Origin of seeding inefficiencies at low momentum

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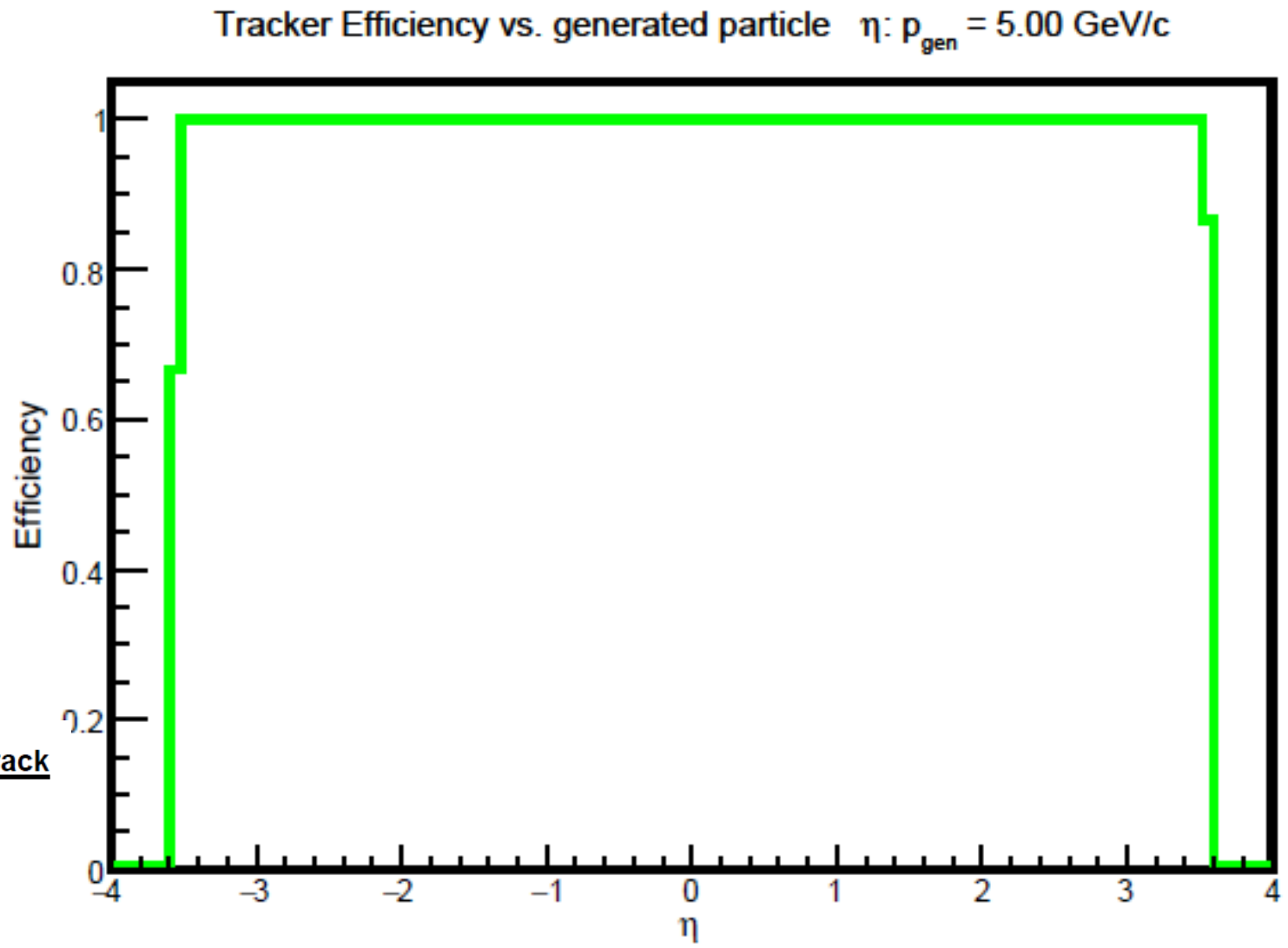
Good seeding and tracking efficiency seen at higher momentum

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

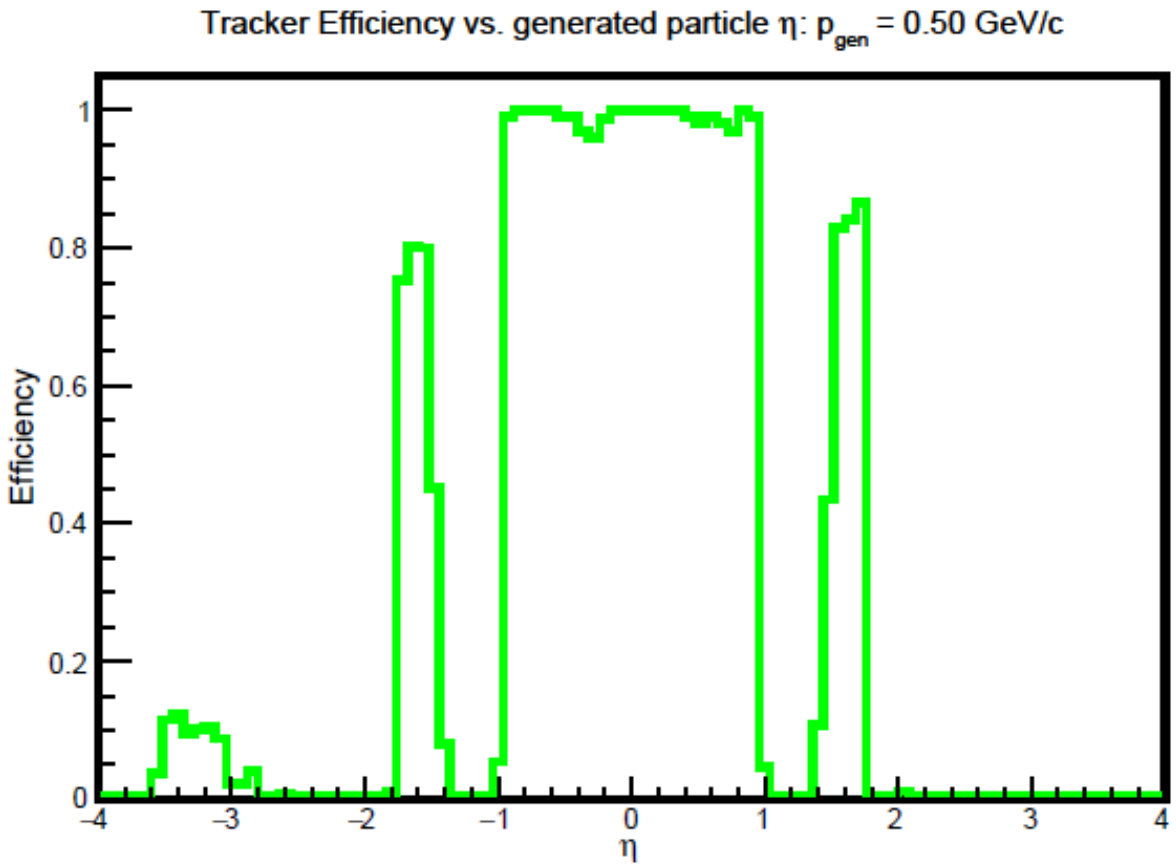
Efficiency in each η_{gen} bin = $\frac{\text{Number of events w/ at least 1 track}}{\text{Number of events}}$



