Measurement of the differential $t\bar{t}$ cross section for high-p_T top quarks in e(μ)+jets events at 8 TeV with the CMS detector

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Motivation

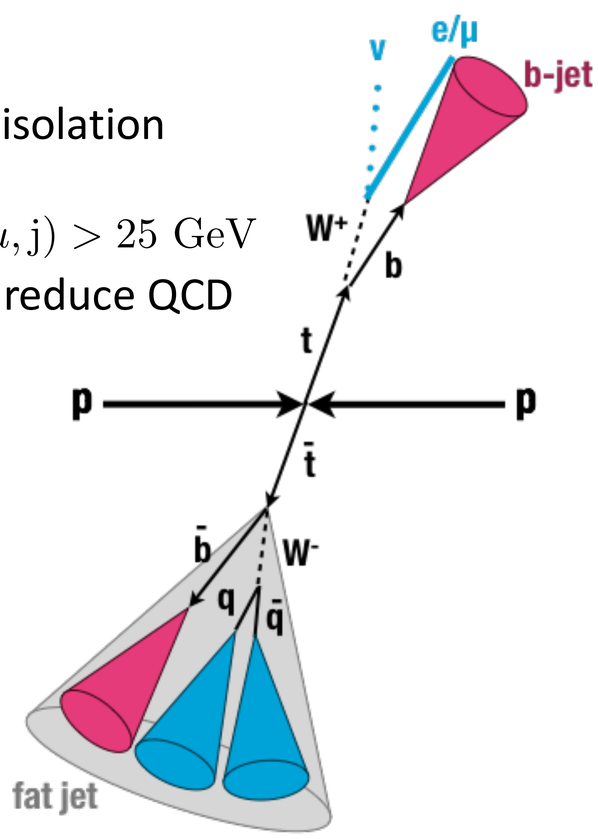
We measure the $t\bar{t}$ cross section as a function of p_T(top) for p_T(top) > 400 GeV. The measurement is performed in the e(μ)+jets final state, using the full CMS 8 TeV dataset of 19.7 fb^{-1}. This is the first measurement in the high-p_T regime at CMS, extending the reach of previous differential measurements. Measuring the $t\bar{t}$ cross section in the high-p_T regime is important as it allows us to validate our MC modelling and reduce theoretical uncertainties. In addition to being an interesting SM measurement, this also improves sensitivity to the many new physics signatures involving boosted tops.

Selection

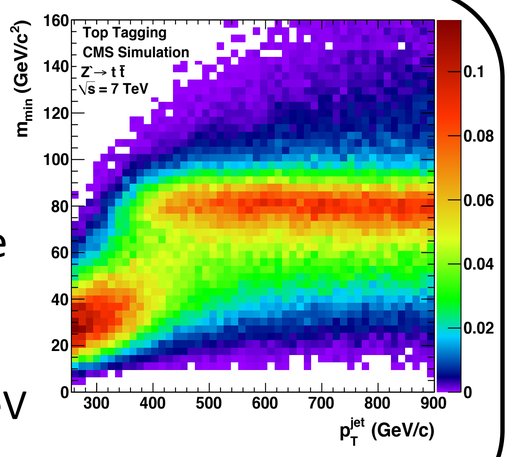
Muon (electron)
- p_T > 45 (35) GeV
- Separated from jets (standard isolation inefficient)
  - $\Delta R(e/\mu, j) > 0.5$ OR $p_T^{rel}(e/\mu, j) > 25$ GeV
- 'Triangular' cut on electron to reduce QCD

b-jet
- Anti-k_T R=0.5
- p_T > 30 GeV
- b-tagged (CSVM)
  - Secondary vertex mass > 0

Top jet
- Cambridge-Aachen R=0.8
- p_T > 400 GeV
- Top-tagged using CMS top-tagger



