Status of SecVtx $t\bar{t}$ Cross Section in 5.3.3_nt

Salvatore Rappoccio: Harvard University

February 10, 2005
Lepton Plus Jets Meeting

- Lepton + Jets $t\bar{t}$ backgrounds : ≥ 1 and ≥ 2 tags
  - **Electroweak/Single Top**
  - **QCD (Non-W) backgrounds**
  - **W+ Heavy flavor**
  - **Mistags**

Prescription

- Prescription : *Nt5*
- Top MC
  - PYTHIA, $m_{top} = 175\ GeV/c^2$: `ttop0z`
- W+HF MC (ALPGEN + HERWIG)
  - $W + \mu\nu b\bar{b} + 0, 1, 2p$
  - $W + \mu\nu c\bar{c} + 0, 1, 2p$
  - $W + e\nu c + 0, 1, 2, 3p$
  - Assume eff same for e and μ
- MC backgrounds:WW/WZ/ZZ/ single top
  - WW (wtop1w : PYTHIA)
  - WZ (wtop1z : PYTHIA)
  - ZZ (ztopcz : PYTHIA)
  - Single top t channel (mtopta : Madevent)
  - Single top s channel (mtopya : Madevent)
  - $Z \to \tau\tau$ (ztop1i : PYTHIA)
- Data
  - Electrons: `bhel0d`
  - Muons: `bhmu0d`
  - JET20/50/70/100: `gjt[1-4]0d`
- Jet Corrections `jetCorr03`, version 5, level 4
- Luminosity (CEM/CMUP, CMX)
  - DQM v7.0: $<$ Sep 2004: 319,305 pb^{-1}

Changes From Last Time

- Updated to official b-tagging SF : 0.909 ± 0.060
- Updated event selection
  - Disallow CMX muons for runs < 150145
  - Require CMU fiduciality

$\Rightarrow$ Hopefully event selection is final

- Added $Z \rightarrow \tau\tau$ estimate
- Analyzed 3.5 and $\equiv 4$ jet bins for top mass

Event Selection And Yield

- Electron selection from JP webpage
- Muon selection from JP webpage
- Jets
  - **Tight:** $E_T > 15$ GeV at Level 4, $|\eta_D| < 2.0$
  - **Loose:** $E_T > 8$ GeV at Level 4, $|\eta_D| < 2.0$
- $\not\!\!E_T > 20$ GeV, corrected to Level 4, also for tight muons
- All vetos except $\Delta\phi$ QCD cut

Jet Multiplicity	1 jet	2 jets	3 jets	4 jets	≥ 5 jets	3.5 jets
Event Yields (319 pb^{-1})						
Pretag Events	30548	4773	763	179	36	277
≥ 1 Tag Events	431	242	94	63	19	38
≥ 2 Tag Events	0	15	17	16	3	6

EW/Single Top

- WW,WZ,ZZ, single top, $Z \to \tau\tau$
- Use MC to estimate these backgrounds
- **Note:** Last meeting had an error in WW cross section (fixed)

$$N_{MC} = \sigma_{theo}\epsilon_{pretag}\epsilon_{tag}\int \mathcal{L}dt$$

WW					
Pretag	130.89 $\pm$ 11.22	127.53 $\pm$ 10.92	26.51 $\pm$ 2.31	4.30 $\pm$ 0.37	0.70 $\pm$ 0.06
≥ 1 Tag	2.41 $\pm$ 0.46	5.04 $\pm$ 0.98	1.26 $\pm$ 0.25	0.20 $\pm$ 0.06	0.05 $\pm$ 0.02
≥ 2 Tag	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.01 $\pm$ 0.01	0.01 $\pm$ 0.01	0.00 $\pm$ 0.00
WZ					
Pretag	19.50 $\pm$ 1.68	21.80 $\pm$ 1.88	4.61 $\pm$ 0.42	0.85 $\pm$ 0.07	0.12 $\pm$ 0.01
≥ 1 Tag	1.94 $\pm$ 0.28	3.02 $\pm$ 0.42	0.64 $\pm$ 0.11	0.12 $\pm$ 0.03	0.02 $\pm$ 0.01
≥ 2 Tag	0.00 $\pm$ 0.00	0.31 $\pm$ 0.07	0.08 $\pm$ 0.02	0.01 $\pm$ 0.01	0.00 $\pm$ 0.00
ZZ					
Pretag	0.79 $\pm$ 0.07	0.79 $\pm$ 0.07	0.34 $\pm$ 0.03	0.08 $\pm$ 0.01	0.00 $\pm$ 0.00
≥ 1 Tag	0.03 $\pm$ 0.01	0.11 $\pm$ 0.02	0.05 $\pm$ 0.01	0.01 $\pm$ 0.01	0.00 $\pm$ 0.00
≥ 2 Tag	0.00 $\pm$ 0.00	0.02 $\pm$ 0.01	0.01 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Single Top, t Channel					
Pretag	14.78 $\pm$ 4.17	15.65 $\pm$ 4.45	1.92 $\pm$ 0.55	0.20 $\pm$ 0.06	0.00 $\pm$ 0.00
≥ 1 Tag	5.31 $\pm$ 1.63	6.48 $\pm$ 1.99	0.80 $\pm$ 0.24	0.09 $\pm$ 0.03	0.00 $\pm$ 0.00
≥ 2 Tag	0.00 $\pm$ 0.00	0.01 $\pm$ 0.00	0.04 $\pm$ 0.01	0.01 $\pm$ 0.01	0.00 $\pm$ 0.00
Single Top, s Channel					
Pretag	4.40 $\pm$ 0.41	8.68 $\pm$ 0.80	1.76 $\pm$ 0.17	0.27 $\pm$ 0.03	0.04 $\pm$ 0.00
≥ 1 Tag	1.71 $\pm$ 0.26	5.15 $\pm$ 0.84	1.05 $\pm$ 0.18	0.16 $\pm$ 0.03	0.02 $\pm$ 0.01
≥ 2 Tag	0.00 $\pm$ 0.00	1.11 $\pm$ 0.24	0.23 $\pm$ 0.05	0.03 $\pm$ 0.01	0.00 $\pm$ 0.00

