Search for Supersymmetry in events with large missing transverse momentum and two leptons in pp collisions at 7 TeV with the ATLAS detector

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In 2010, the Large Hadron Collider (LHC) at CERN opened up a new regime for probing physics beyond the Standard Model. The search for various manifestations of SUperSYmmetry (SUSY) is one of the main tasks of the ATLAS experiment [1] at the LHC. The production of SUSY particles at the LHC can be probed by searching for events with large missing transverse momentum, $E_T^{\rm miss}$, generated by the Lightest Supersymmetric Particle (LSP), the invisible decay product in R-parity conserving SUSY models, and two leptons produced in chargino or neutralino decays [2–10]. Standard Model (SM) processes with two leptons in the final state include W and Z decays, fake leptons from jet misidentification and non-isolated leptons from heavy flavour decays.

The full data sample collected in 2010 by the ATLAS experiment in LHC proton-proton collisions at a center-of-mass energy of 7 TeV, corresponding to an integrated luminosity of 35 pb^{-1} after the application of basic data quality requirements, has been analyzed. Single leptons triggers (e or μ) have been used. Events containing exactly two well reconstructed and isolated electrons or muons with transverse momentum $p_T > 20$ GeV have been selected. Requiring two isolated leptons helps to suppress the QCD multijet production. The detailed analysis of collider and simulated data can be found in [11, 12]. Three analysis were performed, looking for an excess of events with opposite sign (OS), same sign (SS), or same flavour over different flavour (OSSF) leptons, with respect to SM predictions. The signal regions are defined by requiring $E_T^{\rm miss} > 150$ GeV for the OS analysis, and $E_T^{\rm miss} > 100$ GeV for the SS and OSSF analyses. The main SM backgrounds in the signal regions are $t\bar{t}$ production for the OS and OSSF channels, and fake or non-isolated leptons for the SS channel. In addition, there are contributions from Z+jets, di-boson and single-top production. The contributions from the main SM processes, $t\bar{t}$, fake leptons and Z+jets production have been estimated with data driven techniques. The number of observed events in all three analyses has been found in agreement with the SM predictions (see table 1).

Using the observed numbers of events and background expectations in the signal regions, upper limits at 95% confidence level on the cross section times branching ratio times acceptance times efficiency of 0.07 pb (SS channel), 0.09 pb (e^+e^-), 0.21

	OS			OSSF		
	$e^{\pm}e^{\mp}$	$e^{\pm}\mu^{\mp}$	$\mu^{\pm}\mu^{\mp}$	$e^{\pm}e^{\mp}$	$e^{\pm}\mu^{\mp}$	$\mu^{\pm}\mu^{\mp}$
Data	1	4	4	4	13	13
Total SM	$0.92^{+0.42}_{-0.40}$	$1.43^{+1.45}_{-0.59}$	$1.39^{+1.41}_{-0.53}$	3.64 ± 1.24	8.08 ± 2.78	6.91 ± 2.20

	SS		
	$e^{\pm}e^{\pm}$	$e^{\pm}\mu^{\pm}$	$\mu^{\pm}\mu^{\pm}$
Data	0	0	0
Total SM	0.15 ±0.13	$0.09^{+1.17}_{-0.3}$	0.04 ±0.01

Table 1: Total number of observed events and SM expectations in the OS, OSSF, and SS signal regions.

pb ($\mu^+\mu^-$) and 0.22 pb ($e^{\pm}\mu^{\mp}$) have been set to contributions from beyond the SM physics. The results can also be interpreted within the 24-parameter Minimal Supersymmetric Standard Model (MSSM) framework [13]. The 24-parameter MSSM is a generic MSSM on which flavour and CP violation have been imposed. Two grids in the squark and gluino mass plane have been studied: one with a compressed spectrum producing soft final state kinematics, and one with a very light LSP, resulting in harder leptons, jets and E_T^{miss} spectra. For the considered models the lower limits on the squark mass for the compressed spectrum (light neutralino) scenarios are 450 (550) GeV and 590 (690) GeV for the OS and SS analysis, respectively. With the flavour subtraction analysis, the 95% confidence lower limit on the squark mass is 503 GeV for compressed spectrum models, and 558 GeV for light neutralino models.

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