Common Coil Magnet

As a Facility for Conductor and Magnet Development

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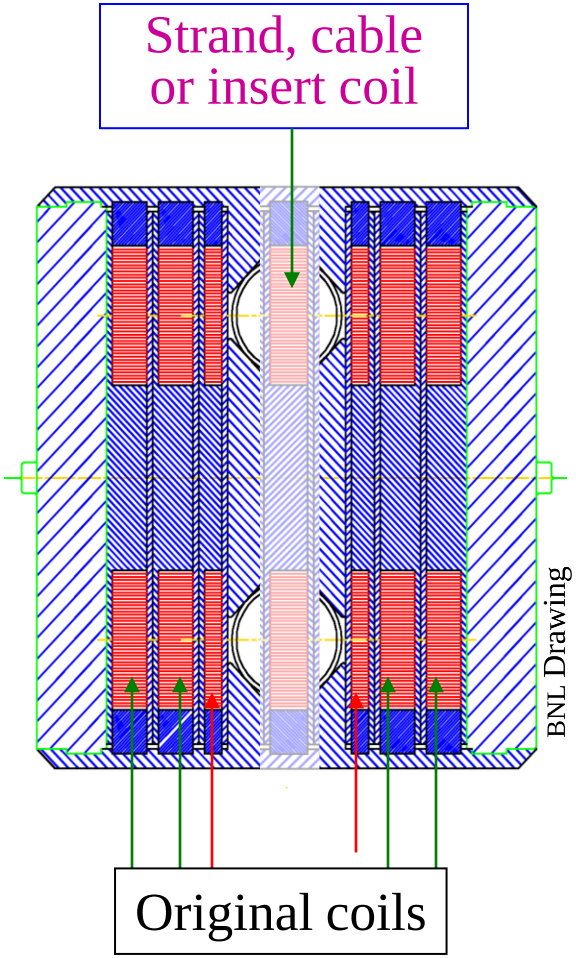
Common Coil Magnet As A Test Facility

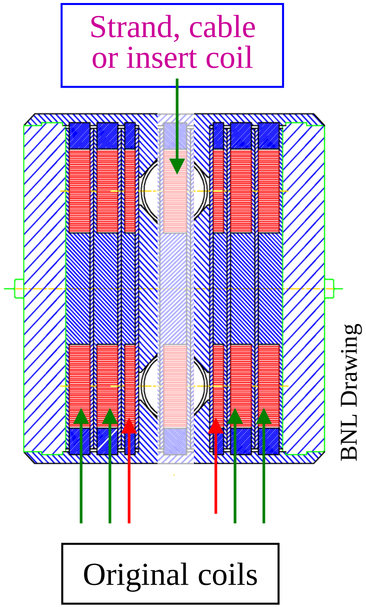


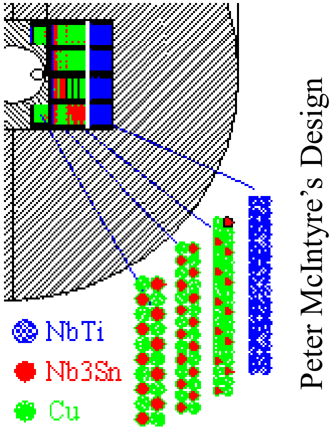
- **A Modular Design with a significant flexibility.**
- **Coil geometry is vertical and flat. That means a new coil module having even a different cable width can be accommodated by changing only few parts in the internal support structure.**
- **The central field can be increased by reducing the separation between the coils.**
- **The geometry is suitable for testing strands, cables, mini-coils and insert coils.**
- **Since the insert coil module has a relatively small price tag, this approach allows both *"systematic"* and *"high risk"* R&D in a time and cost-effective way. This might change the way we do magnet R&D.**
- **Can use the successful results in the next magnet.**

A Few Possible Topics for Cable and Magnet Designs

Examples of systematic and non-conventional design studies:

- Variation in cable/conductor configuration
  - Mixing Cu strand with Nb_3Sn superconductor
  - Heat treatment studies
- Different technologies
  - "*Wind & React*" Vs. "*React & Wind*"
- Different type of conductors
  - Nb_3Al, HTS, etc.
- Different type of conductor geometry
  - Tape, cable
- Stress management module
- Different type of mechanical structures and variations in them
- Different cable insulation and insulating schemes



