

NEW H1 RESULTS ON ISOLATED LEPTONS AND MISSING P_T AT HERA

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The search for events containing isolated leptons (electrons or muons) and missing transverse momentum produced in $e^\pm p$ collisions is performed with the H1 detector at HERA in the period 1994–2005. The analysed data sample corresponds to an integrated luminosity of 279 pb^{-1} , which includes 53 pb^{-1} of e^+p data and 107 pb^{-1} of e^-p data from the new HERA II phase. A total of 40 events are observed in the data, compared to a Standard Model (SM) prediction of 34.3 ± 4.8 . At large hadronic transverse momentum $P_T^X > 25 \text{ GeV}$, a total of 17 events are observed compared to 9.0 ± 1.5 predicted by the SM. In this region, 15 events are observed in the e^+p data compared to a SM prediction of 4.6 ± 0.8 , whereas in the e^-p data 2 events are observed compared to a SM prediction of 4.4 ± 0.7 .

1. Introduction

Events containing a high P_T isolated electron or muon and associated with missing transverse momentum have been observed at HERA^{1,2,3,4}. An excess of HERA I (1994–2000) data events compared to the SM prediction at large hadronic transverse momentum P_T^X was reported by the H1 Collaboration², which was not confirmed by the ZEUS Collaboration, although using a slightly different analysis approach⁴. Most of the HERA I data, luminosity 118 pb^{-1} , were taken in e^+p collisions. The H1 analysis has been updated^{5,6} to include new $e^\pm p$ data from the ongoing HERA II phase (2003–2005), resulting in a total analysed luminosity of 279 pb^{-1} .

2. Standard Model Signal Processes

The signal topology in this analysis is a prominent, isolated lepton accompanied by large, genuine missing transverse momentum. The main

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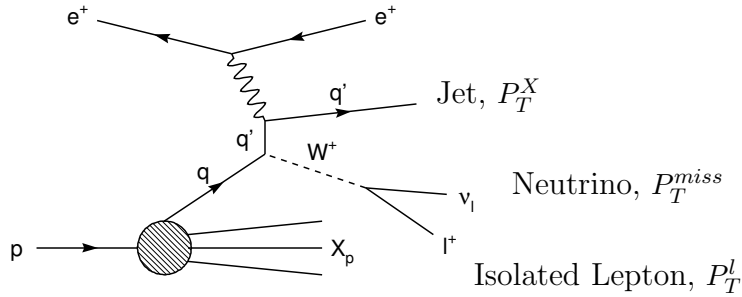


Figure 1. Feynman diagram of the process $ep \rightarrow eW^\pm(\rightarrow l\nu)X$, which is the main SM contribution to the search for events with isolated leptons and missing transverse momentum. The main final state components are also labelled.

SM contribution to such a topology comes from the production of real W bosons with subsequent leptonic decay $ep \rightarrow eW^\pm(\rightarrow l\nu)X$, as illustrated in figure 1. The struck quark quickly hadronises giving rise to the (typically low P_T) hadronic system X , whilst the W decay neutrino escapes undetected, resulting in a substantial transverse momentum imbalance in the event, P_T^{miss} . Additional, smaller signal contributions arise from the production of W bosons via the equivalent charged current process $ep \rightarrow \nu W^\pm(\rightarrow l\nu)X$ and the production of Z^0 bosons with subsequent decay to neutrinos $ep \rightarrow eZ^0(\rightarrow \nu\bar{\nu})X$, which contributes only to the electron channel.

3. Event Selection

The event selection employed is identical to that used in the HERA I analysis². The kinematic phase space is defined as follows: The identified lepton should have high transverse momentum $P_T^l > 10$ GeV, be observed in the central region of the detector $5^\circ < \theta_l < 140^\circ$ and be isolated with respect to jets and other tracks in the event. The event should also contain a large transverse momentum imbalance, $P_T^{miss} > 12$ GeV. Further cuts are then applied, which are designed to reduce SM background, whilst preserving a high level of signal purity. Event quantities sensitive to the presence of high energy undetected particles in the event are employed such as the azimuthal balance of the event, the difference in azimuthal angle between the lepton and the hadronic system and the longitudinal momentum imbalance. To ensure that the two lepton channels are exclusive and may therefore be combined, electron events must contain no isolated muons.

