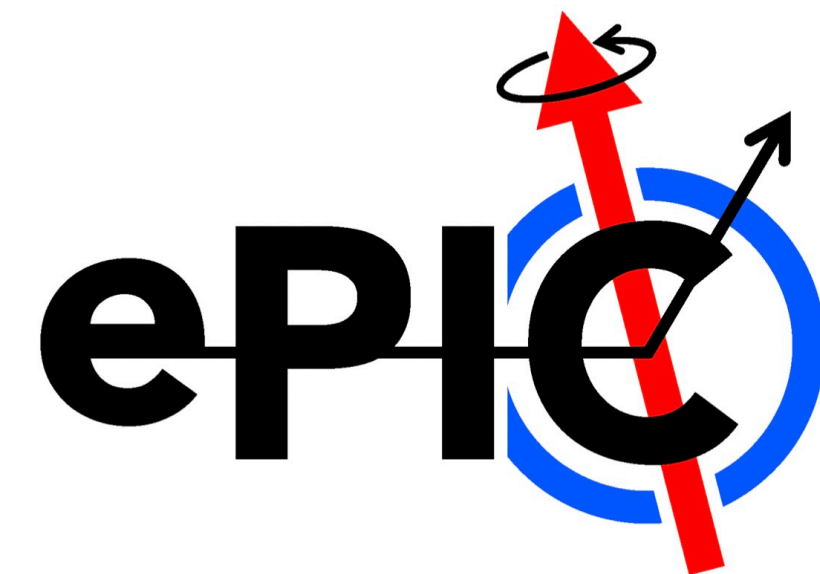# Realistic seeding status

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Intro

- Moving realistic-seeder work to EICrecon

  - Y.S. Lai, et al. worked on (**ACTS-based**) seeder in **Juggler** (including some param optimization)

  - J. Osborn ported sPHENIX optimized (**ACTS-based**) seeder to **EICrecon**

  - Need to optimize parameters

  - Parameters from **Juggler** studies copied over to **EICrecon** seeder
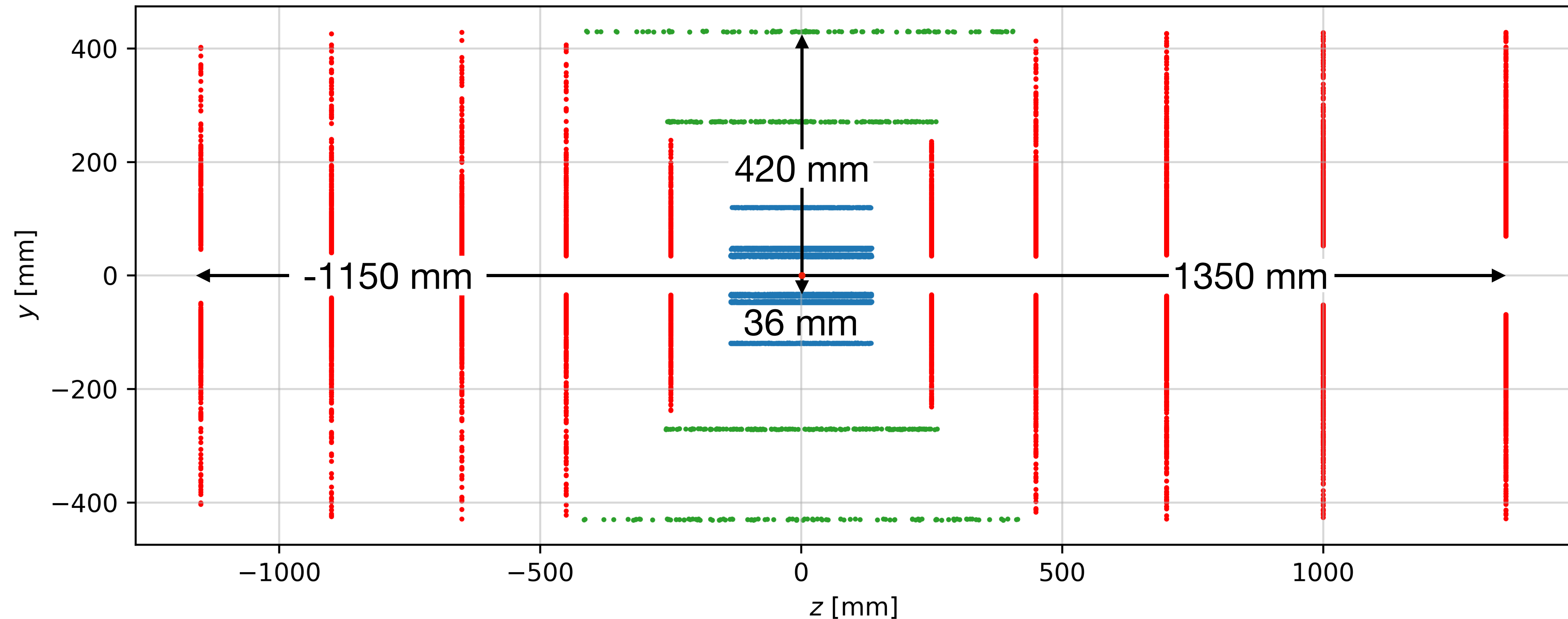
ACTS-based meaning that the base code came from ACTS. Both seeders have common variables, etc.

Parameter description

| Parameter	Description	ElCrecon 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

Parameter description

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Parameter description

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Comparison of both parameter sets

Sample: 10k single pions thrown with $p \in [0,10]$ GeV/c and $\eta \in [-4,4]$, Brycecanyon, ACTS 21.1
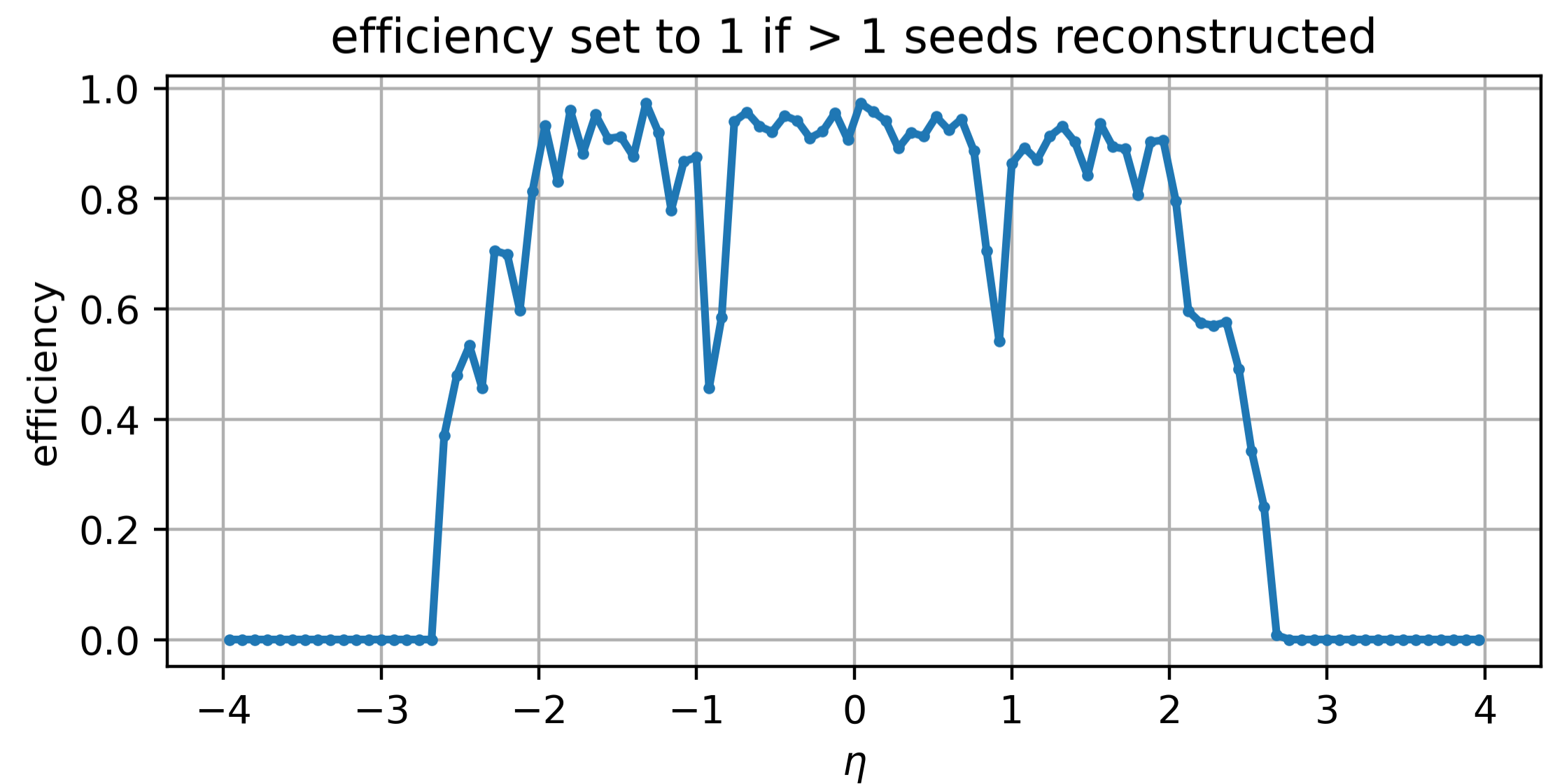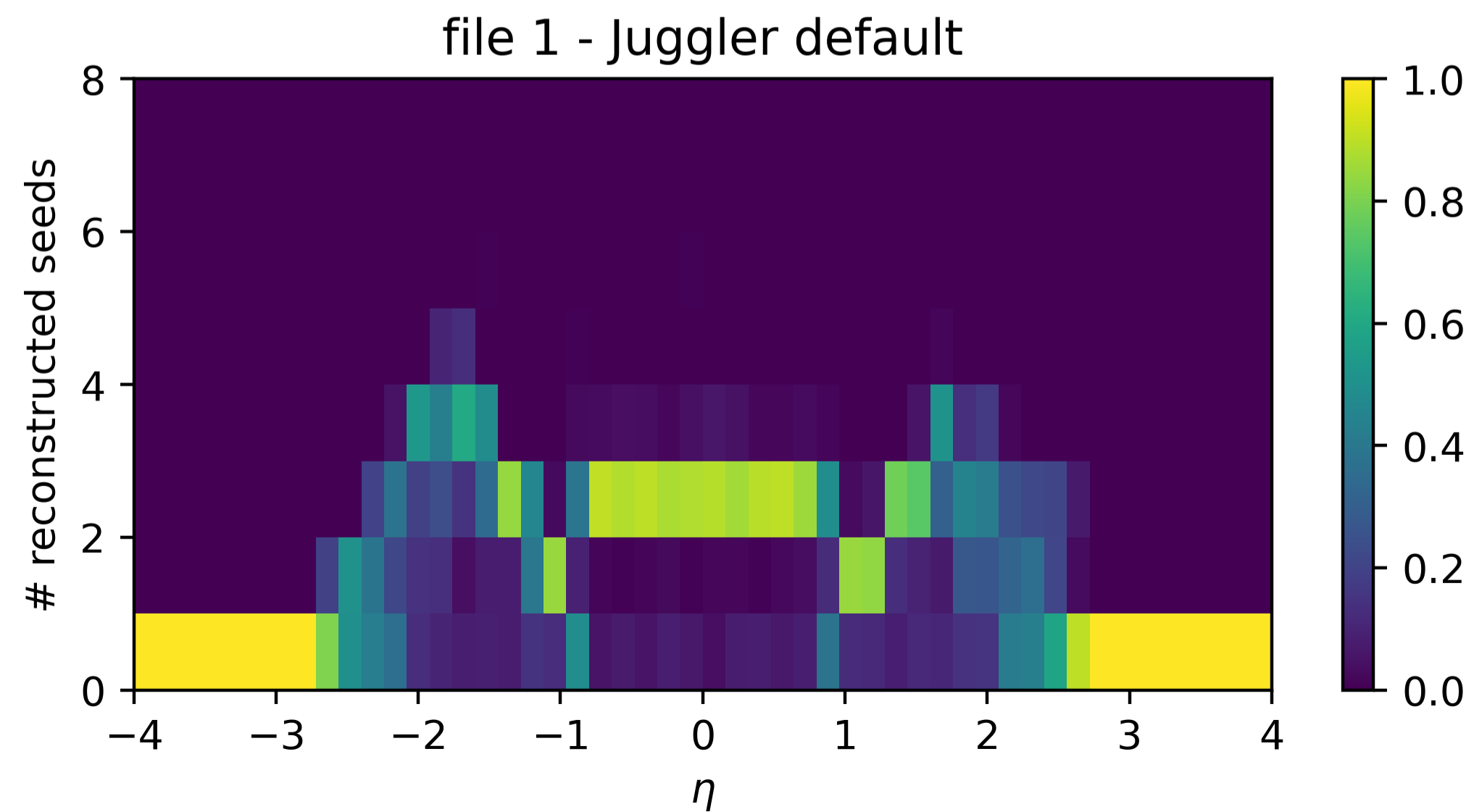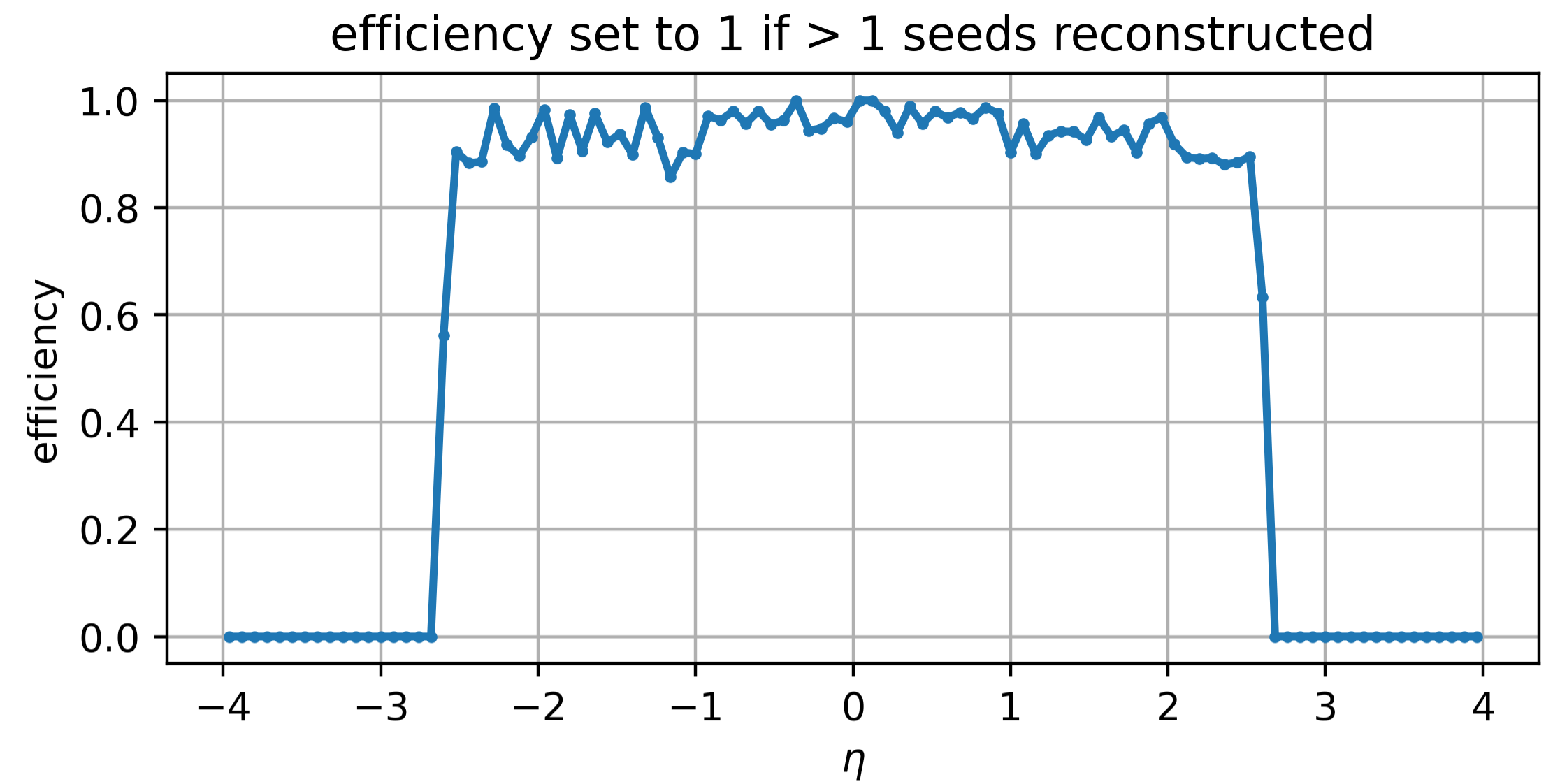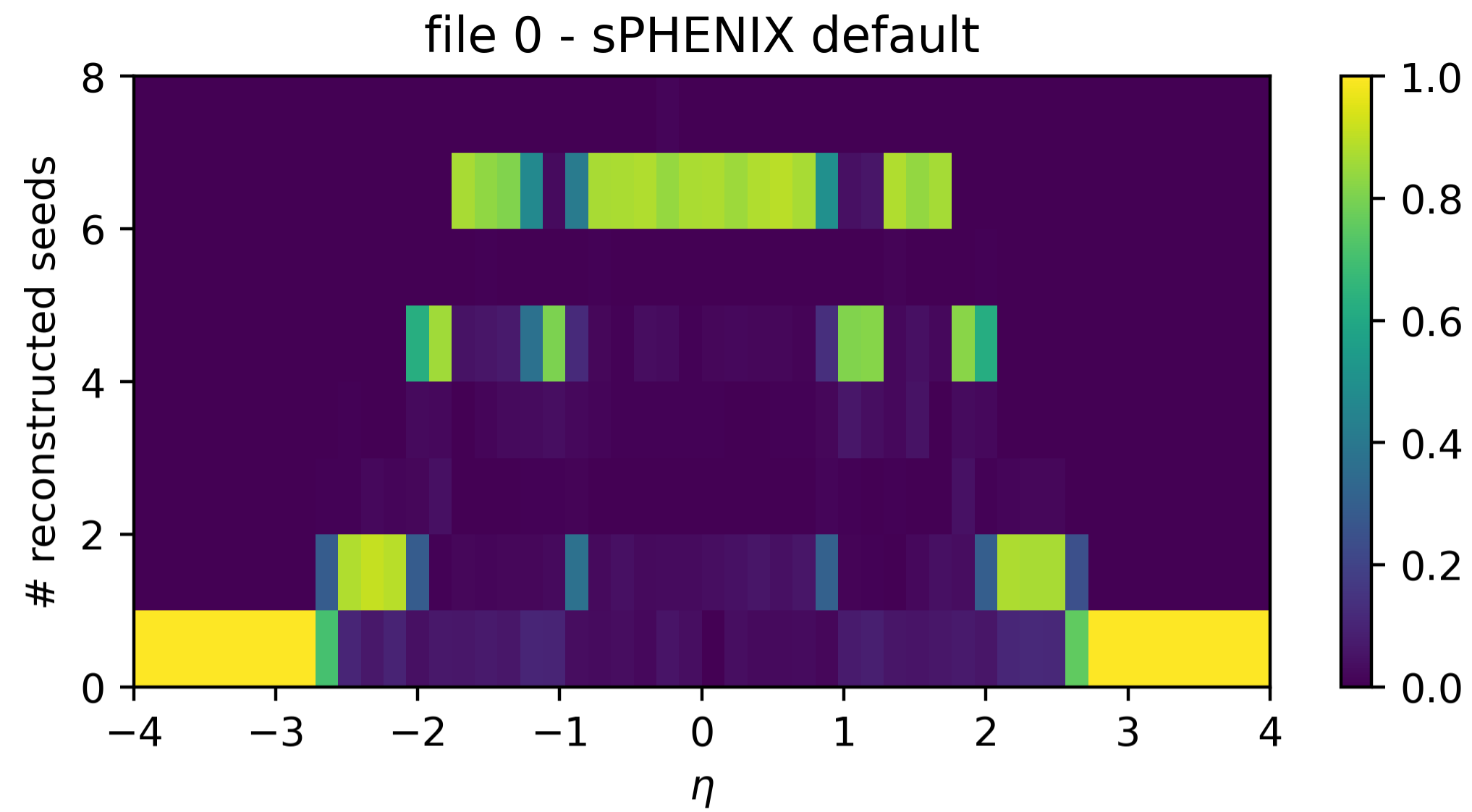
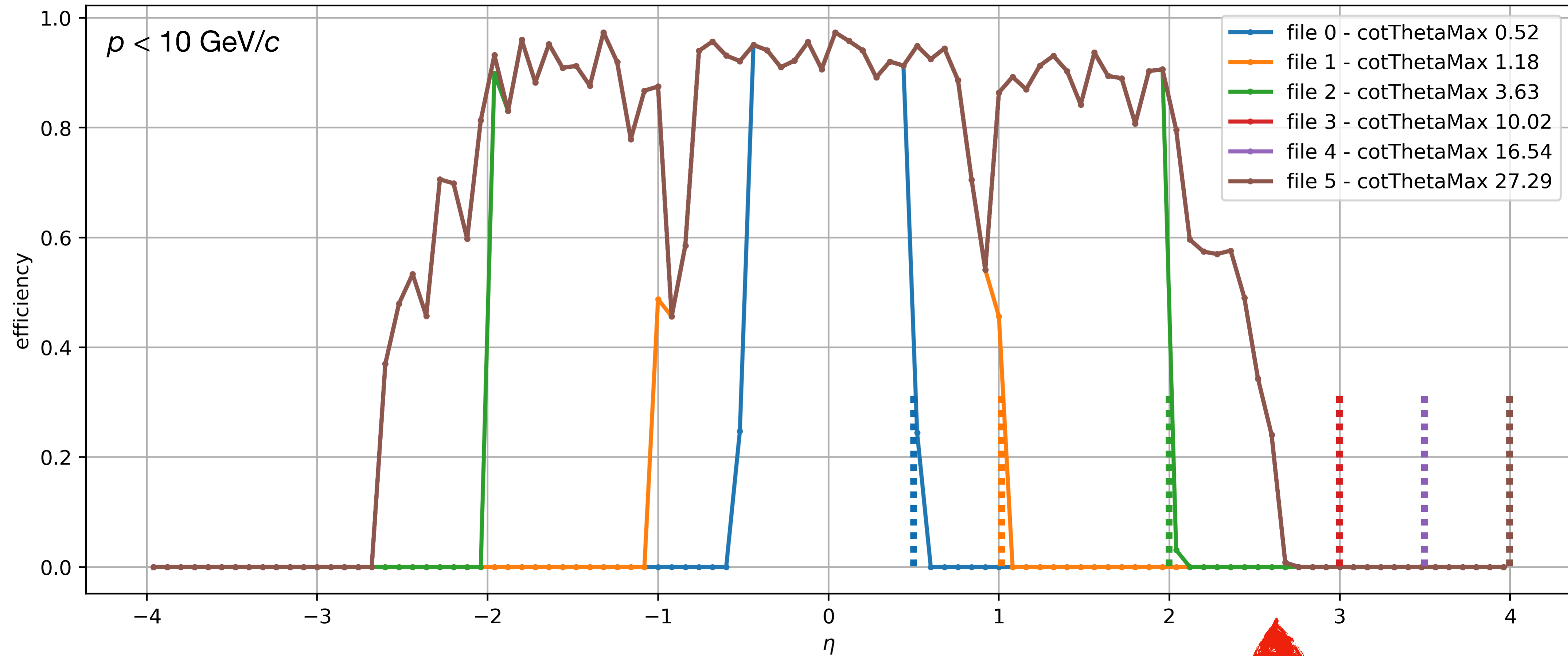# Efficiency dependence on momentum

