



U.S. MAGNET  
DEVELOPMENT  
PROGRAM

# MDP Nb<sub>3</sub>Sn SMCT program overview

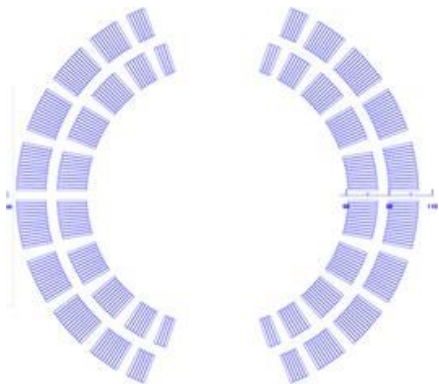
*A.V. Zlobin*

U.S. MDP Collaboration Meeting CM7  
03/21/2023

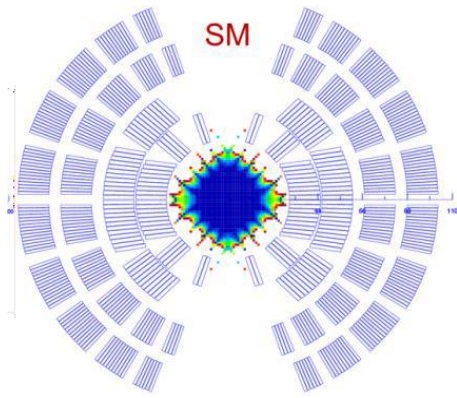


U.S. DEPARTMENT OF  
**ENERGY**

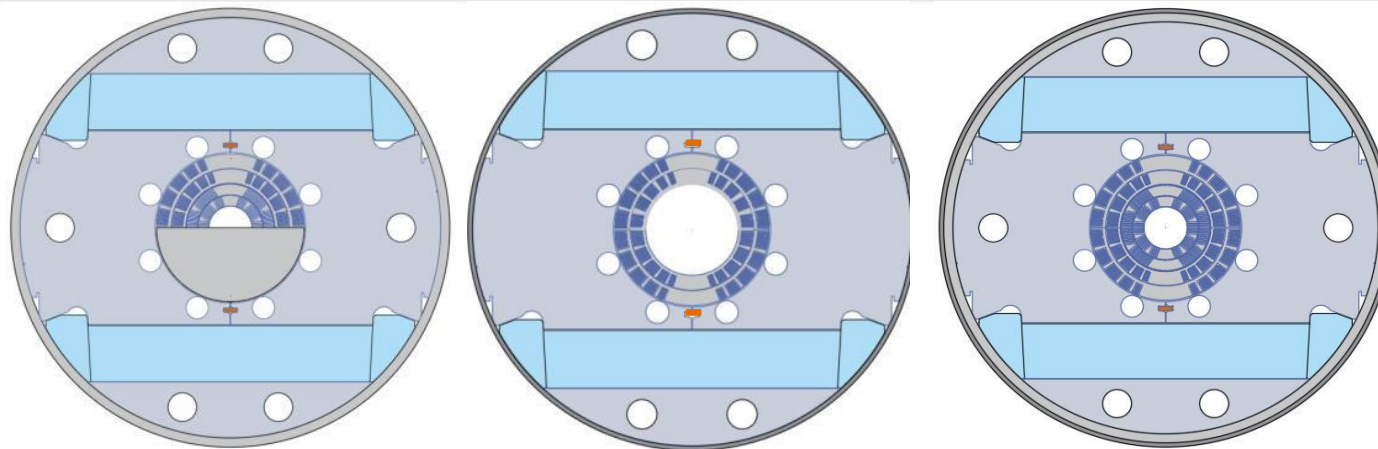
Office of  
Science



ID=120 mm, B<sub>des</sub>~11 T



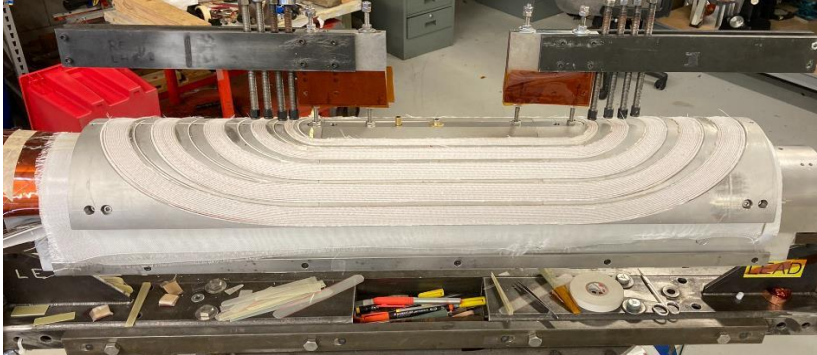
ID=60 mm, B<sub>des</sub>~17 T



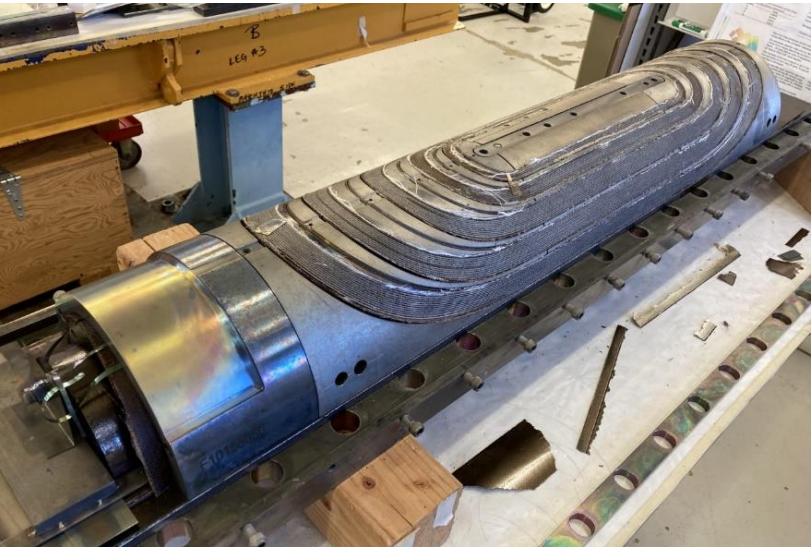
**Cos-theta dipole coils with stress management**

Milestone #	Description	Target
AI-M1a	Development and test of stress management concept using a 2-layer large-aperture and 4-layer small-aperture cos-theta coils and dipole mirror structure.	June-23
AI-M2a	Development, fabrication and test of stress management concept in a 2-layer 120-mm dipole with the field up to 11 T.	June-24
AI-M3a	Assembly and test of stress-management concept in a 4-layer 60-mm 17 T dipole with stress management.	Sept-24





