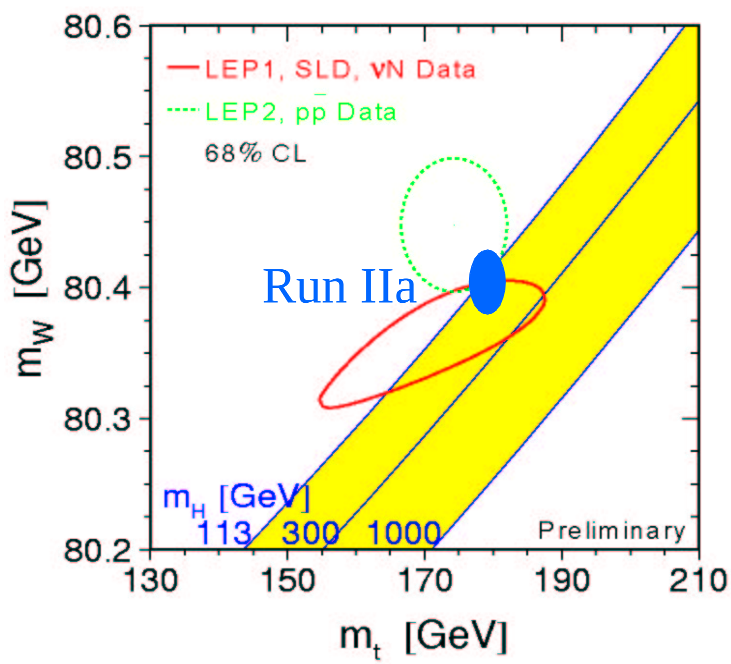
Mass measurement: monitoring the data

How important is to have a well calibrated calorimeter?
The top mass measurement is a very important contribution to testing the standard model at the Tevatron. Present status shows agreement between SM fits of data and direct measurements of MW and Mtop at the 2 σ level.

Electroweek precision measurements



Run II "projected" $\Delta M = \pm 3$ GeV

M(top) = 176.0 ± 4.2 (stat) ± 5.1 (syst) GeV

M(top) = 174.3± 5.1 GeV CDF+D0 comb.
M(W) = 80.450 ± 0.034 GeV LEP+TEV.

Run II TDR says that we will measure the mass with

ΔM(top) = ±3 GeV

This would match a measurent of the W mass with a precision of

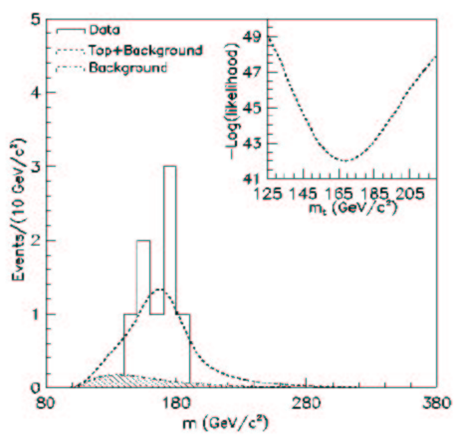
ΔM(W) = ±20 MeV

I think this is ambitious!

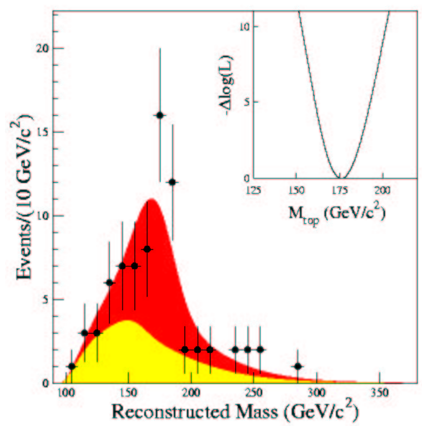
How can we improve the top mass?

Plan is to reduce the systematic error from 5.1 to 2.0 GeV

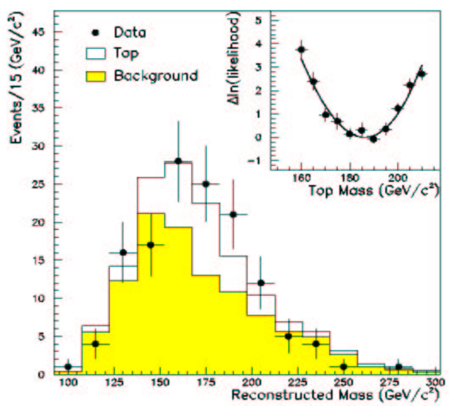
- We used three channels, major systematic error is from jets (>3.8 GeV)



Dilepton, Nev= 8(6.7)



