Tracking with Hashing

Current state

Jeremy Couthures

Generic Detector

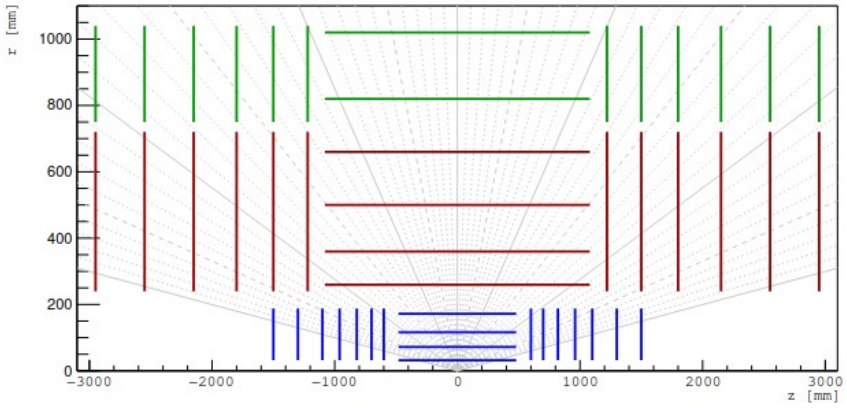
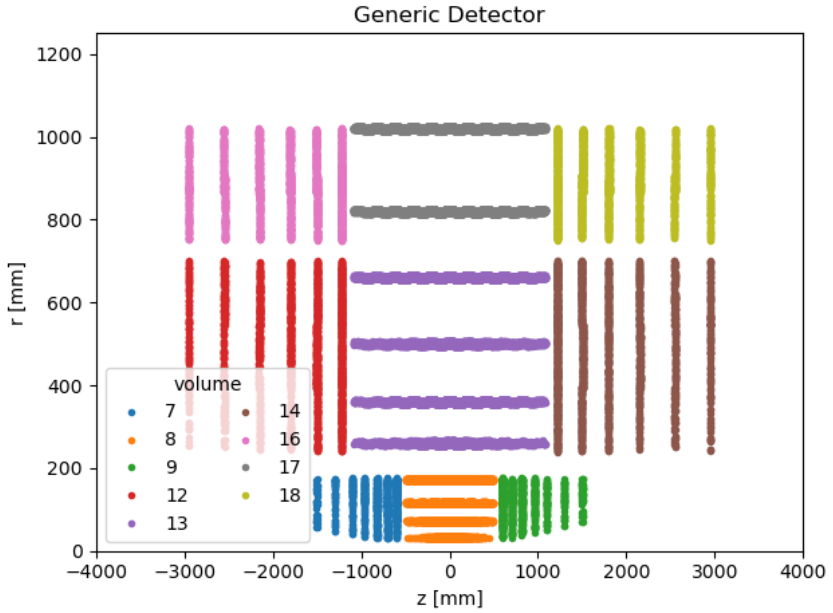


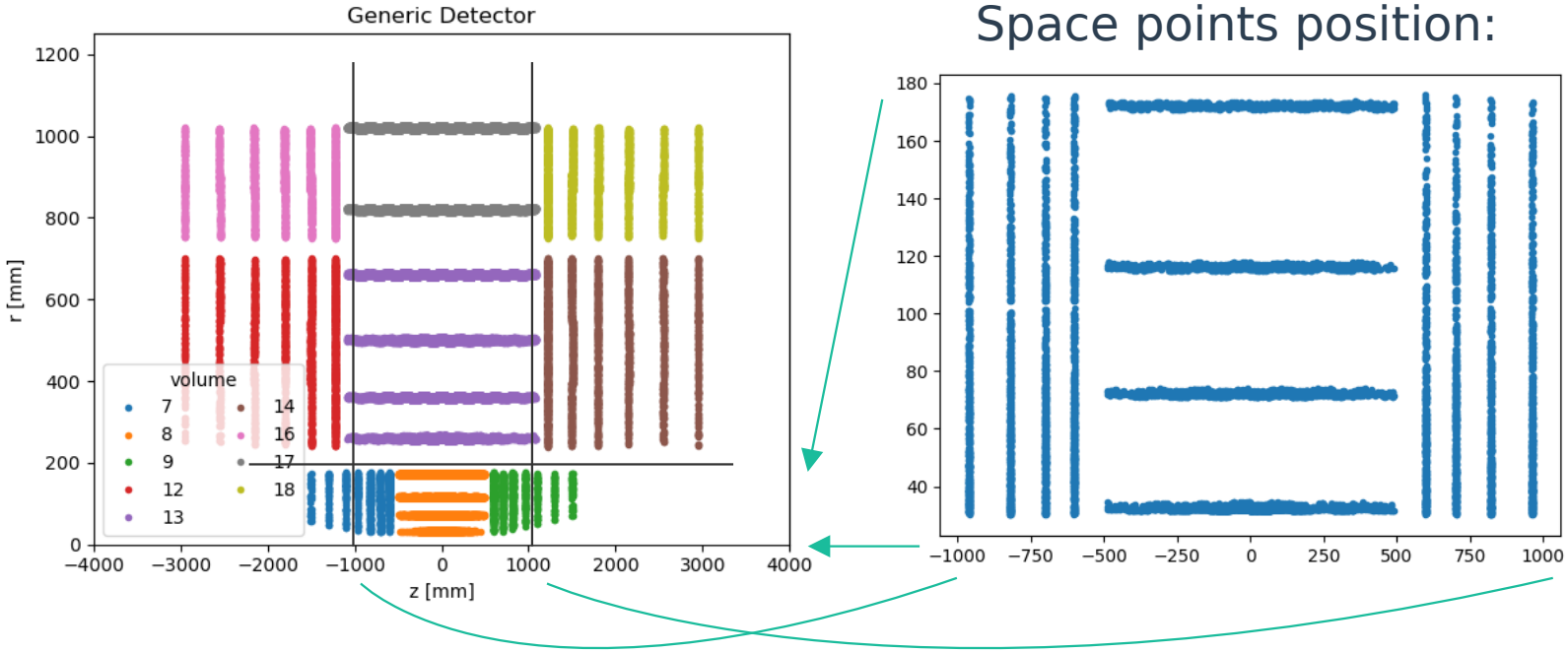
Fig. 1 Sketch of the TrackML detector as used in both the "Accuracy" and "Throughput" phase. Vertical lines indicate disks while horizontal lines indicate cylinders, all with the z axis as axis of revolution. Three different sub detectors build the overall detector setup: a central pixel system (blue), enclosed by first a short strip (red) and then a long strip detector (green).

https://arxiv.org/pdf/2105.01160.pdf



https://github.com/acts-project/acts/issues/926

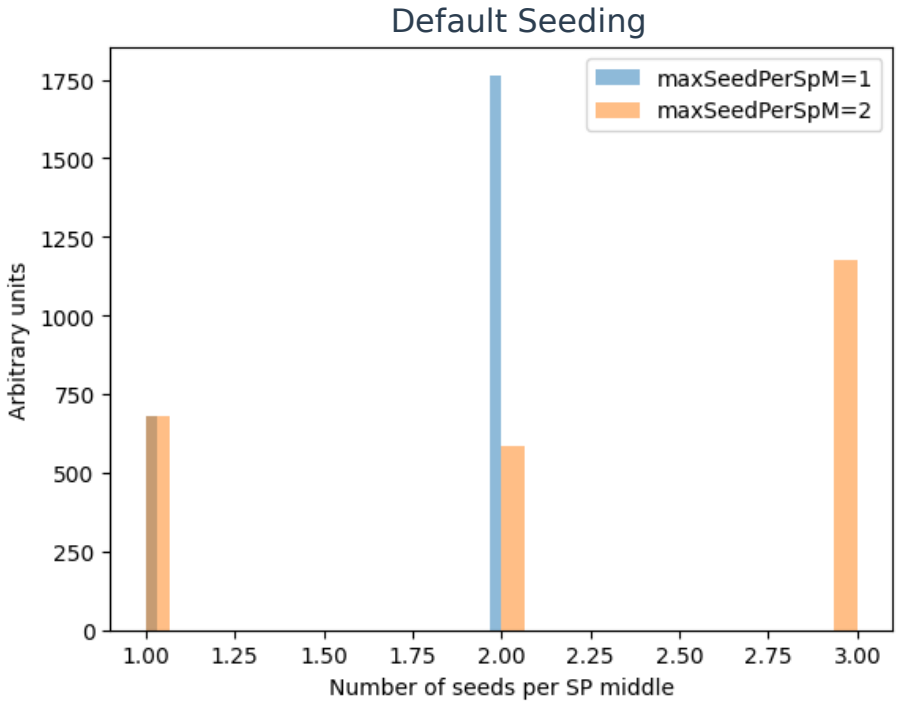
Generic Detector: SP buckets

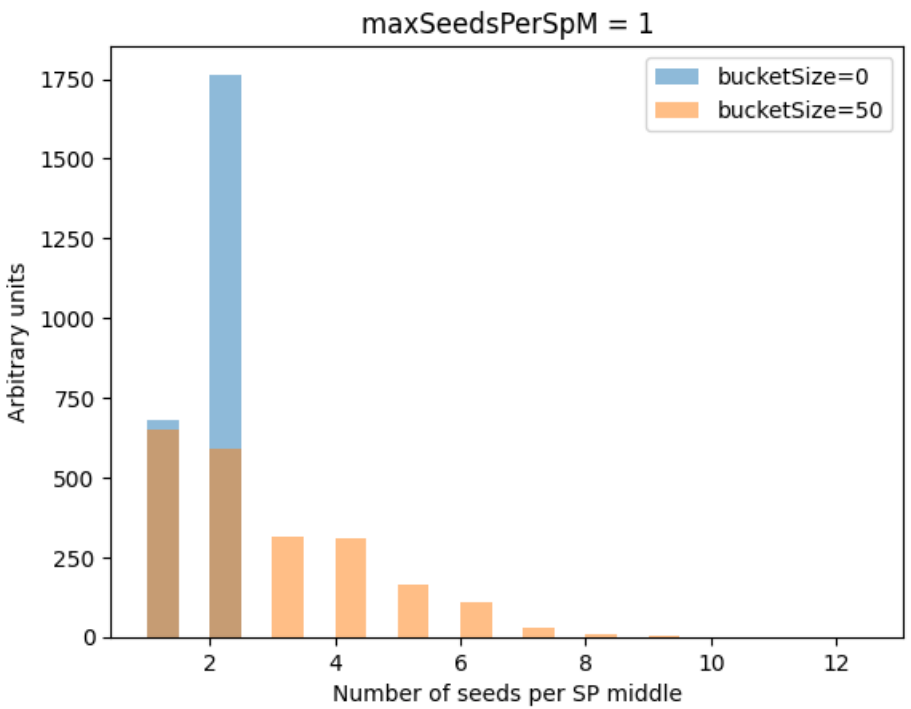


Space points position:

➡ Hashing currently uses only Pixel Space Points

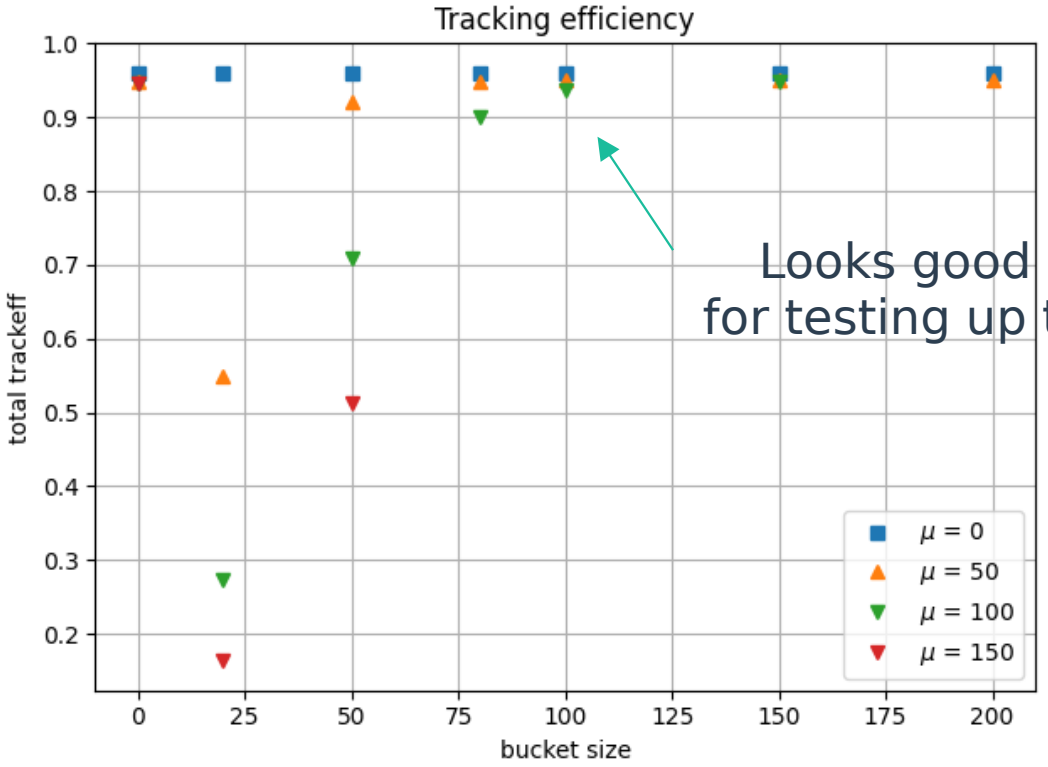
MaxSeedsPerSpM cut





➡ Hashing get through the cut

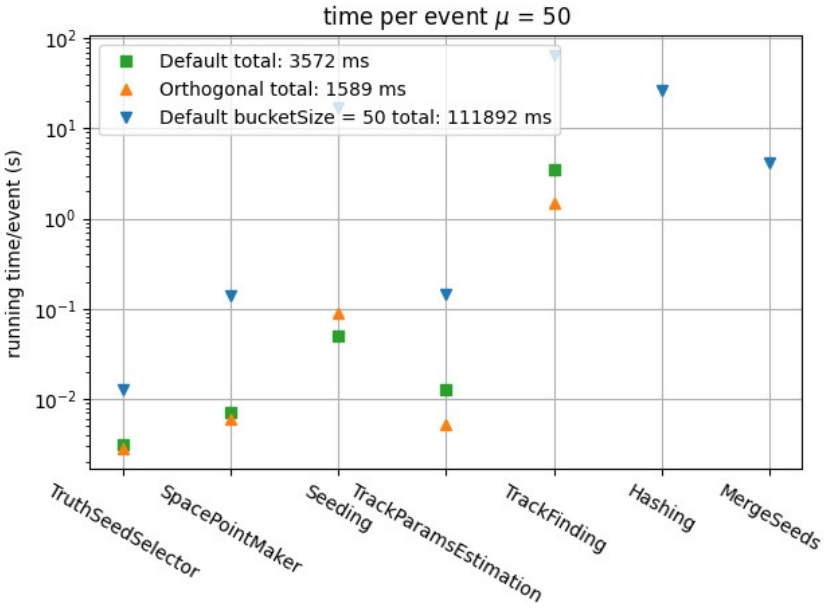
Optimal bucket size



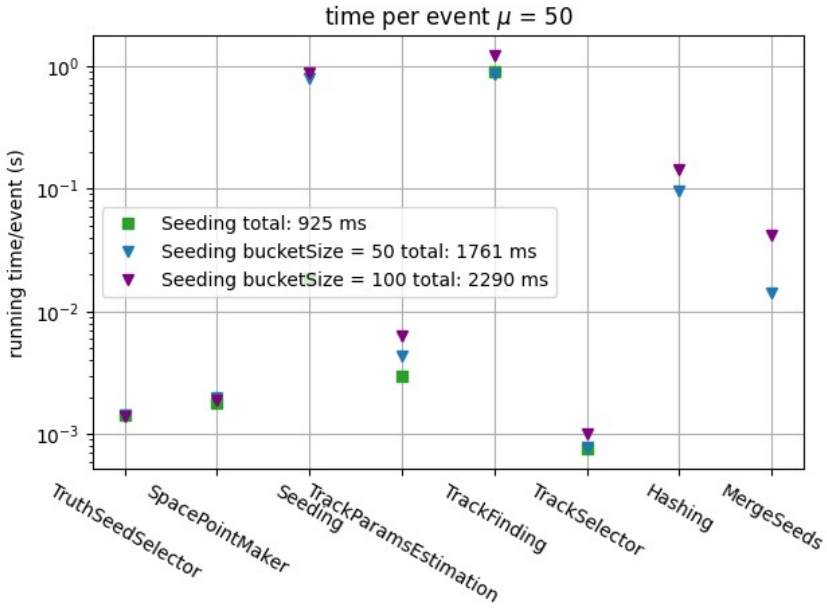
Looks good enough
for testing up to μ = 100

Recent speedups

Before



After



Changed from |η| <= 2.5
to |η| <= 4
→ SPGrid zBinSize increased

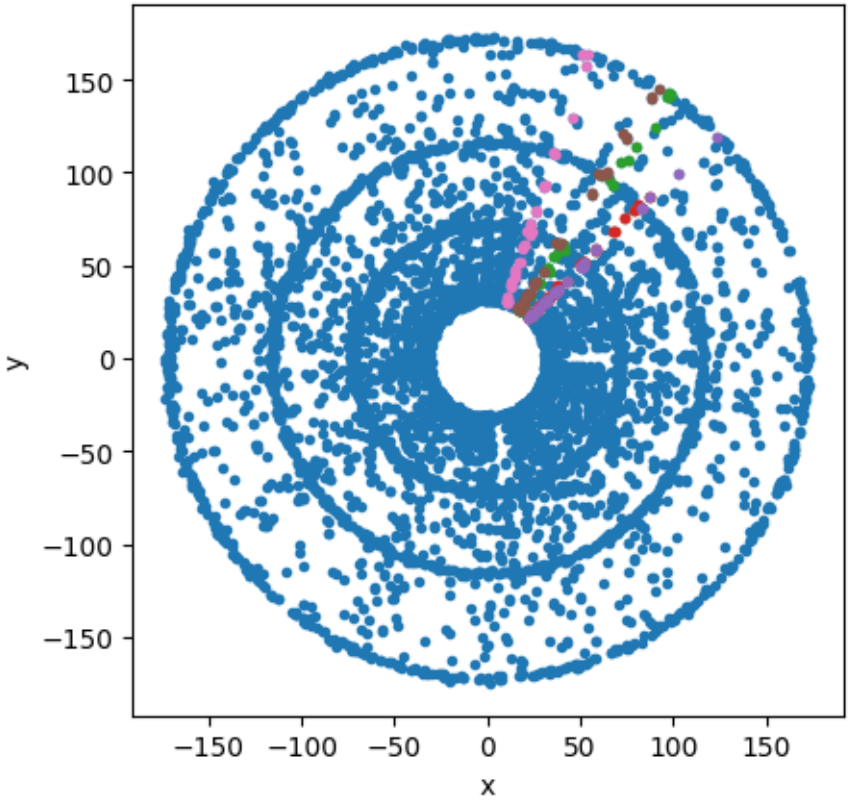
High speedup from removing Identical buckets

