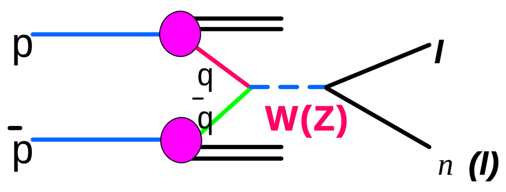
Measurement of the W and Z production Cross Sections With the DZero Detector using the electron decay channel

Introduction

Motivation:

- Test of SM Couplings
- Test of higher order QCD corrections
- Constrain proton PDFs
- Will be used for luminosity normalization in the future



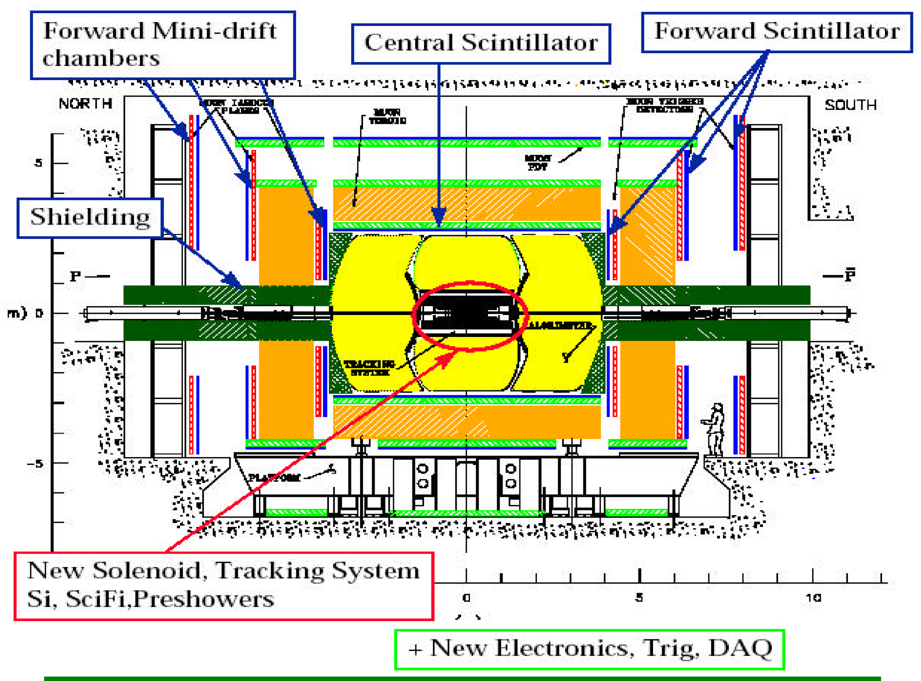
Counting Experiment:

$$s \cdot B = \frac{N_{obs} - N_{bkg}}{A \cdot e \cdot L}$$

- L: Luminosity
- A: Acceptance from MC
- e: Efficiency from Data
- N_{obs}: # of Observed Events
- N_{bk}: # of Background Events

W→ev: Backgrounds (Matrix Method)

- No track matching requirement: $N = N_W + N_{QCD}$
- Add track matching requirement: $N_{trk} = e_{trk} N_W + f N_{QCD}$



All parts of the detector used in this analyses: Calorimeter System and the Tracker

Selection Cuts

Trigger:

- L1: 1 calorimeter tower with E_T>10 GeV (or 2 EM towers with E_T>5 GeV)
- L3: Electron candidate E_T>20 GeV, shower shape cut

Electrons

- **Kinematical Cut:** E_T> 25 GeV
- **Geometrical Cut:** In Central Calorimeter (CC) or Endcap Calorimeter (EC)
- **EMID Cuts:**
- Isolated Electromagnetic Cluster in the Calorimeter
- Large electromagnetic fraction
- Shower shape consistent with MC expectation