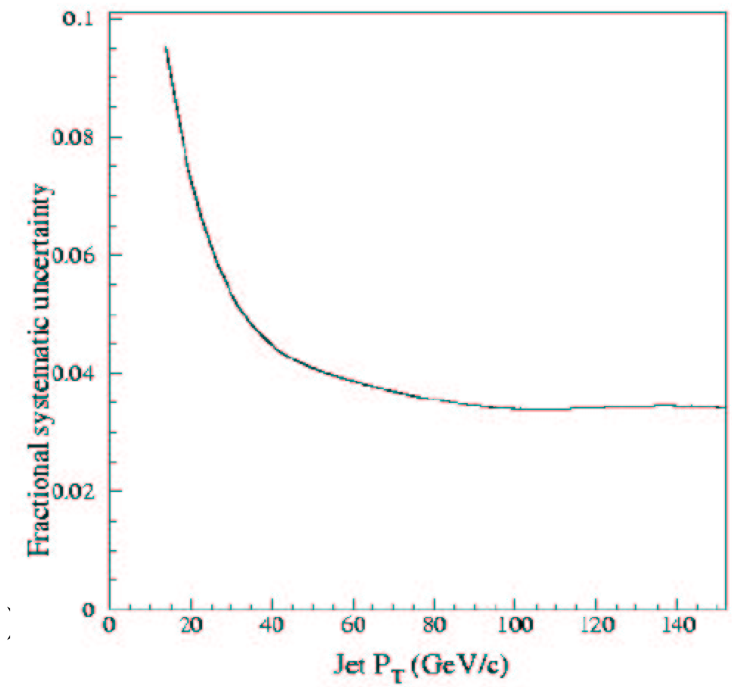
l+jets, Nev=76(40)

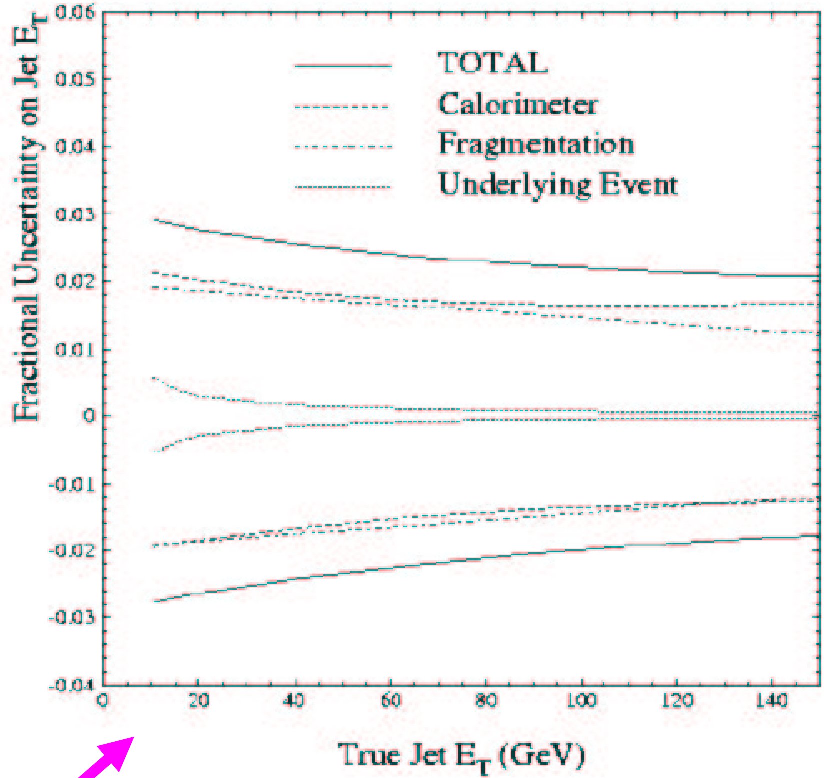


All−had, Nev=187(45)

Channel	dilepton	l+jets	all−had
Mass (GeV)	167.4 ±10.3±4.8	175.9±4.8±5.3	186.0 ±10.0±5.7
Systematic errors:			
Jet energy scale	3.8	4.4	5.0
ISR, FSR	2.7	2.6	1.8
Monte Carlo (gen,sim)	1.1	0.5	1.0
Background shape	0.3	1.3	1.7

Calorimeters systematics on top mass





Major systematics from jets (cone=0. .,

Calorimeter stability	1%
Absolute corr. (+UE) :	2.5%
Relative correction	0.2%, 4% in cracks
UEM (UE from mul. int.)	100 MeV/vertex
OOCC (exp to 55, >55)	6−1.4%

Calorimeters systematics on top mass

- Calorimeter Stability : 1%

  1% ⟶ $\Delta M_t = 0.66\% \; M_t = 1.2$ GeV

- Absolute corrections : 2% $\Delta M_t = 2.4$ GeV

  This sets the E−SCALE, includes:

  calorimeter non linearity uncertainties

  cracks in central calorimeter, etc.

