MILO VERMEULEN 6-2-2020

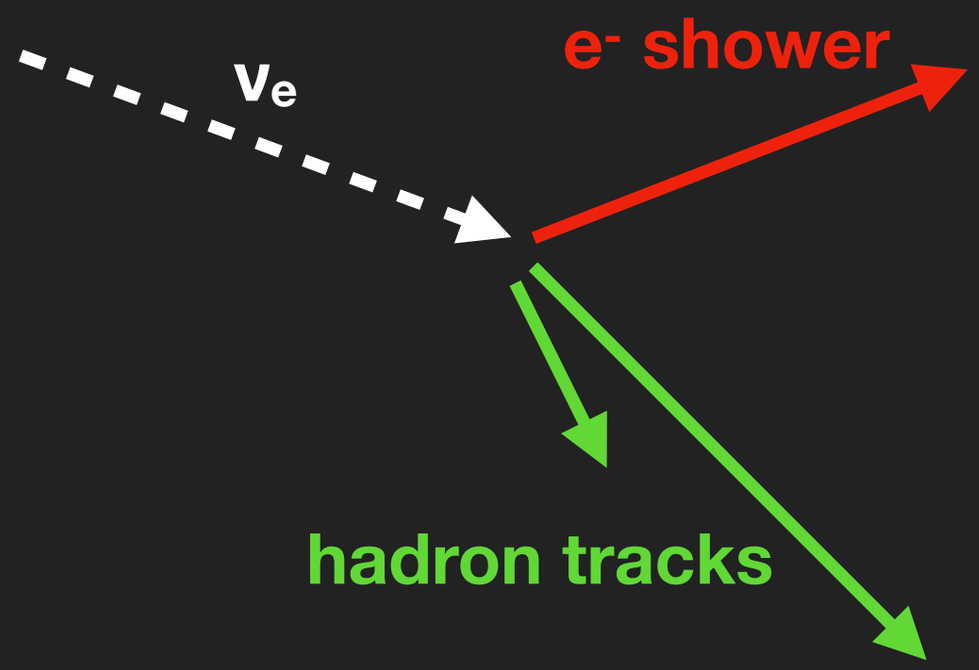
π^0 INVARIANT MASS IN PROTODUNE DATA

BACKGROUND

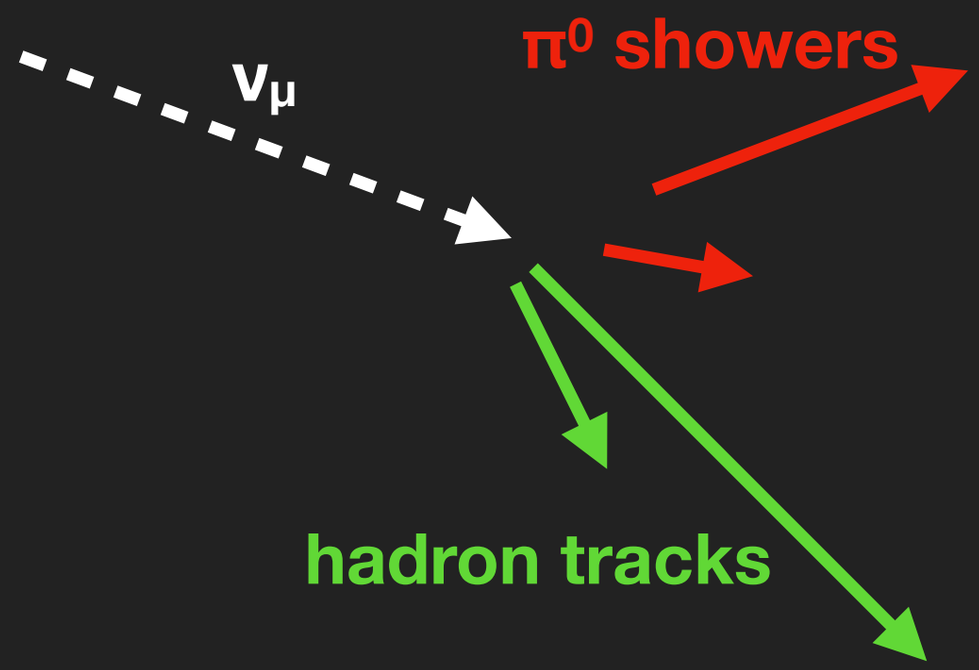
- π^0 are produced in hadronic interactions
- Decay almost immediately: $\pi^0 \rightarrow \gamma\gamma$
- Potential to mimic electron shower
  - Background to $\nu_e + n \rightarrow e^- + p$

