Systematics on Top Mass due to Jets

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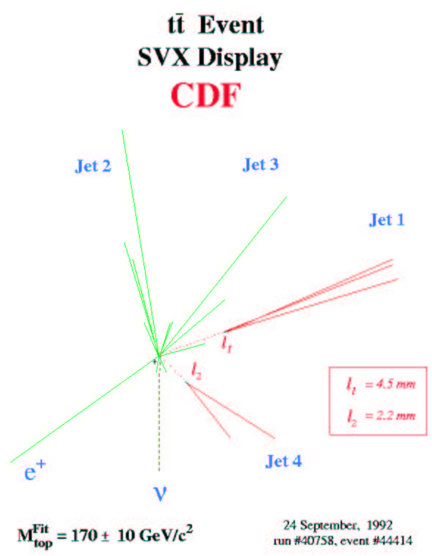
Top Mass Workshop, June 24−25, 2003



Outline

How do you go from 9 to 5 GeV and then down to 2−3 GeV???

Mass systematics for tagged events

Jet systematics: Run I and II

Major questions in present corrections studies

Can we improve absolute and out−of−cone corrections?

Systematic uncertainty SVX−tags

Erik's talk (6/11) : Nev = 11ev N_b = 2.1 ev 72 pb−1

7 (4 jets) + 4 (3.5 jets).

Systematic	Value	Comments	Run I *
Jets	7.9 GeV	Will decrease—Run I−II discrepancy partly unders.	4.1 GeV
ISR/FSR	2.6 GeV	From Run I	1.6 GeV
Generators	1.8 GeV	George/Guram (pre−tagged analysis)	0.5 GeV
PDFs	0~2 GeV	Statistics limited	0.5 GeV
Bkgd shape	0.5 GeV		0.3 GeV
B−tagging	0.1 GeV	Run I SVX only	0.4 GeV
Total	**8.8 GeV**		4.5 GeV

* Run I b−tags: 20 SVX (N_b= 2.2 ev) + 14 SLT (N_b = 5.6 ev)

14 (4 jets) + 6 (3jets) 8 (4 jets) + 6 (4 jets)

Systematics from Jet Corrections

Run I

Run II (Erik's talk)

Sys	Tagged		Tagged, ignoring tags	
	Median	Gaussian	Median	Gaussian
Relative	3.77	3.79 +/- 0.24	3.77	4.05 +/- 0.25
Energy Scale	4.45	4.15 +/- 0.23	5.45	5.73 +/- 0.25
Absolute	2.17	1.93 +/- 0.24	2.41	2.41 +/- 0.28
Underlying Energy	-0.49	-0.31 +/- 0.23	-0.48	-0.52 +/- 0.25
Out-of-Cone	1.21	1.20 +/- 0.23	1.88	1.84 +/- 0.25
Splash-out	1.15	1.26 +/- 0.24	2.00	1.64 +/- 0.25
Relative (data)	0.91	1.11 +/- 0.25	1.56	1.46 +/- 0.28
Cal Stability (data)	0.99	1.07 +/- 0.26	1.12	0.88 +/- 0.29
Energy Scale (data)	4.87	4.71 +/- 0.25	5.23	5.29 +/- 0.28
Total		7.94 +/- 0.72		9.61 +/- 0.79
−(13)		6.39 +/- 0.68		8.02 +/- 0.74

All levels of jet corrections systematics:

- except cal. stability, mult. int. should be 0 for MC.
- add systematics for levels 1−3 as applied to data.

Jet Corrections

The corrections applied to raw cluster energies are :

$$P_T(R) = (P_T^{raw}(R) \times f_{rel} - UEM(R)) \times f_{abs}(R) - UE(R) + OC(R). \quad (10)$$

Here R=$\sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$ is the cone radius chosen for the jet measurement; R=0.4 for top analysis. The corrections are:

