Realistic seeding status

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EIC RNC meeting
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To recap

Optimizing parameters of EICrecon-based realistic seeder

Parameter description

Parameter	Description	EICrecon default	Y.S. Lai's default
bFieldInZ	z component of magnetic field	1.7 T	1.7 T
rMax	Maximum r value to look for seeds	500 mm	440 mm
rMin	Minimum r value to look for seeds	33 mm	33 mm
zMin	Minimum z value to look for seeds	-800 mm	-1500 mm
zMax	Maximum z value to look for seeds	800 mm	1700 mm
beamPosX	Beam offset in x	0	0
beamPosY	Beam offset in y	0	0
deltaRMinTopSP	Min distance in r between middle and top SP in one seed	1 mm	50 mm
deltaRMinBottomSP	Min distance in r between middle and bottom SP in one seed	1 mm	50 mm
deltaRMaxTopSP	Max distance in r between middle and top SP in one seed	400 mm	220 mm
deltaRMaxBottomSP	Max distance in r between middle and top SP in one seed	400 mm	220 mm
collisionRegionMin	Min z for primary vertex	-300 mm	-250 mm
collisionRegionMax	Max z for primary vertex	300 mm	250 mm
cotThetaMax	Cotangent of max theta angle	16	16.54
minPt	Min transverse momentum	100	100 MeV/cotThetaMax
maxSeedsPerSpM	Max number of seeds a single middle space point can belong to - 1	1	0
sigmaScattering	How many standard devs of scattering angles to consider	5	5
radLengthPerSeed	Average radiation lengths of material on the length of a seed	0.1	0.1
impactMax	Max transverse PCA allowed	20 mm	3 mm
rMinMiddle	Min R for middle space point	20 mm	—
rMaxMiddle	Max R for middle space point	400 mm	—
bFieldMin	min B field	—	0.1 T

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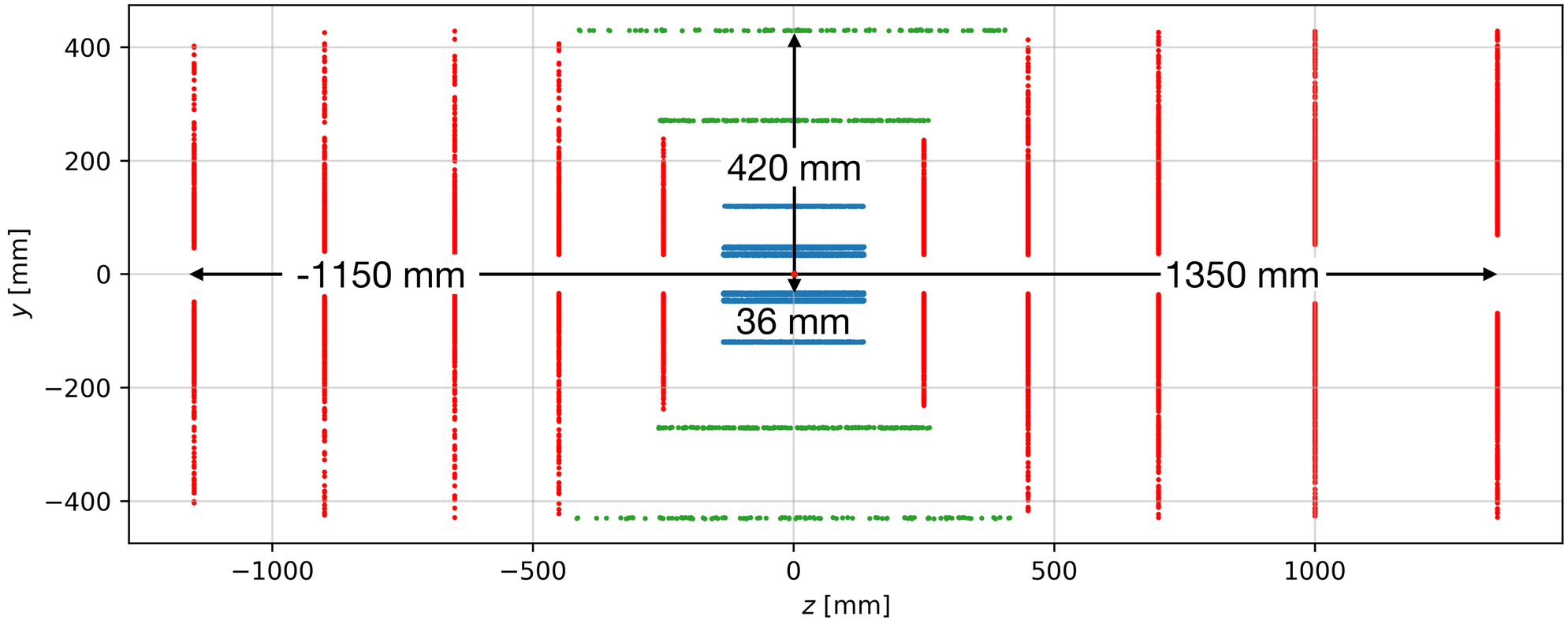

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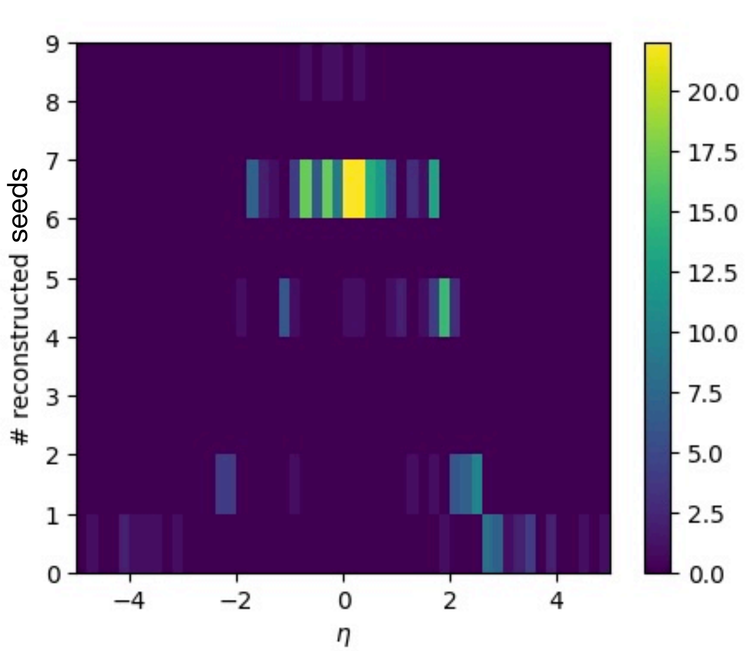
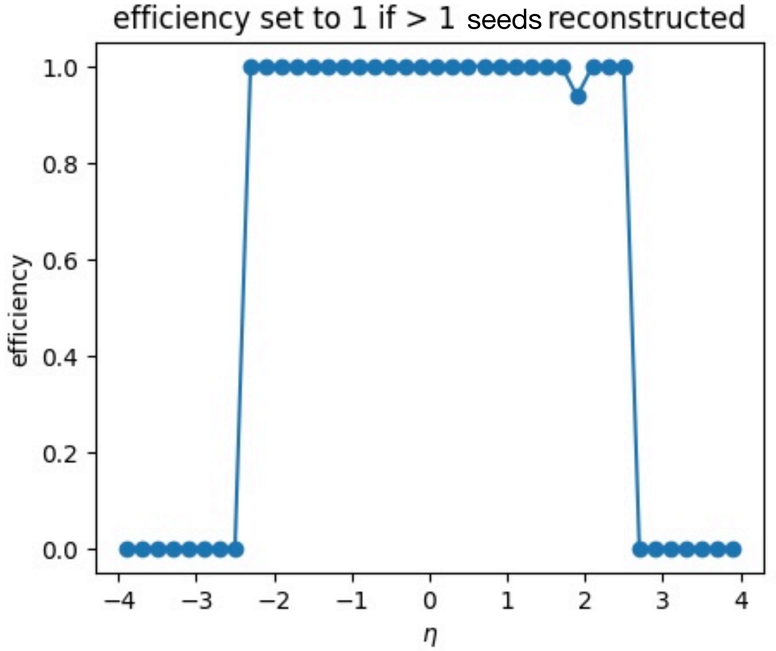
Comparison of both parameter sets

