Search for Supersymmetry in Final States with a Single Lepton, B-jets and Missing Transverse Energy at CMS

Abstract
Motivated by supersymmetric models with light top and bottom squarks, a search for supersymmetry in final states with a single lepton, b-jets and missing transverse energy is performed. The analysis is based on data recorded at the CMS experiment in proton-proton collisions at a center of mass energy of 7 TeV during 2011, corresponding to an integrated luminosity of 4.96 fb⁻¹. Results are interpreted in the context of the Constrained Minimal Supersymmetric Standard Model and a heavy flavor simplified model.

Supersymmetry
Supersymmetry (SUSY) predicts that for each Standard Model (SM) particle there exists a partner particle (sparticle) with identical gauge quantum numbers, but a spin differing by 1/2. Assuming R-parity conservation, sparticles are produced in pairs and their decay chains terminate with the lightest supersymmetric particle (LSP), which is stable. In several SUSY scenarios top and bottom squarks are lighter than the selectron of the 1st generation, which may result in an excess of events with a large multiplicity of 3rd generation squarks.

Signatures
• Large jet and b-jet multiplicity
• Missing transverse energy from two stable LSPs
• Lepton from leptonically decaying top quark or

Selection Event

Selection criteria | Object definition
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1 lepton | Isolated muon or electron with pT > 20 GeV, |< y |< 3.1 and |< |< 3.5, resp.

Veto on 2nd lepton | Muon or electron fulfilling looser criteria.

2-4 jets | Jets with pT > 40 and |< y |< 4.

EmissT > 375 GeV | Scalar sum of the pT of all selected jets

Selection criteria | Object definition
--- | ---
EmissT > 60 GeV | Vectorial sum of the pT of all particle flow objects

1, 2 or ≥ 3 b-jets | Selected jets with 2 tracks with impact parameter significance ≥ 3.3 (track counting algorithm)

Background Estimation from Data
The main background after the event selection with b-jet requirement originates from tt events. For these Y_{miss,T}, E_{miss,T}, H_T, and H_T are only slightly correlated, which allows one to estimate the background using a factorization method:

- Define signal-enriched region D at large values of Y_{miss,T} and H_T and control regions A, B and C:

  Region | H_T / GeV | Y_{miss,T} / GeV
--- | --- | ---
A | H_T > 650 | Y_{miss,T} > 5.5
B | H_T > 650 | Y_{miss,T} < 5.5
C | H_T > 650 | Y_{miss,T} > 5.5

- Calculate expected number of background events in region D from control regions:
  
  \[ N = N_A \cdot N_B \cdot N_C \to N_D = N_A \cdot N_B \cdot N_C \]

  where the correlation between Y_{miss,T} and H_T is taken into account by the factor \( K = 1.20 \pm 0.04 \) estimated from simulated events.

- Systematic uncertainties on data prediction mostly cancel out (only contributions > 1% given):

  | Uncertainty | Delta (1 b-jet) | Delta (2 b-jets) | Delta (≥ 3 b-jets)
--- | --- | --- | ---
Jet energy scale | ± 2.2% | ± 1.4% | ± 4.0%
Jet energy res. | ± 1.7% | ± 1.8% | ± 5.5%
Lepton pT | ± 3.2% | ± 2.0% | ± 12.2%
Cross-sections | ± 0.8% | ± 0.3% | ± 1.0%

- The correlation between Y_{miss,T} and H_T is cross-checked in data in the exclusive 0 b-jet channel

  → An additional uncertainty of 10% is applied on K

Results
95% CL limits are set upon the parameters of the Constrained Supersymmetric Standard Model (cMSSM) and a heavy flavor simplified model using the CLs technique.

- cMSSM
  - \( \tan \beta \sim 10 \), \( A_L = 0 \) and \( \mu > 0 \)
  - ≥1-bjet

Interpretation

Summary & Outlook
A search for SUSY with light 3rd generation squarks has been performed on data collected by the CMS experiment in proton-proton collisions at a center-of-mass energy of 7 TeV, corresponding to an integrated luminosity of 4.96 fb⁻¹. No deviation from the SM has been found. Limits upon the parameters of the cMSSM and a simplified model have been set.

Defining signal regions at larger values of Y_{miss,T} and H_T might increase the sensitivity of this analysis (work in progress).

Reference: CMS PAS SUS-11-028