U.S. MAGNET DEVELOPMENT PROGRAM

Bi2212 SMCT insert coil end design

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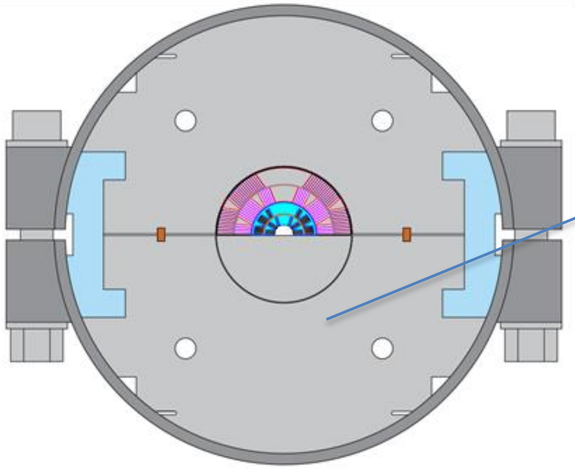
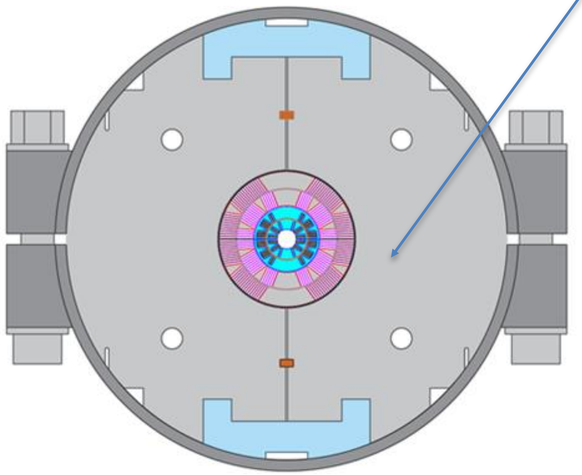
Fermilab

