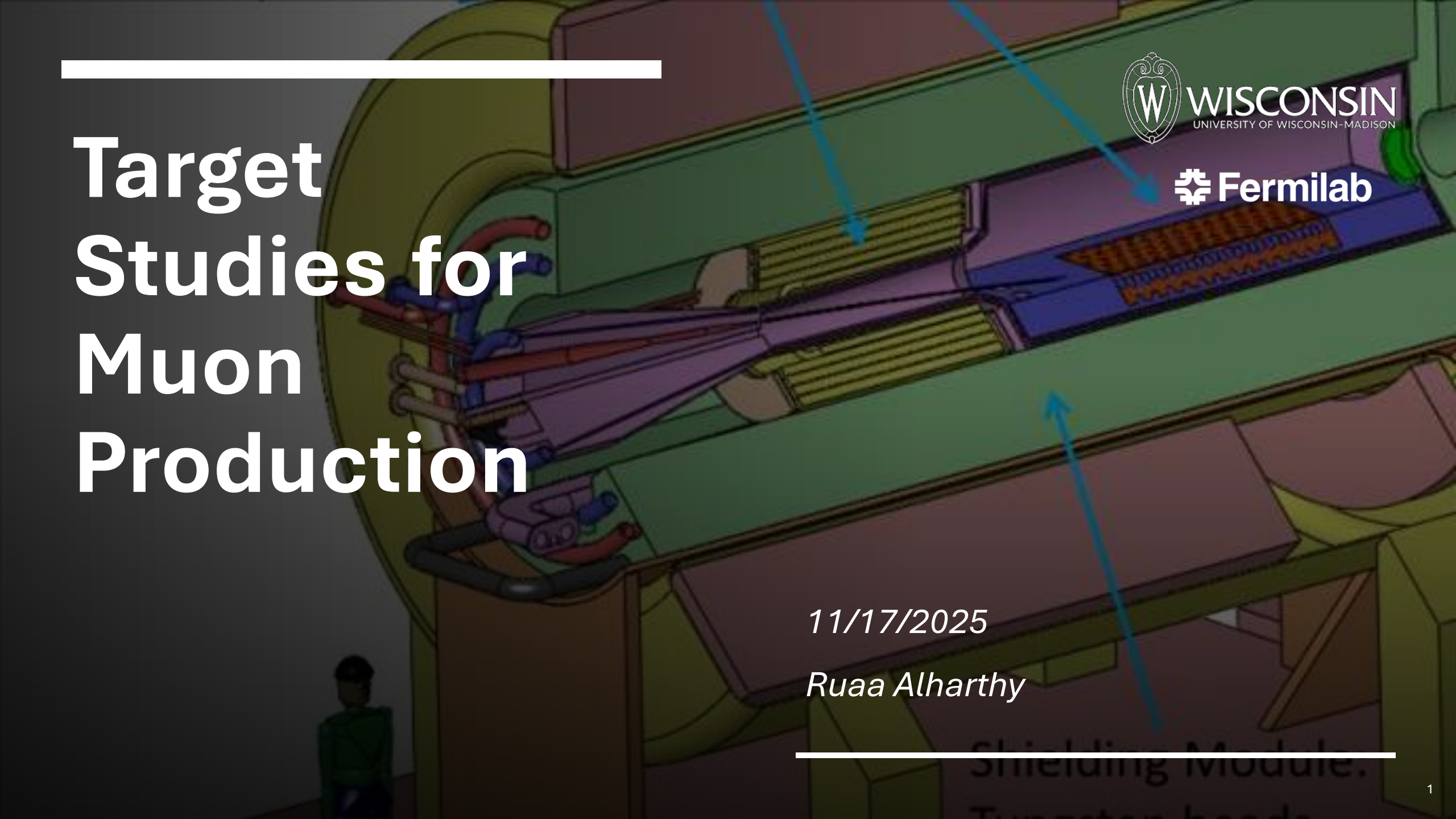
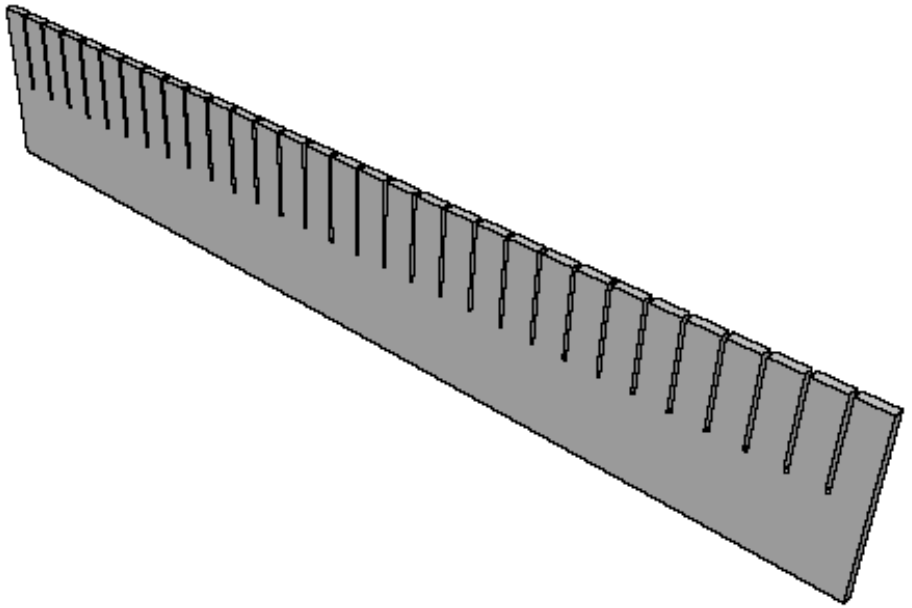
Target Studies for Muon Production



11/17/2025

Ruaa Alharthy

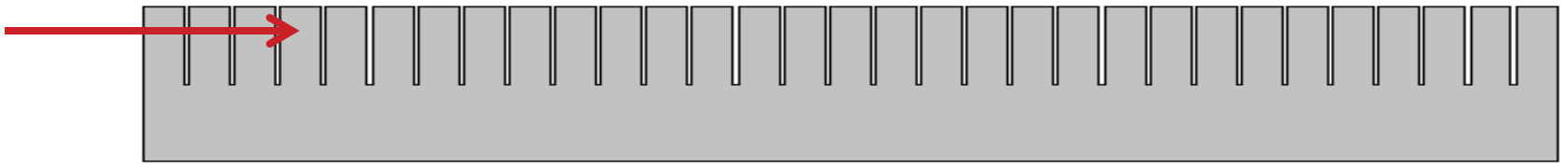
NOvA target design



→Material: Graphite

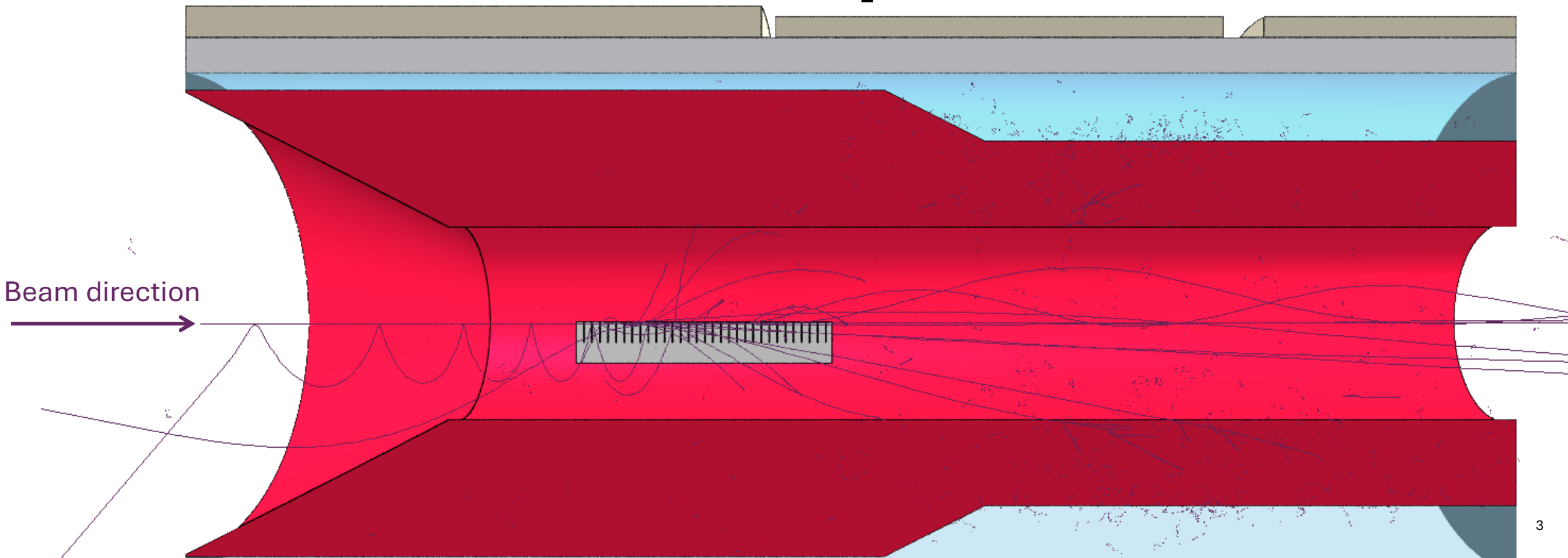
→The target is **78** cm in length and 0.74 cm wide.

