



LHC & SLHC: Accelerator

S. Peggs, LARP leader

LARP

- LHC Accelerator Research Program
= BNL + FNAL + LBNL + SLAC

LAUC

- LHC Accelerator Upgrade Construction

Summary

Heuer's P5 “closing mandate”

General Remarks -3-

Collaboration in network of HEP laboratories/institutes
in **Europe, Americas, Asia**

Mandatory to have accelerator laboratories in all regions
as partners in accelerator development / construction /
commissioning / exploitation

Planning and execution of HEP projects today
need global partnership

Use the exciting times ahead to establish such a partnership



Aymar's "mission need" letter to Orbach, Jan 14 08



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Dr. Raymond L. Orbach
Under Secretary for Science
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC, 20585
USA

Your reference:
Our reference: DG-2008-016-O

Geneva, 14th January 2008

Dear Dr. Orbach:

Following the CERN "white paper initiatives" and the European Steering Group for R&D (ESGARD) recommendations for the LHC Interaction Region (IR) upgrade, the CERN Council has approved a 240 MCHF program to improve the current accelerator infrastructure. This is the first step in a comprehensive plan to increase the LHC performance beyond the nominal design luminosity of $10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$. The goal of this first initiative is to overcome currently known performance limitations in the LHC, opening the possibility for an ultimate performance with a peak luminosity of $2\text{-}3 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ by 2013. In a second initiative, an upgrade program aiming at a tenfold increase of the nominal LHC performance will follow, with an earliest implementation by 2017. These significant improvements in luminosity are guaranteed to enhance the Physics performance of the LHC, both by expanding the experimental reach of the ATLAS and CMS detectors, and by speeding up the attainment of results.

To succeed, the first initiative requires assistance from non-member states, and last summer I solicited support for accelerator development and resources from outside of CERN. The need for U.S. contributions to this initial effort is clear, since the U.S. labs possess a toolbox of unique skills that can be exploited to ensure that the ultimate luminosities can be achieved. Preliminary discussions have already taken place between U.S. and CERN representatives, examining potential contributions such as interaction region magnets and collimators – both of which are essential components in the first initiative.

We are eager to work with you to create a well-defined, realistic proposal, fully supported by CERN management and by the U.S. Department of Energy, for the delivery of U.S. contributions to the first initiative.

Yours sincerely,

Cordially

Robert Aymar

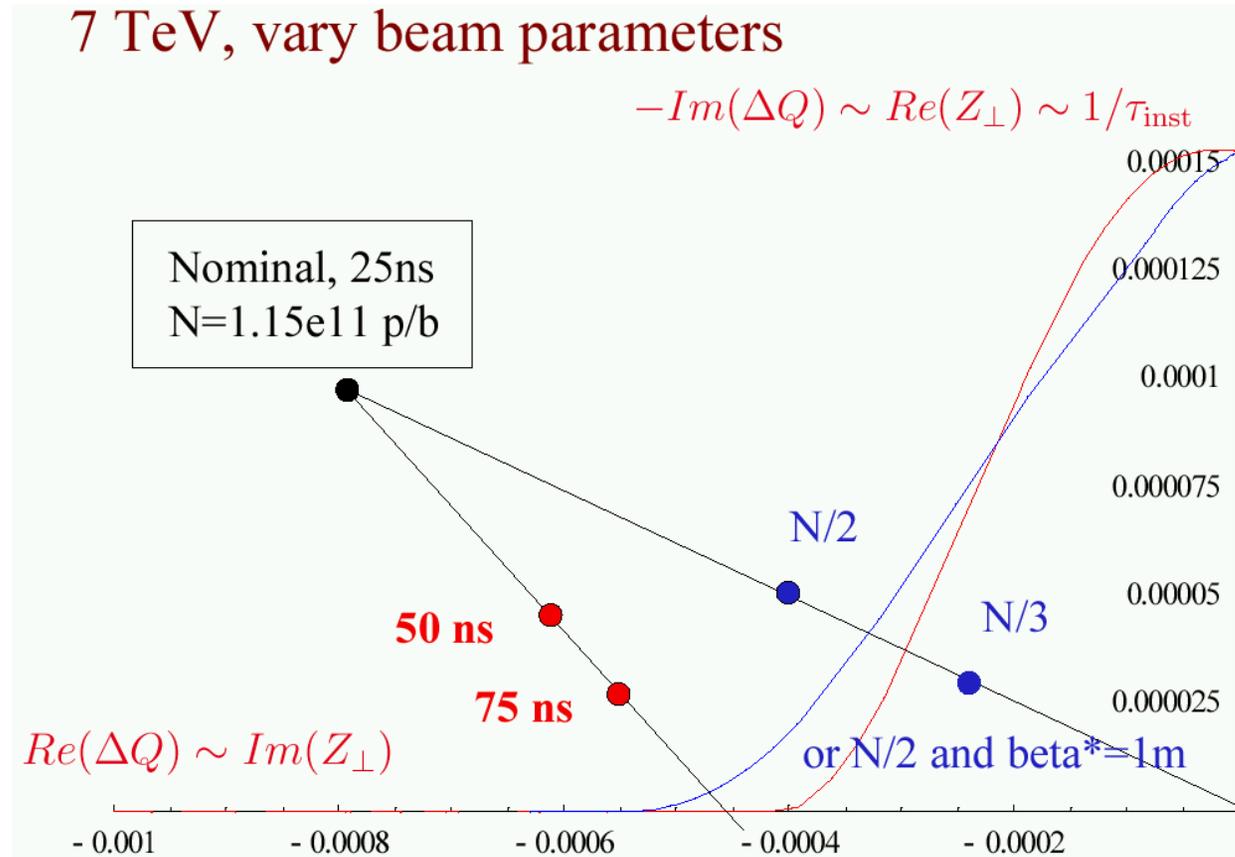
"... this **first** initiative is to **overcome currently known performance limitations** ... for ... a peak luminosity of $2\text{-}3 \cdot 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ by 2013.

