RECENT RESULTS ON ELECTROWEAK AND RELATED PHYSICS FROM DØ

Alan L. Stone (*for the DØ Collaboration)*
Louisiana Tech U., Ruston, LA 71272
E-mail: alstone@fnal.gov

New results on Run II electroweak and related physics results from the DØ experiment utilizing an integrated luminosity up to 50 pb^{-1} from Tevatron $p\bar{p}$ collisions at the $\sqrt{s}$=1.96 TeV are presented.

1 Introduction

The following results utilize data collected by the Run II DØ detector [1] from mid-August 2002 through early January 2003. Up to 50 pb^{-1} of integrated luminosity was available for analyses depending on the reconstruction, trigger and data quality selection criteria. The acceptances are calculated from Monte Carlo. The efficiencies and QCD background are determined from the data.

2 W and Z Production

The measurement of the W and Z boson production cross sections provide tests of electroweak physics and QCD and will in the future allow the determination of the delivered luminosity to higher precision than is presently possible by measuring the inelastic $p\bar{p}$ cross section. The selected data sample is also crucial to gain better understanding of the experiment, in particular for in situ calibration. The utilized luminosity, number of selected candidate events, the measured production cross sections and uncertainties are summarized in Table 1.

The $W/Z \to e + X$ event selection requires at least one isolated EM cluster in the calorimeter with $E_T \geq 25$ GeV. Electron identification and shower shape quality cuts are also made. For the $Z \to ee$ signal, an invariant mass window from 70 to 110 GeV is selected. For the $W \to e\nu$ signal, a match to a central track and missing transverse energy, $\not{E}_T$, $>$ 25 GeV is required.

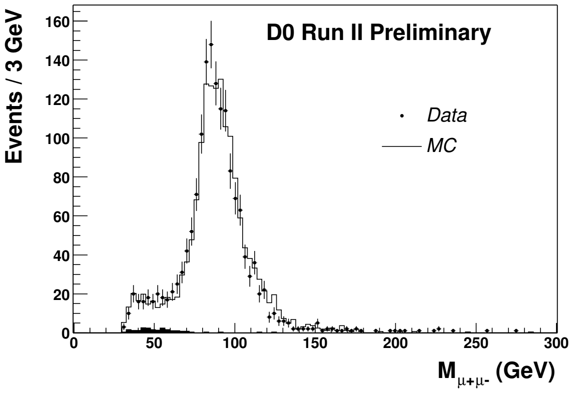

Figure 1: $Z \to \mu\mu$ invariant mass. The data is well described by the Z+Drell-Yan Monte Carlo. The shaded region is the expected background.

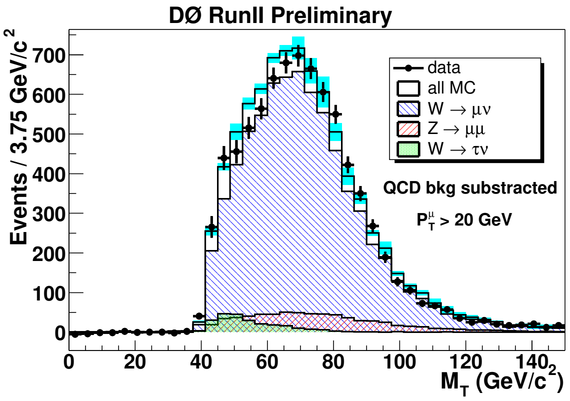

Figure 2: $W \to \mu\nu$ transverse mass. The data is compared to the Monte Carlo and the main non-QCD background sources of $Z \to \mu\mu$ and $W \to \tau\nu$.

The $Z \to \mu\mu$ event selection requires at least two oppositely-charged muons with $p_T \geq 15$ GeV within $|\eta| \leq 1.8$ and $(\Delta R)^2 = (\Delta\phi_{\mu\mu})^2 + (\Delta\eta_{\mu\mu})^2 \geq 4.0$. At least one muon is isolated in the calorimeter and the central tracker. Figure 2 shows the dimuon invariant mass distribution for the resulting 1585 muon pairs (data points), a smeared Monte Carlo (histogram) and the $1.5 \pm 1.0\%$ background from cosmic rays, $b\bar{b}$ and $Z \to \tau\tau$ events (shaded).