BACKGROUND

Oscillation signal: CC ν_e appearance

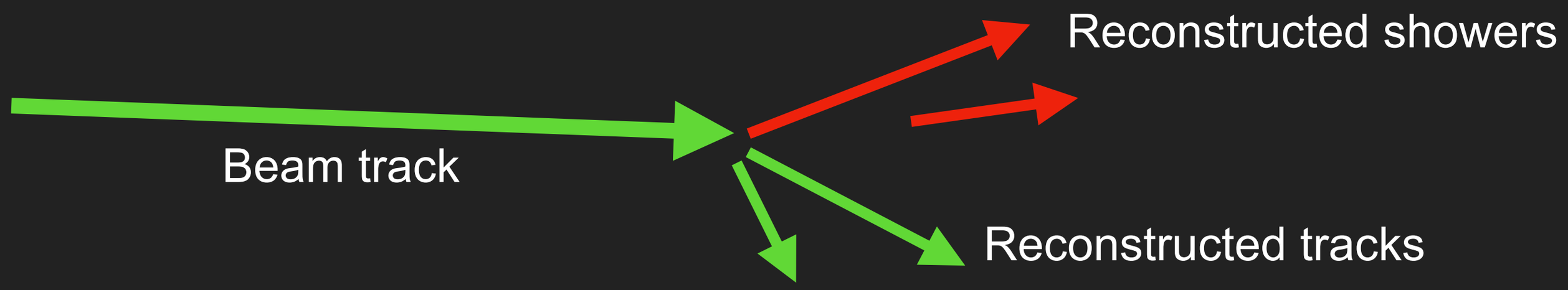


Background: NC ν_μ



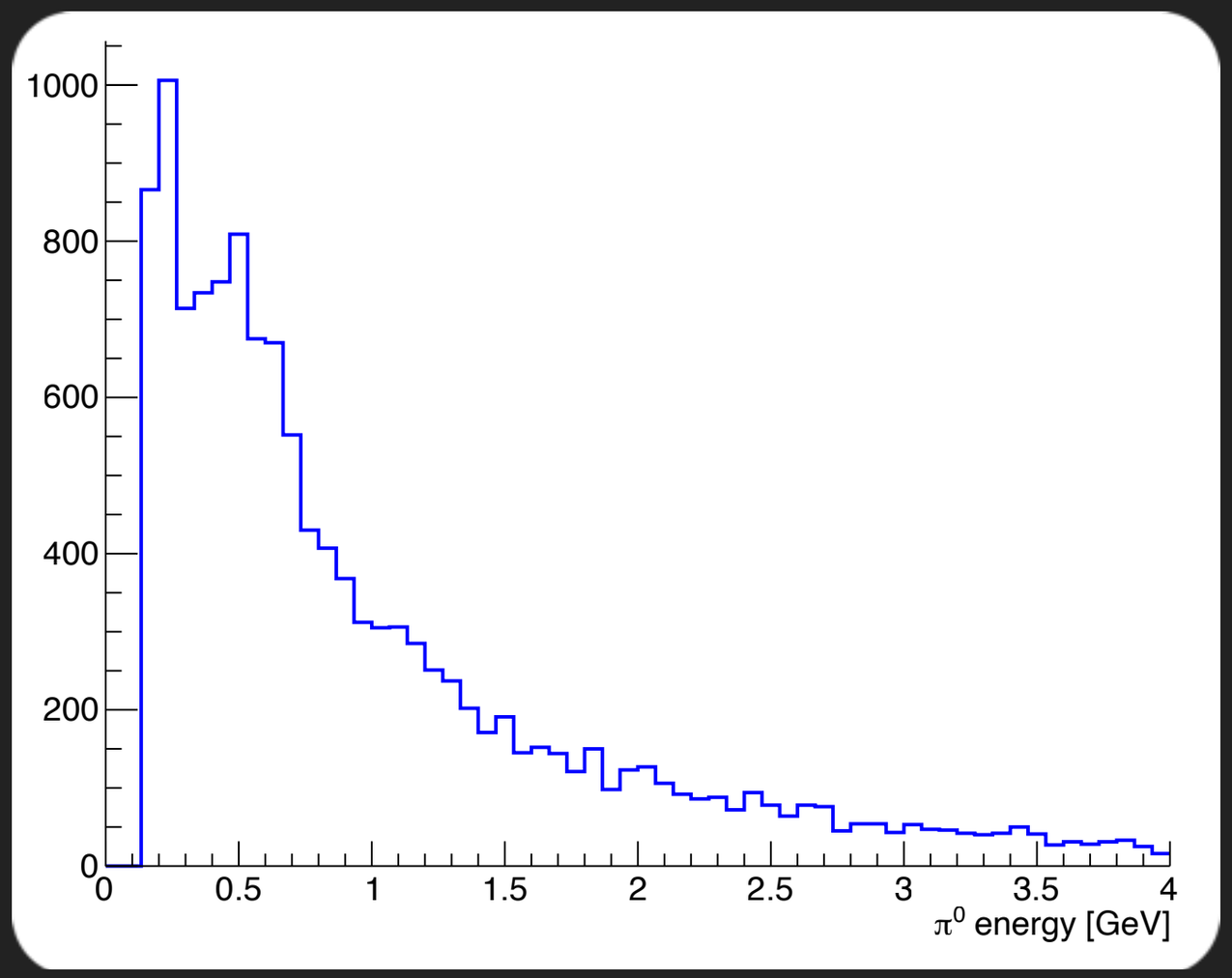
ANALYSIS

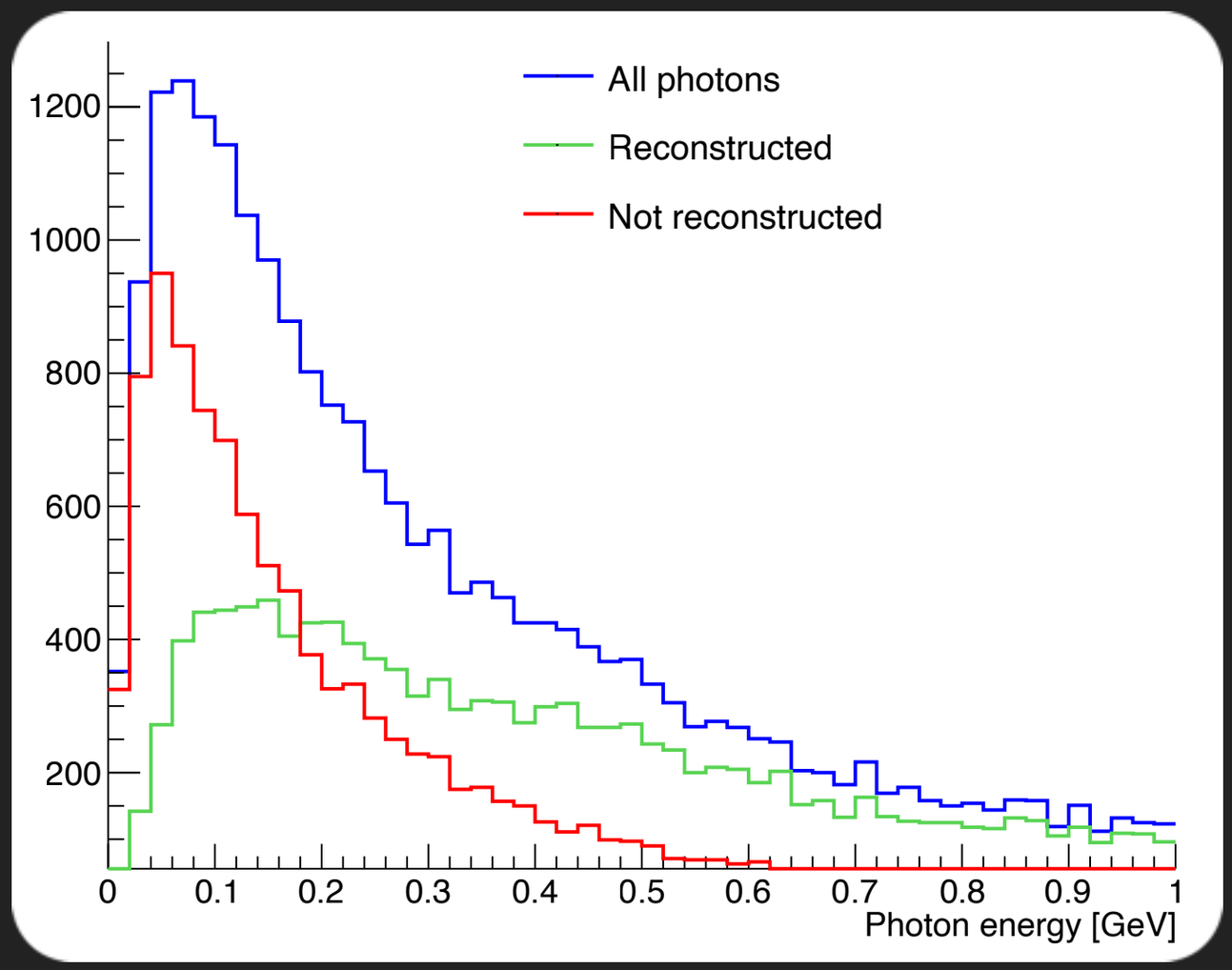
- Consider only daughter objects of primary track
  - Through Pandora particle hierarchy
- Goal: isolate π^+ charge exchange interactions to find π^0s



ANALYSIS

- MC information of primary daughter π^0 and their photons
- 6 GeV ProtoDUNE-SP beam sample (electrons suppressed)



