Measurement of differential $t\bar{t}$ cross sections at $\sqrt{s}$=8 TeV

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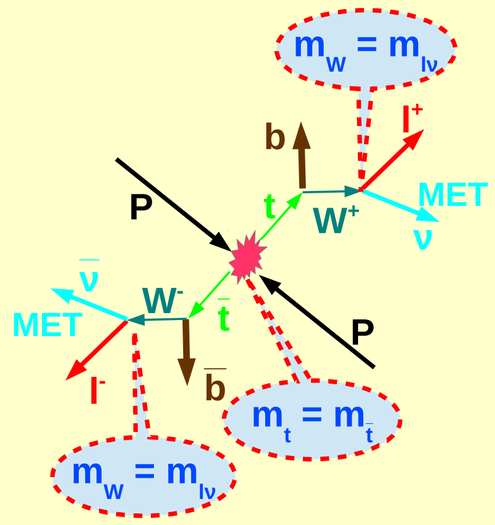
Introduction

The t-quark is important for various SM tests and sensitive to new physics.

The LHC is a t-quark factory. The data set collected in 2012 with the center-of-mass energy $\sqrt{s}$ = 8 TeV provides possibility for high precision measurement of t-quark production cross sections and properties.

The present work is a measurement of single differential normalized cross sections of $t\bar{t}$ pair production in the dilepton final state.



Event selection

At least two opposite sign leptons
- p_T >20 GeV/c
- $|\eta| < 2.4$
- $m_{ll} > 20$ GeV/c^2

At least two jets
- p_T >30 GeV/c
- $|\eta| < 2.4$

At least one jet b-tagged jet

For the same flavour channels
- $| m_{ll} - m_Z | > 15$ GeV/c^2
- $E_T^{Miss} > 40$ GeV/c

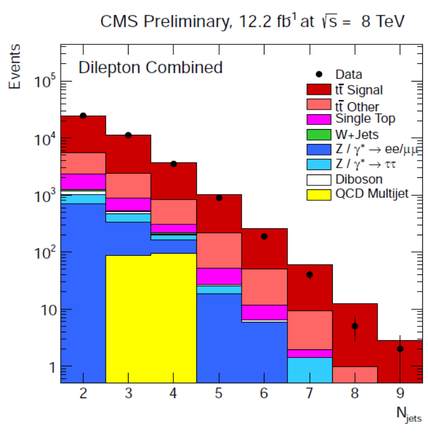
Event reconstruction

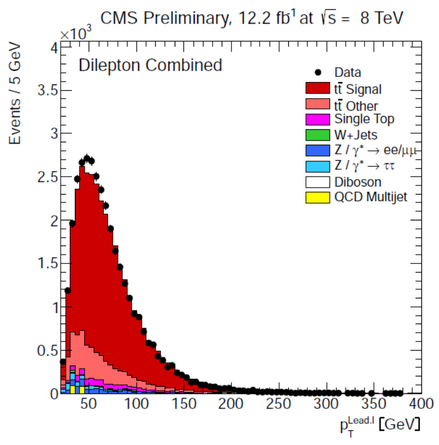
The decay products of the top contain two undetectable neutrinos measured as one object (MET) → event reconstruction needed.

Additional constrains:
- $E_T^{Miss} = p_T(\nu) + p_T(\bar{\nu})$
- $m_W = 80.4$ GeV
- $m_t = m_{\bar{t}} = 172.5$ GeV

Correction for detector effects
- m_t varied in 1 GeV steps, in range [100...300] GeV

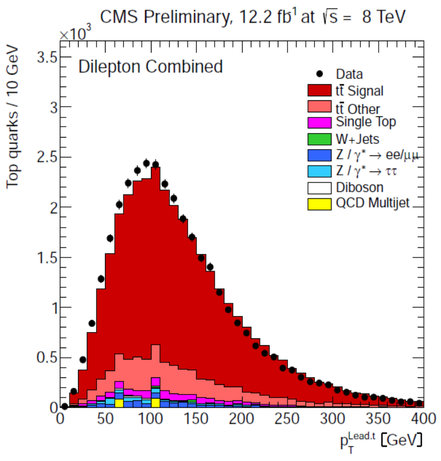
Prefer solutions with:
- b-tagged jets
- most probable ν spectrum

