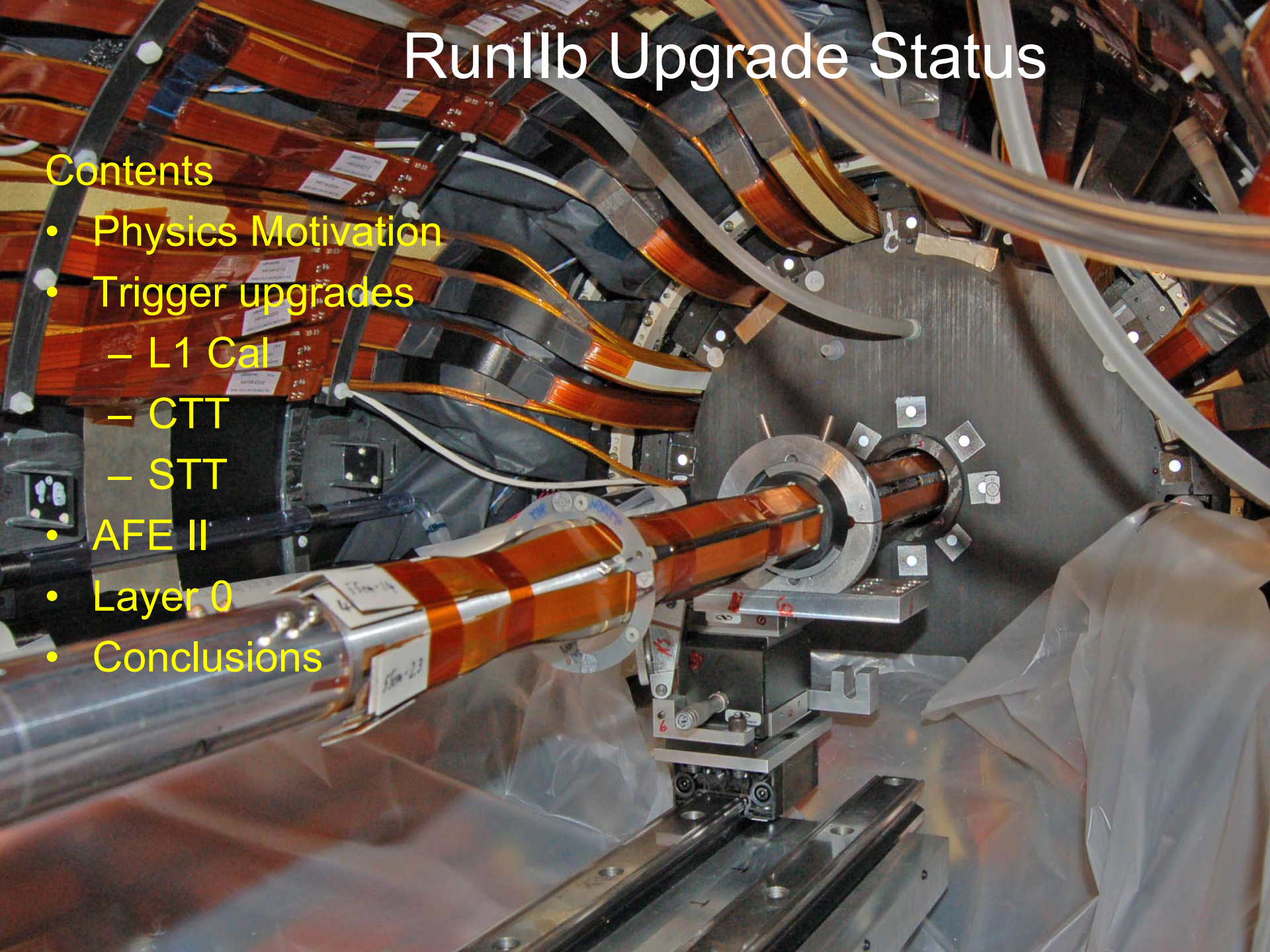
RunIIb Upgrade Status



Contents

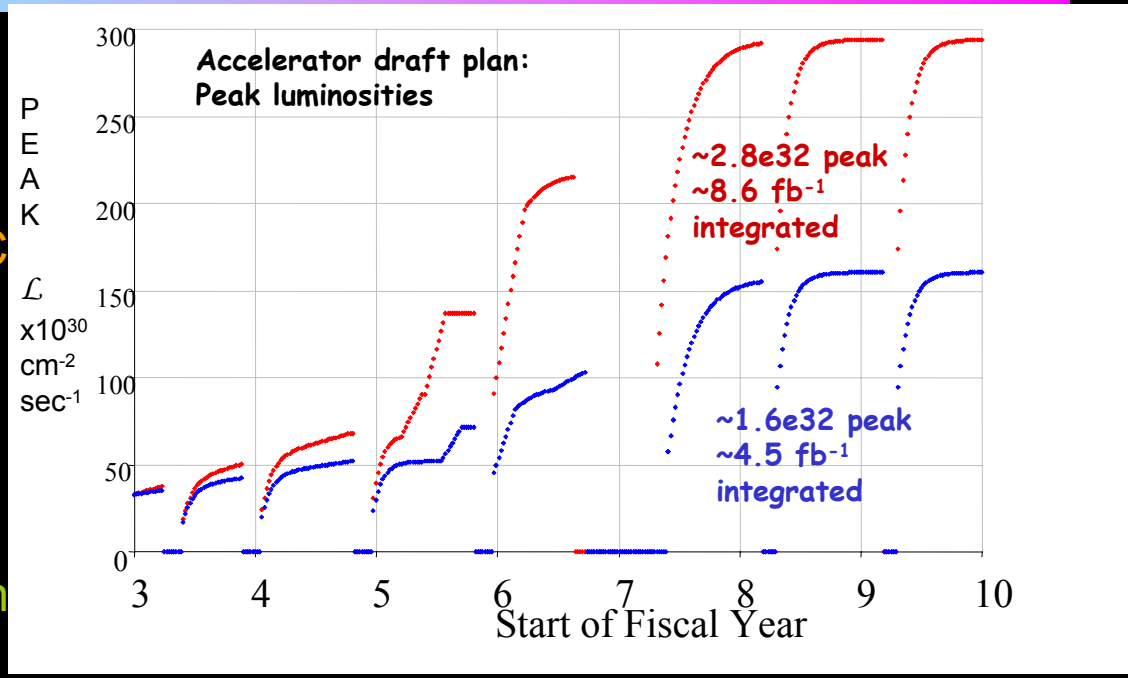
- Physics Motivation
- Trigger upgrades
  - L1 Cal
  - CTT
  - STT
- AFE II
- Layer 0
- Conclusions

RunIIb

RunIIb will be about precision physics. We need to maintain detector performance in a high luminosity environment until 200LHC

- Average of 7 int. per crossing at $2x10^{32}$ (no 132 ns running)
- Significant radiation damage to silicon inner layer expected
- Many trigger rates scale faster than luminosity – trigger =physics in hadron colliders

- Trigger upgrades
  - L1cal, CTT, L2 STT, L2, L3
- Detector performance upgrades
  - AFEII (fiber tracker readout replacement)
  - Layer 0 detector



