

LARP

LARP Support of Crab Cavity Effort

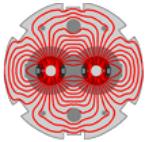
Eric Prebys

Fermilab APC

LARP Program Director

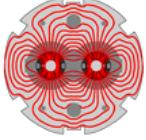


Sept. 18, 2009



LHC Accelerator Research Program (LARP)

- Proposed in 2003 to coordinate efforts at US labs related to the LHC accelerator (as opposed to CMS or ATLAS)
 - Originally FNAL, BNL, and LBNL
 - SLAC joined shortly thereafter
 - Some work (AC Dipole) supported at UT Austin
 - Can consider new membership (Jlab?)
- LARP Goals
 - Advance International Cooperation in High Energy Accelerators
 - Advance High Energy Physics
 - By helping the LHC integrate luminosity as quickly as possible
 - Advance U.S. Accelerator Science and Technology
- LARP includes projects related to initial operation, but a significant part of the program concerns the LHC upgrades



LARP Subtasks

○ Accelerator Systems (~\$3M/year)

- Accelerator physics
- Instrumentation and other hardware
 - Collimation
 - LLRF
 - Crab cavities?

Crab cavities would come out of this

○ Magnet Systems (~\$5M/year)

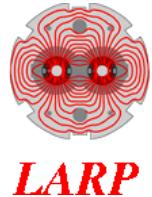
- Goal: demonstrate Nb₃Sn as a viable technology for the ultimate upgrade of the LHC

○ Programmatic Activities (~2M/year)

- Program management, travel, meetings, etc
- Toohig Fellowship
- Long Term Visitor (LTV) program

+~\$2M contingency divided among tasks as needed throughout year

LARP Instrumentation Contributions to initial LHC Operation



○ Schottky detector

- Used for non-perturbative tune measurements (+chromaticities, momentum spread and transverse emmitances)

○ Tune tracking

- Implement a PLL with pick-ups and quads to lock LHC tune
- Investigating generalization to chromaticity tracking

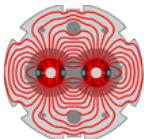
○ AC dipole

- US AC dipole to drive beam
- Measure both linear and non-linear beam optics



○ Luminosity monitor

- High radiation ionization detector integrated with the LHC neutral beam absorber (TAN) at IP 1 and 5.

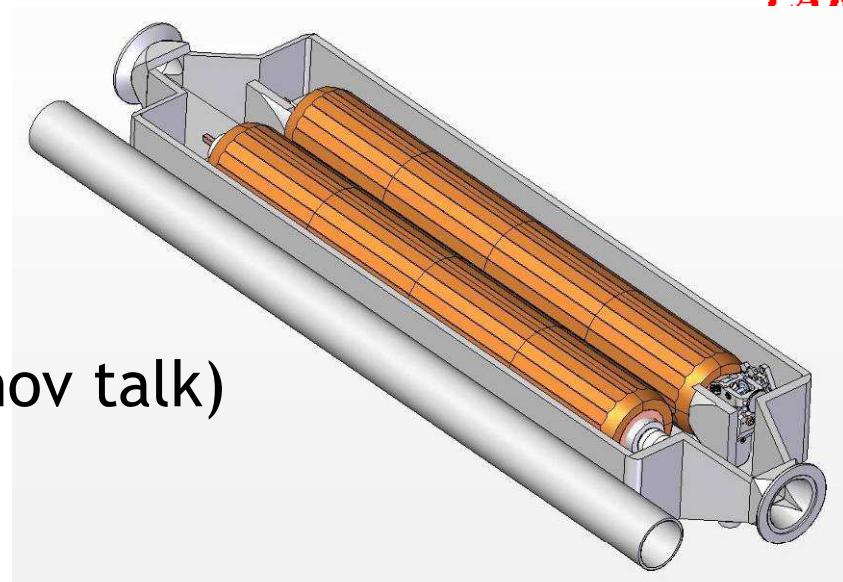


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LARP Accelerator R&D for future LHC

