

Muon Monitor Initial Plots

Nate Muetzel

Importance

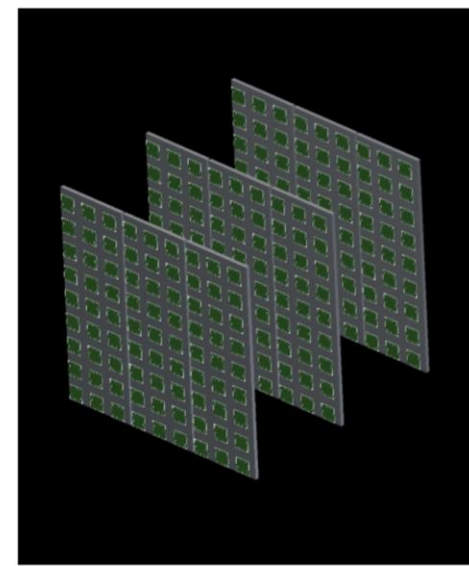
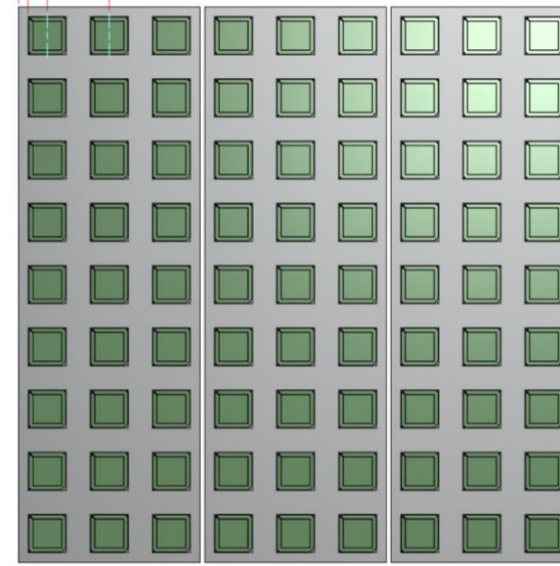
- Provide insight into Muon signals due to changing beam parameters
- Understand abilities and limitations of proposed muon monitoring systems
- Update previous study prior to absorber update

Introduction

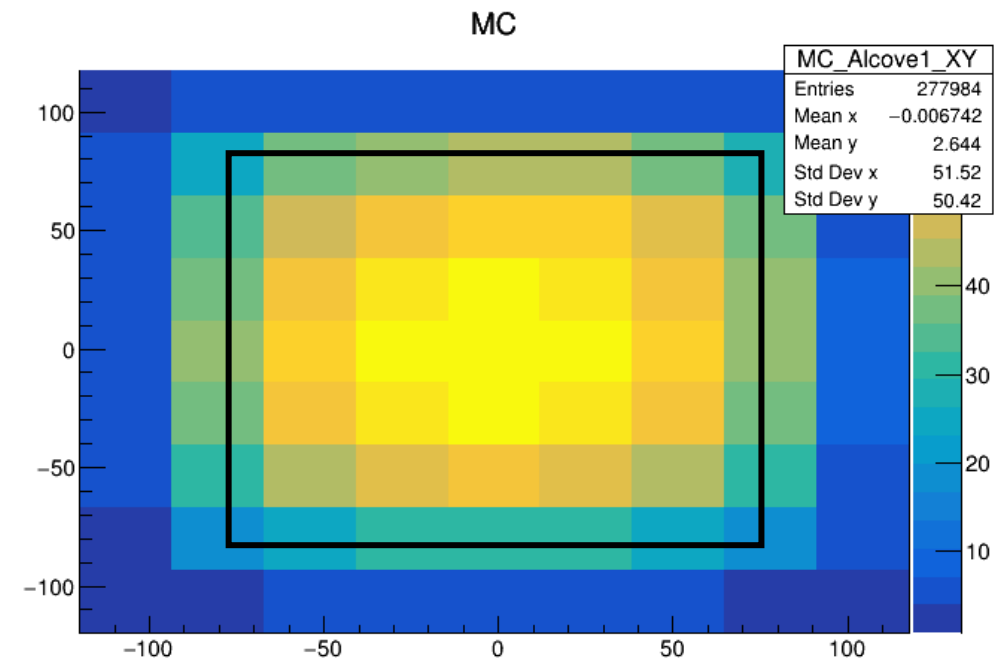
- Plots Made
 - 2-Dimensional Muon Flux
 - 1-Dimensional Muon Flux
 - Neutrino Flux at Far Detector
- Nominal – perfectly aligned beam
- 50M POT – low statistics

Muon Monitors (MuMs)

- Muon Monitors consist of 3 Monitors
- Plots are from Monitor 1
- Plotted information is larger than the MuMs

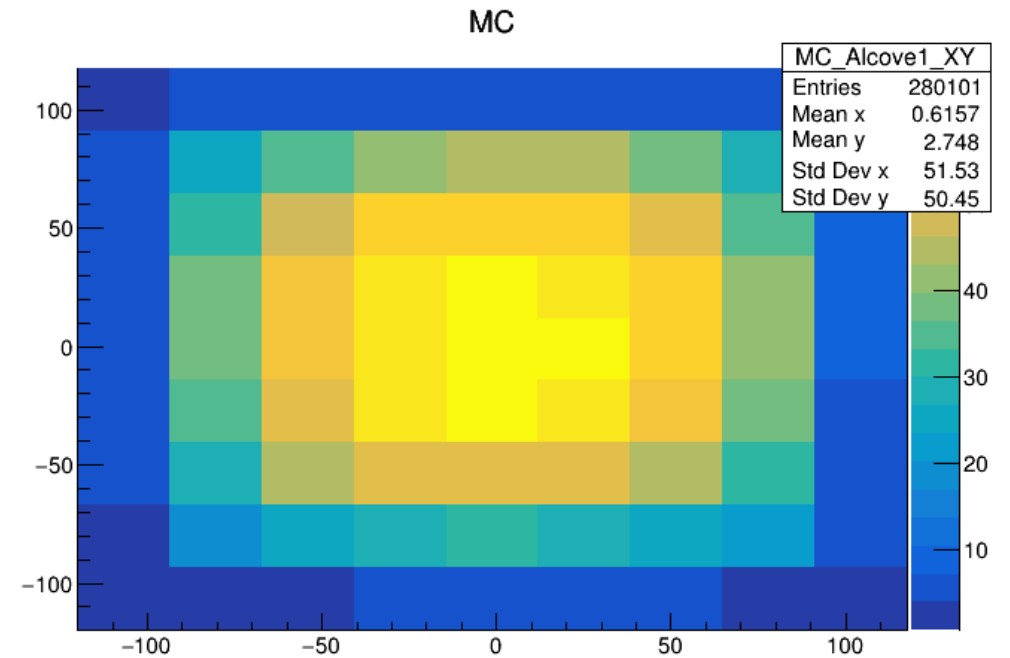
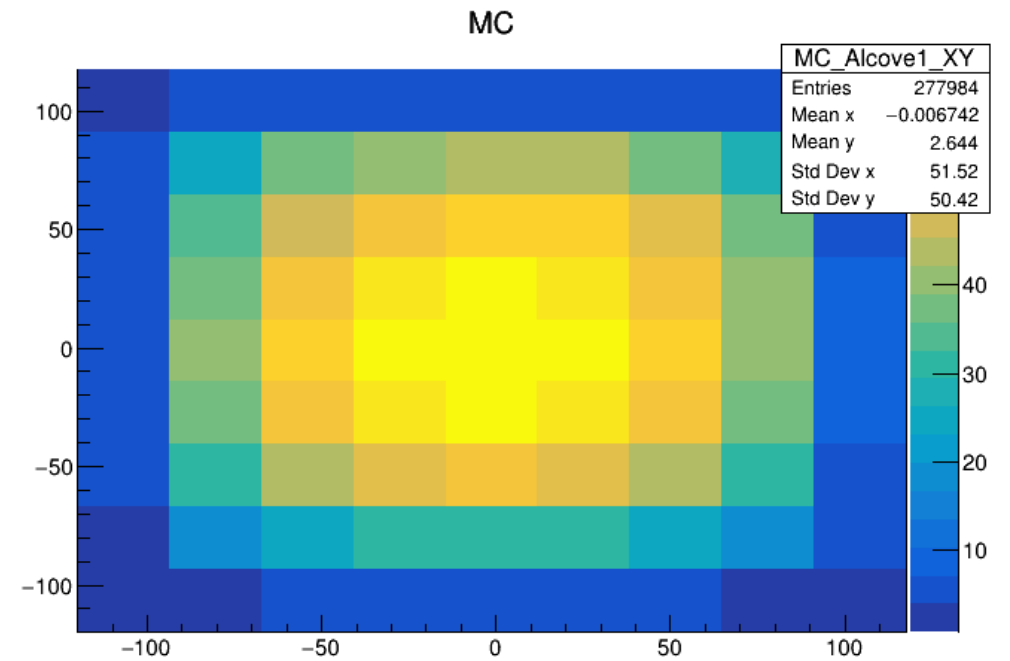


Beamline Technical Design Report



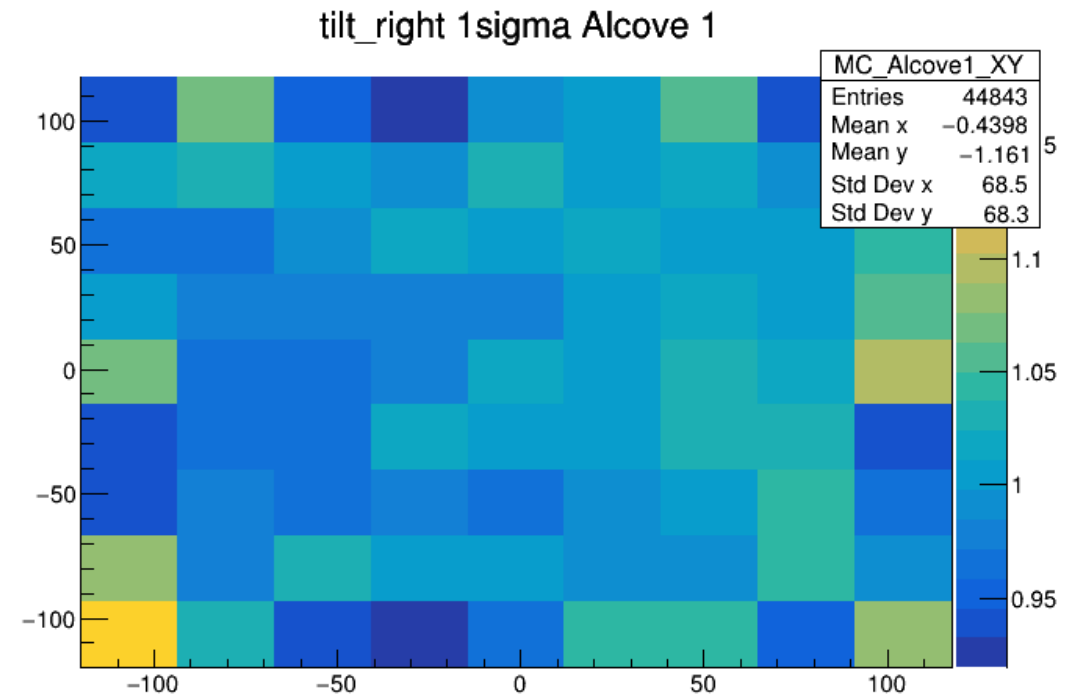
Process

- Initial plots were produced for each simulation
- Nominal seen on top
- Example adjusted plot on bottom – Horn A Tilt Right
- Normalized per 100000 POT



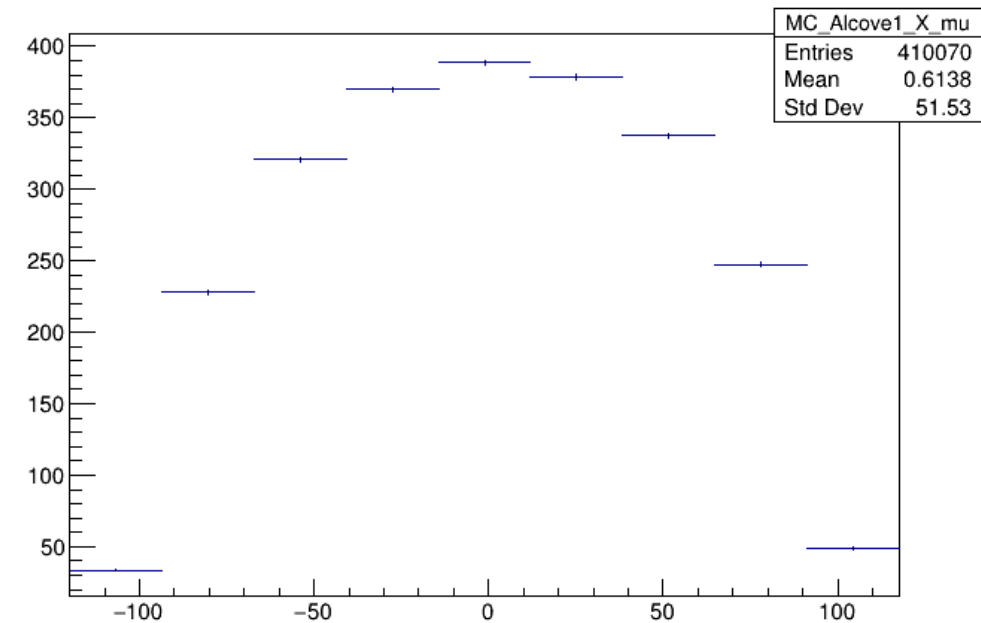
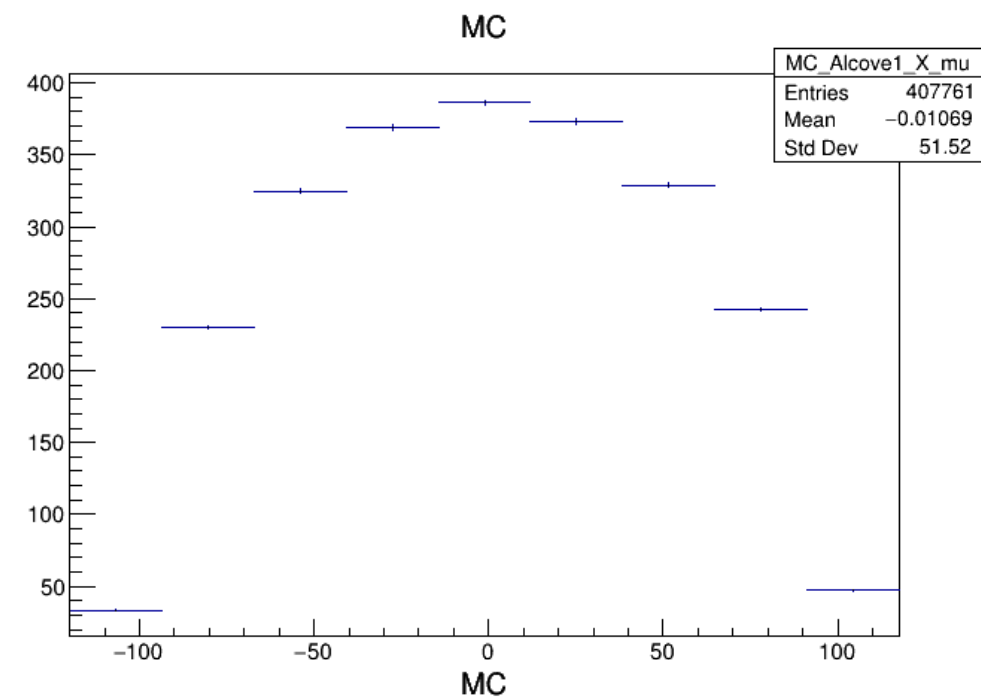
Process

- Ratio taken between adjusted simulation and nominal
- Typically not able to draw conclusions



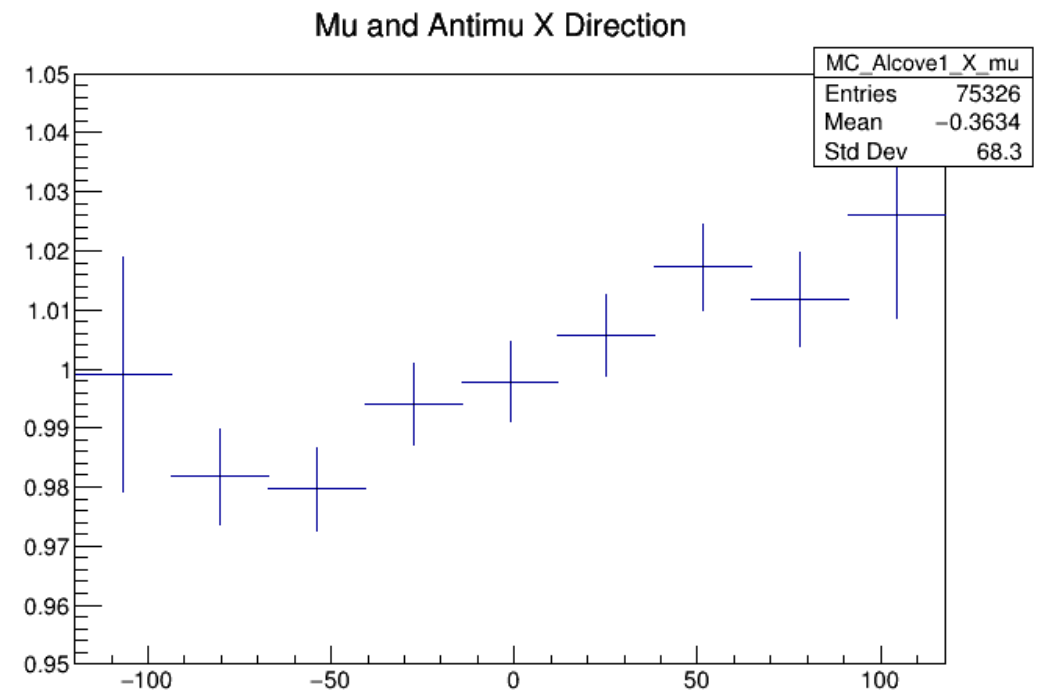
Process

- Similar Process taken for one-dimensional plots
- Nominal seen on top
- Example adjusted simulation below – Horn A Tilt Right



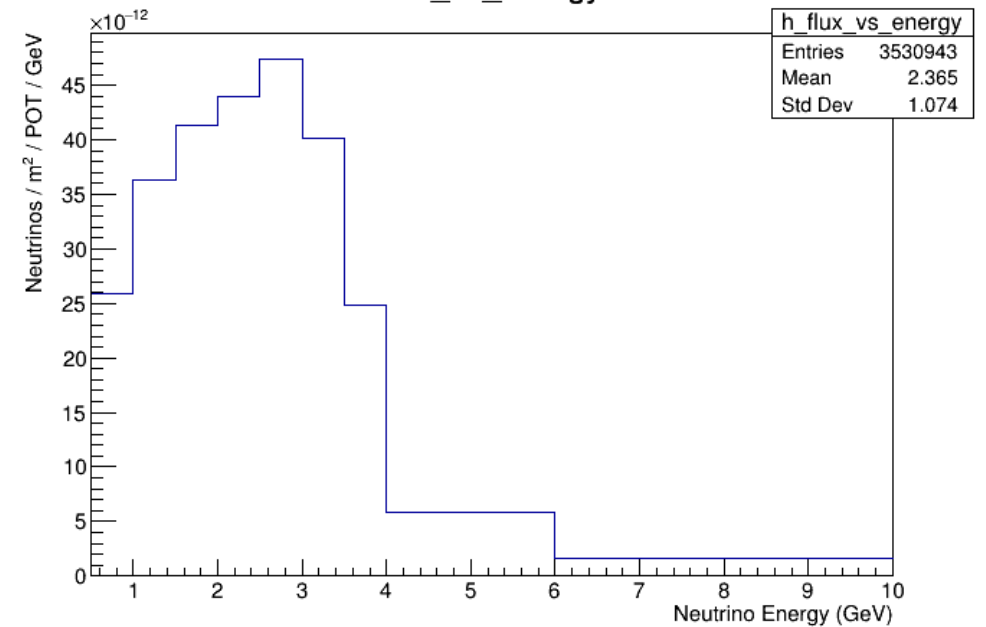
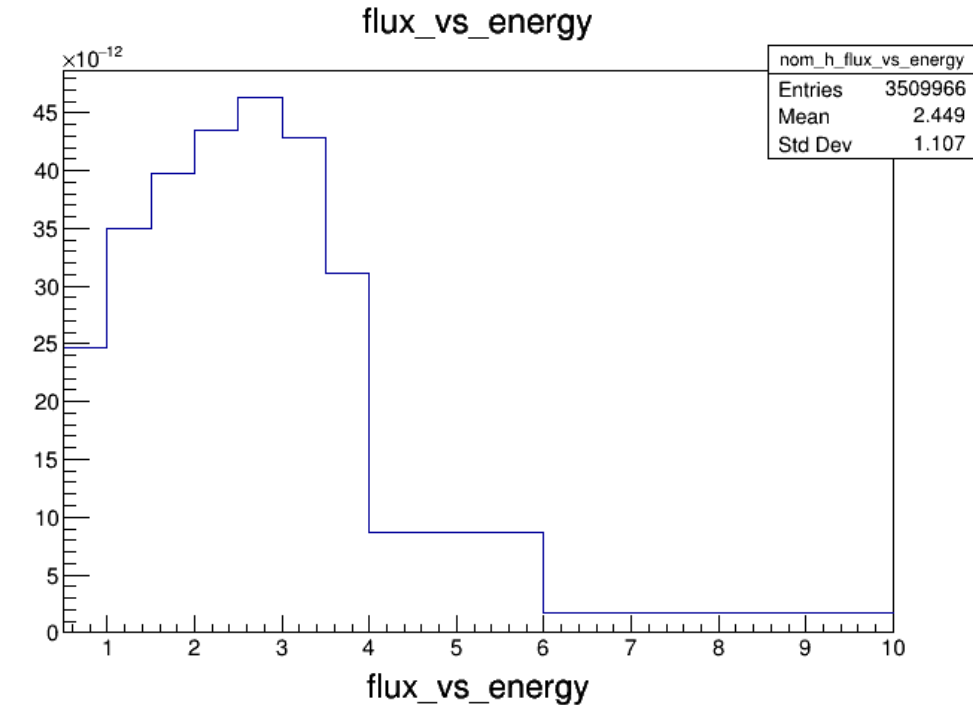
Process

- Ratio taken between adjusted simulation and nominal simulation
- Plots made for both X and Y Direction



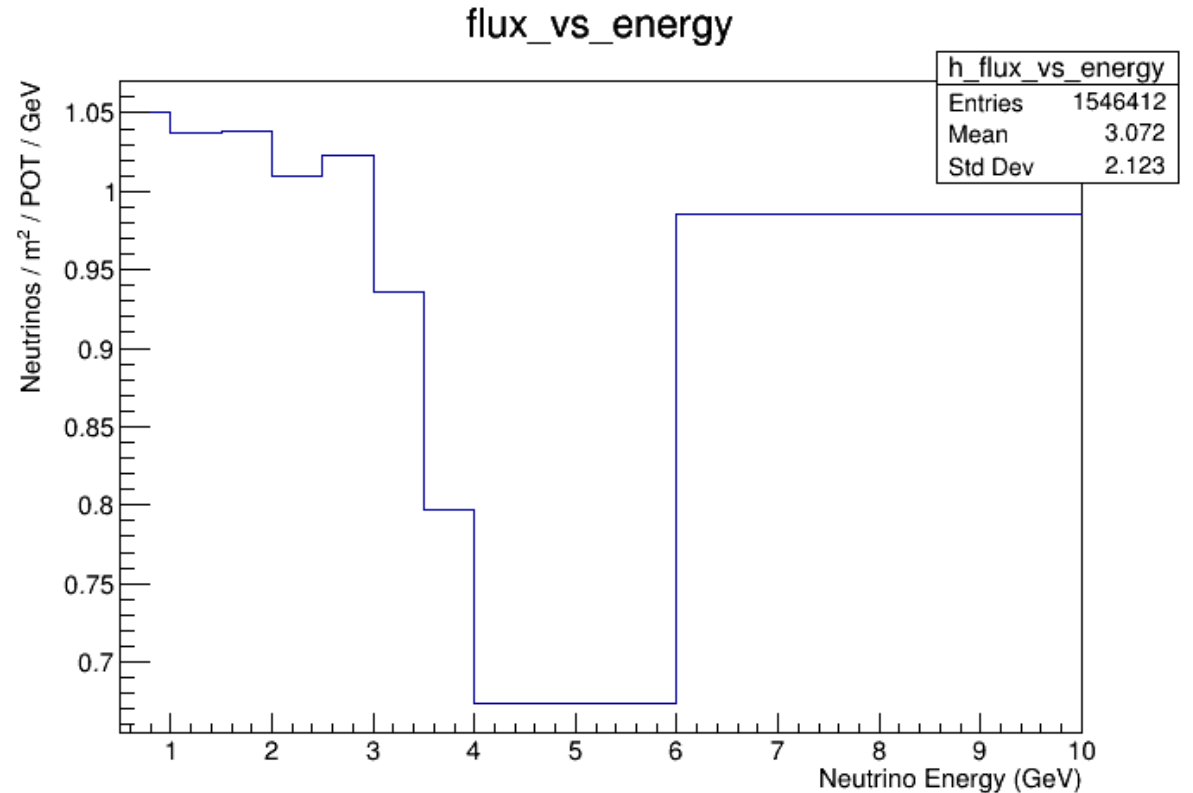
Neutrino Plots

- The same process was carried out for neutrino plots
- Nominal simulation is shown at the top
- Example adjusted is shown on bottom – target upstream degradation



Neutrino Plots

- Ratio taken between adjusted and nominal
- Total neutrino flux
- Muon neutrino flux



- Visible Signal
- No Visible Signal

List of Parameters

Horn A, B, and C

- Eccentricity mX
- Eccentricity pX
- Ellipticity mX
- Ellipticity pX (A)
- Move backward
- Move forward
- Move up
- Move down
- Move left
- Move right
- Tilt up (A,C)
- Tilt down (A,C)
- Tilt left (A,C)
- Tilt right (A,C)

Proton Beam

- Angle X Down
- Angle X Up
- mX
- mY
- pX
- pY
- Radius increase
- Radius decrease

Horn Current

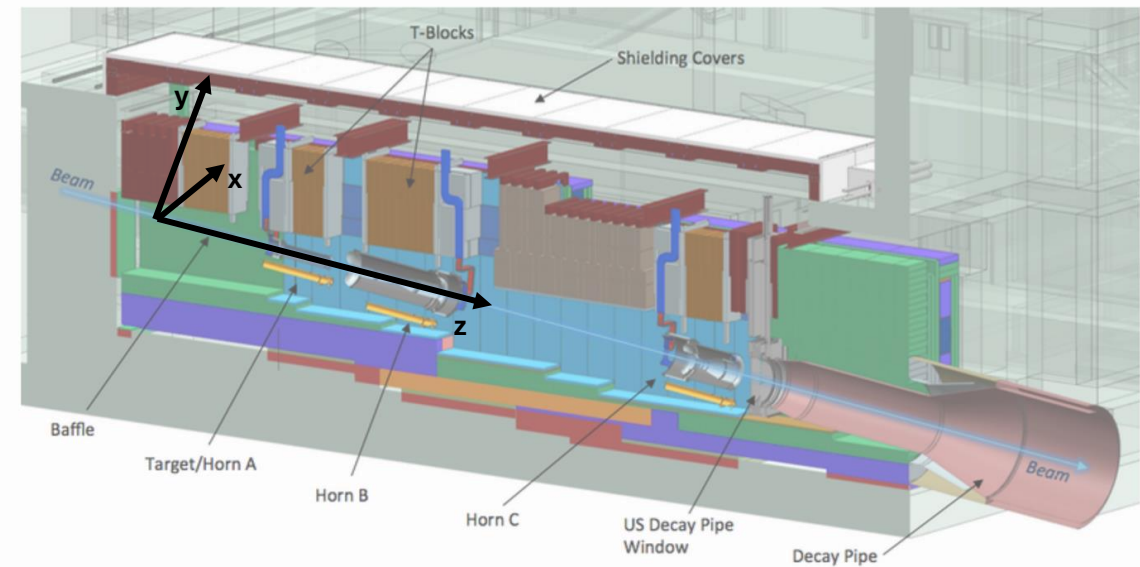
- 297 kA
- 303 kA

Target

- Density Decrease
- Density Increase
- Move backward
- Move forward
- Move up
- Move down
- Move right
- Move left
- Tilt up
- Tilt down
- Tilt right
- Tilt left
- Upstream Degredation

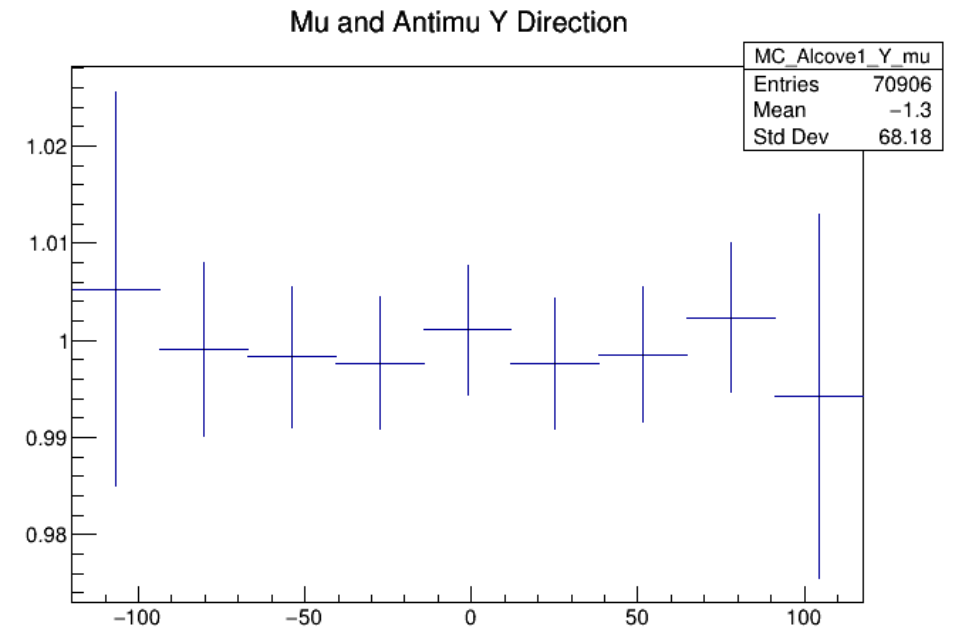
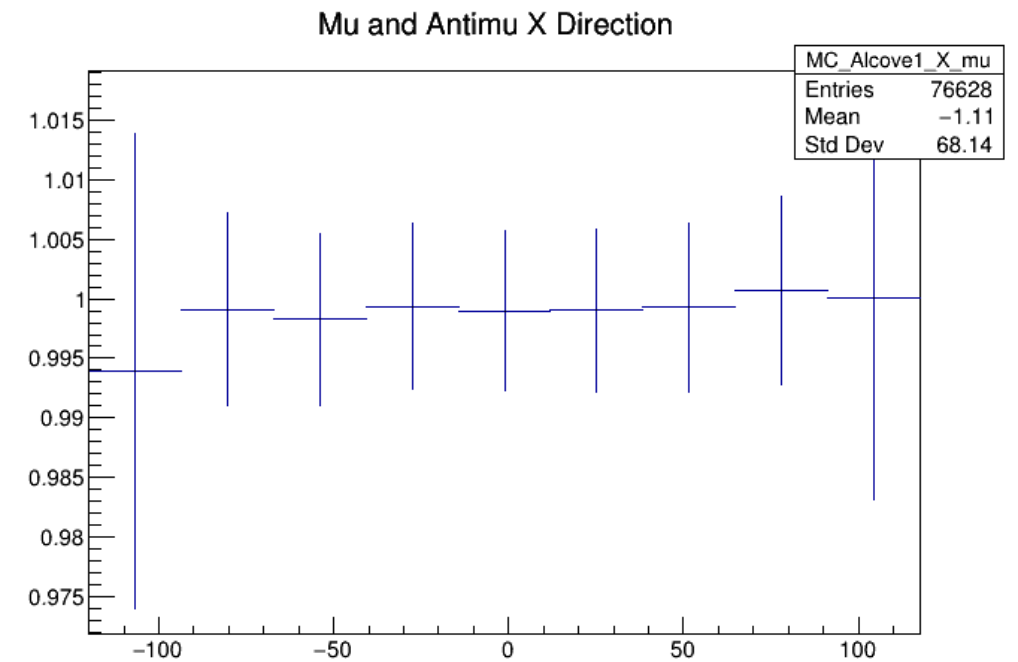
Horn Parameters

- Eccentricity – Inner Conductor z-axis off set from beamline z-axis
 - 0.035 mm (0.070 mm) – Horn A (B/C)
- Ellipticity – distortion of inner conductor radius along x-direction
 - 0.12 mm (0.18 mm) – Horn A (B/C)
- mX = “minus” X
- pX = “positive” X
- Move = 0.5 mm
- Tilt = 0.5 mm at downstream end

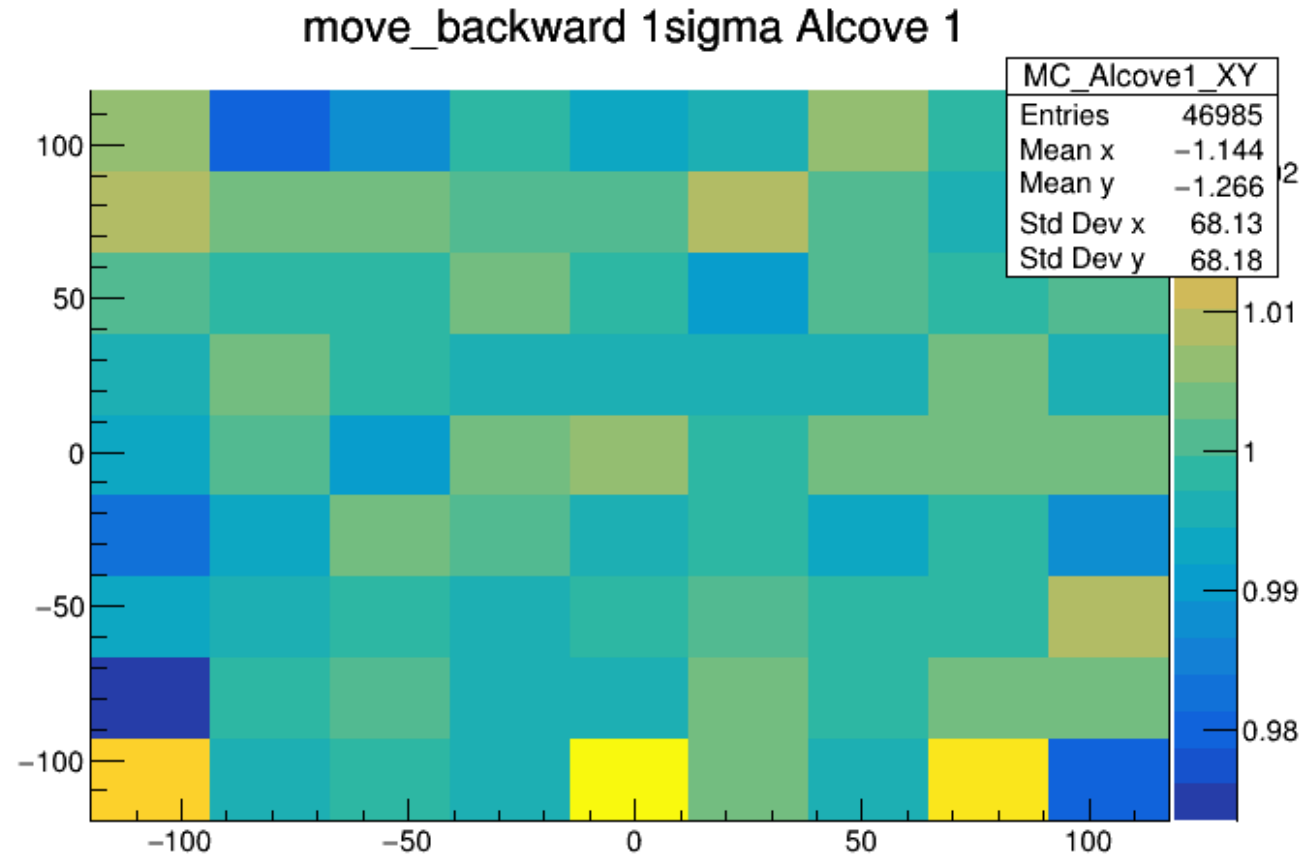


No Visible Signal

- Many ratio plots showed no visible signal
- Example – Horn A Move Backward

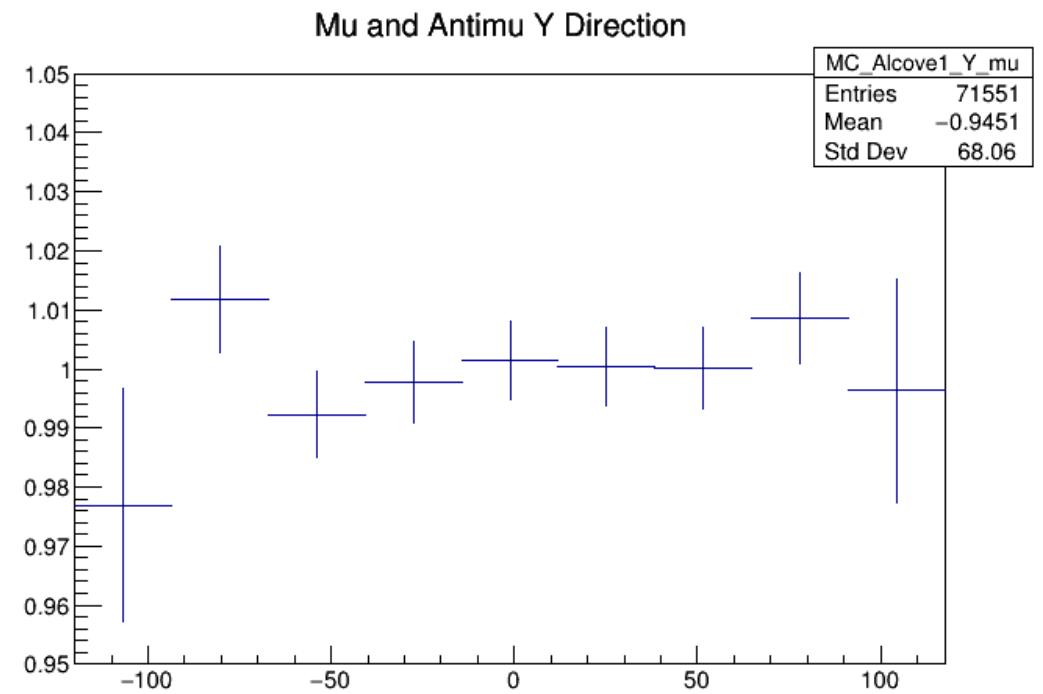
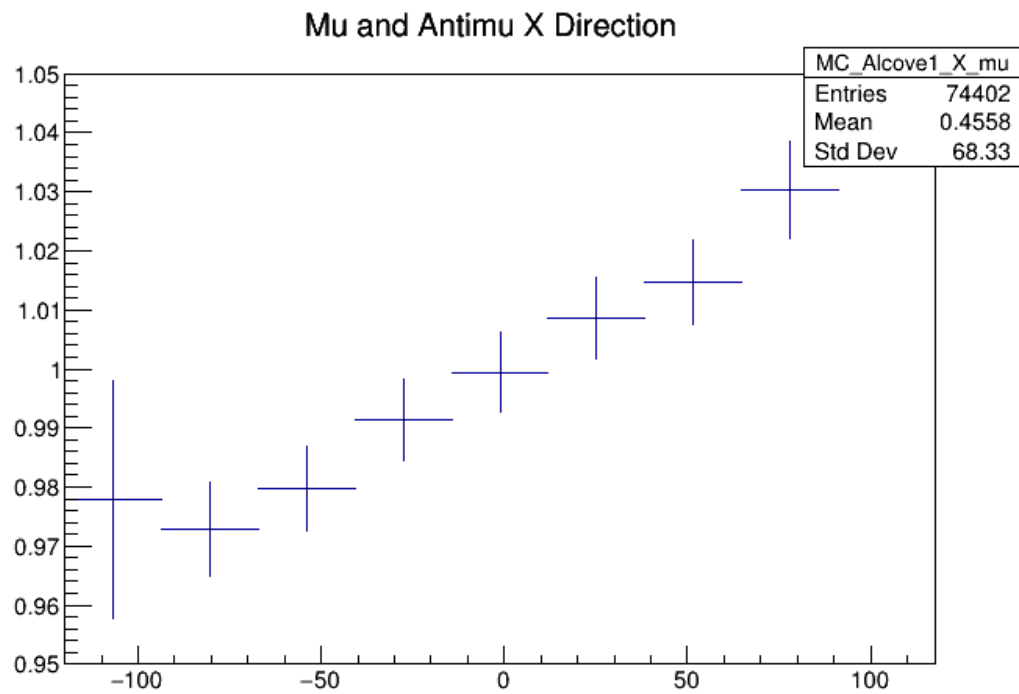


No Visible Signal

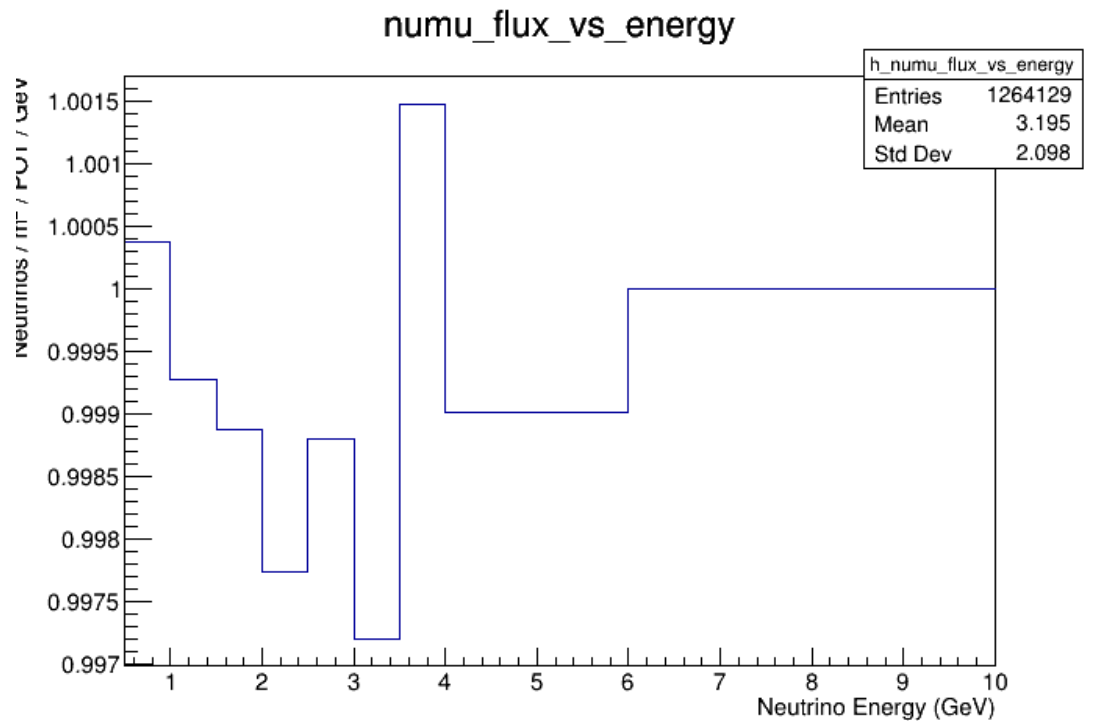
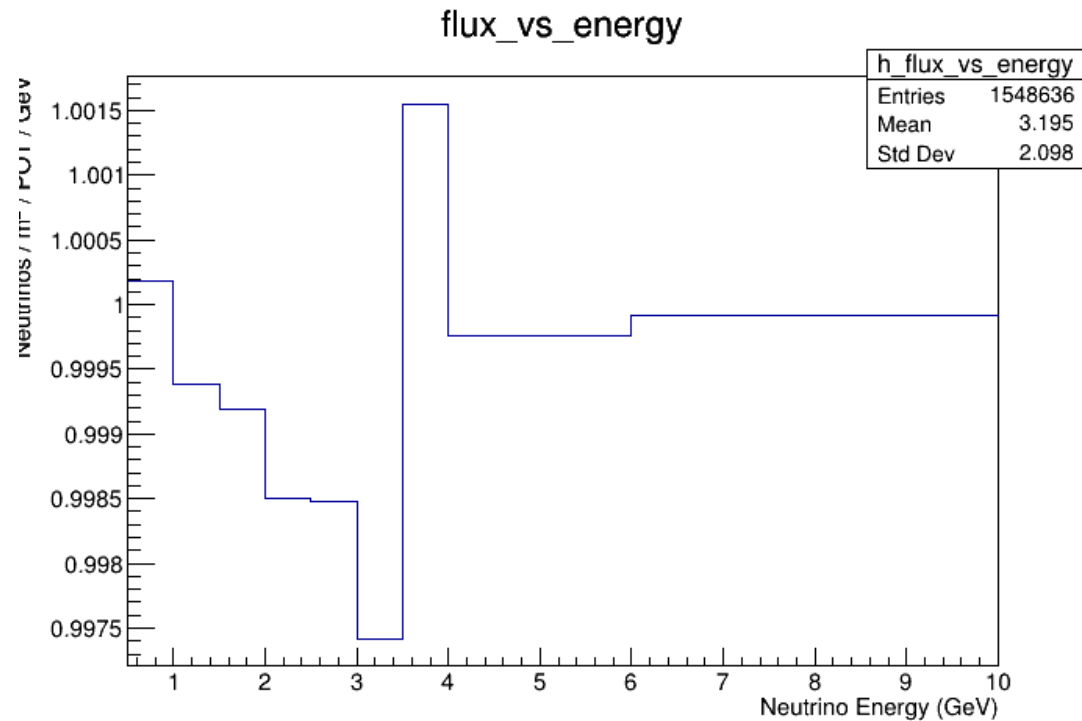


Visible Signals

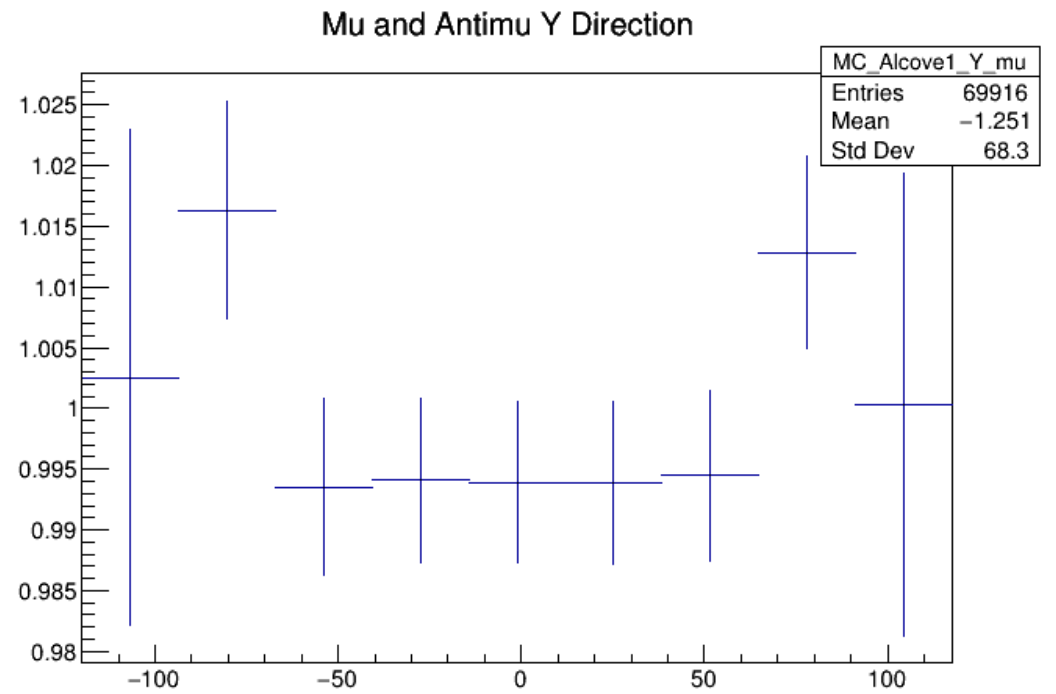
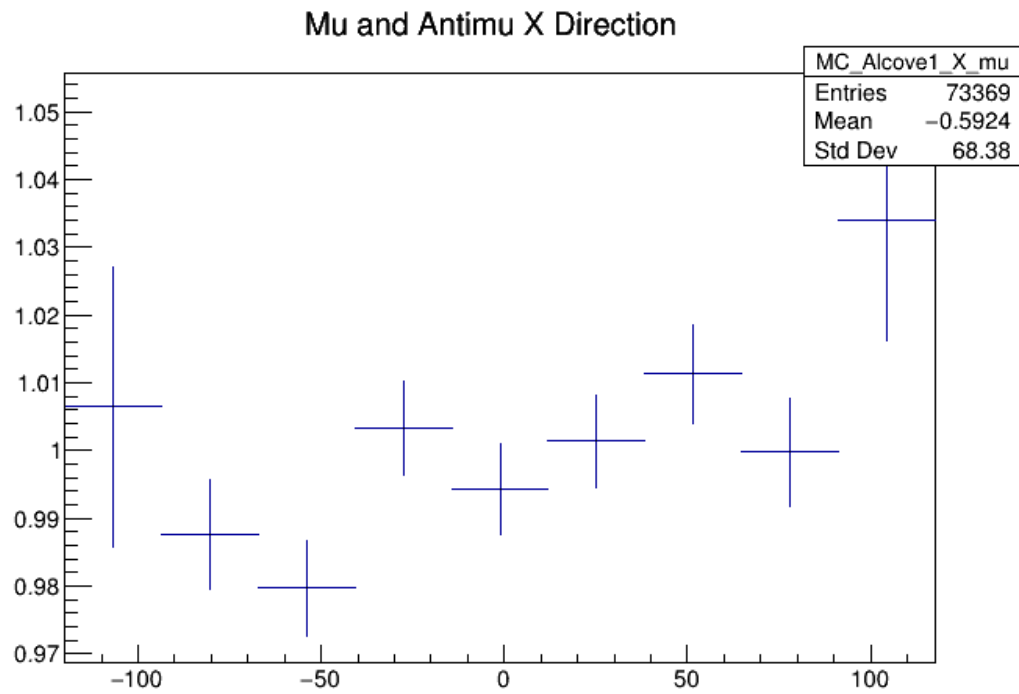
Horn A Eccentricity pX



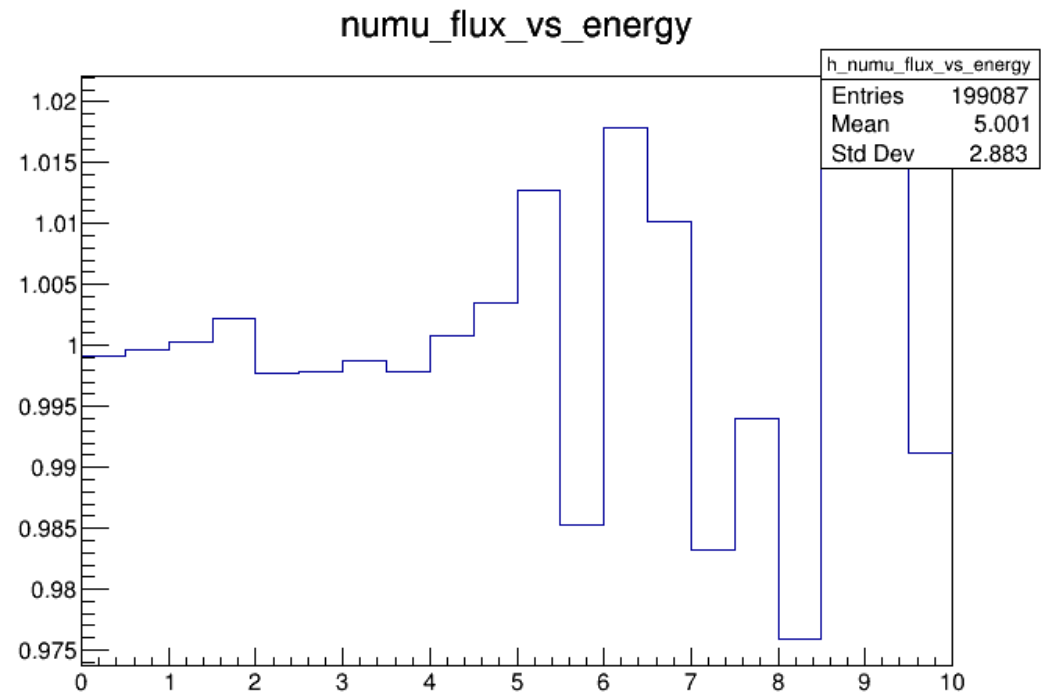
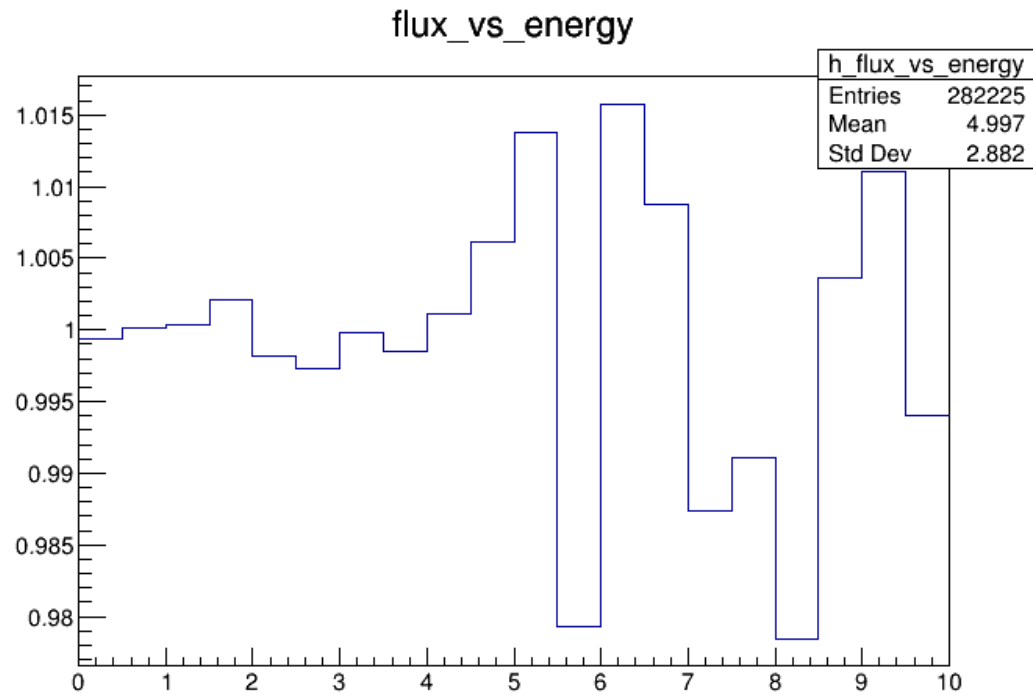
Horn A Eccentricity pX v Flux at Far Detector



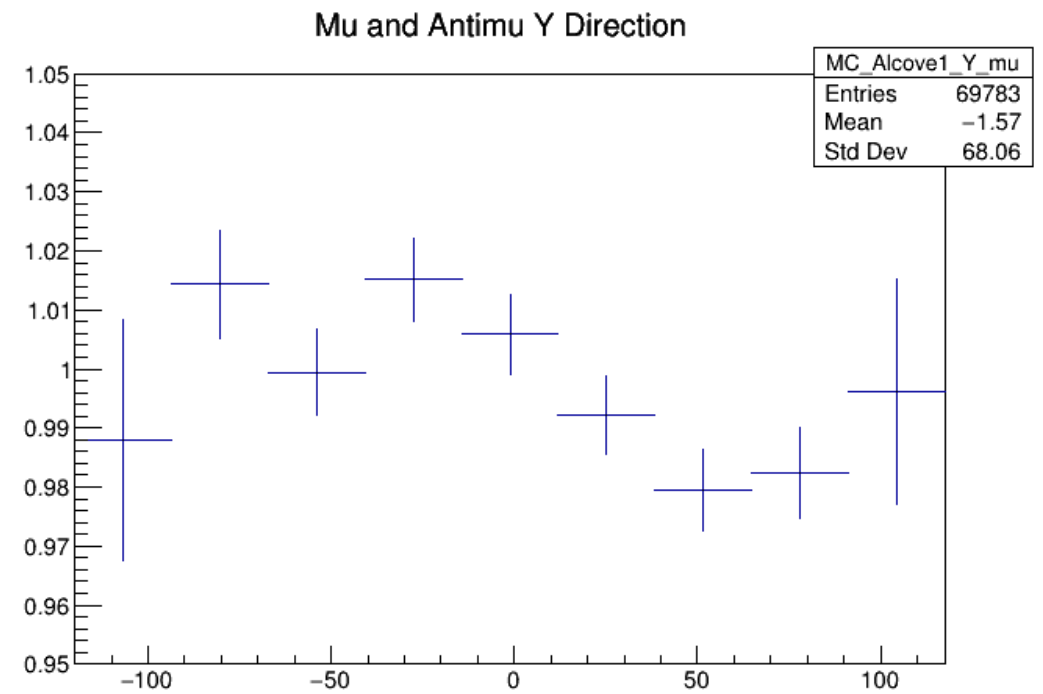
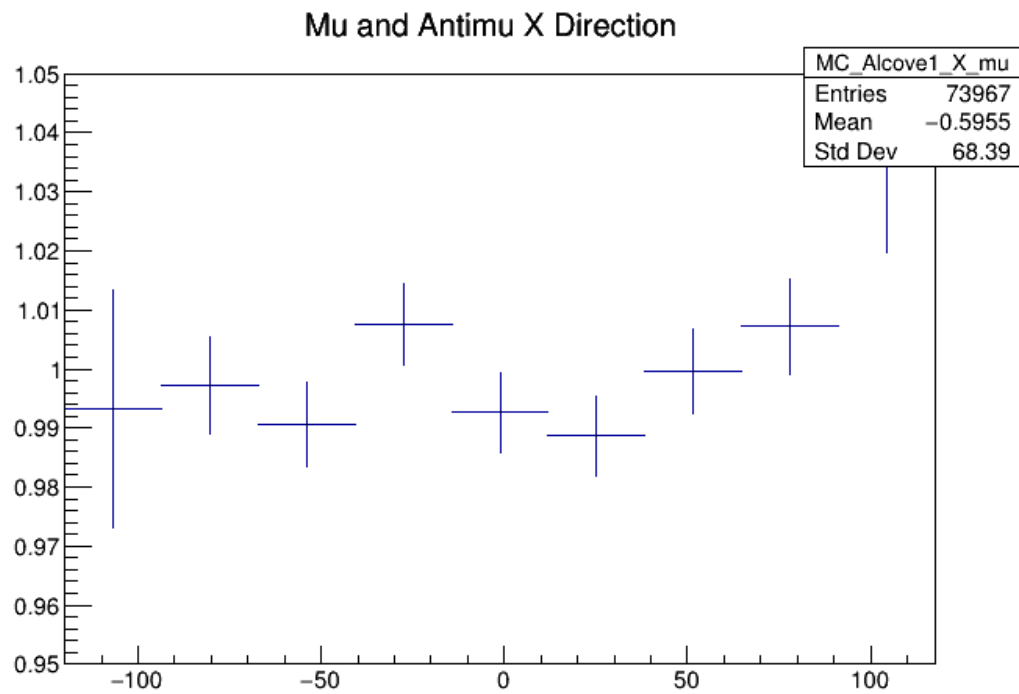
Horn A Ellipticity pX



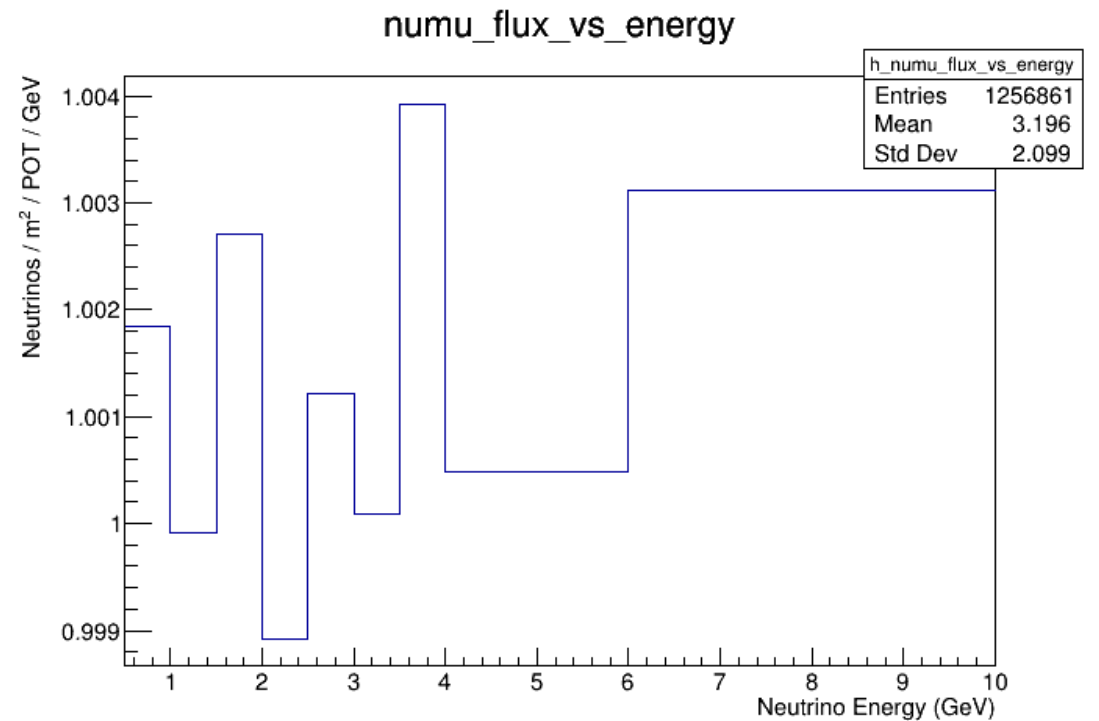
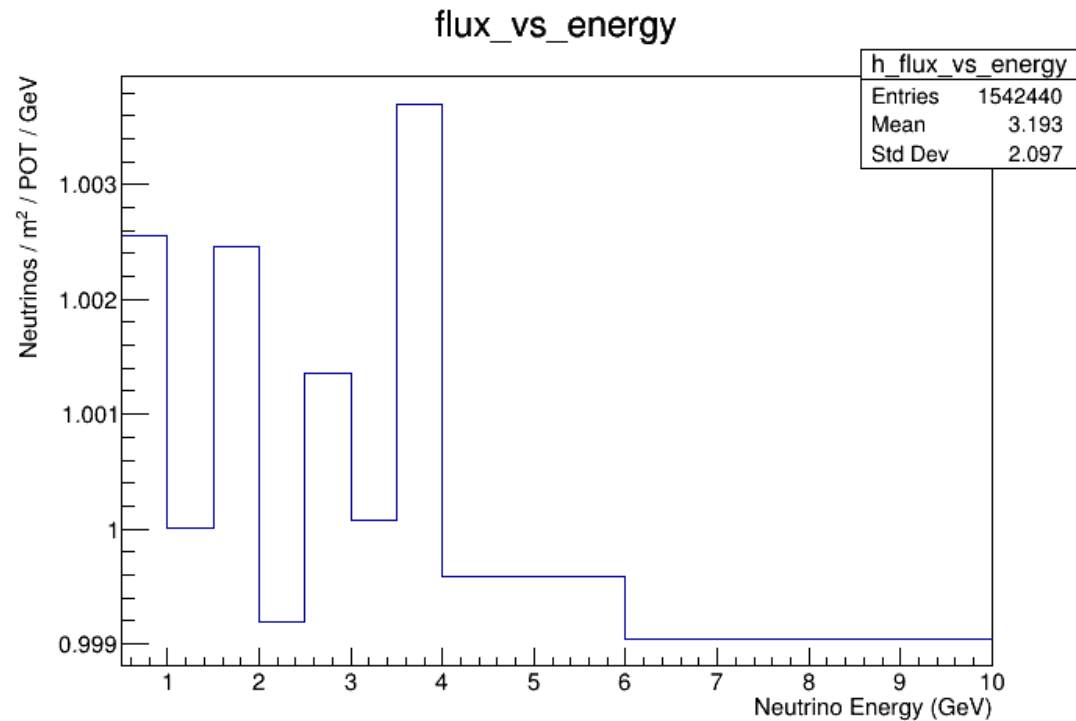
Horn A Ellipticity pX v Flux at Far Detector



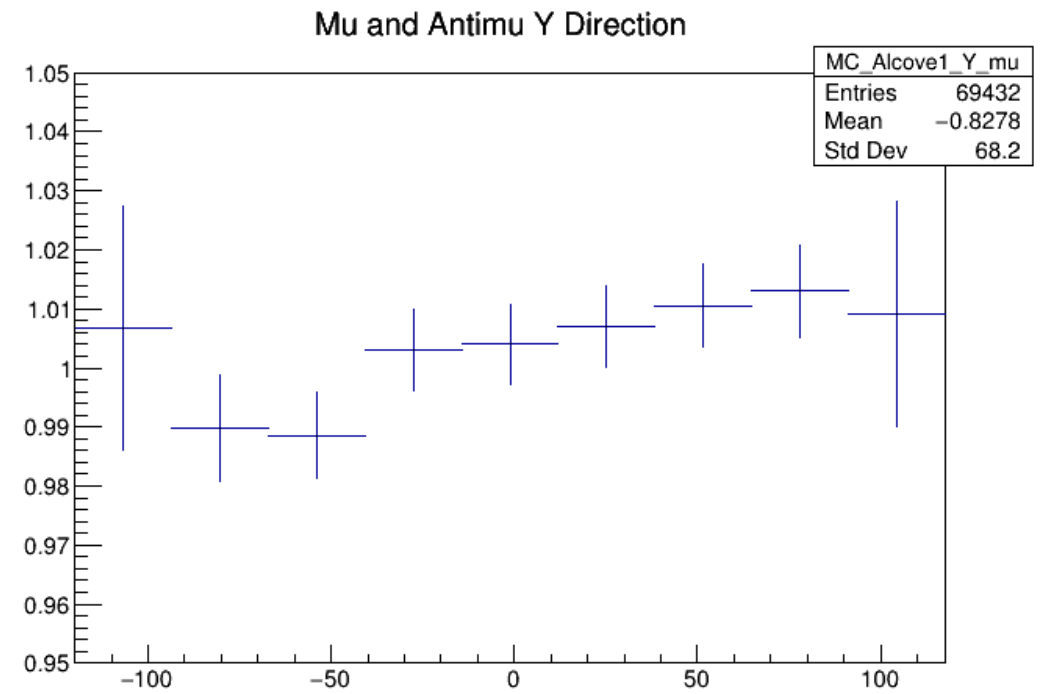
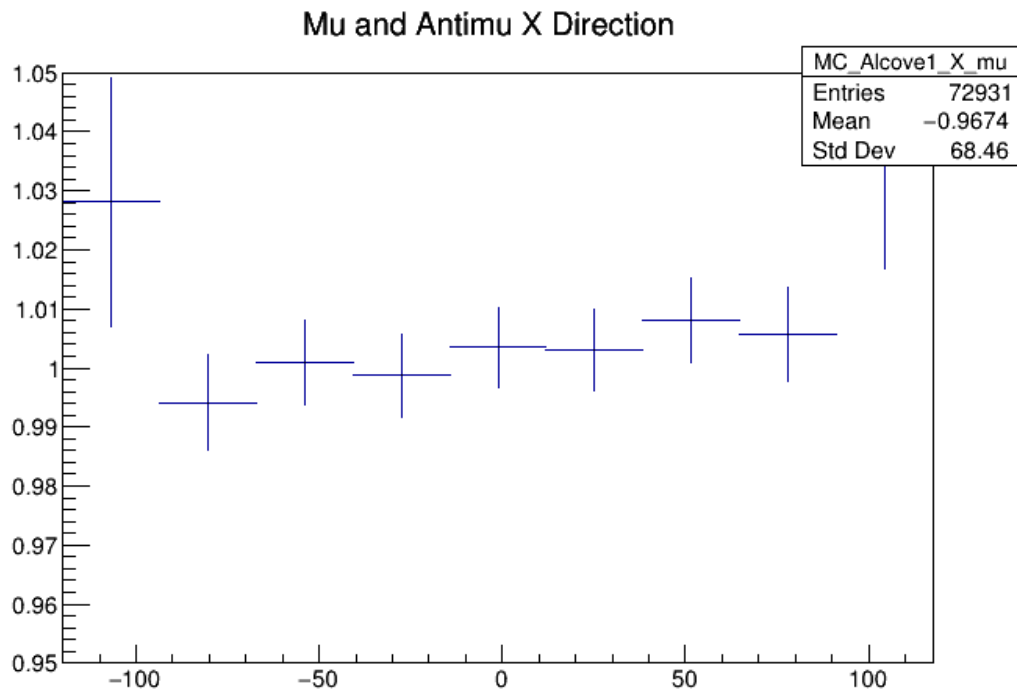
Horn A Move Down



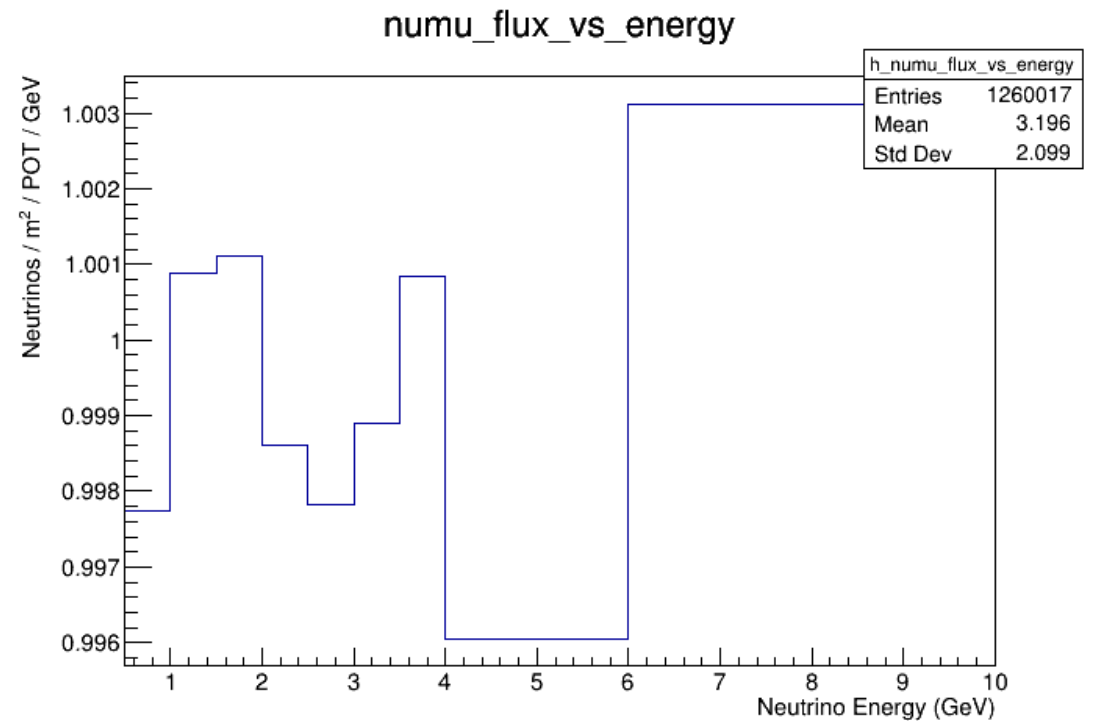
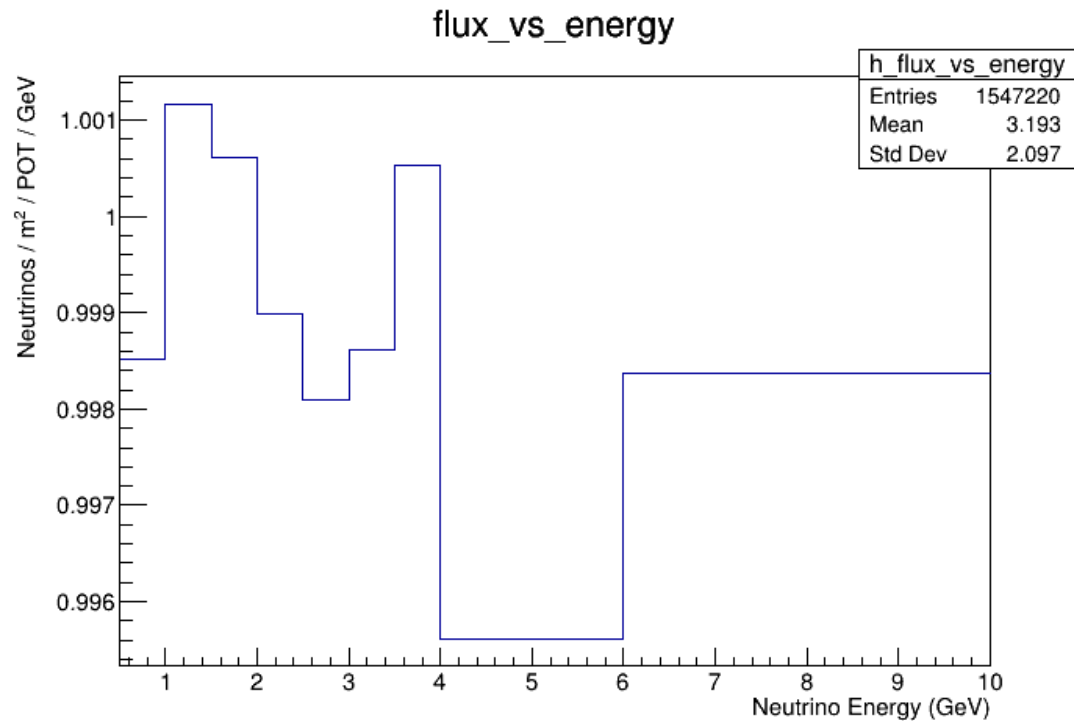
Horn A Move Down ν Flux at Far Detector



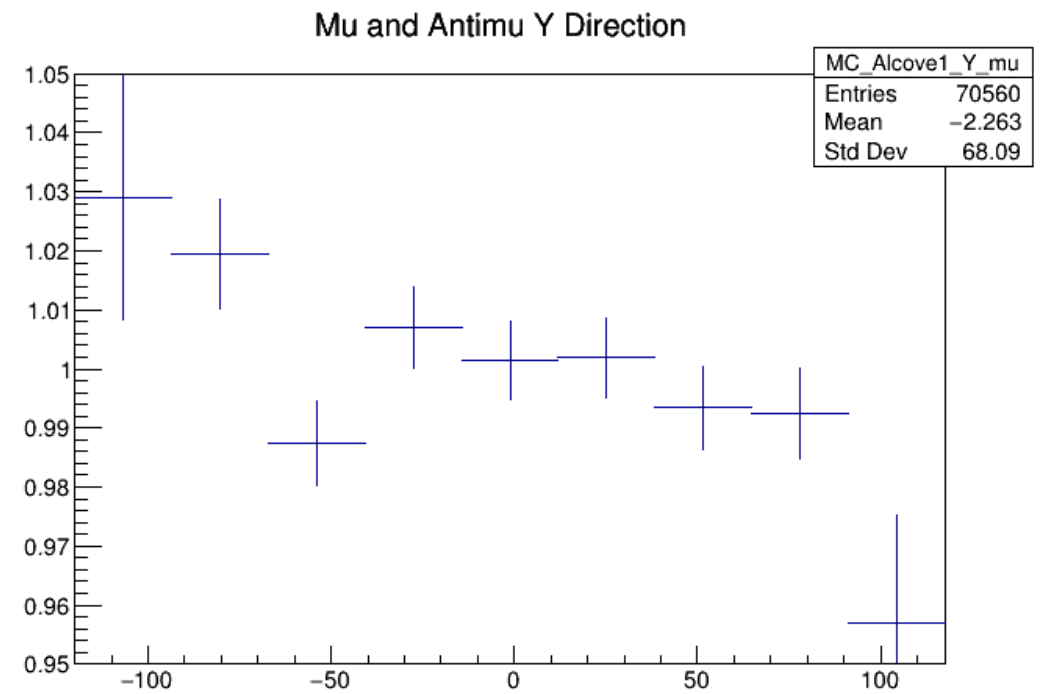
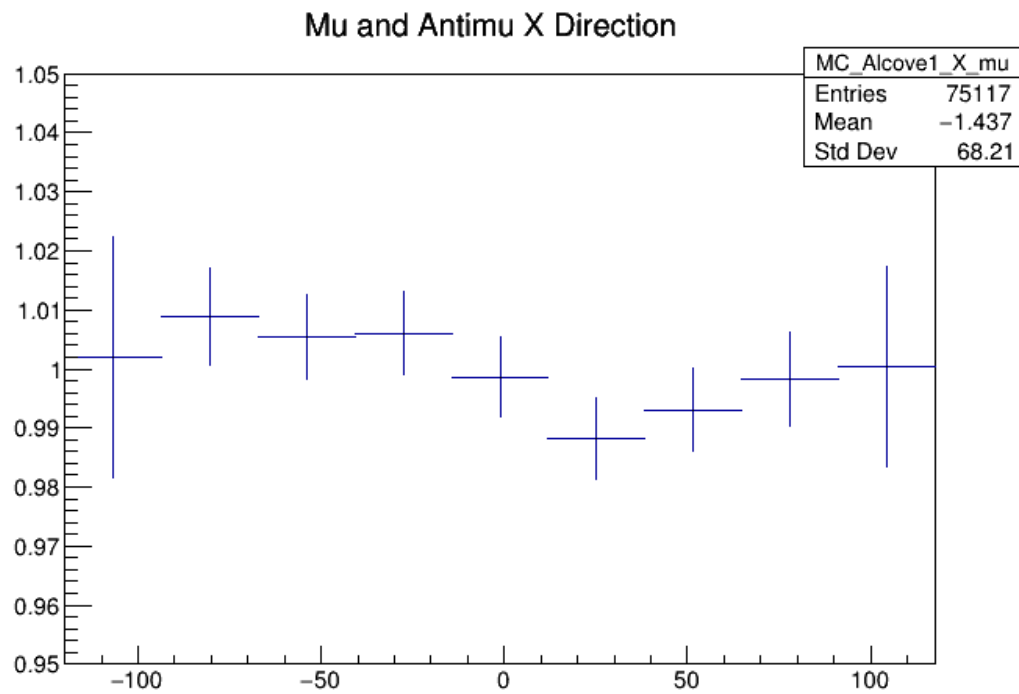
Horn A Move Up



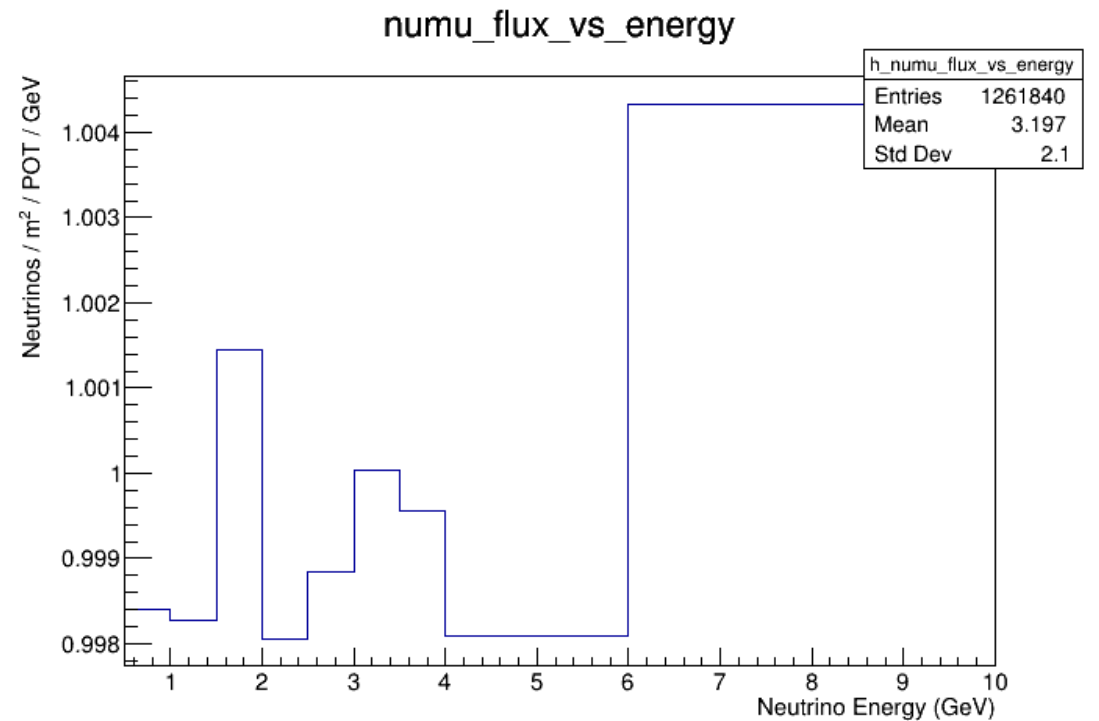
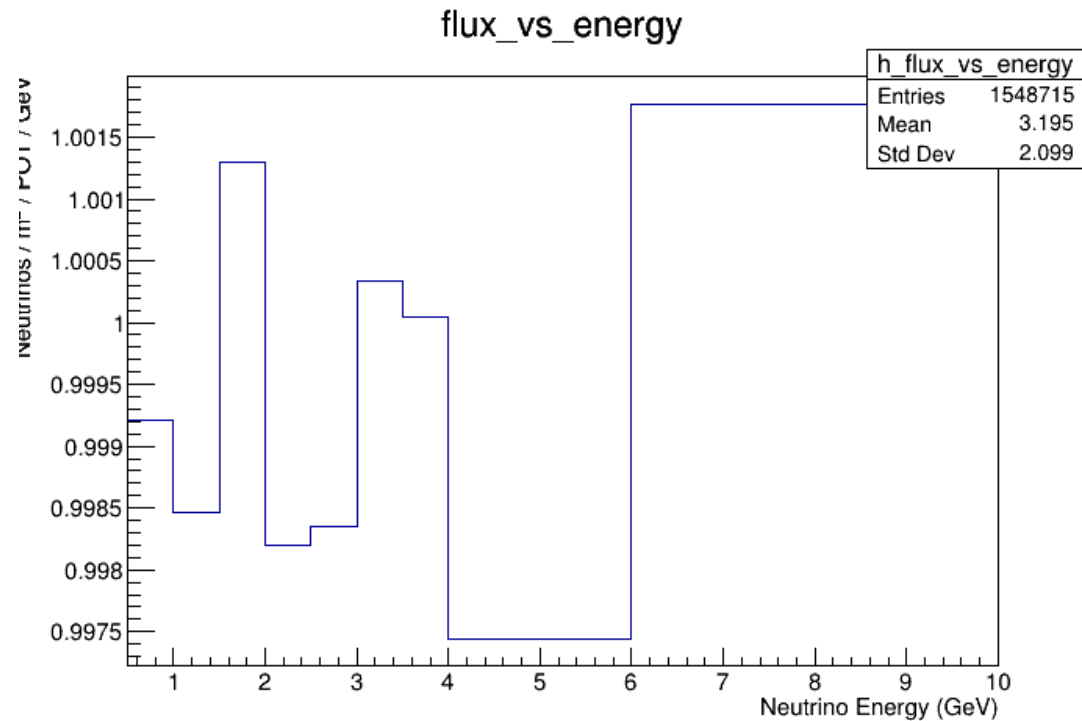
Horn A Move Up ν Flux at Far Detector



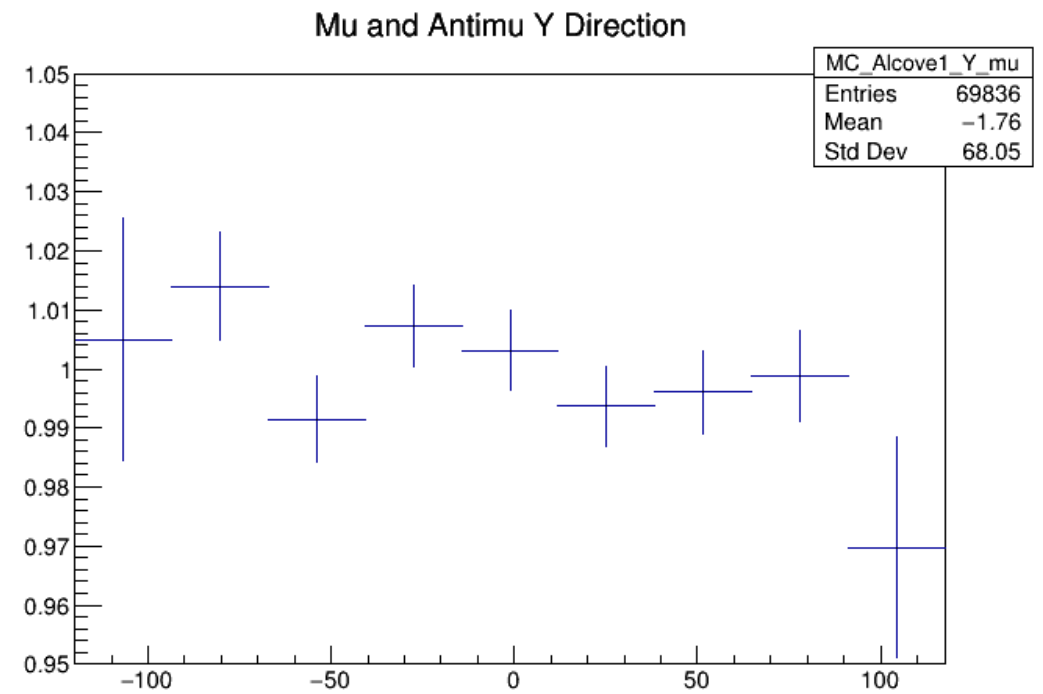
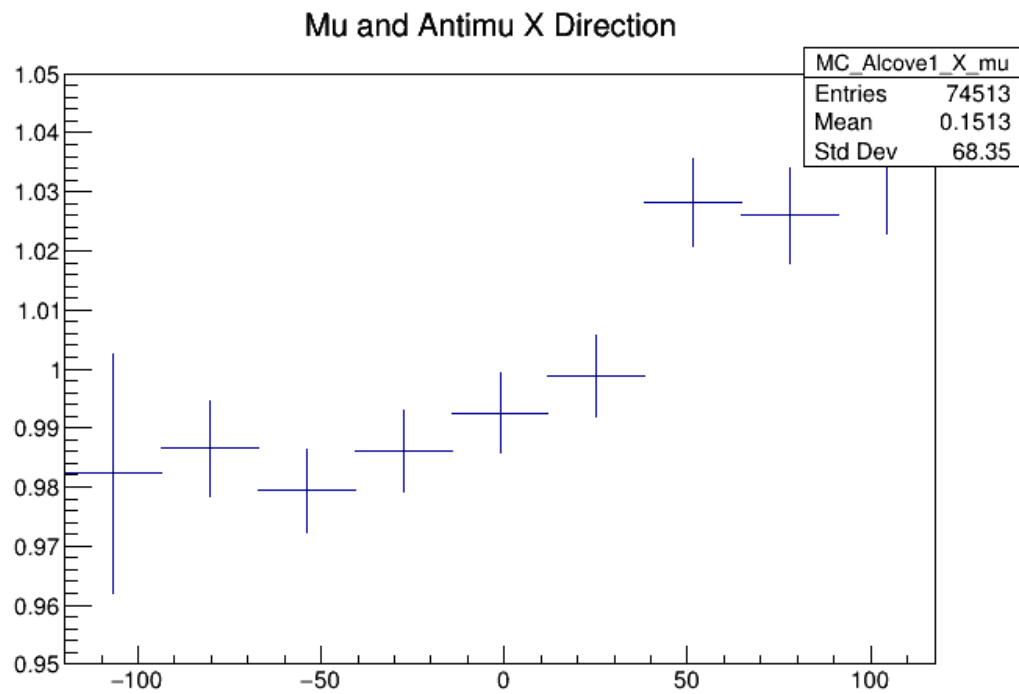
Horn A Move Right



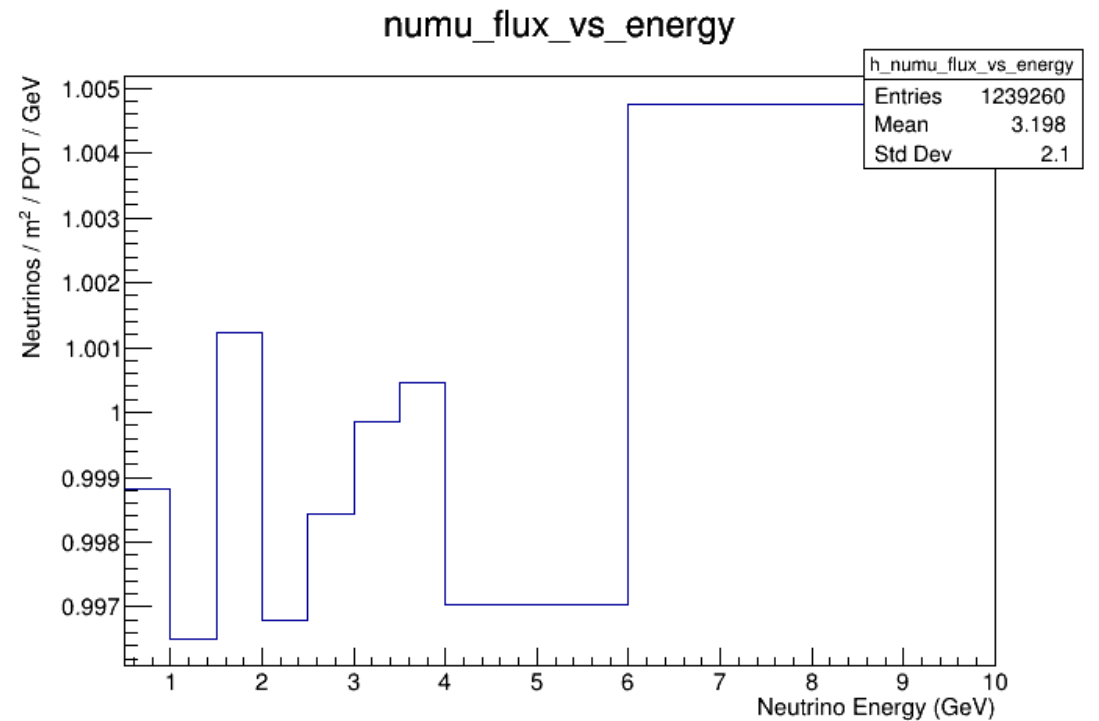
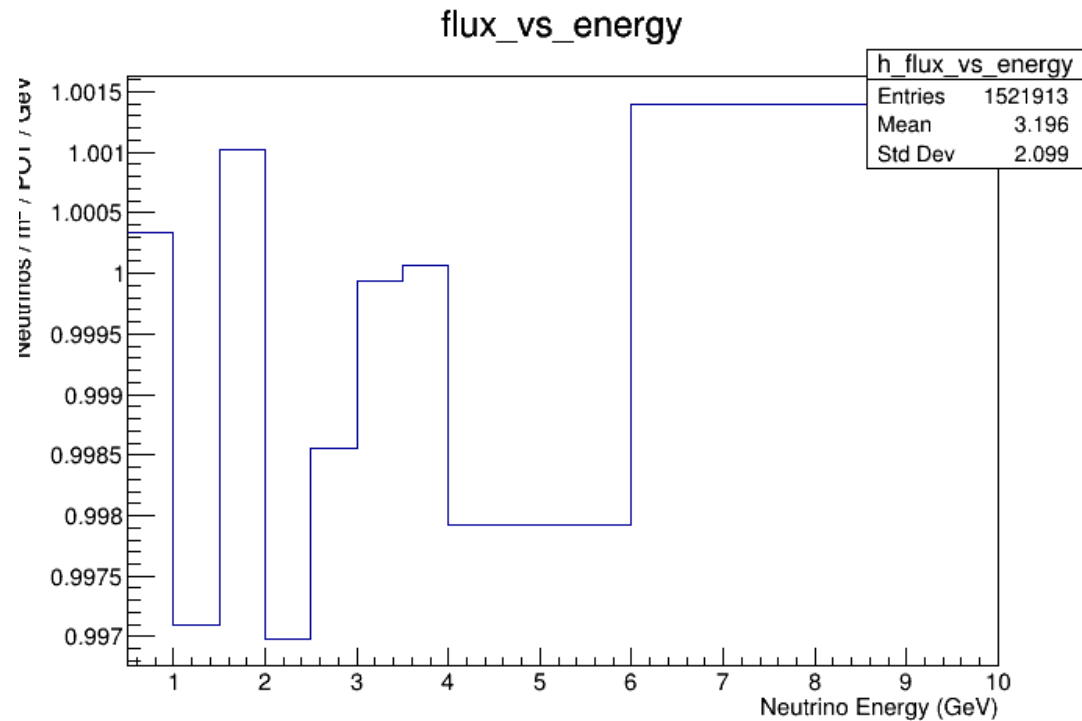
Horn A Move Right ν Flux at Far Detector



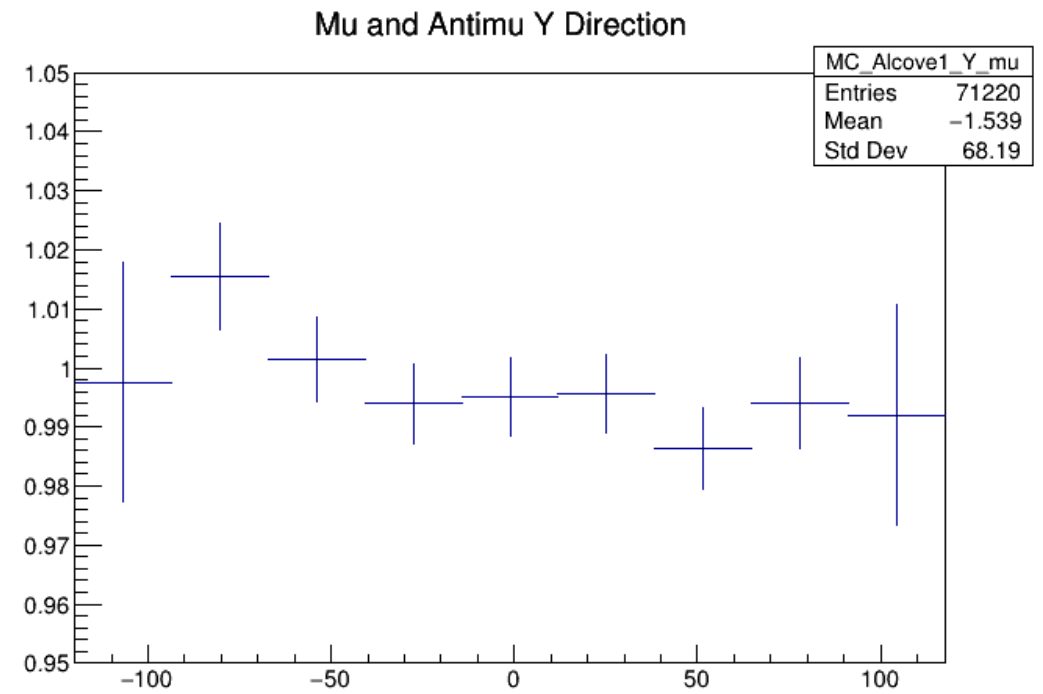
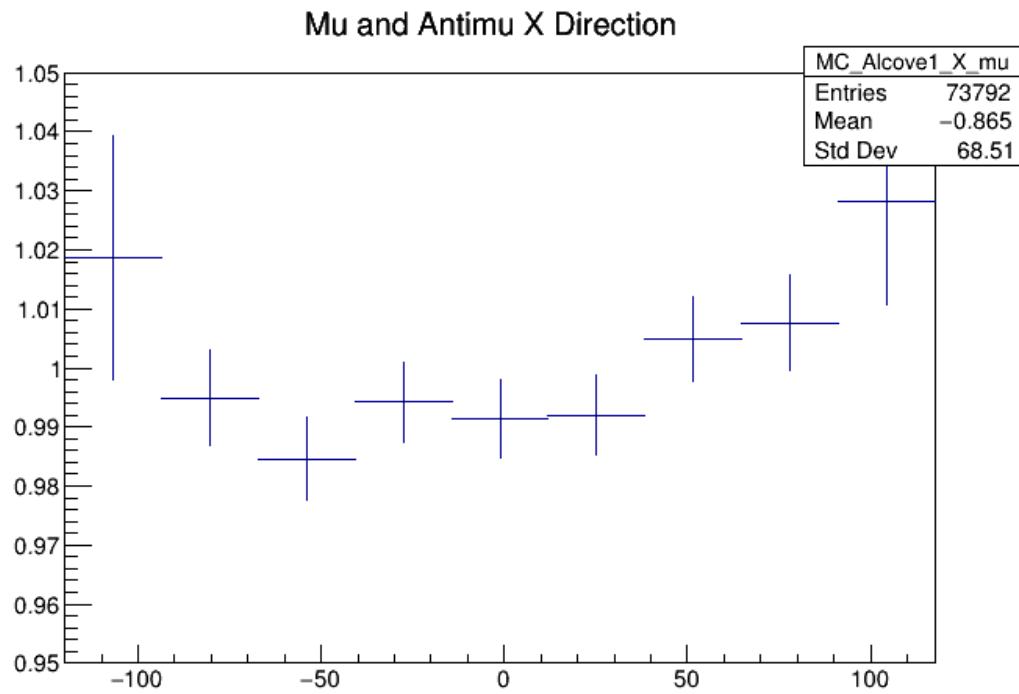
Horn A Move Left



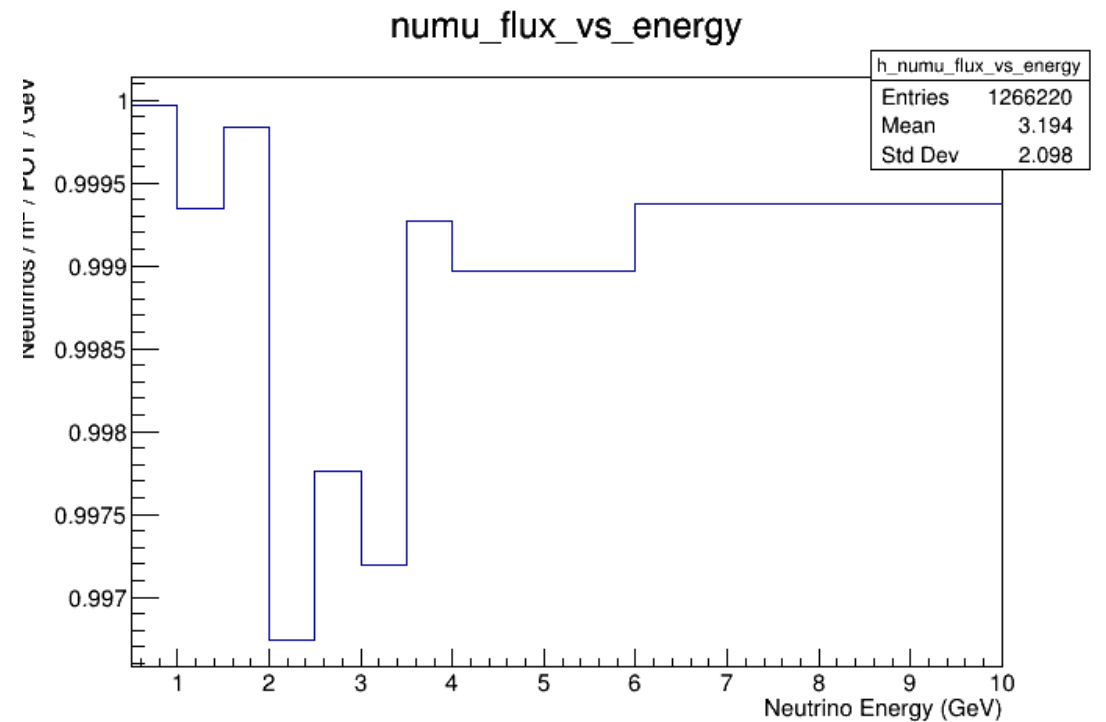
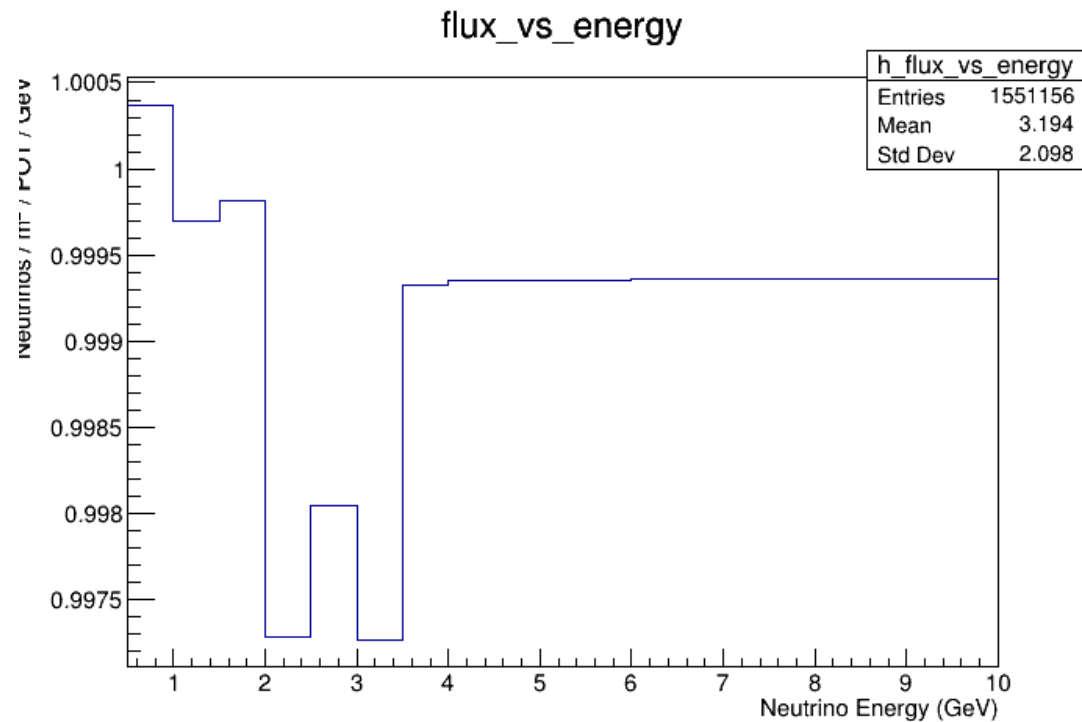
Horn A Move Left ν Flux at Far Detector



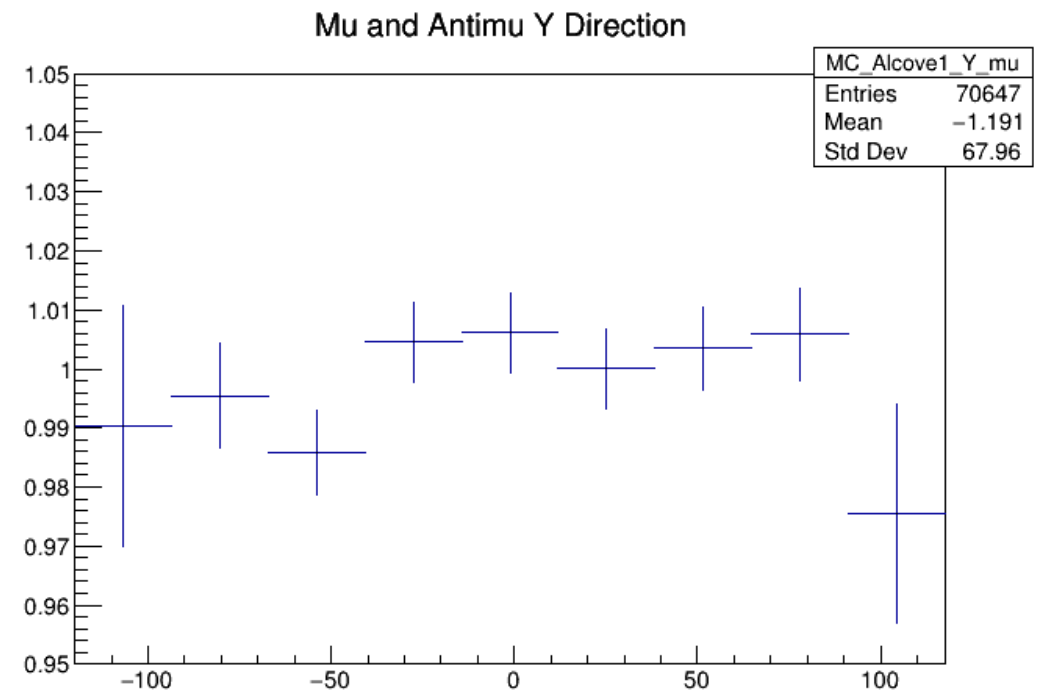
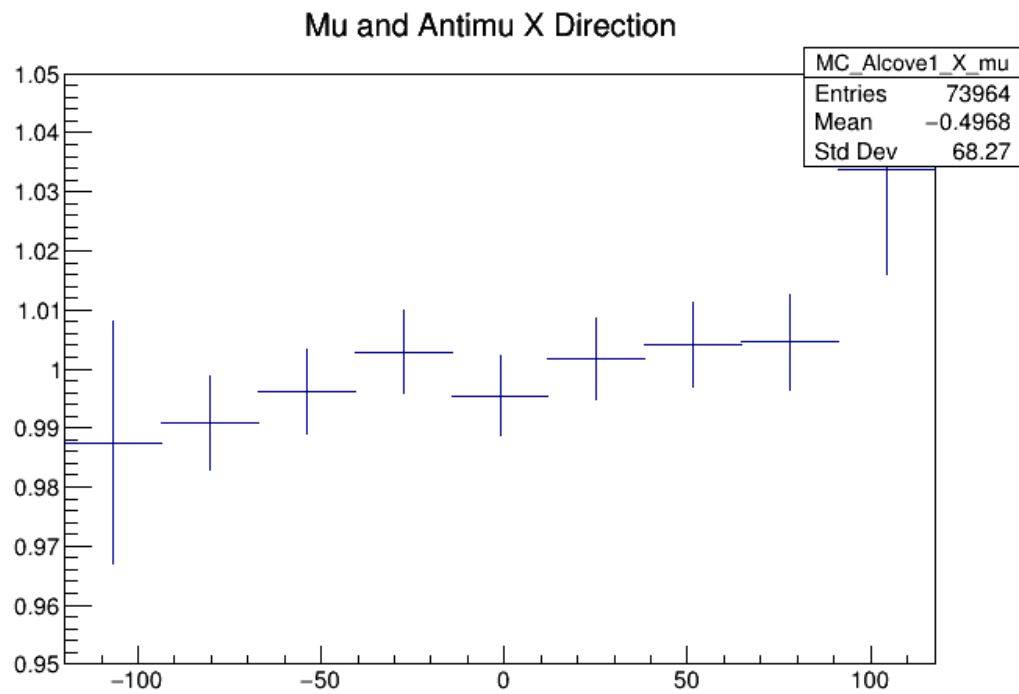
Horn A Tilt Up



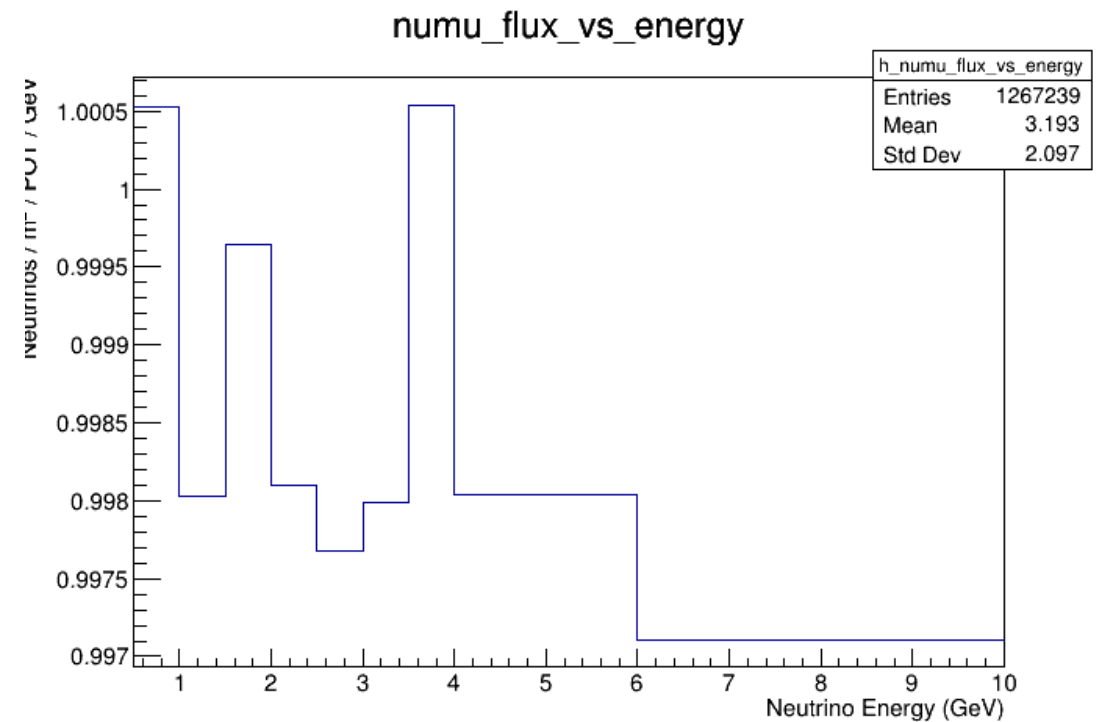
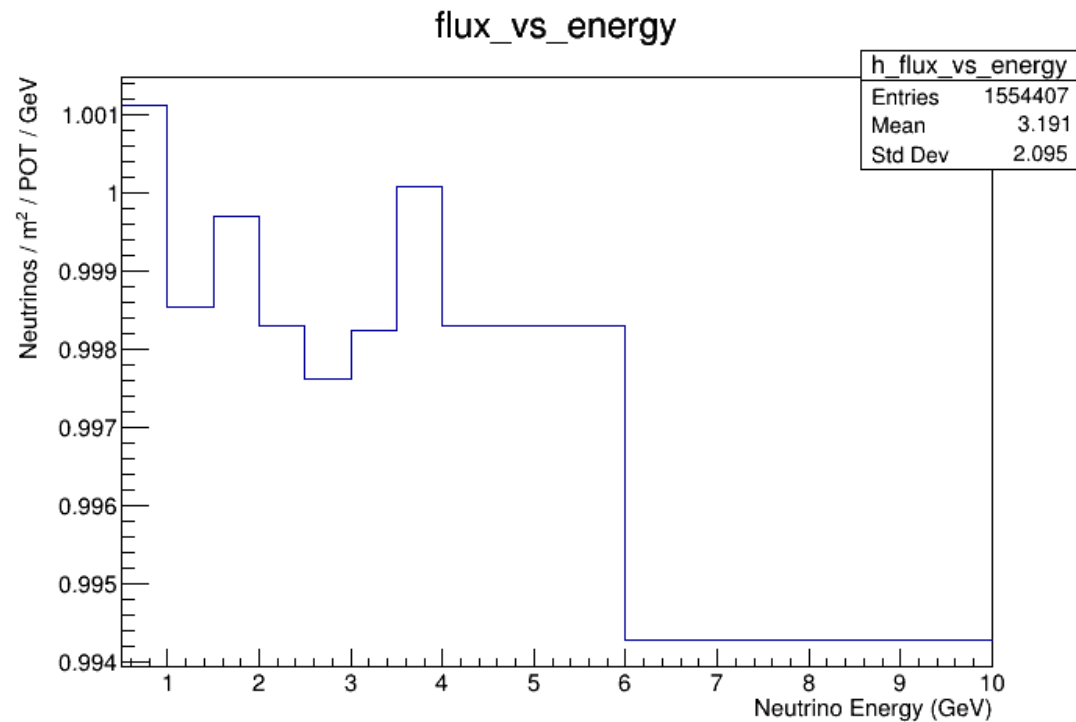
Horn A Tilt Up ν Flux at Far Detector



