

A New Multivariate B-jet Tagger

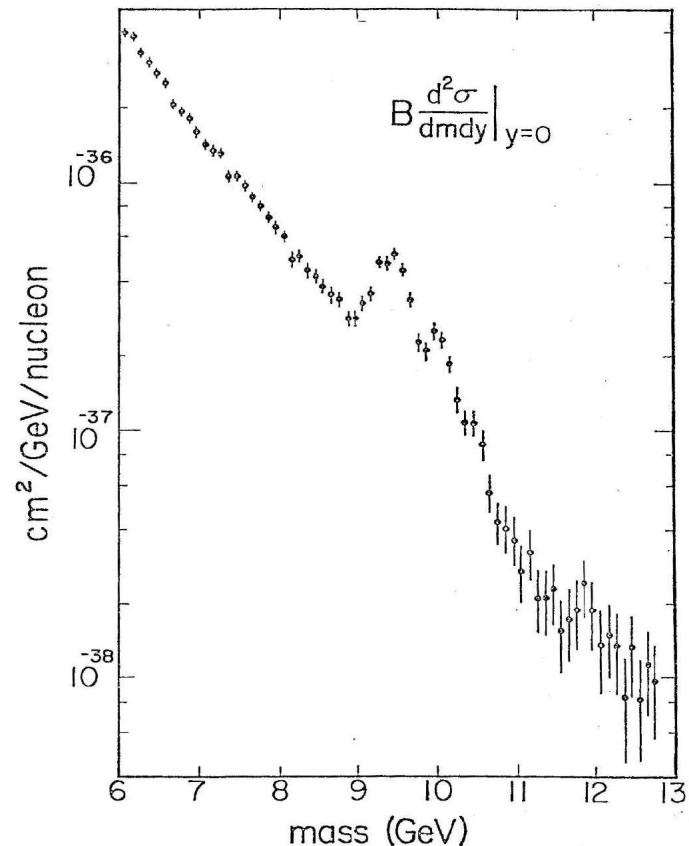
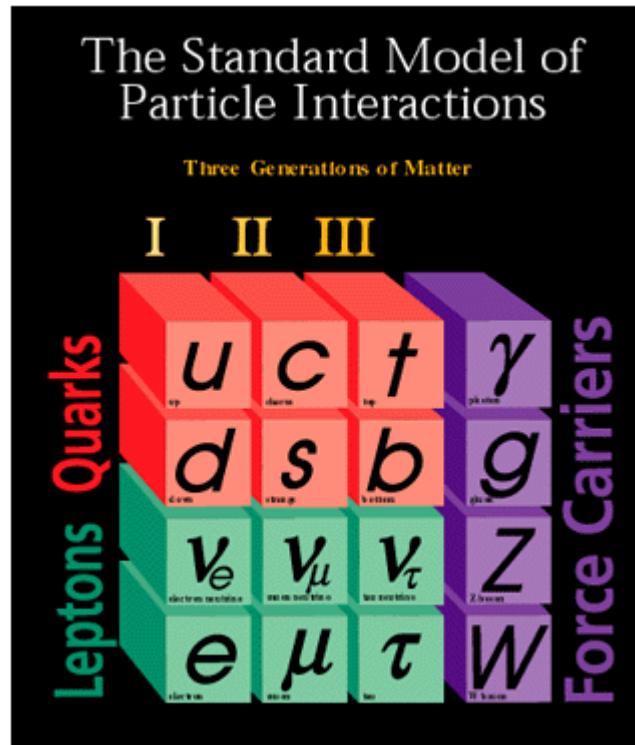
John Freeman

8/12/08

Overview

- Why we want to find b-quarks
- Distinguishing characteristics of the b-quark hadrons
- How we use those characteristics to create a tagger