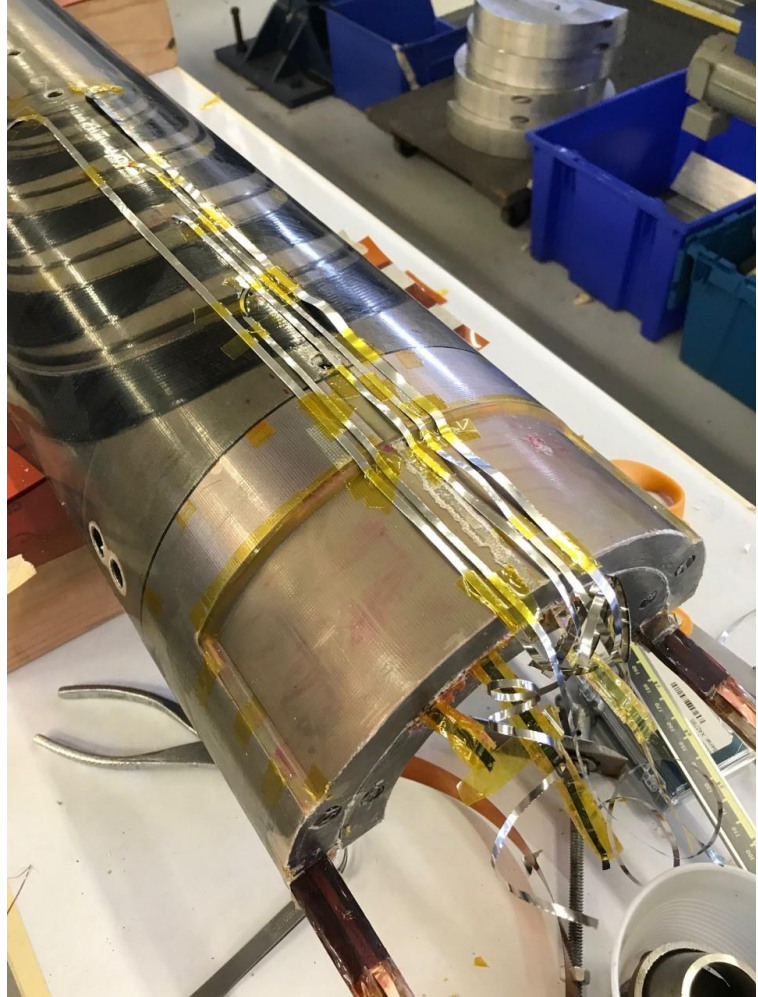
Coil after winding



Coil after reaction



Coil after impregnation with epoxy

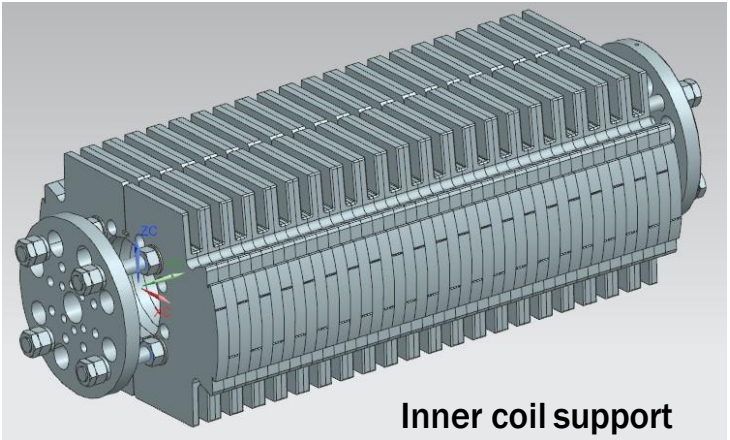


Coil instrumentation

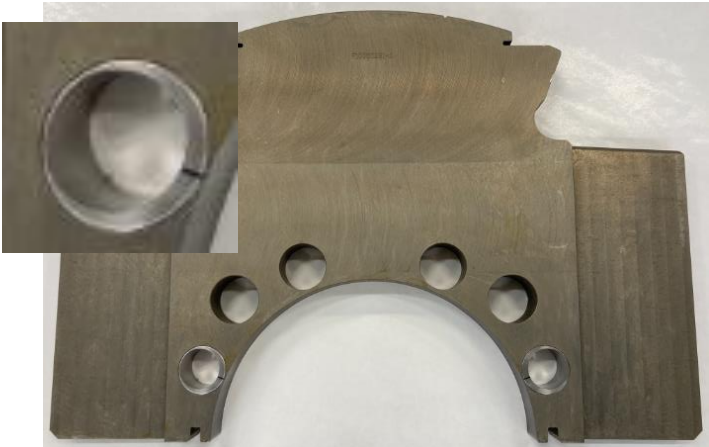




# Structure components modification and procurement



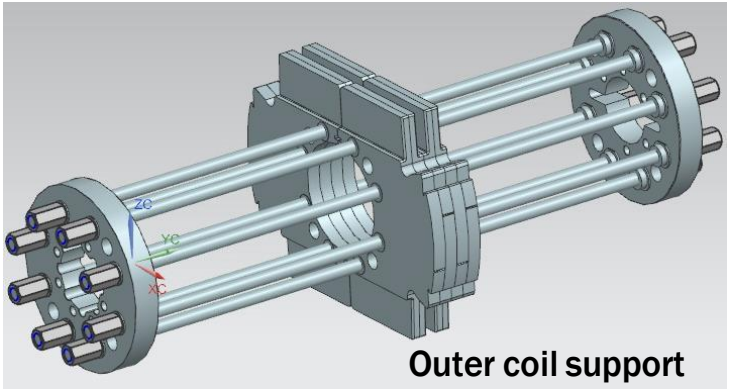
Inner coil support



