The Compact Muon Solenoid Experiment
Conference Report

Mailing address: CMS CERN, CH-1211 GENEVA 23, Switzerland

28 November 2011 (v2, 01 December 2011)

Measurement of single top production in pp collisions at 7 TeV with the CMS detector

Jyothsna Rani Komaragiri for the CMS Collaboration

Abstract

We present the measurement of t -channel single top cross section in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV , using data collected with the CMS experiment during the year 2010. Both the electron-neutrino and muon-neutrino decay channels of W boson from top decay are considered. We explore two complementary multivariate analysis methods to separate signal and background and to extract the cross section for the single top produced in t -channel. The result is compared with the most precise standard model theory predictions.

Presented at *Lepton Photon 2011: XXV International Symposium on Lepton Photon Interactions at High Energies*

Measurement of single top production in pp collisions at 7 TeV with the CMS detector

JYOTHSNA RANI KOMARAGIRI
ON BEHALF OF CMS COLLABORATION^{a,*}

^aKarlsruhe Institute of Technology, Karlsruhe, Germany

Abstract. We present the measurement of t -channel single top cross section in proton-proton collisions at the LHC at a centre-of-mass energy of 7 TeV , using data collected with the CMS experiment during the year 2010. Both the electron-neutrino and muon-neutrino decay channels of W boson from top decay are considered. We explore two complementary multivariate analysis methods to separate signal and background and to extract the cross section for the single top produced in t -channel. The result is compared with the most precise standard model theory predictions.

Keywords. single top, CMS, 2010

PACS Nos. Appropriate pacs here

1. Introduction

The theory of electroweak interactions predicts three different production mechanisms for single top quarks in hadron-hadron collisions: t channel, s channel, and tW (or W -associated). In this article we show first evidence for t -channel single top quark production in pp collisions and perform the first measurement of this cross section in pp collisions at $\sqrt{s} = 7\text{ TeV}$ provided by the LHC. The results are based on the data sample corresponding to an integrated luminosity of $35.9 \pm 1.4\text{ pb}^{-1}$ recorded by the CMS experiment [1], incorporating data taken up to November 2010.

This analysis treats the t -channel production mode as signal, including the other two in the definition of background and utilizes the leptonic decay channels in which the W boson from the top quark decays further into a muon or an electron and a neutrino with a branching ratio $BR(t \rightarrow b \ell \nu) = (10.80 \pm 0.09)\%$, where $\ell = e/\mu$.

2. Analysis

We apply a dedicated event selection, and then perform two complementary measurements. In our first approach we exploit a data driven method using two angular properties specific to t -channel top quark production: the non-central pseudorapidity distribution of the light jet recoiling against the single top and the cosine of the angle, in the reconstructed top-quark rest frame, between this jet and the final-state lepton. In our second

*jyothsna@cern.ch

method we probe the overall compatibility of the signal event candidates with the Standard Model expectations of electroweak top quark production by using a multivariate analysis technique. In the following these analyses will be referred to as 2D-analysis and BDT-analysis, respectively.

The BDT-analysis combines a given set of observables into one single classifier variable bdt . A total of 37 observables have been chosen. The most discriminant ones are the lepton momentum, the mass of the system formed by the reconstructed W boson and the two jets, the p_T of the system formed by the two jets, the p_T of the jet passing tight b-tagging requirements, and the reconstructed top-quark mass.

3. Results and Combination

Figure 1. Comparison of the cross section measurements in all channels in the 2D and BDT analyses, and theoretical calculations under the standard model assumption

The cross section measured in 2D-analysis and BDT-analysis are combined with the BLUE technique [2], considering all uncertainties fully correlated with few exceptions: the statistical error (51% correlation), the W +light partons normalization and shape (data-driven in the 2D analysis and taken from theory in the BDT analysis), the QCD normalization. The correlation of the latter component is poorly known, therefore we consider a 50% correlation and treat the uncertainty on this correlation as an additional systematic (within 0% and 100%), whose impact is found to be negligible.

Figure 1 compares the t -channel cross section extractions in muon and electron decay channels from 2D-analysis and BDT-analysis as well as the combined 2D and BDT measurements.

The combination of 2D and BDT measurements yields the following cross section measurement combined in muon and electron channels:

$$\sigma = 83.6 \pm 29.8(stat. + syst.) \pm 3.3(lumi.) \text{ pb} \quad \text{combined} \quad (1)$$

where the BDT analysis, being more precise, contributes with a larger weight (89%) with respect to the 2D analysis.

Figure 2 compares the combined measurement [3] with the dedicated t -channel cross section extractions at Tevatron [4, 5], demonstrating the large increase due to the higher centre-of-mass energy.

Figure 2. Single top cross section in the t channel versus centre-of-mass energy, comparing our measurement with the dedicated t -channel cross section measurements at Tevatron [4, 5] and with the NLO QCD expectation computed with MCFM in the 5-flavour scheme [6].

Under the assumption that $|V_{td}|$ and $|V_{ts}|$ are much smaller than $|V_{tb}|$, we extract the latter quantity as

$$|V_{tb}| = \sqrt{\frac{\sigma^{exp}}{\sigma^{th}}} = 1.16 \pm 0.22(exp) \pm 0.02(th) \quad (2)$$

where σ^{exp} is taken from (1) and $\sigma^{th} = 62.3^{+2.3}_{-2.4}$ pb is the NLO prediction in the 5-flavors scheme [7].

References

- [1] R. Adolphi *et al.*, *JINST* **0803**, S08004 (2008). CMS collaboration.
- [2] Louis Lyons, Duncan Gibaut and Peter Clifford, *Nucl. Instrum. Meth.* **A270**, 110 (1988).
- [3] Serguei Chatrchyan *et al.*, *Phys.Rev.Lett.* **107**, 091802 (2011). CMS collaboration.
- [4] Victor Mukhamedovich Abazov *et al.*, *Phys. Lett.* **B682**, 363 (2010). D0 collaboration.
- [5] T. Aaltonen *et al.*, *Phys. Rev.* **D82**, 112005 (2010). CDF collaboration.
- [6] John M. Campbell and Keith Ellis, <http://mcfm.fnal.gov/> .
- [7] John M. Campbell, Rikkert Frederix, Fabio Maltoni and Francesco Tramontano, *JHEP* **10**, 042 (2009).