Target Studies for Pion Production

Intrinsic and observable momentum study

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Fermilab

USMCC

6/15/2026

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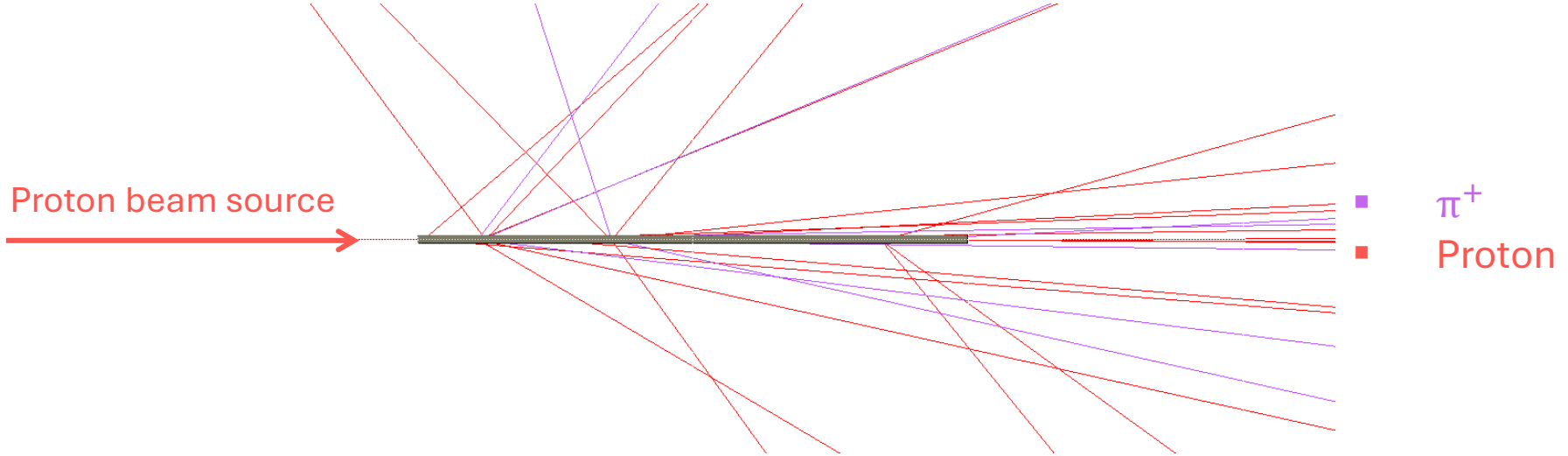
FLUKA setup

Beam	**Energy**	0.8 GeV
	Primaries	100,000
	Beam width	0 (pencil beam)
Target	**Length**	one interaction length
	Radius	0.15 cm
	Material	Graphite, Nickel, Inconel, Tungsten



Intrinsic and observable momentum

→ https://www.sciencedirect.com/science/article/pii/03702693809044 99?via%3Dihub

→ THE MAGNITUDE OF THE PARTON INTRINSIC TRANSVERSE MOMENTUM

→ Intrinsic transverse momentum, kT, is a parameter describing the motion of partons inside the hadron before the hard scattering.

→ A quark inside a pion is not expected to move exactly along the pion's direction. Instead, it has some transverse momentum component kT relative to the pion's momentum.

→ According to the paper, $\langle kT \rangle \approx 0.3 - 0.5$ GeV.

