PROMPT PHOTON PLUS JET PRODUCTION WITH THE ZEUS DETECTOR

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The photoproduction of prompt photons, together with an accompanying jet, has been measured in *ep* collisions at a centre-of-mass energy of 318 GeV with the ZEUS detector at HERA using an integrated luminosity of 77 pb^{-1}. The differential γ+jet cross sections were reconstructed as functions of the transverse energy and pseudorapidity of the prompt photon. Predictions based on leading-logarithm parton-shower Monte Carlo models, next-to-leading-order QCD, and the k_T-factorisation approach are also presented.

1. Introduction

Events containing an isolated photon (prompt photon) are a powerful tool to study hard interaction processes since such photons emerge without the hadronisation phase by which a final state quark or gluon forms an observed jet. In *ep* collisions, the presence of a jet in addition to the photon allows measurements that are more sensitive to the underlying partonic processes than is possible for inclusive prompt-photon events. In particular, final states with a prompt photon with a high transverse energy (E_T) together with a high-E_T jet are directly sensitive to the quark content of the proton through the scattering of the exchanged photon with a quark, $\gamma q \to \gamma q$ (Compton scattering). In this case, the incident photon is point like, and the process is called direct. For exchanged four-momentum transfer close to zero (photoproduction), the additional contribution to prompt-photon events from the $gq \to \gamma q$ process, in which one of the initial partons comes from the photon which displays a hadronic structure (resolved process), can be dominant [1,2,3]. Prompt-photon measurements can be used to constrain

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the parton distribution functions (PDFs) of the proton and of the photon, as well as provide a testing ground for QCD calculations. At present, a number of predictions exist [1,2,3,4] that can be confronted with the data. Several of which are shown in Figure 2.

The first observation by ZEUS of isolated photons accompanied by a hadronic jet in photoproduction [5] used an integrated luminosity of 6.4 pb^{-1}. Distributions sensitive to the intrinsic k_T in the γ+jet final state were later measured by ZEUS [6]. Inclusive prompt-photon cross sections without any jet requirement [7] were also measured earlier at ZEUS. Recently, H1 published results on the γ+jet final state in photoproduction [8].

2. Monte Carlo simulation

The measured cross sections were compared to leading-order Monte Carlo (MC) models which use the QCD parton shower approach to incorporate higher-order QCD effects followed by fragmentation into hadrons. The MC events were generated with the PYTHIA 6.3 and with the HERWIG 6.5 models. Both direct and resolved events were generated. A fully inclusive dijet photoproduction sample was generated to simulate background events.

3. Identification of isolated photons and hadrons

In contrast to previous measurements [5,6,7,8], the present analysis is based on the conversion-probability method which uses information on the frequency with which photons convert to e^+e^- in front of a dedicated preshower detector (BPRE). The conversion probability for a single photon is lower than for multiphoton events arising from neutral meson decays ($\pi^0, \eta, etc.$); therefore, small BPRE signals can be used to identify isolated photons.

The fully inclusive dijet photoproduction background MC was added to the prompt-photon MC based on a χ^2 minimisation procedure of the BPRE signal. Figure 1 shows the BPRE signal with the sum of the prompt-photon MC and the photoproduction background MC.

The combined prompt-photon and background Monte Carlos showed some disagreement with the data. To improve the agreement between MC and data a reweighting was performed in four-dimensional phase space in E_T and η of the photon and the accompanying jet, thus correlations between these kinematic variables were properly taken into account. The final reweighted Monte Carlo was used to calculate the acceptance correction. The reweighted prompt-photon Monte Carlo was also used to calculate the hadronisation correction for the theoretical predictions.