"The need for U.S. contributions to this initial effort is clear, since **the U.S. labs possess a toolbox of unique skills ...**"

LARP Mission statements:

1. Make more LHC luminosity, earlier
2. Use, develop & preserve unique U.S. resources & capabilities in accelerator science & technology

Phase-1 – “overcome performance limitations”



Eg, larger inner triplet quad aperture enables wider collimator jaws, allowing reduced beam impedance even with an increased number of collimators.

More beam, more luminosity. (More flexibility.)

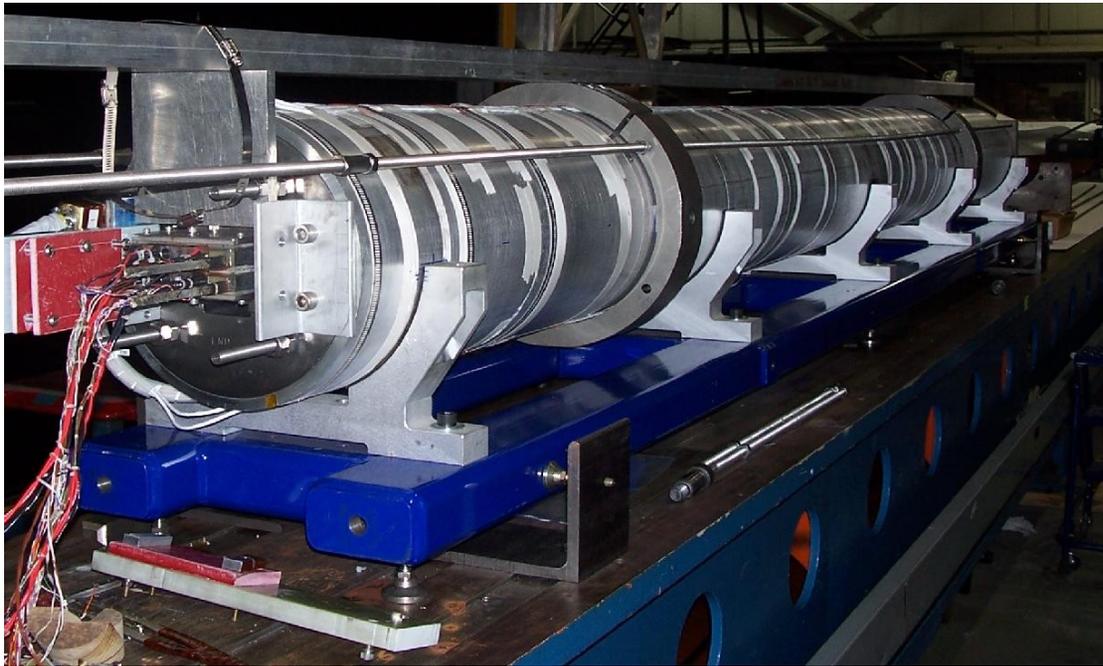


DOE Review – Dec 07

“We thank LARP ... for providing options ... [as] aspects of the R&D take on more of the character of deliverable projects.”

