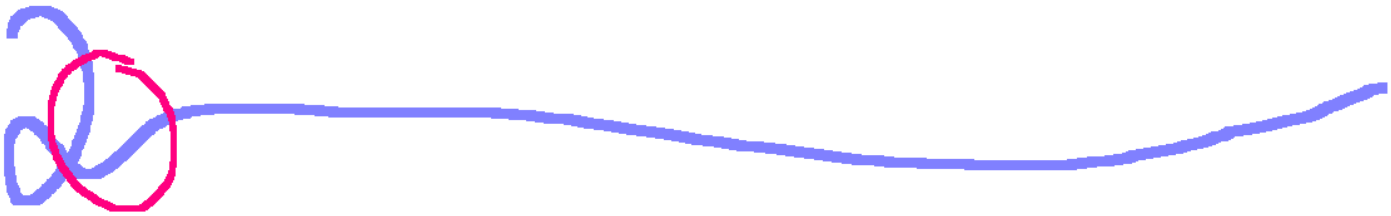
Tau-ID Soviet Style: Quality and Quantity



Yu. Gershtein
Brown U
Feb 7, 2001

Outline

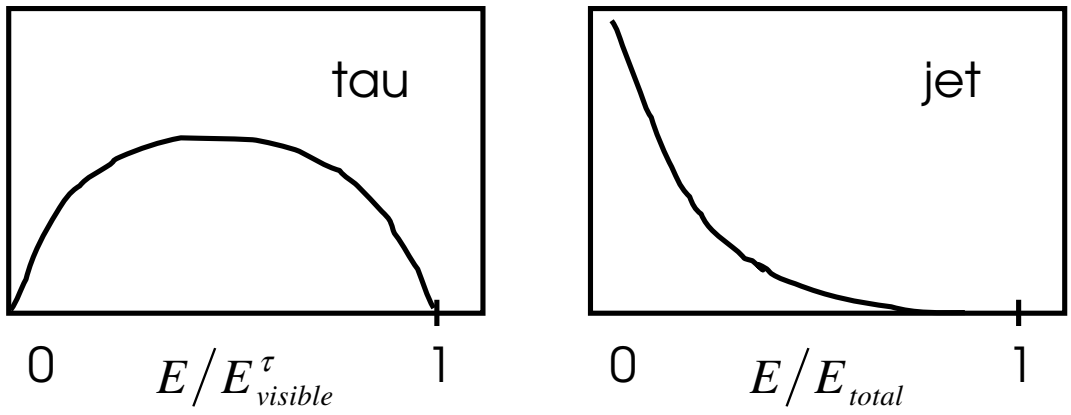
- Introduction
  - what we have learned
- Closer look at variables
  - EM3 clustering
  - What more do we need
- Vertexing in low-multiplicity events
- Clustering efficiency
- Track seeded approach
- What's going on in software
- Plans

Introduction

- Signal is Z->tautau +2.5mb
- Background is QCD-20
  - 100 GeV resonance problem solved!!!
- NN is great. But it should follow, and not precede regular analysis

How Tau's are different from Jets?

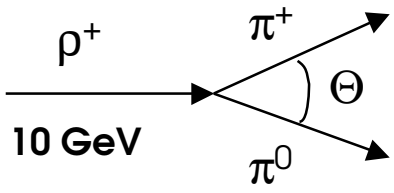
- Both are mixture of charged and neutral hadrons
- Only two things are different:
  - fragmentation function



  - invariant mass

What Gives Rejection

- Strategy depends a lot on what physics you are after
- Probability to have an ISR/FSR jet>10 GeV is about 30%
- However, if one needs more rejection
  - low pt taus are not THAT narrow:



$$\Theta \approx \frac{2M_\rho}{E_\rho} \approx 0.15$$

  - fragmentation function still works -> tracking

Trivial Consequences

- $\tau^- \rightarrow \pi^- \upsilon_\tau$ is the easiest
- $\tau^- \rightarrow \pi^- \upsilon_\tau + n\pi^0$ is harder:
  - daughter particles are softer -> more "jet"-like (fragmentation function!)
  - EMfrac is not very useful
  - key is to find a way to limit the number of neutrals
    - analyze EM3 cells
- Three prongs are the most difficult
- Separate these three final states

Tracking in Taus

taureco

- tau tracks are all tracks with
  - $|\Delta\varphi| < 10°$
  - $|\Delta\theta| < 10°$
- cuts are made on:
  - track RMS
  - number of tracks

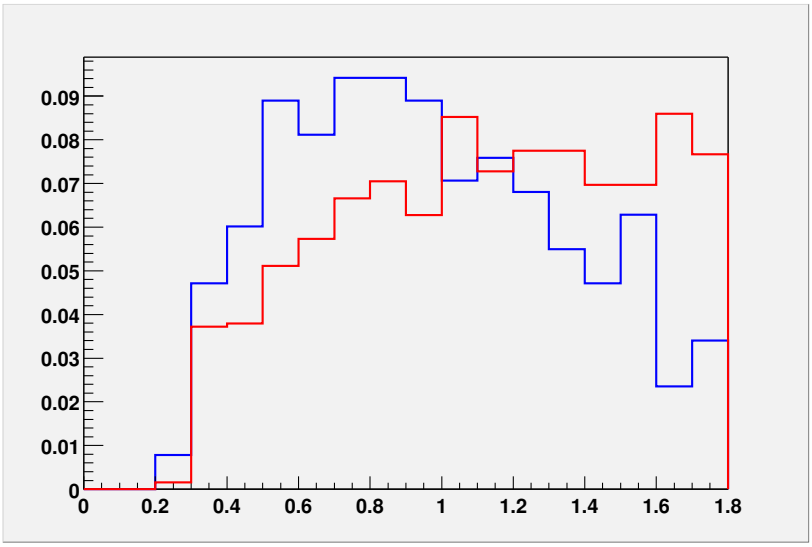
Tracks from tau have right mass and width by const-ruction.
It doesn't matter much how the rest of tracks distributed:
What matters is their total transverse energy

proposed

- order tracks in AOI by p_t
- start with highest p_t track
- go down the list and add tracks only if:
  - Ntrk ≤ 3
  - mass < 2 GeV
  - track p_t > 1.5 GeV
  - charge is O.K
- Make cut on transverse energy of all tracks which are left: $\sum_i E_i \sin\Theta_i$