○ Rotatable collimators

- Can rotate different facets into place after catastrophic beam incidents
- Aim for prototype this year



○ Crystal Collimation (See Mokhov talk)

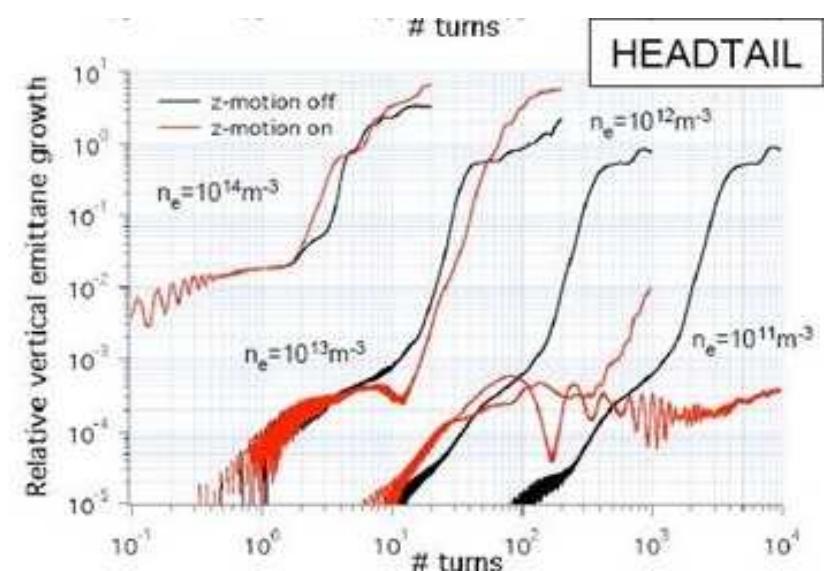
- CRYSTAL Collaboration
- T980

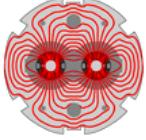
○ Beam-beam studies

- General simulation
- Electron lens (See Shiltsev talk)
- Wire compensation

○ Electron cloud studies

- Study effects of electron cloud in LHC and injector chain (see Furman talk)





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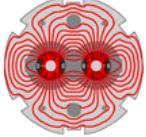
A Few Words about LARP Accounting...

- Somewhere between US and European Rules

- LARP funds pay for materials and services (M&S), most technical and engineering labor, and some scientific labor
- Significant scientific labor and some engineering labor contributed out of lab core programs

- That \$3M/year is really more like \$6M if we count everything (with all overhead).

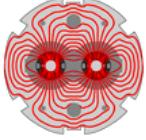
- Remember that by US accounting rules, a “physicist” is about \$250-300k/year.



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LARP Model

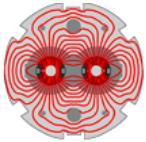
- LARP funds R&D.
 - If technology looks promising, the hope is that it will be taken over by CERN or spun off as a separate project in the US
 - eg, “Accelerator Projects for the Upgrade of the LHC” (APUL) magnet program, which is building D1 separators and feeboxes for the Phase I upgrade.
 - Not really structured like a project, so try to avoid “hard deliverables”
 - Got into some trouble with this with the Lumi monitors
- Crab cavities (even just the US part) too big to fit within LARP
 - Multi-M\$
- LARP can take a steering role in the US R&D, but if crab cavities take off, they will have to get dedicated funding from the DOE
 - ie, don’t assume “LARP funding” is the same as “US funding”
 - LK Len can say more about that than me.



