MAGNET DIVISION: A LOOK AHEAD

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Superconducting Magnet Division

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BROOKHAVEN NATIONAL LABORATORY

a passion for discovery

Office of Science
U.S. DEPARTMENT OF ENERGY

SAFETY: 1279 DAYS = 3.5 YEARS WITHOUT A LOST TIME ACCIDENT

CONGRATULATIONS KEEP UP THE GOOD WORK

MAJOR EVENTS THAT SET THE STAGE

BNL

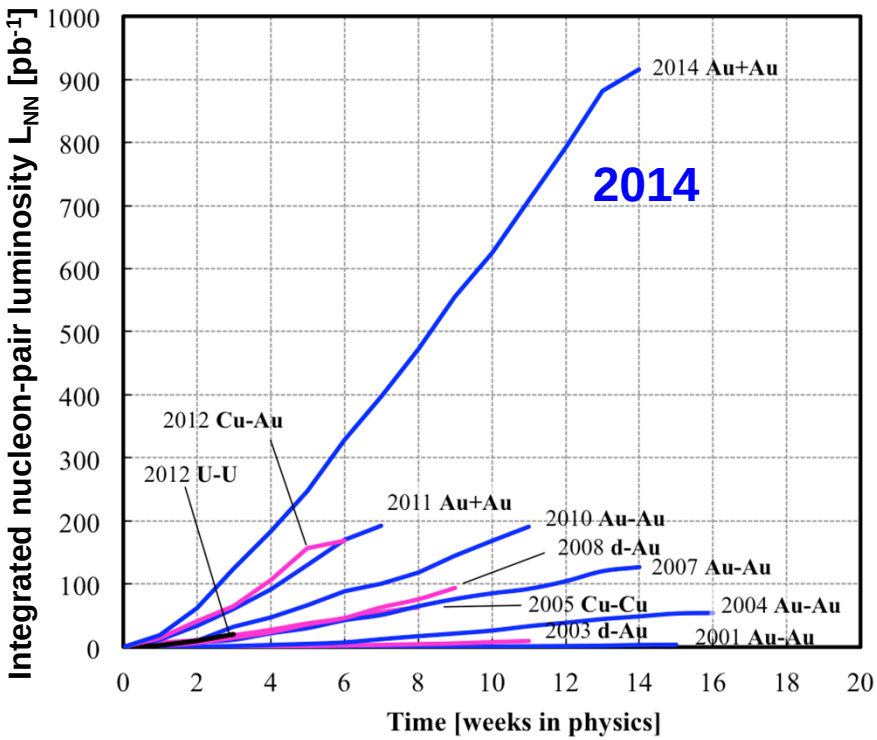
- "Recompete" of the BSA contract for operating BNL.
  - Proposal submitted late June
  - Presentations last week
  - Decision: by November
- Annual Lab Plan presented to Office of Science
  - Includes, for example, draft plans for completing RHIC science mission and transitioning to eRHIC
  - Includes list of BNL Core capabilities: One is Accelerator Science and Technology
  - Presented in early July; went well.

Nuclear Physics

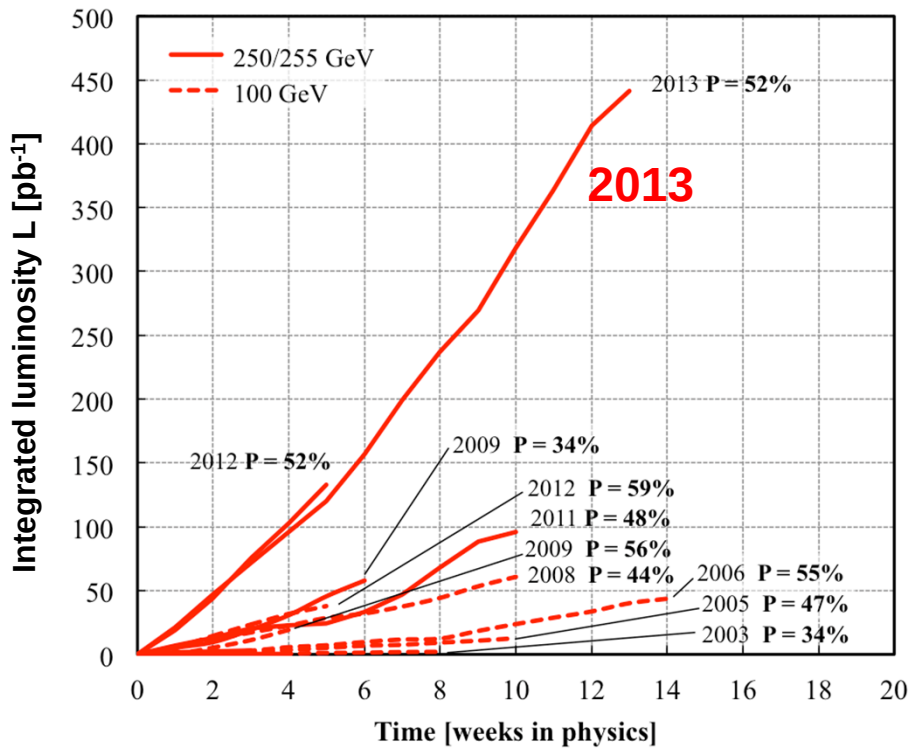
- Addition of $50M to DOE Nuclear Physics budget
- Year-long process to develop a Long Range Plan for Nuclear Physics has recently started
- C-AD's development of an affordable plan for building an electron accelerator for an electron-ion collider (EIC)
  - FFAG magnets for the arc magnets
  - Superconducting magnets as the basis for the IR magnets (magnets nearest the collision points).