Iron laminations with hole inserts



Iron yoke and end support assembly



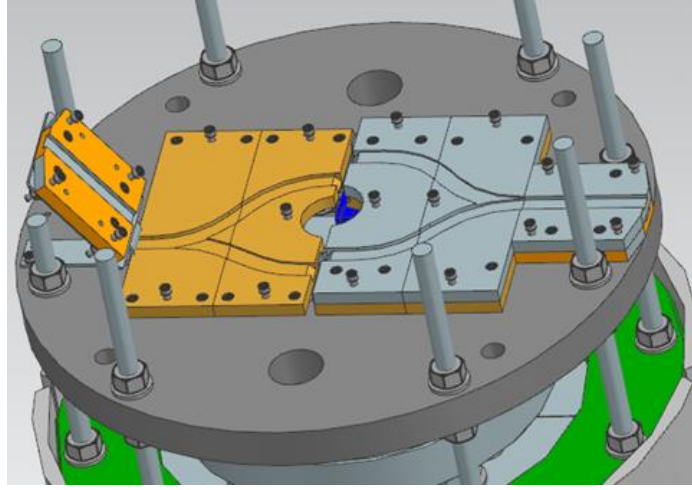
Outer coil support



End plates



Rod with bushing



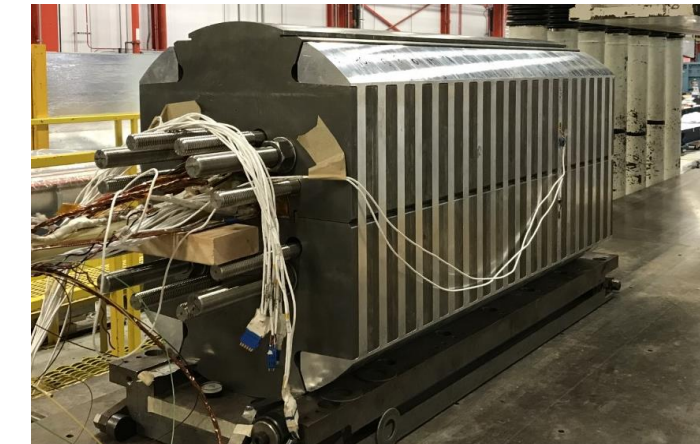
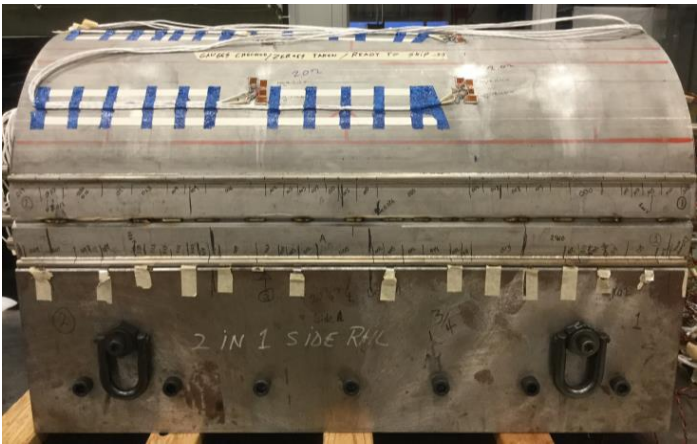
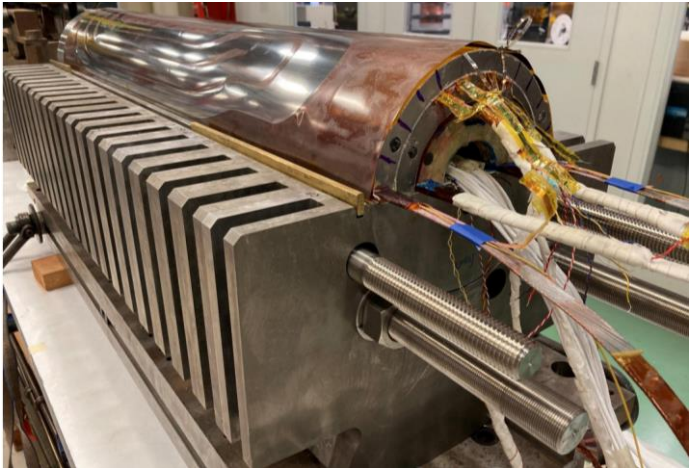
Modified splice block for SMCT coil and two connection configurations