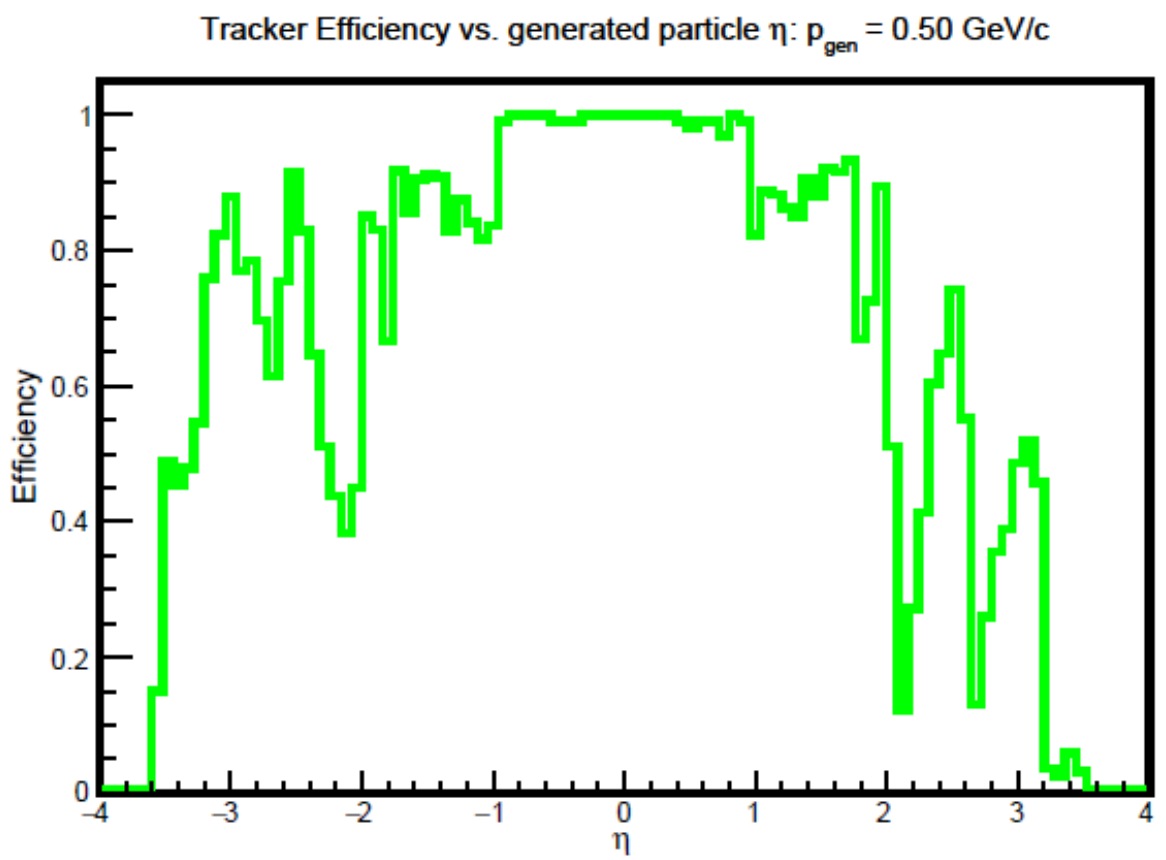
Efficiency at low momentum

10k single negative muons
Eta = [-4,4], Phi = [0,2Pi]
P = 500 MeV/c
(vx,vy,vz) = (0,0,0)