RHIC Integrated Luminosity and Polarization (RHIC II performance!)

Heavy ion runs

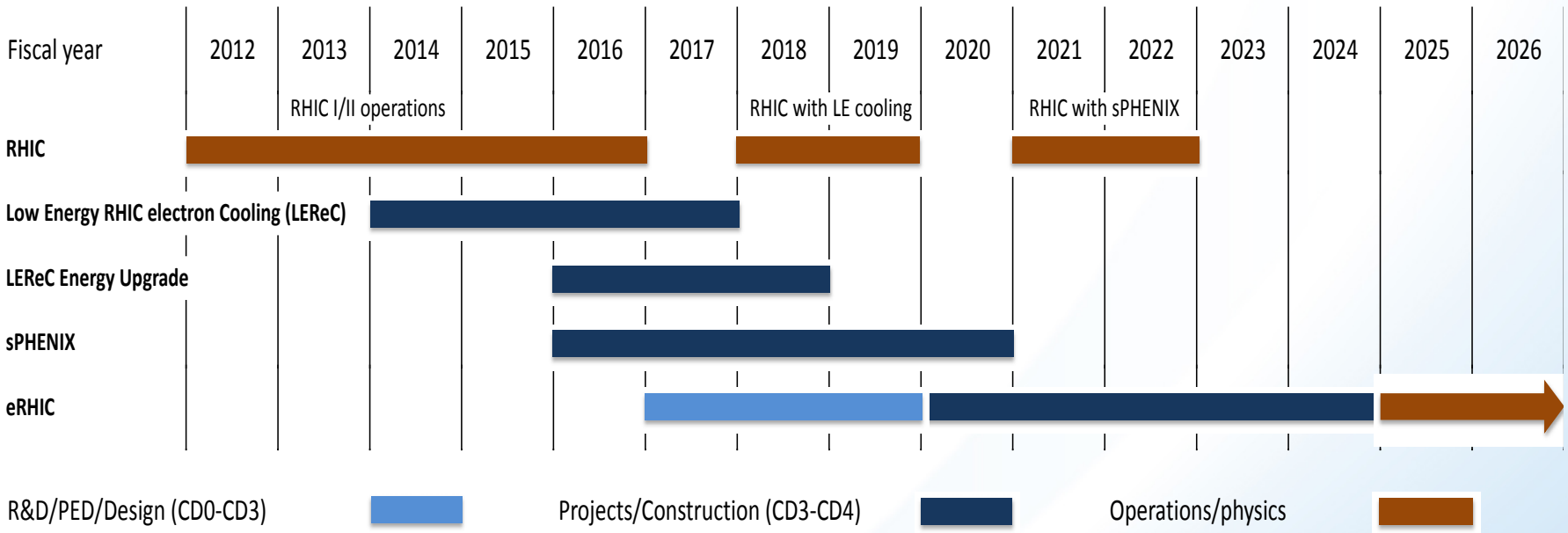


Polarized proton runs



Dramatic increase in performance as a result of R&D, capital projects, Accelerator Improvement Projects, and replacement of obsolete technology

