

On the $W+4$ jets background to the top-quark asymmetry at the Tevatron

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Introduction

- Large top forward-backward asymmetry ($A_{FB}^{t\bar{t}}$) has been observed at the Tevatron.
- Contributions of NNLL QCD, EW corrections, NLO of $t\bar{t}j$, etc. have been discussed, but we do not know the satisfactory answer yet.
- We focus on $W+4$ jets background for this anomalous $A_{FB}^{t\bar{t}}$.

Event Selection & Reconstruction

Event generation

matrix-element level (MadGraph 5)

$$t\bar{t} : p\bar{p} \rightarrow t\bar{t} \rightarrow bW^+ \bar{b}W^- \rightarrow bj\bar{j} + \bar{b}l^-\bar{\nu}_l$$

$$W+4\text{ jets} : p\bar{p} \rightarrow W^- b\bar{b}j\bar{j}$$

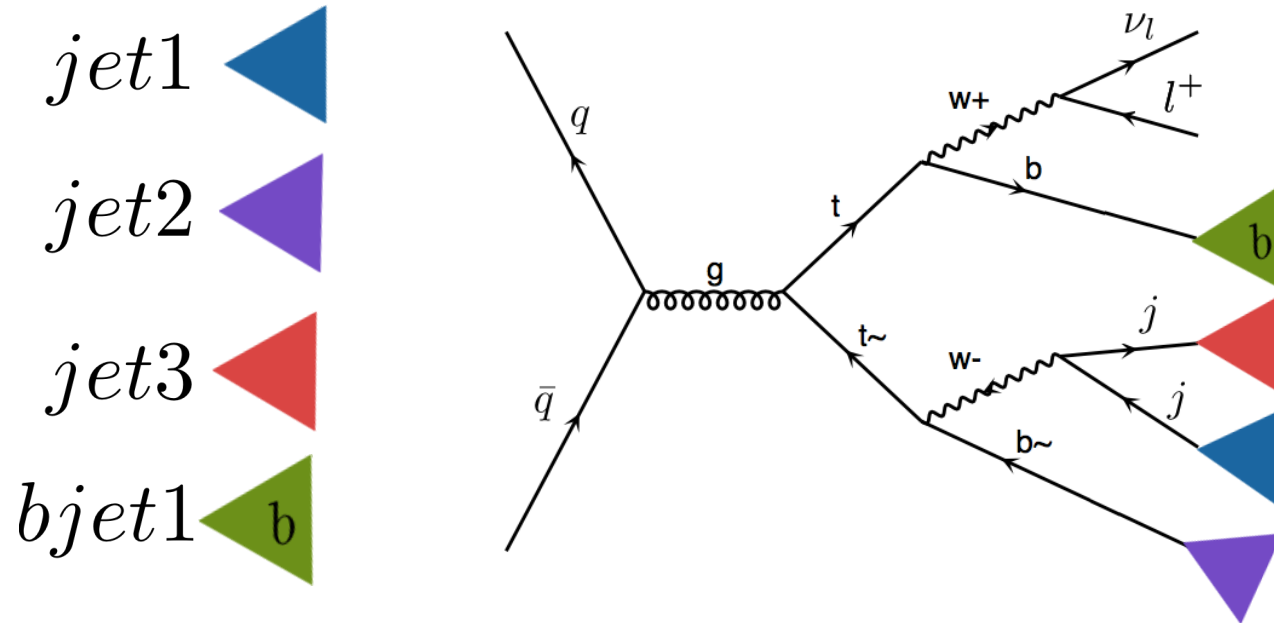
$$p\bar{p} \rightarrow W^- jjj\bar{j} \quad (j = u, d, s, c)$$

- PDF: CTEQ 6L1
- Fact_scale = $M_{t\bar{t}}/2$ ($t\bar{t}$)
20 GeV (W+4 jets)

Event Selection

- # lepton (e or μ) = 1 ($p_T > 20$ GeV, $|\eta| < 2.0$)
- # jets ≥ 4 ($p_T > 20$ GeV, $|\eta| < 2.5$)
 - $\Delta R_{jl} > 0.4$, $\Delta R_{jj} > 0.4$, $\Delta R_{ll} > 0.4$
 - $\max\{p_T^{jet}\} \geq 40$ GeV
- $\cancel{E}_T > 20$ GeV
- # b -tagged jets = 1 or 2
 - b -tag efficiency = 70 %
 - miss- b -tag prob. = 8 %