ACTS 21.1

Default (sPHENIX) EICrecon seeder parameters

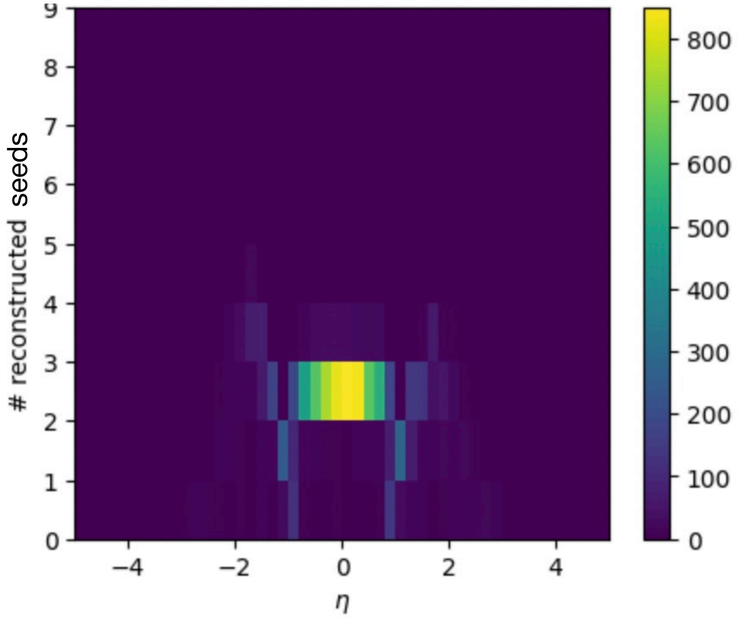


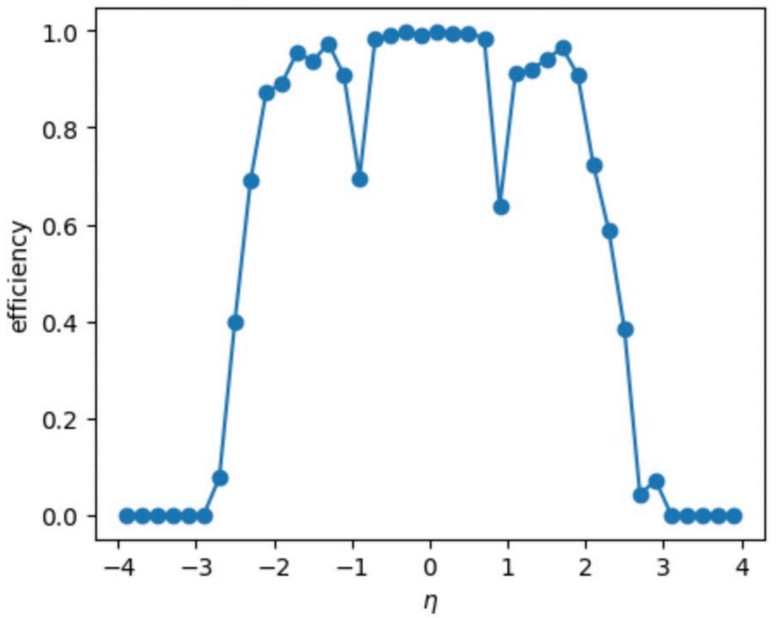


Sample: 10k single pions thrown with $p \in [0,10]$ GeV/c and $\eta \in [-4,4]$

geometry: Brycecanyon

Parameters from juggler





Plot normalization

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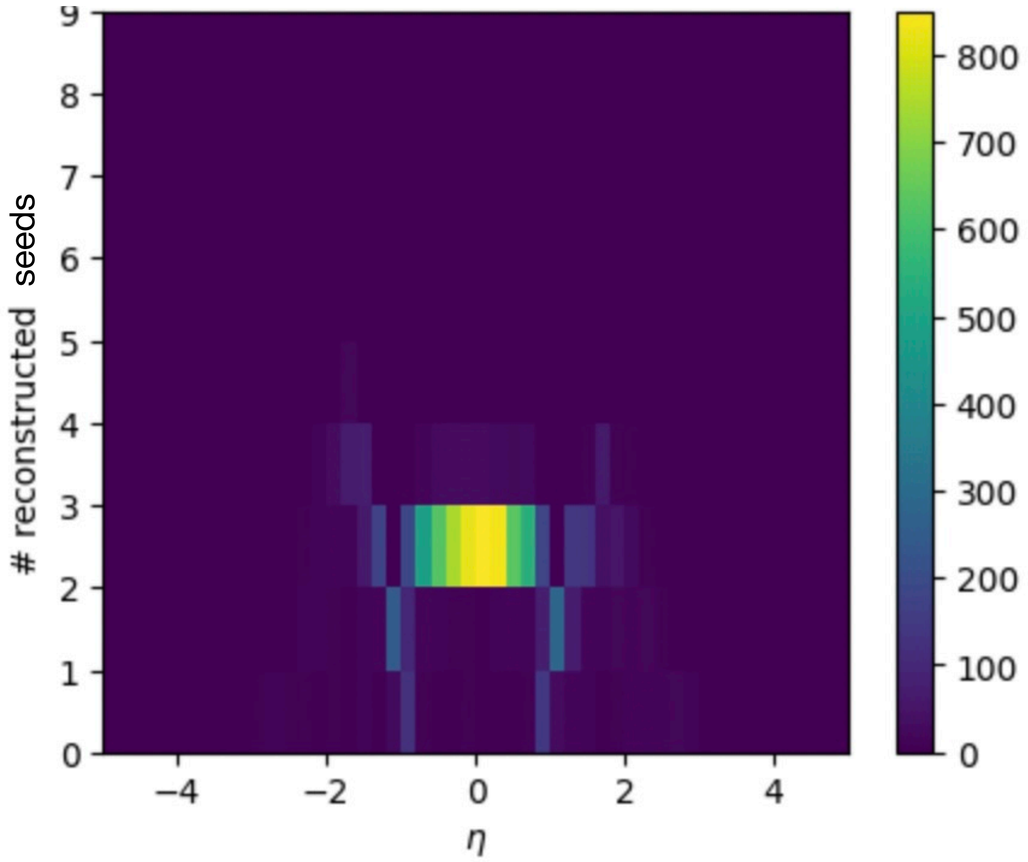
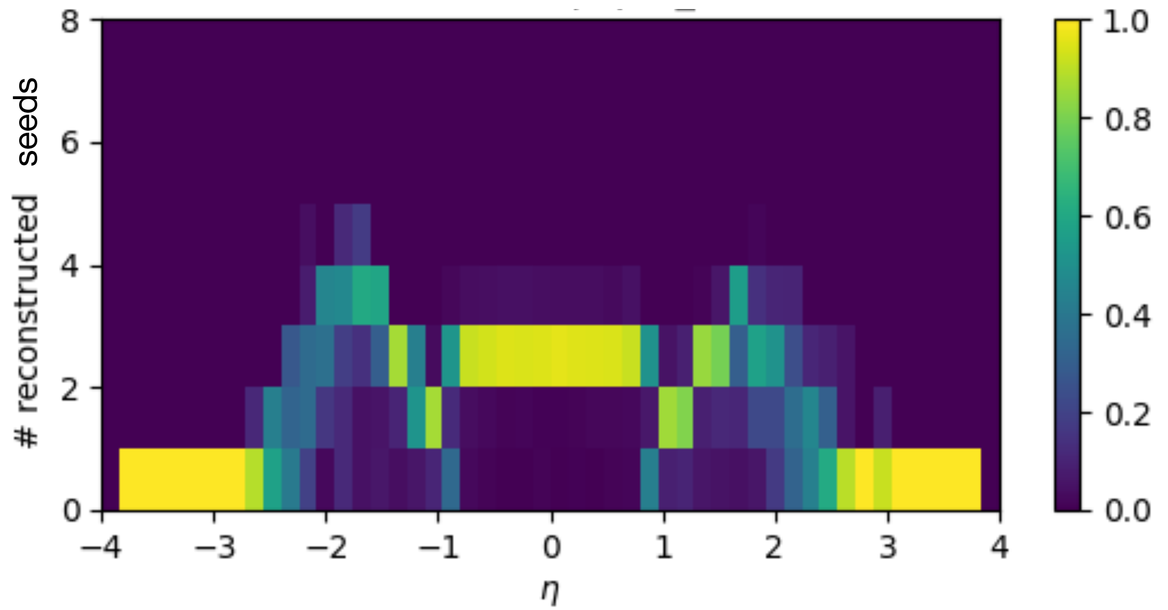
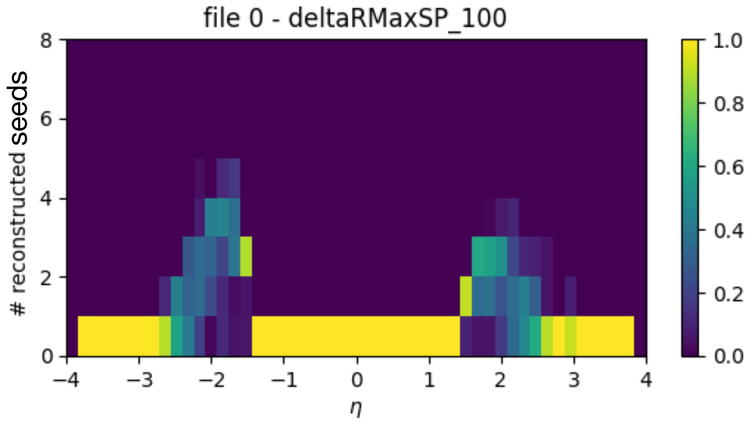


