Quarkonium Topical Group Report

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sPHENIX Collaboration Meeting
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Inner tracker studies for the ALD charge

Configurations

Tracking configurations considered:

I use a 4 layer outer maps tracker for now as a **generic "good outer tracker"**. Will move to a TPC when that simulation is working well.

Best case scenario:

3 layer MAPS inner barrel + 4 layer maps outer tracker

Possible configurations for the ALD charge:

1 layer re-used pixels + 1 layer maps pixels + 4 layer maps outer tracker
(adfrawley/QTG_macros/macro_s/g4simulation/G4_Svtx_1pixel+1maps+4mapsouter.C)

1 layer MAPS pixels + 1 layer re-used pixels + 4 layer maps outer tracker
(adfrawley/QTG_macros/macro_s/g4simulation/G4_Svtx_1maps+1pixel+4mapsouter.C)

1 layer re-used pixels + 4 layer maps outer tracker
(adfrawley/QTG_macros/macro_s/g4simulation/G4_Svtx_1pixel+4mapsouter.C)

Configurations (cont.)

1 layer re-used pixels + 1 layer maps pixels + 4 layer maps outer tracker
(adfrawley/QTG_macros/macro_s/g4simulation/G4_Svtx_1pixel+1maps+4mapsouter.C)
—— re-used pixel layer live fraction = 0.80 (0.914 * 0.87)

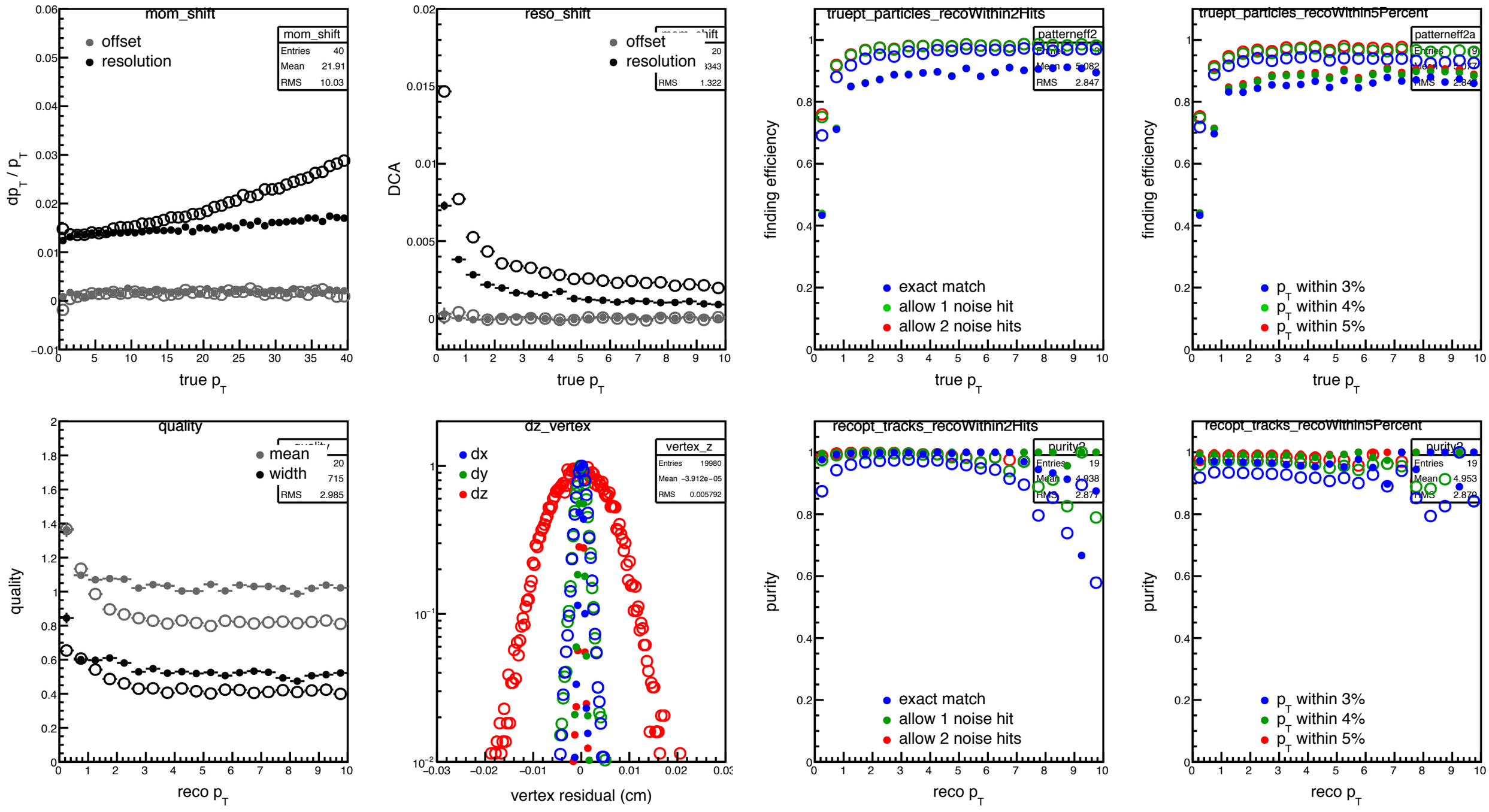
1 layer MAPS pixels + 1 layer re-used pixels + 4 layer maps outer tracker
(adfrawley/QTG_macros/macro_s/g4simulation/G4_Svtx_1maps+1pixel+4mapsouter.C)
—— re-used pixel layer live fraction = 0.77 (0.885 * 0.87)

1 layer re-used pixels + 4 layer maps outer tracker
(adfrawley/QTG_macros/macro_s/g4simulation/G4_Svtx_1pixel+4mapsouter.C)
—— re-used pixel layer live fraction = 0.80 (0.914 * 0.87)

Evaluate these configurations using 10,000 Y(1S) thrown into y < |1|

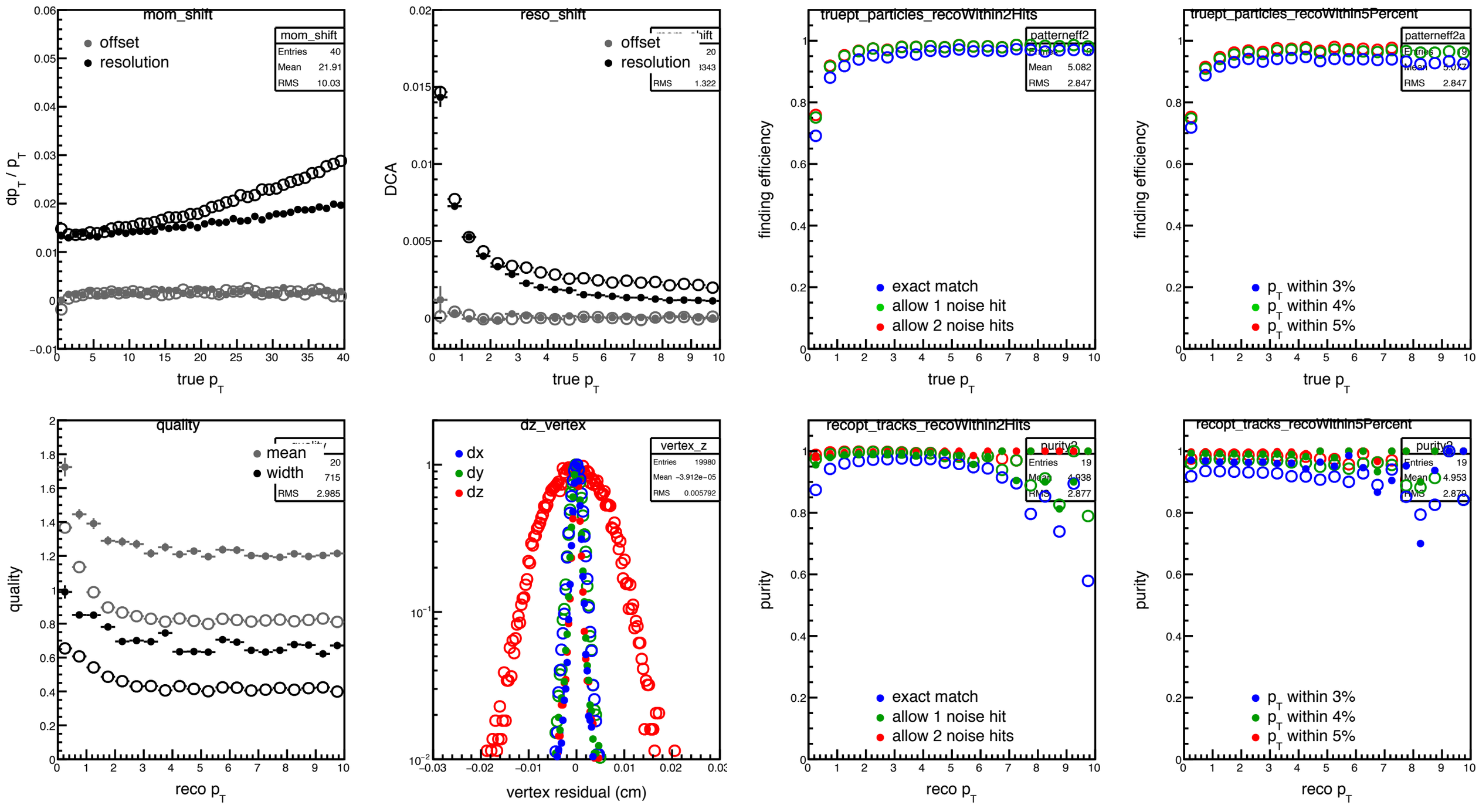
Track quality plots - 10K Hijing events

3 layer MAPS inner barrel + 4 layer maps outer tracker



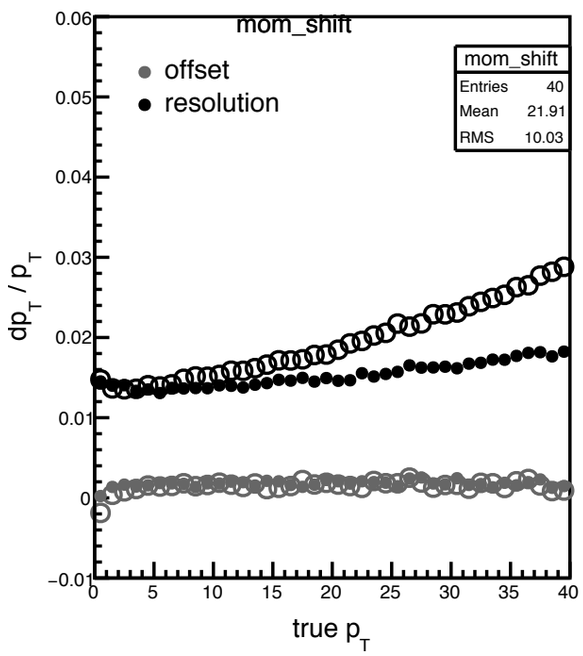
Track quality plots - 10K Hijing events

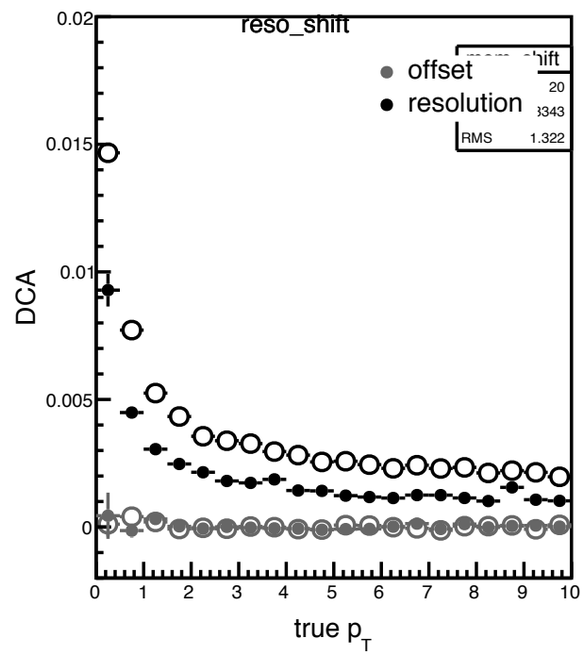
1 layer reused pixels + 1 layer maps + 4 layer maps outer tracker