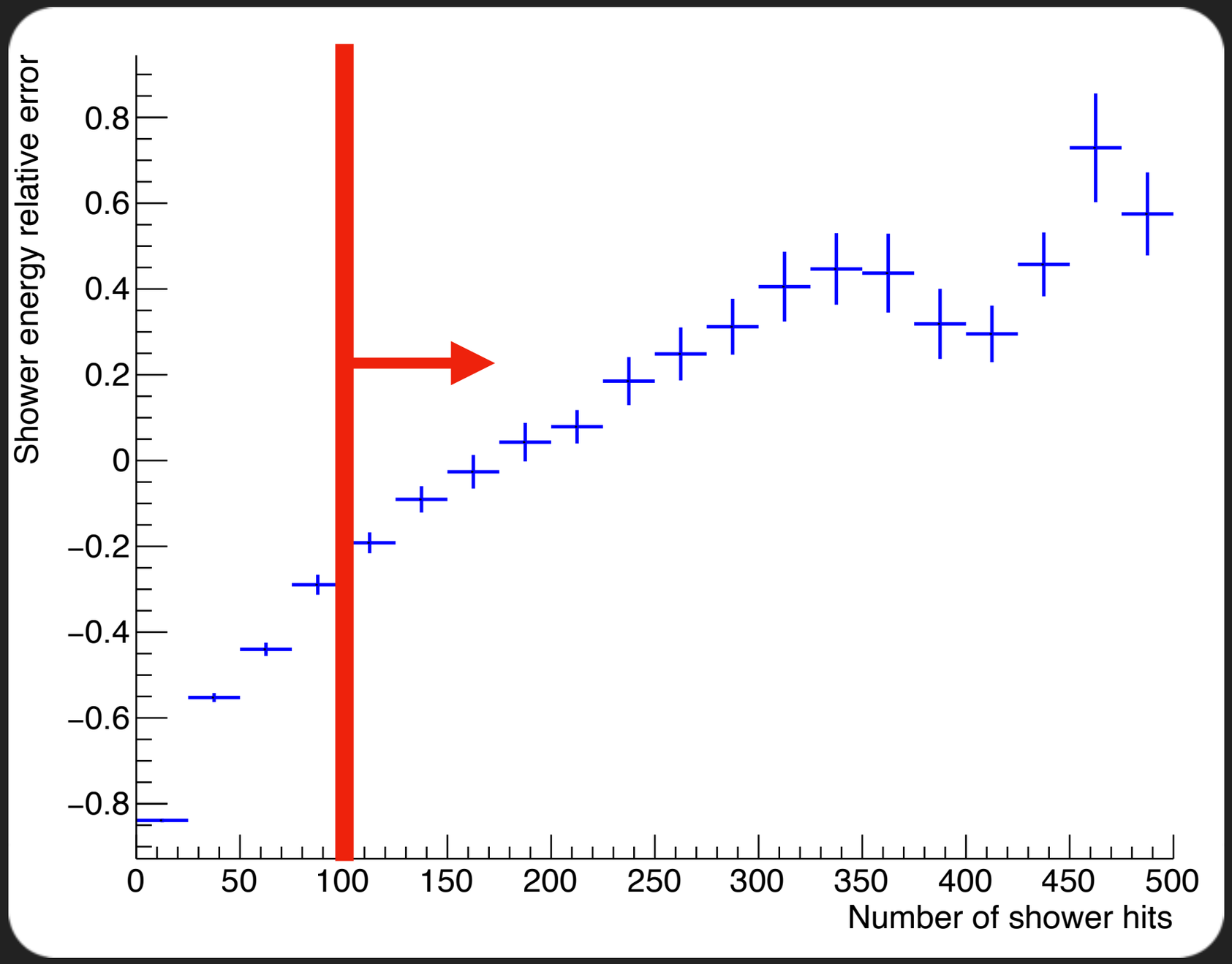


ANALYSIS

- Relevant variables for identifying possible π^0s in data given a shower pair

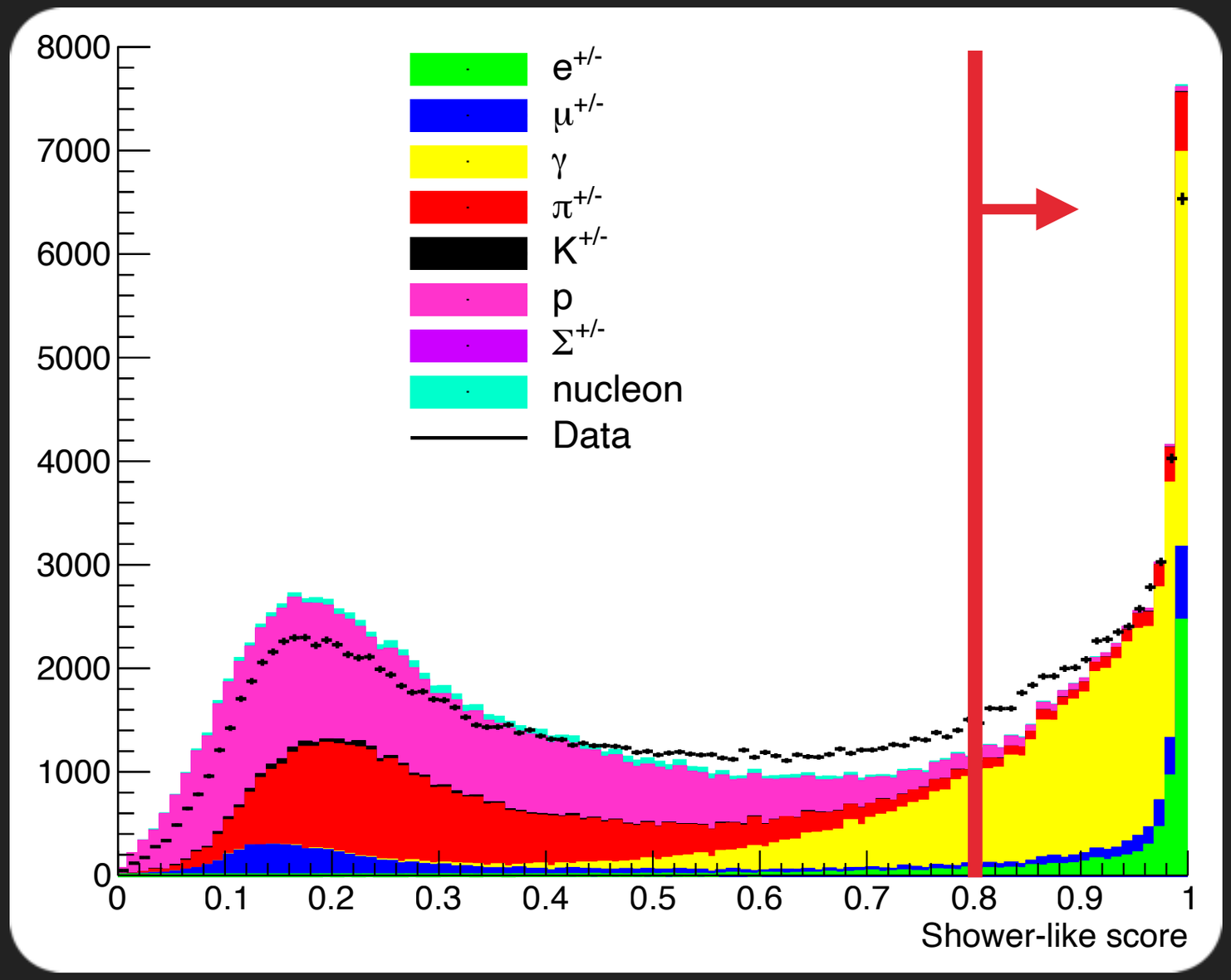
- Number of shower hits
- Shower CNN score
- Shower pointing
- Gap between vertex and shower
- Invariant π0 mass

