Program & Management Overview

Steve Peggs

Prolog

Status report

Charge to LARPAC

Calendar (partial)

Apr	26-28	Collaboration meeting (LBNL)
May	10-12	LARPAC (BNL)
June	5	Executive Committee meeting (FNAL)
June	12-14	DOE Review (FNAL)
Oct	?	Collaboration meeting (BNL)
Nov	?	CERN-U.S. Committee (CERN)

These meetings help the FY07 budget become more realistic as October 1 is approached

Potential new tasks? National Co-ordinators (L2's) are the gatekeepers, and must play an activist role

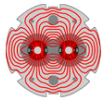
Q3 budget re-tune

	BNL $k	FNAL $k	LBNL $k	SLAC $k	Unallocated $k	Total $k
Current allocation	2130	2410	2980	780	2700	11000
Requested allocation	3264	3300	4086	350	0	11000
Requested increment	1134	890	1106	-430	-2700	0

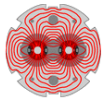
36% ($4.0M) in FY06 goes to Accelerator Systems

52% ($5.7M) goes to Superconducting Magnet R&D

- More accurate re-distribution of "Toohig Fellowship" money
- Allocation of "Management Contingency" to many Tasks, mainly in small allotments.
- Decrease in funds to "Rotatable Collimators" at SLAC, reflecting a late start in engineering on the first prototype.
- Increase in funding to the "Long Racetrack" activity at BNL



Collaboration meeting summary



Magnet highlights

Subscale Quadrupole SQ02 achieved 97% of its short sample limit after extensive testing at LBNL in October 05, and at FNAL in March 06.

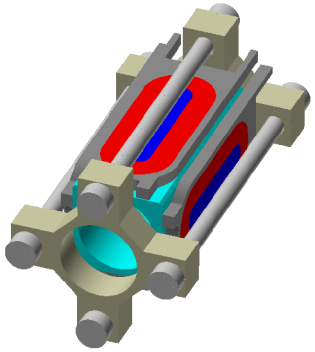
Technical Quadrupole TQS01 has just begun testing, and has reached 87% of it short sample limit.

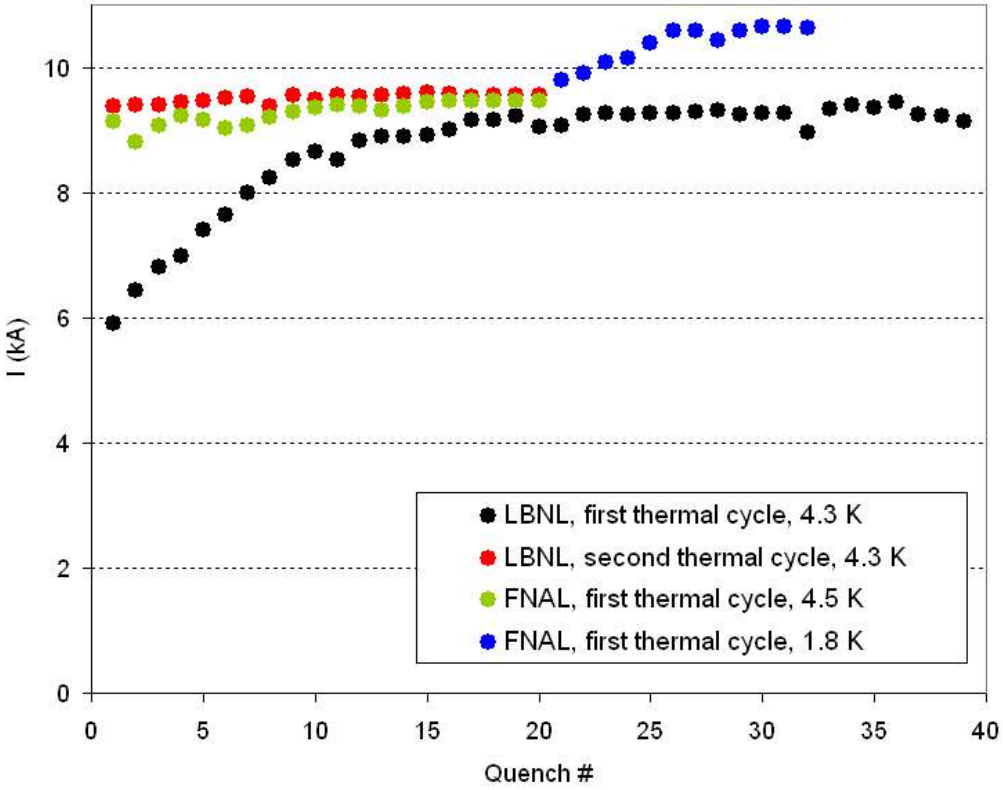
This is a great success for the world's first large bore (90 mm) Nb_3Sn magnet.

