Top quark cross section measurements in CMS

Cristina Ferro
IPHC Strasbourg.

1 Introduction

The most recent results on the measurements of top anti-top quark pair ($t\bar{t}$) and single top production cross sections at 7 TeV are presented. These are obtained using CMS [1] data collected in 2011. The $t\bar{t}$ inclusive cross sections are measured in the lepton+jets, dilepton and fully hadronic channels, including the tau-dilepton and tau+jets modes. The results are combined and confronted with precise theory calculations. In this article also the differential $t\bar{t}$ cross section measurements, the single top cross section measurements and the charge asymmetry measurement are presented.

2 Inclusive cross section measurements

The most suitable channel for precise measurements of the $t\bar{t}$ production cross section is the lepton+jets channel. The analysis is performed by dividing data in different categories of events according to the jet multiplicity and the number of b-tagged jets. The cross section is then extracted with a fit to the mass of the secondary vertex of the jets. One of the main features of this analysis is that the systematic uncertainty are treated as nuisance parameters of the fit. The relative uncertainty in the measurement of the $t\bar{t}$ cross section is $\sim 7\%$ and it is dominated by the uncertainty in modeling of the signal component and by the luminosity measurement. In the remaining channels the $t\bar{t}$ production cross section has been measured by a counting experiment for the dilepton channel, while in the fully hadronic chennel a kinematic fit to the distribution of the reconstructed top mass is used. The most recent results are coming from the hadronic tau+jets channel. In this case the measurement is performed using a multivariate analysis. More in details the signal has been extracted from the backgrounds using a fit to a neural network output distribution. The results of the fit is shown in Fig.1 [2]. Overall the results in these channels are compatible with the theoretical predictions but their uncertainties are larger with respect to the measurements in the lepton+jets channel due to systematic effects mainly connected with the jet energy scale or background estimation. In table 1 the results for the $t\bar{t}$ production cross section measurement for the different channels are presented.

$t\bar{t}$ channel	cross section measurement result (pb)
lepton +jets	164.4 ± 2.8(stat.) ± 11.9(syst.) ± 7.4(lumi.)
dilepton	169.9 ± 3.9 (stat.) ± 16.3 (syst.) ± 7.6 (lumi.)
dilepton + tau	148.7 ± 23.6(stat.) ± 26.0(syst.) ± 8.9(lumi.)
hadronic tau + jets	156 ± 12 (stat.) ± 33 (syst.) ± 3 (lumi)
fully hadronic	136 ± 20 (stat.) ± 40 (syst.) ± 8 (lumi.)

Table 1: Results of the $t\bar{t}$ production cross section measurements in different channels.

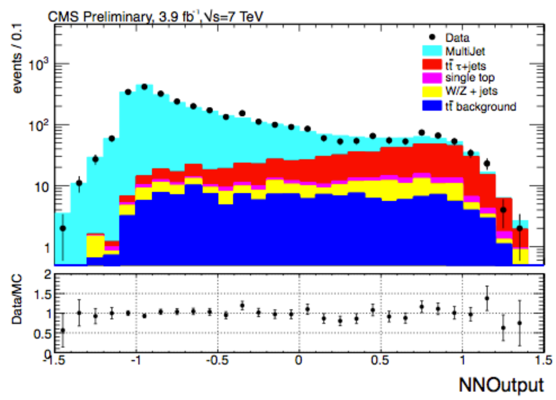

Figure 1: Distribution of the neural network output variable after a fit of the signal and multijet processes to the data.

3 Differential cross section measurements

Thanks to the large statistics recordered by the CMS experiment in 2011, we are able to provide also the measurements of the differential cross section. Differential measurements were performed in the lepton+jets and dilepton channels after the reconstruction of the $t\bar{t}$ kinematics, unfolded to parton level. The differential cross section is measured after background subtraction and unfolding the observed value. There is a very good agreement between the unfolded data and the simulation within the uncertainty of the measurement. One distribution of particular interest is $p_T^{t\bar{t}}$ which is shown in Fig.2 for the dilepton channel [3].

