LARP, LPP-Collider, g-2 Inflector

(LPP, where L = large, includes CERN, Chinese efforts)

Peter Wanderer

Head, Superconducting Magnet Division

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BROOKHAVEN NATIONAL LABORATORY

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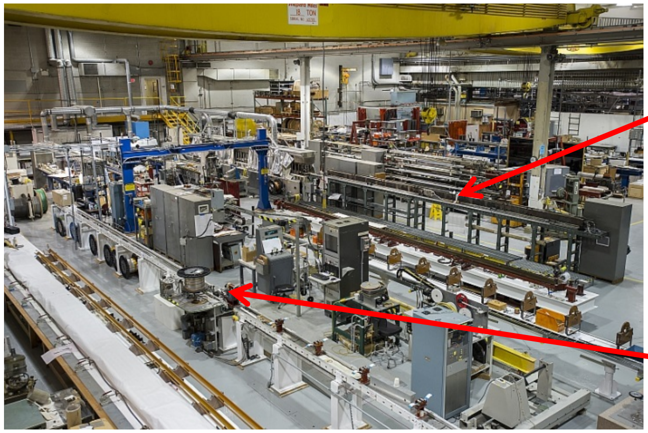
Office of Science U.S. DEPARTMENT OF ENERGY

LARP Common Activities – BNL, FNAL

- LARP (R&D) and US-HiLumi (Project) magnets:
  - 4 steps in coil production process: wind, cure, react, impregnate
  - *R&D:* Fermi wind & cure, BNL react and impregnate
  - *Production*: Two (nearly) coil identical production lines

- Nb_3Sn, HTS conductor test and evaluation:
  - Strand testing in solenoid field (4.5K, 1.9K)
  - Evaluate tests vs specs (Ghosh, Cooley)

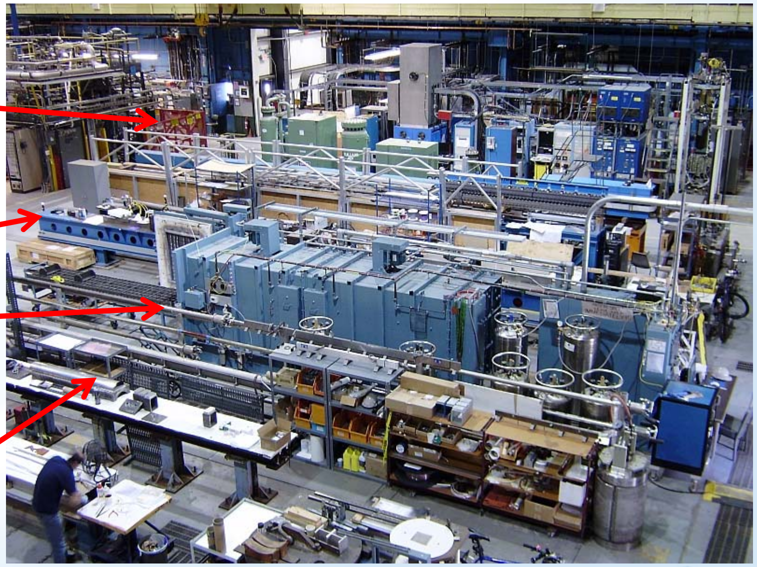
Facility for LARP + Lpp-Collider Magnets



10m coil cure fixture

10m fixtures to be shortened for LARP

10m coil winding fixture



Vertical Test
(1.9K), 24kA

Quad Assembly

4.5m Reaction Oven

4.5m Impregnation

Magnet testing: BNL, FNAL

- Vertical dewar:
  - Fermilab – cold masses up to ~ 3.4m long, 4.5K, 1.9K
  - BNL – cold masses up to ~ 4.2m long, 4.5K, 1.9K (in progress)
    - Will test LARP and US-HiLumi cold masses

- Magnet (cold mass in cryostat), L_{max} > 10m:
  - Fermilab – 4.5K, 1.9K
    - Will test LARP and US-HiLumi magnets
  - BNL – 4.5K, 10kA,…   not planned for use