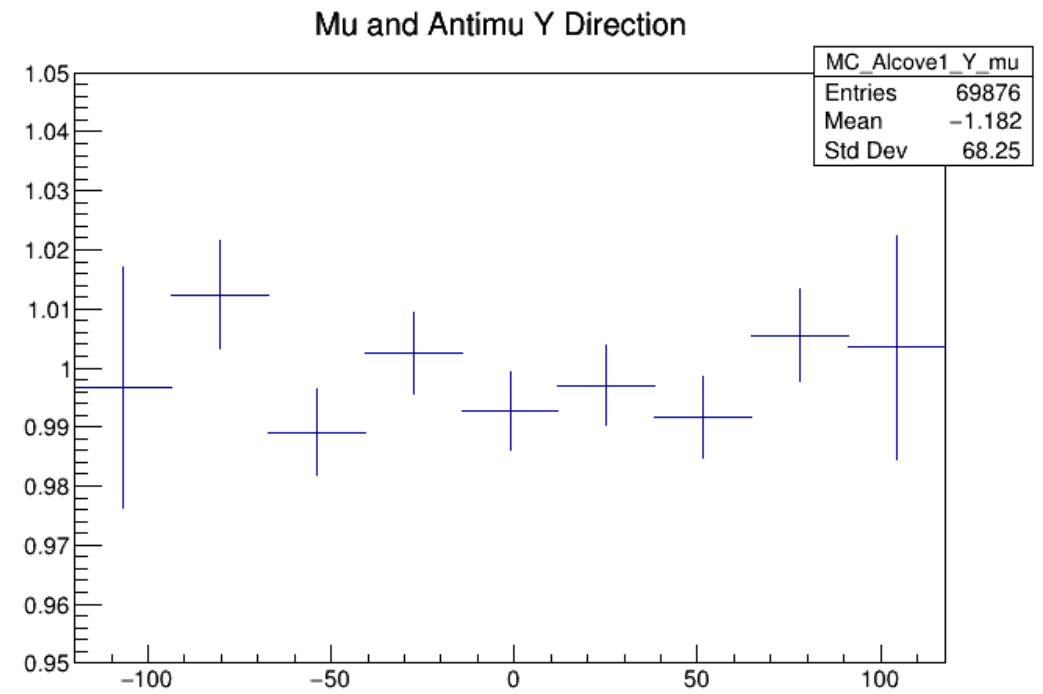
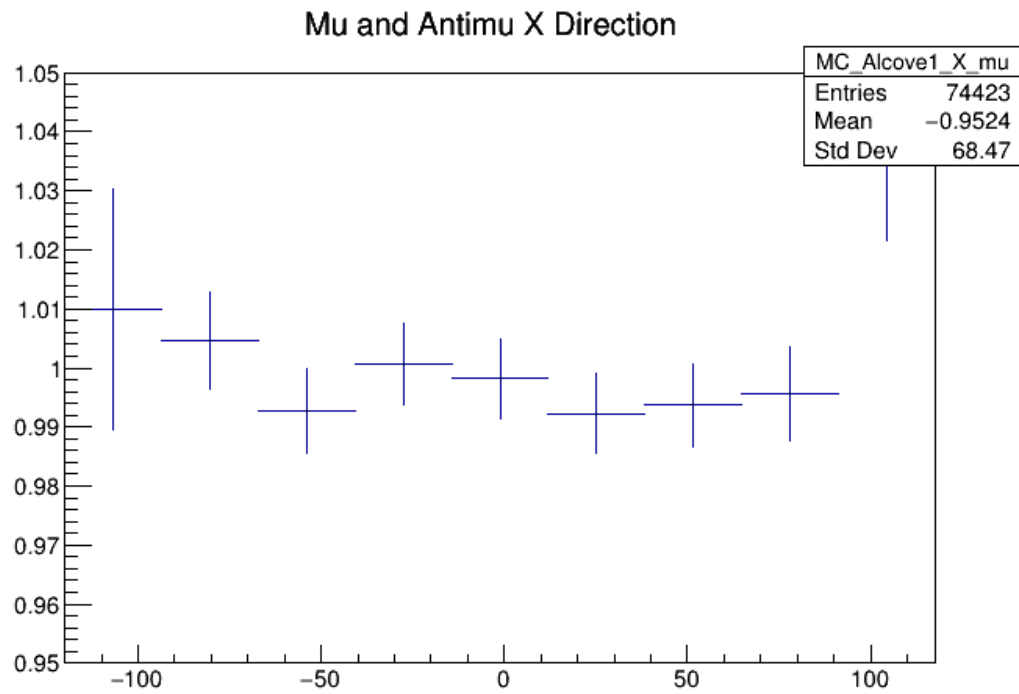
Horn A Tilt Down



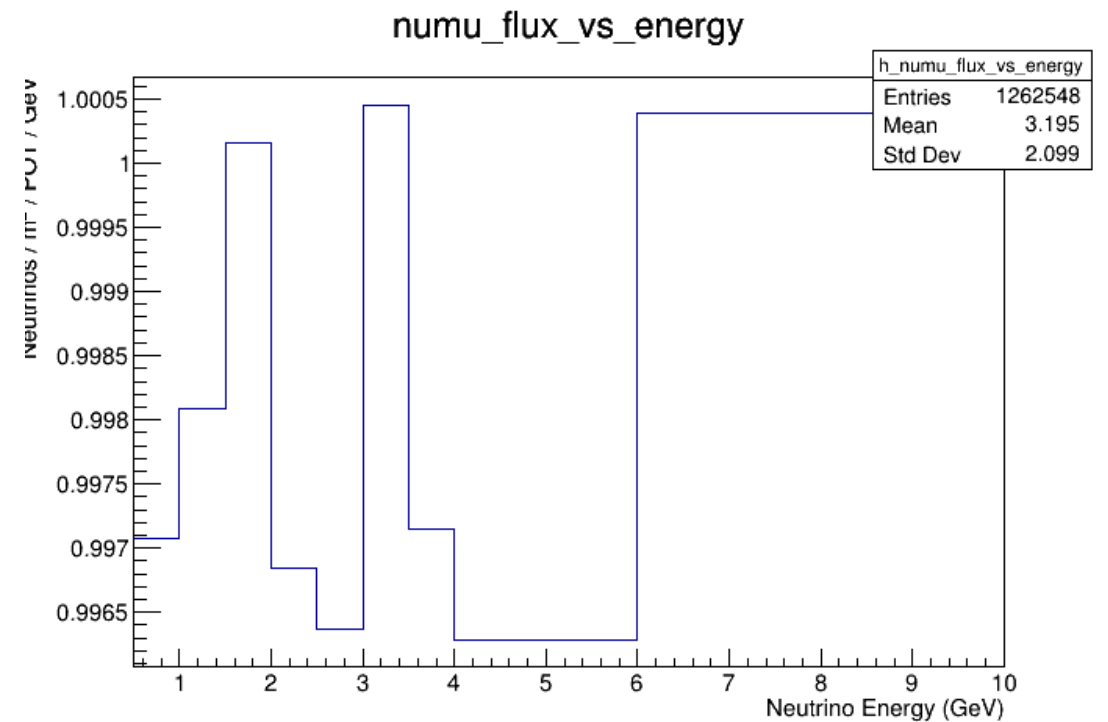
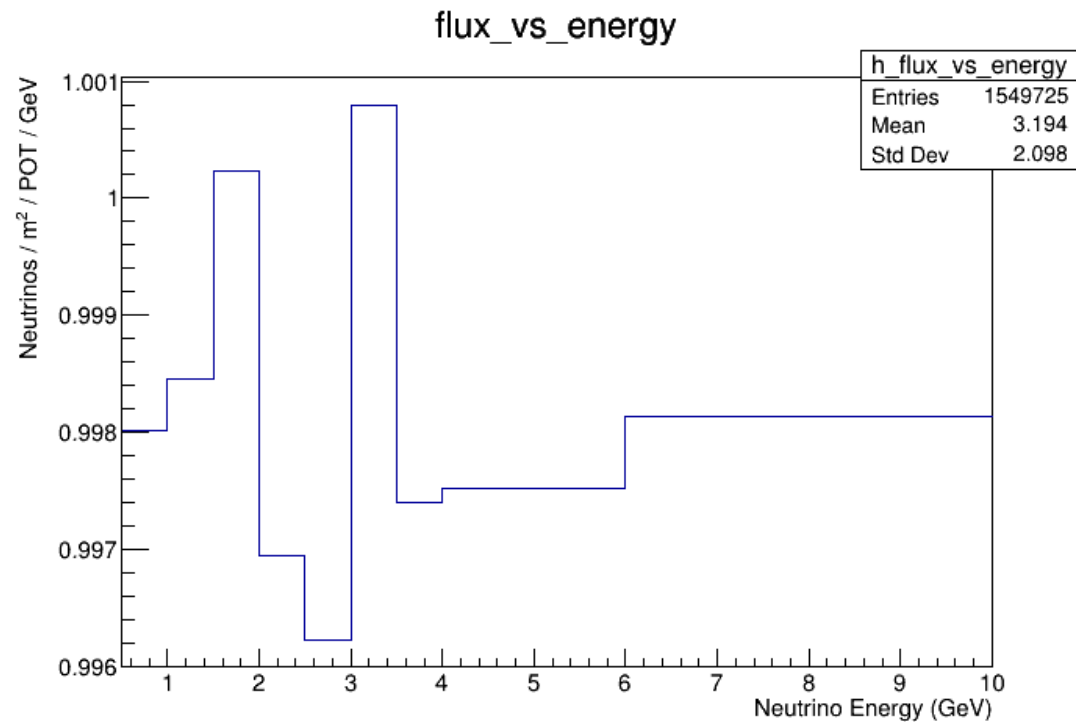
Horn A Tilt Down ν Flux at Far Detector



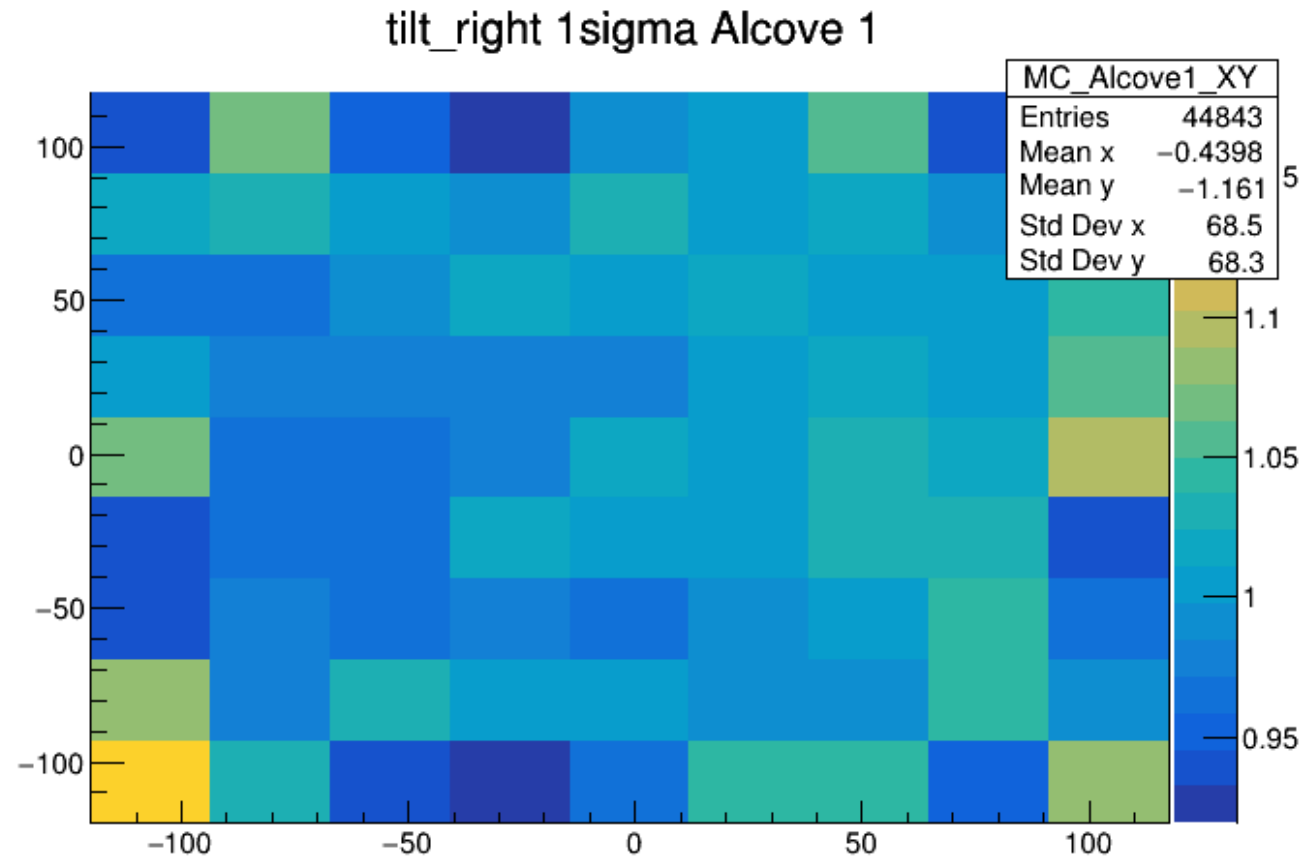
Horn A Tilt Left



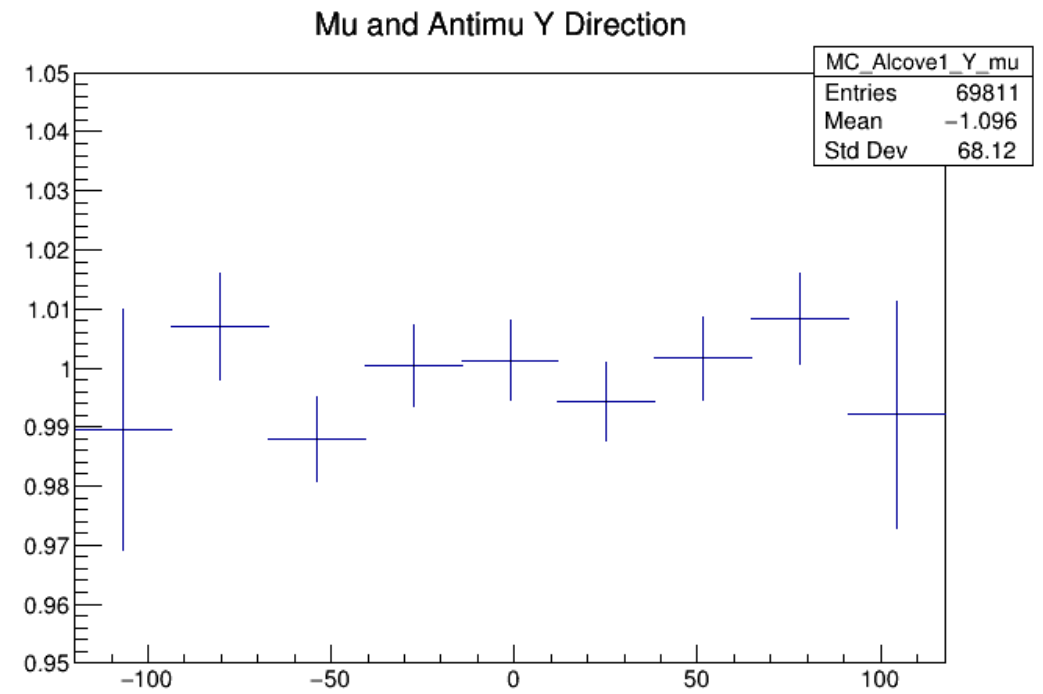
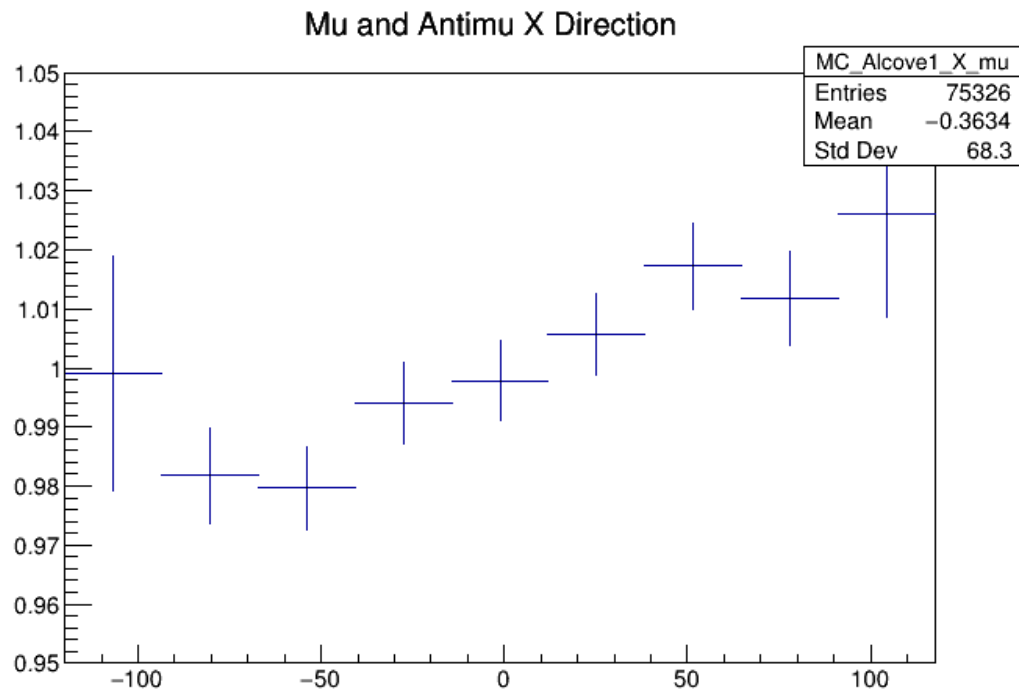
Horn A Tilt Left ν Flux at Far Detector



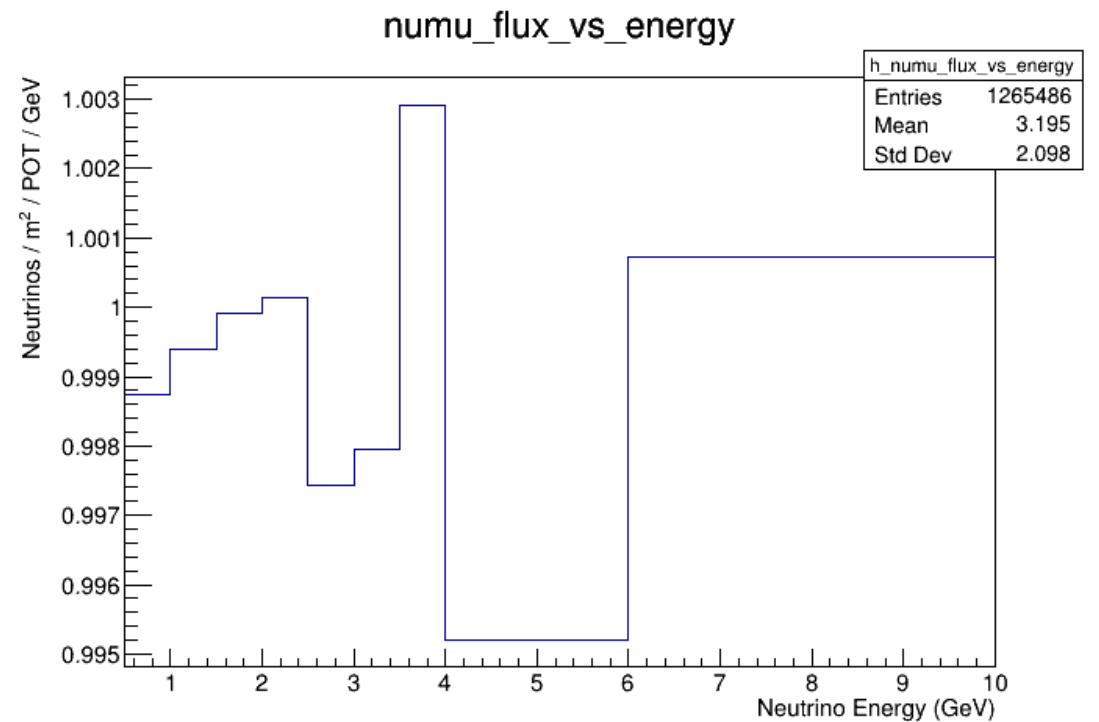
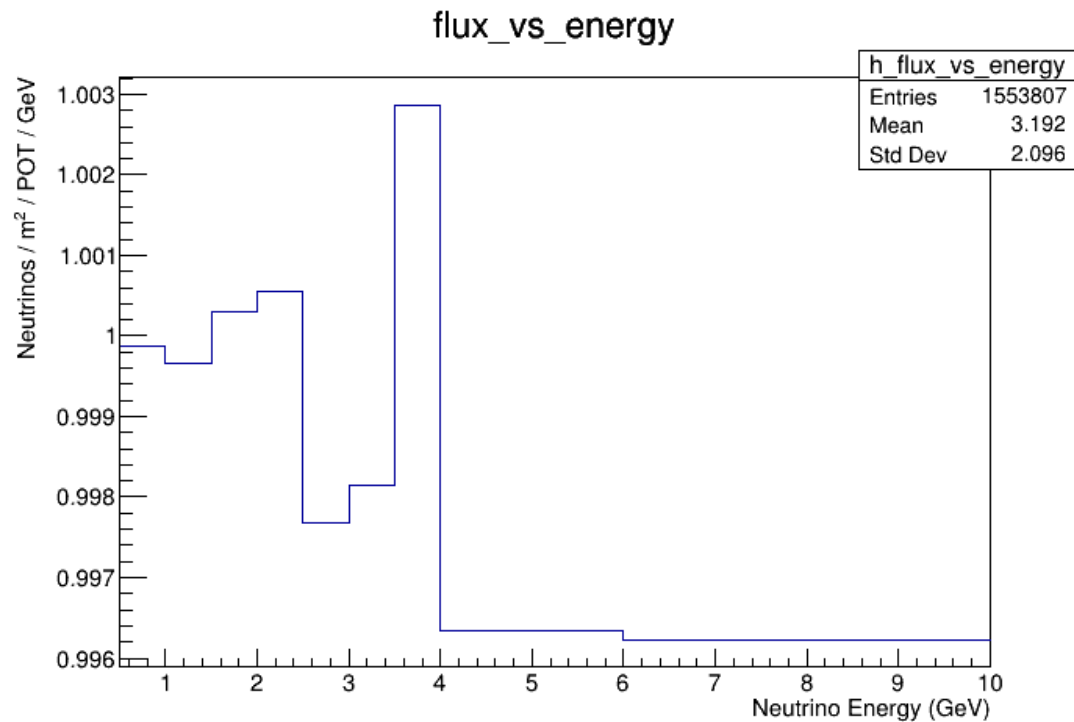
Horn A Tilt Right



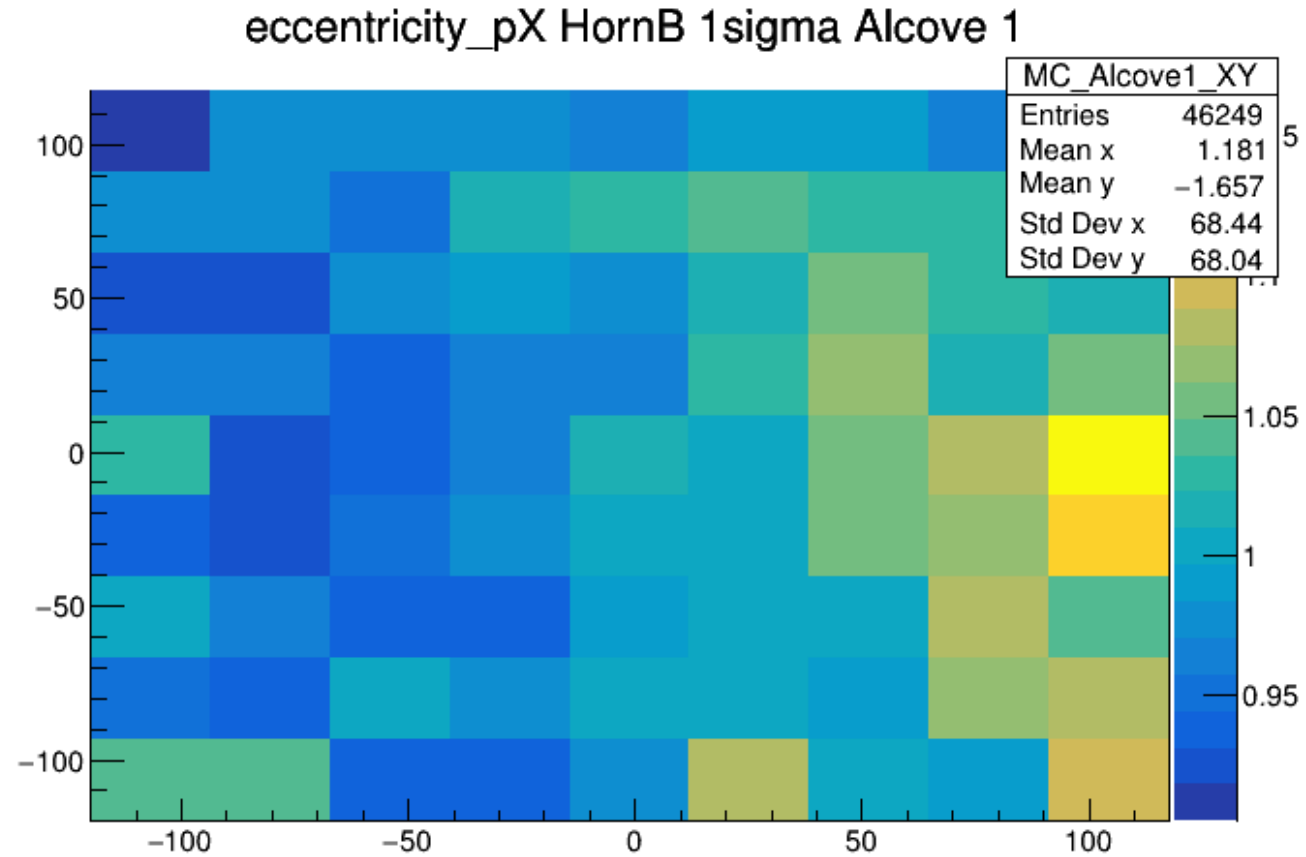
Horn A Tilt Right



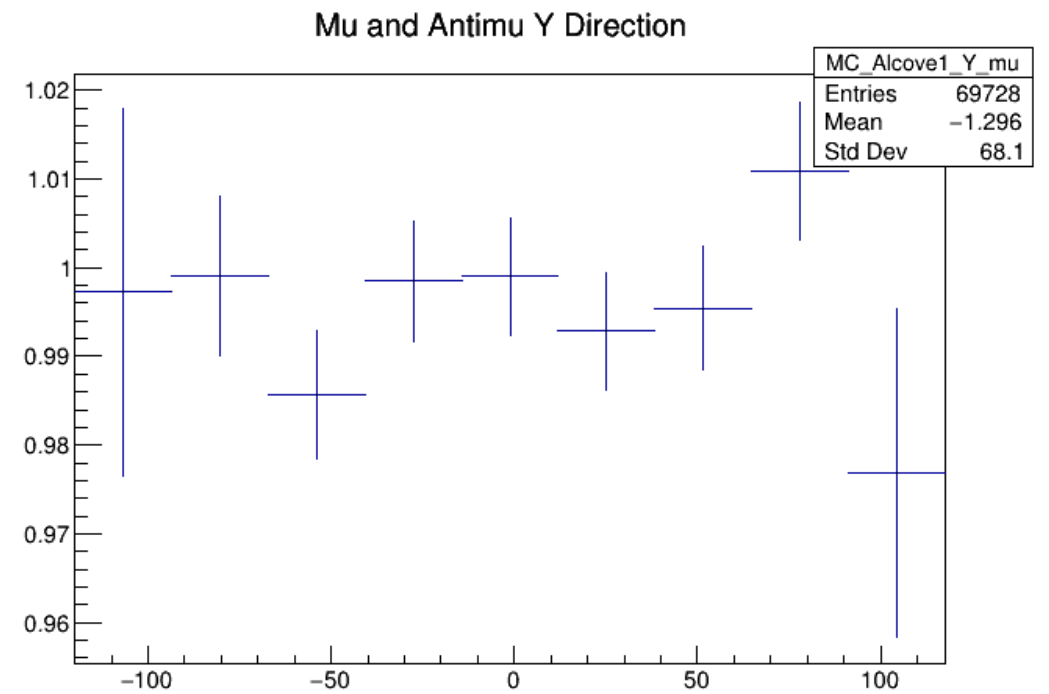
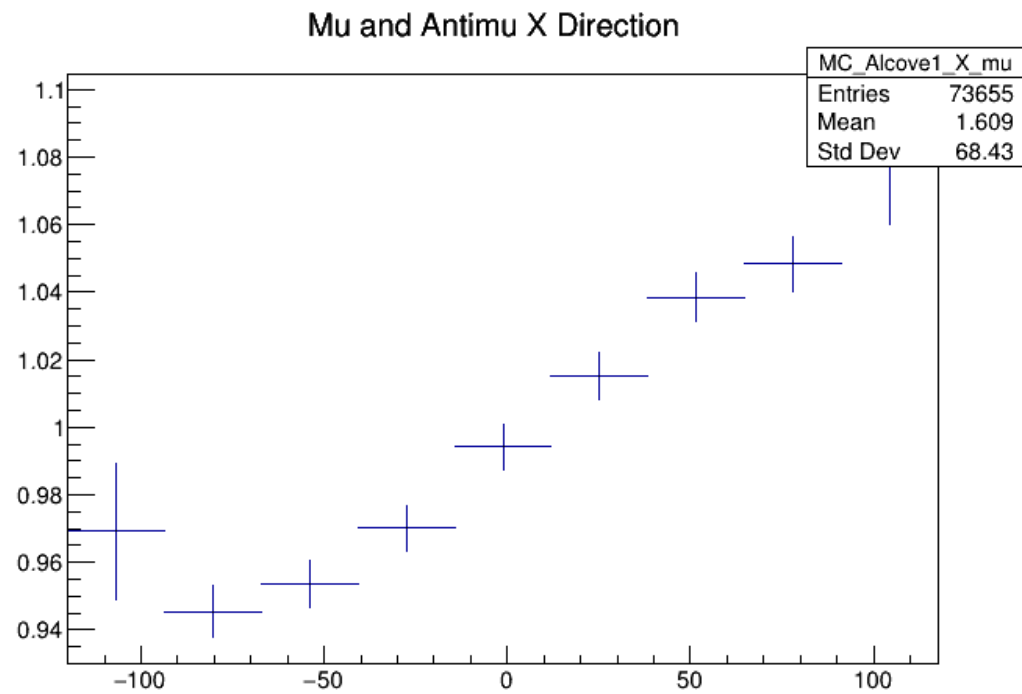
Horn A Tilt Right ν Flux at Far Detector



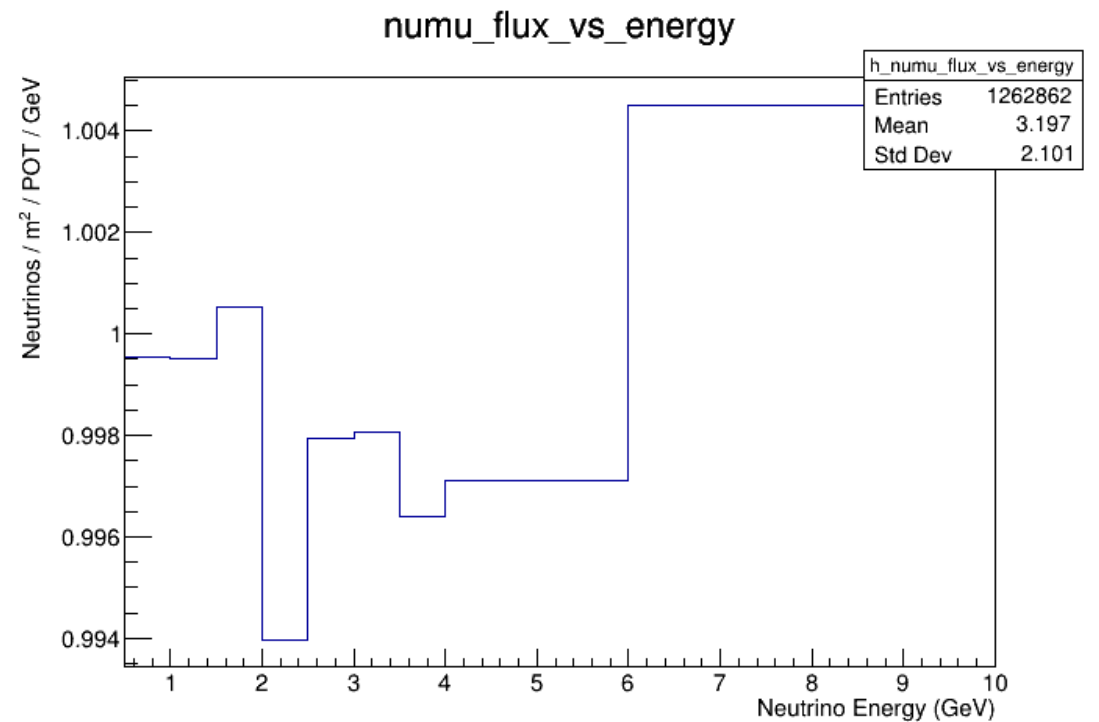
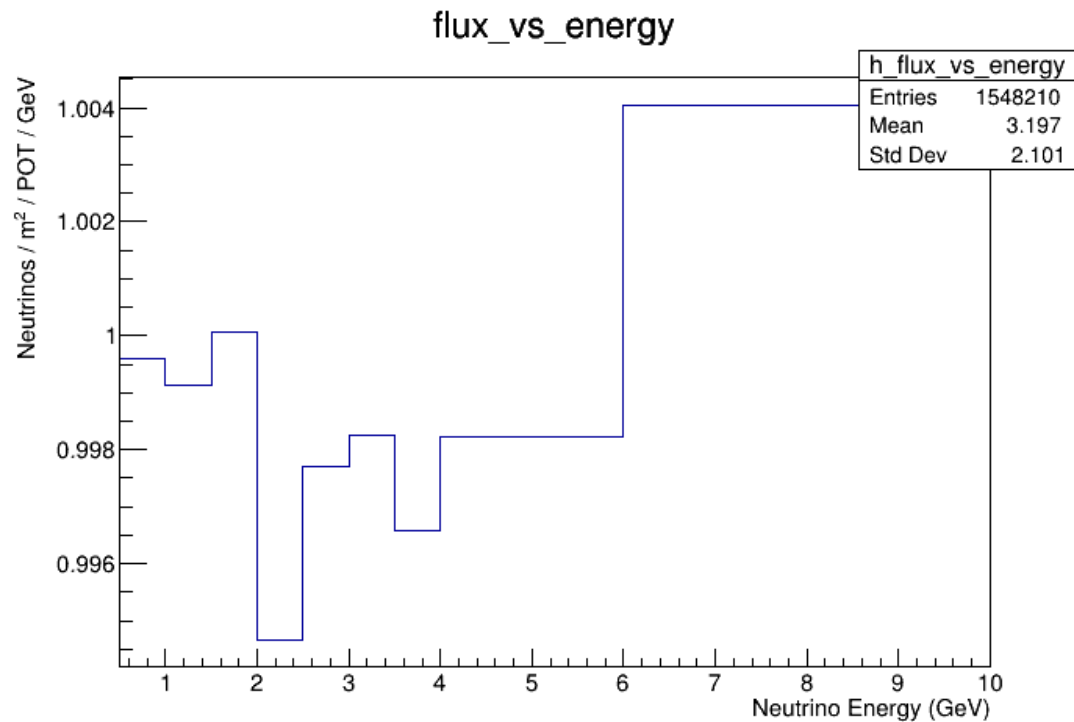
Horn B Eccentricity pX



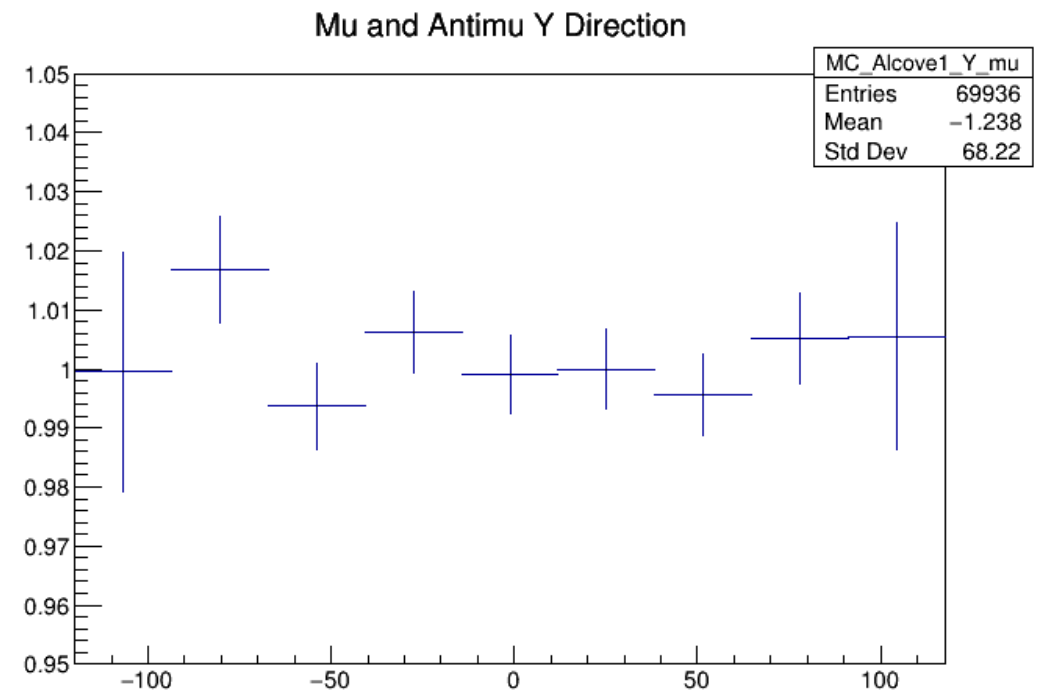
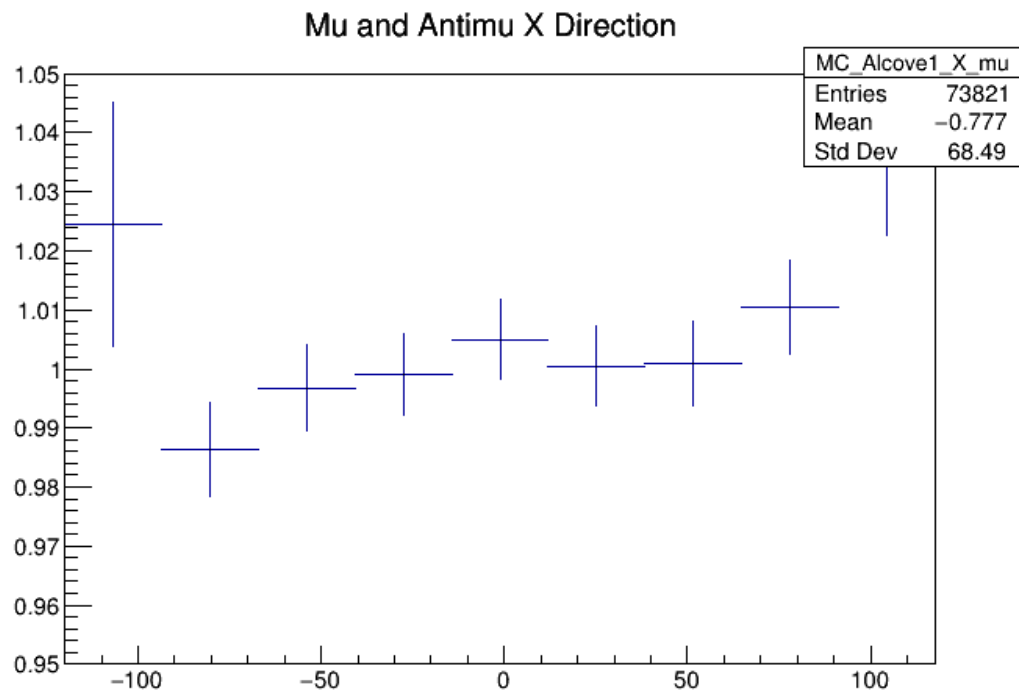
Horn B Eccentricity pX



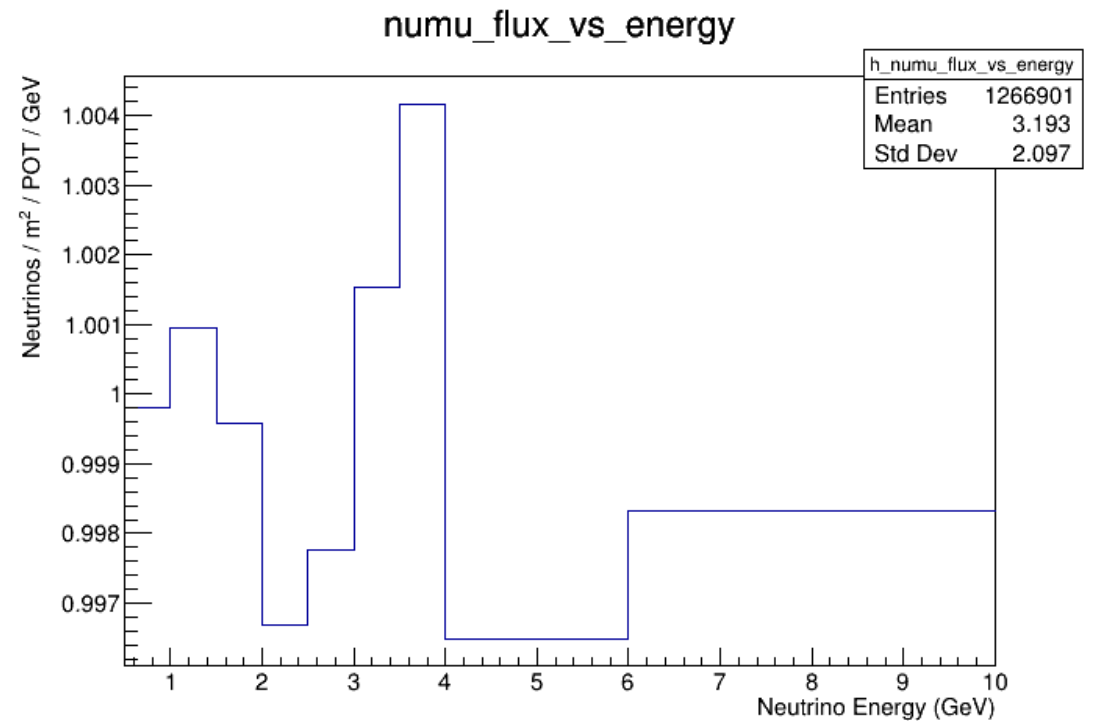
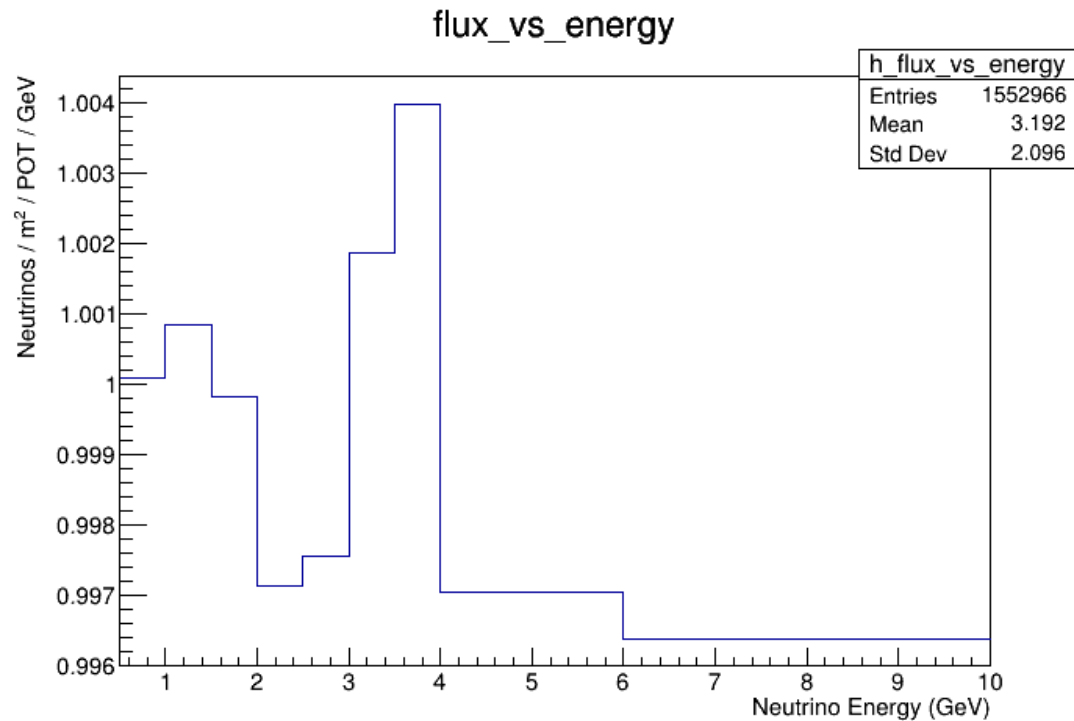
Horn B Eccentricity pX v Flux at Far Detector



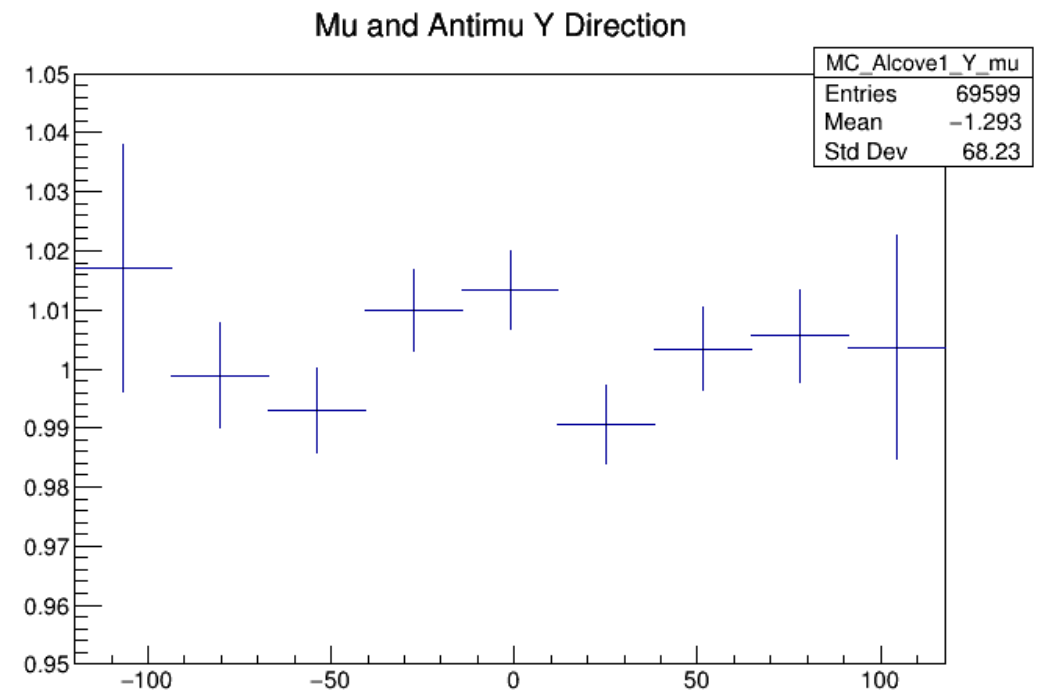
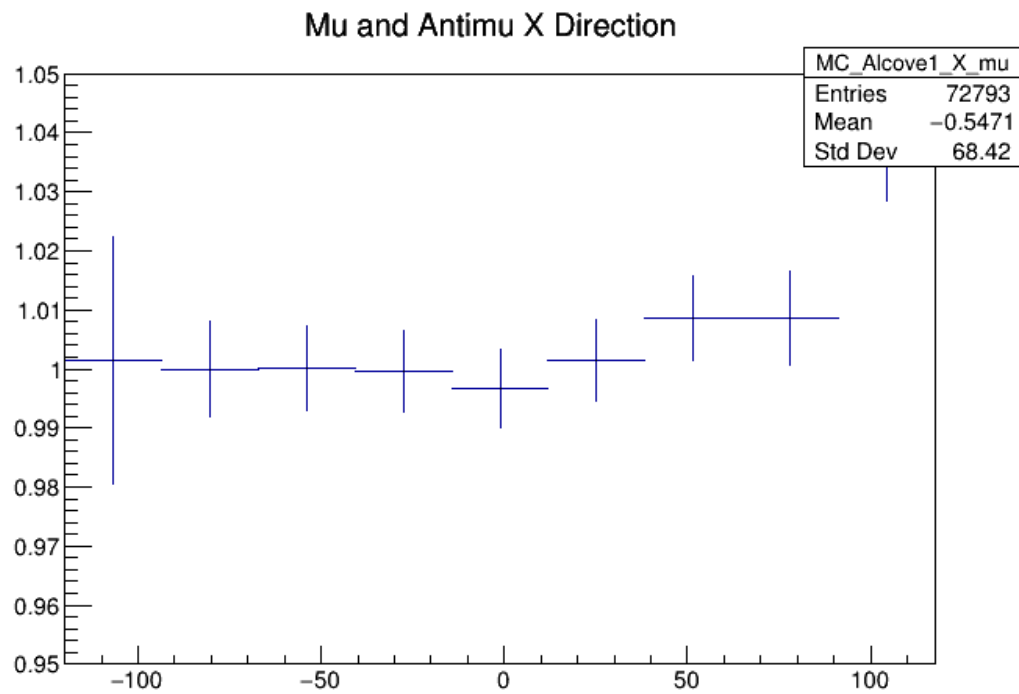
Horn B Move Up



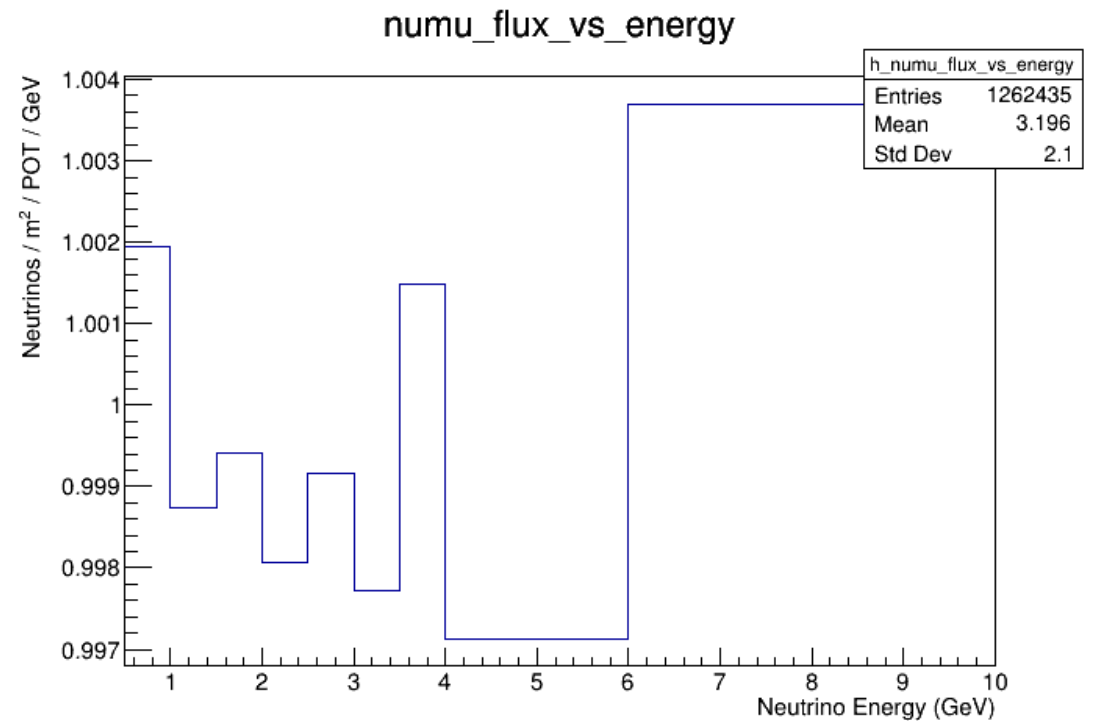
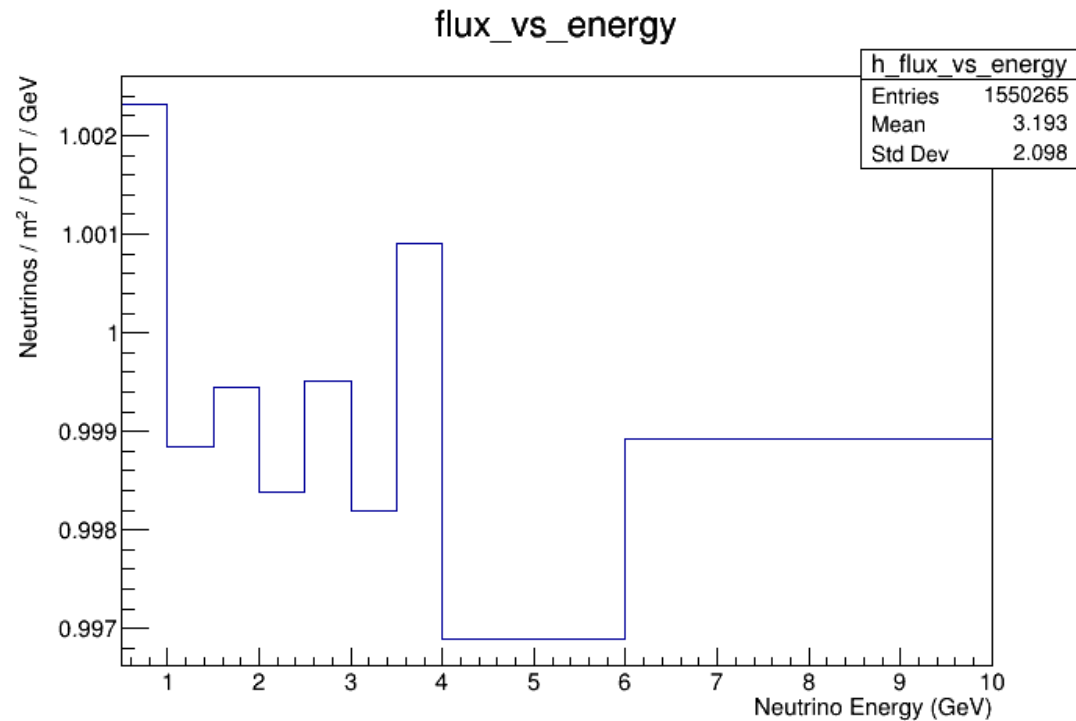
Horn B Move Up ν Flux at Far Detector



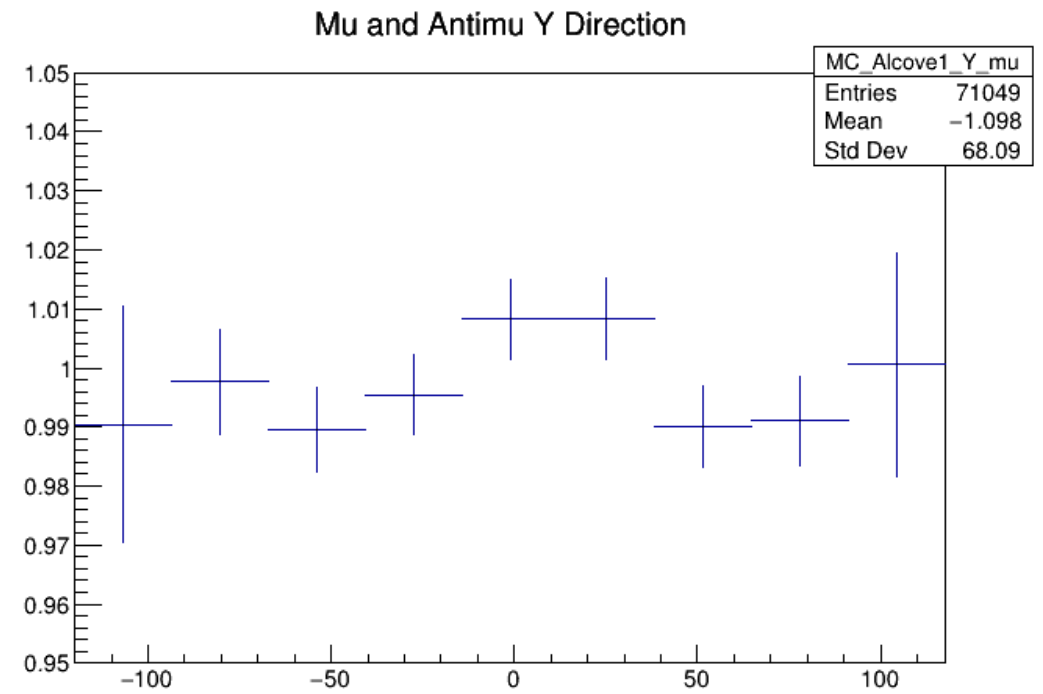
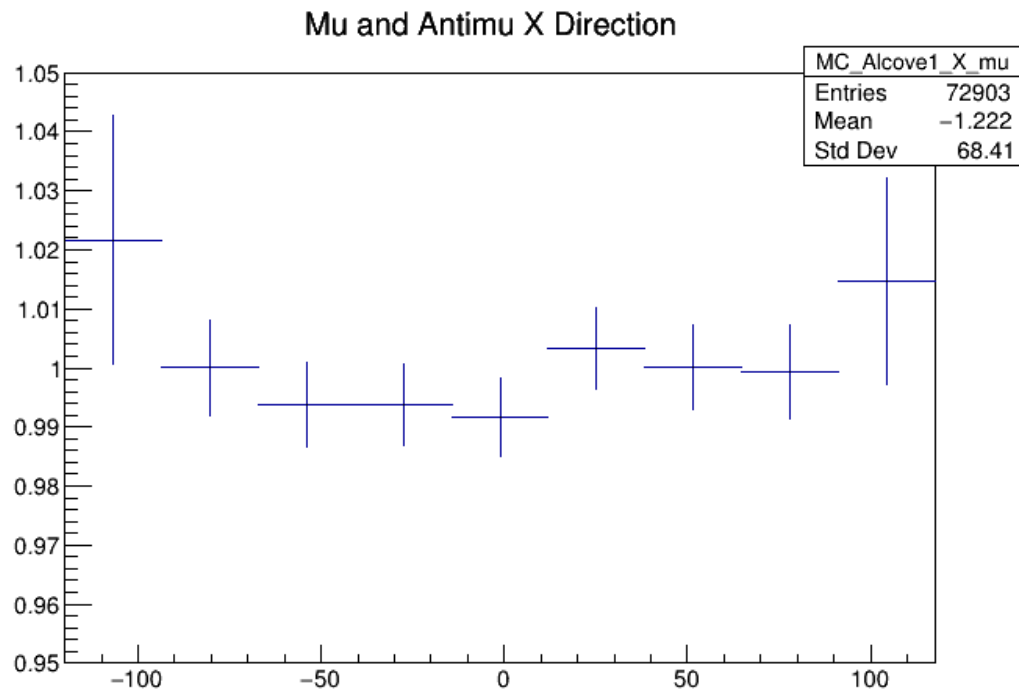
Horn B Move Down



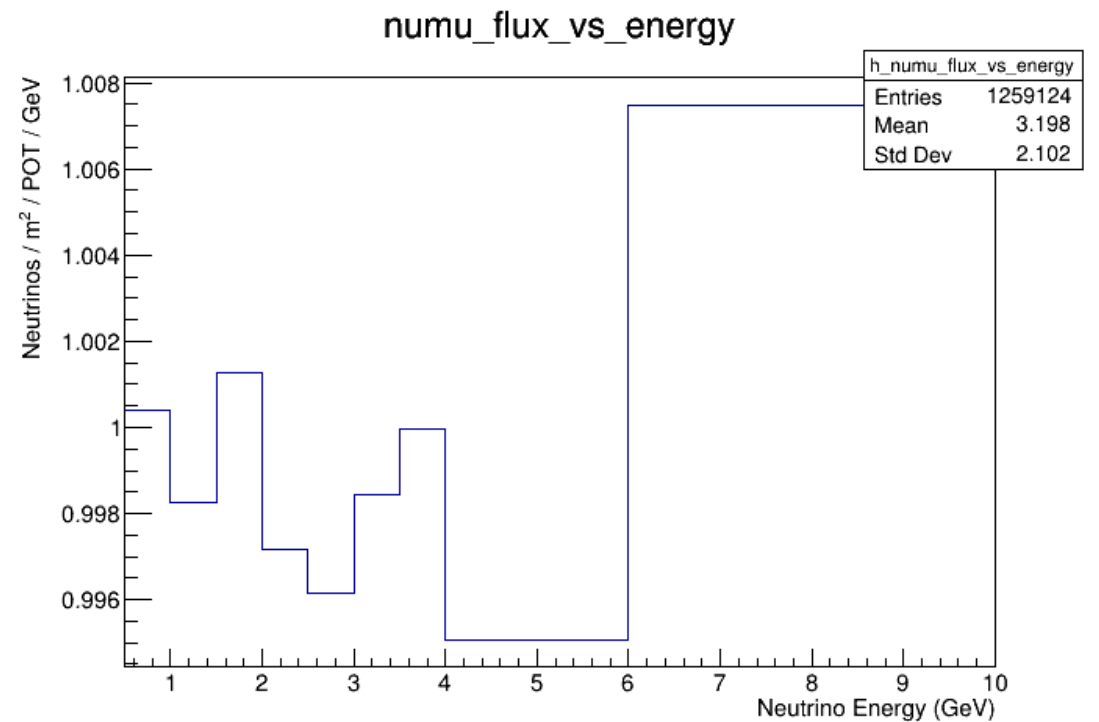
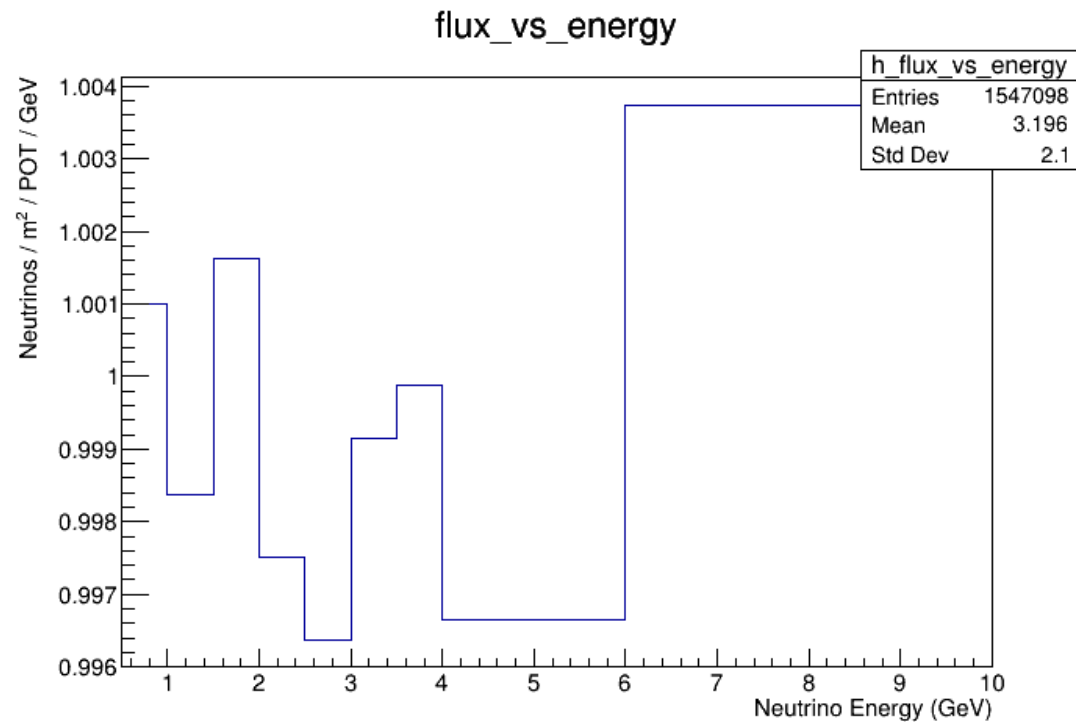
Horn B Move Down ν Flux at Far Detector



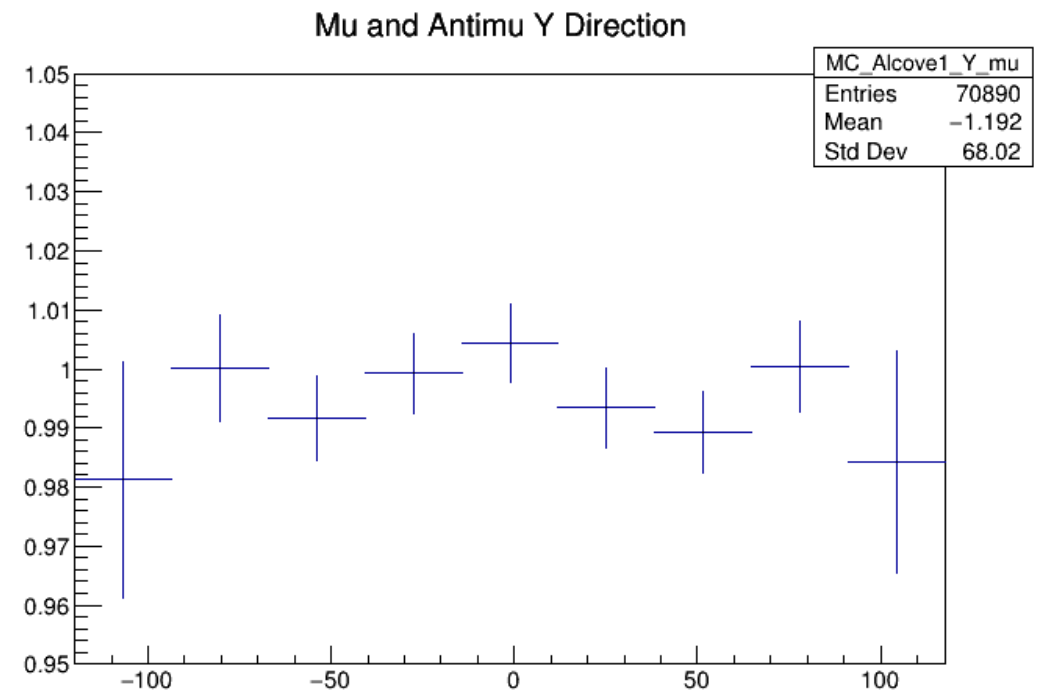
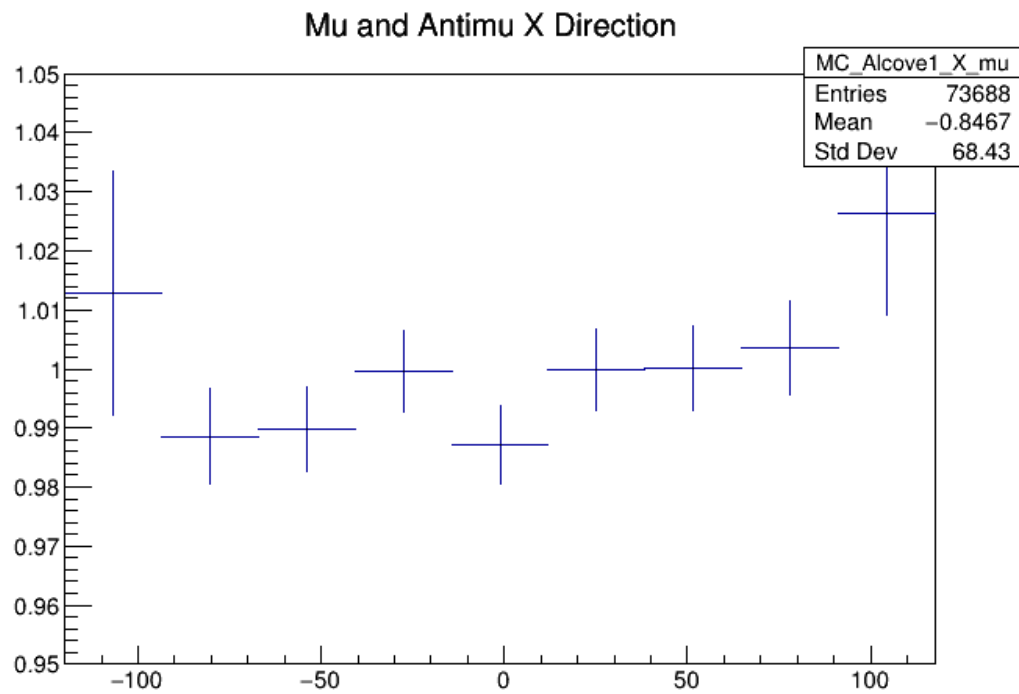
Horn B Move Right



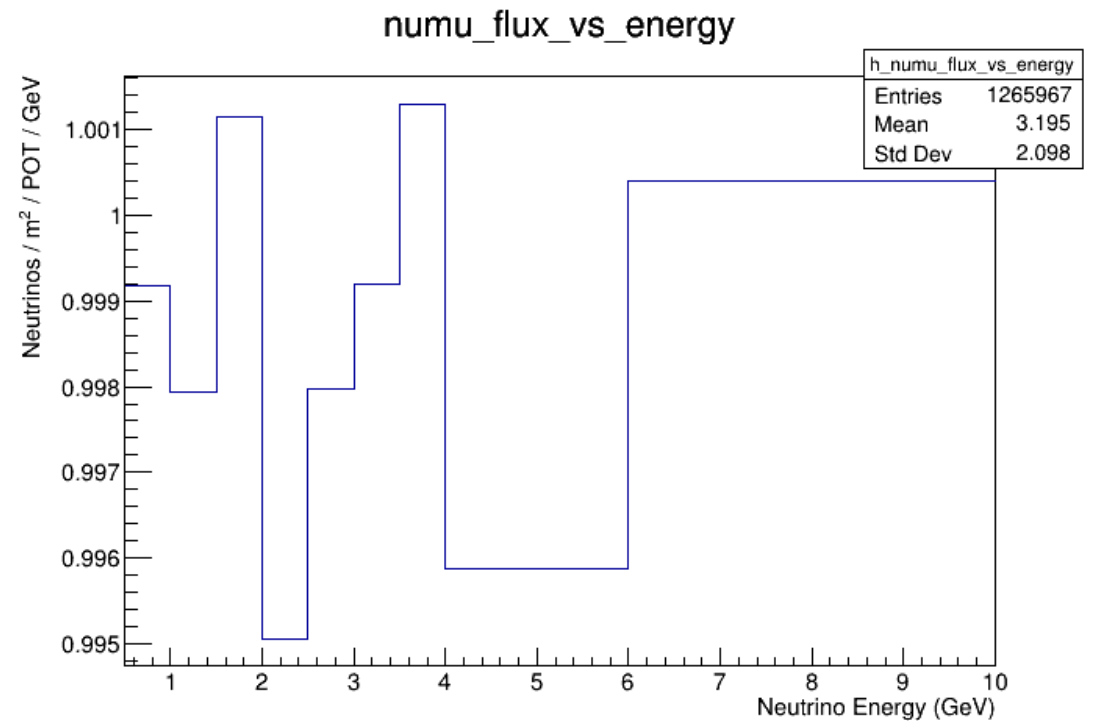
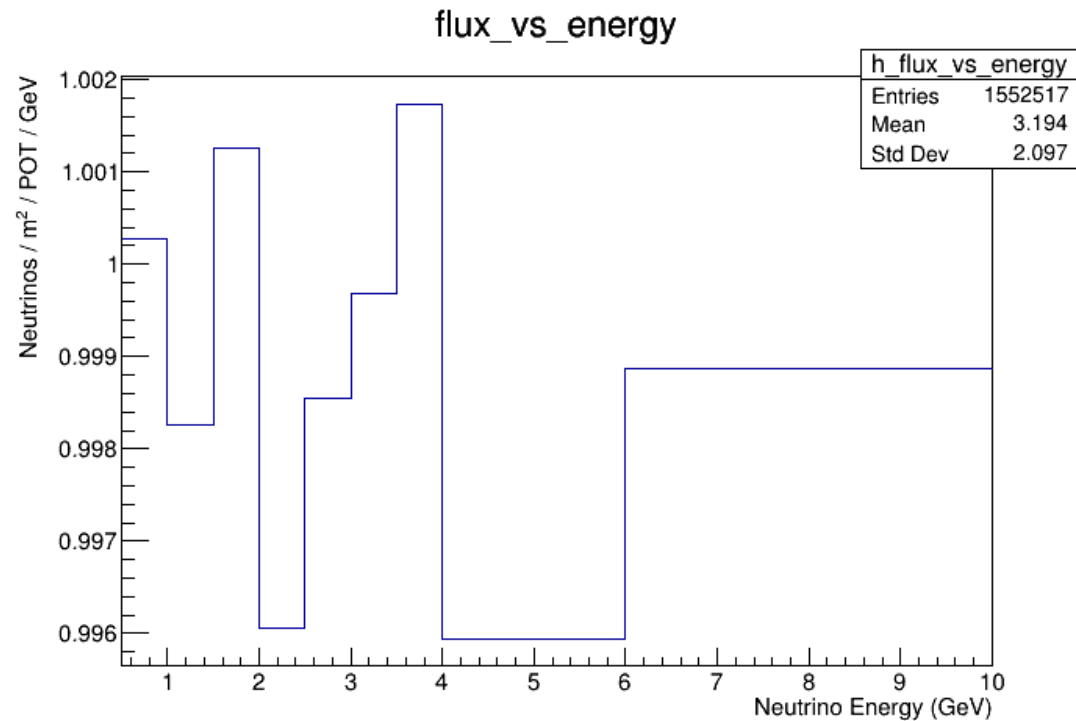
Horn B Move Right ν Flux at Far Detector



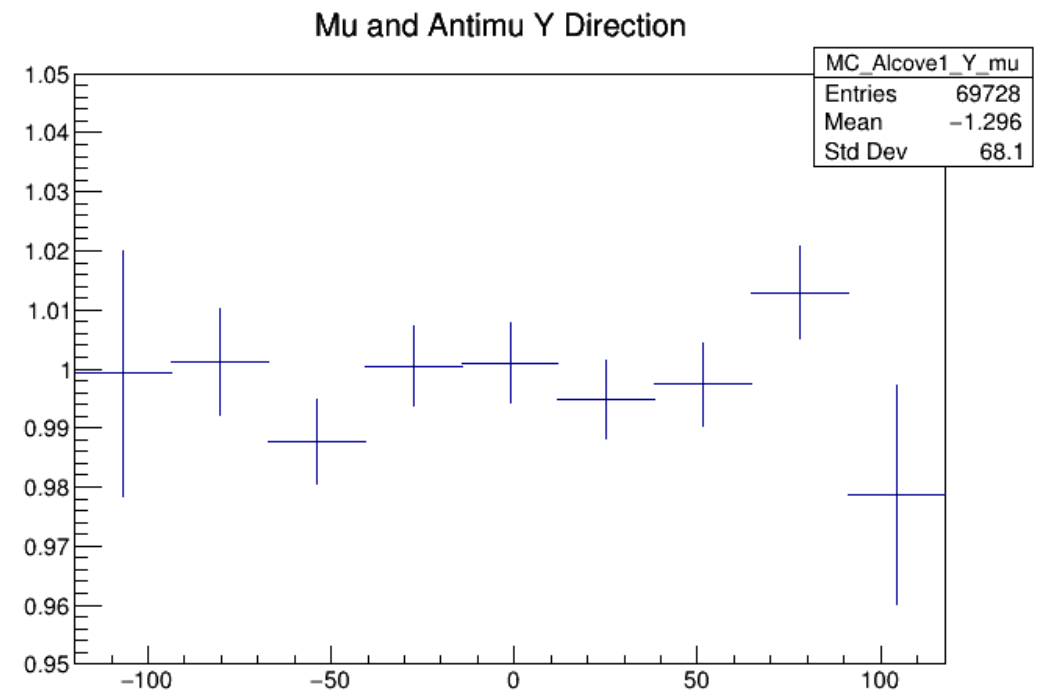
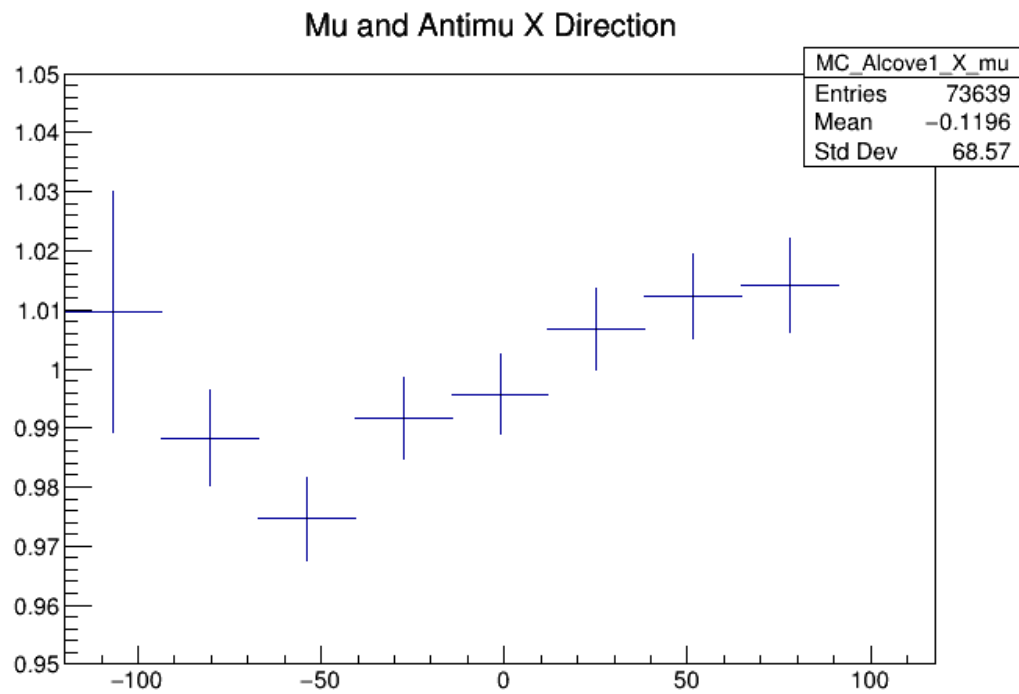
Horn B Move Left



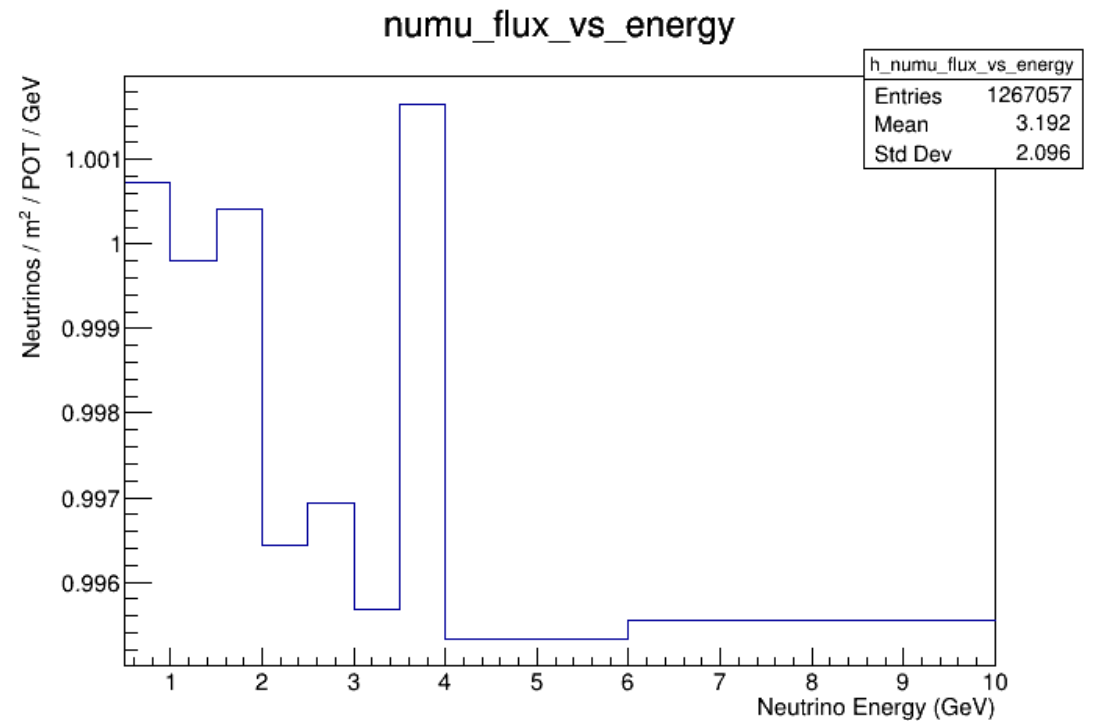
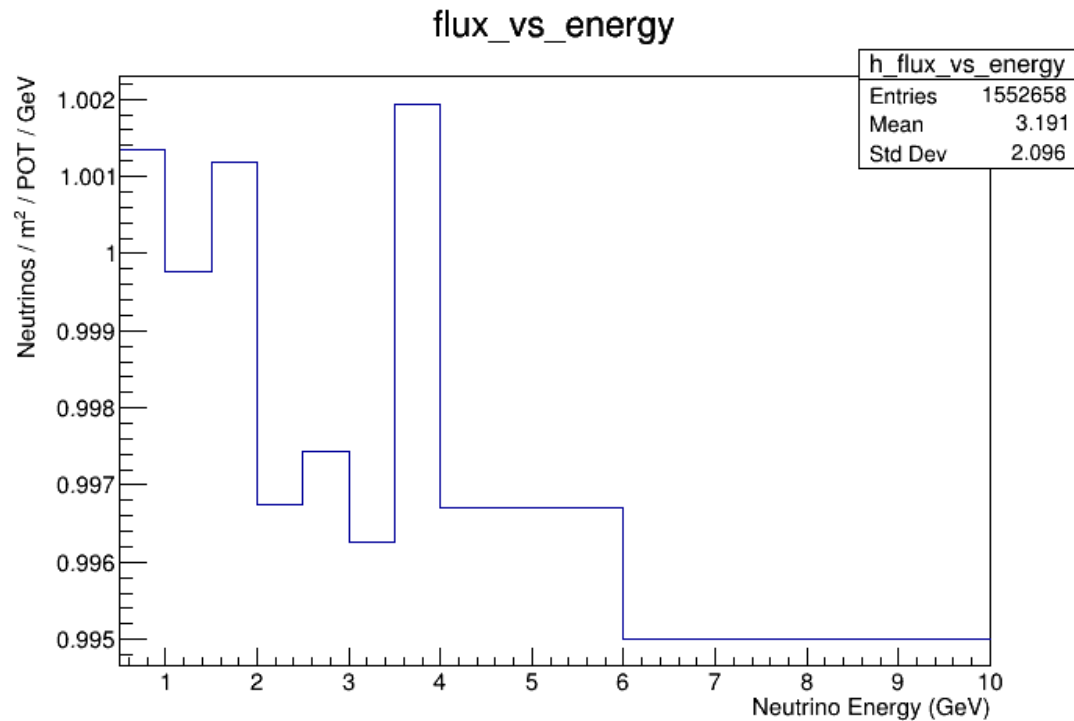
Horn B Move Left ν Flux at Far Detector



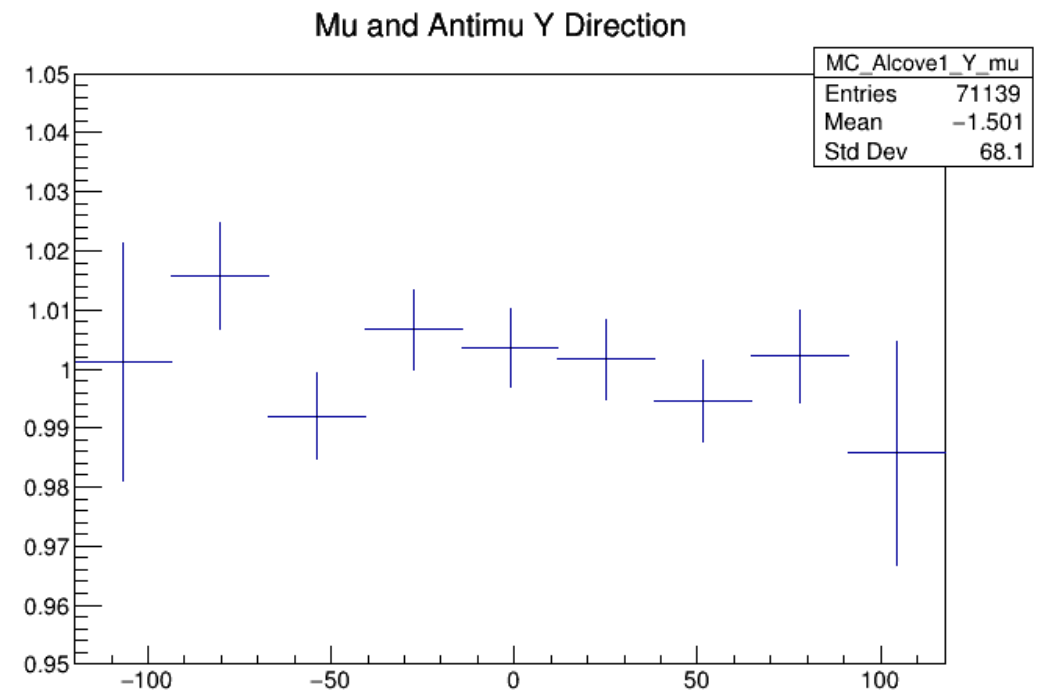
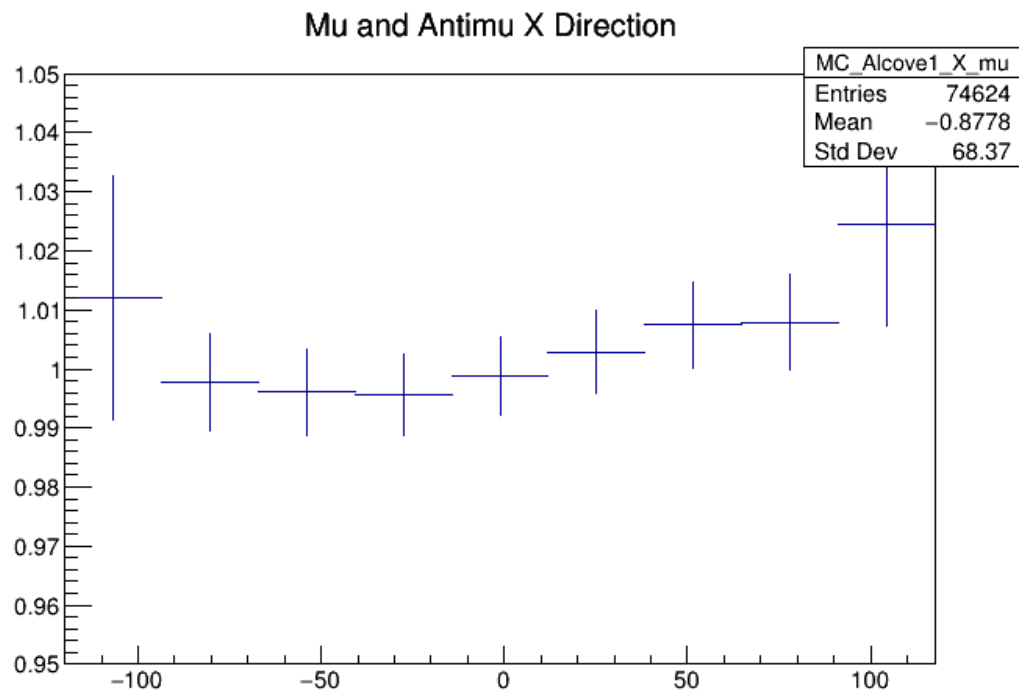
Horn C Eccentricity pX



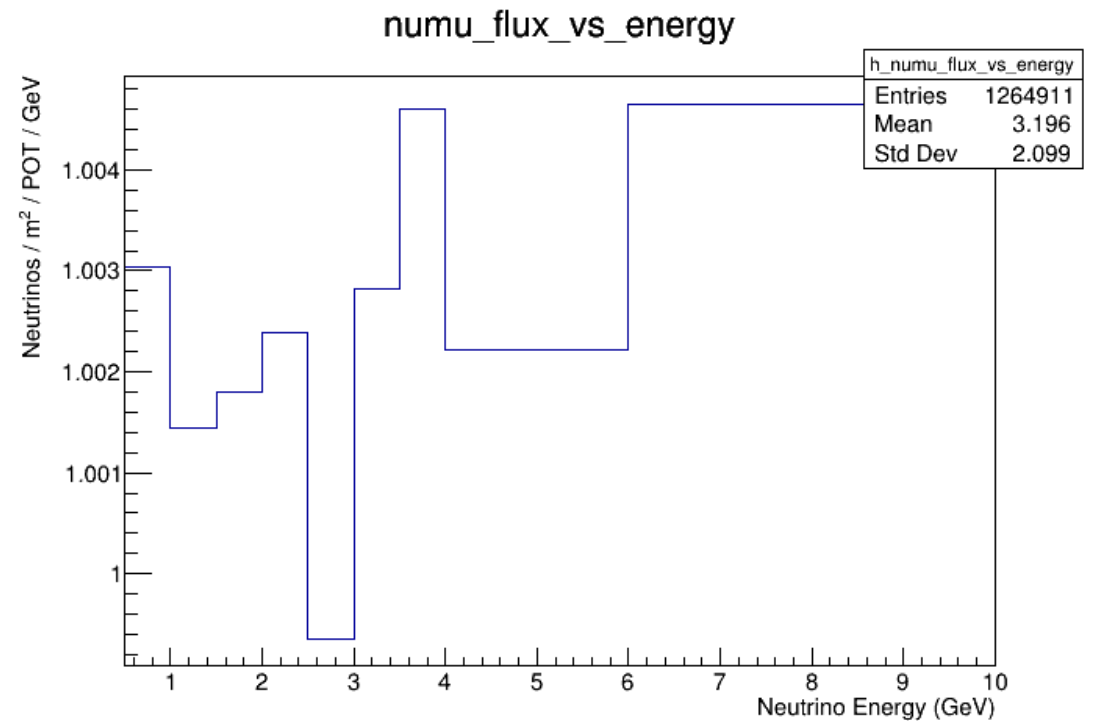
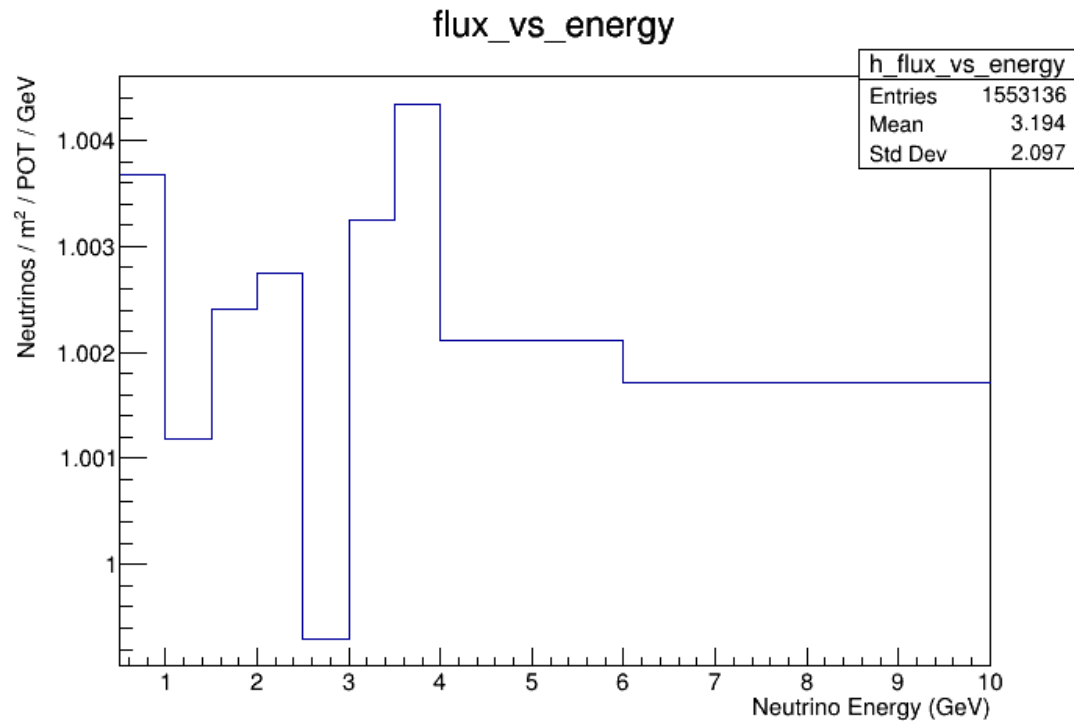
Horn C Eccentricity pX v Flux at Far Detector



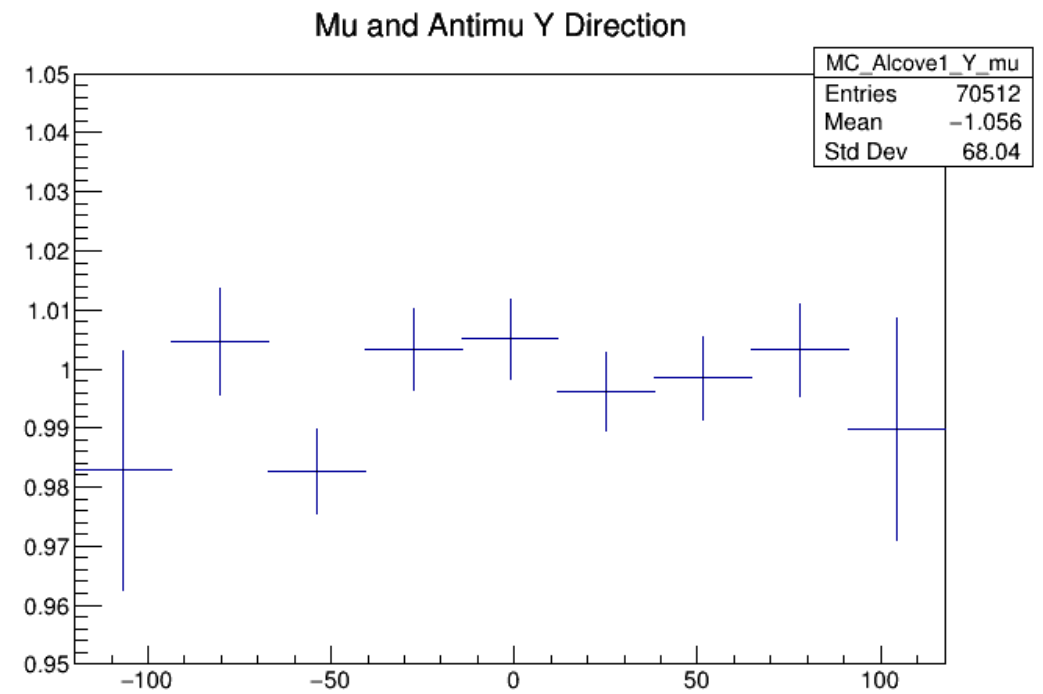
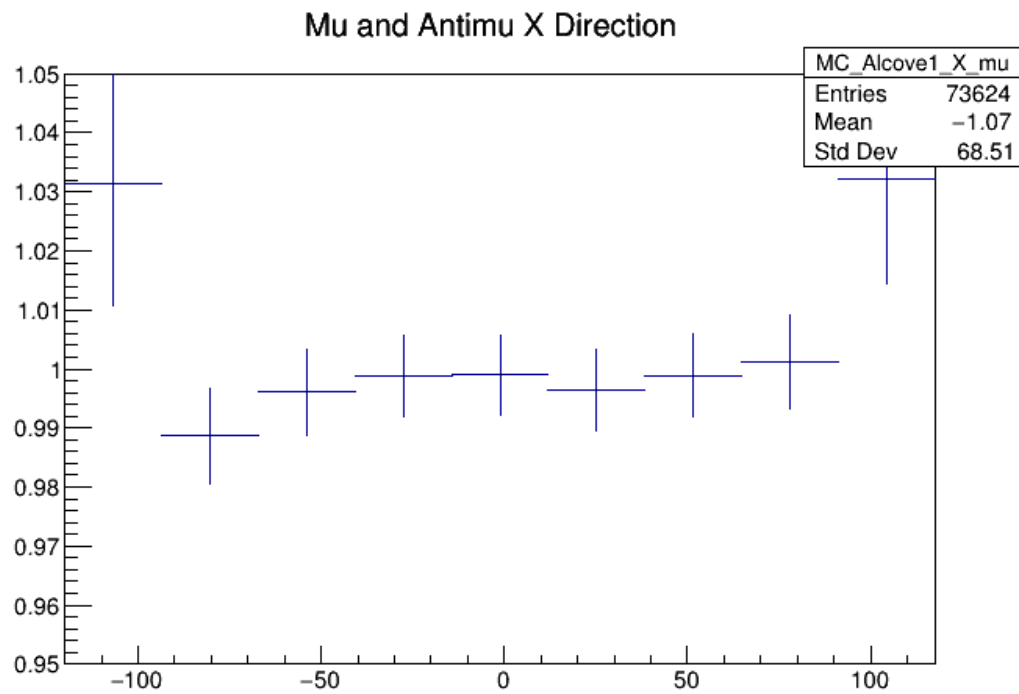
Horn C Move Up



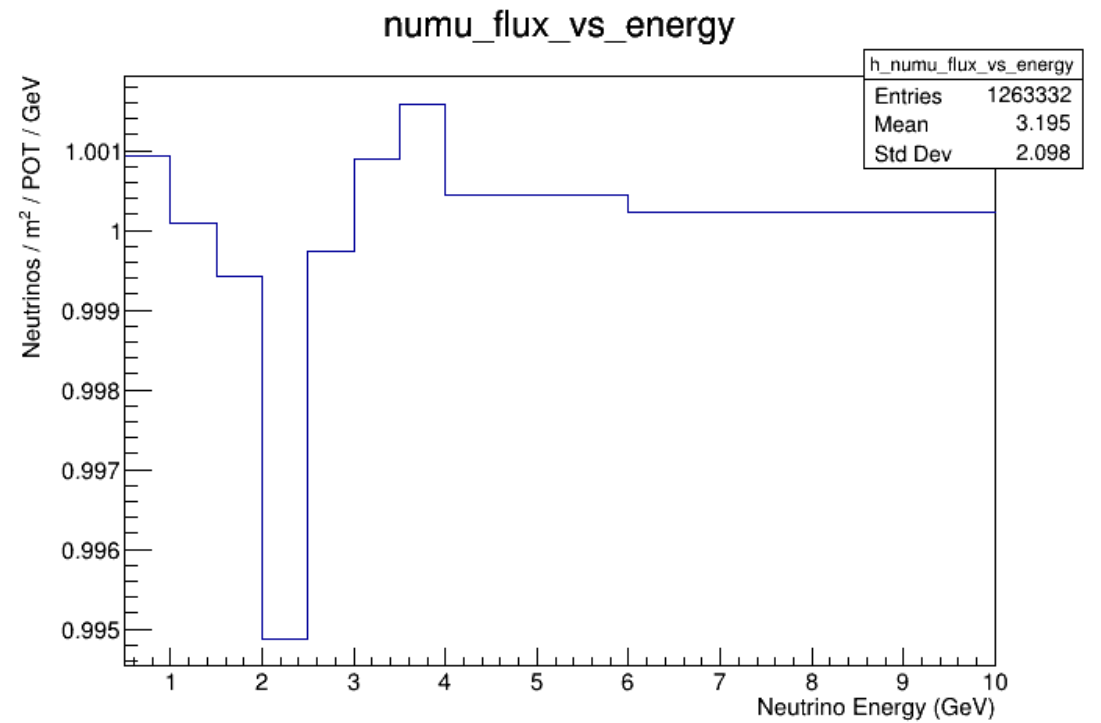
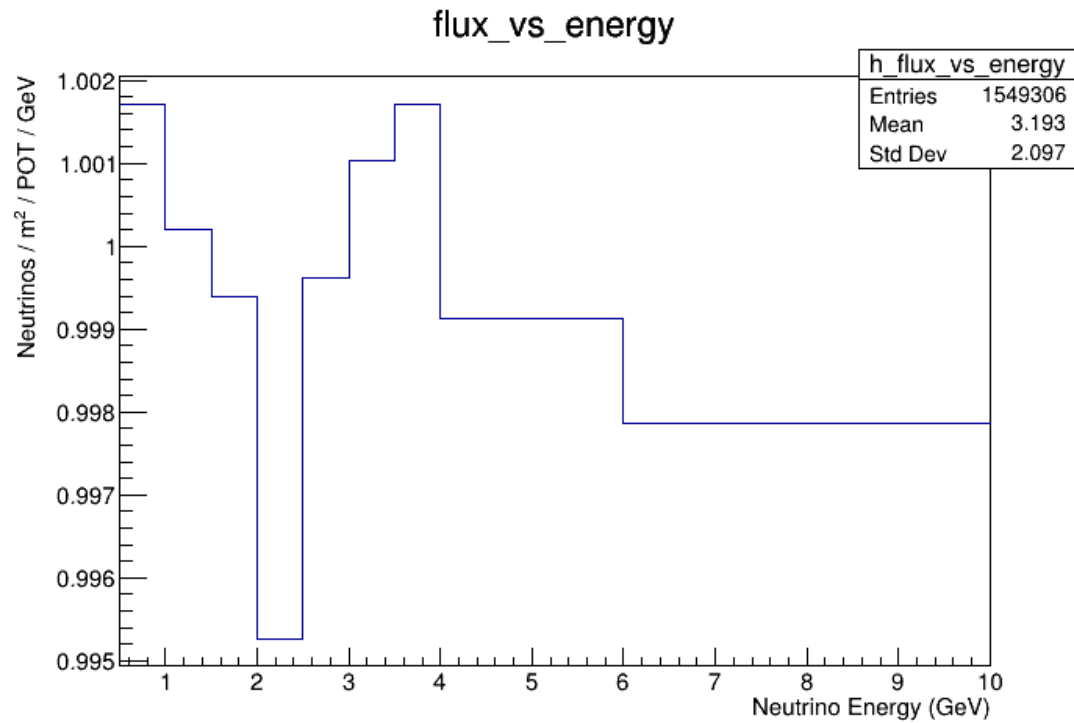
Horn C Move Up ν Flux at Far Detector



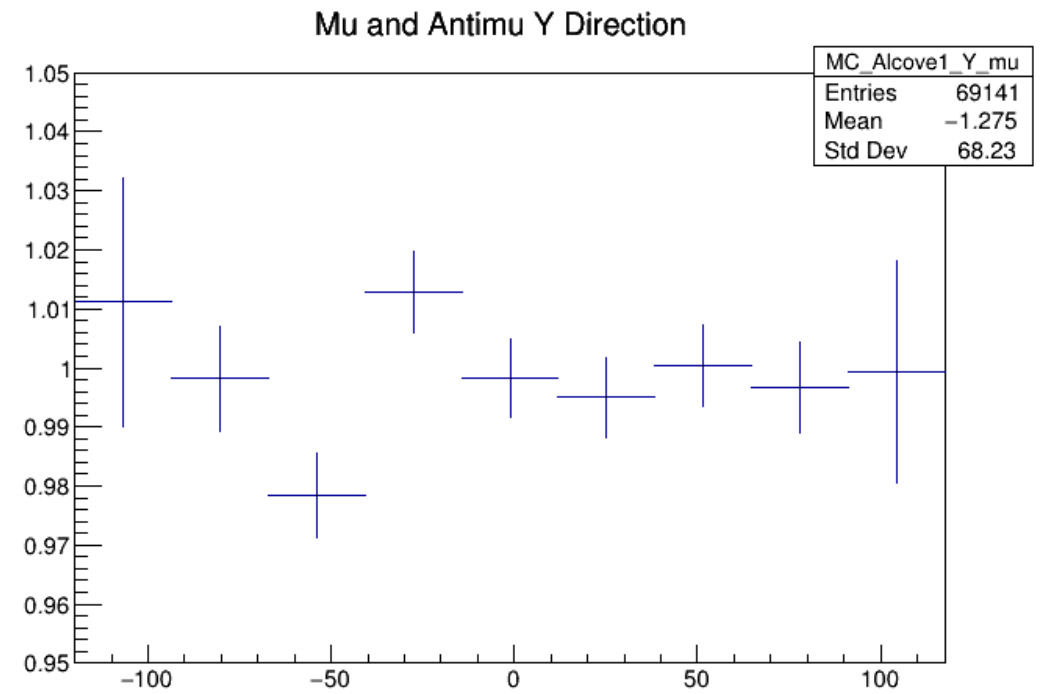
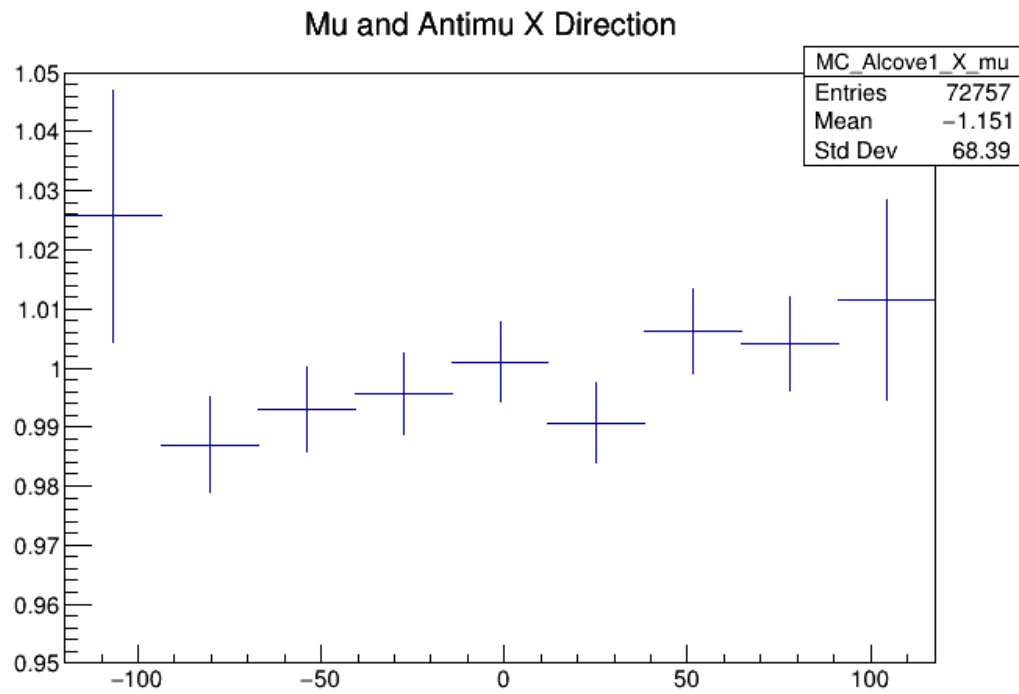
Horn C Move Down



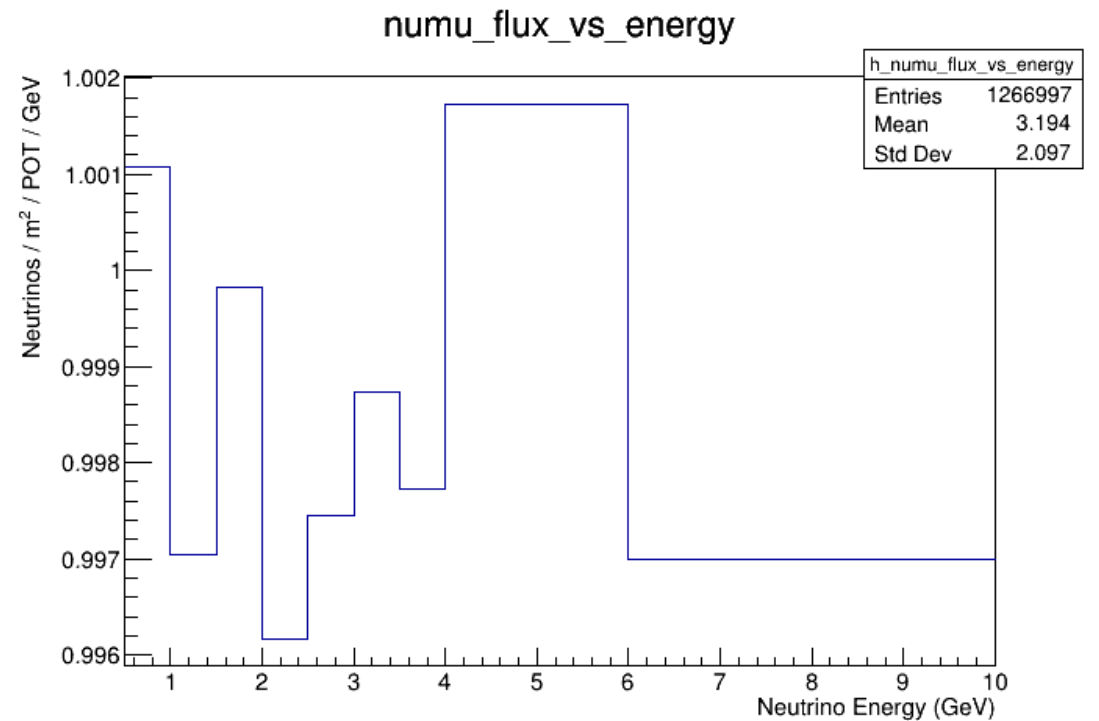
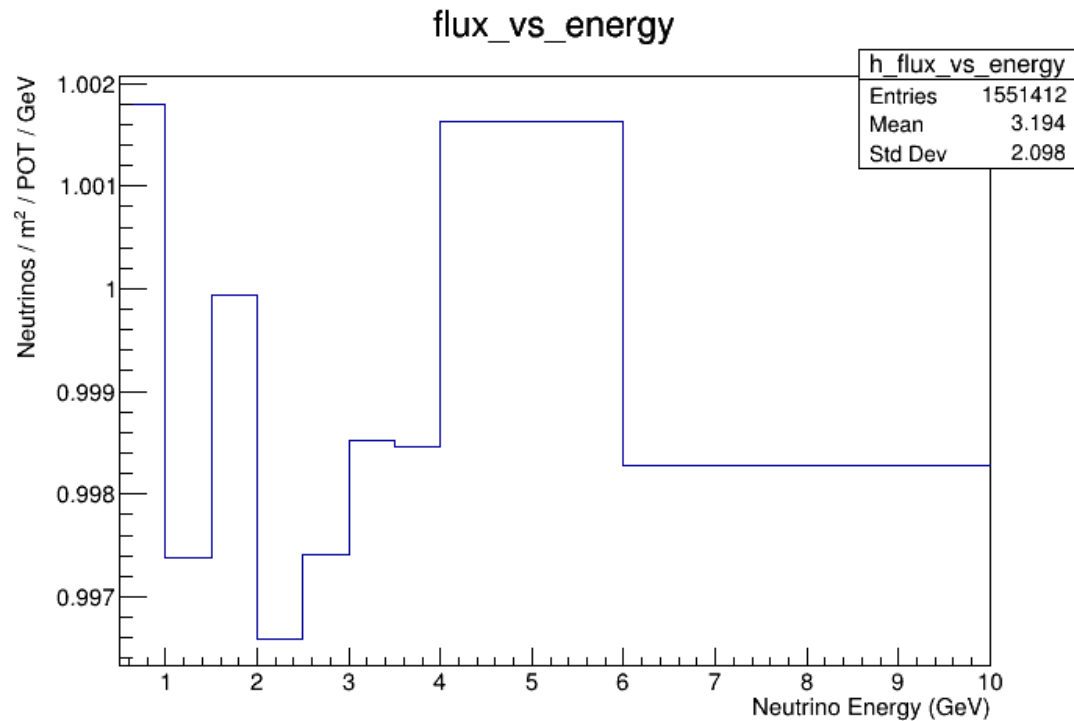
Horn C Move Down ν Flux at Far Detector



