

SC Magnet Division - Directors Program Review

HEP Programs

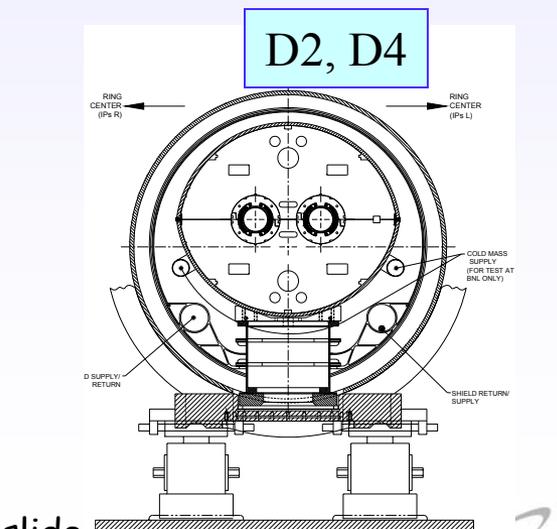
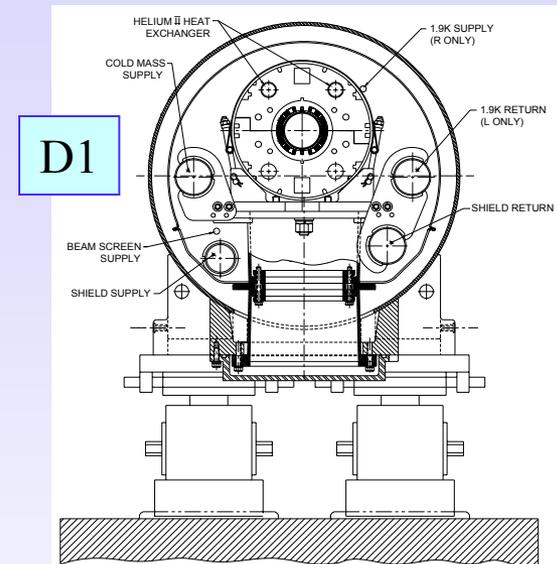
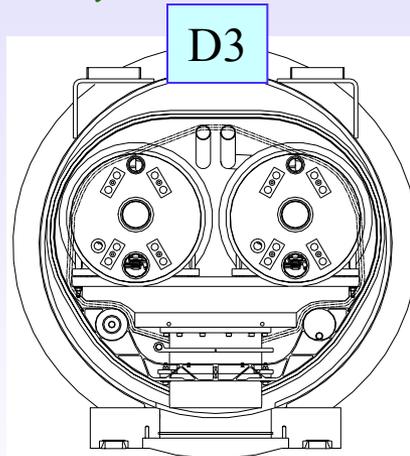
Michael Anerella

HEP Programs

- LHC (CERN)
- LARP (CERN)
- ILC
- Magnet R&D (common coil)
- T2K Neutrino Experiment (JPARC)
- BTeV, MECO (RSVP) - almost

LHC

- Based on 8cm 10M RHIC dipole coil
- 4 distinct production lines, 20 magnets total
- D1 - "1-in-1" 8cm dipole (most like RHIC)
 - 1.8K operation (phase separator)
 - Oversized beam tube
- D2 - "2-in-1" cold mass
 - Stainless steel collars
 - Oblate yoke / shell
 - CERN-style cryostat
 - > 20 tons
- D3 - "2-in-1" cryostat
 - (2) RHIC-style dipoles in CERN-style cryostat
- D4 - "2-in-1" cold mass
 - Similar to D2 but different aperture spacing
 - Converging beam tubes inside parallel coils



LARP (LHC Accelerator Research Program)

- Wind and React Nb_3Sn Coil R&D
 - 0.25M coil program for “tech transfer” from LBNL
 - 4M coil program to test length effects on reaction process

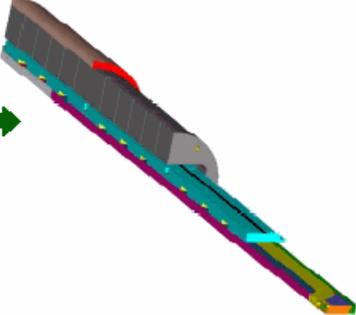


LARP

Long Racetrack - GOALS

1. The final goal is to test **3.6m long Nb_3Sn coils** fabricated with the same technology that will be used for the coils of the long quadrupole
 - target is to reproduce performance of short coils
2. Coils will be tested in an **Al-shell-based supporting structure** (preloaded using bladders and keys) in order to **verify the use of this concept for long magnets**

