W Boson Width Measurement at CDF

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Motivation

Γ_Z LEP ~5 MeV

- tight constraint on neutrino flavours

Γ_W LEP and TEV ~50 MeV

- one of the least well determined SM parameters

precise measurement

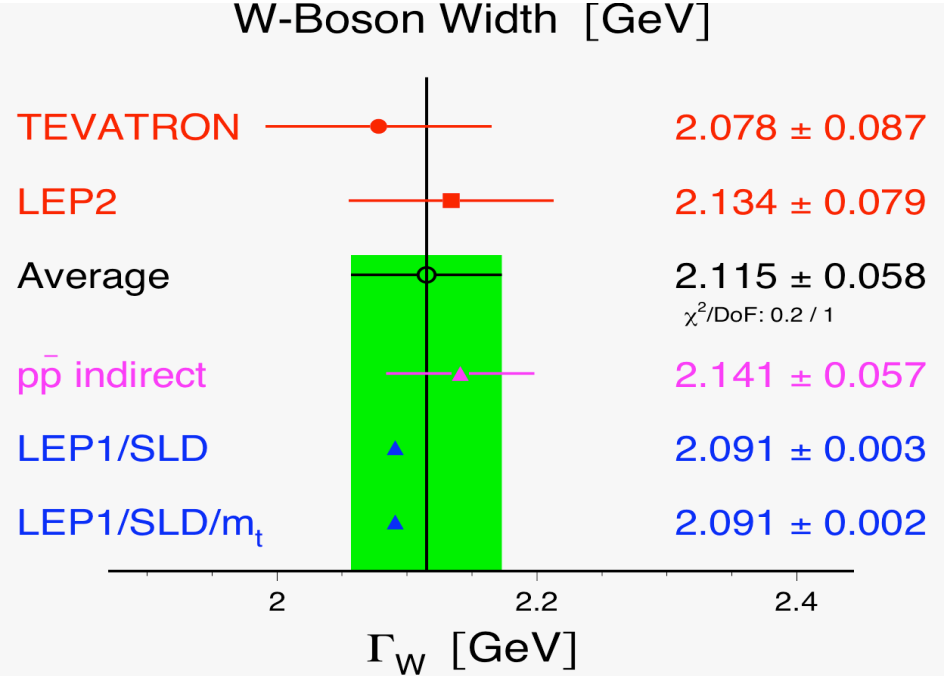
- sensitive new phyiscs
- calibrate resolutions for W mass (assume SM)

Current Status

87 MeV TEV combined

D0 RII 140 MeV

CDF RI 130 MeV

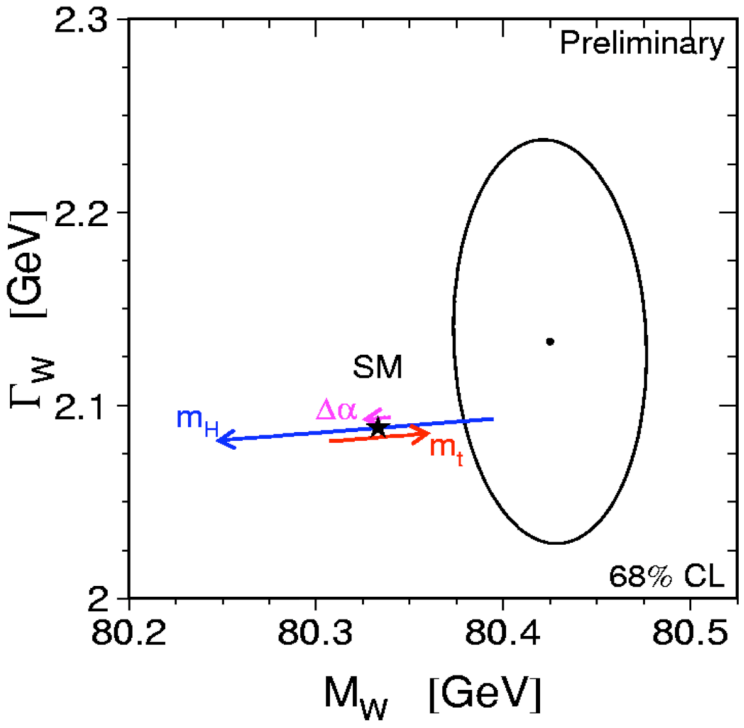


currently looking at 350 pb^{-1} (RI - 110pb^{-1})

expect to have 4fb^{-1} for RII (2009)

