ND-GAr-Lite Acceptance

Andrew Cudd
ND-GAr(-Lite) Meeting
2021/02/08

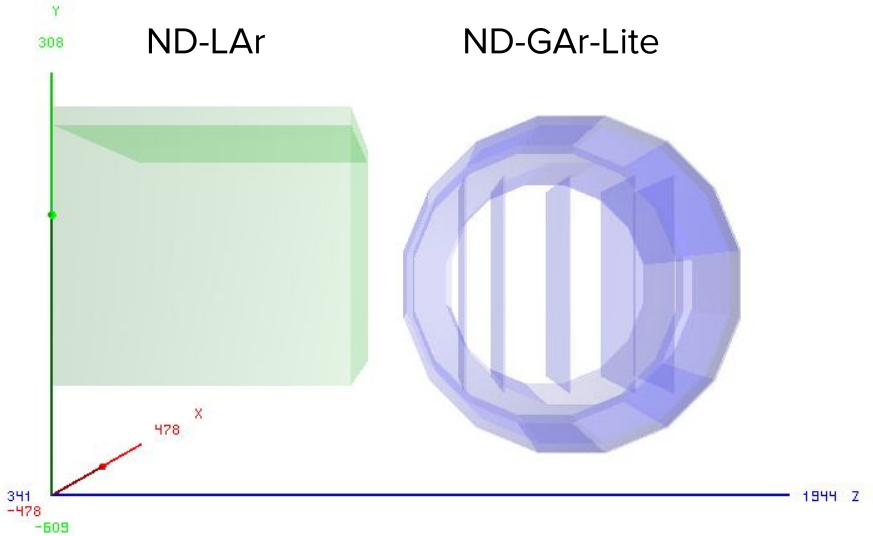
University of Colorado **Boulder**

Day 1 Near Detector

The Day 1 Near Detector configuration is ND-LAr plus a temporary muon spectrometer.

The two designs for the muon spectrometer are SSRI (sign-selected range instrument) and ND-GAr-Lite.

Primary function is to tag and measure muons exiting the liquid argon detector.



Define Acceptance

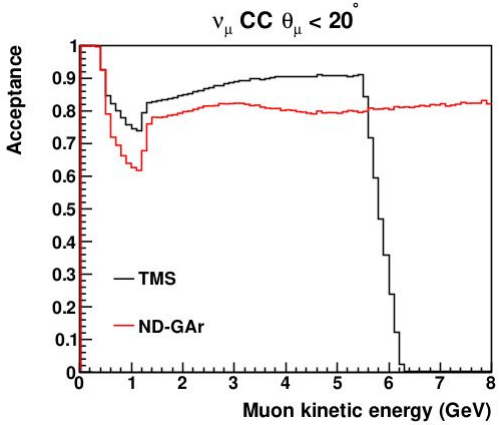
The acceptance for this presentation is defined as the geometrical acceptance of ND-LAr plus ND-GAr-Lite.

No reconstruction efficiencies were taken into account. In fact, no reconstruction was used at all!

All information used is the MC truth information about the incident neutrino and the outgoing muon.

A muon is **accepted** if it is either:

- Fully contained within the LAr active volume
- Crosses the first scintillator plane of GAr-Lite



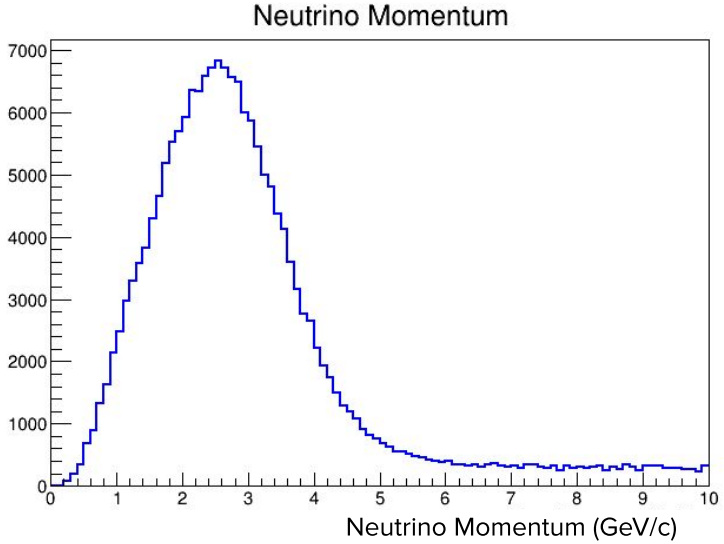
Neutrino Sample & Cuts

Neutrino sample with the ND-LAr and ND-GAr-Lite geometry produced by Eldwan.

