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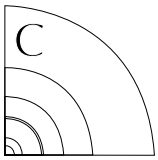


CERN-PH-EP / 2012-322
2013 / 05 / 01

CMS-TOP-11-013

Measurement of differential top-quark-pair production cross sections in pp collisions at $\sqrt{s} = 7$ TeV

The CMS Collaboration

1 Introduction

Measurements of top-quark production cross section and properties have played a major role in testing the standard model (SM) and in searches for new physics beyond it. The large top-quark production rates at the Large Hadron Collider (LHC) give access to a new realm of precision measurements. For the first time, the $t\bar{t}$ pair production rate is sufficiently high to perform a detailed and precise measurement of the $t\bar{t}$ production cross section differentially as a function of various kinematic observables in $t\bar{t}$ events [1]. These measurements are crucial to verify the top-quark production mechanism at the LHC energy scale in the context of SM predictions with various levels of perturbative quantum chromodynamics (QCD) approximations.

and the muon system. They are required to have $p_T > 30\,\text{GeV}$ and $|\eta| < 2.1$ for the ℓ+jets channels, while in the dilepton channels the corresponding selections require $p_T > 20\,\text{GeV}$ and $|\eta| < 2.4$. Isolated muon candidates are selected if they fulfil

more than two leptons, only the lepton pair with the highest p_T sum is considered. Events with an invariant mass of the lepton pair smaller than 12 GeV are removed in order to suppress events from heavy-flavour resonance decays. Dilepton events are required to have at least two jets. At least one of the jets is required to be identified as a b jet to reduce the background contribution. In addition, backgrounds from Z+jets processes in the m^+m and e^+e channels

