W/γ PLUS JETS AT THE TEVATRON*

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Presented here are the recent Run II results on the inclusive cross section for W plus $\geq n$ jet(s) (JetClu $R = 0.4$). These cross sections are compared with Run I data and their ratios are measured for inclusive jet multiplicity for $n = 0$ to 4. The leading order QCD predictions using ALPGEN + HERWIG are compared with the data. Also shown are the comparisons of Diphoton QCD production with next-to-leading order QCD predictions: DIPHOX and ResBos. Finally, the $\gamma+b$ and $\gamma+c$ cross sections are presented as a function of photon E_{T}.

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1. The $W^{\pm} \to e^{\pm}\nu+ \geq n$ jet cross-section

A study of multi-jet production in the reaction $p\bar{p} \to (W \to e\nu)$ at $\sqrt{s} =$ 1.96 TeV is presented. The data sample, collected with the CDF Run II detector at the Fermilab collider, corresponds to an integrated luminosity of 127 pb^{-1}. From this event sample, the W plus n jets cross sections and their ratios have been measured as a function of the inclusive jet multiplicity. Figure 1 compares the results obtained in the Run II analysis with the previous CDF Run I measurement taken at $\sqrt{s} = 1.8$ TeV.

Figure 2 shows the cross sections compared with the leading-order QCD prediction. The leading order ALPGEN Monte Carlo program has been used to generate five W plus n parton samples. The initial and final state radiation are produced by HERWIG [1] which also simulates hadronization and decay of unstable particles and finally adds the underlying event energy properly. Although the theoretical predictions exhibit lower cross section values, these results indicate that a W mass renormalization scale yields better agreement.

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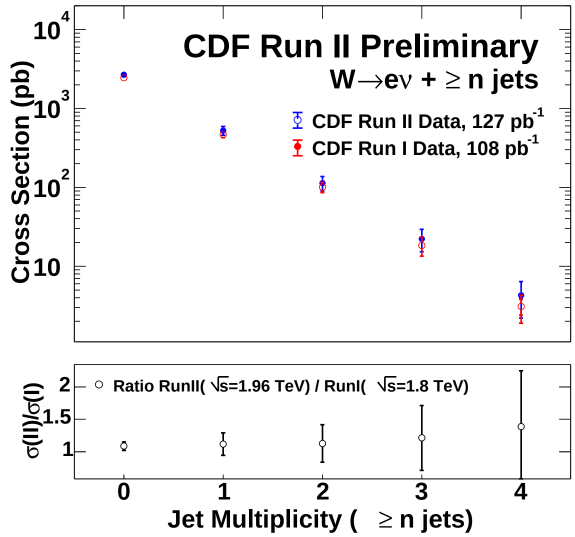

Fig. 1. W plus $\geq n$ jets cross section measured in Run II ($\sqrt{s}$=1.96 TeV) compared to the Run I measurement ($\sqrt{s}$=1.8 TeV). In the lower plot, the ratio between the two measurements is compared to a Monte Carlo prediction calculated at the two center of mass energies.

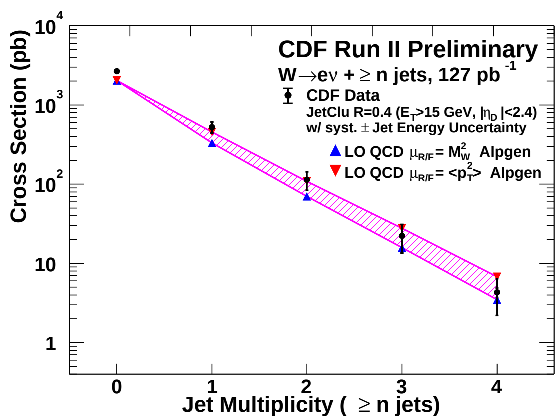

Fig. 2. W plus $\geq n$ jets cross section compared to theoretical prediction. The filled circles are the data measurements with the statistical and systematic uncertainties represented by two different error bars. The filled band indicates the variation of the theoretical prediction with the renormalization scale. The W plus ≥ 0 jets is independent of this parameter.

Figure 3 shows a steeper decline of the jet E_T distribution for the $\langle (P_\mathrm{T}^\mathrm{jet})^2 \rangle$ renormalization scale. This jet E_T behavior reflects the enhancement of α_s at small scale. Figure 4 shows that the dijet invariant mass spectra is quantitatively well reproduced by QCD predictions.

