Towards SMCTD1a/1b
lessons learned from SMCTM1a/1b and proposed improvements

Igor Novitski
MDP CM8
4-30-2024

Outline

- SMCT2 coil design, technology, instrumentation
- Magnet assembly and coil prestress
- Coil radial and axial support
- SMCTD1 mechanical structure
- Coil splice box to reconfigure coil connection to PS

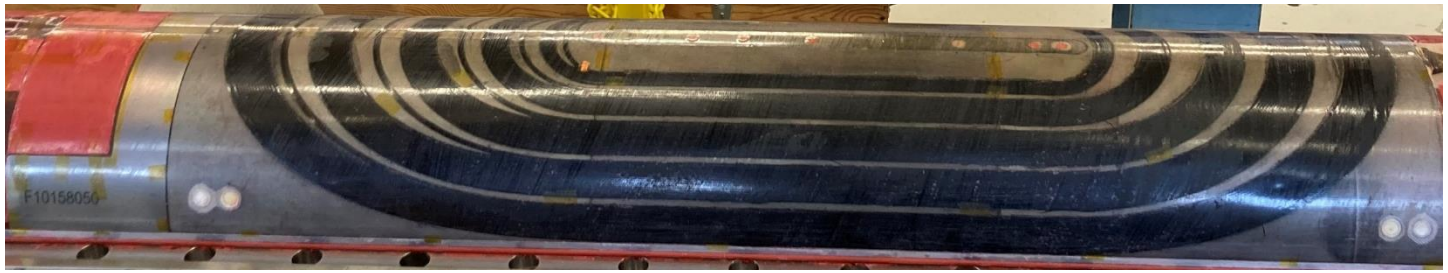
SMCT1 coil fabrication steps

Coil outer layer mandrel before winding

Completed outer layer winding

SMCT coil after reaction

Coil Nb_3Sn and NbTi leads splicing

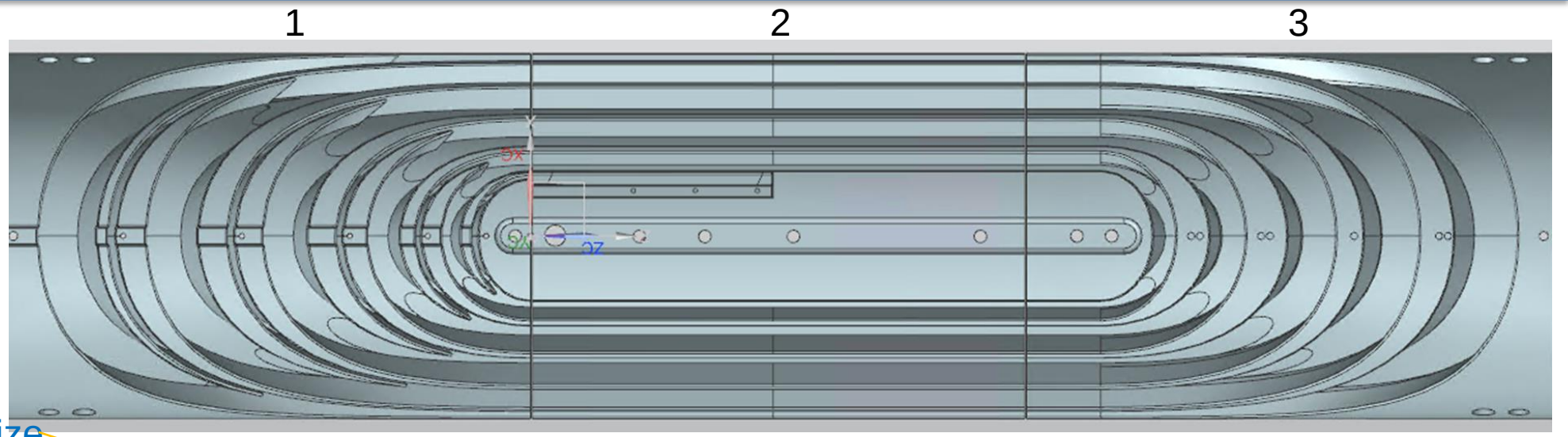


Coil view after epoxy impregnation

SMCT1 coil mandrel modification

SMCT1

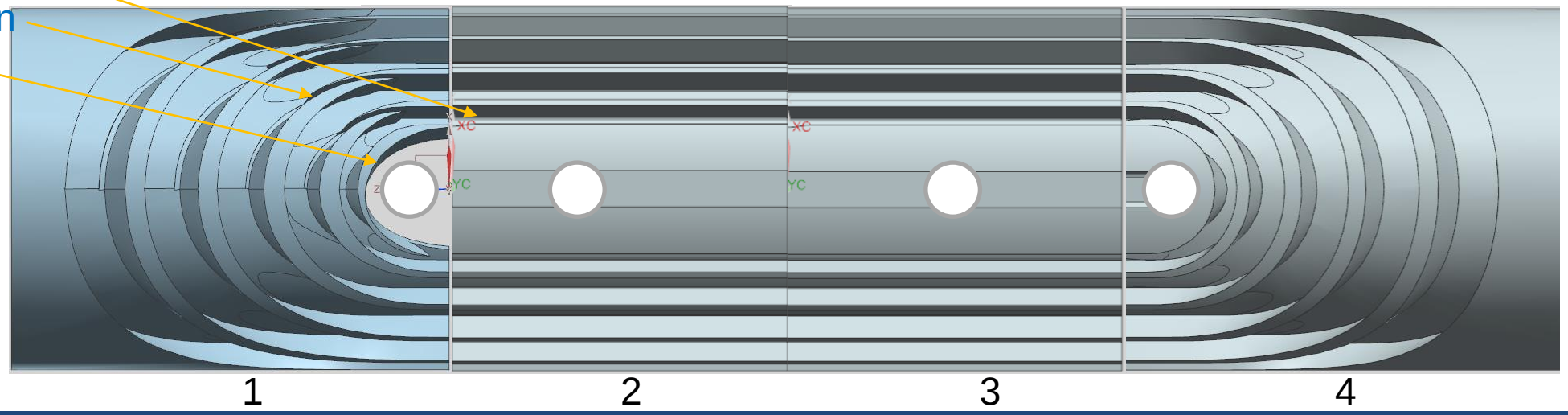
the mandrel demonstrates good protective properties at cold test with a three-section design