file 1 - Juggler default, efficiency set to 1 if > 1 seeds reconstructed
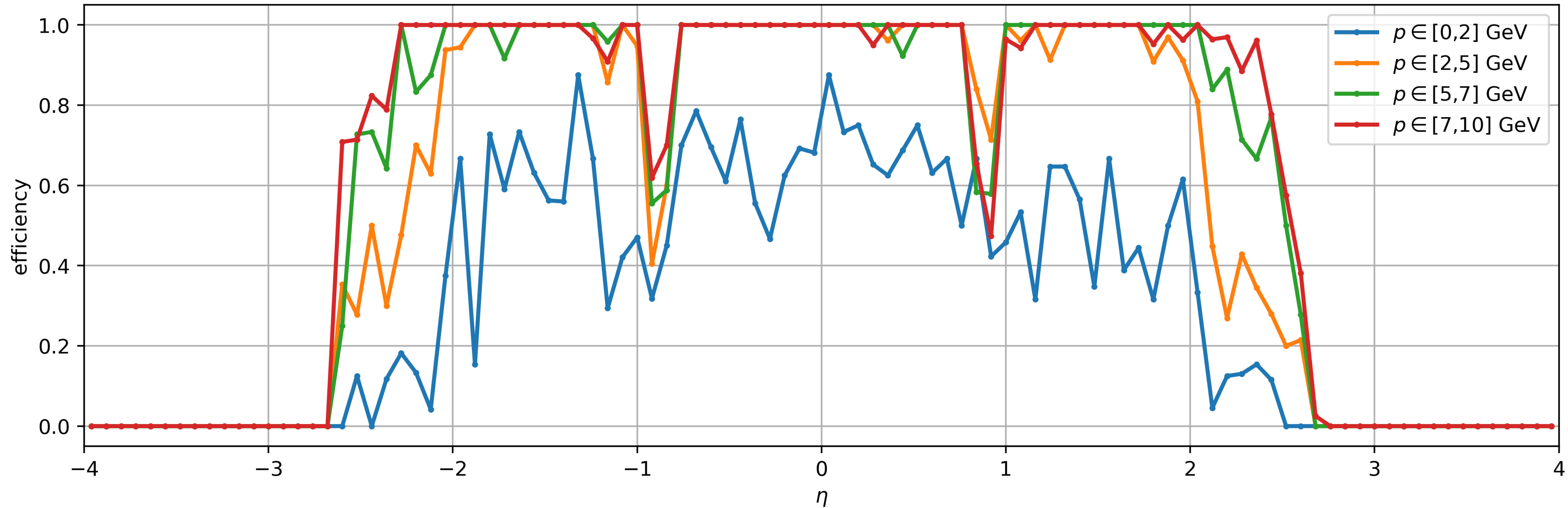
Cotangent of theta max

efficiency set to 1 if > 1 seeds reconstructed

$p < 10$ GeV/c

Legend:
- file 0 - cotThetaMax 0.52
- file 1 - cotThetaMax 1.18
- file 2 - cotThetaMax 3.63
- file 3 - cotThetaMax 10.02
- file 4 - cotThetaMax 16.54
- file 5 - cotThetaMax 27.29

$\cot(\theta_{\max})$	$\theta_{\max}$ [°]	$\eta_{\max}$
0.52	62.5	0.5
1.18	40.4	1
3.63	15.4	2
10.02	5.70	3
16.54	3.46	3.5
27.29	2.10	4

