



US LHC Accelerator Research Program

bnl - fnal - lbnl - slac

US LHC Accelerator Research Program

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For the BNL-FNAL-LBNL-SLAC collaboration

US-CERN Committee for the LARP
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<http://www-td.fnal.gov/LHC/USLARP.html>



Goals of the US LARP

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.

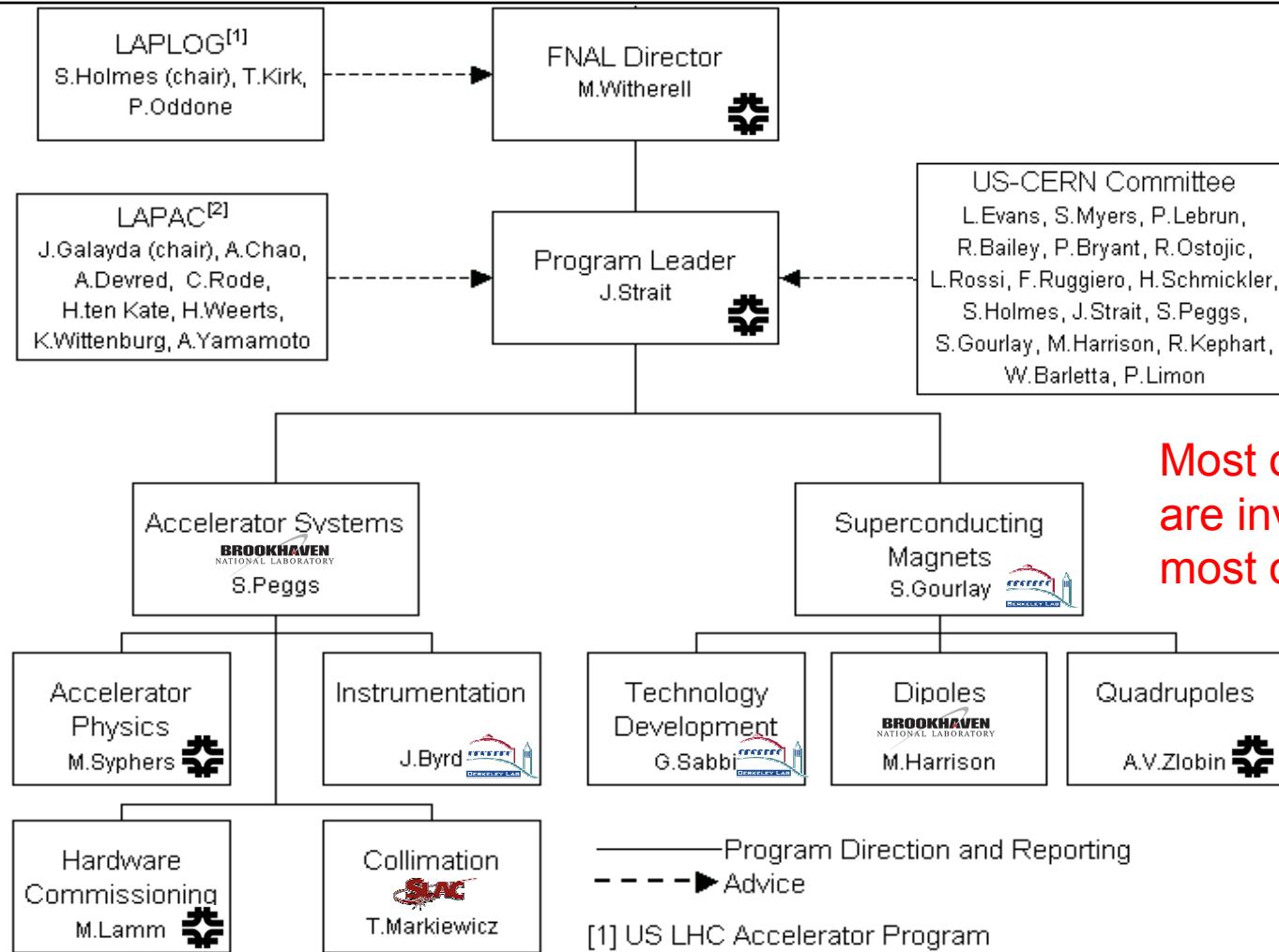
Advance U.S. Accelerator Science and Technology

- 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



Organization



Most of the labs
are involved in
most of the tasks!