Relation to Higgs

Loop correction constraint Higgs mass terms in W_m and Γ_w

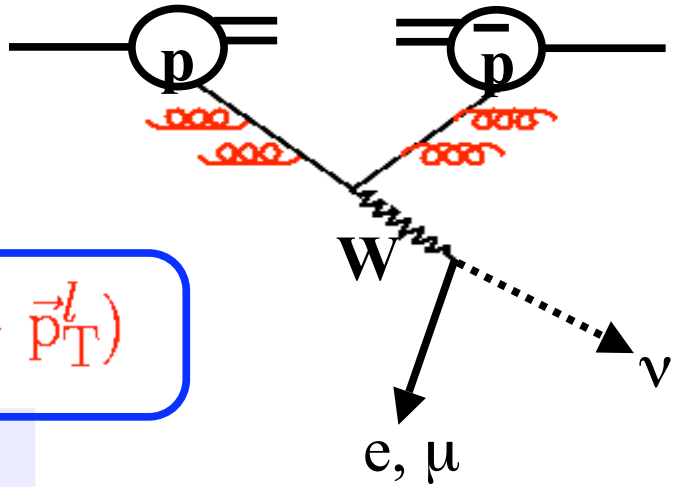


CDF

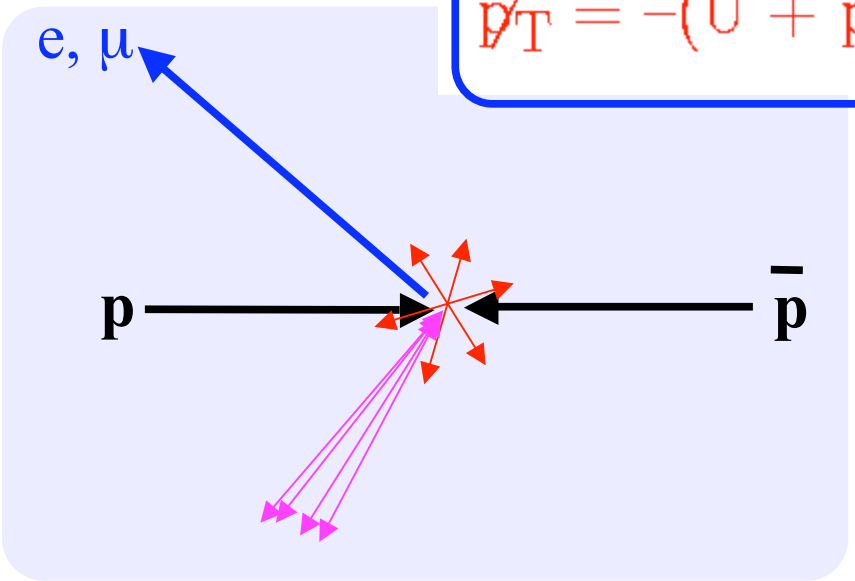
proton - antiproton collider

W boson has momentum

measure M_{tr}



$$\vec{\not{p}}_T = -(\vec{U} + \vec{p}_T^{\,l})$$



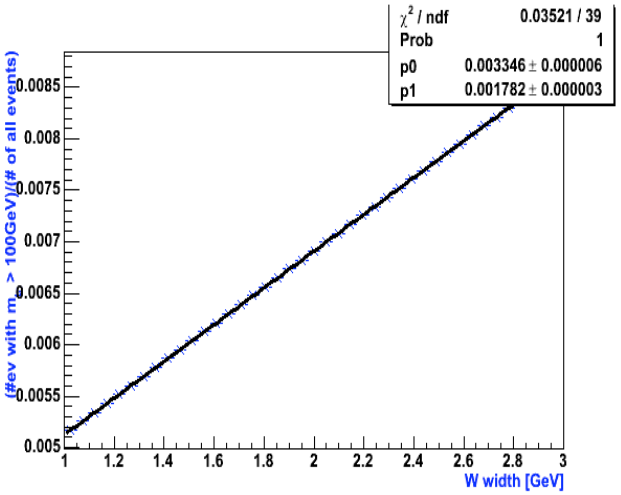
Method

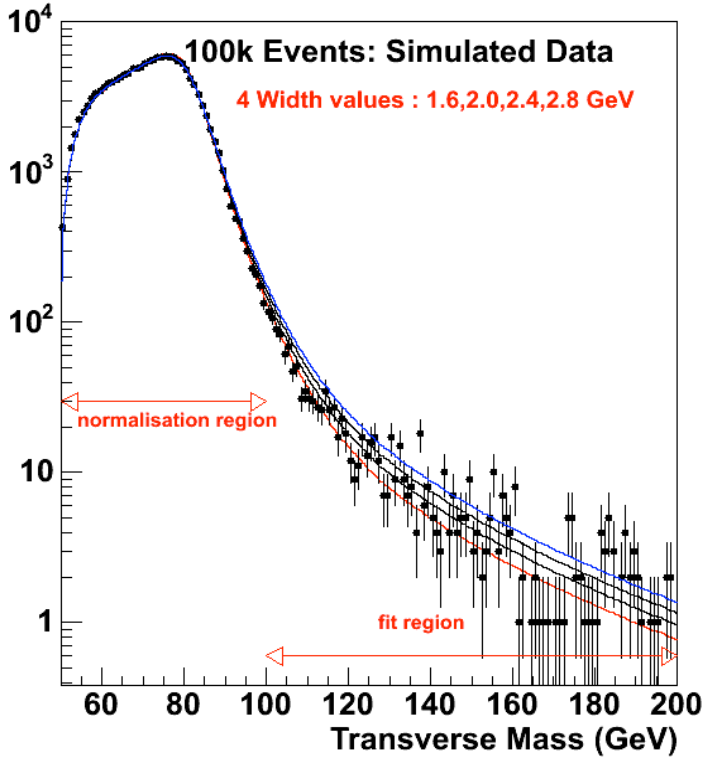
W boson mass has Breit-Wigner distribution