Z→ee

- 70 GeV < m_{ee} < 110 GeV

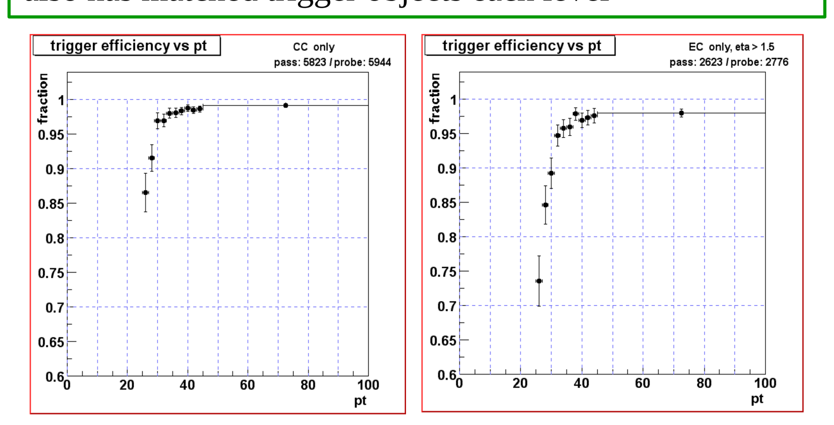
W→en

- Missing transverse energy > 25 GeV
- With and without track matching

Efficiencies

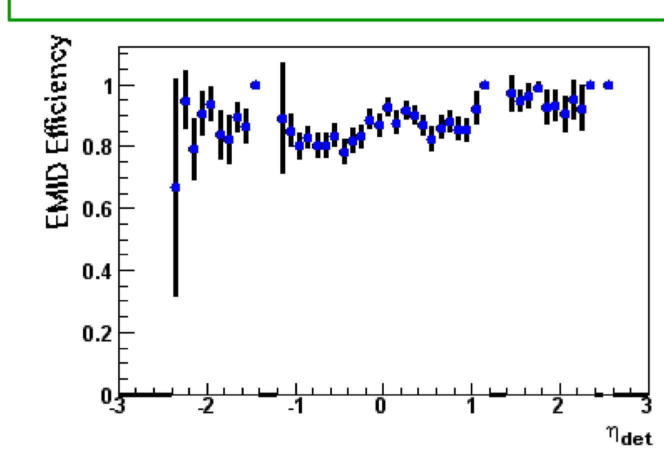
Trigger Efficiency

- **Tag/Probe Method using Z candidates**
- Highest p_T electron is used as the tag electron (Passes EMID cuts and has a matched track) and also has the matched trigger objects at all trigger levels, count the fraction of events in which the second electron (Probe) also has matched trigger objects each level



EM Reconstruction Efficiency

- Tag Electron: Passes the kinematical, geometrical and EMID cuts and also has a matched track
- Probe Electron: Only passes the kinematical and geometrical cuts



Track Matching Efficiency

- Definition

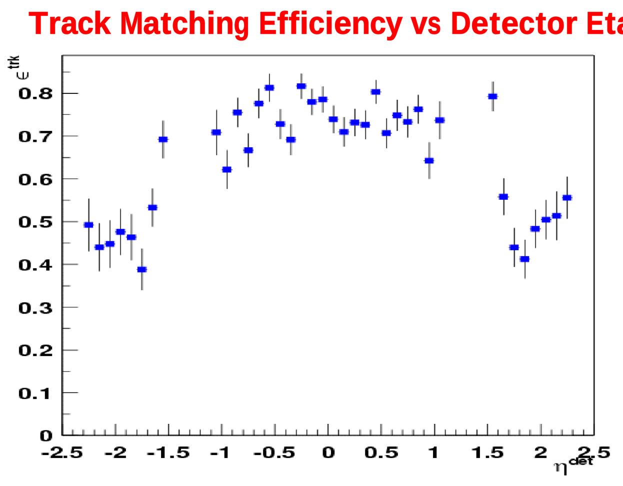
$$c^2 = \left(\frac{\Delta z}{s(z)}\right)^2 + \left(\frac{\Delta f}{s(f)}\right)^2 + \left(\frac{E_T/p_T - 1}{s(E_T/p_T)}\right)^2$$

- Δz and Δϕ are the differences between the track position and the EM cluster position at the third floor of the EM calorimeter, E_T/p_T is the ratio of the measured transverse energy of the cluster to the measured p_T of the track, σ values are the root-mean-squares of the experimental measurements of each quantity
- An electron is matched with a track if $P(\chi^2)$>0.01

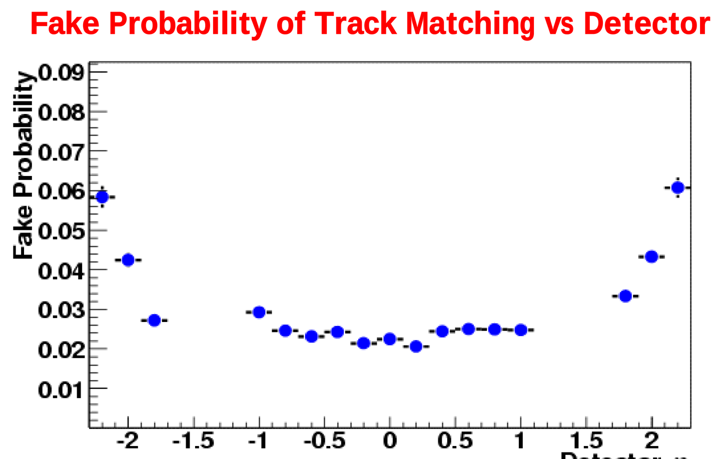
Fake Probability of Track Matching

- Determined by selecting events with an EM cluster that passes EMID requirements and is back-to-back with a jet passing jet quality requirements (These events are actually di-jet events, where one jet fakes the electron)
- The fake track matching probability is the fraction of the EM objects that are found to have a matching track