Program as of June 2003

Accelerator Systems

Instrumentation

Tune feedback, Luminometer, Fast longitudinal density monitor (LDM).

Accelerator Physics

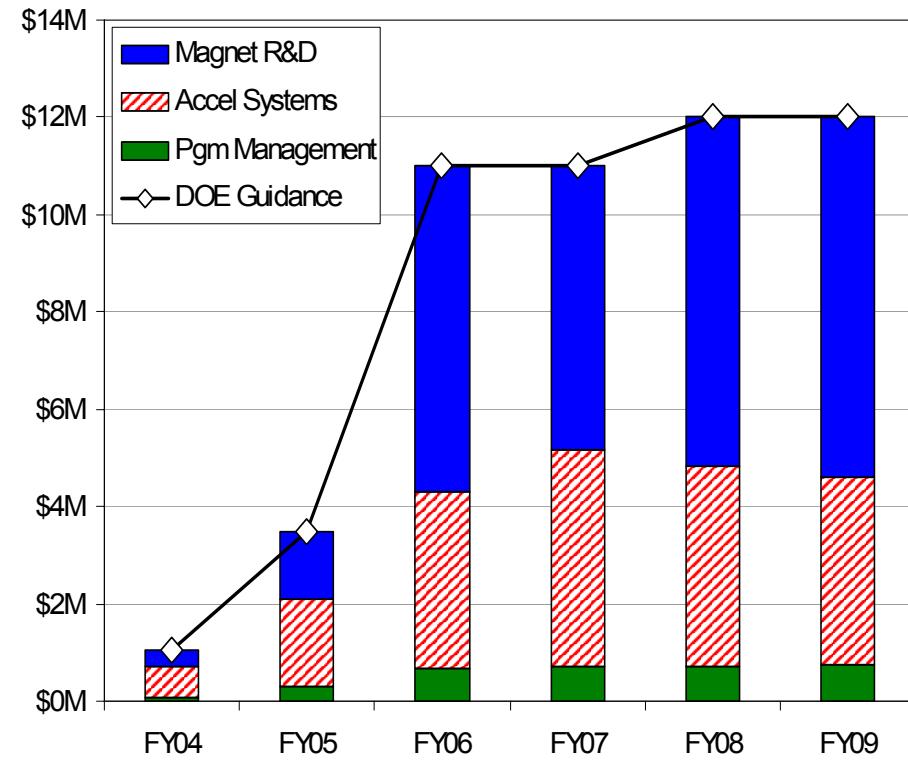
Beam-beam, E-cloud, other vacuum effects, remote ops and maint., IR upgrade design, energy deposition.

Beam Commissioning

Hardware Commissioning

IR Upgrade Magnet R&D

Large-aperture Nb_3Sn quads, Specialized Nb_3Sn dipoles for dipole-first IR, Nb_3Sn technology development.





Program Evolution Since the Proposal

September 2003 Collaboration Meeting

- SLAC proposal to join LARP and develop phase II collimators.
- CERN request to increase priority and advance schedule for abort gap monitor (AGM) as part of LDM development.

DOE funding profile changes:

- FY2004: \$1.05M -> \$1.25M to accommodate above changes.
- FY2005: \$3.5M -> \$3.25M based on President's budget.
- FY2006 and beyond – plan for similar reductions.

February 2004 Collaboration Meeting

- CERN request to drop fast LDM, but retain AGM.
- Add collimation and e-cloud studies using RHIC to AP menu.
- Modest reduction in FY05 magnet R&D budget to accommodate other program elements.



