Single-particle tracking efficiencies – material map effects

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&
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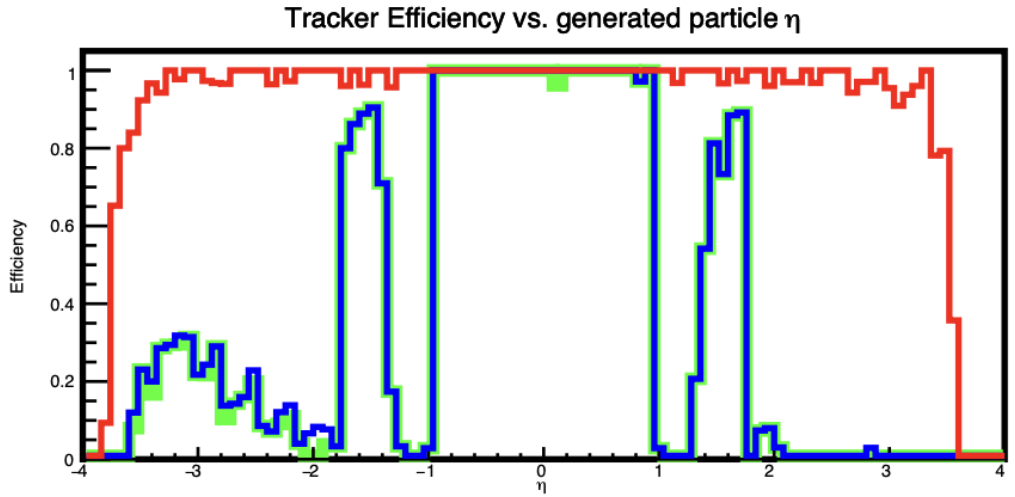
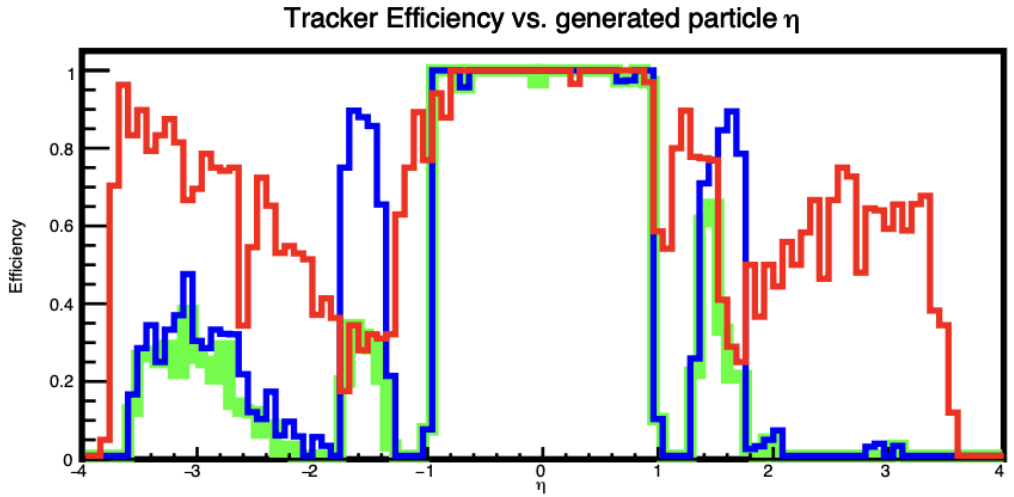
Single-particle tracking efficiency vs. pseudorapidity

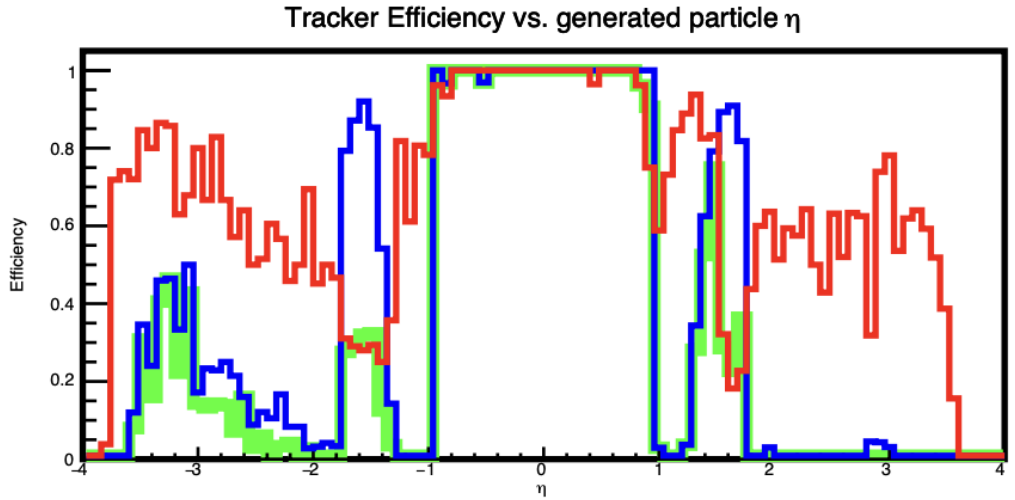
Release 24.10.1



Release 24.11.0



Release 24.11.1

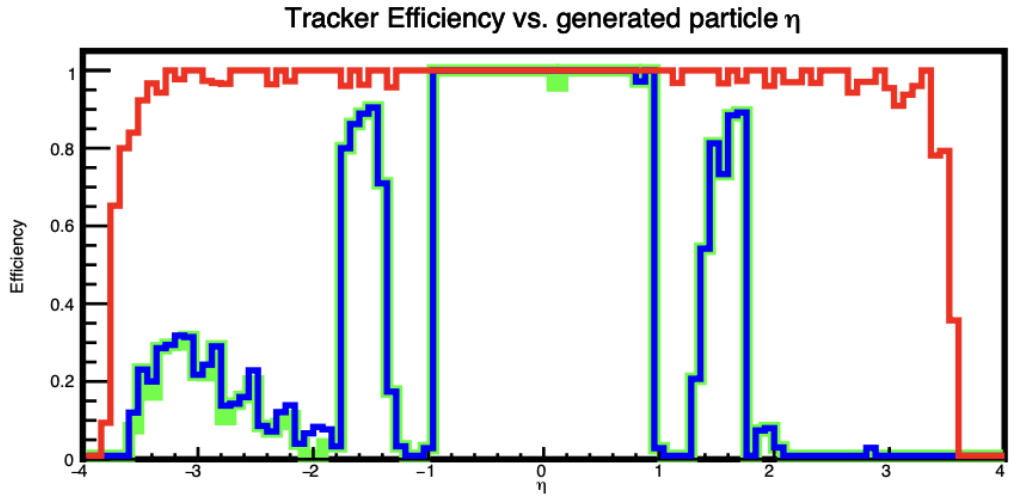


Generated particle:
Single negative muon
P = [500-600] MeV/c
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

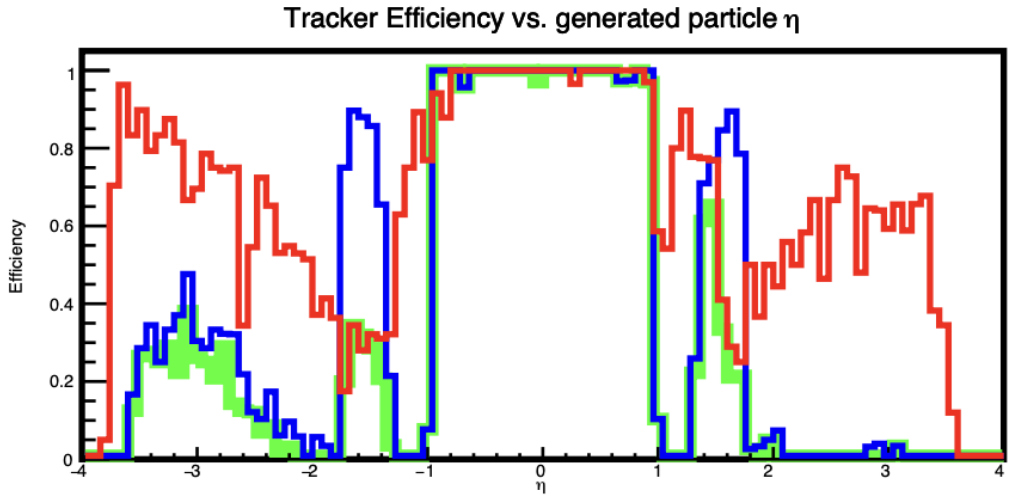
Truth-seeded tracking
Real-seeding tracking: seed level
Real-seeded tracking: track level

Single-particle tracking efficiency vs. pseudorapidity

Release 24.10.1



Release 24.11.0



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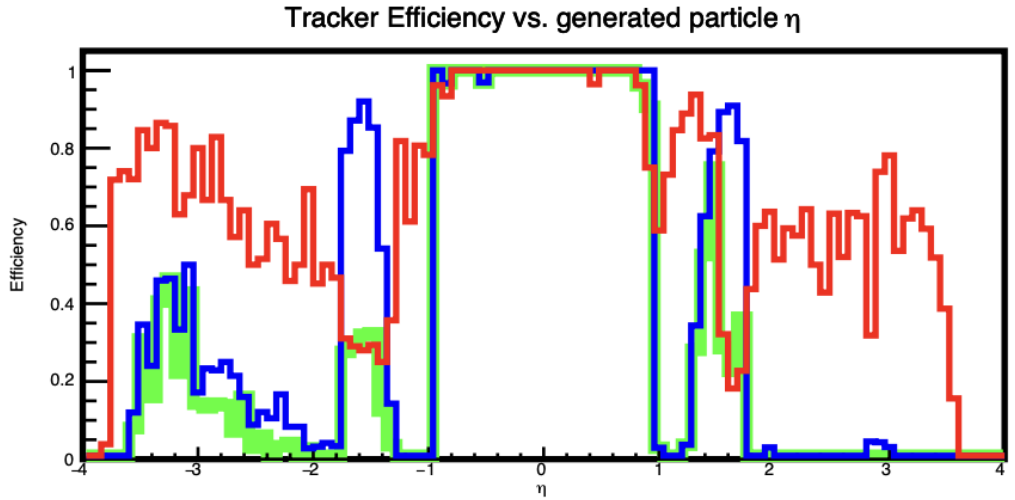

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Truth-seeded tracking

Real-seeding tracking: seed level

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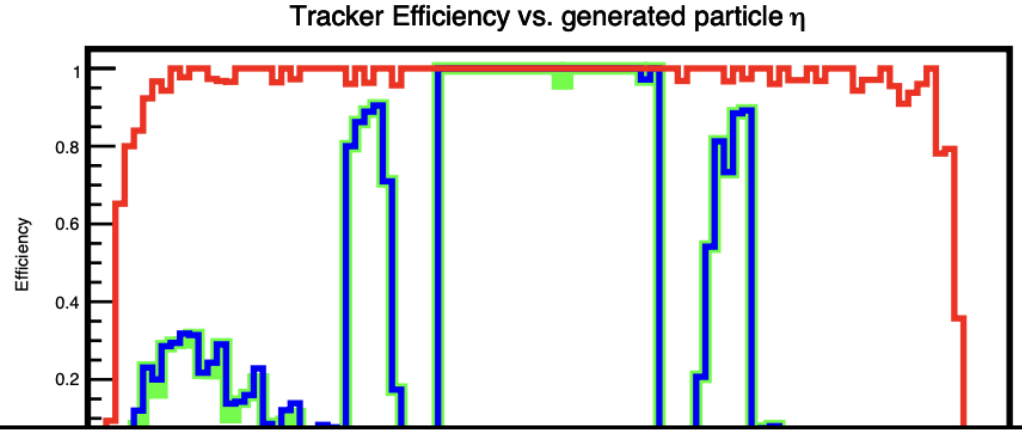
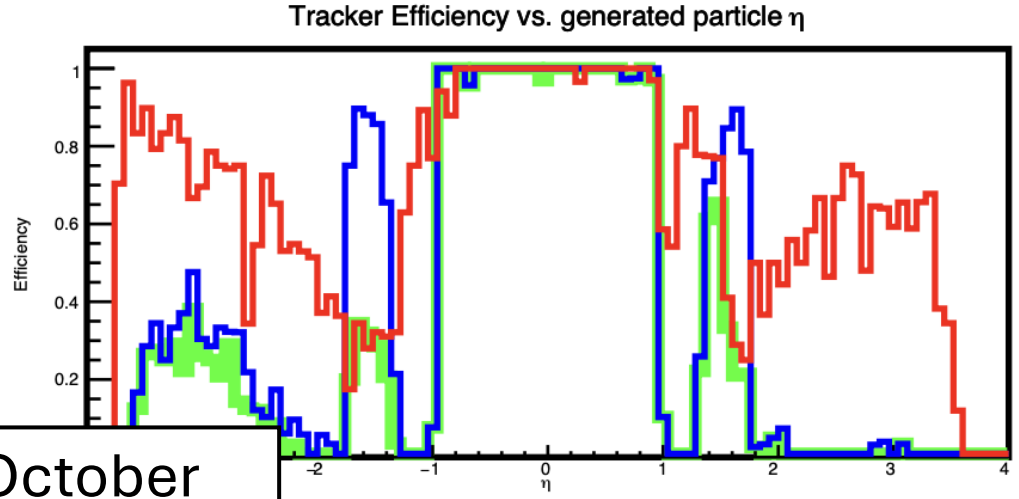
Single-particle tracking efficiency vs. pseudorapidity

Release 24.10.1



Release 24.11.0



We see a drop in the efficiency between the October and November software releases. This problem persists to the current nightly build. (Many of the inefficient tracks do exist in the unfiltered collection, with < 3 measurement hits.)

