

# $\pi^0$ topology reconstruction - update

Dorota Stefan and Robert Sulej  
35ton sim/reco meeting

# $\pi^0$ reconstruction chain in 35t

Hadronic interactions, cosmic muons:

- track reconstruction – subtraction of hadron/muon hits at 3d level. Would be nice to do it at the 2d level.
- vertices reconstruction .

2D showers:

- shower clustering : blurred clustering.
- merging of shower fragments.

**Mike's talk**

3D showers:

- conversion point + direction using DoG *Direction of Gamma* algorithm.
- For now, also shower axis based on PMA segment.

3D merging in case merging in 2D would not be sufficient:

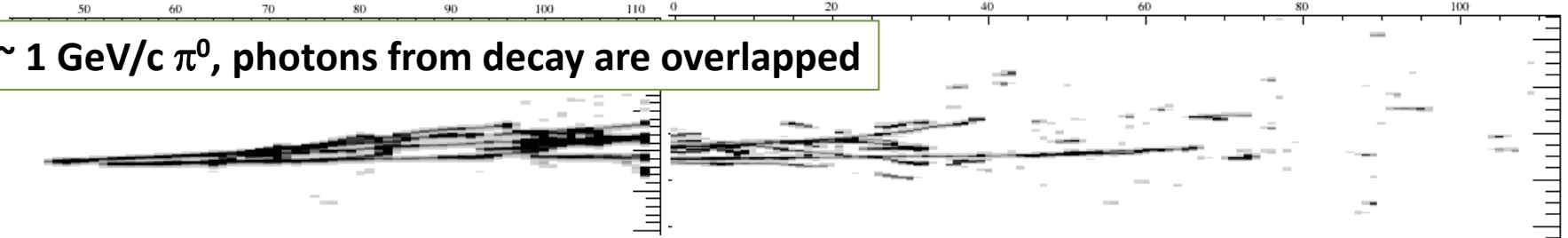
- find reference point
- group shower fragments

**Description of the neutral pion:**

- two cascades.
- two conversion points.
- angle between cascades.
- decay vertex.

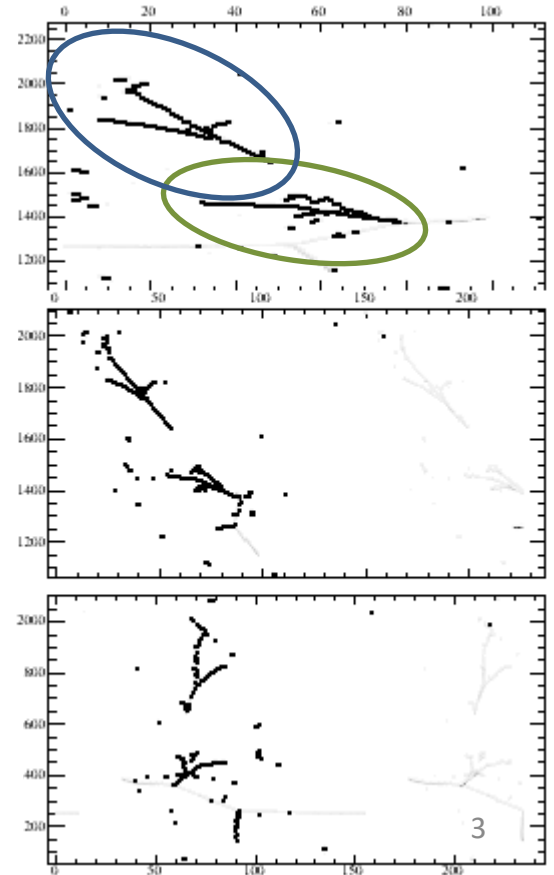
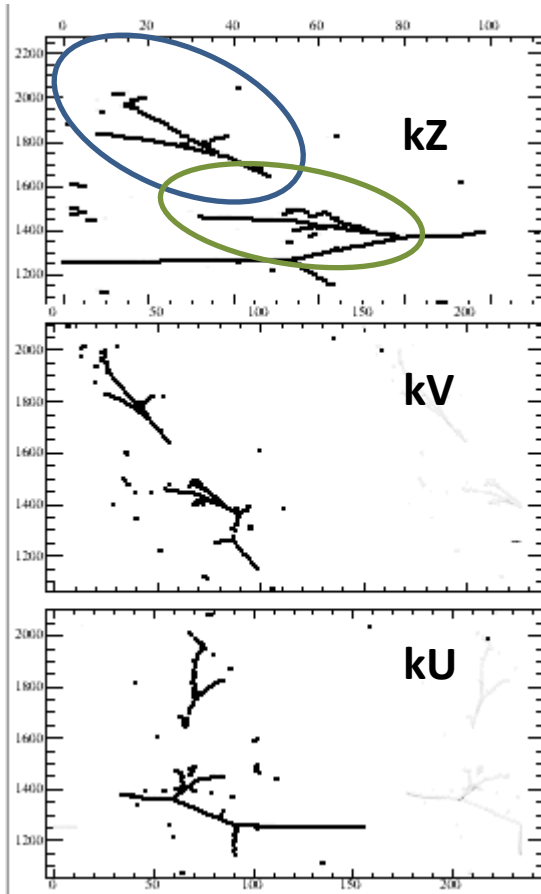
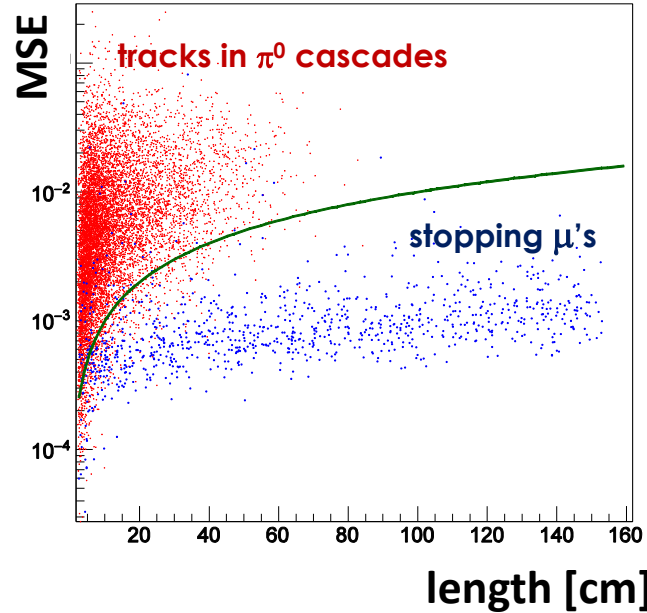
# Showers extraction from other tracks

