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Search for supersymmetric scalar leptons at the LHC Run 2 with the ATLAS detector

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Summary. — Here we present an analysis of the progress on the data collected by the ATLAS detector at the LHC collider at $\sqrt{s} = 13\,\text{TeV}$. The goal is to observe supersymmetric particles and, in particular, the direct pair production of scalar leptons. The scalar leptons decay into leptons and neutralinos. The final state contains two leptons, no hadronic activity and a large missing transverse momentum.

1. – Scalar leptons

An analysis in progress on the search for supersymmetric scalar leptons (or sleptons) is presented. The analysis is based on data collected by the ATLAS detector [1] and produced by the LHC collider with $\sqrt{s} = 13\,\text{TeV}$, during 2015 and 2016.

The Standard Model (SM) does not provide an explanation to many issues, like the dark matter nature and the Higgs boson hierarchy problem. Supersymmetry (SUSY) is a SM extension that provides a solution to these problems by introducing supersymmetric partners of the known particles. The production of supersymmetric particles depends on the type of interaction involved and on the masses of the particles themselves. Squarks and gluinos would be produced in strong interactions with significantly larger production cross-sections than sleptons. The direct electroweak production can dominate SUSY production at the LHC if the masses of the gluinos and the squarks are significantly larger. The current exclusion limits on squark and gluinos masses extend to up to approximately 2 TeV, making electroweak production an increasingly promising probe for SUSY signals at the LHC.

Sleptons direct pair production is considered, with the following decay:

$$\tilde{\ell}^{\pm}\tilde{\ell}^{\mp} \to \ell^{\pm}\tilde{\chi}^0\ell^{\mp}\tilde{\chi}^0,$$

where the neutralino ($\tilde{\chi}^0$) is a supersymmetric particle. The final state consists of two opposite sign leptons (electrons or muons), no hadronic activity and missing transverse momentum from the neutralinos (it is a weakly interacting stable particle so it escapes the detector).

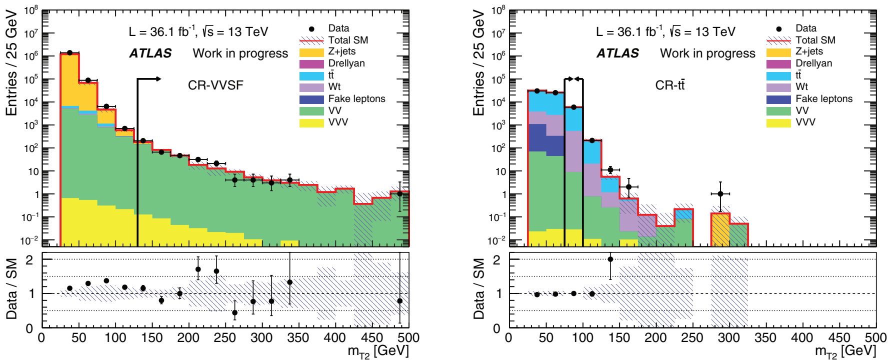

Fig. 1. – Data and estimated backgrounds for the m_{T2} variable in the same flavor diboson (left) and top-antitop (right) control regions.

2. – Analysis strategy

The analysis strategy is similar to the analysis performed during the LHC Run 1 [2], excluding sleptons with a mass up to $m(\tilde{\ell}) = 330\,\mathrm{GeV}$. With the new collected data, it is possible to have a large improvement of this result.

Many SM processes have the same final state of the signal, so the presence of a new particle is expected to be an excess of events over the background. The main contribution comes from the WW and ZZ events (diboson). The analysis is performed selecting a kinematic region optimized to have a good signal/background ratio (signal region).

The key discriminating variable for this analysis is the *stransverse* mass (m_{T2}) [3]. The end-point of the m_{T2} variable is limited from above by the mass of the parent particle: the distribution for diboson events is limited by the W mass, while the sleptons are expected to have a larger mass. So at high m_{T2} value ($m_{\mathrm{T2}} > 100\,\mathrm{GeV}$), a good signal over background ratio is expected. In order to improve the discrimination, a selection on the leptons invariant mass is also applied ($m_{\ell\ell} > 111\,\mathrm{GeV}$).

The signal is expected to have a small cross section, so a precise background estimation is required. Dedicated control regions (CR) have been selected to normalize the main background contributions (diboson, with same or different flavor leptons, and top-antitop processes) to data, in a simultaneous fit. To avoid an overlap with the signal region, $m_{\mathrm{T2}} < 100\,\mathrm{GeV}$ or $m_{\ell\ell} < 111\,\mathrm{GeV}$ is required for the control regions. The m_{T2} distribution in the same flavor diboson and top-antitop CR are reported in fig. 1.

3. – Conclusion

An analysis in progress for the search of sleptons in Run 2 has been presented. The analysis is well advanced and will provide a large improvement over Run 1 results.

REFERENCES

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