b-tagging in Top Physics

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(Wuppertal)

- **Motivation**
- **Interests in b-tagging topics**
- **Progress in b-tag calibration**

Motivation

- Building pixel detector → natural topic is b-tagging
- Improvements in b-tagging and calibration and understanding the behaviour of b-tagging in top events → Improvements in top measurements and understanding of systematics.
- Top events can be used to calibrate b-tagging and possibly charm tagging and light jet rejection. Important in commission phase as well as later.

B-tagging Interests of Wuppertal Group

Aim: Improvements to both b-tagging and top analysis

- Calibration of tag efficiency and rejection using ttbar (Grant Gorfine)
- Optimization of selection
- Jet algorithms – assignment of tracks to jet (Marisa Sandhoff)
  - Comparison b/n Kt and cone algorithms
- Vertexing (Tatjana Lenz)
- Tracking (Sebastian Fleischmann)
- Charm tagging (Sebastian Reuschel)
- Use of flavour tag weights in kinematic fit. Improvements of fit.
  - Repeat and extend what was done in DØ.
- Influence of detector realism – eg misalignment (Grant Gorfine)

B-tagging calibration

- Jet counting
  - Compare 0, 1, 2 tagged b-jets.
    - Expect two and only 2 b-jets.
    - If one can select sample of events that have high fraction of true ttbar then efficiency based on counting tagged jets is less sensitive to wrong jet combinations.

- "b-jet" sample
  - Selection to get high purity b-jet sample (eg by tight cuts on top mass) → can then look at b-tag weight distribution
    - No b-tagging or
    - Use b-tagging on one side only (eg lepton side) and measure b-tag weight of b-jet from other side (eg hadronic side).

Light Jet and charm jet calibration

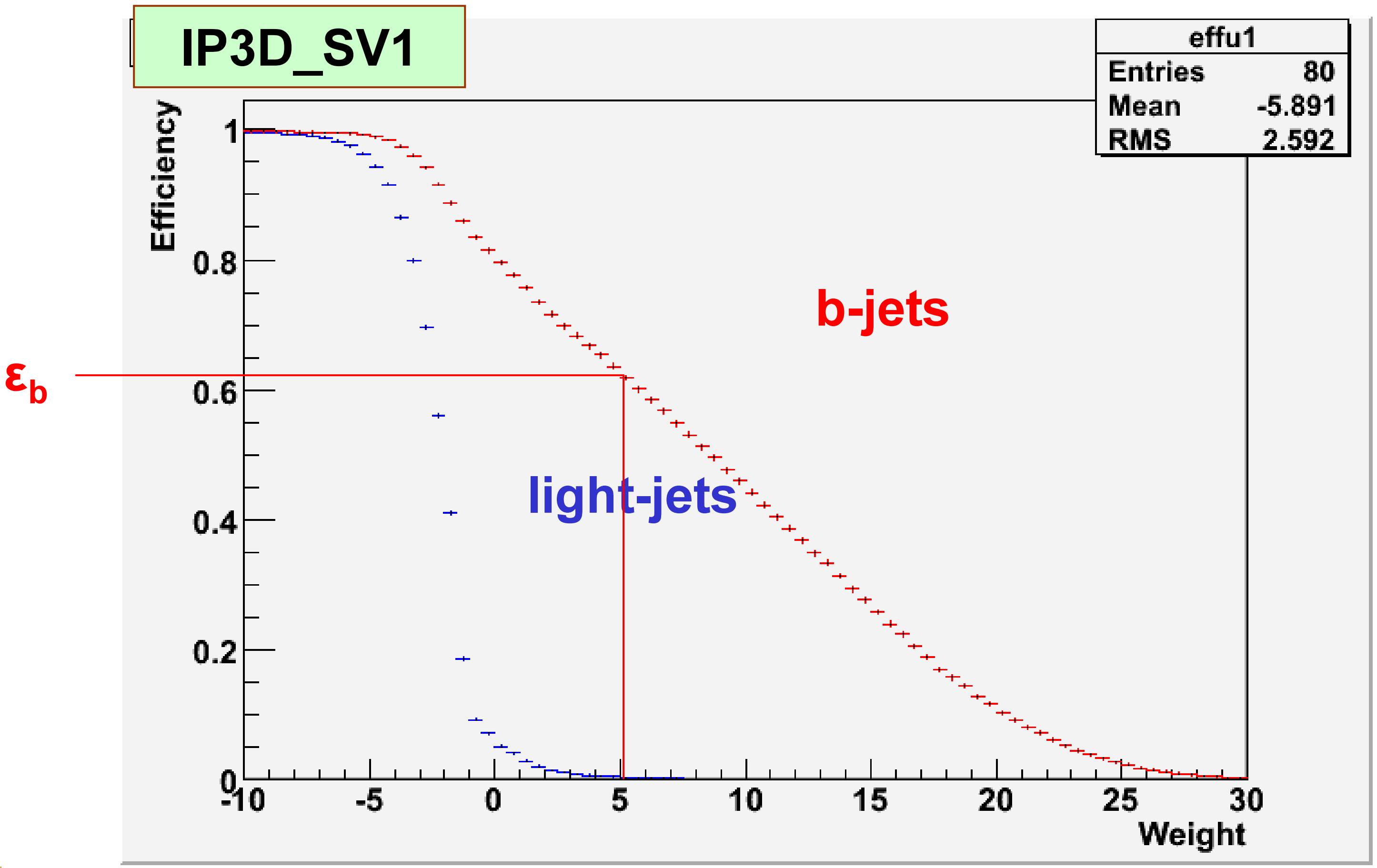
- Can possibly extract information from jet counting.
  - Only expect two b-jets → Presence of three jets tagged as b-jets gives information on mis-tag rate from light jet and/or charm jet.
- Use W's from ttbar to look at light jet and charm jet weights.