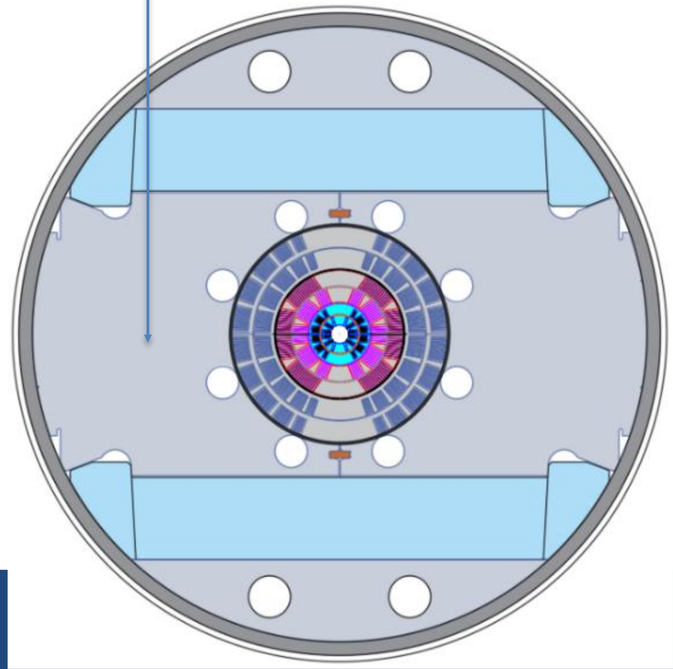
US-MDP General meeting
August 18, 2021

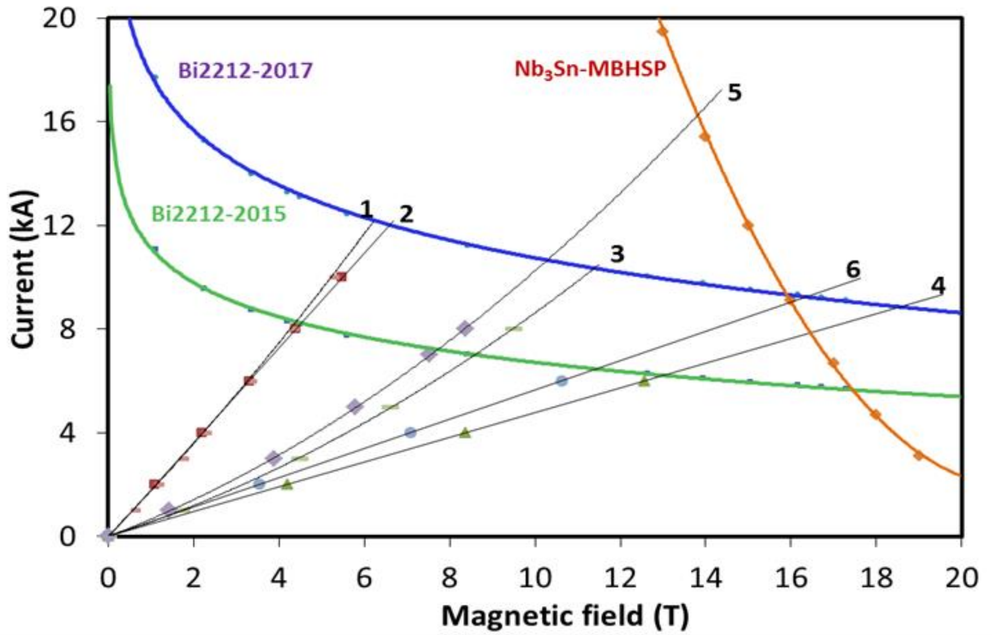
Bi2212 SMCT Dipole Insert Milestones





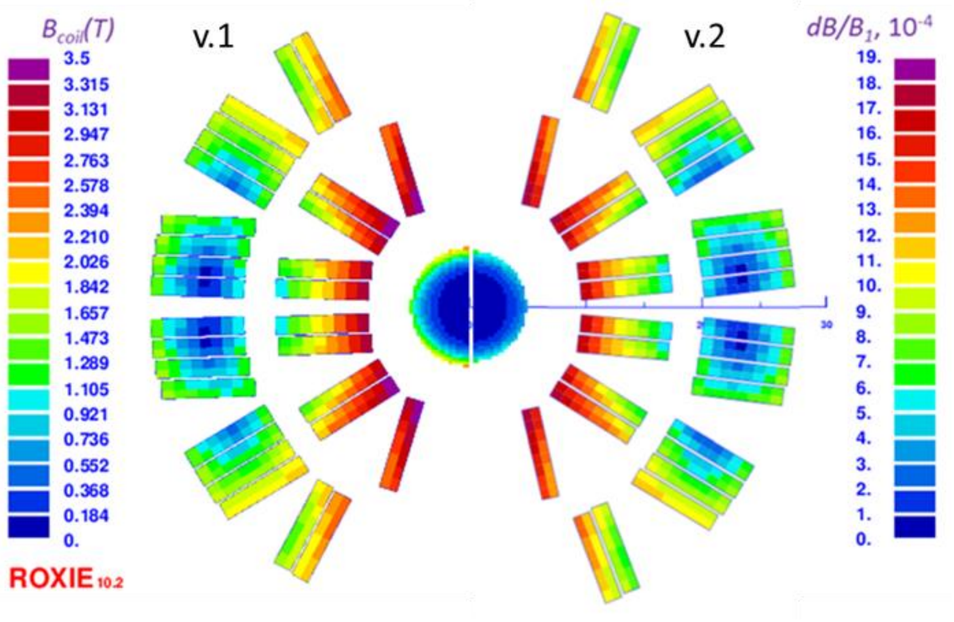
Milestone #	Description	Target
AIIa-M1b	Study strand damages due to cabling, transverse pressure dependence	April 2022
AIIa-M2b	Fabricate the first 2-layer 17-mm aperture Bi-2212 coil using LBNL cable. Coil test independently and inside a 60-mm aperture 2-layer Nb_3Sn dipole coil in mirror configuration.	July 2022
AIIa-M3b	Fabricate the 2nd 2-layer 17-mm aperture Bi-2212 coil using optimized Bi-2212 cable, coil structure, materials and technologies. Coil test independently and inside a 60-mm aperture 4-layer Nb_3Sn dipole coil in mirror configuration.	December 2022
AIIa-M4b	Fabricate another 2-layer Bi-2212 coil using optimized Bi-2212 cable and coil structure. Bi-2212 coil test independently and inside a 60-mm aperture 4-layer Nb3Sn dipole coil.	September 2024

