Study of the SVX- SLT_{μ} tagged W+jets sample

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Outline

- Aim
  - Understand the double tag (SVX-SLT) sample
  - Look for any discrepancy between prediction & data
    - ✓ Counting (& kinematic)
- Method
  - Starting point SVX prediction (no H_T)
  - Determining the efficiencies:
    - ✓ Wbb, Wcc, Wc, Diboson, single top, tt
    - ✓ Mistags
    - ✓ NonW
- Putting it all together
- Plan

Method

❖ Start with the SVX summary table (PRD-cdf7138, Table XIII)

	W+1TJ	σ	W+2TJ	σ	W+>=3TJ	σ
Mistags	40.9	6.1	17	2.4	6.84	1.40
Wbb	37	11.2	22.5	6.5	5.78	2.35
Wcc	13.7	3.4	8	2.2	1.93	0.88
Wc	34.5	9	7.7	2	1.49	0.65
DiBoson, Z->tt	2.2	0.4	2.5	0.4	0.7	0.12
nonW QCD	24.3	3.5	10.5	1.9	4.8	1.69
Single Top	2.6	0.3	4.6	0.5	1.3	0.12
Z+HF	1.1	0.3	0.6	0.2	0.18	0.18
Expected ttbar	0.91	0.08	7.02	0.62	33.90	3.00
Total	157.21	~~16.36~~	80.42	~~7.83~~	56.91	~~4.54~~

Scale to take into corrected bkg

Use SVX measured Xs

$$N_{t\bar{t}} = (N_{tag} - N_{bkg}^{corr}) \mp \delta N_{bkg}^{corr}$$

tt in 1(2) jet bin determined by scaling $N_{tt}^{>=3j}$ by $R_{tt}^{3\to2}$ ($R_{tt}^{3\to1}$)

For each bkg/tt measure ε_{HJ} (eff to get @ least 1 SLT tag in SVX tag jet/event)

Determining ε_{HJ}

- Use MC for Wbb, Wcc, Wc, Diboson, single top, tt

$$\epsilon_{HJ} = \frac{N^R_{SLT} + N^F_{SLT} \times (1 - F_{hf})}{N_{SVX}}$$

for each jet bin

where

- N^R_{SLT}: # of event with a real SLT Tag in SVX tag jet
- N^F_{SLT}: # of event with a fake SLT Tag in SVX tag jet
- F_{hf}: fraction of Heavy Flavor in SLT fake matrix
- N_{SVX}: # of event with SVX Tag

- Few caveats:
  - Wbb/Wcc: combined all 1,2,3 parton files
  - $\varepsilon^{Wc}_{HJ} = \varepsilon^{Wcc}_{HJ}$
  - Single top: combine s & t channel
  - Diboson: use ε^{WW}_{HJ}
  - Skip Z+hf

Would need the split background from SVX guys

Determining ε_{HJ} (cont)

- Mistags

$$\epsilon_{HJ}^{mistag} = N_{tagg}^{SLT} \times < FR > \times (1 - F_{hf})$$

where

- N^{SLT}_{tagg}: mean # SLT taggable track in SVX tag jet in W+jets MC
- <FR>: SLT average fake rate
- F_{hf}: fraction of Heavy Flavor in SLT fake matrix

Assume that get 1 SVX mistag per event

- Non-W (approximate for now, get better estimate from Lucio)
  - Use region C of E_T -vs- Iso $\epsilon_{HJ}^{\text{non}W} = \frac{N_{SLT}}{N_{SVX}}$

    ✓ Lousy stat, combine e/μ, large error

ε_{HJ} summary table

	W+1TJ	σ(stat)	σ(sys)	W+2TJ	σ(stat)	σ(sys)	W+>=3TJ	σ(stat)	σ(sys)
Mistags	0.017	0.002		0.012	0.001		0.011	0.001	
Wbb	0.073	0.002	0.004 0.006	0.081	0.002	0.004 0.007	0.079	0.003	0.004 0.007
Wcc	0.046	0.002	0.003 0.004	0.042	0.002	0.003 0.003	0.043	0.004	0.003 0.003
Wc	0.046	0.002	0.003 0.004	0.042	0.002	0.003 0.003	0.043	0.004	0.003 0.003
DiBoson, Z->tt	0.028	0.005	0.002 0.002	0.035	0.004	0.002 0.003	0.039	0.008	0.003 0.003
nonW QCD	0.120	0.036		0.104	0.031		0.244	0.049	
Single Top	0.075	0.003	0.004 0.006	0.089	0.003	0.005 0.008	0.087	0.004	0.005 0.007
Expected ttbar	0.115	0.012	0.006 0.010	0.118	0.004	0.006 0.010	0.104	0.002	0.006 0.009