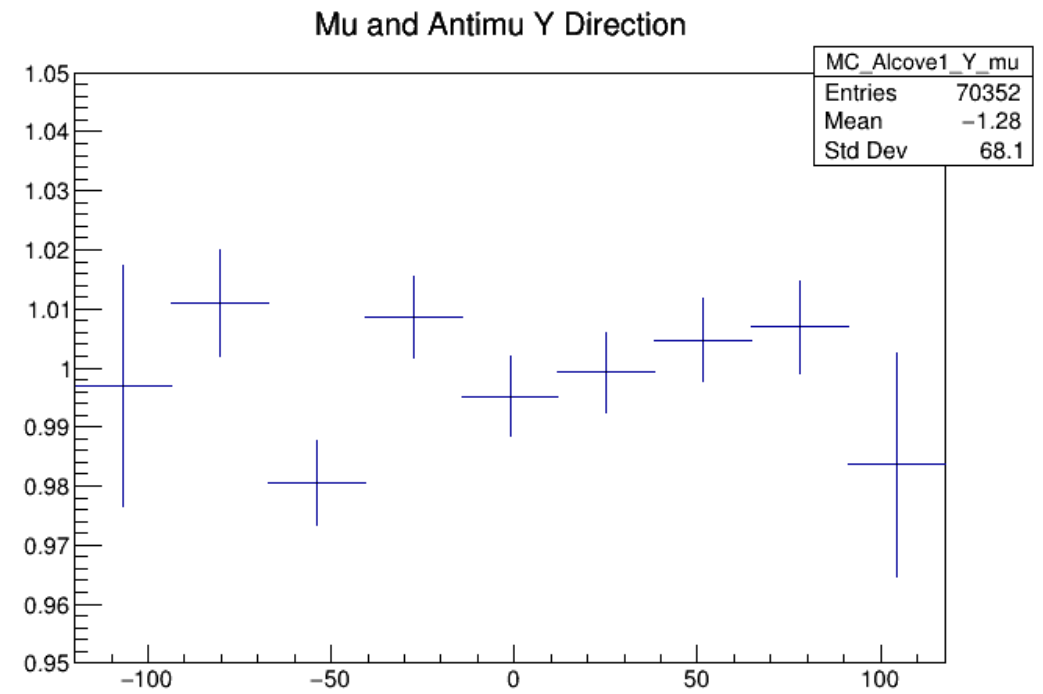
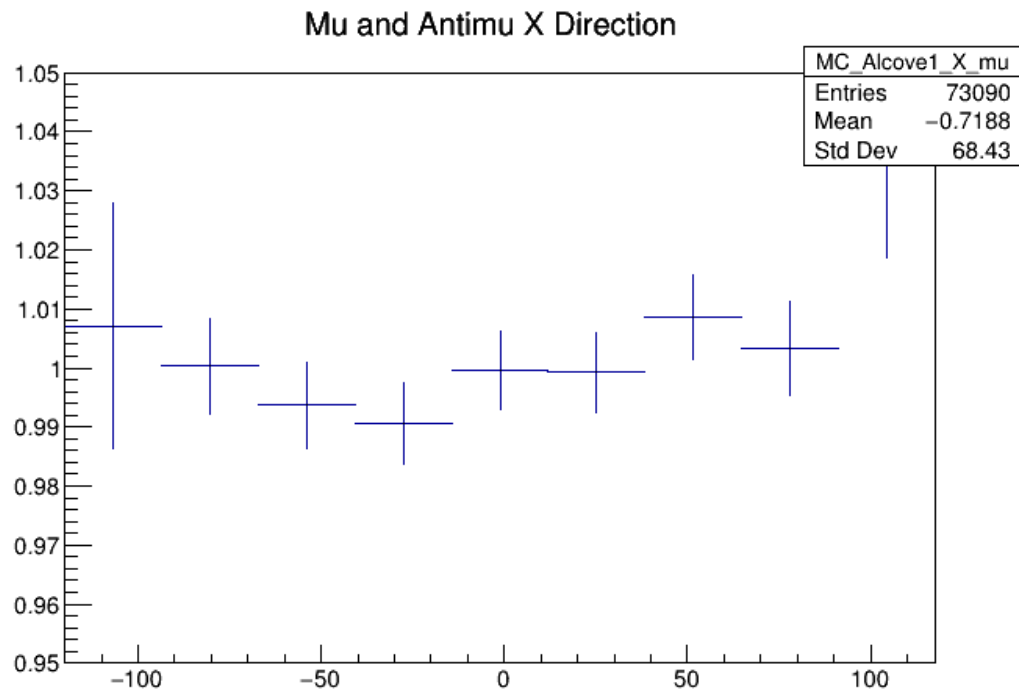
Horn C Move Right



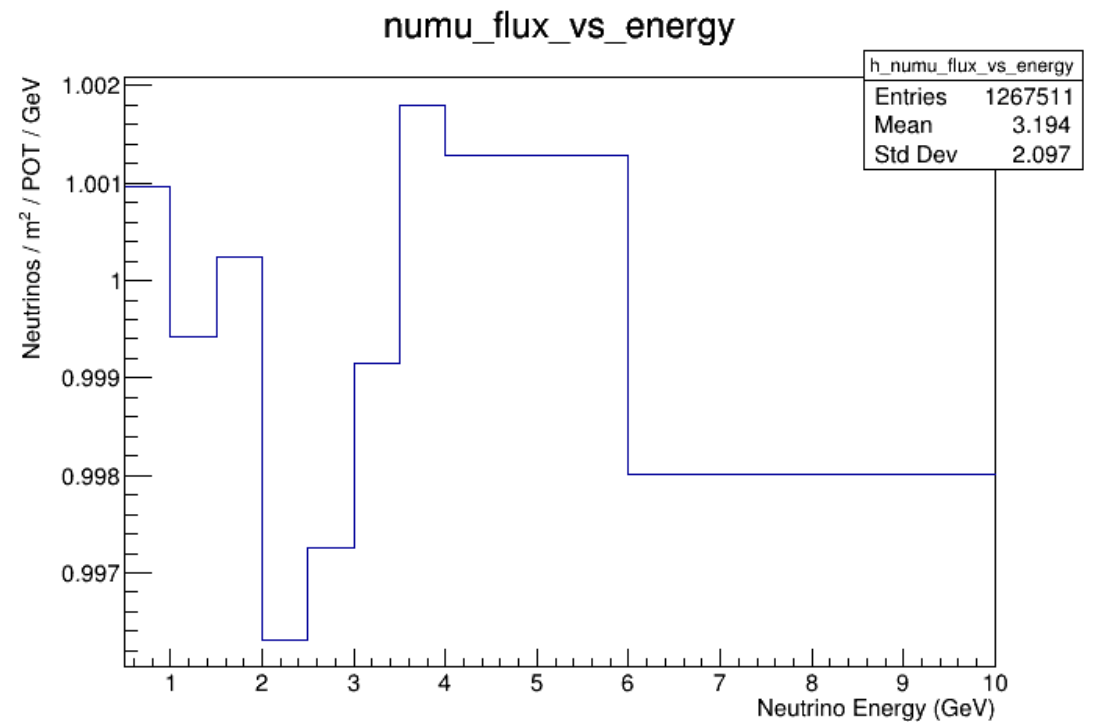
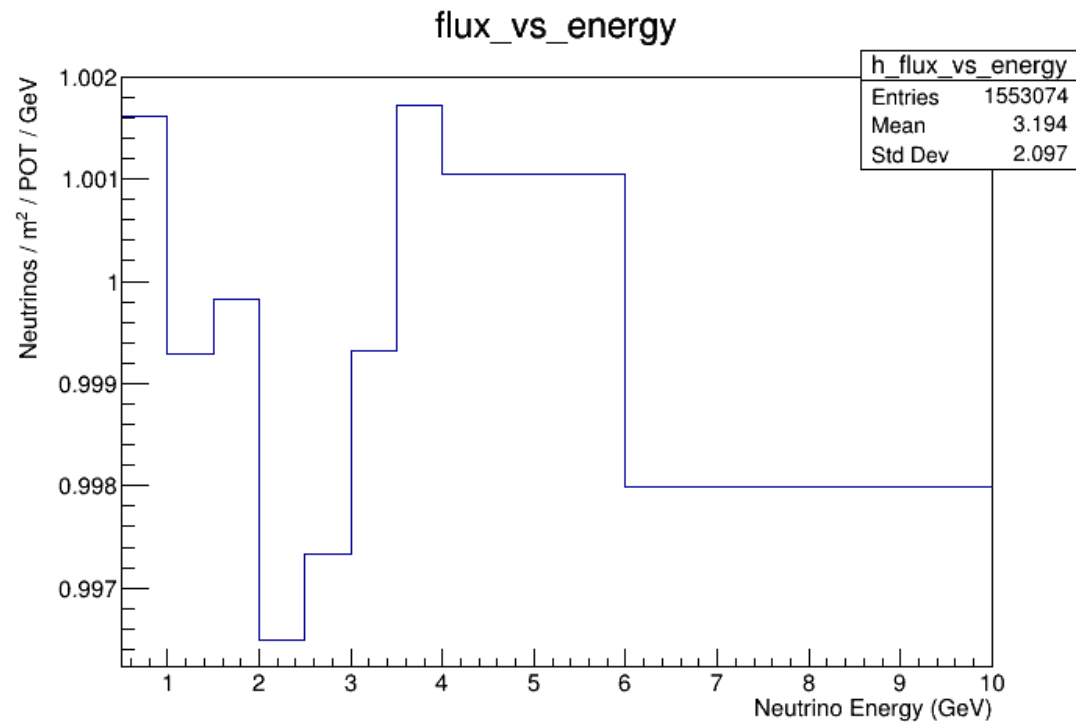
Horn C Move Right ν Flux at Far Detector



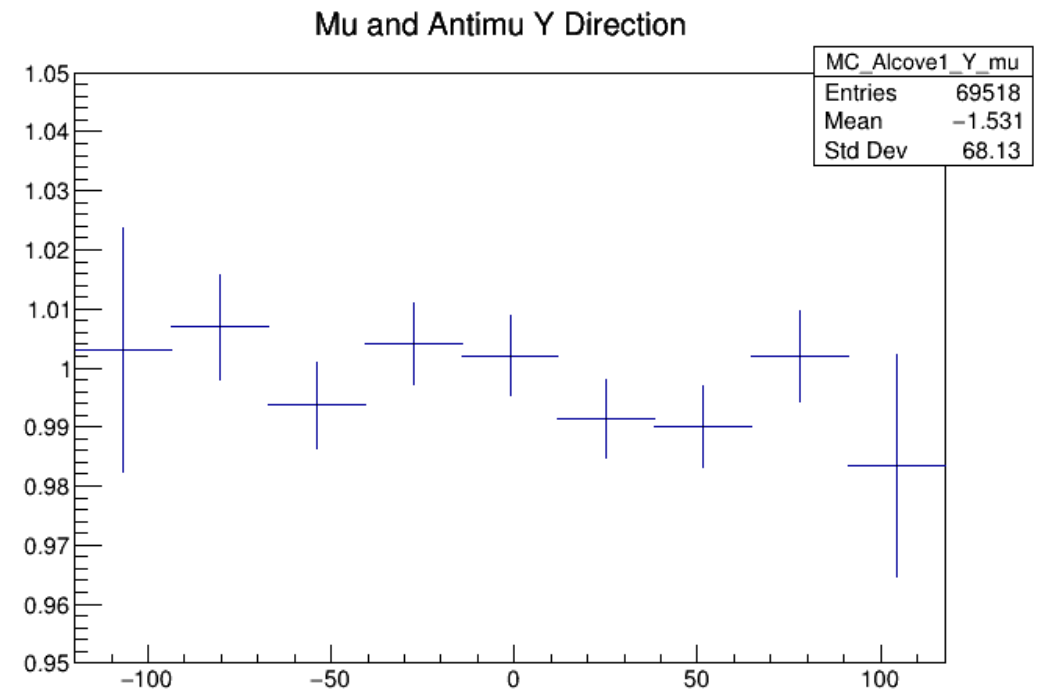
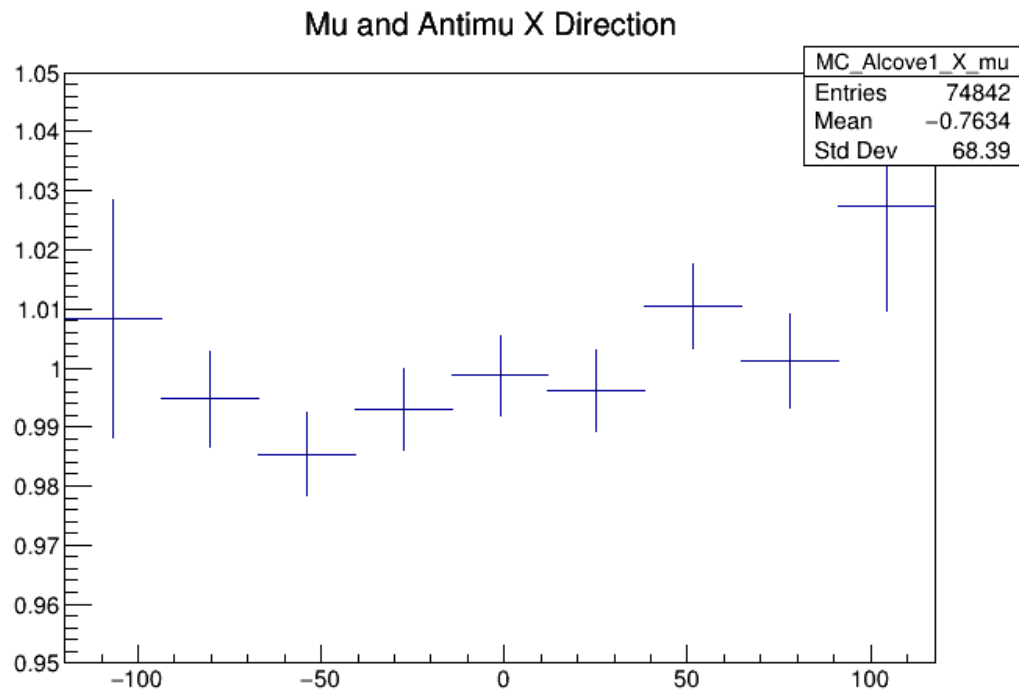
Horn C Move Left



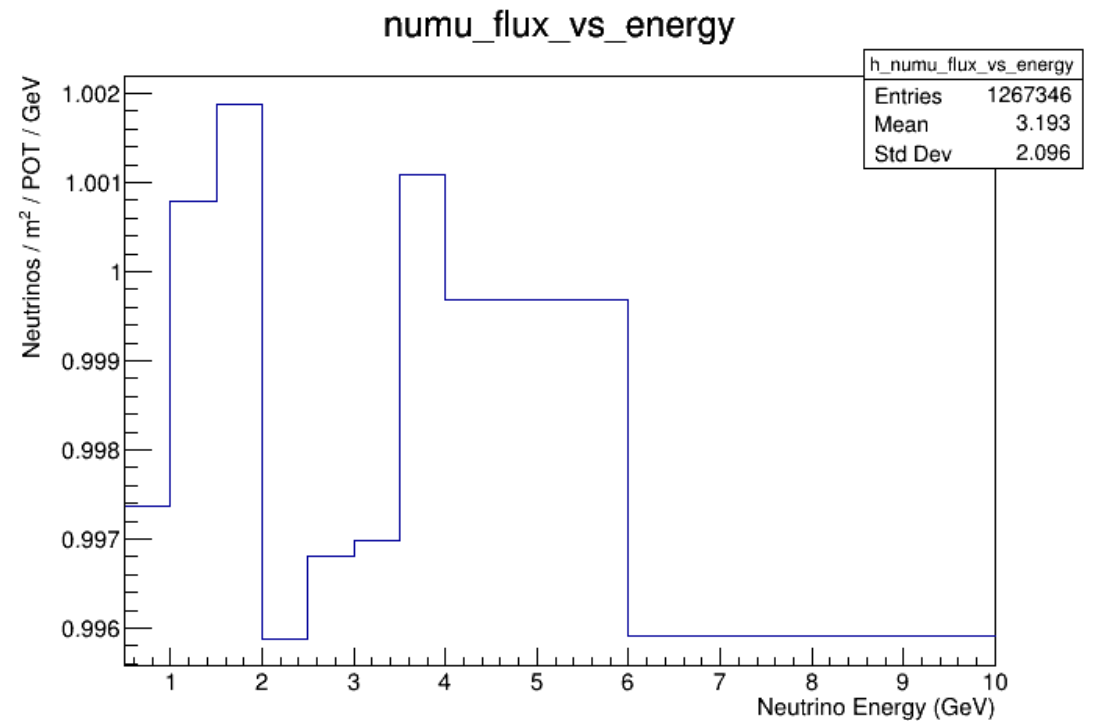
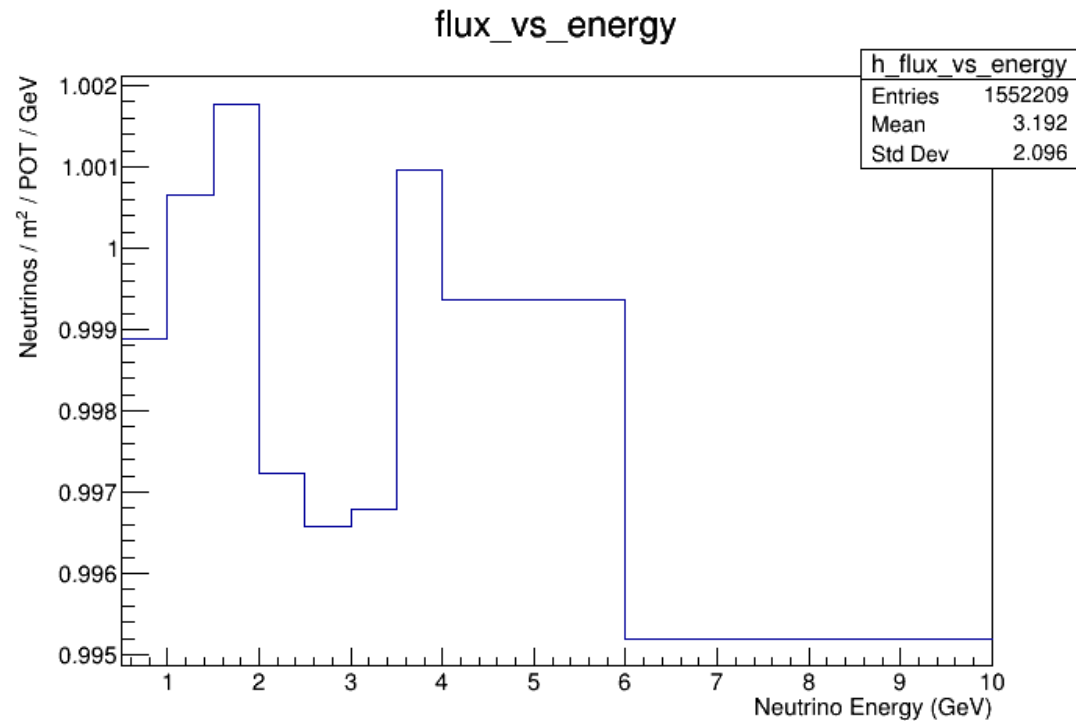
Horn C Move Left ν Flux at Far Detector



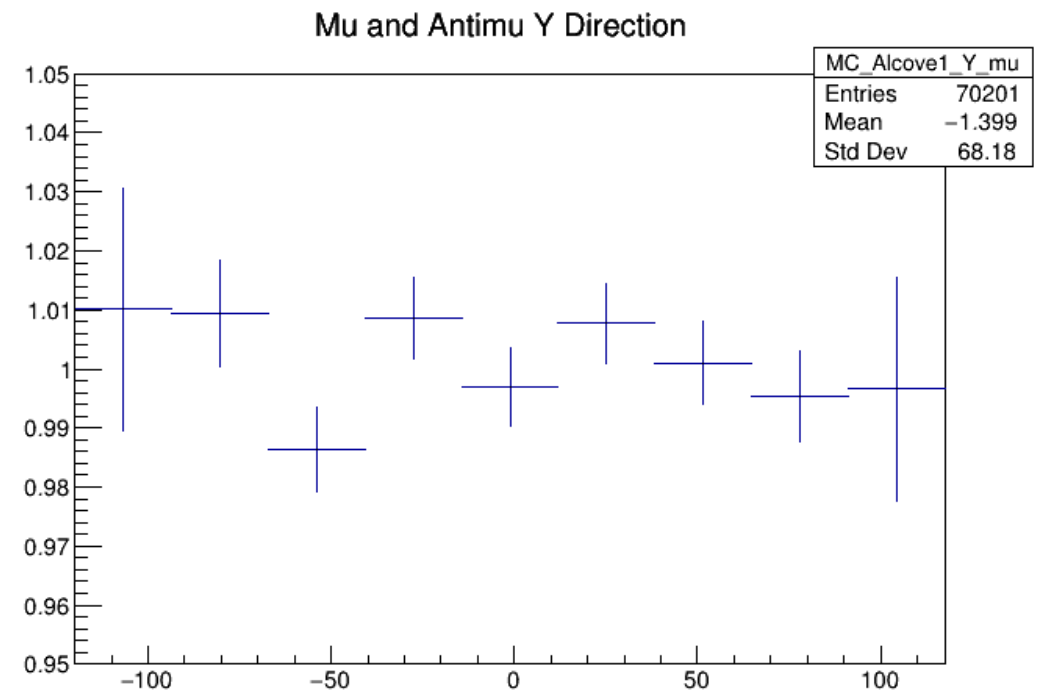
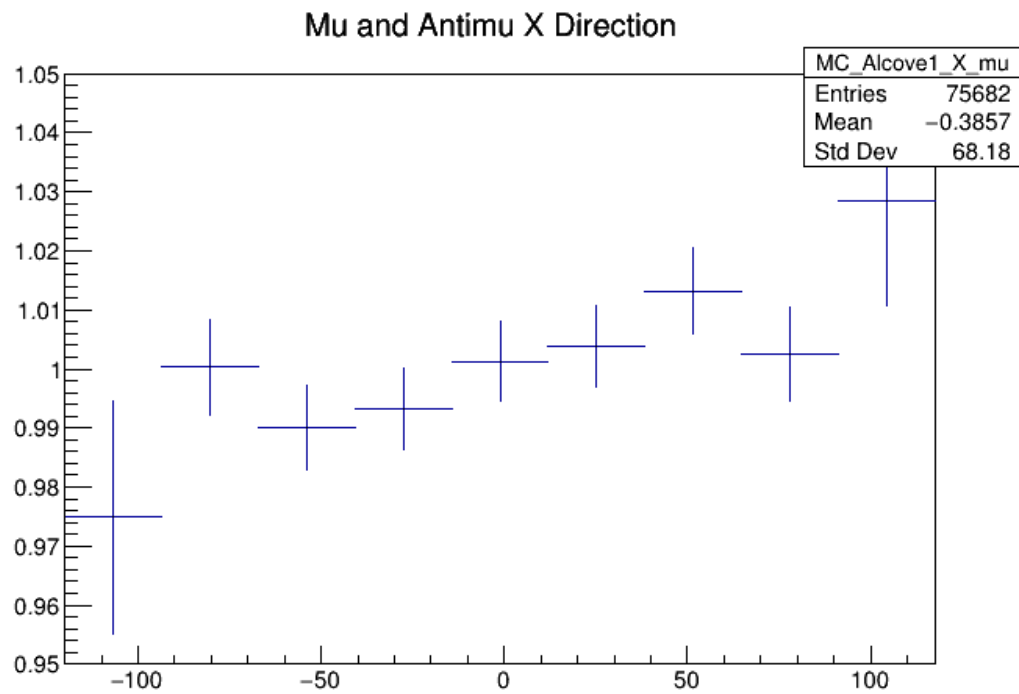
Horn C Tilt Up



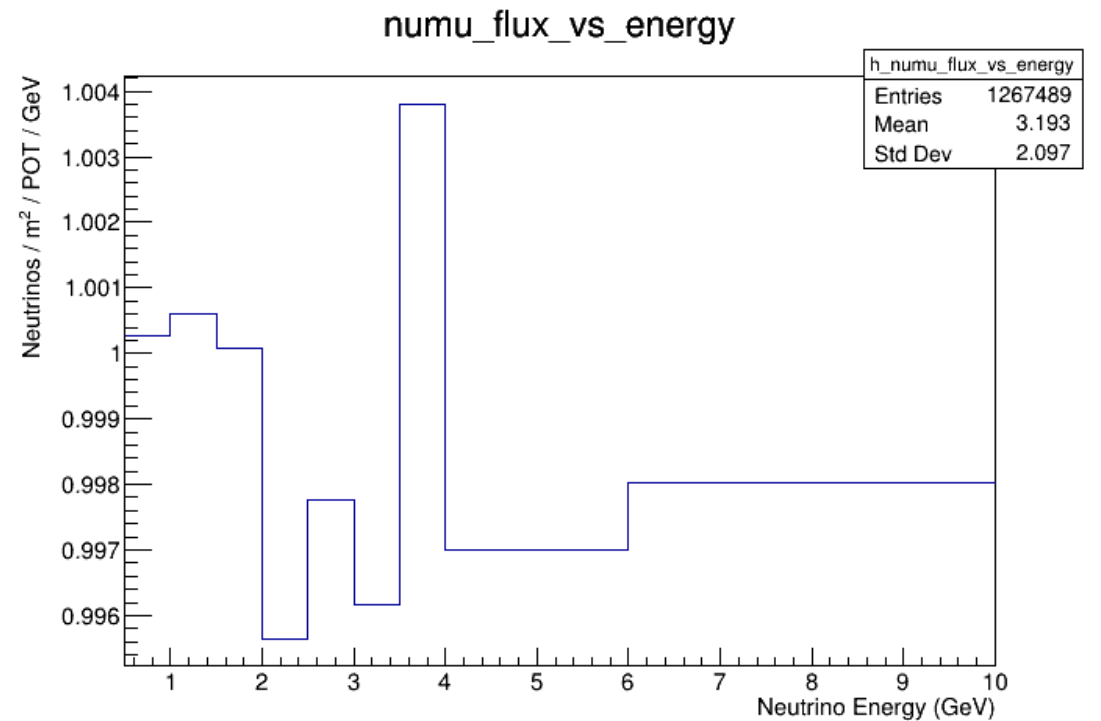
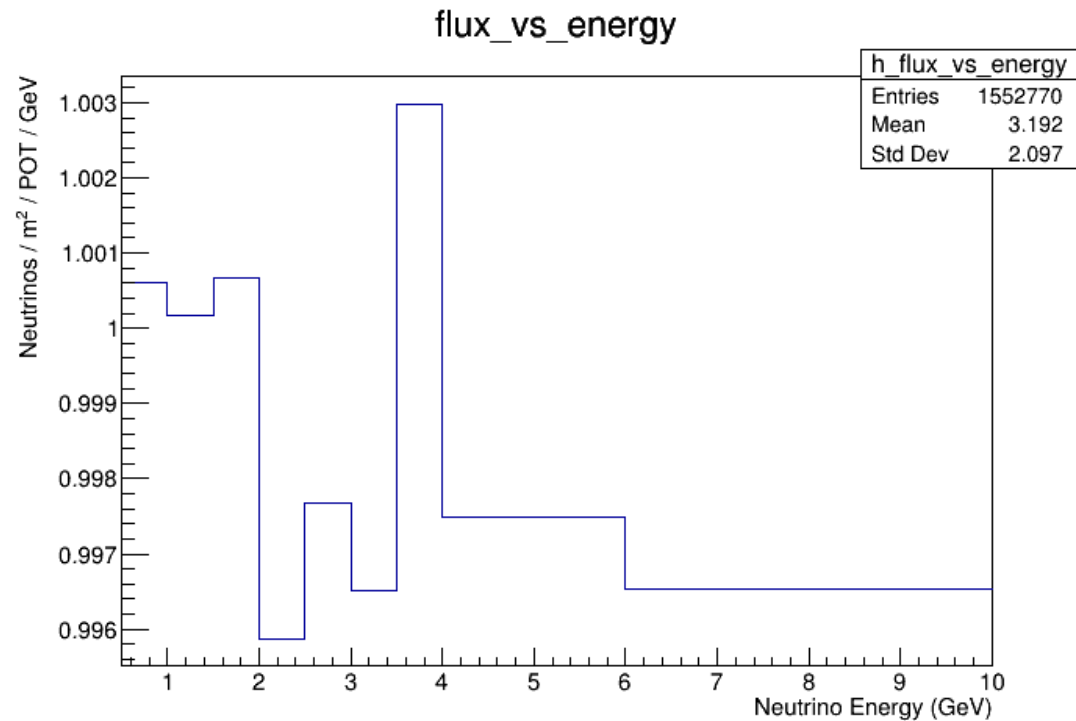
Horn C Tilt Up ν Flux at Far Detector



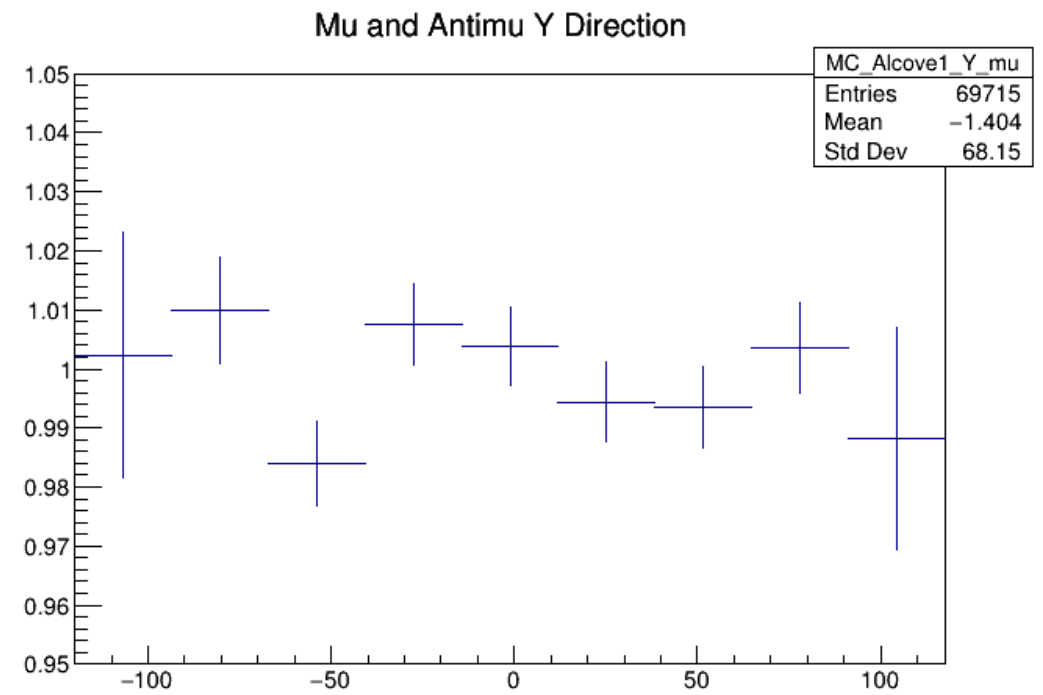
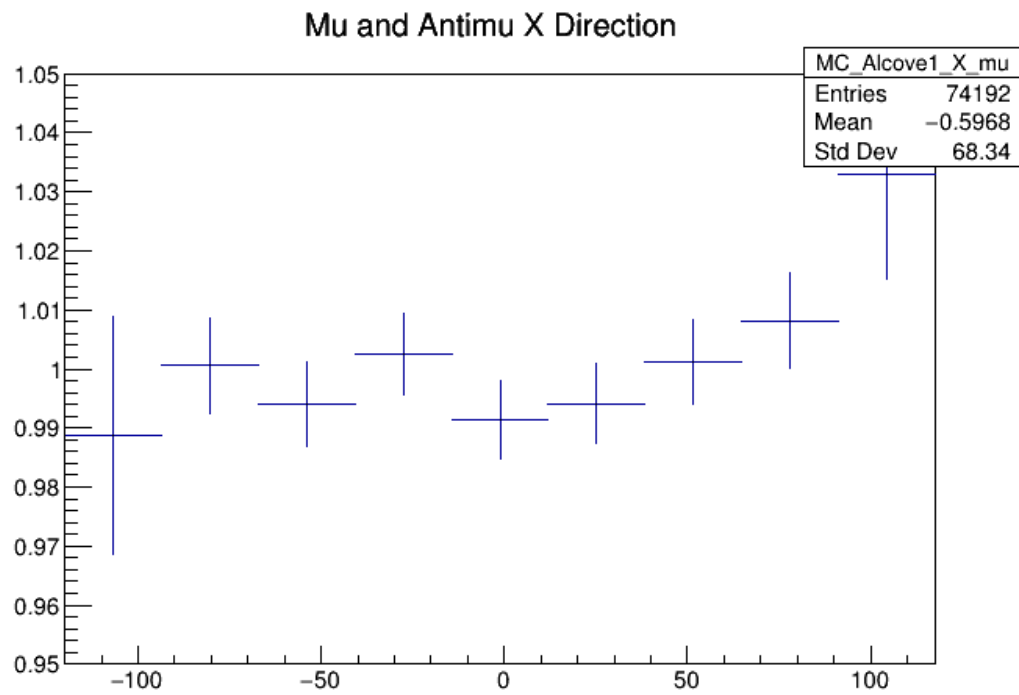
Horn C Tilt Down



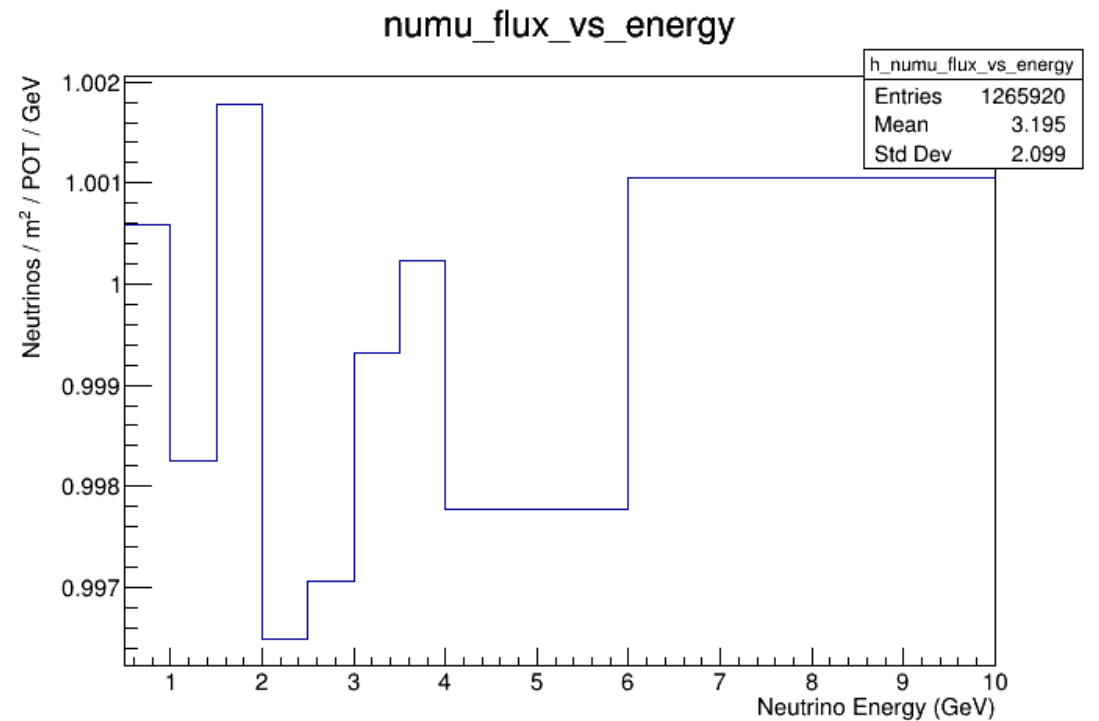
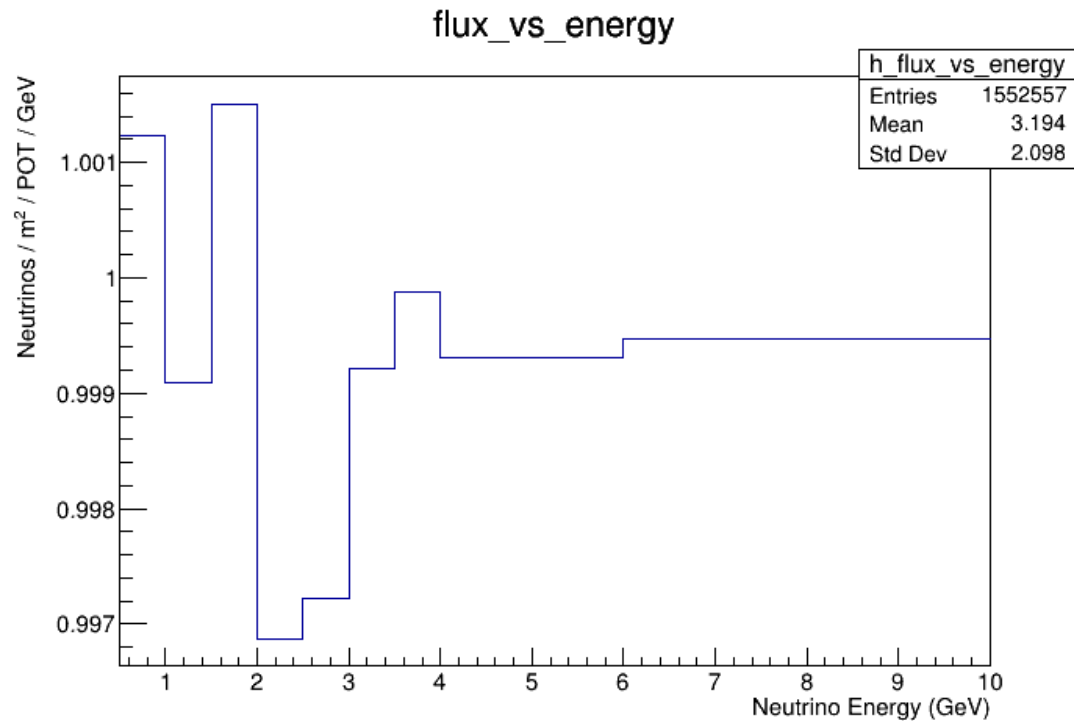
Horn C Tilt Down ν Flux at Far Detector



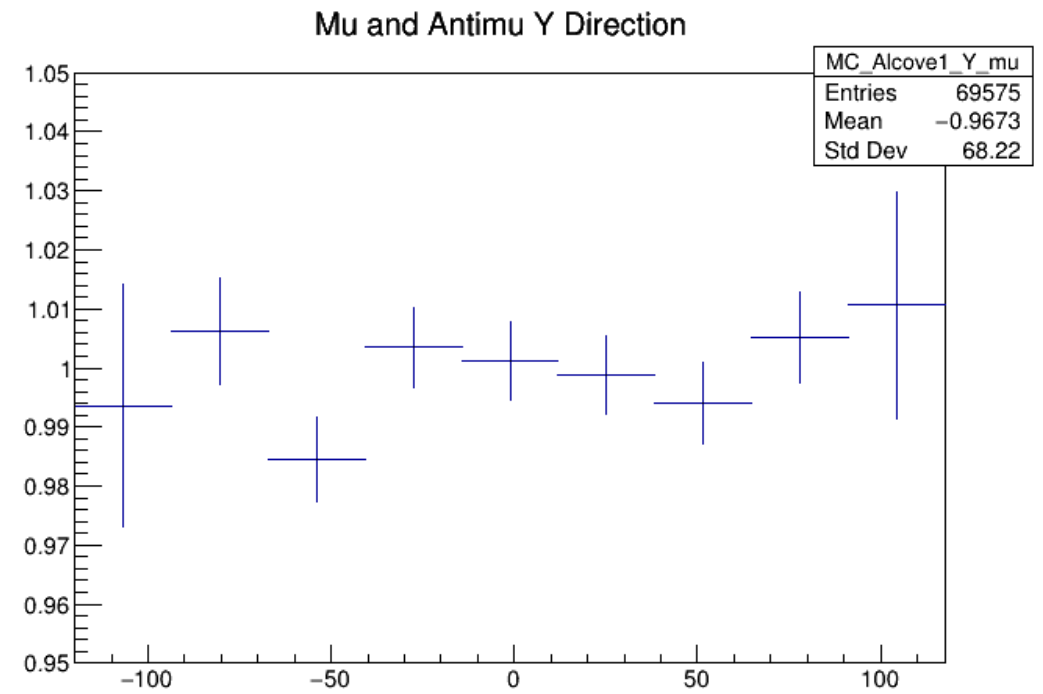
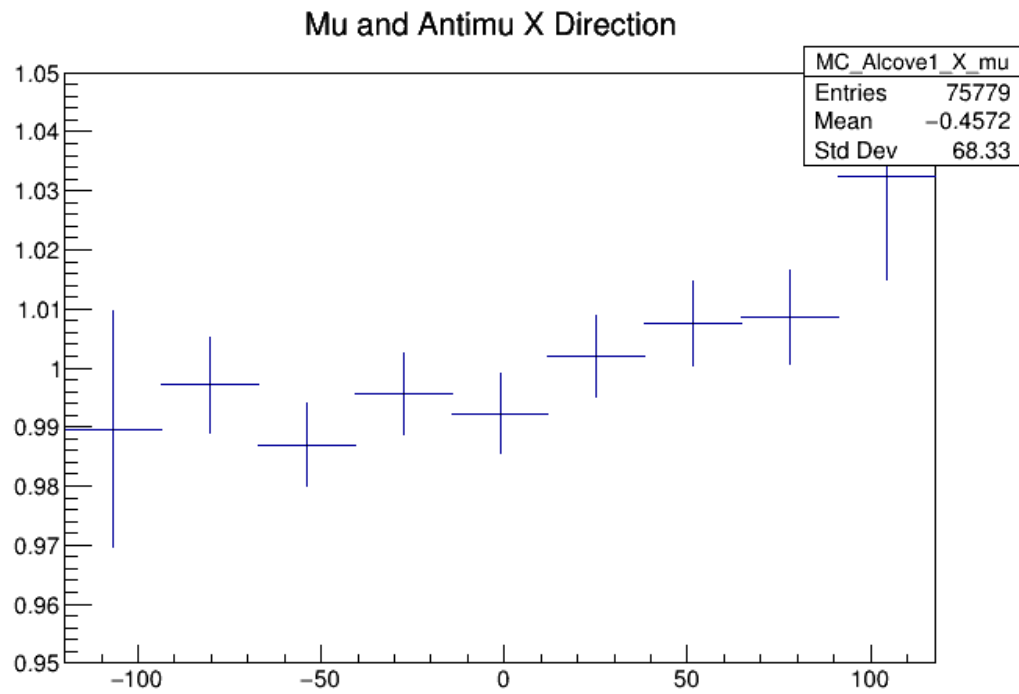
Horn C Tilt Right



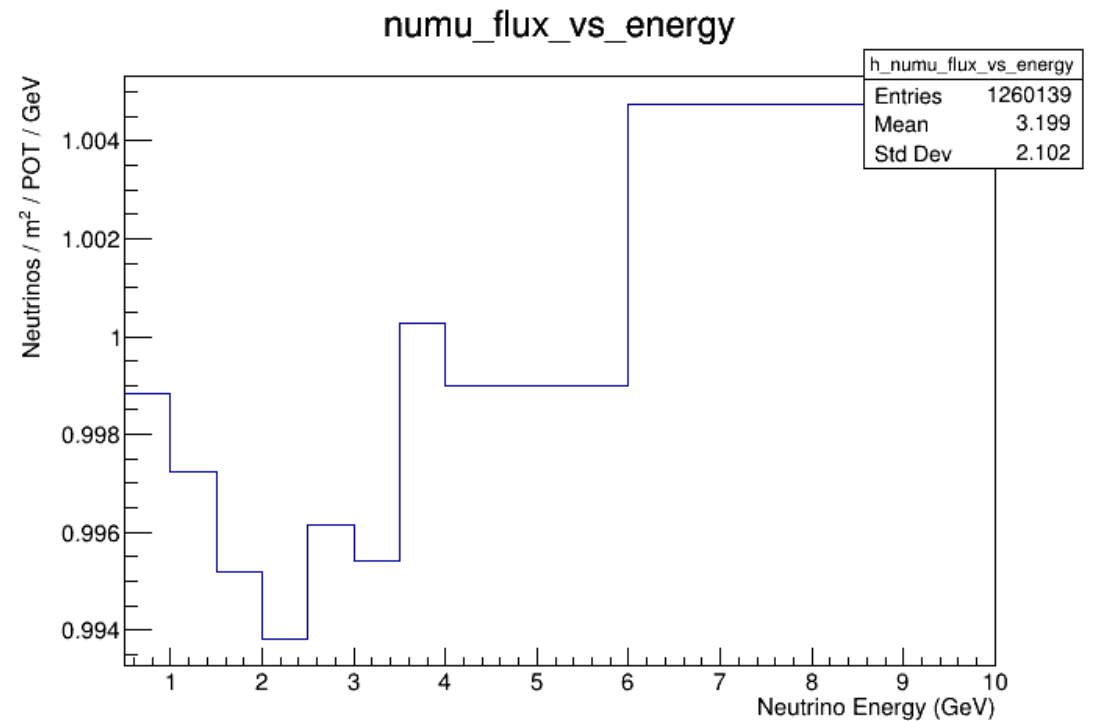
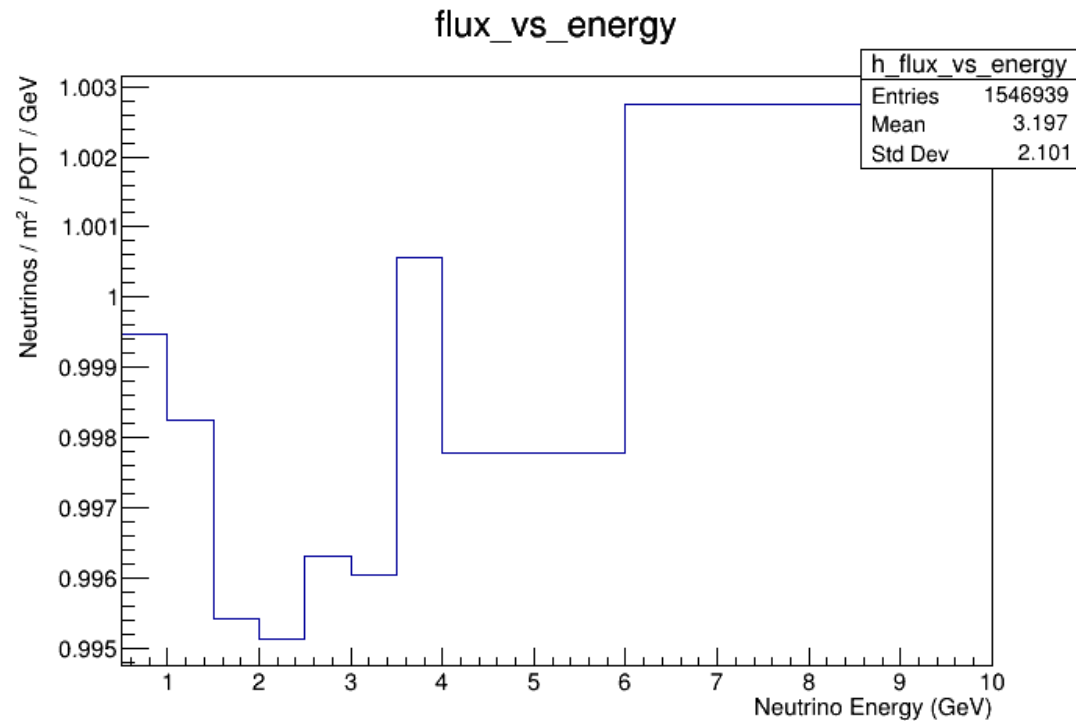
Horn C Tilt Right ν Flux at Far Detector



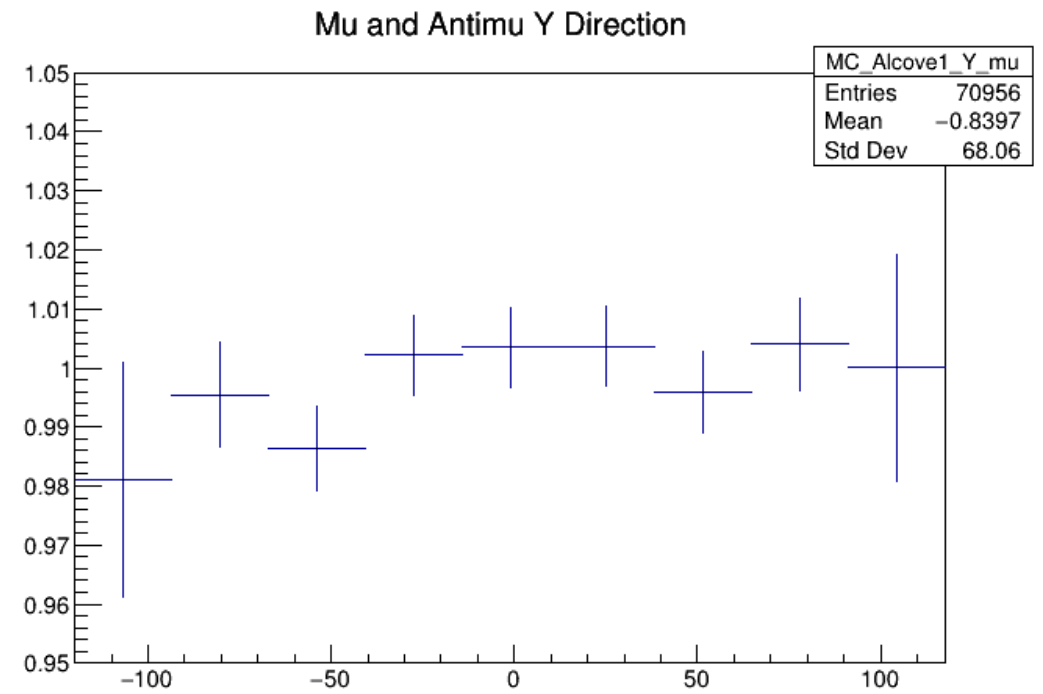
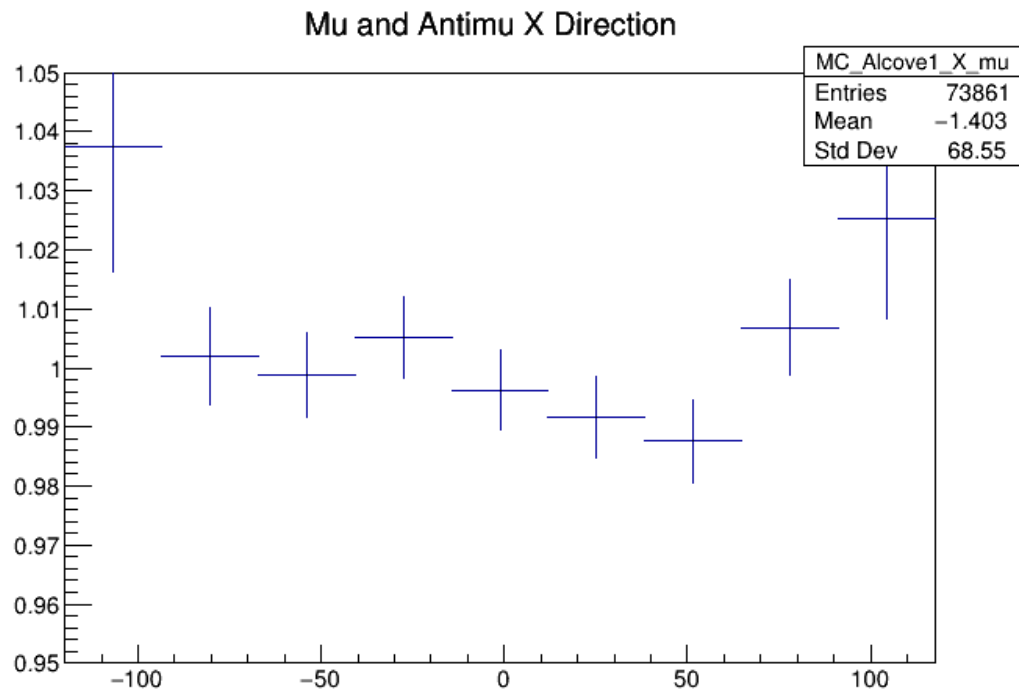
Proton Beam mX



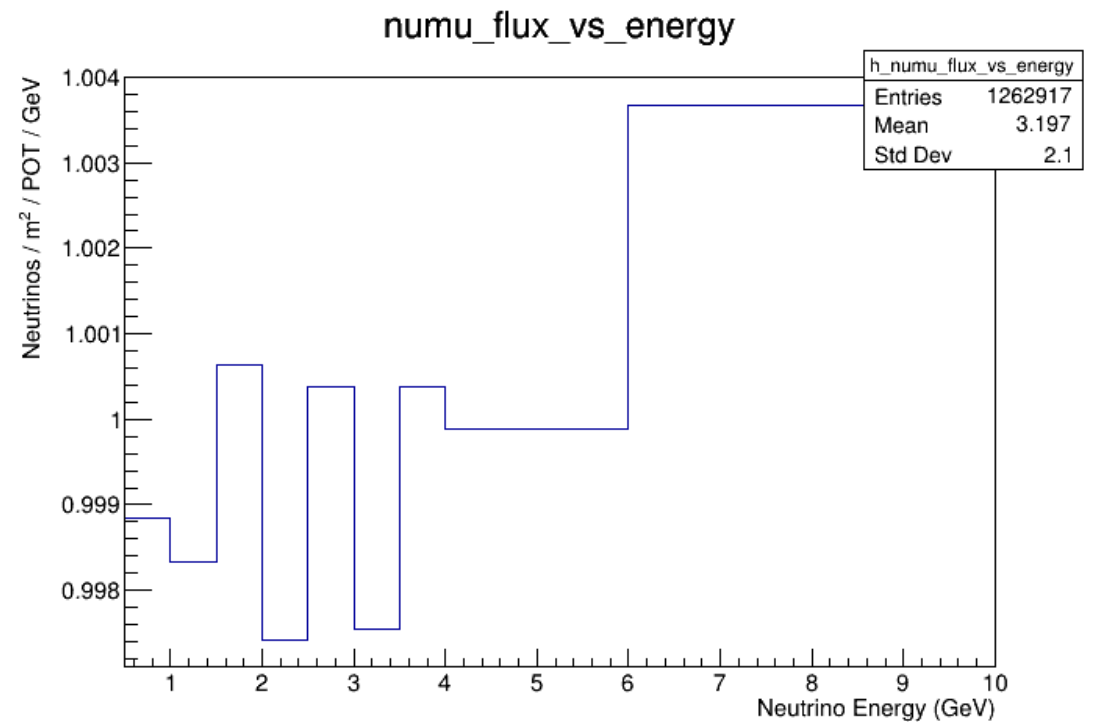
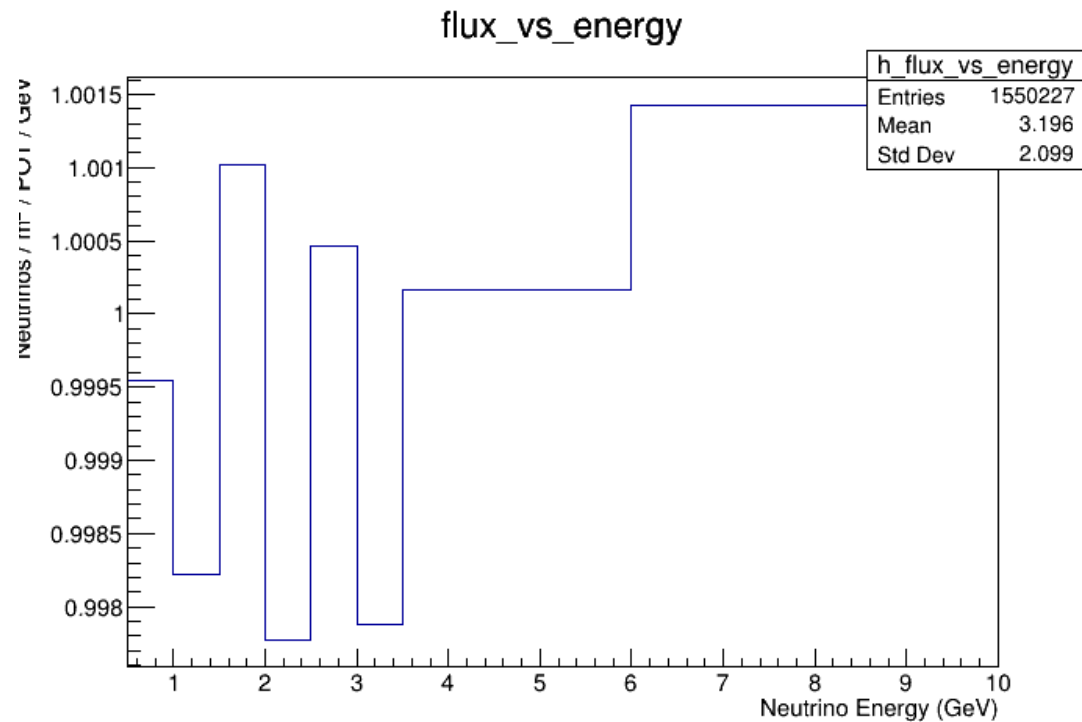
Proton Beam mX v Flux at Far Detector



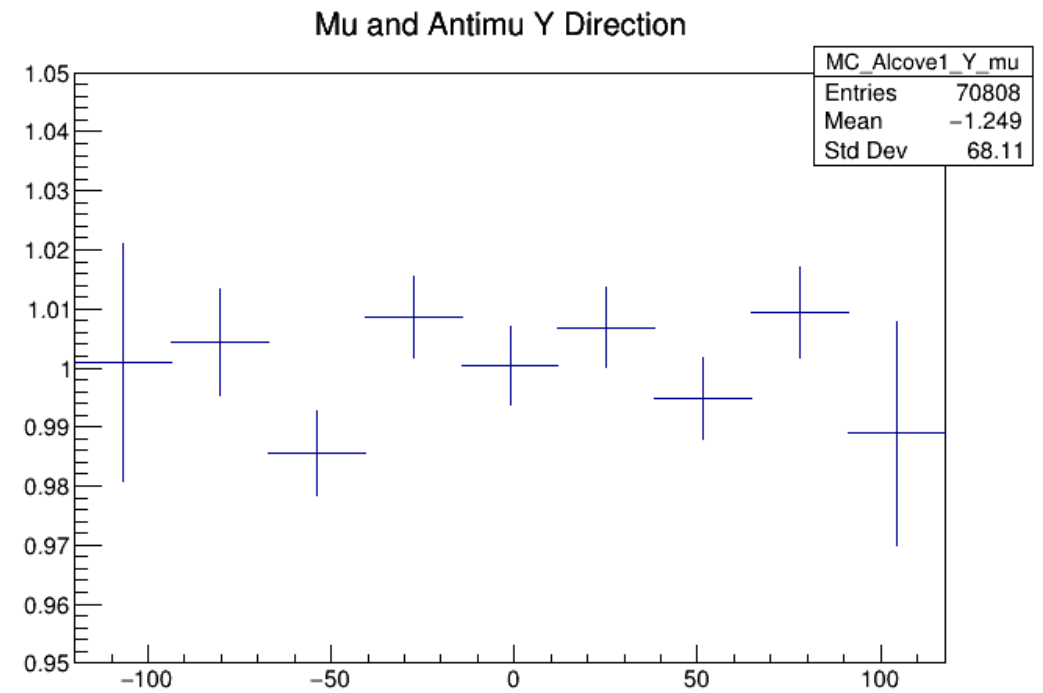
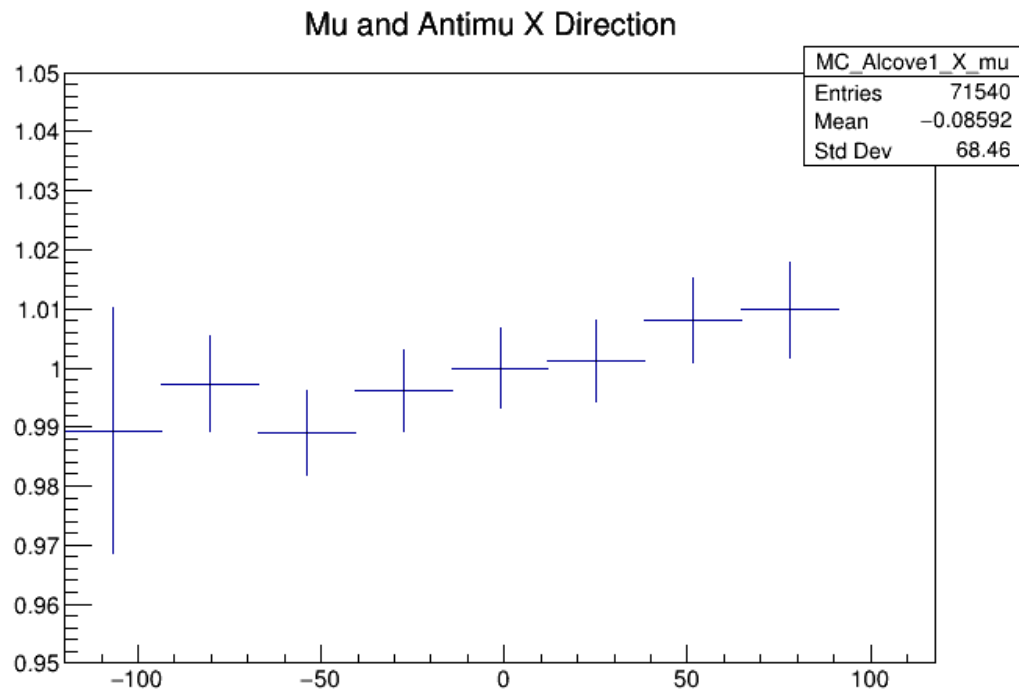
Proton Beam pX



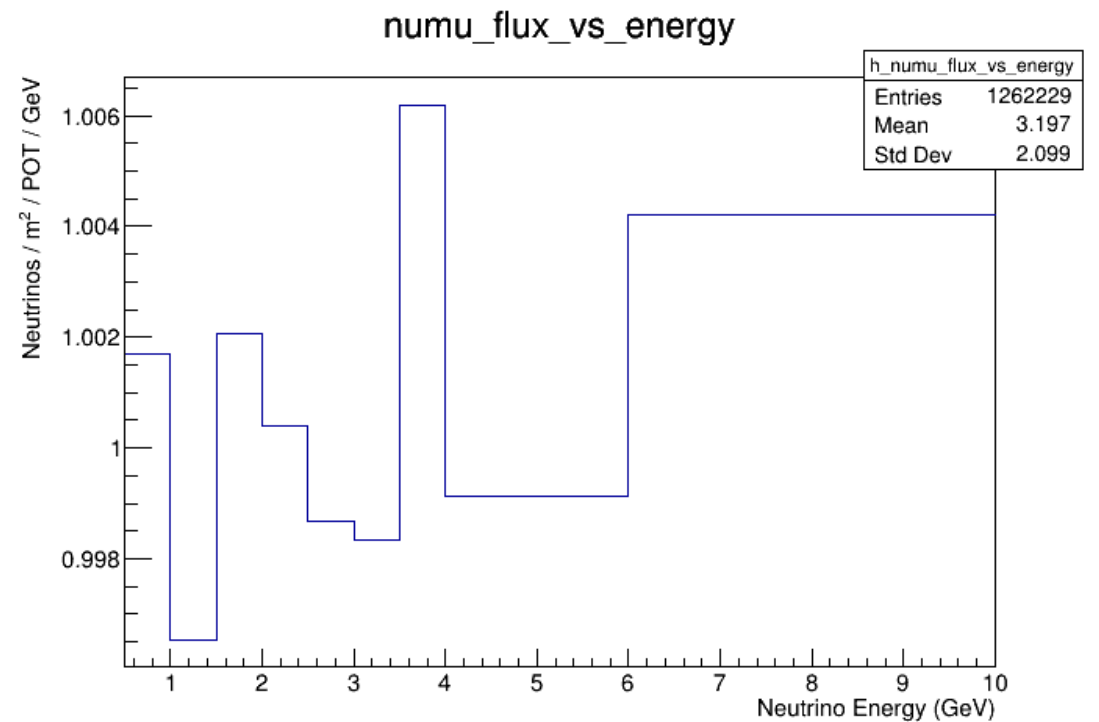
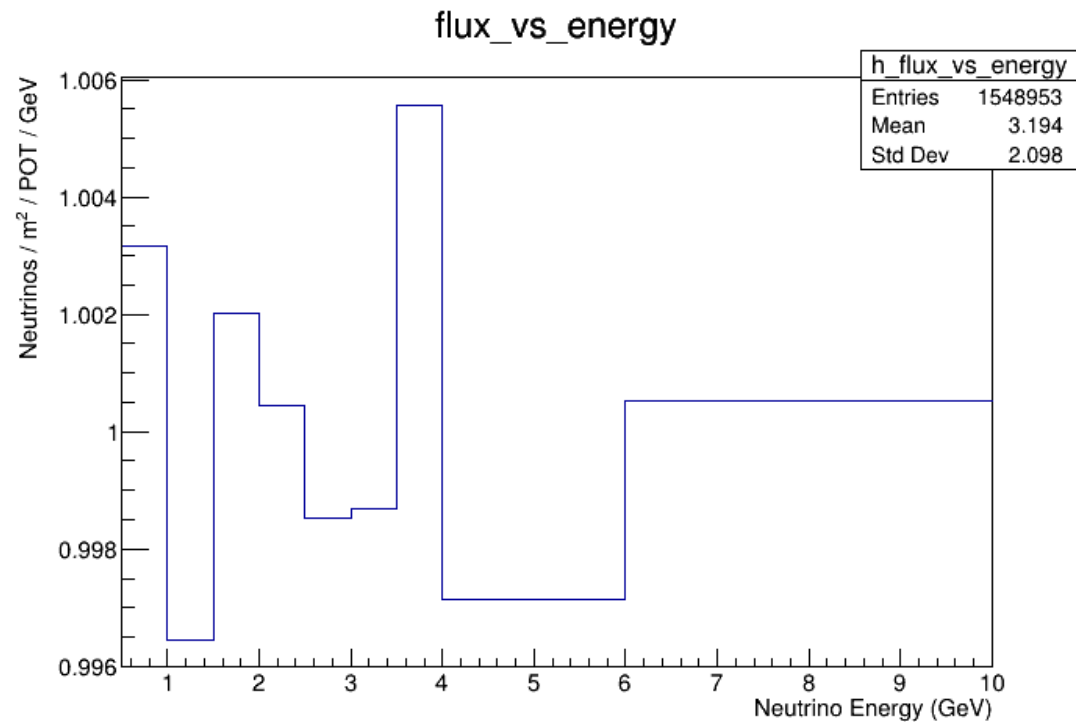
Proton Beam pX v Flux at Far Detector



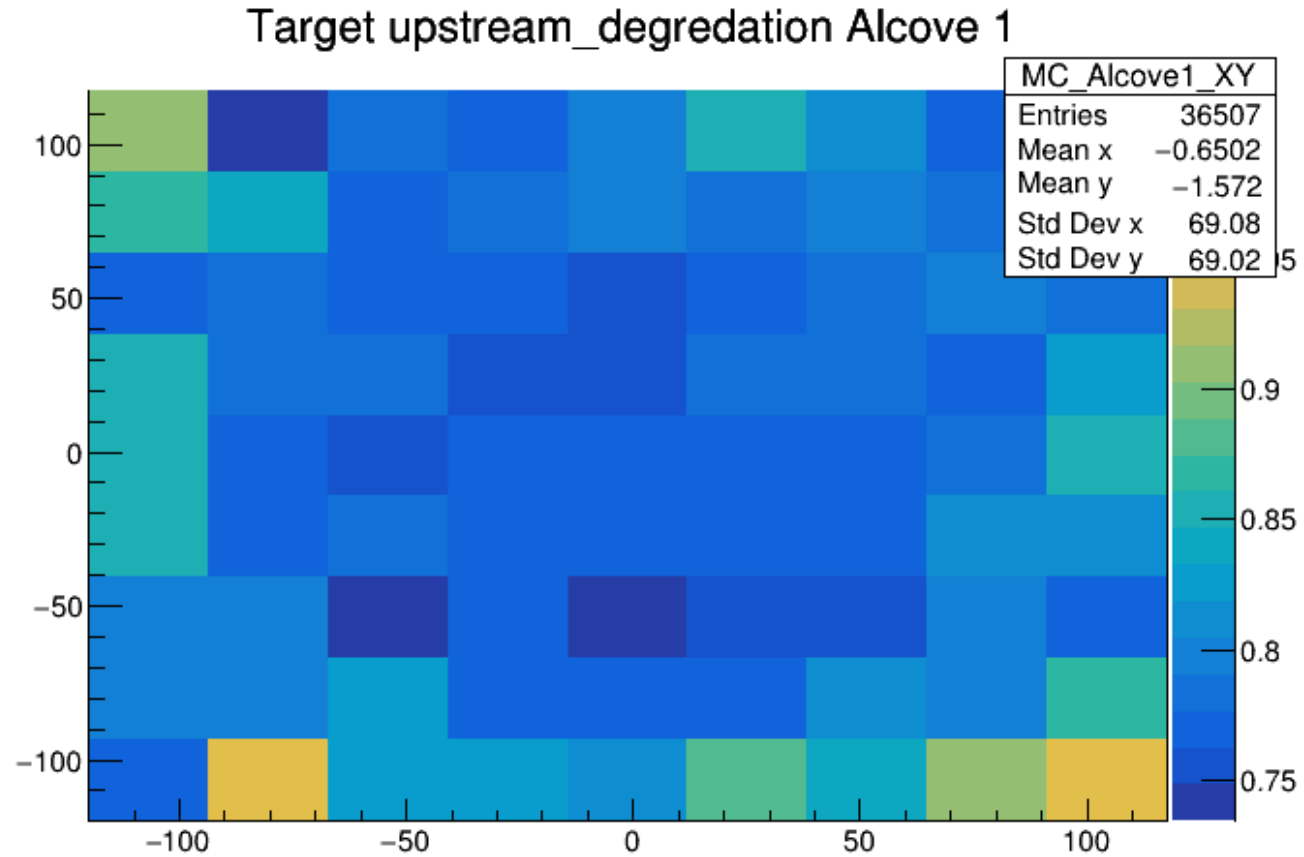
Proton Beam Radius Decrease



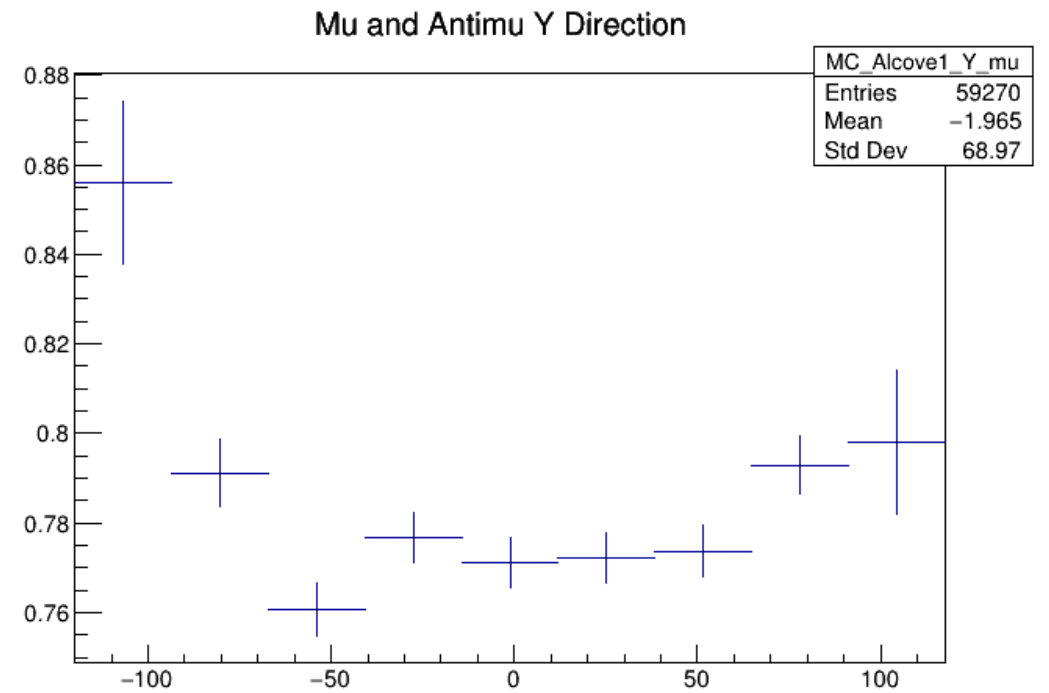
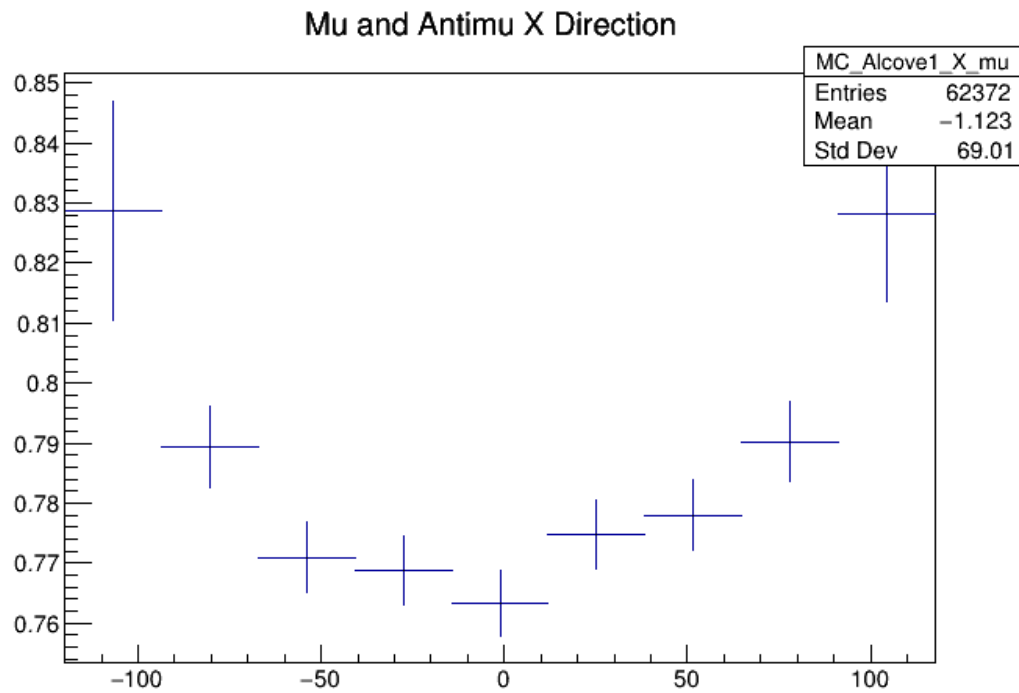
Proton Beam Radius Decrease v Flux at FD



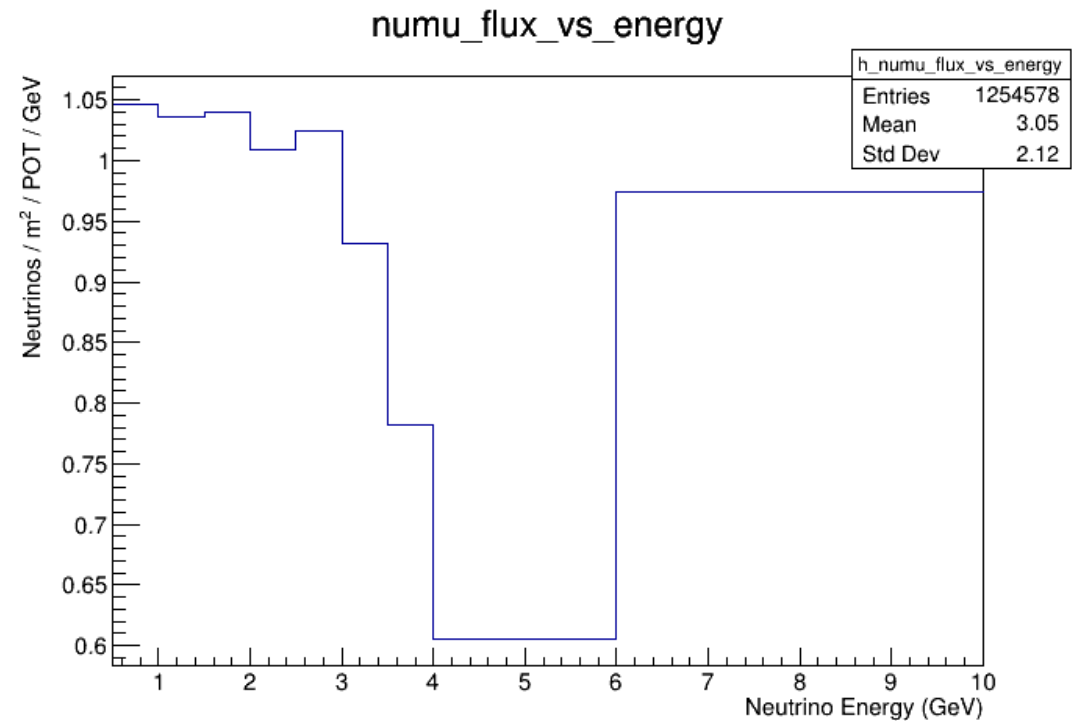
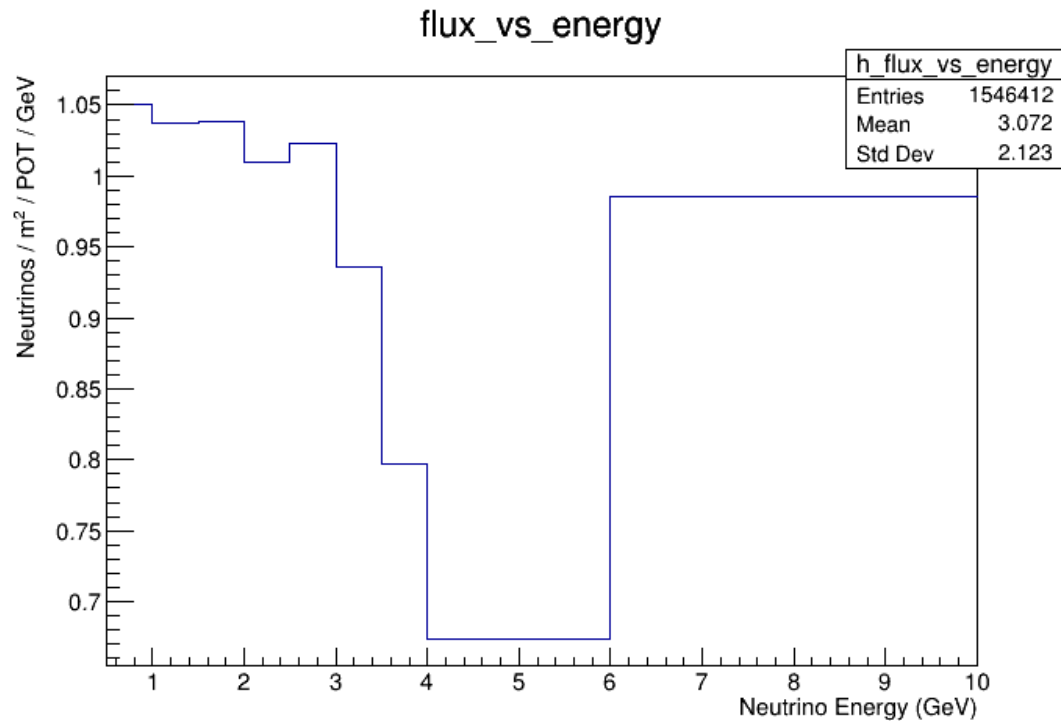
Target Upstream Degradation



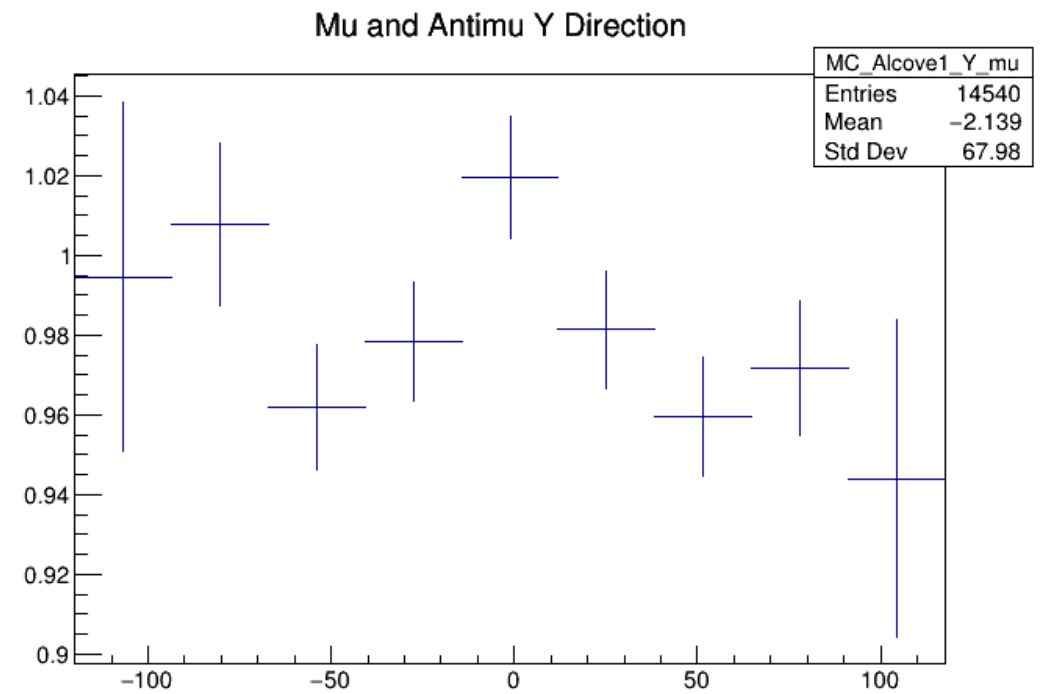
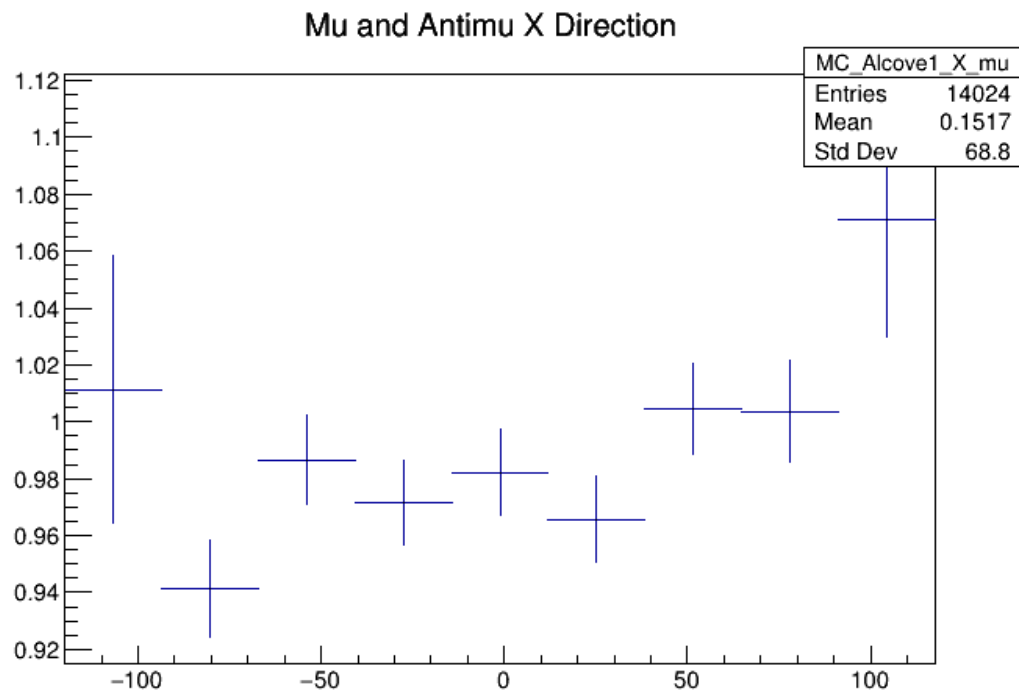
Target Upstream Degradation



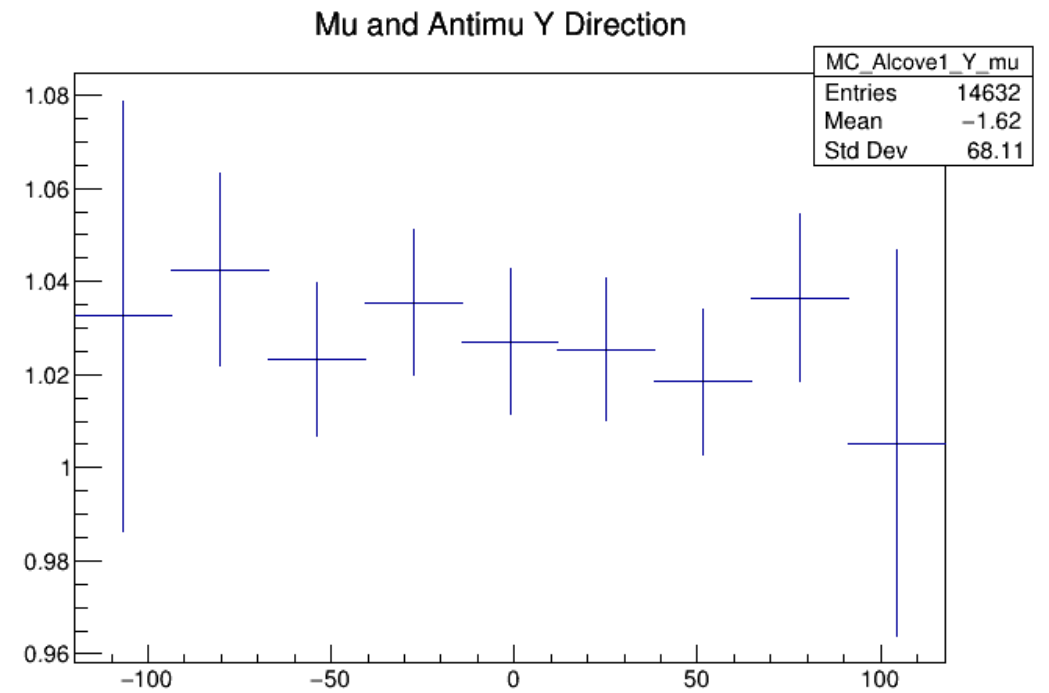
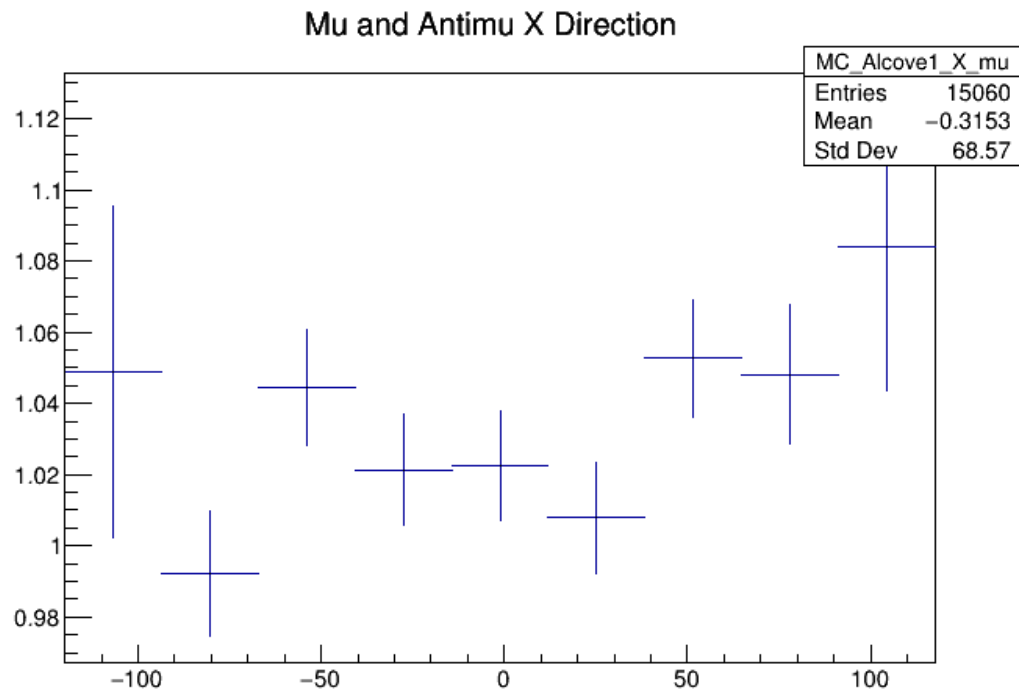
Target Upstream Degradation ν Flux at FD



Horn Current 297 kA



Horn Current 303 kA



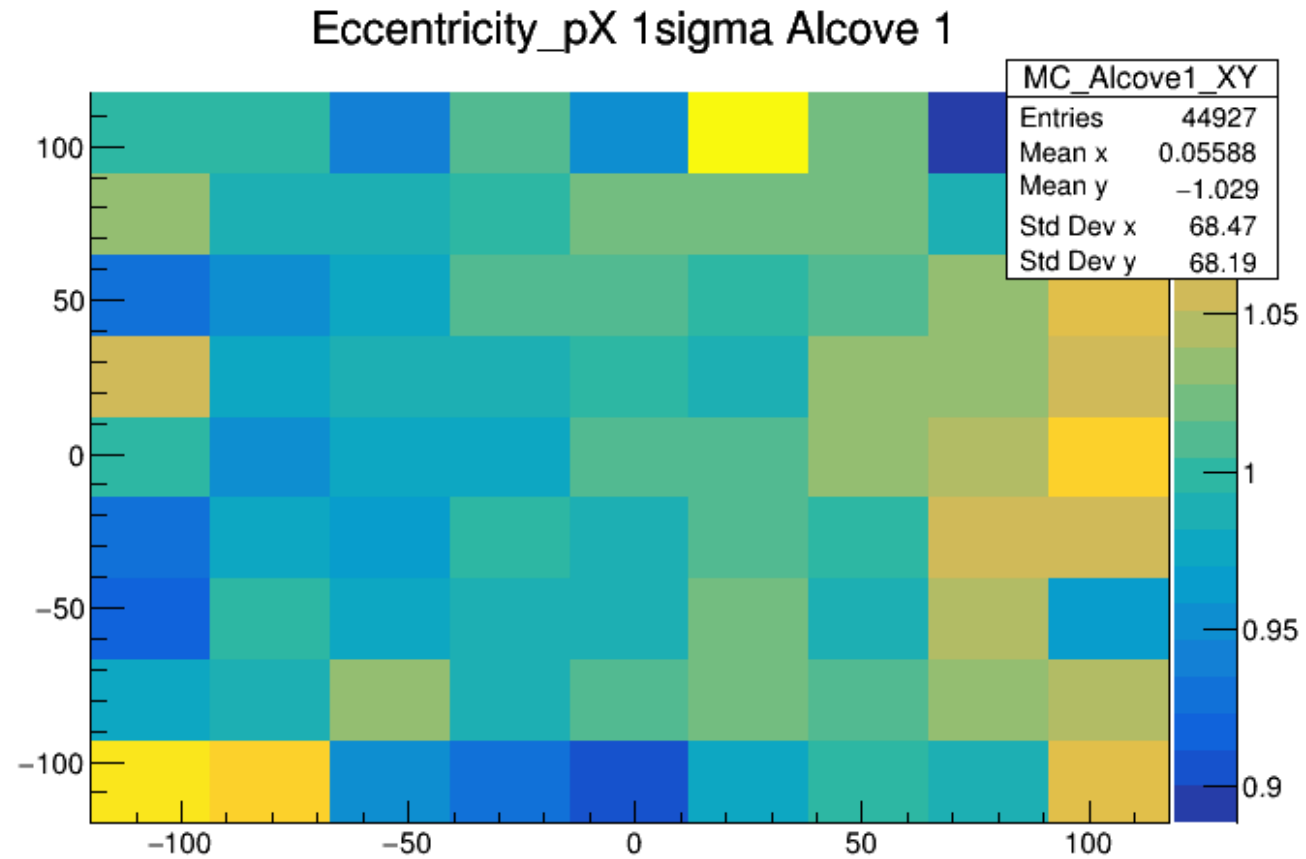
Next Steps

- Run with more statistics
- Re-bin plots to more accurately represent muon monitors
- More parameters to test

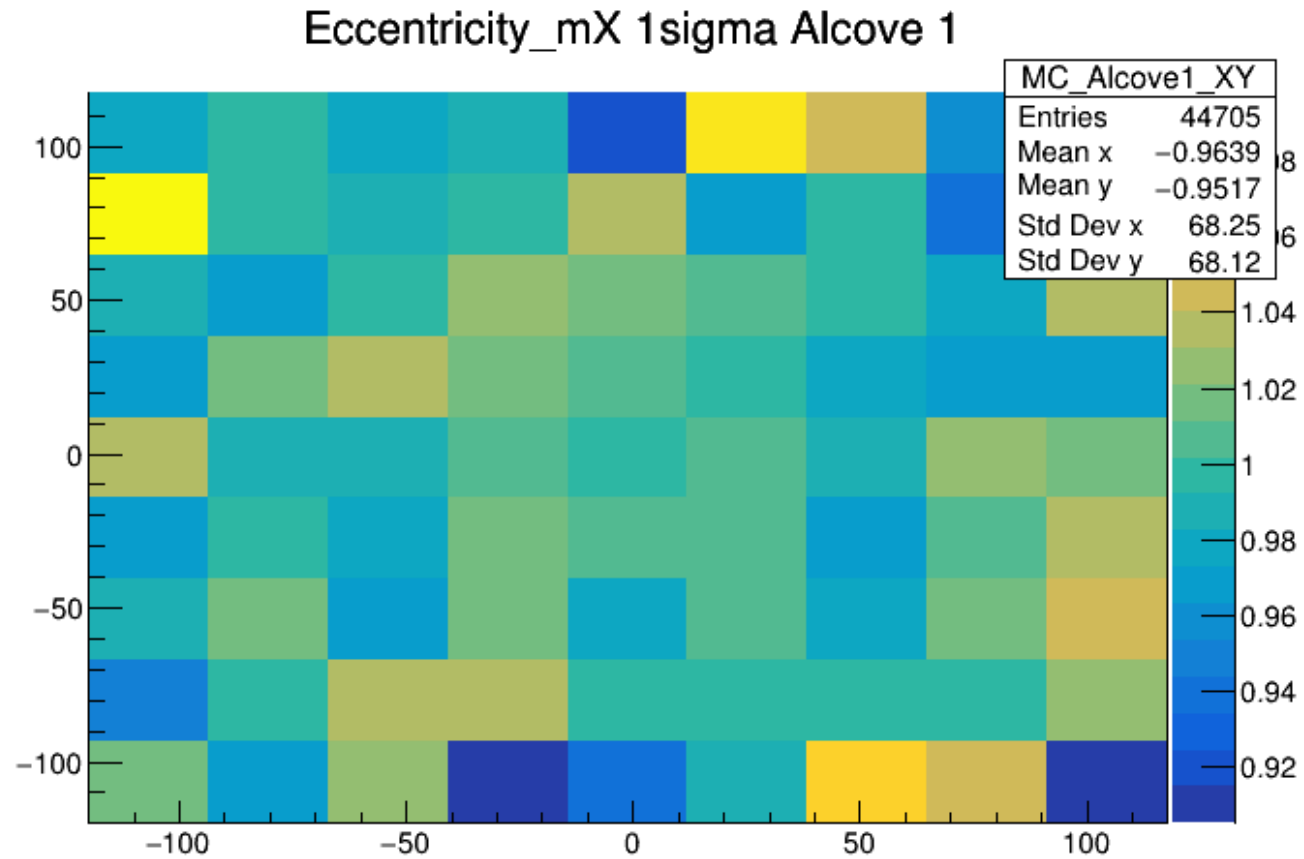
All Plots

Horn A

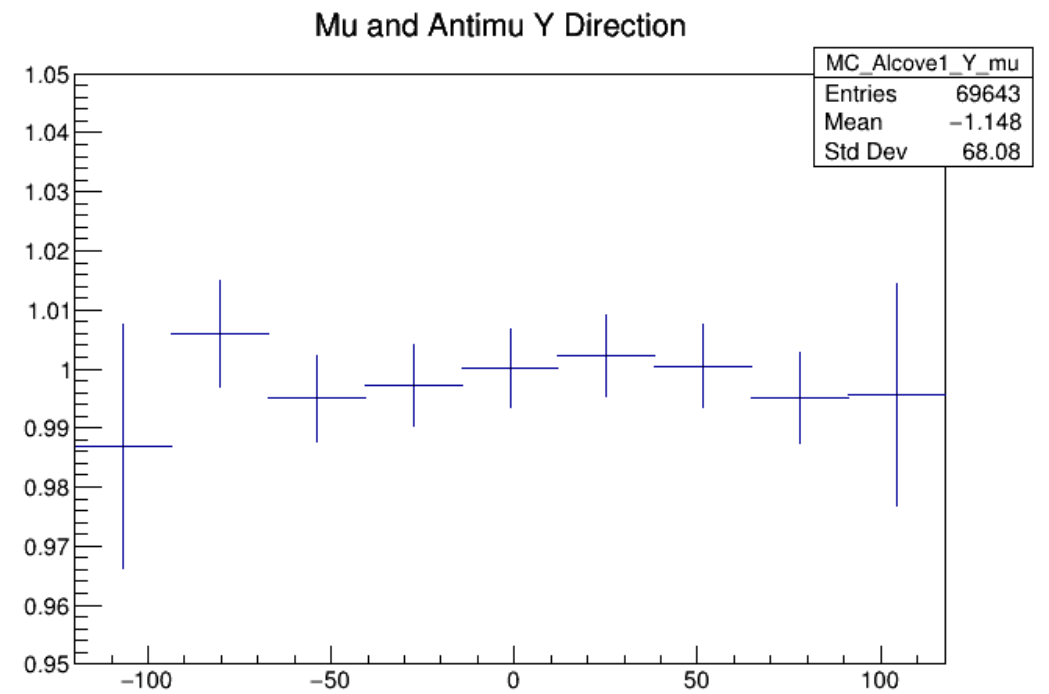
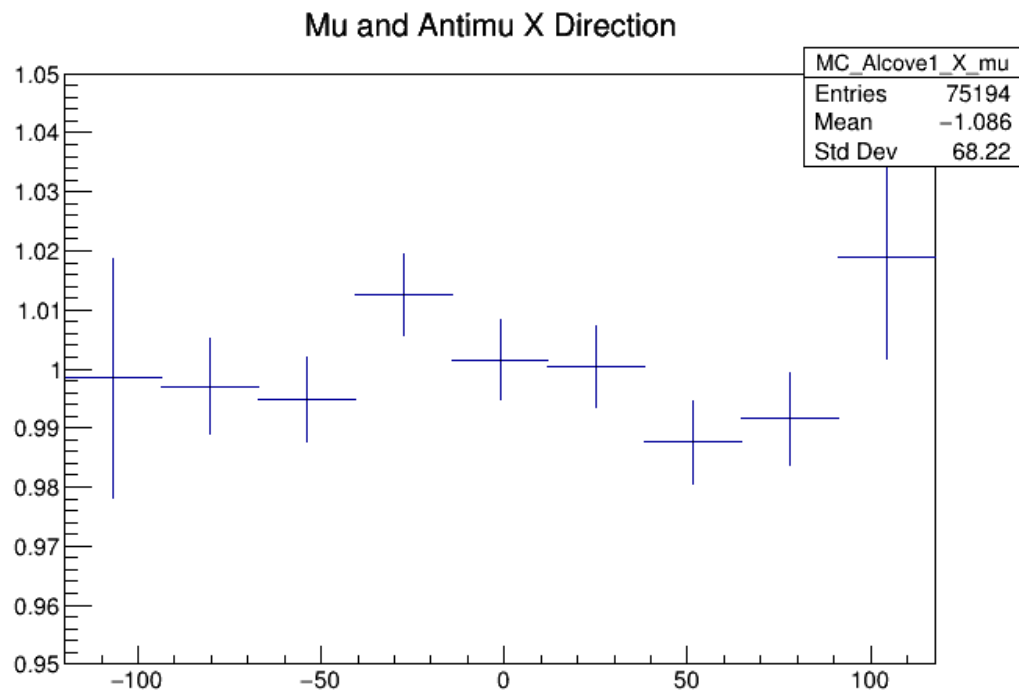
Horn A Eccentricity pX - Alcove 1



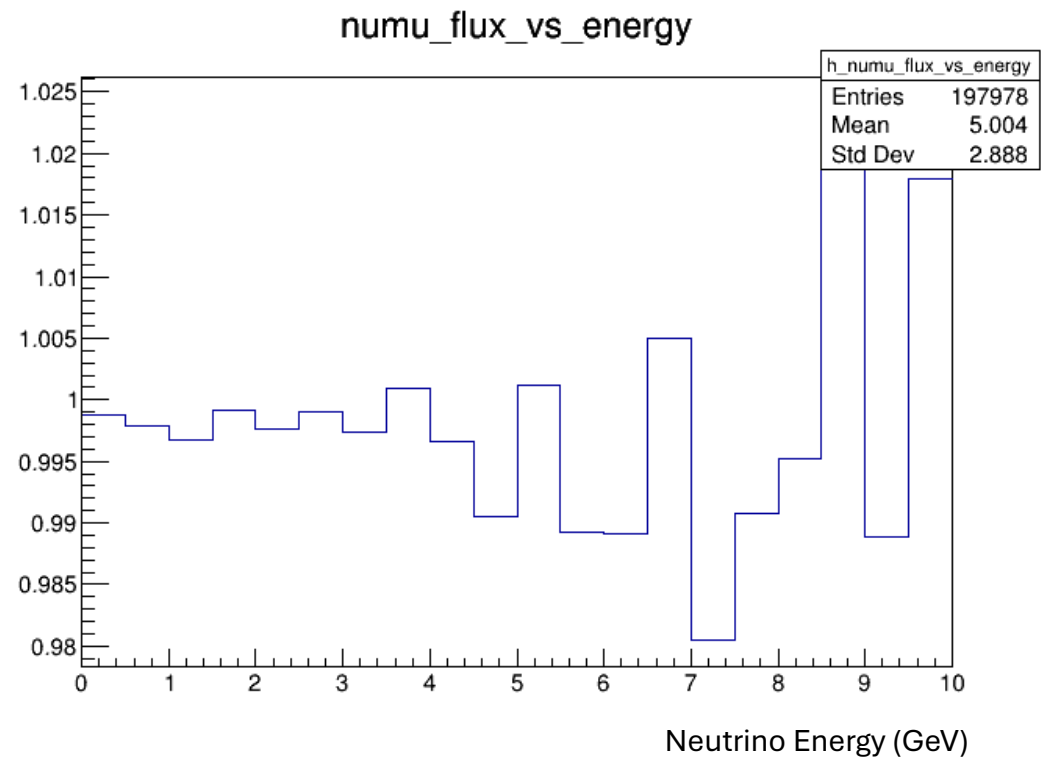
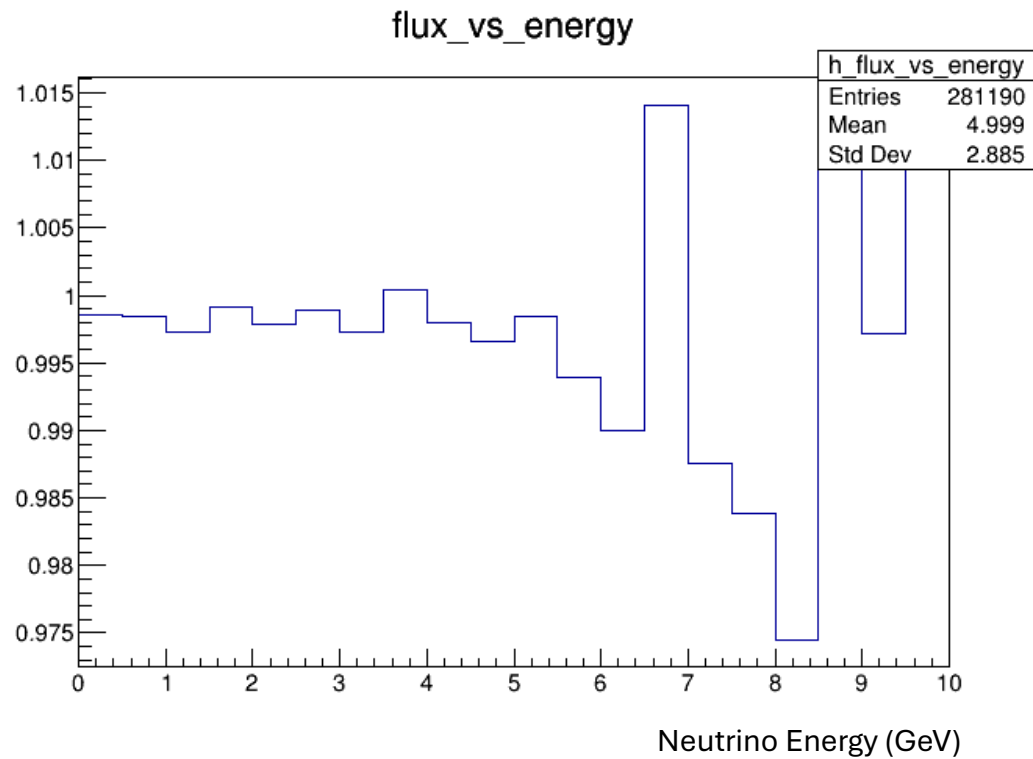
Horn A Eccentricity mX - Alcove 1



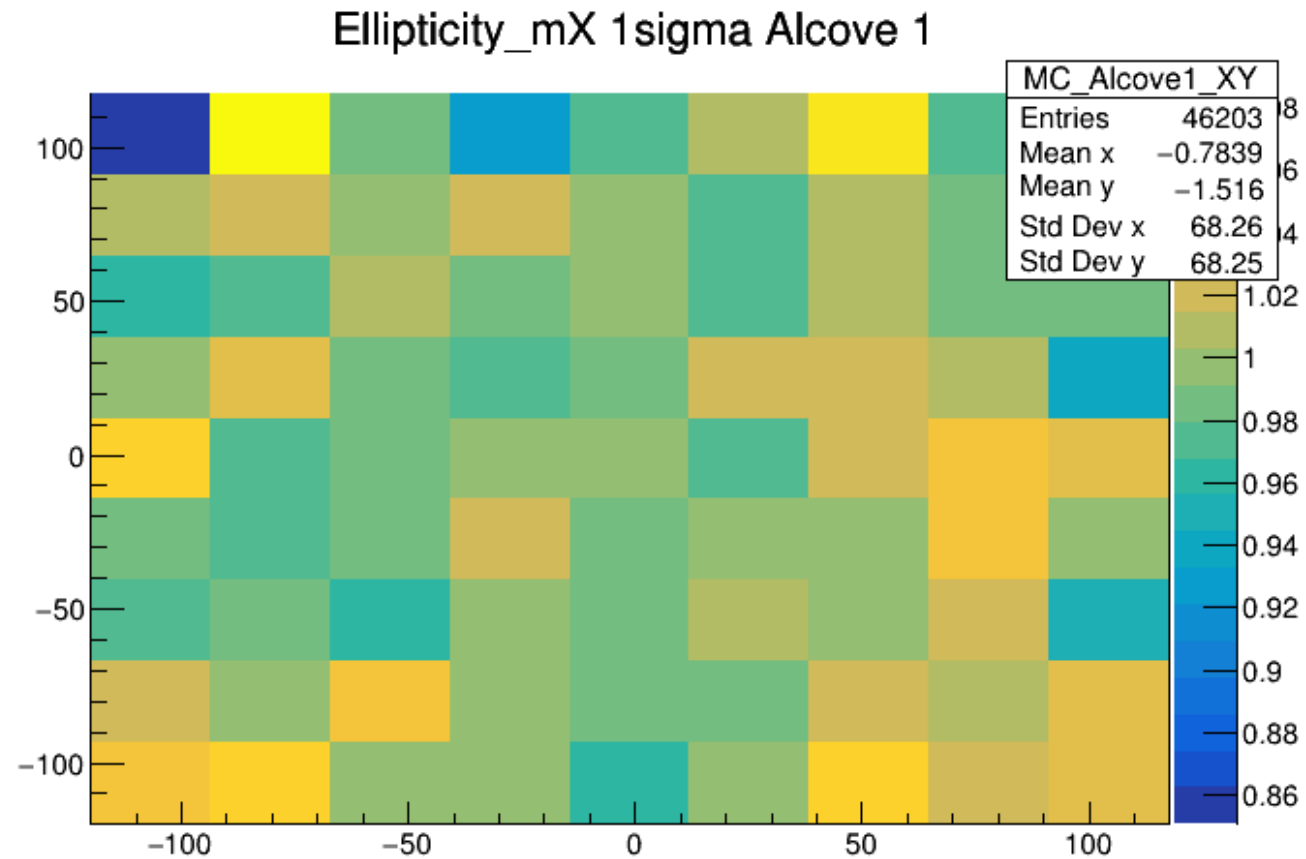
Horn A Eccentricity mX - Alcove 1



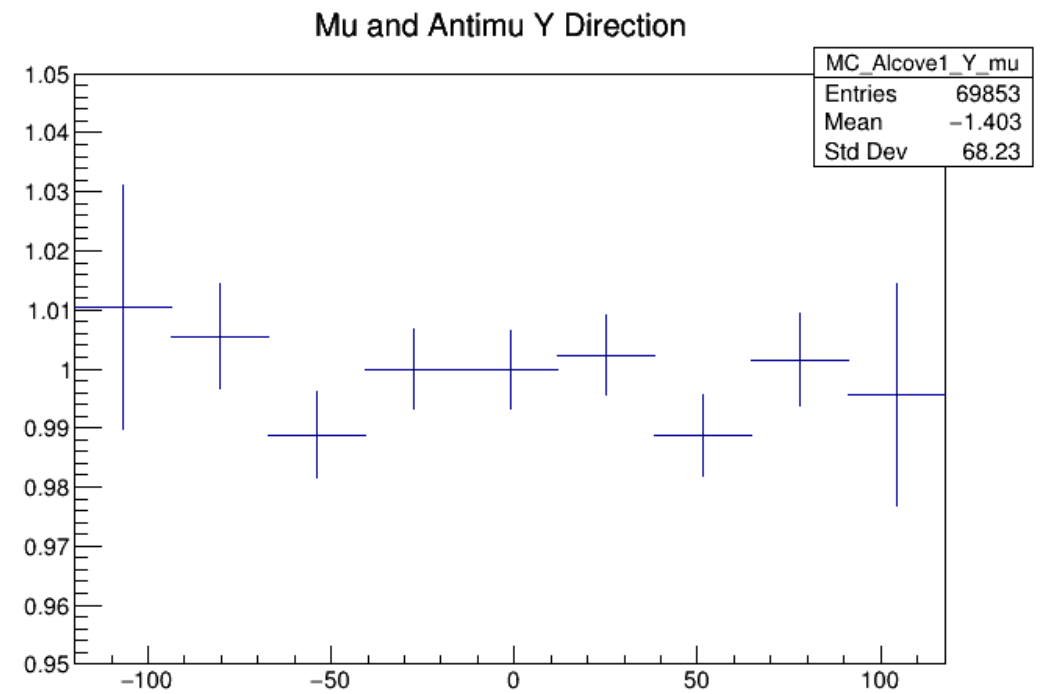
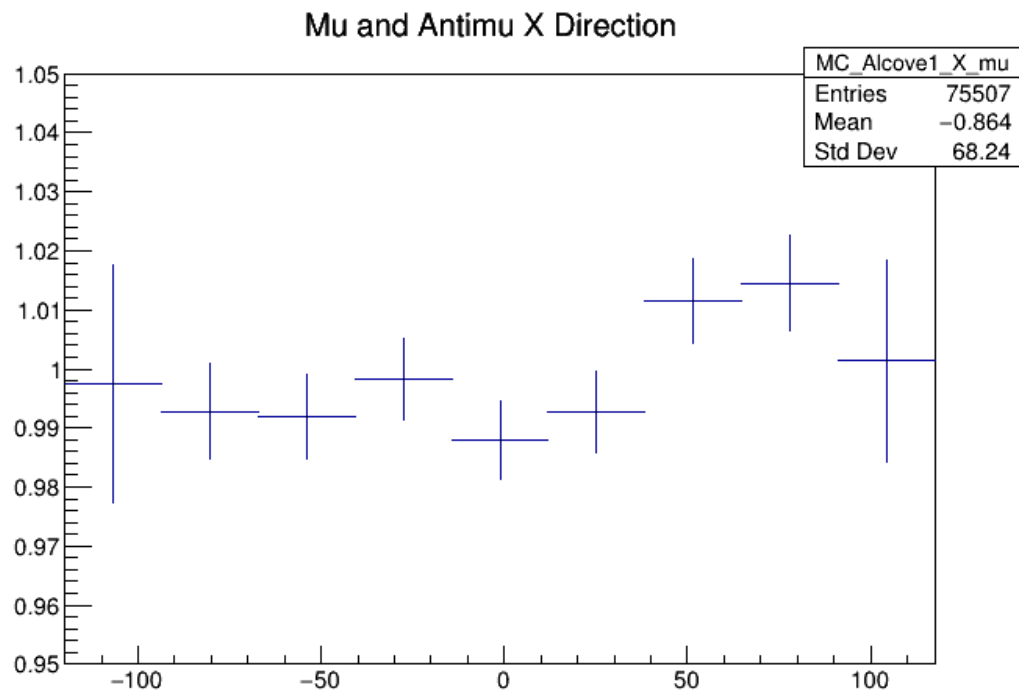
Horn A Eccentricity mX v Flux at Far Detector