Default *deltaPhiMax* parameter = 0.085



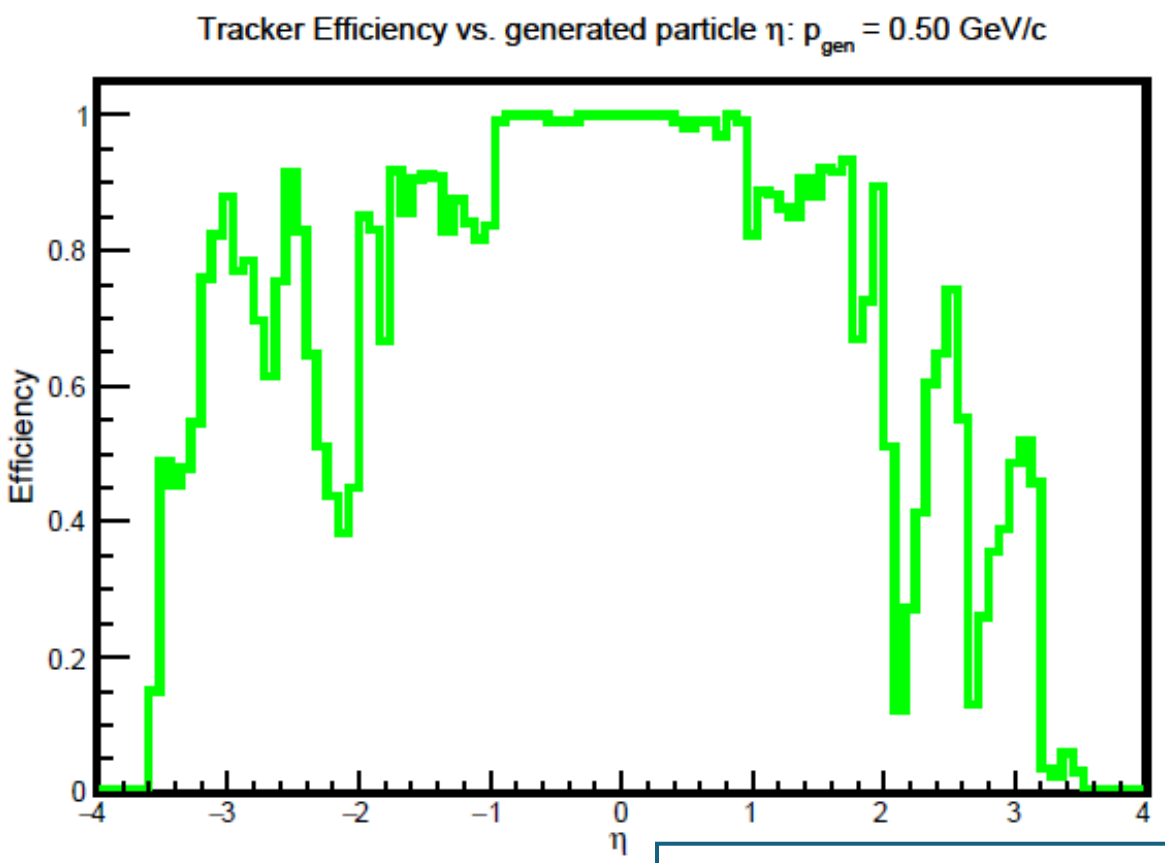
Modified *deltaPhiMax* parameter = 0.16



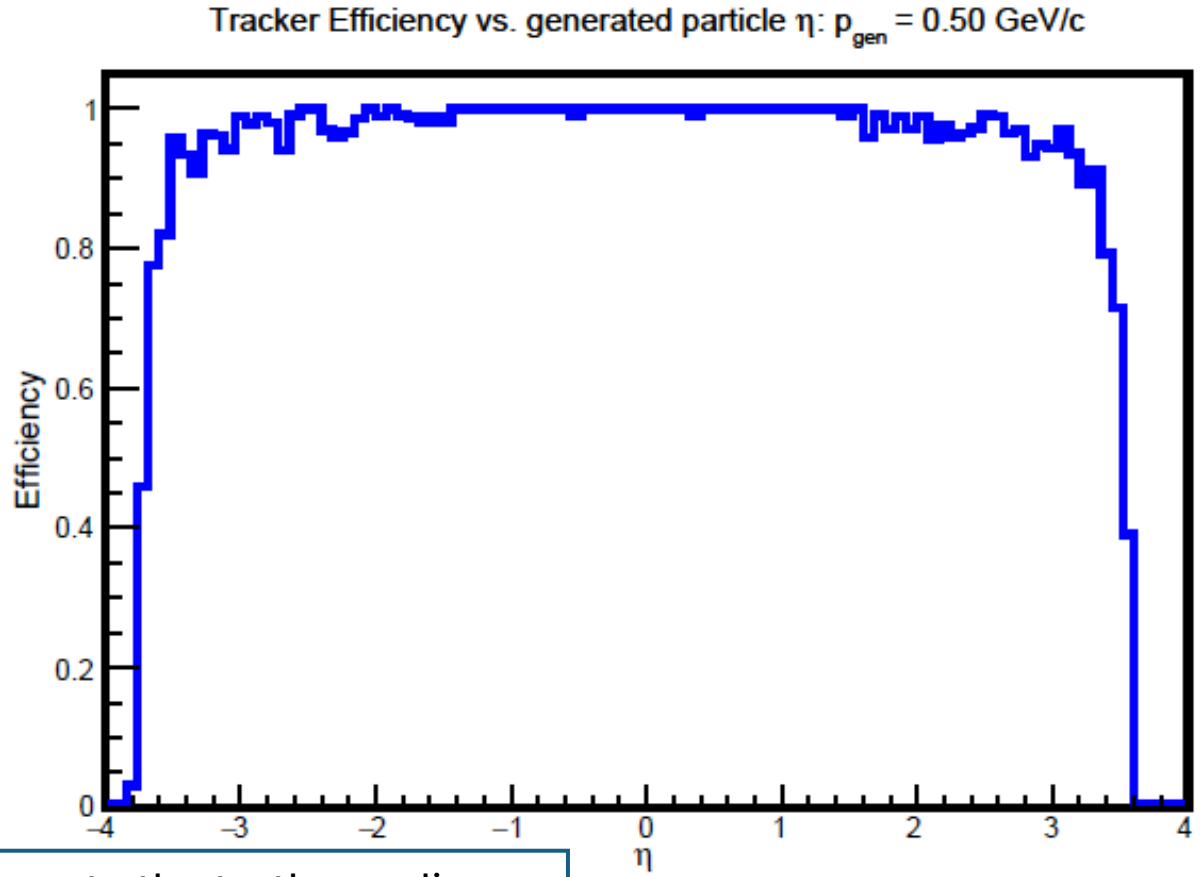
Efficiency at low momentum

10k single negative muons
Eta = [-4,4], Phi = [0,2Pi]
P = 500 MeV/c
(vx,vy,vz) = (0,0,0)

