



U.S. DEPARTMENT OF  
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# 2014 Annual Review of the LHC Accelerator Research Program

## Management

Subcommittee members: Ron Prwivo and Ron Lutha

February 18, 2014

# Management

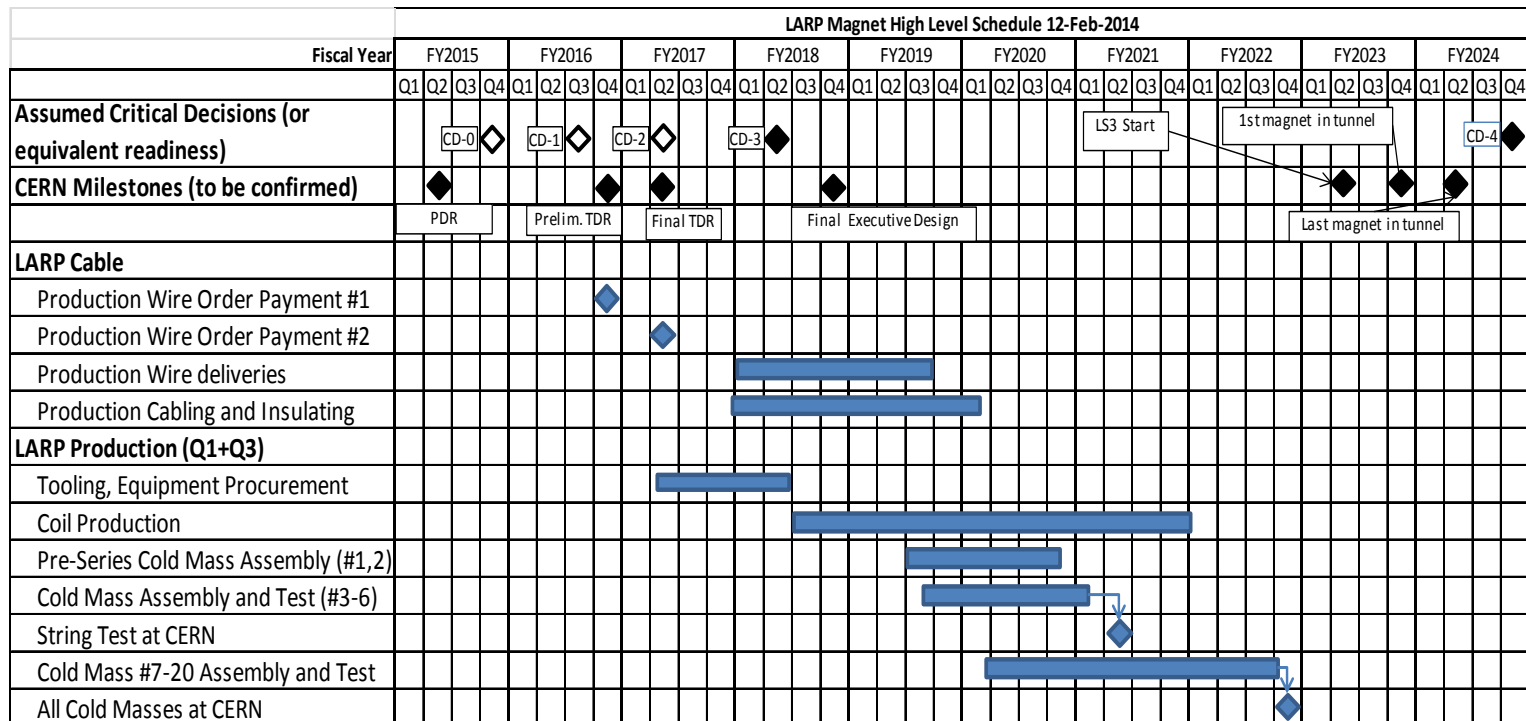
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- **Findings:**
- **LARP Scope Goals:**
  - Magnets
    - 2 short QXF Models
    - 3 Long QXF Prototype and Pre-Production Magnets
    - 2 Single Coil Tests (1 short and 1 long)
    - Technology Transfer to CERN
  - CC
    - Provide hardware and manpower for CC SPS tests
  - WBFS
    - Provide hardware and manpower for WBFS SPS tests

# Management Cont.

- Schedule**

- The LARP program continues for another 3 ½ years and then the fabrication of the U.S. HL LHC is initiated in FY17. Below is the overall schedule for LARP and HL-LHC.