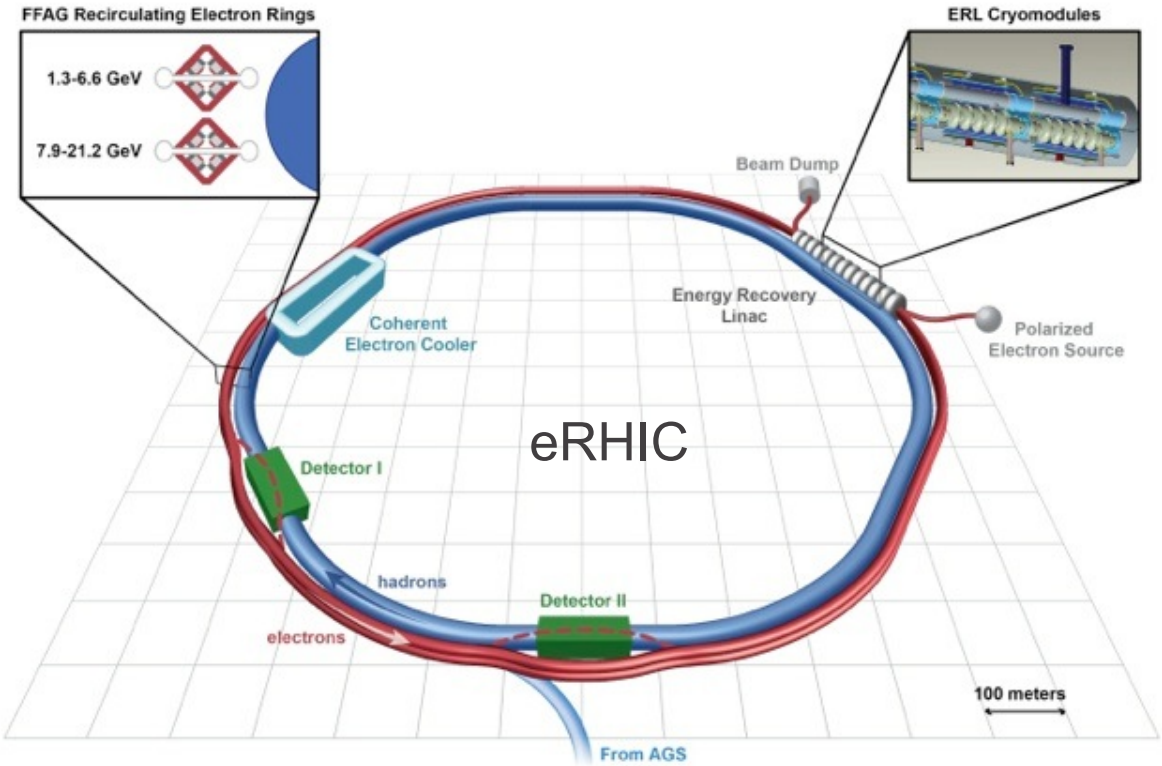
Plan for RHIC operations and possible schedule for eRHIC



BNL's EIC Concept

eRHIC ERL + FFAG ring design @ $10^{33}/cm^2s$

21.2 GeV e^- + 255 GeV p or 100 GeV/u Au.



ePHENIX and eSTAR Letters of Intent

When completed, eRHIC will be the most advanced and energy efficient accelerator in the world