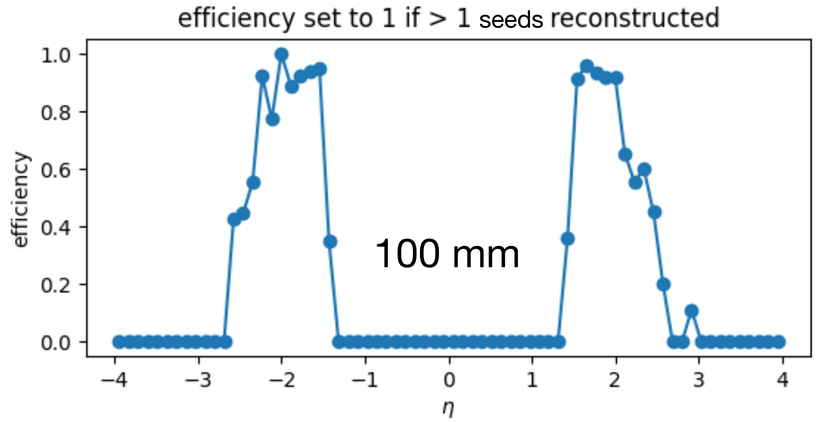


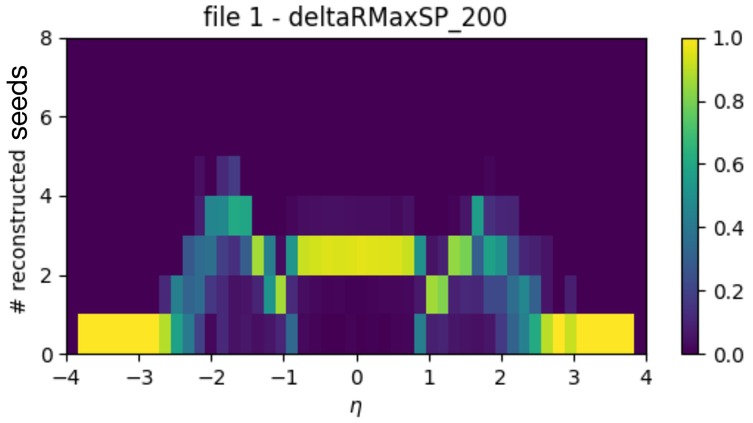
z scale normalized because generation in eta is not uniform

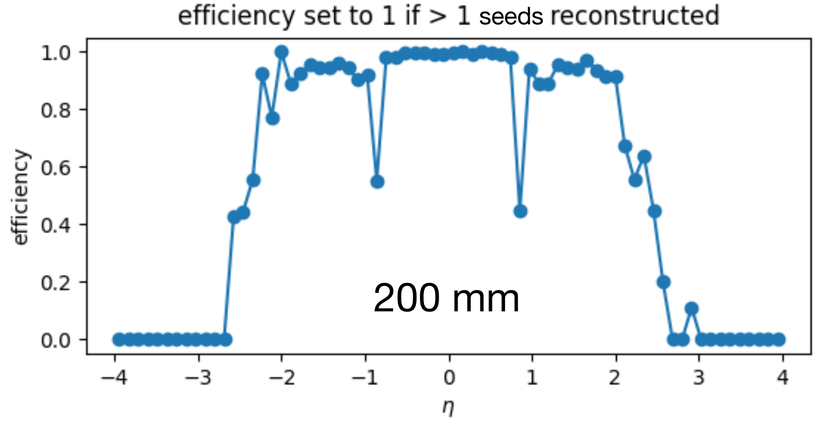
Delta R max SP

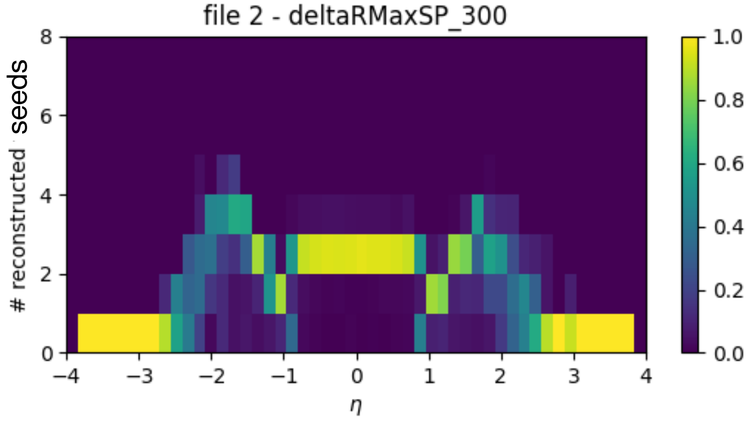
Max distance in r between middle and top (or bottom) space point in one seed