Current Program - Instrumentation

- **Tune Feedback** – on-going BNL-CERN collaboration on PLL.
LAPAC – no major comments
- **Luminometer** – LBNL developing high-pressure ionization chamber and front-end electronics.
LAPAC – “sensible design,” “good progress.”
- **AGM** – LBNL conducting engineering study of gated PMT, leading to “white paper” report by December 2004.
LAPAC – Suggests that US should not take responsibility for an instrument that is part of machine protection system.
=> We agree to end AGM effort after the current study.



Current Program - Instrumentation

- **LDM** – LBNL investigating electro-optical modulator with non-LARP funds.
LAPAC – This could be a useful device for US accelerator physicists to do their research.
=> Lacking strong push from US or CERN AP, we agree not to pursue this within the US LARP.
- **Schottky monitors** – some informal discussions have occurred, but no formal proposal to add this to the LARP has come from within the US labs.
=> This is not part of the program, and was not presented to LAPAC.



Current Program – Accelerator Physics

- Beam commissioning – FNAL led effort involving all US labs
FY05 – participate in TI8 test, plan for future years.
FY06 – participate in sector test, start to integrate into LHC team in anticipation of machine start in 2007.
LAPAC – increase effort in 2005-2006.
=> increased FY05: 0.1 -> 0.4 FTE; FY06: 0.6 -> 1+ FTE.
- Phase I collimation studies – BNL-CERN collaboration performing tests in RHIC and SPS.
LAPAC – no major comments.



Current Program – Accelerator Physics

- E-cloud – LBNL-BNL-CERN collaboration – experiments and calculations of ECE in RHIC and SPS.
LAPAC – need to collaborate with broad community addressing ECE;
“LARP also needs to be more LHC-specific”
- IR design – FNAL/BNL design studies for IR upgrades
LAPAC – no major comments
- Beam-beam calculations – FNAL/LBNL studies of beam-beam impact on IR designs, strong-strong calculations, participation in wire compensation experiment at SPS.
LAPAC – “Wire compensation is an interesting and worthwhile effort.”



Current Program – Phase II Collimator R&D

SLAC effort with FNAL support, in collaboration with CERN

- design studies of phase II collimation system to evaluate feasibility of using NLC-type collimators.
- Review and go/no go decision in spring 2005.
- Start setup for prototype assembly and test in FY2006.

LAPAC – “formidable challenge”

“Is it reasonable to commit to early installation of housings for phase 2 collimators?”



Current Program – **Hardware Commissioning**

FNAL led effort of 3 US labs

- FY05 – installation support and participation in hardware commissioning of first US-provided equipment in the tunnel.
- FY06 – installation support and participation in hardware commissioning of most US-provided equipment; 2 people resident at CERN plus shorter visits.

LAPAC – recommend establishing remote diagnostics capabilities.



Current Program – IR Upgrade Magnet R&D

BNL/FNAL/LBNL integrated program.

- R&D on Nb₃Sn magnets for LHC IR upgrade, leading to a fully-engineered magnet design, ready for production ~2012.
- Main emphasis is on development of large-aperture quadrupoles.
- Secondary program to determine the feasibility of large-aperture, high-field dipoles for the extreme radiation environment of a dipole-first IR.



Current Program – IR Upgrade Magnet R&D

- FY05 program main features
 - Build and test a “simplified” Nb₃Sn quadrupole model.
 - Design studies for IR quads and dipoles.
- FY06 program main features
 - Build and test 2 “more complex” Nb₃Sn quadrupole models.
 - Build and test a “simplified” open mid-plane Nb₃Sn dipole.
 - Develop infrastructure for a long coil.
 - Conductor and material development.



