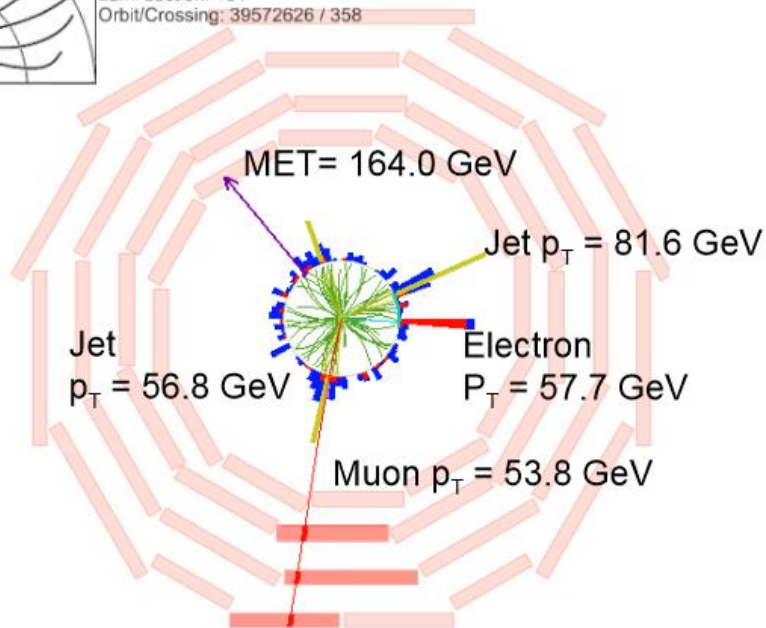


Measurement of the inclusive $t\bar{t}$ cross section in the $e\mu$ channel



CMS Experiment at LHC, CERN
Data recorded: Wed Jul 8 19:26:24 2015 CEST
Run/Event: 251244 / 83494441
Lumi section: 151
Orbit/Crossing: 39572626 / 358



Till Arndt for the CMS Collaboration
TOP 2015
Ischia, 15.09.2015

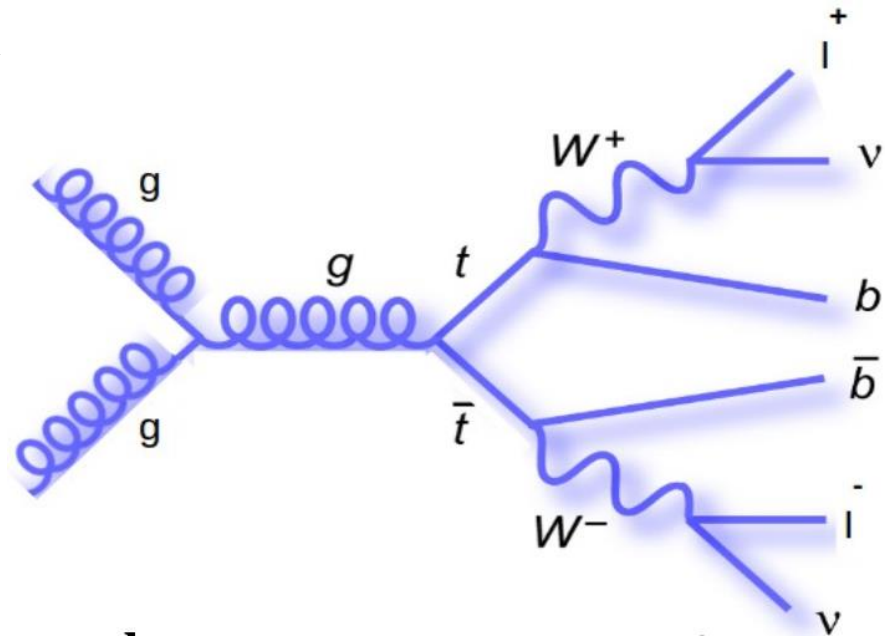
Introduction

- Why is the top pair production cross section important ?
 - First test of possible BSM contributions at new energy
 - Important background for many searches (SUSY, W')
 - Test of perturbative QCD
 - First step to further measurements in top physics
- Goals of this Analysis: Provide a robust first measurement
- Cut & Count approach
- Further information:
 - CMS-PAS-TOP-15-003
 - See also: „Inclusive top pair production at 7,8 and 13 TeV in CMS” by Shannon Crucy
„Inclusive top-quark pair cross section measurement in the CMS detector with the cut&count method” by Juan Rodrigo Gonzalez Fernandez

