DEEP UNDERGROUND
NEUTRINO EXPERIMENT

The University Of Sheffield.

pi0 Shower Reconstruction

Mike Wallbank

Thanks (as always!) to Tingjun, Dom and Robert & Dorota

12/8/2015

pi0 Reconstruction Status

- Worked on the 2D clustering technique Blurred Clustering for a while until ~a month ago.

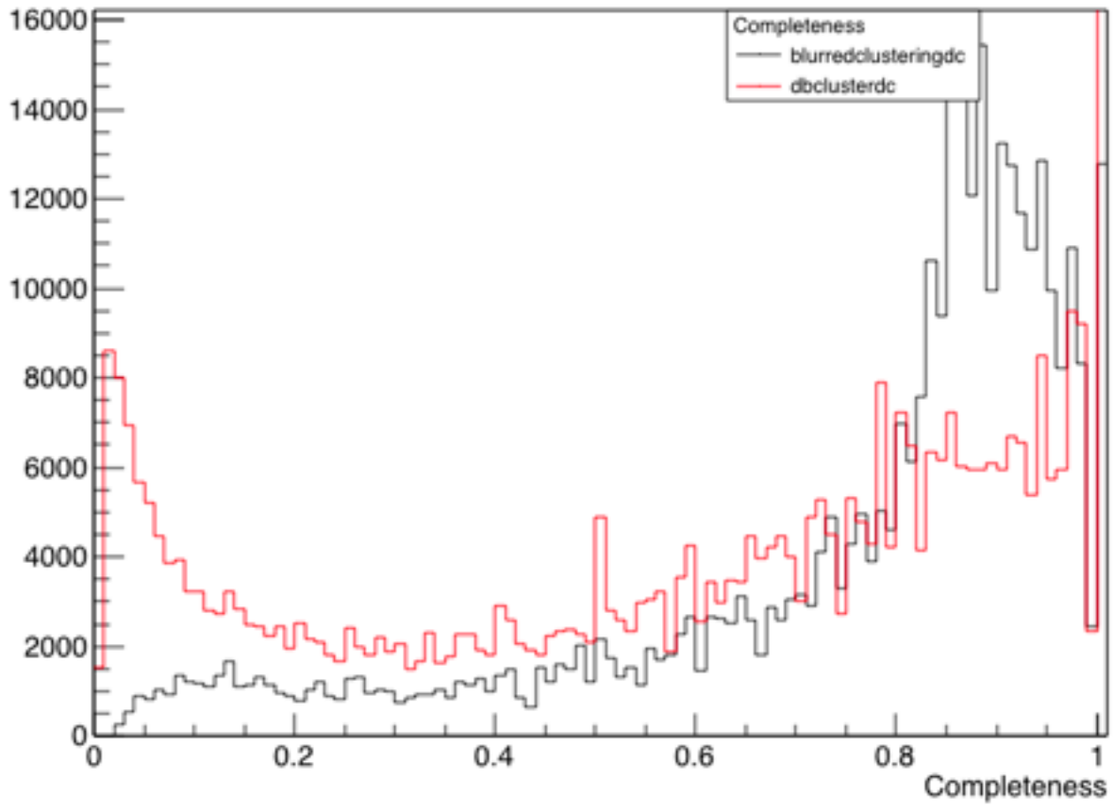
- Showed the final clustering performances in the meeting on 15th July.

- Since then, have been using the 3D tracks which Robert and Dorota find using the clustering to construct EM showers.

- Brief update…

Blurred Clustering

- Reminder of the clustering performance:



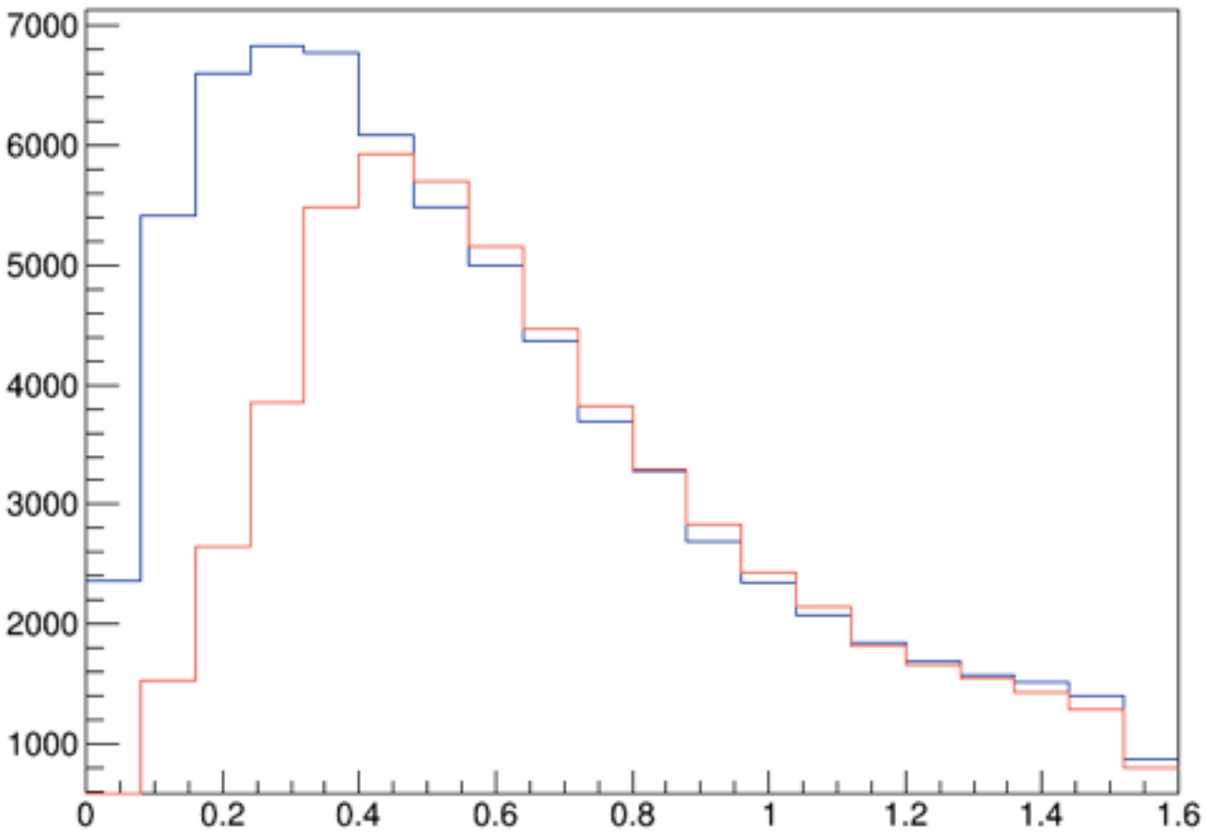
- Have written a document describing the clustering process, including the method, its implementation within LArSoft and how to configure the reconstruction.
  - See DUNE DocDB 54.

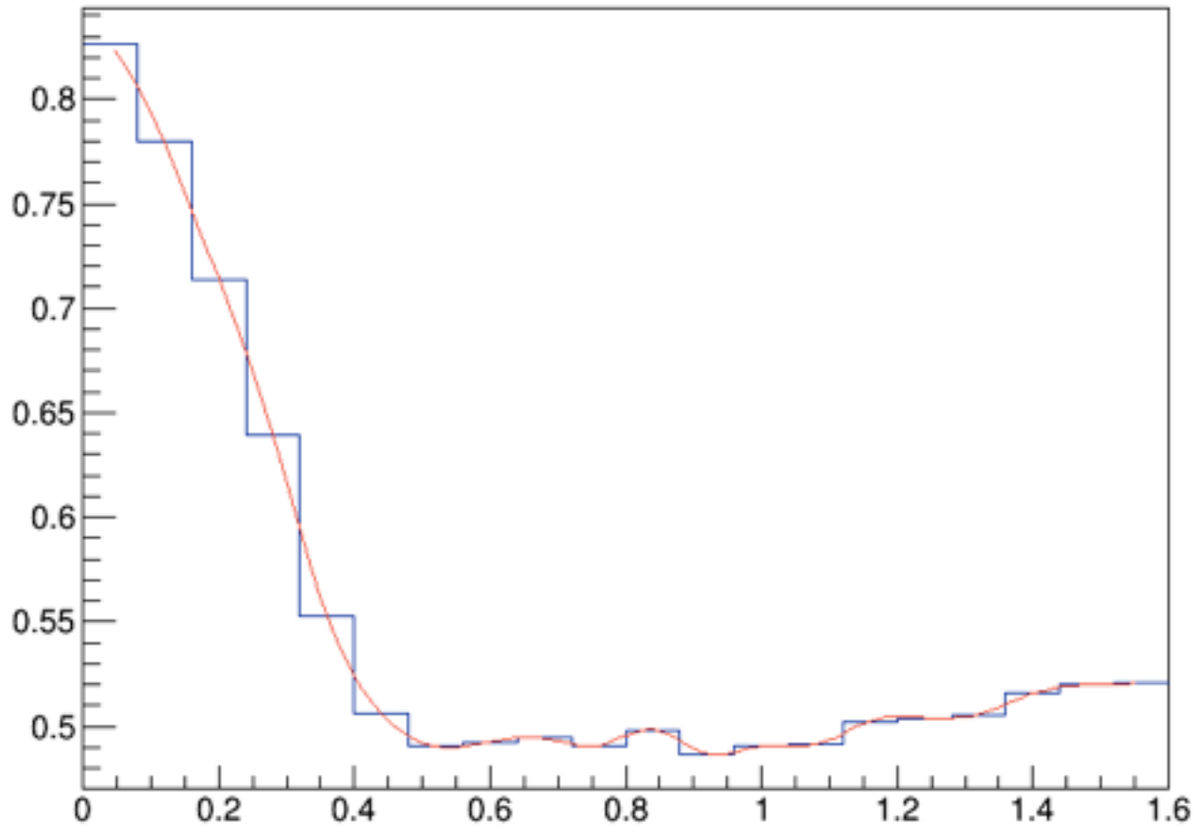
3D Reconstruction

- Robert & Dorota use these clusters and match between the views to form 3D track objects.
- These contain a direction and an estimation of the direction of the shower.
- In order to make 3D showers, these short tracks (>1 per photon) must be merged together and all associated hits be used to find the properties.
- Have been looking at a few different quantities to distinguish these tracks…
  - In all following, blue represents tracks associated with the same true particle and red represents different true photons.
  - PDFs are correctly merged/(correct + incorrect merge)

