Progress with 2212 work

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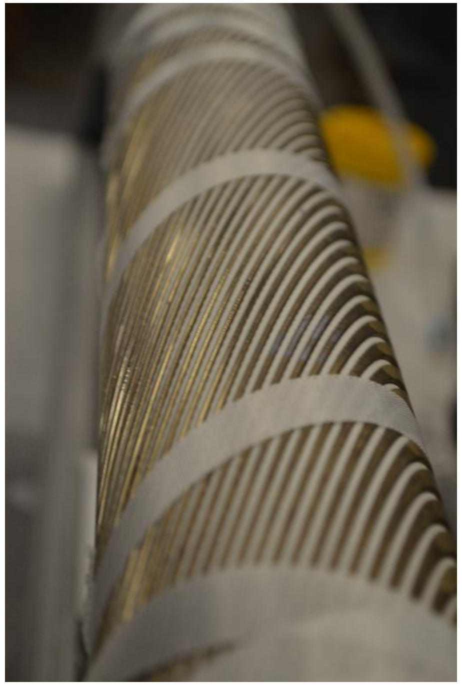
2023/06/21

This work was supported by the U.S. Department of Energy, Office of Science, Office of High Energy Physics (HEP) through the US Magnet Development Program under contract No. DE-AC02-05CH11231.

Renegade Furnace Updates

- The commissioning of the **Renegade** furnace is ongoing:
  - The system has been dried-out
  - The furnace has seen full temperature at 1 bar
  - The furnace has seen full pressure and power
  - The furnace can be safely operated
  - The operation data is being evaluated against the models before moving further
  - Before coil heat treatments, the controls still need PID-tuning and evaluation runs on the representative dummy-CCT mandrel with short samples.

Bi-CCT1 coils and conductors



Three coils wound, basic parameters established, winding methods in place.

Bi-CCT1ILb | **Bi-CCT1OLa** | **Bi-CCT1ILc (deformed mandrel; 1st coil to HT)**

CABLE ID	Y820L1109	Y820L2002
STRAND ID	Nontwisted PMM180207_4, 5, 6 ,7	Nontwisted PMM190118
Powder ID	Engi-Mat lot 103	Engi-Mat lot 156
NO. STRAND	17	17
NOMINAL STRAND DIA (MM)	0.8	0.8
CABLE TRANSPOSITION ANGLE (DEGREE)	15.6	15.6
CABLE TRANSPOTION PITCH LENGTH (MM)	~58	~58
STRAND TWIST PITCH (MM)	~52.1	~52.1

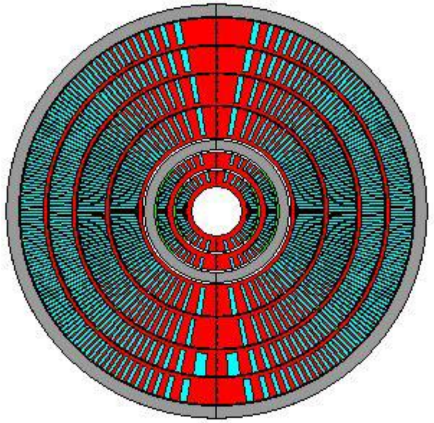
No more cables.
Transverse pressure test Incoming.

Only 38 m left.
Transverse pressure test done.

Bi-CCT1 dimensions, dummy mandrels supporting coil heat treatment optimization and furnace commissioning

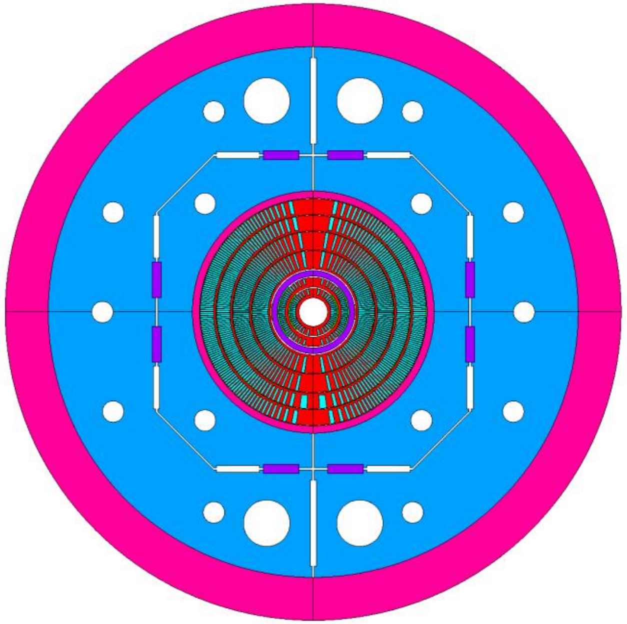
Mandrel	IL (Inner Layer)	OL (Outer Layer)	Dummy mandrel
Material	Aluminum Bronze 954	Aluminum Bronze 954	Aluminum Bronze 954
Mandrel ID (mm)	40	70	69.85
Mandrel OD (mm)	66.2	96.2	96.2
Mandrel length (mm)	850	850	850