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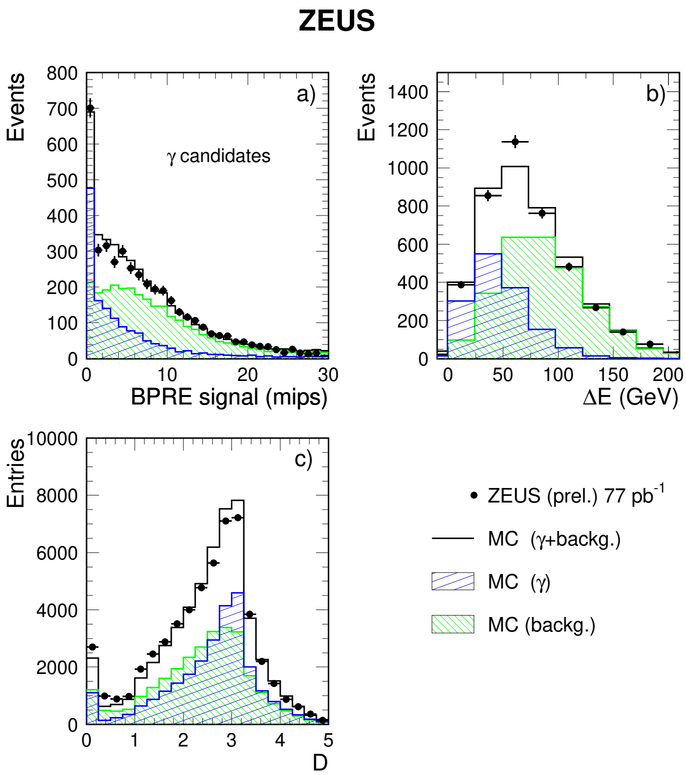

Figure 1. The comparison between the data and the MC for: *a*) the BPRE signal for the photon candidate; *b*) the difference between the total calorimeter energy and the energies of the jet and photon candidate, $\Delta E = E_{tot} - E^{jet} - E^{\gamma}$; and *c*) the distance from the photon candidate to any energy-flow object. The non-hatched histogram is the sum of the prompt-photon MC and the background MC. The fraction of the prompt-photon events was found after a χ^2 minimisation procedure for the BPRE distribution shown in *a*).

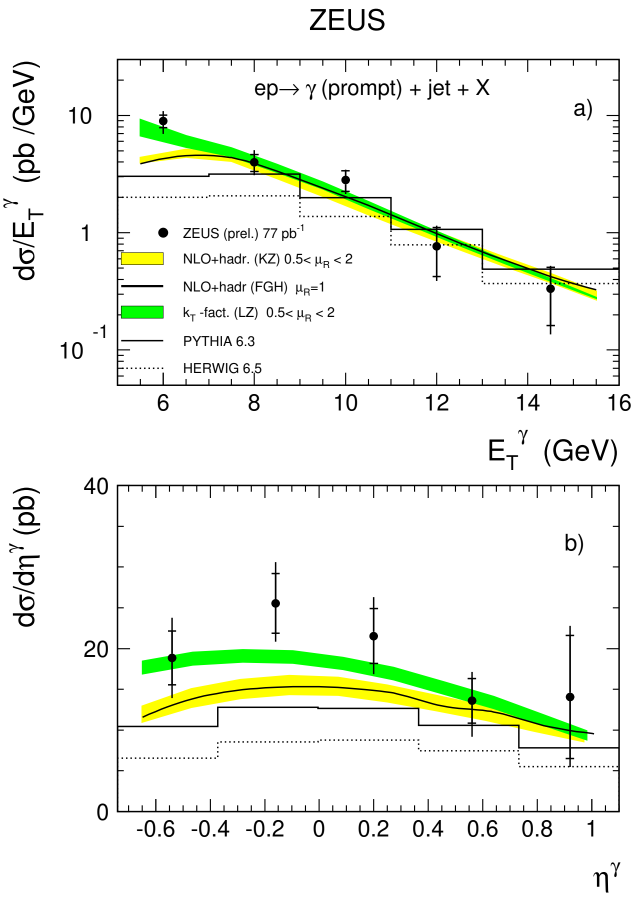

Figure 2. The differential cross sections for the prompt-photon event with an accompanying jet as functions of E_T^γ and η^γ compared to theoretical QCD calculations (with hadronisation corrections included). The histograms show the Monte Carlo models. The inner error bars show the statistical uncertainties, the outer ones show the statistical and systematic uncertainties added in quadrature. The shaded bands correspond to the uncertainty in the renormalisation scale which was changed by a factor of 0.5 and 2.