



# $\pi^0$ Reconstruction Overview and Status

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# Aims

- Understand and reproduce existing work done by Milo Vermeulen.
- Look for extensions or improvements on the existing Analysis and implement them.
- Develop an algorithm to reconstruct the  $\pi^0$  from the TPC data.
- Measure performance of the algorithm, make optimisations etc.

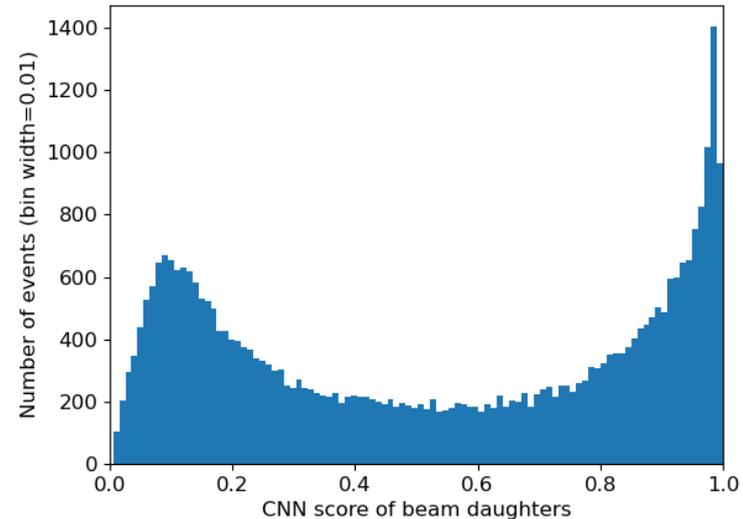
# Status

- Trying to reproduce Milo's plots produced by using Jake Calcutt's PSDPAnalyser module
  - Identified variables not available by the PDSPAnalyser
    - Pandora shower tag for the daughter particles
    - Hit space points
  - Started work on a LarSoft analyser dedicated for  $\pi^0$  studies
- So far production 4 MC has been analysed
  - production 4 data when it is released

# Plots currently produced

- Production 4 run MC with beam momentum of 1GeV
- MC sample used is datadriven SCE, with the nominal beam event generator and full reconstruction
- ~30000 events studied
- Looking at beam daughter showers that pass a CNN score of  $> 0.6$
- No event level selections made

$$CNN = \frac{EM}{(EM + track)}$$



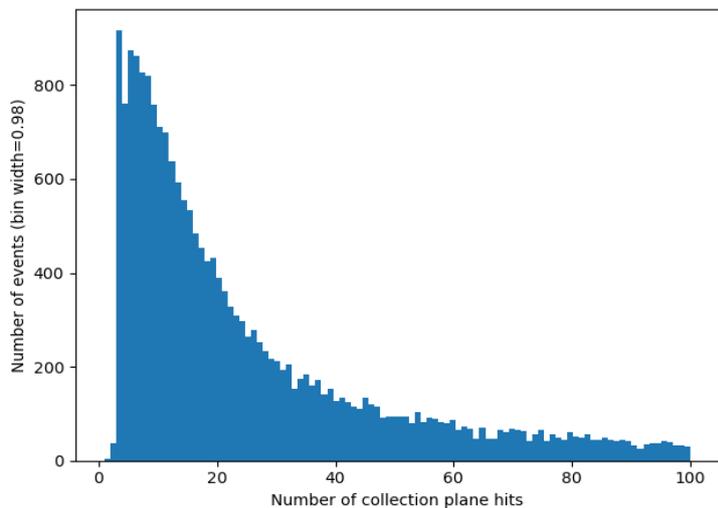
# Milo's data samples

- Used most of Production 2 runs for beam momenta between 1 and 7 GeV
- Around 340K MC and 200K beam events
- The cuts he made in the data are to select pandora shower like daughters and a CNN score  $>0.6$

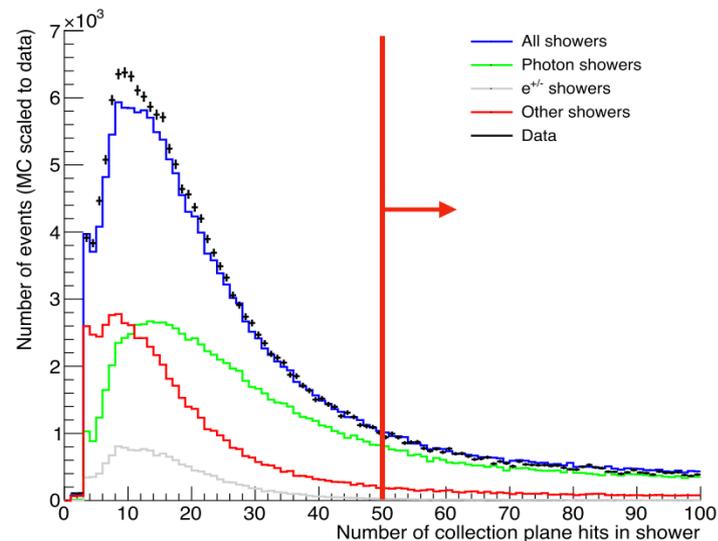
Pandora classification	Shower
CNN score	$> 0.6$

