Z plus jets production at the tevatron

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Abstract. We present preliminary results on inclusive Z(→ee) boson plus jets production in p\bar{p} collisions at \sqrt{s} = 1.96 TeV, based on 1.7 fb\(^{-1}\) of data collected by the CDF experiment. Inclusive jet measurements are performed as a function of p_{T,jet} and jet multiplicity for jets in the region of p_{T,jet} > 30 GeV/c and |y_{jet}| < 2.1. Results are compared to NLO pQCD predictions and are found to be in good agreement.

1. Introduction
The measurement of the inclusive jet production cross section in events with a Z boson in the final state is a stringent test of perturbative QCD (pQCD). The presence of a heavy boson provides the necessary hard scale to carry out pQCD calculations. Boson + jets cross sections are a crucial part of the physics program at the Tevatron as they constitute important backgrounds in searches for new physics such as SuperSymmetry and Higgs.

2. Measurement
The measurement presented here is performed in a well defined kinematic region of the jets and the Z boson decay products. Electrons are required to have E_{T,e} > 25 GeV and be in the range of 66 < M_{ee} < 116 GeV/c^2, where one must be central (|\eta| < 1.0) and the other can either be central or forward (1.2 < |\eta| < 2.8). Jets are reconstructed using the cone based MidPoint algorithm \[1\] with cone radius R=0.7 and are required to have transverse momentum p_{T,jet} > 30 GeV/c and rapidity |y_{jet}| < 2.1.

The Z plus jets cross section measured in data is compared to NLO pQCD predictions. To make this comparison, the data which includes detector level effects such as physical tower boundaries and calorimeter resolution must be unfolded to the hadron level. In addition, the pQCD prediction which is calculated at the parton level must be combined with non-pQCD effects including underlying event and hadronization. PYTHIA \[2\] Monte Carlo (MC) is used to unfold the data and to determine these non-pQCD effects. The PYTHIA samples have been created using two special tuned set of parameters, denoted as PYTHIA-TUNE A \[3\] and PYTHIA-TUNE DW \[4\], that include enhanced contributions from initial-state gluon radiation and secondary parton interactions.

The NLO pQCD predictions are computed using the MCFM program \[5\] with CTEQ 6.1M PDFs \[6\] and the renormalization and factorization scales set to \mu^2 = M_Z^2 + p_T^2(Z).
Figure 1. Left: Measured differential jet shape compared to different Monte Carlo predictions. Right: Measured energy flow in the transverse plane for Z+jets events. Event-by-event, φ = 0 is defined along the direction of the Z boson. The measurement is performed considering calorimeter towers with |y| < 0.7 and compared to PYTHIA-TUNE A and PYTHIA-TUNE DW predictions.

3. Monte Carlo Validation
Since the PYTHIA MC plays a crucial part in the measurement, tests are performed to verify its accuracy in modeling the data.

3.1. Jet Shapes
The differential jet shape, ρ(r), is defined as the average fraction of jet transverse momentum that lies within an annulus of inner radius r − δr/2 and outer radius r + δr/2 around the jet axis, as shown on the left in Figure 1. The jet shape is sensitive to both the hadronization process and the underlying event within the MC. An excellent agreement between data and MC is observed for both PYTHIA tunes.

3.2. Energy Flow
The energy flow, as defined in the transverse plane, is a measure of the energy in each calorimeter tower with respect to the angle of the Z boson, after the energy of the electrons has been removed, as shown on the right in Figure 1. Since the jets balance the Z in the transverse plane, the energy in the towers with small ∆φ are dominated by the underlying event while the towers with large ∆φ have contributions from both the jet(s) and underlying event. As with the jet shapes, the MC matches well to the data.

4. Results
The measured inclusive jet cross section as a function of p_T^{jet} in Z(→ ee) + ≥ N_{jet} data is shown on the left in Figure 2 for N_{jet} ≥ 1.2 compared to NLO pQCD predictions. The theoretical predictions include parton-to-hadron correction factors, C_{HAD}(N_{jet}, p_T^{jet})}, that account for non-perturbative contributions from the underlying event and fragmentation into hadrons.
systematic uncertainty on the cross section is dominated by the uncertainty on the jet energy scale. The cross section decreases by more than three orders of magnitude as $p_T^{jet}$ increases from 30 GeV/c up to about 300 GeV/c. On the right side of Figure 2 is the total cross section as a function of jet multiplicity for up to 3 jets in the final state. Only two events have been observed so far with 4 jets. Although the pQCD predictions are only available for $Z + \geq 2$ jet inclusive samples, there is a constant ratio between data and the leading order MCFM cross section for all measured jet multiplicities. For both cases, the measured cross sections are in agreement with NLO pQCD predictions.

References
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