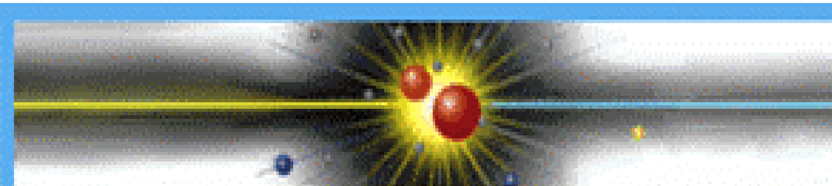
High P_T Physics at CDF



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Outline of this talk

- High P_T Physics at CDF is much broader than a single talk (or even two or three..)
  - ☞ I took one road (see next...)
- Will discuss status of high P_T analysis
  - ☞ Run 2a (2 fb^{-1}) expectations
  - ☞ current performances
  - ☞ (near) future improvements

- Several topics which will be presented in other contributions are not discussed at all

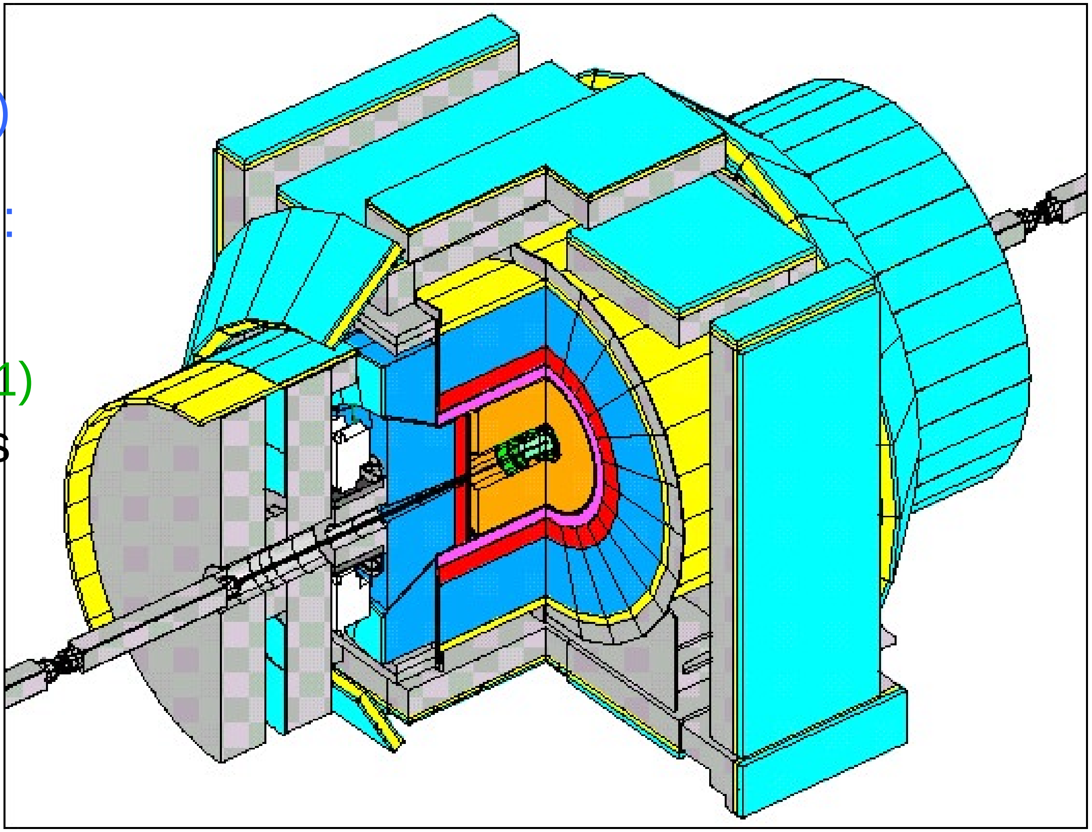
CDF II

☞new tracking system

⇨new drift chamber (COT)

⇨new silicon tracker comprising three detectors:

→L00 (1 SS, r-φ), SVXII (5 DS), ISL (2 DS |η|>1, 1 DS |η|<1)



☞new forward calorimeters ("plug") (1<|η|<3)

☞extended muon coverage

☞added TOF capability

☞new trigger system

⇨moved track trigger to L1

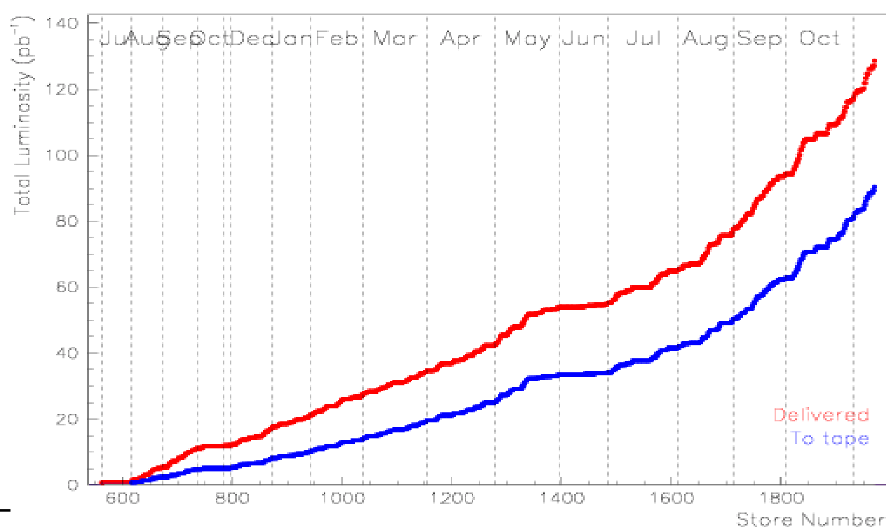
⇨built a Silicon Vertex Trigger (SVT) at L2 to trigger on tracks with large impact parameter

Run II Physics

First results at ICHEP02, updated at HCP

Luminosity situation

- ≈80 pb^{-1} to tape (including part of commissioning)
  - Jets 64 pb^{-1}
  - High Et electrons 55 pb^{-1}
  - SVT with hadronic B trigger 50 pb^{-1}
  - Top l+jets+b-tagging 44 pb^{-1}
    - → requires whole detector to be operational



Red: delivered luminosity

Blu: recorded to tape

Which road?