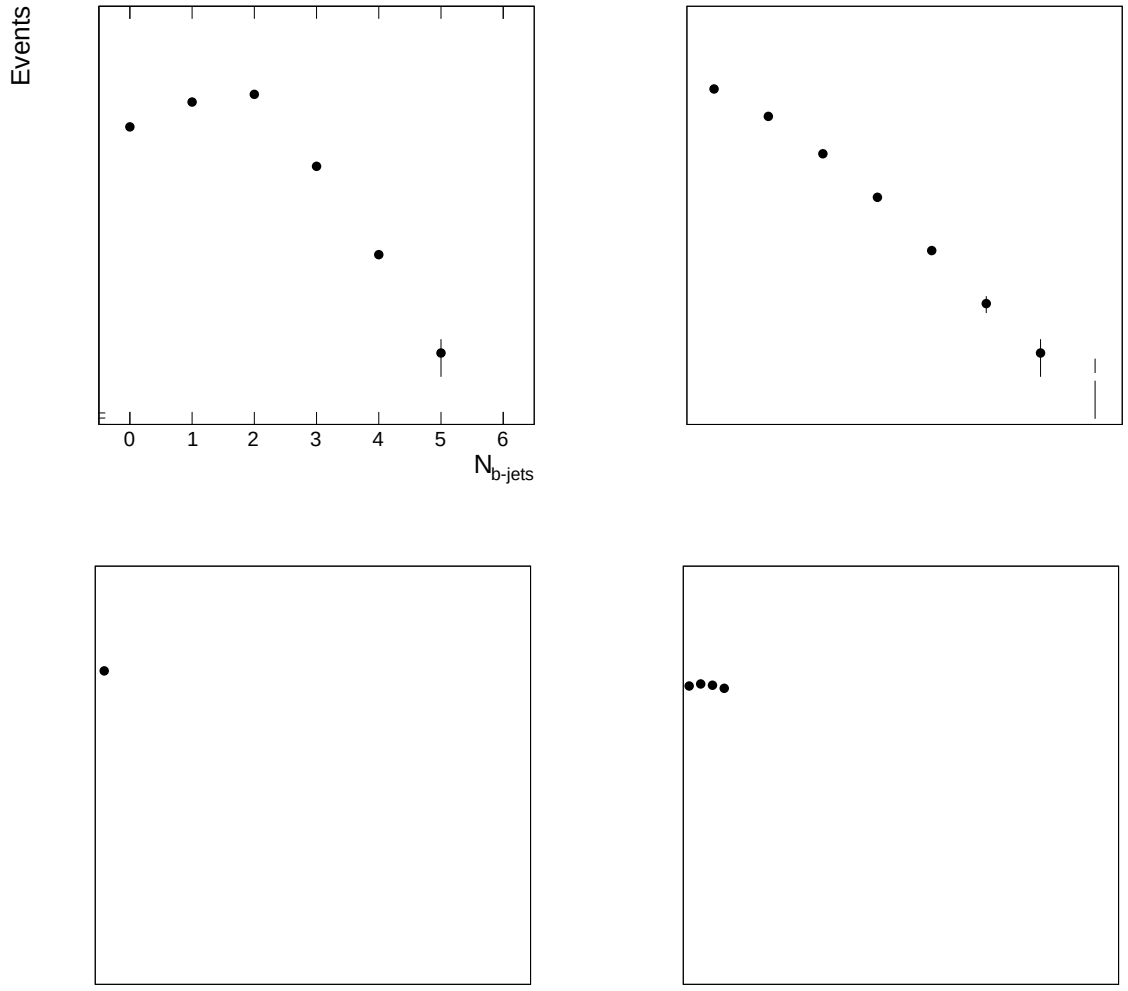


Figure 2: Basic kinematic distributions after event selection for the dilepton channels. The top left plot shows the multiplicity of the reconstructed b-tagged jets. The multiplicity of the reconstructed jets (top right), the p_T of the selected isolated leptons (bottom left), and the p_T of the reconstructed jets (bottom right) are shown after the b-tagging requirement. The Z/g +jets background is determined from data (cf. Section 4.2).

component of the neutrino is treated as a free parameter. Moreover, the fit is constrained to reconstruct two W bosons, each with a mass of 80.4 GeV, and top quark and antiquark with