Vertical Test Facility

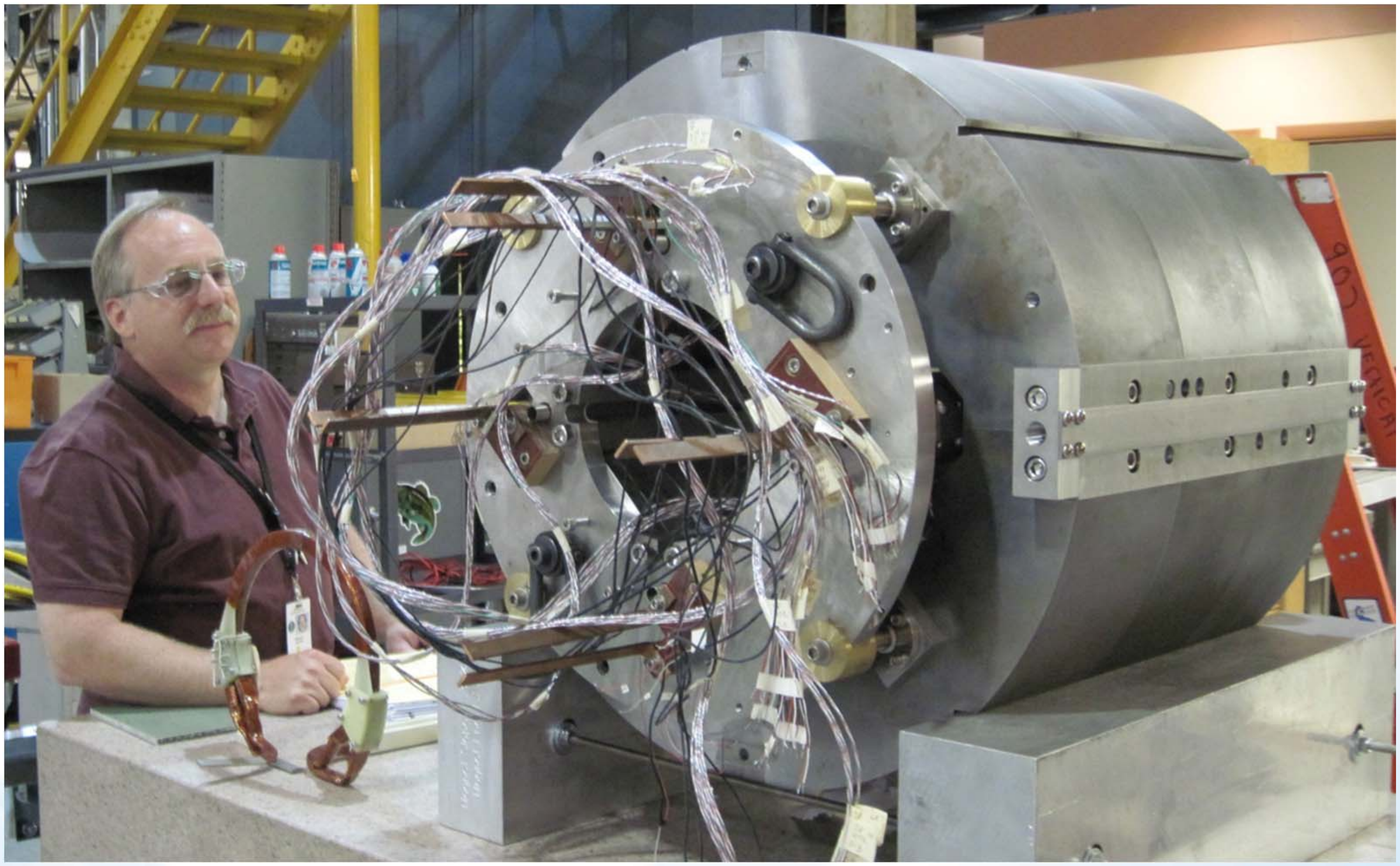
LHC-HL magnet length not yet set. Careful review of suspension, dewar, etc. to match LHC-HL magnet length.

