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The search for 'mirror' quarks with distinguished signatures at the 13 TeV LHC

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Observation of non-zero neutrino masses at a scale $\sim 10^{-1} - 10^{-2}$ eV is a major problem in otherwise highly successful Standard Model. The most elegant mechanism to explain such tiny neutrino masses is the seesaw mechanism with right handed neutrinos. However, the required seesaw scale is so high ($\sim 10^{14}$ GeV), it will not have any direct collider implications. Recently, in our explicit model the seesaw mechanism with the right handed neutrinos at the electroweak scale has been investigated. The model has a mirror symmetry having both the left and right lepton and quark doublets and singlets for the same $SU(2)_W$ gauge symmetry. Additional Higgs multiplets have been introduced to satisfy the precision electroweak tests, and other low energy observables. Because the scale of the symmetry breaking is electroweak, both the mirror quarks and mirror leptons have masses in the electroweak scale in the range $\sim 150 - 800$ GeV. The mirror quarks / leptons decay to ordinary quarks /leptons plus almost massless neutral scalars. We calculate the final state signals arising from the pair productions of these mirror quarks and their subsequent decays. We find that these signals are well observable over the Standard Model background for 13 TeV LHC. Depending on the associated Yukawa couplings, these decays can also give rise to displaced vertices with long decay length (very different from the usual displaced vertices associated with b decays), which will be the distinguished signatures for this model.

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