QCD

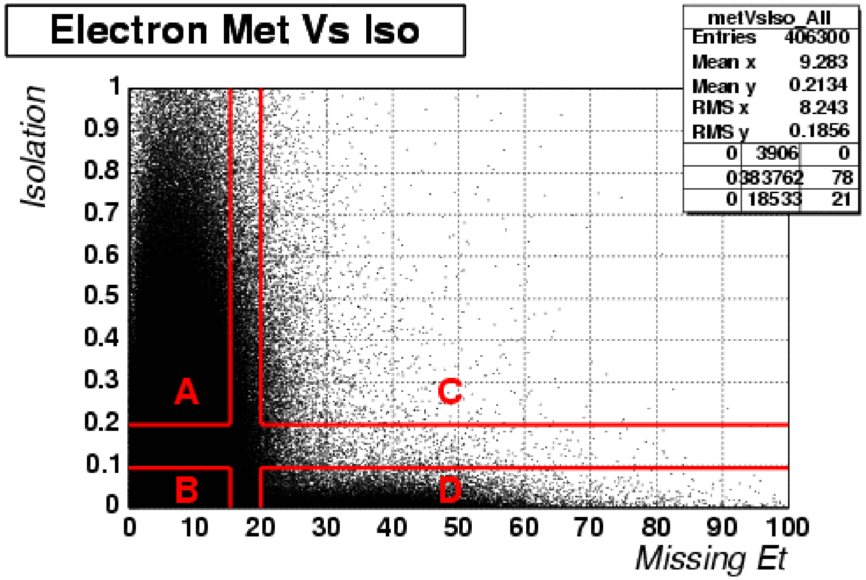
- F_{Non-W}
  - Perform "standard" MET vs ISO region analysis
  - Correct $\not{E}_T$ for both isolated and non-isolated muons
  - Add the muon calorimeter deposits back to MET.
  - Remove jets near leptons
  - Have not yet subtracted top from QCD regions
- Tag rates : weighted average of
  - "Pretag method":

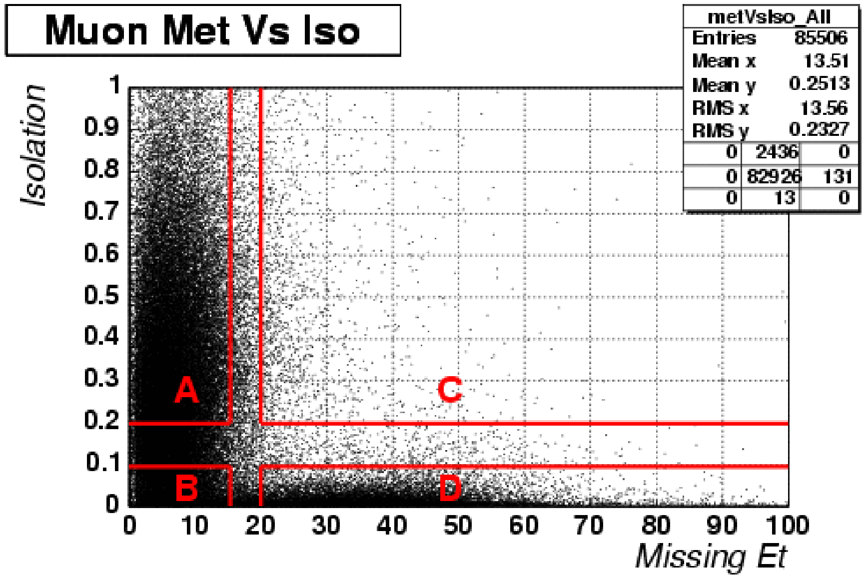
$$N_{Non-W} = \frac{R_B^+ R_C^+}{R_A^+} N_{pre}^D$$

  - "Tag method":