$\sim 1 \text{ GeV}/c \pi^0$ , photons from decay are overlapped



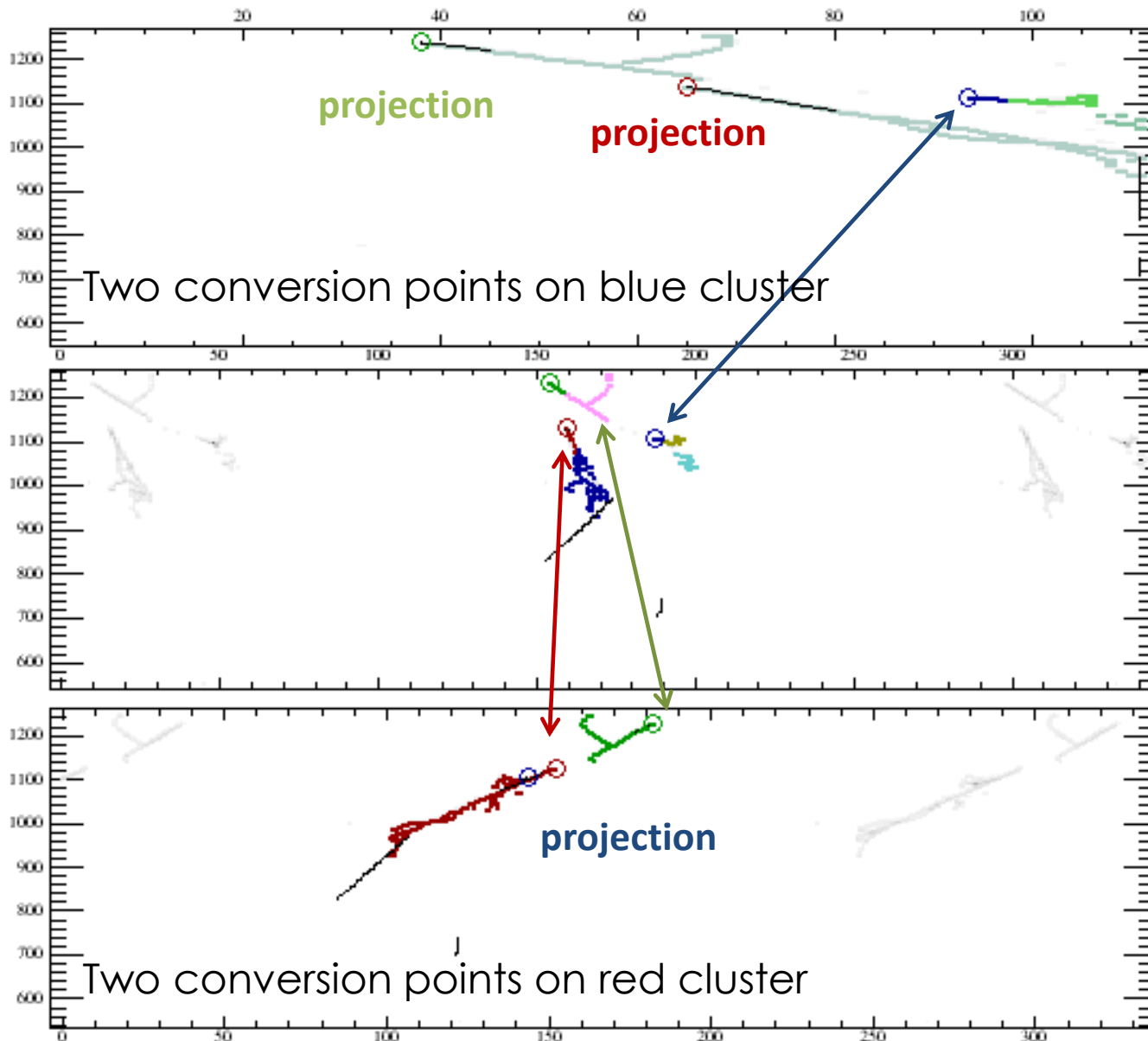
On the 2D level we should be able to extract dense showers .

