HEPAP Subpanel Review - BNL Magnet Division

OUTLINE:

- Staff/budget/facilities/focus
- R&D with NbTi (a familiar, low-temperature superconductor)
  - Magnets for ILC IR
  - High ramp rate magnets for FAIR at GSI
- R&D with Nb_3Sn (less-familiar, low-temperature)
  - Optimize strand reaction process
  - Long racetrack coils (LARP)
- R&D with BSSCO (a "new", high-temperature superconductor)
  - Quad in a high radiation environment (RIA fragmentation)
  - Energy-efficient magnets for new generation light source
- Looking ahead: advanced high-temperature superconductors
  - YBCO, MgB_2
- Closely-related R&D
  - Vibration studies of superconducting magnets for ILC IR

P. Wanderer, February 15, 2006

Staff/Budget/Facilities/Focus

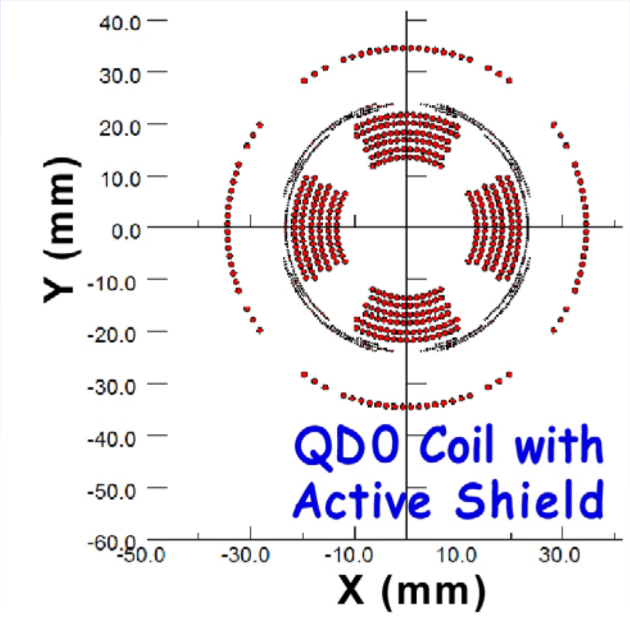
- Staff ~ 55, including 8 on the scientific staff
  FY06 headcount is down, following RHIC & LHC construction
- HEP FY06: 12.5 heads, $3.5 M (LARP, accelerator, ILC)
  Fraction short/medium/long term ~ 0/75%/25%
- Facilities:
  Tooling for production runs, e.g., 20 LHC IR dipoles
  Conductor tests (e.g., magnet for background field)
  Nb_3Sn reaction ovens
  Specialized winding machines:
    - direct wind (CAD/CAM) for new BEPC II IR magnets + …
    - for brittle materials -- e.g., reacted Nb_3Sn
- Focus:
  Specialized accelerator applications ⇒ novel designs
  Short production runs

R&D with NbTi (Tc = 10K, Hc = 10T): Direct Wind

- NbTi: low temperature superconductor (LTS), ductile, wire & cable
- Application: IR magnets with modest field requirements -- e+e-
  CAD/CAM direct wind ⇔ IR optics design with multiple coils

- Example: BEPC II IR, recently completed

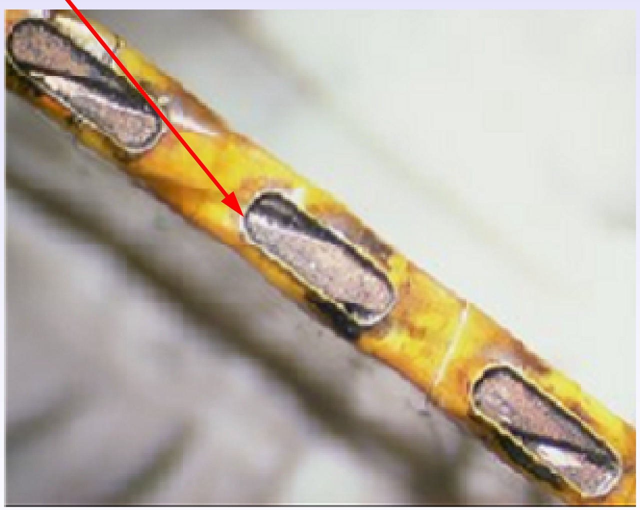
- Example: ILC large-crossing angle IR:
  - Optics designs for both entering and exiting beams
  - Recent: quadrupole with little external field ⇒ crossing angle reduced from 20 mrad to 14 mrad



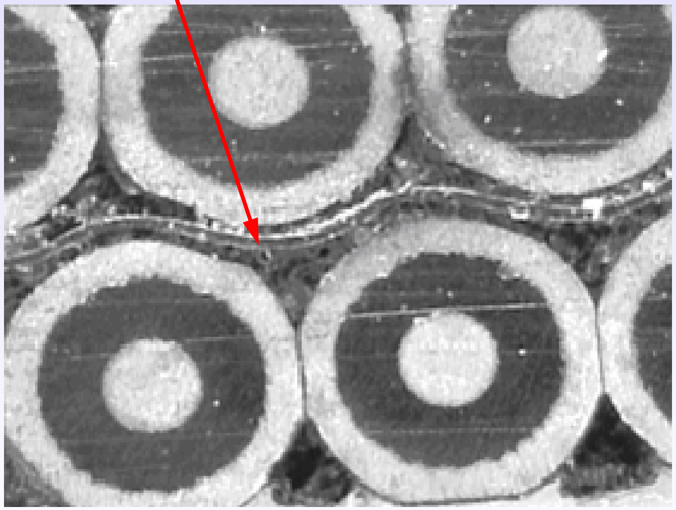
R&D with NbTi (Tc = 10K, Hc = 10T): Fast Ramp