High Energy Physics

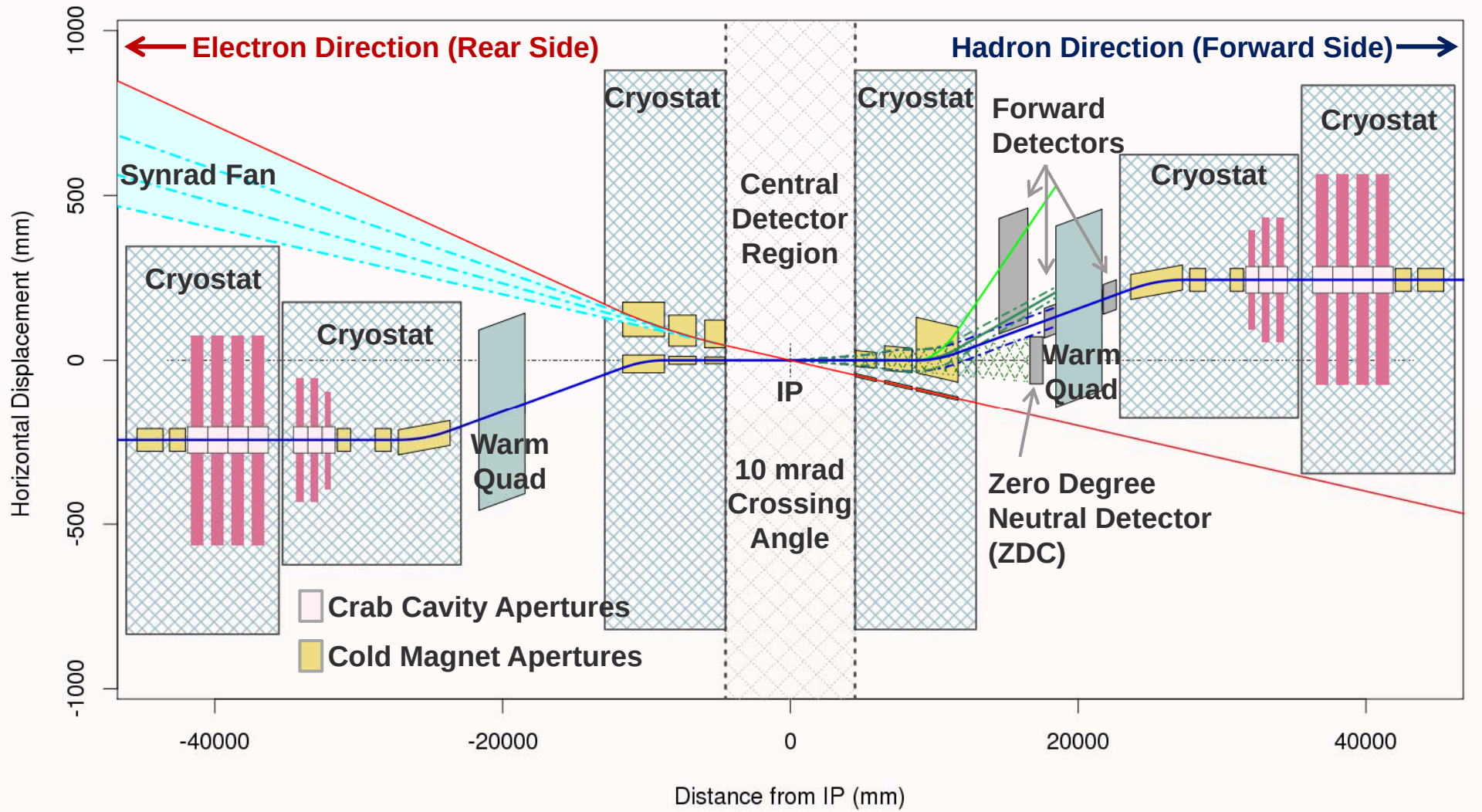
- High Energy Physics Advisory Panel (HEPAP) P5 subpanel ("Particle Physics Project Prioritization Panel") – year-long planning process concluded in June.
  - LARP – highest priority
  - GARD (General Accelerator R&D) – Increase funding – but appoint another subpanel to review GARD in detail – August 25-26 at BNL.
  - ILC – support "critical expertise" (e.g., IR magnets)
- DOE Institutional Review of HEP at BNL (June)
  - BNL HEP found to be well-aligned with P5 priorities