➢ We need to keep the stability to at least 1%

➢ We need to reduce the uncertainties due to non−linearity and possibly cracks (more data)

➢ Will use additional data to reduce the systematics on the E−scale

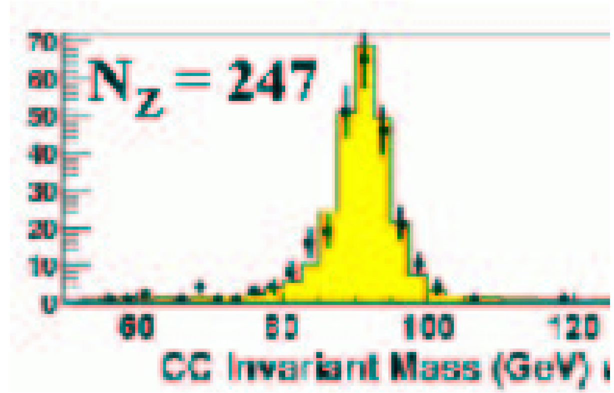
  Z ⟶ b−bar

  gam−jet balance

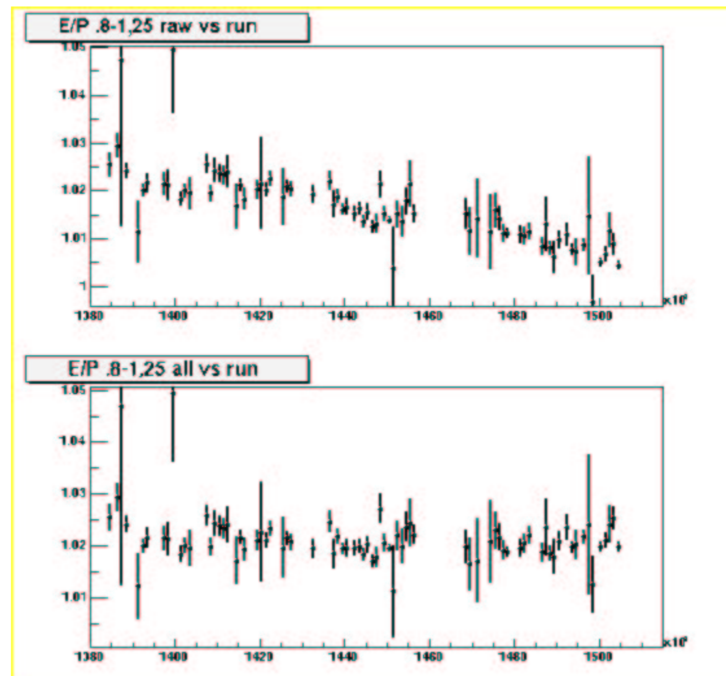
  Z−jet balance

Calorimeter stability to 1% issue

- CEM scale
  known with <2% uncertainty.
  Use M(Z) to check scale. Need factor=1.02



- CEM stability:
  using high P_T electrons
  E/P − vs−Run Number (ETF group).
  2% drift February−August



- As of yesterday afternoon the CEM E−scale was increased in the hardware by
  +3%
  to take these two effects into account.

Calorimeters stability to 1%

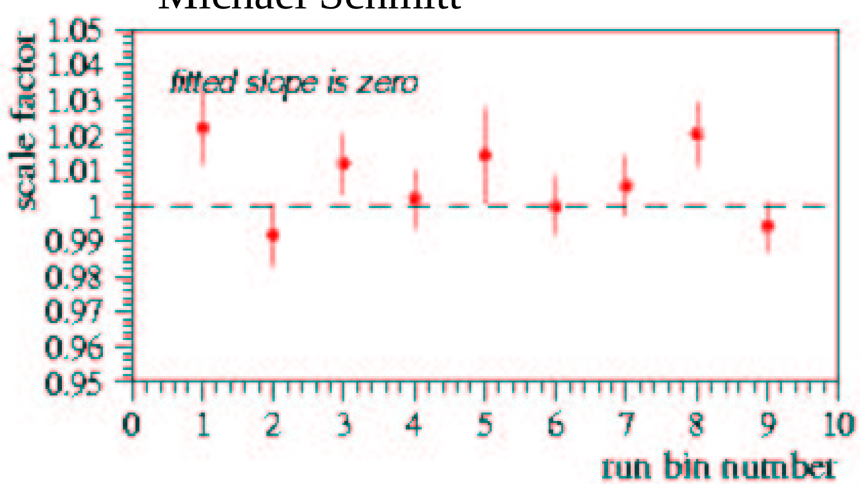
- CHA stability

CHA : using high P_T muons and J/ψ muons.

