Fermi National Accelerator Laboratory

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DØ

# W and Z Decays to Electrons in DØ

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ABSTRACT

The DØ detector has been accumulating data at the Fermilab Tevatron at $\sqrt{s}$ =1.8TeV for several months. In this paper we present the results of a preliminary analysis of $W$ and $Z$ vector boson decays into electrons based on $1.1pb^{-1}$ of data collected from Aug. 26, 1992 through Nov. 2, 1992. The event characteristics, as well as the number of events detected, are in good agreement with expectations.

## 1. The DØ Detector

The DØ detector is composed of three major subsystems; the calorimeters, the central tracking and the muon systems. The electron analysis is based on the calorimetry and charged particle tracking.

The uranium-liquid argon calorimetry is designed with minimal cracks and uninstrumented regions and provides essentially hermetic coverage over the full range of pseudo-rapidity ($\eta \leq |4|$) and azimuthal angle ($\phi$). The calorimeter read-out is arranged in pseudoprojective towers and is finely segmented in both longitudinal(4 electromagnetic(EM) plus 4-5 hadronic(HAD) layers) and transverse dimensions ($\sim 0.1 \times 0.1$ in $\eta, \phi$; $\sim .05 \times .05$ at shower maximum in EM layer 3). The EM calorimeters represent approximately 20 radiation lengths of material and have an energy resolution of roughly $15\%/\sqrt{E}$; the energy resolution for hadrons is approximately $50\%/\sqrt{E}$.

The central tracking system contains a vertex drift chamber, a transition radiation detector, a central drift chamber and forward drift chambers. Tracks reconstructed in these chambers are used to differentiate electrons from photons and neutral hadrons.

## 2. Event Selection

The data sample was taken from the D0 Expressline which diverts selected triggers for immediate analysis. These events represent a subset of all triggers and are selected for their topical interest. In order to analyze the data in a timely fashion, and also to minimize the sources of systematic errors, the analysis was restricted to specific triggers. For the $W \rightarrow e\nu_e$ analysis, events were required to satisfy the following trigger: a Level 1 (hardware) EM trigger tower ($0.2 \times 0.2$ in $\eta, \phi$) was required to pass a transverse energy ($E_T$) threshold of

14GeV; the Level 2 (software) trigger subsequently required an EM cluster (passing shape cuts) with $E_T > 20$GeV and missing $E_T$ also greater than 20GeV. The $Z \rightarrow e^+e^-$ analysis required two Level 1 EM trigger towers above 7GeV and two Level 2 EM clusters above 20GeV.

Offline electron candidates are identified using a nearest neighbor clustering of the EM calorimeter cells. Events selected were required to have an EM cluster with $E_T >$20GeV with a ratio of cluster energy in the EM to total energy of $EM/Total > 90\%$. The cluster shape (transverse as well as longitudinal distributions) was required to agree with testbeam and Monte Carlo expectations. A $\chi^2$ quantity calculated from the full covariance matrix of cluster elements was required to be less than 200. The clusters were further required to be isolated from the rest of the event, where we define the isolation quantity as the total energy within a cone of radius R$=\sqrt{\Delta\eta^2 + \Delta\phi^2} = 0.4$, minus the EM energy in a cone R=0.2, divided by the EM energy in a cone R=0.2. This quantity was required to be less than 0.1. In addition, a track was required to be found in the central tracking chambers and to point at the cluster. Tracks were accepted for which the angles between the track and cluster center were within $|\Delta\phi| < 0.05$ and $|\Delta\theta| < 0.07$ radians. Details of the trigger and electron identification are reported elsewhere.[1,2]

The $W$ analysis required one good electron candidate with $E_T >$ 20GeV and missing $E_T > 20$GeV. The $Z$ analysis required at least one good electron, but relaxed the tracking requirement on the second EM candidate. Both clusters were required to have at least 20GeV $E_T$.