Hard cutoff somewhere in the code

8

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

Middle space point can only belong to 1 seed
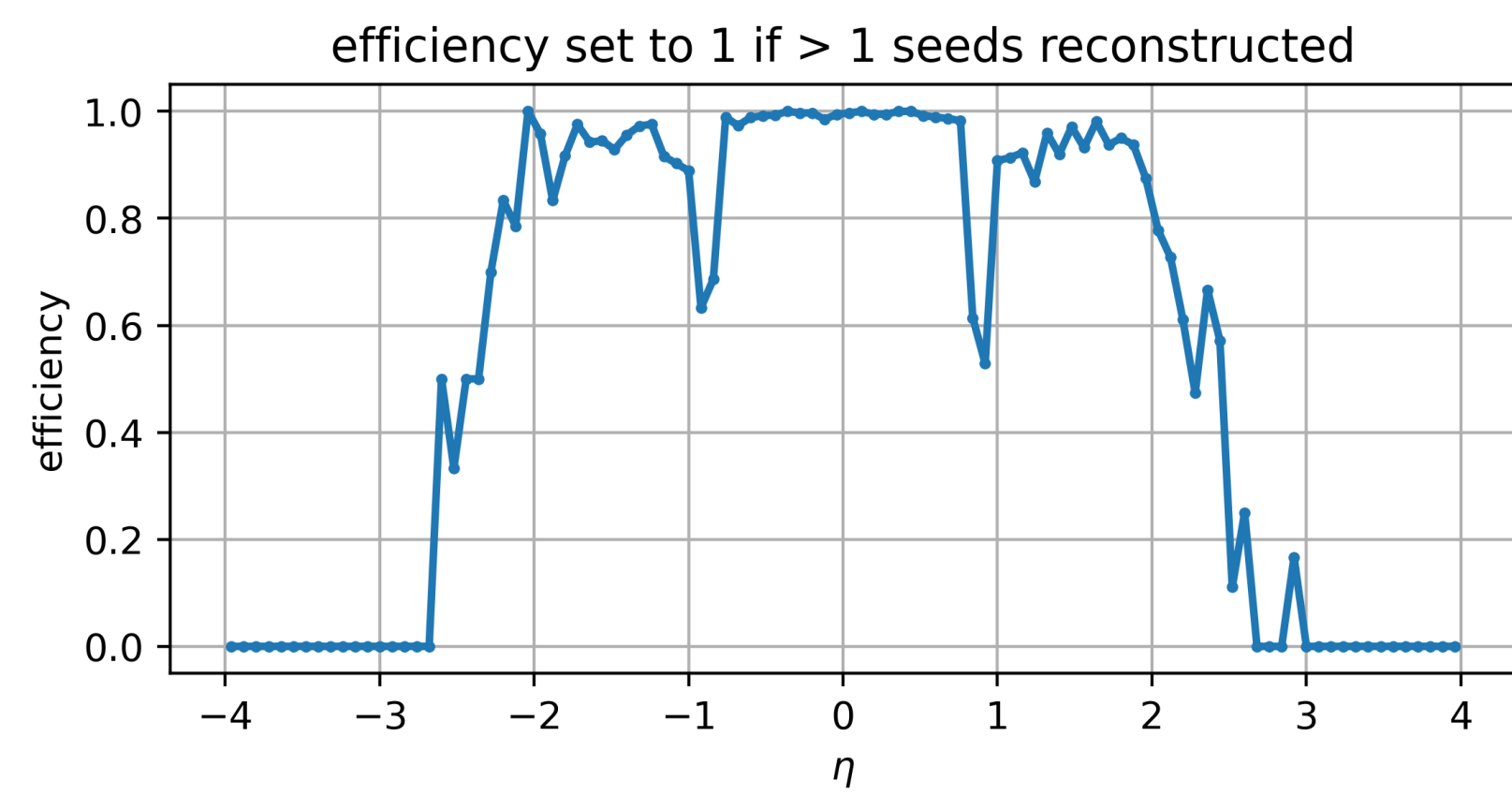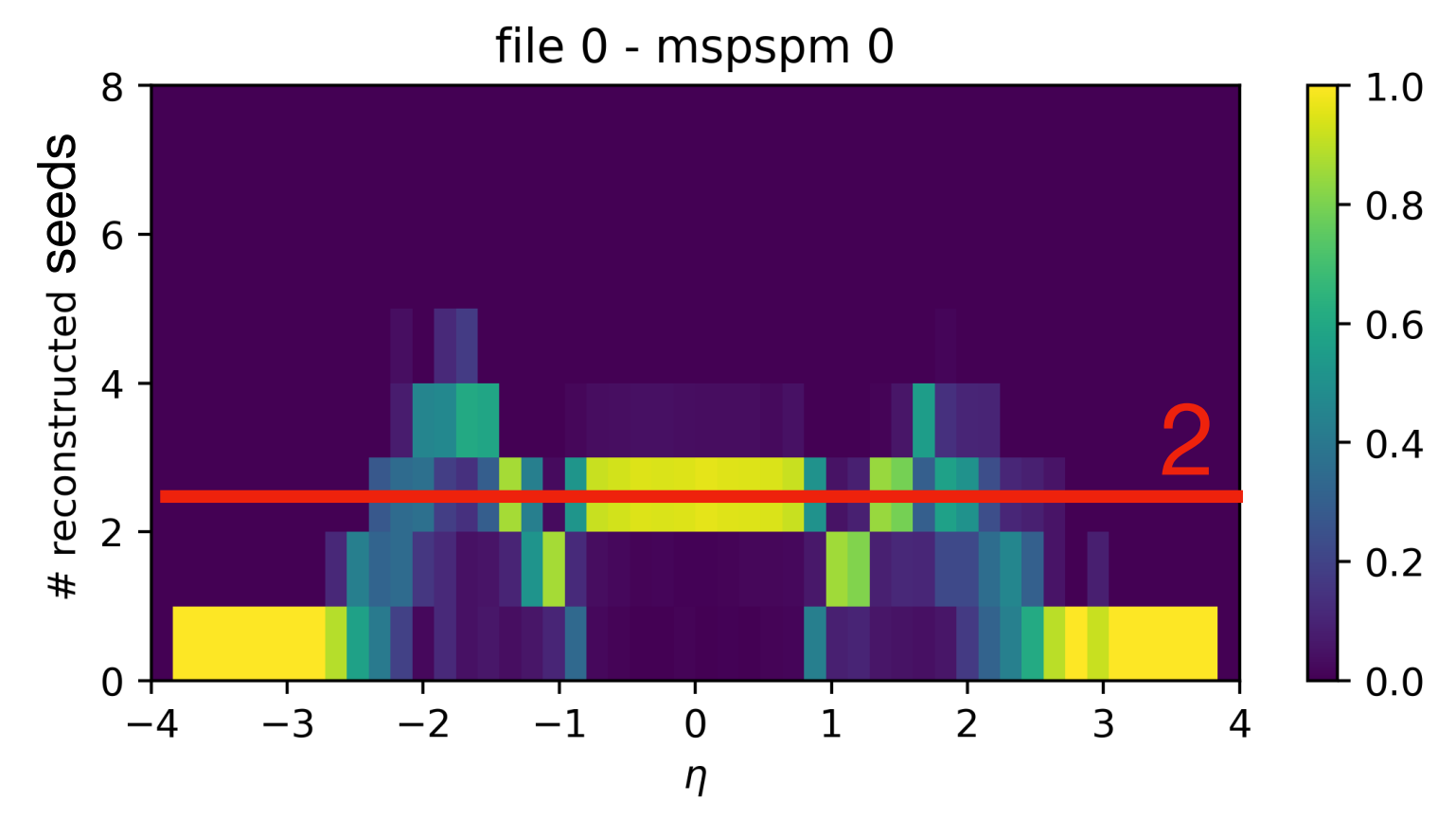
Middle space point can belong to up to 2 seeds
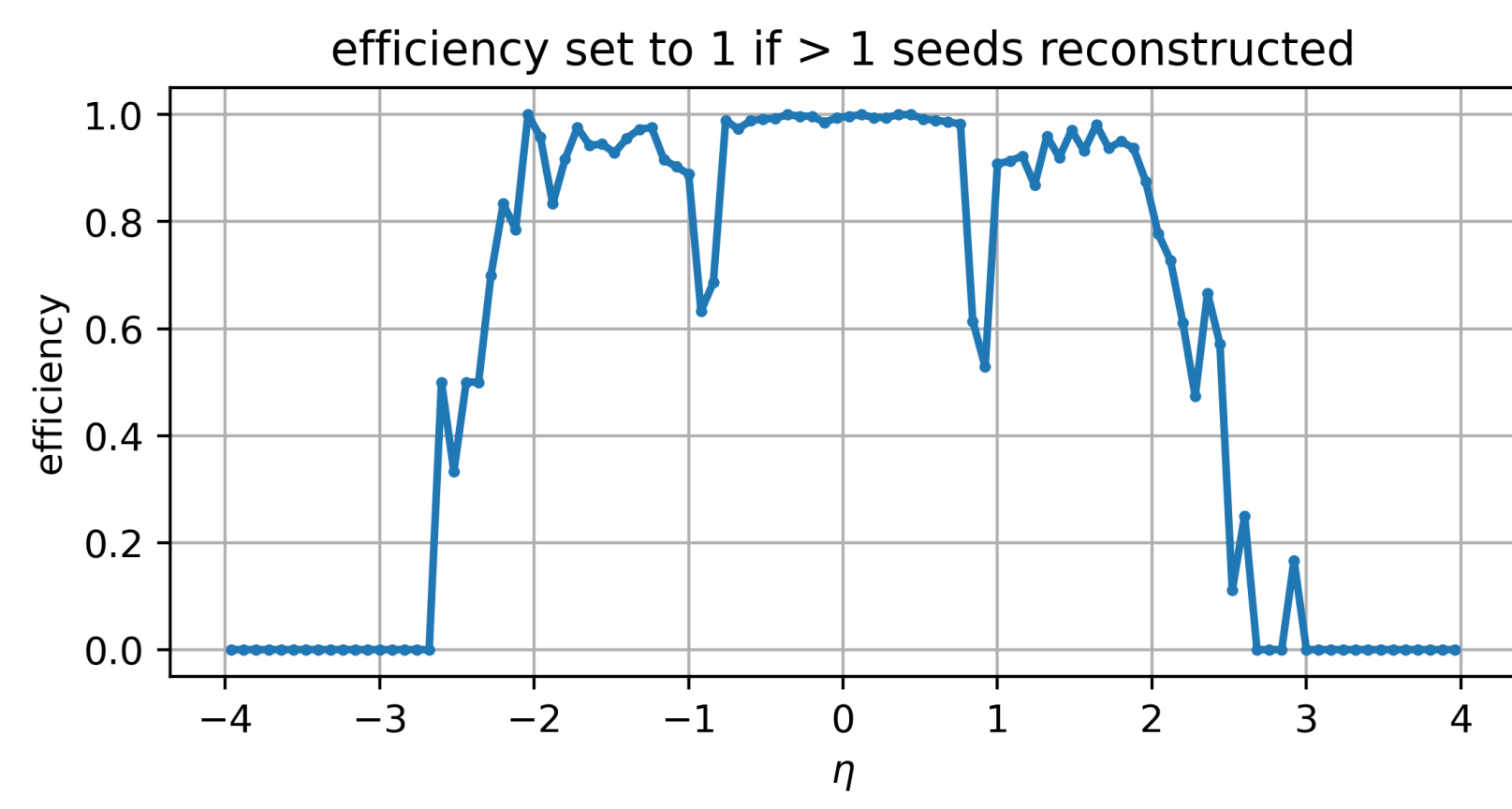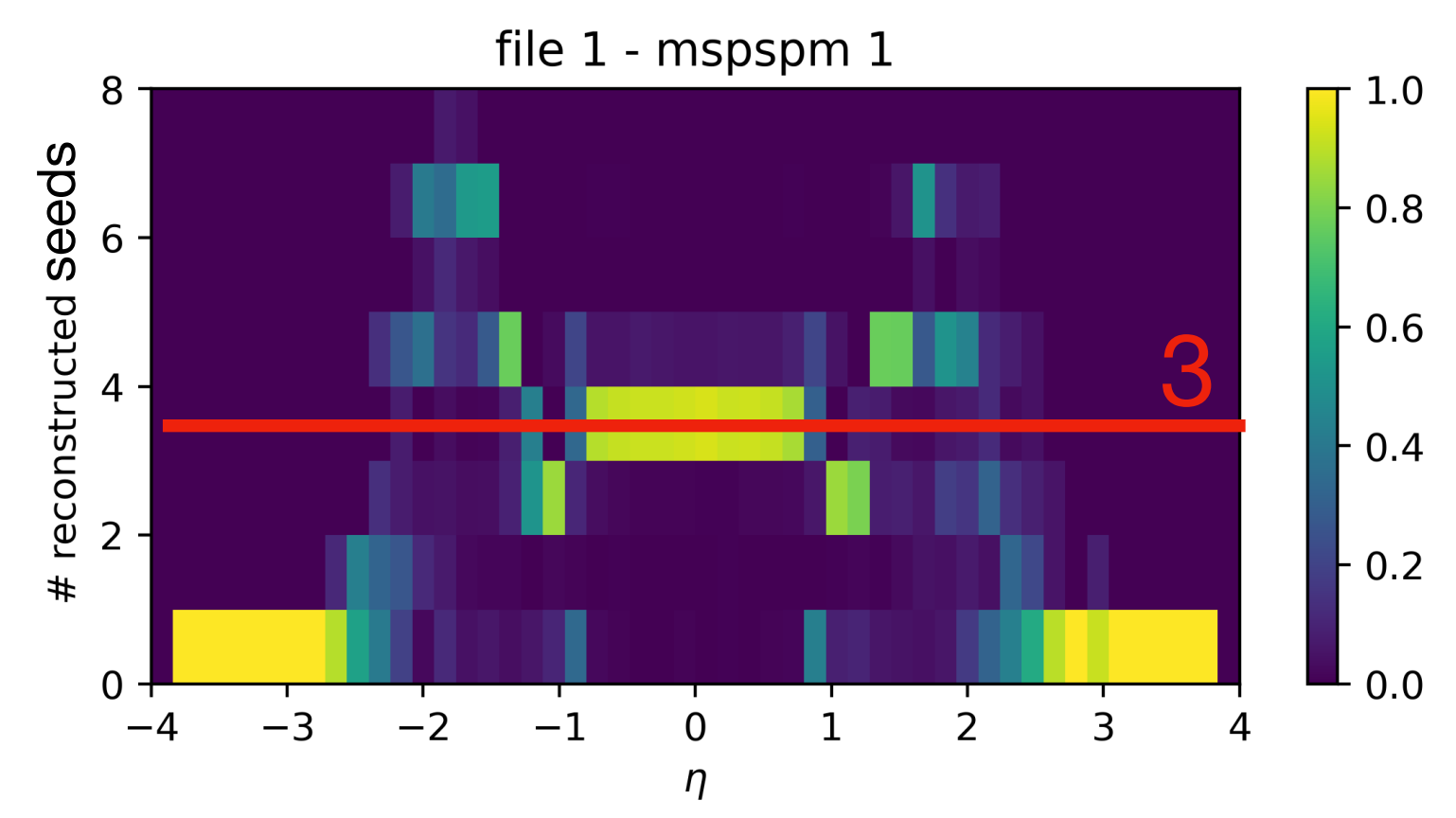
Middle space point can belong to up to 3 seeds