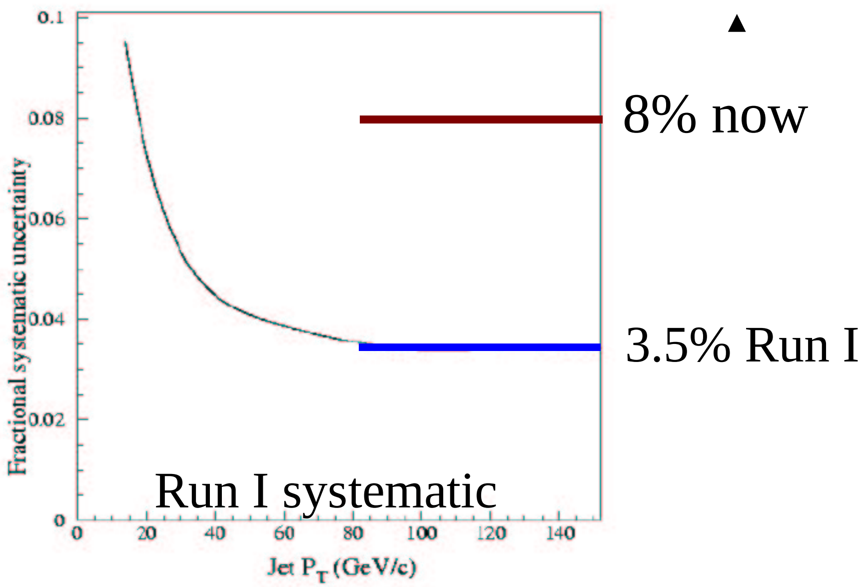
- f_{rel}, the relative energy scale. Corrects for non-uniformities in calorimeter response as a function of η.
- $UEM(R)$ subtracts the energy due to the additional interactions in the event.
- $f_{abs}(R)$, the absolute energy scale. Maps the raw jet energy observed in a cone of radius R into the average true jet energy. This average is determined in the central calorimeter assuming a flat $\mathbf{P_T}$ spectrum.
- $UE(R)$ takes into account the energy due to the underlying event. In Run I minbias events were used for this correction.
- $OC(R)$, corrects for the energy expected to be outside the radius R.

The $f_{abs}(R)$ and $OC(R)$ corrections are functions of the transverse momentum of the jet. The relative correction has only a weak dependence on jet P_T .

Systematics(Winter Conferences)

Comparison with Run I: 3.5% → 8%

CDF−6419



Relative Corrections

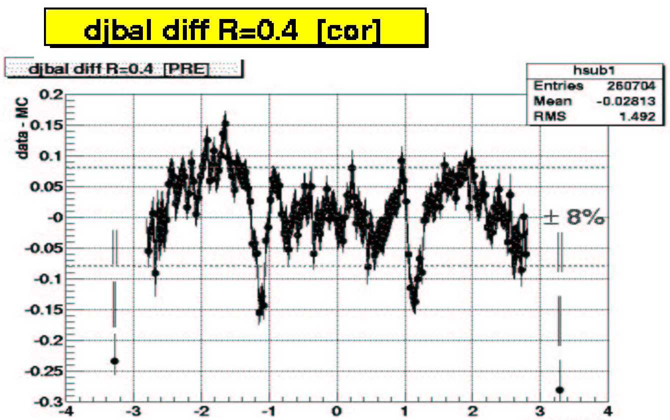
|η| range	MC	data
0.0−0.1	2%	2%
0.1−0.8	0.2%	0.2%
0.8−1.4	4%	15%
1.4−2.0	4%	4%
>2.0	7%	7%

	Run I	Run II data	Run II MC
Calorimeter stability	1%	1%	−
Raw Jets E−scale	−	5%	5%
Relative correction	(0.2 to 4)%	(0.2 to 7)%	(0.2−15)%
Absolute corr. (+UE)	(2.8 to 2.4)%	(2.8 to 2.4)%	−
UEM (UE mult. int.)	100 MeV/vertex	100 MeV/vertex	−
OOCC (8 to 55, >55)	(7 to 1.4)%	(7 to 1.4)%	−
Splash−out	1 GeV	1 GeV	