EM-like vs track-like trajectories



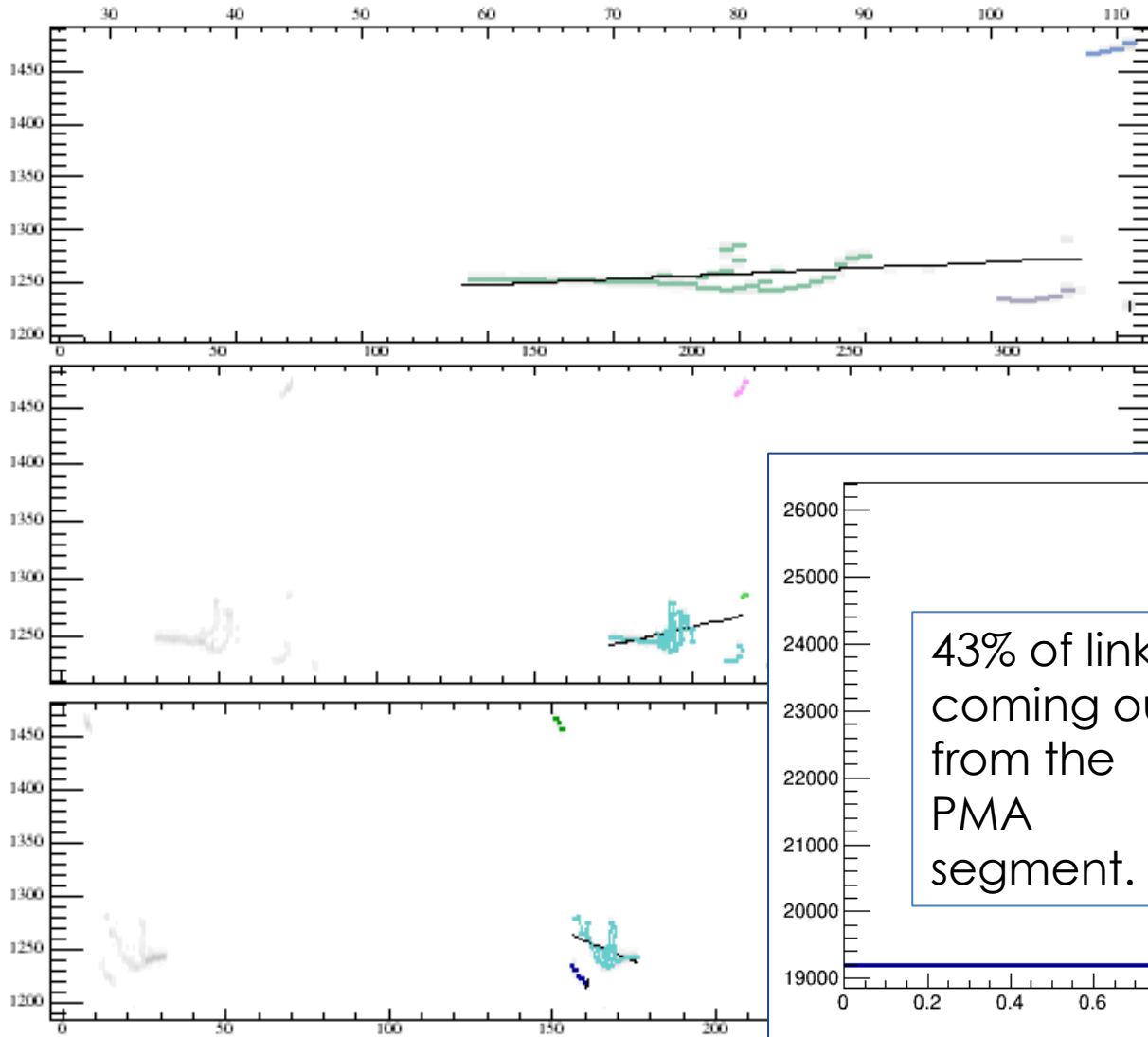
On the 3D level we can distinguish between electron and muon/hadron tracks

# 3D points of conversion from DoG

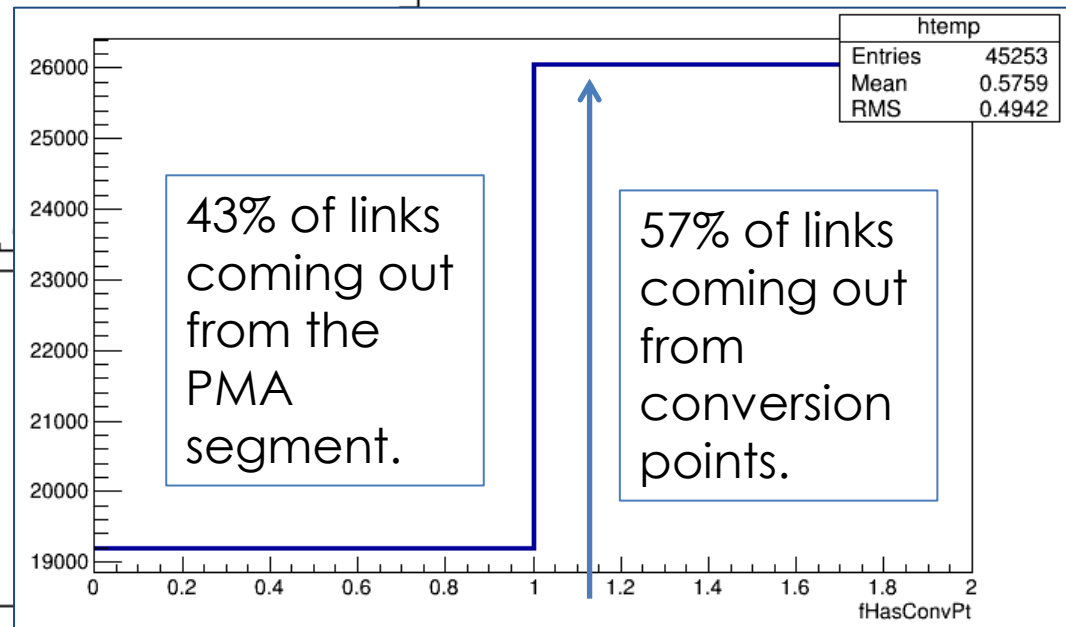


- we can choose the best combination of clusters.
- Clusters crossing tpc's developed by Mike would help to shower reconstruction.

