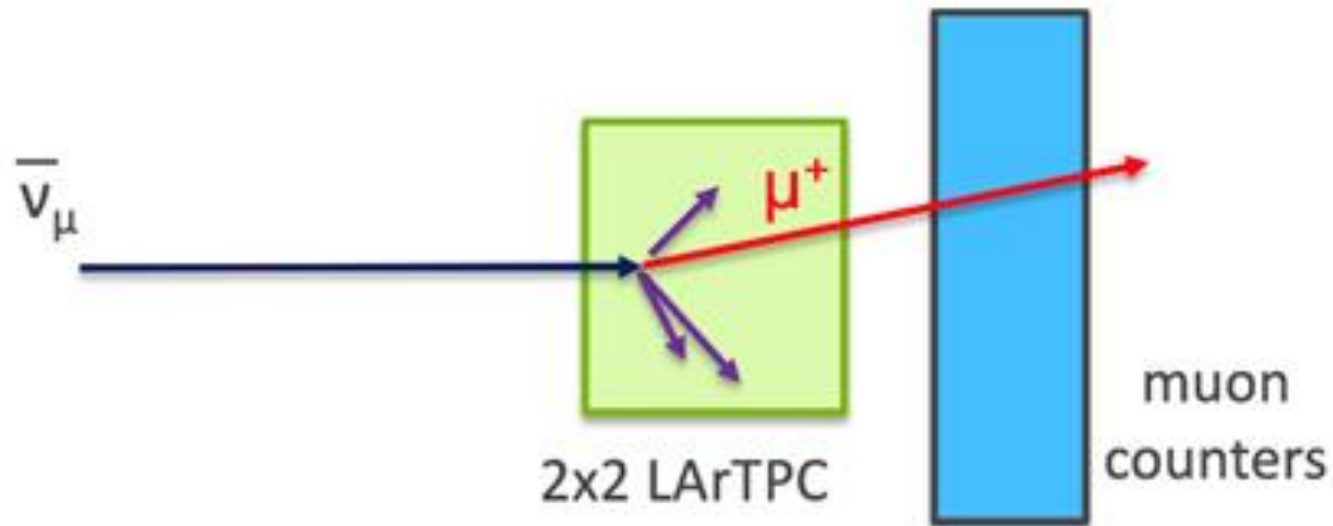


Neutrino Vertices and MINERvA-pairing (Update: June 5, 2024)

M. Bilal Azam, Z. Djurcic, et. al.

Signal Selection

- We are using the latest production sample: [MiniRun5 Beta1 CAFs](#)
- A neutrino CC interaction within Liquid Argon Fiducial Volume (LArFV)
- In the current selection presented here, we require that reconstructed vertex should be within LArFV and 5 cm away from inner and outer boundaries of LAr TPC modules
- Muons have longer track and will not be contained in 2×2 but detected in the muon counter, so the event selection is developed with pairing the muon track component in LAr with those in MINERvA



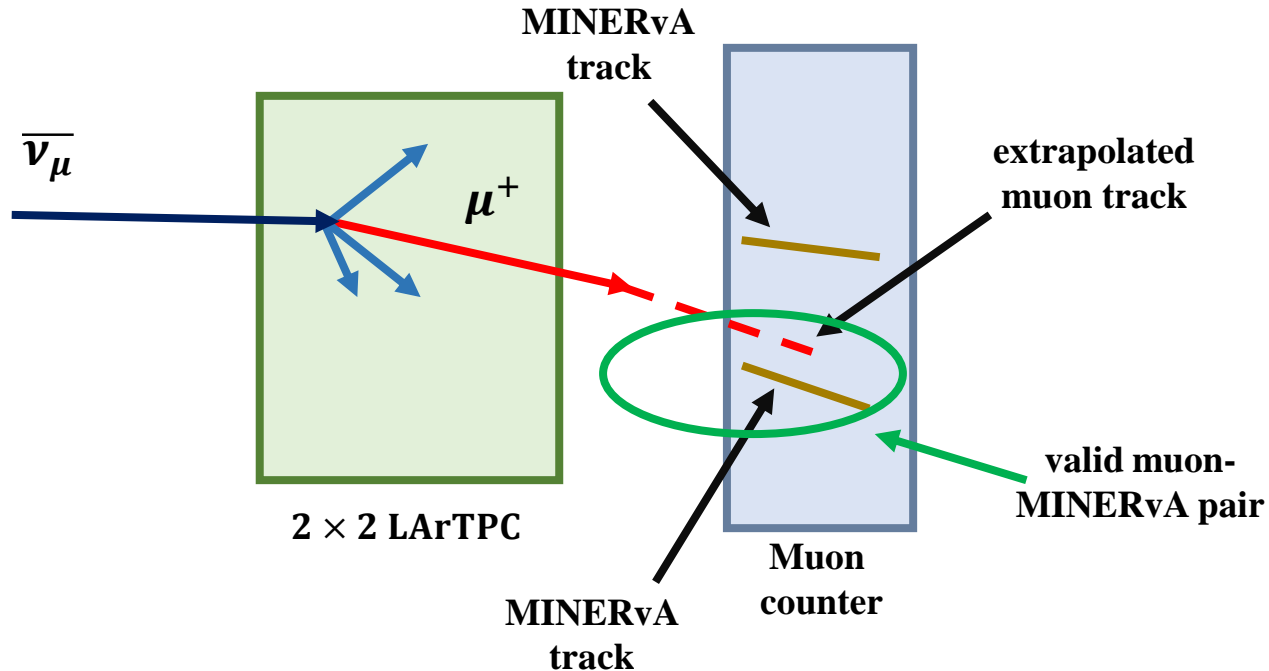
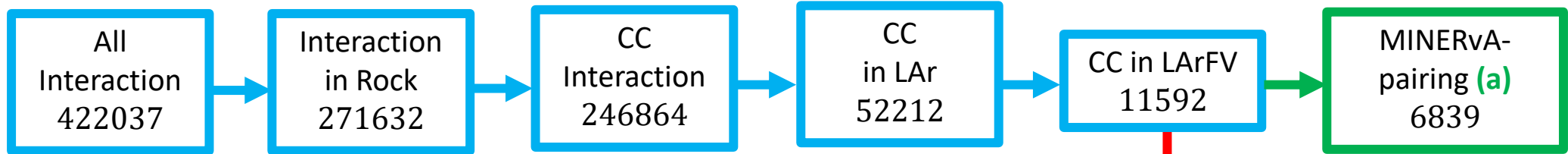
MINERvA-Pairing Criteria