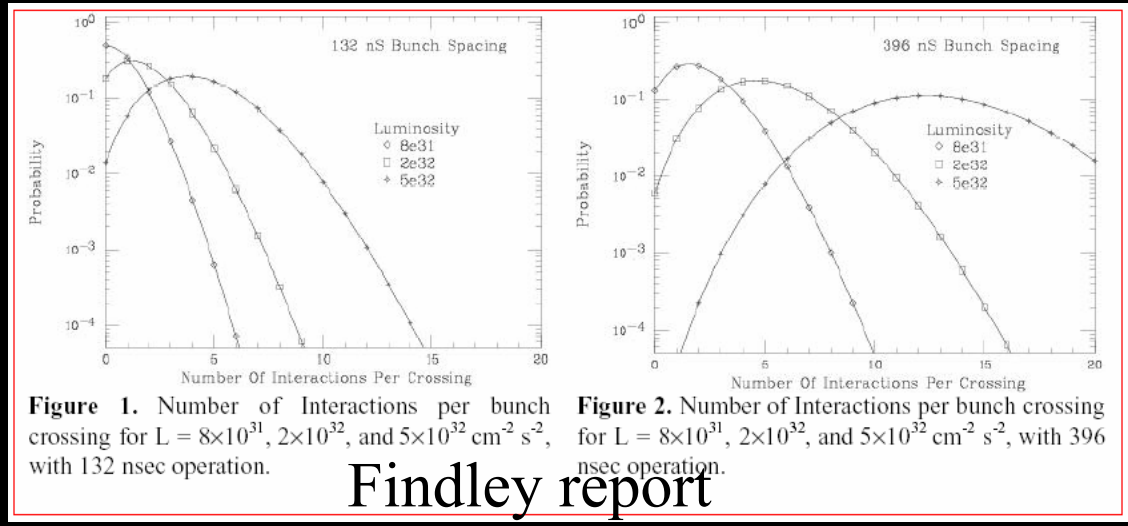
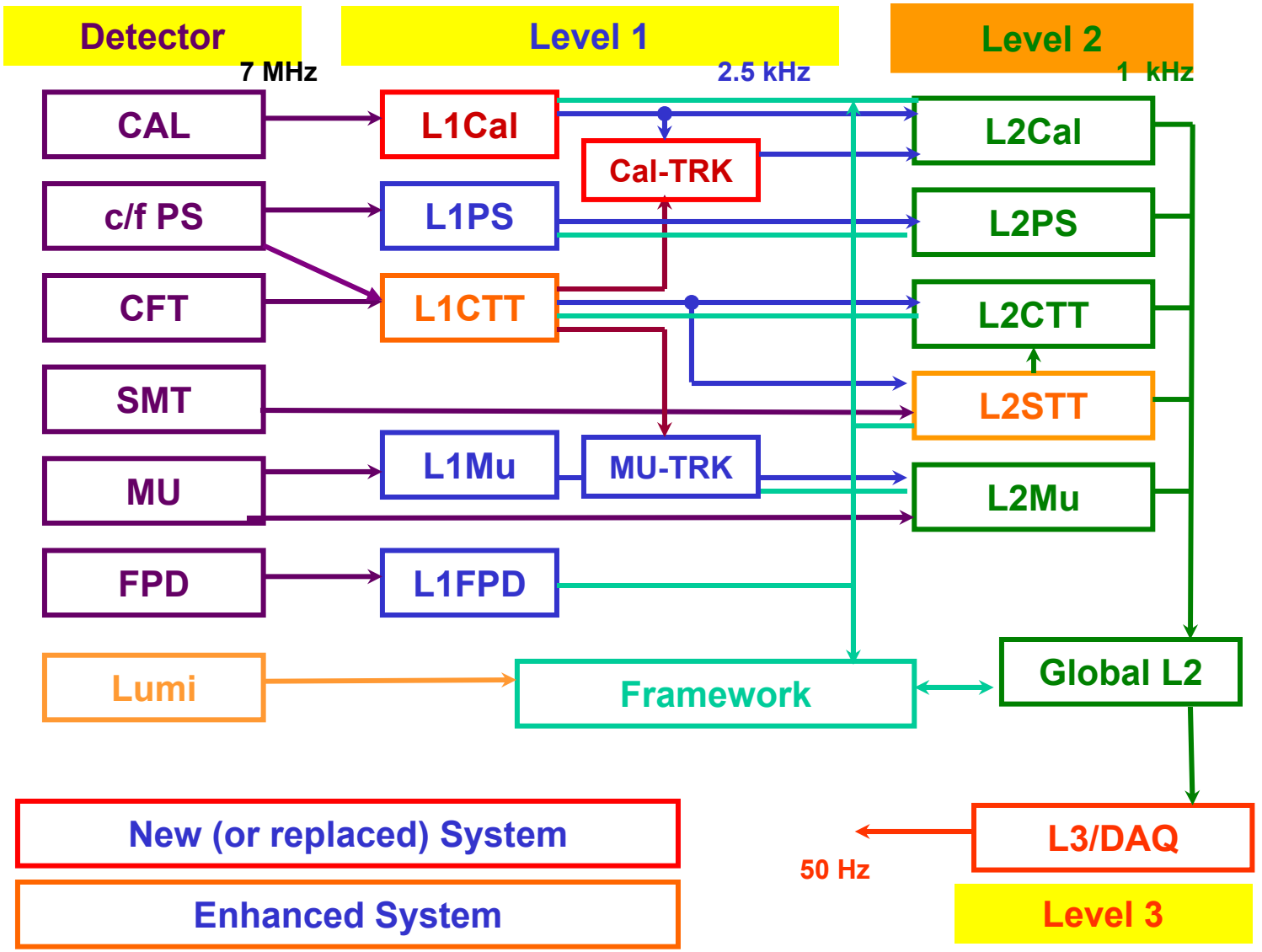


Figure 1. Number of Interactions per bunch crossing for L = 8×10^{31}, 2×10^{32}, and 5×10^{32} cm^{-2} s^{-2}, with 132 nsec operation.

Figure 2. Number of Interactions per bunch crossing for L = 8×10^{31}, 2×10^{32}, and 5×10^{32} cm^{-2} s^{-2}, with 396 nsec operation.

Findley report

Trigger Upgrades



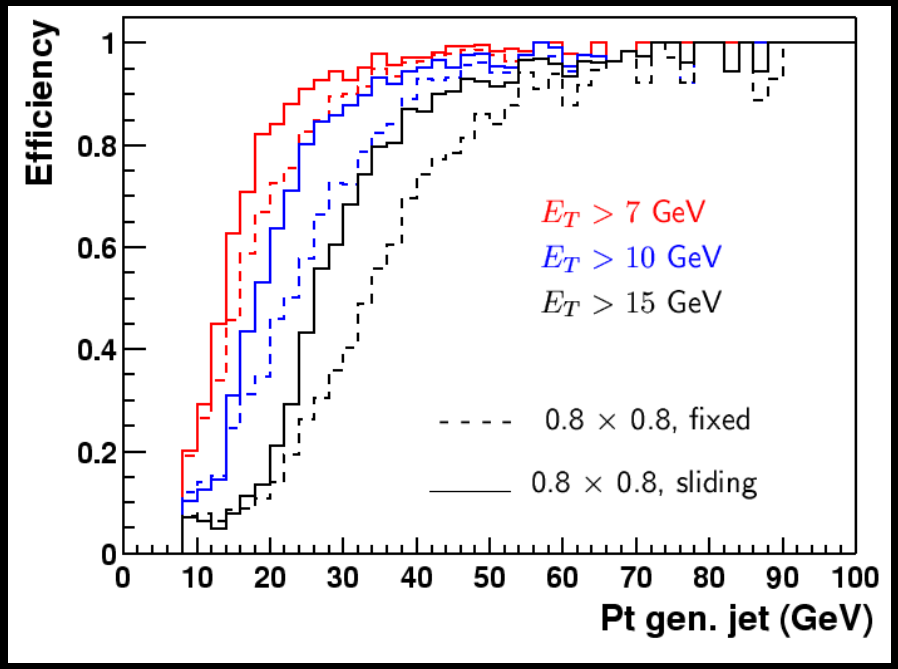
Trigger Upgrade Elements

The DØ Trigger Upgrade consists of

- Complete replacement of Level 1 calorimeter trigger (L1CAL)
  - Sliding windows algorithm for calorimeter object finding
  - More efficient, sharpens turn on curves, topological triggers
  - Feeds L1 Cal Track Match
- Replacement of the DFE's (track finding modules) in the Level 1 Central Track Trigger (CTT)
  - Larger FPGAs allowing singlet equations
  - Holds down rate in high occupancy environment
- A new Level 1 system to match calorimeter objects and tracks (L1caltrack)
  - Uses signals from L1Cal and L1CTT
- Upgraded/additional processors for Level 2 (L2β)
- Incorporation of (new) Layer 0 into the Level 2 Silicon Track Trigger (L2STT)

