Measurement of the Inclusive $t\bar{t}$ cross-section in pp Collisions at $\sqrt{s}$ = 8 TeV with the ATLAS experiment

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ATLAS EXPERIMENT

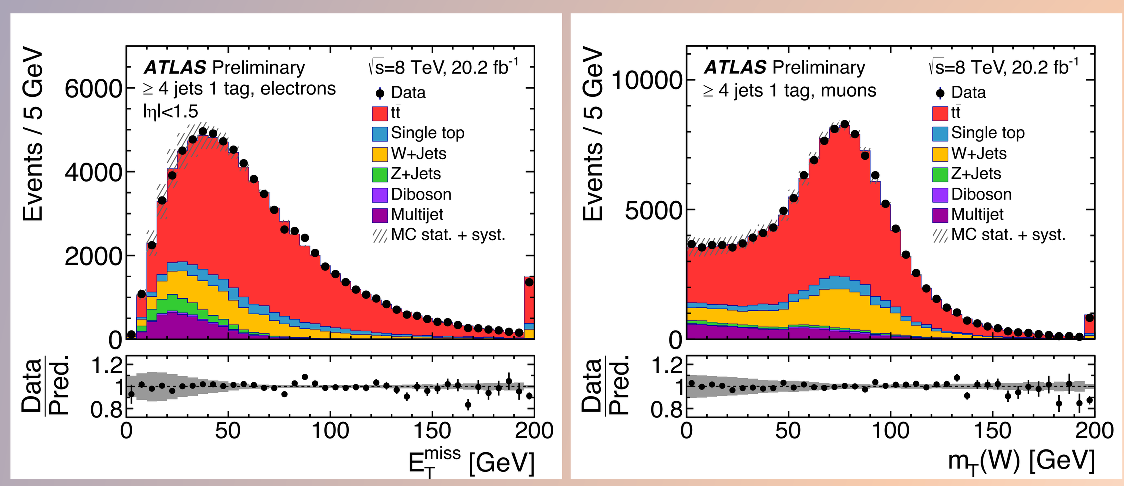
Motivation

The top-quark is the most massive known elementary particle. Its Yukawa coupling to the Higgs boson is close to unity. It may play a special role in the electroweak symmetry breaking. The dominant production process of top quarks is pair production via the strong interaction.

The measurement of the production cross-section provides a stringent test of QCD calculations with heavy quarks and opens a window to potential new physics such as top quark partners degenerate with the SM top-quark.

Multijet background estimation

Its normalisation is estimated by fitting the E_T(miss) distribution using the jet-lepton template in the electron channel and fitting the $m_T(W)$ distribution using the anti-muon template in the muon channel.



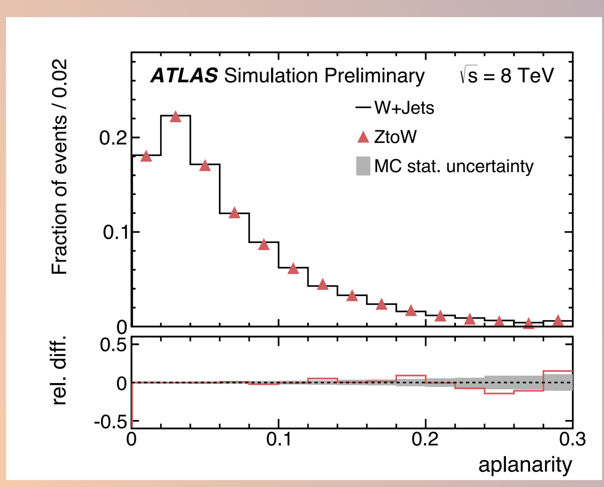
Event selection

The $t\bar{t}$ cross-section is measured in the lepton+jets channel. Events are selected if they include exactly one isolated charged lepton (electron or muon), at least four jets, where at least one of the jets has to be b-tagged and sizable missing transverse energy. Additional requirement on the transverse mass of the W-boson is applied in order to reject multijet background.