Tracking in Taus

For now: use ALL tracks. Should have a requirement of the same primary vertex

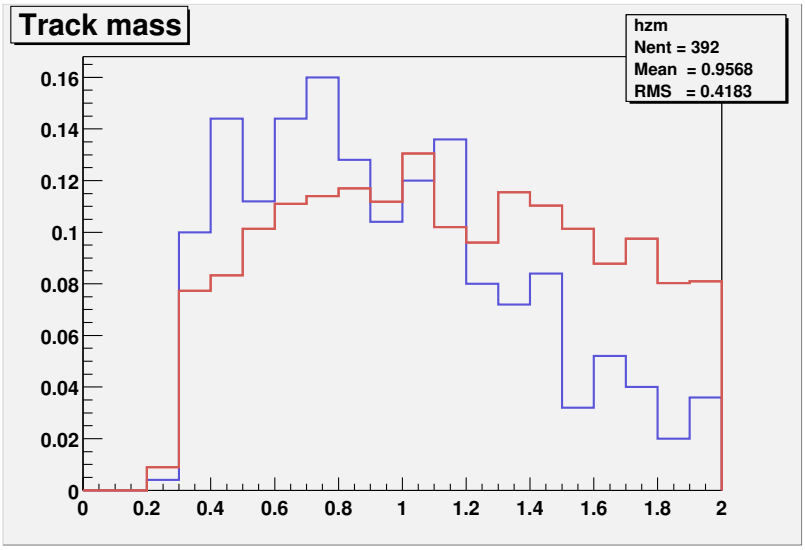


Mass of tracks from tau,

No pt cut on third track

real tau

QCD jet



Mass of tracks from tau

All pt>1.5

real tau

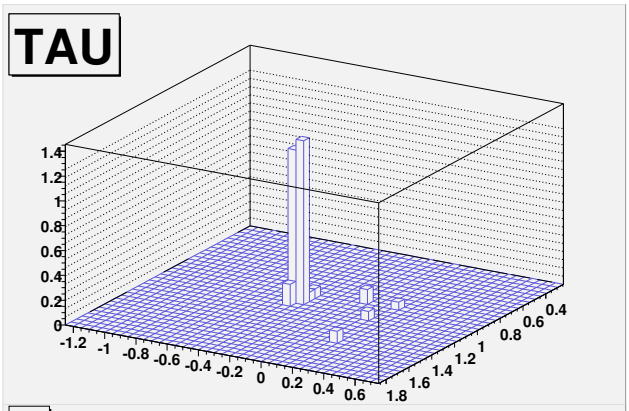
QCD jet

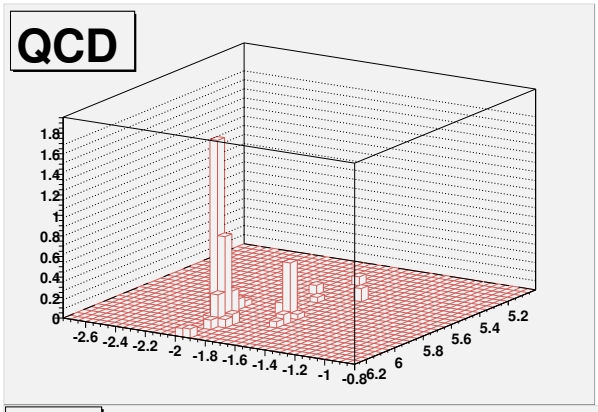
Energy in EM3

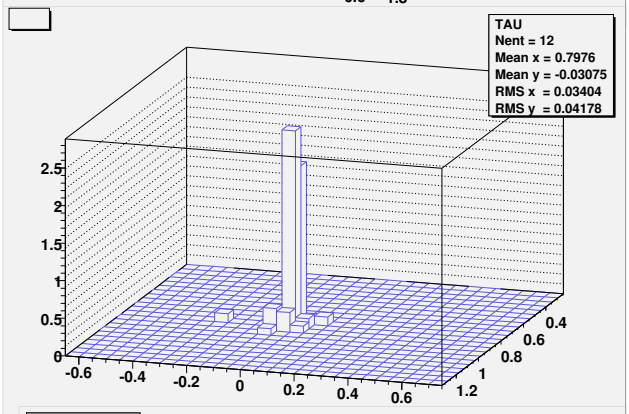
- EM3 is the most finely segmented portion of the calorimeter and more than half of all EM energy is deposited there
- Old way
  - look for high cells
- New way
  - look closer
  - clustering

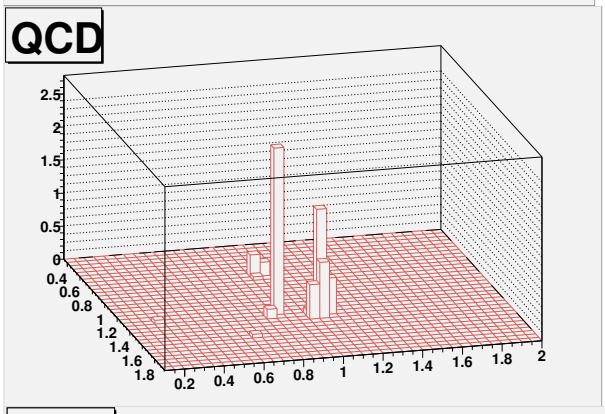
"Typical" Events

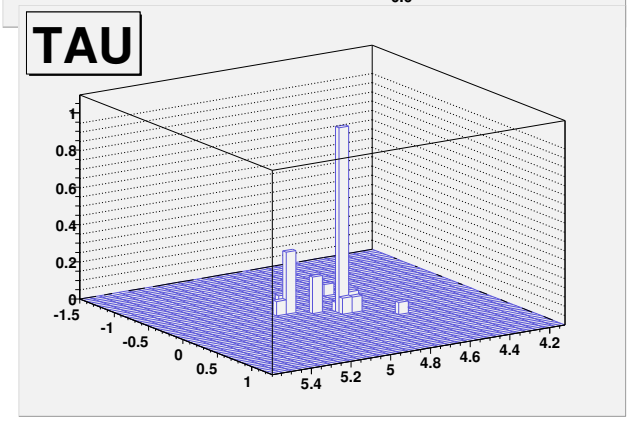
- Cell threshold: 50 MeV -> high enough to kill all noise

