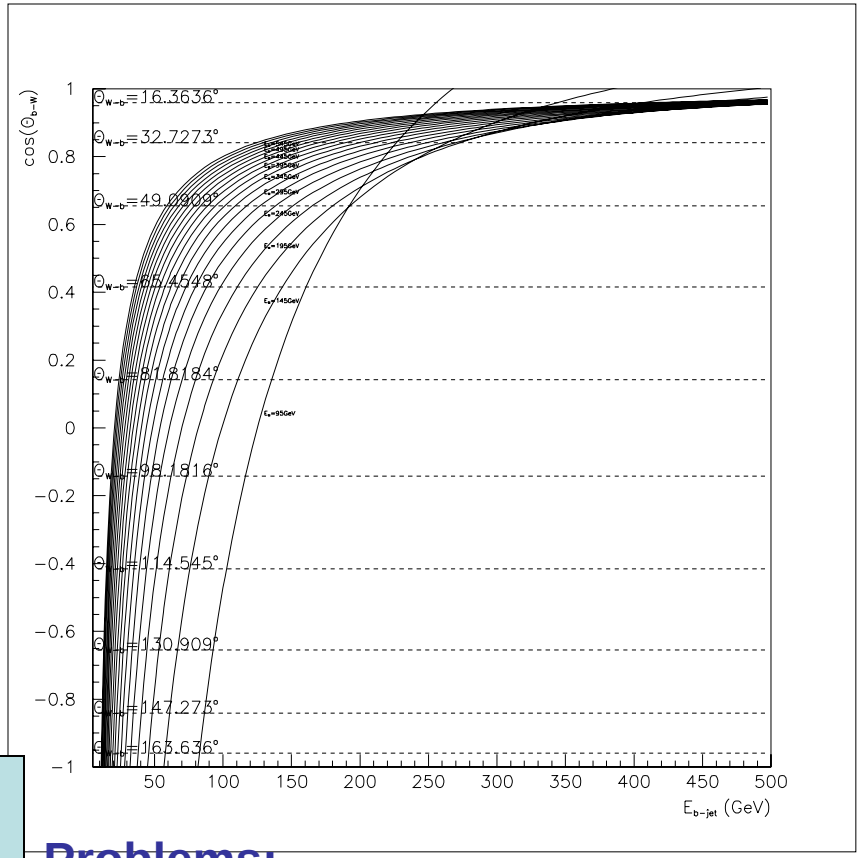
Invisible Higgs analysis in the tth channel

- Mainly tales of woe…
- Hadronic top reconstruction
- An error found in b-tagging

Reconstruction of t->Wb->jjb

- A simple kinematic relation exists between the W and the b jet from top decays
- Checked use for either:
  - ❖ Reject wrong bjj combinations
  - ❖ Correct the b-jet energy scale (Pedro's suggestion)



$$t = b + W \Leftrightarrow m_t^2 = m_b^2 + m_W^2 + 2b \cdot W$$

$$m^2 = m_t^2 - m_b^2 - m_W^2 = 2E_b E_W - 2\left|\vec{p}_b\right|\left|\vec{p}_W\right|\cos\theta_{bW}^{3D}$$

$$\cos\theta_{bW}^{3D} = \frac{2E_b E_W - m^2}{2\left|\vec{p}_b\right|\left|\vec{p}_W\right|}$$

Problems:

Assumes all particles on mass shell…

Depends quadratically on the mass of the top…

Reconstruction of t->Wb->jjb

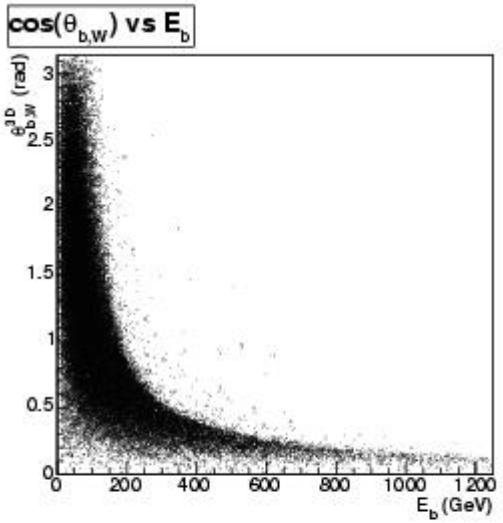
•MC truth:

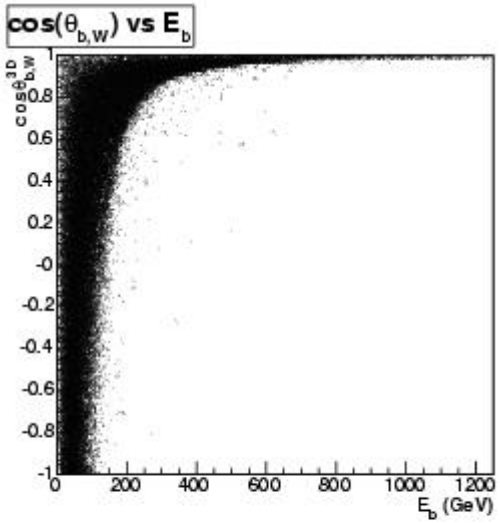
• Kinematical constraint clearly shown in plots

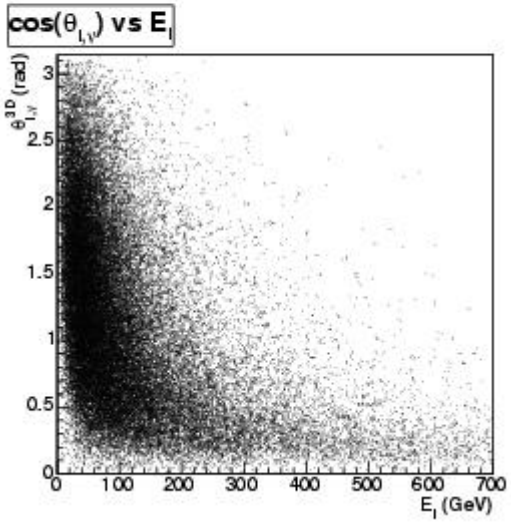
•Top plots: t->bjj

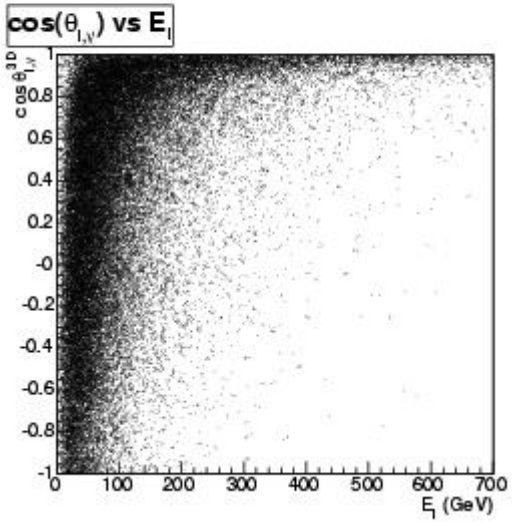
•Bottom plots: t->blν

• Constraints not so useful in t->blν case

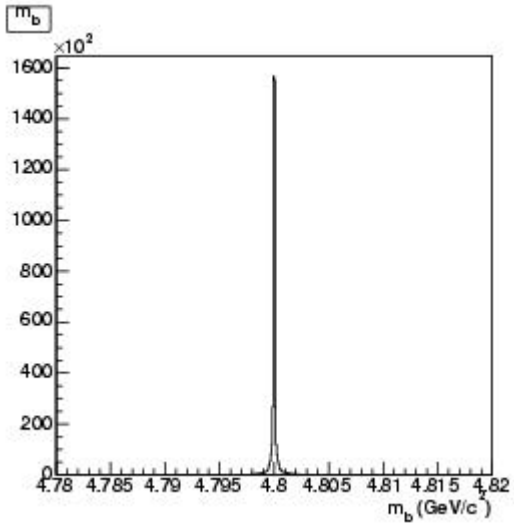


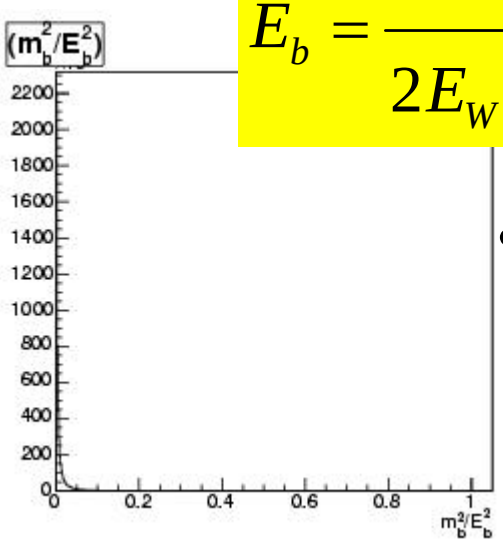


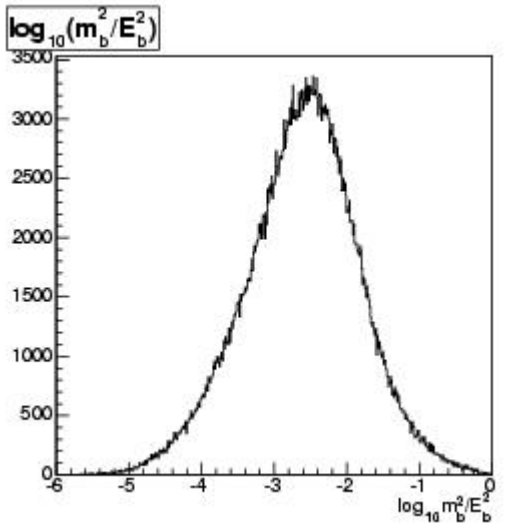


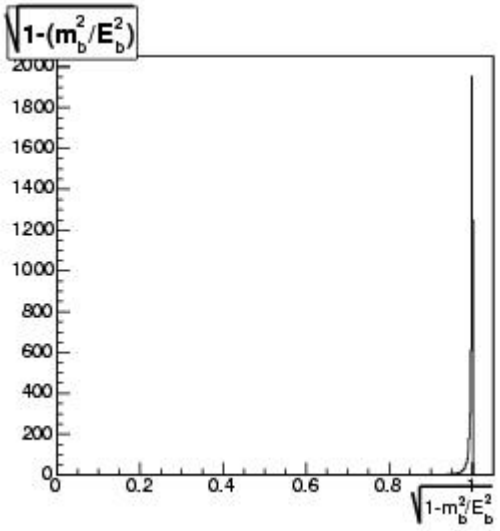


b-jet Energy Scale









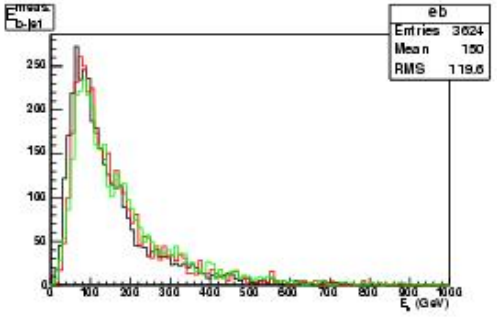
$$E_b = \frac{m_t^2 - m_W^2 - m_b^2}{2E_W - 2|\vec{p}_W|\left(1 - m_b^2/E_b^2\right)^{1/2}\cos\theta_{bW}^{3D}}$$

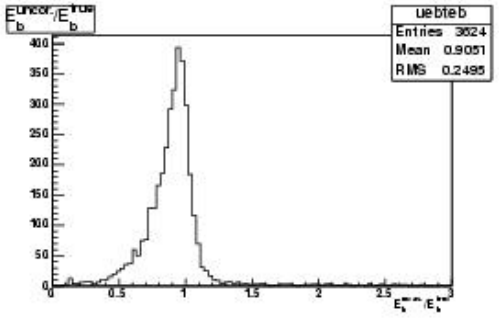
- Expression depends only slightly on the b jet energy E_b, through the term $(1-m_b^2/E_b^2)^{1/2}$
- It can be used iteratively to approximate E_b
- Can we use this to correct for the b-jet energy scale on a event-by-event basis? (the answer will be no…)

b-jet Energy Scale

- Not useful to correct the b-jet mass energy scale, unfortunately (probably due to dependence on square of masses of W and t)