“The U.S. activities proposed for the Phase-1 upgrade must be well defined and coordinated with CERN to avoid future misunderstandings.”

“Contributing to an upgrade of LHC luminosity through U.S. provision of rotatable collimators and Nb_3Sn quadrupole magnets for intersection regions appears to be an excellent thrust that will be well matched to U.S. expertise and will improve overall LHC performance.”



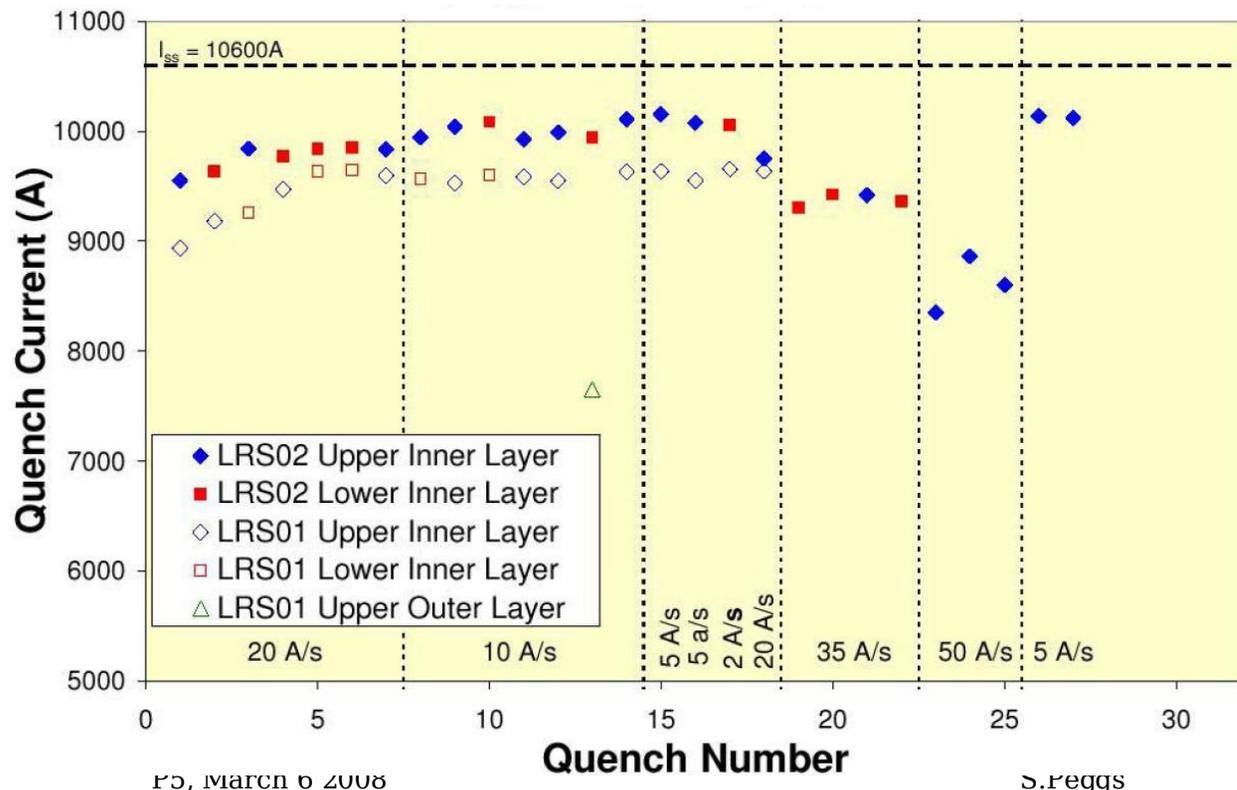
Nb₃Sn magnets

Dec 07 DOE Review

“Excellent progress continues on LARP accelerator systems and Nb₃Sn magnet development.”