$$N_{Non-W} = \frac{N_B^+ N_C^+}{N_A^+}$$

- **Need to re-estimate double tags for QCD : low stats**



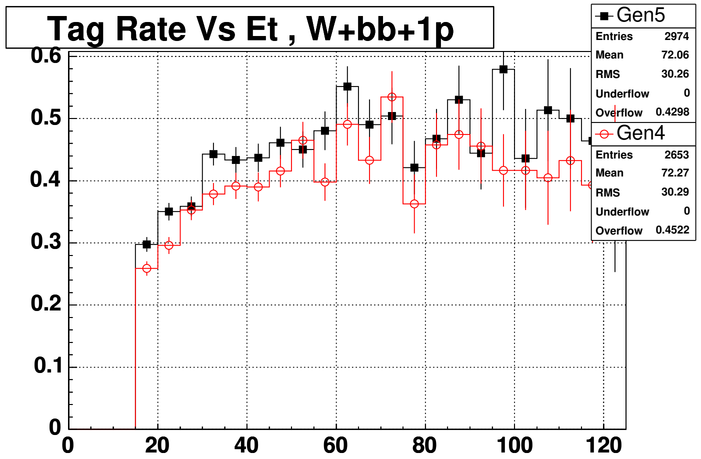


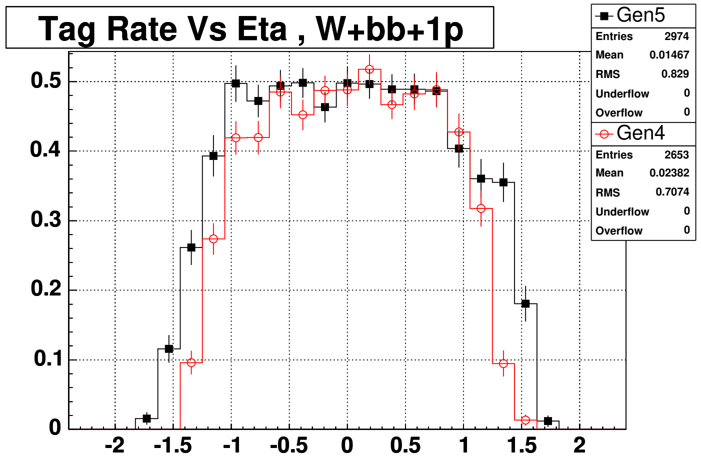
W+HF

- Derive W+HF tag rates from matched b, c quarks in MC
- Use same HFF as publication (CdfNote 7007)
- Use latest MLM matching (exclusive)
- Use $SF = 0.909 \pm 0.060$ (weighted avg of Harvard and Michigan methods)
- *Assuming ϵ's are the same for $W \to e\nu$ and $W \to \mu\nu$*

$$
\begin{aligned}
N_{W+HF} &= (N_{corr}) * F_{HF} * \epsilon_{DATA} \\
N_{corr} &= N^{pretag} * (1 - F_{NonW}) \\
&\quad - N_{t\bar{t}} - N_{EW} - N_{SingleTop}
\end{aligned}
$$

No SF Applied!





10-20% increase in efficiency at higher η

$\times$

10% increase in SF

$=$

20-30% increase expected in efficiency

W+HF Efficiencies : Compare to Gen4

Scale Factor Included

Per-Jet Tagging Efficiencies in W+BB (1B) (%)				
Jet Multiplicity	1 jet	2 jets	3 jets	$\geq$ 4 jets
Gen4 (SF $= 0.81 \pm 0.06$)	26.8 $\pm$ 2.0	27.8 $\pm$ 2.2	29.3 $\pm$ 2.5	24.2 $\pm$ 3.3
Gen5 (SF $= 0.91 \pm 0.06$)	34.8 $\pm$ 2.6	37.6 $\pm$ 3.2	38.2 $\pm$ 6.6	39.6 $\pm$ 3.5
Increase	28%	30%	23%	60%

$\sim$ 20-30% increases in tagging efficiencies

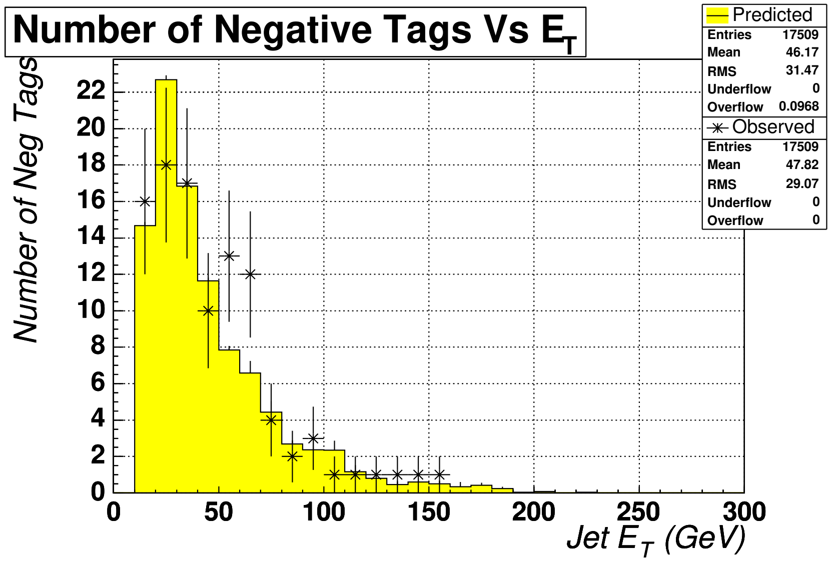
- Still need to figure out what is going on in 4-jet bin

