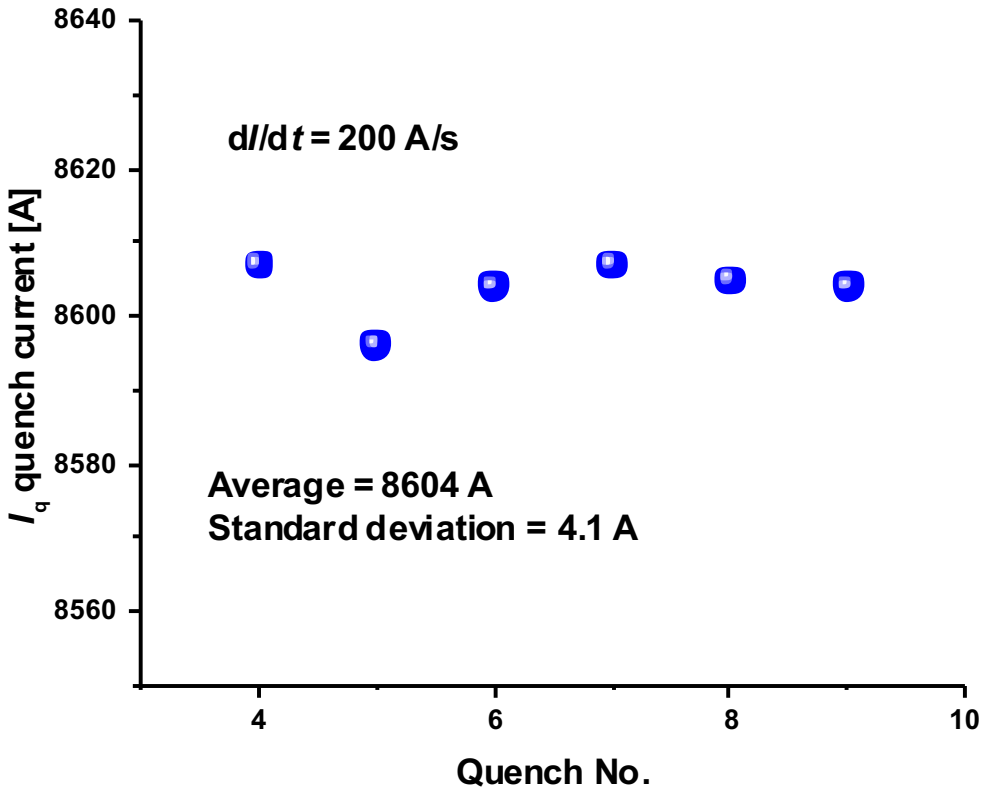
RC coils show high stability: I_q increases with increasing ramp rate (tested up to 200 A/s)





