



U.S. MAGNET  
DEVELOPMENT  
PROGRAM

# $\text{Nb}_3\text{Sn}$ CCT Updates and Next Steps

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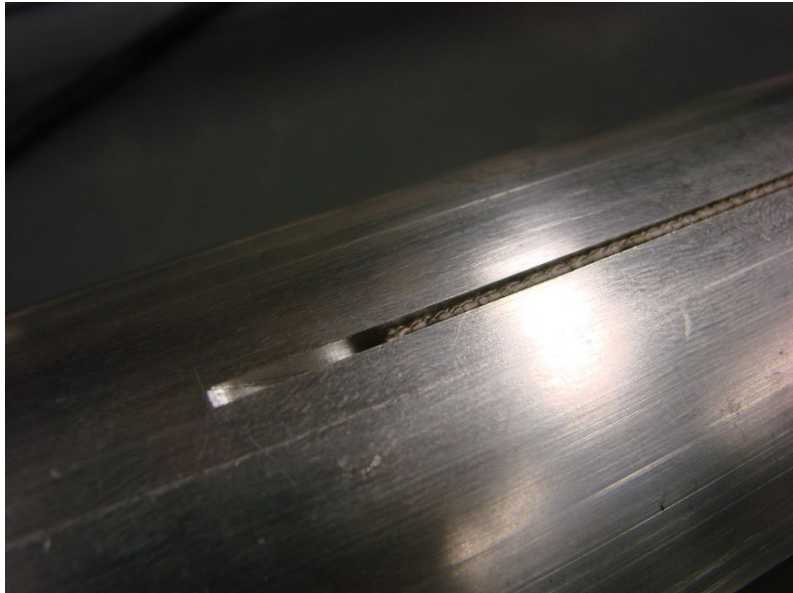
# Outline