ACTS 21.1

$p < 10$ GeV/c

Duplicate seeds, not duplicate tracks?
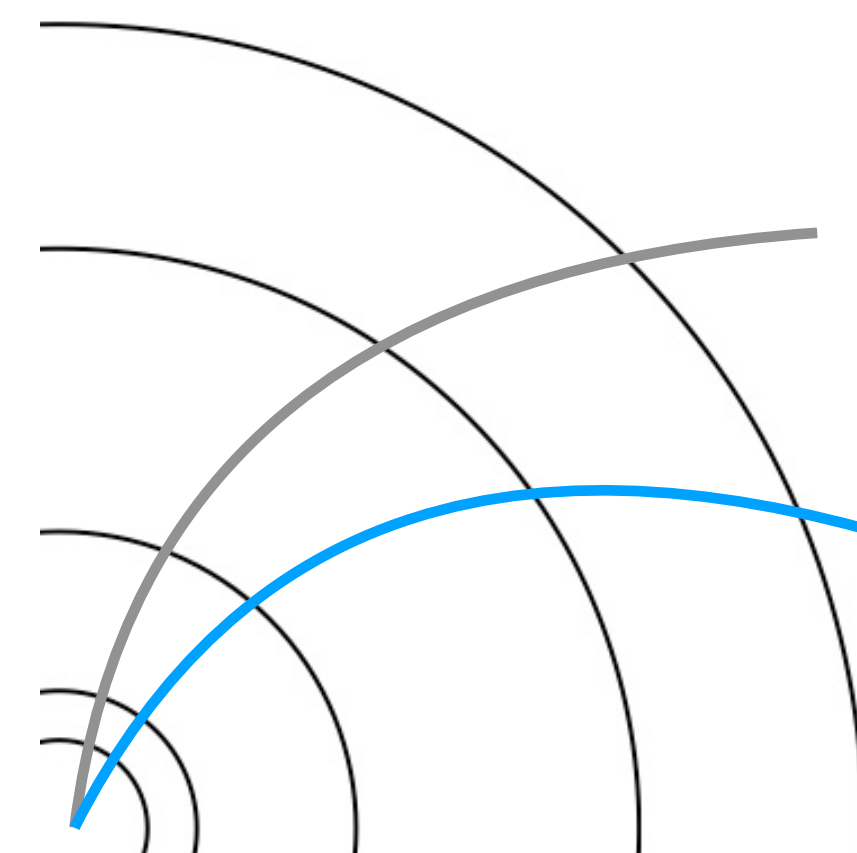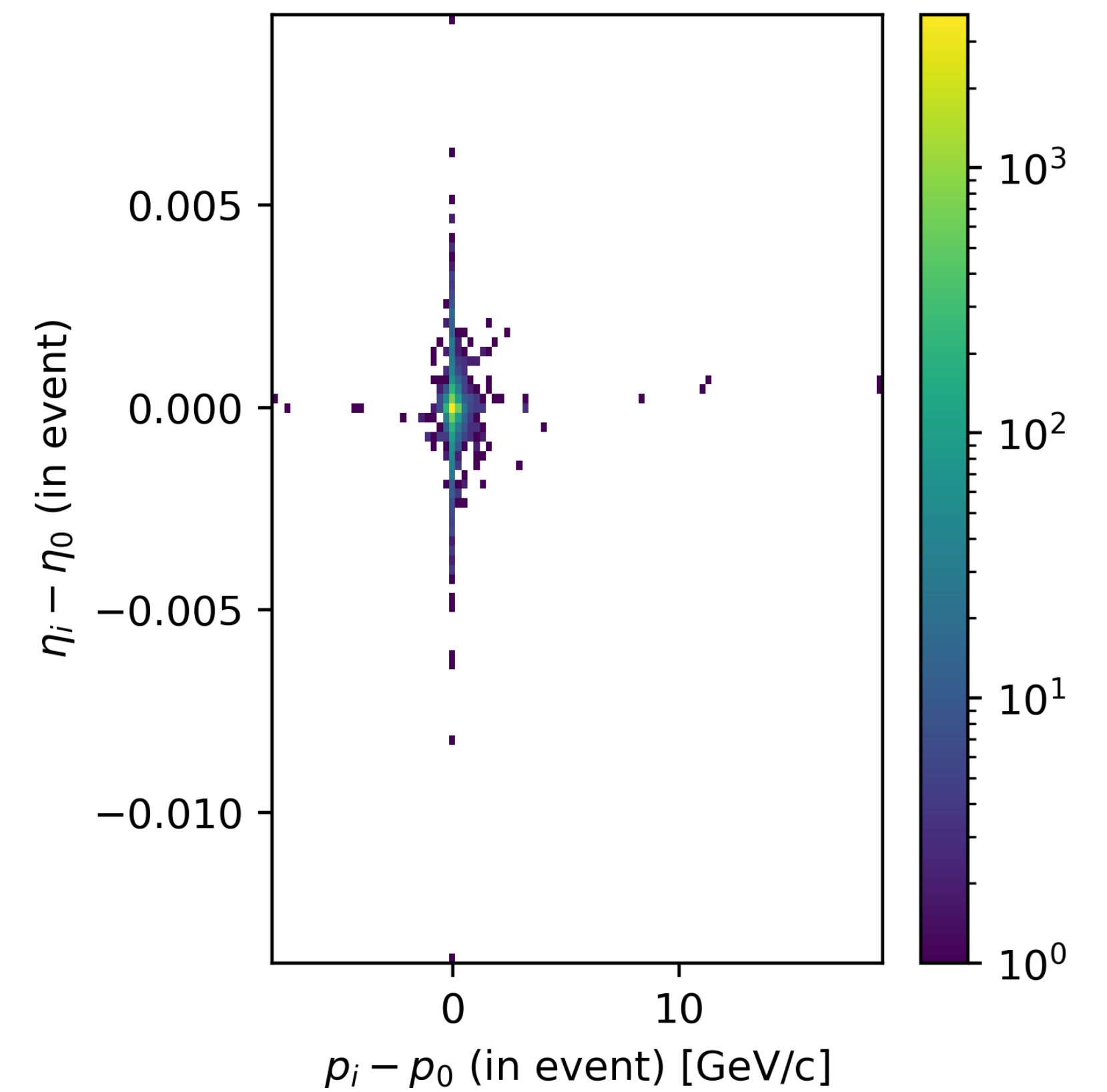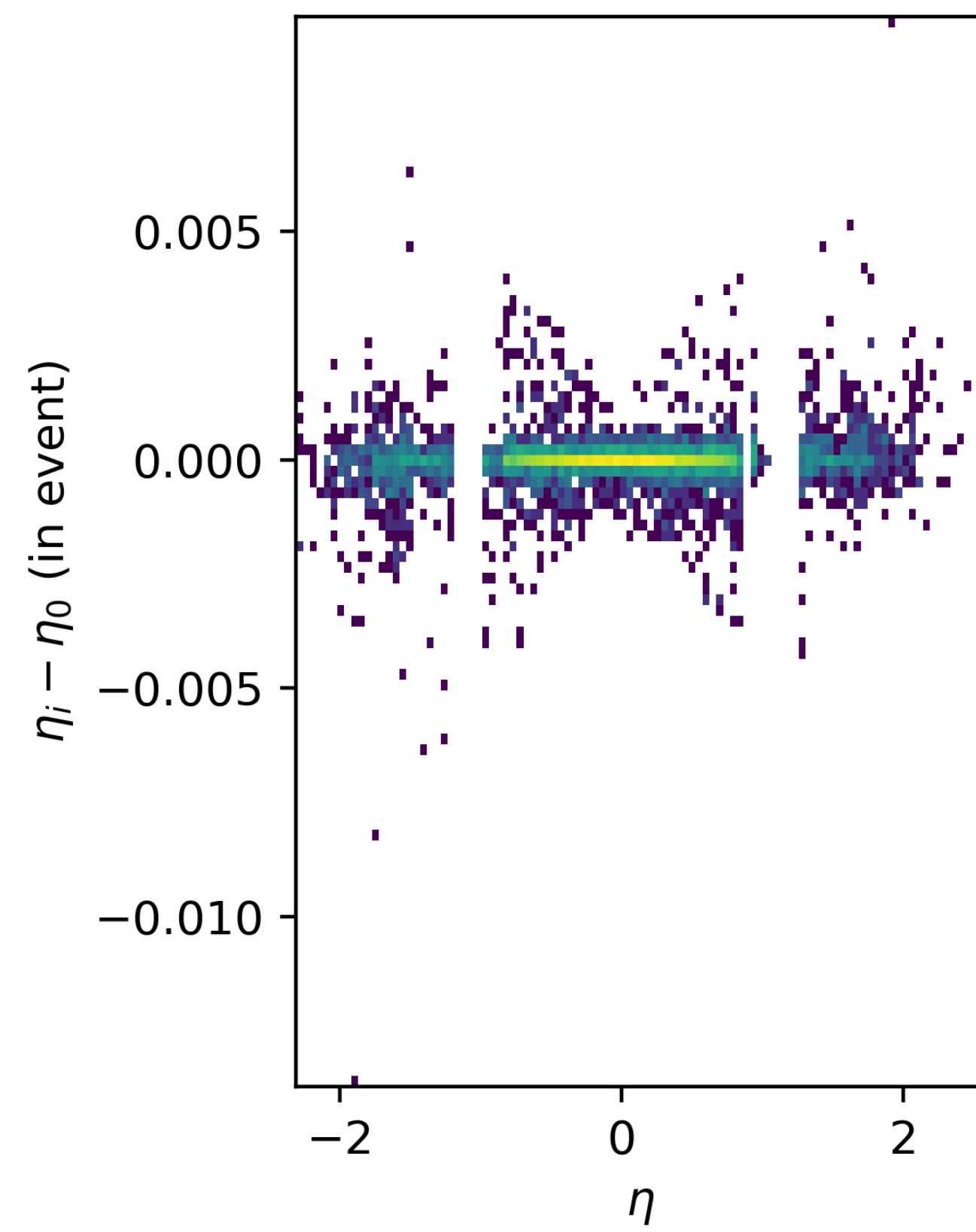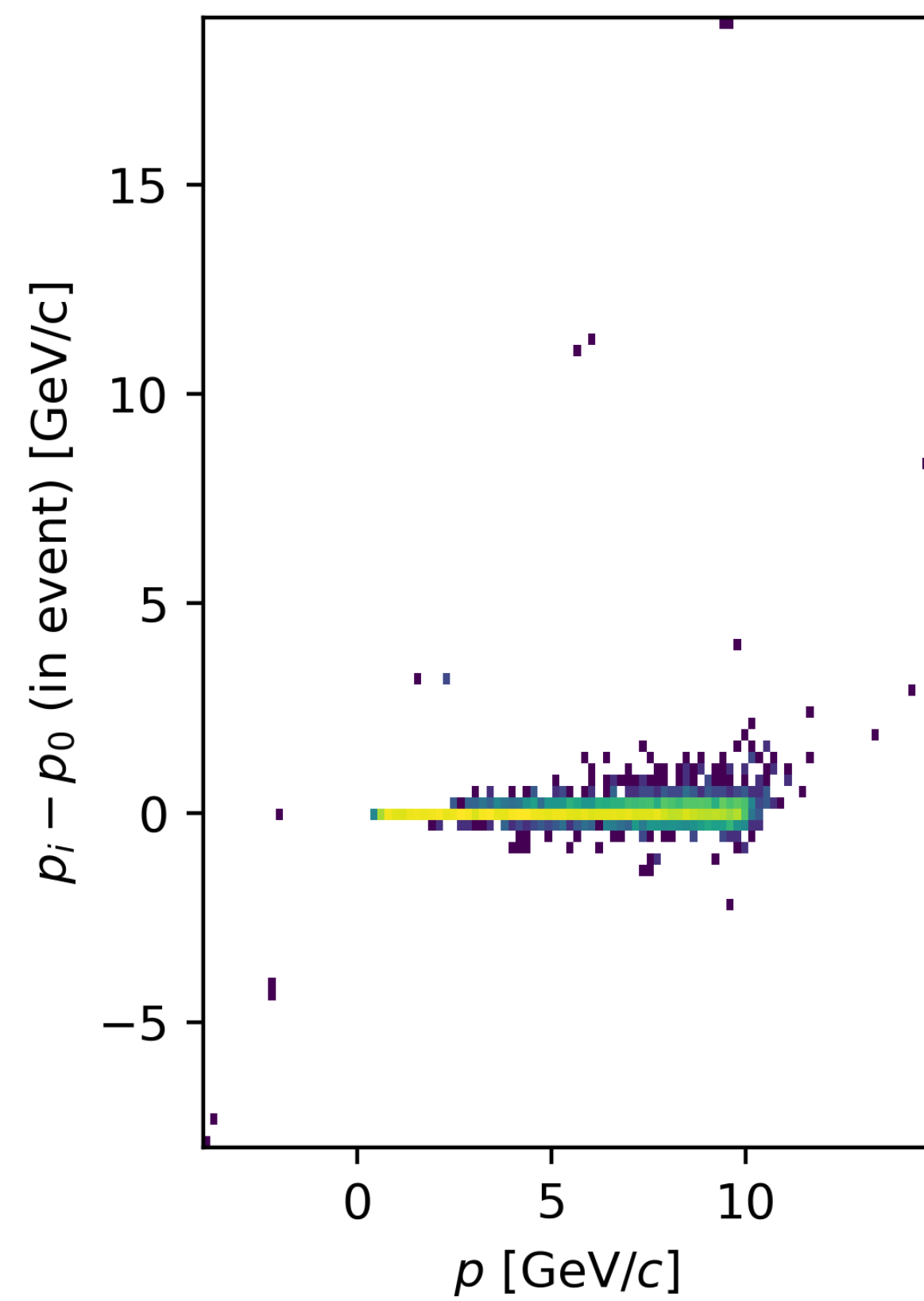
Three seeds,
One track

vs
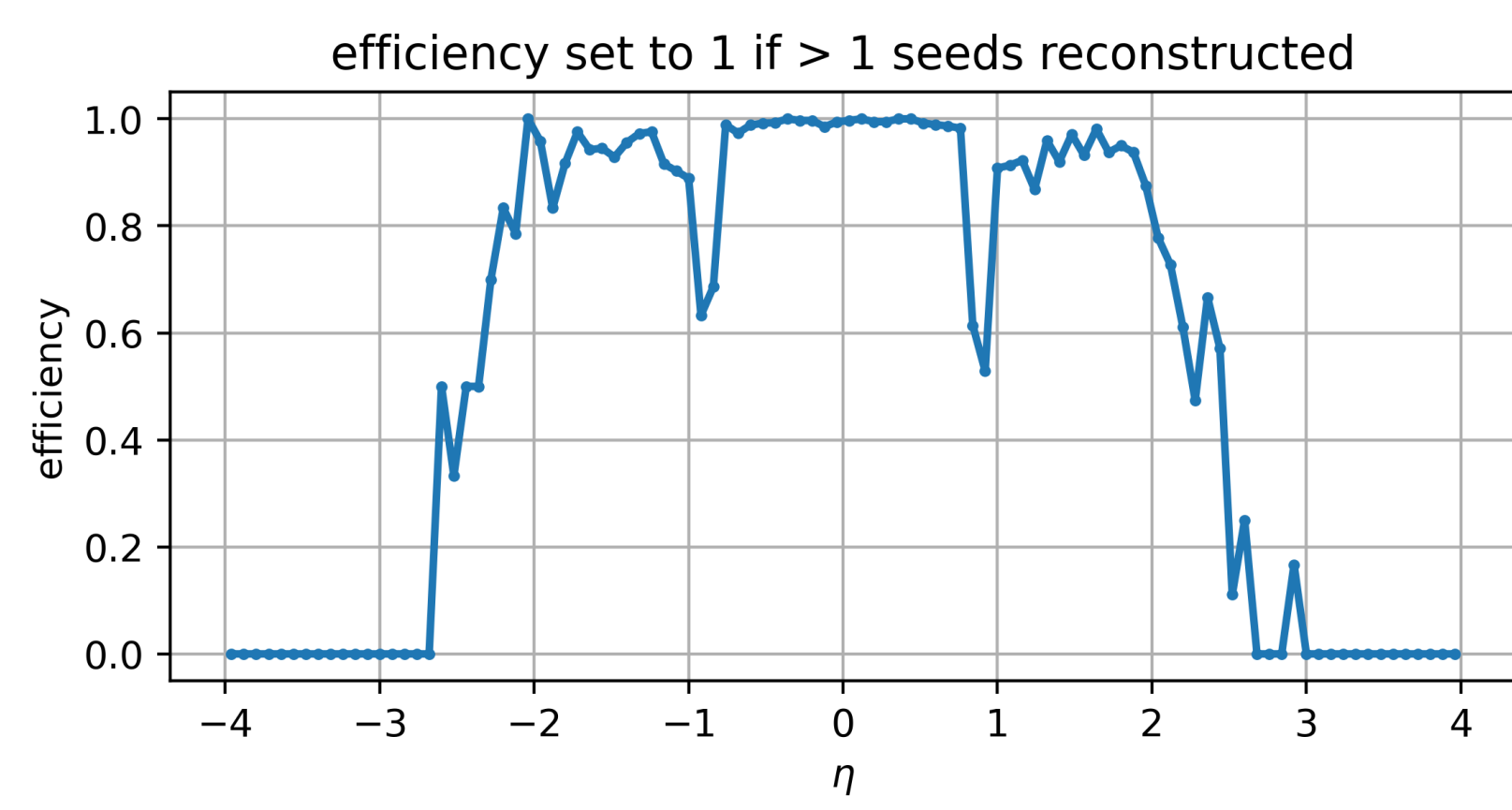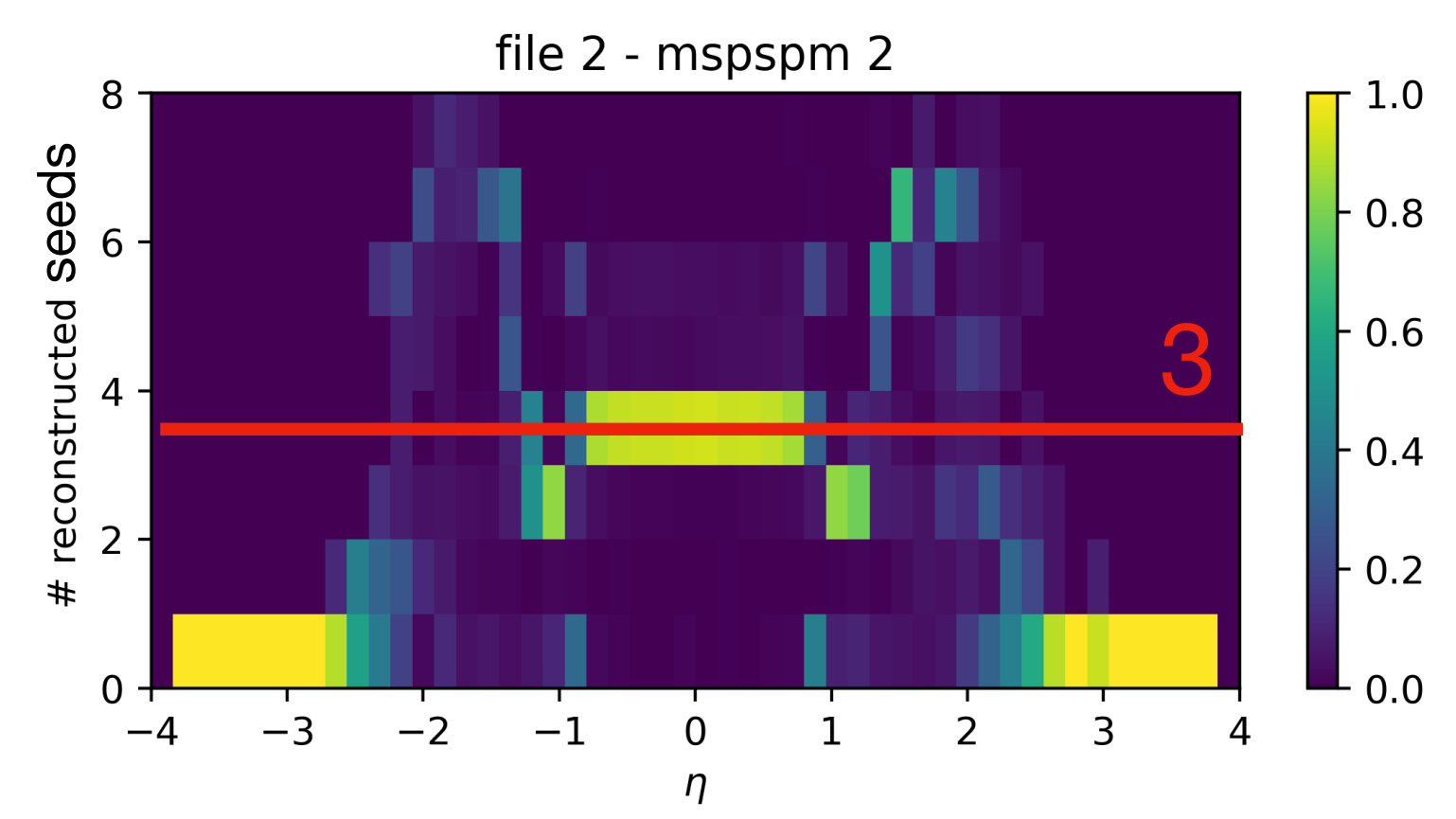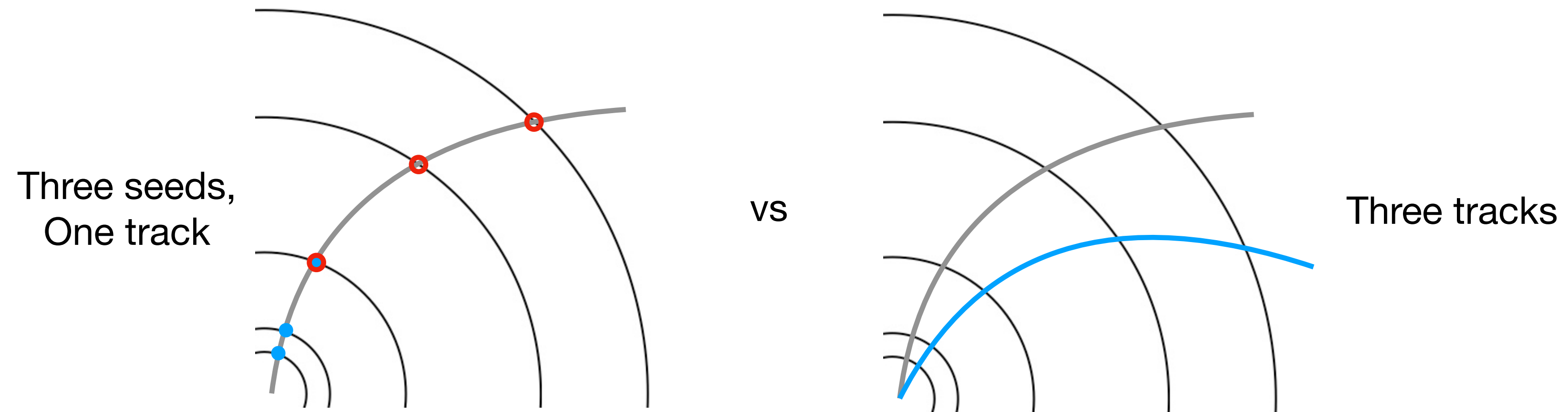
Three tracks