Nonetheless, the 13% shortfall is under investigation.

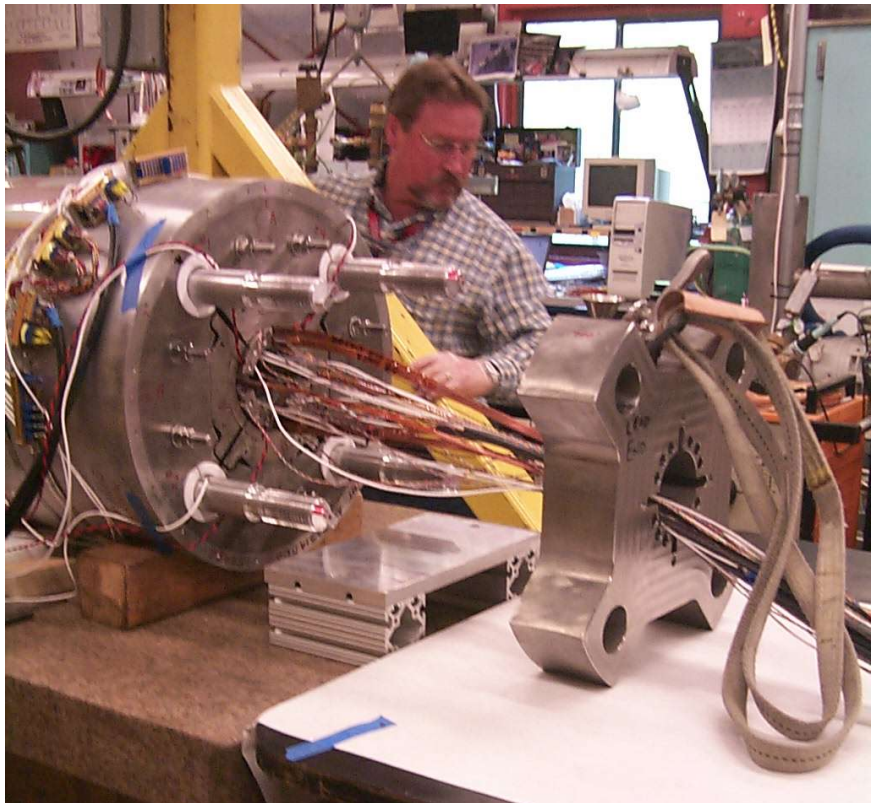
LARP

Subscale quad SQ02





Technical quad TQS01



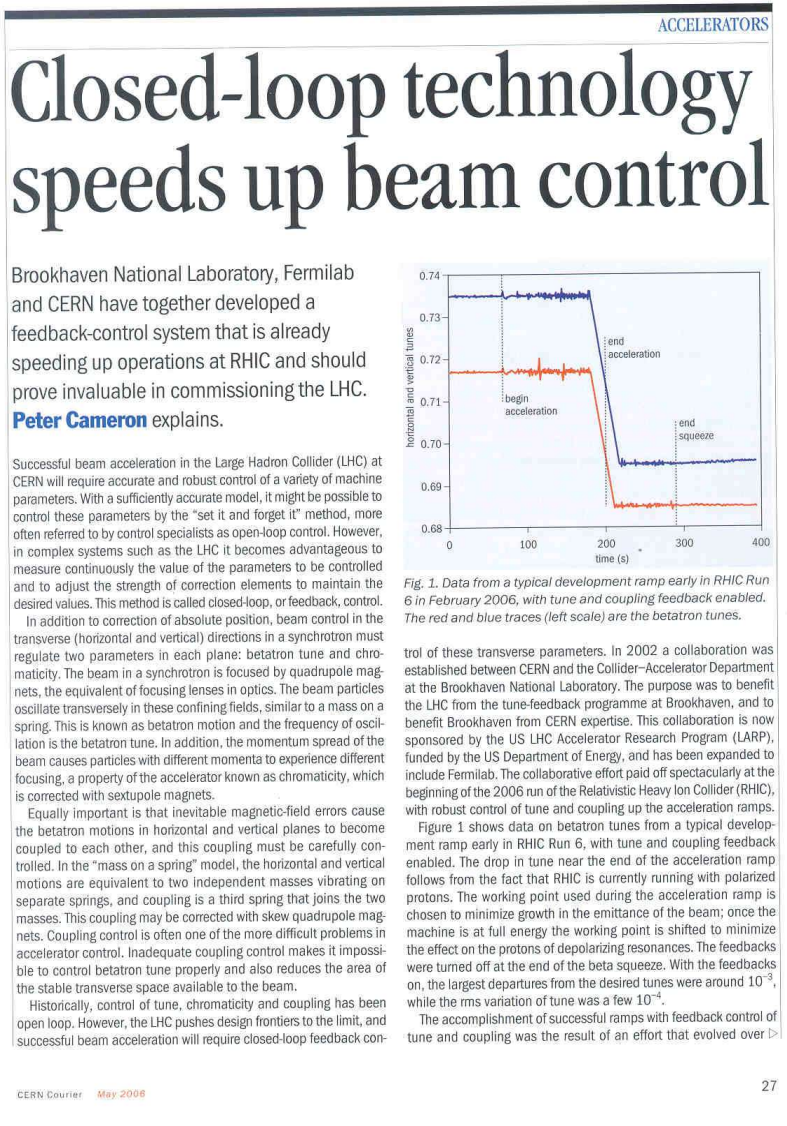
TQS01 End plate assembly

An Accelerator Systems highlight

Simultaneous tune and coupling feedback was demonstrated in RHIC - a world first.

Thanks to work by physicists and engineers from BNL, CERN and FNAL.

This paves the way towards the ultimate goal of chromaticity feedback during snap-back at the beginning of the LHC energy ramp.



ACCELERATORS

Closed-loop technology speeds up beam control

Brookhaven National Laboratory, Fermilab and CERN have together developed a feedback-control system that is already speeding up operations at RHIC and should prove invaluable in commissioning the LHC. **Peter Cameron** explains.

Successful beam acceleration in the Large Hadron Collider (LHC) at CERN will require accurate and robust control of a variety of machine parameters. With a sufficiently accurate model, it might be possible to control these parameters by the "set it and forget it" method, more often referred to by control specialists as open-loop control. However, in complex systems such as the LHC it becomes advantageous to measure continuously the value of the parameters to be controlled and to adjust the strength of correction elements to maintain the desired values. This method is called closed-loop, or feedback, control.

In addition to correction of absolute position, beam control in the transverse (horizontal and vertical) directions in a synchrotron must regulate two parameters in each plane: betatron tune and chromaticity. The beam in a synchrotron is focused by quadrupole magnets, the equivalent of focusing lenses in optics. The beam particles oscillate transversely in these confining fields, similar to a mass on a spring. This is known as betatron motion and the frequency of oscillation is the betatron tune. In addition, the momentum spread of the beam causes particles with different momenta to experience different focusing, a property of the accelerator known as chromaticity, which is corrected with sextupole magnets.