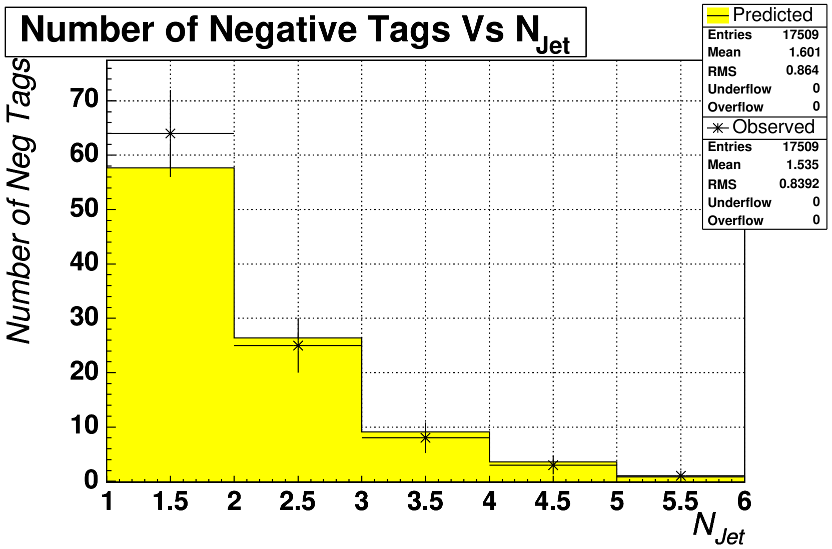
Mistags

- Used matrix presented in CDFNote 7326
- Consider jets with $E_T > 15$ GeV (Level 4), $|\eta_D| < 2.0$
- Use $\alpha_{LF} = 1.1 \pm 0.1$

$$N^{1-tag}_{mistag} = N^{pred}_{-} * \alpha_{LF} * (1 - F_{Non-W})$$

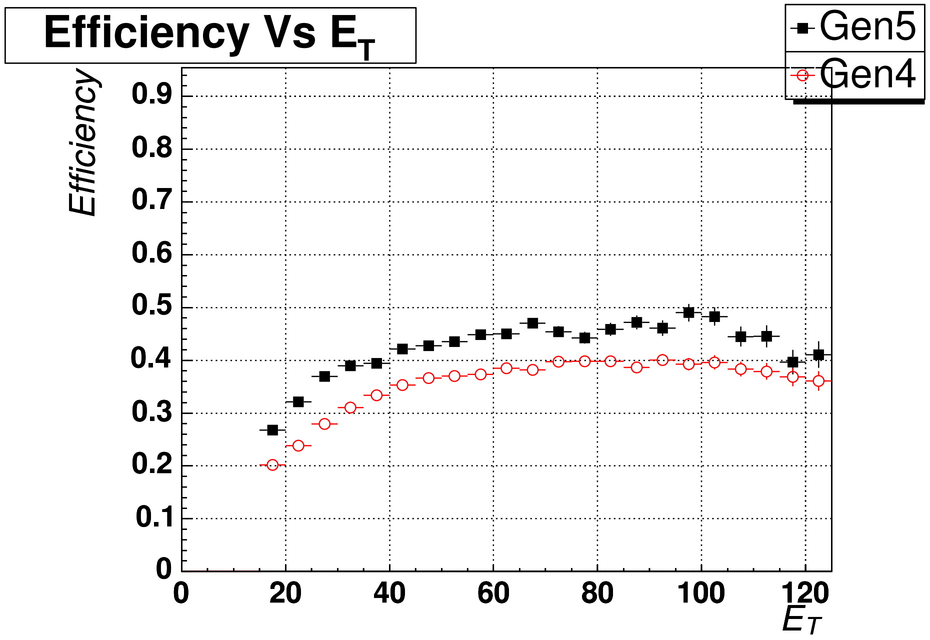
$$N^{2-tag}_{mistag} = N^{pred}_{+-} * \alpha_{LF} * \left(\frac{N^{-} + N^{+}_{NonW} + N^{+}_{W+C}}{N^{+}} \right)$$



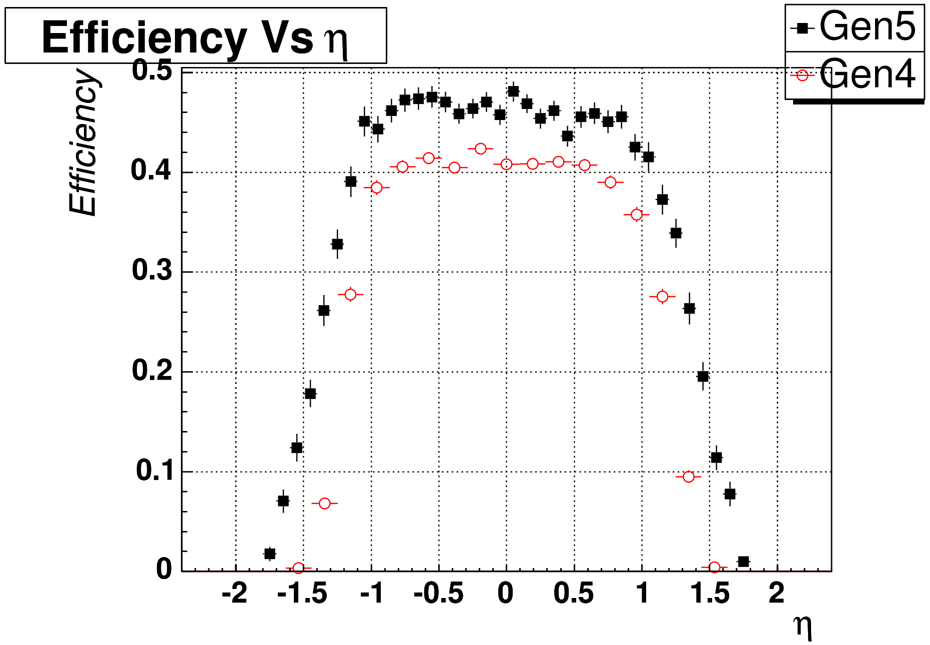


Predicting negative tags well

Efficiency



Efficiency Vs E_T
Gen5
Gen4
Efficiency
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
E_T