➤ MINERvA-pairing (Criteria a):

- A match is identified if the distance between MINERvA and reconstructed track is less than 10 cm.

➤ MINERvA-pairing (Criteria b):

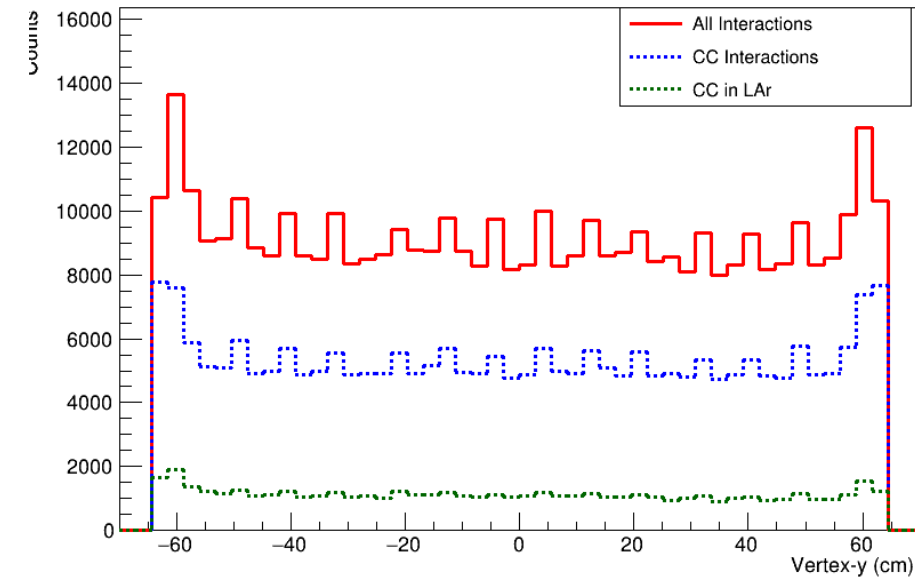
- Distance between MINERvA and reconstructed track is less than 10 cm, and its dot product exceeds 0.9975.



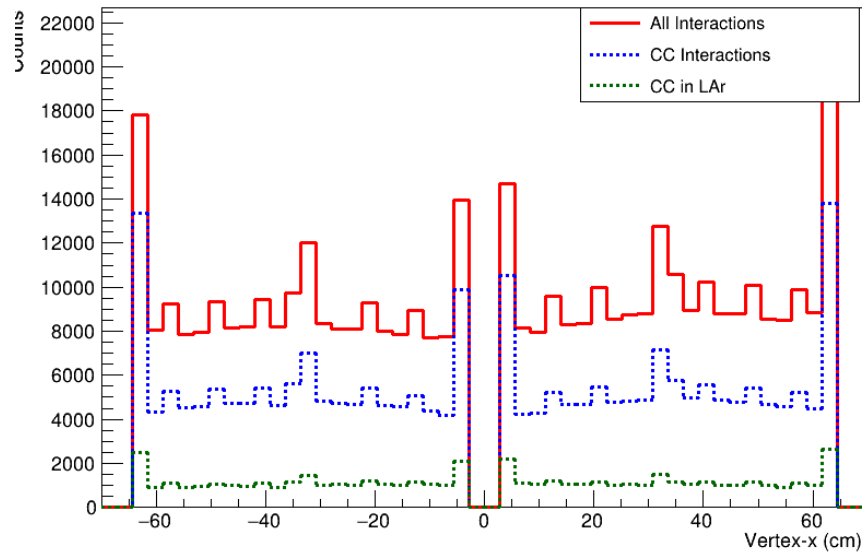
Reconstructed Neutrino Vertex Distribution

- Following neutrino vertices are shown here:
 - All reconstructed vertices,
 - All reconstructed CC vertices
 - All reconstructed CC vertices in LAr
- These vertices are uniformly distributed through x, y, z except z is also showing accumulation near boundaries of the detector.
- Peaks around $x = \pm 35$ cm can also be observed.