Selected numu CC events where the neutrino vertex was within the LAr active fiducial volume ➔ 50 cm cut from all faces except the downstream z-face, where it is 150 cm.

Optionally select events where the angle between the neutrino direction and the muon is less than 20 degrees.

NB: This simulation was performed with the uniform magnetic field.



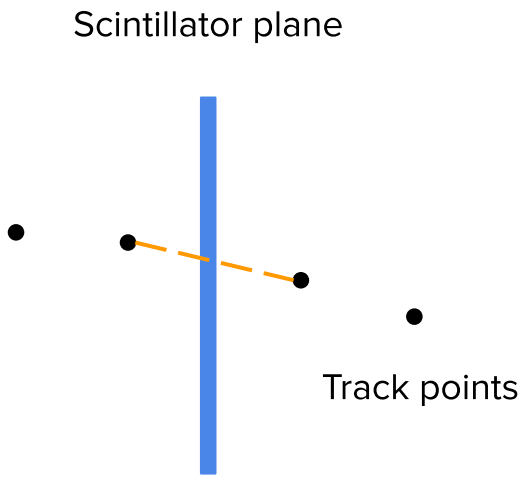
Intersecting Planes

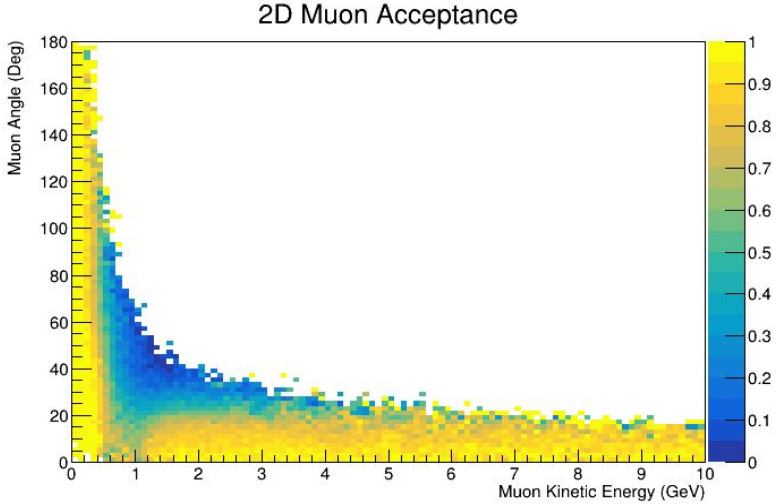
Given a 3D line and a 2D plane, calculate the point where the line intersects the plane (if at all).

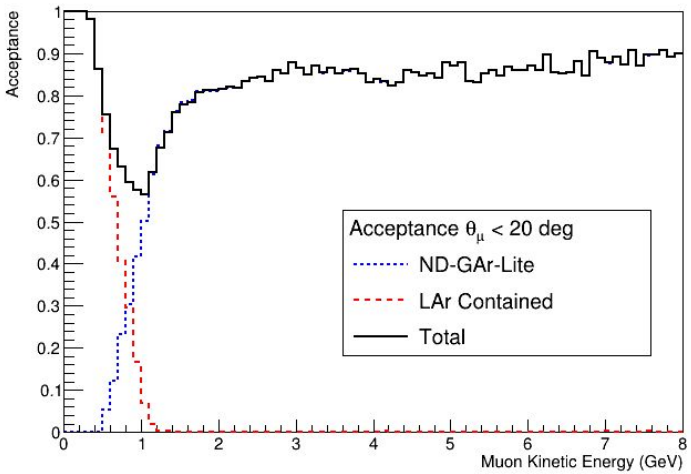
Find the true muon trajectory points in front and behind the first scintillator plane.