Efficiency Vs η
Gen5
Gen4
Efficiency
0.5
0.4
0.3
0.2
0.1
0
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
η

Acceptance and Pretag Efficiency

Something goes here

Systematics

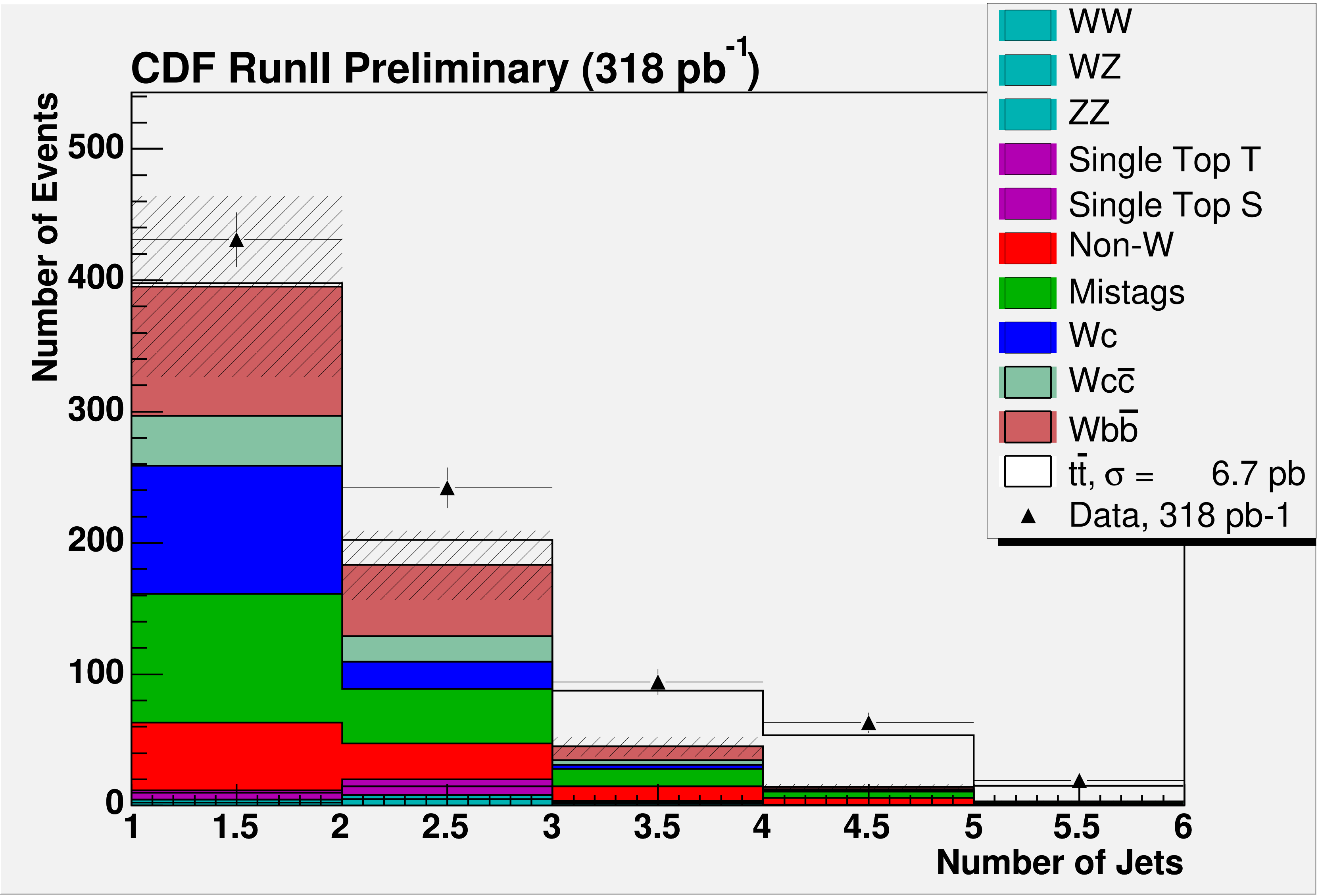
Something goes here

Total Background, ≥ 1 Tags: 319 pb^{-1}

Summary					
Jet Multiplicity	1 jet	2 jets	3 jets	4 jets	≥ 5 jets
Pretags					
Data	30548	4773	763	179	36
$t\bar{t}$ (6.7 pb)	7.27 ± 0.82	38.46 ± 4.14	75.27 ± 8.09	65.15 ± 7.02	19.20 ± 2.11
≥ 1 Tags					
WW/WZ/ZZ	4.38 ± 0.75	8.18 ± 1.42	1.96 ± 0.37	0.34 ± 0.10	0.07 ± 0.03
Single Top	7.02 ± 1.89	11.63 ± 2.84	1.85 ± 0.42	0.25 ± 0.06	0.02 ± 0.01
QCD	51.60 ± 13.24	27.58 ± 7.24	10.81 ± 3.02	5.11 ± 1.61	1.18 ± 0.55
Mistags	98.40 ± 11.85	41.37 ± 4.62	13.07 ± 1.55	5.15 ± 0.57	1.39 ± 0.16
W+C	97.42 ± 24.91	21.02 ± 6.14	3.15 ± 1.99	0.52 ± 0.18	0.07 ± 0.03
W+CC	37.69 ± 10.93	19.25 ± 4.78	3.69 ± 1.57	0.90 ± 0.29	0.07 ± 0.04
W+BB	98.69 ± 30.52	54.07 ± 13.77	10.41 ± 2.96	1.96 ± 0.60	0.32 ± 0.14
Total Background	395.19 ± 68.73	183.10 ± 26.33	44.94 ± 7.37	14.23 ± 2.02	3.11 ± 0.61
$t\bar{t}$ (6.7 pb)	2.39 ± 0.41	19.33 ± 3.02	42.41 ± 6.86	39.09 ± 6.67	11.91 ± 2.12
Data	431	242	94	63	19