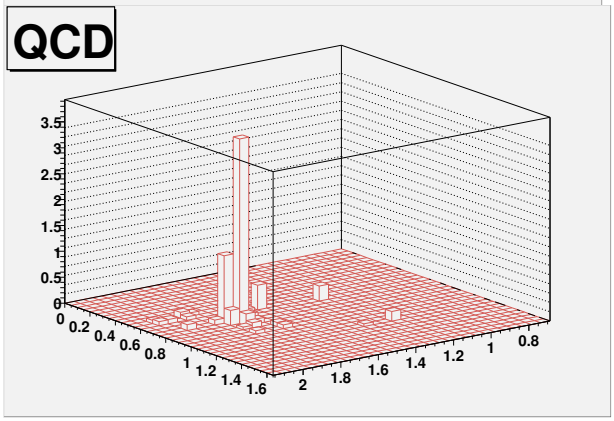






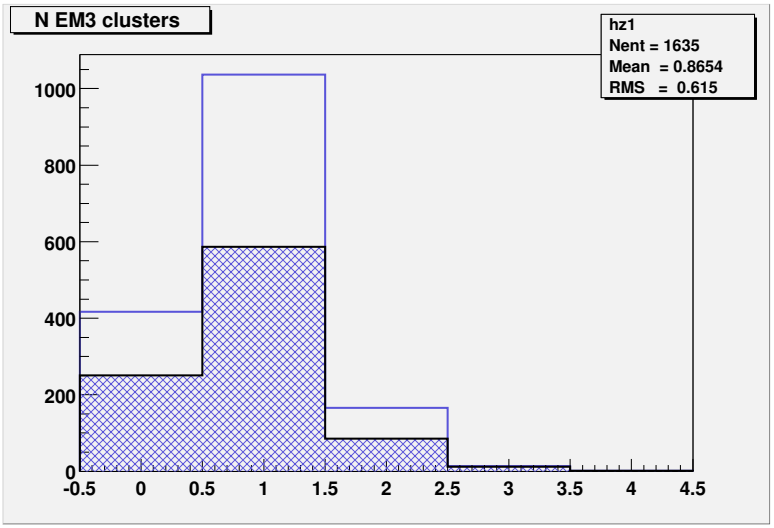






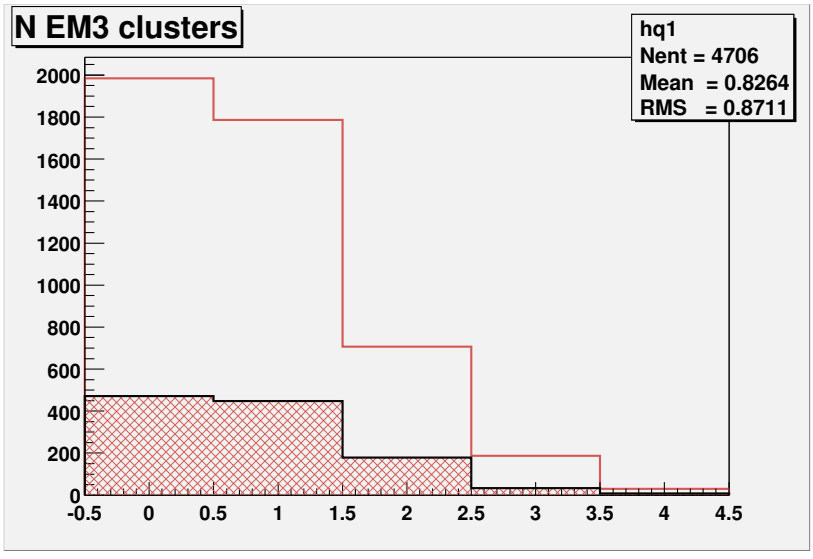
EM3 Clusters

- "Nearest Neighbor" algorithm, Et>0.8 GeV