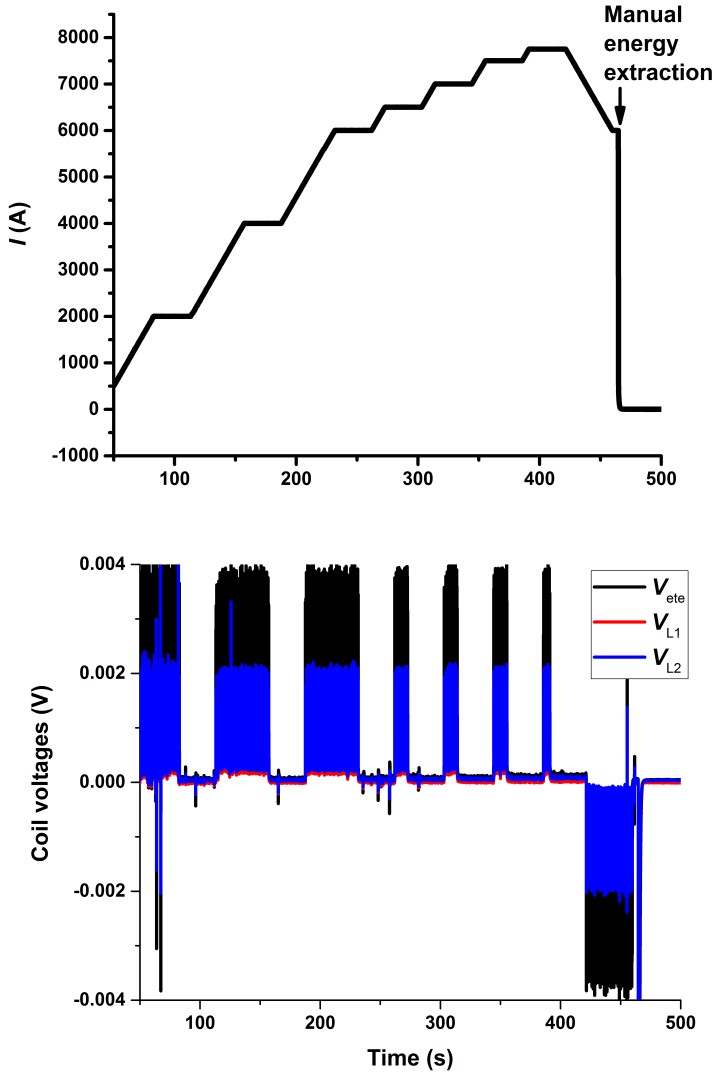
BERKELEY LAB

RC coils are predictable: (1) A clock magnet with quench current varying less than +/- 10 A for repeated quenches and with no quench training

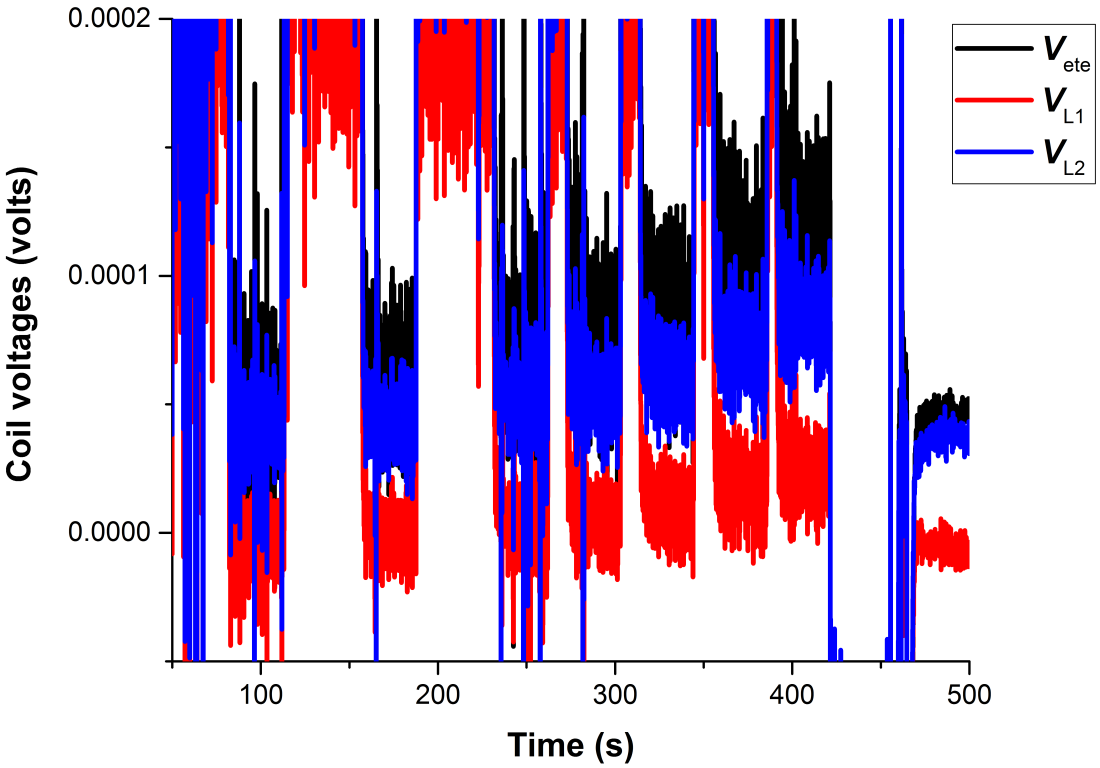


RC coils are predictable: (2) “A quench is coming”.

Watching the coil resistive voltages growing with increasing current, at a resolution of 10^{-5} V, and knowing a quench is coming. This is not possible with LTS magnets and a result of high stability of HTS magnets at 4.2 K.



