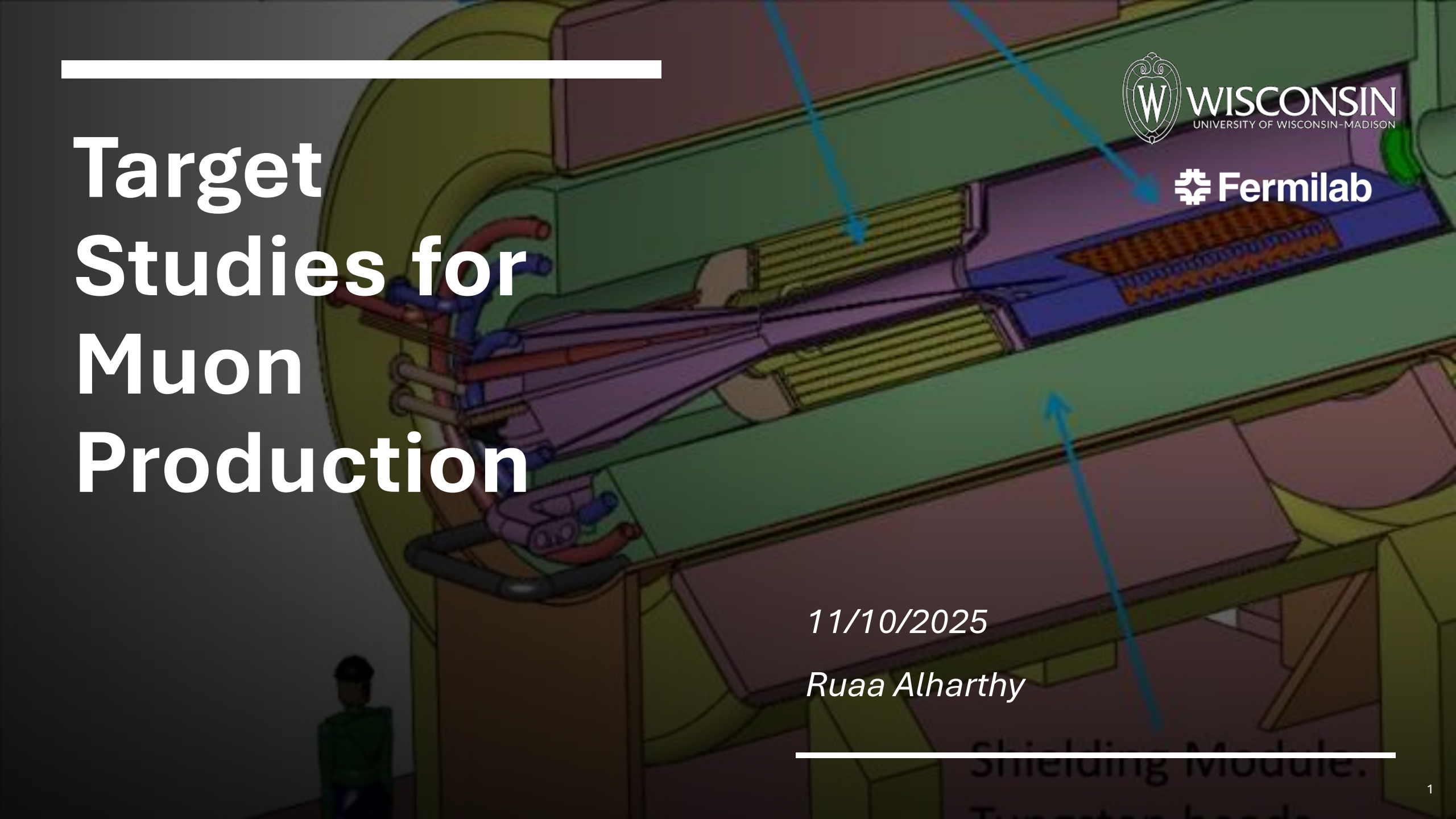
Target Studies for Muon Production

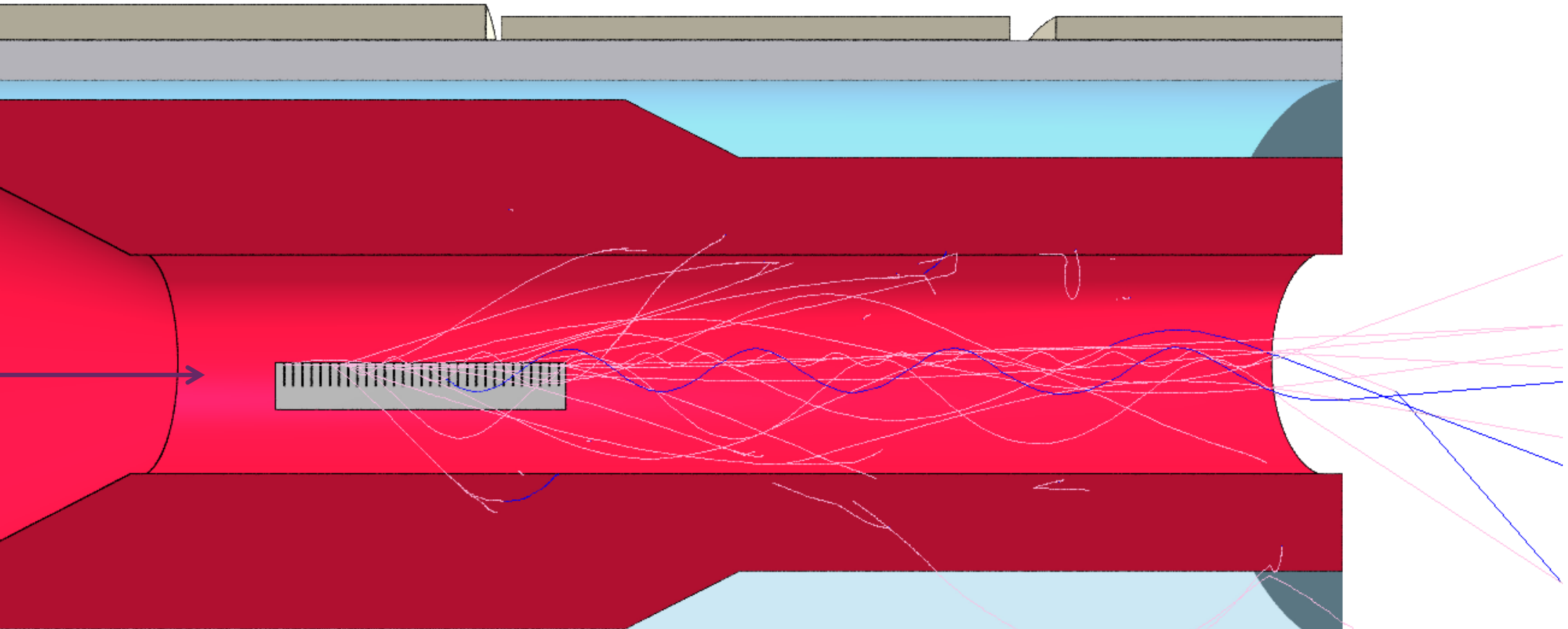


11/10/2025

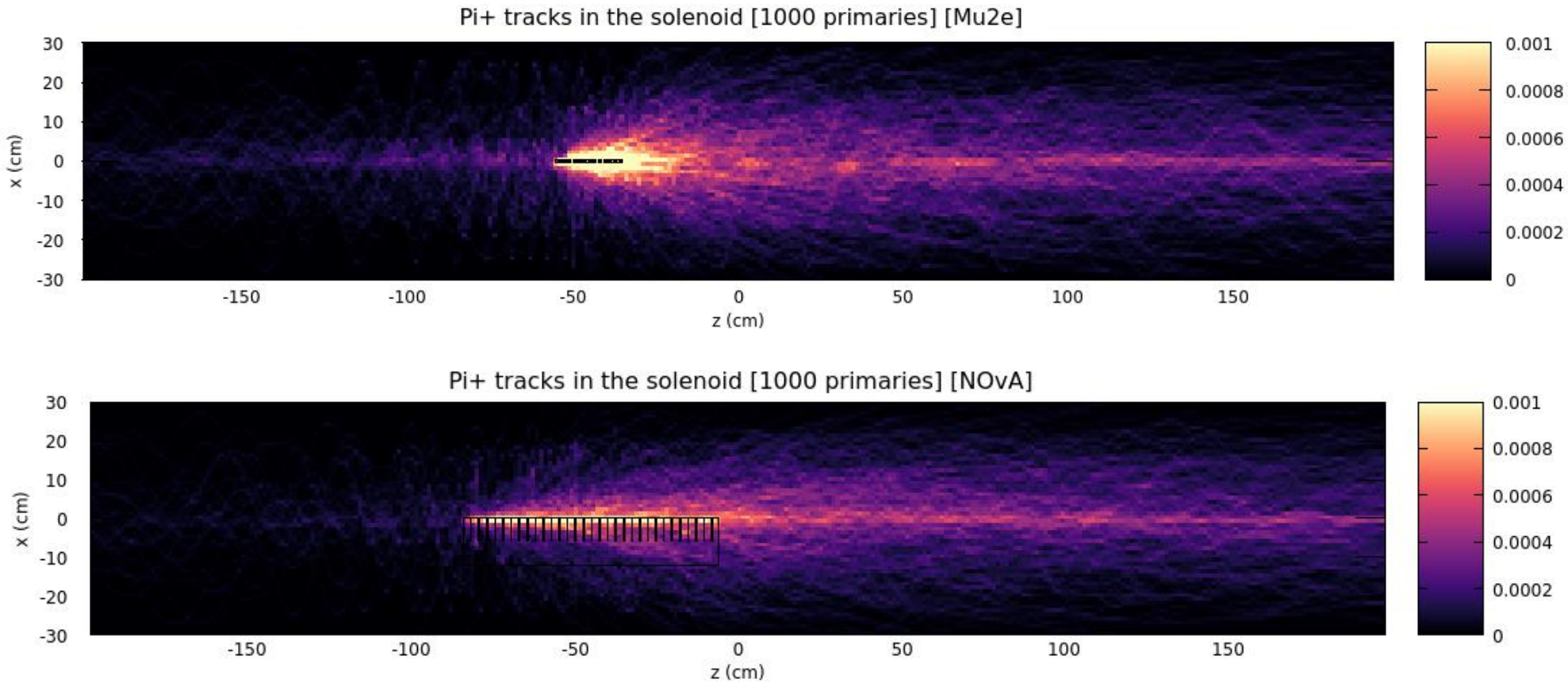
Ruaa Alharthy

Analysis of the $\pi^+\mu^+$ beams

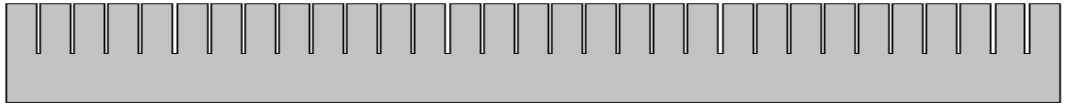
→100,000 primary protons were used in all the simulations

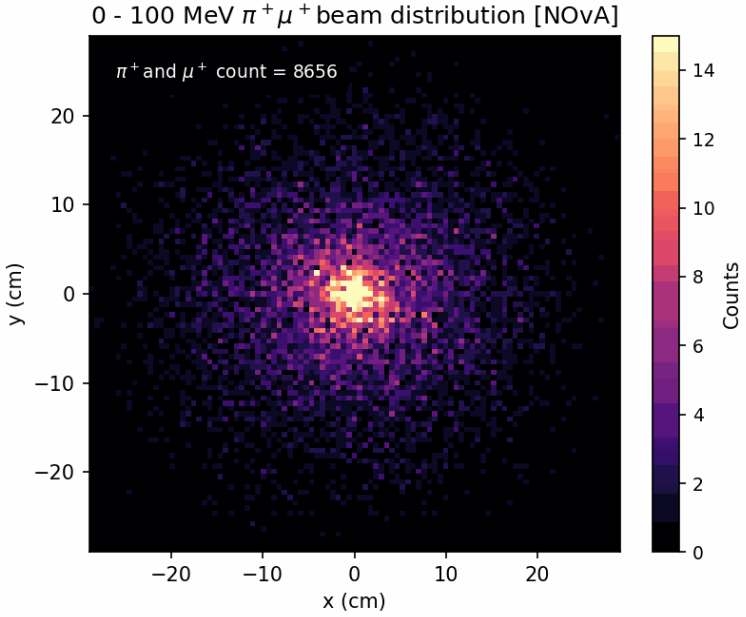