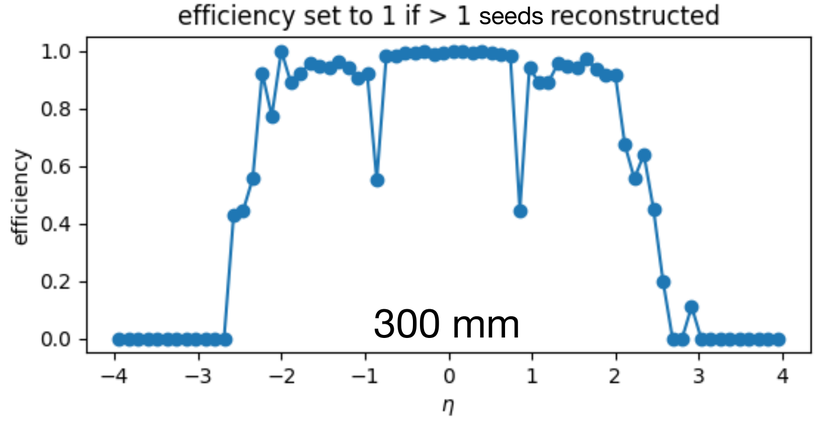








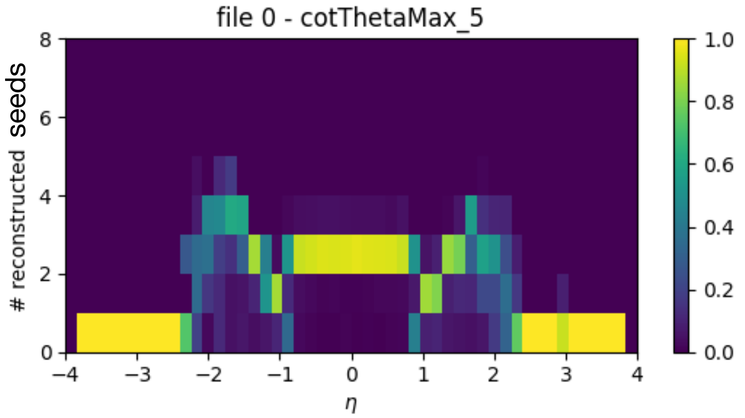


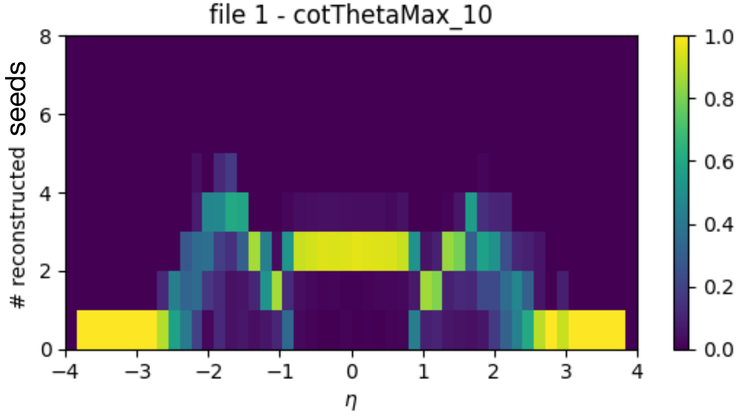


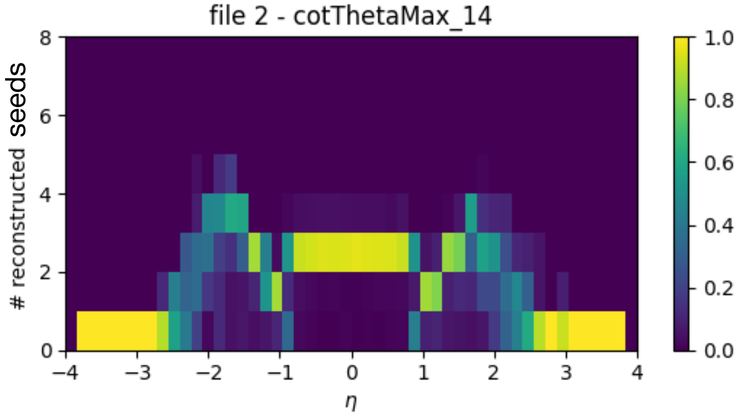
ACTS 21.1

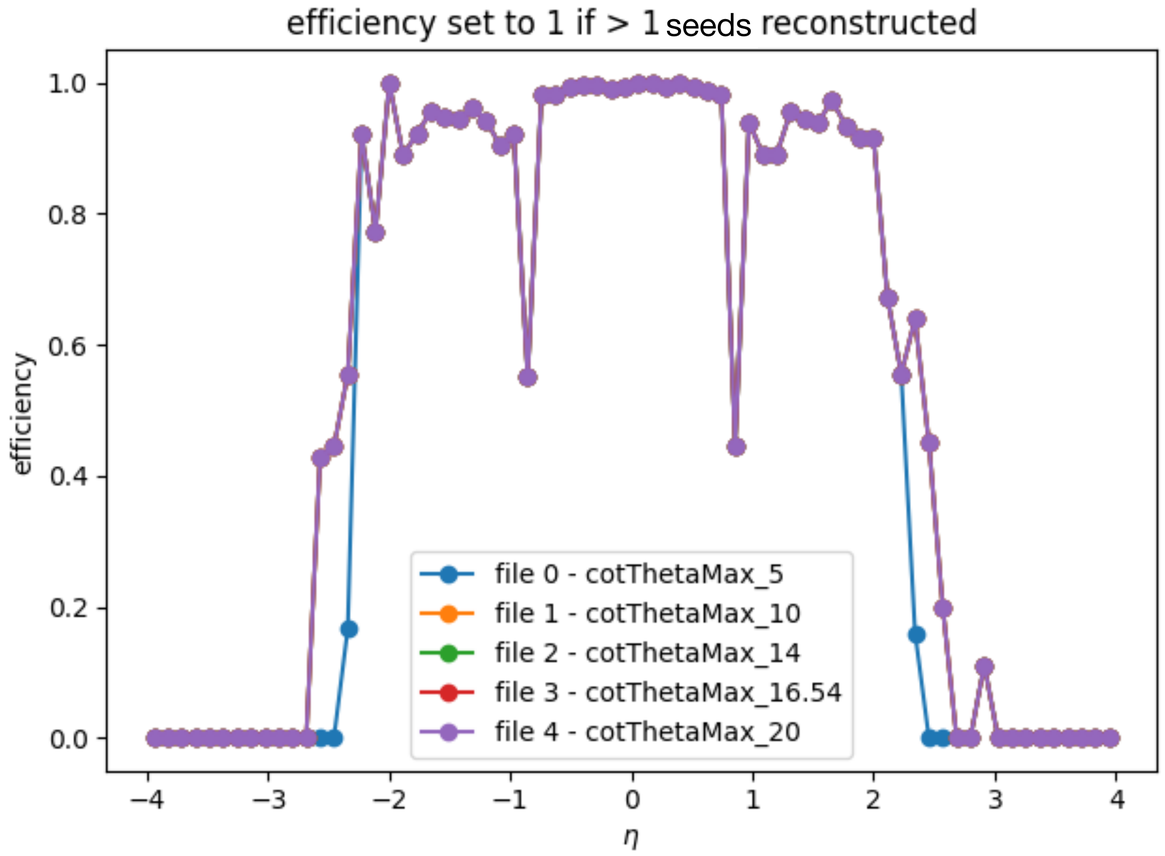
Exploring different Delta R max SP parameters

Cotangent of theta max







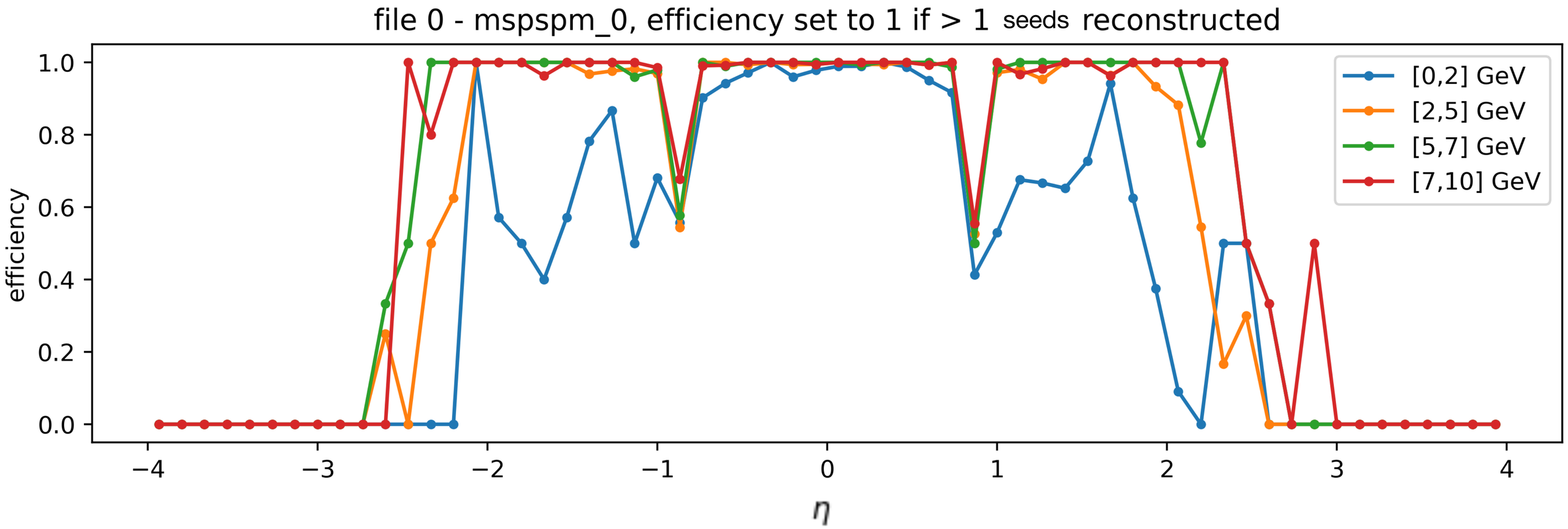


ACTS 21.1

$\cot(\theta_{\max})$	$\theta_{\max}$ [°]	$\eta_{\max}$
5	11.31	2.314
10	5.71	3.005
14	4.09	3.339
16.54	3.46	3.50
20	2.86	3.69

