Common Coil Design for High Energy Collider Dipoles and Unique Magnet R&D

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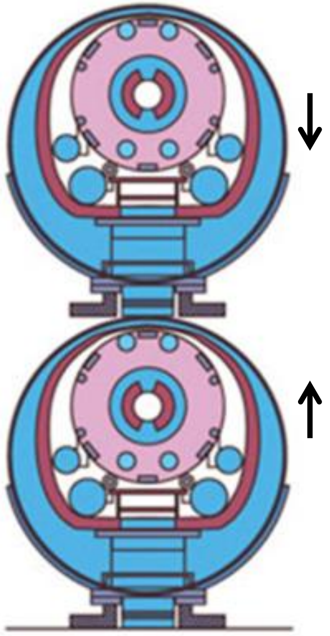
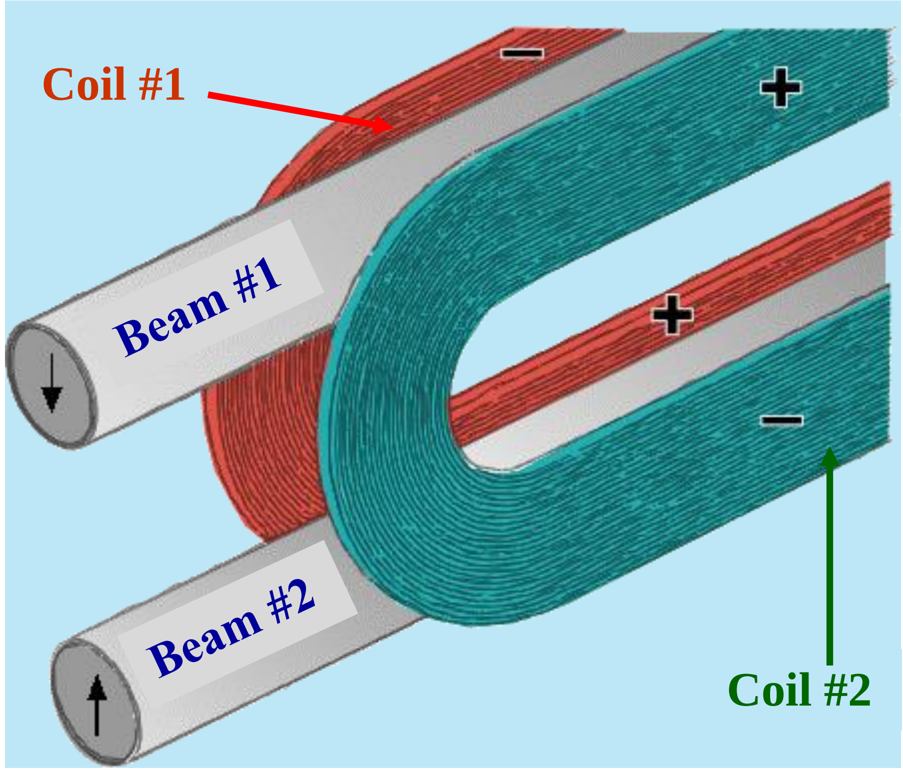
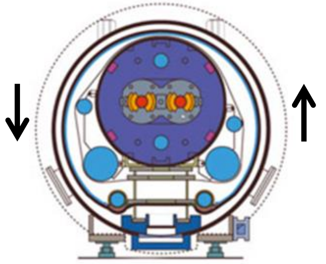
Common Coil Design for Collider Dipoles



SSC





LHC

Common Coil Design

(2-in-1 dipole, both yoke and coil)