Channel	N_{cand}	$\int \mathcal{L}$ dt (pb^{-1})	σ Br (pb)			
$Z \to ee$	1139	42	294	± 11	± 8	± 29
$Z \to \mu\mu$	1585	32	264	± 7	± 17	± 26
$W \to e\nu$	27370	42	3054	± 100	± 86	± 305
$W \to \mu\nu$	7532	17	3226	± 128	± 100	± 323

Table 1: Z and W boson production event sample, integrated luminosity and measured cross sections.

The $W \to \mu\nu$ event selection requires a single isolated muon with $p_T \geq$ 20 GeV within $|\eta| \leq 1.6$ and $\not{E}_T > 20$ GeV where $\not{E}_T$ is corrected for the muon measurement. Figure 2 shows the W transverse mass distribution for the resulting 7352 $W \to \mu\nu$ candidates compared to the Monte Carlo and the main non-QCD background sources of $Z \to \mu\mu$ and $W \to \tau\nu$.

3 Direct Search For $Z' \to ee$

Using 50 pb^{-1} a search for non-SM particles (Z') decaying to lepton-antilepton pairs is conducted assuming the same couplings to quarks and leptons as the Z boson. The event selection requires events with two EM objects with $E_T \geq 25$ GeV in the fiducial regions of $|\eta| \leq 1.1$ or $1.5 \leq |\eta| \leq 2.5$. After subtracting the QCD and Drell-Yan background, 2817 events are observed in the di-electron invariant mass range from 80 to 800 GeV/c^2. No significant excess of events is observed at any mass. In the absence of evidence for this process, an upper limit on the ratio of the Z' and the Z boson production cross sections as a function of the Z' mass is placed. Many of the systematic and luminosity uncertainties cancel. The existence of a Z' with a mass less than 620 GeV is excluded at the 95% confidence level.

4 Top Quark Cross Section Measurement

The Tevatron Run II offers the possibility to study the top quark production as well as its properties such as the mass, spin and p_T in detail [2]. These studies will also provide some answers to the questions if the top quark, being so heavy, is somehow special, if there are more than three quark generations and if the top quark is connected to new physics. Since the electroweak production of single top quarks is more difficult to distinguish from background, only the strong $t\bar{t}$ pair production is considered in the following analyses. The top quark is expected to decay almost entirely into a W-boson and a b-quark. The $t\bar{t}$ cross section measurement is carried out on data samples of $\approx$40 pb^{-1} in dilepton channels ($e\mu$, ee and $\mu\mu$) and lepton+jets channels using two complementary approaches: a fully topological analysis and a soft-muon-tag. The number of selected candidate events, expected signal (assuming $\sigma(t\bar{t})$=7 pb), resulting cross sections and a combined $t\bar{t}$ production cross section measurement are summarized in Table 2.

The $t\bar{t} \rightarrow ll+$ jets event selection requires two isolated electrons or muons with $p_T > 15$ GeV, at least two jets with $p_T > 20$ GeV, a $\not\!\!E_T$ with Z mass cut and a scalar sum of the jet transverse energies $(H_T) > 100$ GeV.

The $t\bar{t} \rightarrow l+$ jets event selection, with or without soft-muon b-tagging, requires one isolated high-E_T electron or muon and a large $\not\!\!E_T$. The two main backgrounds are from W+jets production and multijet events, containing a jet misidentified as an electron or an isolated muon, and mismeasured $\not\!\!E_T$. This provides a data sample enriched in W+jets and top events, within which the absolute normalization of backgrounds from both W+jets and multijet production can be evaluated and statistically subtracted. Additional soft-muon b-tagging or kinematic selections with soft-muon veto are applied to reach the final selection.

