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Search for new physics in same-sign dilepton events in proton–proton collisions at $\sqrt{s} = 13\,\text{TeV}$

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Abstract A search for new physics is performed using events with two isolated same-sign leptons, two or more jets, and missing transverse momentum. The results are based on a sample of proton–proton collisions at a center-of-mass energy of 13 TeV recorded with the CMS detector at the LHC, corresponding to an integrated luminosity of 2.3 fb^{1}. Multiple search regions are defined by classifying events in terms of missing transverse momentum, the scalar sum of jet transverse momenta, the transverse mass associated with a W boson candidate, the number of jets, the number of b quark jets, and the transverse momenta of the leptons in the event. The analysis is sensitive to a wide variety of possible signals beyond the standard model. No excess above the standard model background expectation is observed. Constraints are set on various supersymmetric models, with gluinos and bottom squarks excluded for masses up to 1300 and 680 GeV, respectively, at the 95 % confidence level. Upper limits on the cross sections for the production of two top quark-antiquark pairs (119 fb) and two same-sign top quarks (1.7 pb) are also obtained. Selection efficiencies and model independent limits are provided to allow further interpretations of the results.

1 Introduction

Searches for new physics in final states with two leptons that have same-sign (SS) charges provide a powerful probe for searches of new physics, both because standard model (SM) processes with this signature are few and have low cross sections, and because this signature is produced in a large number of important new-physics scenarios. Examples of the latter include the production of supersymmetric (SUSY) particles [1,2], Majorana neutrinos [3], vector-like quarks [4], and SS top quark pairs [5,6]. In the SUSY framework [7–15], the SS signature can arise through gluino pair production. For example, the Majorana nature of the gluino allows gluino pairs to decay via SS charginos, yielding two SS W bosons. Gluino pair production can also yield four W bosons, e.g., from the decay of four top quarks, which may result in the SS dilepton final state. Alternatively, cascade decays of pair-produced squarks can lead to the SS dilepton signature. Searches for new physics in the SS channel have been previously performed at the CERN LHC by the ATLAS [16–18] and CMS [19–23] Collaborations.

This paper describes a search for new physics in the final state with two or more leptons and including a SS pair ($\mu^{\pm}\mu^{\pm}$, $\mu^{\pm}\text{e}^{\pm}$, or $\text{e}^{\pm}\text{e}^{\pm}$, where μ is a muon and e an electron). The analysis is based on proton–proton (pp) collision data at $\sqrt{s} = 13\,\text{TeV}$, corresponding to an integrated luminosity of $2.3\,\text{fb}^{-1}$ collected with the CMS detector in 2015. The search strategy resembles that used in our analysis of 19.5 fb^{1} of data collected at $\sqrt{s} = 8\,\text{TeV}$ [23], which excluded gluino masses in the four top quark signature up to about 1050 GeV. We design an inclusive analysis sensitive to a wide range of new-physics processes produced via strong interactions and yielding undetected particles in the final state. The interpretations of the results consider R-parity conserving SUSY models [24], as well as cross section limits on the production of two top quark-antiquark ($\text{t}\bar{\text{t}}$) pairs and of two SS top quarks. We also provide model independent limits to allow further interpretations of the results. With respect to Ref. [23], the kinematic regions are redefined and improvements in the event selection are implemented, both of which increase the sensitivity to new-physics scenarios at $\sqrt{s} = 13\,\text{TeV}$.

2 The CMS detector

The central feature of the CMS apparatus is a superconducting solenoid of 6 m internal diameter, providing a magnetic field of 3.8 T. Within the field volume are several particle detection systems. Charged-particle trajectories are measured with silicon pixel and strip trackers, covering $0 \leq \phi < 2\pi$ in azimuth and $|\eta| < 2.5$ in pseudorapidity, where $\eta \equiv -\ln[\tan(\theta/2)]$ and θ is the polar angle of the

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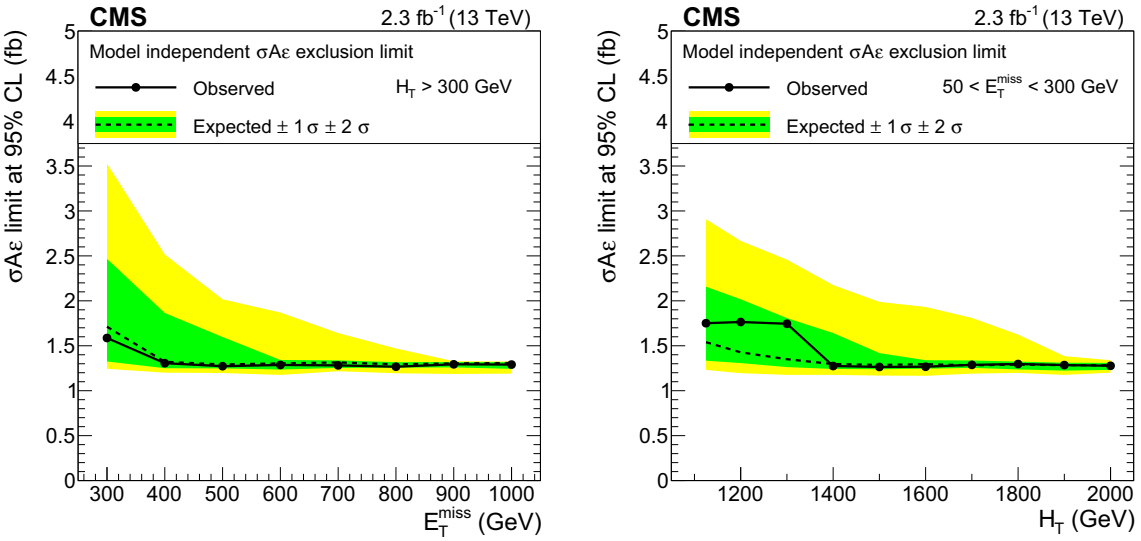

Fig. 8 Limits on the product of cross section, detector acceptance, and selection efficiency, $\sigma\mathcal{A}\epsilon$, for the production of an SS dilepton pair as a function of $E_{\mathrm{T}}^{\mathrm{miss}}$ in HH SR31 (*left*) and of H_{T} in HH SR32 (*right*)

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