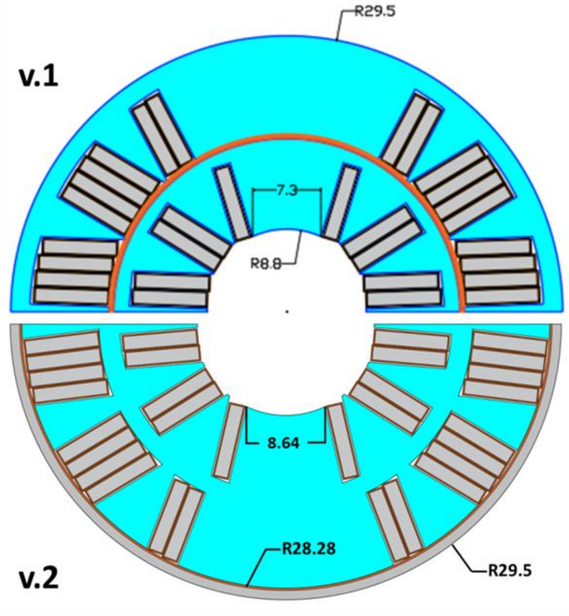




Magnetic and mechanical design improvement

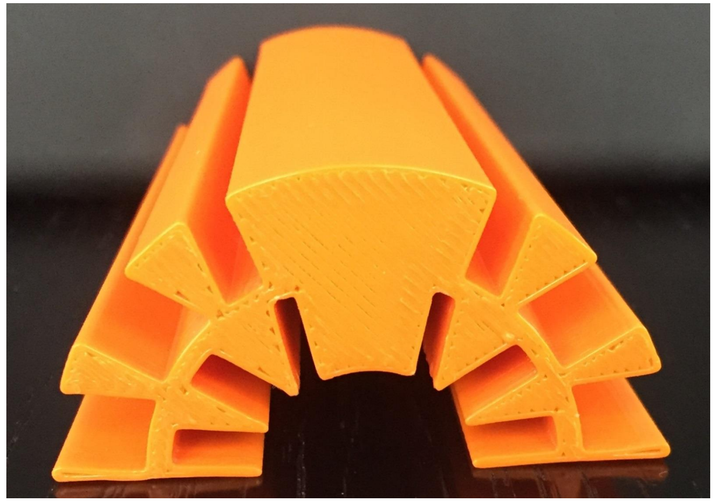
LBNL cable

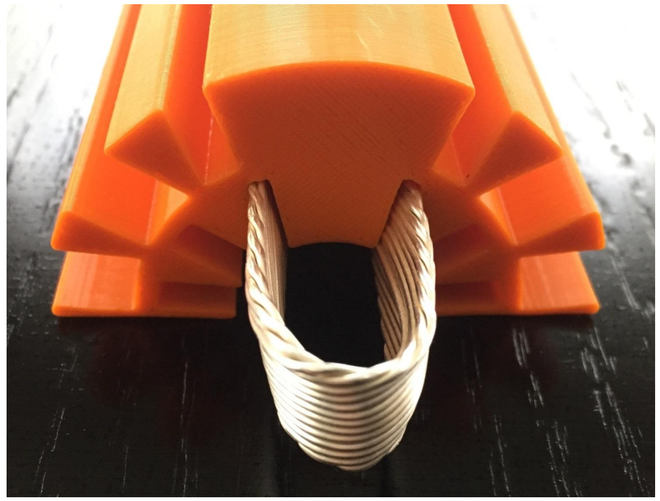


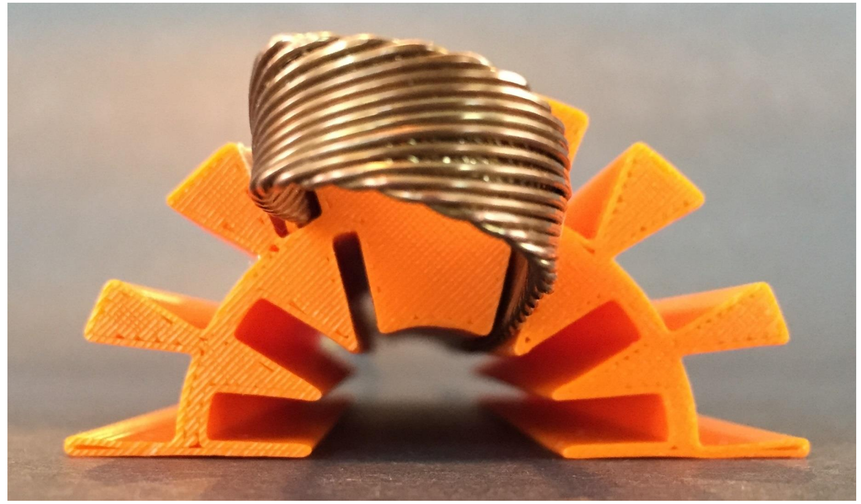


- Aperture from 17 mm to 19 mm
  - larger radius on inner-layer pole
  - better field quality
- One single support structure rather than two
- Coil length = 450 mm

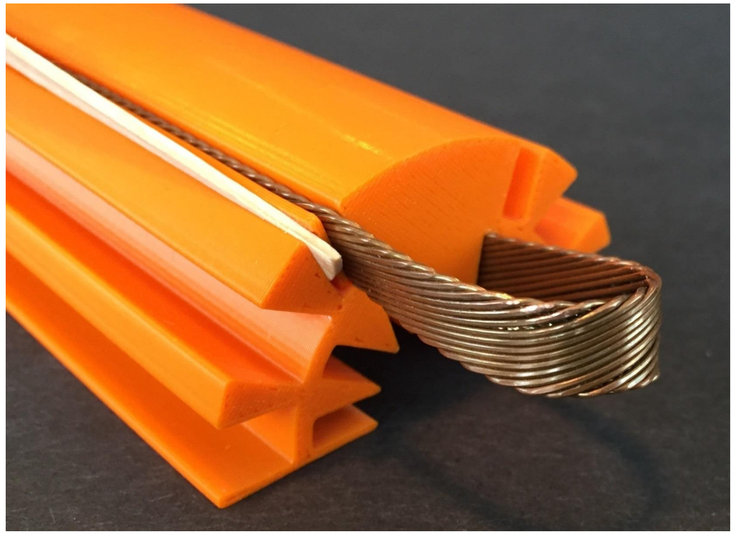
Bi2212 insert structure and winding demonstration



