

DECAY CHARACTERISTICS OF W BOSONS FROM HEAVY QUARKS

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A systematic look at possible t -like phenomena

What handles exist to isolate potential t -like decays (e.g., d_4 , u_4 , $T_{5/3}$) from QCD, W + jets, and t (+ jets)

- Ongoing studies with Christian Flacco, *UC Irvine*
- PGS framework with Pythia 6, default tunes, at 7 TeV c.m. energy
- Fastjet to create 0.4 anti- k_t particle jets
(focus on baseline event properties, not reclustering techniques)

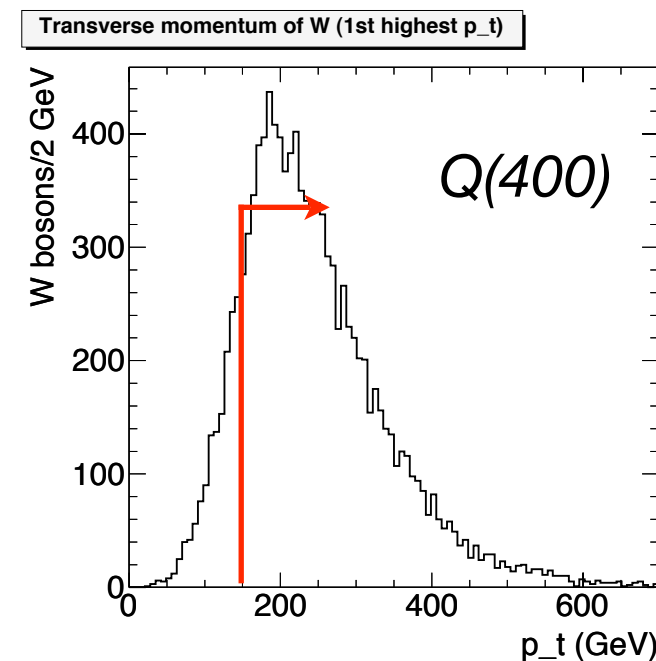
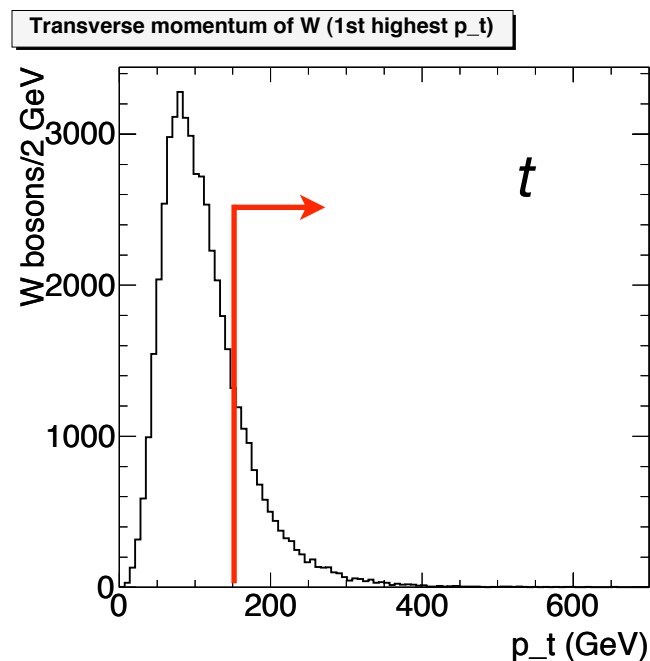
Two questions to explore:

- What information can be used to build a W tag
- Given a W tag, how can it be exploited in searches (i.e., how to suppress t decays and isolate new phenomena)

Samples to consider

Consider signals producing W bosons with $p_t > 150$ GeV and quark daughters $|\eta| < 2.5$:

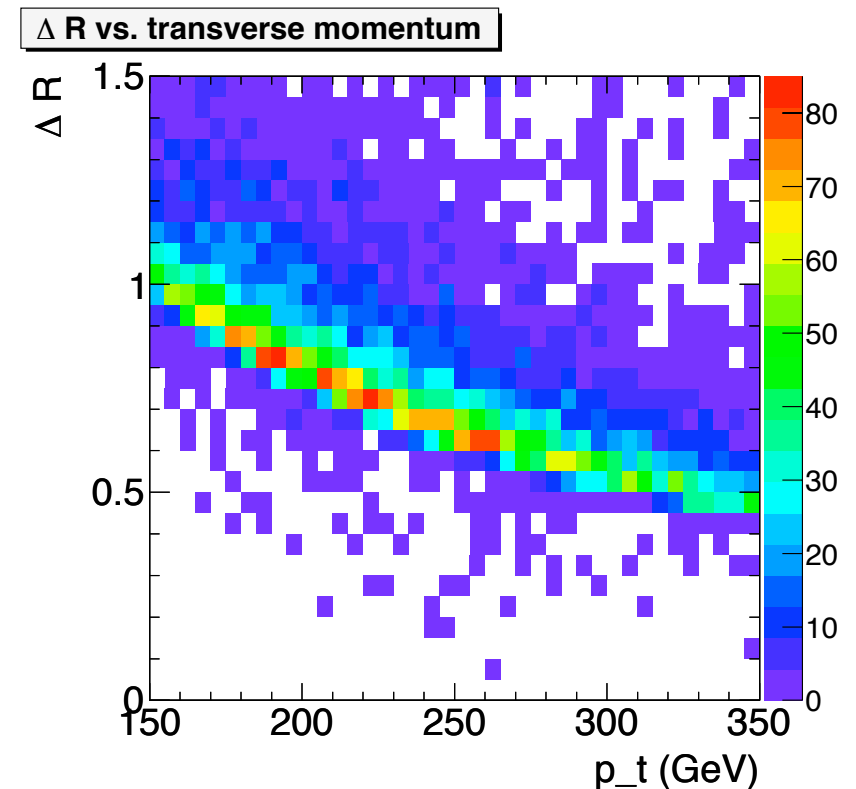
- $t\bar{t} \rightarrow W^+W^-b\bar{b}$: $\sigma * \text{BF} * \varepsilon = (150 \text{ pb}) * (89\%) * (7.7\%) = 10 \text{ pb}$
- $Q_u\bar{Q}_u \rightarrow W^+W^-b\bar{b}$: $\sigma * \text{BF} * \varepsilon = (1.3 \text{ pb}) * (89\%) * (33\%) = 0.38 \text{ pb}$
(for mass = 400 GeV)
- $W + \text{jets}$: $\sigma * \text{BF} * \varepsilon = (78 \text{ nb}) * (68\%) * (0.2\%) = 106 \text{ pb} (?)$
- QCD multijets



Characterization: ΔR vs. p_t

A precise relationship exists among mass, momentum and ΔR

- $(m_W, p_t) \Rightarrow \Delta R$
- Using this as a selection criteria creates a peaked background in the mass distribution (may be OK depending on the analysis).