- **RC6 Test A3, before any actual quenches.**

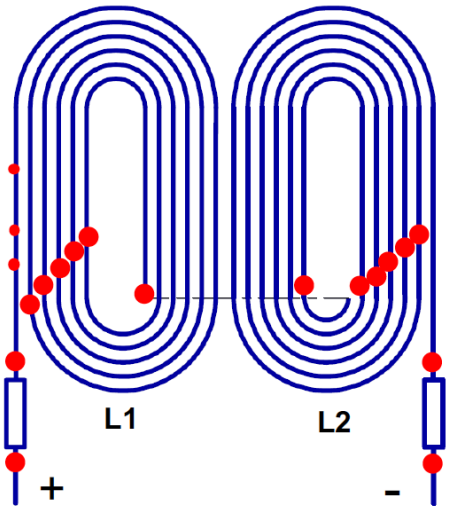


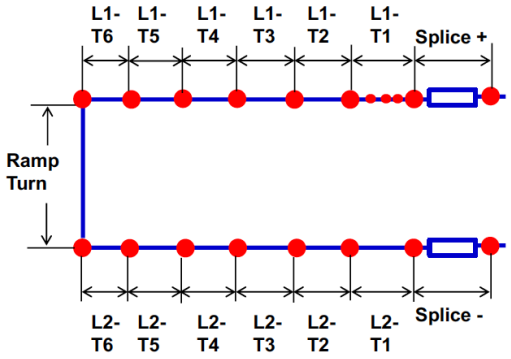
- **Detecting resistive voltages, going to a lower current, no quench.**

