

Impact of Particle Fraction Selection on Tracking Performance

Matt Posik
Temple University

Goal:

Determine whether conclusions from the MPGD-resolution study remain unchanged when tightening the **particle-fraction requirement from 0.5 to 0.8**.

Simulation Files:

- 10k events
- Full background + 1 DIS (NC -- forced)
signal per $2\mu\text{s}$ time window
- Energy: $10\text{ GeV} \times 275\text{ GeV}$
- $Q^2 \geq 1\text{GeV}^2$

Software Versions:

- epic: 26.04.1 (10 μm gold beam
pipe coating)
- ElCrecon: 1.34.0

Detector Configuration:

- epic_Craterlake.xml

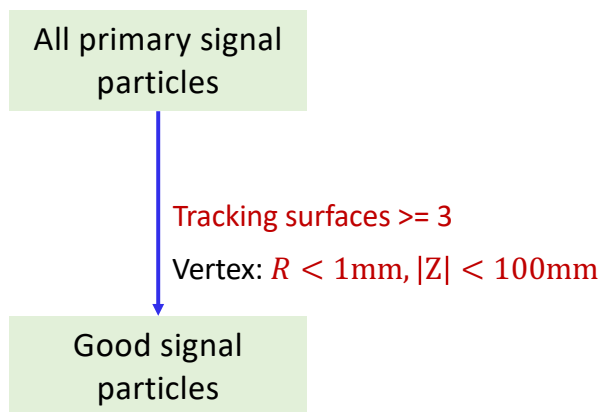
Previous study with particle fraction > 0.5: [Slides](#)

Goals, Cuts, and Definitions

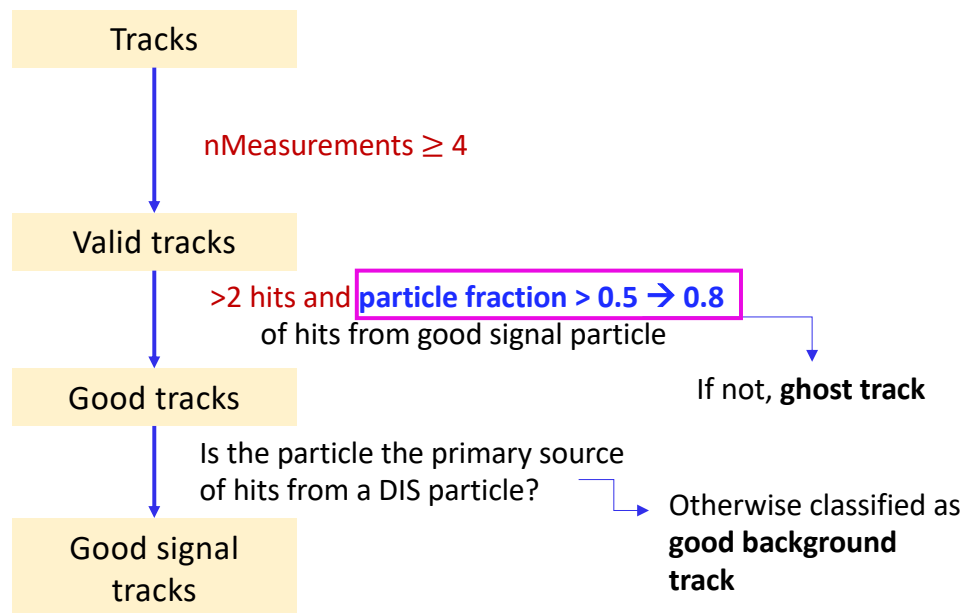


- Study impact of increasing the **particle-fraction requirement** from 0.5 → 0.8

Truth info from MC



Reconstructed Tracks



Tracking efficiency: (Good signal particles w/ good track) / (Good signal particles)

Tracking purity: (Good signal tracks) / (Valid tracks)

Impact of Tightening the Particle Fraction Requirement



Particle Fraction > 0.5 → Particle Fraction > 0.8

Validation of Previous MPGD Conclusions

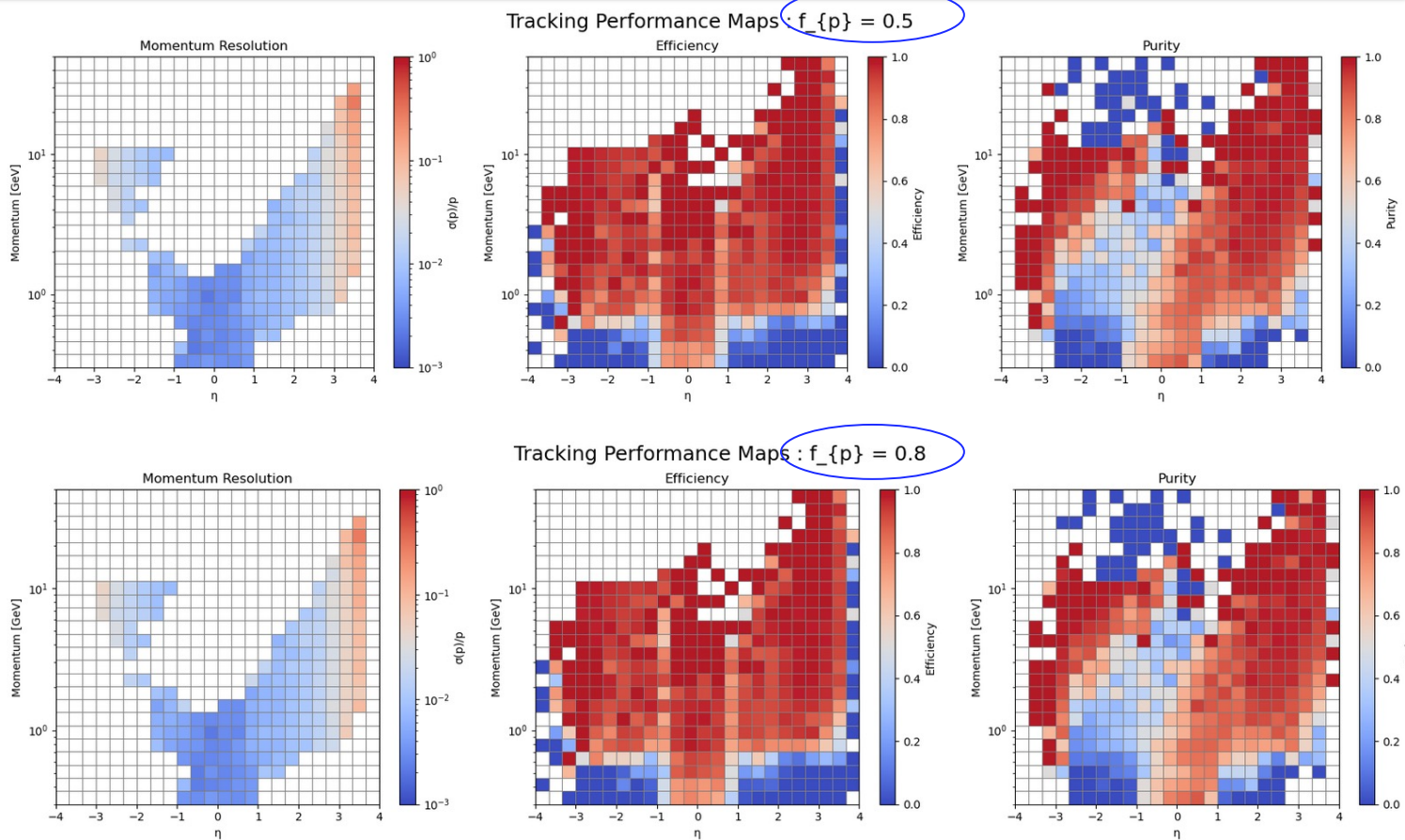
Observable	PF > 0.5	PF > 0.8	Impact
Efficiency	High	High	✓ No Change
Purity	High	Slightly Lower	⚠ Small
Momentum Resolution	Unchanged	Unchanged	✓ No Change
MPGD Resolution Trends	Same	Same	✓ No Change
Physics Conclusions	Same	Same	✓ No Change

