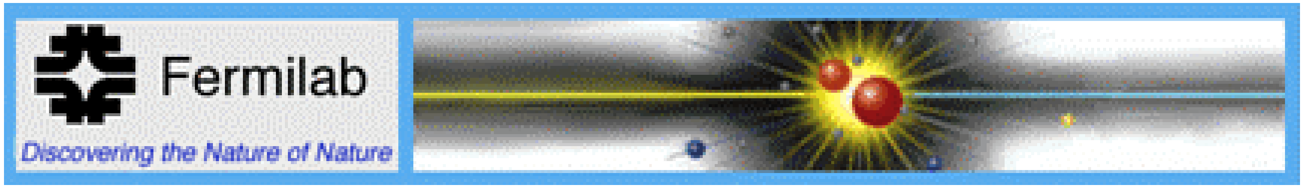
New Tevatron Results



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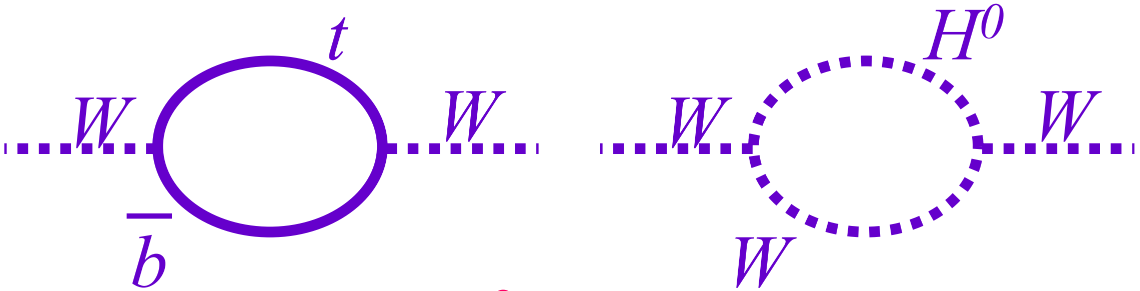
Outline:

- Improved determination of the W mass (D0) New
- Direct measurement of the W width (D0) New
- High Mass Drell Yan pair production (CDF) New

International Europhysics Conference on High Energy Physics
July 12-18, 2001, Budapest, HUNGARY

Measurement of the W Boson Mass

- EW symmetry breaking gives mass to the W boson
- determined at tree level by m_Z or $\sin^2\theta_W$, G_F, α
- dominant radiative corrections



$$\Delta m_W \propto m_t^2 \qquad \Delta m_W \propto \ln m_H$$

➔ important test of the Standard Model

➔ constrain Higgs boson mass

- W mass determined by likelihood fit to Monte Carlo distributions including backgrounds, efficiencies and detector resolutions

W mass: strategy for improved analysis

- Use same method to measure the W mass than our published results
  - Parameterize detector response using $Z \rightarrow ee$ events
  - Obtain W mass from maximum likelihood fit to $M_T(W)$, $P_T(e)$ & $P_T(\nu)$
- BUT use W and Z samples with "edge" electrons
  - $W \rightarrow e\nu$ events with edge electrons used in the fits (3853 events)
  - $Z \rightarrow ee$ events with 1 or 2 edge electrons for calibration (671 events)

⇒New D0 W mass measurement using "edge" electrons

- $Z \rightarrow ee$ events with only one edge electron used to additionally constrain the calibration of non-edge electrons, improving our previous measurements using central and forward electrons by 1% (central) and 8% (forward).

