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Background in the W + jets sample

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In this brief note we present background estimates for the W + jets sample used in the SVX and SLT top analyses. In particular, we estimate the Z and diboson contributions, which are potentially very important if events selected for the SVX and SLT analyses are also to be used in kinematical-type analyses

1 Introduction

The backgrounds to the W selection for the SVX and SLT analyses (see for example CDF 2150 and CDF 2245) are the following :

(1) QCD events with a misidentified lepton or $b\bar{b}$ events with a semileptonic b decay

(2) $W \Rightarrow \tau \Rightarrow e$ or μ

(3) $Z/DY \Rightarrow \tau\tau$, followed by $\tau \Rightarrow e$ or μ

(4) $Z/DY \Rightarrow \mu\mu$, where one of the muons is undetected, or the mass of the $\mu\mu$ pair is outside the Z mass window used for the Z removal in the lepton + jets analysis. The undetected muon in these events will look very much like a neutrino in the detector

(5) $Z,DY \Rightarrow ee$ where one of the electrons is lost in a calorimeter crack, giving rise to spurious missing E_t in the event.

(6) Diboson production (WW,WZ,ZZ)

Background (1) has been estimated (see CDF 2150) to constitute 10 ± 5 % of the W sample, for events with at least one jet. Background (2) has been estimated in our previous W publications to have an acceptance (including branching ratio) of approximately 4% of the direct $W \Rightarrow e$ or μ process. The other backgrounds are estimated below.

2 Diboson background

The diboson (WW,WZ,ZZ) background is estimated using the Isajet + Qfl Monte Carlo, normalized using the NLO cross section predictions (see CDF 2245). The results are the following :

= 1 jet sample	7.7 ± 0.5 ± 3.4	events
= 2 jets sample	6.8 ± 0.5 ± 3.0	events

$\geq$ 3 jets sample	$2.6 \pm 0.4 \pm 1.1$	events

where the first error is due to Monte Carlo statistics, and the second error is systematic (30% for the cross section, 30% for the jet multiplicity model in Isajet, 10% for the luminosity, and 5% for the lepton identification/trigger efficiencies; see CDF 2245).

3 Z/DY$\Rightarrow\tau\tau$ background

This is estimated in the same way, using Isajet + Qfl, normalized to CDF's measured Z cross-section. The results are :

= 1 jet sample	$10.5 \pm 0.6 \pm 3.4$	events
= 2 jets sample	$4.5 \pm 0.4 \pm 1.4$	events
$\geq$ 3 jets sample	$1.7 \pm 0.2 \pm 0.5$	events

Again, the first error is due to Monte Carlo statistics, and the second is systematic (30% for the Isajet jet multiplicity model, 5% for lepton identification/trigger efficiencies; see CDF 2245). Note that we have not estimated an uncertainty due to the $\not{E}_t$ modeling for this process (most of these events tend to have $\not{E}_t$ close to the 20 GeV threshold imposed in the lepton + jets analysis).

4 Z/DY$\Rightarrow$ee or $\mu\mu$ backgrounds

These events can enter the W sample if they are not flagged by the Z removal algorithm, and if there is sufficient missing energy in the event. Z/DY$\Rightarrow\mu\mu$ events with one muon in the central, and the second muon with $|\eta| > 1.1$, or with $\mu\mu$ invariant mass outside the Z window (70 to 110 GeV/c^2), will look just like a W event in our selection. Estimating the $\mu\mu$ background is straight-forward, since we are dealing primarily with a geometric effect. Using Isajet+QFL, and assuming a ratio of production cross sections * branching ratios R = 10.7, we estimate

$$\frac{N(Z/DY\Rightarrow\mu\mu)}{N(W\Rightarrow\mu)} = 10.5 \pm 1.9\ \% \quad \text{(stat error)}$$

where N(Z/DY$\Rightarrow\mu\mu$) is the number of Z or Drell Yan events, and N(W$\Rightarrow\mu$) is the number W$\Rightarrow\mu$ decays in the W sample. This fraction is independent of jet multiplicity, and systematic uncertainties due to the simulation drop out in the ratio.

The electron case is more complicated. In order for a Z/DY$\Rightarrow$ee event to be in the W sample, the Z selection removal must fail, **and** there must be more than 20 GeV of missing energy. Z$\Rightarrow$ee events that fail the Z removal tend to have the second electron in a calorimeter crack, giving also rise to missing energy. In modeling this process with Isajet

+ Qfl we have to rely on the modeling of the calorimeter response to electrons near cracks. This is a subject that has not been really studied (at least by us!). As a guess, we will for now assign a 50% systematic uncertainty due to the simulation. We find :

$$\frac{N(Z/DY\Rightarrow ee)}{N(W\Rightarrow e)} = 4.9 \pm 0.8 \pm 2.5\ \% \qquad \text{(stat + systematic error)}$$

independent of jet multiplicity (for events with at least one jet).

Using the ratios of acceptances given above, the number of events observed in the data (see below) corrected for the all other backgrounds, and taking the acceptance for W⇒e to be a factor of 1.8 higher than for W⇒μ, we can then calculate the contributions due to Z/DY⇒ee or μμ as a function of jet multiplicity. These estimates are summarized in the Table given in the next Section.

5 Summary

In the following table we summarize all the backgrounds in the W sample as a function of jet multiplicity :

N_{jet}	No. events	QCD+$b\bar{b}$	Diboson	Z/DY⇒ττ	Z/DY⇒μμ	Z/DY⇒ee	W⇒τν
1	1713	171 ± 85	7.7 ± 3.4	10.5 ± 3.5	52 ± 9	43 ± 23	≈ 57
2	281	28 ± 14	6.8 ± 3.0	4.5 ± 1.5	8 ± 2	7 ± 4	≈ 9
≥ 3	52	5.2 ± 2.6	2.6 ± 1.2	1.7 ± 0.6	1.5 ± 0.4	1.2 ± 0.6	≈ 1.6

Note that the estimate for DY/Z⇒ee/μμ for the ≥ 3 jets sample have been made starting from estimates of the relative acceptances of W and Z events, and are then normalized to the data themseves. This is done assuming that tthere is no top in the data. If there is, then the estimates for the N_{jet} ≥ 3 sample have to be revised downward by (42.5 - N_{top})/42.5, where N_{top} is the number of top events in the sample (42.5 is obtained by subtracting from the 52 events observed in the data the estimates for the first three backgrounds in the Table shown above).