Eur. Phys. J. C (2017) 77:710
DOI 10.1140/epjc/s10052-017-5267-x

THE EUROPEAN PHYSICAL JOURNAL C

Regular Article - Experimental Physics

Search for new phenomena with the M_{T2} variable in the all-hadronic final state produced in proton–proton collisions at $\sqrt{s} = 13\,\text{TeV}$

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Received: 12 May 2017 / Accepted: 26 September 2017 / Published online: 26 October 2017

Abstract A search for new phenomena is performed using events with jets and significant transverse momentum imbalance, as inferred through the M_{T2} variable. The results are based on a sample of proton–proton collisions collected in 2016 at a center-of-mass energy of 13 TeV with the CMS detector and corresponding to an integrated luminosity of 35.9 fb^{-1}. No excess event yield is observed above the predicted standard model background, and the results are interpreted as exclusion limits at 95% confidence level on the masses of predicted particles in a variety of simplified models of R-parity conserving supersymmetry. Depending on the details of the model, 95% confidence level lower limits on the gluino (light-flavor squark) masses are placed up to 2025 (1550) GeV. Mass limits as high as 1070 (1175) GeV are set on the masses of top (bottom) squarks. Information is provided to enable re-interpretation of these results, including model-independent limits on the number of non-standard model events for a set of simplified, inclusive search regions.

1 Introduction

We present results of a search for new phenomena in events with jets and significant transverse momentum imbalance in proton–proton collisions at $\sqrt{s} = 13\,\text{TeV}$. Such searches were previously conducted by both the ATLAS [1–5] and CMS [6–9] Collaborations. Our search builds on the work presented in Ref. [6], using improved methods to estimate the background from standard model (SM) processes and a data set corresponding to an integrated luminosity of 35.9 fb^{-1} of pp collisions collected during 2016 with the CMS detector at the CERN LHC. Event counts in bins of the number of jets (N_j), the number of b-tagged jets (N_b), the scalar sum of the transverse momenta p_T of all selected jets (H_T), and the M_{T2} variable [6,10] are compared against estimates of the background from SM processes derived from dedicated data control samples. We observe no evidence for a significant excess above the expected background event yield and interpret the results as exclusion limits at 95% confidence level on the production of pairs of gluinos and squarks using simplified models of supersymmetry (SUSY) [11–18]. Model-independent limits on the number of non-SM events are also provided for a simpler set of inclusive search regions.

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 solenoid volume are a silicon pixel and strip tracker, a lead tungstate crystal electromagnetic calorimeter, and a brass and scintillator hadron calorimeter, each composed of a barrel and two endcap sections. Forward calorimeters extend the pseudorapidity (η) coverage provided by the barrel and endcap detectors. Muons are measured in gas-ionization detectors embedded in the steel flux-return yoke outside the solenoid. The first level of the CMS trigger system, composed of custom hardware processors, uses information from the calorimeters and muon detectors to select the most interesting events in a fixed time interval of less than 4 μs. The high-level trigger processor farm further decreases the event rate from around 100 kHz to less than 1 kHz, before data storage. A more detailed description of the CMS detector and trigger system, together with a definition of the coordinate system used and the relevant kinematic variables, can be found in Refs. [19,20].

3 Event selection and Monte Carlo simulation

Events are processed using the particle-flow (PF) algorithm [21], which is designed to reconstruct and identify all particles using the optimal combination of information