- General Updates
  - CCT subscale updates and plans
  - CCT6 updates and plans

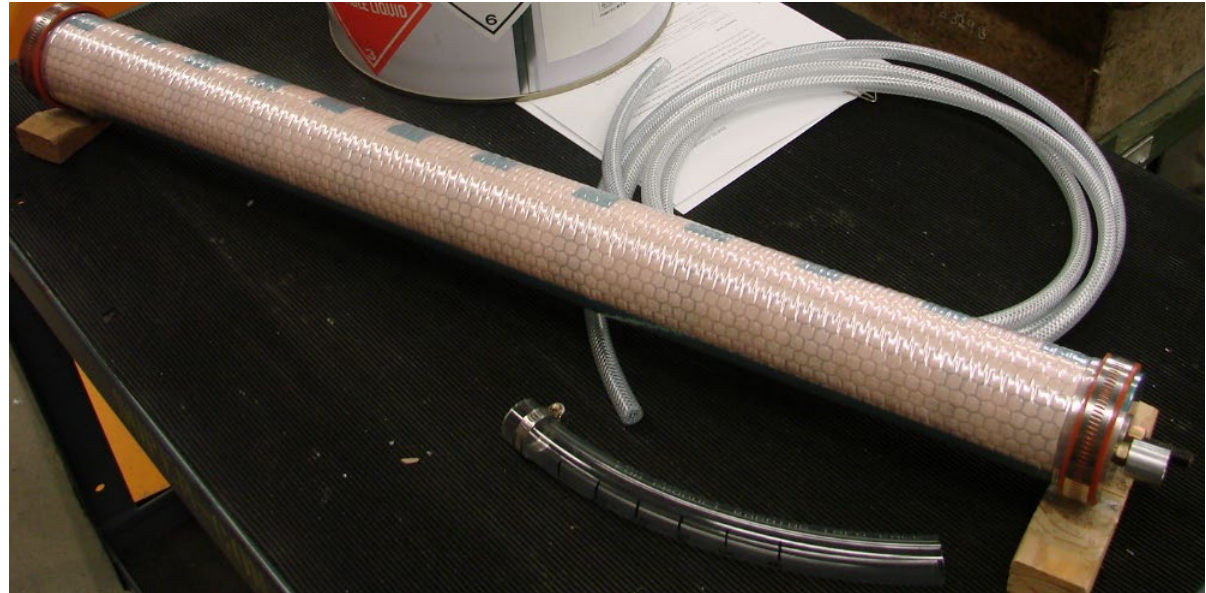
# CCT Subscale

- Two subscales planned for near future
  - Telene impregnated coils (part of US-Japan program)
  - Filled epoxy impregnated coils
- Test coil with straight grooves is at Fermilab for impregnation test with Telene

Test Coil Groove



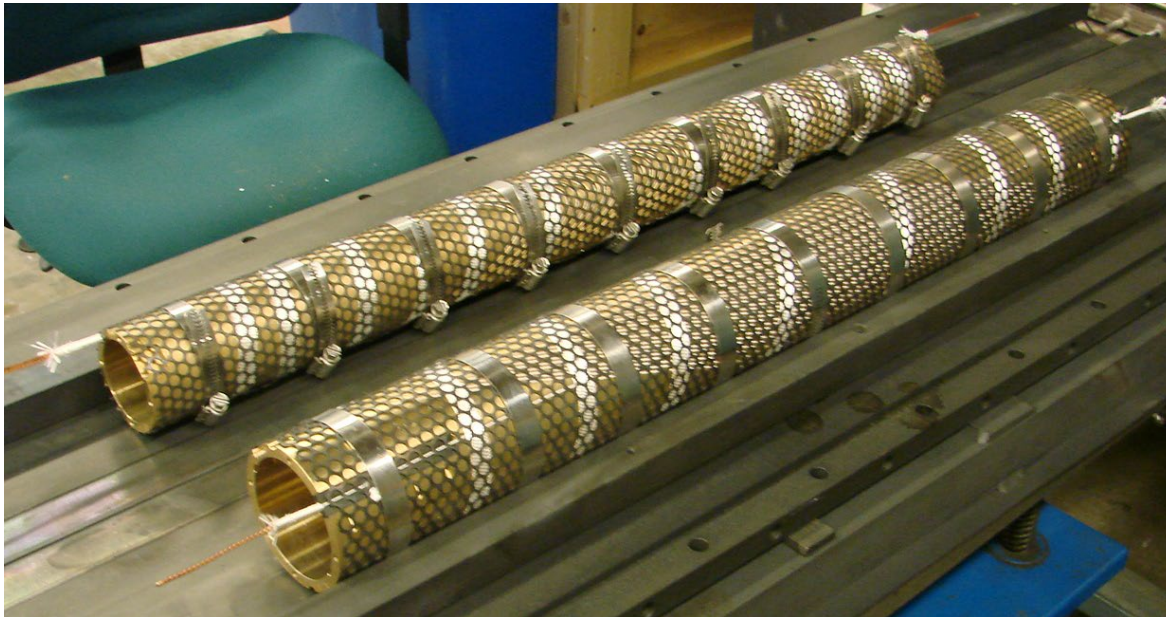
Test Ready for Impregnation



# CCT Subscale Current Activities

- Both inner and outer layer coils for Telene impregnation are ready for shipping
- We will wait until test coil is potted in case any changes to impregnation materials need to be made based on test feedback (this is unlikely)

