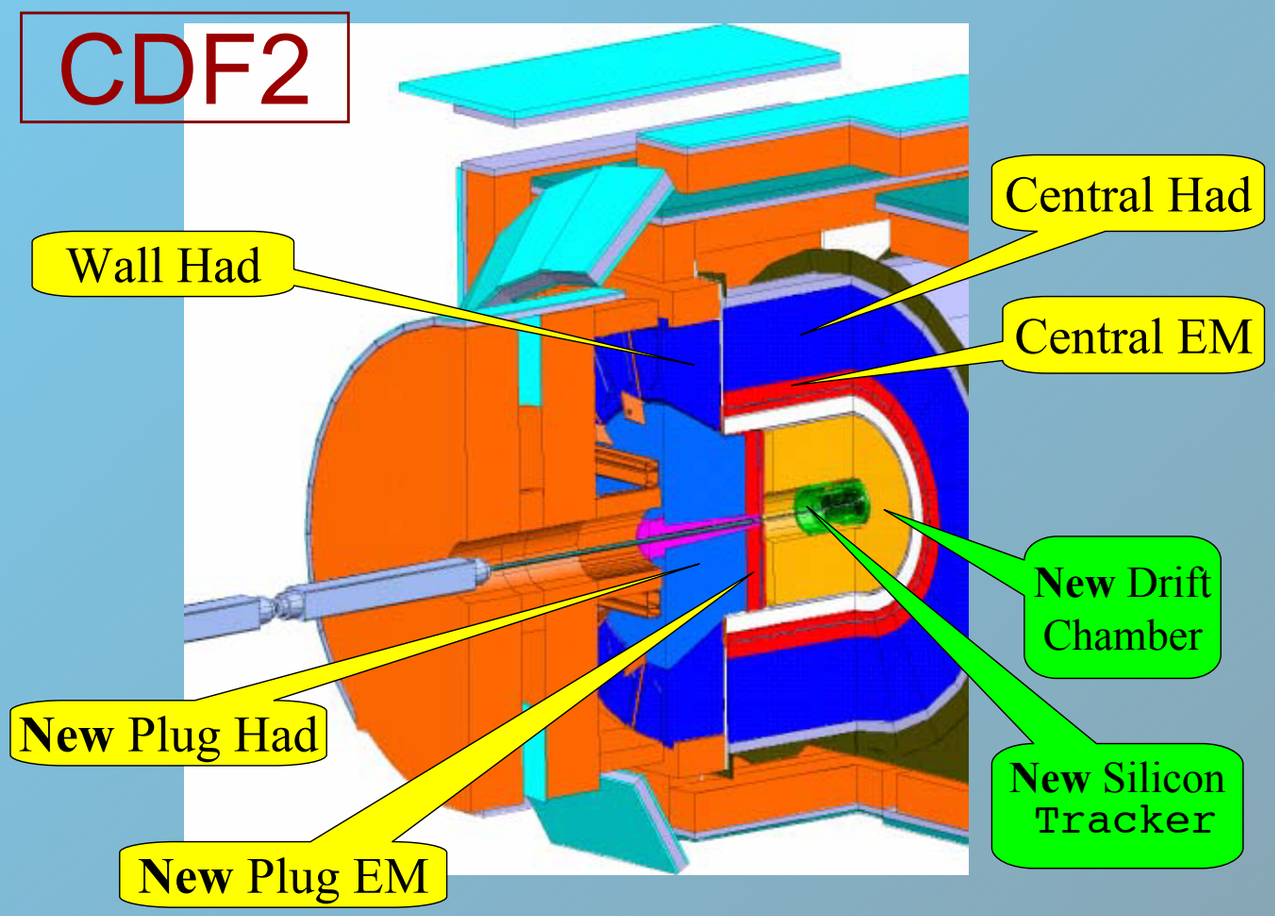
Status of the Calorimeters



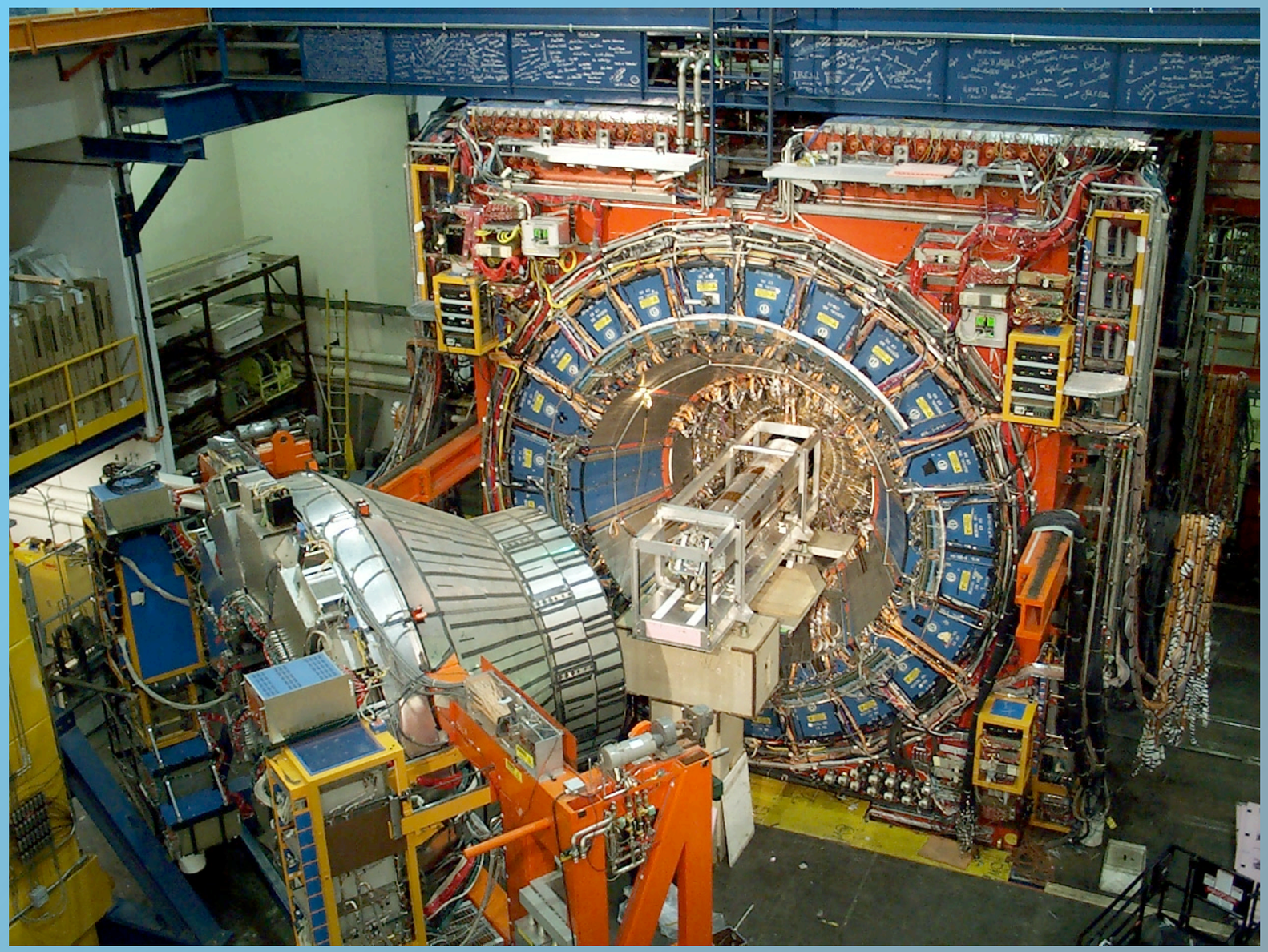
Mark Mattson
Wayne State University
for the
CDF Calorimeter Group

CALOR 2006
June 5, 2006

Plan

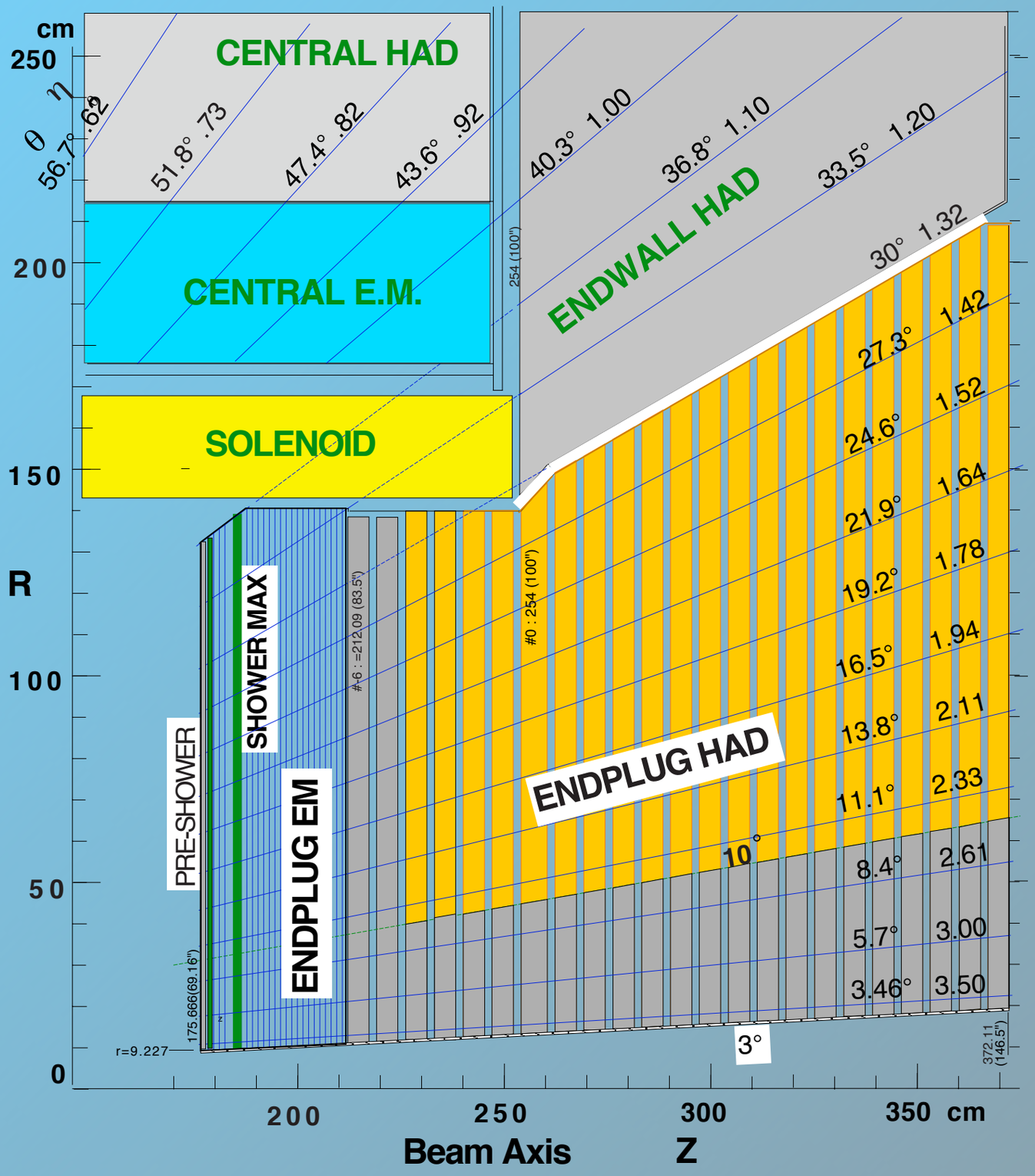
- CDF II calorimetry
  - Mix of systems made during Run I, before Run II, and upgrades since the beginning of data taking
  - Not discussing the muon detectors, miniplug (extreme forward calorimeters), or the EM-timing system (talk by Max Goncharov after the coffee break)
    - Talks on specific systems were made at multiple conferences (CALOR02, Snowmass05, etc.)
- Operational experience
  - Problems discovered during data taking
- Selected recent physics results
  - Demonstrate the calorimeter capabilities