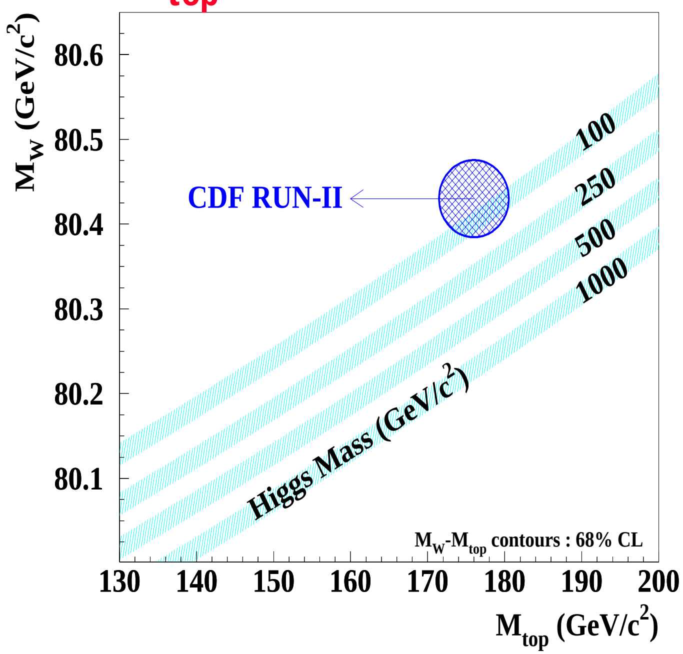
Run 2a, with 2 fb^{-1} will provide:

Event yields per experiment

Sample	Run 1*	Run 2a
$W \to l\nu$	77k	2300k
$Z \to ll$	10k	202k
WV ($W \to l\nu$, V=W,γ,Z)	90	1800
ZV ($Z \to ll$, V=W,γ,Z)	30	500
tt (mass sample, >=1Btag)	20	800

(*)Run 1: 100 pb^{-1}/experiment
l=e,μ

M_W ~30 MeV/c²
M_{top} ~3 GeV/c²



Truth is in the Masses !

Masses..What is needed

W mass measurement needs

- ☞excellent control of systematics (energy scale, material budget), PDFs
- ☞excellent understanding of E flow in the event

Top mass measurement is a benchmark:

- ☞large η coverage for leptons and jets
- ☞excellent jet energy resolution and energy scale
- ☞b-tagging in dense jet environment
- ☞good understanding of QCD processes
  - ⇨background (W+njets)
  - ⇨ISR and FSR
  - ⇨...

W Mass uncertainties

In Run 1:

- → 80.433±0.079 (CDF)
- → 80.483±0.084 (D0)
- → 80.454±0.06 (comb.)

⇨ syst. gov.d by size of control samples

- → l^+l^- used for lepton energy scale($J/\psi,\Upsilon$)

⇨ PDF (W asimmetry)

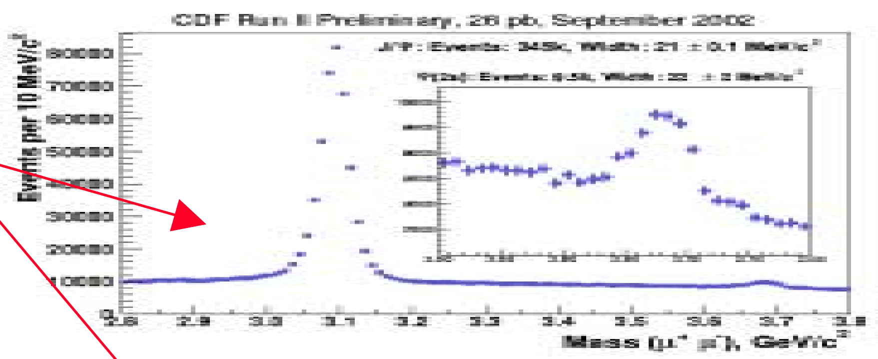
⇨ P_{T_W} measured by P_{T_Z}

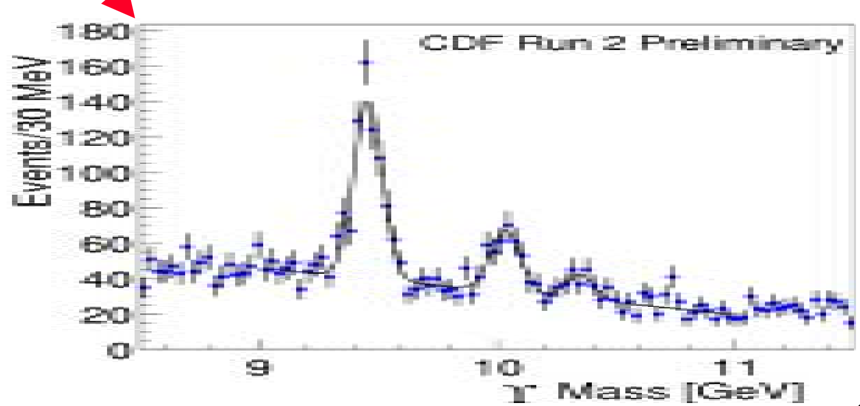
CDF Run Ib W→ μν data: uncertainties scaling stat.

Source	uncert. (MeV/c^2)
Fit statistics	100
Momentum scale	85
Recoil model	35
Background	25
Mom.resolution	20
Selection bias	18

In Run 2:

☞ larger statistics in control samples will reduce experimental systematics





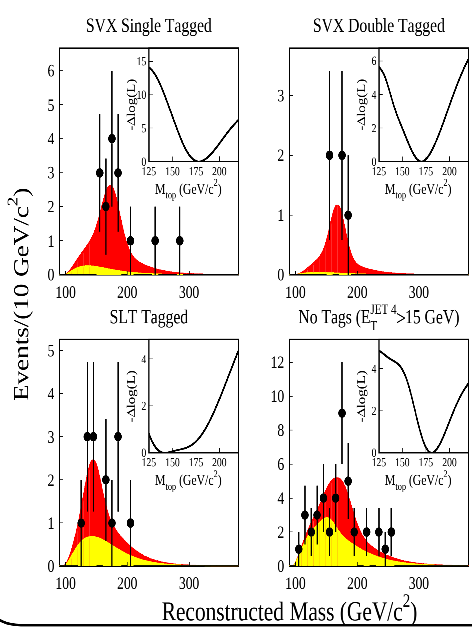
Top mass

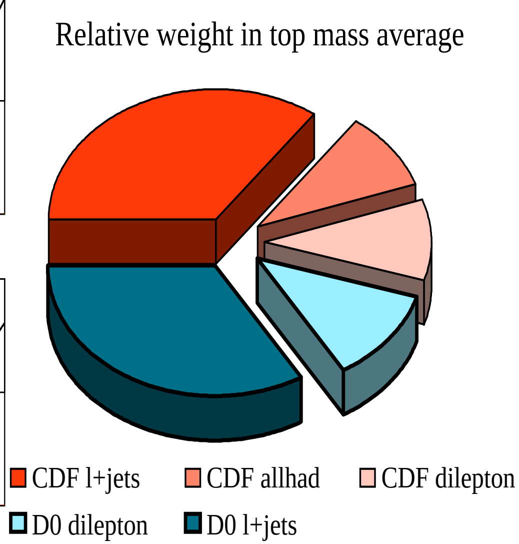
Run I (combined)

➪ $174.3 \pm 3.2 (st.) \pm 4$ (syst) GeV/c^2

- syst dominated by statistics in control samples
- most of the weight due to l+jets sample

CDF l+jets Run 1(2a) syst.	
Source	**Gev/c^2**
Jet en.scale	4.4(2.2)
ISR and FSR	1.8(1)
background	1.3(0.5)
b-tag bias	0.4
PDF	0.3
Total	4.9(2.5)





In Run II:

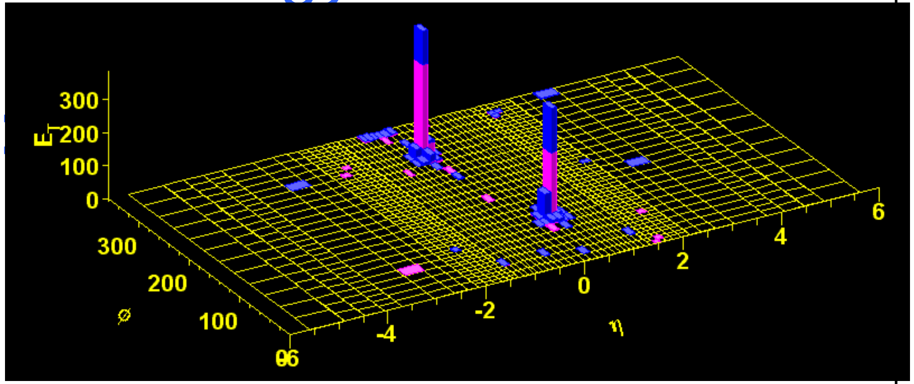
- uncert. down to
  ➪ ± 3 GeV/c^2 (1 in 10 fb^{-1})

most improvements from jet energy scale:

- using W's and $Z \rightarrow bb$

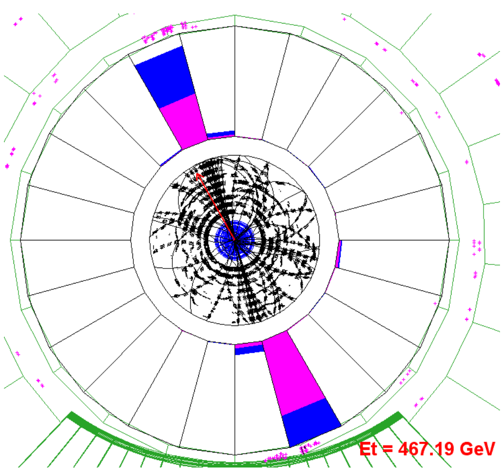
Jet Physics

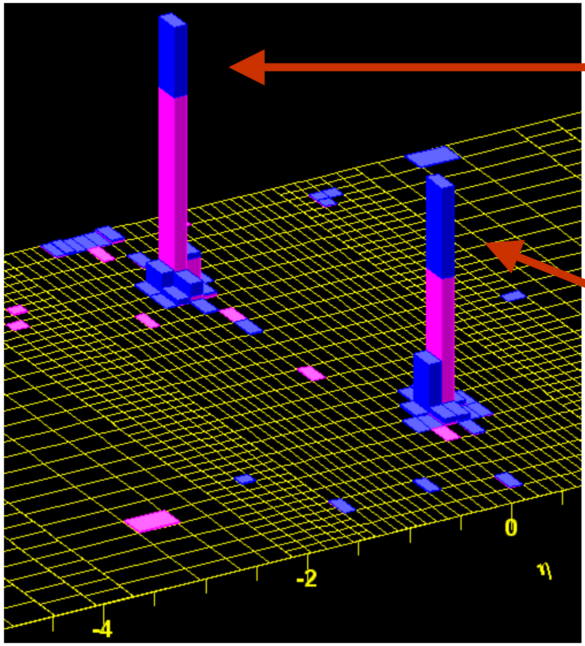
New calorimeter, work on energy scale in progress. Interesting events already on tape:



largest jet E_T recorded !

Dijet Mass = 1146 GeV (corr)