- shorter, symmetric ends
- adjusted pole grooves size
- short inter-block transition
- layer jump at the end
- 4pc instead of 3pc

SMCT2

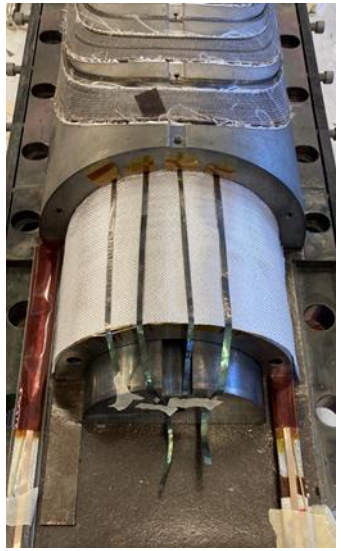
- in procurement
- printing next week



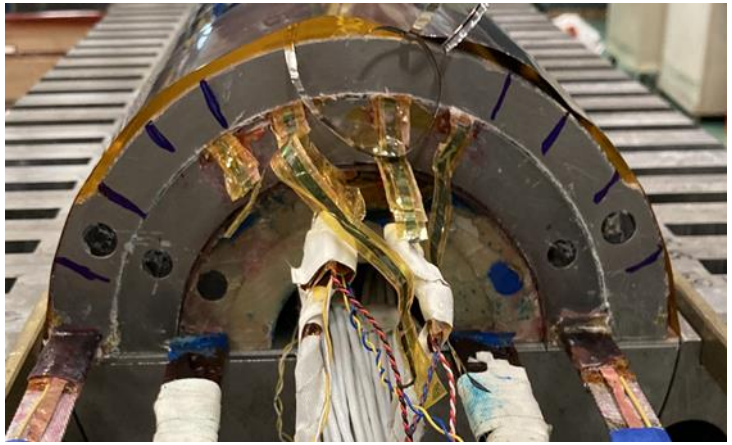
VTs for SMCT1 coil

VT on L1 LE

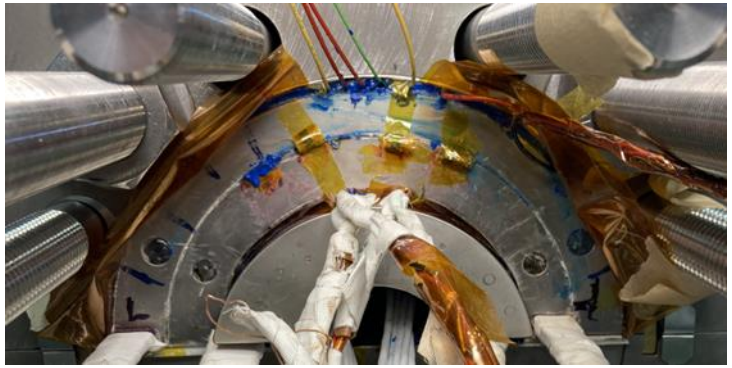
VT placed inside interlayer insulation



Splice block installation before impregnation



VT strips after impregnation

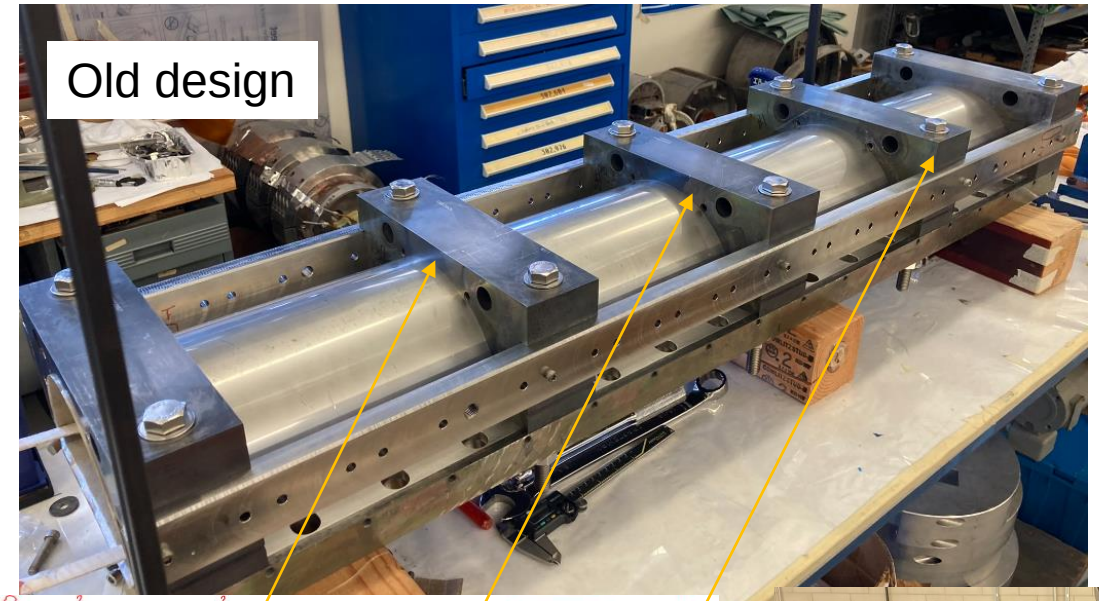


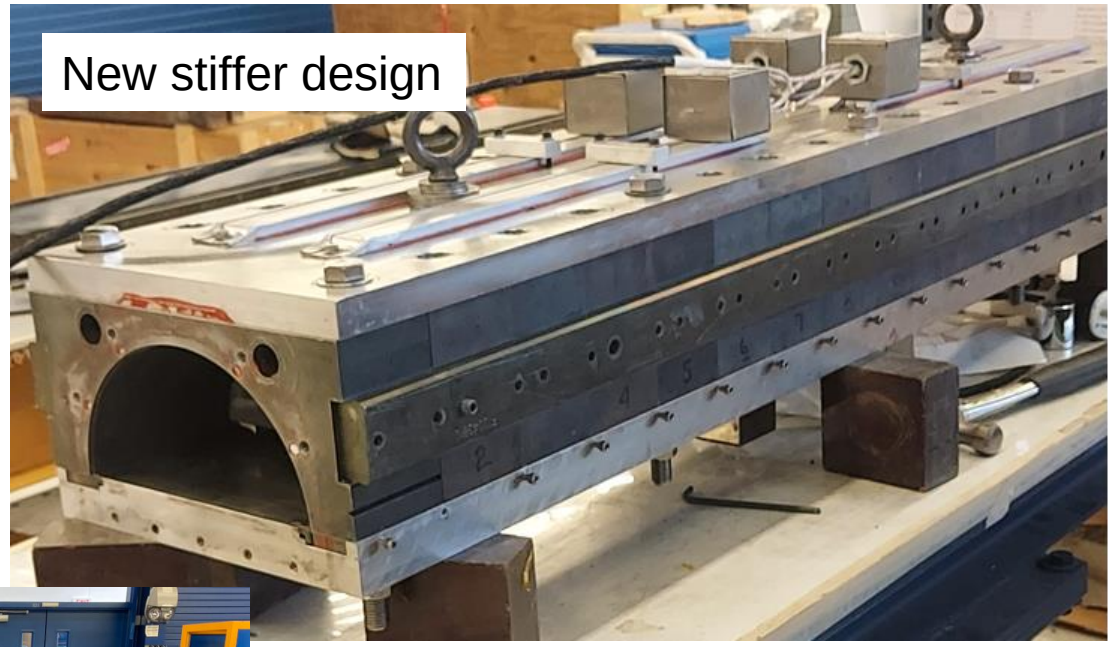