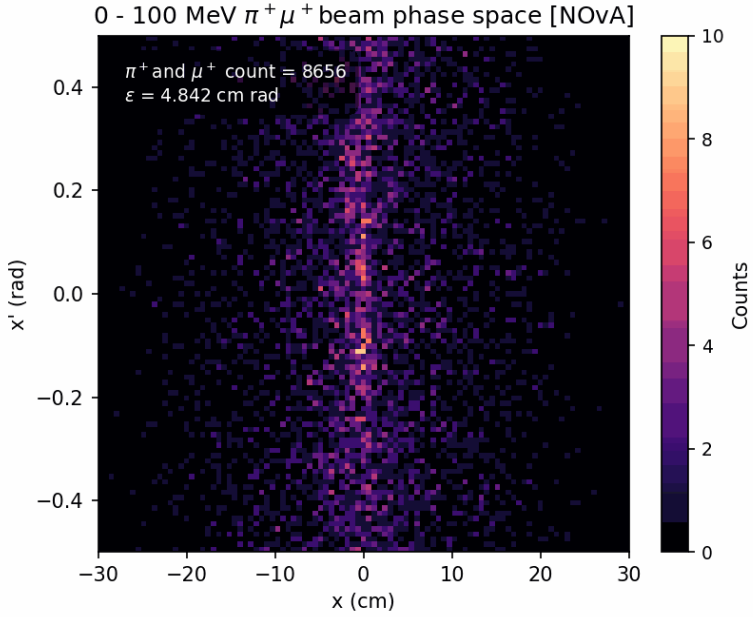
Pion tracks

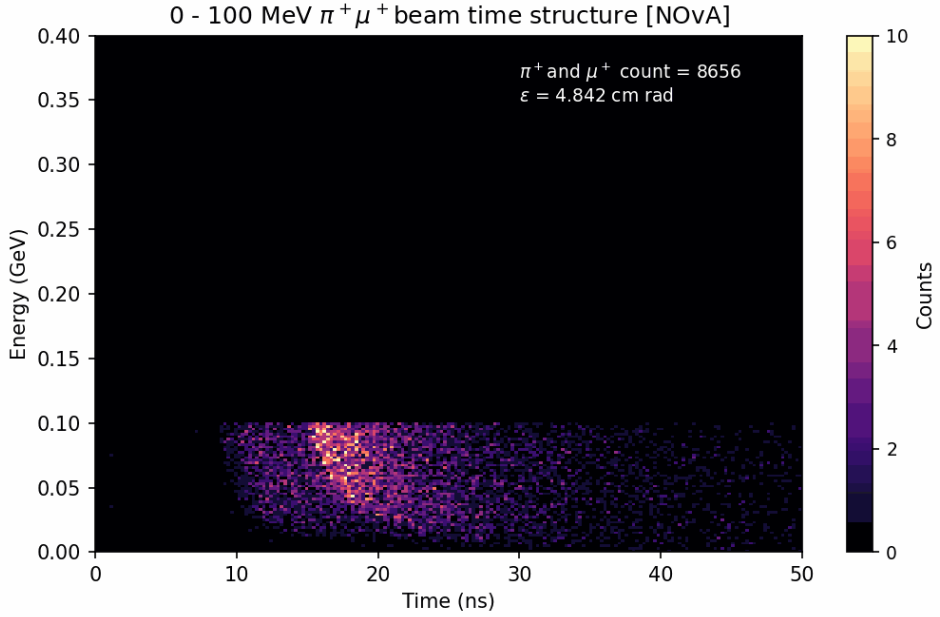

Pi+ tracks in the solenoid [1000 primaries] [Mu2e]
x (cm)
z (cm)
30
20
10
0
-10
-20
-30
-150
-100
-50
0
50
100
150
0.001
0.0008
0.0006
0.0004
0.0002
0
Pi+ tracks in the solenoid [1000 primaries] [NOvA]
x (cm)
z (cm)
30
20
10
0
-10
-20
-30
-150
-100
-50
0
50
100
150
0.001
0.0008
0.0006
0.0004
0.0002
0

