Abstract

We present the ratio of the transverse momentum of Z/γ* plus jets to γ + jets in proton-proton collisions. We also present the measurement of the differential transverse momenta cross-sections separately. The data were collected with the CMS detector at √s = 8 TeV, corresponding to an integrated luminosity of 19.7 fb⁻¹. A precise measurement of the individual cross-sections allows for a stringent test of high multiplicity NLO perturbative QCD calculations from BlackHat and other multi-purpose Monte Carlo generators in several phase space selections. It also acts as a test to validate a commonly used method to estimate backgrounds arising from Z to invisible decays in BSM searches with CMS-collected data.

Event Selection

Leptons p_T > 20 GeV, |y| < 2.4
Jets p_T > 30 GeV, |y| < 2.4, R(ΔR) > 0.5, reject jets from pileup and p_T > 100 GeV
Photons Isolated photons (< 10 GeV within a cone of radius 0.3), |y_T| < 1.4, p_T > 100 GeV

Systematics

The largest systematic errors considered are:
- Jet Energy Scale - negligible for the n_{jets} ≥ 1 selection, dominant at low p_T otherwise (up to 10%)
- Scale Factor Uncertainty - 3-5%, largest in n_{jets} ≥ 1
- Luminosity Uncertainty - flat 2.6% effect

The remaining errors considered (Lepton Scale, Pileup, Background, Jet Energy Resolution, Lepton Resolution, and Unfolding) were minor, all separately less than 0.5%. The background-subtracted detector level distributions from data are unfolded to the particle level which accounts for detector resolution effects and efficiencies.

Conclusions

We find that the ratio of data to MC for Z/γ* + jets and γ + jets is not well reproduced for LO ME+PS Monte Carlos. We observe a linear increase with increasing vector boson p_T for MadGraph+Pythia8 and Sherpa. At NLO (BlackHat), we find a reduction in the discrepancy in shape between data and MC for Z/γ* + jets, indicating that it is likely related to missing higher-order effects. In all cases, we observe that the ratio of p_T to p_T_jets saturates at p_T ≥ 314 GeV. This agrees with the LO predictions that state that the mass difference is the only distinction between the two processes. In the n_{jets} ≥ 1 selection, the plateau is R_{data} = 0.957 ± 0.066 when divided by the average leptonic branching fraction (3.8058 ± 0.0023%).

MadGraph+Pythia8 predicts the ratio with a value of R_{data} = 0.0391, which is higher than that observed in data by 21% ± 8% (stat+syst). Higher-order effects beyond LO are smaller than the experimental uncertainties.

References