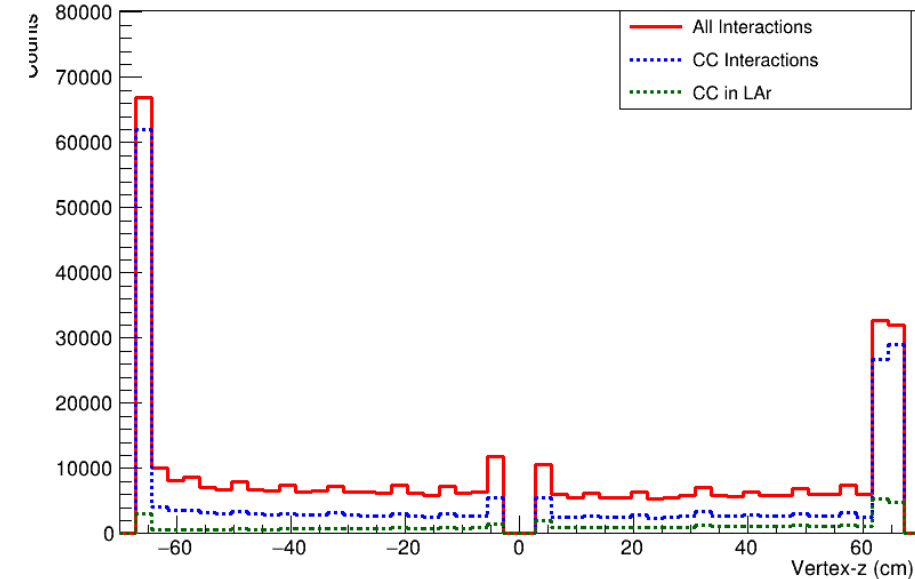
Reconstructed Neutrino Vertex-y



Reconstructed Neutrino Vertex-x



Reconstructed Neutrino Vertex-z



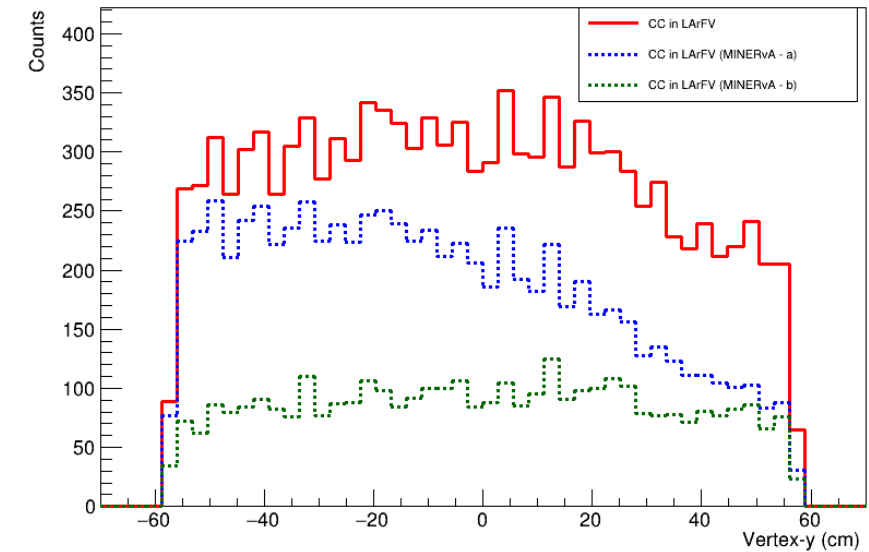
MINERvA-Pairing on Neutrino Vertices

➤ Following neutrino vertices are shown here:

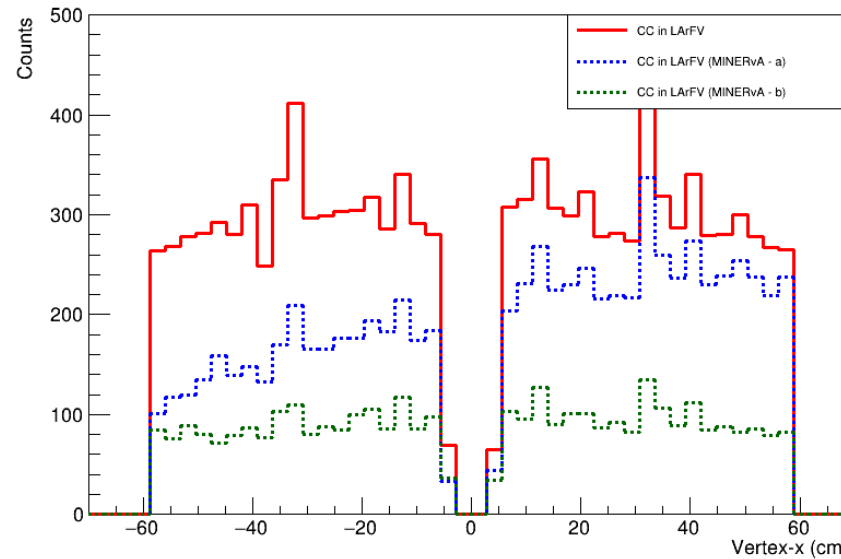
- All reconstructed CC vertices in LArFV
- All reconstructed CC vertices in LArFV with MINERvA-pairing (**Selection a**): distance between MINERvA and reconstructed track is less than 10 cm.
- All reconstructed CC vertices in LArFV with MINERvA-pairing (**Selection b**): Distance between MINERvA and reconstructed track is less than 10 cm, and its dot product exceeds 0.9975.

➤ A difference in the distribution of x and y vertices can be observed. In **Selection a**, sloppy trends can be seen but for **Selection b**, these depict rather uniform trends. Vertex- z does not big differences under both selection criteria.