SMD WORK FOR C-AD

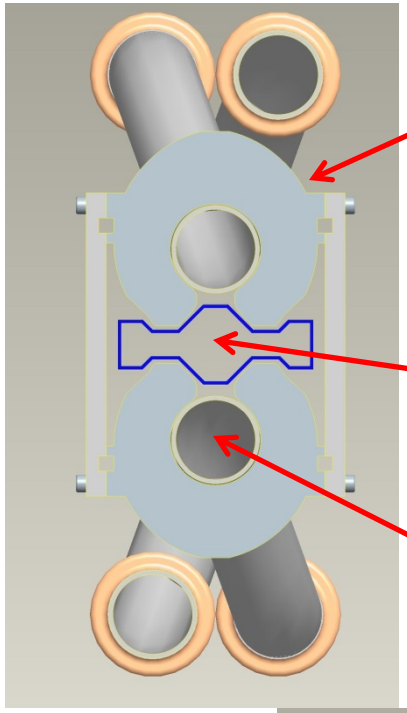
SMD for C-AD – long range

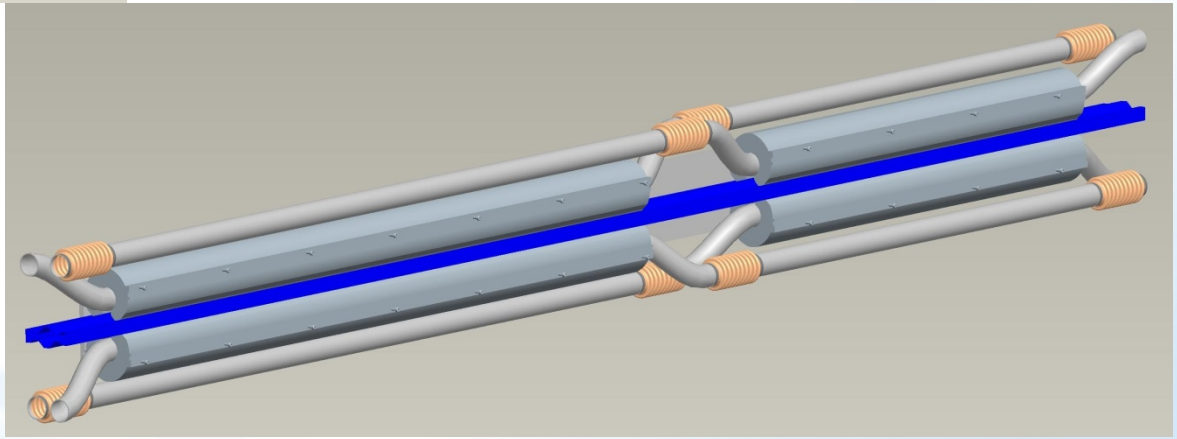
- Design of IR magnets to focus the electron and ion beams for collision is very difficult
  - Analogy: collide ping pong balls with billiard balls
  - Brett's is finding a solution using superconducting magnets
    - Direct Wind magnets of novel design
    - RHIC-like magnets (e.g., D0)
- Design of magnets for electron ring also very difficult, since they are a major cost-driver
  - Design field shape: FFAG (fix focus alternating gradient)
  - Baseline implementation: permanent magnets
  - Alternative: HTS (Ramesh+Mike). Seeking LDRD funds.
- Updates of Direct Wind, Cryo technology
  - A huge task - Labview, National Instruments replace PCs and Vax

eRHIC IR (under development)



HTS in FFAG magnets (evolving …)





SMD for C-AD in FY15

- Measure magnets for low energy cooling system (LEReC), to be installed summer 2015.
- ERL gun and leads of HTS solenoid to be improved. Work in March and April. Tight schedule. (Ramesh – build, test model of leads)
- Open damaged helical magnet, possibly repair.
- Measure model FFAG permanent magnets – shimming an issue.
- Build, measure HTS FFAG (if LDRD funded)
- BaBar magnet from SLAC, for sPHENIX: rebuild helium vent system, test at low current.
- Modify Direct Wind machine for heavier conductor, wind demo for eRHIC IR magnets
- Continue to update Direct Wind, Cryo systems
- Possibly modify electron lens solenoid to allow higher field operation. (Decision in 2 weeks?) – would be high priority

SMD WORK FOR HEP

SMD for HEP – LARP

- FY15-FY17: LARP (R&D)
  - Increase ($12.9M to $14M) less than needed to meet scope, schedule requirements prior to start of Project
  - Nb_3Sn optimization, order
  - React & Impregnate, 1.4 m → 4 m coils
  - Modify Wind and Cure tooling, start W&C process ~ FY16
  - Mods for 1.9 K tests → test mirror quad → test quad
- FY18-FY21: LARP Project
  - Nb_3Sn QA
  - W, C, R, I coils
  - Testing: determined by LARP scope, which is not yet set

SMD for HEP – GARD, ILC, and Texas

- GARD - P5: Focus on 100 TeV pp collider. (Recall: LHC now 14 TeV)
  - Superconductor evaluation, interaction with vendors
  - Establish YBCO (ReBCO) engineering design parameters for high field magnets (e.g., detectors)
  - Collaboration with Chinese IHEP?
- ILC – P5: ok to fund "critical expertise"
  - FY15 funding being sought to complete model IR quad, test at 1.9 K, measure vibration.
- Texas A&M magnet test – end of FY14

WORK OUTSIDE OF NP, HEP

SMD – NSLS II

- Move NSLS I experimental rooms (“hutches”) to NSLS II.
- Magnetic field measurements as needed
- Staff loan

- Now completing work on SCRF.

