Preliminary study of neutron reconstructed object and first look at reconstructed δP_T in 1cm cube

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Introduce myself

-Name: Ki-Young Jung

-Affiliation: Chung-ang university neutrino group

-Grade: senior

-Plan at working on DUNE: at least 3 years

that's me

"I've work with Sunwoo and Guang since this year.
I have plan to work on the neutron detection studies,
especially with 1.5cm cube"

Contents

-Comparison neutron production between GENIE3 and GENIE2

-Check the time resolution in the full reconstruction

-Look transverse momentum with the full reconstruction

Compare GENIE3 (3_06 G1810b) with GENIE2 (2_12_10)

(Only consider neutrino CC interaction with carbon)

Purpose

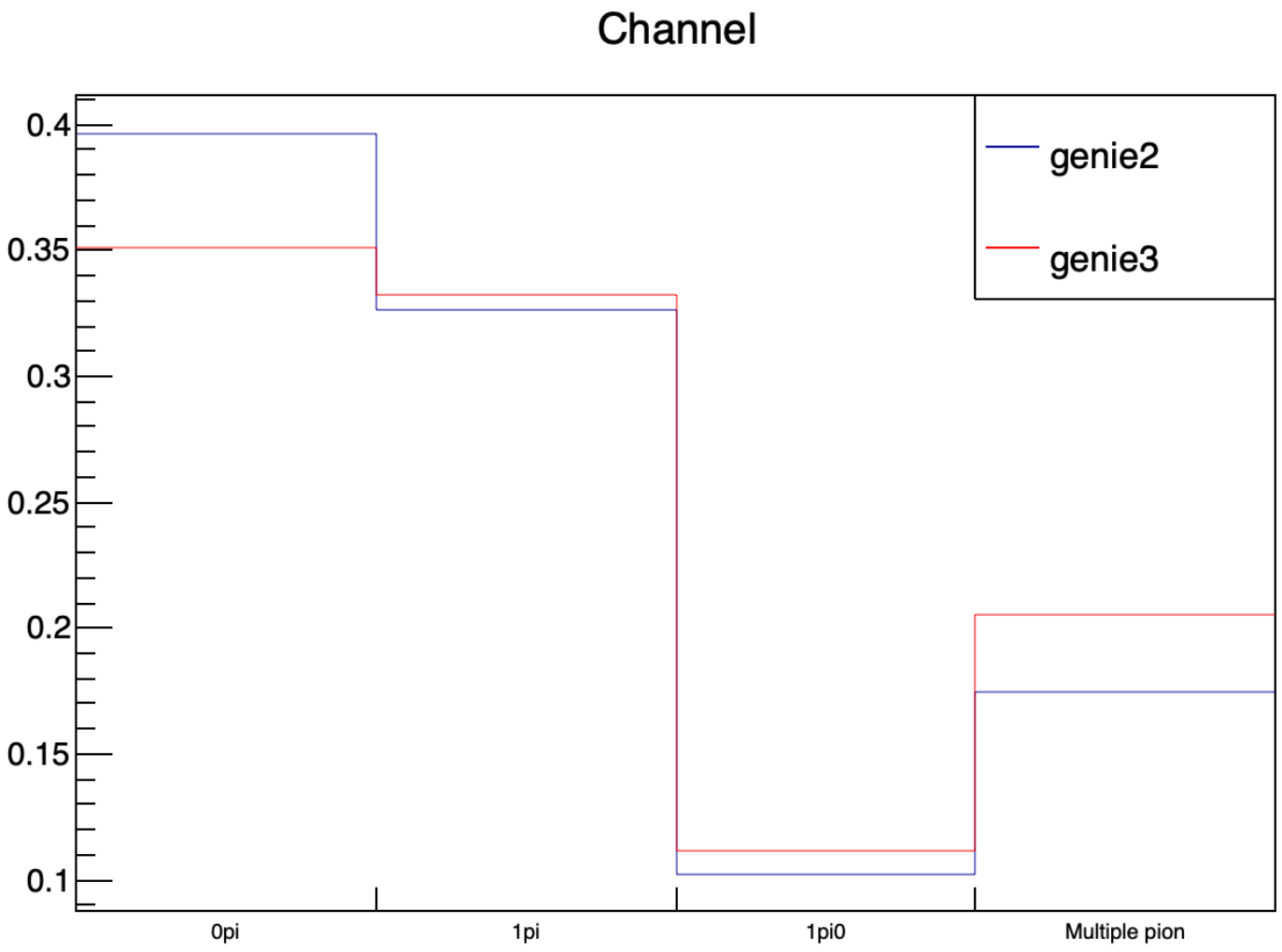
-How different is the fraction of each pion channels?

-How many final neutrons are produced for each pion channels?

-How different is the neutron energy spectrum for each pion channels?

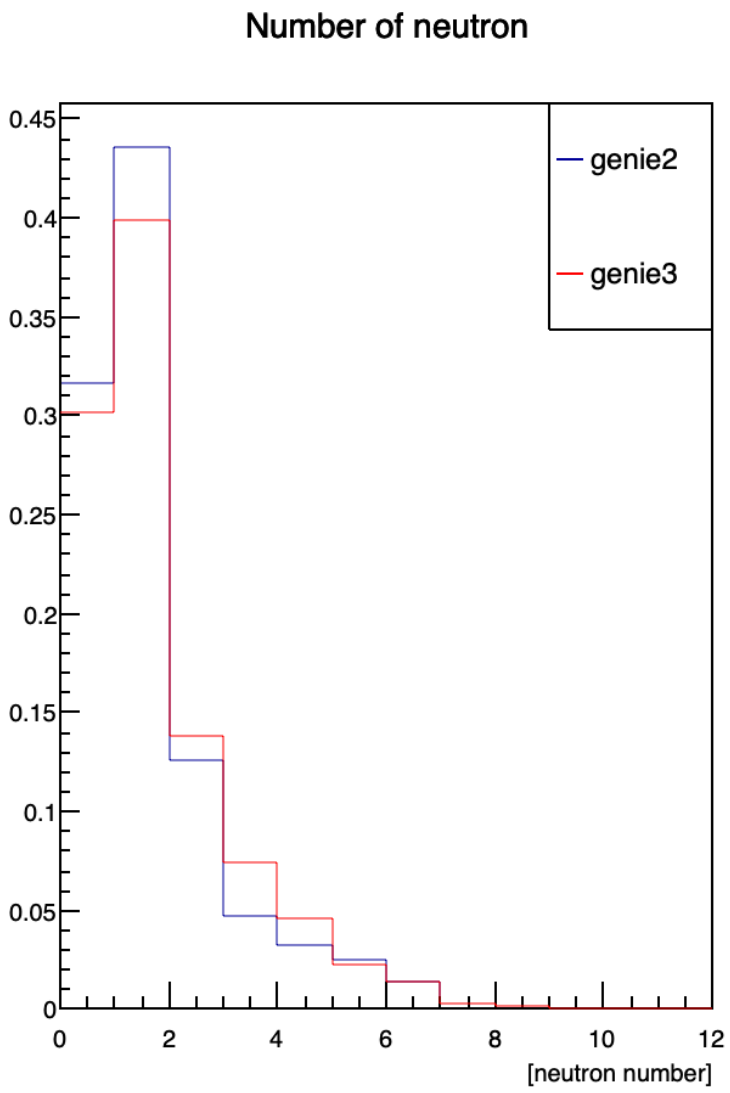
Any suggestions on other GENIE3 tunings are welcome!