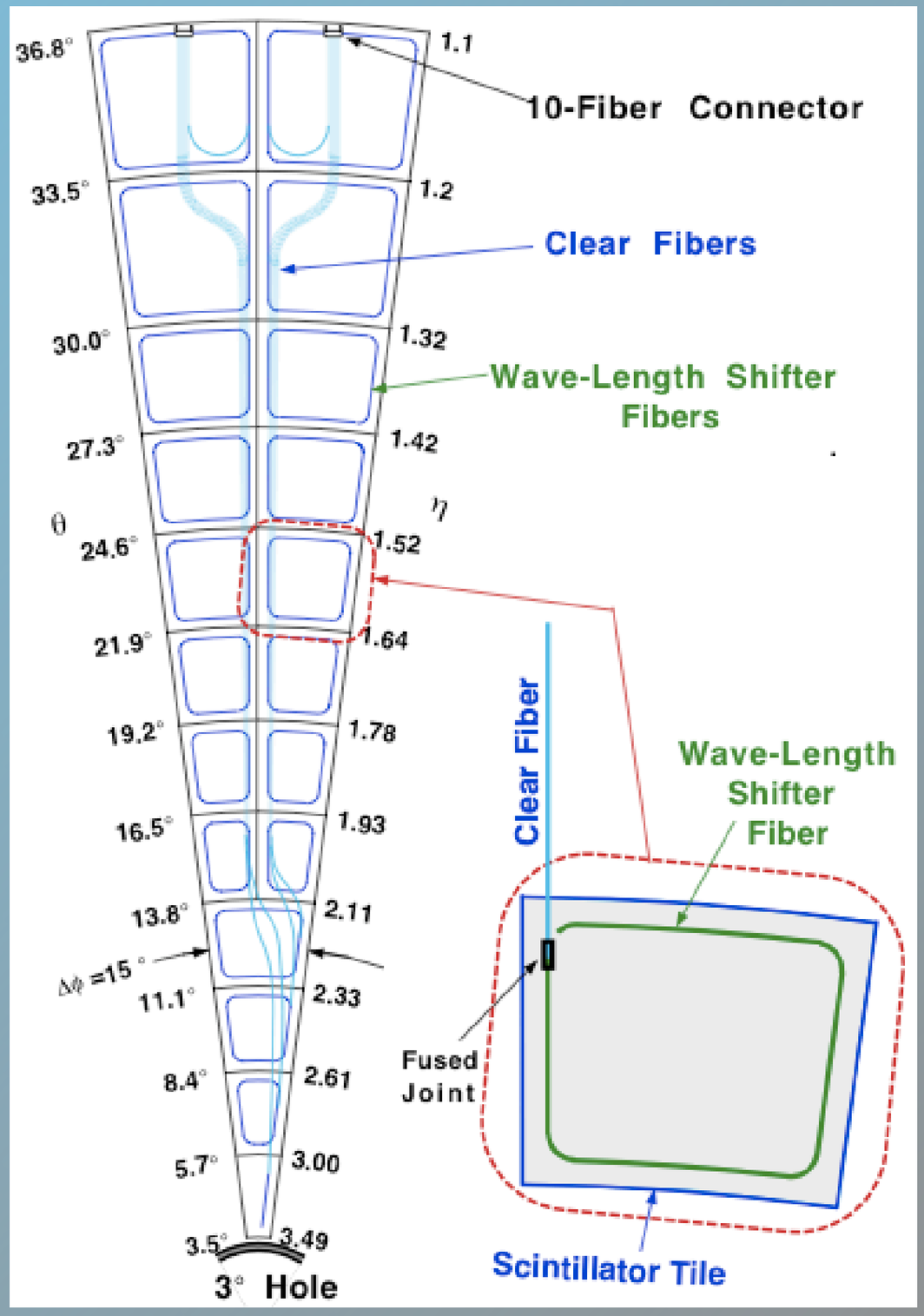
CDF II Calorimeters



- Phi - 15 degree wedges
- Same Central and Endwall calorimeters from Run I (scintillator plate with WLS bars)
- New for Run II
  - Plug Calorimeter: scintillator tile with WLS fibers replaced the Run I gas calorimetry
  - EM and HAD readout electronics
- Fall 2004
  - Central Preshower and Crack Detectors

Plug Calorimeter

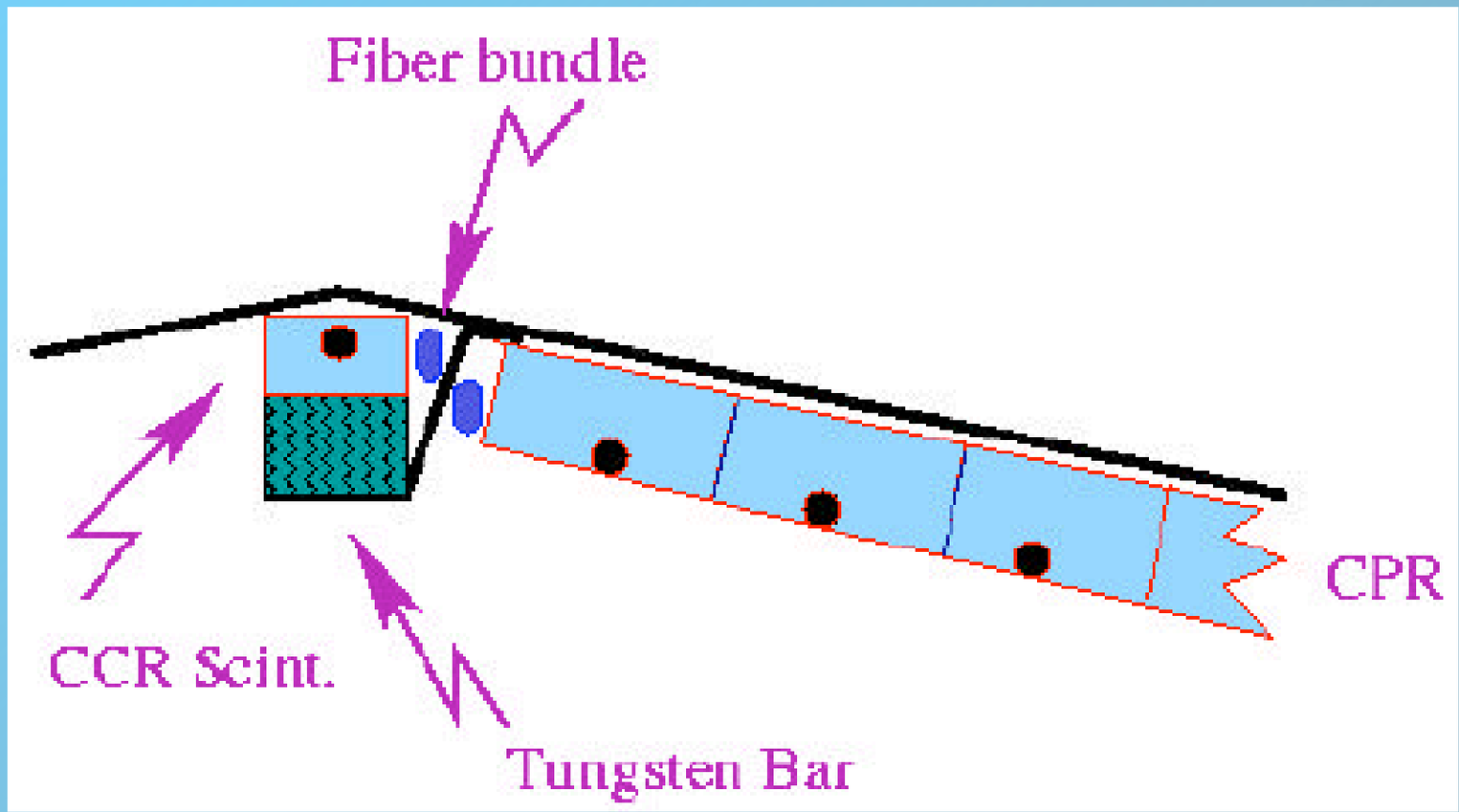


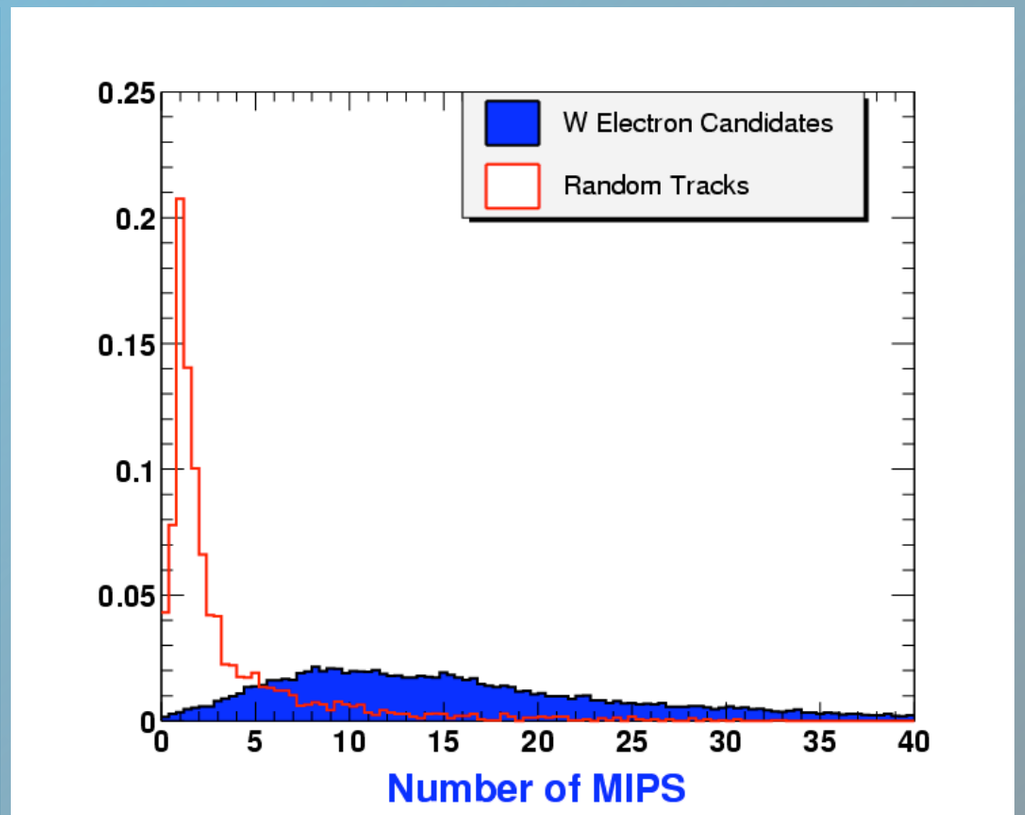


Similar Technology for Plug and Central Calorimeters

	Central (Endwall)	Plug
EM lead-scintillator sampling	18 radiation lengths $\sigma_E/E = 13.5\%/\sqrt{E} \oplus 1.5\%$ $\lvert\eta\rvert < 1.1$	23.2 radiation lengths $\sigma_E/E = 16\%/\sqrt{E} \oplus 1\%$ $1.1 < \lvert\eta\rvert < 3.64$
HAD steel-scintillator sampling	4.7 interaction lengths CHA $\sigma_E/E = 50\%/\sqrt{E} \oplus 3\%$ WHA $\sigma_E/E = 75\%/\sqrt{E} \oplus 4\%$ $\lvert\eta\rvert < 1.3$	6.8 interaction lengths $\sigma_E/E = 80\%/\sqrt{E} \oplus 5\%$ $1.2 < \lvert\eta\rvert < 3.64$
Shower Maximum (ES)	PWC for phi scintillating strips for Z ~ 2 mm res for W electrons	2 layers scintillating strip/WLS fiber 1.5 mm wire res
Pre-Shower (PR)	12.5 x 12.5 x 2 cm tiles	1 cm thick tiles shadow PEM towers