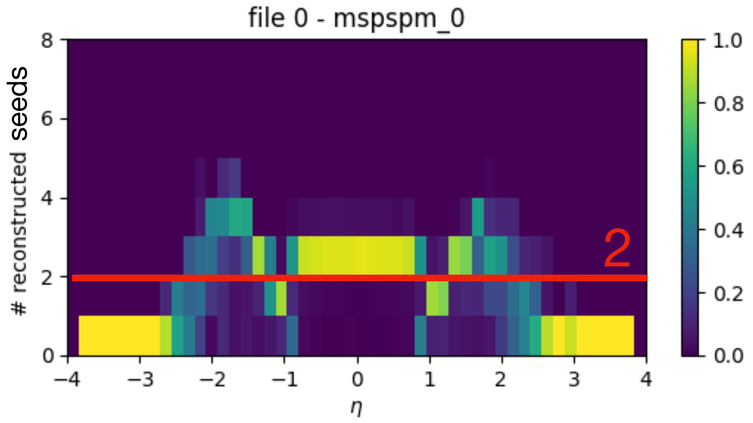
Efficiency dependence on momentum

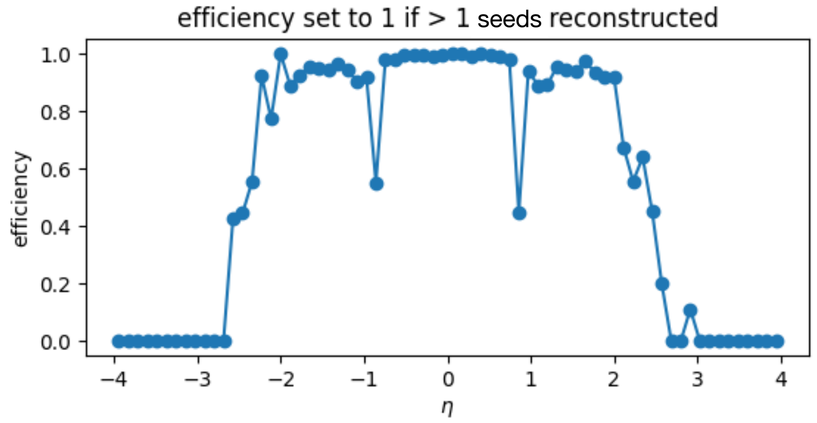
ACTS 21.1



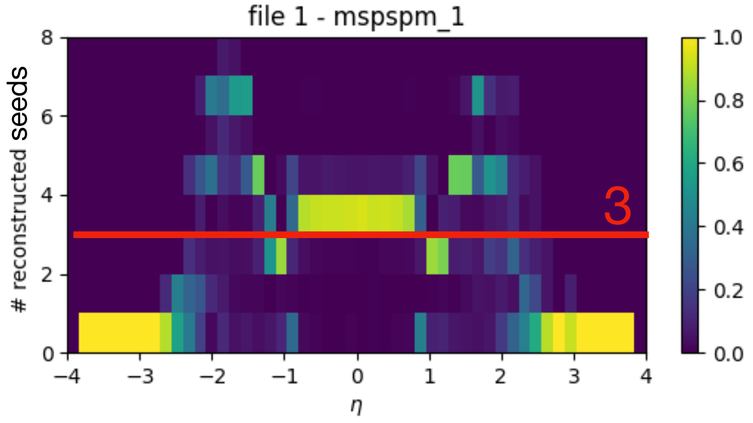
Max number of seeds a single middle space point can belong to - 1

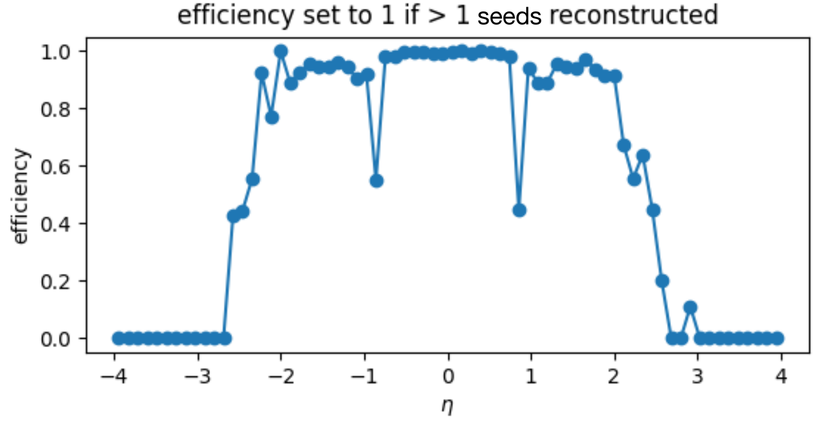
Middle space point can only belong to 1 seed



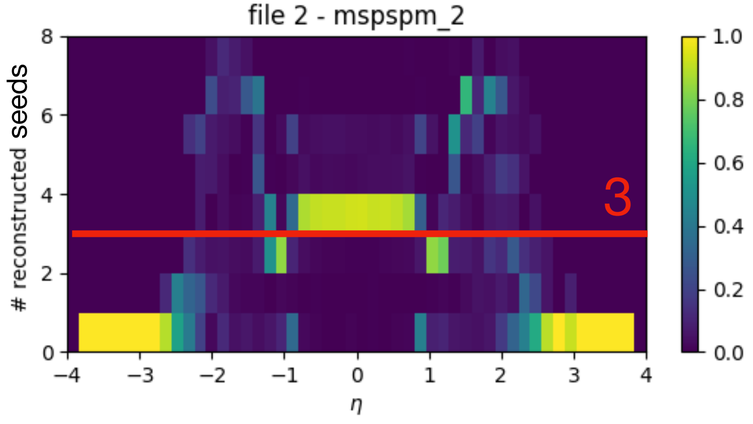


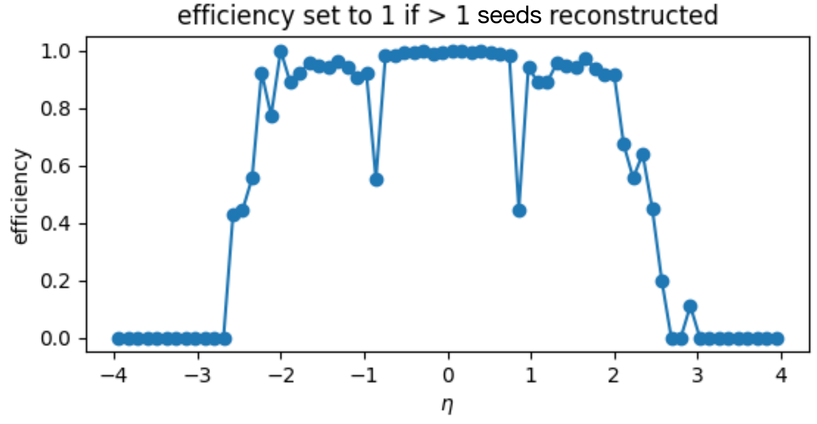
Middle space point can belong to up to 2 seeds





Middle space point can belong to up to 3 seeds



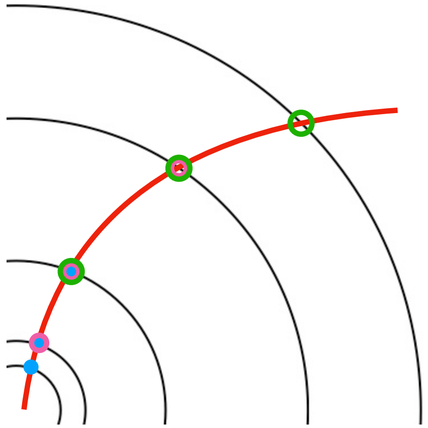


ACTS 21.1

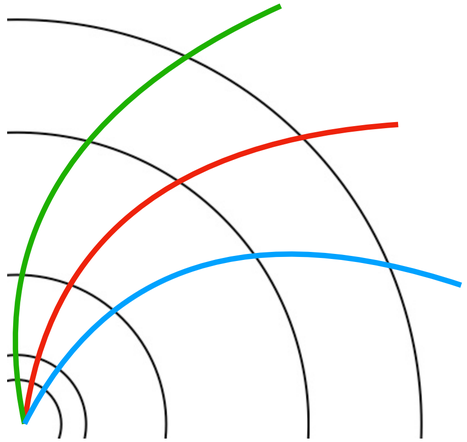
Duplicate seeds, not duplicate tracks?

