Search for direct top squark pair production in final states with two leptons in pp collisions data collected at 13 TeV centre of mass energy using 3.2 fb^{-1} of ATLAS data [1].

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The top squark can decay into a variety of final states, depending, amongst other factors, on the hierarchy of the mass eigenstates formed from the linear combination of the SUSY partners of the Higgs and the electroweak gauge bosons. IThe relevant mass eigenstates in this analysis are the lightest chargino ($\tilde{\chi}_1^{\pm}$) and the $\tilde{\chi}_1^0$. Previous ATLAS analyses using data at $\sqrt{s} = 7$ TeV and 8 TeV have placed exclusions limits at 95% confidence level (CL) on both the $\tilde{t}_1 \to b + \tilde{\chi}_1^{\pm}$ and $\tilde{t}_1 \to t + \tilde{\chi}_1^0$ decay modes. Limits on top squarks direct production have also been placed by the CMS, CDF and D0 collaborations.

Two possible sets of SUSY mass spectra are considered in this paper, assuming that the mixing of the neutralino gauge eigenstates is such that the $\tilde{\chi}_1^0$ is mostly the supersymmetric partner of the SM boson B (before electroweak symmetry breaking) and taking into account previous experimental constraints from the LEP experiments, from which $m(\tilde{\chi}_1^{\pm}) > 103.5$ GeV is derived.

In both sets of spectra the $\tilde{t}_1$ is the only coloured particle contributing to the production processes.The $\tilde{t}_1$, assumed to be $\tilde{t}_L$, decays via $\tilde{t}_1 \to b + \tilde{\chi}_1^{\pm}$, where $m(\tilde{t_1}) - m(\tilde{\chi}_1^{\pm}) > m(b)$, and the $\tilde{\chi}_1^{\pm}$ (assumed to be mostly the supersymmetric partner of the SM W boson before electroweak symmetry breaking) subsequently decays into the lightest neutralino (assumed to be the LSP) and a real W boson.

The top squarks are pair-produced and, since only the leptonic decay mode of the $W^{(*)}$ is considered, the events are characterised by the presence of two isolated leptons (e, μ) with opposite charge, and two b-quarks. Significant missing transverse momentum $\mathbf{p}_{\mathrm{T}}^{\mathrm{miss}}$, whose magnitude is referred to as E_T^{miss}, is also expected from neutrinos and neutralinos in the final states.

The kinematics of the $\tilde{t}_1 \to b + \tilde{\chi}_1^{\pm}$ decay mode depend upon the mass hierarchy of the $\tilde{t}_1$, $\tilde{\chi}_1^{\pm}$ and $\tilde{\chi}_1^0$ particles. In this document, an analysis [2] targeting the $\tilde{t}_1 \to b + \tilde{\chi}_1^{\pm}$ decay mode with large $m(\tilde{\chi}_1^{\pm}) - m(\tilde{\chi}_1^0)$ is presented, performed using 3.2 fb^{-1} of integrated luminosity from LHC pp collisions at 13 TeV collected by the ATLAS detector [1].

Events are required to contain exactly two opposite charge leptons (OS), with the same flavour (SF, $\mu\mu$ or ee) or with a different flavour (DF, $e\mu$). Events with three or more signal leptons are vetoed.

Then, events of interest are retained if they contain a leading lepton with $p_T > 25\ GeV$ and a second lepton with $p_T > 15\ GeV$.

In case of SF pairs, the dilepton invariant mass m_{ll} is required to be larger than 20 GeV. This is motivated by the lack of MC simulated samples for very low-mass Drell-Yan processes.

The two variables:

- $\mathrm{R_1} = \frac{\mathrm{E_T^{miss}}}{\mathrm{m_{eff}}} = \frac{\mathrm{E_T^{miss}}}{\mathrm{E_T^{miss}} + \mathrm{p_T(l_1)} + \mathrm{p_T(l_2)} + \mathrm{p_T(j_1)} + \mathrm{p_T(j_2)}}$ considering the two jets with highest transverse momentum
- the leptonic stransverse mass, m_{T2}

are finally used for signal from background discrimination (in particular, R_1 is useful to reject diboson events).

The dominant SM background contribution to the SRs is expected to be the diboson production with two leptons and two neutrinos in the final state (called $\ell\ell\nu\nu$). The normalization of the $\ell\ell\nu\nu$ background from the MC simulation to the data in case of SF[1] lepton events is determined using the rate measured in a control region (CR) to extrapolate it to the expected background yield in the SRs. Since the $t\bar{t}$ contribution is a priori relevant in the various fit regions, a dedicated CR for this background is also defined. Other background sources (Wt, Z/γ^*+jets, ttW, ttZ and ttH) which provide a sub-dominant contribution to the SRs are determined from MC simulation only. The fake and non-prompt lepton background consists of semi-leptonic $t\bar{t}$, s-channel and t-channel single top, W+jets and light- and heavy-flavour multijet events. The contribution

[1]In case of DF lepton events the MC simulation has been found in perfect agreement with observations.