Inner and Outer Layer Coil Reaction

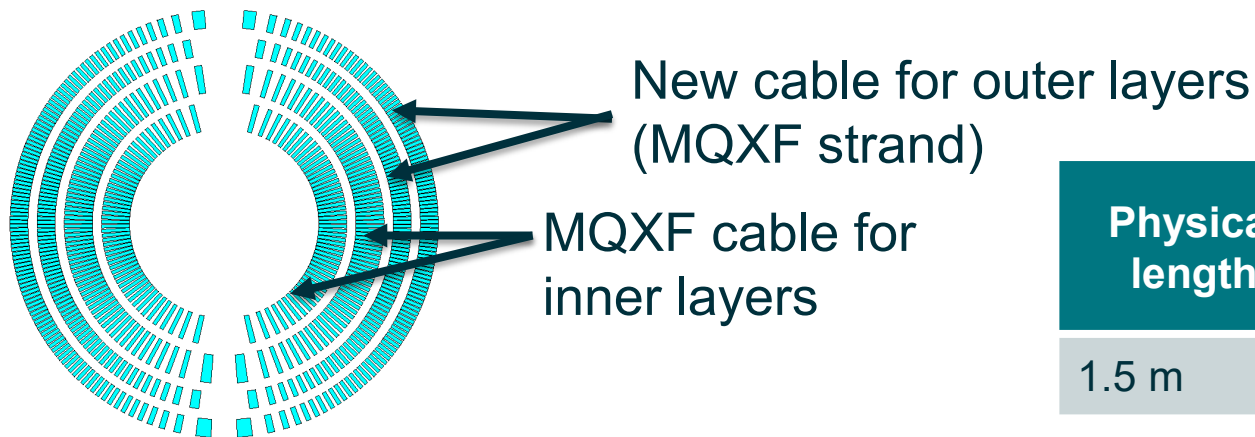
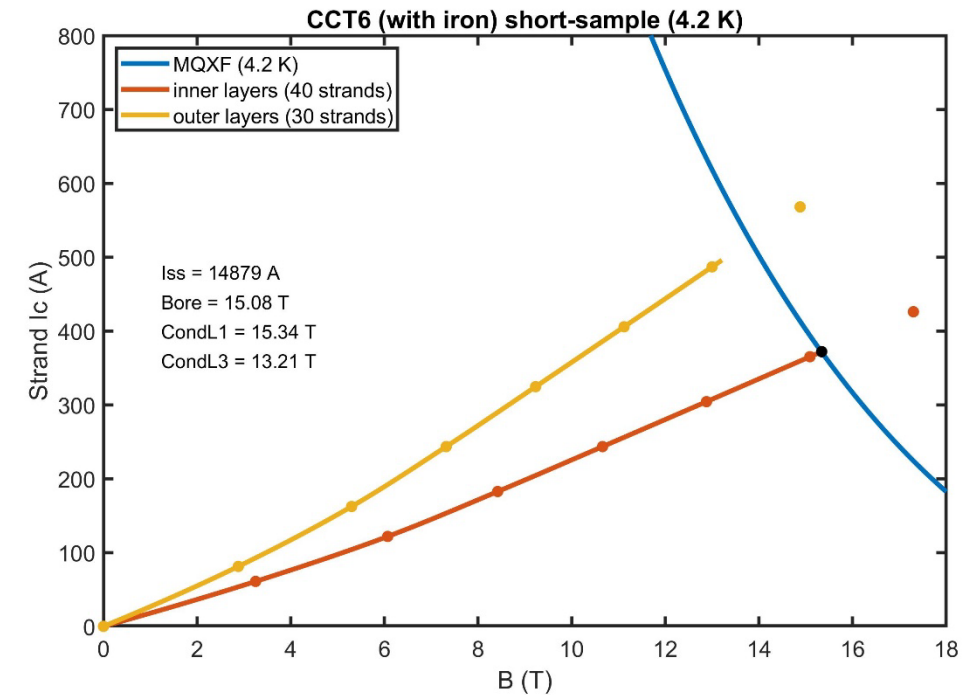


Inner and Outer Layer Coils Ready for Shipping



# CCT6 Design was Updated Based on Feedback from Test Coil Machining, Widing, and Reaction

- Design was updated with MQXF cable for inner layers and new cable for outer layers (as presented at USMDP collaboration meeting)