Central Upgrades





- CPR - Central Pre-Radiator, tile-fiber system similar to the Plug
  - Occupancy of existing gas Pre-shower would have been too high
- CCR - Central "Crack" gas detector
  - 7% of phi angle at edges of the wedges recovered

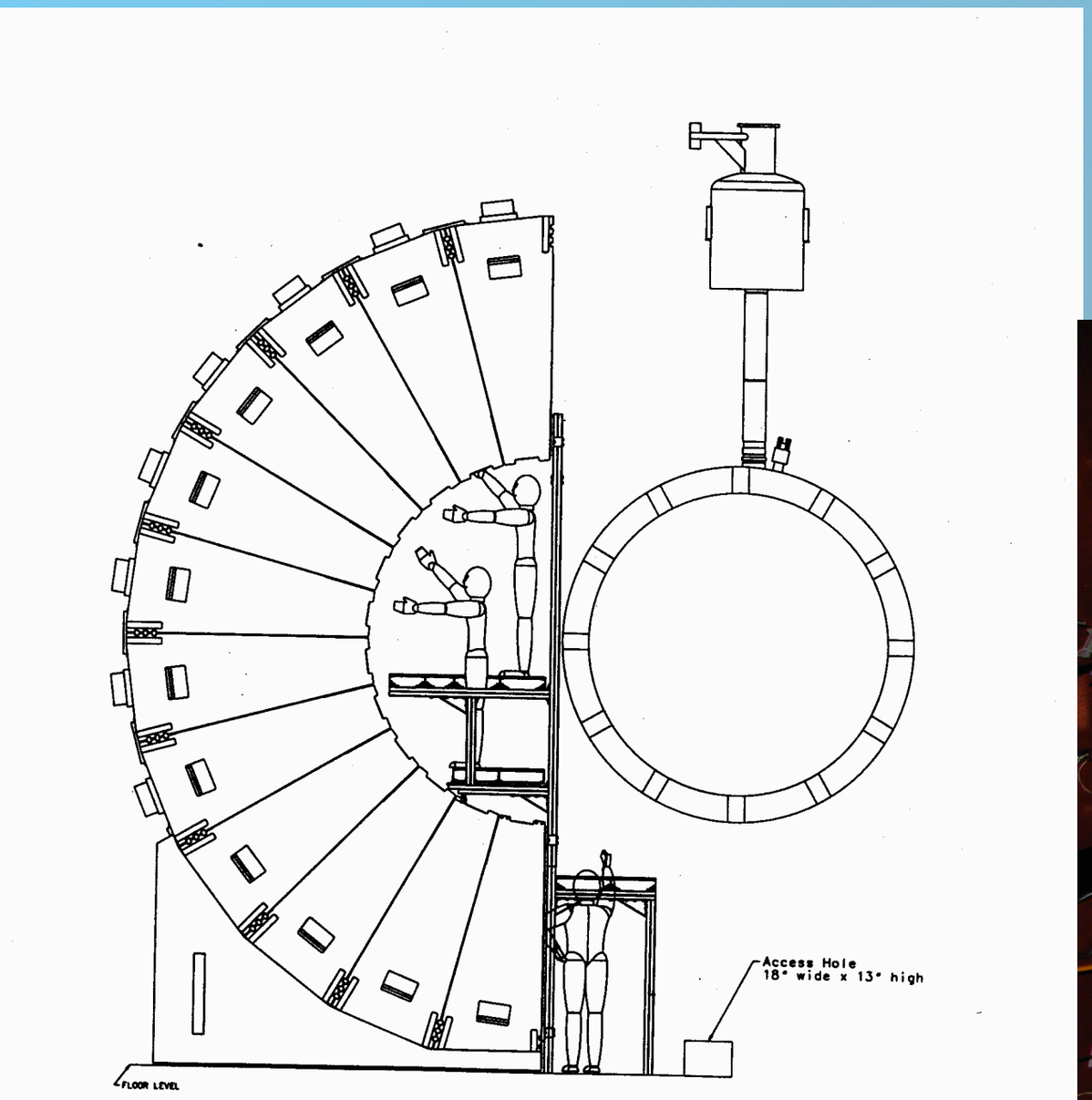
Steve Kuhlmann

(Argonne National Laboratory)

presented by: **G. Introzzi (INFN & Univ. of Pavia)**

ILC workshop - Snowmass - August 23, 2005

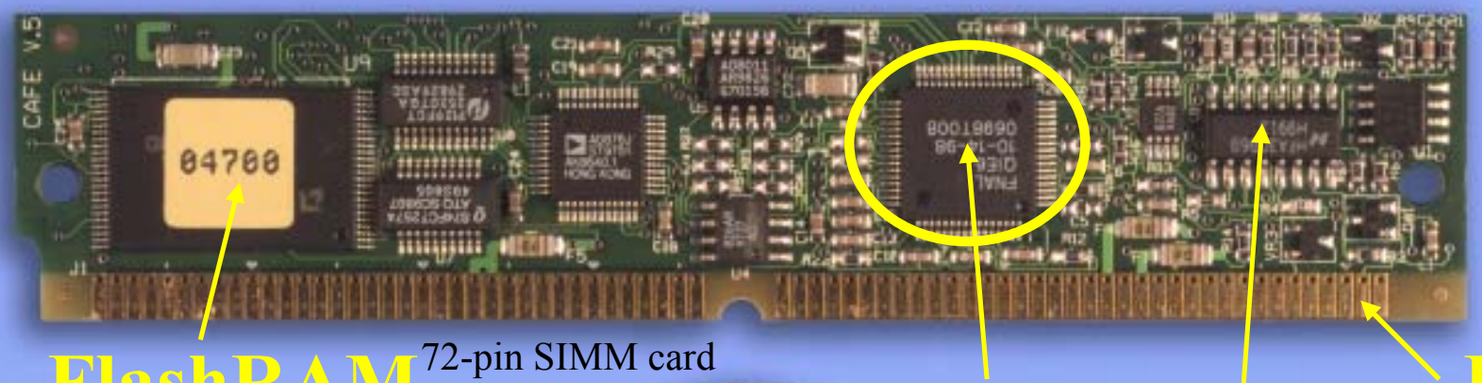
Pre-shower / Crack Detectors



Front End Readout Electronics

Front

CAFÉ = Calorimeter Front End



FlashRAM 72-pin SIMM card

QIE6

Current Buffer

Input

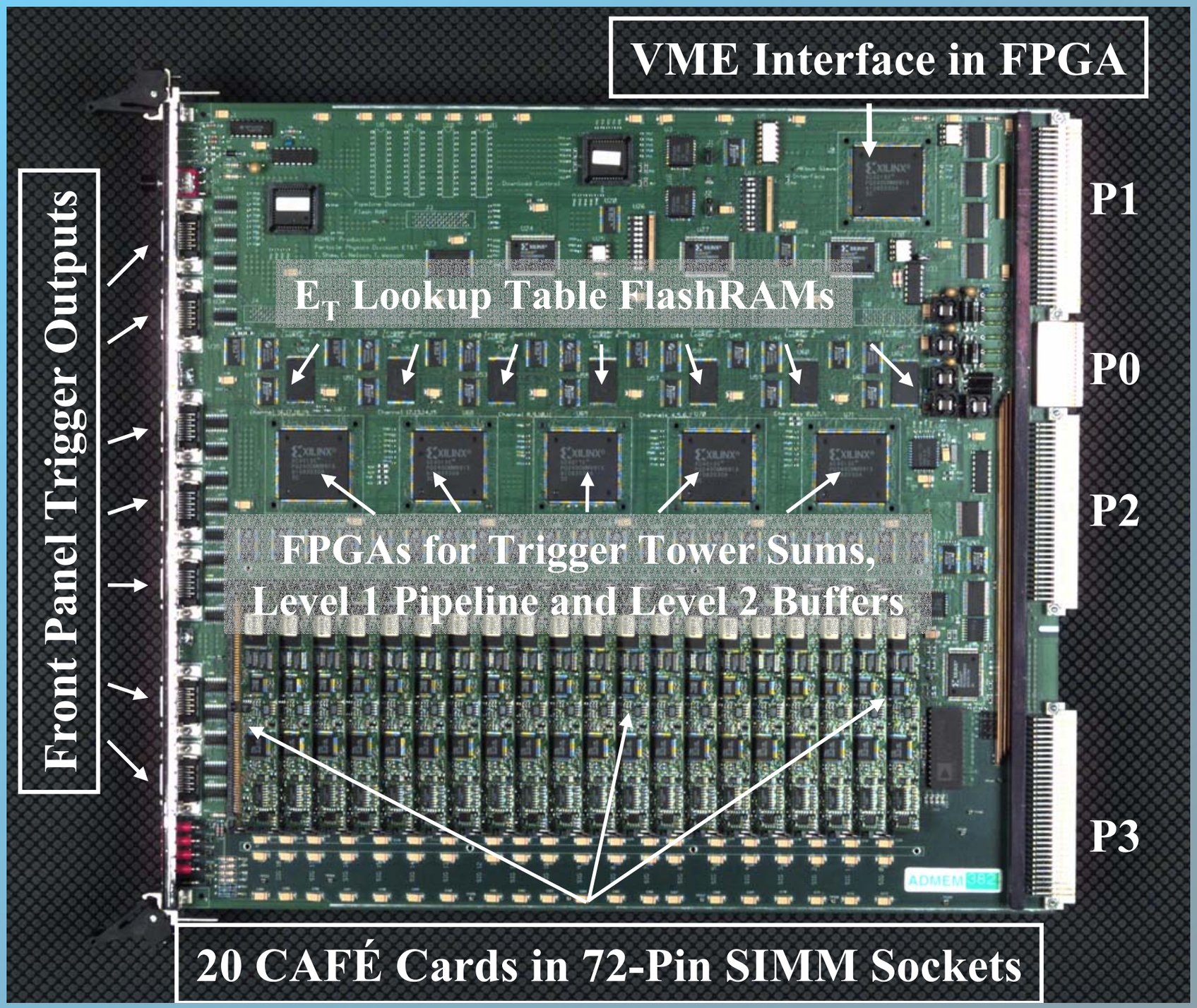
Source Current Amplifier

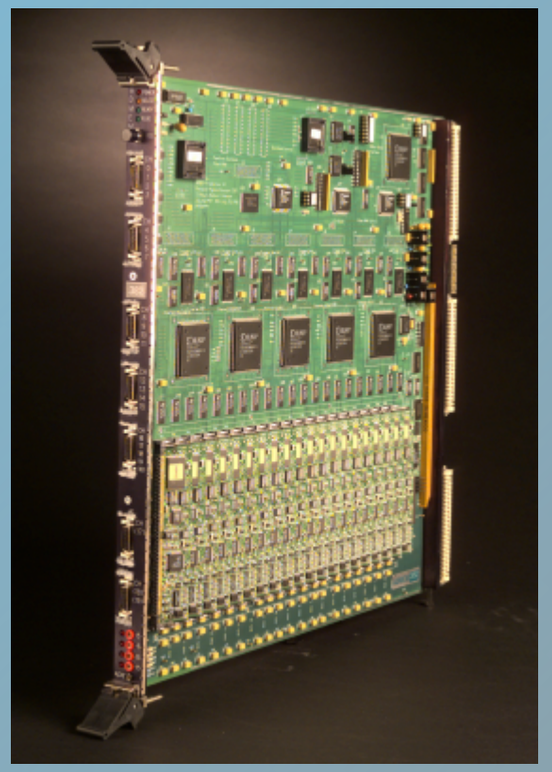
Calibration Curr. Source

Back

- 800 GeV range
- Low noise: 5-6 MeV for PEM/ PHA
- 132 nsec charge integration
- QIE6: 10 bit ADC
- 4416 CAFEs in detector hall

