Calorimetry Upgrade

Steve Kuhlmann, Level-2 Manager

Joey Huston, Level-3 Manager Preshower

Dave Toback, Level-3 Manager EM Timing

Preshower/Crack

- University of Tsukuba
- INFN (Pisa, Roma, Trieste/Udine)
- JINR (Dubna)
- Argonne National Laboratory
- Michigan State University
- Rockefeller University
- FNAL

Electromagnetic Timing

- Texas A&M
- INFN (Frascati)
- University of Chicago
- University of Michigan
- Argonne National Lab
- FNAL

Calorimetry Personnel

Preshower/Crack

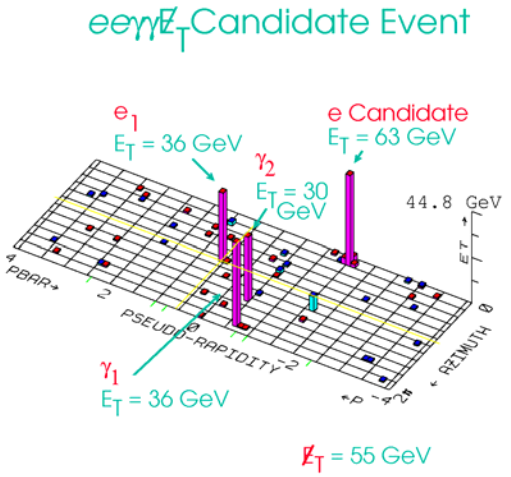
- University of Tsukuba, Fumi Ukegawa
- INFN (Pisa, Roma, Trieste/Udine), Nicola Turina, Maurizio Iori, Aldo Penzo, Giovanni Pauletta
- JINR (Dubna), Julian Boganov
- Argonne National Laboratory, Steve Kuhlmann, Larry Nodulman, Jim Grudzinski (Eng), Ken Wood (EA), Frank Skrzecz (EA), Zeljko Matijas (Tech), Tim Nephew (Tech)
- Michigan State University, Joey Huston, Bob Miller, Carl Bromberg, Ron Richards (Eng), Mike Nila (Tech)
- Rockefeller University, Stefano Lami, Michele Gallinaro
- FNAL, Lab 5,7,8 personnel

Electromagnetic Timing

- Texas A&M, Dave Toback, Max Goncharov, Sung Won Lee, Peter Wagner, Slava Krutelyov, Vadim Khotilovich
- INFN (Frascati), Marco Cordelli, Stefano Miscetti, Fabio Happacher
- Argonne National Laboratory, Bob Wagner
- University of Chicago, Henry Frisch+techs
- University of Michigan, Eric James, Myron Campbell
- FNAL, Dervin Allen and Karen Kephart's groups

Calorimetry Upgrade Motivation

- Maintain capabilities of current Preshower detector, used in almost ½ of Run I papers.
- Preshower expected to suffer high occupancy and aging effects in Run IIB.
- New Preshower and Crack detectors will provide much better fiducial coverage, fewer hits from pileup, and improved jet energy resolutions.
- Electromagnetic timing needed to reject photon backgrounds from cosmic rays and beam halo, in new physics searches such as SUSY.



Calorimetry 2004 Installation Overview

- Remaining EM Timing Hardware Installation estimated to take ~4 weeks. Finished by end of September if all parts available.
- Preshower/Crack Installation estimated to take ~12 weeks with a careful, mostly serial approach. (Do 1 wedge and test completely with cosmics, then 1 arch of 12 wedges and test, then next arch, then final two arches)
- More than 30 “volunteers” so far to help with installation, in addition to FNAL techs.
- The focus of this talk is parts readiness, with mention of important installation issues, most installation details left for breakout session.

Electromagnetic Timing

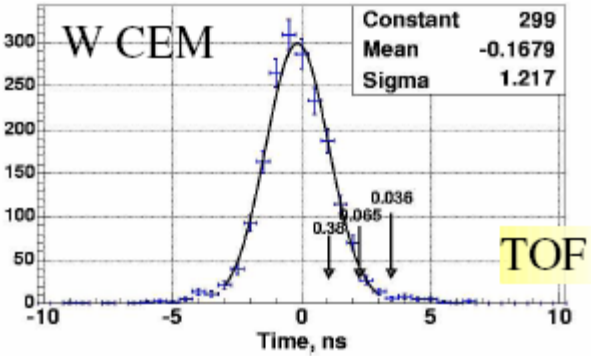
My Quote from the April 2004 PMG:

"Ready to Finish Installation this Fall,
Endplug and Partial-Central Installations working well."

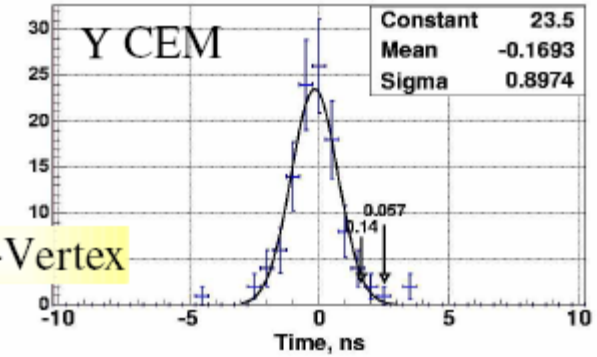
50% Correct!

Electromagnetic Timing

Electrons from W's and Y's

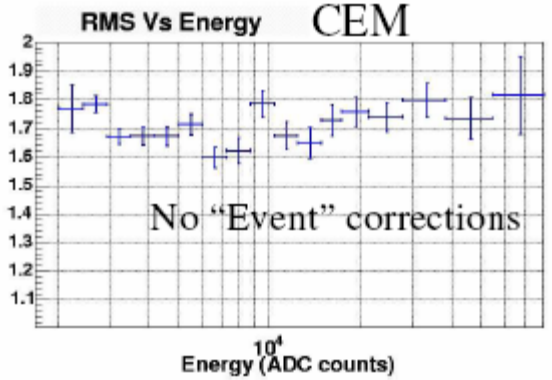


TOF +Vertex



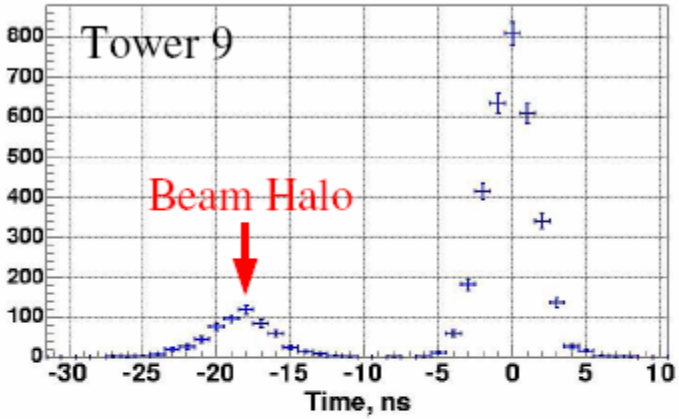
- "Event" corrections ~0.5 ns
- "Event" corrections are analysis dependent

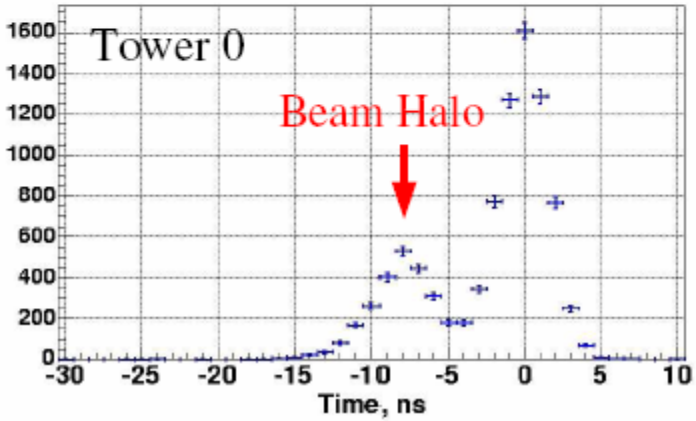
- Resolution is energy dependent.
- Resolution – from 0.9 to 1.2 ns



