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Search for supersymmetry in final states with jets, missing transverse momentum and isolated leptons with the ATLAS detector in 5 fb^{-1} of $\sqrt{s}$=8 TeV pp collisions

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Abstract. We present an inclusive search for supersymmetry (SUSY) by the ATLAS experiment at the LHC in proton-proton collisions at a center-of-mass energy $\sqrt{s}$ = 8 TeV in final states with jets, missing transverse momentum and one isolated electron or muon. The search is based on the data from the early 2012 data-taking period, corresponding to an integrated luminosity of 5.8 fb^{-1}. No excess is observed in the data, and limits on supersymmetry are set in the MSUGRA/CMSSM model.

1 Introduction

Supersymmetry (SUSY) is one of the promising theories which propose a solution to the hierarchy problem of the Standard Model (SM) and a natural candidate for dark matter. We search for a SUSY signature in final state with one isolated lepton, multijets, and large missing transverse momentum ($E_{\mathrm{T}}^{\mathrm{miss}}$). A dataset corresponding to 5.8 fb^{-1} recorded by the ATLAS [1] detector at $\sqrt{s}$ =8 TeV at the LHC [2] in early 2012 is used in the analysis.

2 Event selection

As a pre-selection, exactly one isolated electron or muon with p_{T} ≥25 GeV is required. If a second lepton with p_{T} ≥10 GeV exists in the event, the event is vetoed. Since a SUSY particle tends to have a large jet multiplicity because of its long cascade decay chain, at least 4 jets with p_{T} ≥80 GeV are required. This selection also efficiently reduces the background events, especially W+jets production. Further reduction of W+jets and $t\bar{t}$ (semi-leptonic decay) events is obtained by requiring the transverse mass of lepton and missing transverse momentum (m_{T}) to be larger than 100 GeV. R-parity conserving SUSY leads to a stable LSP (lightest SUSY particle) in the final state which escapes the detector without any interaction. Therefore, $E_{\mathrm{T}}^{\mathrm{miss}}$ tends to be larger for the signals. We require $E_{\mathrm{T}}^{\mathrm{miss}}$ ≥250 GeV in the analysis to improve the sensitivity. Since a large jet activity makes the $E_{\mathrm{T}}^{\mathrm{miss}}$ resolution worse, $E_{\mathrm{T}}^{\mathrm{miss}}/m_{\mathrm{eff}} > 0.2$ is applied to keep the discrimination power even in such cases, where m_{eff} is defined as a scalar sum of the transverse momentum of lepton, $E_{\mathrm{T}}^{\mathrm{miss}}$, and jets. Finally, m_{eff} ≥800 GeV is applied to define our Signal Region (SR), reducing the remaining Standard Model (SM) backgrounds, such as $t\bar{t}$ (di-leptonic decay). A further improvement of the sensitivity over a wide range of signal masses is pursued by performing a shape fit of the m_{eff} distribution, dividing m_{eff} into four bins (from 800 GeV to 1600 GeV, with the last bin being inclusive to higher m_{eff} events.)

3 Background estimation

The dominant backgrounds in the SR are W+jets and $t\bar{t}$, which are estimated by Monte Carlo simulation. They are normalized in two dedicated Control Regions (CRs), where the W+jets ($t\bar{t}$) component is enhanced by a looser $E_{\mathrm{T}}^{\mathrm{miss}}$ selection of 100-180 GeV and b-jet veto (tagging), then extrapolated to the SR based on the Monte Carlo shape. Figure 2 shows the m_{eff} distributions in the CRs. Other minor backgrounds are all estimated using Monte Carlo normalized by the nominal cross-sections with the appropriate uncertainties. Multijets background is estimated in a data-driven way.

The Monte Carlo agreement with the data is checked in two ways. First, $E_{\mathrm{T}}^{\mathrm{miss}}$, along which the Monte Carlo shape is extrapolated from CR to SR, is checked with a looser selection. All the other cuts are removed except for the lepton and the jets selections to increase the statistics. As shown in Figure 2, the Monte Carlo describes the $E_{\mathrm{T}}^{\mathrm{miss}}$ shape well within the uncertainty. Second, a validation region is defined near the SR by loosening the $E_{\mathrm{T}}^{\mathrm{miss}}$ selections to 180 GeV-250 GeV and the jet p_{T} thresholds to 40 GeV and the correctness of the extrapolation is checked in this region. The estimated number of events in the validation region is found to be consistent with the data as shown in Table 1.

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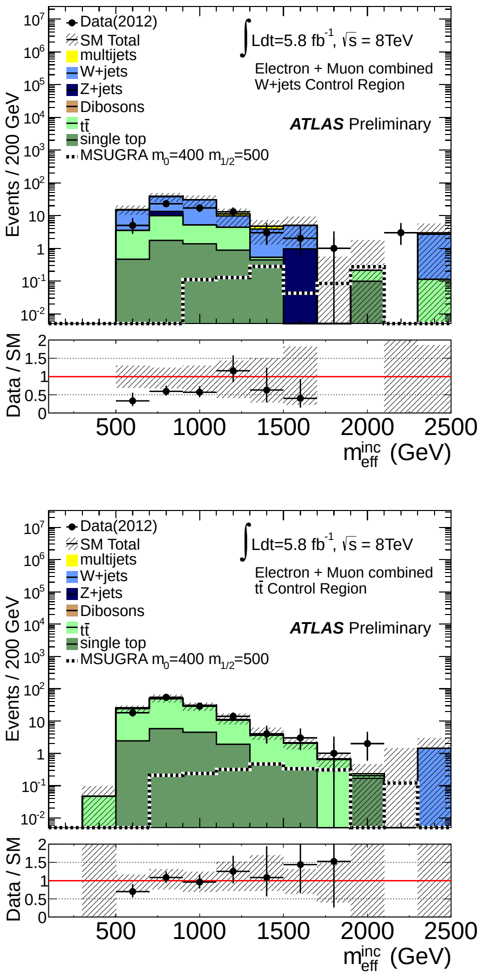