VT strips before pusher plate gluing

L1 VTs were lost during coil production

- Change the shape and location of flags and foils on the coil
- Technological channels and pockets will be introduced into the design of the splice blocks

Reaction/Impregnation tooling





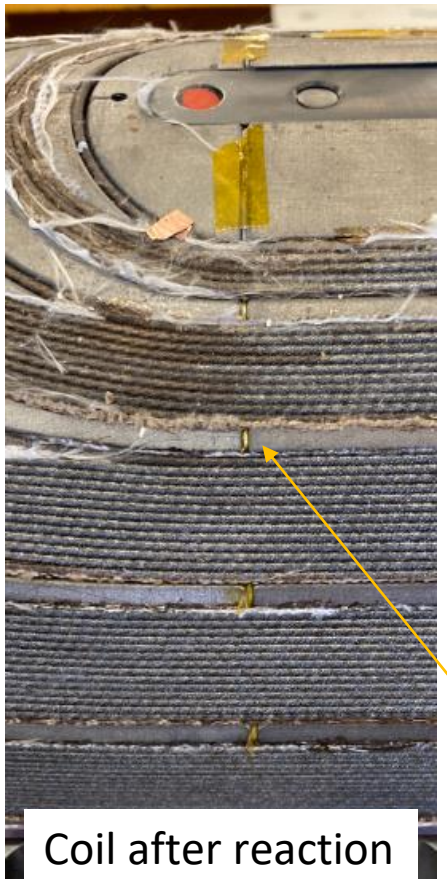
Correlation of coil size variation and tooling block position

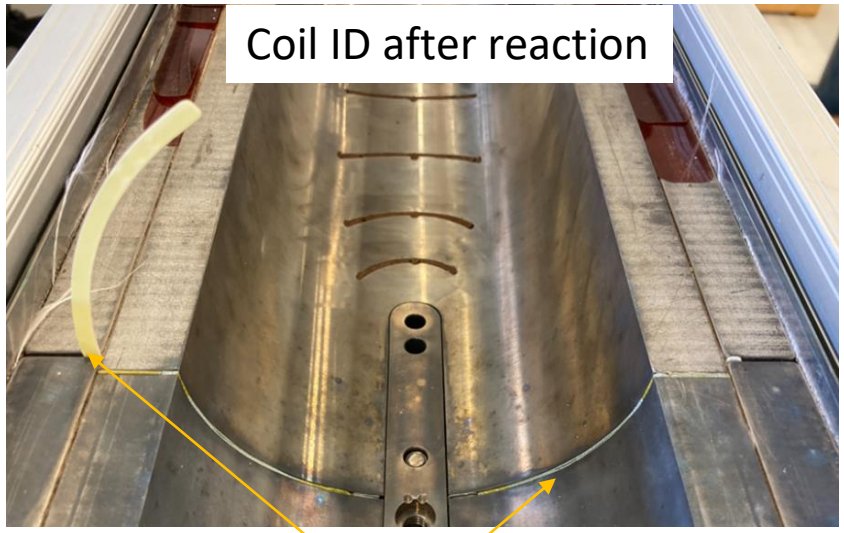
- increased number of blocks: 17vs5
- better support for coil mandrel
- improve coil size uniformity