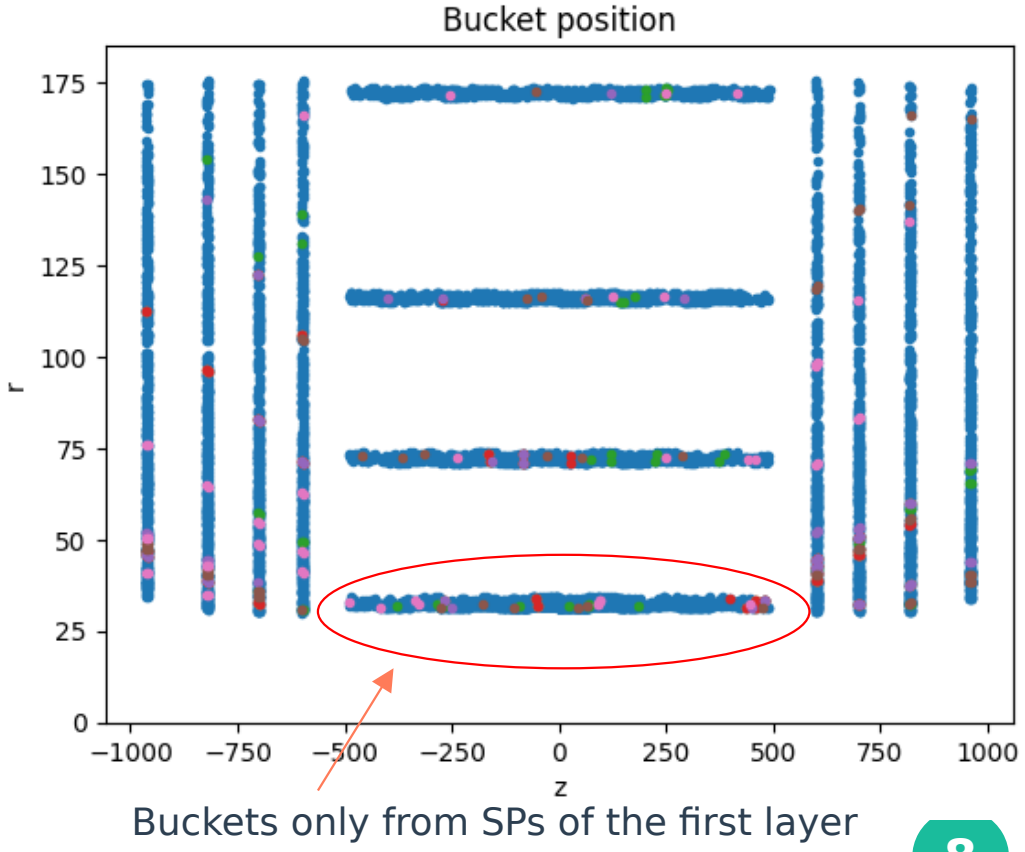
Use only SPs from layer 0 to create the buckets

Default configuration

Hashing only from Space Points of layer 0
Mu = 50
Bucket Size = 100
MaxSeedsPerSpM = 1
Generic Detector
|η| <= 4

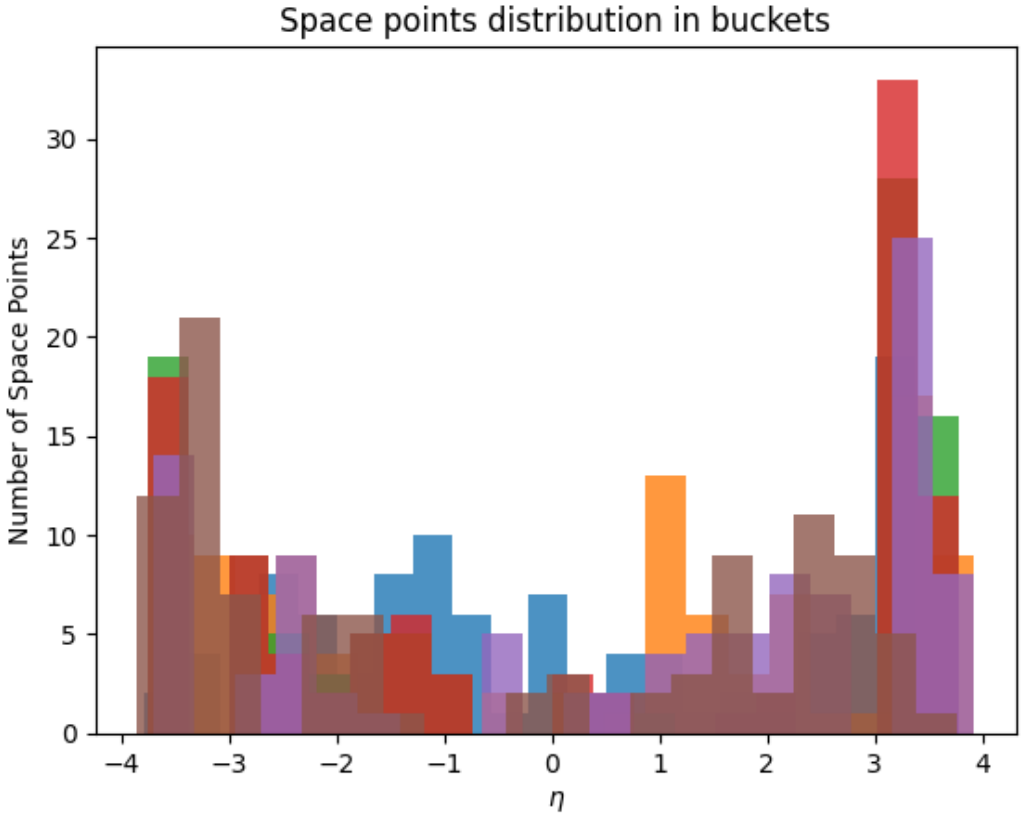
Bucket position: phi



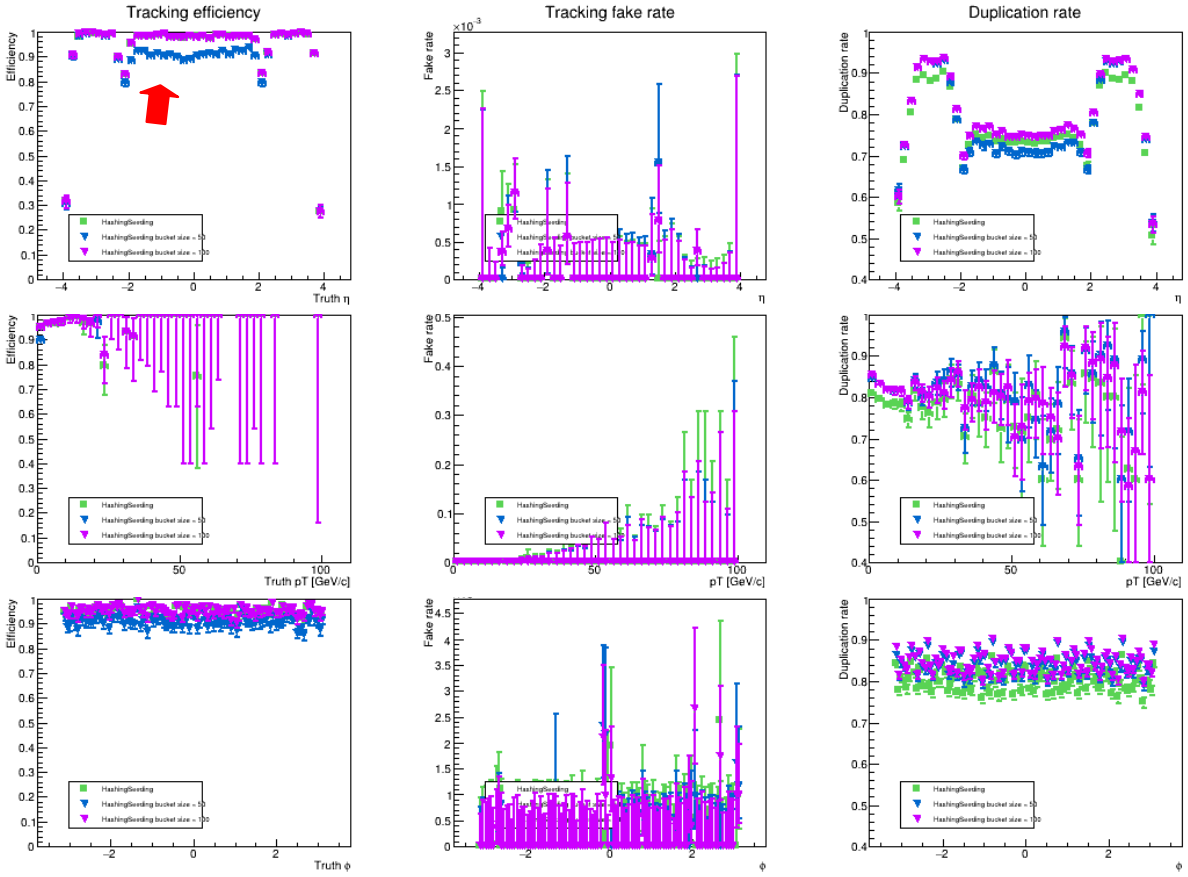


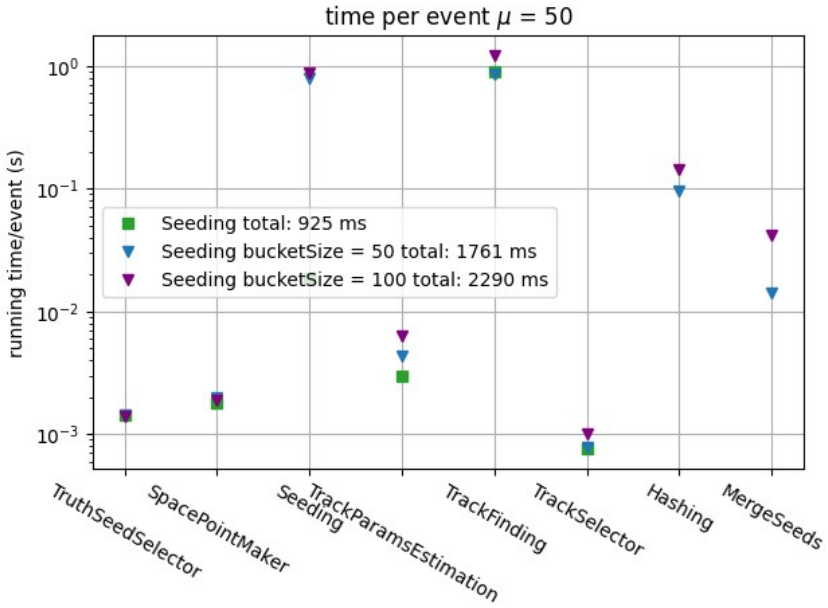
Buckets only from SPs of the first layer