⇒Improved W mass measurement from non-edge electrons

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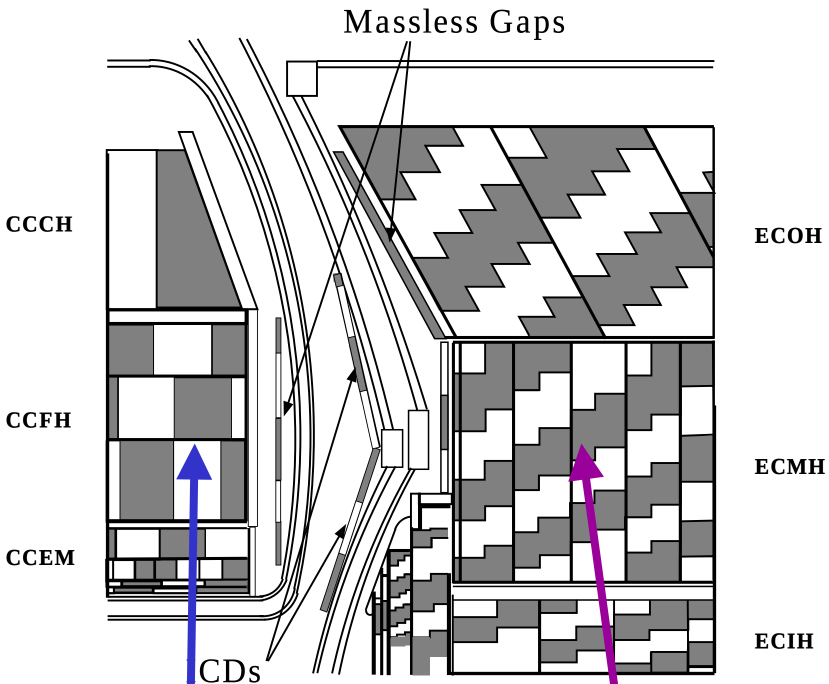
What is the "edge" region?



