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Search for SUSY with a customized top tagger with the CMS experiment

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This proceeding presents a search for direct and gluino-mediated production of supersymmetric scalar top-quark pairs in the all-hadronic final state using top tagging. The result of search is based on a 13 TeV proton-proton sample collected with the CMS detector at the LHC in 2016, corresponding to an integrated luminosity of 36 fb^{-1}. The results of the search are interpreted in several simplified models (SMS).

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1. Introduction

The supersymmetric extension of the standard model is a promising solution for the hierarchy problem in the standard model. The hierarchy problem can be cured with the existence of light higgsino, top squarks, bottom squark or gluino, which can decay into lightest supersymmetric particle (LSP). The LSP can be neutral and stable under R-parity conservation, which provide us a candidate for dark matter. Therefore, supersymmetry represents an exciting theory for us to explore.

A search in missing transverse energy, extended transverse mass, b-jets and top-quarks final state are presented in this proceeding. A customized top-jet tagging algorithm was designed in order to obtain the relatively high efficiency for all relevant values of the top quark transverse momentum.

2. Top tagger and background estimation

A cut-based top jet tagger is applied for the analysis of the 2015 data[1]. The cut-based top jet tagger has a good efficiency over the top quark p_T spectrum. However, the mistag rate, i.e., the rate at which an object that is not a top quark is erroneously tagged as such by the top tagging algorithm, is relatively high with this algorithm. Therefore, we designed a new top tagger, to reduce the mistag rate. The new top tagger[2] has two major upgrades: large R jets are introduced to tag boosted top or W for the mono-jet and di-jet top system, and a random forest[3] based multivariate algorithm is applied for the tri-jet top system. Comparing with the cut-based method, the mistag rate reduced by half with the new tagger.

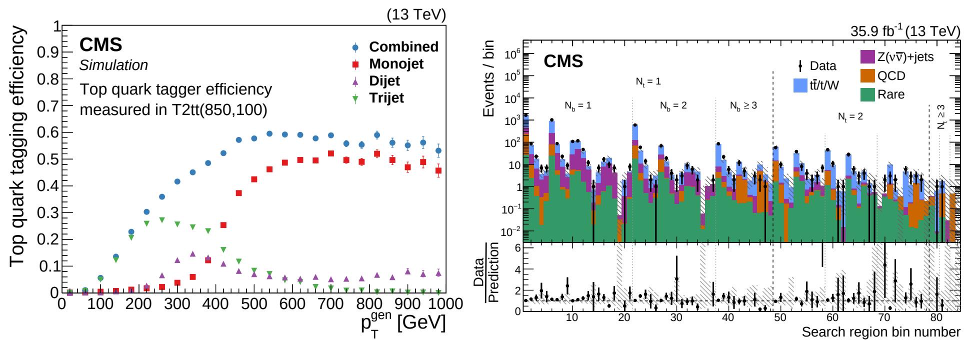

Figure 1: Efficiency of the top quark tagger (left plot) as a function of generator-level top quark p_T for the monojet (red boxes), dijet (magenta upper-triangles), and trijet (green lower-triangles) categories and for their combination (blue circles), as determined using T2tt signal simulation events. The right plot is observed event yields in data (black points) and predicted SM background (filled solid area) for the 84 search bins. The lower panel shows the ratio of data over total background prediction in each search bin.

In this analysis, search region is divided into 84 search bins[4]. The major background in this analysis is events with lepton that misidentified as jet or hadronically decayed τ. The remaining standard model background contributions, like $Z \to \nu\bar{\nu} + jets$, QCD multijets, $t\bar{t}Z$ and other rare processes, also cannot be ignored in some search bins.

The tagging efficiencies and standard model backgrounds predictions are shown in Fig 1.

3. Results

The analysis is interpreted in severl simplified models[5]. T1tttt and T2tt interpretations are presented in Fig 2.

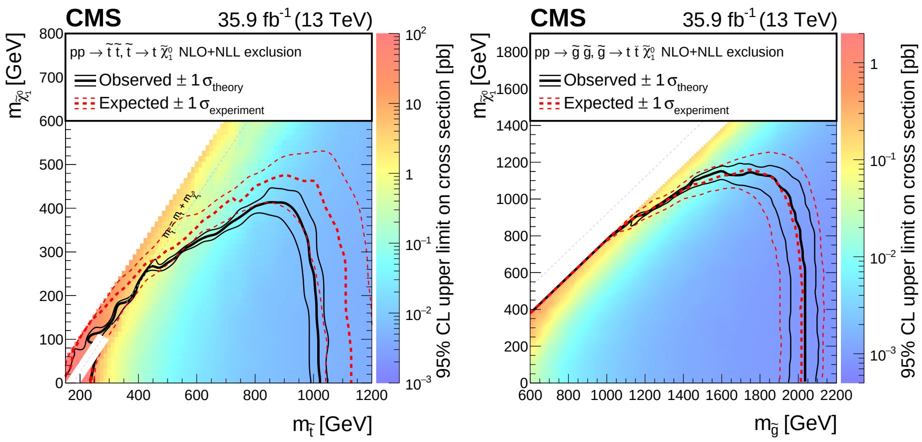

Figure 2: Exclusion limit at 95% CL for the signal models in this search: top squark pair production with the top squark decaying into a top quark and neutralino (T2tt, left), and top squarks from cascade decays of gluinos (T1tttt, right).

No excess of events above the expected standard model background is observed. The result is interpreted in the context of simplified supersymmetric models as 95% confidence level upper limits on the cross section of gluinos and top squarks pair production processes. The T2tt model has been excluded for top squark masses up to 1020 GeV. The corresponding exclusions on the gluino mass are up to 1810-2040 GeV, depending on the type of models. The naturalness[6] of the SUSY MSSM RPC simplified models are under challenge with large 13 TeV data samples now being collected at the LHC.

References

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