- Removed top from pretags (not for QCD bkg)
- Remove QCD from mistag/W+HF pretags

W+≥1 Tags



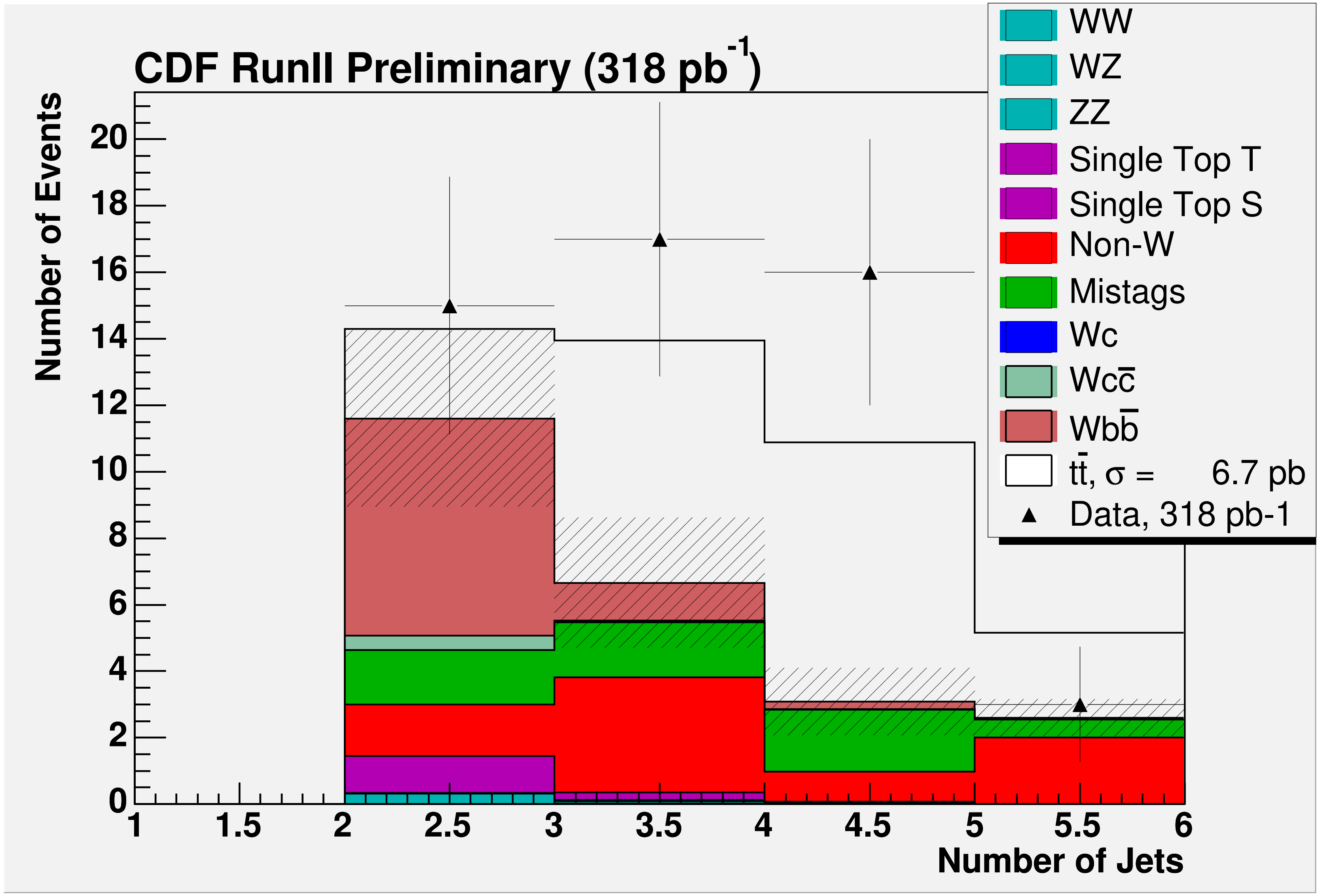
CDF RunII Preliminary (318 pb^{-1})
Number of Events
0
100
200
300
400
500
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
Number of Jets
WW
WZ
ZZ
Single Top T
Single Top S
Non-W
Mistags
Wc
Wc$\bar{c}$
Wb$\bar{b}$
t$\bar{t}$, σ = 6.7 pb
Data, 318 pb-1