Energy of b jet and 2 correction iterations





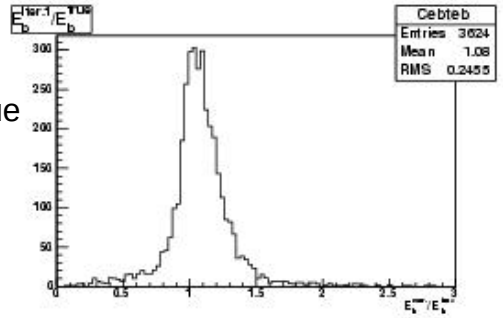
$E_b^{uncorr.}/E_b^{true}$

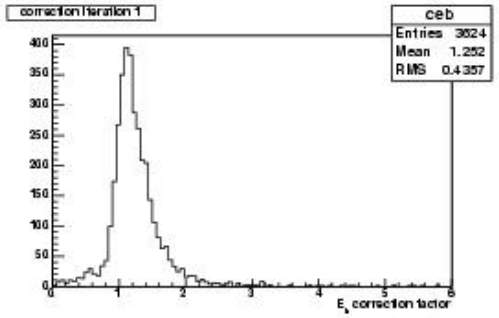
μ = 0.906

σ = 0.25

1^{st} iteration: $E_b^{iter.1}/E_b^{true}$

μ = 1.08 σ = 0.24

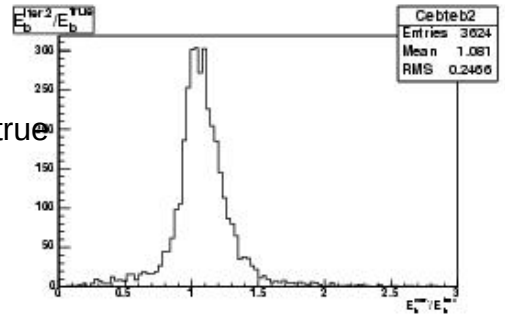


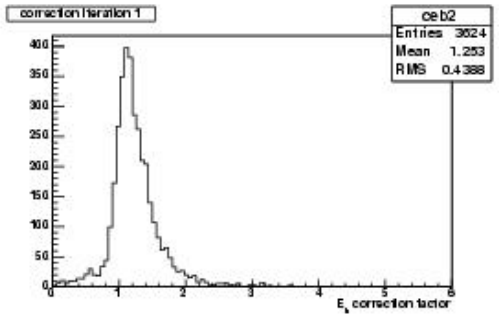


1^{st} iteration: $E_b^{iter.1}/E_b^{uncorr.}$

2^{nd} iteration: $E_b^{iter.2}/E_b^{true}$

μ = 1.08 σ = 0.25

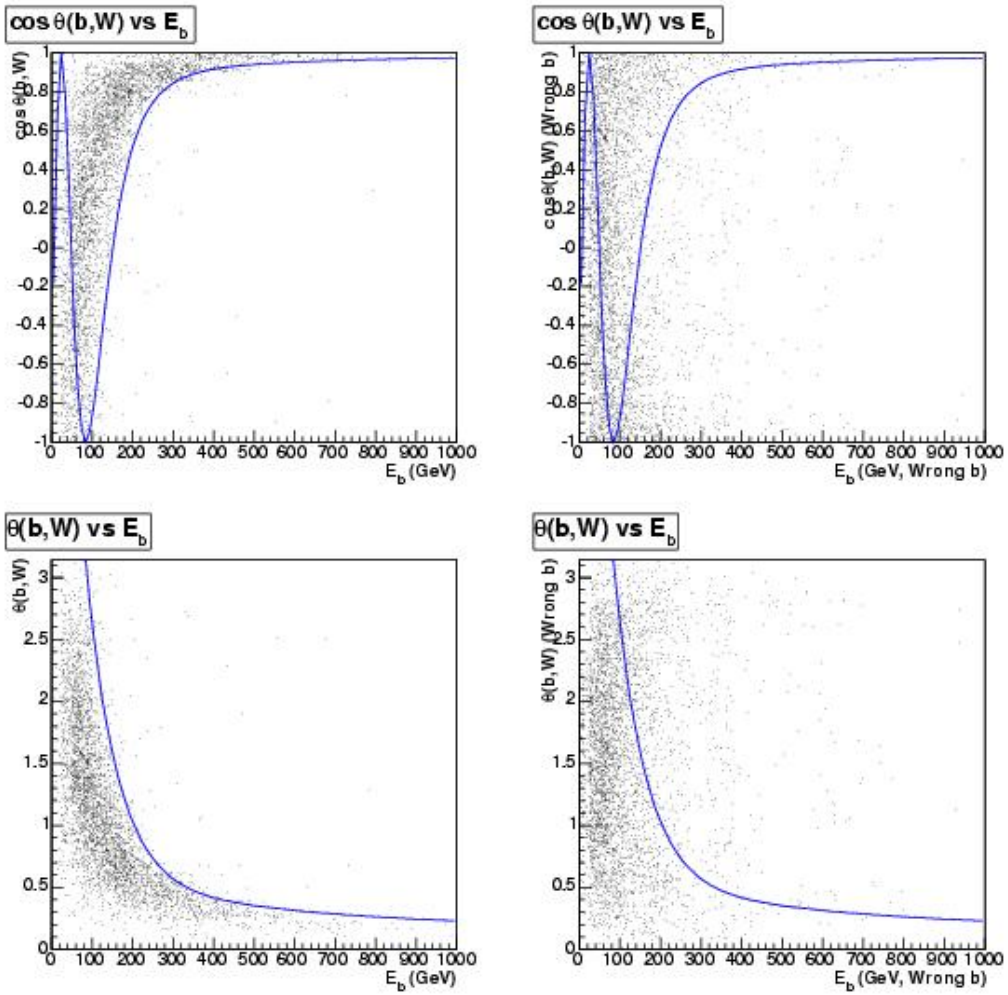




2^{nd} iteration: $E_b^{iter.2}/E_b^{uncorr.}$