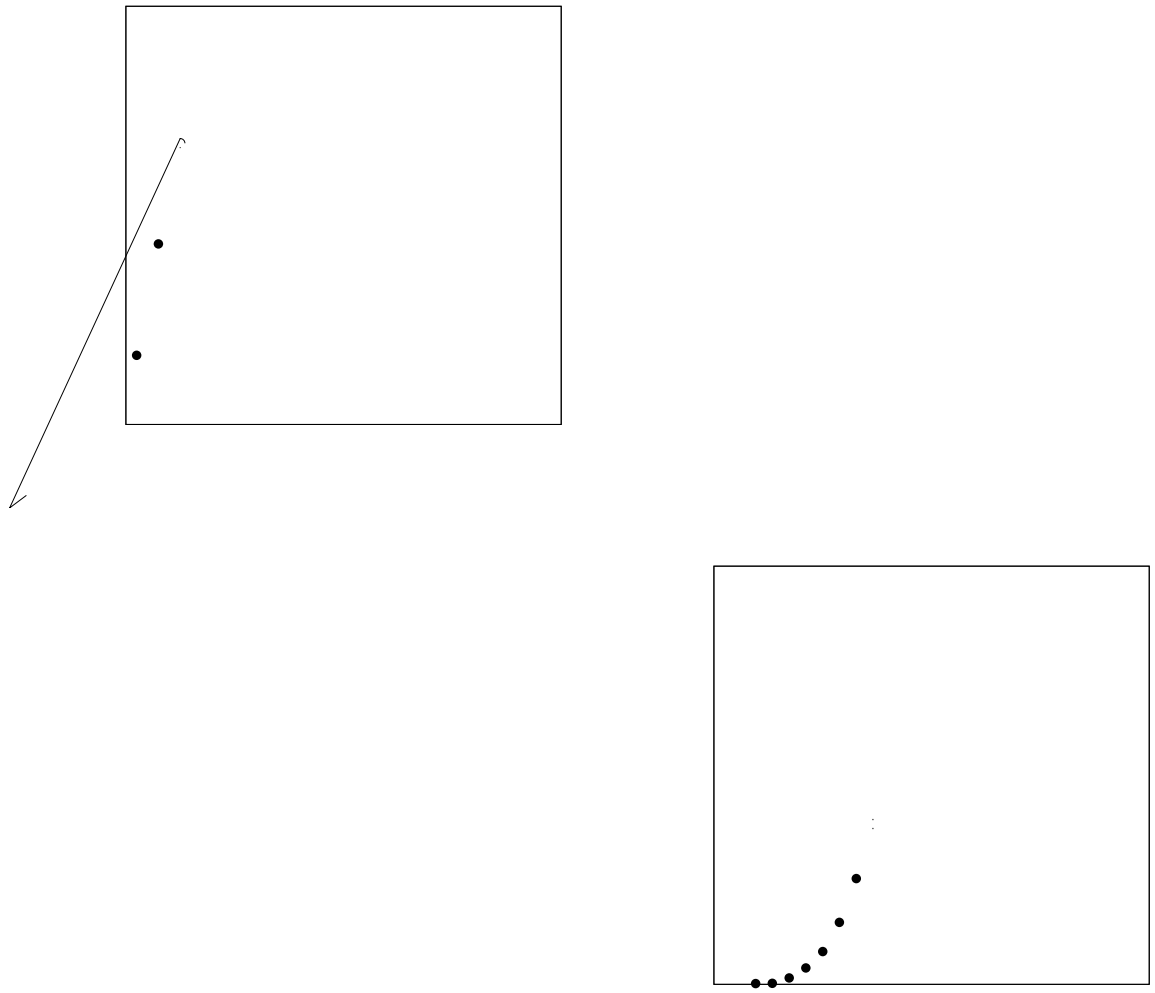


Figure 4: Distribution of top-quark and $\bar{t}$

section, which is determined to be 73.5 mb [43]. The systematic uncertainty is determined by varying this cross section within its uncertainty of 8%.

5.2 Model Uncertainties

The impact of theoretical assumptions on the measurement is determined by repeating the analysis, replacing the standard MADG

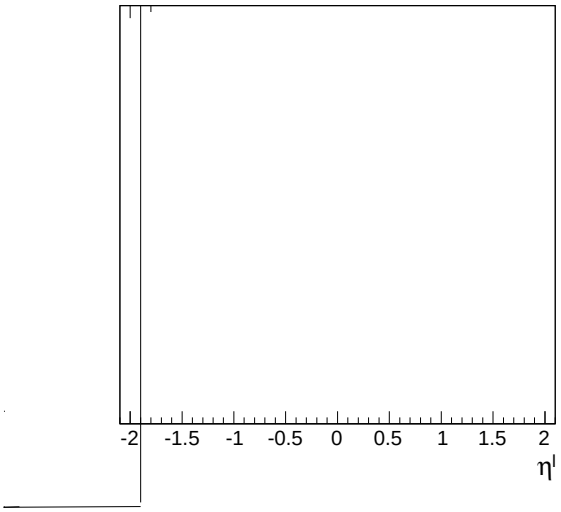
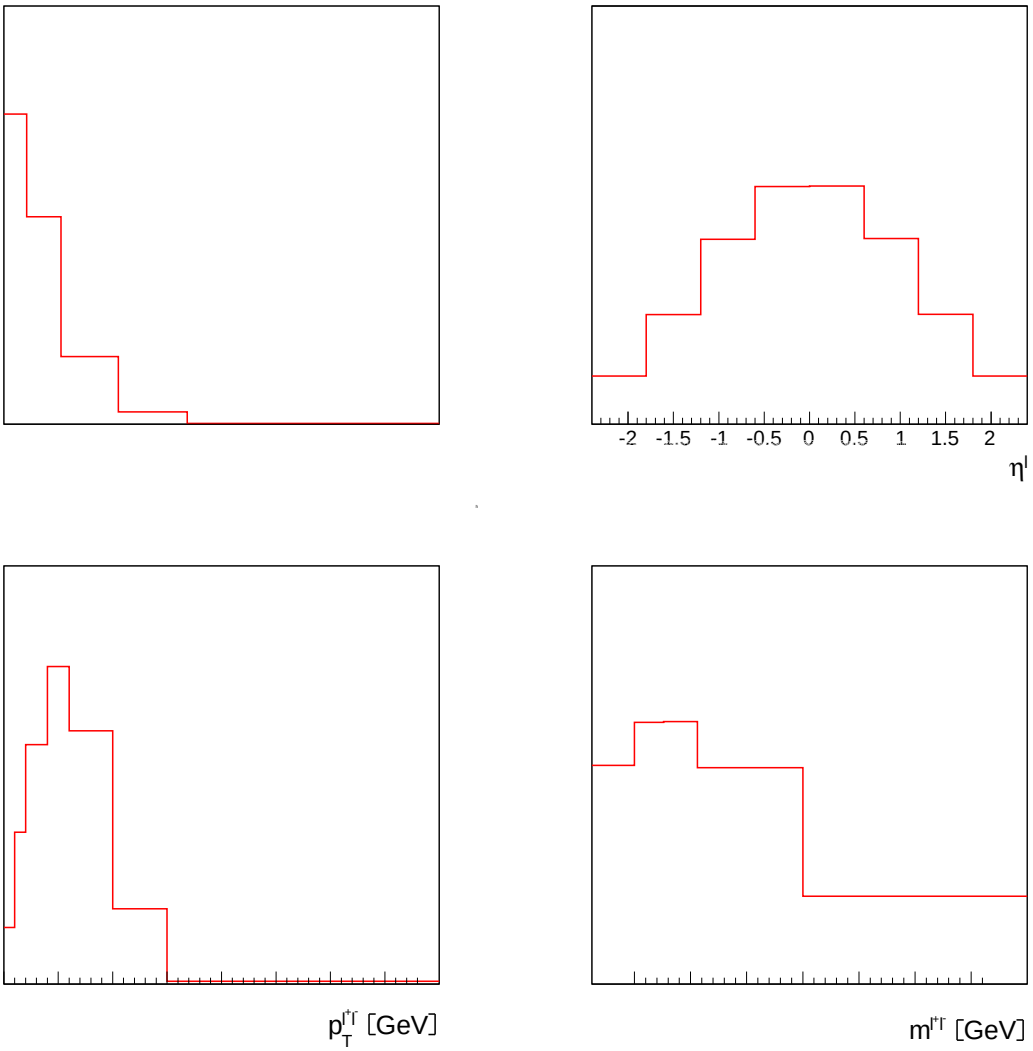