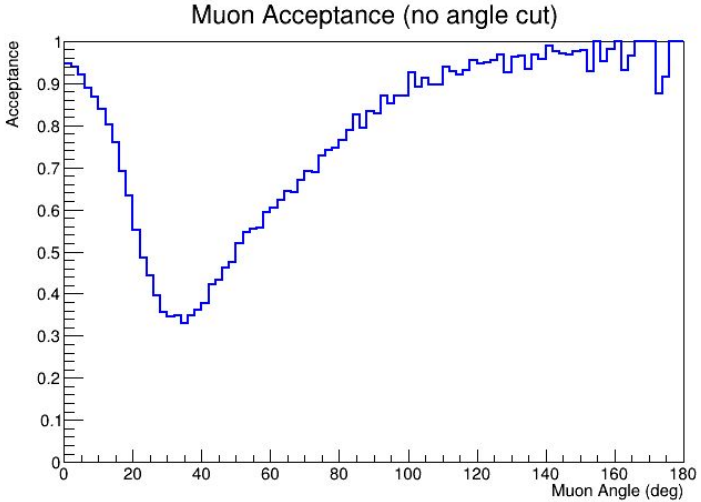
Draw a vector between them and calculate the intersection with the (infinite) scintillator plane.

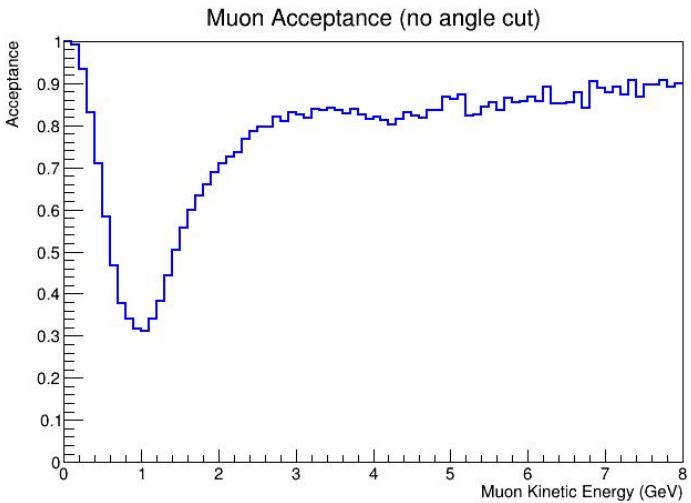
Check if intersection falls within the scintillator boundary.

