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The LBNL CCT Program

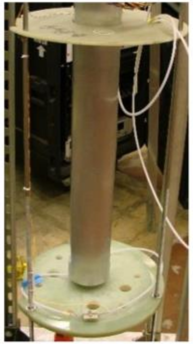
See also: the US-MDP CCT Program Review

https://conferences.lbl.gov/event/88/

26.06.2017, CD1 Conceptual Design Review

LBNL/MDP CCT Program Up to Now

- CCT1
  - 2.5 T short-sample dipole
  - 50 mm clear bore
  - 8 strd. NbTi cable (0.65 mm SSC Outer)
  - not impregnated
  - 11/2013: tested up to 2.5 T



- CCT2
  - 5.3 T short-sample dipole
  - 90 mm clear bore
  - 23 strd. NbTi cable (0.8 mm SSC Inner)
  - epoxy impregnated
  - 5/2015: tested up to 4.7 T

- CCT3
  - 10.0 T short-sample dipole
  - 90 mm clear bore
  - 23 strd. Nb3Sn cable (0.8 mm OST 54/61)
  - 3/2016: tested up to 7.4 T
  - Suspect Conductor damage as possible cause of current limit

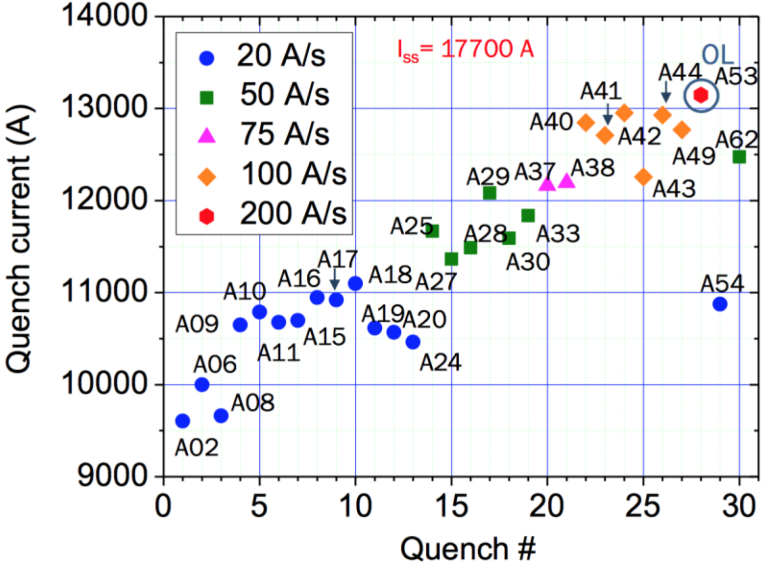
Source: D. Arbelaez (LBNL)

CCT3 Results

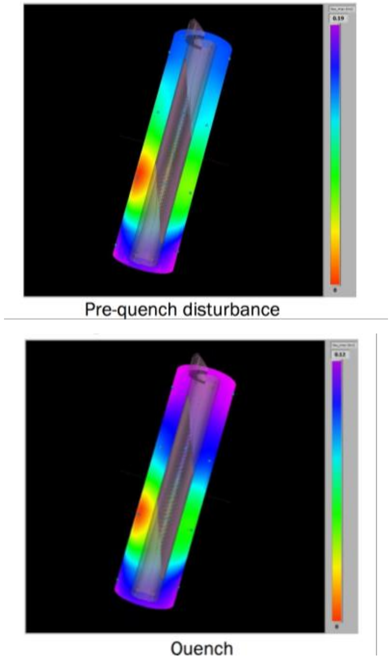
- 56 current extractions conducted; 30 were natural quenches and the rest was triggered by instabilities / flux jumps
- The highest quench current was 13147 A, yielding 7.4 T dipole field in the bore and 8.3 T at the conductor
- The absolute majority of quenches occurred within the first four turns of the inner layer (A23), counting from the lead end.