Coil layout: flat double-layer racetrack coils
Techn. successfully developed at LBNL and successfully modified at FNAL



← From 1 foot to 3.6m →

Long Racetrack Coil R&D – G. Ambrosio

“Long Racetrack Coil R&D”

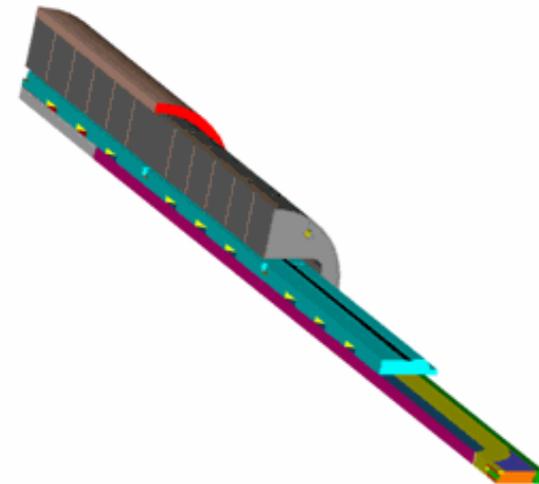
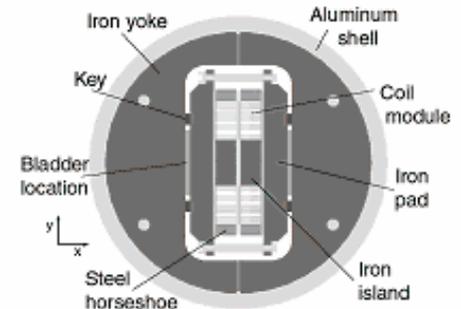
FY06

- Build and test (2) “subscale” (~ 12” long) double layer coils
 - Use LBNL parts and tooling *
 - Build BNL skills with W&R Nb₃Sn before committing expensive sums of superconductor
- Design and build tooling & equipment for 4M W&R Nb₃Sn coils

FY06 – FY07

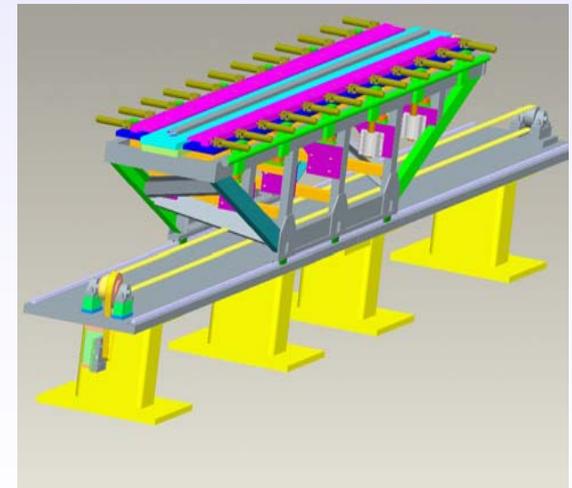
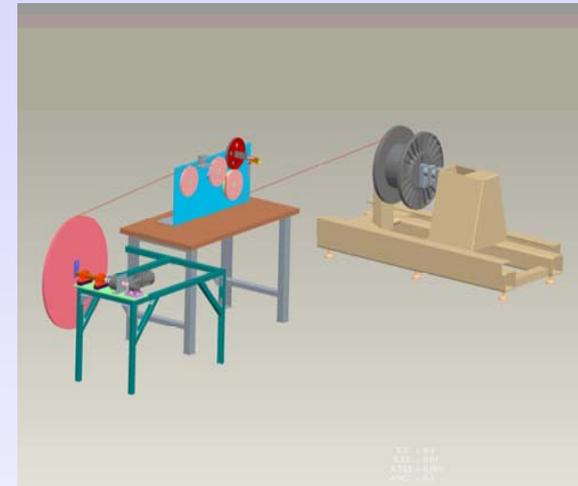
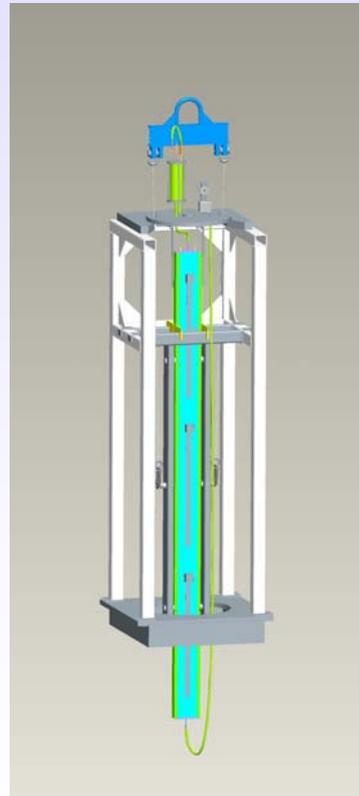
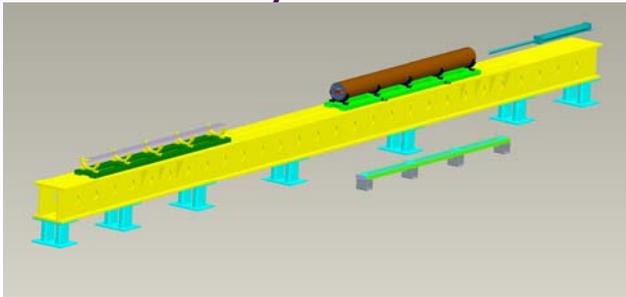
- Build and test (2) 4M double layer coils
 - Use LBNL support fixture*
 - Test length effects using technology established w/subscale coils