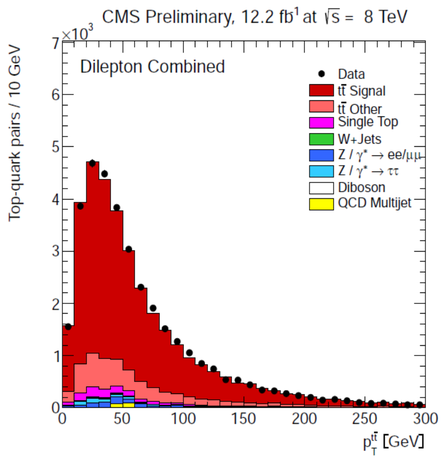


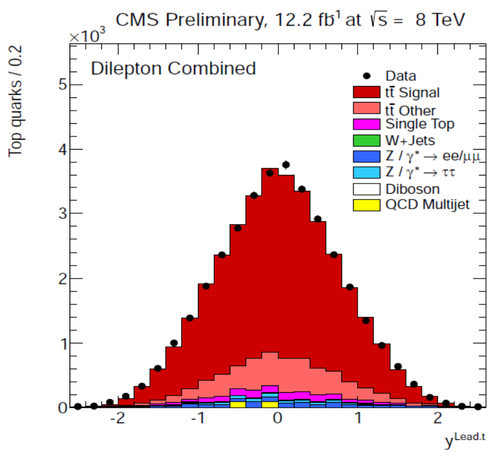


Control Plots

- Jet multiplicity (top left)
- Leading lepton p_T (top right)
- Leading top p_T (bottom left)
- $p_T(t\bar{t})$ (bottom center)
- t-quark *y* (bottom right)







Cross section determination

The normalized differential cross section in bins of the variable X is defined as:

$$\frac{1}{\sigma}\frac{d\sigma^i}{dX} = \frac{1}{\sigma}\frac{\sum_{i,j} A_{ij}^{-1}\left(N_{data}^j - N_{bg}^j\right)}{\Delta X^i \epsilon^i L}$$

correlation matrix; number of signal events; luminosity; inclusive cross section; bin width; efficiency

- **Migration corrections:** Singular Value Decomposition Unfolding (based on MadGraph+Pyhtia)
  - **Correlation between bins:** correlation matrix
- **Unfolding** performed separately for each decay channel
- Final result obtained from the **statistical combination** of all channels.
- Differential cross sections in bins of t-quark quantities are corrected to the **full phase space**
- In bins of the lepton and b-jet variables measurement is done in the **visible phase space:**

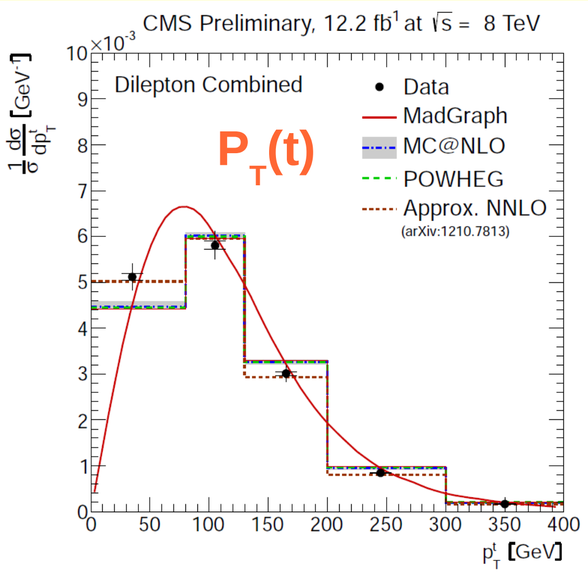
For leptons	For b-jets
• p_T > 20 GeV	• p_T > 30 GeV
• $\|\eta\| < 2.4$	• $\|\eta\| < 2.4$

