



State of LARP & LAUC

S. Peggs

LARP

Snapshot

Magnet & Accelerator

LAUC

(LHC Accelerator Upgrade Construction)

Proposal development

Summary

Conclusions

“Make more LHC luminosity, earlier”

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

Garoby at “Beam07”

Heuer at P5

Conclusion

- The pace of work is good and will accelerate in the near future.
- We have to strengthen our links with the community and establish new collaborations.



We need You!

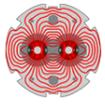
General Remarks -3-

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



LARP

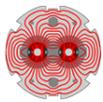
LARP



Closeout statement for internal review of LARP

on Dec 5, 2007

- We thank LARP management for their excellent presentation of the status of the program, for providing options for future direction of LHC accelerator activities, for the frank and open discussion of management issues, and the **increased need for prioritization of tasks, as some aspects of the R&D take on more of the character of deliverable projects.**
- **Excellent progress continues on LARP accelerator systems and Nb₃Sn magnet development.** Nevertheless, judging from the Nov 28-29, 2007 review of LQ magnet structure, **important issues** pertaining to quench performance and stress still **remain to be fully resolved.**

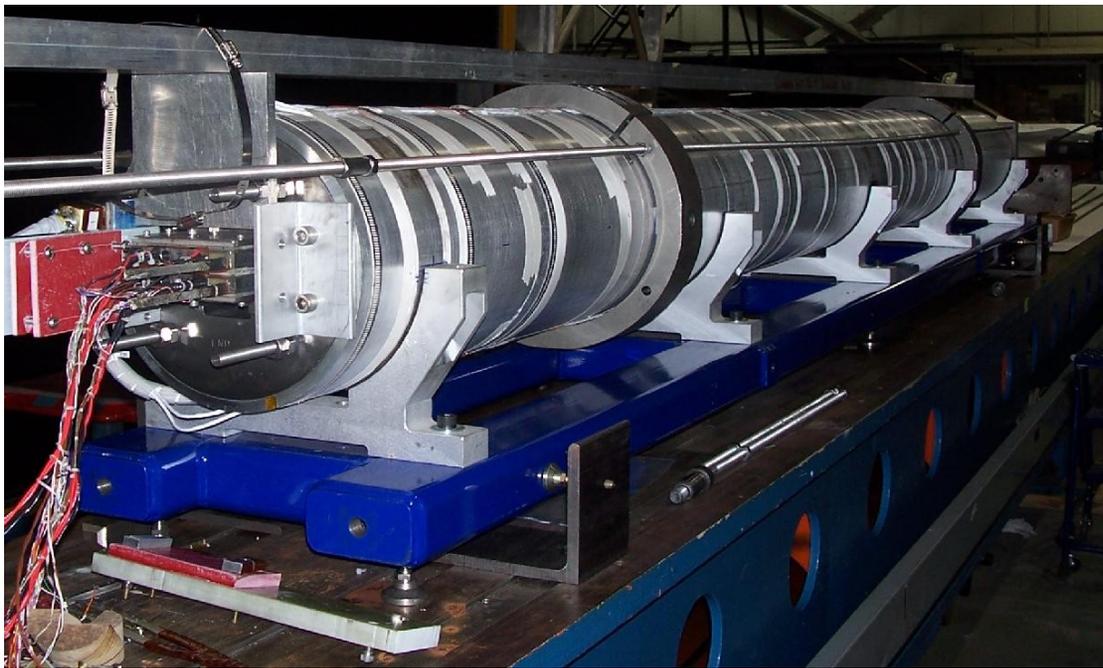


LARP

Closeout statement – 2

- 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. As with all projects of this magnitude, this step requires a full specification of goals, and we urge the development of realistic deliverables and schedules, recognizing that no project funds can be expected before FY'10, and that any initial expenditures for R&D will have to be covered through the existing LARP budget.