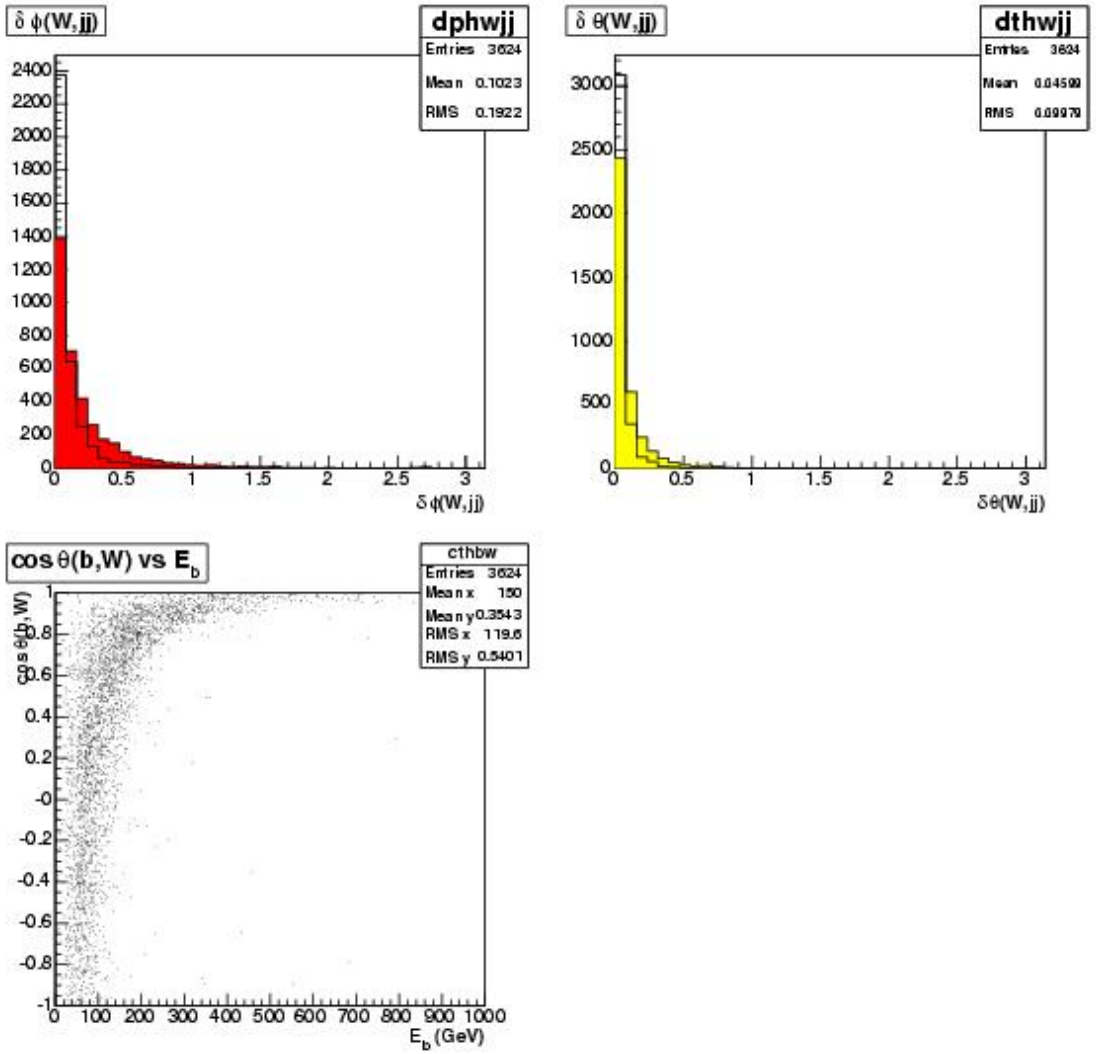
Reconstruction of t->Wb->jjb

- Even after detector smearing with Atlfast, reconstruction of t -> bjj decay may benefit from kin.constraint
- Left: good bjj combinations
- Right: right jj combination but wrong b jet
- Envelope of scatter plot is one way to cut on bad combinations



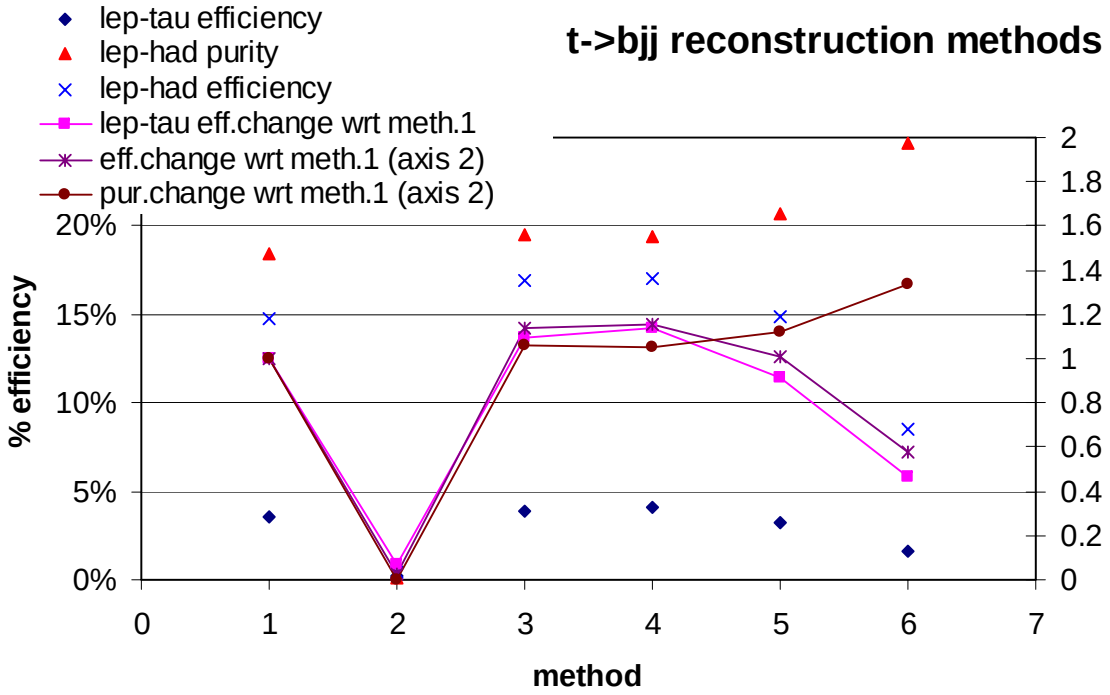
Reconstruction of t->Wb->jjb

- W reconstruction:
  - Find jets j_1 and j_2 within $\theta^{3D}<0.4$ of true quarks from W->qq
  - Calculate W momentum from j_1+j_2
- Using the right jet combination, W angle reconstructed better than with quarks from W->qq after ISR (histos in red and yellow are from from truth information)



Reconstruction of t->Wb->jjb

- Several methods were tried
- Tried lep-had and lep-tau (to se if background could be rejected)
- In general, best performance from simultaneously trying bjj combinations (method 3)
- Kinematic constraint has similar performance (meth. 4-6) can have better purity) but sensitive to mass of top