Angle

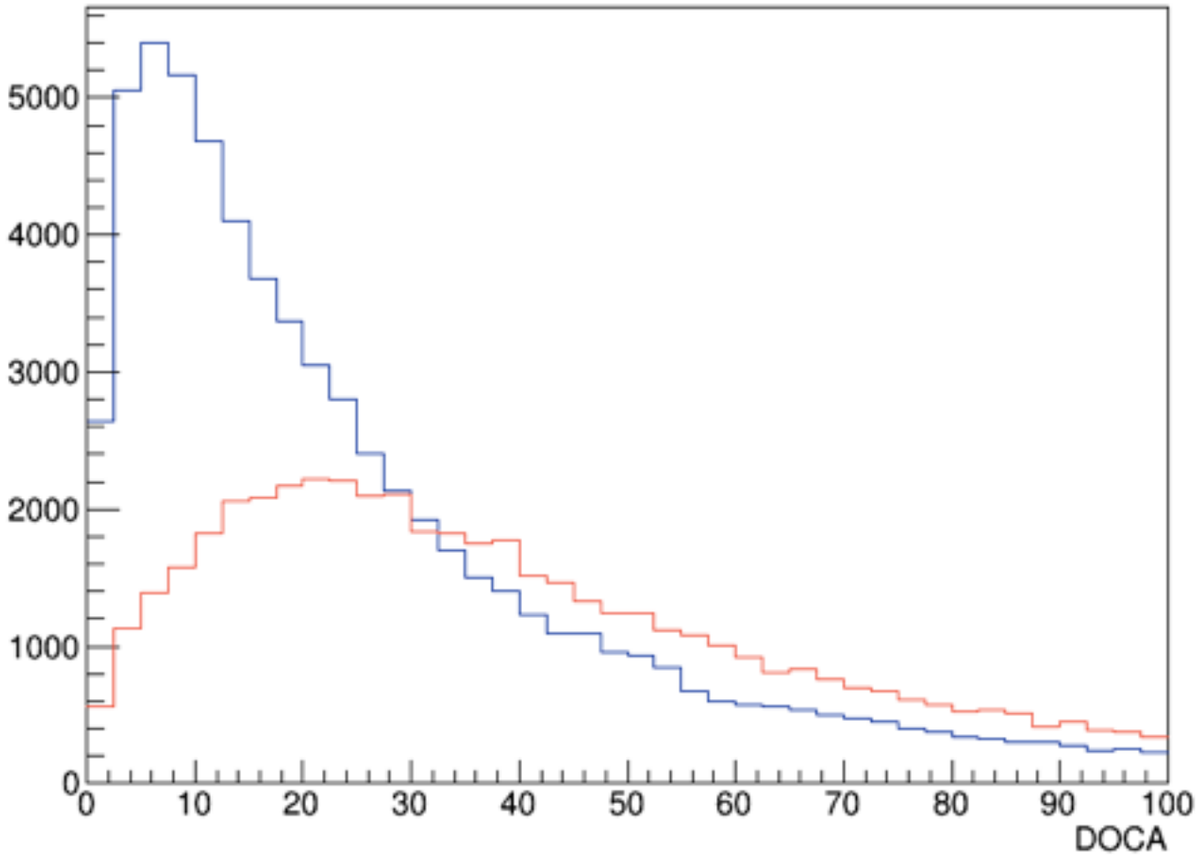
- The angle between two tracks (3D [i.e. not projected on 2D]):
- PDF on the right showing probability of being correct!