# 3D PMA segment $\approx$ 3D PCA



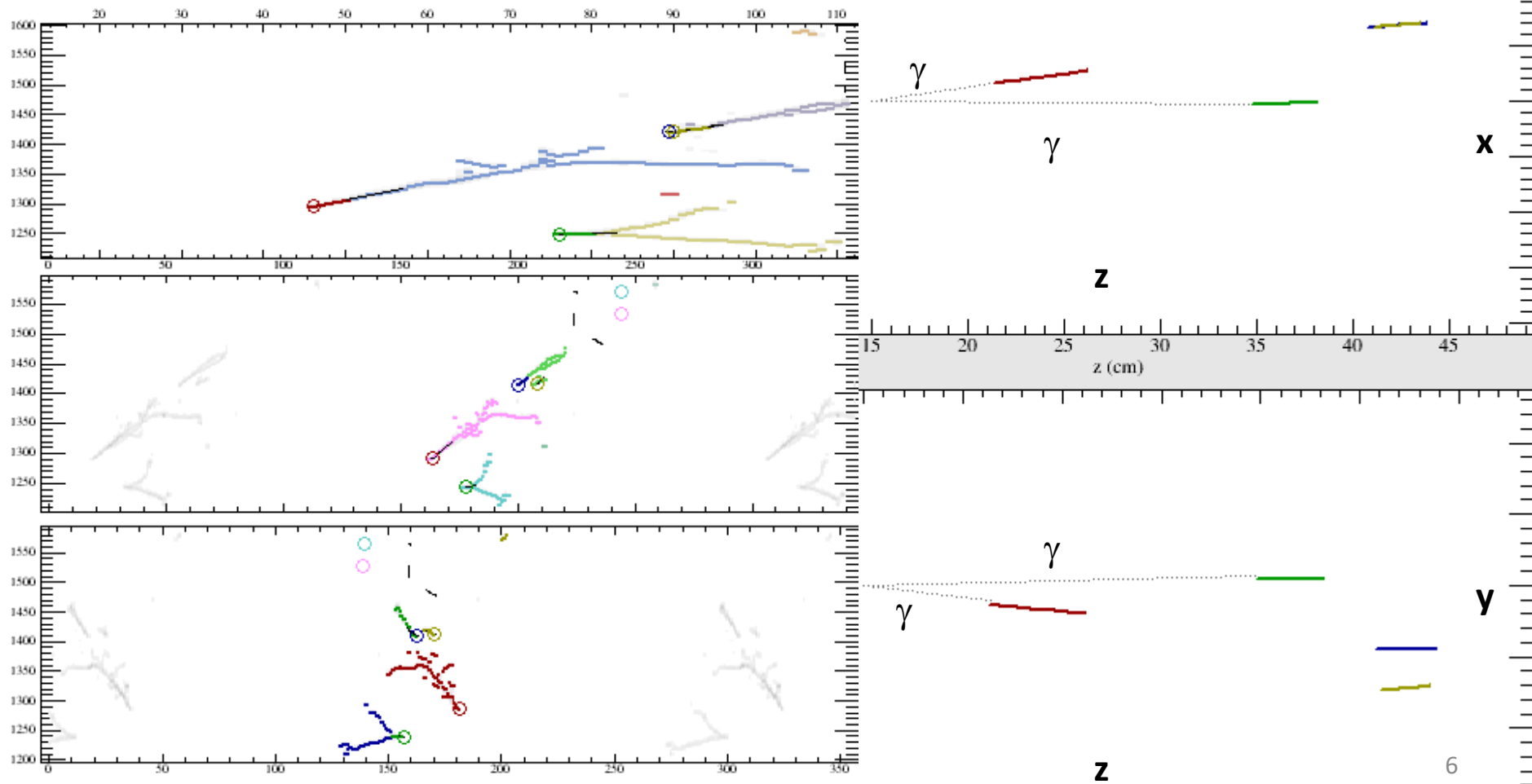
It turns out that direction is better estimate from DoG than PMA  $\rightarrow$  to do: make DoG more efficient.



# 3D merging

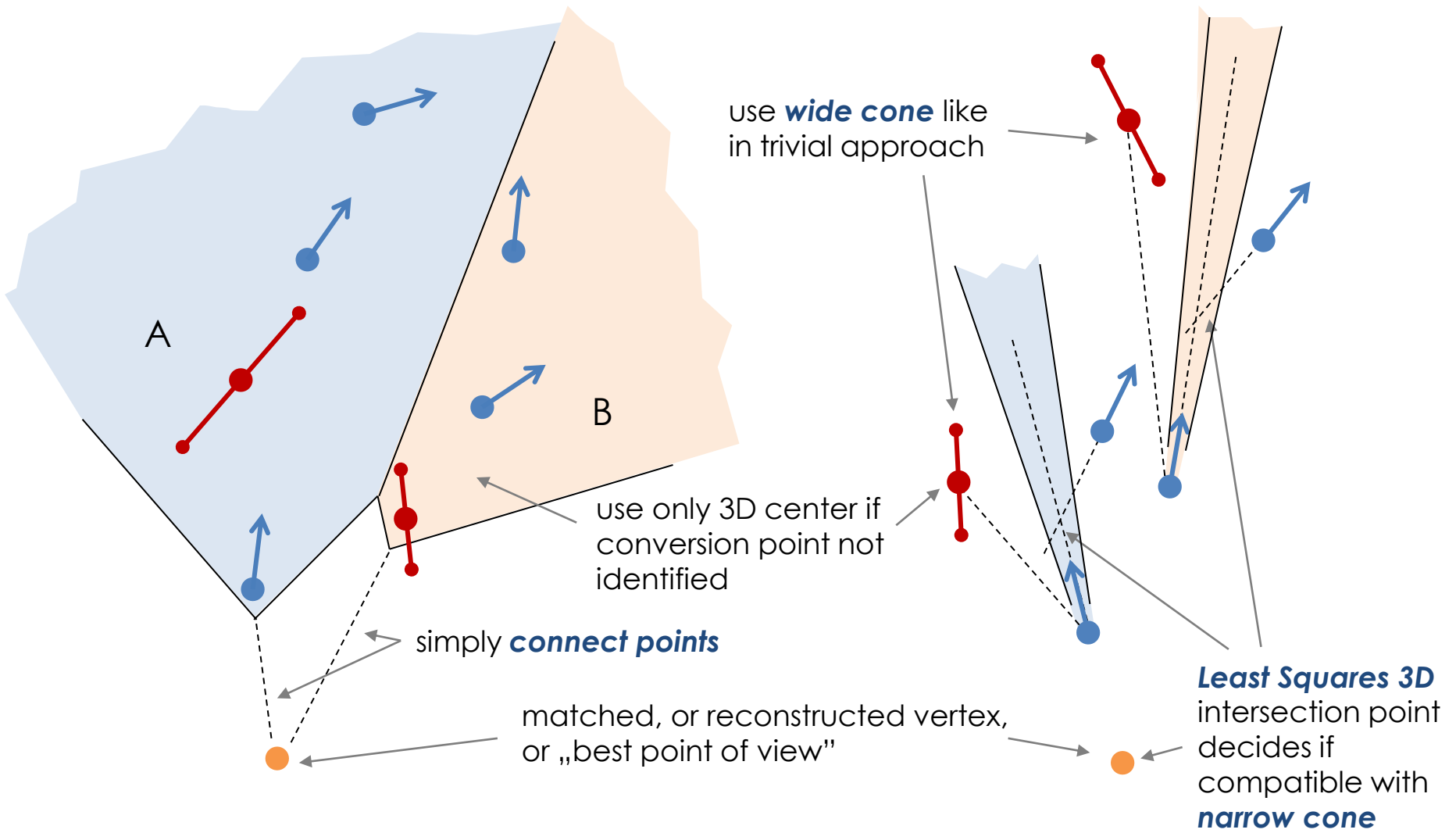
The key is to do the proper sorting and grouping of the shower fragments → find the best reference point.