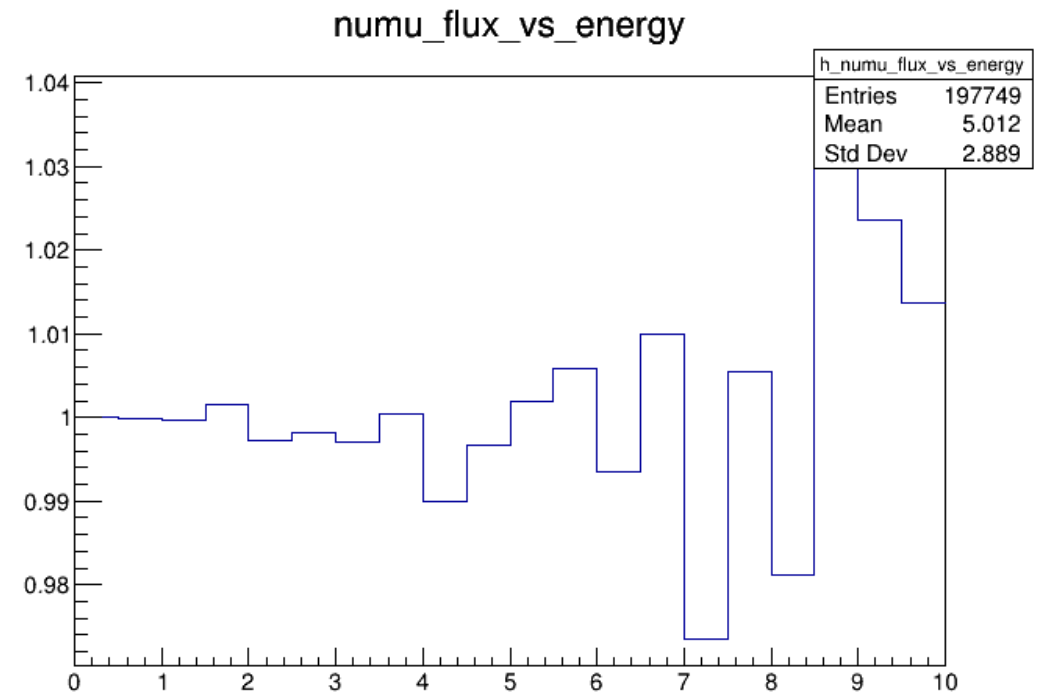
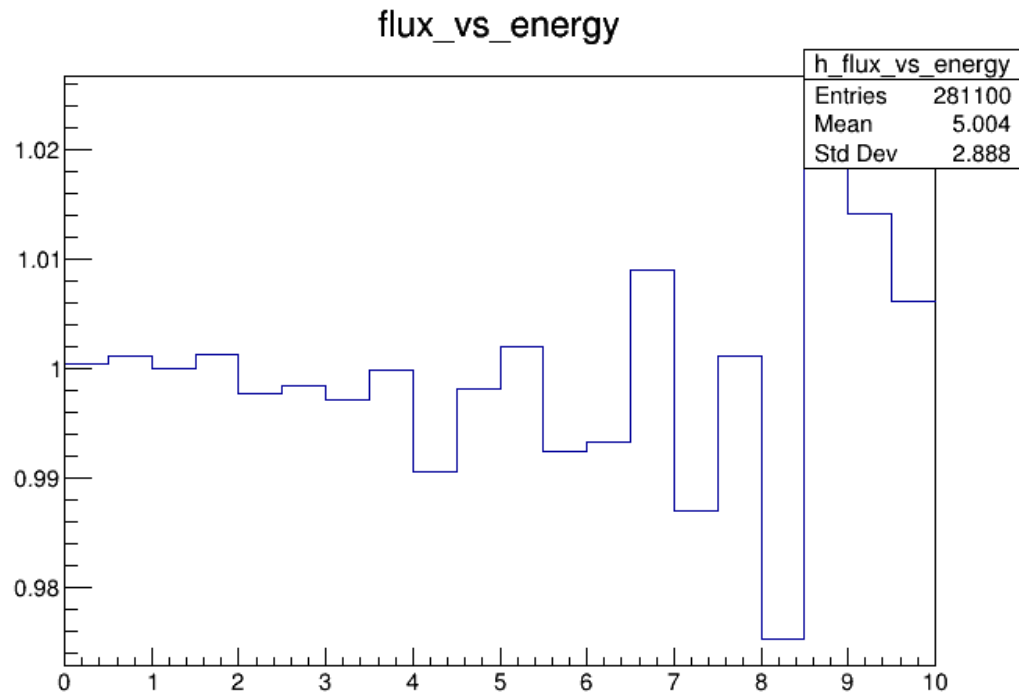
Horn A Ellipticity mX - Alcove 1



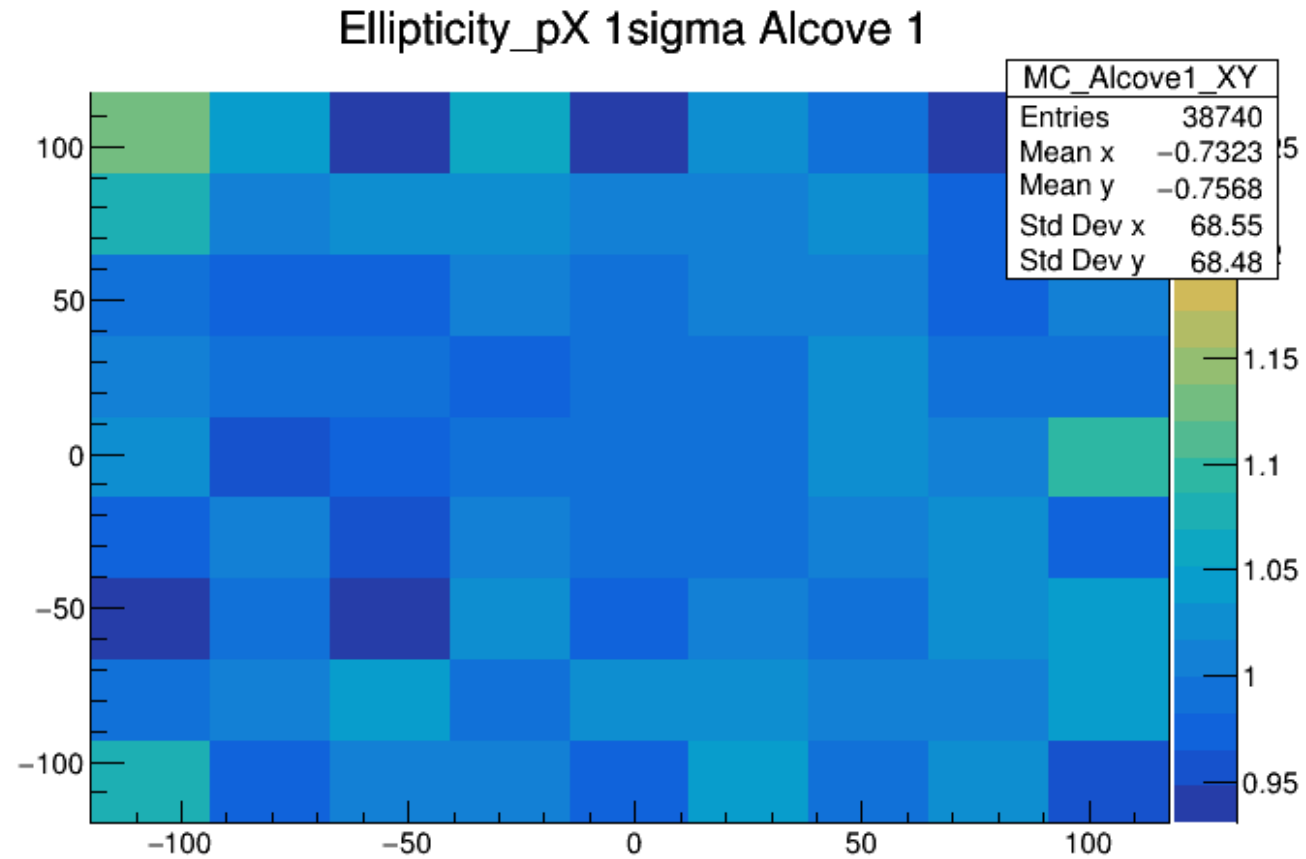
Horn A Ellipticity mX - Alcove 1



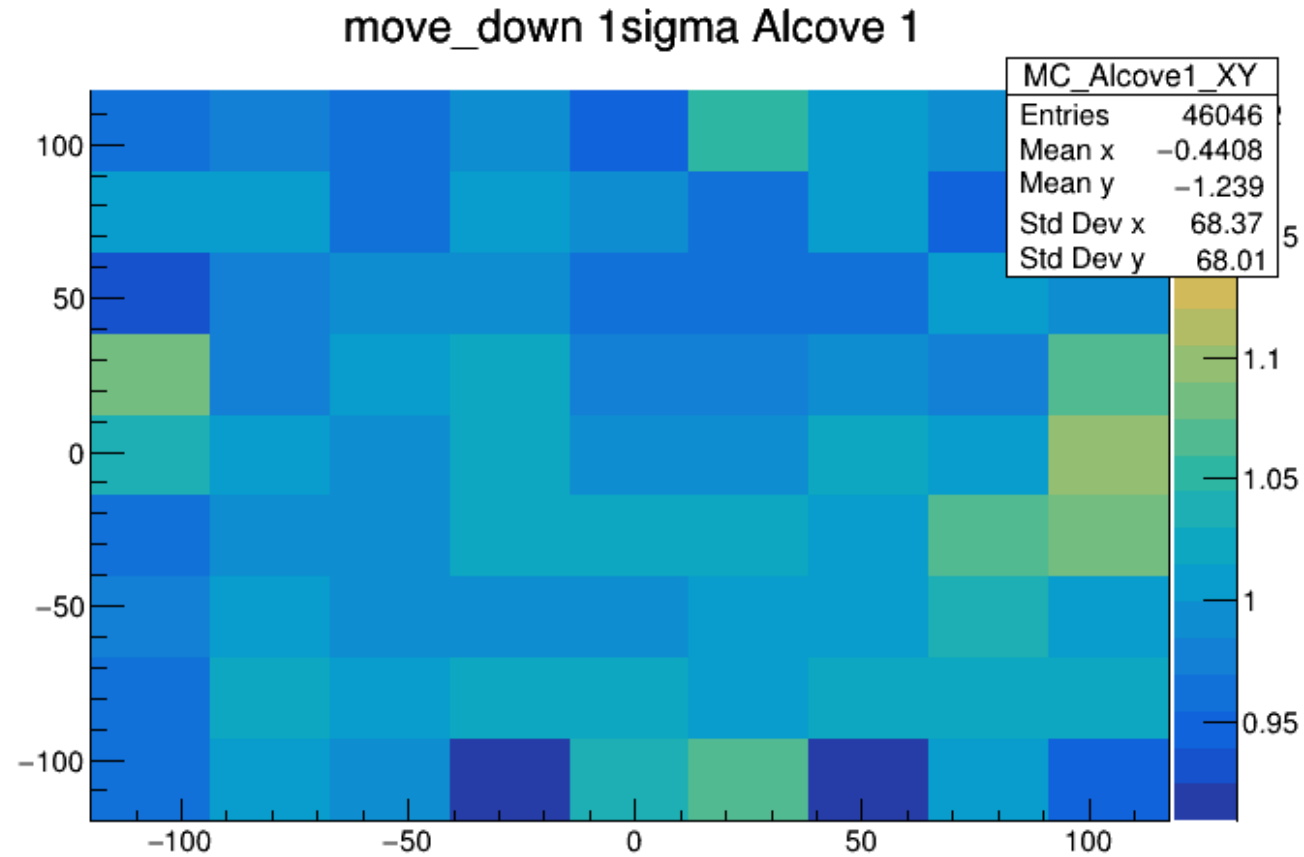
Horn A Ellipticity m_X v Flux at Far Detector



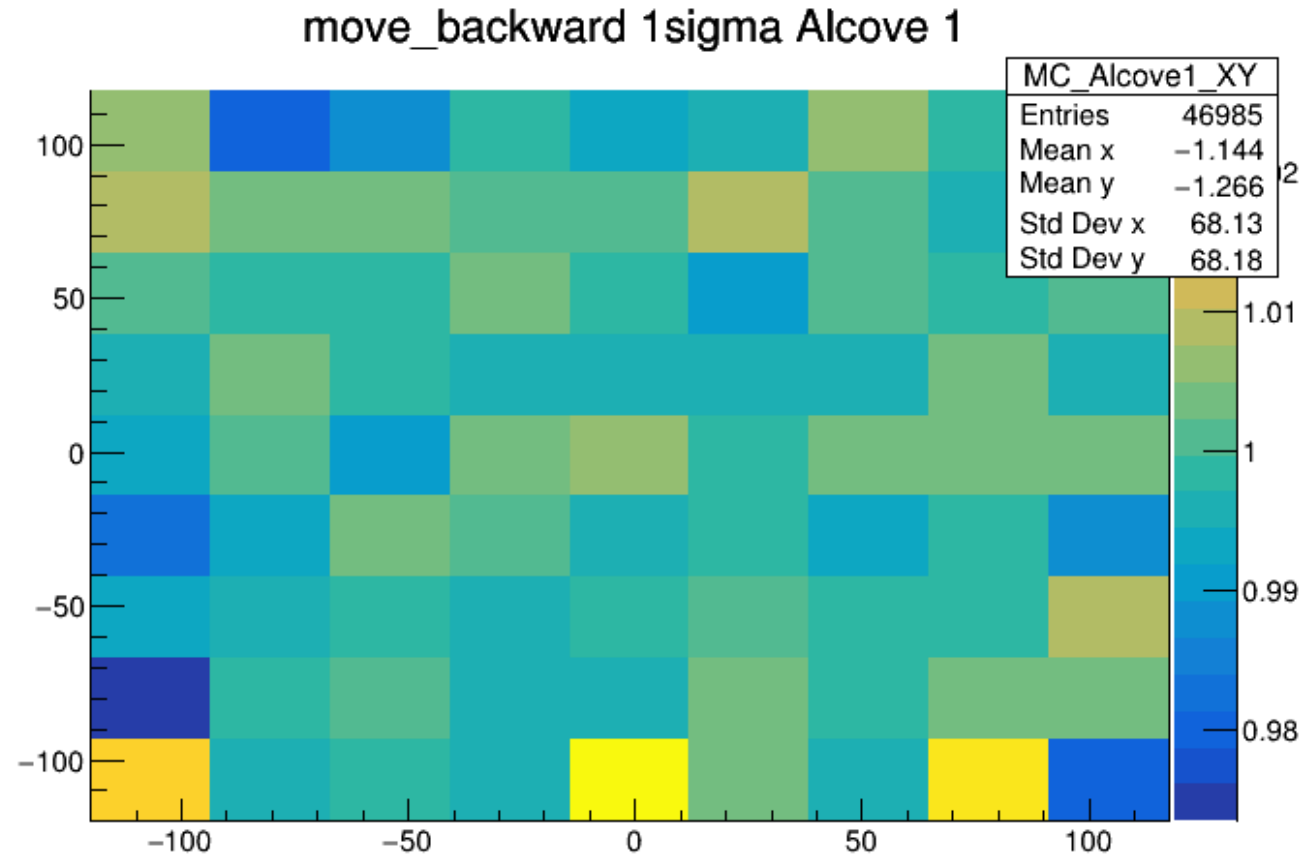
Horn A Ellipticity pX - Alcove 1



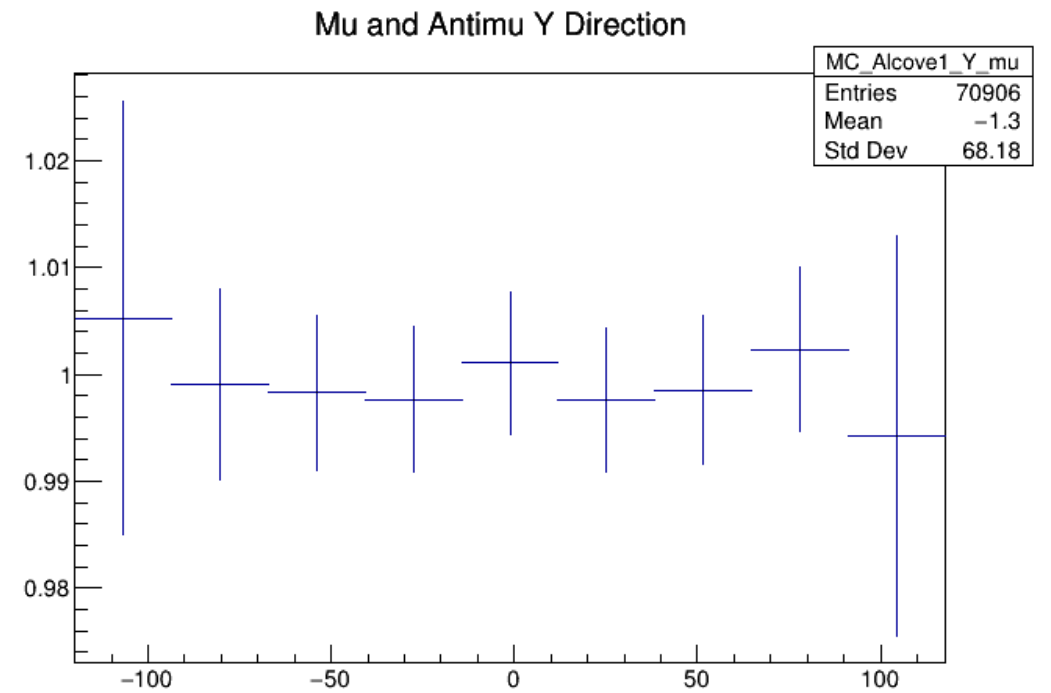
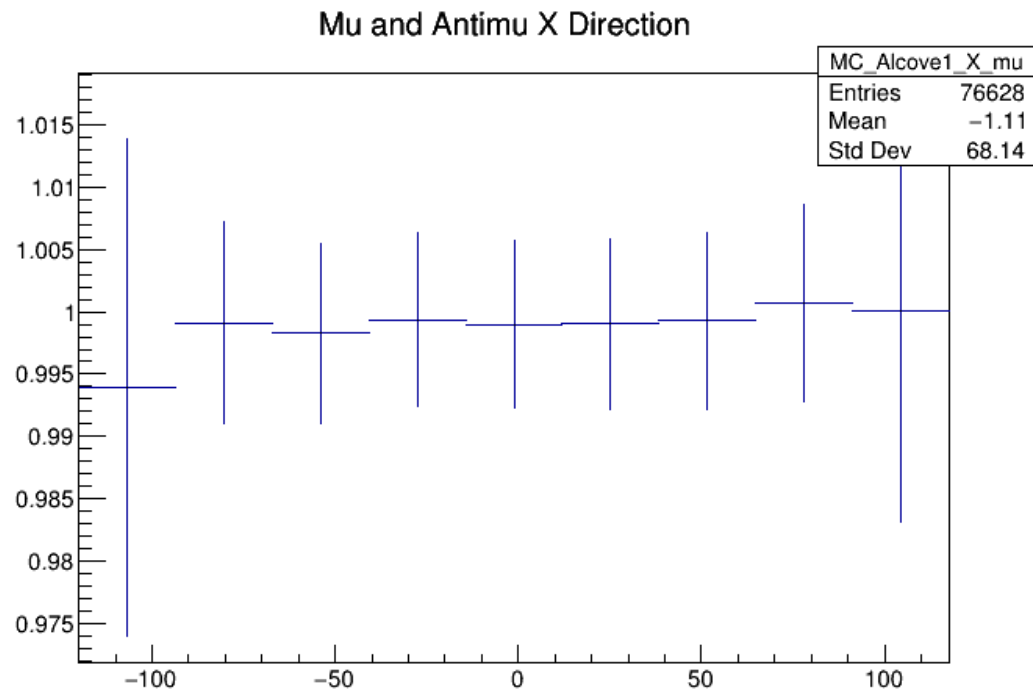
Horn A Move Down - Alcove 1



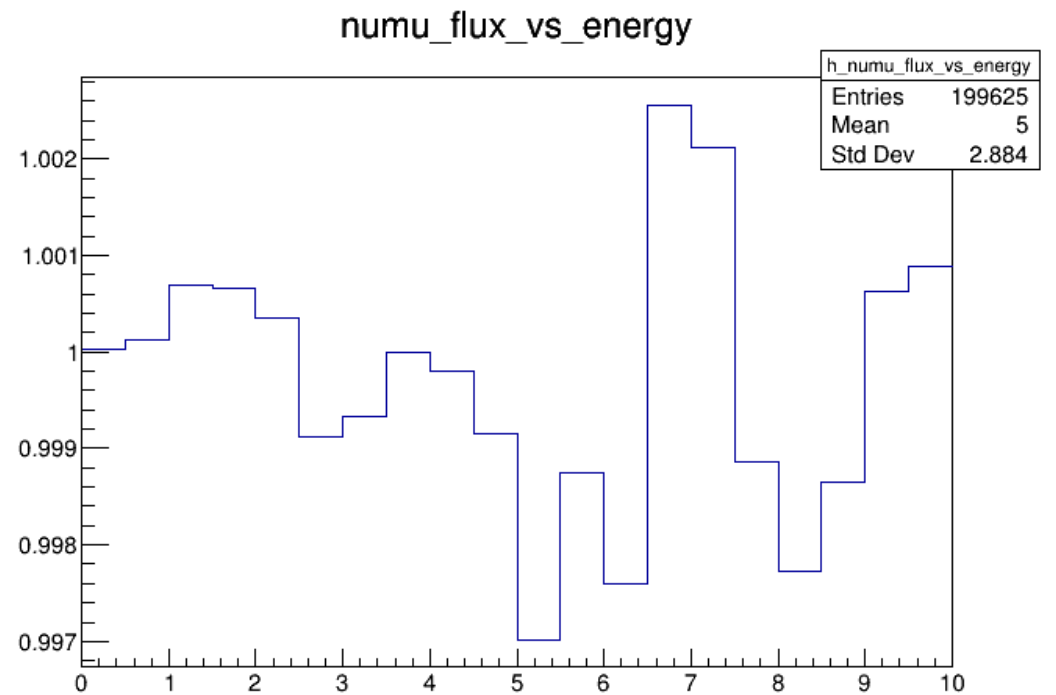
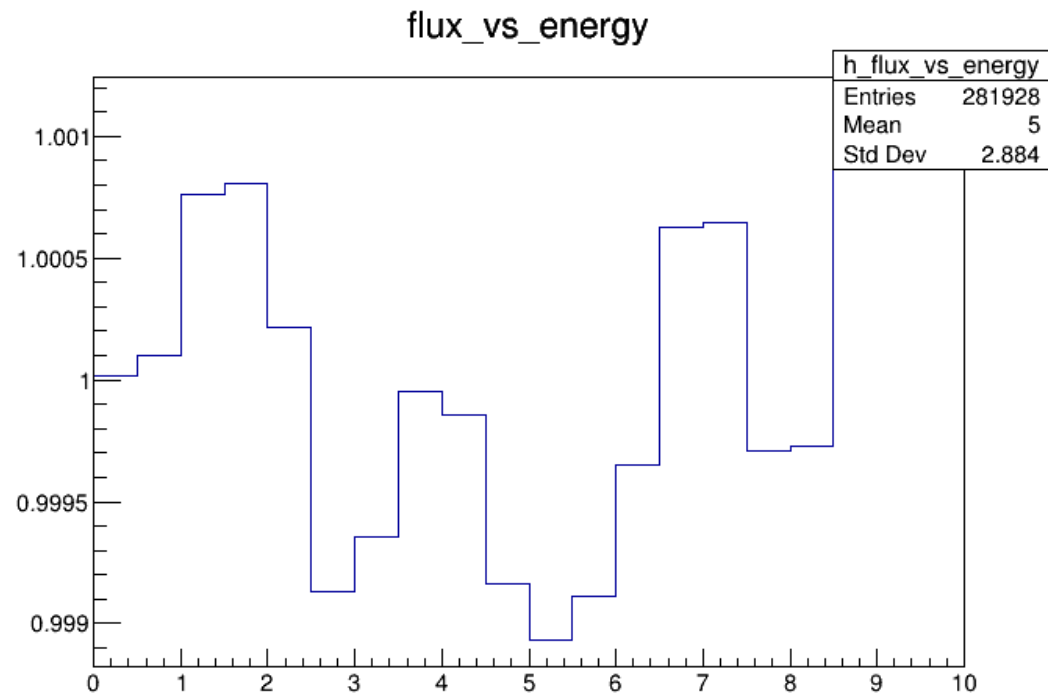
Horn A Move Backward - Alcove 1



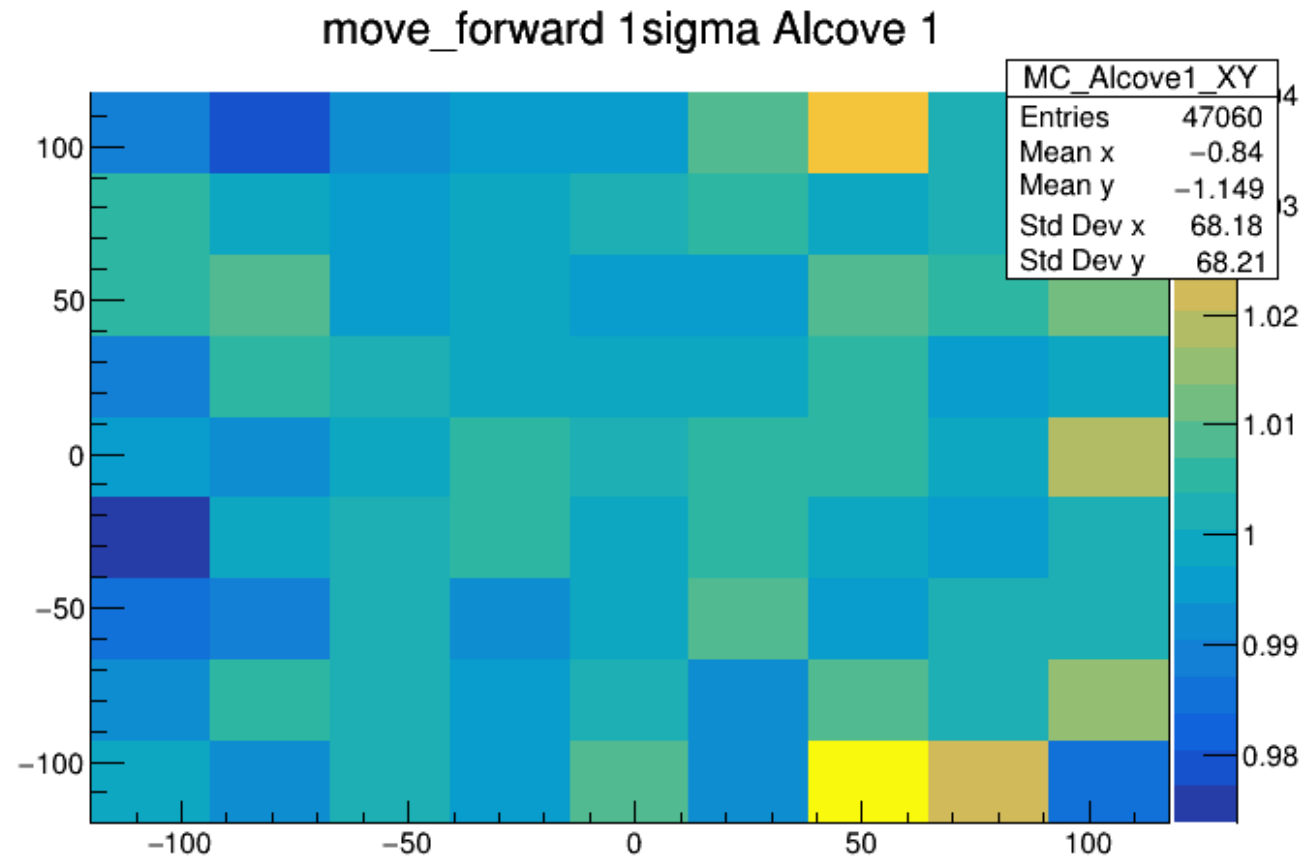
Horn A Move Backward – Alcove 1



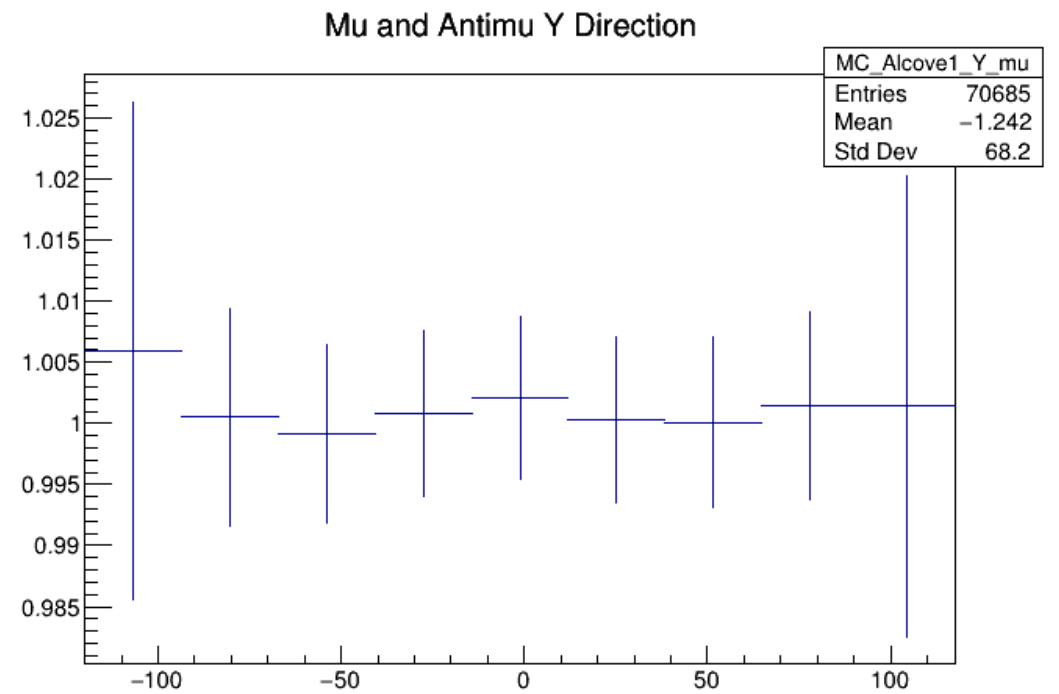
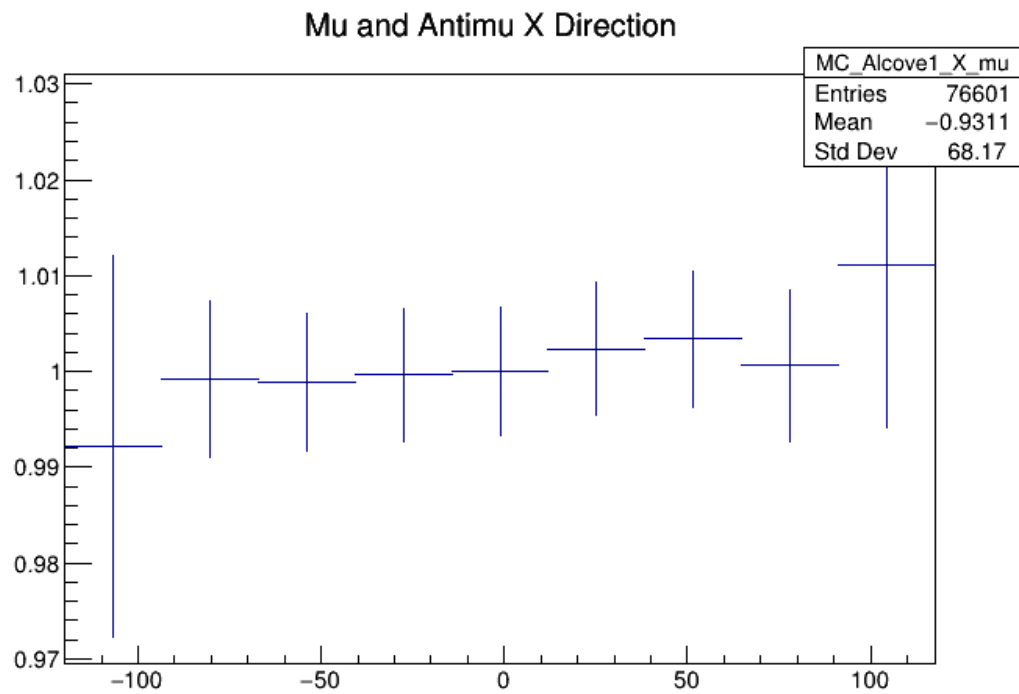
Horn A Move Backward v Flux at Far Detector



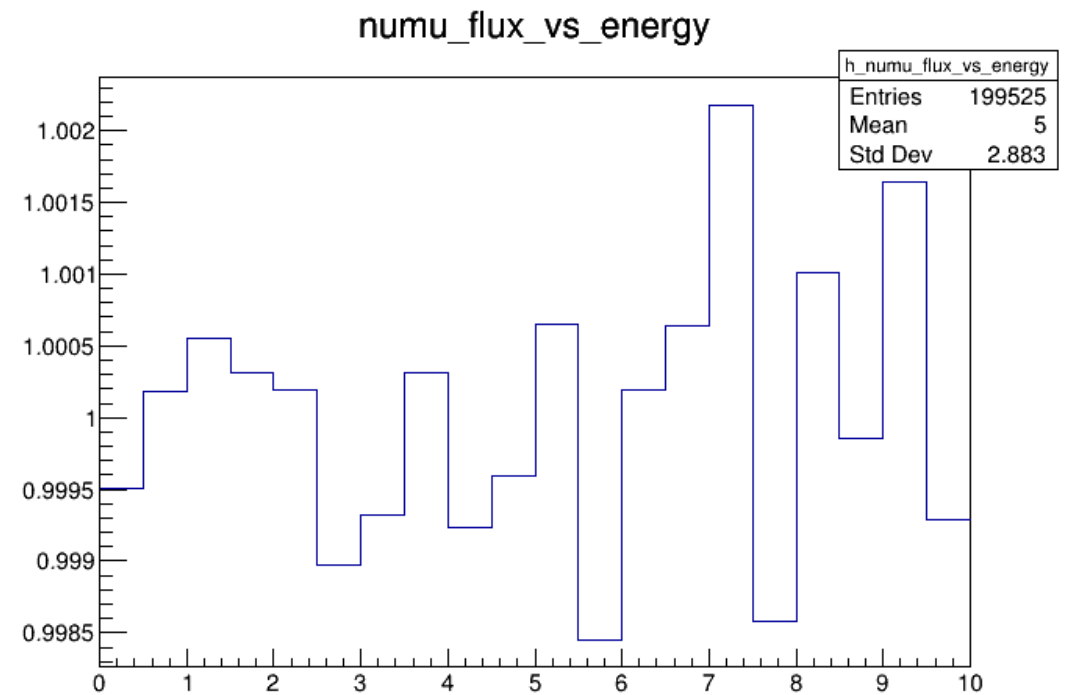
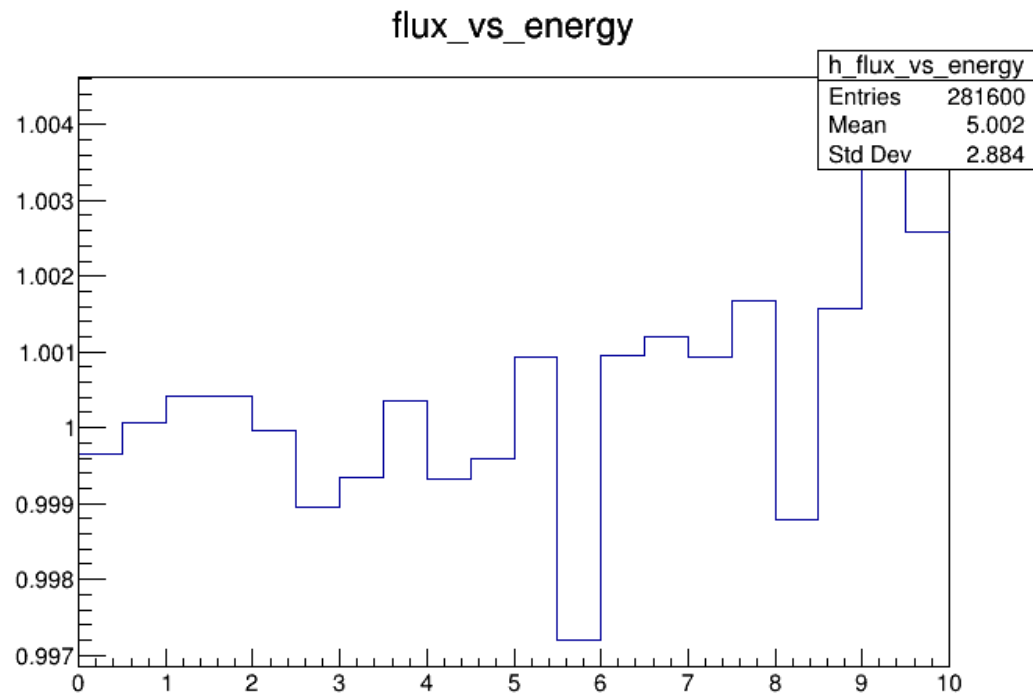
Horn A Move Forward – Alcove 1



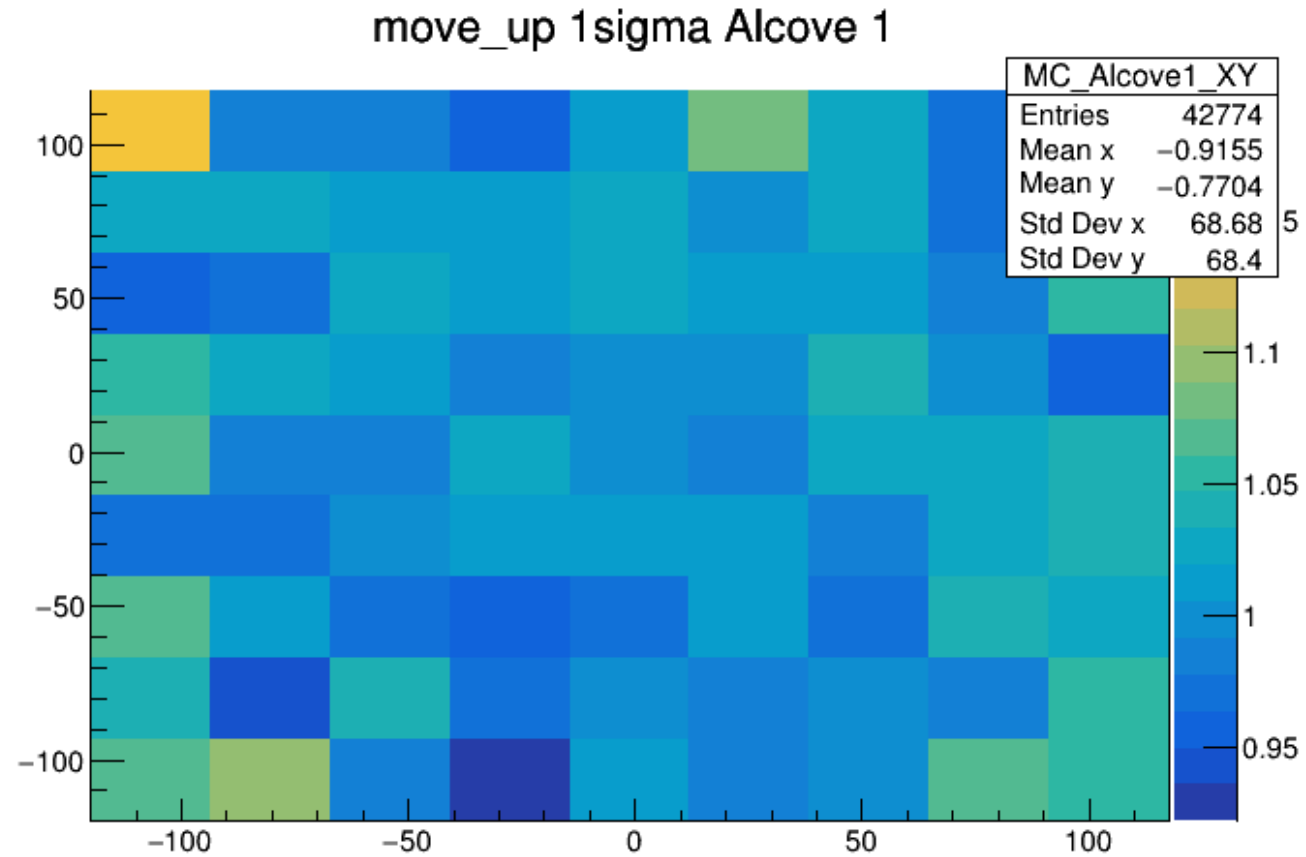
Horn A Move Forward - Alcove 1



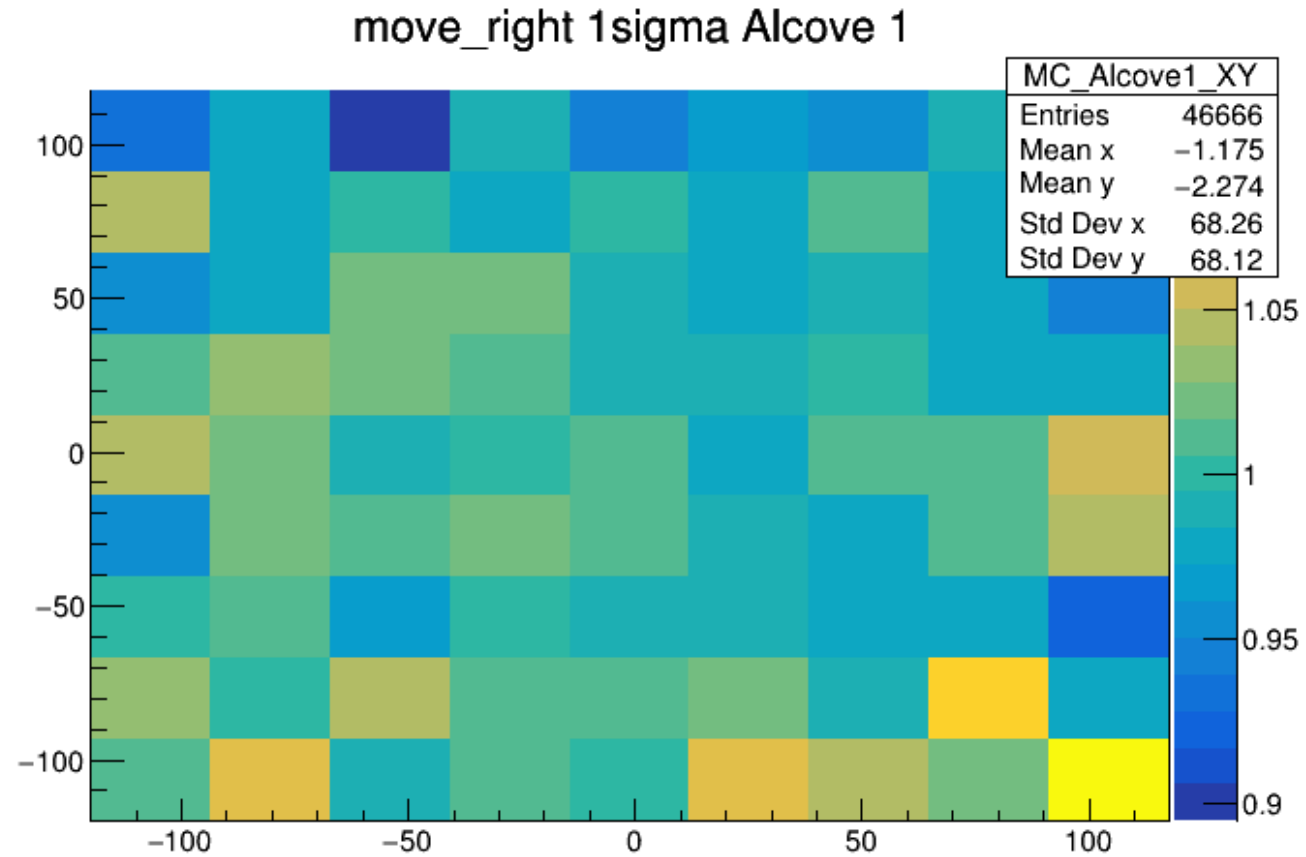
Horn A Move Forward v Flux at Far Detector



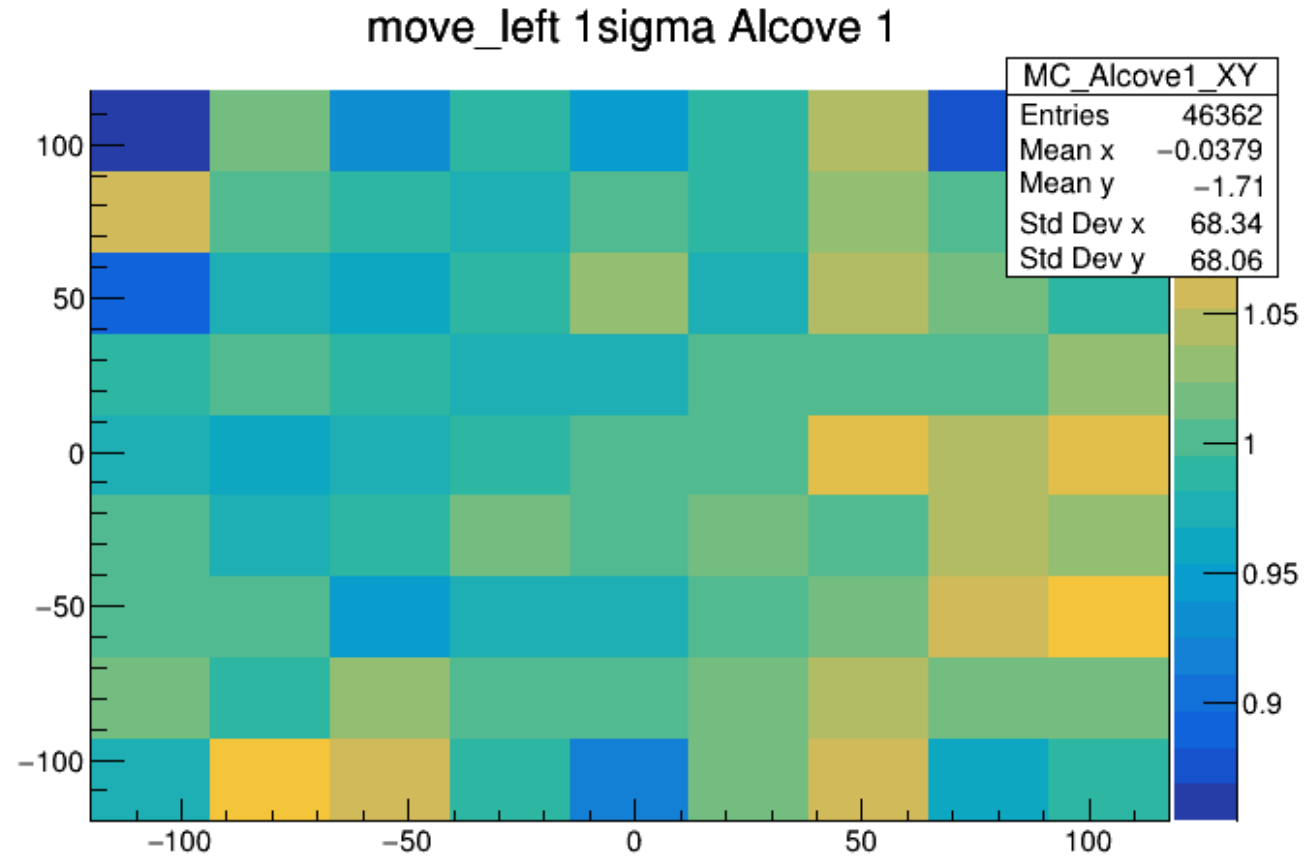
Horn A Move Up – Alcove 1



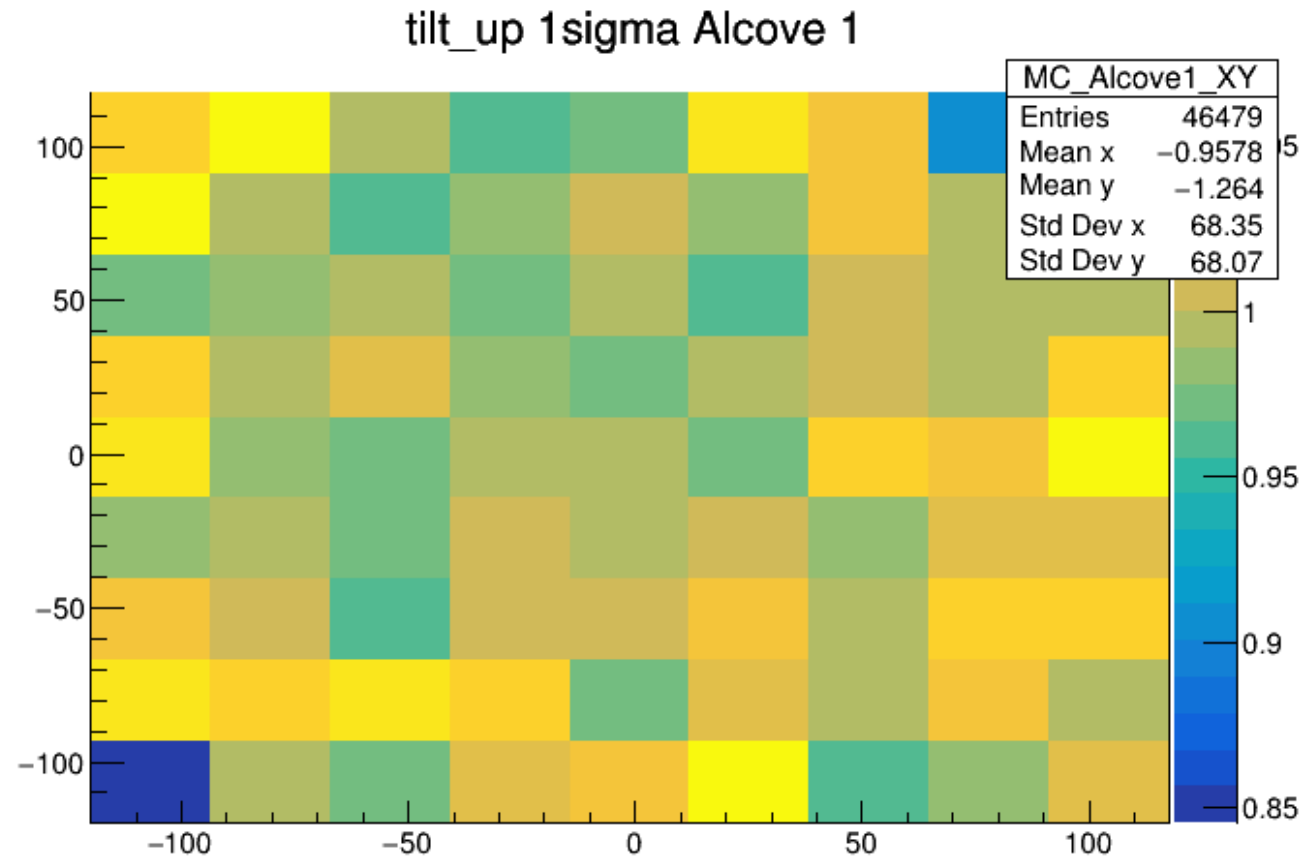
Horn A Move Right – Alcove 1



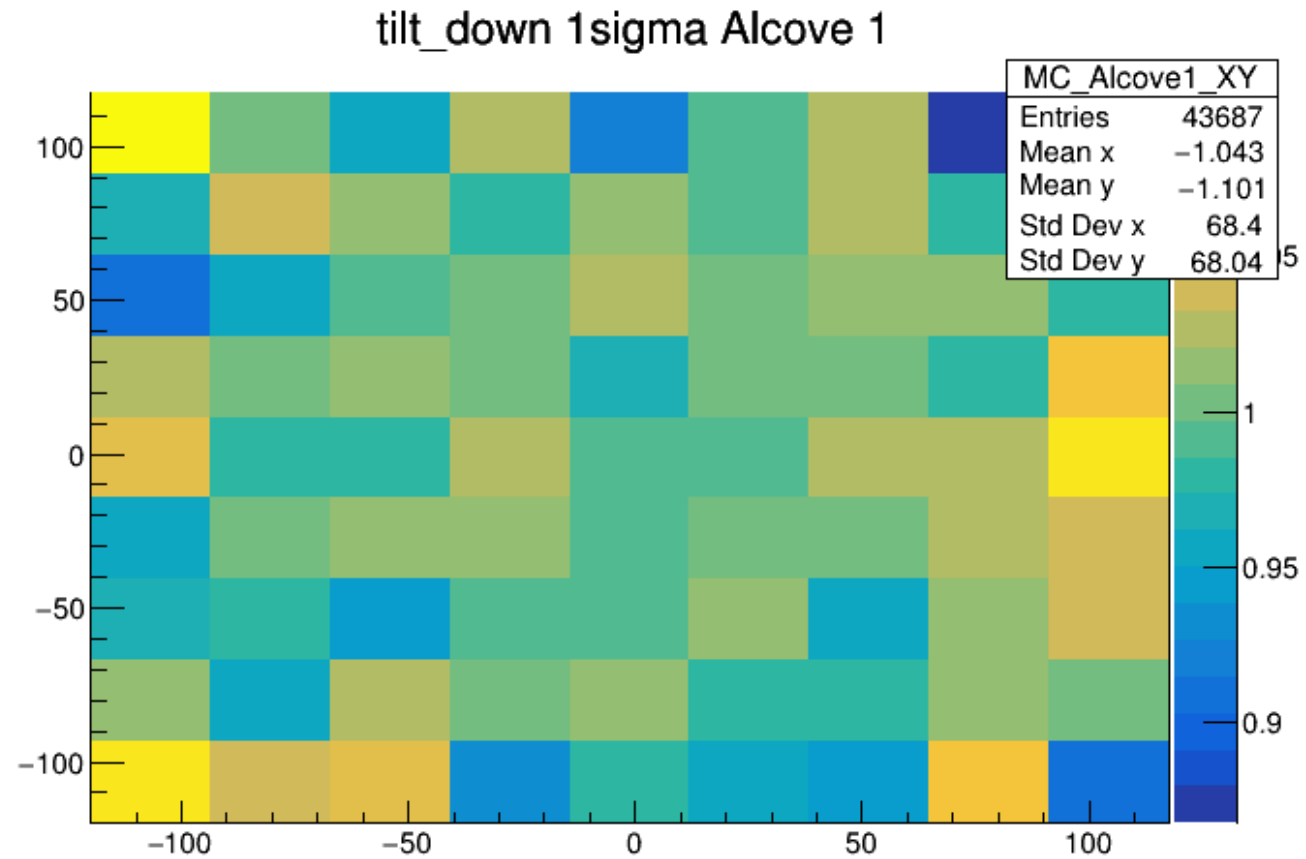
Horn A Move Left – Alcove 1



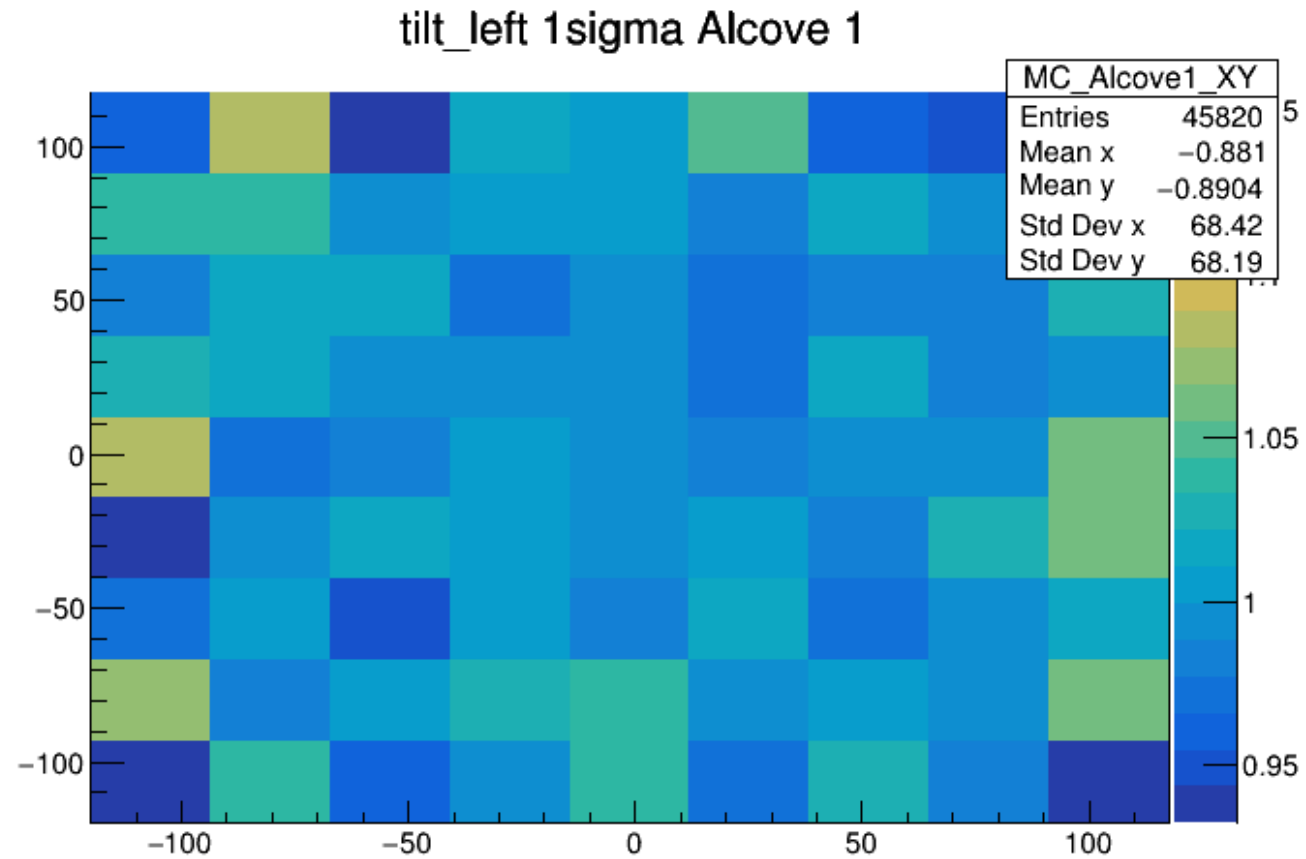
Horn A Tilt Up – Alcove 1



Horn A Tilt Down – Alcove 1

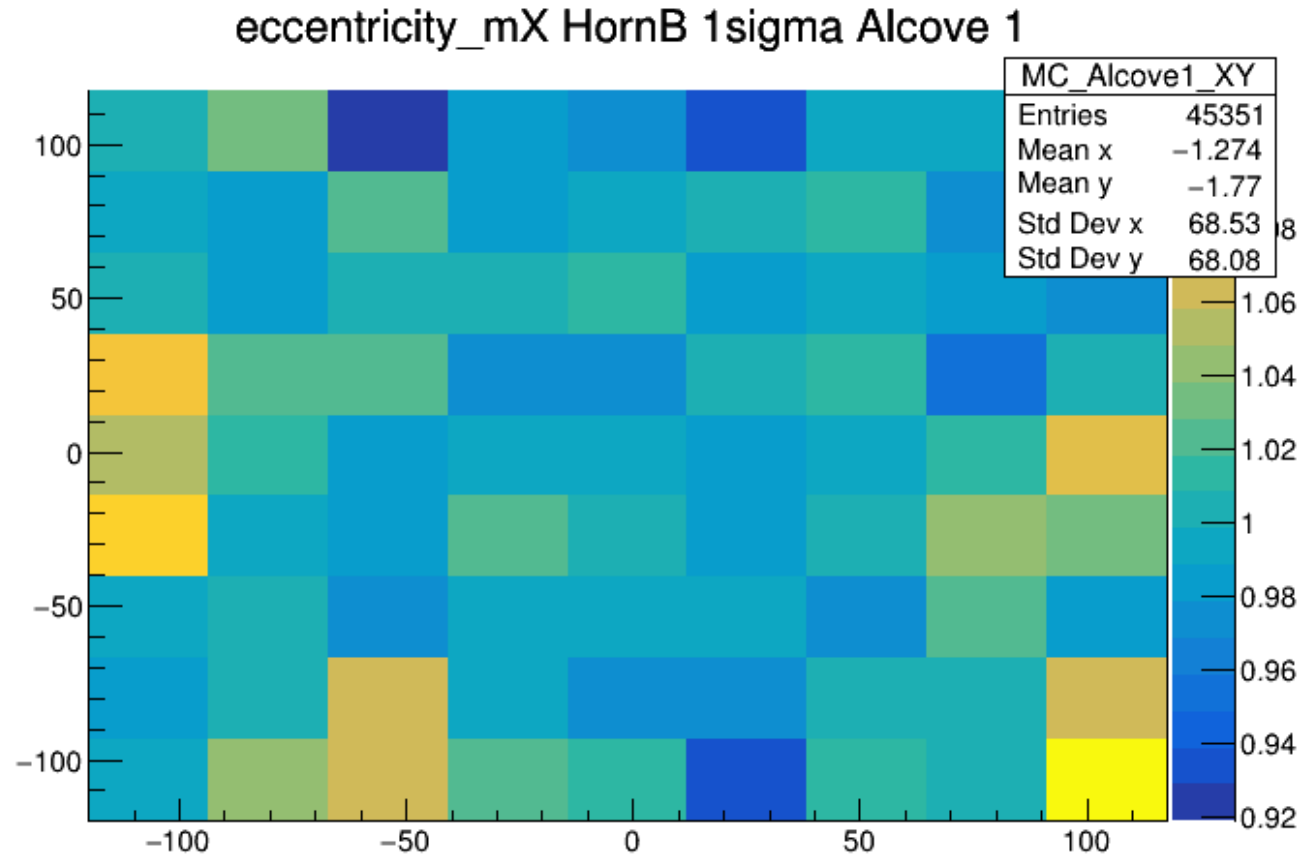


Horn A Tilt Left – Alcove 1

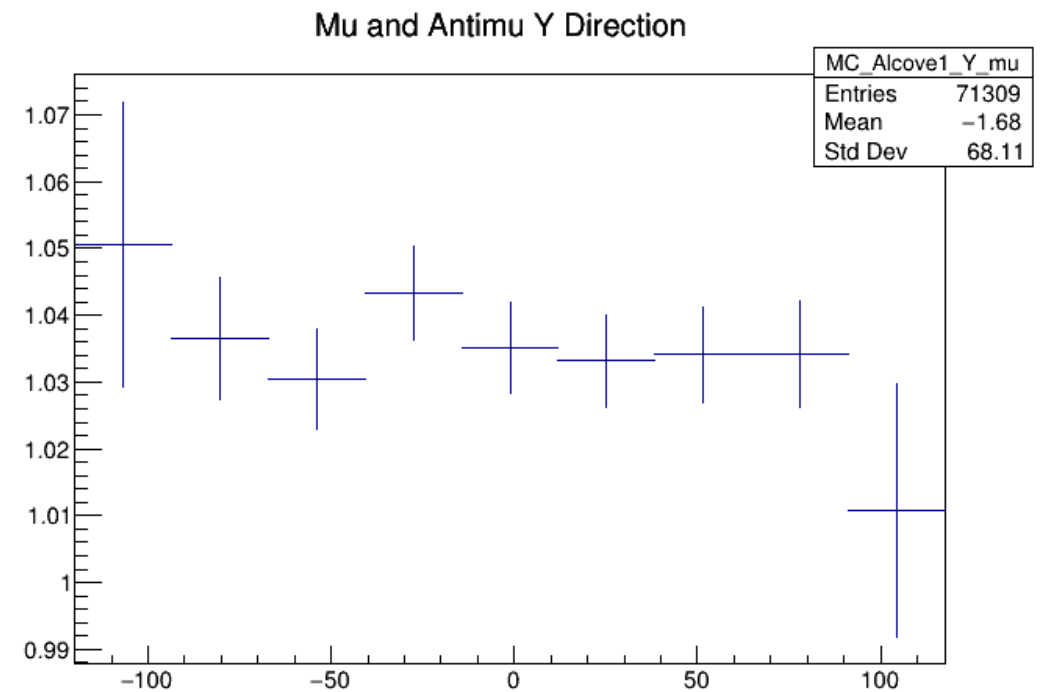
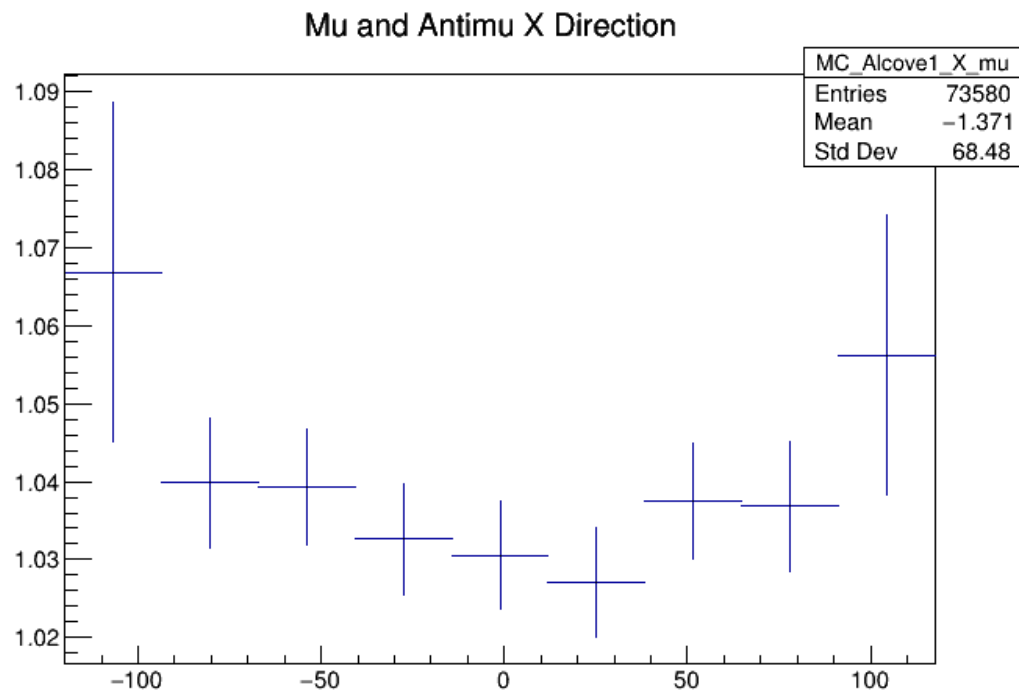


Horn B

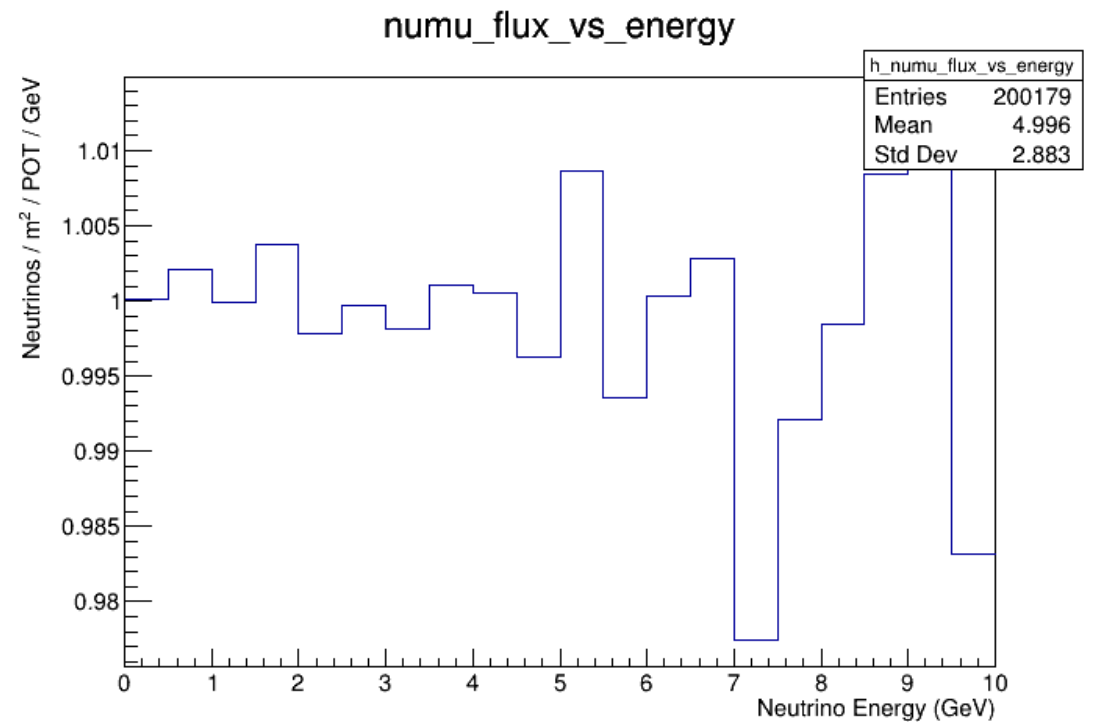
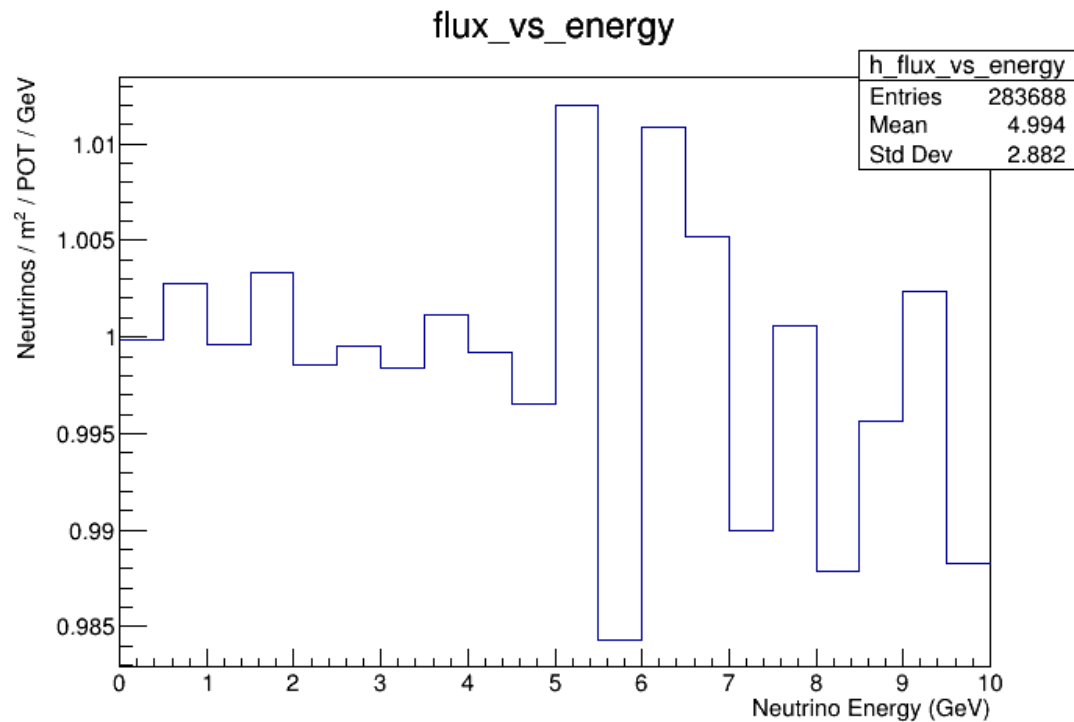
Horn B Eccentricity mX - Alcove 1



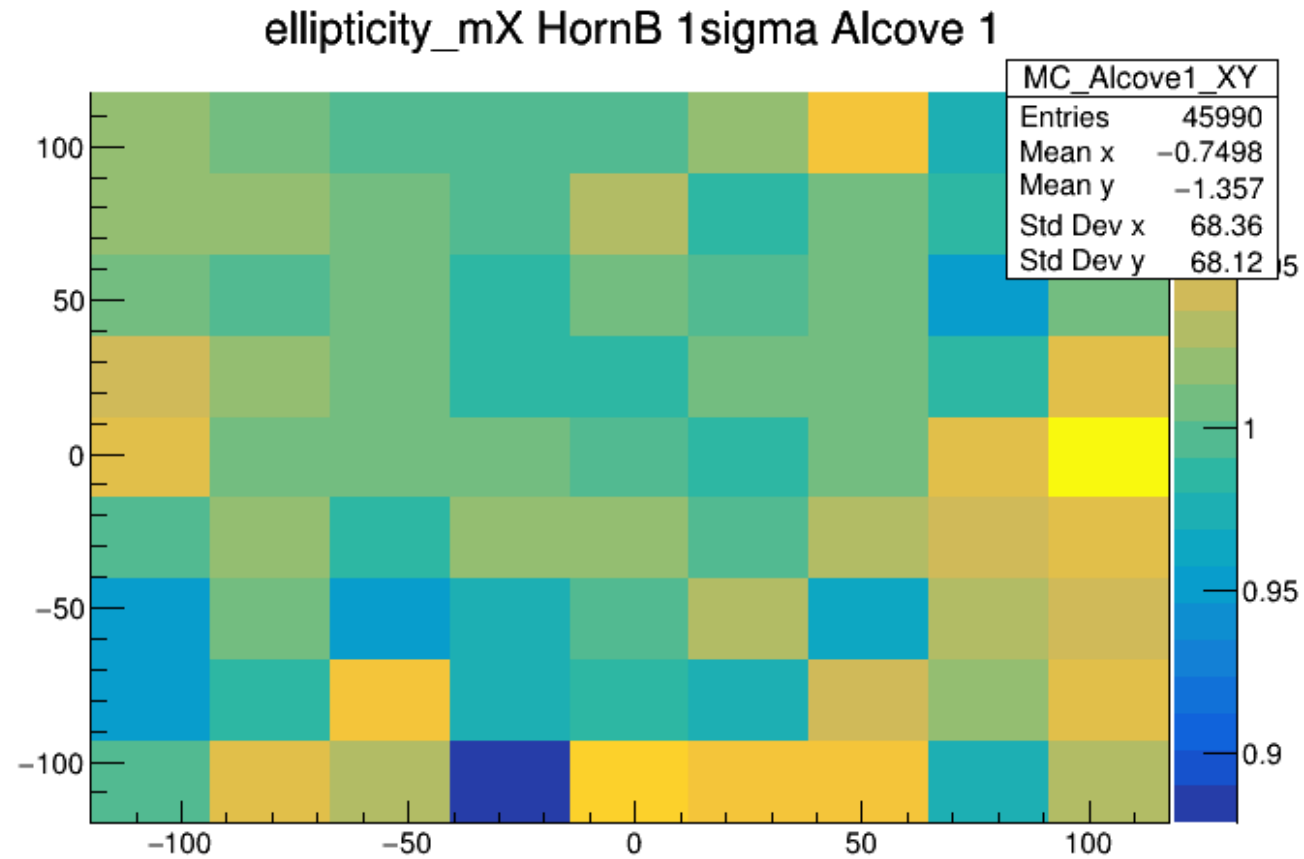
Horn B Eccentricity mX - Alcove 1



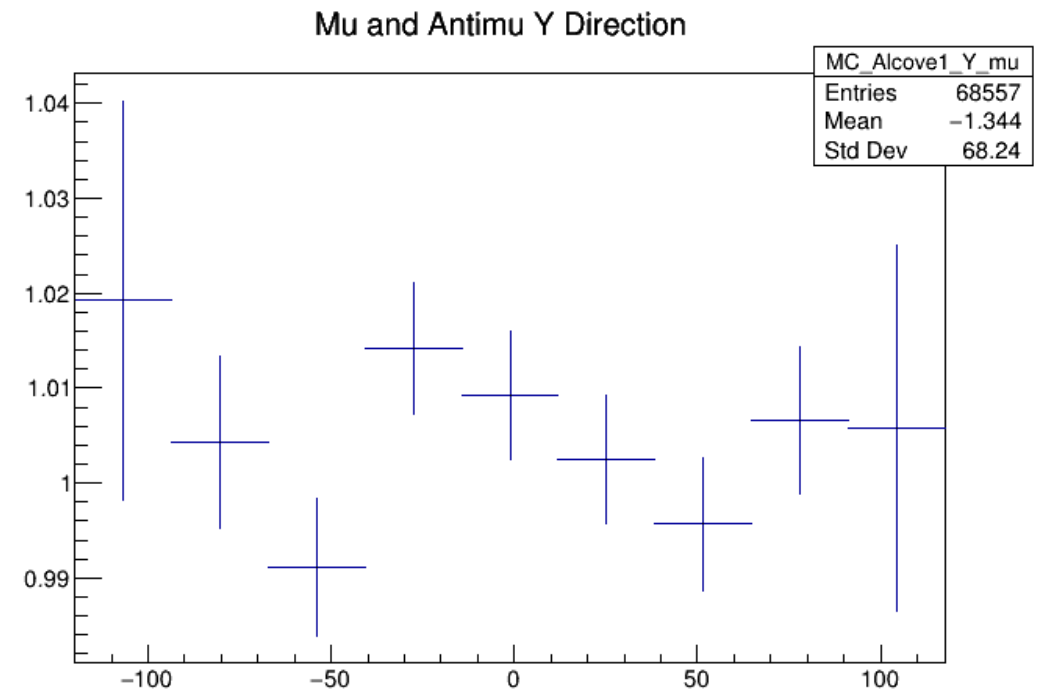
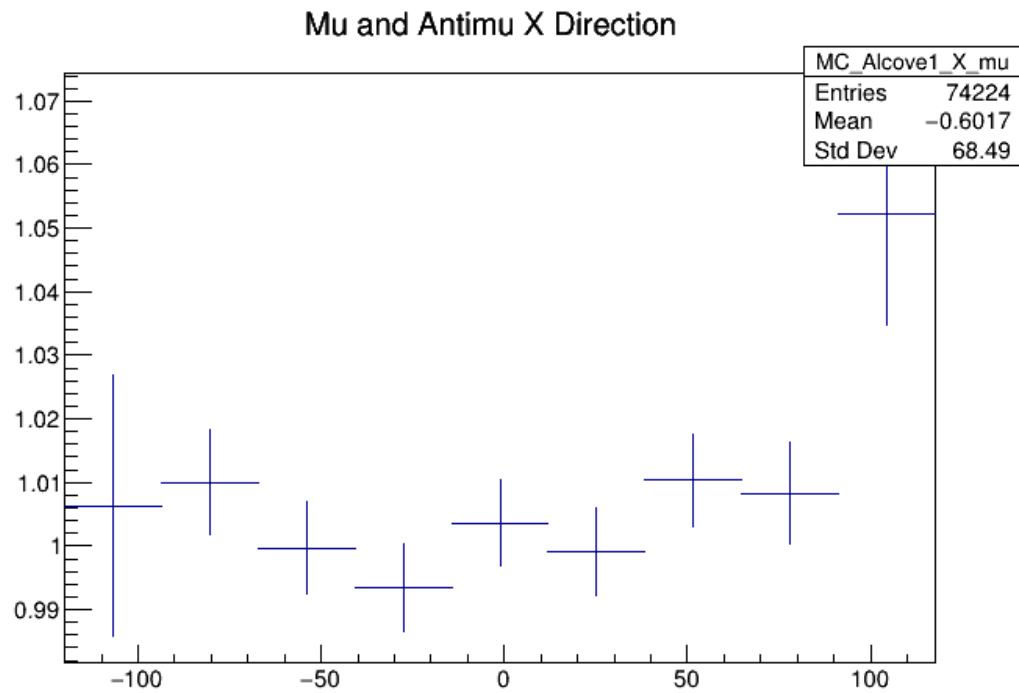
Horn B Eccentricity mX v Flux at Far Detector



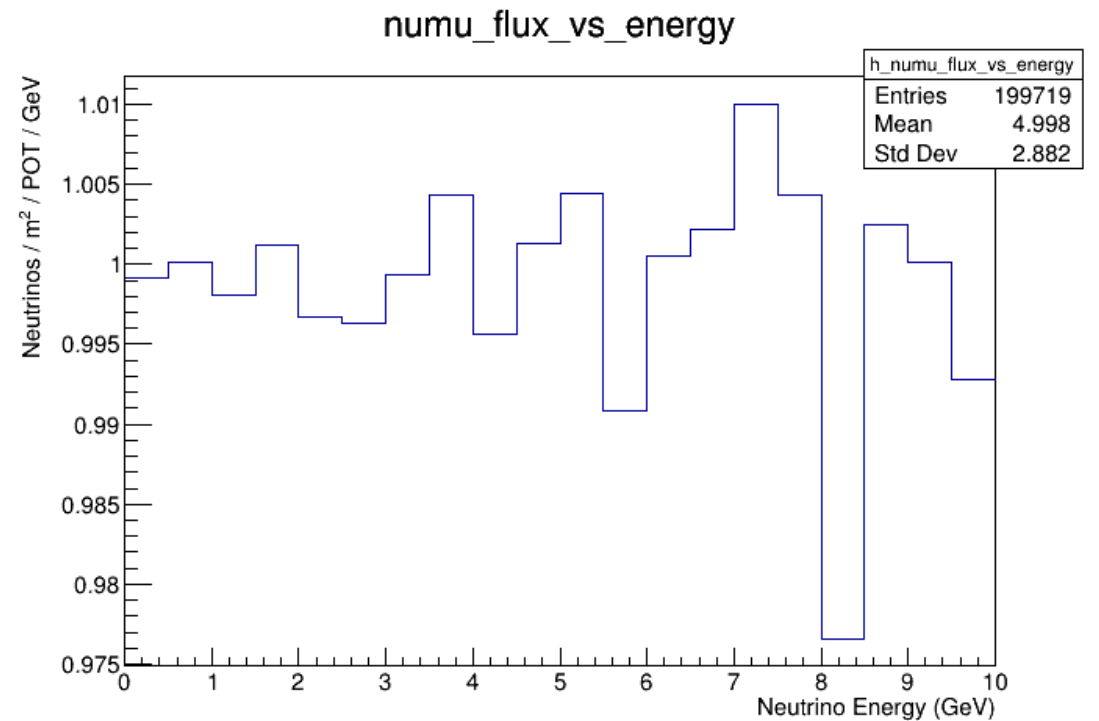
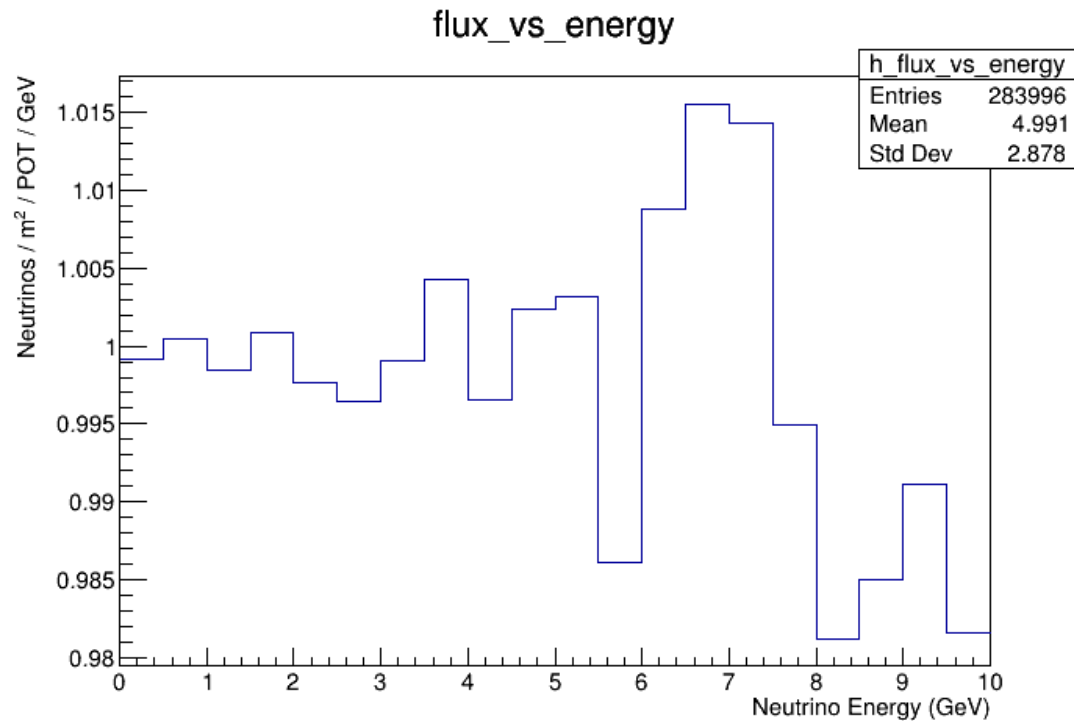
Horn B Ellipticity mX - Alcove 1



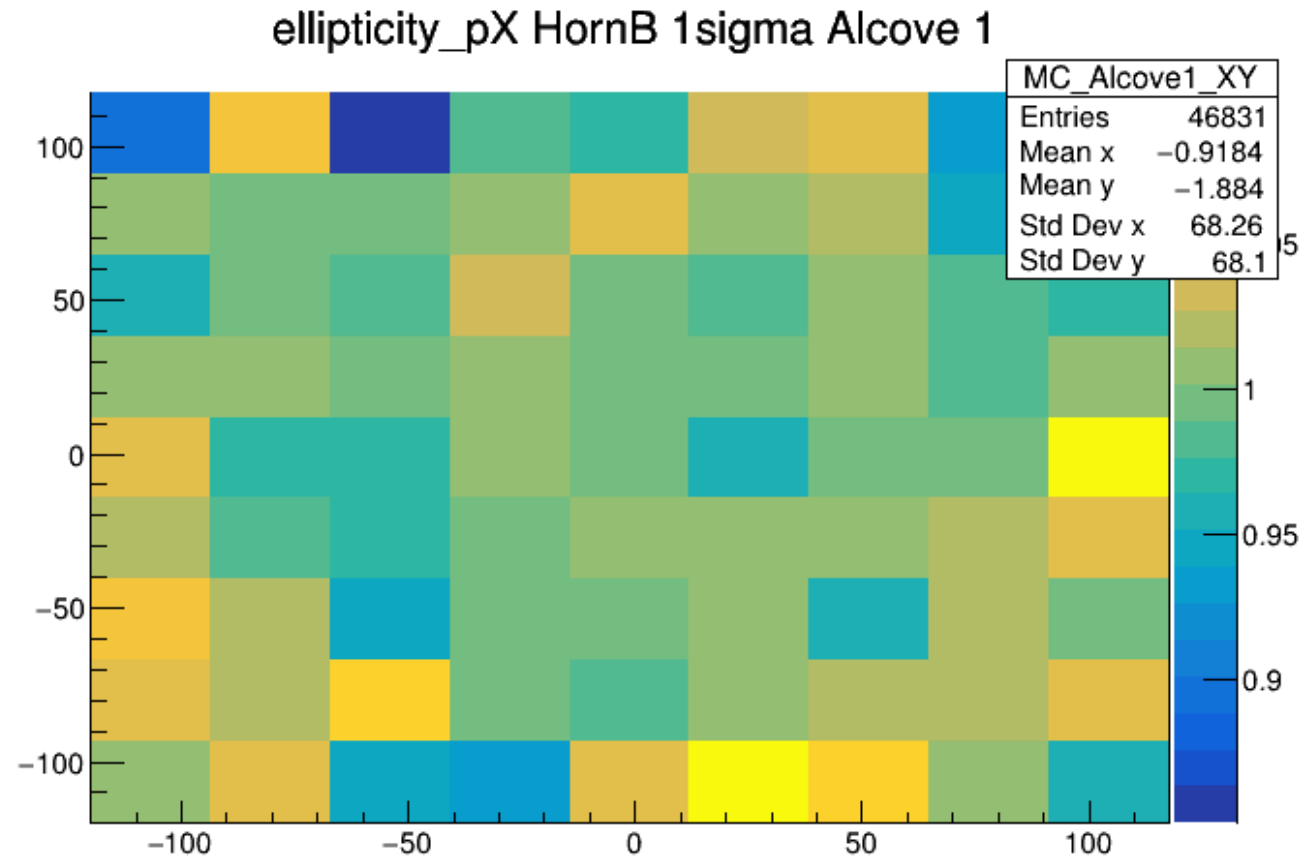
Horn B Ellipticity mX - Alcove 1



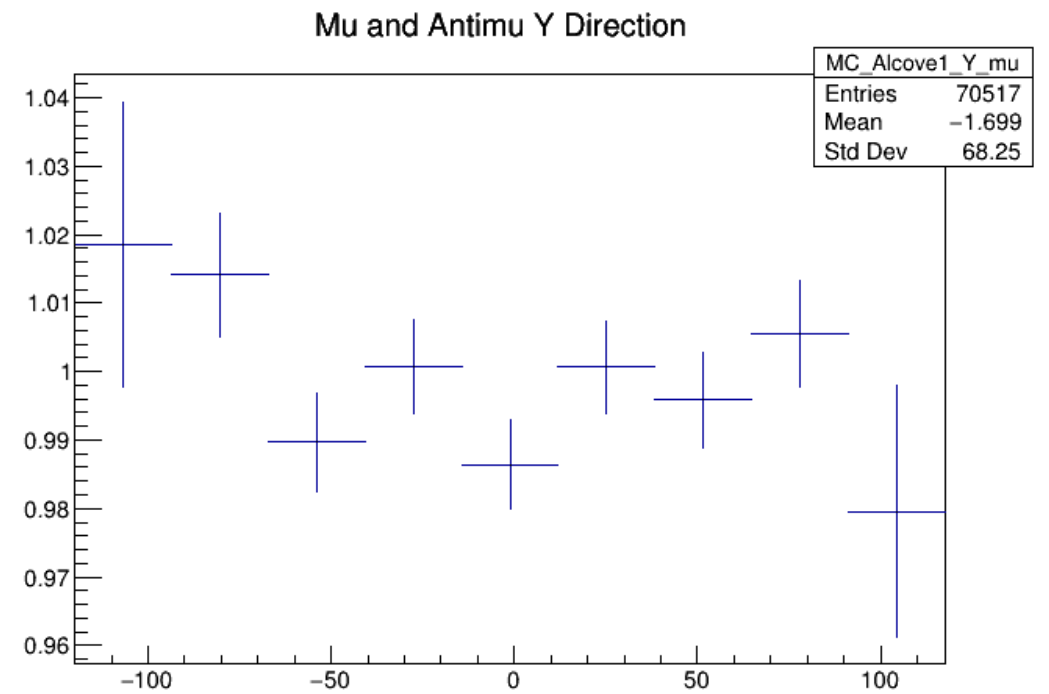
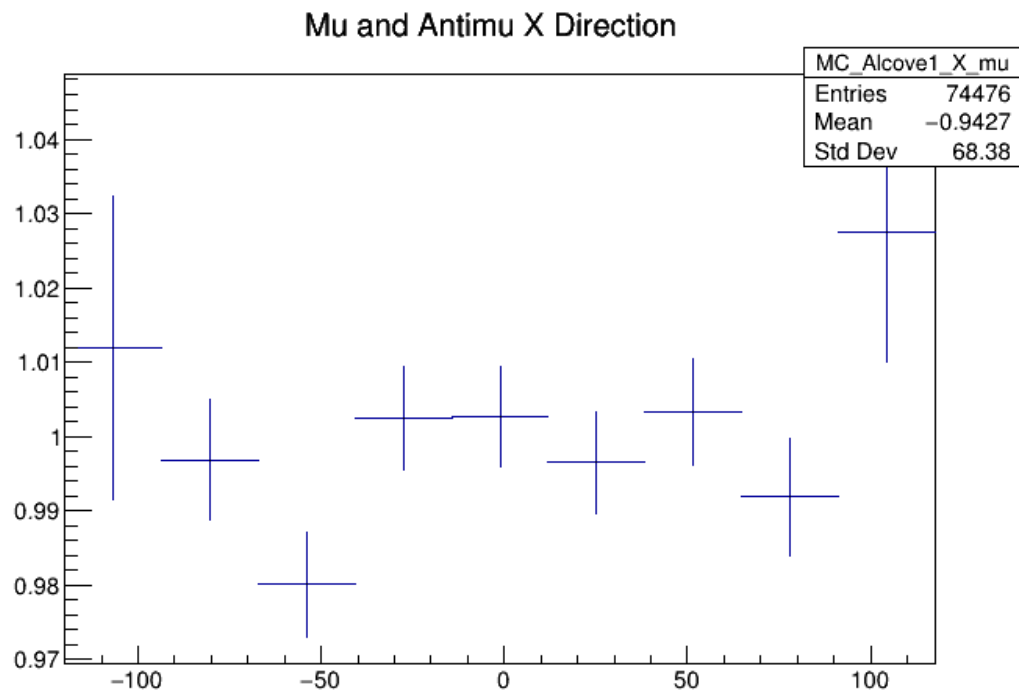
Horn A Ellipticity mX v Flux at Far Detector



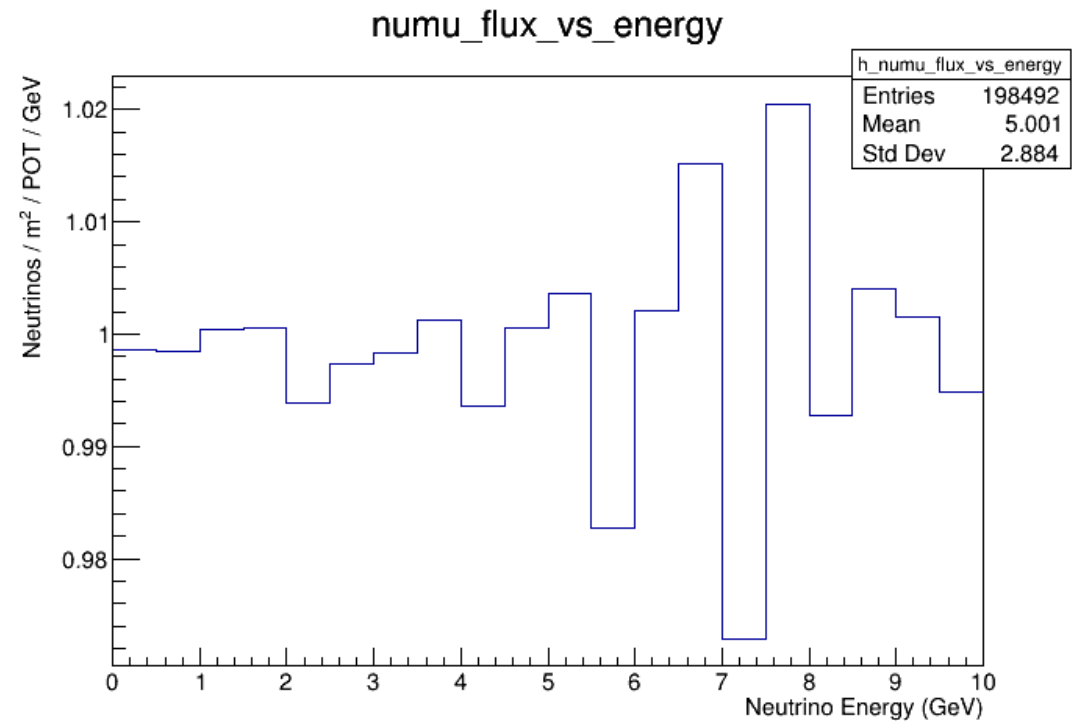
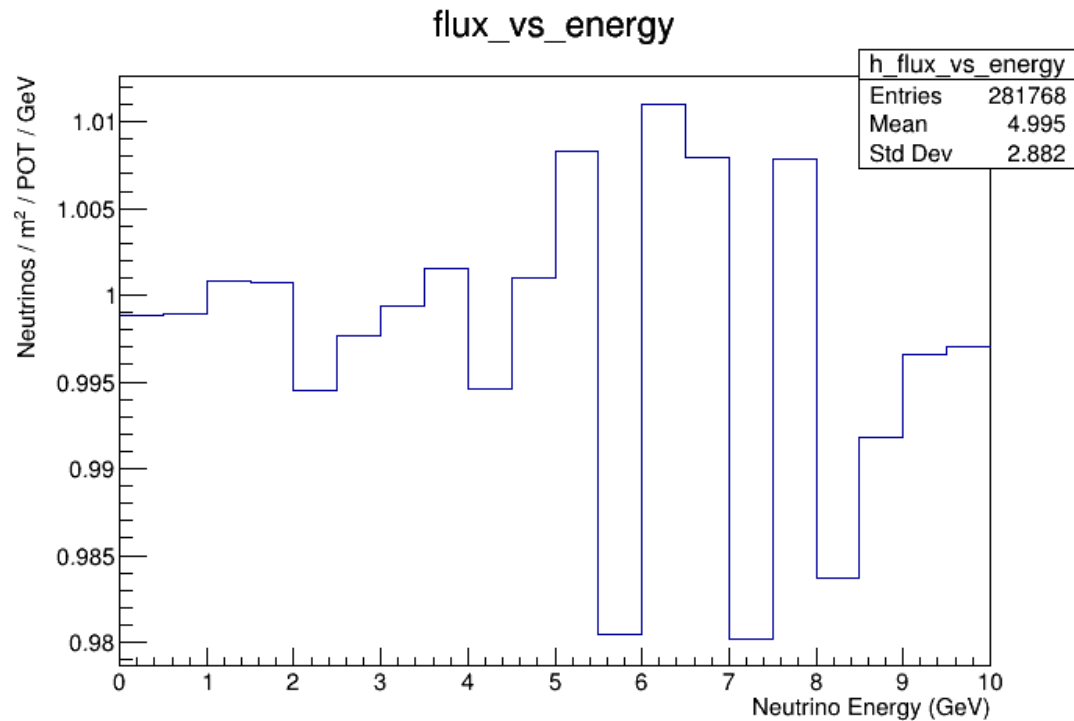
Horn B Ellipticity pX - Alcove 1



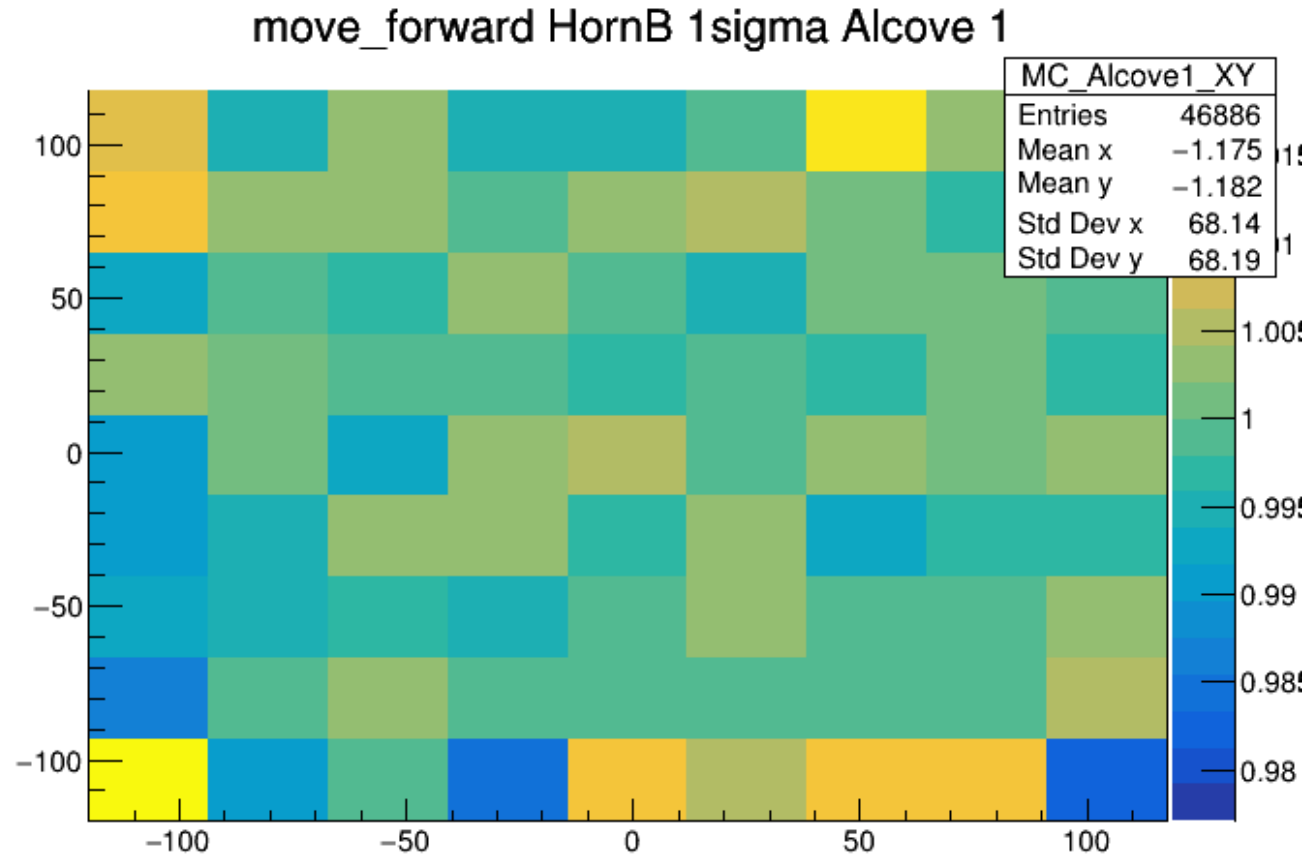
Horn B Ellipticity pX - Alcove 1



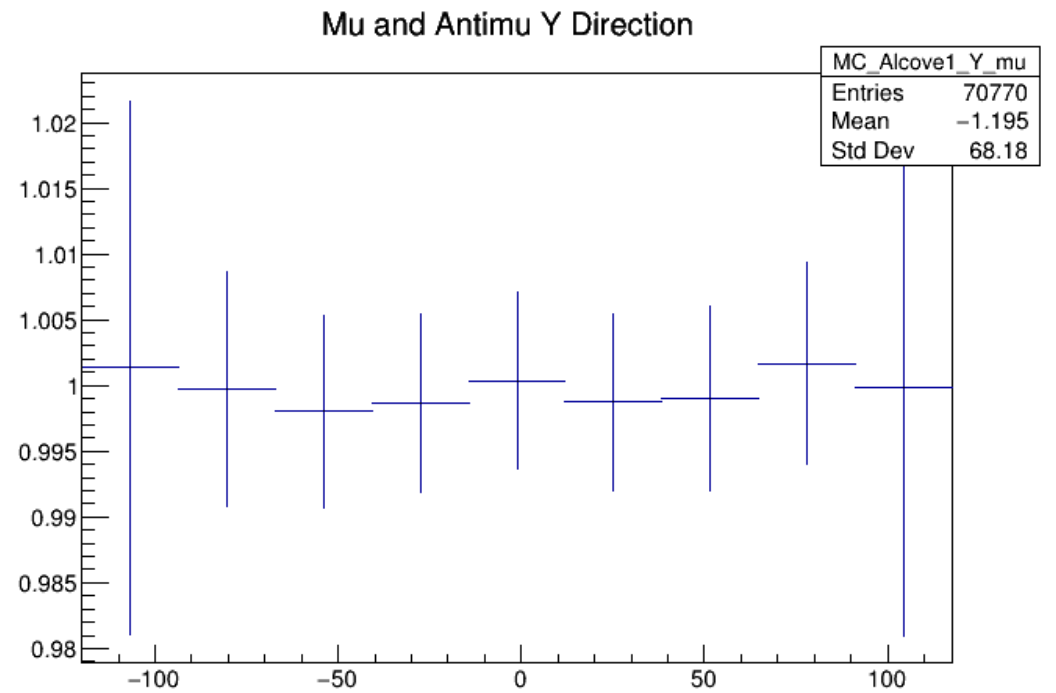
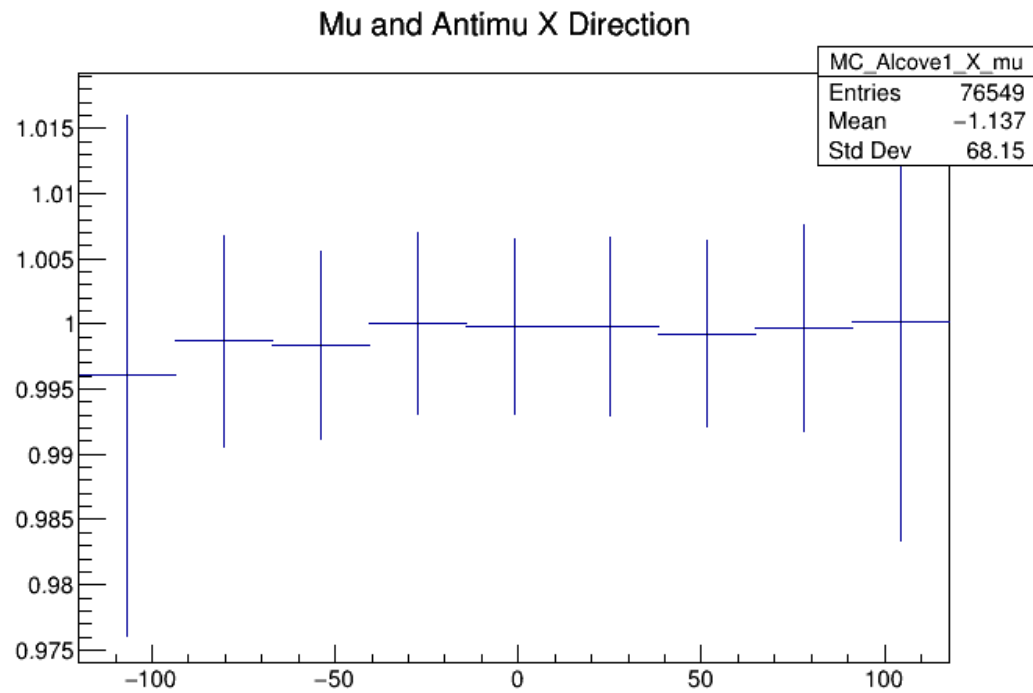
Horn B Ellipticity pX v Flux at Far Detector



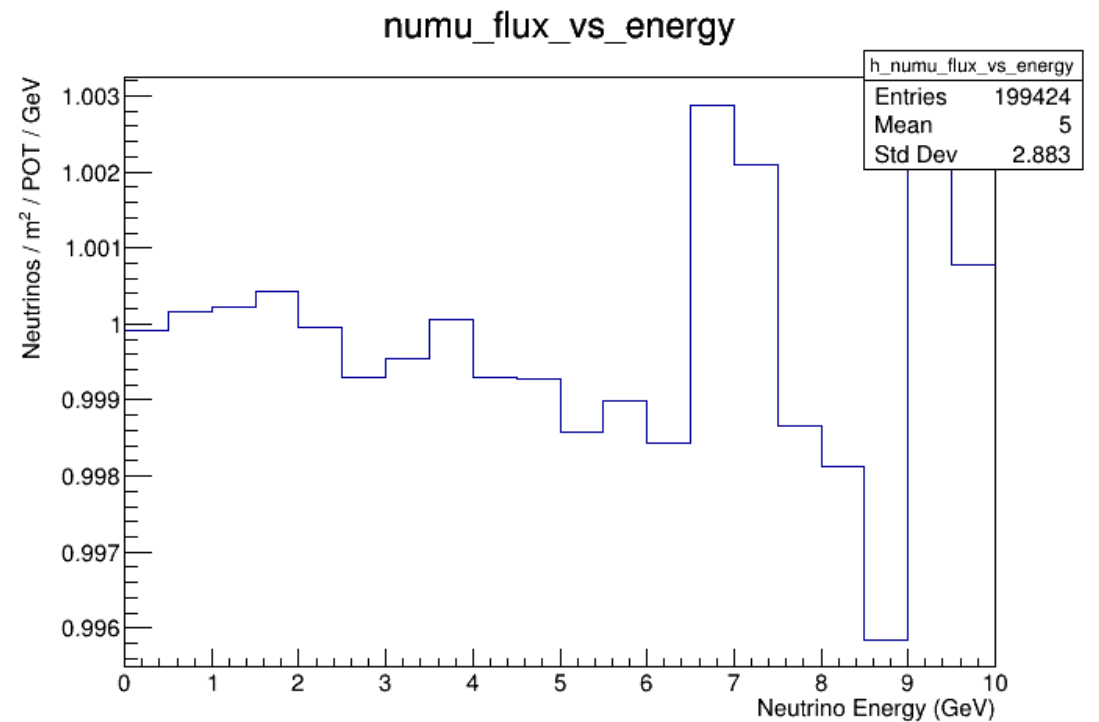
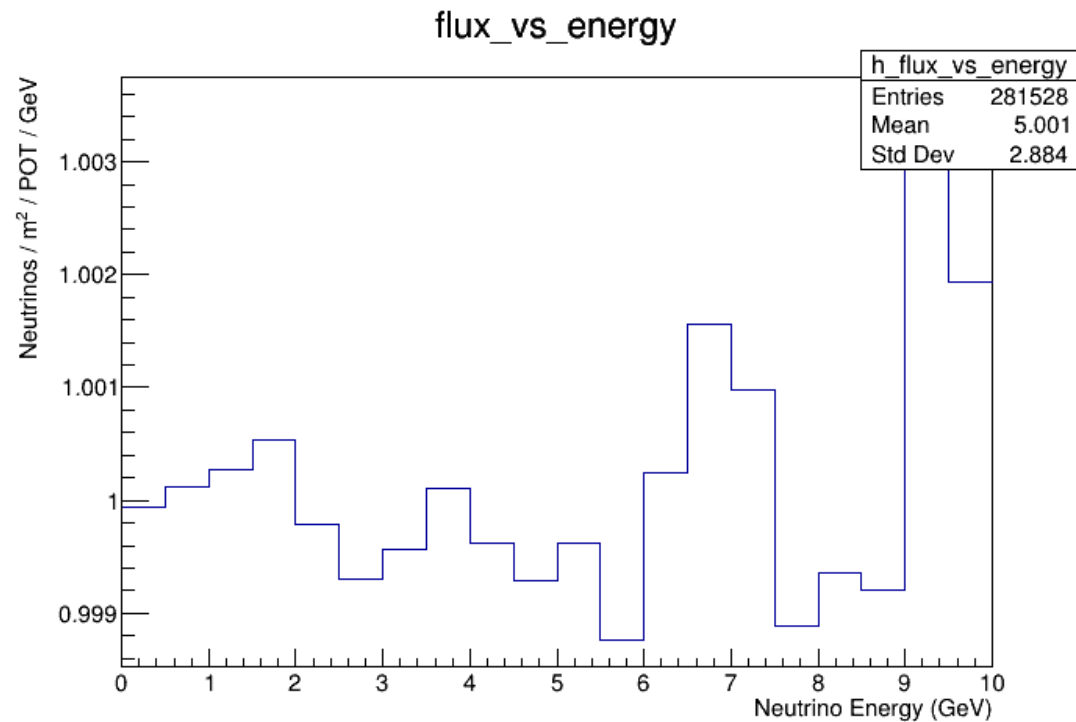
Horn B Move Forward - Alcove 1



