PROCEEDINGS OF SCIENCE

Measurements of single top production in $p\bar{p}$ collisions at $\sqrt{s}$=1.96 TeV using data collected with the DØ detector at the Fermilab Tevatron Collider

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An updated single top quark production cross section measurement using 5.4 fb^{-}1 integrated luminosity collected in proton-antiproton collisions at Tevatron is presented, including a model independent measurement of the t-channel single top production cross section. Extraction of the top quark width, using single top t-channel production cross section and the $t\bar{t}$ branching fraction is also presented.

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The standard model (SM) of particle physics predicts, in addition to pair production of top-antitop quarks, the production of single top quarks via the electroweak force. DØ and CDF experiments found first evidence of such production in 2009 [1, 2]. This production mode is very interesting because it provides opportunity to probe Wtb couplings and direct measurement of the CKM matrix element $|V_{tb}|$. Single top production cross section and kinematics can be sensitive to many scenarios beyond SM. Single top production at Tevatron is mainly through s-channel and t-channel production, shown in Fig.1. Here we present single top s+t-channel production cross section measurement and a model independent measurement of t-channel production cross section, using 5.4 fb^{-1} integrated luminosity.

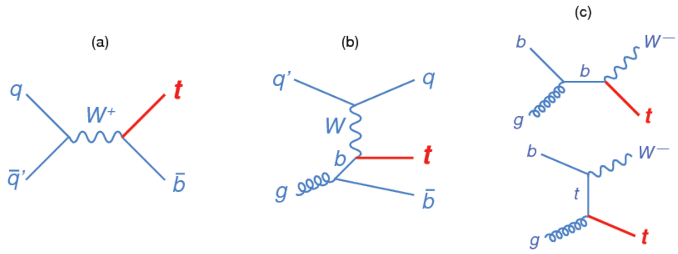

Figure 1: Representative Feynman diagrams for (a) s-channel single top quark production, (b) t-channel production, and (c) tW production. For analysis at Tevatron we consider only the s- and t-channel processes as the tW production cross section is negligible.

1. s+t-channel cross section measurement

The final state from single top quark production consists of an isolated lepton (e, μ), missing transverse energy and 2-4 jets, out of which at least one jet is required to be identified as a b-jet. The dominant backgrounds to this signature are W+jets, $t\bar{t}$ pairs, and multijet QCD production. Figure 2 shows data-background comparison for different distributions before and after the b-tagging requirement. This analysis makes use of multivariate techniques to enhance the discrimination between signal and the backgrounds. A W+jets dominated sample with exactly two jets and $H_T < 175$ GeV , and $t\bar{t}$ dominated sample with exactly four jets and $H_T > 300$ GeV are defined as crosscheck and are shown in Fig. 2 (e,f). Finally several multivariate methods, Bayesian neural networks, Boosted decision trees, and Neuro-evolution network, are used to enhance signal and background discrimination. Output of these discriminants is then combined into one filter. The cross section is measured to be 3.4$\pm$0.7 (stat + syst) pb, using a Bayesian approach. Using this cross section measurement we set 95% C.L. limits on $|V_{tb}|$ > 0.79. For details of this analysis please see [3].

2. t-channel model independent cross section measurement

The t-channel measurement uses the same selection and multivariate techniques as used for s+t channel cross section measurement but optimized to maximize the sensitivity for the t-channel production, by treating the s-channel process as a background. The final discriminant is shown in Fig. 3. Thus far, the single top production cross section is measured as the sum of s- and t-channel,