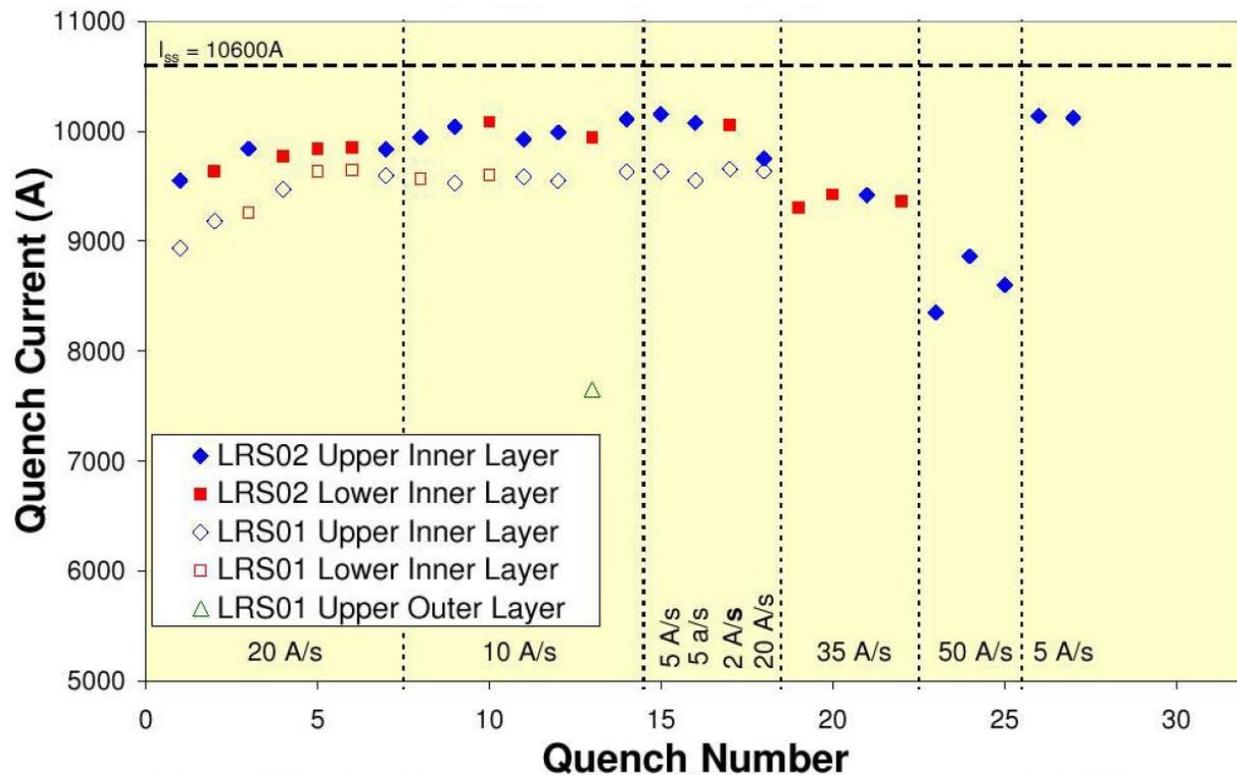
- The U.S. activities proposed for the Phase-I upgrade must be well defined and coordinated with CERN to avoid future misunderstandings. Decisions pertaining to scope, schedule and implementation of U.S. deliverables should be agreed upon jointly between the U.S. and CERN, and not decided by CERN alone. (The degree of mutual understanding in Phase-I is certain to affect any U.S. contributions to possible subsequent upgrades of the LHC.)



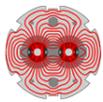
Nb₃Sn success

February 08

A 4 meter long Nb₃Sn LR (Long Racetrack) magnet reached **96% of short sample limit.**



LQ (Long Quad) & HQ (High field Quad) series are the next stepping stones toward installation ...



Magnet sequence table

Type	Length [m]	Aperture [mm]	Gradient [T/m]	Peak coil Field [T]	Accelerator Qualities	Purpose	Comment
SQ	0.3	110 - 130	>80	>11	Alignment	Conductor, mechanical and quench studies	Complete
LR	4	0	N/A	>11	None	Length scale-up with racetrack coils	Complete
TQ	1	90	>200	>11	Mag. measurements	Test bed for conductor & LQ	Ongoing
LQ	4	90	>200	>11	Structure alignment	Demonstrate Nb ₃ Sn technology in long mags	2009 goal
HQ	1	~ 130	>175	>13	Field Q & alignment	Short model for QA	High peak field
QA	~ 4	~ 130	~130	~ 10	All	Install in LHC well before Phase 2 upgrade	Slot compatible
QB	tbd	tbd	tbd	tbd	All	Phase 2 upgrade magnet	

TQ (Re-)assembly & collaborative testing at CERN.