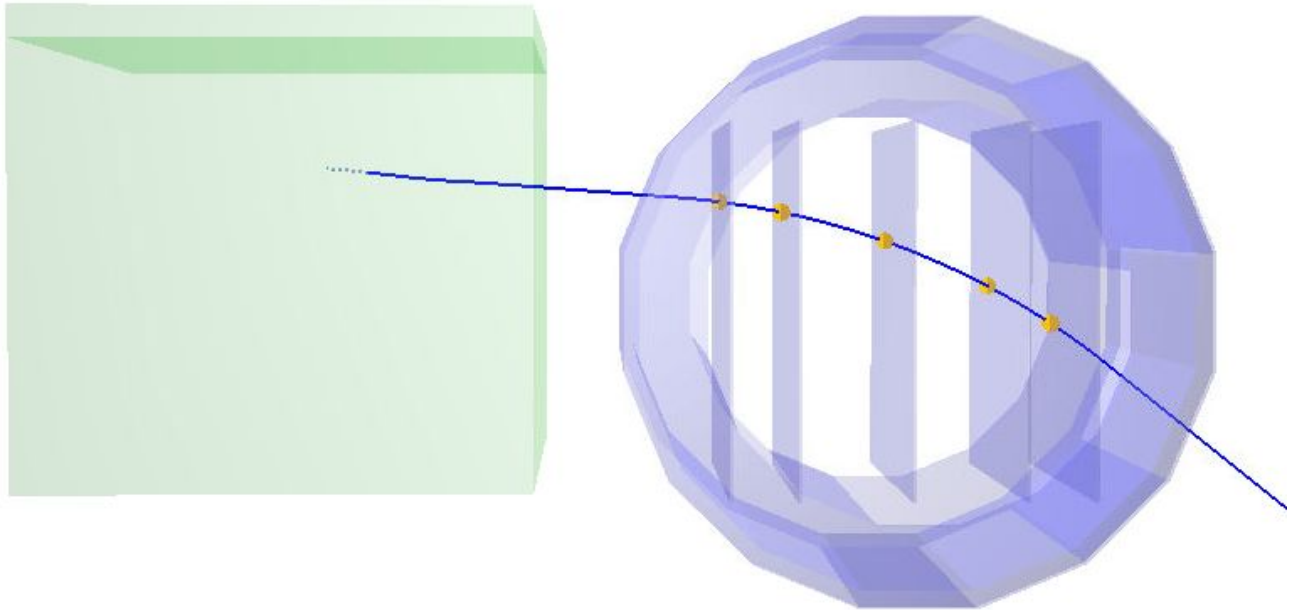



2D Muon Acceptance
Muon Angle (Deg)
Muon Kinetic Energy (GeV)

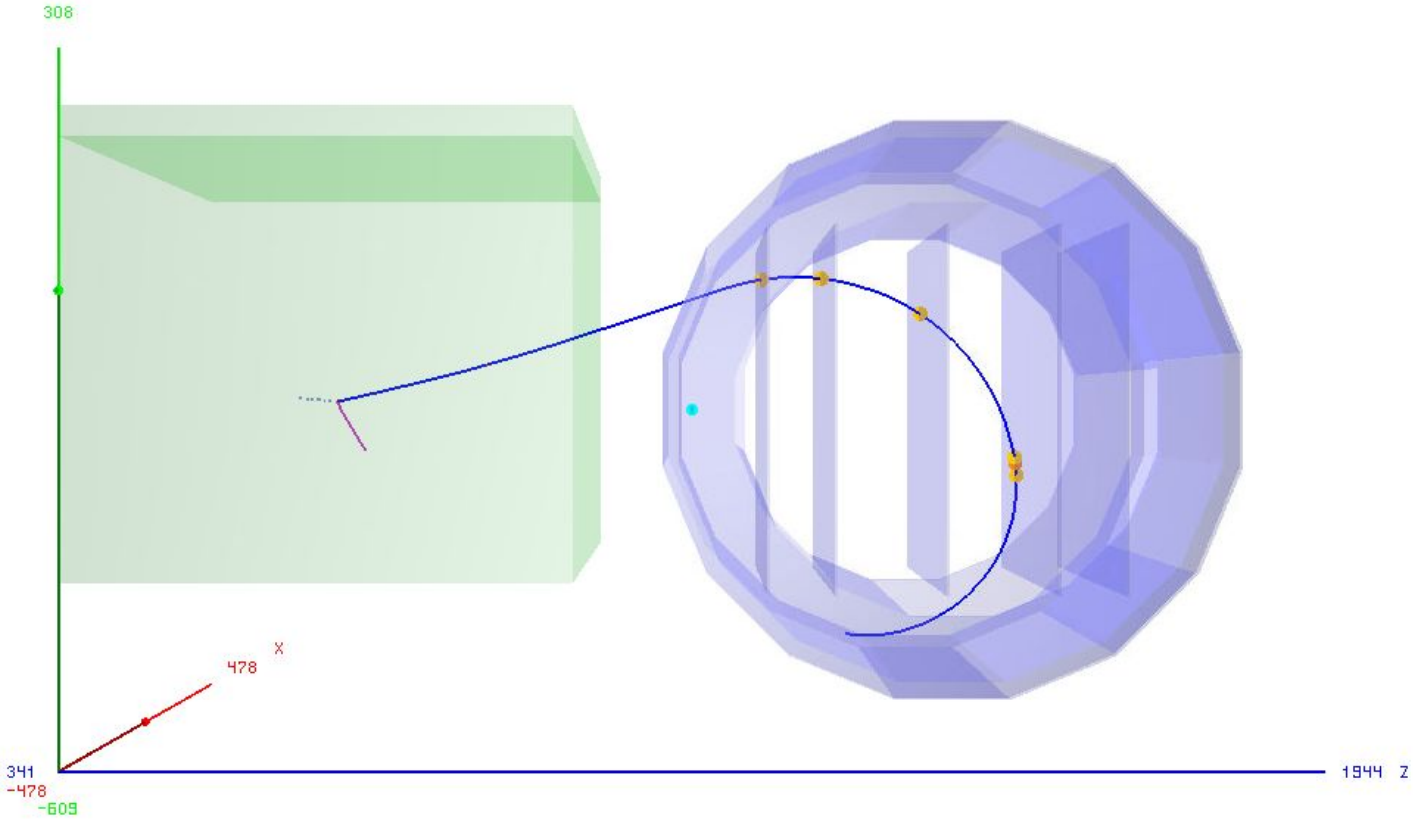

Acceptance
Muon Kinetic Energy (GeV)
Acceptance θ_μ < 20 deg
ND-GAr-Lite
LAr Contained
Total