# SMCTM1 assembly (details in Igor's talk)

Dipole mirror configuration with horizontal yoke split



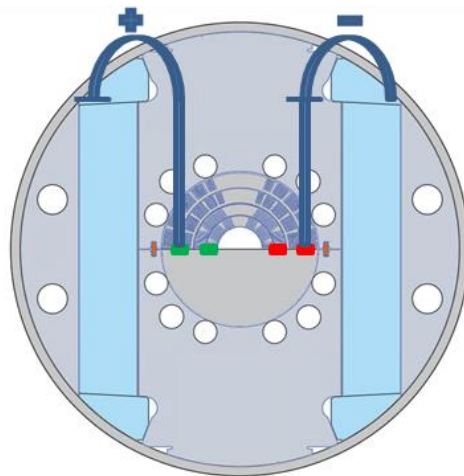
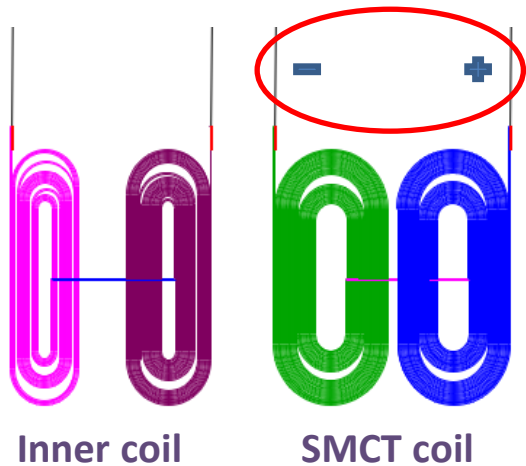




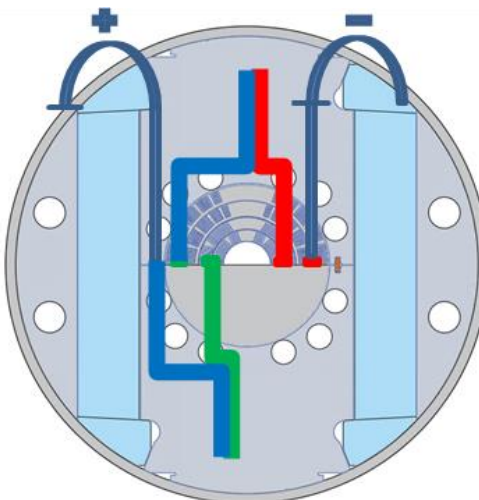
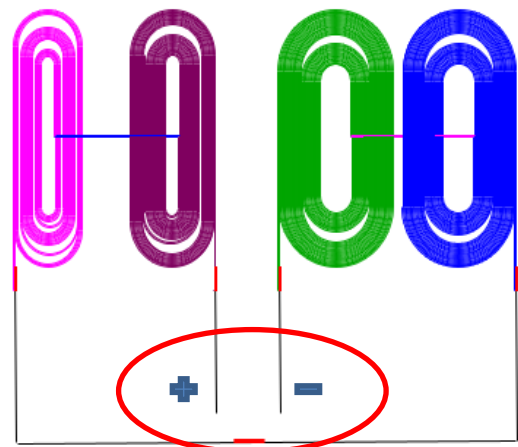
# SMCTM1 test steps and configurations

Preparation to SMCTM1 test has started including test configurations, test steps and documentation