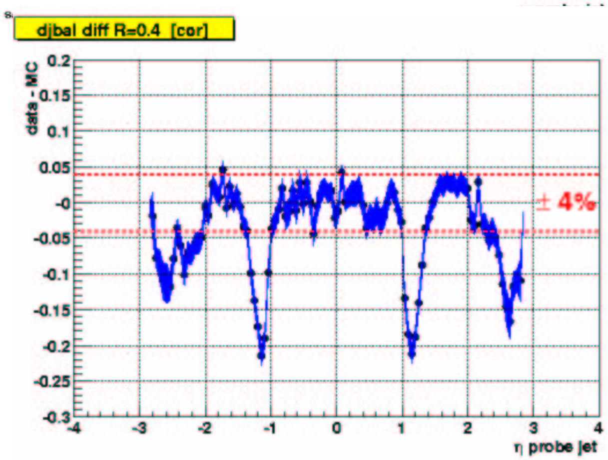
Plug systematics

Systematics on relative corrections set by difference between data and MC

- Crack (WHA) disagreement still large
- Peculiar shape of simulation for $|\eta| > 1.4$
  - linear rise between 1.4 and 2.4

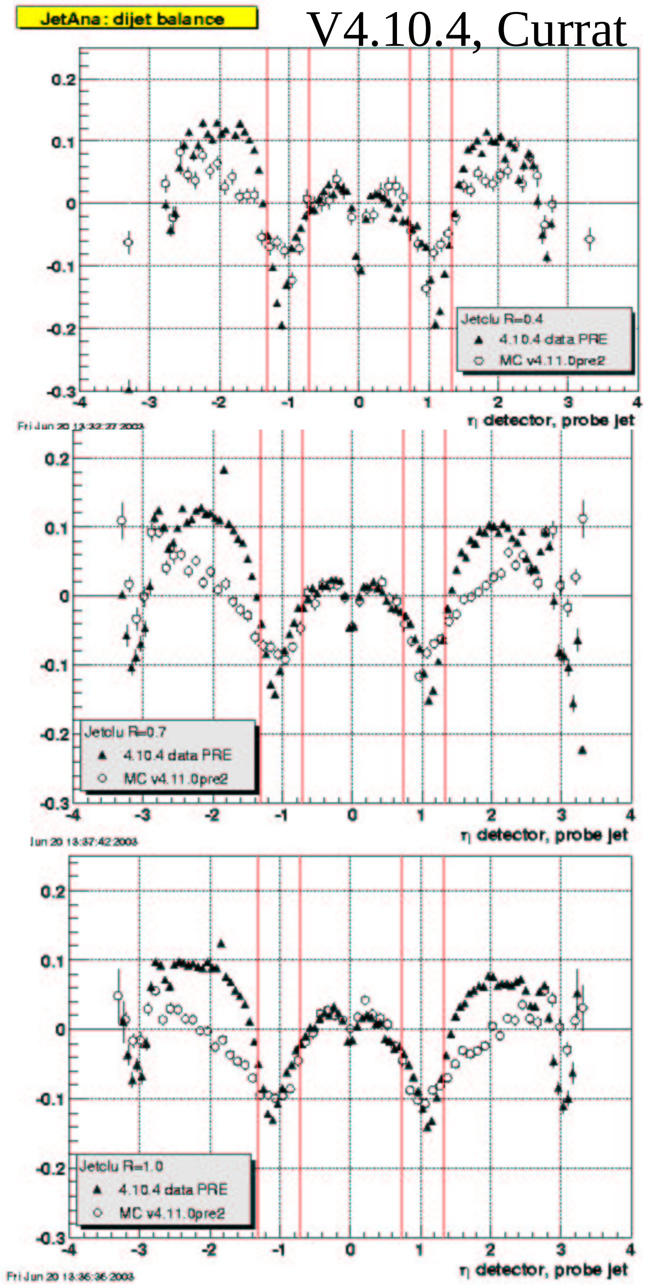


V4.10.4 :
smaller cracks
+− 8% in central



Winter conferences

+−4% in central



Central calorimeter systematics

Info comes from γ−jet balance.

See 5% (now 3%) difference from Run I
not cone dependent (CDF−6280)