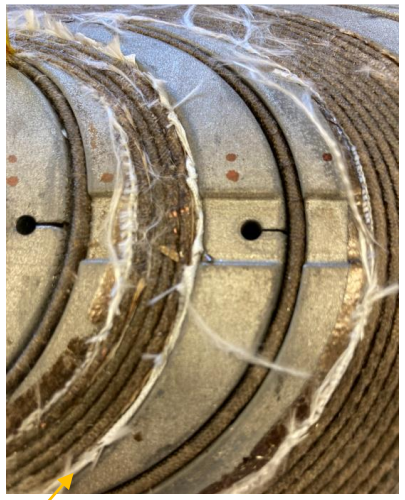
Tooling in house

Epoxy in coil blocks


LE after winding


Coil after reaction

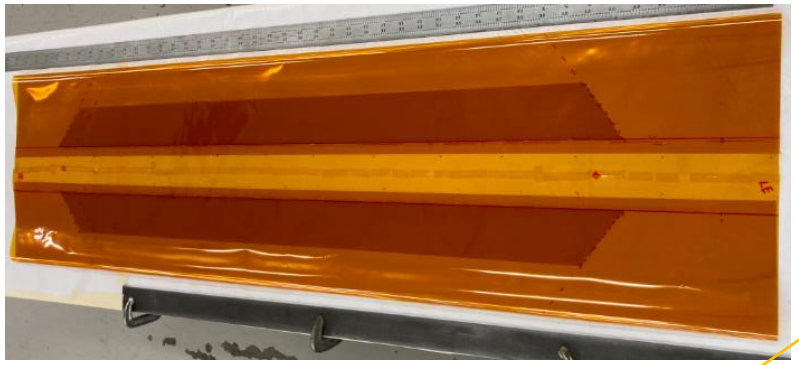

Coil ID after reaction

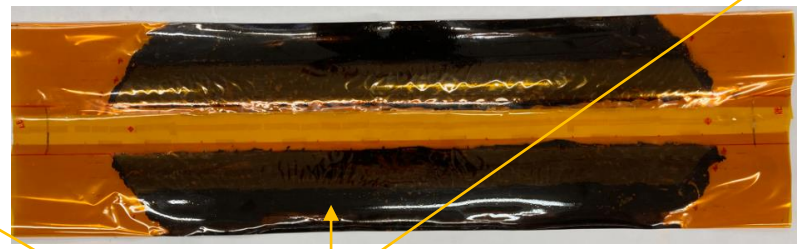

Coil OD after reaction

After reaction most, of the voids are located at the outer radii of the grooves and between mandrel parts

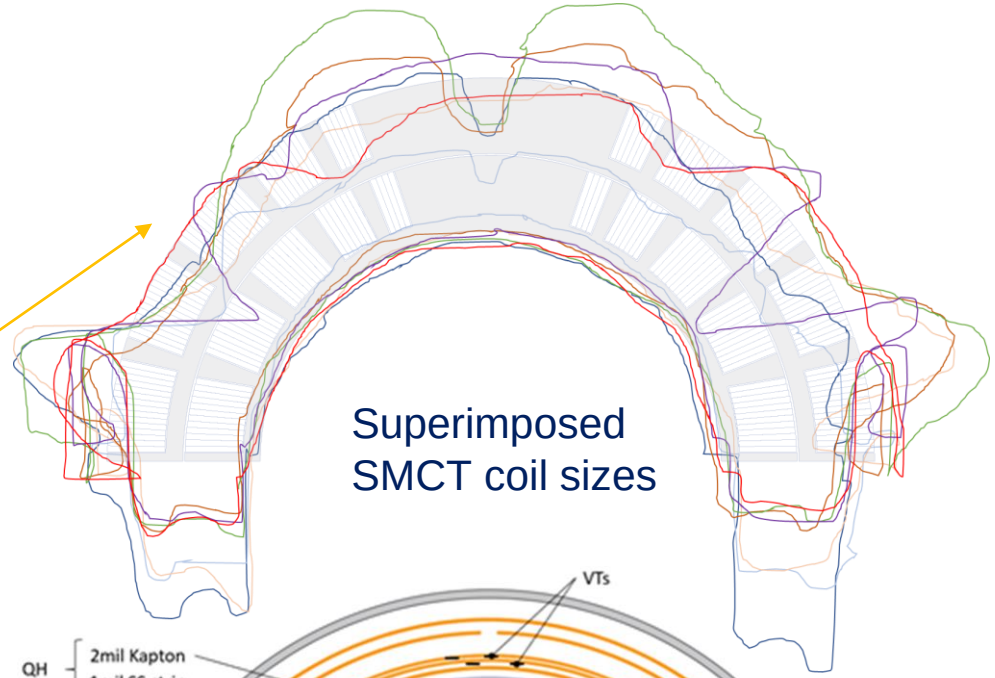
- volume of epoxy reduced wrt 15T outer coils with conductors aligned to coil OD
- L1 voids were not properly filled with glass due to inaccessibility - technological channels for gaps patching

