EVENTS WITH HIGH-P_T LEPTONS AND MISSING MOMENTUM AT ZEUS

M. CORRADI
(on behalf of the ZEUS Collaboration)
INFN Bologna
Via Irnerio 46, Bologna, Italy
E-mail: corradi@mail.desy.de

Events with isolated electrons and missing transverse momentum have been selected in 249 pb^{-1} of $e^{\pm}p$ collisions at HERA, including recent $e^{-}p$ data from the 2004-2005 running period. The number of selected events is in good agreement with the Standard Model expectation.

1. Introduction

At HERA, events with isolated high-p_T leptons and large missing transverse momentum, $P_T^{\rm miss}$, are expected to come from W production with a subsequent leptonic decay, $W \to l\nu$. Since the Standard Model (SM) cross section for this process is quite small, $\sigma(ep \to WX) \times B(W \to l\nu) \sim 0.1$ pb [1,2], the search for such events could be sensitive to rare processes beyond the SM. ZEUS has found good agreement between data collected in the '94-2000 running period (HERA-I) and the SM predictions, both in the electron and in the muon channels [3,4]. On the other hand, the H1 collaboration reported an excess over the SM for events with an isolated high-p_T lepton, large $P_T^{\rm miss}$ and a hadronic system with large transverse momentum, $P_T^X > 25$ GeV, in e^+p collisions [5]. It is therefore interesting to look at new data from the current HERA run (HERA-II) and to apply selection criteria as close as possible to those used by H1.

The analysis presented here extends previous results[6] by including for the first time a sample of e^-p data comparable in luminosity with the e^+p sample. The e^+p sample consists of data collected in the 1999-2000 (luminosity $L = 66\,\mathrm{pb}^{-1}$) and in the 2003-'04 ($L = 40\,\mathrm{pb}^{-1}$) data-taking periods. The sample of e^-p data was collected in the 1998-'99 ($L = 17$ pb^{-1}) and in the 2004-'05 ($L = 126$ pb^{-1}) running periods. The beam energies were $E_e^{\rm beam} = 27.5$ GeV and $E_p^{\rm beam} = 920$ GeV in all the data sets.

The selection was designed to be similar to the H1 one, compatibly with the differences. Only the electron channel has been studied at the moment.

2. Results

Isolated electron candidates were reconstructed as electromagnetic (EM) clusters in the calorimeter matched to a track from the central tracking detector (CTD). The electron isolation was ensured by requiring less than 4 GeV (beside the EM cluster) in an $\eta - \phi$ cone of radius 0.8 around the candidate and no other charged tracks in a cone of radius 0.5. An initial sample of events with one electron and large missing momentum was obtained requiring: $P_T^{\rm miss} > 12$ GeV; an electron candidate with energy $E^e > 8$ GeV; transverse momentum $p_T^e > 5$ GeV and polar angle $\theta_e < 2$ rad. The requirement of a matching track in the CTD limits the acceptance for forward electrons to roughly $\theta_e > 0.3$ rad.

The SM expectation was obtained from Monte Carlo (MC) event generators, combined according to their cross sections. The following processes were considered: W production (generated with EPVEC [1]), Neutral Current (NC) and Charged Current DIS (generated with DJANGOH) and dilepton events (generated with GRAPE).

Figure 1 shows the distribution of several variables for the initial sample of HERA-II e^-p data and the corresponding SM MC expectation. The peak at zero in the acoplanarity angle, $\phi_{\rm acop} = \angle(\vec{p}_T^{\,e}, -\vec{P}_T^{\rm miss})$, shows that the sample is dominated by NC DIS events in which the transverse momentum of the hadronic system was underestimated. There is reasonable agreement between data and MC.

The final sample was obtained by applying the following cuts, designed to reduce the NC DIS background, to the initial sample:

- ($P_T^{\rm miss} > 25$ GeV or $Q_e^2 > 5000$ GeV^2), where Q_e^2 is Q^2 reconstructed from the electron assuming that it is the scattered DIS electron;
- $E - P_z < 50$ GeV, where E and P_Z are the total final-state energy and longitudinal momentum, respectively;
- $p_T^e > 10$ GeV;
- $\theta_e < 1.5$ rad;
- $\phi_{\rm acop} > 0.3$ rad.

The number of events in the final sample and the corresponding SM expectation are shown in Table 1 for the different data taking periods and for

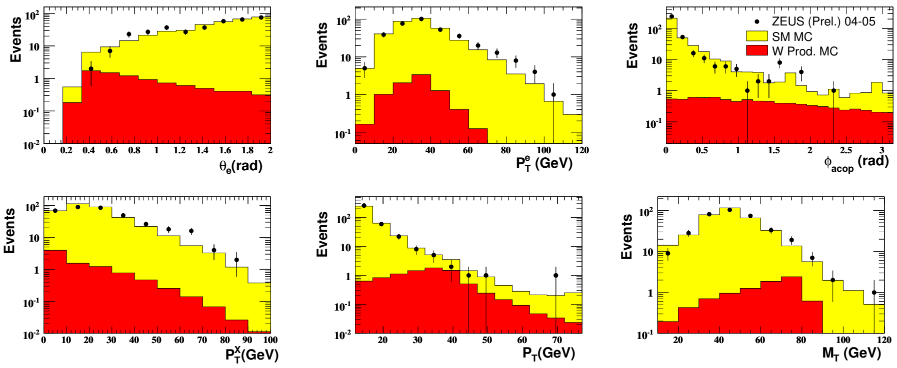

Figure 1. Comparison of 2004-2005 e^-p data (points) with the expectation from SM MC (histogram) for different variables: the polar angle (θ_e) and transverse momentum (p_T^e) of the electron, the acoplanarity angle ($\phi_{\rm acop}$), the hadronic (P_T^X) and the missing ($P_T \equiv P_T^{\rm miss}$) transverse momenta and the transverse mass of the electron-$\vec{P}_T^{\rm miss}$ system (M_T). The distributions are shown before the final selection. The dark histogram shows the expected contribution from W production.