→The target has 31 fins, each measuring 2.4 cm in length along the beam direction, and 6.3 cm in height, spaced by 0.05 cm gaps.

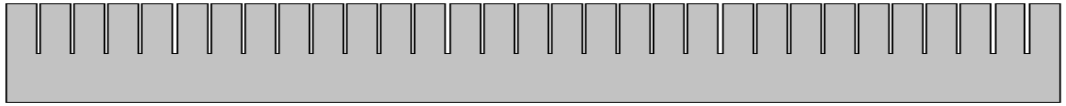


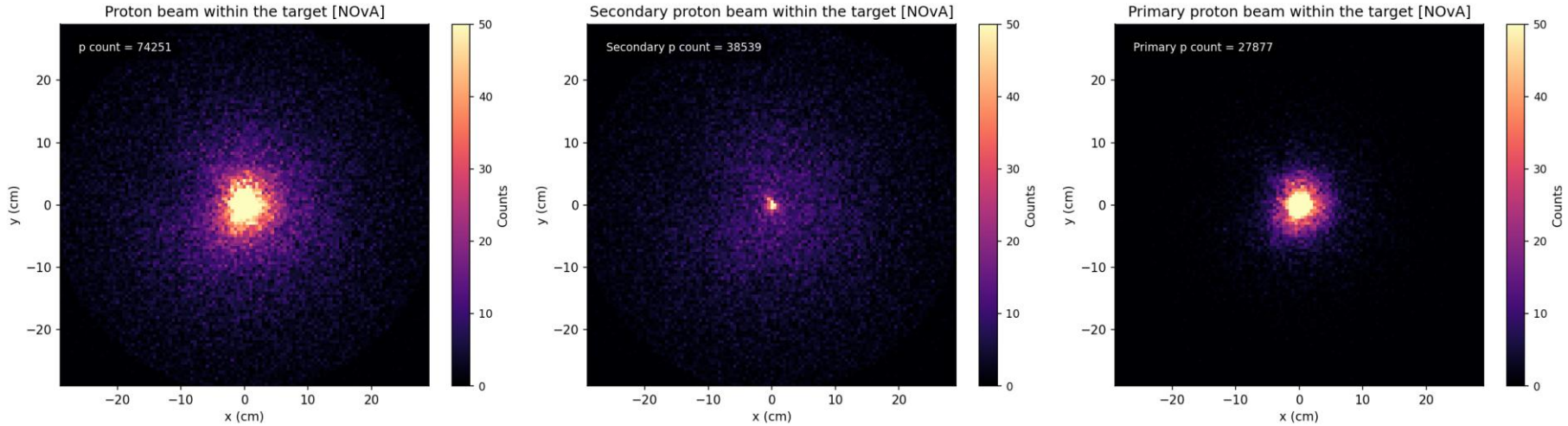
Analysis of the proton beams

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

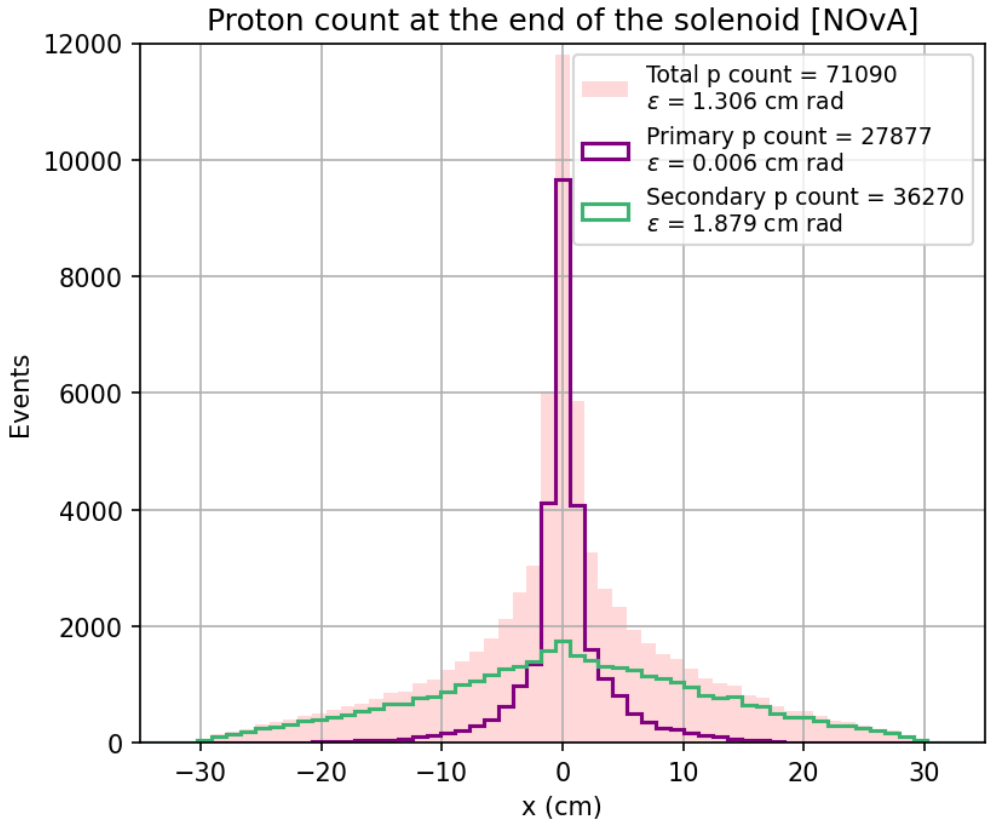


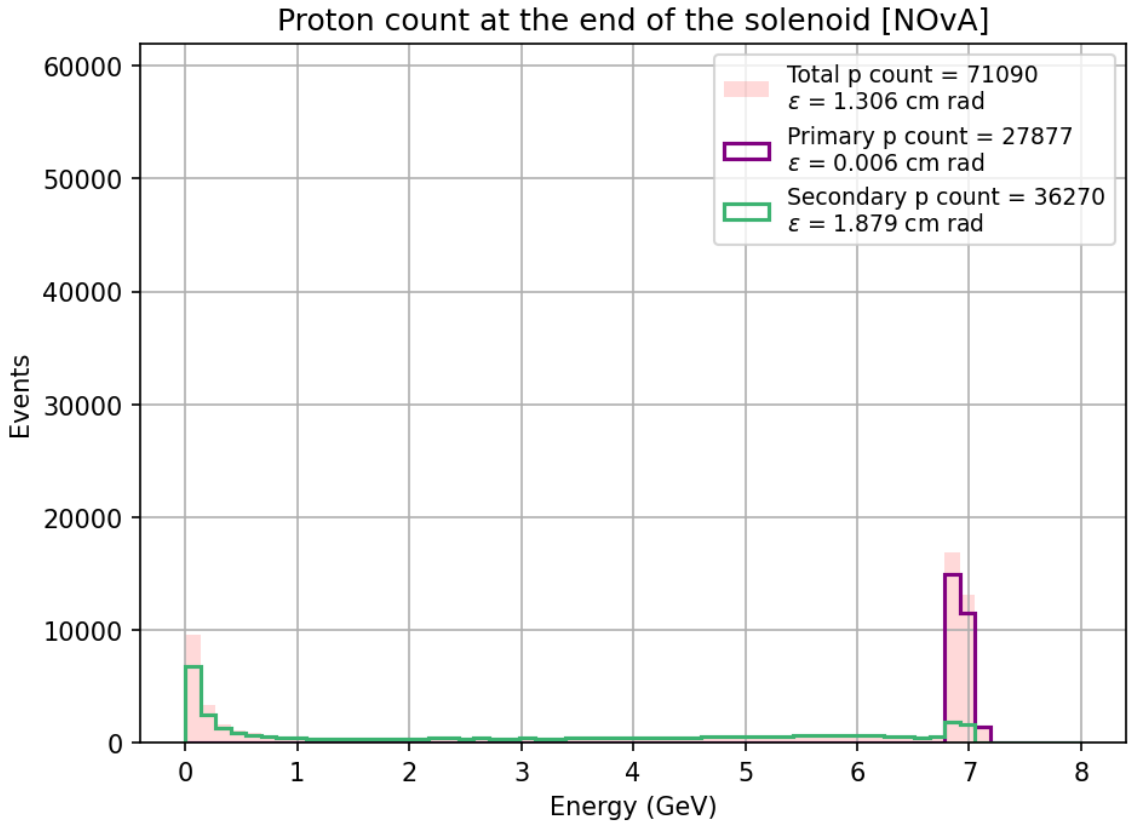
Proton beams detected at the end of the solenoid [NOvA]