Shims for SMCT1 coil

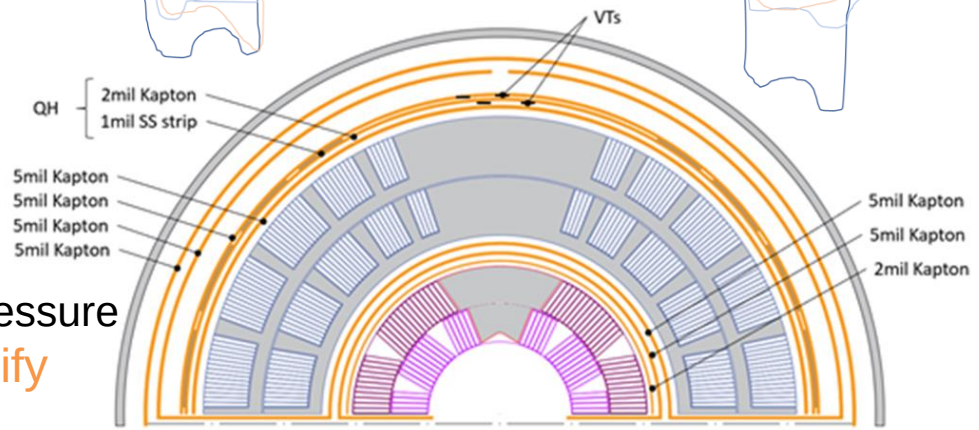




MP and OD casted shims



Superimposed SMCT coil sizes



Coil shim plan

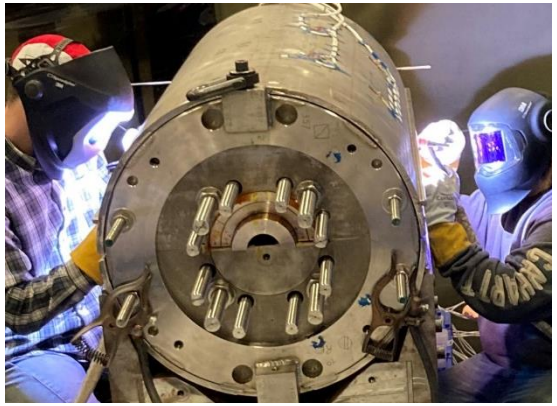
MP and OD shims were casted using real iron laminations under small press pressure

- tooling improvement will provide better coil size uniformity and simplify shim plan for the dipole magnet

