



Z+jet over γ +jet cross-section ratio

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Abstract

The ratio of the production cross-sections for the processes Z/γ^* +jet and γ +jet has been measured at 8 TeV. The full 2012 data collected by the CMS detector are analyzed and correspond to an integrated luminosity of 19.7fb^{-1} . The measurement is performed in the kinematic region of $p_{\text{T}}^{\text{V}} > 100\text{ GeV}$ and in the rapidity range $|y^{\text{V}}| < 1.4$. The analysis is shown with different jet multiplicities and H_{T} requirements. We present as well the measurement of the photon cross-section in the same range and the cross-section ratio between the different jet multiplicities for the photon selection.

Keywords:

photon, jet, Z, ratio, gamma, cross-section

1. Introduction

Measuring the cross-section ratio differentially in p_{T} of the Z+jet over the γ +jet processes, allows to establish the existence of a plateau, that it is supposed to be reached in the ultrarelativistic range, where $p_{\text{T}}^Z \gg m^Z$ [1]. This plateau is sensitive to the parton distribution functions (pdf) composition and it is used in new physics searches to evaluate the irreducible background of invisible decays of the Z-boson. The $Z \rightarrow \ell\ell$ is a proxy for calibration of the $Z \rightarrow \nu\bar{\nu}$ process, and γ +jet is used to extrapolate the Z spectrum where the leptonic decays of the Z don't have enough statistics, like high p_{T} or high H_{T} . High order quantum chromodynamics (QCD) and/or electroweak (EW) corrections may induce deviation from the flatness of the plateau, making this measurement useful also for higher order Monte Carlo generators. The measurements of the Z+jet over γ +jet cross-section ratio, the γ +jet differential cross-section at 8 TeV, and the cross-section ratio between the different jet multiplicities for the photon selection are presented based on data recorded by the CMS [2] detector. The corresponding measurements for the Z-boson are presented in [3].

2. Background estimation of the photon measurement

The main background to the photon measurement is due to isolated neutral mesons decays into pairs of collimated photons, that are reconstructed in the calorimeter as a single electromagnetic cluster. Its estimation is performed statistically in each bin of the analysis and fully data-driven [3]. The background template for the fit is performed with the inversion of the requirement on the σ_{min} shower-shape variable, which measures the extension of the shower in pseudorapidity with the energy weighted spread within the 5x5 crystal matrix around the most energetic crystal [4], while the signal template is construct using the random-cone technique [5]. An example of purity fit is shown in figure 1 for the bin with $100 \leq p_{\text{T}}[\text{GeV}] < 111$, and $N_{\text{jets}} \geq 1$ where the blue line represent the total fit, the dashed green line the signal template component and the red line the background template, and the markers the distribution measured in data, against which the fit is performed.

3. Photon+Jet at 8 TeV

The differential photon cross-section is briefly presented here [3]. The offline selection for the photon

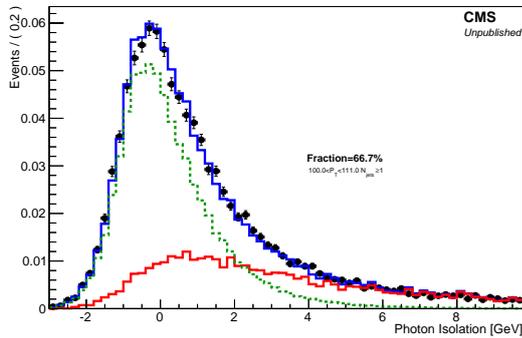


Figure 1: the purity fit on the photon component of the photon isolation in the photon transverse momentum bin between 100 and 111 GeV in data. The black dots are the data points, the green line is the signal template, in red the background component. The blue line represents the fit and the legend shows the resulting purity fraction of 66%.

identification is designed to be slightly tighter than the trigger requirements, and the photon is asked to be in the central rapidity range ($|\eta^\gamma| < 1.4$). An extra jet (anti-kt with radius parameter $R = 0.5$ and momentum of $p_T > 30\text{GeV}$) is required to be in the event.

The differential cross-section ratio with respect to the number of jets in the event, i.e., $d\sigma/dp_H^\gamma(N_{\text{jets}} \geq 2)$ over $d\sigma/dp_H^\gamma(N_{\text{jets}} \geq 1)$ and $d\sigma/dp_H^\gamma(N_{\text{jets}} \geq 3)$ over $d\sigma/dp_H^\gamma(N_{\text{jets}} \geq 2)$, is shown in figure 2. Data and MC agree quite well, and suggest the event composition at high energies, where more and more events will have more and more hadronic activity associated.

4. Z+jet over photon+jet cross-section ratio

Z+jet over photon+jet cross-section for $N_{\text{jets}} \geq 1$ and for $H_T > 300\text{ GeV}$ are presented in figure 3. For this ratio the MadGraph predictions for both processes are normalized to the LO cross-section provided by the generator. The Monte Carlo simulations reproduce the shape observed in data, but the integrated value is overestimated by about 20%. The result is observed to be stable with respect to additional requirements on the hadronic activity in the event as show in figure 3, where the selection $H_T > 300\text{GeV}$ is applied.

5. Conclusion

MadGraph (LO multi-leg MC) reproduces correctly the shape of the Z+jet over photon+jet cross-section ratio, but it overestimated the integral value by about 20%. Within the present statistical uncertainty the simulations

well describe the data even when applying different requirements on the extra hadronic activity in the event.