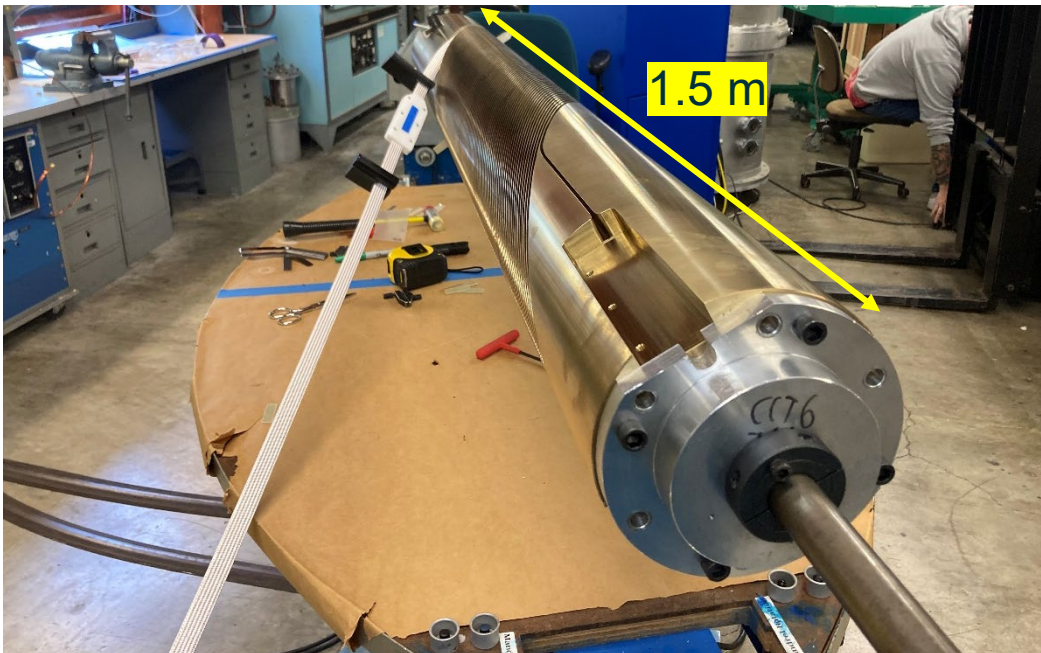


Physical length	L (1% of B1)	Bbore @ 4.2 K SS	Bcond @ 4.2 K SS	Bbore @ 1.9 K SS	Bcond @ 1.9 K SS
1.5 m	194 mm	15.1	15.3	16.3	16.6

# Layer 1 Mandrel Winding Tests Ongoing

- Currently practicing / refining winding technique and tools before starting winding of layer
  - Ensure cable is positioned where we want in the groove
  - Avoid any de-cabling or displacement of strands within the cable