- Use the reconstructed directions from DoG of individual showers.
- Use the reconstructed orientations from PMA segments.

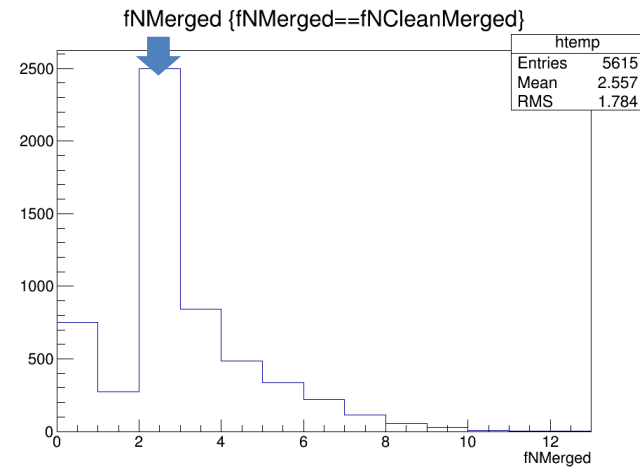
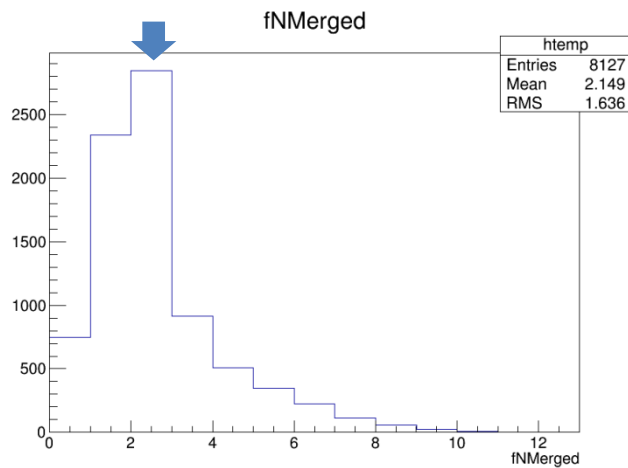


trivial, take-all approach  
cascade can start with PMA segment  
...effectively wide 3D cones

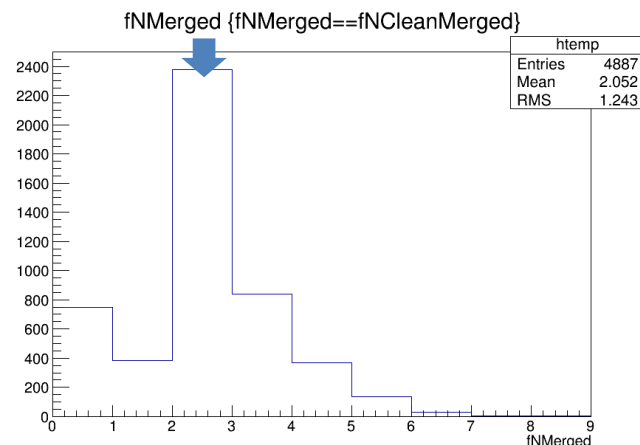
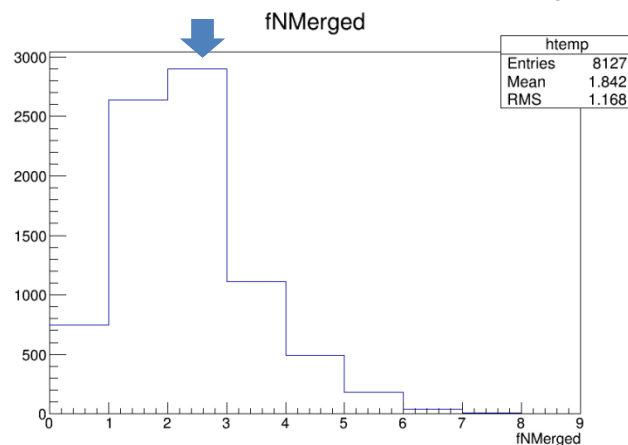
use-directions approach  
both cascades need initial conversion point  
profit from the high resolution of direction reco