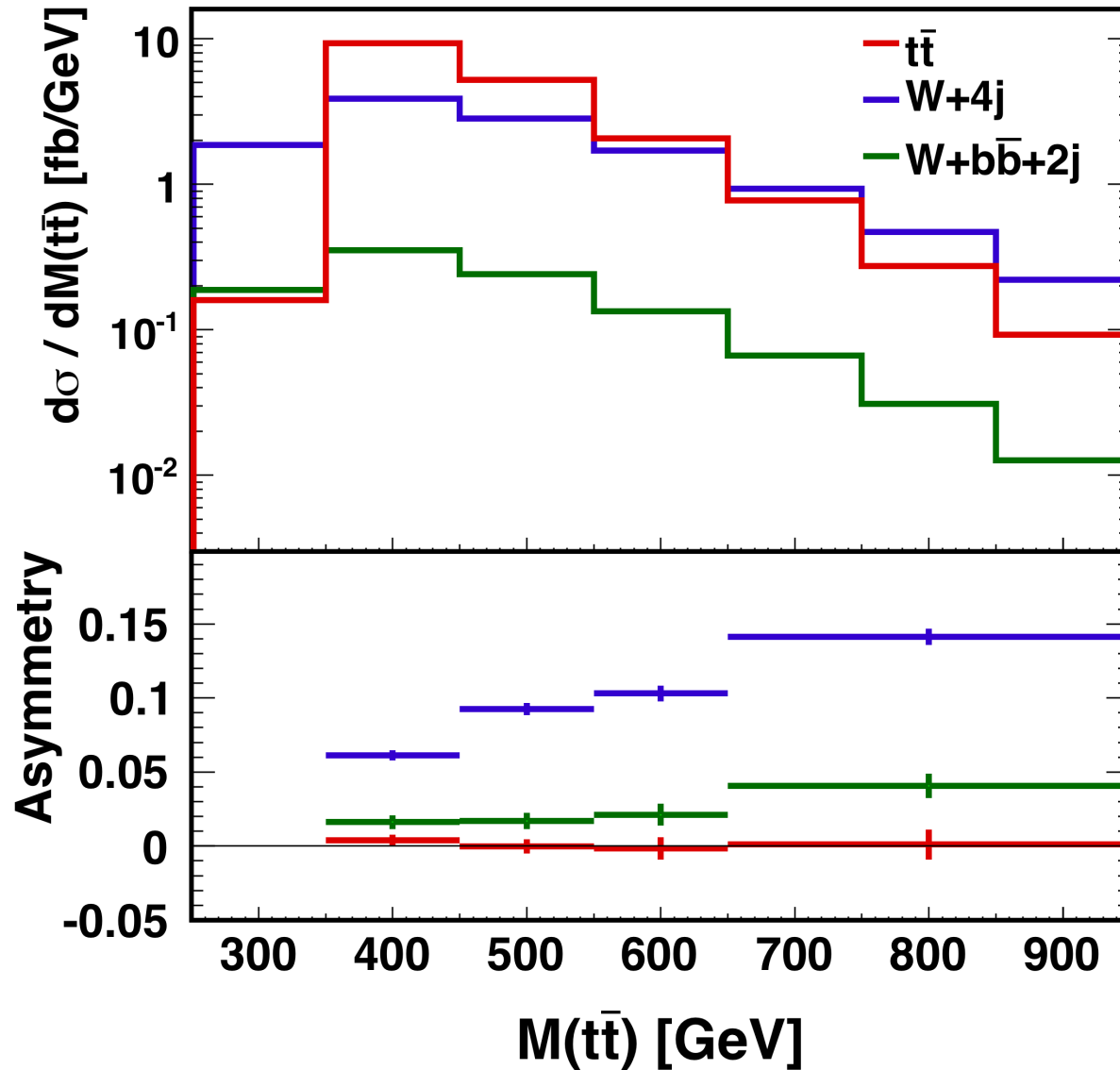
Reconstruction of top & antitop



$$\chi^2 = \left(\frac{M_{jj} - M_W}{\Gamma_W^2} \right)^2 + \left(\frac{M_{l\nu} - M_W}{\Gamma_W^2} \right)^2 + \left(\frac{M_{bjj} - M_t}{\Gamma_t^2} \right)^2 + \left(\frac{M_{bl\nu} - M_t}{\Gamma_t^2} \right)^2$$