Total Background, ≥ 2 Tags: 319 pb^{-1}

Summary					
Jet Multiplicity	1 jet	2 jets	3 jets	4 jets	$\geq$ 5 jets
Pretags					
Data	30548	4773	763	179	36
$t\bar{t}$ (6.7 pb)	7.27 $\pm$ 0.82	38.46 $\pm$ 4.14	75.27 $\pm$ 8.09	65.15 $\pm$ 7.02	19.20 $\pm$ 2.11
$\geq$ 2 Tags					
WW/WZ/ZZ	0	0.33 $\pm$ 0.08	0.10 $\pm$ 0.03	0.03 $\pm$ 0.02	0.00 $\pm$ 0.00
Single Top	0	1.12 $\pm$ 0.24	0.26 $\pm$ 0.06	0.04 $\pm$ 0.01	0.00 $\pm$ 0.00
QCD	0	1.55 $\pm$ 0.73	3.46 $\pm$ 1.75	0.91 $\pm$ 0.81	2.00 $\pm$ 0.50
Mistags	0	1.64 $\pm$ 0.49	1.65 $\pm$ 0.59	1.87 $\pm$ 0.59	0.53 $\pm$ 0.24
W+C	0	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
W+CC	0	0.44 $\pm$ 0.22	0.06 $\pm$ 0.07	0.02 $\pm$ 0.01	0.00 $\pm$ 0.00
W+BB	0	6.52 $\pm$ 2.27	1.13 $\pm$ 0.59	0.22 $\pm$ 0.09	0.06 $\pm$ 0.03
$t\bar{t}$ (6.7 pb)	0	2.70 $\pm$ 0.62	7.30 $\pm$ 1.63	7.80 $\pm$ 1.74	2.56 $\pm$ 0.59
Total	0	11.60 $\pm$ 2.65	6.66 $\pm$ 1.96	3.08 $\pm$ 1.01	2.60 $\pm$ 0.56
Data	0	15	17	16	3

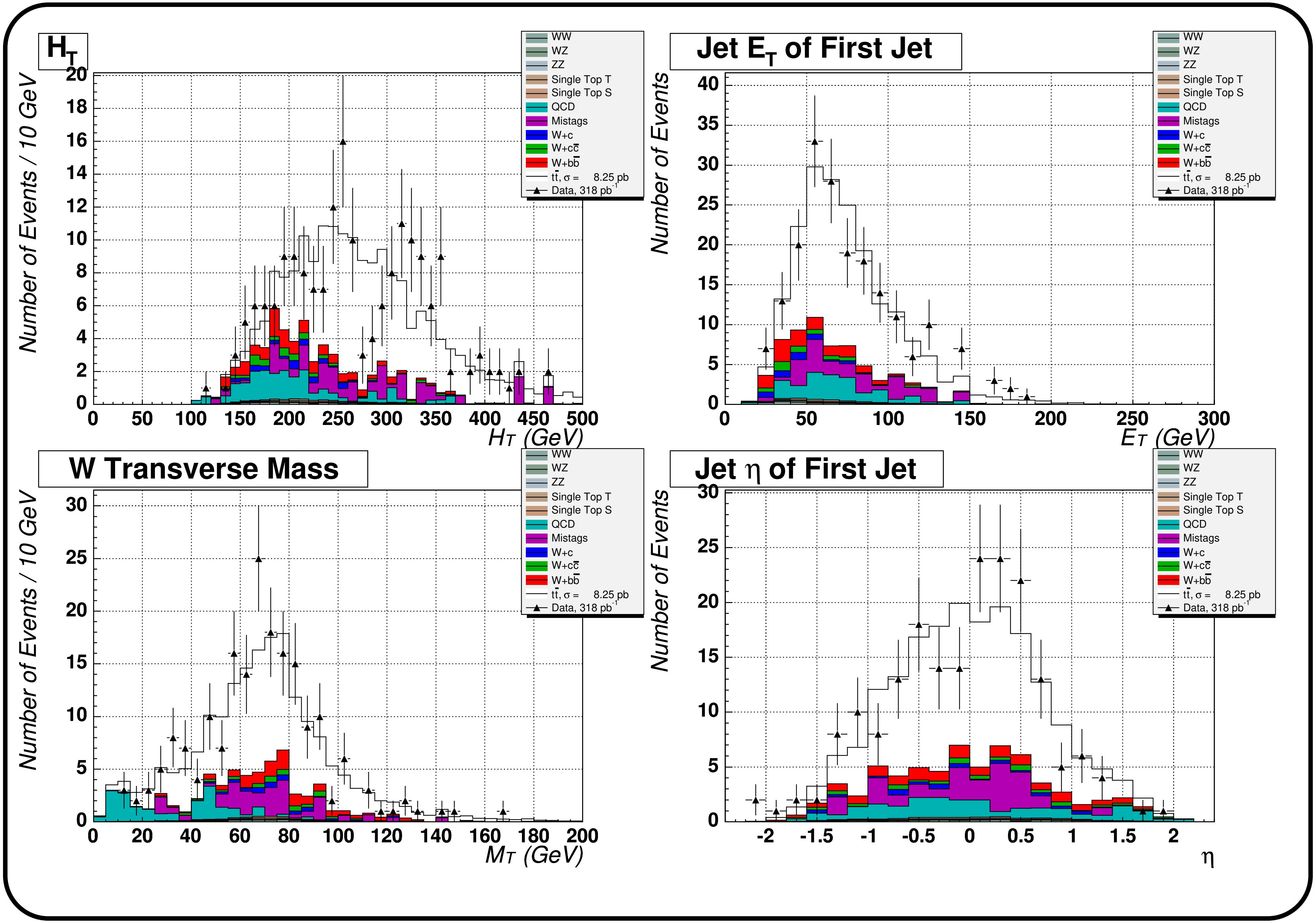
- Removed top from pretags (not for QCD bkg)
- Remove QCD from mistag/W+HF pretags