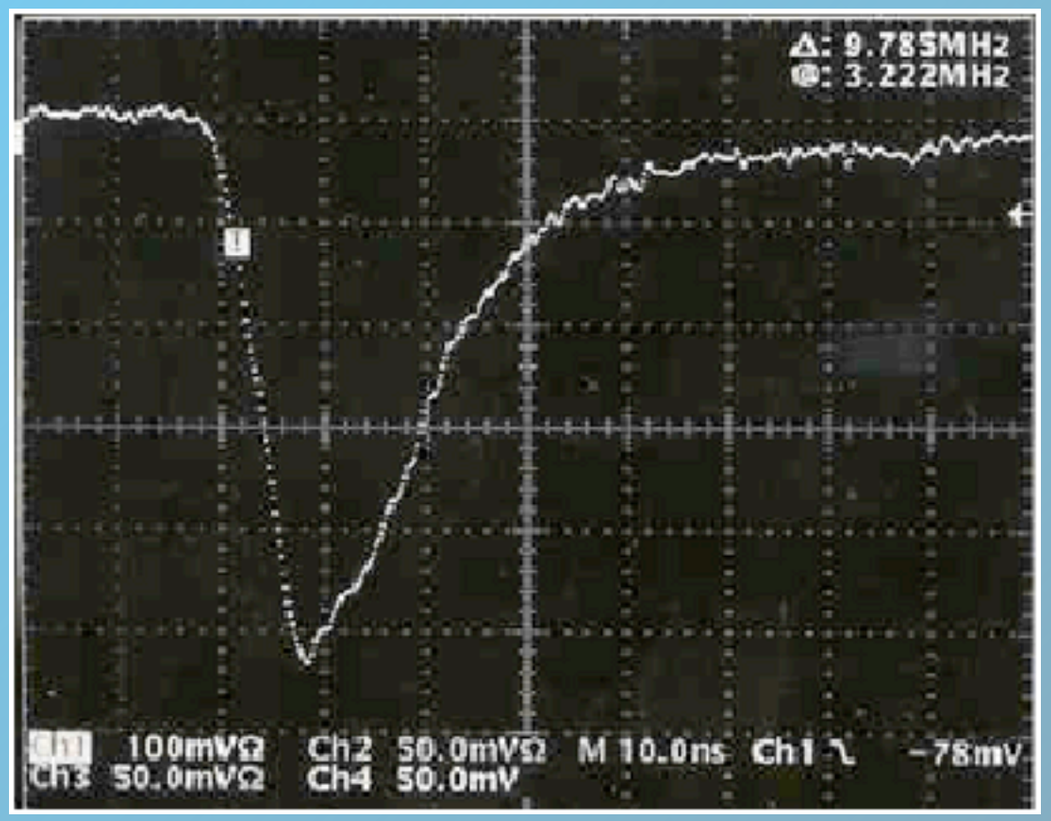
Readout Electronics





- Holds all of the CAFE cards for a wedge of the system
- Digital tower sums for L1 trigger
- Nearly no deadtime
- 240 ADMEMs in detector hall

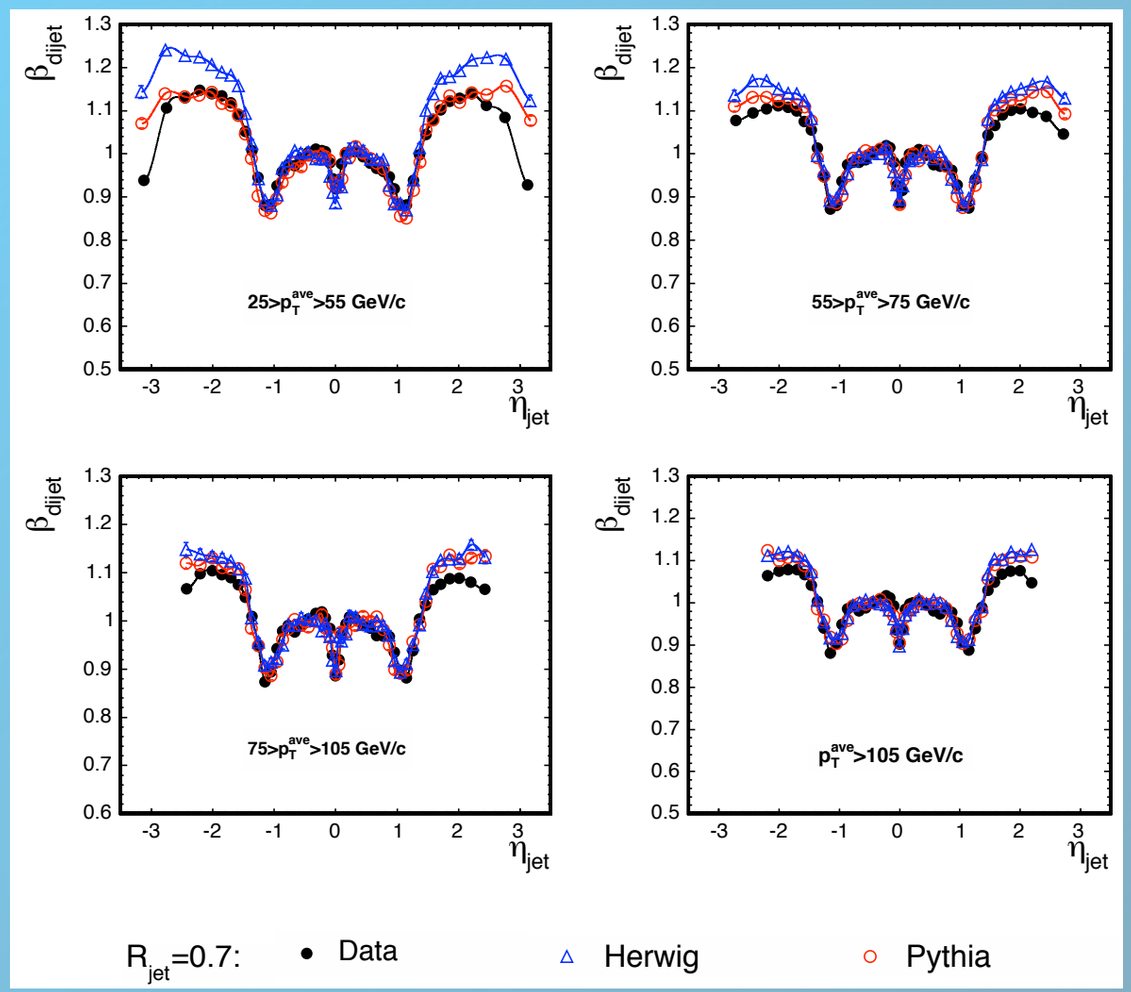
FER Operational Issues

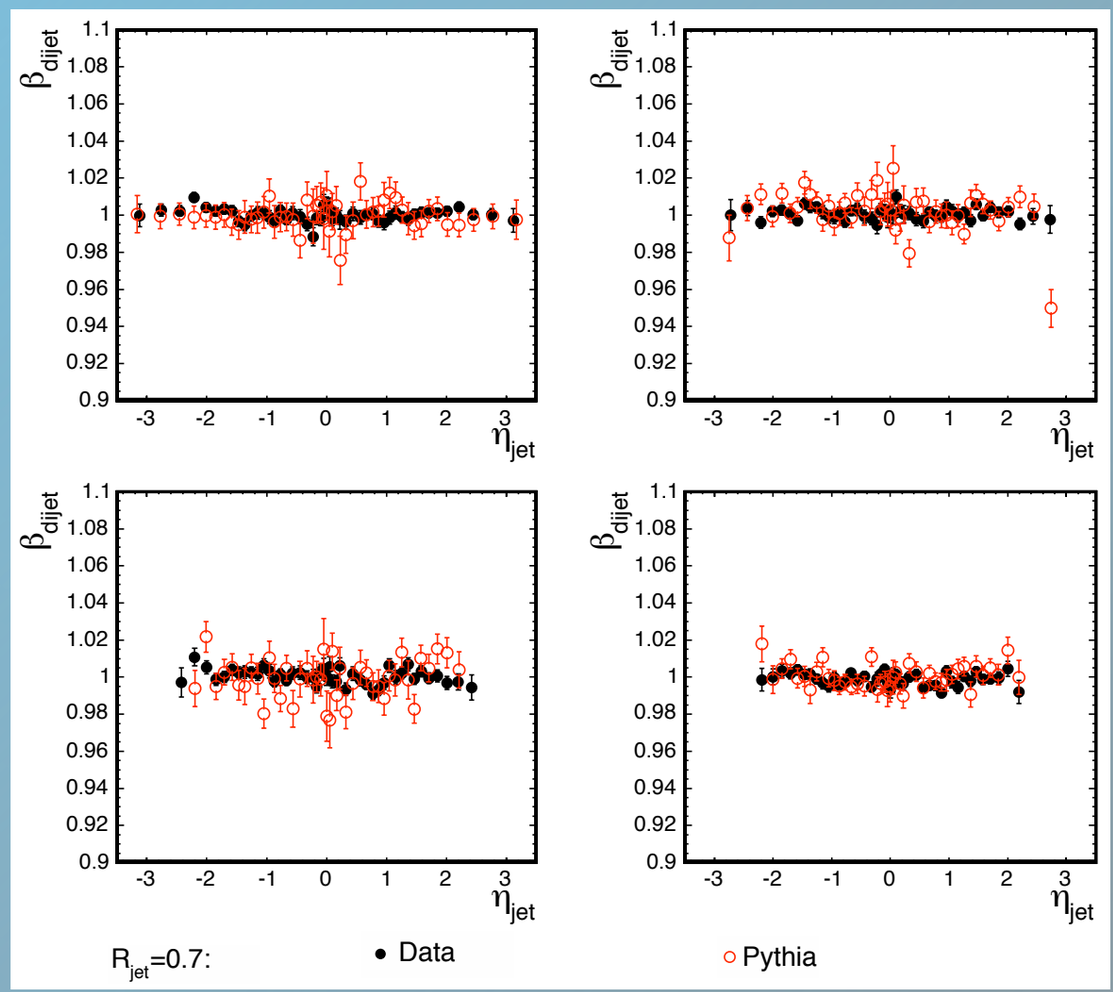


150 GeV test beam PHA
FWHM 20 nsec

- 132 nsec charge integration gate collects 93.6% (HAD) or 97.4% (EM) of the charge
- CALOR02 reported failure rate
  - CAFE ~0.65% per year, (~30 units)
  - ADMEM ~3% per year (~8 units)
- Current failure rate is about half of that
  - would be even less, if not for the rare unscheduled power outages