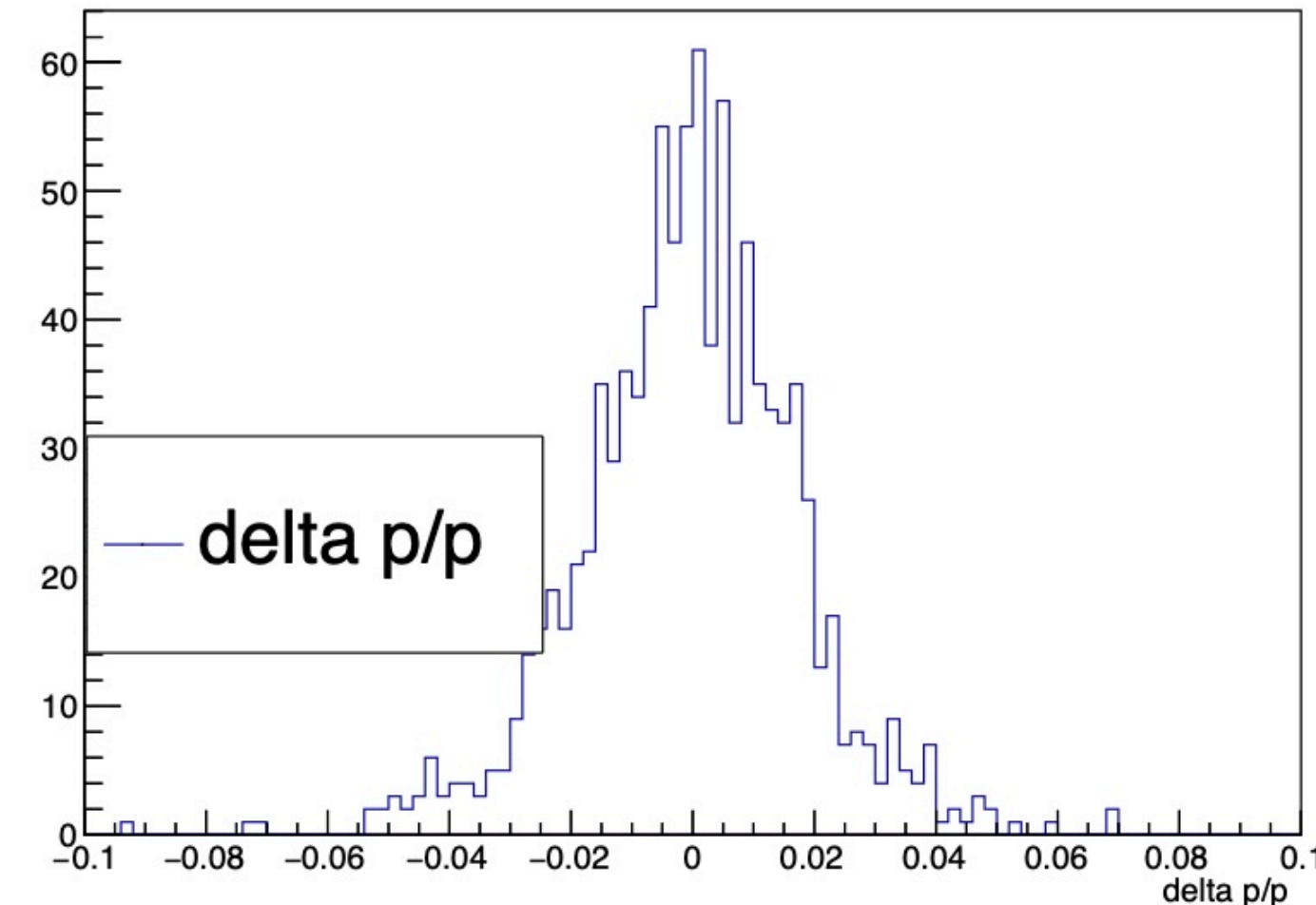# Duplicate seeds, not duplicate tracks?

ACTS 21.1

Three seeds,
One track

vs

Three tracks

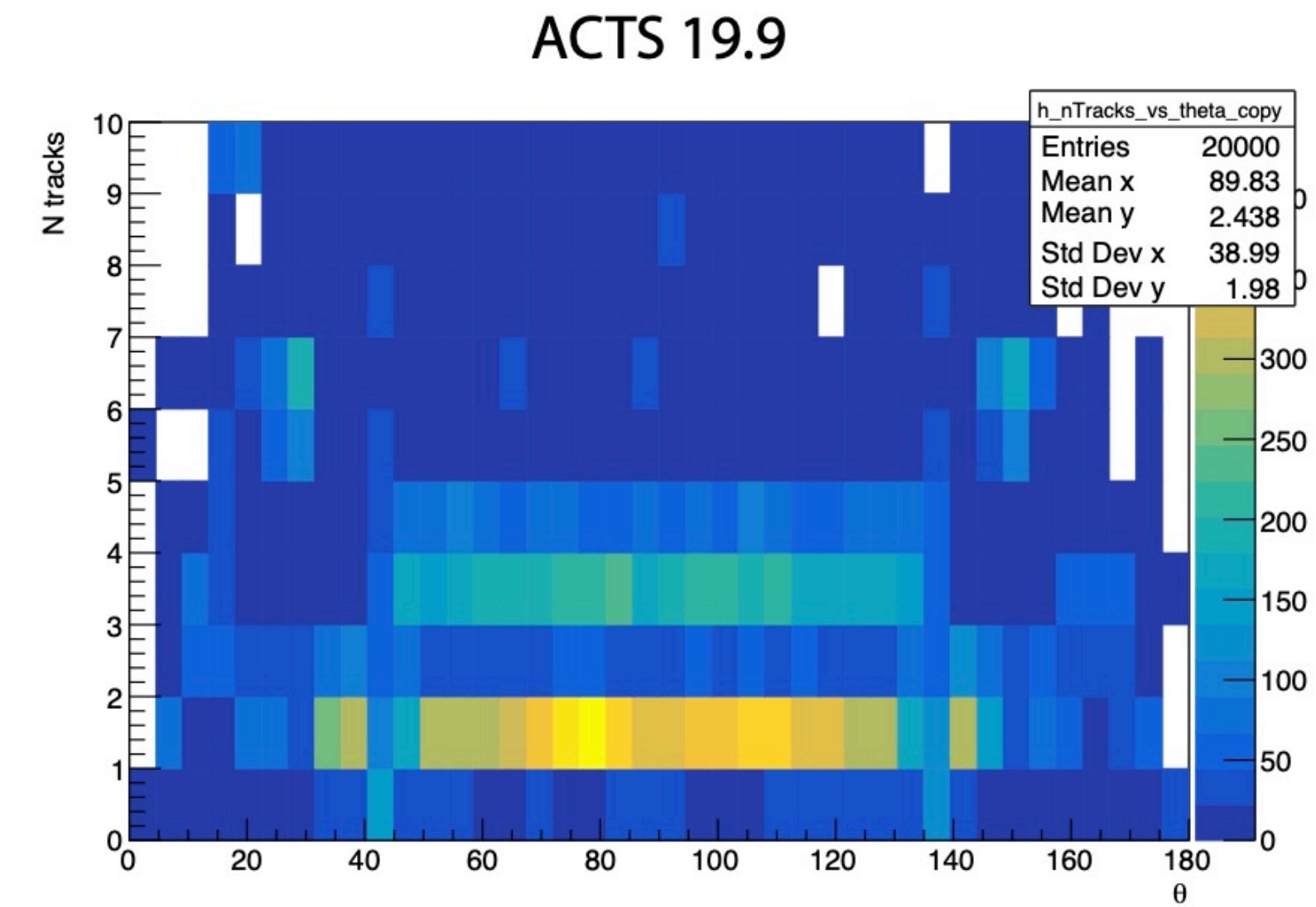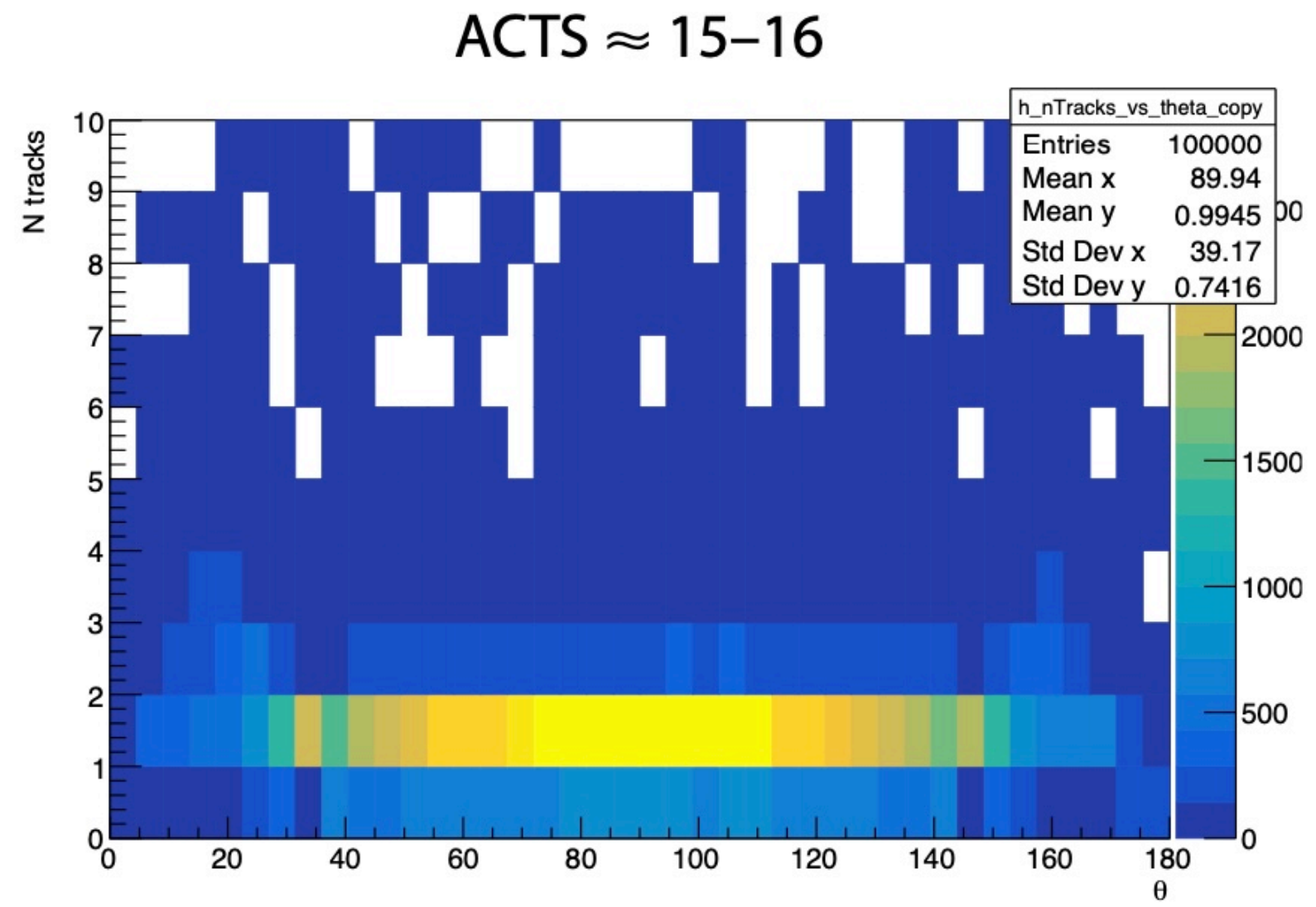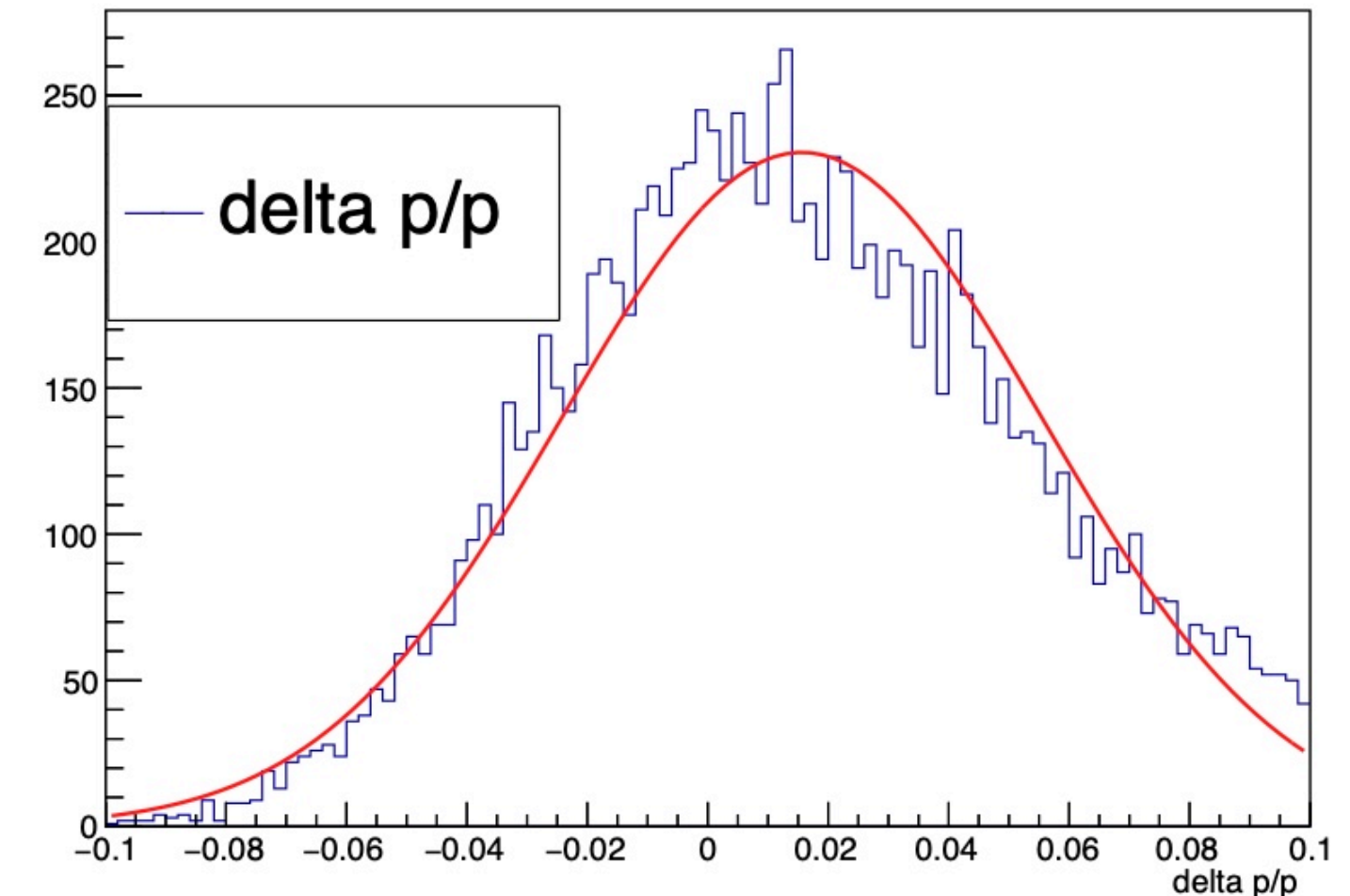# Duplicate seeds, not duplicate tracks?