- The conclusions of the previous MPGD study are unchanged when the particle-fraction requirement is tightened from 0.5 to 0.8.

2D Map Comparisons Particle Fraction: 0.5 vs. 0.8



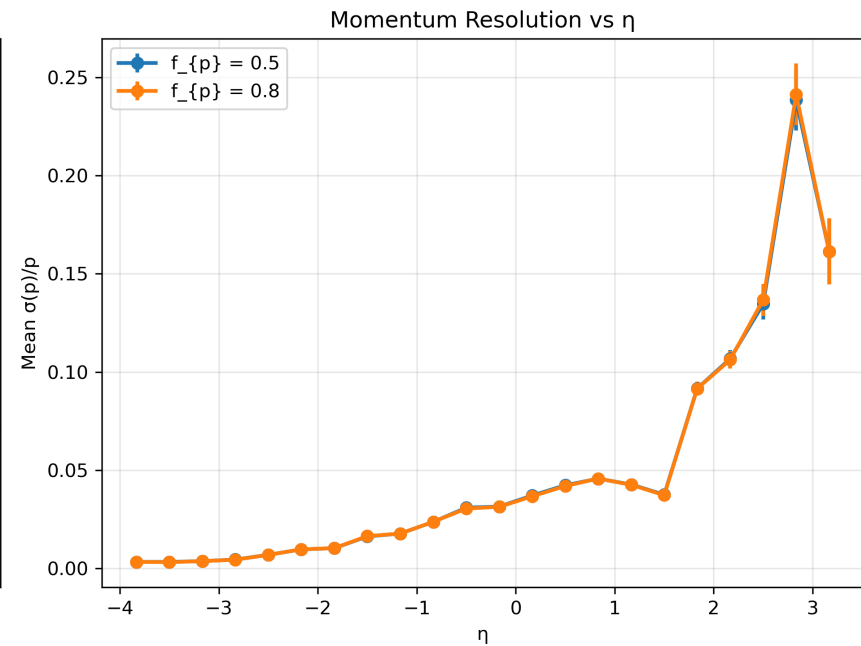
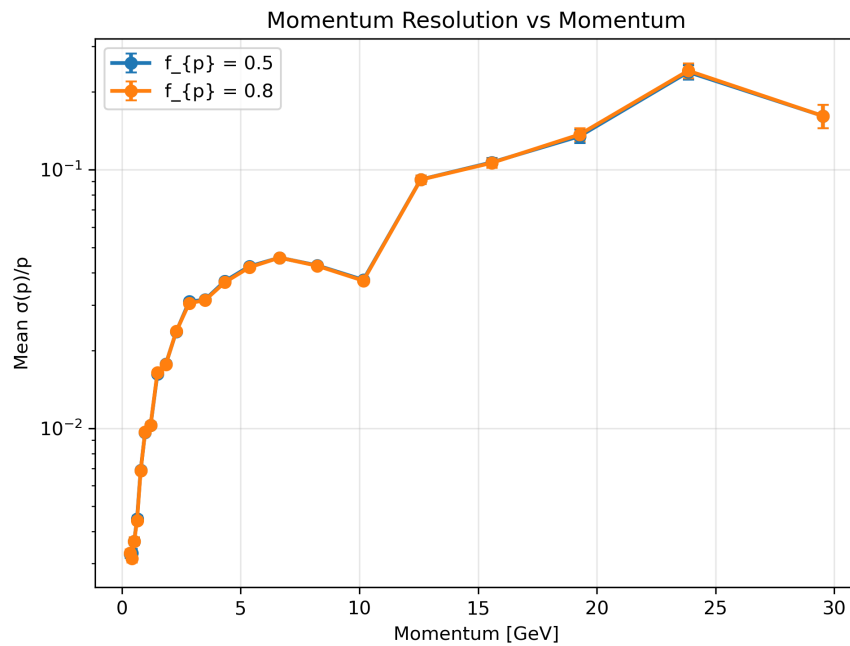
➤ Similar distributions



Momentum Resolution Comparison (150 μm MPGD)

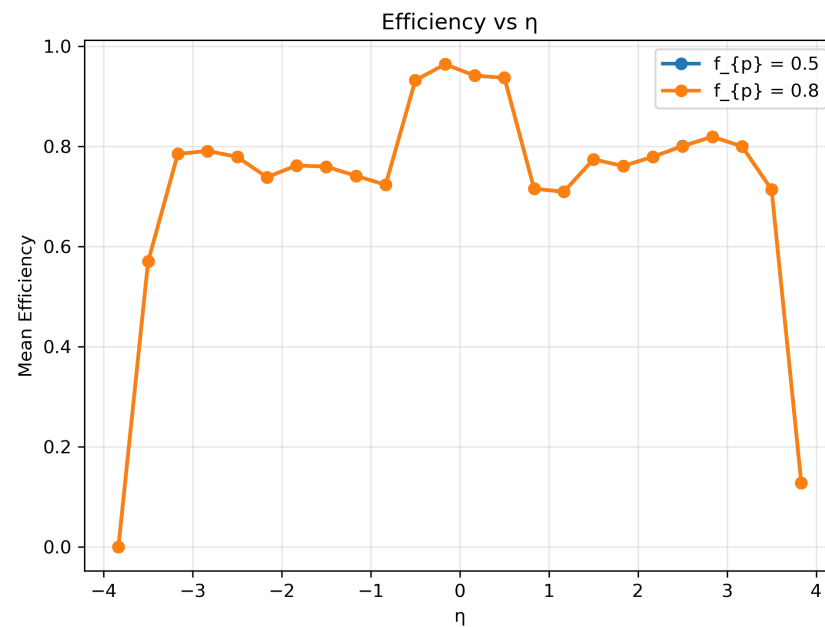
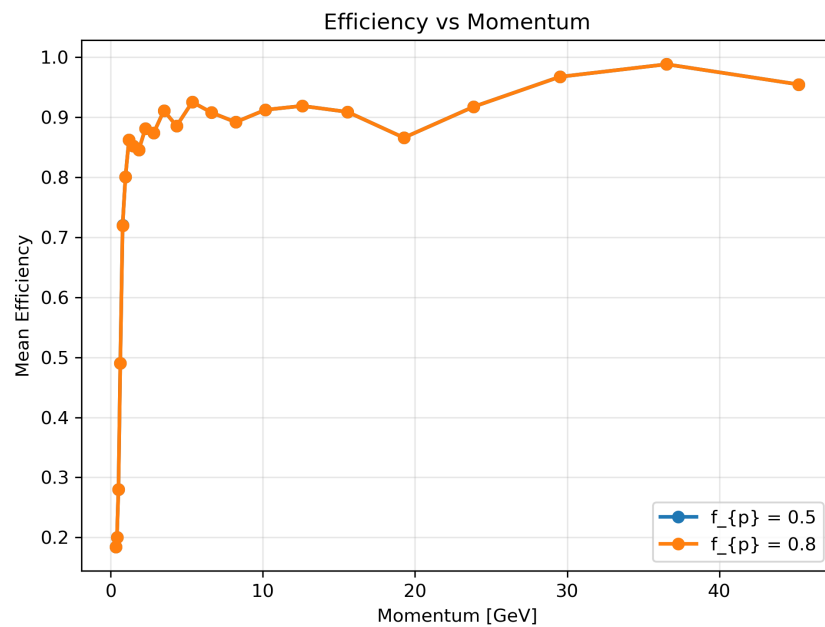