measure smeared M_{tr}

low systematics at large M_{tr}

Γ_w from simulated N_{tail} / N_{tot}



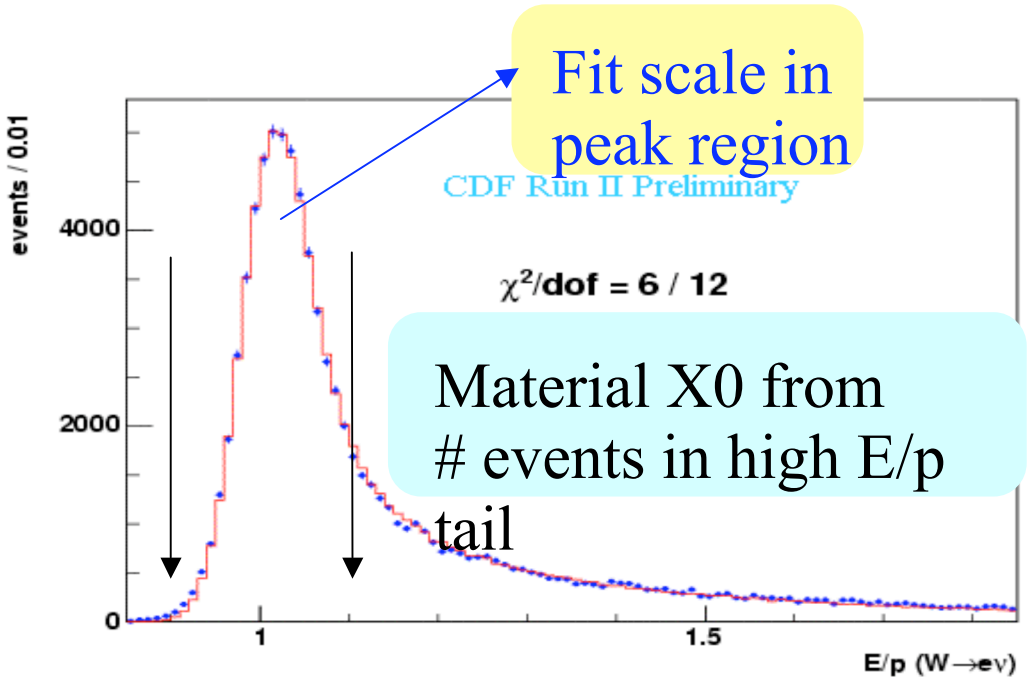


Method

weighted fortran MC (with QED radiation)

fast parametric detector simulation

example E/P



no generator level QCD - parameterize from Z data

Boson pT

NLO pQCD for $p_T^W > 25$ GeV

$P_T^W < 40$ GeV to reduce background

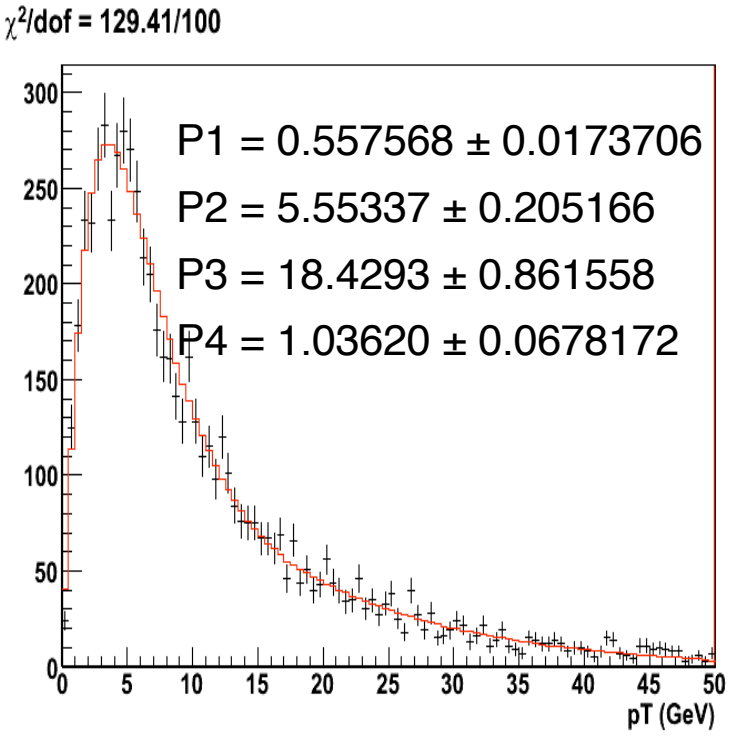
Majority of data is non-perturbative/soft regime