Lpp-Collider Magnets

- BNL: ReBCO (tape) – Ramesh Gupta, HTS PI
  - Have sensitive quench detection
  - Have built accelerator magnet (FRIB), medium field
  - Have built high field solenoids (15T +…)
- Fermilab et al: Bi2212 (round strand, Rutherford cable)

- For ~ 20T, need magnets using high temperature superconductors (HTS), including hybrid magnets (HTS + Nb_3Sn). Common coil design uses racetrack coils, which are relatively simpler to build.
- Need open midplane dipoles for synchrotron radiation.

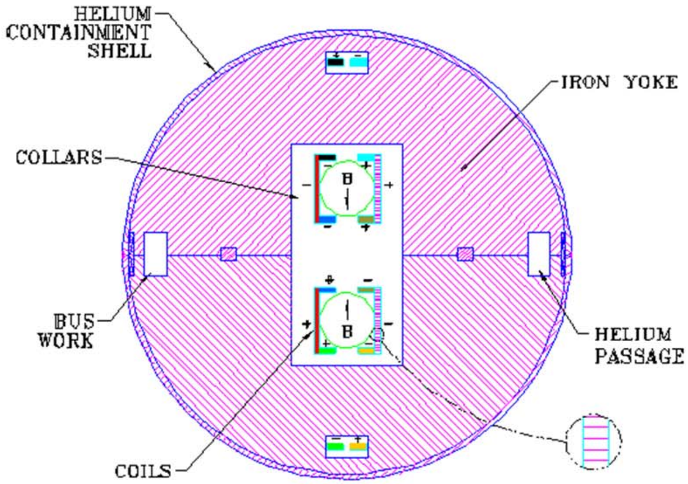
FRIB HTS Fragmentation Quadrupole



Superconducting Magnetic Energy Storage – ARPA-E

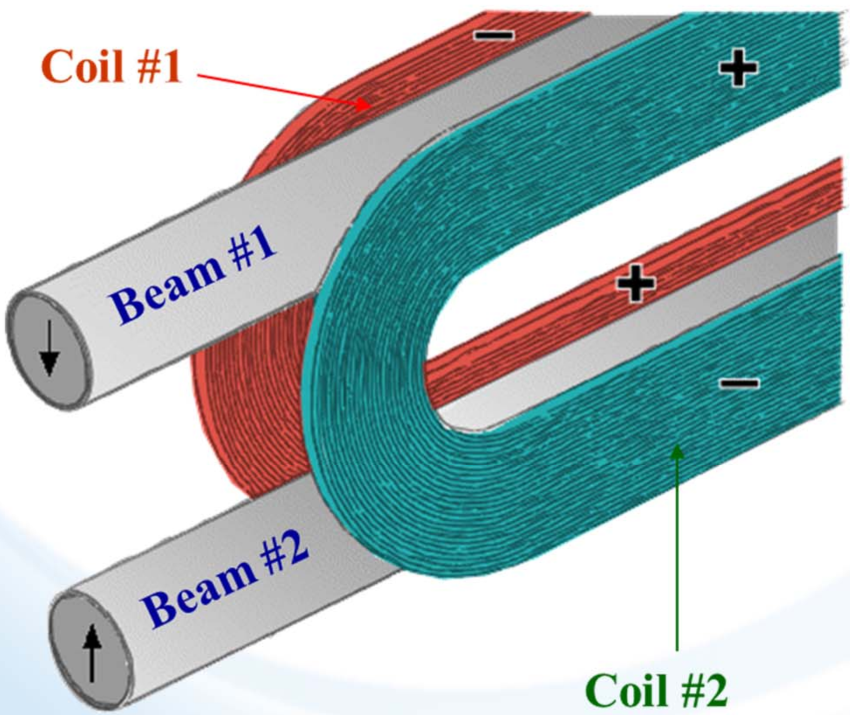
46 pancakes in coil.
Magnet achieved 12.5 T (27 K), 350 A.

