

Measurement of Normalized Differential $t\bar{t}$ Production Cross-Section



Ivan Asin Cruz
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Introduction

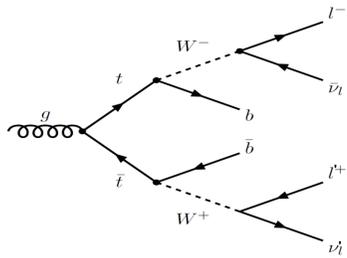
Within the Standard Model (SM) the top quark plays an important role:

- t -quark physics important **test of SM**
- sensitive to **gluon PDF** at high x
- sensitive to **ISR/FSR**
- tuning of theories and models
- new physics can be evident in top final states

The LHC 2012 data taking period:

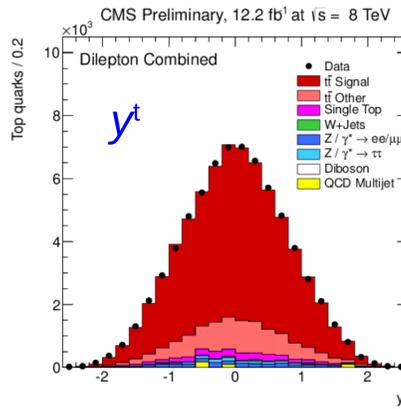
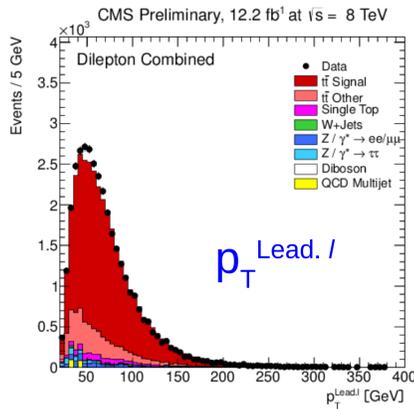
- produced a large number of $t\bar{t}$ events, $\sim 5M$
- allows **precision measurements of SM**
- in a new energy regime $\sqrt{s} = 8$ TeV

In this analysis, normalized differential cross section is measured in the $t\bar{t}$ pair dilepton decay channel.



Event Selection

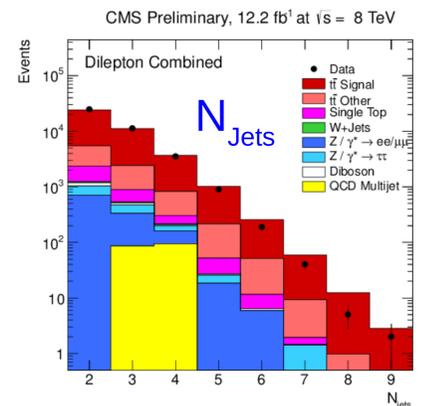
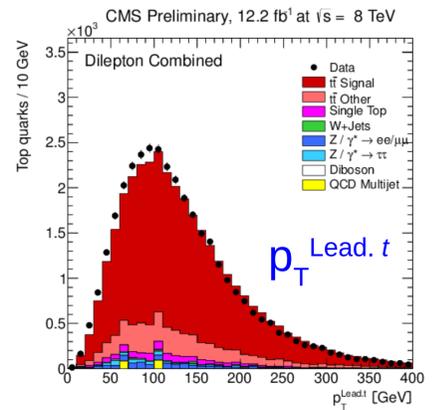
- ≥ 2 isolated leptons (e or μ)
- opposite sign
- $p_T > 20$ GeV/c
- $|\eta| < 2.4$
- $m_{ll} > 20$ GeV/c²
- ≥ 1 b-tag jet
- ≥ 2 jets
- $p_T > 30$ GeV/c
- $|\eta| < 2.4$
- In ee or $\mu\mu$ channels
- $|m_{ll} - m_z| > 15$ GeV/c²
- $E_T^{Miss} > 40$ GeV/c



$t\bar{t}$ Event Reconstruction

t -quark directly not measurable \rightarrow event reconstruction.
Input: reconstructed leptons, jets and E_T^{Miss}

- System underconstrained due to 2 ν 's
- $E_T^{Miss} = p_T(\nu) + p_T(\bar{\nu})$
- $m_W = 80.4$ GeV
- $m_t = m_{\bar{t}} = \text{fixed}$
- m_t varied in 1 GeV steps, in $m_t \in [100, 300]$
- Prefer solutions with
- b-tagged jets
- most probable ν spectrum



Unfolding & Normalized Differential Cross-Section

Correct the measurement for migrations:

- due to the finite experimental resolution

Method:

- regularized unfolding
- to **minimize** global bin-by-bin **correlations**

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

Correlation Matrix A_{ij} \rightarrow $t\bar{t}$ signal events

Inclusive cross-section σ Binwidth ΔX^i Efficiency $\epsilon^i L$

Normalized differential cross section measured in:

- full phase space: t -quark and $t\bar{t}$ pair properties
- visible phase space: lepton and/or jet properties

Visible Phase Space

- Leptons**
- $p_T > 20$ GeV
- $|\eta| < 2.4$
- b-jets**
- $p_T > 30$ GeV
- $|\eta| < 2.4$