We want to check if the issue is related to an outdated Acts material map.

ticle:
muon
eV/c
]
0,0)

Truth-seeded tracking

Real-seeding tracking: seed level

Real-seeded tracking: track level

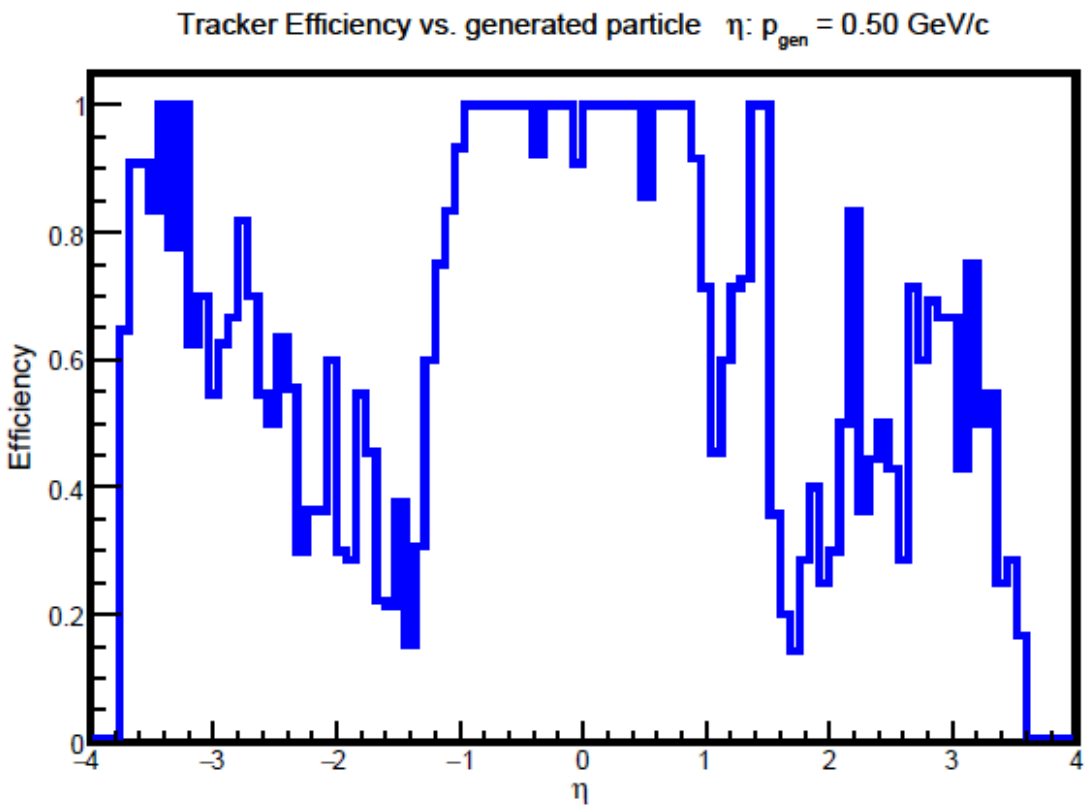
Creating and using an updated material map

- We run the script https://github.com/eic/epic/blob/main/scripts/material_map/run_material_map_validation.sh to create an updated Acts material map file.
- We use the updated material map in EICRecon by including the **-Pacts:MaterialMap=material-map.json** running option
- We then compare the efficiency results with the default map (in the nightly software build) and the new map.

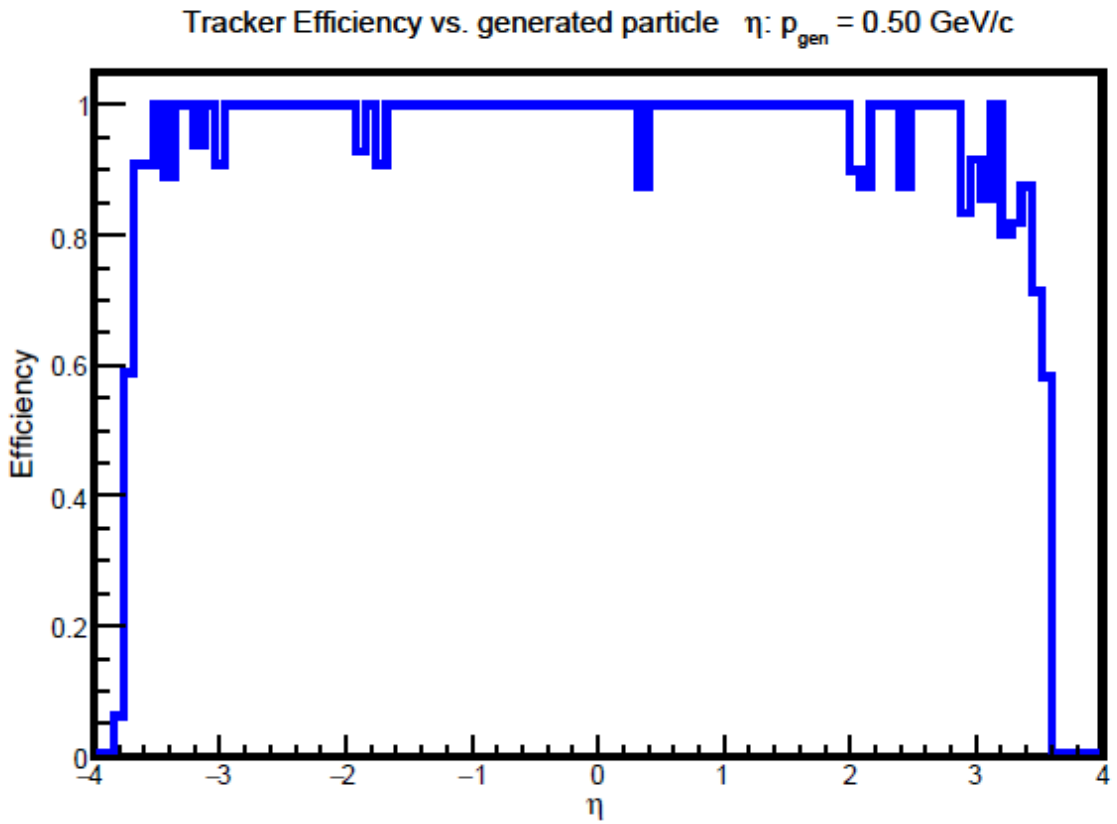
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Truth-seeded tracking: p = 500 MeV/c