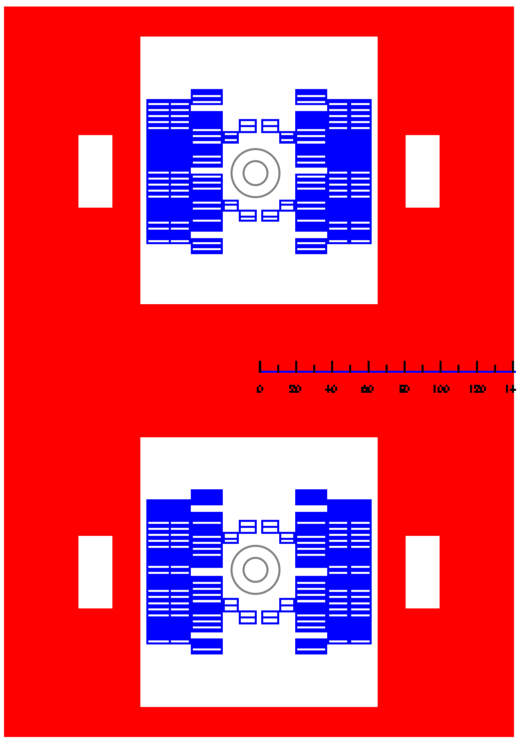


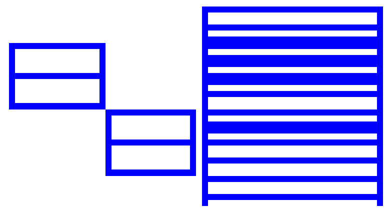
A Common Coil Design Study With A Reduction in Insulation Volume

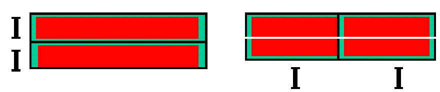
A Common Coil Design with all harmonics < 10^{-5} (geometric).

Uses a different cable in auxiliary coils to simulate tilted blocks with two flat blocks.

All conductors are in series.





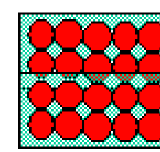


Same current, same inductance but less fraction of insulation (15% => 8%)

Pair of cable during coil winding

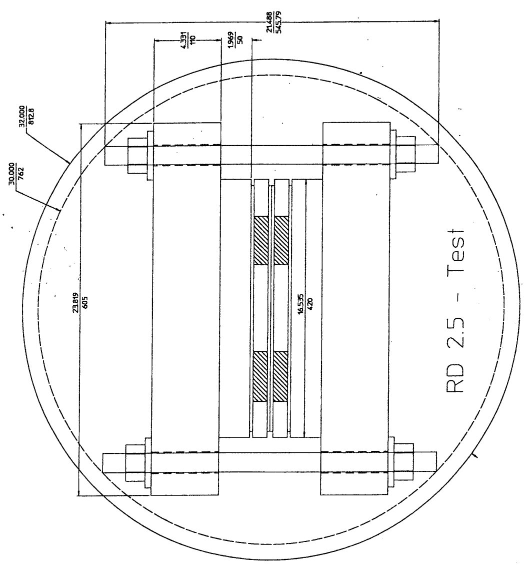
Cable on cable during cable winding

Current sharing issues



RD3 Reincarnations for A Test Facility

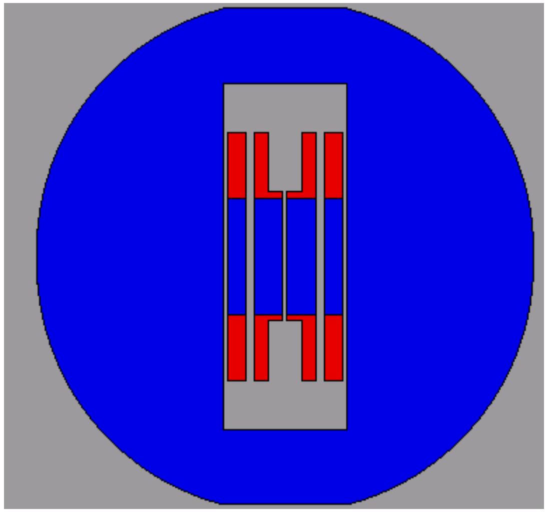
Purpose of this exercise



- Design a Test Facility with RD3 components.

Use RD3/RT1 coil modules.

Minimize new components.