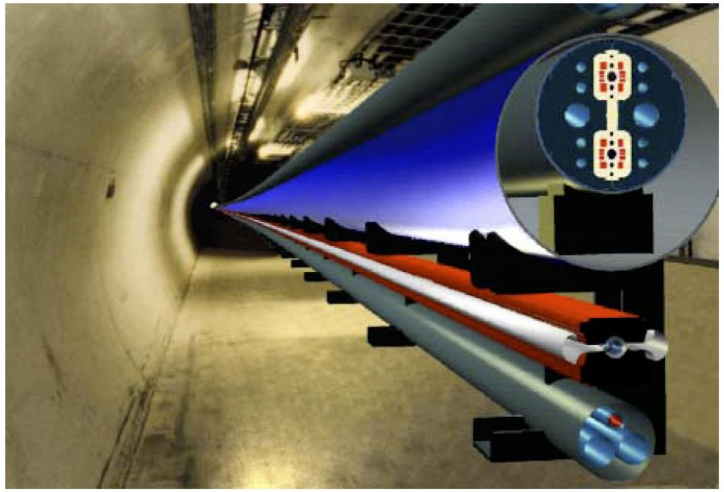
Used in the US VLHC Proposal

Very Large Hadron Collider

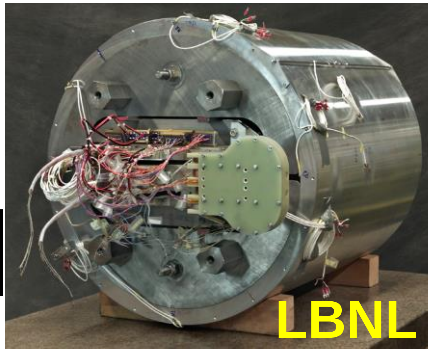
SLAC-R-591
Fermilab-TM-2149
June 4, 2001

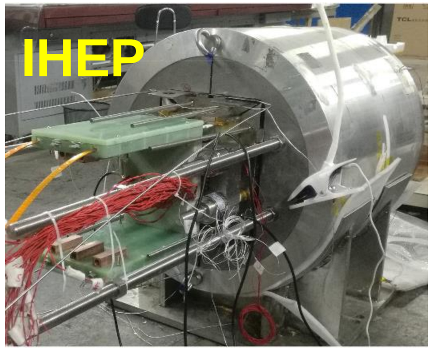
Design Study for a Staged
Very Large Hadron Collider

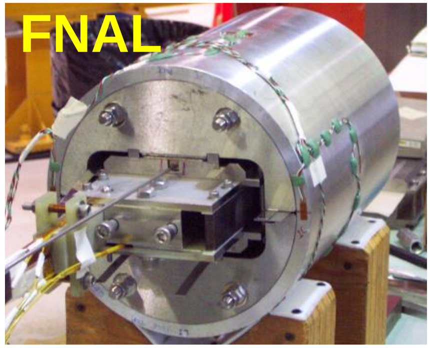
Report by the collaborators of
The VLHC Design Study Group:
Brookhaven National Laboratory
Fermi National Accelerator Laboratory
Laboratory of Nuclear Studies, Cornell University
Lawrence Berkeley National Laboratory
Stanford Linear Accelerator Center
Stanford University, Stanford, CA, 94309