W+jets background modelling

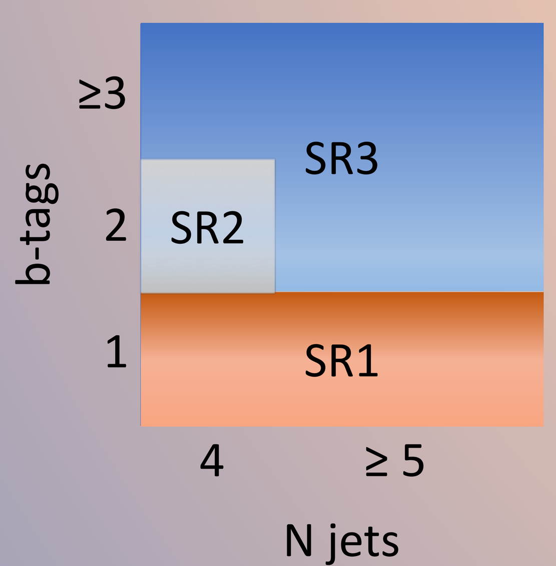
W+jets is the main background. It is modelled by a data-driven method using Z+jets events selected from data by requiring two opposite charged leptons of the same flavour and the invariant mass of the two leptons to be close to the Z-boson mass. Events are then converted to W+jets events through

- Scaling the energy of the leptons by m_W/m_Z
- Dropping one of the leptons randomly
- Re-calculating the missing transverse energy of the event



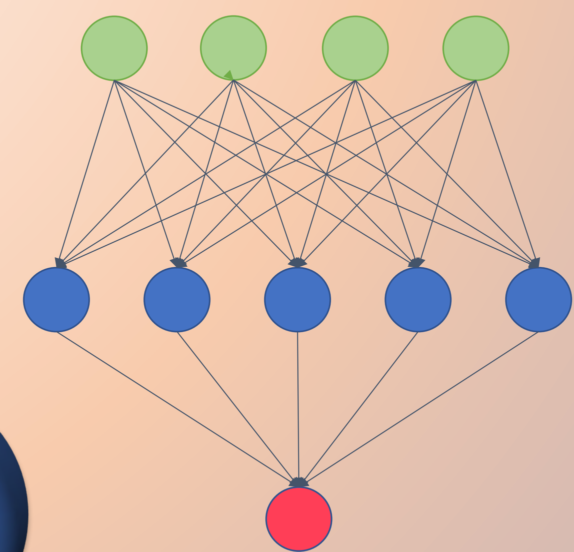
Analysis strategy

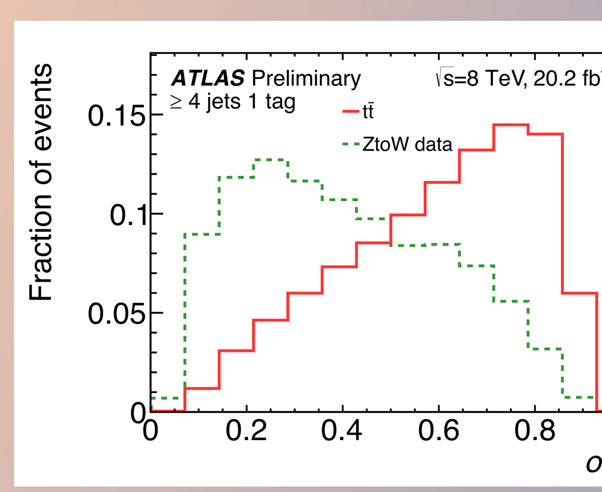
Selected events are separated into three disjoint signal regions in order to constrain major systematic uncertainties due to the modelling of the jet energy scale and b-tagging efficiency. A simultaneous maximum likelihood fit is performed in the three signal regions.



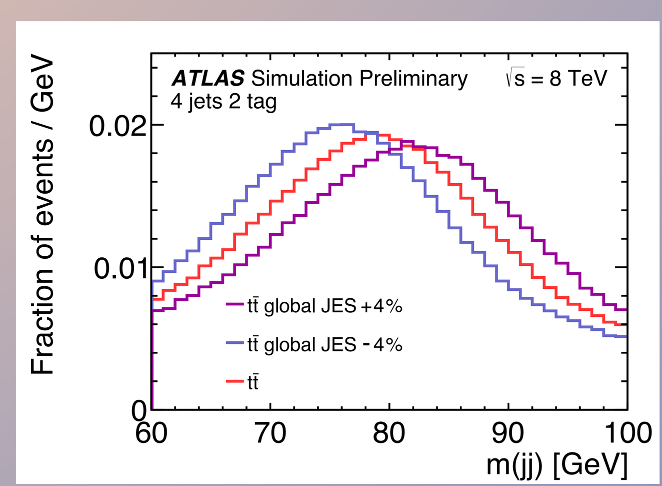
Discriminating observables

A neural network is trained to enhance the separation between $t\bar{t}$ and W+jets events. The neural network output distribution is used as the discriminating variable in SR1 and SR3.