* Collaborative effort



New LARP Major Equipment

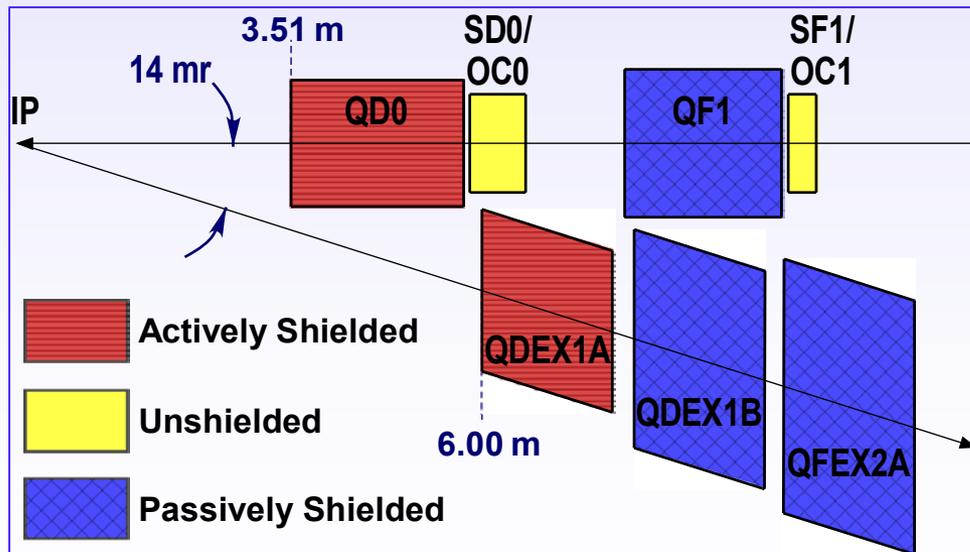
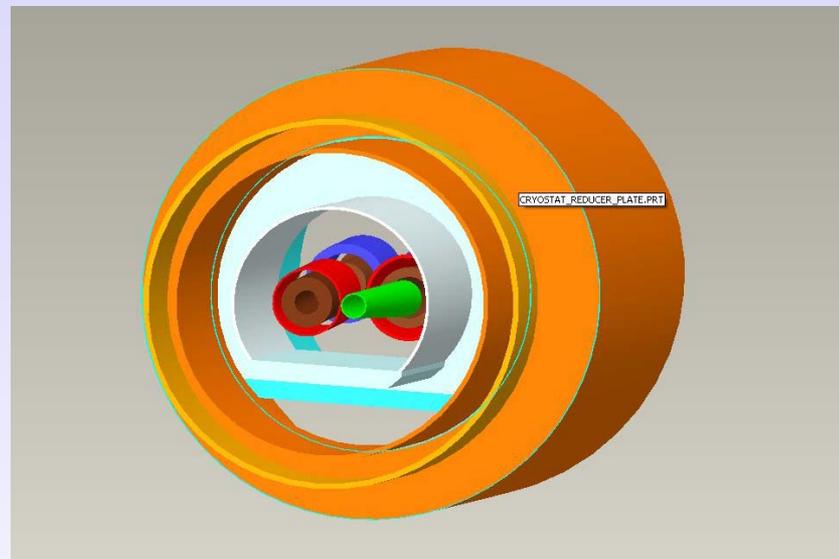
- Cable re-spooling line
- Winding machine shuttle, clamps
- Reacting fixture
- Reacting oven
- Impregnation fixture
- Coil lifting fixture
- Lifting / up-righting fixture
- Prep / wiring station
- Assembly station