SMCTM1 Mirror assembly steps

Coil block on the mirror

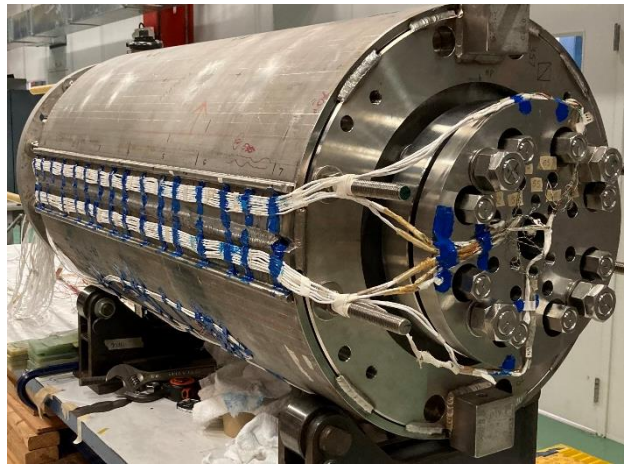
Iron yoke assembly

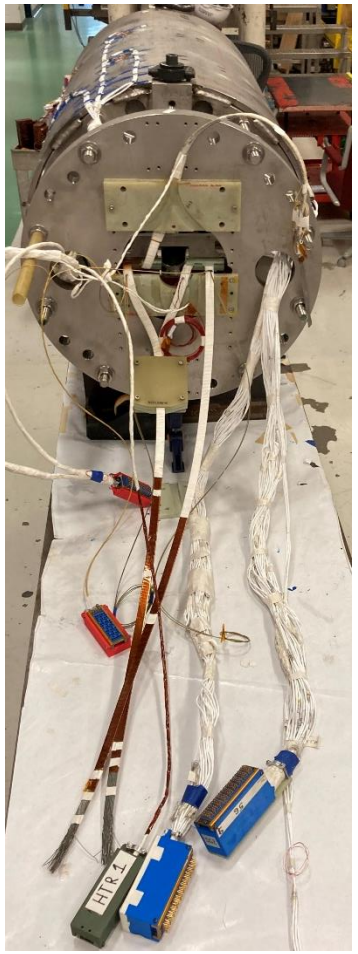


Welding contact tooling for a root pass and weld prep filling

Clamping contact tooling

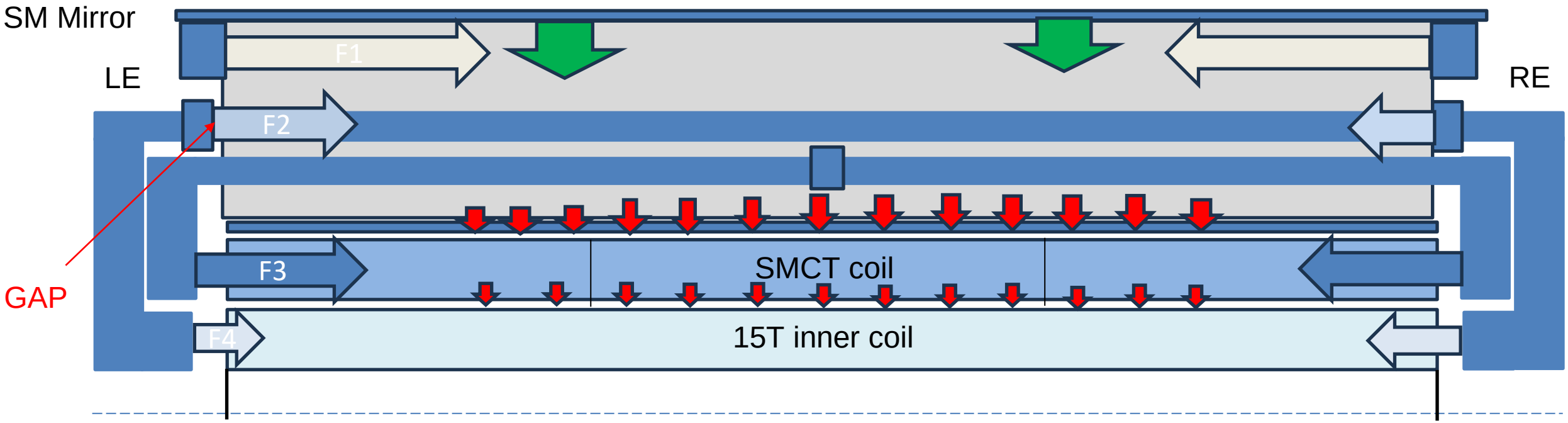
Clamped Iron yoke





Ends loading and electrical connectors

End mechanics for SMCTM1: coil side



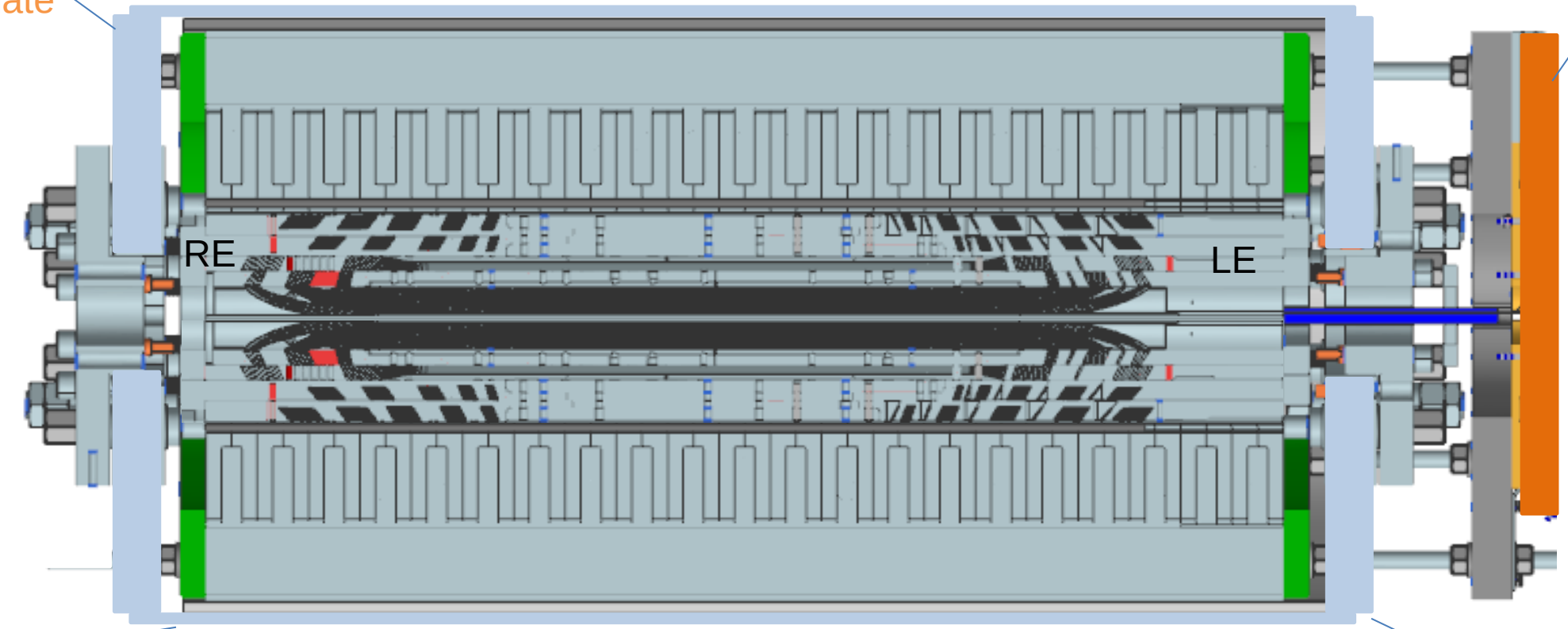
- SMCT coil axial support works acceptable
- Inner coil support requires modification
- Work is in progress to improve the concept within the MDP working group
- The proposed design will be reviewed

SMCTD1 Dipole Magnet radial support improvement

SMCT Dipole requires stronger radial support structure
(add 5mm shell using AUP technology for VMTF cryostat)

