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A search for supersymmetric particles in events with two leptons and E_T^{miss} with the ATLAS experiment at the LHC

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Summary. — The signature characterized by 2 leptons and missing energy offers a very promising venue for the discovery and measurement of Supersymmetry signals at the LHC. The results on the search for this signature, performed with the data collected in 2010 by the ATLAS experiment, are presented.

PACS 12.60.Jv – Supersymmetric models.

1. – Description

In this article, the first results of searches for the production of Supersymmetric (SUSY) particles at ATLAS in final states with two leptons and missing transverse energy E_T^{miss} are presented. The full 2010 ATLAS pp dataset, collected at the LHC at $\sqrt{s} = 7\,\mathrm{TeV}$ and corresponding to an integrated luminosity of $35\,\mathrm{pb}^{-1}$, is used in this analysis [1]. According to SUSY theories, leptons are produced through the decays of charginos and neutralinos into W and Z bosons, and into real or virtual sleptons (the SUSY partners of leptons) if their masses are light enough. The main sources of leptons in Standard Model (SM) events are W, $t\bar{t}$ and Z decays, fake leptons from misidentification of jets and non-isolated leptons from heavy flavour decays. Two search strategies, requiring two isolated leptons with electric charge of the same sign (SS) or of opposite sign (OS), are described. The signal region (SR) for OS (SS) events is defined by the requirement $E_T^{miss} > 150\,\mathrm{GeV}$ ($100\,\mathrm{GeV}$), chosen through optimization of the expected signal significance for a selection of SUSY models.

The main SM background for the SS analysis arises from SM processes generating events containing at least one fake or non-isolated lepton. These processes mainly consist of $t\bar{t}$, single-top, W+jets and QCD light and heavy flavour jet production. This background is estimated from data using a matrix method [2] which allows to determine the numbers of events containing fake-fake, fake-real, real-fake and real-real lepton pairs.

The number of $t\bar{t}$ events in the OS signal region (SR) is obtained by multiplying the observed number of $t\bar{t}$ events in an appropriately defined control region (CR) by a factor $F(\mathrm{CR} \to \mathrm{SR})$, defined as the ratio between the number of $t\bar{t}$ MC events in the SR and

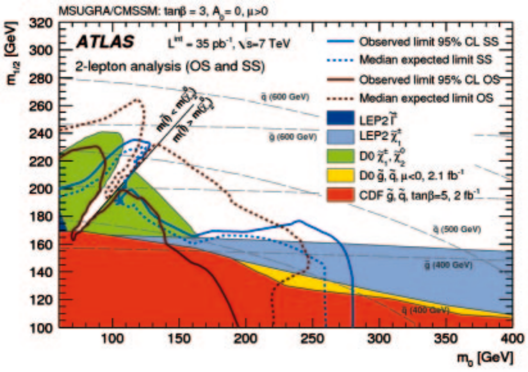

Fig. 1. – Exclusion in the mSUGRA/CMSSM $(m_{\tilde{q}}, m_{\tilde{g}})$ plane for $\tan\beta = 3$, $A_0 = 0$ and $\mu > 0$, together with existing limits [4]. Note: the illustrated D0 limit assumes $\mu < 0$. The expected (dashed line) and observed (full line) 95% C.L. exclusion limits are shown for the opposite sign (black line) and for the same-sign (blue line) analysis.

the number of $t\bar{t}$ MC events in the CR. A partially data-driven approach is adopted to estimate the contribution from Z production in the $\ell^+\ell^-$ channels of the OS analysis.

The expected total number of SM events in the SR is 0.28 ± 0.14 for the SS analysis compared with zero events observed in the data, and 3.7 ± 1.6 for the OS analysis compared with 9 events observed in the data. So for the SS channel the background expectations are in agreement with the observation, while in the OS analysis the number of observed events is larger but in reasonable agreement with the background expectation: the probability of the background to exceed the number of observed events is 12.8%.

The limits and the exclusion p-values on the contributions from new physics are then derived from an appropriate profile likelihood ratio $\Lambda(s)$, generating pseudo-experiments with test statistic $\Lambda(s)$ and one-sided upper limits are set [3]. Using the observed numbers of data events and background expectations in the SR, 95% confidence upper limits on the *effective* cross sections (cross section $\times$ branching ratio $\times$ acceptance) are obtained for new physics processes producing lepton pairs and E_T^{miss}: 0.07 pb for SS channels, 0.09 pb for e^+e^- channel, 0.21 pb for $\mu^+\mu^-$ channel and 0.22 pb for $e^\pm\mu^\mp$ channel. These results are interpreted as limits in the supersymmetric parameter space. *E.g.*, in fig. 1 the limits on the $(m_{\tilde{g}}, m_{\tilde{q}})$ plane (masses of gluino and squark, super-partners of gluon and quark respectively) are shown. Depending on model assumptions, limits are placed on the squark mass between 450 and 690 GeV for squarks approximately degenerate in mass with gluino, extending the coverage of previous experiments [4].

In conclusion, the observed numbers of events in the signal regions of all the analysis are compatible with Standard Model expectations and so, for the moment, no clue of new physics has been found.

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