
Target Studies for Muon Production



3/24/2025

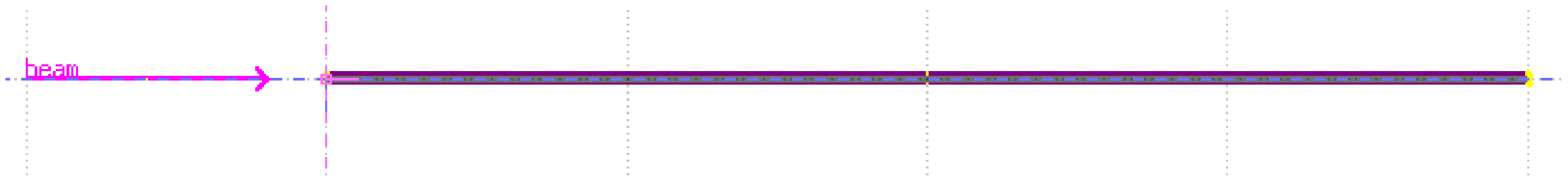
Ruaa Alharthy

Shielding Module.

Simulation setup

- Material = *Graphite*
- Length = *20* cm (half an interaction length)
- Radius = 0.15 cm
- No magnetic field
- 100,000 primaries
- Various energy proton beams

Beam	Energy [GeV]	Energy/nucleon
p	0.8	0.8
4-He	1.6	0.4
Li	2.4	0.34
Au	63.2	0.32



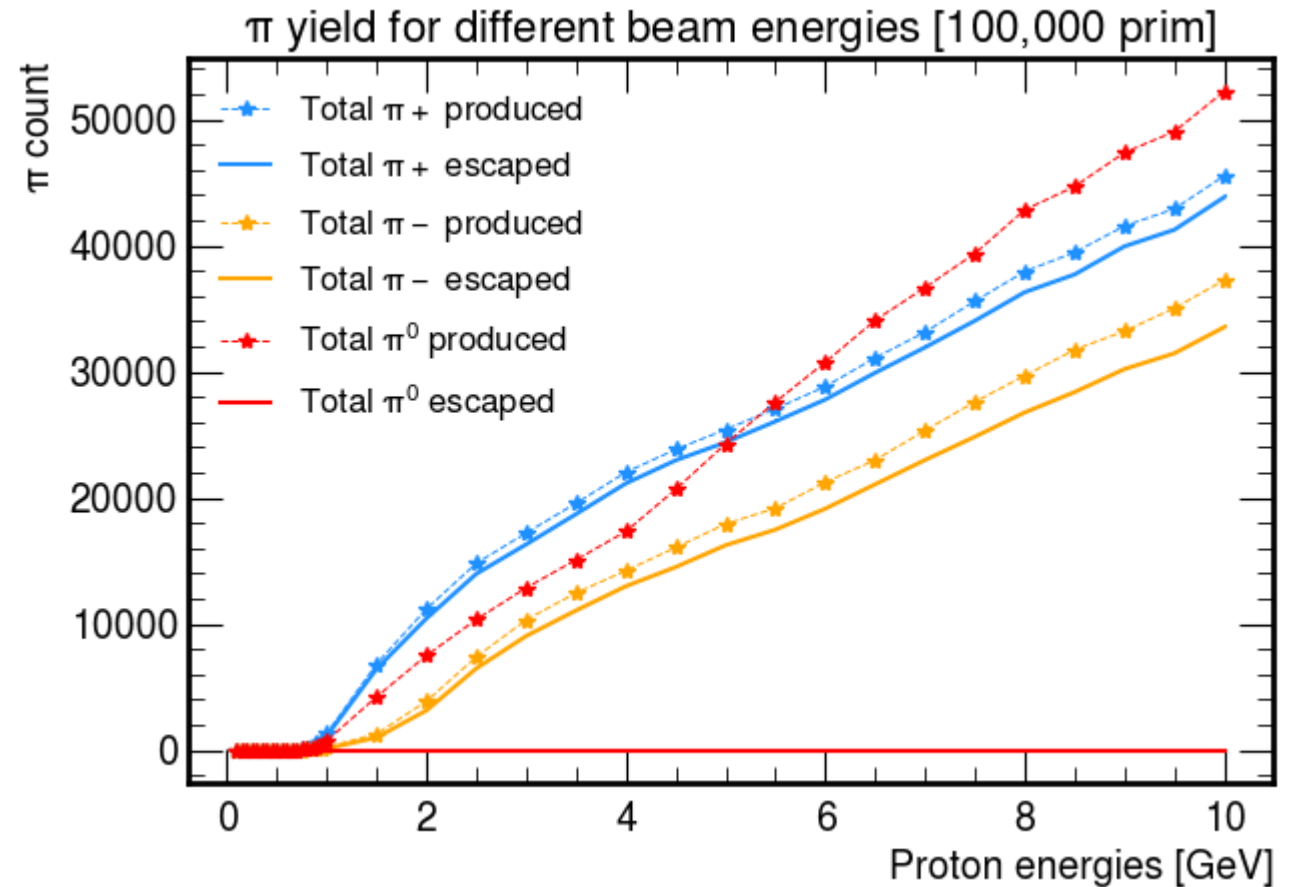
π yields for different beam energies

→ The following plot shows total number of pions produced and total number of pions that have escaped the target.