$\pi^+\mu^+$ beams detected at the end of the solenoid [NOvA]

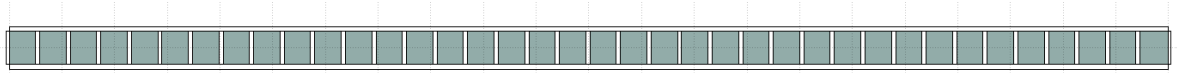


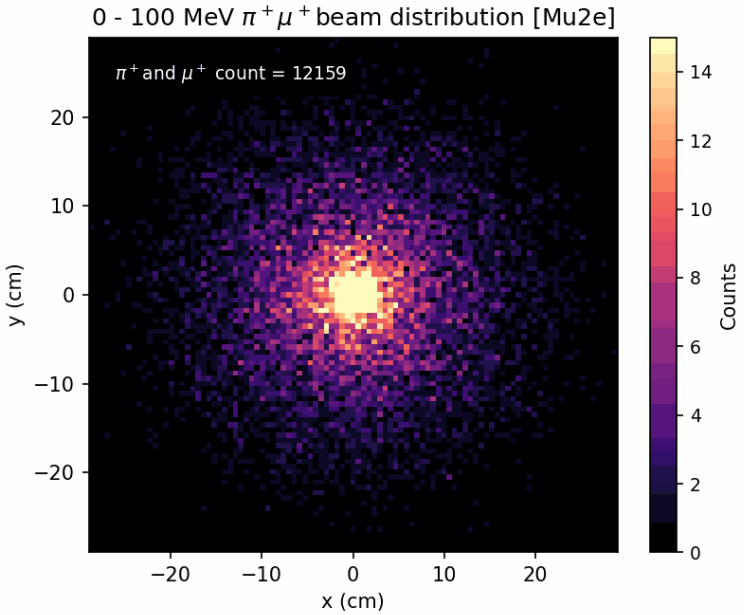


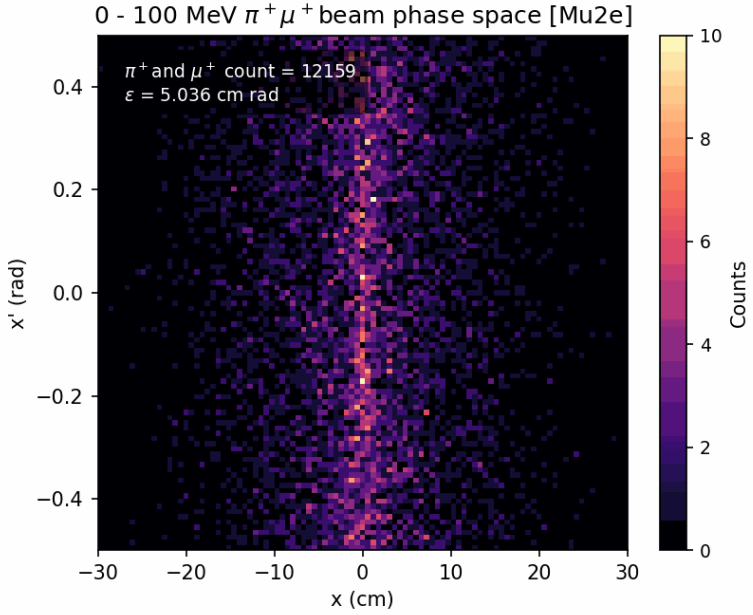


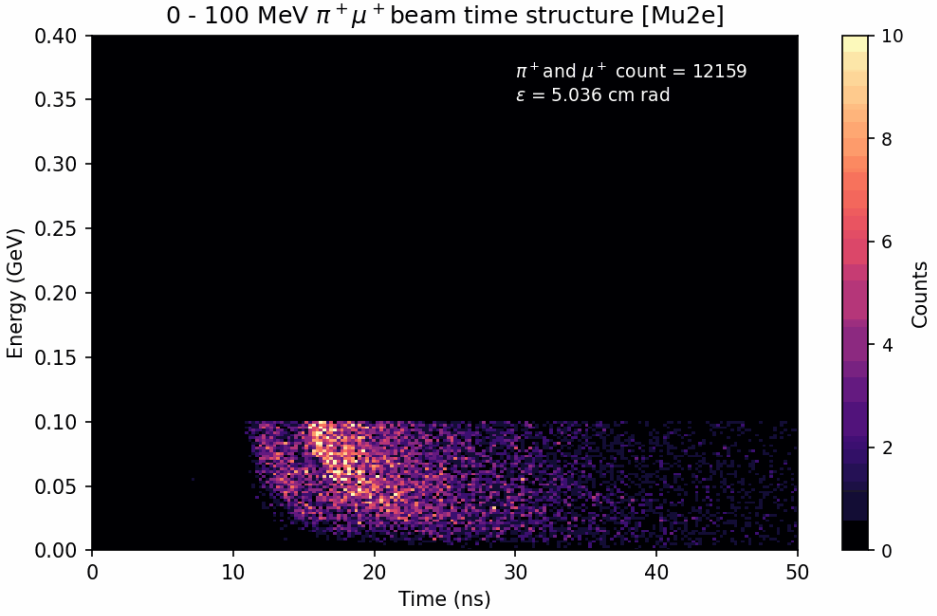


$\pi^+\mu^+$ beams detected at the end of the solenoid [Mu2e]