New pizza box for lead's reconnections

New end plate



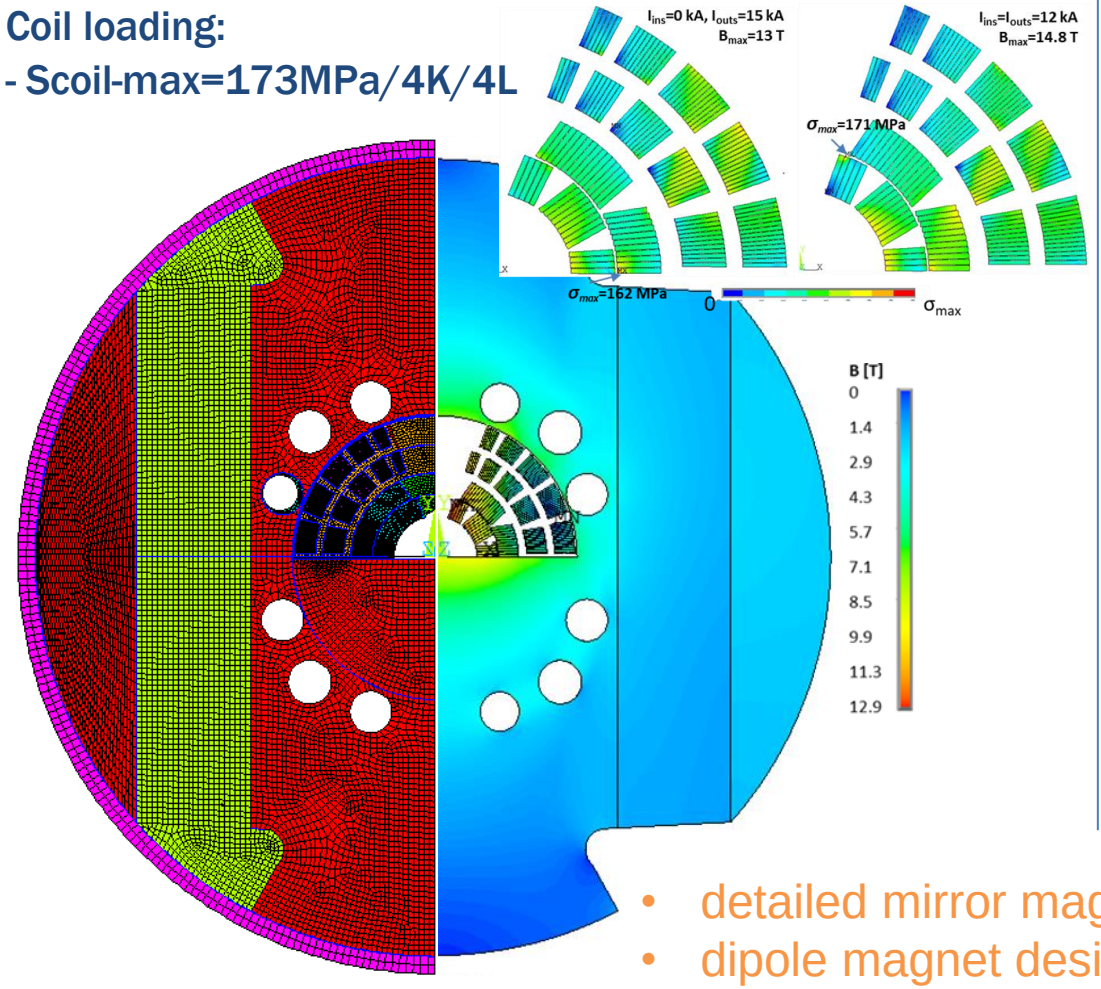
5mm ss shell

design work in progress

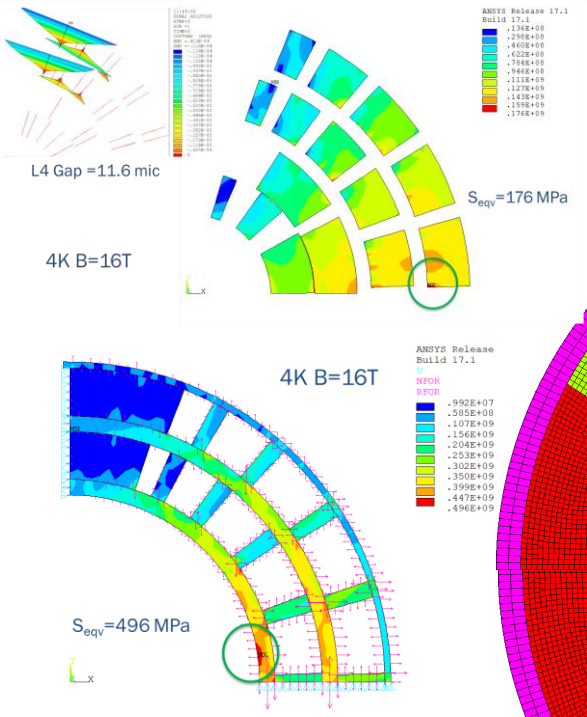
New end plate

2D FEA for SMCT Mirror and Dipole Magnets

Coil loading:
- Scoil-max=173MPa/4K/4L

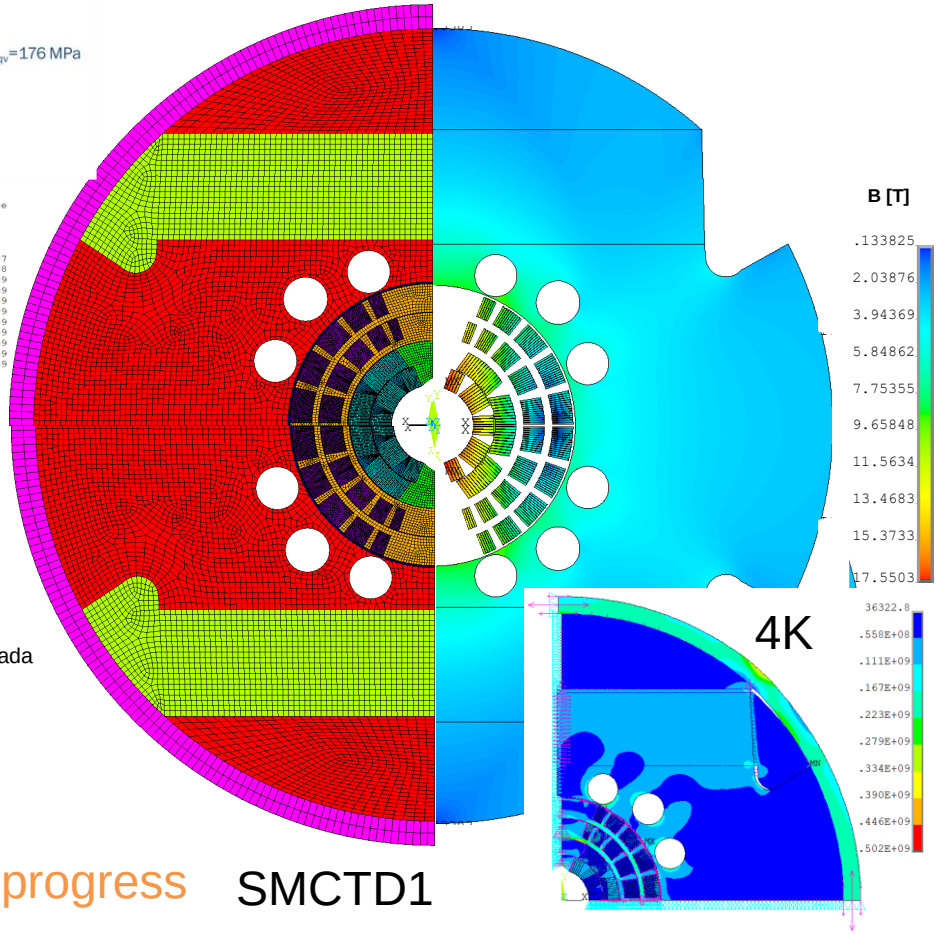


SMCTM1



CONCEPTUAL DESIGN OF A 17 T Nb3Sn ACCELERATOR DIPOLE MAGNET*
A.V. Zlobin et. IPAC2018, Vancouver, BC, Canada

