Measurement of the top quark pair production cross section in dilepton final states with ATLAS

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1 Introduction

The production cross section of top quark pairs in proton-proton (pp) collisions at $\sqrt{s} = 7$ TeV using 35 pb^{-1} data recorded with the ATLAS detector in 2010 is measured. The goal of the analysis is to provide a benchmark test of perturbative QCD and the Standard Model (SM) by measuring the $t\bar{t}$ production cross section in data and compare the measurement with theoretical predictions. Within the SM, the top quarks almost exclusively decays to a W-boson and a b-quark. For this analysis we select events where both W-bosons from $t\bar{t}$ decay to a lepton and a neutrino. The branching ratio of this process is 6.5%. The theoretical expectation for $t\bar{t}$ production cross section in pp collisions at $\sqrt{s} = 7$ TeV is 165^{+11}_{-16} pb [1].

2 Object and event selection

Dilepton candidate events are required to contain ee, $\mu\mu$ or $e\mu$ in the final state. The events where W-boson decays to a τ-lepton and a neutrino and τ itself decays leptonically are included in the signal. Electrons and muons are required to be well isolated objects reconstructed in the central part of the detector $|\eta| < 2.5$ with $p_T > 20$ GeV. Electrons from the transition region between the barrel and endcap calorimeters are excluded, $1.37 < |\eta| < 1.52$. The same kinematic requirements are applied for jet selection, reconstructed from topological clusters with distance parameter $R = 0.4$.

Events are triggered by a single lepton trigger, requiring an association between one of the selected leptons and the trigger object ($\Delta R < 0.15$). The candidate events contain exactly two oppositely charged leptons and at least two jets. In order to suppress the contribution from Drell-Yan background, ee and $\mu\mu$ events must satisfy $E_{\mathrm{T}}^{\mathrm{miss}} > 40$ GeV and $|m_{ll} - m_Z| > 10$ GeV, where m_Z is the PDG value of Z-boson mass pole 91.2 GeV. For the $e\mu$ channel H_{T}, defined as the scalar sum of the transverse energies of the two selected leptons and all selected jets, must satisfy $H_{\mathrm{T}} > 130$ GeV.

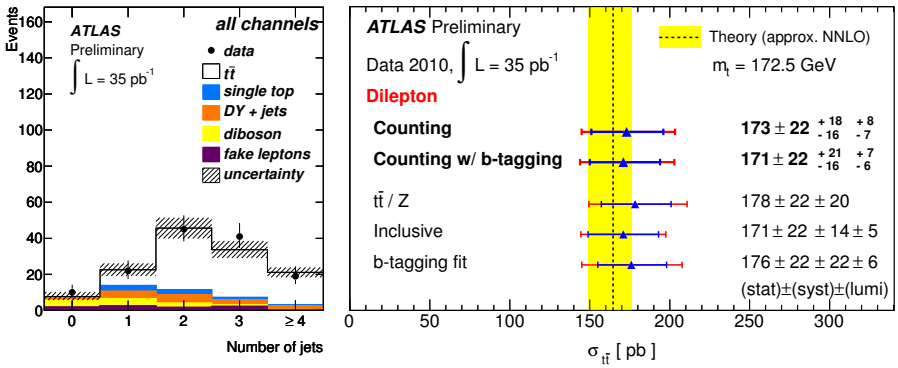

Figure 1: Jet multiplicity distribution without the $N_{jets} \leq 2$ and b-tagging requirements(left). The $\sigma_{t\bar{t}}$ cross section measurements from different methods(right).

3 Cross section measurement

The cross section is extracted using a cut and count method, where the number of events passing selection criteria from data are compared with the expected background. The contribution from Drell-Yan and backgrounds containing fake leptons are estimated from data. Other sources from electro-weak processes such as single-top and diboson production are estimated from simulation. Two independent analyses are performed with and without using b-tagging of jets [2]. For the analysis using b-tagging the requirements on E_{T}^{miss}, m_{ll} and H_{T} are loosened. For both analyses the results from the three sub-channels are combined using a likelihood fit. The impact of systematic uncertainties from leptons, jets, pile-up, theoretical cross sections, data driven methods, generation and simulation are included into the likelihood fit. Additional studies are performed to corroborate these measurements: a technique that normalizes the $t\bar{t}$ signal yield to the measured rate of Z-boson decays, a two-dimensional template shape fit using $E_{\mathrm{T}}^{\mathrm{miss}}$ vs the number of jets and a simultaneous measurement of $\sigma_{t\bar{t}}$ and the b-tagging efficiency using the number of b-tagged jets. Measured cross sections from different methods with statistical and systematic uncertainties are shown in the Figure 1. All the measurements are in good agreement with each other and the SM prediction.

References

[1] S. Moch, P. Uwer, Phys. Rev. **D78** 034003 (2008); U. Langenfeld, S. Moch, P. Uwer, `arXiv:0907.2527` [hep-ph]

[2] ATLAS-CONF-2011-034, http://cdsweb.cern.ch/record/1337784