Track Matching Efficiency vs Detector Eta



Fake Probability of Track Matching vs Detector Eta

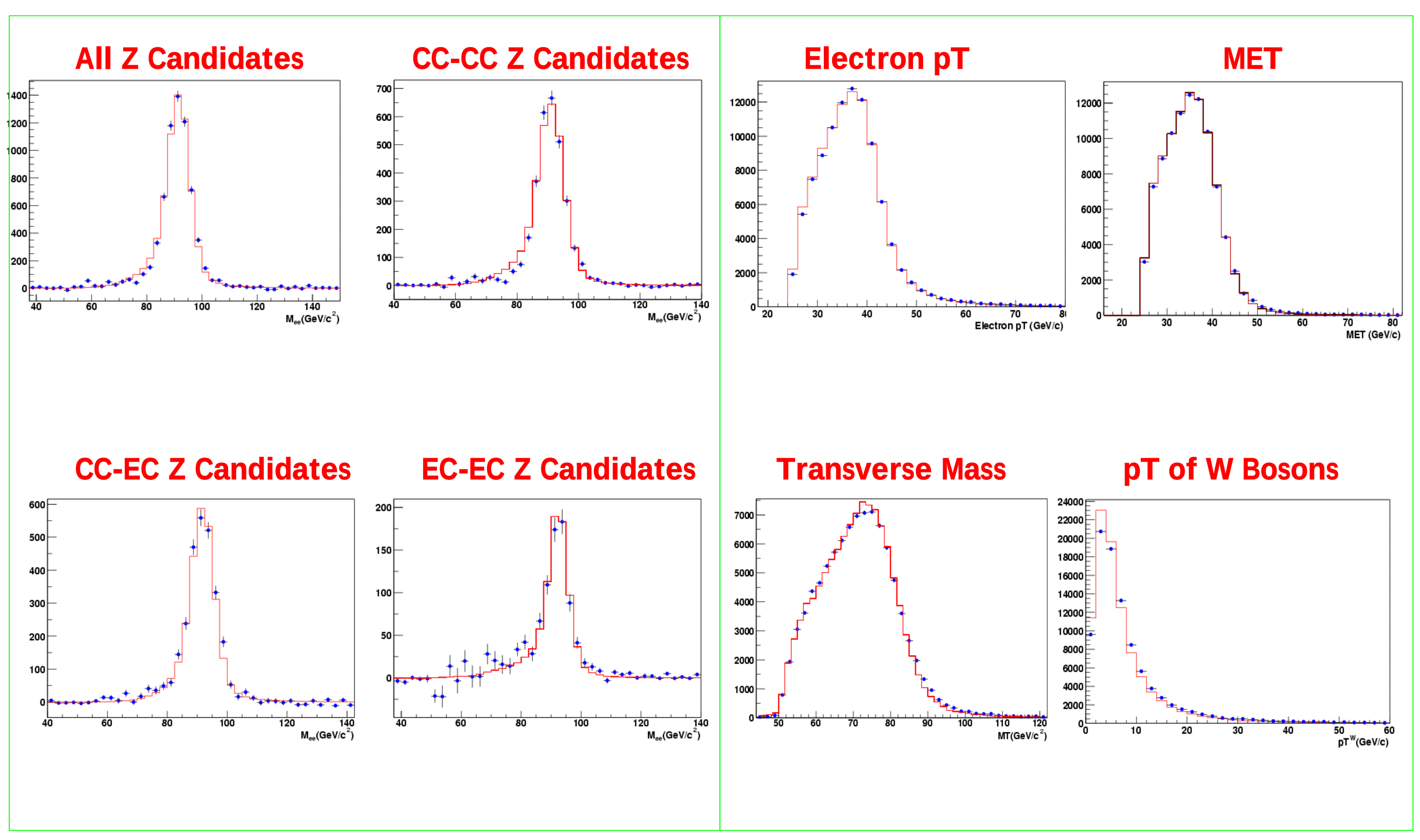


Parameterized Monte Carlo Simulation (PMCS)