- Momentum-resolution trends are **unchanged** after tightening the particle-fraction requirement.



Efficiency Comparison (150 μm MPGD)

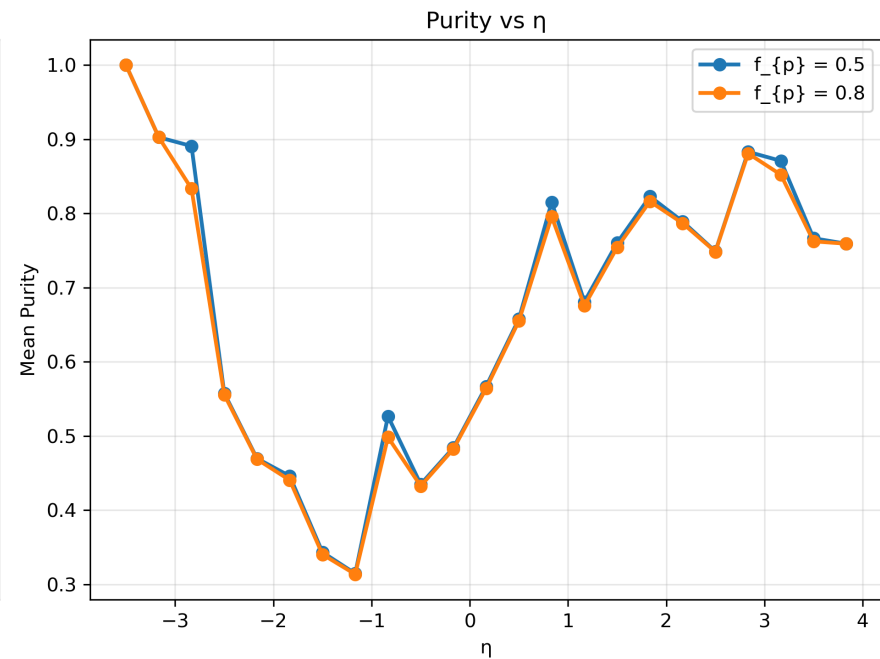
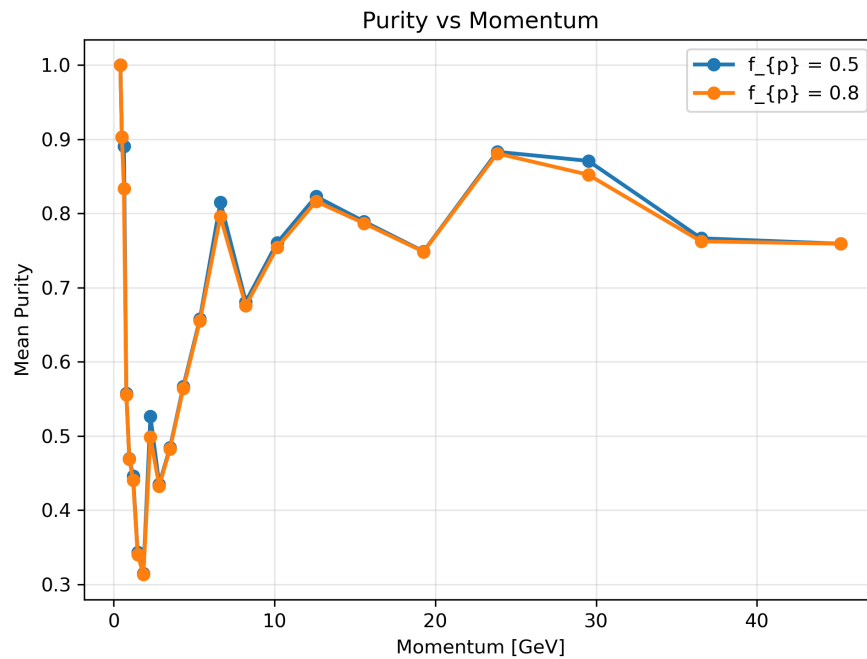
- Raising particle-fraction requirement from 0.5 to 0.8 produces **negligible** changes in tracking efficiency.



Purity Comparison (150 μm MPGD)



- Purity decreases slightly ($\sim 0.6\%$) when increasing the particle-fraction requirement from 0.5 to 0.8 due to the removal of a small number of tracks.