SMCTM1 Test 1:  
SMCT (outer) coil  
powered



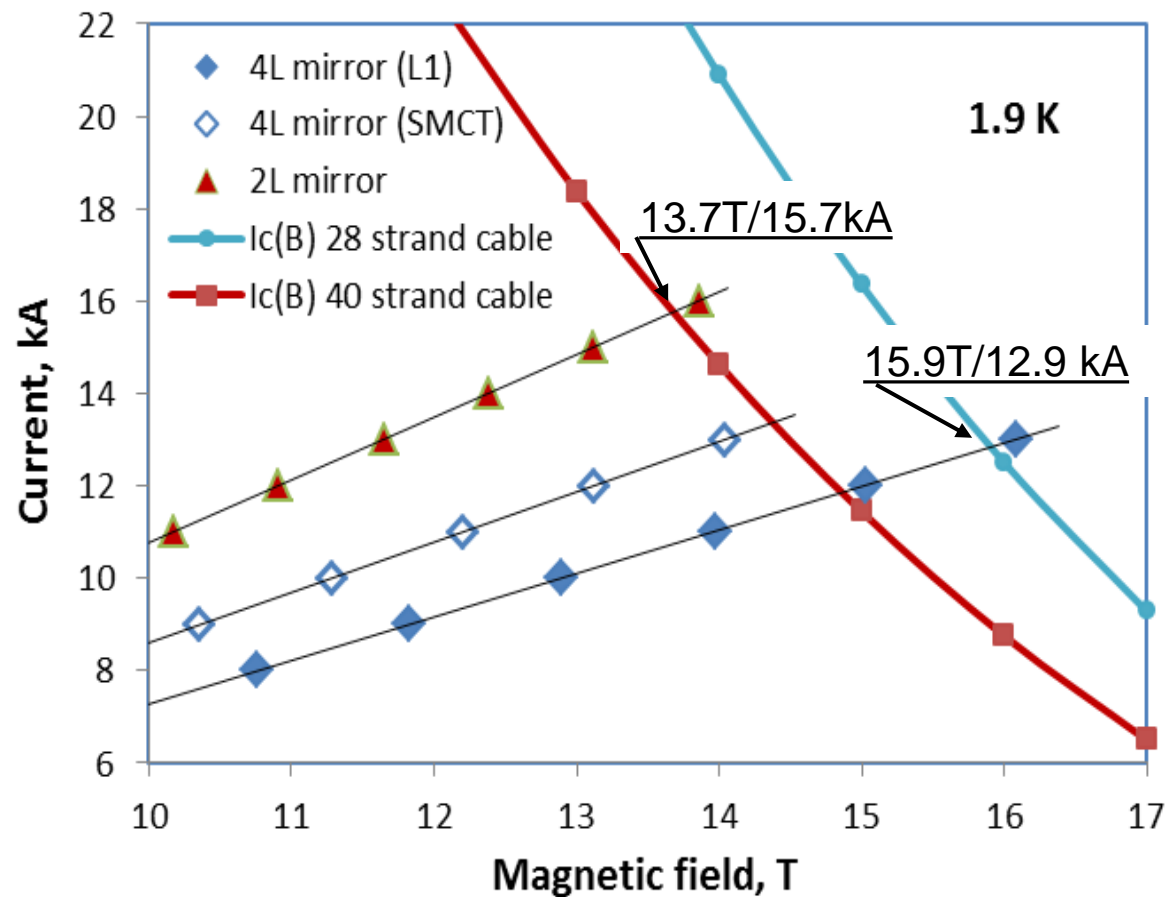
SMCTM1 Test 2:  
15 T inner and  
SMCT (outer) coils  
powered

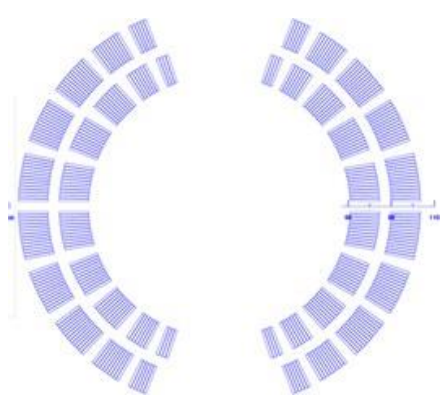




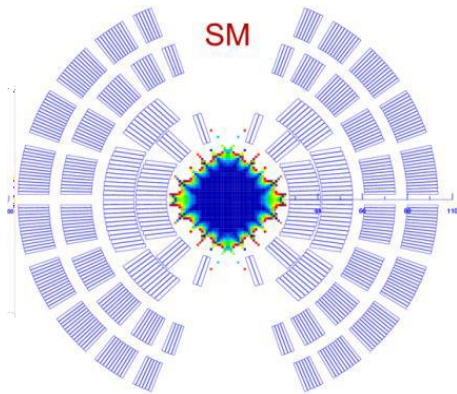
## SMCTM1 conductor limits

- $I_c(B)$  curves of 40-strand (SMCT coil) and 28-strand (inner coil)  $Nb_3Sn$  cables at 1.9 K.
- Load lines of SMCT and insert coils in 2L and 4L dipole mirror configurations.
- Short sample limits
  - $B_{max} = 13.7$  T at 15.7 kA – 2L mirror
  - $B_{max} = 15.9$  T at 12.9 kA – 4L mirror
- $B_{max}$  in the SMCT coil in the 4L mirror at the conductor limit is 13.9 T which is practically on the same level as in the 2L mirror.