CCT3 reached 74% of short sample current after 28 quenches

➢ Unusual "inverse" ramp-rate dependence of quench current



Quench #2, acoustic localization



Source: M. Marchevsky (LBNL)

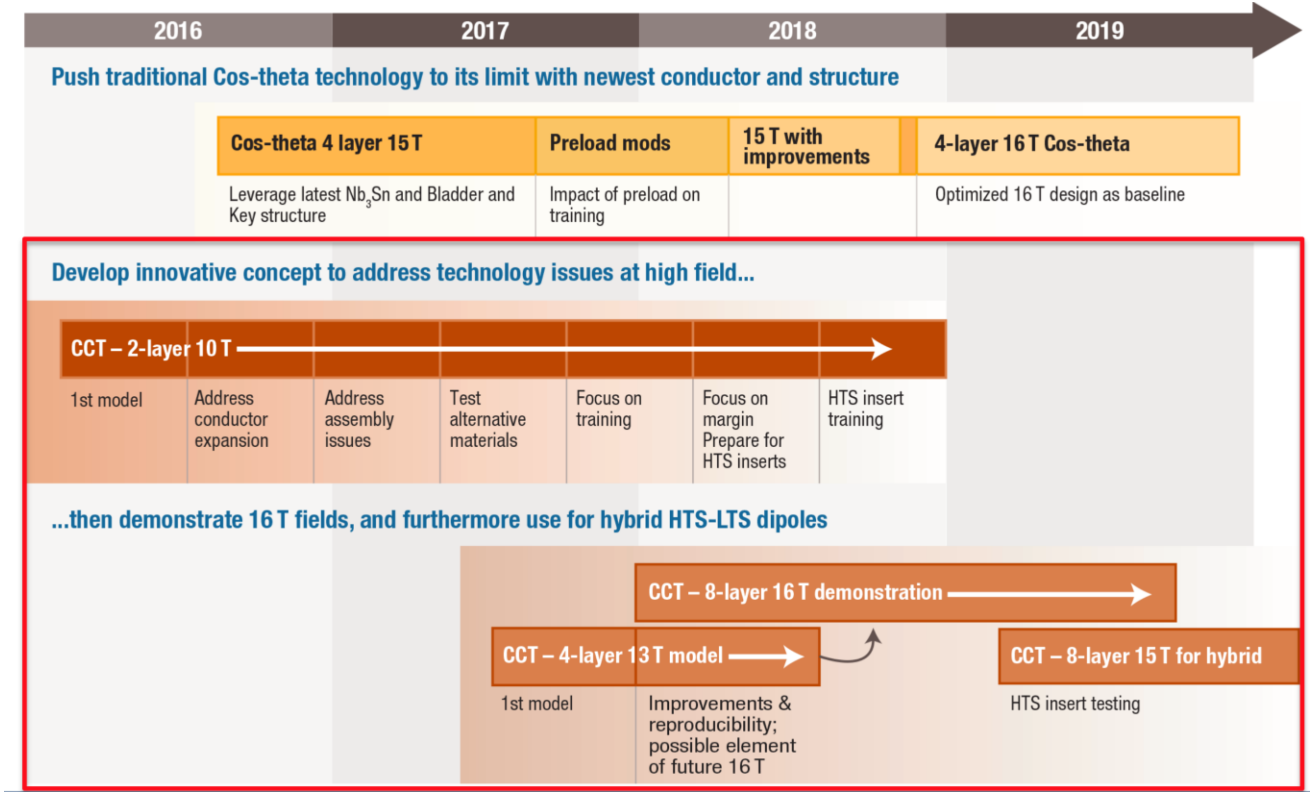
LBNL/MDP CCT 2-Layer Program

	CCT3	CCT4	CCT5
Bore size [mm]	90	90	90
Groove design	constant width	1.25 mm gap at pole	1.65 mm gap at pole
Conductor	RRP 54/61 Ta doped	RRP 54/61 Ta doped	RRP 108/127 Ti doped
HT Temp [C]	650	660	665
Potting configuration	full magnet	full magnet	individual layers
Epoxy	CTD-101K	CTD-101K	FSU Mix 61
Layer-to-layer interface	bonded	mold released	mold released