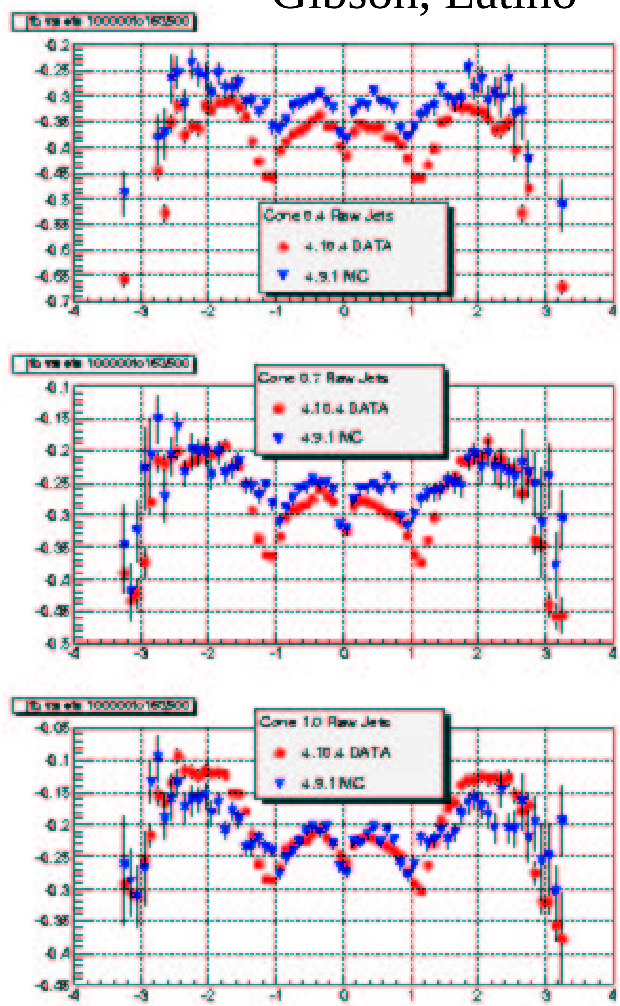
Plug MC: linear rise here as well
WHA region agrees with di−jet balance

MC−data disagreement in central:
- R=1.0 Smallest disagreement
- R=0.4 Largest disagreement

What can it be:
- underlying event
- jet shapes, i.e., need to tune parton shower and fragmentation

Raw jets, γ−jet balance

Gibson, Latino

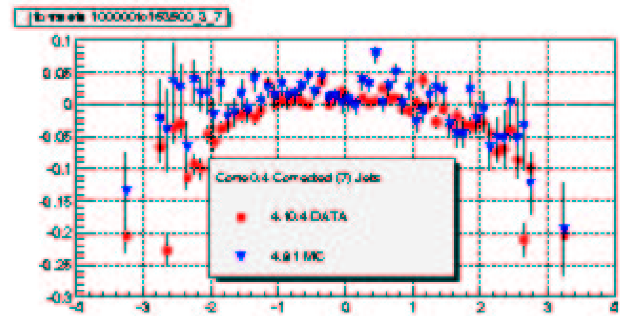


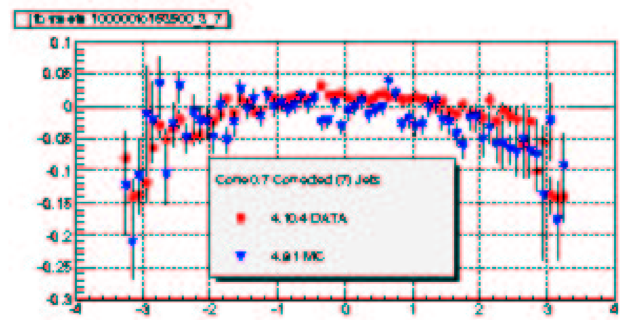
Central calorimeter systematics

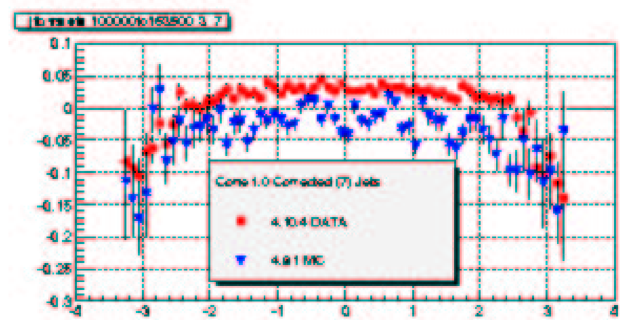
Corrected jets show a cone dependence as well:

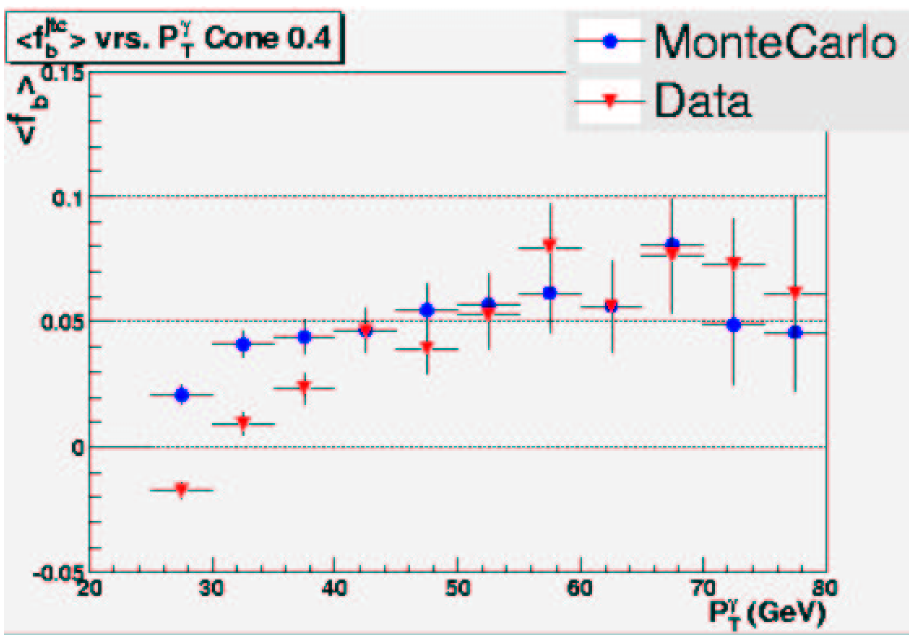
- R=0.7 is OK in central
- R=0.4 is higher in MC
- R=1.0 is lower in MC

Pt dependence of γ−jet balance possibly due to threshold effects (MC is not flat)









How do we get back to Run I?

Understand 5% (now 3%) shift in raw E−scale

Understand Monte Carlo

- cone dependence in gam−jet balance (central calorimeter)
  - is it a generator problem (jet shapes)?
  - Was underlying event tuned for R=0.7 only?
- WHA simulation
- Plug simulation : strange eta dependence

In principle we should do better in Run II:

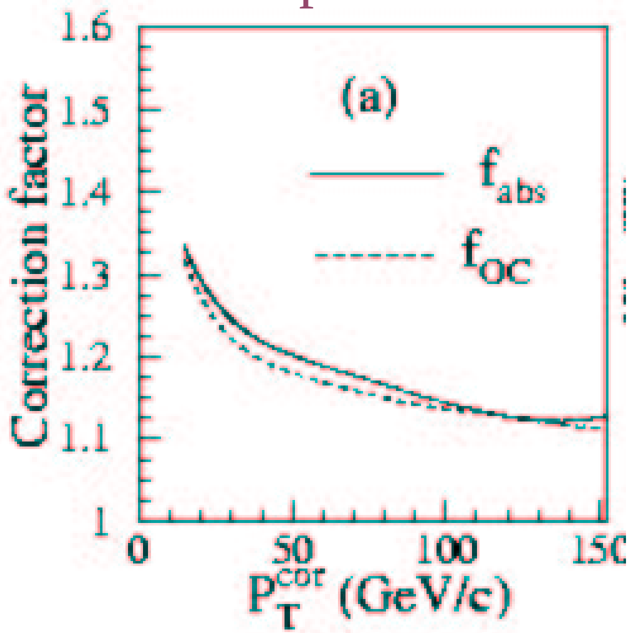
Tower corrections done more often on line. Offline correction done when needed {Beate's code).

See Beate's talk on plans for the jet correction group

Sys errors from absolute and out of cone

Corrections are the same size. Systematics on absolute corr. are larger

Can we improve and how?