→ Blue represents π^+

→ Orange represents π^-

→ Red represents π^0



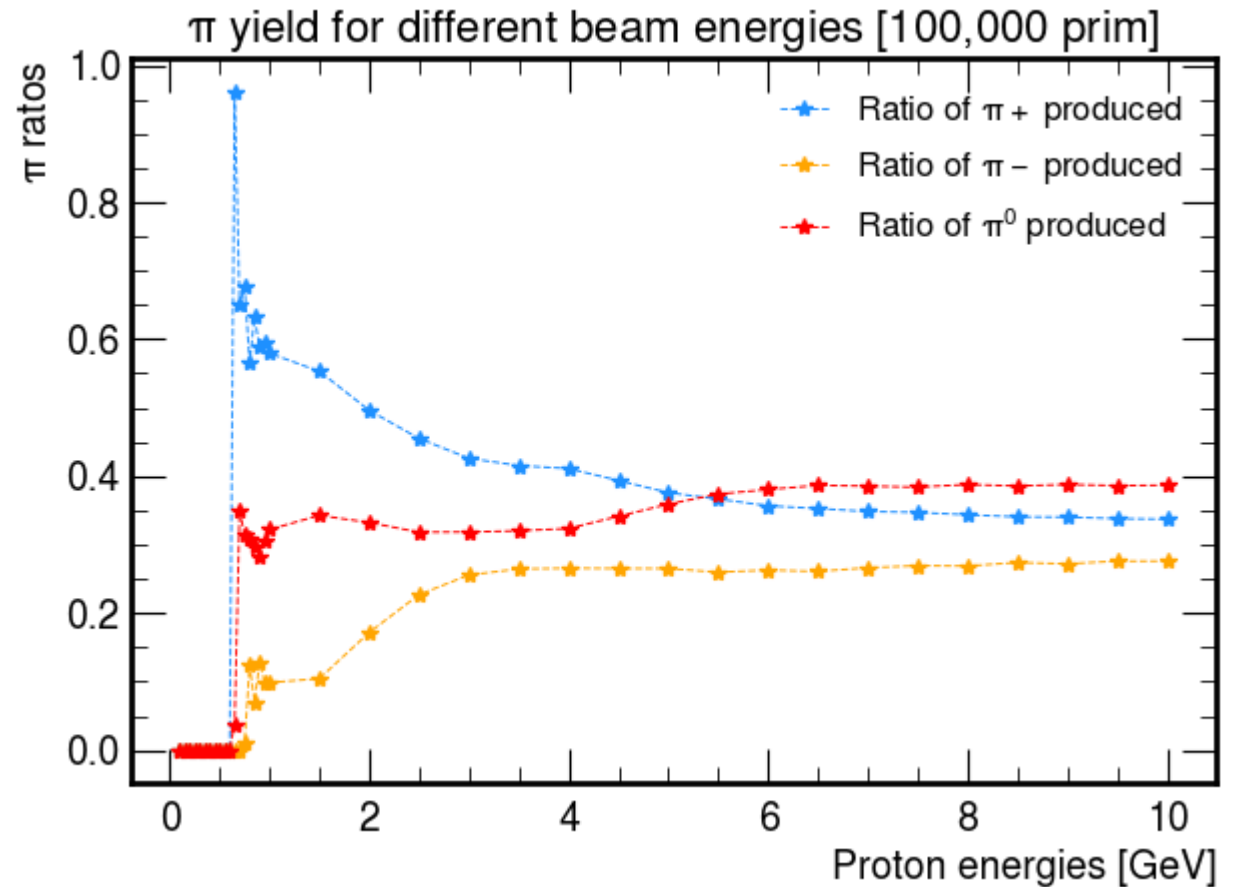
π yields for different beam energies

→ The following plot shows the ratio of each of the pion types divided by all pions produced.