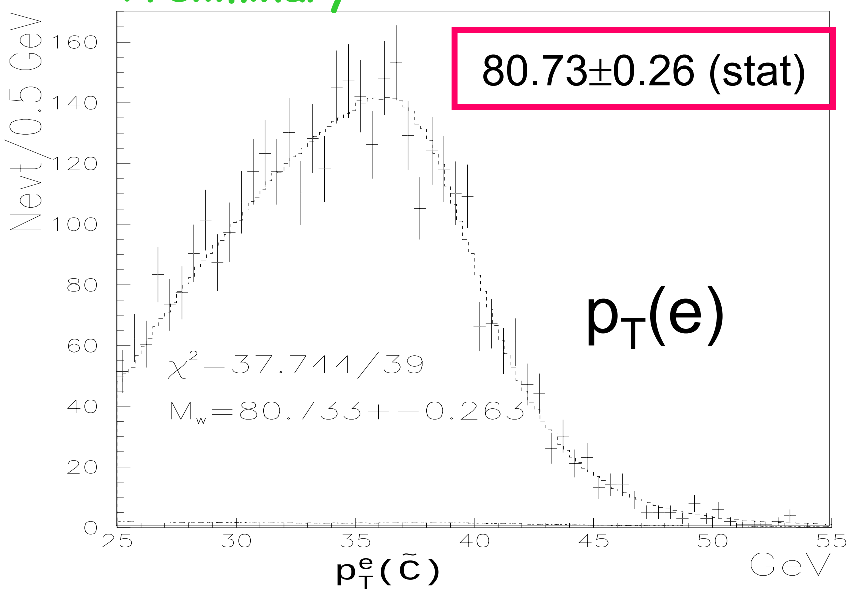
Central Calorimeter

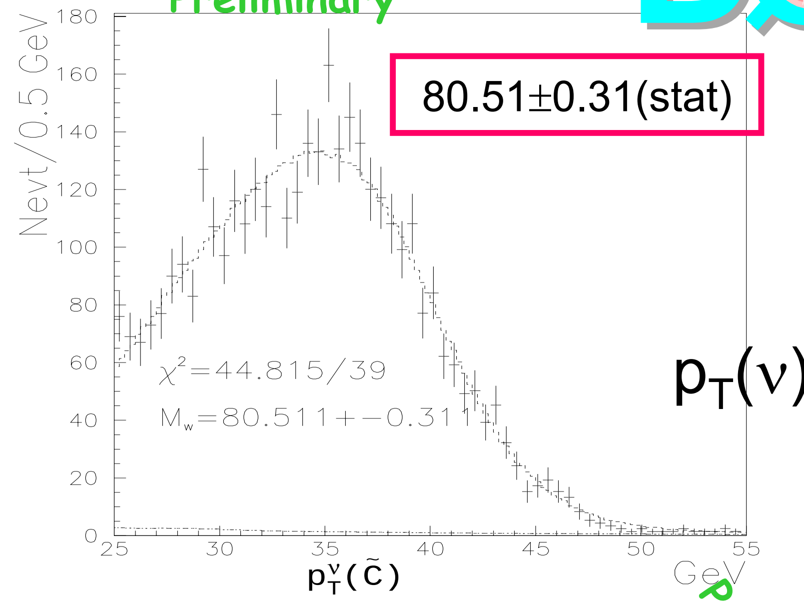
Forward Calorimeter

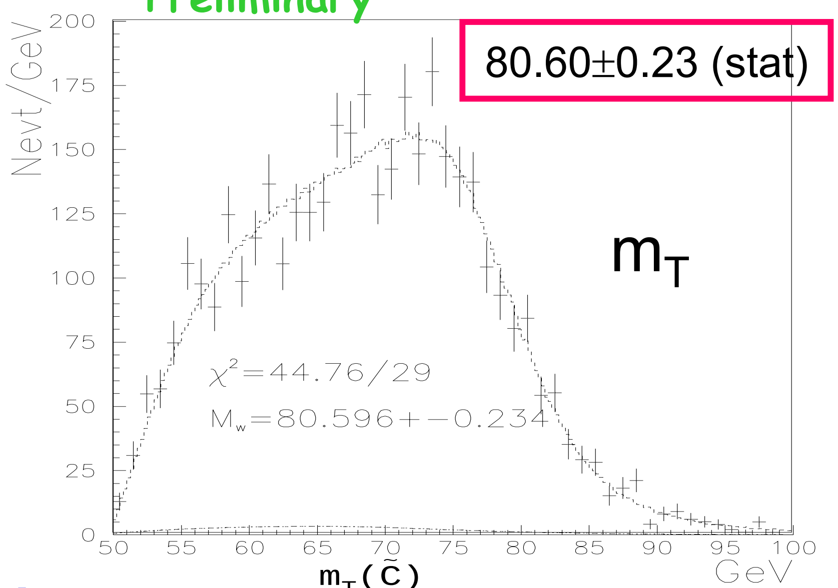
Central Calorimeter
32 EM modules

Boundary between
modules: "edge"

W Boson Mass from edge electrons







80.574±0.405 GeV

Preliminary

- Dominant Uncertainties:
  - Statistics (234 MeV)
  - EM scale (270 MeV)
  - EM resolution (267 MeV)
  - Theory (17 MeV)
  - Exp systematics (55 MeV)

Improved W Mass measurements (hep-ex/0106018)

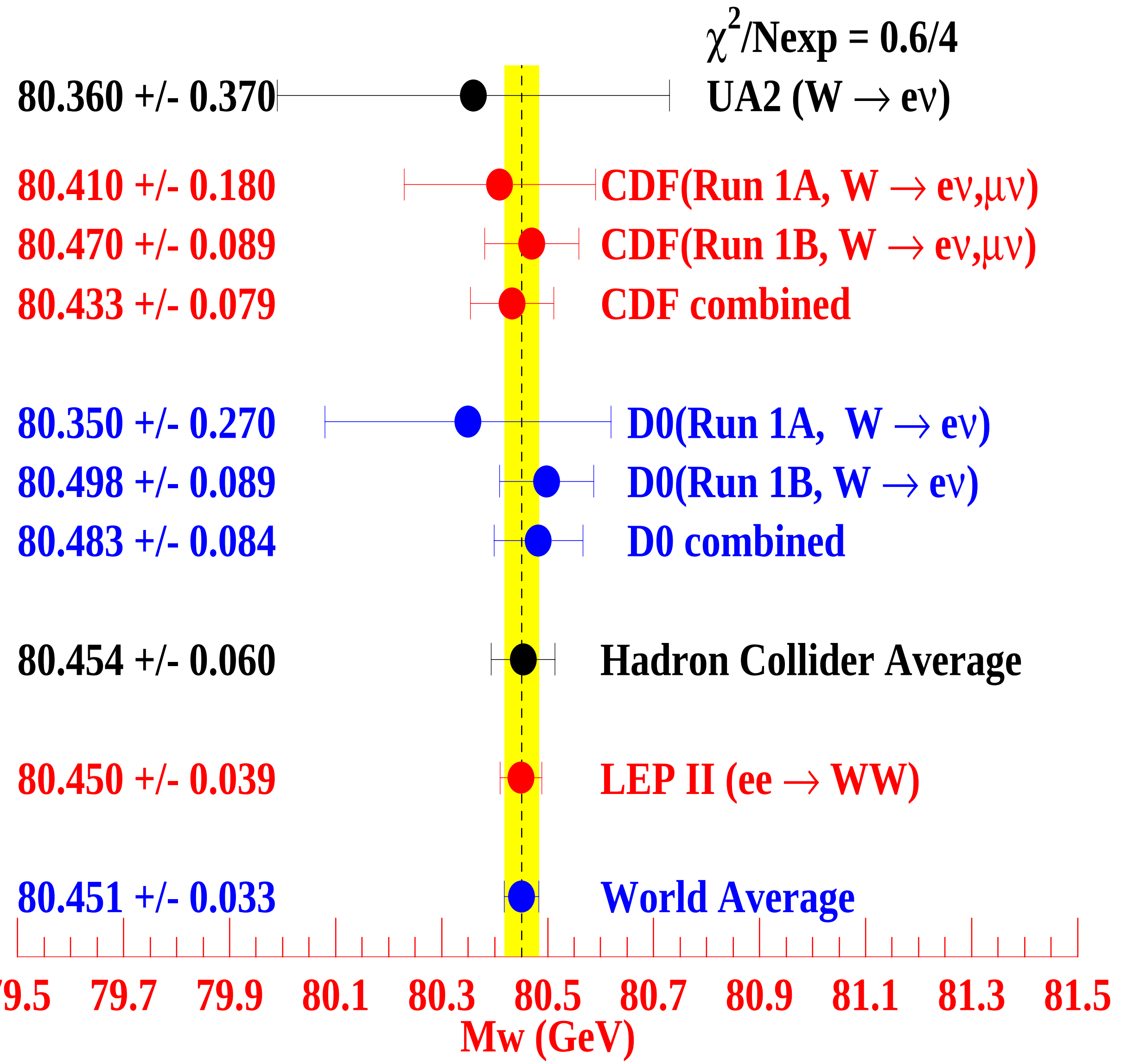
Updated D0 measurement with additionally constrained calibration and edge electron fits