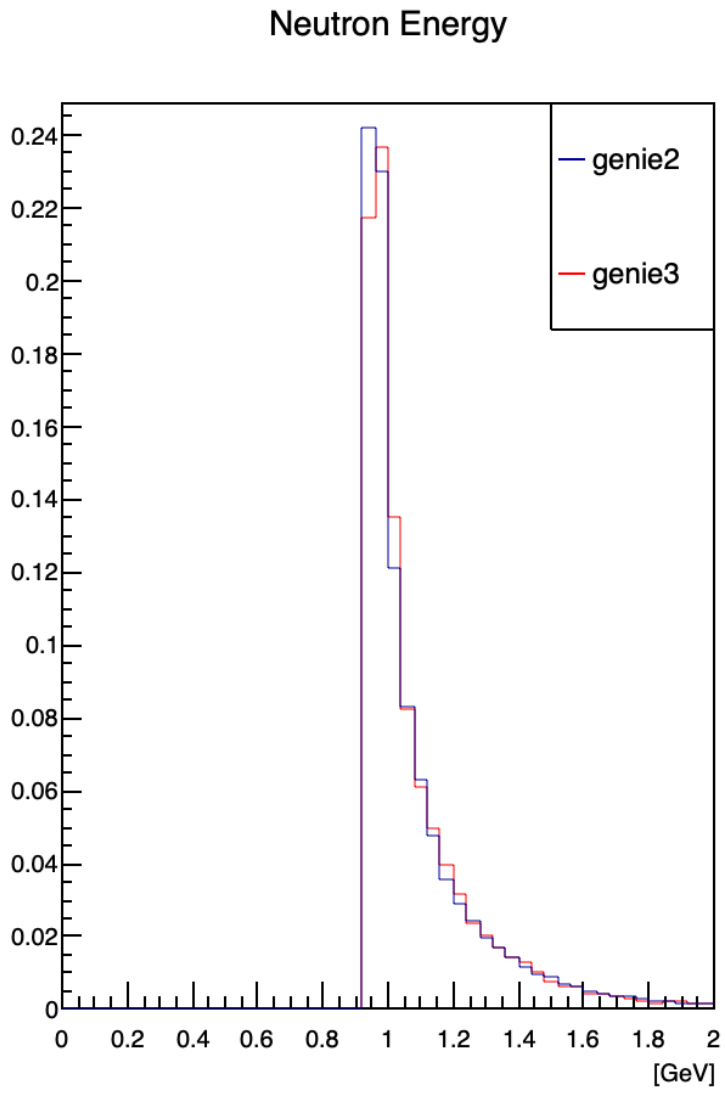
Channel fraction in CC interaction



Separate channel by pion number

Neutron number and energy in $1\pi^{\pm}$ channel

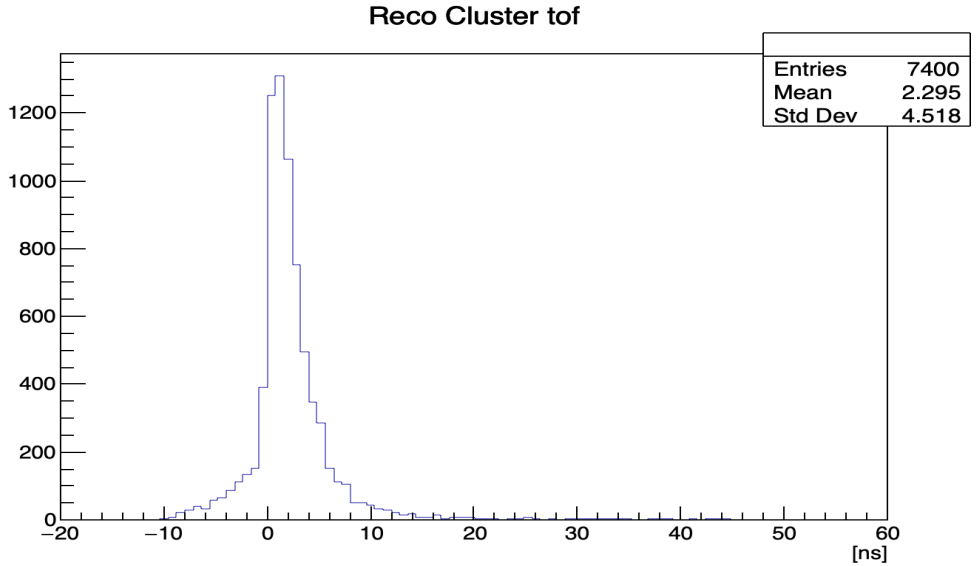


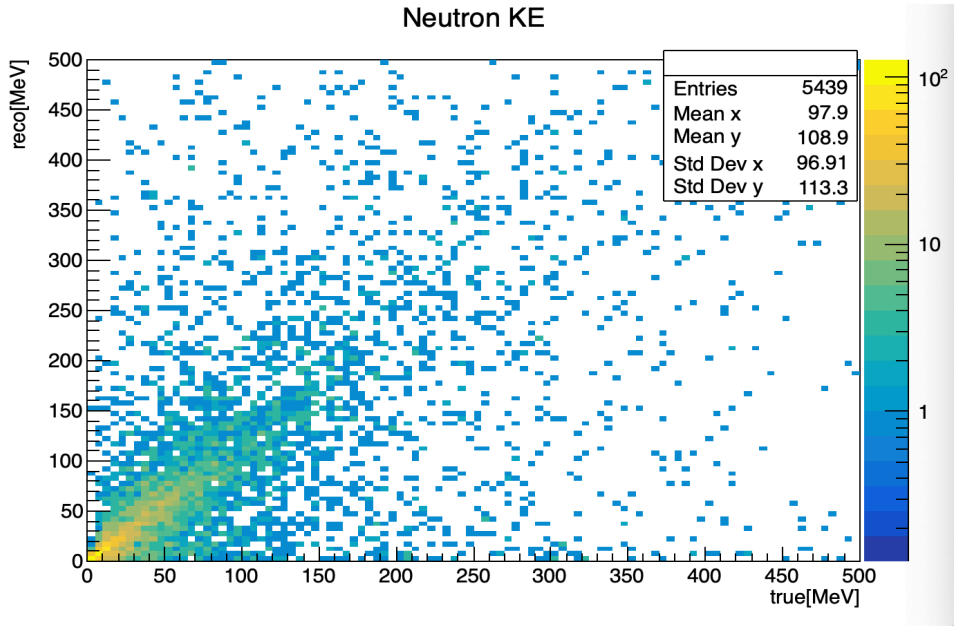


Average number of neutrons per event in $1\pi^{\pm}$ channel:
GENIE2: 1.18
GENIE3: 1.31

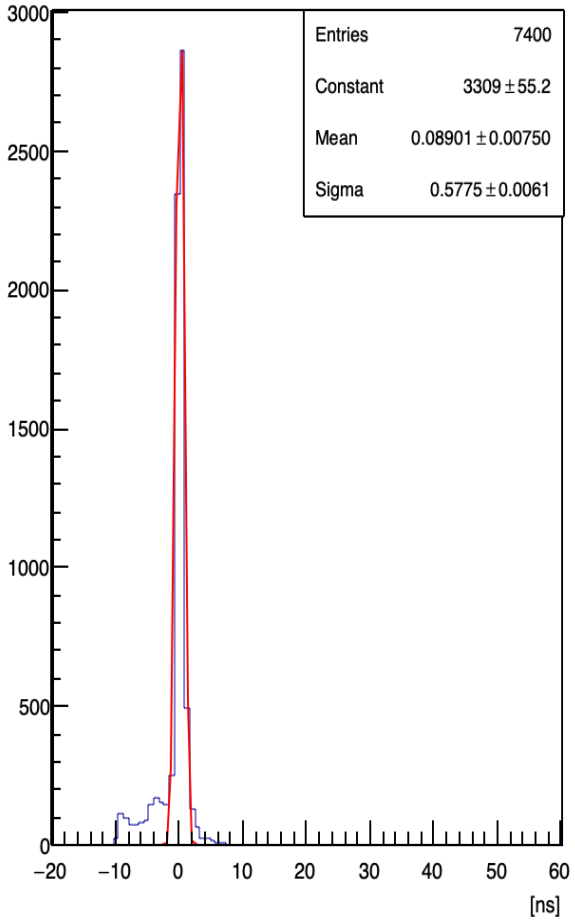
Number of events:
GENIE2: 69772
GENIE3: 11530