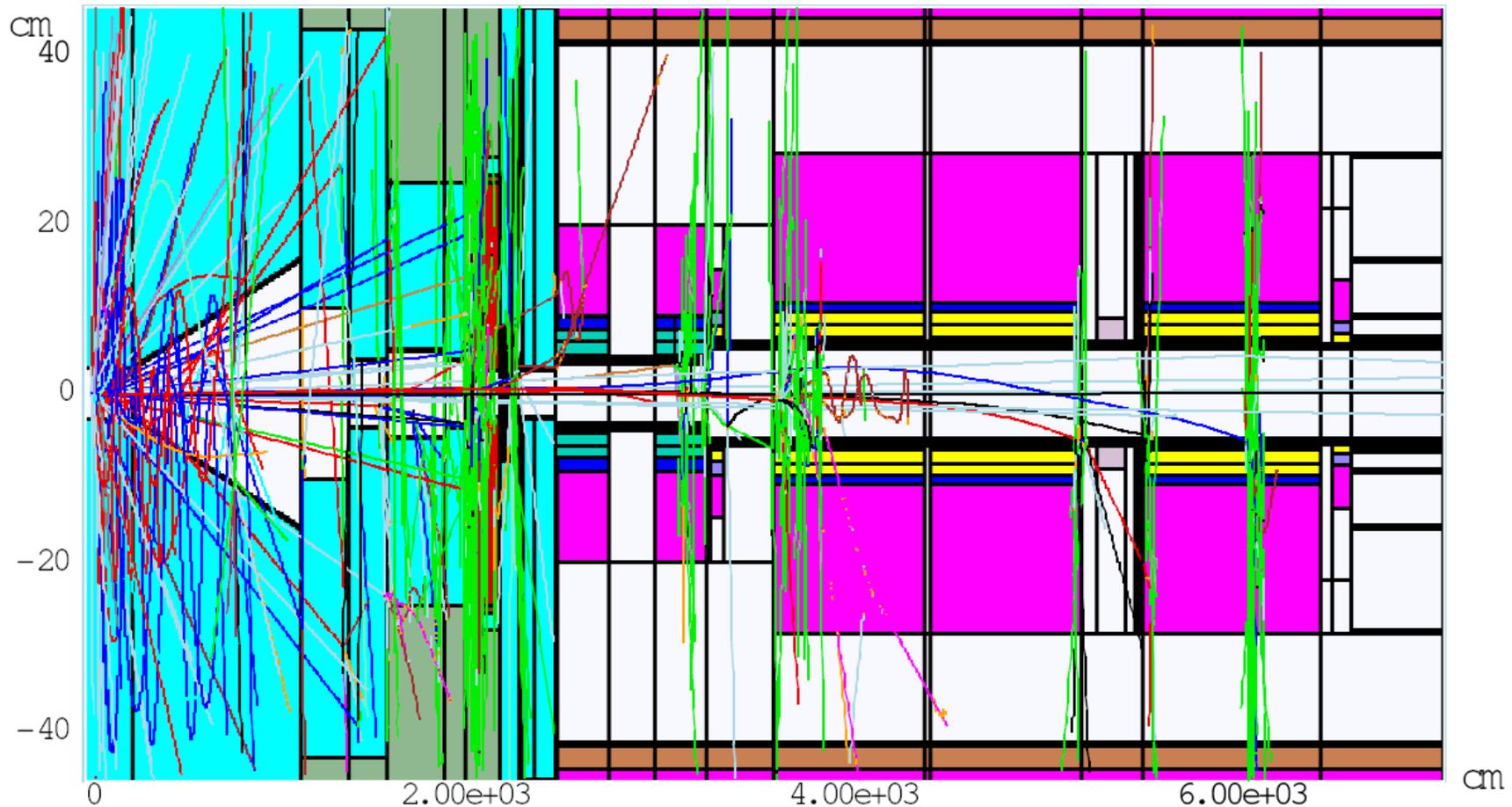
LQ Current focus of attention. Declare victory in battle (but not in war) in 2009?

HQ In many ways a prototype for QA. Squeeze play – what are the specs for the Phase-1 upgrade?

QA Phase-1 era: install in **slot compatibility** with NbTi.