- **Electron Smearing:**
- Extrapolate the generator-level electrons from the primary vertex to the electromagnetic calorimeter
- Electrons are divided into different types according to their positions in the calorimeter
- Smear electron Energy, Detector Eta and Phi

- **Missing transverse energy (MET) Smearing:**
- Use the four vectors of the generator-level electrons and neutrino to calculate the transverse momentum of the recoil jet at the generator level
- Smear electron and the recoil jet
- Add the contribution of underlying events
- Calculate the smeared MET

Data-MC Comparison



Blue Dot: DATA (Background Subtracted) Red Hist: MC

Acceptance and PDF Uncertainty

- Acceptance determined from PMCS
- CTEQ6 PDFs (20 pairs of error PDFs)

- **PDF Uncertainty:**

$$\Delta X = \frac{1}{2}\sqrt{\sum_{i}^{pairs}[X(s_i^+) - X(s_i^-)]^2}$$

- Where the uncertainty on an observable X is DC, the sum runs over the pairs of PDFs, and $X(s_i^{\pm})$ are the values of X determined using the PDF pairs.

Other Backgrounds for Z ® ee

- **Drell-Yan Contribution:**
- Small effect (2.0%) in the mass window of 70 < m_{ee} < 110 GeV
- **QCD Background:**
- Determined from Data by fitting signal and background shape

Other Backgrounds for W ® en

- W→tn→ennn (1.5 %, Determined from MC)
- Z→ee (negligible)

WZ Cross Sections times Branching Ratio

	Value	Uncertainty
Trigger Efficiency	98%	2%
EMID Efficiency	85.6%	1%
Tracking Efficiency	73%	2%
Track Match Fake Probability	2.3%	1%
MC Acceptance: Ws	27.6%	0.4%
MC Acceptance: Zs	13.6%	0.3%
Number of Ws	27370	898
Number of Zs	1139	42
Luminosity	41.6 pb^{-1}	4.16 pb^{-1}

	σ_W uncertainty	σ_Z uncertainty	R Uncertainty
Statistics	21 pb	9 pb	0.35
Background Estimation	91 pb	4 pb	0.37
Trigger Efficiency	58 pb	-	0.20
EMID Efficiency	33 pb	6 pb	0.12
PDF Uncertainty	39 pb	5 pb	0.17
EM Scale	40 pb	2 pb	0.09
EM Resolution	6 pb	1 pb	0.03
Hadronic Scale	20 pb		0.07
Hadronic Resolution	6 pb		0.02
Boson p_T	3 pb	-	0.01
Luminosity	284 pb	28 pb	

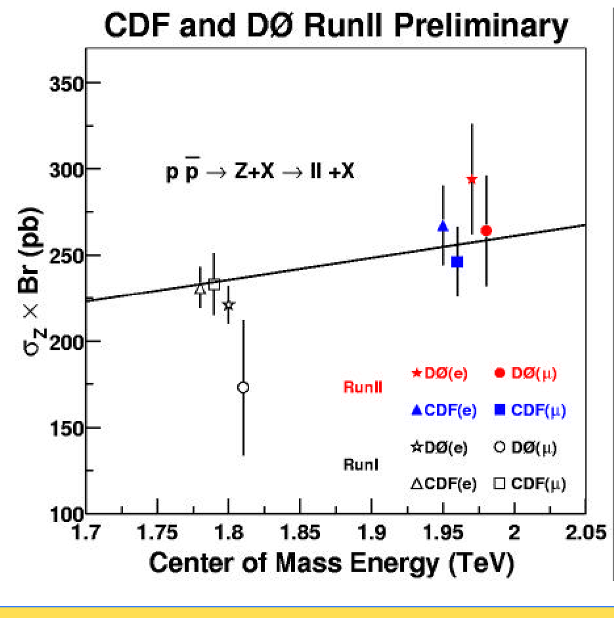
$$s(Z) \times B(Z \to ee) = 275 \pm 9_{stat} \pm 9_{sys} \pm 28_{lum}\ pb$$

$$s(W) \times B(W \to e?) = 2844 \pm 21_{stat} \pm 128_{sys} \pm 284_{lum}\ pb$$

$$R = \frac{s(W) \times B(W \to e?)}{s(Z) \times B(Z \to ee)} = 10.34 \pm 0.35_{stat} \pm 0.48_{syst}$$

Official DZero Results for EPS

CDF and DØ RunII Preliminary



CDF and DØ RunII Preliminary