# Plots currently produced

CNN score > 0.6

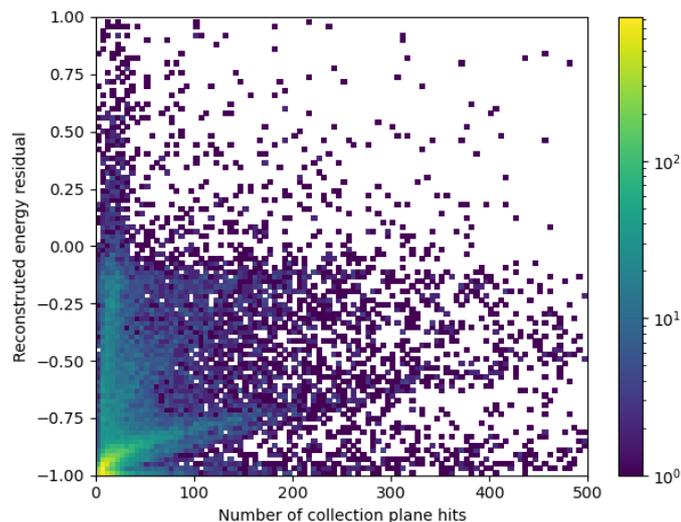


Pandora classification	Shower
CNN score	> 0.6



# Plots currently produced

CNN score > 0.6

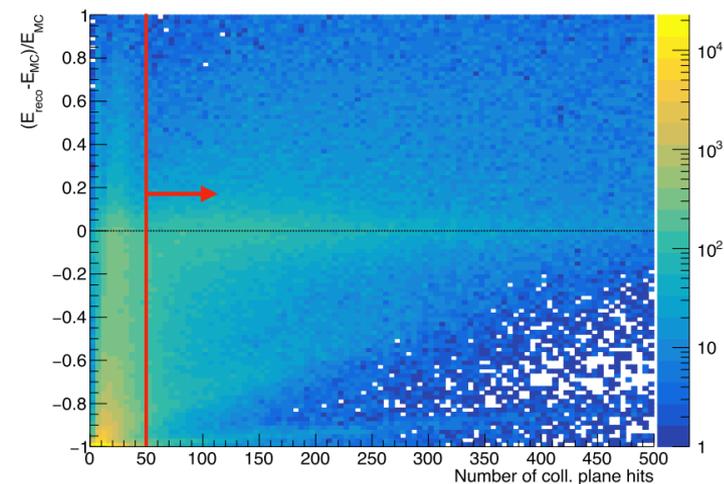


Pandora classification

Shower

CNN score

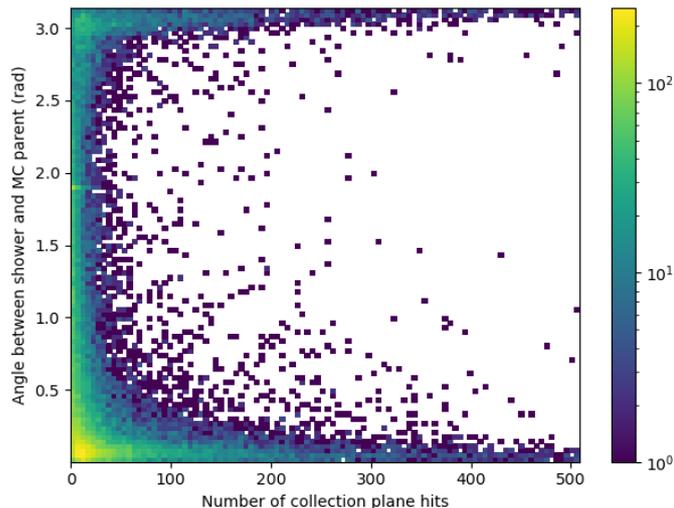
> 0.6



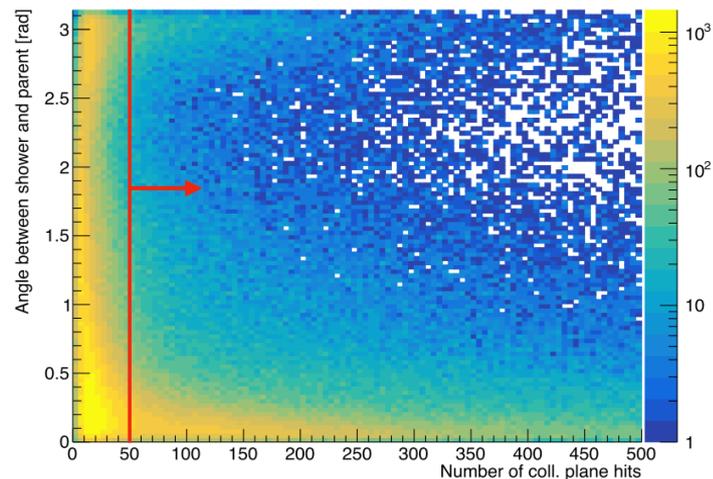
$$energy\ residual = \frac{E_{reco} - E_{MC}}{E_{MC}}$$