• Modify standard Rutherford cable, insulation, magnet construction to tolerate high ramp rates (RHIC 0.06 T/s $\Rightarrow$ GSI 4 T/s)

Holes in cable's Kapton insulation



Thin ss foil between cable layers



• Work on 1 m model dipole for GSI recently completed

• Future application: upgrade high-energy injector (e.g., SPS)

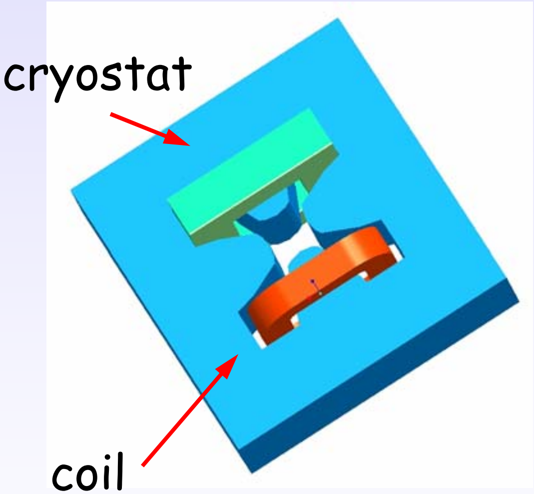
R&D with Nb_3Sn (Tc = 20 K, Hc = 20 T)

- LTS, brittle after reaction, available as wire and cable
- OHEP funding for strand optimization and testing
  mostly used to support LARP
- LARP magnet work:
  wind ductile cable, react ("wind & react")
  talks by Peggs, Gourlay
- OHEP funding for magnet R&D:
  react cable, *then* wind coil ("react & wind")
  recent successful test of 1 m 9.3 + T common coil dipole
  handling techniques generally applicable to HTS
- Issue: insufficient OHEP funding for cable test facility
  facility recently shut down

R&D with BSSCO (Tc ~ 80 K, Hc > 30 T)

- BSSCO: high temperature superconductor (HTS), brittle, tape
  High Tc ⇒ tolerates larger temperature variation than LTS
  brittle tape ⇒ planar coils (usually racetrack), DC magnet

- Application: RIA fragmentation quad (1st quad after target)
  - Superferric design - warm iron - only 2 coils -run with cryocooler
  - R&D goal: mirror quad (1 coil, ~ design gradient and forces)
  - R&D so far: successful test of first 25% of coils with iron



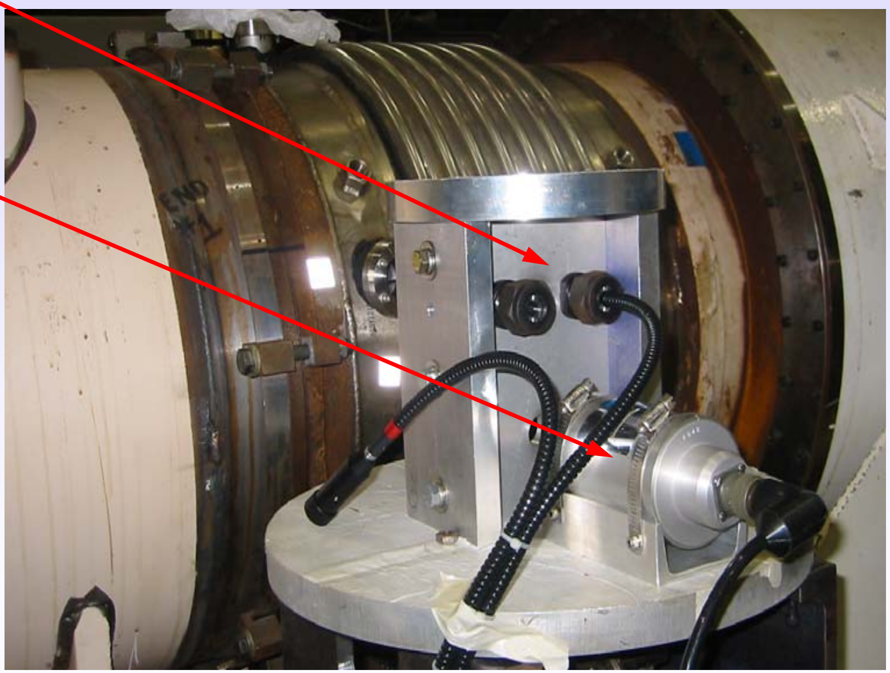
- Further in the future: "2nd generation HTS," YBCO -- soon available in long lengths -- higher current, wider than BSCCO

R&D -- energy efficient systems

- Goal: reduce energy use
  - Replace resistive magnets with HTS magnets operating at elevated temperatures and cooled by cryocoolers
- DC magnets (tape & cable ok)
  - application: proton transport line (e.g., AGS to ν target)
  - application: storage ring (e.g, SNS, NSLS II)
  - use of cryocooler and superconducting magnet in accelerator: AGS snake for polarized p+
- Ramped magnets (cable needed)
  - MgB_2 wire -- ductile wire not yet available -- we are tracking R&D in BNL Metallurgy Department -- long range

R&D: ILC vibration studies

- Explore technologies for measuring magnet motion at the nm level:
  - dual laser vibrometer
  - geophone



- Photo: setup for first measurement of the motion of a superconducting magnet at 4.5 K.

- Planning for high-resolution measurement of the center of a quad.

BNL Magnet Division Summary

- Tight coupling:
  properties of superconducting materials
  magnet production facilities, some unique
  accelerator requirements

- Unique applications across a broad range of HEP and HEP-related accelerator applications