Results

$M_{t\bar{t}}$ distribution

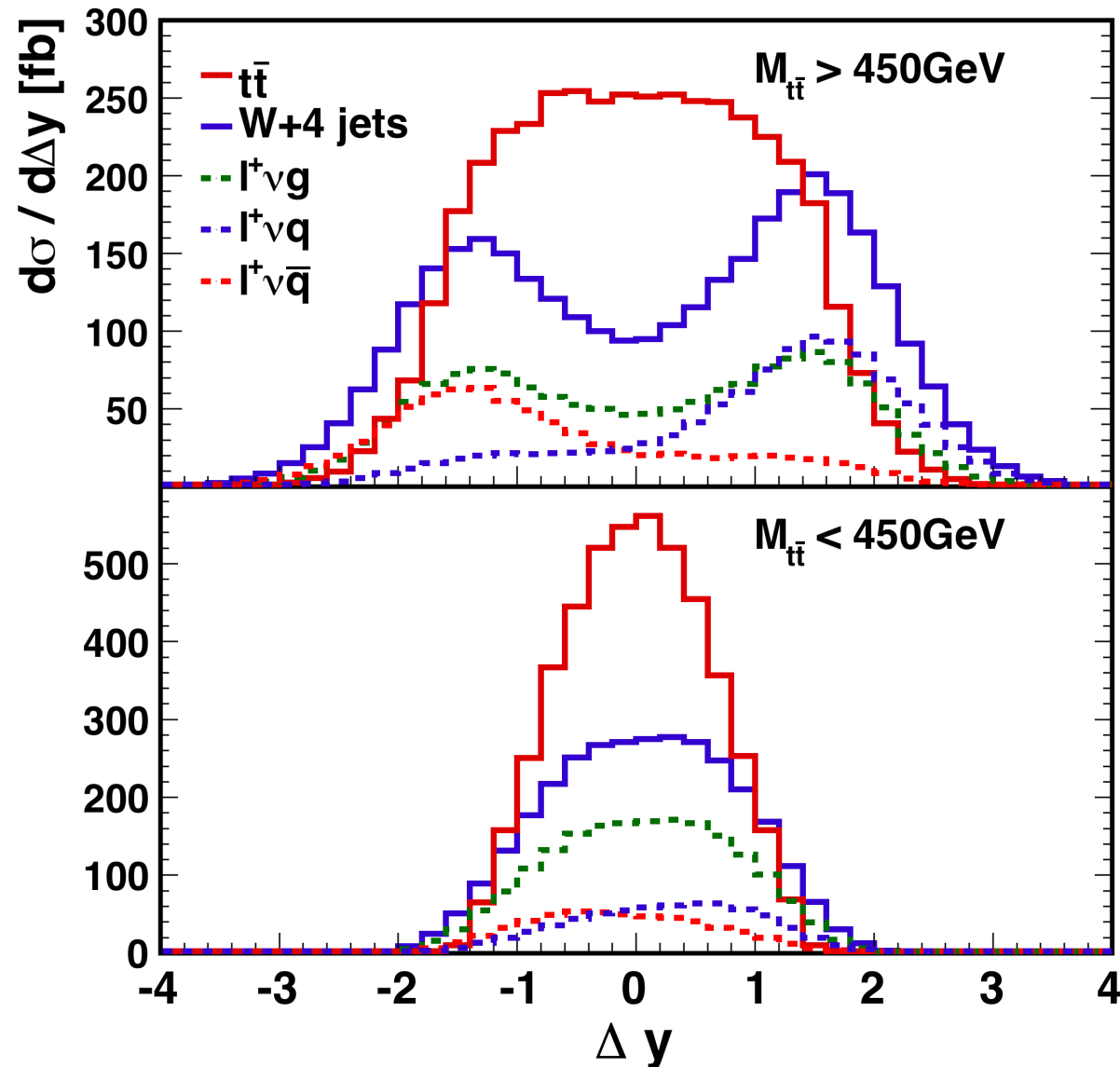


$$\sigma(t\bar{t}) = 1.8 \text{ pb}$$

$$\sigma(W+4j) = 1.2 \text{ pb}$$

$$\sigma(W+2b+2j) = 0.1 \text{ pb}$$

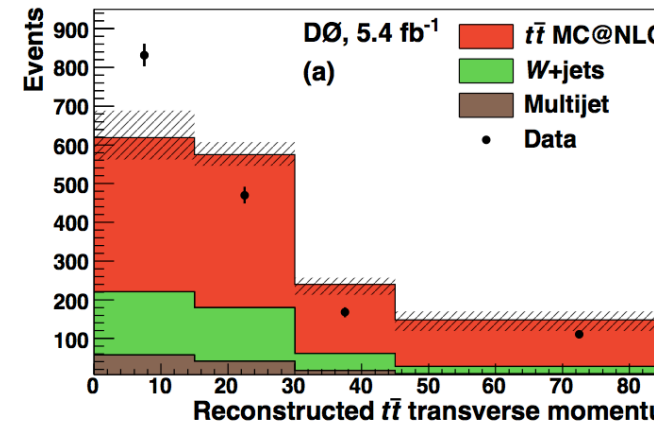
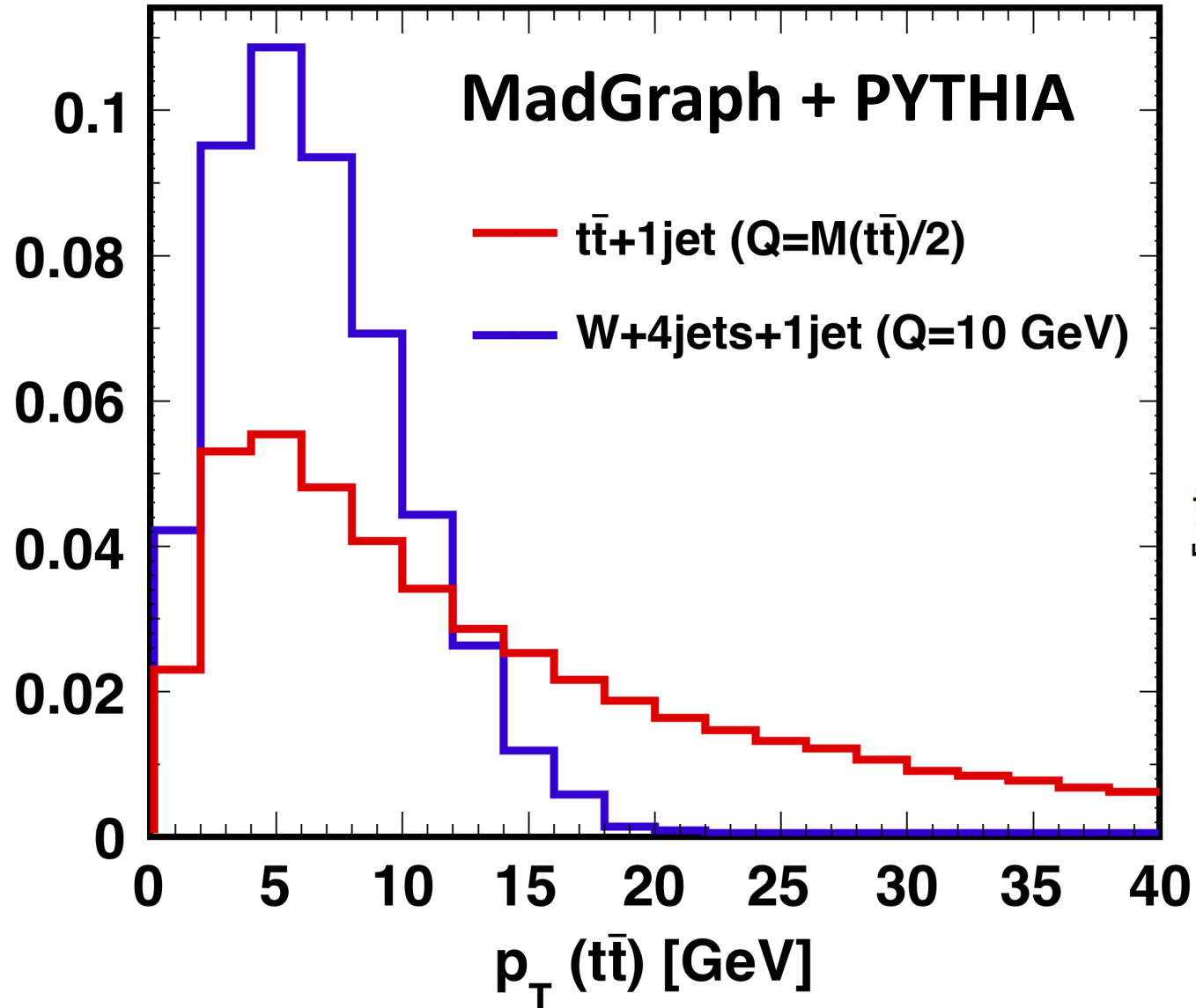
Δy distribution



$$A_{FB}(W+4\text{jets}) = 11\%$$

$$A_{FB}(W+4\text{jets}) = 6\%$$

$p_T(t\bar{t})$ distribution



Summary

- We investigated **W+4 jets** background in detail on $M_{t\bar{t}}$, Δy and $p_T(t\bar{t})$ distributions.
- **Large $A_{FB}^{t\bar{t}}$** is seen in W+4 jets background.
- Anomaly in $p_T(t\bar{t})$ by D0 may suggests BG contaminations in signal than expected.
- We suggest to **re-evaluate W+4 jets BG** at the Tevatron, comparing with distributions we discussed.