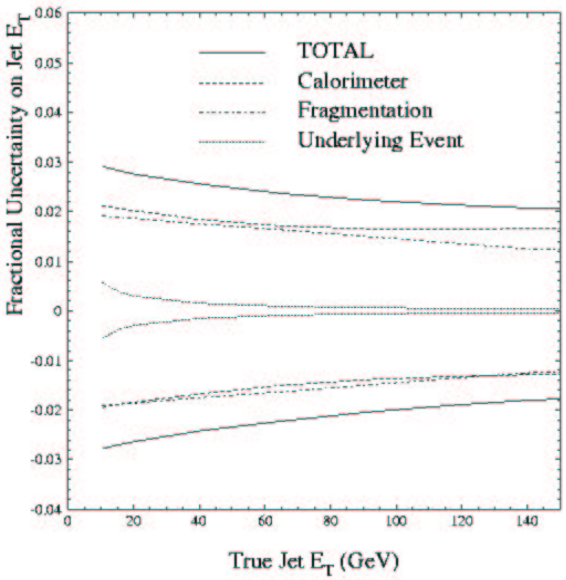


Sys. from Absolute correction include:

Calorimetry: cracks, non linearity, response across wedge, pion and e response etc

Fragmentation tuning:

can we use COT+SVX tracking?



Improve Sys on absolute corrections:

Z −jet balance (light q jets)

γ−jet balance (light q jets)

double tags (light q jets)

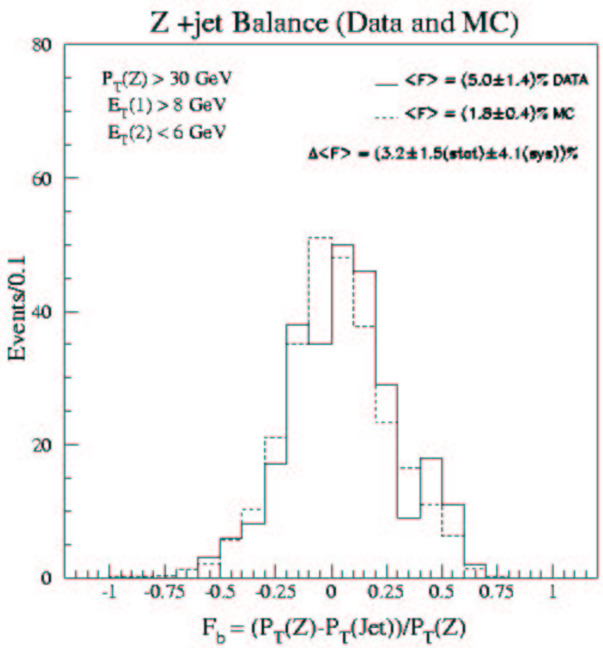
Z to b−bbar (Tommaso's talk) (b jets)

Reduce Sys. On Absolute Correction

Z −jet balance Data and MC comparison

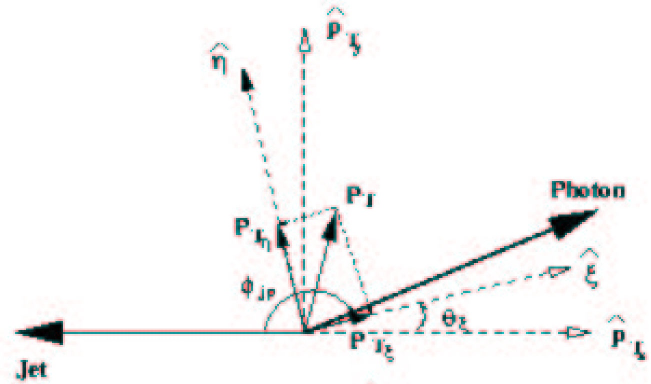
Run I Analysis

$\Delta F=(3.2\pm1.5 \pm4.1)\%$



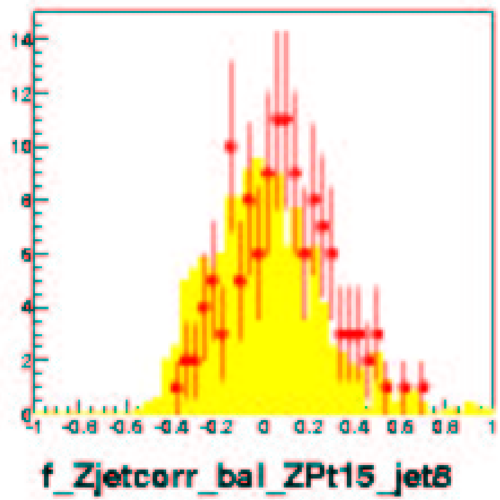
CDF−3983, LG/Lys

Uses bisector technique



PT(Z) >30 GeV

Run II Initial data−MC comparison



YKK+Erik (in progress)