Default material map



Updated material map

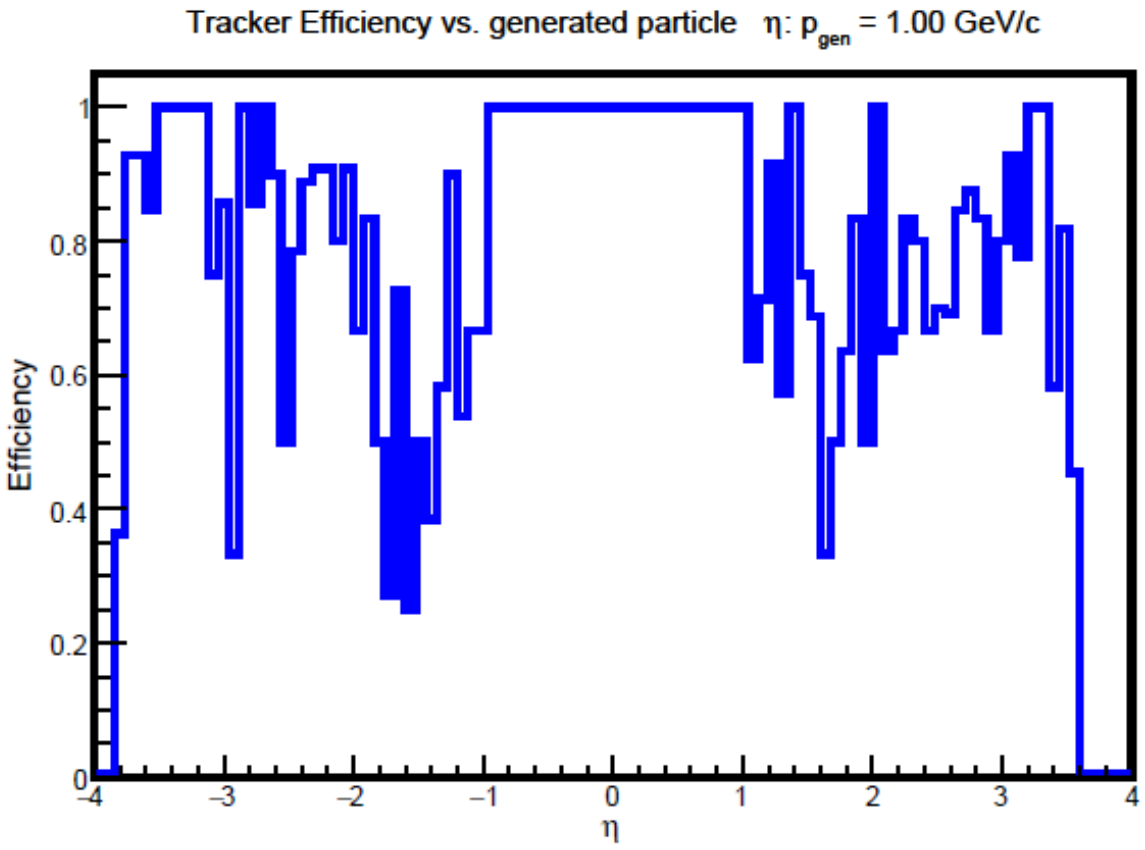


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

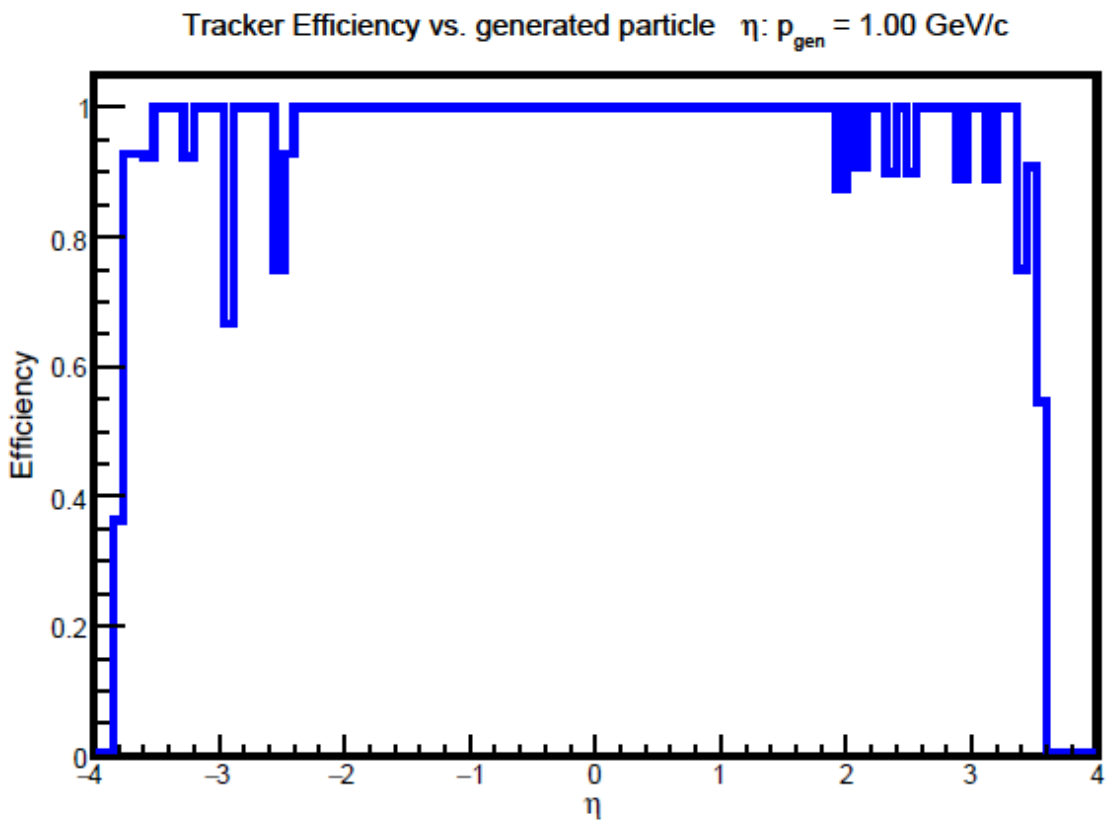
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Truth-seeded tracking: p = 1 GeV/c

Default material map



Updated material map

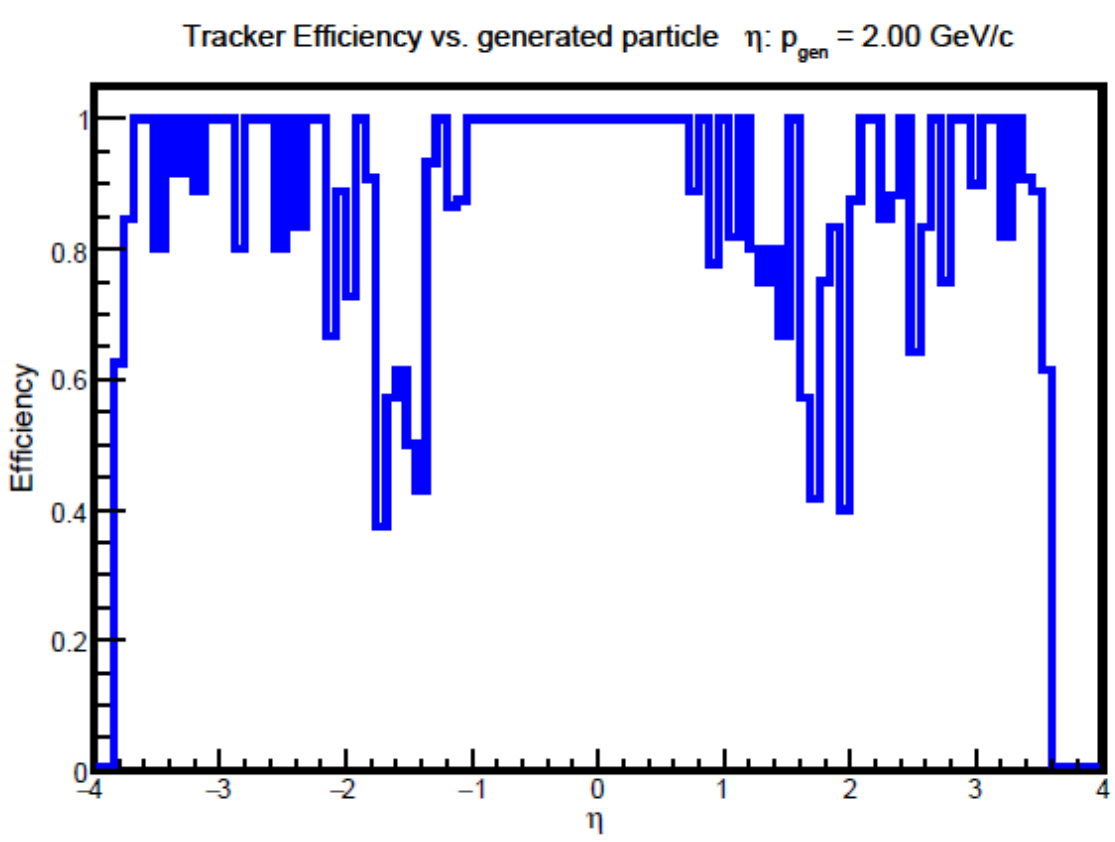


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

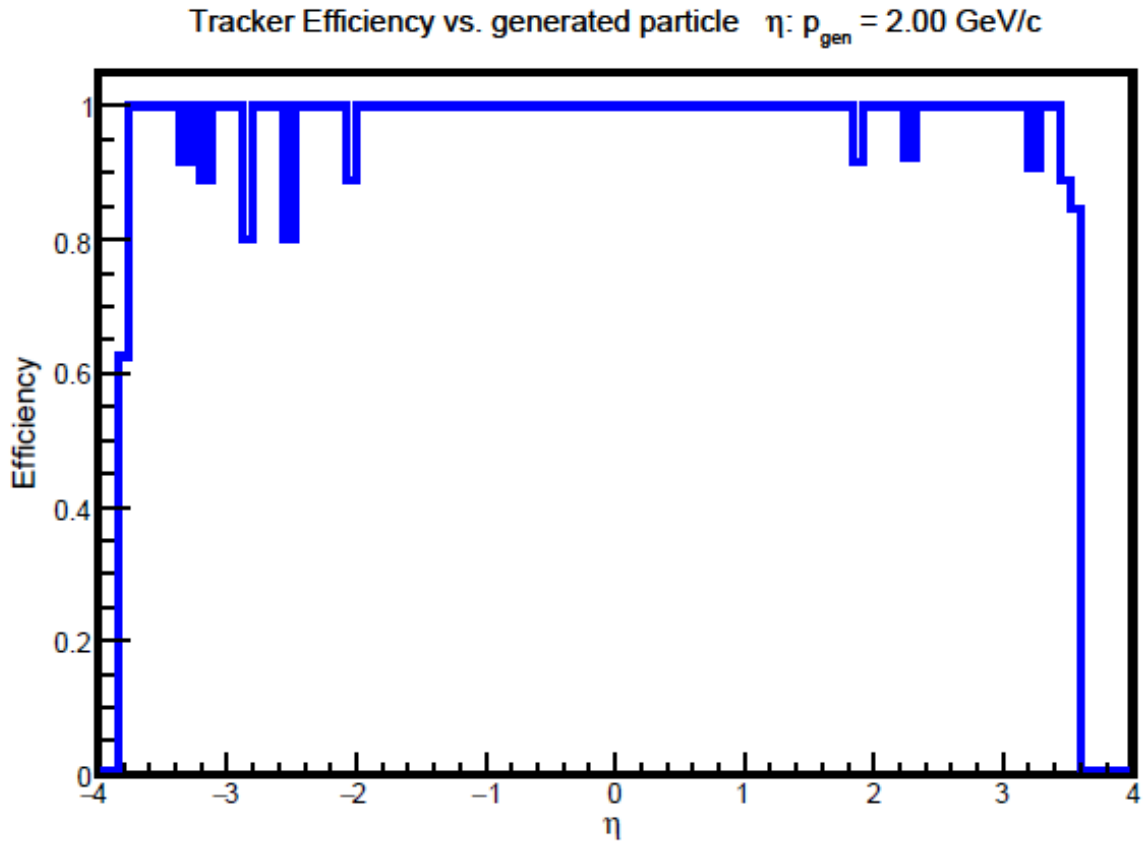
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Truth-seeded tracking: p = 2 GeV/c