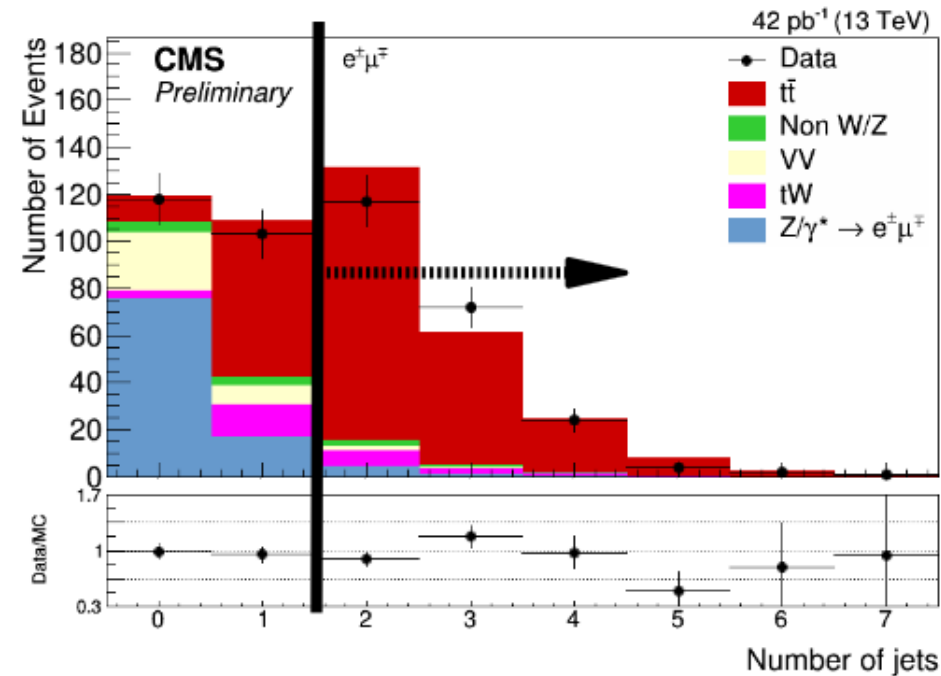


Analysis Setup

- Luminosity: 42 pb^{-1} (50 ns run in July 2015)
- MC: Powhegv2 + Pythia8 as nominal $t\bar{t}$ sample
 - Systematics: aMC@NLO + Pythia8 , Powhegv2 + Herwig++
 - Backgrounds: aMC@NLO+Pythia8 (Drell Yan, W+Jets), Powhegv2 + Pythia8 (single top) and Pythia8 (Di-boson)
- Trigger: Di-lepton $e\mu$ cross trigger
- Selection
 - ≥ 2 OS leptons ($1e, 1\mu$), $p_T > 20 \text{ GeV}$, $|\eta| < 2.4, m_{e\mu} > 20 \text{ GeV}$
 - 2 Jets with $p_T > 30 \text{ GeV}$ and $|\eta| < 2.5$
- Final result:
$$\sigma(t\bar{t}) = \frac{N_{\text{Data}} - N_{\text{Bkg}}}{A \cdot \epsilon \cdot \text{BR} \cdot \int dt L}$$