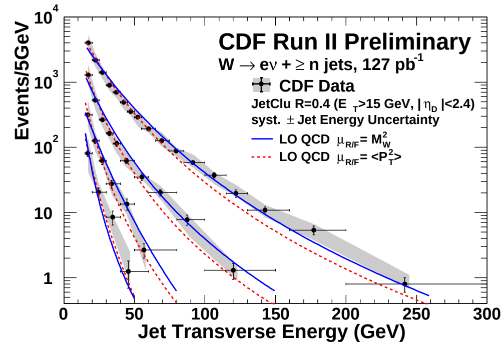

Fig. 3. Data to theory comparison for the highest E_T jet distribution in the W plus $\geq$1 jet sample, for the second highest E_T jet distribution in the W plus $\geq$2 jet sample, for the third E_T jet distribution in the W plus $\geq$3 jet sample and for the fourth highest E_T jet distribution in the W plus $\geq$ 4 jet sample. The gray band represents the jet energy systematics. The solid line is a fit to the theoretical distribution calculated with the renormalization scale set to M_W^2, while the dashed line is a fit to the theoretical distribution calculated with a renormalization scale set to $\langle (P_\mathrm{T}^\mathrm{jet})^2 \rangle$.

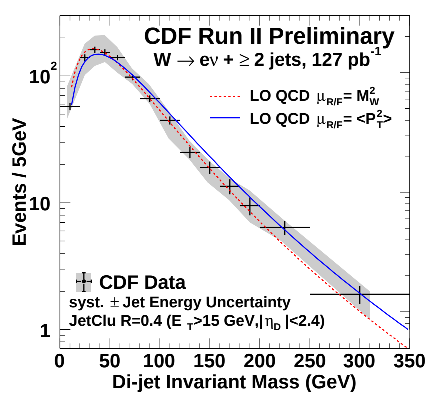

Fig. 4. Data to theory comparison for the dijet invariant mass in the W plus $\geq$ 2 jet sample. The gray band represents the jet energy systematics. The solid line is a fit to the theoretical distribution calculated with the renormalization scale set to M_W^2, while the dashed line is a fit to the theoretical distribution calculated with a renormalization scale set to $\langle (P_\mathrm{T}^\mathrm{jet})^2 \rangle$.

2. Diphoton cross section measurement

The diphoton cross section measurement uses 207 pb^{-1} of data collected by CDF II. These results are compared with next-to-leading order QCD predictions: DIPHOX [2] and ResBos [3]. Figure 5 shows that both calculations agree very well with data in the mass distribution, except for the very low end. This rate increase of DIPHOX over ResBos is pronounced in figure 6. DIPHOX populates the low delta-phi by including NLO fragmen-

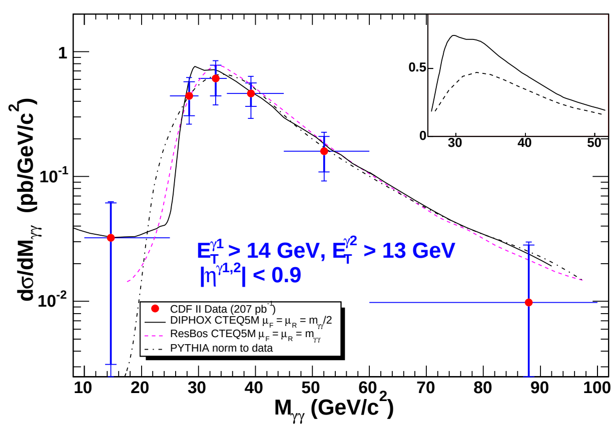

Fig. 5. The diphoton differential cross section as a function of the invariant mass from CDF Run II data, along with predictions from DIPHOX (solid), ResBos(dashed), and PYTHIA (dot-dashed). The PYTHIA predictions have been scaled up by a factor of 2. The inset shows, on a linear scale, the total NLO cross section from DIPHOX with(solid)/without(dashed) the gluon–gluon contribution.

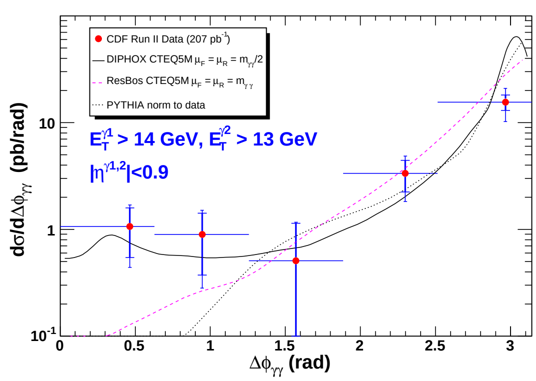

Fig. 6. The differential cross section as a function of $\Delta\Phi_{\gamma\gamma}$ between the two photons from CDF Run II data, along with predictions from DIPHOX(solid), ResBos(dashed), and PYTHIA (dot-dashed). The PYTHIA predictions have been scaled up by a factor of 2.