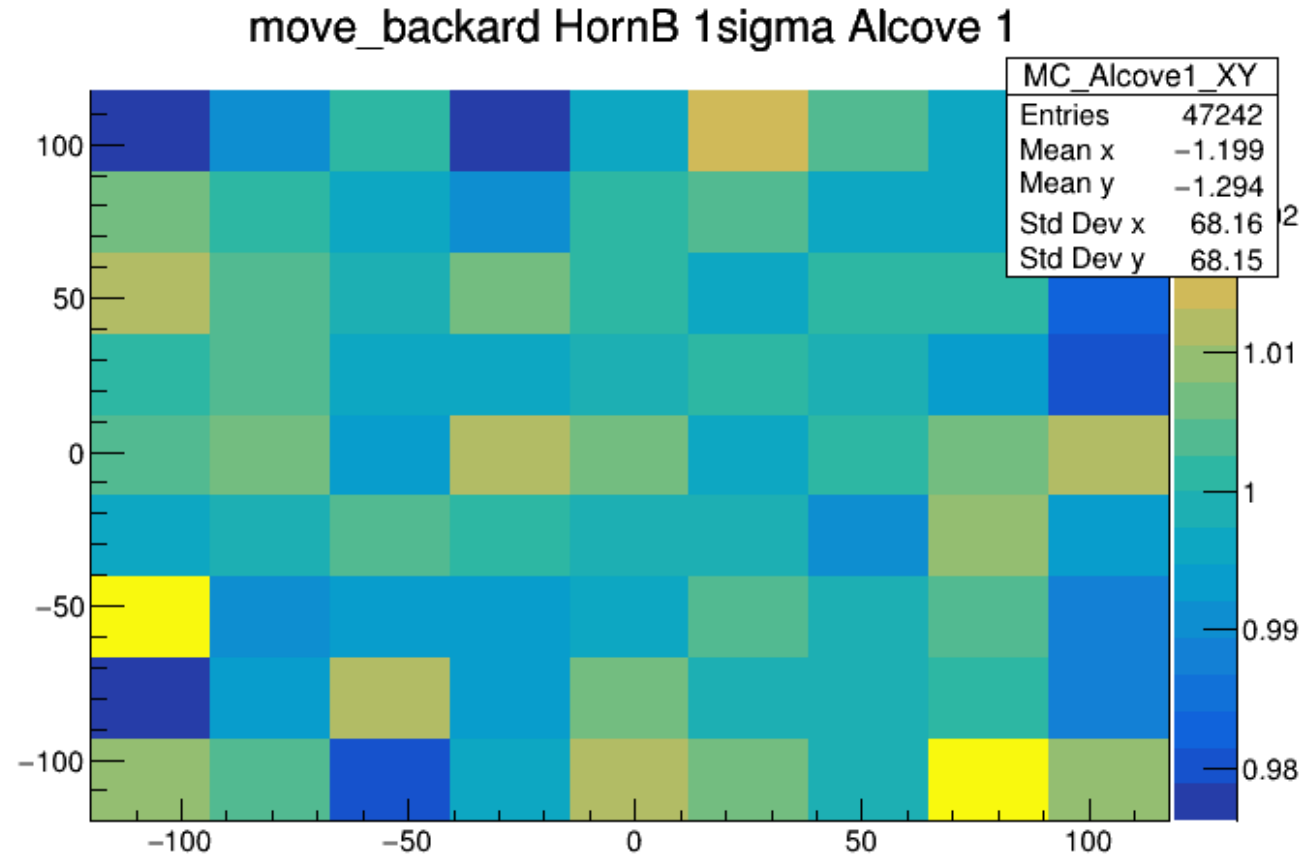
Horn B Move Forward - Alcove 1



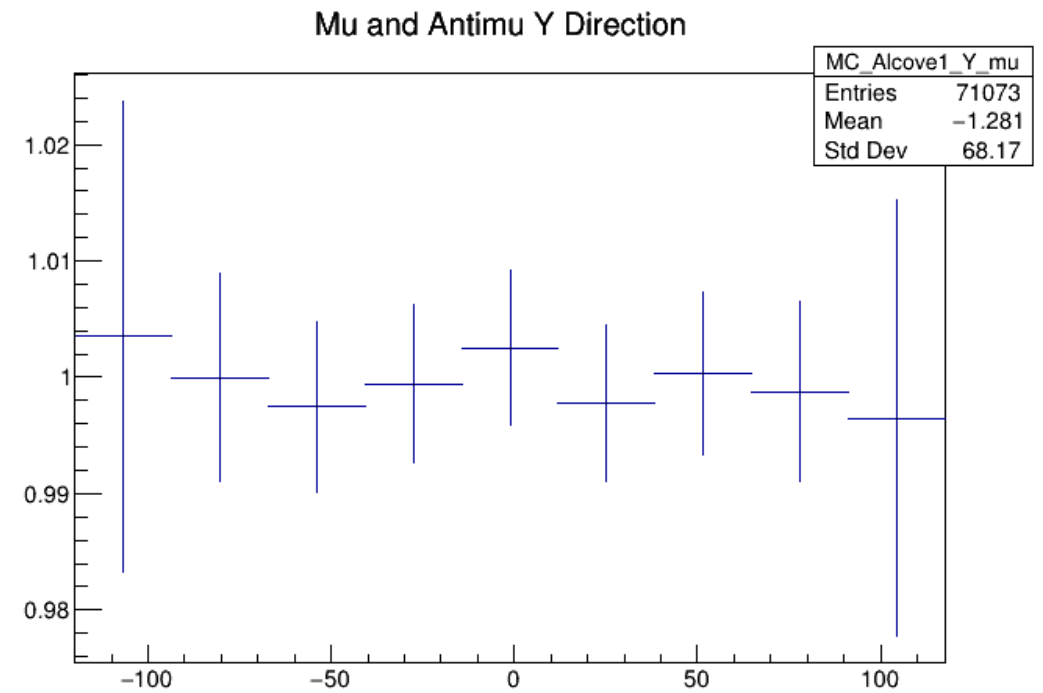
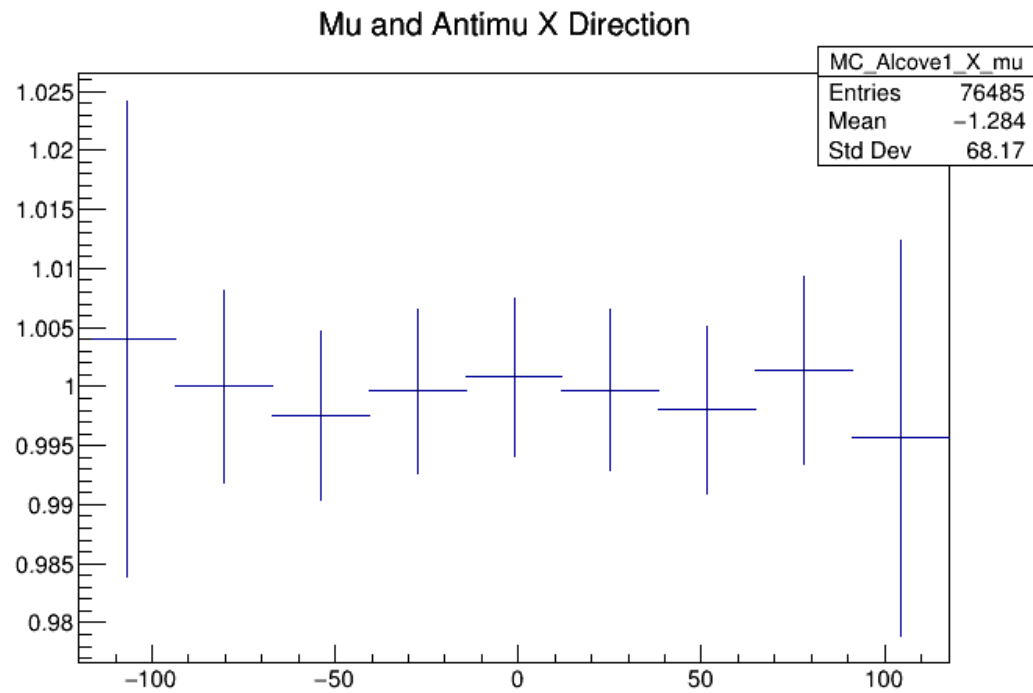
Horn B Move Forward ν Flux at Far Detector



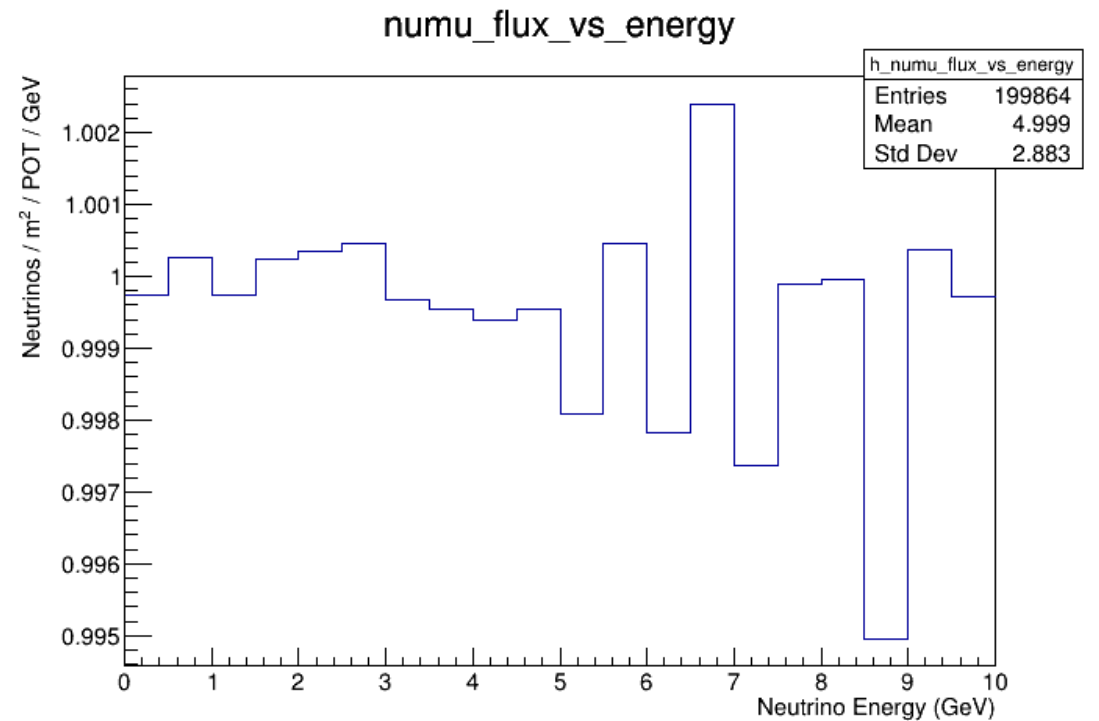
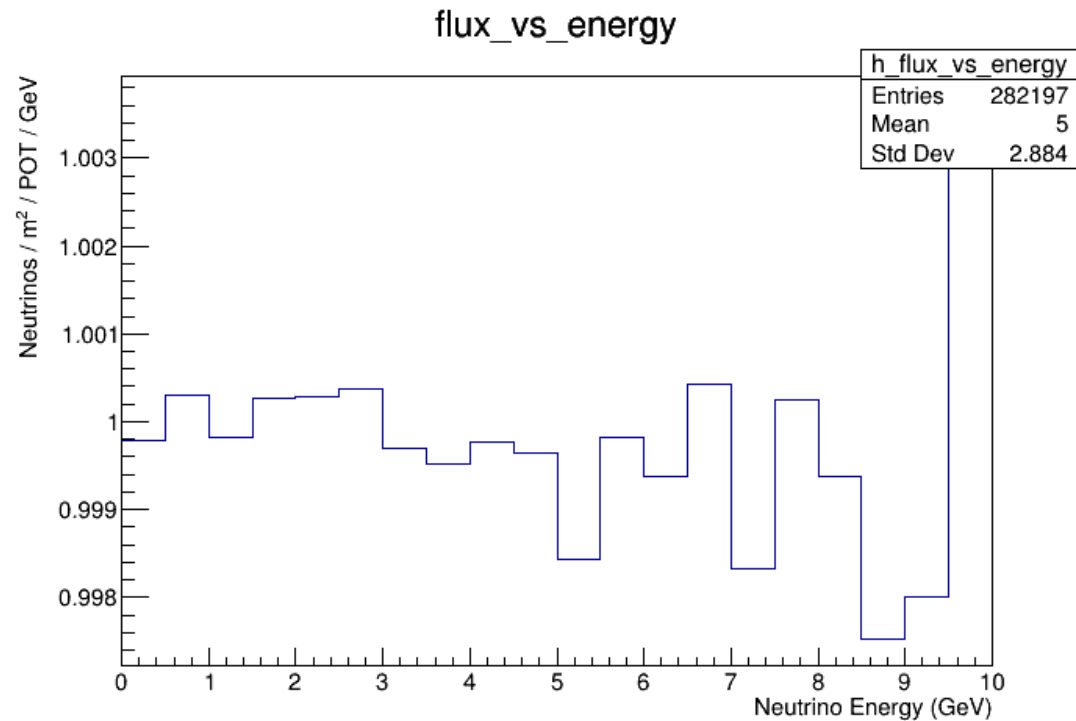
Horn B Move Backward - Alcove 1



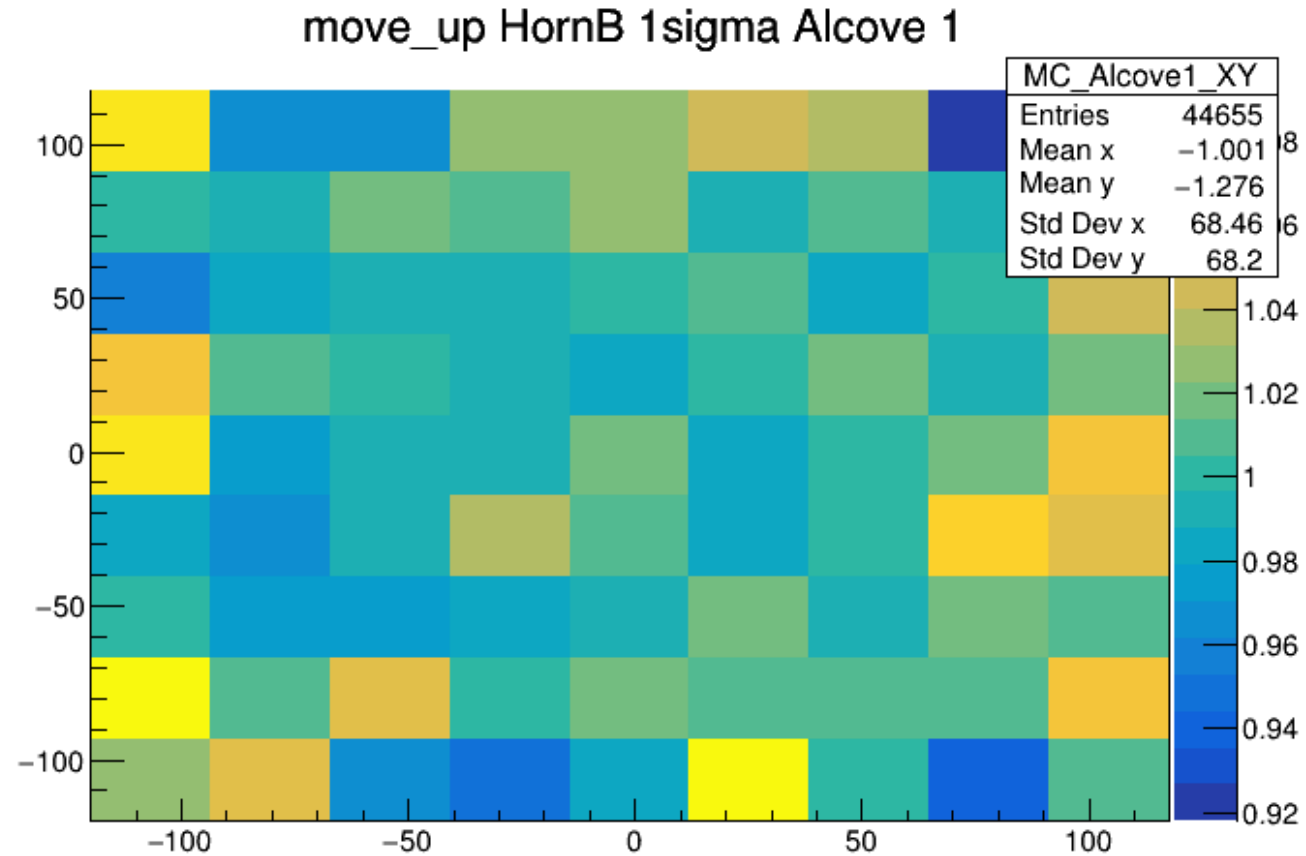
Horn B Move Backward - Alcove 1



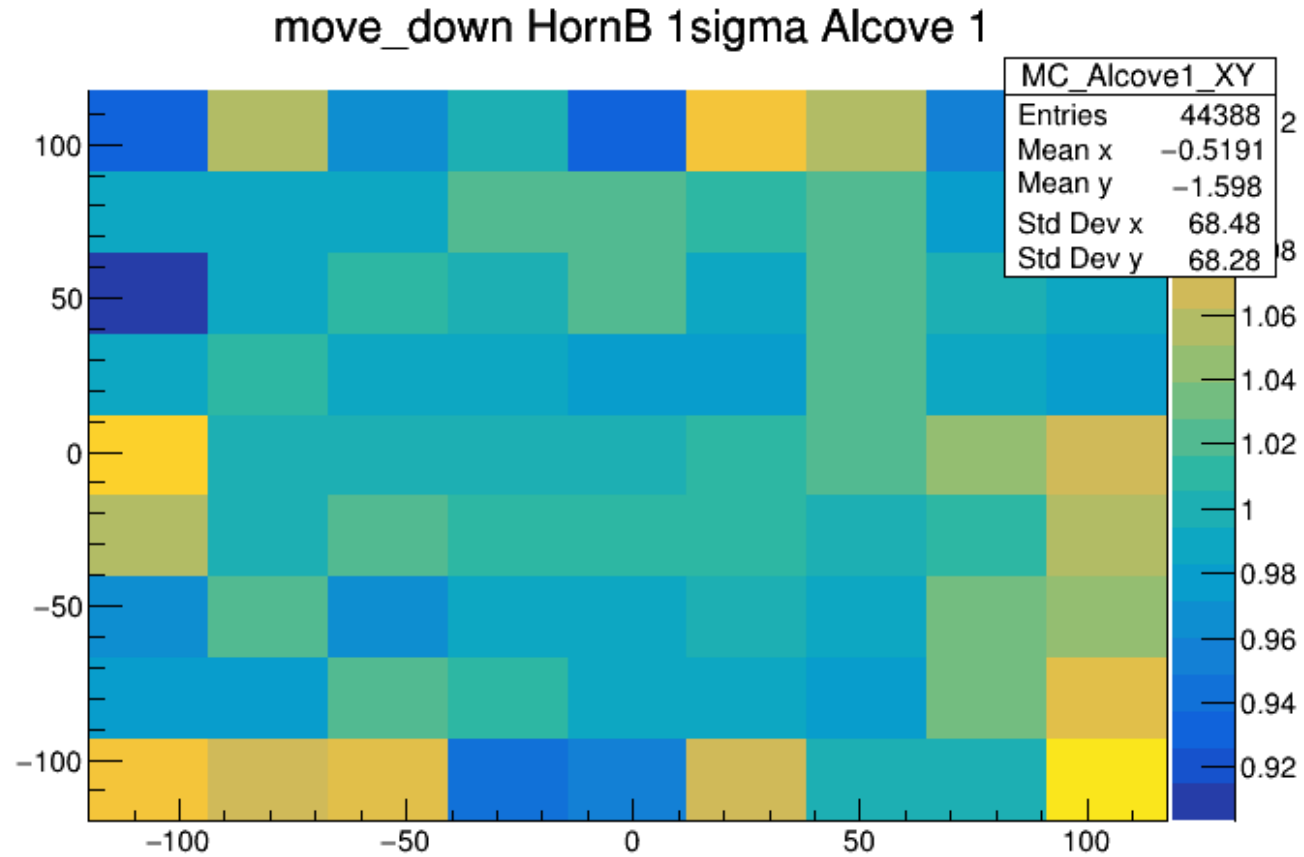
Horn B Move Backward ν Flux at Far Detector



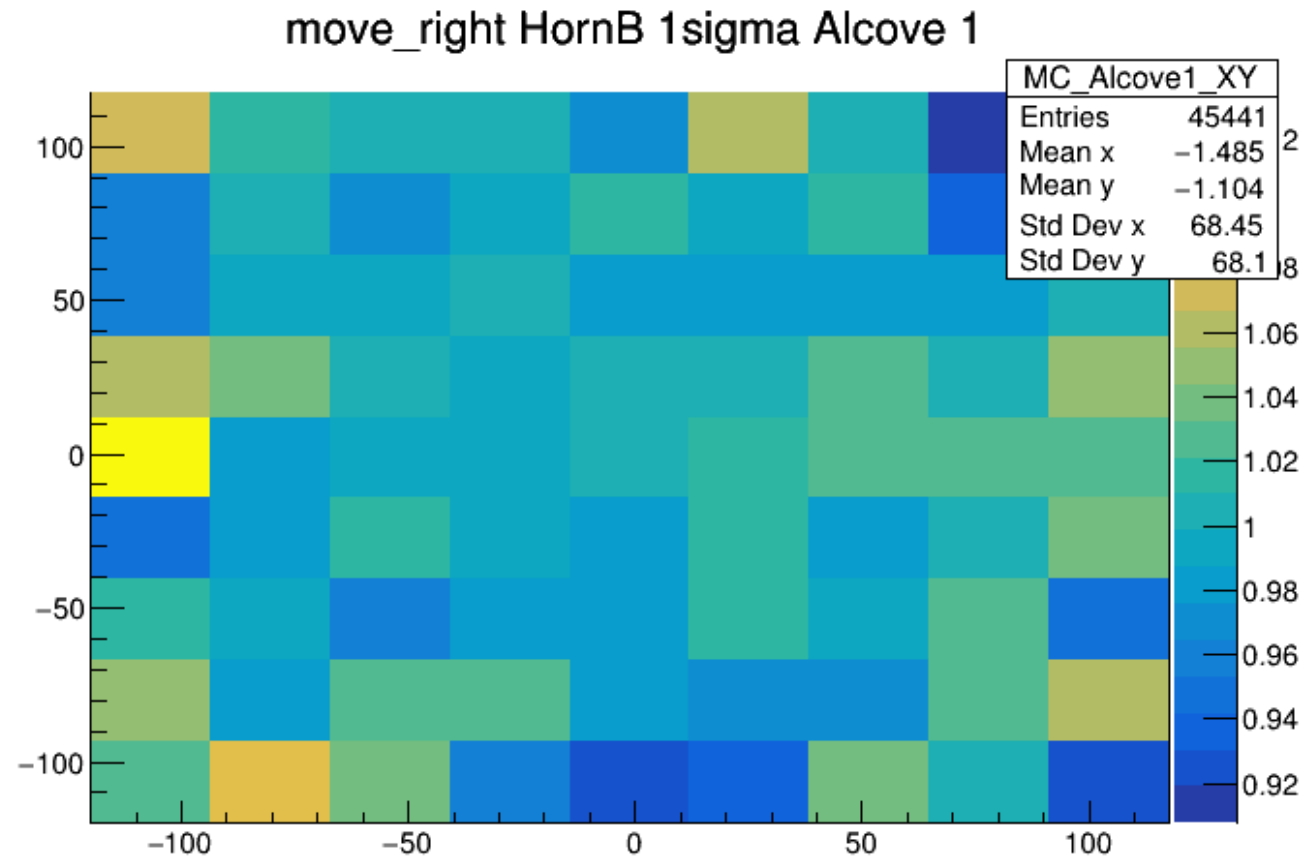
Horn B Move Up - Alcove 1



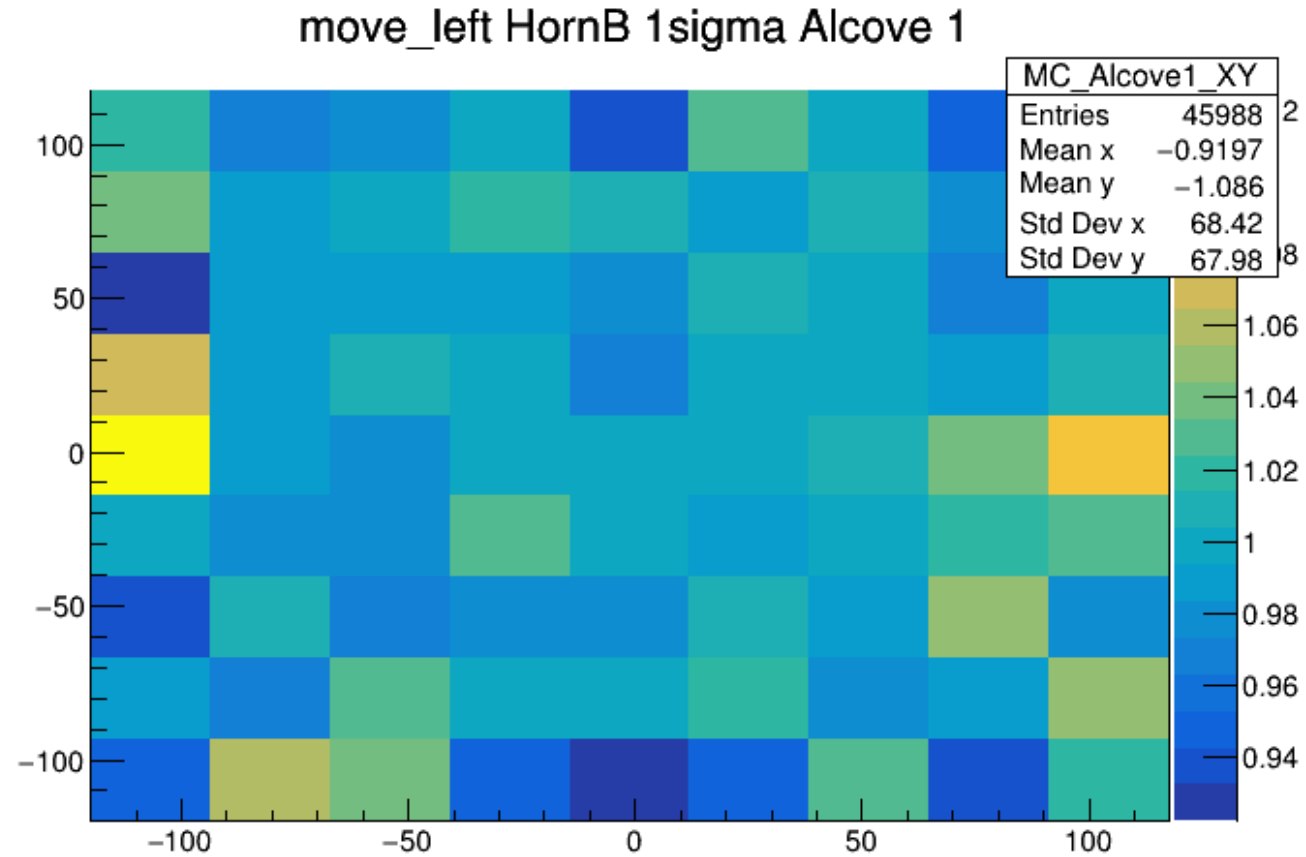
Horn B Move Down - Alcove 1



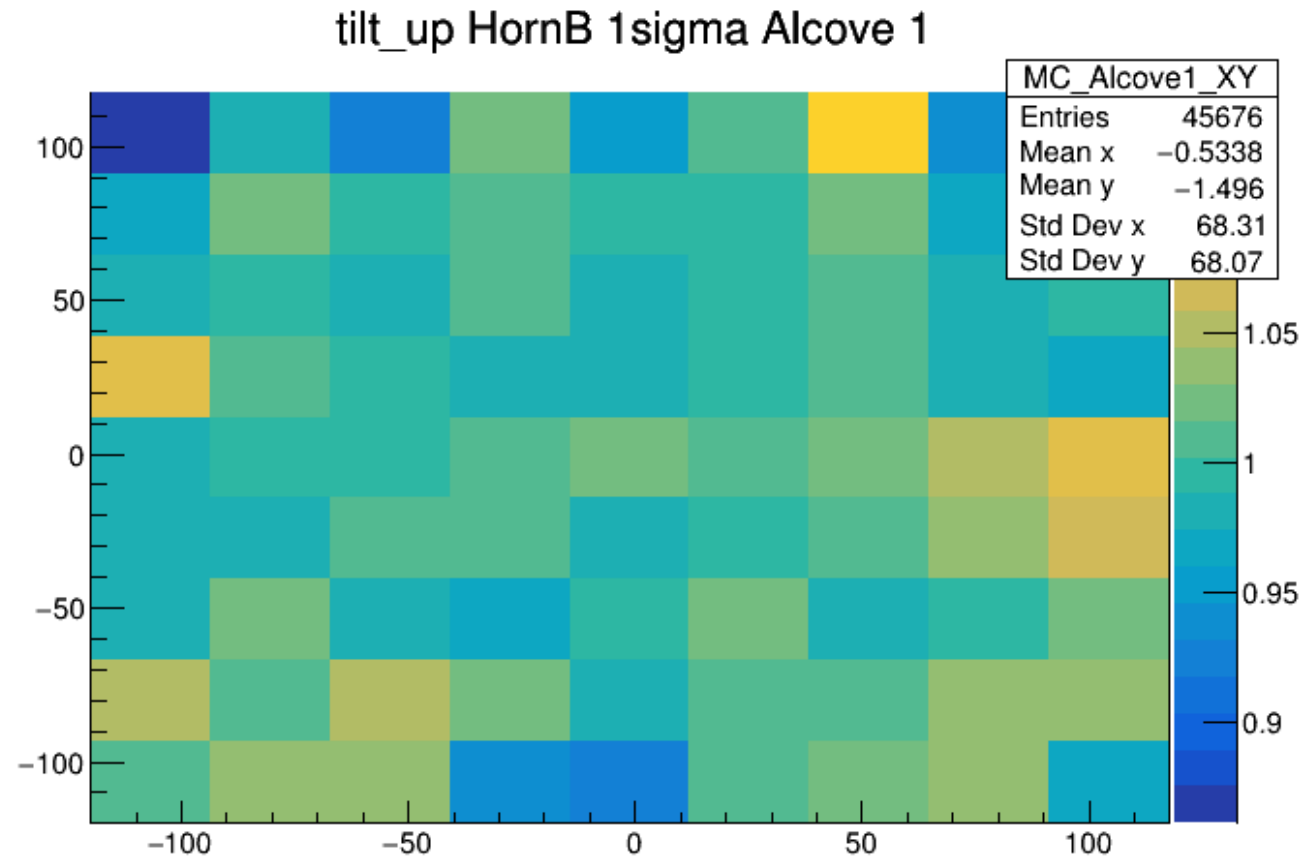
Horn B Move Right - Alcove 1



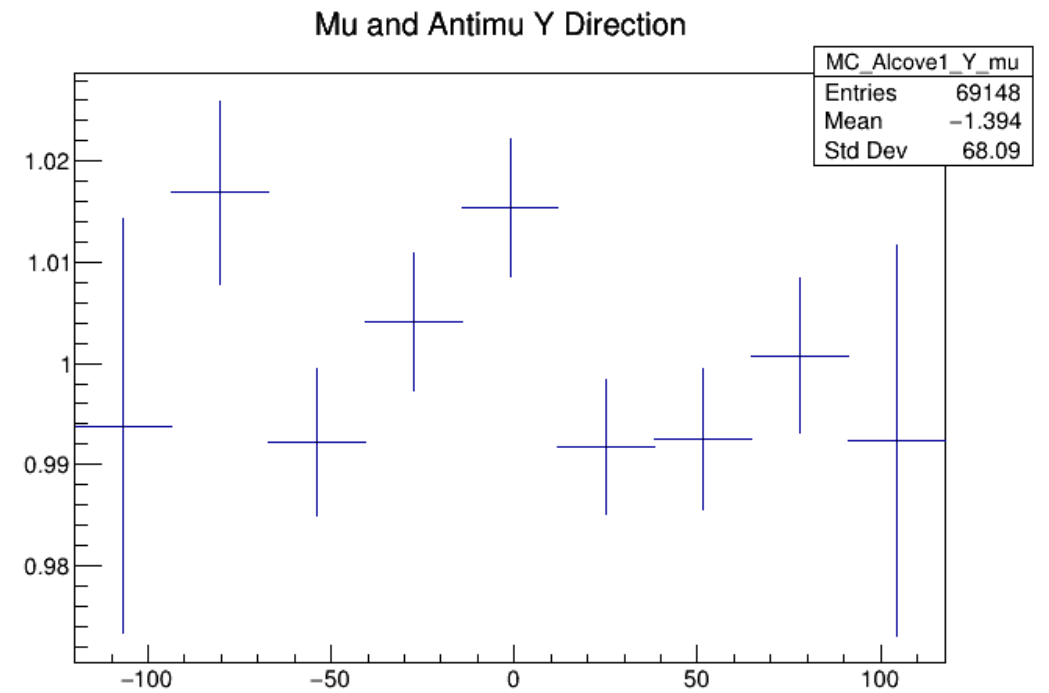
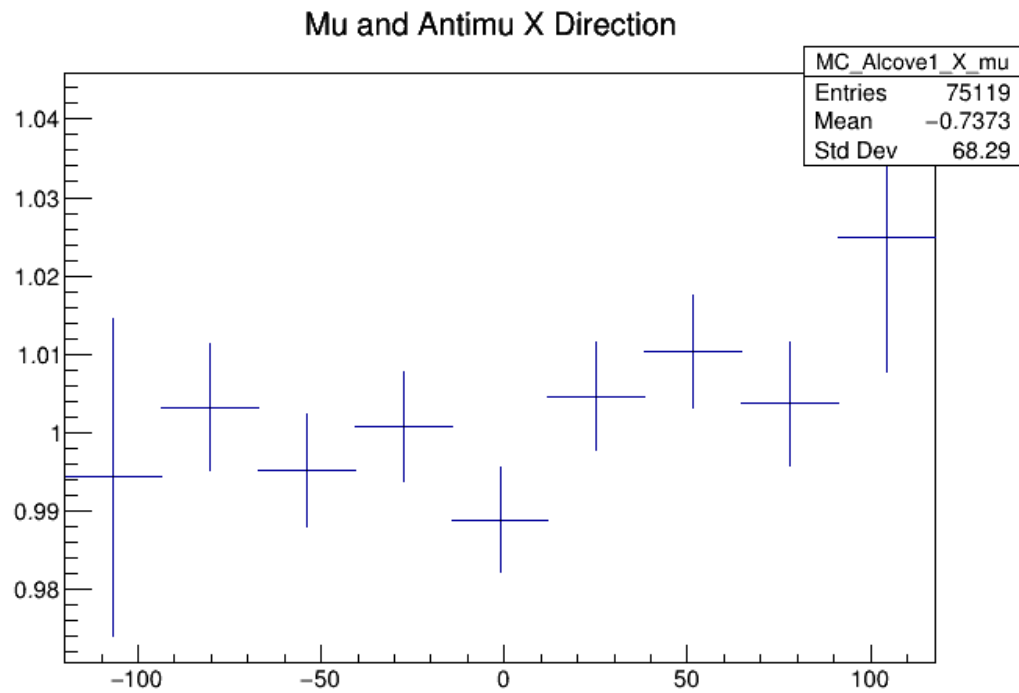
Horn B Move Left - Alcove 1



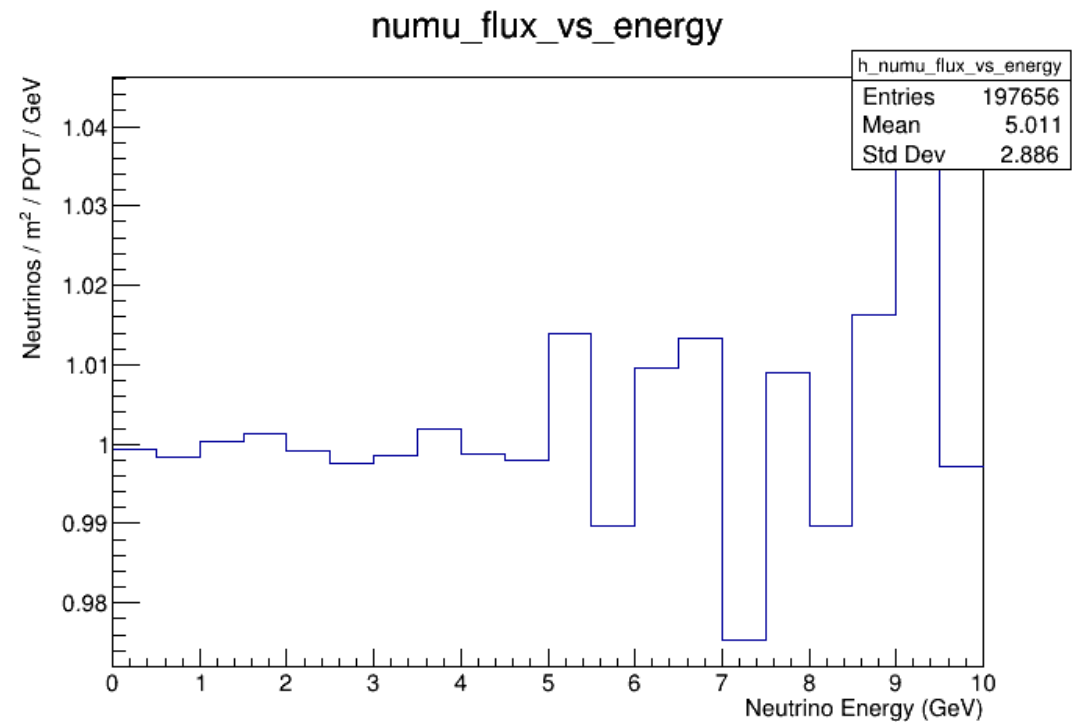
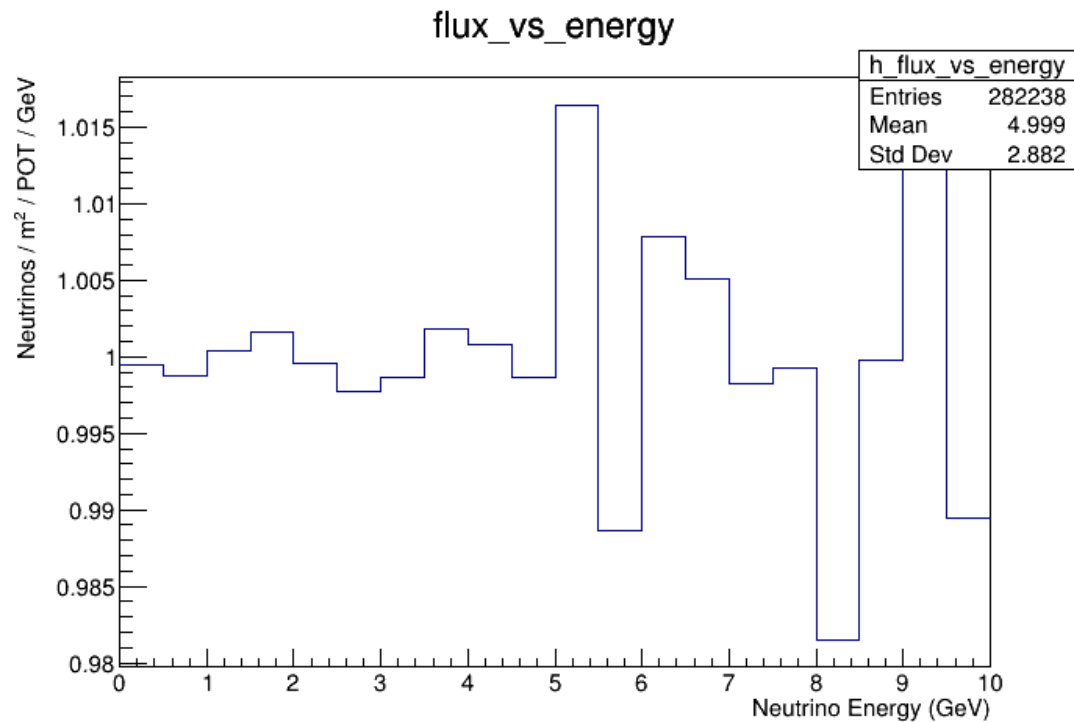
Horn B Tilt Up - Alcove 1



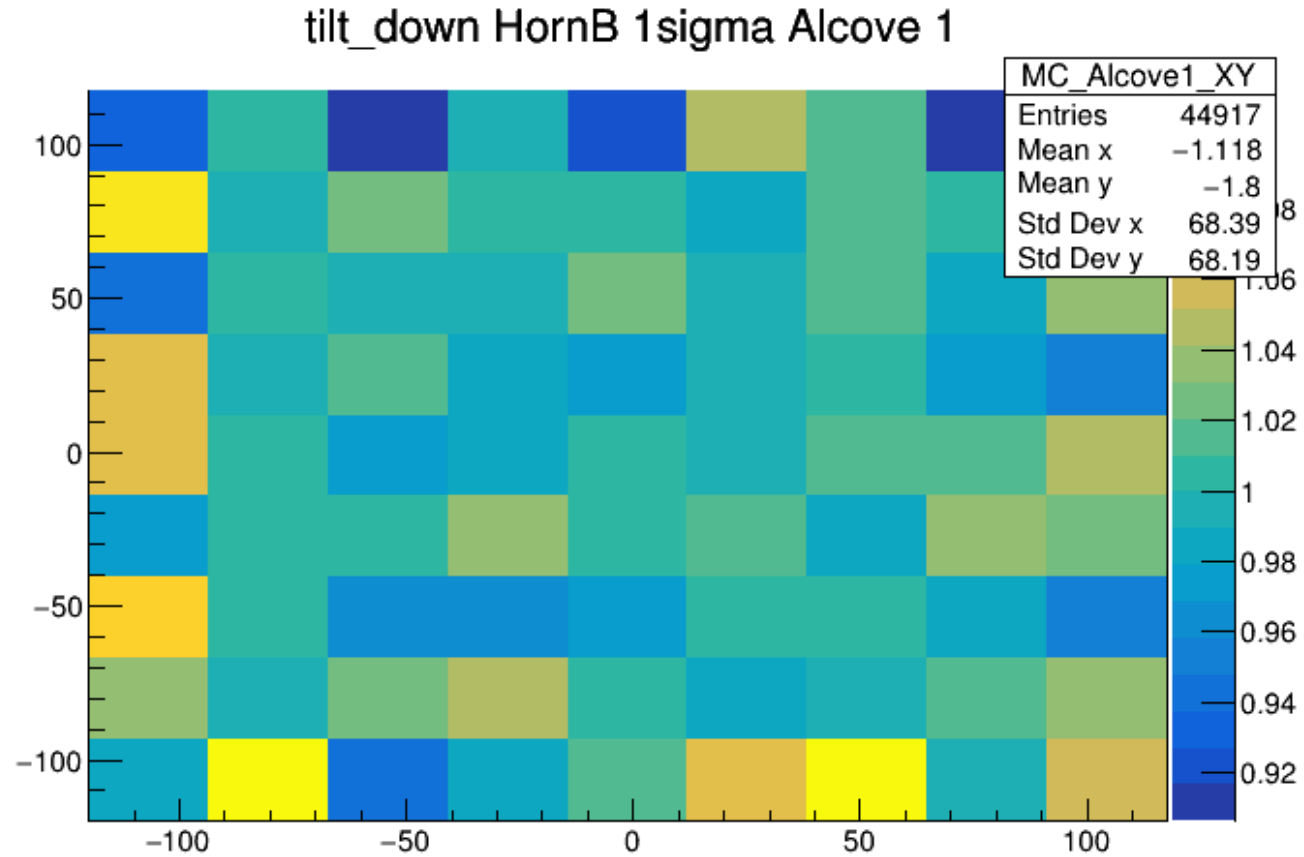
Horn B Tilt Up - Alcove 1



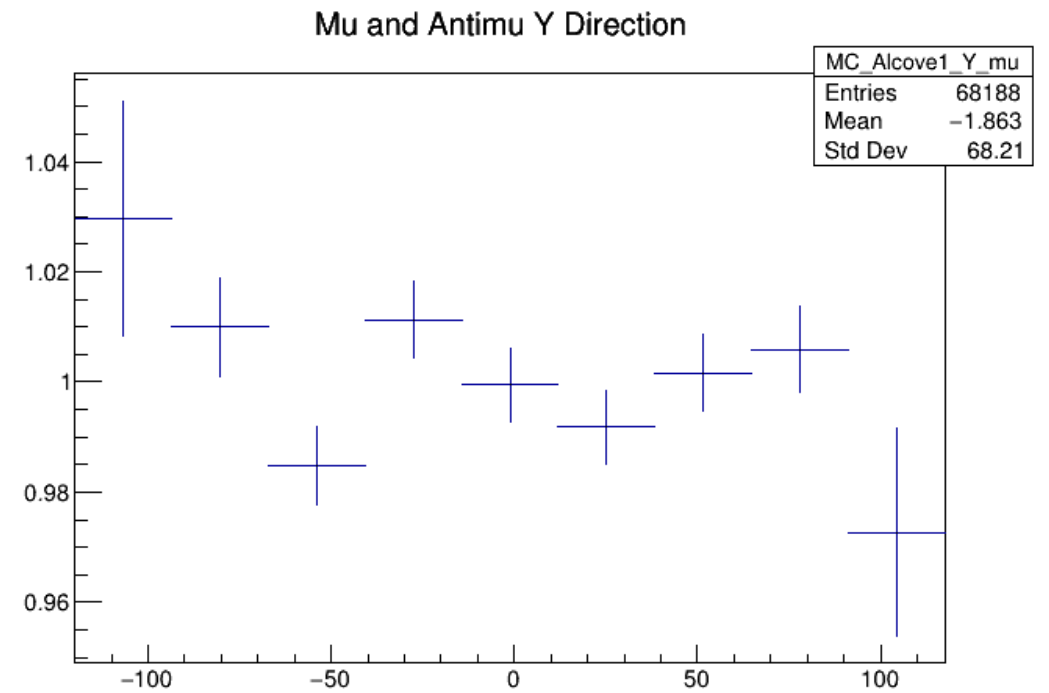
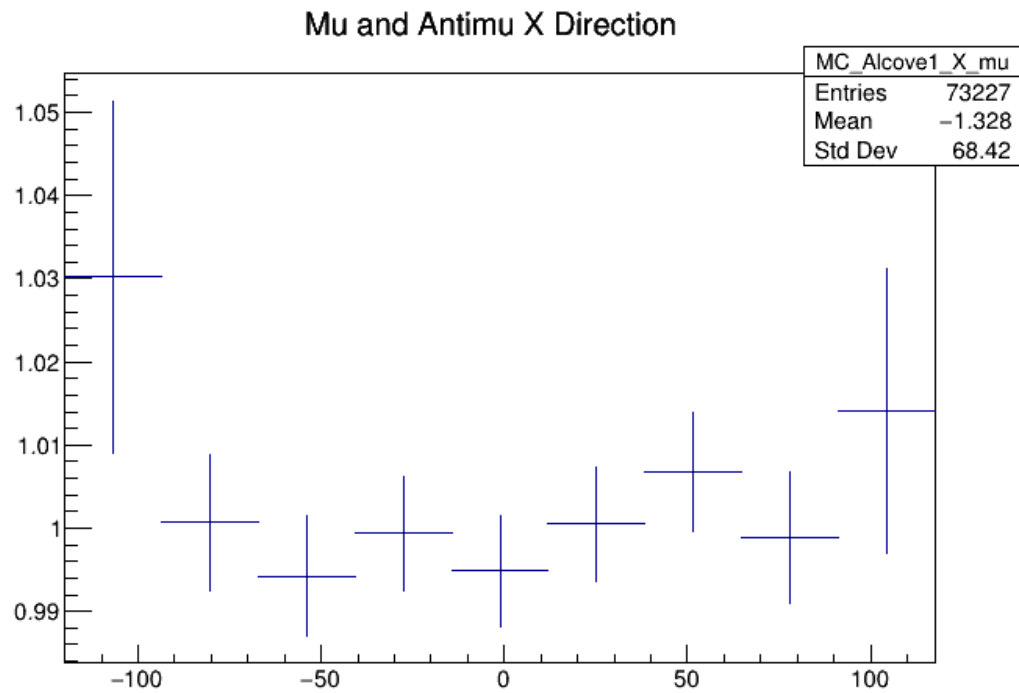
Horn B Tilt Up ν Flux at Far Detector



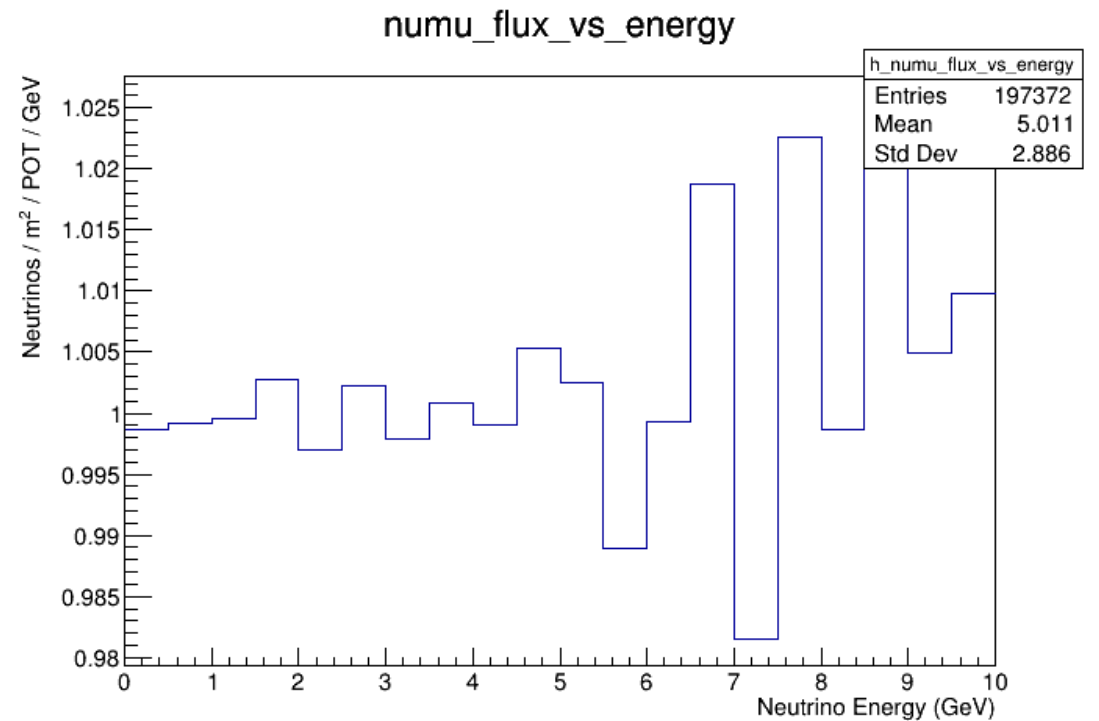
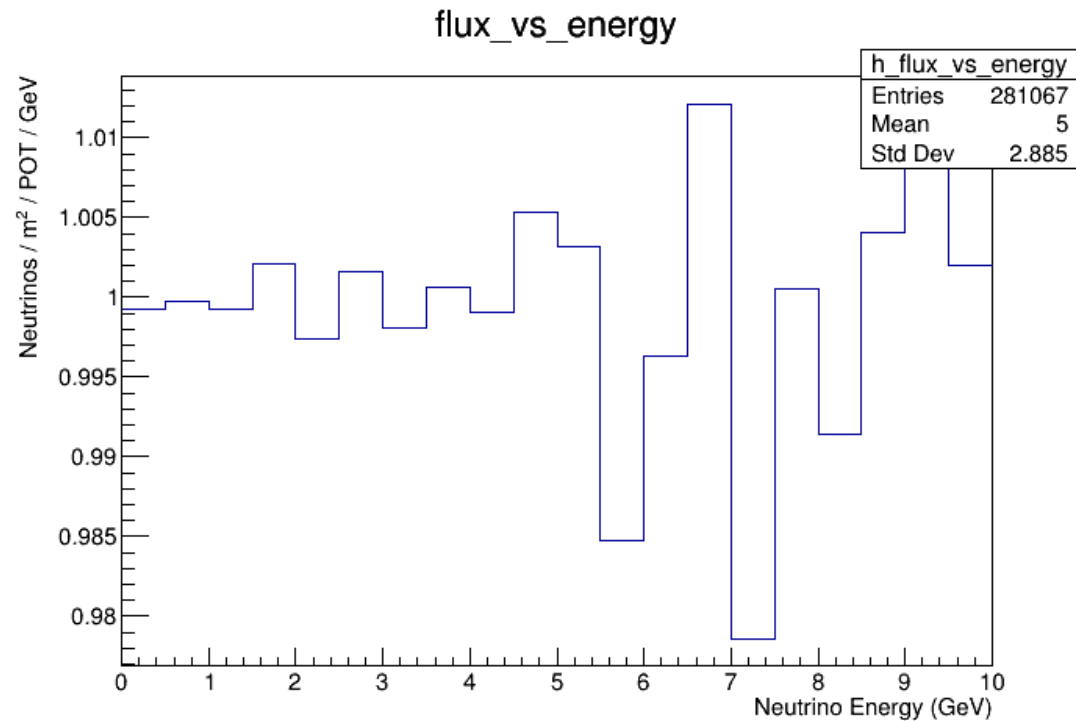
Horn B Tilt Down - Alcove 1



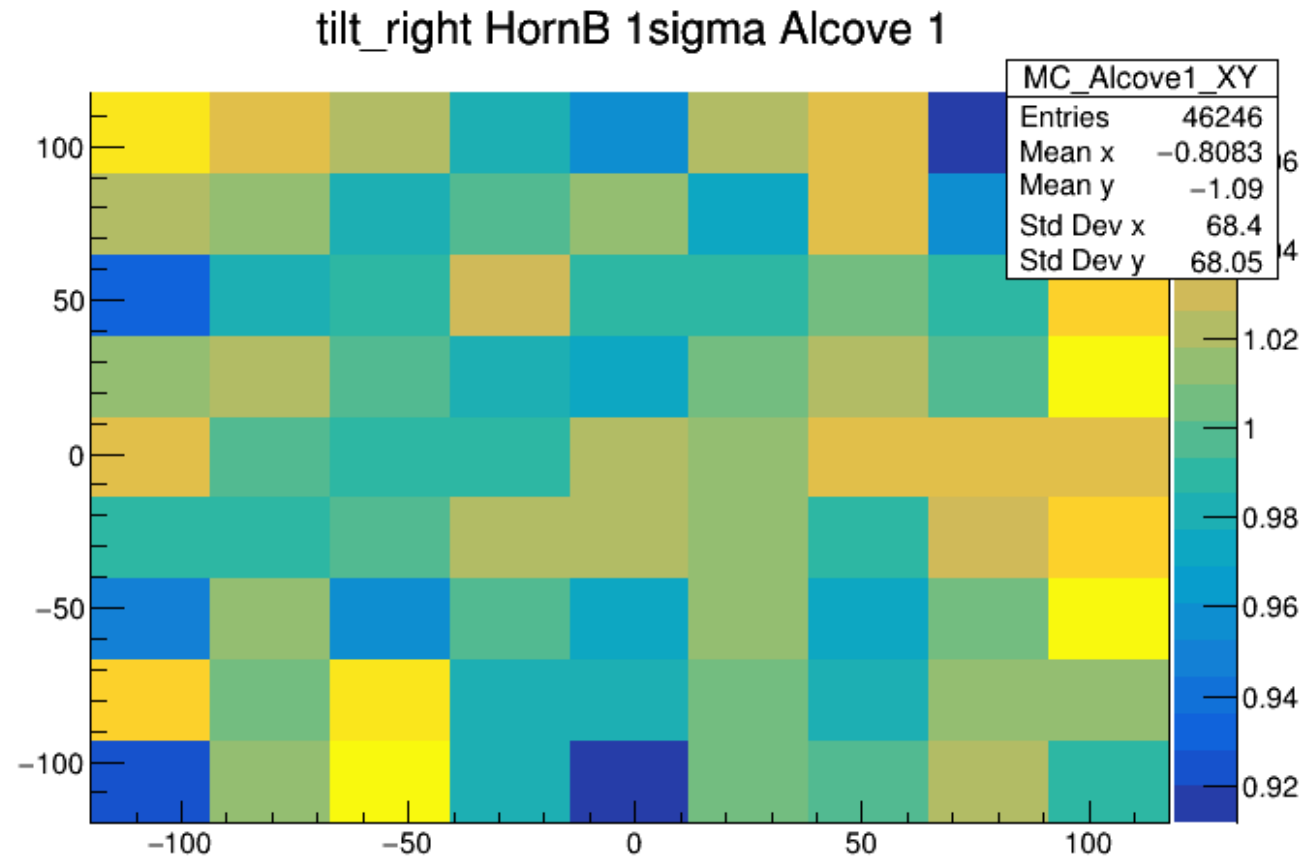
Horn B Tilt Down - Alcove 1



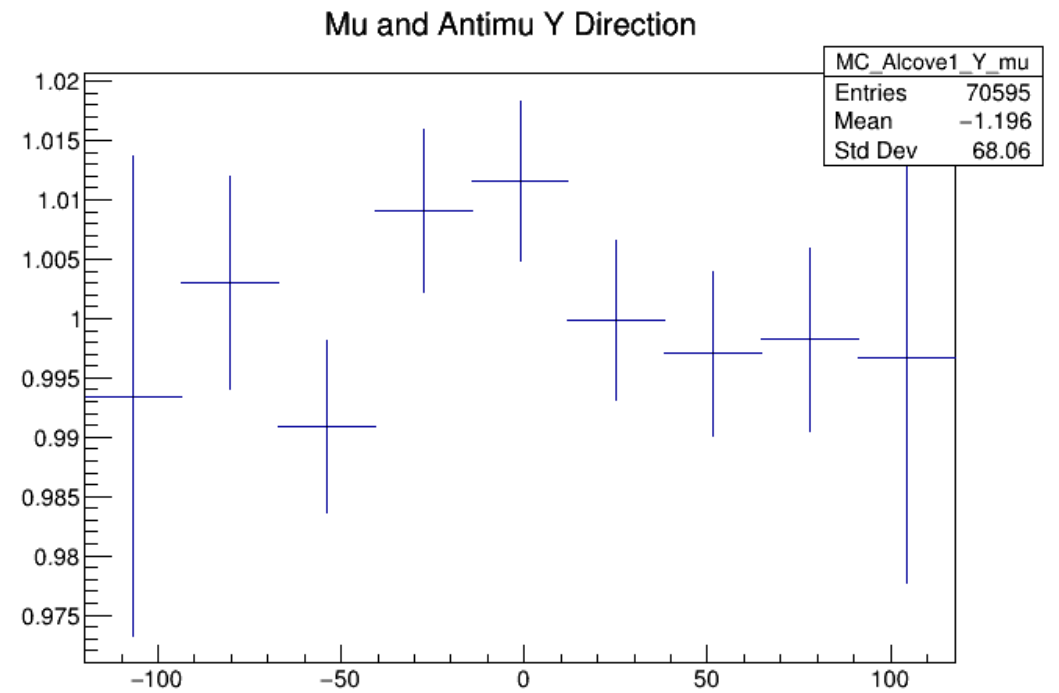
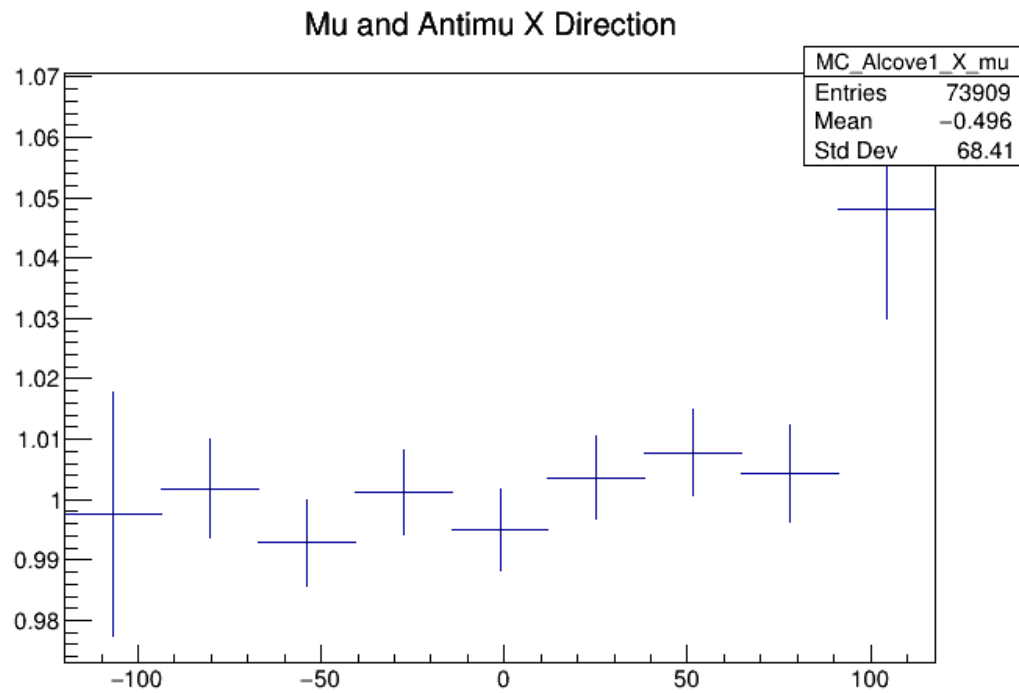
Horn B Tilt Down ν Flux at Far Detector



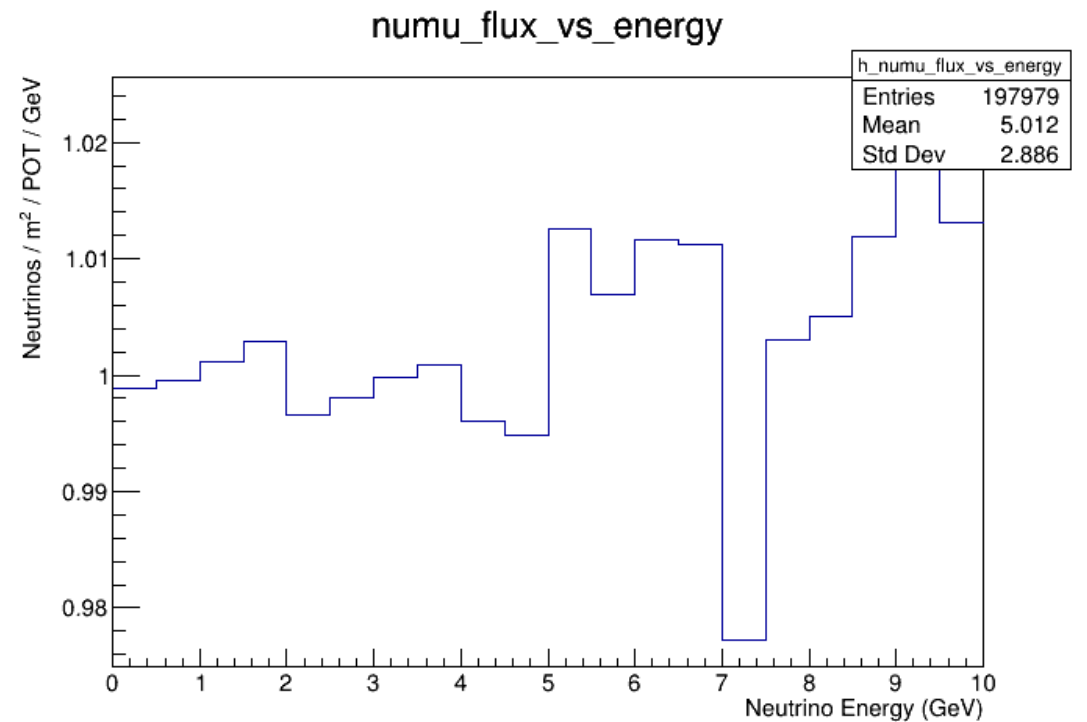
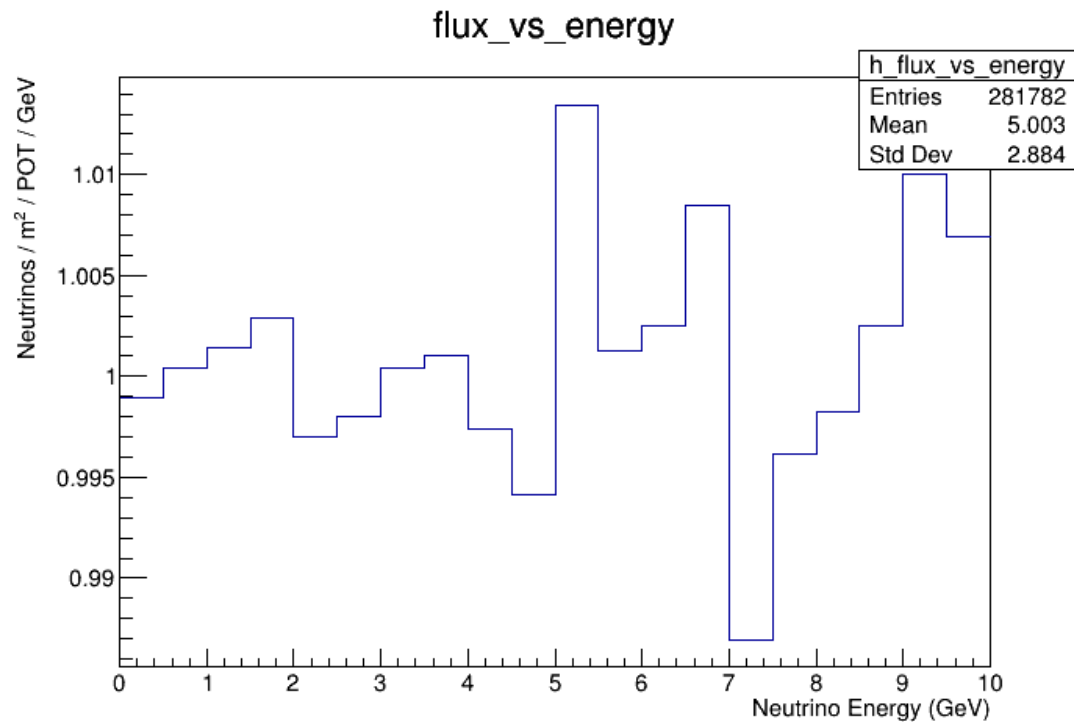
Horn B Tilt Right - Alcove 1



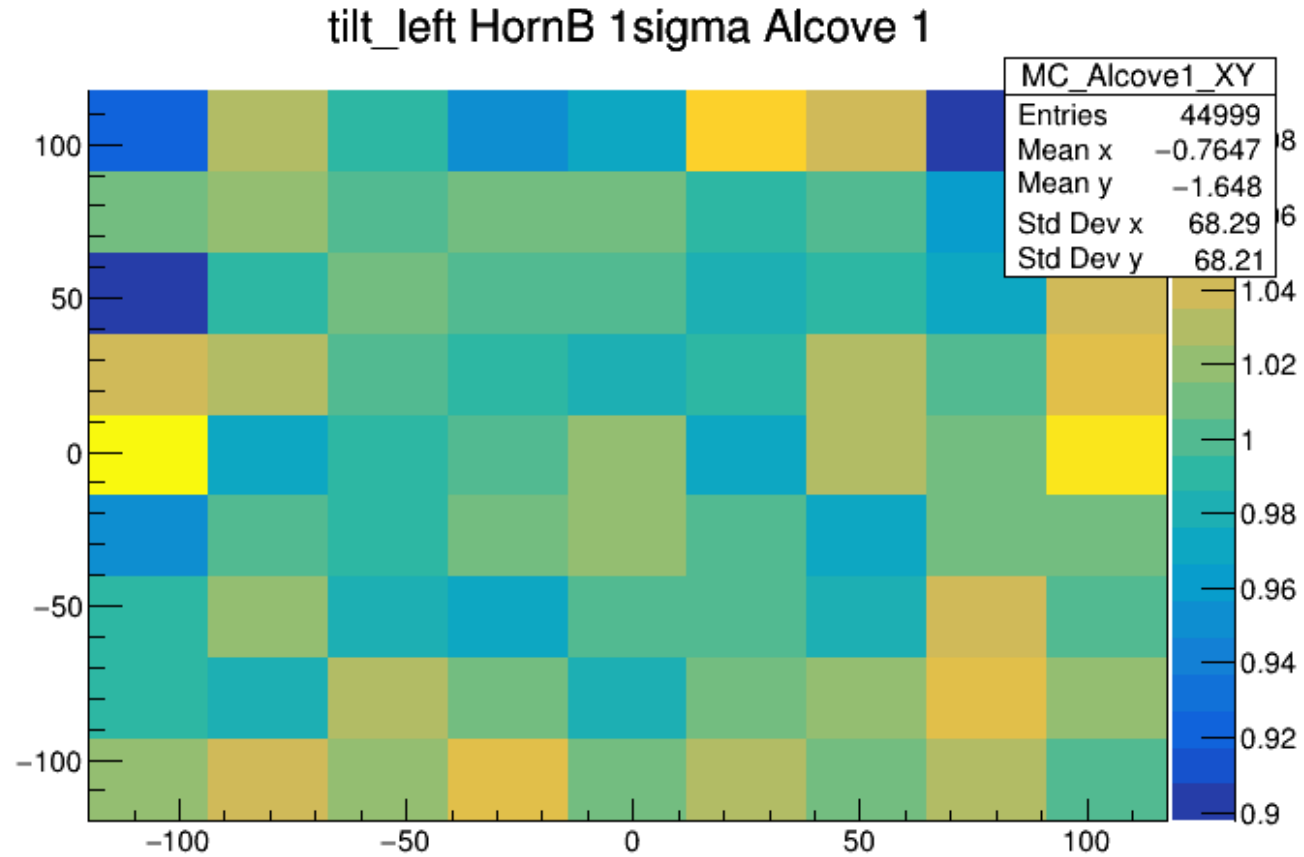
Horn B Tilt Right - Alcove 1



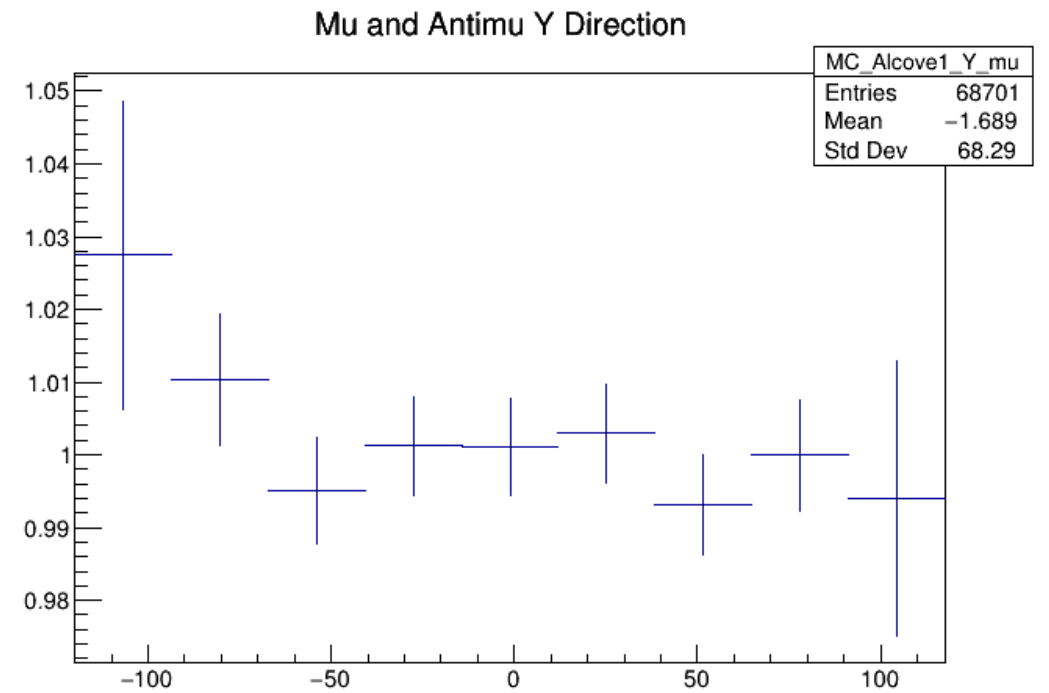
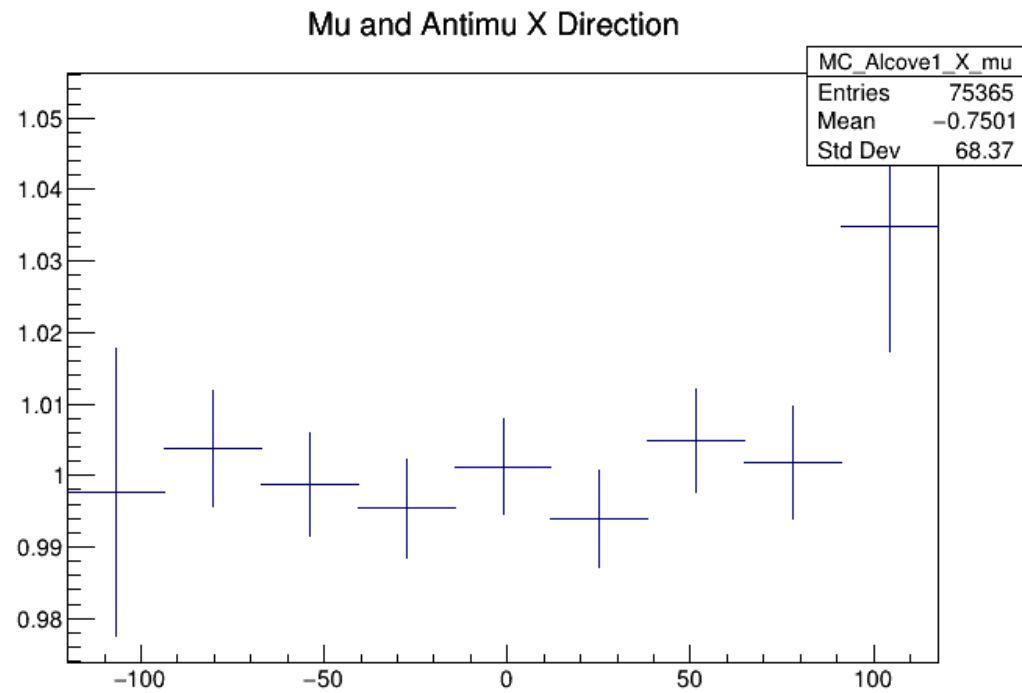
Horn B Tilt Right ν Flux at Far Detector



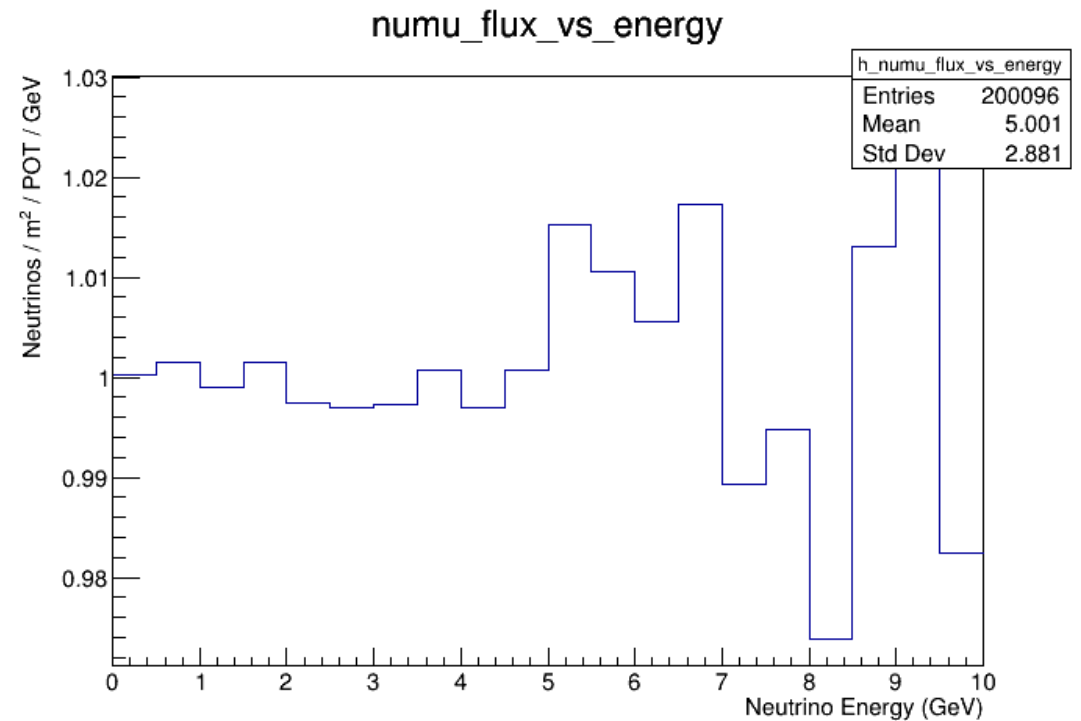
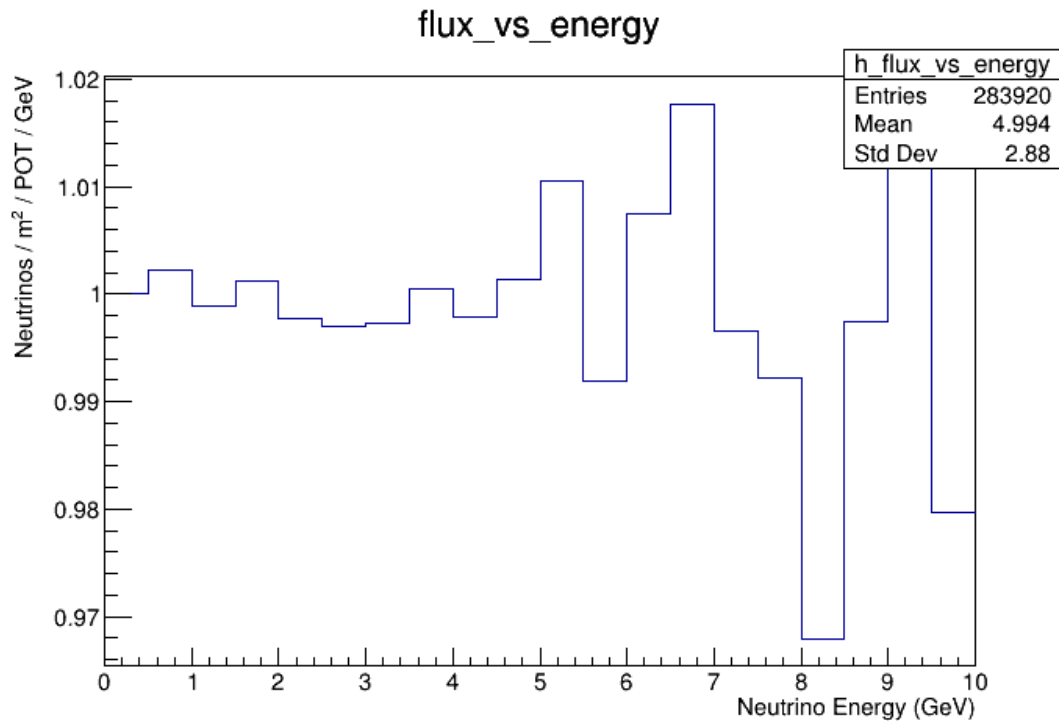
Horn B Tilt Left - Alcove 1



Horn B Tilt Left - Alcove 1

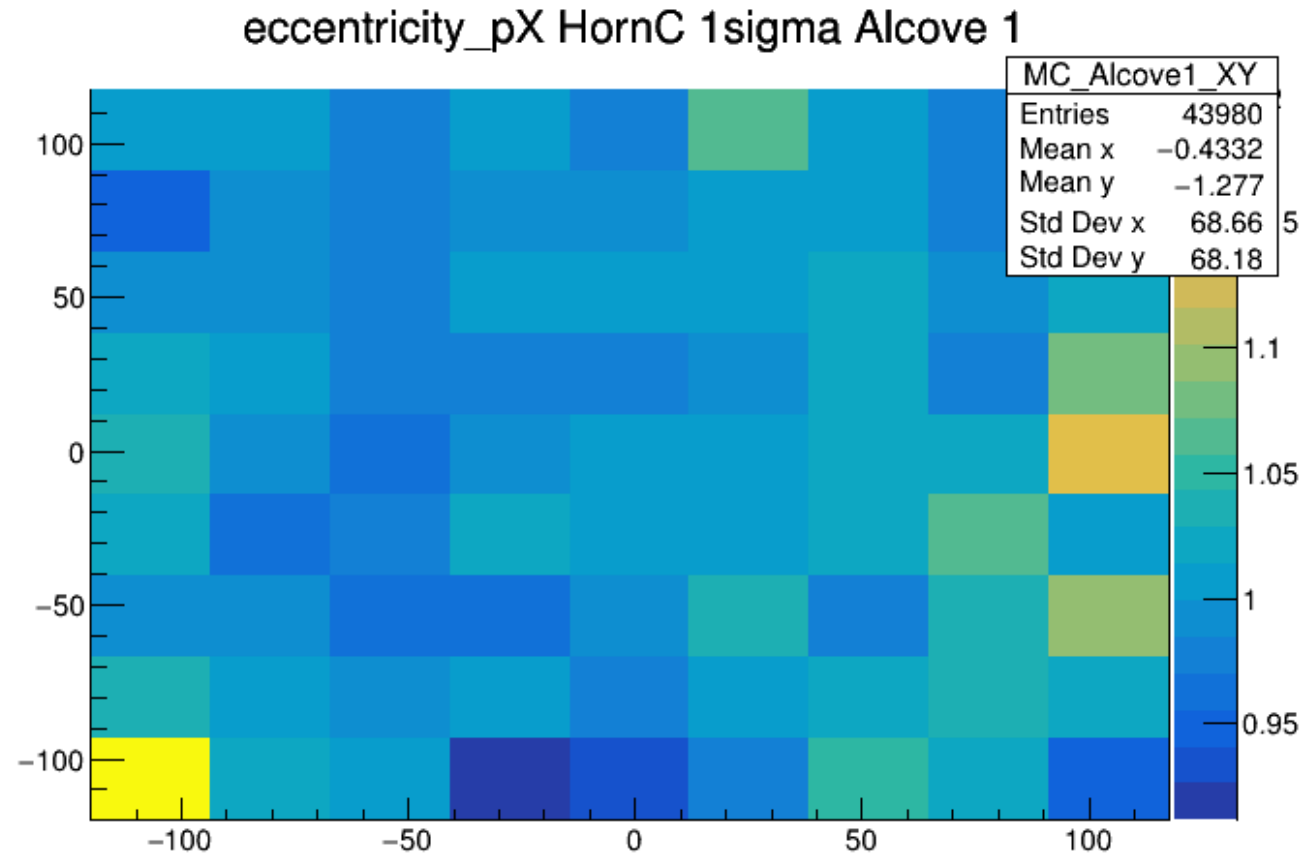


Horn B Tilt Left ν Flux at Far Detector

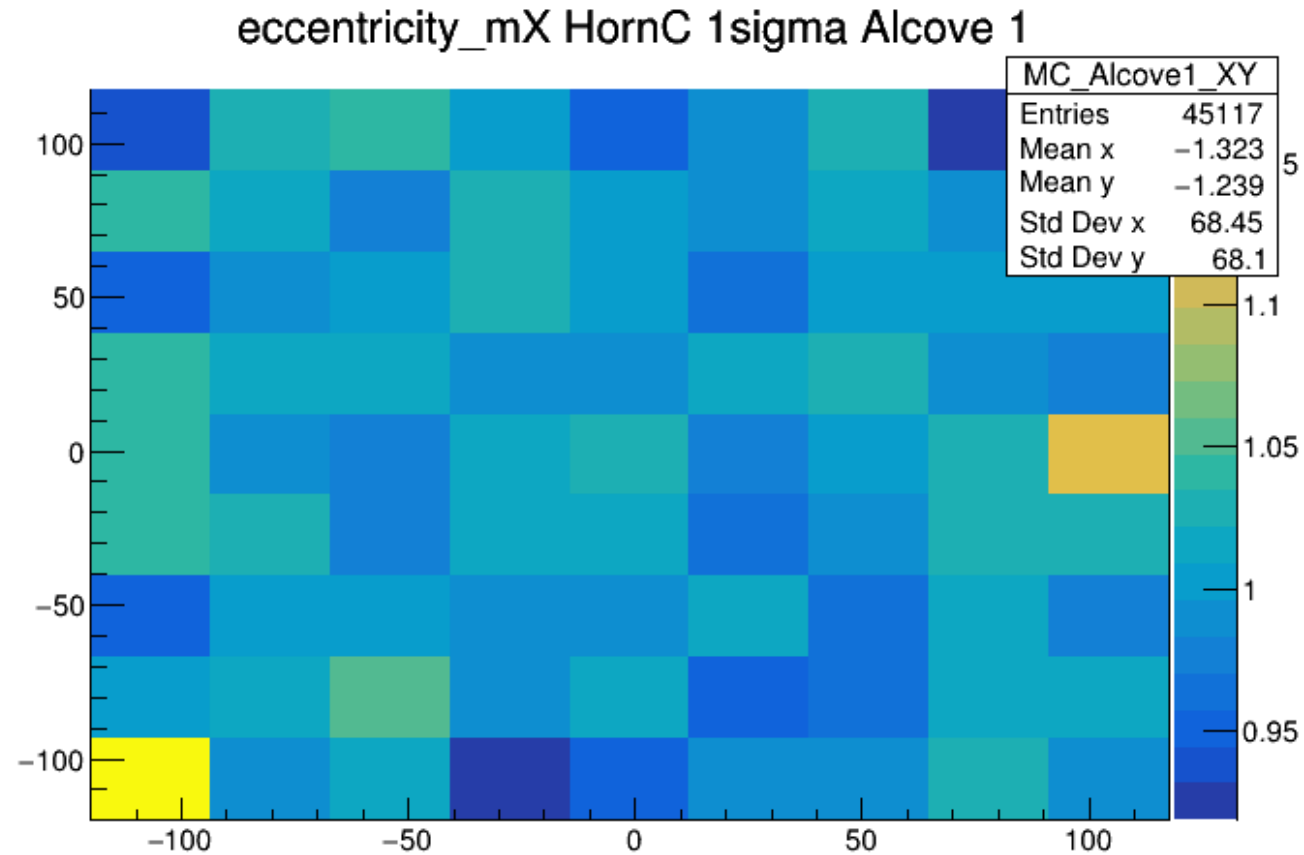


Horn C

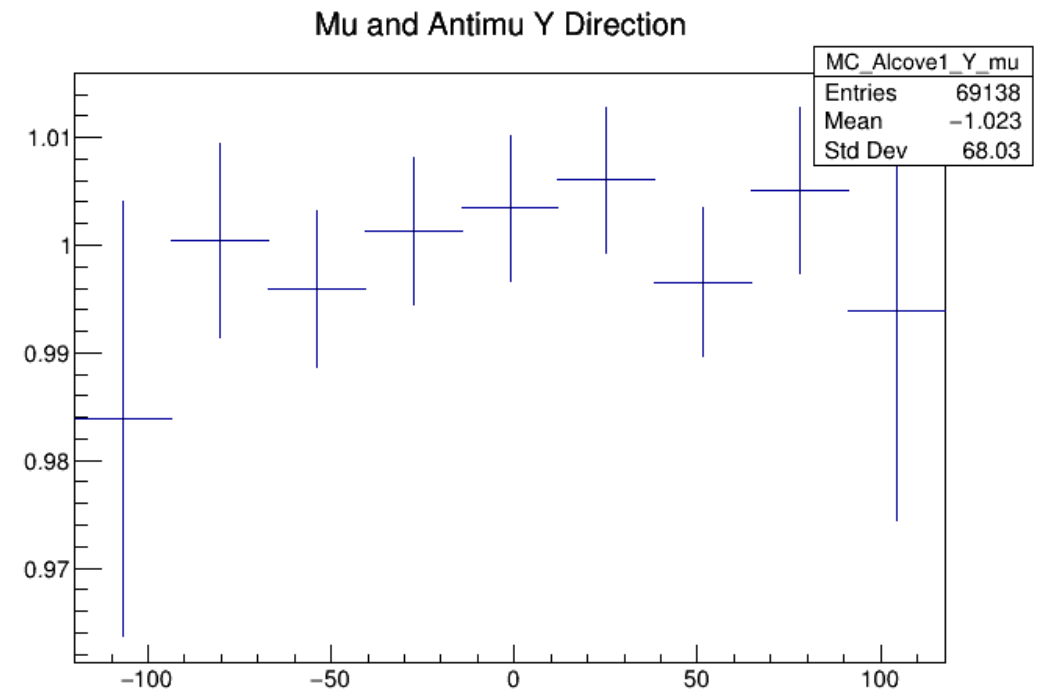
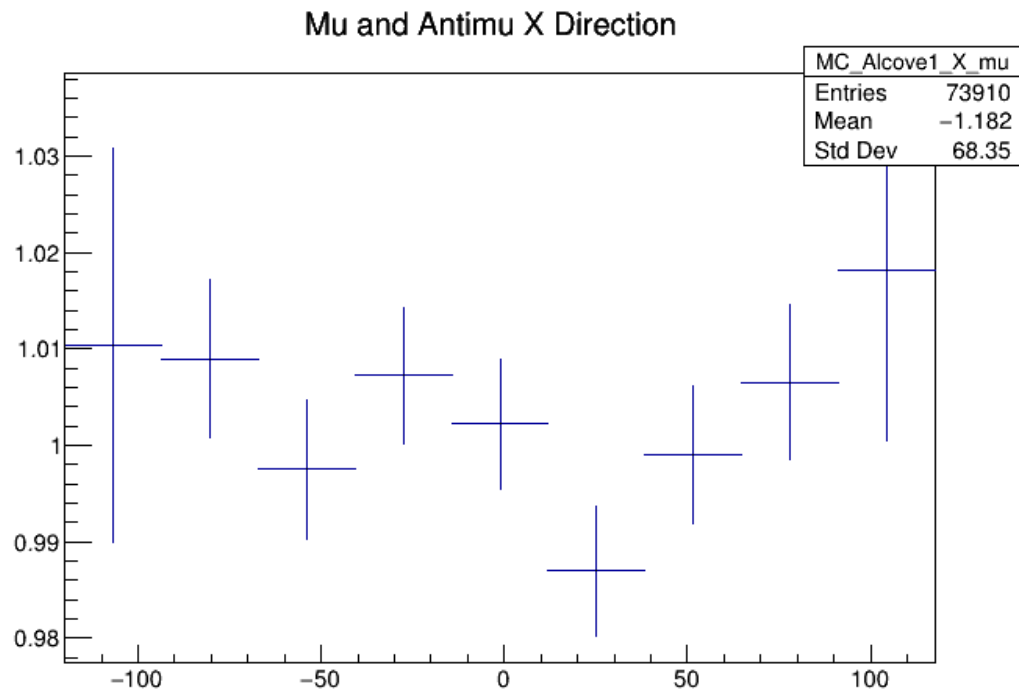
Horn C Eccentricity pX – Alcove 1



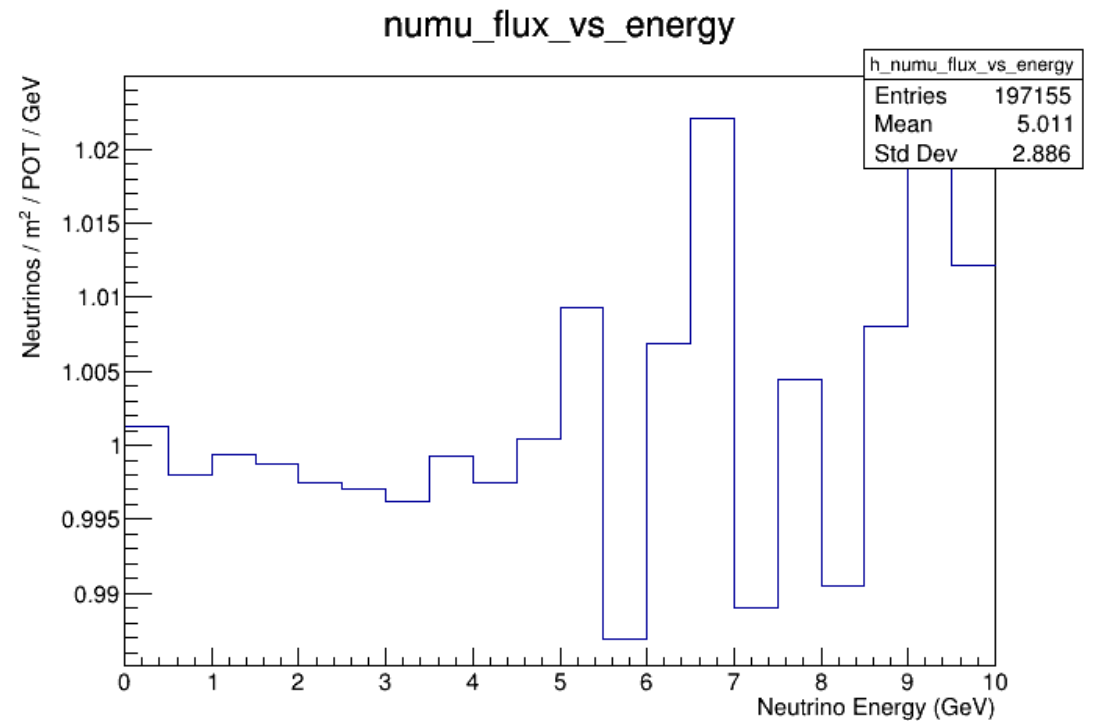
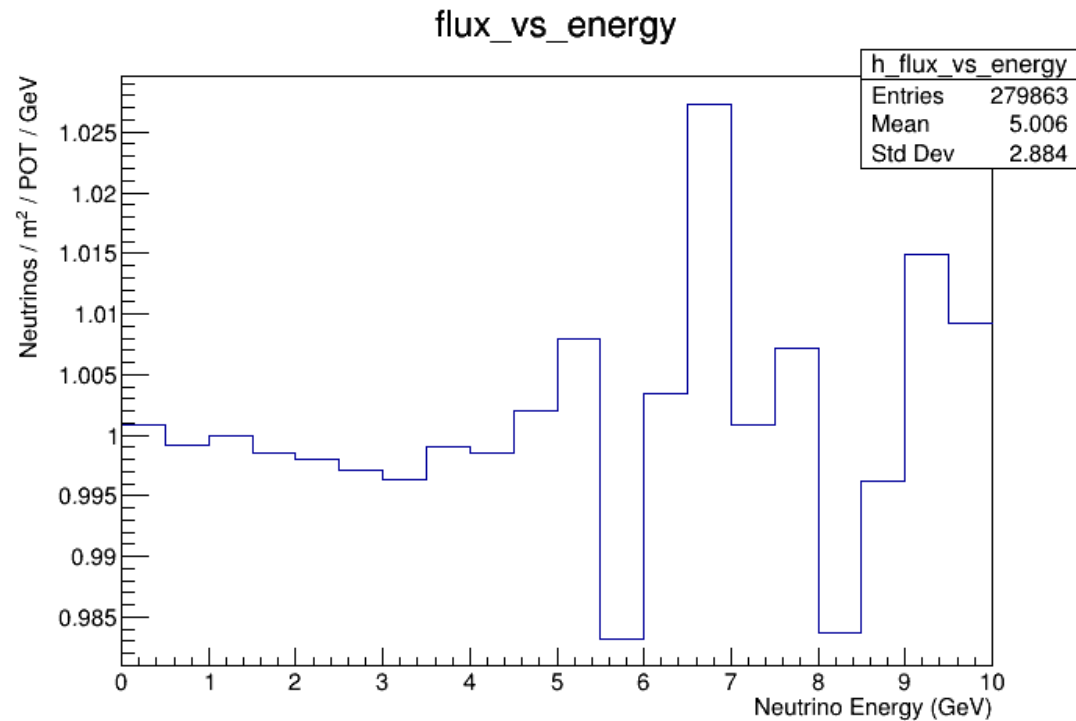
Horn C Eccentricity mX – Alcove 1



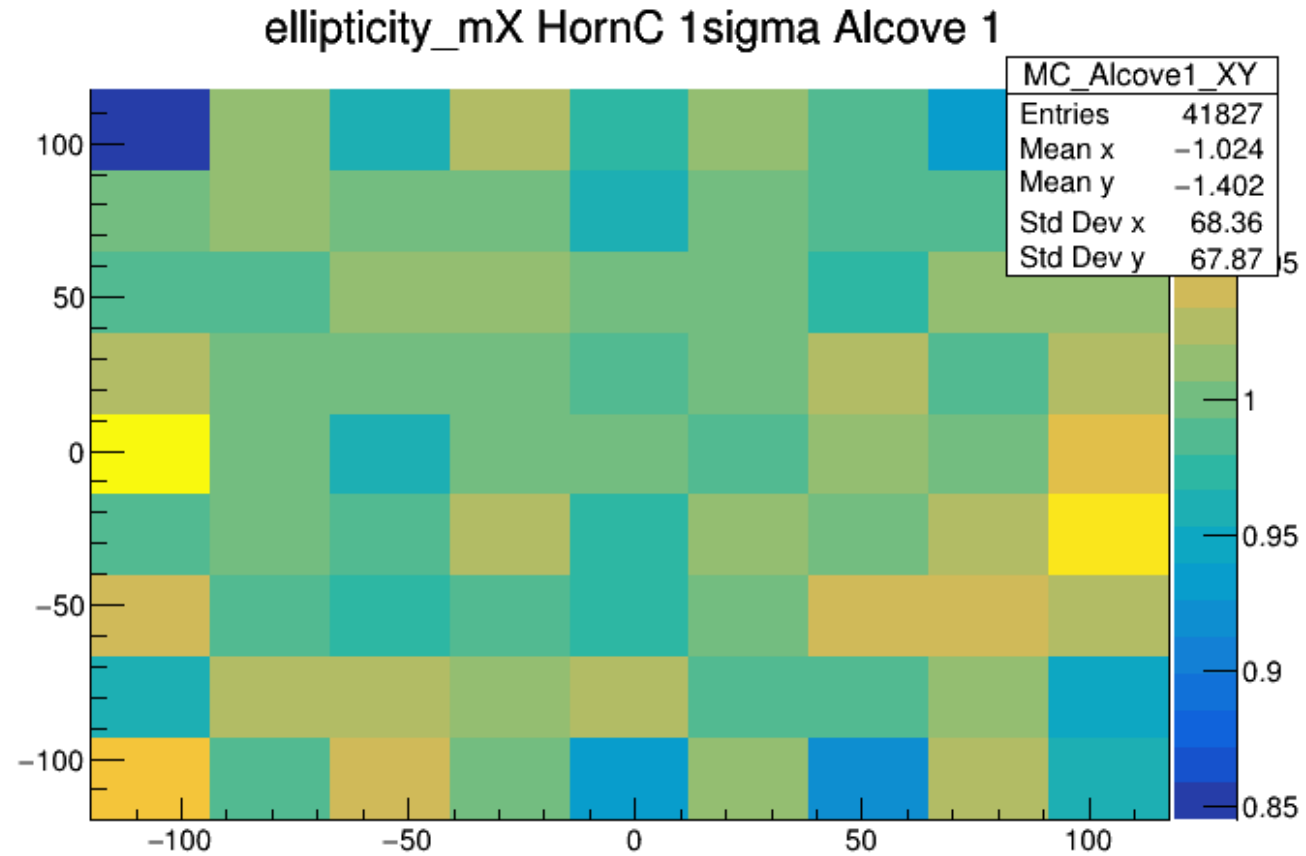
Horn C Eccentricity mX – Alcove 1



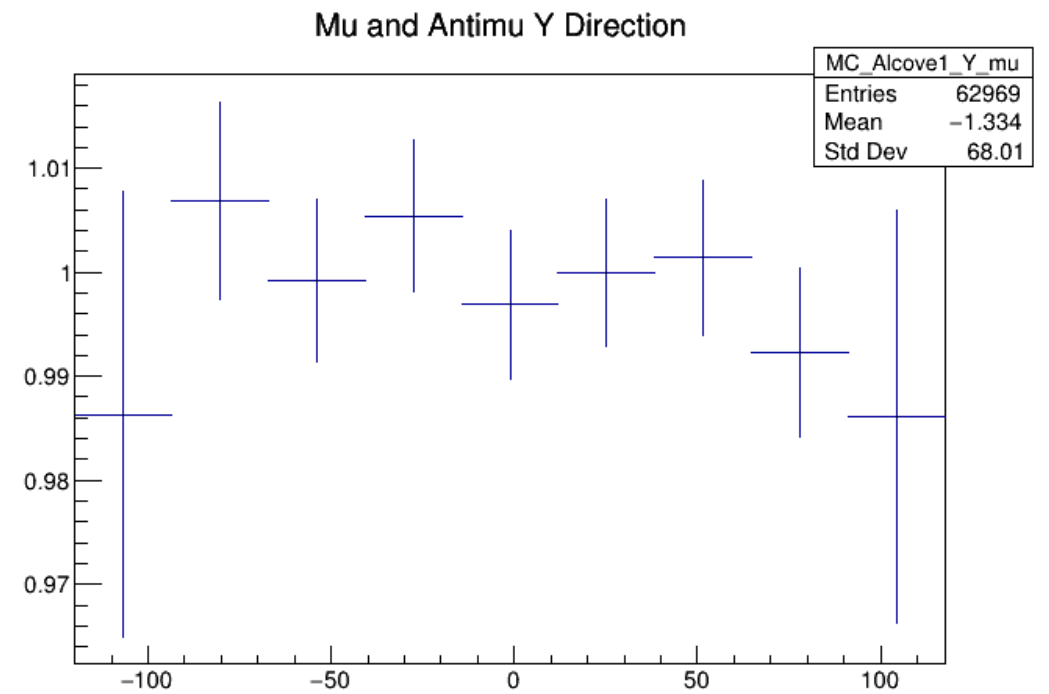
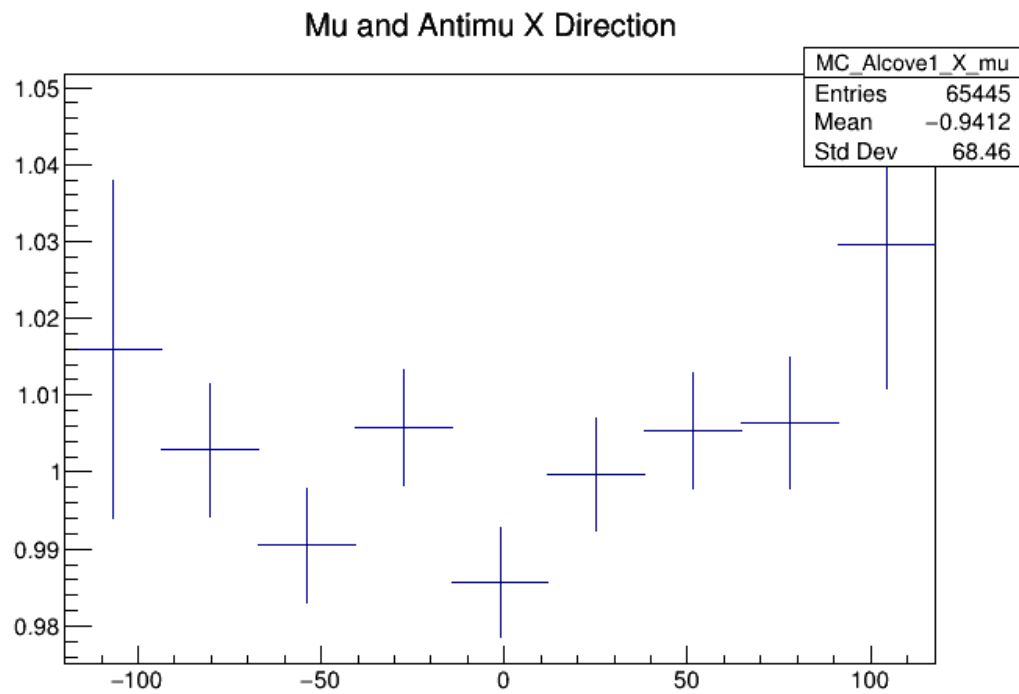
Horn C Eccentricity mX v Flux at Far Detector



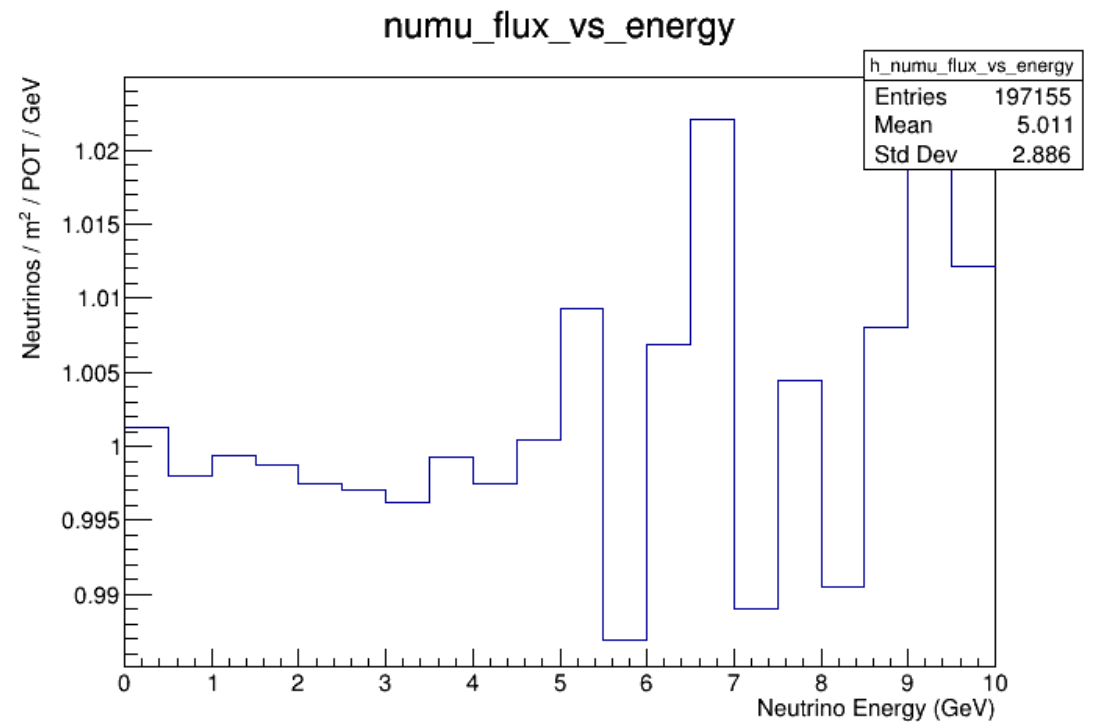
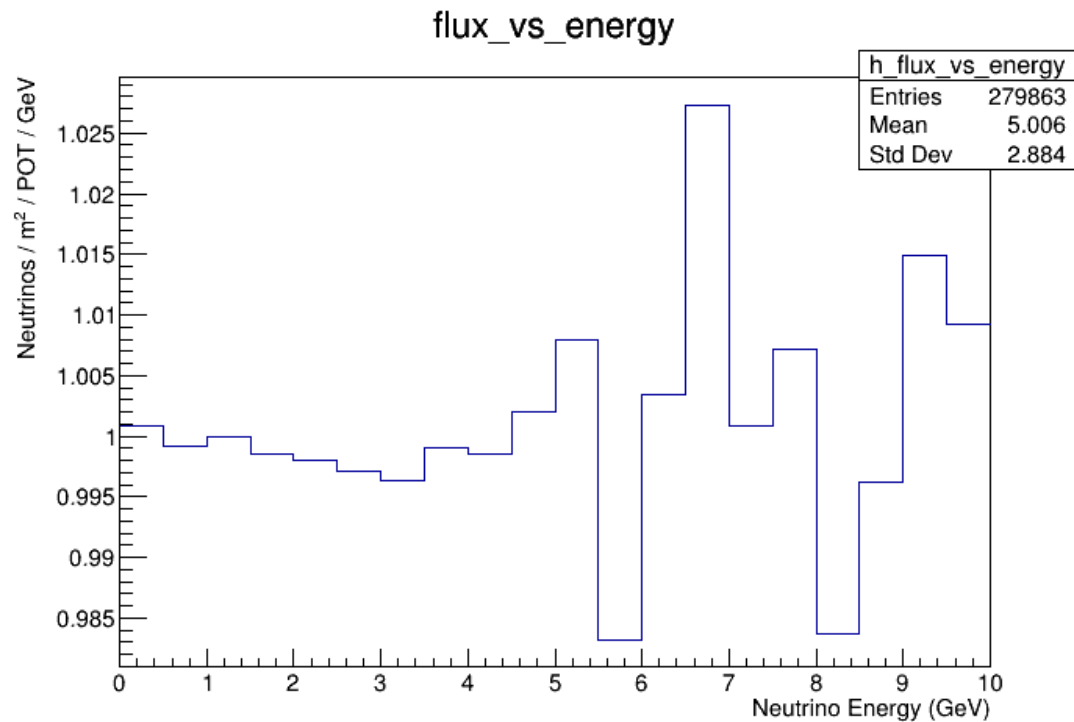
Horn C Ellipticity mX – Alcove 1