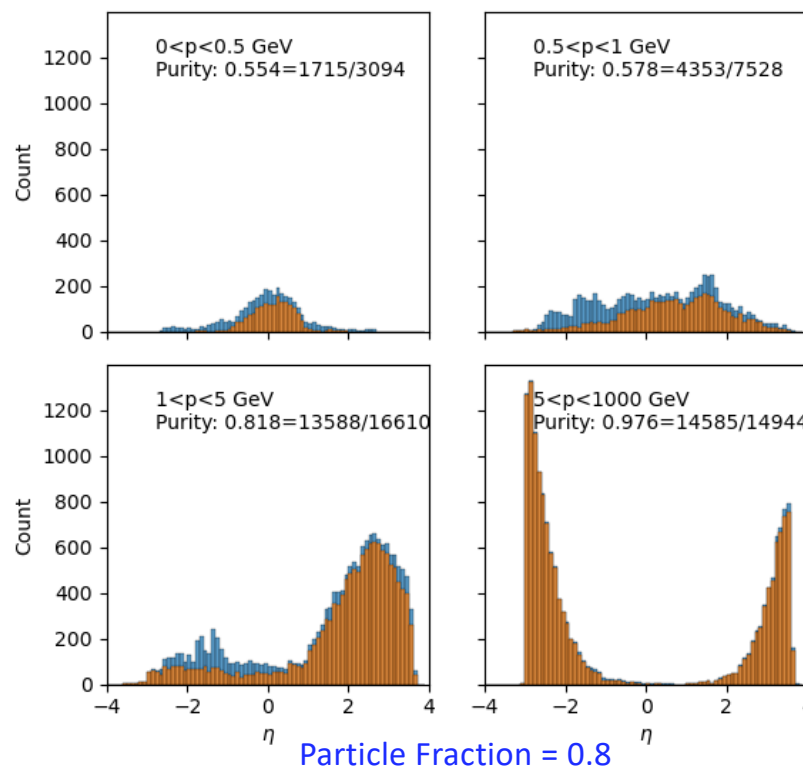
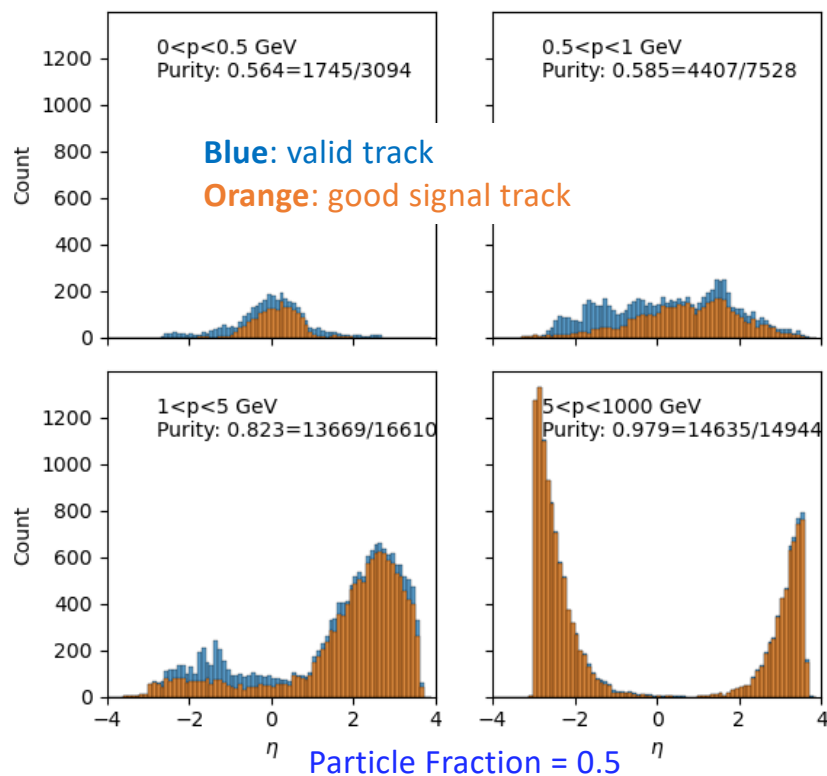


Purity Comparison (150 μm MPGD)



Purity (4 hits) | 10x275, 150um | total = 0.817 (34456/42176)

Purity (4 hits) | 10x275, 150um | total = 0.812 (34241/42176)



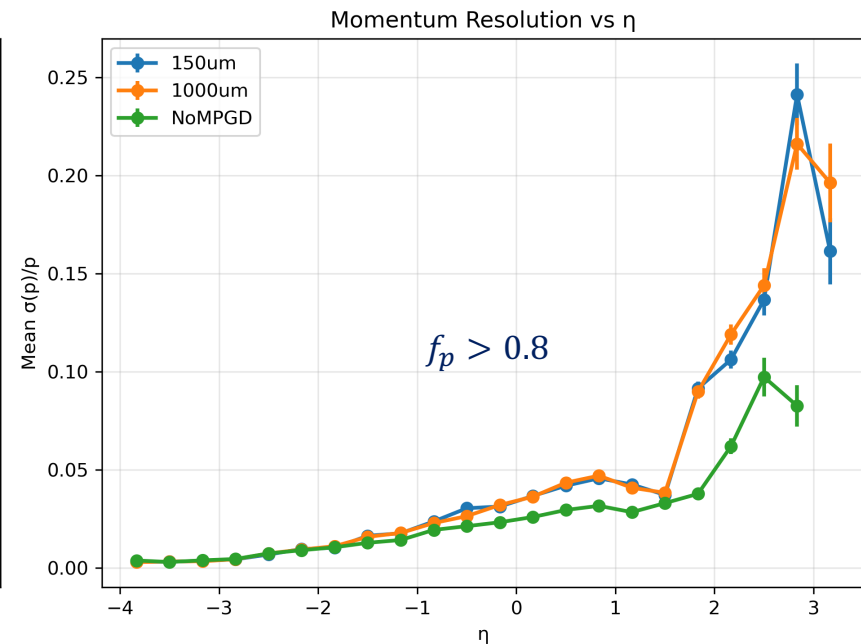
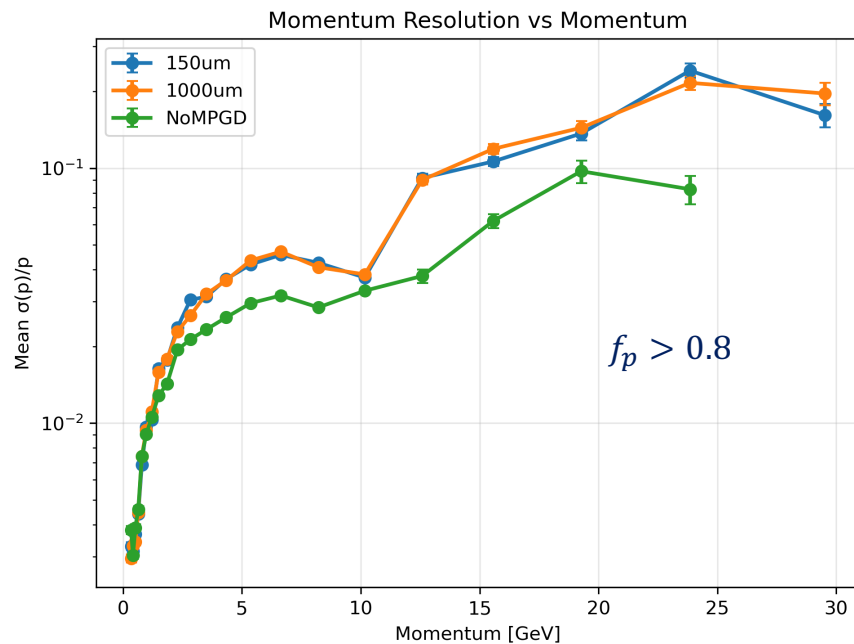
➤ Increasing particle fraction requirement from 0.5 to 0.8 removes 215 reconstructed tracks