4 Single Top production

Single top quarks can be produced through the s and t-channels and in association with a W boson. The dominant production mode is the t-channel. The most recent result for this channel is $\sigma(\mathrm{t}) = 70.2 \pm 11.5(\mathrm{stat.} + \mathrm{syst.}) \pm 3.4(\mathrm{lumi.})$ pb obtained

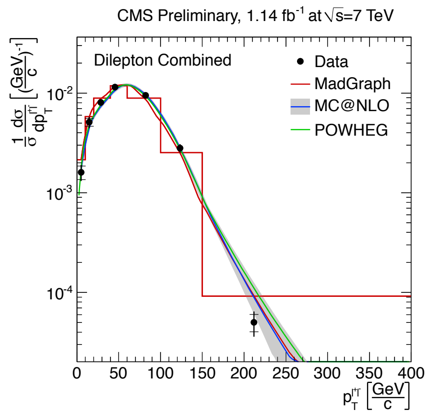

Figure 2: Differential cross section measurement with respect to the p_T of the $t\bar{t}$ system, for the dilepton channel. The measurements are compared to the predictions from Madragph, POWEGH, and MC@NLO Monte Carlo generators.

using a fit to the pseudo-rapidity of the recoiling jet. The comparison of the current measure with the Standard Model expectation is presented in Fig.3. The value of the $|V_{tb}|$ coupling has been also derived. Assuming $|V_{td}|, |V_{ts}| << |V_{tb}|$ we find $|V_{tb}| = 1.04 \pm 0.09(exp) \pm 0.02(th)$ [4].

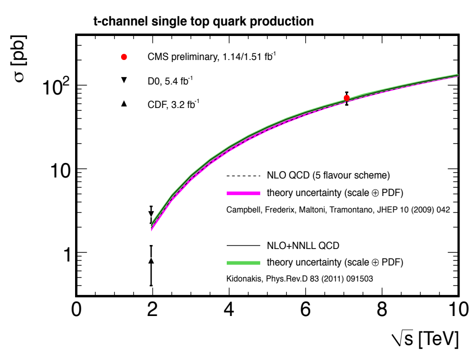

Figure 3: Comparison of the current measurement for the single top $t-$channel cross section production with the Standard Model expectation.

5 Charge asymmetry measurements

The difference in the angular distributions between top quarks and antiquarks have been measured. In addition to the inclusive measurement, for the first time at the

LHC also differential measurements of the charge asymmetry are performed. The invariant mass, the rapidity, and the transverse momentum of the $t\bar{t}$ system are chosen as differentiating variables since they are sensitive to the different processes contributing to the overall charge asymmetry [5]. The measured inclusive asymmetry of AC = 0.004 ± 0.010(stat.) ± 0.012 (syst.) and the measured differential asymmetries are consistent with the predictions from the standard model (Fig.4).

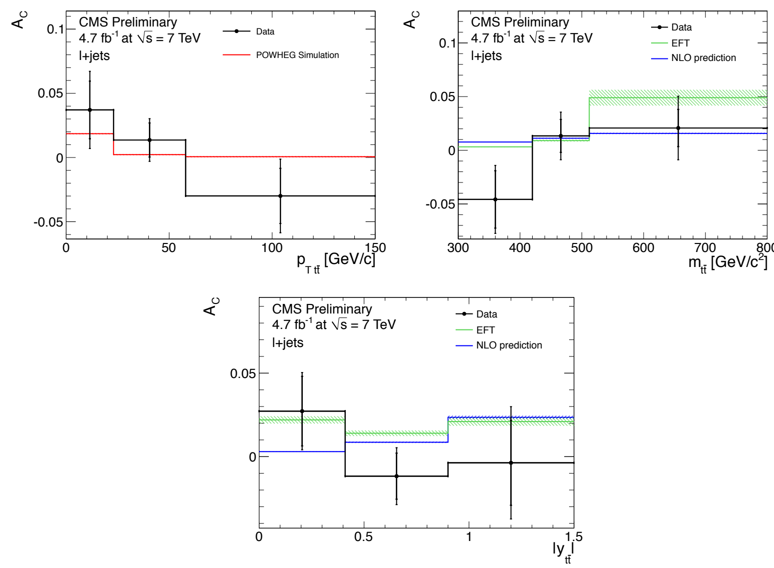

Figure 4: Differential measurements of the charge asymmetry with respect to three different differentiating variables: the transverse momentum, the invariant mass and the rapidity of the $t\bar{t}$ system.

References

[1] CMS Collaboration, J. Inst. 3 (2008) 361.

[2] CMS collaboration,CMS-PAS-TOP-11-004.

[3] CMS collaboration,CMS-PAS-TOP-11-013.

[4] CMS collaboration,CMS-PAS-TOP-11-021.

[5] CMS collaboration,CMS-PAS-TOP-11-030.