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Search for electroweak production of supersymmetric particles in final states with at least two hadronically decaying taus and missing transverse momentum with the ATLAS detector in proton-proton collisions at $\sqrt{s}$ = 8 TeV

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A search for the production of weakly coupled supersymmetric particles decaying into final states with at least two hadronically decaying taus and missing transverse momentum is presented in this poster. The complete 2012 data sample of $\sqrt{s}$ =8 TeV proton-proton collisions is used in the analysis, which was recorded with the ATLAS detector at the CERN Large Hadron Collider corresponding to a total integrated luminosity of 20.7 fb^{-1}. Exclusion limit at 95% confidence level are derived in the context of the phenomenological Minimal Supersymmetric Standard Model and Simplified Model, characterized by the presence of low mass staus.

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1. Introduction

Supersymmetry (SUSY) is one of the most appealing extensions to the Standard Model (SM). Theoretically it can provide a possible solution to the fine tuning problem, and a natural dark matter candidate. In the search presented here, Simplified Models [1] based on $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ production and $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ production, where the charginos and neutralinos decay with 100% branching fraction to final states with (s)taus, are considered. A similar situation may also be realized in the framework of the phenomenological minimal supersymmetric standard model (MSSM), the pMSSM [2], where the dominant electroweak production channels are $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ and $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$.

2. Event Selection

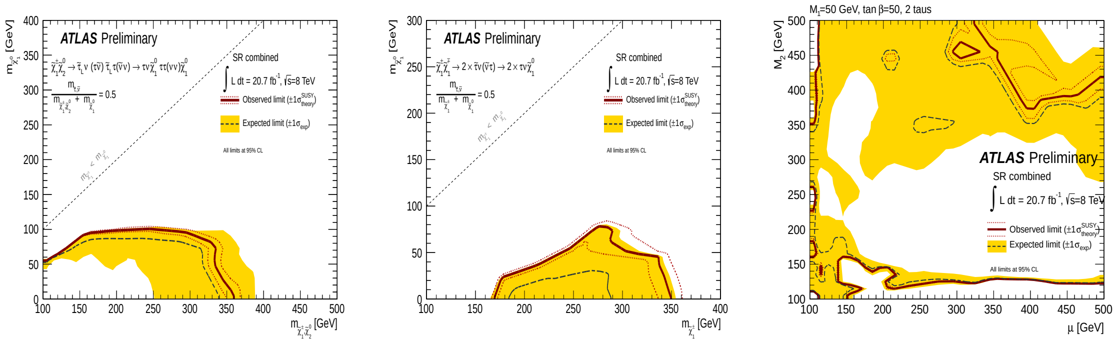
This analysis[3] is focusing on the final states with at least two hadronically decaying taus and missing transverse momentum, using the 8 TeV proton-proton collison data sample recorded with the ATLAS detector at the LHC with a total integrated luminosity of 20.7 fb^{-1}. At least one tau pair is required to have opposite sign (OS). The leading and next to leading taus are required to have p_T higher than 40 GeV and 25 GeV respectively. Each event is required to have a di-tau and/or $E_{\mathrm{T}}^{\mathrm{miss}}$-based trigger fired. Events with at least two taus of medium quality in view of the jet-tau discrimination are selected. Events with at least one opposite sign tau pair, which have a visible invariant mass within 10 GeV of the fitted value of the Z mass (81 GeV, taking into account missing energy caried by neutrinos) are rejected. At tree level, no jet is present in the SUSY processes of interest, however, jets can be generated from initial state radiation (ISR). To reduce backgrounds with top quarks but allow for ISR, either an event-based jet veto, rejecting events containing light central jets, forward jets or b-jets, or a b-jet veto only, rejecting events containing b-jets, is applied.

To further purify the selection of signal events, requirements on $E_{\mathrm{T}}^{\mathrm{miss}}$ and m_{T2} [4] are applied. In events where more than two taus are selected, m_{T2} is computed among all possible OS tau pairs and the largest value is chosen. Two optimized signal regions are defined, referred as OS m_{T2} and OS m_{T2} nobjet :

- **SR OS-m_{T2}**: A jet veto is applied. Events are required to have $E_{\mathrm{T}}^{\mathrm{miss}} > 40$ GeV and $m_{\mathrm{T2}} > 90$ GeV;
- **SR OS-m_{T2}-nobjet**: A b-jet veto is applied. Events are required to have $E_{\mathrm{T}}^{\mathrm{miss}} > 40$ GeV and $m_{\mathrm{T2}} > 100$ GeV.

3. Background Estimation

The main sources of SM background, multi-jet production and W+jets events, where the contribution of jets misreconstructed as taus dominates, are taken from data. The background control regions are selected with the same cuts as the signal region, except that the taus are only required to fullfil the loose tau identification. In addition, taus with tight tau identification are rejected in the control region to reduce the possible signal contamination. The normalization factors are calculated from lower m_{T2} regions. The multi-jet and W+jets background estimation has been validated in the control regions with different background composition.



(a) (b) (c)

Figure 1: 95% CL exclusion limits for Simplified Models with (a) chargino-neutralino, (b) chargino-chargino production, and (c) pMSSM with M_1=50 GeV, tanβ=50 [3]. The SR with the best expected limit at each point is used. The dashed lines show the 95% CL expected limits, including all uncertainties except the theoretical signal cross-section uncertainty (PDF and scale). The solid band around the expected limit shows the $\pm 1\sigma$ result where all uncertainties, except those on the signal cross-sections, are considered. The $\pm 1\sigma$ lines around the observed limit represent the results obtained when moving the nominal signal cross-section up and down by the $\pm 1\sigma$ theoretical SUSY signal uncertainty.

Contributions from real tau background (irreducible background) arise mainly from $t\bar{t}$, single top, $t\bar{t}$+V, Z/γ^*+jets and di-boson (WW, WZ and ZZ) processes and are estimated from simulation. The difference in efficiency of the tau identification and trigger between data and MC has been taken into account for both real and fake taus.

4. Results

No deviation from the Standard Model expectation is observed. Exclusion limits at 95% confidence level are derived in the scenario of the phenomenological Minimal Supersymmetric Standard Model and Simplified Models in figure 1.

For Simplified Models, chargino masses up to 340 GeV are excluded for a massless lightest neutralino assuming they are from decay of direct wino-like chargino pairs via intermediate tau slepton. In the case of pair production of degenerate charginos and next-to-lightest neutralinos, masses up to 330 (300) GeV are excluded for neutralino masses below 50 (100) GeV.

References

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