Search for SUSY Trilepton Events in the Focus Point Region with ATLAS at the LHC

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The following study focuses on the trilepton final state, a signature which is especially important in supersymmetry (SUSY) when squarks are very heavy. This signature arises in particular in the so called Focus Point region of the mSUGRA parameter space, a region which is also allowed by WMAP constraints [1]. The trilepton events can either come from a cascade decay from gluinos or squarks or from direct production of charginos and neutralinos as shown on Figure 1.

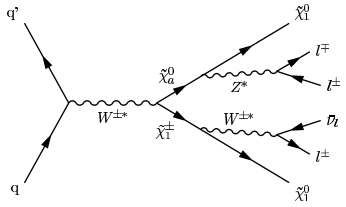

Fig. 1: Direct production of charginos and neutralinos, decaying into a trilepton final state.

This study has been performed using the full simulation of the ATLAS detector (using GEANT). 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.)	450	547 350	MC@NLO/Jimmy
WW (lept.)	40	50 000	Herwig
$W^{\pm}Z$ (lept.)	15.7	47 900	Herwig
ZZ (lept.)	3.8	49 800	Herwig
Zb (lept.)	159	18 900	AcerMC+Pythia
$Z\gamma$ (lept.)	3.3	10 000	Pythia

Table 1: List of the different backgrounds to 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.

A cut based analysis has been performed. To pass the selection, the event must be triggered by either an electron or a muon trigger. The signal is selected by asking for 3 charged leptons (either electron or muon), with amongst them at least one pair of Opposite Sign Same Flavour leptons. The invariant mass of this lepton pair is required to be outside a window of ±10 GeV around the Z mass.

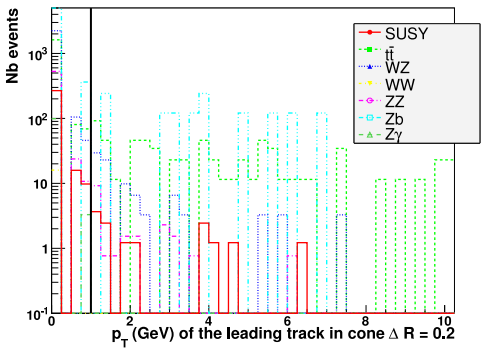

Fig. 2: P_T of the leading track in cone ΔR=0.2 around all muons. The cut applied on this variable is indicated (black line).

Cuts on the missing transverse energy and the track isolation of the leptons (Figure 2) are also made and are very important to get rid of the reducible $t\bar{t}$ and Zb background. Table 2 summarizes the cut flow.

Samples	cuts				
	No cuts	Cut1	Cut2	Cut3	Cut4
SUSY ($\tilde{\chi}_i^0 \tilde{\chi}_j^{\pm}$)	370	264	57	48	31
SUSY (other)	59 772	18 907	140	86	83
$t\bar{t}$	4 510 000	3 482 238	1 710	292	292
WW	400 000	117 112	0	0	0
$W^{\pm}Z$	157 000	58 316	1 252	236	161
ZZ	38 200	20 899	325	28	8
Zb	1 590 000	813 528	4 117	242	0
$Z\gamma$	33 000	12 375	46	3	0

Table 2: Cut flow for signal (SUSY Focus Point) and backgrounds for 10 fb^{-1}. Cut1 = event triggered; Cut2 = Cut1 $\wedge$ 3 leptons ; Cut3 = Cut2 $\wedge$ mass cut on the invariant mass of the 2 leptons OSSF ($|M_{l^+l^-} - M_Z|$ >10 GeV); Cut4 = Cut3 $\wedge$ $\not{E}_T$ >30 GeV. The SUSY signal has been split between neutralinos/charginos contribution and other production mechanisms.

After all these cuts, the main background is $t\bar{t}$. A significance of ∼4.7 can be achieved with 10 fb^{-1} which means one year of low luminosity running. The signal events surviving all the cuts consist mainly in trileptons from cascade decays of gluinos, which have a higher jet activity (see Figure 3), with a substantial fraction (∼27%) also coming from direct neutralinos/charginos production.

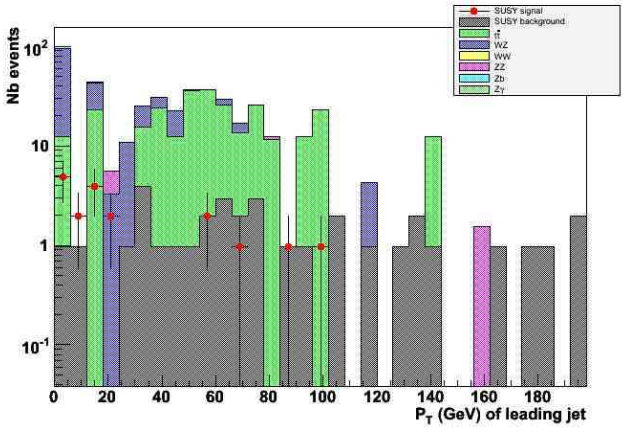

Fig. 3: Leading jet P_T spectrum for SUSY neutralinos/charginos production (red points) and for Standard Model and SUSY backgrounds (plain) after all the cuts.

A jet veto cut ($P_T^{leading\ jet}$ <20 GeV) allows to remove most of the contribution from the cascade decay (6 remaining events) and to select only the charginos/neutralinos (20 events), but the significance drops. Using this additional cut, the main background turns out to be the irreducible WZ process.

References

[1] H. Baer *et al.*, J. Cosmol. Astropart. Phys. **05** (2003) 006