Development of A High Field Magnet for Neutrino Factory Storage Rings

Ramesh Gupta
Brett Parker
Superconducting Magnet Division
LDRD Project No. 01-79

With additional contributions from:
M. Anerella, J. Escallier, A. Ghosh,
M. Harrison, J. Schmalzle, J. Sondericker, E. Willen

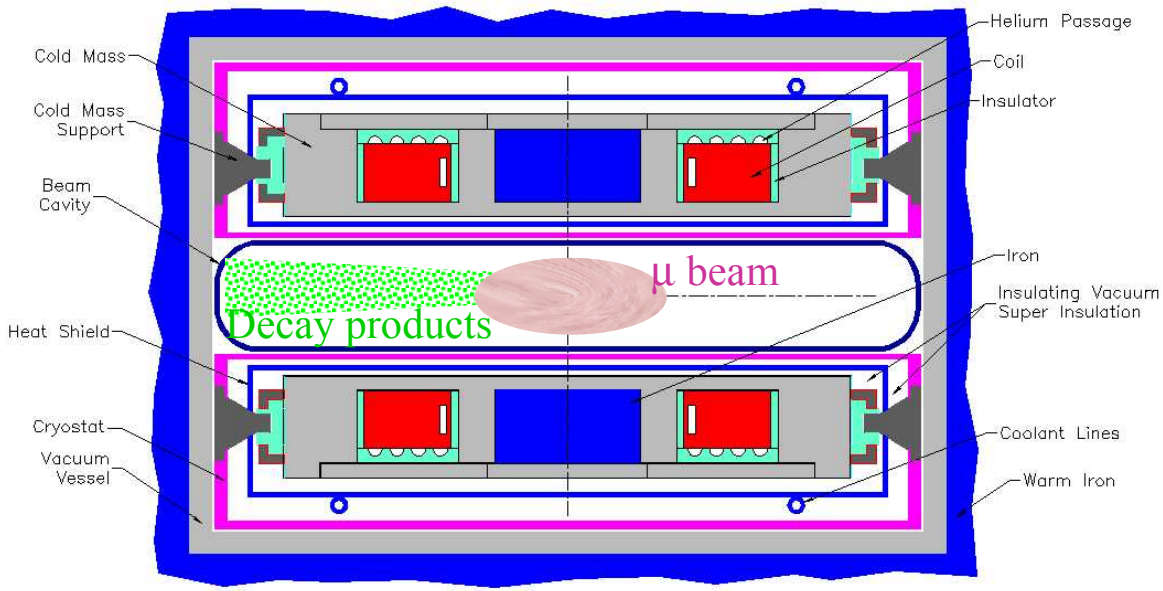
Magnet Design for ν Factory

Design Principles and Requirements:

Decay products clear superconducting coils

Compact ring to minimize the environmental impact
(the machine is tilted)

⇨ Need high field magnets and efficient machine design



Storage ring magnet design
(simple racetrack coils with open midplane)

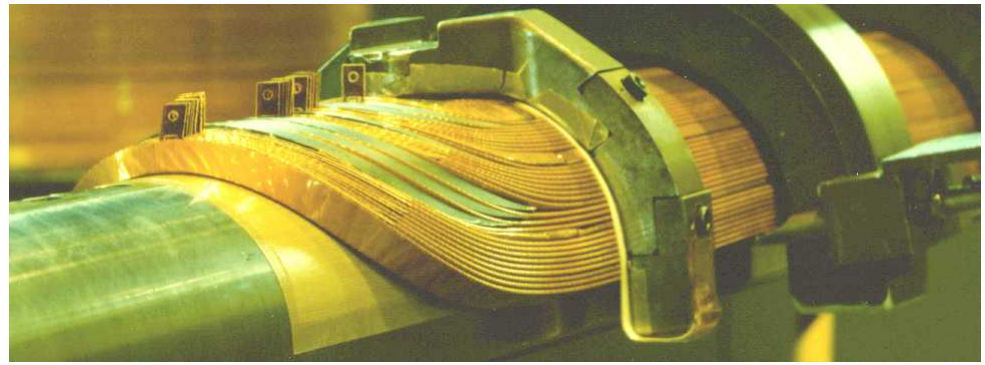
High Field Magnet Design

Design Issues:

- Must use brittle superconductors

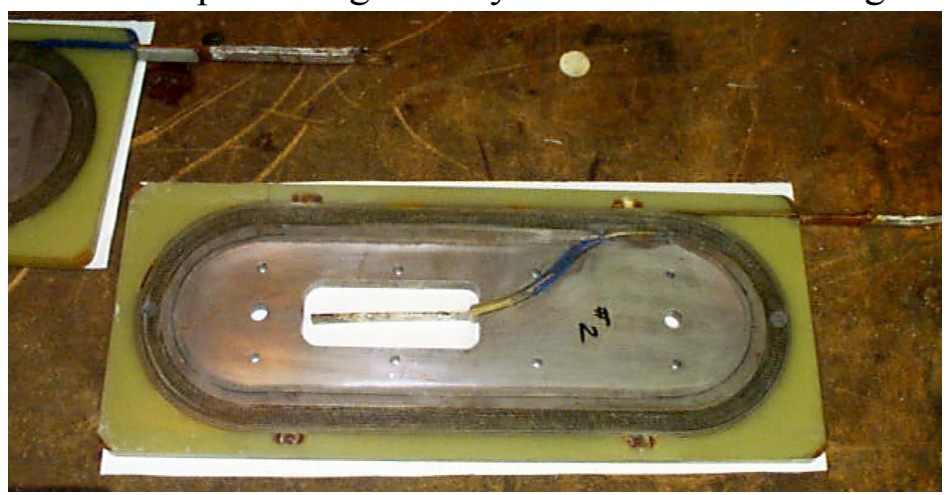
  Nb_3Sn, HTS

- Large Lorentz forces
- Large energy deposition
- Cold coils, Warm iron
- Need compact cryostat
- Large heat leak



Conventional design (e.g., RHIC magnets)

- Complex 3-d geometry -- not suitable for high fields

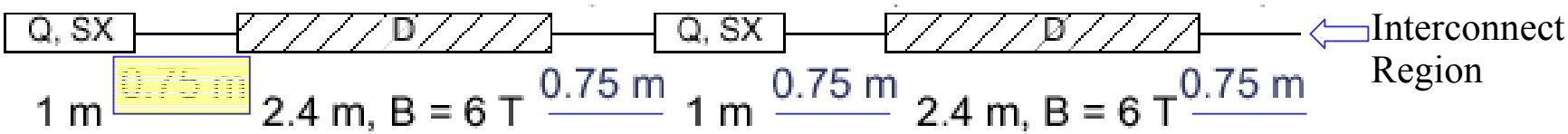


Conductor friendly racetrack coil geometry (separate program)

- Suitable for high field magnets with brittle material

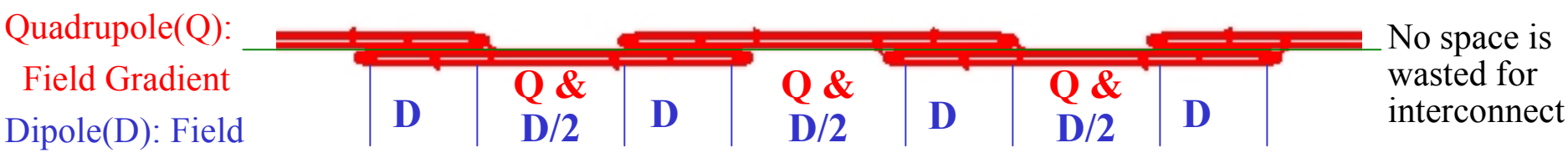
Innovations for a Compact Ring

- Skew quadrupole needs NO conductor at midplane (B. Parker)
- In study 1 (50 GeV), ~1/3 space was taken by inter-connect regions



Gets worse at lower energy (50 => 20 GeV in study 2)

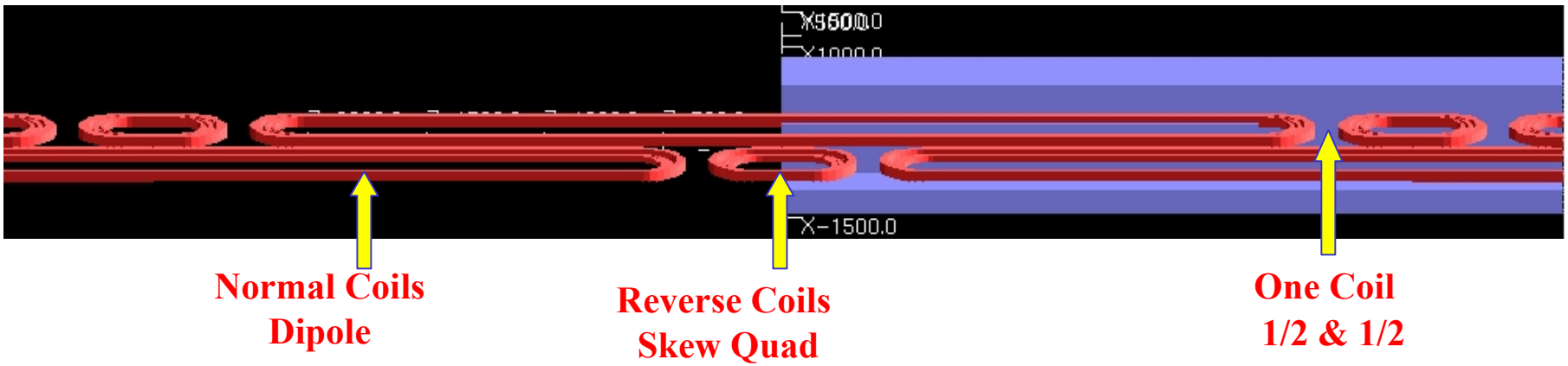
- New magnet system design makes a productive use of all space

