PROCEEDINGS OF SCIENCE

Measurement of the top quark cross-section in the single-lepton channel in pp collisions at $\sqrt{s} = 7$ TeV using kinematic fits and b-tagging information with the ATLAS Experiment

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The measurement of the $t\bar{t}$ production cross-section in the single-lepton channel in pp collisions at a centre-of-mass energy $\sqrt{s}$ =7 TeV is presented. The analysis is based on a multivariate discriminant distribution in 3, 4 and $\geq$ 5 jet bins using three kinematic variables and b-tagging information. With a data sample of about 35 pb^{-1} recorded by ATLAS in 2010 the inclusive top quark production cross-section is measured to be $\sigma_{t\bar{t}}$ = 186 $\pm$ 10 (stat.)$^{+21}_{-20}$ (syst.) $\pm$ 6 (lumi.) pb. Combination with the dilepton analysis without b-tagging using a dataset of 690 pb^{-1} results in a total uncertainty of 7%. Both measurements are in agreement with theory predictions.

The 2011 Europhysics Conference on High Energy Physics-HEP 2011,
July 21-27, 2011
Grenoble, Rhône-Alpes France

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ATL-PHYS-PROC-2011-217
02 November 2011

PoS(EPS-HEP2011)468

1. Introduction

Measuring the top quark pair production cross-section is a very good test of perturbative QCD in the Standard Model, whose predictions for $\sigma_{t\bar{t}}$ now have uncertainties at the level of 10% [1]. Furthermore, top quark events are the dominant background to some Higgs scenarios and searches for New Physics. This measurement is based on the excellent ATLAS capabilities for tracking, tagging and energy deposition measurements [2].

Top quarks do not hadronise but decay almost exclusively via a b-quark and a W-boson. The so-called semi-leptonic channel, in which one W-boson decays hadronically and the other one leptonically, shows best overall performance between statistical and systematic uncertainties. Semi-leptonic decays happen in 45% of all cases. In this analysis only muon and electron final states are considered.

2. Method

The event selection closely follows the event topology. A central, isolated and high-p_T lepton, significant missing transverse energy, and at least three central, high-p_T jets reconstructed with the anti-k_T algorithm ($R = 0.4$) are required. In addition, cuts on the transverse leptonic W boson mass are applied to suppress contribution from QCD multi-jet events. Details can be found in [3]. Even though tight selection cuts are applied, not all backgrounds can be rejected. The following backgrounds need to be well understood: W+jets production, including heavy flavour jets, Z/γ+jets production, diboson production, single top quark production, and QCD multi-jet events faking leptons. The first four are estimated using Monte Carlo assisted methods. Multi-jet background is difficult to model and therefore estimated from data. For the muon+jets channel a matrix method is used whereas for the electron+jets channel a full model is obtained using cut inversion. The normalization for each process is obtained from the likelihood fit described in the following.

Events with 3, 4 and ≥ 5 jets are used for the measurement. The major background to top quark production is W+jets production. Therefore, topological differences between top quark pair and W+jets processes are used to create a projective likelihood discriminant: lepton η, aplanarity, p_T sum of all but the leading 2 jets divided by p_z sum of all objects, and mean b-tagging weight of the two most b-like jets. The likelihood discriminant, D, is in the form of $D = S/(S+B)$, where S is signal and B is background. It is constructed for each analysis channel, i.e. for both electron+jets and muon+jets channel in the 3, 4 and ≥ 5 jets bins each. The fit to data is performed in all analysis channels simultaneously. The systematic uncertainties are considered as additional nuisance parameters δ_i allowing data to constrain them (the uncertainties considered can be found in [3]). The parameter of interest, i.e. the top quark pair cross-section, is allowed to float freely. All other fit parameters are constrained to their measured values using Gaussian terms in the likelihood.

3. Results

The top quark pair production cross-section obtained from the fit is:

$$\sigma_{t\bar{t}} = 186 \pm 10\,(\text{stat.})^{+21}_{-20}\,(\text{syst.}) \pm 6\,(\text{lumi.})\,\text{pb},$$

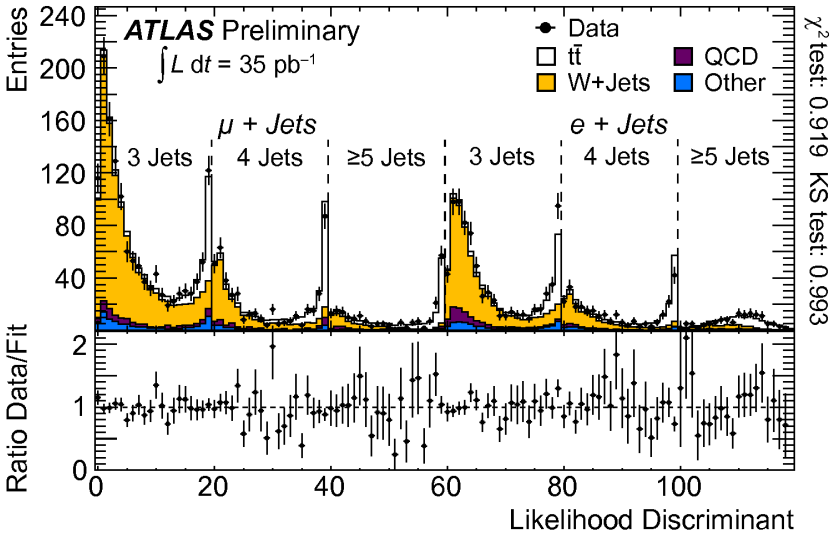

Figure 1: (Top) D distribution of data superimposed on expectations, scaled to the results of the fit (ranging from 0-20 in each bin). The left bins correspond to the muon channel and the right bins to the electron channel, p-values for statistical tests shown on the right-hand axis. (Bottom) Ratio of data to fit result [3].

which is in agreement with the Standard Model. The fit result can be seen in Fig. 1. The dominant systematic uncertainties are b-tagging calibration (7.5%), W+heavy flavour contributions (7%), initial and final state radiation modelling (4%).

Several independent measurements with and without b-tagging have been performed by the ATLAS collaboration. They are all in agreement within uncertainties. The measurement presented yields a relative uncertainty of the top quark pair cross-section measurement of 13% after one year of data-taking. The combination of this measurement with the dilepton analysis without b-tagging using a dataset of 690 pb^{-1} from 2011 data-taking results in a total uncertainty of 7% [4].

References

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