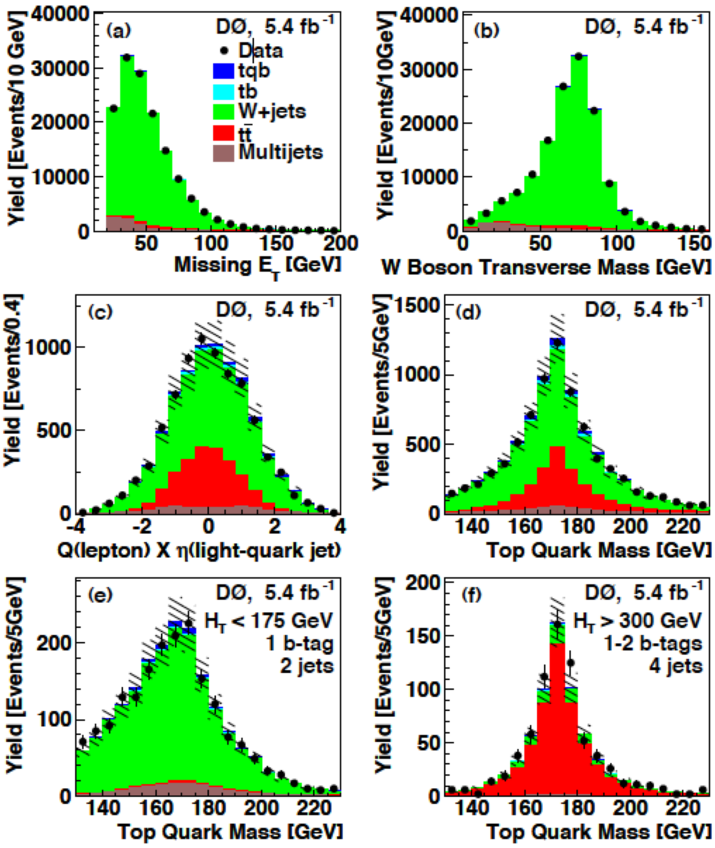

Figure 2: Comparisons between the data and the background model for different distributions: before (a, b), and after (c,d) b-jet identification. (e) is a crosscheck sample dominated by W+jets, and (f) is a cross-check sample dominated by $t\bar{t}$pair events. The hatched bands show the $\pm 1\sigma$ uncertainty on the background prediction.

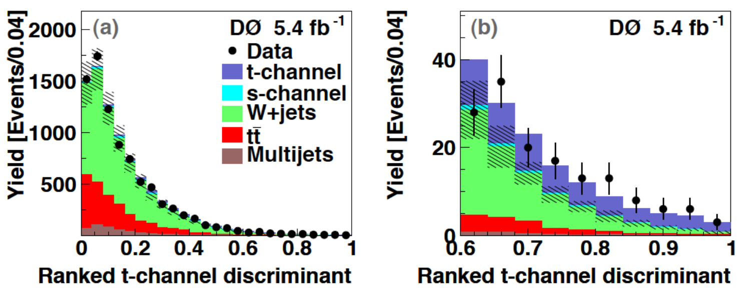

Figure 3: Comparison of the signal and background models to data for the combined t-channel discriminant for (a) the entire discriminant range and (b) the signal region. The bins have been ordered by their expected S:B. The hatched bands show the uncertainty on the background prediction, which includes s-channel.

assuming the relative rate between the two processes as predicted by the standard model. But this assumption may not hold for new physics scenarios. Therefore, for t-channel cross section measurement, we construct a two dimensional posterior probability density as a function of the cross sections for both the t-channel and s-channel single top quark production. The t-channel cross section is then extracted from a one-dimensional posterior probability density obtained by integrating over the s-channel axis, thus not making any assumptions about the value of the s-channel cross section. The 2D posterior probability is shown in Fig. 4. The measured t-channel cross section is 2.90 ± 0.59 (stat + syst) pb, corresponding to a significance of 5.5 standard deviations. For details of this analysis please see [4].

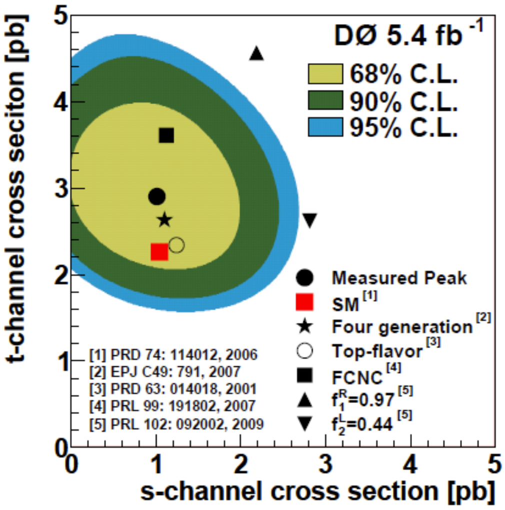

Figure 4: Posterior probability density for s-channel vs t-channel single top quark production in contours of equal probability density. The measured cross section and various theoretical predictions are also shown.

3. top quark width measurement

We can extract the total width of the top quark from the partial decay width ($t \to Wb$) and the branching fraction B($t \to Wb$). We use two independent measurements for this extraction: The partial width is obtained from the measured t-channel cross section for single top quark production [5], and the branching fraction is extracted from a measurement of the ratio $R = B(t \to Wb)/B(t \to Wq)$ in $t\bar{t}$ events [6], in 2.3 fb^{-1} and 1 fb^{-1} of integrated luminosity, respectively. Assuming $B(t \to Wq)$ = 1, where q includes any kinematically accessible quark, the total width is 2.1$\pm$0.6 GeV which translates to a top quark lifetime of $3\pm1 \times 10^{-}25$s. The use of the partial width measurement alone yields the limits on the total decay width $>$1.2 GeV and lifetime $< 5\times10^{-}25$s, at 95% C.L. An update of this measurement using latest t-channel cross section measurement and branching fraction measurement in $t\bar{t}$ events is in progress.

References

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