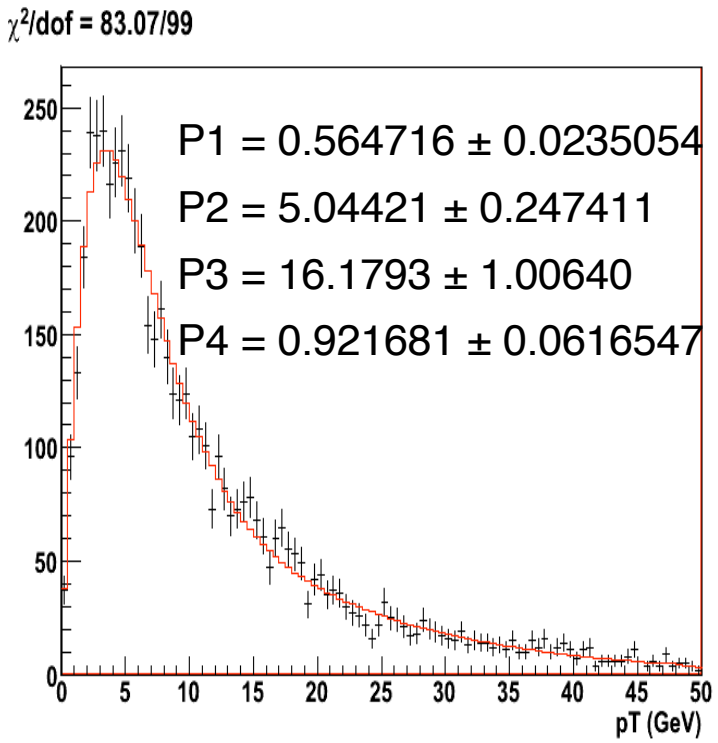
Use 4 parameter functional form

$$\frac{(\frac{P_T}{50})^{P_4}}{\Gamma(P_4+1)}\left[(1-P_1)\,P_2^{P_4+1}e^{\frac{-P_2 P_T}{50}} + P_1 P_3^{P_4+1}e^{\frac{-P_3 P_T}{50}}\right]$$