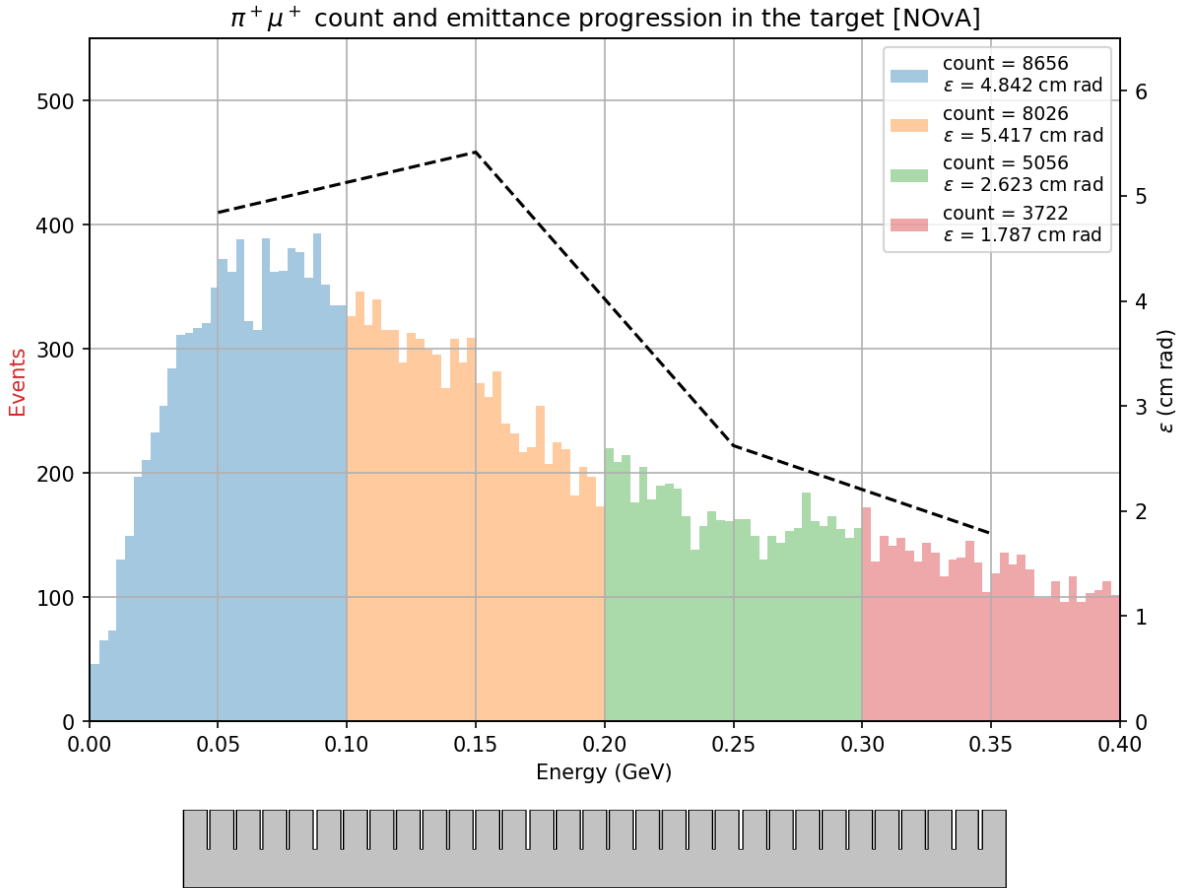


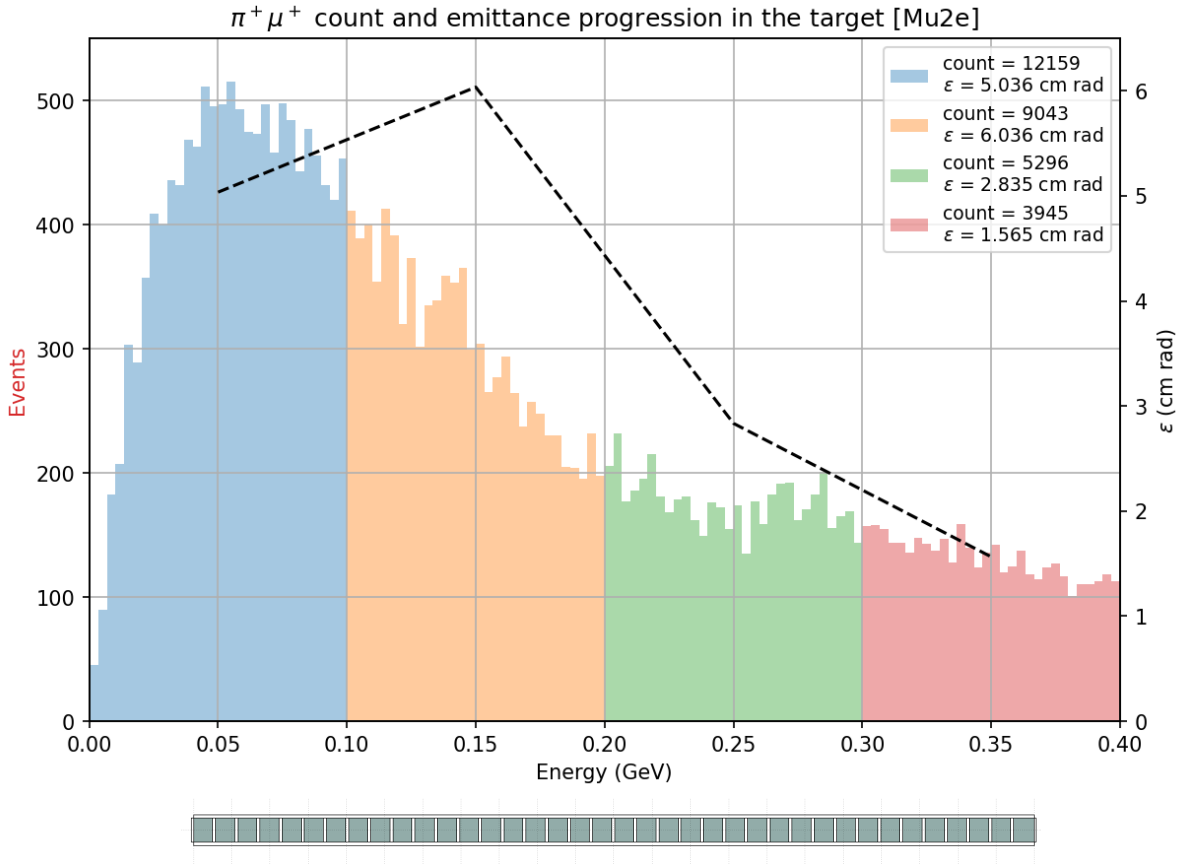




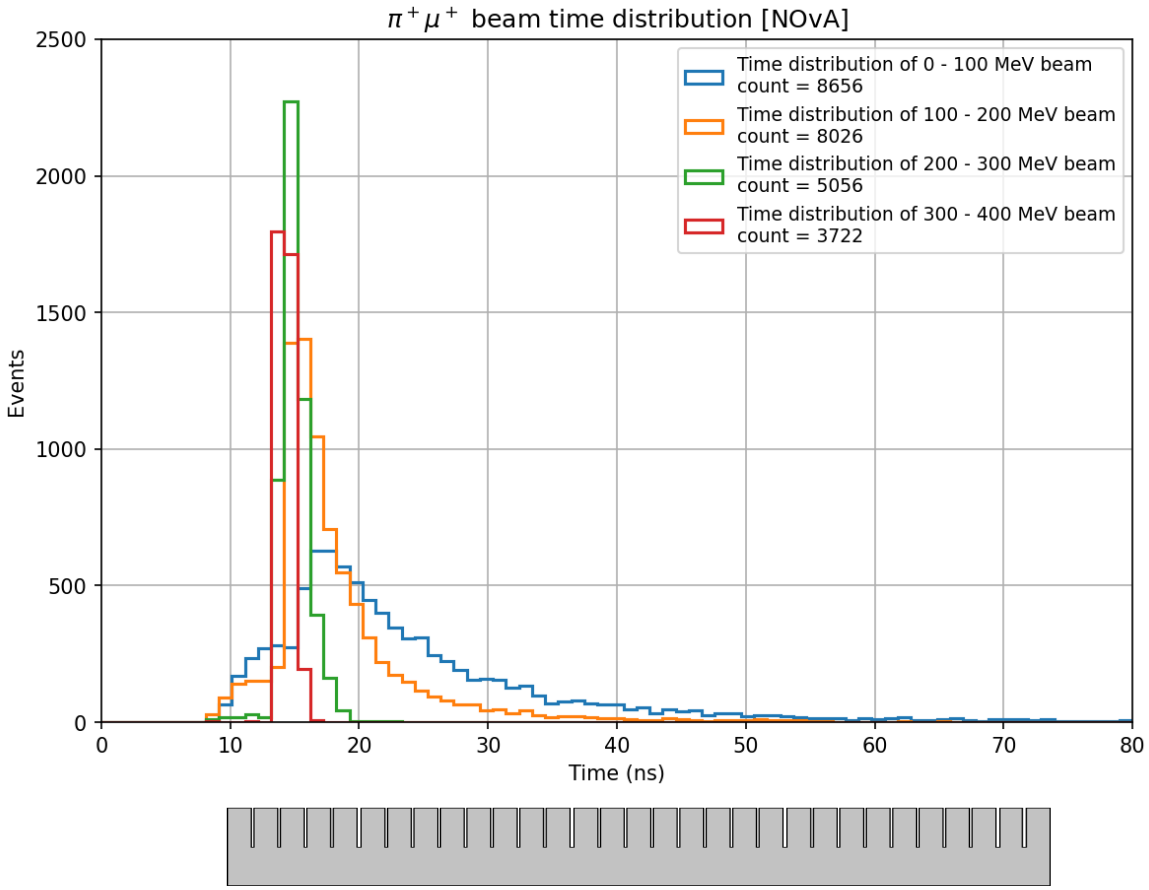