Check time resolution

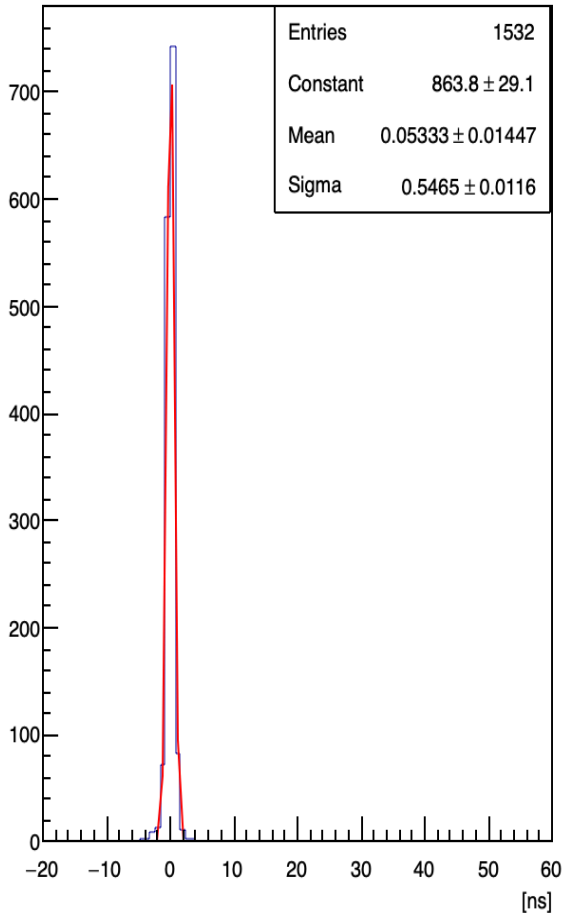




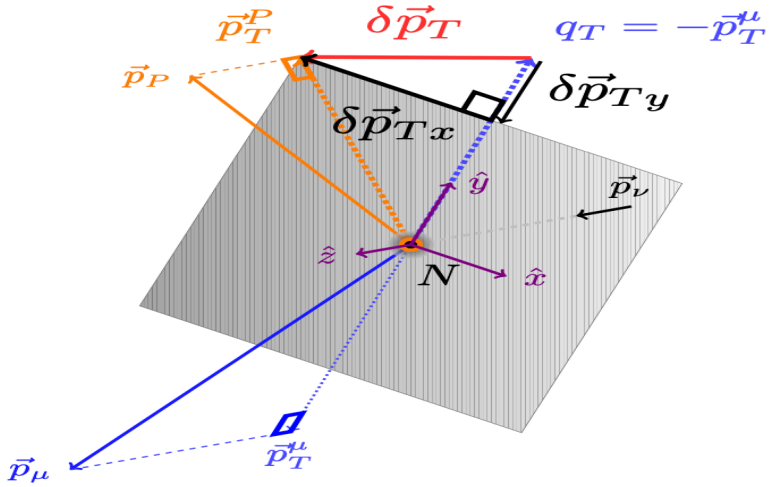
reco tof-true tof (for cluster)



reco tof-true tof (for track)



Low transverse momentum



[arXiv:1910.08658v5]

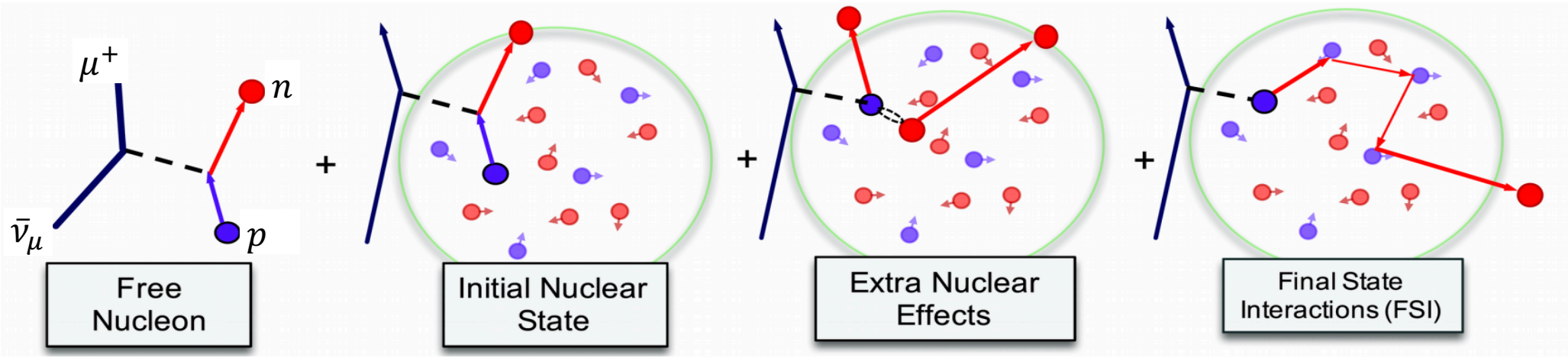
- When neutrino interacts nucleon, there is nuclear effect.
For example Fermi motion, Binding energy and Pauli blocking etc.

- Nuclear effect impacts on final state particle momentum.

- It leads to bias the reconstructed neutrino energy.

- If we select the low δP_T sample, then we can obtain nuclear effect free sample.

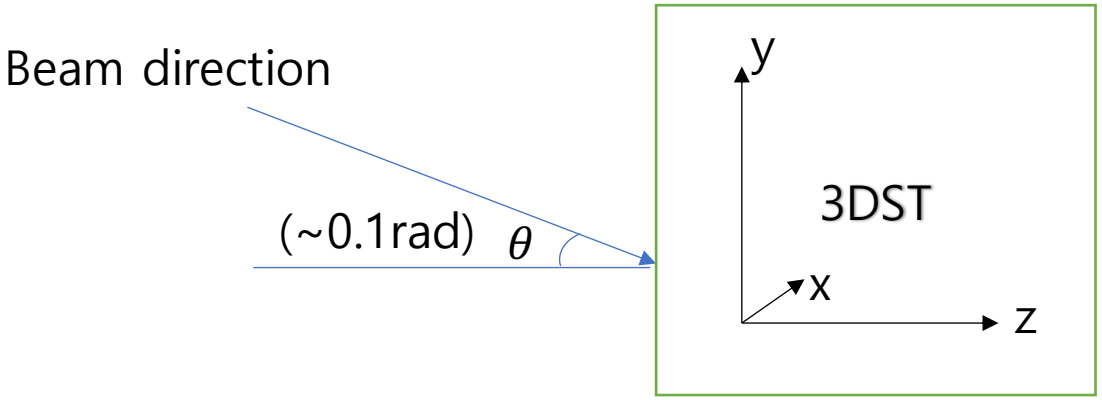
"Check neutron information, δP_T is just an example."



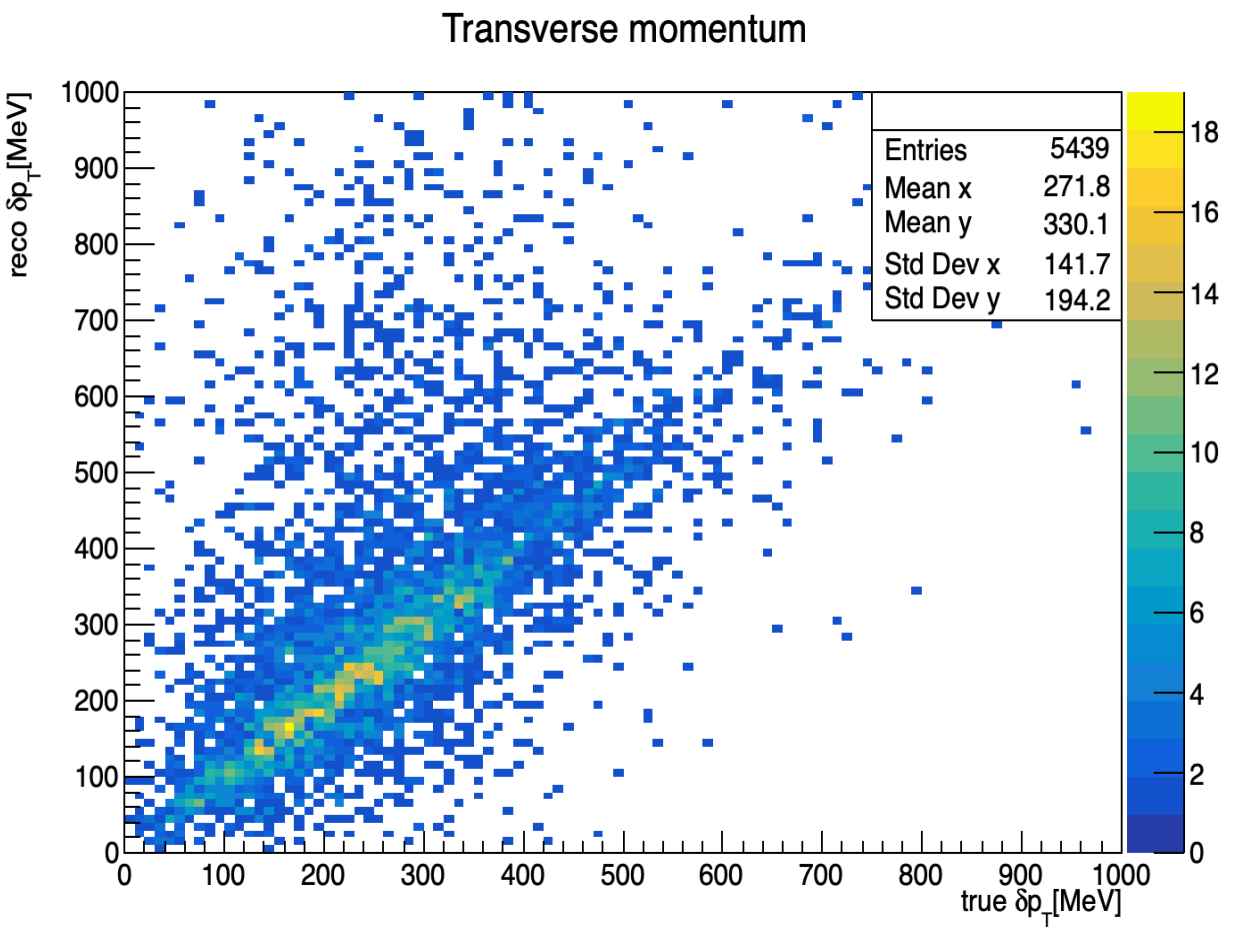
[link]

Reconstruct transverse momentum

- First, only look Single track and single neutron event
- Consider all final states as muon or neutron after background cut(purity 95%).
- Get a muon momentum from true info considering 4% smearing .