BiCCT1 inside CCT6

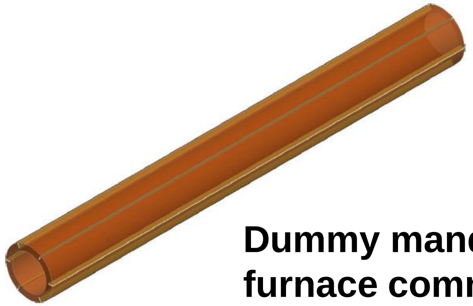


By LGF

BiCCT1 inside CCT6 and structure



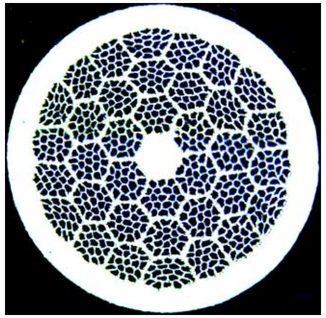
Mariusz Juchno

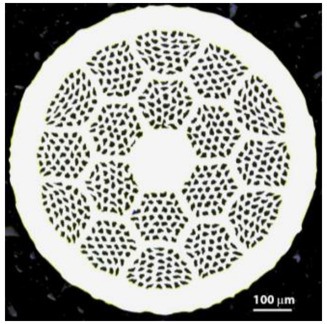


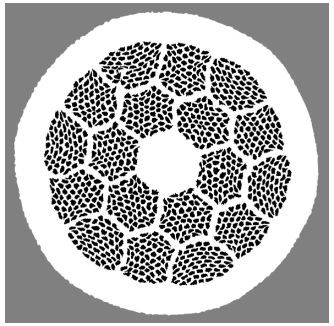
Dummy mandrel supporting coil heat treatment optimization, furnace commissioning, cable and insulation related studies.

Conductor and its architecture

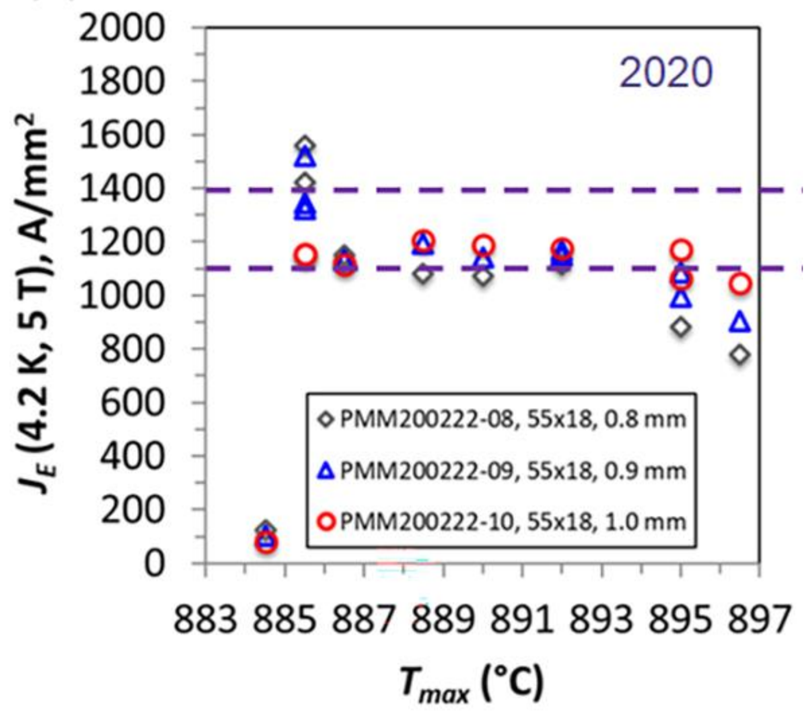
Strands	Powder	Coils
19 x 36, 0.8 mm strands	Nexans	RC1
37 x 18, 0.8 mm strands.	Nexans	RC2/3
55 x 18, 0.8 mm strands.	Engi-Mat	RC5/6/7/8, BIN5c1, BIN5OLa, Bi-CCT1OLa, Bi-CCT1ILb/c.