Modified *deltaPhiMax* parameter = 0.16



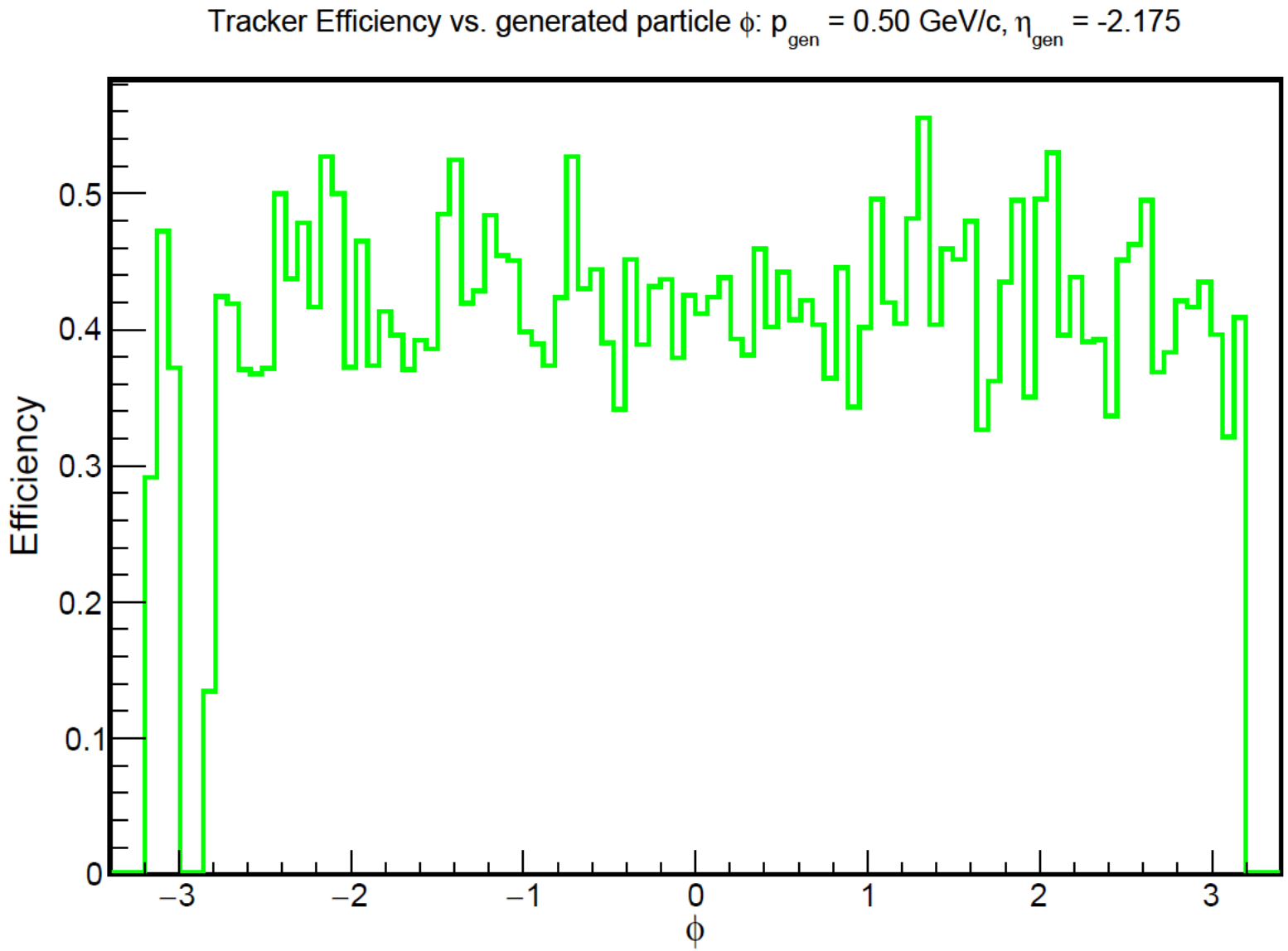
Truth-seeded track reconstruction with at least 3 measurement points used in track fit



We should be able to get close to the truth-seeding efficiency result with realistic seed finding

Test: Throw particles at fixed momentum and eta

10k single negative muon events
Eta = -2.175, Phi = [0,2Pi]
P = 500 MeV/c
(vx,vy,vz) = (0,0,0)