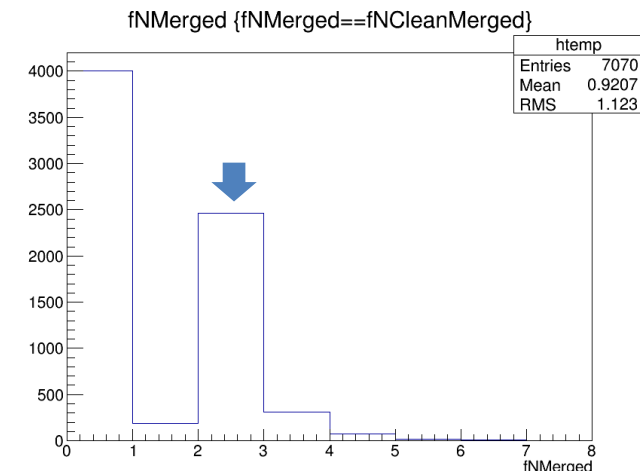
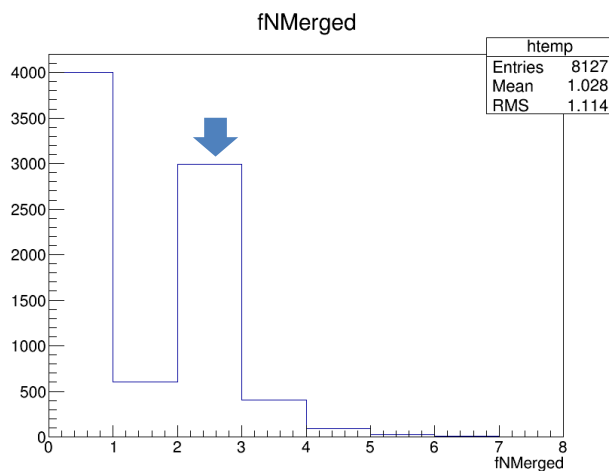
trivial cone  
+ MC vertex



trivial cone  
+ best p.o.v.