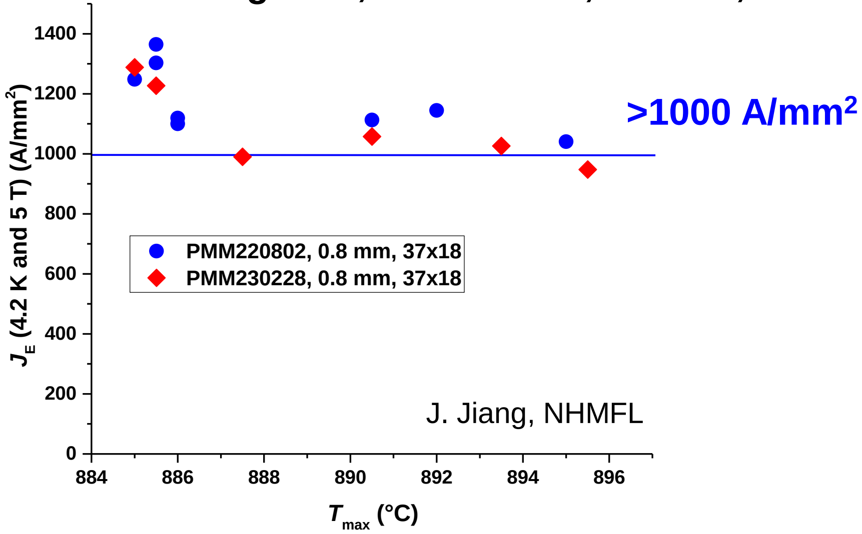


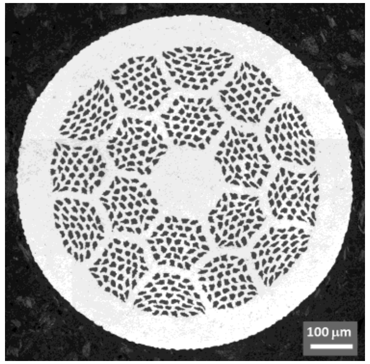
Jiang, 10.1109/TASC.2023.3236870



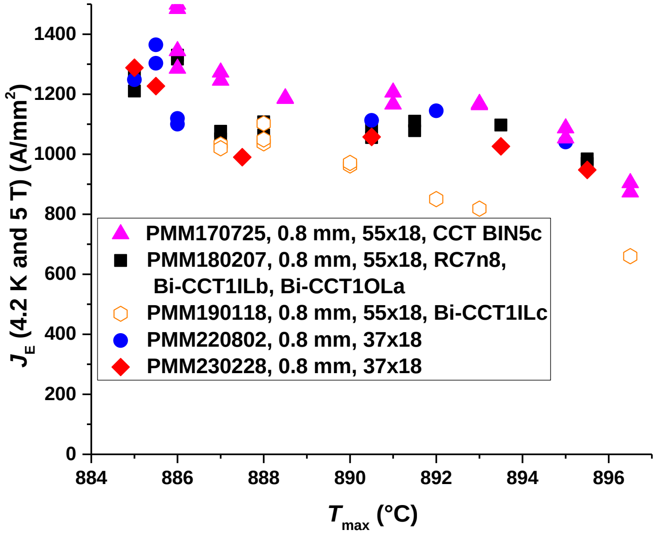
New (SBIR) wires and verification with BIN5 type cables and magnets

SBIR collaboration
Engi-Mat, Bruker OST, NHMFL, LBNL





PMM220802

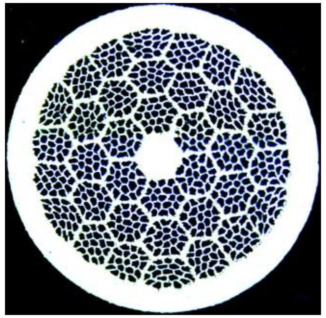


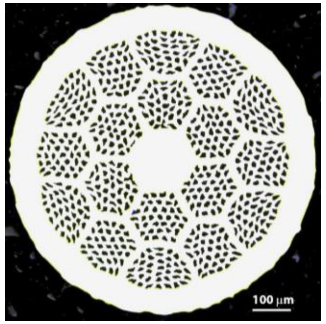
- **37 x 18, 0.8 mm strands.**
- **Billet #1: PMM220802, 305 m; Billet #2: PMM230228, 270 m;**

