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Search for direct production of supersymmetric partners of the top quark in the all-jets final state in proton-proton collisions at $\sqrt{s} = 13\,\text{TeV}$

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Abstract: A search for direct production of top squark pairs in events with jets and large transverse momentum imbalance is presented. The data are based on proton-proton collisions at a center-of-mass energy of 13 TeV, collected with the CMS detector in 2016 at the CERN LHC, and correspond to an integrated luminosity of $35.9\,\text{fb}^{-1}$. The search considers a variety of R-parity conserving supersymmetric models, including ones for which the top squark and neutralino masses are nearly degenerate. Specialized jet reconstruction tools are developed to exploit the unique characteristics of the signal topologies. With no significant excess of events observed above the standard model expectations, upper limits are set on the direct top squark pair production cross section in the context of simplified supersymmetric models for various decay hypotheses. Models with larger differences in mass between the top squark and neutralino are probed for masses up to 1040 and 500 GeV, respectively, whereas models with a more compressed mass hierarchy are probed up to 660 and 610 GeV, respectively. The smallest mass difference probed is for masses near to 550 and 540 GeV, respectively.

Keywords: Hadron-Hadron scattering (experiments), Supersymmetry

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In the regions of parameter space where the mass difference between the $\widetilde{\mathrm{t}}_1$ and $\widetilde{\chi}_1^0$ is smaller than the mass of the W boson, we consider four-body decays of top squarks in which top squark masses up to 580 GeV are excluded for a neutralino mass of 540 GeV. An additional decay that is relevant in this parameter space is one in which the top squark decays to a bottom quark and a $\widetilde{\chi}_1^{\pm}$, that then decays to a virtual W boson and a $\widetilde{\chi}_1^0$. Here, top squark masses up to 660 GeV are excluded for a neutralino mass of 610 GeV. Finally, we consider decays through a flavor changing neutral current process where the $\widetilde{\mathrm{t}}_1$ decays to a c quark and a $\widetilde{\chi}_1^0$. In this case, $\widetilde{\mathrm{t}}_1$ and $\widetilde{\chi}_1^0$ masses up to 560 GeV and up to 520 GeV, respectively, are excluded.

In summary, we present a search that takes advantage of a large new set of data collected by the CMS experiment in 2016, as well as a variety of new methods that yield exclusion limits for a wide array of top squark decay modes in planes of $m_{\widetilde{\chi}_1^0}$ versus $m_{\widetilde{\mathrm{t}}_1}$ and $m_{\widetilde{\mathrm{t}}_1} - m_{\widetilde{\chi}_1^0}$ versus $m_{\widetilde{\mathrm{t}}_1}$ that extend significantly beyond those obtained in previous searches.

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