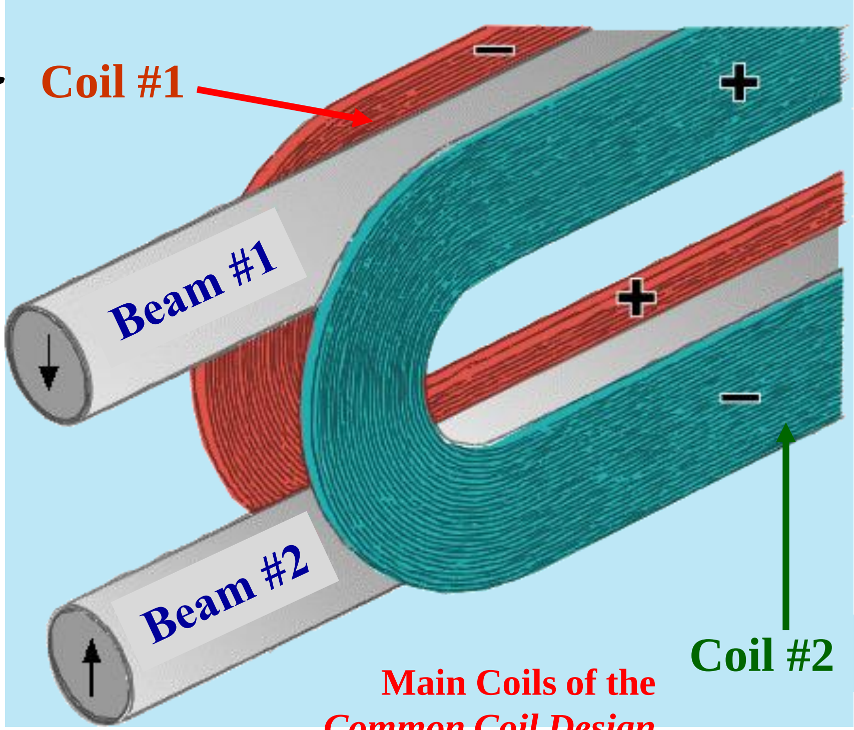
Work supported in part by the Department of Energy contract DE-AC03-76SF00515.