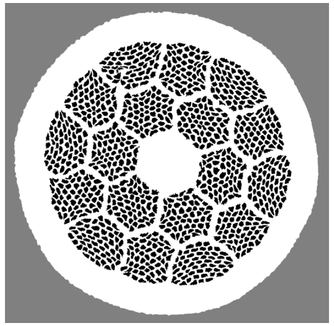
- **To be made into a BIN5 type, 9-strand Rutherford cable (4.0 mm x 1.44 mm)**
- **To check performance of extracted and rolled strands to understand the role of wire architecture in achieving high J_c in a cable and CCT magnet.**
- **Coil production follows (with experimenting insulation materials for removing leakage).**

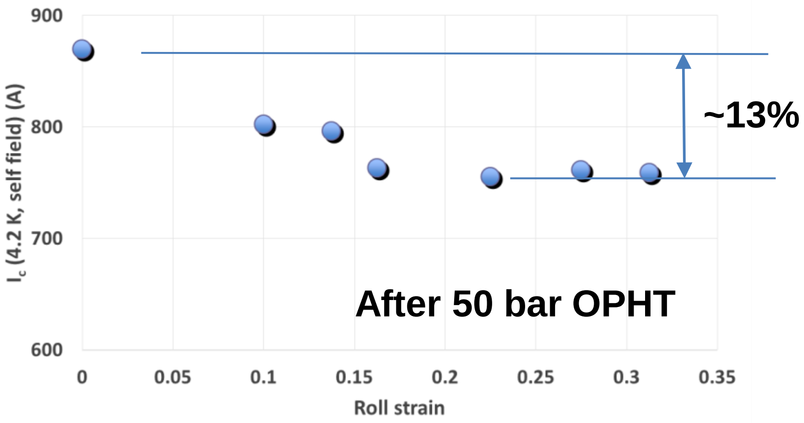
Conductor and its architecture

Strands	Powder	Coils
19 x 36, 0.8 mm strands	Nexans	RC1
37 x 18, 0.8 mm strands.	Nexans	RC2/3
55 x 18, 0.8 mm strands.	Engi-Mat	RC5/6/7/8, BIN5c1, BIN5OLa, Bi-CCT1OLa, Bi-CCT1ILb/c.