Back up slides

Reconstruction of top

$$p_{W^-}^i = p_l + p_{\nu i}$$

$$p_{\nu i} = (E_T \cosh \eta_i, E_T x, E_T y, E_T \sinh \eta_i)$$

$$\eta_1 = \eta_l + \cosh^{-1}(x)$$

$$\eta_2 = \eta_l - \cosh^{-1}(x)$$

$$x = \frac{m_W^2}{2p_T^l p_T^{\cancel{E}_T}} + \cos(\Delta\phi_{l\cancel{E}_T})$$

use 4 leading jets (including b-tagged jet) for reconstructions

For the other W

Select W candidates (j1,j2)

$$|m_{j_1, j_2} - m_W| < \alpha m_W$$

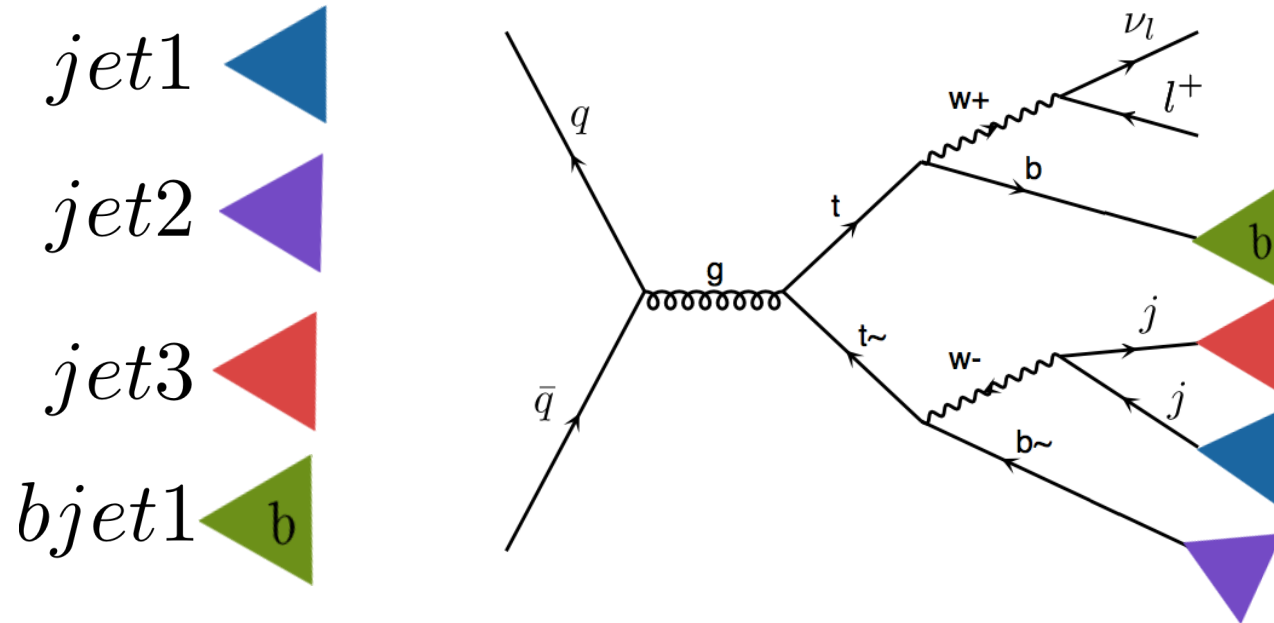
If no candidate,
throw away the event

b1 = b-tagged jet

b2 = b-tagged jet (if # b =2)

the remained jet (if # b =1)

Reconstruction of top & antitop



$$\chi^2 = \left(\frac{M_{jj} - M_W}{\Gamma_W^2} \right)^2 + \left(\frac{M_{l\nu} - M_W}{\Gamma_W^2} \right)^2 + \left(\frac{M_{bjj} - M_t}{\Gamma_t^2} \right)^2 + \left(\frac{M_{bl\nu} - M_t}{\Gamma_t^2} \right)^2$$

$$+ \sum_{i=l,jets} \left(\frac{p_T^{i,meas} - p_T^i}{\sigma_i^2} \right)^2 + \sum_{j=x,y} \left(\frac{p_j^{UE,meas} - p_l^{UE}}{\sigma_j^2} \right)^2$$

Mass distribution of top (lep)