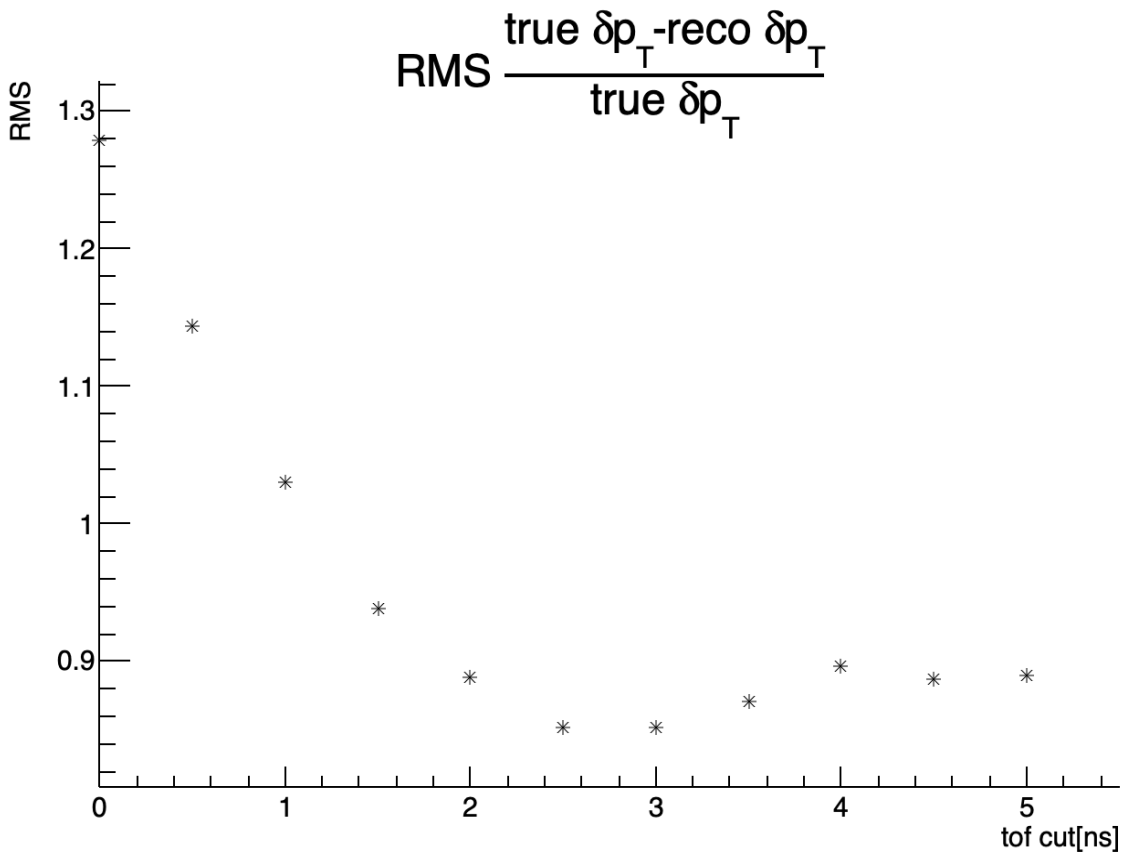


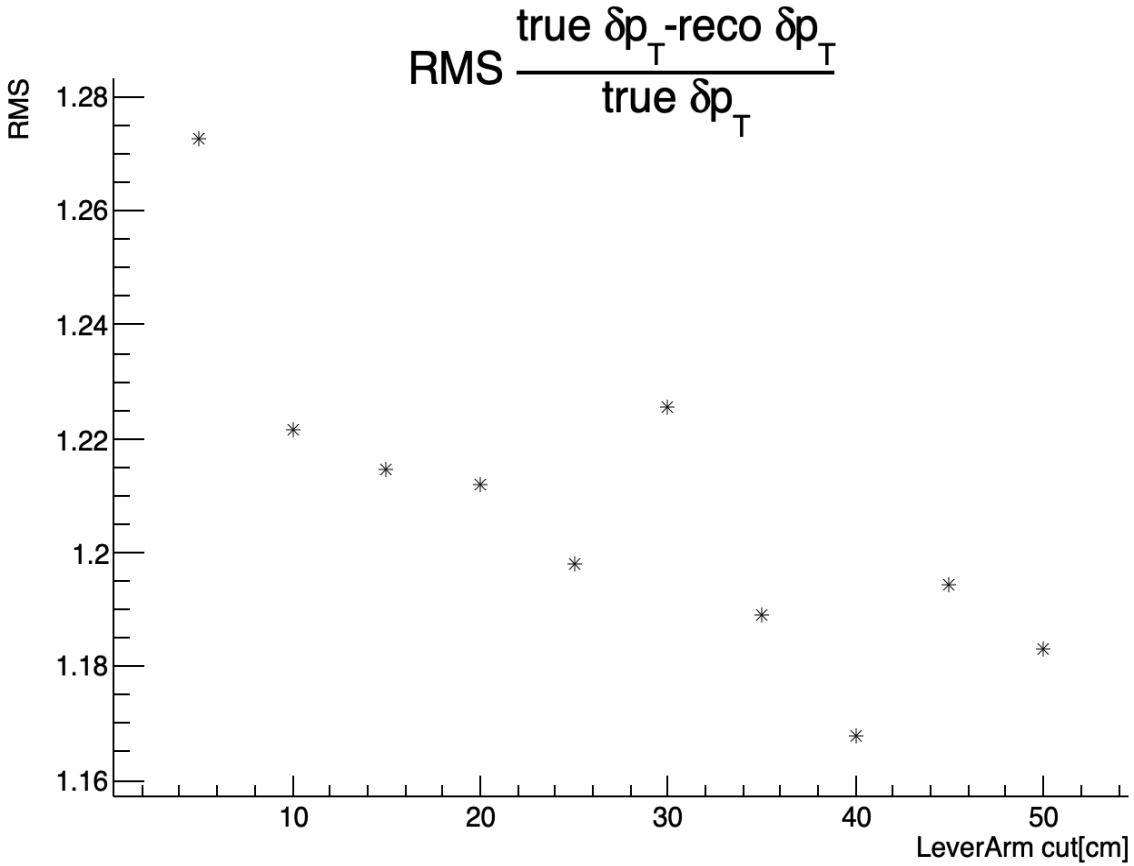
Need to projection on each event



[Signal of Cluster]