1 - jj combination |m_jj-80.4|<15GeV + bjj combination |m_bjj-175|<25GeV + pTjets>15GeV

2 - highest pTjj + bjj combination |m_bjj-175|<25GeV + pTjets>15GeV

3 - bjj combinations with |m_jj-80.4|<15GeV and |m_bjj-175|<25GeV + pTjets>15GeV

4 - same as 3 + maximum theta_b,jj < envelope

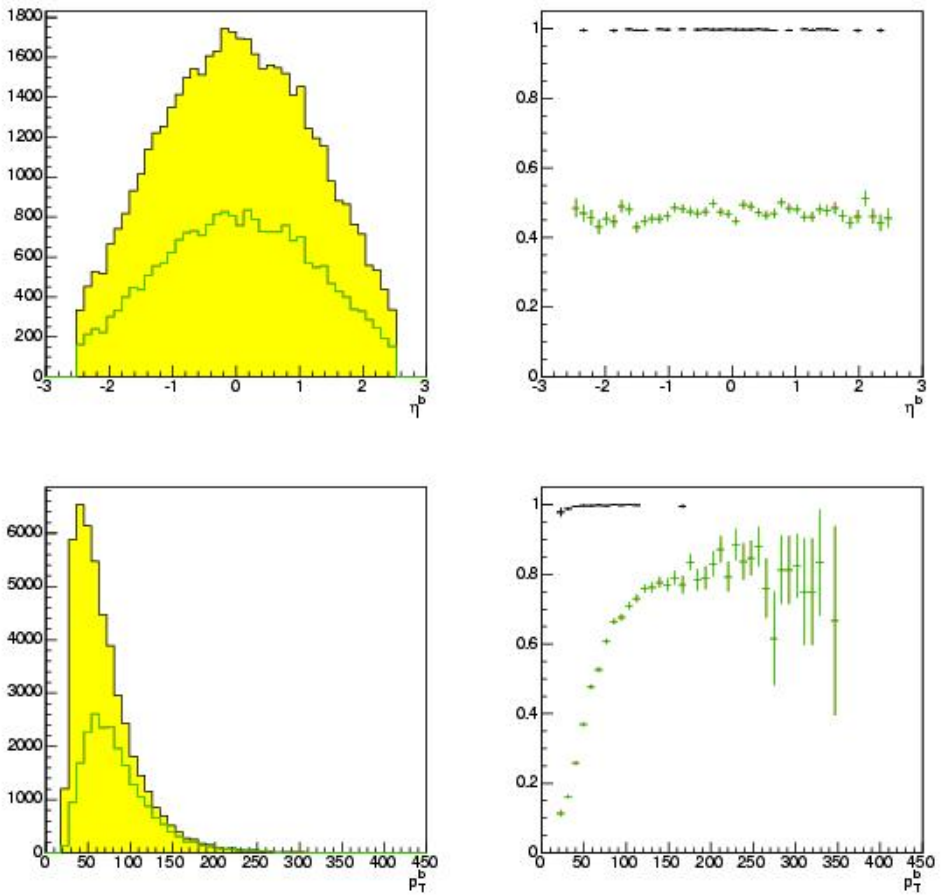
5 - same as 3 + 0.75 < Eb_rec/Eb_nom(thetab,jj) < 1.25

6 - same as 3 + 0.9 < theta_b,jj/theta_bjj(E_b) < 1.1

Good combination: R(t,bjj) < 0.1 + R(W,jj) < 0.1 + R(b,bjet) < 0.1

b-jet tagging efficiency in Atlfast

- Method:
  - For one true b quark in event (|eta|<2.5, E_b>15 GeV) search for any jet (tagged + un-tagged) within R cone of 0.2
  - If a jet is found ("b-labelled"), look for a "b-tagged" jet within R<0.2
  - For each class (labelled, tagged) fill histos using p_T and eta of true quark, to avoid migrations in plots
  - Efficiency is b-tagged/b-labelled (vs. eta or pT)
- Left plots: eta and p_T of true (yellow), labelled (red) and tagged (green)
- Right plots: labelled/true (red), tagged/true (green) and efficiency (brack)



Efficiency ~1 !!! Something was wrong

Found a mistake in my code…