(8% improvement)

New World Average

direct measurements

80.451 ± 0.033 GeV



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Direct Measurement of the W Width

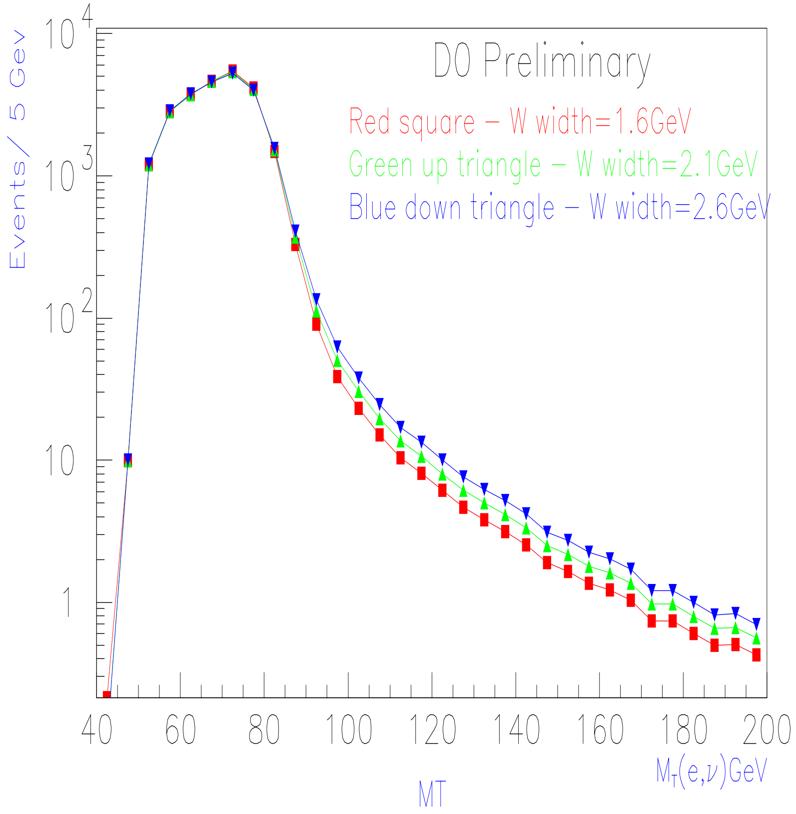
• Direct Measurement avoids using theoretical inputs.

