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Search for physics beyond the SM in ep collisions at HERA

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Recent updates on searches for physics beyond the Standard Model at the ep collider HERA are presented. Various channels involving high-p_T leptons and/or large missing p_T were explored looking for possible deviations respect to the Standard Model predictions. Limits are presented and SM quantities are evaluated in the absence of an indication of new physics.

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1. Introduction

The ep collider HERA ended operations in June 2007, after 15 years of successful activity. During this long period of data taking each of the two experiments, H1 and ZEUS, collected an integrated luminosity of ~ 0.5 fb^{-1}. A lot of results on searches for physics beyond the Standard Model (SM) have been produced; in this report we summarize some recent updates obtained by ZEUS on leptoquarks, tau-pair production, high-p_T leptons and W production (combining H1 and ZEUS data), single top.

2. Leptoquarks

HERA is an ideal place for leptoquark (LQ) [1, 2] studies, due to the ep initial state. Such states, foreseen by many SM extensions, can be directly produced by the fusion, via a Yukawa coupling λ, of the incoming electron or positron with a quark in the proton. If the LQ mass is lighter than the centre of mass energy ($\sqrt{s} = 318$ GeV) the production is dominated by an s-channel resonance while, in case of a larger mass, also the u-channel contributes. After the production, LQs can decay to e-jet or ν-jet with topologies identical to neutral current or charged current deep inelastic scattering. The analysis looks for possible deviation in the predicted e-jet or ν-jet invariant mass. Figure 1 shows preliminary ZEUS results for two scalars LQs which couple to e^+u and $e^-u/\nu d$. ZEUS limits are compared to the results of the experiments at the other colliders and are the best for LQ masses larger than 340-380 GeV.

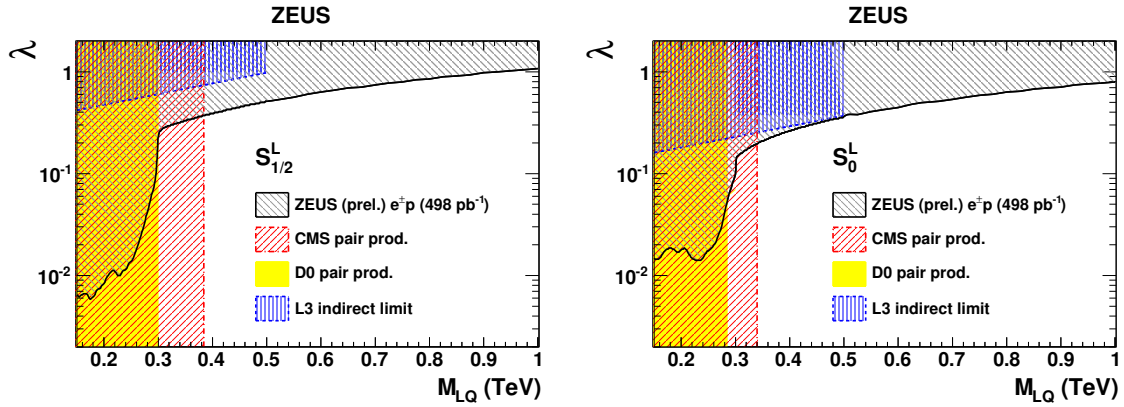

Figure 1: ZEUS limits on the Yukawa coupling as a function of the mass for two scalars LQs which couple to e^+u (left) and $e^-u/\nu d$ (right). The boundaries from the other colliders are also reported.

3. Tau-pair production

The production of isolated-lepton pairs at HERA is an electroweak process predominantly due to $\gamma\gamma$ interactions and predicted with high precision within the SM framework. Possible deviations from the predictions could be a hint of new physics. Recently ZEUS presented a study on ditau events [3] which used data collected in 2004-2007, corresponding to an integrated luminosity of 0.33 fb^{-1}. All the tau decay channels were exploited in all combinations except ee and $\mu\mu$ final

Topology	(e-)e-μ	(e-)e-jet	(e-)μ-jet	(e-)jet-jet	Total
Data	4	7	4	10	25
Total MC	$3.6^{+1.3}_{-0.3}$	$8.8^{+1.8}_{-0.8}$	$8.0^{+2.2}_{-1.2}$	$14.4^{+2.2}_{-3.5}$	$34.8^{+3.9}_{-3.8}$
$\tau^+\tau^-$ MC	$3.0^{+0.3}_{-0.2}$	$5.3^{+0.3}_{-0.2}$	$5.9^{+0.5}_{-0.5}$	$9.0^{+0.4}_{-0.3}$	$23.2^{+0.7}_{-0.7}$

Table 1: Summary table of the selected events for the tau-pair analysis.