ACTS 21.1

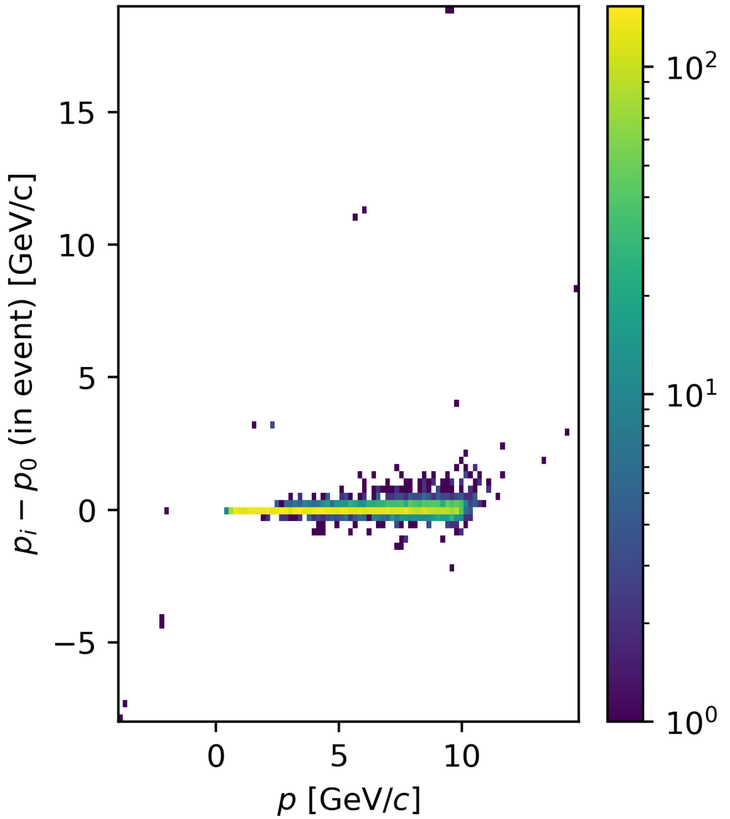
Three seeds,
One track

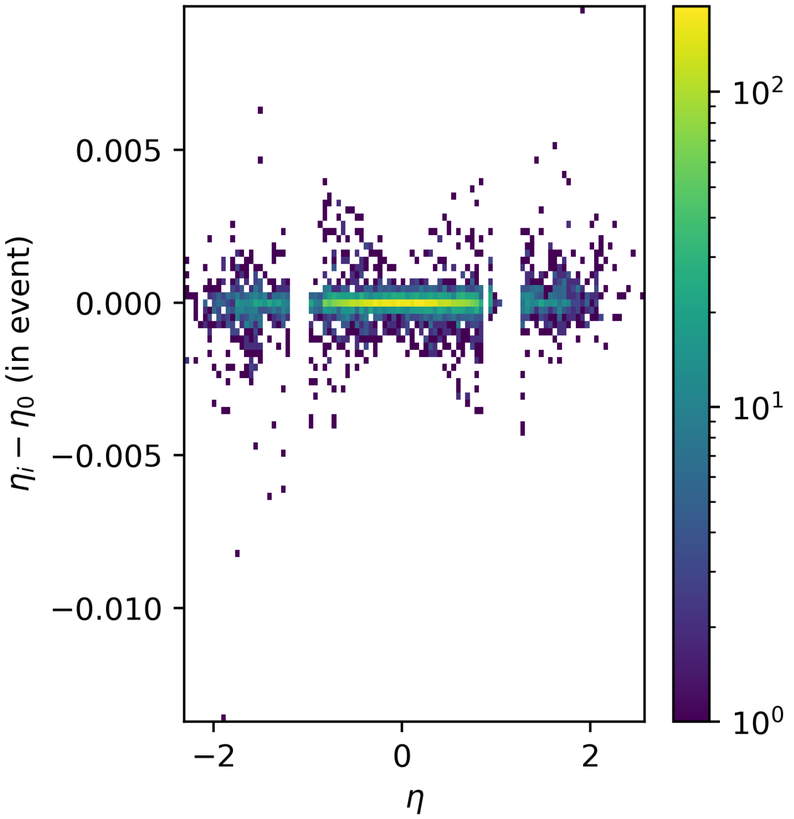


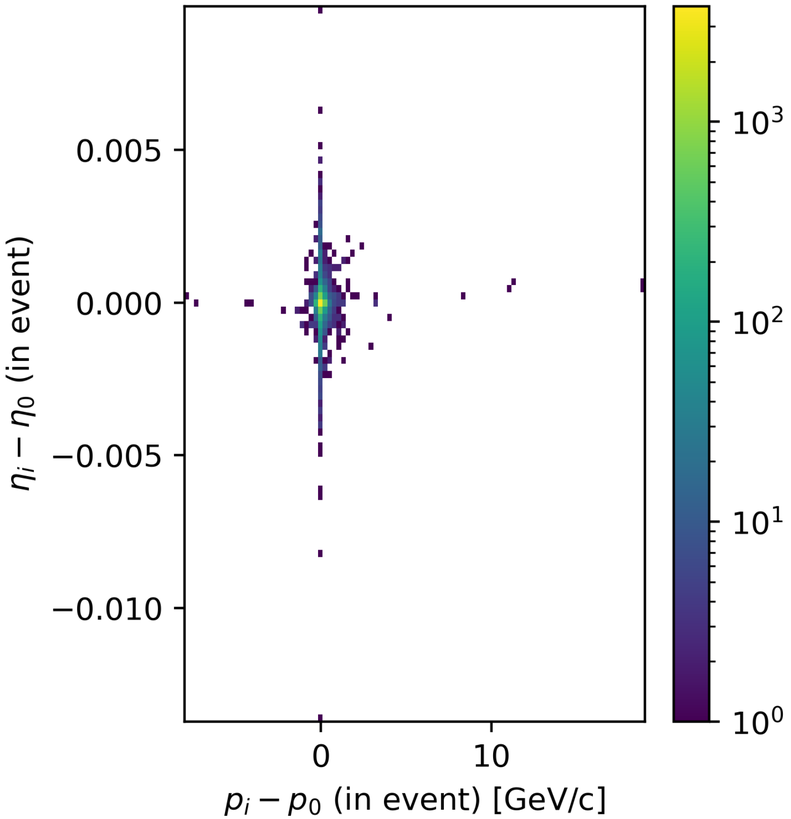
vs



Three tracks

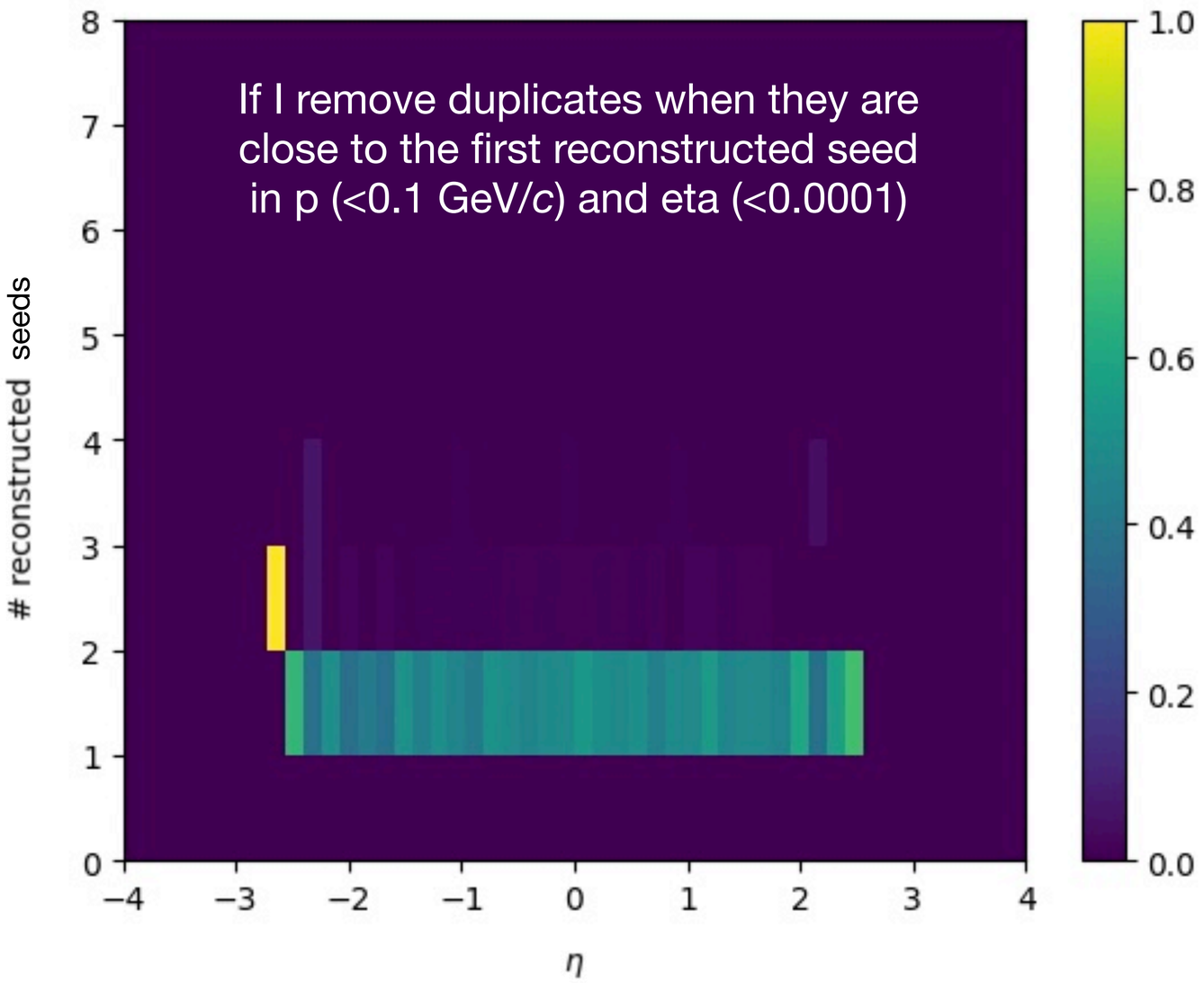






Duplicate seeds, not duplicate tracks?

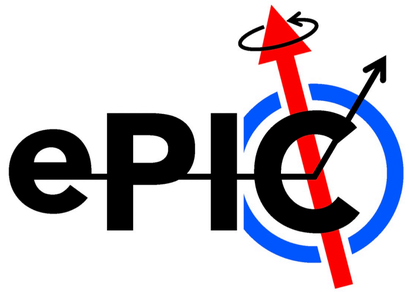
ACTS 21.1



Summary

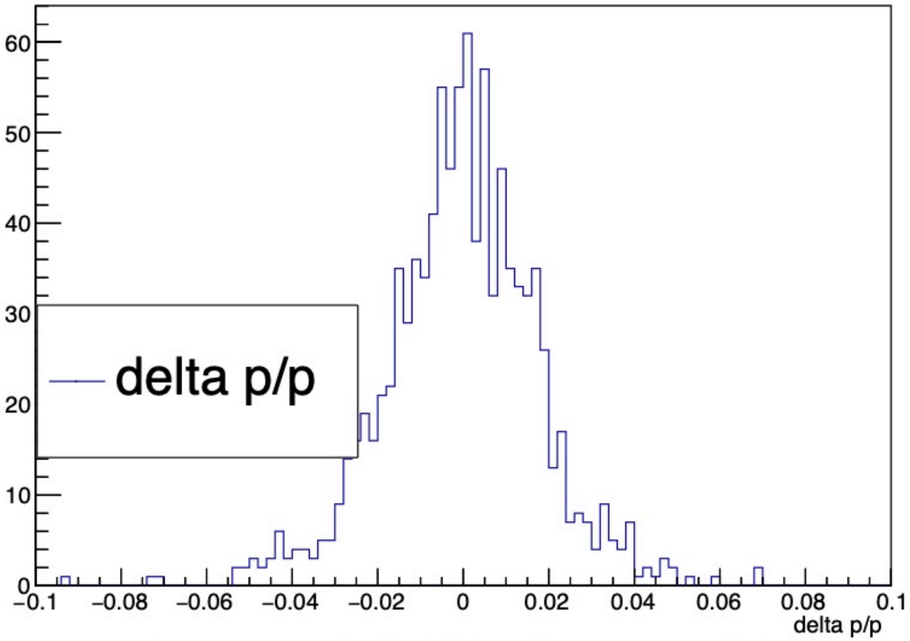
- Started exploring the phase space of seeder parameters
- Need to add a few plots to the checks (e.g. momentum resolution)
- While we see many duplicate seeds, they seem to describe the same track
  - Should maybe define some criterion to remove these duplicate seeds
  - e.g. using fit metrics
  - These do not exist at the moment in the EICrecon output (use Barak’s plugin?)
  - Are current duplicate seeds ranked already?

