

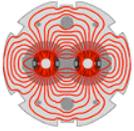
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Lumi Monitor Plans to Complete

A. Ratti

LARP CM11
FNAL, Oct 27-28, 2008

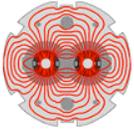


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Introduction



- A very different presentation
 - If you care about technical issues..there is always the web!
- A **very** brief summary of FY08 activities and accomplishments, then planning for completion
- Present the detailed plans to complete the monitors through hardware commissioning
- Includes cost, schedule, risk analysis, contingency
- Beam commissioning plans discussed in instrumentation talk on Tuesday

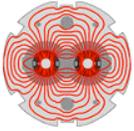


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Accomplishments in FY08



- Recorded first beam on day one
- Delivered four detectors to CERN
- Completed (simplified) gas systems
- Completed phase 1 firmware and software programming
- Systems integration underway

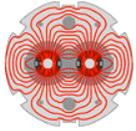


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FY08 Highlights



- HV cables performance
- Reported at CM10
 - Initial design had unexpected leaks
 - Caused noise comparable to actual lumi signals
 - Resulted in the complete redesign of the flange/HV cable assembly

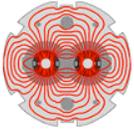


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FY08 Highlights (cont.)



- Recovered from HV cable leaks
 - Now working on integration of PA and Detector
- As we were developing a solution for HV cables, we completed the detectors
 - Two shipped and installed in LHC in Spring
 - Adequate for low luminosity run in 2008
 - Must be retrofit to match final design
 - Balance (2 more) at CERN ready for installation
 - New configuration completed in September

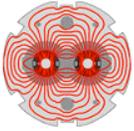


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CERN's Position



- Bravin's memo - June 1
 - CERN procured and installed a PMT based system for 2008 run
 - LBNL/LARP should focus on making sure ionization chambers are ready in 2009
 - Devices have to be installed and commissioned by day one of the 2009 run
 - CERN will monitor very closely
 - Control systems support limited by beam commissioning priority

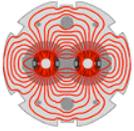


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LARP's Response



- Will deliver by July 2008:
 - ✓ Two gas systems - done
 - ✓ One complete detector - done
 - ✓ Firmware and software for phase I - done
- By December 2008:
 - Balance of hardware
 - Two more detectors - done (modifications pending)
 - All electronics - in progress
- Start regular communications through ASAC

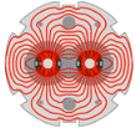


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Installation and Integration in LHC



- After Sep.10 LHC conditions are now different
 - Tunnel access now much more limited
 - No early beam results
 - Extent of the shutdown and startup not yet known
 - Warmup and bakeout?
 - Uncertainty in LHC schedule
 - Will schedule our activities accordingly
- Detector installation
 - Two installed systems need retrofit + two additional systems ready to install
 - Will complete well in advance of 2009 startup as LHC access permits

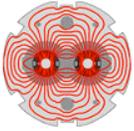


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Project Structure



- 1 Lumi Project
 - 1.1 Systems Production
 - 1.1.1 Electronics @ LBNL
 - 1.1.2 Gas Systems Upgrades
 - 1.1.3 Detector Upgrades
 - 1.1.4 DAQ System
 - 1.2 Integration Tests @ LBNL
 - 1.3 Hardware Commissioning at CERN
 - 1.4 DAQ Integration with CERN Software
 - 1.5 Physics Studies
 - 1.6 Documentation
 - 1.7 Project Oversight