Boson pT

minimize $\chi 2$ for Z data using gaussian parametric smearing

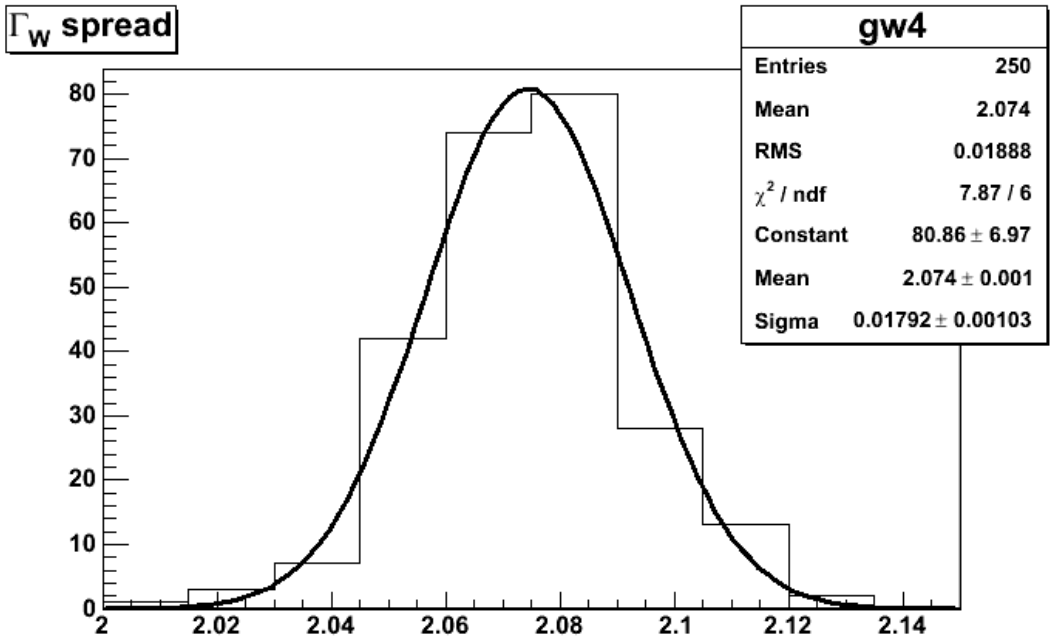




Boson pT

use Z fit for W simulation

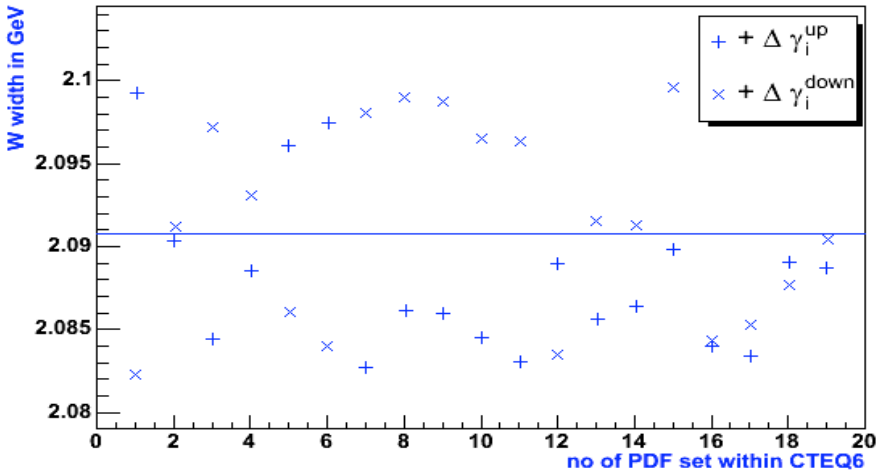
error on width 20 MeV



PDF error systematic

