Measurement of the Top-Quark Pair Differential Cross-Section in the Dilepton Channel at 8TeV

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for the CMS collaboration

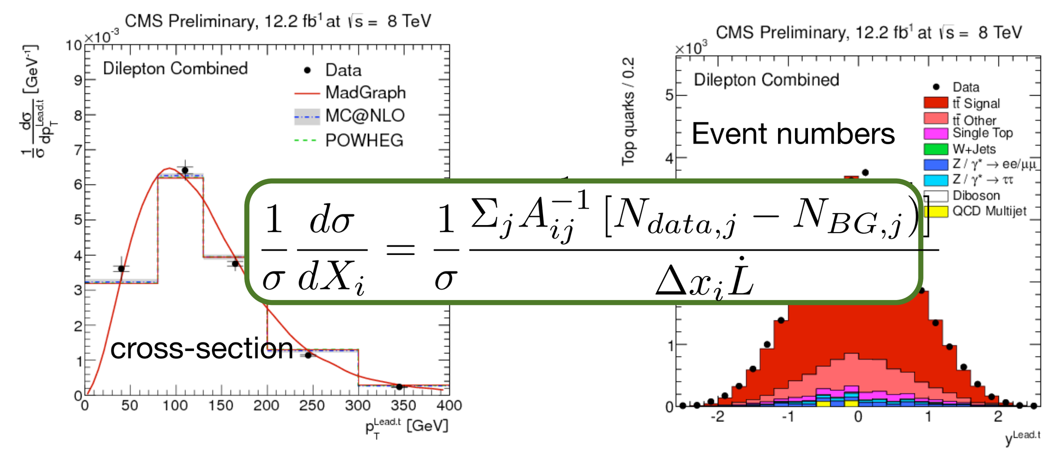
Measurement of the Differential Cross-Section

During 2012, the LHC ran a center-of-mass energy of 8 TeV. We present here a measurement of the top quark cross-section as a function of variables of the individual top quarks, the top-quark system, as well as the decay products of leptons and b-jets. We also present a particle-level definition of the top quark (pseudotop). All measurements are background subtracted and corrected for finite detector resolution and efficiency. The measurements are performed on 12 fb^{-1} of proton-proton collisions.

Unfolding & Binning

Bins are chosen such that the **Purity** and **Stability**, measures of migrations in and out of the bins, are about 50%.

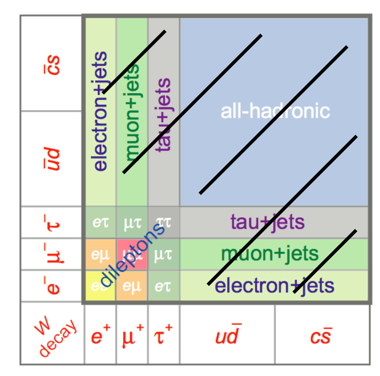
$$Stability^i = \frac{N^i_{rec\&gen}}{N^i_{gen}} \qquad Purity^i = \frac{N^i_{rec\&gen}}{N^i_{rec}}$$



$$\frac{1}{\sigma}\frac{d\sigma}{dX_i} = \frac{1}{\sigma}\frac{\Sigma_j A^{-1}_{ij}[N_{data,j} - N_{BG,j}]}{\Delta x_i \dot{L}}$$

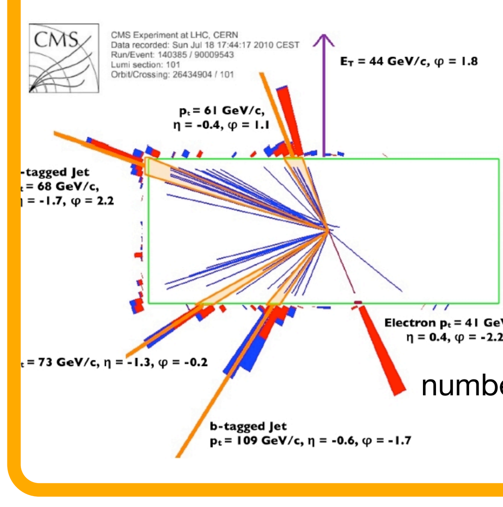
The finite resolution and efficiencies of the CMS detector are corrected for using a process of regularized unfolding