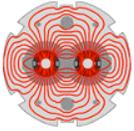


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1.1.1 - Analog Electronics



- Pre-Amps Production
 - Shield board
 - Signal board
 - HV board
 - Relay board

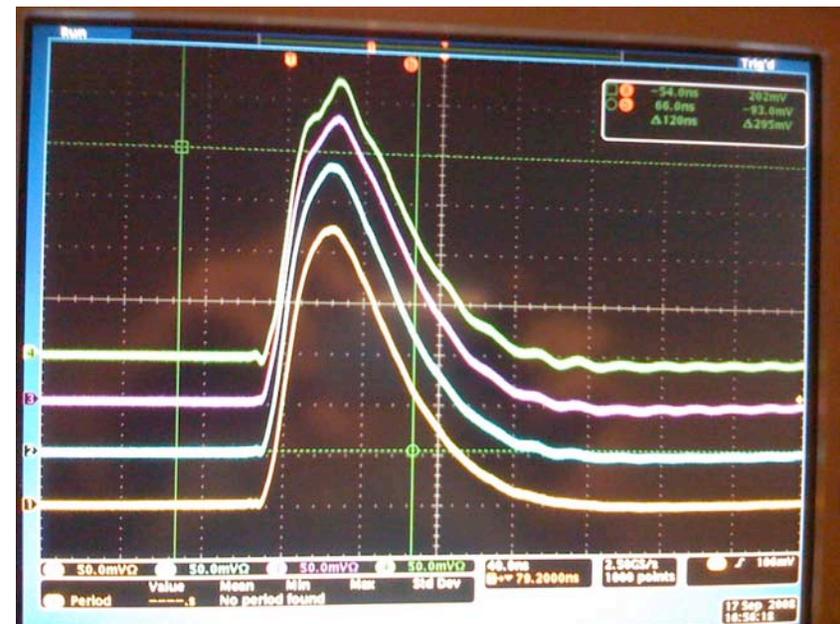
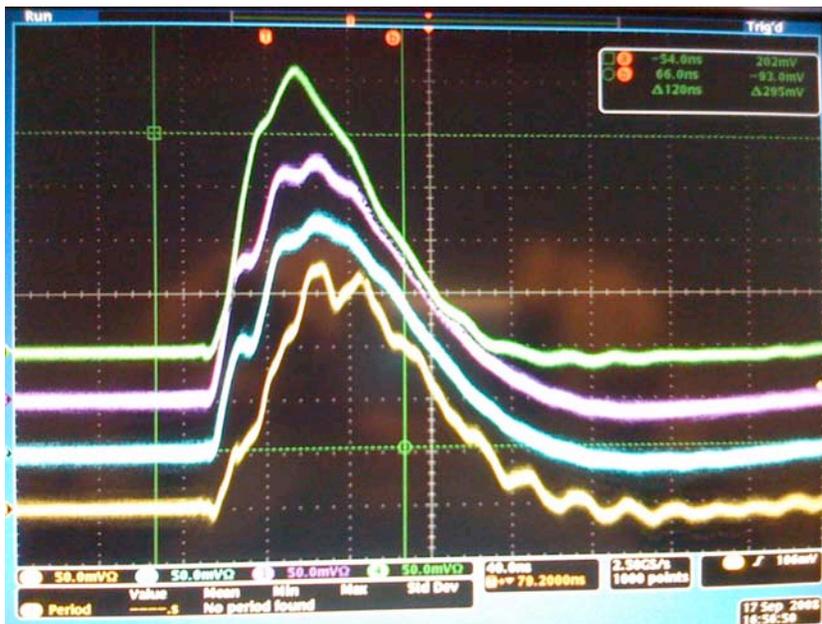


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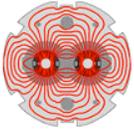
1.1.1 - Detector-PA Integration



- Detector - Pre-Amp studies
 - Understand interdependencies
 - Optimize configuration



Test pulse - with and without load (detector)

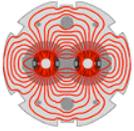


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1.1.1.2 - PA Production

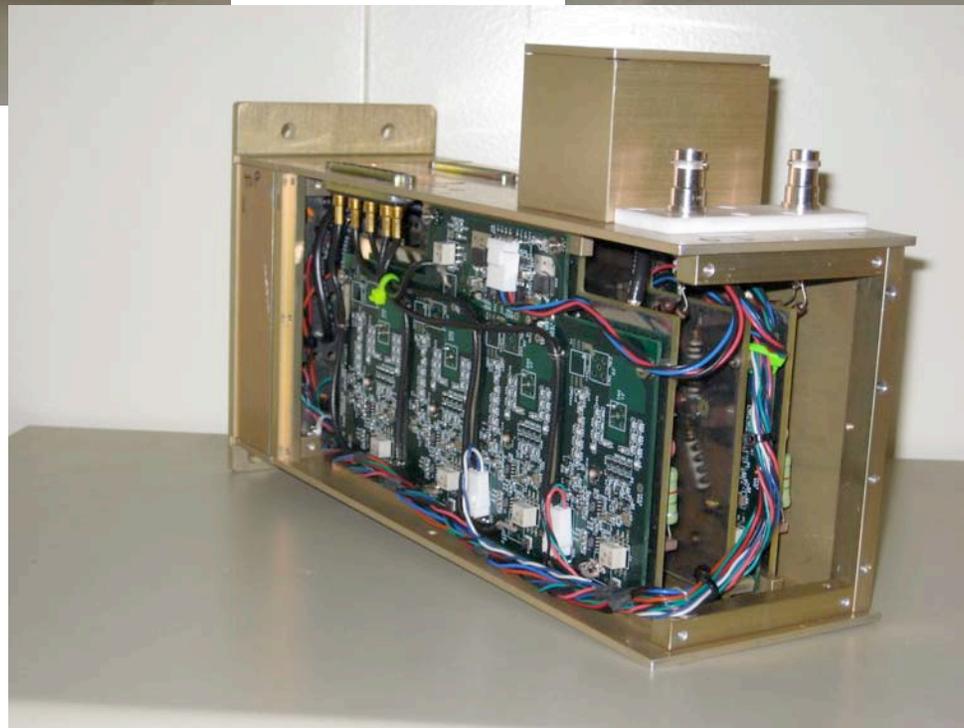
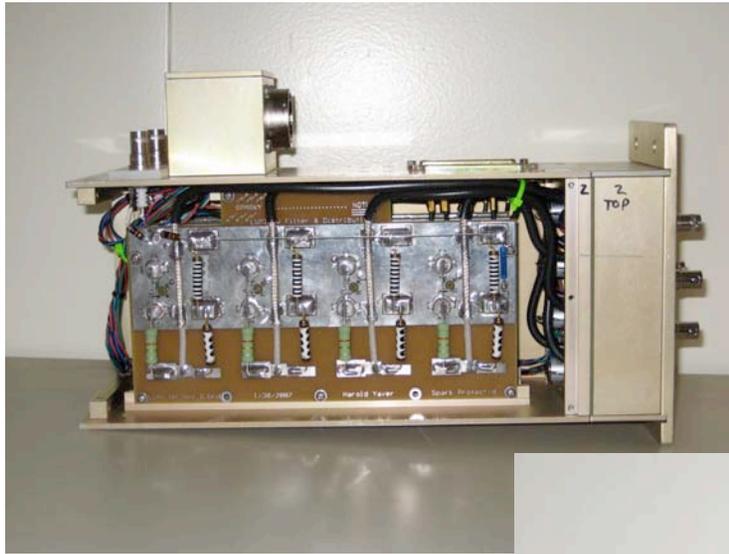