Muon Acceptance (no angle cut)
Acceptance
Muon Angle (deg)

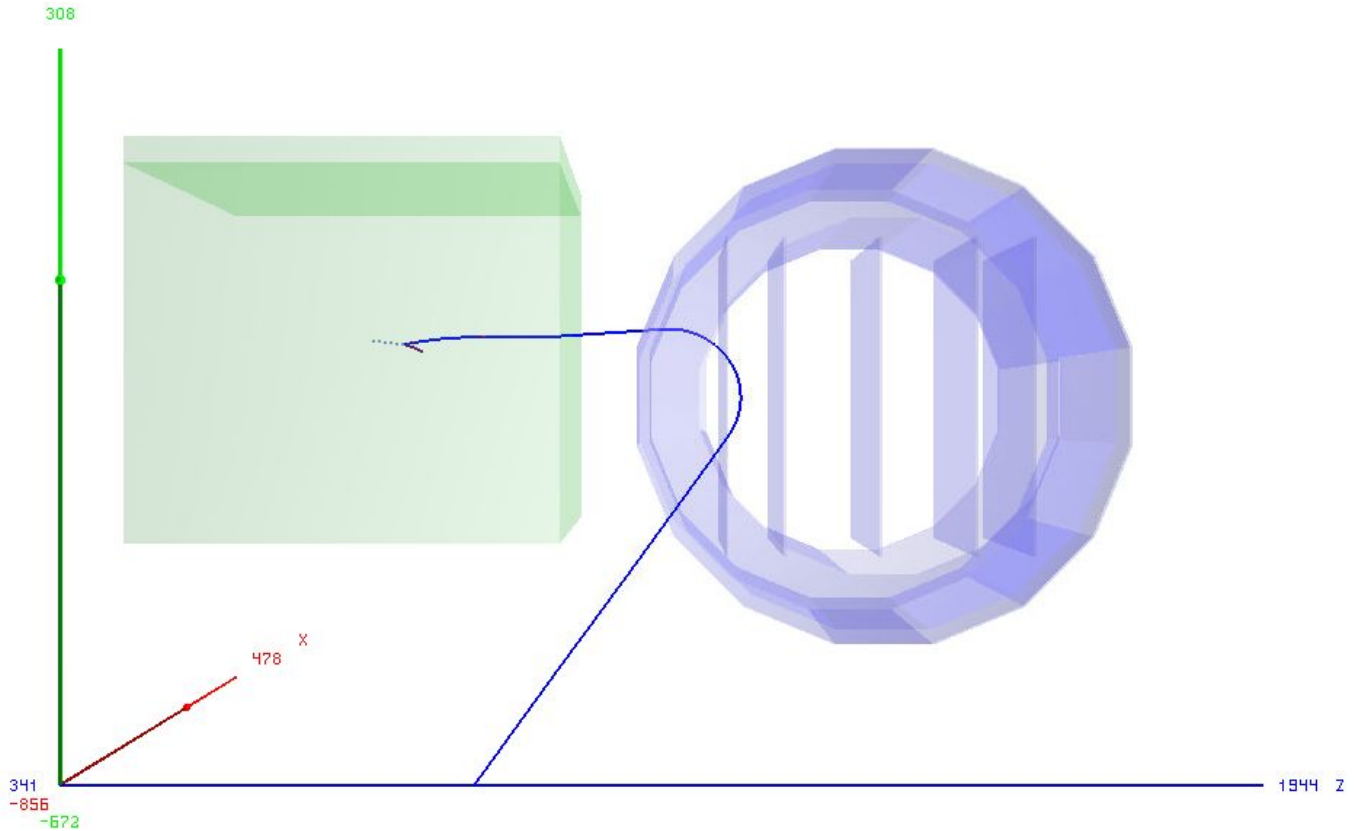

Muon Acceptance (no angle cut)
Acceptance
Muon Kinetic Energy (GeV)



