DEEPLY VIRTUAL COMPTON SCATTERING AT H1 AND ZEUS

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Results on Deeply Virtual Compton Scattering at HERA measured by the H1 and ZEUS Collaborations are presented. The cross section, measured for the first time, is reported for $Q^2 > 2\,\mathrm{GeV}^2$, $30 < W < 120\,\mathrm{GeV}$ and $|t| < 1\,\mathrm{GeV}^2$.

1 Introduction

The study of exclusive final states in electron-proton diffractive interactions is a very powerful tool to investigate the applicability and the relevance of perturbative Quantum Chromo Dynamics (QCD) in this field[1]. At HERA, the wide kinematic range in the photon virtuality, Q^2, provides particular insight into the interplay between perturbative and non-perturbative regimes in QCD. Moreover, a considerable interest comes from the access diffractive events give to a new class of parton distribution functions, the skewed parton distributions (SPD)[2] that can be interpreted as parton correlation functions in the proton.

Here we report the first results on the Deeply Virtual Compton Scattering (DVCS) (Fig. 1a) i.e. the diffractive scattering of a virtual photon off a proton:

$$e^+ + p \to e^+ + \gamma + p. \tag{1}$$

This reaction is dominated by the purely electromagnetic Bethe-Heitler (BH) process (Fig. 1b and c) whose cross section, depending only on QED calculations and proton elastic form factors, is precisely known and therefore can be subtracted.

Compared to vector meson production, DVCS is theoretically simpler because the composite meson in the final state is replaced by the photon, thus avoiding large uncertainties due to the unknown meson wave functions.

In the presence of a hard scale, the DVCS scattering amplitude factorises[3,4,5] into a hard scattering part calculable in perturbative QCD and parton distributions which contain the non-perturbative effects due to the proton structure. In practice, even at Q^2 values above a few GeV^2, the perturbative regime is strongly influenced by non-perturbative effects which have to be model based. In the following, HERA measurement are compared to

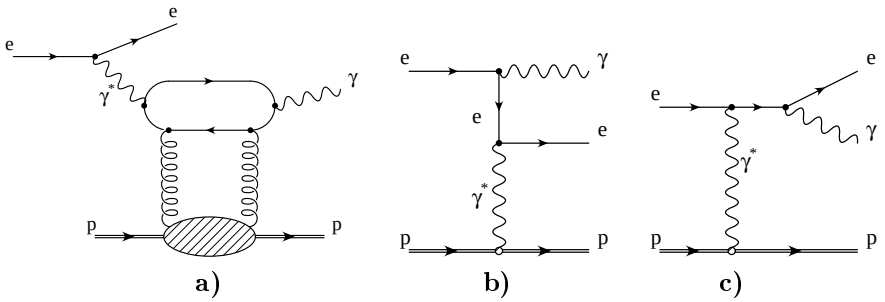


Figure 1. The DVCS (a) and the Bethe-Heitler (b and c) processes.

the LO prediction of L. Frankfurt, A. Freund and M. Strikman (FFS)[6]. NLO predictions have been presented for the first time at this workshop[7].

2 Analysis strategy

Around the interaction region both experiments, H1 and ZEUS, are equipped with tracking devices which are surrounded by calorimeters. Since the proton escapes the main detector through the beam pipe only the scattered electron and photon are measured. Therefore the event selection is based on demanding two electromagnetic clusters, one in the backward and one in the central or forward part of the detector ($\theta \lesssim 140^o$ - the backward direction ($\theta = 0$) is defined as the direction of the incoming electron). If a track can be reconstructed it has to be associated to one of the clusters and determines the electron candidate. To enhance the DVCS contribution in comparison to the Bethe–Heitler process the phase space has to be restricted by demanding the photon candidate in the forward part of the detector.

The H1 analysis selects more specifically the elastic component by using, in addition, detectors which are placed close to the beam pipe and which are used to identify particles originating from proton dissociation processes.

