Tools for π^0 Reconstruction

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What is this talk

- Overview
- Taus vs Jets
- Software framework and use
- Example of performance results (on Taus)
- Possible improvements

Sorry – results on jets not there yet

Why was the code developed

- Improve:
  - Spatial resolution of reconstructed τ's
  - Mass reconstruction for QCD background suppression
  - Energy resolution (if possible)

The final tau parameters are calculated using tracks and reconstructed π^0's only.

Tau vs Jets

- “Tau reconstruction” applies to hadronic decays only
- It is a reconstruction of the hadronic system and the neutrino is not included

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- Hadronic taus are narrow jets: visible decay products typically contained in cone $\Delta R \sim 0.05-0.17$ rad
- Tight isolation requirements are applied
- Low track multiplicity: 1,3
- Low π^0 multiplicity: 0-3

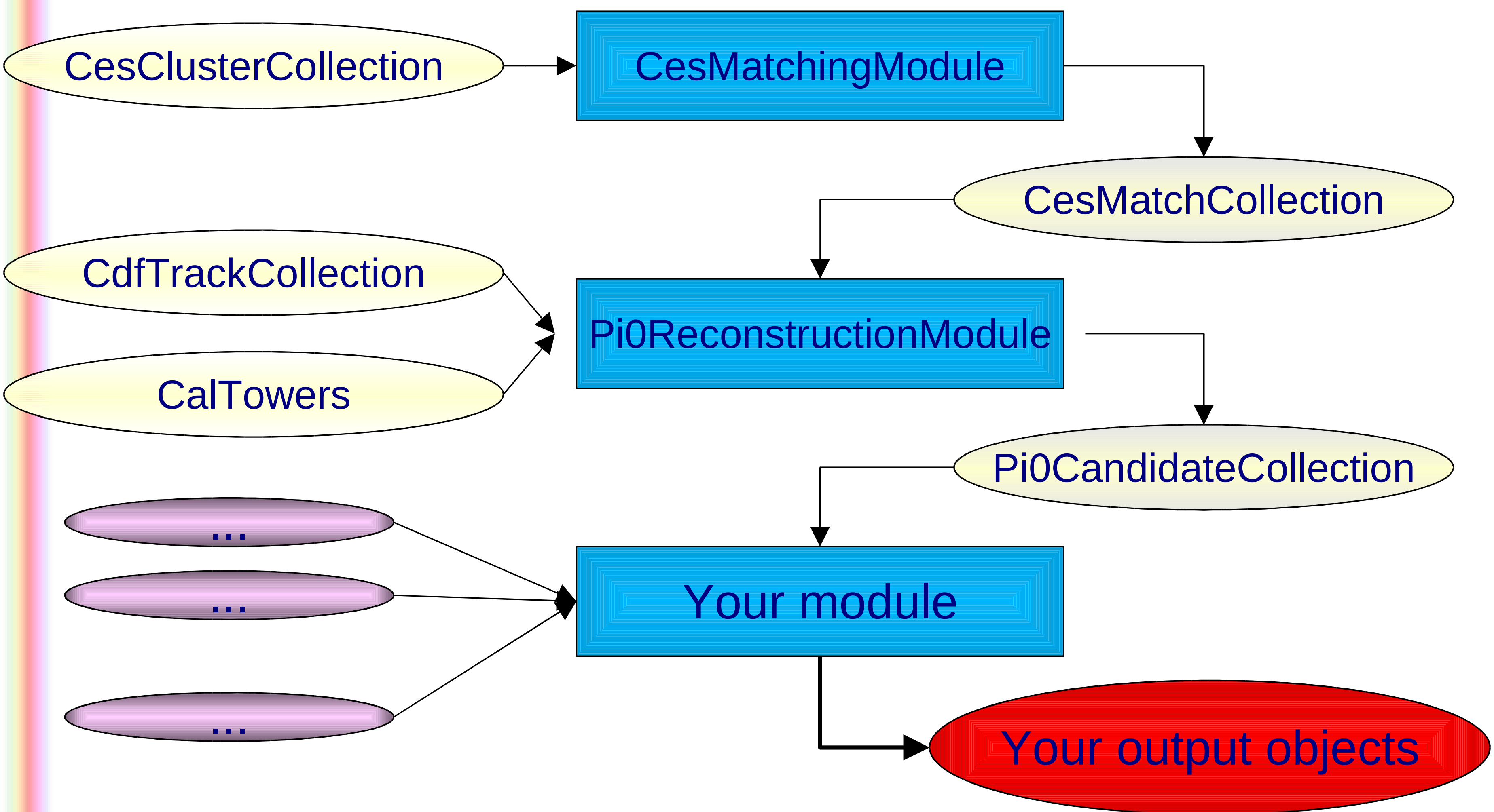
Common ground: very often several particles (tracks, π^0's) hit the same tower