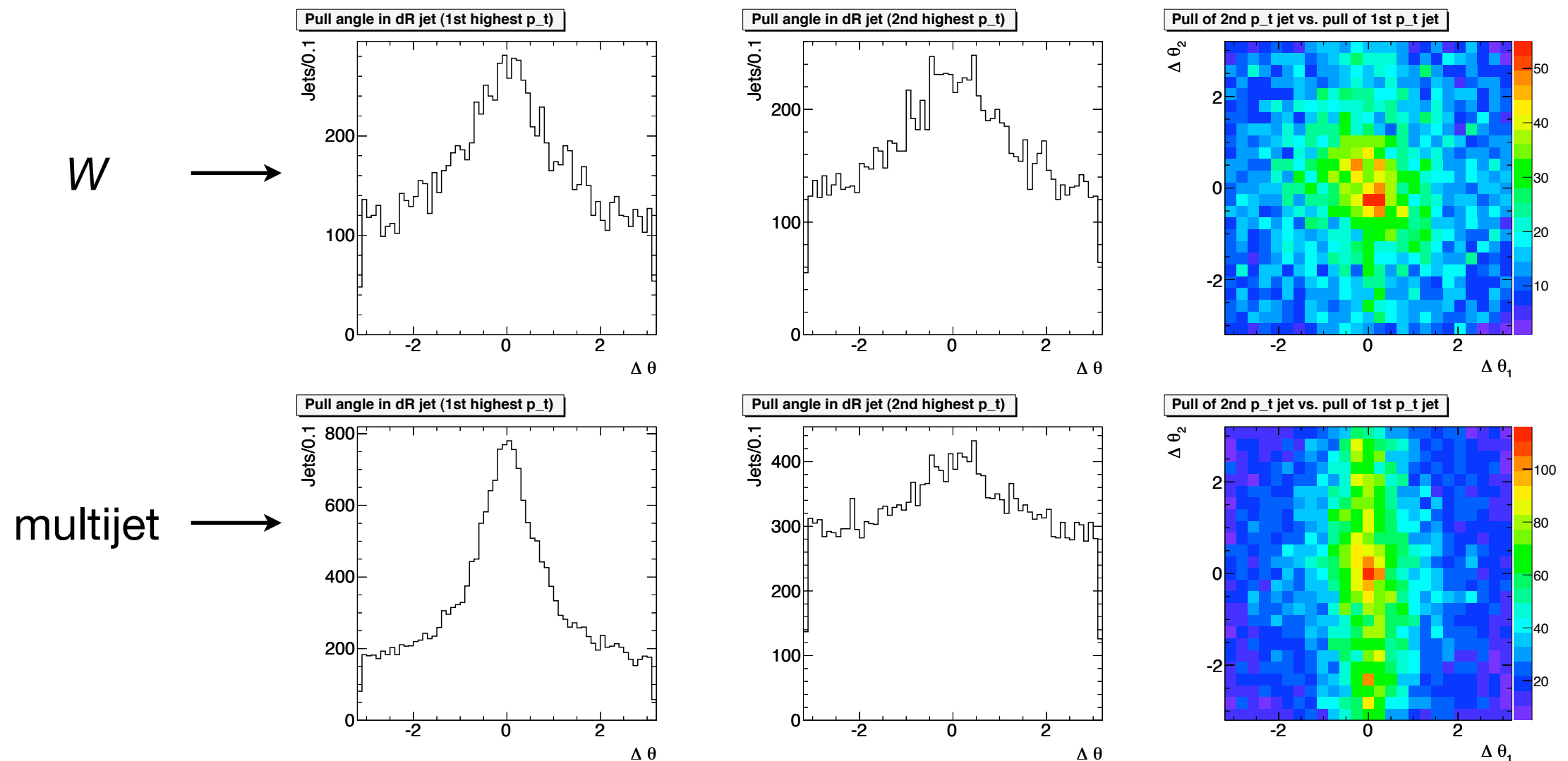


(generated from u_4 sample)

Characterization: color strings

W bosons are color singlets; the jets in the decay will not be color-connected to other jets in the events.

