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Top physics with the ATLAS detector at LHC

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Summary. — The recent results on top quark production measurements in proton-proton collisions at 13 TeV, obtained with the ATLAS detector at the Large Hadron Collider are presented. Total single top quark cross-section measurements and total and differential top quark pair ($t\bar{t}$) cross-section are reported. The results are compared to the latest QCD theoretical calculations.

1. – Introduction

The top quark was discovered by both the CDF [1] and DØ [2] Collaborations in 1995 at the Tevatron collider. It is the most massive elementary particle known ($m_t = 172.99 \pm 0.41(\text{stat.}) \pm 0.74(\text{syst.})\,\text{GeV}$ [3]) and due its very short lifetime, the top quark decays before hadronizing. This allows to experimentally test the properties of a bare quark. Top quark physics provides a sensitive probe to test the validity of the Standard Model and a tool to investigate the Higgs boson properties and to potentially discover physics beyond the Standard Model. Some of the recent results achieved by the ATLAS Collaboration using data collected in 2015 with an integrated luminosity of $\mathcal{L} = 3.2\,\text{fb}^{-1}$ at $\sqrt{s} = 13\,\text{TeV}$ are here presented. A more complete list of results is available at the ATLAS public top quark results website [4].

2. – Single top quark cross-section

At the LHC, top quarks can be produced individually through the electroweak interaction involving the tWb vertex. There are three single top quark production modes: the t-channel process, the W-associated production (Wt) and the s-channel process. The t-channel process is the dominant single top quark production mode, while, the s-channel is a rare process. In fig. 1 a summary of the single top quark cross-section measurements is shown. In the figure the cross-sections are reported as a function of the centre-of-mass energy for the three above-mentioned processes.

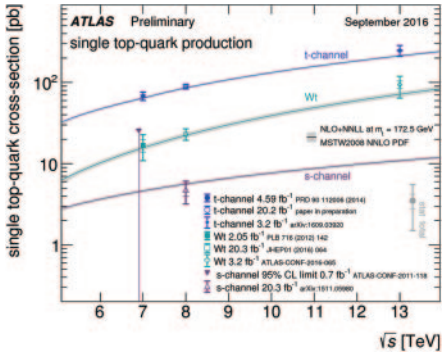

Fig. 1. – ATLAS summary plot for single top quark cross-section measurements as a function of the centre-of-mass energy [4].

3. – Top quark pair cross-section measurements

Top quark pairs ($t\bar{t}$) are produced in proton-proton collisions via strong interactions. At the LHC about 85% of the top-antitop pairs are produced by the gluon-gluon interactions. The remaining 15% is the production by the quark annihilation process. The top quark decays almost exclusively into a W boson and a b quark. So, the $t\bar{t}$ events can be classified as decay products of two W bosons. The final signatures of the W bosons can be a quark pair or a lepton-neutrino pair. The total $t\bar{t}$ cross-sections have been measured in different final states. In fig. 2 a summary of the total inclusive cross-sections as a function of the centre-of-mass energy is shown.

Differential cross-sections have been measured as a function of different $t\bar{t}$ system kinematic variables. The experimental measurements, performed in different channels, allow a precision test of the predictions of perturbative QCD. In fig. 3 an example of differential cross-section measurement is shown as a function of the hadronic top quark P_T. This measurement has been performed in a fiducial phase-space, at particle level and the results have been compared with the latest theoretical predictions. More differential distributions are available in [4].

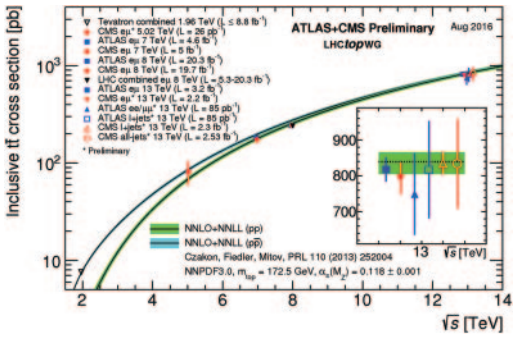

Fig. 2. – ATLAS+CMS summary plot for the total inclusive top quark pair cross-section measurements [4].

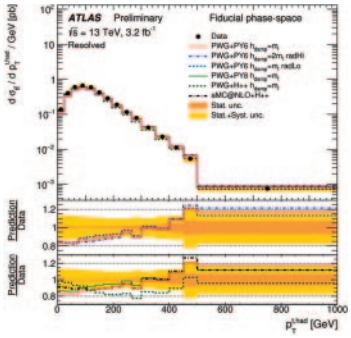

Fig. 3. – Differential cross-section measurement as a function of the hadronic top quark P_T in the ℓ+jets final state [5].

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