Inner Layer CCT6 Mandrel Winding



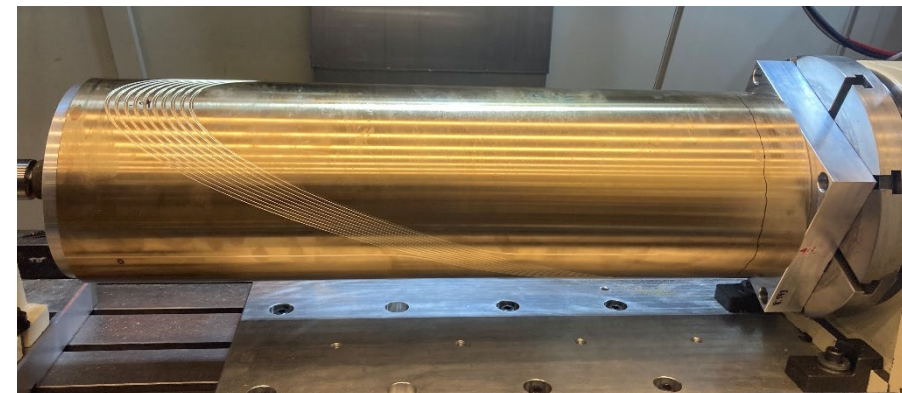
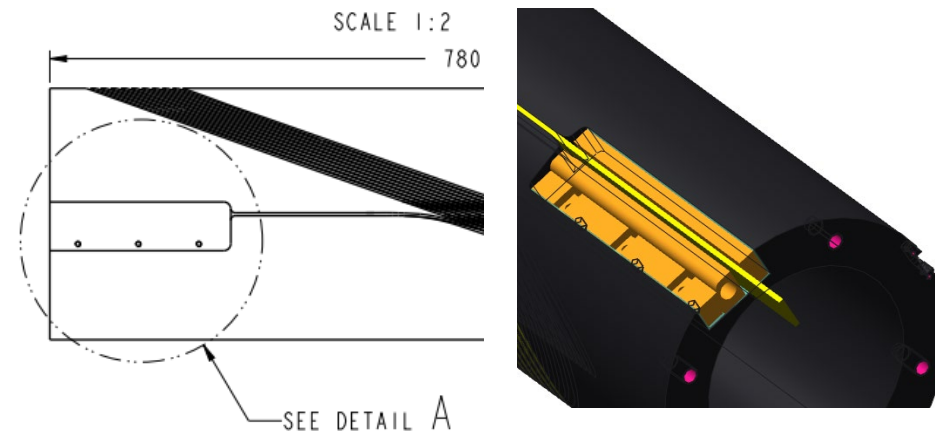
Inner Layer CCT6 Mandrel Winding



# Layer 2 Mandrel Test

- 10-turn layer 2 mandrel is being machined
  - Contains 2 different types of grooves (1 set is same as for L1 and second set has slightly larger gap)
  - Will perform winding and reaction test to select groove geometry for L2 mandrel
- Will use larger diameter cutting tool with goal to improve machining efficiency
- Plan to test splicing process on 10-turn test mandrel before splicing is performed on L1 coil

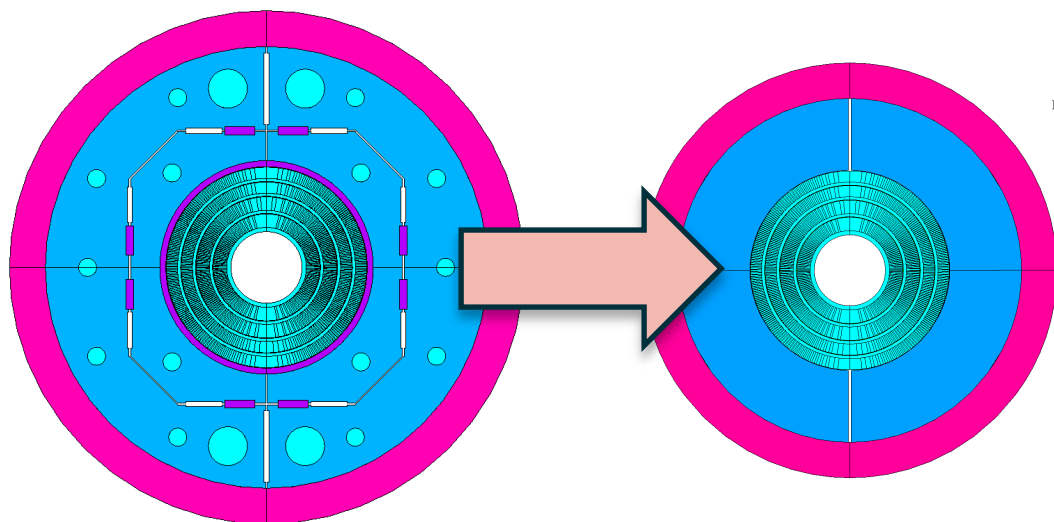
10-turn Layer 2 Mandrel



# CCT6 Next Steps

- Winding of Layer 1
- Complete 10-turn layer 2 test (machining, winding, reaction, splicing)
- Complete fabrication of layers 1 and 2
- Finalize design of outer layers and structure
  - Complete quench protection study to finalize outer layer grading
  - Further optimization of 3D mechanical design leading to choice of final structure (ongoing)