Default material map



Updated material map

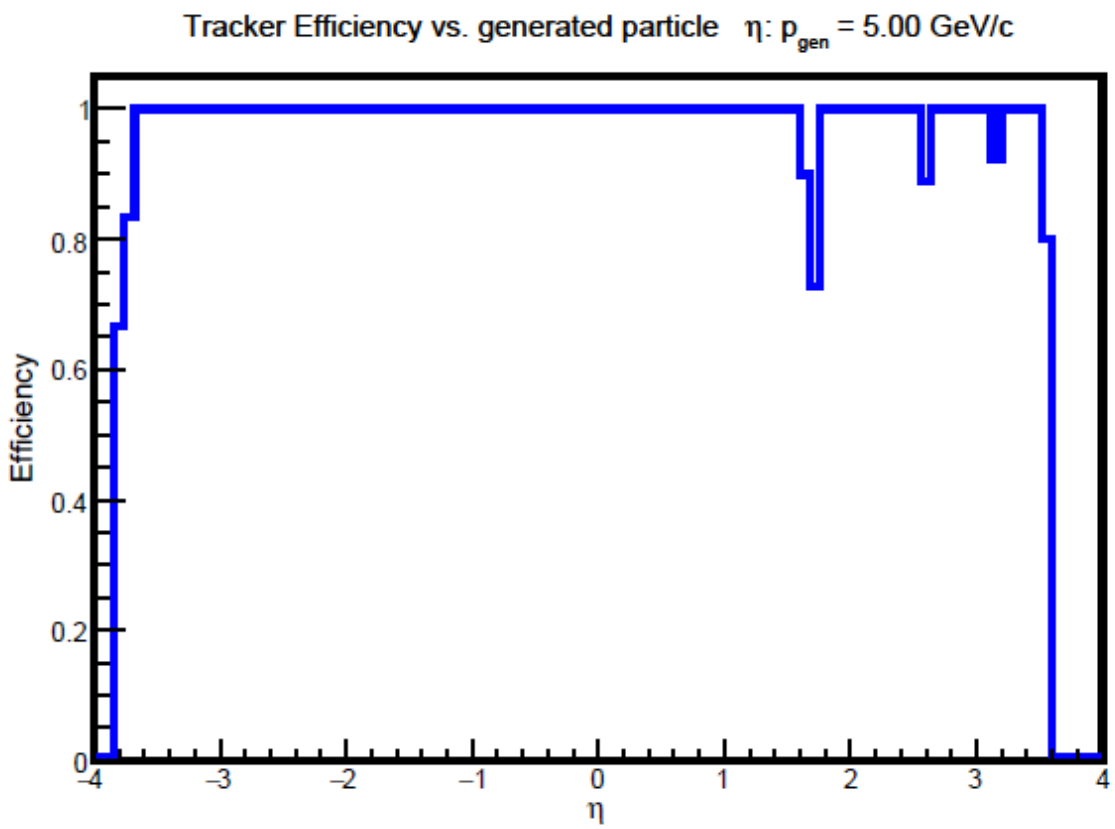


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

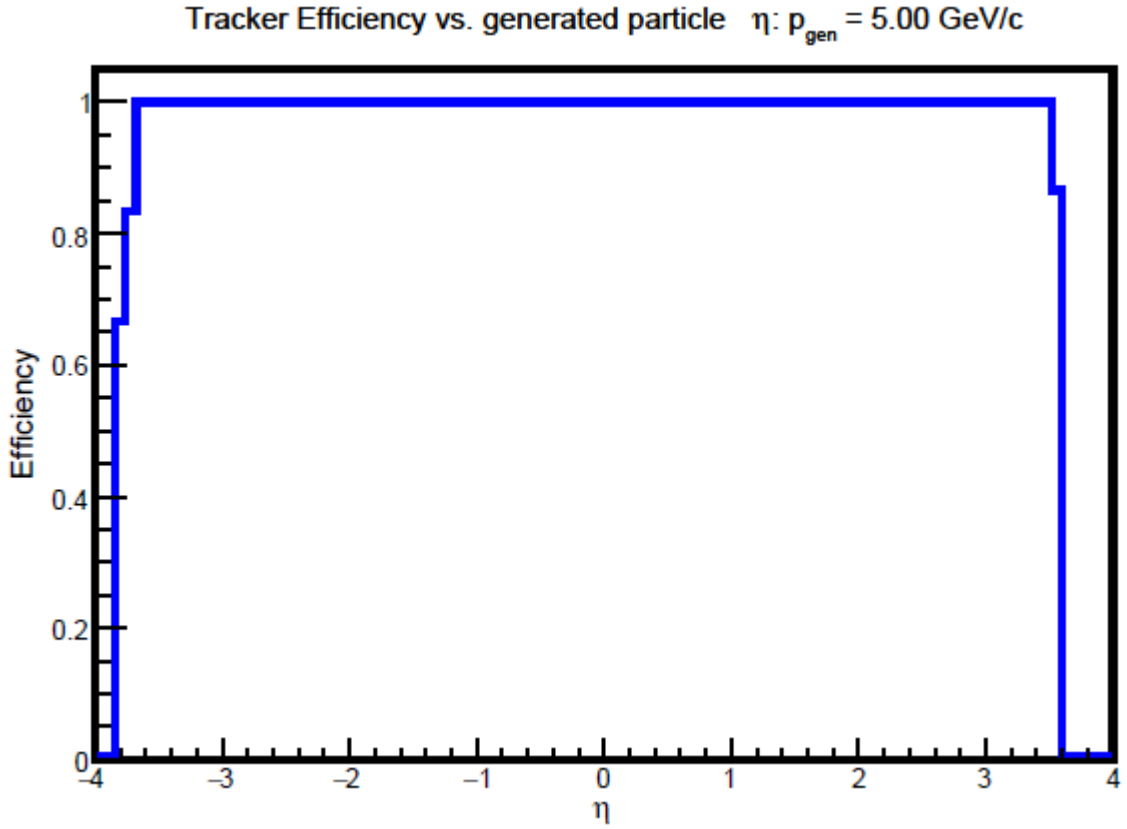
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Truth-seeded tracking: p = 5 GeV/c

Default material map



Updated material map

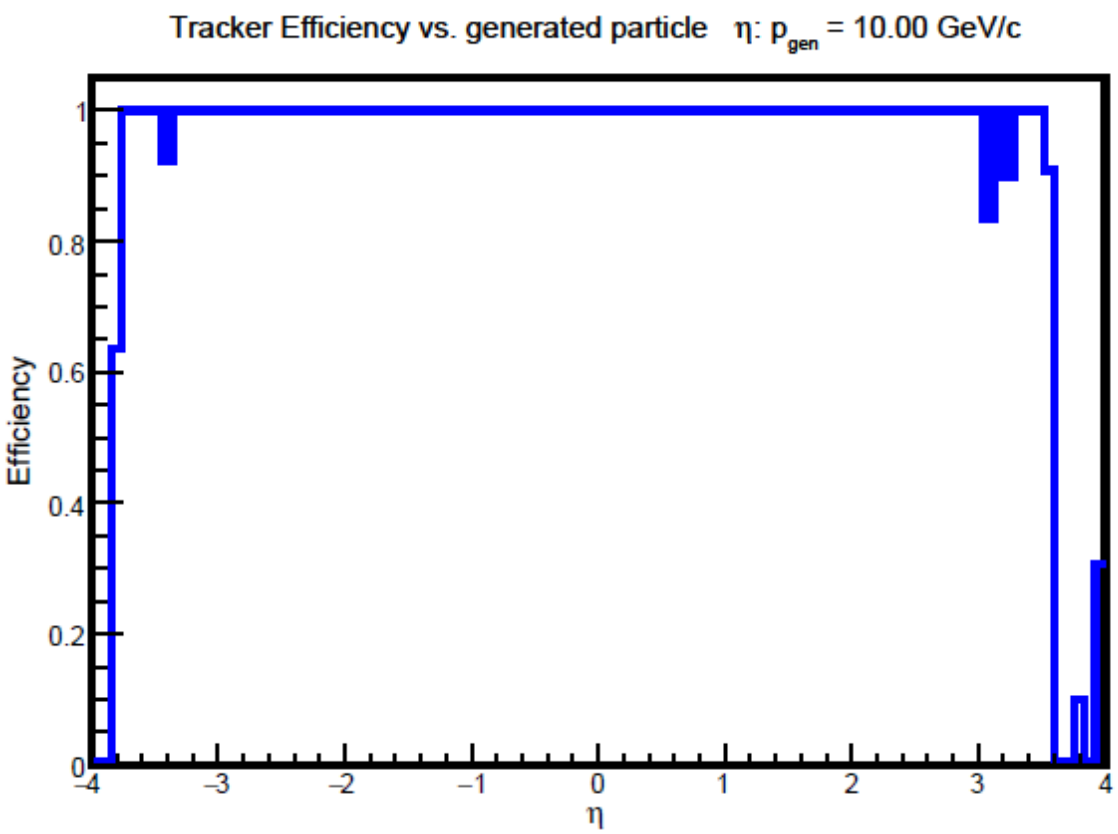


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

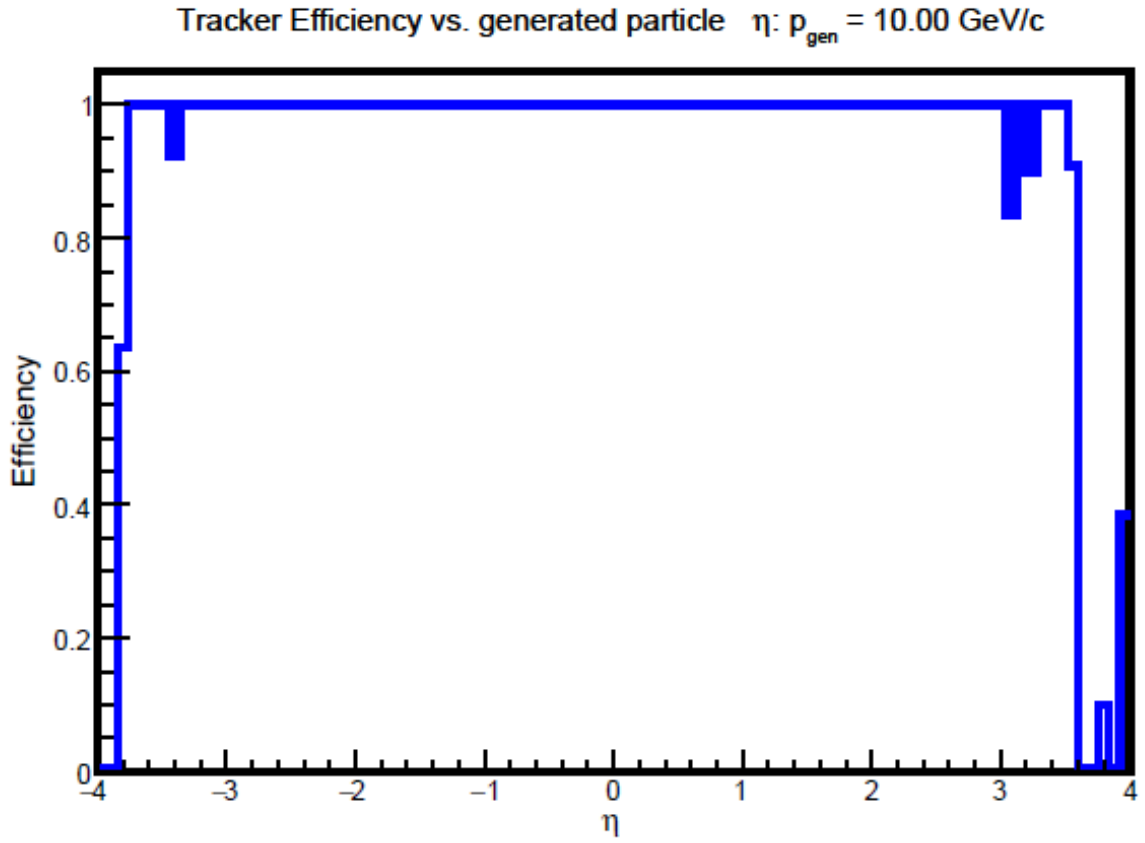
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Truth-seeded tracking: p = 10 GeV/c