Construct the “pull” for signal and QCD background

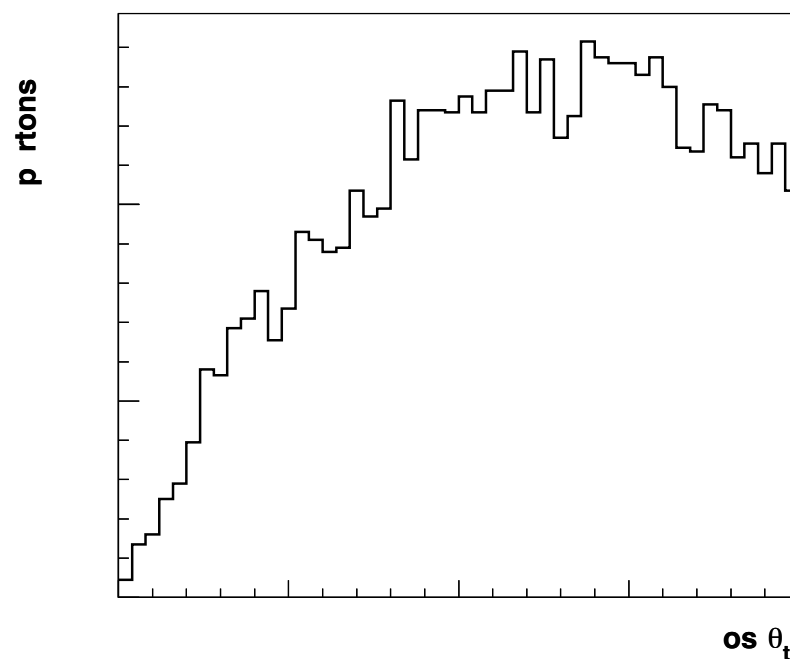


J. Gallicchio and M. D. Schwartz, “Seeing in Color: Jet Superstructure,” arXiv:1001.5027 [hep-ph]

Characterization: polarization

The polarization of the W depends on the production mechanism (QCD vs. heavy quark)

- To measure this, need to identify the jet flavor (charm tagging?)
- Not clear that this affects reconstruction techniques