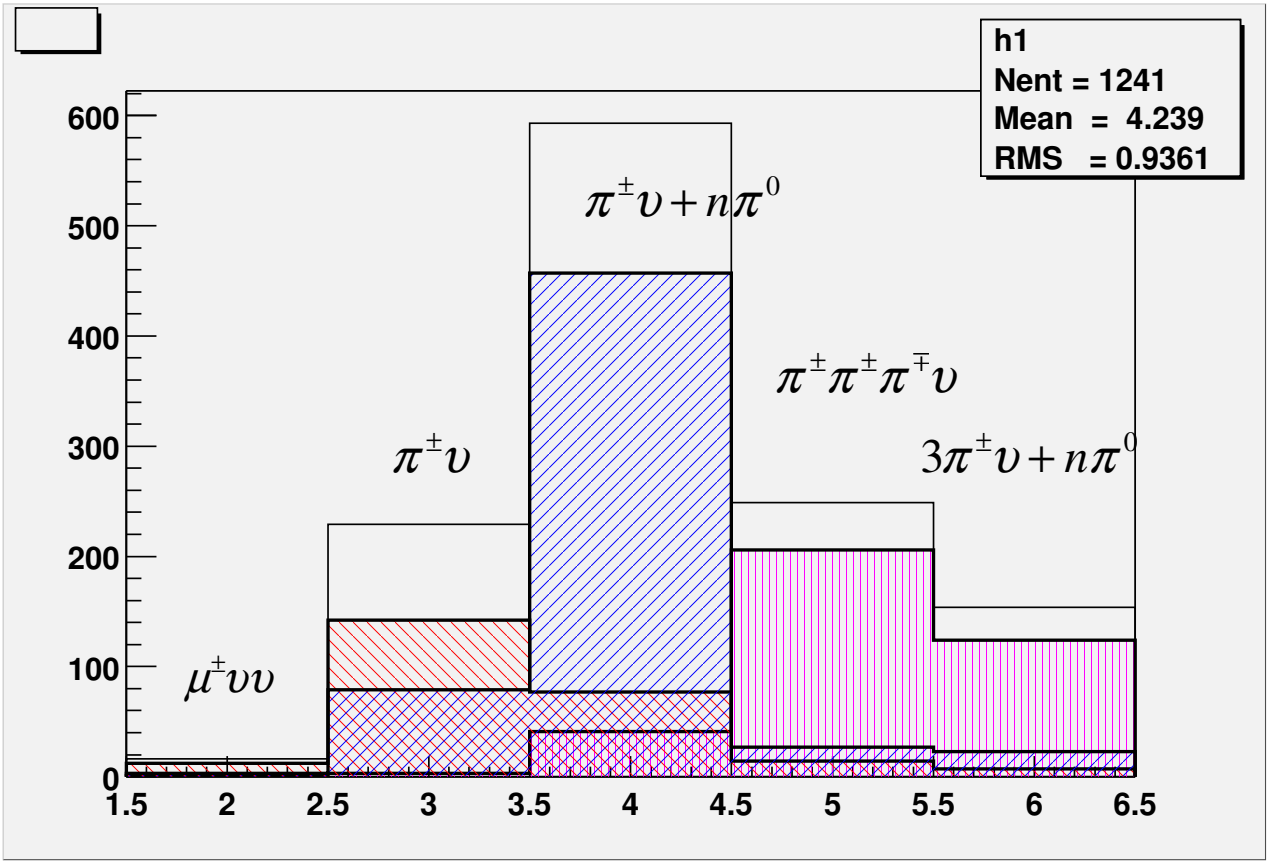
Z-> tau tau

QCD 20



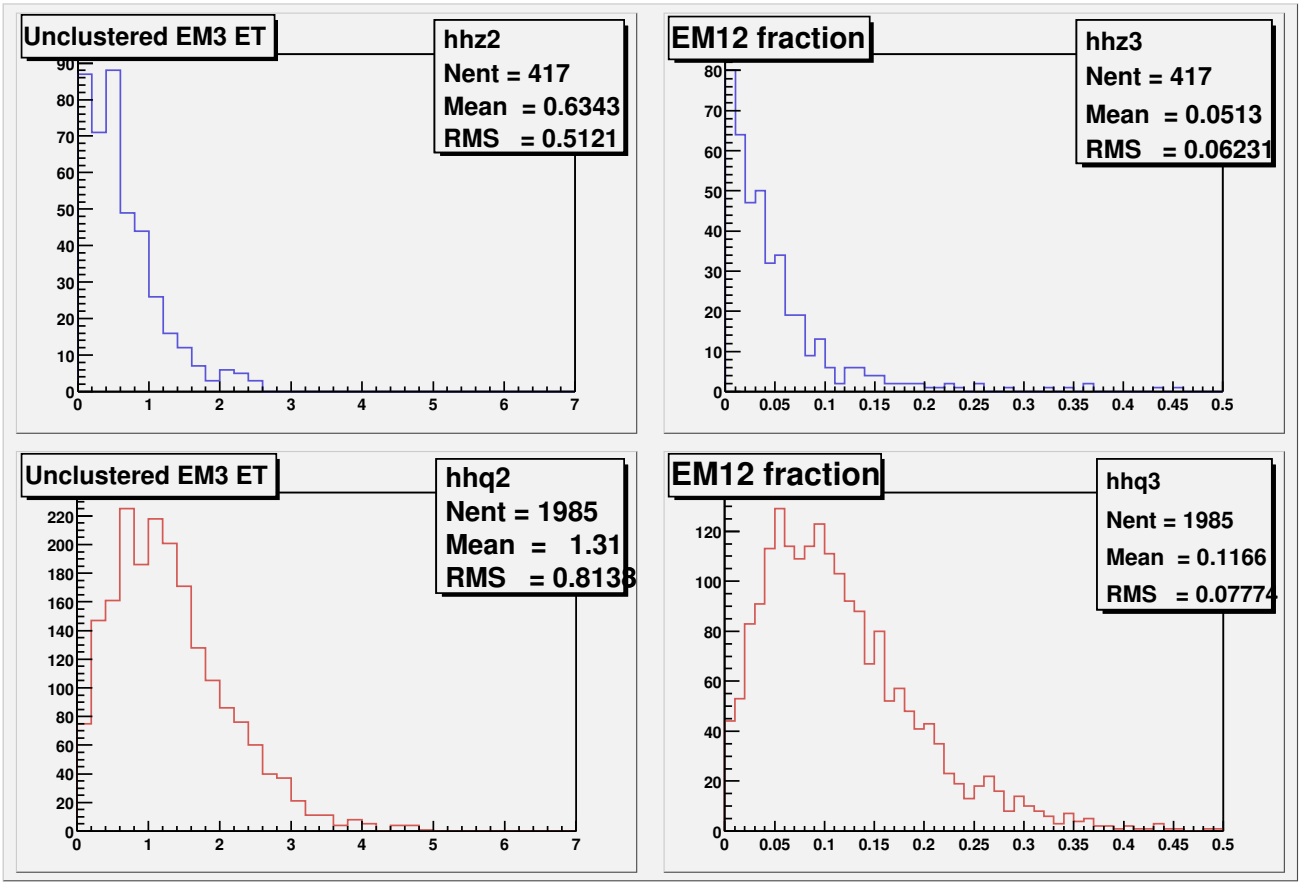
Three Tau Types

1. $N_{trk}=1$, $Et_{em3clus}<0.8$ GeV
2. $N_{trk}=1$, $Et_{em3clus}>0.8$ GeV
3. $N_{trk}>1$