quark P_{ll} content determines lepton rapidity

high efficiency/resolution tracking $\eta < 1$



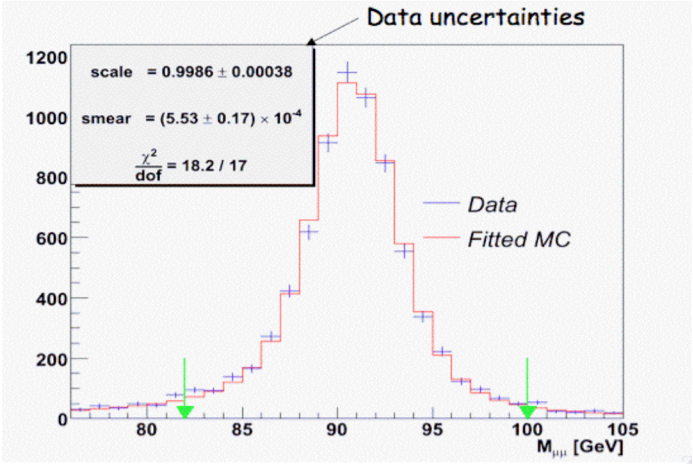
- CTEQ6 ± 25 MeV
- MRST ± 15 MeV

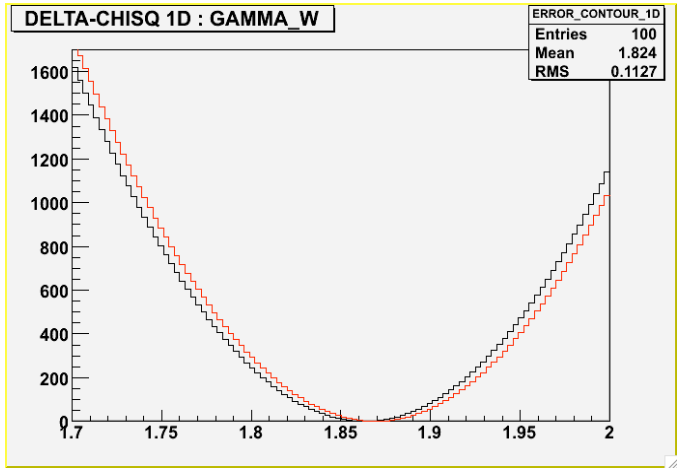
Momentum scale and resolution