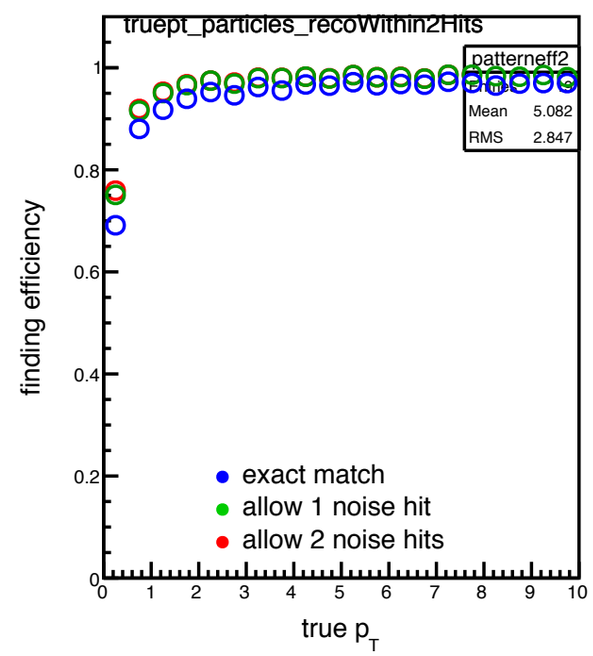


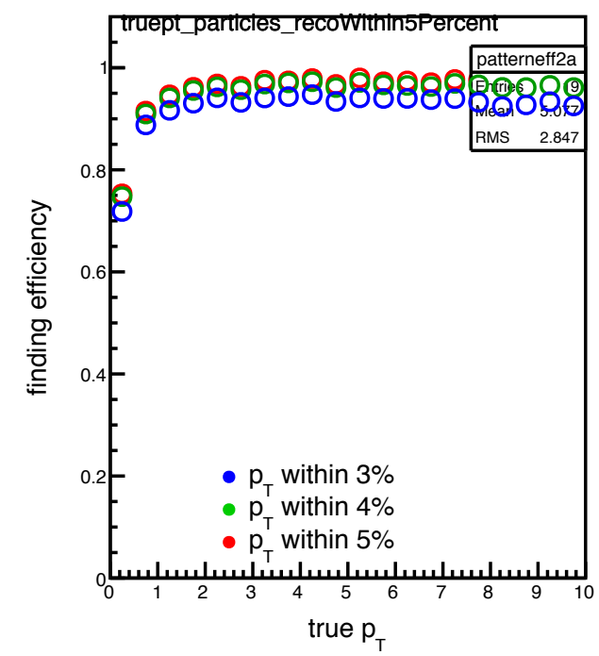
Track quality plots - 10K Hijing events

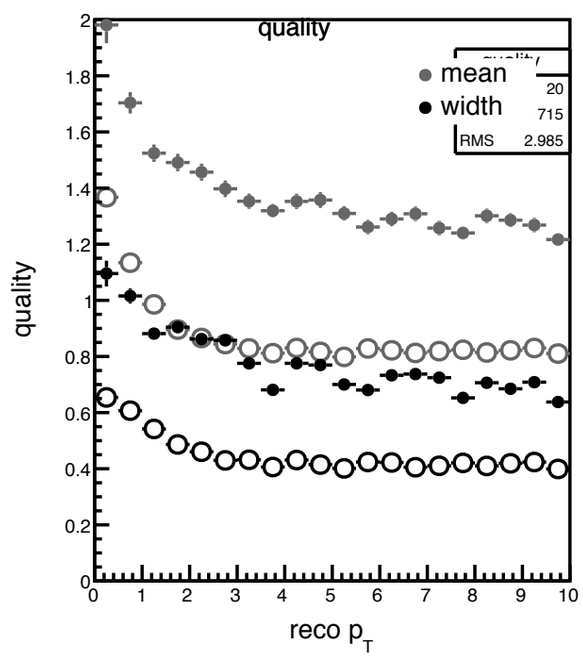
1 layer maps + 1 layer re-used pixels + 4 layer maps outer tracker