5 Conclusion

DØ has measured the W and Z production cross section measurements in the electron and muon channels at the Run II center-of-mass energy of 1.96 TeV (Figure 3a). Assuming the same SM-Z couplings to quarks and leptons, the Z' is excluded at 95% CL at a $m_{Z'} < 620$ GeV. The $t\bar{t}$ production cross section has been measured to $\sigma(p\bar{p} \rightarrow t\bar{t}) = 8.5\ ^{+4.5}_{-3.6}(\mathrm{stat})\ ^{+6.3}_{-3.5}(\mathrm{sys})\ \pm 0.8(\mathrm{lum})$. Taking the systematic uncertainties on the background estimate into account, the significance of the observation corresponds to a three-statistical-deviation effect (Figure 3b).

Channel	N_{obs}	N_{exp}	σ (pb)
$\sigma(t\bar{t} \to ee+$ jets)	4	0.3	$29.9\ ^{+21.0}_{-15.7}$(stat) $^{+14.1}_{-6.1}$(sys) ± 3.0(lum)
$\sigma(t\bar{t} \to e\mu+$ jets)	1	0.5	
$\sigma(t\bar{t} \to \mu\mu+$ jets)	2	0.3	
$\sigma(t\bar{t} \to e+$ jets)	4	1.8	$5.8\ ^{+4.3}_{-3.4}$(stat) $^{+4.1}_{-2.6}$(sys) ± 0.6(lum)
$\sigma(t\bar{t} \to \mu+$ jets)	4	2.4	
$\sigma(t\bar{t} \to e+$ jets) $+ \mu$	2	0.5	
$\sigma(t\bar{t} \to \mu+$ jets) $+ \mu$	0	0.4	
$\sigma(t\bar{t} \to X)$	17	6.2	$8.5\ ^{+4.5}_{-3.6}$(stat) $^{+6.3}_{-3.5}$(sys) ± 0.8(lum)

Table 2: The observed and expected number of $t\bar{t}$ signal events after applying all selection criteria with the resulting and combined cross sections.

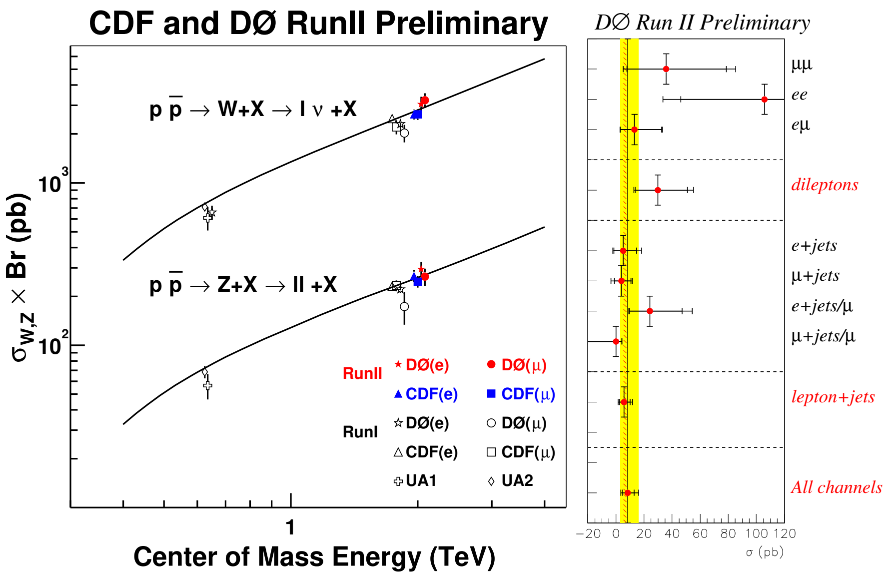

Figure 3: On the left is the $\sigma\ Br$ for W and Z bosons in the e and μ decay modes as a function of $\sqrt{s}$ at $p\bar{p}$ colliders. On the right is the summary of $t\bar{t}$ cross section measurements at $\sqrt{s}$=1.96 TeV.

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References

[1] J. Ellison, Proceedings of the 15th International Workshop on High-Energy Physics and Quantum Field Theory, Tver, Russia (Sep. 14-20, 2000).

[2] DØ Collaboration, FERMILAB-CONF-03-200-E, Jul. 2003.