Putting it all together

	W+1TJ	σ(stat)	σ(sys)	W+2TJ	σ(stat)	σ(sys)	W+>=3TJ	σ(stat)	σ(sys)
Mistags	0.697	0.104		0.203	0.029		0.074	0.015	
Wbb	2.690	0.814	0.0105 0.0166	1.824	0.527	0.0079 0.0126	0.455	0.185	0.0019 0.0031
Wcc	0.624	0.155	0.0017 0.0023	0.333	0.092	0.0009 0.0011	0.082	0.038	0.0002 0.0003
Wc	1.571	0.410	0.0042 0.0058	0.321	0.083	0.0008 0.0011	0.064	0.028	0.0002 0.0002
DiBoson, Z->tt	0.063	0.011	0.0001 0.0002	0.088	0.014	0.0002 0.0002	0.028	0.005	0.0001 0.0001
nonW QCD	2.916	0.433		1.092	0.200		1.171	0.416	
Single Top	0.196	0.023	0.0008 0.0012	0.410	0.045	0.0020 0.0031	0.114	0.010	0.0005 0.0008
Expected ttbar	0.105	0.014	0.0006 0.0010	0.829	0.079	0.0053 0.0083	3.531	0.313	0.0201 0.2963
Total	8.86	1.93 1.94	0.01 0.02	5.10	0.91 0.99	0.01 0.02	5.52	0.29	0.02 0.30

Observed tag	7	5	1
Poisson Prob	0.340	0.598	0.026

Plan

- Short term:
  - Tidy up the few caveats & get a better mistag/nonW estimates
  - Compare kinematics variables with expectation
    - ✓ (@ least 1/2 jet bin)
  - Write cdfnote
  - Write PRL

- Longer term plan
  - Move to 5.3 to get all the new goodies & larger data sample
    - ✓ High p_T b-tag meeting next week
  - Move toward SLT method 2 background

TABLE XIII: Background summary for the single-tag selection. The total backgrounds are given before and after the correction for $t\bar{t}$ events in the pretag W+jets sample.

			$H_T > 0$ GeV		$H_T > 200$ GeV	
Jet multiplicity	W + 1 jet	W + 2 jets	W + 3 jets	W + $\geq$ 4 jets	W + 3 jets	W + $\geq$ 4 jets
Pretag	15314	2448	387	107	179	91
Mistags	40.9 ± 6.1	17.0 ± 2.4	5.2 ± 0.7	2.6 ± 0.4	3.3 ± 0.4	2.3 ± 0.3
$Wb\bar{b}$	37.0 ± 11.2	22.5 ± 6.5	5.0 ± 1.3	1.6 ± 0.5	2.8 ± 0.8	1.4 ± 0.4
$Wc\bar{c}$	13.7 ± 3.4	8.0 ± 2.2	1.6 ± 0.5	0.6 ± 0.2	0.9 ± 0.3	0.5 ± 0.2
Wc	34.5 ± 9.0	7.7 ± 2.0	1.4 ± 0.4	0.3 ± 0.1	0.7 ± 0.2	0.3 ± 0.1
$WW/WZ/ZZ, Z \to \tau\tau$	2.2 ± 0.4	2.5 ± 0.4	0.6 ± 0.1	0.1 ± 0.0	0.3 ± 0.1	0.1 ± 0.0
non-W QCD	24.3 ± 3.5	10.5 ± 1.9	3.4 ± 0.7	1.4 ± 0.4	1.7 ± 0.4	1.2 ± 0.3
single top	2.6 ± 0.3	4.6 ± 0.5	1.1 ± 0.1	0.2 ± 0.0	0.8 ± 0.1	0.2 ± 0.0
Z+HF	1.1 ± 0.3	0.6 ± 0.2	0.2 ± 0.1		0.10 ± 0.05	
Total	156.3 ± 19.1	73.4 ± 9.8	18.5 ± 2.2	6.9 ± 0.9	10.5 ± 1.3	6.0 ± 0.8
Corrected Total	156.3 ± 19.1	73.4 ± 9.8	23.1 ± 3.0		13.5 ± 1.8	
Data	160	73	29	28	21	27

Calculating the error

- Not so straight forward since use N_{tt} from the measured SVX Xs, hence correlation between background and tt