February 08

A 4 m long Nb₃Sn magnet reached 96% of short sample limit, (albeit without complex ends & all accelerator qualities)





Schedule & guidance

Phase-1 ($\sim 2 \times 10^{34}$)	Begin installation Begin data taking	Dec 2012 2013
Phase-2 ($\sim 10^{35}$)	Begin installation Begin data taking	~ 2015 2016/17

\$M	2009	2010	2011	2012	2013	2014	2015	2016	2017
R&D (LARP)	18	13	13	14	14	14	15	15	15
Construction (Phase-1)		15	20	10	5				
Construction (Phase-2)				10	15	20	20	15	10

“... we urge the development of realistic deliverables & schedules, recognizing that **no project funds can be expected before FY'10**, & that any **initial expenditures** for R&D will have to be covered **through the existing LARP budget.**”



LAUC proposal

February 24, 2008
Version 0.4

LHC Accelerator Upgrade Construction Project Proposal

Contributors: S. Peggs (editor), I. Ben-Zvi, J. Byrd, W. Fischer, J. Fox, J. Kerby, P. Limon, T. Markiewicz, G. Sabbi, V. Shiltsev, P. Wanderer.

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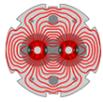
An ad hoc **committee** (Peggs, J.Kerby, P.Limon, T.Markiewicz, G.Sabbi, P.Wanderer) has constructed a draft proposal.

Robust discussion is ongoing – LARP, LARP labs, CERN, DOE.

Goal: Phase-1 proposal ready for review in **June, 2008**.

Bottom-up costs are currently in the factor-of-two range.

Phase-2 activities are not yet included, although LAUC will come to propose to build Niobium-Tin magnets.



Six activities

The proposed activities are **relatively independent**, with **varying levels of cost, readiness, risk and priority**.

Phase 1

Collimators

Superconducting magnets (hybrid)

SPS Electron cloud feedback

Post Phase-1 R&D

Electron Lenses

Crab cavities

SPL RF Modules

The “Phase-1” set has entered close discussion with CERN.

“Post Phase-1 R&D”: promising, exciting, but unproven.



Phase-1 IR Upgrade

Rotatable collimators

36 Rotatable Collimators could be constructed, or a smaller number, depending on the relative success of LARP and CERN R&D efforts.

Installation could be rather asynchronously with respect to the Phase-1 interaction region upgrade.

Superconducting magnets.

Provide as many as 16 quadrupole coldmasses necessary to upgrade all 4 inner triplets.

SPS electron cloud feedback

Beam studies (with LARP involvement) summer 2008.

Leverages resources successfully applied in the B-factory.



Post Phase-1

Electron lenses

Two lenses are **in operation** in the Tevatron, but **not in routine use** as beam-beam compensation devices.

The **LARP-funded prototype** to be installed in RHIC is intended to **unequivocally establish their technical effectiveness** as compensation devices.

Crab Cavities

Burgeoning **international interest**, including **CARE** (Daresbury) and **Japan** (KEK). Beam test prototype ~2011

Asynchronous installation is possible, in between Phase-1 and Phase-2 upgrades.



LAUC organization

LAUC would be **separately funded** from LARP. It would be **continuously active**, from the Phase-1 through Phase-2.

It would perform a **minimal amount of research** and only an appropriate amount of development, since **LAUC's task is construction**.

The **R&D necessary** to advance an activity to a state of readiness for inclusion in LAUC **is expected to be performed within LARP**, which itself would perform little or no construction.

While LARP and LAUC would be funded separately, nonetheless their **strategic planning would be linked**.



Summary – 1

- 1) Phase-1 upgrade activities are already in close discussions with CERN and DOE.
- 2) A reviewable proposal for Phase-1 will be released in June, synchronized and co-ordinated with the release of the CERN LIUWG report.
- 3) “Post Phase-1 R&D” activities are exciting and promising, but unproven.
- 4) Mature R&D topics migrate from LARP to LAUC, which would have linked strategies but separate organizations.
- 5) Some construction activities are asynchronous with respect to “monolithic” Phase-1 and 2 upgrades.
- 6) LARP's FY09 R&D supplement enables acceleration into an FY10 Construction Project start for LAUC.



Summary – 2

7) As HEP accelerators in the U.S. turn off, we must **avoid accidentally dismantling strategic capabilities** in accelerator science and technology that are generating broad benefits in HEP today, in the future, and beyond HEP. These strategic resources could only be rebuilt slowly and painfully.

“Make more LHC luminosity, earlier”

“Use, develop & preserve unique U.S. resources & capabilities in accelerator science & technology.”