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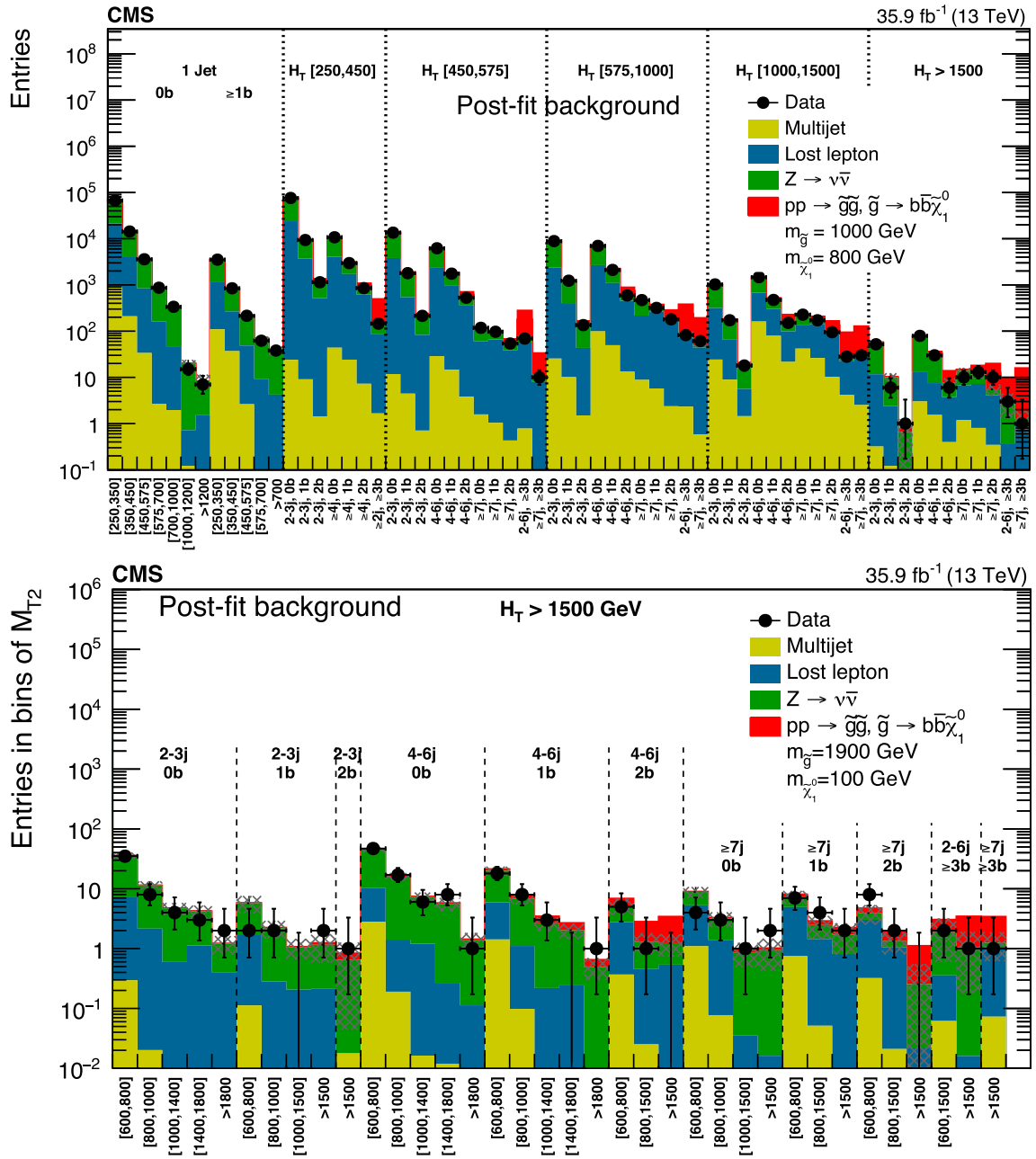

Fig. 14 (Upper) The post-fit background prediction and observed data events in the analysis binning, for all topological regions with the expected yield for the signal model of gluino mediated bottom-squark production ($m_{\tilde{g}} = 1000\,\text{GeV}$, $m_{\tilde{\chi}^0_1} = 800\,\text{GeV}$) stacked on top of the expected background. For the monojet regions, the $p_{\text{T}}^{\text{jet1}}$ binning is in units of GeV. (Lower) Same for the extreme-H_{T} region for the same signal with ($m_{\tilde{g}} = 1900\,\text{GeV}$, $m_{\tilde{\chi}^0_1} = 100\,\text{GeV}$). On the x-axis, the M_{T2} binning is shown in units of GeV. The hatched bands represent the post-fit uncertainty in the background prediction. For the extreme-H_{T} region, the last bin is left empty for visualization purposes

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