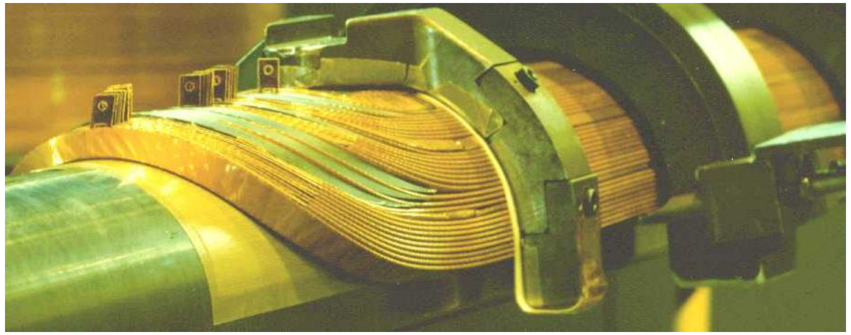




Common Coil Design - The Basic Concept



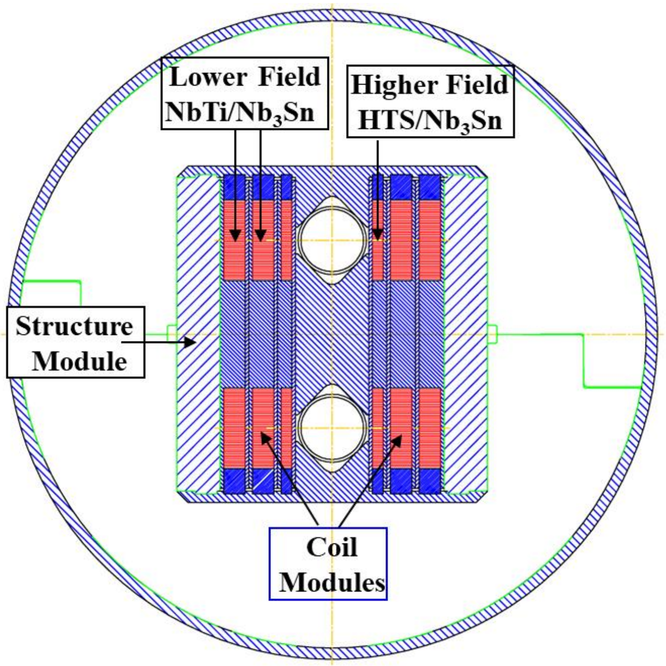
Main Coils of the
Common Coil Design

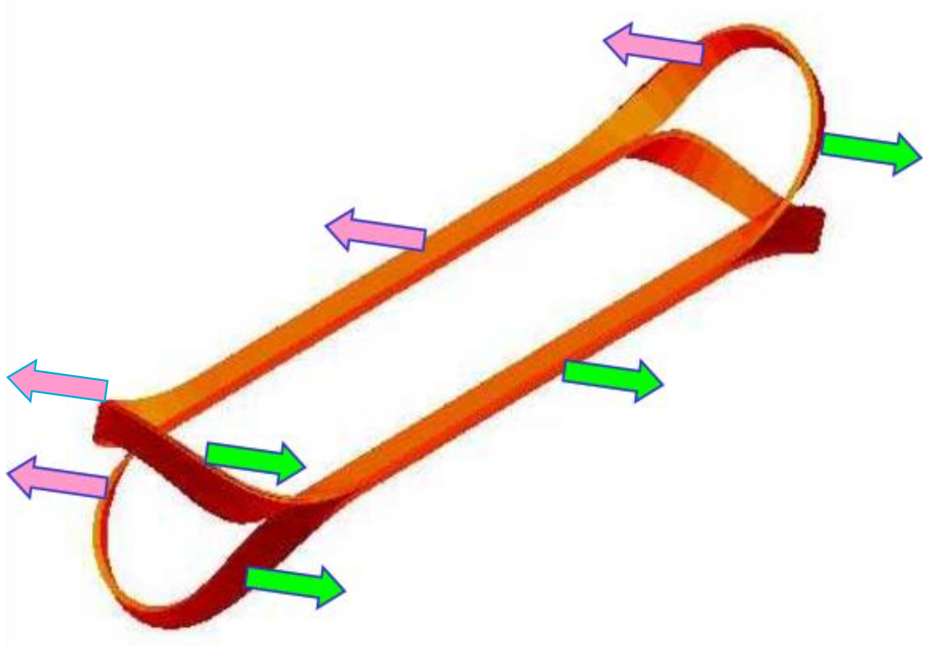


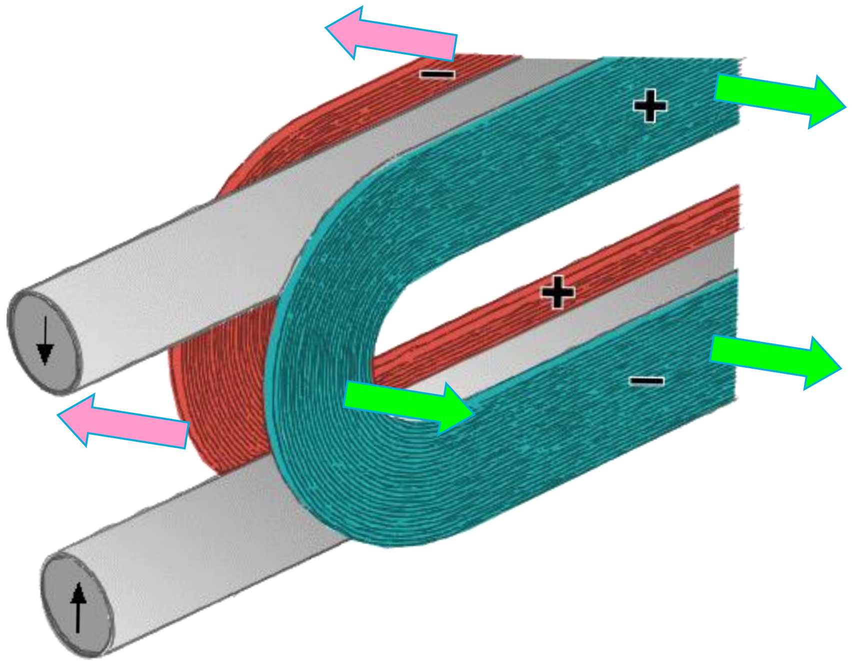
- Simple 2-d coil geometry for colliders
- Conductor friendly with large bend radii (determined by the spacing between two apertures) without complex 3-d ends
- Facilitates many conductors (High current HTS cables) and technologies (React & Wind)
- Minimum requirements on big expensive tooling and labor
- Fewer coils (about half) as the same coils are common between the two apertures (2-in-1 geometry for both iron and coils)
- Potential for producing low cost, more reliable (less margin) high field magnets