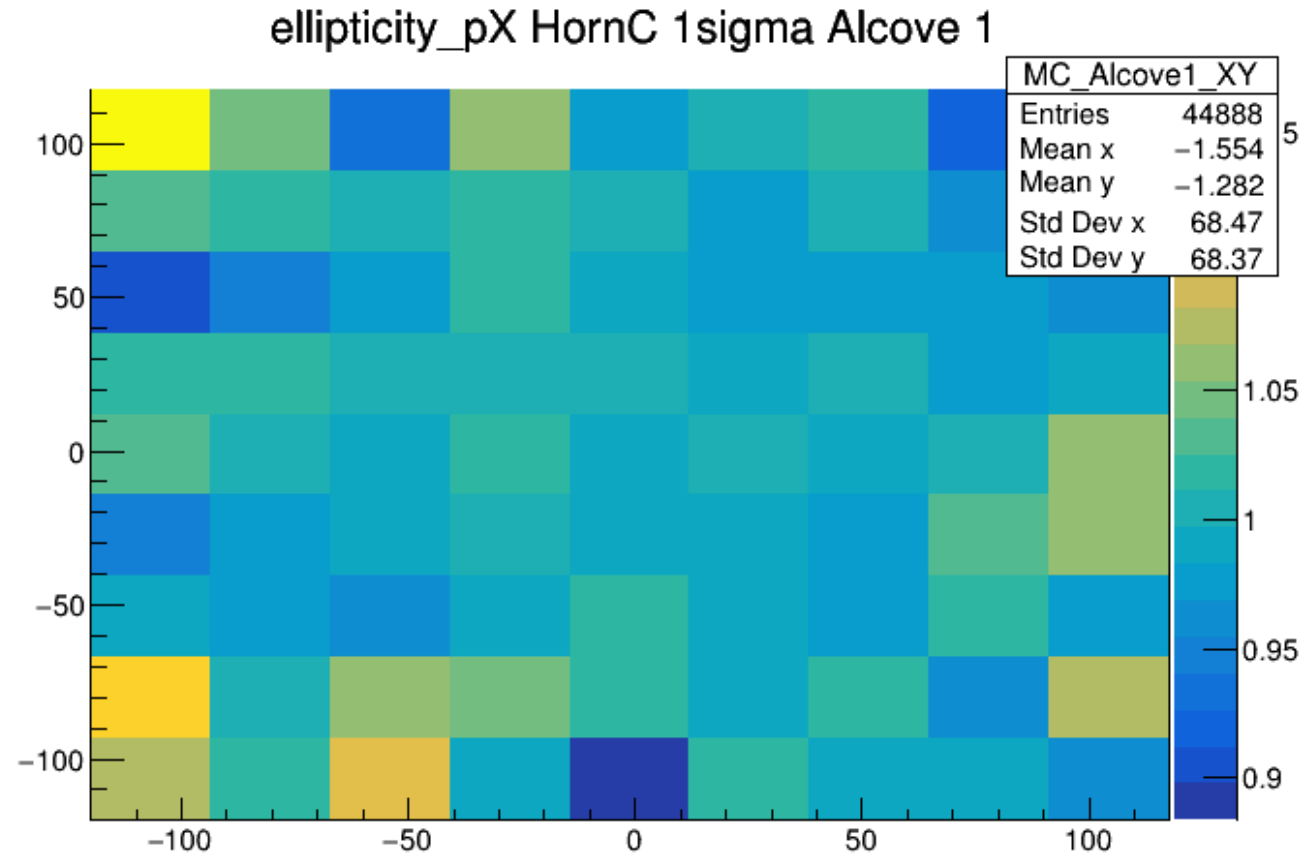
Horn C Ellipticity mX – Alcove 1



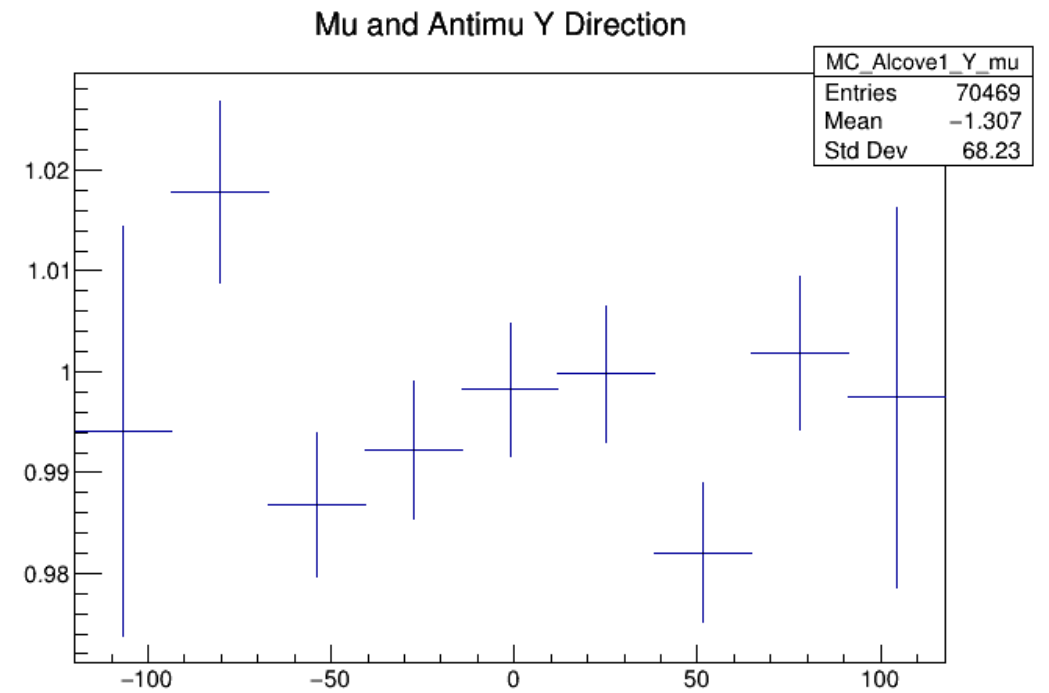
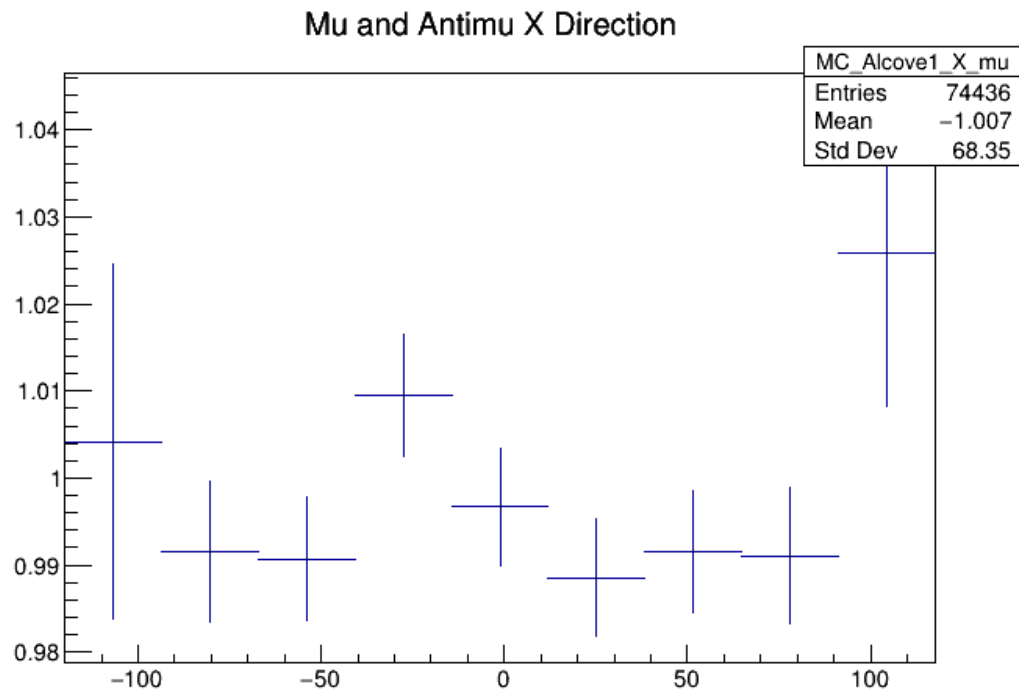
Horn C Ellipticity mX v Flux at Far Detector



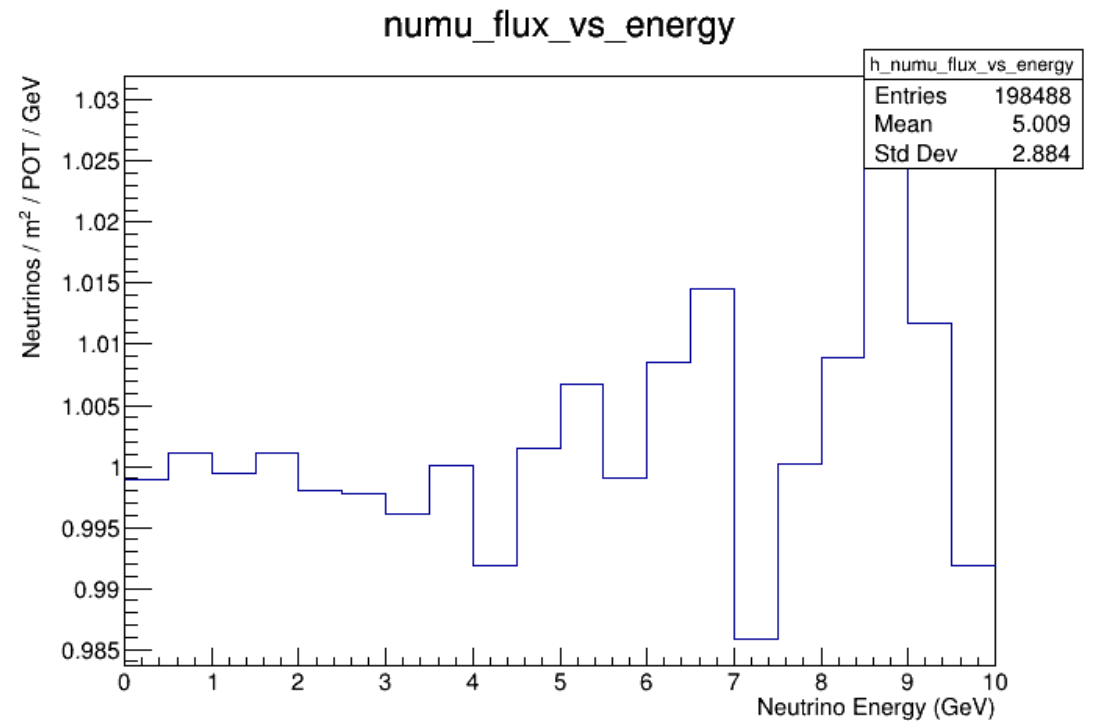
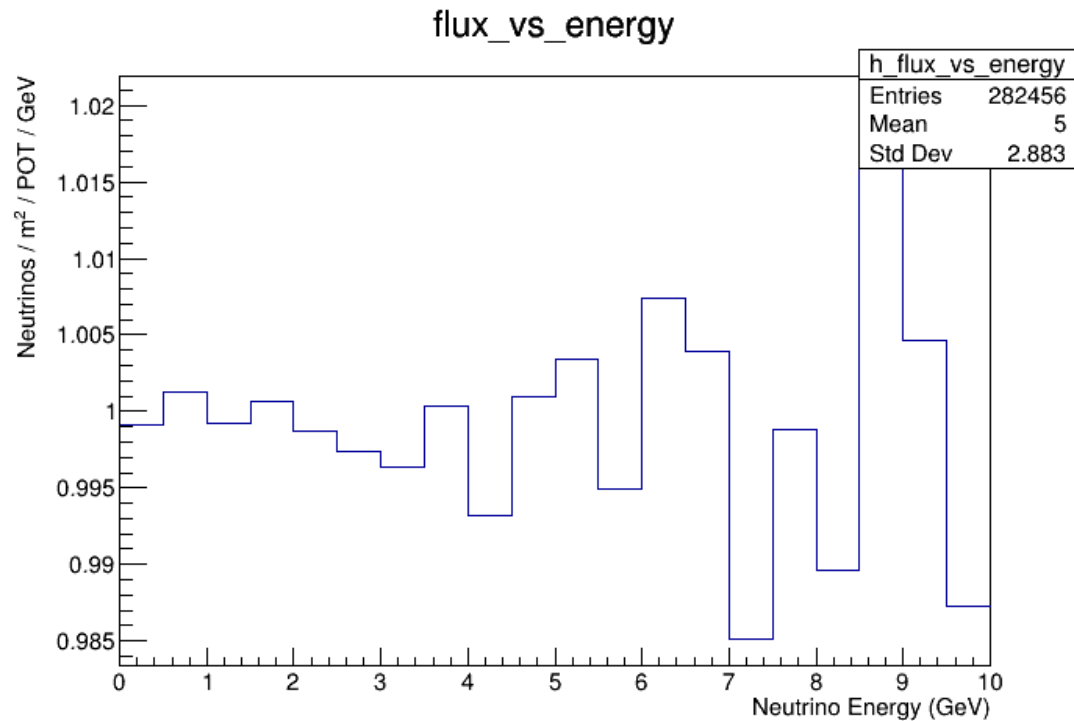
Horn C Ellipticity pX – Alcove 1



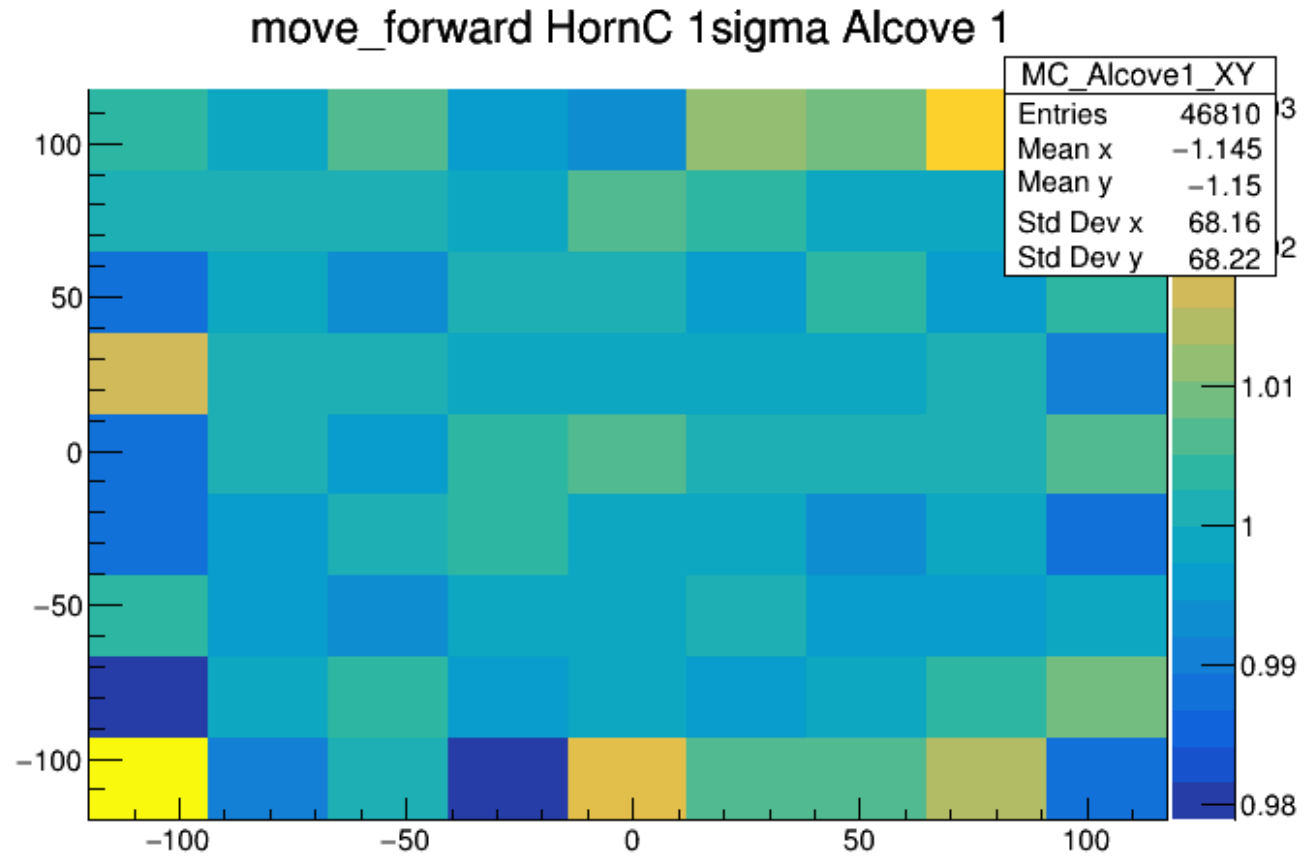
Horn C Ellipticity pX – Alcove 1



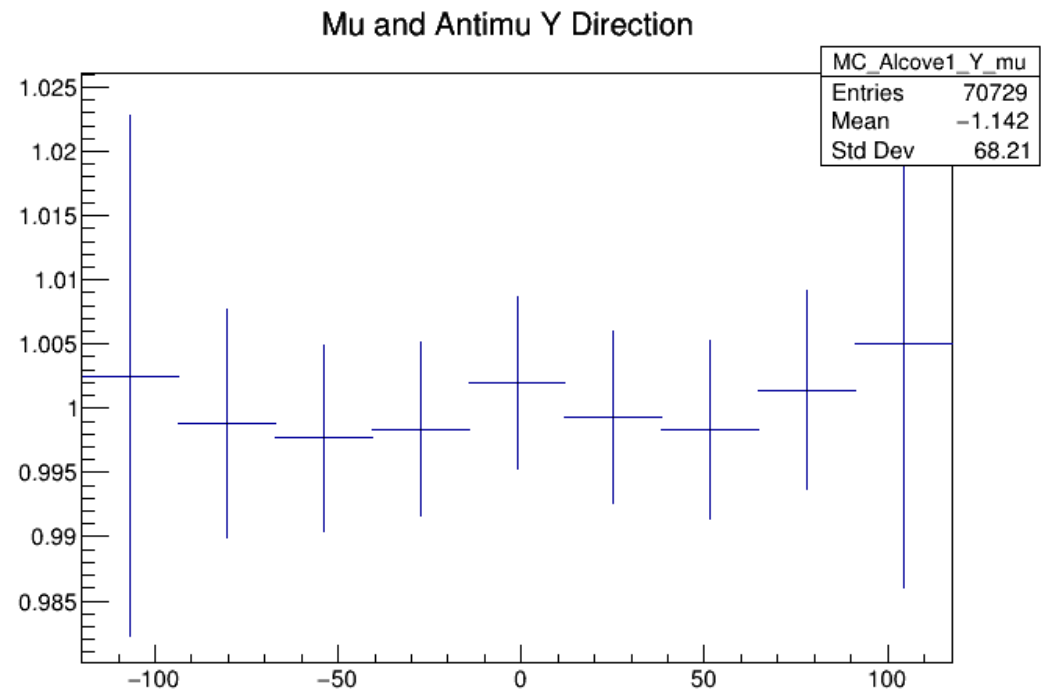
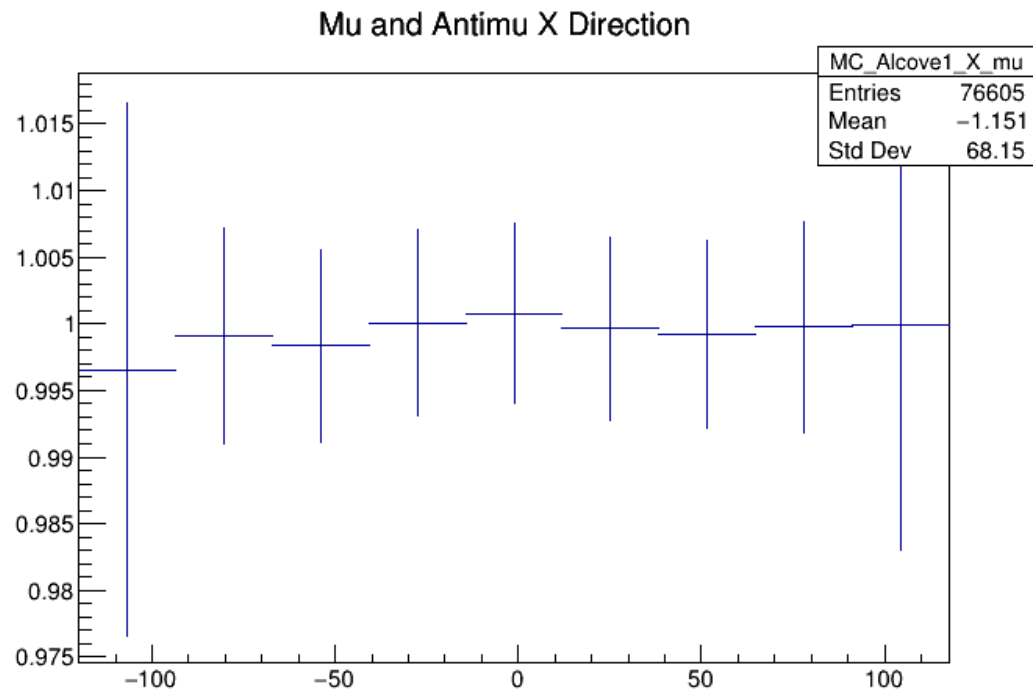
Horn C Ellipticity pX v Flux at Far Detector



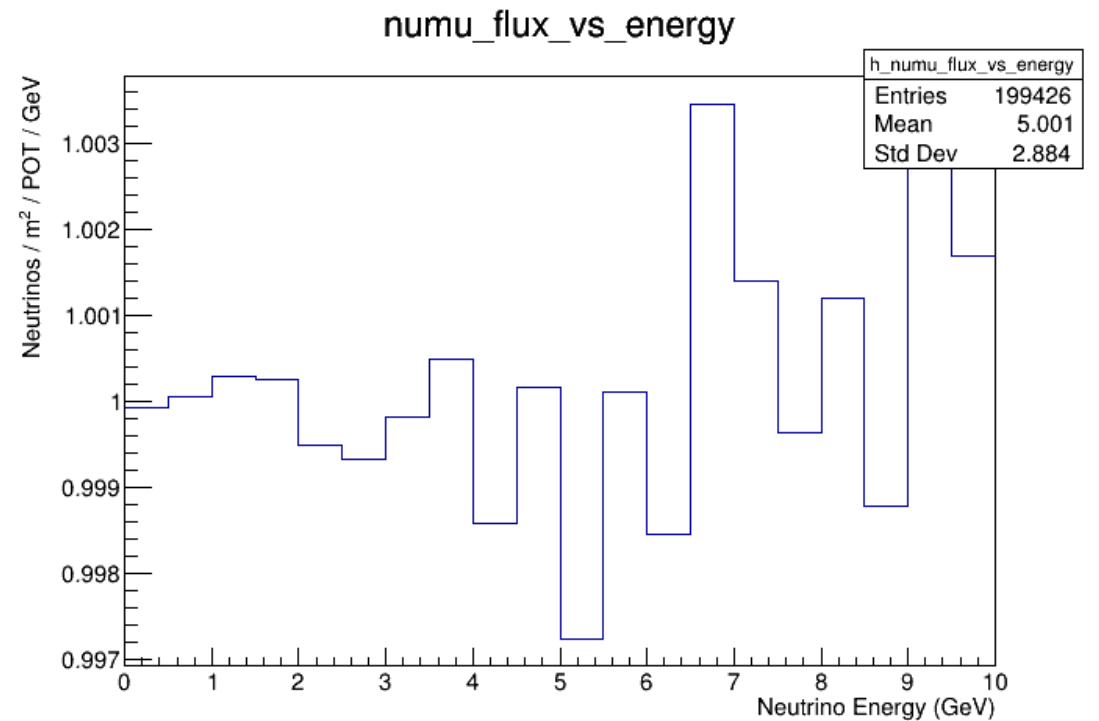
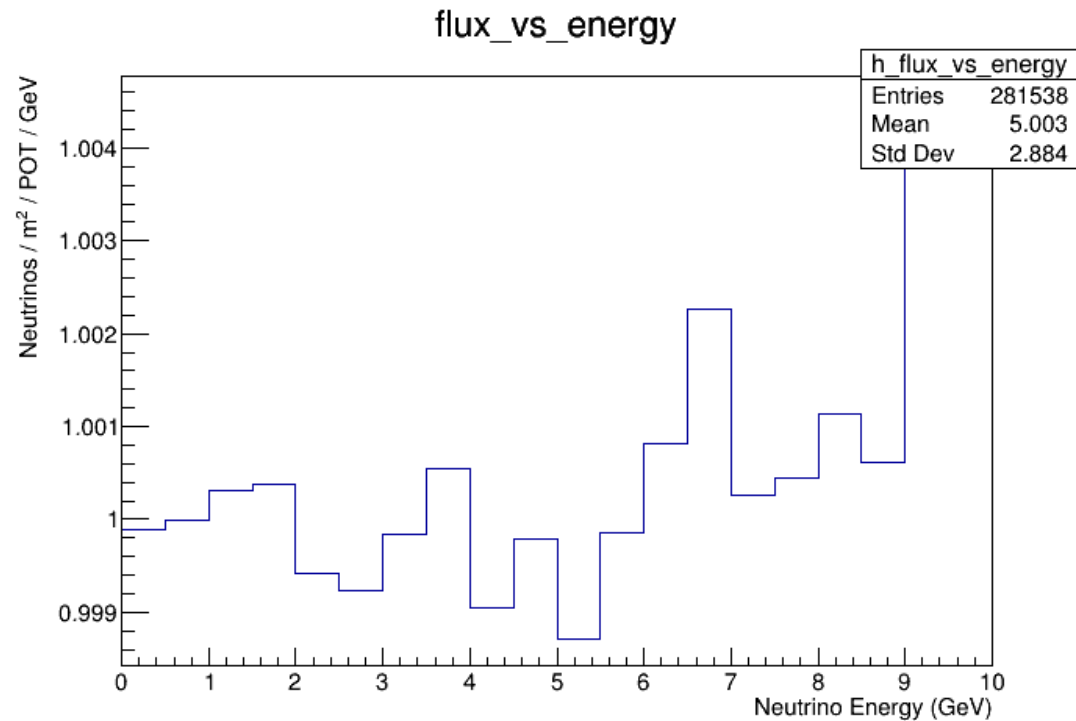
Horn C Move Forward – Alcove 1



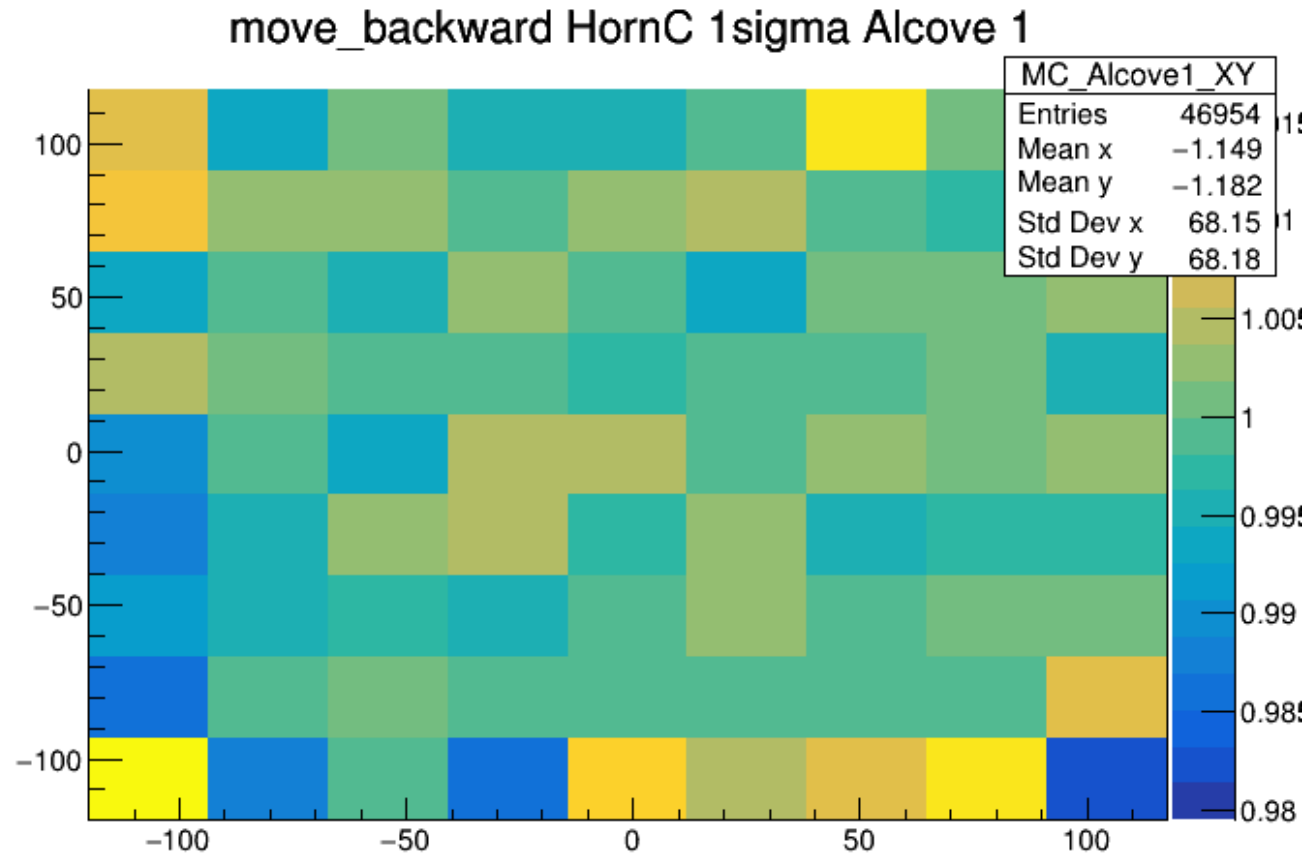
Horn C Move Forward – Alcove 1



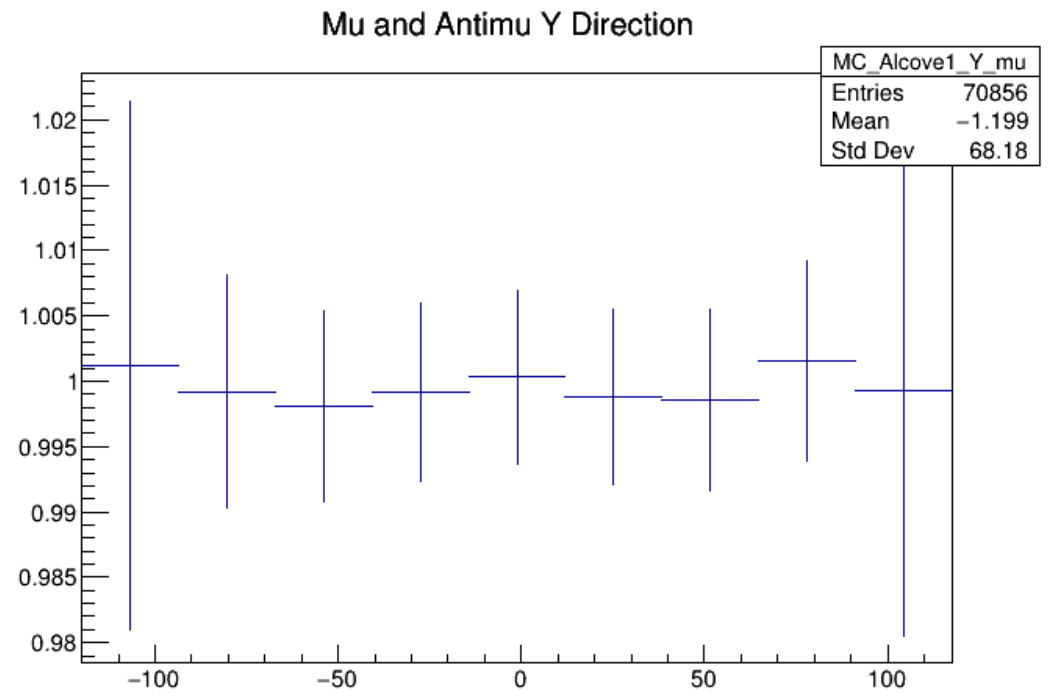
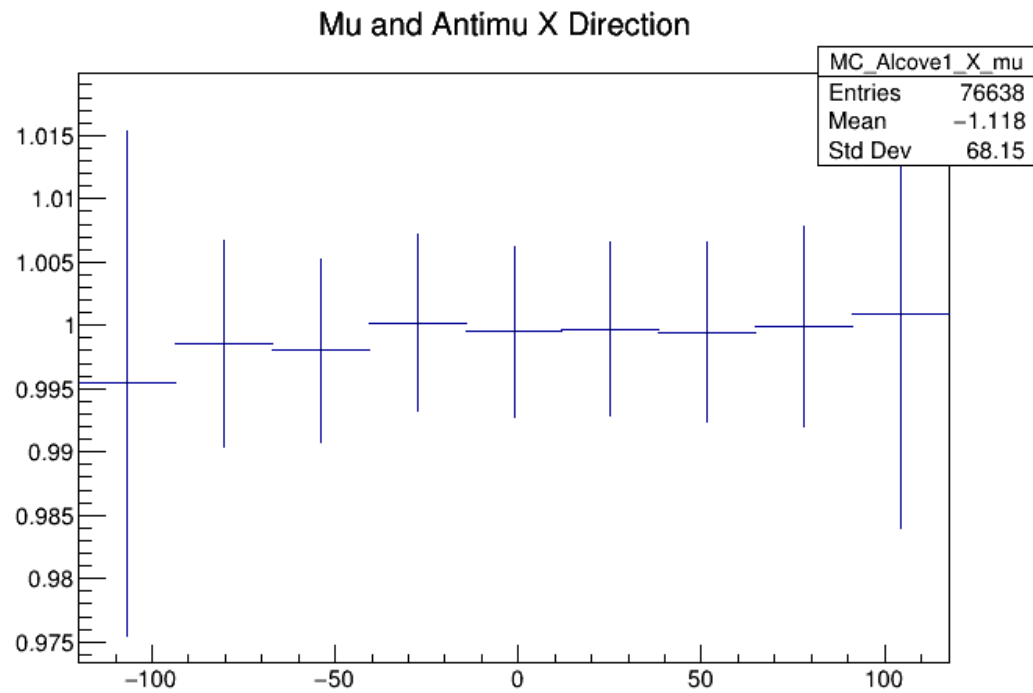
Horn C Move Forward v Flux at Far Detector



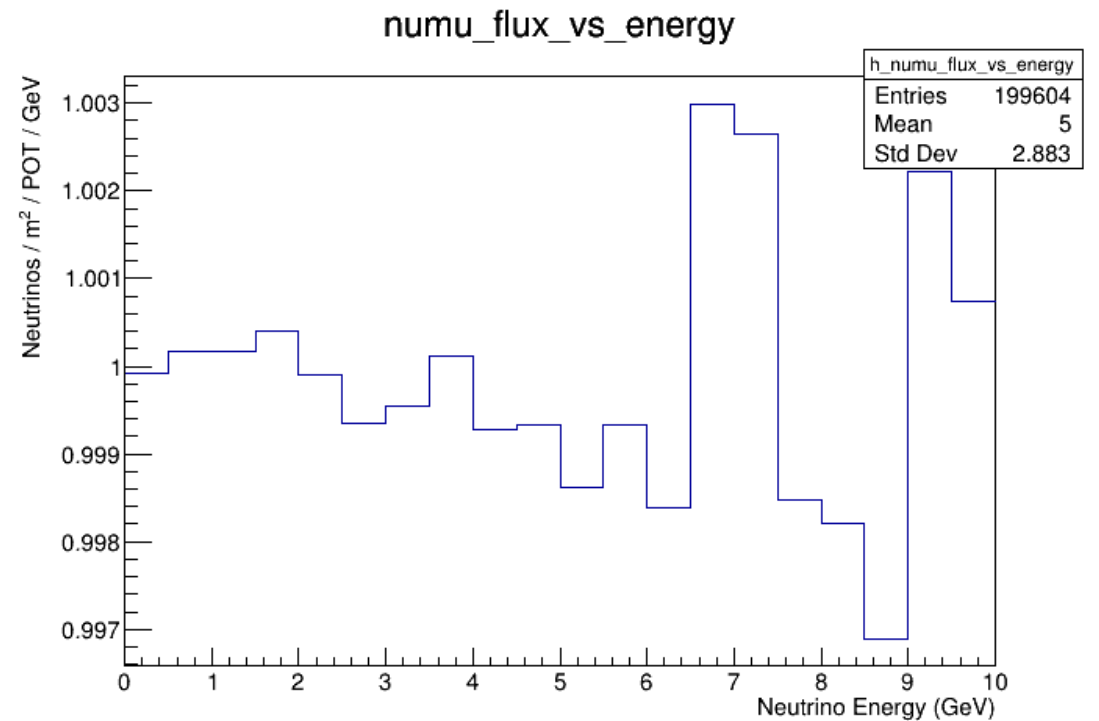
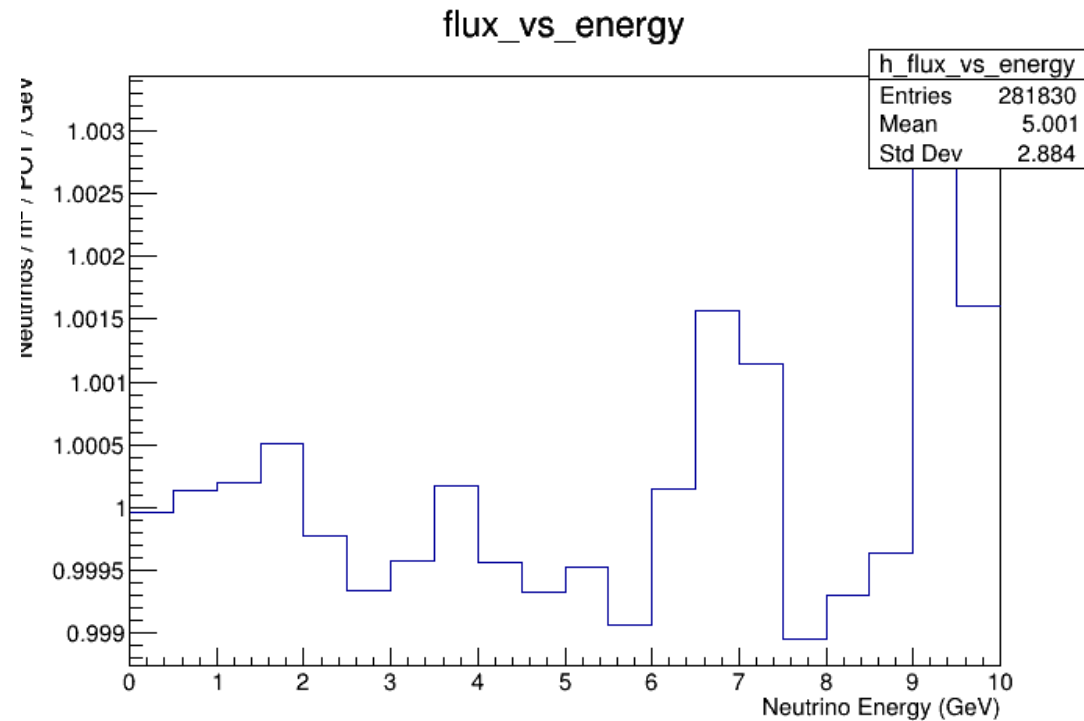
Horn C Move Backward – Alcove 1



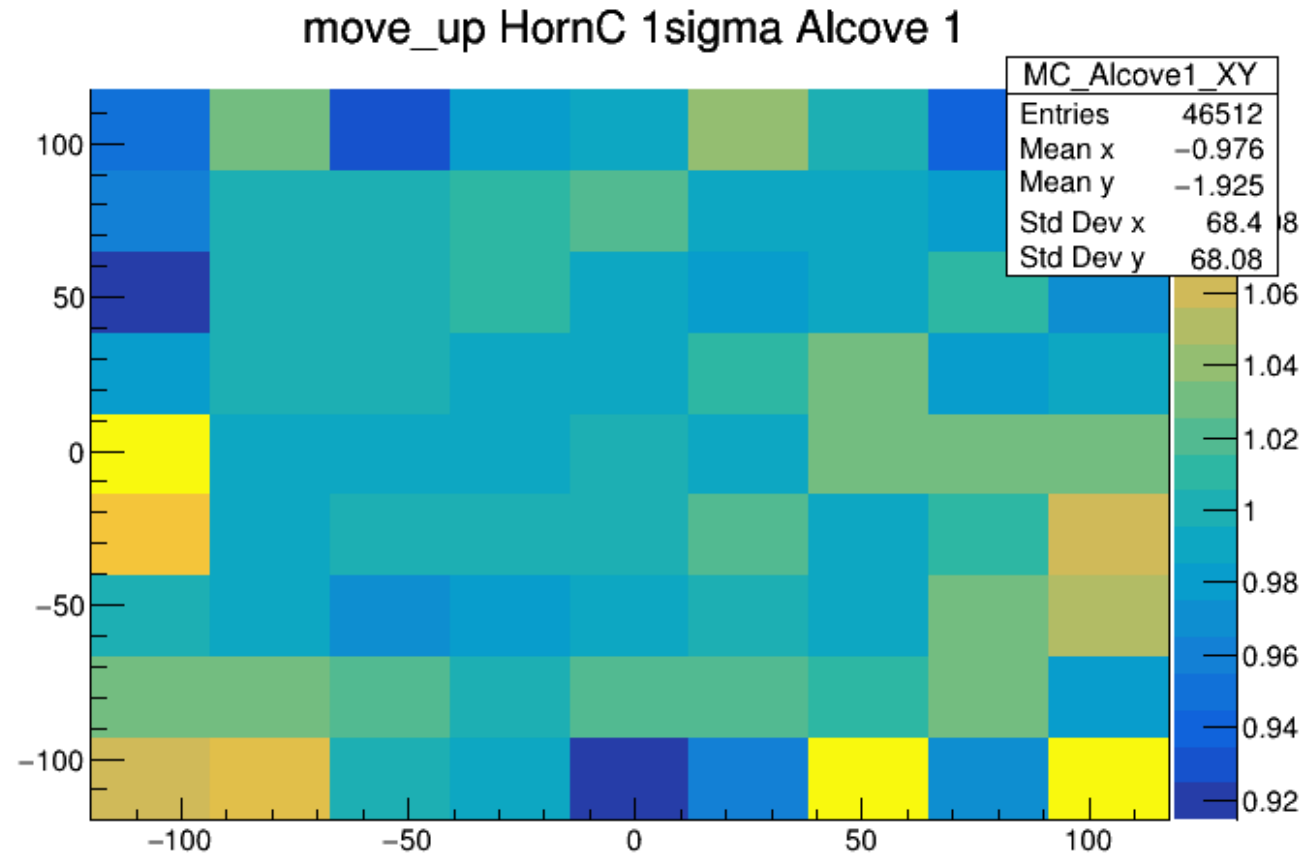
Horn C Move Backward – Alcove 1



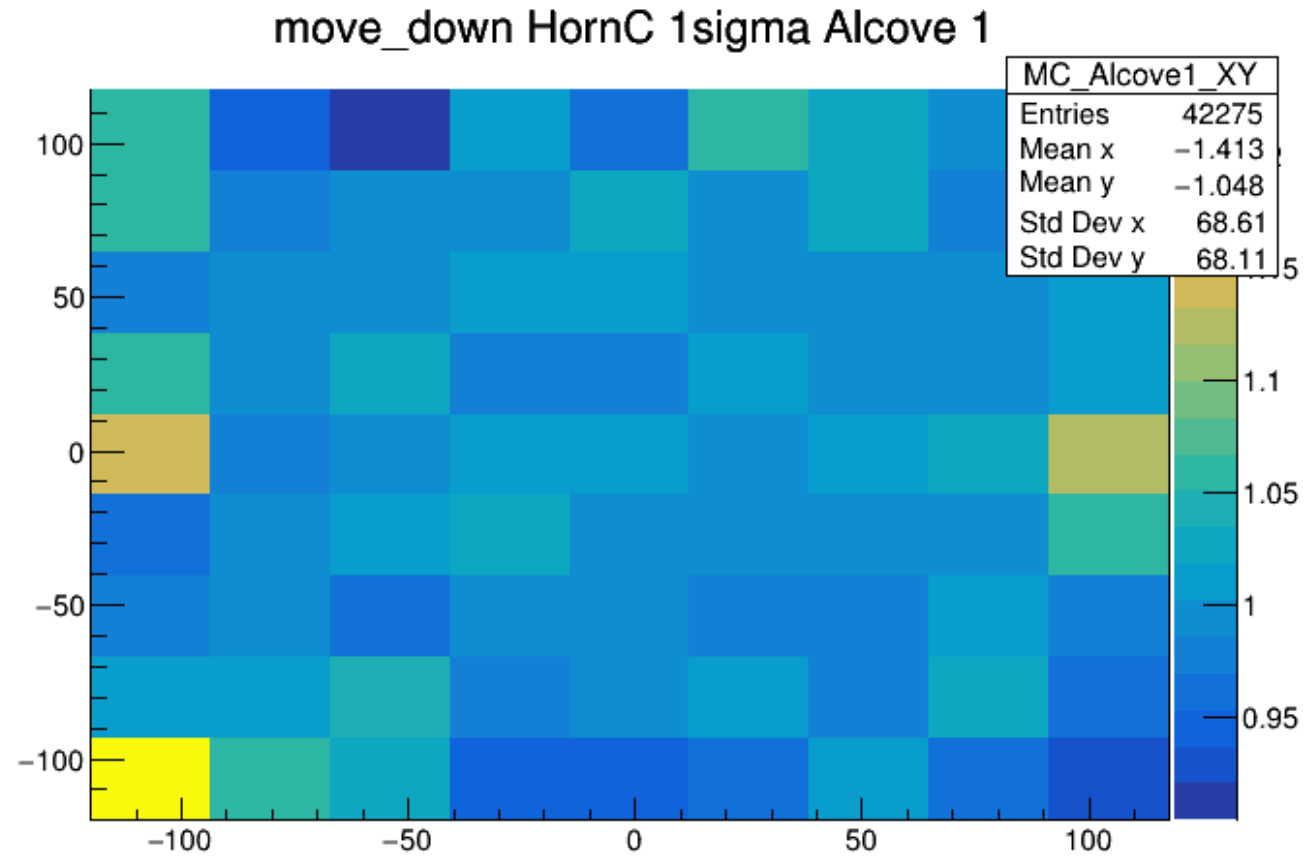
Horn C Move Backward ν Flux at Far Detector



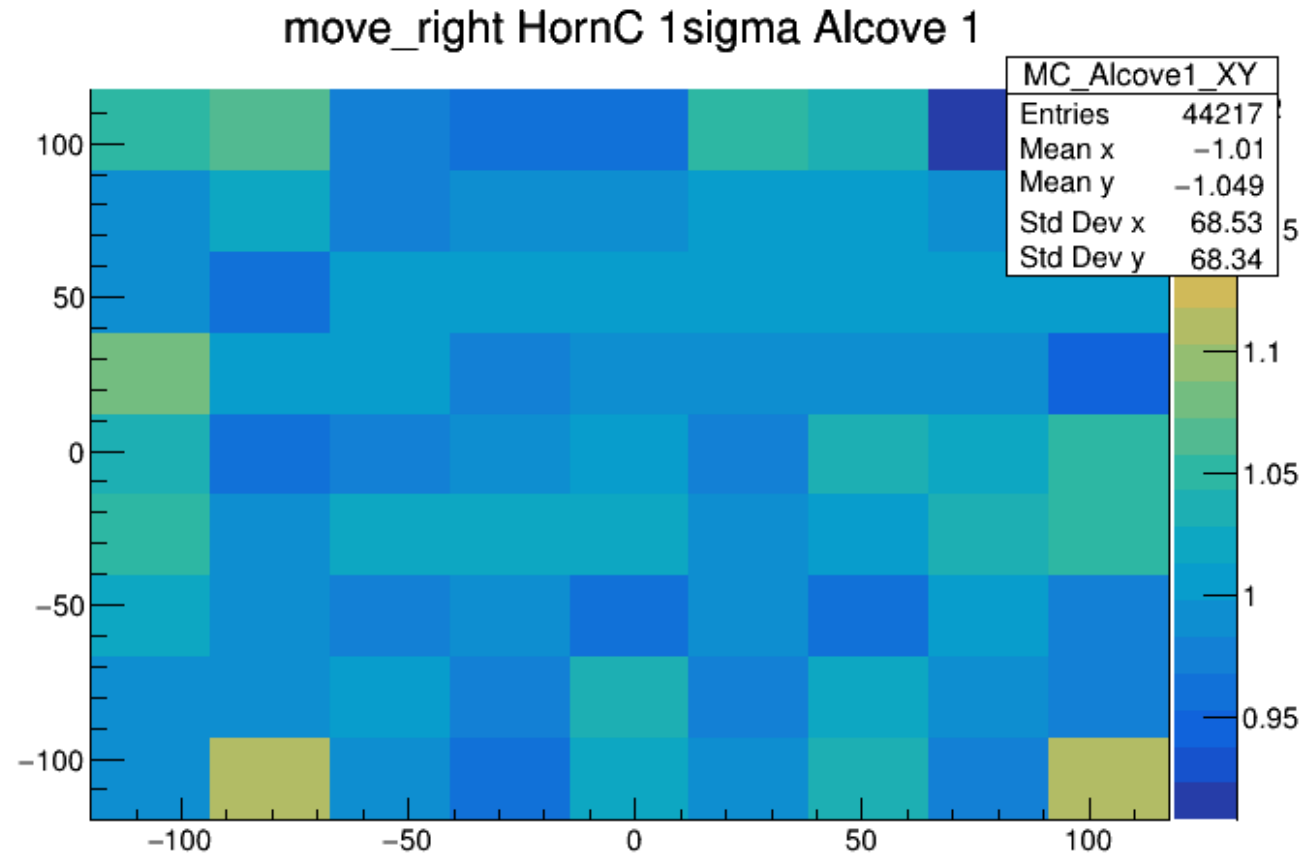
Horn C Move Up – Alcove 1



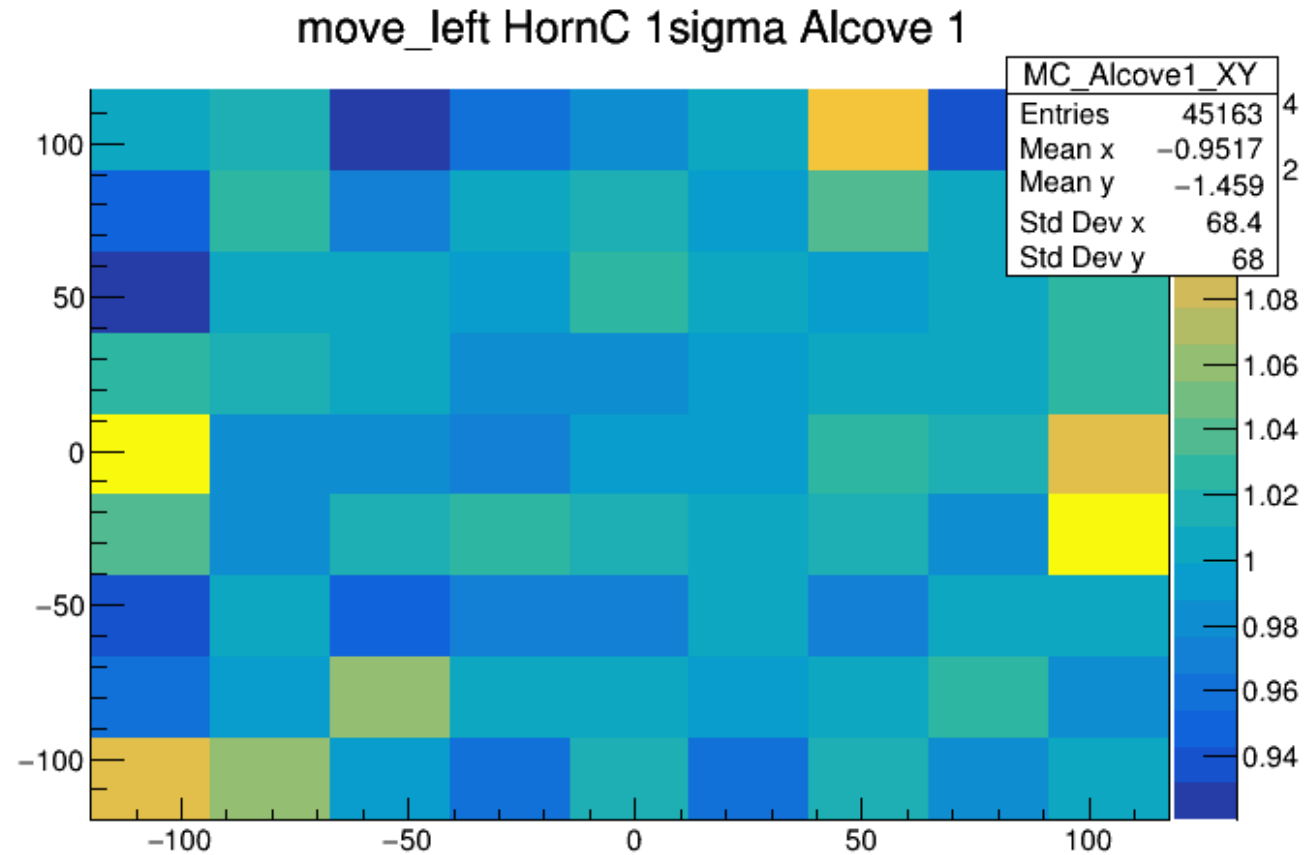
Horn C Move Down – Alcove 1



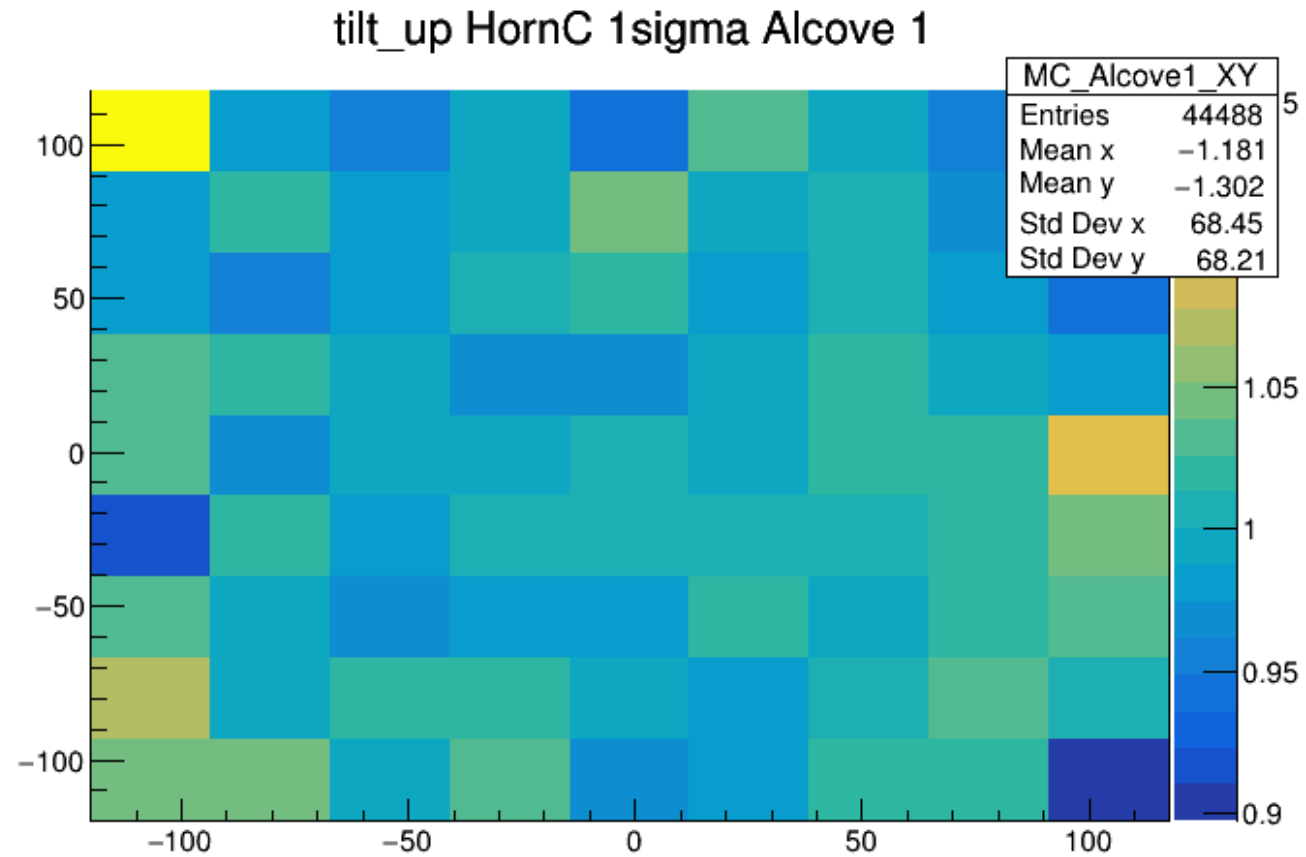
Horn C Move Right – Alcove 1



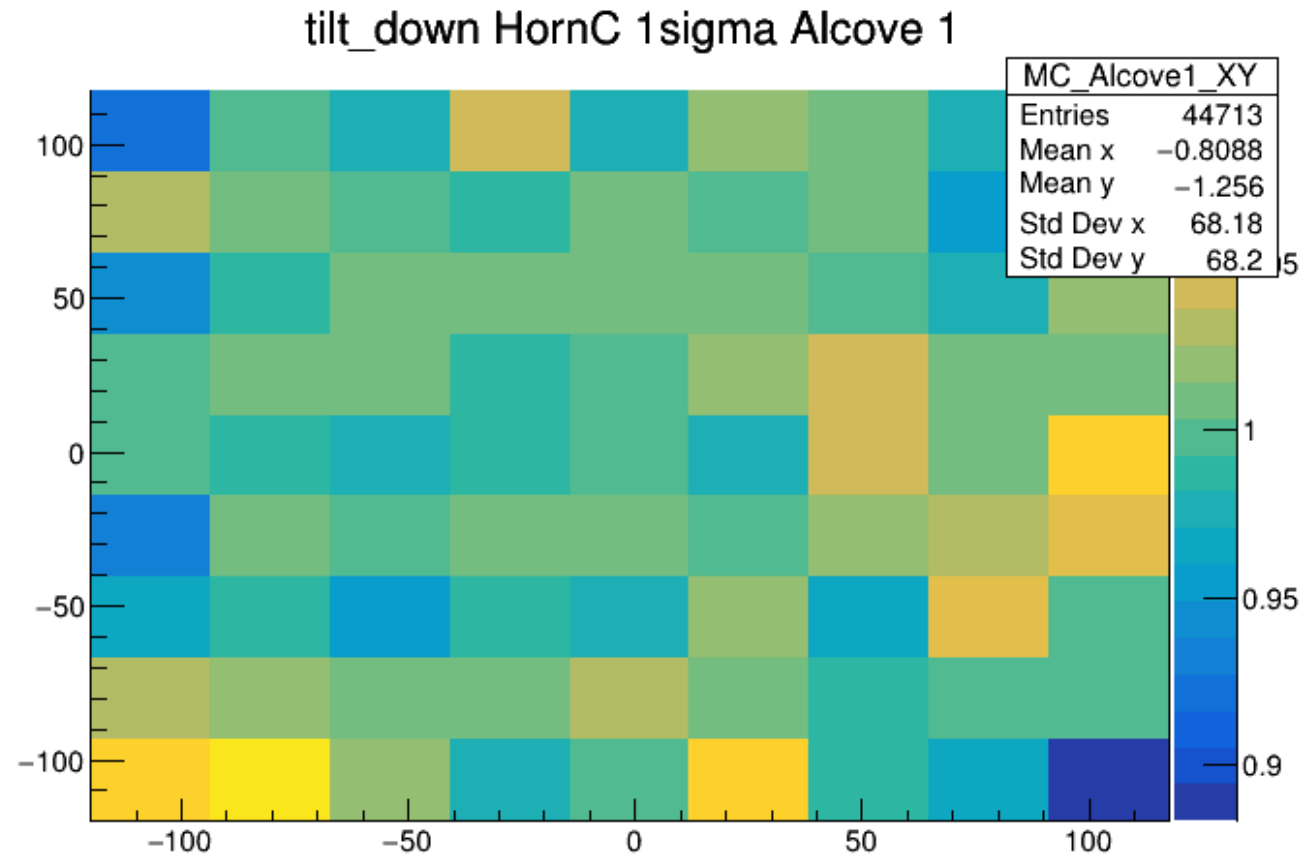
Horn C Move Left – Alcove 1



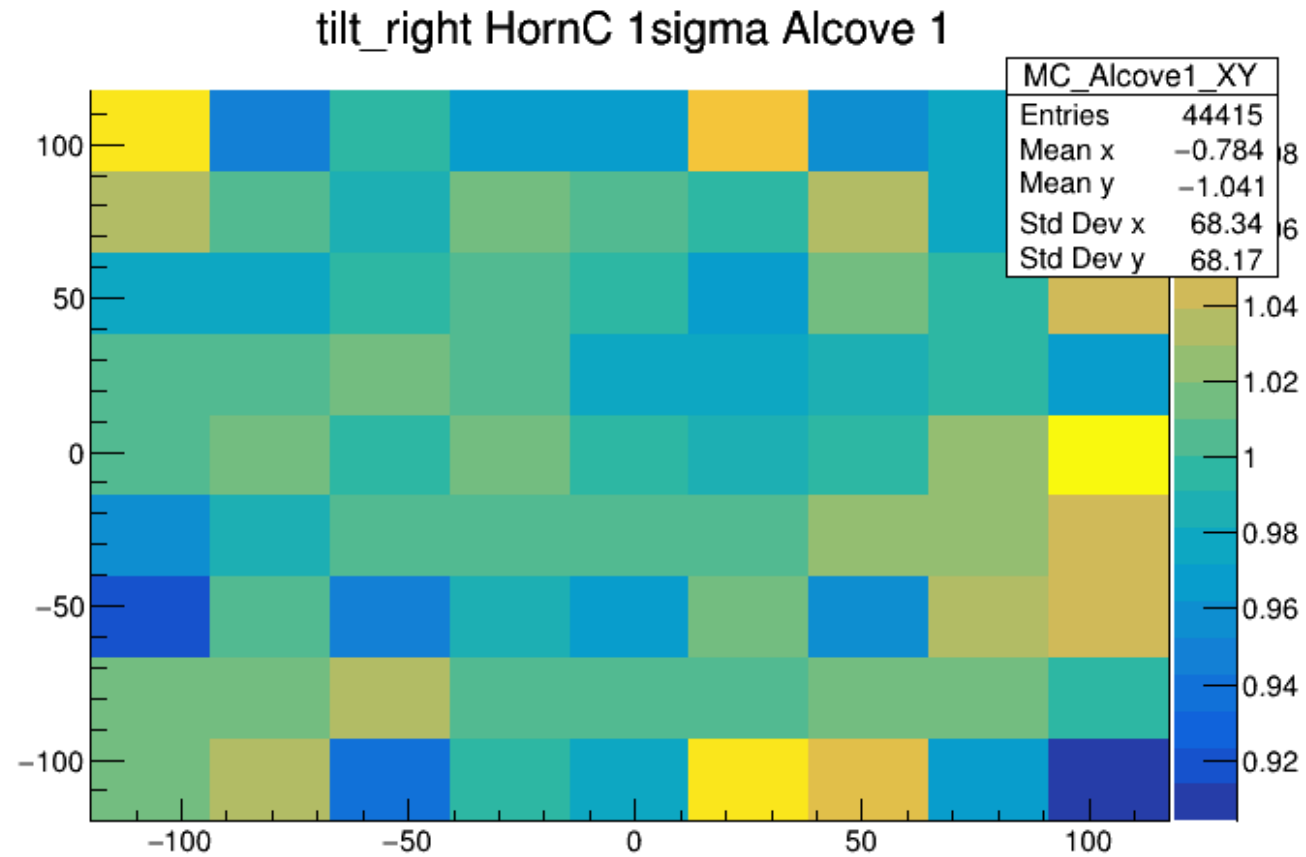
Horn C Tilt Up – Alcove 1



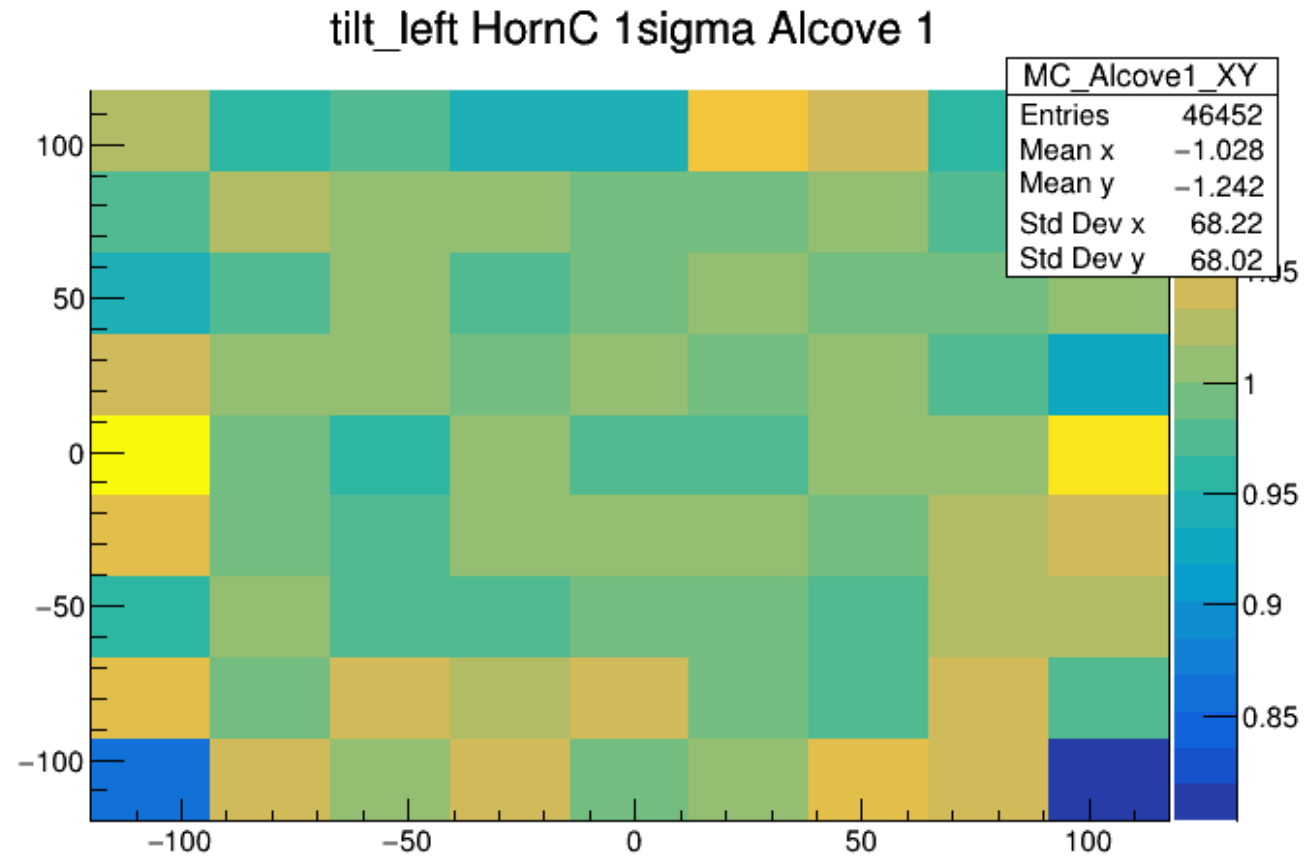
Horn C Tilt Down – Alcove 1



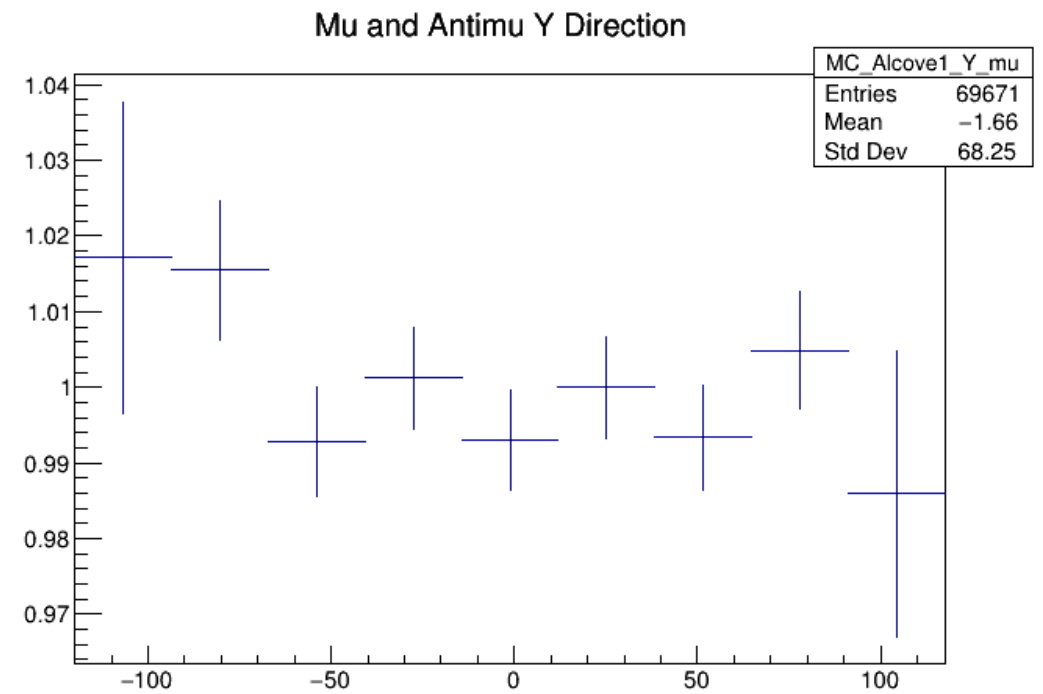
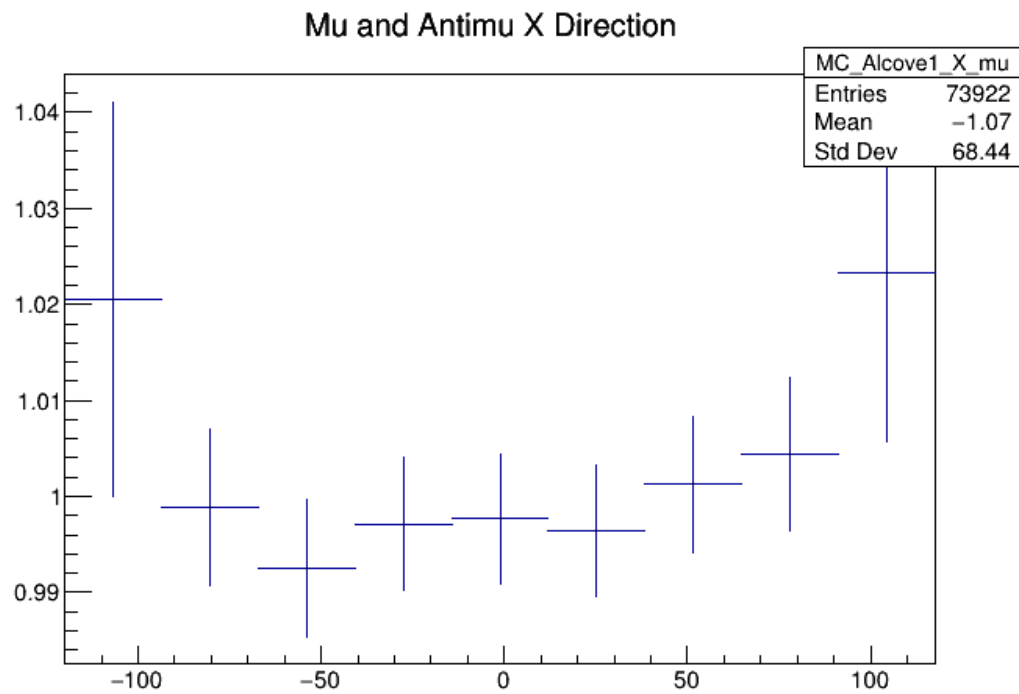
Horn C Tilt Right – Alcove 1



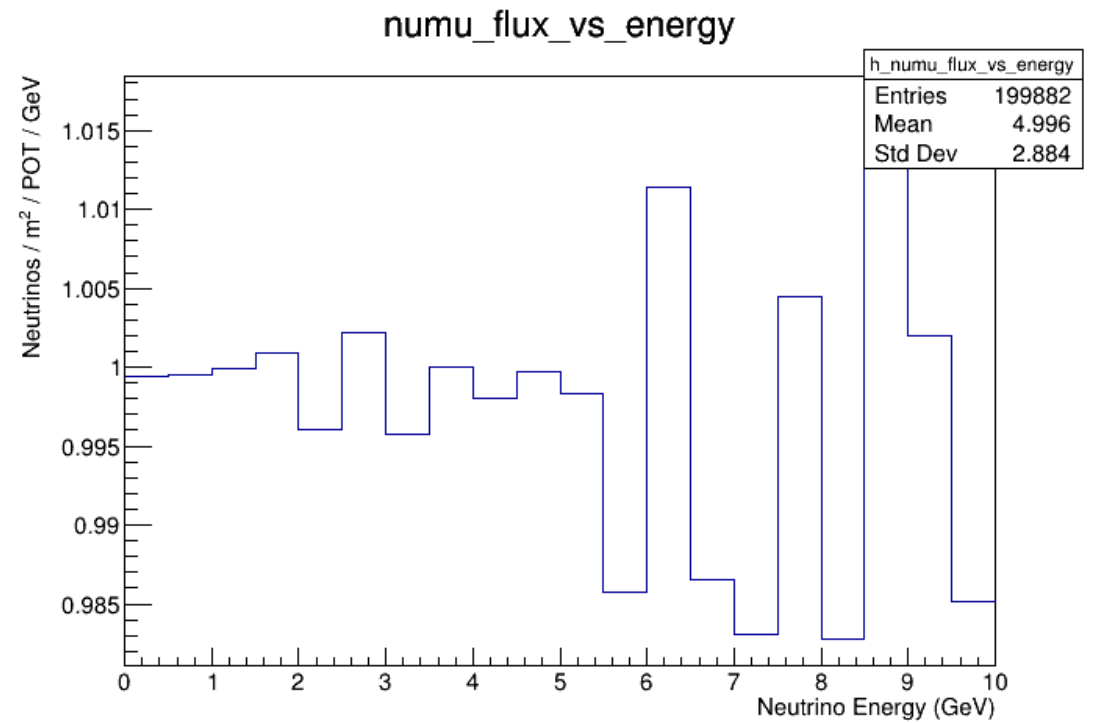
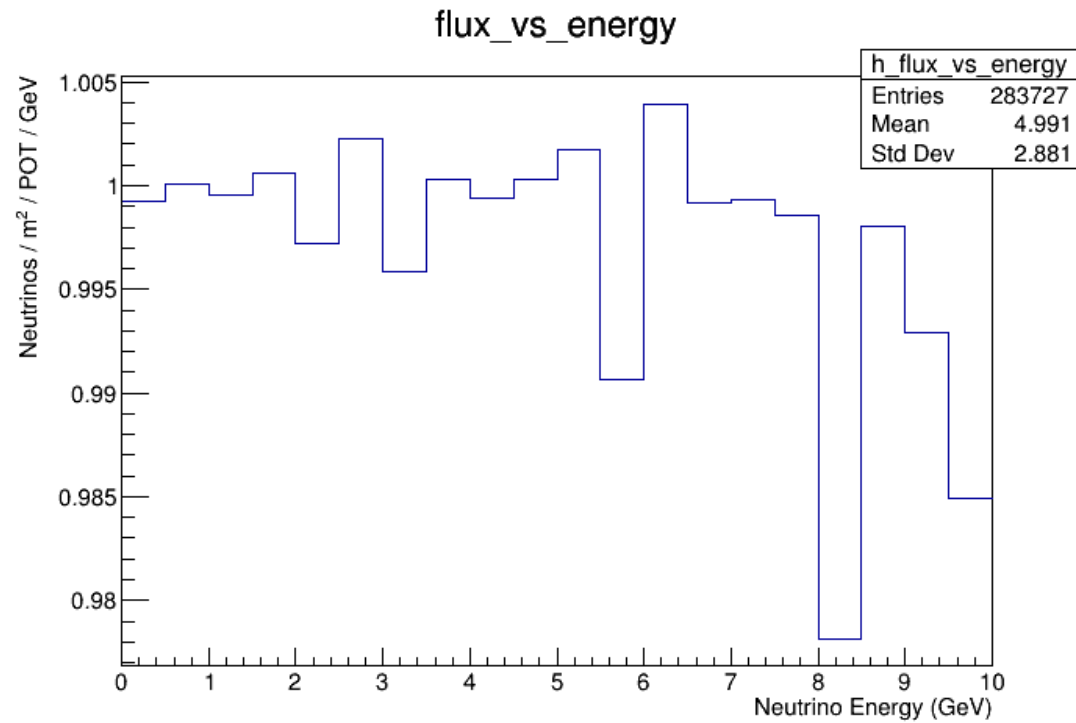
Horn C Tilt Left – Alcove 1



Horn C Tilt Left – Alcove 1

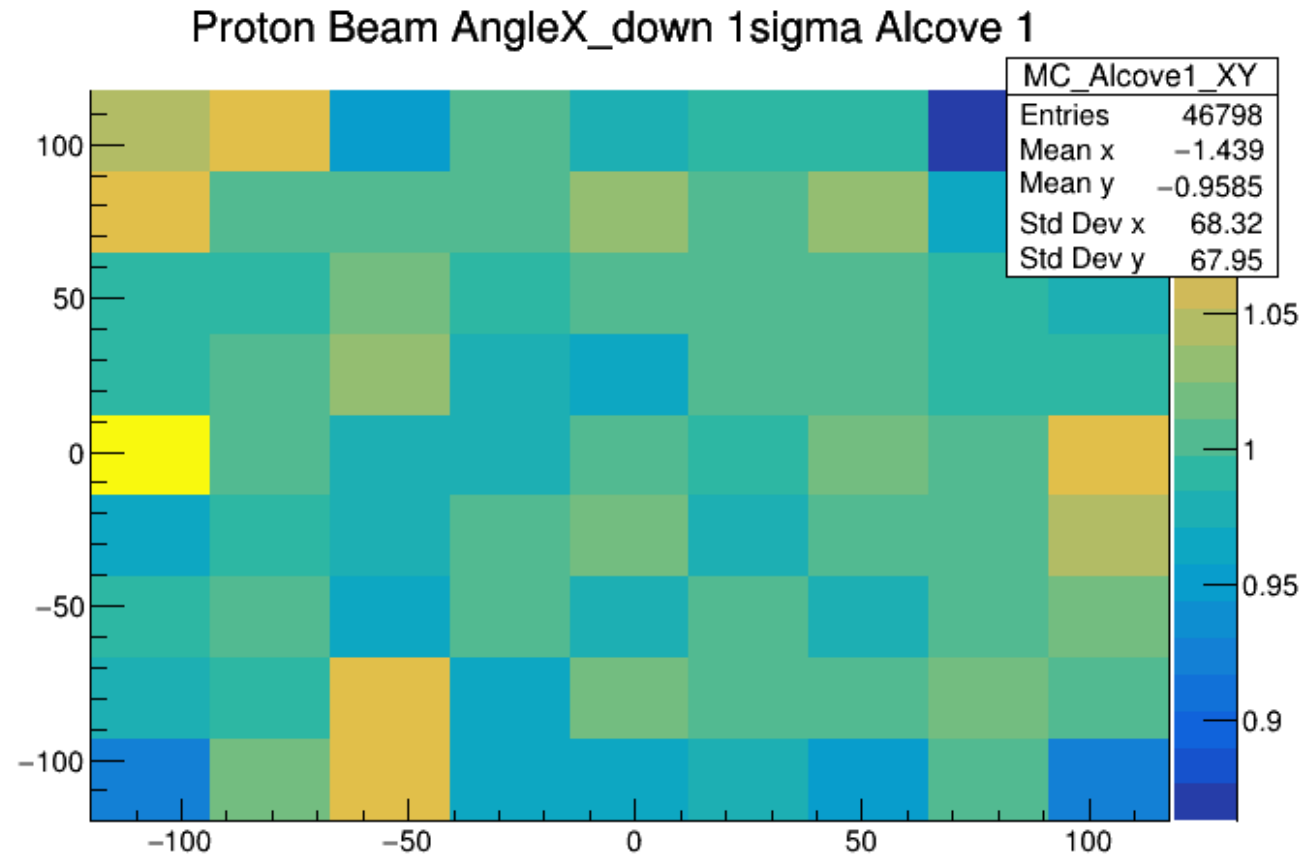


Horn C Tilt Left ν Flux at Far Detector

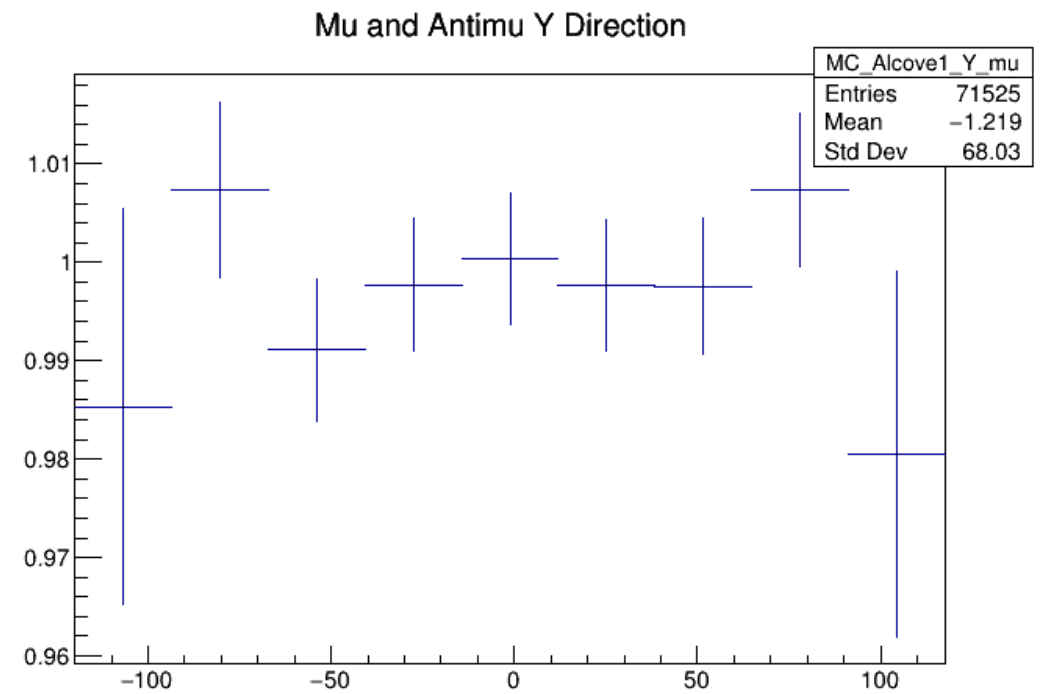
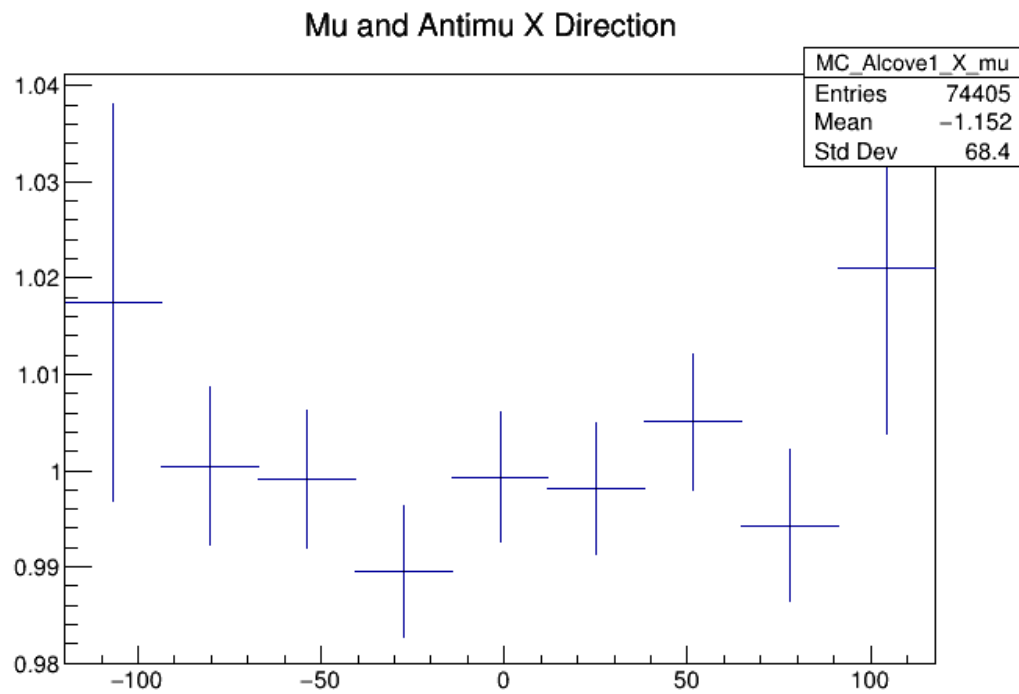


Proton Beam

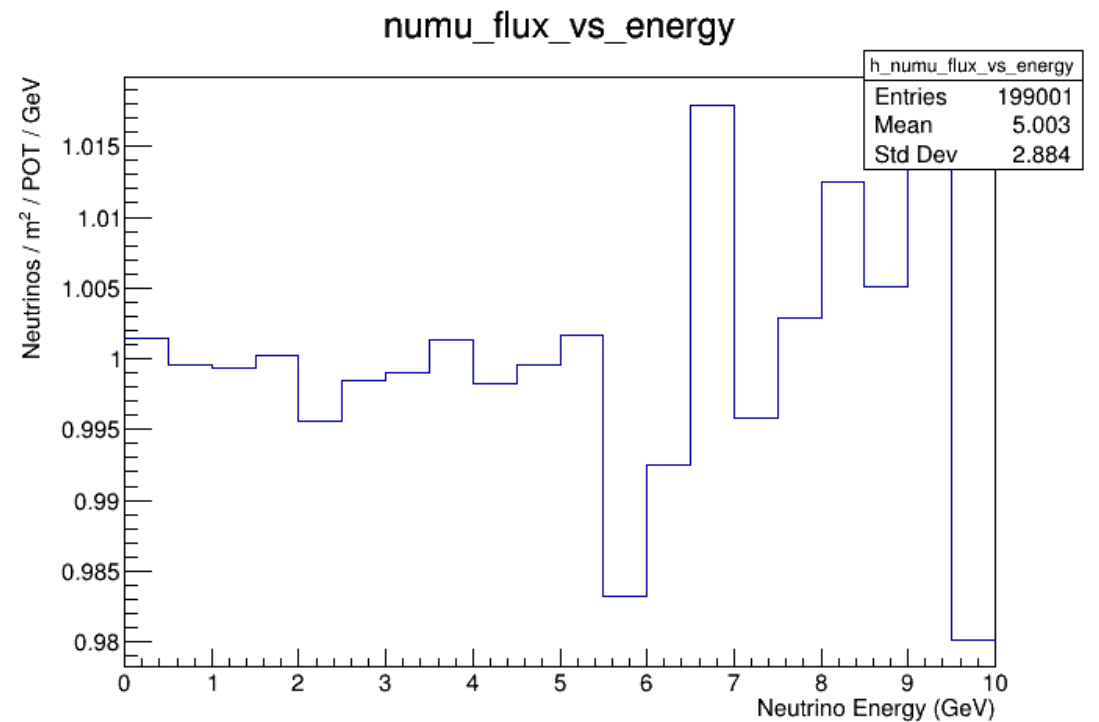
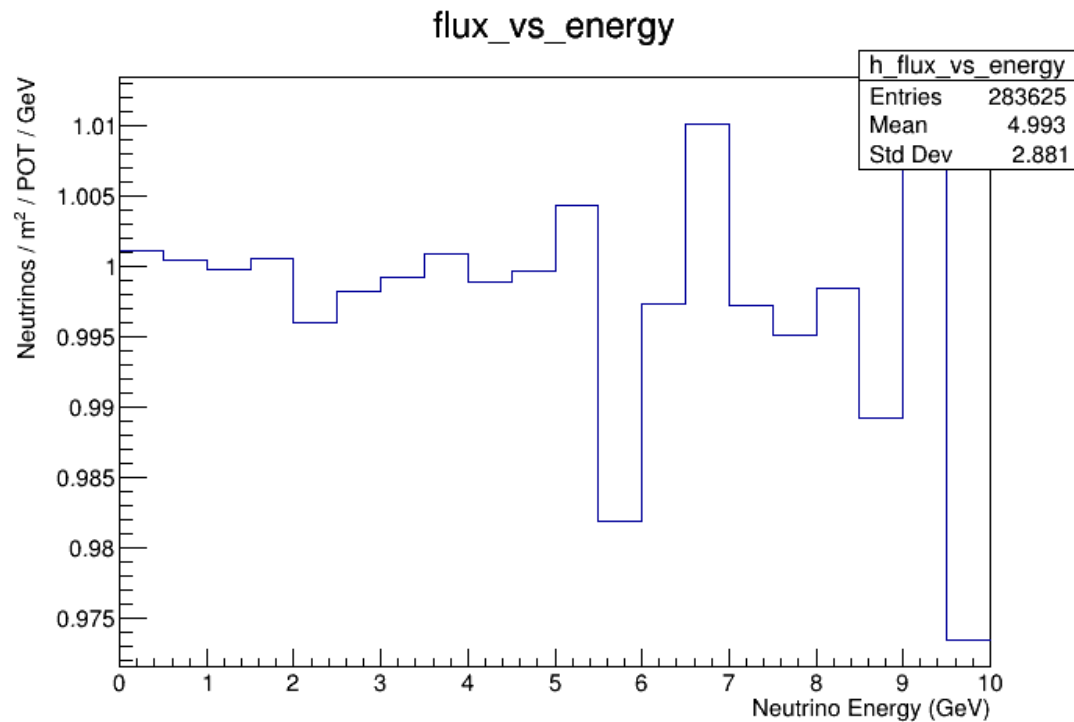
Proton Beam AngleX Down – Alcove 1



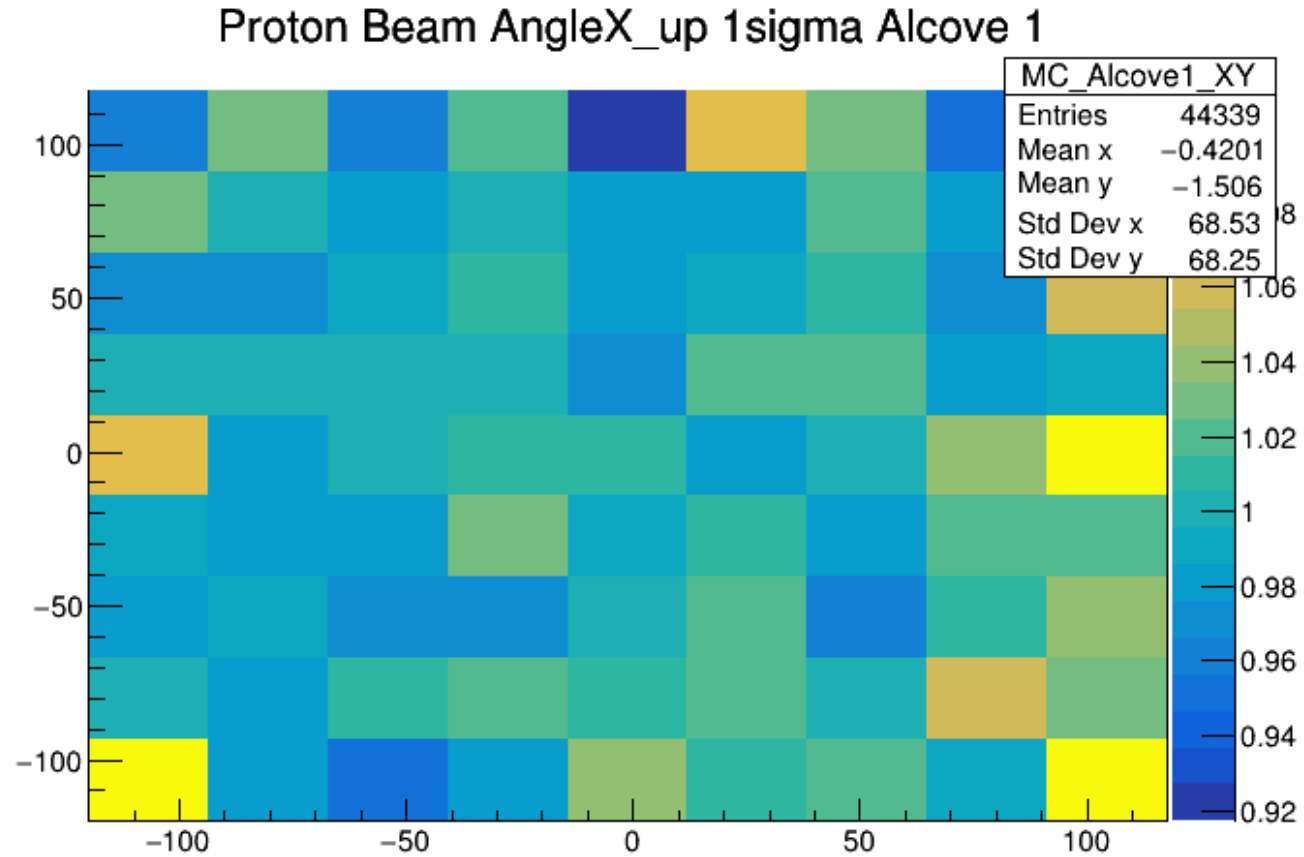
Proton Beam AngleX Down – Alcove 1



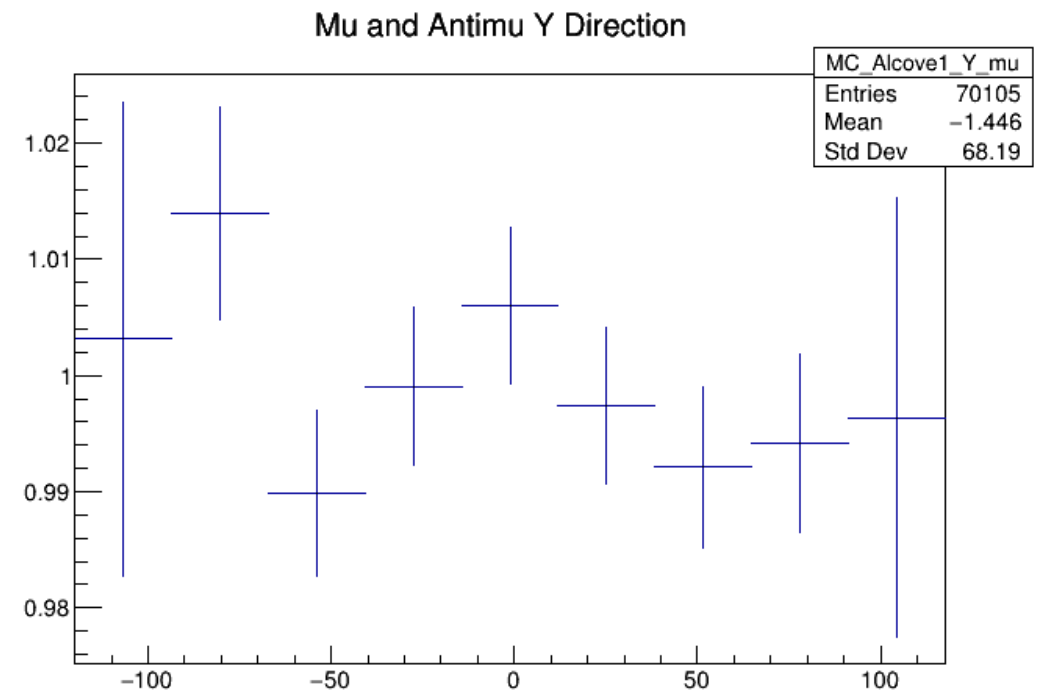
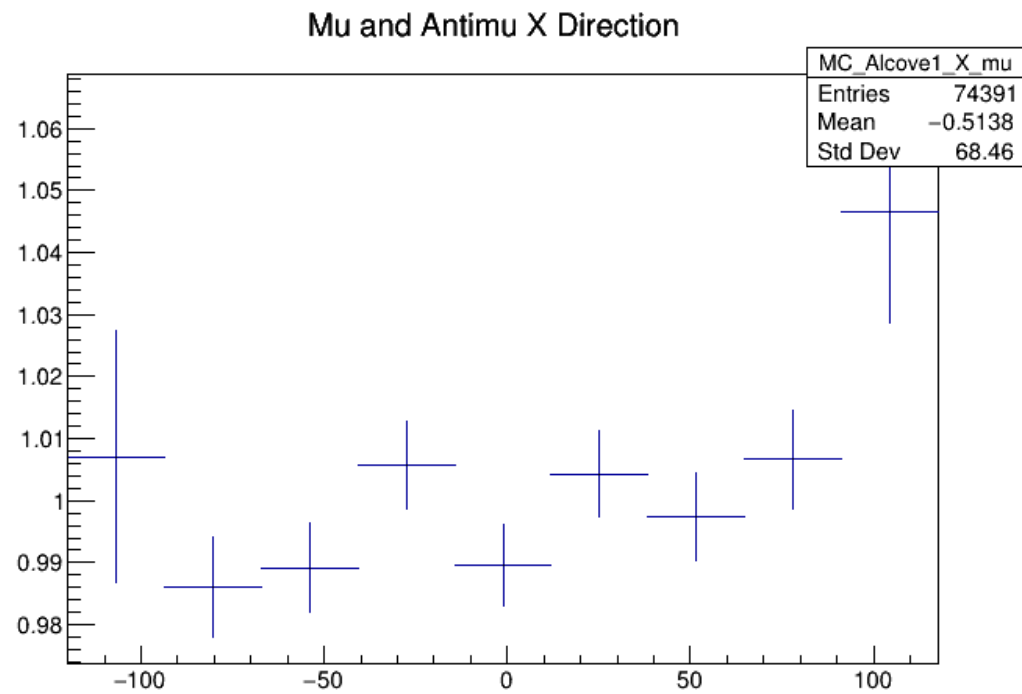
Proton Beam AngleX Down ν Flux Far Detector



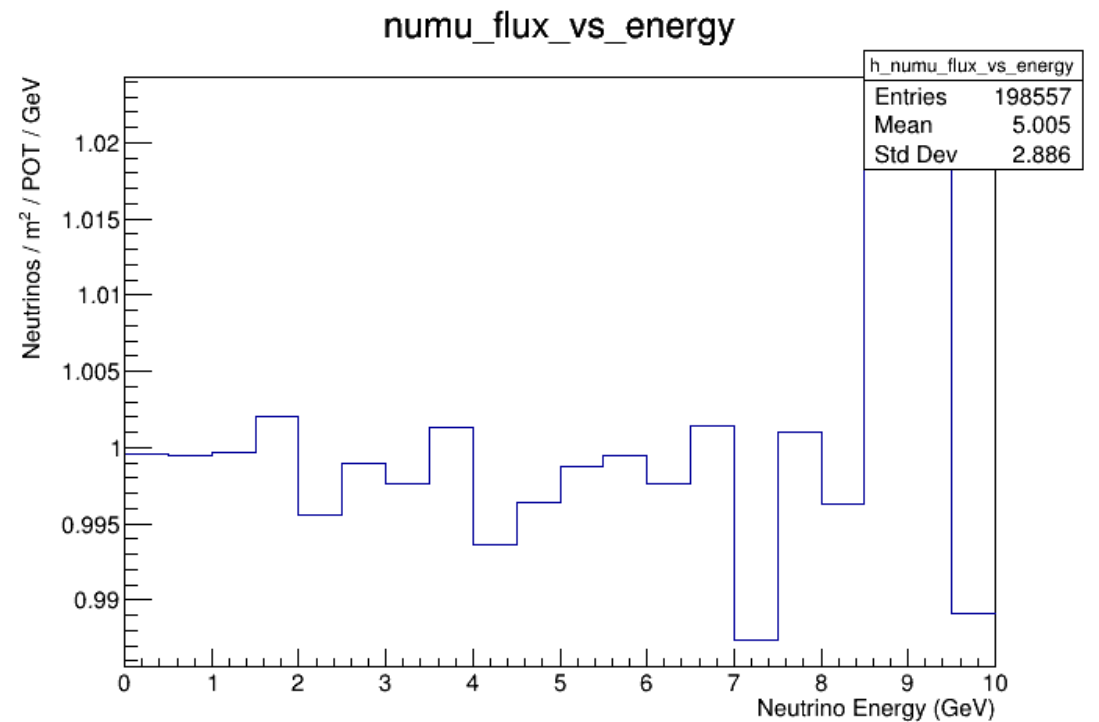
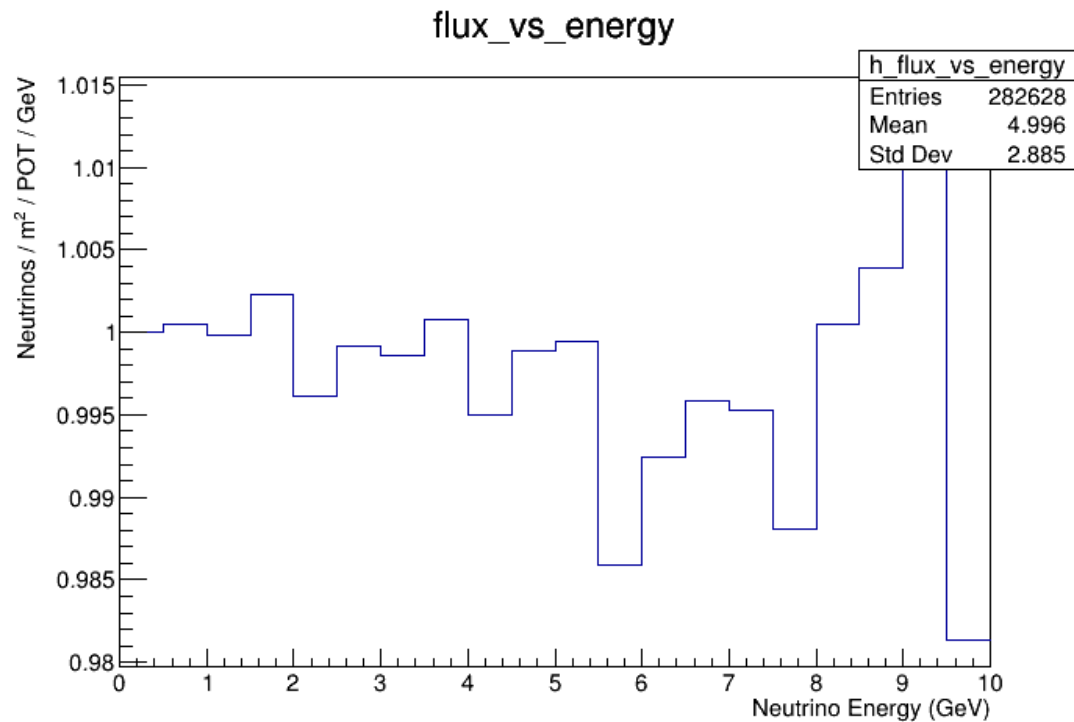
Proton Beam AngleX Up – Alcove 1



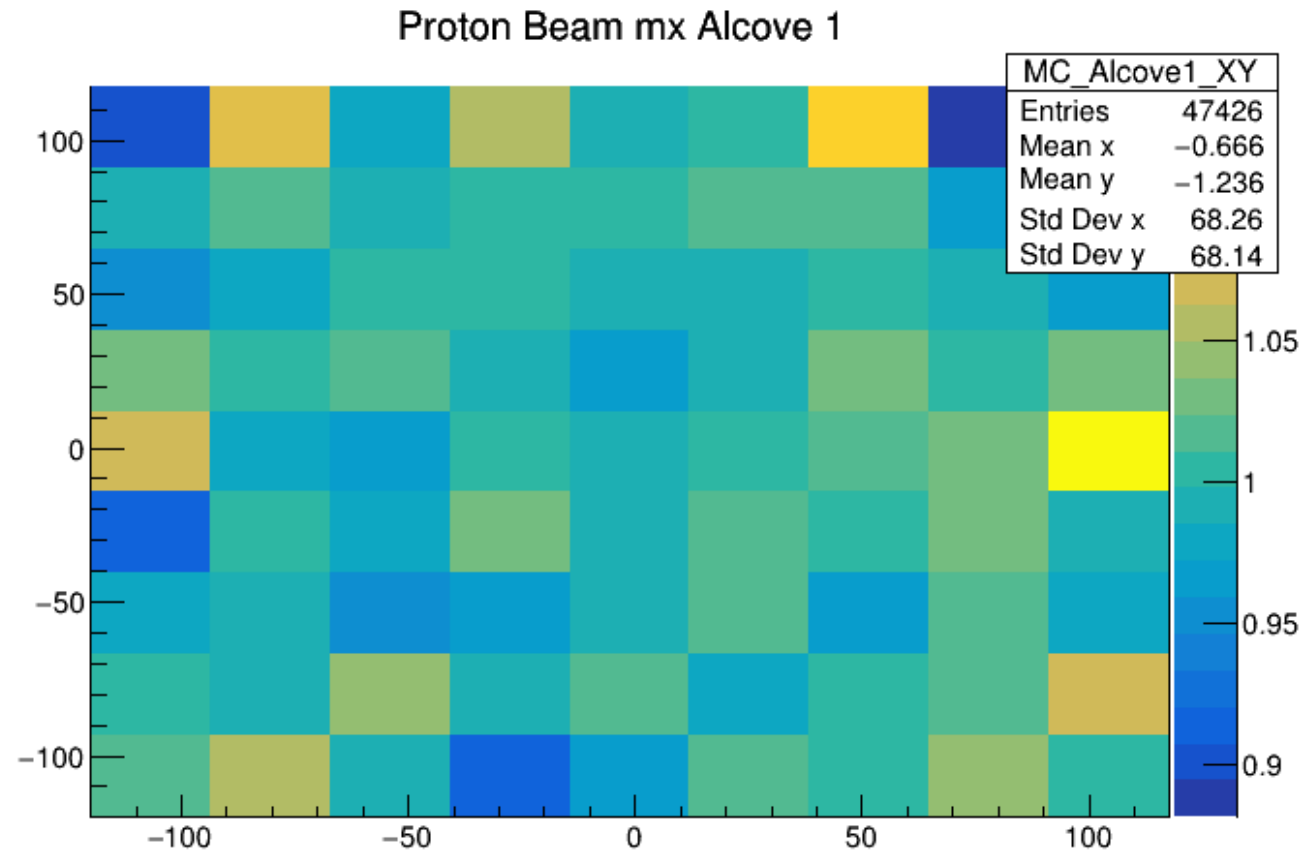
Proton Beam AnlgeX Up – Alcove 1



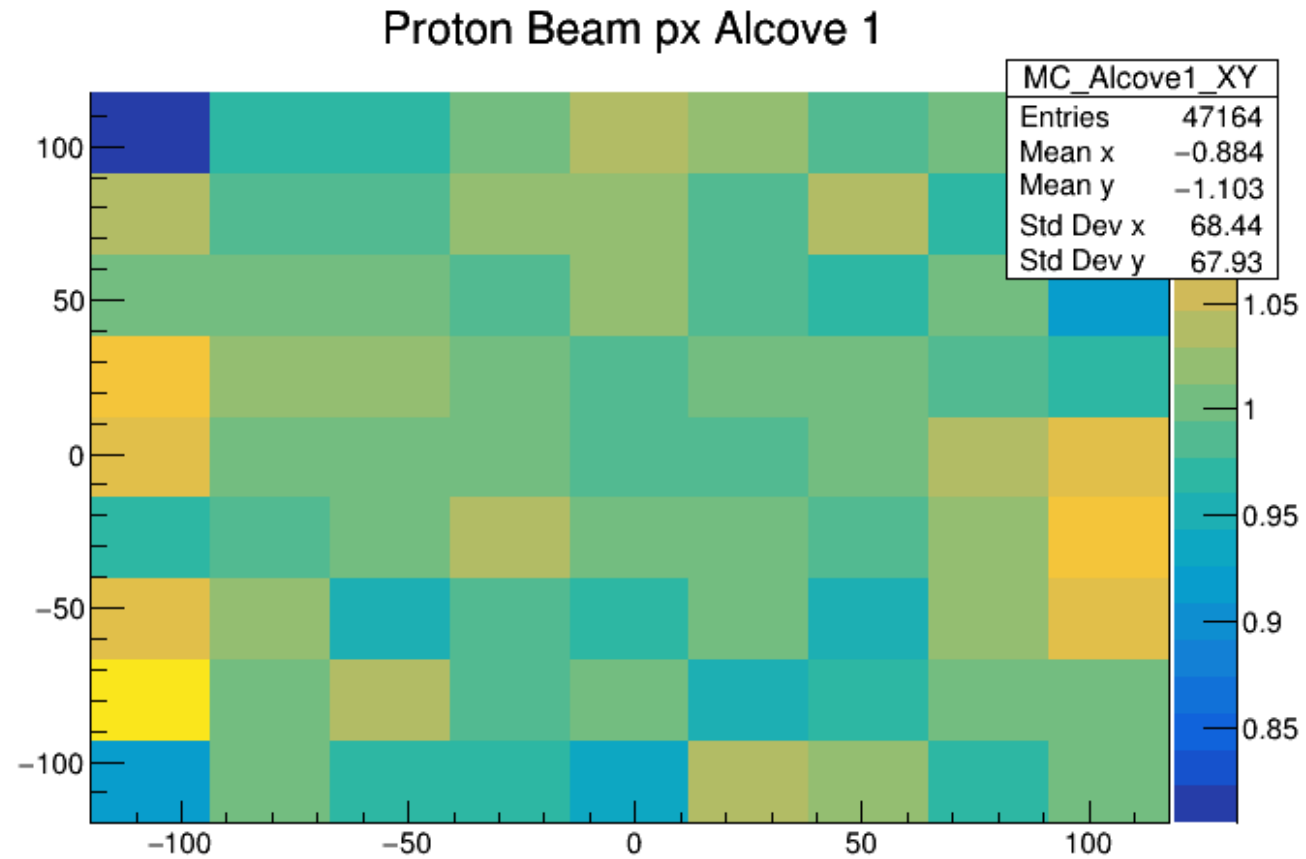
Proton Beam AngleX Up v Flux Far Detector



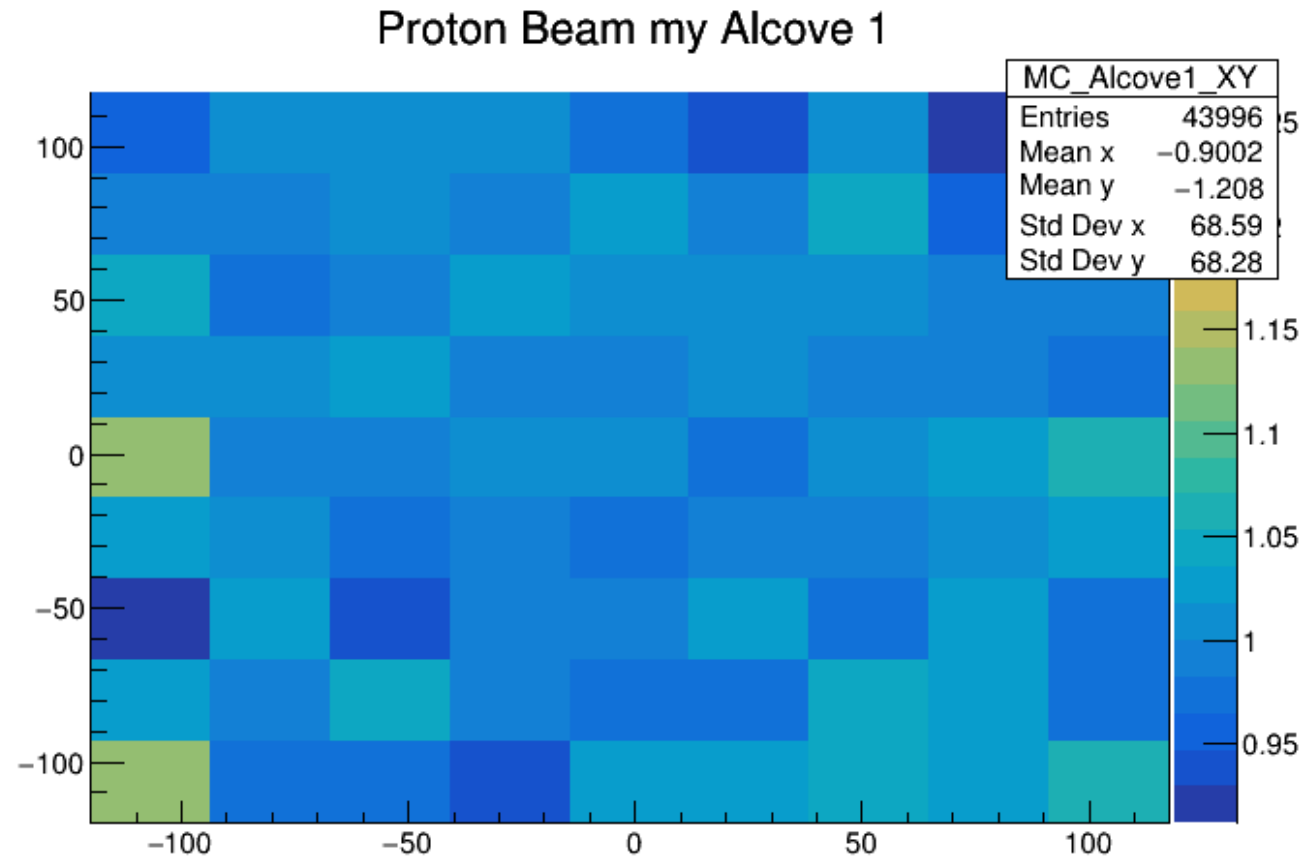
Proton Beam mX – Alcove 1



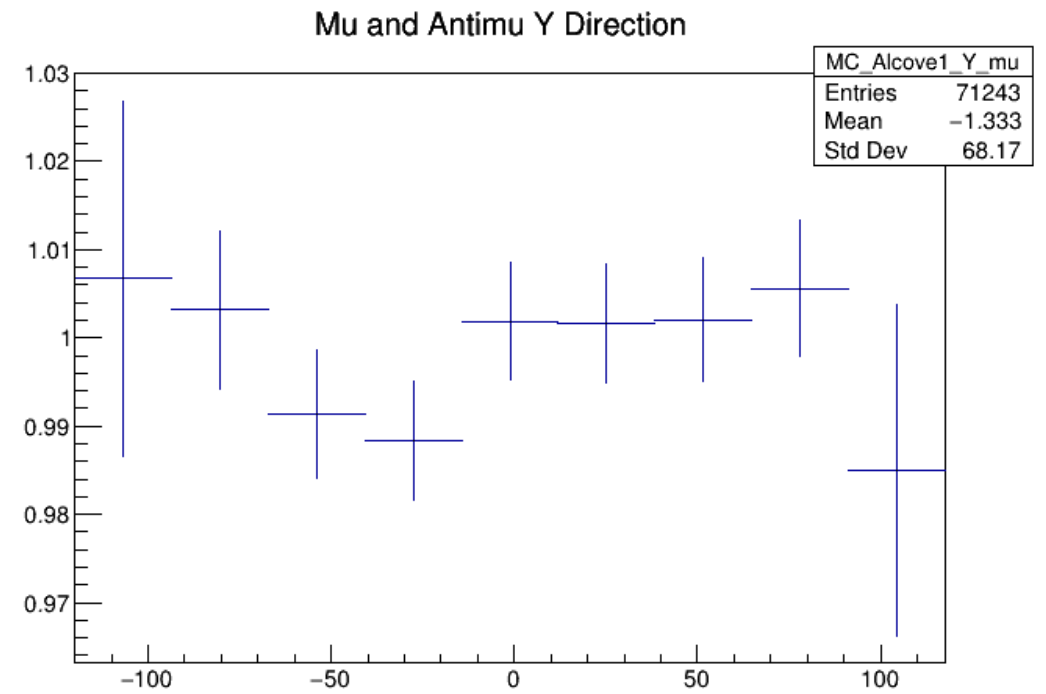
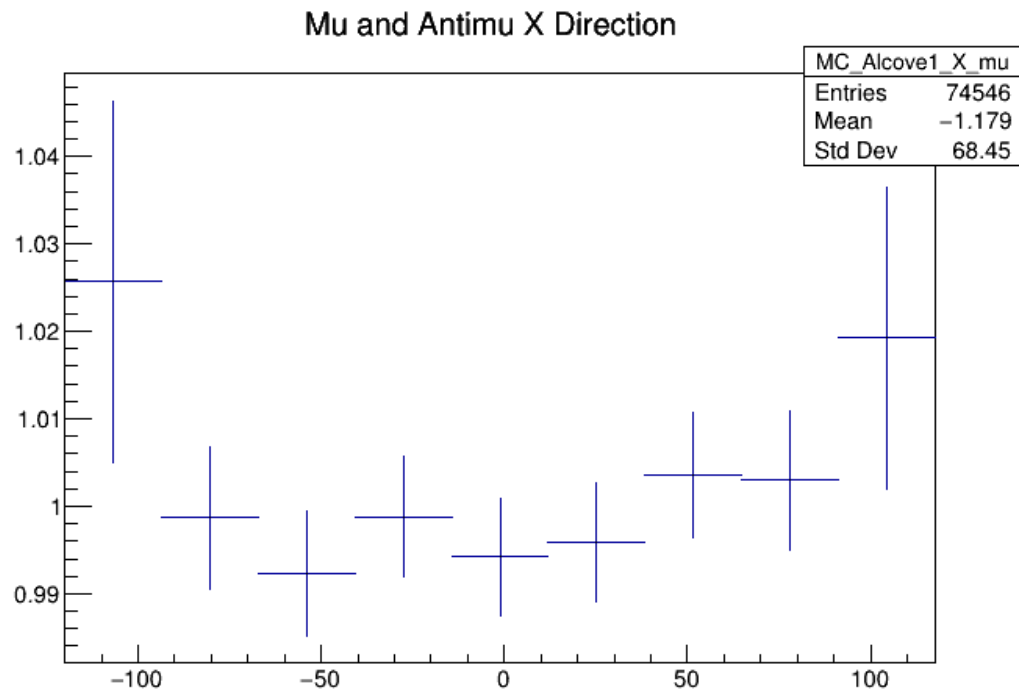
Proton Beam pX – Alcove 1