These are all done and installed and are being tested

Calorimeter Level 1



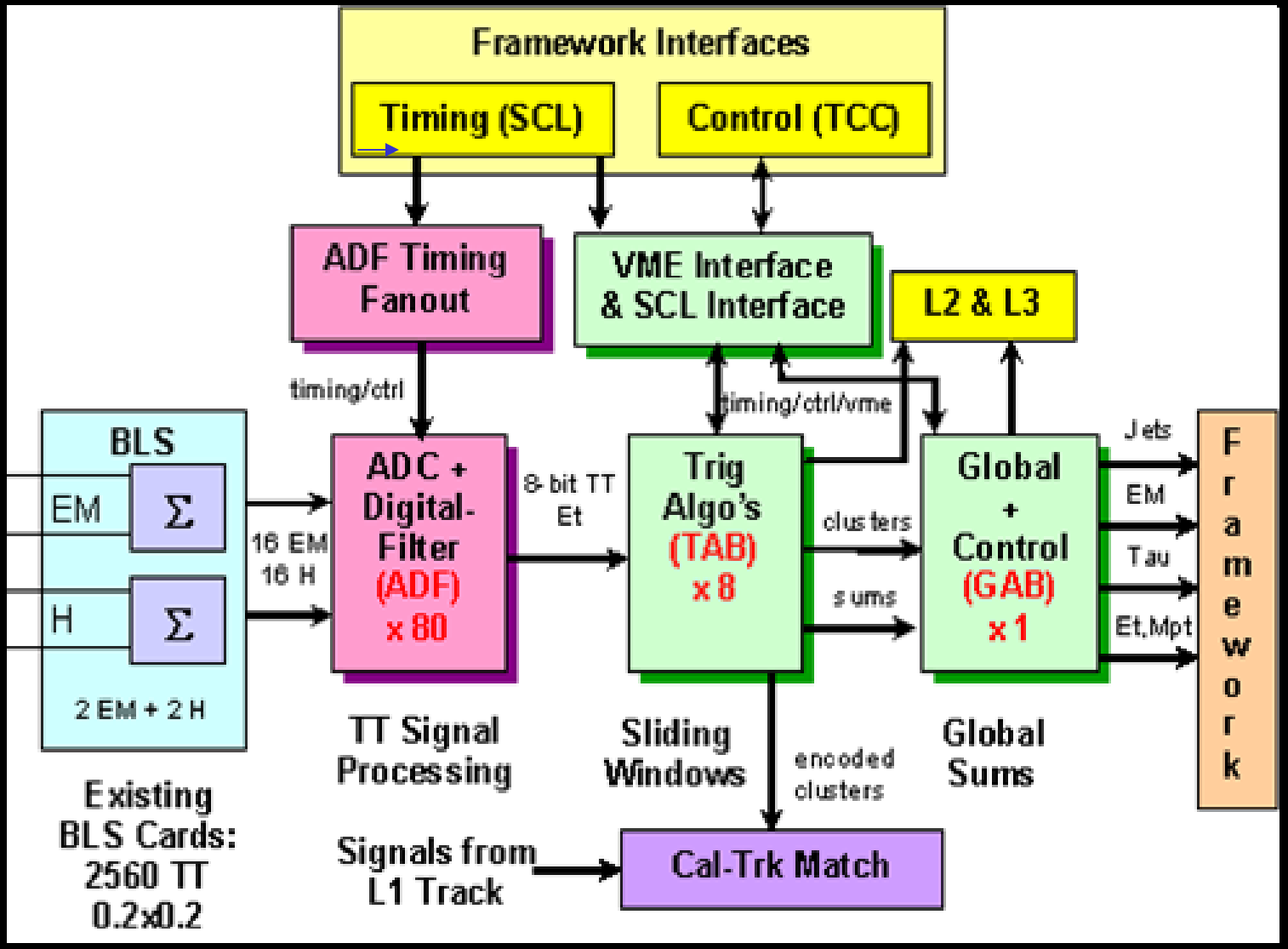
Convert from an analog-based to a digital system

- sharpens trigger thresholds
- more flexible topological cuts
- Requires removal of old trigger hardware

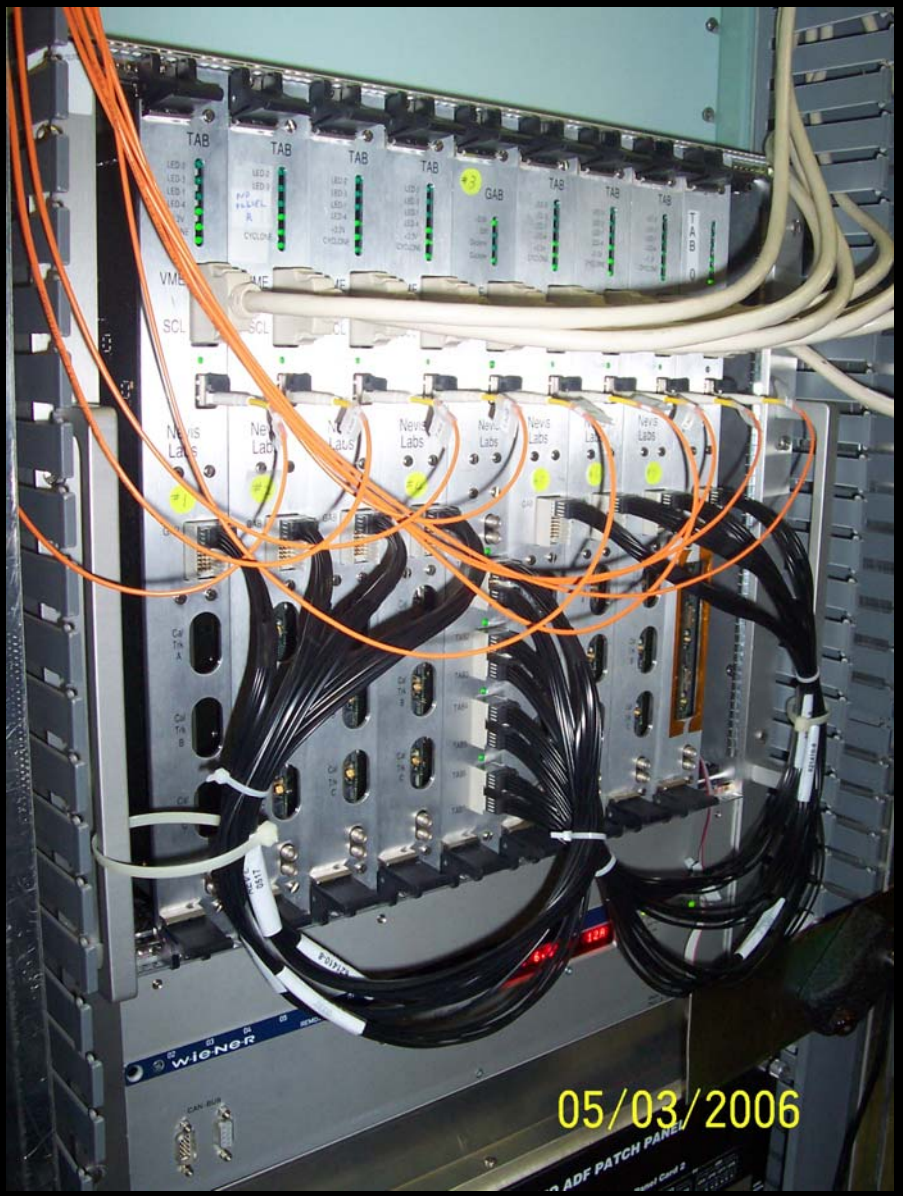
Cal-Track Match

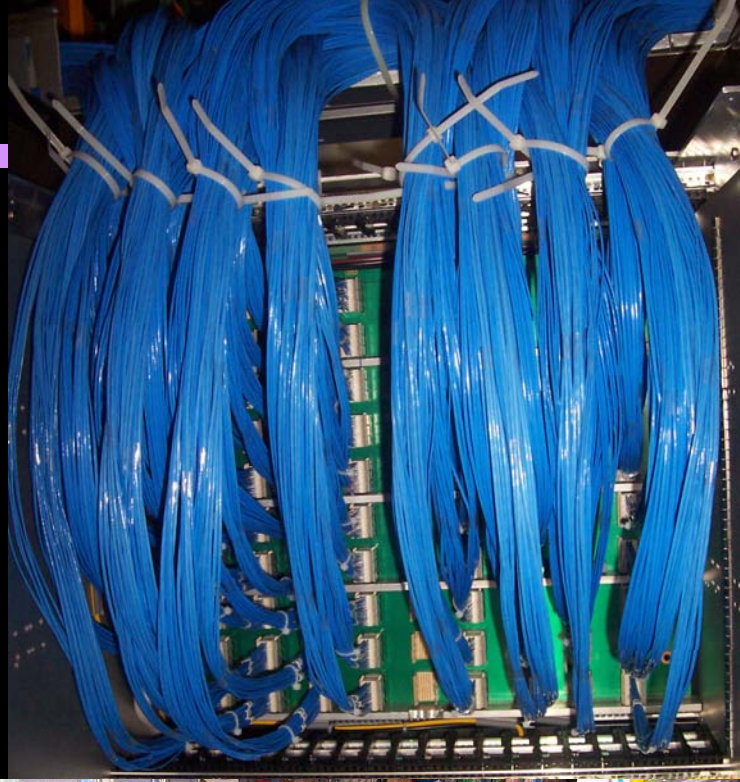
- Exploit new L1Cal trigger
- Improve Run IIa ϕ matching granularity x8
- Needed in triggers for Higgs searches
  - electrons in WH and H $\rightarrow$ W*W modes
  - taus in H $\rightarrow \tau\tau$ and H$^+ \rightarrow \tau\nu$
- Fake EM rejection is improved by ~x2, fake τ rejection is improved by ~x10
- Very modest upgrade modeled on existing Mu-Track match system
  - Very few changes with respect to Mu-Track