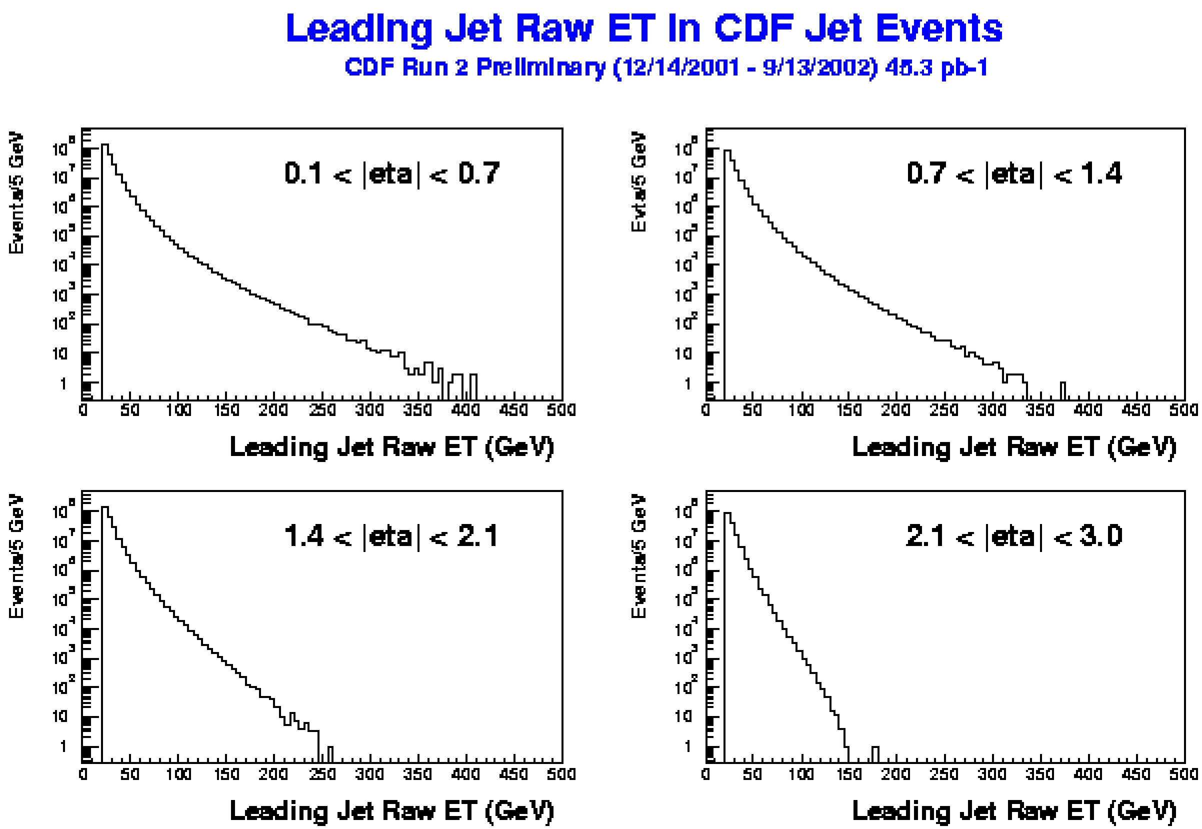


J_2 E_T = 528 GeV (corr)
J_2 η = -0.55 (correct z)

J_1 E_T = 538 GeV (corr)
J_1 η = 0.20 (correct z)

Corrected E_T and mass are preliminary

Jet Physics



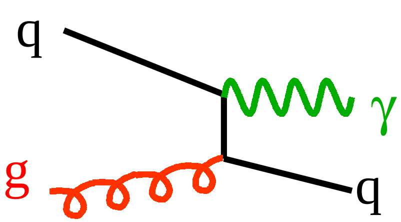
new calorimeter for $|\eta| > 1$

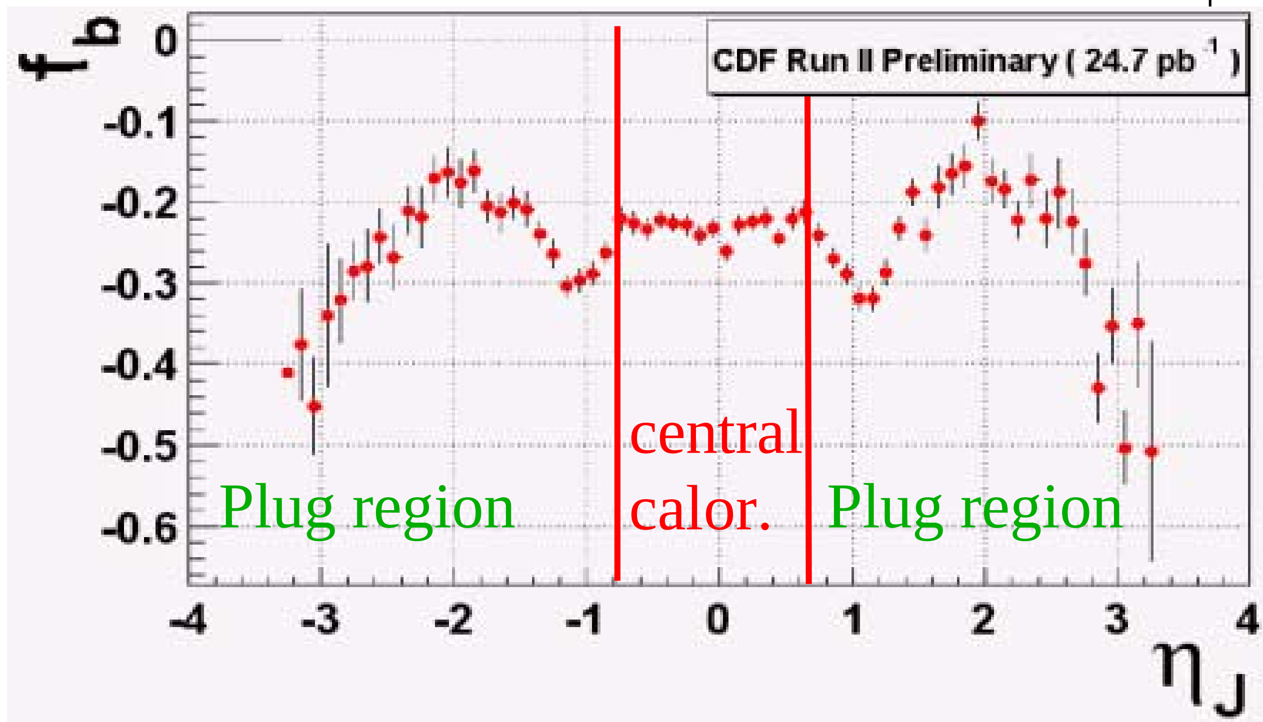
Corrected E-scale by the 2003 Winter Conferences