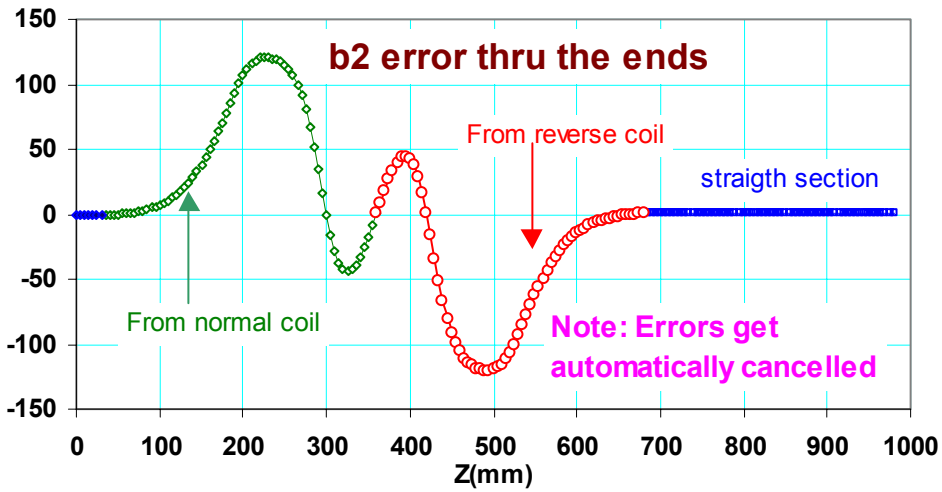


Shorter cells ⇨ smaller aperture, improved beam dynamics

More Innovations for 3-d Effects

Reverse coils to cancel all field errors in the ends





New Magnet System Design

> Good field quality

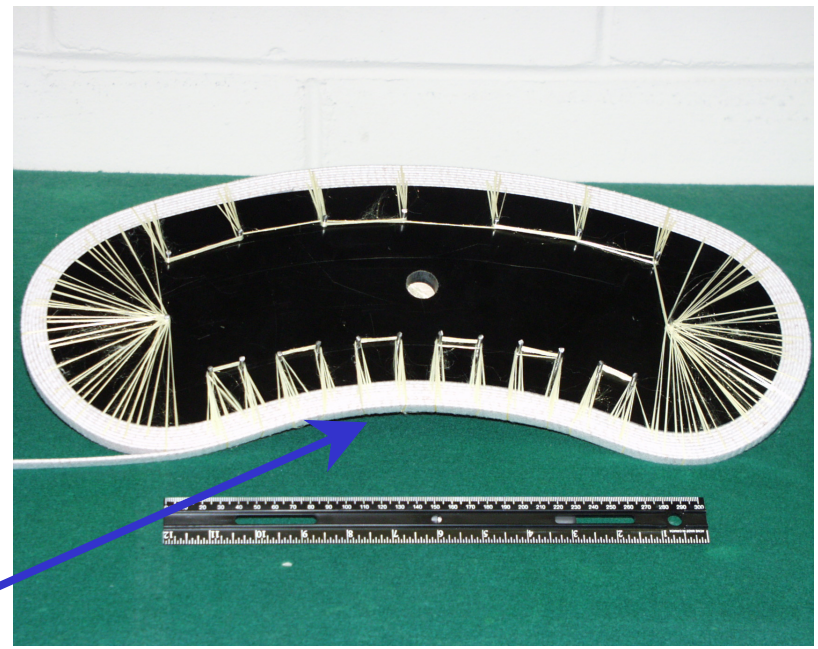
> Makes ring small

Important for BNL site

Status and Progress

Significant progress (accomplishments) and innovations to date

- **Conceptual design completed**
- **Initial magnetic and mechanical analysis performed**
  - magnet design is strongly coupled with the lattice design (being developed in parallel under different funding)
- **A method to obtain large reverse curvature devised**



Goals For the Rest of the Year

- Complete magnetic & structural analysis
- Continue on the detailed engineering design
  (including support structure and cryostat)
- Develop tooling design for winding coils, vacuum impregnation, etc.
- Obtain superconductor for making coils for model magnet
- Develop test fixture/setup

Goals For the Next Year

- Build necessary tooling for a model magnet
- Build short SC coils (4 + 2 spares; double layer)
- Test these coils in the following configurations:
  - Dipole 
  - Quadrupole 
  - Combined function magnet 
- Continue work on improving design to make storage ring more compact and more efficient