Electromagnetic Timing

Beam Halo

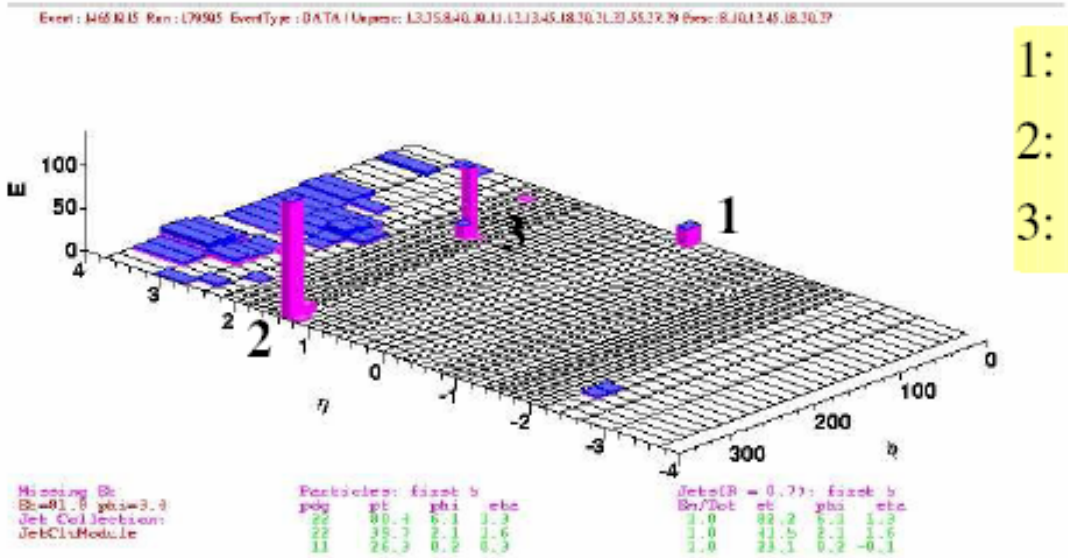




- Beam Halo: CEM wedges 0 & 23.
- The halo peak moves closer to the primary one as halo traverses towers from east to west.
- Two peaks indistinguishable in the West Tower 3 --> Resolution suffers.
- Halo peak time < primary peak.

Electromagnetic Timing

Rare 3 electron, WZ Candidate event



1: T_{HAD} = -13.6ns, T_{EM}=1.57ns

2: T_{HAD} = ---------, T_{EM}=3.22ns

3: T_{HAD} = ---------, T_{EM}=0.63ns

Electromagnetic Timing

Equipment to be Installed in the Fall

- CEM harnesses:
  - 48 Wedges total
  - 4 already installed
  - Remaining 44 are done, tested and ready to go
- TB's and ASD's
  - 27 board pairs are electrically sound and tested
  - Need more of these… (more on this)
- Long Cables:
  - Tested and installed, nothing to do
- TDC Crate and TDC's
  - All in and working (will need 2 more…)

Electromagnetic Timing

Transition Boards Mechanical Problems

- 16 TB installed in the PEM, 2 in the CEM: working well, no failures
- During installation of CEM it was discovered that there are mechanical flaws with the TB
  - Slightly too thick
  - Slightly too tall
  - Holes for front panel mounting not quite in the right spot (off by 1 mm) or the right size

Being Remade at FNAL, due end of August

Electromagnetic Timing

Mapping Issues

- It was decided that the mapping design for the CEM needs to have all timing lines go into the same crate as the energy readout (ADMEM) lines.

Implications of New Requirement

- Add a TB/ASD to each CEM rack
  - Total of 8 new board pairs
  - Not enough from spares => Build new (more on this later)
  - Power and space requirements are ok (PJW)

Electromagnetic Timing

Making more ASD's/TB

Have negotiated an agreement with Marco/INFN & Rob/Bob/FNAL for who will build what (see web site)

- INFN will make 10 more ASD/TB (8 + 2 spares)
  - Ordered
  - First half of ASD's should arrive in late July
  - Rest in mid-September (need parts)
  - FNAL will provide same parts as last time (connectors, front panels)
  - Most are in stock, FP have 4 week lead time; to be ordered this week.
- INFN will make 30 more bulkhead boards (3 bulkhead boards/TB x 10 new)
  - Ordered
  - Scheduled to arrive mid-September
- FNAL will make enough make TB's enough main PCB to cover the CEM + the extra 10 needed
  - Get rest of drawings this week
  - Design will take ~2 weeks
  - Lead time for fabrication/stuffing <3 weeks
  - Parts to be ordered this week
  - Completion scheduled for end-of-August

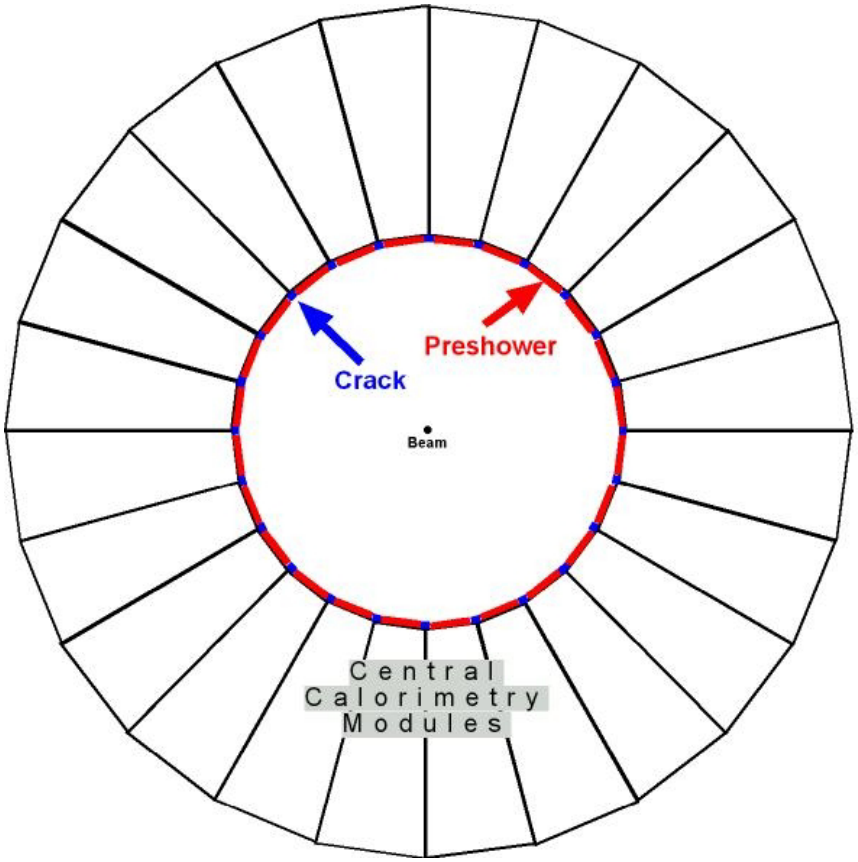
Electromagnetic Timing

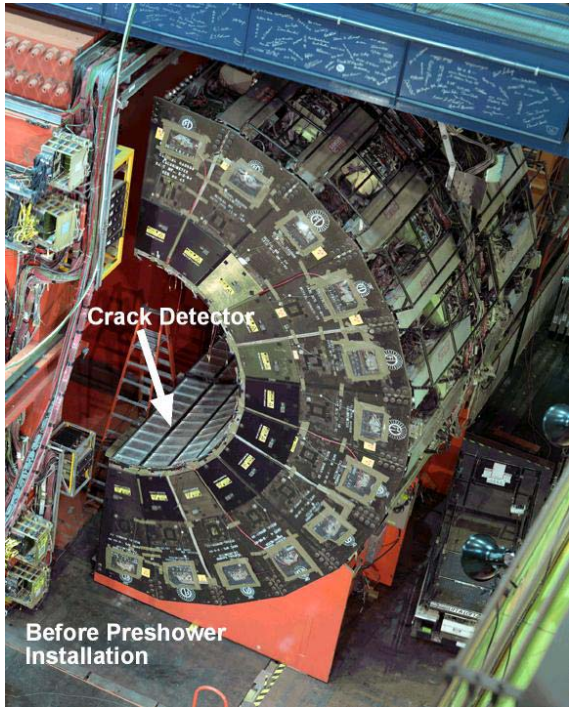
Summary

- Additional ASD's & TB's with improved mechanical specs will improve the robustness of the system
- Both are in progress and on schedule to be ready for the installation
- No known road-blocks.
- Everything thing else ready for installation in August

Recent Internal CDF Readiness Review agreed with the conclusions from this talk…

Preshower/Crack Detectors





Preshower/Crack Progress

Brief History

- Lehman 2002 review: Original aggressive (no contingency) schedule projects completion October 2004.
- Italian funding of scintillator and fibers delayed a year due to uncertainties in Run IIB.
- Japan able to accelerate final phototube purchase to make possible a fall 2004 installation.
- Current schedule shows completion of detector in August, using about 20% of contingency funds.