If I remove duplicates when they are
close to the first reconstructed seed
in p (<0.1 GeV/c) and eta (<0.0001)

ACTS version impact

ACTS ≈ 15–16

ACTS 19.9
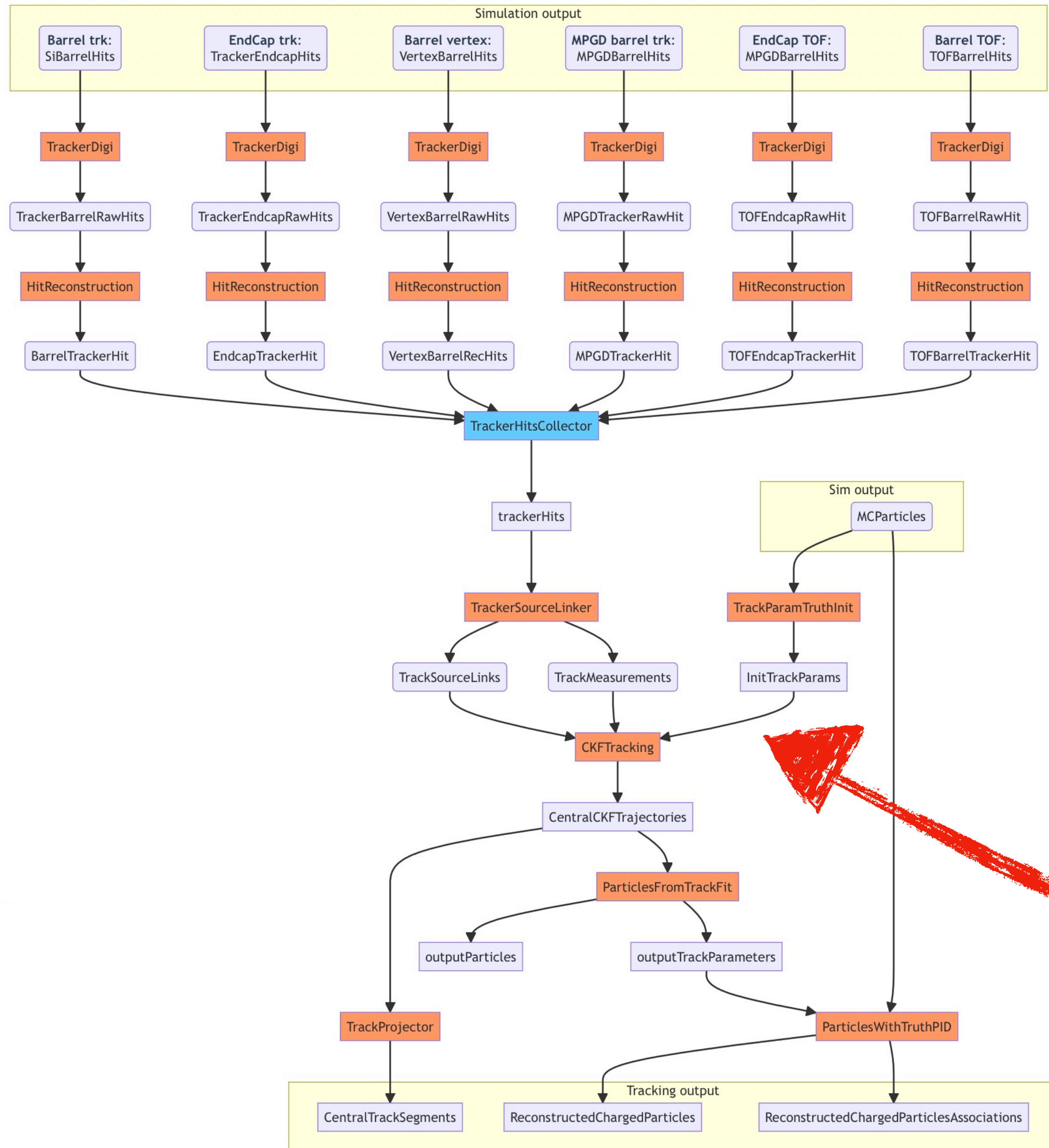

$1 < p < 2\,\text{GeV}/c, 2 < \eta < 2.5$

ACTS 19.9, ≈ 2%

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

ACTS 20.3, $3.98 \pm 0.03\%$

# Realistic seeding not used for track reco at the moment

- The orthogonal seeder is running within DD4HEP and finds seeds

- However, there's no option to use those seeds instead of truth

- Currently working on adding an option to switch

Summary

- Started exploring the phase space of seeder parameters

- While we see many duplicate seeds, they seem to describe the same track

  - Should define some criterion to remove duplicate tracks

  - e.g. using fit metrics (do not exist yet in the standard EICrecon output)