• Explores the region above W pole where new physics could appear

  • Direct measurement has sensitivity to corrections to the coupling of the W to fermions

• Lineshape shown from Monte Carlo including Detector response

• The tail region of $M_T(W)$ is sensitive to $\Gamma(W)$ and can be used to extract $\Gamma(W)$



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Direct Measurement of the W Width

- $M_T(e,\nu)$ lineshape modeled with W mass fast Monte Carlo
  - W mass from momentum dependent Breit-Wigner x PLF
  - y and p_T distribution from Ladinsky-Yuan and NLO pQCD
  - W decay from Mirkes ($e\nu$) and Berends-Klein ($e\nu\gamma$)
  - Detector Modeling tuned to Z to ee distributions
- Fit $M_T(W)$ data distribution in $90 < M_T(W) < 200$ GeV window to signal MC + background prediction for different values of $\Gamma(W)$.
- Dominant Uncertainties:
  - Recoil modeling (60 MeV)
  - EM modeling (50 MeV)
  - Backgrounds (22 MeV)
  - W mass and p_T (20 MeV)

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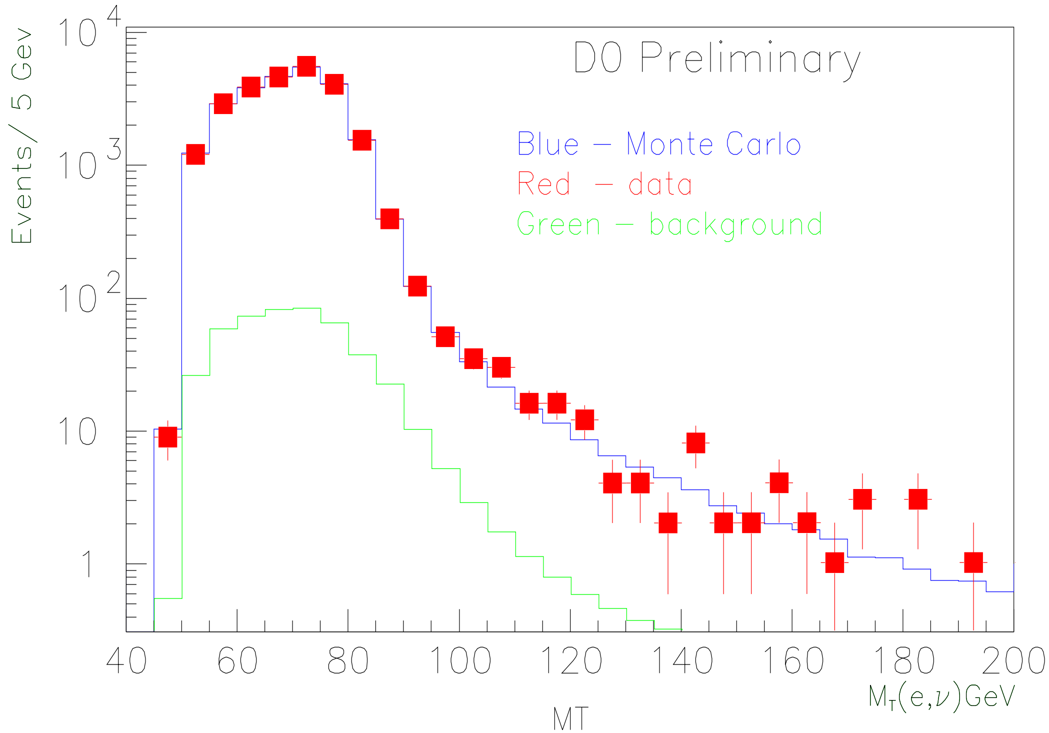
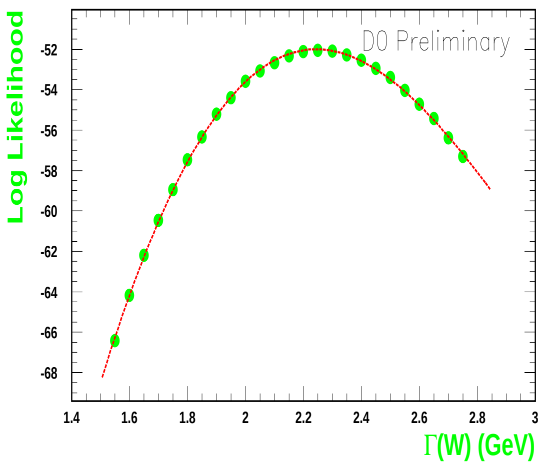
Direct Measurement of the W Width





$\Gamma(W) = 2.231\ ^{+0.145}_{-0.138}$ (stat) $\pm$ 0.092 (syst) GeV

CDF direct $\Gamma(W)$=2.055 $\pm$ 0.100 $\pm$ 0.075 GeV (e + μ)

SM prediction: $\Gamma(W)$=2.0937 $\pm$ 0.0025 GeV

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Drell-Yan Continuum Production

• Measurements of the mass dependence of the production cross section ppbar $\rightarrow e^+ e^- + X$ ($d\sigma/dM$) and the forward-backwards asymmetry (A_{FB})

• Improve published results by

  • Using electrons in the plug ($1.1<|\eta|<2.4$) and forward ($2.2<|\eta|<4.2$) calorimeters.