Hadronic Energy Scale

Use J/ψ muons to measure MIP in had. calorimeters

☞ (Run II)/(Run 1) = 0.96±0.05





γ-jet balancing to study jet response

$f_b = (p_T^{jet} - p_T^{\gamma})/p_T^{\gamma}$

Run Ib (central): f_b= -0.1980 ± 0.0017

Run II (central): f_b= -0.2379 ± 0.0028

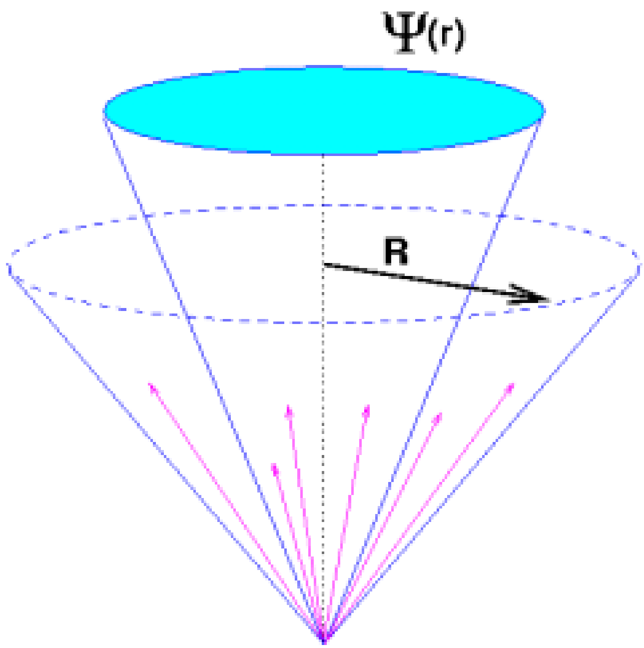
} Δf_b = (4.0 ±0.4)%

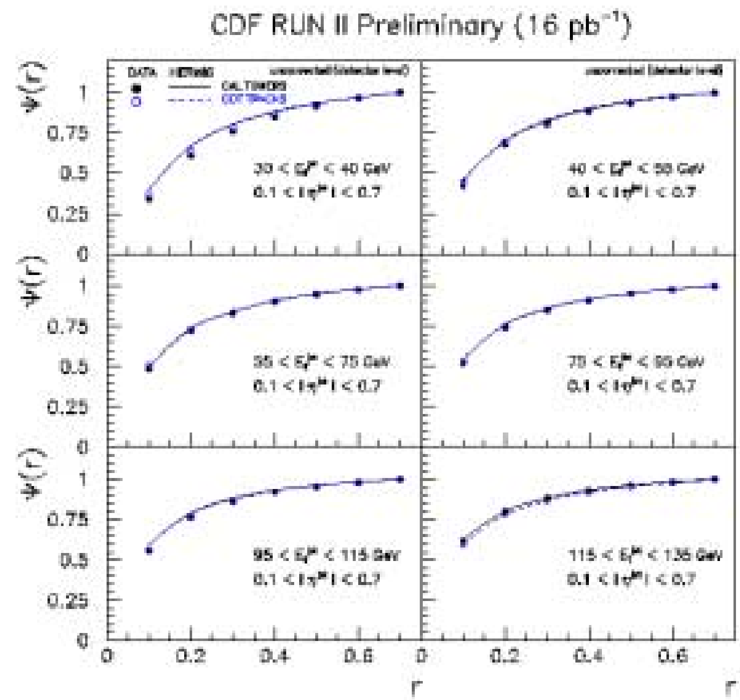
Plug region corrections in progress

Jet Phyics

Study jet behaviour at 1.96 TeV and compare to MC distribution:

$$\Psi(r) = \frac{1}{N_{jets}} \Sigma_{jets} \frac{E_T(0,r)}{E_T^{jet}(0,R)}$$





Still using fixed cone of R=0.7

Jet Phyics

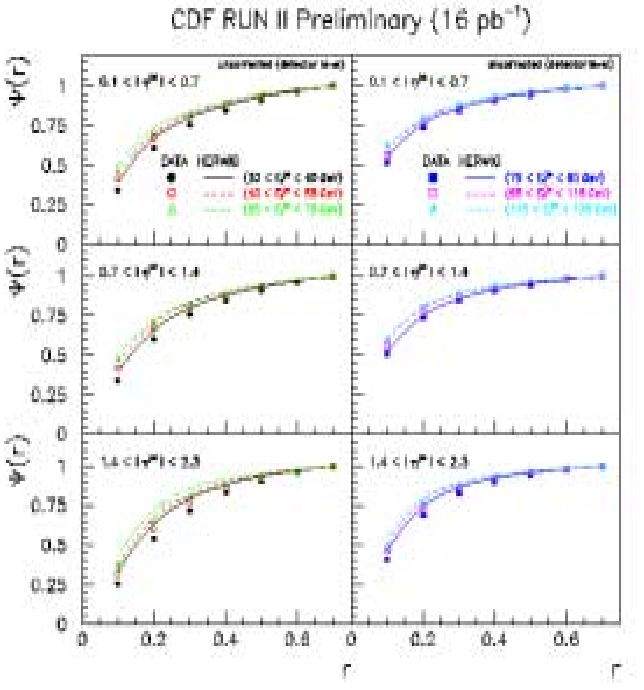
Agreement good but not as good at large |η|

- ☞ compare different Et bins (calorimeter only) vs Herwig for various η bins:
  30<Et<135