- Significant impact from ACTS version

- Currently, no option to use the orthogonal seeder (beyond producing the seeds)
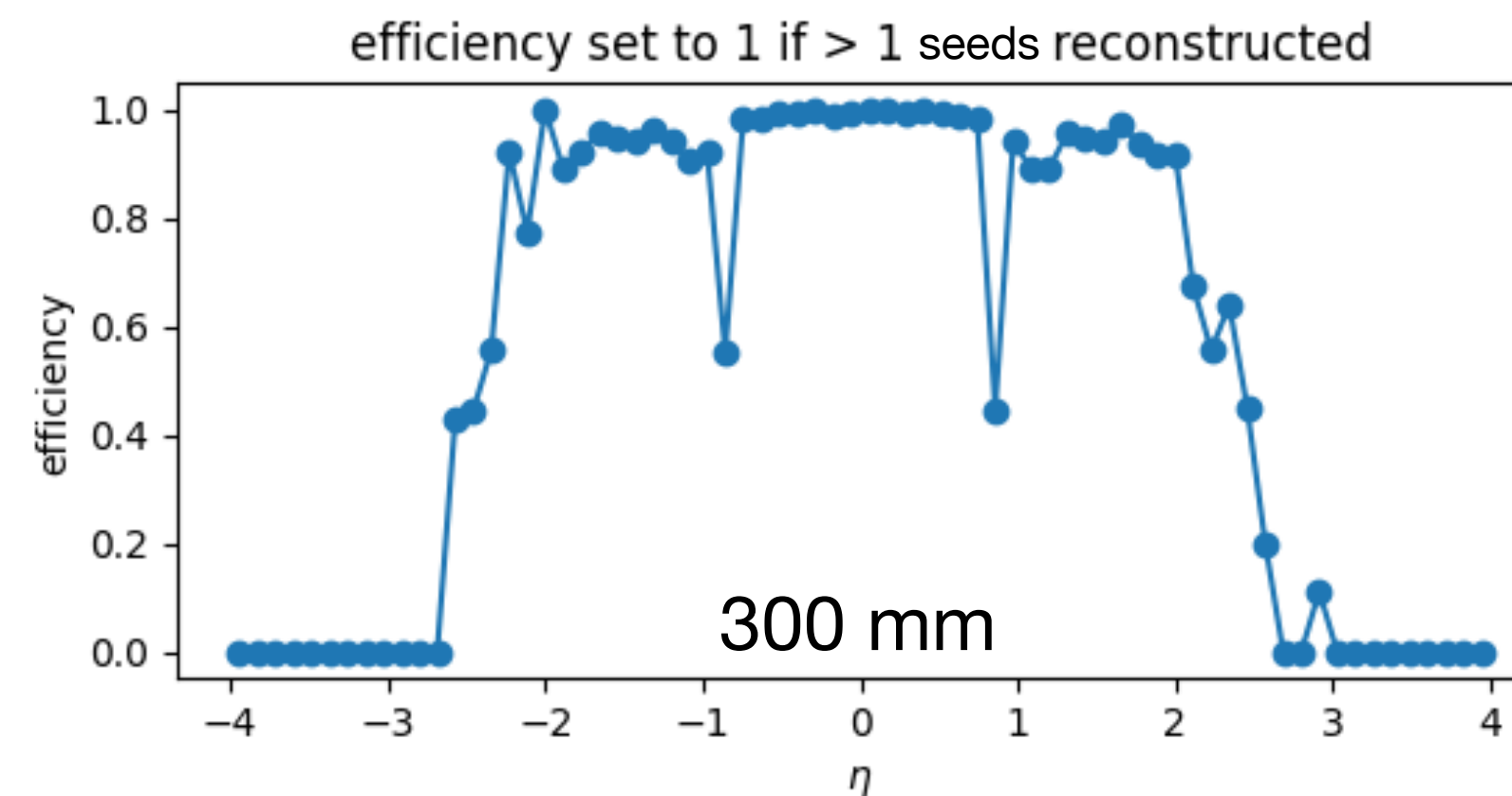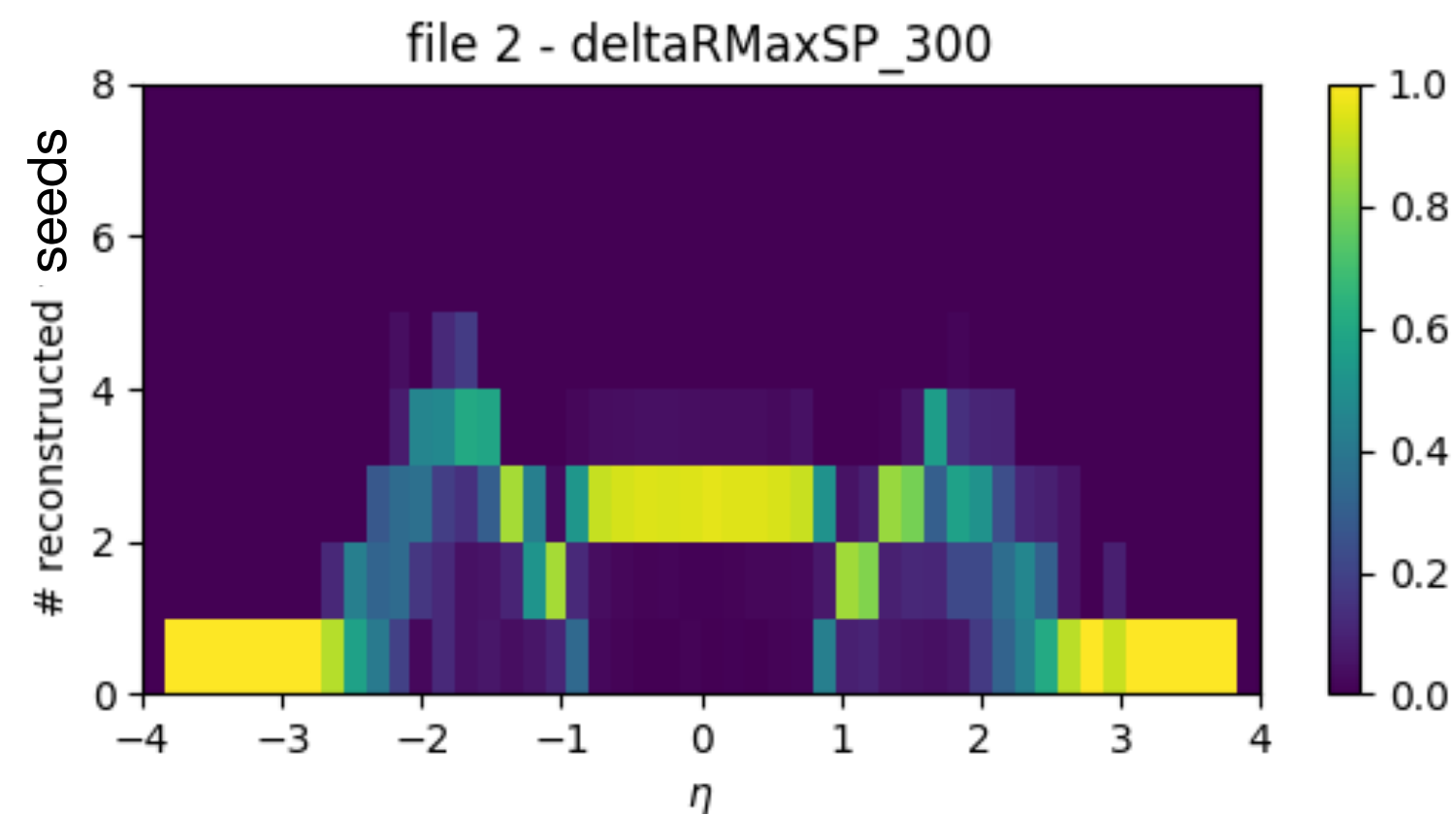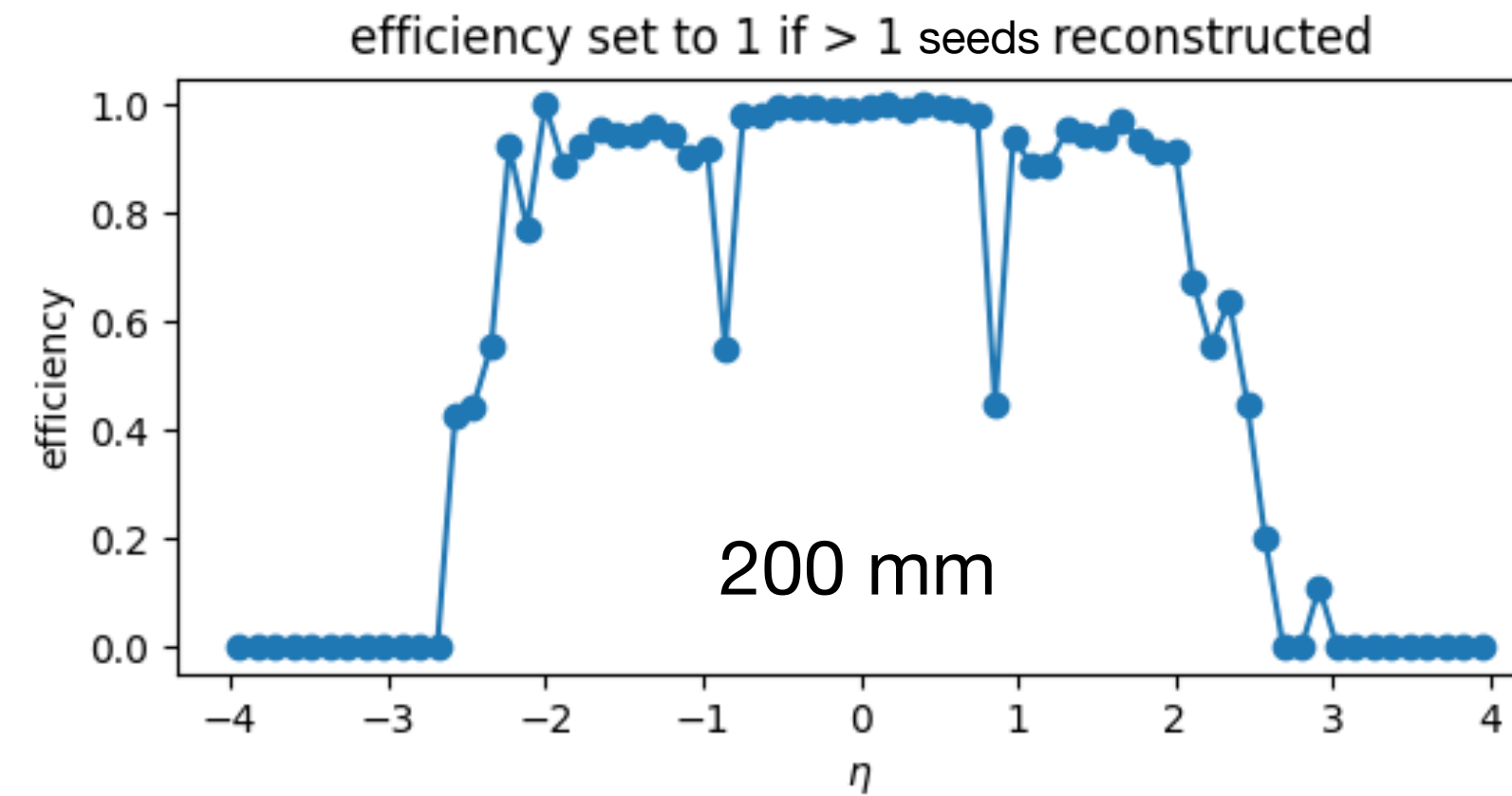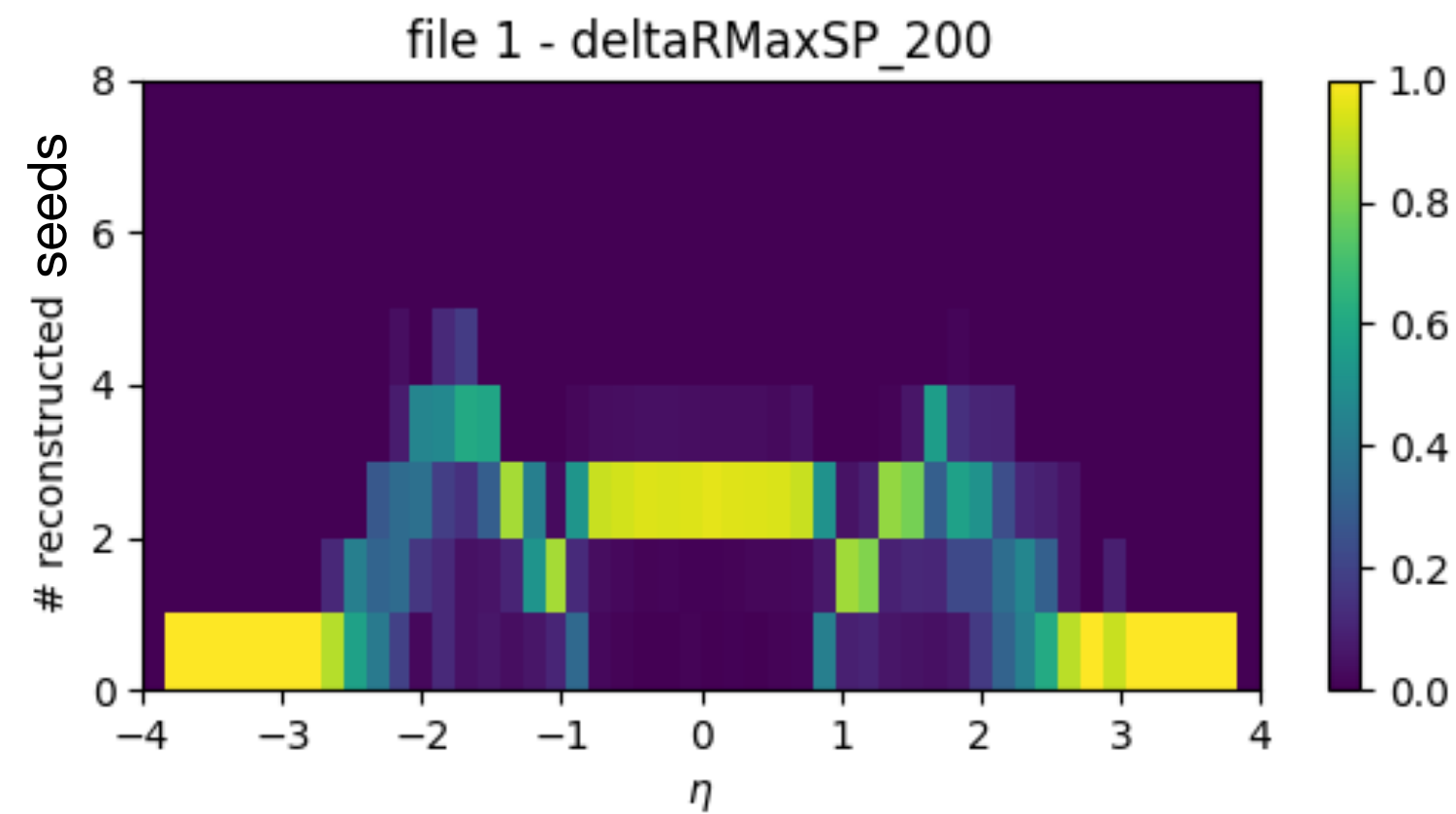
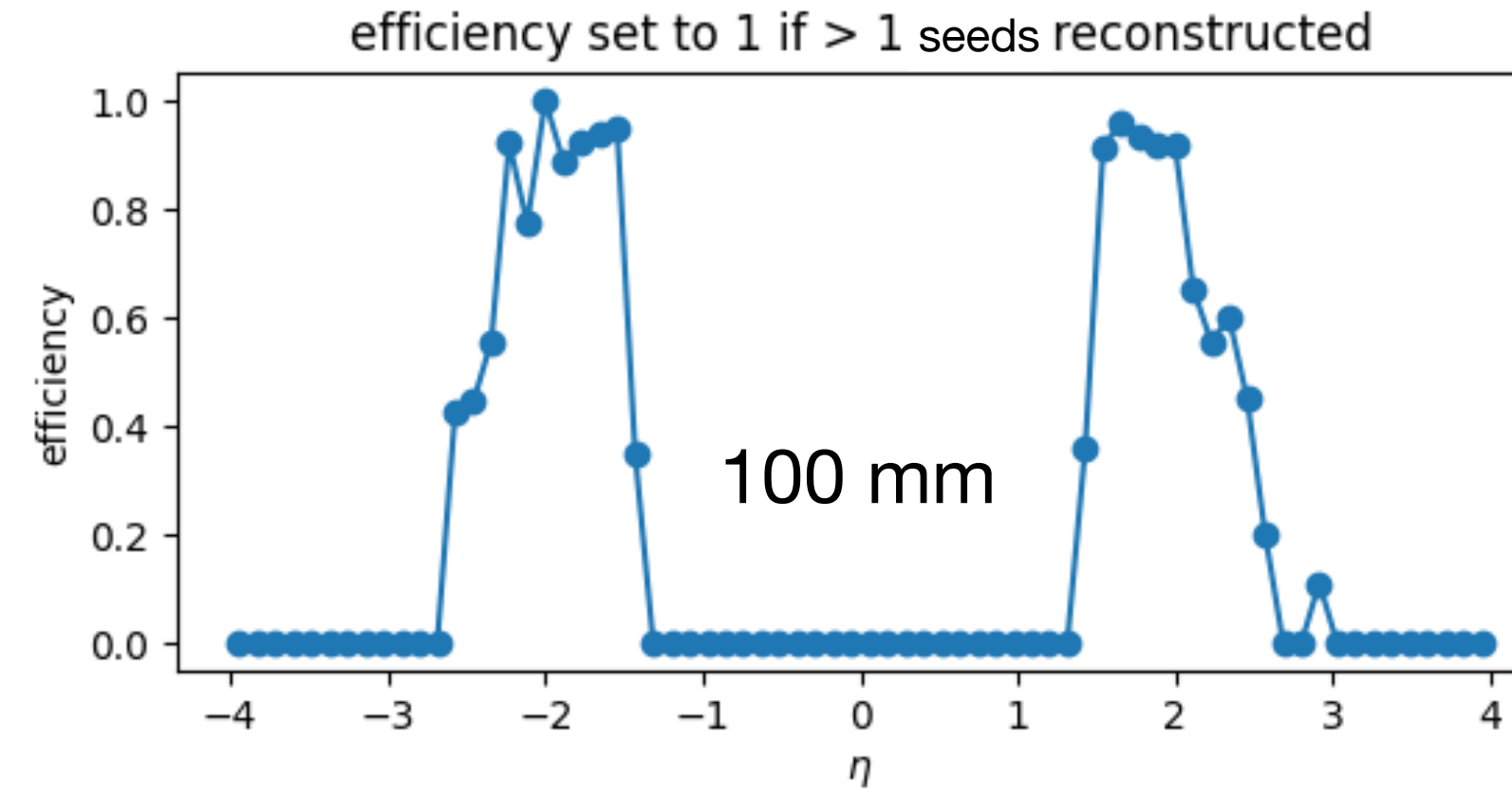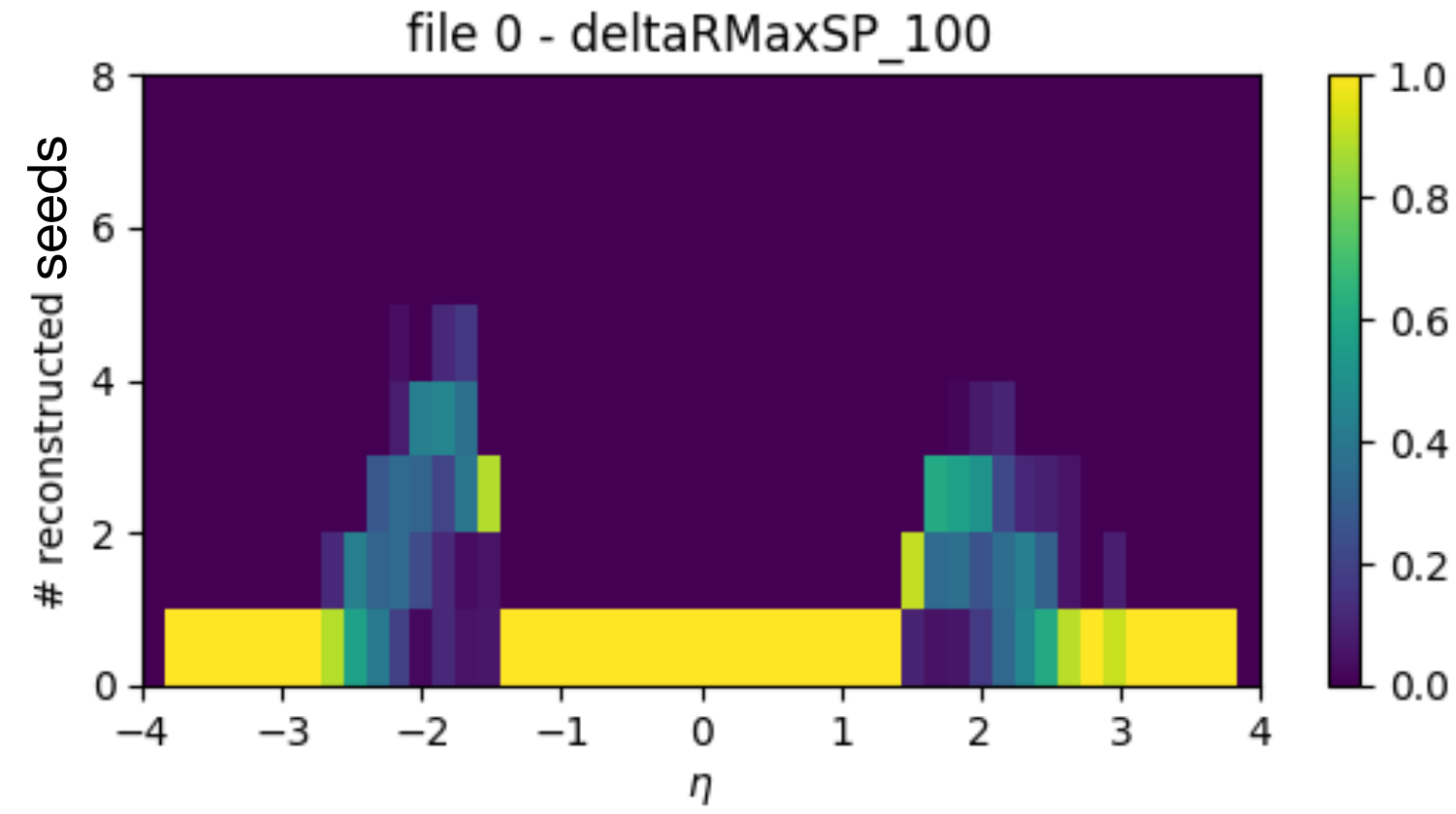# Thanks for your attention
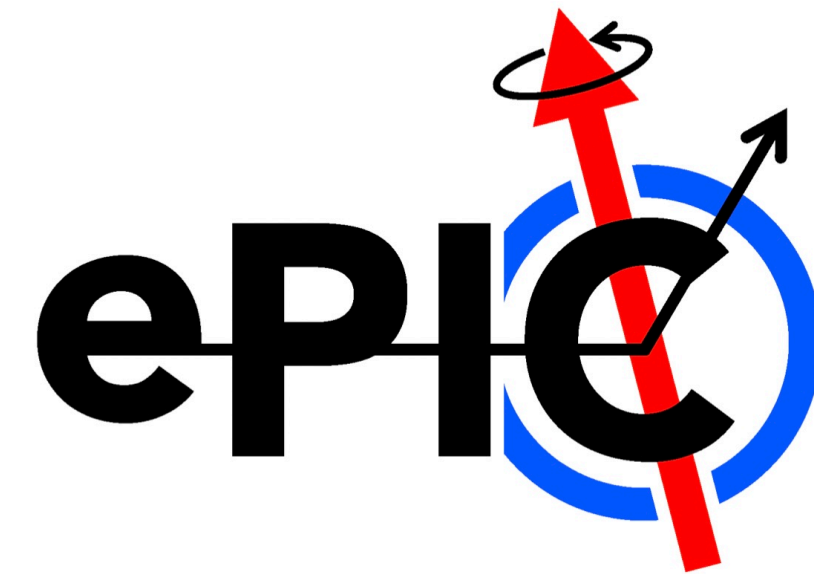
Backup