need to understand detector response

scale for data and smearing for simulation

for tracking 2D fit to muon Z data



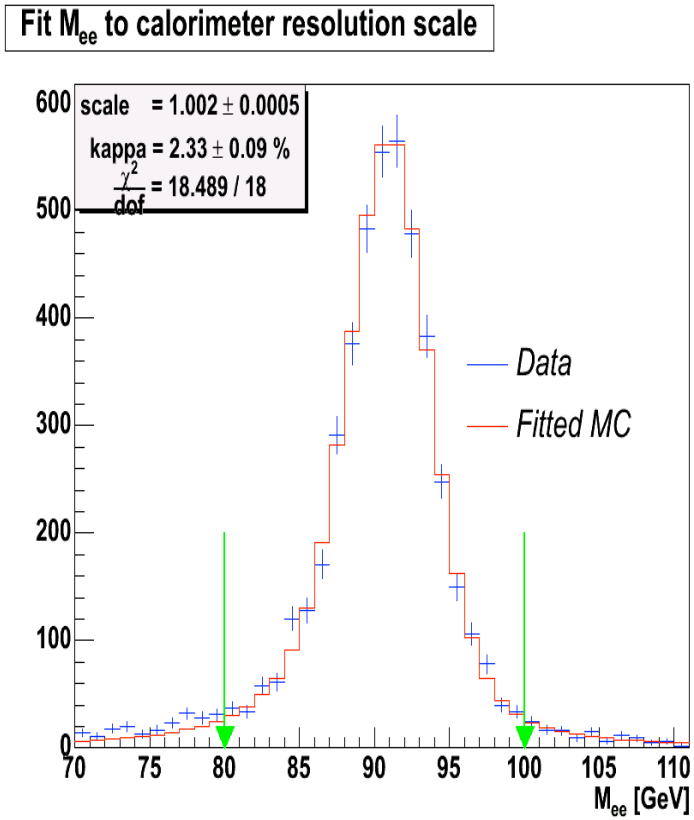


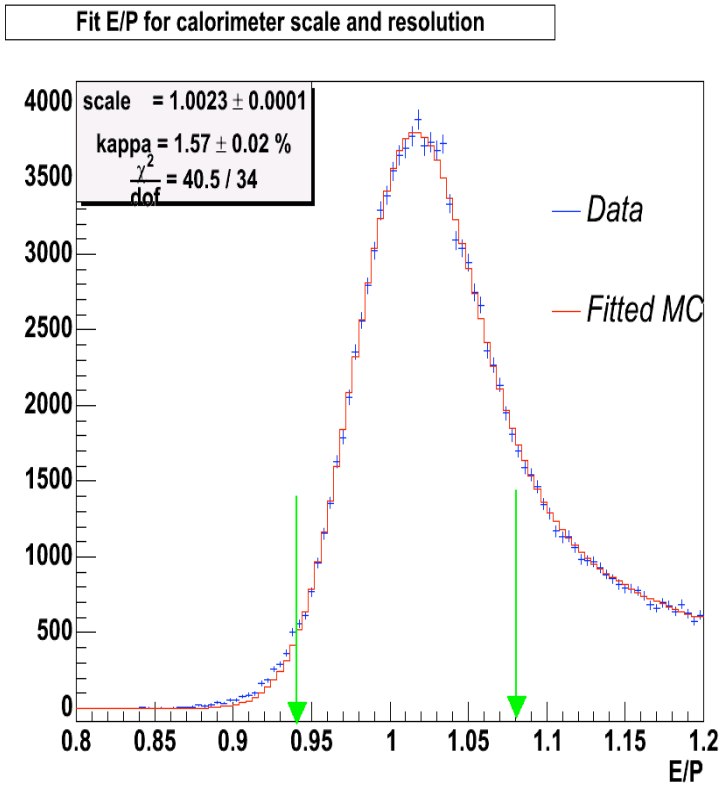
Z statistics determine momentum systematic