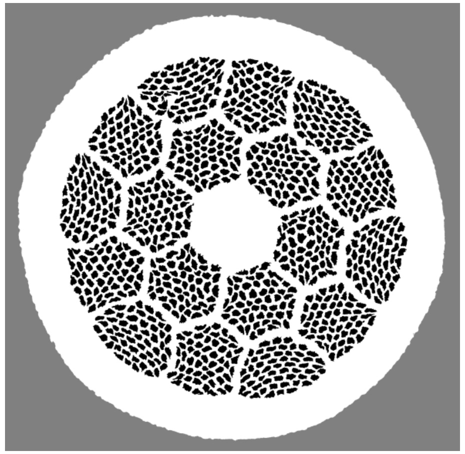




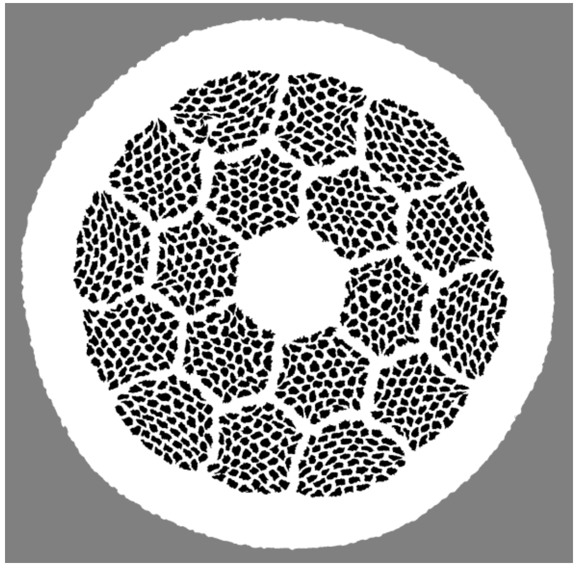




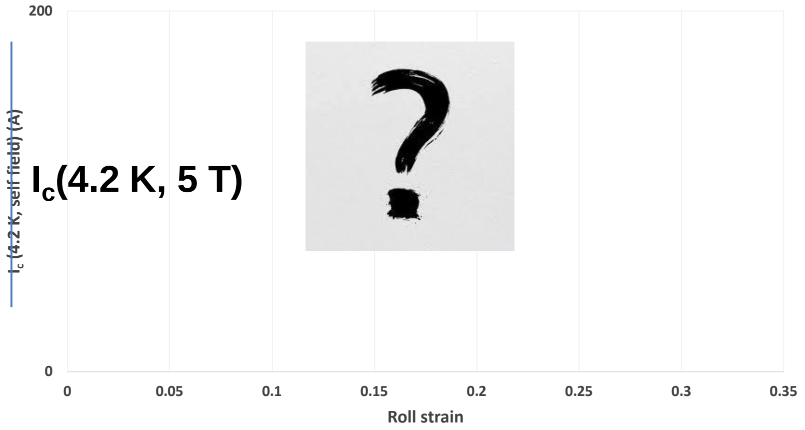
An accompanying study to deepen understanding of the science of acehiving high J_e in OPHT Rutherford cables



PMM170725, 0.8 mm,
55 x 18
CCT BIN5c



PMM211005, 1.0 mm,
55 x 18
CCT Bi-CCT2



Samples have been rolled; heat treatment, I_c measurement and microstructural characterizations to be completed.

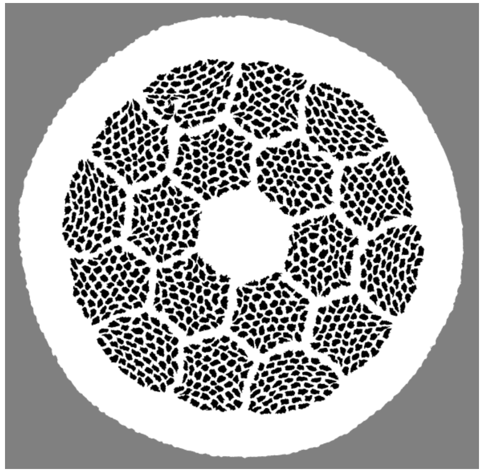
Studies might need to expand to other strands.

Bi-CCT2 design: Strand and cable

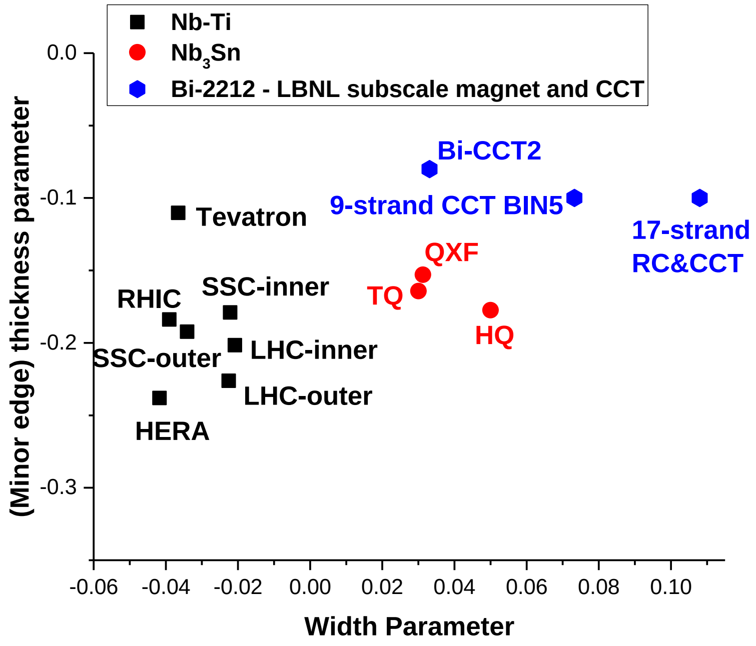
A cable fab request submitted:

	No. of Strands	Strand Dia (mm)	Pitch Angle	Pitch Length (mm)	Cable Width (mm)	Cable Thickness (mm)	Packing Factor	Notes
1	9	0.800	16.40	25.501	4	1.42	83.02%	CCT BIN5 cable 1093
2	17	0.800	15.75	50.103	7.8	1.4	81.21%	Bi-CCT1 cable 1109
3	23	1.000	15.50	86.065	12.3	1.84	82.83%	Bi-CCT2 cable candidates