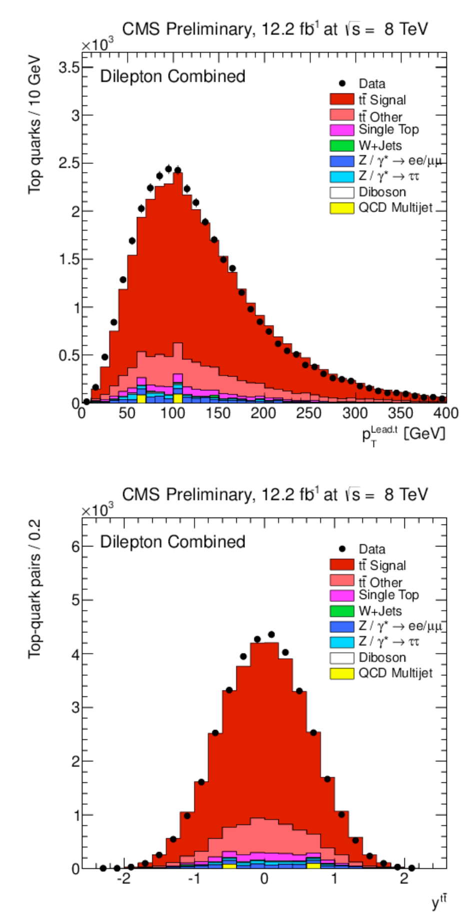
Event selection and background determination



We apply the following criteria to obtain a sample of events that consists of ~90% top-quark pairs

- MET > 40 (not for eμ)
- |η|<2.4
- 2 oppositely charged leptons
- at least two jets
- at least one b-tag (2 for particle level)
- 76GeV< m_{ll}< 106GeV (not eμ)





Data-driven background model:

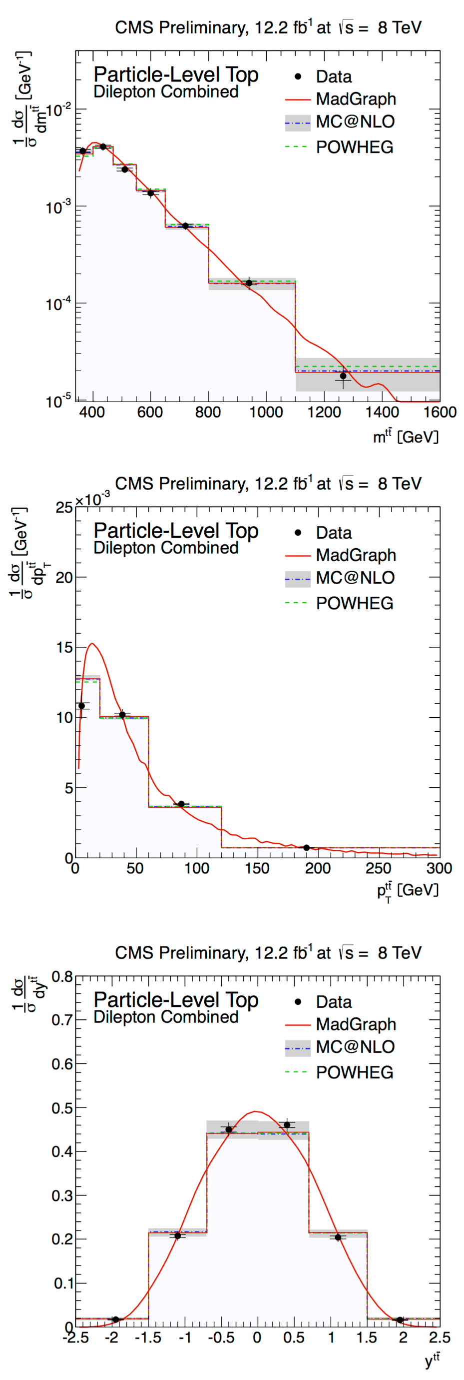
In the dilepton channel, the main source of background in the ee/μμ channels is expected to be from Drell-Yan pairs. We use a data driven approach to estimate the background outside the Z-mass veto region(76GeV< m_{ll} < 106GeV) from the data inside.