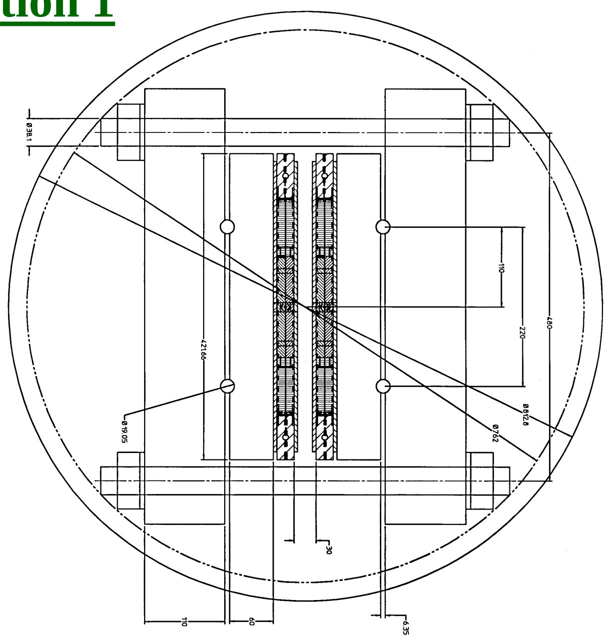
RT1 (uses RD3 outer coils) ~12 T

No Real Gap/space between coils.

RD3 : 13.7 T -- 40 mm coil aperture; but really too small a space (after internal structure) for using it as a Test Facility.

Test Facility with Outer Coils Only

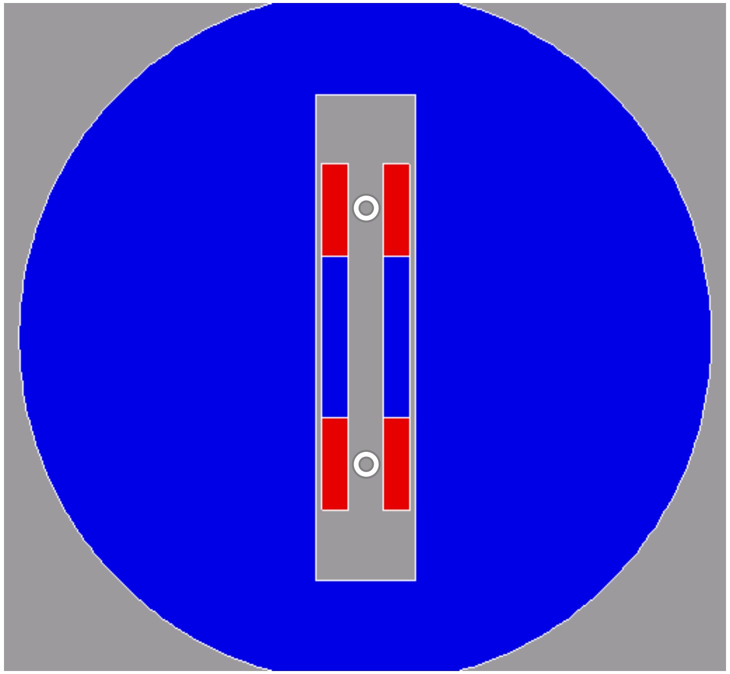
Option 1



Modified RT1 for facility with 30 mm coil spacing.