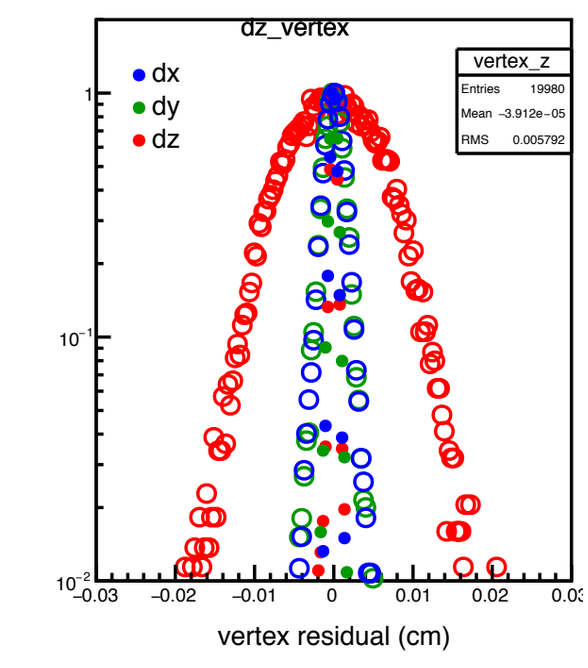


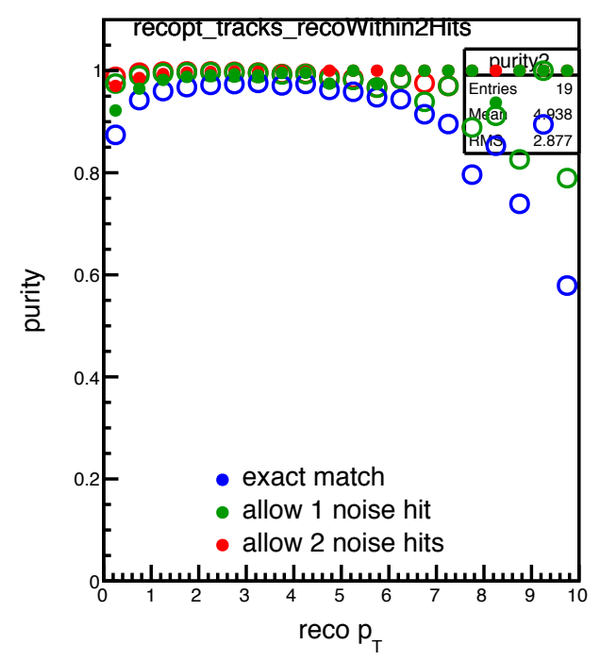


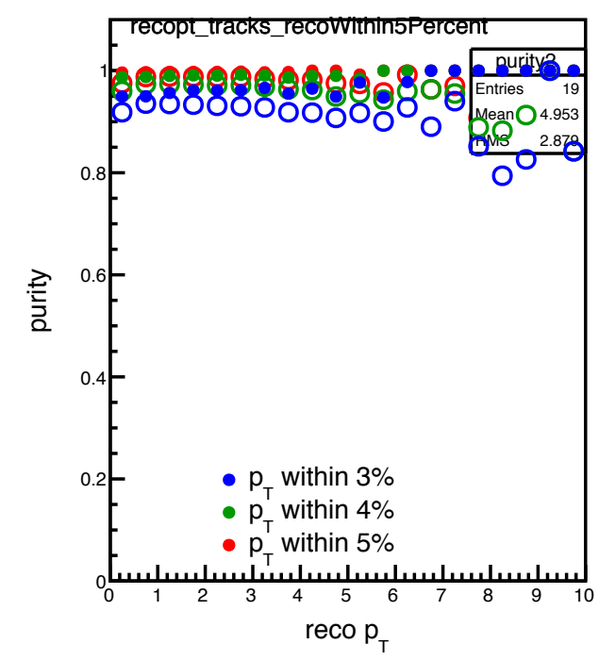






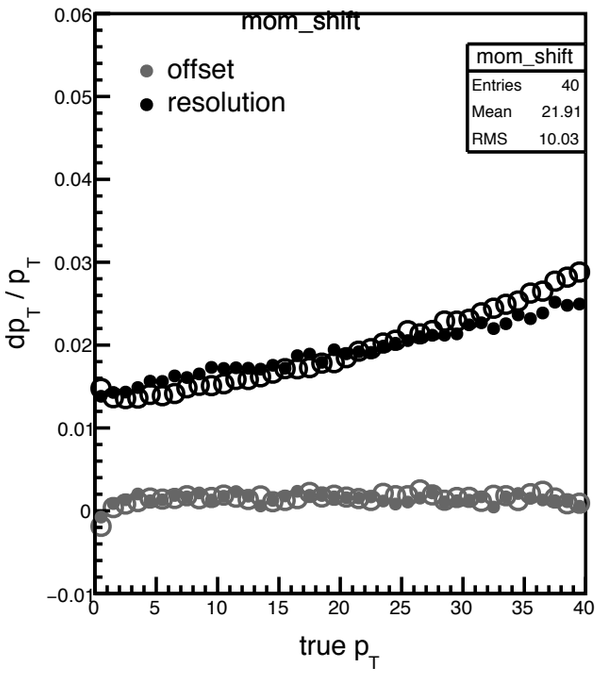


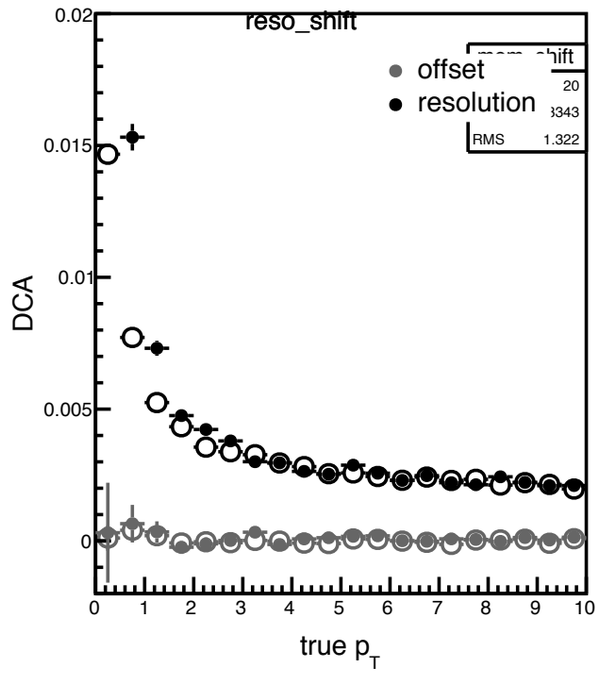


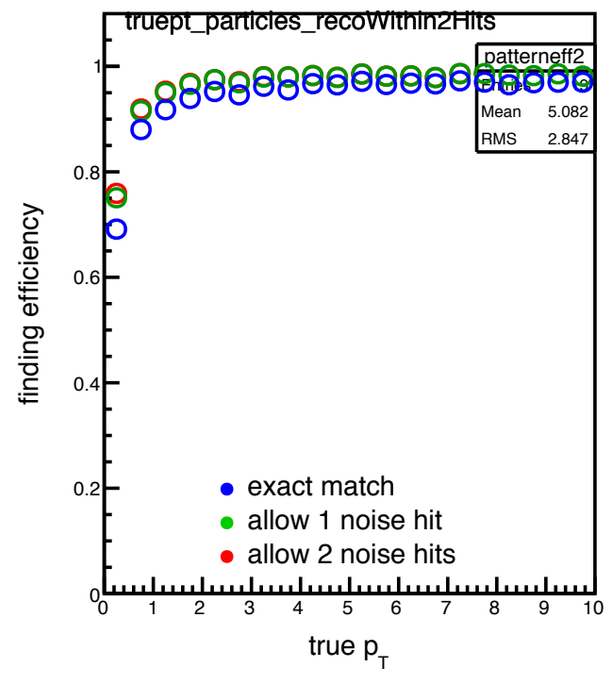


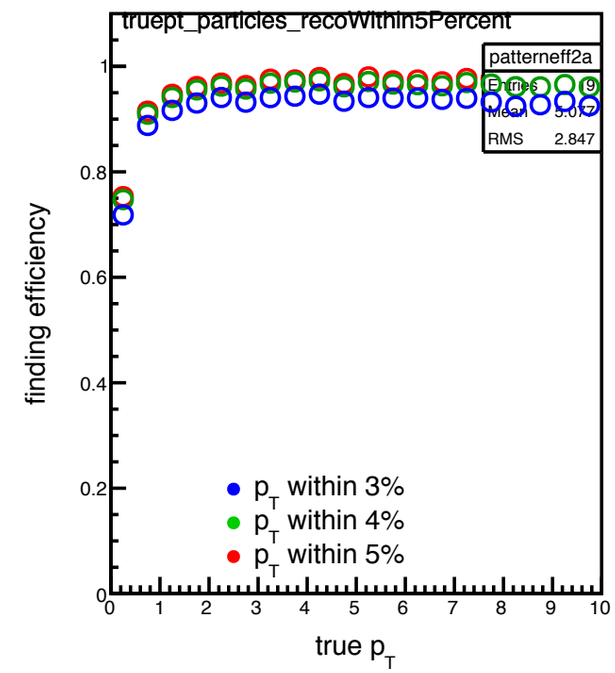
Track quality plots - 10K Hijing events

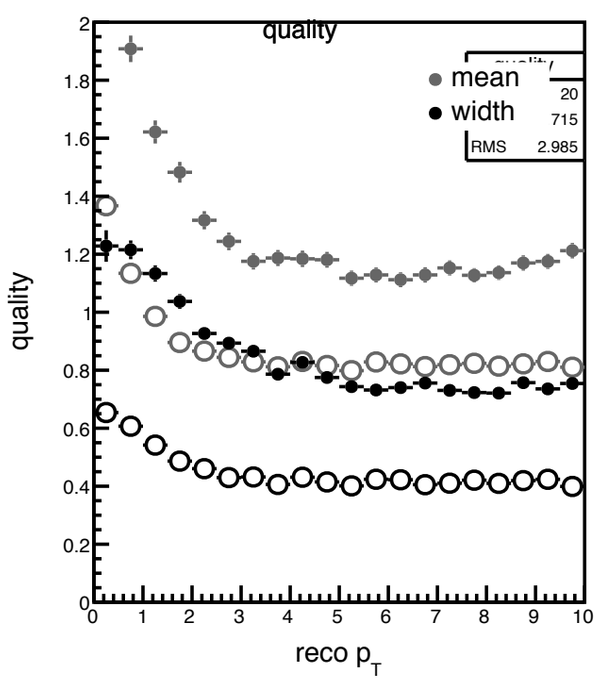
1 layer re-used pixels + 4 layer maps outer tracker