PMM211005, 1.0 mm, CCT Bi-CCT2



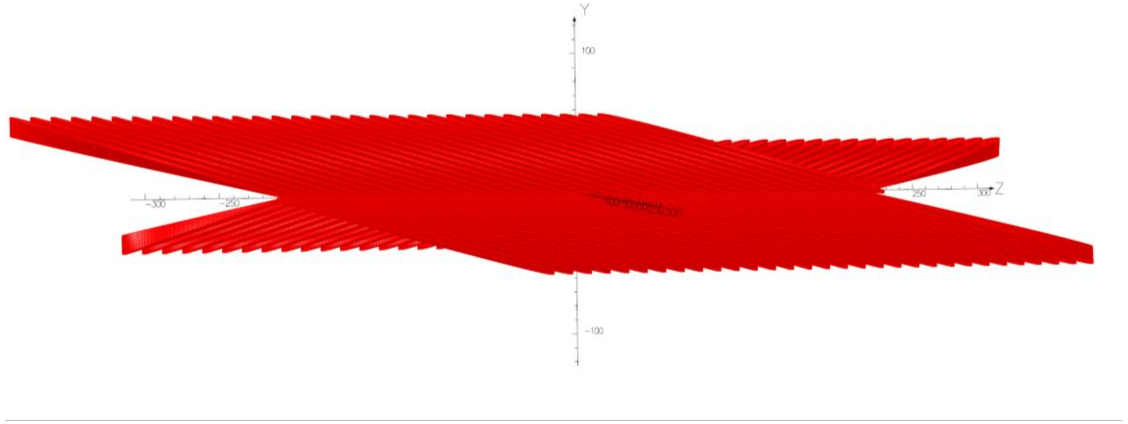
Ag-Mg sheath t ~ 0.067 mm,
~24% larger than that of 0.8 mm wires.
Does it reduce leakage?



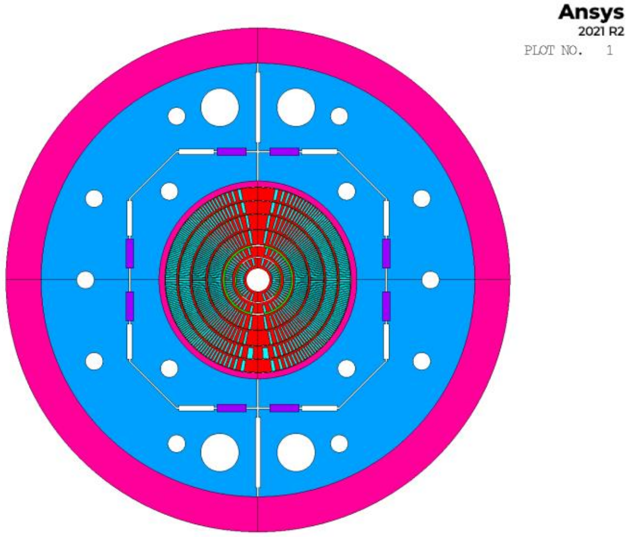
Bi-CCT2 design: Magnetic and geometrical

By LGF

Mandrel	IL (Inner Layer)	OL (Outer Layer)
Material	Aluminum Bronze 954	Aluminum Bronze 954
Mandrel ID (mm)	40	79.1
Mandrel OD (mm)	75.1	114.2
Mandrel length (mm)	850	850