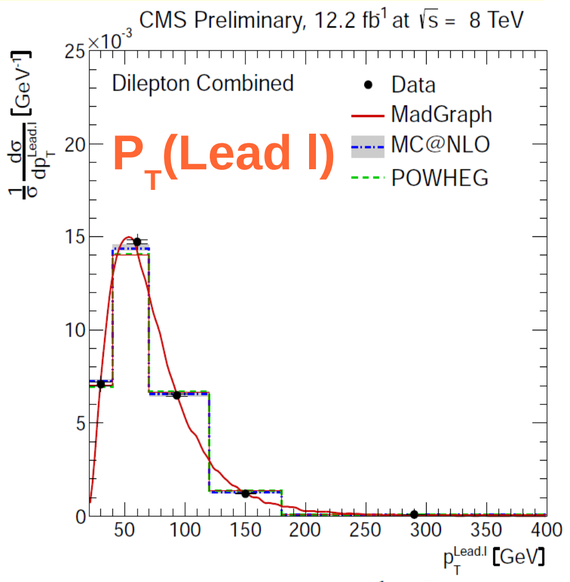
RESULTS

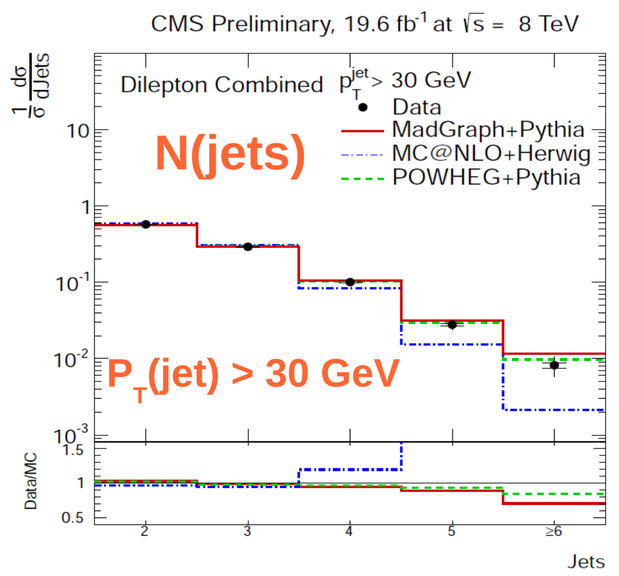
The measurement of the normalized differential cross sections of $t\bar{t}$ production is shown in bins of $p_T(t)$, p_T(leding l), jet multiplicity, $p_T(l\bar{l})$, $p_T(t\bar{t})$ and $m(t\bar{t})$.

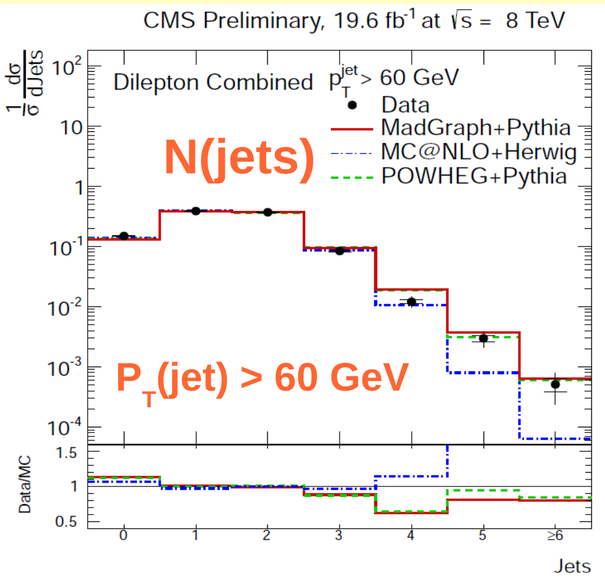
The 2012 data set was used.