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General Trends in LARP Accelerator Funding

- Historically dominated by two projects
 - Rotatable Collimator
 - Lumi Monitor
 - Together made up ~2/3 of Accelerator Systems Budget
- As these ramp down, projects which are moving to take their place include
 - R&D for PS2
 - Lots of interest at CERN and in US
 - Synergy with Project X
 - Well matched to LARP
 - E-cloud feedback in SPS
 - Mostly SLAC and LBL
 - Crab cavities
 - Interesting, but no way LARP can support entire US end.
 - Have taken a “wait and see” attitude



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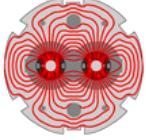
Potential Funding for Crab Cavities in FY10

- Initial FY10 budget: Total \$337k

- BNL: \$256k
 - Mostly Rama
- FNAL: \$6k
 - Travel
- LBNL: \$6k
 - Travel
- SLAC: \$69k
 - Continue R&D on SLAC cavity design

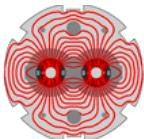
- Pending outcome of review

- Could potentially release ~few hundred k\$ from contingency over course of year



Funding Beyond FY10

- Rotatable Collimator budget will ramp down further, which could free up money for crab cavities, *however*, overall budget expected to shrink as budget for Phase I magnet program (APUL) grows:
 - Bottom line: LARP crab cavity support will probably stay in the range \$300k-\$600k/year.
 - With a strong signal from CERN, it could go higher, but probably not to the \$1M/year level.
- Caveat:
 - LARP will not continue to support efforts for a Phase I (IR4) test unless there is an unambiguous commitment from CERN to support such a test.



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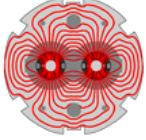
Latest CERN Schedule (for what it's worth)

Priorities		Q4	2010				2011				2012				2013				2014			
			Q1	Q2	Q3	Q4																
1	LHC Operation assumed	O	O	O	O	O	Sh	Sh	O	O	Sh	O	O	O	Sh	O	O	Sh	Sh	Sh	O	O
1	SPS operation and exploitation	O	O	O	O	O	Sh	O	O	O	Sh	O	O	O	Sh	O	O	Sh	Sh	Sh	O	O
1	PS Operation and Exploitation	O	O	O	O	O	Sh	O	O	O	Sh	O	O	O	Sh	O	O	Sh	Sh	Sh	O	O
1	Booster Exploitation and Operation	O	O	O	O	O	Sh	O	O	O	Sh	O	O	O	Sh	O	O	Sh	Sh	Sh	O	O
1	Source/LINAC2 op and exploitation	O	O	O	O	O	Sh	O	O	O	Sh	O	O	O	Sh	O	O	Sh	Sh	Sh	Sh	Sh
	Linac3/LEIR/Ions Operation	Sh	Sh	O	O	O	Sh	O	O	O	Sh	O	O	O	Sh	O	O	Sh	Sh	Sh	O	O
1	LHC 3-4 magnet repair for spares		C	C	C	C																
1	Consolidation all accelerators	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
2	LINAC4 assumed	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	Sh	Sh	Sh	O	O
2	Inner Triplets assumed	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	Sh	Sh	Sh	O	O

Potential
Crab Cavity
Installation?

↑
Phase I
Upgrades

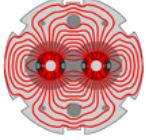
- Could CERN commit to a crab cavity test in IR4 in 2013?
 - And could we meet that schedule?



LARP

My “take away” from this meeting so far...

- The case for crab cavities has gotten very strong
- At this point:
 - Could *possibly* down-select from among 800 MHz elliptical designs
 - Nowhere near the point to choose among compact designs.
- However, elliptical cavities don't appear feasible for the local solution.
- This raises the question whether there is a point to developing the elliptical cavities at all:
 - Still a question whether Phase I test will occur.
 - Would it make more sense to put all our efforts into the final solution.



Important Questions

- Can we get a commitment that a Phase I test can occur? **LARP**
- Can we meet that timescale?
- What will “CERN” accept as evidence that crab cavities are a viable technology:
 - Is a Phase I test in the LHC necessary?
 - Does it tell us enough?
 - Could we do a test in the SPS or elsewhere?
- Can crab cavities be made “safe”?
 - Potential show stopper
- Can IR4 be modified to permanently accommodate elliptical cavities?
 - If so, is a global scheme potentially the best solution?