L1 Cal Trigger

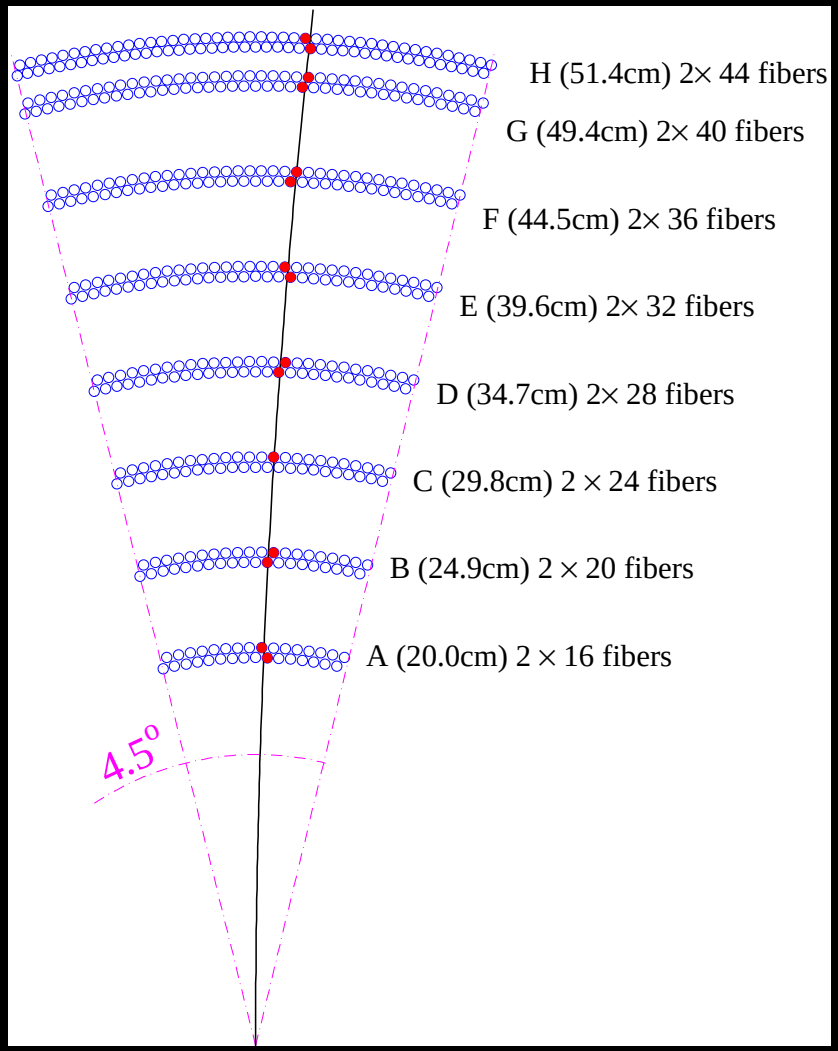


L1 Cal Installation





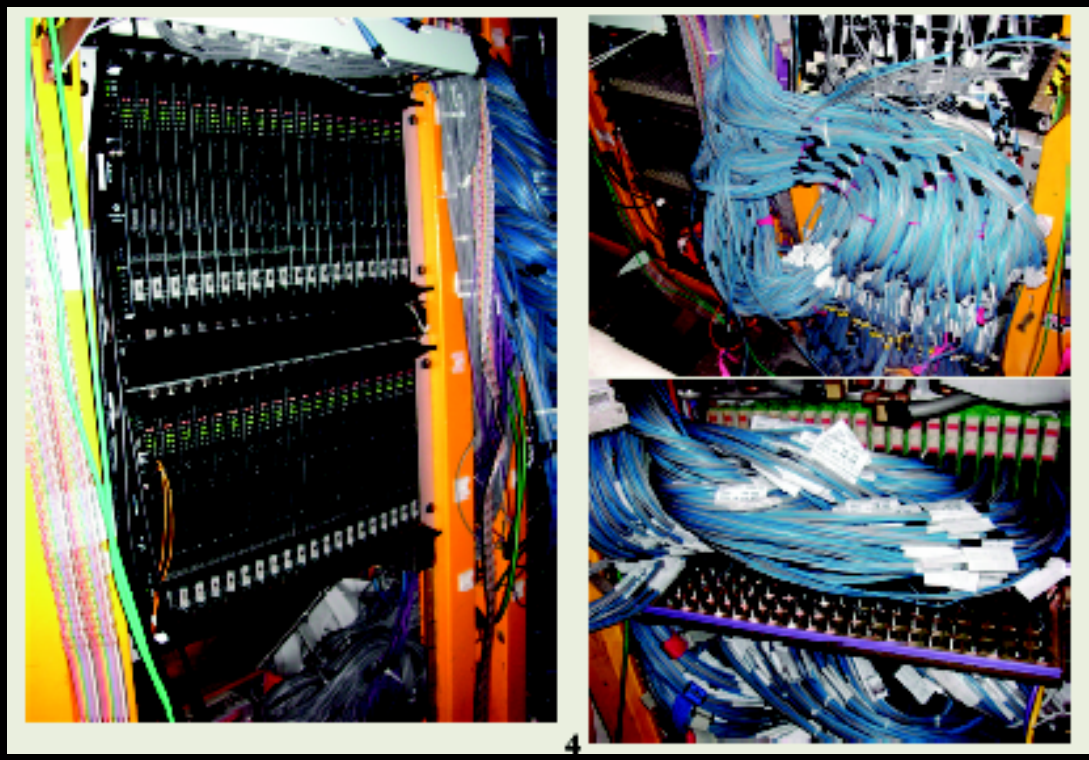
L1 CTT



- Level 1 Central Track Trigger (CTT) essential for electrons, muons, taus ($WH \rightarrow l\nu jj$)
- Tracking trigger rates very sensitive to occupancy
- Upgrade stategy:
  - Use new large FPGAs to provide flexible triggering
  - Narrow tracker roads by using individual fiber hits (singlets) rather than pairing adjacent fibers (doublets)
  - Calorimeter-track matching at L1

CalTrack, CTT Installation

Cal-trk match boards



DFE boards installed on the platform

To do

- Final cabling and ORC
- Connect and test CTT outputs at L1caltrack
- Cosmic ray running

Trigger Upgrade Status

- All subsystems are installed
  - L2, Online, STT are complete and tested
  - CTT, L1Cal being tested
- All appear to work well and are on schedule
- Parallel effort on the “V15” trigger list has been ongoing to implement hardware changes in the online algorithms

Other parallel activities:

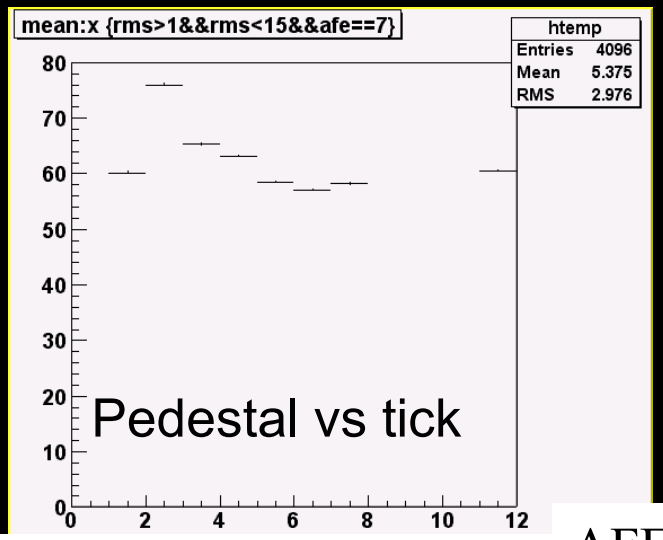
Rework muon control boards, study calorimeter noise and grounding), rebuild luminosity counters, recover bad SMT channels, ICD modifications, muon system calibrations, power supply modifications

We will be ready when the beam turns on

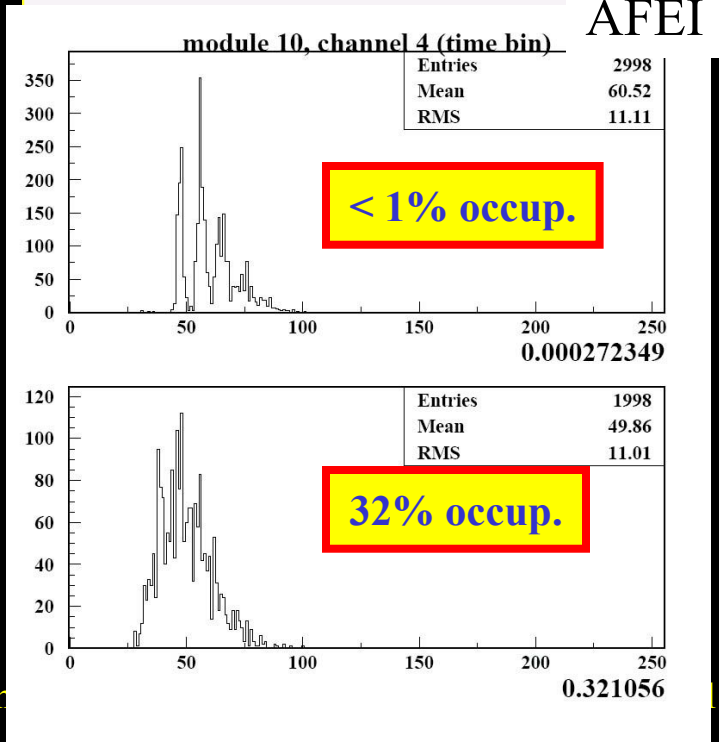
AFE II

- Replacement for the existing AFE CFT readout board
  - Replace SIFT/SVX II with TRiP-t and commercial ADC
  - TRiP-t will allow timing (z information) from CFT
- Benefits
  - Lower noise –> lower thresholds.
  - Stable pedestals

    We will recover signal that would be lost at high luminosity
  - Z information -> easier pattern recognition. Decrease tracking time and improve efficiency
- Starting production – boards to be installed as received and tested

