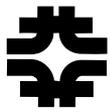




LHC Machine Commissioning/Ops

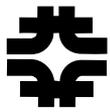
Tanaji Sen/APC
for
Mike Lamm/TD
FRA Physics Visiting Committee
April 25/26 2008

- History of participation
 - Hardware Commissioning
 - Beam Commissioning and Operation
 - Conclusions
-



Fermilab Commitment to LHC Commissioning

- Charter member of LARP LHC Commissioning Effort
 - Logical extension of USLHC Accelerator project
 - Oversight of installation, commissioning of US deliverables
 - Beam Commissioning, accelerator physics and beam instrumentation
- 2005 Call from CERN DG for US help in HC /US response
 - Fermilab has committed up to 10 FTE to CERN Hardware commissioning
 - Commissioners are integral part of "US deliverable" and global commissioning
- Beam Commissioning and other Accelerator based support
 - LARP beam Commissioning effort
 - LAFS
- Remote Operations Center at Fermilab
 - Possible role in beam commissioning and LHC ops



LHC Inner Triplet repairs

- 27 March 2007: the inner triplet at 5Left failed a pressure certification test





LHC Inner Triplet repairs

Repair of the Triplet was made a priority of the Laboratory, a team from Fermilab, CERN, KEK and LBNL formed.

By mid-May the team converged to a solution for reinforcement of the magnet cryostat supports and the DFBX internal piping

CERN and FNAL shared procurement responsibilities

CERN, the LARP HC team already in place (4 FNAL, 1 LBNL), and additional FNAL personnel traveling to CERN shared assembly and installation responsibilities

By mid-June the prototype fix was successfully tested

By the end of August all repairs and installations were complete

Inner Triplet progress since last fall driven by scheduling constraints on machine hardware commissioning as a whole

Now:

All Inner Triplets are in the LHC tunnel

7 (of 8) have passed pressure tests

4 are at 2 K; one more is in process of cooling down

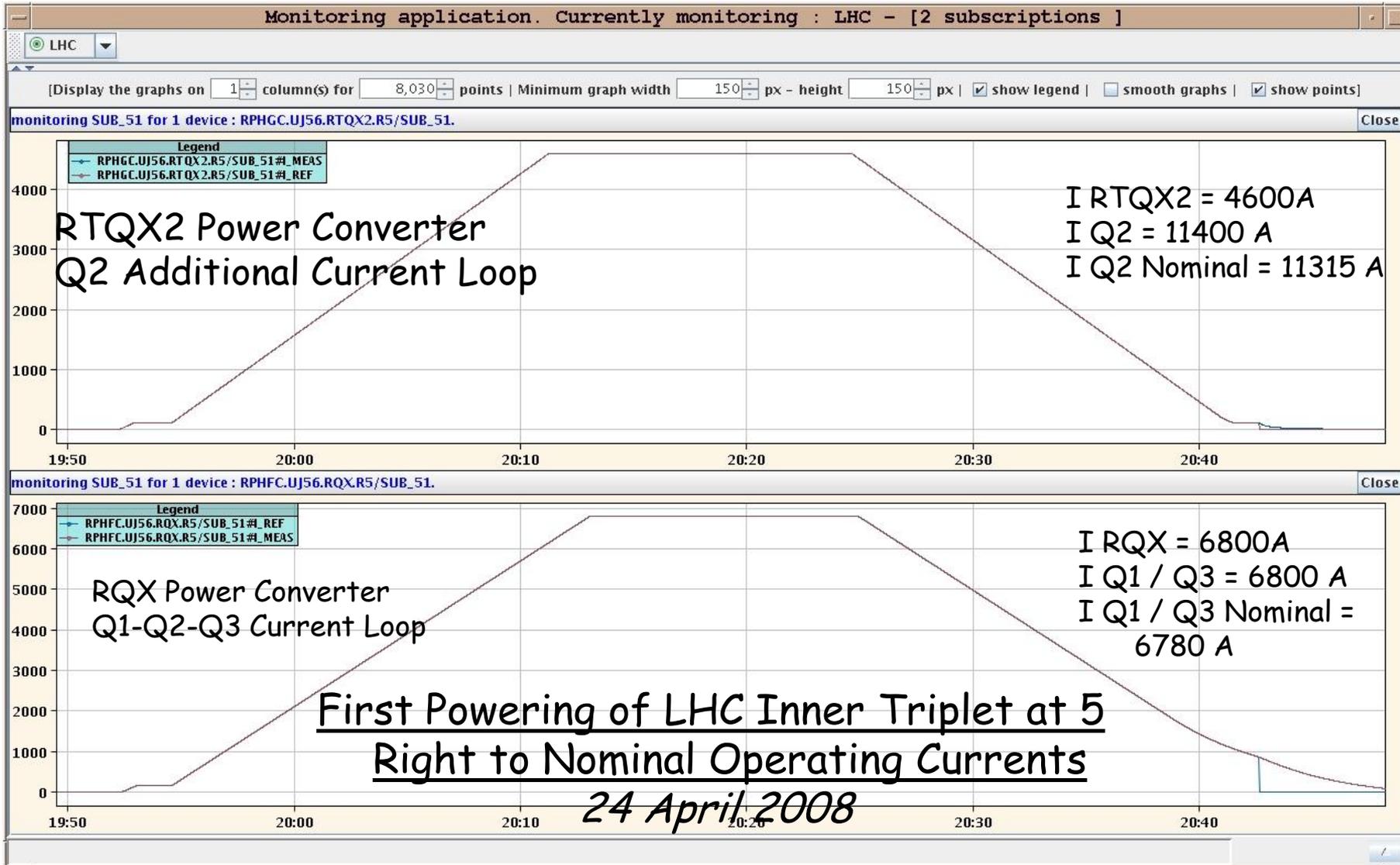
1 is in process of powering tests; another on the verge of starting

