IL NUOVO CIMENTO **40 C** (2017) 26
DOI 10.1393/ncc/i2017-17026-5

Colloquia: IFAE 2016

Search for top squark with two leptons in the final state at LHC Run 2 with the ATLAS detector

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received 17 October 2016

Summary. — An analysis in progress on the data collected by the ATLAS detector at the LHC collider at $\sqrt{\mathrm{s}} = 13\,\mathrm{TeV}$ is presented. The goal is to observe supersymmetric particles and, in particular, the pair production of top squarks. The decay considered is top squark into chargino and b quark, followed by the decay of chargino into W boson and neutralino. Considering only the W leptonic decay, the final state contains two leptons, two b-jets and large missing transverse momentum.

1. – Squark top

In this proceeding, an analysis in progress on the search for the top squark is presented. The analysis is based on the data collected by the ATLAS detector [1] and produced by the LHC collider with $\sqrt{\mathrm{s}} = 13\,\mathrm{TeV}$, during the 2015 data taking.

Standard Model (SM) is not a complete theory, because it does not provide an explanation to many issues, like the dark matter nature and Higgs boson hierachy problem. Supersymmetry (SUSY) is a SM extension, that provides a solution to these problems by introducing supersymmetric partners of the known particles. With regard to the Higgs hierachy problem, the largest cotribution to the Higgs mass running is due to the top-quark coupling. Therefore the top supersymmetric partner (top squark, $\tilde{t}$) play the role to compensate the top contribution attenuating this effect.

Top squark pair production is considered. The top squark then decays into

$$\tilde{t} \to \tilde{\chi}^{\pm} + b \to W^{\pm} + \tilde{\chi}^0 + b \to l + \nu_l + \tilde{\chi}^0 + b,$$

where the chargino ($\tilde{\chi}^{\pm}$) and the neutralino ($\tilde{\chi}^0$) are supersymmetric particles. Only $W^{\pm}$ decaying into electron or muon and neutrino is considered. Therefore the final state consists of 2 opposite sign leptons, 2 b-jets and missing transverse momentum from 2 neutrinos and 2 neutralinos (it is supposed to be a weakly interacting stable particle so it escapes the detector).

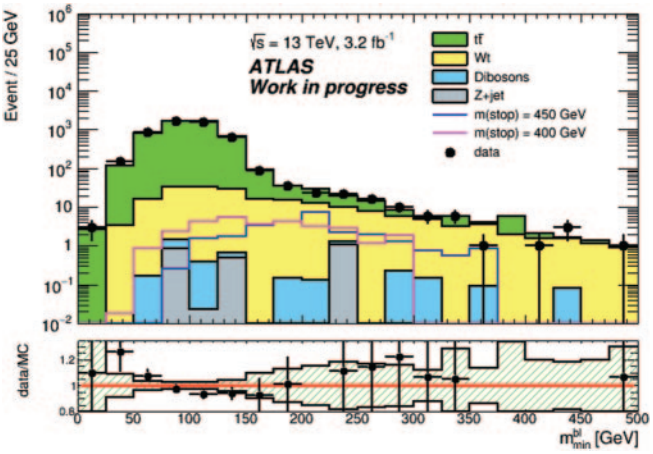

Fig. 1. – Data and estimated backgrounds for $m_{\text{min}}^{\text{bl}}$ for the control regions selection.

2. – Analysis strategy

A similar analysis has already been performed during the LHC Run 1 [2], giving an exclusion region around $m(\tilde{t}) = 300\,\text{GeV}$. With the new collected data, it is possible to improve this result.

Many SM processes have the same final state so the presence of a new particle is expected to be an excess of events over the background. The main contributions come from top-antitop and single-top events. 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 hadronic *stransverse* mass, defined as

$$m_{\text{T2}}^{\text{2bjet}} = \min_{\text{q}_{\text{T}}^{(1)}+\text{q}_{\text{T}}^{(2)}=\text{p}_{\text{T}}^{\text{miss}}} \left\{ \max \left[M_{\text{T}}^{2}\left(p_{\text{T}}^{\text{b-jet1}}, \text{q}_{\text{T}}^{(1)}\right), M_{\text{T}}^{2}\left(p_{\text{T}}^{\text{b-jet2}}, \text{q}_{\text{T}}^{(2)}\right) \right] \right\}.$$

The end-point of the $m_{\text{T2}}^{\text{2bjet}}$ variable is limited by the mass of the parent particle: the distribution for top-antitop events is limited by the top mass, while the top squark is expected to have a larger mass. So at high $m_{\text{T2}}^{\text{2bjet}}$ value ($m_{\text{T2}}^{\text{2bjet}} > 220\,\text{GeV}$), a good significance is expected.

The signal is expected to have a small cross section, so a precise background estimation is required. Dedicated control regions have been selected for the two background contributions in order to check the compatibility between data and Monte Carlo simulations. To avoid an overlap with the signal region, $m_{\text{T2}}^{\text{2bjet}} < 180\,\text{GeV}$ is required for both control regions. Then, to separate top-antitop from single-top events, the minimum invariant mass selected between the possible b-jet and lepton combination ($m_{\text{min}}^{\text{bl}}$) is used. Observing the $m_{\text{min}}^{\text{bl}}$ distribution (fig. 1), $m_{\text{min}}^{\text{bl}} < 170$ GeV is choosen to select the top-antitop control region, while $m_{\text{min}}^{\text{bl}} > 170$ to select the single top control region. The expected signal contamination in the two regions is, respectively, about 1% and 5%.

3. – Conclusion

The analysis is performed using 2015 data, but it will be extended to 2016 data as soon as they are available. With these new data, an improvement over the Run 1 results will be possible.

REFERENCES

[1] ATLAS Collaboration, *JINST*, **3** (2008) S08003.
[2] ATLAS Collaboration, *JHEP*, **06** (2014) 124.