Does tightening the particle-fraction cut modify the conclusions of the previous MPGD-resolution study? → **No**

MPGDs Extend Acceptance More Than They Improve Momentum Resolution



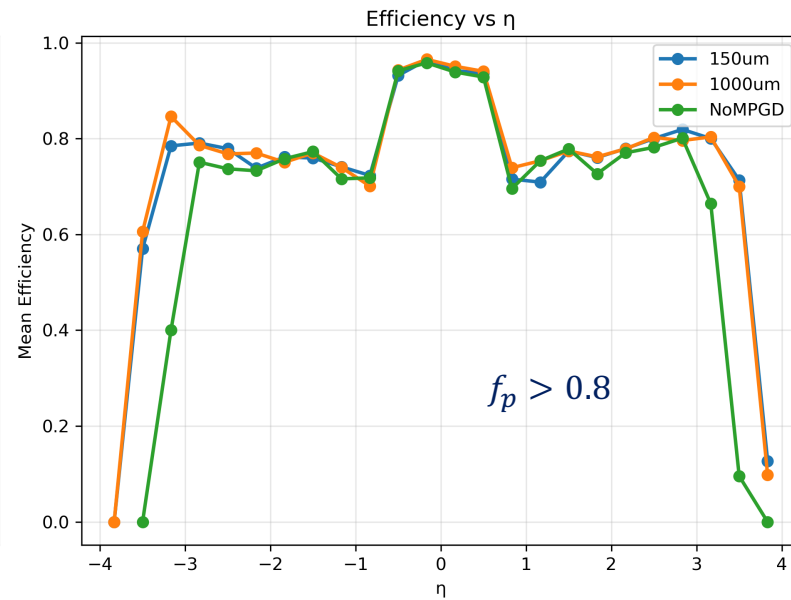
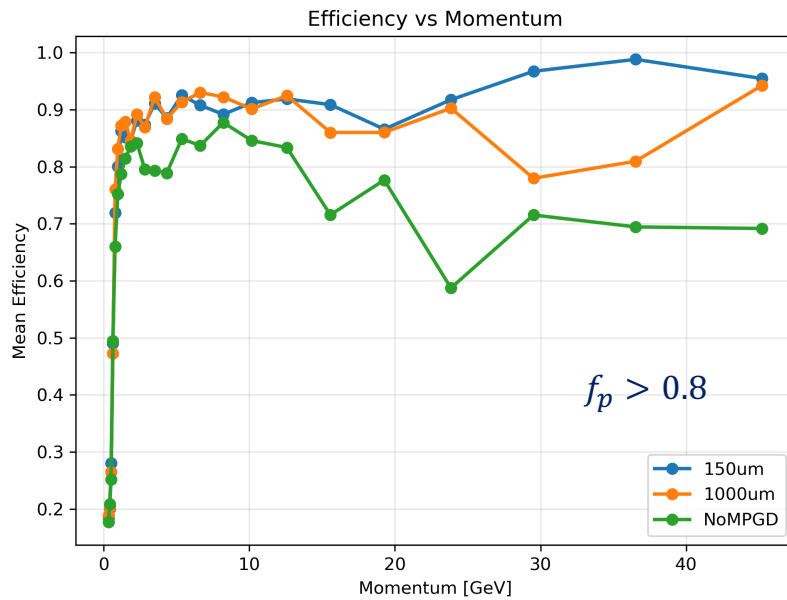
- Dependence on MPGD resolution shows same trends as with particle fraction > 0.5 cut
- MPGDs provide limited improvement in intrinsic momentum resolution because track fits are dominated by silicon measurements. However, MPGDs significantly extend track reconstruction kinematic coverage kinematic coverage.



MPGDs Improve Reconstruction Efficiency



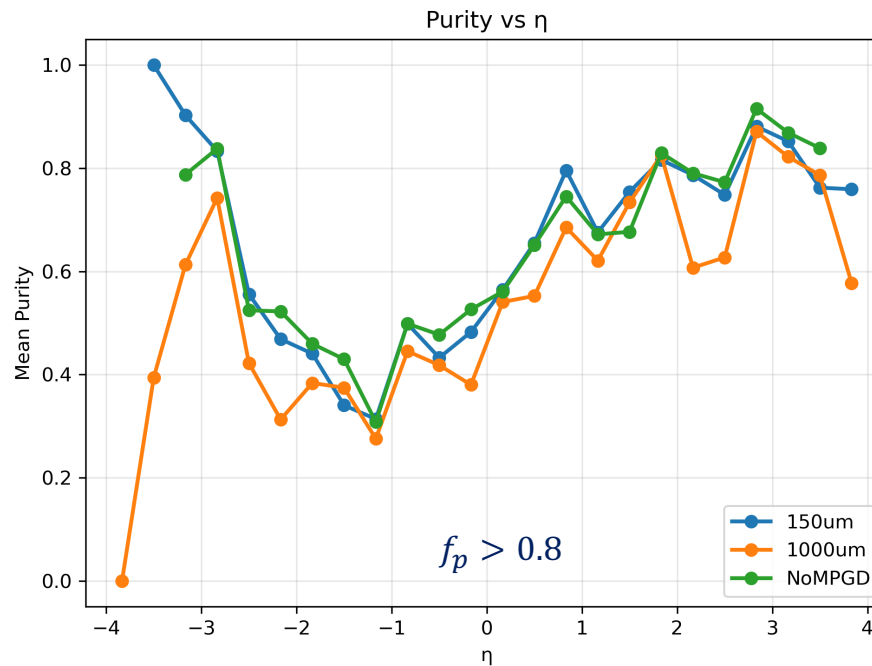
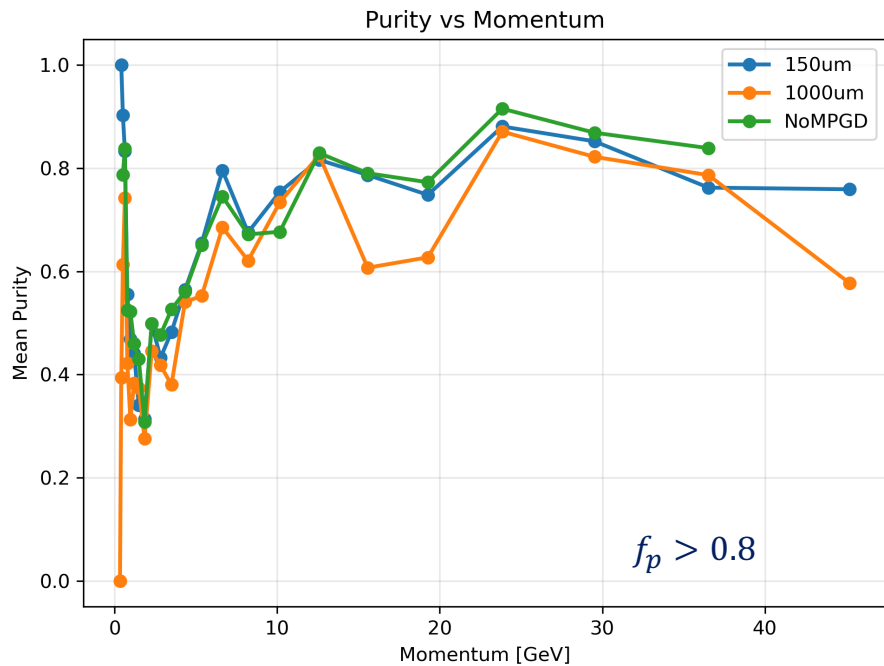
- Dependence on MPGD resolution shows same trends as with particle fraction > 0.5 cut
- MPGDs improve reconstruction efficiency and extend kinematic reach.