Event Yields



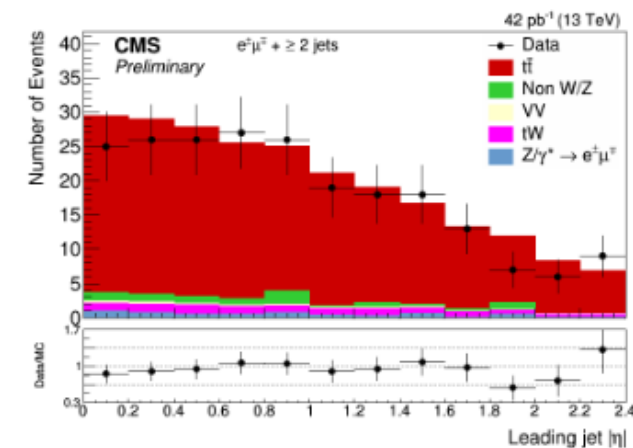
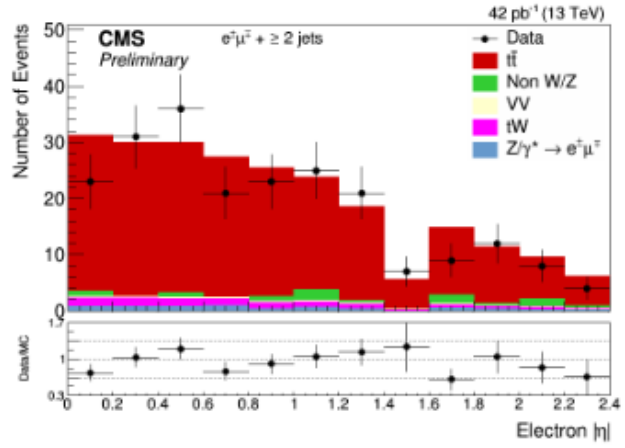
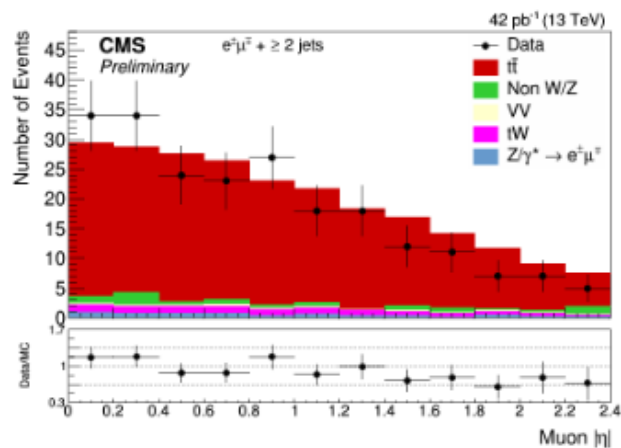
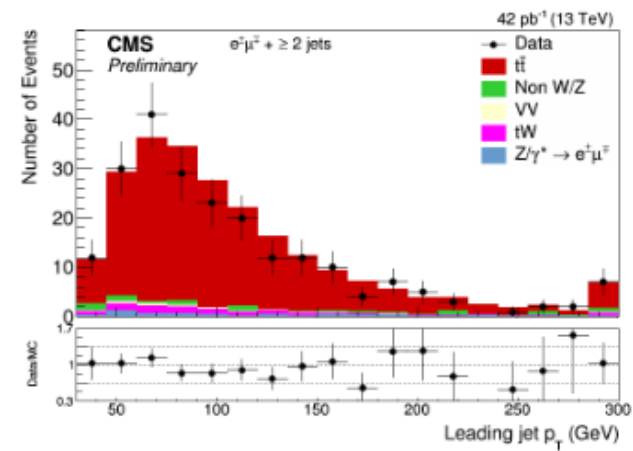
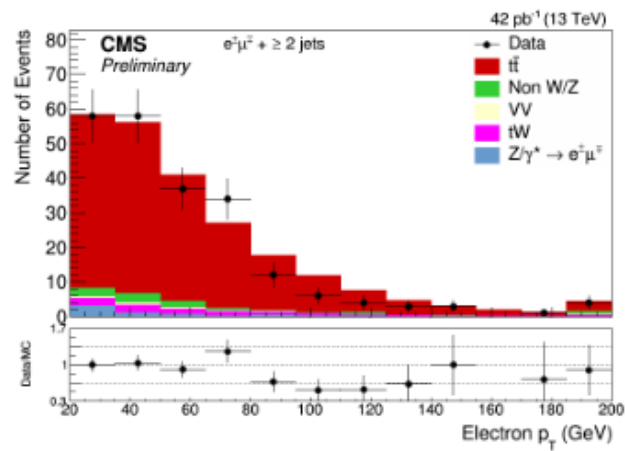
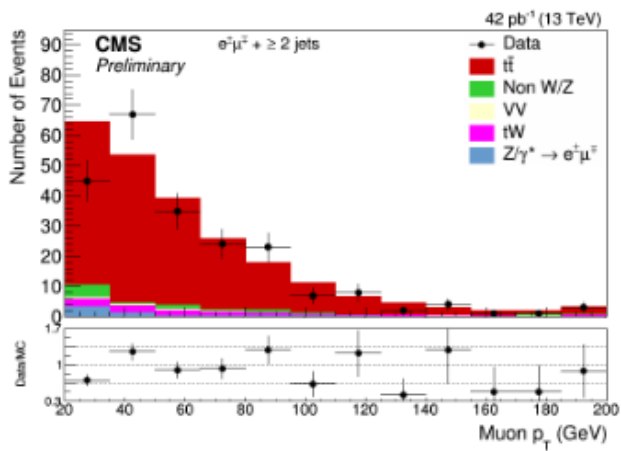
Source	Number of events $e^+\mu^-$
Drell–Yan	6.4 ± 1.2
Non-W/Z leptons	8.5 ± 4.3
Single top quark	10.6 ± 3.4
VV (V = W or Z)	2.6 ± 0.9
Total background	28.1 ± 5.7
$t\bar{t}$ dilepton signal	207 ± 16
Data	220