Equally important is that inevitable magnetic-field errors cause the betatron motions in horizontal and vertical planes to become coupled to each other, and this coupling must be carefully controlled. In the "mass on a spring" model, the horizontal and vertical motions are equivalent to two independent masses vibrating on separate springs, and coupling is a third spring that joins the two masses. This coupling may be corrected with skew quadrupole magnets. Coupling control is often one of the more difficult problems in accelerator control. Inadequate coupling control makes it impossible to control betatron tune properly and also reduces the area of the stable transverse space available to the beam.

Historically, control of tune, chromaticity and coupling has been open loop. However, the LHC pushes design frontiers to the limit, and successful beam acceleration will require closed-loop feedback control of these transverse parameters. In 2002 a collaboration was established between CERN and the Collider–Accelerator Department at the Brookhaven National Laboratory. The purpose was to benefit the LHC from the tune-feedback programme at Brookhaven, and to benefit Brookhaven from CERN expertise. This collaboration is now sponsored by the US LHC Accelerator Research Program (LARP), funded by the US Department of Energy, and has been expanded to include Fermilab. The collaborative effort paid off spectacularly at the beginning of the 2006 run of the Relativistic Heavy Ion Collider (RHIC), with robust control of tune and coupling up the acceleration ramps.

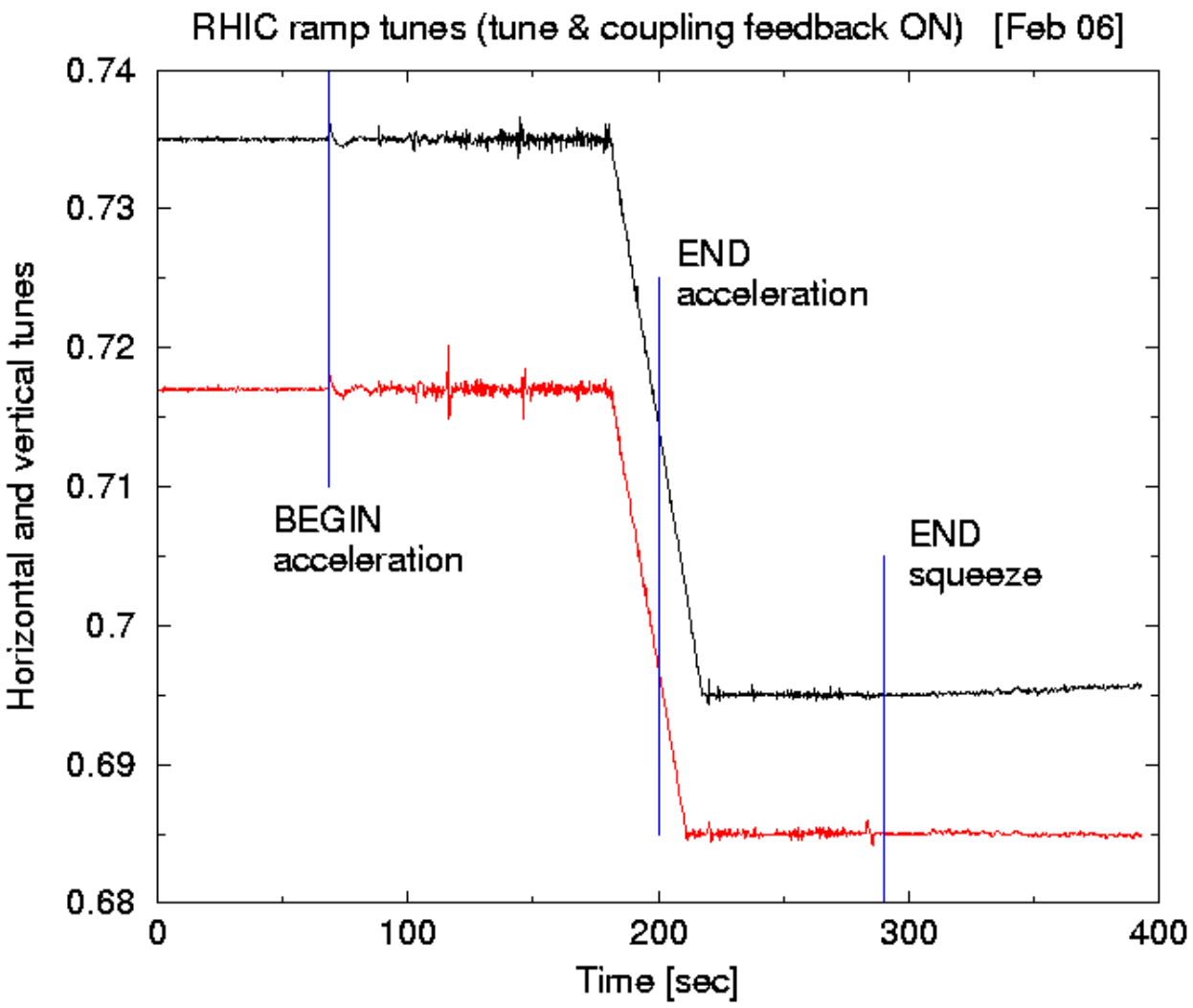
Fig. 1. Data from a typical development ramp early in RHIC Run 6 in February 2006, with tune and coupling feedback enabled. The red and blue traces (left scale) are the betatron tunes.