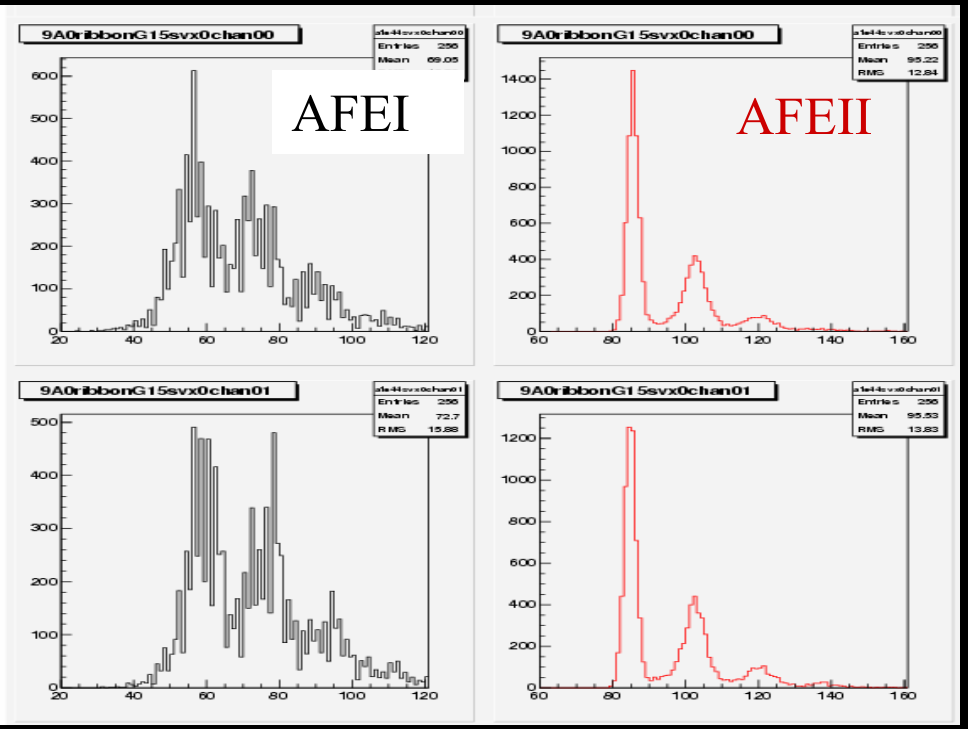


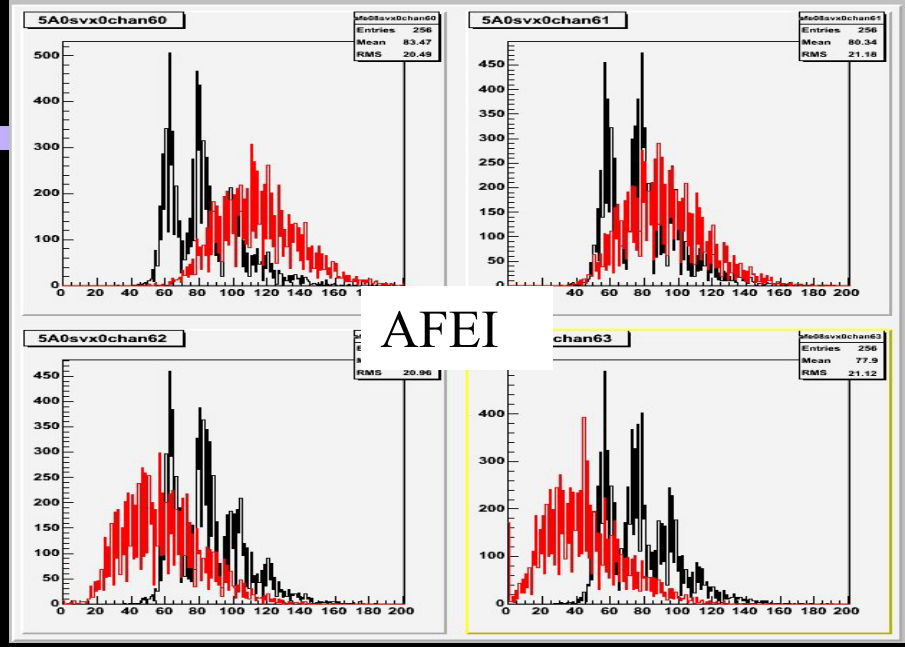
AFEI

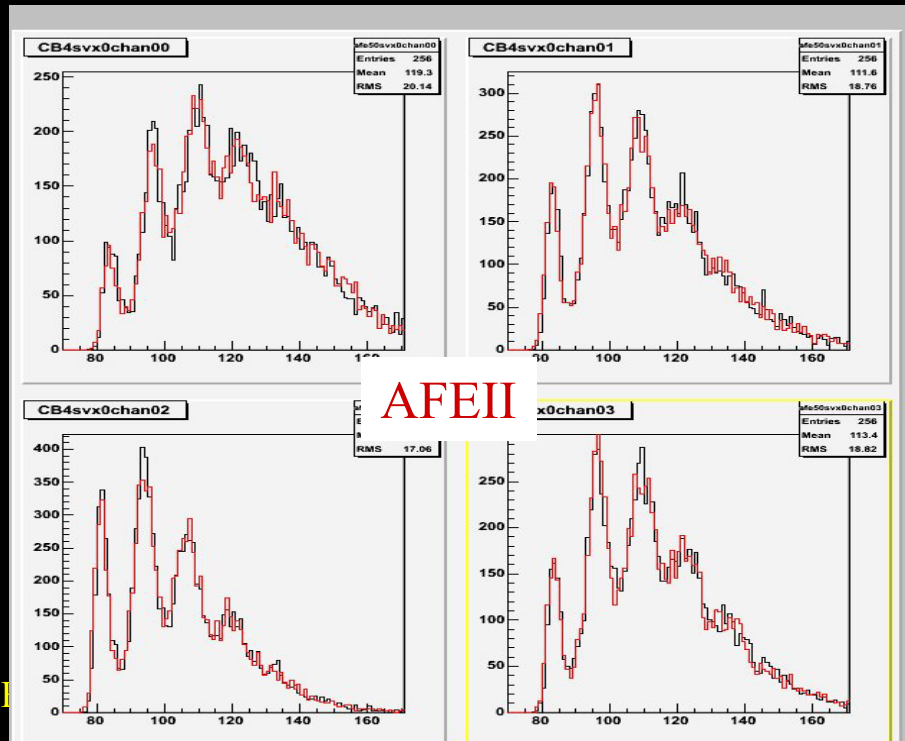


AFE II Performance

Pulser response





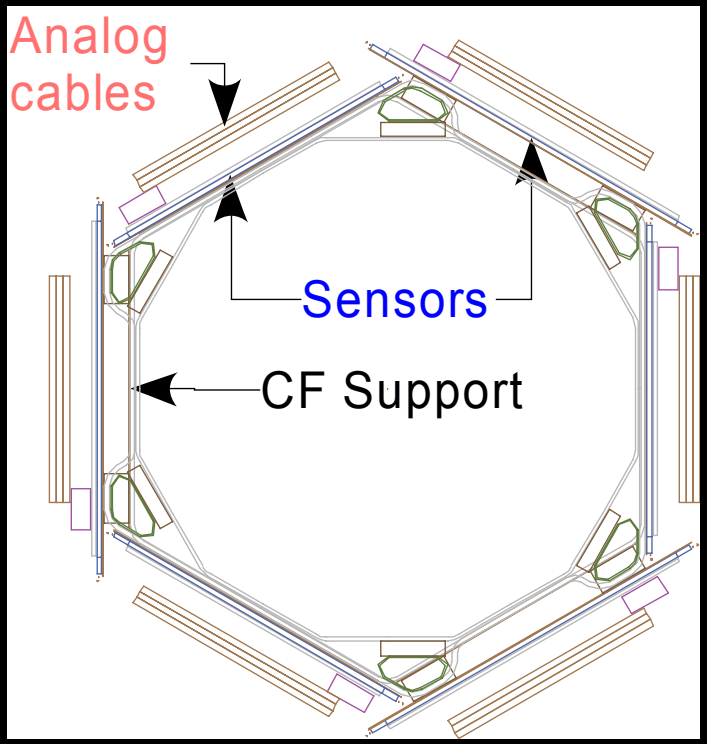


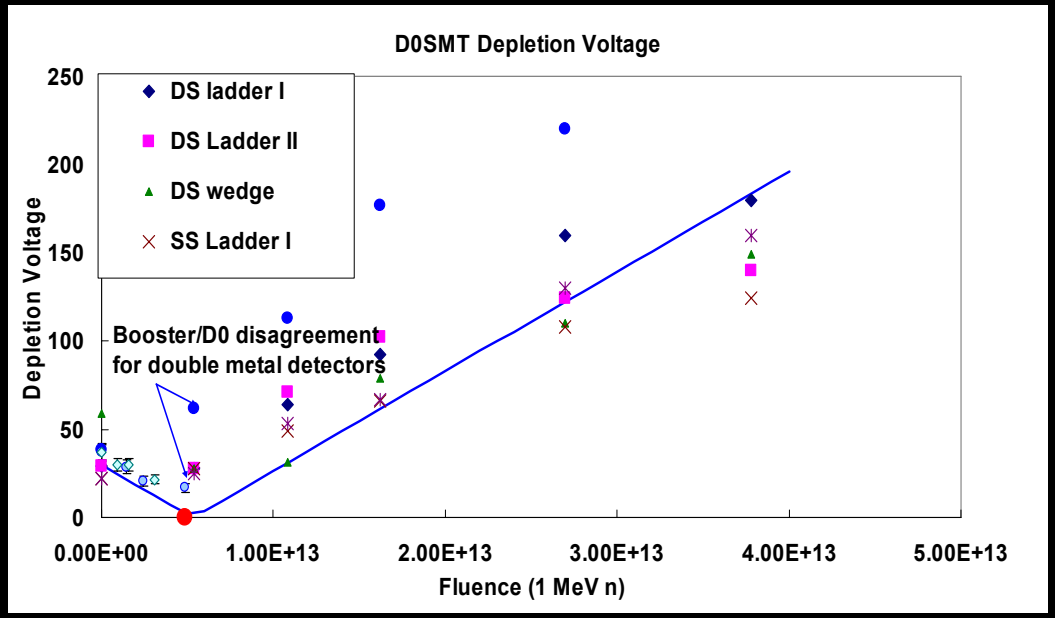
Black – discriminators off

Red - discriminators firing

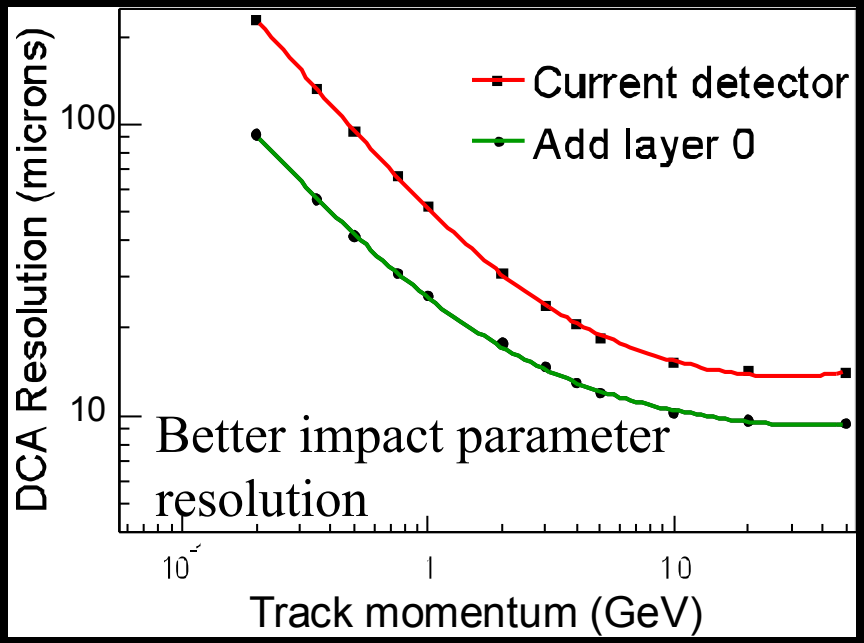
Layer 0

- Retain B ID, tracking, and vertexing if layer 1 fails due to radiation damage
- Improve impact parameter resolution- analog cables move hybrids out of volume to minimize mass
- Use RunIIb R&D (and funding)