Current Program – IR Upgrade Magnet R&D

LAPAC – Recommend concentrating resources on a limited number of options. Main effort should be on quadrupoles, and effort on dipoles should be limited:

- “Given the limited resources the magnet program must be well focused on the most demanding challenge given the present knowledge of the luminosity upgrade layouts.”
- “Consequently the red line through the program must be to go from short quadrupole models as fast as possible to the first long quadrupole magnet and to reduce the parallel tracks to a minimum.”
- “it may be worthwhile to pursue all design computations to a similar level of maturity, and then, to select a baseline design and to stick to it for the short model and long prototype magnet fabrication.”

=> FY05 program is consistent with LAPAC.

FY06 program will be tuned based on LAPAC advice as well as experience with FY05 program.



Proposed FY2005 Budget

WBS	Task	
	US LHC Accelerator Research Program	3250
1	Accelerator Systems	1790
1.1	Instrumentation	590
1.1.1	<i>Tune feedback</i>	195
1.1.2	<i>Luminometer</i>	395
1.1.3	<i>LDM / AGM</i>	0
1.2	Accelerator Physics	575
1.2.1	<i>Beam Commissioning</i>	80
1.2.2	<i>Phase I Collimation Studies</i>	75
1.2.3	<i>Electron Cloud</i>	110
1.2.4	<i>Interaction Regions and Beam-Beam</i>	310
1.3	<i>Phase II Collimator R&D</i>	240
1.4	<i>Hardware Commissioning</i>	385
2	Magnet R&D	1260
2.1	<i>Quad Design Studies</i>	140
2.2	<i>Dipole Design Studies</i>	155
2.3	<i>Sub-scale tests</i>	106
2.4	<i>Simplified quadrupole model</i>	745
2.5	<i>Long coil development</i>	0
2.6	<i>Conductor development</i>	114
3	<i>Program Management</i>	200

Budget is consistent with DOE funding guidance, which is \$0.25M (7%) below original plan.

But actual funding will not be known until Congress passes the DOE budget bill, probably not until some time in the fall.



CERN “Guiding Comments”

We are in general agreement regarding most of the items in this letter. However, there are several points which must be discussed.

- Magnet R&D
 - This is a core component of our program and cannot be considered as “contingency” for the other parts. We have committed ourselves to development of a production-ready design in time for an LHC luminosity upgrade, and substantial investment of time, manpower and materials will be required to meet this commitment.
 - We do not believe that it is productive to pursue further R&D on NbTiTa superconductors. We *do*, however, plan to carry out a systematic comparison between the capabilities of IR upgrades built with NbTi vs. Nb₃Sn magnets.



CERN “Guiding Comments”

- Beam instrumentation
 - We agree with the request to end the AGM/LDM collaboration with the completion of the AGM “white paper” study.
 - No proposal for Schottky monitors has come from within the US Labs, and our budget cannot accommodate another item at this time. Therefore Schottky monitoring is not part of the LARP.



CERN “Guiding Comments”

- “Hard Deliverables”

It is important that we make good on our commitments. But, we do not consider it useful to formally itemize deliverables as “hard” vs. “soft”.

The definition of a “hard deliverable” is not, itself, so “hard.”

- To us, “hard deliverables” would be well-defined hardware for installation in the LHC on a well-defined schedule, for which we take major responsibility.
 - No system meets this requirement at this time, although the luminometer might in the foreseeable future.
- An expanded definition *could* include
 - commitment to develop a design to a production-ready state, but without a commitment to build the installed devices, e.g. phase II collimators or upgrade quadrupoles.
 - commitment to deliver a particular level of effort, e.g. hardware and beam commissioning.



Conclusions

The main elements of the US LARP are:

- Beam Instrumentation
- Accelerator Physics and Beam Commissioning
- Phase II Collimation R&D
- Hardware Commissioning
- Magnet R&D for an IR upgrade.

These address the complementary goals:

- To make the LHC the strongest possible tool for HEP.
- To advance (US) accelerator physics and technology.

We continue to value our collaboration with CERN on LHC. We plan to continue to strengthen it and make it highly productive for all parties.