  • Reduced backgrounds in the forward region (tighter tracking cuts)

  • QED radiative corrections for the change in mass from the emission of the final state photons allows measurement of A_{FB} in small bins over a large range of mass.

• Compare to Standard Model Drell-Yan predictions and search for evidence of new interactions

  • additional gauge bosons

  • quark-lepton compositeness

  • exchange of R-parity violating SUSY particles

  • leptoquarks

  • extra dimensions

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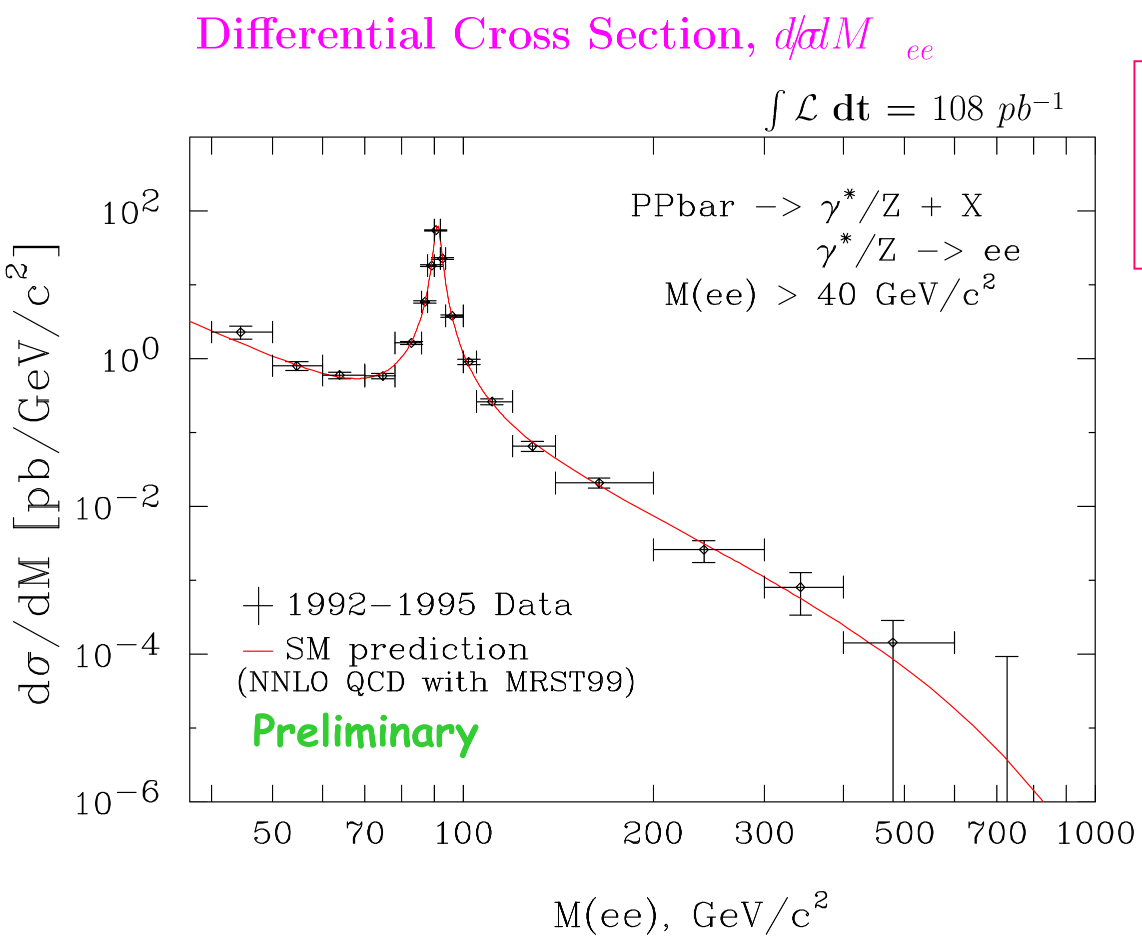
Mass dependence of the production cross section (FERMILAB-PUB-01/116-E)