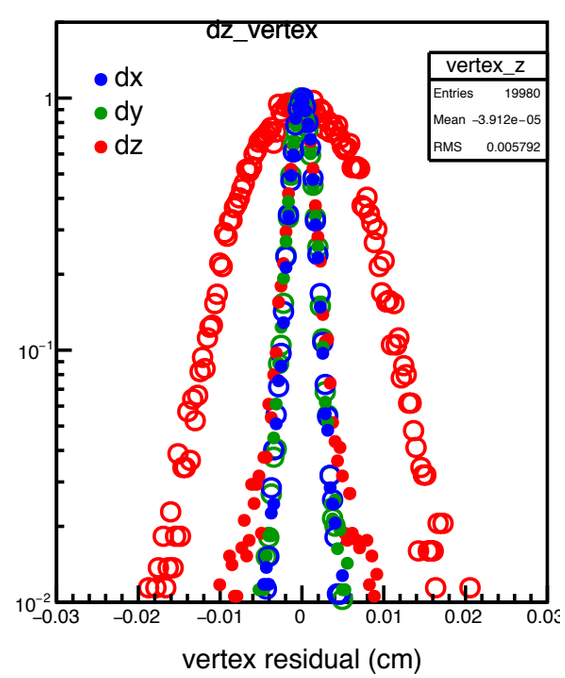


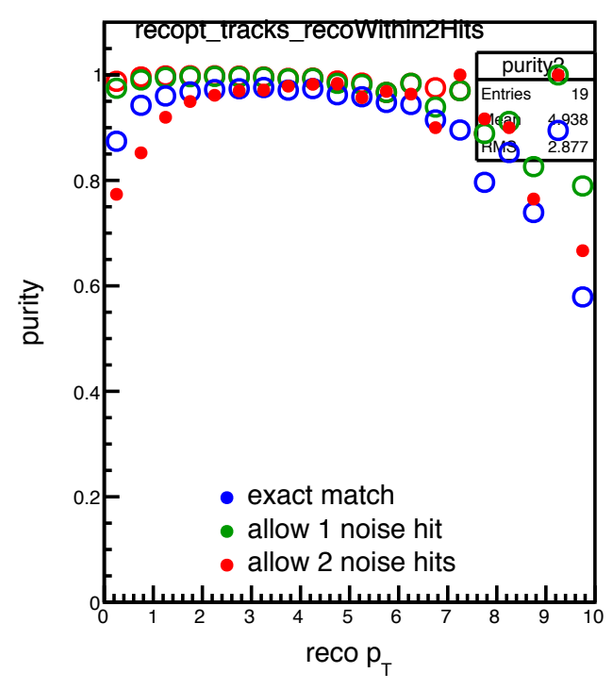


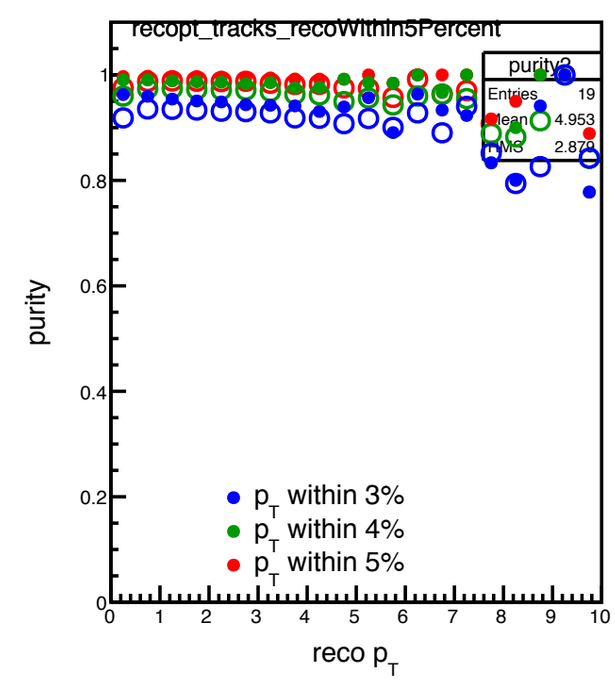








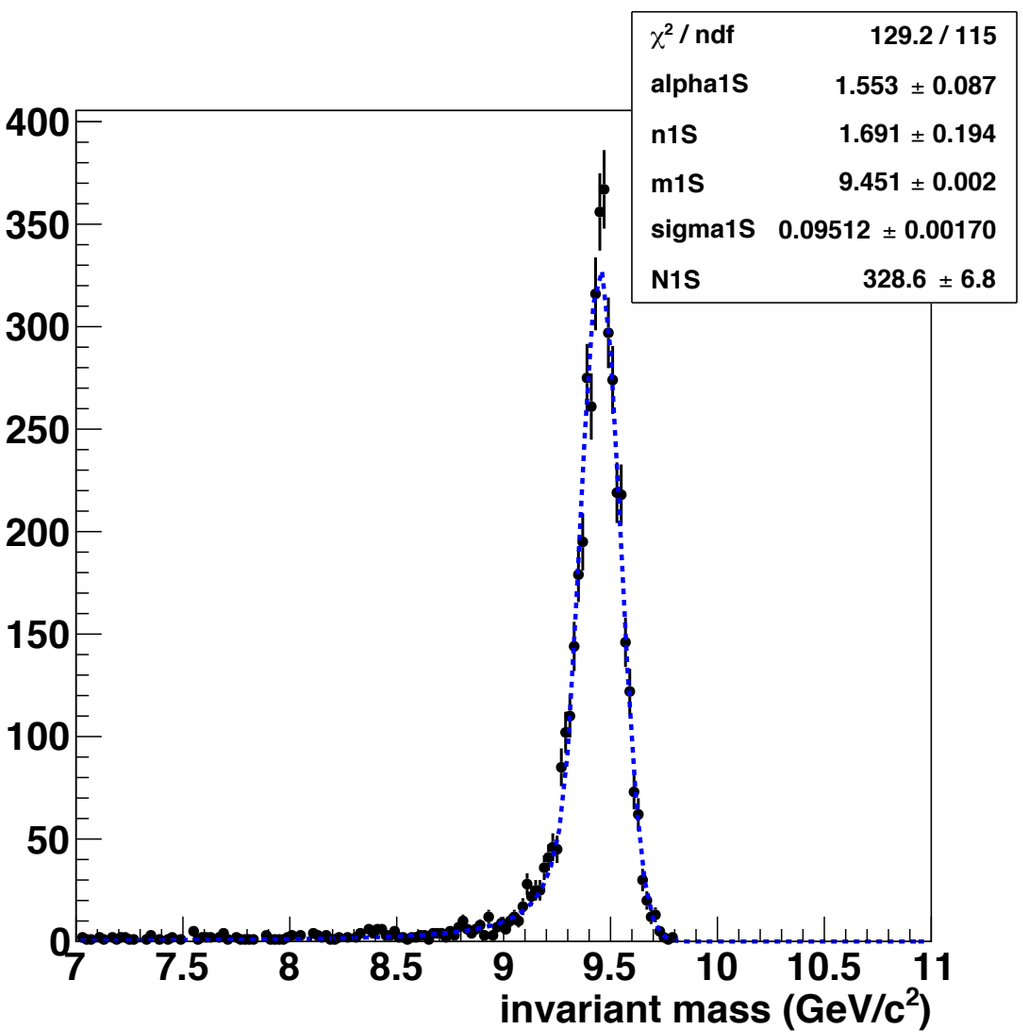




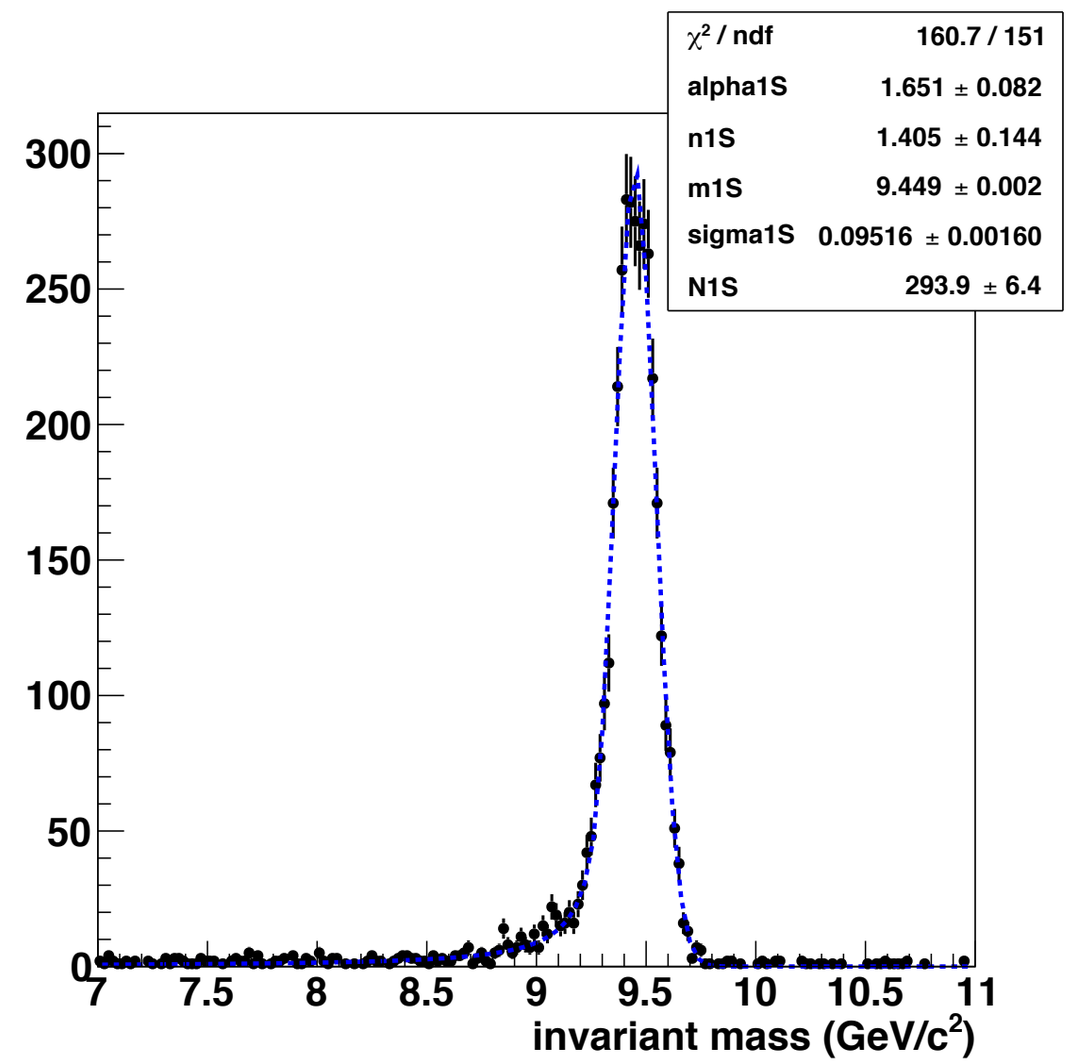
Embed Upsilons in 10K Hijing events

No EMCal match, so identify electrons in reconstructed tracks using truth information —- (PDG code = +11 or -11). Also keep track of whether the electrons were from the Upsilon decay or not (but do not require it).

Throw 10,000 single Upsilons



Embed 10,000 Upsilons in central Hijing



These are for the 7 layer maps detector

Embedded Upsilons - 10K Hijing events

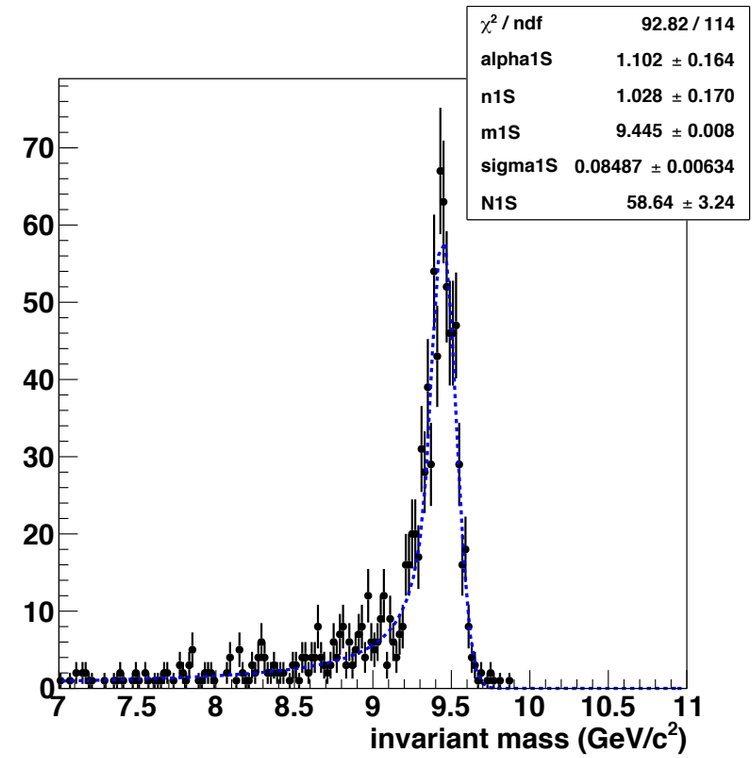
2 layers re-used pixels + ganged strips outer tracker

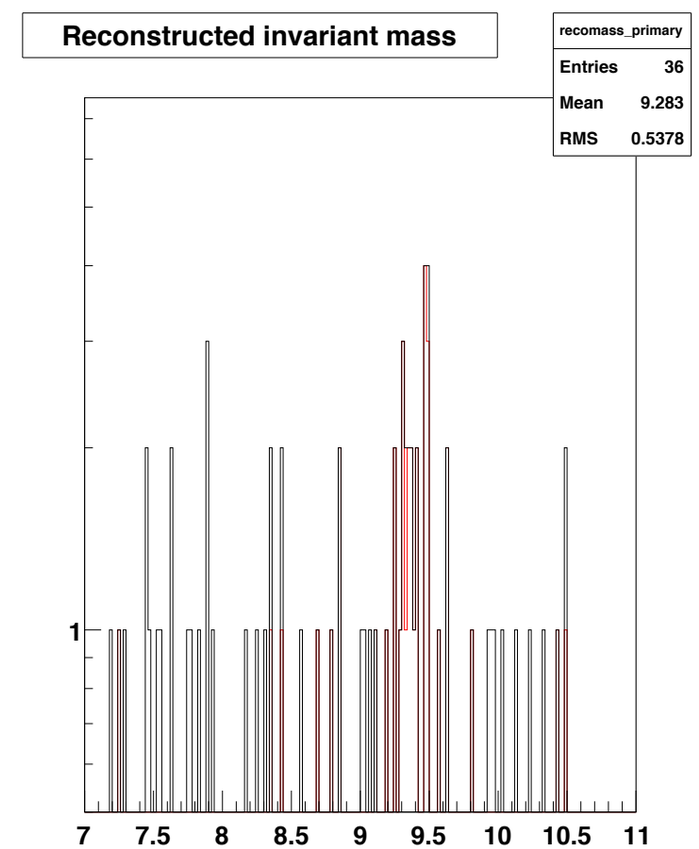
10,000 Upsilons thrown

Single Upsilons:
1458 reconstructed

Embedded in Hijing:
36 entries from primary tracks (red)
71 entries total

~ 97.5% loss due to occupancy





Embedded Upsilons - 10K Hijing events

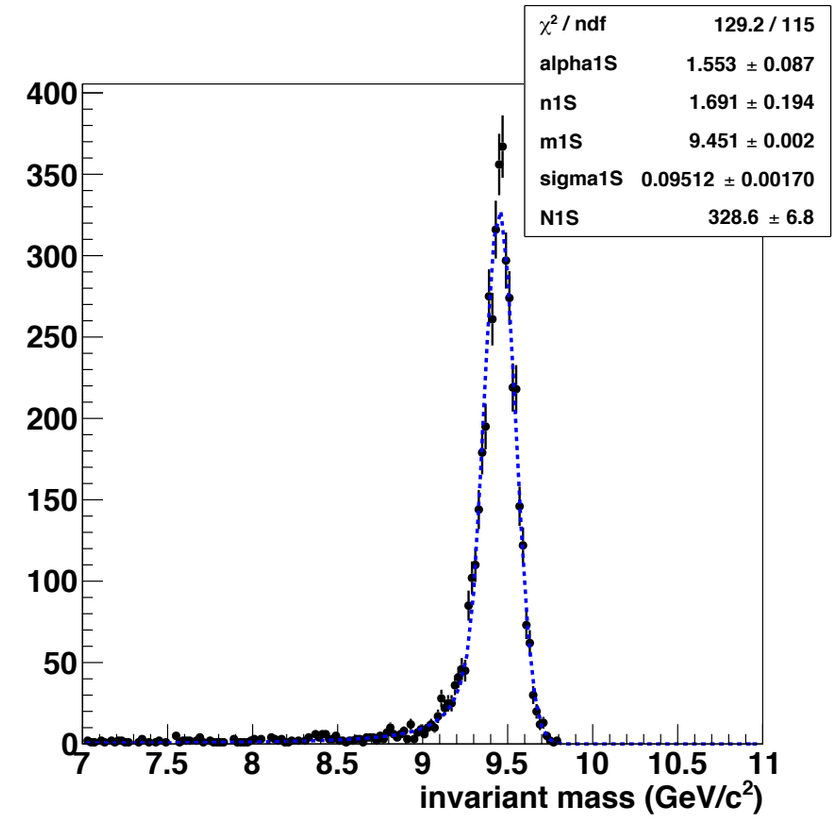
3 layer inner maps + 4 layer maps outer tracker