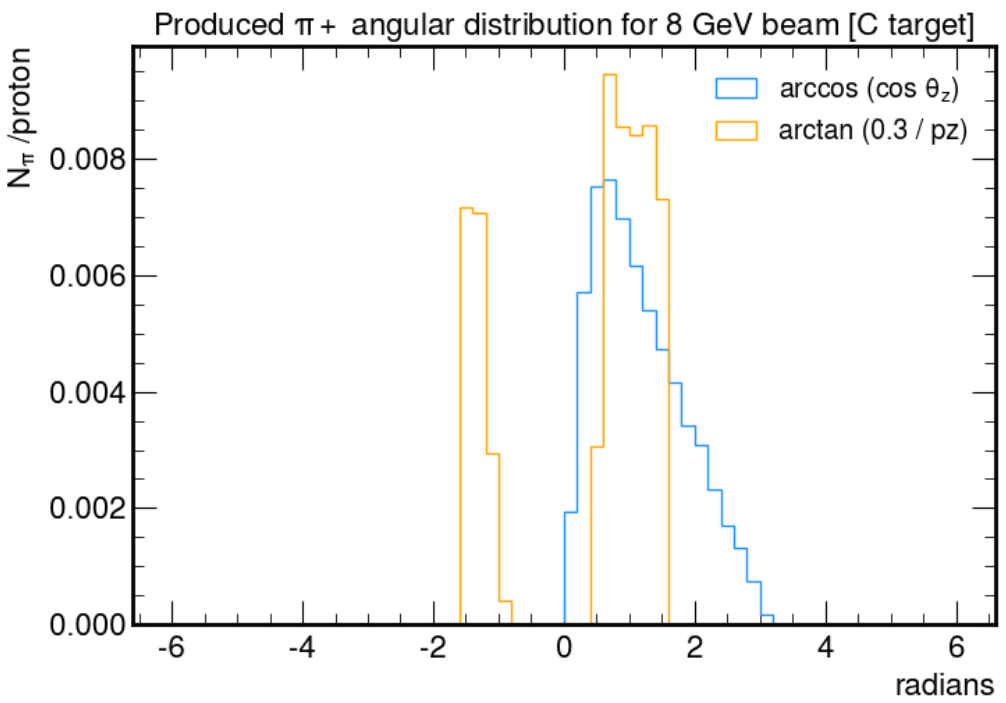
→ I ran a few simulations to test this theory. I ran simulations using 0.8 and 8 GeV proton beams fired onto targets of 4 different materials (Graphite, Nickel, Inconel, Tungsten).

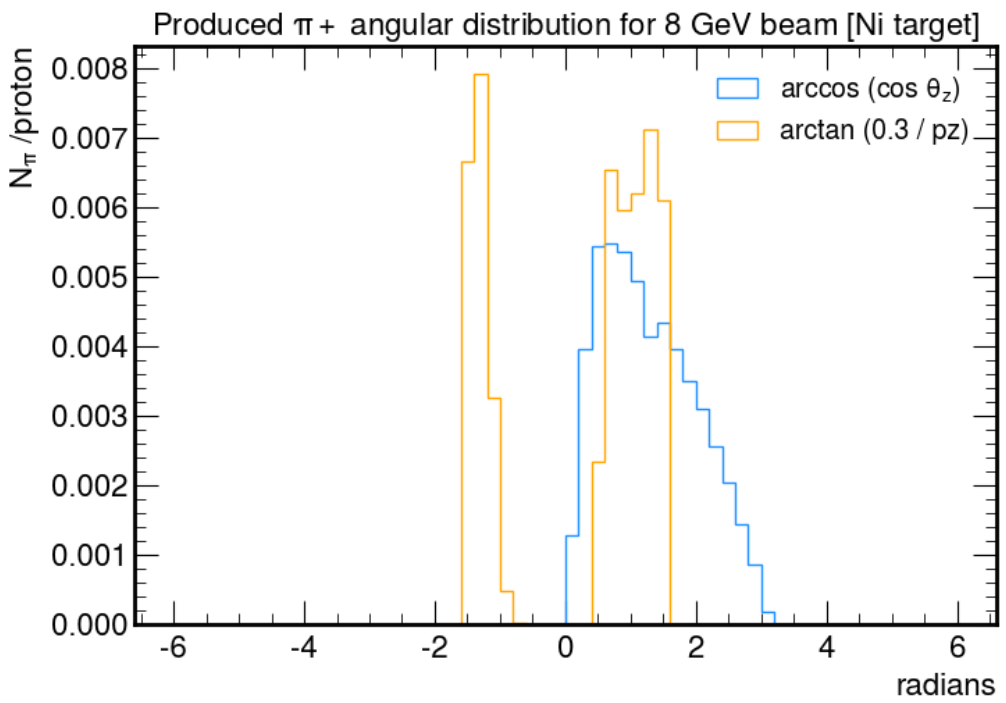
→ Here, I will show plots for the distributions of pT and angle θ of the pions w.r.t the beam axis