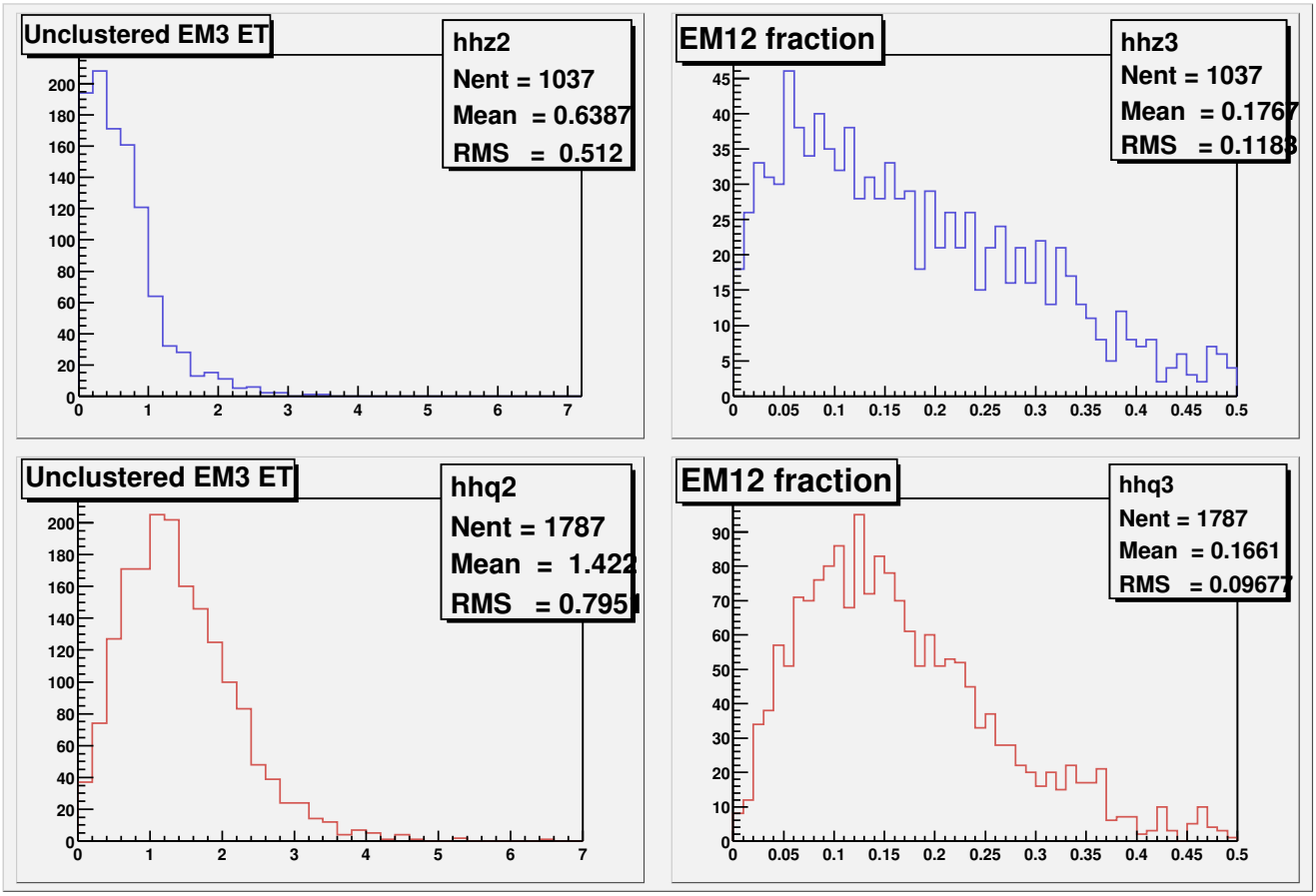
No EM3 Clusters

- As before, EM veto works very good



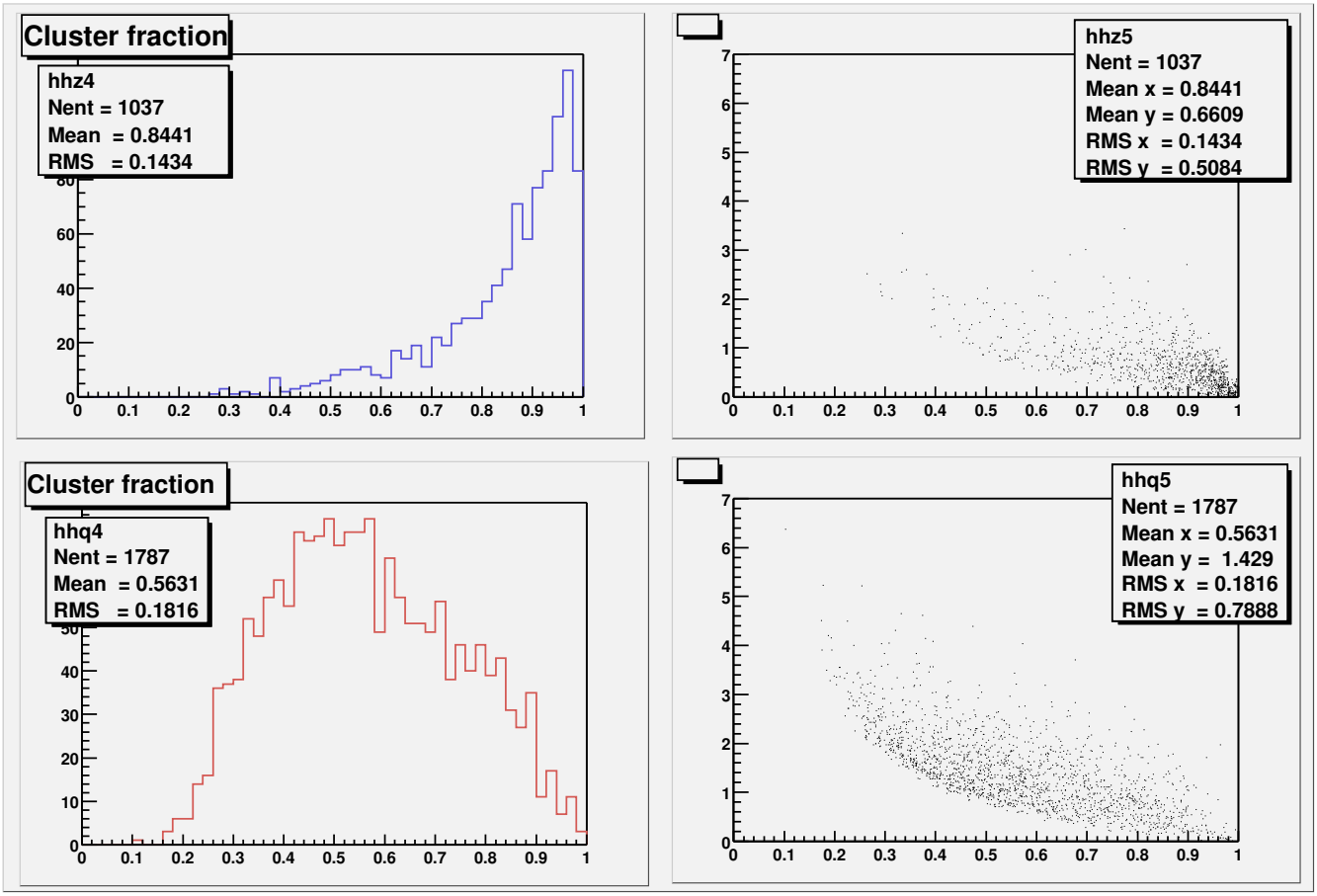
One EM3 Cluster

- EM12 fraction is pretty useless now



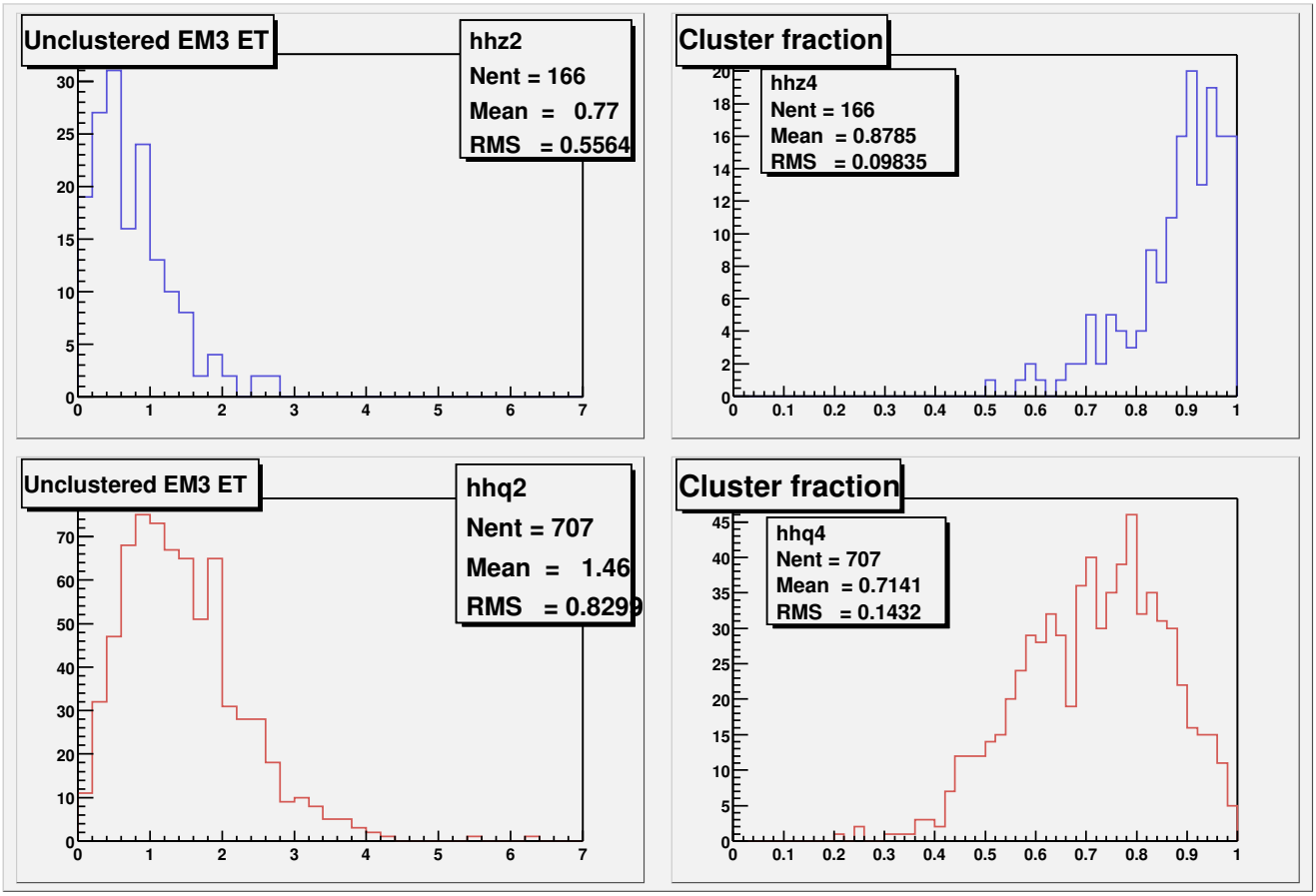
One EM3 Cluster

- EM3 profile is replaced by fraction of energy in the cluster

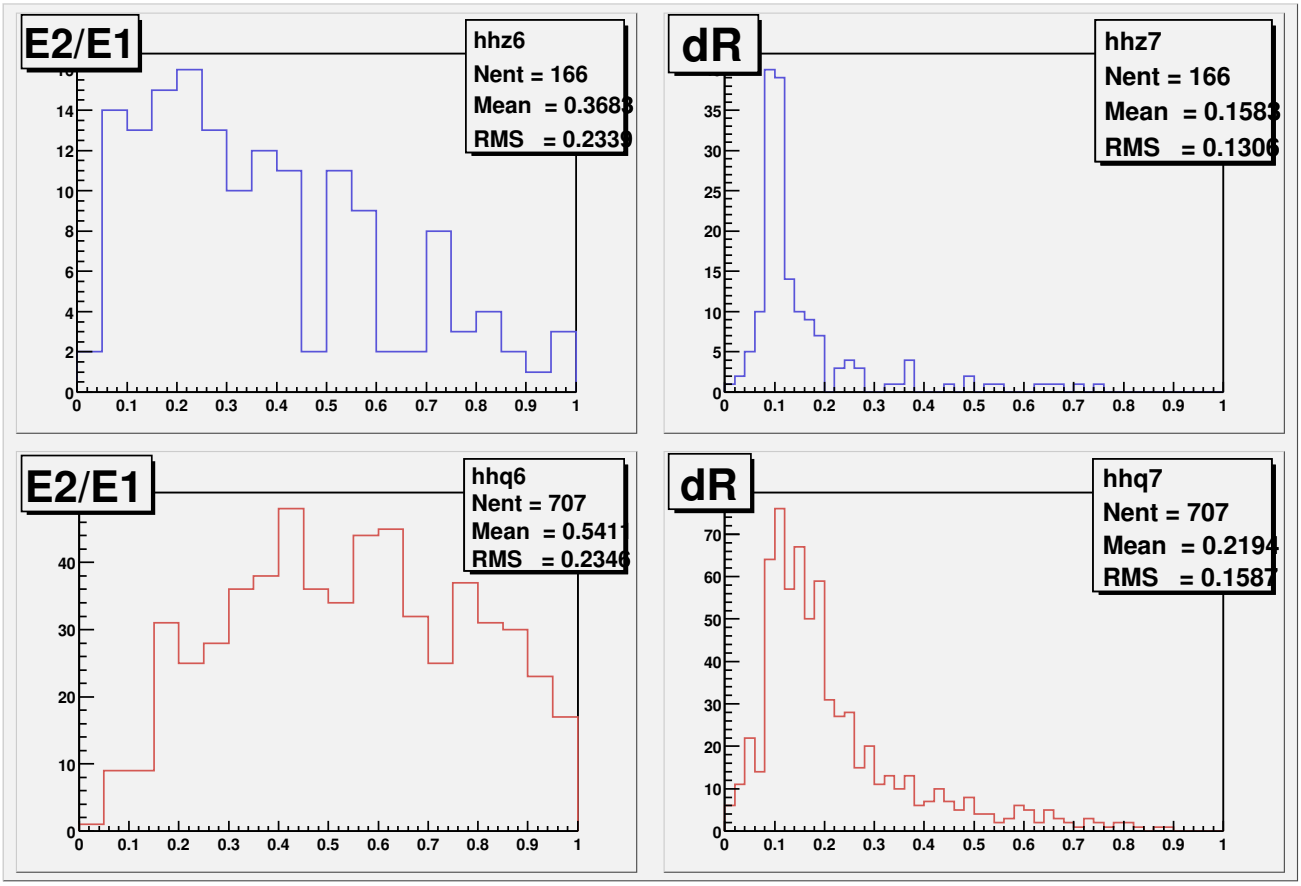


Two EM3 Clusters

- Similar to the case of one