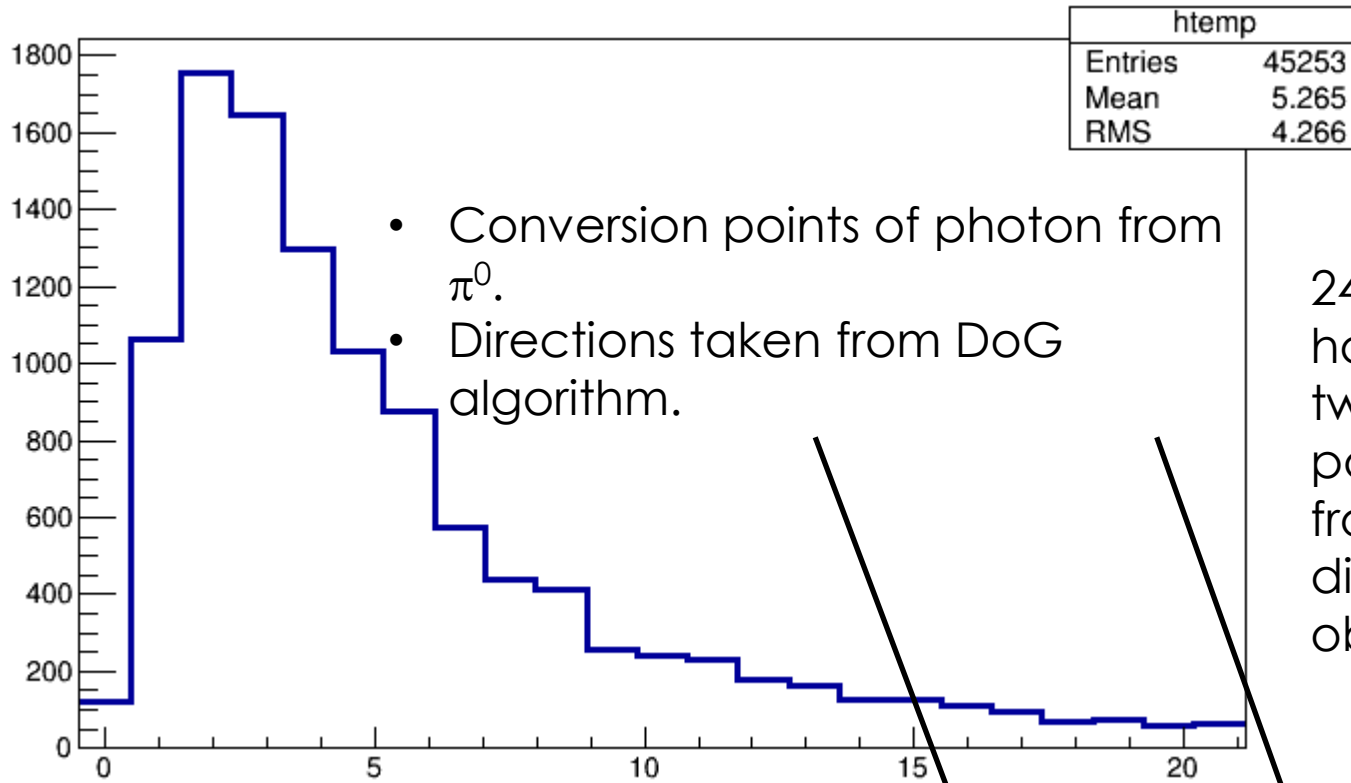
narrow cone  
+ cascade directions





# All elements together: reconstruction of $\pi^0$ topology

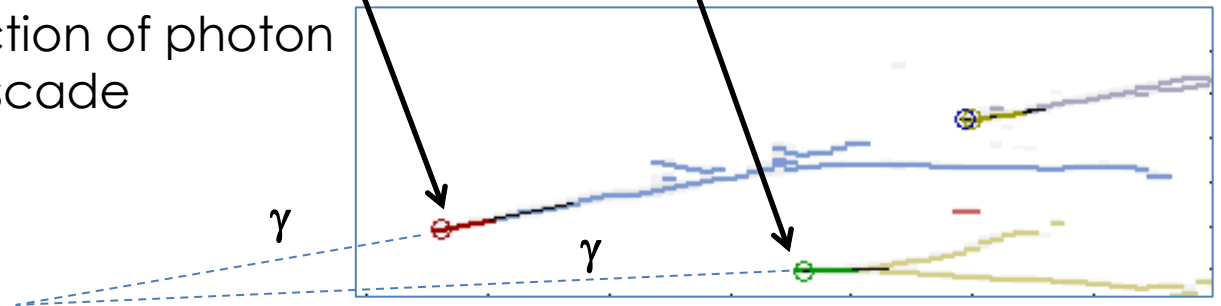
a)



- Conversion points of photon from  $\pi^0$ .
- Directions taken from DoG algorithm.

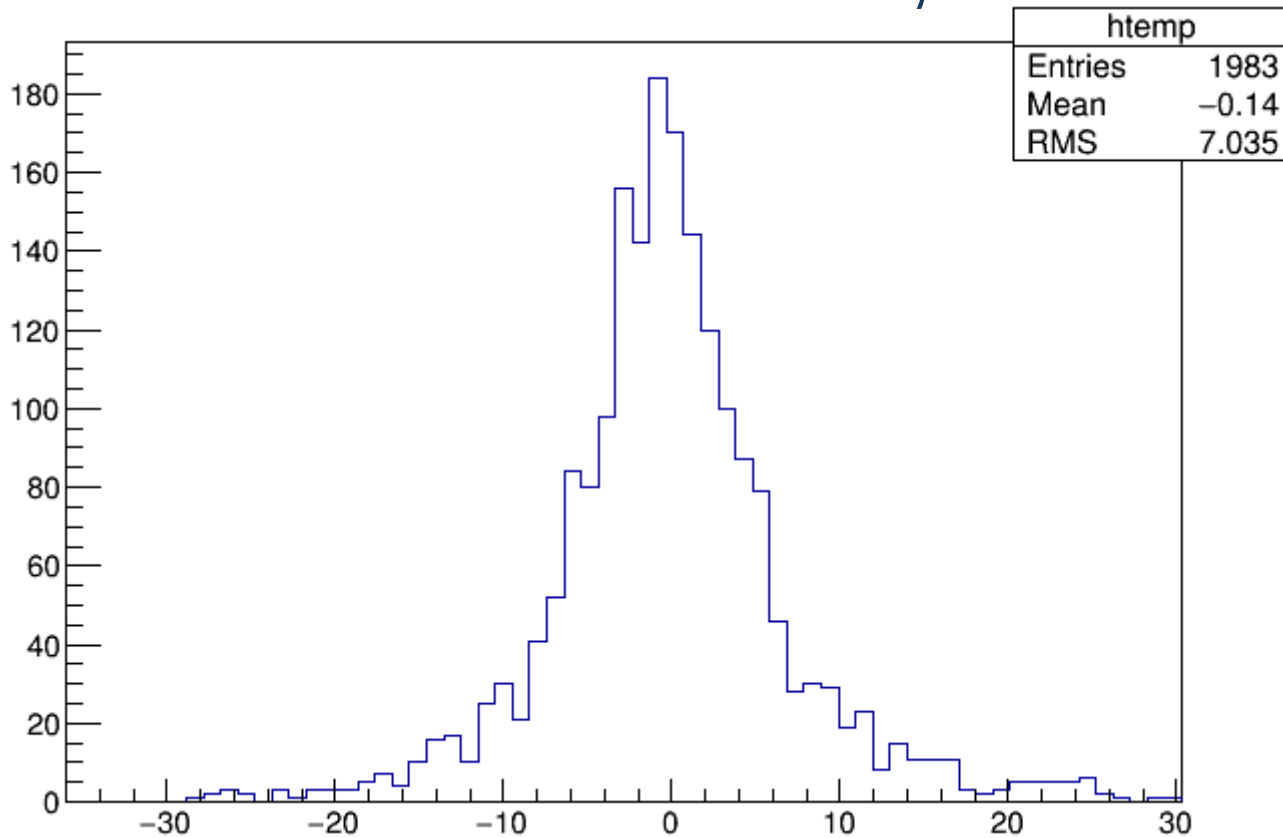
24% of all events have reconstructed two conversion points of photons from  $\pi^0$  and both directions were obtained from DoG.

Angle between MC direction of photon and reco direction of cascade

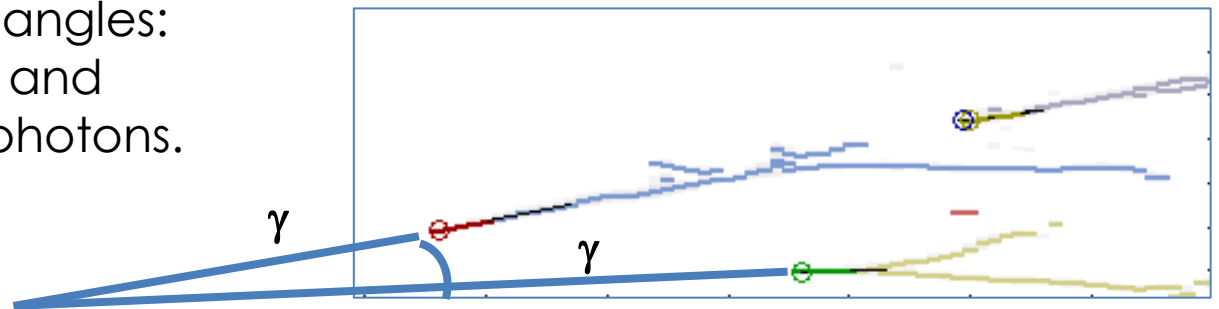


# All elements together: reconstruction of $\pi^0$ topology

b)