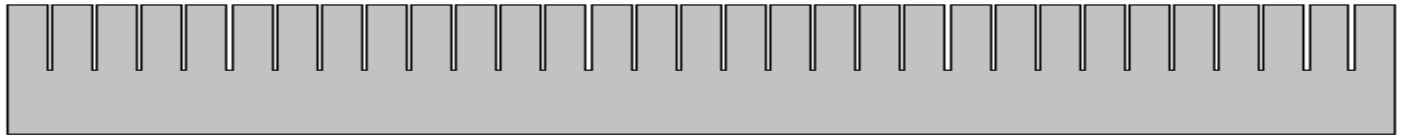




Proton beams transverse and energy distribution at the end of the solenoid [NOvA]

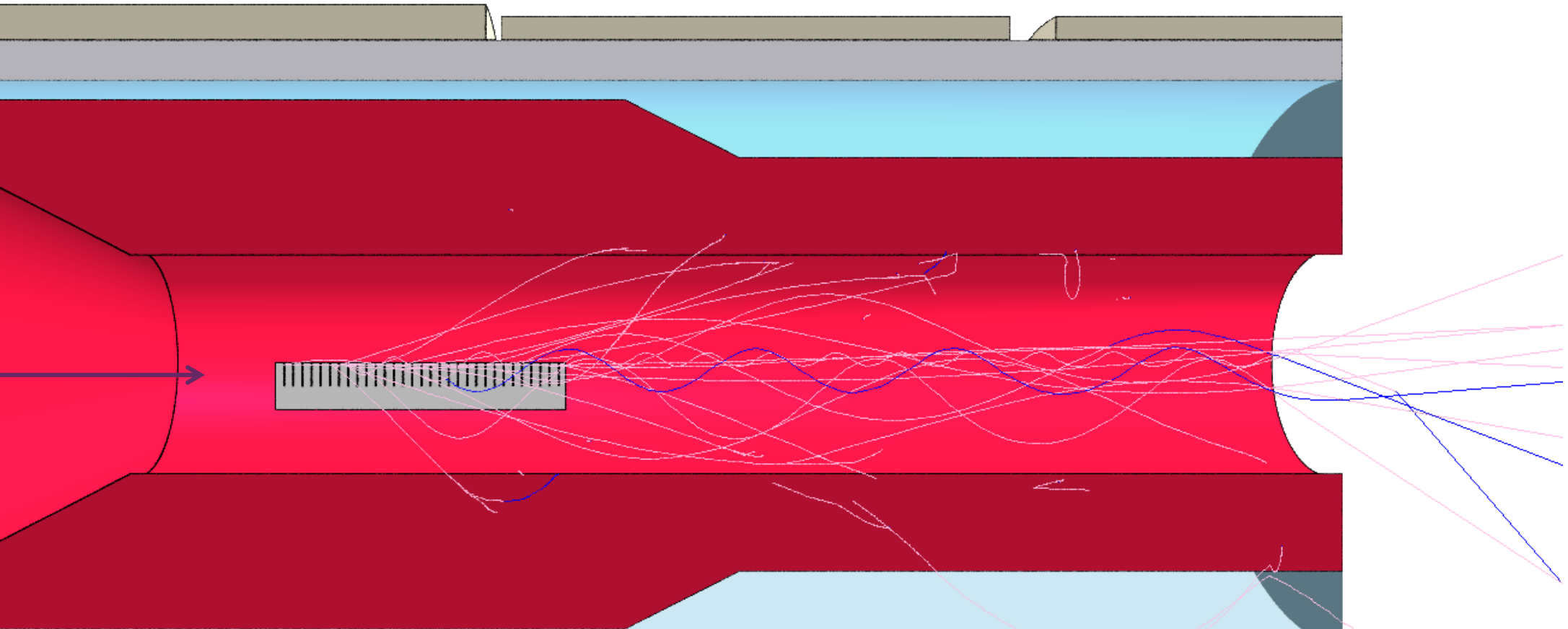




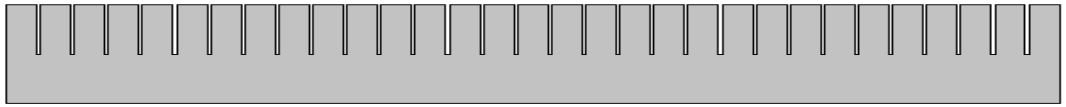


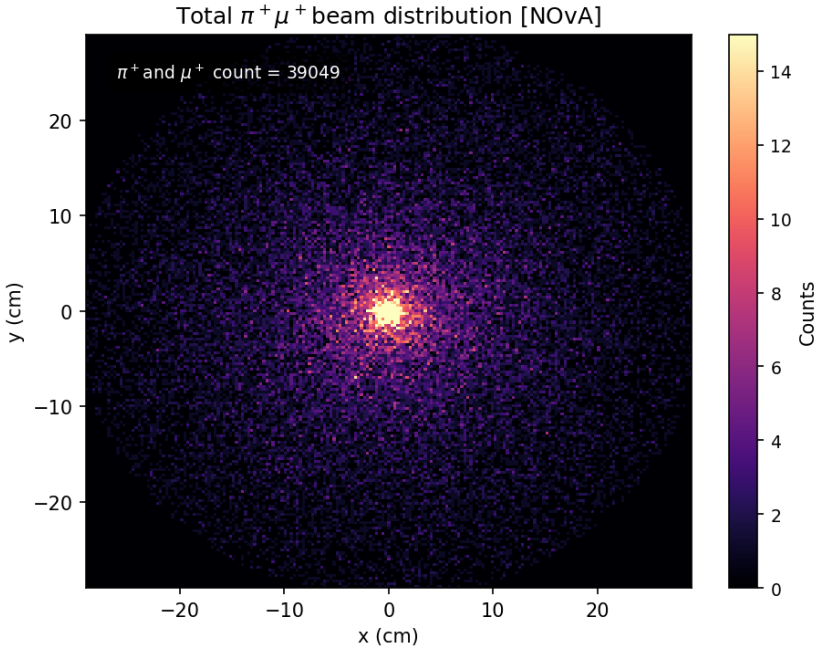
Analysis of the $\pi^+\mu^+$ beams

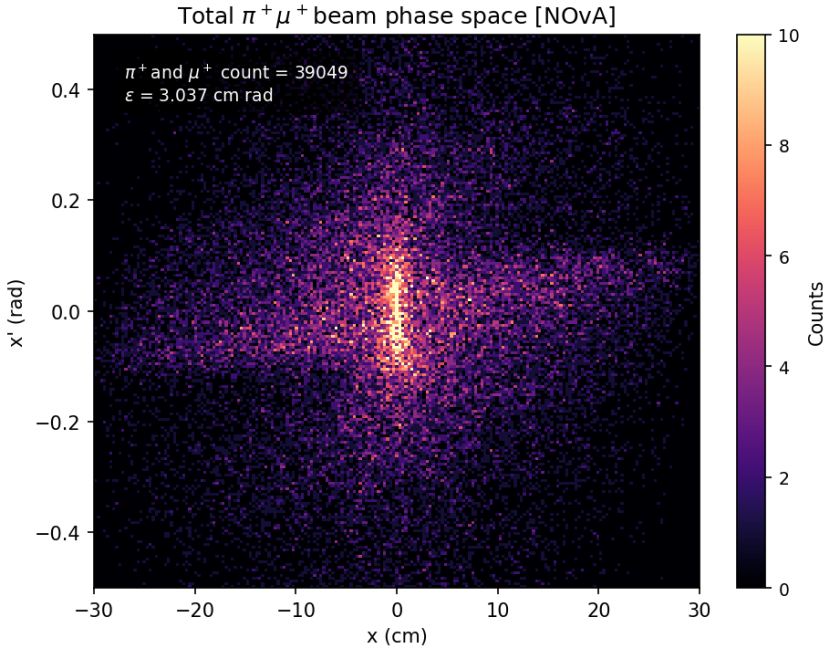
→100,000 primary protons were used in all the simulations