<1% drift February−June

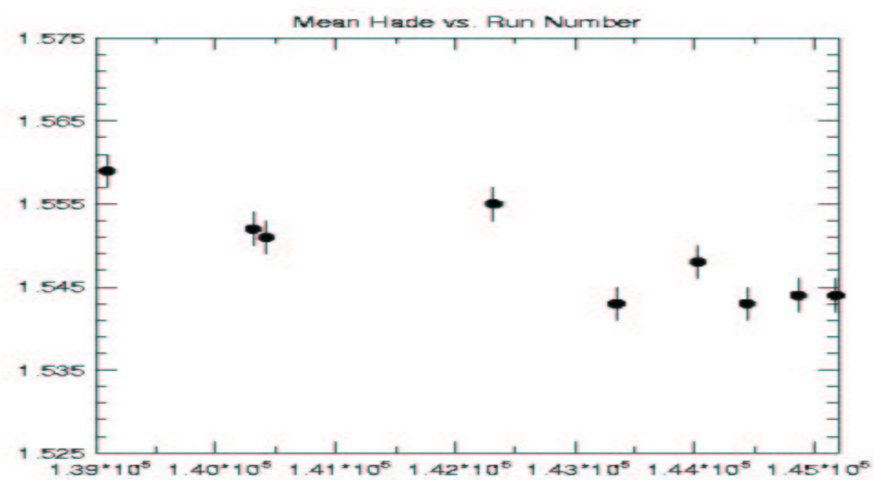
high-p_T muons

Michael Schmitt



J/ψ muons

Robyn Madrak



Central Calorimeter E−scale

CHA scale from Muons

Use MIP peak. Compare with run I.

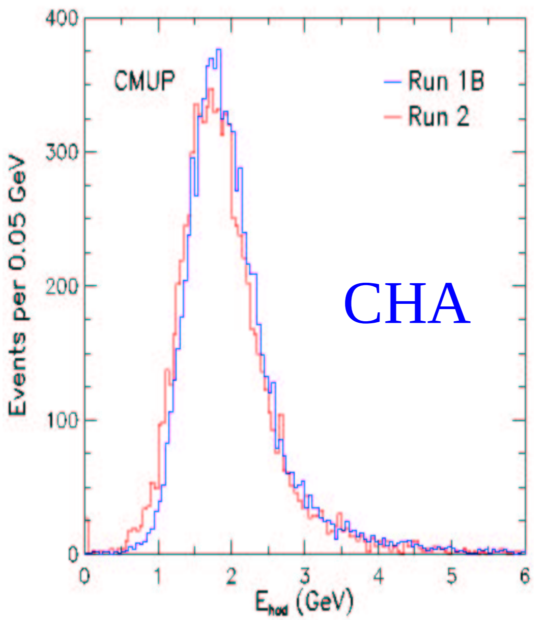
High P_T muons sample (Hyunsoo Kim)

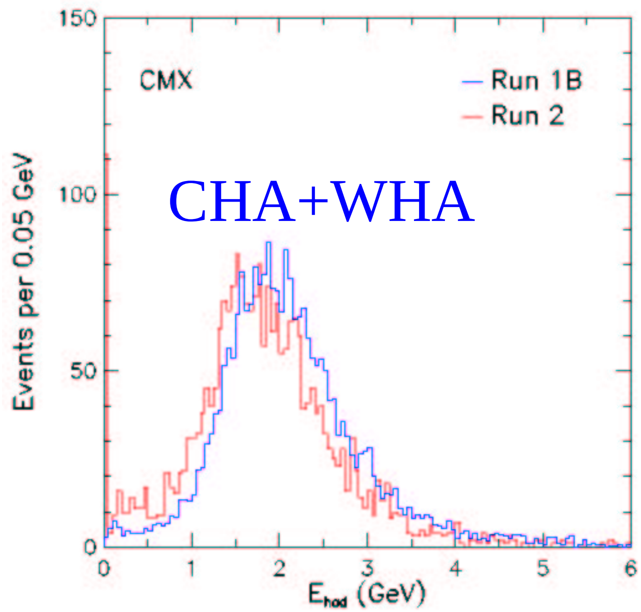
J/ψ muons (Robyn Madrak)