Quench detection threshold ~ 1 mV



Common Coil Design
(The Basic Concept)

- **Simple 2-d** geometry with large bend radius (no complex 3-d ends)
- **Conductor friendly** (suitable for brittle materials – can do both Wind & React and React & Wind)
- **Compact** (compared to single aperture LBL's D20 magnet, half the yoke size for two apertures)
- **Block design** (for large Lorentz forces at high fields)
- **Efficient** and methodical **R&D** due to simple & **modular design**
- **Minimum** requirements on big expensive **tooling and labor**
- **Lower cost magnets** expected

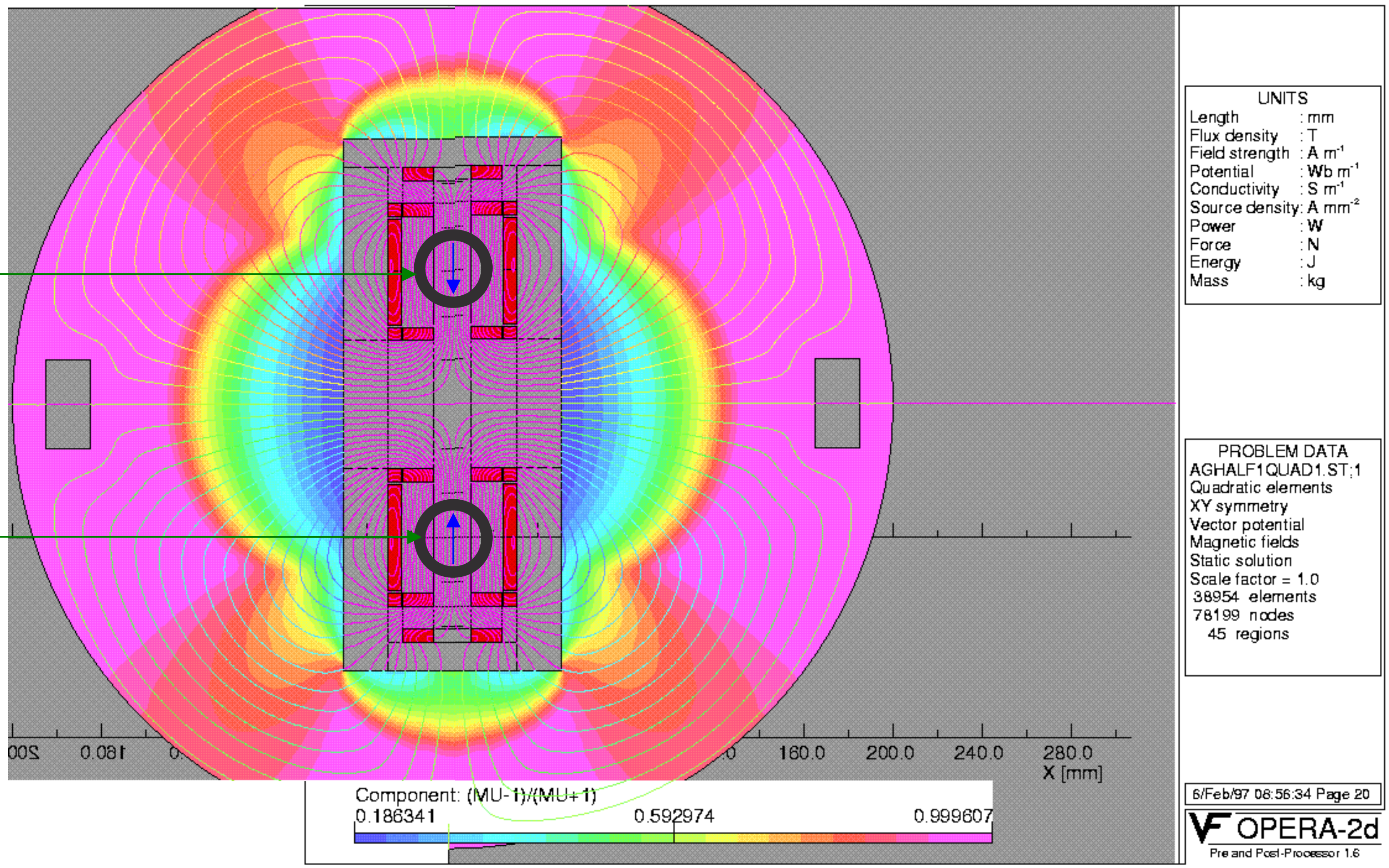


Main Coils of the *Common Coil Design*

Concept for 15T HTS Common Coil dipole

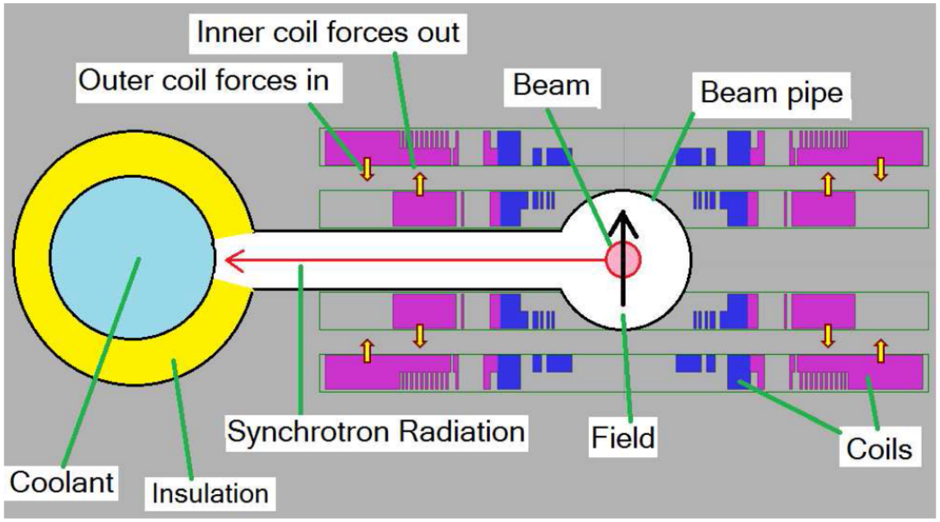
Aperture #1

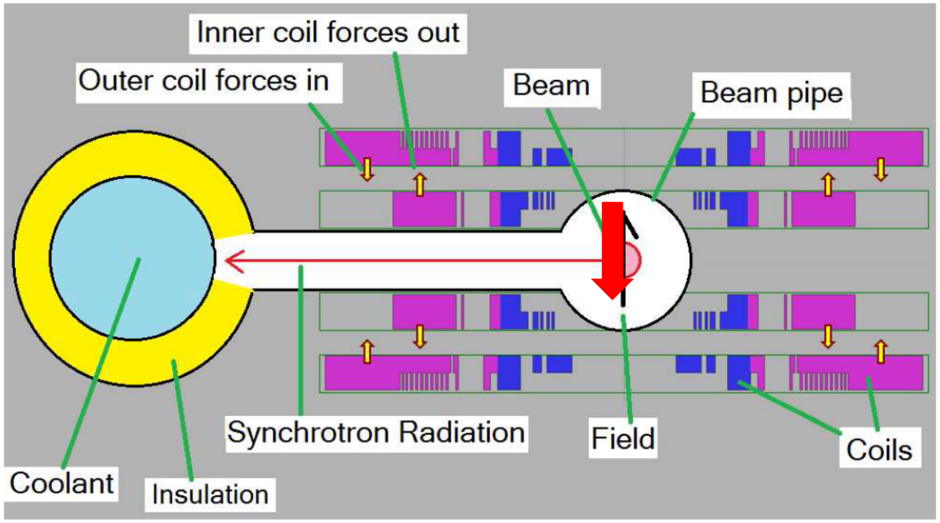
Aperture #2



Yoke diameter << yoke for single aperture dipole

Concept for Common Coil open midplane hybrid dipole





Features:

- Common coil design
- Balance of forces on inner and outer coils → open midplane
- HTS + LTS coils

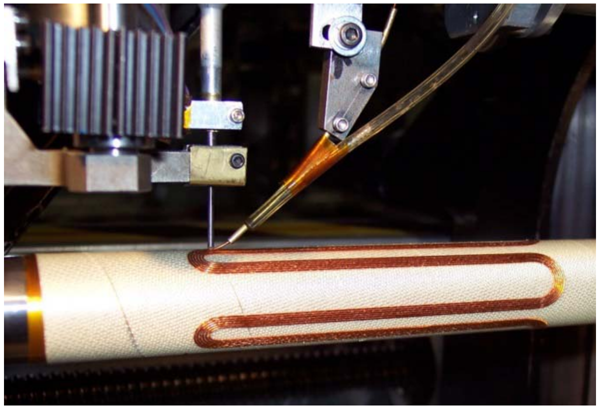
Issue:

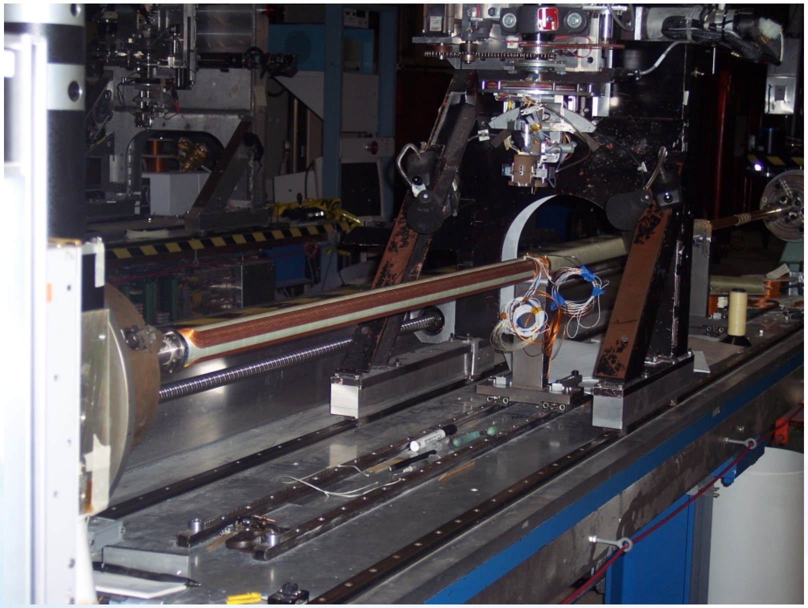
- Effect of coil end fields

Direct Wind facility
ILC prototype IR magnets, g-2 inflector concept

- Semiautomatic machine for winding single strand and small NbTi cables on cylindrical support tubes.
- Ultrasound used to bond insulated wire to support tube.
- Software to translate full 3D coil design to wire locations on support tube.
- 11 parameters in wiring file
- Essential: skilled technicians.
- Direct Wind coils at BNL, DESY, CERN, IHEP, KEK, JPARC, ILC R&D.