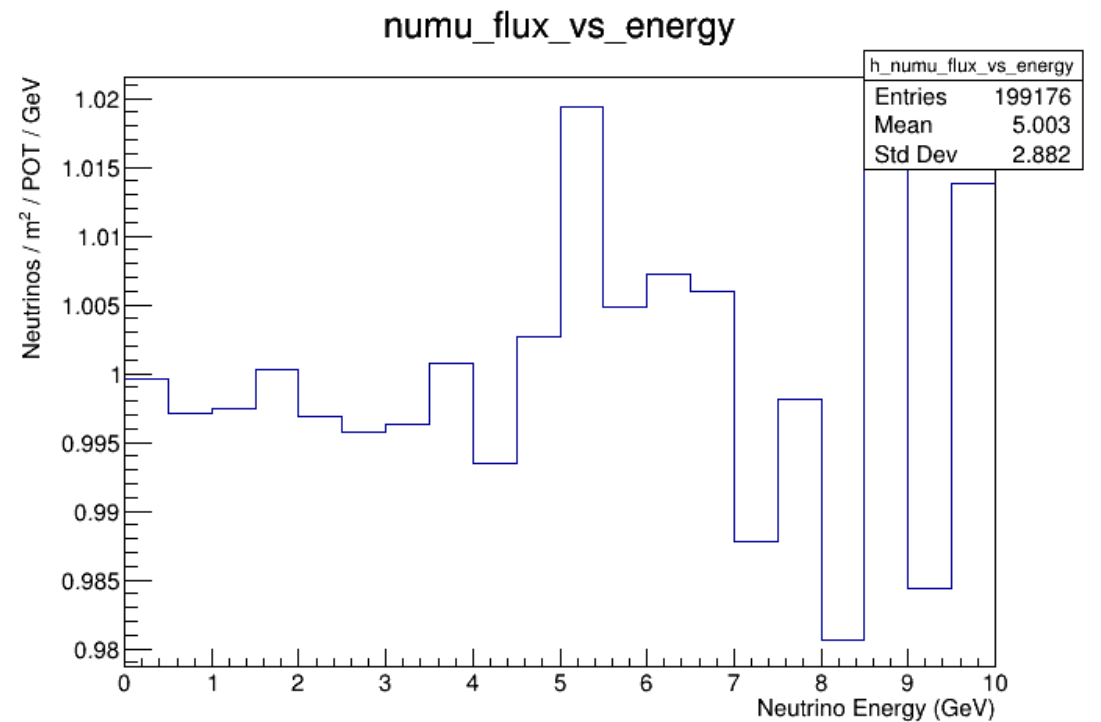
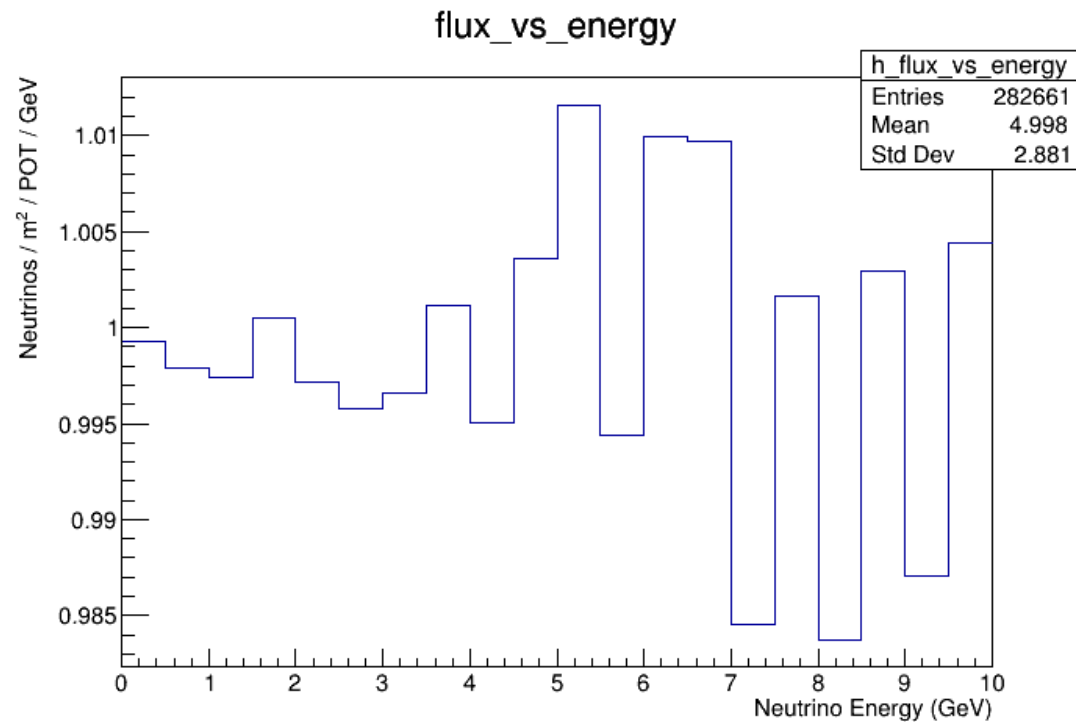
Proton Beam mY – Alcove 1



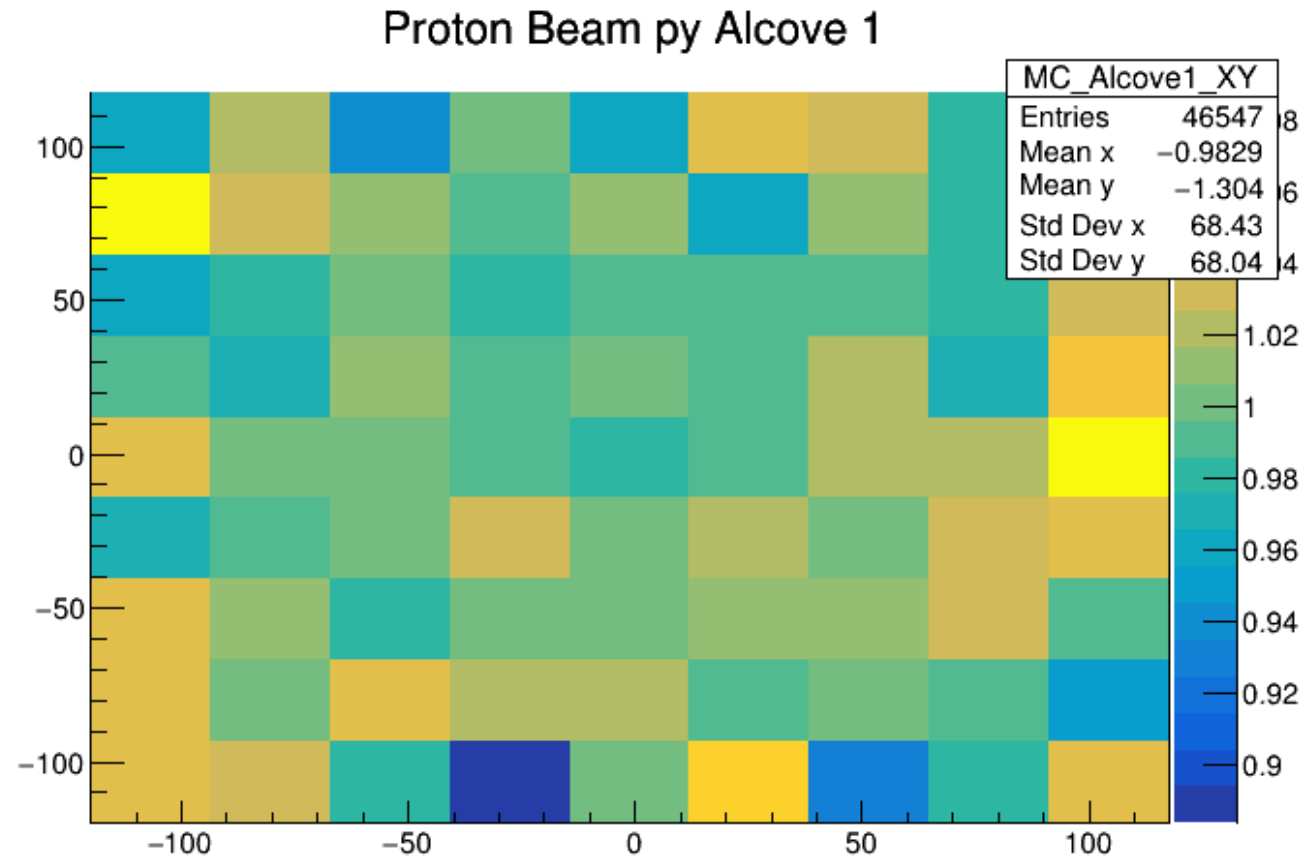
Proton Beam mY – Alcove 1



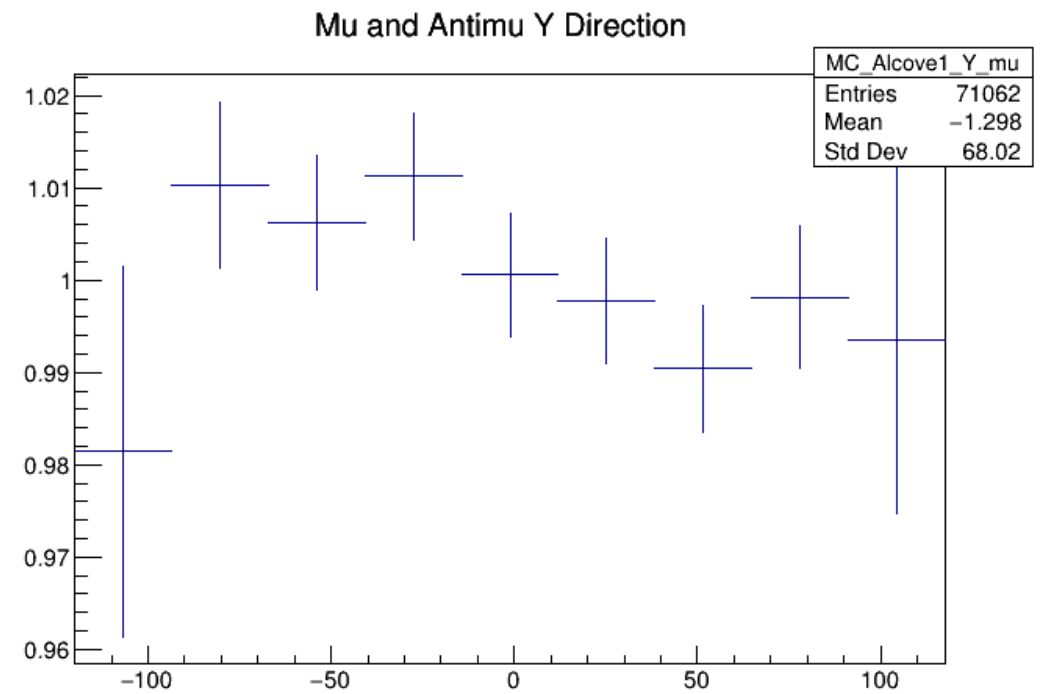
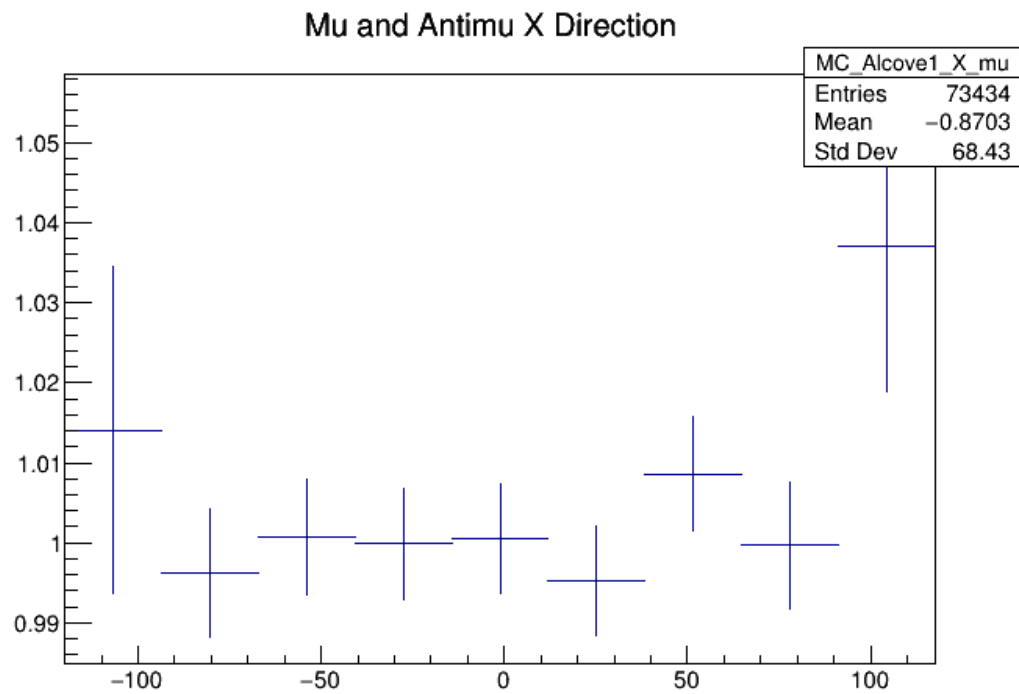
Proton Beam $mY \nu$ Flux at Far Detector



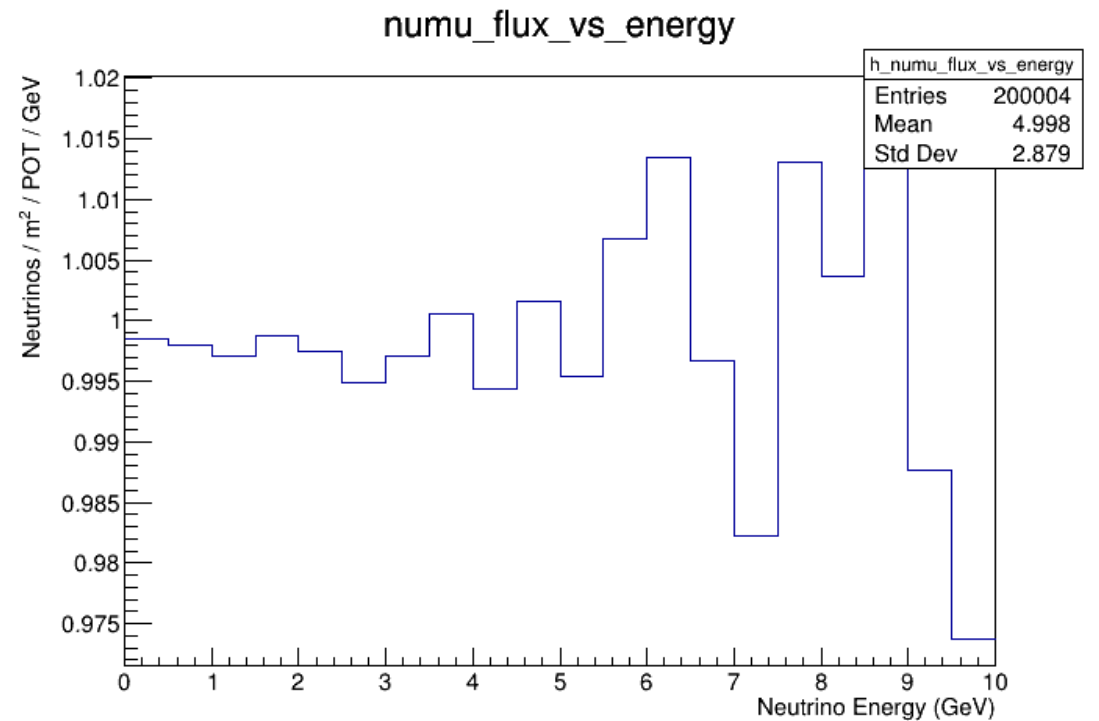
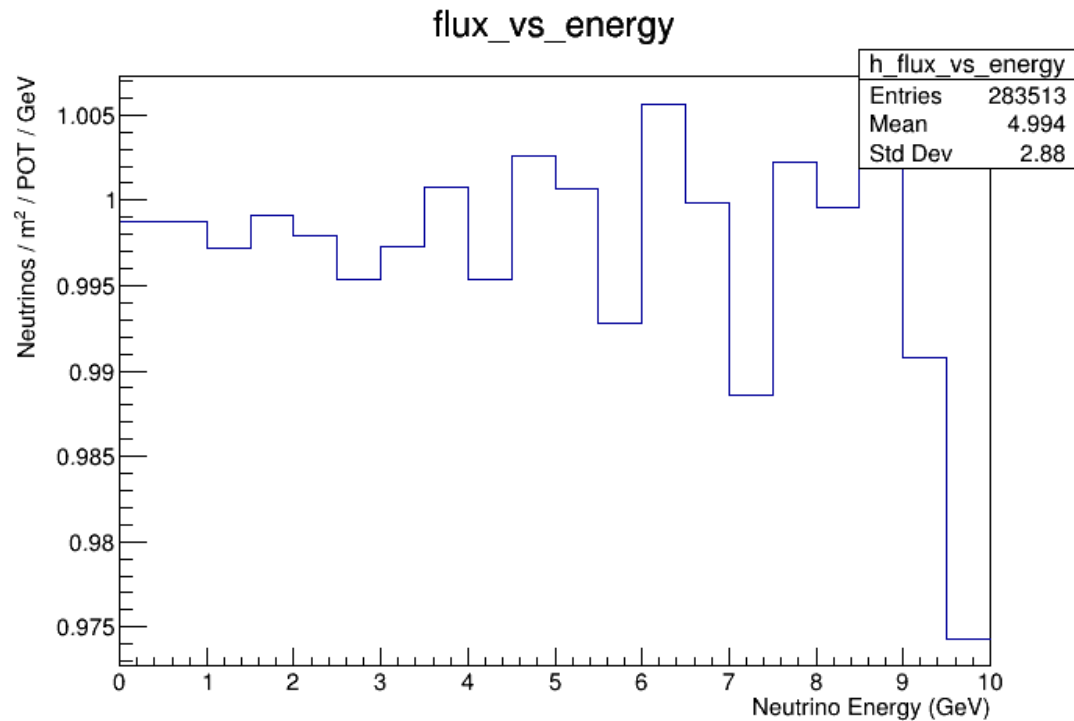
Proton Beam pY – Alcove 1



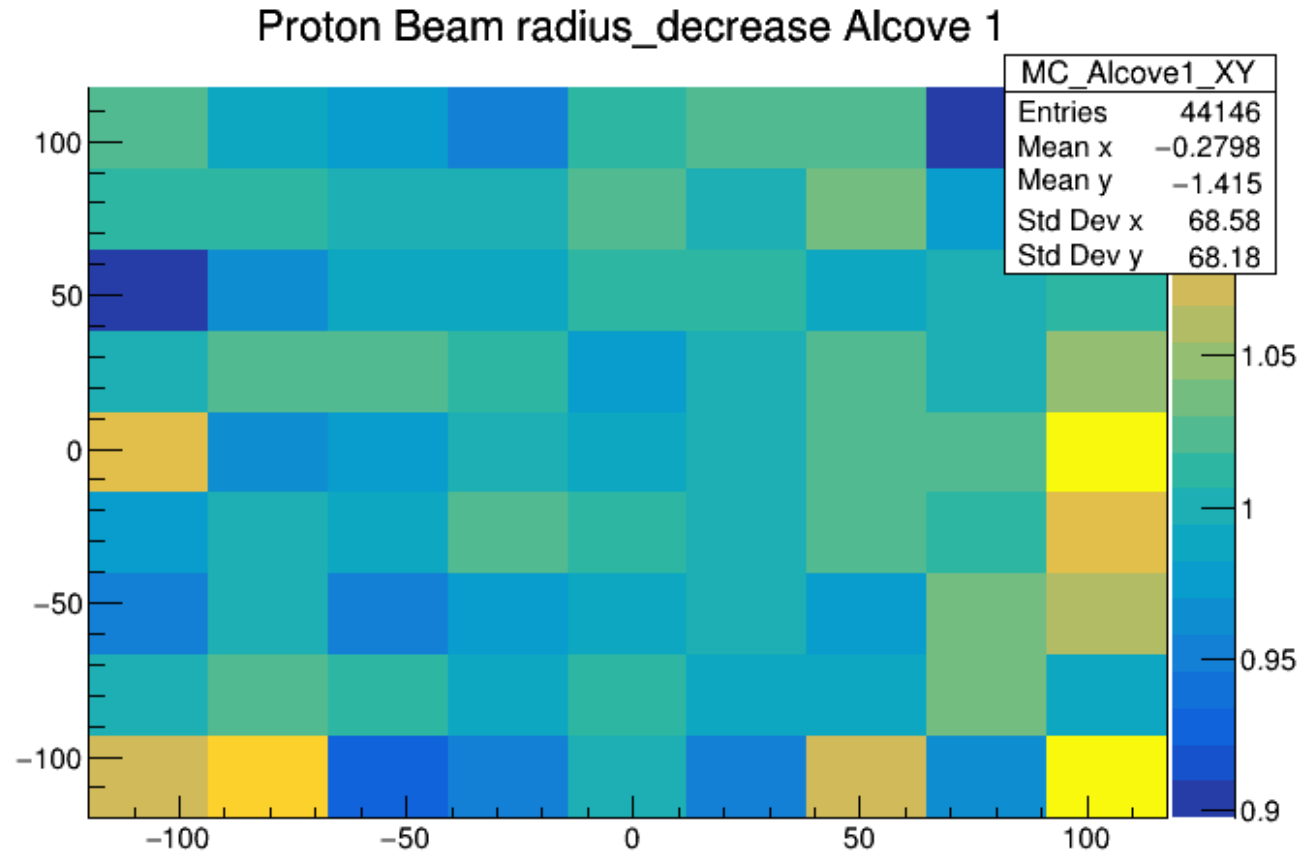
Proton Beam pY – Alcove 1



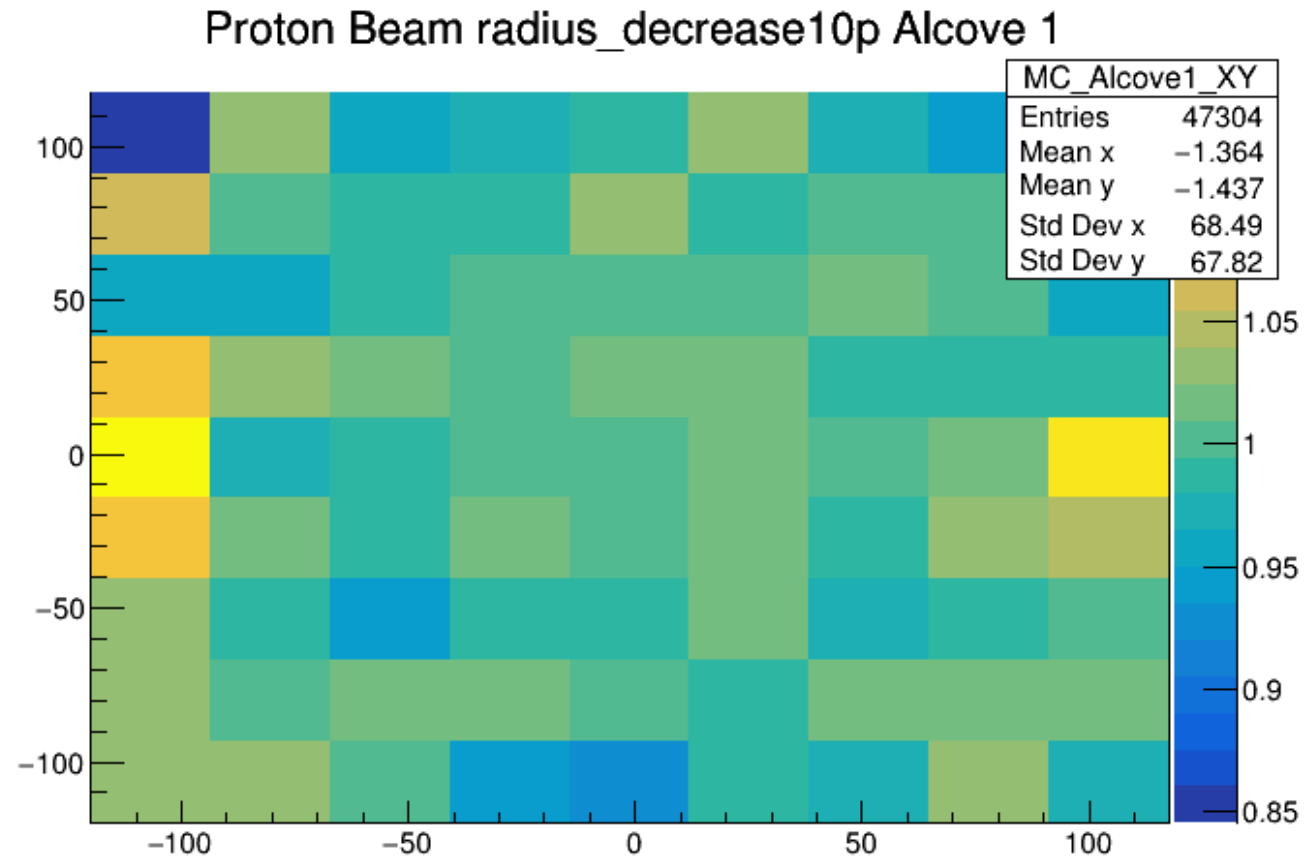
Proton Beam pY ν Flux at Far Detector



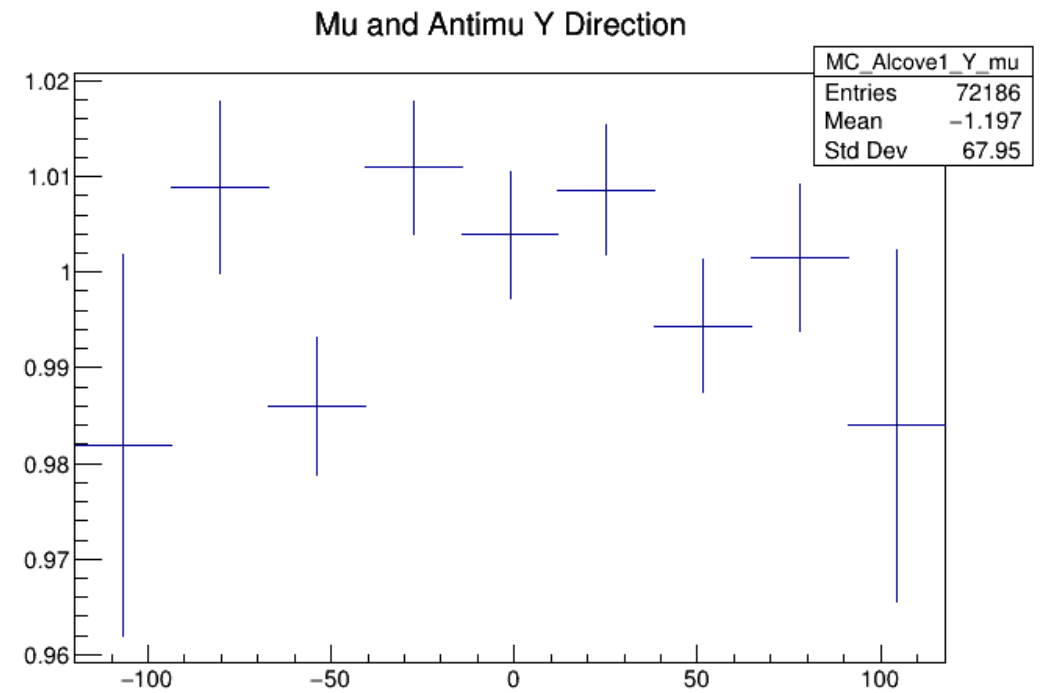
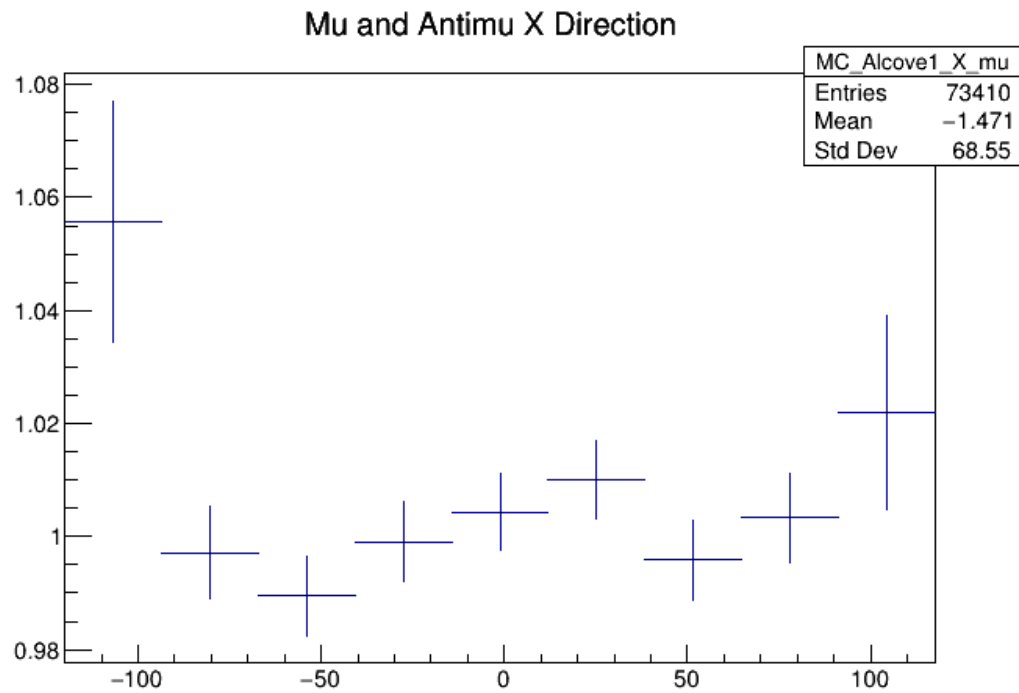
Proton Beam Radius Decrease – Alcove 1



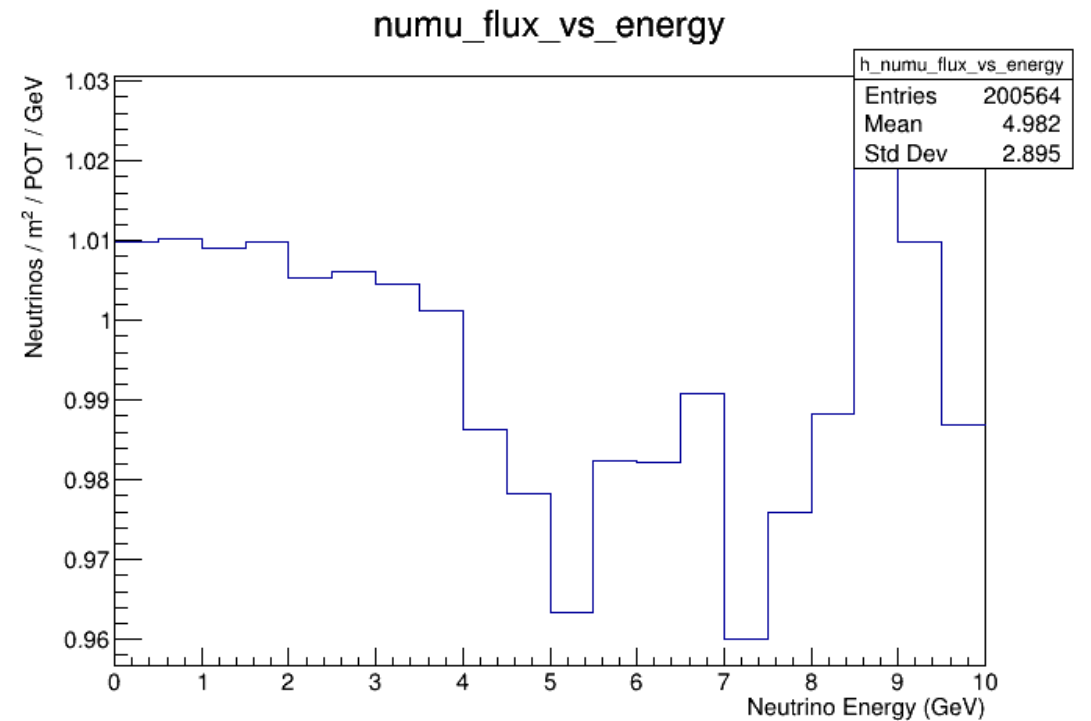
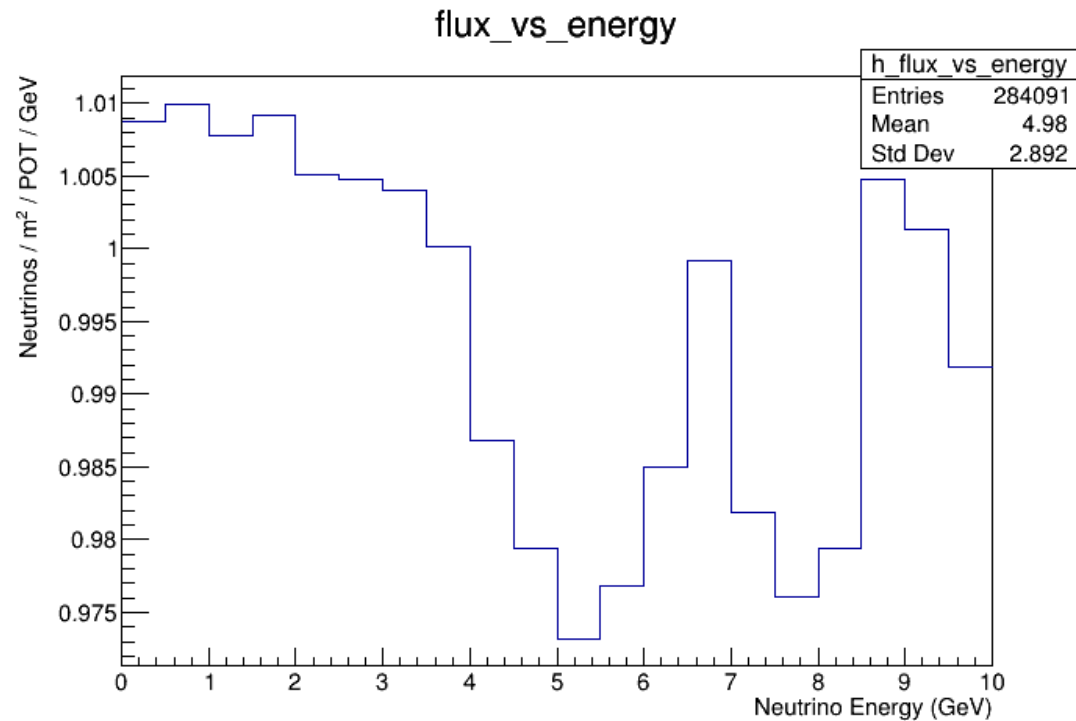
Proton Beam Radius Decrease 10p – Alcove 1



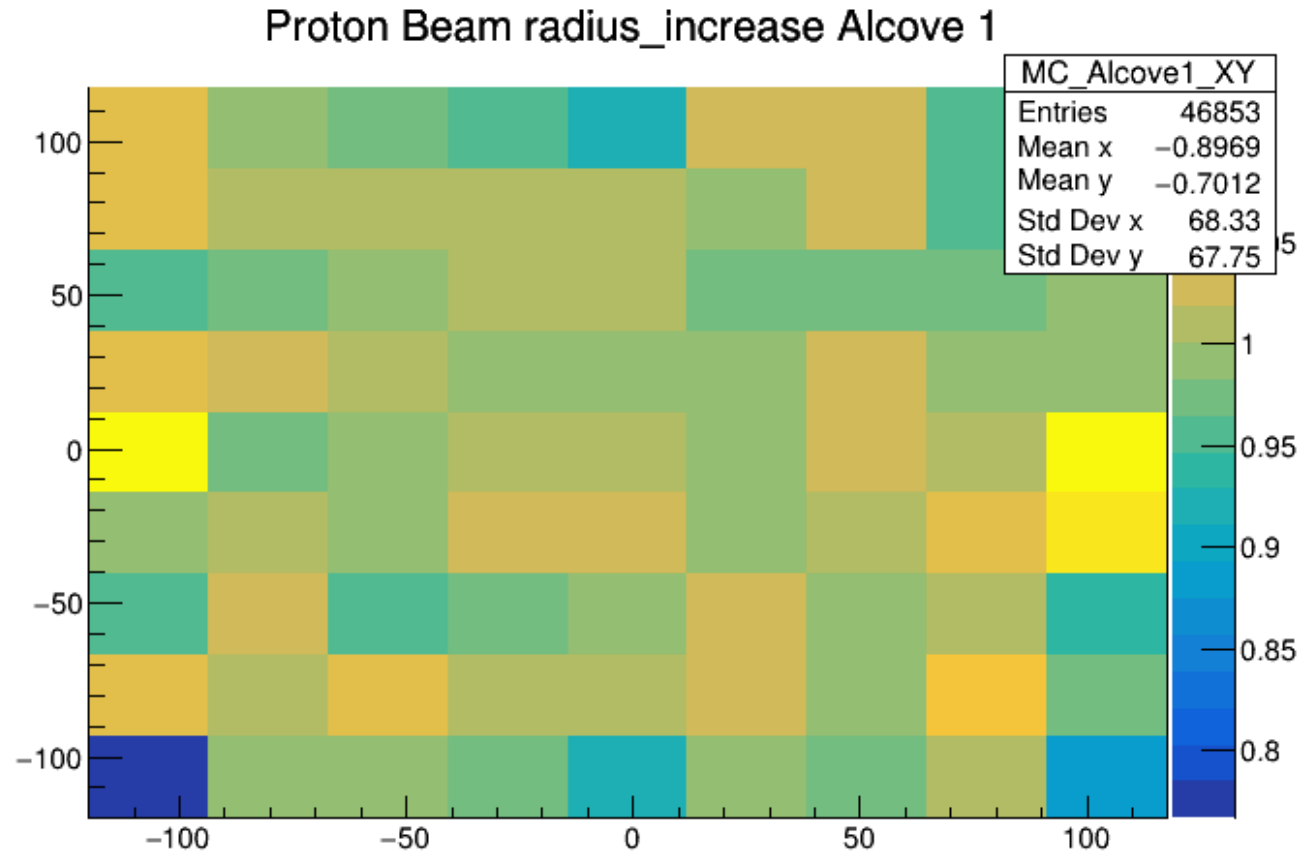
Proton Beam Radius Decrease 10p – Alcove 1



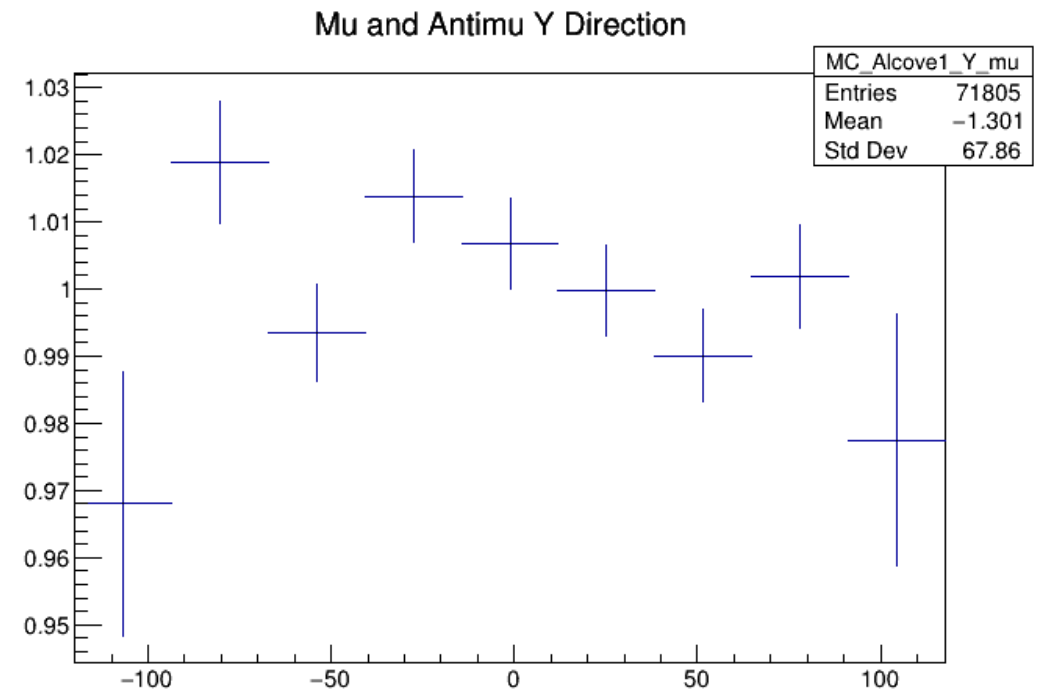
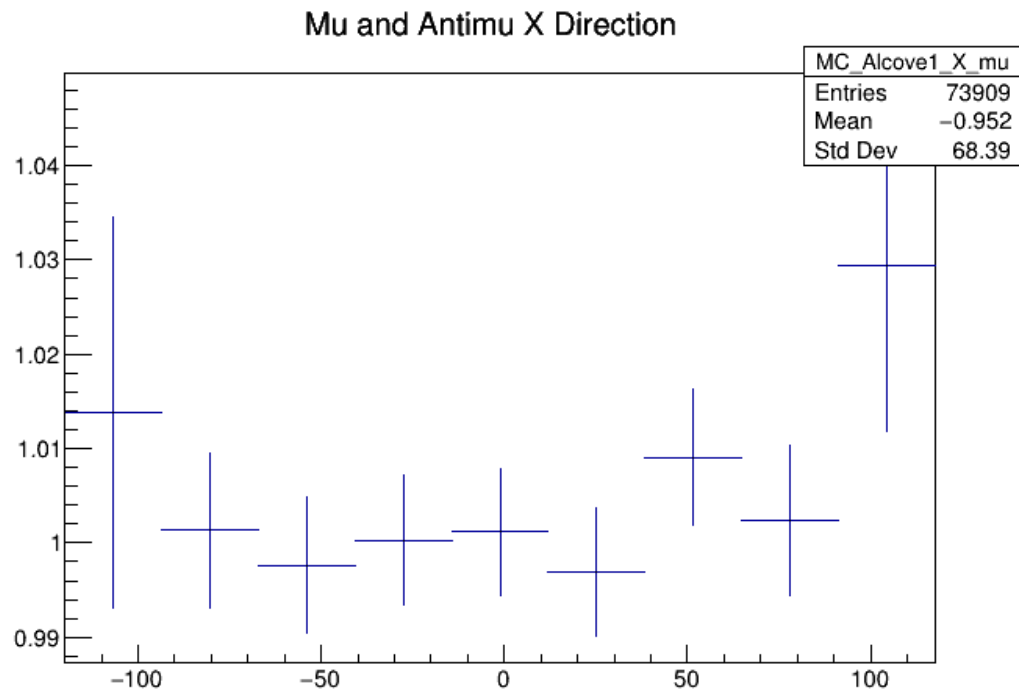
Proton Beam Radius Decrease 10p v Flux FD



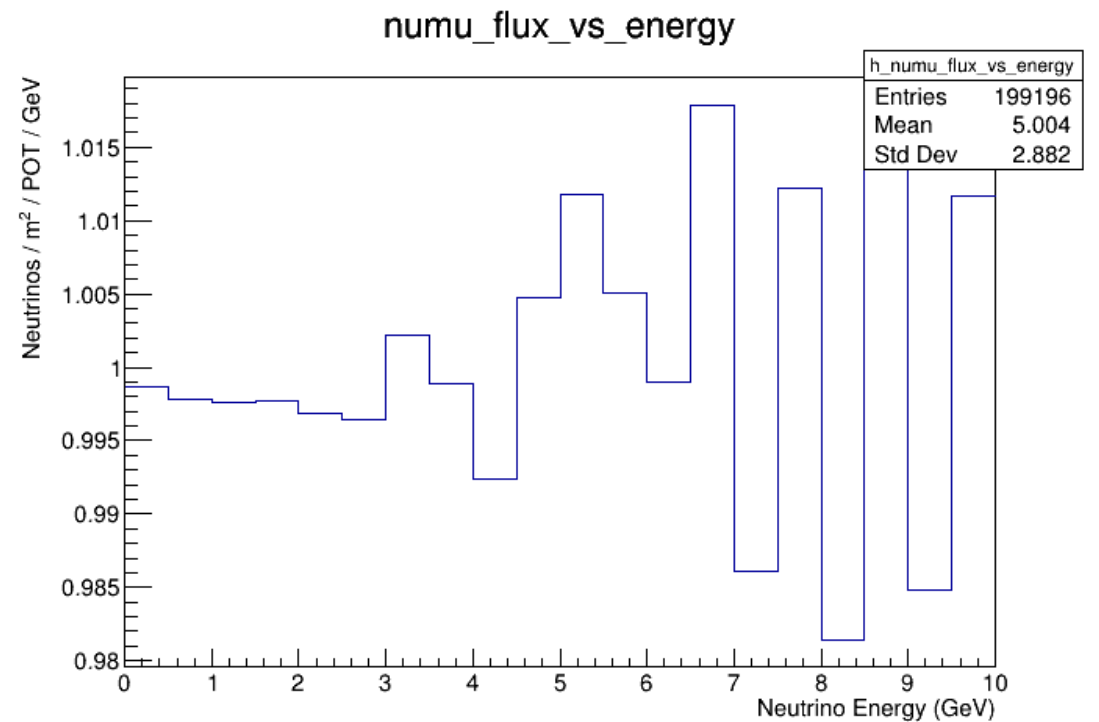
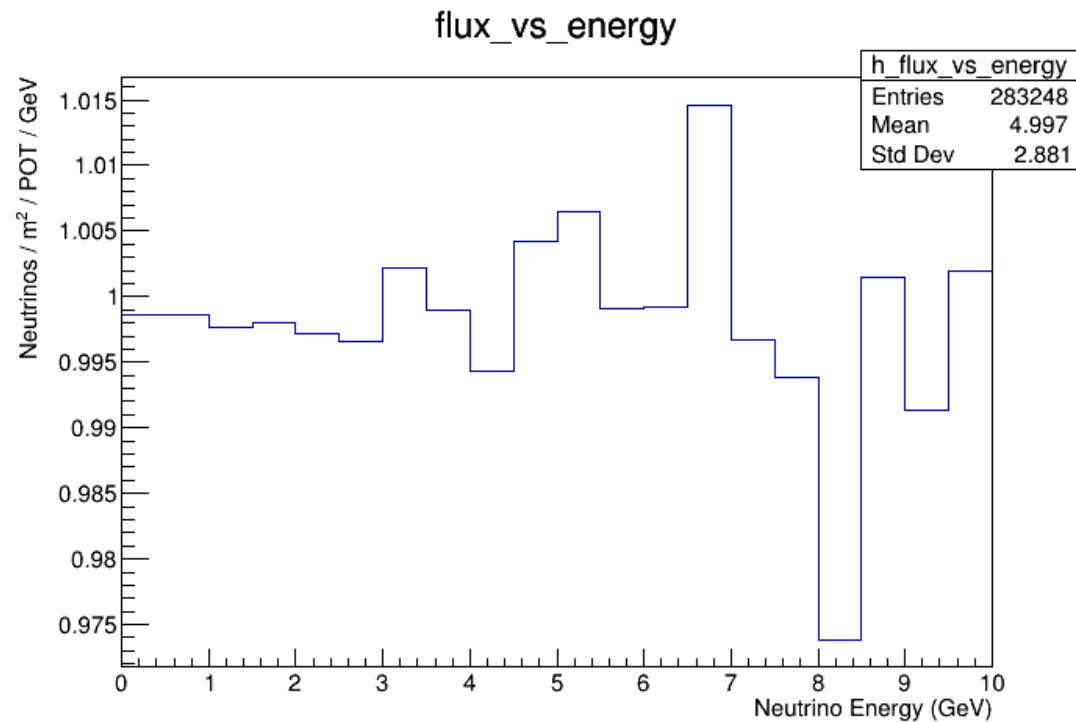
Proton Beam Radius Increase – Alcove 1



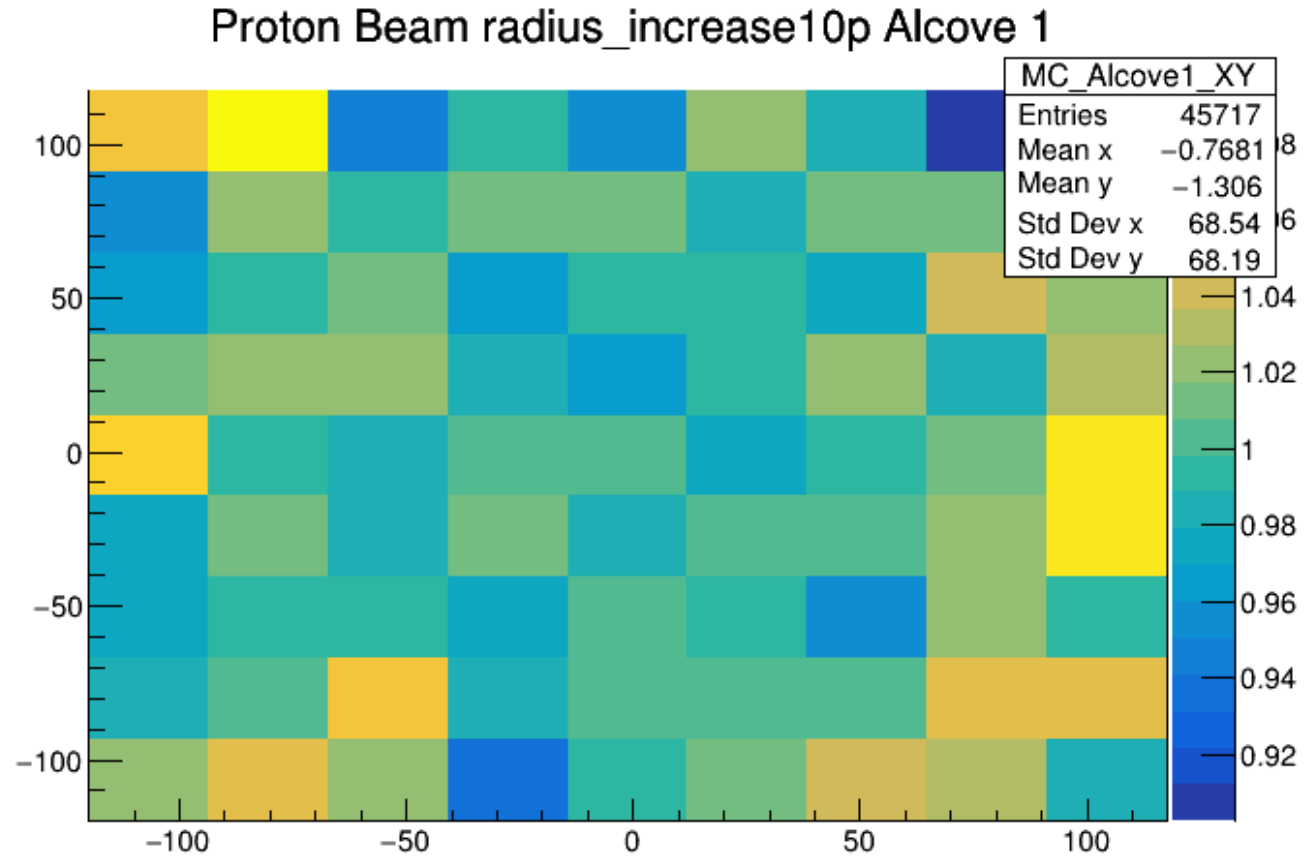
Proton Beam Radius Increase – Alcove 1



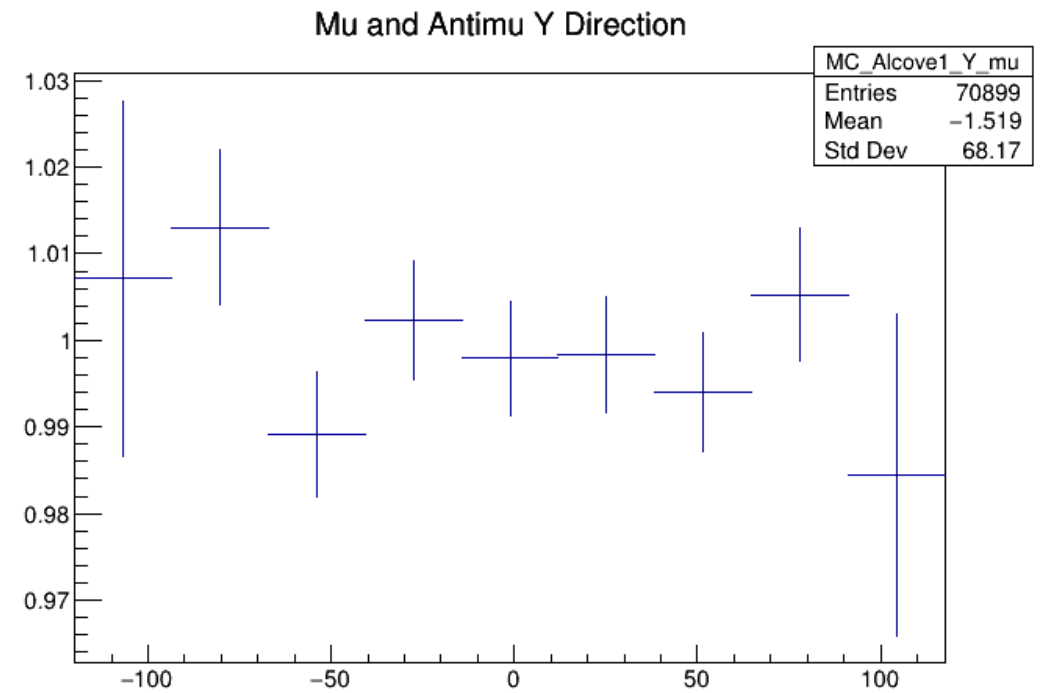
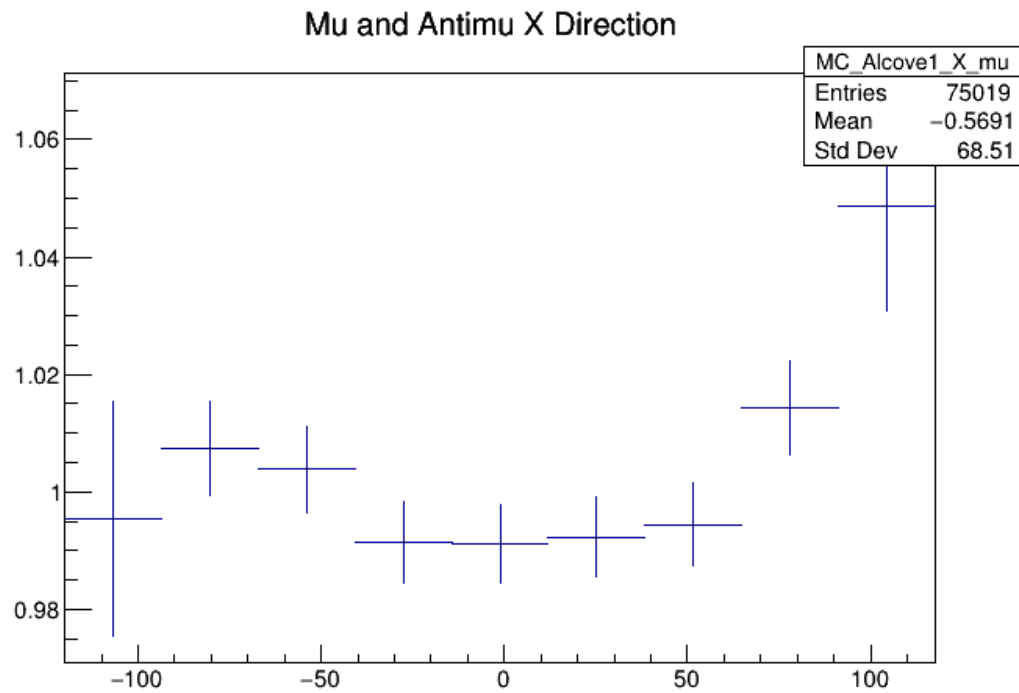
Proton Beam Radius Increase v Flux at FD



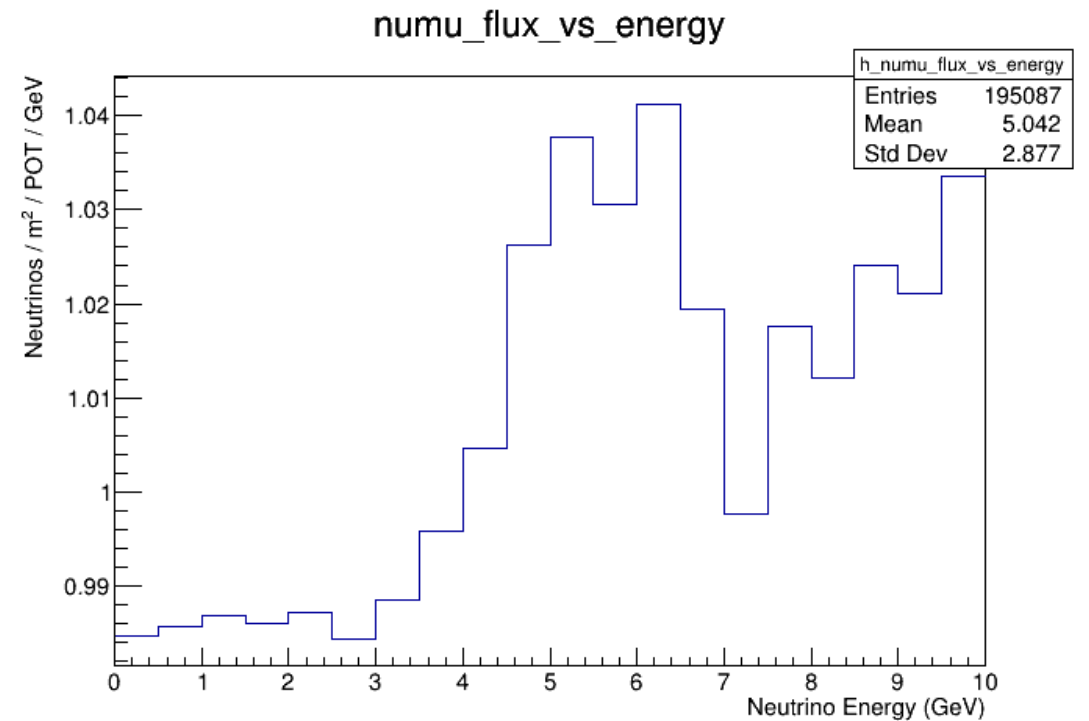
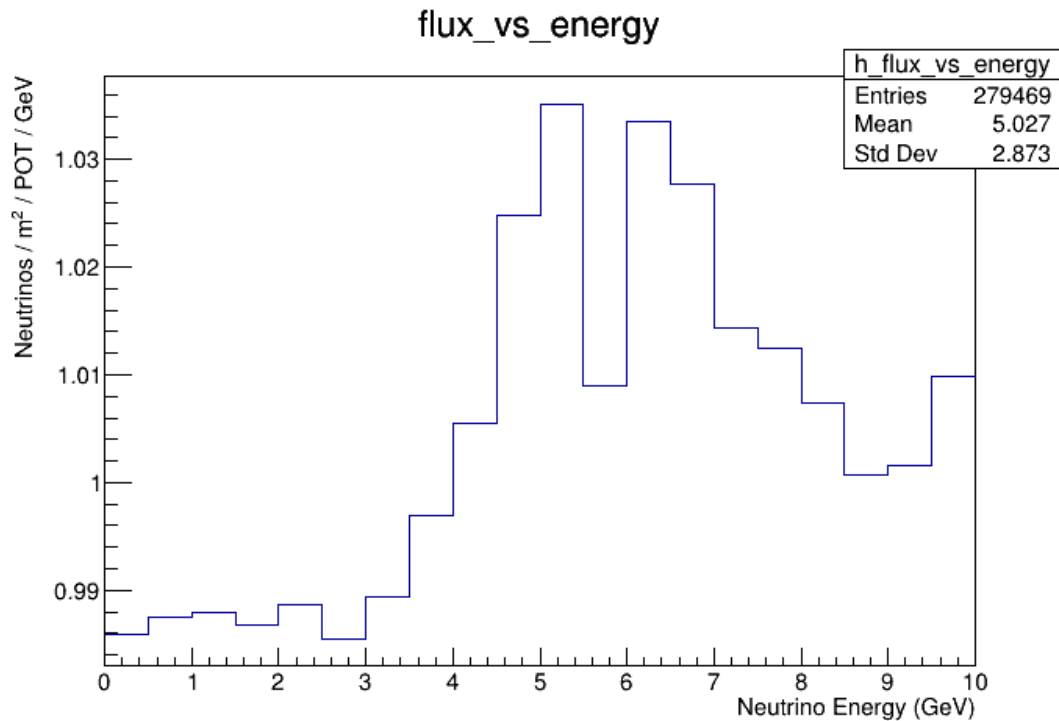
Proton Beam Radius Increase 10p – Alcove 1



Proton Beam Radius Increase 10p – Alcove 1

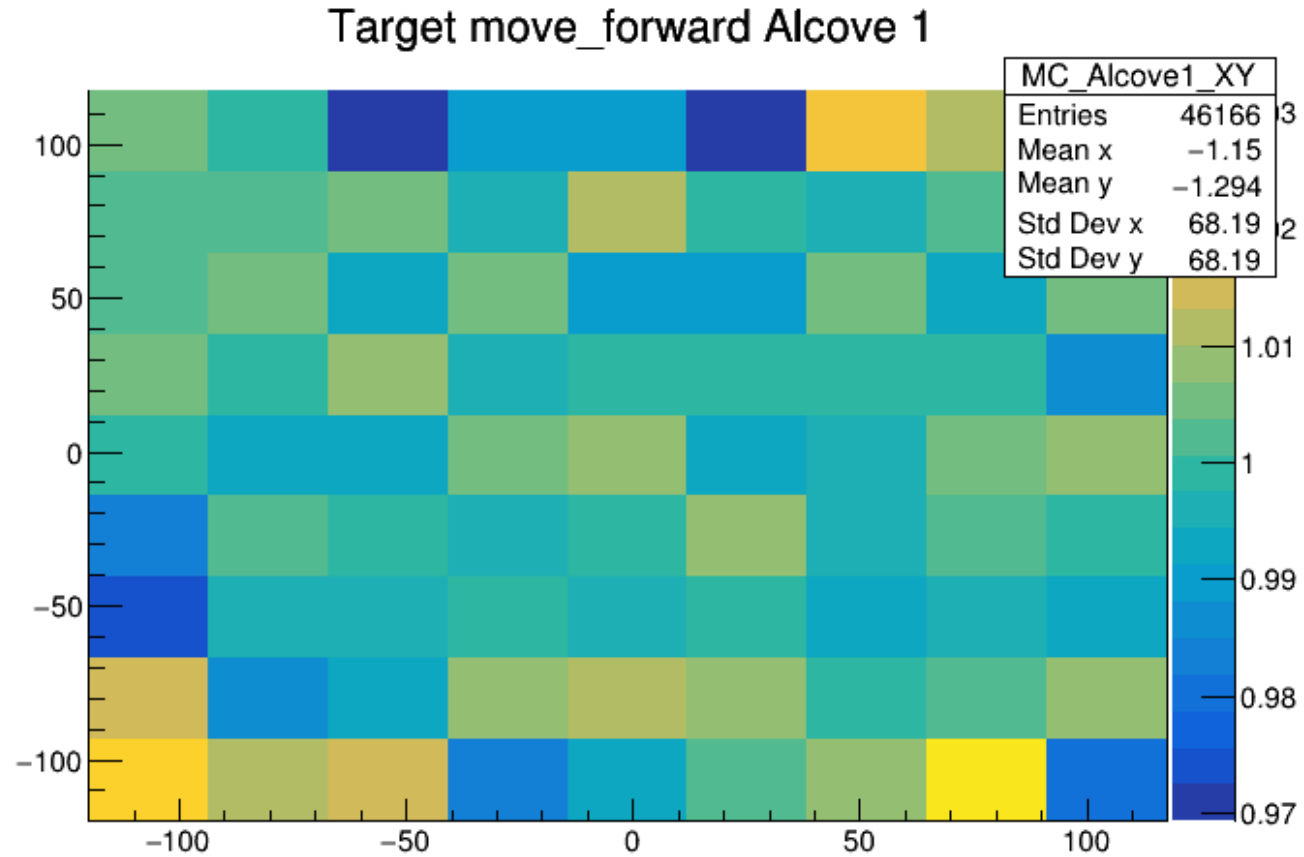


Proton Beam Radius Increase 10p v Flux FD

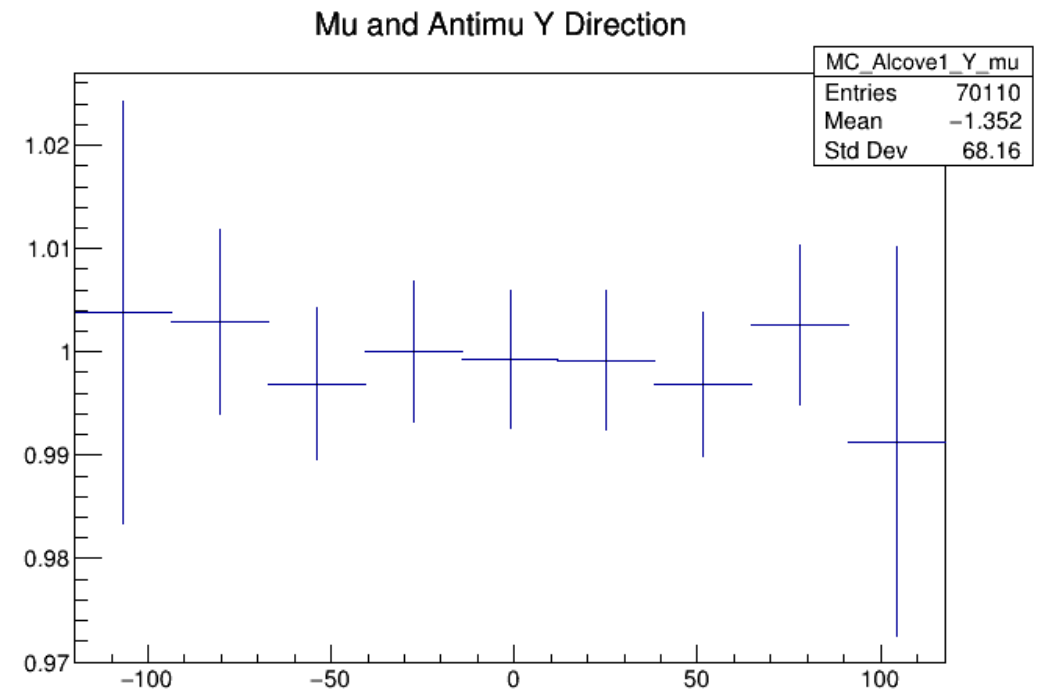
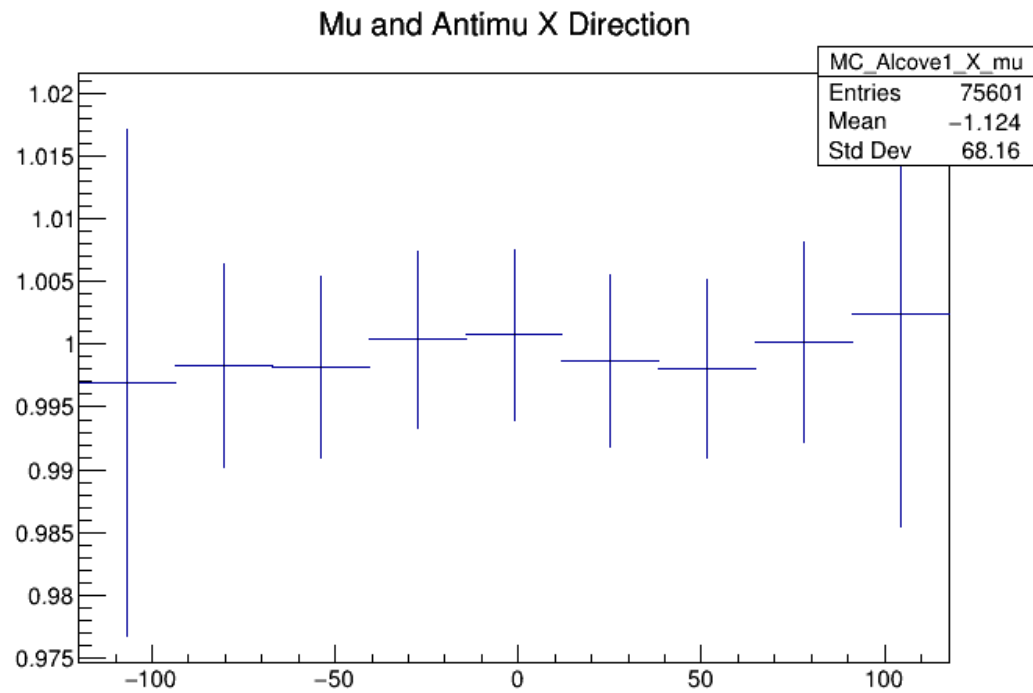


Target

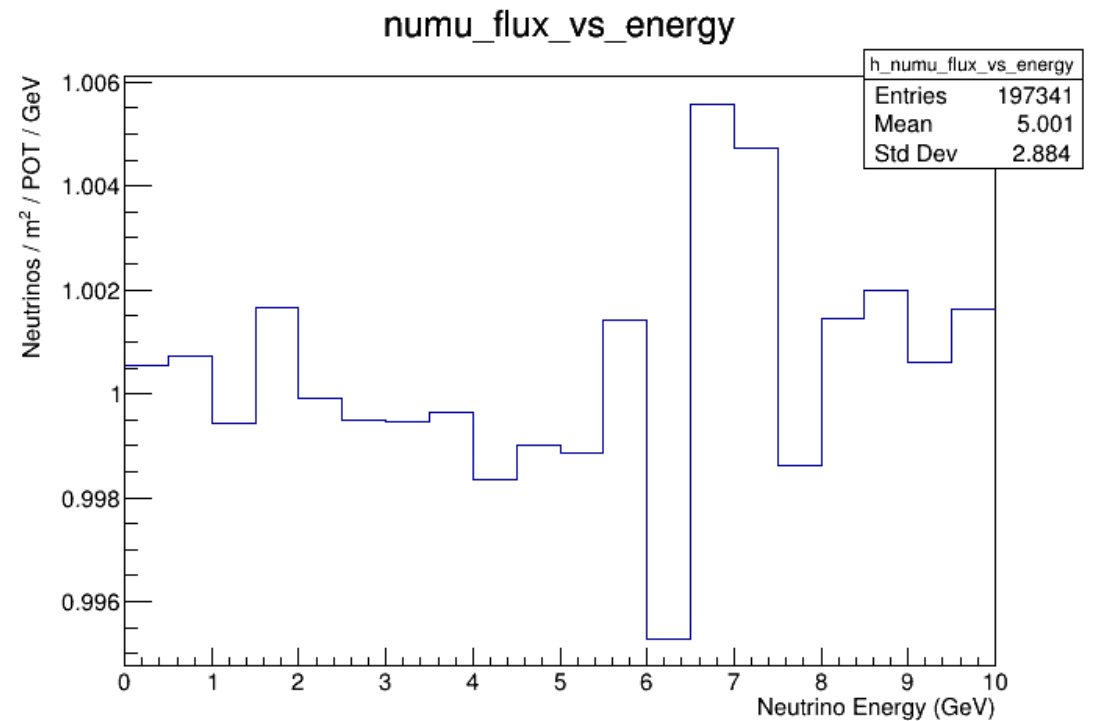
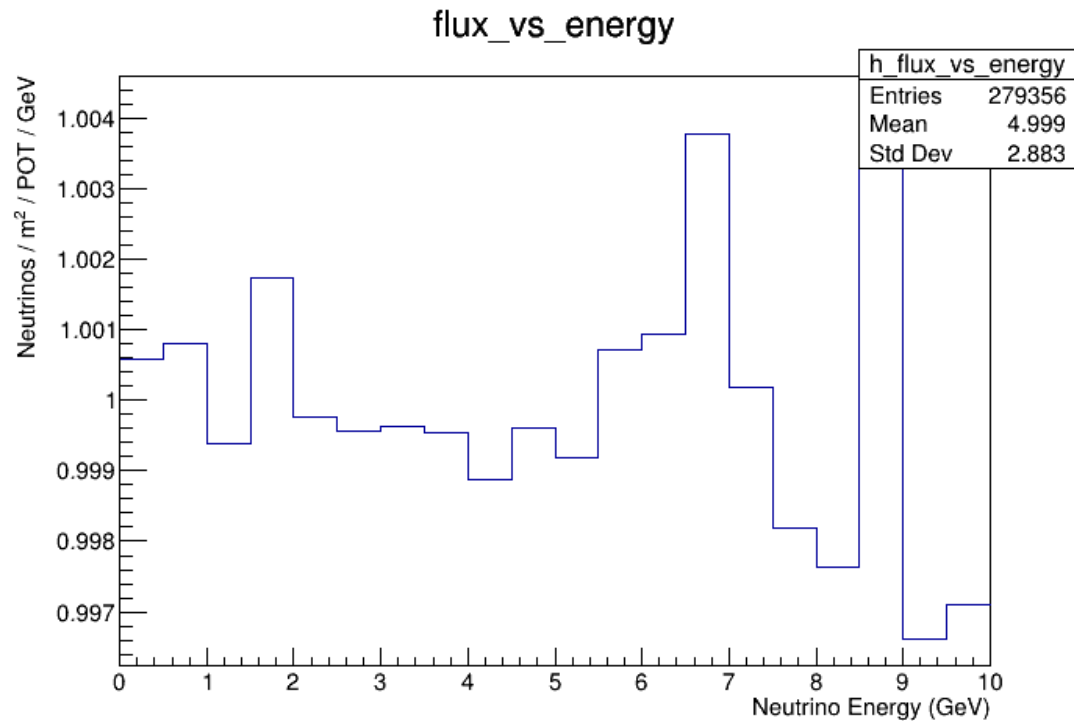
Target Move Forward – Alcove 1



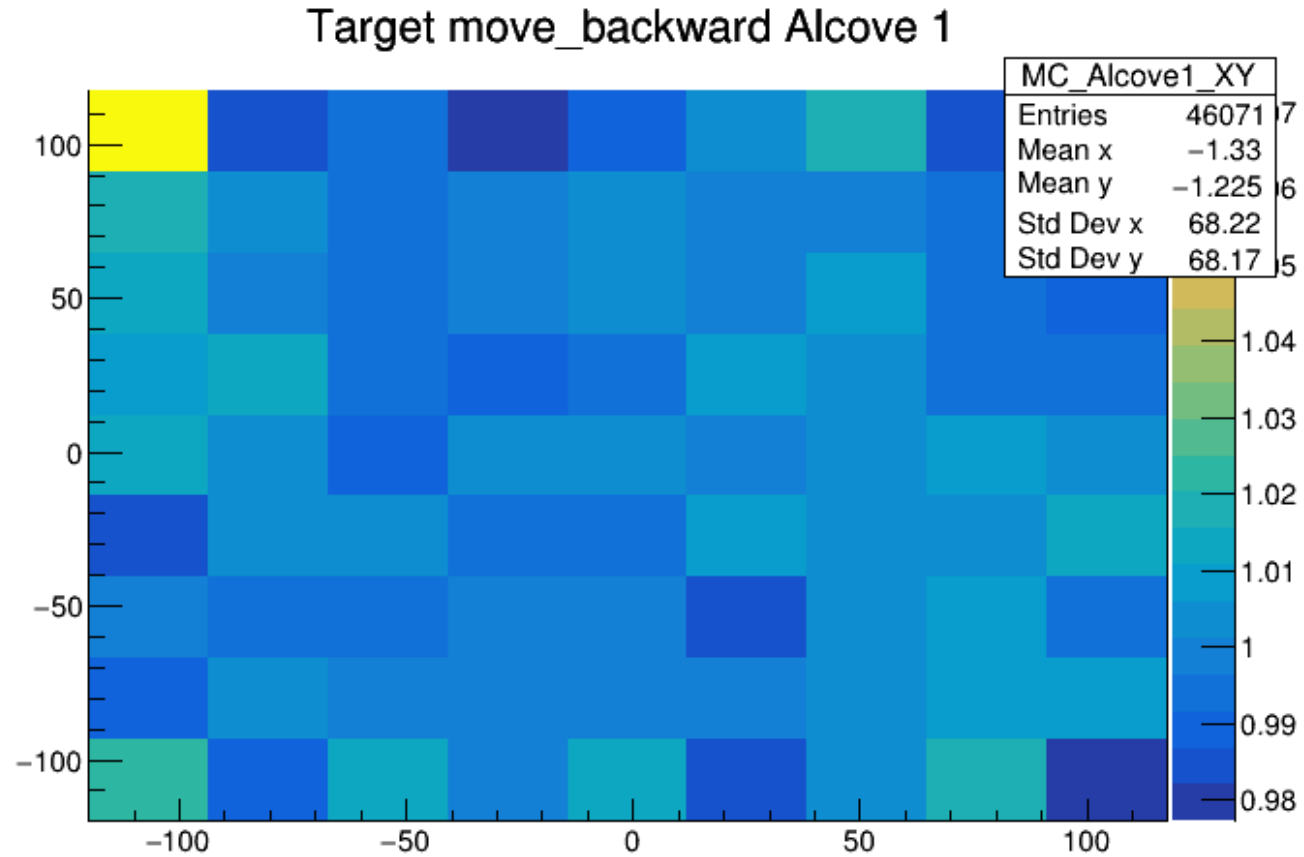
Target Move Forward – Alcove 1



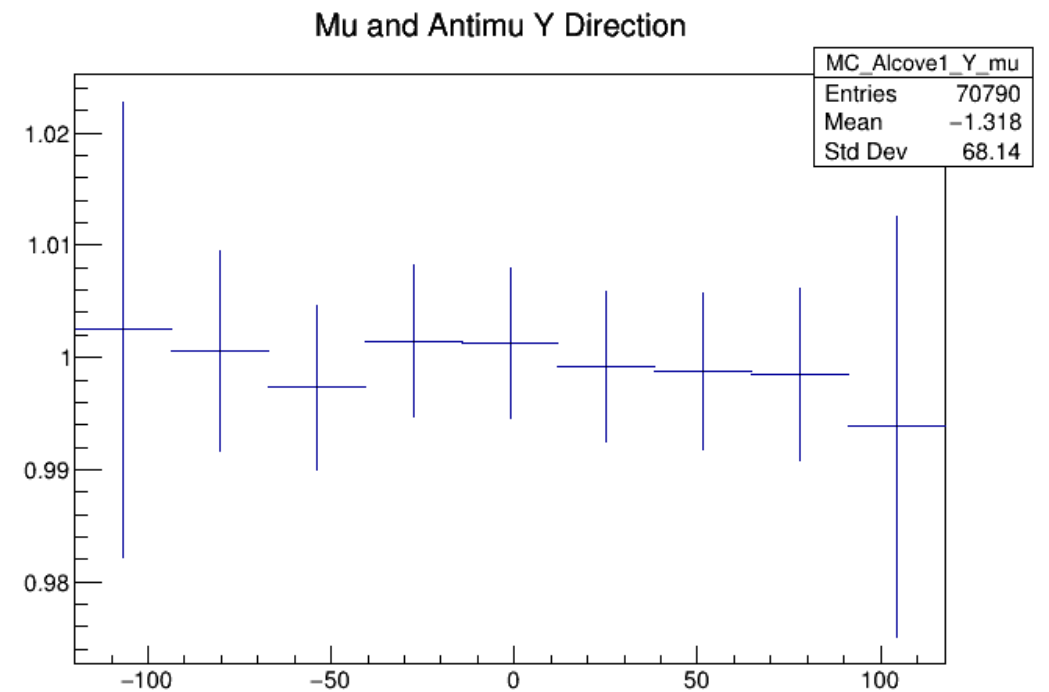
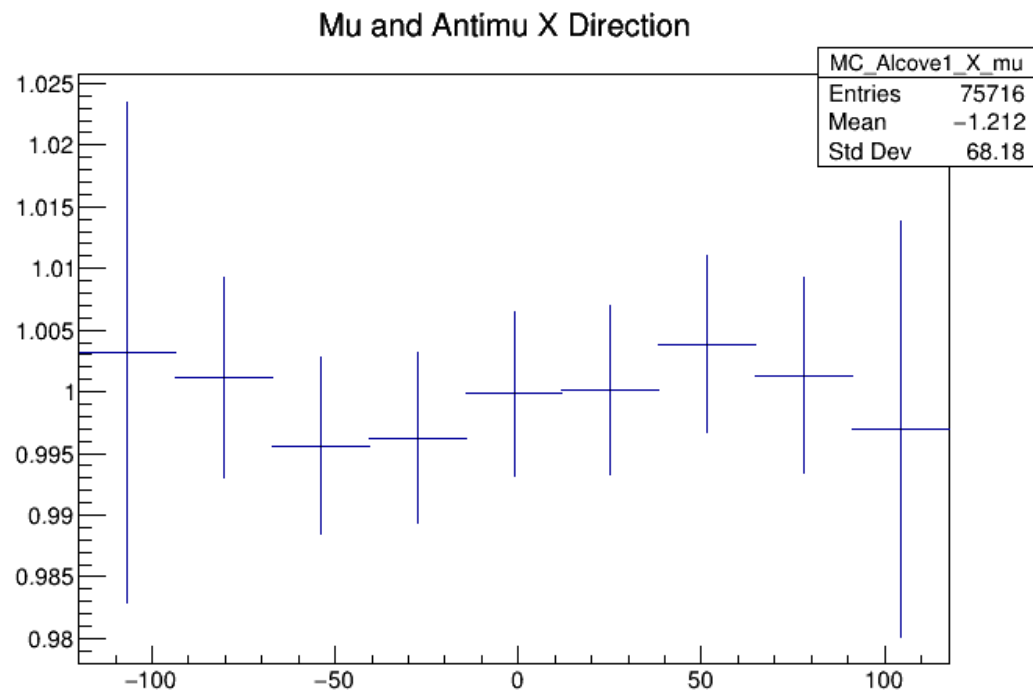
Target Move Forward ν Flux at FD



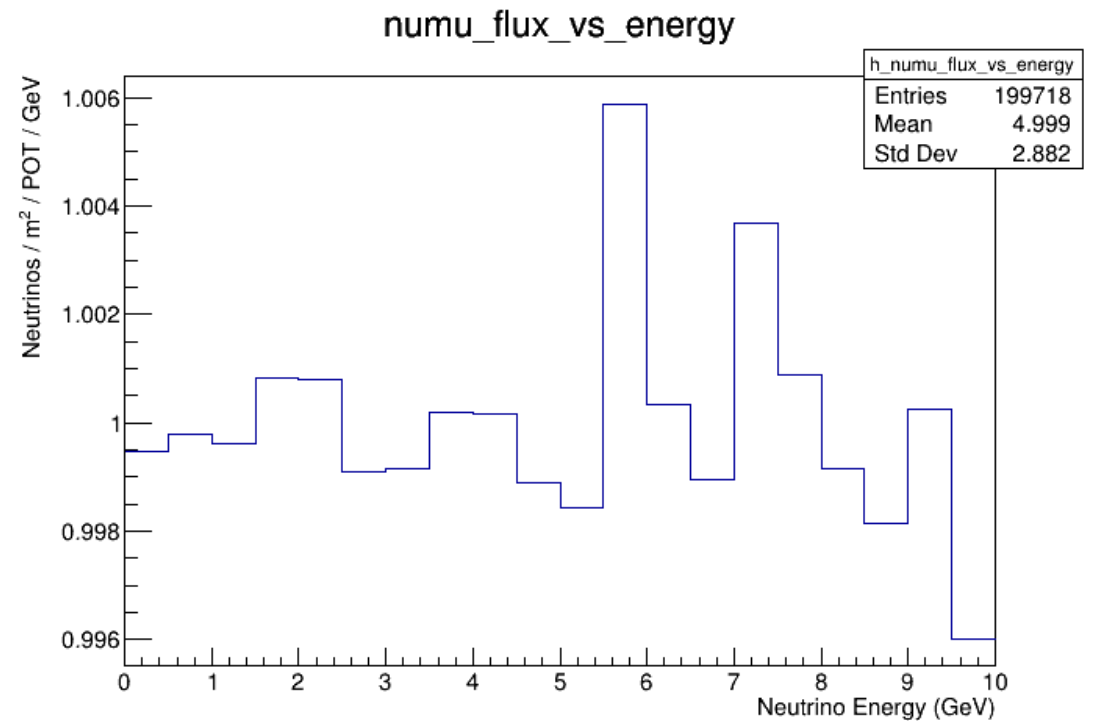
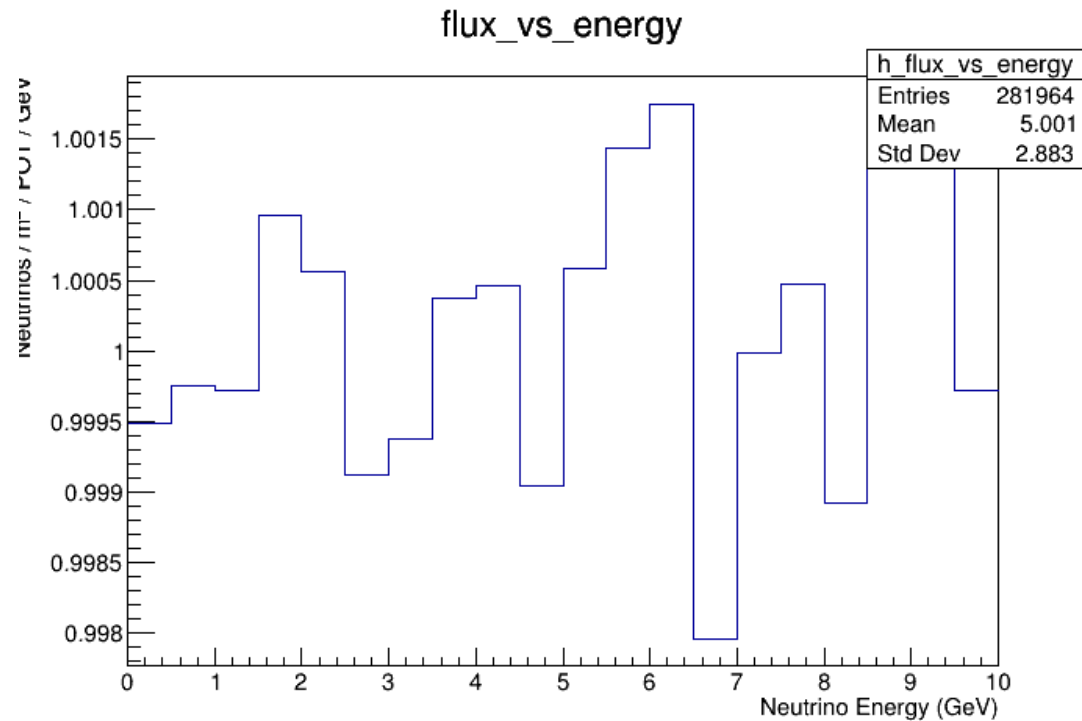
Target Move Backward – Alcove 1



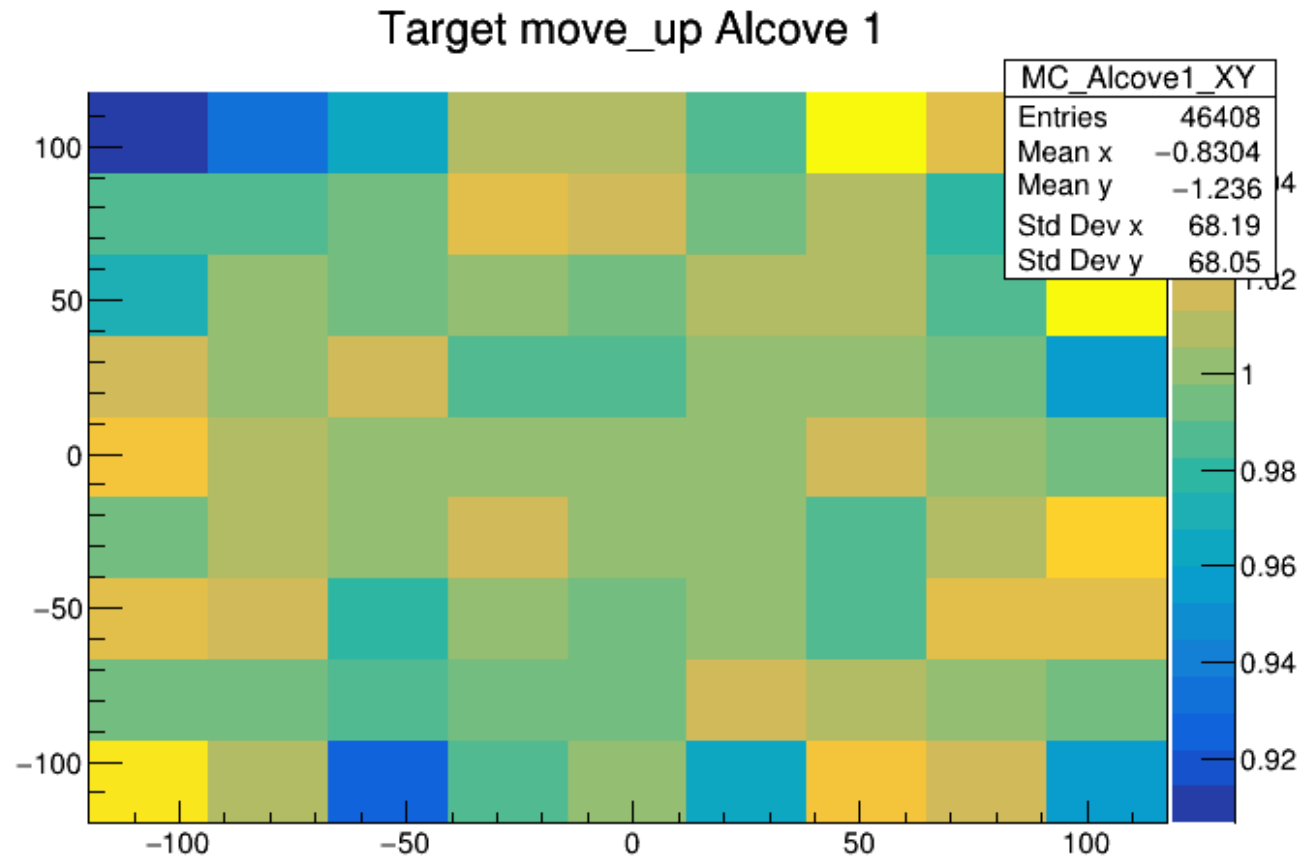
Target Move Backward – Alcove 1



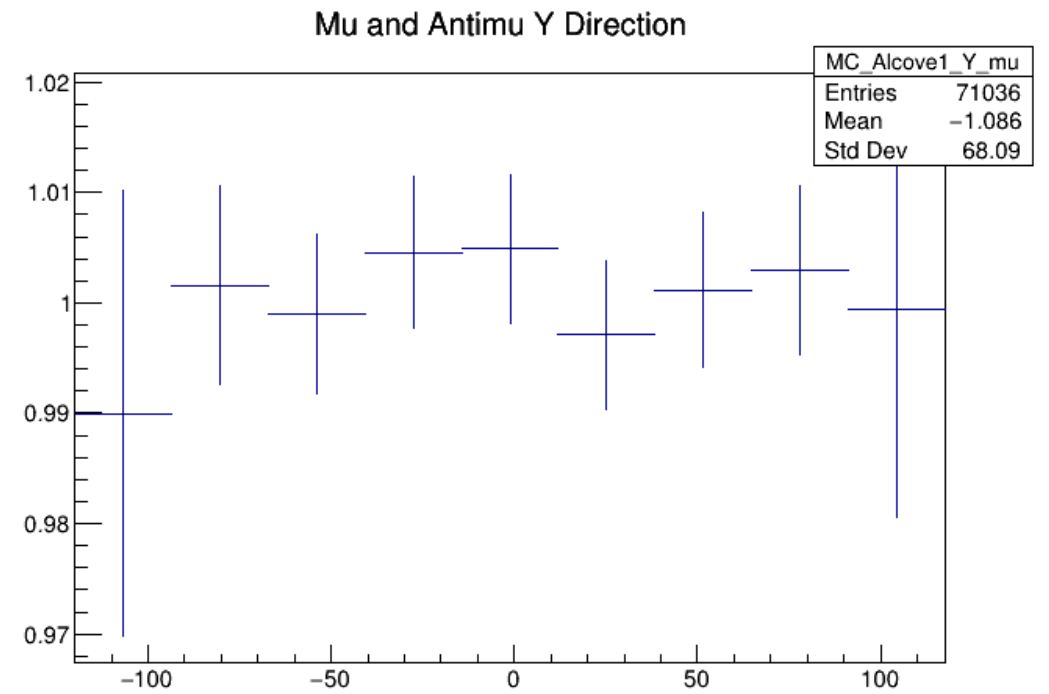
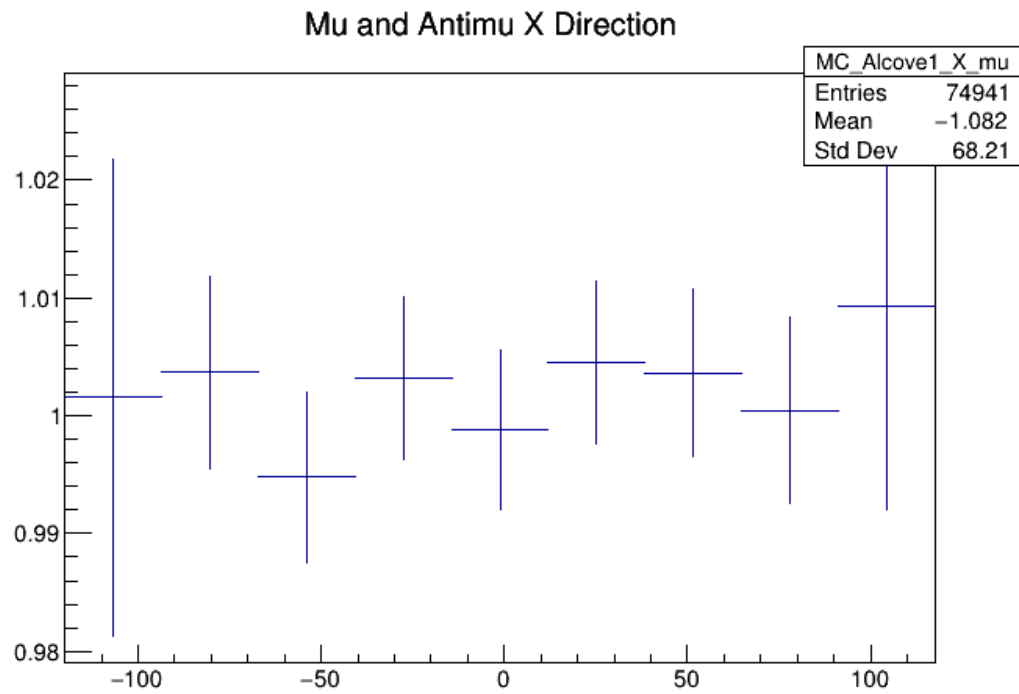
Target Move Backward v Flux at FD



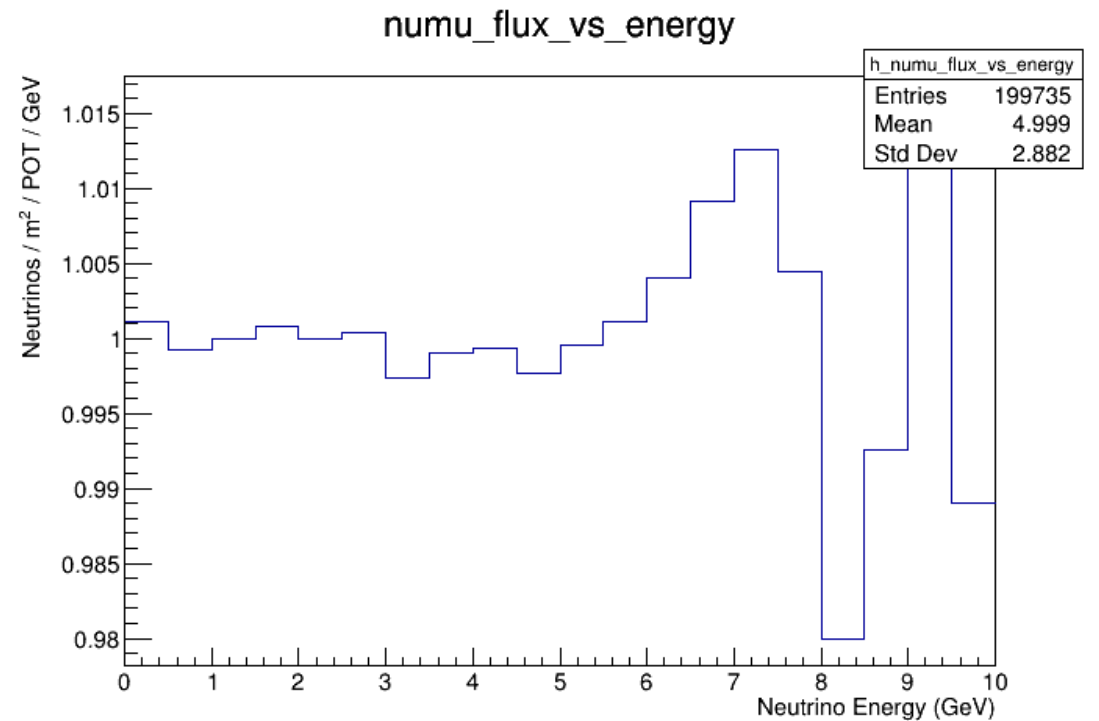
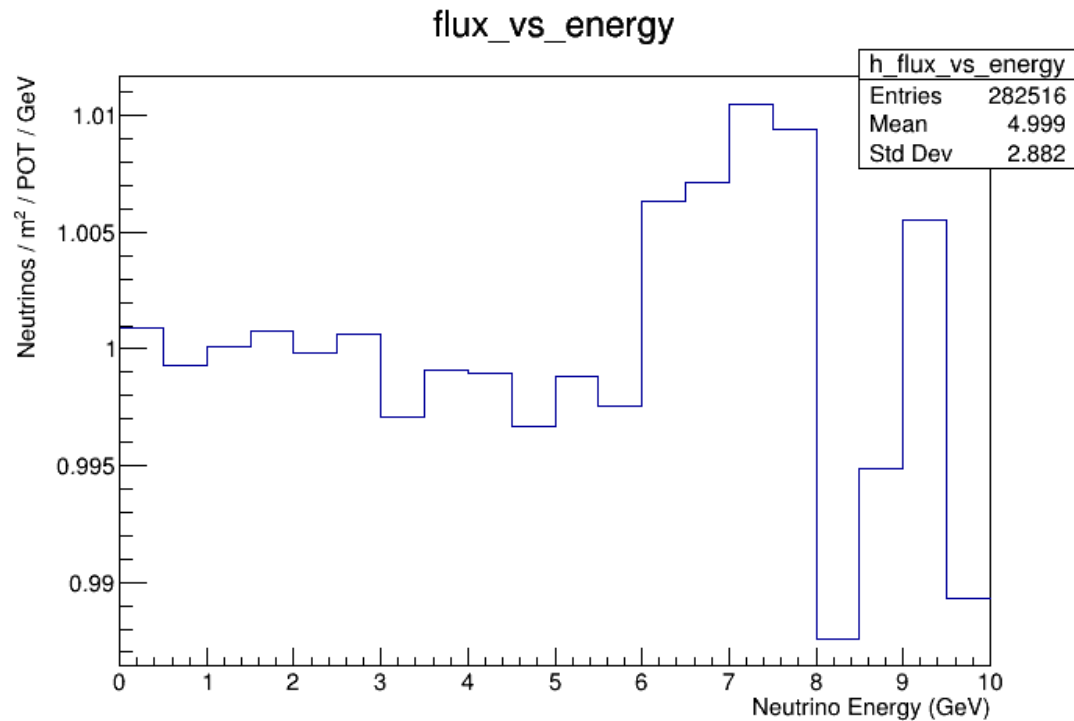
Target Move Up – Alcove 1



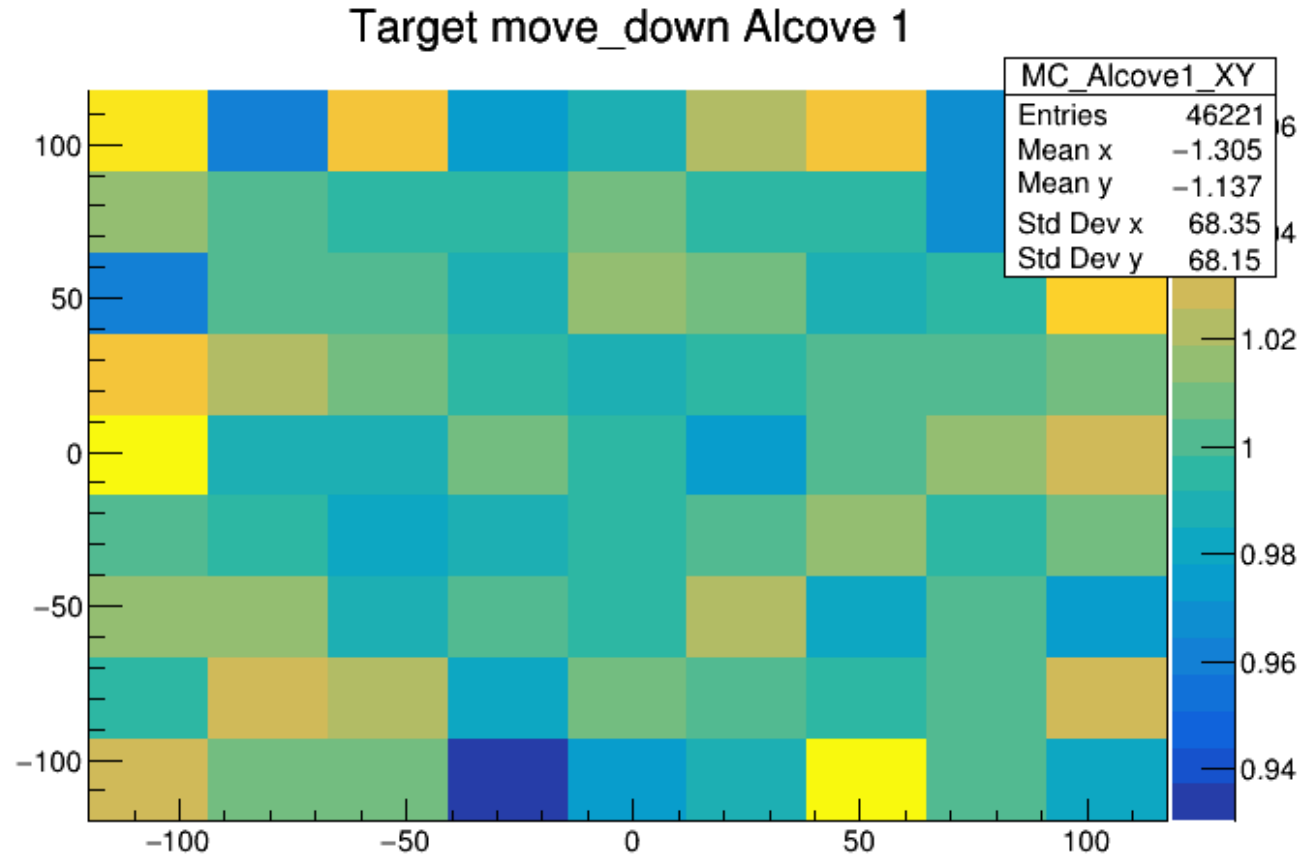
Target Move Up – Alcove 1



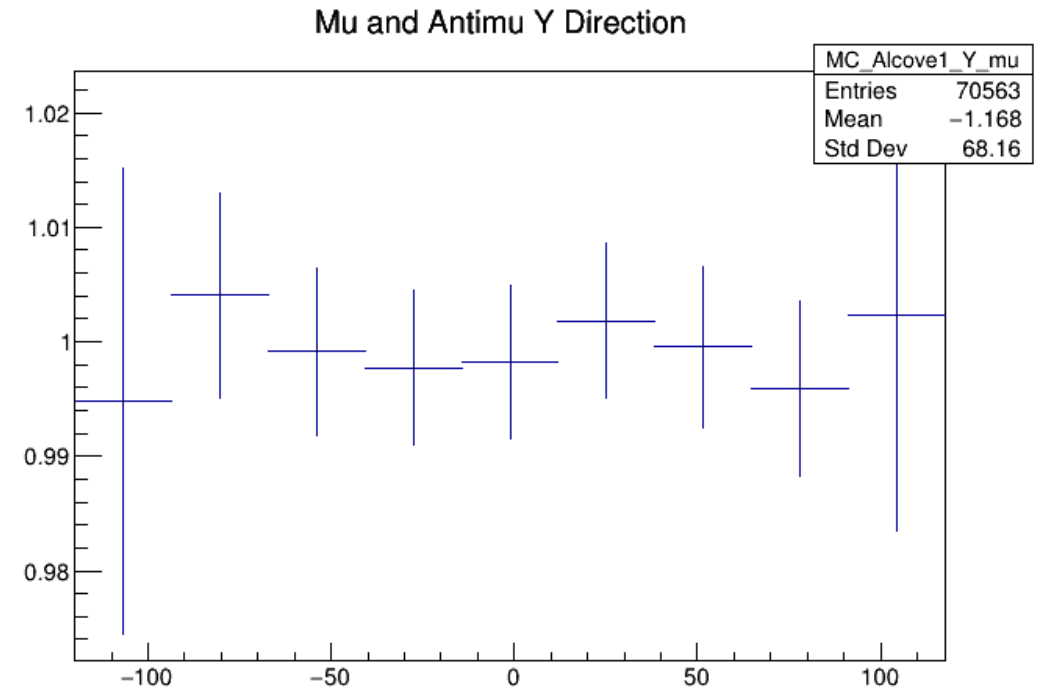
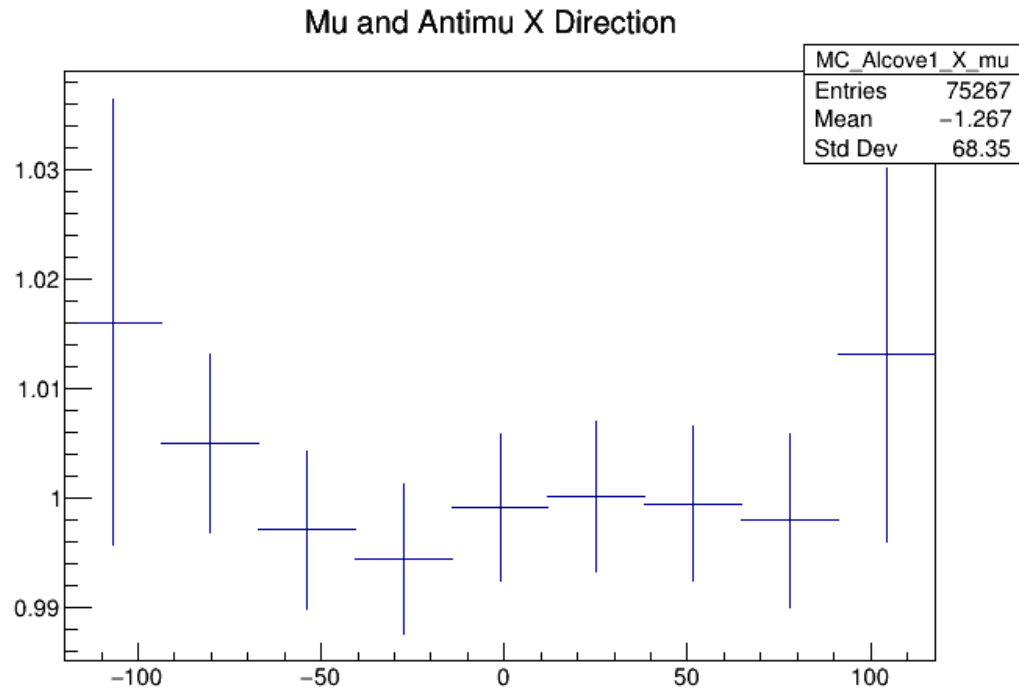
Target Move Up ν Flux at FD