Two EM3 Clusters



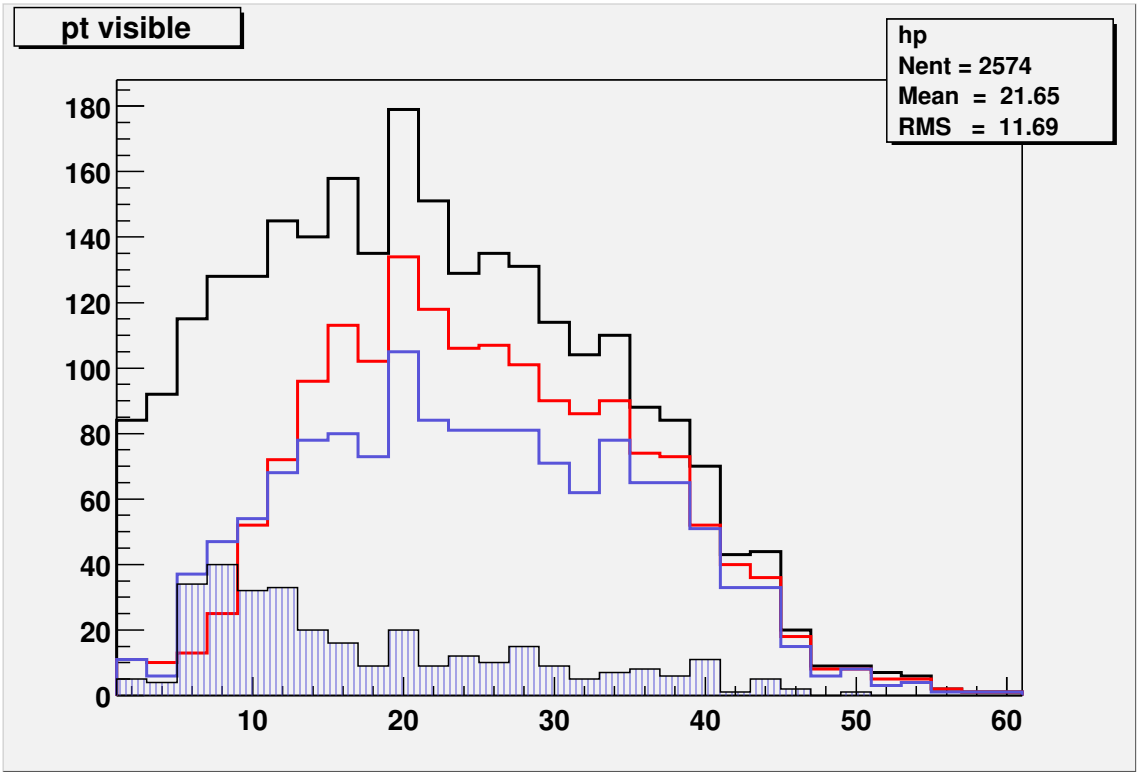
- Also, have additional handles
  - di-cluster mass does not work, as QCD clusters are softer

What is Needed

- More work on calorimeter shape variables for better background rejection
- More work on reconstruction of tau visible energy and direction
  - easier for types 1 and 3
  - EM3 clusters for type 2
    - clustering in EM1-3 ?