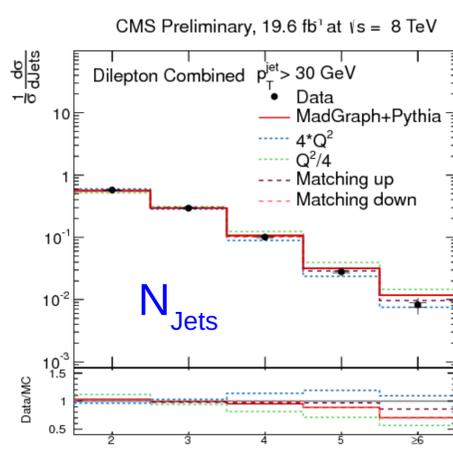
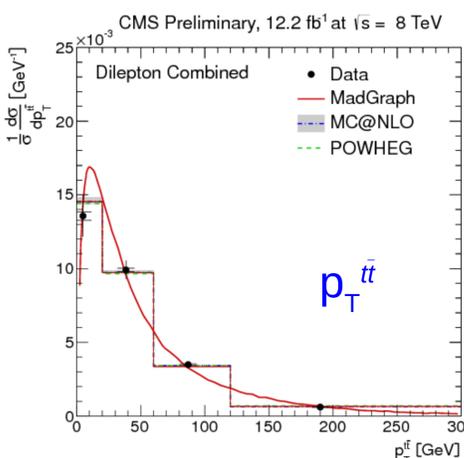
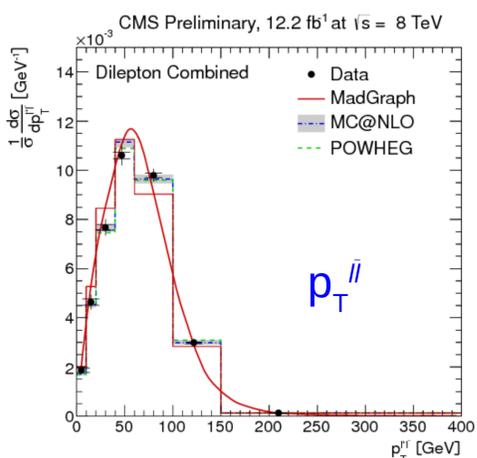
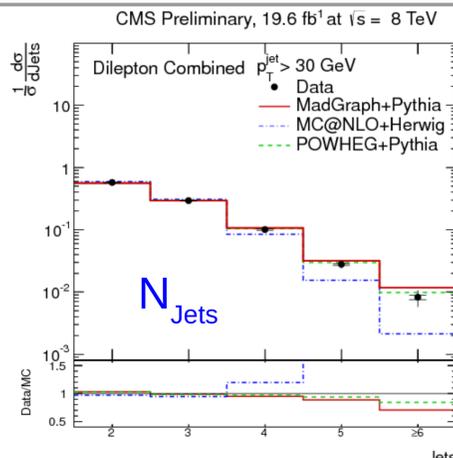
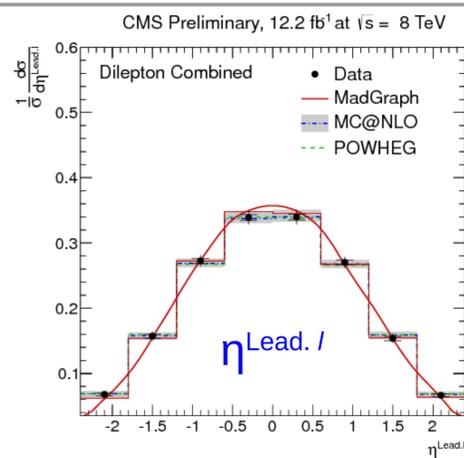
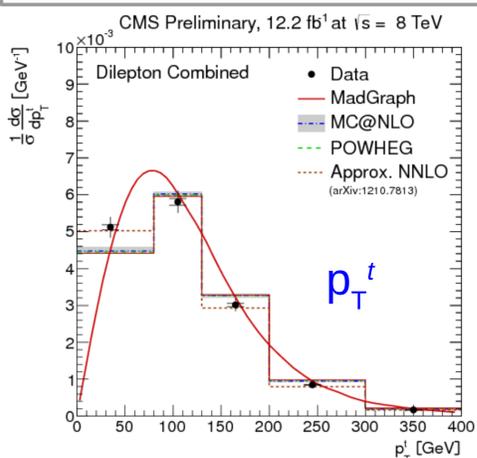
Plots:

- Leading lepton p_T (top left)
- Top quark y (top center)
- Leading top p_T (right top)
- Jet multiplicity (right bottom)

First CMS differential cross-section measurements at $\sqrt{s} = 8$ TeV are shown as function of transverse momentum, (pseudo-)rapidity, multiplicity (in different p_T thresholds) and invariant mass of the final state lepton, lepton-pair, b-jet, top quark and $t\bar{t}$ system.

Results

Results are compared to several predictions from MadGraph+Pythia, POWHEG+Pythia, MC@NLO+Herwig and Approx. NNLO (when available). The results as a function of jet multiplicities are also compared to predictions from MadGraph with varied Q^2 scale and jet-parton matching thresholds.



Uncertainties

- Estimated independently in:
- each bin
 - each distribution
 - each channel
- Global uncertainties cancel out due to normalization.
- Main uncertainties:
- Q^2 scale: 1-4%
 - Matching: 1-3%
 - JES: 1-3%

Summary

- Results show:
- good agreement with SM predictions
 - t -quark distributions seem to prefer Approx. NNLO predictions
 - better description of high jet multiplicities by:
 - MadGraph and POWHEG (interfaced with PYTHIA)
 - MadGraph with increased scales