Default material map



Updated material map

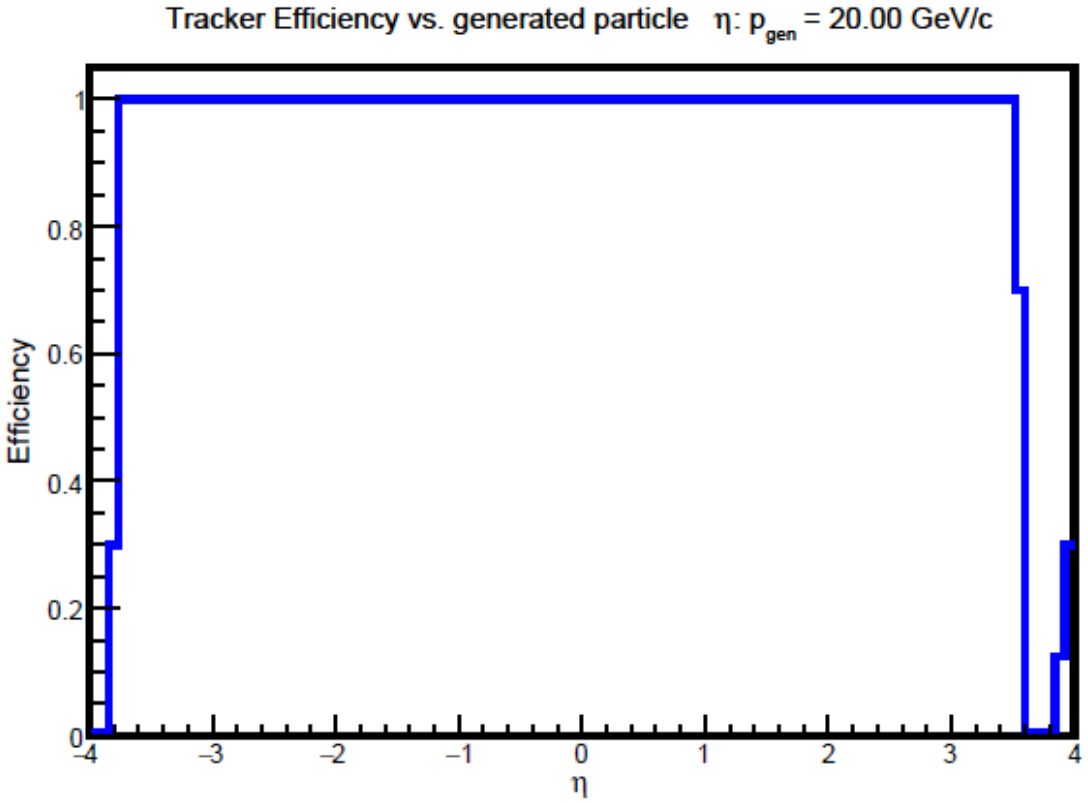


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

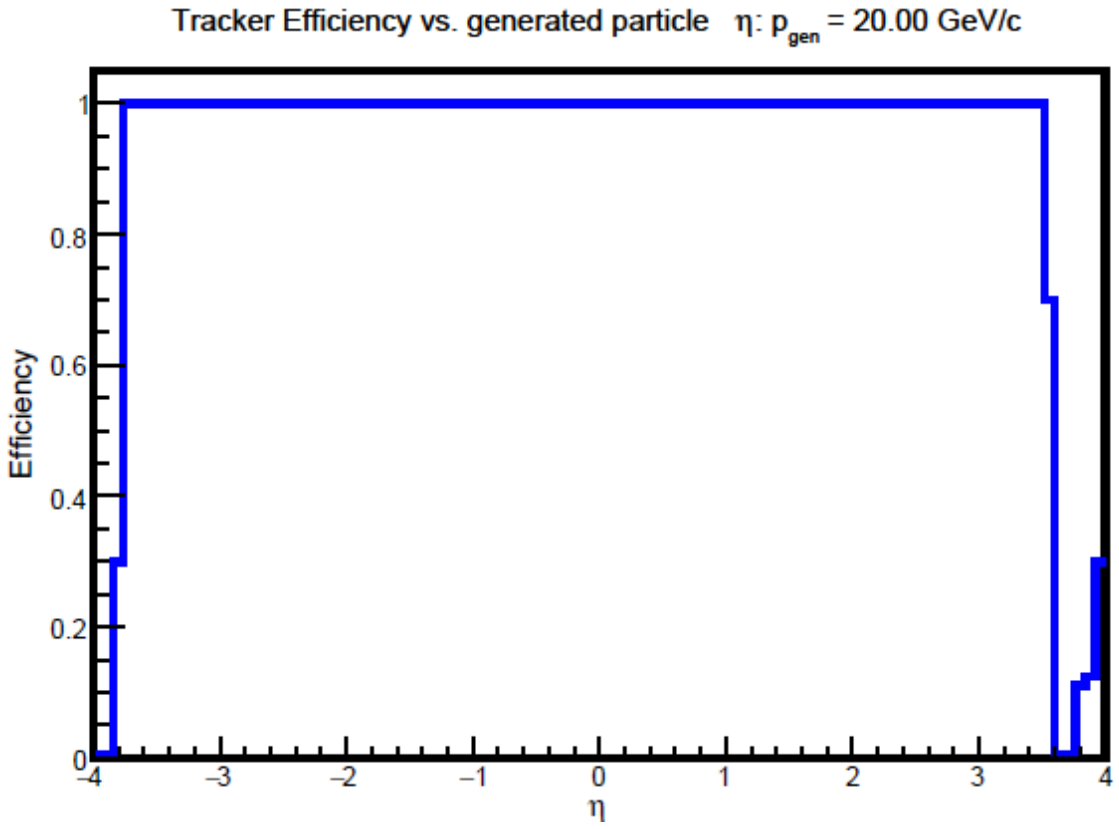
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Truth-seeded tracking: p = 20 GeV/c

Default material map



Updated material map

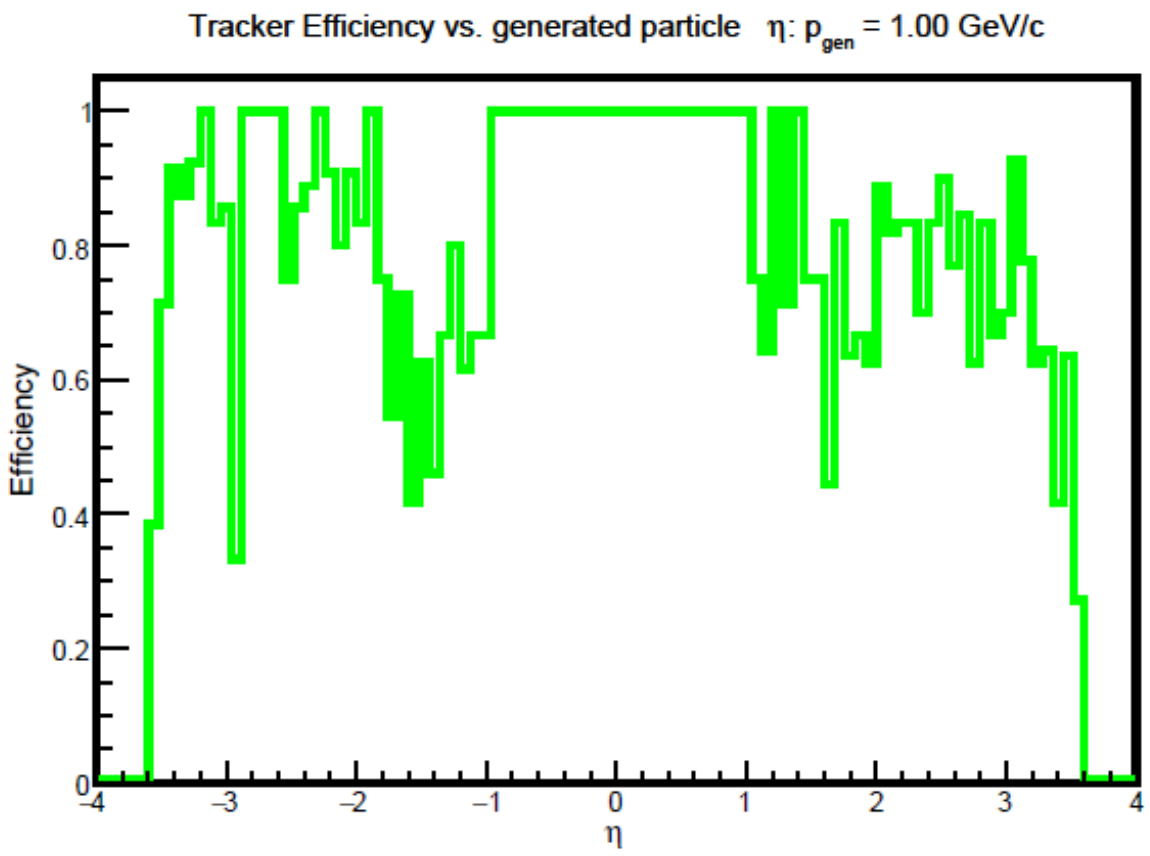


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

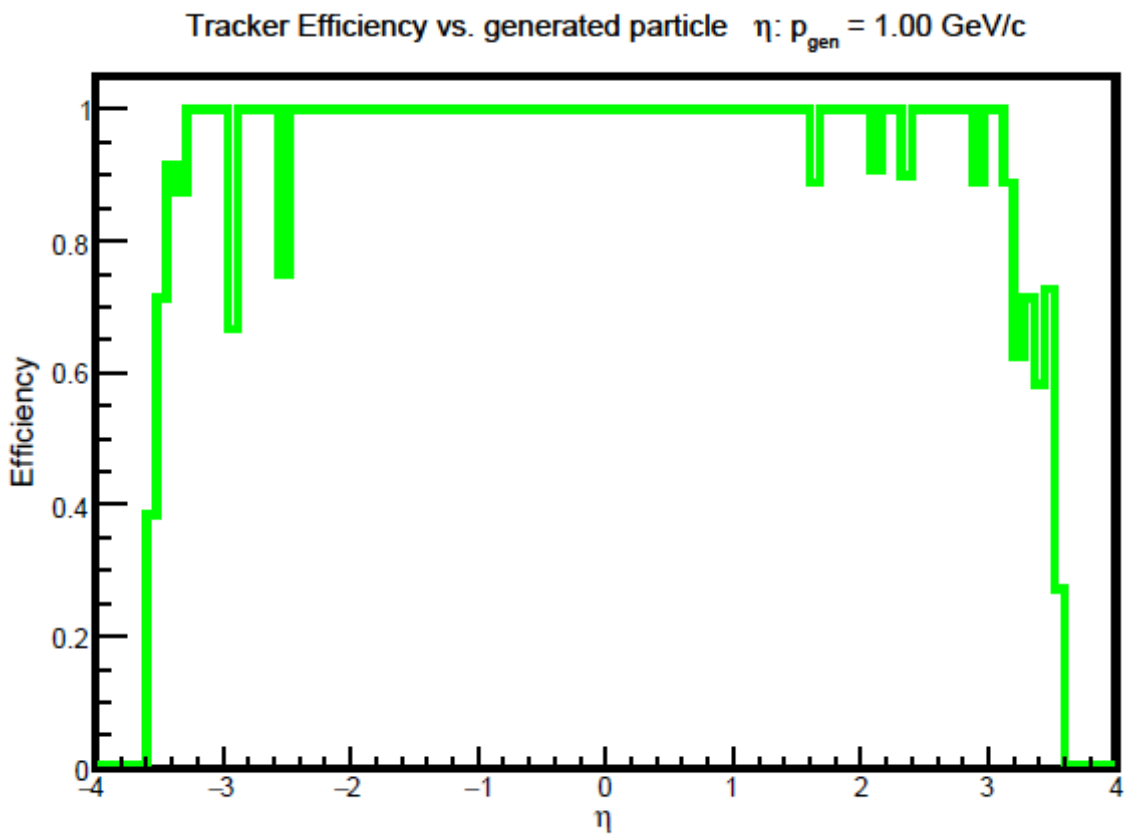
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Real-seeded tracking: p = 1 GeV/c