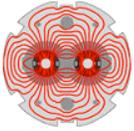
- PA Assembly process
 - PA board loaded by vendor
 - Load HV board
 - Mate HV board to PA board
 - Fab and mount shield board
 - Connect HV relays board and compartment
 - Wire 28 pin Burndy connector
 - 4x2 DC bias supplies, 3x3 RTD signals, 4+2 Relay selector bias, 5 BJT damage
- All parts at LBL (need shield boards)
- Several cleaning steps and slow soldering of ground shields to maintain HV performance
- 6-8 days per unit



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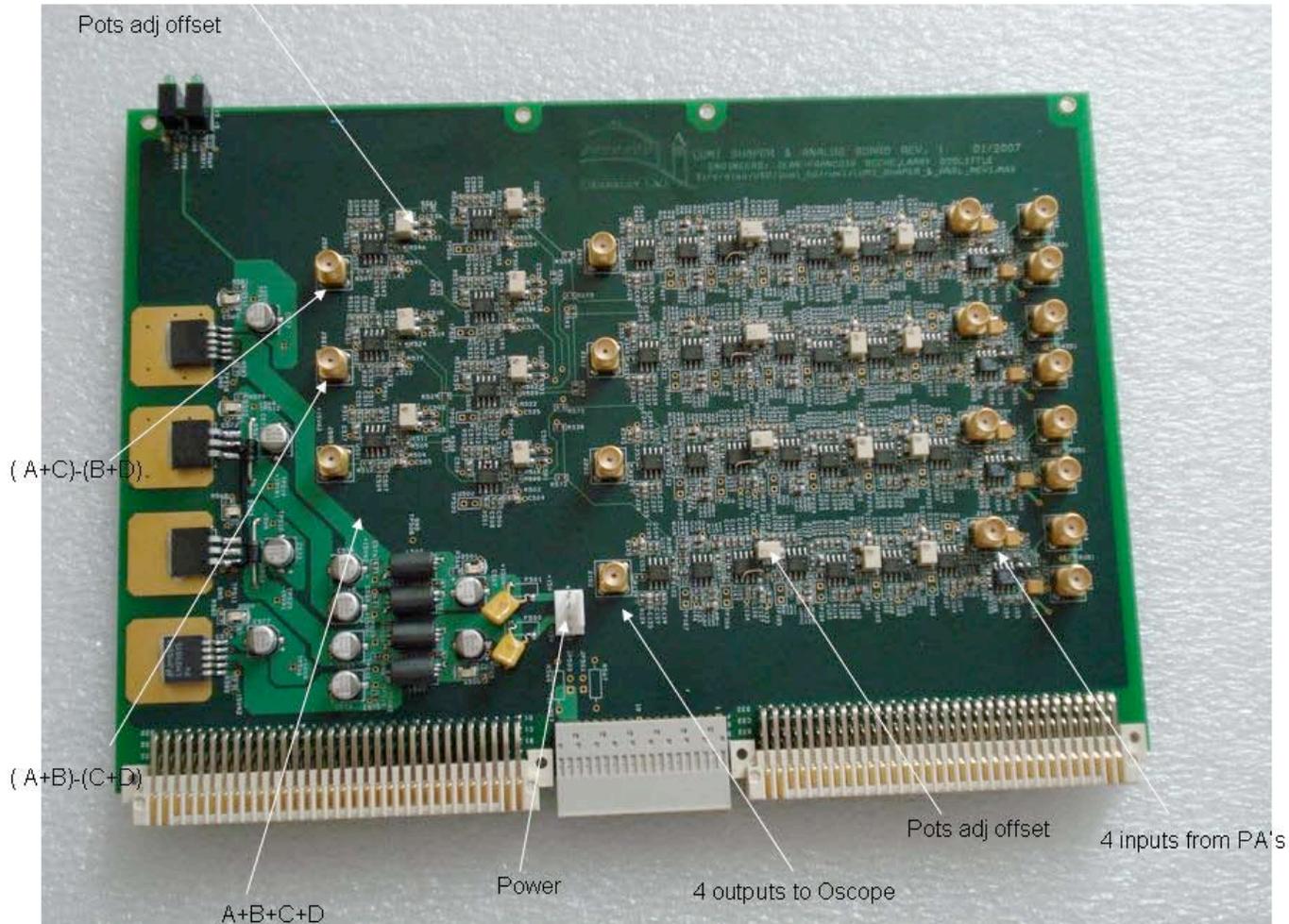
1.1.1.2 - PA Assembly