Progress so far

- Just starting – results preliminary
- Looked at ttbar events, no background
  - CSC T1 sample - semileptonic ttbar events using MC@NLO.
  - ~10k events
- Looked at jets in b-tag collection
  - Cone4 jets by default
- Checked tagging efficiencies
- Jet counting (comparison of 0,1,2 tagged b-jets)
- Looked at truth info to select events.

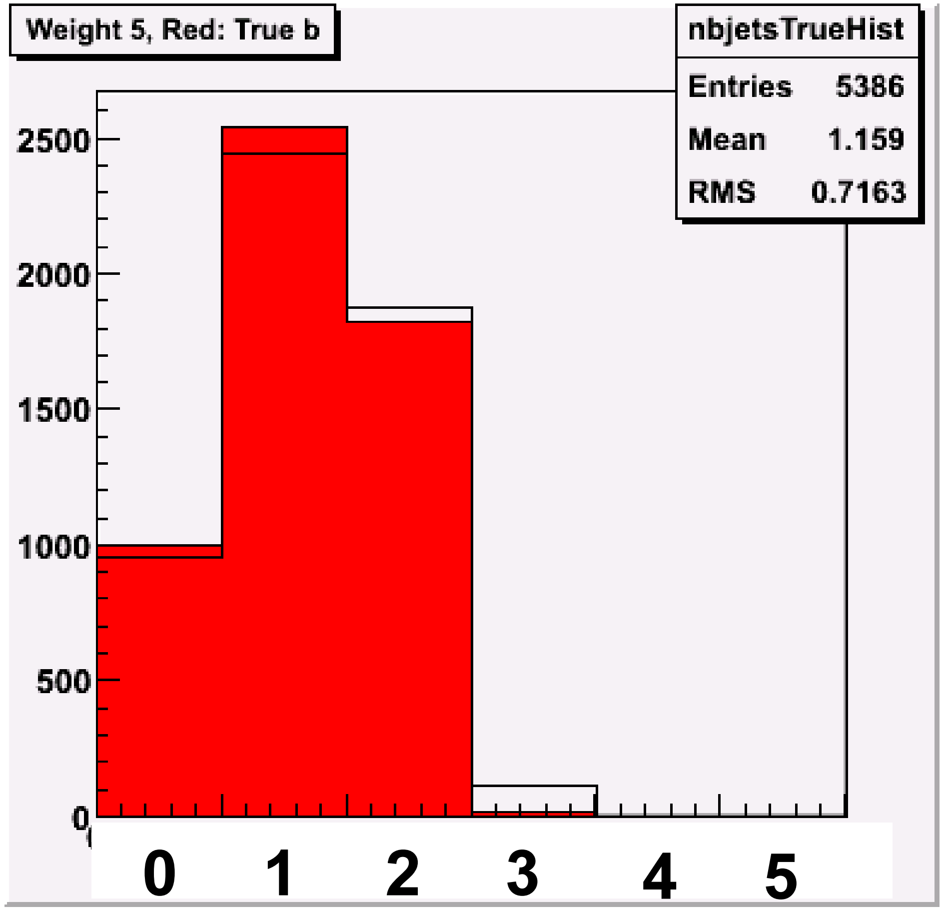
Tag Efficiency

T1 sample - ttbar



Jet Counting

- Unfilled histogram
  - number of jets tagged as b-jet (weight > weightCut, weightCut = 5 here)
- Red histogram
  - number of jets tagged as b-jet AND labeled as true b-jet.
- Discrepancy mostly due to charm jets



Jet Counting …

- Jet counting (0,1,2 tagged jets)
  - $\epsilon = \epsilon_b \times \epsilon_{\text{jet reconstructed and selected}}$

    = Efficiency of b from top being reconstructed and tagged.
  - Assuming high rejection and only 2 true b-jets

    Prob (2 bjet) $= \epsilon^2 = n_2 / n_{tot}$

    Prob (1 bjet) $= 2\epsilon(1-\epsilon) = n_1 / n_{tot}$

    Prob (0 bjet) $= (1-\epsilon)^2 = n_0 / n_{tot}$

    We get various expressions for ϵ, eg

    $\epsilon = 1/(1+n_1/2n_2)$ (Eqn 1)

    $\epsilon = 1/(1+2n_0/n_1)$ (Eqn 2)

Jet Counting …

- No event selection,
- Jet p_T>15 GeV, $|\eta|$< 2.5
  - Standard cuts used when quoting b –tag efficiencies
- No background

$\varepsilon = 1/(1+n_1/2n_2)$ (Eqn 1)
$\varepsilon = 1/(1+2n_0/n_1)$ (Eqn 2)