No bisector analysis

Very different cuts

PT(Z) >15 GeV

Sys. on Absolute Corrections

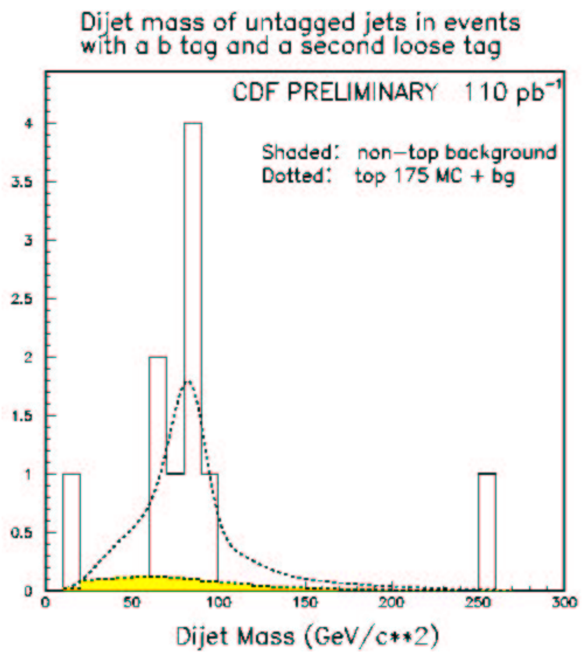
Double tagged events: t+tbar $\rightarrow$W($\rightarrow$jet jet) b +W($\rightarrow$l v) b