Eta of buckets

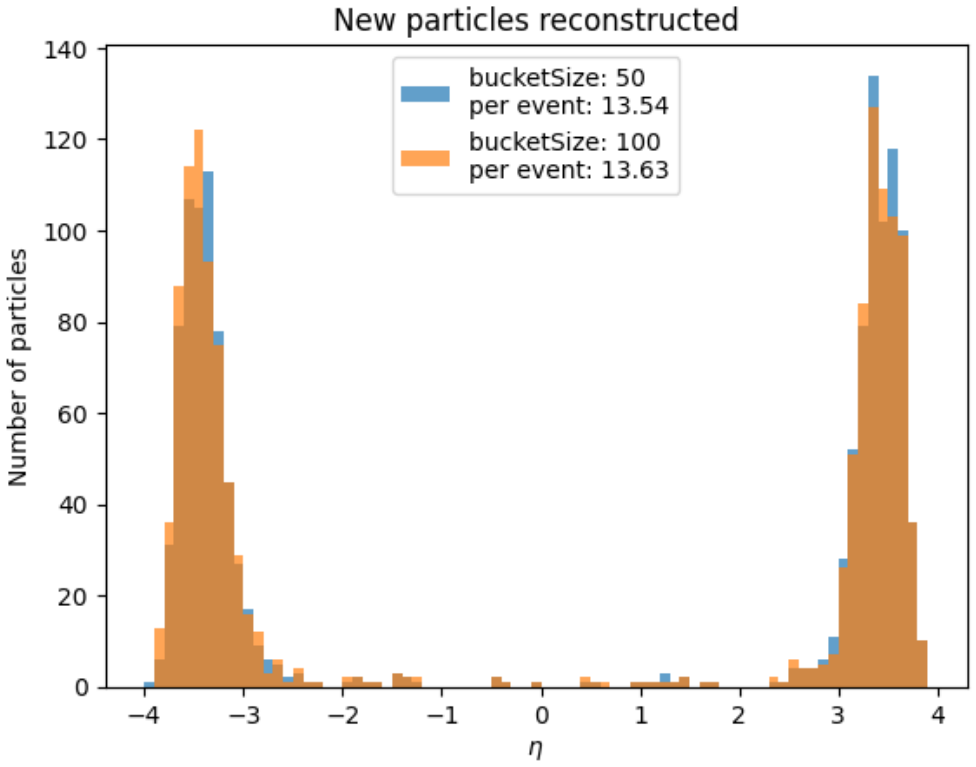


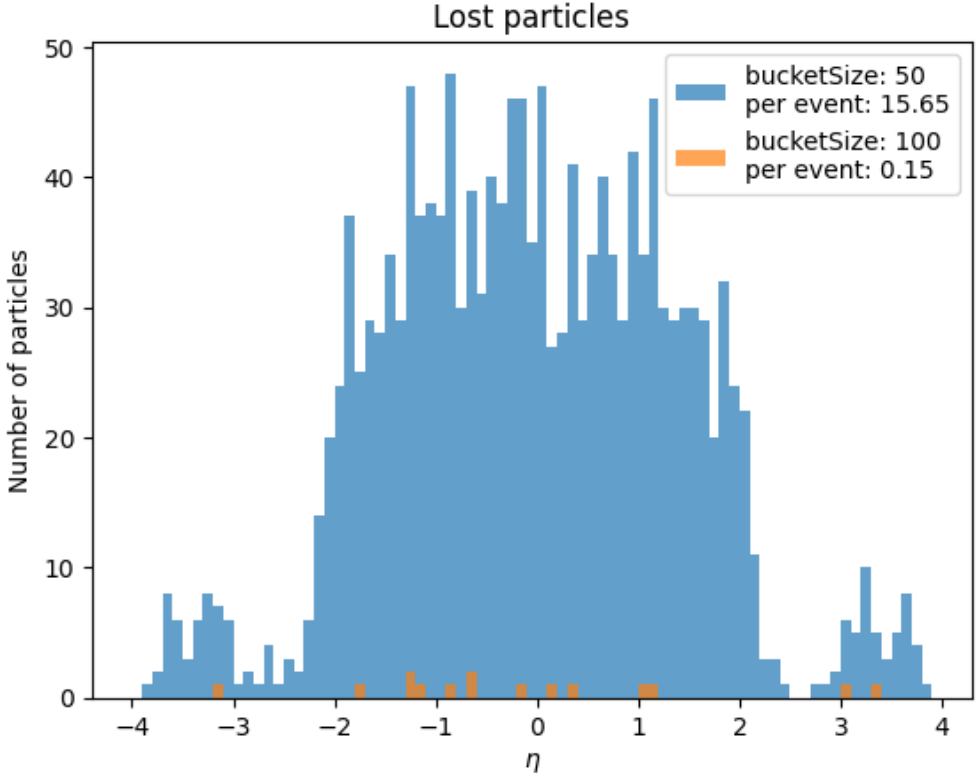
Performances μ = 50



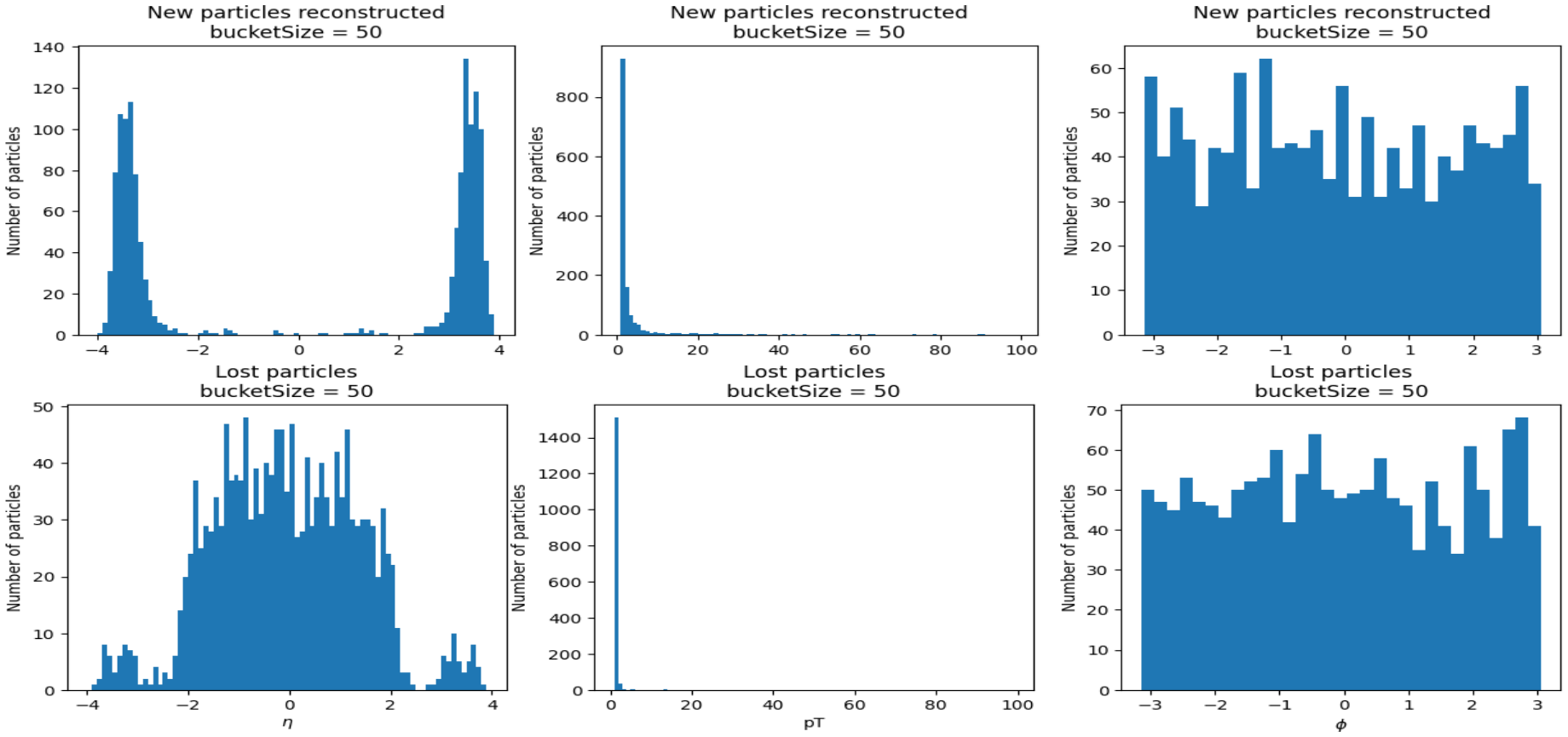


Bucket size effect

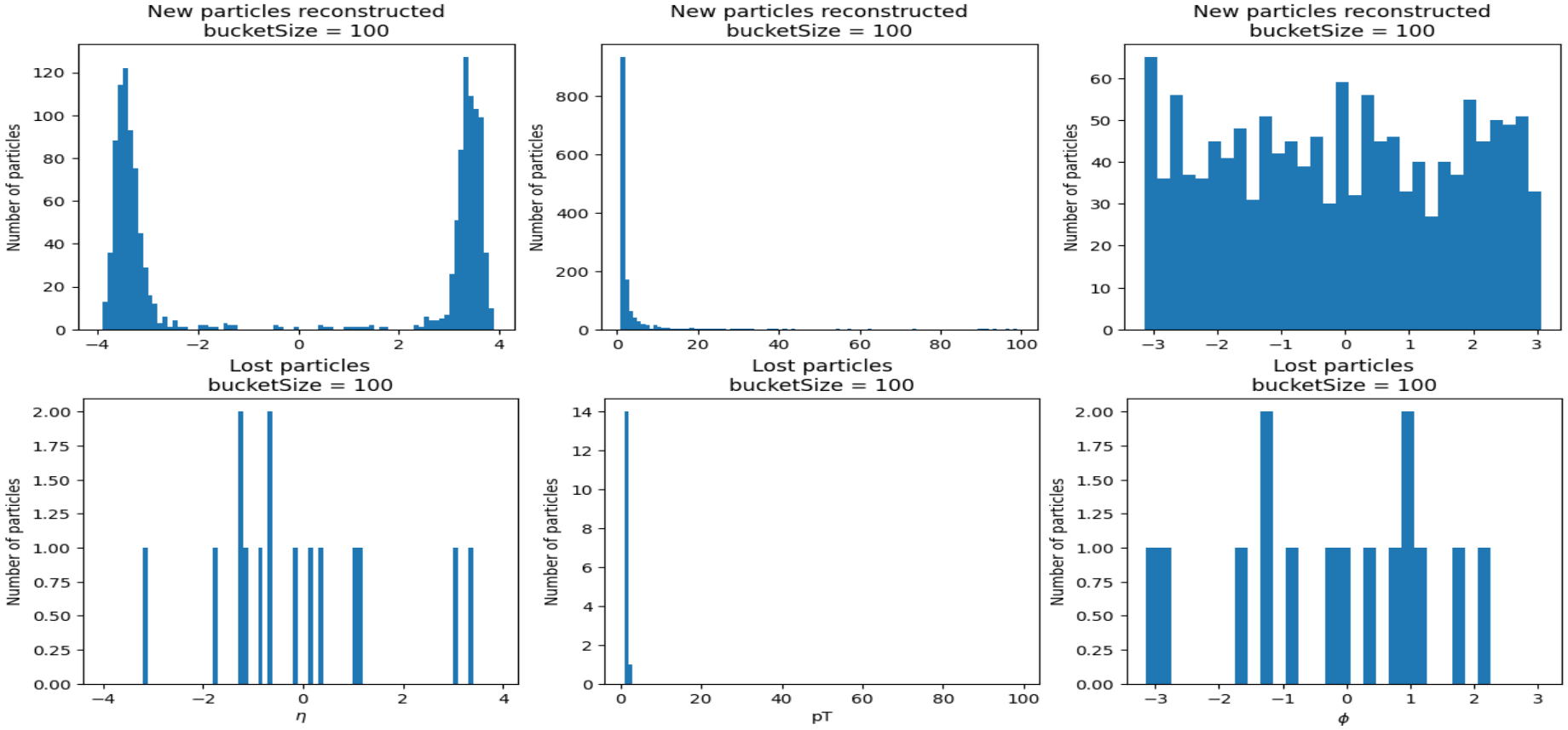




Reconstructed particles: bucketSize 50



Reconstructed particles: bucketSize 100