# Management Cont.

- Funding:**

	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	LARP TOTAL	PROJECT TOTAL
LARP funding	\$16M	\$16M	\$16M							\$48M	
LLI (pre-Project funding)		\$10M	\$23M								\$33M
Project funding (MIE)				\$34M	\$51M	\$43M	\$31M	\$17M	\$6M		\$182M
<b>TOTAL</b>	<b>\$16M</b>	<b>\$26M</b>	<b>\$39M</b>	<b>\$34M</b>	<b>\$51M</b>	<b>\$43M</b>	<b>\$31M</b>	<b>\$17M</b>	<b>\$6M</b>	<b>\$48M</b>	<b>\$215M</b>

- The LARP program is presently funding limited at approximately \$13M/year and has requested \$16M/year for the next three years.
- Approximately \$33M is being request for Long Lead Items that will be requested prior to CD-0.

# Management

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- **Comments:**

- Much positive progress from the prior reviews has occurred with the additional focus of the new management and revised organization.
- Past action items have been appropriately addressed and there is a good understanding of what can be done within the limited resources of the LARP R&D program.
- It appears the programmatic efforts are on track for initiation of the HL-LHC project.
- Project risks that need to be mitigated:
  - Additional funding streams
  - Potential inadequate LARP funding
  - Nb<sub>3</sub>Sn magnets has never been used in a HEP particle accelerator
  - Attention needed for contingency and scope contingency

# Management

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- **Recommendations:**

1. Lock down the technical parameters for the Nb<sub>3</sub>Sn procurement by end of FY-2014.
2. Work with the Program Office and the Site Office on issuing the LLI procurements before CD-0/1/2.
3. Explore the possibility of CERN being able to lend the project the Nb<sub>3</sub>Sn superconductor.
4. Assign a Federal Project Director from DOE to help support the project from the Fermi Site Office assisting in the development of the project prior to CD-0 request.

# Charge Questions

- **Goals and management plans of the new LARP director;**
  - Yes, the LARP Director has concentrated available funds for the key goal being the design and prototyping of the quadrupole magnets. 75% of the LARP funding is going to the development of the magnets.
- **The effectiveness in strategic planning, development of appropriate core competencies, implementing a prioritized and optimized program for potential participating in future accelerator upgrades at the LHC at CERN; specifically, are these LARP activities well aligned with the present and anticipated LHC schedule;**
  - Yes, the success of the development of the LARP R&D effort will support the launch of the HL-LHC project in the timeframe of the FY18. There appears to be good coordination between LARP and CERN.
- **The quality and significance of the LARP scientific and technical accomplishments, and the merit, feasibility and impact of its planned development program;**
  - Yes it appears that the technical developments of the magnets are making good progress. The Crab Cavities and the Wide Band work are underfunded and will be difficult to provide the required product.
- **Will these accomplishments lead to mature technical readiness for the DOE CD-n sequence? What will be the demonstration of these goals, and;**
  - Yes, the achievements of the goals of the LARP R&D program should help achieve the early Critical Decisions of the HL-LHC. The LLI procurements prior to CD-0 are aggressive and combining the CD0/1/2 into one action is unusual and will be needed to be coordinated with the DOE Program Office and the DOE Fermi Site Office.
- **The effectiveness and appropriateness of the laboratory interactions to maximize the leveraging of existing infrastructure and expertise available at those laboratories.**
  - Yes, it appears that the interactions between Fermilab/LARP, the supporting laboratories, and CERN are effective.



# Magnets

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Subcommittee members: Al Zeller and Ken Marken

## Findings:

1. The direction of LARP R&D is correctly aligned with the priorities of CERN's high luminosity upgrade and in close collaboration with CERN's R&D effort. The new IR quads have the highest priority, with the crab cavities the next most important. Ultimately the crab cavities will be required, but as they will not be completely validated until 2017, the development must take second place. LARP's present budget is approximately 75% allocated towards the development of the high-field Nb<sub>3</sub>Sn quadrupoles. The deliverables in 2017 are 2 short models and 3 long models. The deliverables for the magnet project are 16 4-m long cold masses plus 4 spares.