- Field quality
- Conductor damage
- Cost and scalability
- Training

Source: D. Arbelaez (LBNL)

LBNL/MDP: Beyond 2-Layer Magnets



Source: MDP

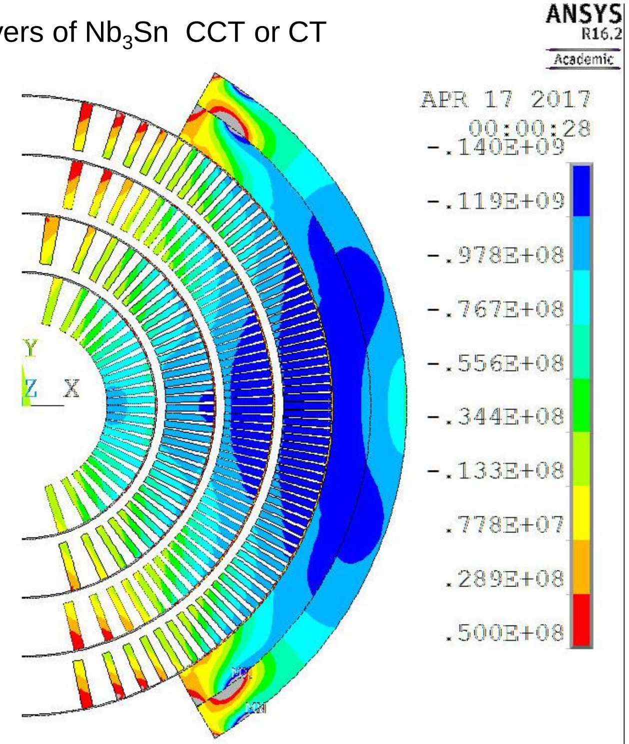
Beyond FCC Specs

- The future of high field magnets will depend on a structure that significantly reduces conductor stress.

	mat.	I0-ss (A)	Bcond
Lay1,2	Bi2212	10788	19.49
Lay3,4	Nb3Sn	10788	16.75
Lay5,6	Nb3Sn	10788	15.58