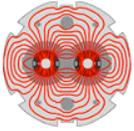




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1.1.1.3 - Electronics - Shapers



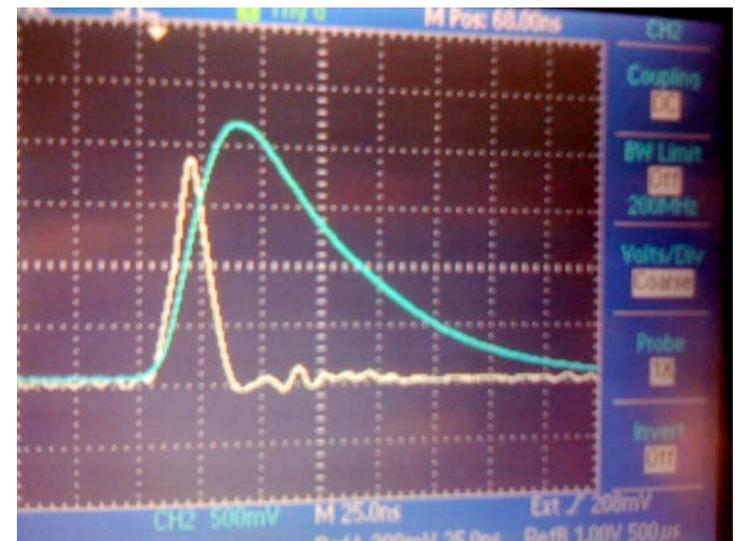


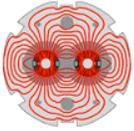
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1.1.1.3 - Pre-Amp Shaper Integration



- Pre-Amp Shaper studies
 - Optimize => minimize peaking time
 - Package shaper in shielded box
 - Study interaction with PA
 - Study/measure effect of long cable



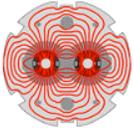


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1.1.1.3 - Shapers - Plans



- Package in separate chassis
 - Control noise and interference
 - Does not require VME installation
 - Needs independent power supply
- Bench test and integrate with Pre-Amps
- Need 2 per IP, 4 total
 - Will assemble one spare



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1.1.1.4 - Supporting Electronics

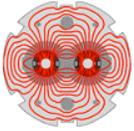


Racks are ready in both counting rooms

- CERN installed:
 - VME crates
 - BOBR board for orbit clock
 - Network hub
 - Cable patch panels for semi-rigid cables
 - DC ps for shapers
- LBL adding:
 - Boards and modules
 - Local readout points
 - Distribution system to share signals



IP1 Rack

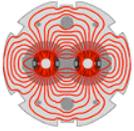


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1.1.1.4 - Electronics - Racks



- Detector Interface Chassis
- Cabling
 - by CERN
- Equipment (procurement)
 - Scopes
 - Linear Power Supplies (from CERN's stores)
 - 1 15V 1.5A Supplies
 - SCEM code: 07.61.24.150.7; CNB: CN5-151.5-CERN-V-CAP
 - 4 $\pm 15V$ Supplies
 - SCEM code: 07.61.24.160.5; CNB: CN5-D151-CERN-V-CAP
 - 1 5V 2.5A Supply
 - SCEM code: 07.61.24.130.1; CNB: CN5-52.5-CERN-V-CAP
 - Shaper Power supplies - 6V, 0.5A

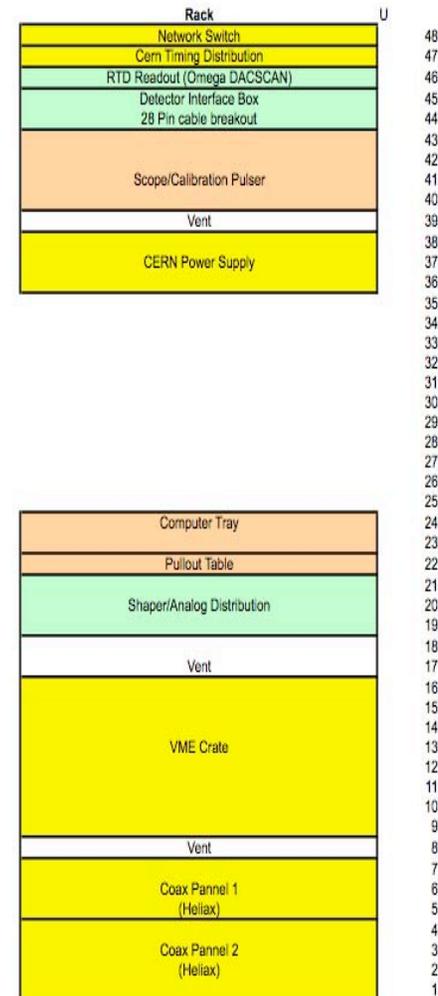


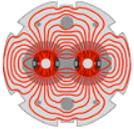
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1.1.1.4 - Rack Layout