Preshower/Crack Progress

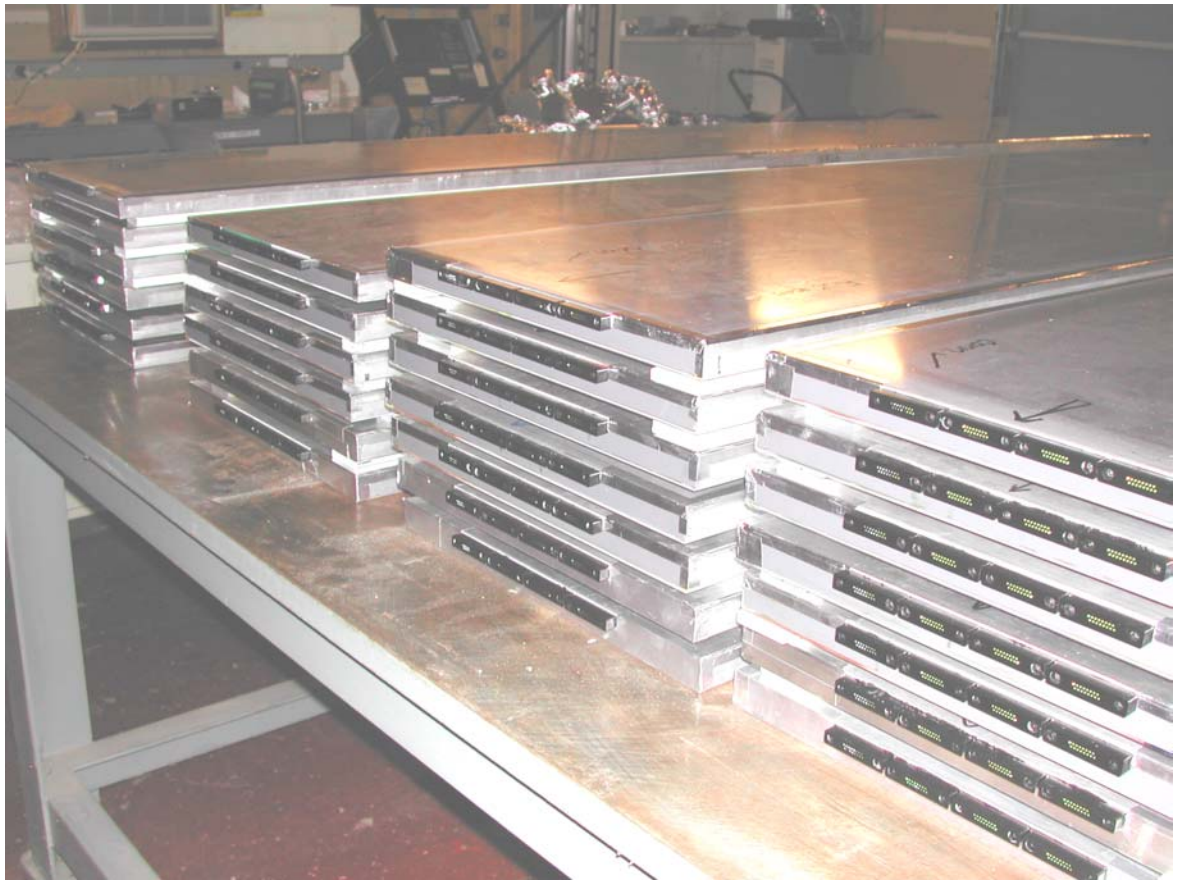
- Preshower detector assembly will be complete by Aug 15th. (ANL, INFN, KCHEP, MSU, Rockefeller)
- All phototubes for Preshower/Crack delivered and tested (Tsukuba).
- All Preshower scintillator at FNAL Lab 8 (Dubna).
- Fiber splicing for both Preshower/Crack completed by FNAL Lab 7. (INFN)
- 40/48 Wedges of spliced fiber bundles completed. (MSU)
- HV system delivered and mounted (INFN).
- PMT Boxes will be complete Aug 1 (MSU).
- Signal cables/transition cards first arch complete Aug 1, rest by end of August (ANL).

Preshower/Crack Progress

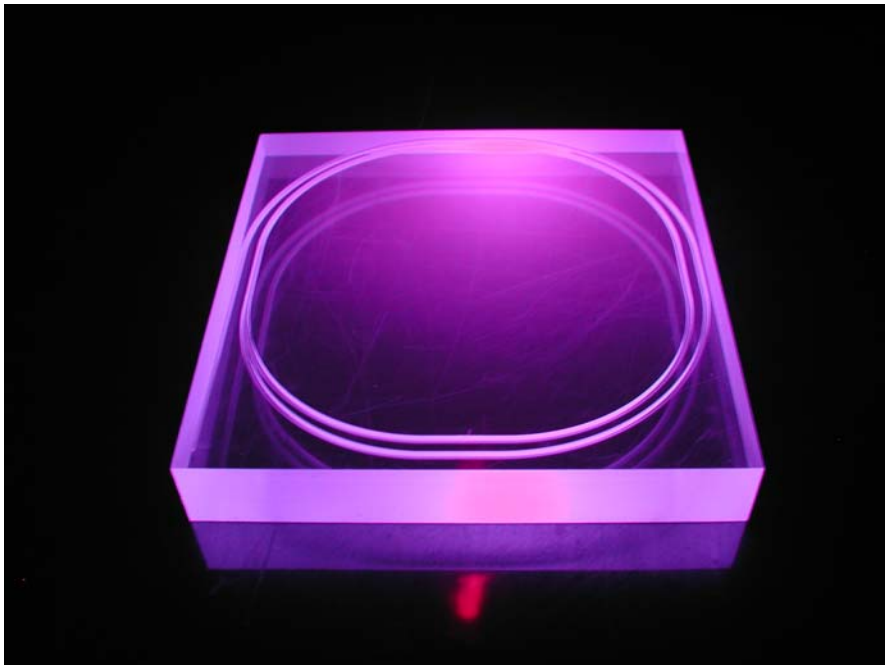
- Crack detector and clear fiber cable production underway, will be discussed more later.
- Focus shifting to installation issues, 400 mounting brackets for Preshower complete.
- Scaffold design tested at B0, passed safety review.
- Software ready to test detectors with cosmics the day they are installed.

Preshower Detectors

35/48 Modules completed. 1/day assembly continues at ANL.