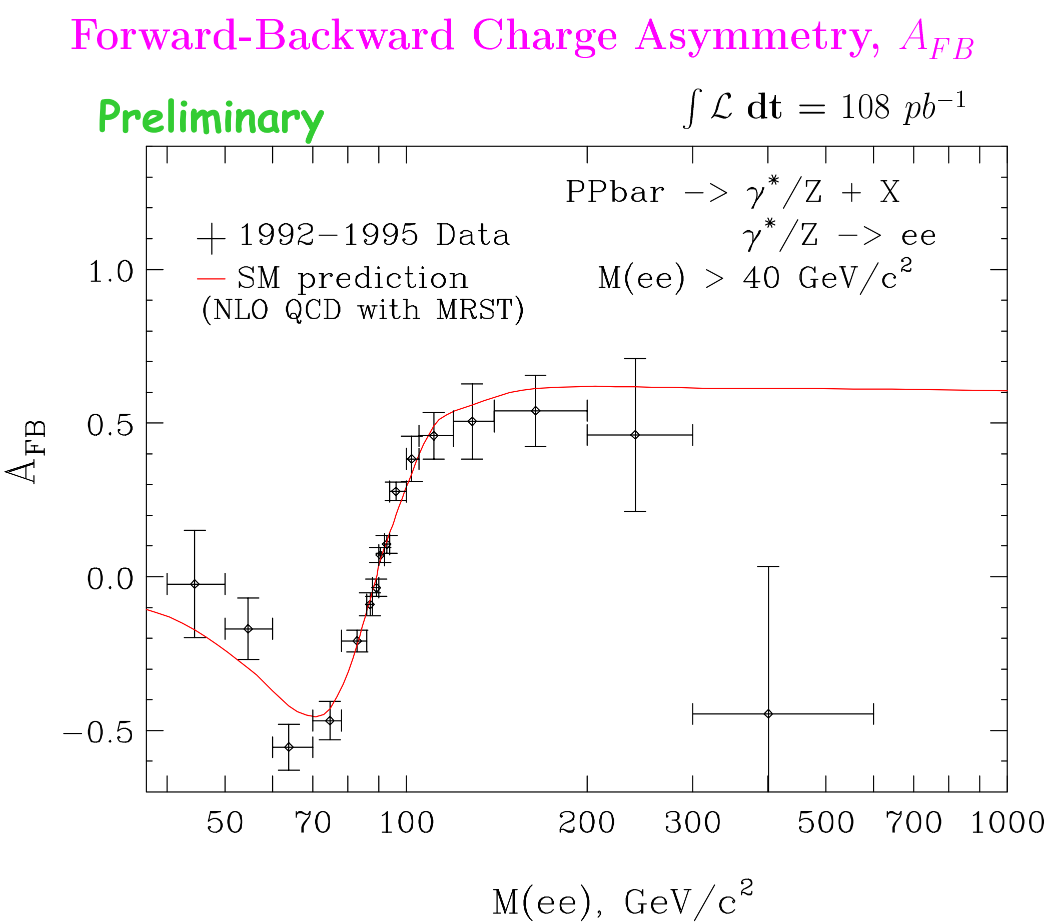
$$\frac{d\sigma}{dM_i} = \frac{d_i - b_i}{a_i \times \varepsilon_i \times L \times \Delta M_i}$$

Solid line is NNLO QCD calculation with MRST99 (NLO) PDFs, scaled up by a factor 1.11.

Good agreement with SM prediction

Mass dependence A_{FB} (FERMILAB-PUB-01/116-E)

$$A_{FB}^{i} = \frac{\left(\frac{d\sigma}{dM_i}\right)^{+} - \left(\frac{d\sigma}{dM_i}\right)^{-}}{\left(\frac{d\sigma}{dM_i}\right)^{+} + \left(\frac{d\sigma}{dM_i}\right)^{-}}$$



Solid line is NLO QCD calculation with MRST (NLO) PDFs

- +/- correspond to hemispheres of e wrt proton in Collins-Soper frame
- Good agreement with SM
- The highest bin (4 events - 300<Mee<600GeV) is 2.2σ below the SM prediction (probability of 2.5%)
- Negative asymmetry in this region could result from new interactions