MPGD Resolution Above ~1mm Degrades Purity



- Dependence on MPGD resolution shows same trends as with particle fraction > 0.5 cut
- Purity worsens with worsening MPGD resolution, with notable performance degradation around MPGD resolution of 1mm



Key Findings:

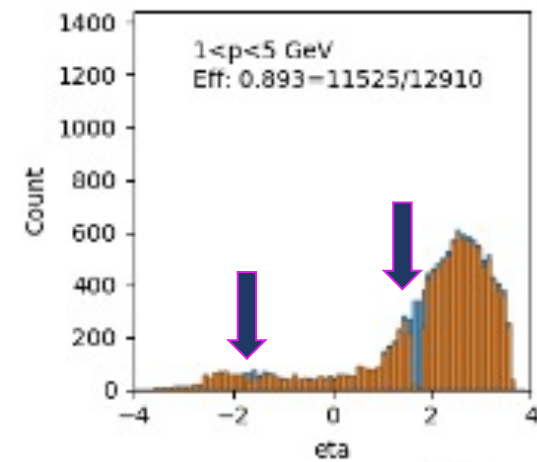
1. Raising particle fraction from 0.5 \rightarrow 0.8 removes \sim 215 tracks.
2. Tracking efficiency is unchanged
3. Tracking purity changes only slightly (\sim -0.6%)
4. Momentum-resolution trends are unchanged.
5. MPGD resolution studies reproduce previous conclusions:
 - MPGDs improve efficiency and acceptance
 - Purity degrades for MPGD resolution $>$ \sim 1mm
 - MPGDs primarily improve pattern recognition rather than intrinsic momentum precision.

Next Steps



□ Investigate Si-MPGD acceptance gap near $1.7 \leq |\eta| \leq 1.9$ when requiring a MPGD

hit on the track



Backup



MPGD Geometry: 26.04.1



Detector	Z_{\min} [mm]	Z_{\max} [mm]	R [mm]
BOT	-1925	1675	730
CyMBaL	-1025	1450	550 - 615

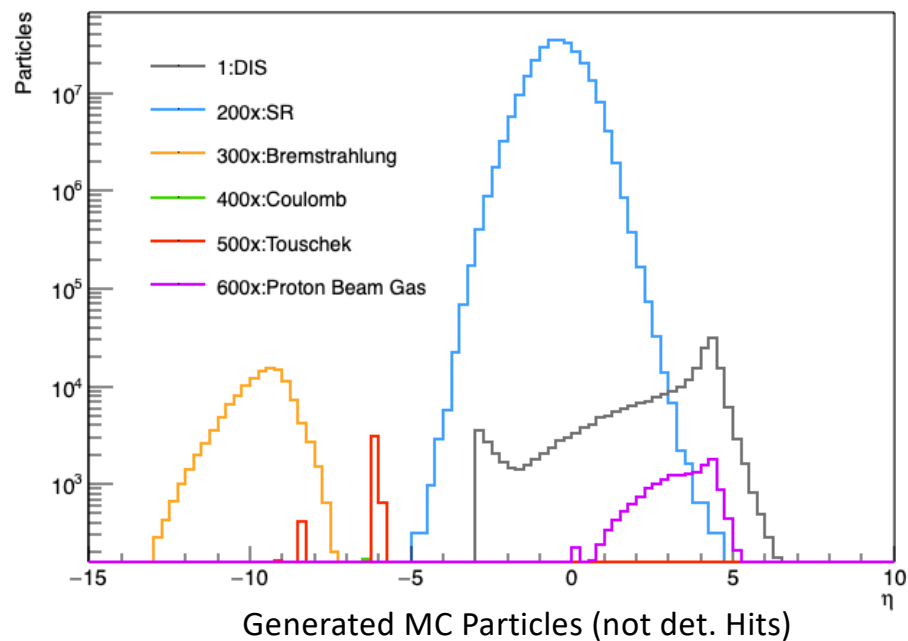
Detector	R_{\min} [mm]	R_{\max} [mm]	$\sim Z$ [mm]
L1-ECT	50	420	-1200
L2-ECT	50	420	-1075
H1-ECT	70	420	1285
H2-ECT	70	420	1410