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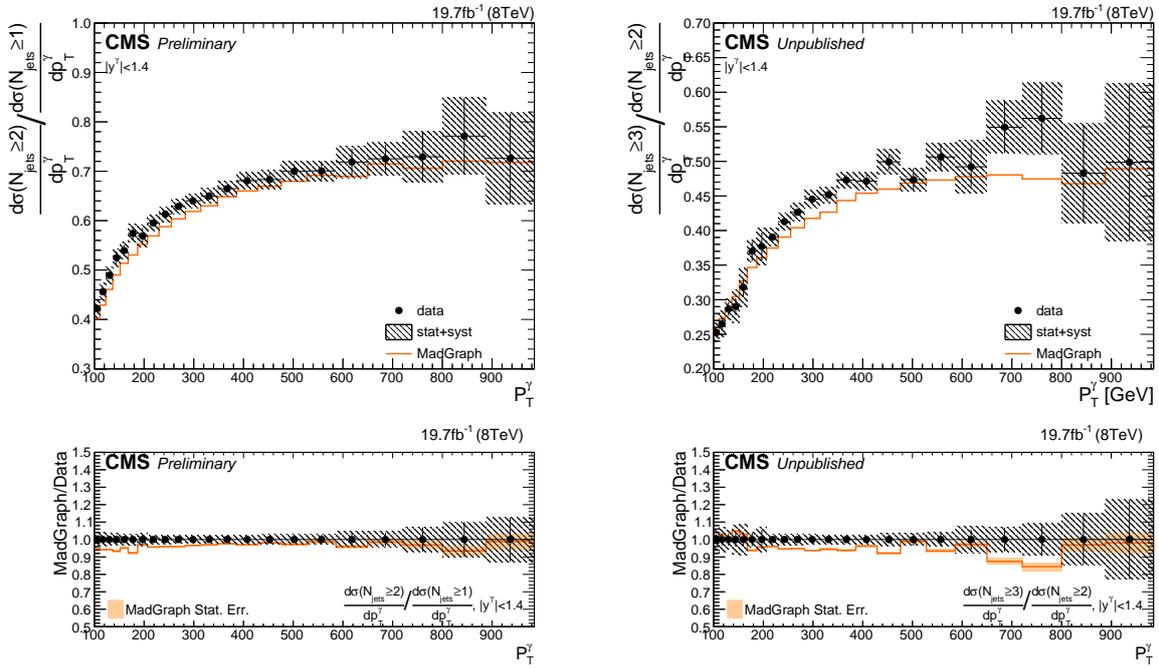


Figure 2: The γ differential transverse momentum cross-section in an inclusive γ + jets, $N_{\text{jets}} \geq 2$ over γ + jets, $N_{\text{jets}} \geq 1$ selection and γ + jets, $N_{\text{jets}} \geq 3$ over γ + jets, $N_{\text{jets}} \geq 2$ for central rapidity ($|y_\gamma| < 1.4$) in data compared with prediction from MadGraph5.1.3.30+Pythia6.4.26. The hatched (grey) band represents the total uncertainty on the measurement, while the error bars show the statistical uncertainty. The shaded bands around MC/data ratios of MadGraph represent the statistical uncertainty of the MC prediction.

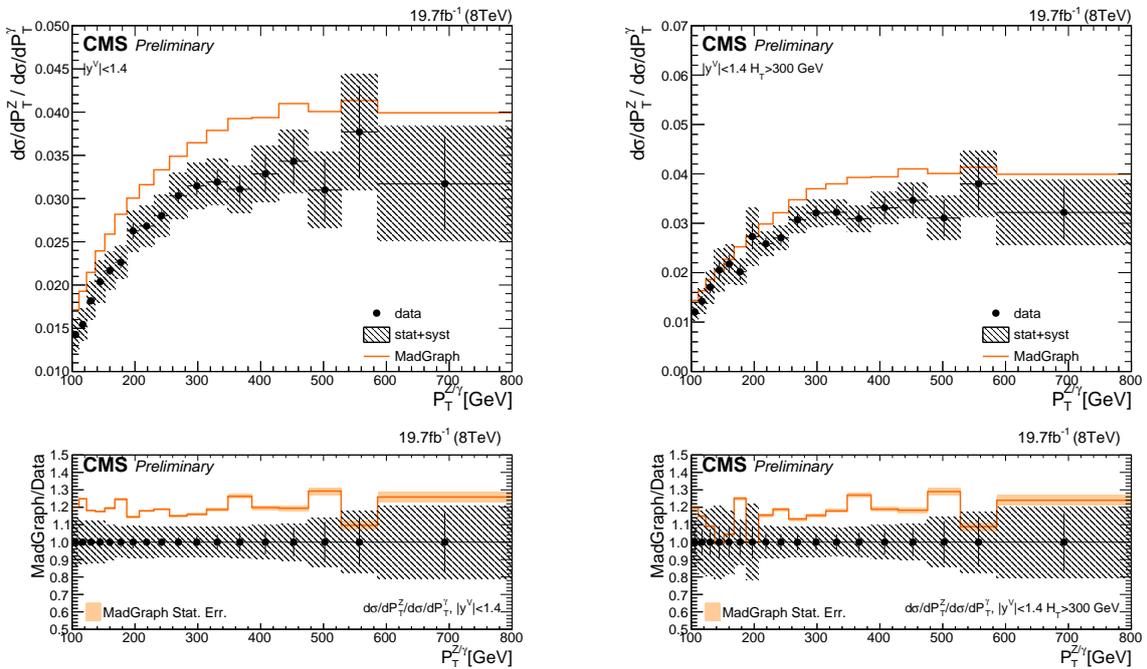


Figure 3: Differential cross-section ratio $Z/\gamma^* + \text{jet}$ over $\gamma + \text{jet}$. Left: $N_{\text{jets}} \geq 1$, Right: $H_T > 300\text{GeV}$. The data points are compared to predictions from MadGraph5.1.3.30+Pythia6.4.26 using LO cross-sections for both processes. The shaded band around the MadGraph to data ratio represents the statistical uncertainty of the MC prediction.