



**US LHC Accelerator Research Program**  
***brookhaven - fermilab - berkeley***

US LHC Accelerator Research Program

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For the BNL-FNAL-LBNL LHC Accelerator Collaboration

Fermilab Long Range Planning Committee

Open Meeting on LHC

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# US Contribution to LHC Construction



The US labs are making a major contribution to the construction of the IRs:

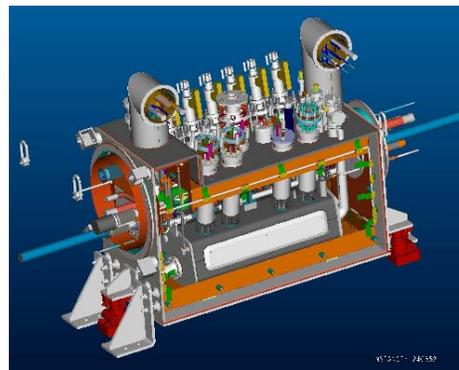
**IR Quads (FNAL)** →

Beam Separation Dipoles (BNL)

IR Feedboxes and absorbers (LBNL)

And in SC cable for the main magnets:  
(LBNL, BNL, US Industry)

**FNAL is the Lead Lab.** ↙



We plan to extend the US-CERN collaboration into the research phase.



# US LHC Accelerator Research Program (LARP)



## Program Goals

### **Advance High Energy Physics**

- Help bring the LHC on and up to design performance quickly.
- Improve LHC performance by advances in understanding and instrumentation.
- Use LHC as a tool to gain deeper knowledge of accelerator science and technology.
- Extend LHC as a frontier HEP instrument with a timely luminosity upgrade.

### **Advance U.S. Accelerator Science and Technology**

- Keep skills sharp by helping commission the LHC.
- Conduct forefront AP research and development.
- Advance U.S. capabilities to improve the performance of our own machines.
- Prepare U.S. scientists to design the next generation hadron collider.
- Develop technologies necessary for the next generation of hadron colliders.

### ***Advance International Cooperation in the High Energy Accelerators***



## Summary of Planned Program



- Help commission the hardware delivered by the US LHC Accelerator Project and later by the LARP
- Help commission the LHC with initial beam.
- Develop and build new instruments that will improve the operation of the LHC and help us perform accelerator physics experiments.
- Use the LHC to perform experiments and test calculations and theories of fundamental accelerator science.
- Perform accelerator physics studies and advanced magnet R&D that will result in the IR designs and prototype IR magnets for a timely LHC luminosity upgrade.

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*For more info, see <http://www-td.fnal.gov/LHC/USLARP.html>*



# Accelerator Systems



## Beam Commissioning

- The participation of experienced US accelerator physicists – *one on each shift* – will help **bring the LHC to design luminosity more quickly.**
- Participation in commissioning is a **once-in-a-decade opportunity** to “learn from the school of hard knocks.”

## Accelerator Physics

- **Accelerator physicists must exploit the LHC** for the same reason as High Energy Physicists – **it is the collider at the frontier.**

## Advanced Beam Instrumentation

- Developing real time tune and chromaticity feedback; longitudinal density monitor; fast luminosity measurement.

**This work will help the LHC deliver the highest possible performance, and enable us to design and build the next generation hadron collider with confidence.**



# Luminosity Upgrades



A x10 luminosity upgrade requires upgrades to a number of accelerator systems:

- **Interaction region magnets**  
=> smaller  $\beta^*$ , larger crossing angle, fewer parasitic collisions.
- **RF system**  
=> shorter bunches *or* crab cavities *or* superbunches.
- **Instrumentation, diagnostics, feedback systems**  
=> understand and deal with instabilities limiting beam current.