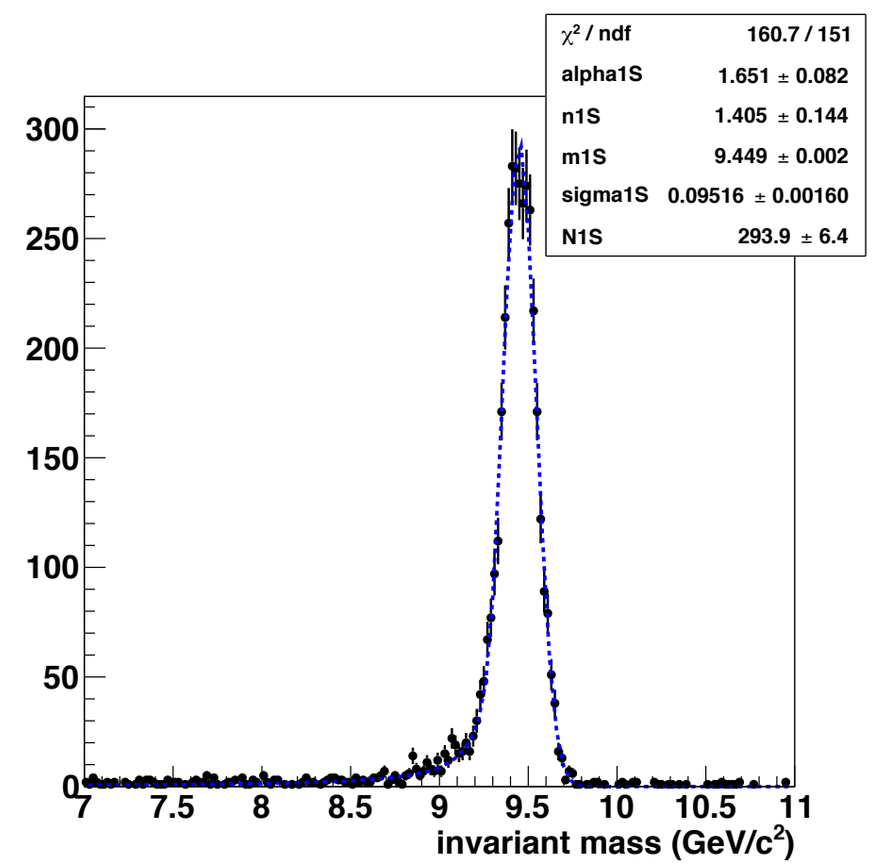
10,000 Upsilons thrown

Single Upsilons:
4444 reconstructed (0.444)
mass resolution 95 MeV

Embedded in Hijing:
9471 thrown:
4027 entries from primary tracks (0.425)
4038 entries total
mass resolution 95 MeV

~ 4% loss due to occupancy





Embedded Upsilons - 10K Hijing events

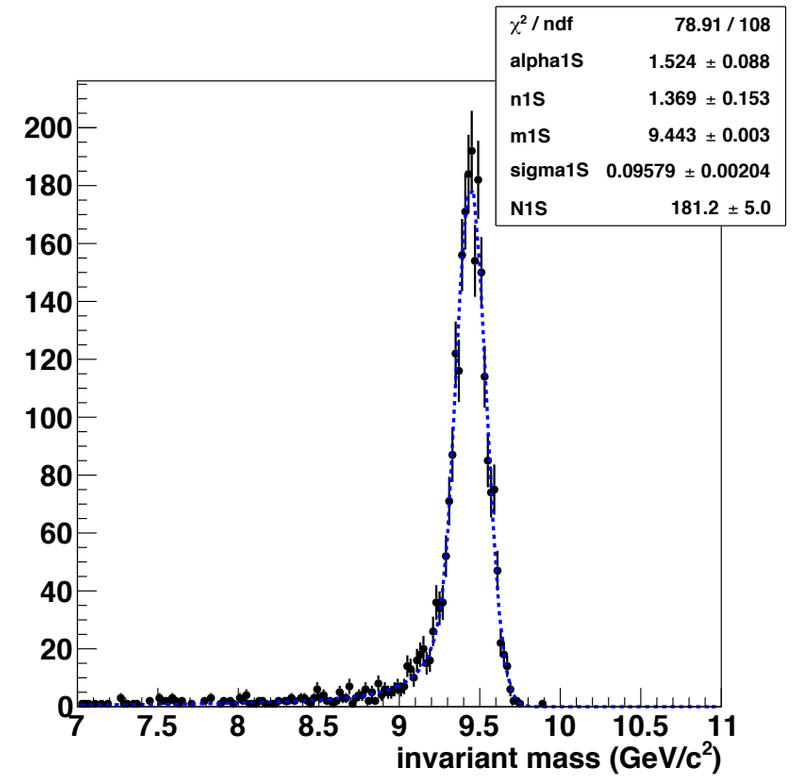
1 layer maps +1 layer re-used pixels + 4 layer maps outer tracker

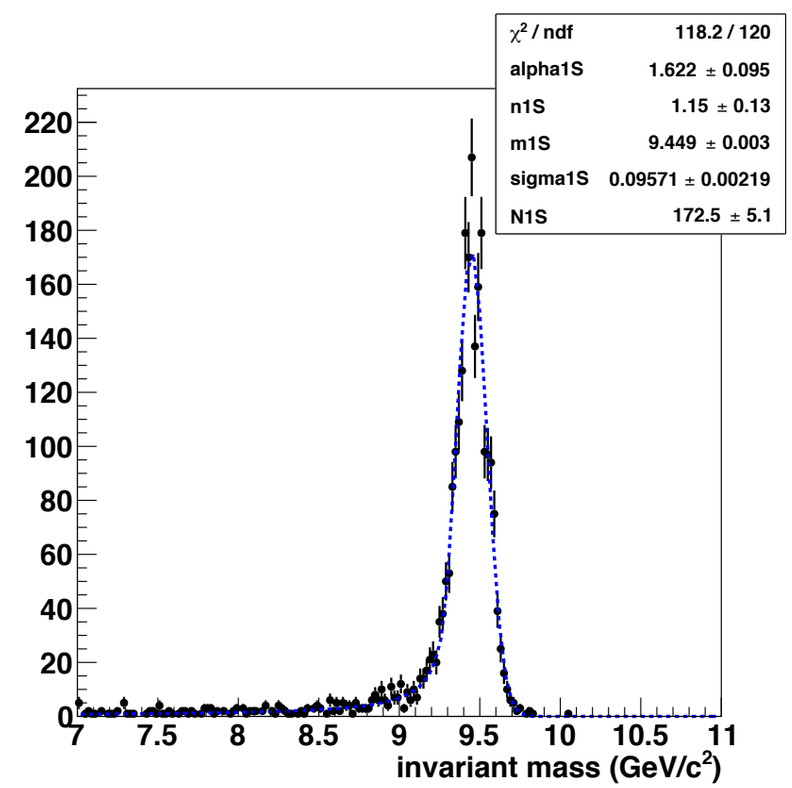
10,000 Upsilons thrown

Single Upsilons:
2557 reconstructed
mass resolution 96 MeV

Embedded in Hijing:
2477 entries from primary tracks (red)
2487 entries total
mass resolution 96 MeV

~ 3% loss due to occupancy





Embedded Upsilons - 10K Hijing events

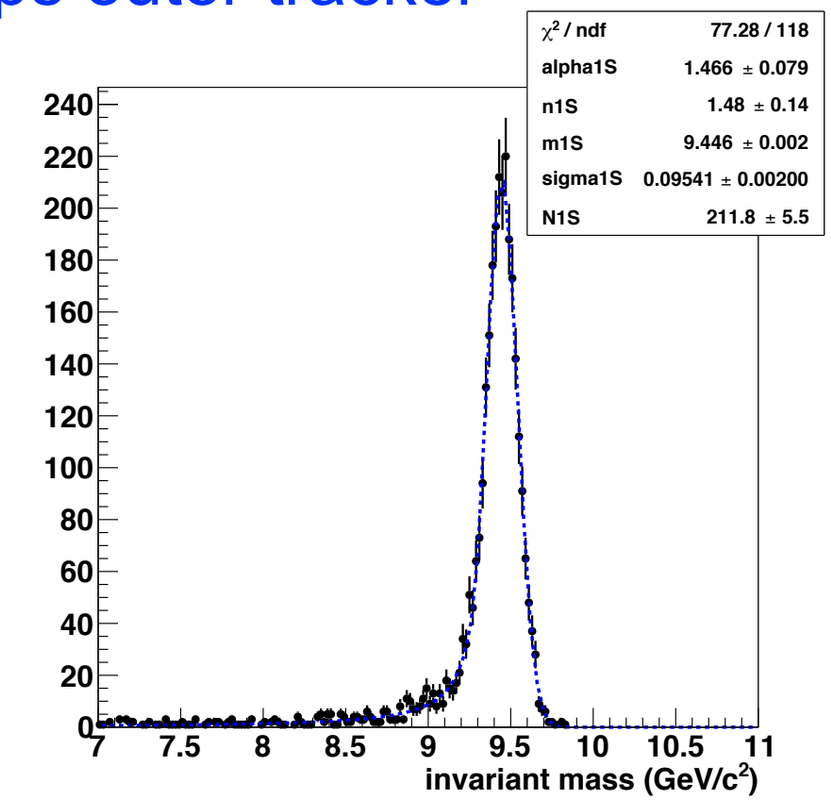
1 layer re-used pixels + 1 layer maps + 4 layer maps outer tracker