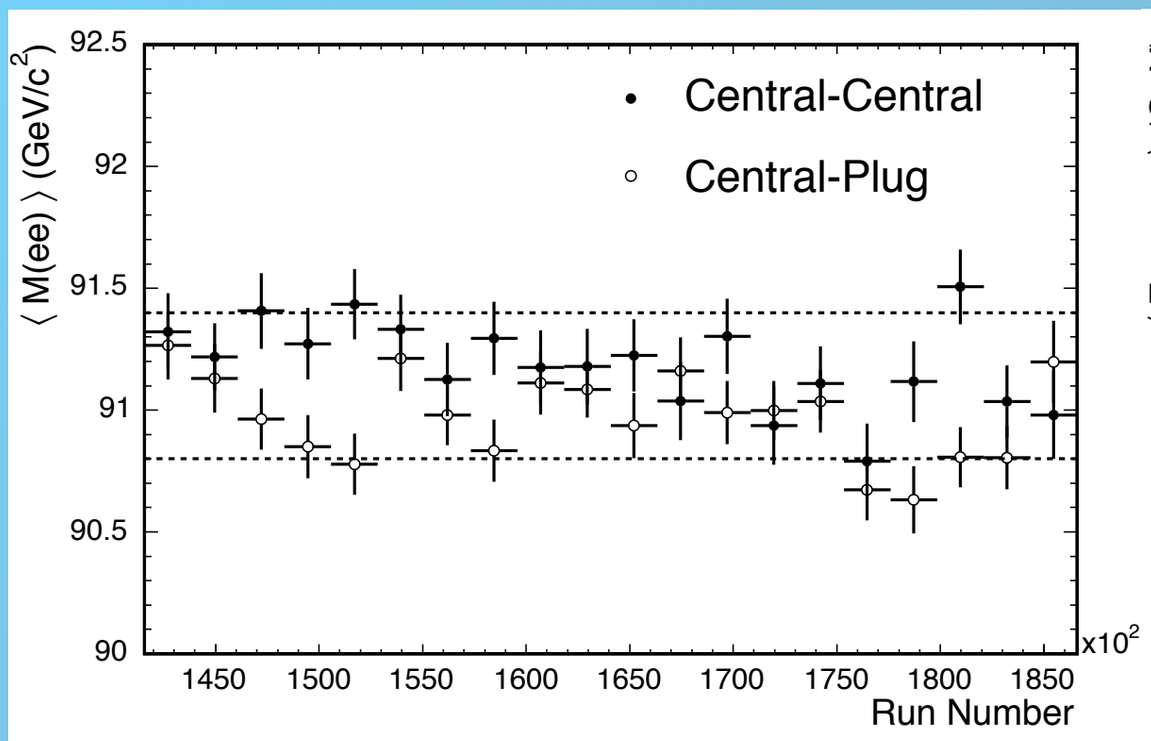
Jet Energy Scale

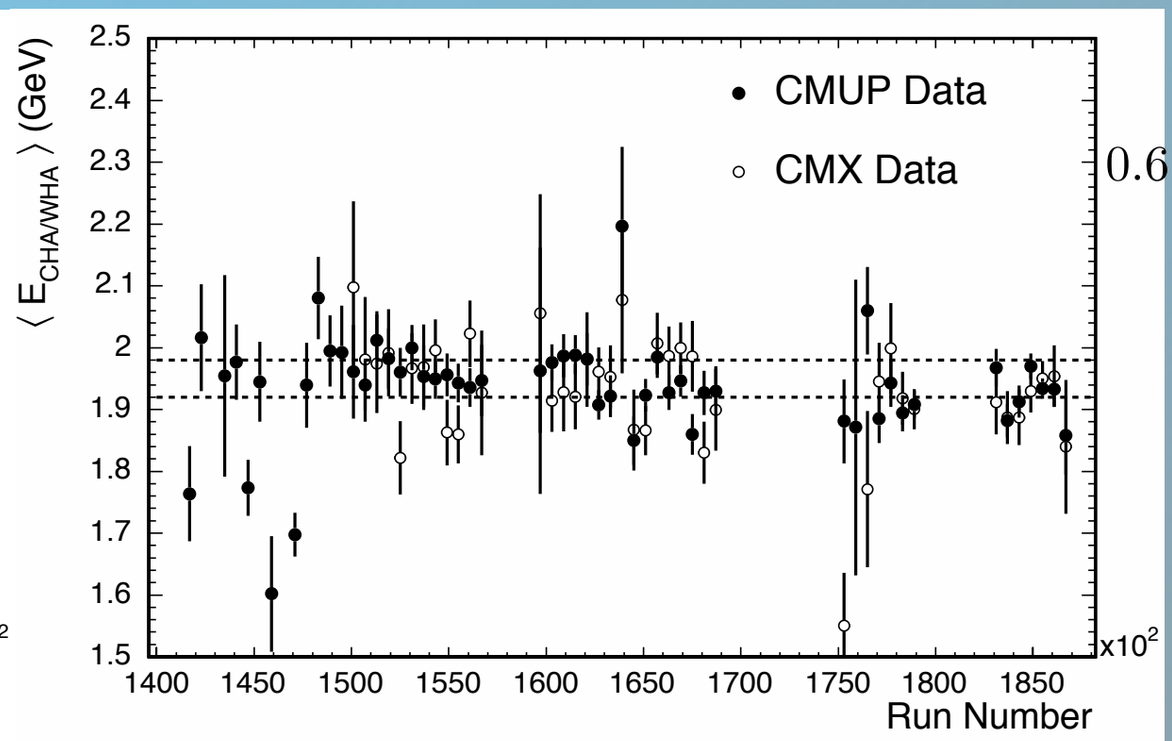




- "Determination of the Jet Energy Scale at the Collider Detector at Fermilab", NIMPR accepted (hep-ex/0510047)
- EM tested with Z -> ee
- Had tested with 60 GeV pion test beam