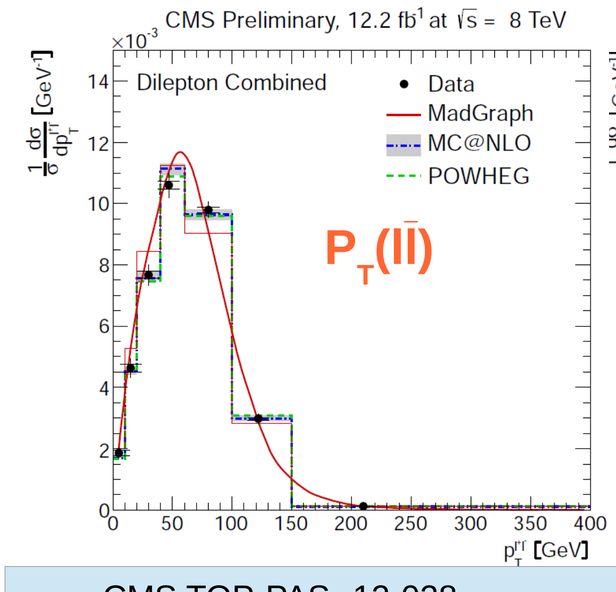
The systematic uncertainties are determined separately for each bin by variation of efficiency correction factors, signal simulation with varied simulation parameters, jet-parton matching scale, Q^2-scale, t-quark mass. The main source of systematic uncertainties are the Q^2-scale variation (typically 4%), JES variation (typically 3%) and matching (typically 3%).

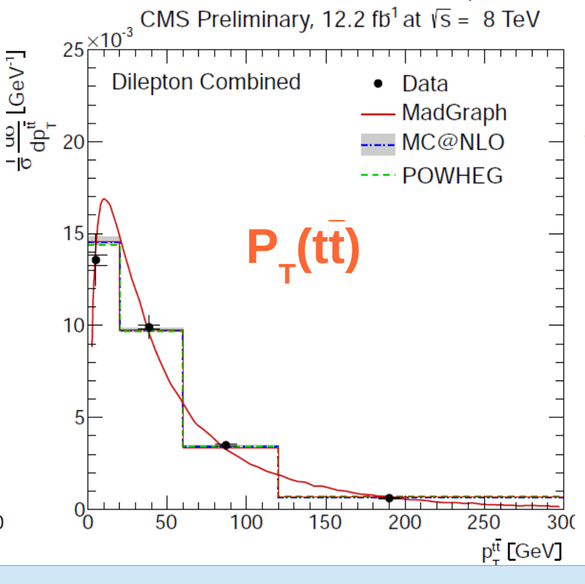


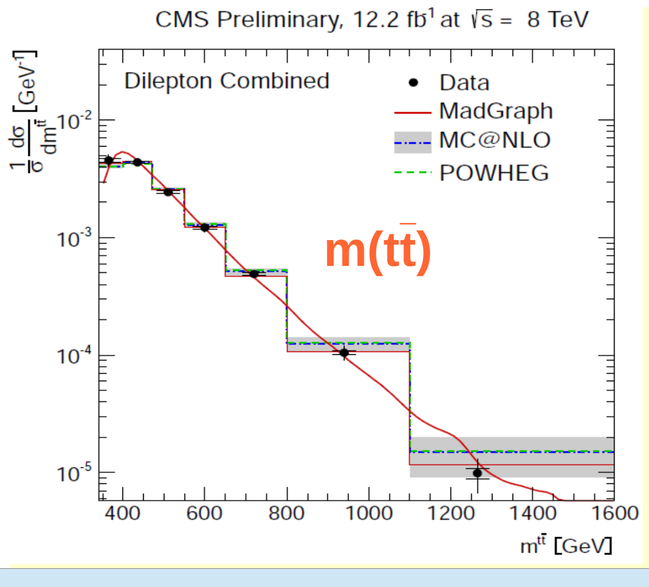












Summary

- The normalized differential $t\bar{t}$ production cross sections were measured for the 2012 data set
- In general a good agreement with SM predictions is observed
- The t-quark distributions agree the best with approx. NNLO
- High jet multiplicities prefer POWHEG+Pythia

Documentation

CMS TOP-PAS--12-028
https://cds.cern.ch/record/1523664

CMS TOP-PAS--12-041
https://cds.cern.ch/record/1547532