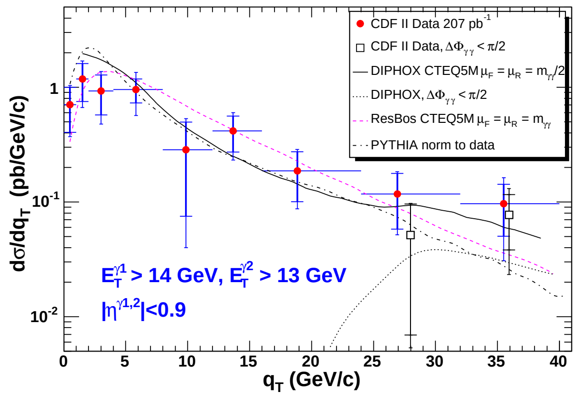

Fig. 7. The differential cross section as function of diphoton system $P_{\rm T}$ (referred as "$q_{\rm T}$") from CDF Run II data, along with predictions from DIPHOX (solid), ResBos(dashed), and PYTHIA(dot−dashed). The PYTHIA predictions have been scaled up by a factor of 2. Also shown, at larger $q_{\rm T}$, are the DIPHOX prediction (dot) and the CDF Run II data (open squares) for the configuration where the two photons are required to have $\Delta\Phi_{\gamma\gamma} < \pi/2$.

tation contributions[4], while ResBos includes only leading order contributions. This effect shows up as a shoulder structure around 27 GeV/c in the DIPHOX curve of figure 7.

3. Photon plus heavy flavor production

The results below are preliminary and use 66.7 pb^{-1} of data. Figure 8 shows the $\gamma + b$ cross section compared with PYTHIA Tune A [5]. In order to distinguish between c and b (and uds) production, Monte Carlo templates of secondary vertex masses are employed. Using templates for these shapes from simulation, the fraction of b, c and light events in a sample can be calculated using TFractionFitter [6]. Figure 9 shows the $\gamma + c$ cross section. These cross sections are presented as a function of photon $E_{\rm T}$ in order to test QCD predictions at different energy scales. All photon $E_{\rm T}$'s exceed 25 GeV to gain maximal statistical sensitivity to deviations that could signal new physics production. An excess in any $\gamma + b$, $\gamma + c$, or $\gamma + b + c$ channel could signal new physics, for example through light stop or techniomega production [7].

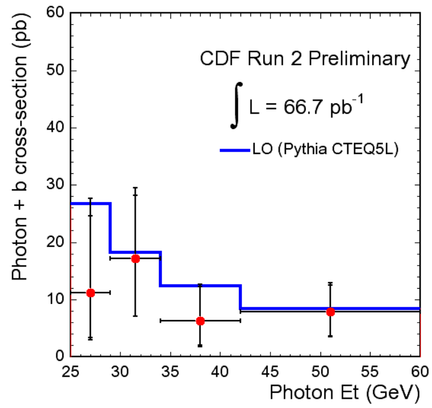

Fig. 8. Photon + b cross section as a function of photon E_{T}. Data are shown by points, and LO expectation by the solid line. The statistical (innermost notch) and statistical × systematic errors are shown. Note that this analysis presupposes the b fraction of tagged events.

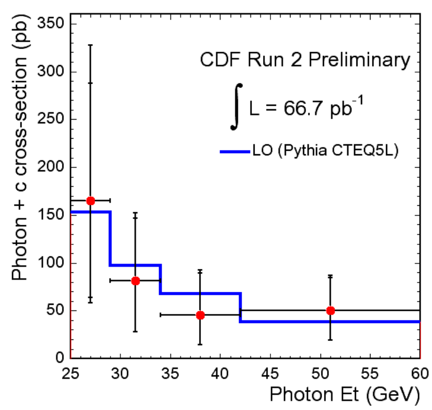

Fig. 9. Photon + c cross section as a function of photon E_{T}. Data are shown by points, and LO expectation by the solid line. The statistical (innermost notch) and statistical × systematic errors are shown. Note that this analysis presupposes the c fraction of tagged events.

4. Summary

The comparison to the Run II ($\sqrt{s} = 1.96$ TeV) W plus $\geq n$ jet(s) cross section to the Run I ($\sqrt{s} = 1.8$ TeV) shows an ∼10 percent higher W inclusive cross section. This behavior is enhanced by the jet multiplicity; in the

W plus ≥ 4 jets the Run II measurement is about 40 percent higher than the Run I result. The dependence of the W plus $\geq n$ jet(s) cross sections on the center of mass energy is well reproduced by the theoretical calculation. Both the jet transverse energy and dijet invariant mass spectrum are quantitatively well reproduced by QCD predictions.

In both the Diphoton and Photon plus heavy flavor production, we see general agreement with the theoretical predictions. These results show no evidence yet of new physics production.

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