Joint IR Studies

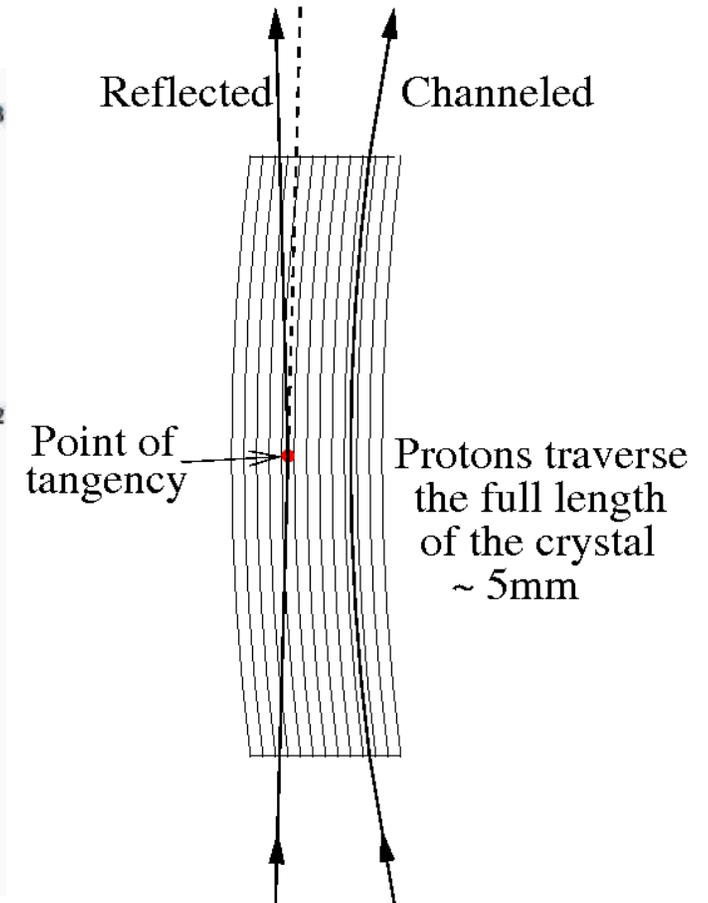
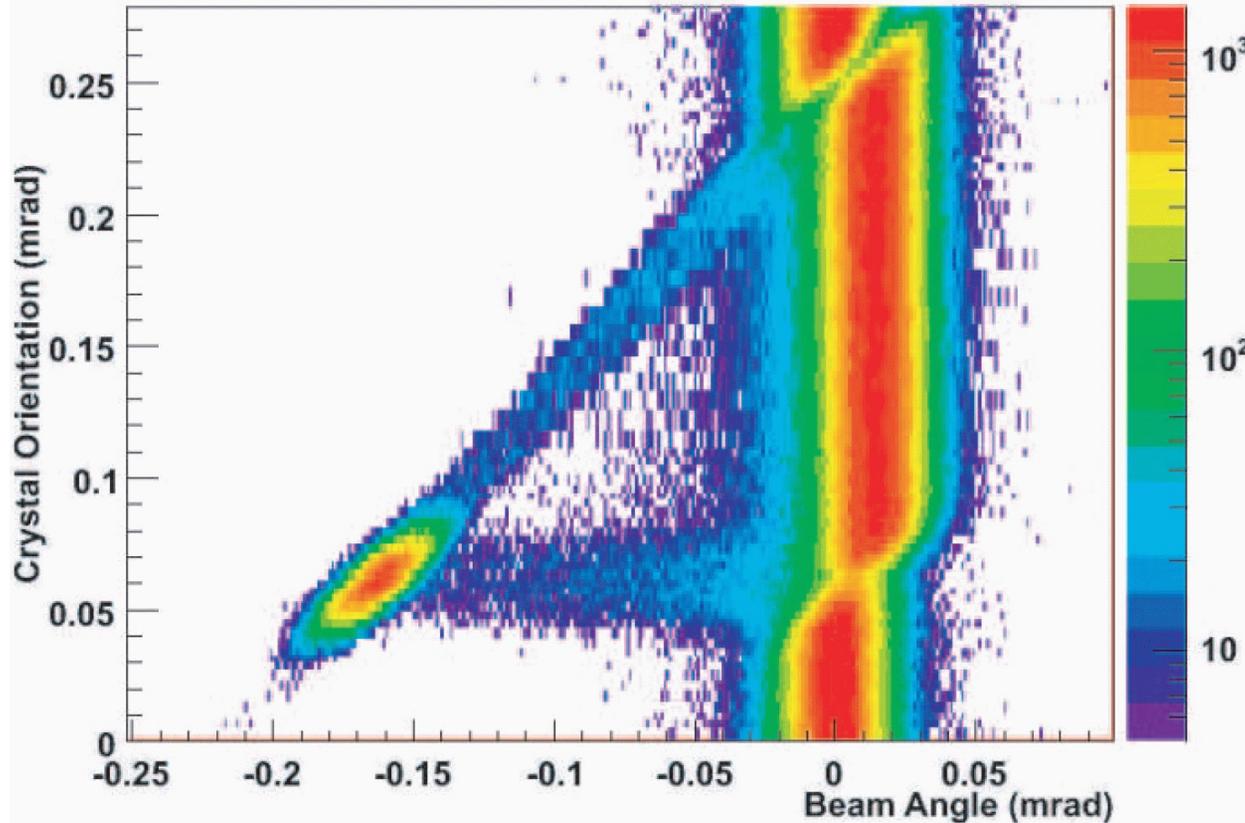
Eg, energy deposition at 7x7 TeV