Figure 1 shows data on betatron tunes from a typical development ramp early in RHIC Run 6, with tune and coupling feedback enabled. The drop in tune near the end of the acceleration ramp follows from the fact that RHIC is currently running with polarized protons. The working point used during the acceleration ramp is chosen to minimize growth in the emittance of the beam; once the machine is at full energy the working point is shifted to minimize the effect on the protons of depolarizing resonances. The feedbacks were turned off at the end of the beta squeeze. With the feedbacks on, the largest departures from the desired tunes were around 10^{-3}, while the rms variation of tune was a few 10^{-4}.

The accomplishment of successful ramps with feedback control of tune and coupling was the result of an effort that evolved over ▷

CERN Courier, May 2006

Tune & coupling feedback



"Military precision" in ability to maintain desired tunes

Stunning tune proximity is possible!

~ 0.0007

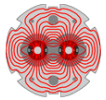
Unique skills of individuals:

Cameron (BNL)

Tan (FNAL)

Gasior, Jones (CERN)

combine to benefit all: BNL,CERN, & FNAL



IR & Hardware Commissioning

So far: 6 people from FNAL & 2 from LBNL are good matches to joint needs.

Peak of 7 FTEs during the expected peak in early CY07.

Of that, ~1.5 FTEs will work on the IR Commissioning of US deliverables.

Bad news: start date for early activity postponed to Sept 1st.
Good news: the date is SET.

Peter Limon is extending his stay into early 07.

"General unofficial feeling is that hardware commissioning will not be finished even by Dec 2007"

LBNL participation is not fully resolved ...

Accelerator Systems deliverables

Four items have been identified by LARP and CERN as "hard deliverables":

- they are crucial to LHC performance
- "plan B" is weak or non-existent.

Would need special protection in the face of a budget shortfall.

1) Luminosity Monitors.
A review held on April 24 noted good progress .

2) Tune Feedback.
A "Final Design Review" will be held this summer or early fall.

3) Beam and Instrumentation Commissioning.
A vetting procedure needs to be established to ensure excellence.

4) Rotatable Collimators.
This longer time scale item is on track, despite a slow start

Magnet Strategy

The sole goal of the magnet program is to

> demonstrate long strong quadrupoles using Nb_3Sn technology by 2009.