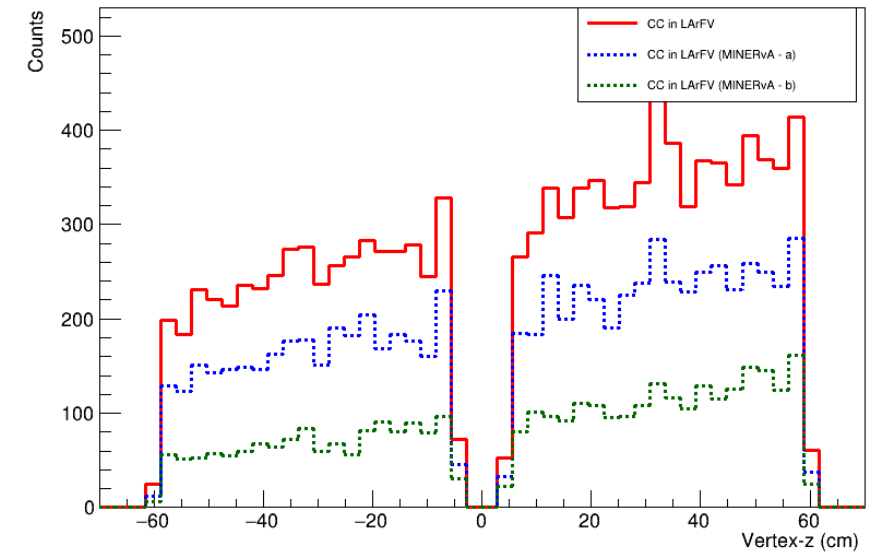
Reconstructed Neutrino Vertex-y



Reconstructed Neutrino Vertex-x



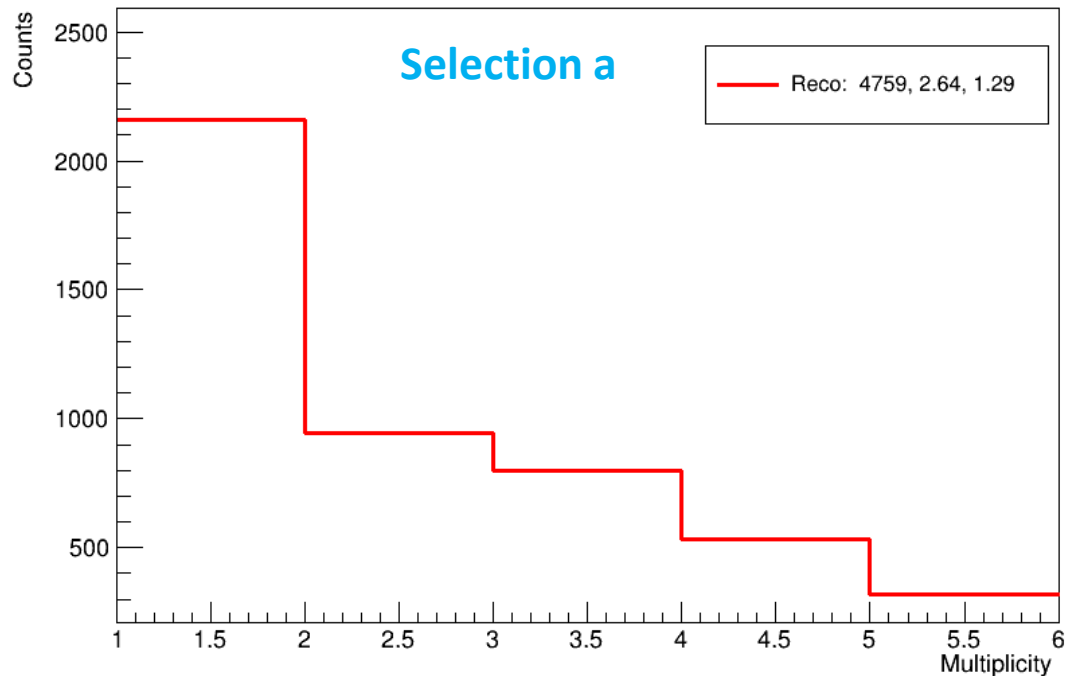
Reconstructed Neutrino Vertex-z



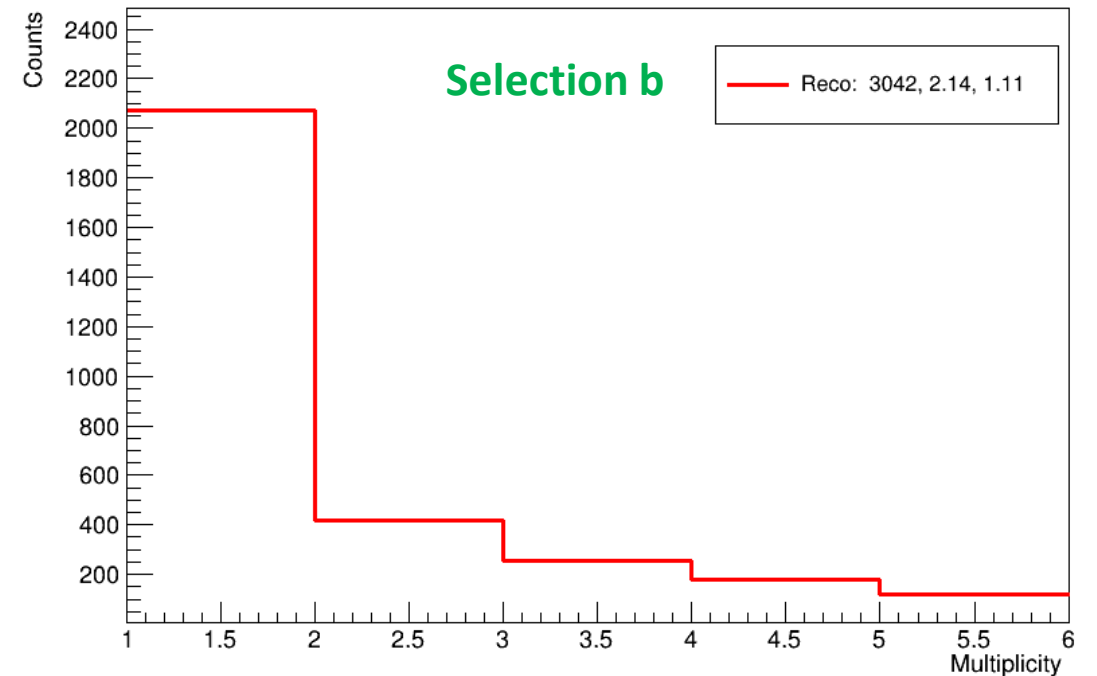
Charged Hadronic Multiplicity Distribution

- Reconstructed charged hadronic multiplicity distribution is shown under both selection criteria.
- Minimum track length is set to be > 5 cm.
- Multiplicity distribution remains unaffected.