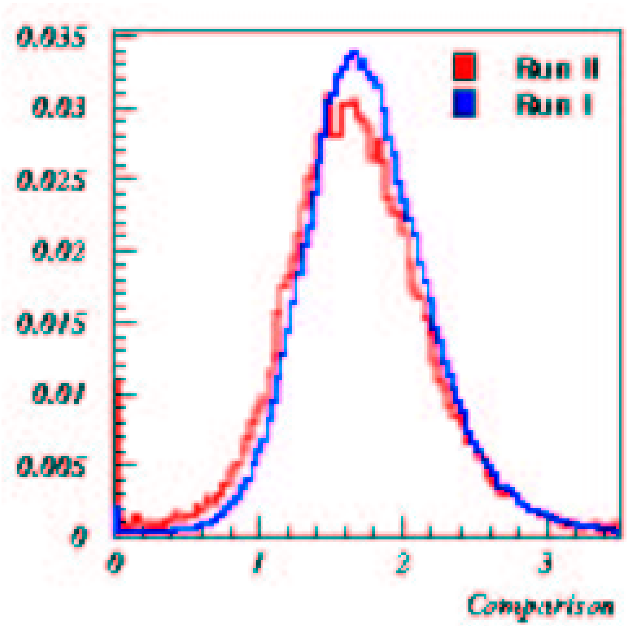
CMUP
M_{II}/M_I=0.958

CMX
M_{II}/M_I=0.901

$(M)_{II}/(M)_I$= 0.960 ±0.005



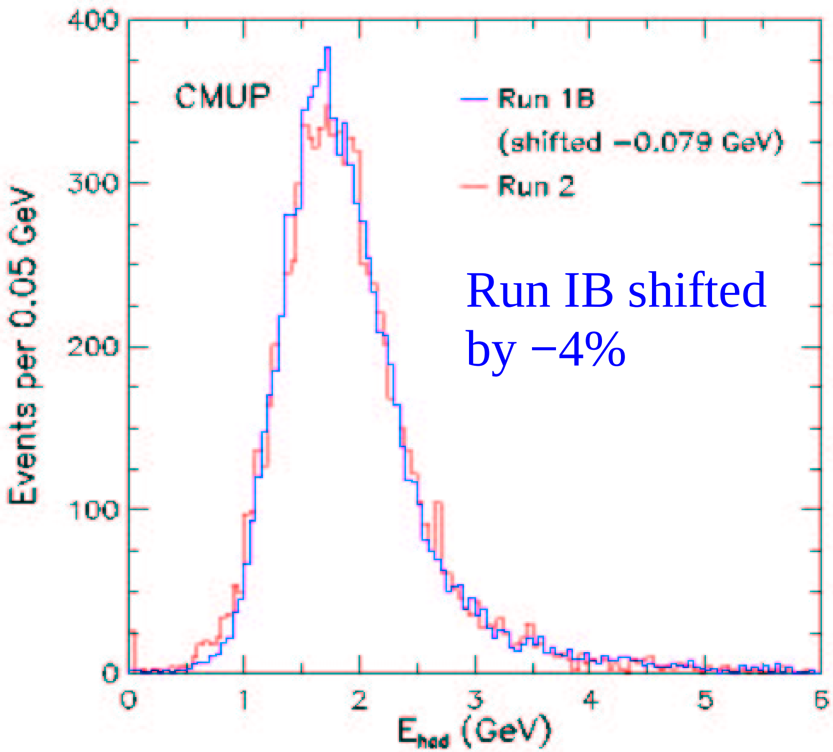


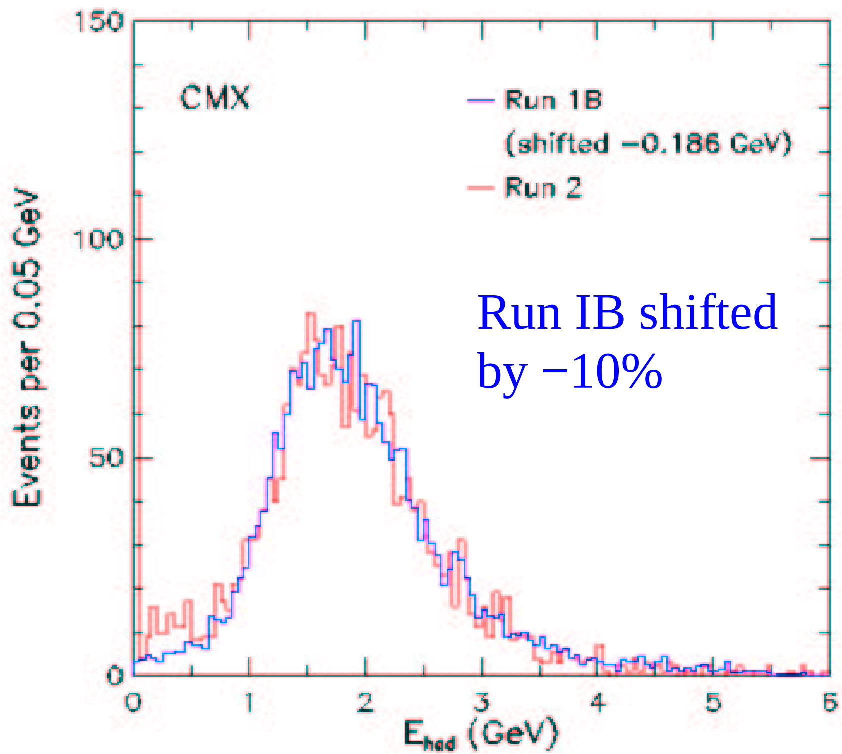


More on high P_T muons

Hyunsoo Kim doing more work on muons from W/Z

- Looked at new possible fits to the data
- Compared the CHA and CMX data after shifting the E−scale by the values found above.