Test: Throw particles at fixed momentum and eta

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Eta = -2.175, Phi = [0,2Pi]
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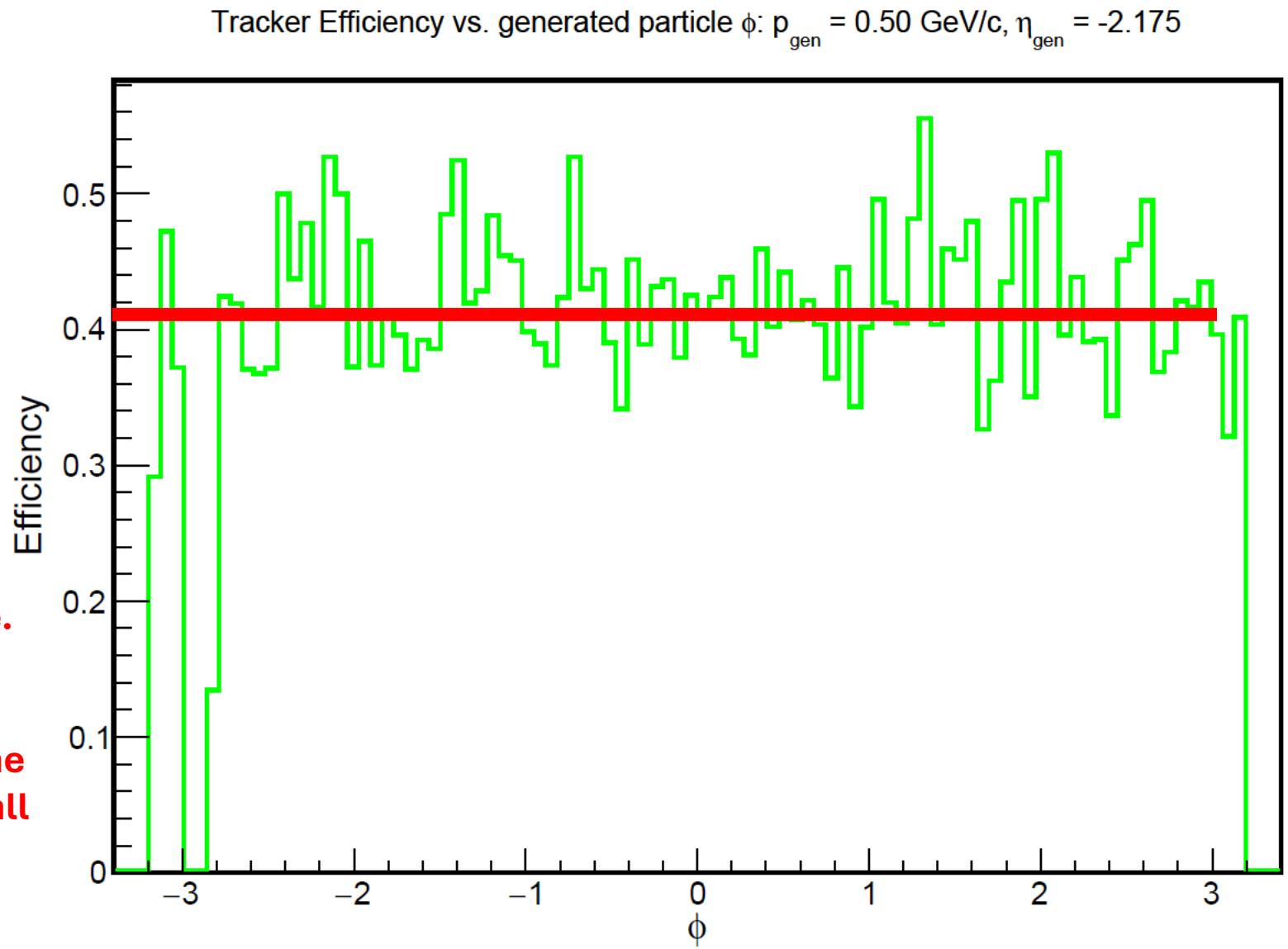
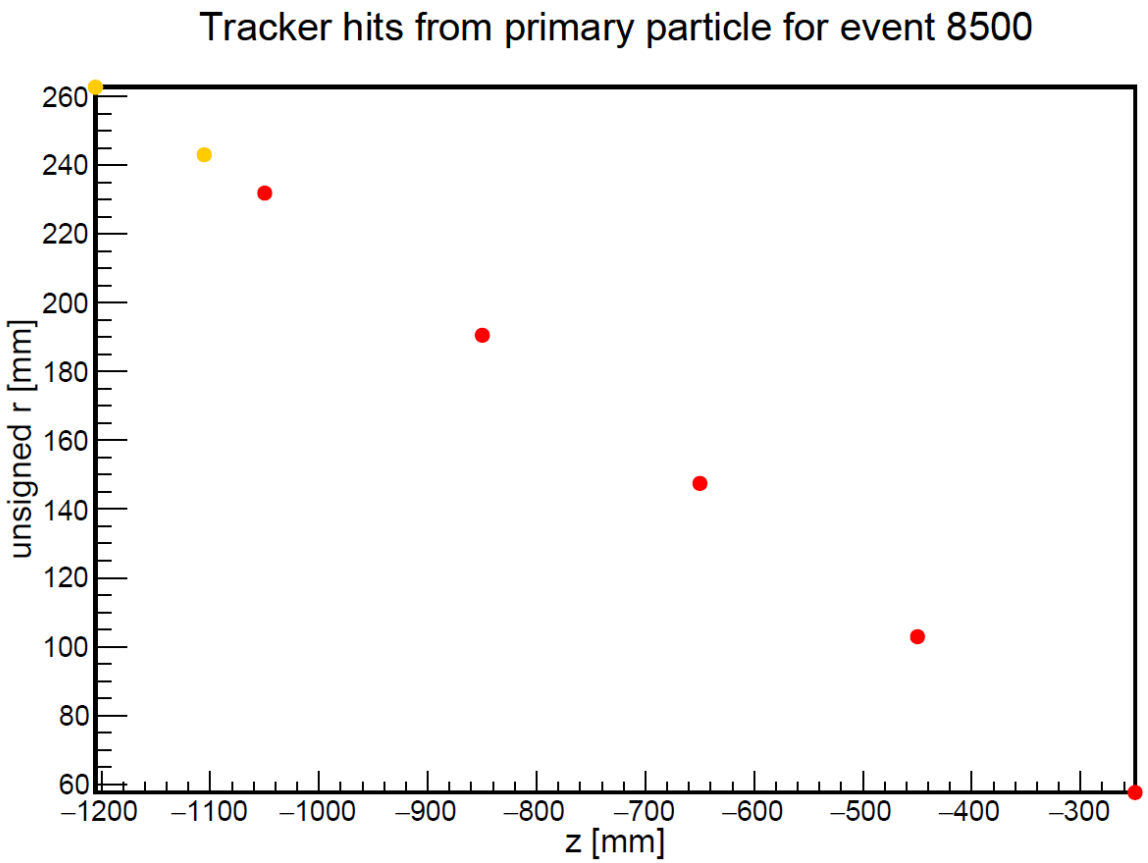
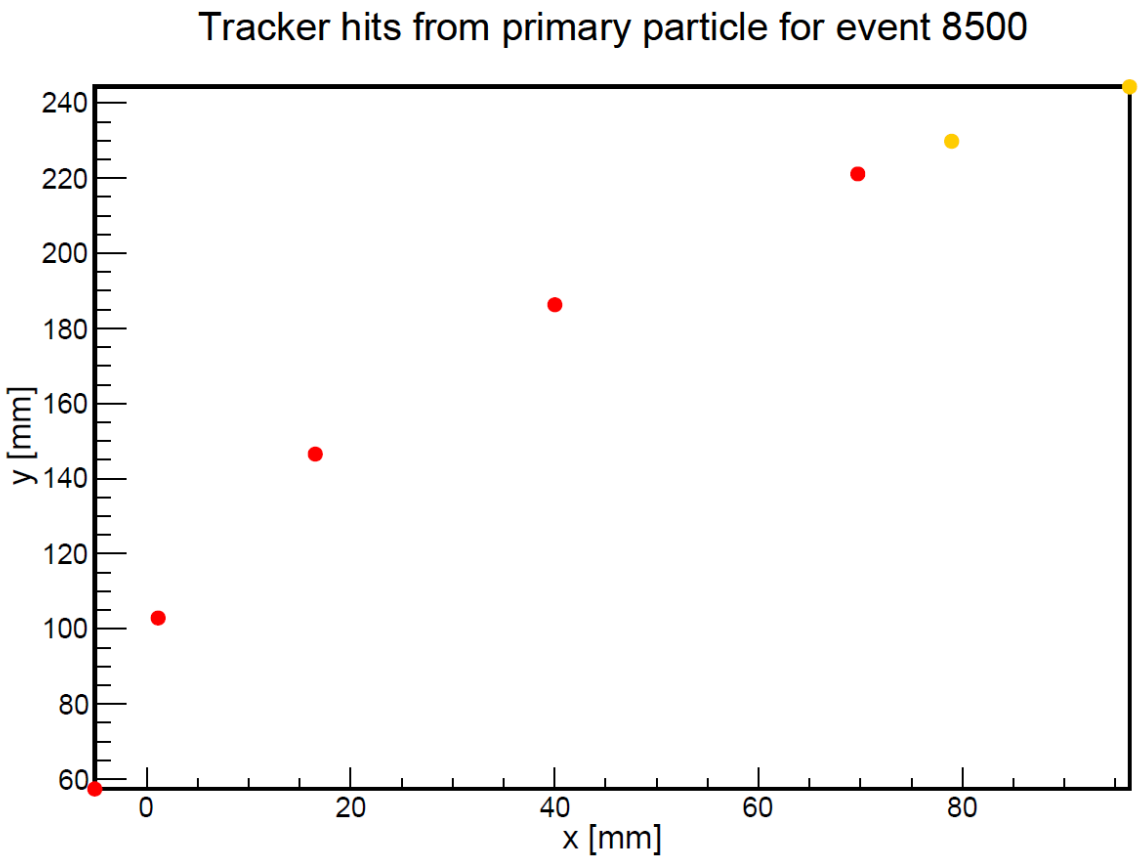