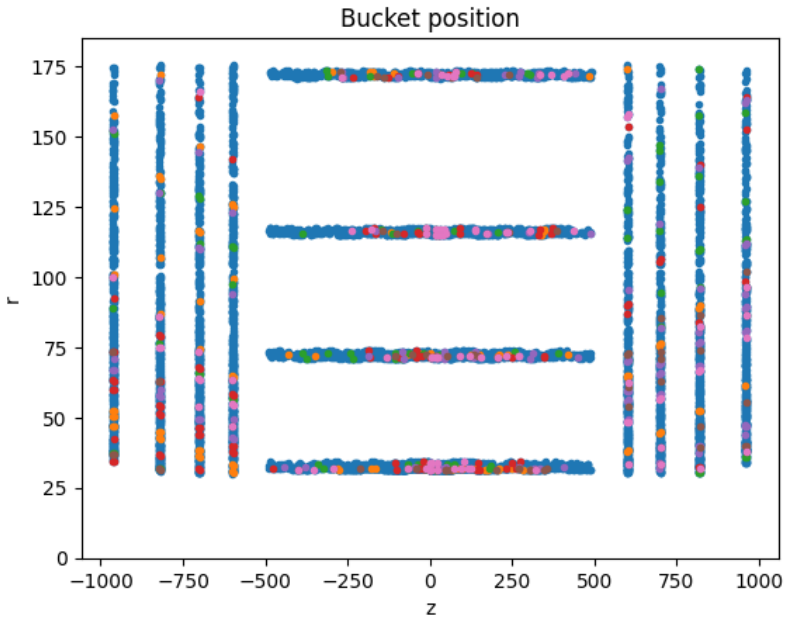


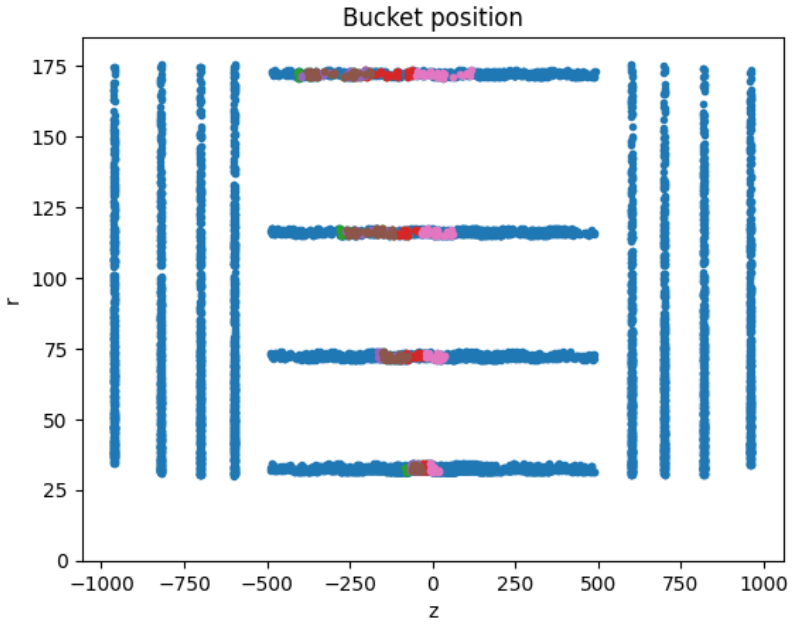
Other metric: ΔR

Angular: Δφ

$\Delta R = \sqrt{(\Delta\varphi^2 + \Delta\eta^2)}$

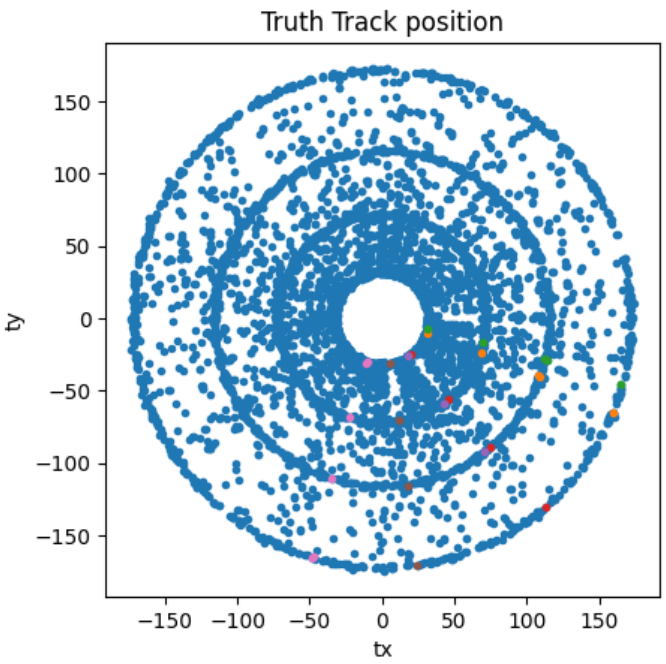
If $\Delta\varphi > \pi$:
$\Delta\varphi = 2*\pi - \Delta\varphi$