Preshower Test Results

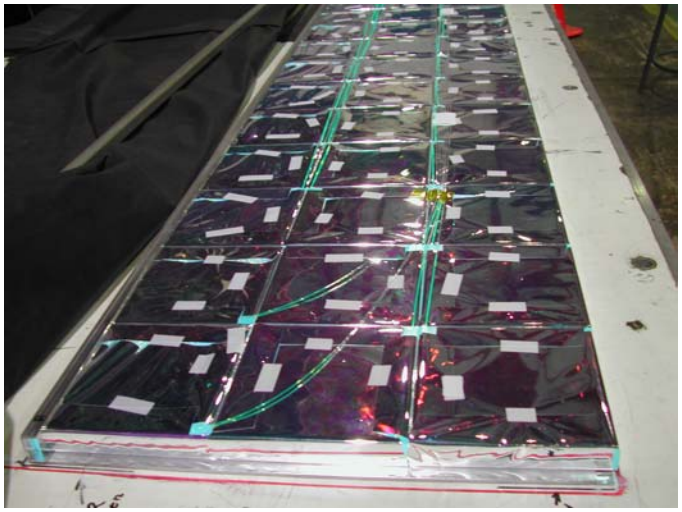


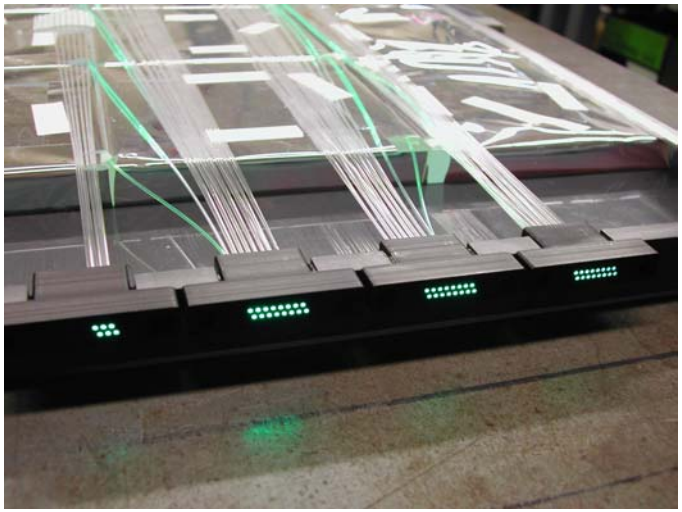
Dubna scintillator + keyhole/double-spiral groove + 3M superreflector + Kuraray fiber achieved 37 pe/MIP without optical glue, 44 pe/MIP with glue.

This significantly reduced assembly time, only the farthest 6 tiles are glued.

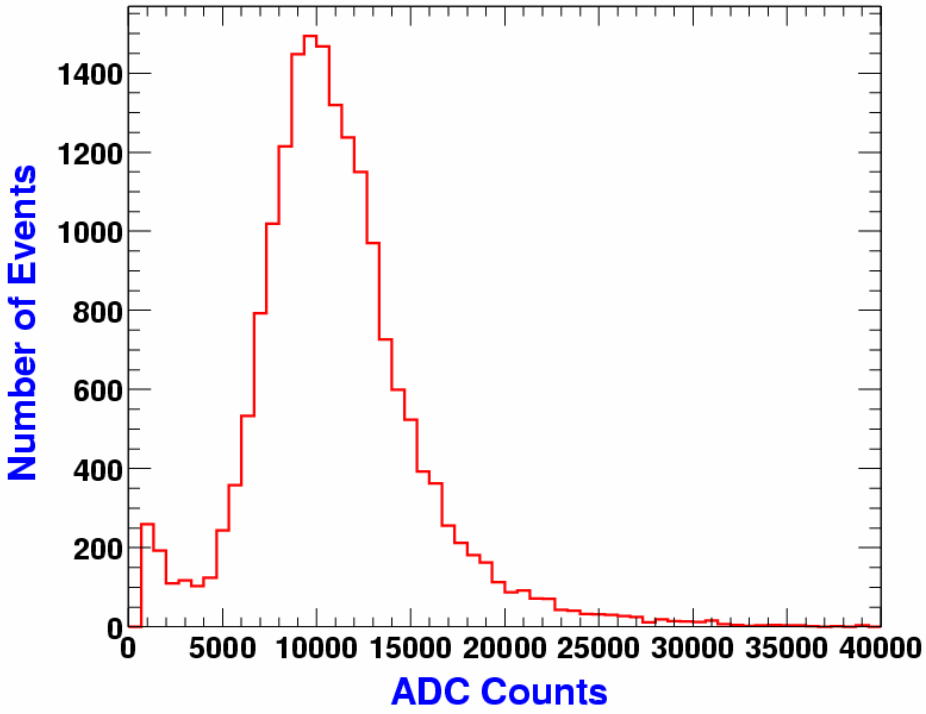
Lose x3-4 along optical path to PMT (attentuation+splice+connector)

Preshower Test Results





Production module cosmic data, consistent with 16 pe/MIP after full optical path, well above the spec of 5 pe/MIP.



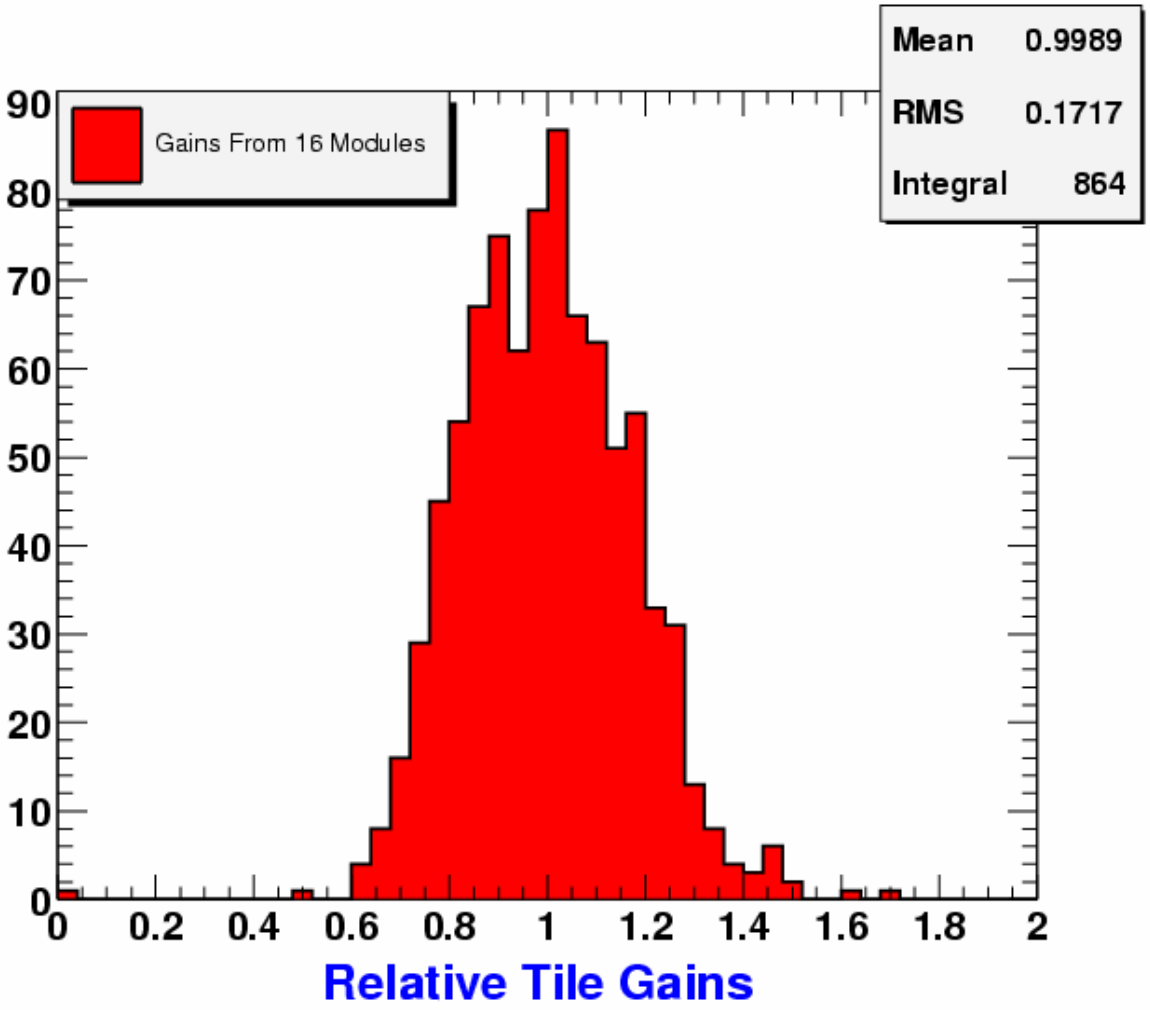
Preshower Test Results

Good Uniformity and 99.9% Working Tiles in 29 tested modules.

