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Measurement of the differential cross section of the production of pairs of top quarks with the ATLAS experiment at the LHC

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Summary. — The current status of the measurements of the top-antitop ($t\bar{t}$) differential cross section with respect to the $t\bar{t}$ system transverse momentum (p_T) is presented. The used data sample of 4.7 fb^{-1} is recorded with the ATLAS detector at the Large Hadron Collider.

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1. – Introduction

The *top* quark (t) is the most massive known particle. Its high mass suggests strong connections with the spontaneous electroweak symmetry breaking mechanism and with exotic processes. The inclusive $t\bar{t}$ cross section in proton-proton collision with $\sqrt{s} = 7$ TeV has been measured with increasing precision by both ATLAS [1] and CMS [2] and the results are in good agreement with the theoretical Standard Model predictions obtained through approximate Next to Next Leading Order (aNNLO) [3].

In this paper, we will present the current status of the analysis on the *differential* cross section of the production of $t\bar{t}$ pairs, as a function of the transverse momentum (p_T). The topology of the events under study is the "semi-leptonic channel". This final state consists of 4 quarks, one lepton (electron or muon) and a neutrino.

2. – Description of the analysis

Data from LHC pp collisions collected by the ATLAS detector during the 2011 are used in the analysis, corresponding to an integrated luminosity of 4.7 fb^{-1}. A detailed description of the detector can be found in [4].

Simulated top quark pair events are generated using the MC@NLO Monte Carlo generator normalized to a cross section of 164.4 pb from aNNLO calculations. Parton

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showering and underlying events are modelled using HERWIG and JIMMY, respectively. Single-top events are also generated using MC@NLO while the production of W/Z bosons in association with jets is simulated using the ALPGEN generator interfaced to HERWIG and JIMMY. In the case of the W + jets sample, the overall normalization is evaluated using a data-driven method. Diboson events (WW, WZ and ZZ) are generated using HERWIG. The QCD multijet background is estimated using the data-driven *matrix method*.

To select events with the semi-leptonic topology, the appropriate single-electron or single-muon trigger is required. The events are also required to contain exactly on reconstructed high-p_T lepton.

To reject QCD multijet background, cuts on the E_T^{miss} and the W transverse mass are applied. Events are required to have at least four high-p_T jets, of which at least one identified as a b-jet. Further details on the used samples and the event selection can be found in [1].

The top and antitop four-vectors are reconstructed using a kinematic likelihood fit [5]. The likelihood takes as inputs the measured energies of four jets, the measured energy of the lepton, and the missing p_T. If there are more than four high-p_T jets in the event, all the combinations of four jets from the five jets in the event with highest p_T are considered. The combination of four jets, E_T^{miss} and lepton that maximises the likelihood is considered the reconstructed final state object.

Finally, unfolding methods are used to correct the final, background subtracted, distributions for the detector effects and selection efficiencies in order to compare the results to the theoretical predictions. The $t\bar{t}$ cross section σ_j, in a particular bin j of the variable of interest, is given by

$$N_i = M_{ij} A_j \sigma_j \mathcal{L} + B_i. \tag{1}$$

The "matrix inversion" unfolding method calculates the cross section in the j bin by inverting (1).

The current main sources of uncertainty come from systematic effects, particularly from the jet energy scale. The propagation of the various systematic uncertainties to the final result are assessed by re-running the analysis varying in turn each systematic effect by one standard deviation (up and down) and adding them in quadrature, assuming their independence.

3. – Conclusions

At the moment we are analyzing all the data collected by ATLAS in the 2011 and we observe a good agreement betweend data and MC at the level of the reconstructed objects, which are inputs for the kinematic fit that allows the reconstruction of the $t\bar{t}$ system. In order to make direct comparisons with the theoretical distributions, the differential distributions must be corrected for detector and selection effects.

REFERENCES

[1] The ATLAS Collaboration, *Phys. Lett. B*, **711** (2012) 244.
[2] The CMS Collaboration, *Phys. Rev. D*, **85** (2011) 092004.
[3] Aliev M. *et al.*, *Comput. Phys. Commun.*, **182** (2011) 1034.
[4] The ATLAS Collaboration, *JINST*, **3** (2008) S0803.
[5] The ATLAS Collaboration, *Eur. Phys. J. C*, **72** (2012) 2039.