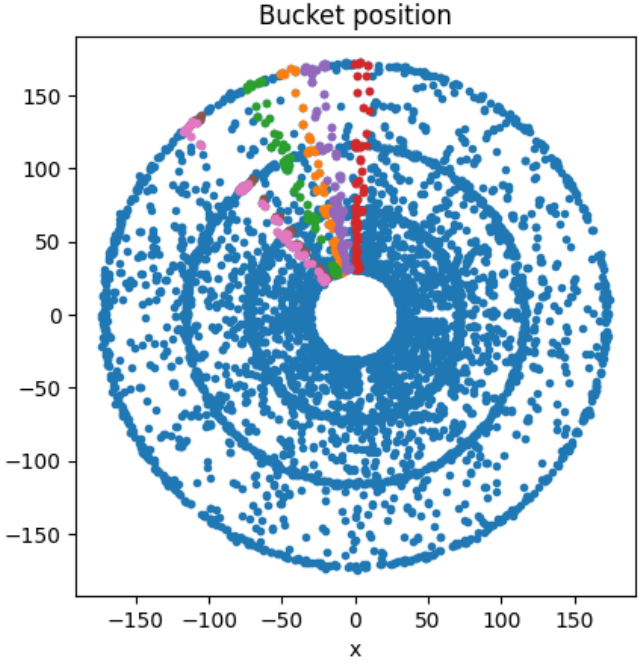


Comparison x y plan

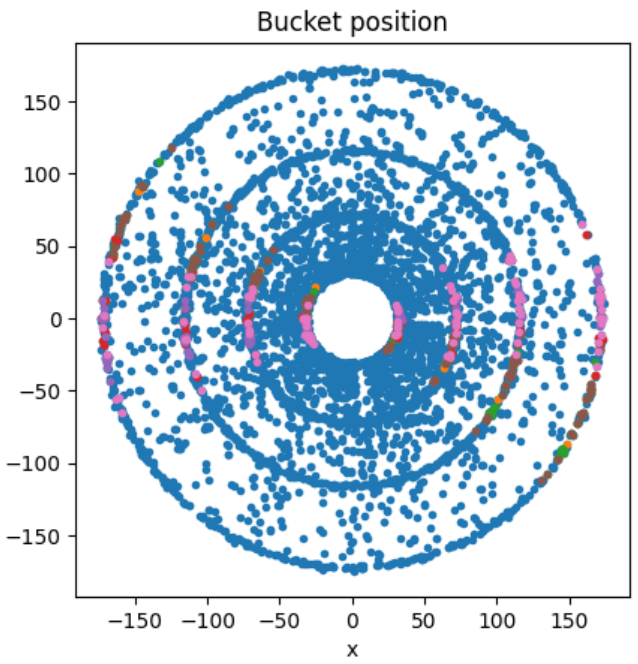
Truth Tracks (hits)



Angular: Δφ

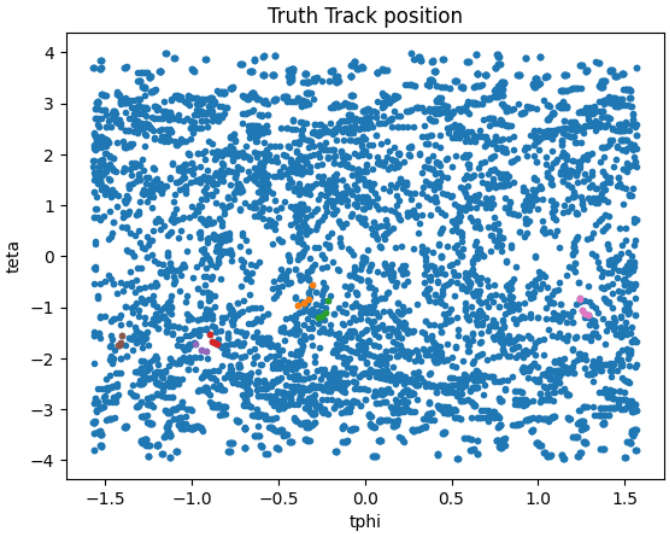


ΔR

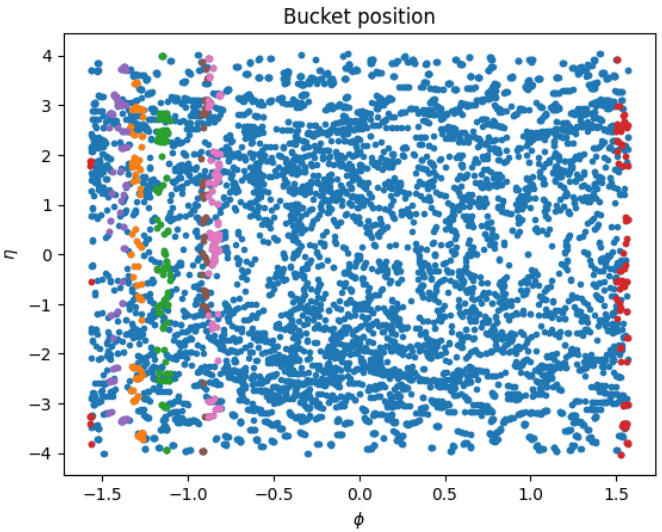


Comparison phi eta plan

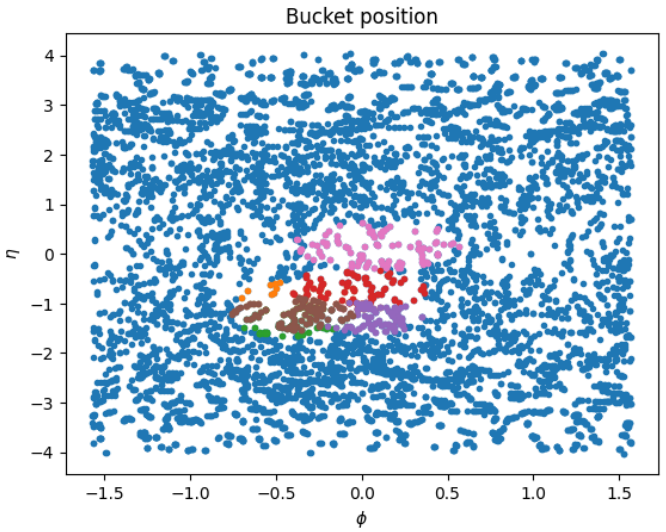
Truth Tracks (hits)



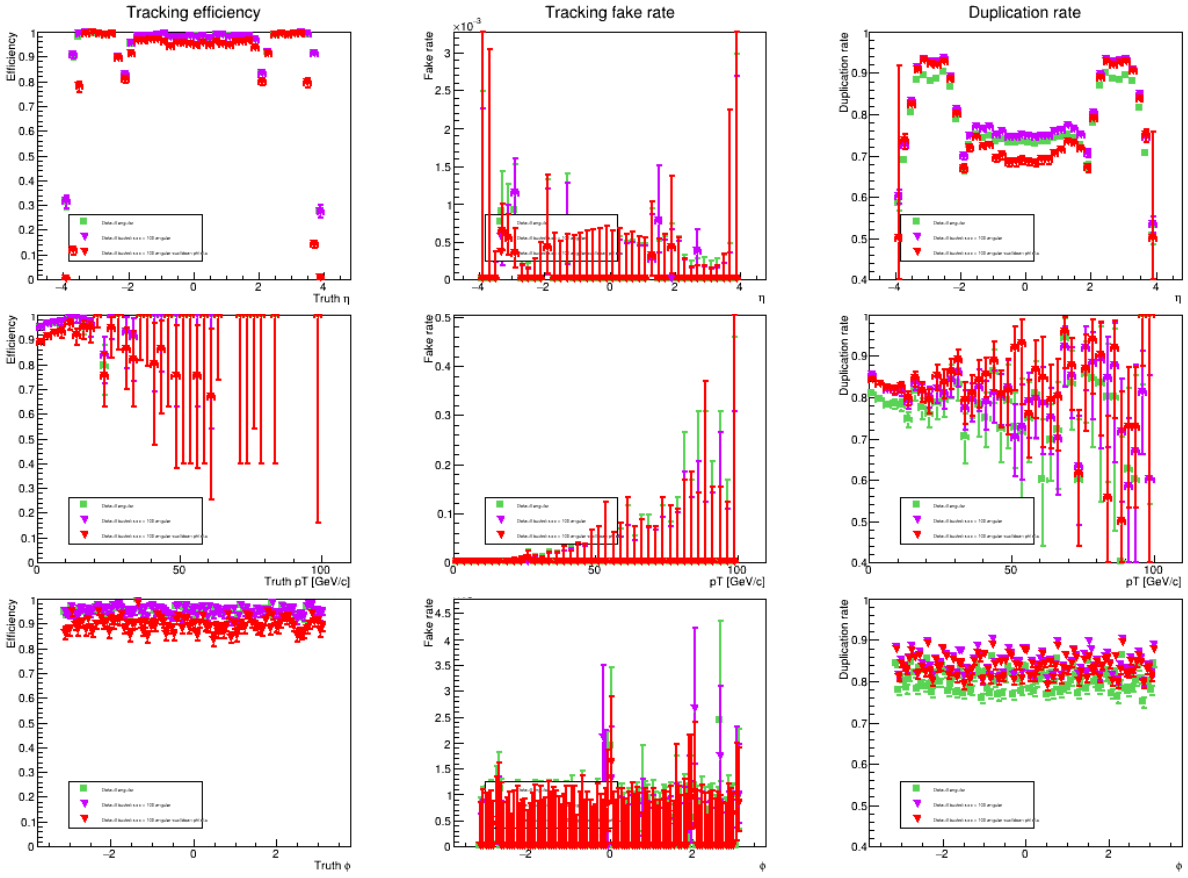
Angular: Δφ

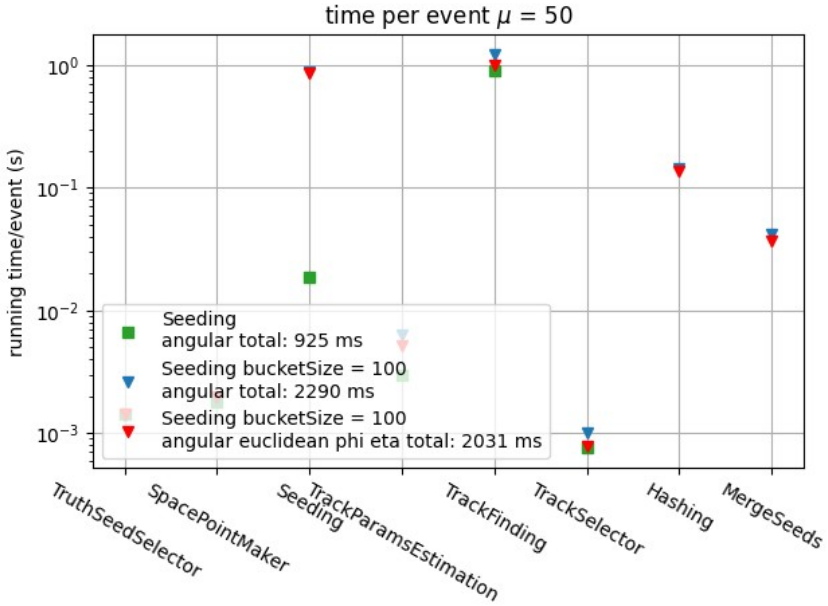


ΔR



Performances μ = 50 comparison





Conclusion

- **Hashing huge speedup: now ~2x Default time**
- **Hashing get through MaxSeedsPerSpM cut**
- **New particles are in the forward region**