- CERN provided (Yellow)
- LBL Provided (Green)
- Purchases - by LBL (Tan)





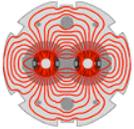
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1.1.1.4 - Detector Interface Chassis



Functions:

- Power 2 Preamps
- Read Preamp/Detector RTDs
 - through Omega DACScan
- Control Preamp Relays
 - through Omega DACScan and front panel
- Measure Preamp Supply voltages and currents
 - through Omega DACScan
- Front panel Test Points for Preamp supply voltages and currents
- Power selector switches in the preamps



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1.1.1.4 - Detector Interface

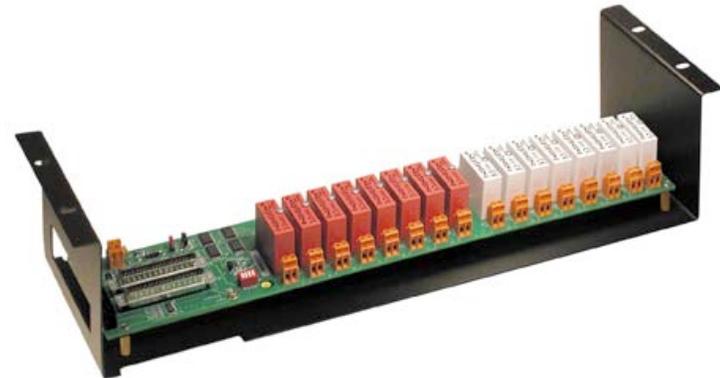
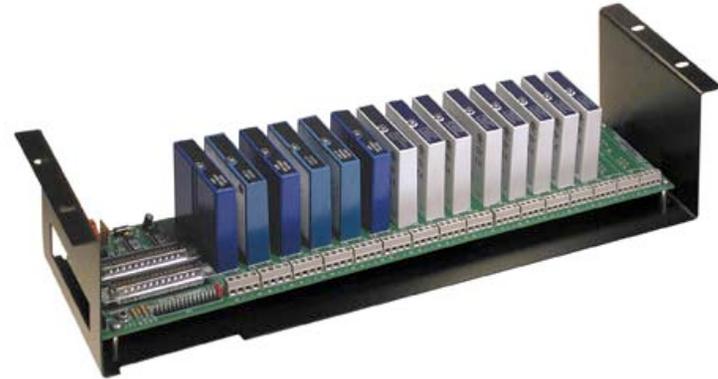


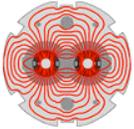
Signal Conditioners:

- OM5-IP-100-C
 - Temperature
- OM5-IV-20A-C
 - Supply Voltage
- OM5-IV-1A-C
 - Supply Current (Voltage across 1 Ohm shunt)

- OMB-DBK207 - Analog Interface
- DCI5-C
 - Digital Input
- DCO5-C
 - Digital Output

- OMB-DBK208 - Digital Interface





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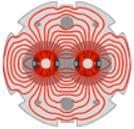
1.1.1.4 - Detector Interface Controller



- Provides Analog I/O, Digital I/O and Frequency I/O to Ethernet-Based Systems
- All I/O Can Be Synchronous, Enabling Precise Timing Between Various I/O Functions
- 8 Differential or 16 Single-Ended Inputs, Expandable up to 256 Voltage or 896 Thermocouple Channels Using Signal Conditioning and Expansion Options
- Up to 40 Built-In TTL-Level Digital I/O, Expandable Up to 256 Channels of Isolated I/O Using Low-Cost Isolation Modules
- Includes Support for Visual Basic, C/C++, ActiveX/COM, LabVIEW, MATLAB and DAS



OMB-DAQSCAN-2005

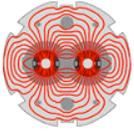


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1.1.2 - Gas Systems



- Systems were built, shipped and installed
- A few action items
 - Add repaired flow meters
 - Continue testing control software
 - Add sensors on hi pressure supply line
 - Perform pressure test by CERN/LHC compressed gases group
- All work must be done on site at CERN
 - Only some software studies at LBL



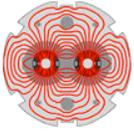
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1.1.3 - Detectors



- Modifications required to installed units
 - Add glass tubes
 - Add ceramic tubes
- Must follow assembly procedure almost from the beginning



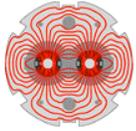


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1.1.3 - Detector High Voltage Testing



- Once mounted in pressure vessel
- Pressurize to 10 atm absolute
- Connect pre-amp
- Gradually ramp to 2.2kV
- Monitor each channel for leaks
 - Up to 10/min allowed
 - Test Pre-Amp alone first
- Procedure to be repeated after installation