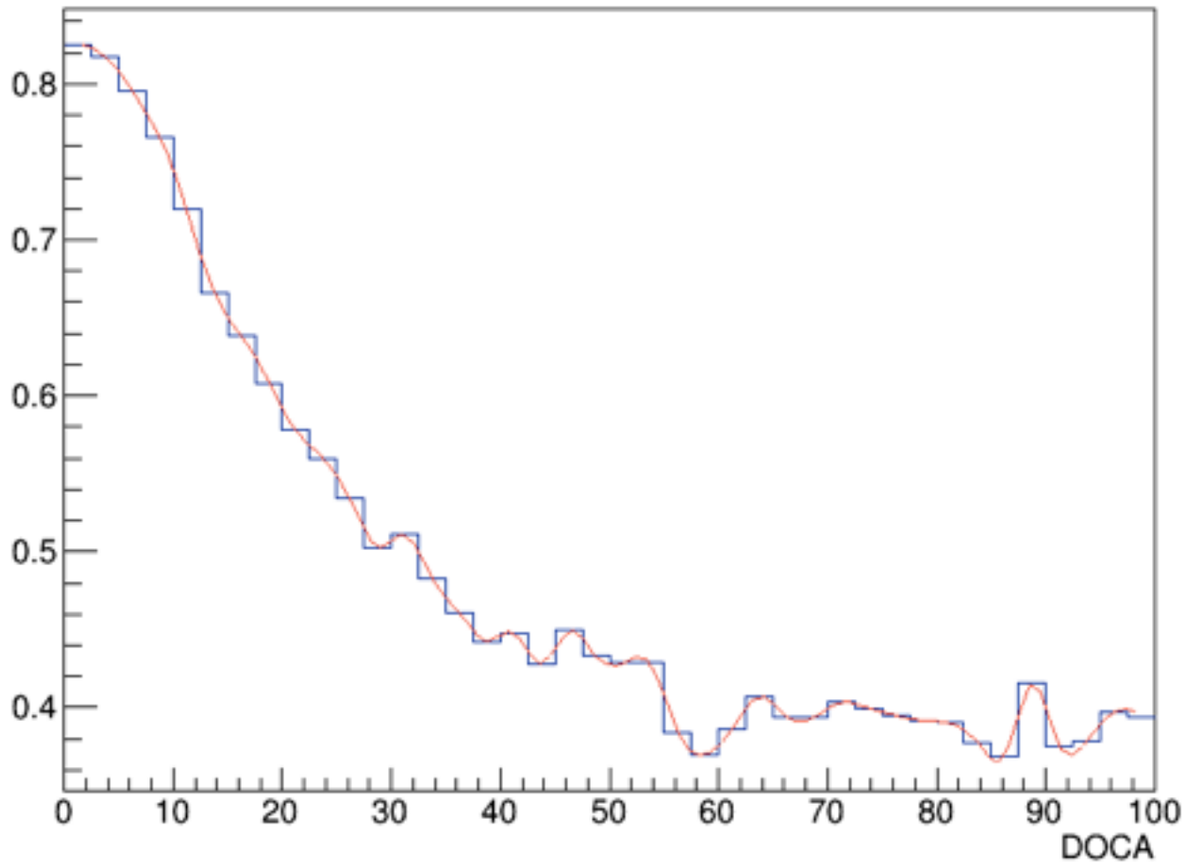




DOCA

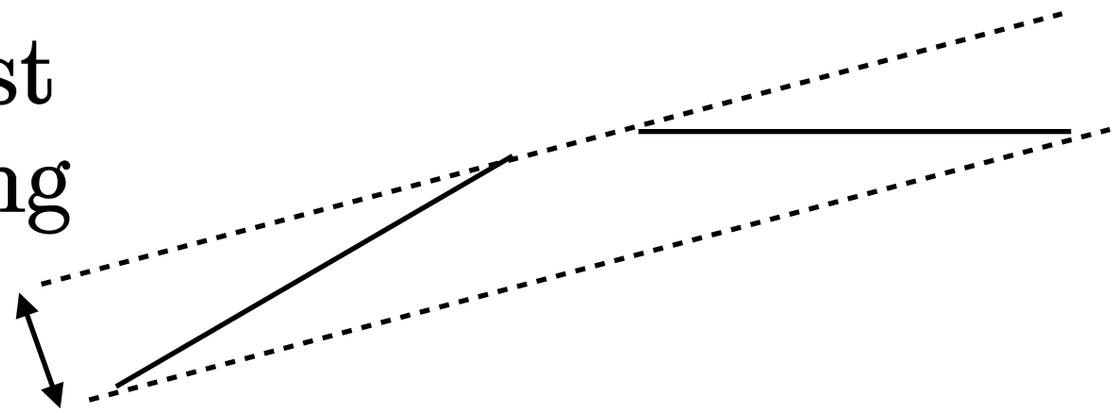
- Distance of Closest Approach is the distance that minimises the length of a line drawn between the two 3D tracks.
- Again, distributions on left of PDF on right…