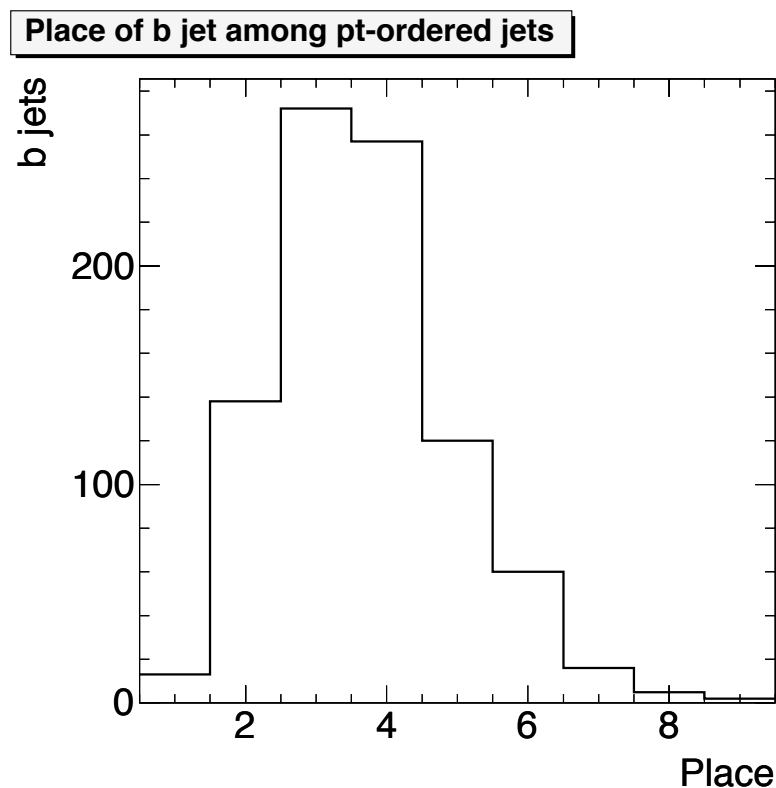


Angle between d -type parton
and t quark
in the W rest frame

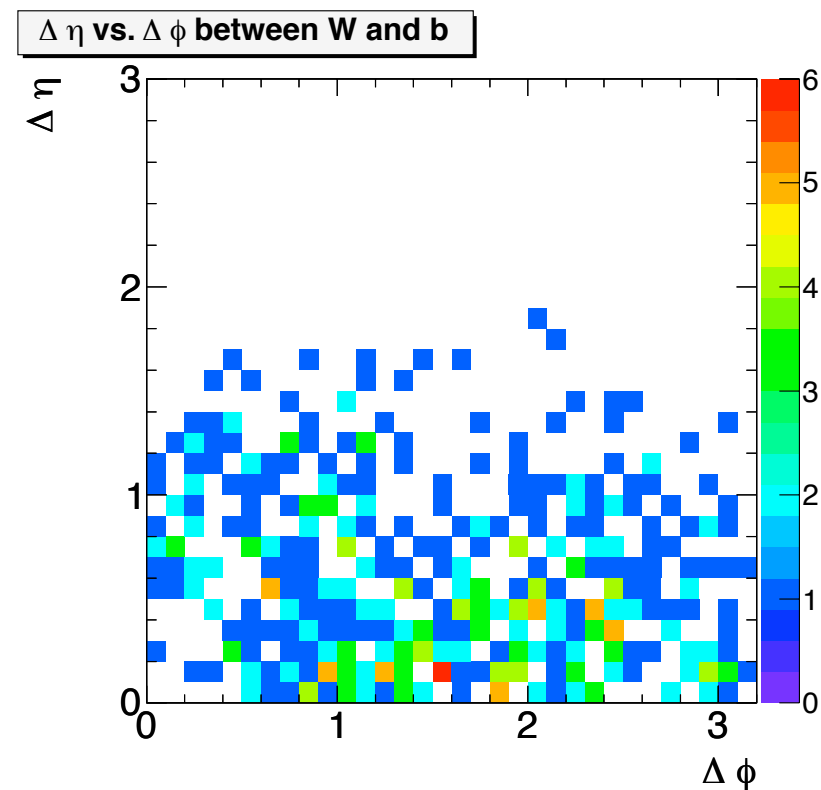
Associating with a b jet

For W bosons from t decays, what is the relationship between it and the associated b jet?

The b jet is among the high- p_t jets in the event;
but not typically the highest



The b jet is nearby in η ,
but may be further away in ϕ

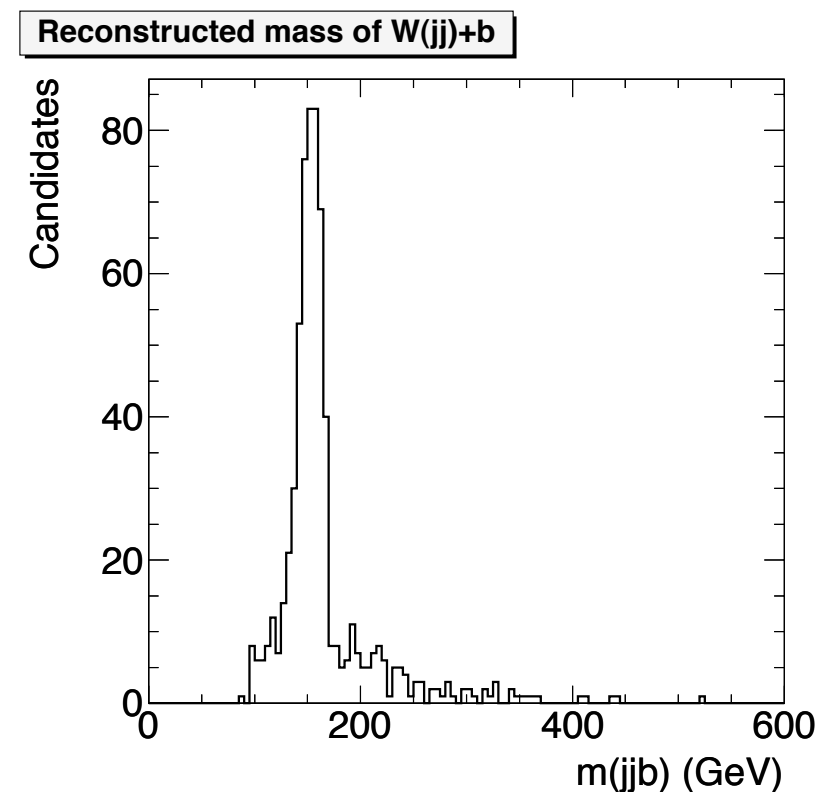


Reconstructing t mass

By selecting a high- p_t jet, with $|\Delta\eta| < 1$ and tagged as a b jet, obtain the mass peak below

- Assumes W reconstruction is under control (crucial for background rejection)
- Can find a similar peak in W + jets (i.e. single top production)

Signal only; backgrounds will depend on event selection



Conclusions

Finding high- p_t W bosons can provide an important handle on busy events

- Focusing on the W rather than on the t provides a baseline for searches for weakly decaying particles
- Reconstructing boosted W allows one to leverage b tagging by reducing combinatorics
- Understanding these events should provide useful information for commissioning top taggers