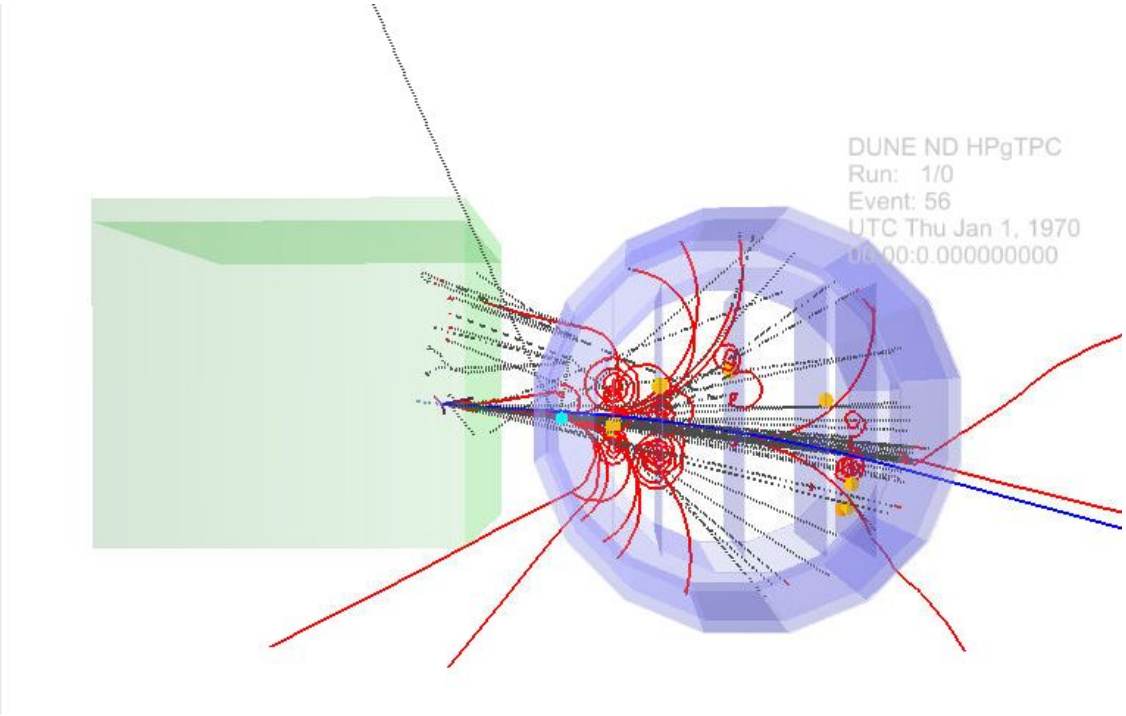
Event Displays!



Event Displays!



Event Displays!



Event Displays!

Apologies for the poor image resolution.

Summary

Geometrical acceptance of ND-GAr-Lite is similar to ND-GAr and SSRI.

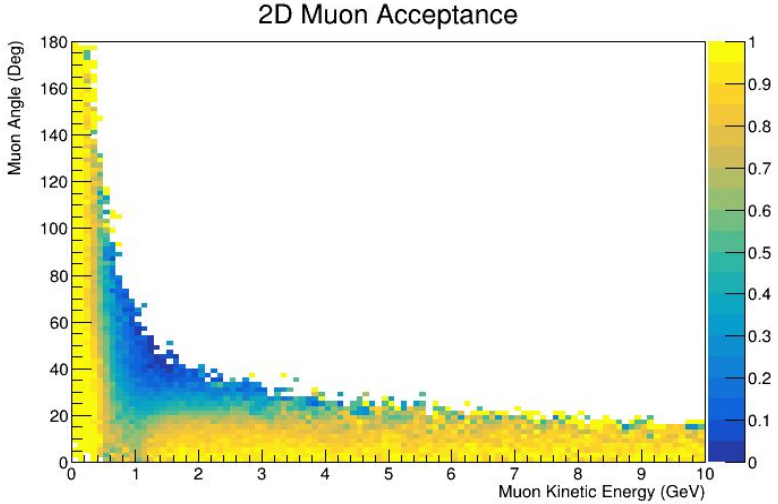
Differences are probably due to assumptions made in the calculation of acceptance, or due to the differing geometry between the three detectors.