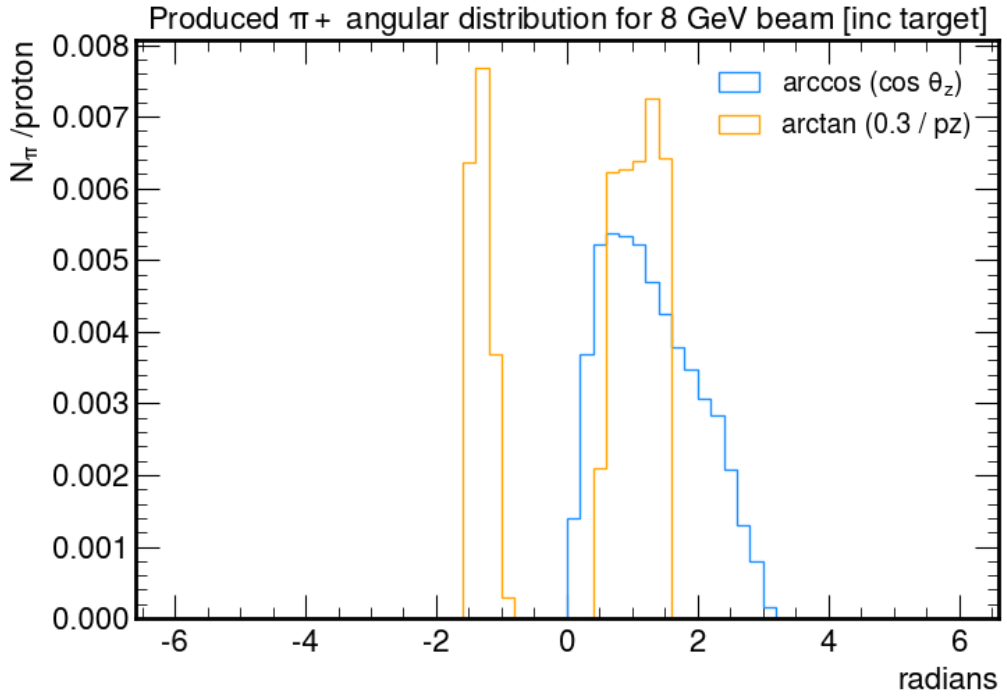
0.8 GeV beam

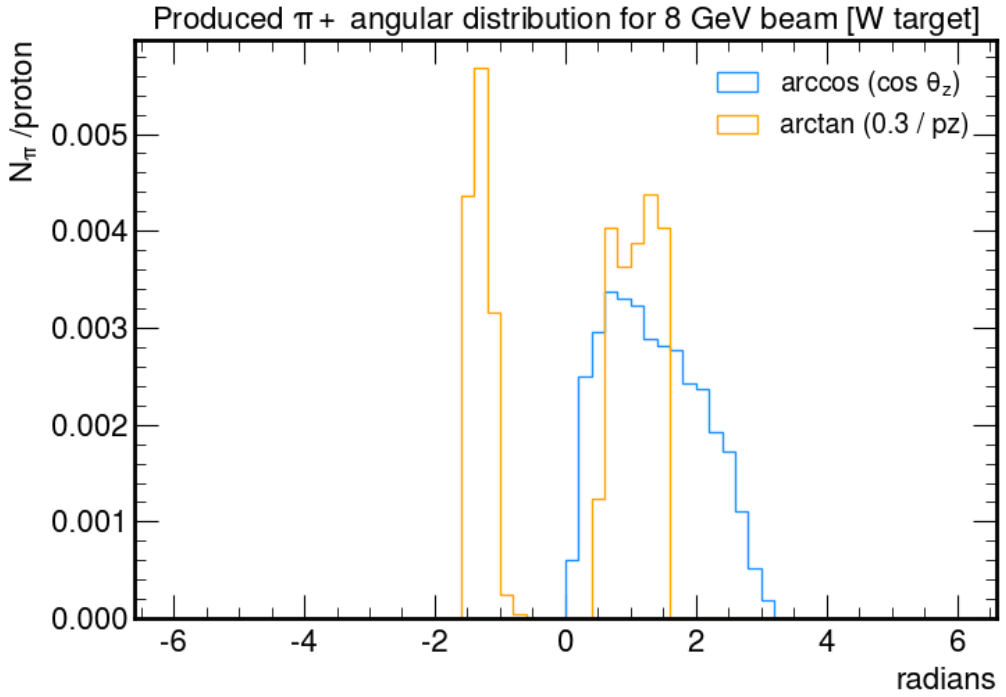
π+ angular distributions

Comparison between θ as measured by FLUKA (blue) and θ as computed using pT = 0.3 (orange)