Weight	ϵ_b	(Eqn 1)	(Eqn 2)
0	0.791 ± 0.003	0.680 ± 0.007	0.621 ± 0.013
5	0.618 ± 0.004	0.515 ± 0.012	0.481 ± 0.013
10	0.445 ± 0.004	0.363 ± 0.020	0.347 ± 0.014

➔ Differences due to not all b-jets being reconstructed and selected, overlapping jets, …

Jet Counting …

- Select "good" ttbar events using truth
  - Both b quarks from top are close to a reconstructed jet (deltaR < 0.3)
  - Unambiguous association - no other quarks from ttbar nearby (deltaR > 0.7) - avoid merged jets

Weight	ϵ_b *	(Eqn 1)	(Eqn 2)
0	0.791 ± 0.004	0.774 ± 0.007	0.707 ± 0.018
5	0.618 ± 0.005	0.606 ± 0.012	0.561 ± 0.017
10	0.444 ± 0.005	0.433 ± 0.020	0.412 ± 0.018

* ϵ_b **calculated using only b's from top**

➔ With good event selection expect to be able to extract b-jet efficiency. Not dependent on wrong jet combinations.

Next steps

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  - Understand remaining discrepancies and influence of light quark and charm quark on these ratios.
  - Repeat with some realistic ttbar analysis and work on event selection
    - Using kinematic fit from DØ.
  - Look at backgrounds

  - Can benefit from jet algorithm work being done in group → better jet assignments.

Summary

- Interests
  - Calibration, selection, jet algorithms, vertexing, tracking, charm-tagging, kinematic fitting.
- Started with investigating tagged jet counting in ttbar events.
  - Results so far are encouraging