Two modules with dead tiles will become spares.

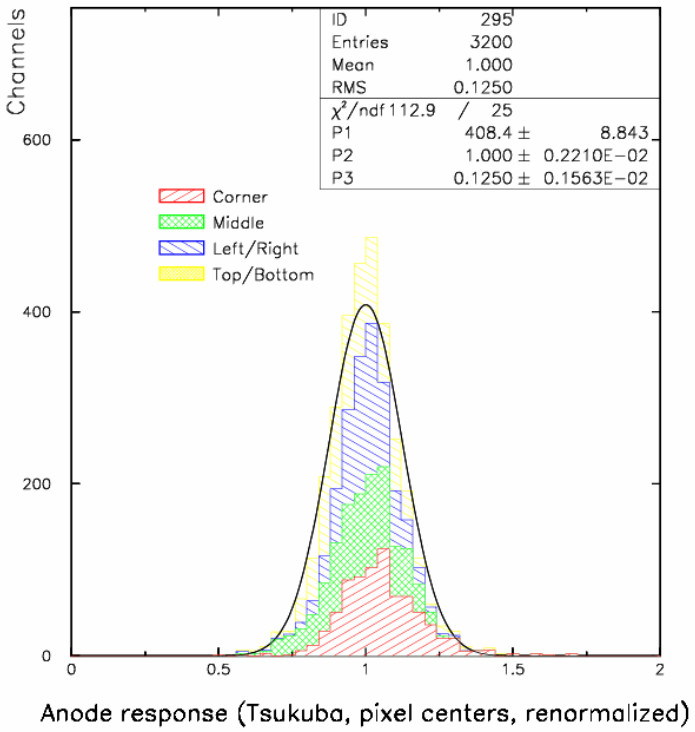
Gain variation known to be mostly due to scintillator variation.

Each tile is easily calibrated/recalibrated with MIP peaks in 5 minutes of collider data.



Preshower/Crack PMTs

- **220 R5900 16-channel PMTs, delivered and tested at Tsukuba.**
- **Well ahead of schedule.**

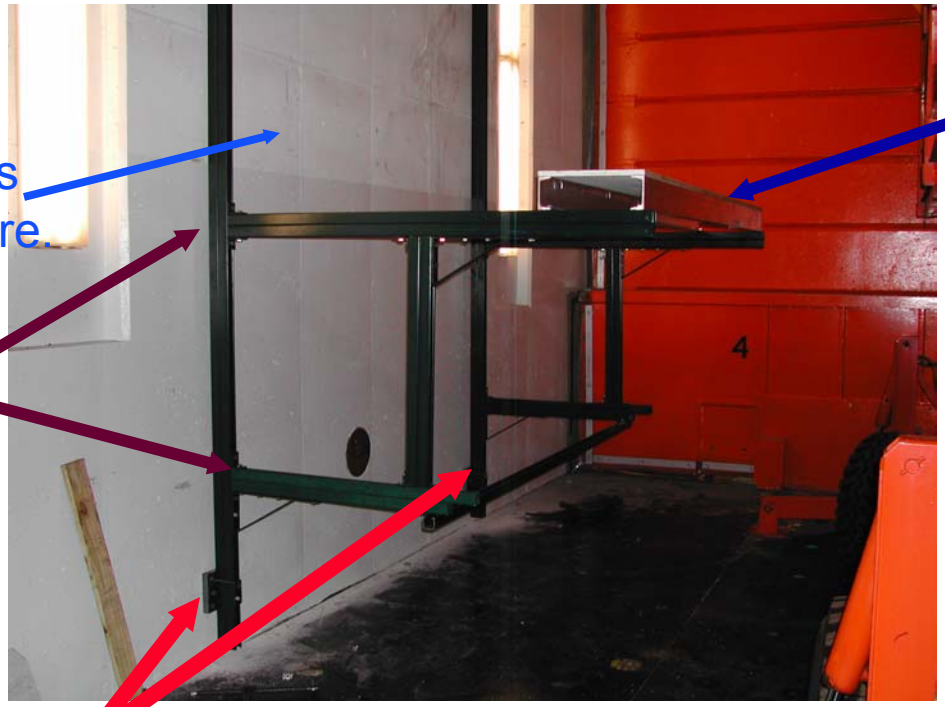


Crack Detector Status

- Only 3/48 Crack detectors assembled so far.
- Four month delay due to FNAL/ANL bureaucracy in scintillator purchase ($8K!).
- Fiber bundles for 20 detectors arrive at ANL today. Rest expected within 2 weeks. All other parts in hand.
- Fiber routing is fast and easy, 15 minutes/detector compared to 5 hours for Preshower. One person job rather than two persons for Preshower.
- Will be finished by end of August.

Scaffold for Installation

Installation Scaffold designed and built at FNAL, currently mounted in Assembly Hall.



Crossbars for harness attachment will go here.

2 stories

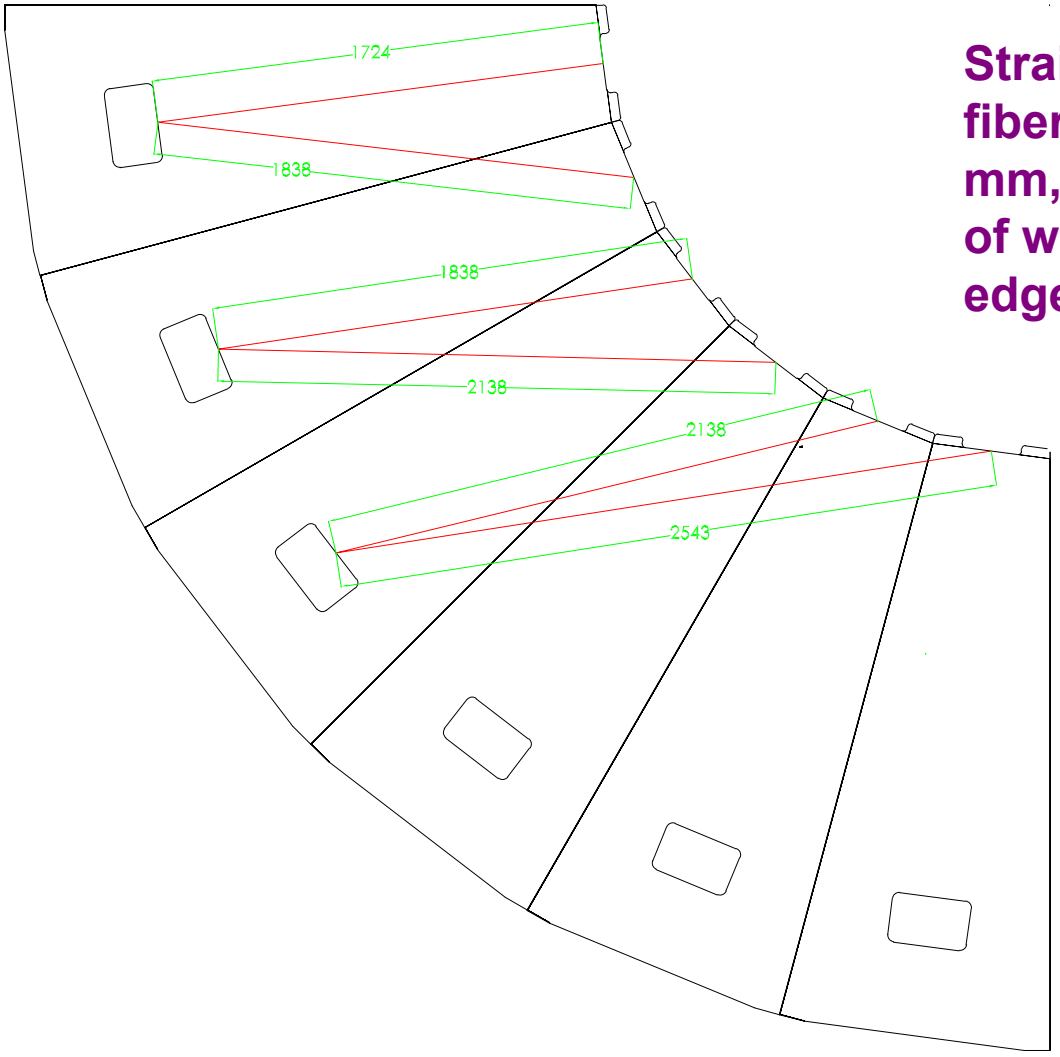
These modular steps will fill both stories.