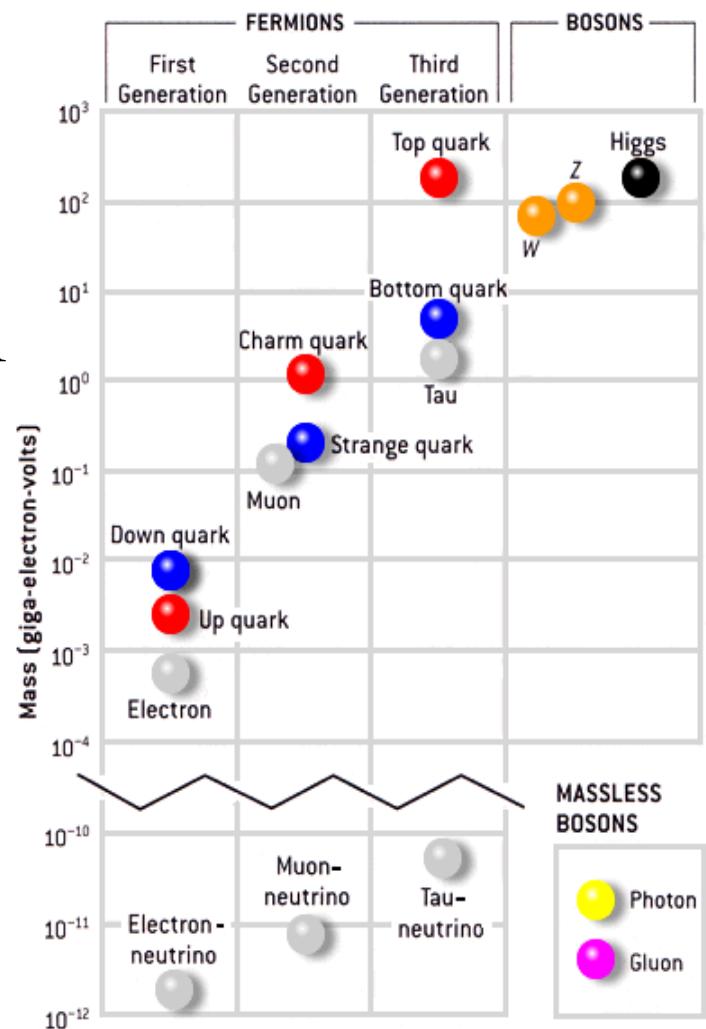
Standard Model (I)



