Inclusive Differential p_T Cross Section for the Z boson

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for the
DØ Collaboration

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Motivation and Theory

- Improve M_W precision by constraining vector boson production parameters
- Test vector boson production phenomenology
  - Ladinsky-Yuan(1993); Arnold-Kaufman(1990); Altarelli-Ellis-Greco-Martinelli(1984)
  - parameterize low p_T (<30 GeV/c) behavior as

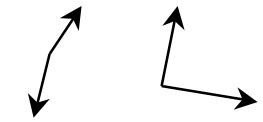
$$\frac{d\sigma}{dp_T^2\,dy} \propto \int d^2b\, e^{i\vec{b}\cdot\vec{q}_T} W(b_*)\, e^{-S(b)}$$

$$b_* = \frac{b}{\sqrt{1 + b^2/b_{max}^2}} \qquad S(b) = b^2[g_1 + g_2 \ln(b_{max}Q/2) + g_3 x_1 x_2]$$

  - g_1, g_2, and $g3$ values obtained from high statistics low energy Drell-Yan data and CDF p_T(Z) data from 1989 Collider Run (365 events)
  - Most sensitive to g_2 in region near M_Z
- Test QCD/ Search for new physics at high p_T

Data Selection and Reconstruction

- Fiducial and Kinematic requirements
  - $|\eta|<1.0$ (Central Calorimeter; CC) and $1.5<|\eta|<2.5$ (End Cap Calorimeter; EC)
  - not within 5% of φ module boundary for $|\eta|<1.0$
  - $E_T>25$ GeV
  - $76<M_{ee}<106$ GeV/c^2
- Electron Quality and Tracking
  - isolated object
  - transverse and longitudinal shape consistent with an electron
  - at least one of the two electron candidates must have a track that matches well with the calorimeter cluster



CCCC CCEC

2188 events with two central electrons (CCCC)

1818 events with one central electron and one forward electron (CCEC)

4006 events total

Measurement Components

Goal: Measure smeared cross section as a function of p_T ($d\sigma/dp_T$) and compare to smeared theory

- Account for p_T dependent corrections
  - Acceptance; fiducial and kinematic requirements
  - Identification efficiency; e^- quality requirements
  - Background
- Determine cross section in p_T bins

$$\sigma_i = (d_i - b_i)/ a_i \varepsilon_i$$

σ_i = cross section in bin I

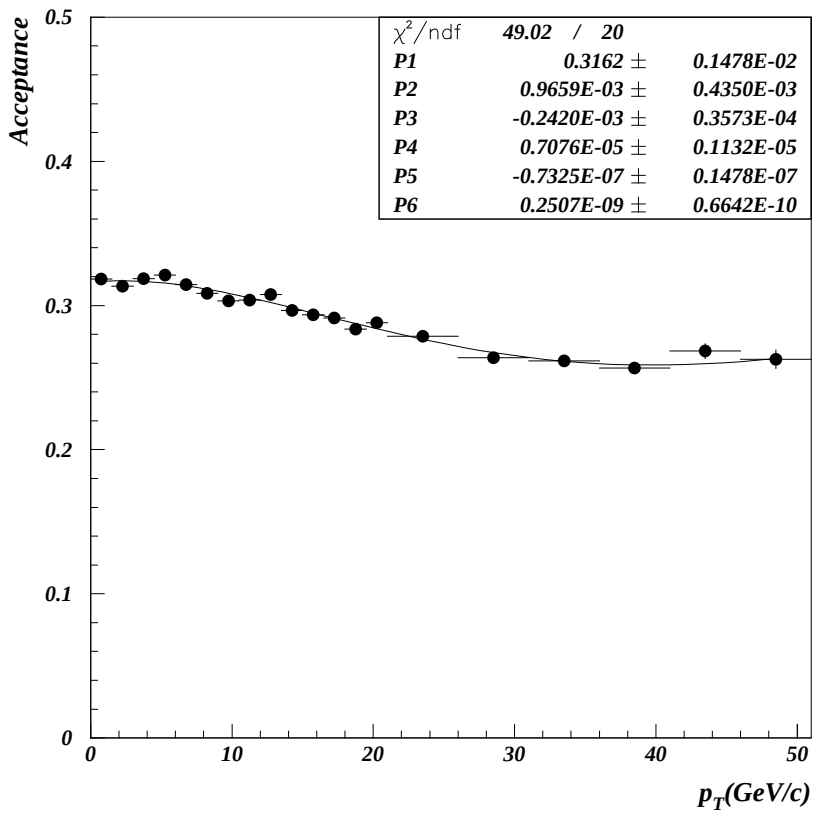
d_i = data events in bin i; b_i = background in bin i