# Magnets (Findings -2)

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2. The new program manager, Giorgio Apollinari, has well stated R&D and project goals and appears to have the objectives of ramp down of LARP R&D and the establishment of the LHC luminosity upgrade.
3. With funding far below the planned \$16M per year budget, they have made significant progress on the 150 mm bore QX magnet design and have started the planning necessary to transition to an approximately \$200M project.
4. The technical achievements continue to be excellent. Institutional support and integration with CERN are remarkable, often resulting in three conference calls per week.



# Magnets (Comments)

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## Comments

1. Budgets have been presented for the remainder of the R&D and for the project; however, there are inconsistencies in how the data are presented. Having consistency will insure that everyone understands the limitations.
2. The magnet development looks to be under-funded and imposes a schedule risk. A budget of around \$15M would be more appropriate.
3. Plans to use CDP funds for strand procurement are not consistent with the purpose of CDP, nor with the CDP budget. A series of purchases of identical 132/169 RRP strand in FY13-FY16 appear to be for magnet supply rather than conductor development. Conductor for magnets is more appropriately purchased to specification and not through an R&D contract.



# Magnets (Comments-2)

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4. It's not clear why construction management is part of LARP and not just the project. While some development of construction management is required, the goals and process could be laid out with more clarity.
5. It is possible to keep making incremental improvements to the design of the conductor for the length of the project. The point where one has to stop is rapidly approaching.
6. Procurement seems to be missing from the project management group. Do the labs pick this up?
7. CDP funding contribution is an uncertainty and a risk factor.
8. GARD funding contribution is an uncertainty and a risk factor.
9. Although the QXF magnets are a world first in size, energy and stress for  $\text{Nb}_3\text{Sn}$ , we saw no electromechanical modeling results. There is risk in this scale-up, we need to see how this is being managed.



# Magnets (Recommendations)

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## Recommendations:

1. Make a final decision on the magnet strand by end FY14
2. Clarify the costs and benefits of HQ and LHQ construction and testing. This is a continuation of a recommendation from the 2012 Review.
3. Provide stronger evidence, including electromechanical modeling, that the planned QXF structure is adequate for managing the strain in this larger, higher stress magnet.
4. Explore possibilities other than CDP for funding strand procurement for the QXF model coils, including the possibility of a CERN “loan” of strand.





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Crab Cavities

Stephen G Peggs, Richard York, Joe Preble

# Charge, LARP 2014 Crab Cavities

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- **The effectiveness in strategic planning, development of appropriate core competencies, implementing a prioritized and optimized program for potential participating in future accelerator upgrades at the LHC at CERN; specifically, are these LARP activities well aligned with the present and anticipated LHC schedule;**
  - LARP has an effective crab cavity collaboration in place. The team clearly has an demonstrated expertise in the technology. The program has reduced the scope of the effort to match the resource constraints while maintaining a focus on the highest leverage and intellectual deliverables.
- **The quality and significance of the LARP scientific and technical accomplishments, and the merit, feasibility and impact of its planned development program;**
  - The crab cavity program has developed two cavity designs that are well suited to the luminosity program at CERN. These are innovative designs that are well suited to production and use in an accelerator.
- **Will these accomplishments lead to mature technical readiness for the DOE CD-n sequence? What will be the demonstration of these goals? and;**
  - The current funding jeopardizes the probability of success. An additional \$1.5M per year would be appropriate for the effort.



# Charge, LARP 2014 Crab Cavities

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- **The effectiveness and appropriateness of the laboratory interactions to maximize the leveraging of existing infrastructure and expertise available at those laboratories.**
  - LARP has engaged ODU, FNAL, BNL, SLAC and LBNL in the collaboration to good effect. The project could be enhanced by stronger communication with Lancaster and Daresbury collaborators.