→ Blue represents π^+

→ Orange represents π^-

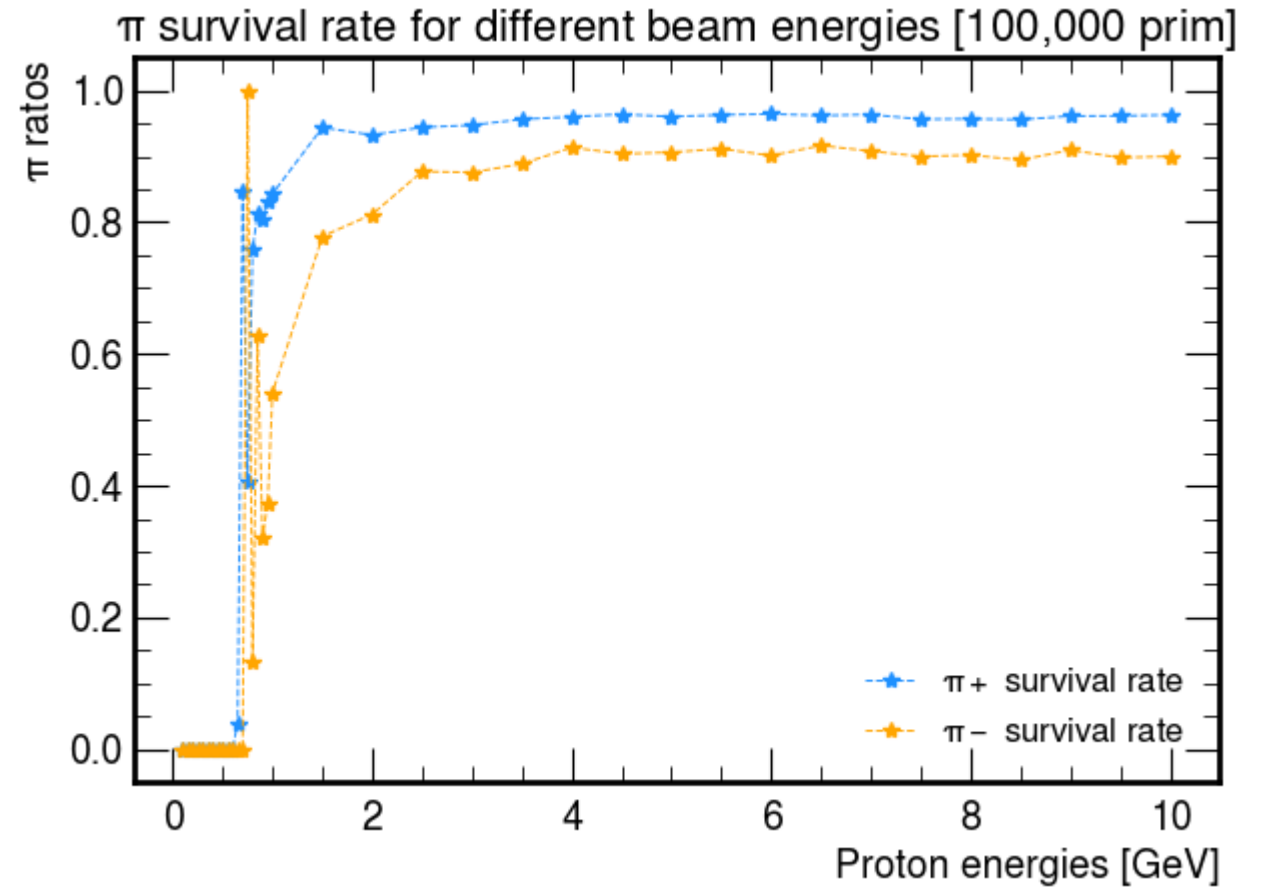
→ Red represents π^0