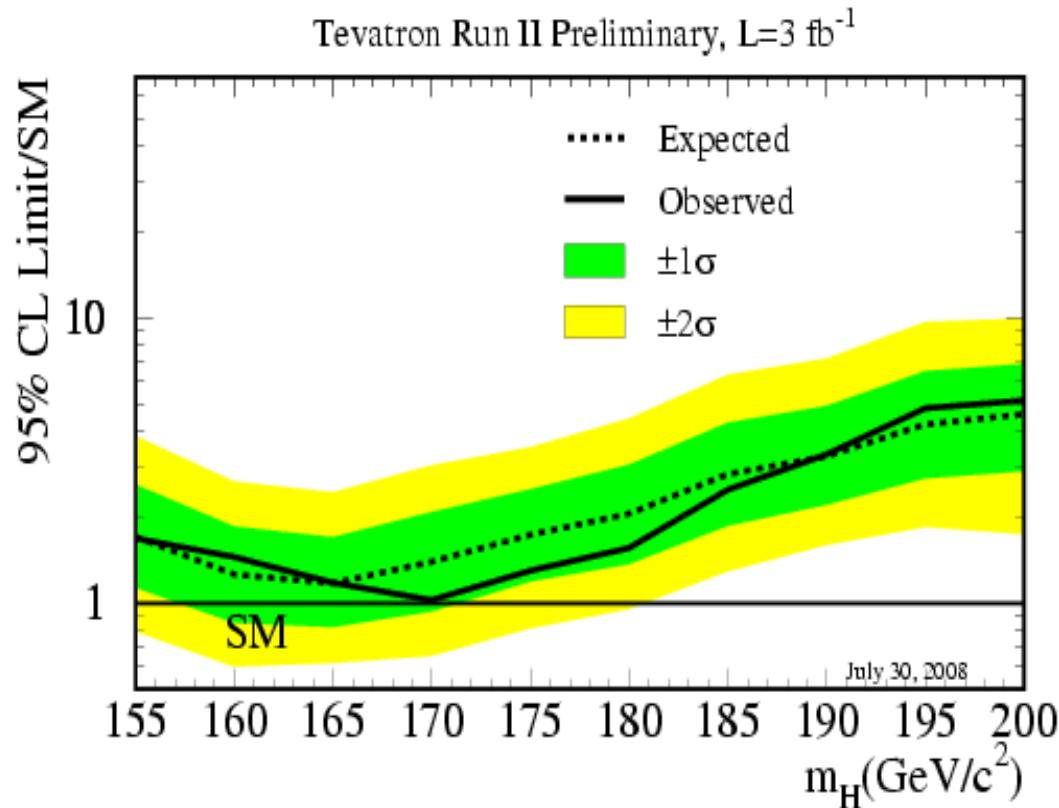
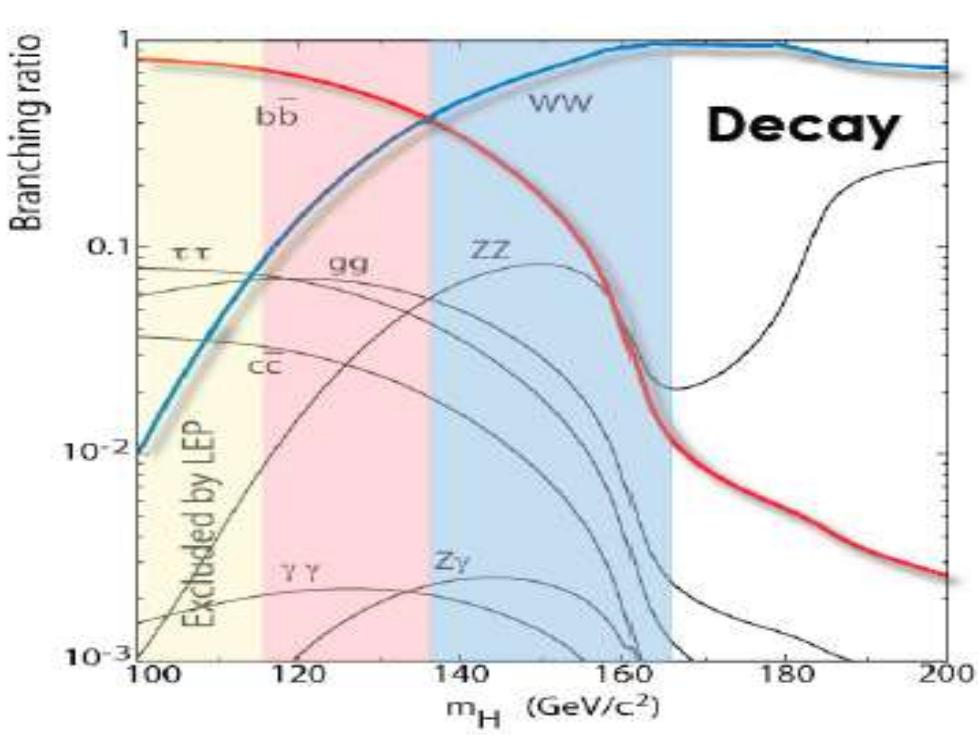
- b-quark one of the 6 quarks
- Second-to-last quark discovered (by Lederman et. al, here at FNAL, 1978)
- What's so special about it... ?

Standard Model (II)

- Second most massive quark
 - $\sim 4\text{-}5 \text{ GeV}/c^2$
 - If Higgs too light to decay to on-shell W's ($H \rightarrow WW$), then...
 - Next heaviest particle: the b-quark!
($H \rightarrow b\bar{b}$)