ILC (International Linear Collider)

Beam Delivery System:

- Final focus magnets
- Extraction line

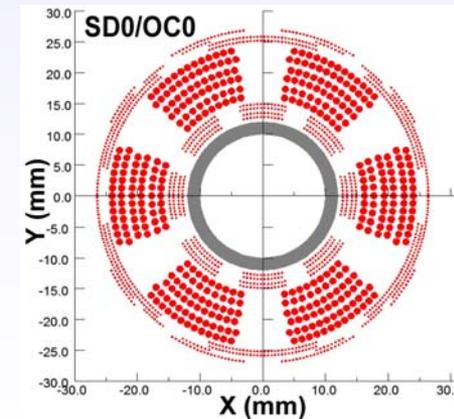
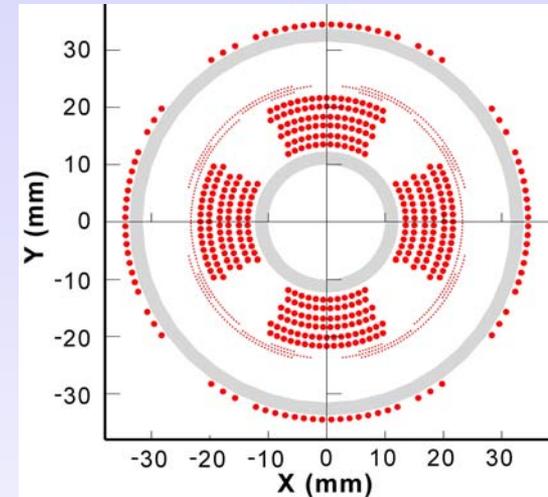


Direct wind technology (as before) makes the design possible. Also:

- Common helium vessel for all elements
- Vibration, stability issues (@ 10nM level)
- 1.8K operation
- Many other challenges

ILC Beam Delivery System Magnet R&D - Short term goals

- FY05: QD0 test coil completed & tested
- FY06:
 - Fabricate and test a short Octupole/Sextupole coil. Higher order magnetic elements require tighter bend radius onto a very small (20 mm) tube. This was non-trivial
 - Continue the 14 mrad conceptual design
 - Design "early tooling" for a 2m coil
 - Winding machine supports
 - Wrapping machine



ILC Beam Delivery System Magnet R&D - 3 Yr R&D Plan

- FY07

- Detailed design of "Prototype" magnet system
- Conceptual design of cryogenic (heat exchanger) & power lead systems
- Design of assembly tooling
- "early tooling" assembly
- Construction of vibration test mock-up
- Start Prototype quad coil fab