Variable	SR definition	
	DF	SF
$m_{\ell\ell}$[GeV]	>20	>20 and <71 or >111
m_{T2}[GeV]	>145	
R_1	>0.3	

Table 1
Signal regions used in the analysis.

from this background is small (less than 10% of the total background). It is estimated with a data-driven method.

Event candidates, with different flavours (DF) or same flavours (SF) leptons, are considered to belong to a signal region (SR) if they pass the requests described in Table 1. No excess of events is observed in data. Limits are set using the confidence level (CL_s) likelihood ratio. Systematic uncertainties are included in the likelihood function as nuisance parameters with a Gaussian probability density function. All uncertainties previously described are taken into account, as well as those due to the detector response and the integrated luminosity. For each signal hypothesis, the fit of the top pair and boson pair normalisation is re-done taking into account the signal contamination in the control regions. The results obtained are used to derive limits on the mass of a pair-produced $\tilde{t}_1$ decaying with 100% branching ratio into the lightest chargino and a b-quark. For each point the SR giving the best expected sensitivity is used to set the limits. The sensitivity of this search depends on three parameters, namely the top squark, lightest chargino and neutralino masses. Two-dimentional slices of these parameters are made to derive the exclusion limits: in the $\tilde{t}_1$-$\tilde{\chi}_1^0$ mass plane for a fixed value of $m(\tilde{t}_1) - m(\tilde{\chi}_1^{\pm}) = 10\ GeV$ (Fig. 1) and in the $\tilde{t}_1$-$\tilde{\chi}_1^0$ mass plane for $m(\tilde{\chi}_1^{\pm}) = 2m(\tilde{\chi}_1^0)$ (Fig. 2). Top squark masses up to 570 GeV are excluded at 95% CL for a massless neutralino and a chargino approximately degenerate with the top squark.

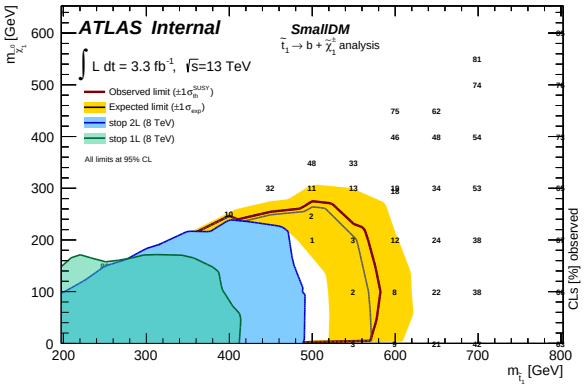

Figure 1. Exclusion limits at 95% CL from the analysis of 3.2 fb^{-1} of 13 TeV collision data on the masses of the stop and $\tilde{\chi}_1^0$, for a fixed $m(\tilde{t}_1) - m(\tilde{\chi}_1^{\pm}) = 10\ GeV$ and assuming BR($\tilde{t} \to \tilde{\chi}_1^{\pm} b$) = 1. The dashed line and the shaded band are the expected limit and its $\pm 1\sigma$ uncertainty, respectively. The thick solid line is the observed limit for the central value of the signal cross section. The expected and observed limits do not include the effect of the theoretical uncertainties on the signal cross section. The dotted lines show the effect on the observed limit when varying the signal cross section by $\pm 1\sigma$ of the theoretical uncertainty. The expected limit from the previous preliminary search in the two-lepton (2L) channel is also reported.

REFERENCES

1. ATLAS Collaboration, JINST 3 S08003 (2008) 1-407
2. M. Aliev et al., Search for top squark pair production in final states with two leptons, ATL-COM-PHYS-2015-325(2016)

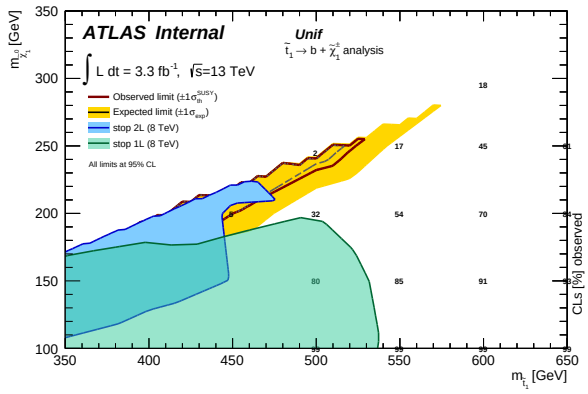

Figure 2. Exclusion limits at 95% CL from the analysis of 3.2 fb^{-1} of 13 TeV collision data on the masses of the stop and neutralino, for $m(\tilde{\chi}_1^{\pm}) = 2m(\tilde{\chi}_1^0)$ and assuming BR$(\tilde{t} \to \tilde{\chi}_1^{\pm} b) = 1$. The dashed line and the shaded band are the expected limit and its $\pm 1\sigma$ uncertainty, respectively. The thick solid line is the observed limit for the central value of the signal cross section. The expected and observed limits do not include the effect of the theoretical uncertainties on the signal cross section. The dotted lines show the effect on the observed limit when varying the signal cross section by $\pm 1\sigma$ of the theoretical uncertainty. The limit from the preliminary search in the one-lepton (1L) channel and from the published 7 TeV searches are also reported.