    - remove early had. showers ?
    - can PS do anything?
- Previous item will make possible to construct track-calorimeter mass

Vertexing

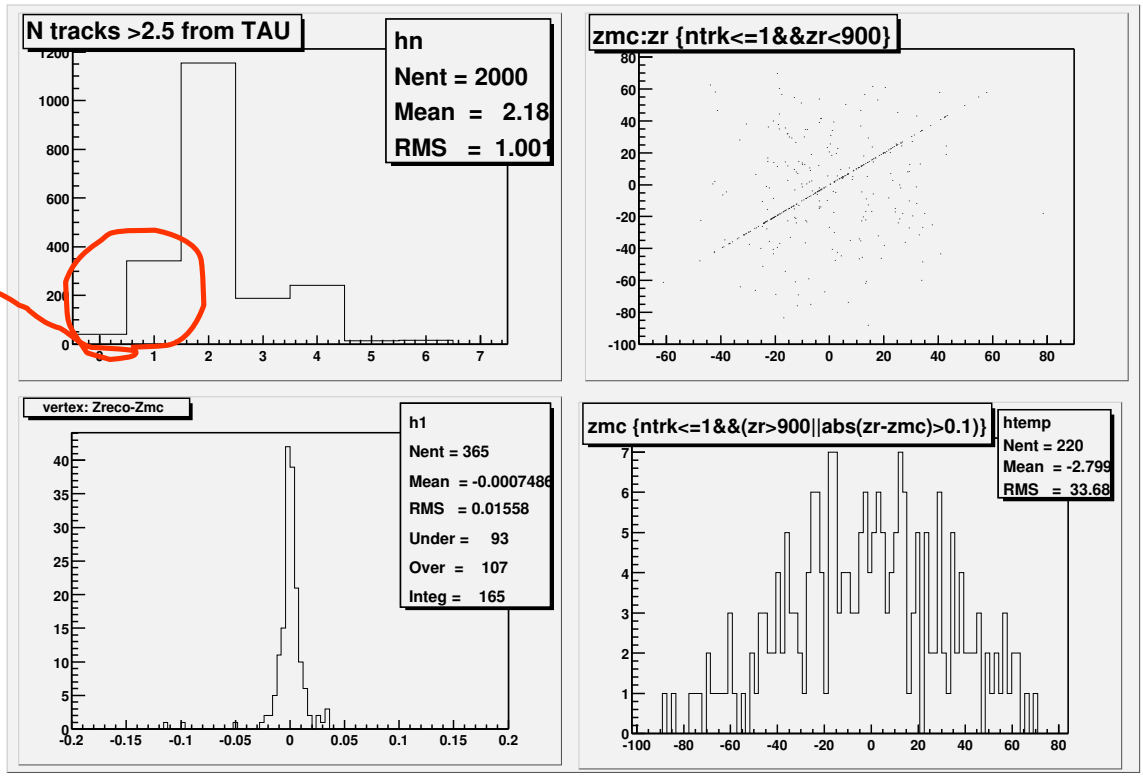
- Why is it a problem?
  - Calorimeter clustering
  - track matching
  - MC matching -> efficiency



Picking the Right Vertex

- Divide events into "hard" and "easy":
  - more than 2 tau daughters with p_t>2.5 GeV are "easy"