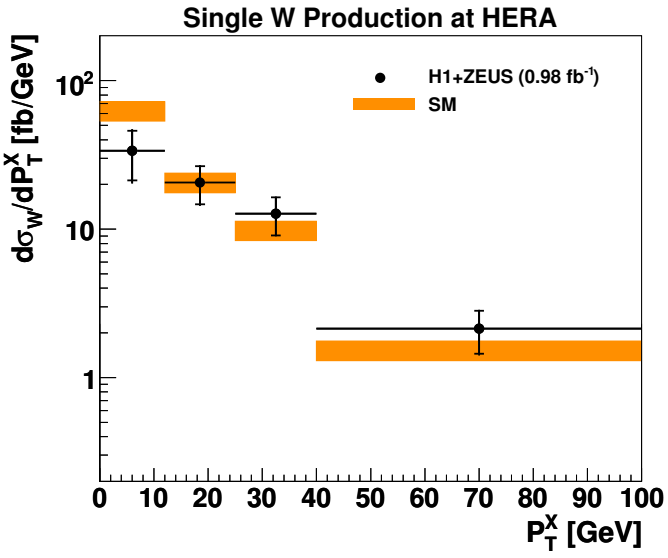

Figure 2: Single-W production cross section in different hadronic P_T bins compared with SM predicitons.

states which are affected by large contamination from $\gamma\gamma \to ee/\mu\mu$. Table 1 shows the results of the selection; reasonable agreement with the SM prediction was observed in all the studied channels. The tau-pair production cross-section was measured in the kinematic region $p_T > 5$ GeV and $17^\circ < \theta < 160^\circ$ for both taus and found to be $\sigma = 3.3 \pm 1.3$ (stat.)$^{+1.0}_{-0.7}$ (syst.) pb, in good agreement with the SM prediction of $\sigma_{SM} = 5.67 \pm 0.16$ (theor.) pb.

4. High-p_T leptons and single top

Events with one high-p_T lepton (electron or muon) and missing p_T have been extensively studied at HERA [4, 5]. Because of the clean signature and the low expected background, they are very well suited to look for possible signals beyond the SM. The production of W boson is the only SM source of this kind of events. The process is characterized by low values of the hadronic P_T (P_T^X) and the cross section is ~ 1 pb. H1 and ZEUS have recently combined their analysis using a common phase space [6]. The results showed a reasonable agreement between data and SM expectations and the W production cross section was measured in different P_T^X bins, see fig. 2. The total inclusive single-W cross section was measured to be $\sigma = 1.06 \pm 0.16$ (stat.)± 0.07 (syst.) pb, in good agreement with the SM prediction at NLO, $\sigma_{SM} = 1.26 \pm 0.19$ (theor.) pb.

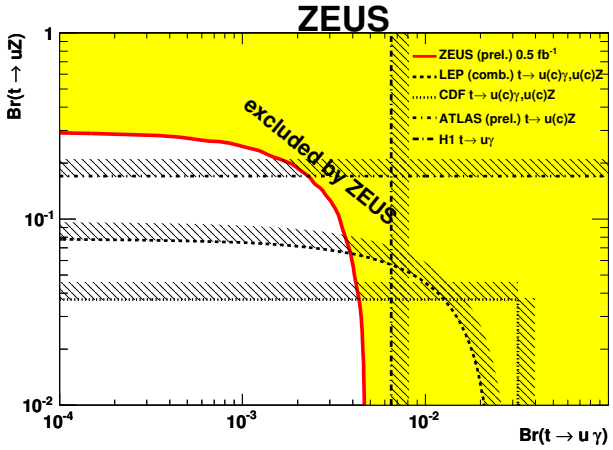

Figure 3: Boundaries in the plane Br($t \to u\gamma$), Br($t \to uZ$) for the anomalous branching ratios of the top.

The same topology could also be produced by anomalous top production via flavour changing neutral current, the only remarkable difference being the larger P_T^X, respect to the W production, due to the b quark from top decay. In particular the top quark at HERA can be produced through anomalous couplings $tu\gamma$ or tuZ. The preliminary ZEUS boundaries on anomalous branching ratios of the top due to such couplings, obtained using the full HERA data sample, are shown in fig. 3. The constraints of H1 and of the experiments at the other colliders are also shown. For values of the top branching ratio to uZ below 0.04, the ZEUS limits are the best to date.

5. Conclusions

This report contains a summary of recent ZEUS results on searches for physics beyond the Standard Model at HERA in events with high-p_T leptons and/or missing transverse momentum. In particular, new results on leptoquarks, tau-pair production, W production (combining H1 and ZEUS data) and single top have been presented. The results are always competitive with and complementary to the other colliders.

References

[1] H1 collaboration, F.D. Aaron et al., DESY 11-123, July 2011, Accepted by Phys. Lett. **B**;

[2] ZEUS collaboration, S. Chekanov et al., Phys. Rev. **D68** (2003) 052004;

[3] ZEUS collaboration, H. Abramowicz et al., JHEP **02** (2011) 117;

[4] H1 collaboration, F.D. Aaron et al., Eur. Phys. J. **C64** (2009) 251;

[5] ZEUS collaboration, S. Chekanov et al., Phys. Lett. **B672** (2009) 106;

[6] H1 and ZEUS collaborations, F.D. Aaron et al., JHEP **03** (2010) 35;