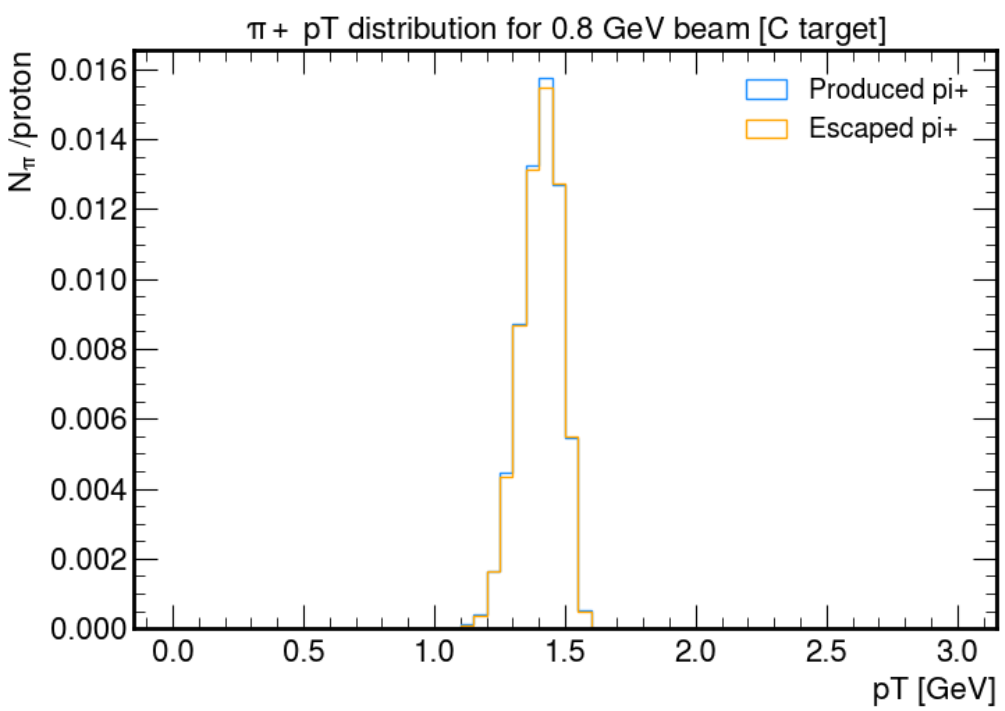


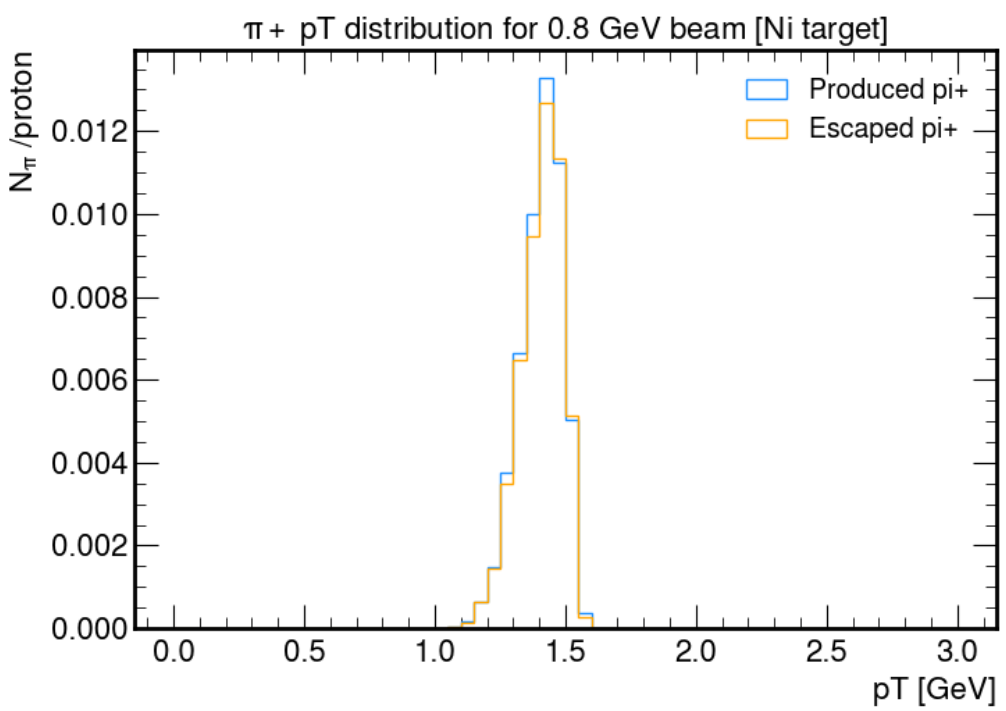


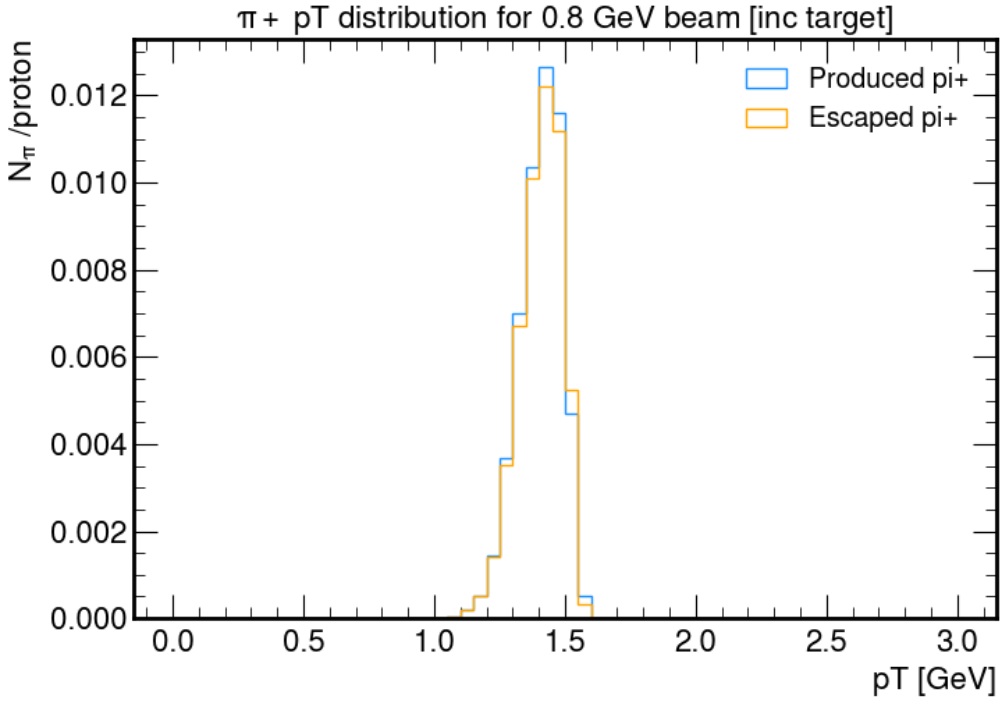
0.8 GeV beam

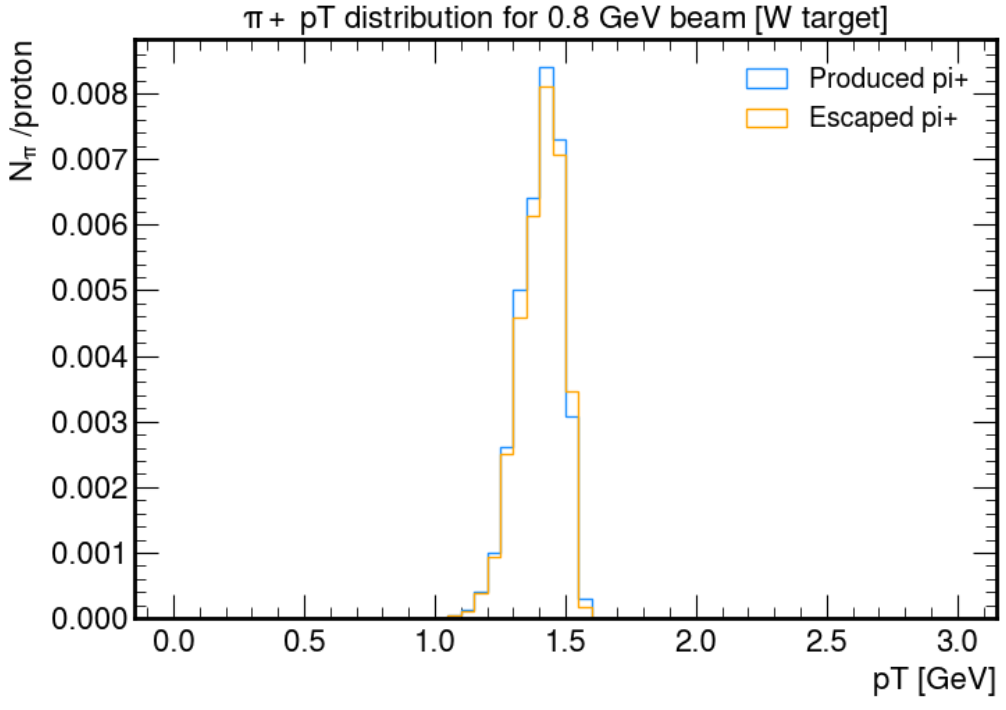
π+ pT distributions

These plots show the pT distributions of pions produced in different targets









Notes

→Fermilab uses pT = 0.3 as an approximate value for the intrinsic momenta of the muons produced for the neutrino experiment.

→Katsuya suggested to test whether it would be relevant to use the same approximation for muon collider target experiments.

→The paper mentioned that they needed to apply corrections for widening effects caused by multiple scatterings within the target. I attempted to reduce this issue by running the simulations using 0.1 cm targets but the shape of the pT and angle distributions remain the same.

→Not sure about the relevance, but I think Fermi motion nucleons might be contributing to the larger observed values of pT.

→I am still learning about intrinsic momenta of pions produced inside the targets with Katsuya's guidance.