Thanks for your attention



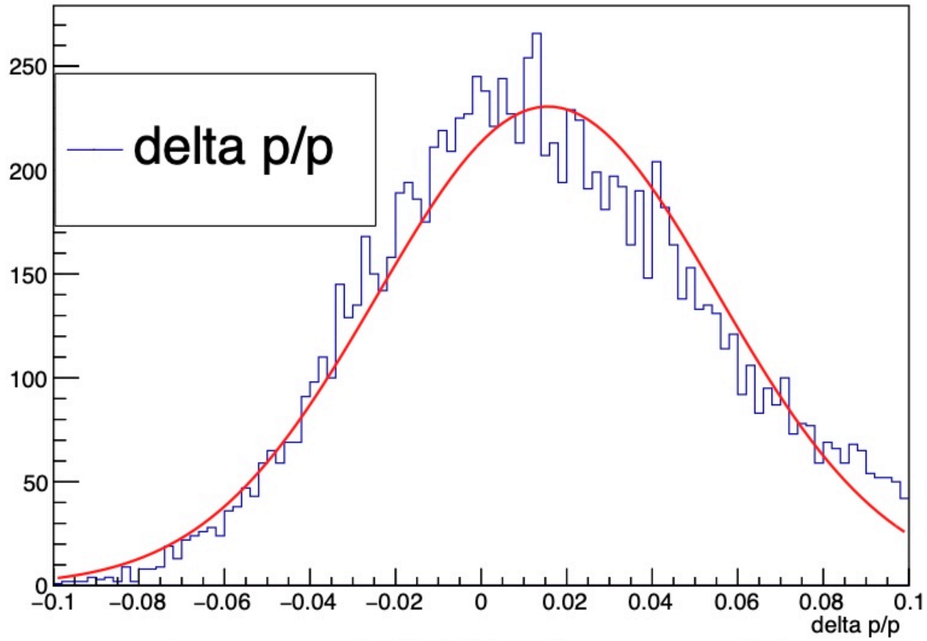
Backup

ACTS version impact



$1 < p < 2\,\mathrm{GeV}/c, 2 < \eta < 2.5$

ACTS 19.9, $\approx 2\%$



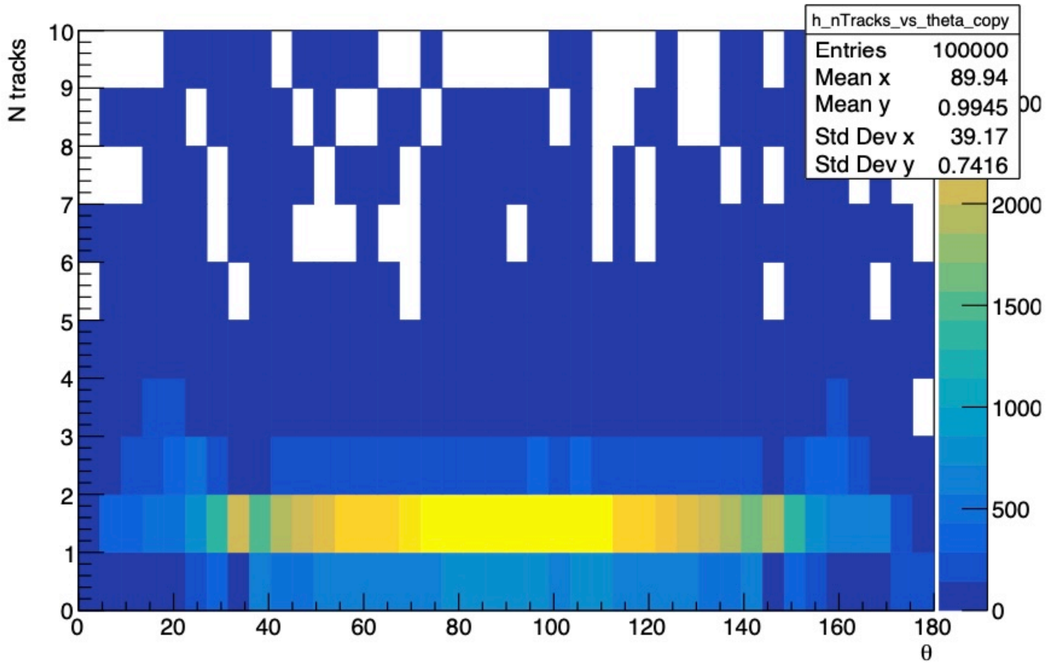
$1 < p < 2\,\mathrm{GeV}/c, 2 < \eta < 2.5$

ACTS 20.3, $3.98 \pm 0.03\%$

- The code is prepared for ACTS 21.x, and I ran it earlier today
- There are visible seed filter changes, and the performance/additional parameter tunings has to be understood

Slide from Y.S.Lai (based on Juggler)

ACTS version impact



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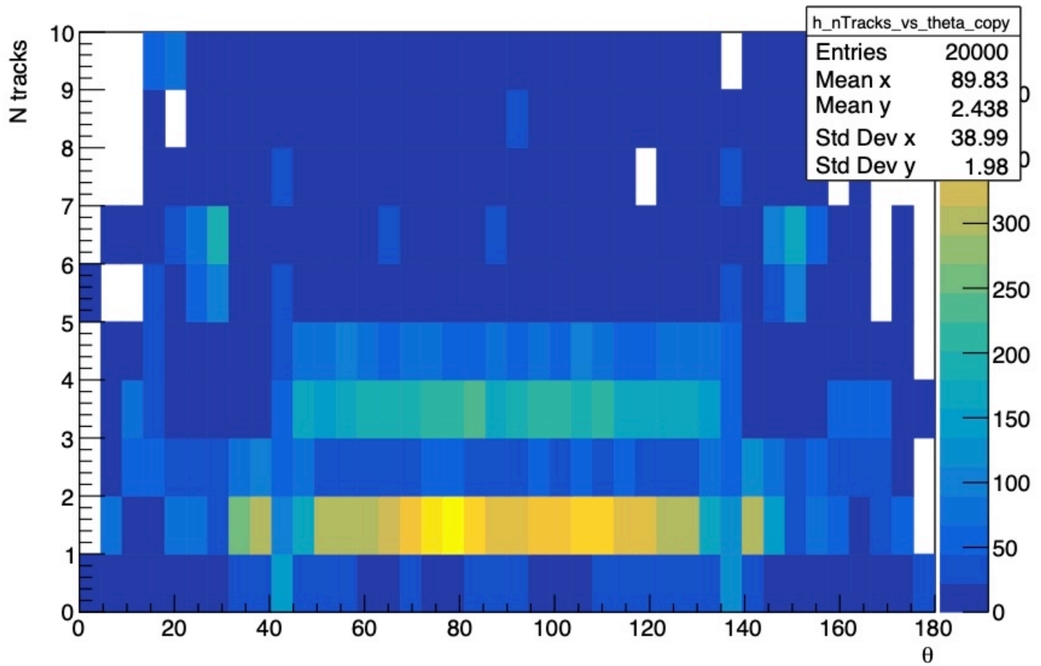
ACTS ≈ 15–16



$1 < p < 2\ \mathrm{GeV}/c$

ACTS 19.9

- Also N_{track} used to be much more “normal”
- 19.9 infact retuned to maximally reduce duplicate seeds

Slide from Y.S.Lai (based on Juggler)

Source (Y.S. Lai's params)

https://eicweb.phy.anl.gov/EIC/juggler/-/blob/acts-seeding-21/JugTrack/src/components/TrackParamACTSSeeding.cpp

```
float bFieldInZ = 1.7 * Acts::UnitConstants::T;
float cotThetaMax = std::sinh(3.5);
float minPt = 100 * Acts::UnitConstants::MeV / cotThetaMax;
float rMax = 440 * Acts::UnitConstants::mm;
float zMin = -1500 * Acts::UnitConstants::mm;
float zMax = 1700 * Acts::UnitConstants::mm;
float deltaRMin = 50 * Acts::UnitConstants::mm;
float deltaRMax = 220 * Acts::UnitConstants::mm;
//
float collisionRegionMin = -250 * Acts::UnitConstants::mm;
float collisionRegionMax = 250 * Acts::UnitConstants::mm;
float maxSeedsPerSpM = 0;
float sigmaScattering = 5;
float radLengthPerSeed = 0.1;
float beamPosX = 0 * Acts::UnitConstants::mm;
float beamPosY = 0 * Acts::UnitConstants::mm;
float impactMax = 3 * Acts::UnitConstants::mm;
```

```
/// The minimum magnetic field to trigger the track
/// parameters estimation
double bFieldMin = 0.1 * Acts::UnitConstants::T;

/// Constant term of the loc0 resolution.
double sigmaLoc0 = 25 * Acts::UnitConstants::um;
/// Constant term of the loc1 resolution.
double sigmaLoc1 = 100 * Acts::UnitConstants::um;
/// Phi angular resolution.
double sigmaPhi = 0.02 * Acts::UnitConstants::degree;
/// Theta angular resolution.
double sigmaTheta = 0.02 * Acts::UnitConstants::degree;
/// q/p resolution.
double sigmaQOverP = 0.1 / Acts::UnitConstants::GeV;
/// Time resolution.
double sigmaT0 = 1400 * Acts::UnitConstants::s;

int numPhiNeighbors = 3;

float deltaRMiddleMinSPRange = 10. * Acts::UnitConstants::mm;
float deltaRMiddleMaxSPRange = 10. * Acts::UnitConstants::mm;
```

Source (J. Osborn's params)

https://github.com/eic/EICrecon/blob/main/src/algorithms/tracking/OrthogonalTrackSeedingConfig.h

```
float m_rMax = 500. * Acts::UnitConstants::mm;
float m_rMin = 33. * Acts::UnitConstants::mm;
float m_deltaRMinTopSP = 1. * Acts::UnitConstants::mm;
float m_deltaRMaxTopSP = 400. * Acts::UnitConstants::mm;
float m_deltaRMinBottomSP = 1. * Acts::UnitConstants::mm;
float m_deltaRMaxBottomSP = 400. * Acts::UnitConstants::mm;
float m_collisionRegionMin = -300 * Acts::UnitConstants::mm;
float m_collisionRegionMax = 300 * Acts::UnitConstants::mm;
float m_zMin = -800. * Acts::UnitConstants::mm;
float m_zMax = 800. * Acts::UnitConstants::mm;
```

```
float m_maxSeedsPerSpM = 1;
float m_cotThetaMax = 16;
float m_sigmaScattering = 5;
float m_radLengthPerSeed = 0.1;
float m_minPt = 100.; // MeV
float m_bFieldInZ = 0.0017; //kTesla
float m_beamPosX = 0;
float m_beamPosY = 0;

/// Maximum transverse PCA allowed
float m_impactMax = 20. * Acts::UnitConstants::mm;

/// Middle spacepoint must fall between these two radii
float m_rMinMiddle = 20. * Acts::UnitConstants::mm;
float m_rMaxMiddle = 400. * Acts::UnitConstants::mm;
```