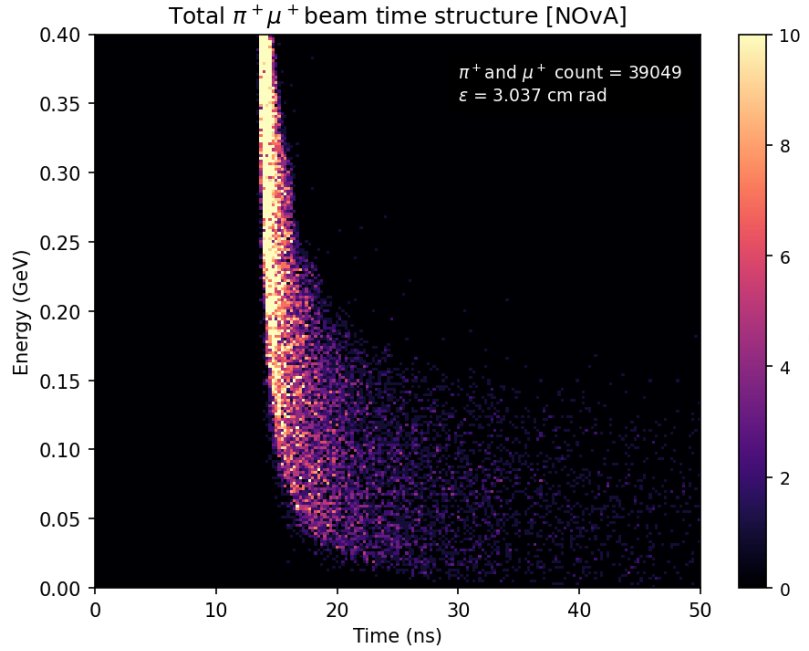


Total $\pi^+\mu^+$ beams detected at the end of the solenoid [NOvA]





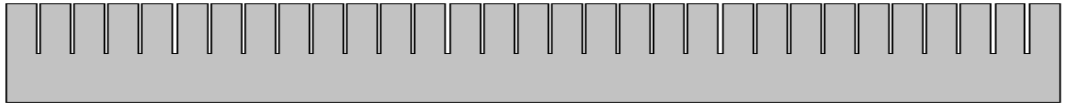


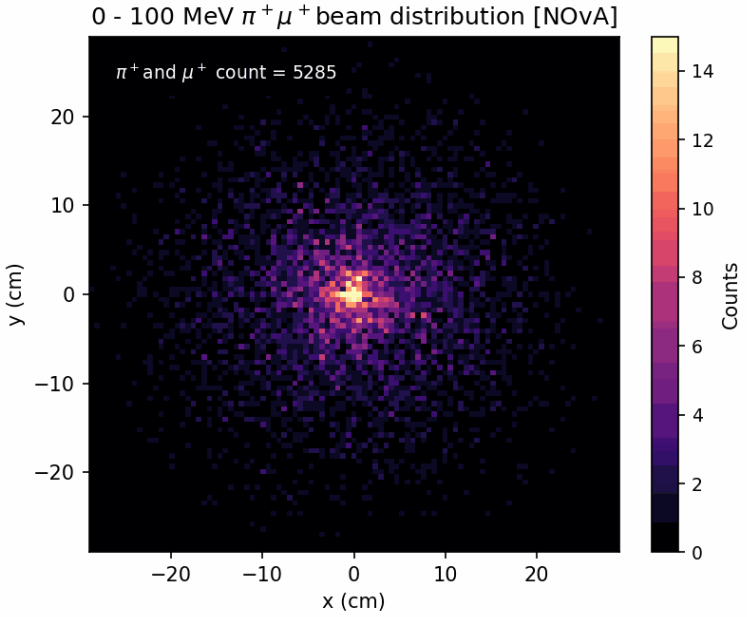


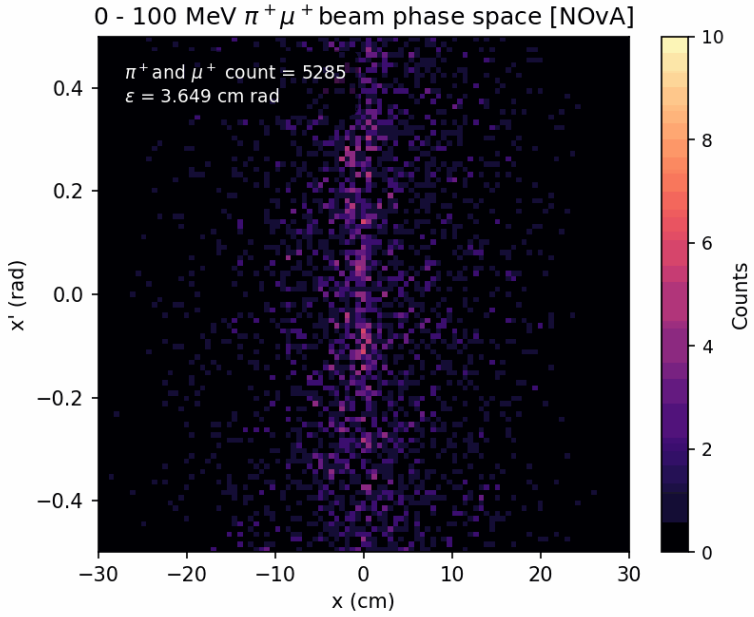
Total secondary protons	36,270
Total $\pi^+\mu^+$ detected at the end of the solenoid	39,049

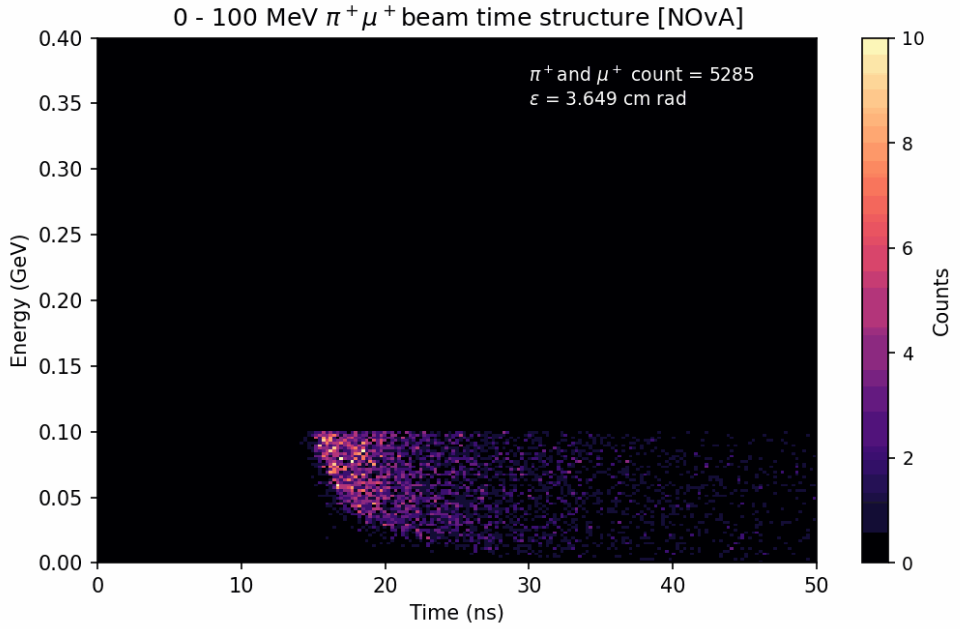
→ I am thinking that it may be a good idea to find how many were produced from secondary protons.