- FY08

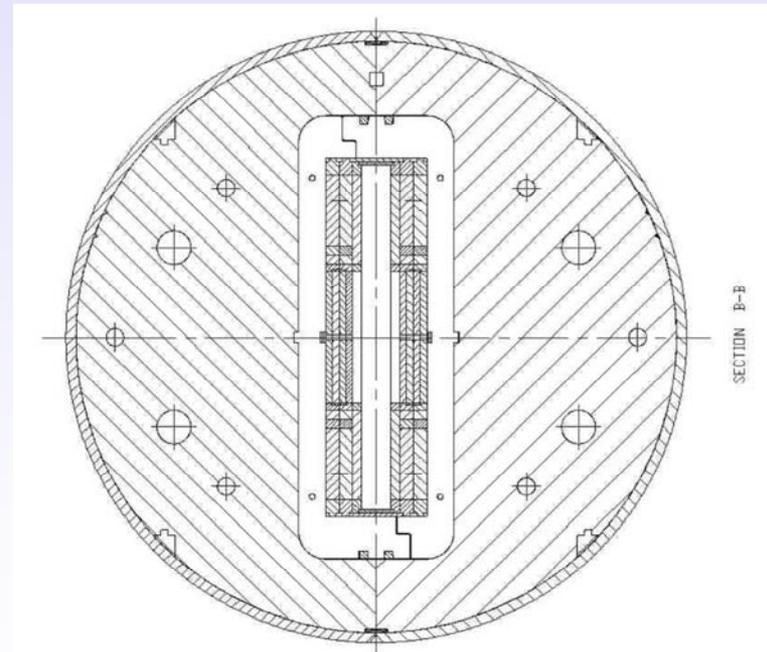
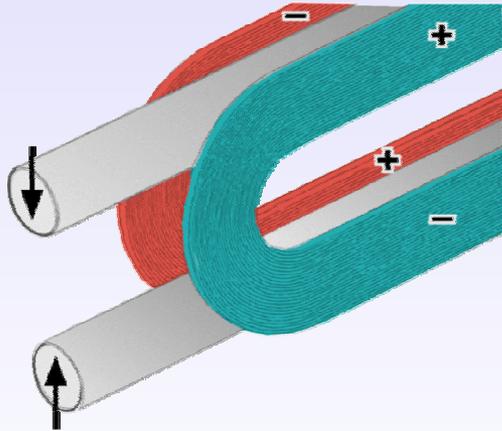
- Design of test tooling
- Detailed design of cryogenics and power leads
- Fab of prototype parts & tooling
- Finish prototype quad coil fab, start prototype cold mass fab
- Start prototype cold mass fab

- FY09

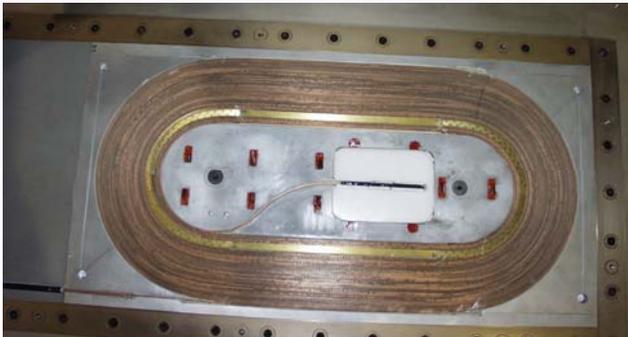
- Finish fab of heat exchanger, test tooling
- Finish prototype cold mass, cryostat fab
- **Cold test magnet**

High Field Magnet R&D

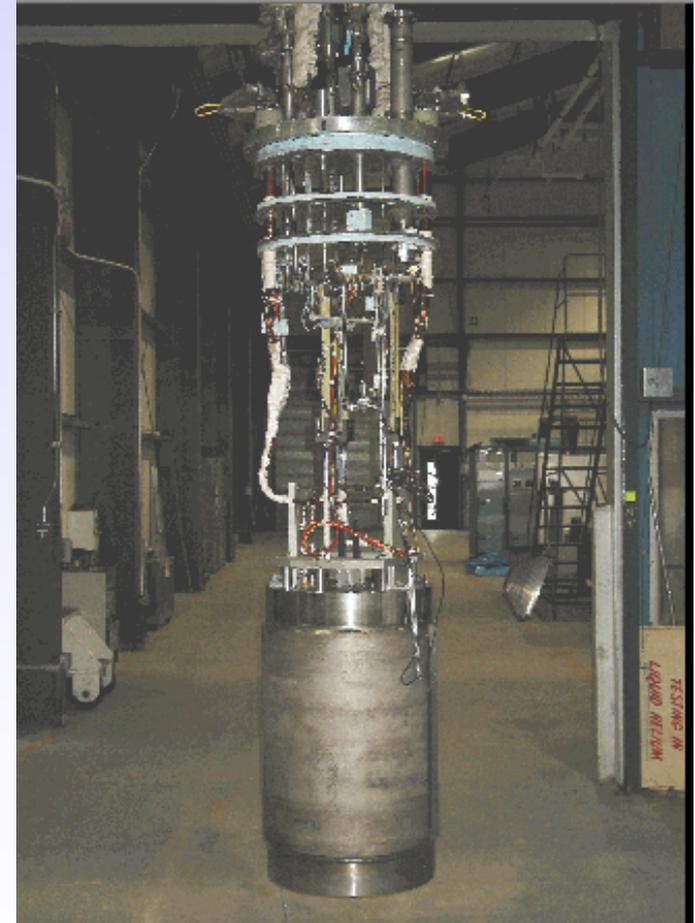
Nb₃Sn React-and-Wind (HTS cable compatible technique) common coil magnet completed and measured this year. This marks the end of a multiyear Nb₃Sn development program.