Lower attachments to calorimeter wedges

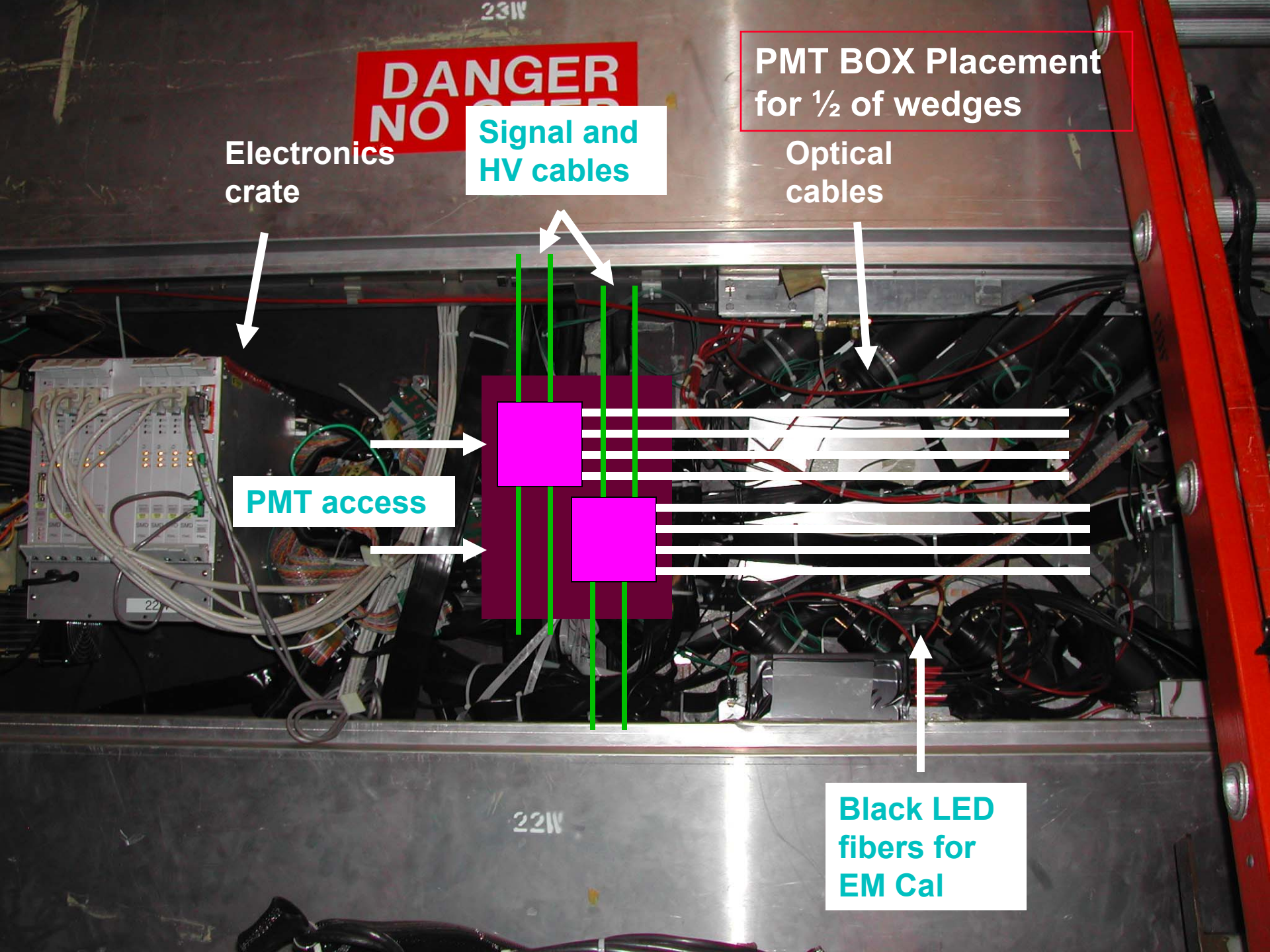
Clear Fiber Optical Cables

- Main Installation Issue for Preshower/Crack.
- Length of cables is at best an educated guess. Need full scaffold and PMT boxes installed to measure best lengths.
- Extra 50 cm of cable causes 10% loss of light yield, and is a good place to cause fiber damage.
- PMT box placement changes depending on wedge, and complete plan changed 4 times in last long access.
- Fiber run up the side of wedge is a tight fit.
- Plan is to make ½ of the optical cables before shutdown with educated guess, then after first week of shutdown make the rest (takes about 1.5 weeks per arch).

Optical Cables



Straight line fiber lengths in mm, from edge of wedge to edge of window.


PMT BOX Placement for ½ of wedges
Electronics crate
Signal and HV cables
Optical cables
PMT access
Black LED fibers for EM Cal


Tight fit in last long access!
Scraped sides of connector on 1 arch, fine on the other arch.
MSU has since trimmed connector by 1.5 mm.

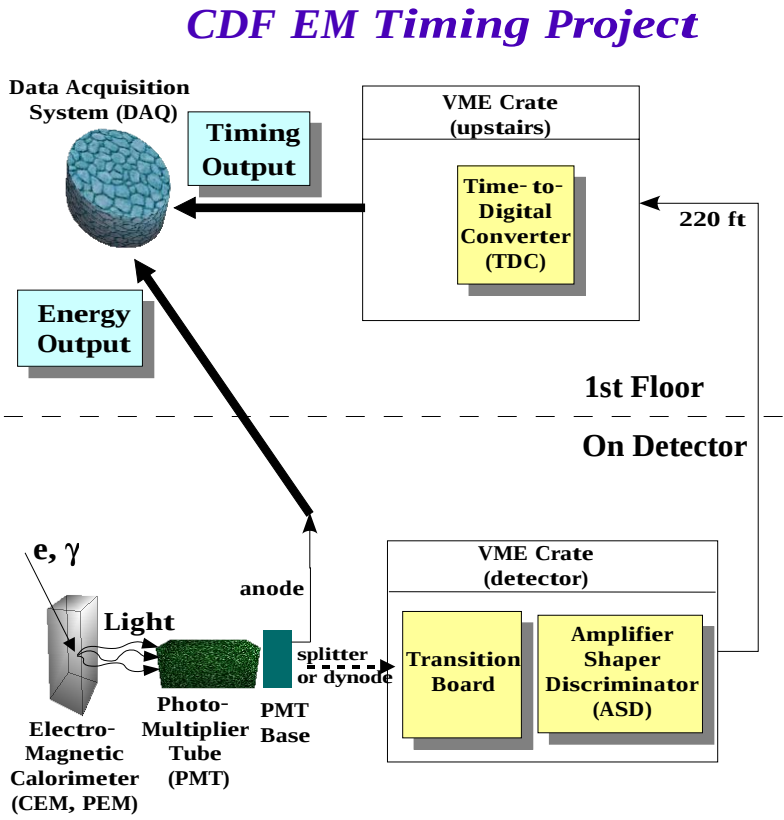
Preshower/Crack Summary

- Detector will be ready for fall installation.
- Many new aspects to this installation. Expect problems, hopefully solvable on a short time scale.
- Installation is staged in case a partial installation is necessary.