➤ Background estimation (single top and di-boson from MC)

- DY MC prediction normalized to Z peak in data
- Non W/Z : estimated from same-sign control region with scale factor from MC



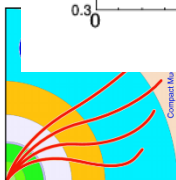
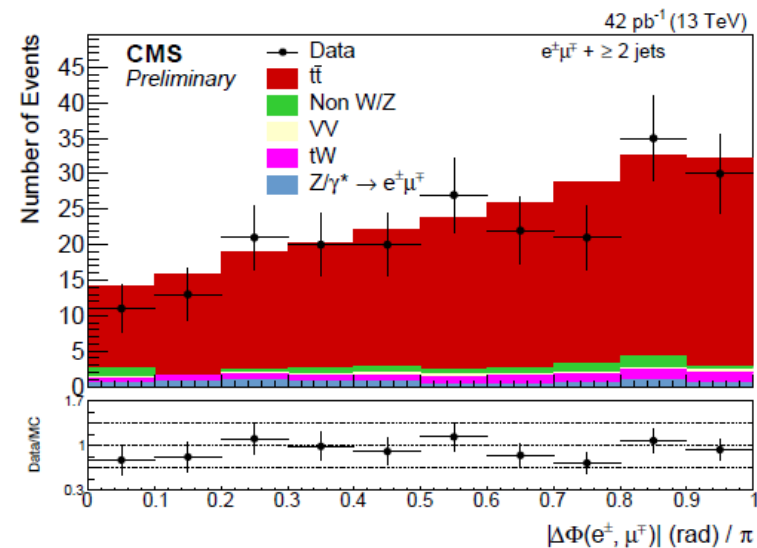
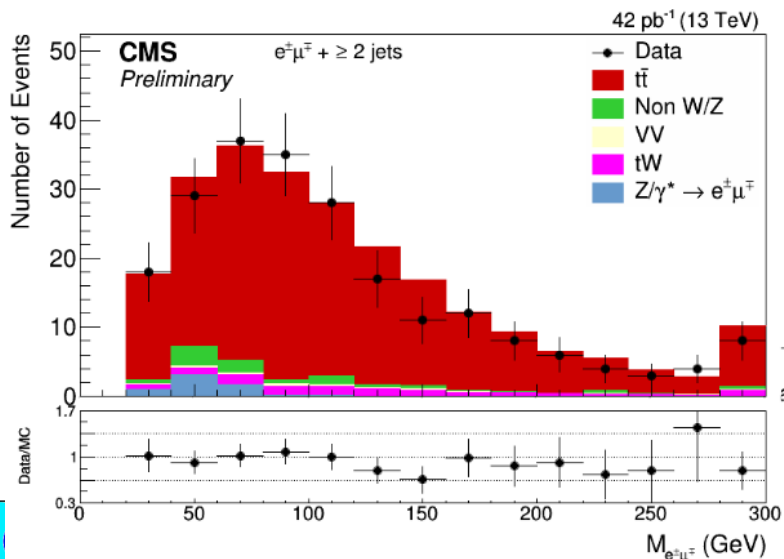
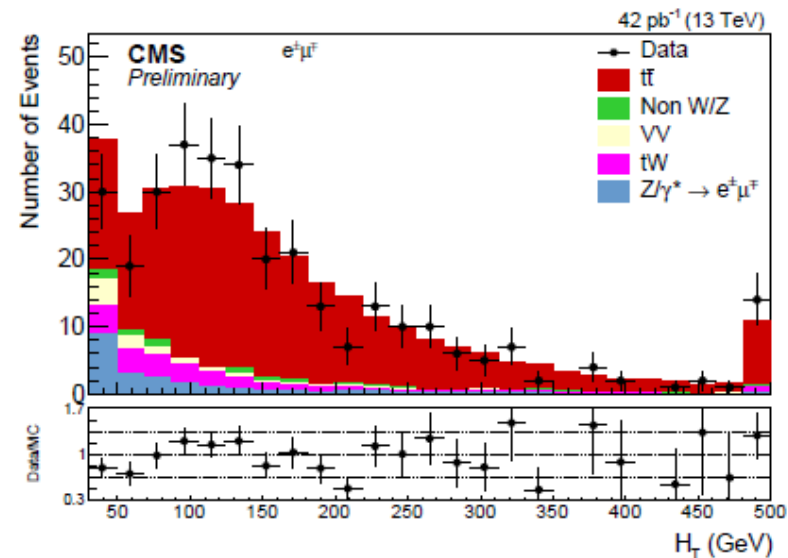
Kinematic distributions: Event Reconstruction