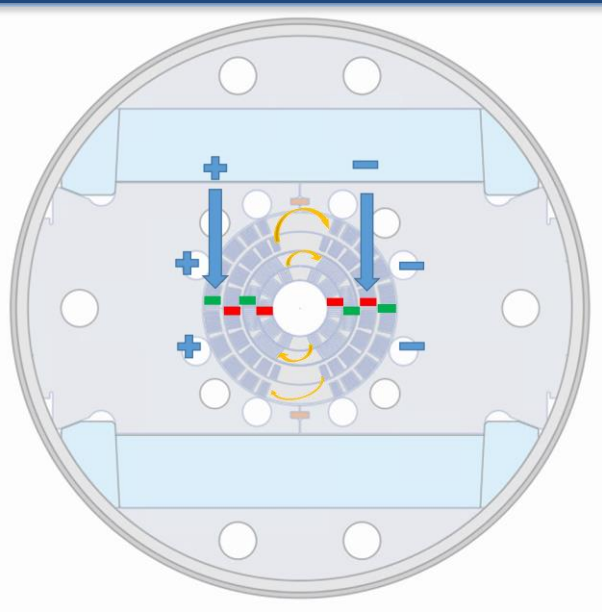
Coil loading:
- Scoil-max~180MPa/4K/4L



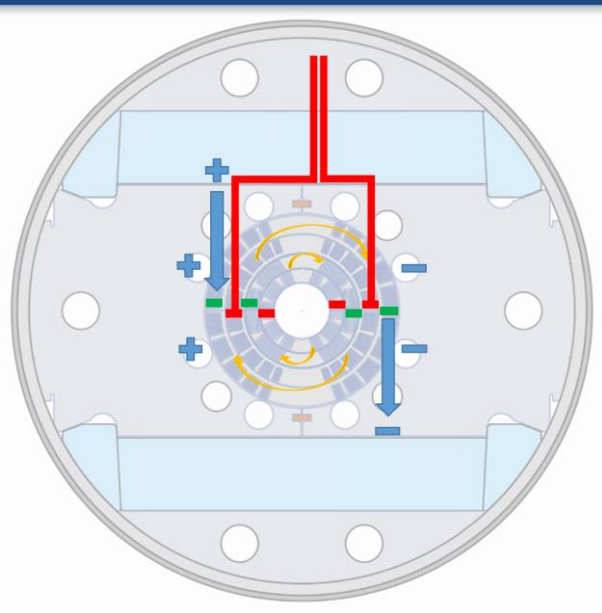
SMCTD1

- detailed mirror magnet design complete
- dipole magnet design concept completed
- detailed dipole design on 3-tests cases in progress

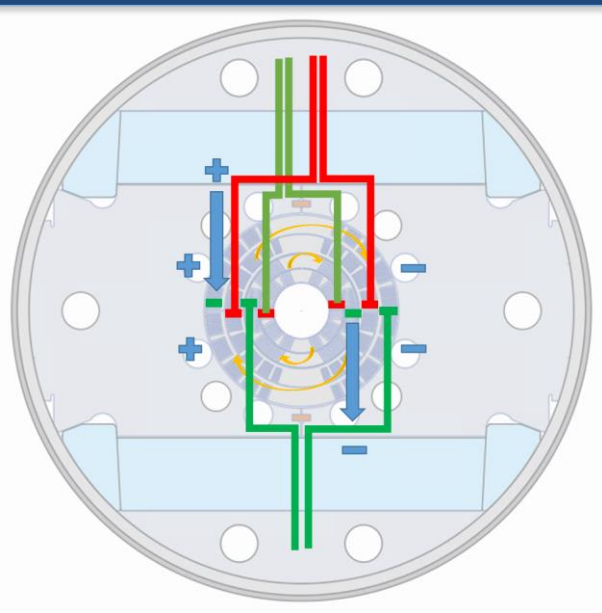
One warm assembly with 3 cold tests



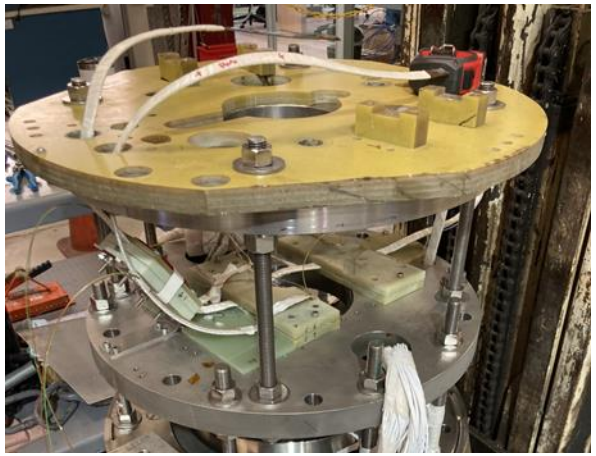
New SMCT coil test
in “mirror configuration”



SMCT 2L Dipole test



SMCT 4L Dipole test



Resplicing area at magnet support plate

- “one assembly-two tests” idea has been successfully checked
- concept saved resources and allow to obtain various data
- coil leads resplicing show normal splice parameters at cold test
- 3-tests concept requires redesign of the magnet “pizza box”

Current lead splicing

Summary

SMCTD1 Dipole

- new SMCT2 coil will be assembled with SMCT1 coil and two 15T inner coils for 3 tests in 4Lconfiguration
- finalize design, optimize coil azimuthal preload and axial support

SMCT1 coil, degradation reduction

- Coil mandrel design optimization
  - short symmetric ends
  - short inter-block transition and layer jump
- Reaction-impregnation tooling upgrade
  - better coil size uniformity
- Winding/reaction process improvement
  - optimized block size and inter-block transition
  - better control coil axial motion during HT

SMST2 coil training improvement

- Minimize epoxy in the coil blocks
- Optimize coil azimuthal preload

Coil instrumentation upgrade (VT in L1 and L2)

- improve design and technology of VT installation