CMS top tagger
- Top decay products merged for p_T>400 GeV
- Identify top using jet substructure
- Require
  - ≥ 3 subjets
  - Subjet pairwise min mass > 50 GeV
  - 140 GeV < jet mass < 250 GeV



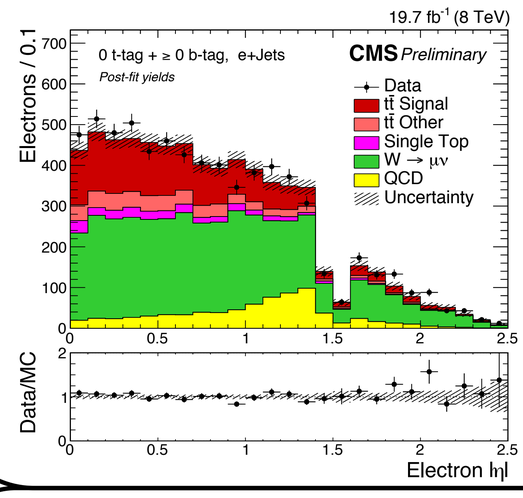
CMS PAS JME-10-013

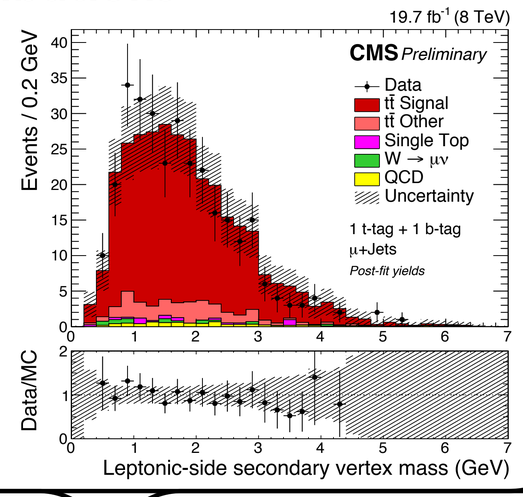
Kinematic Fit

- Define 3 exclusive kinematic regions
  - 0 top-tag
  - 1 top-tag 0 b-tag
  - 1 top-tag 1 b-tag

  ↕ Background dominated / Signal dominated
- Do simultaneous kinematic fit in 3 regions to determine
  - Constraints on experimental systematic uncertainties
  - Background normalizations
  - Top-tagging scale factor
  - Signal yield for p_T(top) > 400 GeV

Fitted Distributions



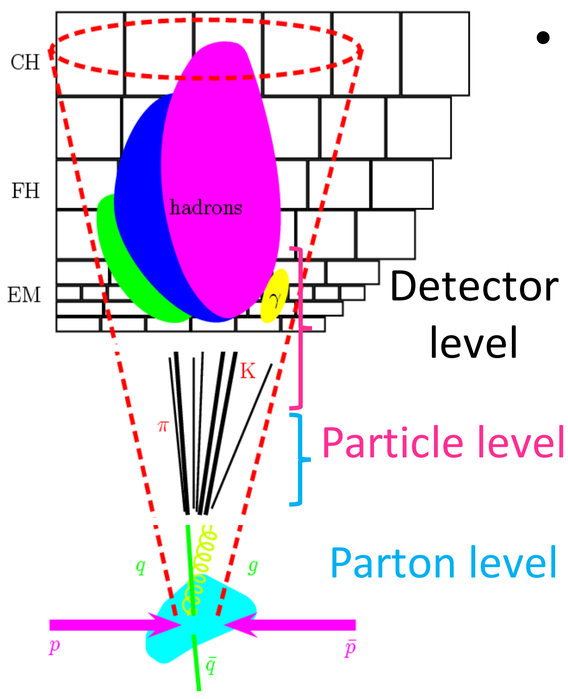


Systematic Uncertainties
- Jet energy scale / resolution
- Top-tagging SF
- Background rates — Experimental
- PDF
- Renormalization & factorization scale — Theoretical