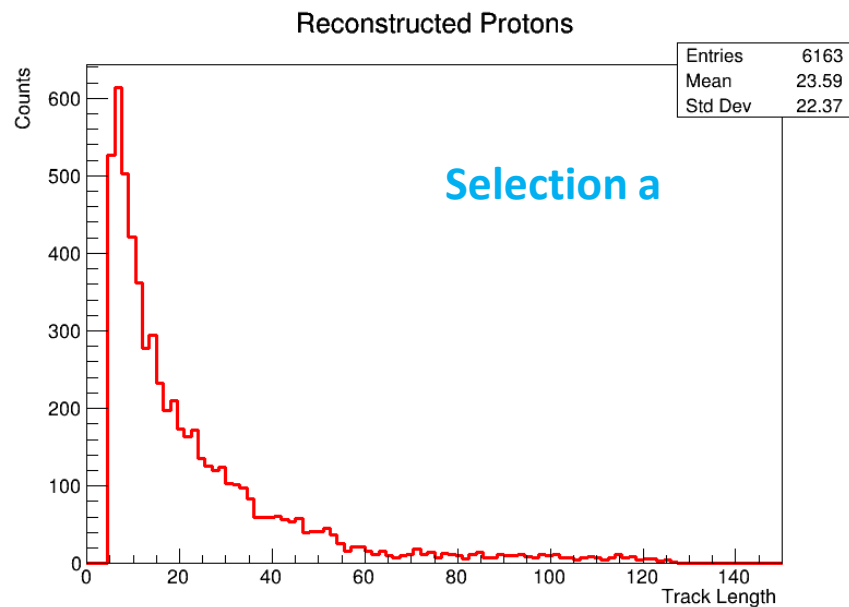
Reconstructed Track Multiplicity



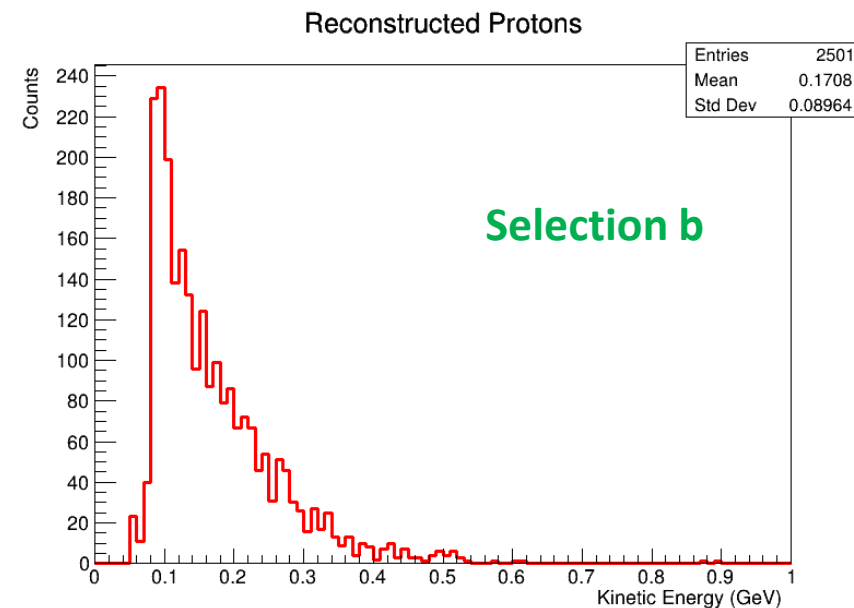
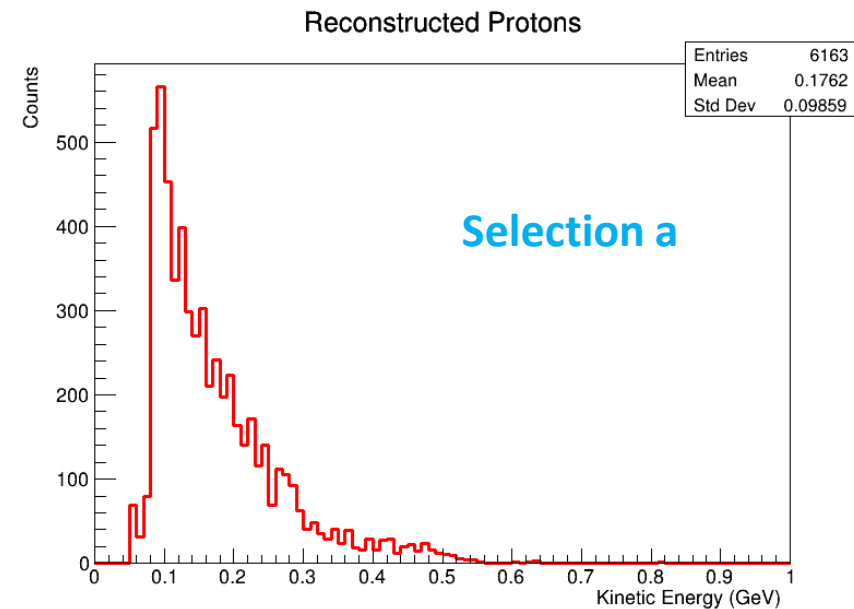
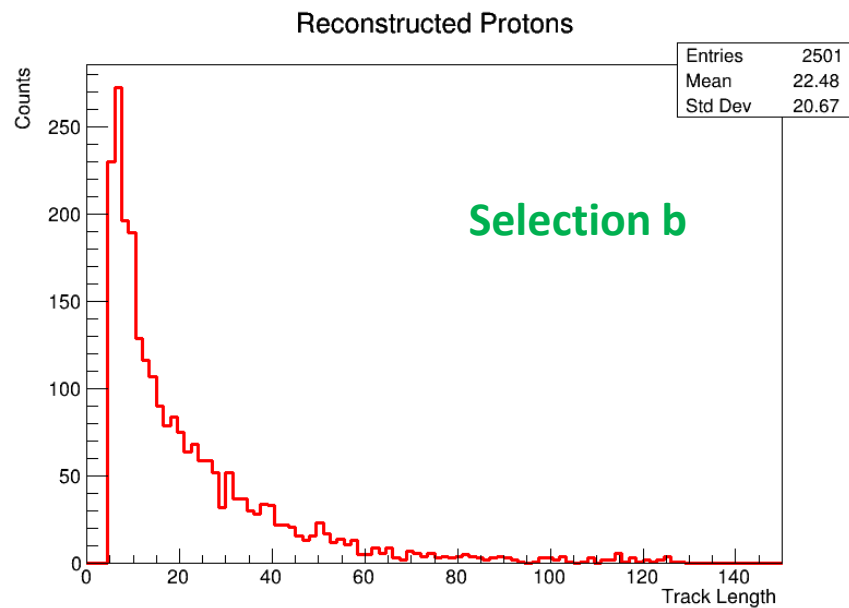
Reconstructed Track Multiplicity