BiCCT2 inside CCT6



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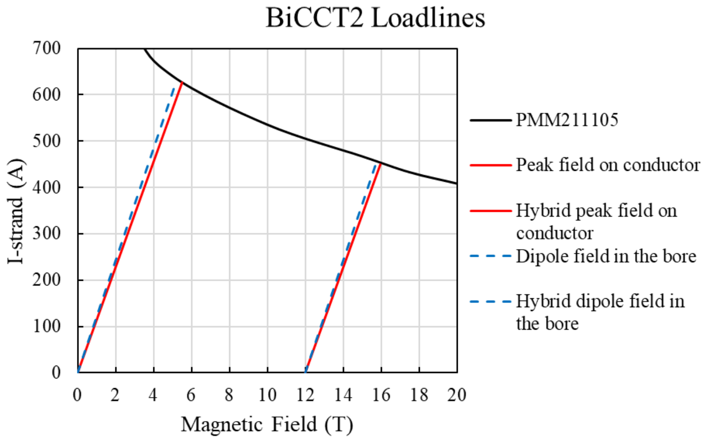
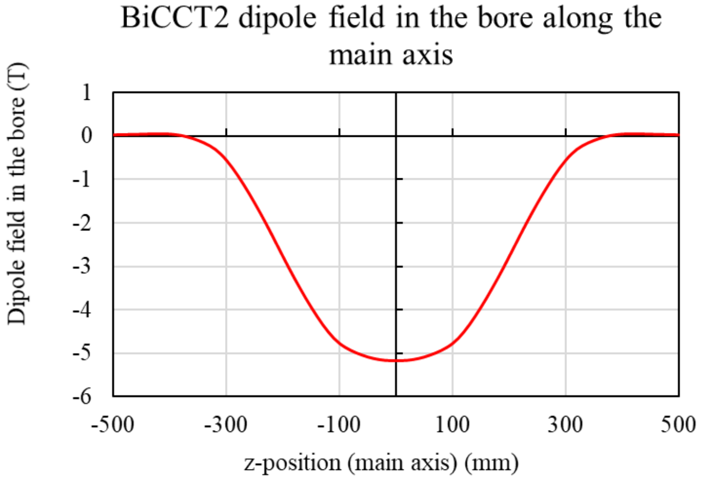




- **PMM211105 has a less-than-optimum J_E of ~850 A/mm^2 at 4.2 K and 5 T.**

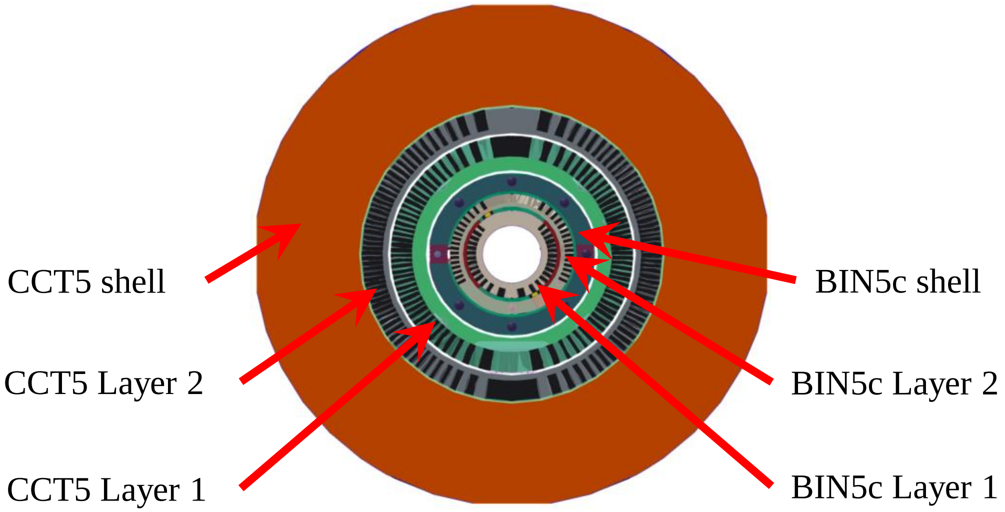
Bi-CCT2 fabrication challenges

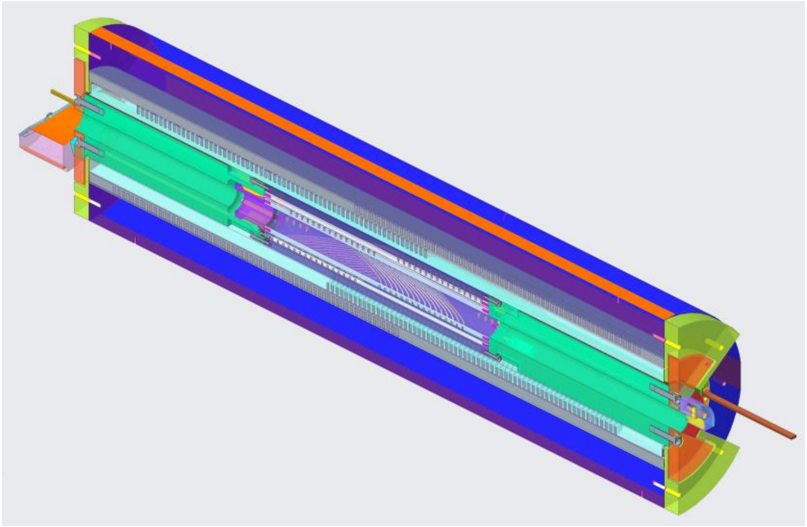
An attempt to wind 13 mm wide cable (dummy cable, w MgO paper, 13.28 mm x 1.54 mm) to a CCT mandrel (3D printed. Bluestone) with a winding radius of 24 mm shown to be difficult.