SMD – other DOE

- FRIB (Michigan State) – CD3 review just completed.
  - Fragmentation quad: expect to complete magnet for installation (replace limiting coil, build cryostat)
  - D3 dipoles – possibly wind the copper coils for curved dipoles using the Universal Winder – awaiting drawings
- g-2: Direct Wind design is an alternative for inflector magnet. CD2 review 7/29.
- Argonne – upgrade of Light Source – Animesh consulting on magnet design, measurement
- J Lab – expect little additional work
- EERE (energy efficiency & renewable energy) – proposal to use Direct Wind coils in wind generator – awaiting decision by EERE.
- Non-scaling FFAG superconducting gantry for proton and Carbon radio-therapy proposal (with C-AD) – DOE Accel. Stewardship

g-2 (Fermilab) inflector magnet design

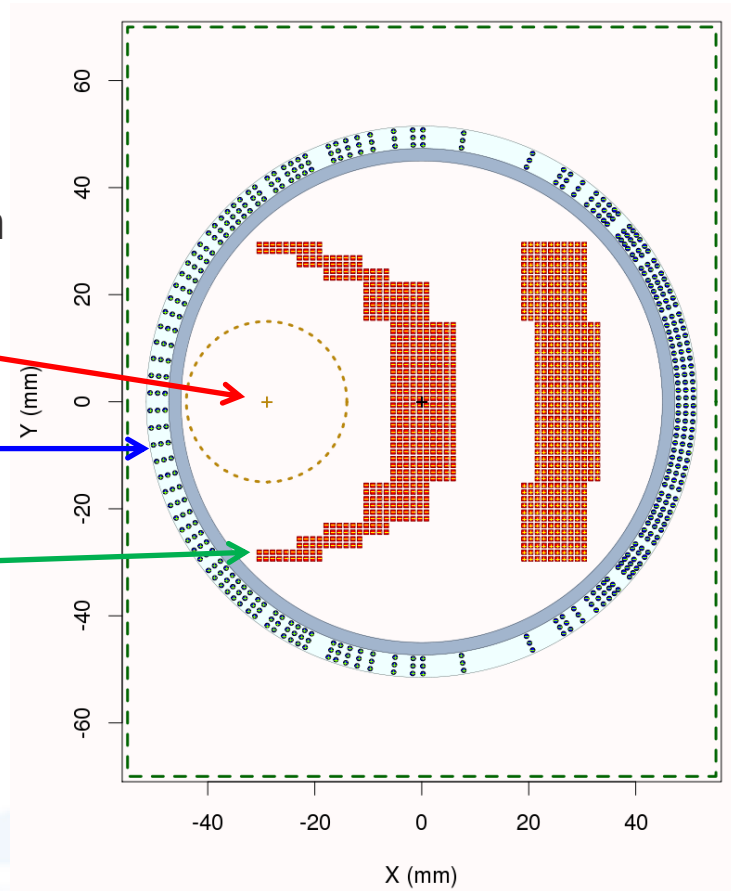
Goal: increase # of muons transferred to storage ring by inflector magnet
Just completed: conceptual design (Brett) with cost estimate (Mike et al.)

Inflector 100 mm diameter, 1.5m 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

SMD – SBIR Subcontracts

- Hypertech – Phase II – test (10K-20K) MgB_2 solenoid – demonstrate suitability for use in accelerator – specifically Cu solenoids next to electron lens main solenoid (Direct Wind).
- Muons, Inc. – Phase II – YBCO – make cosθ dipole coil for FRIB fragment separator region – curved, length > 1m. Challenge: winding a non-planar coil using a tape conductor.
- Particle Beam Lasers – Phase I – YBCO – cosθ dipole for accelerator
- SupraMagnetics – Phase II – test Nb_3Sn wires

SMD – non-DOE

- Spare correctors for KEKSuperB (after 2-3 years of running; commissioning begins Jan. 2016)
- Generation #3 of octupole magnet for CERN antimatter experiment? (Funding being sought)
- High field solenoid for rare particle search (Korea – physicist from BNL on staff in Korea) – YBCO.
  - Initial funding received.
- Army SMES - ??

Summary

- Over the next few years, work for others will be important in maintaining our current level of work.
  - Tech, engineering, scientist staff is well-regarded
- Over the longer run, eRHIC and LARP will provide an opportunity for growth, passing on of expertise.