ANALYSIS — NUMBER OF SHOWER HITS

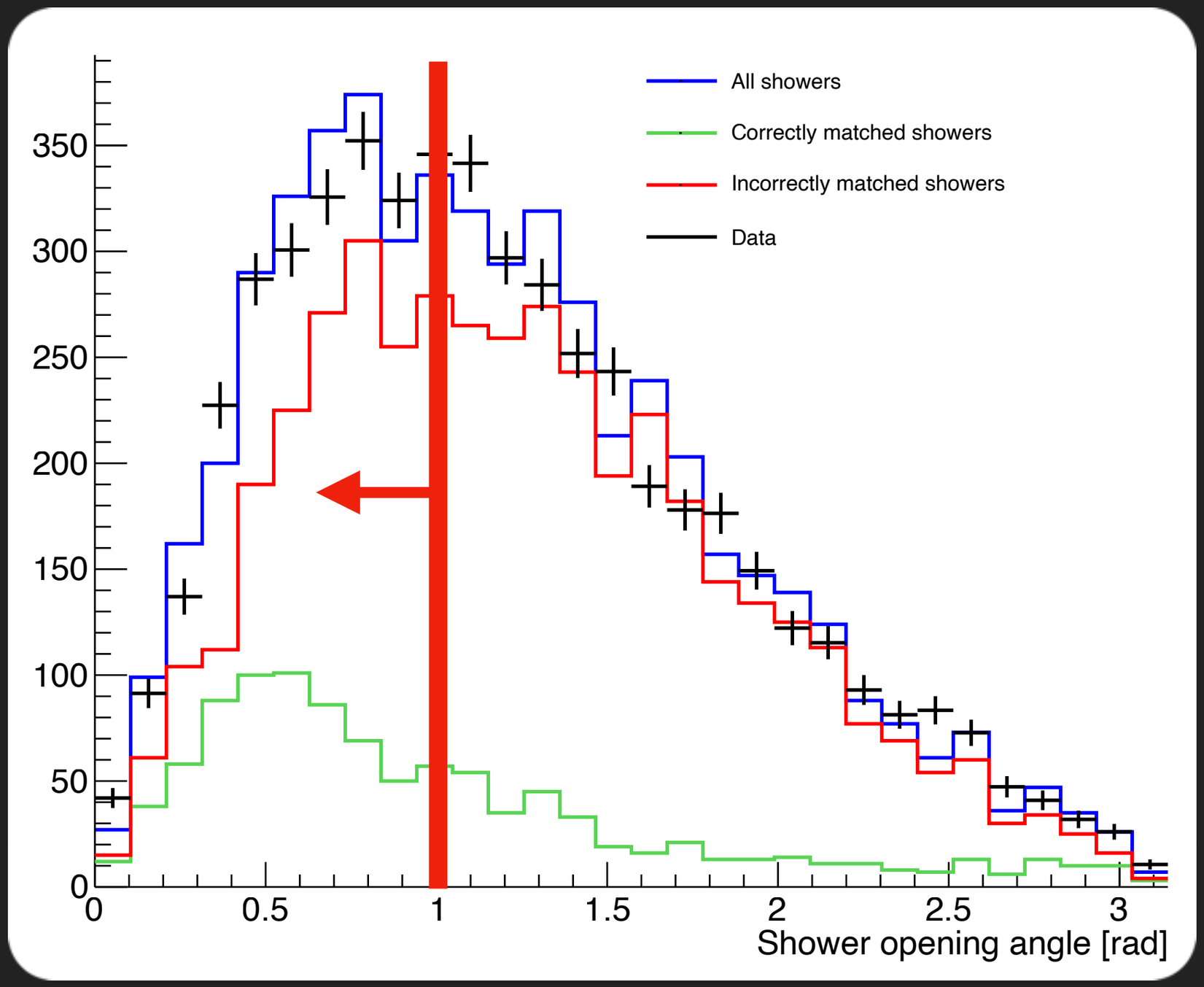


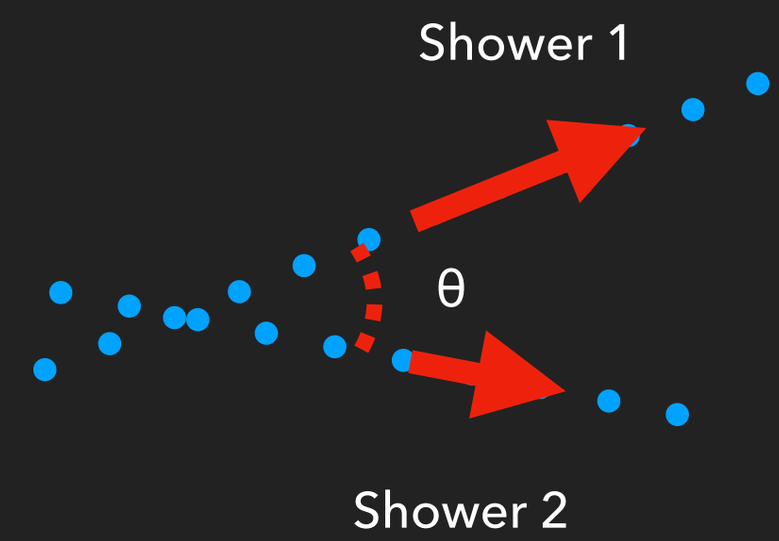
ANALYSIS — SHOWER CNN SCORE

- CNN assigns shower-like score to each hit in detector
- Average per object to get that object's total shower-like score