Background Rates

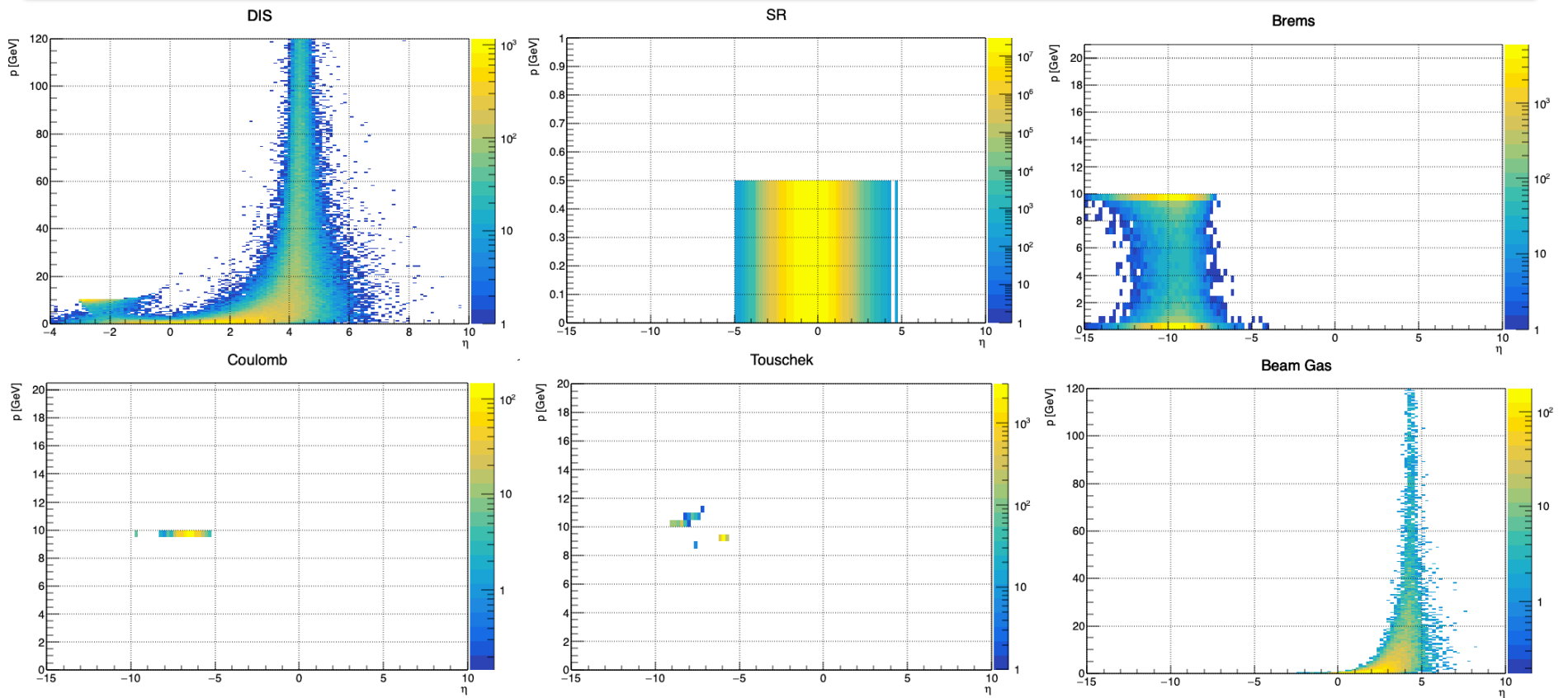


Table: Rates taken from [simulation repository](#)

Source	f [kHz]
DIS	1/event
synrad	13,277,000
e-Brems (10,000 Ahr)	3177.25
e-Coulomb (10,000 Ahr)	29.56
e-Touschek (10,000 Ahr)	233.5
Proton Beam Gas	32.60



Generated MC Momentum vs. η Source Distributions



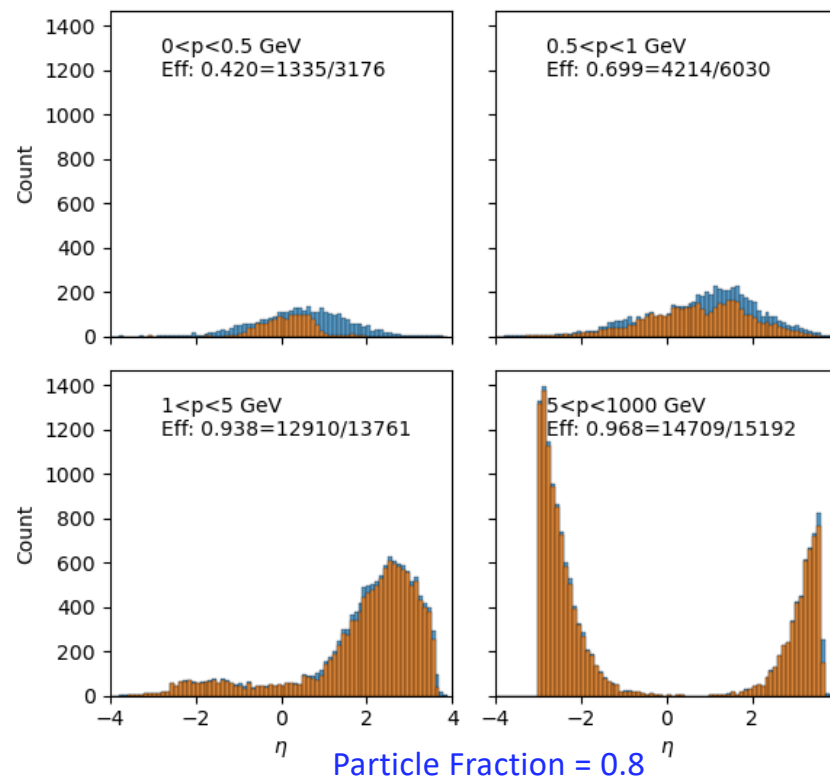
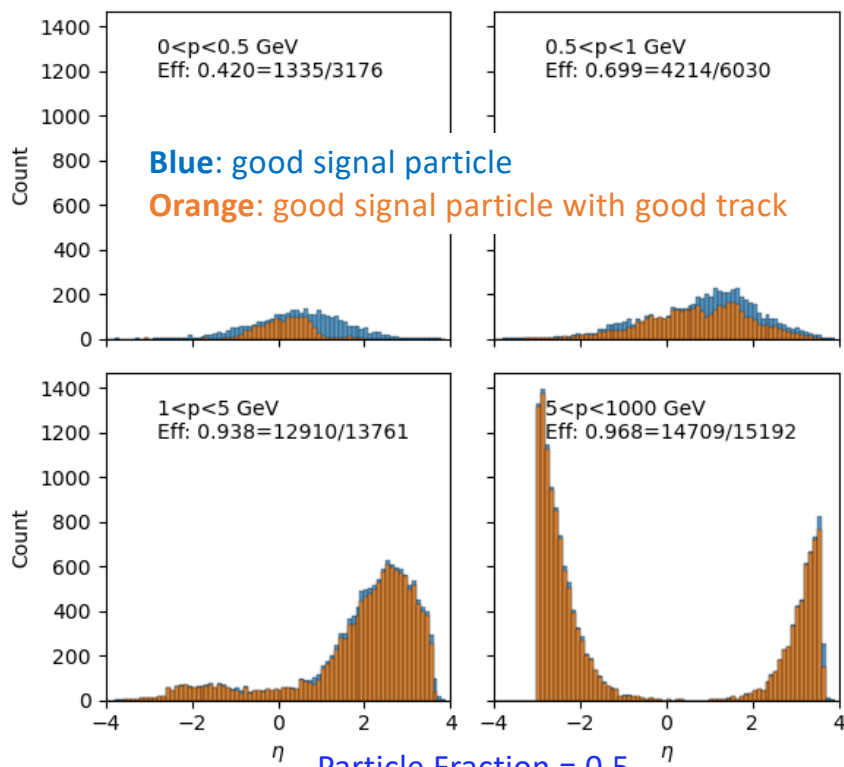
Note different vertical (momentum) scales

Efficiency Comparison (150 μm MPGD)



Efficiency (4 hits) | 10x275, 150um | total=0.869 (33168/38159)

Efficiency (4 hits) | 10x275, 150um | total=0.869 (33168/38159)