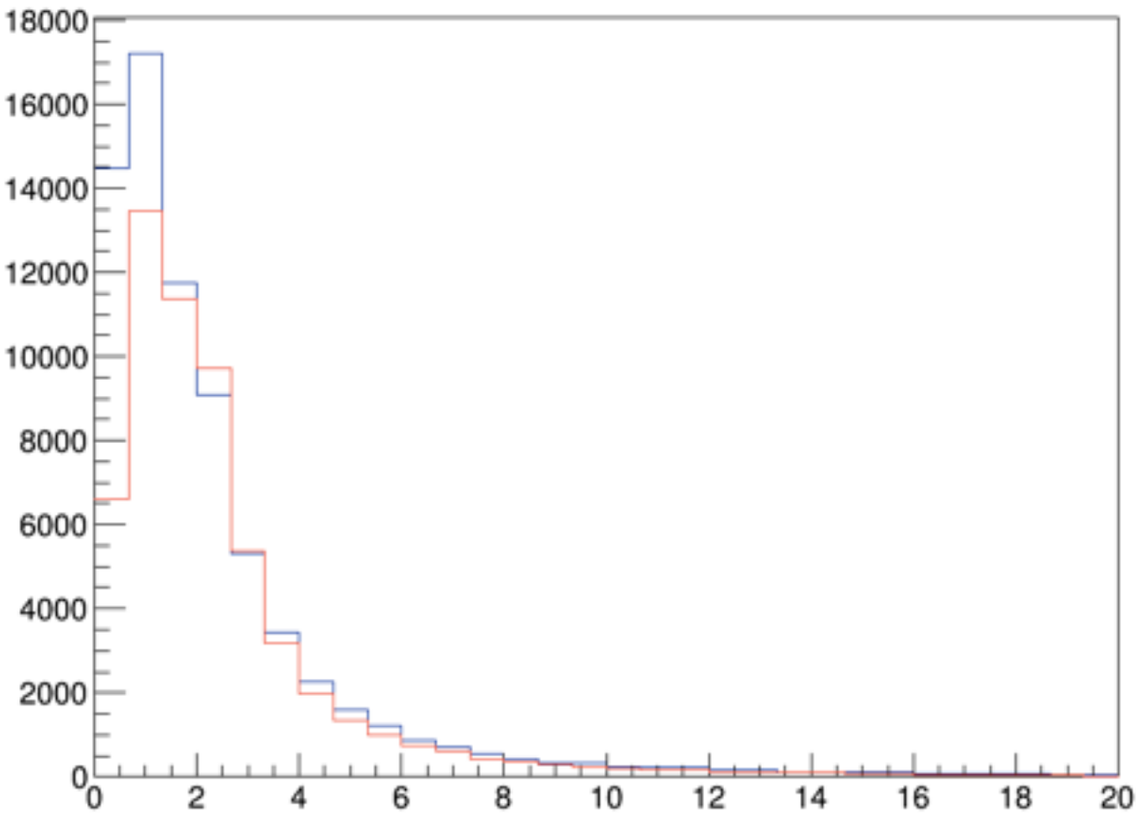


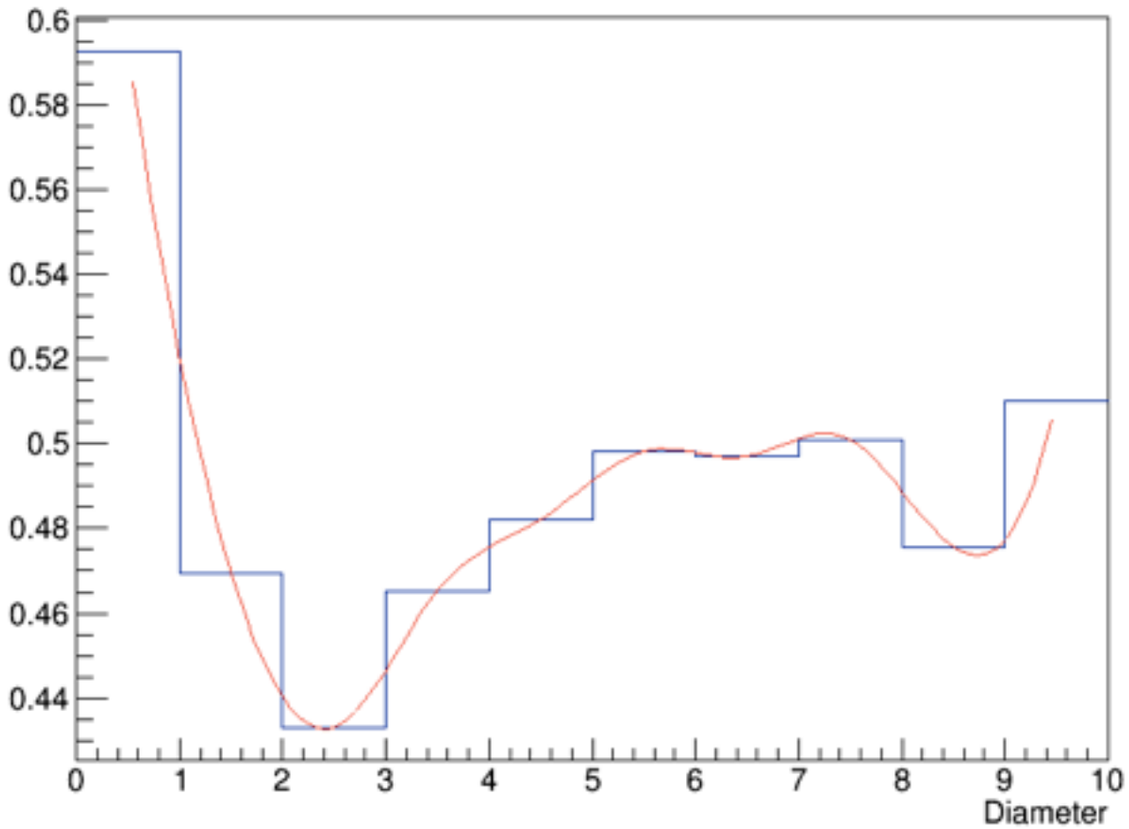


Tube Diameter

- The diameter of a tube which just encompasses the two tracks being considered.