Particle tracks ($E > 5$ MeV) for 1 pp-event at 7x7 TeV

Substituting Nb_3Sn for NbTi substantially increases operational margins, frees space, & verifies new technology for Phase-2.

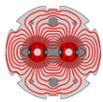
Crystal collimation experiments – Tev & SPS



Fermilab AAC: "... unique opportunity ... to build a case for an LHC implementation of a **collimation scheme that incorporates crystals** as a key component."

"... **revolutionize collimation systems** in ... LHC & ... future accs."

Newly understood **Volume Reflection** has great significance ???



LARP

Arrivals & departures

CERN

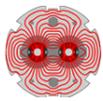
- Jan. 08** Evans takes control of LHC Accelerator Upgrade (Phase-1), in parallel to Accelerators & Beams (Myers) & Accelerator Technology (Lebrun) departments.
- June 08** Resurrect the “Director of Accelerators” posn?
- Jan. 09** New DG & new Director of Accelerators(?)

LARP

- Feb 08** LK Len named as DOE Liaison for LARP. Welcome LK, thanks Bruce!
- April 08** Eric Prebys named as next LARP leader!
- Aug. 08** Transfer from Peggs to Prebys completed



LAUC



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

Cardially

Robert Aymar

"... 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 ..."



THREE White Paper upgrades

LAUC would make substantial contributions to the THREE “White Paper” LHC luminosity upgrades.

Taken together, the **three upgrade components** are expected to double or triple the nominal luminosity of $10^{34} \text{ cm}^{-2}\text{sec}^{-1}$. They are:

- “Phase-1” **IR Upgrade** (R. Ostojic)
- “Phase-II” **Collimators** (R. Assmann)
- “Stage 1” **Injectors: Linac4** (M. Vretenar)

The component project leaders (in parentheses) report to the overall Project Leader (L. Evans).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	SUM
LARP actual [\$M]	1.1	3.3	11.0	11.0	11.9									38.3
LARP guidance	1.3	3.5	11	11	12	18*	12	12	12					
CLP-1							[Bar spanning 2010-2012]			[Bar for 2013]				20-30
CLP-2									[Bar spanning 2012-2013]		[Bar spanning 2014-2015]		[Bar for 2016]	



U.S.-LHC Accelerator Upgrade (LAUC)

Phase-1 Proposal (short version)

S. Peggs (editor), M. Lamm, T. Markiewicz, A. Ratti, G. Sabbi, P. Wanderer.

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IR Upgrade → Inner Triplet Magnets

Collimators → Collimators

Linac4 → Linac4 Low Level RF



R&D

Proposal excludes exciting long term R&D topics that show great potential for “Phase-2” LHC upgrades.

The R&D necessary to advance such topics to a state of readiness for inclusion in a construction project is expected to be performed in LARP.

LARP itself would perform little or no construction.

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



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.

1) Superconducting magnets.

- a) Provide (eg) 4 Nb_3Sn quadrupole coldmasses with ~ 130 mm bore for installation in all 4 inner triplets, as “slot-compatible” replacements for NbTi Q3 magnets.
- b) Provide NbTi dipoles with 180 mm bore as 4 D1 beam splitters, using the DX design installed in RHIC.
- c) System engineering. “Exploit and develop unique [human] resources” eg magnet physicists & cryo engineers.