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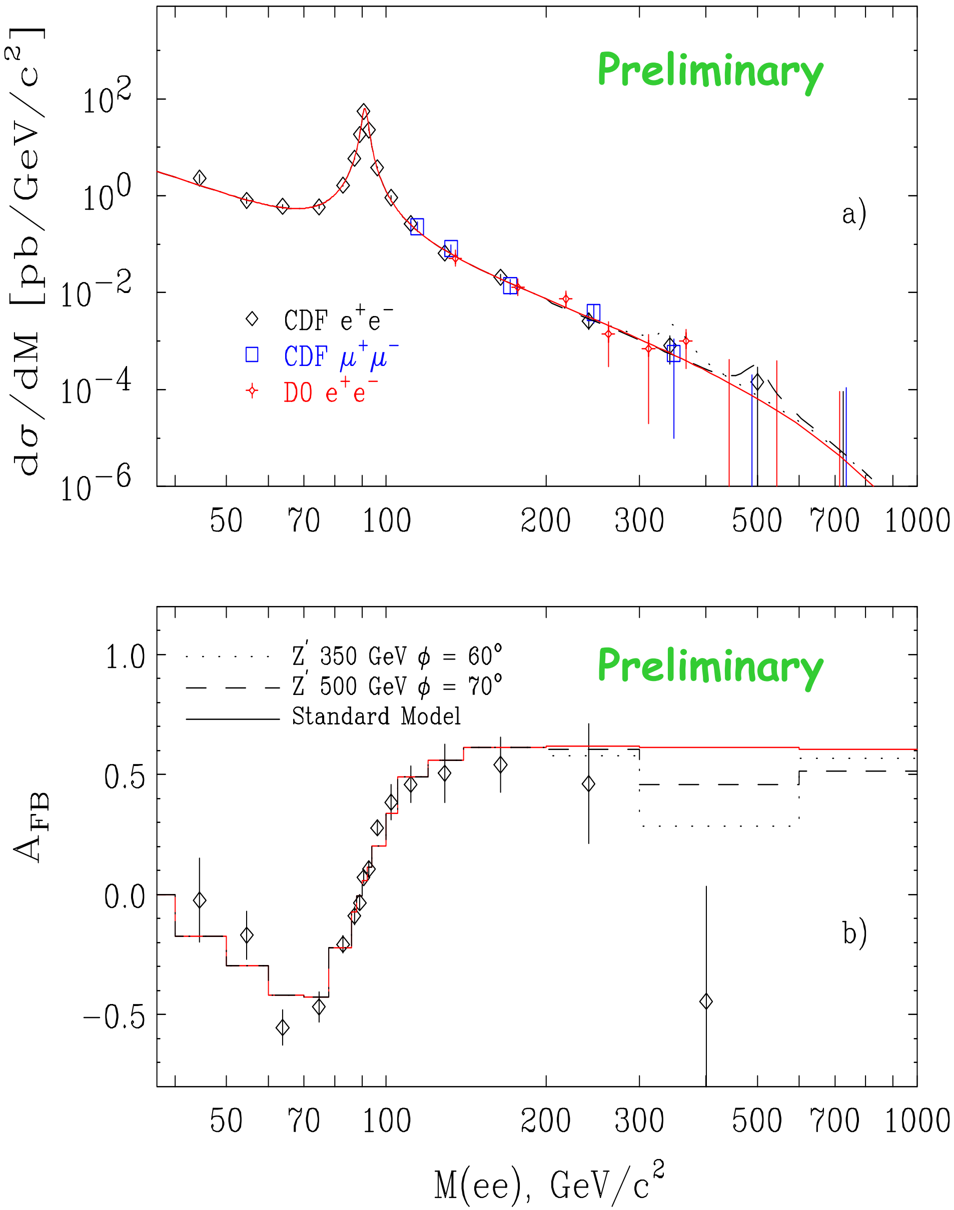
Implication of a 300-500GeV Z' to Tevatron data



(Bodek & Baur)

- Full line: SM predictions

· *Good agreement*

- Additional E_6 Z' prediction shown
- Assume couplings to third generation is large, width~10%M(Z')
- Tevatron Z' limits (~600GeV) assumed Z couplings and 1% width
- Data compatible with an extra Z' (350/500GeV, width=10% mass) with enhanced couplings to third generation quarks
- CDF data can be included in global EW fits to search for physics beyond the SM (hep-ph/0102160)

Conclusions

- Improved measurement of the W mass using "edge" electrons
  - 8% improvement in combined D0 result.
- Direct measurement of the W width from D0
  - Good agreement with previous measurements and SM predictions.
- Mass dependence of the e+e- production cross section and forward-backwards asymmetry from CDF
  - Agrees with SM predictions
  - 2.2 σ below SM prediction for A_{FB} in the (300,600) GeV mass bin compatible with new interaction
  - Data can be used in combined EW fits to look for interactions beyond the SM