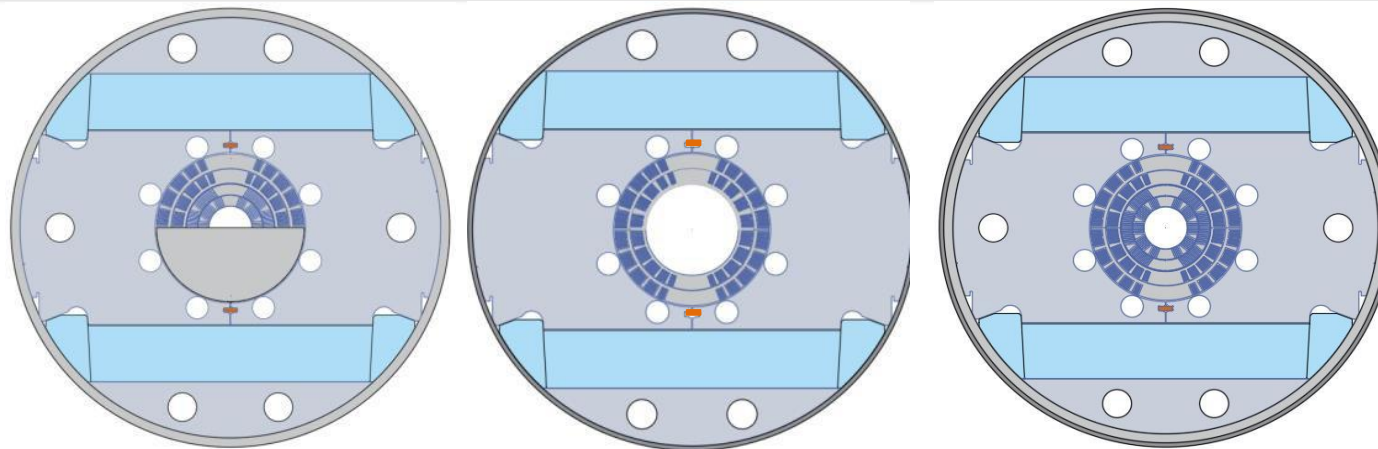




ID=120 mm, B<sub>des</sub>~11 T



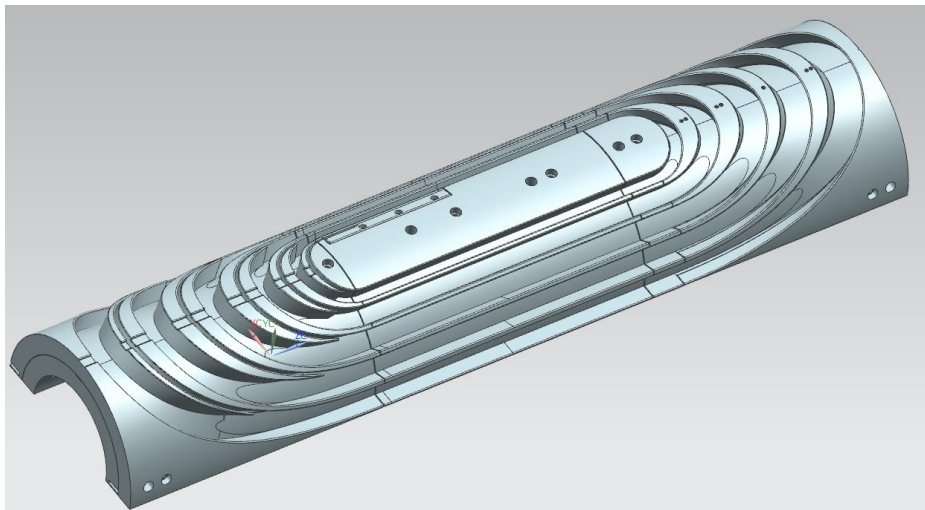
ID=60 mm, B<sub>des</sub>~17 T



**Cos-theta dipole coils with stress management**

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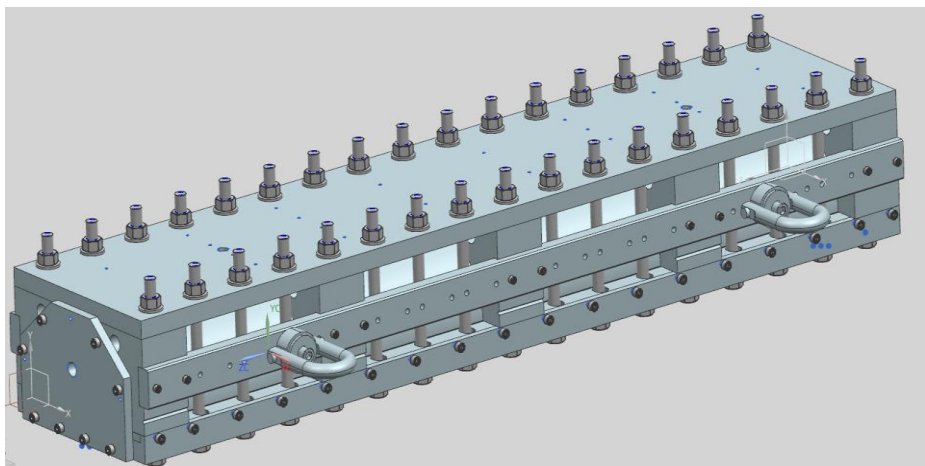