Reconstruct transverse momentum

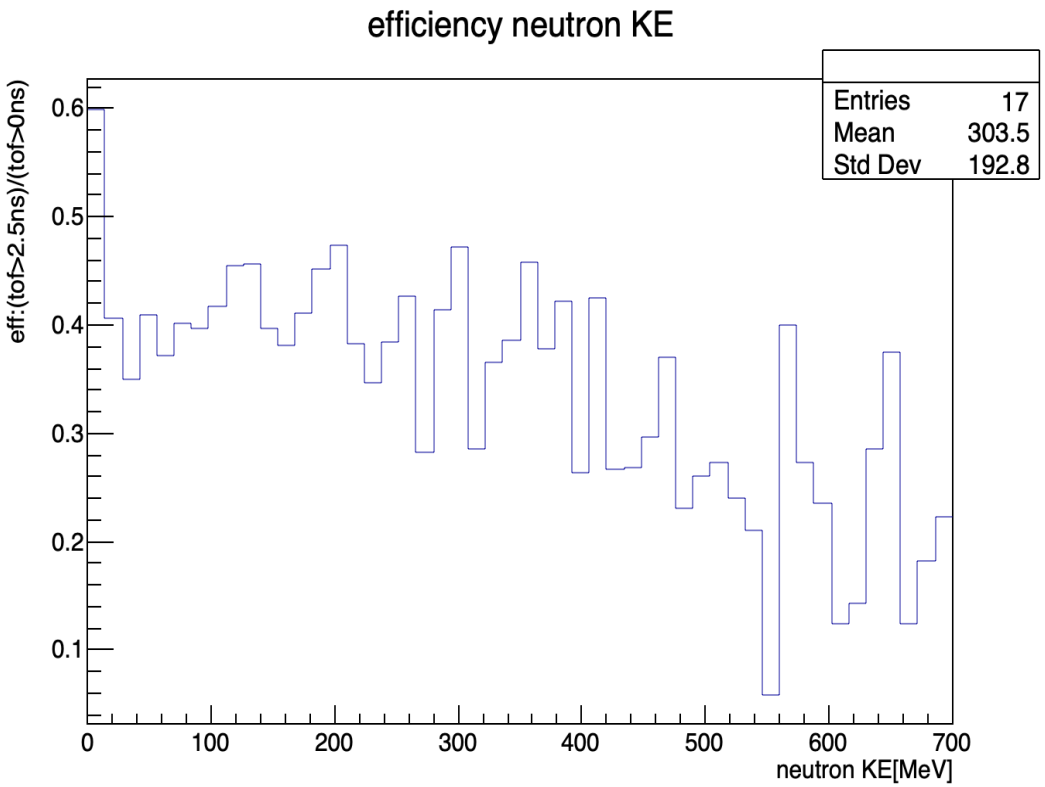




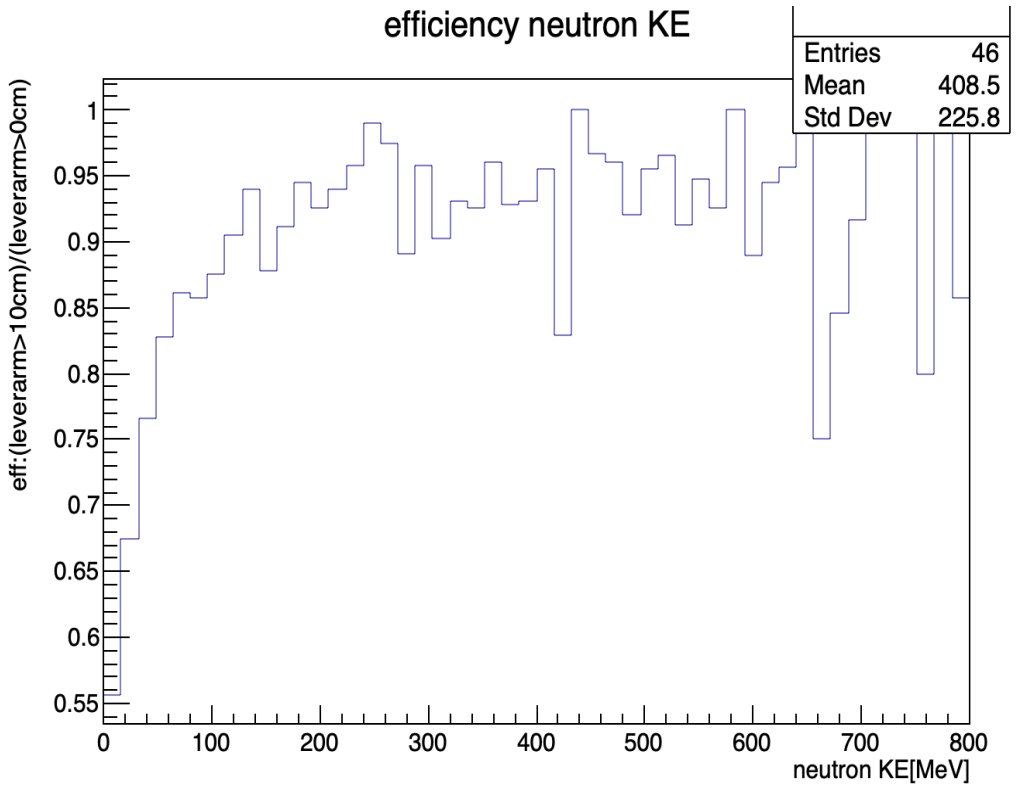
- If select 2.5ns tof cut and 10cm lever arm cut, we can get better reslut of $reconstructed\ \delta P_T$.
- We can't cut on both variables since that will induce a KE cut directly.

After cut phase space check!