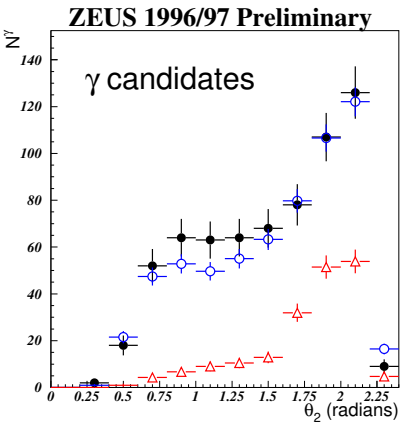
3 Results

3.1 ZEUS

The first observation of the DVCS process was reported by the ZEUS collaboration in 1999[8]. In the analysis a photon virtuality $Q^2 > 6\,\mathrm{GeV}^2$ is demanded. In Fig. 2 the polar angular distribution of the photon candidates

is shown. A clear signal above the expectations for the Bethe–Heitler process is observed. The LO calculation including the DVCS and the Bethe–Heitler processes achives a good description of the experimental data. A clear DVCS signal is still seen after the photon energy cut is increased. Also a shower shape analysis of the calorimetric clusters was performed that shows that the signal originates from photons and not from π^0 background.

Figure 2. Distribution (uncorrected) of the polar angle of the photon candidate with an energy above 2 GeV. Data correspond to the full circles. The prediction for the Bethe–Heitler process is indicated by the open triangles. The prediction of Frankfurt et al. based on calculations including the Bethe–Heitler and the DVCS process is indicated by the open circles.



3.2 H1

In the H1 analysis, the DVCS cross section is measured in the kinematic region: $2 < Q^2 < 20\,\mathrm{GeV}^2$, $|t| < 1\,\mathrm{GeV}^2$ and $30 < W < 120\,\mathrm{GeV}$. The proton dissociation background has been estimated at around 10% and subtracted statistically assuming the same W and Q^2 dependence as for the elastic component. The acceptance, initial state radiation of real photons and detector effects have been estimated by MC to extract the elastic cross section.

In Fig. 3 the differential cross sections as a function of Q^2 and of W are shown. The data are compared with the Bethe–Heitler prediction alone and with the full calculation including Bethe–Heitler and DVCS. The description of the data by the calculations is good, in shape and in absolute normalization when a t slope is chosen between 7 and 10 GeV^{-2} covering the measured range for light Vector Meson production.

It is important to notice that, at the LO in the leading twist approximation, the interference term cancels out when integrating over the azimuthal angle of the final state photon (as in the differential cross sections in Q^2 and of W).

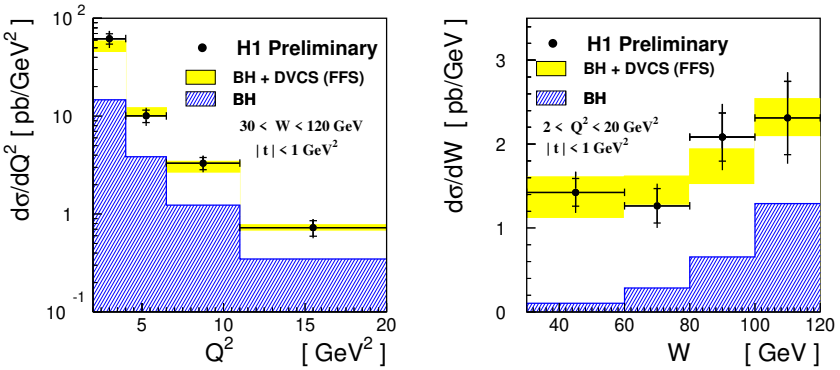


Figure 3. The measured cross sections of the reaction $e^+p \to e^+\gamma p$ as a function of Q^2 and W are shown and compared to theoretical predictions. The uncertainty in the theoretical prediction, shown here as a shaded band is dominated by the unknown slope of the t-dependence of the DVCS part of the cross section, assuming $7 < b < 10\,\mathrm{GeV}^{-2}$.

4 Conclusion

The DVCS process has been observed by the H1 and ZEUS Collaborations. The first Cross section measurements have been presented. The experimental results are well described by the LO calculations of Frankfurt et al.

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