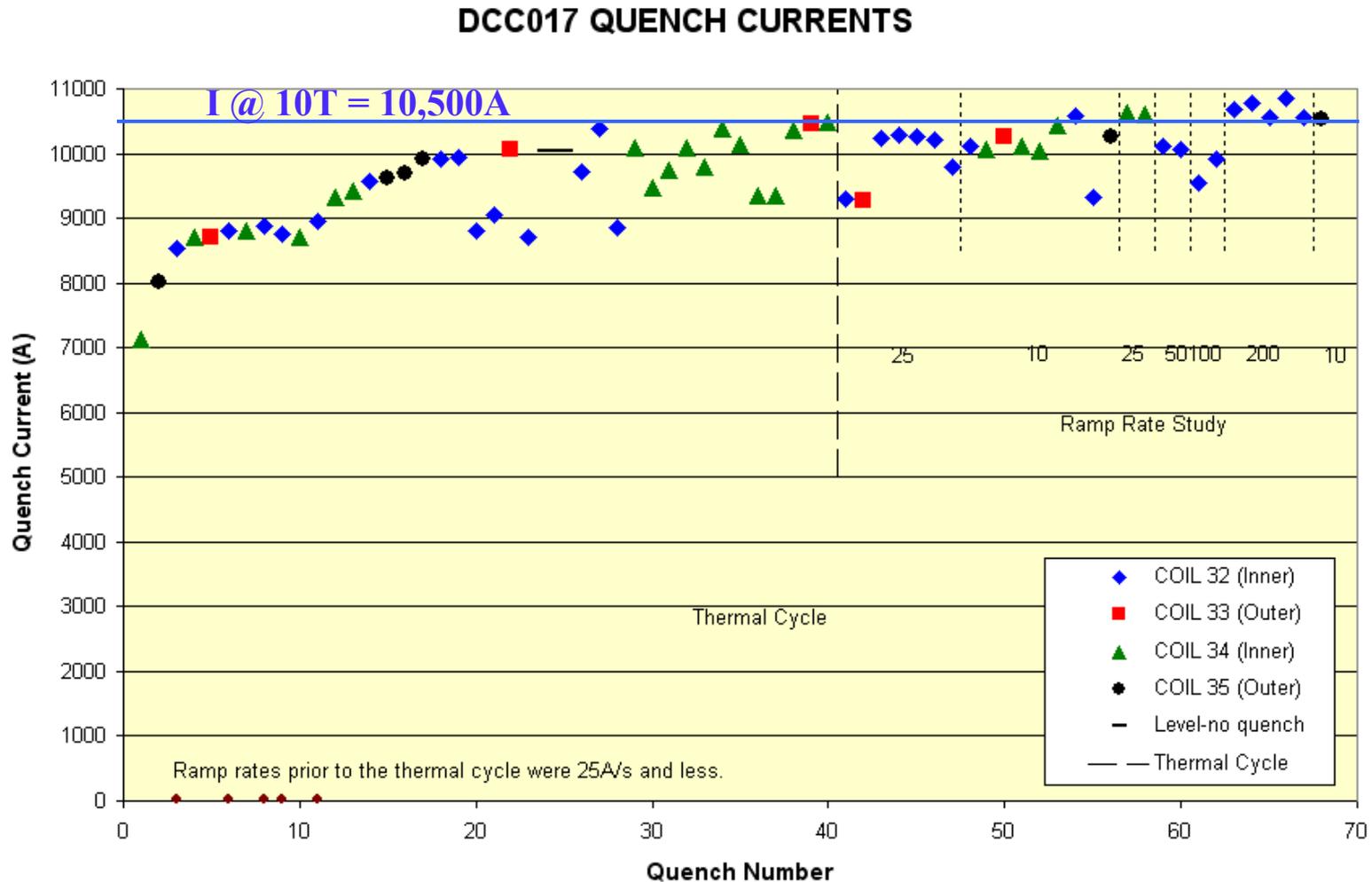
4 cm gap and ~ 10T at short sample



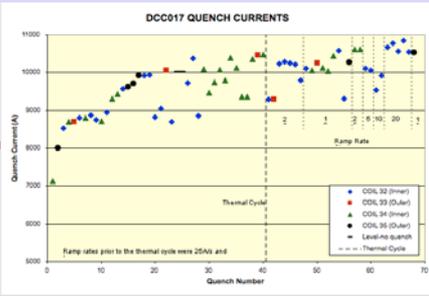
DCC017 during fabrication and en route to the Test Dewar