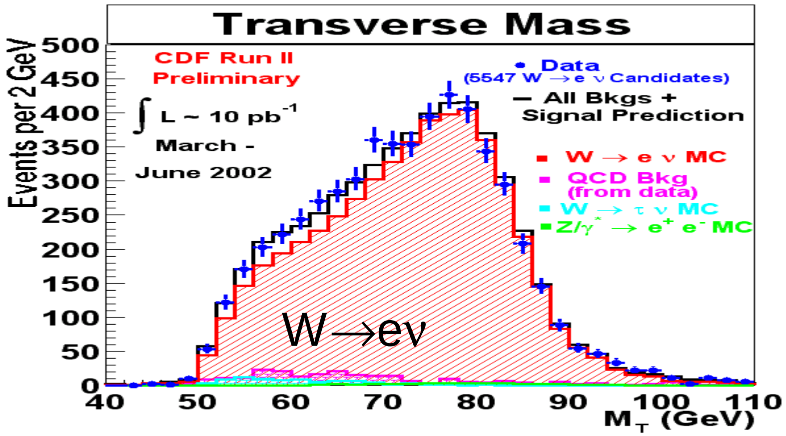
  0.1<η<2.3

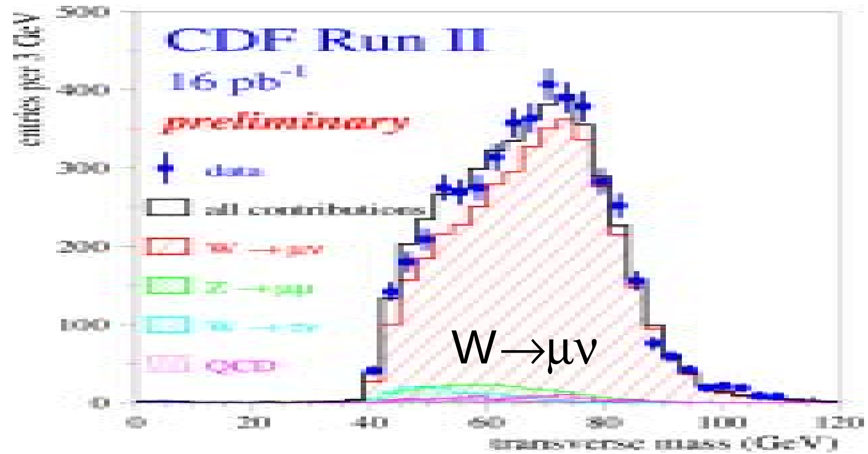
- ☞ jets get narrower with Et

- ☞ Herwig predics too narrow jets at large η



First EWK Physics Results





σxBr(W→eν)	2.60±0.07(stat)±0.11(syst)±0.26(lum) nb
σxBr(W→μν)	2.70±0.04(stat)±0.19(syst)±0.27(lum) nb

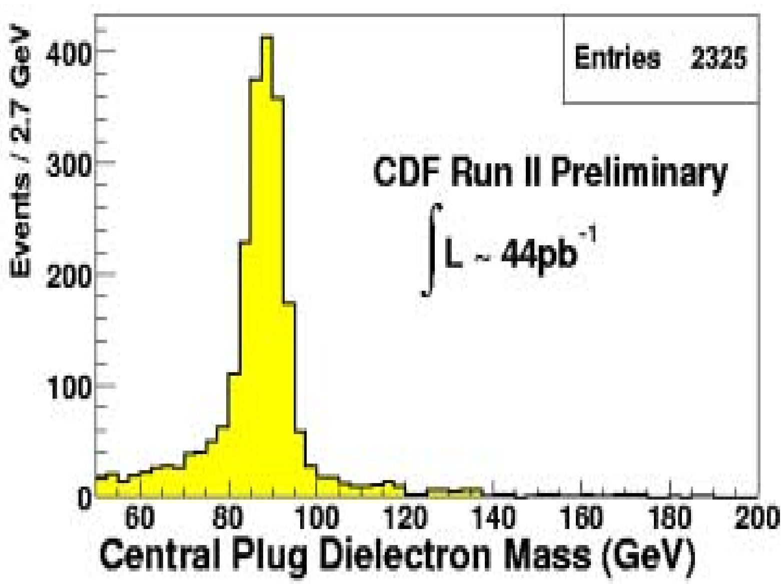
luminosity uncertainty now ±6 %

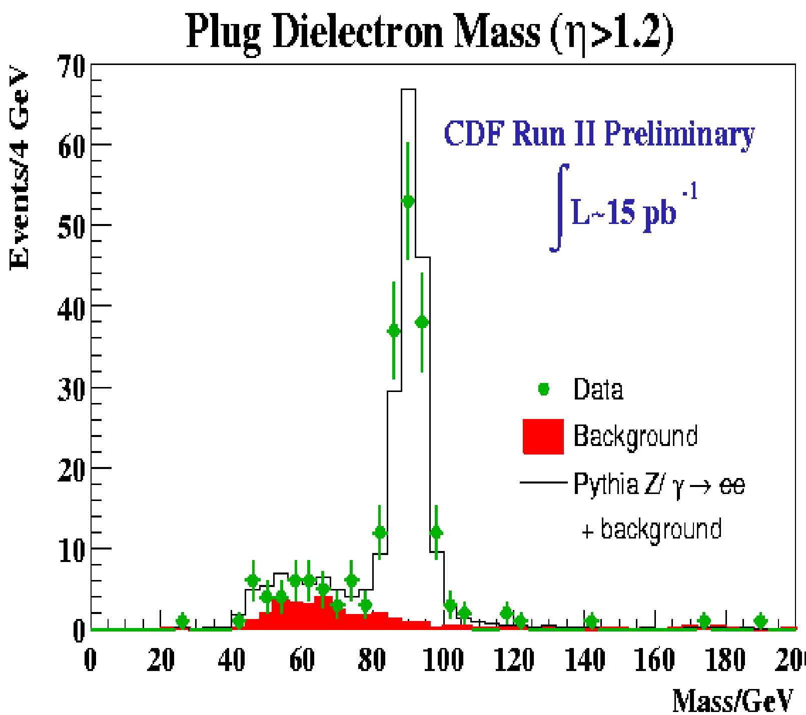
Expectation at √s= 1.96 TeV: 2.73 (Stirling,NNLO)

EWK Physics: near future

New tools for physics:

- ☞forward electrons, using silicon tracking (coverage up to |η|<2), Z signal with one or both candidates in "plug" calorimeters
- ☞room for improvements (track trigger?)

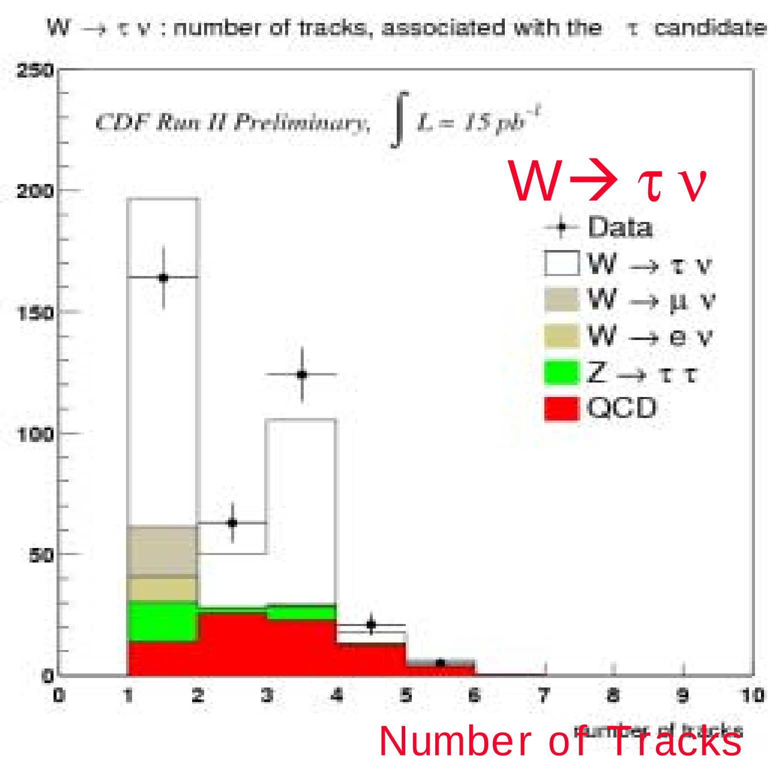




EWK Physics: near(?) future

New tools for physics:

- τ signal was seen offline in run 1, where L1 tracking was not available
- W→τν, CDF developed a track-based trigger



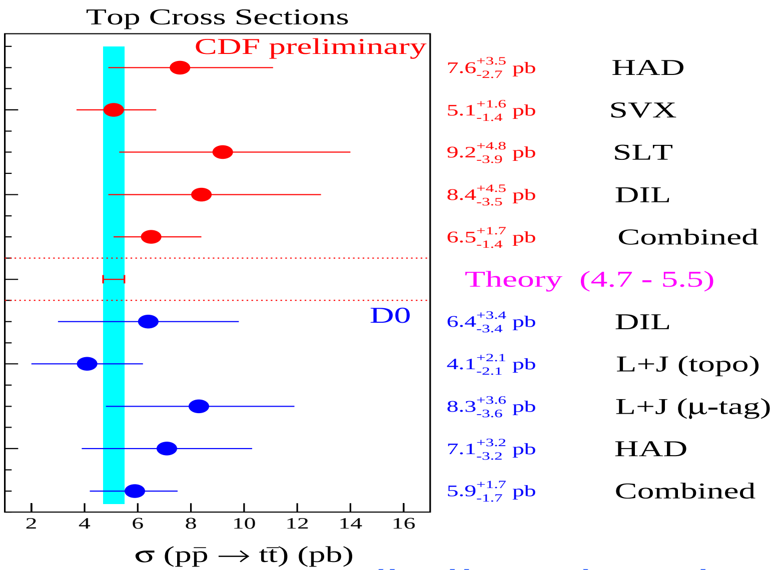
Z→ττ?

Extended μ coverage...

Top couplings

In Run 1

⇨ x-section determination



⇨ V_{tb} (indirect) ratio 0:1:2 b-jet in top events

$$R = \frac{B(t \to W + b)}{B(t \to W + q)} = \frac{|V_{tb}|^2}{|V_{td}|^2 + |V_{ts}|^2 + |V_{tb}|^2}$$

$$R = 0.94^{+0.31}_{-0.24}$$

$$|V_{tb}| = 0.97^{+0.16}_{-0.12}$$

$$|V_{tb}| > 0.78 \ (@90\%\text{c.l.})$$

In Run 2a

- ☞ xsec uncert. <10%
- ☞ top FCNC

	$1 fb^{-1}$	$10 fb^{-1}$
B(t→Zq)	1.510^{-2}	3.810^{-3}
B(t→γq)	3.10^{-3}	410^{-4}

⇨ S.M. B(t→Ws)(0.1%)?

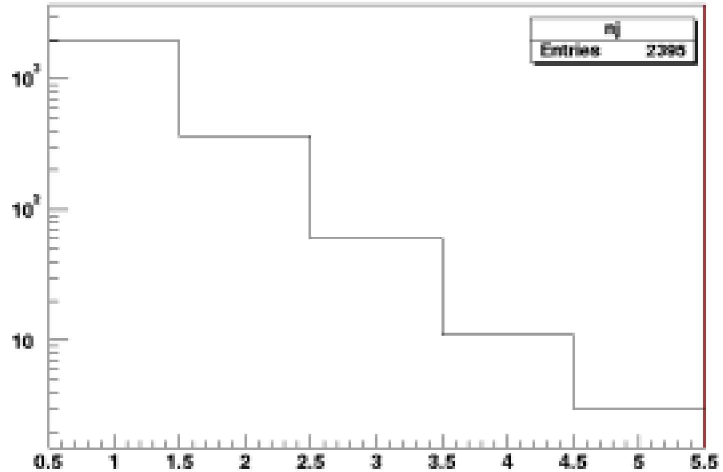
- ☞ Vtb
  - ⇨ to 3% (indirect)
  - ⇨ to 15% (direct)
- ☞ W helicity:
  - ⇨ SM prediction= 69% for B(t→W_tb)
    - → Run I=70.6±1.6%
    - → few %

Is Top back ?

Validation in progress

- ☞55 pb-1 for l+jets sample
- ☞44 pb-1 if b-tagging required
- ☞cross section by Winter Conferences