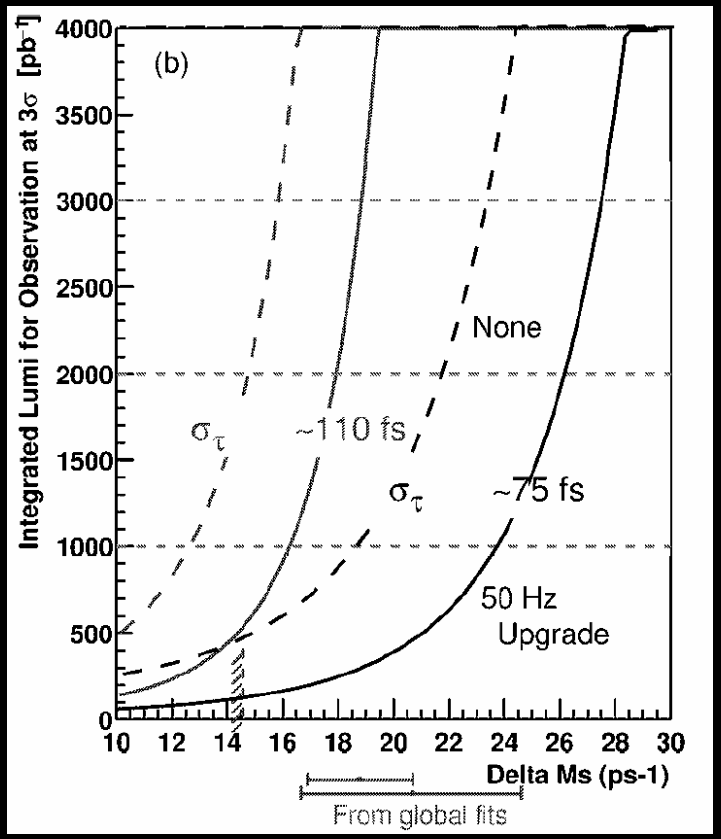


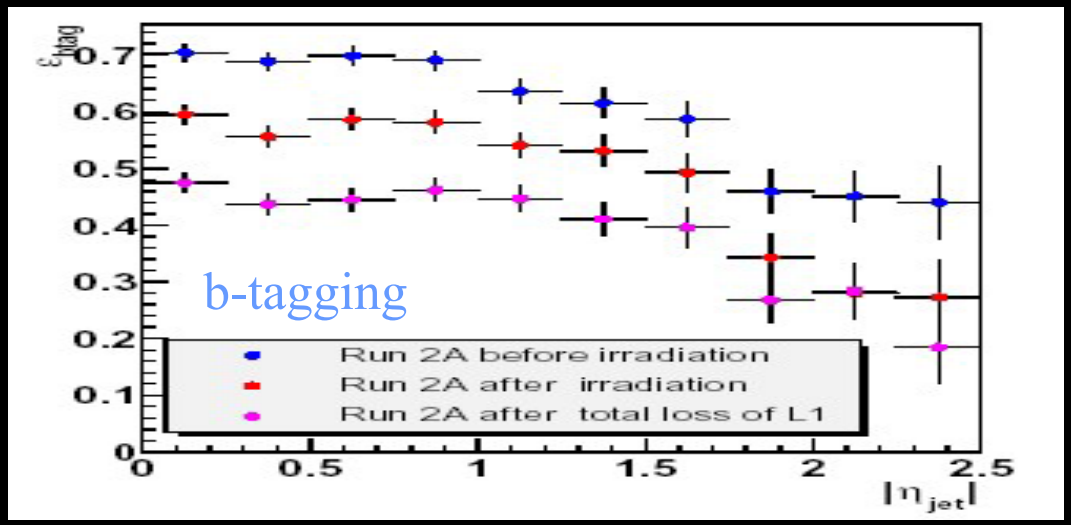


L0 Physics Impact



Improved Bs mixing sensitivity



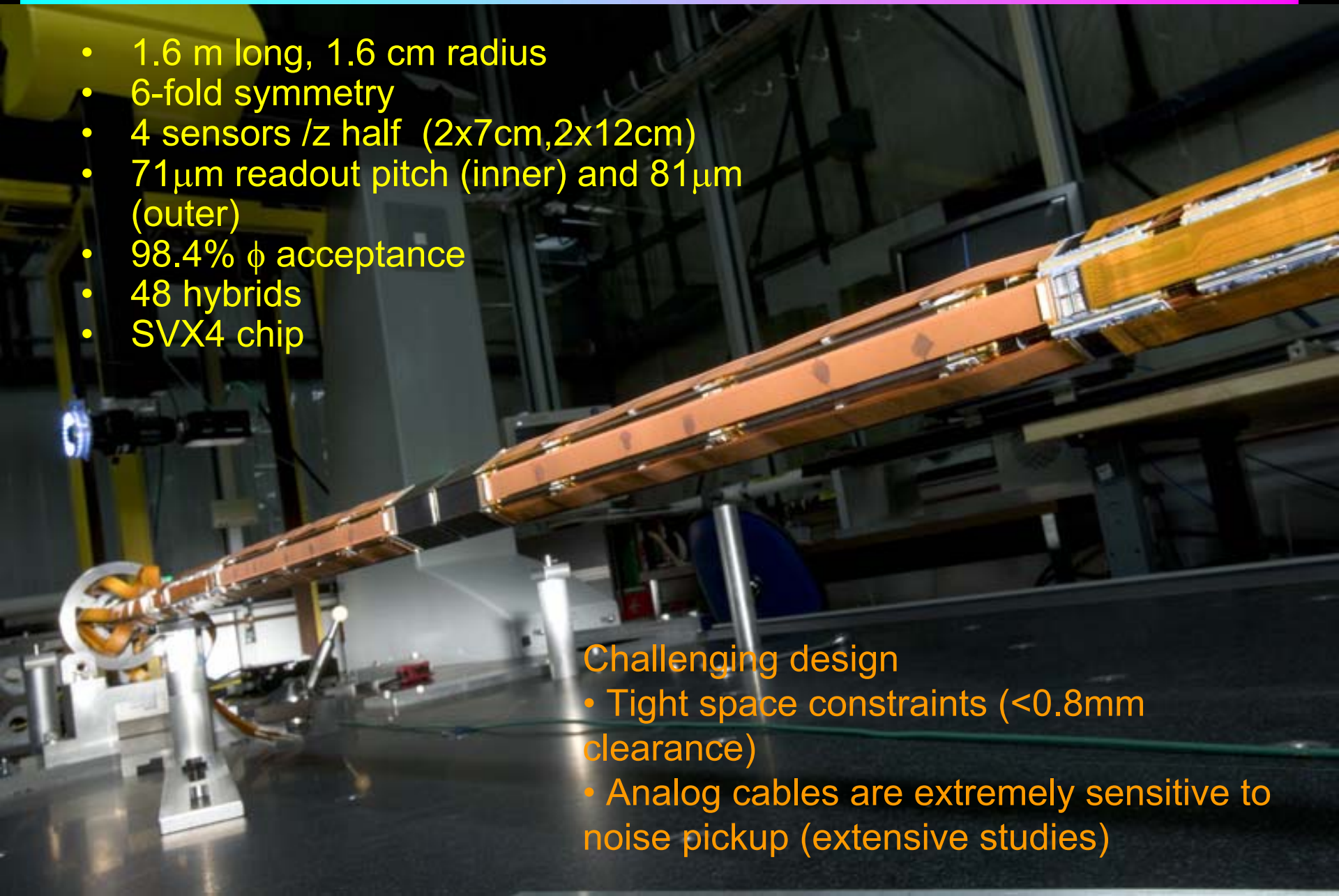


b-tagging efficiency per jet (RunIIb study)

	L0	L5	L0+L5
ε	47%	41%	48%

Relative increase of b-tagging efficiency is 15%

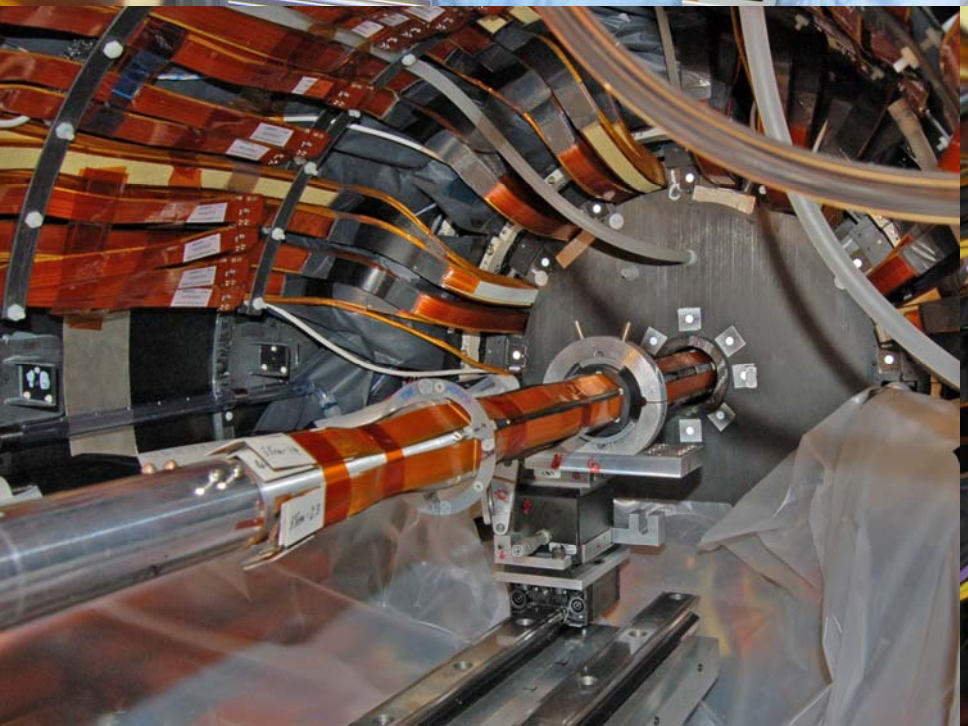
