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A Search for Leptoquark Bosons and Lepton Flavor Violation in e^+p collisions at HERA

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A search for new bosons possessing couplings to lepton-quark pairs is performed in the H1 experiment at HERA using 1994→1997 data corresponding to an integrated luminosity of 37pb^{-1}. First generation leptoquarks (LQs) are searched in very high Q^2 neutral (NC) and charged (CC) current-like data samples which are compared to Standard Model (SM) expectations from deep-inelastic scattering (DIS). A deviation in the Q^2 spectrum previously observed in the 1994→1996 dataset at $Q^2 \geq 15000$ GeV^2 remains, though with less significance. This deviation corresponded to a clustering in the invariant mass spectrum at $M \simeq 200$ GeV which is not observed with the 1997 dataset alone. The NC DIS data is used to constrain the Yukawa couplings of first generation scalar and vector LQs in the Buchmüller-Rückl-Wyler effective model, taking into account s- and u-channel LQ contributions as well as the interference with SM boson exchange. Scalar LQs are excluded for masses up to 275 GeV for a coupling of electromagnetic strength ($\lambda = 0.3$) For any LQ type, constraints are established for $\lambda \leq 1.0$ for masses up to 400 GeV. The NC and CC DIS data is combined to constrain λ for arbitrary branching ratios in a generic model. Exclusion limits are derived which considerably improve earlier LQs search results from HERA and extend beyond the coupling-mass domain covered so far at other colliders for a small branching ratio to e^+q. For a branching ratio to e^+u pair as small as 10%, leptoquark masses up to 260 GeV are ruled out by the present analysis for a coupling $\lambda = 0.3$. Leptoquarks possessing couplings to mixed fermion generations, which could lead to signals of lepton flavor violation (LFV), are searched in events with a high transverse momentum μ or τ. No $\mu + X$ or $\tau + X$ event candidate is found that is compatible with the specific hypothesis of LFV due to a leptoquark. Constraints are set on the Yukawa coupling involving the μ and τ lepton for a mass range extending beyond the domain presently covered at other colliders and by low energy experiments.