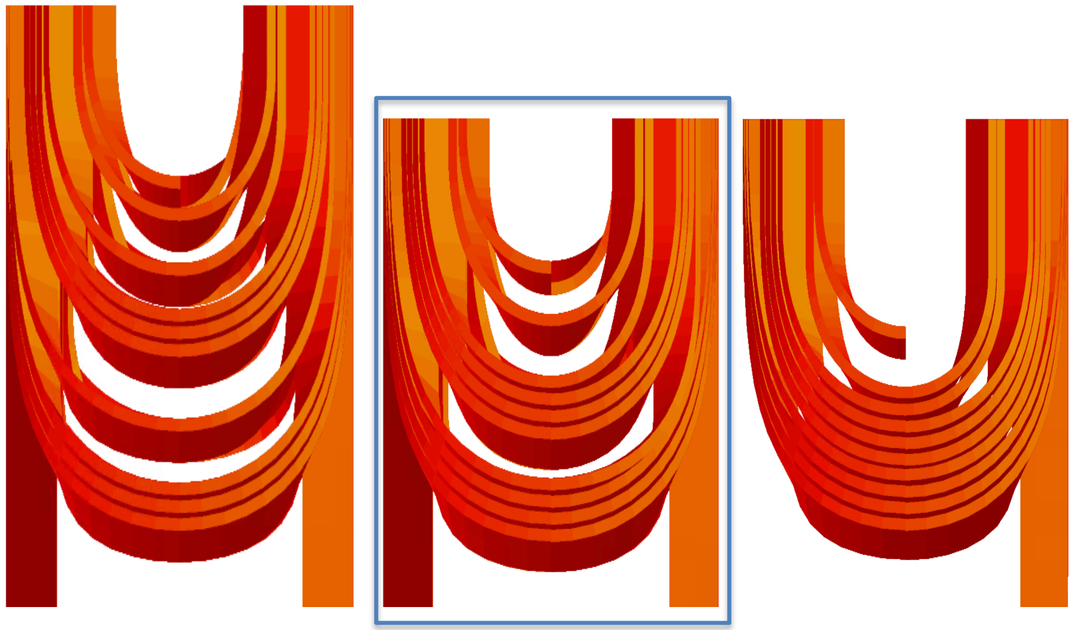


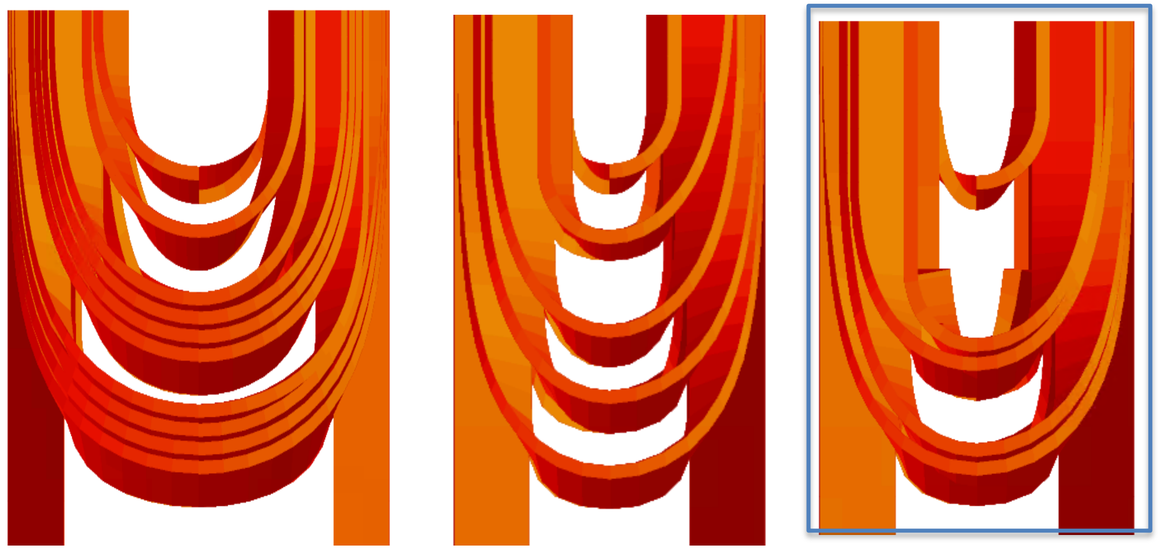


- Nb_3Sn LBNL cable ~10 m long with same width as Bi2212 cable and slightly smaller thickness was used for practice winding.
- Next: coil end design