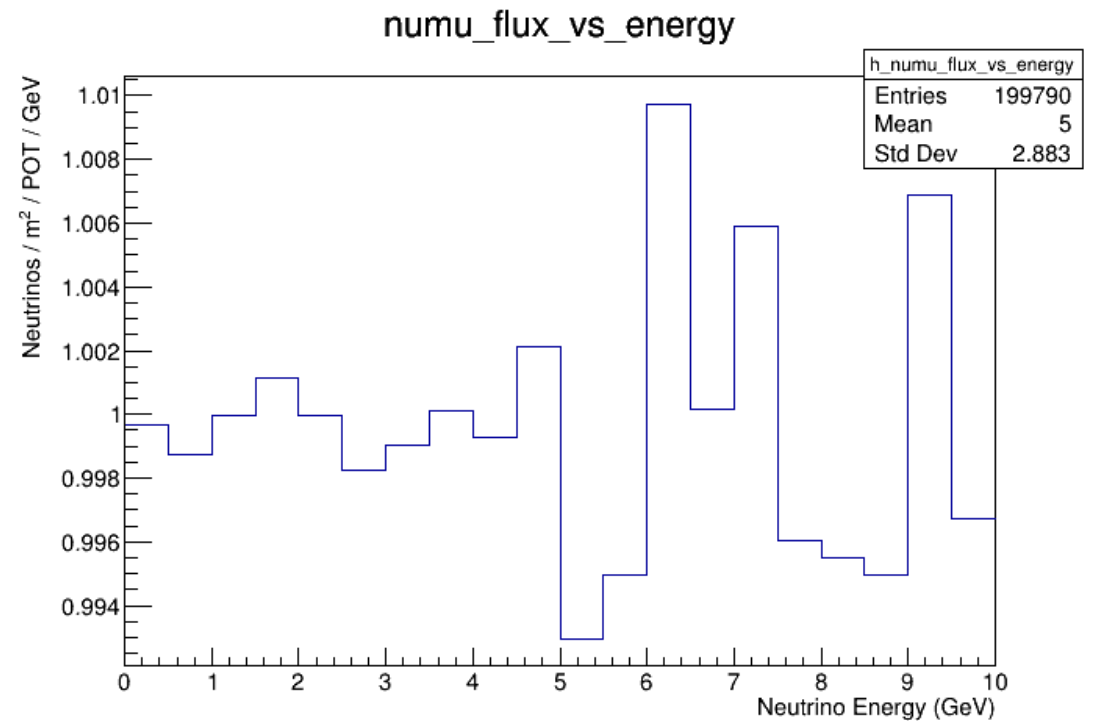
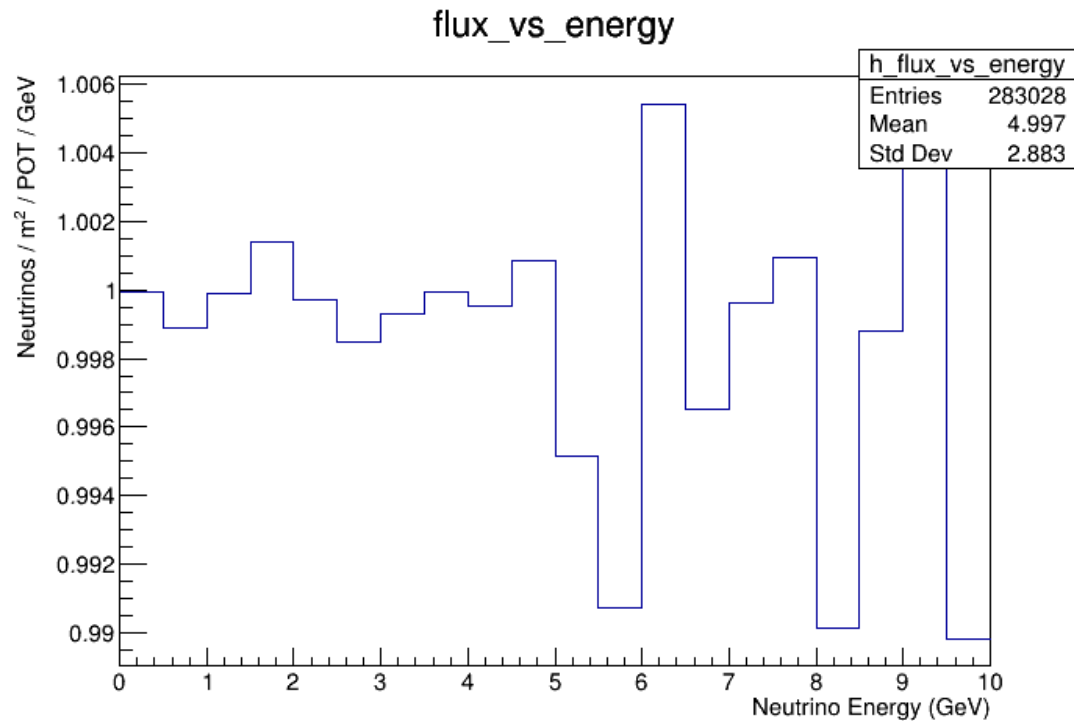
Target Move Down – Alcove 1



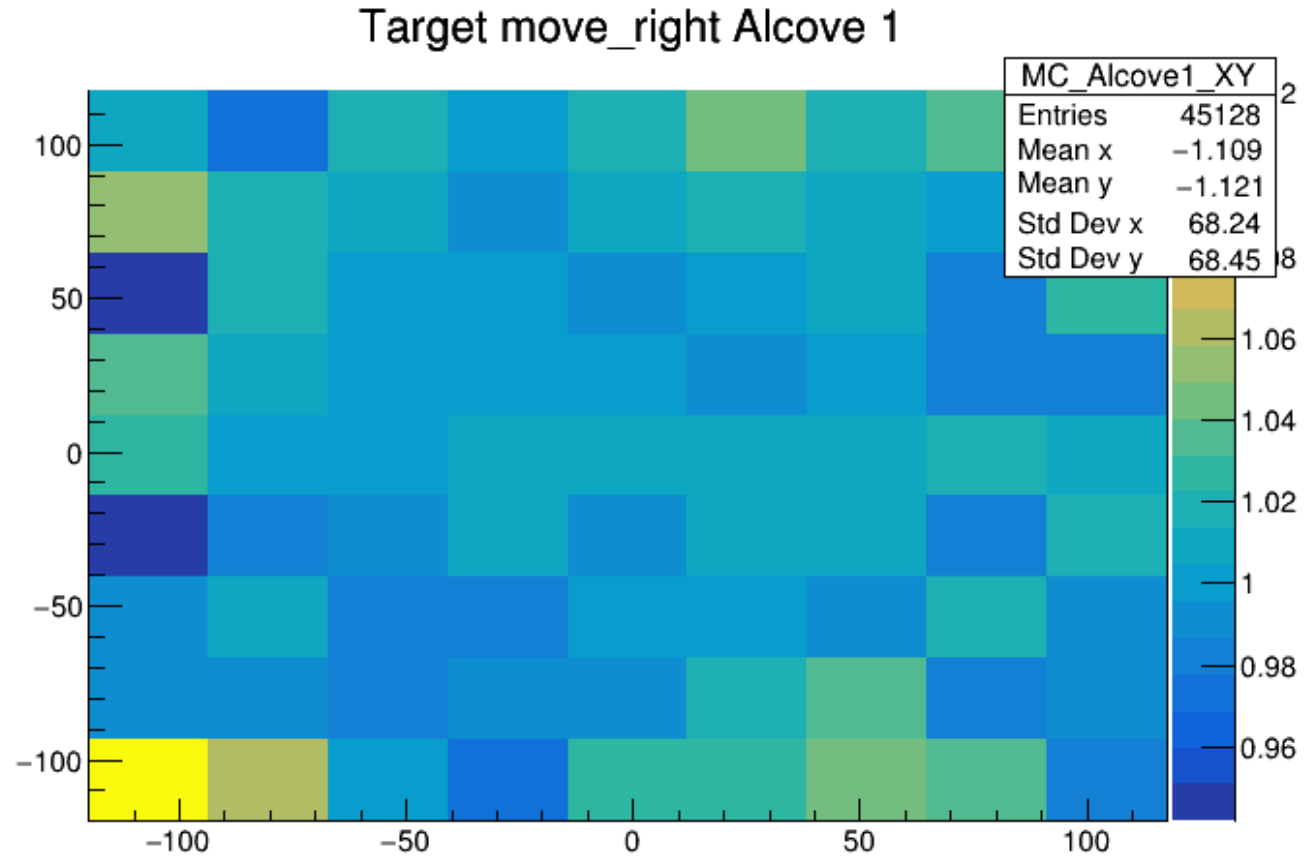
Target Move Down – Alcove 1



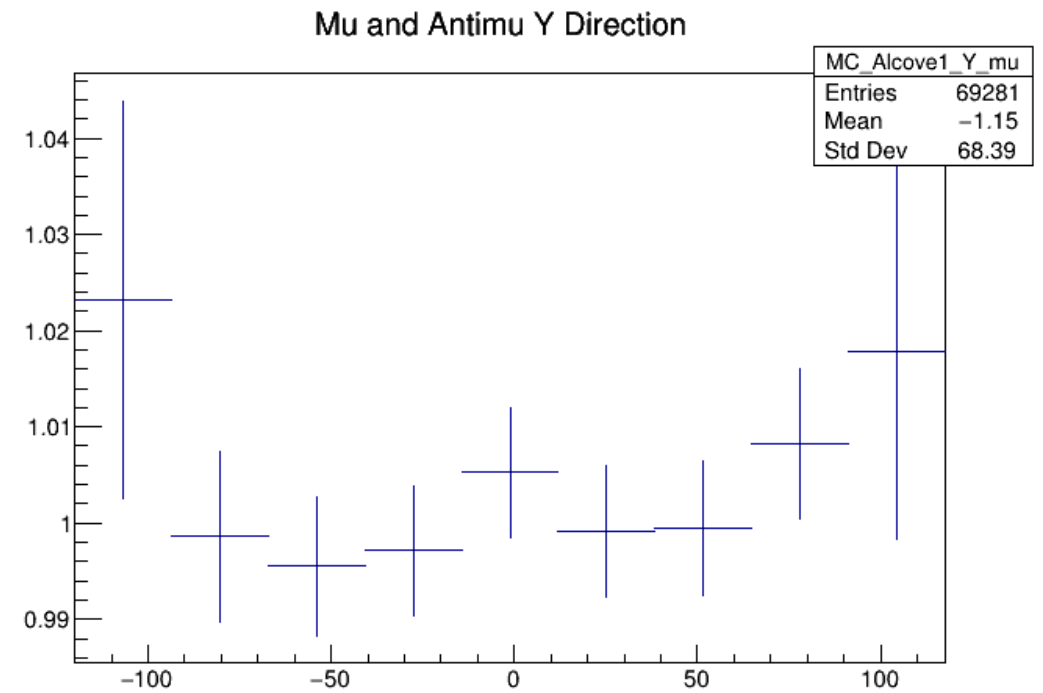
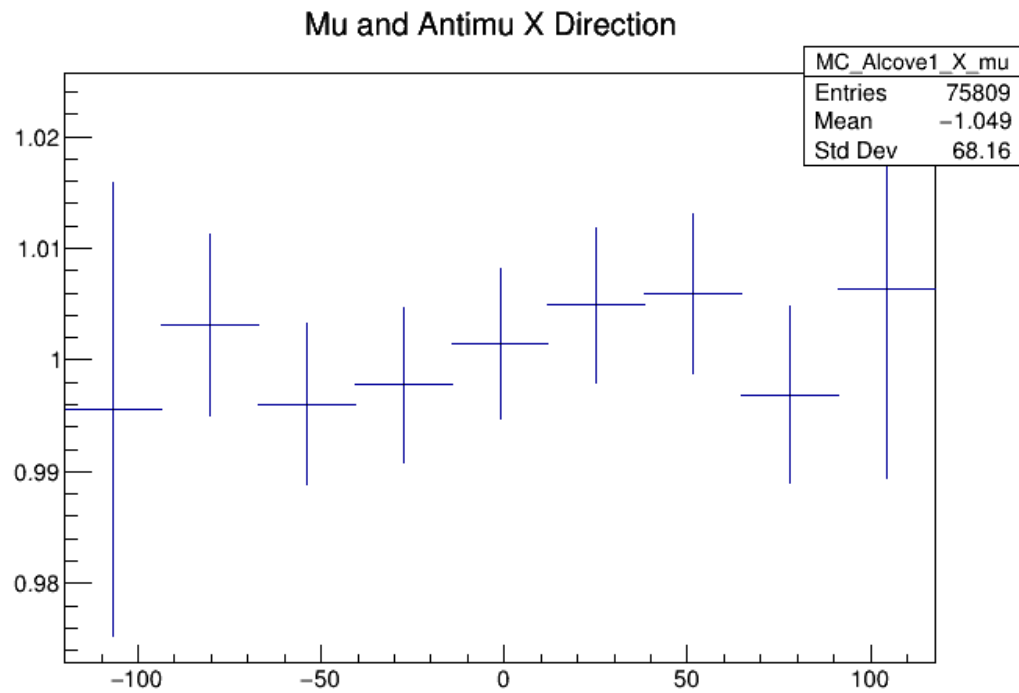
Target Move Down ν Flux at FD



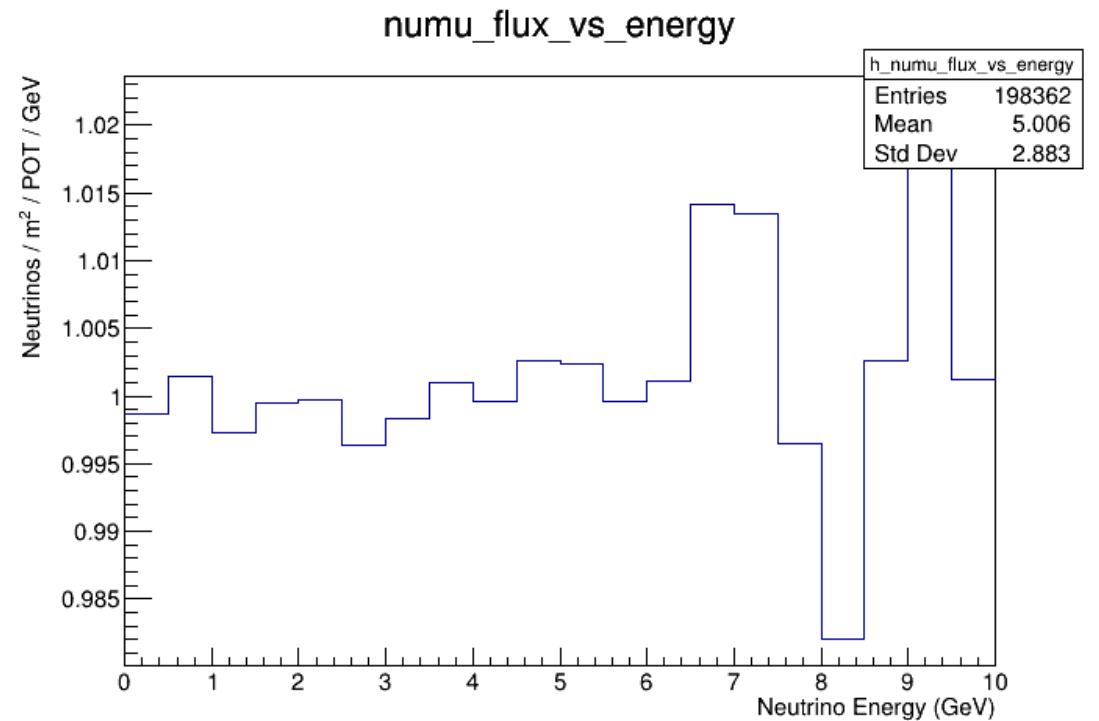
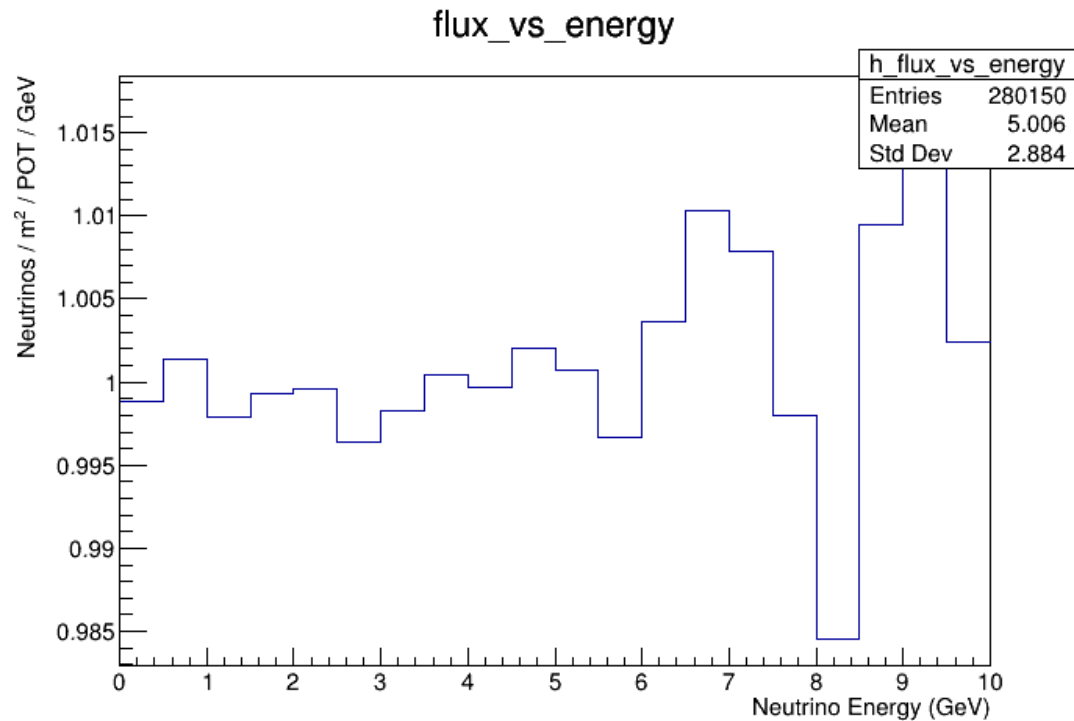
Target Move Right – Alcove 1



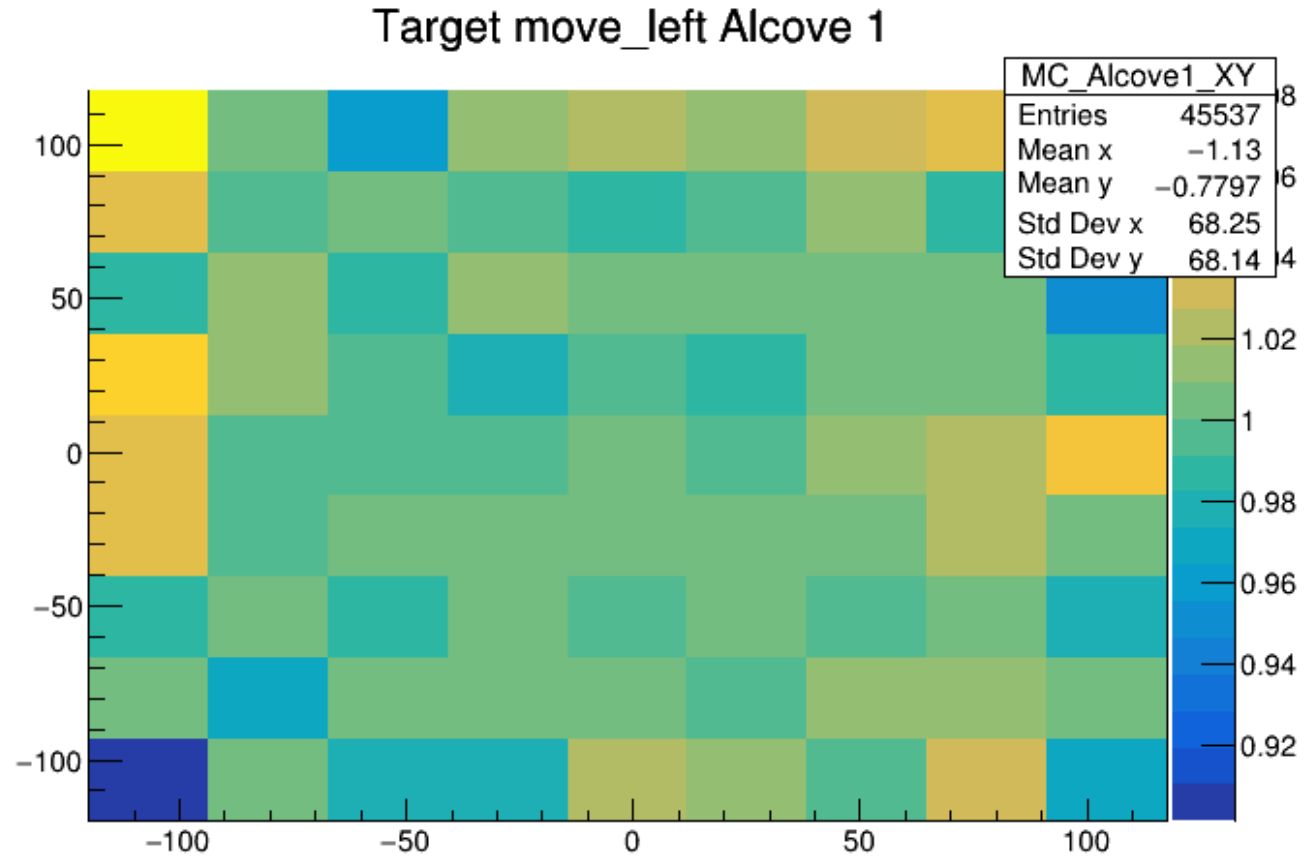
Target Move Right – Alcove 1



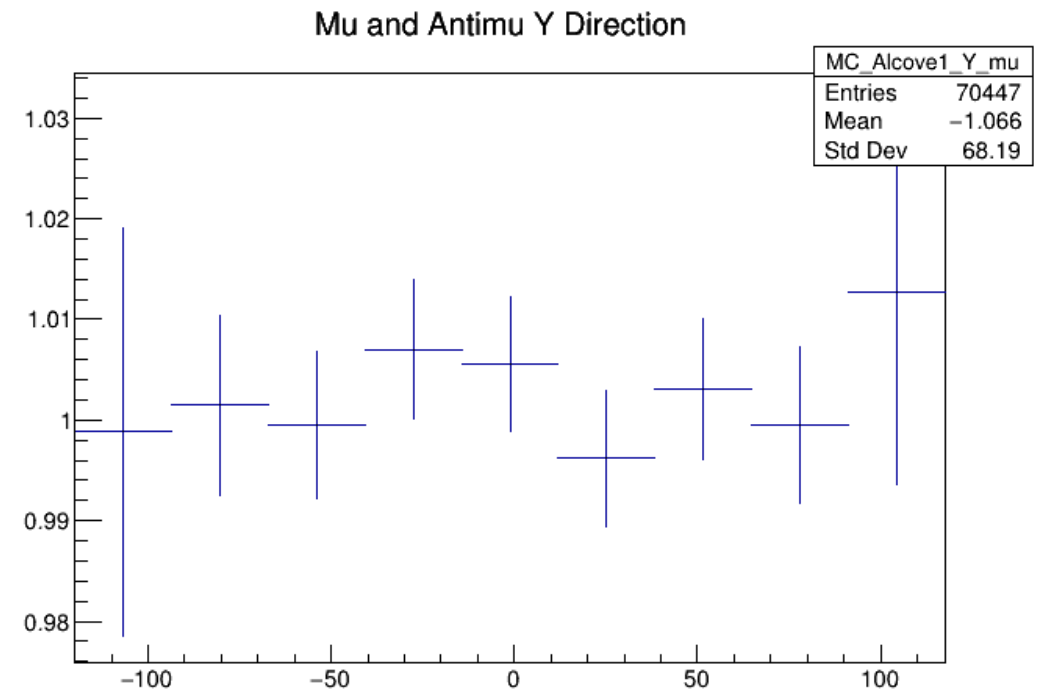
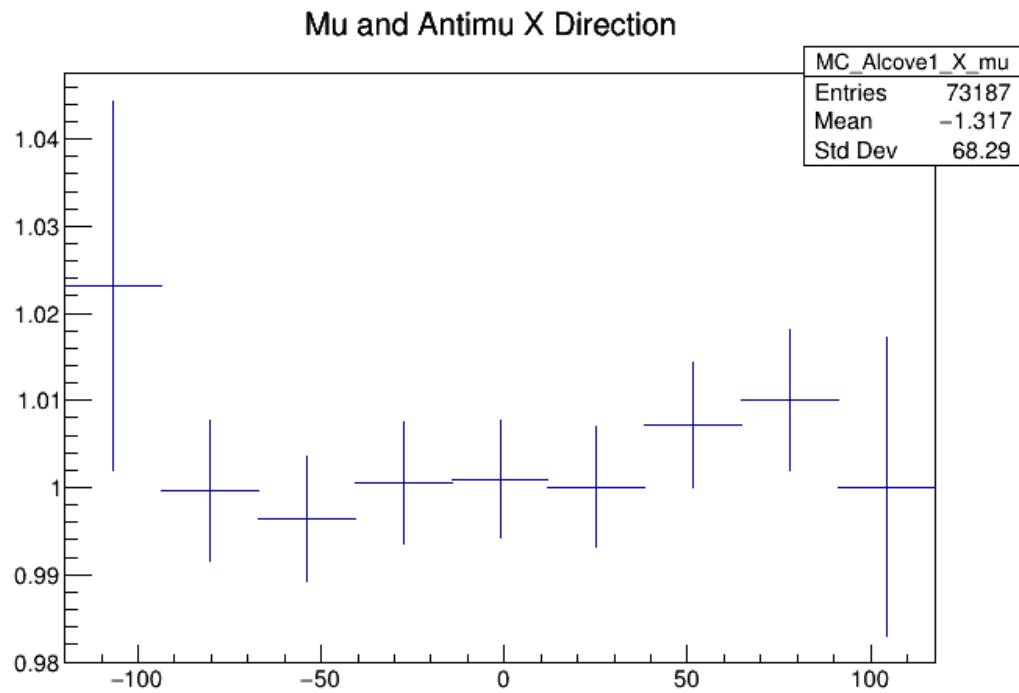
Target Move Right ν Flux at FD



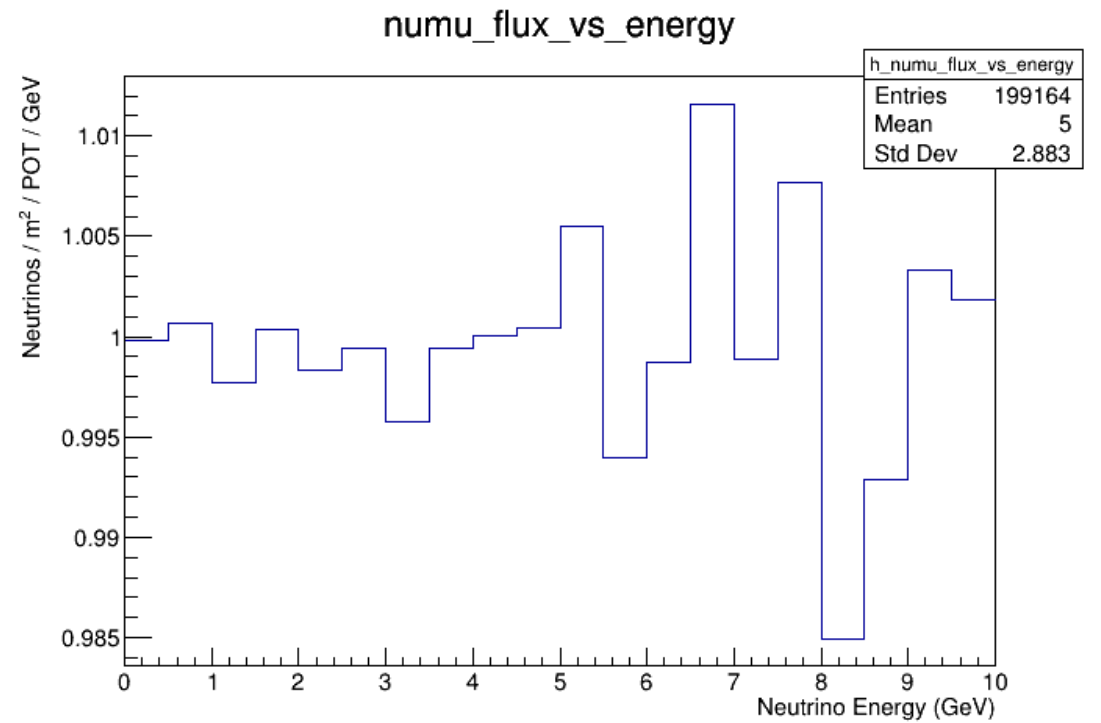
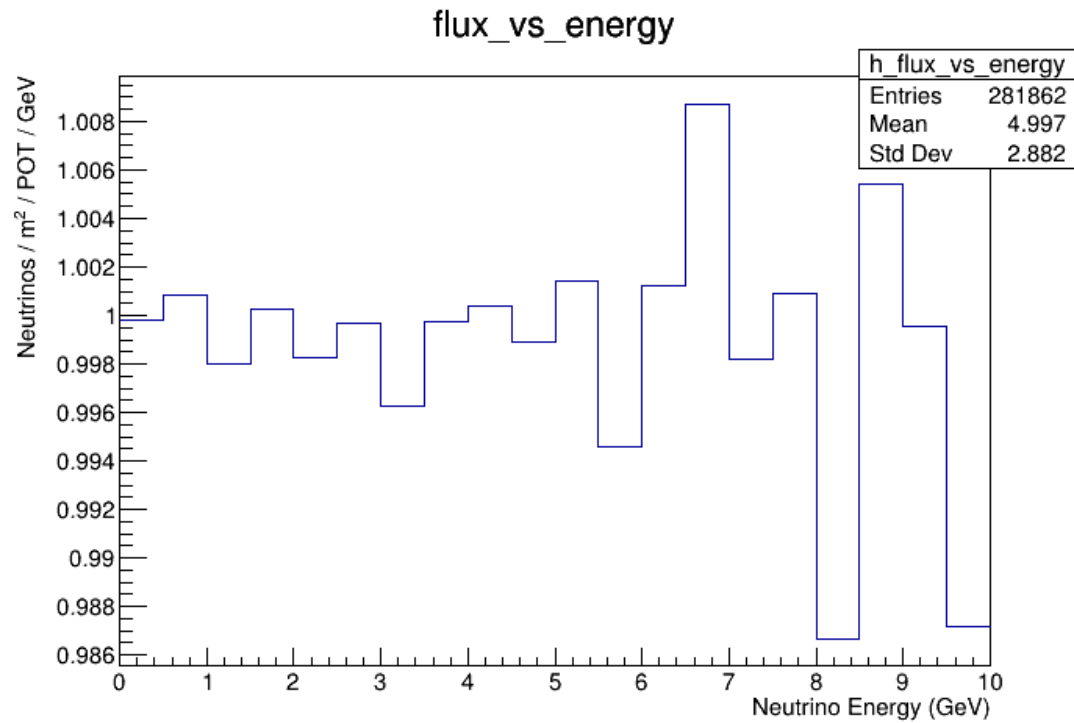
Target Move Left – Alcove 1



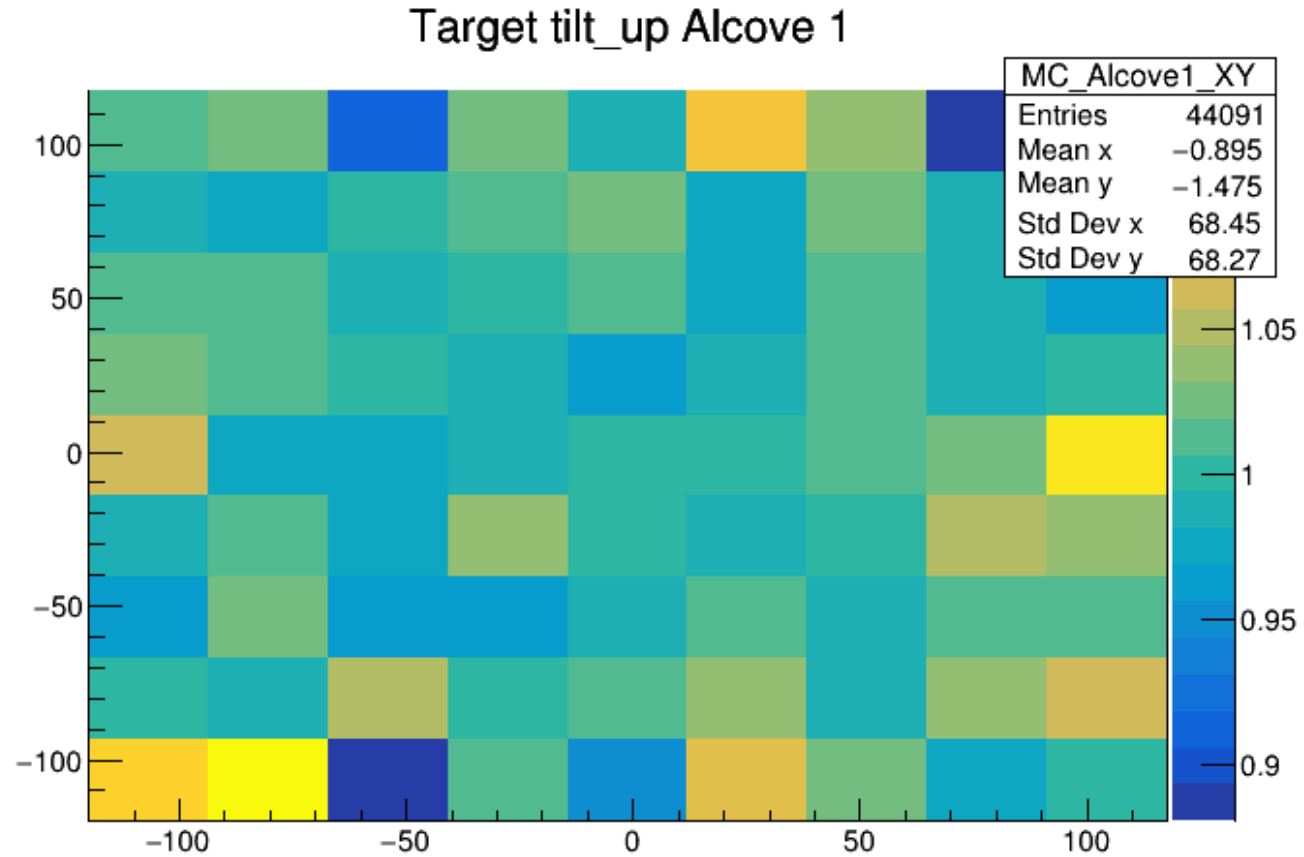
Target Move Left – Alcove 1



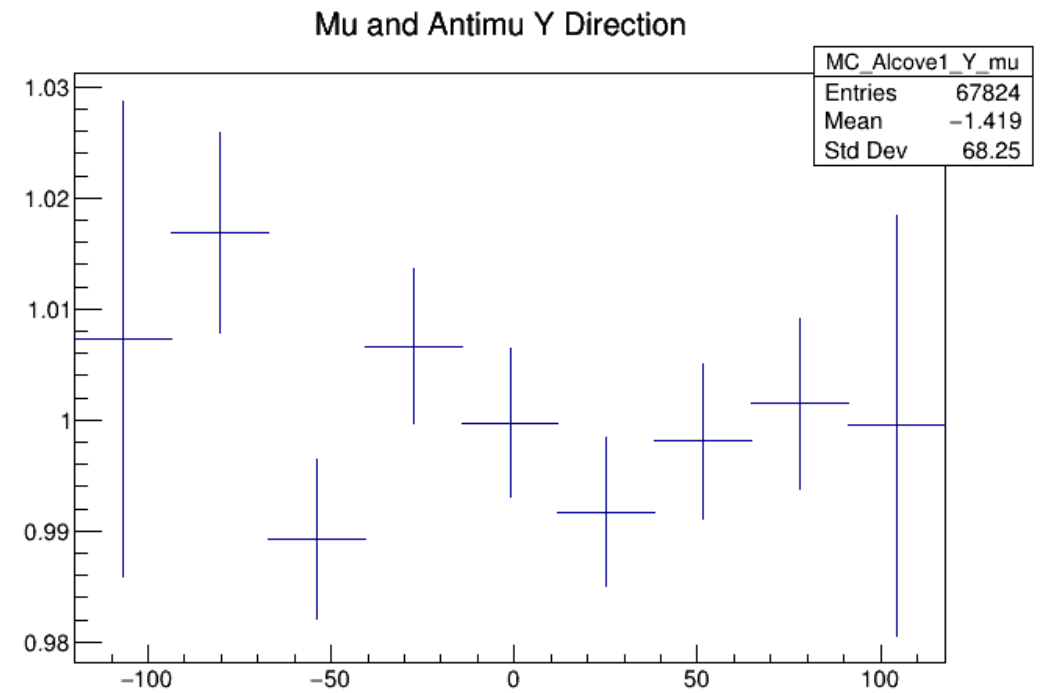
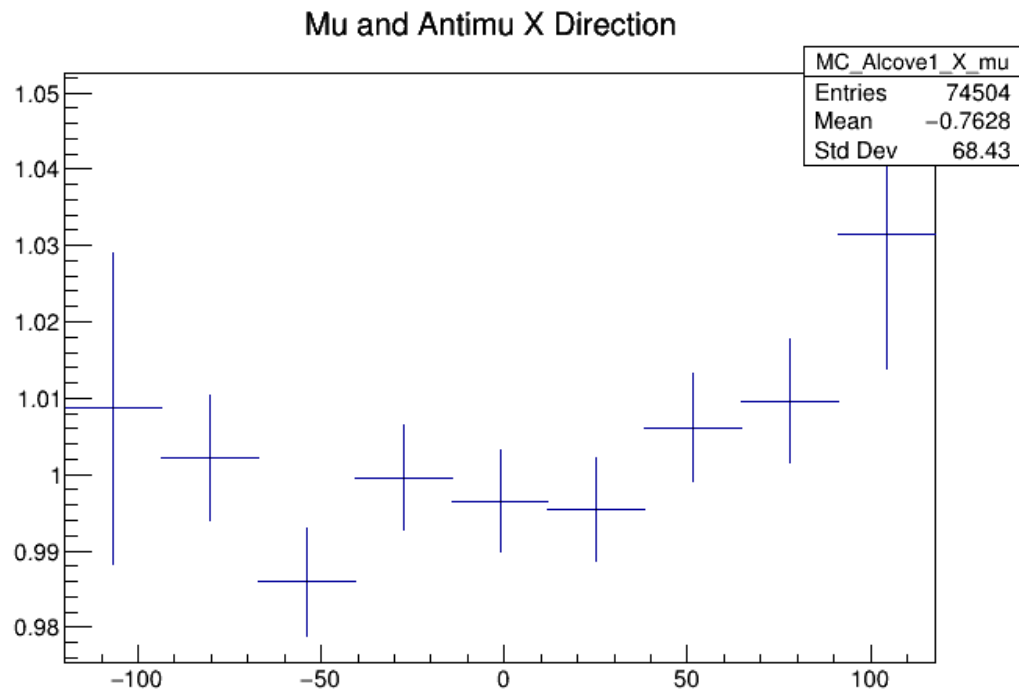
Target Move Left ν Flux at FD



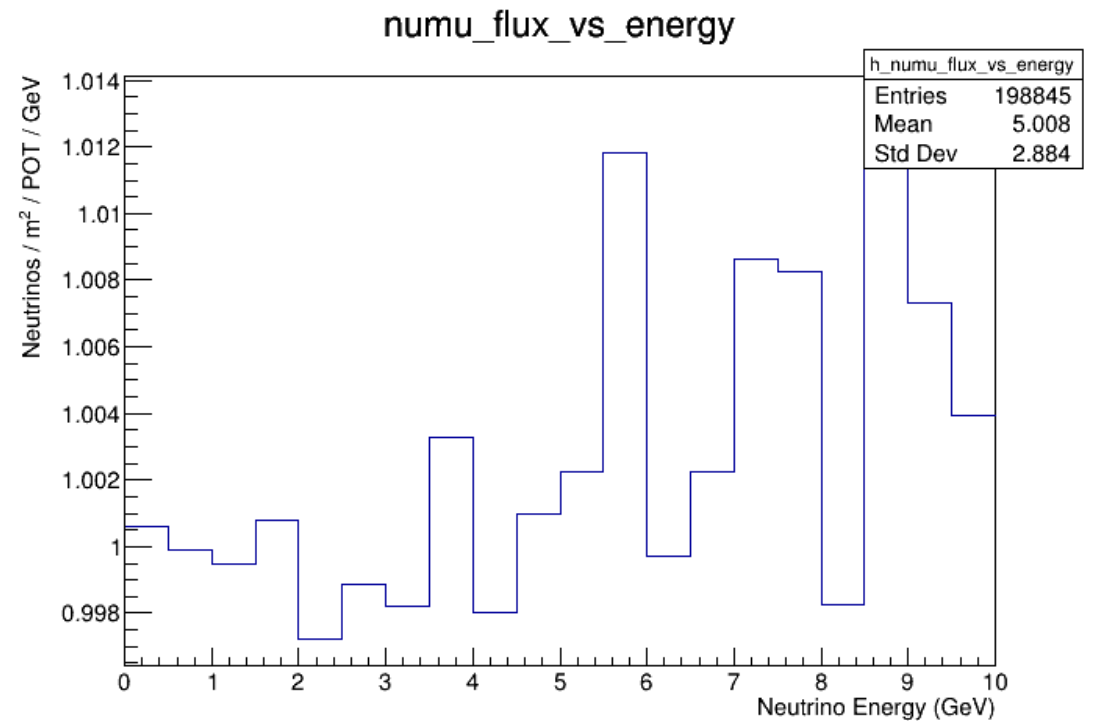
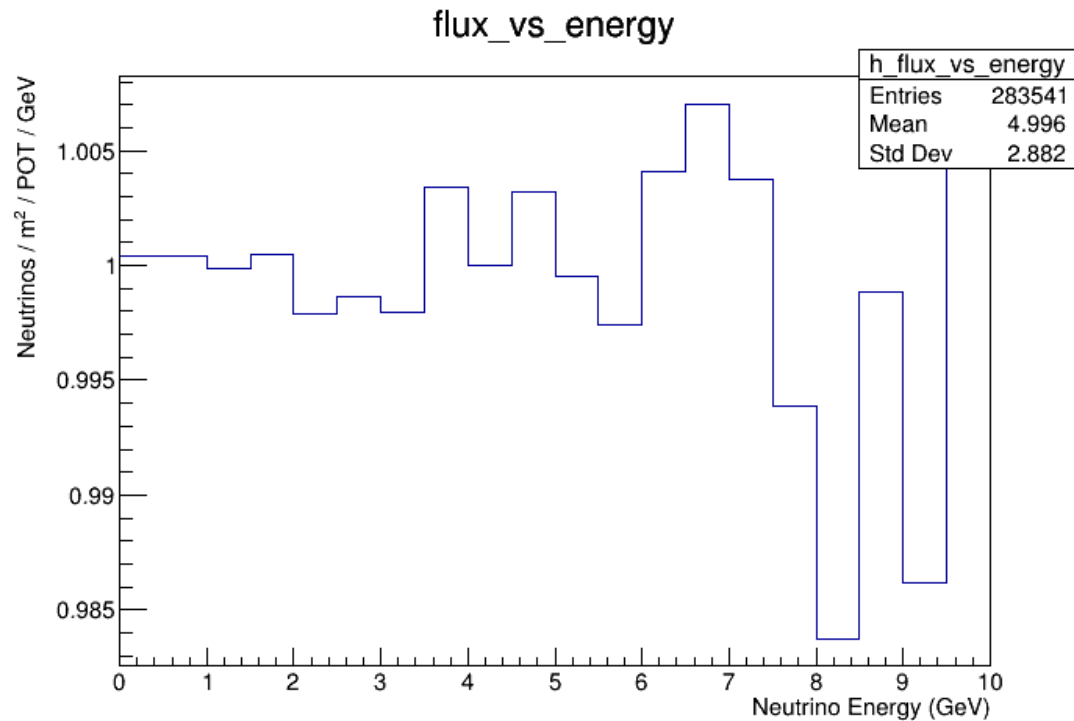
Target Tilt Up – Alcove 1



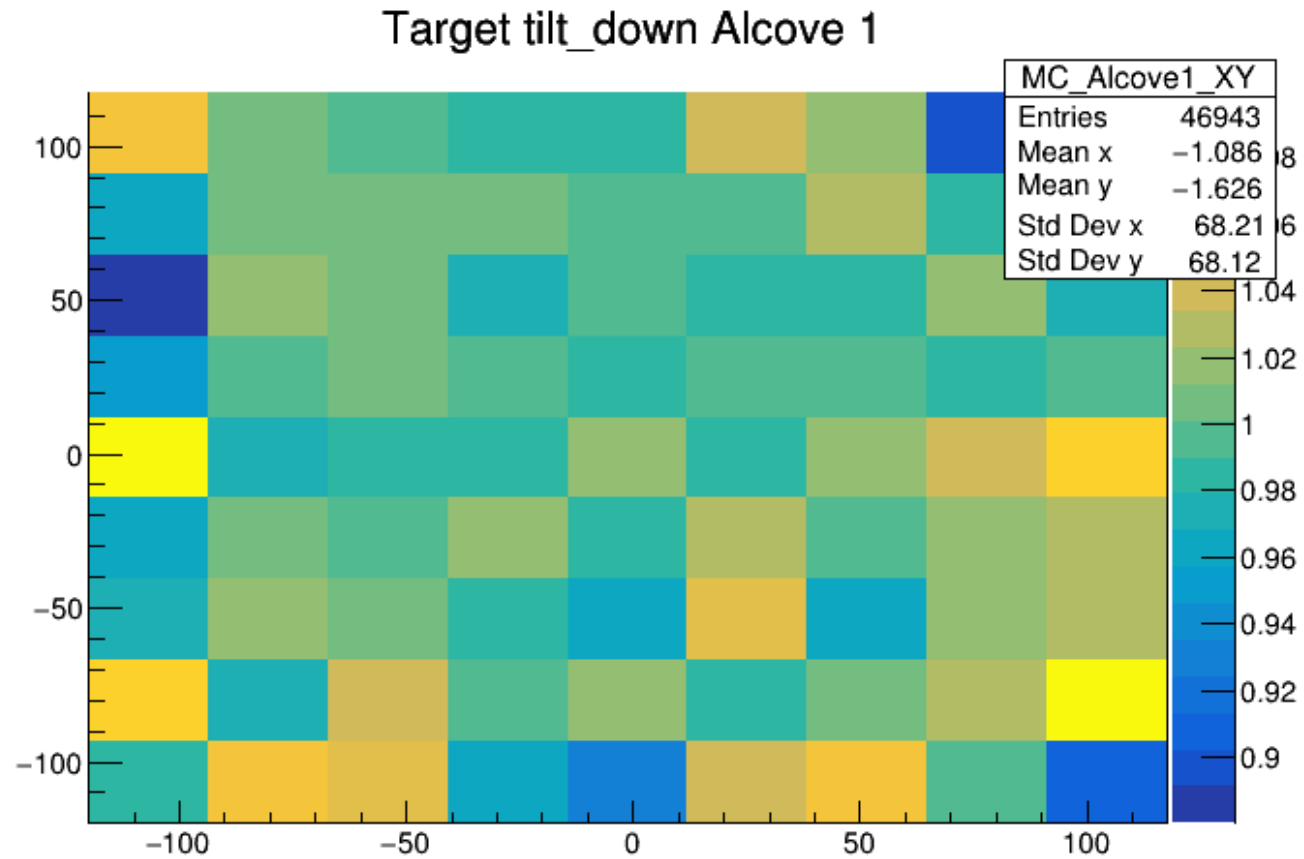
Target Tilt Up – Alcove 1



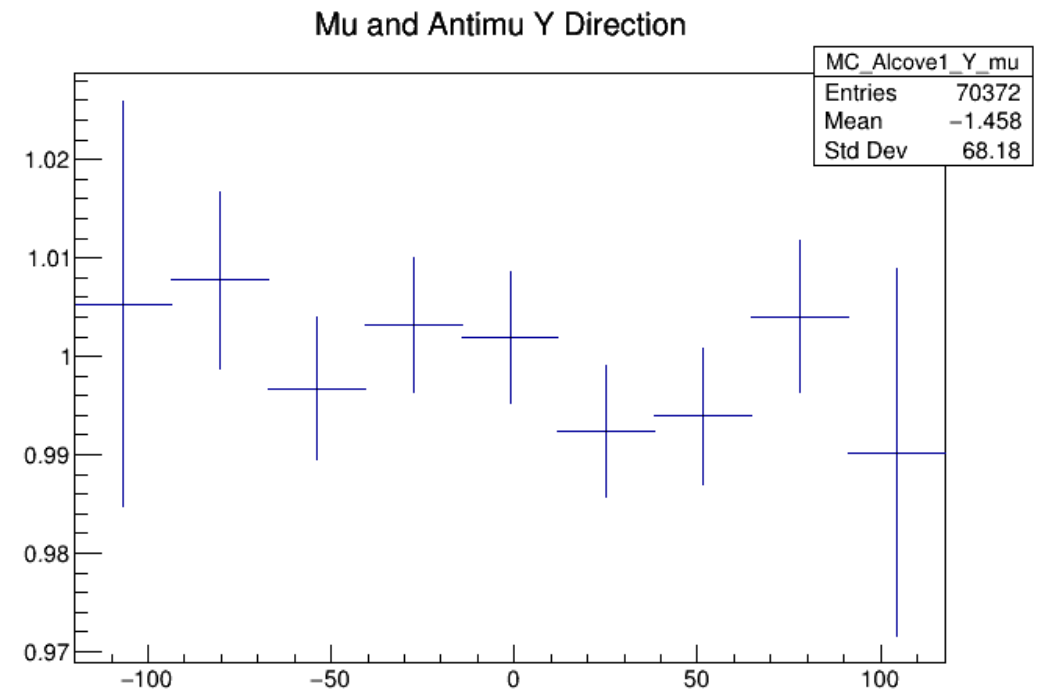
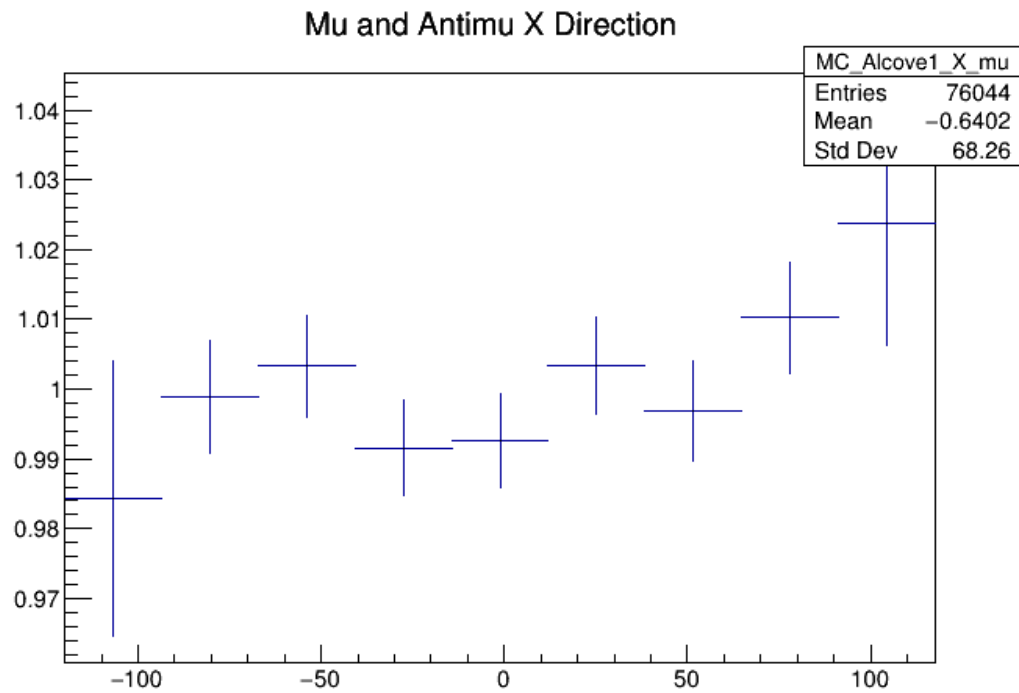
Target Tilt Up ν Flux at FD



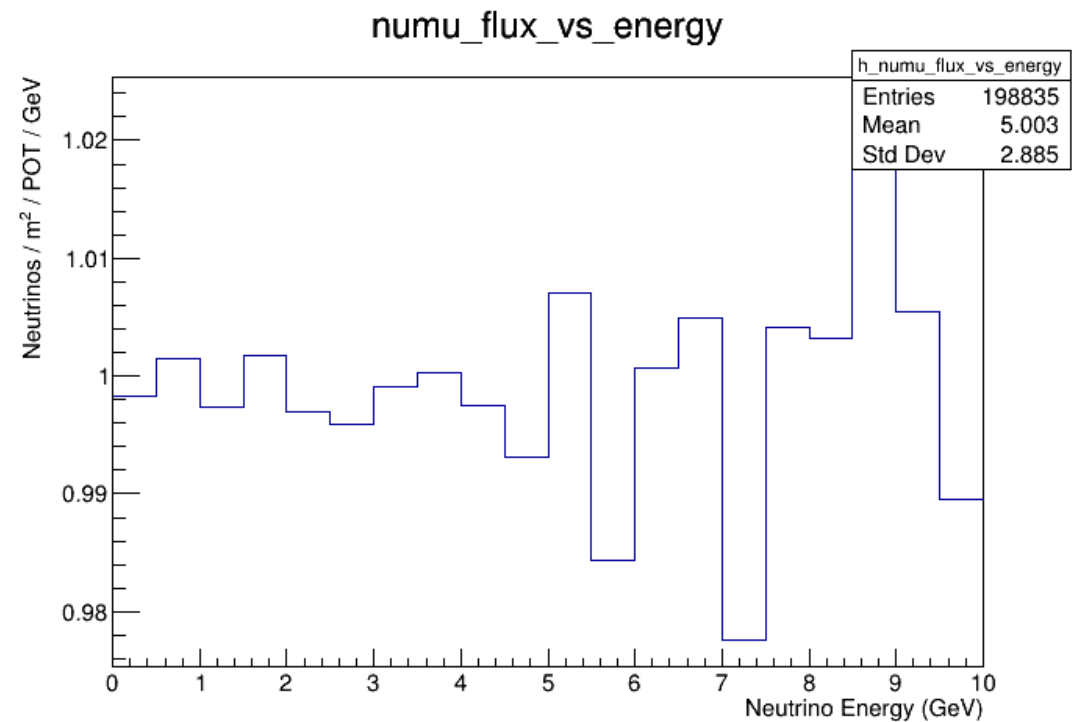
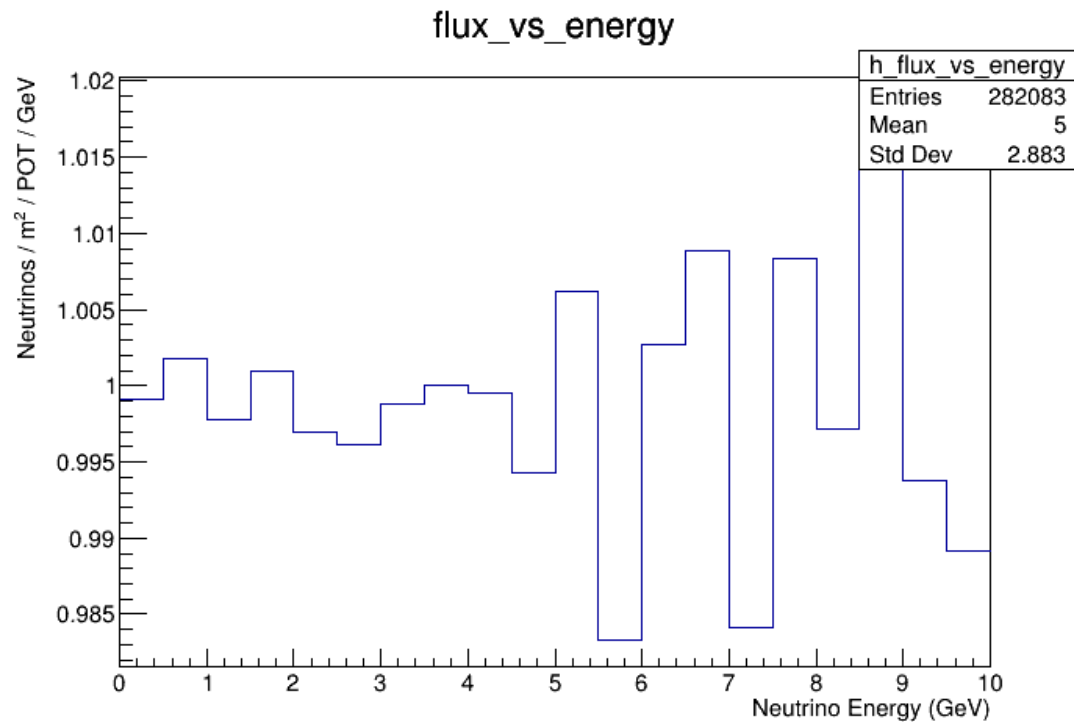
Target Tilt Down – Alcove 1



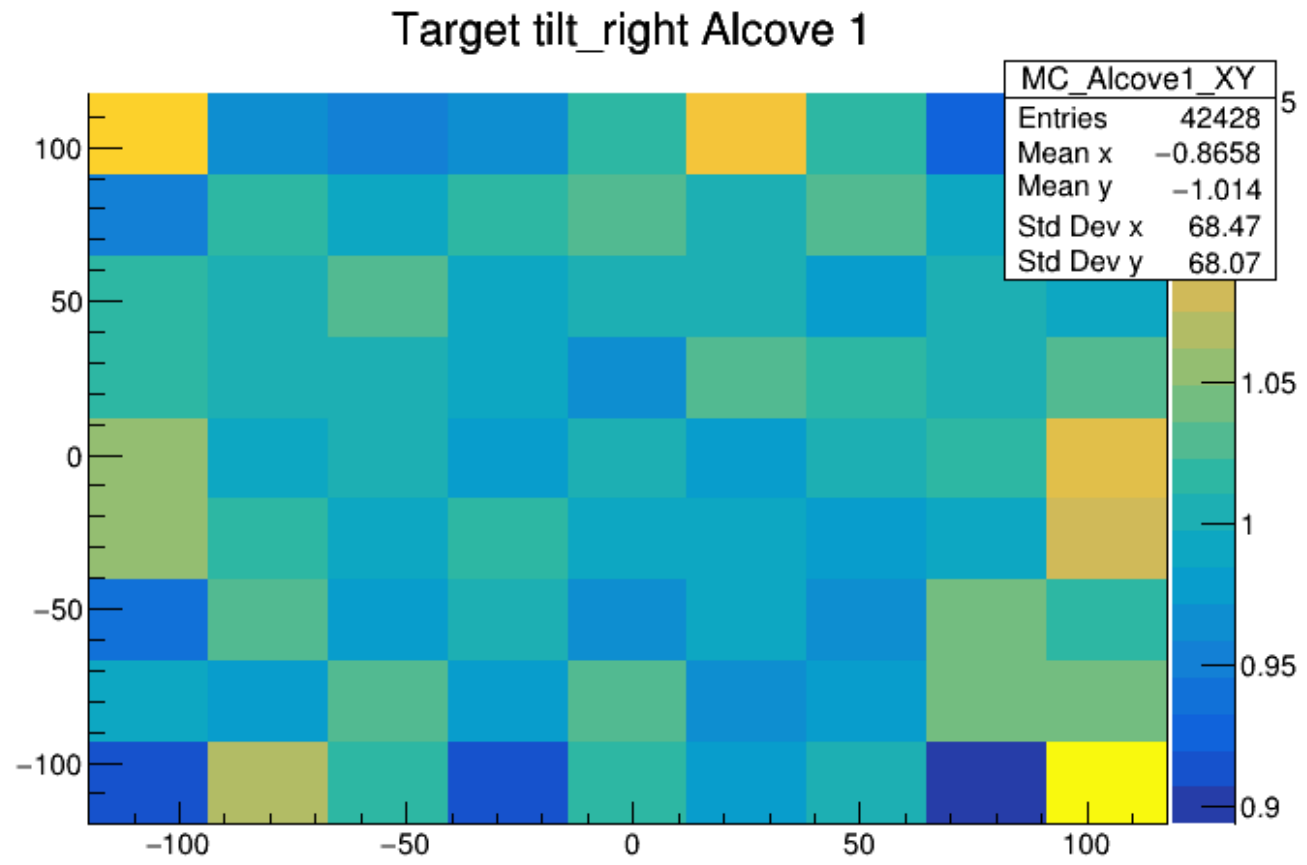
Target Tilt Down – Alcove 1



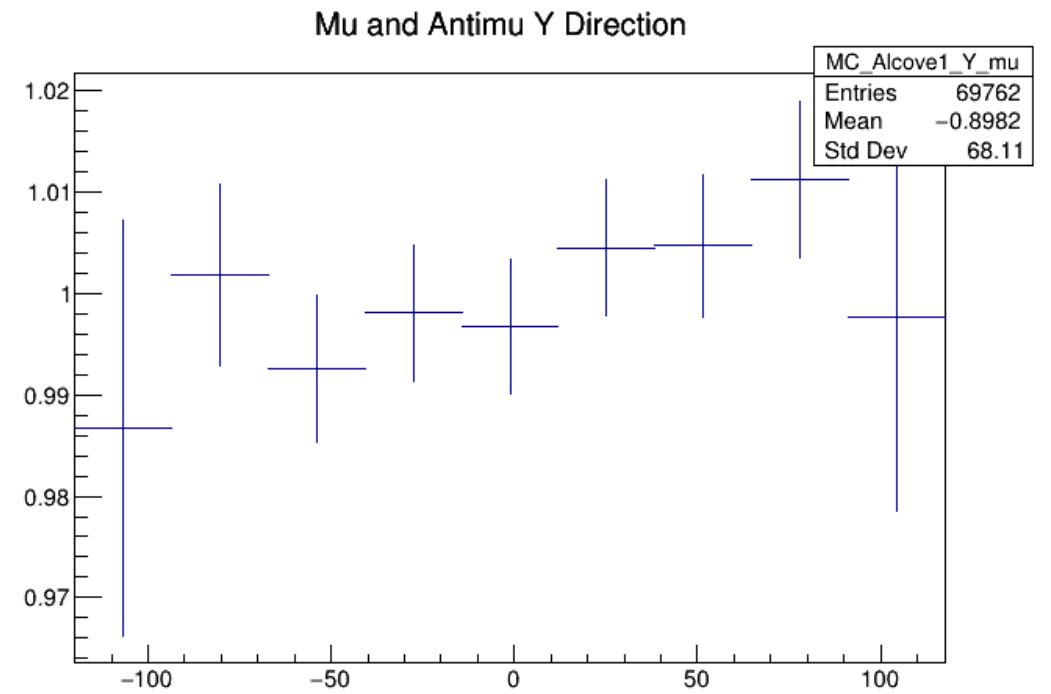
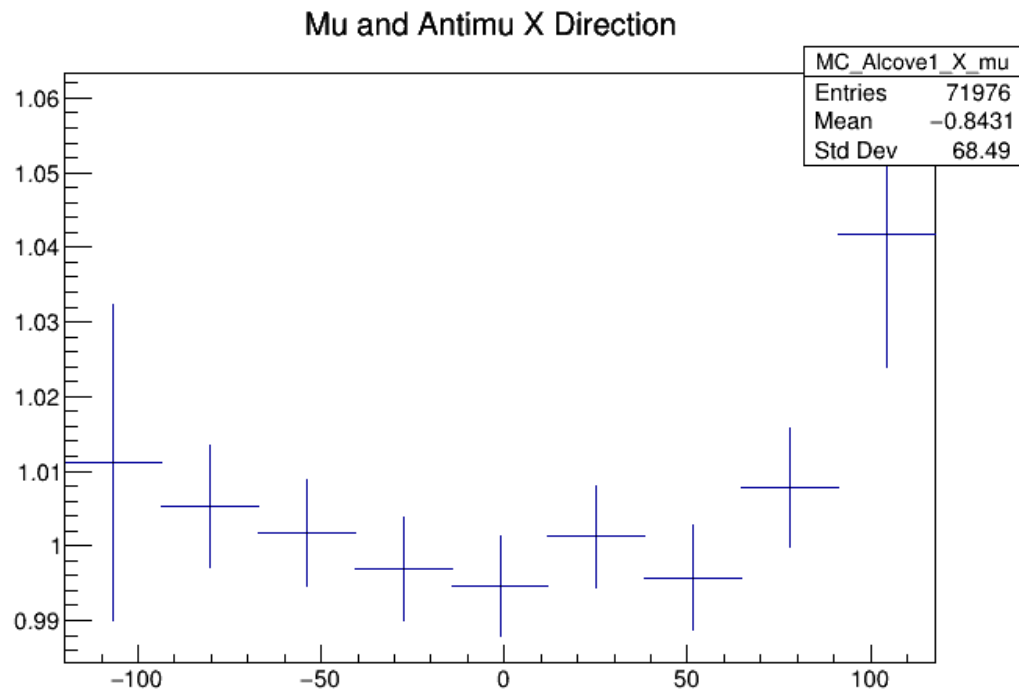
Target Tilt Down ν Flux at FD



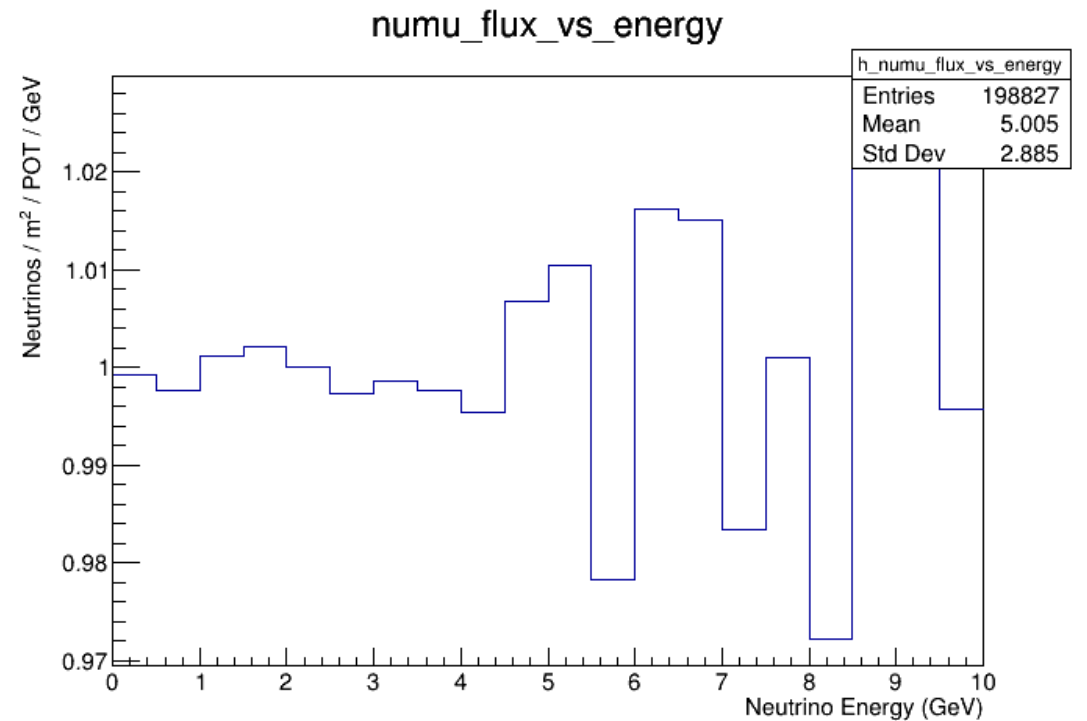
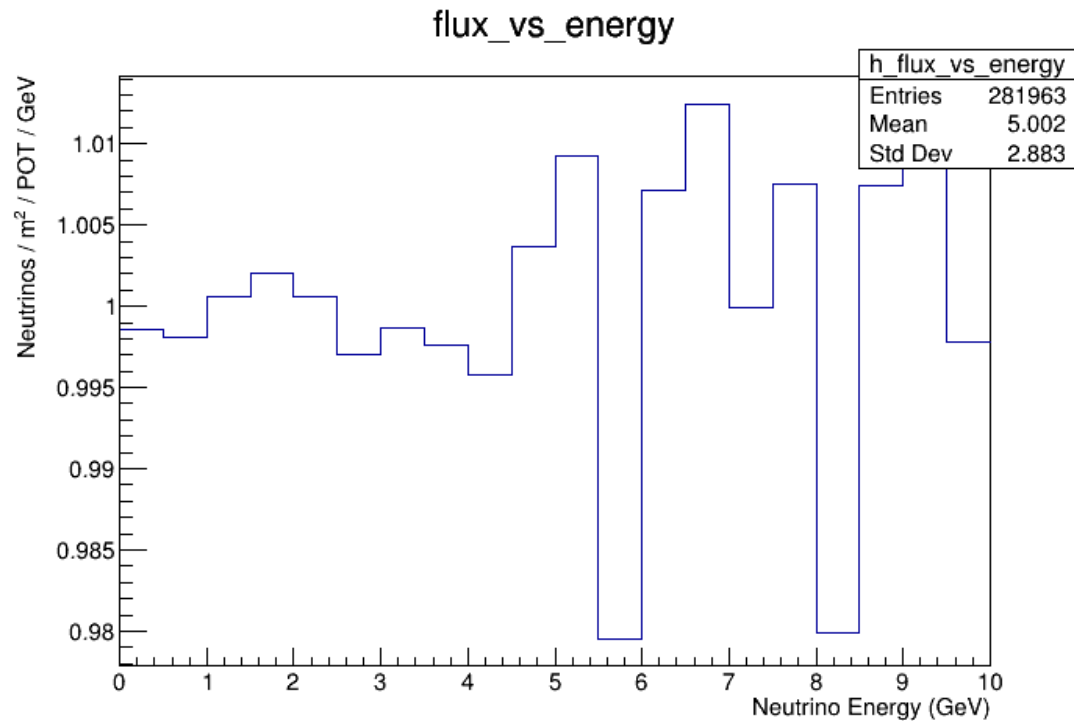
Target Tilt Right – Alcove 1



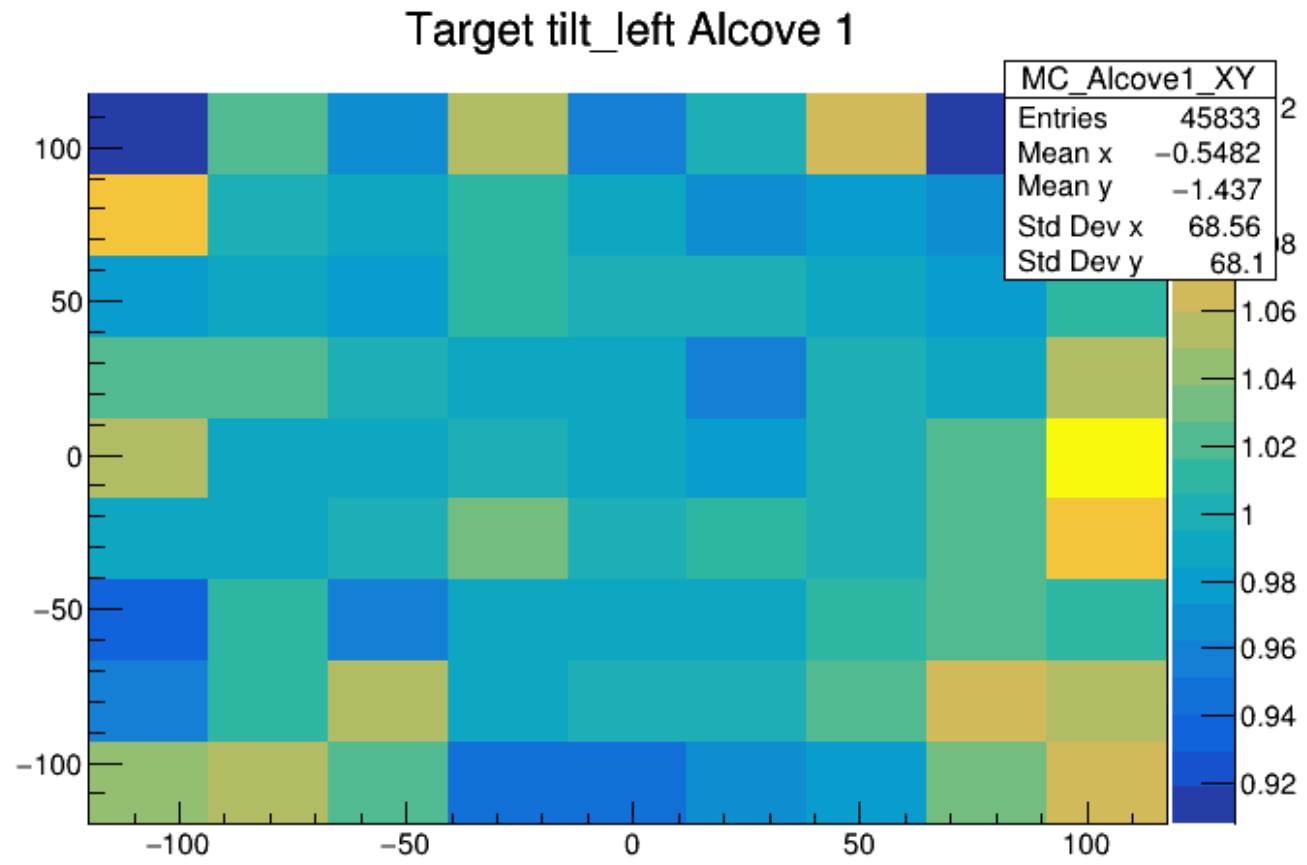
Target Tilt Right – Alcove 1



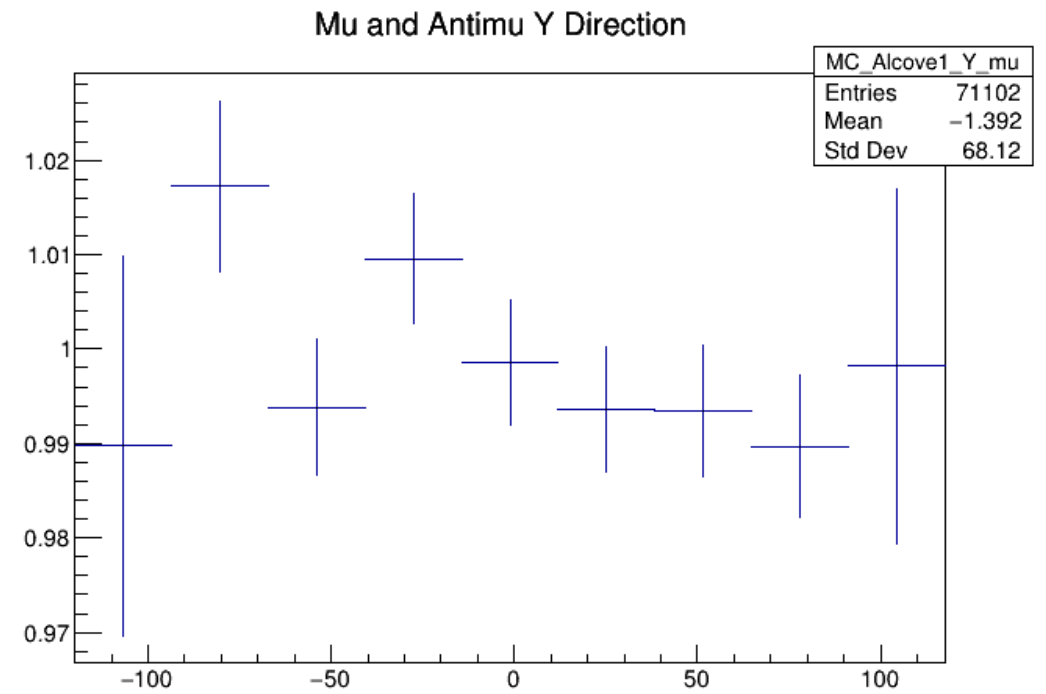
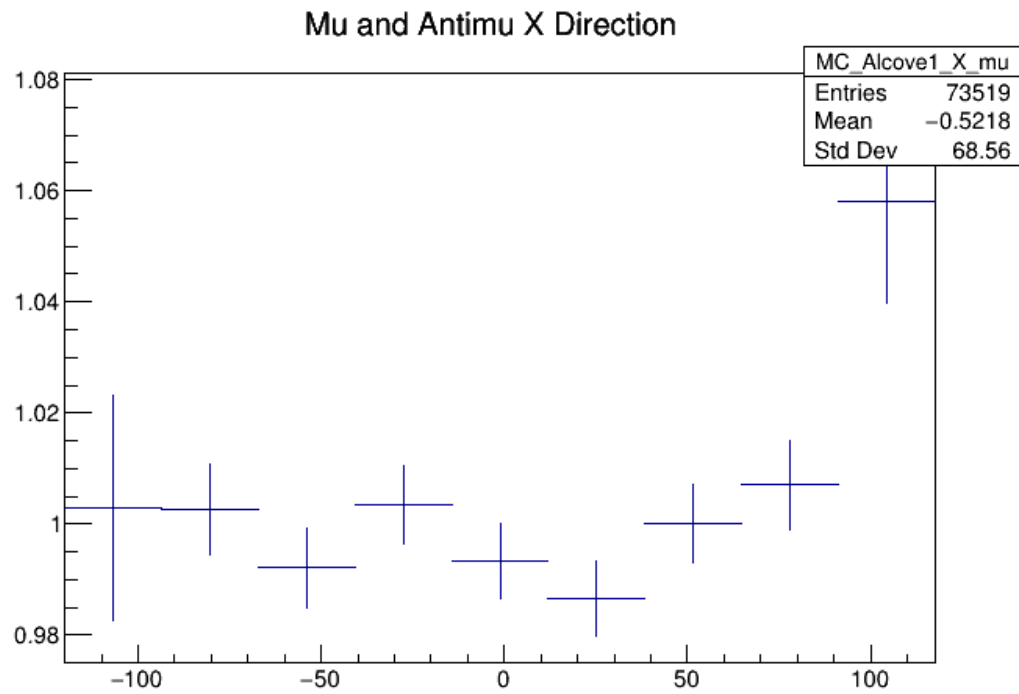
Target Tilt Right v Flux at FD



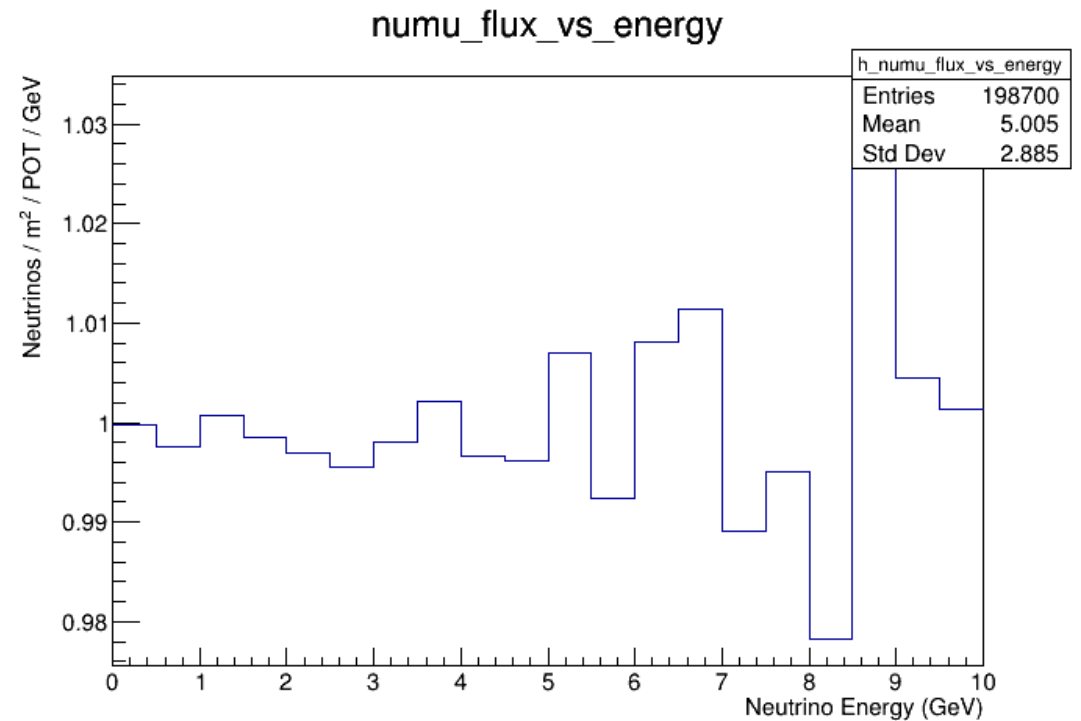
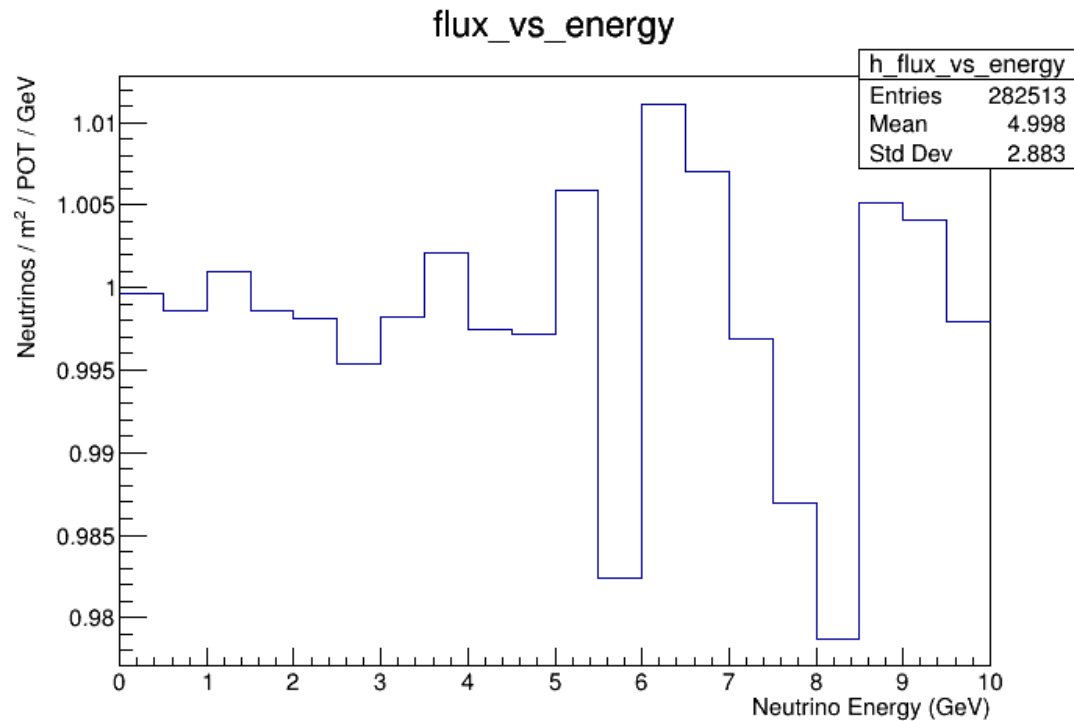
Target Tilt Left – Alcove 1



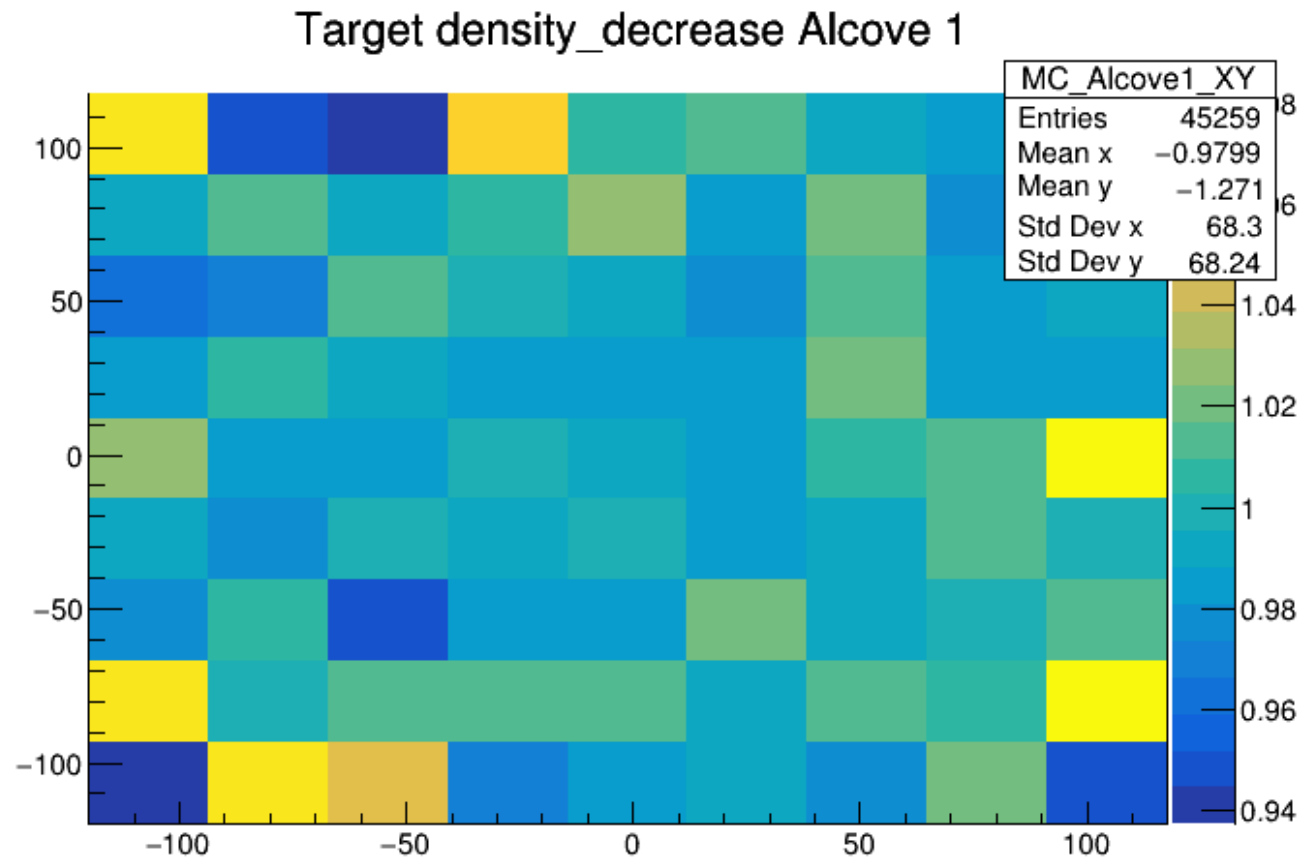
Target Tilt Left – Alcove 1



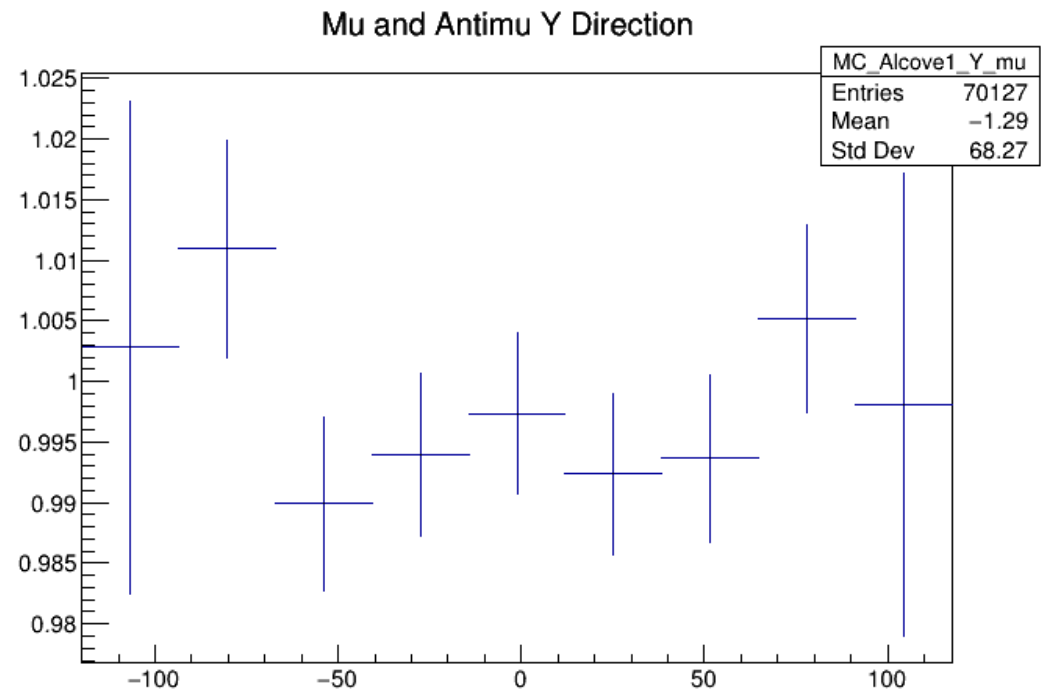
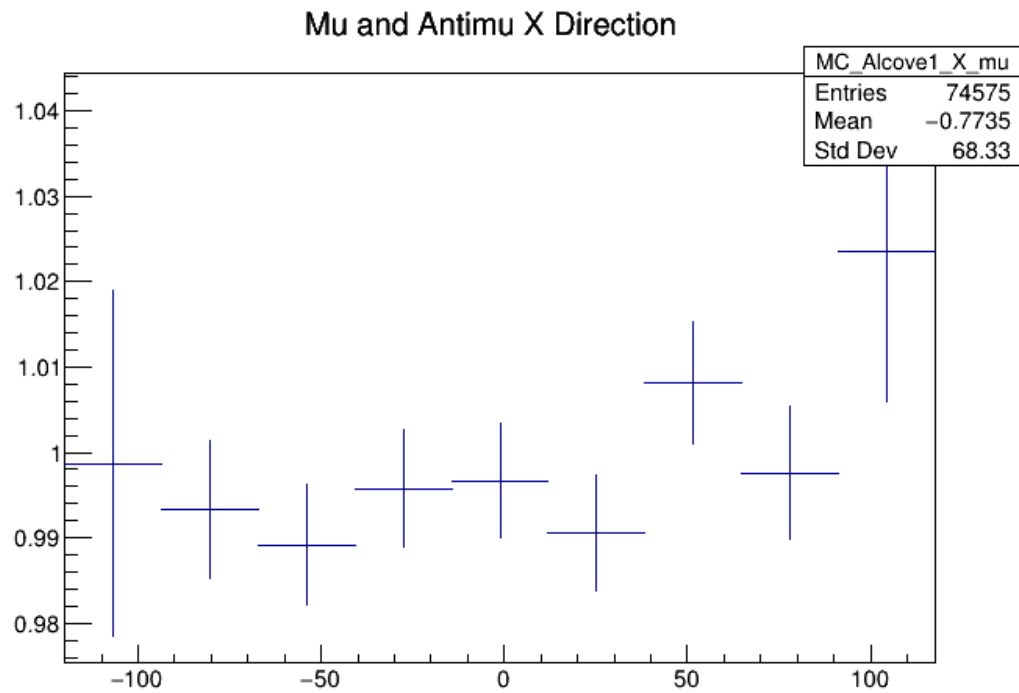
Target Tilt Left v Flux at FD



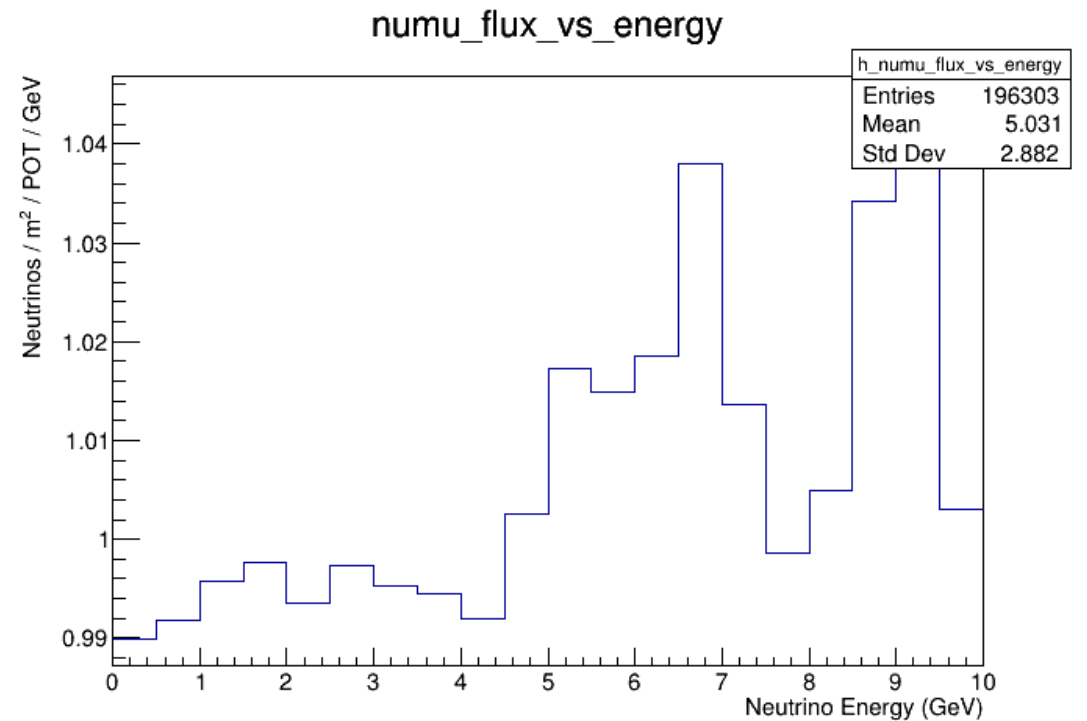
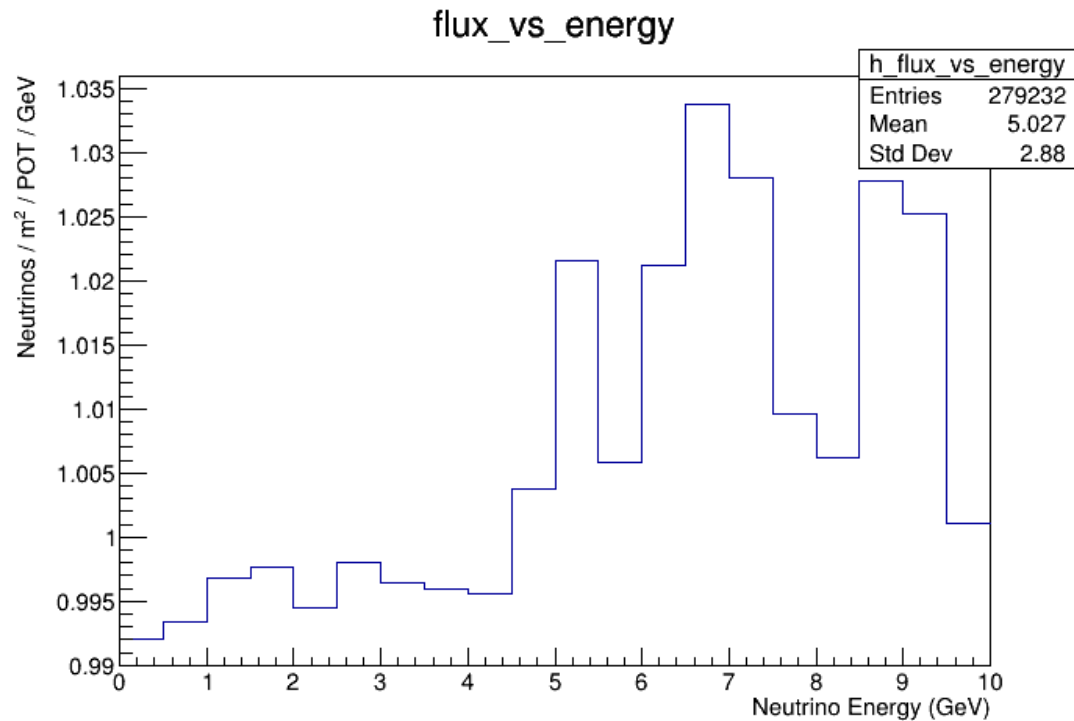
Target Density Decrease – Alcove 1



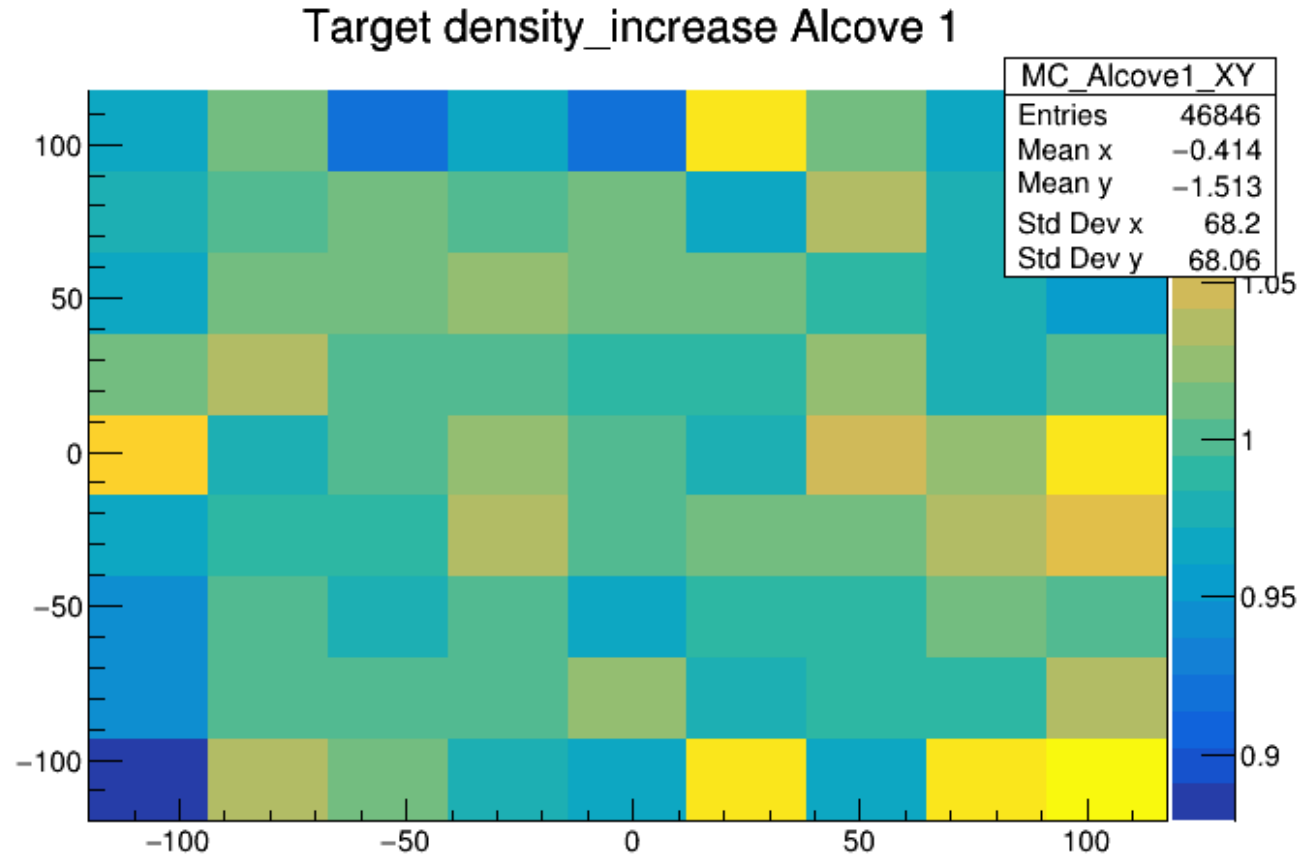
Target Density Decrease – Alcove 1



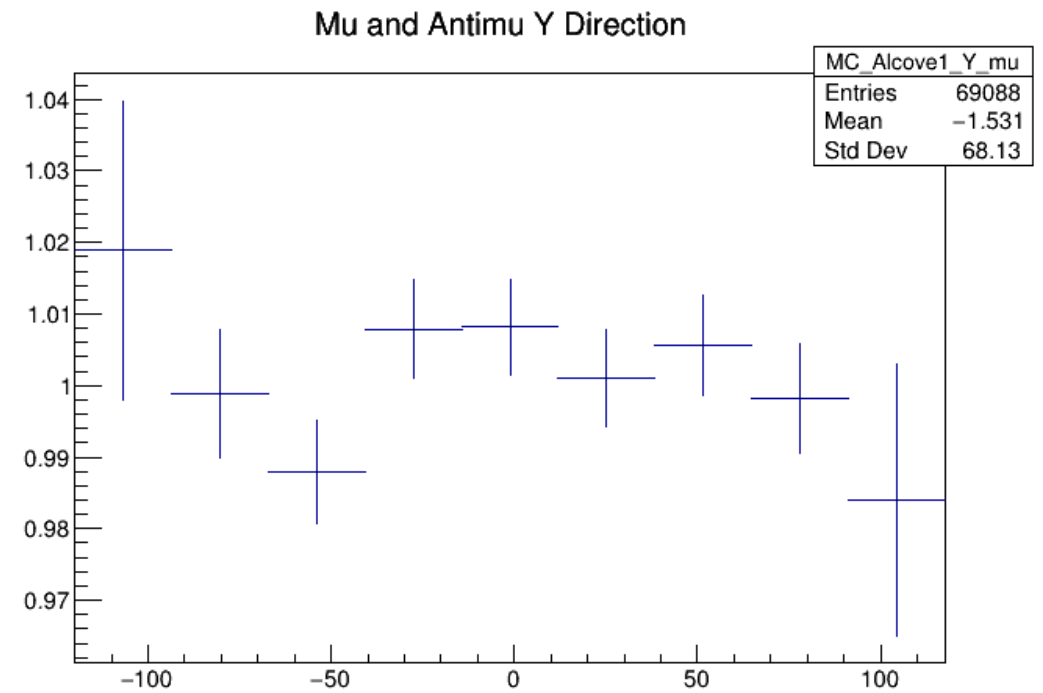
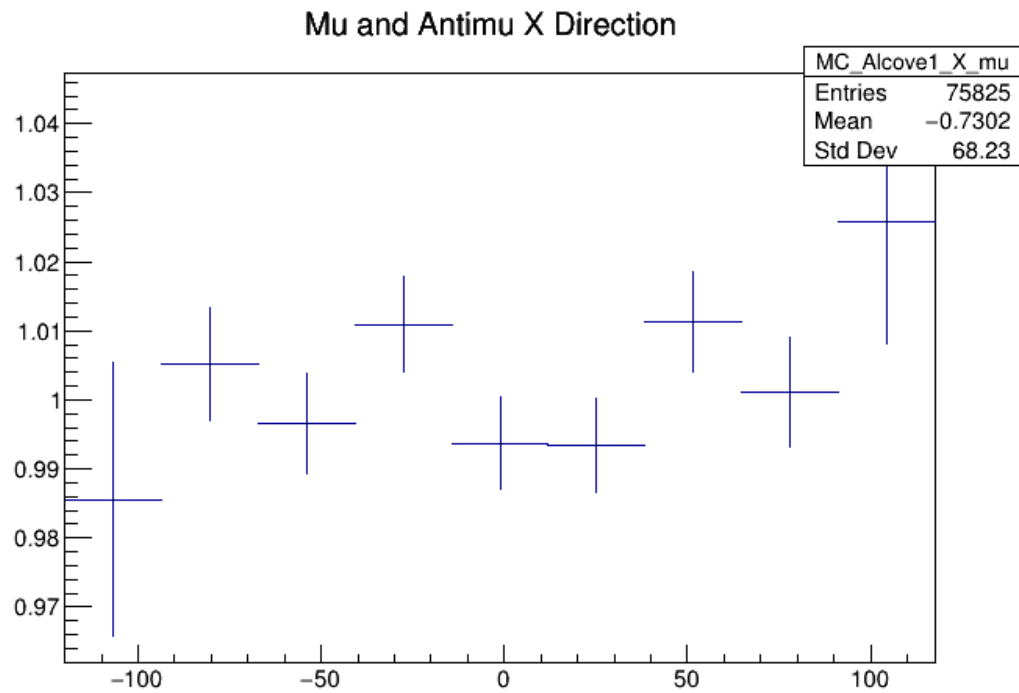
Target Density Decrease v Flux at FD



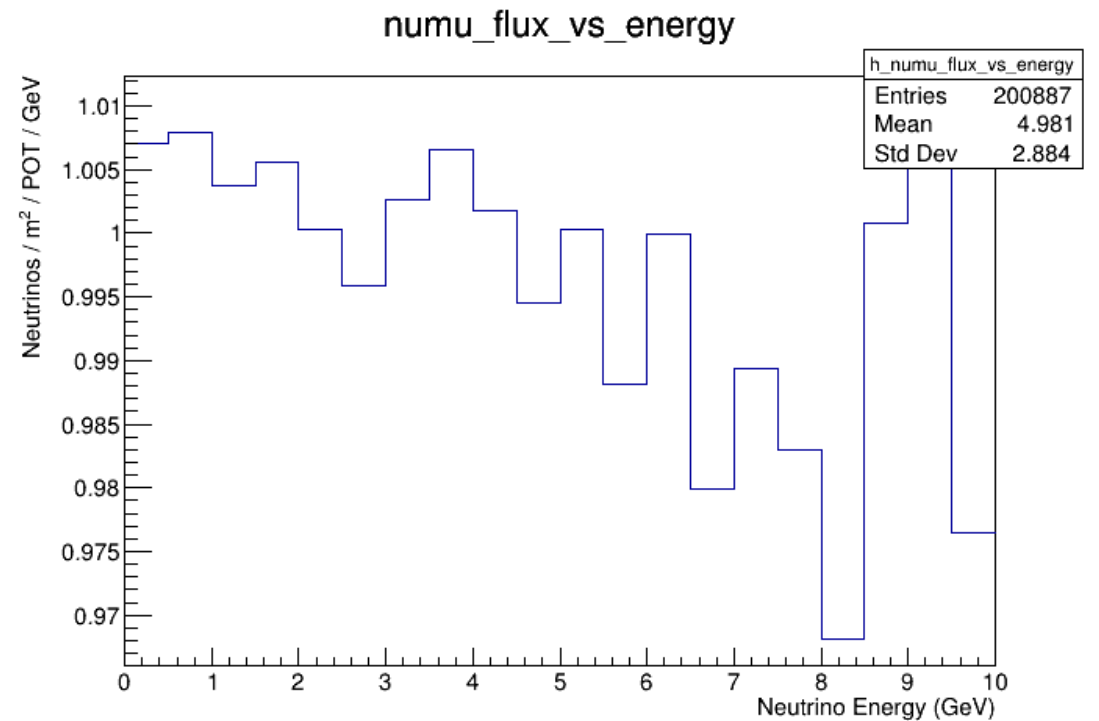
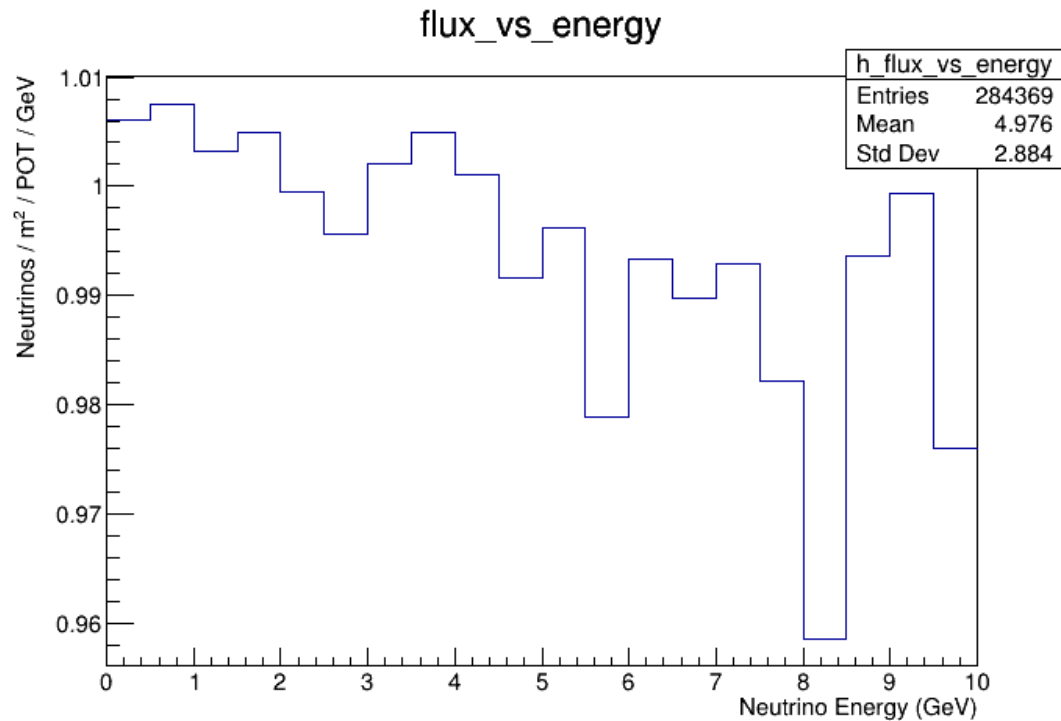
Target Density Increase – Alcove 1



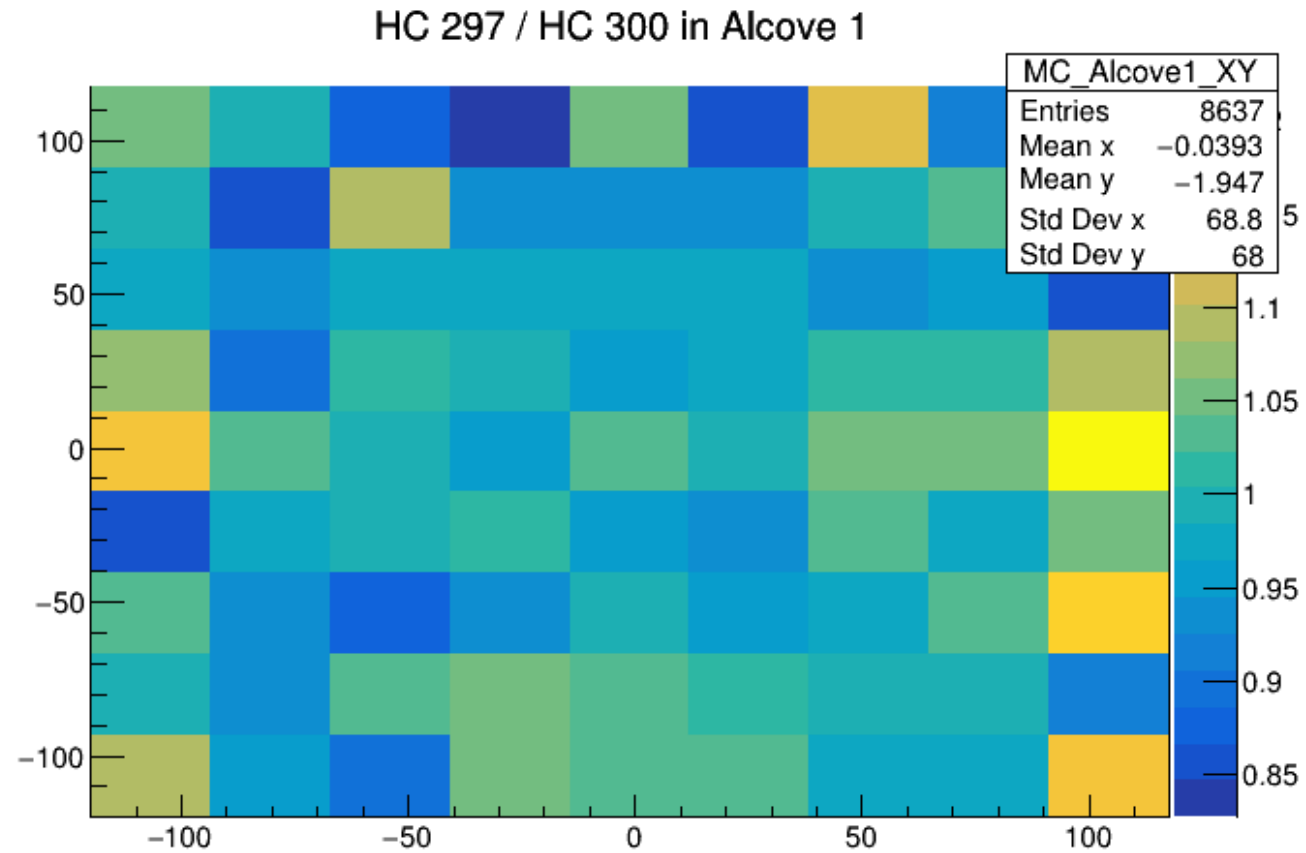
Target Density Increase – Alcove 1



Target Density Increase v Flux at FD



Horn Current 297 kA



Horn Current 303 kA