Figure 5: Normalised differential $t\bar{t}$ production cross section in the ℓ+jets channels as a function of the p_T^{ℓ} (left) and h^{ℓ} (right) of the lepton. The superscript 'ℓ' refers to both ℓ^+ and ℓ^-. The inner (outer) error bars indicate the statistical (combined statistical and systematic) uncertainty. The

which there exists some discrepancy between the different generators.



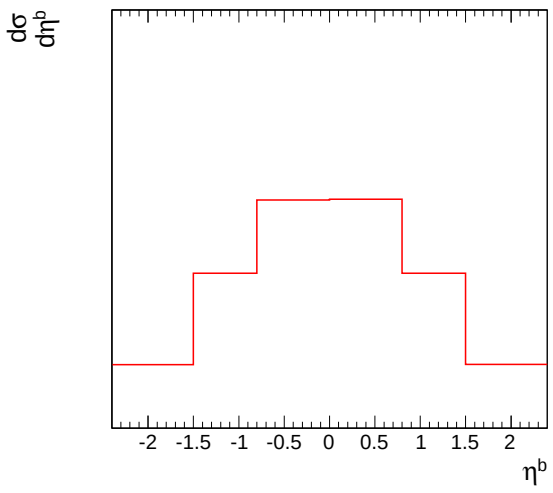


Figure 8: Normalised differential $t\bar{t}$ production cross section in the dilepton channels as a function of the p_T^b (left) and h^b (right) of the b jets. The superscript 'b' refers to both b and $b\bar{b}$ jets. The inner (outer) error bars indicate the statistical (combined statistical and systematic)

Figure 9: Normalised differential $t\bar{t}$ production cross section in the `+jets channels as a function of the p_T^t (top left) and y^t

References

[1] ATLAS Collaboration, "Measurements of top quark pair relative differential cross-sections with ATLAS in pp collisions at $\sqrt{s}$ = 7 TeV", (2012). arXiv:hep-ex/1207.5644.

[2] C. T. Hill, "Topcolor: top quark condensation in a gauge extension of the standard model", *Phys. Lett. B* **266** (1991) 419,

A Normalised Differential Cross Section Values

rential $t\bar{t}$ cross section as a function of b-jet observables in the `+jets
momentum of the b jets p_T^b and the pseudorapidity of the b jets h^b.

GeV]	$1/s\, ds/dp_T^b$	stat. [%]	sys. [%]	total [%]

Table 4: Normalised differential $t\bar{t}$ cross section as a function of top-quark observables in the `+jets channels: the transverse momentum of the top quarks p_T^t, the rapidity of the top quarks y^t, the transverse momentum of the top-quark pair $p_T^{t\bar{t}}$, the rapidity of the top-quark pair $y^{t\bar{t}}$, and the invariant mass of the top-quark pair $m^{t\bar{t}}$.

p_T^t bin [GeV]	$1/\sigma \, d\sigma/d \, p_T^t$	stat. [%]	sys. [%]

Table 5: Normalised differential $t\bar{t}$ cross section as a function of lepton observables in the dilepton channels: the transverse momentum of the leptons p_T^{ℓ}, the pseudorapidity of the leptons h^{ℓ}, the transverse momentum of the lepton pair, $p_T^{\ell\ell}$, and the invariant mass of the lepton pair $m^{\ell\ell}$.

p_T^{ℓ} bin [GeV]	$1/\sigma \, d\sigma/dp_T^{\ell}$

Table 7: Normalised differential t

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