Jet Energy Scale



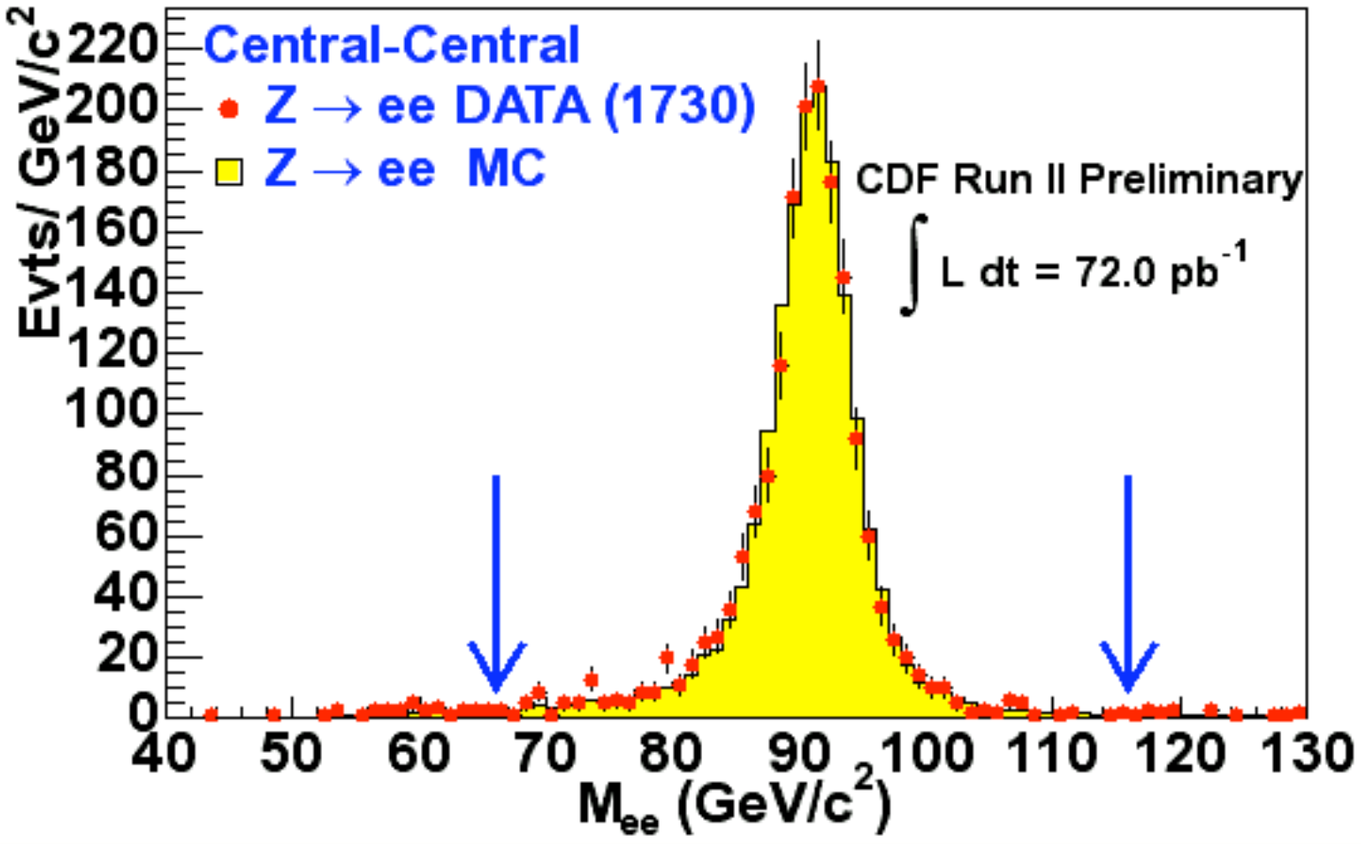


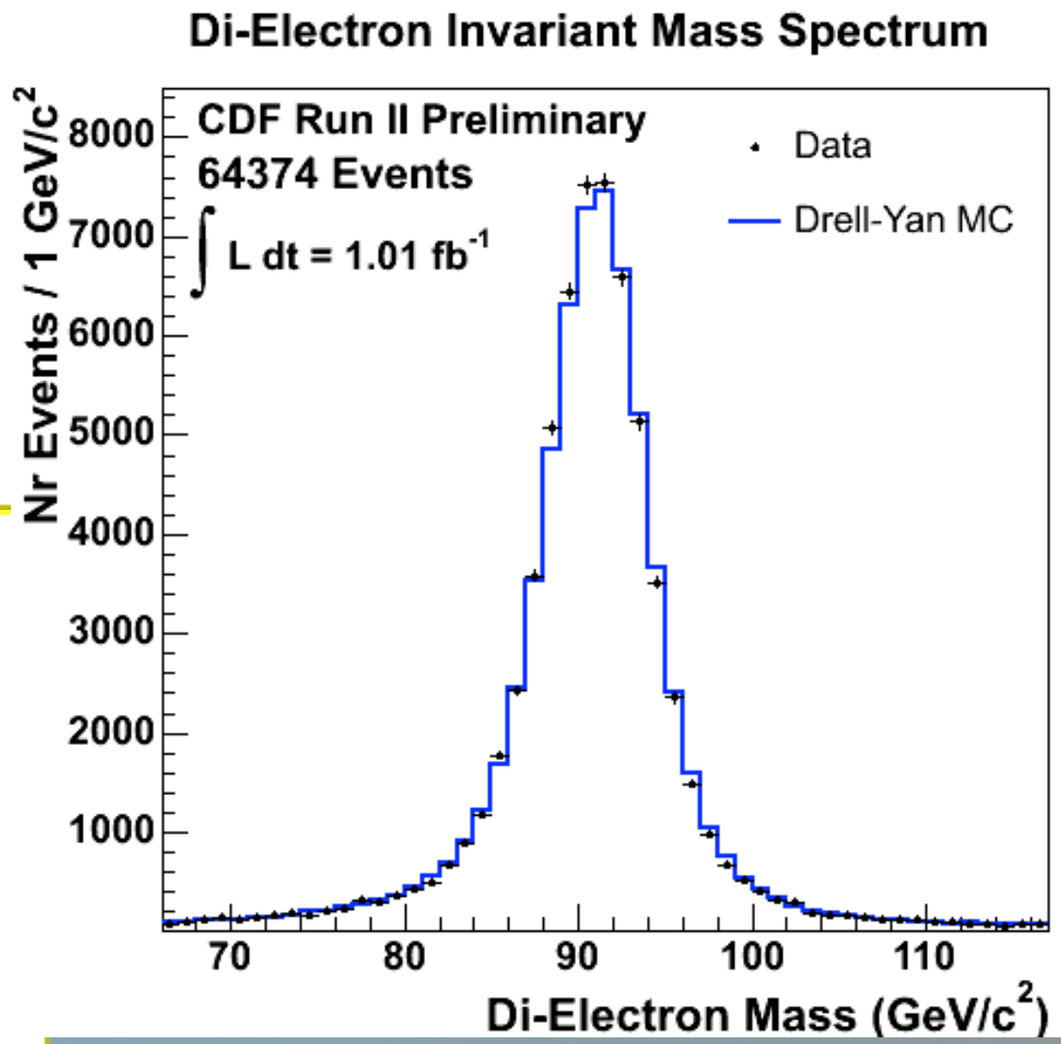
$|\eta| < 0.6$

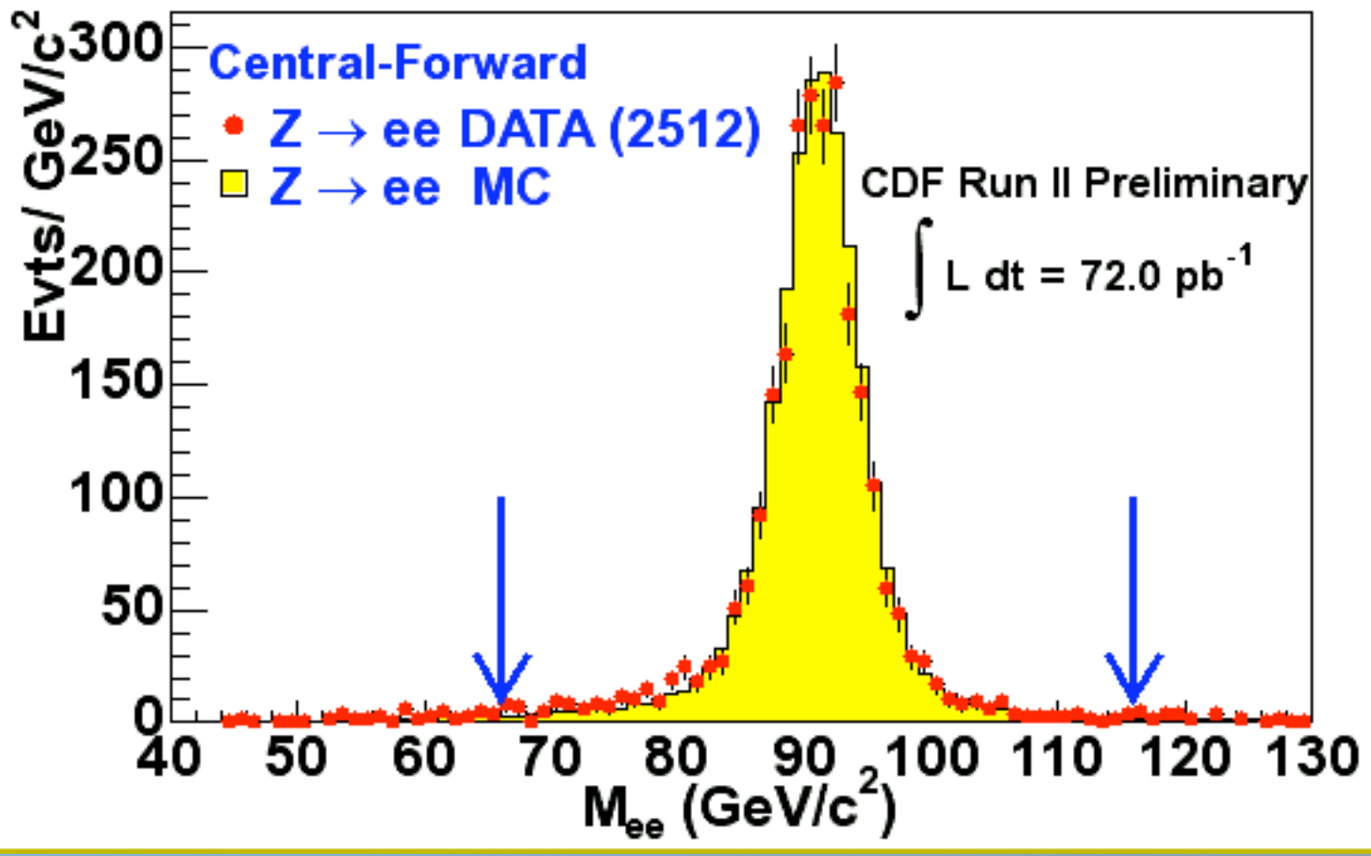
$0.6 < |\eta| < 1.0$

April 2002 - September 2004

- Pedro Movilla Fernandez will discuss the CDF calorimeter simulation
- Z mass stable versus time to within 0.3%
- Mean muon energy from W->mu nu candidates within 1.5%
- For more information, refer to the paper
  - www-cdf.fnal.gov/physics/new/top/public/jets/cdfpublic.html

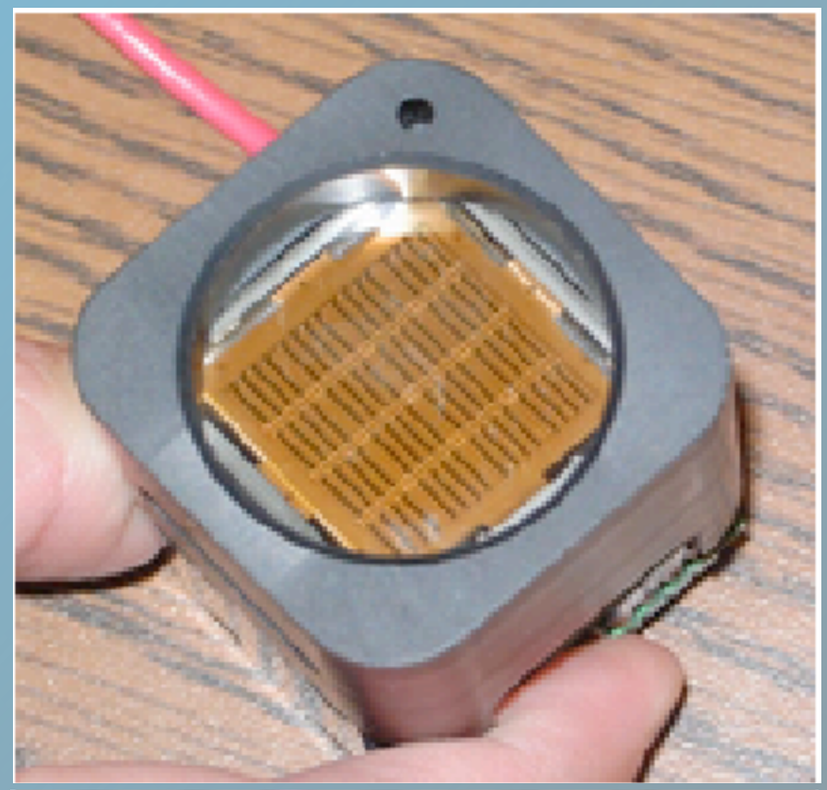

Central-Central
Z → ee DATA (1730)
Z → ee MC
CDF Run II Preliminary
∫ L dt = 72.0 pb-1
Evts/ GeV/c2
Mee (GeV/c2)

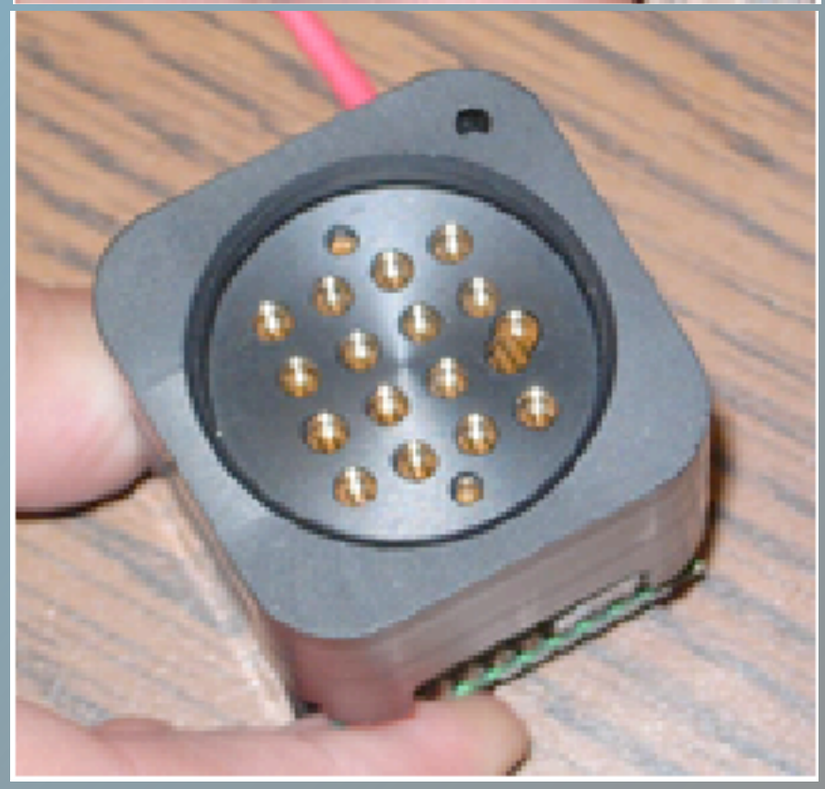

Di-Electron Invariant Mass Spectrum
CDF Run II Preliminary
64374 Events
∫ L dt = 1.01 fb-1
Data
Drell-Yan MC
Nr Events / 1 GeV/c2
Di-Electron Mass (GeV/c2)


Central-Forward
Z → ee DATA (2512)
Z → ee MC
CDF Run II Preliminary
∫ L dt = 72.0 pb-1
Evts/ GeV/c2
Mee (GeV/c2)

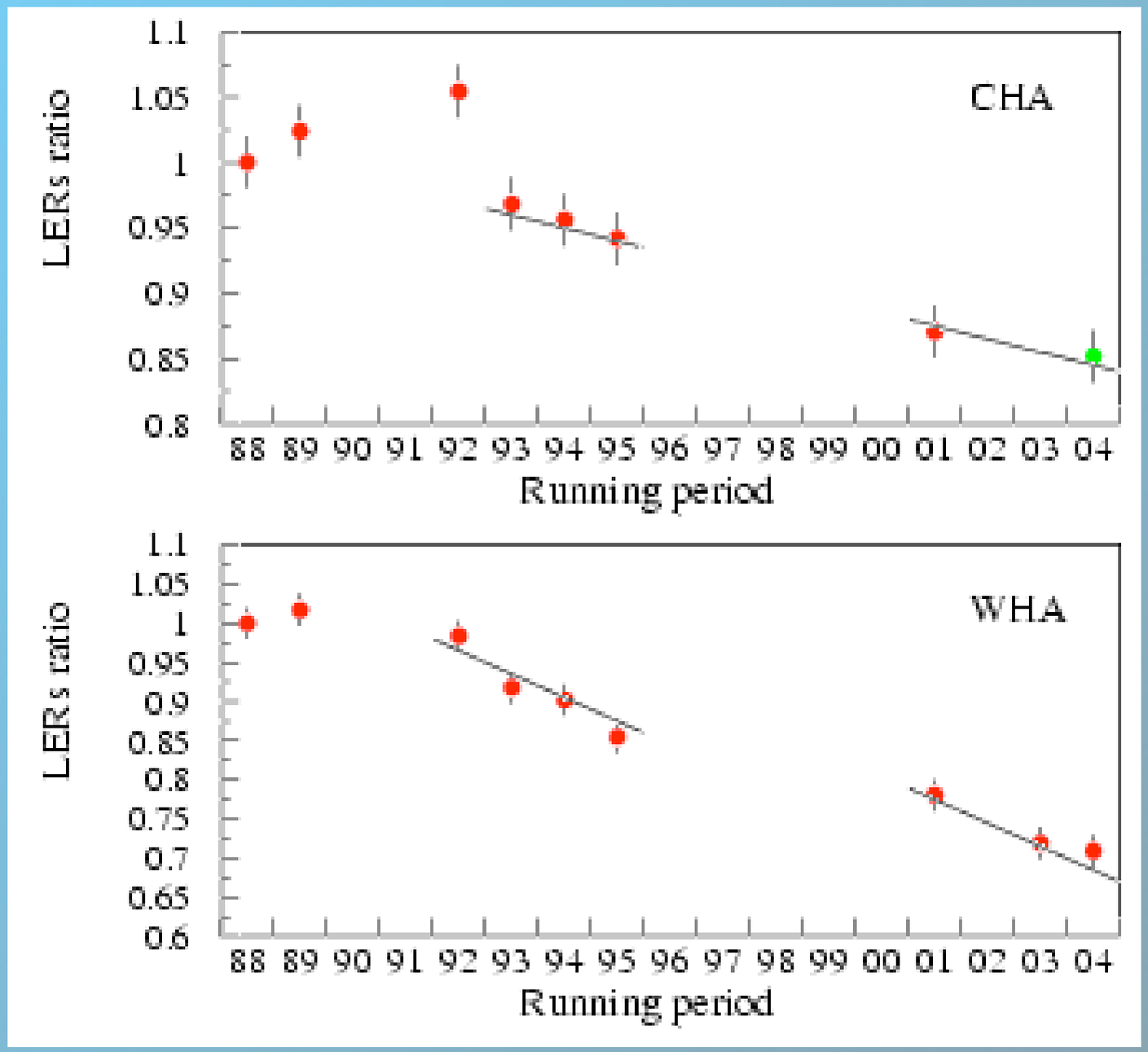
Cross-talk for MAPMT

- Gap between fiber cookie and MAPMT for the PES was slightly larger than expected
  - 2.5mm, compared to 1mm for test stand
- 1 mm fibers
- Cross-talk was 6%, expected ~0.5%
- Installed baffles (”blinders”)
  - Crosstalk ~ 1.4%
  - Signal reduction 8.5%