Bss ~11.5 T

Option 2

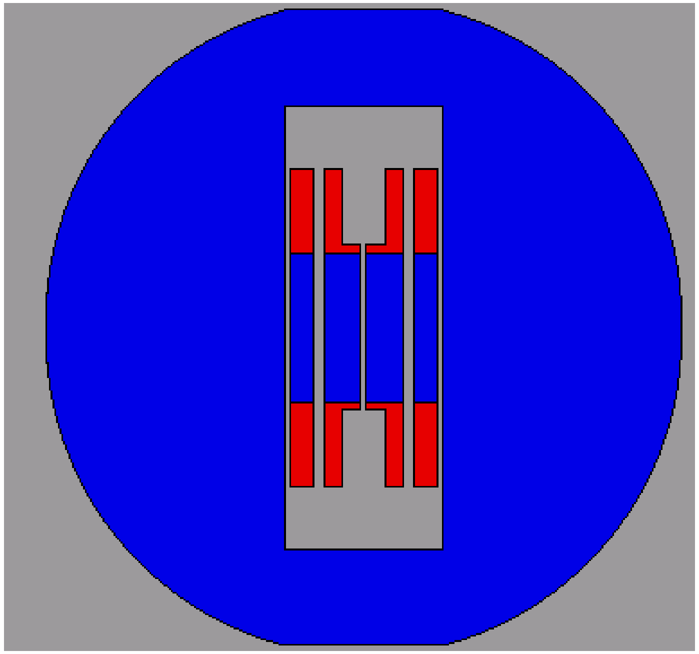


Outer Coils in RD3-type structure with iron yoke -- 30 mm coil spacing

Bss ~12.1 T

Test Facility with All Coils

Original RD3 design

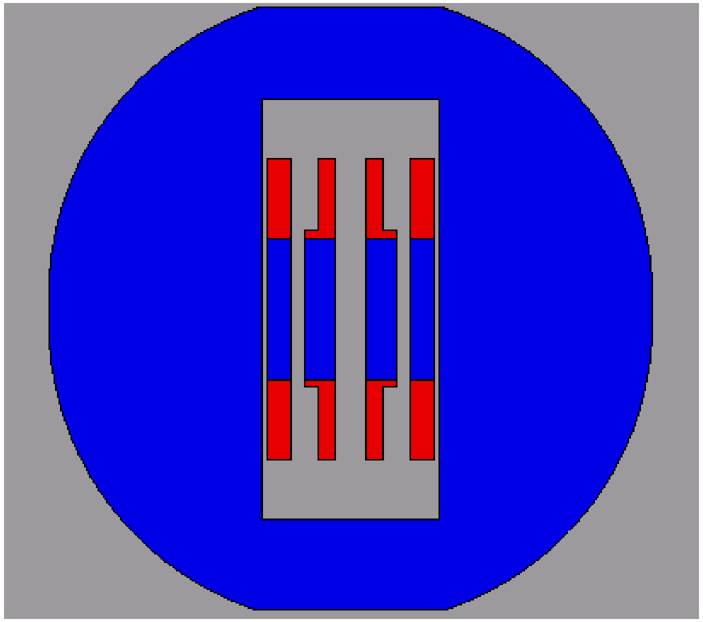


40 mm aperture but really too small a space for a Test Facility.

Bss ~13.7 T

RD3 with inner coils flipped

(Bill Barletta's suggestion)



The above geometry puts the structure blocking the test space on the other side.

Bss ~13.7 T for 30 mm separation

Bss ~ 13.2 T for 40 mm separation

* The above trick worked because of a peculiar situation that the outer coil had ~15% margin over the inner coil.

Summary of Test Configurations

REFERENCE DESIGN STUDIES : (not suitable for a test facility)	Bss (T)	Stored Energy (J/mm)	Fx (N/mm)	Fy (N/mm)
RD3 original design as per spec (40 mm aperture)	14.3	1800	9200	260
RD3 (with Nb3Sn strand data for inner & outer coils)	**13.7**	**1640**	**8450**	**240**
RD3 outer coils (no real gap - 9.5 mm coil sepation)	12.6	240	4850	-200
RT1 outer coils only - no yoke and no real gap)	12.1	240	4160	-170

Possible configurations for a test facility	Bss (T)	Stored Energy (J/mm)	Fx (N/mm)	Fy (N/mm)
RD3 outer coils only with yoke (30 mm separation)	12.1	520	5170	-210
RT1 outer coils only and no Yoke (30 mm separation)	11.5	520	4010	-170
RD3 outer + "inner coils flipped" (30 mm separation)	13.7	1800	8390	621
RD3 outer + "inner coils flipped" (40 mm separation)	13.2	2080	8330	770
RD3 inner coils flipped (30 mm - No yoke, structure?)	13.3	1760	6070	160

A configurations for a high field coil test	Bss (T)	Stored Energy (J/mm)	Fx (N/mm)	Fy (N/mm)
RD3 inner coils flipped; same structure (almost no gap)	14.7	1120	8340	120

Some of these calculations are preliminary (only 2-d calculations).
However, 3-d (end) effects, etc. are not expected to reduce the computed short sample by over 1 tesla.

These kinds of tests, permutations & combinations are only possible due to the flat vertical coil geometry in common coil design.

In Conclusion, A Personal Opinion:

The "Common Coil Geometry" provides a unique and flexible *"Test Facility*"* for conductor and magnet development.

*a.k.a.:

Magnet R&D Factory