Kinematic Distributions: New physics ?

➤ First look at observables potentially sensitive to new physics

- E.g. M_{ll} and $|\Delta\phi(e, \mu)|$ (spin correlations)
- No hints yet, but very low statistics



Systematic Uncertainties

> Statistical uncertainty on same order as systematic uncertainty (without luminosity)

> Dominant Systematic uncertainties

- Luminosity (preliminary, results from VdM scan expected soon)
- Trigger efficiencies: Estimated from monitoring triggers
- Lepton ID/ISO
- Jet energy scale: Derived from a 4% flat uncertainty

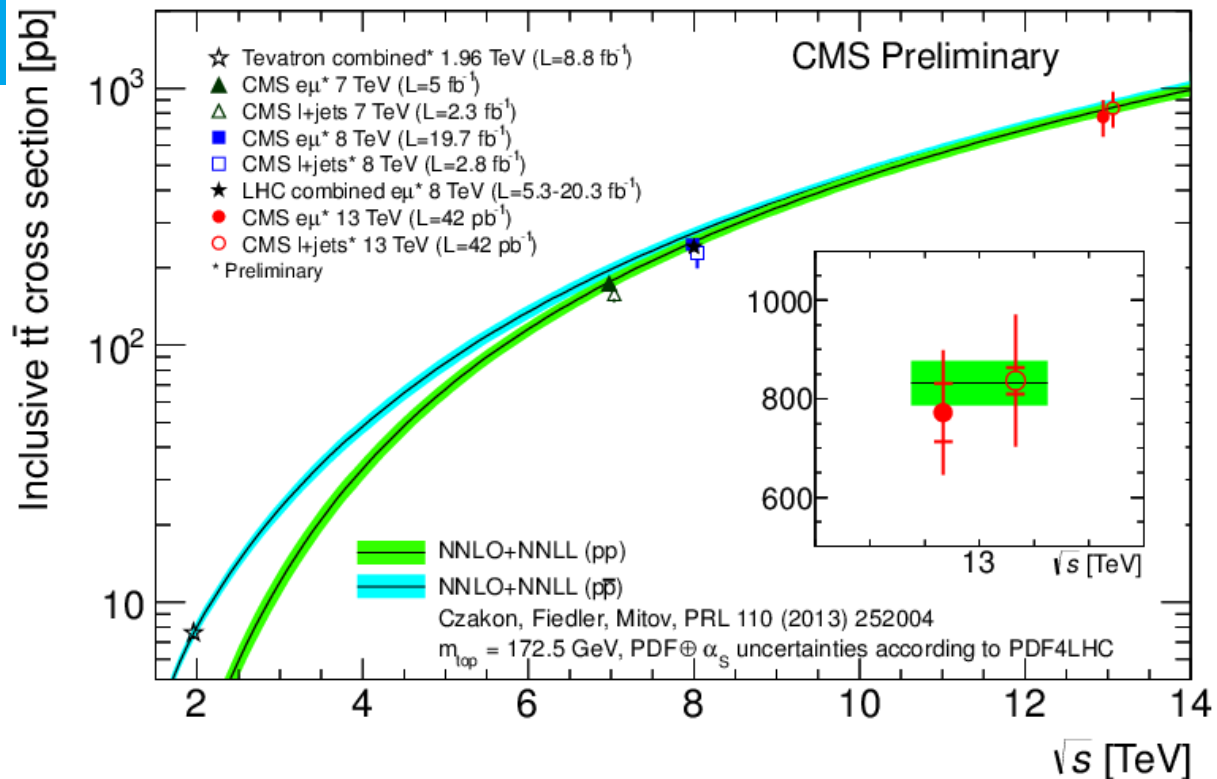
> All main contributions expected to be reduced