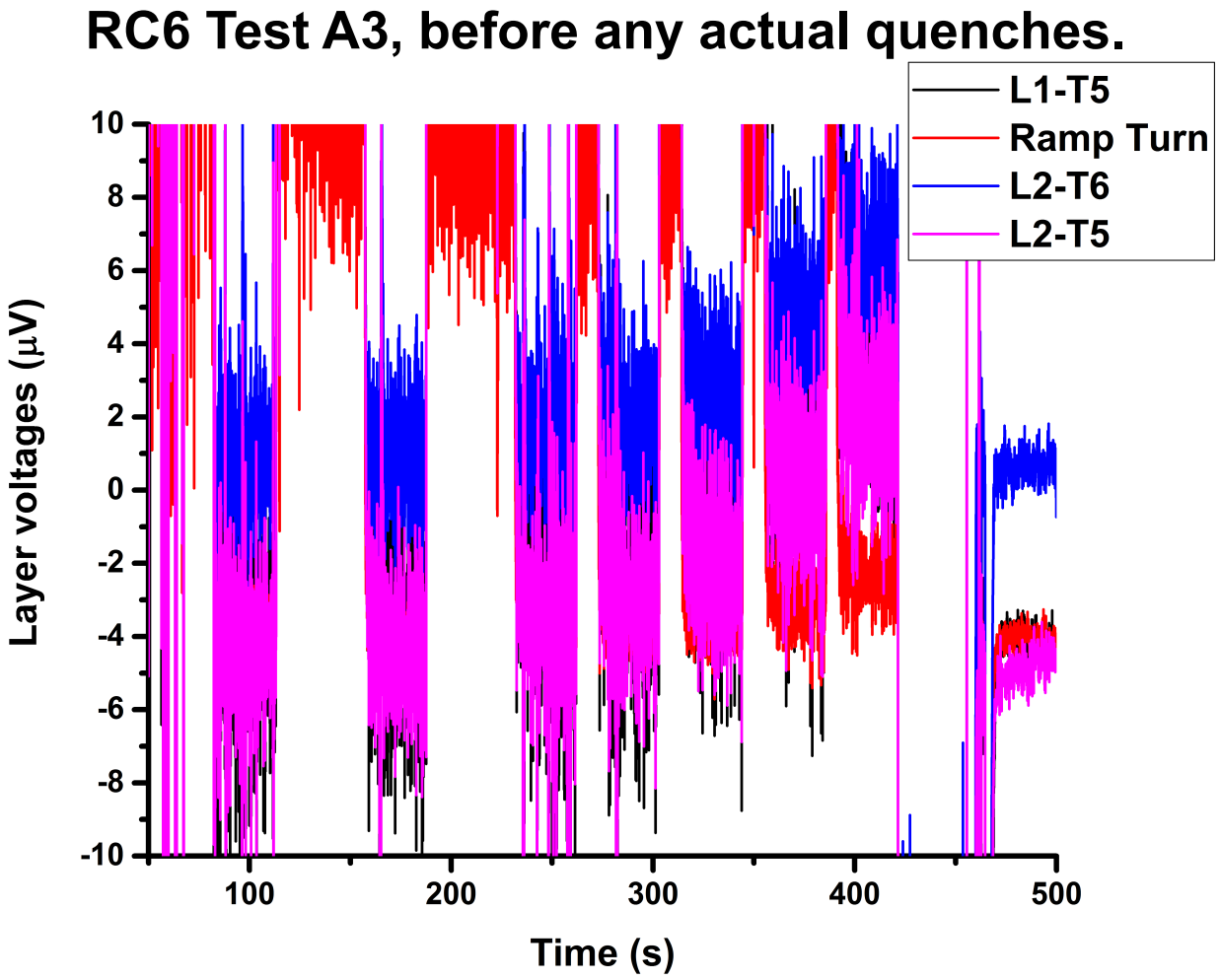
BERKELEY LAB

RC coils are predictable: (2) “A quench is coming”.

The growing resistive voltages can be detected at a resolution of 10^{-6} V for dedicated, high-field conductor regions.





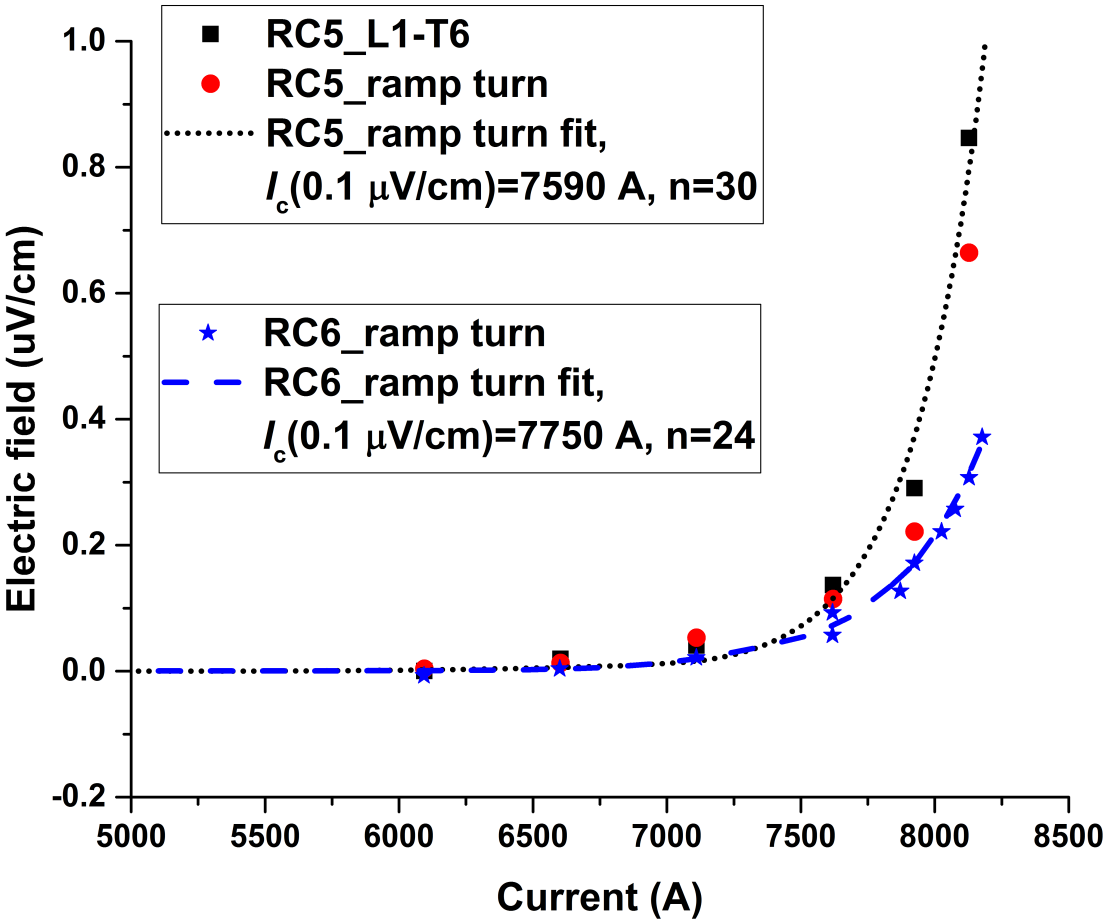


BERKELEY LAB

RC5 – *E-J* characteristics defined with a stair-case *I*(*t*) run – a global superconducting transition