After tof>2.5ns cut

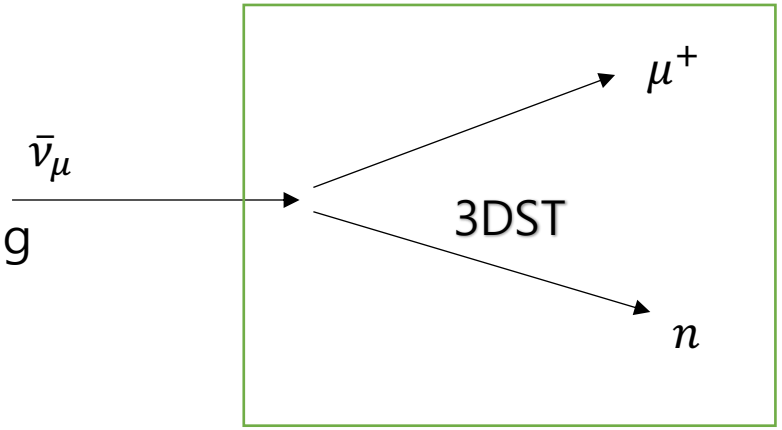


After leverarm >10cm cut

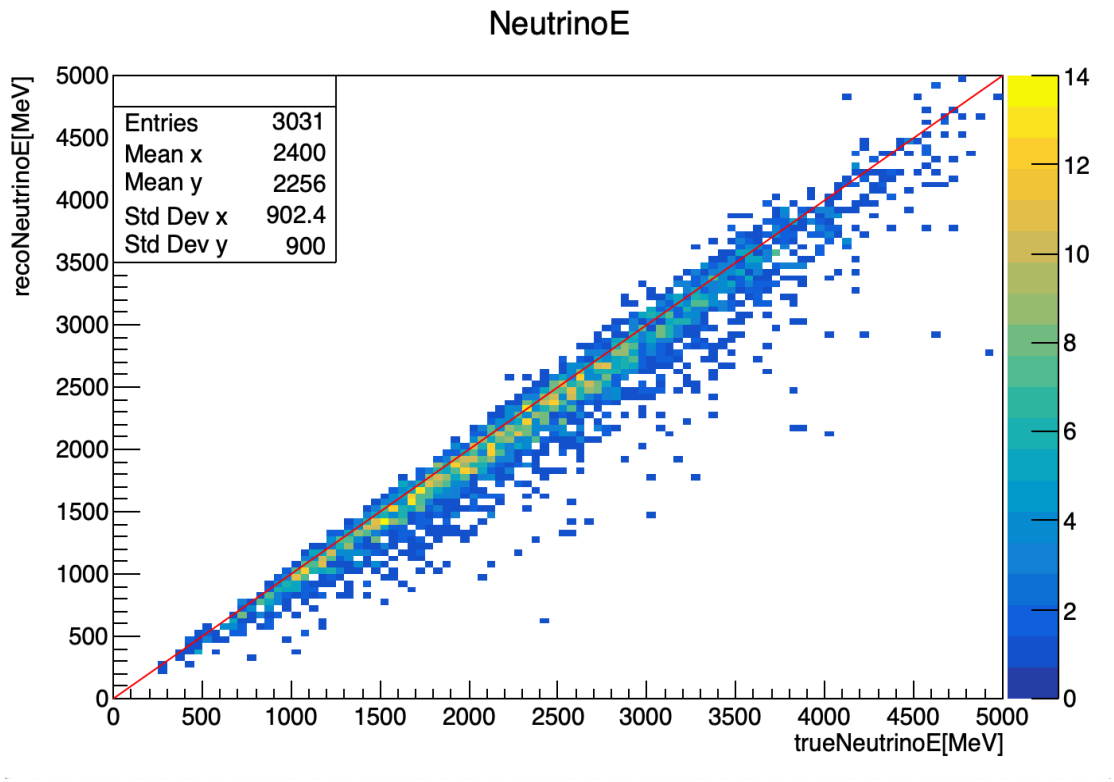


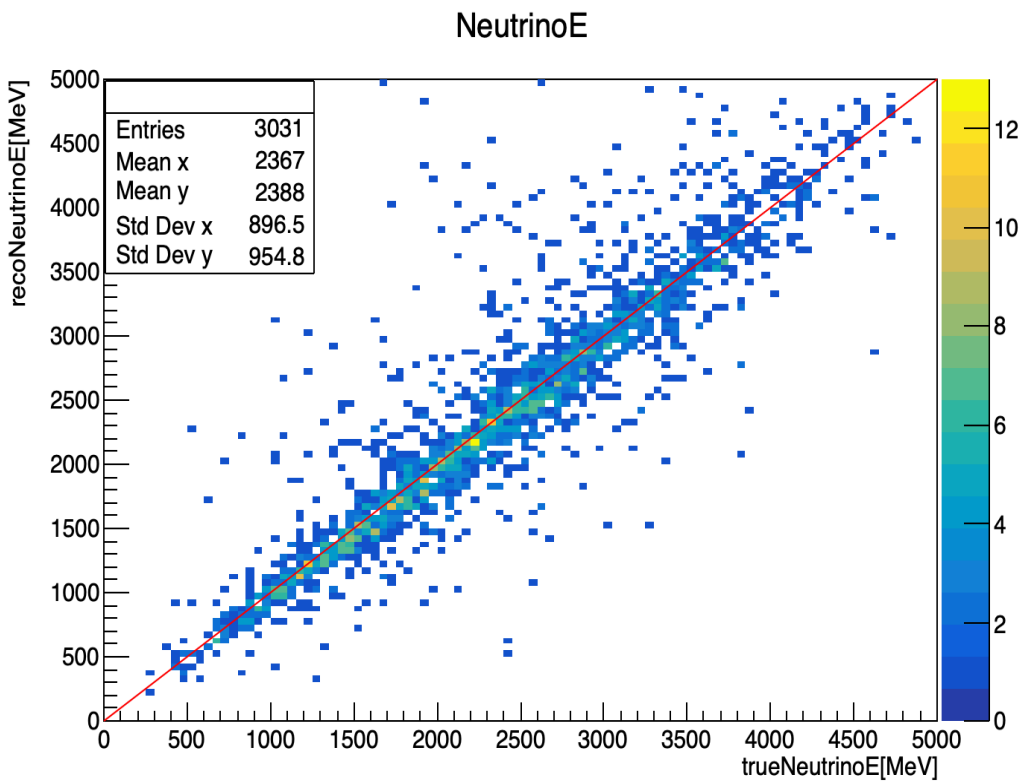
Usual way to get neutrino E

➢ Usually, sum all of the final particle energy deposit except muon inside fiducial volume and add muon energy considering 4% smearing



➢ But we have leverarm and tof of neutron!
Assume reconstruction neutrino energy equals to sum of neutron kinetic energy and muon energy.





Summary

-GENIE3 can make more final neutrons than GENIE2 can at all channel.

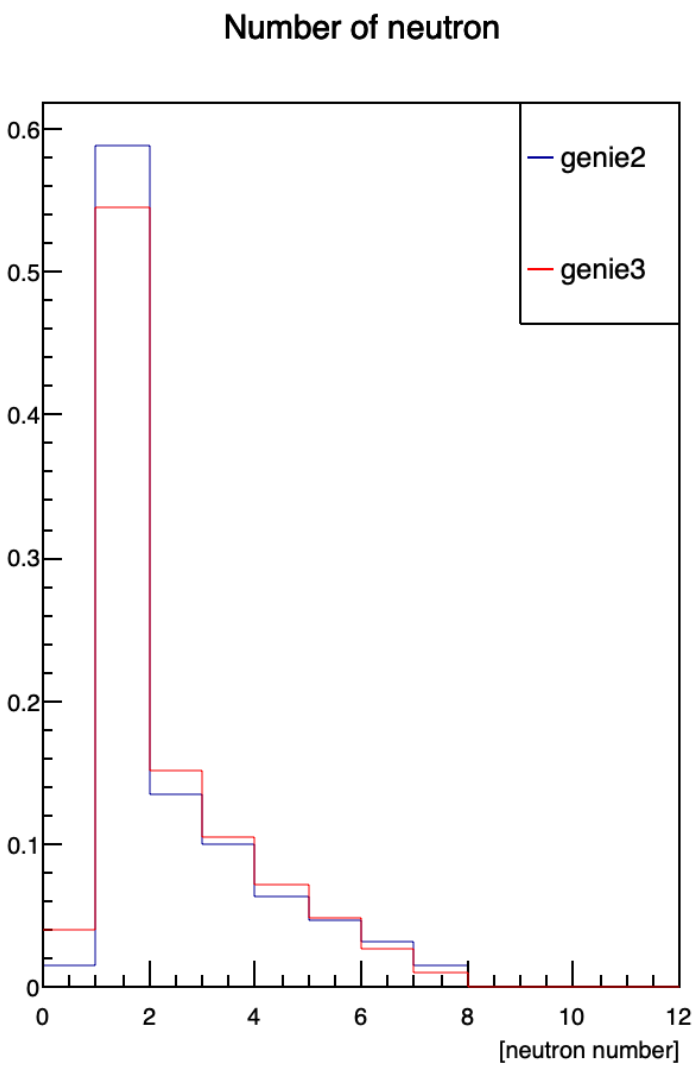
-Time resolution is reliable in the reconstruected file.

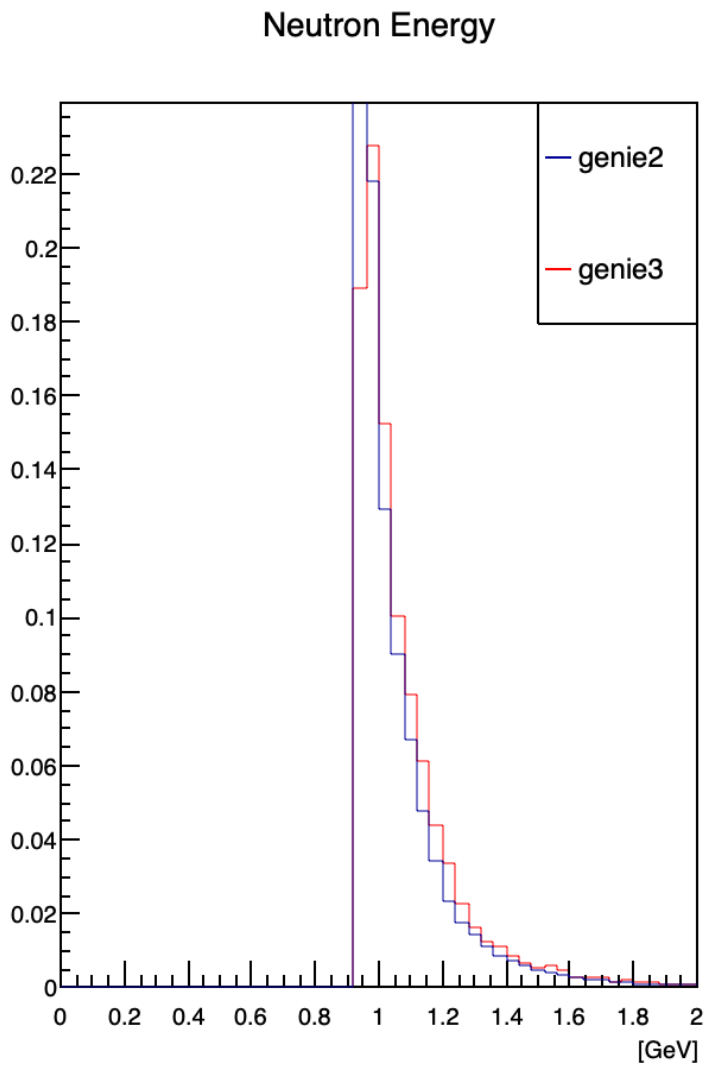
-Initial study suggest leverarm cut greater than 10cm, tof cut greater than 2.5ns will give us better δP_T reconstruction.

-We need to consider projection later in δP_T study.