Default material map



Updated material map

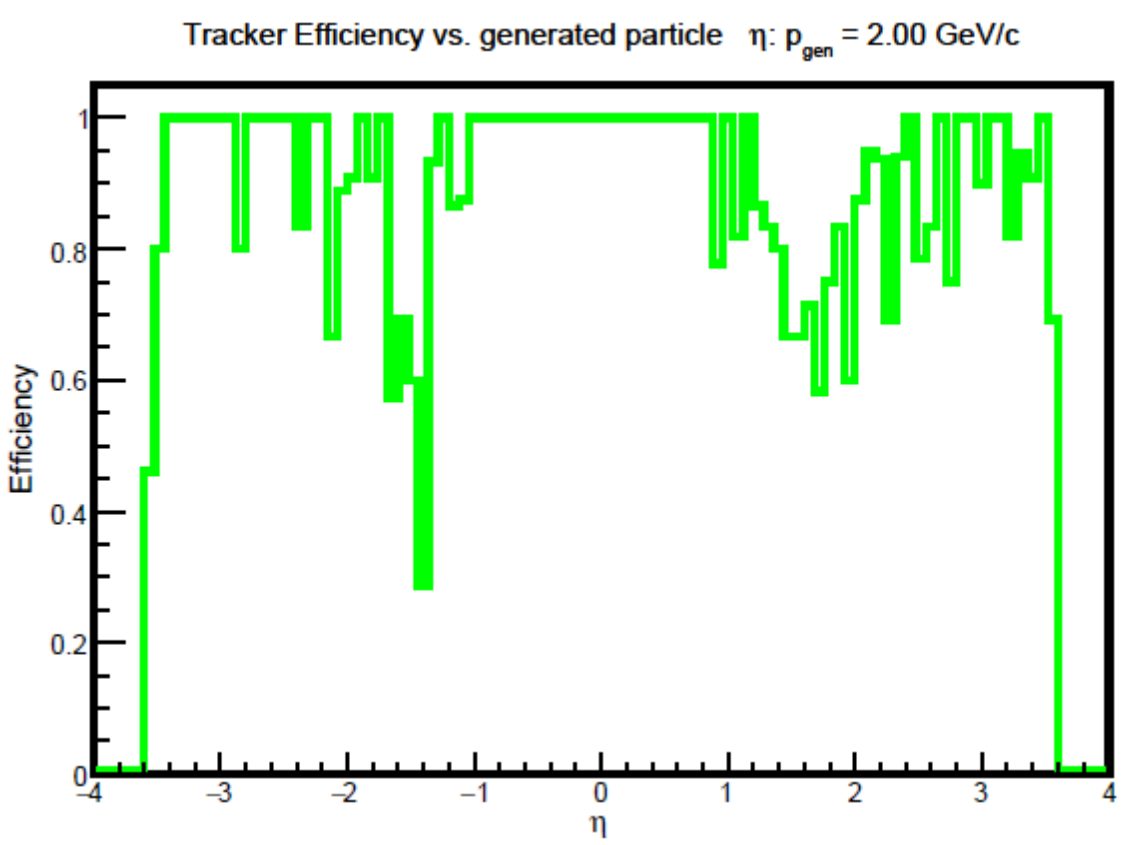


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

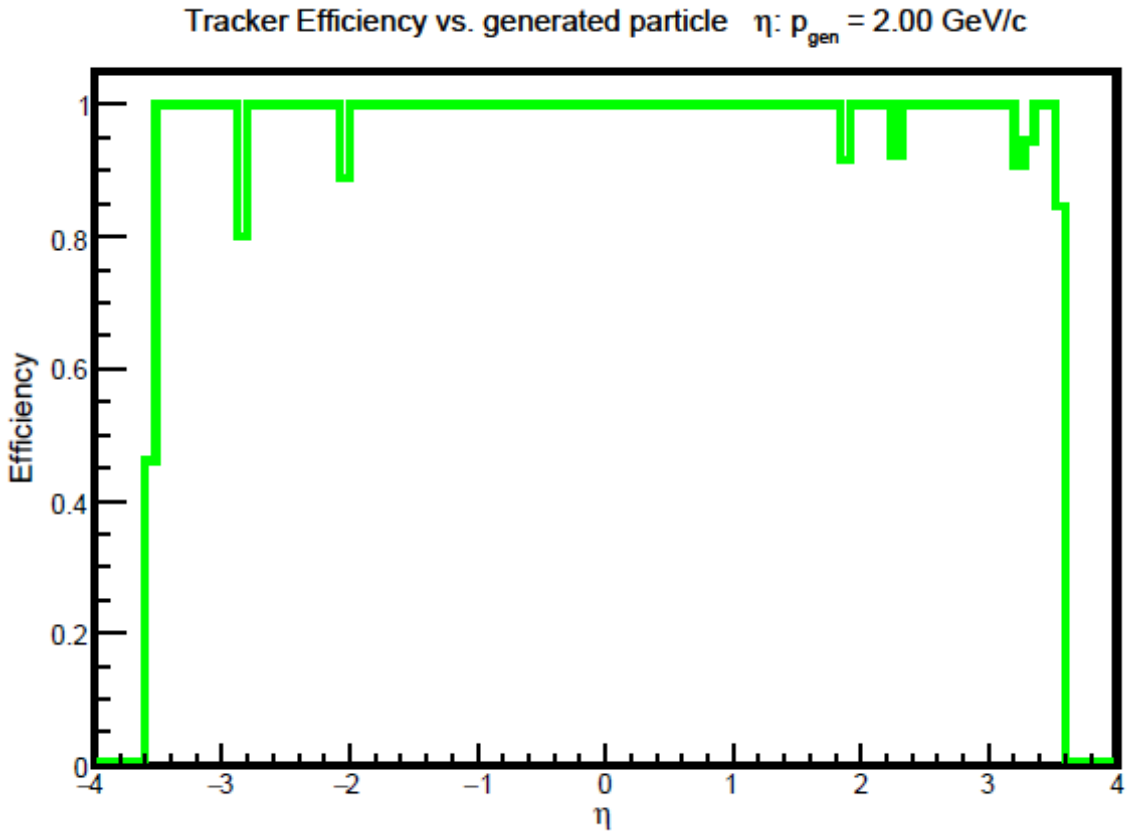
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Real-seeded tracking: p = 2 GeV/c

Default material map



Updated material map

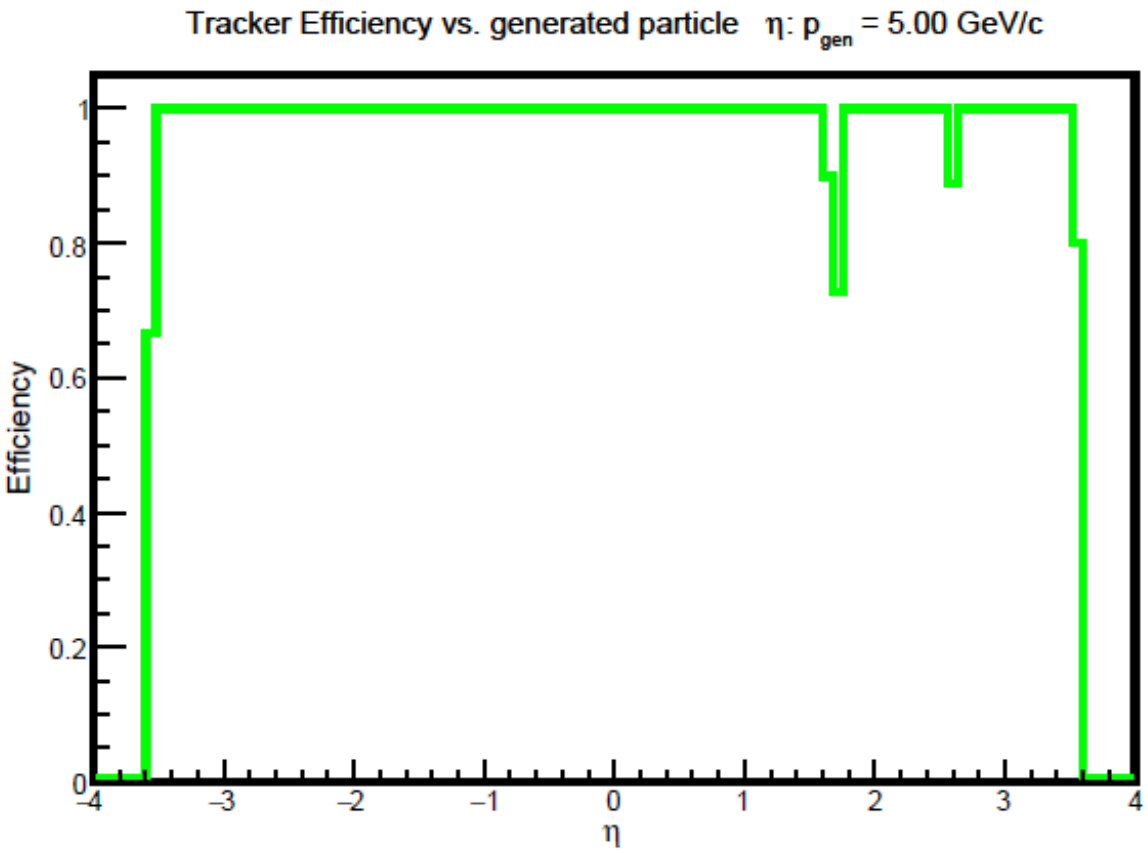


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

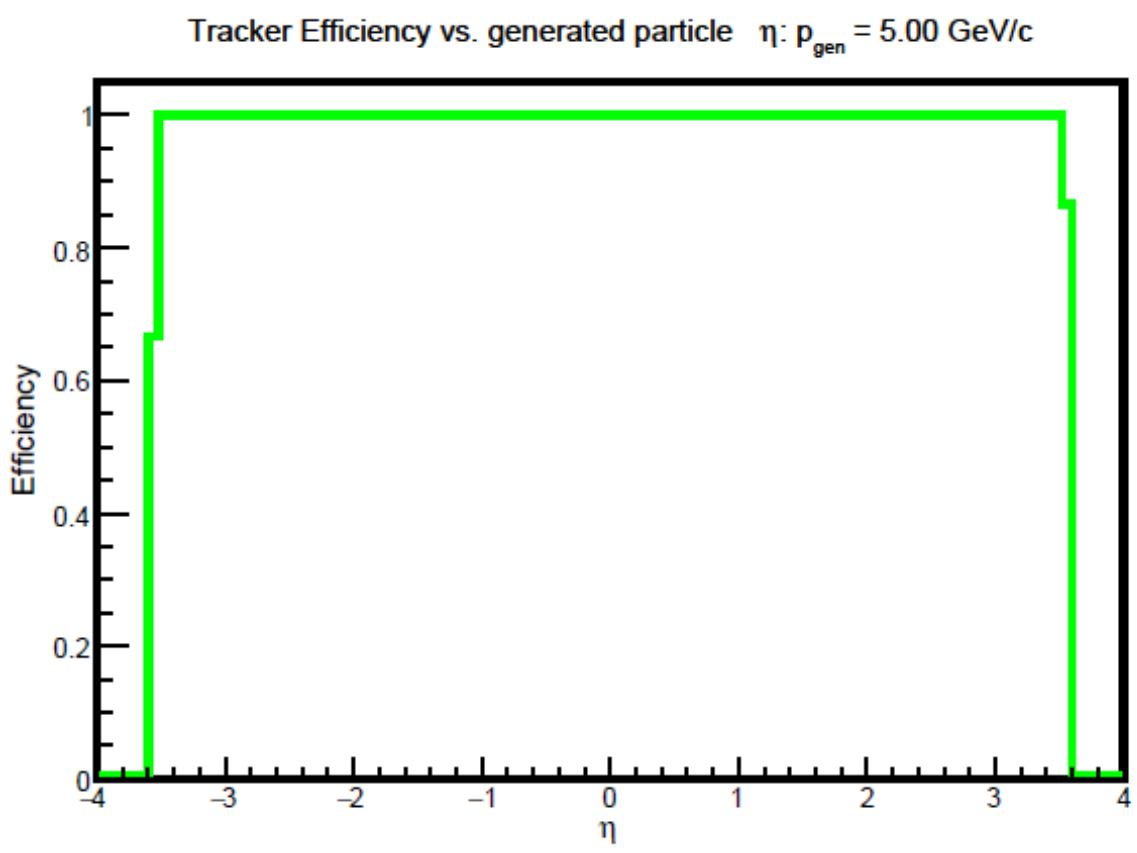
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Real-seeded tracking: p = 5 GeV/c