Independent Root Cause Analysis conducted for the laboratory by EG&G

Implementation plan in preparation by Ad Hoc Committee



Successful Powering of 1st triplet





Hardware Commissioners 2006-present

- Station at CERN for +1 Year duration
 - Become CERN Paid Project associates
 - Substantial support from LARP and home institution
 - Become members of appropriate CERN AT group
 - Cryogenics, Powering/protection or IR magnet group
 - Full shared responsibility from groups commissioning tasks, however:
 - Special priority given to Hardware originating from the US.. (i.e. Separation dipoles, DFBX feedboxes and IR quads)
- Benefit to Both CERN and US!
 - All have assumed major responsibilities in their respective groups
 - Commissioning of US deliverables are getting the proper amount of care and attention in a very complex global commissioning environment
 - Presence at CERN was extremely valuable in resolving the IR quad and feedbox "mechanical issues" discovered during high pressure tests in 2005-6



The FNAL Commissioners



Bob Flora FNAL



Christine Darve FNAL



Roger Rabehl FNAL



Peter Limon FNAL



Sandor Feher FNAL



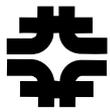
What they have been doing....

Management

- **Peter Limon** (Nov. 2005-July 2007) Assigned to AT-MEL
 - **Local LARP leader** /Official LARP Safety Liaison
- **Jim Kerby** (July 2007-2008 replaced Peter Limon as lead LARP person at CERN)

Cryogenics

- **Roger Rabehl** (Oct. 2006-Sept. 2007) Assigned to AT-ACR
 - **Lead** cryo engineer for CERN feed boxes (DFB)
 - Wrote procedures for cooldown, calculations on required helium flows for operations... added instrumentation to DFB's
- **Christine Darve** (Sept. 2007-Dec. 2008) Assigned to AT-ACR
 - CERN cryo **point of contact** for US feedboxes (DFBX)
 - Cryogenic operations specialist



Long Term Commissioners Stationed at CERN

Powering, Quench Protection and Magnet Analysis

- **Bob Flora** (Oct. 2006-Dec. 2008) Assigned to AT-MEL
 - Quench Protection Instrumentation
 - Major responsibilities in quench protection group
 - Software algorithms for inductive voltage compensation
 - **Team leader** within quench protection group
- **Sandor Feher** (Sept. 2006-Dec. 2008) Assigned to AT-MEL
 - **Overseeing** powering/commissioning of US deliverables
 - IR Magnets, HTS Leads, Quench analysis
 - Quench protection and arc magnet extraction circuits
 - Team leader within quench protection group



Status of Commissioning as of April 22, 2008

- CERN plan: Commission accelerator for 5TeV operation in summer 2008, work towards 7TeV.
- So far: 3 Sectors have been partially commissioned
 - Arc/dipoles quads to ~5TeV in one sector to date
- Stable superfluid operation
 - Now successfully launching multiple cryo "cooldown fronts"
 - Unscheduled cryo-down times occur ~once every 2 weeks
- Powering and quench protection commissioning follows the cryo commissioning
 - There are over 100 circuits/sector. To each circuit is assigned a commissioning team; typically 4 "commissioning fronts" in parallel in the Central Control Room (CCC)
 - Logistically challenging!
 - Some specialty magnets are commissioned to full "7 TeV" field
 - BNL Separation dipoles, for example
 - IR quads will be commissioned to full 7 TeV "squeeze" gradient



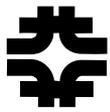
Present Sector for Power Commissioning: Sector 5-6