Some of the Advantages of the Common Coil Design

- **Easier segmentation for hybrid designs (Nb_3Sn and NbTi + HTS)**
- **Lower internal strain on the conductor under Lorentz forces**
- **Lower cost, rapid turn around magnet R&D due to a modular design**
- **BNL design facilitates a new type of magnet and conductor R&D**

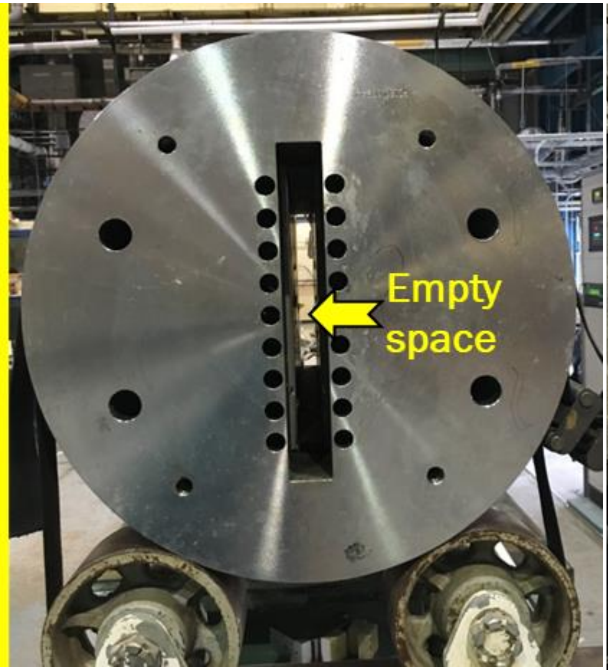


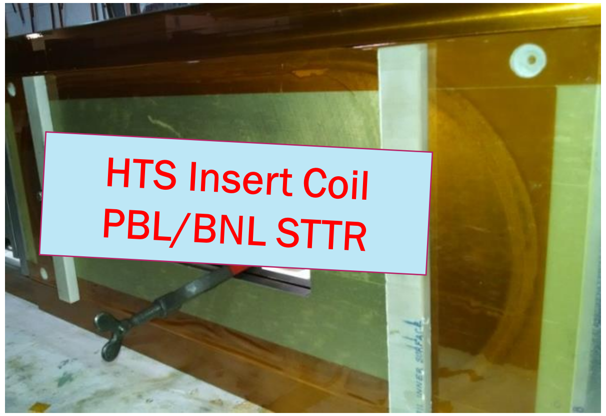


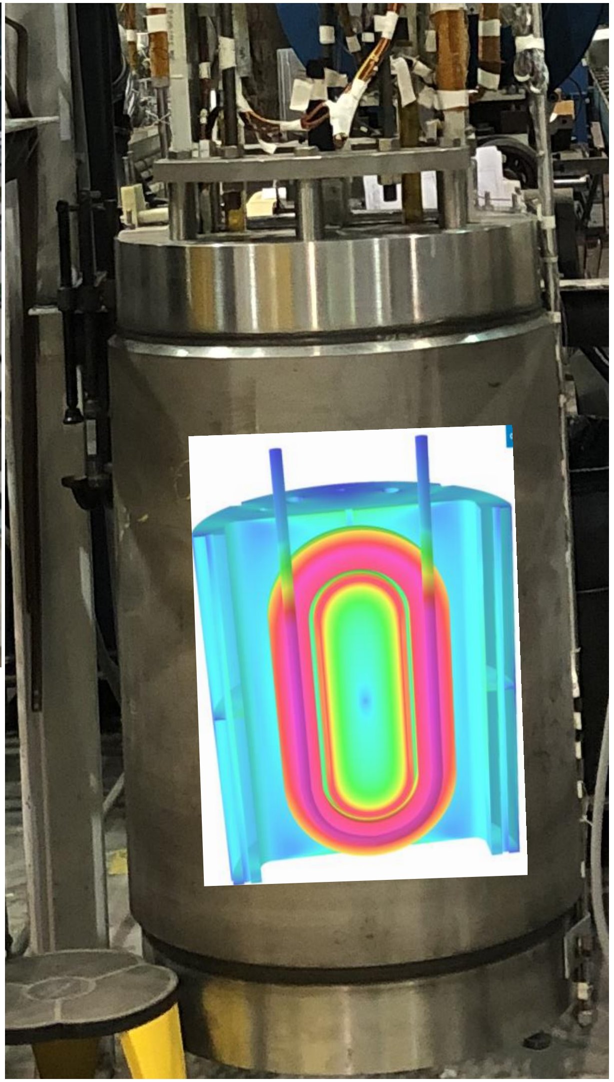