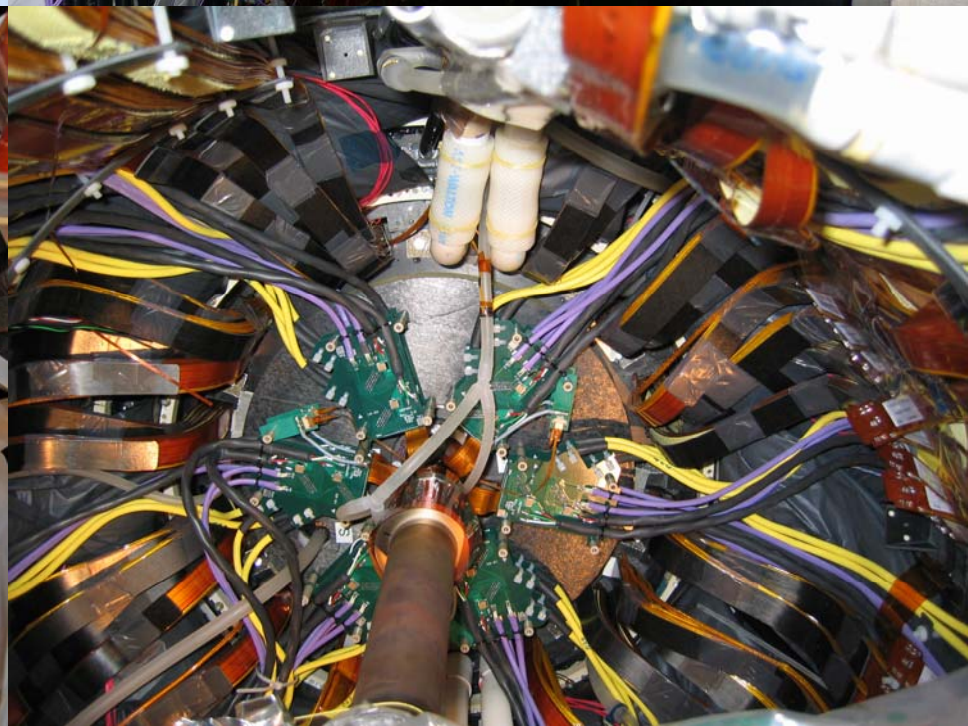
Layer 0 Geometry



- 1.6 m long, 1.6 cm radius
- 6-fold symmetry
- 4 sensors /z half (2x7cm,2x12cm)
- 71μm readout pitch (inner) and 81μm (outer)
- 98.4% ϕ acceptance
- 48 hybrids
- SVX4 chip

Challenging design
- Tight space constraints (<0.8mm clearance)
- Analog cables are extremely sensitive to noise pickup (extensive studies)