a_i = acceptance for bin i; ε_i = efficiency for bin i

- Normalize to total cross section to account for non- p_T dependent corrections

Acceptance

- Use parameterized detector simulation
- Include trigger turn on, E_T cut, ηcut, ϕ cut

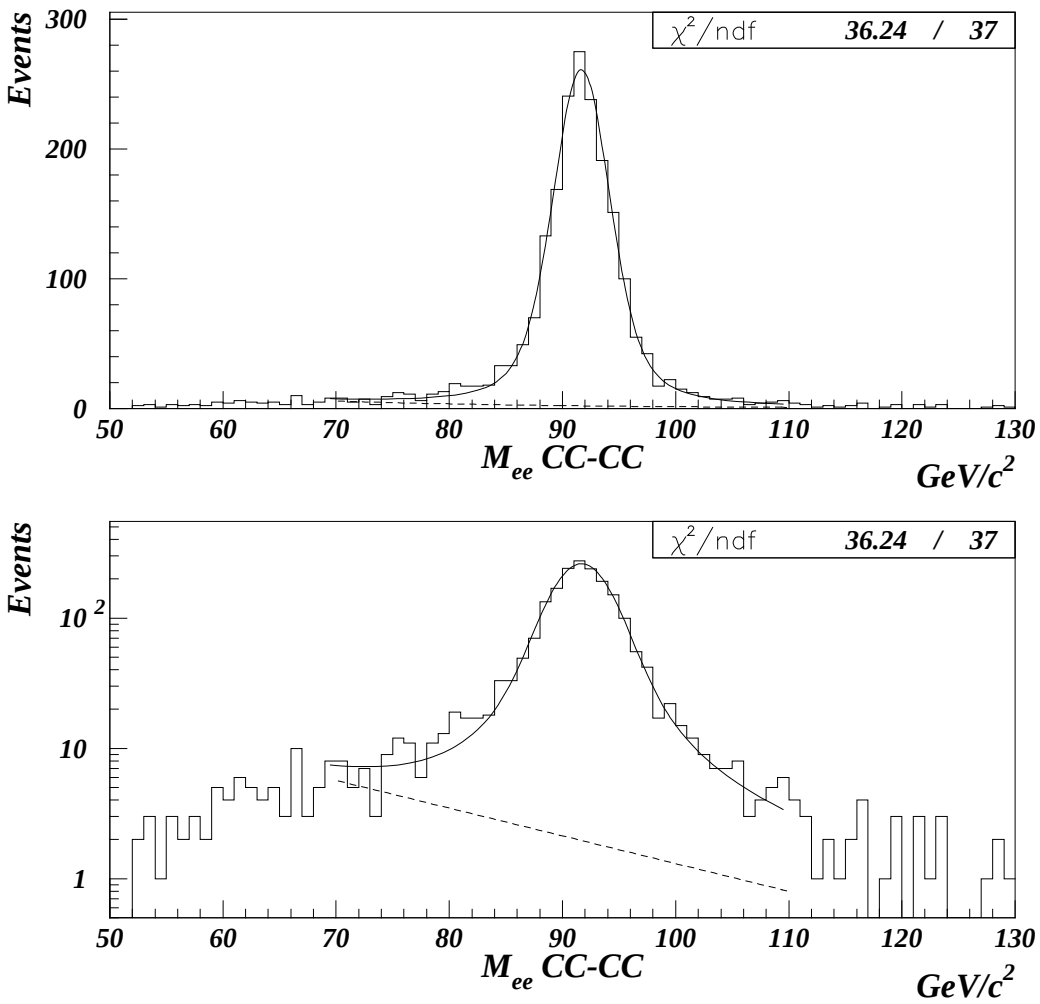


- Fit to fifth order polynomial
- Errors from MC statistics only

Background

- QCD type events primary background
  - jj/γj contributions ≈ 50/50
  - $\sigma(\gamma j)/\sigma(jj) \approx 10^{-3}$; Probability(j->e) $\approx 10^{-3}$
- Use γj data to get shape of background in p_T and invariant mass
  - High statistics
  - 50% γj purity
- Fit invariant mass to Breit-Wigner convoluted with a Gaussian over a fixed background
  - CCCC exponential
  - CCEC quadratic
- Add p_T distributions from different topologies according to their relative contributions to the background