We see inefficiency over whole phi range.

Almost identical events can get different seeding results. This means there is some cut being applied that is sensitive to small fluctuations in detector hit positions.

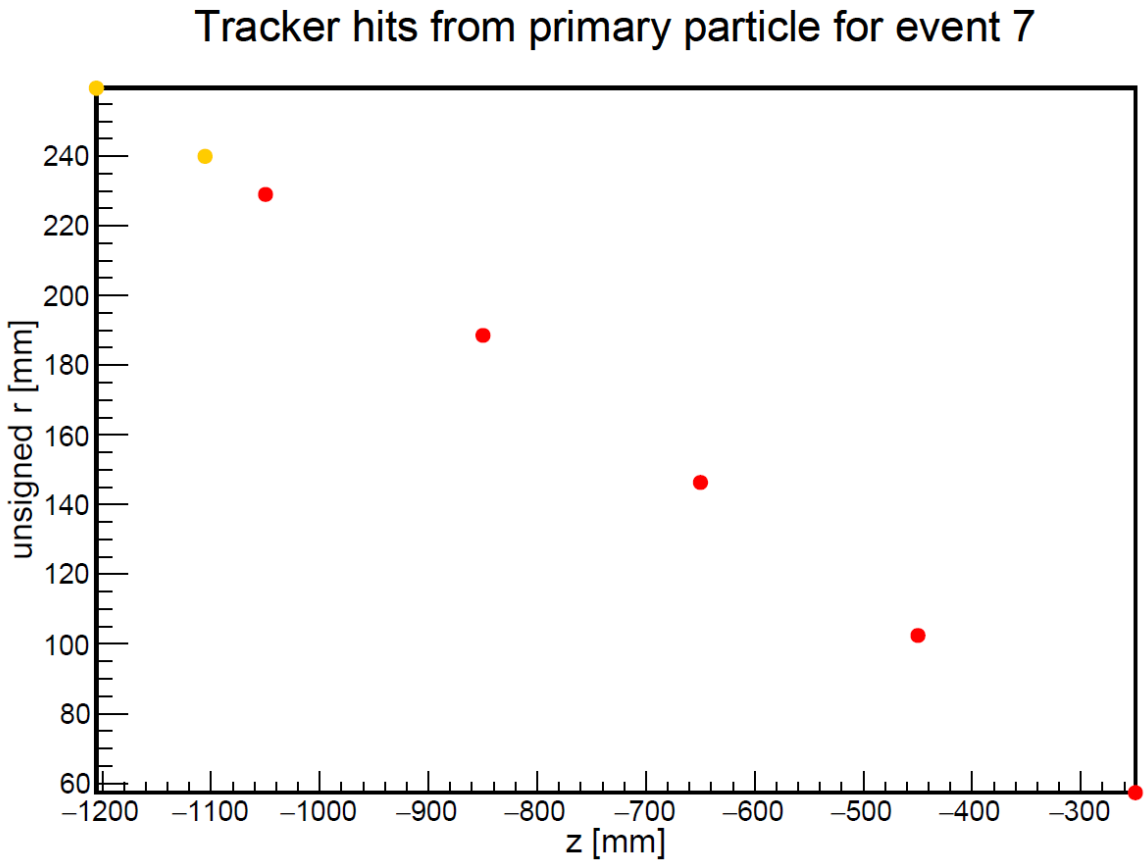
Example event: Forms one seed

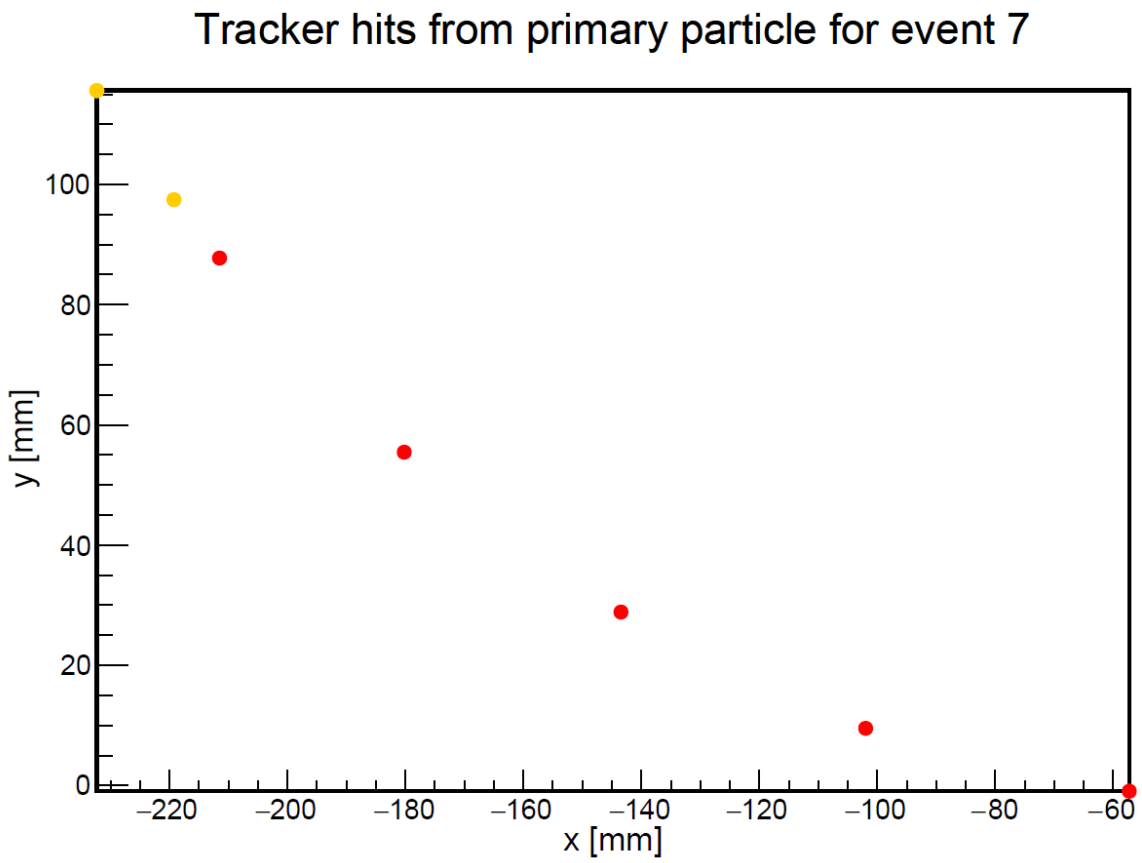




Single negative muon events
Eta = -2.175, P = 500 MeV/c
(vx,vy,vz) = (0,0,0)

Example event: Fails to form any seed





Single negative muon events
Eta = -2.175, P = 500 MeV/c
(vx,vy,vz) = (0,0,0)

Hardcoded cut in Acts Orthogonal seed finder

- There is a hardcoded cut in the Acts Orthogonal seed finder that is causing our failure to find seeds at low momentum for some particles.
- What is happening:
  - We have particles where valid bottom and top space point candidates are found around a middle space point (passing all doublet-level cuts including *validTuple*).
  - However, when *filterCandidates* attempts to combine these into triplets, all combinations are rejected by the hardcoded $|tanLM - tanMT| > 0.005$ angular consistency cut.