$\geq$ 3 jets

$$N_{t\bar{t}}^{HJ} \pm \delta N_{t\bar{t}}^{HJ} = N_{t\bar{t}} \times \epsilon_{HJ}^{t\bar{t}} \pm \sqrt{(N_{t\bar{t}} \times \delta\epsilon_{HJ}^{t\bar{t}})^2 + (\delta N_{bkg}^{corr} \times \epsilon_{HJ}^{t\bar{t}})^2}$$

$$\pm \qquad \mp$$

$$N_{bkg_i}^{HJ} \pm \delta N_{bkg_i}^{HJ} = N_{bkg_i} \times \epsilon_{HJ}^{bkg_i} \pm \sqrt{(N_{bkg_i} \times \delta\epsilon_{HJ}^{bkg_i})^2 + (\delta N_{bkg_i} \times \epsilon_{HJ}^{bkg_i})^2}$$

$$\pm \qquad \pm$$

$$N^{HJ} \pm \delta N^{HJ} = N_{t\bar{t}}^{HJ} + \sum N_{bkg_i}^{HJ}$$

$$\pm\sqrt{(N_{t\bar{t}} \times \delta\epsilon_{HJ}^{t\bar{t}})^2 + \sum (N_{bkg_i} \times \delta\epsilon_{HJ}^{bkg_i})^2 + \sum [(\epsilon_{HJ}^{t\bar{t}} - \epsilon_{HJ}^{bkg_i}) \times \delta N_{bkg_i}]^2}$$

Calculating the error (cont)

- 2(1) jet bin:
  - Issue is that N^{2j}_{tt} is related to the cross section measure ≥3 jets bin ($N^{\geq 3j}_{tt}$). Hence δN^{2j}_{tt} is related to $\delta N^{\geq 3j}_{tt}$

$$N^{2j}_{t\bar{t}} \pm \delta N^{2j}_{t\bar{t}} = (N^{3j}_{t\bar{t}} \mp \delta N^{3j}_{t\bar{t}}) \times R_{3\to 2}$$

$$N^{HJ\ 2j}_{t\bar{t}} \pm \delta N^{HJ\ 2j}_{t\bar{t}} = N^{2j}_{t\bar{t}} \times \epsilon^{t\bar{t}\ 2j}_{HJ} \pm \sqrt{(N^{2j}_{t\bar{t}} \times \delta\epsilon^{t\bar{t}\ 2j}_{HJ})^2 + (\delta N^{2j}_{bkg} \times \epsilon^{t\bar{t}\ 2j}_{HJ})^2}$$

$$\pm \qquad \mp$$

$$N^{HJ\ 2j}_{bkg_i} \pm \delta N^{HJ\ 2j}_{bkg_i} = N^{2j}_{bkg_i} \times \epsilon^{bkg_i\ 2j}_{HJ} \pm \sqrt{(N^{2j}_{bkg_i} \times \delta\epsilon^{bkg_i\ 2j}_{HJ})^2 + (\delta N^{2j}_{bkg_i} \times \epsilon^{bkg_i\ 2j}_{HJ})^2}$$

$$\pm \qquad \pm$$

$$N^{HJ\ 2j} = N^{HJ\ 2j}_{t\bar{t}} + \sum N^{HJ\ 2j}_{bkg_i}$$

100% anti-correlated

$$\delta N^{HJ\ 2j} = N^{2j}_{t\bar{t}} \times \delta\epsilon^{t\bar{t}\ 2j}_{HJ} \oplus N^{2j}_{bkg_i} \times \delta\epsilon^{bkg_i\ 2j}_{HJ} \oplus (\delta N^{2j}_{bkg} \times \epsilon^{t\bar{t}\ 2j}_{HJ} - \sum \delta N^{2j}_{bkg_i} \times \epsilon^{bkg_i\ 2j}_{HJ})$$

uncorrelated

$$\delta N^{HJ\ 2j} = N^{2j}_{t\bar{t}} \times \delta\epsilon^{t\bar{t}\ 2j}_{HJ} \oplus N^{2j}_{bkg_i} \times \delta\epsilon^{bkg_i\ 2j}_{HJ} \oplus \delta N^{2j}_{bkg} \times \epsilon^{t\bar{t}\ 2j}_{HJ} \oplus \sum \delta N^{2j}_{bkg_i} \times \epsilon^{bkg_i\ 2j}_{HJ}$$

ε_{HJ} systematic error

- For the real part
  - $\pm 1\sigma$ of the ε_{SLT} parameterization $\rightarrow$ 1%
  - Systematic error on ε_{SLT} due to the non-isolation $\rightarrow$ +0%, -8%
- For the fake part
  - Systematic error on the SLT fake matrix $\rightarrow$ 10%
- Common to both
  - Systematic error on the SF tracking reconstruction $\rightarrow$ 5%

- Take the systematic $\delta\epsilon_{HJ}^{t\bar{t}\ sys}$ & $\delta\epsilon_{HJ}^{bkg_i\ sys}$ as correlated