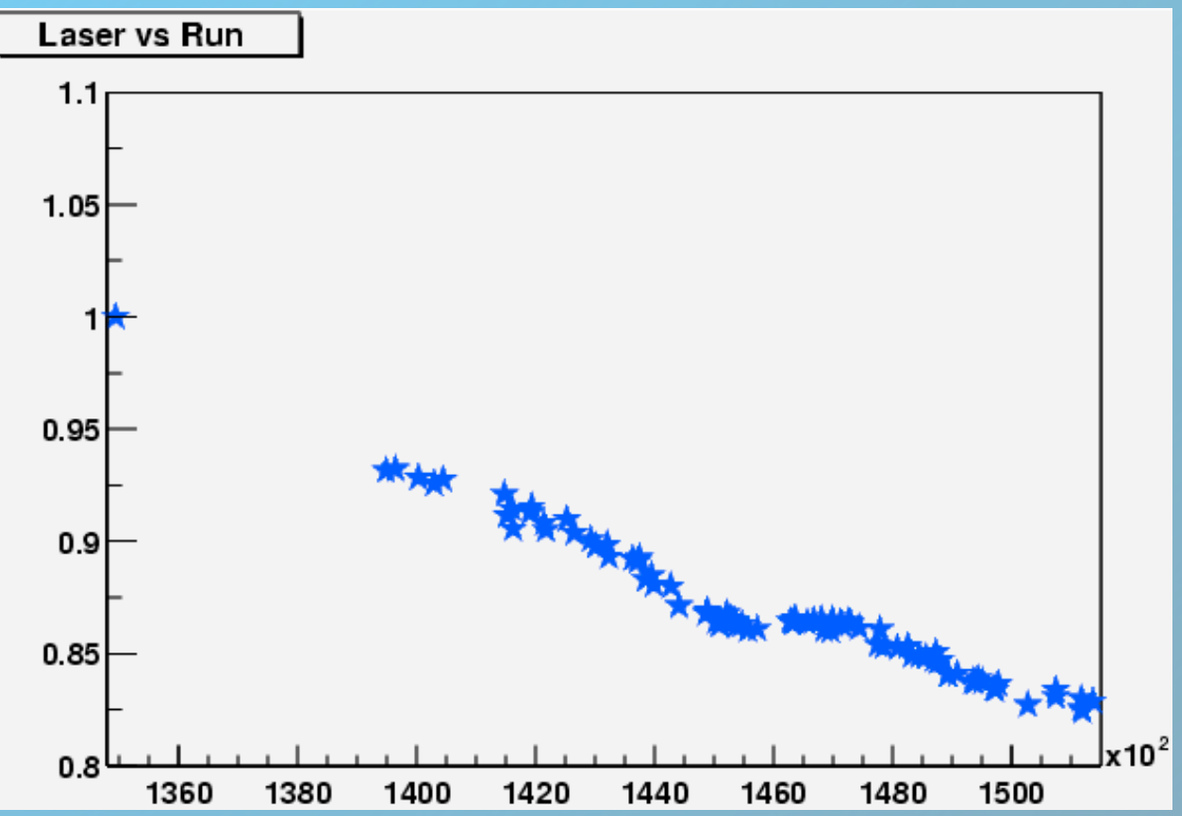


Plug PMT gain loss



- Monitor light energy response decrease, due to scintillator and PMT aging
- Unexpected PMT gain loss, largest for towers near the beamline
- Plug laser and radioactive source calibrations reveal that it is not from scintillator aging
- Not seen in the plug showermax (PES) or pre-shower (PPR) detectors

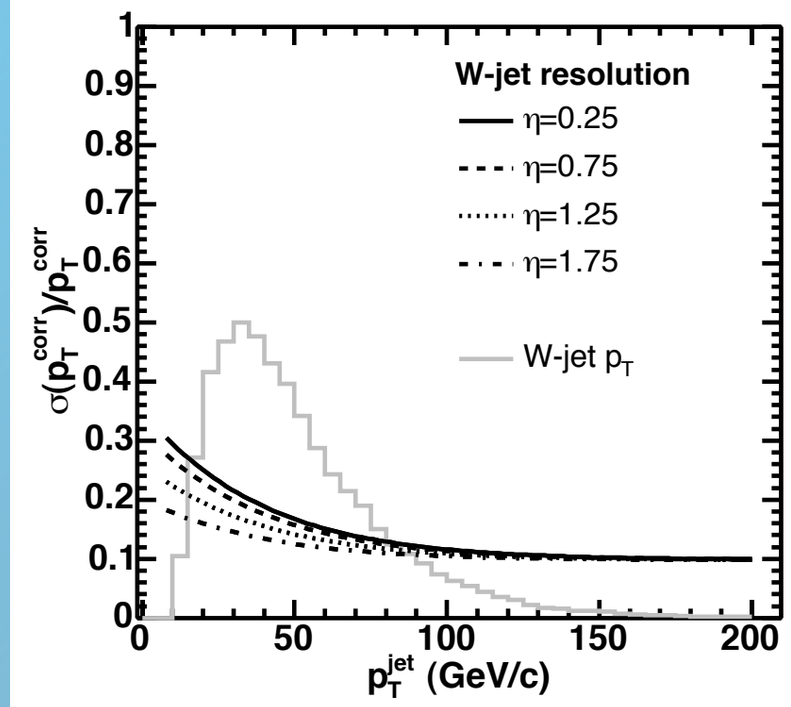
PMT Gain Loss

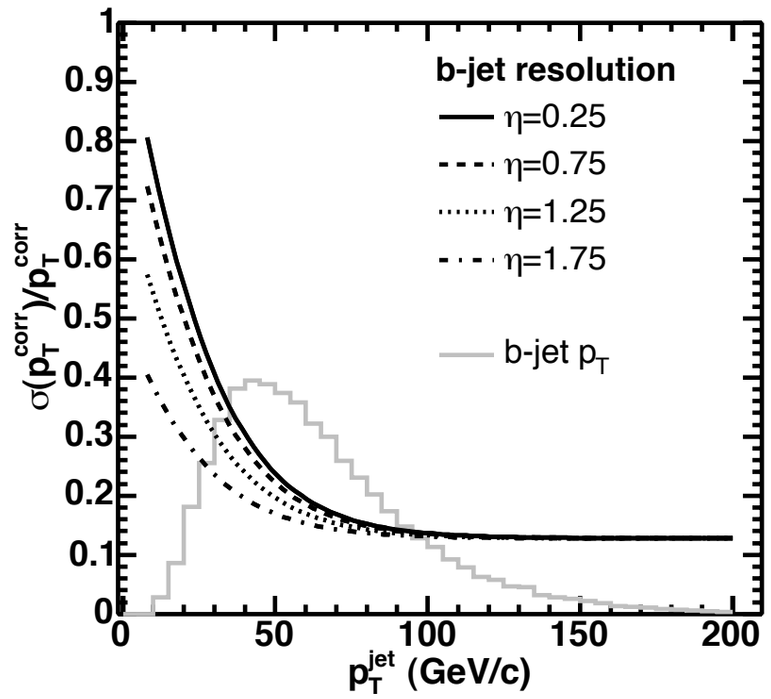


Tower gain drops seen in laser calibration in a 3 month span in 2002

- Reduce integrated charge
  - Lower gains for high eta tubes
  - Leave HV on standby during beam scraping
- Didn't eliminate the problem, but gain loss is acceptable for running through 2009
  - Low eta towers: 1% loss in 2002, 3% loss in 2003
  - High eta towers: ~20% loss in 2002, 8% loss in 2003
- Not completely understood