Source	$\Delta\sigma_{t\bar{t}}$ (pb)	$\Delta\sigma_{t\bar{t}}/\sigma_{t\bar{t}}$ (%)
Data statistics	60	7.7
Trigger efficiencies	39	5.0
Lepton efficiencies	33	4.3
Lepton energy scale	< 1	≤ 0.1
Jet energy scale	20	2.6
Jet energy resolution	< 1	≤ 0.1
Pileup	2.8	0.4
Scale (μ_F and μ_R)	1.5	0.2
$t\bar{t}$ NLO generator	15	1.9
$t\bar{t}$ hadronization	14	1.8
PDF	12	1.5
Single top quark	14	1.8
VV (V = W or Z)	3.5	0.5
Drell-Yan	3.9	0.5
Non-W/Z leptons	8	1.0
Total systematic (no integrated luminosity)	62	8.0
Integrated luminosity	93	12
Total	126	16.4



Results

- Agreement between CMS, ATLAS and theory



- Cross section results:

- Result: $772 \pm 60(\text{stat.}) \pm 62(\text{syst.}) \pm 93(\text{lumi.}) \text{ pb}$
- CMS $l+jets$: $836 \pm 27(\text{stat.}) \pm 88(\text{syst.}) \pm 100(\text{lumi.}) \text{ pb}$ (CMS-PAS-TOP-15-005)
- ATLAS result: $825 \pm 49(\text{stat.}) \pm 60(\text{syst.}) \pm 83(\text{lumi.}) \text{ pb}$ (ATLAS-CONF-2015-033)
- Theory (NNLO+NNLL): $832^{+40}_{-46} \text{ pb}$ (Czakon, Fiedler, Mitov, PRL 110 (2013), 252004)

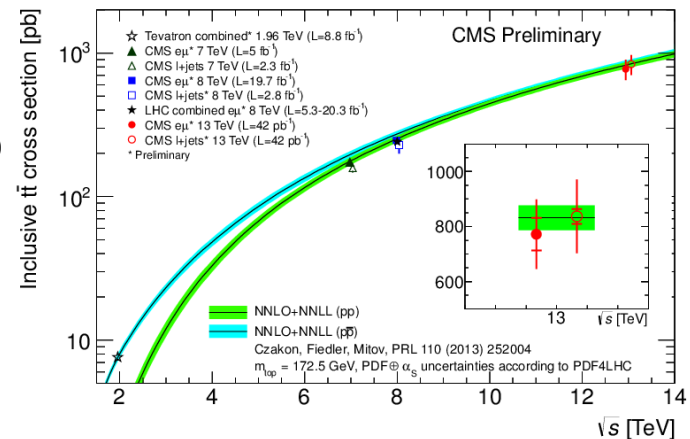


Conclusions

➤ We measured the top cross section at 13 TeV

in the di-leptonic channel with CMS

- $\sigma(t\bar{t}) = 772 \pm 60(\text{stat.}) \pm 62(\text{syst.}) \pm 93(\text{lumi.})\text{pb}$
- Agreement between experiments and theory
- Basis for further analyses



Thank you for your Attention