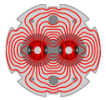
A single minded focus is currently necessary to maximize the probability of success

Nonetheless a modest diversification of the magnet program may begin to be appropriate in 2008.

Supporting LHC IR Upgrades will always remain the broad goal.

LARP would like to develop closer ties with CARE

Would also like to see a global strategy for IR Upgrades



European Strategy Document

"A Strategy for European Superconducting Accelerator Magnet R&D Aimed at LHC Luminosity Upgrade" [CARE, March 06] includes 2 non-European authors (of 12): Gourlay & Peggs

Quotes from the document:

"… the viability of Nb_3Sn technology … should be demonstrated by 2010."

"The LARP effort to demonstrate the feasibility of long Nb_3Sn quadrupole magnets is vigorously encouraged by CERN"

"Rather than competing, NED and LARP goals are synergistic – each supports the other."

"The timely and successful completion of the LARP and NED programs will be instrumental (and be mandatory) … for … an LHC IR upgrade"

University involvement

The involvement of U.S. universities could significantly enhance Accelerator Science at the LHC.

We are groping towards ways in which the DOE funded labs in LARP can work effectively with the (mostly) NSF funded universities that have appropriate talent and resources.

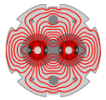
Loose connections are being formed in four potential areas:

1) University of Texas (Kopp). AC Dipole topics.

2) MIT (Barletta, Milner). Demonstration of Optical Stochastic Cooling at the MIT-Bates ring.

3) National High Field Magnet Laboratory (Larbalestier). Material testing and R&D.

4) Texas A&M (McIntyre). Exotic magnets.



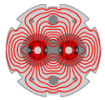
FY07 budget planning

The "Blue Sky" Task Sheets now in preparation for FY07 (and FY08) will exceed the $11M budget guidance given by the Department of Energy, and

Will need editing to establish the financial plan that will implemented on October 1.

In particular, major new initiatives seeking LARP funding will face critical evaluation and prioritization by LARP and CERN committees.

Although LARP explicitly maintains an "open door" policy for new tasks, most are rejected or deferred, often in spite of great technical merit, in order to defend existing priorities.



Charge to LARPAC

"The Committee is asked to review …"

LARP

Strategic goals

1) Potential diversification of Magnet R&D beyond the 2009 “technology demonstration” goal

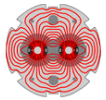
- goal always remains LHC luminosity
- CARE-HHH-AMT has a broader view

2) Cohesiveness of the Accelerator Systems program

- inverse problem: is it too diverse?

3) Potential new tasks and partnerships

- universities & NSF
- Magnet strategies: Europe & the world



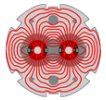
Program execution

1) Progress of the Magnet R&D and Accelerator Systems programs

- Dry Run for the DoE review

2) Are milestones sufficiently well defined?

- Magnet strawmen:
  - Is it clear how LRS01 & LRS02 feed into LQ's?
  - Explain the magnet program in a slow elevator
  - Track the magnet program
- Acc Sys strawmen:
  - Instrumentation delivery on time?
  - Track long term Accelerator Physics goals?



Management issues

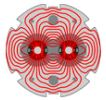
1) Ensuring excellence in (beam) commissioning

- Hardware & IR Commissioning “was” easy
  - Main actors well known from construction project
  - Relatively short term activity ~18 months

- Beam, Instrumentation & AP long stay folk
  - Broad scope, long term ~ 10 years
  - Prioritization and evaluation by LARP & CERN
  - Youth versus experience
  - “Justice must be seen to be done …”

2) Documentation of mutual understandings between LARP and CERN, and within LARP

- Eg, Alex Ratti's plan
- Will be a big topic at DOE Review …



"The Committee is also given lattitude to pursue, and to offer coments and recommendations on, any other items which it deems important to the success of the program"