# Plots currently produced

CNN score > 0.6



Pandora classification Shower  
CNN score > 0.6



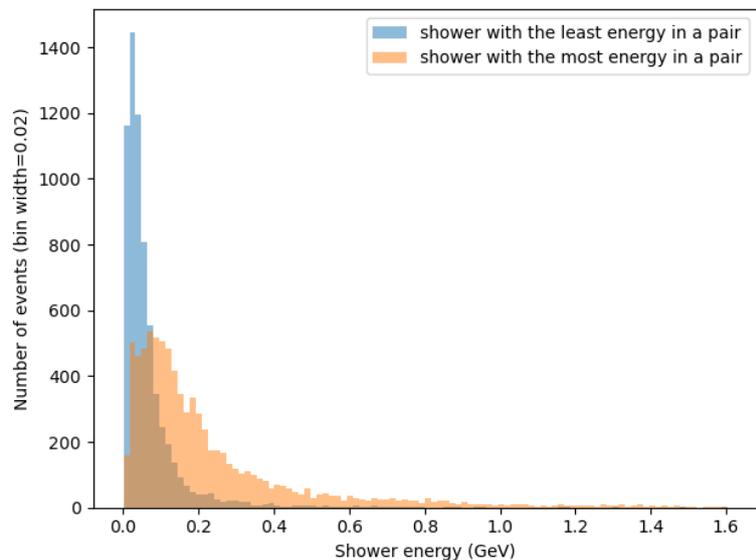
MC parent is the MC particle associated to the reconstructed shower.

# Plots currently produced

CNN score

> 0.6

(Now looking at shower pair variables)

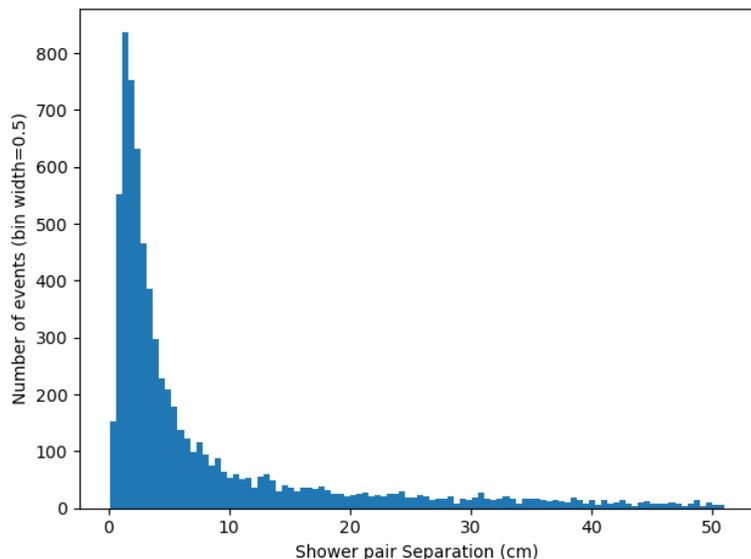


# Plots currently produced

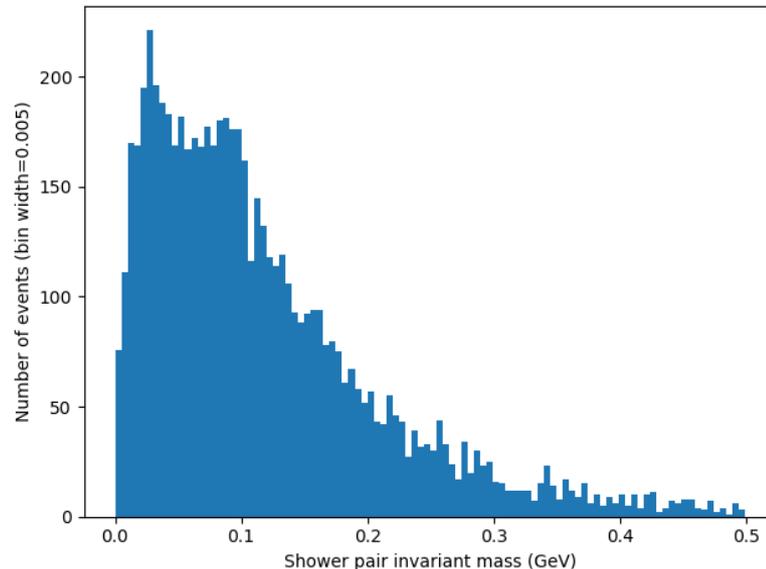
CNN score

> 0.6

(Now looking at shower pair variables)



Separation is the distance between the start points of each shower in the pair.



# Next steps

- Reproduce Milo's "shower start hits" variable
  - In dedicated  $\pi^0$  analyser
- Reproduce previous results with production 4 data/MC
- Optimise selection
  - Consider other variables?
  - Define a few purity/efficiency working points to optimise?
- Suggestions are welcomed!