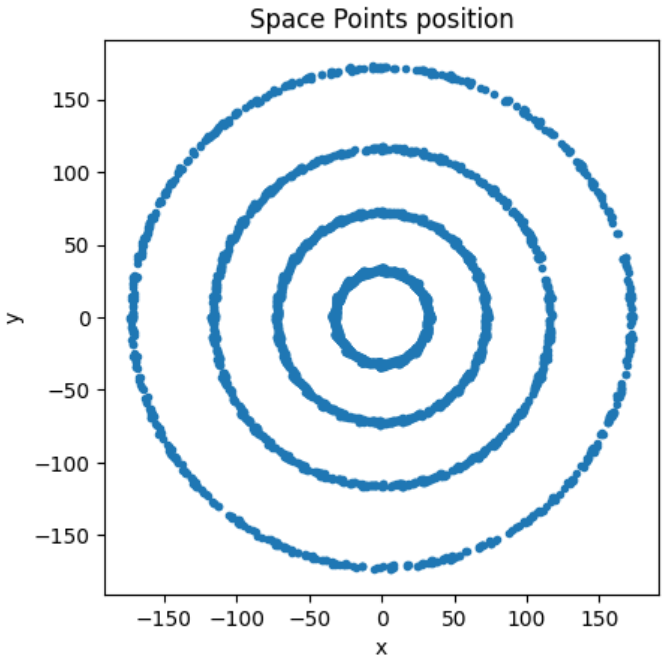
What’s next?

- **Test other metrics**
- **Make the seeding algorithm create seeds only once**
- **Reduce the number of buckets using overlaps**
  Split between η < 0 and η > 0?
- **Use different bucket size in center and forward regions**

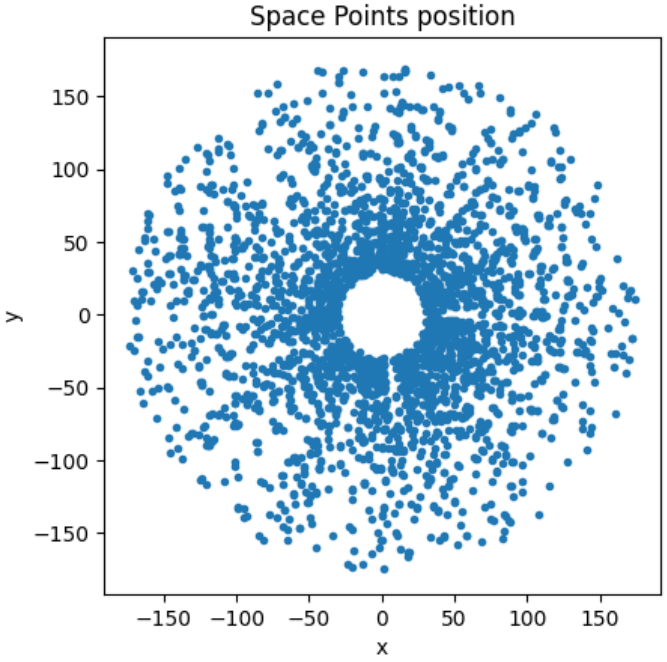
Backup

Space point position

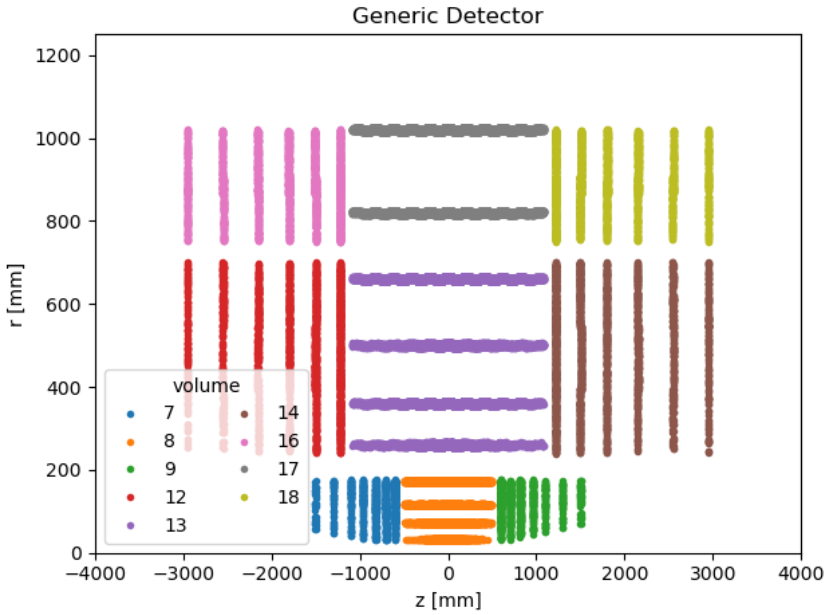
Barrel



Rings



Generic Detector volumes



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volumeID=vol=2: { { { BeamPipe::Barrel | { Pixel::NegativeEndcap | Pixel::Barrel | Pixel::PositiveEndcap } } | PST::Barrel } | { SStrip::NegativeEndcap | SStrip::Barrel | SStrip::PositiveEndcap } }
volumeID=vol=3: { { BeamPipe::Barrel | { Pixel::NegativeEndcap | Pixel::Barrel | Pixel::PositiveEndcap } } | PST::Barrel }
volumeID=vol=4: { BeamPipe::Barrel | { Pixel::NegativeEndcap | Pixel::Barrel | Pixel::PositiveEndcap } }
volumeID=vol=5: BeamPipe::Barrel
volumeID=vol=6: { Pixel::NegativeEndcap | Pixel::Barrel | Pixel::PositiveEndcap }
volumeID=vol=7: Pixel::NegativeEndcap
volumeID=vol=8: Pixel::Barrel
volumeID=vol=9: Pixel::PositiveEndcap
volumeID=vol=10: PST::Barrel
volumeID=vol=11: { SStrip::NegativeEndcap | SStrip::Barrel | SStrip::PositiveEndcap }
volumeID=vol=12: SStrip::NegativeEndcap
volumeID=vol=13: SStrip::Barrel
volumeID=vol=14: SStrip::PositiveEndcap
volumeID=vol=15: { LStrip::NegativeEndcap | LStrip::Barrel | LStrip::PositiveEndcap }
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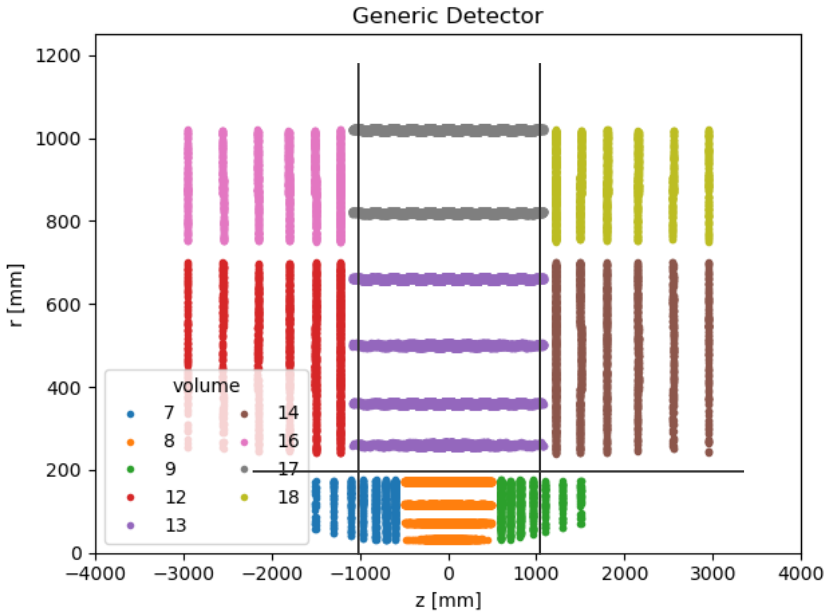
volumeID=vol=18: LStrip::PositiveEndcap

https://github.com/acts-project/acts/issues/946#issuecomment-900504099

Generic Detector: Space point formation



SP formation on geometry:

[{"layer": 2,"volume": 8},
{"layer": 4,"volume": 8},
{"layer": 6,"volume": 8},
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{"layer": 4,"volume": 9},
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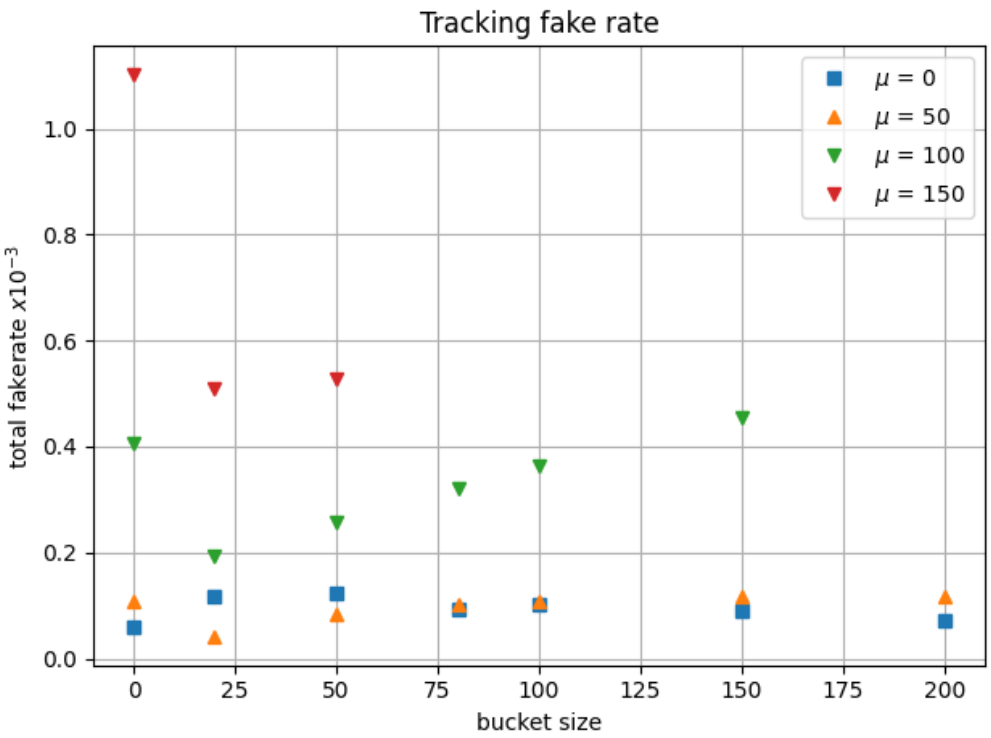
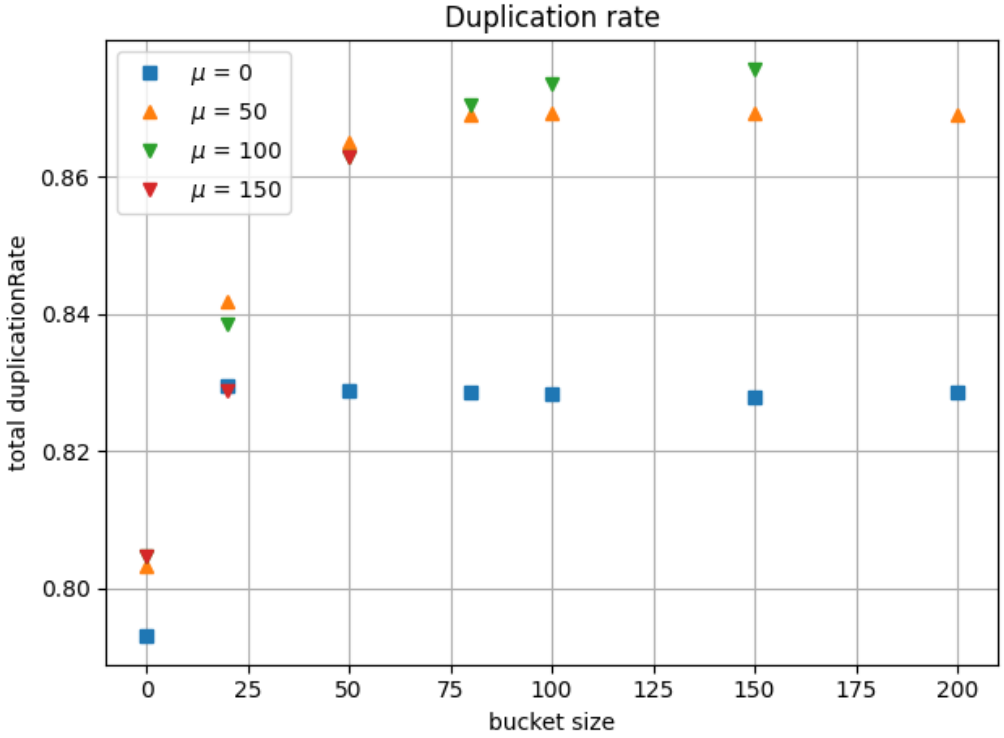
{"layer": 8,"volume": 9},
{"layer": 14,"volume": 7},
{"layer": 12,"volume": 7},
{"layer": 10,"volume": 7},
{"layer": 8,"volume": 7}]

geoSelection-genericDetector.json

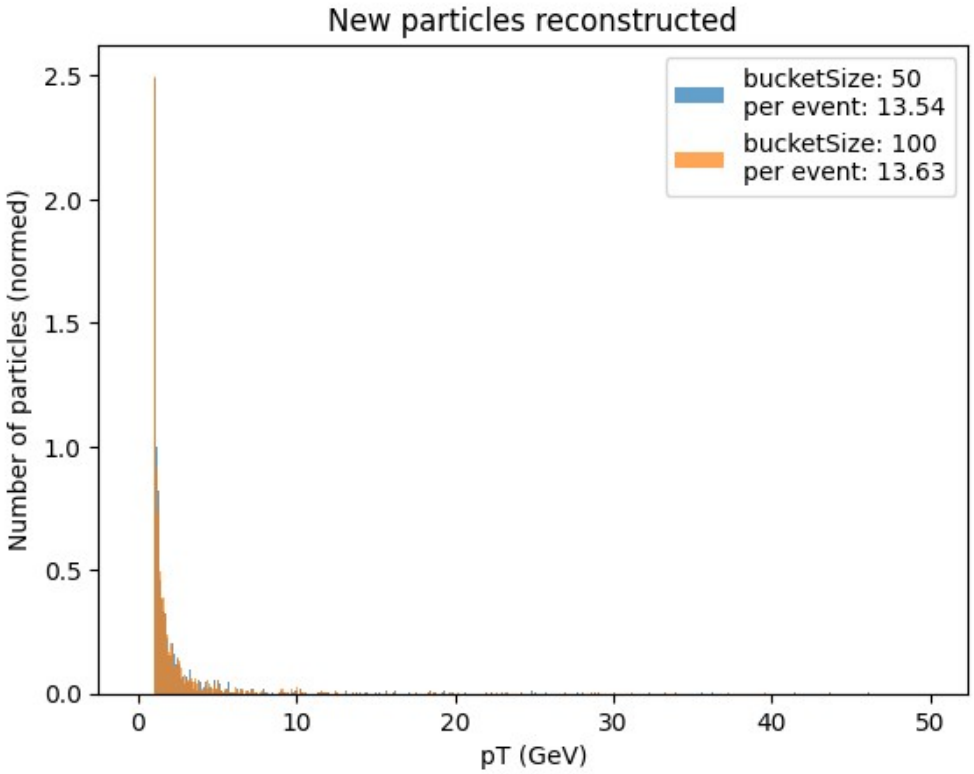
Layer numbering: 2 by 2, starts at 2; in a volume, increases from left to right and bottom to top

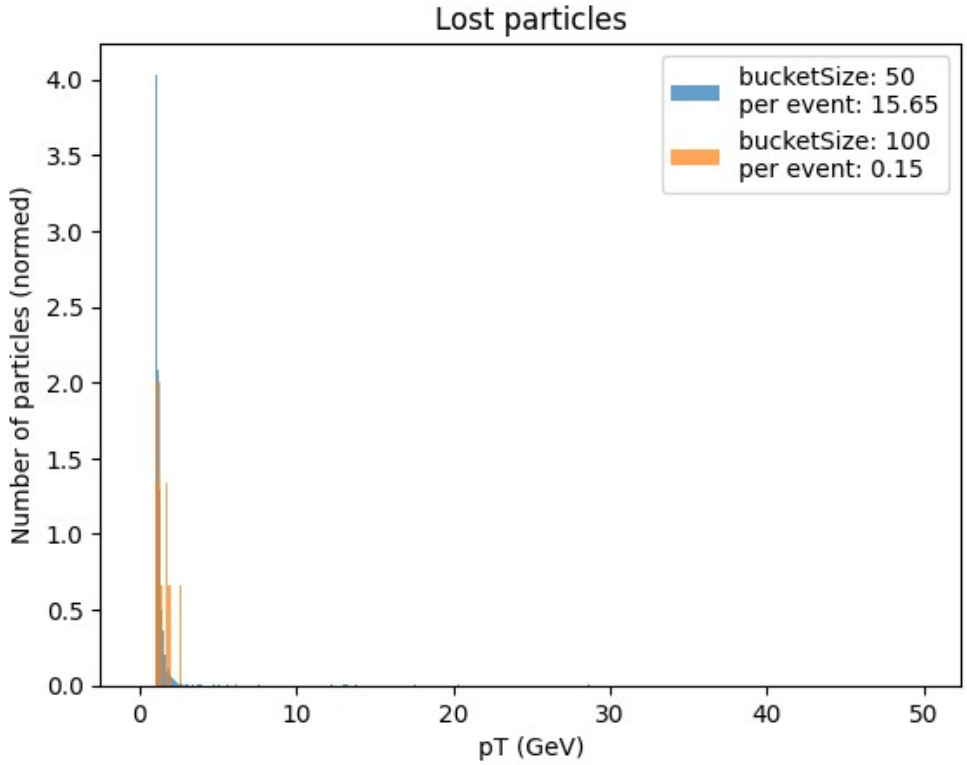
Optimal bucket size (2)





reconstructed particles pT





Mean eta bucket