Racetrack Coil Magnets for Neutrino Storage Ring and Muon Collider

Ramesh Gupta
Superconducting Magnet Division
Brookhaven National Laboratory
Upton, NY 11973 USA
gupta@bnl.gov
http://magnets.rhic.bnl.gov/Staff/gupta
Basic Design Principles from Mike Harrison:

- Nb-Ti Racetrack coils
- Design Field: ~5 T
- Decay products clear SC coils at midplane
- Warm iron
- Compact cryostat
- Low cost
One major design consideration: Reduce the amount of energy deposited in cold structure.

Decay electrons get back towards main aperture by (a) Reverse field and (b) Magnet saggitta which knob to use how much may depend on E & B

In neutrino storage ring, is ~10% energy deposition acceptable?
Cutout in yoke to optimize field quality: Model used in MARS Studies (Brett Parker)

Relative Field Error on midplane: $10^{-4}$ to $10^{-3}$
(Positive rise is deliberate)
Common cryostat for two coil halves:
For a better mechanical and cryogenic design

Earlier Version

Current Version

Magnet Design Evolution
Magnetically Optimized Design

Preliminary optimized design for field quality

Relative Field Error on midplane: $\sim 10^{-4}$ to $10^{-3}$

(Positive rise on midplane is deliberate)
Future Design Work and Other Possibilities

Work on the present configuration continues on:

- Magnetic Design
- Mechanical Design
- Cryostat Design

More design evolution to be based on MARS Studies (Brett Parker)

- How many watts are actually deposited in coils, etc. under different scenarios?
- If not much, coils can tolerate a modest temperature rise and still be superconducting
  - The coils can be brought significantly down towards midplane for better efficiency
    - Higher field, lower forces.
- High Field Option (8-10 T Nb$_3$Sn):
  - More R&D, other designs and technologies, more expansive
  - Another Benefit of Nb$_3$Sn -- higher Tc, allows higher heat deposition

In all cases coils are flat and clear bore tube (original design principles)
Since, most energy deposition is on one side, the coil on other side can be brought closer to midplane, or one can have a “C magnet”. This generates a combined function magnet, actually with a higher field. But with only of one type of focussing. Imagine a lattice where long dipole have focussing of one kind and the other type of focussing comes from traditional quadrupoles. AP Issues?

Almost linear drop in field  
Constant gradient on axis  
(can be optimized further)