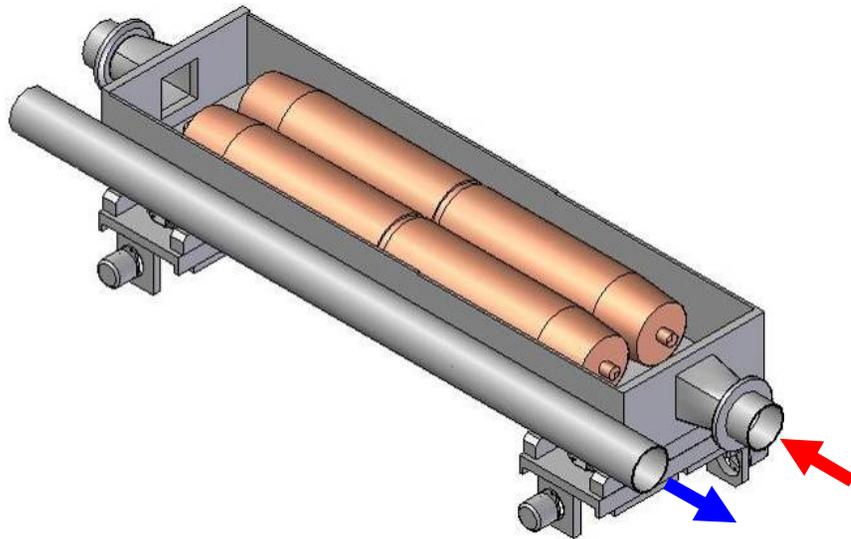
RIGHT

Unfair competitive advantage: “off-the-shelf” DX magnets



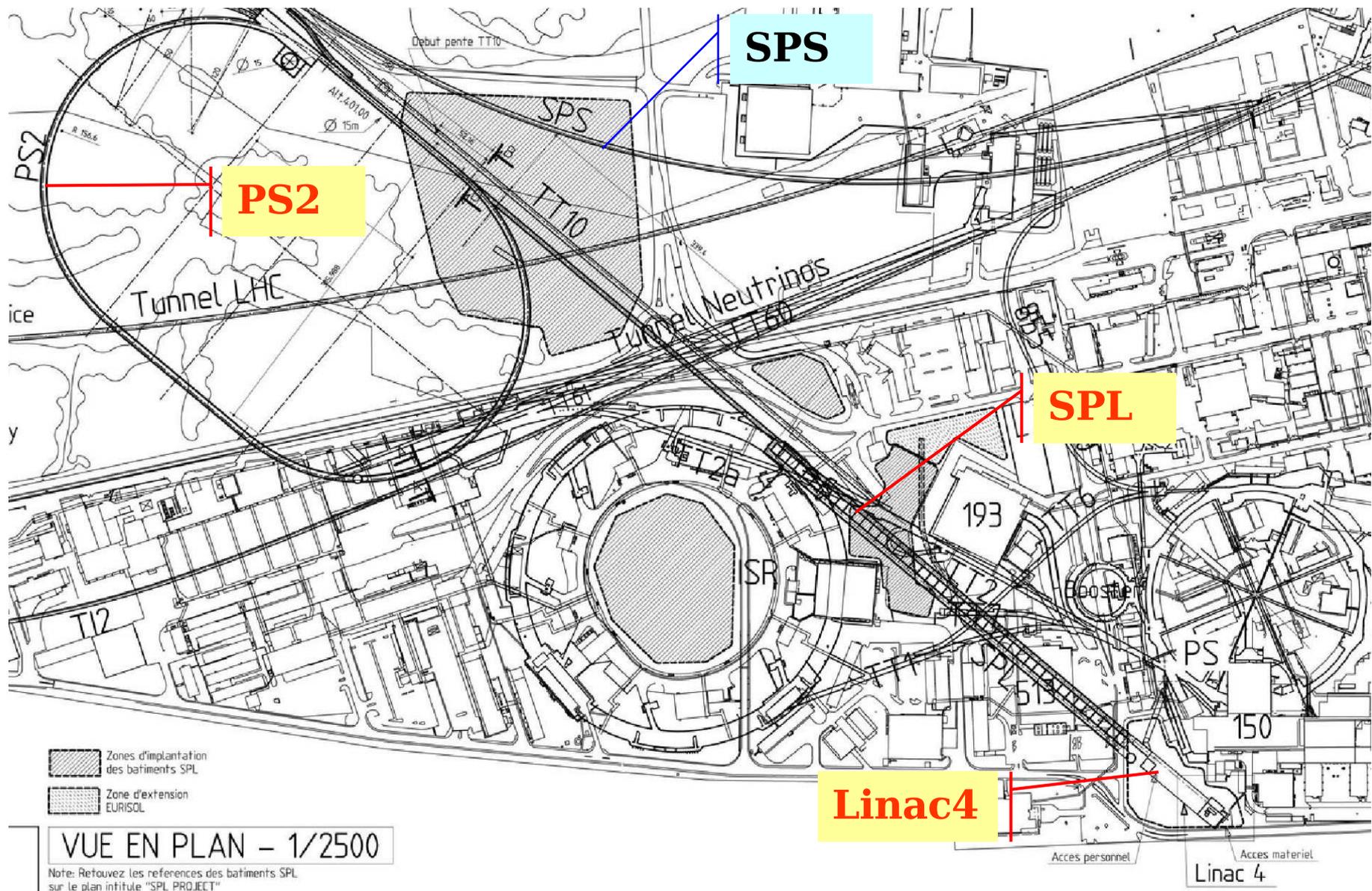
2) Collimators

As many as 36 rotatable collimators could be constructed.



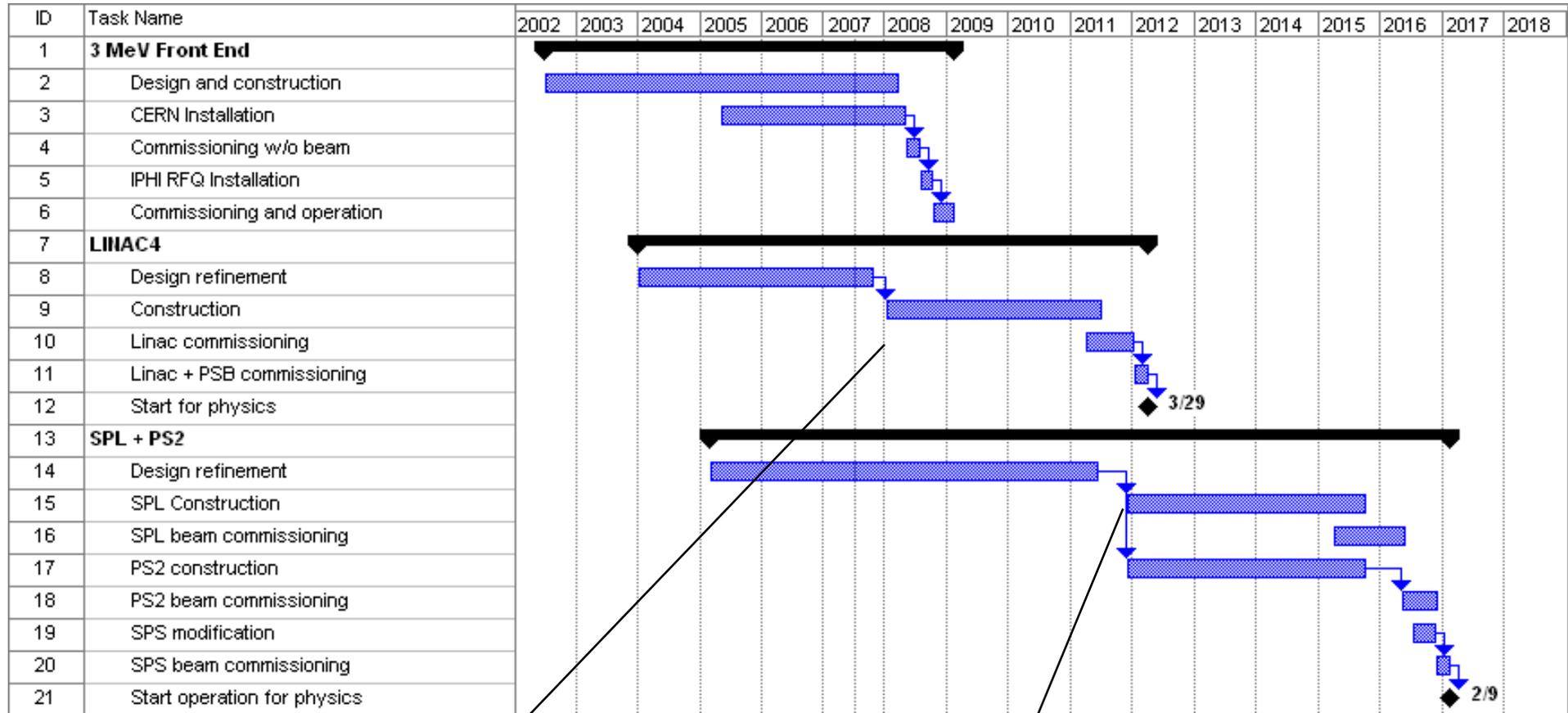
Markiewicz: “It is unequivocally clear that it is **premature to unilaterally suggest building 36 collimators** based on the SLAC design. The plan of studies outlined above must be followed to determine the optimum collimation solution for the LHC.”