two bins of the hadronic transverse momentum: $12 < P_T^X < 25$ GeV and $P_T^X > 25$ GeV. Three new events with $P_T^X > 25$ GeV have been found in the 2004-05 e^-p data, the highest-P_T^X one is shown in Figure 2.

The SM expectation is in good agreement with the data. In total 4 events are observed at $P_T^X > 25$ GeV to be compared with 4.4 ± 0.5 expected, where the uncertainty on the SM expectation includes the MC statistics but not theoretical uncertainties. Good agreement is also found when the data are divided into an e^+p and an e^-p sample. The SM expectation is dominated by W production ($\sim 60\%$ of the total SM expectation), the rest being due to background from NC DIS, CC DIS and dileptons.

3. Conclusions

Events with isolated electrons and missing transverse momentum were selected in 249 pb^{-1} of $e^\pm p$ data. Four events are found at $P_T^X > 25$ GeV, in agreement with the SM expectation of 4.4 ± 0.5.

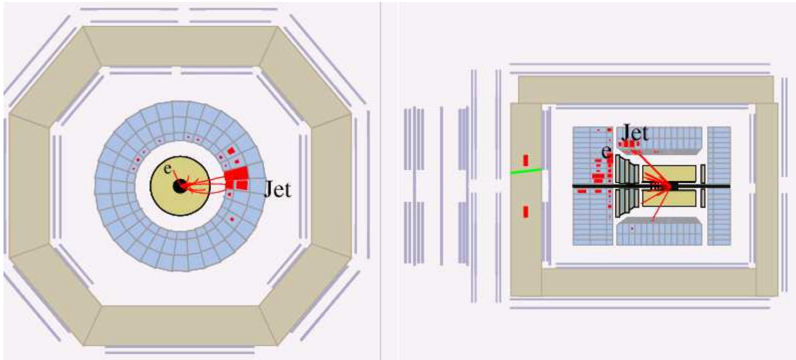

Figure 2. Event display of the highest-P_T^X event: $P_T^{\text{miss}} = 33.5$ GeV, $P_T^X = 32.4$ GeV, $P_T^e = 16.5$ GeV, $M_T = 38.1$ GeV and $\phi_{\text{acop}} = 1.38$ rad.

Table 1. Number of events in the final selection and corresponding SM expectation in two bins of P_T^X. The first four lines show different data sets separately, the 5^{th} and 6^{th} lines show the same results grouped into e^+p and e^-p samples and the 7^{th} line shows the total $e^\pm p$ sample. The last line shows the result of a similar analysis by H1. The uncertainty on the SM expectation reflects the MC statistics only. The fraction of expected SM events coming from W production is shown in parenthesis.

Data set	$12 < P_T^X < 25$ GeV N_{obs} / N_{SM} (W)	$P_T^X > 25$ GeV N_{obs} / N_{SM} (W)
ZEUS (prel.)		
98-99 e^-p (17 pb^{-1})	$1/0.23 \pm 0.06(67\%)$	$0/0.32 \pm 0.09(65\%)$
04-05 e^-p (126 pb^{-1})	$3/1.75 \pm 0.36(57\%)$	$3/2.54 \pm 0.46(51\%)$
99-00 e^+p (66 pb^{-1})	$1/1.04 \pm 0.11(57\%)$	$1/0.92 \pm 0.09(79\%)$
03-04 e^+p (40 pb^{-1})	$0/0.46 \pm 0.10(64\%)$	$0/0.58^{+0.08}_{-0.09}(76\%)$
98-05 e^-p (143 pb^{-1})	$4/1.98 \pm 0.36(58\%)$	$3/2.86 \pm 0.46(53\%)$
99-04 e^+p (106 pb^{-1})	$1/1.50 \pm 0.15(59\%)$	$1/1.50^{+0.12}_{-0.13}(78\%)$
98-05 $e^\pm p$ (249 pb^{-1})	$5/3.5 \pm 0.4(58\%)$	$4/4.4 \pm 0.5(61\%)$
H1 (prel.)		
94-05 $e^\pm p$ (279 pb^{-1})	-	$11/4.7 \pm 0.9(69\%)$

References

1. U. Baur, J.A.M. Vermaseren, D. Zeppenfeld, Nucl. Phys. B **375** (1992) 3.
2. K.P. Diener, C. Schwanenberger, M. Spira, Eur. Phys. J. C **25** (2002) 405.
3. J. Breitweg *et al.* [ZEUS Coll.], Phys. Lett. B **471** (2000) 411.
4. S. Chekanov *et al.* [ZEUS Coll.], Phys. Lett. B **559** (2003) 153.
5. D. South, *these proceedings*, and references therein.
6. J. Ferrando, *Proceedings of the International Europhysics Conference on High Energy Physics (HEP-EPS 2005), Lisbon, Portugal, 21-27 July 2005*, PoS **HEP2005** (2006) 319.