Pi0 reconstruction code

- Part of standart CDF code, follows all conventions
- Part of Tau and TauMods packages, however, independent from the rest of the tau code
- At the moment limited to CES (no use of PES)
- Relies on matched CES clusters to determine position
- Use CEM to assign energy
- Requires vertex information to get four-vectors

- Consists of two modules:
  - CesMatchingModule
  - Pi0ReconstructionModule

Data flow in pi0 reconstruction



CesMatchingModule

- Creates a global collection of matched CES strip/wire clusters by looping over all CES half-wedges (24x2x2)
- Strip/wire cluster matching is performed based on CES energy
  - 1w-1s; 1w-2s; 2w-1s
- Uses dedicated collection of unbiased clusters
- Cluster widths can be set in the talk-to (default is 5 strips/wires)
- Creates a collection of CesMatch objects - hold information on :
  - ϕ, z
  - CES energy;
  - links to the CES clusters etc.

Cluster matching algorithm

- Create ordered lists of strip and wire clusters for each half-wedge
- Start with the highest energy cluster and make all possile combinations with one and two clusters of the other type
  (for example: if the highest energy cluster is a strip cluster, make all combinations 1s-1w, 1s-2w)
- Select the combination with smallest ΔE
  (in the above case $\Delta E_i = E^{strip} - E_i^{wire}$; $\Delta E_{jk} = E^{strip} - (E_j^{wire} + E_k^{wire})$)
- Test whether the smallest ΔE is consistent with a match:
  $|\Delta E| < k * \sigma(E_{av})$; $E_{av} = (E^{strip} + E_i^{wire})/2$; $E_{av} = (E^{strip} + E_j^{wire} + E_k^{wire})/2$
  - Match acceptable: remove the participating cluster from lists and proceed
  - Not acceptable: remove the highest energy cluster and proceed

Cluster matching algorithm (cont.)

- $\sigma(E_{av})$ is determined using data electron sample, coef k is chosen to optimize matching efficiency (k~3-4)
- Matching efficiency = measure of utilization of the clusters in the half wedge"; can de defined as $\varepsilon = 1 - N_{cl}^{unmatched}/N_{cl}$
- Remaining unmatched strip clusters assigned ϕ= center of wedge and treated as "matches"

