

Searches for New Physics at HERA

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HERA, the world's only $e - p$ Collider at DESY, Hamburg, running 1991 – 2007, was ideally suited for searches for physics beyond the Standard Model due to its unique initial state. The H1 and ZEUS experiments with their asymmetric design provided 4π Coverage, excellent lepton ID and HFS reconstruction to detect any exotic signatures. The poster summarised here presents recent results on searches at HERA, most of them utilising the full HERA dataset of about 0.5 fb^{-1} per experiment and including the first combined H1+ZEUS results.

1 Signature Searches

1.1 General Search

A model-independent search for deviations from the Standard Model (SM) prediction is performed [1]. All event topologies involving isolated electrons, photons, muons, neutrinos and jets with transverse momenta above 20 GeV are investigated in a single analysis. Events are assigned to exclusive classes according to their final state. Figure 1 shows the event yields in each of the classes for e^+p (a) and e^-p (b) collisions separately. Overall the data (black dots) agree well with the SM expectation within the total uncertainties (shaded band). A dedicated algorithm is used to search for deviations from the SM in the distributions of the scalar sum of transverse momenta or the invariant mass of final state particles and to quantify their significance. Variables related to angular distributions and energy sharing between final state particles are also introduced to study the final state topologies. No significant deviation from the SM expectation is observed in the phase space covered by the analysis. Many channels are also investigated in dedicated analyses, some of which are summarised below.

1.2 High- P_T Leptons

The first combined paper by H1 and ZEUS presents a study of events with at least two high transverse momentum leptons (electrons or muons) [2]. This signature is sensitive to physics beyond the SM. The overall agreement with the SM prediction is good, but at high invariant masses, more interesting events are observed than predicted. This is visible in distributions of the invariant mass of the two highest P_T leptons, M_{12} , and the sum of the lepton transverse momenta $\sum P_T$.

A search for events containing isolated leptons (electrons or muons) and missing transverse momentum is performed by the H1 and ZEUS experiments in a common phase space [3]. The observed event yields are compared to the prediction from the Standard Model which is

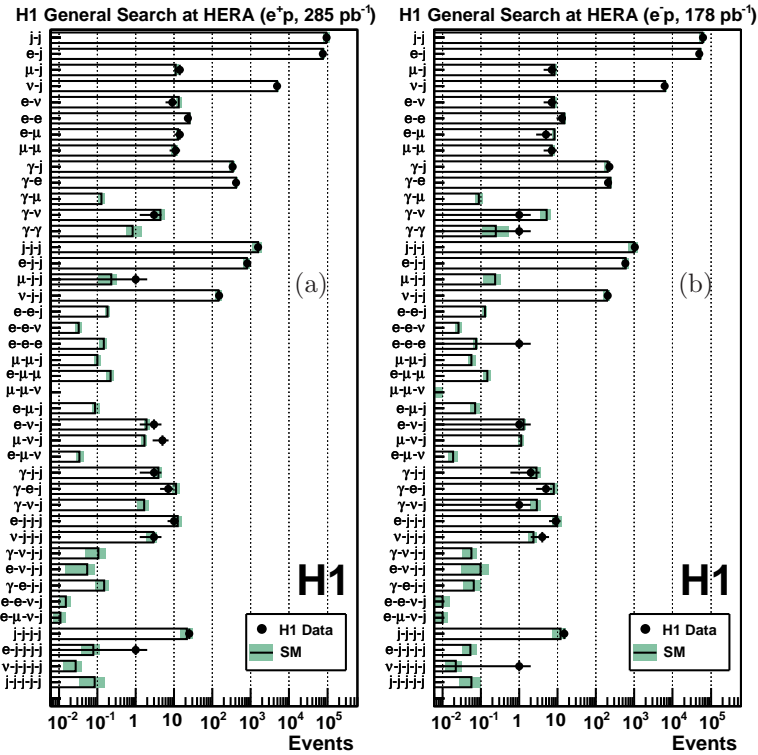


Figure 1: The data and the SM expectation for all event classes with observed data events or a SM expectation greater than 0.01 events for e^+p collisions (a) and e^-p collisions (b). The error bands on the predictions include model uncertainties and experimental systematic errors added in quadrature.

dominated by single W production. In general good agreement is found. The total single W boson production cross section is measured to be 1.07 ± 0.18 pb, in agreement with the SM expectation of 1.26 ± 0.19 pb.

At high hadronic transverse momentum P_T^X the isolated leptons signature is the same as for single top production. Inspired by events observed in the region $P_T^X > 25$ GeV by H1 [4] this is studied using anomalous effective FCNC couplings $\kappa_{tu\gamma}$, ν_{tuZ} [5]. The resulting HERA limits on $\kappa_{tu\gamma}$ explore a domain not covered by other colliders.

2 Model Searches

2.1 Squarks in R -Parity Violating SUSY

A search for squarks in the Minimal Supersymmetric Standard Model with R -parity violation is performed [6]. The resonant production of squarks via a Yukawa-type coupling λ' is considered, taking into account direct and indirect R -parity violating decay modes. No evidence for squark production is found in the (multi-)lepton and (multi-)jet final state topologies investigated.

Squarks of the first and second generation with masses up to 275 GeV are excluded in the considered part of the parameter space for a Yukawa-type coupling of electromagnetic strength at 95% confidence level.

2.2 Contact Interactions

A search for deviations of the inclusive NC cross sections from the SM prediction at high Q^2 is performed [7]. Since no significant deviations are observed, various BSM models can be constrained. Limits are derived on the effective mass scale Λ in $eeqq$ contact interactions ($\Lambda > 3.8 - 8.9$ TeV), on the mass to the Yukawa coupling ratio for heavy-leptoquark models ($M_{LQ}/\Lambda_{LQ} > 0.41 - 1.88$ TeV), on the effective Planck-mass scale in models with large extra dimensions ($M_S > 0.94$ TeV) and on the quark charge radius ($R_q < 0.63 \cdot 10^{-16}$ cm).

2.3 Excited Fermions

A search for excited fermions (electrons, neutrinos and quarks) is performed [8, 9, 10]. The interactions are described by an effective Lagrangian for gauge mediated models where the excited fermions couple to the electroweak and strong gauge groups, parametrised by coupling parameters f , f' and f_s , respectively.

All decay channels are considered for all fermion types. No evidence for excited fermion production is found. Mass dependent exclusion limits on excited fermion production cross sections and on the ratio f/Λ of the coupling to the compositeness scale are derived. These limits extend the excluded region compared to previous excited fermion searches.

3 Bibliography

References

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