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Hunting for scalar Leptoquarks with boosted Tops and light Leptons

ABSTRACT

The LHC search strategies for leptoquarks (LQ) that couple dominantly to a top quark are different than for the ones that couple mostly to light quarks. We consider charge 1/3 (ϕ_1) and 5/3 (ϕ_5) that decay to a top quark and a charged lepton (tℓ) giving rise to a resonance system of a boosted top and a high-pT lepton. On studying the pair production and single production of LQ, we find that single production of top-philic LQ in association with a lepton and jets could be significant for order one (ϕ -t- ℓ) coupling. We propose a search strategy of selecting events with at least one hadronic-top and two high-pT same flavor opposite sign leptons. Our estimation shows that a scalar LQ of mass 1.7 TeV can be discovered at the 14 TeV LHC with 3 ab^{-1} of integrated luminosity.

OBJECTIVE

- LQ play a key role in explaining the anomalies in B-physics.
- Our primary motivation is to study the discovery reach of a scalar LQ at the 14 TeV HL-LHC.
- Our objective is to compute the 5σ discovery reach for 2 different LQ for various scenarios and 2 benchmark branching ratios (BR), i.e 100% and 50%.

METHOD

- We introduce simplified Lagrangians of the different scalar LQs that we wish to study.
- The desired decay channel of these LQ are $t\ell$. We alter the couplings in order to obtain the desired benchmark scenarios.
- We generate signal and background process using the event generator Madgraph and shower the events using Pythia. The events are detected using the detector software Delphes. The hadronic tops which are one of our desired signal is reconstructed using a top tagger known as HEPToptagger.
- Applying similar cuts on the signal and background events, we obtain No. of signal and background events N_s and N_{BG} .Using this, we calculate the significance $\mathcal{Z}$.

$$\mathcal{Z} = \sqrt{2(N_s + N_{BG}) \ln\left(\frac{N_s + N_{BG}}{N_{BG}}\right) - 2N_s}$$

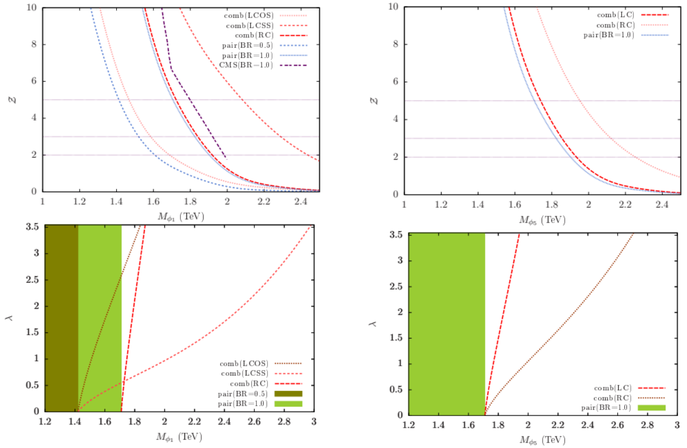
$$\mathcal{L} \supset \lambda_\ell(\sqrt{\eta_L}\bar{t}_L^C \ell_L + \sqrt{\eta_R} t_R^C \ell_R)\phi_1 + \lambda_\nu \bar{b}_L^C \nu_L \phi_1 + H.C$$

$$\mathcal{L} \supset \tilde{\lambda}_\ell(\sqrt{\eta_L}\bar{t}_R \ell_L + \sqrt{\eta_R}\bar{t}_L \ell_R)\phi_5 + H.C$$

$pp \to \phi\phi \to (t\ell)(t\ell)$ Pair Production

$pp \to \phi t\ell \to (t\ell)t\ell$ Single Production

RESULTS



CONCLUSION

- We obtained the 5 σ discovery reach for ϕ_1 in the LCSS scenario as 2.1 TeV at the 14 TeV HL-LHC.
- In the LCSS scenario, the BR for $\phi \to t\ell$ mode is 50% the reach for the pair production is only 1.4 TeV.
- This significant improvement is due to the constructive interference among certain single production diagrams

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