Extra Slides for Breakout

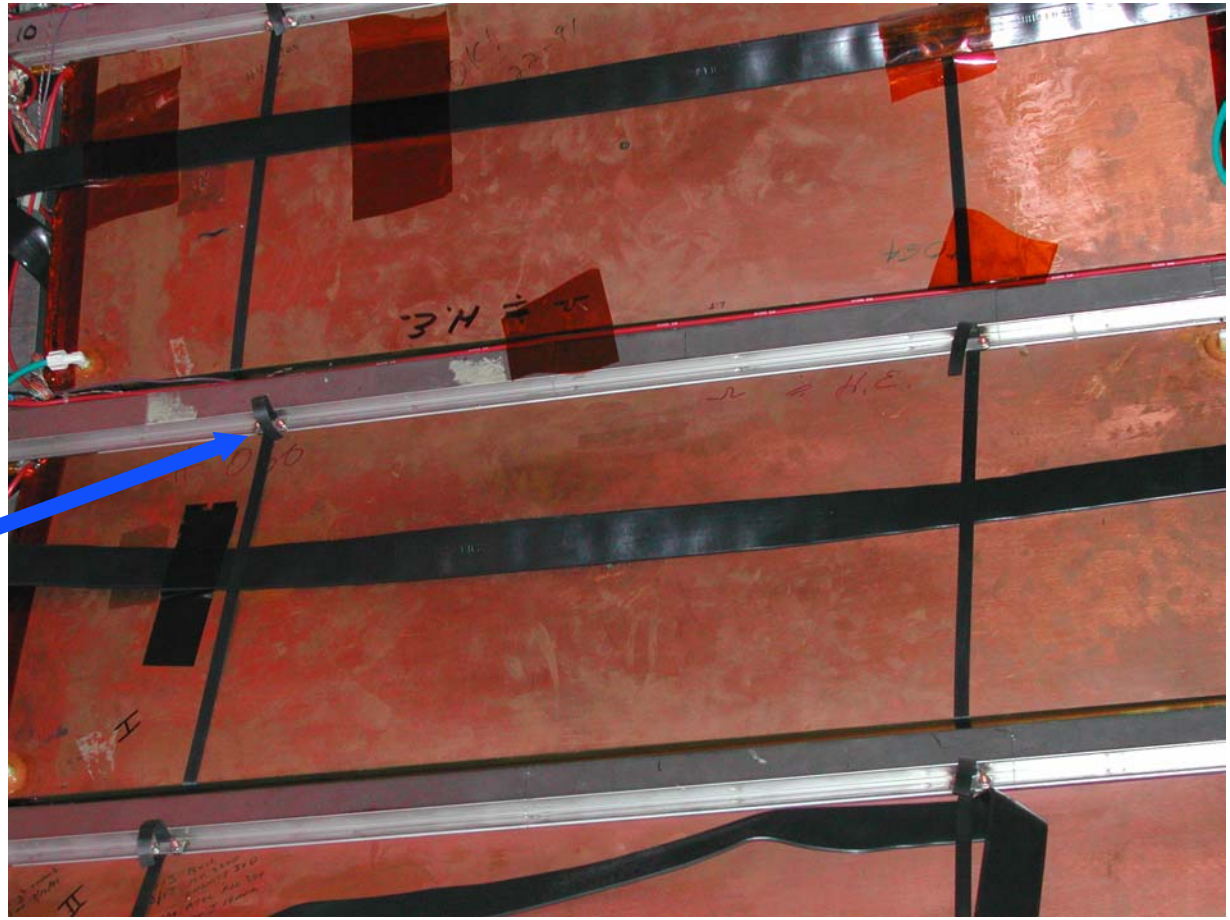
Electromagnetic Timing

- Virtually identical to existing system on hadron calorimeter
- Re-use electronics and well-established technologies
- Add splitters for CEM. PEM already readout-ready
- Build more ASD's
- Recycle TDC's, crate and tracer. Purchase new power supply and processor
- Make cables and connectors



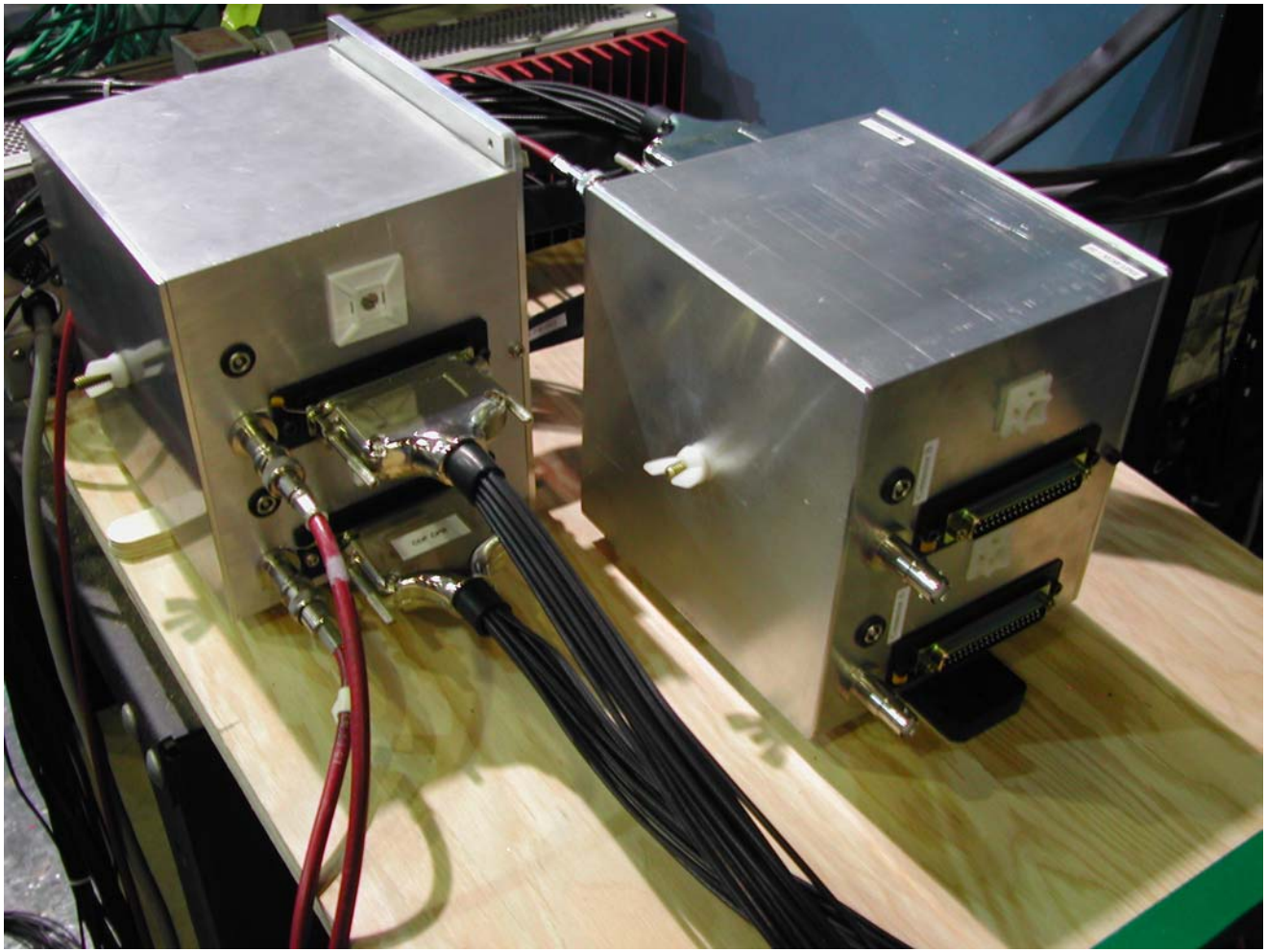
½ of Installation has a confined entry point

Will Mount New Preshower in similar fashion to old.