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

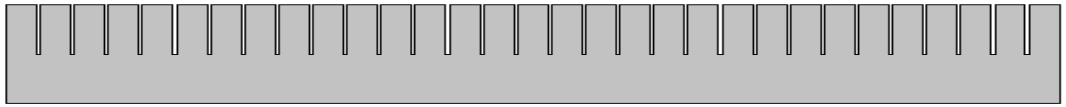


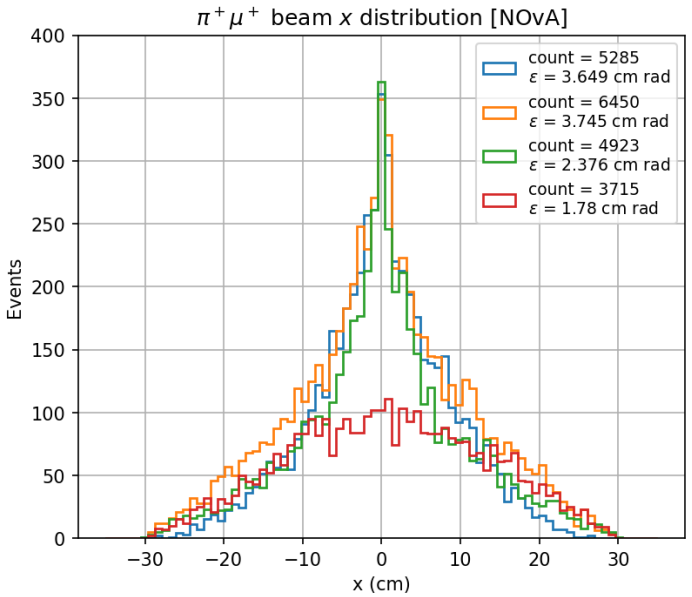


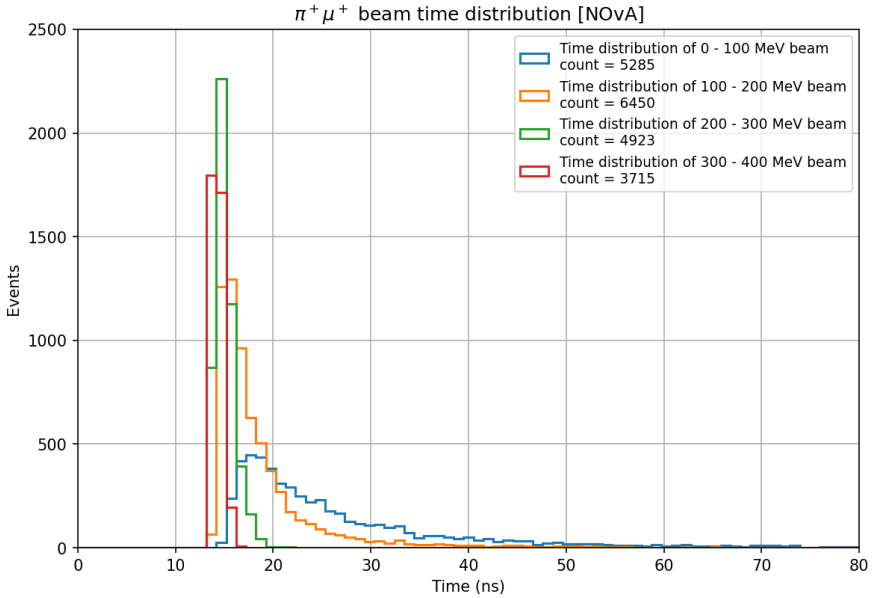


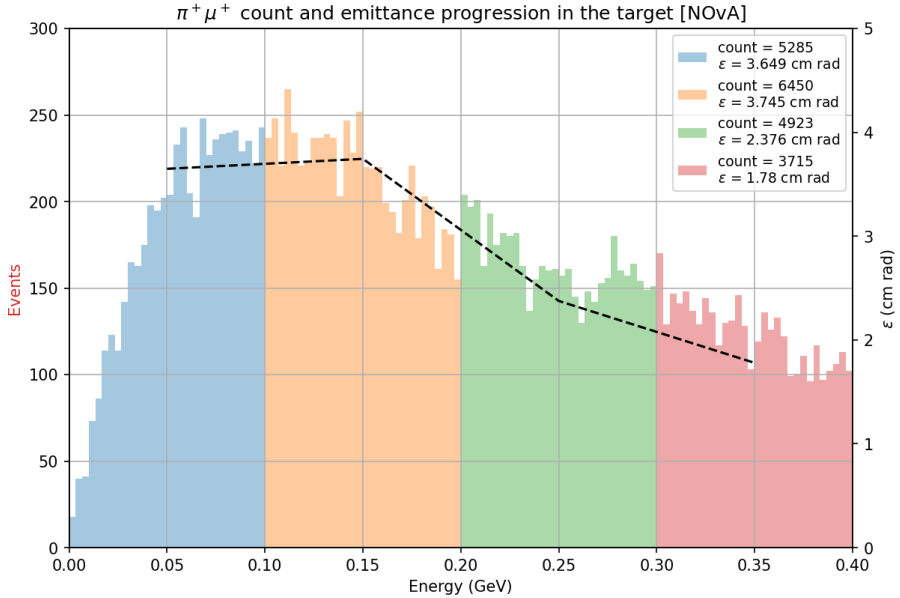


$\pi^+\mu^+$ beams detected at the end of the solenoid [NOvA]

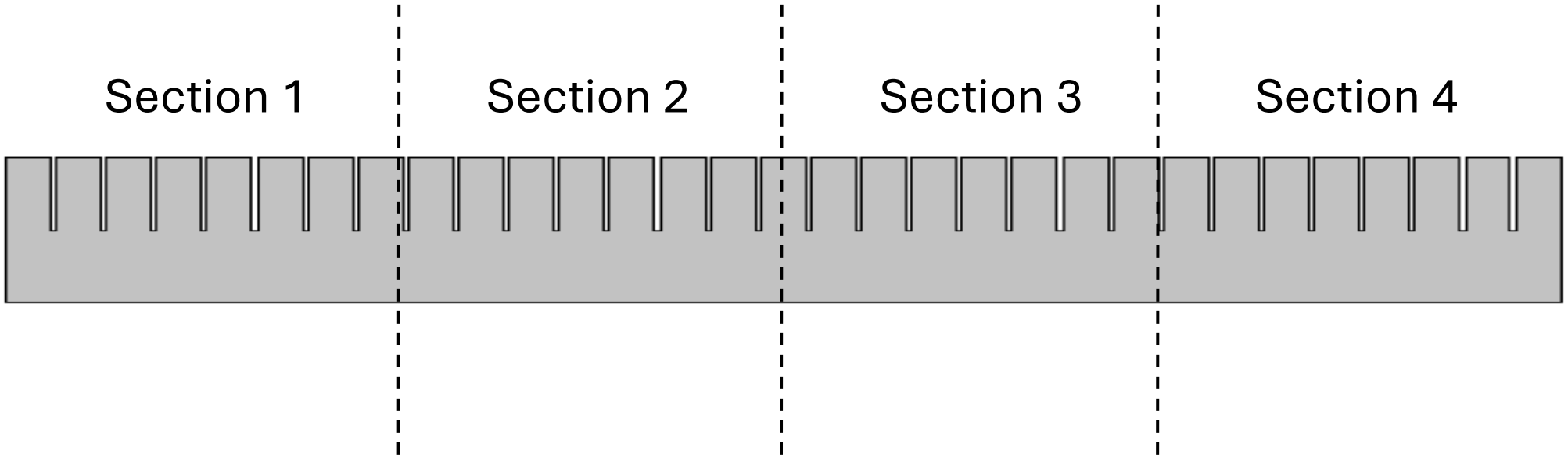








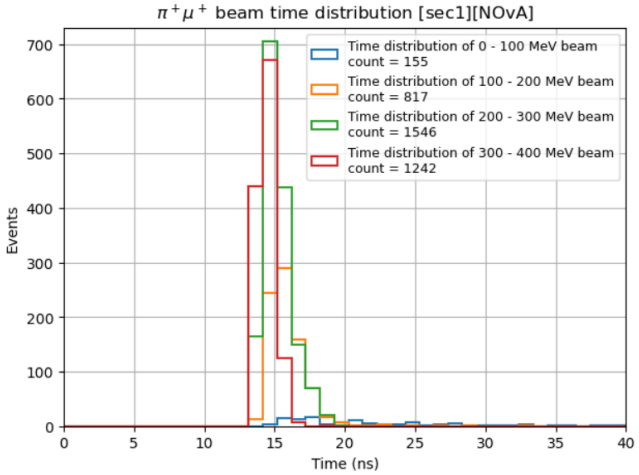
Here, I sectioned the NOvA target

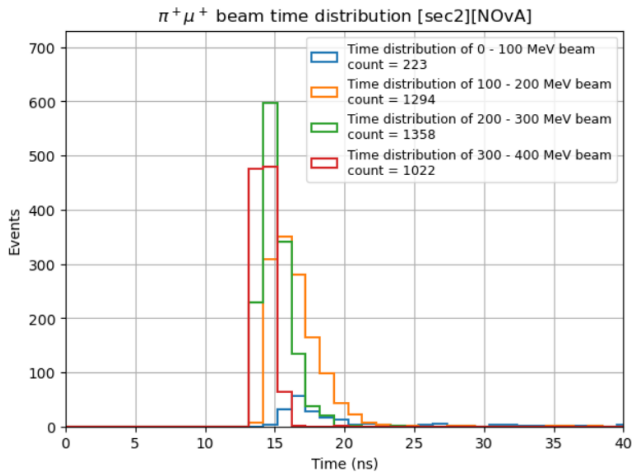


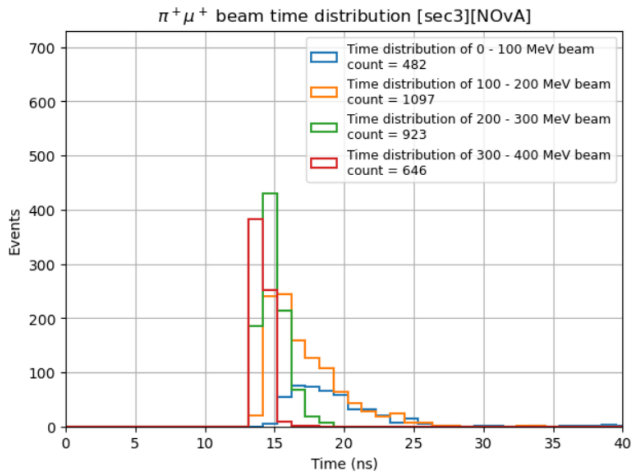
→New definitions:

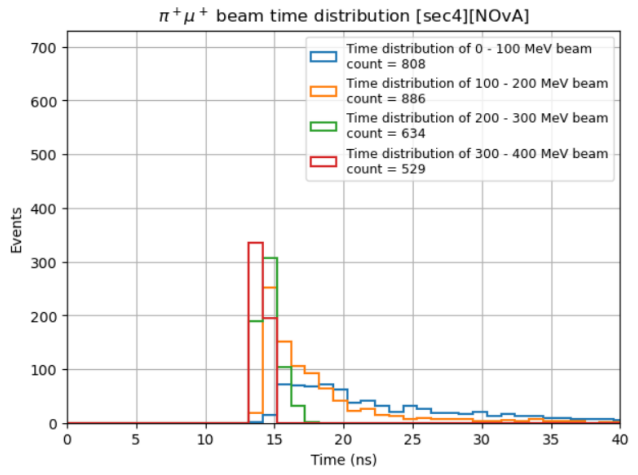
- →Full simulation: where all the particles that exit the target are recorded.
- →Partial simulation: where particles from a particular section are allowed to continue and particles that exit the target from other sections are killed.

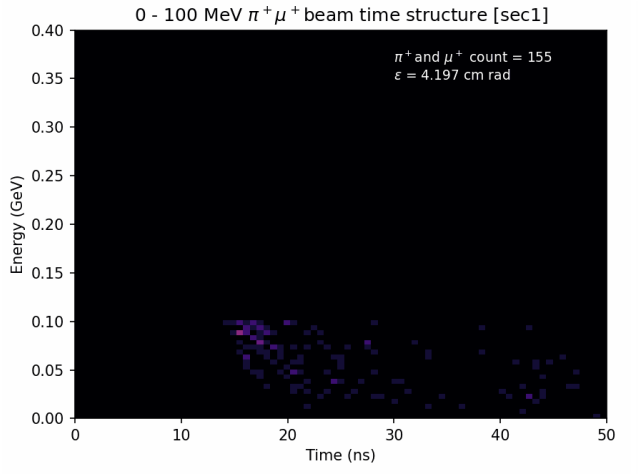
$\pi^+\mu^+$ beams time distribution for different sections [NOvA]

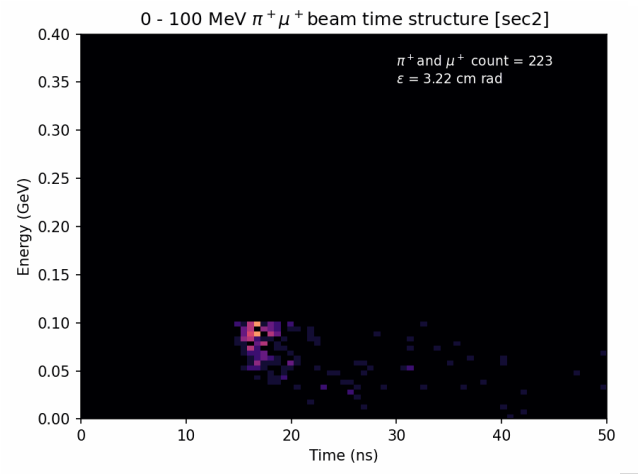


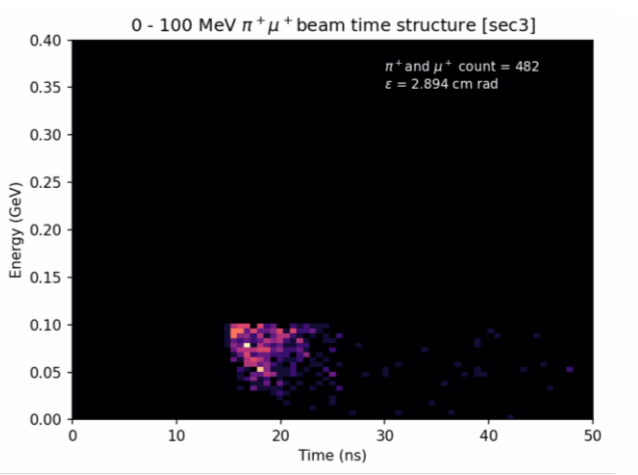


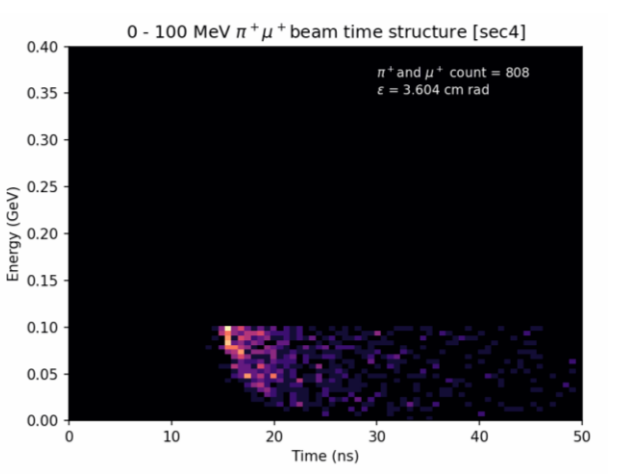




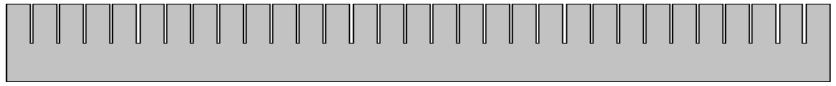


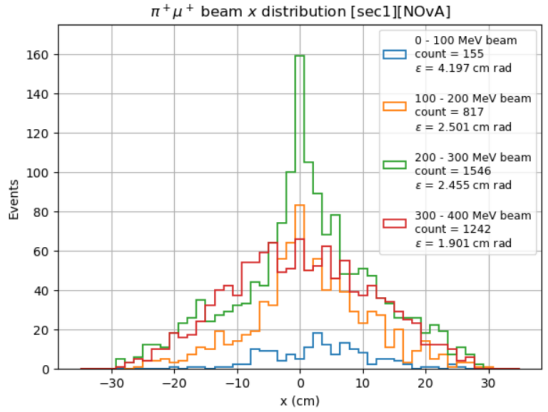


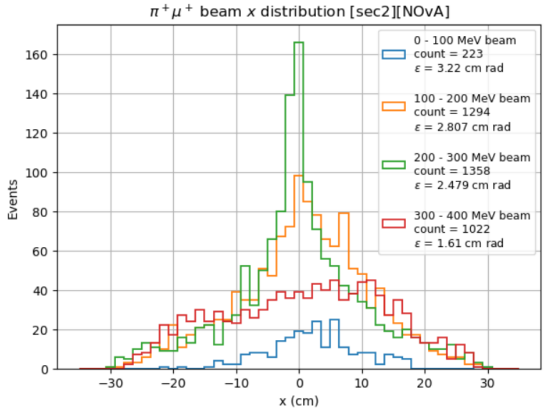


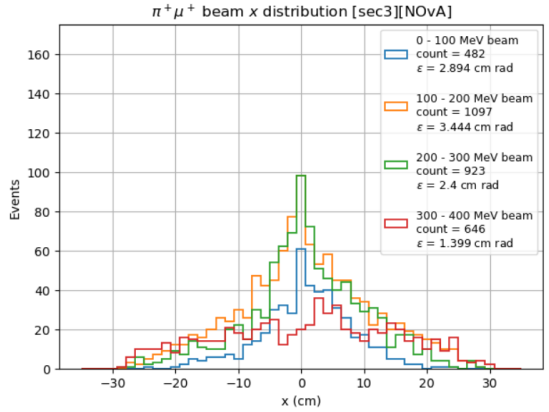


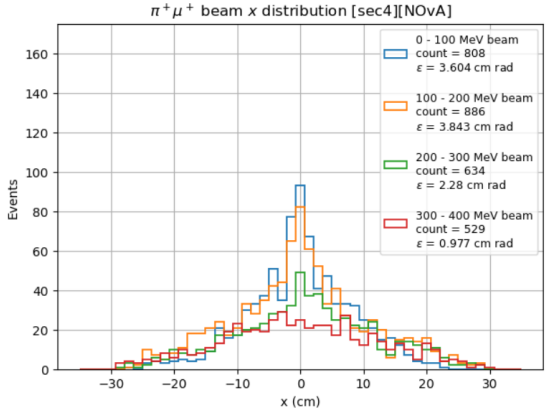
$\pi^+\mu^+$ beams transverse distribution for different sections [NOvA]