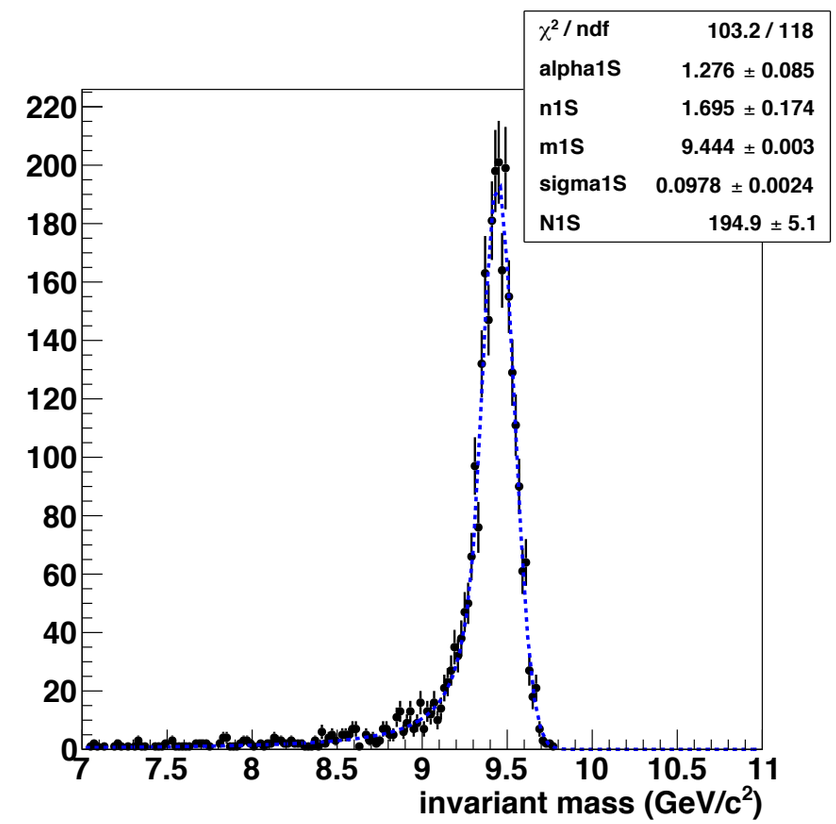
10,000 Upsilons thrown

Single Upsilons:
2981 reconstructed
mass resolution 95 MeV

Embedded in Hijing:
2926 entries from primary tracks (red)
2934 entries total
mass resolution 98 MeV

~ 2% loss due to occupancy





Embedded Upsilons - 10K Hijing events

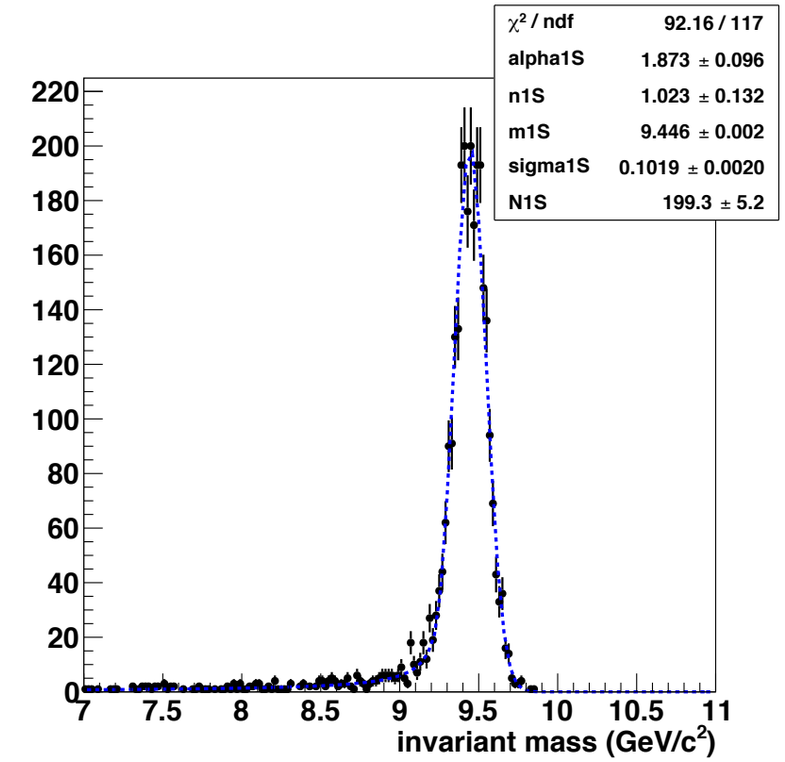
1 layer re-used pixels + 4 layer maps outer tracker

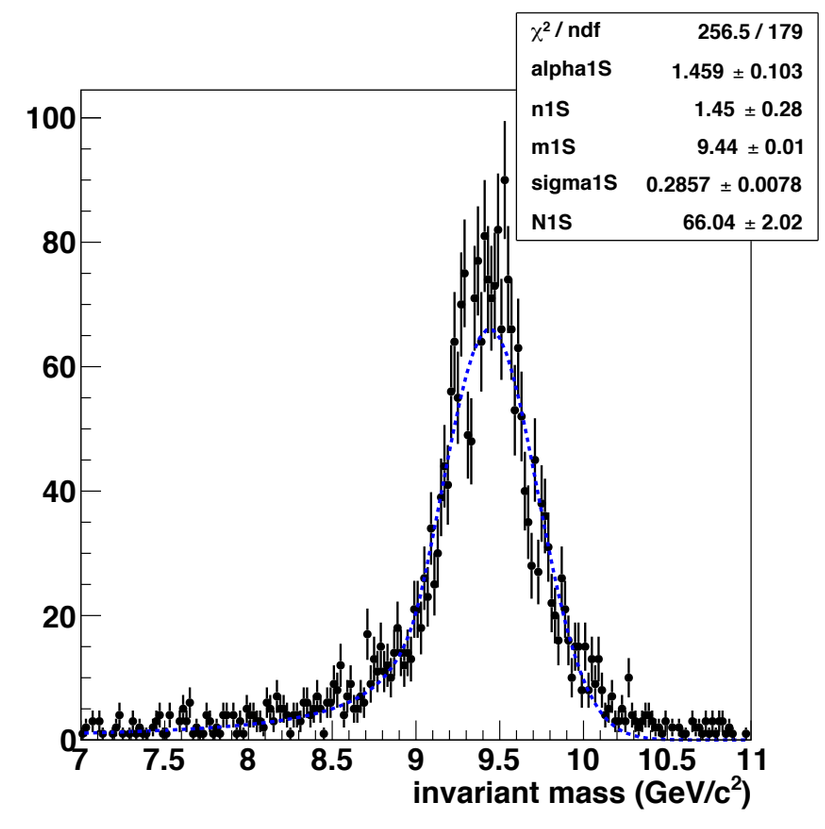
10,000 Upsilons thrown

Single Upsilons:
2878 reconstructed
mass resolution 102 MeV

Embedded in Hijing:
2765 entries from primary tracks (red)
2876 entries total
mass resolution 286 MeV

~ 4% loss due to occupancy





EMCal Matching

Descoping suggestions for EMCal:

- Reduction of EMCal acceptance
  - Reduces yield by a factor
  - Reduces range of rapidity covered

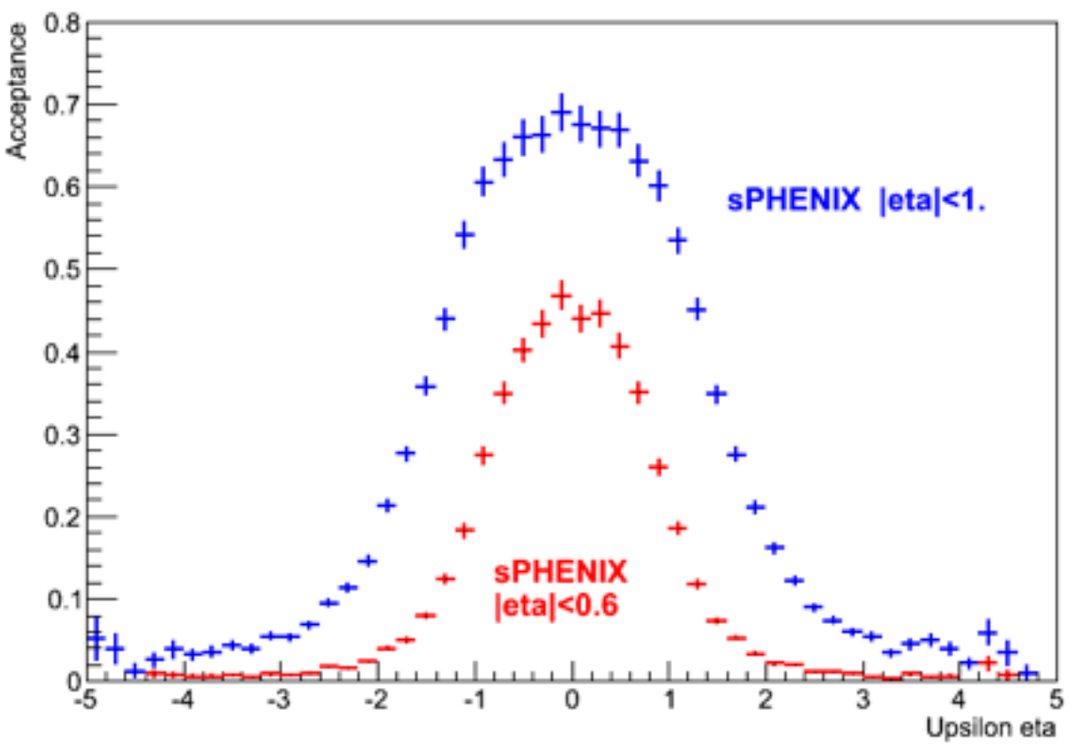
- Ganging of EMCal towers
  - Coarser EMCal segmentation affects
    - Precision of matching to tracks
    - Cluster overlaps are worse
  - Reduces hadron rejection given by E/p cut