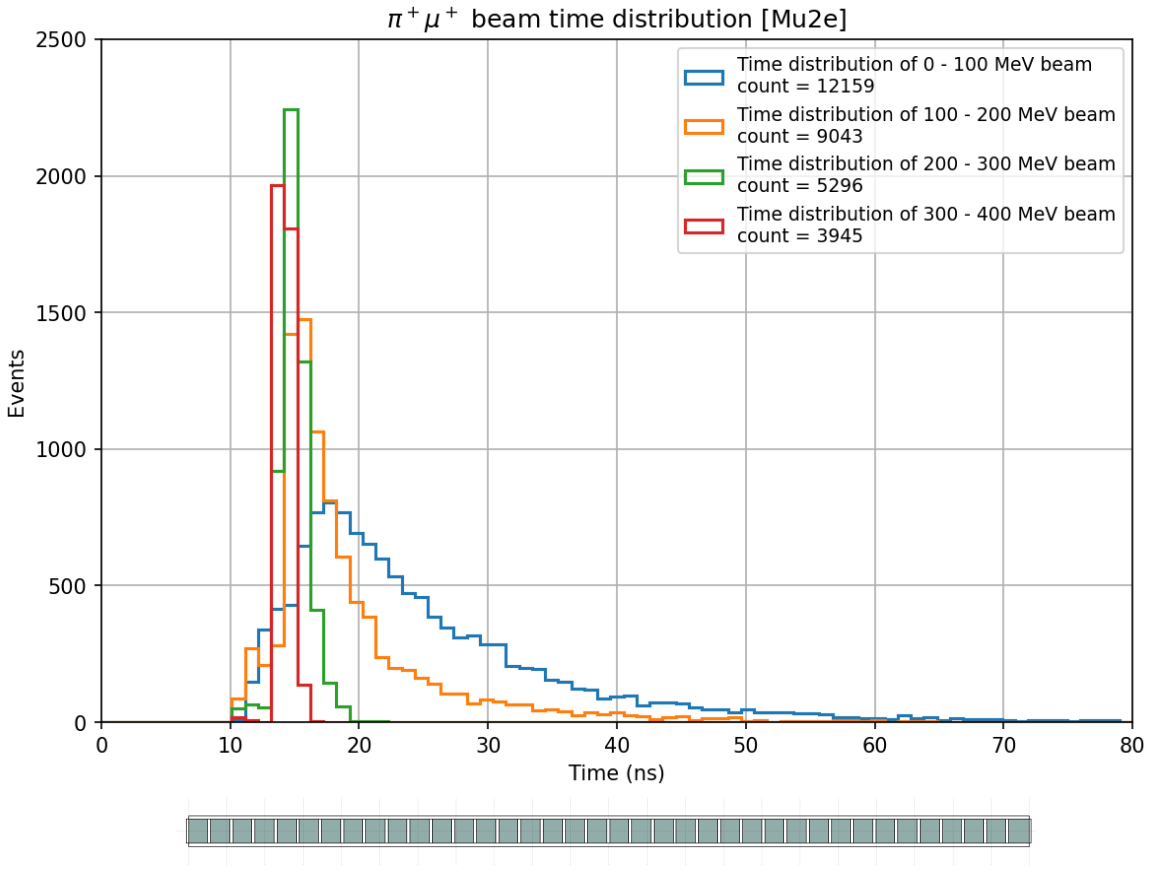
$\pi^+\mu^+$ beams energy distribution and emittance at the end of the solenoid