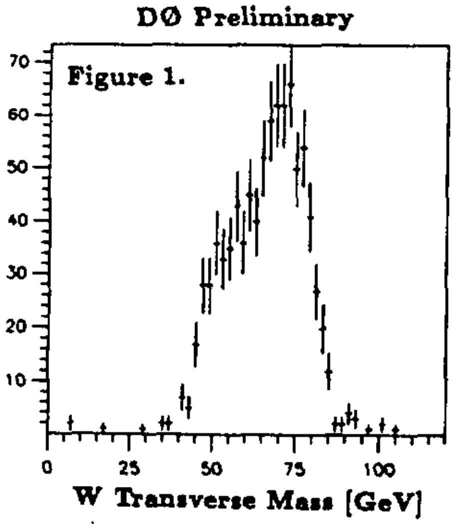
## 3. W and Z event characteristics

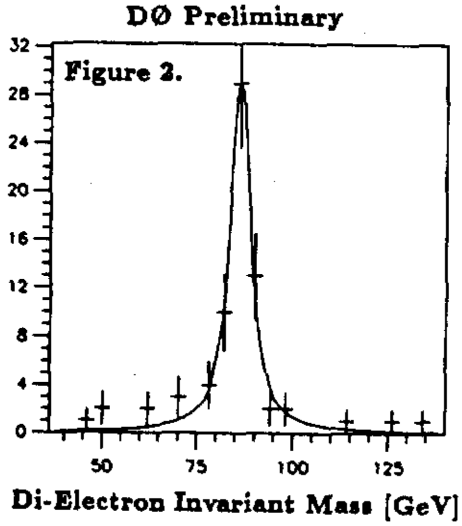
With the event selection criteria described in the previous section, we are left with 882 $W \rightarrow e\nu_e$ candidates and 72 $Z \rightarrow e^+e^-$ candidates. The $W$ candidate transverse mass distribution (defined as $m_T^2 = 2E_T^e E_T^\nu(1 - cos(\phi^{e\nu}))$ is presented in Figure 1 and exhibits a sharp Jacobian edge in good agreement with Monte Carlo simulations. The invariant mass of the two electrons in the $Z$ candidate sample is plotted in Figure 2, along with a Breit-Wigner fit to the distribution. The signal is very clean and sharply peaked; the fitted value of the mass is (86.0±0.6(statistical)±5% scale error). The scale error represents the systematic uncertainty in the transfer of absolute calibration from testbeam studies to the detector. It should be stressed that these are preliminary, uncorrected values.

## 4. W cross section

The production cross section times the branching ratio ($\sigma_W^e$)

for the process $\bar{p}p \rightarrow W + X$ where $W \rightarrow e\nu_e$ was derived from the following expression: $\sigma_W^e = (N_{candidates} - N_{background})/(\epsilon \cdot \int \mathcal{L}dt)$ The sources of background events which we have considered to date are: $W \rightarrow \tau^{\pm}\nu_e$ where $\tau \rightarrow e\nu_\tau\nu_e$ which is estimated from Monte Carlo simulations to comprise less than ~5% of the signal; additionally, background from QCD processes are estimated to be less than 1%, as are events arising from $Z \rightarrow e^+e^-$ where one of the electrons is "lost", thereby mimicking the neutrino. The efficiency for detecting $W \rightarrow e\nu_e$ events is estimated from Monte Carlo simulations as well as analysis of the collider data. The trigger efficiency (including geometrical acceptance) is estimated to be ~56%, and the cumulative effect of all the offline requirements reduces the overall efficiency for this analysis to $31 \pm 5\%$. The data represent $1.1pb^{-1}$($\pm$ 15% systematic), from which we obtain $\sigma_W^e = 2.3 \pm .5$ nb.




## 5. Conclusions

Preliminary results on the event characteristics of the vector boson decays $W \rightarrow e\nu_e$ and $Z \rightarrow e^+e^-$ have been obtained using the newly commissioned DØ detector. The number of events detected, as well as the masses of the particles are in good agreement (within our current systematic errors) with published values.

## 6. References


1. J. Linnemann, Triggering the DØ detector, , *These proceedings.*
2. M. Narain, Electron Identification in DØ , *These proceedings.*