Bore field	19.33

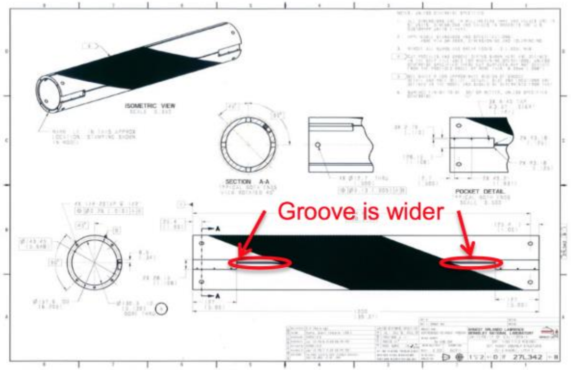
Fields with iron in 2D tosca

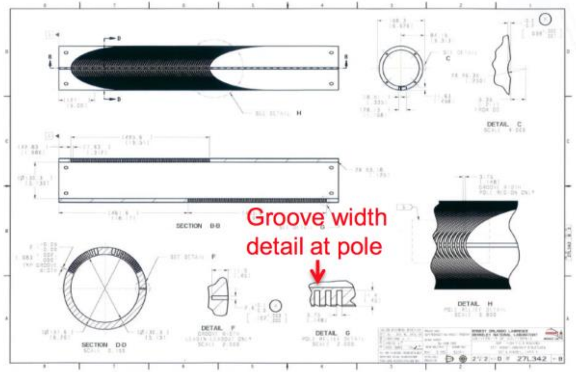


Source: L. Brouwer, S. Caspi

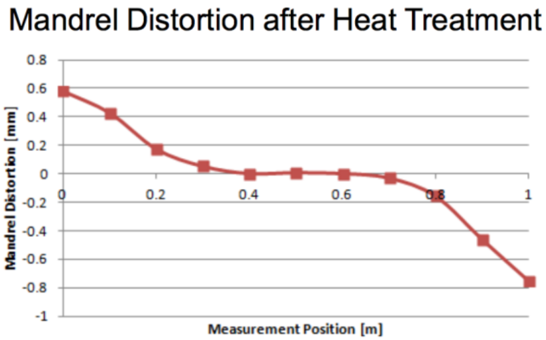
LBNL/MDP CCT Experience

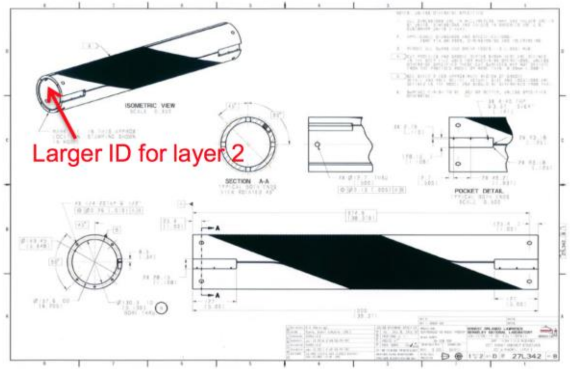
CCT3 alleged cable damage → increase in groove width.





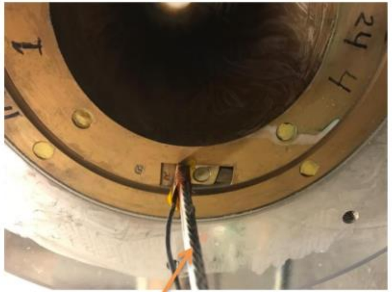
CCT4 mandrel distortion and assembly problems → increase layer-2 ID.





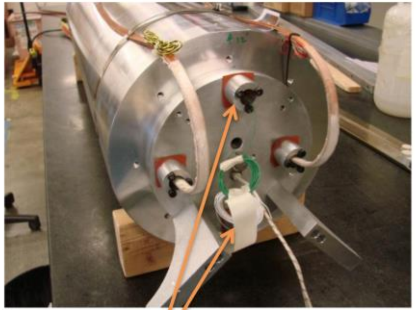
LBNL/MDP CCT Experience

Cable filled with solder rather than silicon for improved leak tightness.



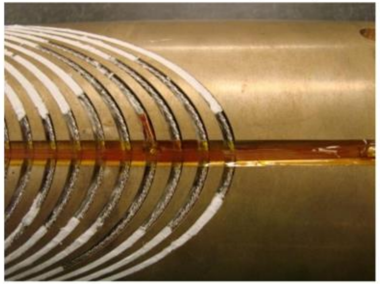
Cable filled with solder

Fewer instrumentation wires through use of PCB V-taps.

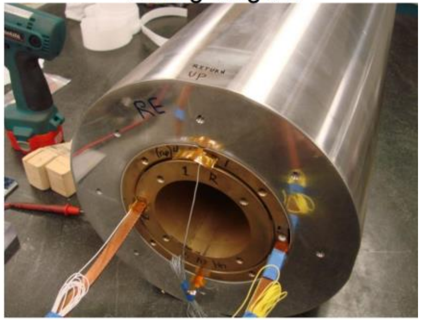


Number of Instrumentation ports have been reduced

Flexible PCB Voltage Tap



Flexible PCB Voltage Taps Exiting Magnet



Similarities and Differences with LBNL Program

- Similarities and direct input:
  - Former material.
  - Cable, heat treatment
  - Channel dimensions, assembly gaps.
  - Mold-released layers.
  - NHMFL Mix 61 resin (as CCT5).
  - Possibly individual-layer impregnation and assembly options.
  - 3-D mechanical-modeling techniques.
  - Review of technical design by LBNL Engineer Ray Hafalia.
  - Use of extensive foto documentation, LBNL drawings, skype consultancy, etc.
- Complementary PSI topics:
  - Mica insulation.
  - Inductive-compensation wire.
  - Spar thickness.
  - Thin Al protective shell and external structure.
  - CD2 inclined channels.
  - Study of alternative manufacturing processes.

END