W+≥2 Tags



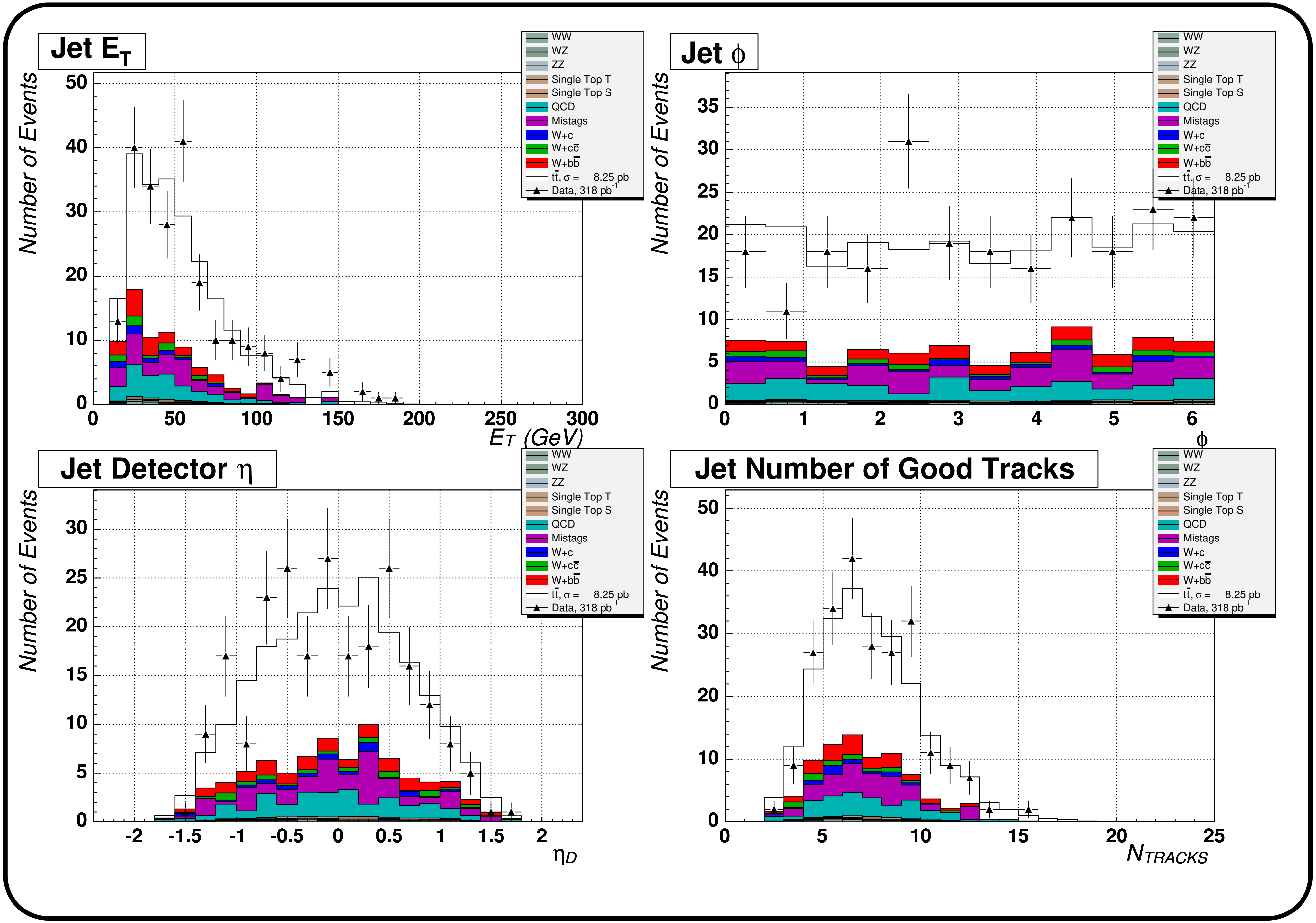
CDF RunII Preliminary (318 pb^{-1})
Number of Events
Number of Jets
0
2
4
6
8
10
12
14
16
18
20
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
WW
WZ
ZZ
Single Top T
Single Top S
Non-W
Mistags
Wc
Wc$\bar{c}$
Wb$\bar{b}$
t$\bar{t}$, σ = 6.7 pb
Data, 318 pb-1

Plots



H_T
Number of Events / 10 GeV
H_T (GeV)
Jet E_T of First Jet
Number of Events
E_T (GeV)
W Transverse Mass
Number of Events / 10 GeV
M_T (GeV)
Jet η of First Jet
Number of Events
η
WW
WZ
ZZ
Single Top T
Single Top S
QCD
Mistags
W+c
W+cc̄
W+bb̄
tt̄, σ = 8.25 pb
Data, 318 pb^-1

Plots


Jet E_T
Number of Events
E_T (GeV)
Jet ϕ
ϕ
Jet Detector η
η_D
Jet Number of Good Tracks
N_{TRACKS}
WW
WZ
ZZ
Single Top T
Single Top S
QCD
Mistags
W+c
W+c$\bar{c}$
W+b$\bar{b}$
t$\bar{t}$, σ = 8.25 pb
Data, 318 pb^{-1}

Fitting

Something goes here

Summary