

Search for SUSY Trilepton Events with ATLAS at the LHC

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The Standard Model (SM), despite all its success, has many drawbacks, amongst them are the hierarchy as well as the naturalness problem. These drawbacks let us think that the SM is not the ultimate theory, but only the low energy approximation of a more fundamental theory. One of the best motivated theory beyond the SM is Super-Symmetry (SUSY). It predicts the existence of a set of new particles associated with each particle of the SM with the same quantum numbers but different spin. In an unbroken SUSY these particles have the same mass as their SM partners; since none of them is observed SUSY must be broken. Many SUSY breaking models have been developed (mSUGRA, GMSB, AMSB...) to explain this breaking.

In the analysis presented below, we have studied the direct production of charginos and neutralinos decaying into a trileptons final state (see figure 1) in the mSUGRA model assuming R-parity conservation with the ATLAS detector at the LHC. The signature looked at is 3 charged leptons¹.

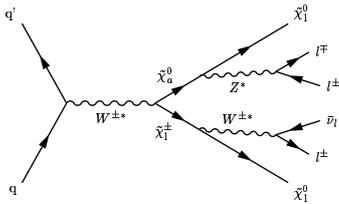


Fig. 1: Direct production of charginos and neutralinos, decaying into a trileptons final state.

This analysis has been performed using the full simulation of the ATLAS detector (using GEANT). For the signal, two points (in the so called bulk and focus point regions [1]) in the mSUGRA parameter space have been chosen in regions in which the lightest supersymmetric particle would be the source of the dark matter (as measured by WMAP).

The major backgrounds have been simulated and are summarised in the following table.

Background	$\sigma \times BR$ (pb)	Nb of simulated events	Event generator
$t\bar{t}$ (not all had.)	461	483 550	MC@NLO/Jimmy
$W^\pm Z$ (lept.)	27	44 000	Herwig
ZZ (lept.)	11	48 050	Herwig
Wt	26.7	72 600	AcerMC

Table 1: List of the different backgrounds for the SUSY trilepton events. The cross-section of these backgrounds, as well as the number of fully simulated events and the Monte Carlo generator used are also indicated.

Concerning the trilepton signature, the study in the bulk region shows that SUSY could be discovered within one year of low luminosity ($10 fb^{-1}$). For the analysis, we only

require 3 charged leptons (either electron or muon with $p_T > 15$ GeV), with amongst them at least one pair of Opposite Sign Same Flavour (OSSF) leptons, whose invariant mass is under 80 GeV. Table 2 summarises the cut flow for $10 fb^{-1}$. $t\bar{t}$ is clearly the main background. After all the cuts a significance (S/\sqrt{B}) of 5.1 is found. As no missing transverse energy² cut is used in this analysis, this search could be performed at the LHC start-up.

Samples	cuts			
	No cuts	Cut1	Cut2	Cut3
Signal (Bulk region)	186 000	3 724	468	300
$t\bar{t}$	4 610 000	67 650	4 754	3 399
Wt	267 000	1 180	18	14
ZZ	20 700	3 106	127	15
WZ	78 300	4 092	517	32

Table 2: Cut flow for signal (Bulk region) and backgrounds for $10 fb^{-1}$. cut1 requires 2 leptons OSSF; cut2 = cut1 \wedge 1 additional charged lepton; cut3 = cut2 \wedge mass cut (< 80 GeV) on the invariant mass of the 2 leptons OSSF.

The situation for the focus point region is much more difficult due to the smaller cross-section and requires further improvements. Various sets of isolation and p_T cuts have been tested, and first results show a significance of about 1.4 for $10 fb^{-1}$ can be obtained. Work is on-going to study the influence of isolation cuts and of jet veto to increase this significance. Trigger effects will have also to be taken into account since the lepton selection efficiency is not uniform versus η and ϕ as seen in figure 2.

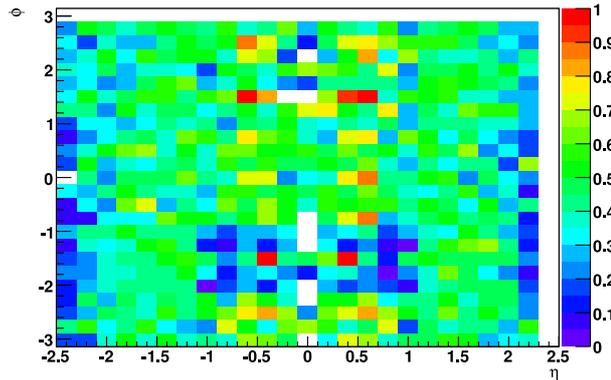


Fig. 2: LV1 trigger efficiency for a given trigger menu (L1.MU40). Cold regions correspond to detector effect (e.g. feet for $-1 < \phi < -2$ and $|\eta| < 1.2$ or services at $\eta=0$.)

References

- [1] H. Baer and C. Balazs, J. Cosmol. Astropart. Phys. **0305** (2003) 006

¹Either electron or muon. Tau is not studied here.

²Missing transverse energy is a quantity hard to compute on hadronic colliders as the LHC. It will need an extensive calibration study.