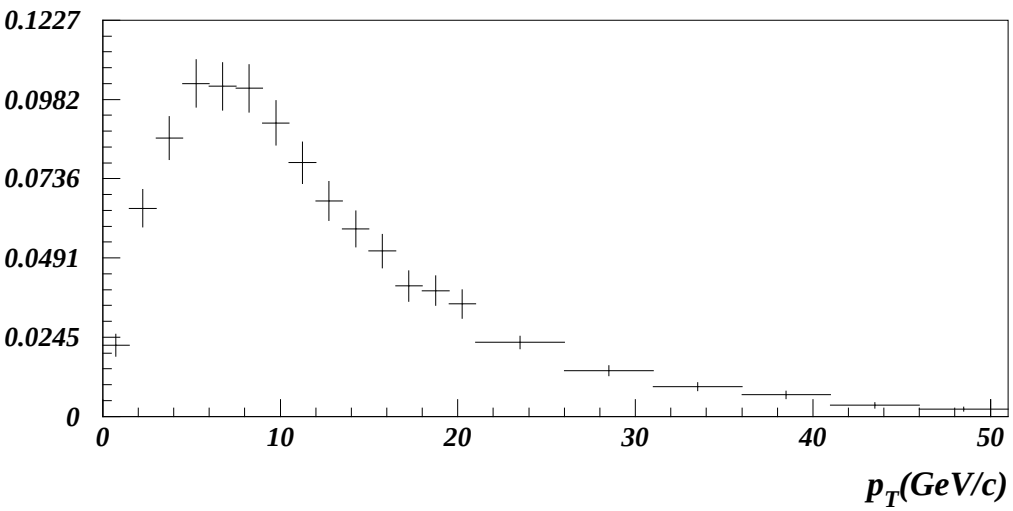
Background Level

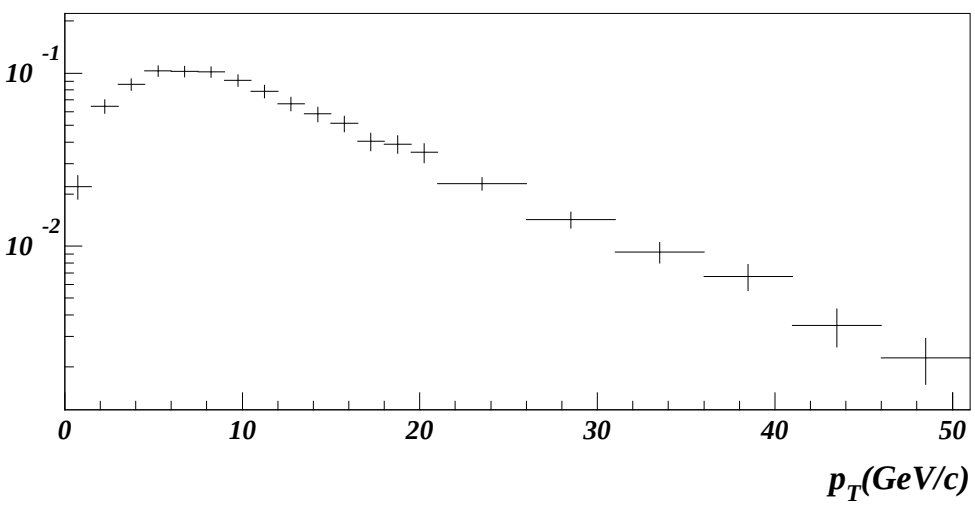


f_{back}(CCCC) = 0.046+/-0.007

f_{back}(CCEC) = 0.036+/-0.011

Background Shape

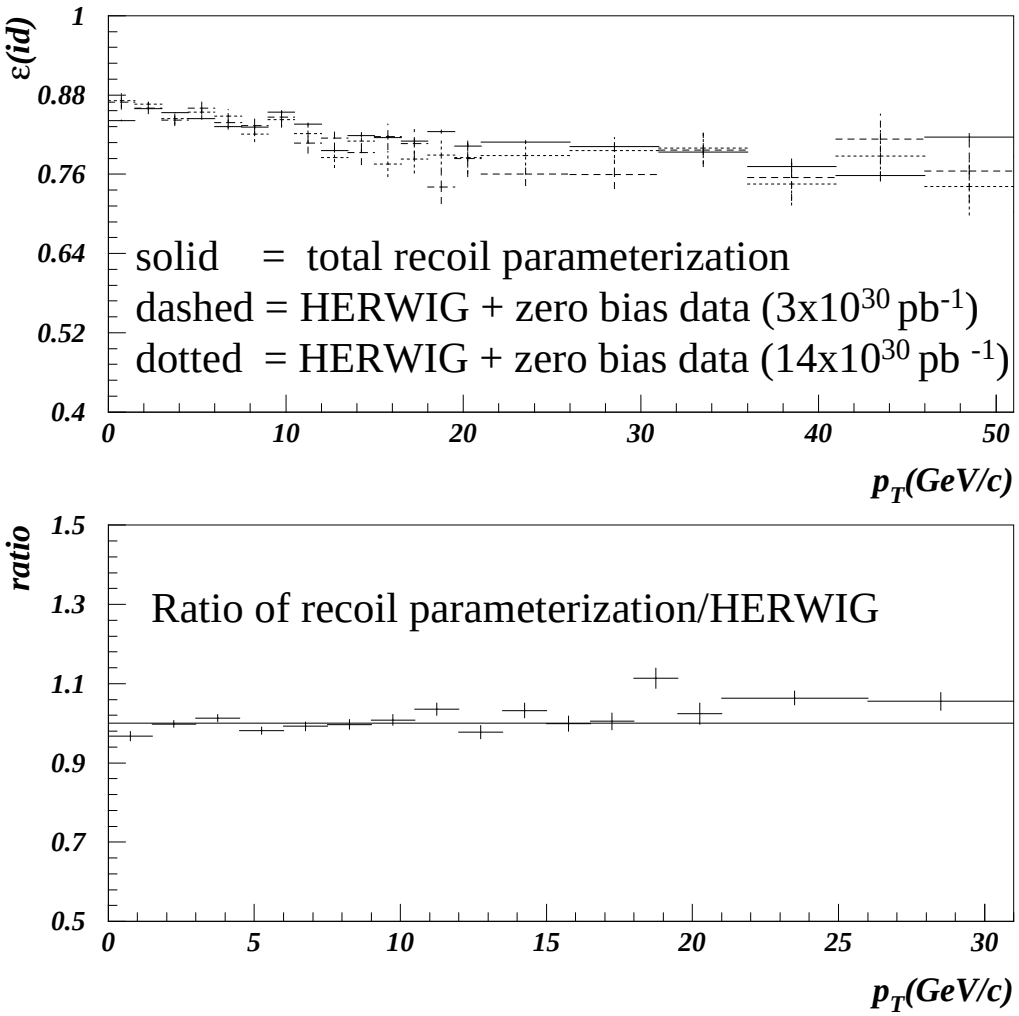