# Exploring Design of a Simplified Structure using “smart-shim” Assembly Techniques

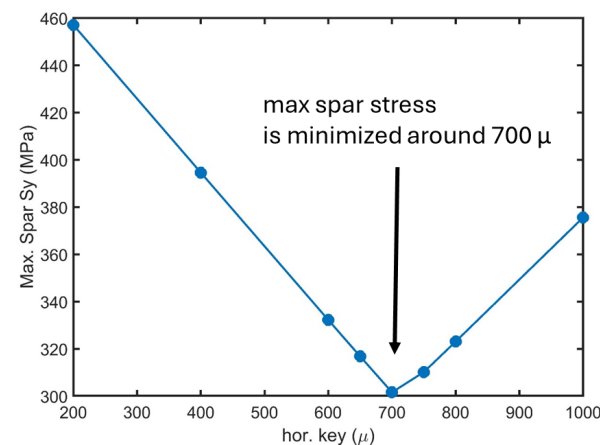


Room temperature preload is now adjusted during the yoke into shell assembly process (we give up some flexibility for simplicity and a stiffer structure)

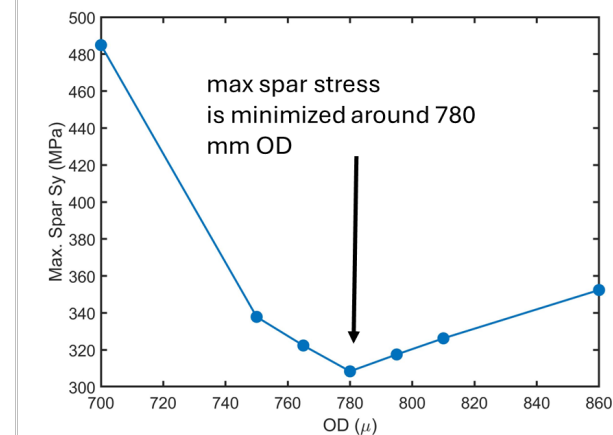
Assembly procedure with the simplified structure

- stretch shell using bladders/keys in vertical split at pole
- inflate Kapton bags between layer 4 and yoke and let cure

Optimized key and bladder structure (860 mm OD)



Optimized simplified structure (780 mm OD)