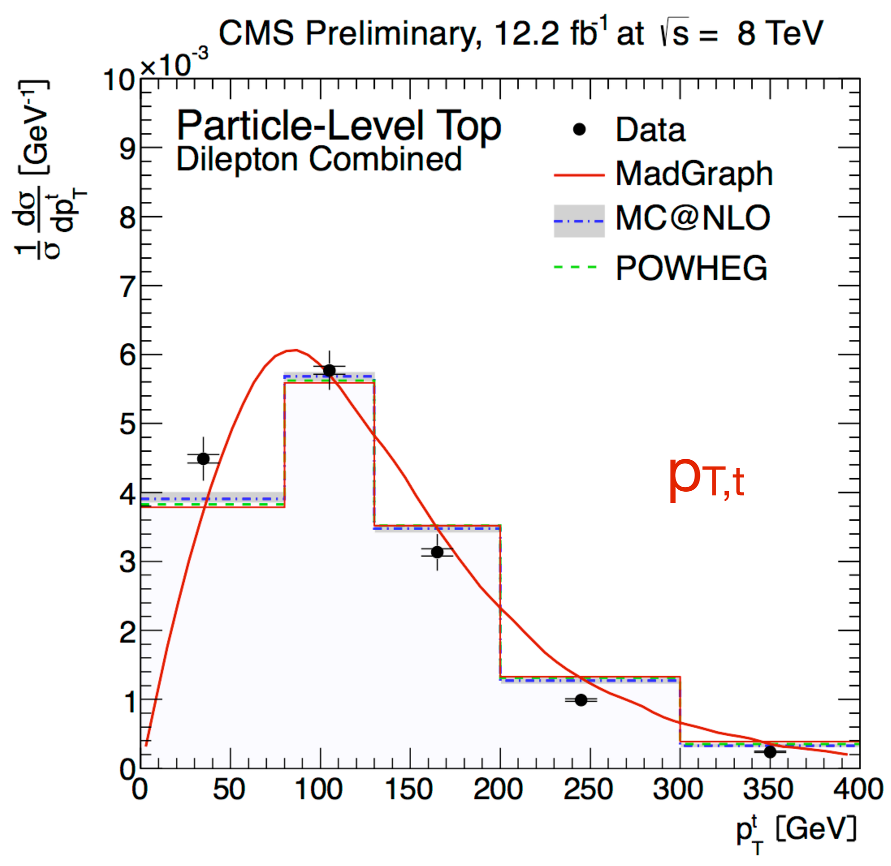
$$N^{ll}_{out} = R^{ll}_{out/in}(N^{ll}_{in} - 0.5N^{e\mu}_{in}k_{ll}) \qquad k_{\mu\mu} = \sqrt{\frac{N_{\mu\mu,loose}}{N_{ee,loose}}}$$

number expected bg events expected — Ratio inside and out (from MC) — Number inside — Number inside in eμ — Reconstruction efficiency