A Unique Common Coil Dipole (DCC017) at BNL for Rapid-turn-around, Low-cost Magnet R&D

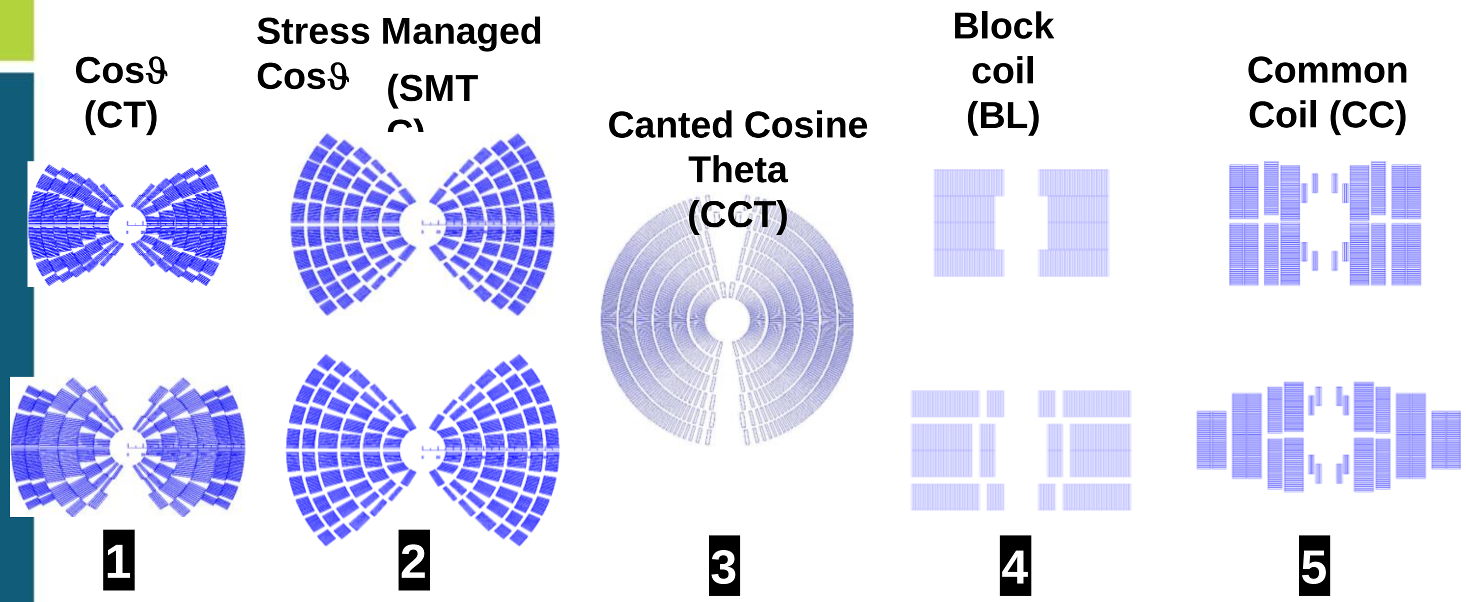
- 10 T, Nb_3Sn dipole with a large open space for high field insert coil testing
- New coil(s) in the magnet without any disassembly
- Coils become an integral part of the dipole magnet
- A new coil test essentially becomes a new magnet test
- Can test bent cables in dipole field at variable temperature (fusion)
- Can test new technologies (demonstrated R&W)