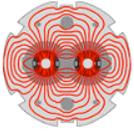


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1.1.4 - DAQ System



- All DAQ hardware in the racks
 - Provided by CERN
- Firmware programming by LBNL
 - In two phases
- Software
 - Local LabVIEW by LBNL
 - FESA class by CERN

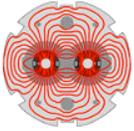


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1.1.4 - Phase II DAQ programming



Existing interface panel (LabVIEW)

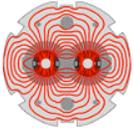


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1.1.4 - DAQ Development



- Adopted firmware infrastructure from AB/BI group
 - Environment successfully imported at LBNL
 - Much easier for CERN to import in FESA
 - LBL found most infrastructure work done
- Memory map defined
 - official interface between the LabView system from LBNL and the LHC control system
- Effort included in LAFS
 - Help from Elliott McCrory (FNAL at CERN for LAFS) to integrate in the control system
 - AB/CO to deliver FESA class interface



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1.1.4 - DAQ Phased Development

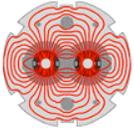


FY08 - Phase I

- Programming environment
 - Crate operation and I/O
- Counting mode
- Stacking

FY09 - Phase II

- Pulse height mode
- Deconvolution
- Crossing angle
- Requires $L > 5 \cdot 10^{32}$ for beam commissioning
 - 25 ns bunch spacing
 - Nominal bunch intensity
 - Collision multiplicity > 1
 - β squeeze



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1.2 - Integration Tests @LBNL

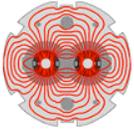


1.2.2.1 - Detector --> PA integration

1.2.2.2 - Shaper --> Detector-PA integration

1.2.2.3 - DAQ integrated testing

1.2.3 - Test spare detector at ALS

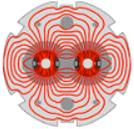


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1.2.3 - Detector Testing @ ALS



- Since LHC beam returns in 2009 we plan to test the (spare) detector @ ALS BTS line
 - Validate new cable configuration on ALS beam
 - Test cable performance with high intensity signals
 - Infrastructure available from previous test
 - 2 axis table, gas lines, signal lines
 - Important to coordinate with analog electronics integration
 - Only one spare available

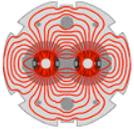


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1.3 - Hardware commissioning @ CERN



- **Systems installation at CERN**
 - Detector Controller Chassis
 - All rack equipment
 - Cabling checkup and calibration
- **Detector installation**
 - Electrical lab tests
 - Gas pressure lab tests
- **Complete QA check lists**

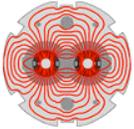


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1.4 - Software integration



- CERN will provide final software
 - System FESA class driver
 - Expert control panel
- No dedicated panel needed in the CCC
 - Only transfer lumi data through DIP at 1 Hz
- LabView software from LARP to operate the system
 - Will be replaced by final system when ready

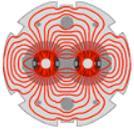


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1.5 - Physics Studies



- MARS/Fluka modeling
 - In support of the ongoing systems development
 - In preparation for LHC beam operations
- SPS and other beam test data analysis
- DAQ programming support
 - Specification and testing

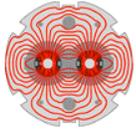


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1.6 - Documentation



- While Eric and Tom asked to not spend any money on documentation in FY09, we need to find a way to deliver to CERN the appropriate documents
- Will have detailed schematics of what we're building
- Will need to produce
 - system drawings
 - operating guides
 - As-built mechanical drawings

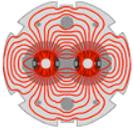


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1.7 - Project Support



- Project management
- Admin and budget support
- Travel
- Shipping

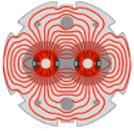


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Cost Control Measures in FY08



- Offset negative impact of HV cables
- Scope reduction
 - Gas system - reduced functionality
 - Online radiation damage monitoring - removed from system
- Delayed tasks
 - Shaper Integration - to FY09
 - Pre-Amp Production - to FY09

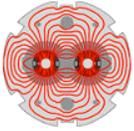


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Complete Risk Analysis



- Completed a traditional full risk analysis
- Identified and analyzed ~20 areas of risk
 - Technical
 - Cost, schedule and management
- Estimated impact
 - Probability, cost and schedule
- Corresponding calculated contingency - \$186k
- Schedule impact could also be calculated
 - Between 0.5 and 12 months if
 - all activities were uncorrelated
 - Only a few actually occur



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Risk Analysis - Pre-Amp



Work Area: Technical - Pre-Amp

Risk: Speed, Impedance match

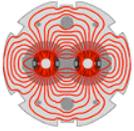
Probability: 50%

Cost Impact: 10k

Schedule Impact: 0.5 months

Notes:

Earlier bench measurements have shown effects of mismatches on calibration signals. In addition, some of the measured waveforms are slower than those in previous versions. If this is confirmed to be a problem, it should be possible to resolve it with component changes and fixes to the existing boards



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Risk Analysis - Shaper



Work Area: Technical - Shaper

Risk: Oscillation

Probability: 30%

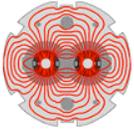
Cost Impact: \$70k

Schedule Impact: 2 months

Notes:

Preliminary tests show oscillation could occur in some of the channels.