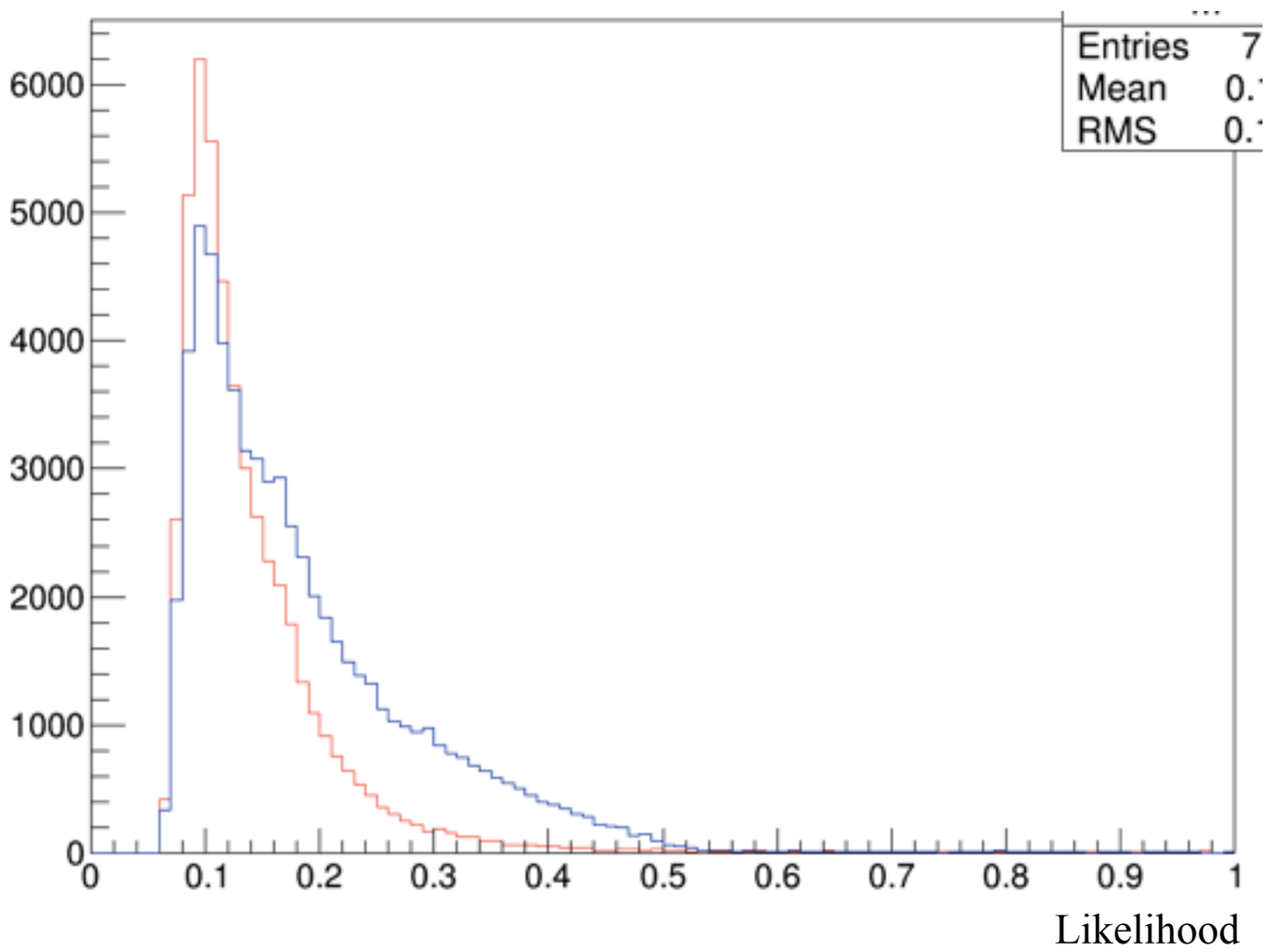


Diameter

Likelihood

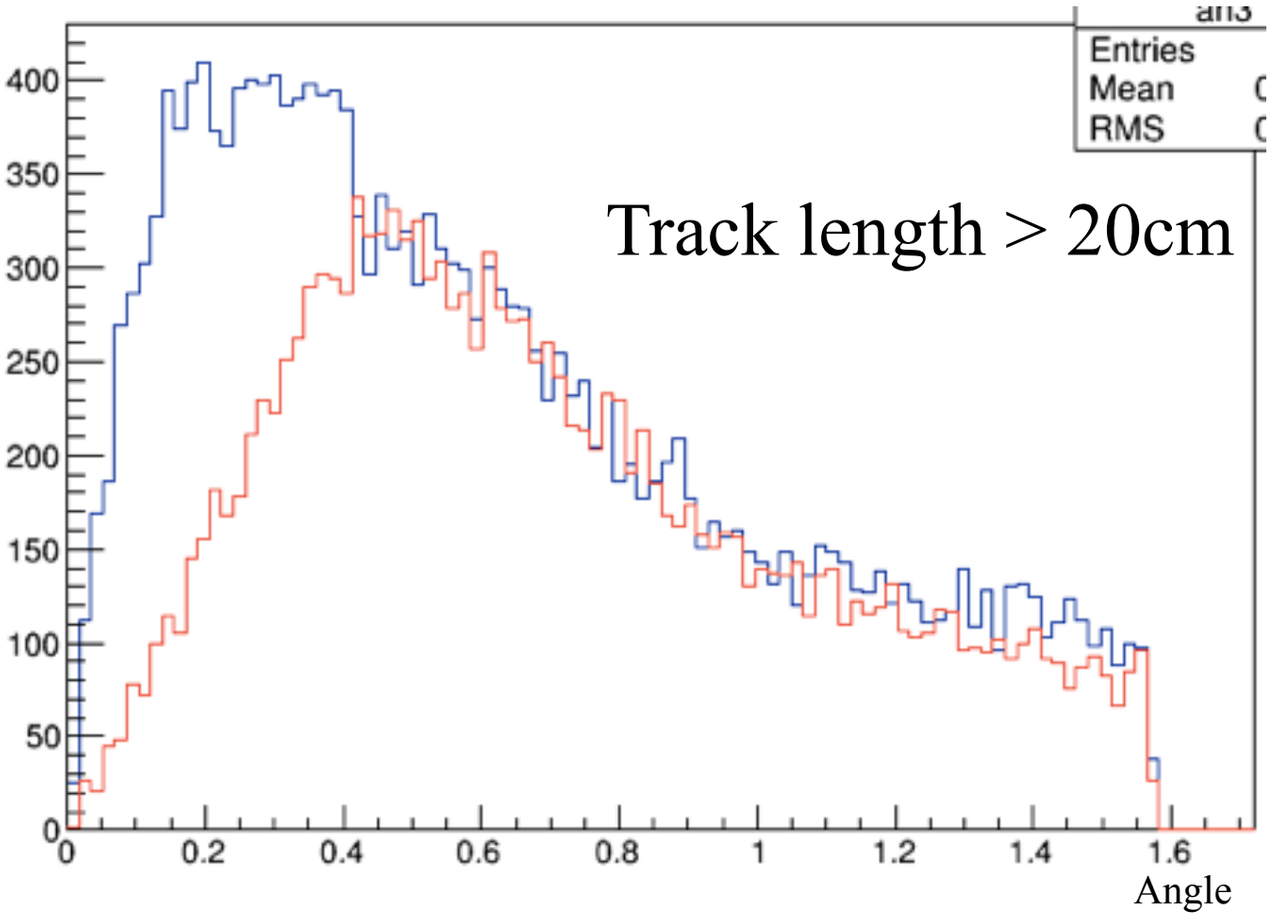
- Take probability values for each of the distributions from the pdfs, and form a likelihood.