## SMCT coil structure

- shorten inter-block transitions
- optimize inter-block space
- move interlayer transition to LE block

### Goals:

- reduce coil end length
- minimize SMCT structure post-processing

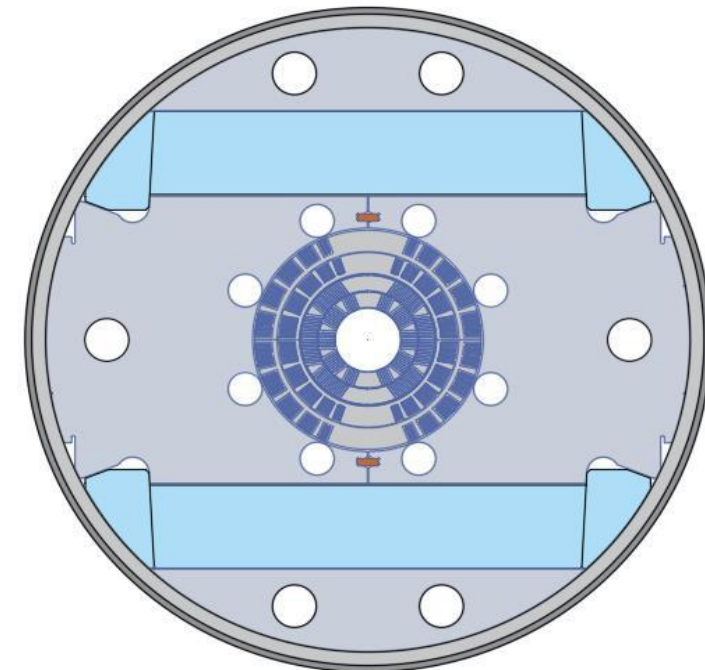


## Reaction-Impregnation tooling

- add missing blocks to

### Goal:

- improve coil size precision



## Magnet structure

- Additional shell

### Goal:

- reinforce structure radial strength

- The 1<sup>st</sup> SMCT coil has been fabricated, measured and instrumented
- Structure components have been modified and procured
- SMCTM1 assembly with horizontally split yoke is in progress (*details in Igor's talk*)
- Preparation to SMCTM1 test has started
  - configurations, test steps and documentation
  - magnet test in 2L and 4L mirror configurations in April-June
  - SMCTM1 SSLs:  $B_{\max}=13.7$  T at 15.7 kA (2L) and  $B_{\max}=15.9$  T at 12.9 kA (4L)
- SMCT coil design, tooling and structure optimization is planned for the next step
- Nb<sub>3</sub>Sn SMCT coil R&D plan has been reviewed and updated
  - milestone delays are due to COVID and limited resources (ENG, TECH)
- The work progress and results are being presented and discussed at various meetings and conferences and published (*see next slide*)



### Presentations (since CM6):

1. I. Novitski, “Nb<sub>3</sub>Sn SMCT task overview and coil status,” MDP general meeting, 06/08/2022
2. I. Novitski, “Nb<sub>3</sub>Sn SMCT coil status,” Meeting with PSI, 06/15/2022
3. I. Novitski et al., “Design and assembly of a large-aperture Nb<sub>3</sub>Sn cos-theta dipole coil with stress management in dipole mirror configuration,” ASC2022, October 27, 2022.
4. I. Novitski, “SMCT coil status,” MDP general meeting, 11/09/2022
5. I. Novitski, “SMCTM1 mirror assembly,” FNAL SCR D group meeting, 03/13/2023

### Publications:

1. I. Novitski, A.V. Zlobin, E. Barzi, D. Turrioni “Design and assembly of a large-aperture Nb<sub>3</sub>Sn cos-theta dipole coil with stress management in dipole mirror configuration,” IEEE Trans. on Appl. Supercond., Vol. 3x, Issue x, 2023.

### MT-28 abstracts:

1. A.V. Zlobin, I. Novitski, M. Baldini, E. Barzi, S. Stoynev, D. Turrioni, “Development and test of the first 120-mm diameter Nb<sub>3</sub>Sn cos-theta dipole coil with stress management”