This could have a simple fix (ie. addition of a compensating resistor), or could lead to the need of more extensive rework.



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Risk Analysis - Detector



Work Area: Technical - Detector performance

Risk: Final coaxial cable configuration performance

Probability: 15%

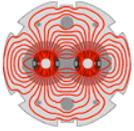
Cost Impact: \$50k

Schedule Impact: 3 months

Mitigation: ALS test

Notes:

The final configuration of the coaxial cables insulation has not been tested with beam. If we have problems, we could have to rework the configuration (different insulation, adjusted dimensions for better impedance...).



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Risk Analysis - Shipping



Work Area: Technical - Installation and Hardware Commissioning

Risk: Shipping damage

Probability: 5%

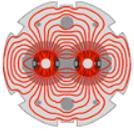
Cost Impact: \$60k

Schedule Impact: 3 months

Mitigation: spares

Notes:

Problems in shipping could cause damage to components or even their loss or permanent damage



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Risk Analysis - Physics Studies



Work Area: Technical - Physics studies

Risk: System's operation harder to understand than anticipated

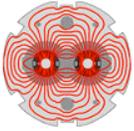
Probability: 30%

Cost Impact: \$60k

Schedule Impact: 6 months

Notes:

Understanding the experimental conditions of the system (backgrounds, beam-gas interactions, effects of ZDCs, nearby collimators....) could be harder than anticipated.



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Risk Analysis - Management



Work Area: Cost, Schedule, Management

Risk: Additional reporting required

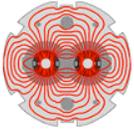
Probability: 25%

Cost Impact: \$40k

Schedule Impact: none

Notes:

There is the potential that someone will request more frequent or detailed reporting to track progress than planned. In the event, we'll need to add project controls staff. No impact on schedule



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Risk Analysis - Staffing



Work Area: Cost, Schedule, Management

Risk: Availability of necessary personnel

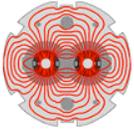
Probability: 15%

Cost Impact: \$20k

Schedule Impact: 2 months

Notes:

There is risk that some of the required personnel becomes unavailable. In case, additional staff will need to be identified, assigned and trained.



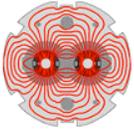
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Risk Analysis - Other



- Other areas include
 - Management, cost and schedule
 - Currency exchange fluctuations
 - Procurement delays
 - Safety accident

 - Technical
 - Detector degradation with time/radiation
 - Long term system stability and operations
 - Firmware development harder to complete

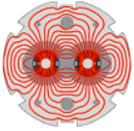


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Cost Estimate



- LBL actual FY09 rates directly related to the staff assigned to the tasks
- Used off-site rates for those with extended travel
- All costs include corresponding overhead
 - Travel, materials, and shipping
 - Labor

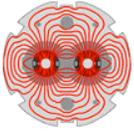


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Major Milestones



- Dec 18, 2008
 - Ship Rack Electronics
- Jan 31, 2009
 - Ship Preamps and Shapers
 - Complete Detector Installation
- March 4, 2009
 - Hardware installation tested with scopes
- April 1, 2009
 - Hardware + Software installation complete
 - All systems ready for LHC beam
- Sep 20, 2009
 - DAQ Phase II complete

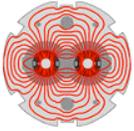


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Contingency Analysis



- Itemized by task
- More risk associated with unknown items
 - those depending upon the LHC schedule
 - Higher technical risk
- Overall contingency of ~26%, \$182k
- Very good agreement with risk analysis assessment



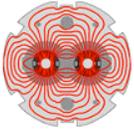
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Effort Summary



- Total 4400 hours
- About 2.4 FTE
- Beam commissioning support request made separately

| | |
|---------|-----|
| Phy | 298 |
| Phy-Off | 127 |
| PostDoc | 622 |
| EE6 | 241 |
| EE6-off | 166 |
| EE5 | 430 |
| EE3 | 723 |
| EE2 | 700 |
| Tech | 689 |
| Budget | 202 |
| Admin | 202 |