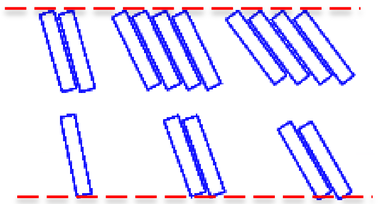


End design options and criteria



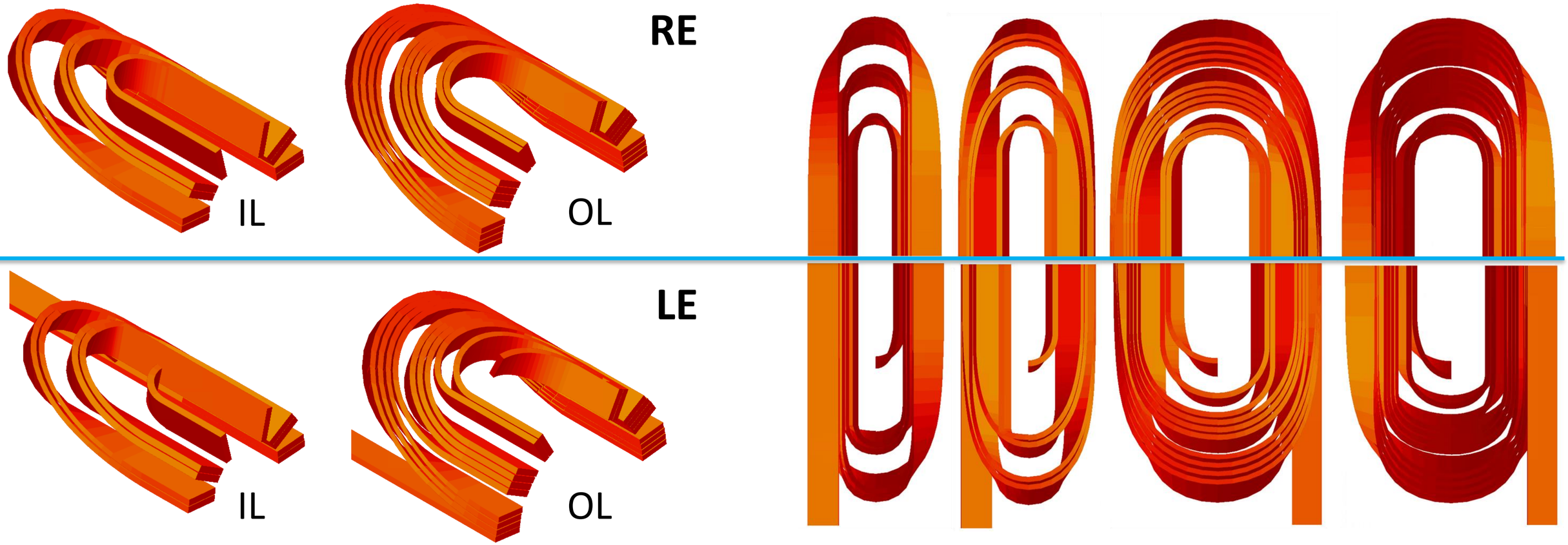


- ROXIE 3D
- Constant perimeter
- OL: OD turn alignment
- IL: ID turn alignment



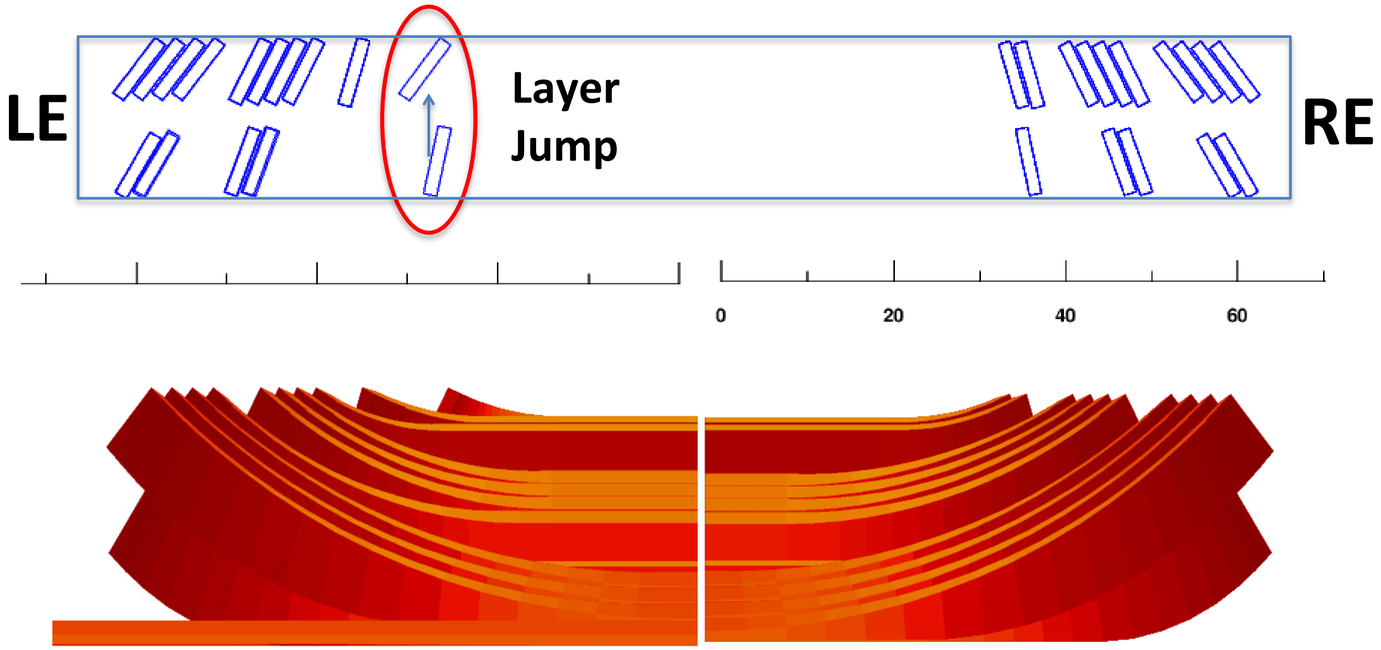
- Minimal end length
  - o determined by the OL coil
- Minimal cable deformation
- Avoiding single turn in a groove