Vertical Dewar Cold Test Results



High Field Magnet R&D Summary



- First react-and-wind (R&W) Nb₃Sn magnet* that has met (or even come close) to design parameters (i.e., REACHED CONDUCTOR LIMIT, with training). * magnet with aperture!
- Demonstrates that flat R&W coils work with this technique; no issues with extending to long coils.
- Erratic quench performance may have been due to the high level of energy deposition deposited into the coil during quenching,
- Program terminated for now due to budgetary considerations, BUT HOPE TO BUILD HTS RUTHERFORD CABLE INSERT COILS (SOON).

T2K (From Tokai To Kamioka Neutrino Oscillation Experiment)

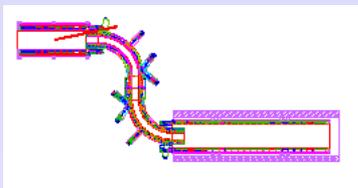
- Direct Wind Correctors for KEK JPARC program
 - Initially combined function coils for inside bore of main combined function magnet (prototype delivered)
 - Reconfigured as 2 layer corrector, conduction cooled, for interconnect region (prototype delivered)
 - 3 production units to be made in FY07 - DOE funds



Final: Conduction Cooled Dipole in a Magnetic Yoke

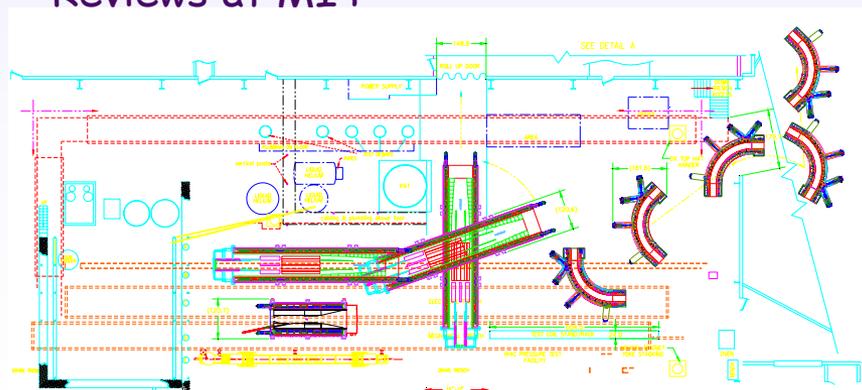


BTeV, MECO (RSVP) - almost



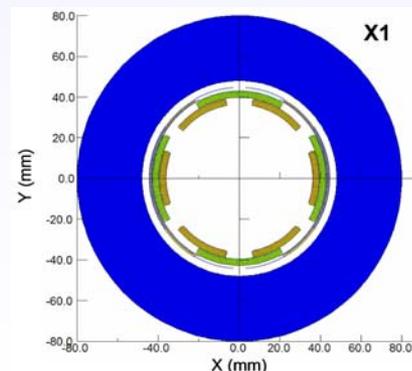
MECO

- Several large sc solenoids for AGS RSVP
- \$3M+ assembly, test & integration by SMD
- Cost & schedule
- Detailed production plan
- Reviews at MIT



BTeV

- 16 multi-layer direct wind correctors for FNAL
- \$2M+ construction by SMD
- Magnetic design completed
- Test pattern wound
- Comprehensive cost, schedule, production plan
- FNAL, DOE Reviews at FNAL



Summary

- LHC - Completed, all magnets meet requirements
- LARP - ongoing; present program and funding limited; potential in upcoming years
- ILC - huge opportunity to impact Beam Delivery System, much work to do
- Magnet R&D (common coil) - painfully slow but gratifying progress so far; potential for additional R&D
- T2K (KEK, JPARC) - good responsiveness to changing requirements; furthers global physics