Calorimeters systematics

•

The CHA E−scale was raised by +4% yesterday based on these studies

Still to do:

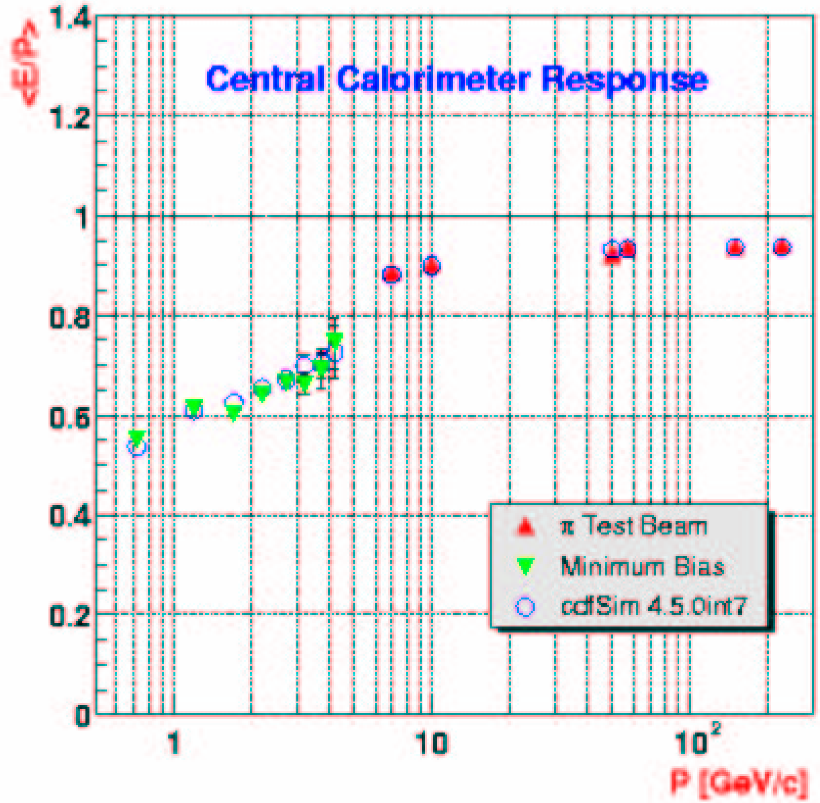
- Find tower−to−tower corrections for CHA (in progress)
- Study E−scale for WHA (J/psi muons compare Run I with Run II
- Get tower−tower corrections for WHA (BMU trigger?)

Simulation tuning: low P_T pions

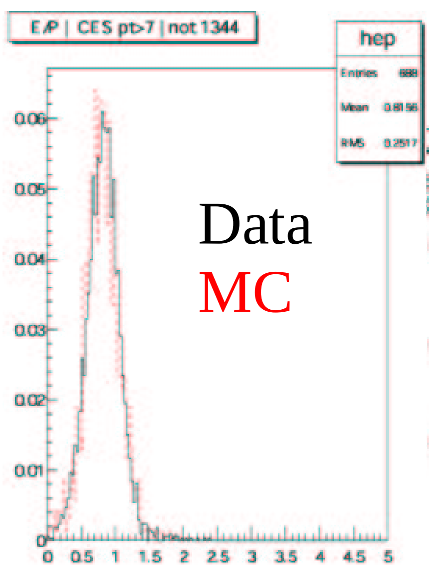
Soon Yung Jun

- Calorimeter E−scale set by 57 GeV test beam data taken in 1991.
- GFLASH tuned to test beam data above 8 GeV (see CDF−5886). Plug+Central and minbias data (CDF−5874) for PT<5 GeV

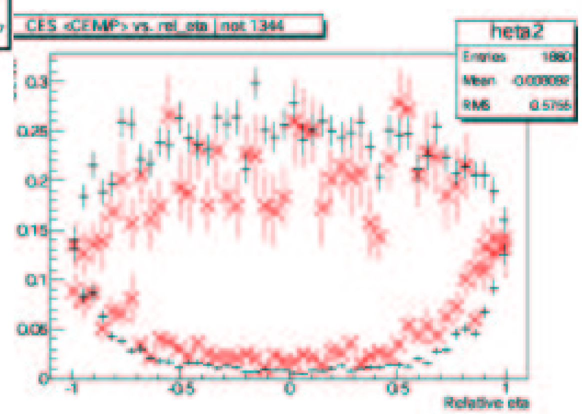
  New track trigger data: 3 and 7 GeV Baumgart+Shochet, CDF−6093