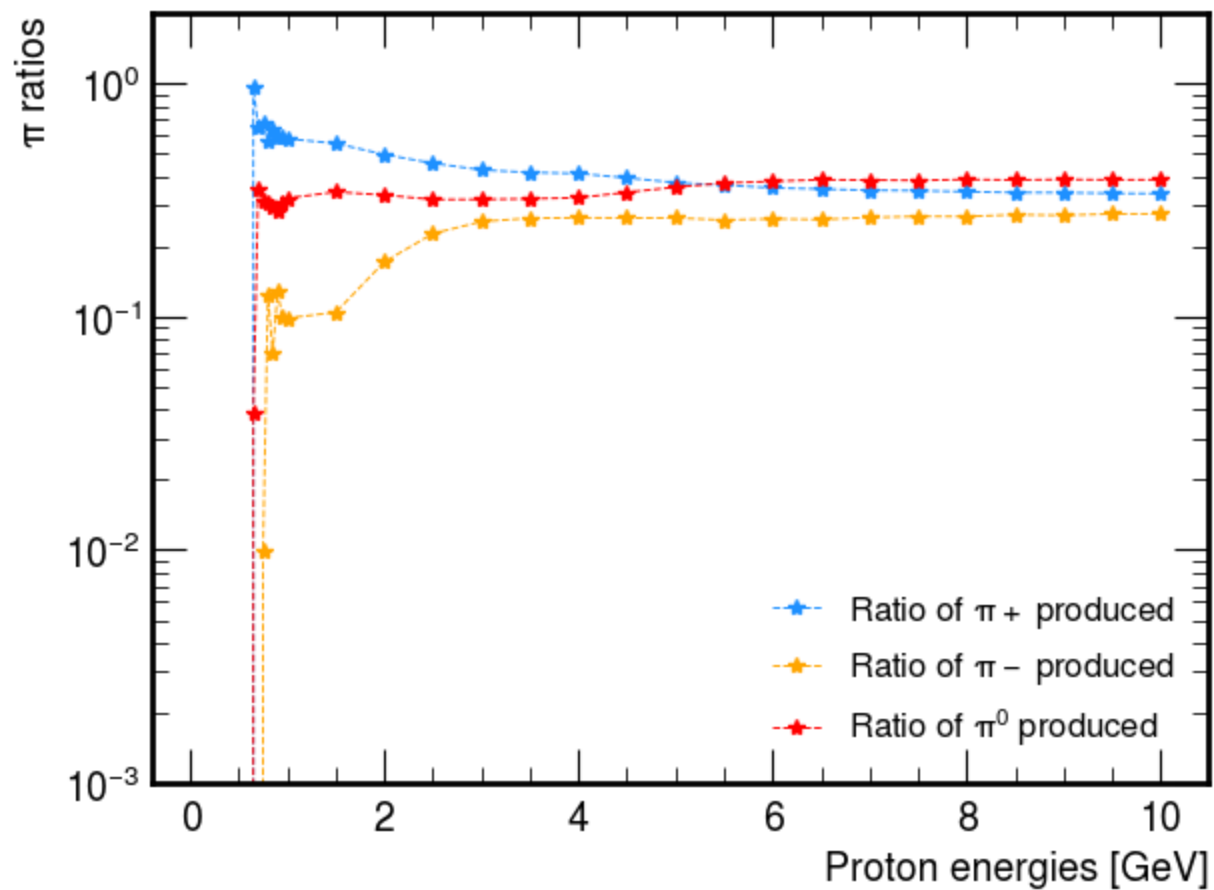
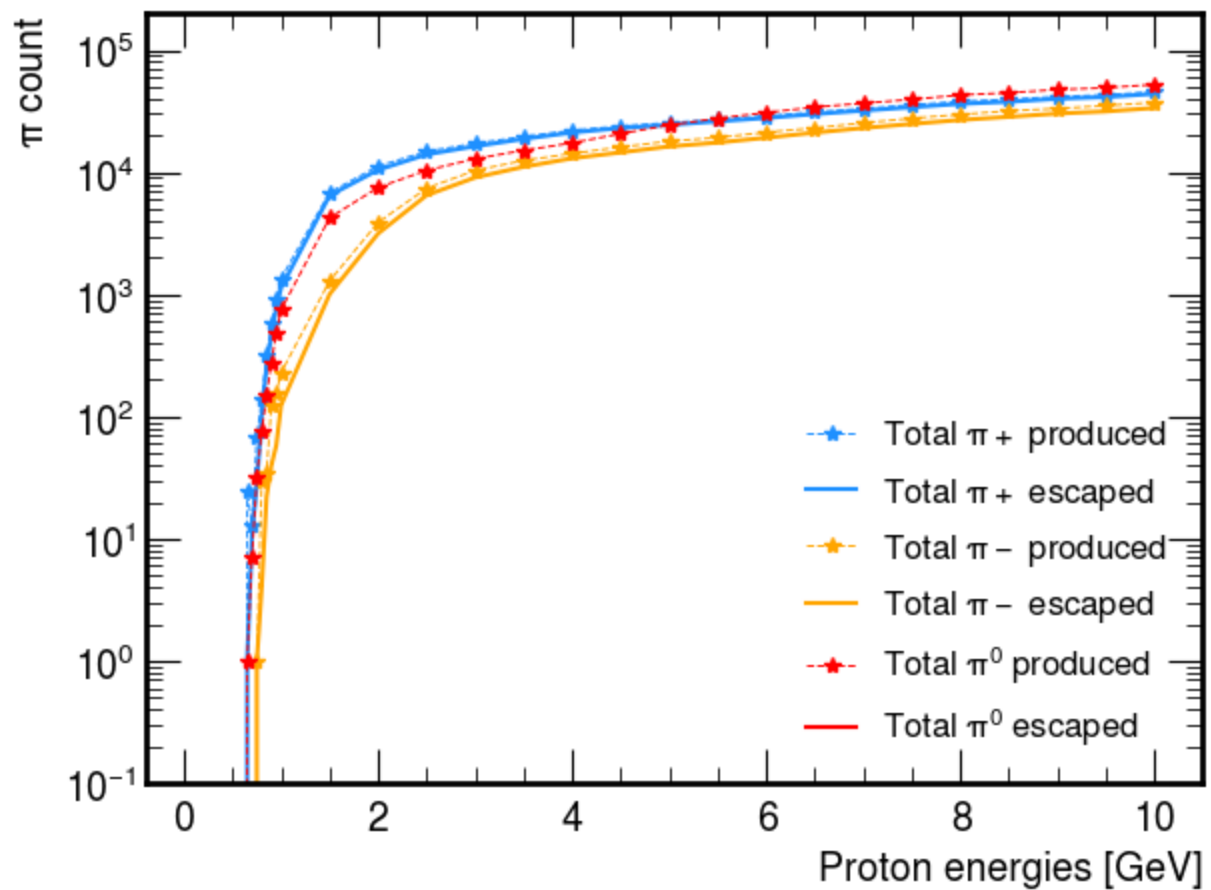


π survival rate for different beam energies

→ The following plot shows the ratio of pion survival relative to the total pions produced for each type.