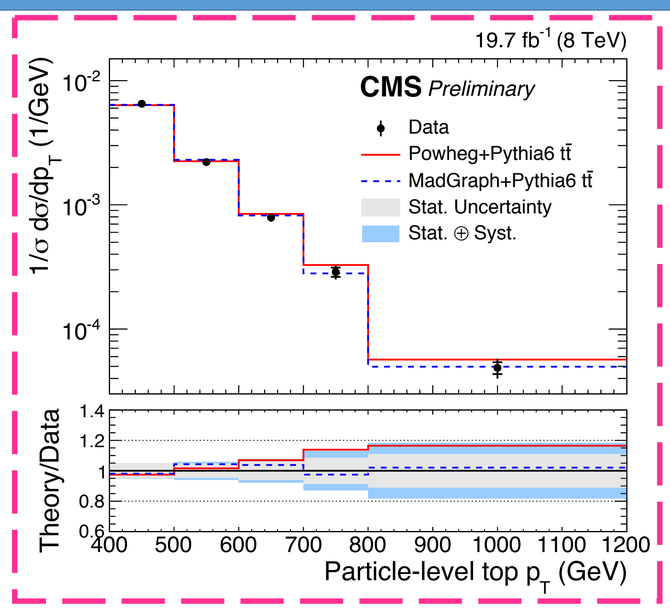
Backgrounds
- Non-signal
- Single top
- W+jets — From MC
- QCD → From data sideband

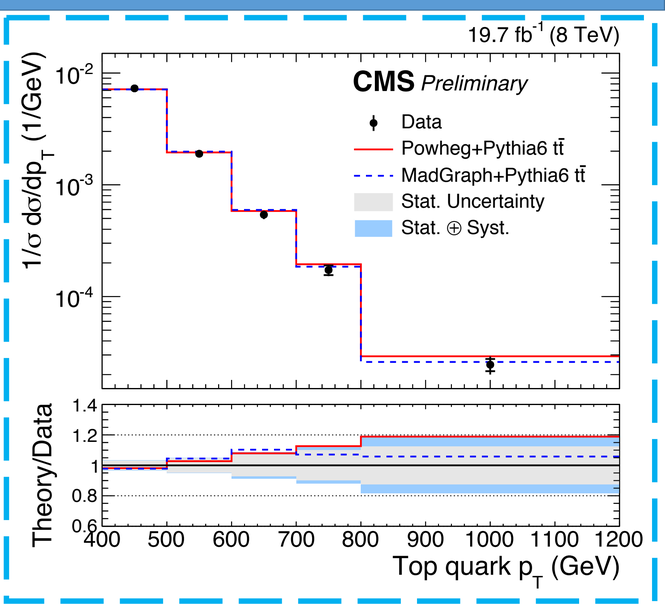
Cross Section

- Measure integrated cross section for p_T(top) > 400 GeV and normalized differential



- Measurement done at particle and parton level
  - Particle-level phase space defined to closely match detector selection → reduces generator dependence
  - Correct background-subtracted data for acceptance, bin migration





Inclusive cross section (p_T > 400 GeV):

1.28 ± 0.09 (stat+syst) ± 0.10 (PDF) ± 0.09 (Q^2) ± 0.03 (lumi) pb (particle)

1.44 ± 0.10 (stat+syst) ± 0.13 (PDF) ± 0.15 (Q^2) ± 0.04 (lumi) pb (parton)

Powheg prediction: 1.49 pb (particle) / 1.67 pb (parton)

Conclusions

The $t\bar{t}$ production cross section is measured in bins of p_T(top) at particle and parton level in the high-p_T regime. The inclusive cross section for p_T(top) > 400 GeV is measured to be 14% lower than predicted by Powheg. In addition, the differential cross section is softer than predicted by Powheg, although consistent within uncertainties. This result will contribute to validating MC modelling and improving sensitivity to new physics, and is a first step towards future measurements at 13 TeV.

Documentation

CMS PAS TOP-14-012