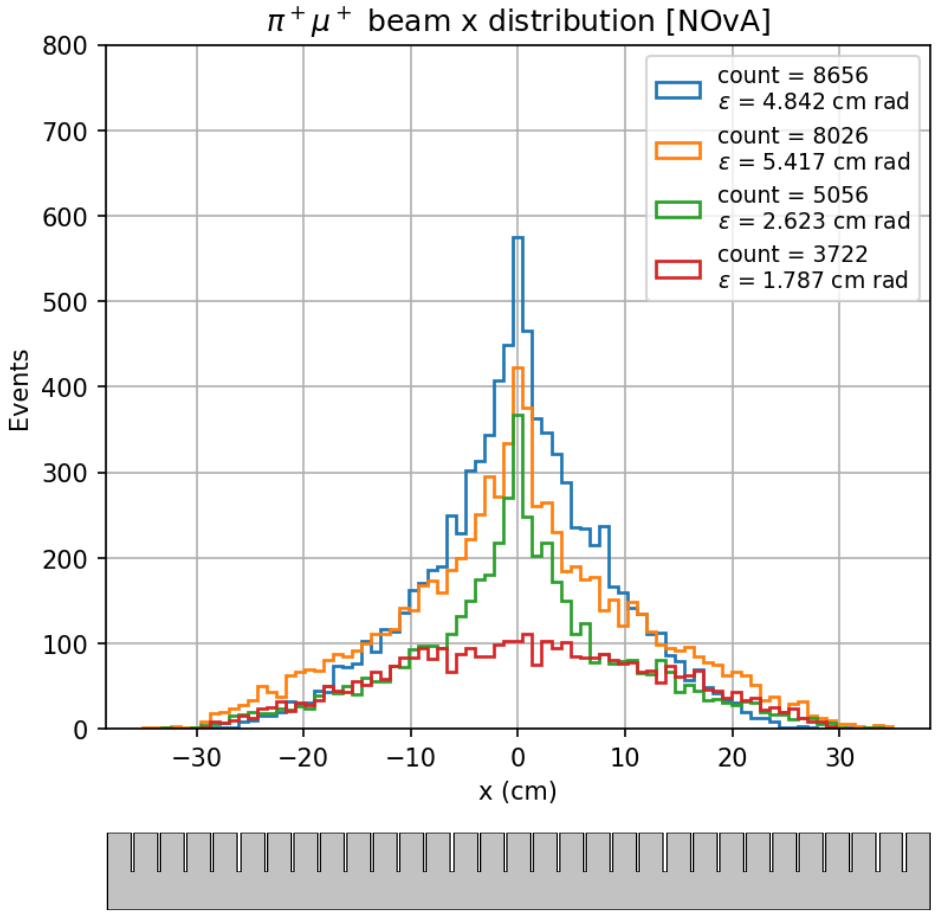


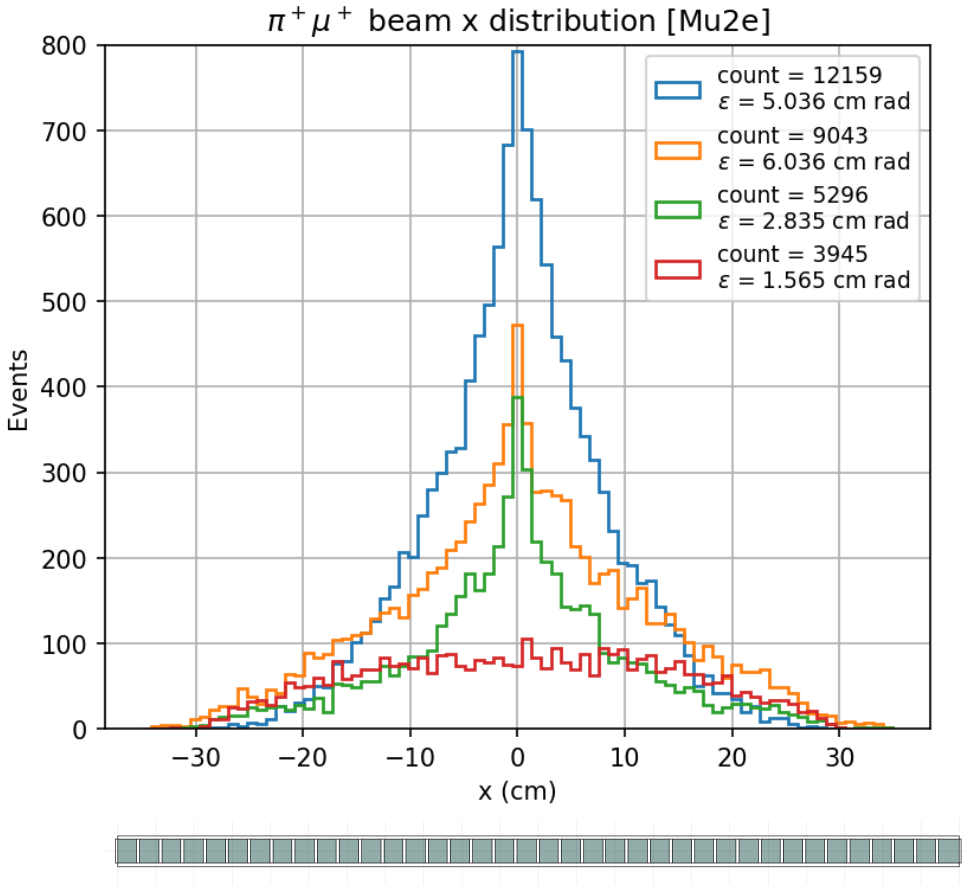
$\pi^+\mu^+$ beams time distribution at the end of the solenoid



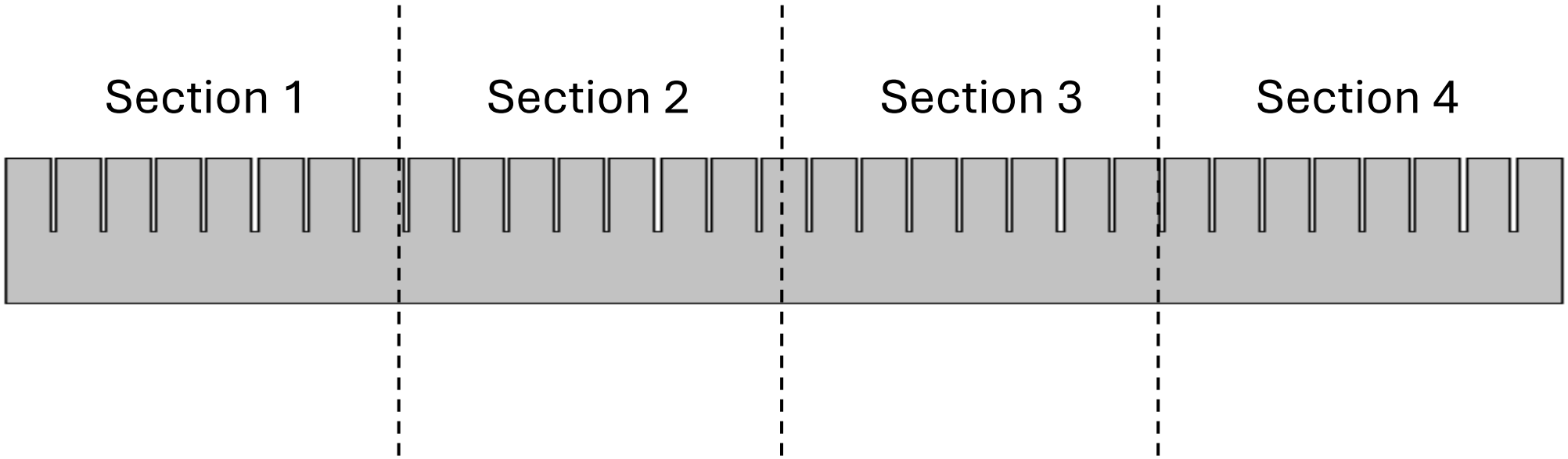


$\pi^+\mu^+$ beams transverse distribution at the end of the solenoid

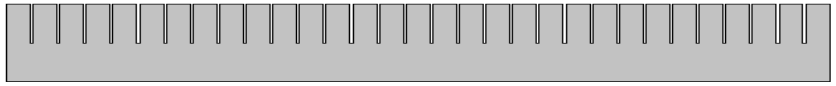


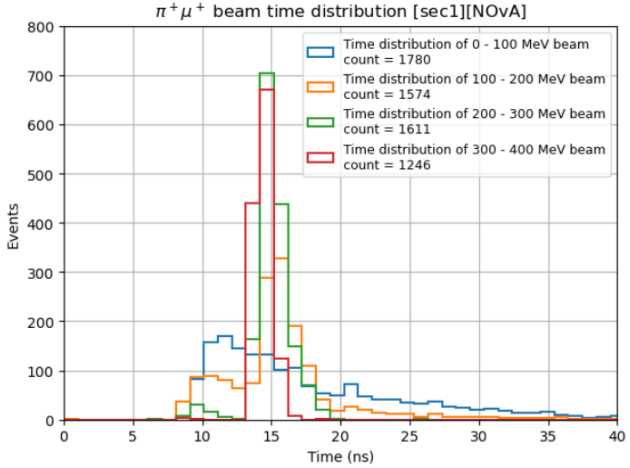


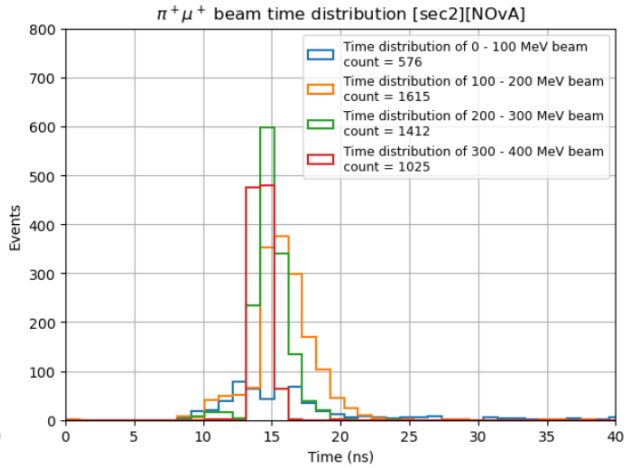
Here, I sectioned the NOvA target

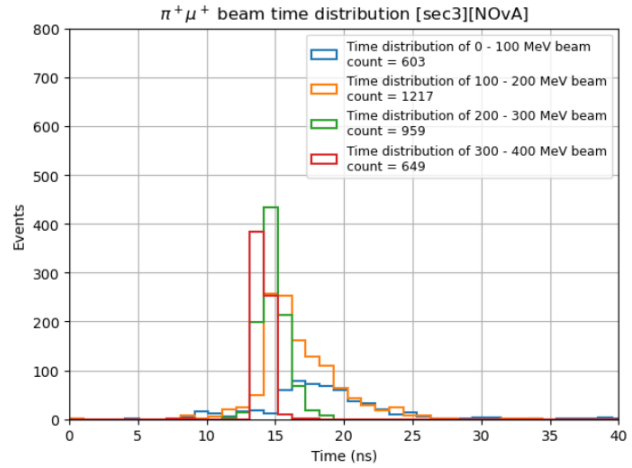


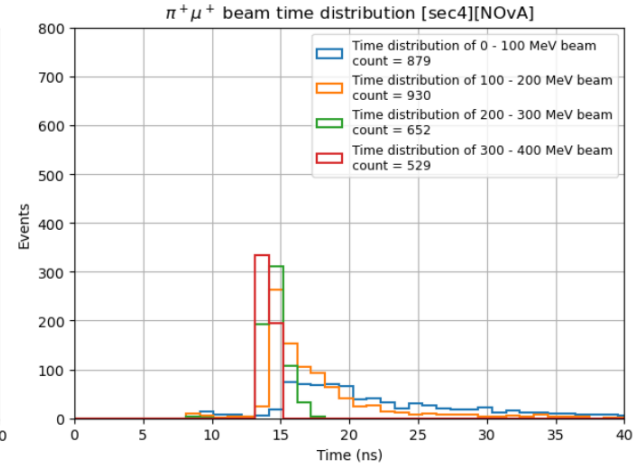
$\pi^+\mu^+$ beams time distribution for different sections [NOvA]