Default material map



Updated material map

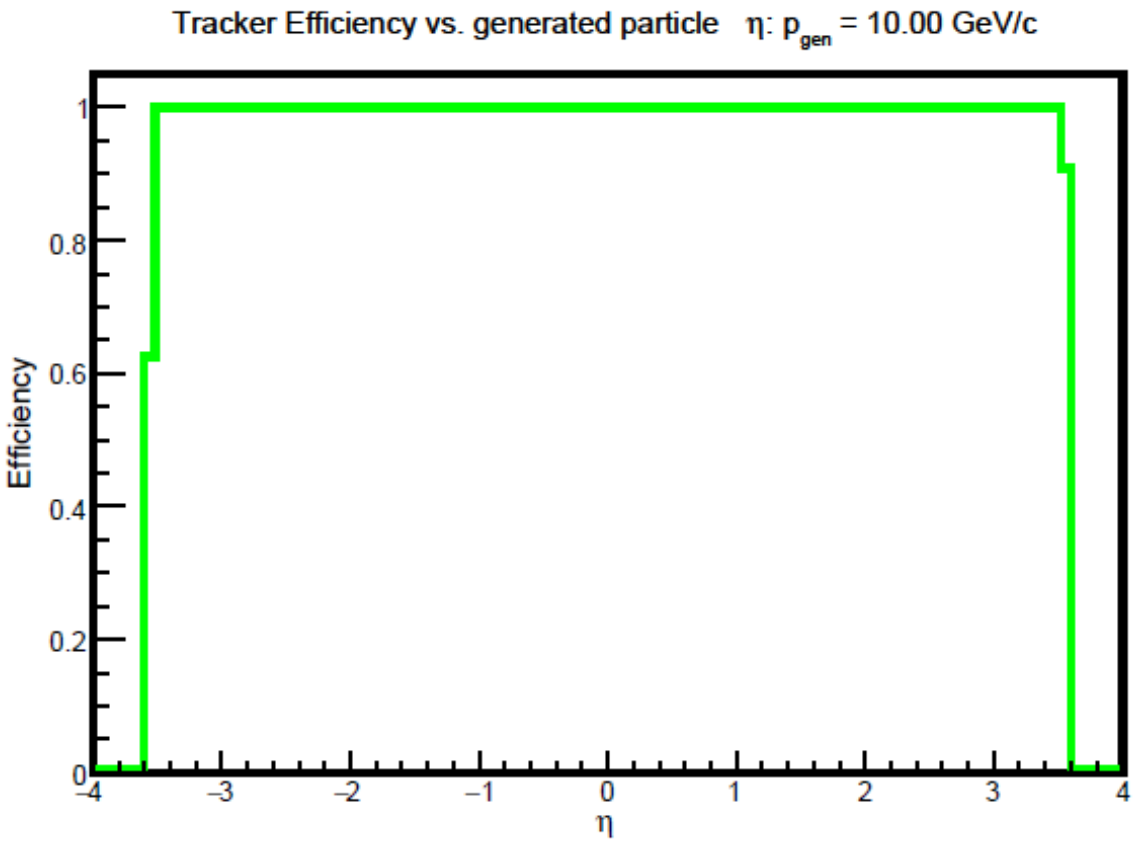


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

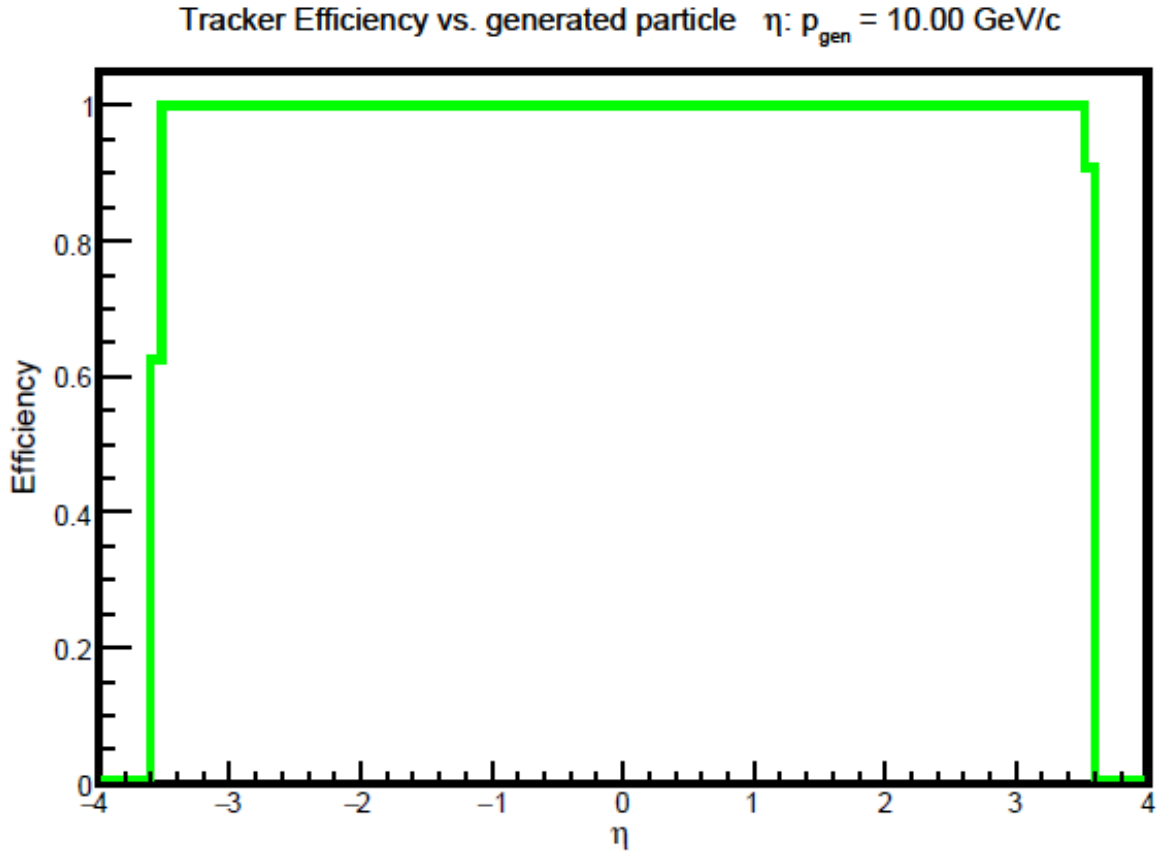
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Real-seeded tracking: p = 10 GeV/c

Default material map



Updated material map

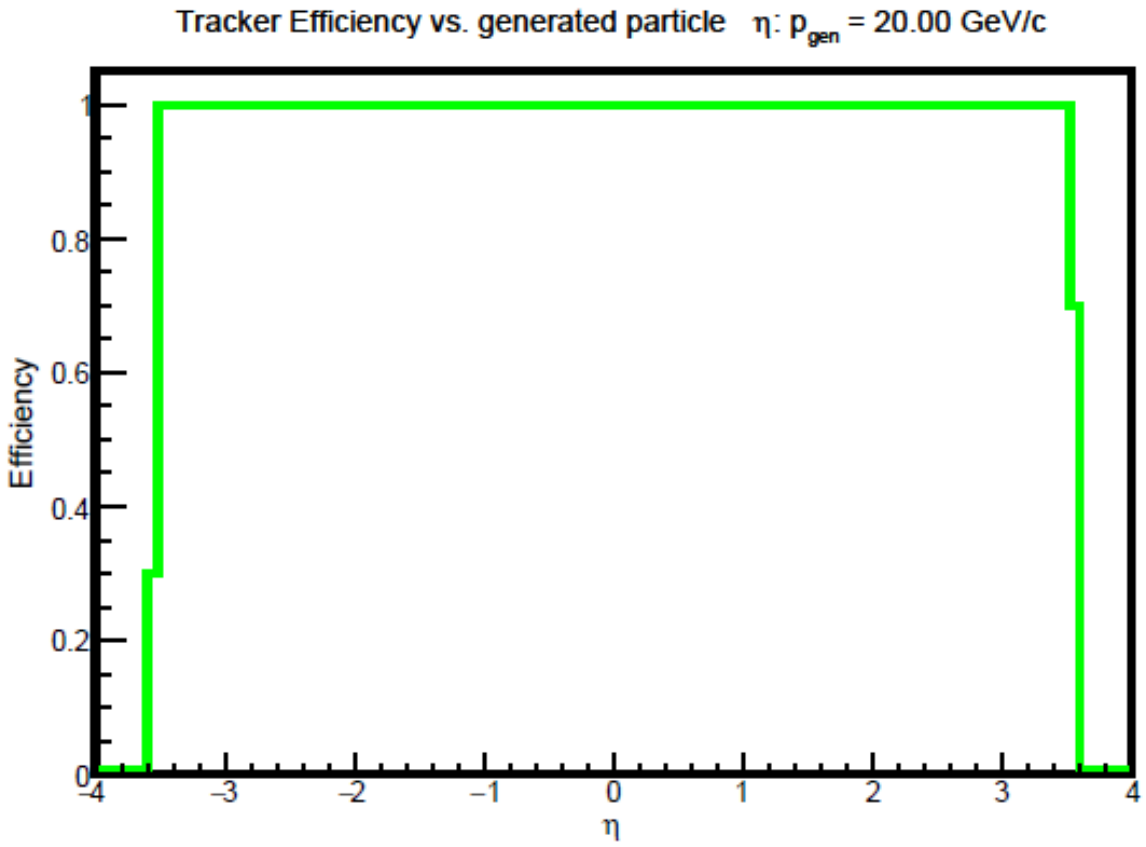


Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

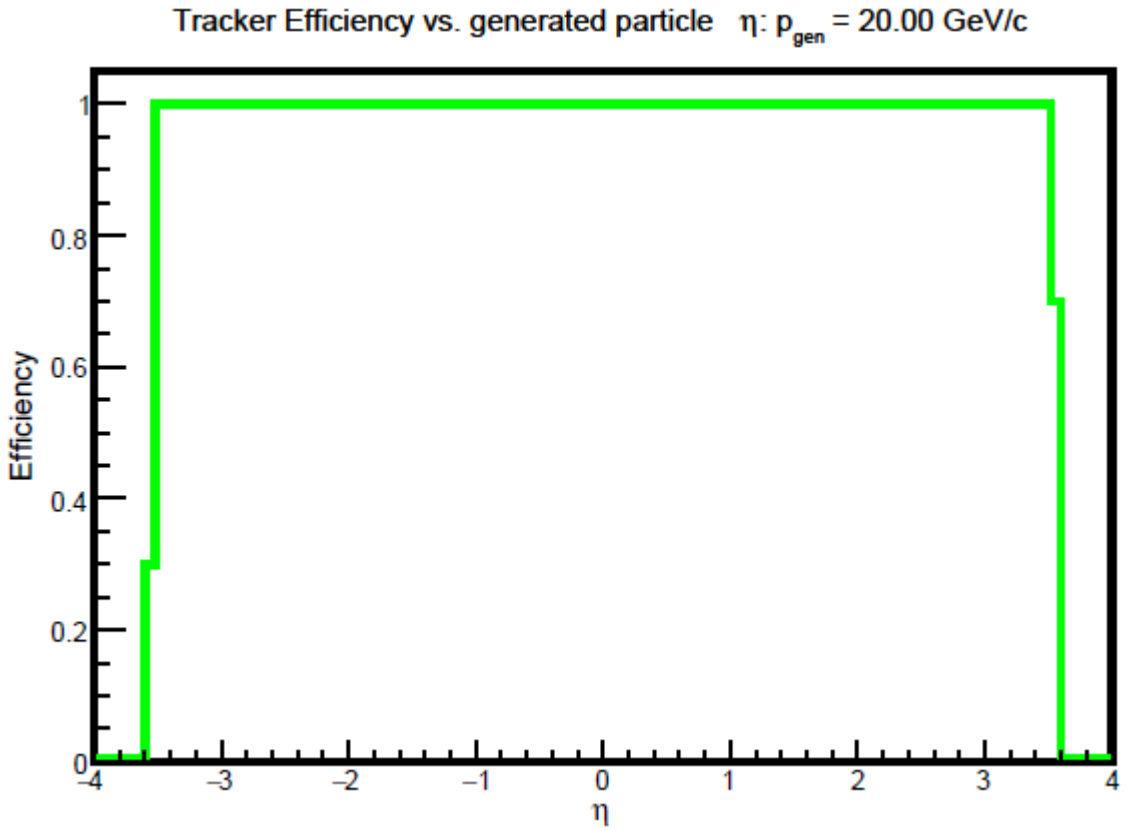
Generated particle:
Single negative muon
Eta = [-4,4]
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Real-seeded tracking: p = 20 GeV/c