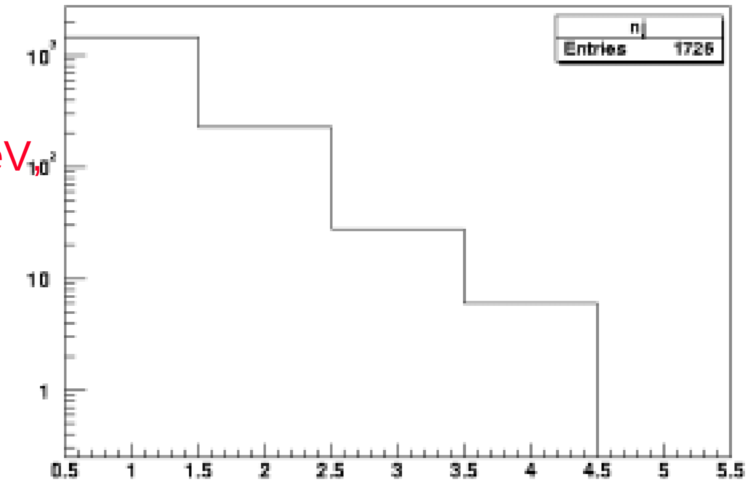
$W \to e\nu$ + n jets



$E_T^j > 20$ GeV,
$|\eta| < 2$

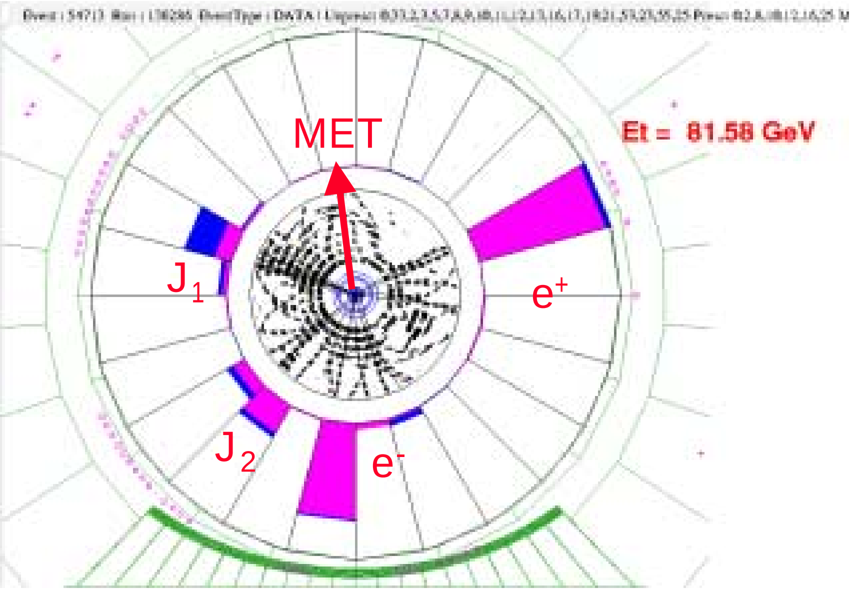
number of jets

$W \to \mu\nu$ + n jets

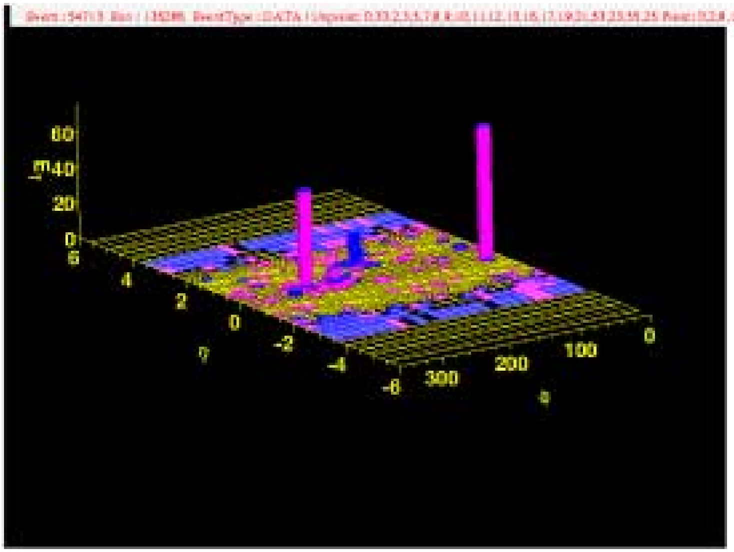


number of jets

Dilepton ttbar candidate



Et e+ 73
Et e- 56
Et Jet 1 35
Et Jet 2 34
Missing Et 43 GeV
M(e+e-) 118 GeV/c2



Beyond...

A number of tools still to be understood in terms of physics opportunities

- ☞ $Z \rightarrow$ bbar sample using calorimeter/SVT
  - ⇨ jet energy scale correction
  - ⇨ more physics...
- ☞ $Z \rightarrow \tau\tau$
  - ⇨ new physics?
- ☞ larger η acceptance for WW, $W\gamma$,WZ
  - ⇨ keep looking for unexpected

With larger dataset..

accelerator challenge (in fb^{-1})

FY	base	stretch
2002	0.08	0.08
2003	0.2	0.32
2004	0.4	0.6
2005	1.0	1.5
2006	1.5	2.5
2007	1.5	3.0
2008	1.8	3.0
Total	6.5	11.

Hunting for the Higgs is one part of a wider physics program:

- ☞ 2 fb^{-1} exclude m_H=115 GeV(*); SUSY at large tanβ
- ☞ 5 fb^{-1}:3σ signal for m_H=115 GeV(*); search through most of the SUSY Higgs parameters space
- ☞ 10 fb^{-1}:3σ signal for m_H=115-125, 155-175 GeV(*)

Looking for unexpected phenomena in our data

(*)Results from the Fermilab Higgs Working Group. Being reexamined by CDF and D0

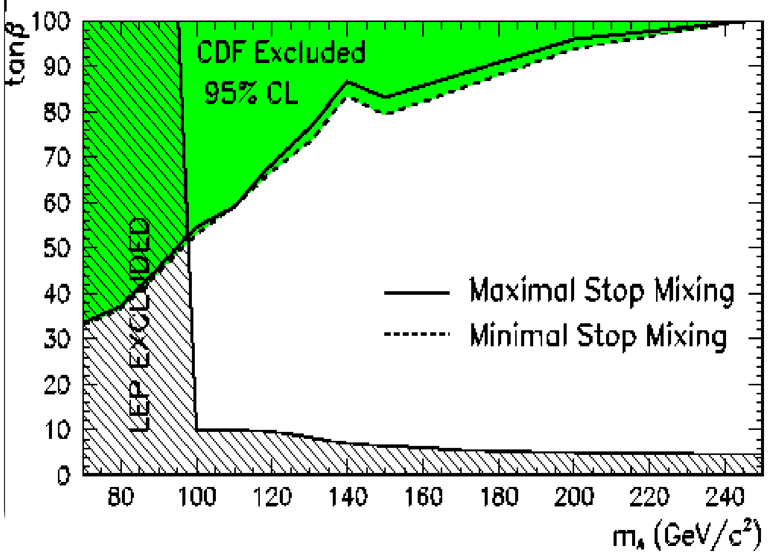
Conclusion

In the near future expect results on:

- ☞W/Z production, decays, M_W
- ☞top physics: top production and decay B.Ratios

Longer term, new tools will be very useful for

- ☞SUSY, Higgs, searches...
  - ⇨work needed !



1 fb^{-1}
m_A =150 GeV,
tan β = 50