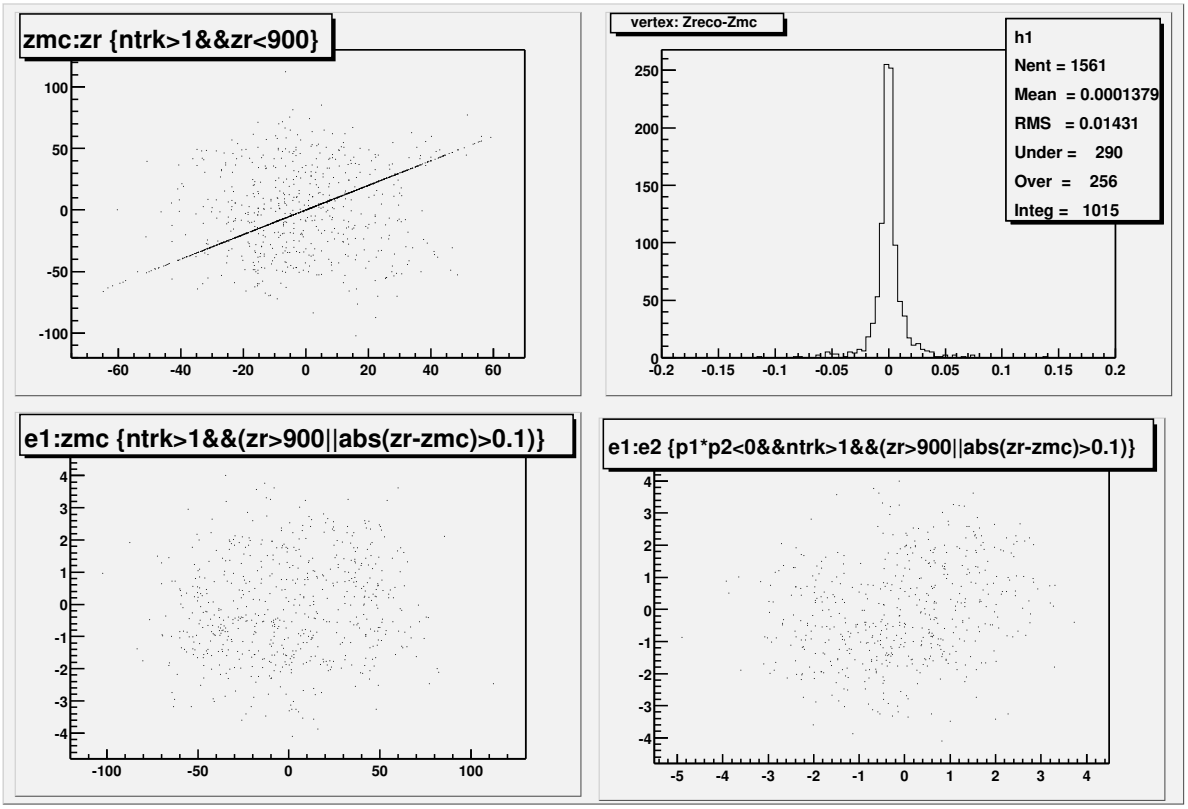
hard



384 events -> 365 with verex -> 165 picked right

Picking the Right Vertex

- "EASY" events are not much easier for current vertexing!



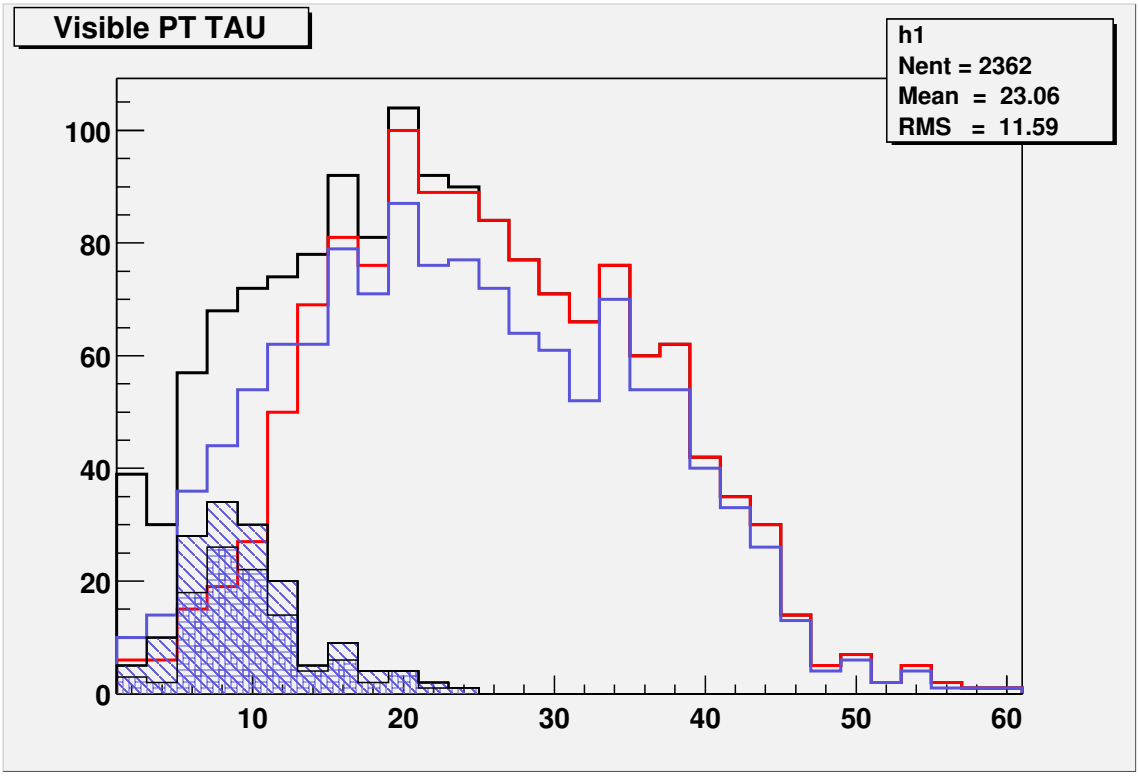
1616 evts -> 1561 with vertex -> 1015 picked right

Picking the Vertex from Wrong Branch

- Took CHVTX vertex – I.e. associated with highest pt track
- SURPRIZE!!!
  - for "hard" events get 203 vertices right instead of 165
  - for "easy" events get 1135 vertices right instead of 1015
- Clearly, selecting vertices based on pt sum does not work. Need to bias weights to higher pt

Clustering Efficiency

- Now it makes sense!!!



- Missed clusters with high Ptvisible are in the cracks between cryostats

Track seeded Tau's

- Start with an isolated track
  - primary vertex – is the vertex associated with the track
  - if no vertex is associated with the track – make one from the track and the beam line
- Get CalData with respect to this vertex, and take everything within 0.7 simple cone
- Treat the resulting object same way as now

Software

- tau_quality package is in t132
- Contains:
  - all tracking variables
  - some EM3 stuff (no clustering, will come soon)
- However, will be called from taureco only in the next release
- tau_trkcluster is being coded. Should expect first version in a week or two