RC5 I_q

RC6 I_q

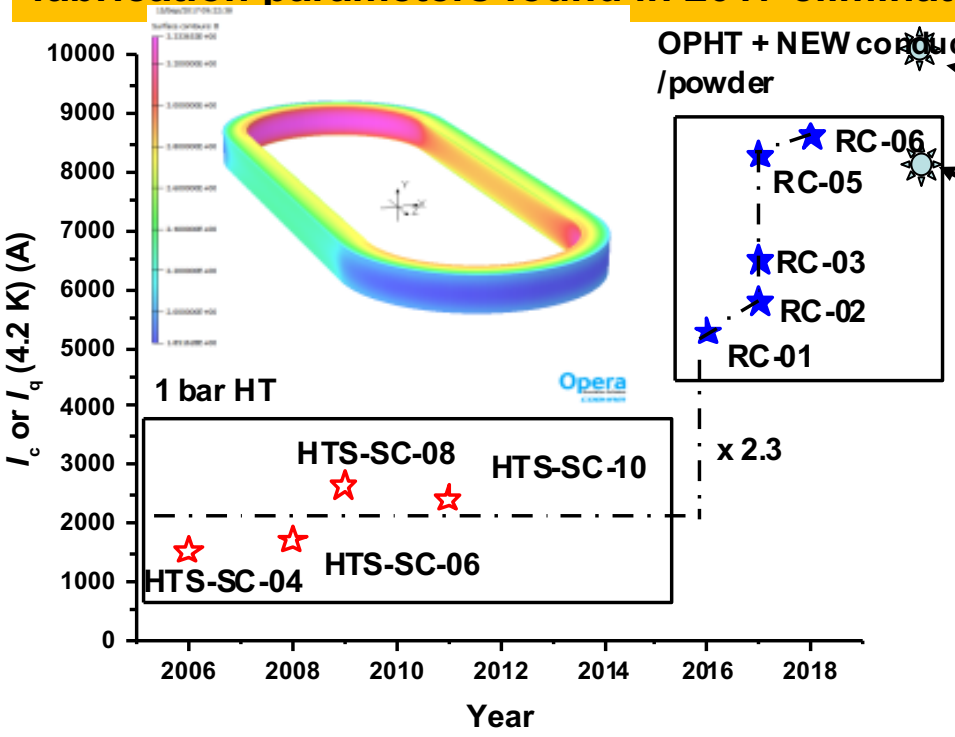


Recommend to operate magnets below I_c(0.1 mV/cm), about 10% lower than their I_q.

BERKELEY LAB

What is next ? Reliability demonstration (with twisted wires) and going to new heights

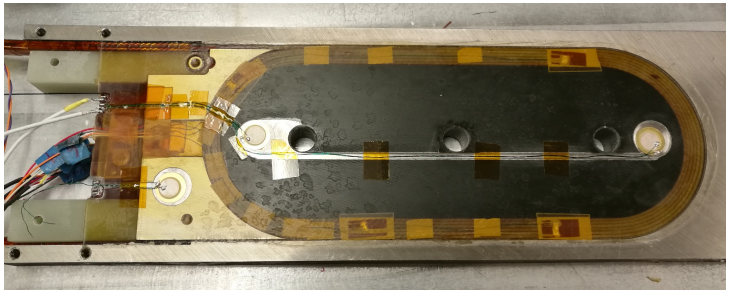
RC1-6 made from wires not twisted. 2016 twisted CDP wires degraded and new fabrication parameters found in 2017 eliminated degradation, now applied in 2018.



