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Non-Top Background Estimate for Single Top in 162 pb^{-1}

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Abstract

We present the estimates for the non-top background in our single top search using 162 pb^{-1} of CDF Run II data.

While the $t\bar{t}$ and di-boson background can be estimated using the theoretical cross-section predictions and acceptance from Monte Carlo, this method does not work for W plus multi-jet backgrounds because those cross-sections are not reliably predicted by theory. The selection cuts of our single top analysis are described in Ref. [1]. Five different classes of events contribute to our non-top background (other than di-boson) events: $Wb\bar{b}$, $Wc\bar{c}$, Wc, mis-tags and non-W events.

For the lepton+jets $t\bar{t}$ cross section measurement a background estimate was performed which is partly based on CDF data and partly on Monte Carlo simulations (known as method 2) [2]. We base our background numbers on this estimate. To take into account differences between the $t\bar{t}$ cross-section analysis and our analysis we re-scale the numbers by cut-efficiencies obtained from Monte Carlo events ($Wb\bar{b}$, $Wc\bar{c}$, Wc, mis-tags) or data (non-W). We use the following Monte Carlo samples generated by Alpgen:
$We\nu BB0p$ (atop40), $W\mu\nu BB0p$ (atop46), $W\tau\nu BB0p$ (atop4c),
$We\nu CC0p$ (atop43), $W\mu\nu CC0p$ (atop49), $W\tau\nu CC0p$ (atop4f),
$We\nu C1p$ (atop1w), $W\mu\nu C1p$ (atop4w),
$We\nu 2p$ (atop02), $W\mu\nu 2p$ (atop08), $W\tau\nu 2p$ (atop2e).
When we use the same cuts as used in the $t\bar{t}$ analysis, we obtain a certain number of events $N_{\eta 2}$. We then apply the different cut-scenarios we want to evaluate: extended jet definition up to $|\eta| < 2.8$ ($N_{\eta 2.8}$), $M_{\ell\nu b}$ ($N_{M\ell\nu b}$), E_T(jet 1) > 30 GeV (N_{jet1}), exactly one b-tag (N_{1tag}), exactly one b-tag and E_T(jet 1) > 30 GeV ($N_{1tag,ET}$, exactly two b-tags

Process	Wbb0p	Wcc0p	Wc	Mis-tags	non-W
$N_{\eta 2}$	4169	967	1389	9121	1198
$N_{\eta 2.8}$	4388	1021	1524	9900	1219
$N_{M\ell\nu b}$	2036	439	679	4036	359
N_{jet1}	1731	375	597	3276	328
N_{1tag}	1646	426	673	–	327
$N_{1tag,ET}$	1394	365	591	–	298
N_{2tag}	390	13	6	–	32

Table 1: Number of events for different cut scenarios.

(N_{2tag}). The numbers of events for these cut scenarios are given in Tab. 1. The mis-tag samples are treated special. If we apply the b-tag requirement only very few events remain. Too little to predict cut efficiencies for the subsequent cuts. Therefore, we apply the mistag matrix to each jet and consider this jet b-tagged which has the highest mis-tag efficiency.

Based on the numbers in Tab. 1 we calculate scale factors for the different scenarios which are shown in Tab. 2. We evaluate errors due to a change in jet energy scale on these scale factors. Those numbers are given in Tab. 3 The background estimate for the

Process	Wbb0p	Wcc0p	Wc	Mis-tags	non-W
$\epsilon_{\eta 2.8}$	1.0525	1.0558	1.0972	1.0854	1.0175
$\epsilon_{M\ell\nu b}$	0.4640	0.4300	0.4455	0.4077	0.2945
ϵ_{jet1}	0.3945	0.3673	0.3917	0.3309	0.2691
ϵ_{1tag}	0.3751	0.4172	0.4416	–	0.2682
$\epsilon_{1tag,ET}$	0.3177	0.3575	0.3878	–	0.2445
ϵ_{2tag}	0.0889	0.0127	0.0039	–	0.0263

Table 2: Scale factor for different cut scenarios.

Process	Wbb0p	Wcc0p	Wc	Mis-tags	non-W
$N_{M\ell\nu b}$	11.5%	10.8%	11.0%	16.1%	15.5%
N_{jet1}	13.0%	12.4%	12.9%	17.9%	15.9%
N_{1tag}	13.0%	11.2%	11.2%	–	15.9%
$N_{1tag,ET}$	14.5%	12.7%	13.2%	–	16.3%

Table 3: Relative errors on scale factors for different cut scenarios.

$t\bar{t}$ analysis is presented in Tab. 4. The resulting number of W+Jets events predicted for the single top analysis are given in Tab. 5. To get the total number of non-top events we need to include the number of di-boson events.

Process	Wbb0p	Wcc0p	Wc	Mis-tags	non-W
N	22.5 ± 6.5	8.0 ± 2.2	7.7 ± 2.0	17.0 ± 2.4	10.1 ± 1.7

Table 4: Predicted number of background events for $t\bar{t}$ cross-section analysis.

Process	Wbbar	Wccbar	Wc	Mistags	non-W	$\sum$ W + jets
N_{btag}	23.68±6.84	8.45±2.32	8.45±2.19	18.45±2.60	10.28±1.73	69.30±11.78
$N_{M\ell\nu b}$	10.99±3.42	3.63±1.07	3.76±1.06	7.52±1.61	3.03±0.69	28.93±5.82
N_{jet1}	9.34±2.96	3.10±0.94	3.31±0.96	6.11±1.39	2.77±0.64	24.63±5.09
N_{1tag}	8.88±2.81	3.52±1.05	3.73±1.06	7.52±1.61	2.76±0.64	26.42±5.21
$N_{1tag,ET}$	7.52±2.43	3.02±0.91	3.28±0.95	6.11±1.39	2.51±0.59	22.44±4.56
N_{2tag}	2.11±0.67	0.11±0.03	0.03±0.01	0.00±0.00	0.27±0.06	2.52±0.71

Table 5: Number of expected W+jets events in single top analysis.

Process	W + Jets	di-boson	Total Non-Top
N_{btag}	69.30 ± 11.78	2.25 ± 0.27	71.55 ± 11.78
$N_{M\ell\nu b}$	28.93 ± 5.82	1.02 ± 0.14	29.95 ± 5.82
N_{jet1}	24.63 ± 5.09	0.93 ± 0.13	25.56 ± 5.09
N_{1tag}	26.42 ± 5.21	0.94 ± 0.13	27.36 ± 5.21
$N_{1tag,ET}$	22.44 ± 4.56	0.85 ± 0.12	23.29 ± 4.56
N_{2tag}	2.52 ± 0.71	0.07 ± 0.02	2.59 ± 0.71

Table 6: Number of expected non-top events in single top analysis.

References

[1] Catalin Ciobanu et al., *Event detection efficiency for single top events in CDF*, CDF note 7057, Version 1.0, June 2004.

[2] H. Bachacou, J. Nielsen and W. Yao, *Optimized Measurement of the $t\bar{t}$ Production Cross Section in the SECVTX Tagged Sample*, CDF note 6902, Version 3.0, March 2004.