$$\mathcal{L} = p_{angle} \times p_{DOCA} \times p_{tube}$$



Aside... Longer Tracks

- It occurred to me yesterday that this approach may be ok for long tracks, but since most tracks were short it was failing...



Total length of the two tracks peaks at ~5units and tails off sharply.
The distribution on the left is only for tracks with total length >20

- Doesn't appear to matter...!

Notes on the ~MVA

- Very very little separation seen between correctly/ incorrectly merged tracks using these variable distributions.
- Looked at all possible likelihood permutations.
- This is despite reasonably good individual separation
  - Highly correlated variables
  - The variables show a small difference but largely have the same distribution and the same tail.
- This approach seems very difficult to take much further…

Next Idea: Merge in 2D

- The convention in LArSoft is to perform the clustering in each TPC and plane separately (==> 24 views in 35t!) and then merge between TPCs in 3D.

- During the development of the Blurred Clustering method, I wrote an algorithm which used a PCA to merge fragmented showers together and worked incredibly well, so it may make sense to cluster across the TPCs in 2D.

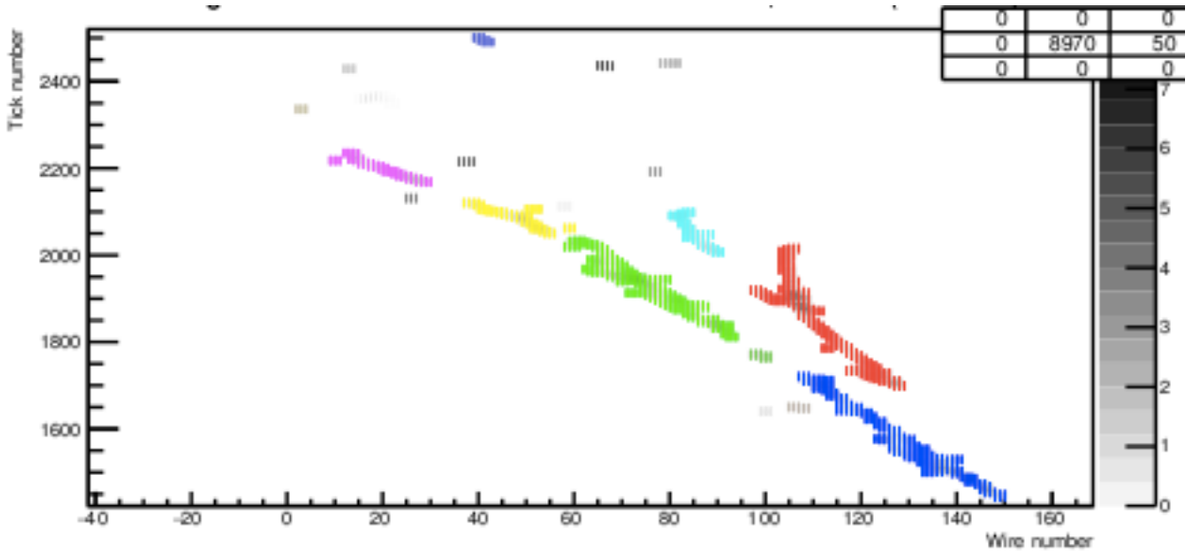
- So only 3 views per event (each plane), which can then be matched to make 3D tracks and will (hopefully) be much easier to make showers!