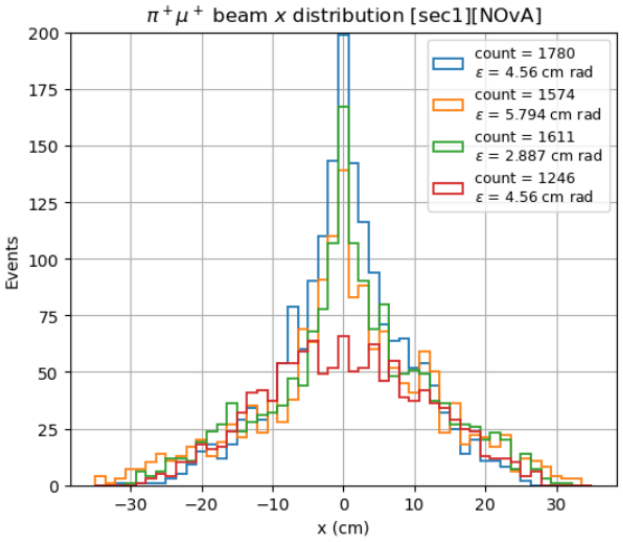


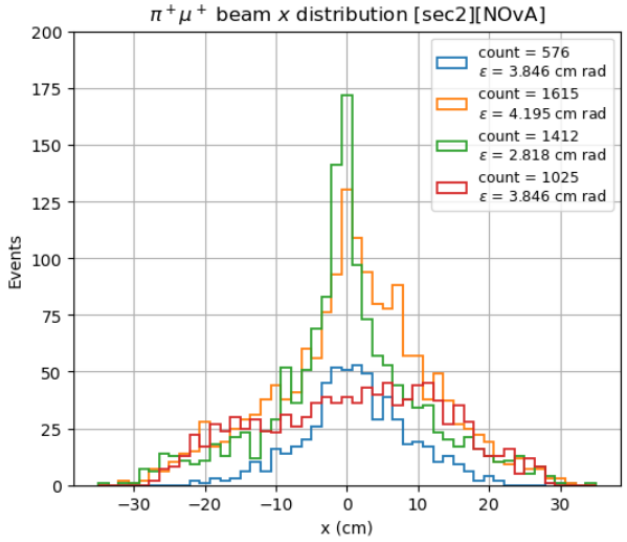


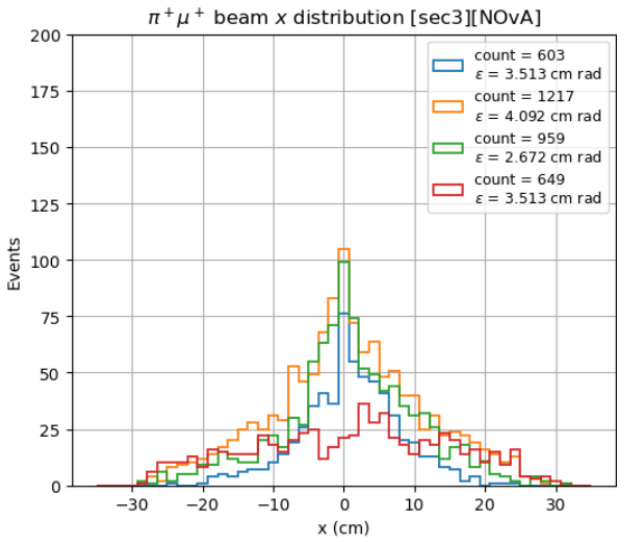


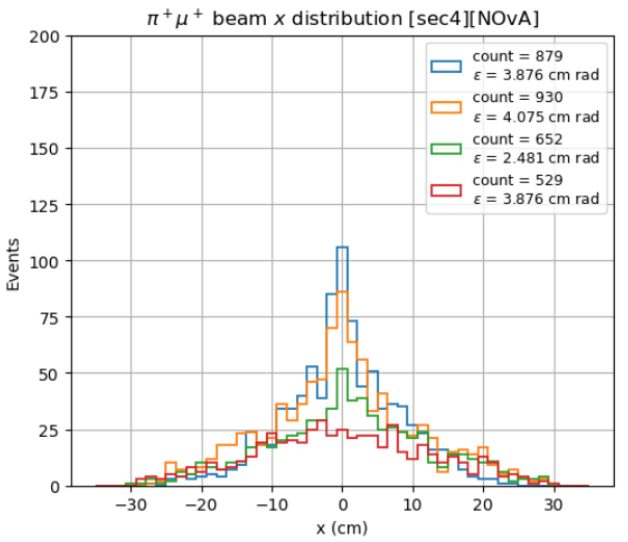


$\pi^+\mu^+$ beams transverse distribution for different sections [NOvA]