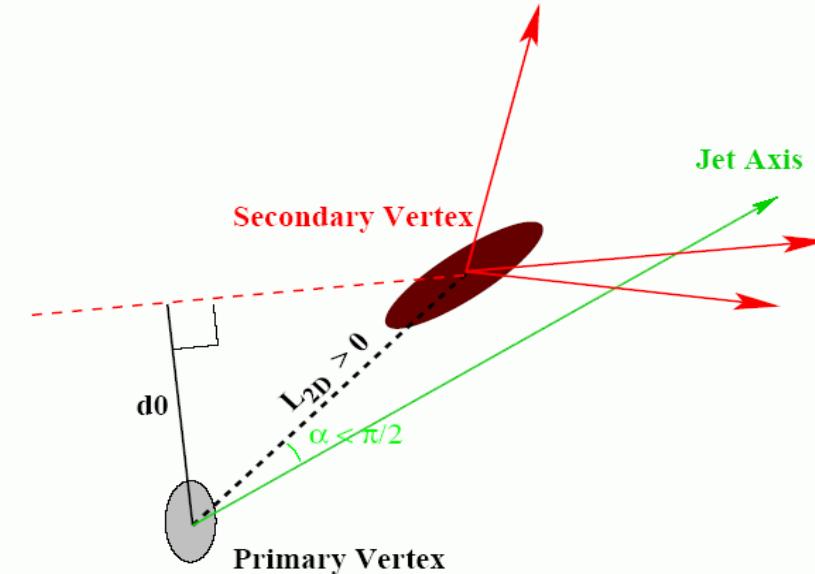


The Light Higgs



- Increasingly, it looks as if the SM Higgs is light
 - Already excluded at 95% confidence at $170 \text{ GeV}/c^2$
 - In fact, all direct and indirect info on the Higgs indicates the Higgs $< 144 \text{ GeV}/c^2$ at 2 sigma

How Do We Identify b-quarks?