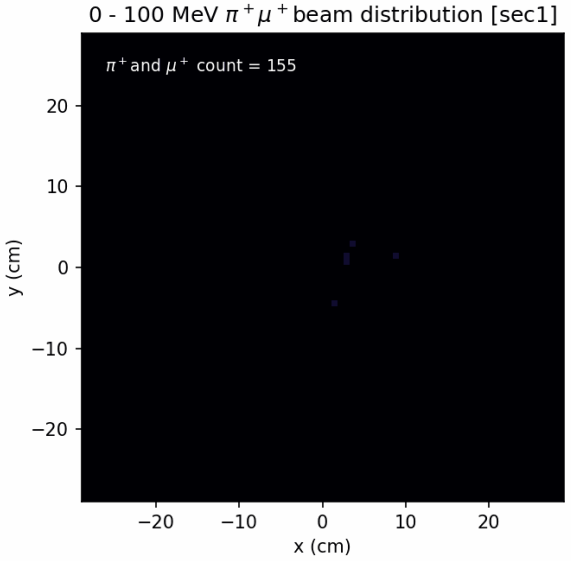


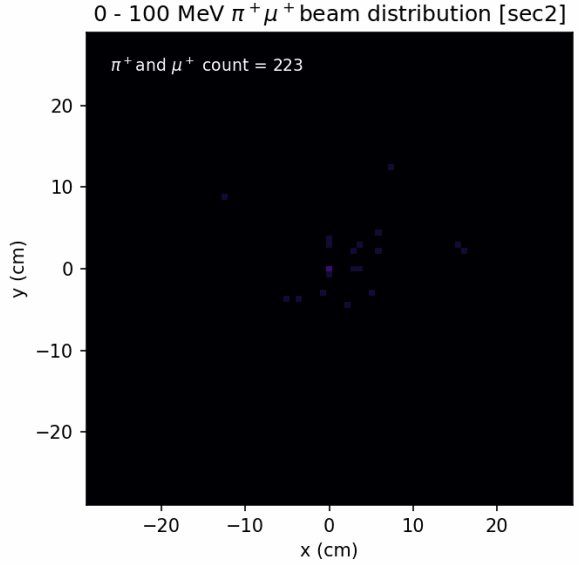


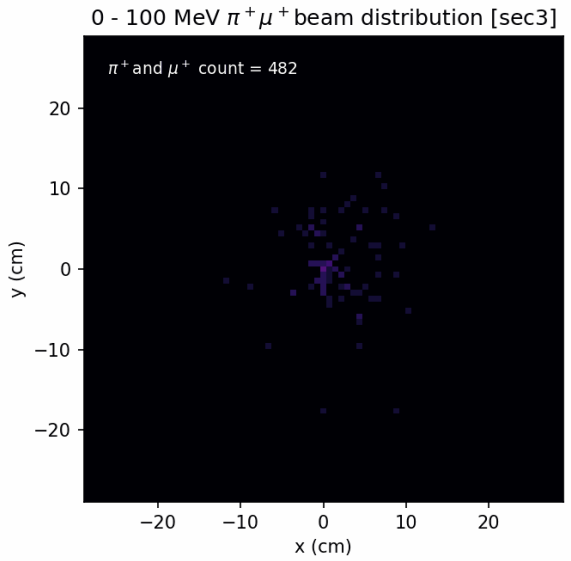


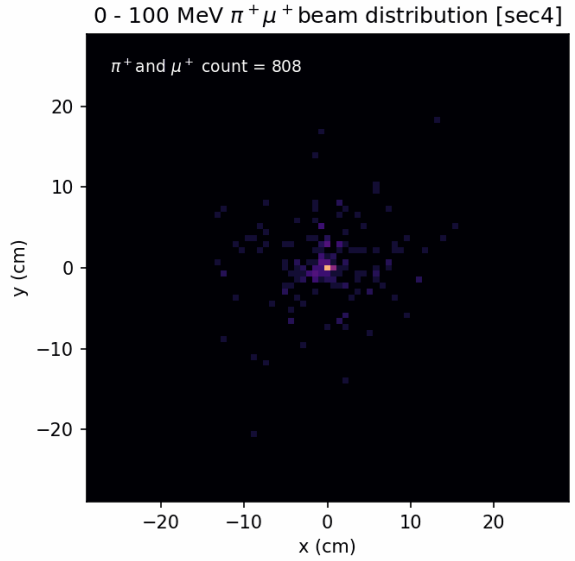




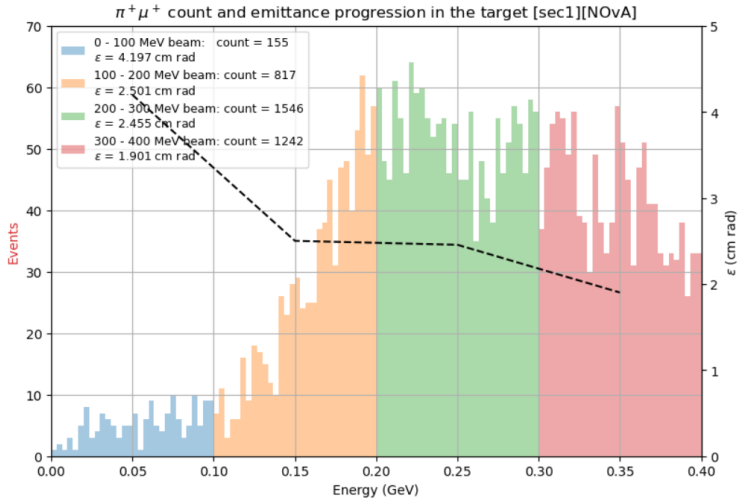


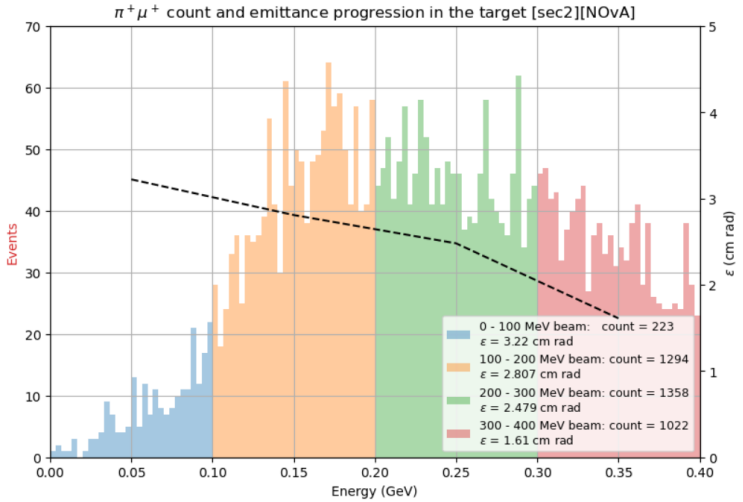


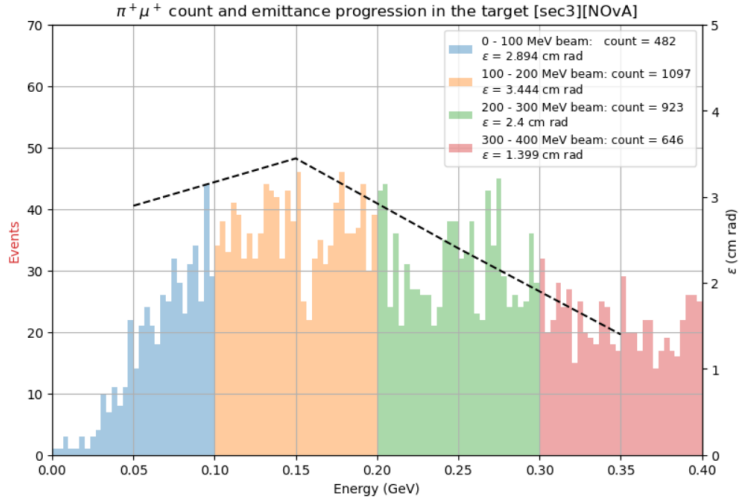


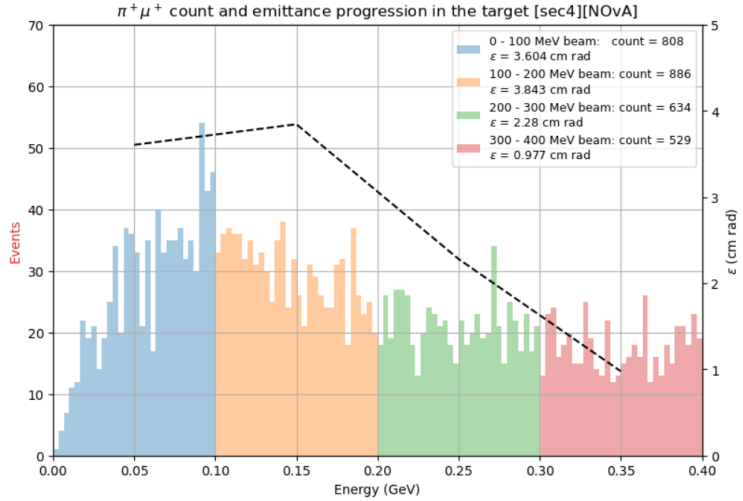


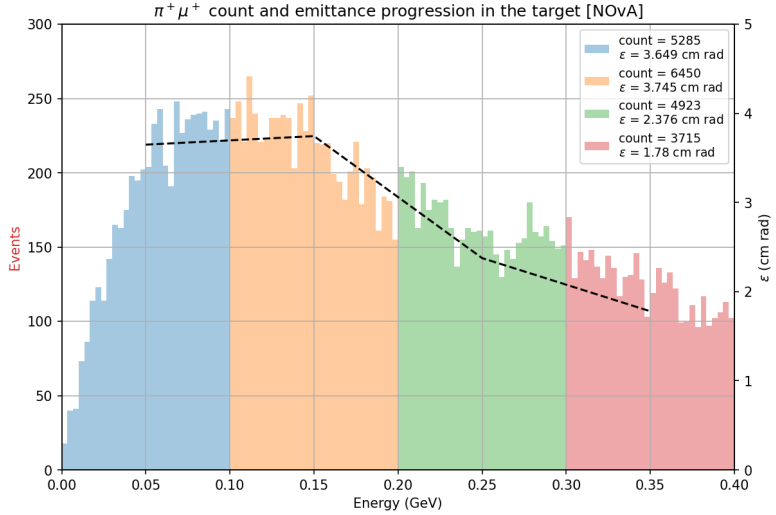
$\pi^+\mu^+$ beams energy distribution for different sections [NOvA]





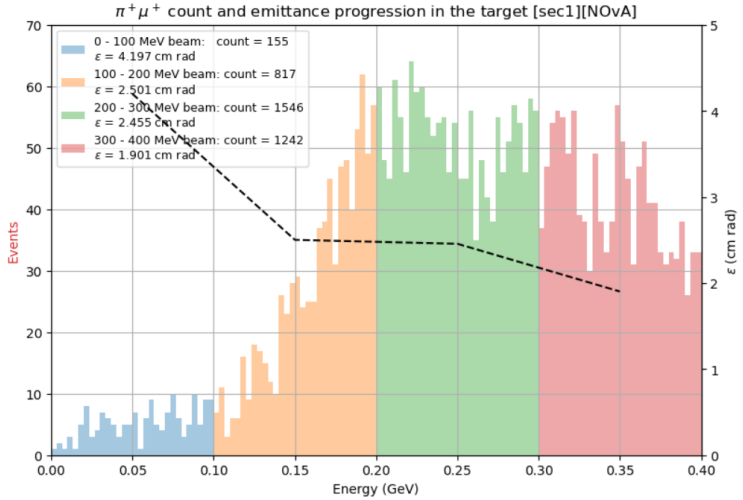


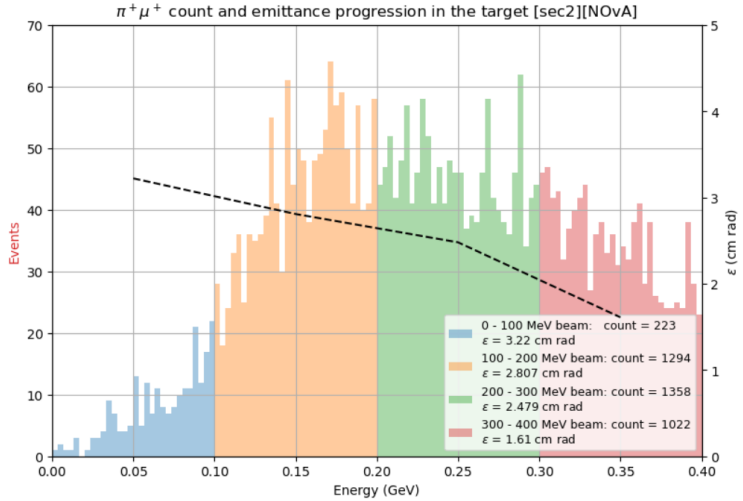


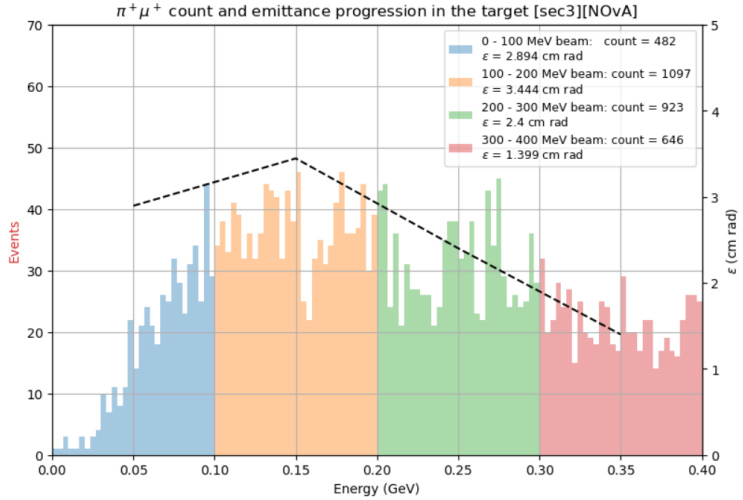


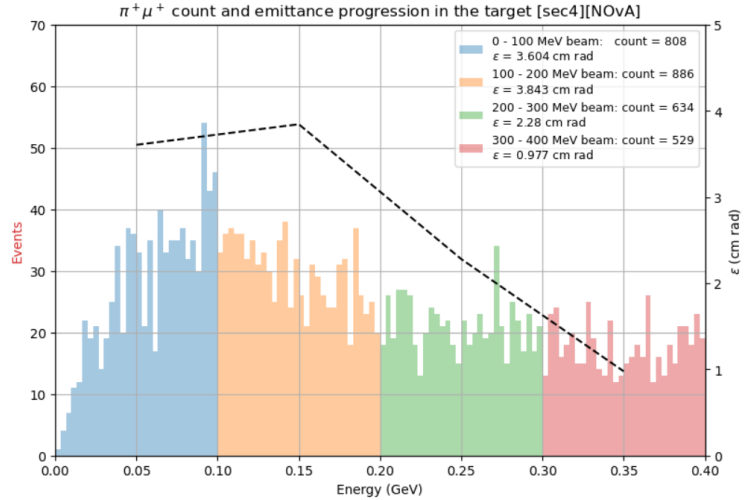
→Full Simulation

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









Section	***Total $\pi^+\mu^+$ under 400 MeV***
1	3760
2	3907
3	3148
4	2857
Total	*13,672*

From full simulation	*20,373*

Notes ☺

→There are several questions that came up last time:

- →The total number of pions and muons produced in both simulations (partial and full) did not match last time.
- →The total pions and muons less than 400 MeV detected in partial simulations is less than the total pions and muons detected in full simulations.
- →The energy distribution plots in slide 13 do not add up. The total secondary particles detected within the range 0-100 MeV for partial simulations are drastically lower than those detected in the full simulation.