- Most data agree with the tuned MC



Lateral shower shape



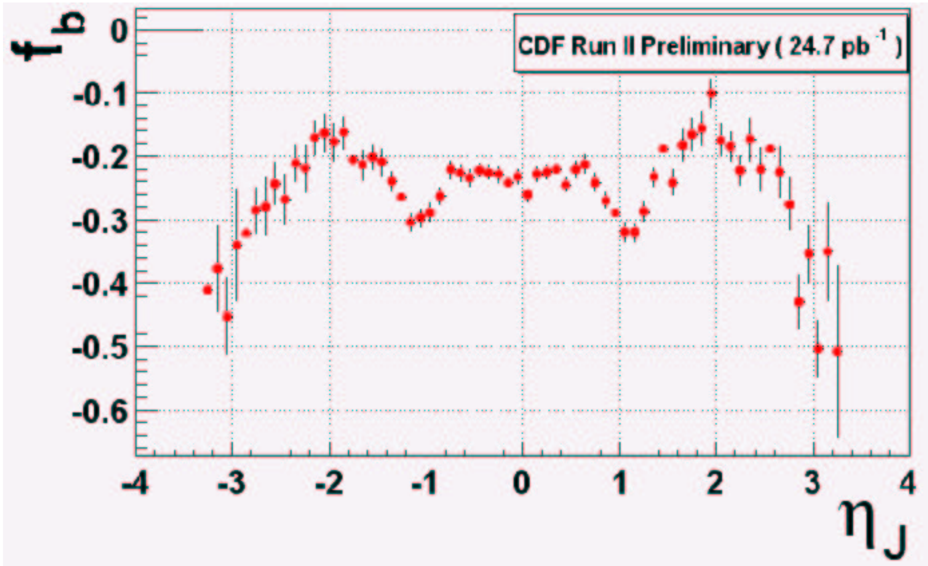
- V4.5.2 has the tuning to minbias data
- New tuning being done to fit lateral shower shape and take into account CHA E−scale change

Gam−Jet balance

Use γ−jet balance to find jet scale compared with run I.

$$f_b = (P_T^{Jet} - P_T^{\gamma})/P_T^{\gamma}$$

- All corrections applied to the γ



Giuseppe Latino

Find: $f_b = -0.2436 \pm 0.0024$ Run II

$f_b = -0.1980 \pm 0.0017$ Run I

$\Delta f_b = (-4.5 \pm 0.3)\%$

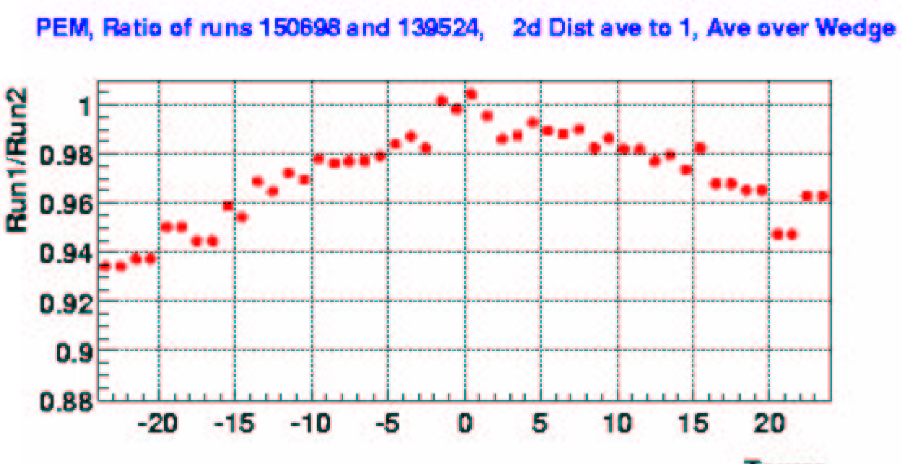
This 4.5% is not yet understood. 4% CHA energy shift is not sufficient to explain it, as HAD energy contribution = 0.37 in central calorimeter. PHA can contribute to the loss.

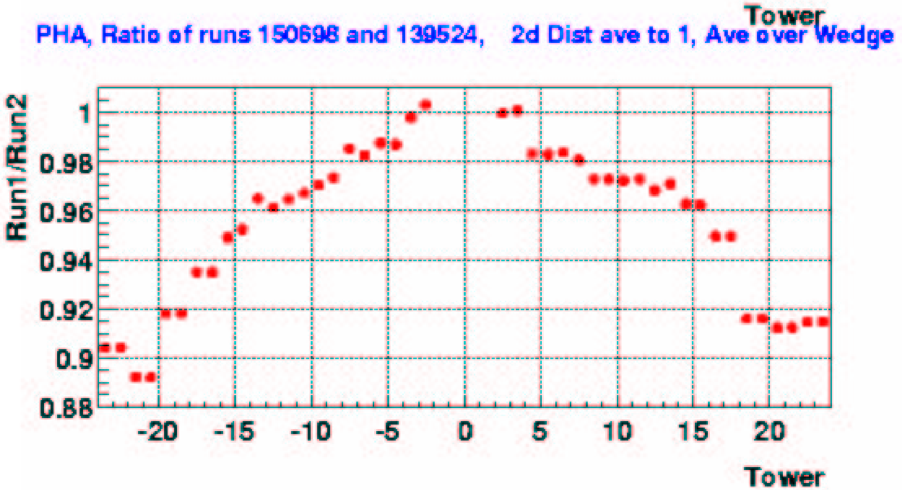
Investigating low P_T signal loss

Time dependence of Plug gains

Laser calibration has shown time dependence of the PM tubes response.
Calorimeter group trying to understand this and avoid it in the future.