- This will be the first full commissioning of a DFBX and inner triplet quads
 - Minor problems with temperature control of DFBX power leads have been corrected (CERN issue); effort led by US hardware commissioners in collaboration with other CERN staff
 - Power supply and interlocks checks completed, magnets pass all hipot and instrumentation checks
 - So far, IR Quads powered to 500 amps without incident
 - Powering program continues towards full powering at 7 TeV

Triplet 5 Right - tested April 24, 2008

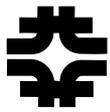
Cooldown for Sector 7-8 is well underway

- Feed box is full of liquid helium, Darve/Feher are organizing test of power lead temperature control



Beam Commissioning Plans (1)

- It is very likely that beam will be circulated in this calendar year!
 - Target is 5TeVx5TeV by the summer/fall 2008
 - Well defined program starting with low intensity, zero crossing angle and single bunch, moving towards 25 ns bunch spacing, full intensity, full squeeze
- General areas of participation: Vacuum, Beam Transfer, RF, Beam Instrumentation, AP, Operation and Hi level controls
- Beam hardware commissioning in the US is coordinated through LARP, (Task leader Elvin Harms/Fermilab)
- Beam software contributions is coordinated at Fermilab through (LAFS) (Leader Dave McGinnis, project leaders: Gysin, Patrick and McCrory)



Beam Commissioning Plans (2)

- By mutual agreement, participation is through individual projects
 - Work accomplished through short term visit to CERN, work at home institution
 - Long term visitor status to CERN is also possible through LARP and home institution support
- Present area of participation of Fermilab:
 - Schottky Monitor
 - Tune tracker
 - Other beam related tasks
- LARP beam commissioners are meeting with CERN counterparts this week at CM-10 to discuss plans for FY09



LAFS = LHC at FNAL Software

- Part of LHC@FNAL
- A core group of 10 Fermilab* people
 - All Fermilab people are working ~30% on LAFS
- Provide software support for the LHC
 - With a long term view to be involved in the commissioning and operations of the LHC
 - LAFS is mutually beneficial to CERN and Fermilab
 - We provide CERN with a valuable software service
 - In return, we are trained on LHC control system so that we are poised to make valuable accelerator contributions in the future
- We are involved in several projects
 - Each project has a leader in LAFS and a contact at CERN
 - Prescription
 - Write Requirements Document
 - Get CERN AB-Controls and AB-Operations approval and liaison
 - Work together with CERN folks to design and complete the project

*Membership not restricted to Fermilab employees



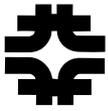
LAFS Projects

- Role-Based Access Control, "RBAC" (Gysin)
Completed and thoroughly integrated in LHC Software Architecture
- Web Fixed Display (Petrov)
Completed
- Beam Diagnostics Applications (McCrorry, Nicklaus, Cai)
Completed:
 - Wire Scanner, Synchrotron Radiation Monitor
 - Diagnostics Applications Library
 - Fitting, histograms, bunch numbering, GUI elements, etcIn requirements/design phase:
 - Residual Gas Monitor, Schottky, Luminosity Mons, Abort Gap Monitor, Tune
- Daemon Infrastructure, "DI" (Gysin)
 - To allow operators, engineers and scientists to create, test and deploy stand-alone processes that can be counted on to run when they are needed.
 - Many Beam Instrumentation applications require a daemon
e.g., Sync Light produces emittance, but must read lattice functions.



LAFS Participants

- Leader: D. McGinnis (AD)
- Project Leaders:
 - S. Gysin (CD), J. Patrick (AD), E. McCrory (AD)
- Other workers (AD, APC)
 - J. Cai, D. Nicklaus, A. Petrov, G. Annala, D. Still, J. Slaughter.
 - T. Bolshakov (left the lab, March 08)
- McCrory at CERN for 2 years:
 - ~100% CERN/LAFS work.
 - Aug 2007 through Summer 2009.



•LHC Beam Participation

- SPS and other Injector Beam Studies
- LARP Instrumentation (possibly with LAFS)
- LHC Commissioning and Beam Studies (especially for luminosity upgrades)
- Informal discussion as to integration into CCC begun (LARP work station); further discussion needed



- **LHC Hardware Commissioning**
 - Keep LHC Project Associates engaged after return
 - US/LARP deliverable monitoring
 - **Schottky, Luminometer?**
 - Discussions in progress
- **LAFS**
 - Continue Applications development



Conclusions

- Fermilab is making important contributions to the commissioning of the LHC
 - Assure proper operation of our deliverables
 - Facilitate overall commissioning and operation readiness for beam and subsequent HEP
- Shift in emphasis from hardware commissioning to beam commission in FY08 as the prospect of beam approaches
 - FY08 ongoing
 - Plans for FY09 being developed this week
 - Use of remote operations centers is a part of this planning



Backups



Cartouche / Cartridge Design