# LARP 2014 Crab Cavities

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## 2.3.Crab Cavities

### 2.3..1 Findings:

- Crab Cavity functional specification has been supplied by CERN
- Global collaboration lead by CERN includes Lancaster/STFC, BNL, FNAL, LBNL, ODU, SLAC and US industry.
- The current plan calls for providing cavity cold masses for CERN integration into a cryomodule to be installed for the 2016- 2017 SPS run period.
  - A cryomodule will contain one cavity design. Two cryomodule test will be required to test the two cavity designs. A cavity order will be determined to decide which cavity design will be integrated into a cryomodule first.
- Three proof of principle cavities have been produced. One of each of three types of cavities have been produced; UK r-rod cavity (EuCARD/CERN), ODU-SLAC Double-ridge cavity and BNL quarter-wave cavity ( LARP and SBIR/STTR). The Double-ridge and quarter-wave final design 3D models are scheduled to be delivered to US industry in April 2014.
- Multipacting simulation on all 3 types is done. Detailed modeling continues for rf couplers, FPC and HOM.





# LARP 2014 Crab Cavities

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## 2.3.2 Crab Cavities: Comments

- The main goal of the prototyping to validate the technology of the crab cavities has been accomplished.
- US has made significant and important contributions to the crab cavity R&D. US should have a leading role in the production phase.
- Adequate funding is needed to gain ground on cavity final design and production to stay on course.
  - Presently the program relies on the performance of an industrial partner on a SBIR contract to supply dressed cavities. This is a significant risk. Resources and schedule are tight for this deliverable.
  - It is not clear what the program will do if the SBIR vendor does not produced the required cavities
- The cryostat design is being performed by Lancaster/CERN which will make coordination of the cavity interfaces to the design more challenging.



# LARP 2014 Crab Cavities

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## Crab Cavities: Recommendations

1. Complete the design and analysis of the rf couplers, HOM and FPC, for both cavity designs. This is preferred for the April 2014 final design
2. Review the resources and schedule required to produce four crab cavities in two cold masses to ensure there is a reasonable probability of meeting the program requirements. A plan should be available by the end of summer 2014.
3. Develop a means to effectively coordinate the interface between the dressed cavity and cryostat designs. This is needed as soon as possible.





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# 2014 Annual Review of the LHC Accelerator Research Program

February 18, 2014  
WBFS

Stephen G Peggs, Richard York, Joe Preble

# Wide Band Feed Back – Charge [1]

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It is requested that your review evaluate:

- **Goals and management plans of the new LARP director;**
  - The Wide Band Feed Back was not listed as highest priority.
- **The effectiveness in strategic planning, development of appropriate core competencies, implementing a prioritized and optimized program for potential participating in future accelerator upgrades at the LHC at CERN; specifically, are these LARP activities well aligned with the present and anticipated LHC schedule;**
  - Concern that the scope and schedule are incompatible with resources provided. An additional \$500k per year would make a significant difference.
- **The quality and significance of the LARP scientific and technical accomplishments, and the merit, feasibility and impact of its planned development program;**
  - The WBF has made substantial accomplishments with efficiency capitalizing on extant expertise at DOE national laboratories. This work is very much appreciated and encouraged by CERN.



# Wide Band Feed Back – Charge [2]

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It is requested that your review evaluate:

- **Will these accomplishments lead to mature technical readiness for the DOE CD-n sequence?**
  - Success is jeopardized by minimum available funding.
- **What will be the demonstration of these goals? and; The effectiveness and appropriateness of the laboratory interactions to maximize the leveraging of existing infrastructure and expertise available at those laboratories.**
  - This is good example of DOE national lab expertise being used to make substantial contributions on the world stage.
- **What are the scientific and technical risks associated with the proposed program, and are the available resources for LARP being optimally used to achieve the planned goals?**
  - The risks are largely because of funding. The resources provided are being optimally utilized.



# Wide Band Feed Back – Findings [1]

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- The Wide Band Feed Back team has achieved substantial success and has delivered a one bunch feed back system.
- Currently SPS WBFS is one of three deliverables proposed for the construction project.
- Given appropriate funding, they will with high probability deliver the necessary hardware in the appropriate time frame.



# Wide Band Feed Back – Comments [1]

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- The proposed funding reductions will jeopardize or even prevent the probability of delivering the necessary hardware in the appropriate time frame.
- It may be possible to reprogram some of the proposed construction activities to be part of an ongoing R&D program even after initiation of the construction project.
- Extension to include an LHC WBFS may be natural in the future.



# Wide Band Feed Back – Recommendations

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1. It is recommended that the project work with CERN to define early preliminary list of functional specifications for the SPS WBFS, by the end of 2014.