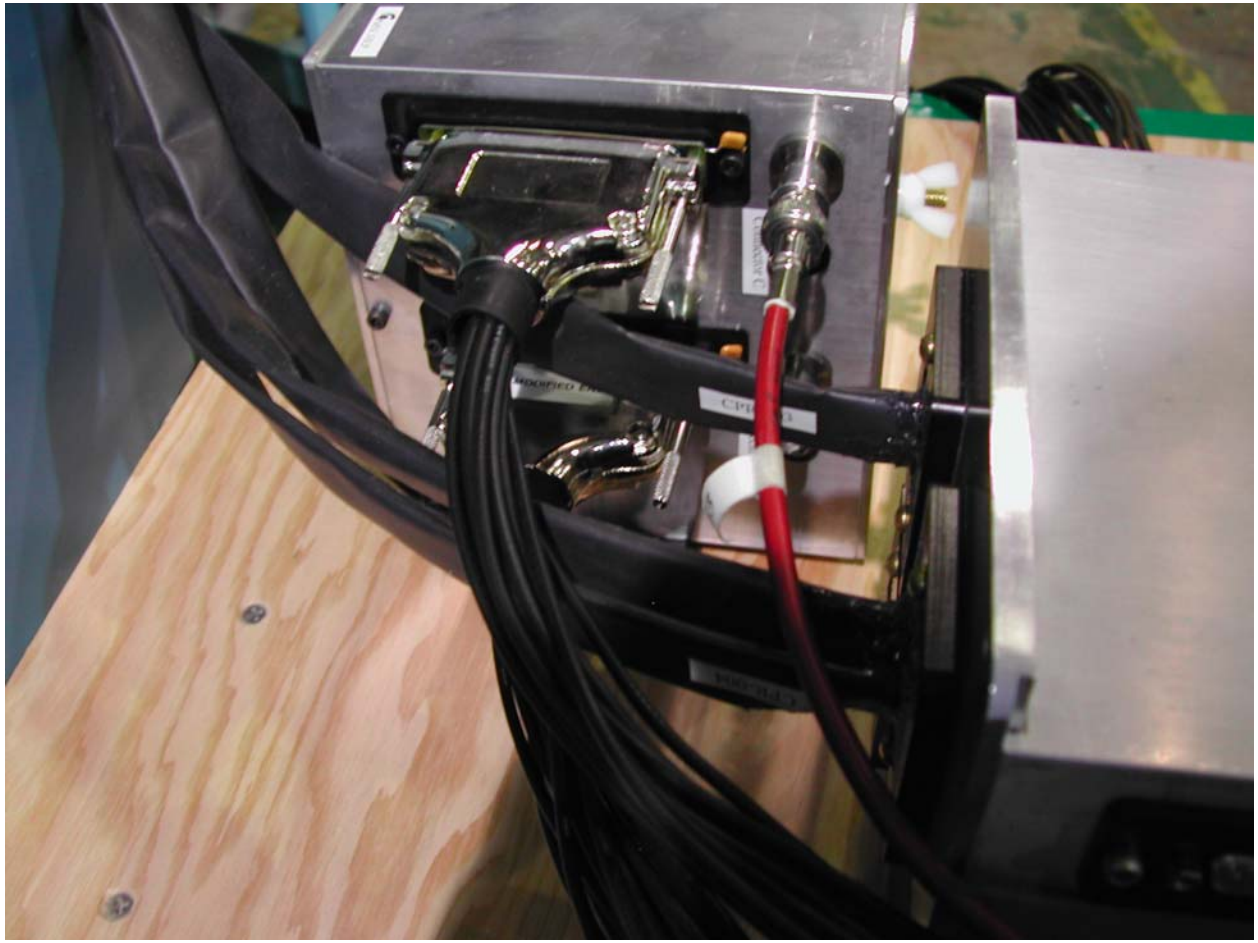


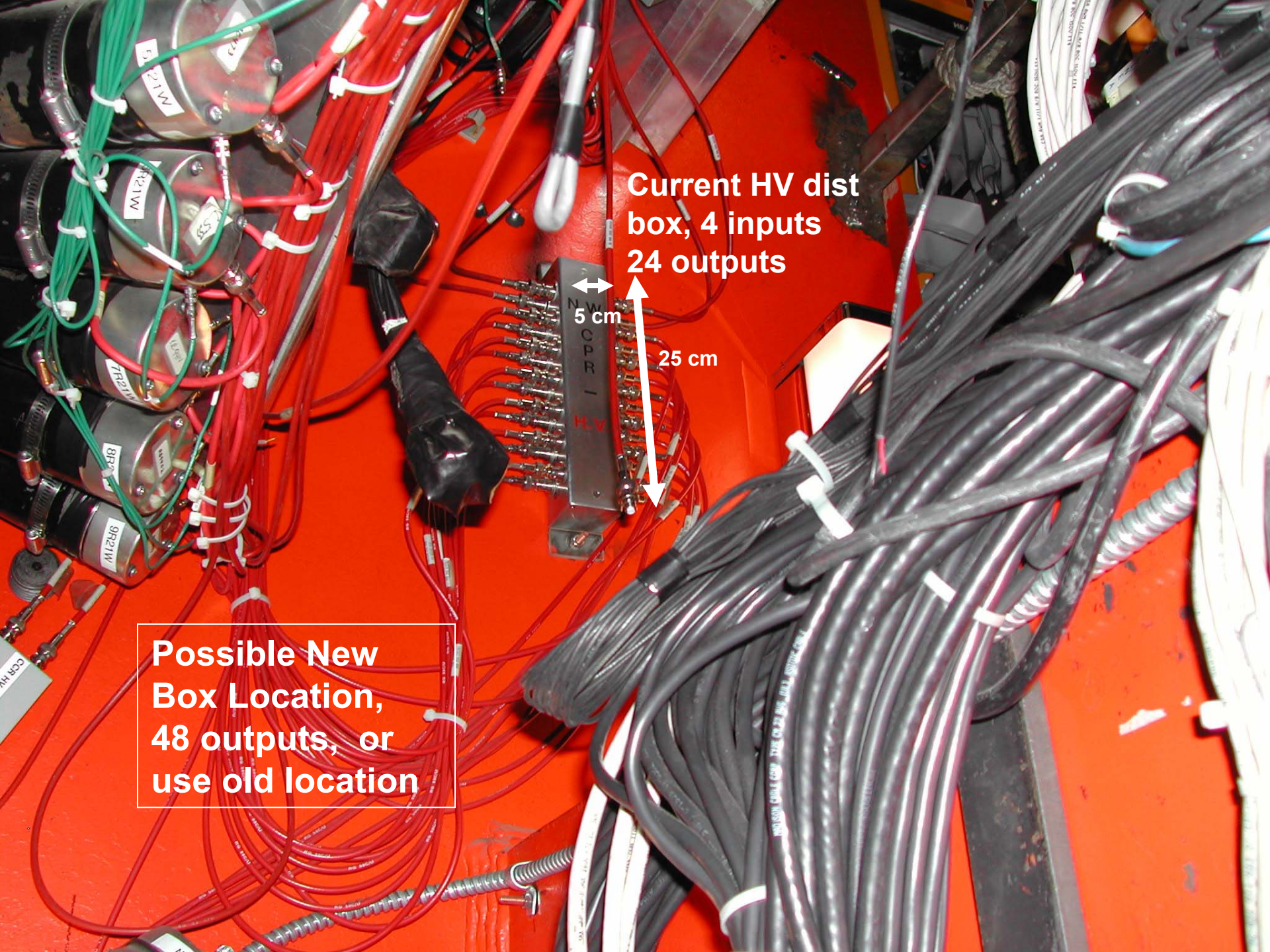
New stainless steel brackets slide on existing studs.

Preshower/Crack PMT boxes



Preshower/Crack PMT Boxes




Current HV dist box, 4 inputs 24 outputs
5 cm
25 cm
Possible New Box Location, 48 outputs, or use old location

Preshower/Crack Detectors

- Reuse existing electronics except for new transition board and signal cables.