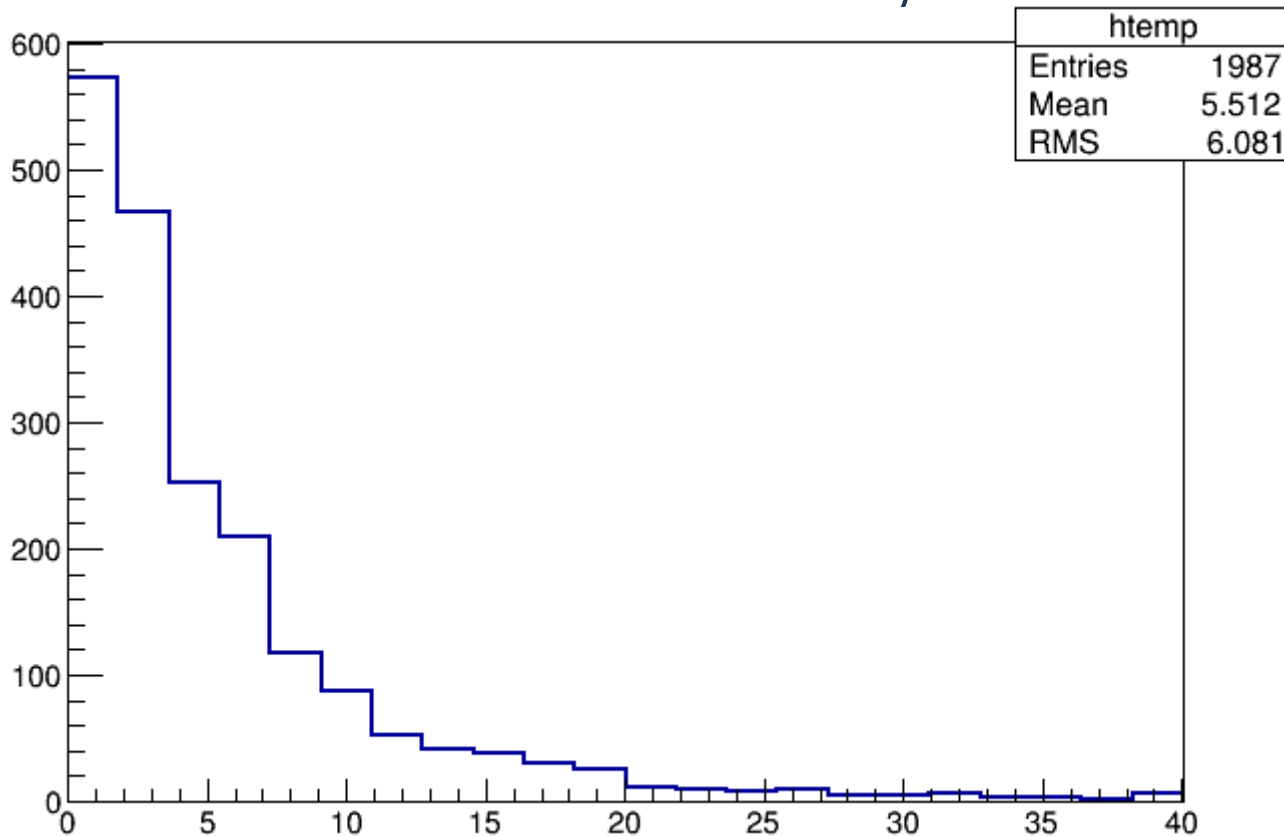


Difference between angles:  
reconstructed angle and  
mc angle between photons.

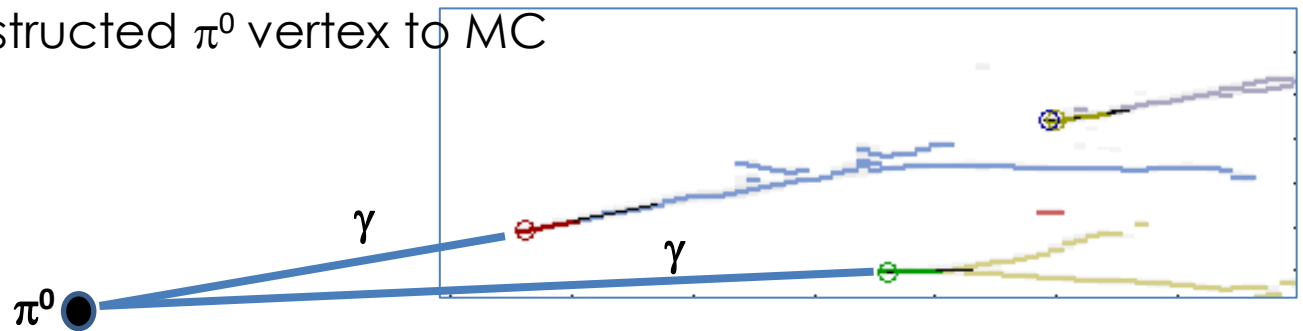


# All elements together: reconstruction of $\pi^0$ topology

c)



Distance of reconstructed  $\pi^0$  vertex to MC



# Summary

- There are many stages of the reconstruction to arrive to  $\pi^0$  topology identification and reconstruction.
- Each of the pieces of reconstruction can be improved.
- Probably we are at the stage when we can collect all modules, algorithms with Tingjun and Mike and try to run them on more complicated events, like charged 1 GeV/c pions that produce other tracks and also neutral pions  $\rightarrow$  see how many  $\pi^0$  we will be able to find.