Ratio of Semileptonic and Dileptonic $t\bar{t}$ Decays in ATLAS at the LHC

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At the Large Hadron Collider at CERN top-antitop ($t\bar{t}$) events will be produced with a cross section σ of around 830 pb. With about 30% probability top pairs decay semileptonically into final states with four jets, lepton (electron or muon) and respective neutrino. For another 5% of the $t\bar{t}$ events a dileptonic decay is expected. Here the final state signature is composed of two jets, two leptons and two neutrinos. Deviations from the ratio of these two decays would be a sign of new phenomena, e.g. a charged Higgs boson.

Given here is an estimate for the statistical precision of such a cross section ratio measurement during the first year of ATLAS at the LHC, corresponding to an integrated luminosity of 10 fb^{-1}.

In the semileptonic decay channel the largest expected backgrounds are events with leptonic W decays and additional jets, and pure QCD multijet events where one jet is misidentified as an electron. Another background is single top events.

The $t\bar{t}$ events have been centrally simulated with the next-to-leading-order generator MC@NLO as well as the W + jets background. The single top background was created with AcerMC. All these samples apply the full ATLAS detector simulation. For the QCD background ALPGEN samples together with a parametrised detector simulation have been taken and a fake electron probability of 10^{-3} was chosen for the model as described in [1].

The subsequent cuts have been chosen for the best selection significance $S = \frac{\sigma}{\Delta\sigma}$. Required are the firing of the "electron 25 GeV" or "muon 20 GeV" trigger, exactly one electron or muon with a transverse momentum of at least 30 GeV, 4 or more jets with transverse momenta above 20 GeV of which at least 2 jets exceed 40 GeV, and missing transverse energy ($\not\!\!E_T$) larger than 20 GeV. Figure 1 outlines the cut flow described. After all cuts the significance amounts 508 for 10 fb^{-1} integrated luminosity.

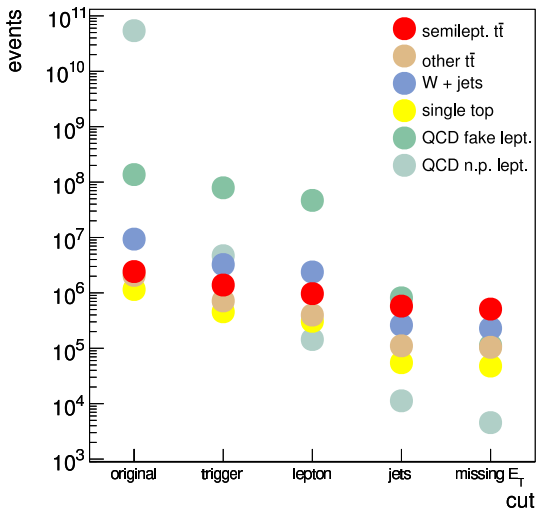

Fig. 1: Cutflow for the semileptonic channel.

In the dileptonic channel the MC@NLO $t\bar{t}$ events have been taken again as signal sample. For the Z + jets background, samples created with PYTHIA were used, for the diboson background from WW, WZ & ZZ + jets, HERWIG samples have been available. The W + jets background (PYTHIA) originating from fake leptons has been modelled the same way as the QCD background in the semileptonic channel, again for a fake electron probability of 10^{-3} plus a random charge.

For the dileptonic channel the selection requires again the firing of the "electron 25 GeV" or "muon 20 GeV" trigger, exactly 2 reconstructed leptons which must be oppositely charged, a first jet with transverse momentum above 55 GeV and a second above 40 GeV. When combined both leptons must not have a mass in the window between 85 and 95 GeV to reduce the Z background and as the final step $\not\!\!E_T$ must be at least 25 GeV. Figure 2 illustrates the presented selection. In the end a significance for the dileptonic channel of 165 is achieved for 10 fb^{-1} integrated luminosity.

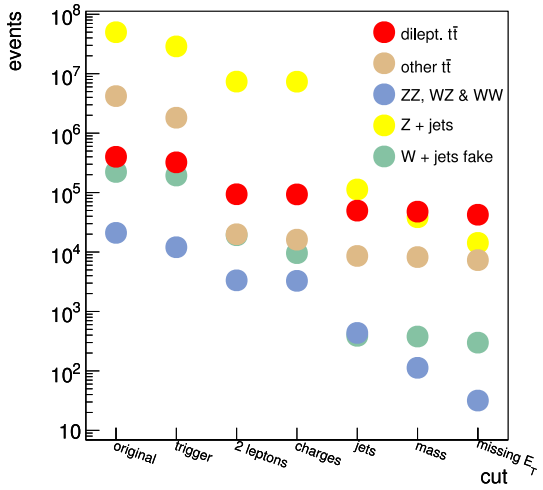

Fig. 2: Cutflow for the dileptonic channel.

Combining these results for both channels yields the statistical precision for the cross section ratio of

$$\Delta R_{\ell\ell/\ell}/R_{\ell\ell/\ell}(\text{stat.}) = \sqrt{\left(\frac{1}{508}\right)^2 + \left(\frac{1}{165}\right)^2} = 0.6\% \quad (1)$$

If the systematics on the missing transverse energy measurement are too uncertain to apply the $\not\!\!E_T$ cuts, the statistical precision of the ratio slightly drops to 0.7%. The estimation of such and other systematic uncertainties is in progress.

References

[1] R. Mameghani *et al.*, Annual report 2006, p. 40