Default material map



Updated material map



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Generated particle:
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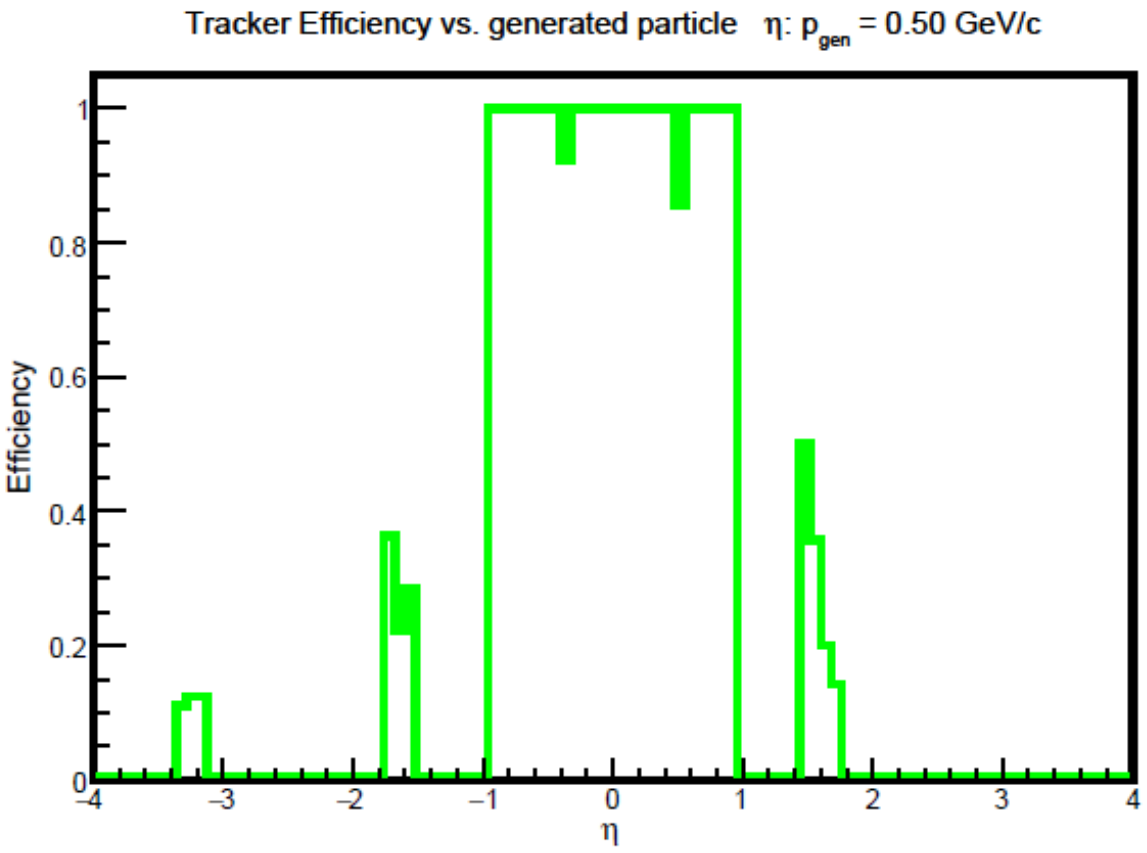
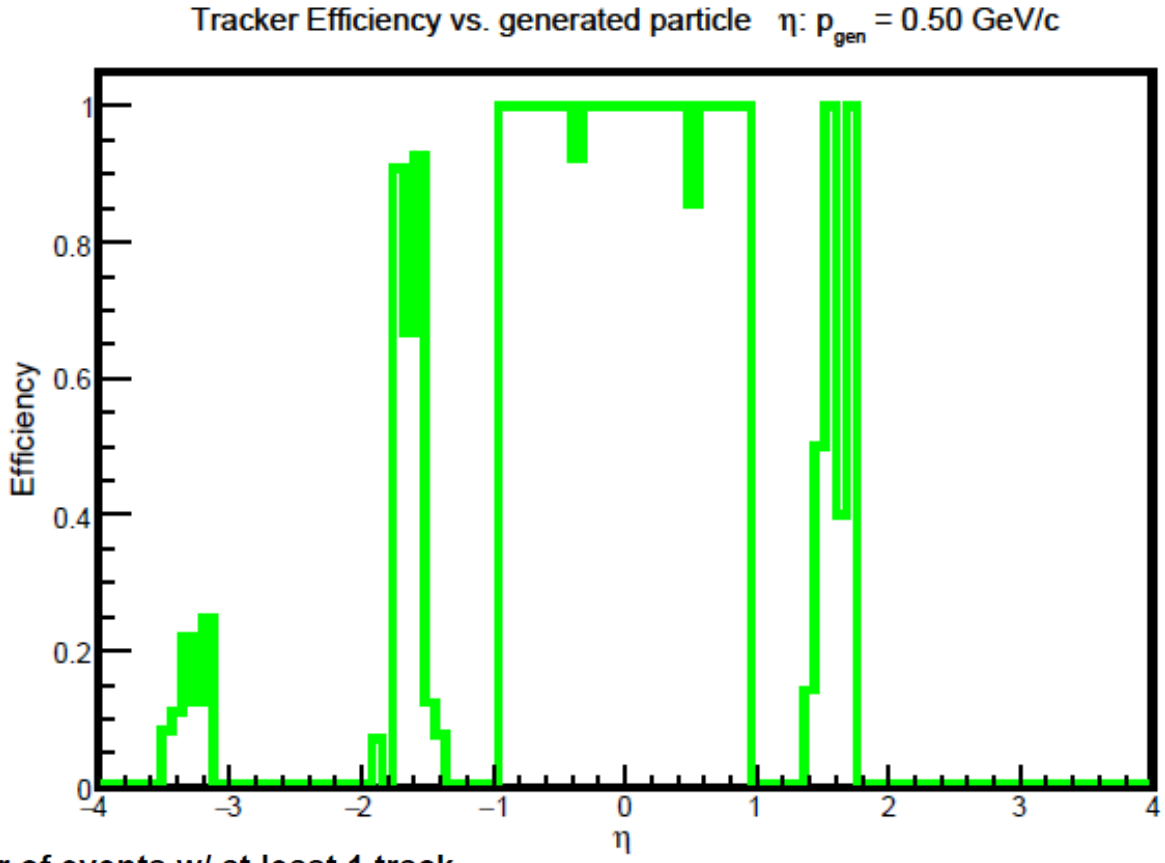
Phi = [0,2Pi]
(Vx,Vy,Vz) = (0,0,0)

Real-seeded tracking: p = 500 MeV/c

Default material map



Updated material map



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Generated particle:
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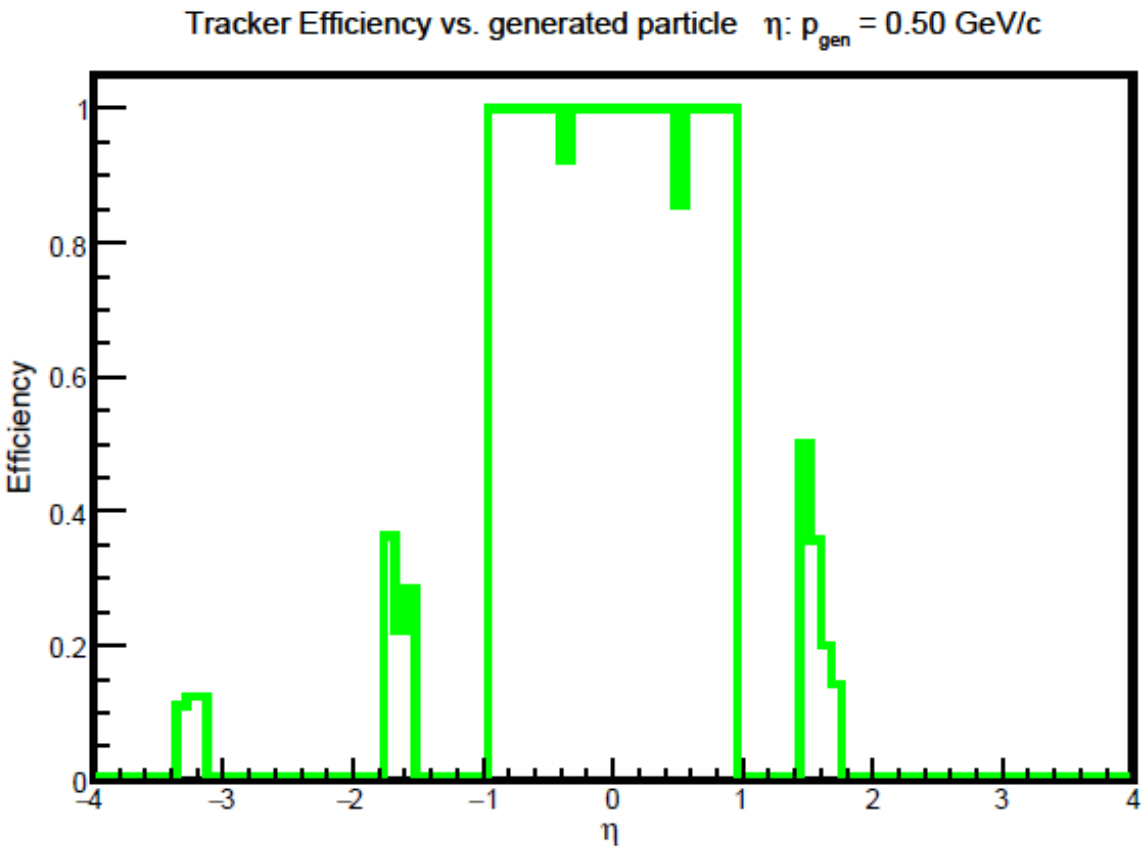
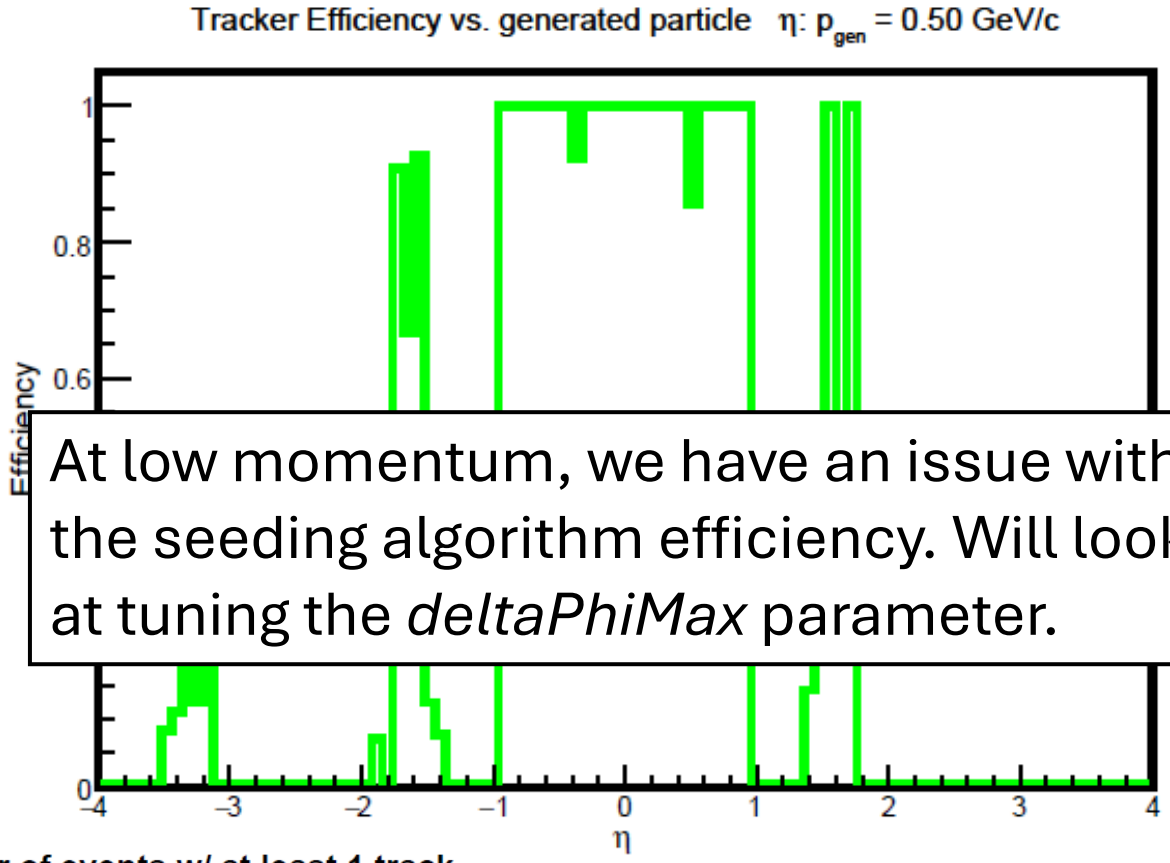
Real-seeded tracking: p = 500 MeV/c

Default material map



Updated material map



At low momentum, we have an issue with the seeding algorithm efficiency. Will look at tuning the *deltaPhiMax* parameter.

Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$

Conclusions / Next Steps

- The tracking inefficiencies that we see since the November software release can be addressed through an updated material map. We should include an updated map in the next official software release.
- To monitor the single-particle tracking efficiencies more effectively, we will work to complete a tracking efficiency benchmark: https://github.com/eic/detector_benchmarks/tree/tracking_performances_efficiency
- With the corrected material map, we will study the effect of tuning the seeding algorithm on the reconstruction efficiency for low-momentum particles.