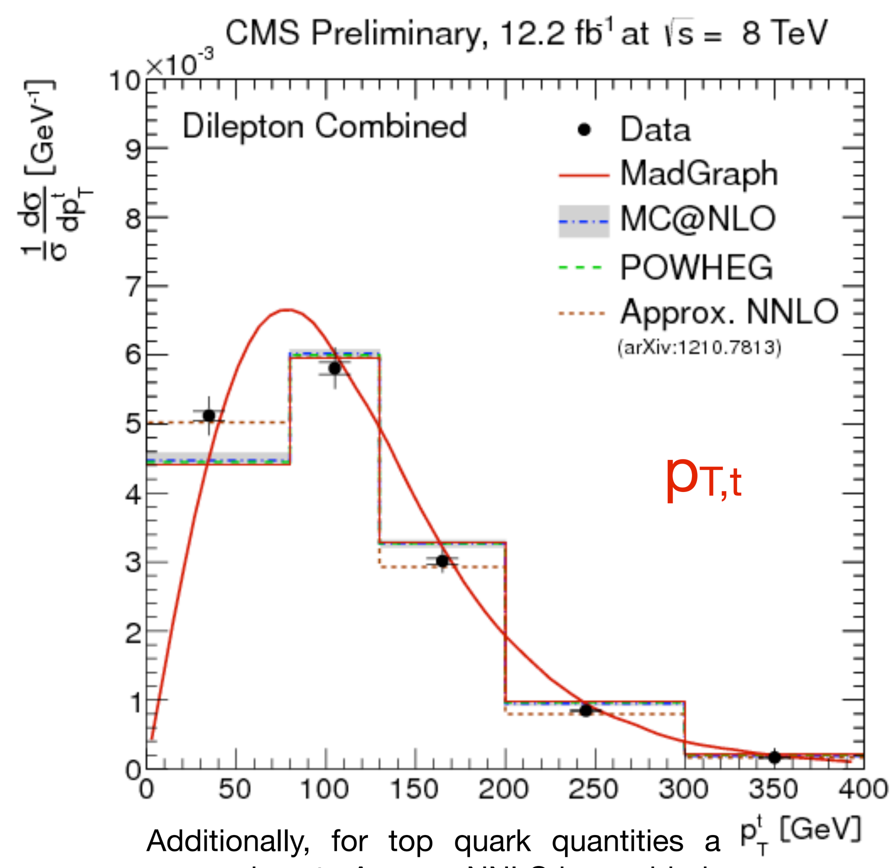
Results

Particle Level

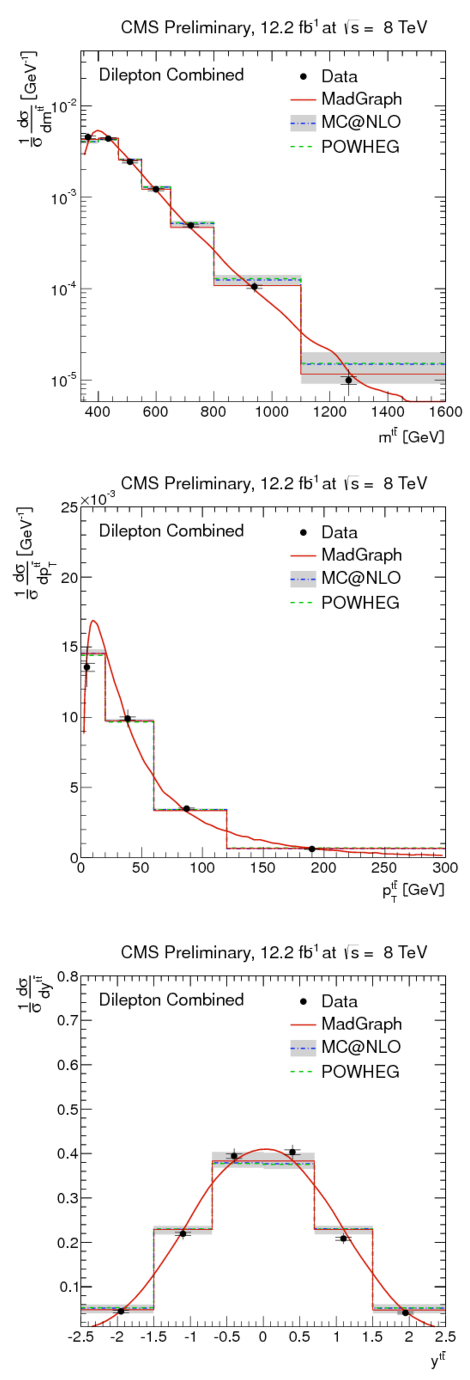




Parton Level



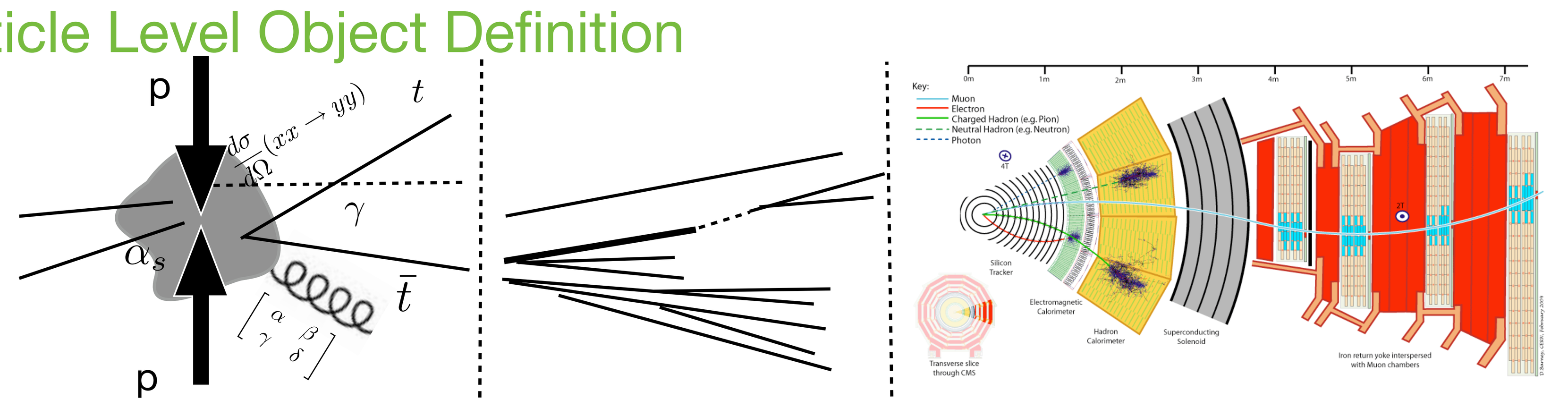
Additionally, for top quark quantities a comparison to Approx. NNLO is provided