  - This cut is too tight for our geometry, where the bottom–middle and middle–top slopes can differ by more than 0.005 rad for low-momentum particles.

v46.0.0 acts / Core / include / Acts / Seeding / SeedFinderOrthogonal.ipp

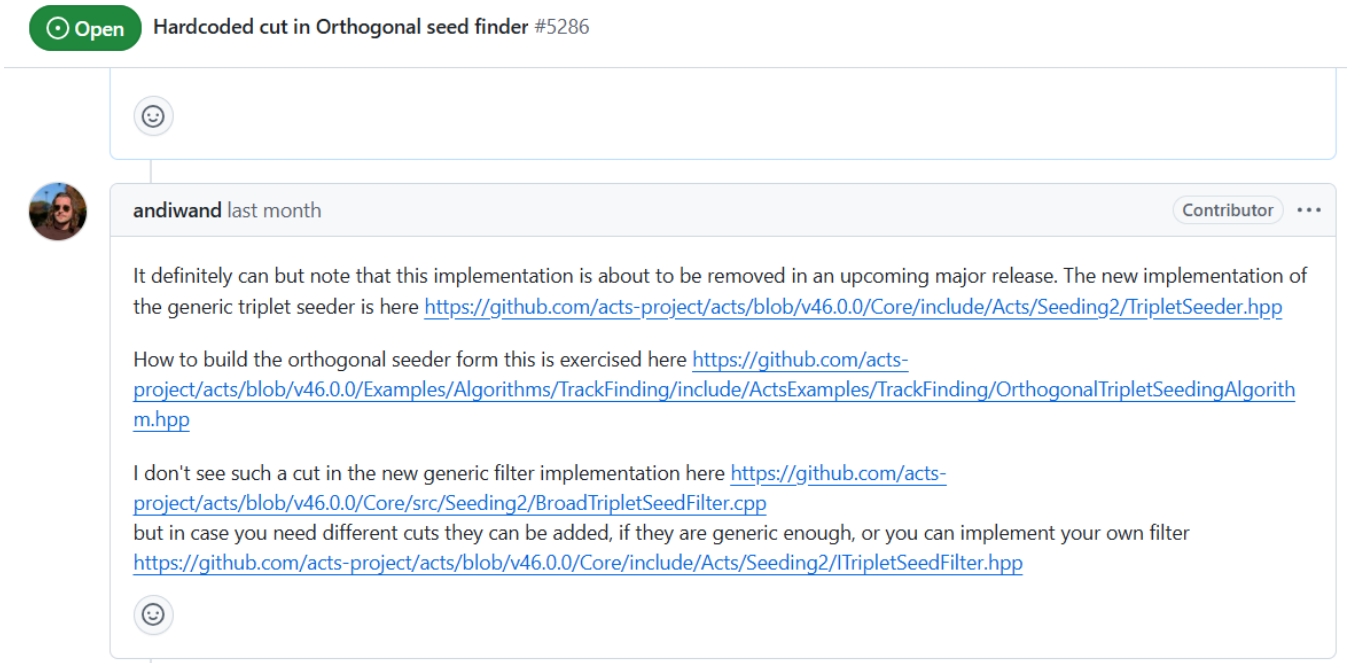
Code Blame 807 lines (702 loc) · 29.2 KB

```
362         }
363         if (m_config.seedConfirmation &&
364             candidates_collector.nHighQualityCandidates()) {
365           minCompatibleTopSPs++;
366         }
367
368         // clear all vectors used in each inner for loop
369         top_valid.clear();
370         curvatures.clear();
371         impactParameters.clear();
372
373         float tanLM = std::atan2(rM - bottom[b]->radius(), zM - bottom[b]->z());
374
375         for (std::size_t index_t = t0; index_t < numTopSP; index_t++) {
376           const std::size_t t = sorted_tops[index_t];
377           auto lt = linCircleTop[t];
378
379           if (std::abs(tanLM - tanMT[t]) > 0.005) {
380             continue;
381           }
```


https://github.com/acts-project/acts/blob/v46.0.0/Core/include/Acts/Seeding/SeedFinderOrthogonal.ipp