Direct Wind machines (2)





g-2 Inflector Magnet Design

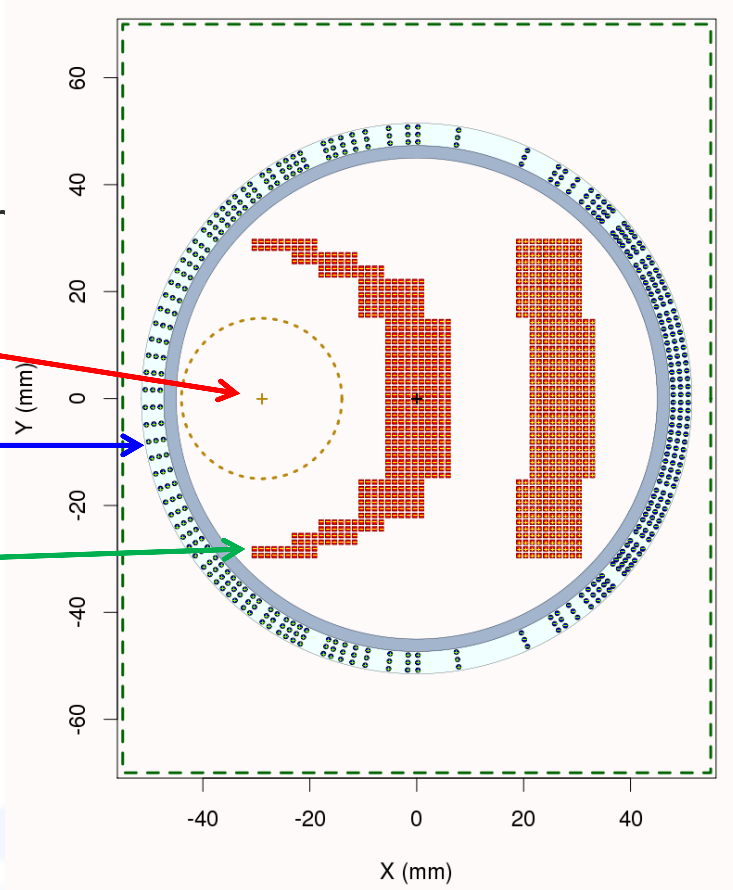
Alternative to baseline design (design used at BNL).
Goal: factor of two increase in # of muons transferred to storage ring.
Conceptual design, cost estimate completed – waiting for CD-2 review.

Inflector 100 mm diameter, 1.5 m length

Muon beam center

Direct Wind coil

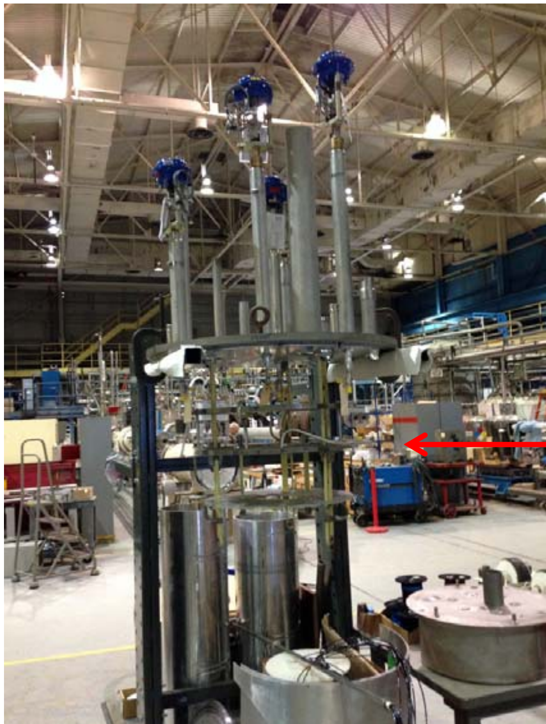
Block coil



Concept: *external* field of the block coil adds to the field of the Direct Wind coil to produce ~1.5 T at the beam center; fields cancel outside the Direct Wind coil.

Design: Brett Parker

ILC model final focus magnet system



Cryo interface to IR coils

Status: construction 95% complete, asking for funds to complete, test

Brett Parker: optics, coil design, machine-detector interface

2m IR coils

Summary

- LARP magnets: Coil manufacture, material specifications and testing, test of cold masses
- LARP SCRF: crab cavities (in C-AD)

- LPP-Collider magnets
  - Key concepts: common coil, open midplane dipole
  - Extensive experience with ReBCO material, magnets

- g-2 inflector concept to increase muon flux