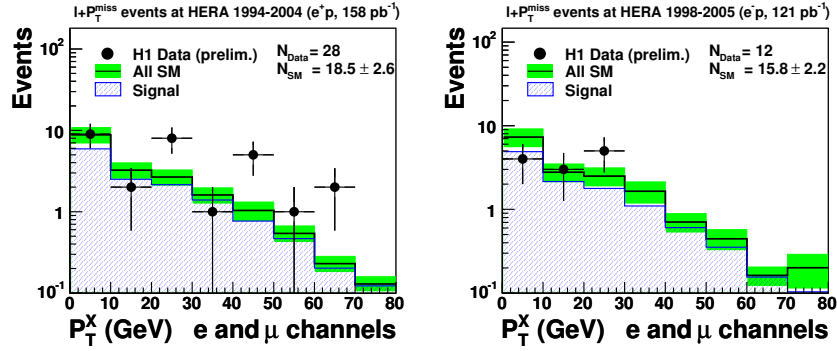


Figure 2. The hadronic transverse momentum spectra of the observed events in the H1 isolated lepton analysis. The e^+p data sample is shown on the left and the e^-p data sample on the right. The data are the points, the full histogram is the SM expectation and the shaded band is the total SM error. The signal component, dominated by real W production, is shown by the hatched histogram.

4. Results

In the final event sample a total of 40 events are observed in the H1 data, compared to a SM prediction of 34.3 ± 4.8 . The hadronic transverse momentum spectra of the $e^\pm p$ data are presented in figure 2. At large values of P_T^X , a kinematic region atypical of SM W production, an excess of e^+p data events is observed over the SM expectation, as can be seen in figure 2 (left). For $P_T^X > 25$ GeV a total of 15 data events are observed in the e^+p data compared to a SM prediction of 4.6 ± 0.8 , equivalent to a fluctuation of approximately 3.4σ . Figure 3 shows an event in the HERA II e^+p data containing an isolated electron, missing P_T and a hadronic jet with large P_T^X . Interestingly, a similar excess is not observed in the current e^-p data sample, as can be seen in figure 2 (right), where 2 data events are observed compared to a SM prediction of 4.4 ± 0.7 . The e^-p data sample now includes almost a factor of 10 increase in statistics with respect to the HERA I data set. A summary of the results is presented in table 1.

5. Summary

The search for events containing high P_T isolated electrons or muons and missing transverse momentum produced in $e^\pm p$ collisions is performed using data collected by the H1 detector at HERA in the period 1994–2005, corresponding to an integrated luminosity 279 pb^{-1} . At large values of $P_T^X > 25$ GeV an excess of events is observed in the e^+p data sample,

where 15 events are observed compared to a SM prediction of 4.6 ± 0.8 . No such excess is observed in the e^-p data sample or in the recent re-analysis performed by the ZEUS Collaboration^{7,8}. The continued increase in luminosity from the HERA II programme will hopefully clarify the observed H1 excess in the e^+p data at large hadronic transverse momentum.

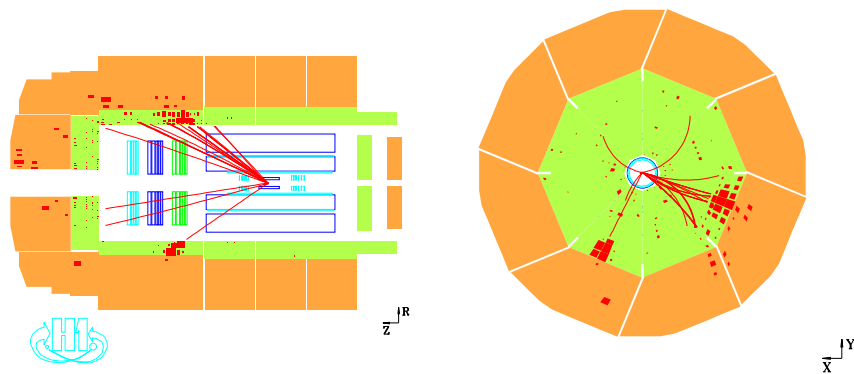


Figure 3. Display of an event with an isolated electron, missing transverse momentum and a prominent hadronic jet recorded by the H1 experiment in the HERA II e^+p data.

Table 1. Summary of the H1 search for events with isolated electrons or muons and missing transverse momentum, in the kinematic region $P_T^X > 25$ GeV. The number of observed events is compared to the SM prediction for the e^+p , e^-p and $e^\pm p$ data sets.

H1 Preliminary $P_T^X > 25$ GeV	e channel obs./exp.	μ channel obs./exp.	combined e & μ obs./exp.
1994-2004 e^+p 158 pb ⁻¹	9 / 2.3 ± 0.4	6 / 2.3 ± 0.4	15 / 4.6 ± 0.8
1998-2005 e^-p 121 pb ⁻¹	2 / 2.4 ± 0.5	0 / 2.0 ± 0.3	2 / 4.4 ± 0.7
1994-2005 $e^\pm p$ 279 pb ⁻¹	11 / 4.7 ± 0.9	6 / 4.3 ± 0.7	17 / 9.0 ± 1.5

References

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