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Two same sign and three lepton final states in four top production at the LHC

The limitations of the standard model (SM) have led the community of particle physics to search for different physics models beyond the SM (BSM). With the discovery of the Higgs boson at the LHC completing the SM of particle physics and its measured properties are compatible with the one predicted by the SM, this does not exclude the possible existence of additional scalar bosons provided their mixing with SM Higgs is small. It has been found that the extension of the 2HDM model with a singlet scalar well describes the multi-lepton anomalies at the LHC, where the mass of heavy scalar $m_H \approx 270$ GeV, the mass of singlet scalar $m_S \approx 150$ GeV. One of those anomalies is the excess production of two same-sign leptons and three isolated leptons in association with b -jets. Both the ATLAS and CMS experiments have reported sustained excesses in these final states. Here, we focus on the CP-odd scalar of the 2HDM+S model which is the heavy pseudoscalar (A) in the mass range 400-600 GeV. The leading decays of the heavy pseudoscalar are $A \rightarrow t\bar{t}, ZH$ producing four top quarks and four lepton final states. We investigate the production of two same-sign and three leptons from the production of four top quark final states. We discuss the differences between the SM and BSM production mechanisms of four top quarks from $t\bar{t}A$ ($A \rightarrow t\bar{t}, ZH$).

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