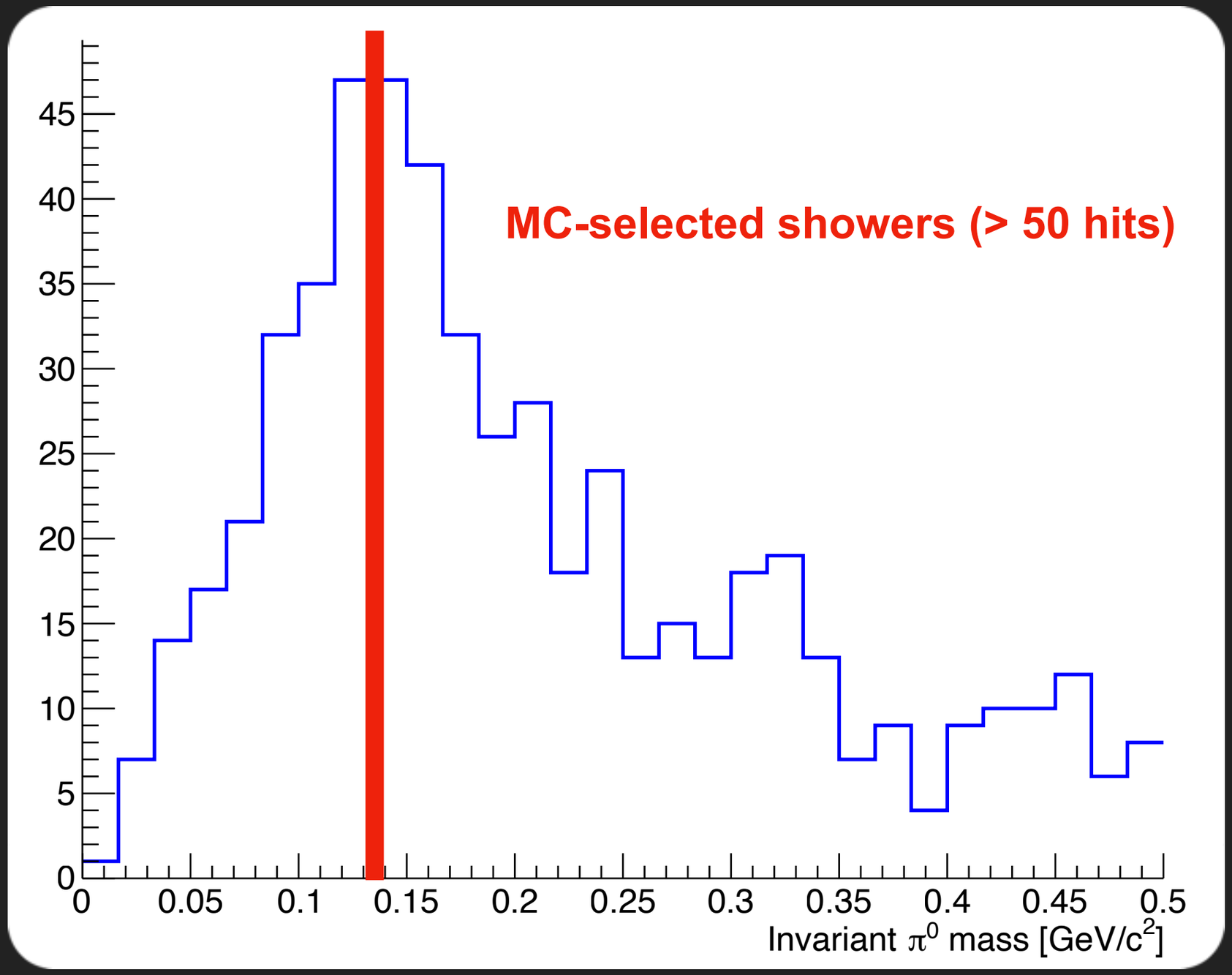


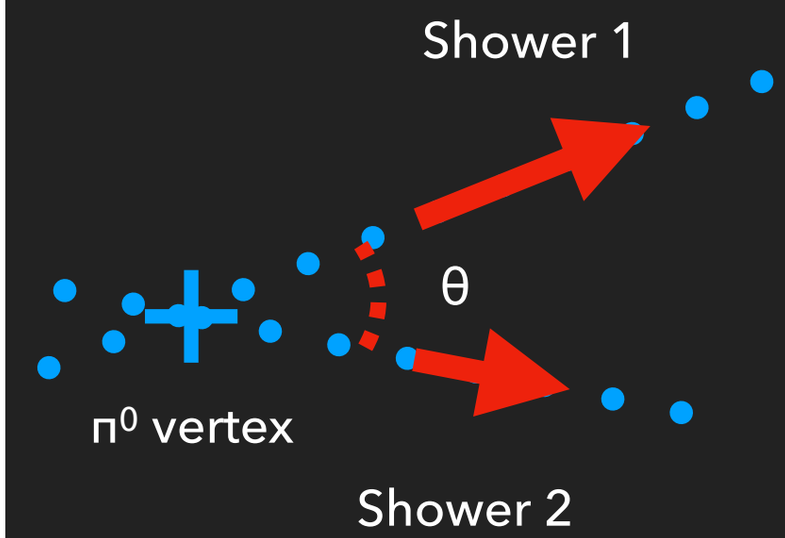
ANALYSIS — SHOWER OPENING ANGLE





ANALYSIS — INVARIANT MASS





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