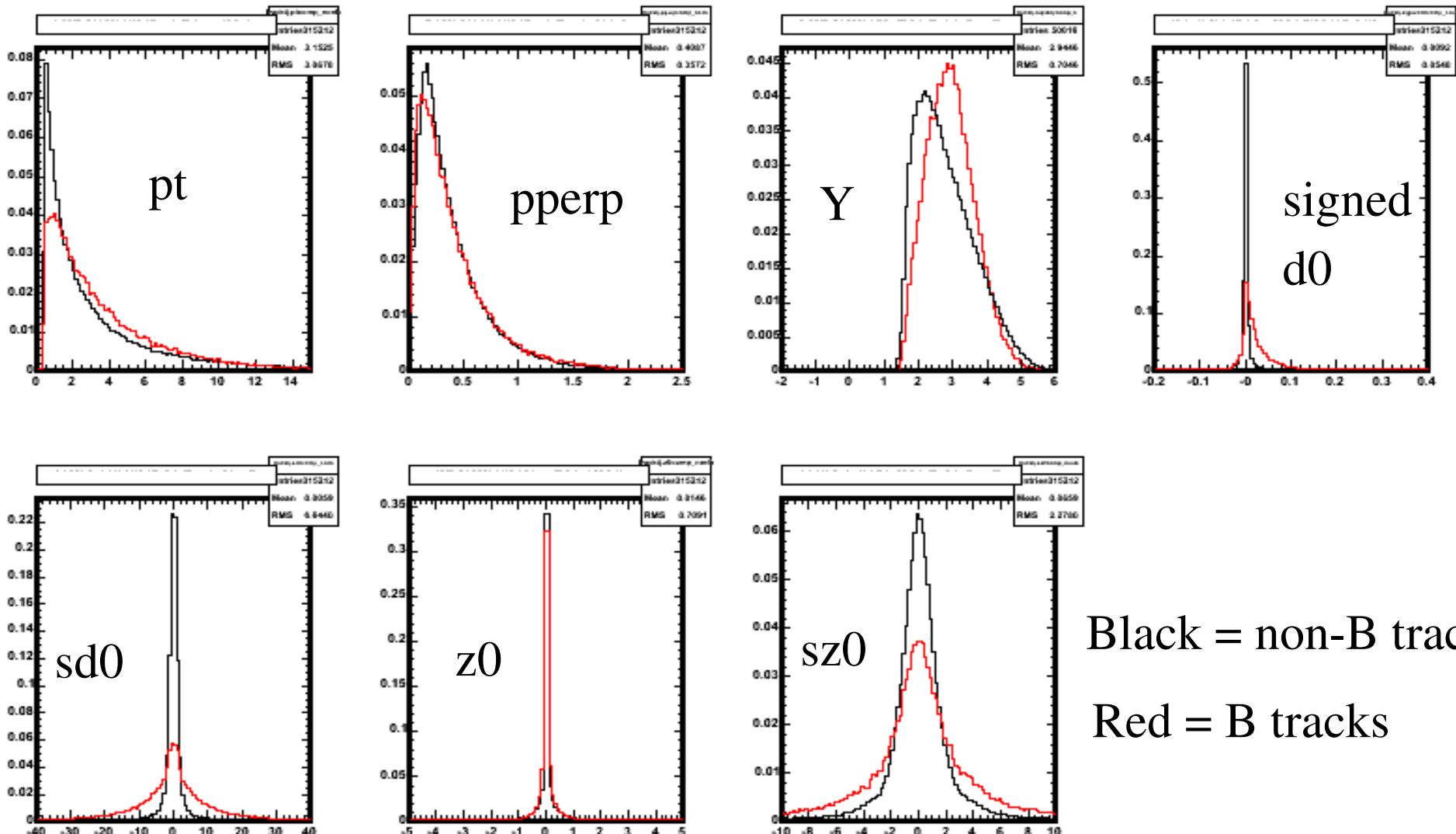


- b quarks hadronize into B mesons and baryons
- Typical lifetime is $O(10^{-12} \text{ ps})$
 - B hadron will travel a couple of millimeters before decaying, enough that its decay products (tracks) can be reconstructed into a secondary vertex
- Also: invariant mass of B-tracks; # of tracks in a jet

Our Approach

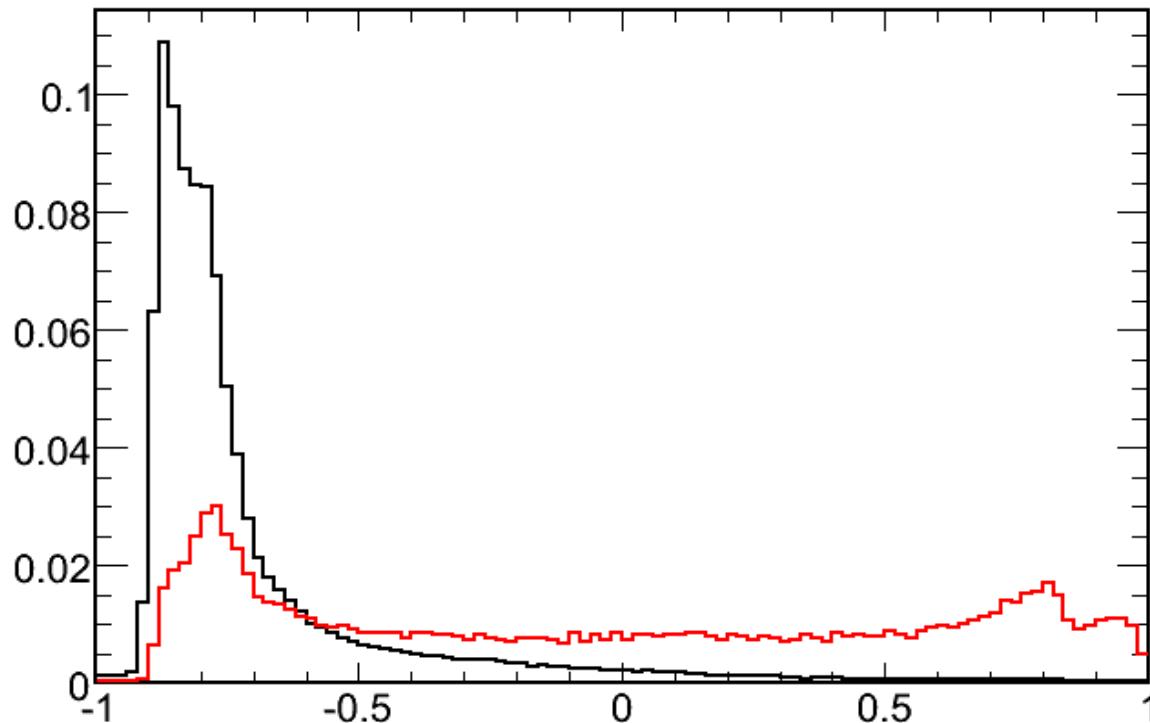
- Find properties of tracks that indicate they came from a B-hadron
 - Signed impact parameter (d_0), and impact parameter significance (s_{d0}) relative to the primary vertex
 - z position (and its significance) (z_0 , s_{z0})
 - Momentum transverse to jet axis (p_{\perp})
 - Rapidity wrt the jet axis (Y)
 - Track pt