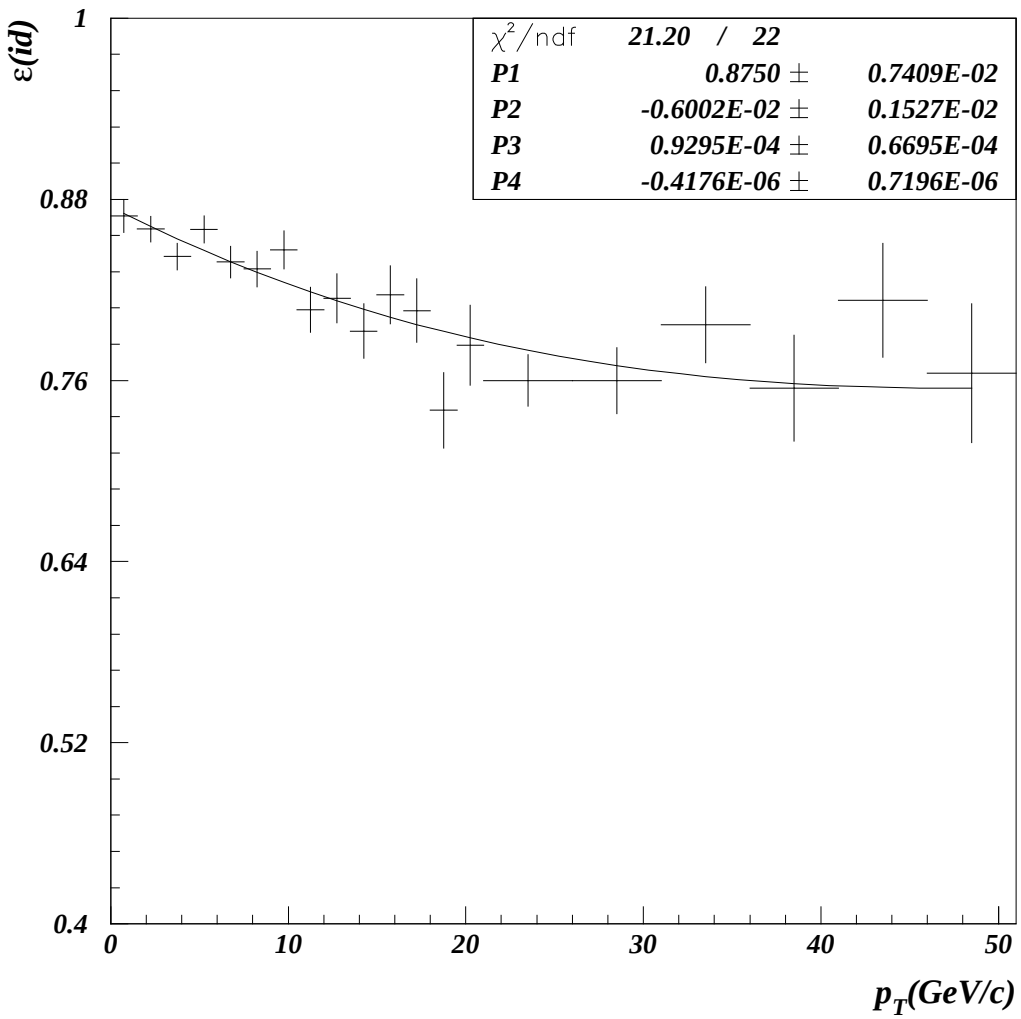
Identification Efficiency

- e^- quality cuts are less efficient if the hadronic activity in the event is close to the electron
- Effect parameterized for $p_T < 30$ GeV/c in terms of total hadronic recoil
  - Data + Geant e-
  - Good agreement between data and MC for e^- cluster shapes
- Extend to higher p_T using HERWIG MC + GEANT e^- + zero bias data
- Fit to cubic and use fit values for ε_i in the cross section calculation
- Errors from MC statistics only