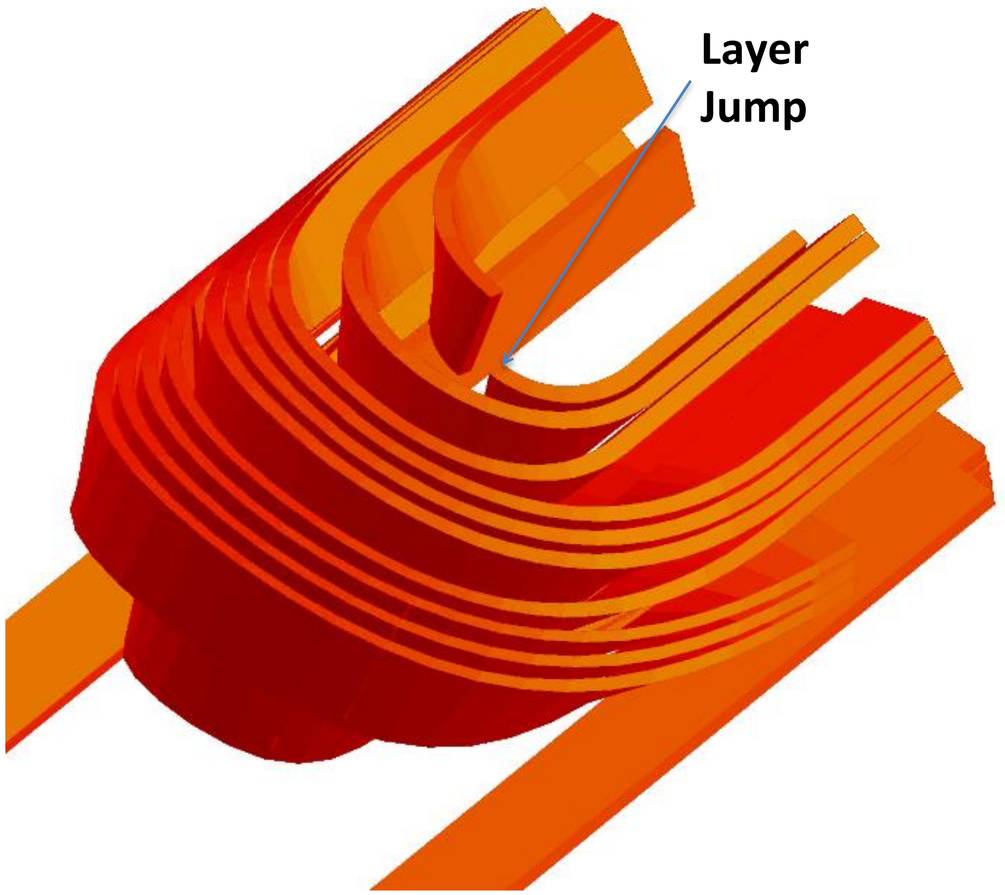
Bi2212 SMCT insert RE and LE design



- **Cable deformation:** ***both RE and LE within 0.9 - 1.14***
- **Cable length:** ***RE 1.776 m and LE 1.885 m***