Back up

Neutron number and energy in 0π channel

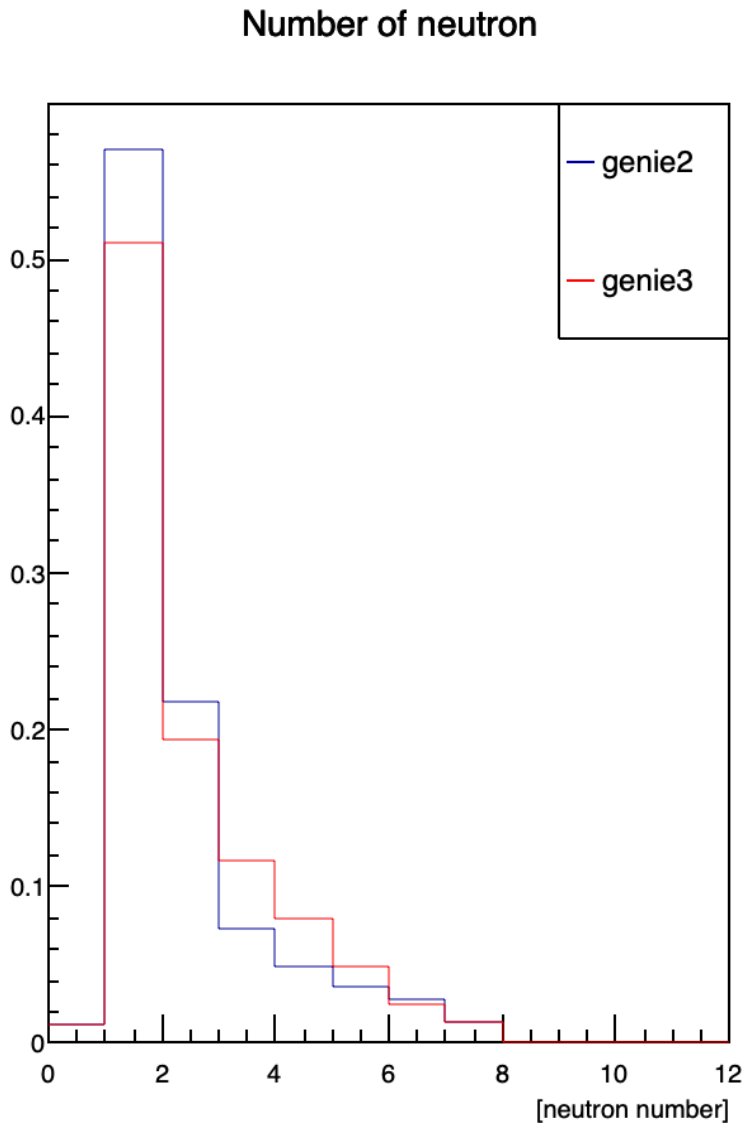


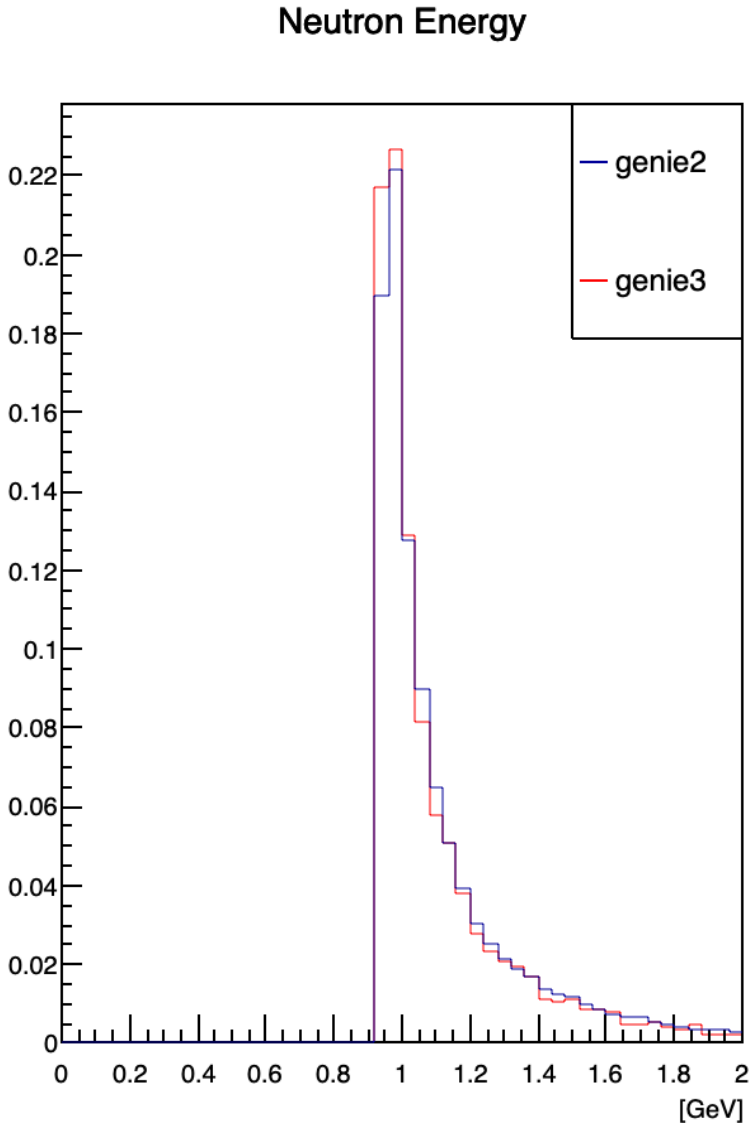


Average neutron number per event in 0π channel:
GENIE2: 1.95
GENIE3: 1.93

Number of events:
GENIE2: 84648
GENIE3: 12195

Neutron number and energy in $1\pi^0$ channel

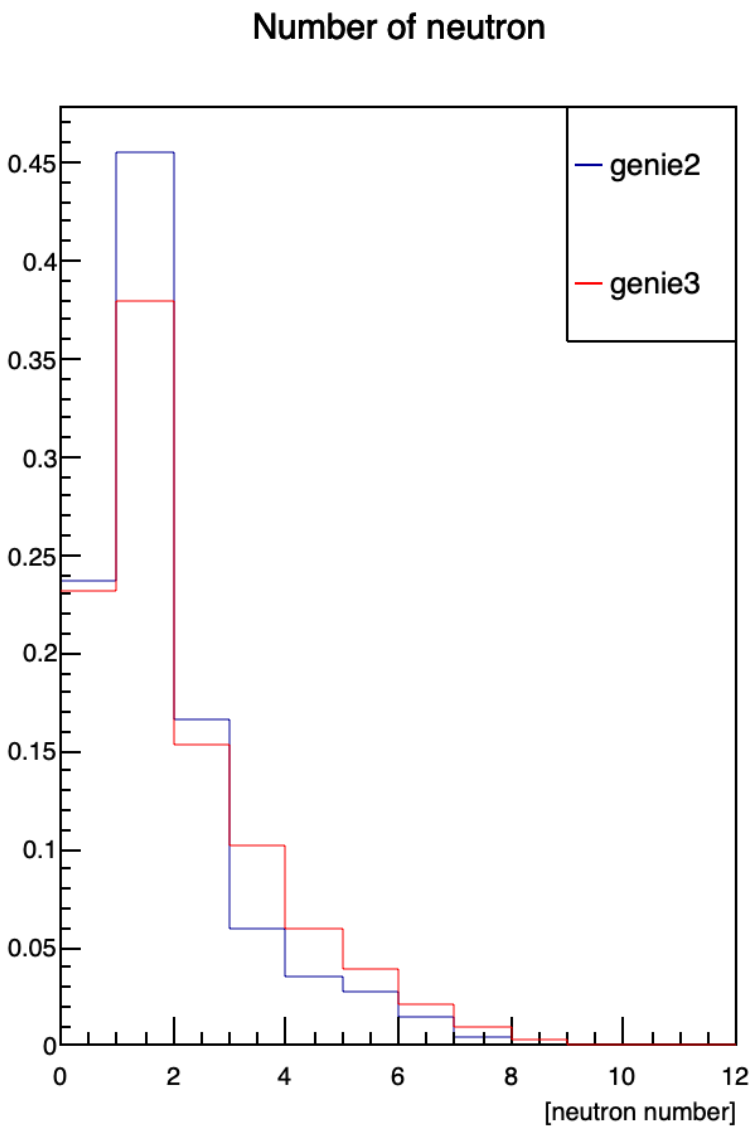


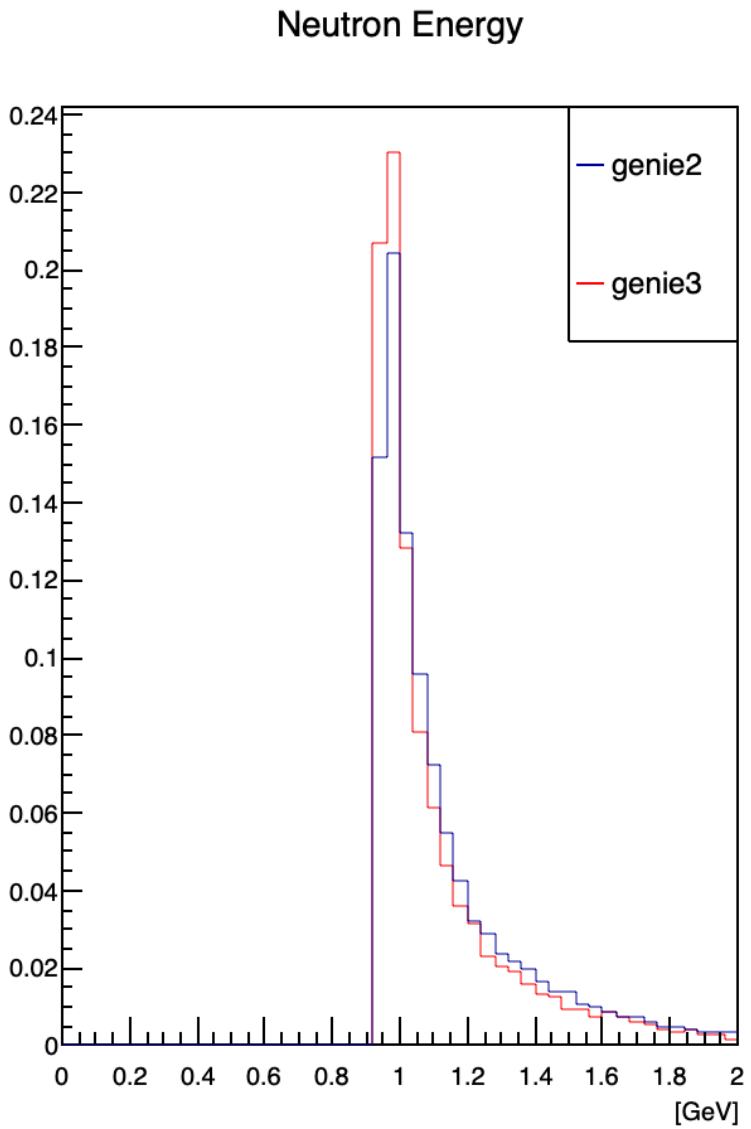


Average number of neutrons per event in $\mathbf{1\pi^0}$ channel:
GENIE2: 1.86
GENIE3: 2.05

Number of events:
GENIE2: 21860
GENIE3: 3862

Neutron number and energy in multiple π channel



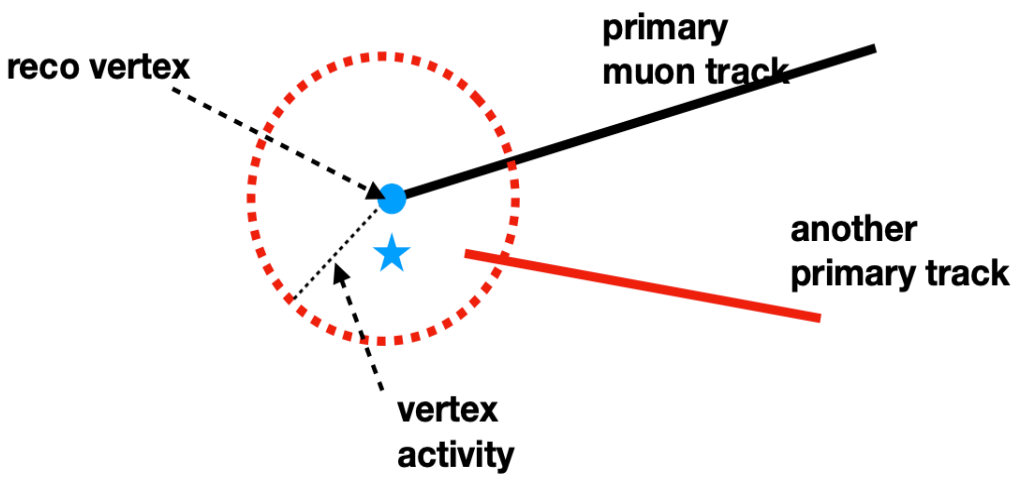


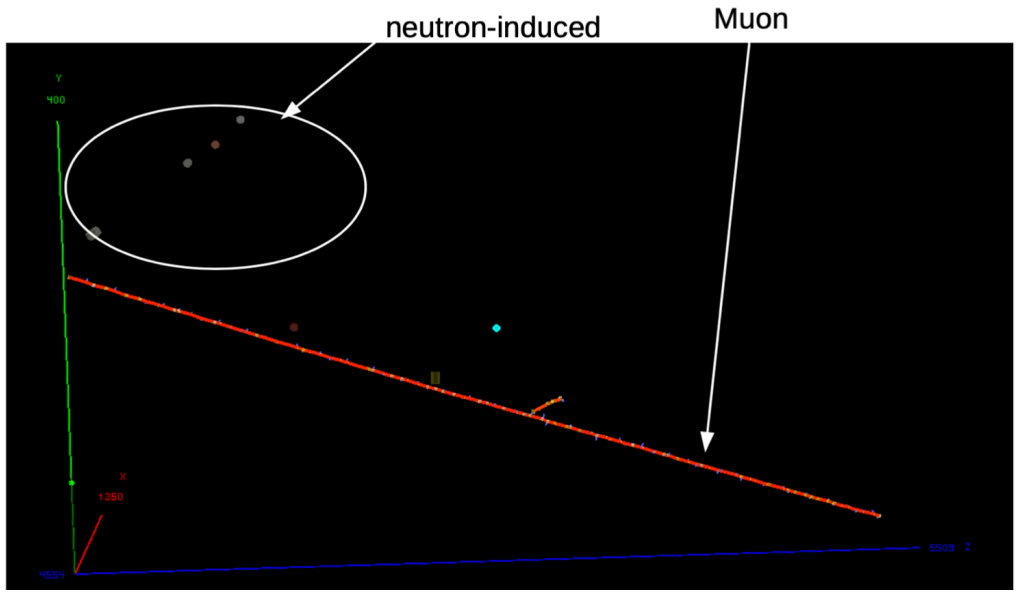
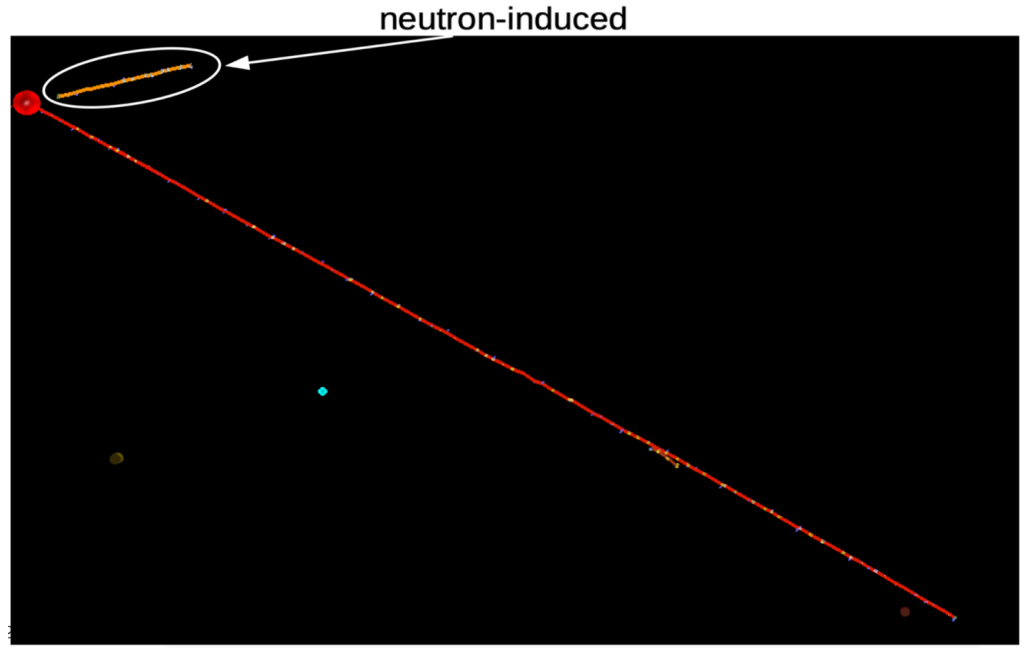
Average number of neutrons per event in multiple pion channel:
GENIE2: 1.37
GENIE3: 1.65

Number of events:
GENIE2: 37317
GENIE3: 7130

How to select the signal?

- we select the single track intending for CC0π



- Time of flight: muon time – object median time

- object includes cluster and track