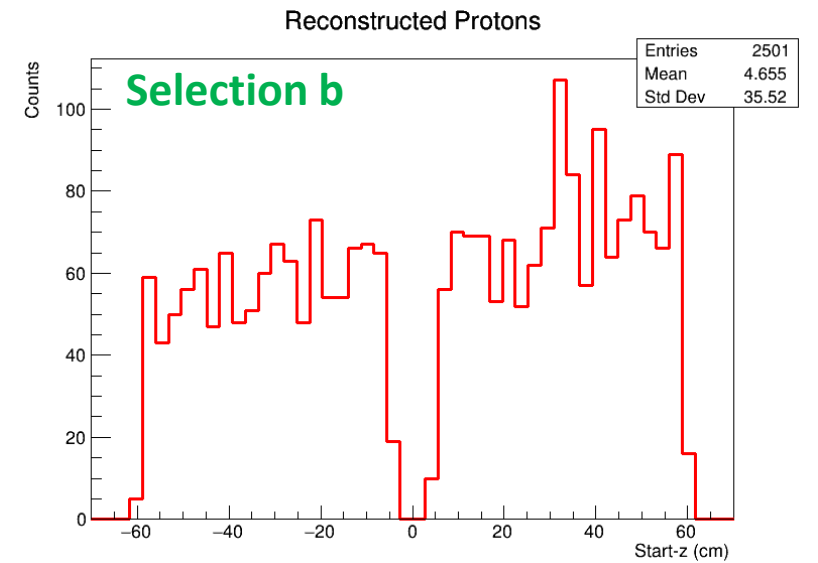
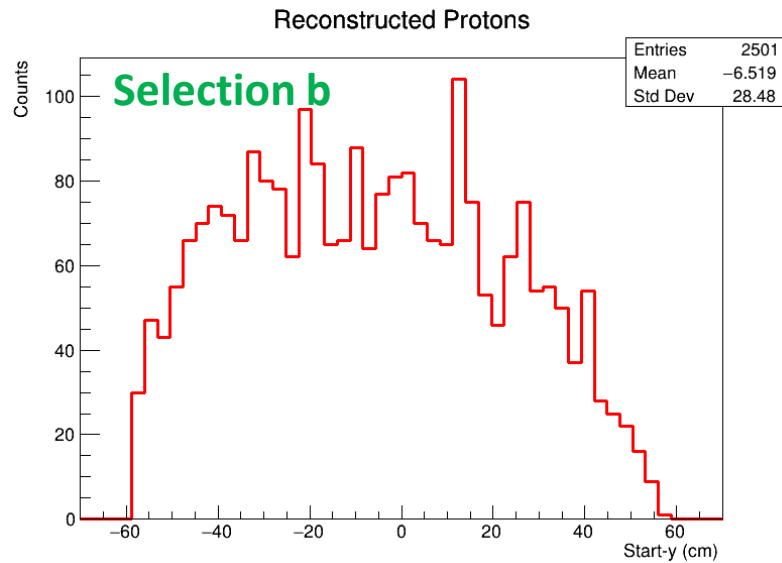
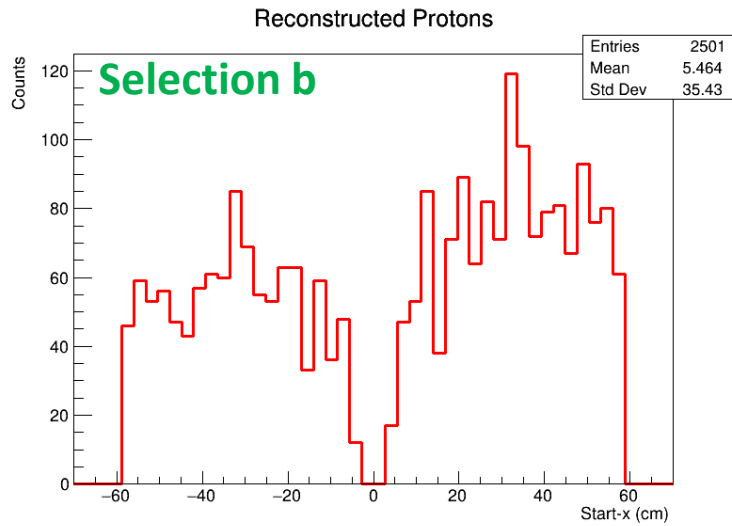
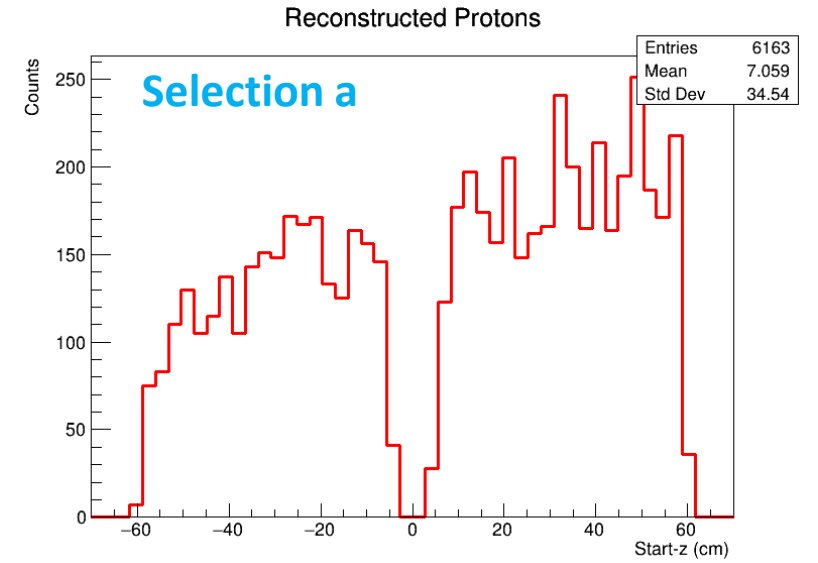
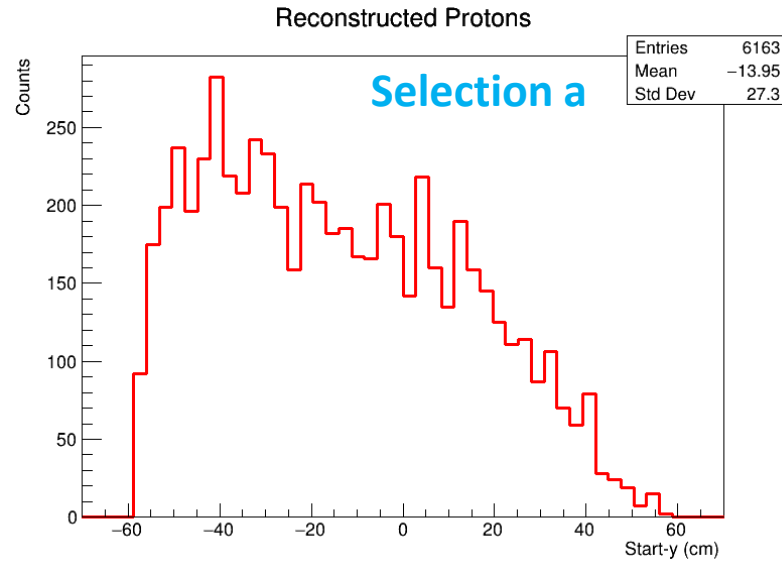
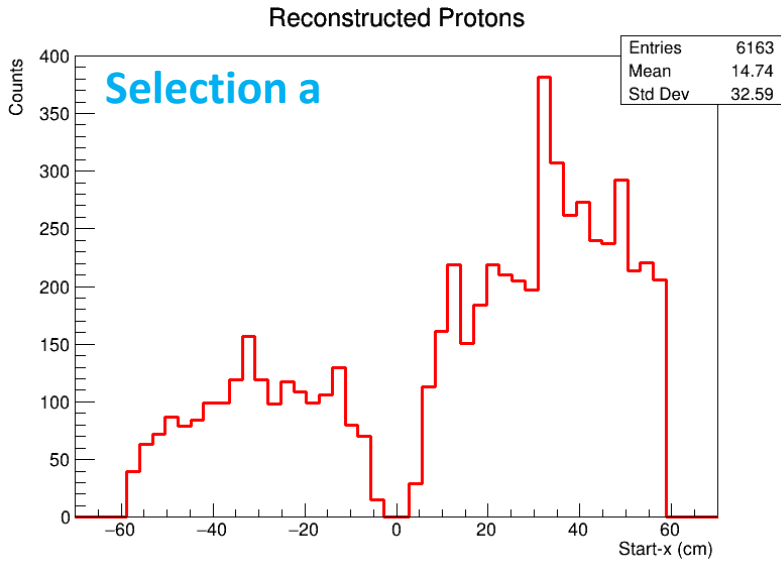
Distributions of Reconstructed Protons



- We present different features of the reconstructed protons because these are important.
- Tracks are within LArFV and > 5 cm.
- The track length (in cm) and kinetic energy distributions of reconstructed protons are shown here.
- No major differences can be seen here.



Distributions of Reconstructed Protons (*contd.*)



Remarks

- The selection will be continuously updated with new improved simulated data, and the final selection would be informed by measured data.