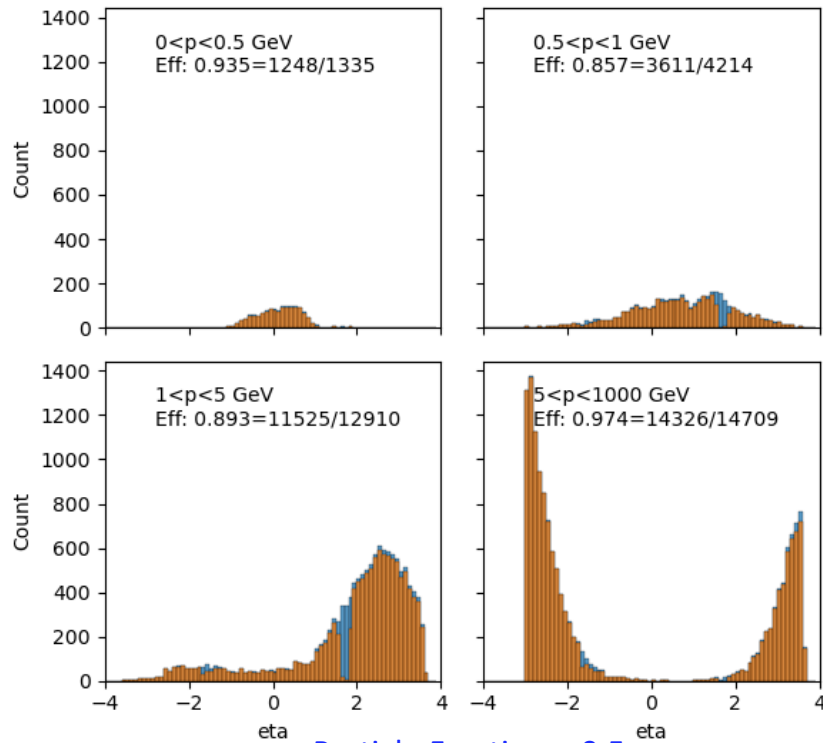
➤ Raising particle-fraction requirement from 0.5 to 0.8 produces negligible changes in tracking efficiency.

Fast Fraction: MPGD Resolution = 150 μm



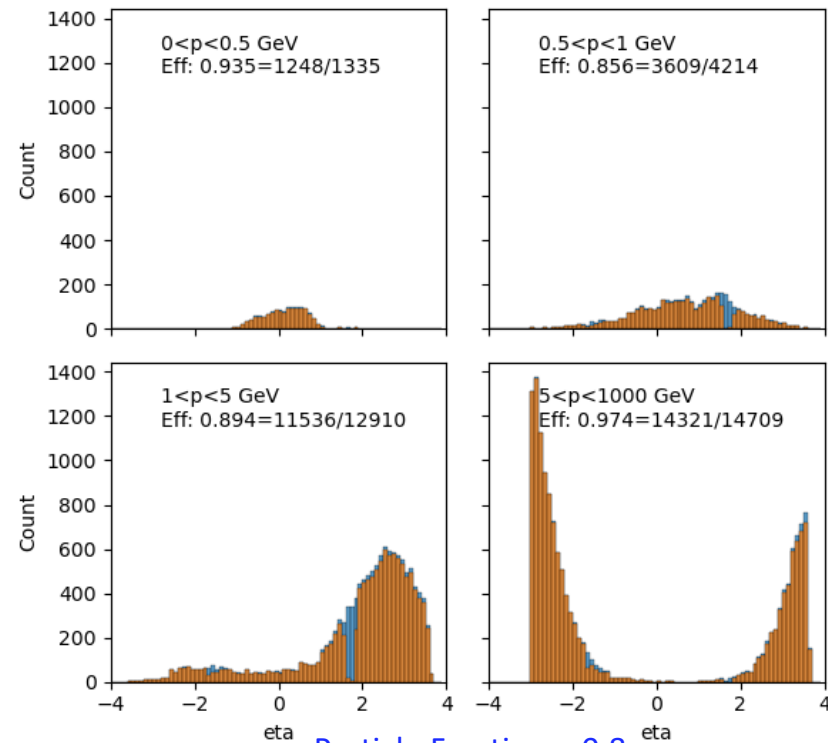
3D OR TOF Efficiency (4 hits) | 10x275, 150um | total=0.926 (30710/331)

3D OR TOF Efficiency (4 hits) | 10x275, 150um | total=0.926 (30714/331)



Particle Fraction = 0.5

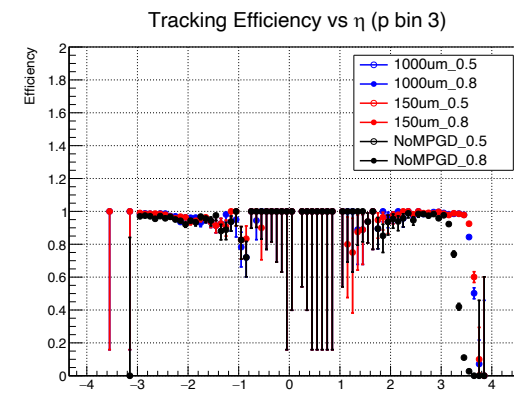
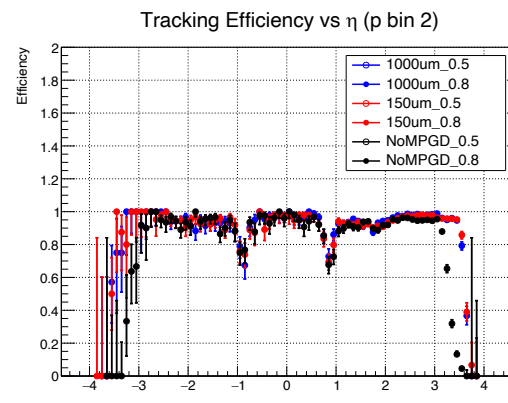
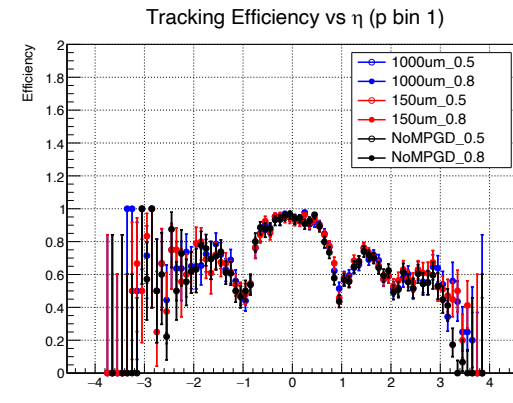
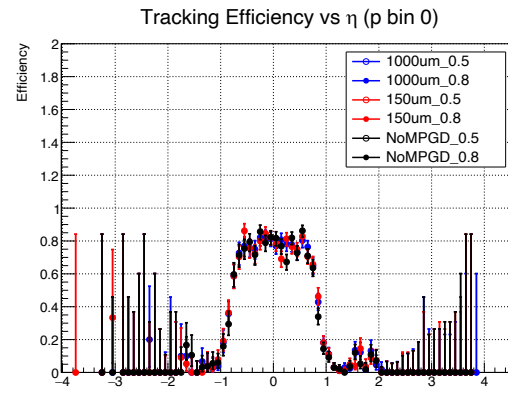
➤ No change in fast fractions



Particle Fraction = 0.8

Fast fraction: (Good signal particles w/good track + (MPGD || TOF) hit) / (Good signal particles w/ good track)

Efficiency Comparisons



Purity Comparisons