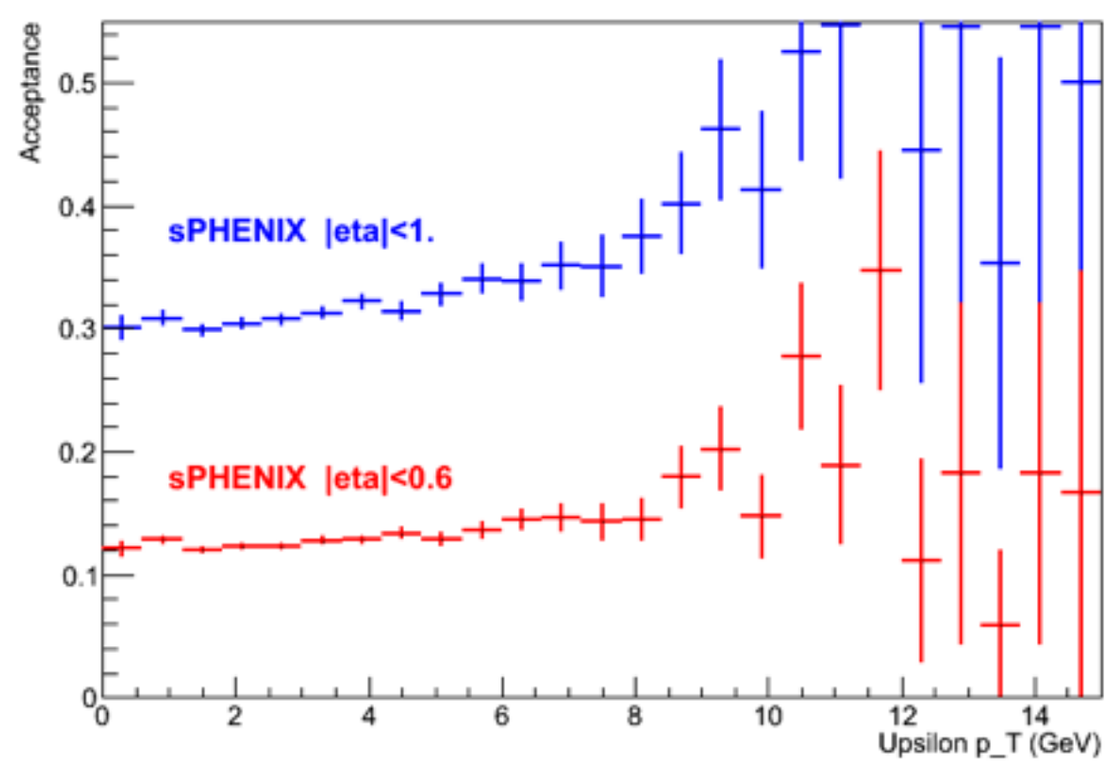
Reduction of EMCal acceptance

Generator level calculation of effect of reducing acceptance to |η| < 0.6

Reduces Upsilon yield by a factor of ~ 0.4

Not good, but not fatal to the program



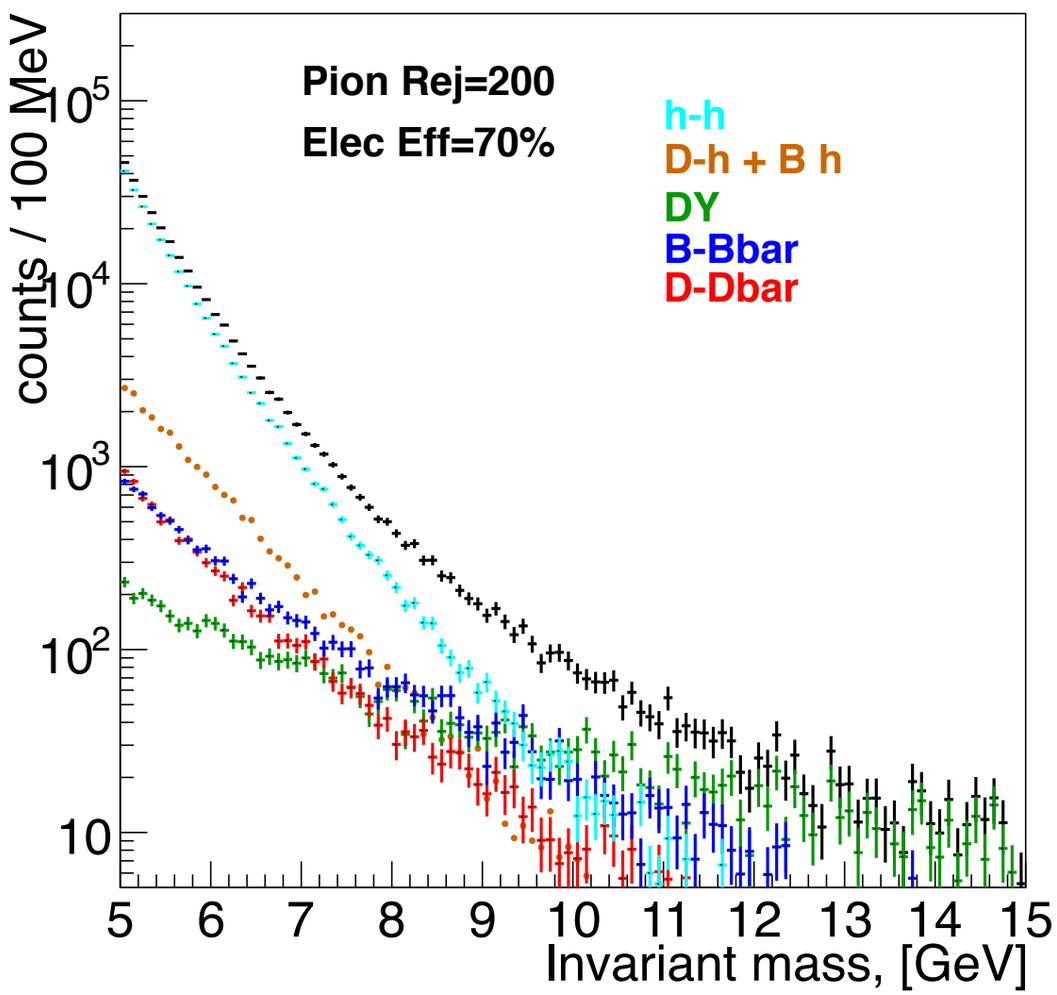


Electron ID

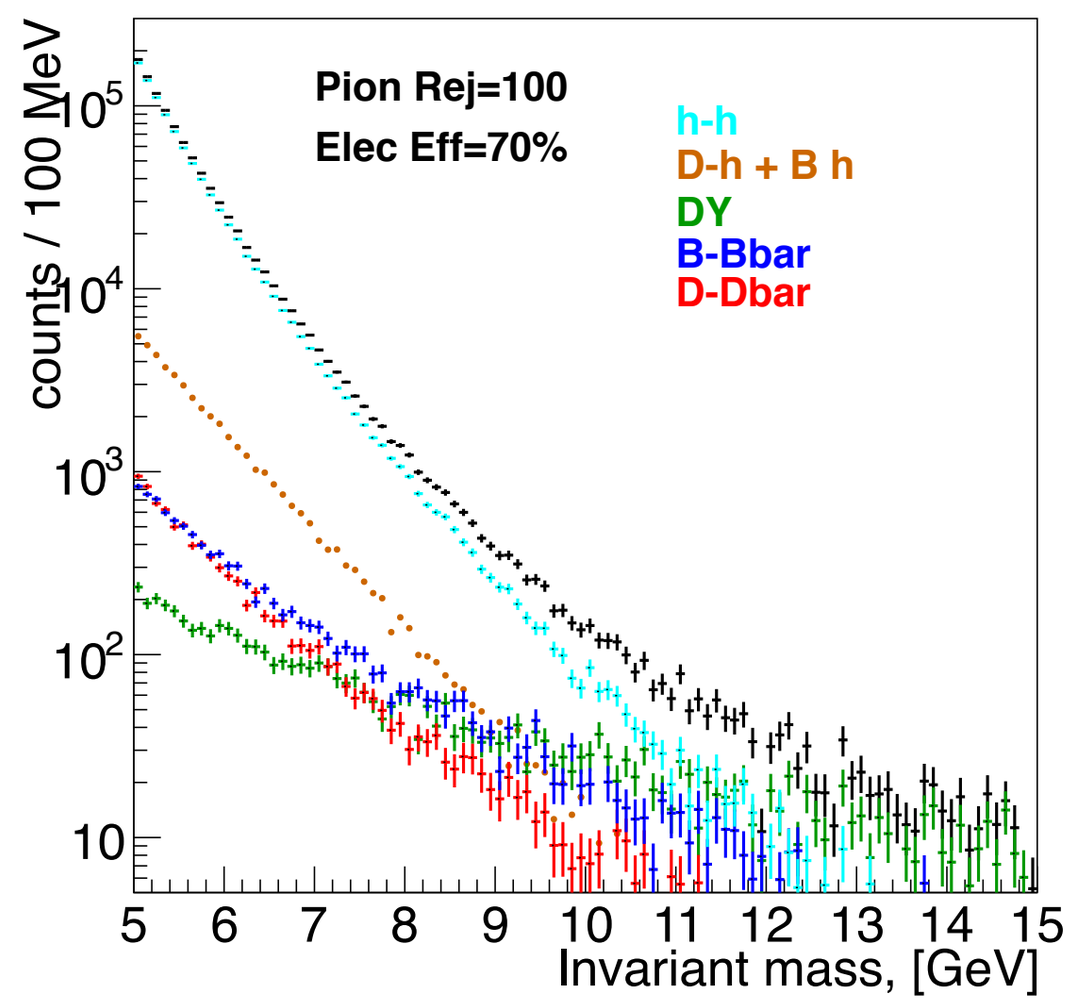
From Jin: pion rejection at 4 GeV/c drops from 200 to 100 with 2x2 tower ganging. This increases the background contribution from misidentified hadrons by a factor of 2.

- h-h component increases by 4
- D-h and B-h increase by 2
- DY and correlated heavy flavor are unchanged

No change in tower size



2x2 ganging of towers



Tracking + EMCal

Jin has studied electron/pion separation using full G4 simulations.

But those simulations to not allow us to study the effect of fake tracks that match to calorimeter clusters. For that we need a fast simulation that allows us to try various tracking configurations with matching to the EMCal for all reconstructed tracks, including fake tracks.

Kurt Hill has made a fast simulator that can be used to address this.

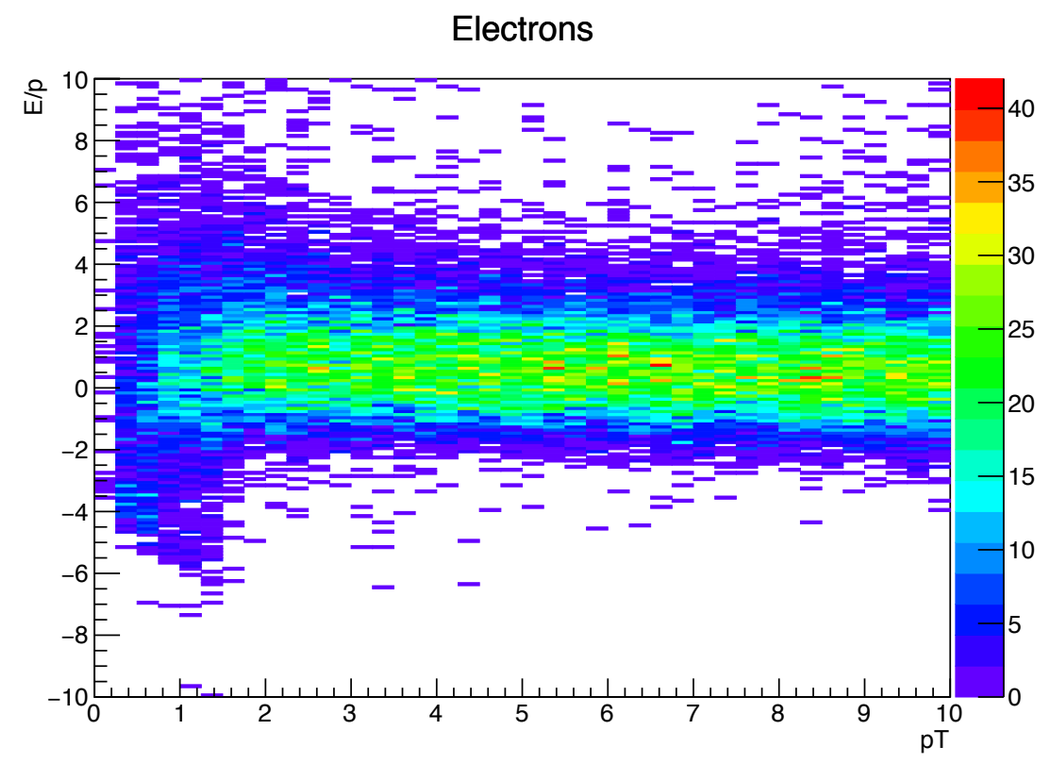
It uses a parameterization of the CEMC response to pions and electrons