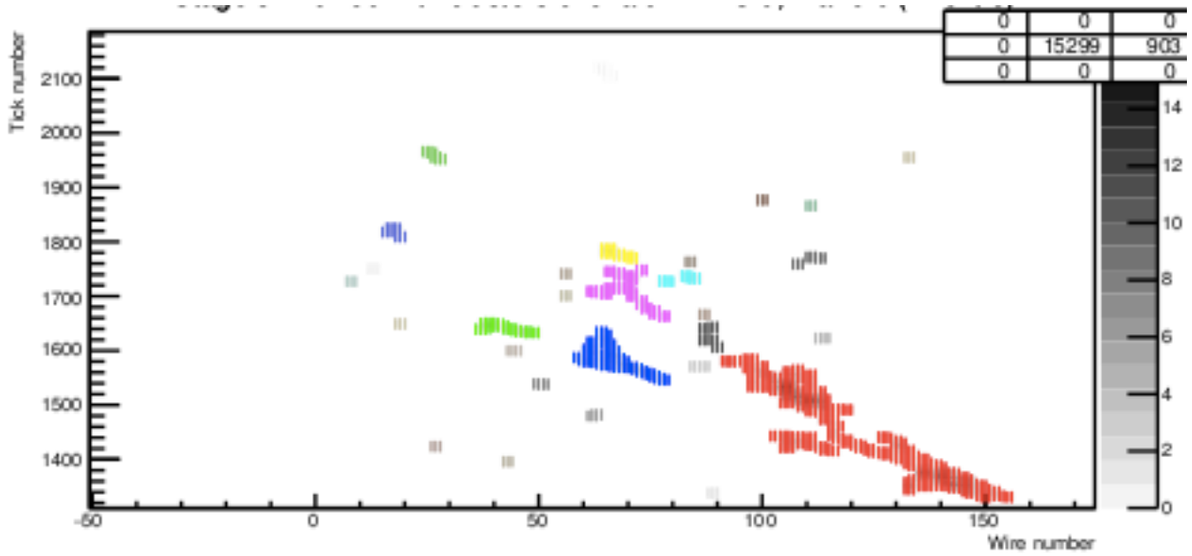
Global Wire Coord

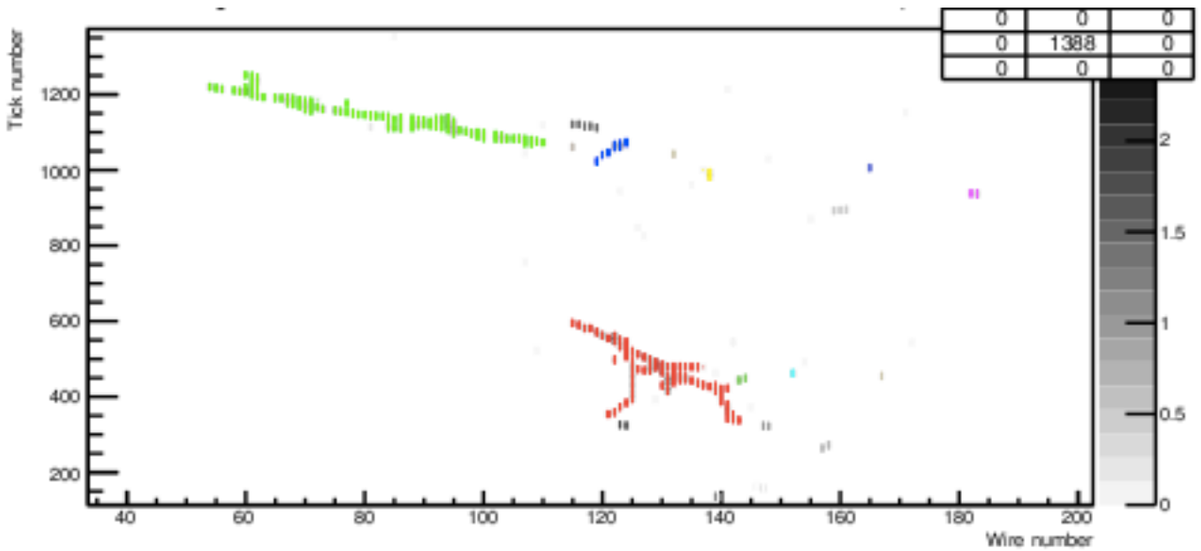
- This idea means needing to define global coordinates across a TPC.
  - Will be one TPC eventually but right now splitting into 2 (long/short drift volume) and only considering large one.

- Need a wire number which is global across the merged TPC; use LArSoft geometry method Geometry::WireCoordinate()
  - Takes a coordinate and a reference TPC/plane to calculate the displacement, converting to a wire number by considering the wire pitch.

Reconstruction Across the Merged TPC







Reconstruction Across the Merged TPC

- Works OK straight out the box.
- Will need to be retuned (again…) though!
- Looks like it shows some promise so will pursue this
  - Retune, make tracks again, look at making showers!

Summary

- Shower reconstruction proving tricky!
- Aiming to get this finished before the collaboration meeting so it can be shown — so ~3 weeks.

- Going to carry on looking at performing the clustering in 2D across all the TPCs, and then matching these ready-merged clusters.
- Hopefully update on this next week!