How to resolve this

Opened an Acts issue. The current implementation of the seeder we are using is deprecated. The new implementation does not have this hardcoded cut.



https://github.com/acts-project/acts/issues/5286

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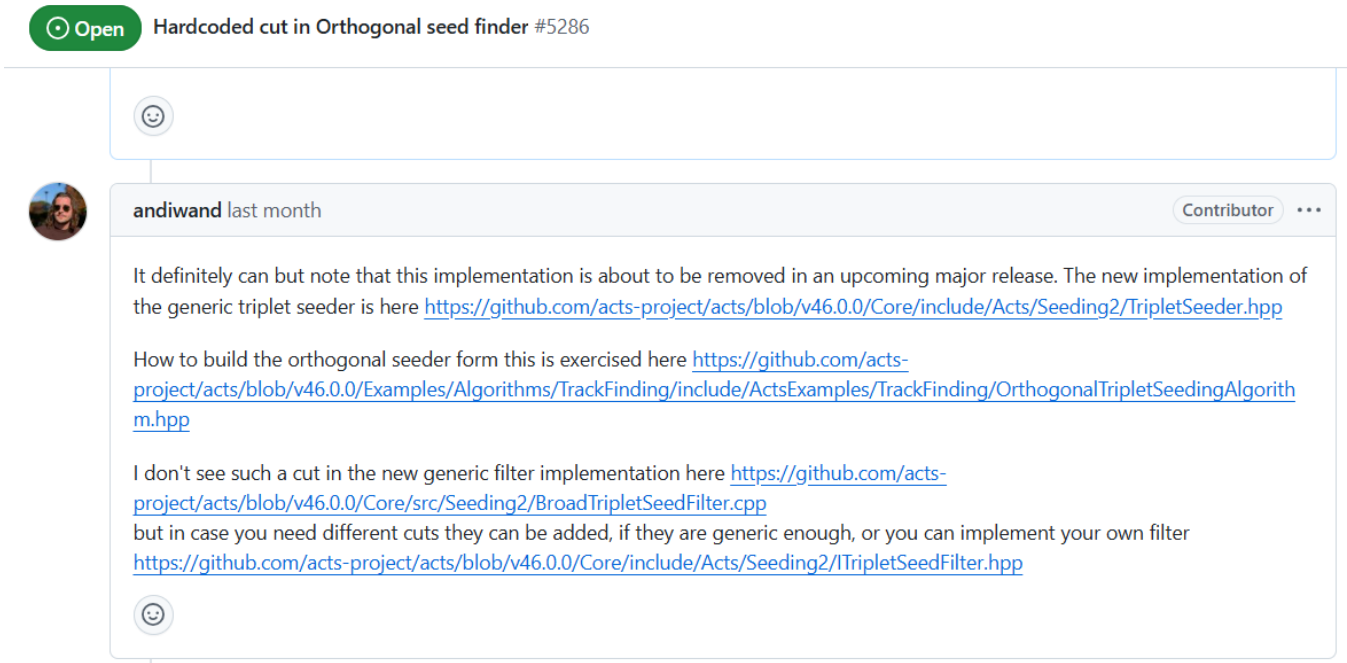
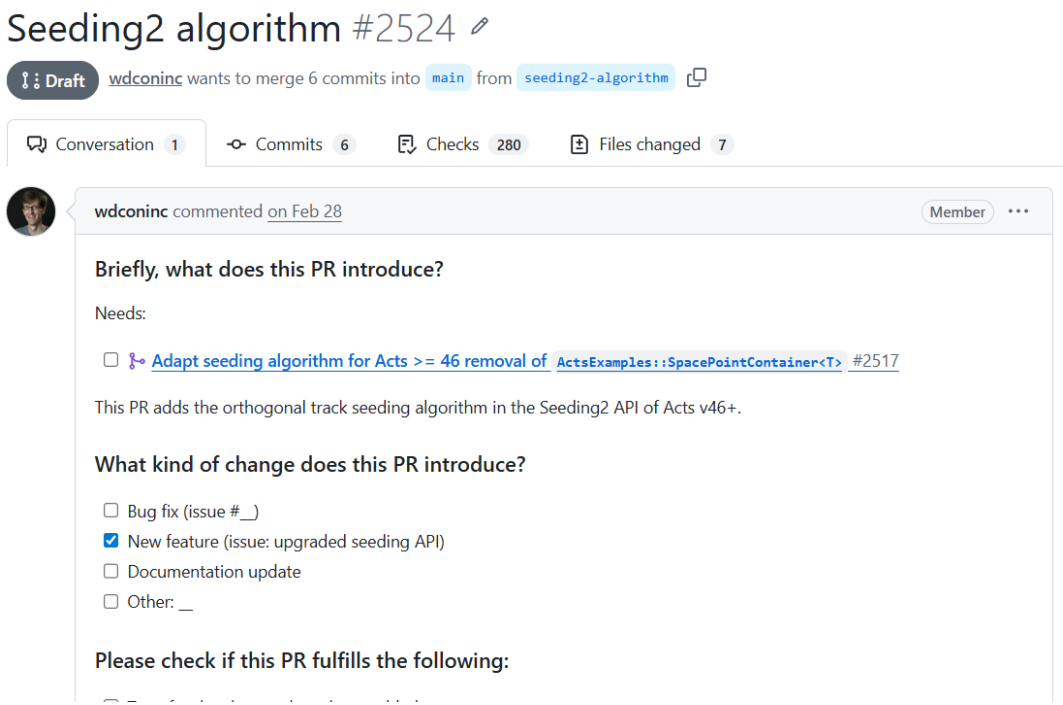


https://github.com/acts-project/acts/issues/5286

The next step then is to incorporate the new Acts seeding implementation into EICRecon. So, my plan is to start helping with this



https://github.com/eic/EICrecon/pull/2524