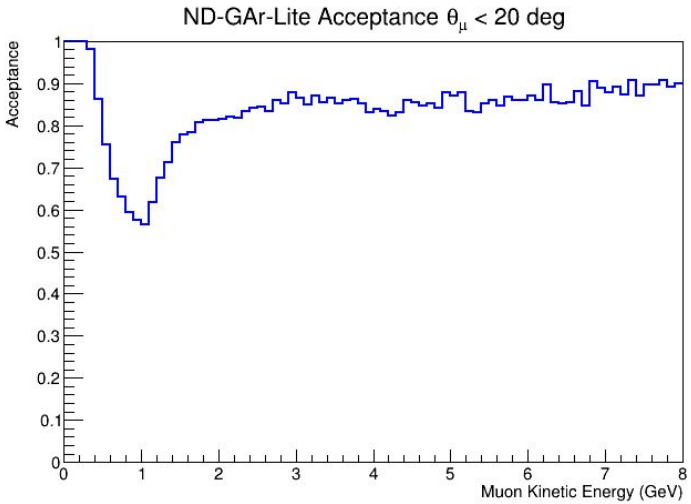
Defining acceptance by hitting the first plane is not the same thing as reconstructing tracks.

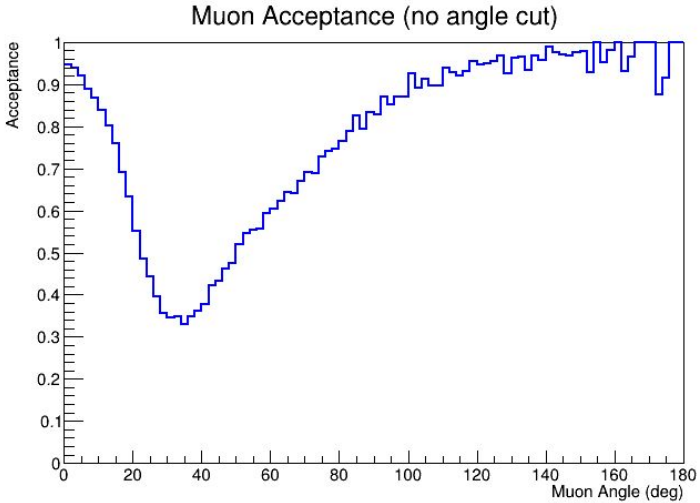
Next steps:

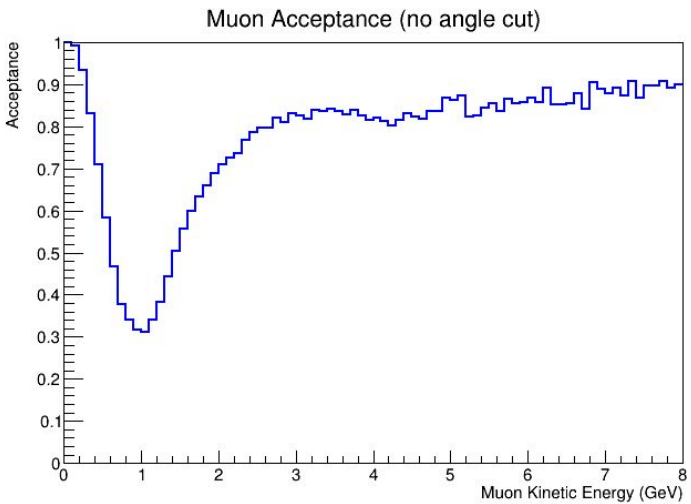
- Implement track matching for calculating actual efficiency.
- Adjusting the scintillator plane spacing for increased acceptance/efficiency at low muon momentum/energy.
- Simulate with magnetic field map.

Backup


2D Muon Acceptance
Muon Angle (Deg)
Muon Kinetic Energy (GeV)


ND-GAr-Lite Acceptance θ_μ < 20 deg
Acceptance
Muon Kinetic Energy (GeV)


Muon Acceptance (no angle cut)
Acceptance
Muon Angle (deg)


Muon Acceptance (no angle cut)
Acceptance
Muon Kinetic Energy (GeV)