PROCEEDINGS OF SCIENCE

Measurement of jets in $t\bar{t}$ events with ATLAS

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The jet multiplicity was measured with the ATLAS detector at the LHC in single-lepton $t\bar{t}$ events in proton–proton collisions at a center-of-mass energy of 7 TeV. After background subtraction, corrections were made for detector efficiencies and resolution effects. The results are compared to model predictions consisting of fixed-order matrix element calculations matched to parton showers.

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1. Introduction

The jet multiplicity was measured with ATLAS [1] at the LHC [2] in single-lepton top–anti-top events (e+jets and μ+jets) with jet p_{T} thresholds of 25, 40, 60, and 80 GeV [3]. States with up to 8 jets (inclusive) were considered.

The motivation for the measurement is to constrain radiation parameters, test perturbative quantum chromodynamics (pQCD) and understand the background for many searches. The measurement was fully unfolded to the particle level in a fiducial region using the full 2011 7 TeV data set with an integrated luminosity of 4.7 fb^{-1}.

2. Event selection and correction procedure

Events were triggered using electrons with a transverse momentum of 20 or 22 GeV or muons with 18 GeV. Electrons in the pseudorapidity range $|\eta| < 2.47$ were selected, excluding the region $1.37 < |\eta| < 1.52$. Muons were required to have $|\eta| < 2.5$. Exactly one lepton with $p_{\mathrm{T}} > 25$ GeV was required, with no other lepton with $p_{\mathrm{T}} > 15$ GeV. Events were required to have three jets or more, with $p_{\mathrm{T}} > 25, 40, 60$, or 80 GeV. Jets were calibrated using the ATLAS EM+JES calibration and were required to have a jet vertex fraction larger than 0.75. The missing transverse energy was required to be above 30 GeV in both channels and the W transverse mass above 35 GeV. At least one jet with $p_{\mathrm{T}} > 25$ GeV was required to be b-tagged with the ATLAS MV1 tagger, operating at 60% efficiency for b-quarks in simulated $t\bar{t}$ events.

The particle-level selection, which defines the fiducial volume of the measurement, was closely matched to the reconstruction-level one. The b-jets were required to have a b-hadron within $\Delta R < 0.3$. Electrons, muons and neutrinos were matched to W particles in the generator record.

The reconstructed jet multiplicity spectrum was corrected back to the particle-level inside the selected kinematic range, by accounting for detector efficiencies, resolution effects and biases. The data were correcting according to

$$N_{\mathrm{part}} = f_{\mathrm{part!reco}} \cdot M_{\mathrm{res}} \cdot f_{\mathrm{reco!part}} \cdot f_{\mathrm{accpt}} \cdot (N_{\mathrm{reco}} - N_{\mathrm{bgnd}}), \tag{2.1}$$

where N_{reco} is the total number of reconstructed events, N_{bgnd} is the background contribution, f_{accpt} is an acceptance correction for all selection efficiencies except for the jet multiplicity requirement, $f_{\mathrm{reco!part}}$ is a correction for events passing the jet multiplicity requirement at the reconstruction level but not at the particle level, M_{res} is a response matrix applied iteratively using Bayesian unfolding, $f_{\mathrm{part!reco}}$ is an efficiency correction factor correcting for events which fulfill the particle-level jet multiplicity requirement but fail the same at the reconstruction level, and N_{part} is the total number of fully corrected events.

3. Results

Figure 1 shows results in the electron channel (those of the muon channel are qualitatively similar). For $p_{\mathrm{T}} > 25$ GeV, all predictions agree well with the data in the three and four-jet bins. MC@NLO+HERWIG [8, 5] agrees with data for $n_{\mathrm{jets}} = 3$, 4, 5 and $p_{\mathrm{T}} > 25$ GeV, but underestimates for $n_{\mathrm{jets}} \geq 6$. It continues to underestimate as the p_{T} cut increases, indicating a

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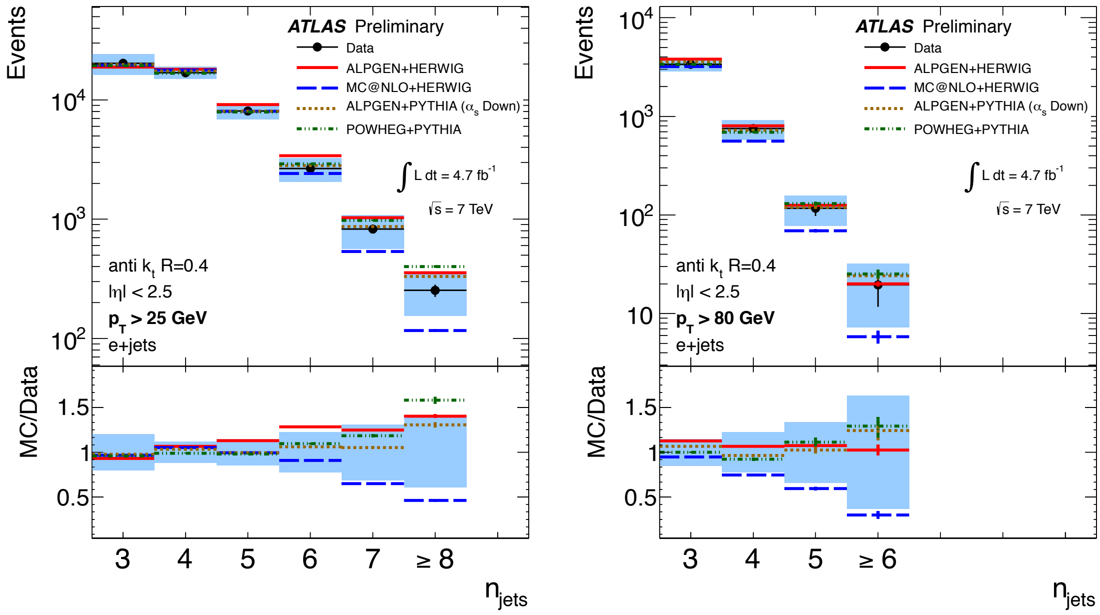
p_T spectrum that is too soft. POWHEG+PYTHIA [9, 6, 7] is in reasonable agreement with the data for all p_T thresholds. The ALPGEN+PYTHIA [4, 6, 7] α_S up variation gives a higher jet multiplicity than is observed in the data. ALPGEN+PYTHIA, ALPGEN+HERWIG [4, 5] and ALPGEN+PYTHIA α_S down are consistent with data for all jet p_{jets} thresholds. The data seem to favor a softer α_S than the default value.



(a) $p_T > 25$ GeV (b) $p_T > 80$ GeV

Figure 1: The particle-jet multiplicities [3] for the electron channel and the jet p_T thresholds (a) 25 and (b) 80 GeV. The data are shown in comparison to the ALPGEN+HERWIG [4, 5], ALPGEN+PYTHIA [4, 6, 7] (α_S-down variation), MC@NLO+HERWIG [8, 5] and POWHEG+PYTHIA [9, 7] models. Data points and their corresponding statistical uncertainty are shown in black, whereas the total uncertainty is shown as a shaded band. The predictions are shown with their statistical uncertainty.

References

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