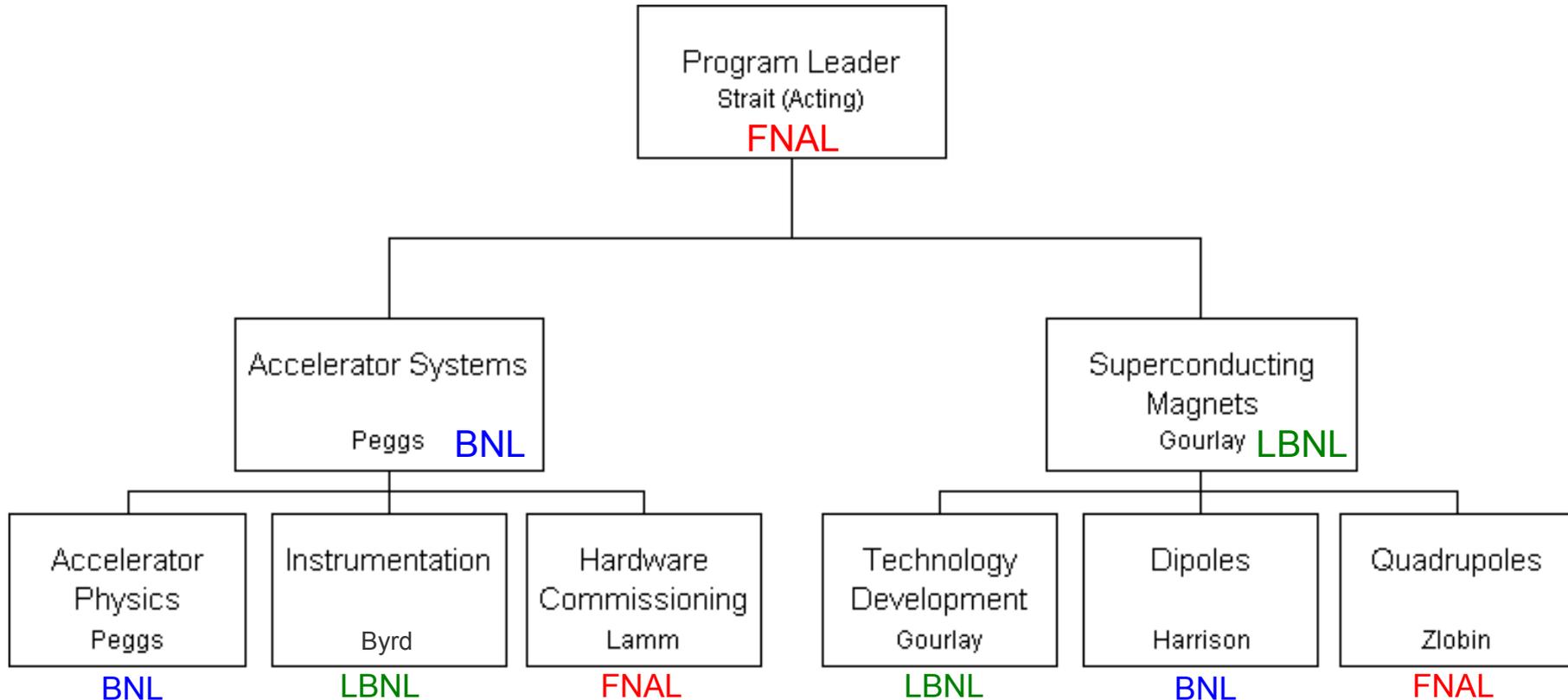
The US LARP intends to

- Play a **leading role in the development of new IRs**, in both **accelerator physics** and **magnet R&D**.
- Make **significant contributions** to required **diagnostics and feedback**.

We are **exploring** how the US might contribute to **RF system upgrades**.