Layer Jump





- Layer jump approach: bend inner cable up to match the outer layer cable angle

Next design steps

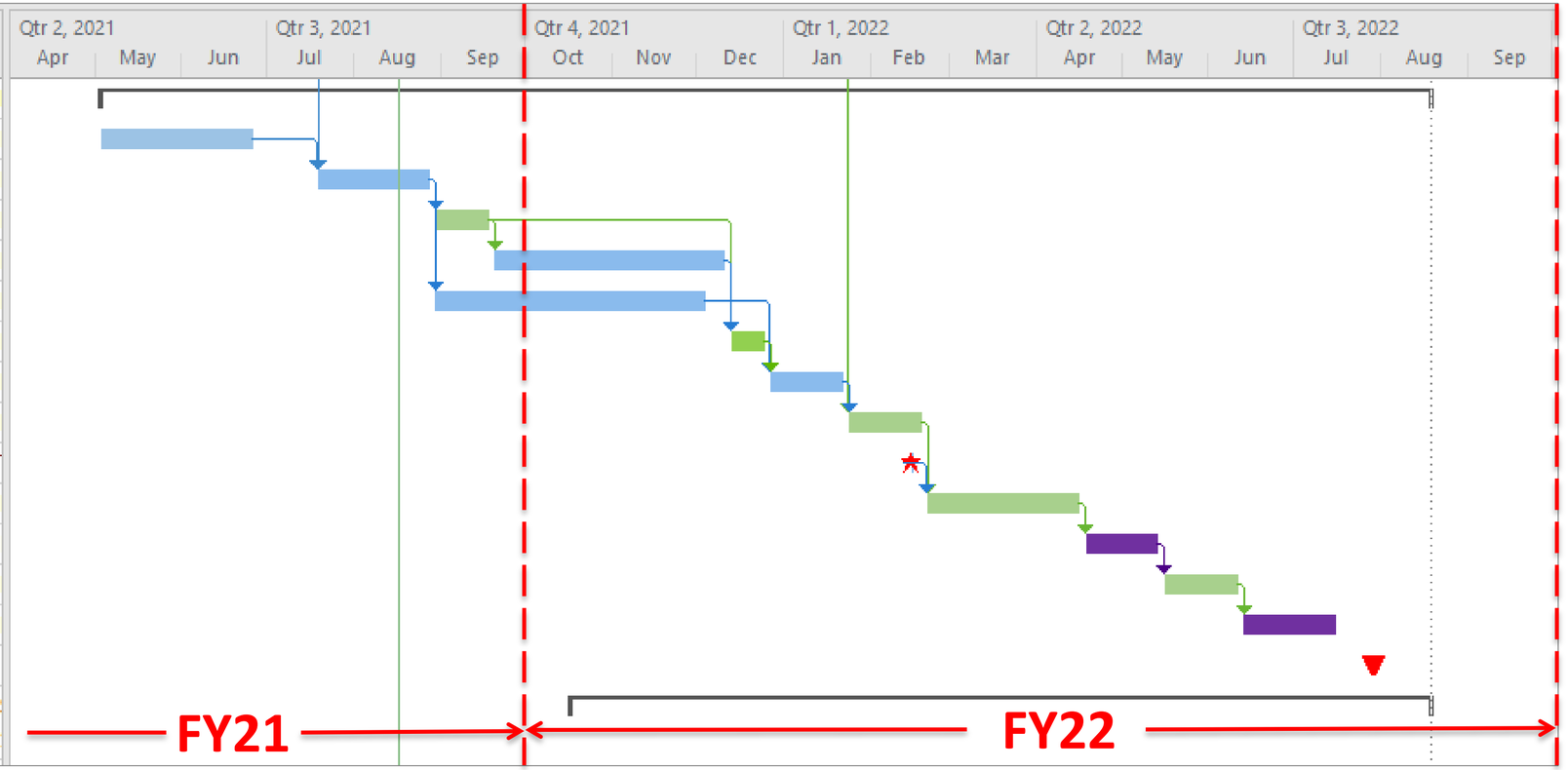
- Check LE and RE cable parameters with BEND
- Design Layer Jump
- Produce solid model of support structure with ends
- Produce files for 3D printing, print plastic parts
- Wind and impregnate practice coil using Nb_3Sn cable
- Cut and inspect coil ends
- Optimize end design (if needed)

Need to complete this in FY21

Bi2212 SMCT insert schedule

	Task Mode	Task Name	Duratio
18		**Task 2. Bi2212 insert coil R&D**	**339 days**
19		3D coil design concept	8 wks
20		3D coil design	6 wks
21		practice coil fabrication/analysis	3 wks
22		coil part procurement	12 wks
23		R/I tooling design & fabrication	14 wks
24		coil winding	2 wks
25		coil reaction (NHMFL)	4 wks
26		coil impregnation/instrumentation	4 wks
27		HTS/LTS mirror assembly and test review	1 day
28		4L HTS/LTS HFDM mirror assembly	8 wks
29		HTS coil in 4L HFDM test	4 wks
30		mirror warm-up and coil reconnection	4 wks
31		HFDM test with 4L coil	5 wks
32		USMDP milestone	1 day
33		**Task 2-1. 2nd Bi2212 insert coil design and fabrication**	**219 days**

GANTT CHART



- Coil reaction at NHMFL in January 2022 (need to discuss and coordinate)
- Magnet assembly and test review in February 2021

Intense schedule with COVID-19 and limited resources!