RC9 + RC10, PMM170123 like (maybe twisted) + RC3 leakage control

RC7 + RC8, with twisted wires

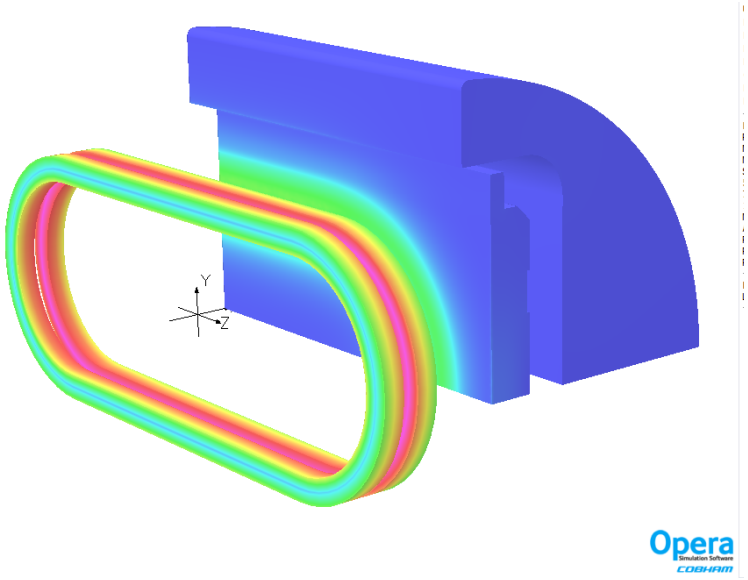
RC7-10 – same 2018 CDP wire, batch processing; wire delivered; cables to be made.



BERKELEY LAB

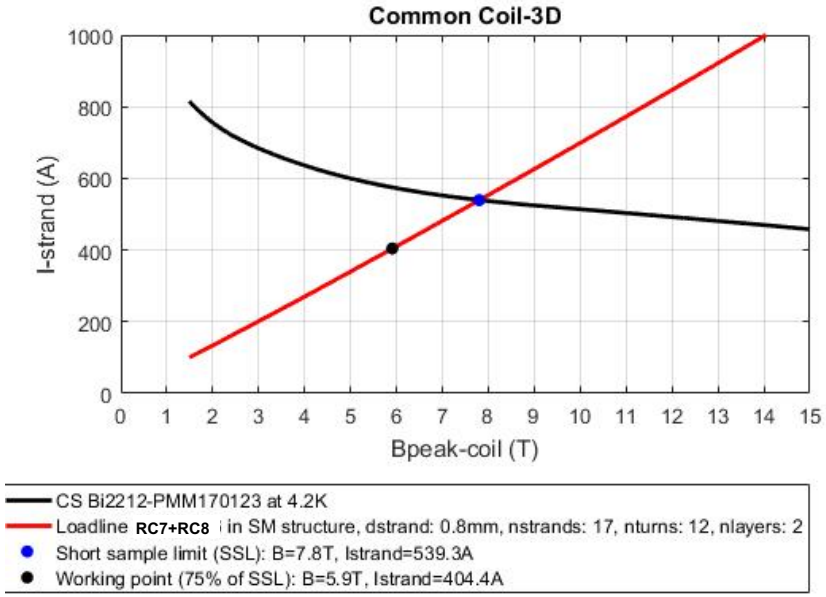
Quench protection with CLIQ for 2212 – Daniel Davis

RC7 + RC8 in LBNL subscale-magnet structure



Opera by Laura Garcia Fajardo

RC7 + RC8 – likely 12 turns/layer Instead of 6 turns/layer.