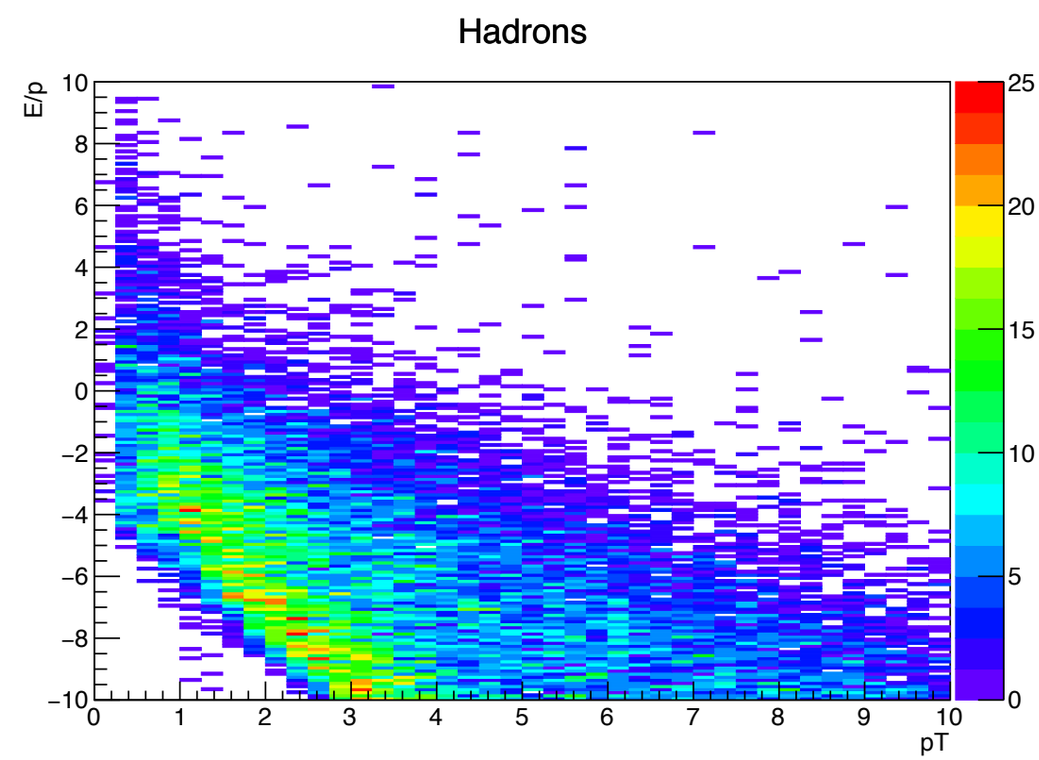
- The CEMC is replaced by a black hole that absorbs all of the energy
- The fast simulation puts energy in the CEMC towers for every truth hit on the black hole
- The tracks are matched to the fast sim CEMC tower energies

Tracking + EMCal

Sigmalized E/p distributions for electrons and pions.

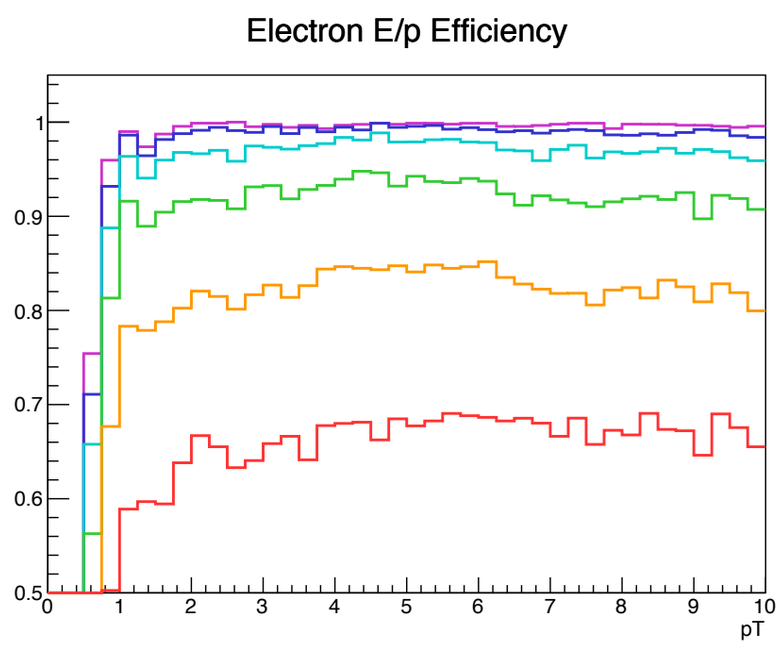
These are from low occupancy events (5 electrons + 5 pions)

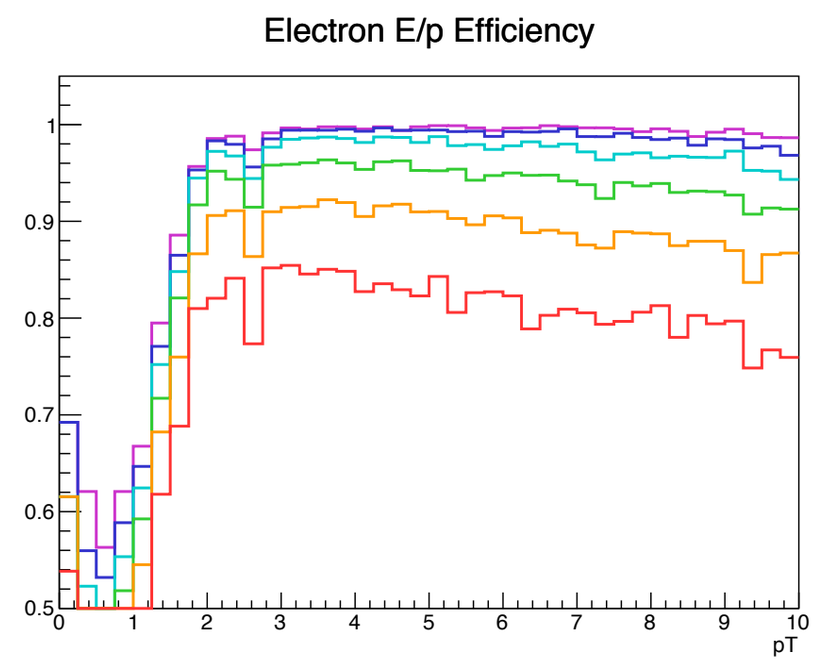


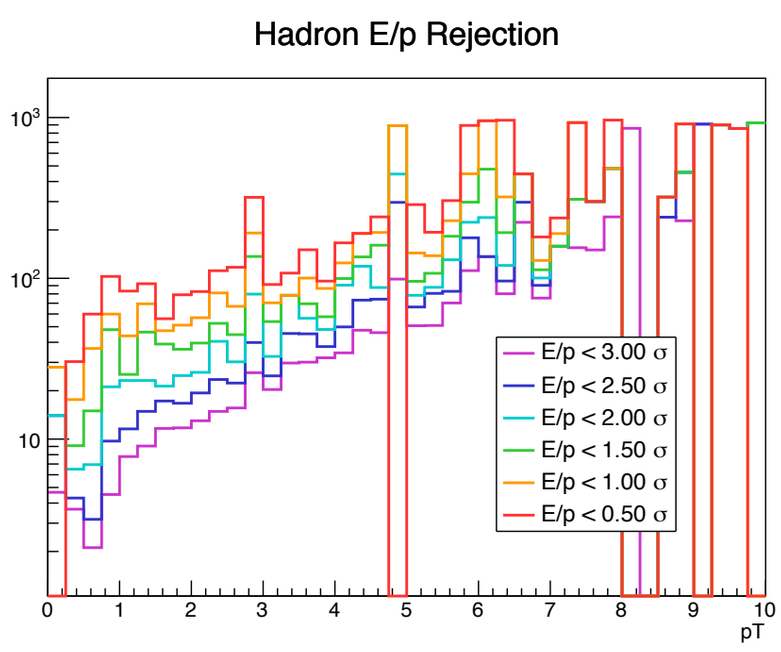


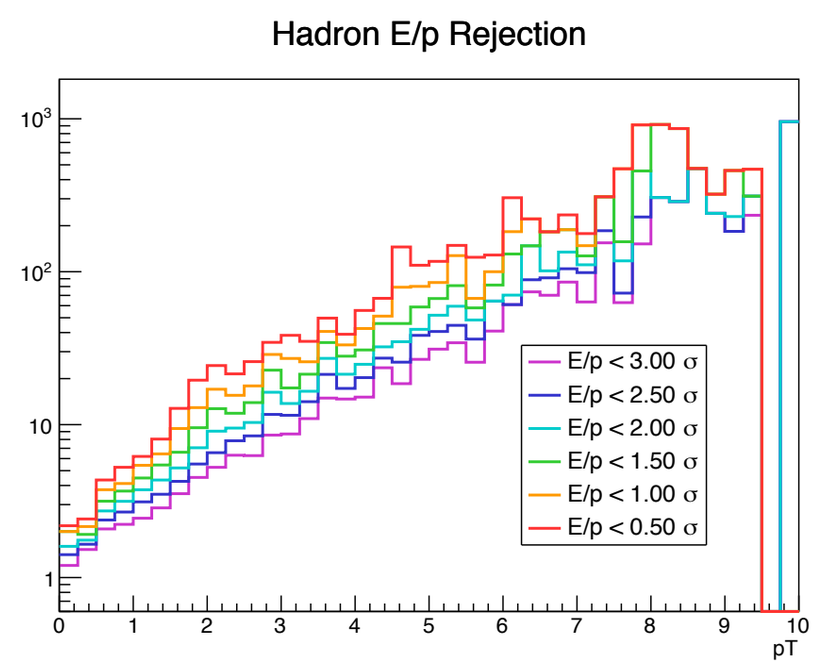
Tracking + EMCal

Examples for two tracking configurations. Early days yet, but we will use this to study effect of occupancy and fake track rates.









Conclusions

Caveat: Inner tracker studies done only with perfect outer tracker (MAPS)

- We have no clue how these options will work with the TPC
- We also can not say if we will need additional tracking between inner barrel and TPC

The inner tracker will have to be a minimum of 1 maps layer and 1 reused pixel layer

The CEMC options of reducing eta and ganging towers look to be acceptable, although undesirable, for the Upsilon measurement

Still working on the effect of fake tracks and other occupancy issues on the electron ID