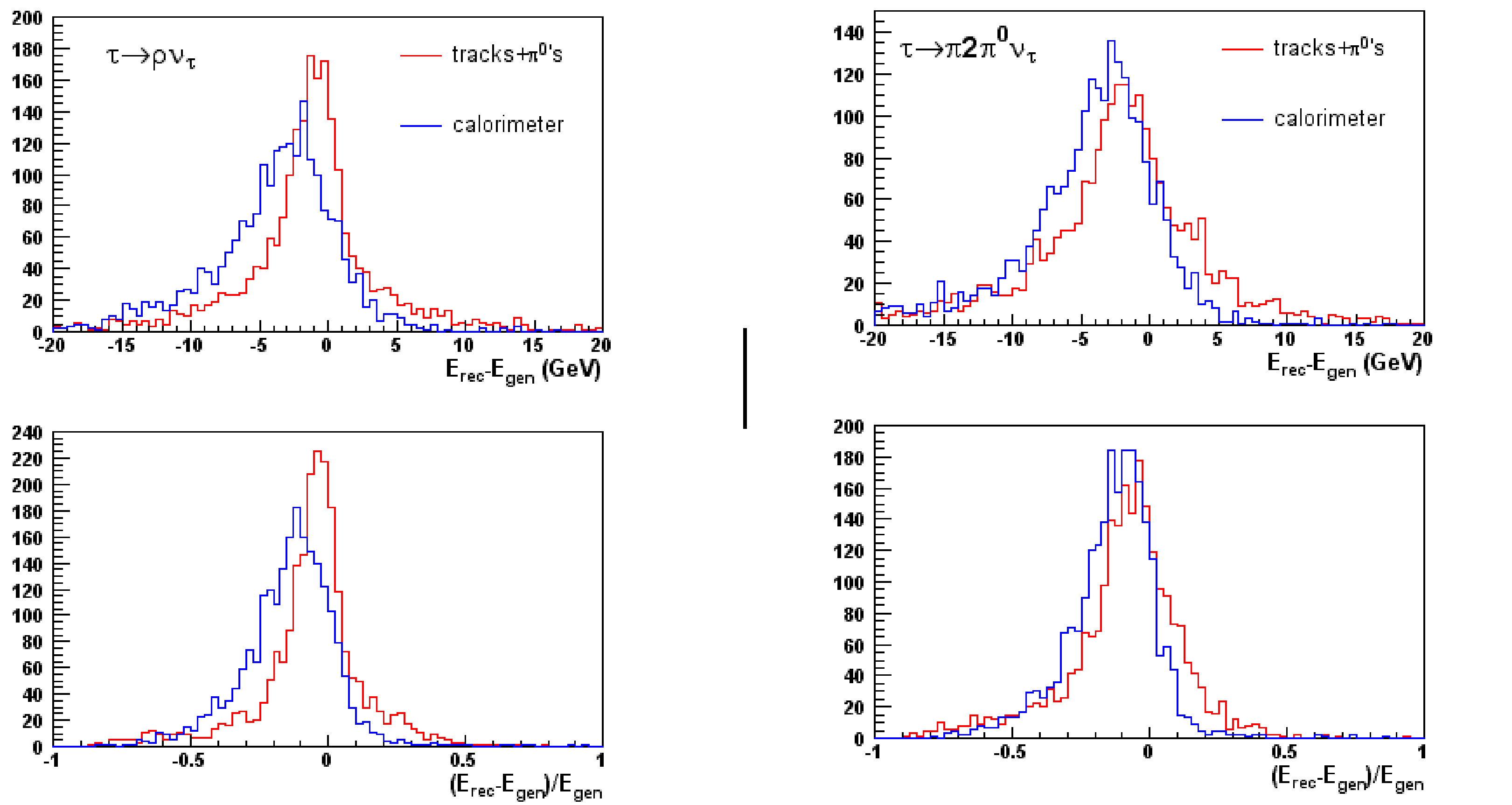
The collection of CesMatches for the event is stored in the event record

Pi0ReconstructionModule

- Creates a global collection of "π^0's" (π^0/γ):
  - (ϕ, *z*) from CesMatch objects that are not matched by charged tracks (default separation: 2cm)
  - *E* from CEM energy in the tower under the match
    - ✔ E is corrected for contributions from charged pions (using Steve Kuhlmann's results for average responce)
    - ✔ In case of multiple matches in the same tower energy is assigned proportional to CES energies
- Pi0Candidate objects hold information on
  - ϕ, *z* coordinates
  - Energy
  - links to the CesMatch, CalTower, etc.
- CdfPi0 objects do not contain the 4-vectors: a method of the class provides this information when the user specifies a *z*-vertex in his/her code

Collection of Pi0Candidates stored in the event record

Energy resolution for decays with pi0's



Prospects

- Account for energy leakage in pi0 towers
- More careful treatment of track-deposited EM at the edges of towers
- Use cluster info

- Modified versions of the code will be released in a couple of days
- Test on Jets