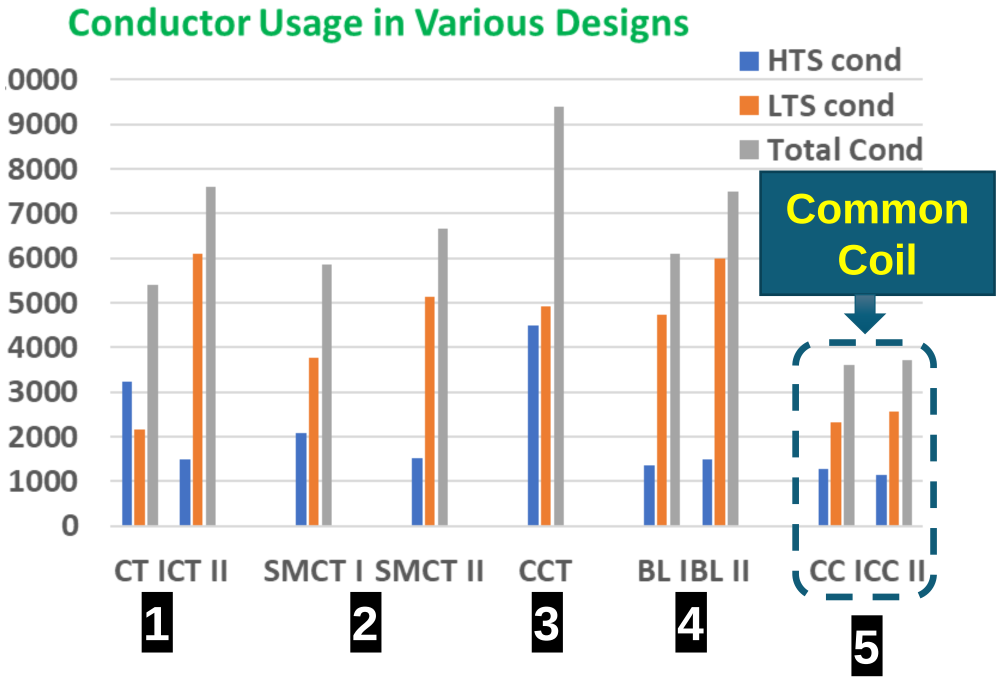






Status of the Common Coil Geometry in 20 T Design Studies under USMDP for Collider Dipoles





- Comparative studies of 20 T designs (as presented at MT) revealed that the common coil design uses significantly less conductor than the other designs.
- This finding is opposite to that expected from the conventional wisdom.
- Explanation comes from the basic design principles. As the design field gets higher, relative ratio between the bore area and the coil area changes significantly.

Summary and Work Ahead

- Common coil dipole offers several advantages – suitable for high fields, allows more conductor (e.g. high current HTS cables) and technologies (e.g. React & Wind beside wind & React), simpler geometry for lower cost, etc.
- Several common coil dipoles with main coils have been built and tested; however, none with the pole coils necessary for the field quality.
- Build pole coils and demonstrate them (proof-of-principle in DCC017).
- Perform cost estimates of R&D dipoles and for large scale series production.
- Take advantage of BNL common coil dipole DCC017 for lower cost, rapid-turn-around R&D, including some which are not possible elsewhere.
- Accepting a new design has its challenges. It must be thoroughly proven.