Laser data Feb−August

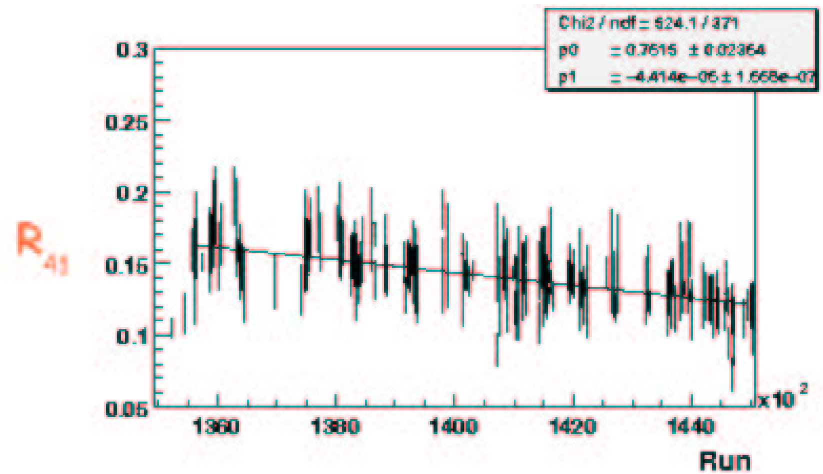




Howard Budd

Looking at data

- Jet rates Frank Chlebana



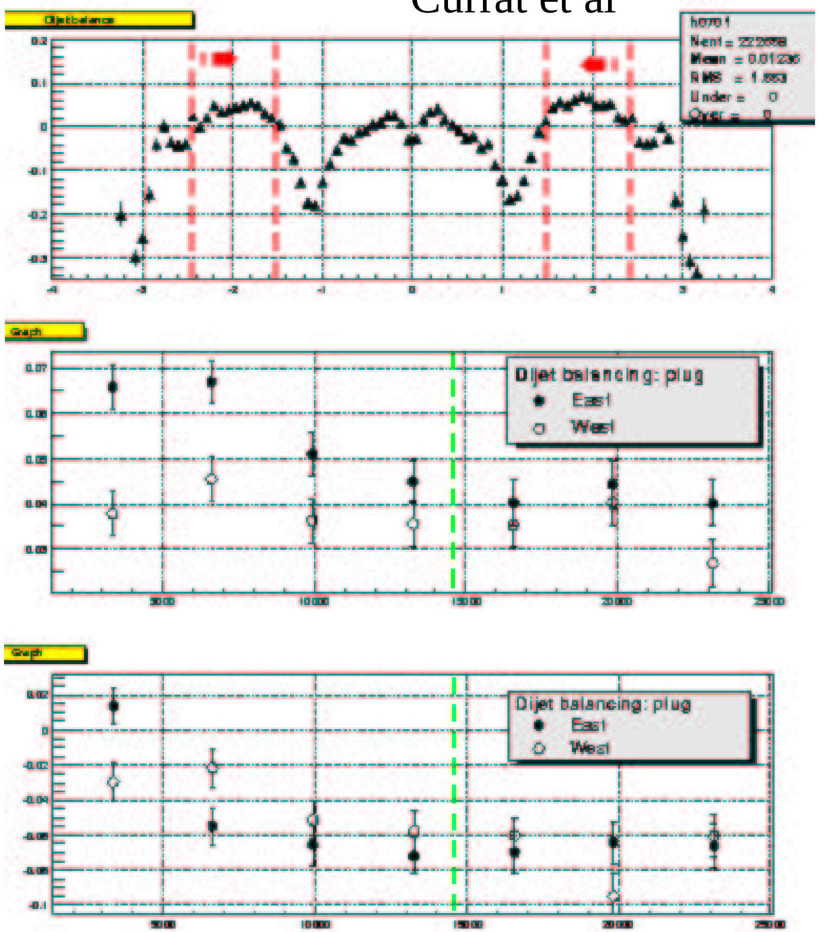
$$R_{41} = \frac{\text{Njets @ Eta 4}}{\text{Njets @ Eta 1}}$$

- Min bias (Beate, Gibson, Thompkins)
- Di−jet data and gam−jet

Effect of Gain Changes in the Plug

- Results from di−jet balance. EMF in the plug is (50−60)%

Currat et al



Di−jet balance using all data between Feb and August

η = 1.5−2.4 drop: −1% west
−2% east
stable after shutdown

η > 2.4 drop: −4% west
−7% east
stable after shutdown

Using this and all other information, we need to find a time correction!!!

Summary

- Particle response:
  - CEM electrons E−scale OK within ~2%
    We need to keep this within 1%. FIXED! E−scale went up by 3%
  - CHA muon MIP peak is shifted by −4%. FIXED!!.
  - WHA scale to be determined from muons
  - PEM+PHA need lots of work because of gain changes with time

- Absolute corrections from gam−jet balance
  - Central jet E−scale lower by 4.5% from run I
    Some of this due to CHA and WHA E−scale shifts
    More Myron mode data being studied to assess low Pt losses

- Central−Plug relative Corrections :
  Plug gain changes: needs correction as a function of time and eta.

- Calorimeter simulation tuning needs second pass, because of CHA shift

Calorimeters systematics on top mass

•