Identification Efficiency

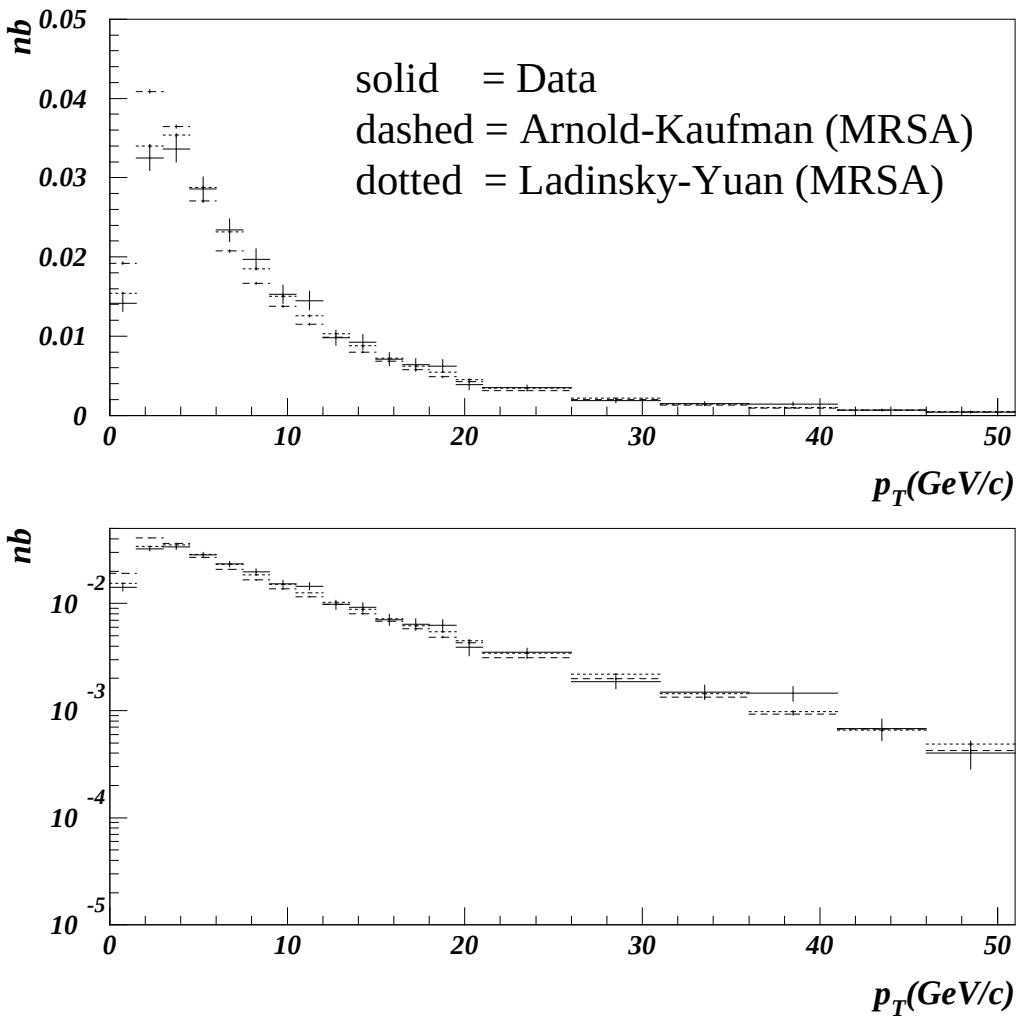


Identification Efficiency



- Fit to third order polynomial
- Errors from MC statistics only

Preliminary Results



- Comparing phenomenology to data

  χ^2/dof (Arnold-Kaufman) = 86/20

  χ^2/dof (Ladinsky-Yuan) = 16/20

Conclusion

- All results preliminary
- Future plans
  - unsmear data
  - Fully determine systematic uncertainties
  - Fit for optimal values of non-perturbative parameter, g_2
  - Extend to $p_T > 100$ GeV/c