Figure 1. $m_{\rm eff}$ distributions in W+jets control region (top) and $t\bar{t}$ control region (bottom). Electron and muon channels are combined [3].

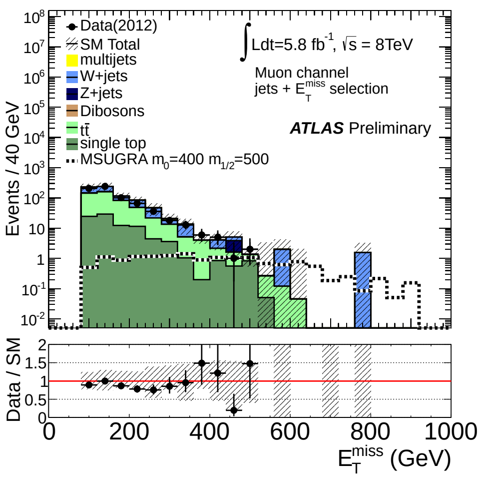

Figure 2. $E_{\rm T}^{\rm miss}$ distribution in a loose region. Only 1-muon and four jets with $p_{\rm T}$ ≥80 GeV are required here [3].

Channel	SM expectation	Observed
Electron	40.0±6.9	32
Muon	40.2±8.2	30

Table 1. The number of events in the validation regions [3].

4 Result and Interpretation

Figure 3 shows the $m_{\rm eff}$ distributions in the SRs for both of the channels. No excess is found in the range where the signal is expected. The integrated numbers of events in $m_{\rm eff}$ ≥800 GeV are summarized in Table 2. We expect 9.0 ± 2.8 and 7.7 ± 3.2 SM events for the electron and muon channels, and consistent numbers of events are observed : 10 and 4 events, respectively.

Since no excess is found, a 95% C.L. exclusion limit is calculated in the MSUGRA/CMSSM model (Figure 4). For $\tan\beta = 10$, $A_0 = 0$ GeV and $\mu > 0$, gluinos with mass below 0.9 TeV are excluded.

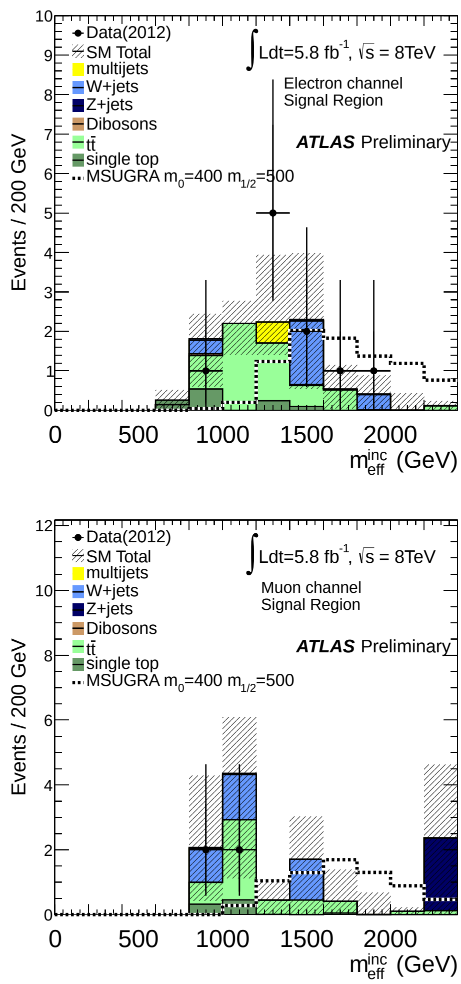

Figure 3. $m_{\rm eff}$ distributions in the SR. Electron (Muon) channel is shown on the top (bottom) [3].

References

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[2] L. Evans and P. Bryant, JINST **3**, S08004 (2008)

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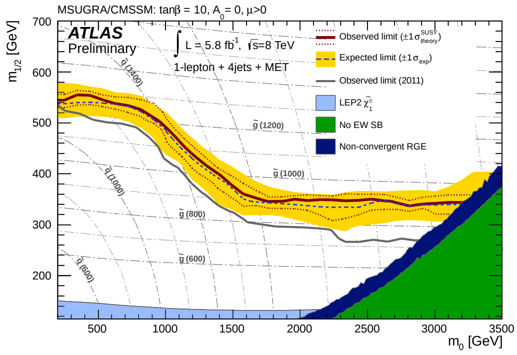

Figure 4. The 95% C.L. exclusion limit on the MSUGRA/CMSSM model [3].

Channel	SM expectation	Observed
Electron	9.0±2.8	10
Muon	7.7±3.2	4

Table 2. The number of events in the signal regions [3].