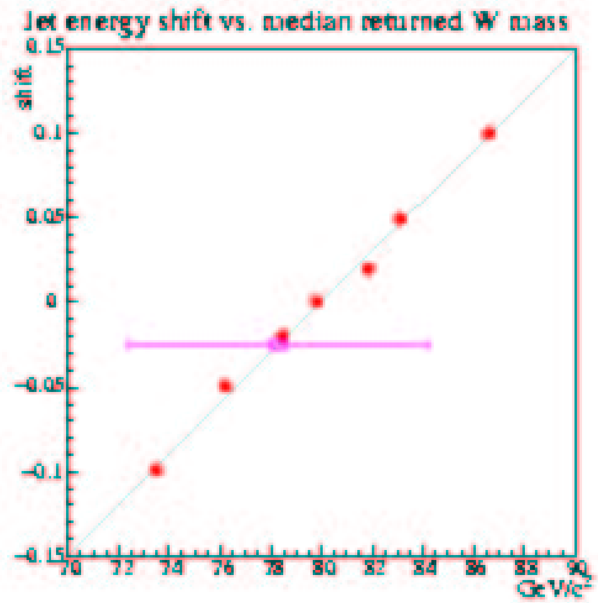
CDF−3543, Wilkinson, Hollebeck

Run I result: 9 events with 2 big−tags

$\Delta M = (-2.5 \pm 8.8)\%$

MW = 78.1±4.4±2.9 GeV



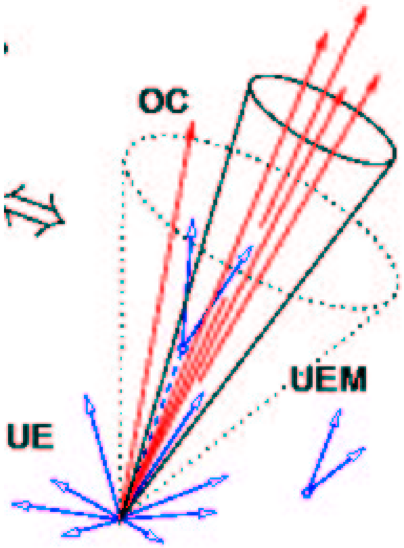


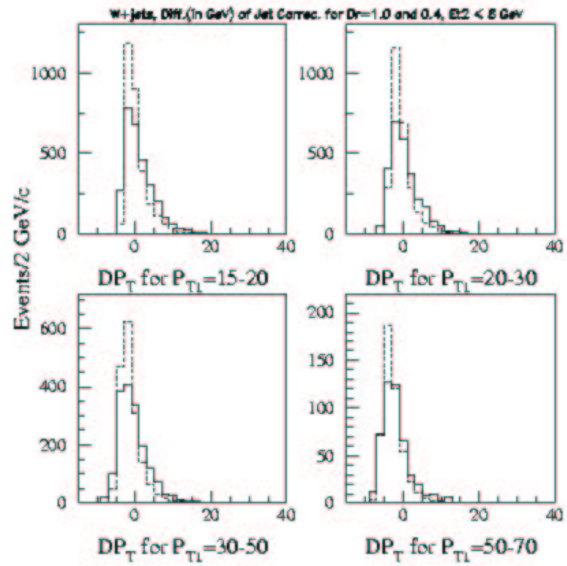
2 fb−1 expect factor 50 in yield (luminosity, acceptance, better b−tagging)

$\sigma = 8.8\%/\sqrt{50} = 1.25\%$ on E−scale (from 2.5%)

Sys. FromOut of Cone corrections

Run I OC systematics study CDF−3253 (LG/Lys)

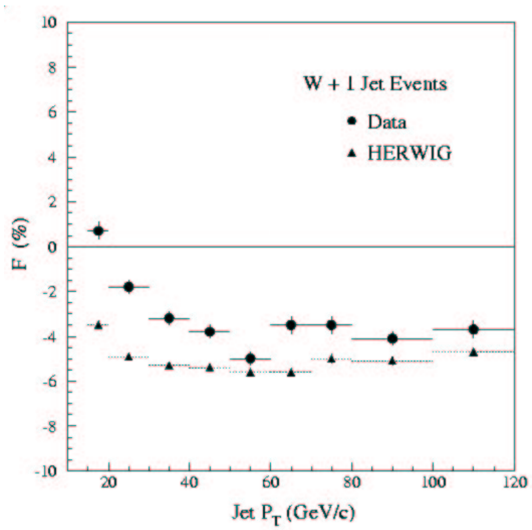


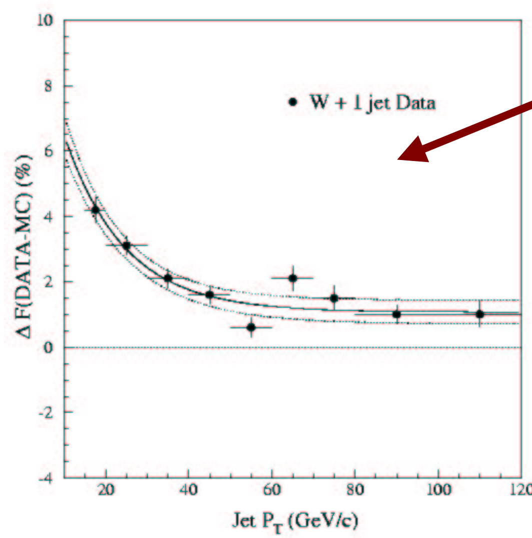


Looked at PT in annulus between 0.4 and 1.0 :data and Monte Carlo.

Shapes are different: difference 4 to 1.5 GeV

Sys. = (7 to 1.4)%





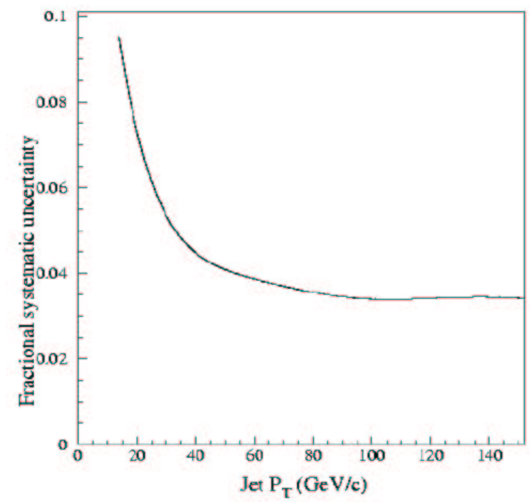
Can we improve?
Tune MC to look like the data

Can we improve the top mass meas.?

Plan is to reduce the systematic error from 5.1 to 3.0 GeV

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

Channel	dilepton	l+jets	all−had
Nev(sig/back)	6.7/1.3	40/36	45/142
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



Major challenge: reduce jet systematics
reduce ISR,IFR (better understanding/tuning of MC)

Use other fitting tecniques to reduce the effect of the systematics