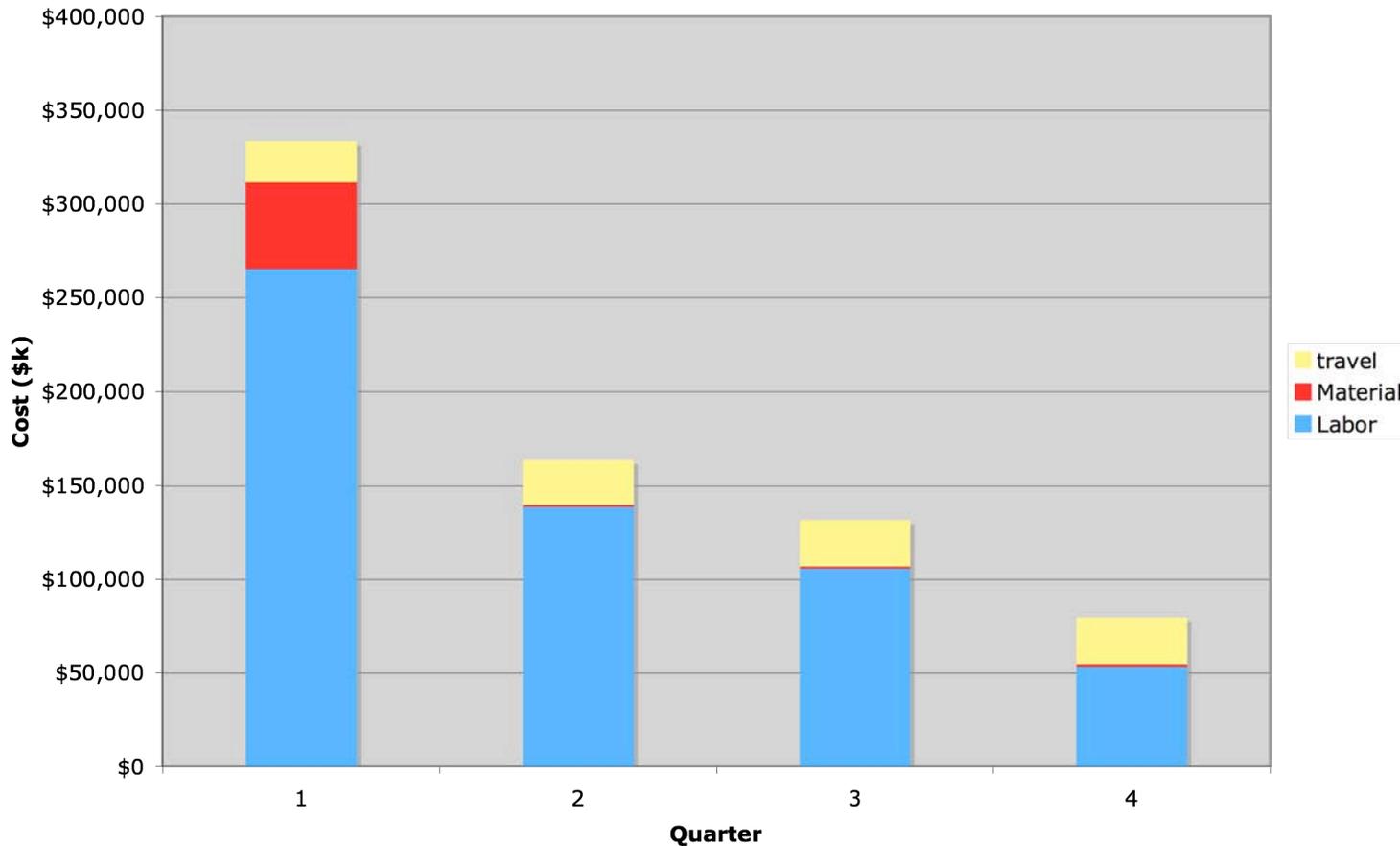


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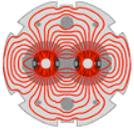
Project Cost by Quarter



Lumi Project by Quarter



70% of budget spent in Q1 and Q2

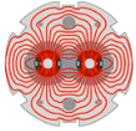


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Comments



- It is essential that LARP carries out the systems commissioning with beam
 - The requirements on systems performance drastically change with LHC operating modes
 - Very unlikely that the LHC will reach full luminosity in FY09 (Sep. 2009)
 - Potential tasks for Toohig fellow or postdoc
- CERN involvement in 2009 will be essential to the smooth operation of the device in the future
 - Full hardware handover will be completed in 2009

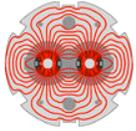


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Handoff to CERN



- CERN has been involved with many aspects of systems
 - Increased presence since 2007
 - Contributions to detector rework and optimization
 - Gas systems installation and commissioning
- Inviting CERN to participate to Berkeley activities (visit in Nov.-Dec.)
 - Beam test at ALS --> detector operation
 - Bench test of DAQ phase I firmware
 - Analog electronics modules production and testing
 - pre-amp and shaper
- Plan to continue during installation and HW commissioning at CERN
- Continue CERN's involvement in firmware development during phase II programming

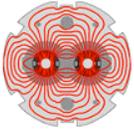


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Summary



- Estimated the project through completion
 - \$708k
- Contingency estimated in two independent ways
 - 26% of TEC
- Identified critical path
 - Shaper production
 - Phase II firmware
- Added resources to meet LHC shutdown schedule



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Conclusions



- We overcame a significant technical problem
 - Delivered all auxiliary systems as promised
 - All detectors at CERN for final installation
- We presented a detailed budget and schedule with contingency to the completion of the construction project
 - Contingency will be held at LARP
- We have identified the resources to execute this plan as described
- We depend upon LHC schedule to be able to complete the task