In all results, the data points have been placed at the intersection of the fit to the MadGraph simulation (the curve) and the measurement in that bin (horizontal line).

Also shown are the binned results of the POWHEG simulation and the MC@NLO simulation. The MC@NLO has also been provided with one-sigma error bands.

Particle Level Object Definition



All generator objects reconstructed with stable generated particles

Leptons: four-vector sum of all photons in a 0.1 cone

MET: Four vector sum of two selected neutrinos

Jets: Anti-kT jets with size parameter 0.5

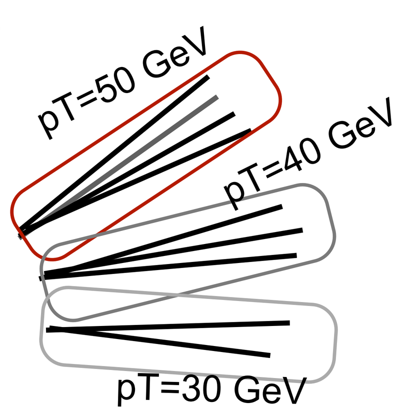
Reconstructed using all stable particles with parents from hadrons

B-tagging: "Ghost" tagging

Recluster the Generator Jets including B-Hadrons with pT~0

$$B^* \xrightarrow{decay} B^0 \xrightarrow{\times 10^{-20}} B^0$$

Final state B-hadron is scaled down and added to the particle list for clustering



Anti-kT algorithm clusters ghost B-Hadron with one jet

jet 4-vector remains unchanged!

Common definition developed with ATLAS!

Top System Reconstruction

Particle Level Objects

First, create the "pseudo-W" by summing the four vectors of the leptons and neutrinos (m_{Wx}) in both possible combinations. Choose the permutation that minimizes:

$$|m_{W1} - m_{W,true}| + |m_{W2} - m_{W,true}|$$

where mW,true = 80.4 GeV

For the pseudotop, we take the four-vector sum of the chosen two pseudo-W bosons with all particle-level tagged b-jets (m_{tx}) and choose the permutation that minimizes:

$$|m_{t1} - m_{t,true}| + |m_{t2} - m_{t,true}|$$

where mt,true = 173.5 GeV

Reconstructed Objects - Kinematic Reconstruction:

The system is underconstrained due to the presence of two neutrinos. We take these four-vectors

- 2 b-tagged (or leading) jets
- 2 leptons
- MET

and the constraints:

- m_W = 80.4 GeV
- m_{top} = $m_{antitop}$ = fixed
- $p_{T,\nu1}$ + $p_{T,\nu2}$ = MET

To solve the underconstrained system, the neutrino energy is fit to an MC spectrum and solutions are accepted for a top masse between 100-300 GeV in 1GeV increments. Solutions are then ranked according to number of b-tags and the match to the MC spectrum.

Systematic Uncertainties

By normalizing the differential cross section to unity many systematics cancel out, e.g. luminosity. The remaining systematics are primarily shape-only and reduced in magnitude. The uncertainties are calculated in each bin of measurement. Systematic uncertainties dominate the uncertainty in measurement

Conclusions

Good agreement seen between data and SM predictions.

Top pT observed to be softer than MC but well-described by Approx. NNLO.

Good agreement with l+jets (see poster by J. Lange TOP-12-027).

Full particle level definition developed and implemented!

Additional details and documentation

CMS PAS TOP-12-028

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