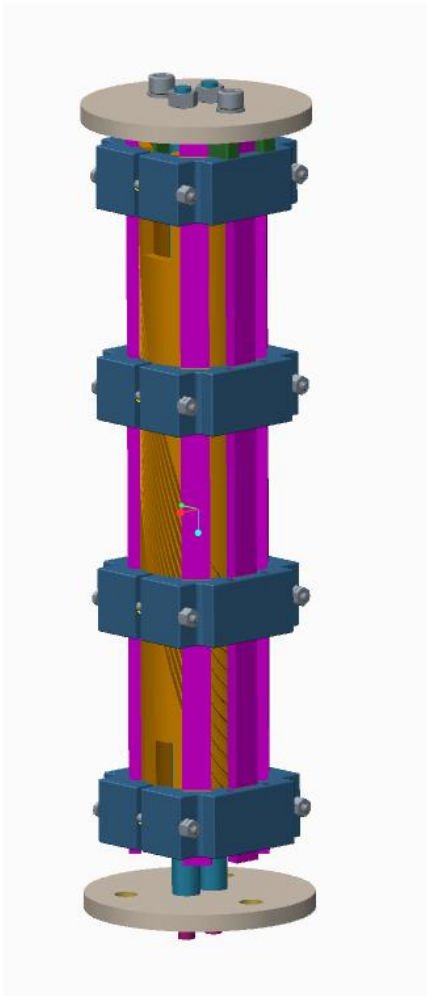
Daniel Davis – FSU PhD thesis work

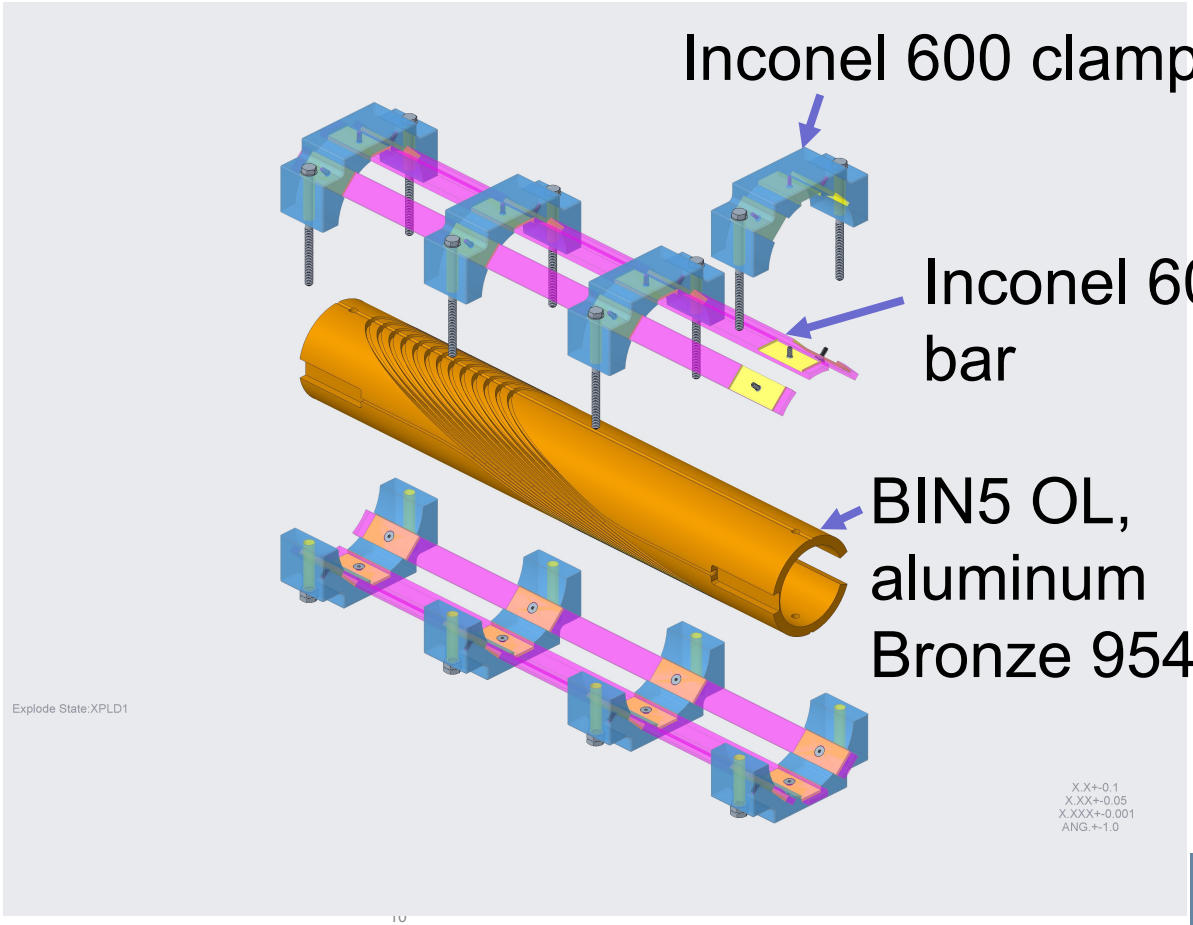
BERKELEY LAB

Moving along with CCT demo – BIN5 OL

- **Cables ready and HT fixture assembly being manufactured.**
- **Coils to FSU in ~2 months.**

CAD by Ray Hafalia Jr.





BERKELEY LAB

Summary

RC6 – a new record.

- **High stability and lack of training.**
- **Predictive - "A quench is coming."**
- **Predictive - "I_q fluctuates by +/- 10 A."**
- **Global V-I transition defined.**

- **Racetrack coil program – what is next?**

- **CCT BIN5 is coming.**