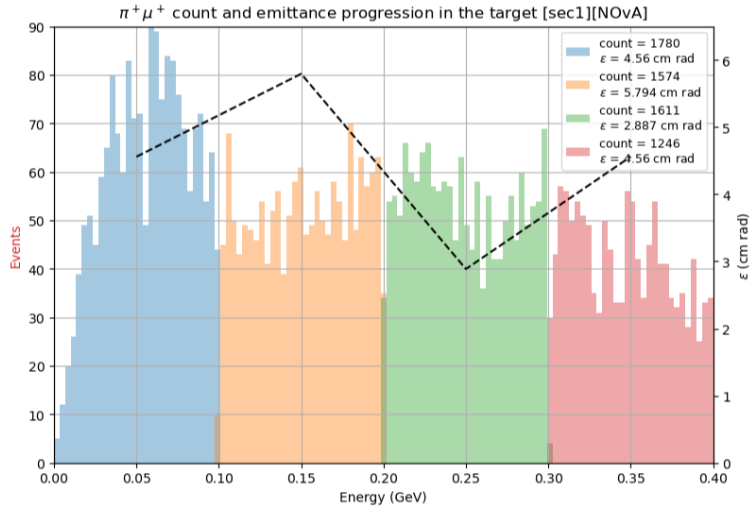


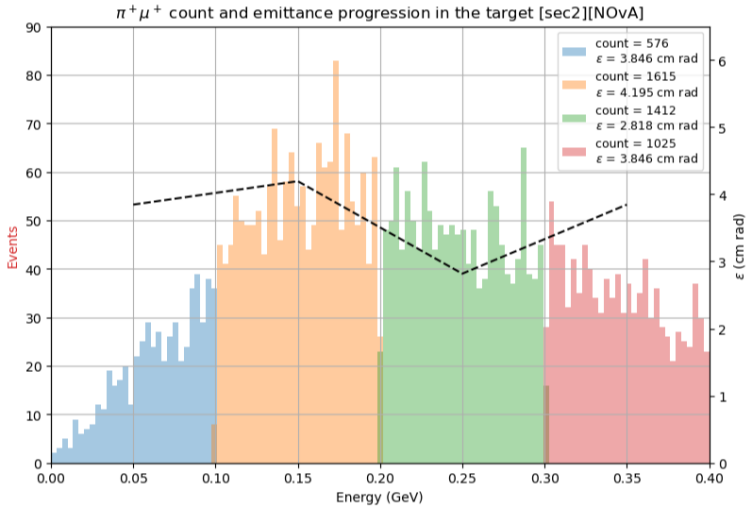


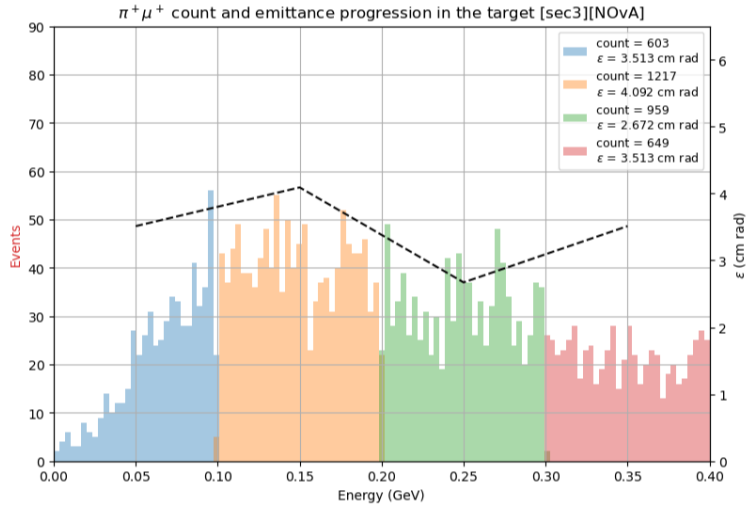


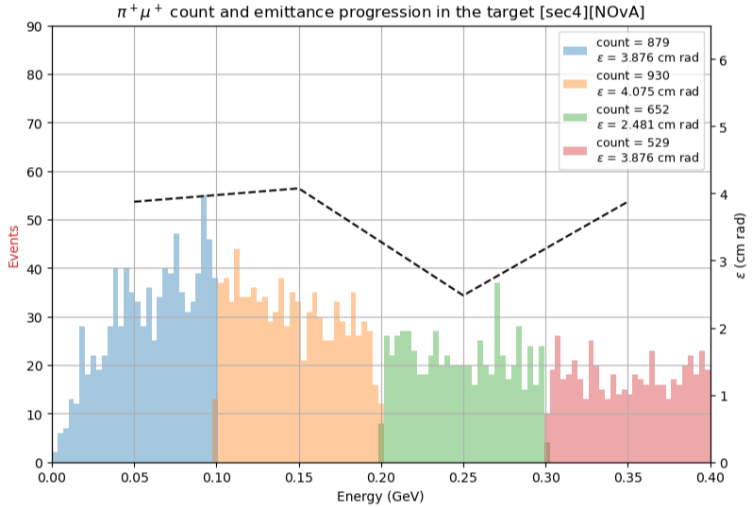


$\pi^+\mu^+$ beams energy distribution for different sections [NOvA]

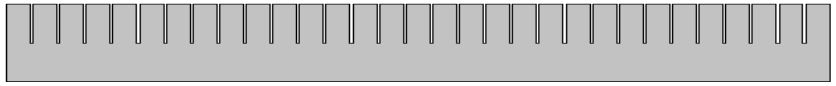




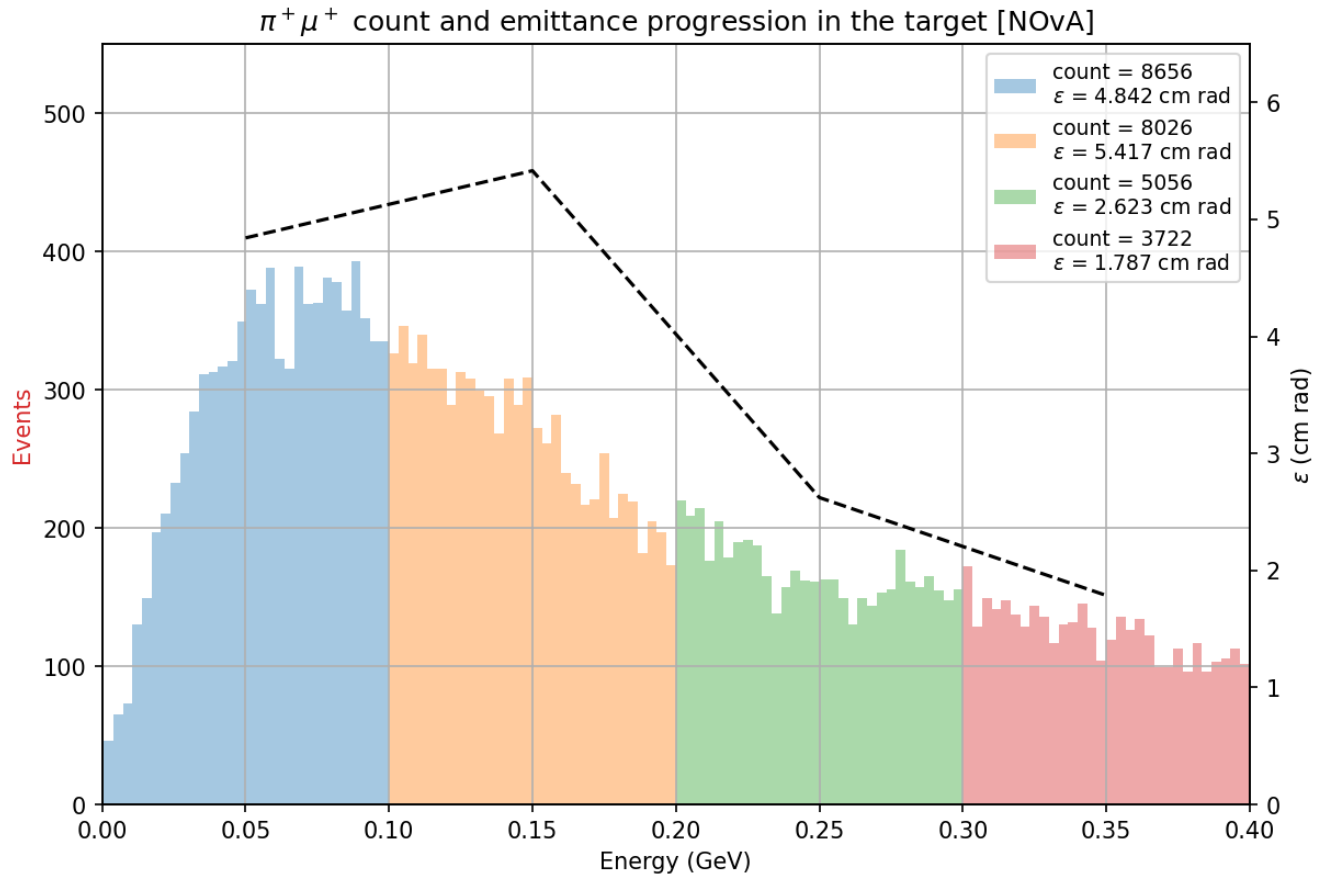




$\pi^+\mu^+$ beams energy distribution for different sections [NOvA]



→From the full simulation:



Summary

→The emittance and the time distribution seems to improve for higher energy $\pi^+\mu^+$ beams (300 – 400 MeV), which is expected.

→However, we are losing more particles for the beams in that energy range.

→The results of this week indicate that the emittance calculated from the fullscale simulation does not agree with the partial simulations of different sections of the NOvA target.

→Look at the beam characteristics of $\pi^+\mu^+$ particles produced at different sections of the target.