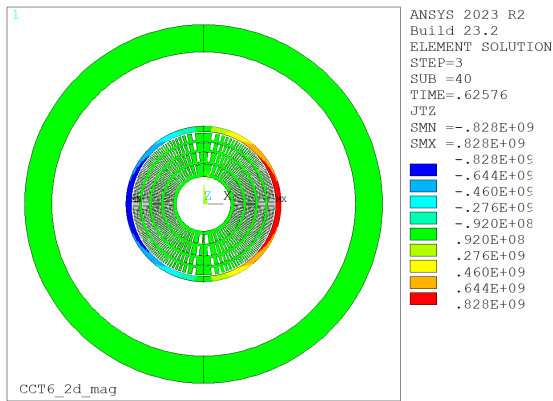


*Concept and calculations by L. Brouwer*

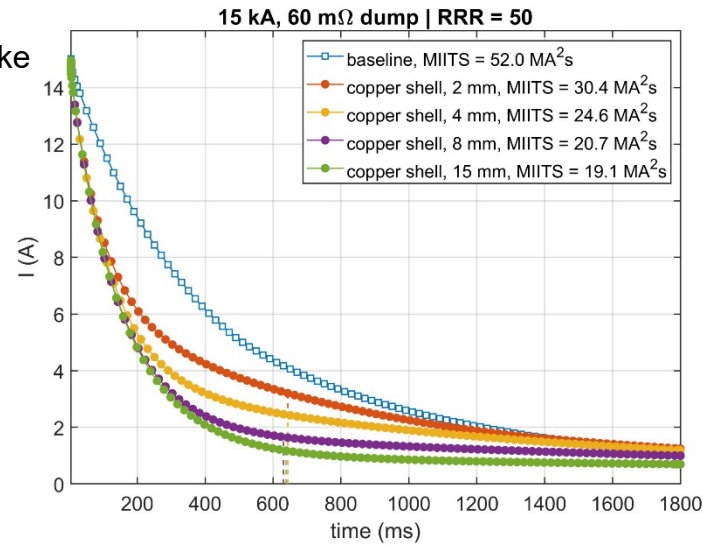
# Quench protection studies needed to define outer layer cable parameters

Preliminary studies have been performed to explore the addition of low resistivity material for energy transfer (through eddy currents)

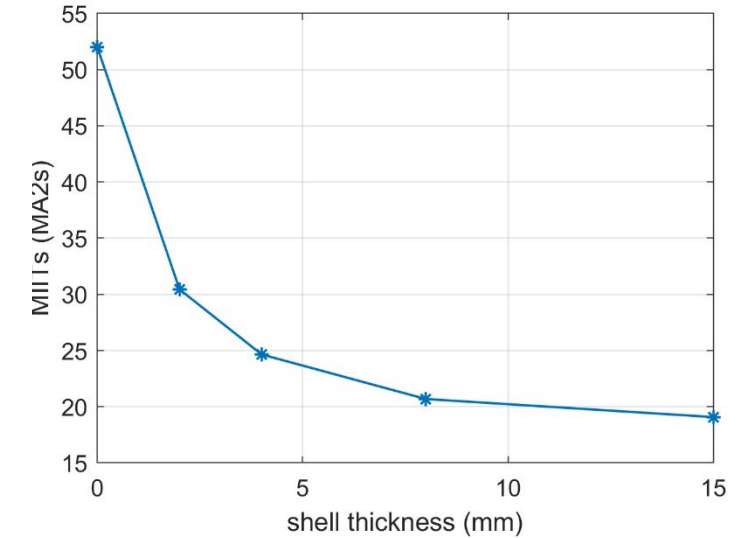
Cu shell added between coil and yoke



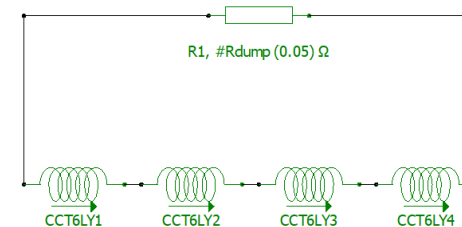
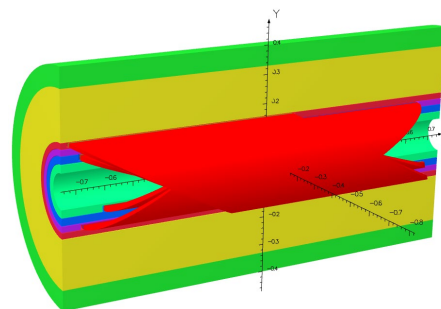
## Circuit coupled modeling in ANSYS



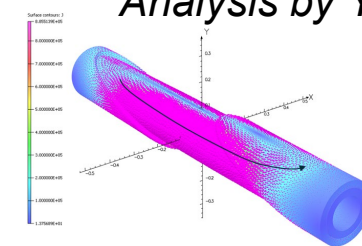
Analysis by Yufan Yan



## Opera3D quench module for including propagation



Analysis by Ye Yang



# Conclusions

- Starting up activities on CCT6 and subscale again after a break in funding
- Telene subscale coils ready for impregnation test  
impregnation on dummy coil
- Making progress on CCT6 Layer 1 and 2 coil fabrication
- Upcoming work on finalizing design of outer layers and structure for CCT6
- Plan to also focus on CCT5W data analysis over next several months (LBNL and FNAL)