- Blue represents π^+
- Orange represents π^-
- Red represents π^0

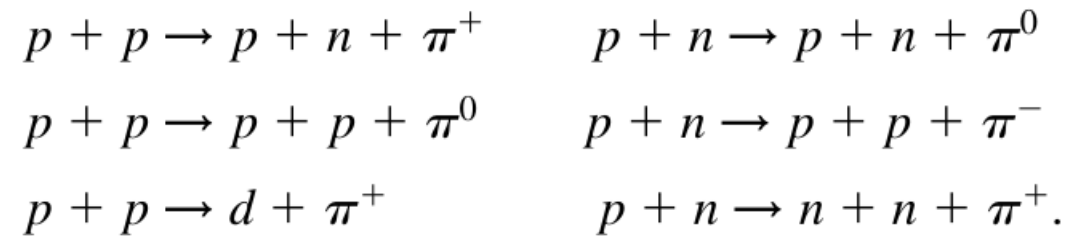




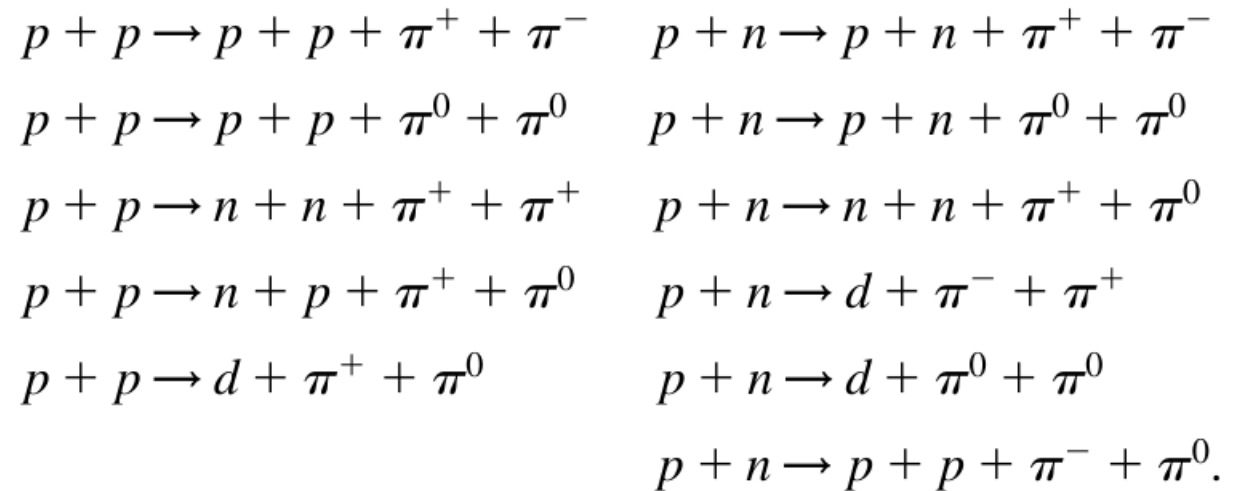
Notes

→ <https://journals.aps.org/prab/pdf/10.1103/PhysRevSTAB.16.014701>

→ Simulations of surface muon production in graphite targets



These are known as single pion production processes, and occur with an energy threshold of 280 MeV in the laboratory frame. Above a laboratory frame energy threshold of 600 MeV, it is also possible to produce pairs of pions in the following proton-nucleon reactions:



In practice, appropriately intense beams of surface muons are produced by powerful high energy (500–1000 MeV) proton beams such as those in operation at large scale central facilities

This week...

- Ran simulations for a 0.8 GeV proton beam and a 0.8 GeV neutron beam.
- The neutron beam simulations are not meant to emulate reality, but are used to learn about charged pion yield that result from different nuclear interactions inside the target.
- The motivation is to find a good justification for the discrepancy in amounts of charged pions that escape the target.
- To achieve this, I was working on a more robust code to extract pion and muon production information (instead of recording only the particles that have escaped the target) from Fluka simulation. I want to say that I have something that is more robust than what I had before. However, its robustness depends on the fact that there is no magnetic in the simulation setup.
- Here, I chose to run simulations for different target lengths ranging from $0.1 \lambda_I$ to $1.5 \lambda_I$ for graphite and tungsten
 - Tungsten: 1 – 15 cm (15 simulations/beam)
 - Graphite: 4 – 60 cm (15 simulations/beam)