Distributions



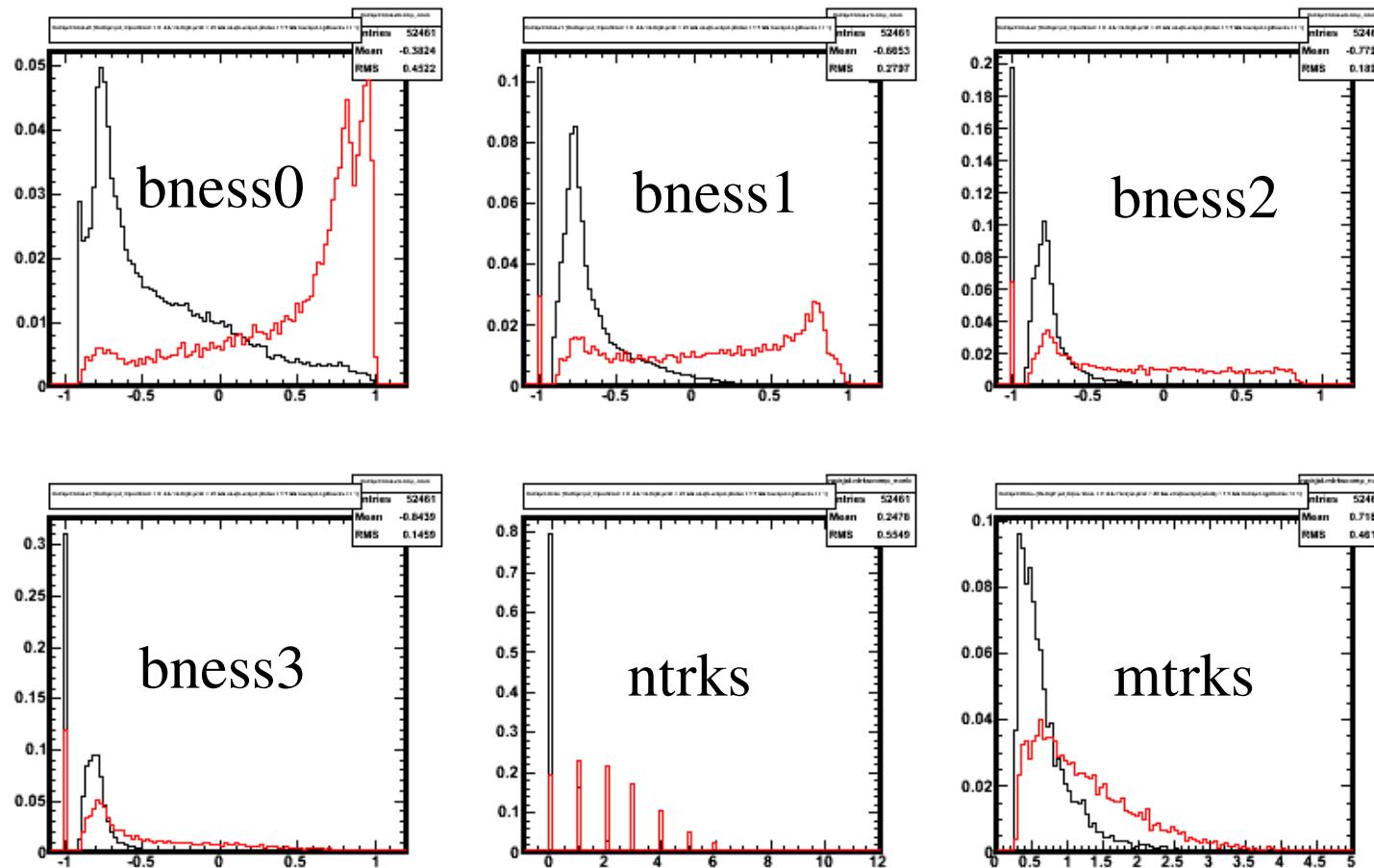
Track Bness Separation

```
trackj.MLP_weight &gt; trackj.jetlink == 0 && trackj[trackj.jetlink].jet > 30 && abs(trackj[trackj.jetlink].eta) < 1.5 && trackj[trackj.jetlink].nghosttracks == 1 && abs(trackj.thrust_p4.sumet) < 500
```



- Putting these variables into a NN, we can separate tracks from B's vs. tracks not from B's – and then feed the output discriminator into a B-jet discriminator

For the Jet Discriminator



Also Useful...

- 7.9% of b-jets contain a track considered a likely muon vs. 1.4% of non-b-jets
- 10% of b-jets contain a good kshort candidate vs. 4.7% of non-b-jets