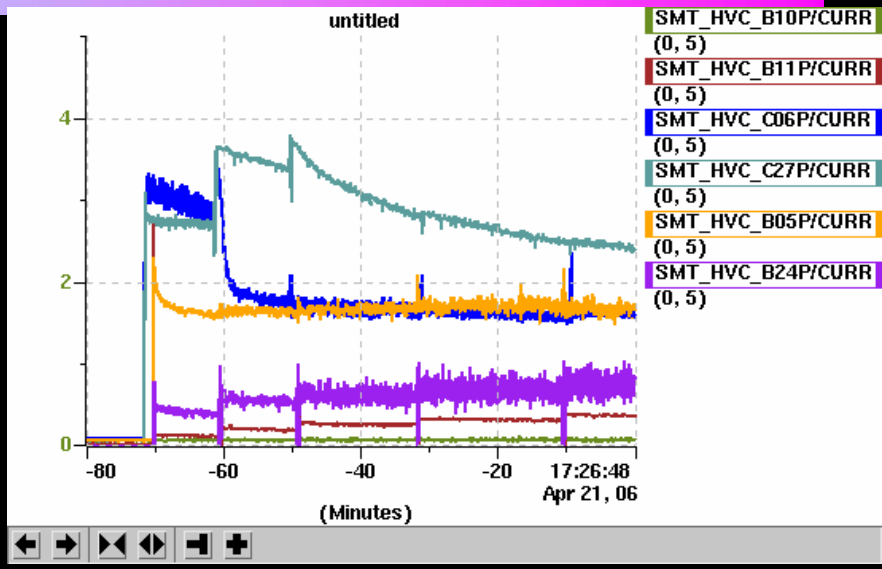


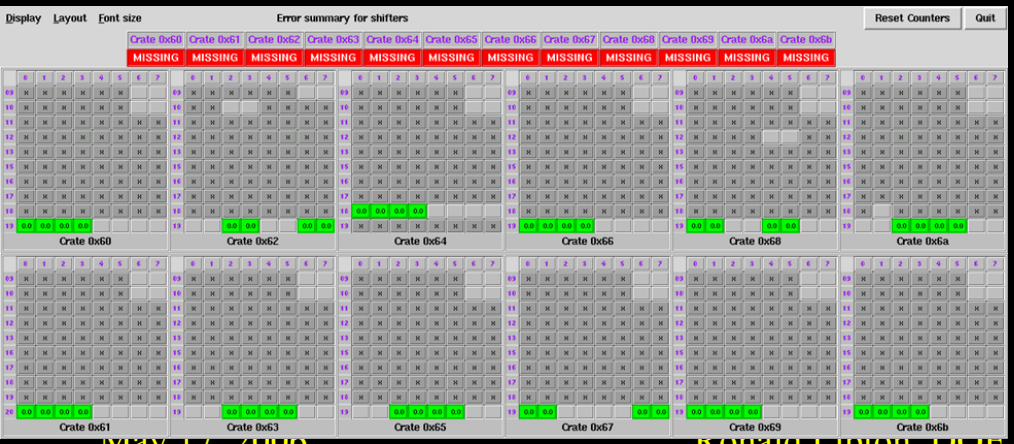



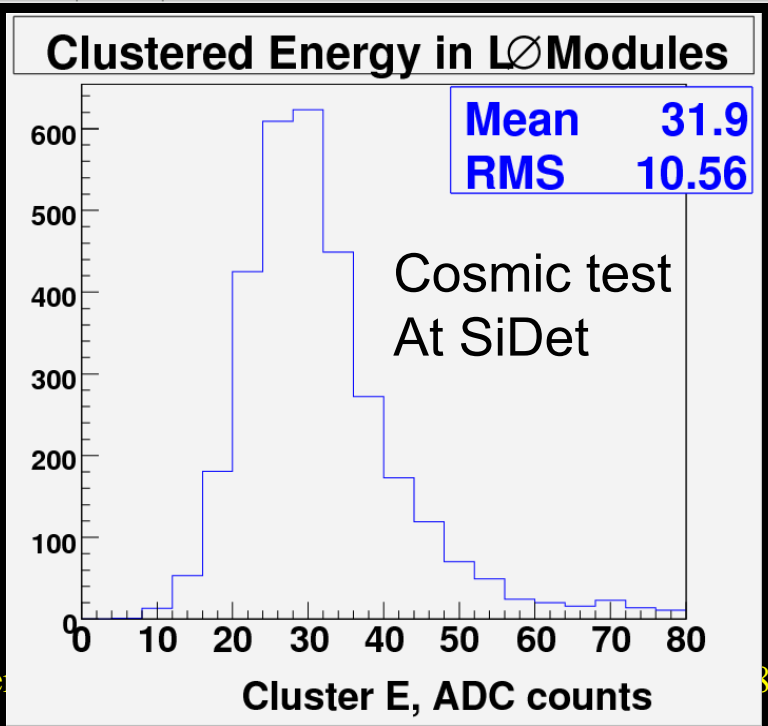
L0 Installation

L0 Performance

- All chips read out
- ~15 bad channels
- Bias currents are low
- Readout is error free
- *No significant coherent noise*
  - 15:1 to 18:1 total S/N
  - Unaffected by
    - Grounding
    - Beam pipe coupling
    - Welder noise



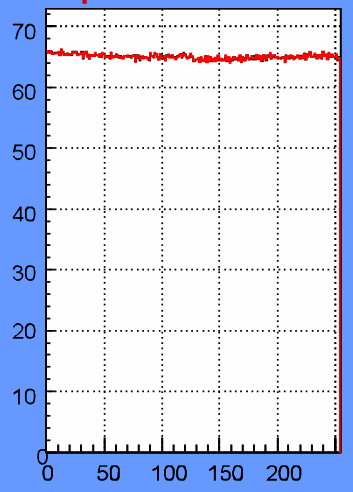


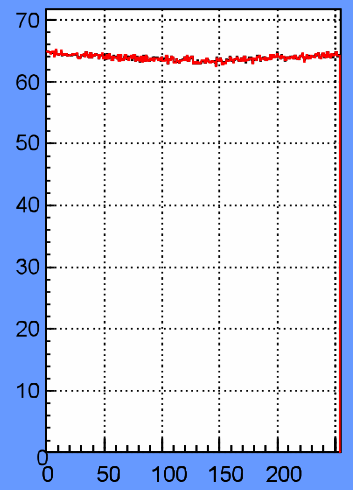


L0 Performance

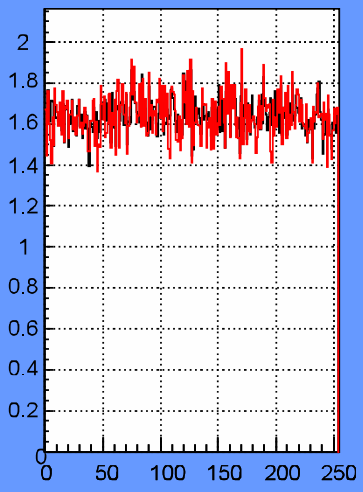
Barrel 4 - 7 cm sensors 34 cm cables, 2 ϕ locations

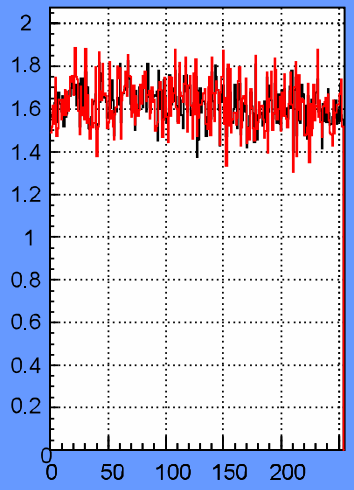
Average pedestals



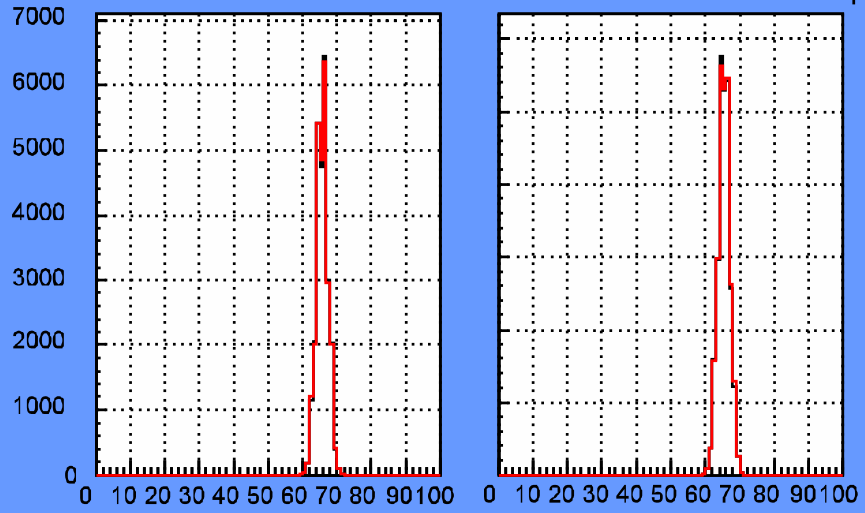


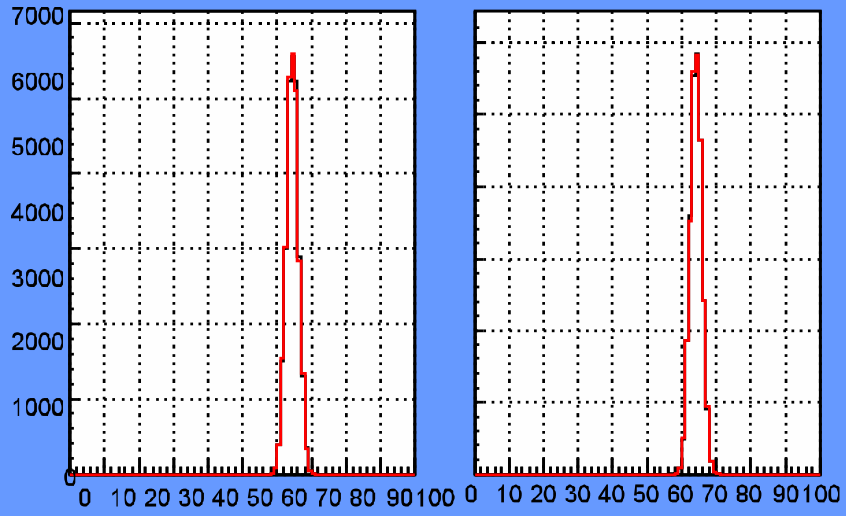
Random and total noise





Pedestal histograms





Conclusions

- Run2b upgrades are nearly complete and have been very successful
- Their success is a tribute to the excellent work done by the technicians, engineers and physicists involved in design, production, installation, and testing these devices.

We will be ready for the physics opportunities in the final years of Tevatron running.