Challenge: De-cabling.
Tools/parameters to optimize: Tooling for minimizing de-cabling. TiO_2 coated and bonded insulation sleeve. Mechanical properties of cables (annealing states and cable pitch length).

Groove parameters and winding methods will be optimized first before entering into mandrel fabrication.

BIN5 insert for CCT5





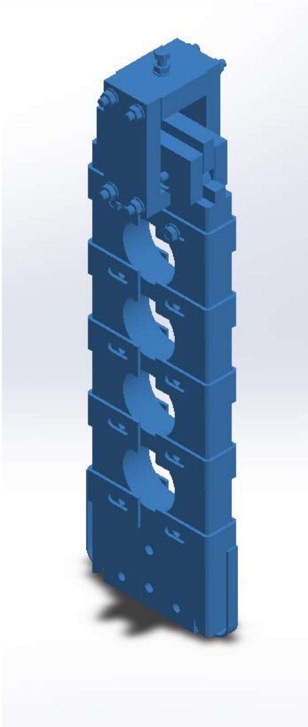
- **Moving towards insert coil performance verification, assembly with Al shell, instrumentation, assembly with Al alloy extensions.**

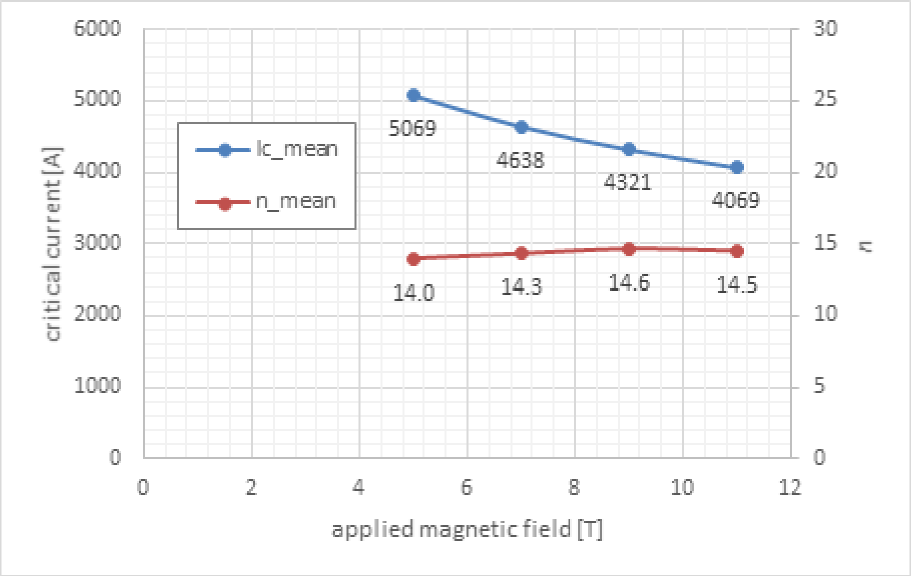
Cable transverse pressure experiments

Three samples have been tested (2020, 2022, 2023June).
The fourth sample is being prepared.

Europe (CERN): Uni. Twente
US sides (MDP): LBNL, NHMFL

Presentation in July 2023.





Third sample, LBNL2002, Apri2023 NHMFL HT, June2023TwenteMea

LBNL2002 (Bi-CCT1ILc coil, 17-strand Rutherford, PMM190118)

Sample #4: LBNL1109 (Bi-CCT1ILb and BiCCT1OLa, 17-strand Rutherford, PMM180207)

Recent talks

- **Bi-2212 Coil technology, Progress and Challenges, Ulf Trociewitz, Youngjae Kim, Daniel Davis**
- **Progress and plans at LBNL for fabricating 1 m long CCT Bi-2212 coils, Laura Garcia Fajardo.**