Injector layout



Injector schedule

Linac4 is in construction, PS2 is in R&D



Linac4 approval

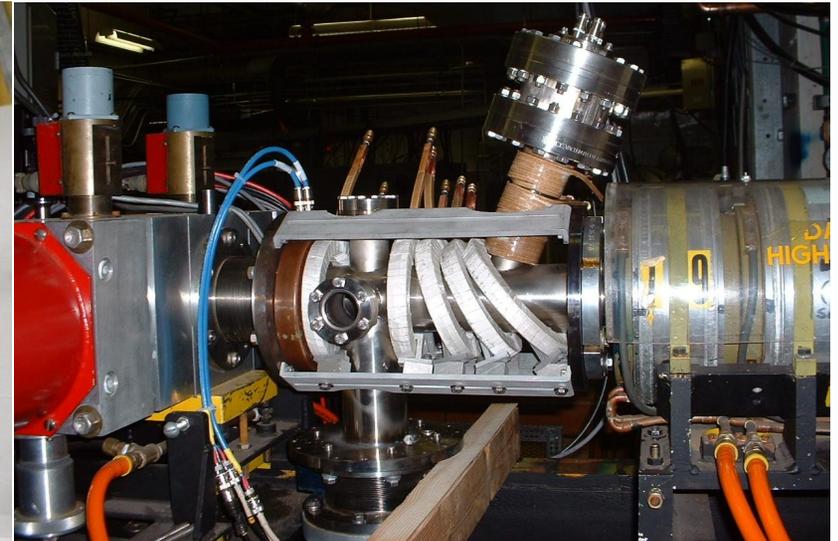
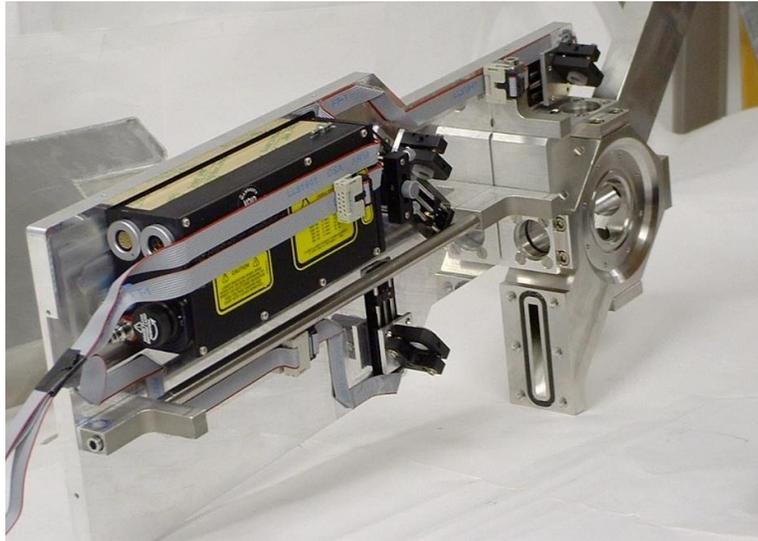
SPL & PS2 approval

3) Advanced instrumentation

- a) **Laser Profile Monitor** derived from SNS model, for installation as a non-destructive diagnostic in Linac-4 (and later SPL?)
- b) **Low Level RF** FPGA software as developed for SNS (& PEP-2) for installation in Linac-4 (& SPS & SPL?)

RIGHT

Laser
Profile
Monitor
prototype
components



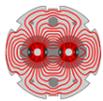


Summary



Summary

- 1) LARP & LAUC are separate, with co-ordinated strategies.
- 2) “LAUC Phase-1” aims at a FY10 start. Technical discussions with CERN continue (next week).
- 3) The LAUC proposal will be ready for review in June, at/with the LARP review(?) **Three major components:**
 - a) Superconducting magnets,
 - b) Collimators,
 - c) Advanced instrumentation (Linac4)
- 4) “Post Phase-1” R&D activities are exciting & promising, but are part of LARP, not LAUC.
- 5) How (whether) to incorporate PS2 studies into LARP?
- 6) Welcome, Eric – may you live in exciting times!



LARP



“You won't have Nixon to kick around anymore, because, gentlemen, this is my last press conference.”

Richard M. Nixon