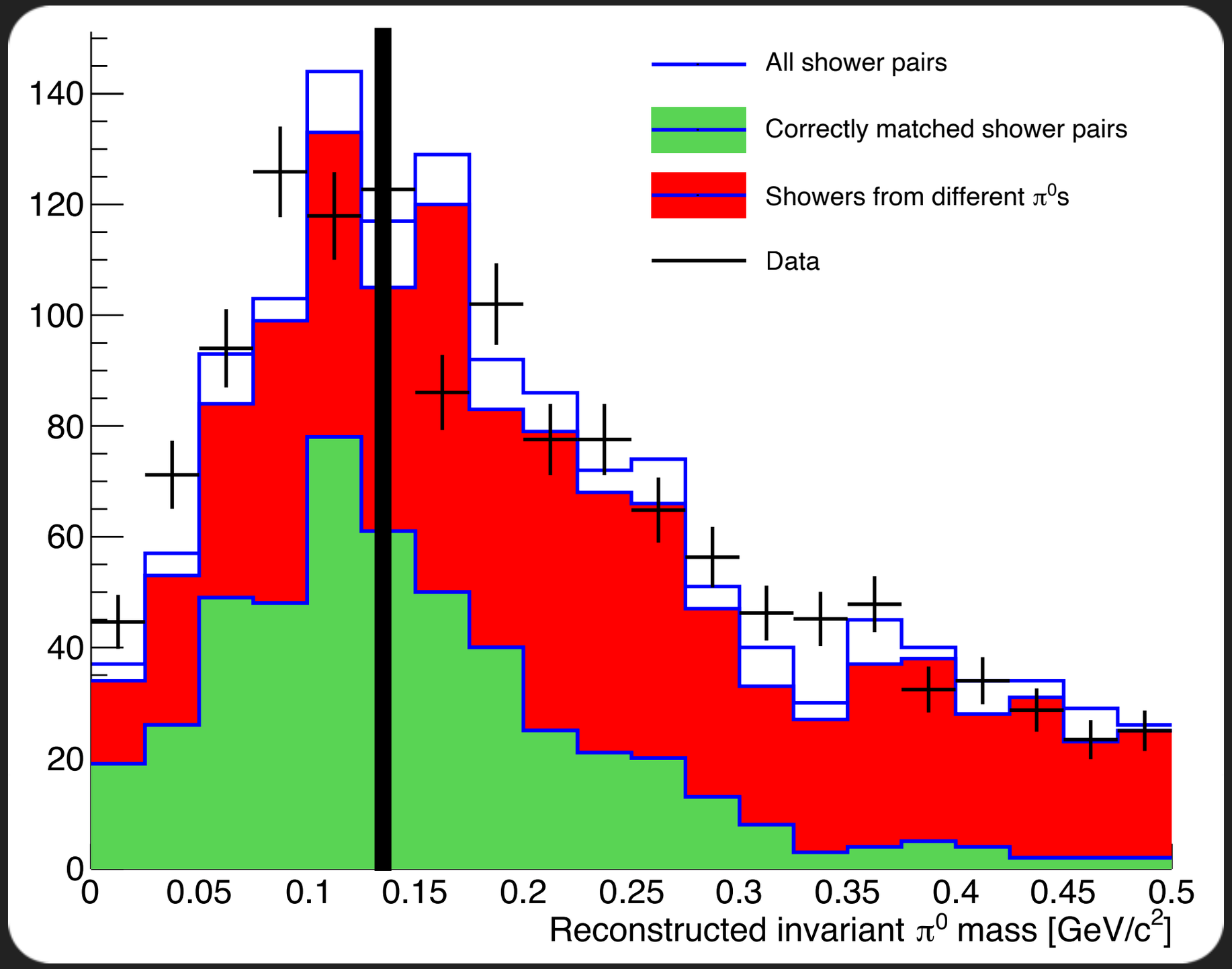
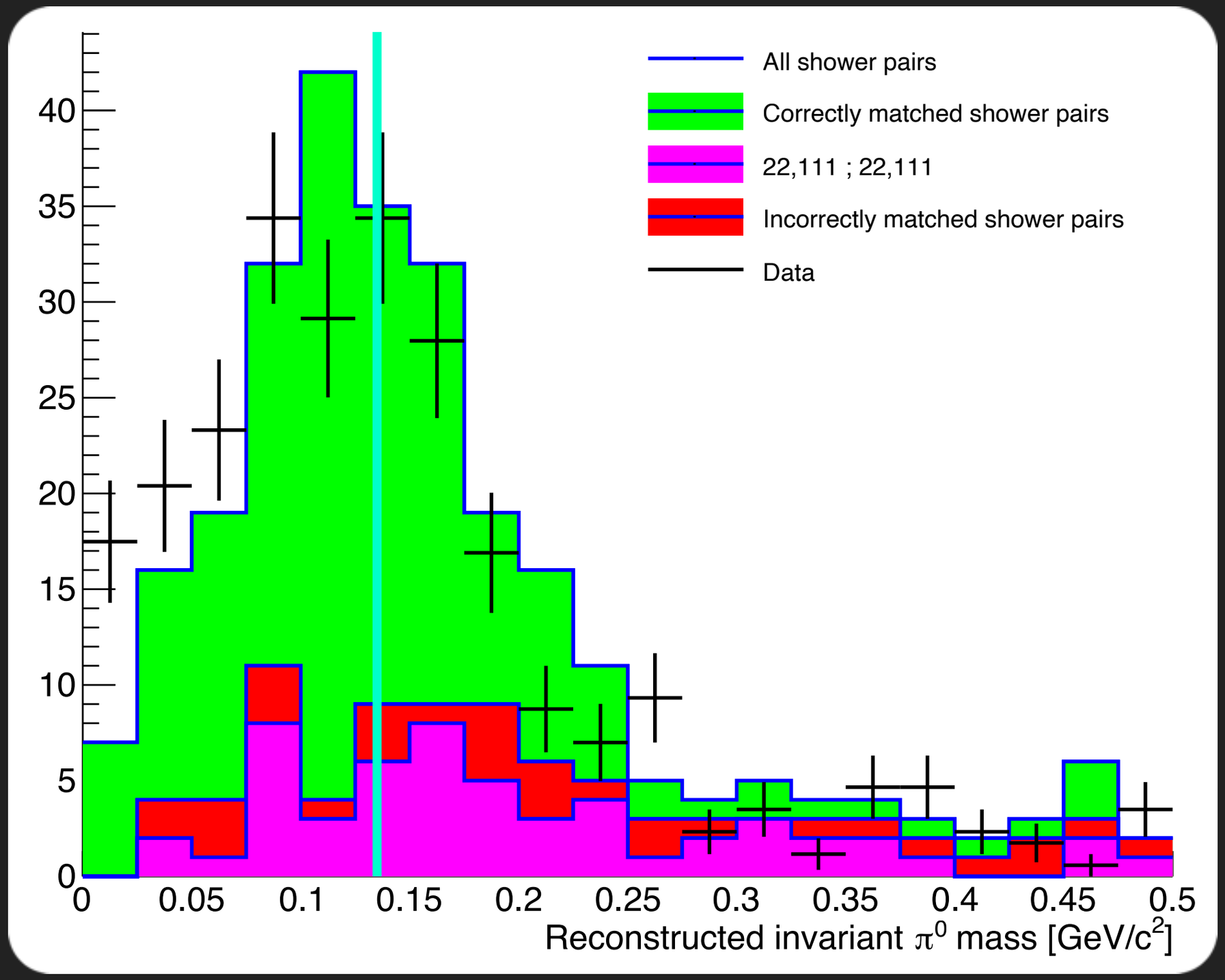


ANALYSIS — INVARIANT MASS IN 1 GEV



ANALYSIS — CONCLUSIONS / NEXT STEPS

- Great preliminary results in finding π^0 showers
- Low statistics due in part to aggressive cuts
- To do:
  - Improve shower energy reconstruction
  - Consider all showers near primary interaction point – step away from Pandora
  - Many more variables to consider: BDT?