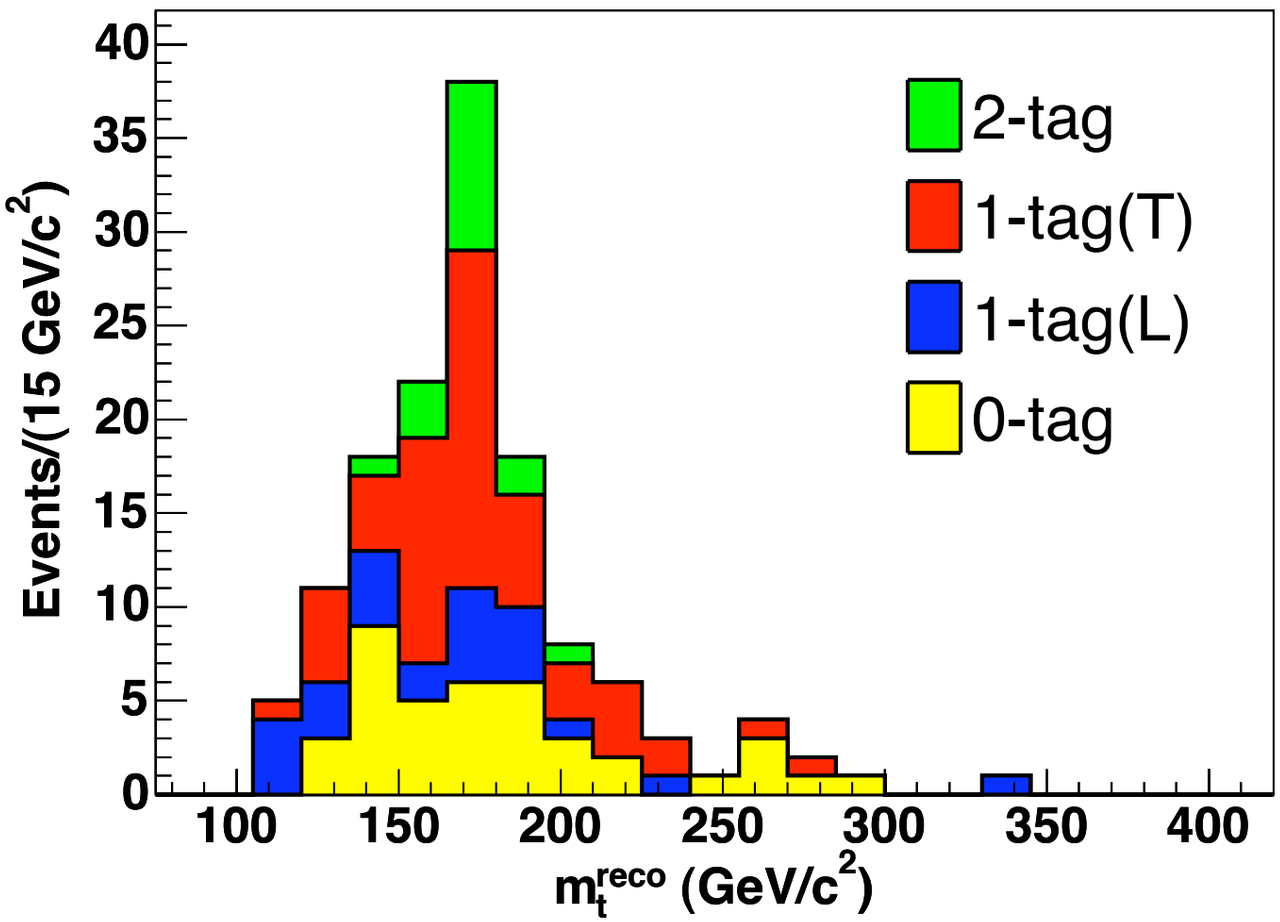
Selected Results

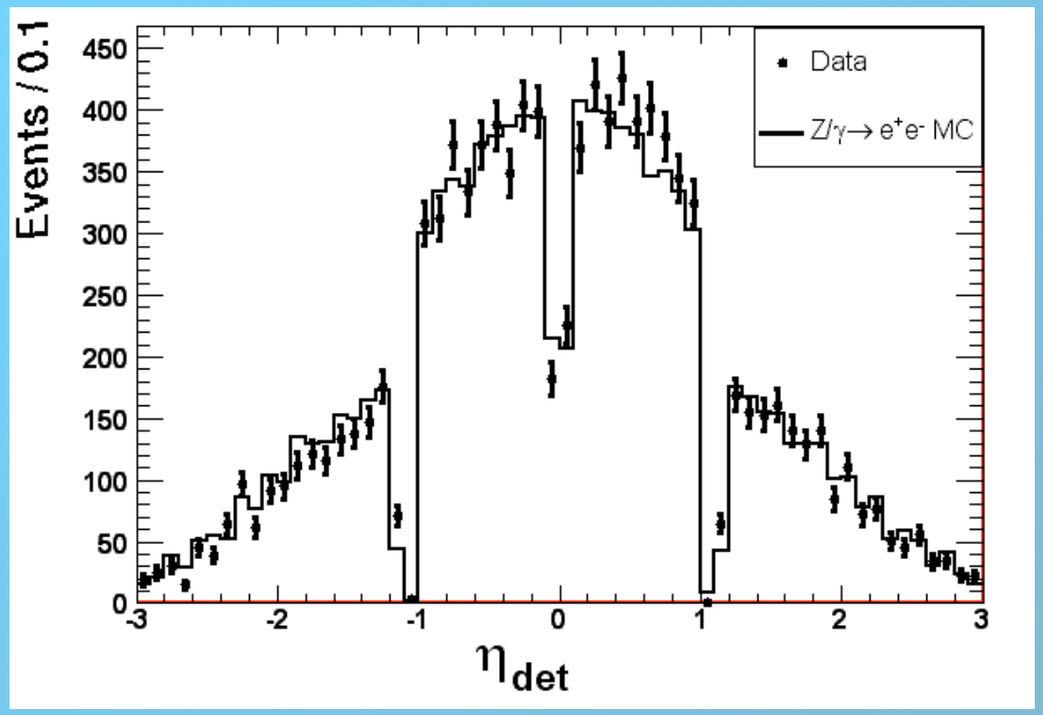




"Top Quark Mass Measurement Using the Template Method in the Lepton + Jets Channel at CDF II"

Phys. Rev. D. 73, 032003 (2006)





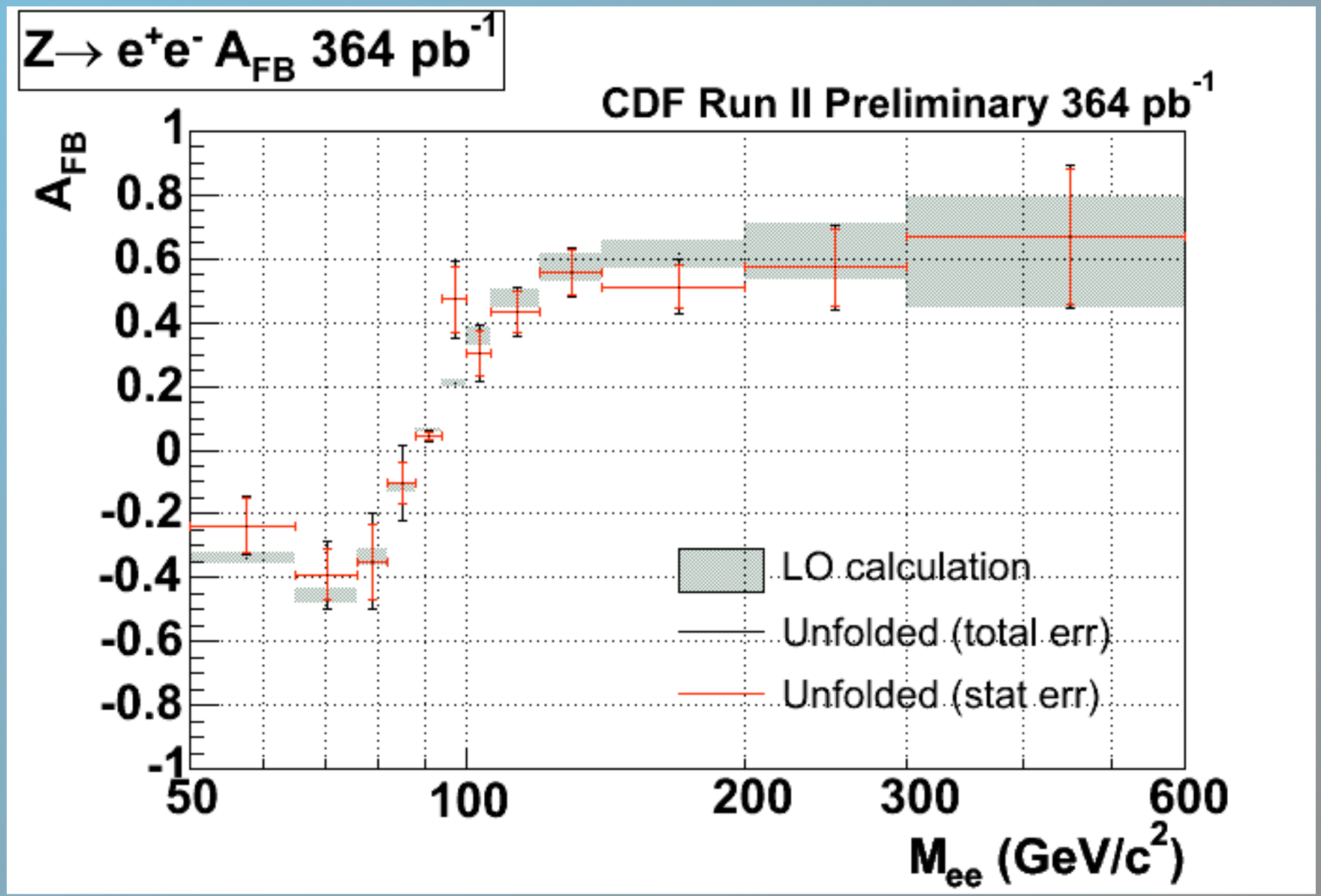
"Measurement of the forward-backward charge asymmetry of electron-positron pairs in pbar-p collisons at sqrt(s)=1.96 TeV"

PRD 71, 052002 (hep-ex/0411059)

Recent update with 5x integrated luminosity

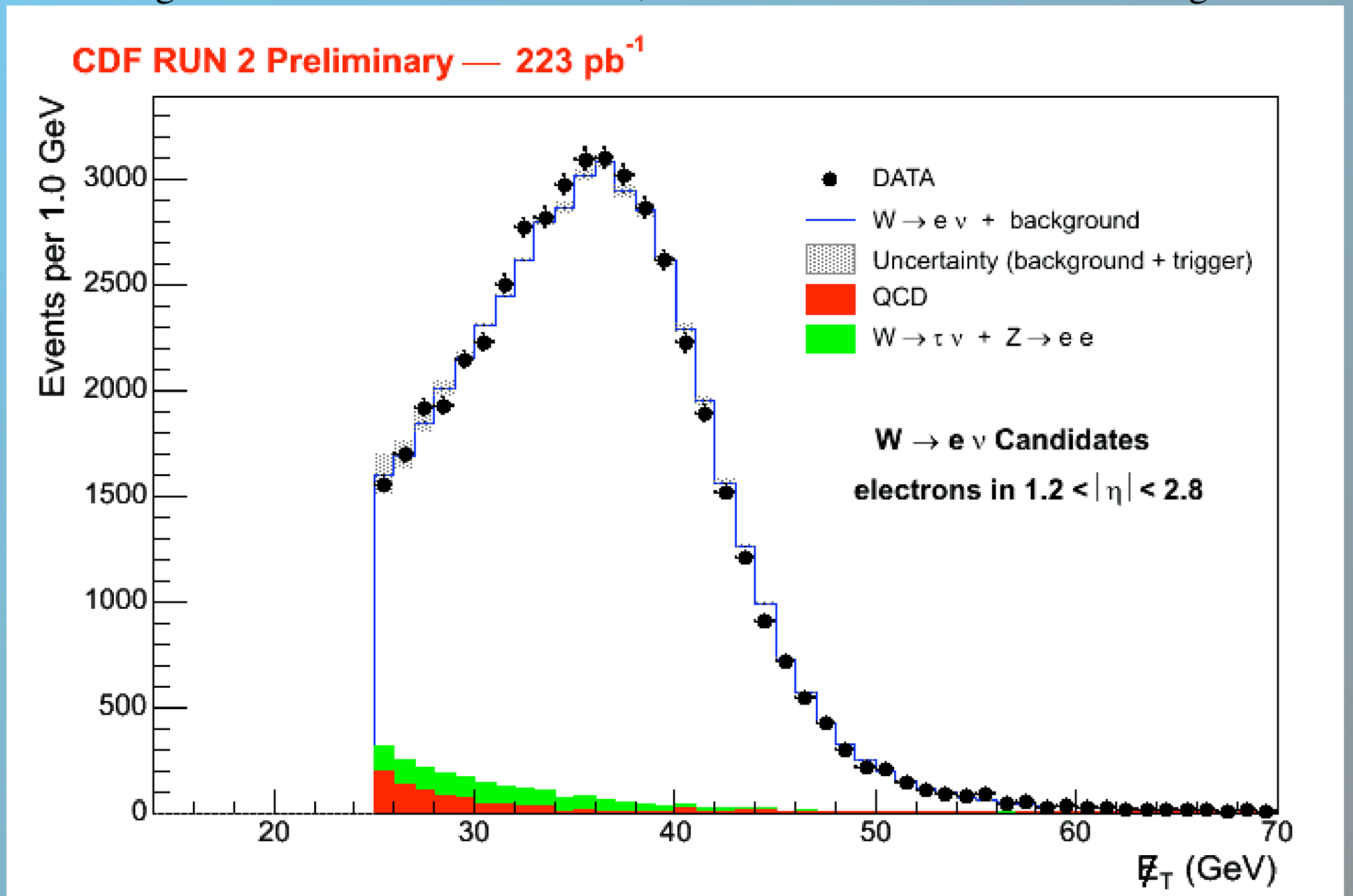
preliminary

http://www-cdf.fnal.gov/physics/ewk/2006/afb



"Measurement of sigma(p-pbar->W) x BR(W->e nu)
with electron identified by the Plug Calorimeter (1.2<letal<2.8)"
preliminary
http://www-cdf.fnal.gov/physics/ewk/2006/plugw

Cross-section consistent with results using electrons in the Central Cal only
Missing Et resembles the electron Pt, overall measurement of recoil is good



In Closing...

- Plug Calorimeter has been operating since the beginning of Run II
- All calorimeter upgrades for Run II have been completed
  - During the recent extended shutdown, only maintainance and fixes for dead channels
- Expect more results to take advantage of the upgrades
  - 380/pb --> Sept 2004
  - Results with up to 1/fb