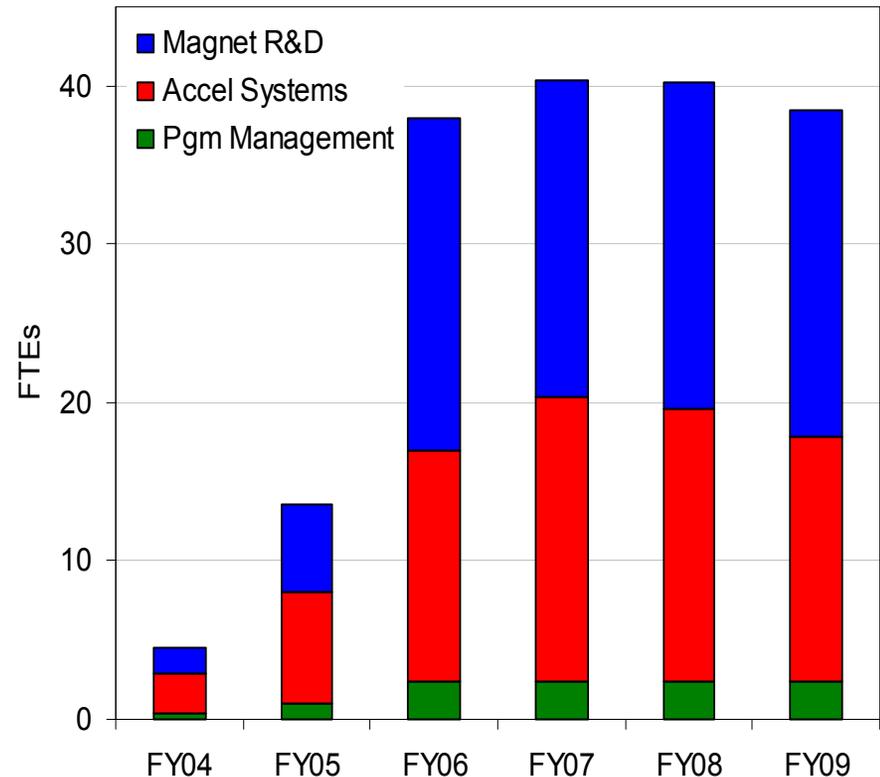
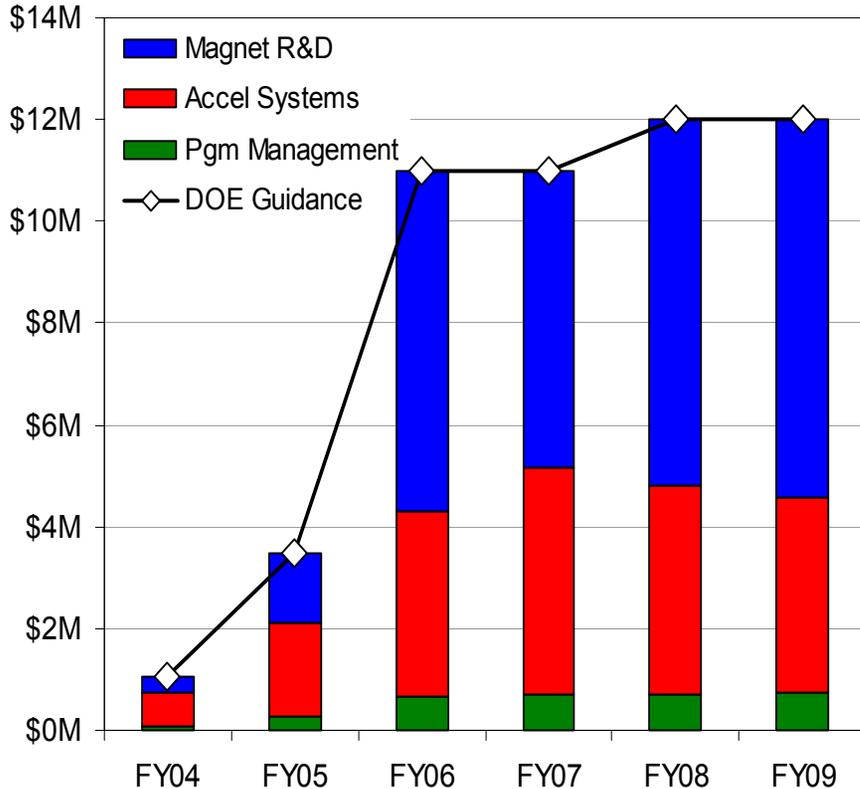
# National Organization



We are discussing adding additional institutions to the collaboration.



# Funding and Budget



Funding to be allocated on programmatic basis.  
... No predetermined split among the labs.



## Questions for Discussion



- **How important is collaboration on the LHC accelerator to the future of Fermilab and to the future of US HEP?**
- Is work we have chosen appropriate, or should other elements be added?
- **Is the planned level of effort right?**
  - \$11-12M/year, ~40 FTEs with 1/3 ~ 1/2 of this at FNAL.
  - Should effort be larger or smaller?
  - Should Fermilab invest in LHC accelerator effort beyond the earmarked LHC funding from DOE?
- How strongly should we solicit collaboration with other US labs and with universities? How much interest is there among potential collaborators?