In SR2, the invariant mass of the two untagged jets m(jj) is utilised to reduce the uncertainty on the JES. The sensitivity of m(jj) on the JES is shown using simulated samples with modified JES correction factors.



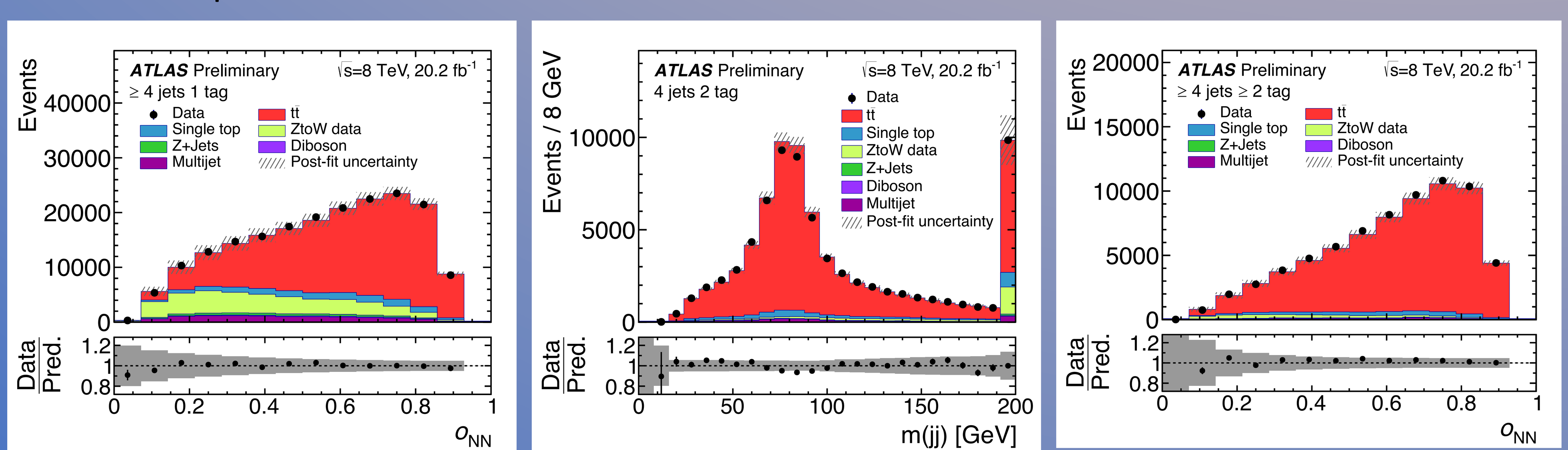
Systematic uncertainties

The systematic uncertainties are evaluated using pseudo-experiments. In each of these pseudo-experiments, the detector effects, background contributions and modelling uncertainties are varied within their systematic uncertainties. They impact yields of processes and shapes of the template distributions used in the three signal regions. Correlations between rate and shape uncertainties are taken into account.

Extraction of the $t\bar{t}$ cross-section

A binned maximum-likelihood fit is performed in the three signal regions. Scale factors $\beta^{t\bar{t}}$ for the signal, β^{W1} and β^{W23} for the W+jets background and two nuisance parameters δ_i, the b-tagging efficiency correction factor $\delta_{b\text{-}tag}$ and the JES correction factor δ_{JES} are fitted simultaneously. For the W+jets background, two uncorrelated scale factors are used to account for differences in the flavour composition of this background. β^{W1} for SR1 and β^{W23} for SR2 and SR3.

Event yields of the other small backgrounds are not allowed to vary in the fit, but instead are fixed to their theoretical prediction.



The total uncertainty on the $t\bar{t}$ cross-section is 5.7 %

Results

The inclusive $t\bar{t}$ cross-section is measured to be [1]:

$\sigma_{t\bar{t}}$ **= 248.3 ± 0.7 (stat.) ± 13.4 (syst.) ± 4.7 (lumi.) pb**

Assuming a top-quark mass of m_{top}= 172.5 GeV

References

[1] ATLAS-CONF-2017-054