resolution systematic ±10 MeV

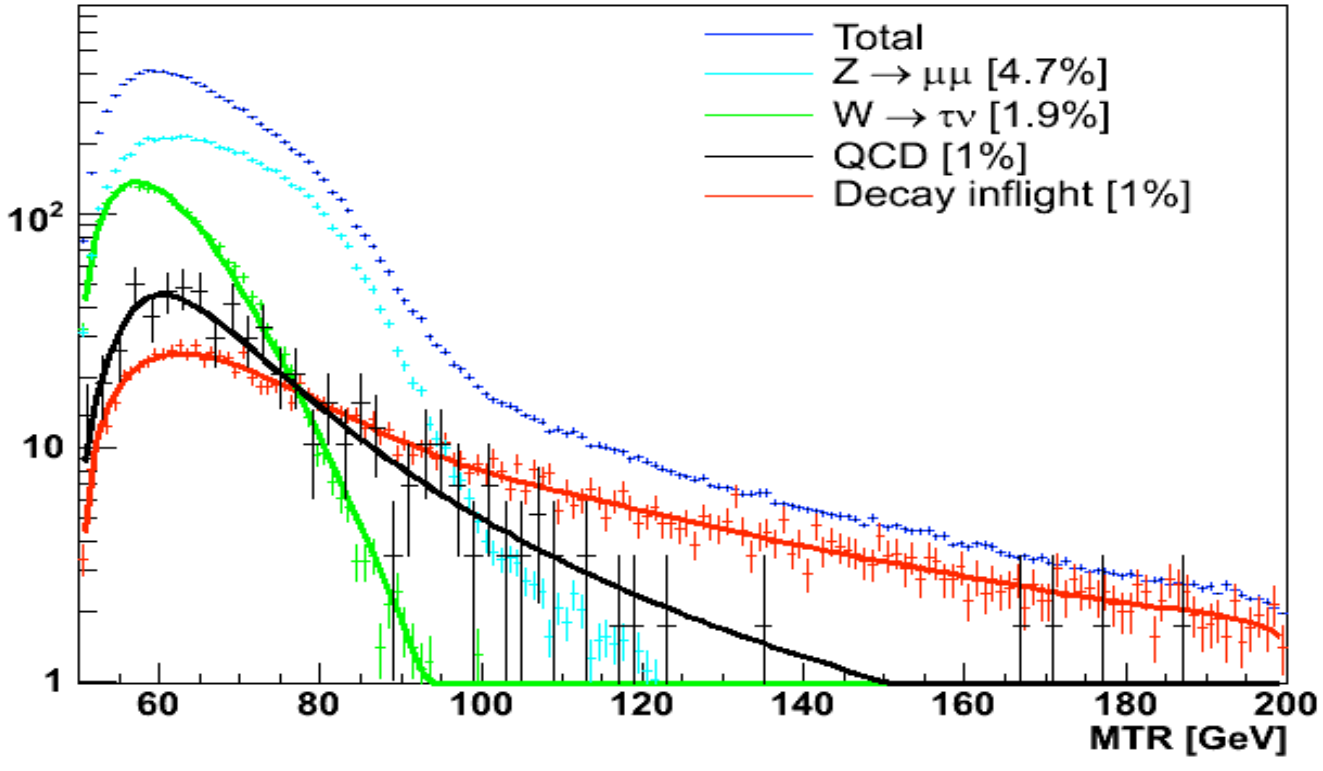
CEM scale and resolutions

minimize χ^2 for 2D fit to M_{ee} and E/P





Backgrounds



Summary

measured and estimated systematics

	Systematic (MeV)
W model (pT + pdf)	30
Lepton Scale/Non Linearity	35
Backgrounds	20
Detector Model/Lepton-ID	20
Recoil	30
Lepton Resolution	10
QED	10
Mw(40MeV)	10
Combined (e+mu)	**55**

Conclusion

Tevatron will substantially reduce uncertainty on W boson width.

CDF should achieve error as good as combined LEP2 results with 0.4 fb^{-1}

With final dataset expect error of ~30 MeV