Delta R max SP

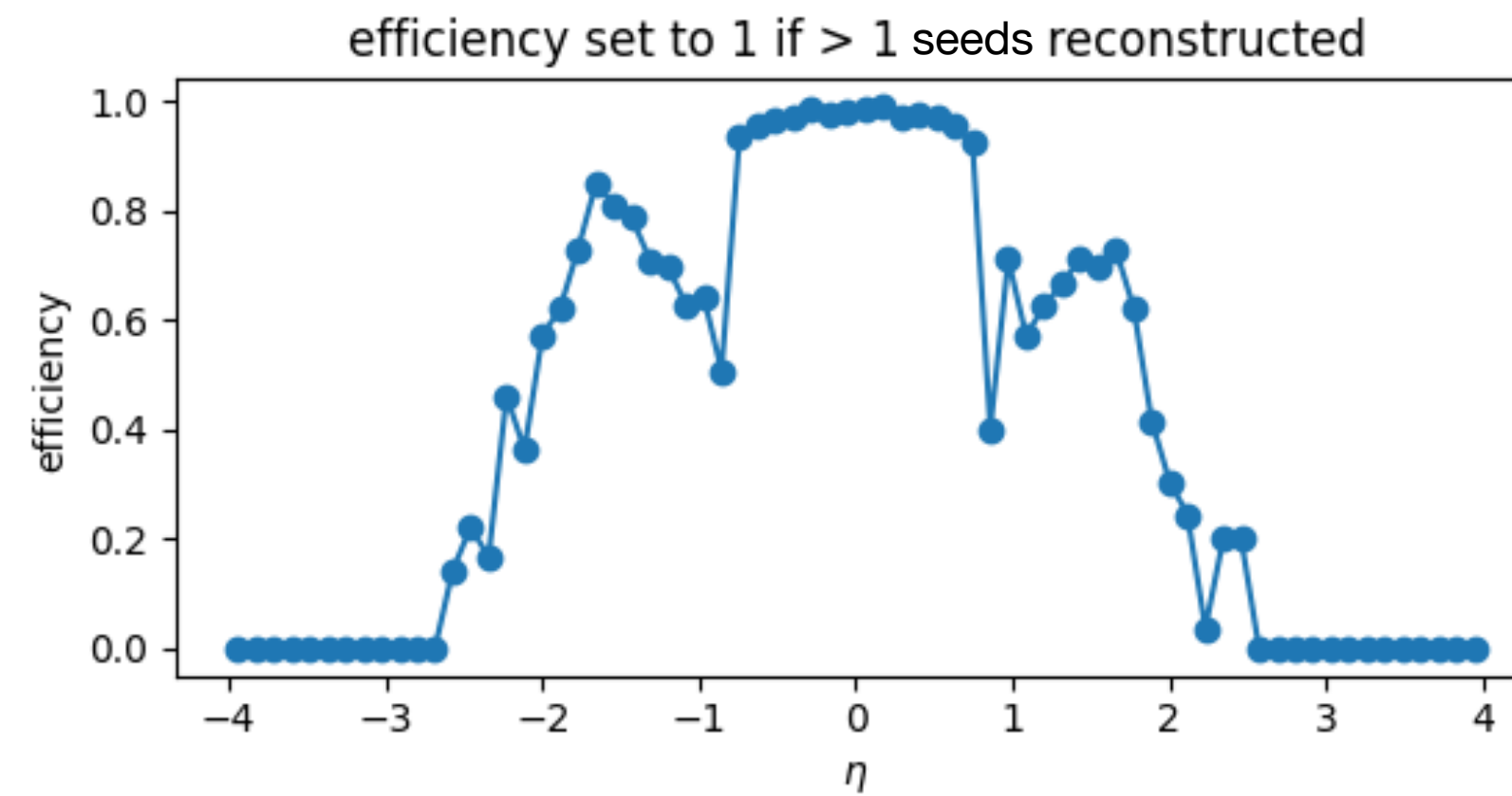Max distance in r between middle and top (or bottom) space point in one seed
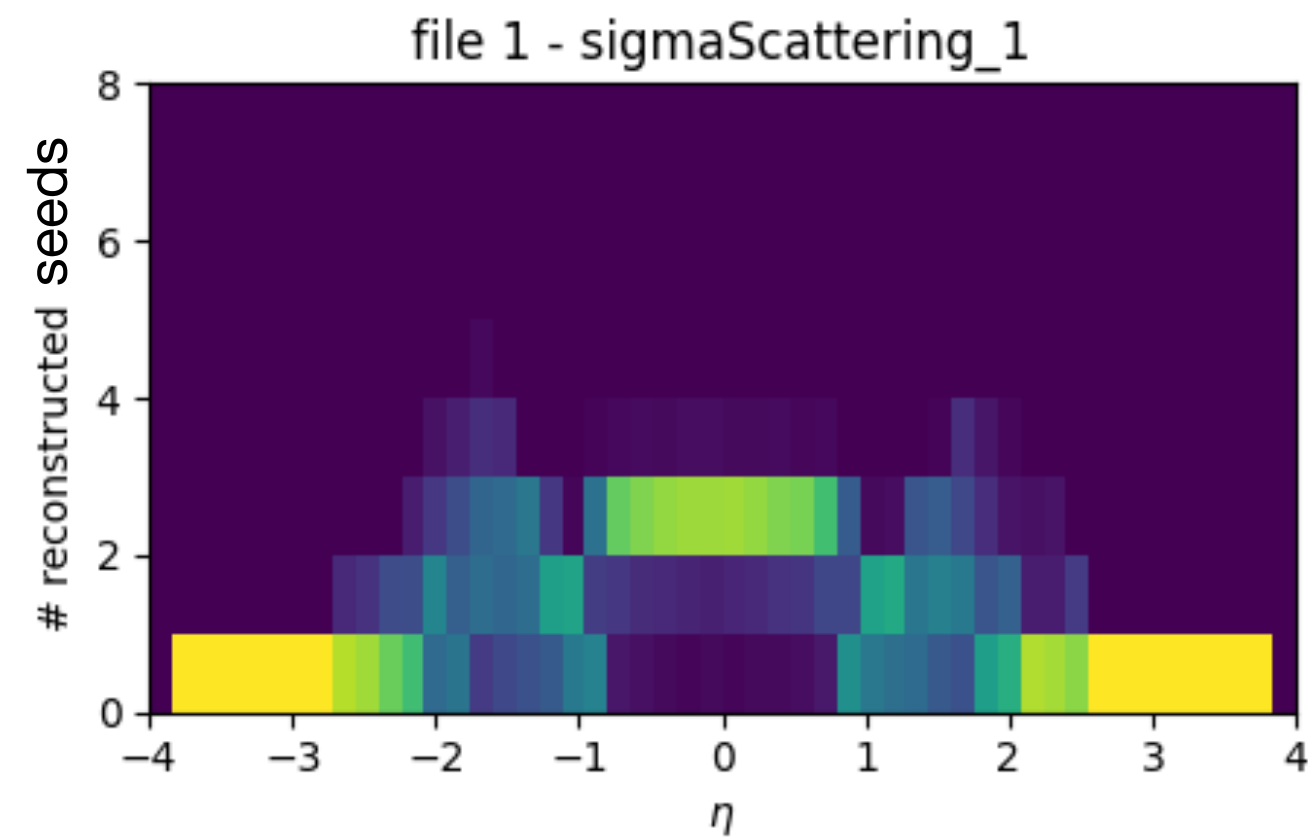
ACTS 21.1

Exploring different Delta R max SP parameters

Sigma scattering
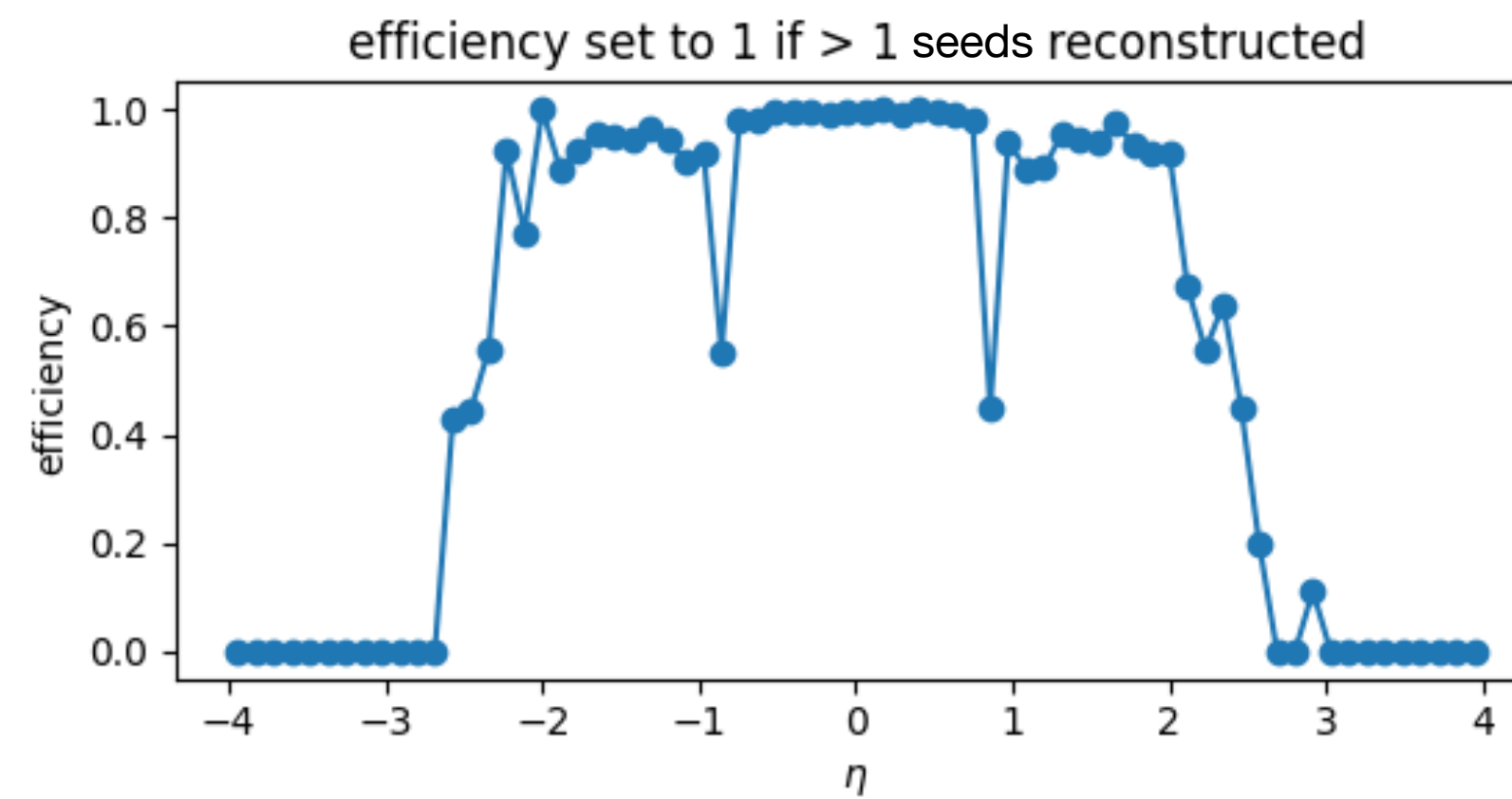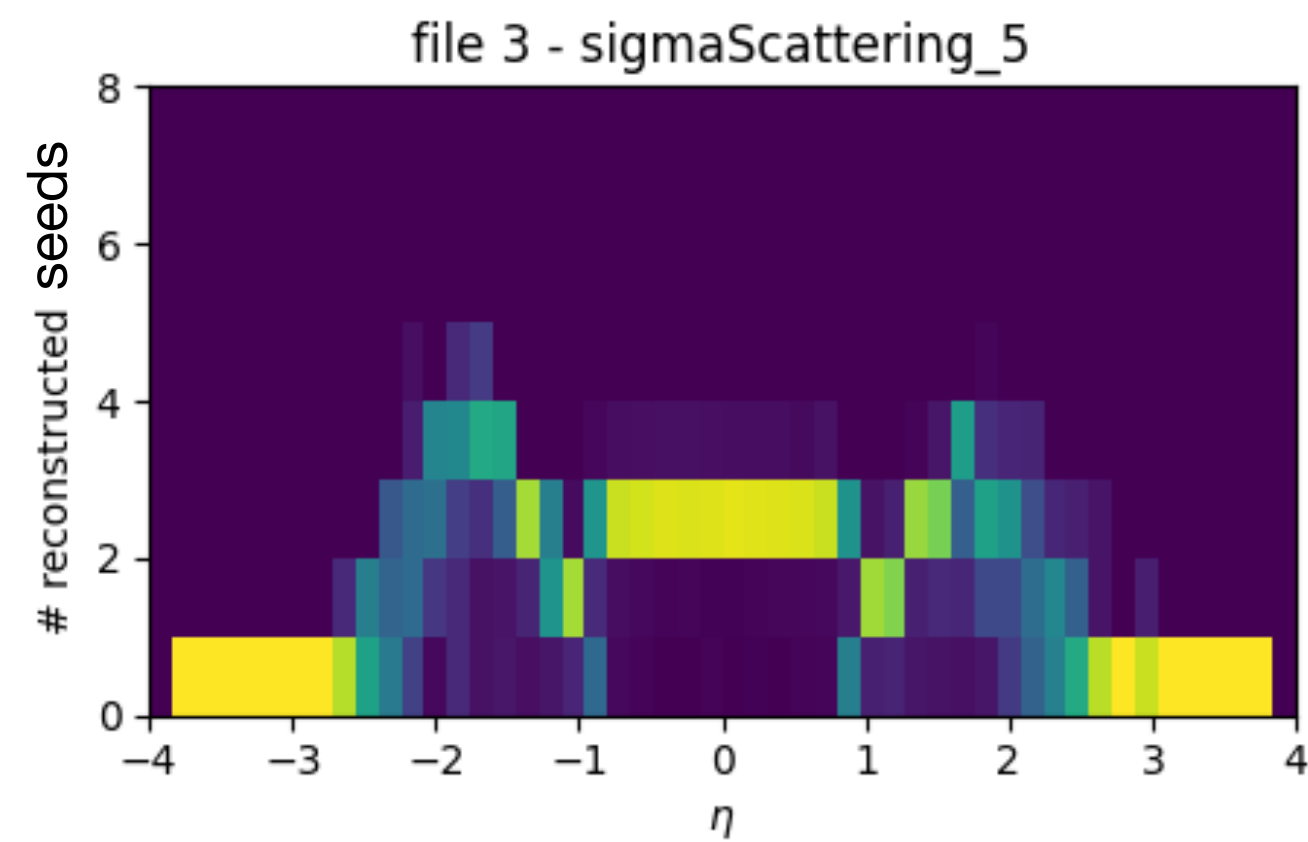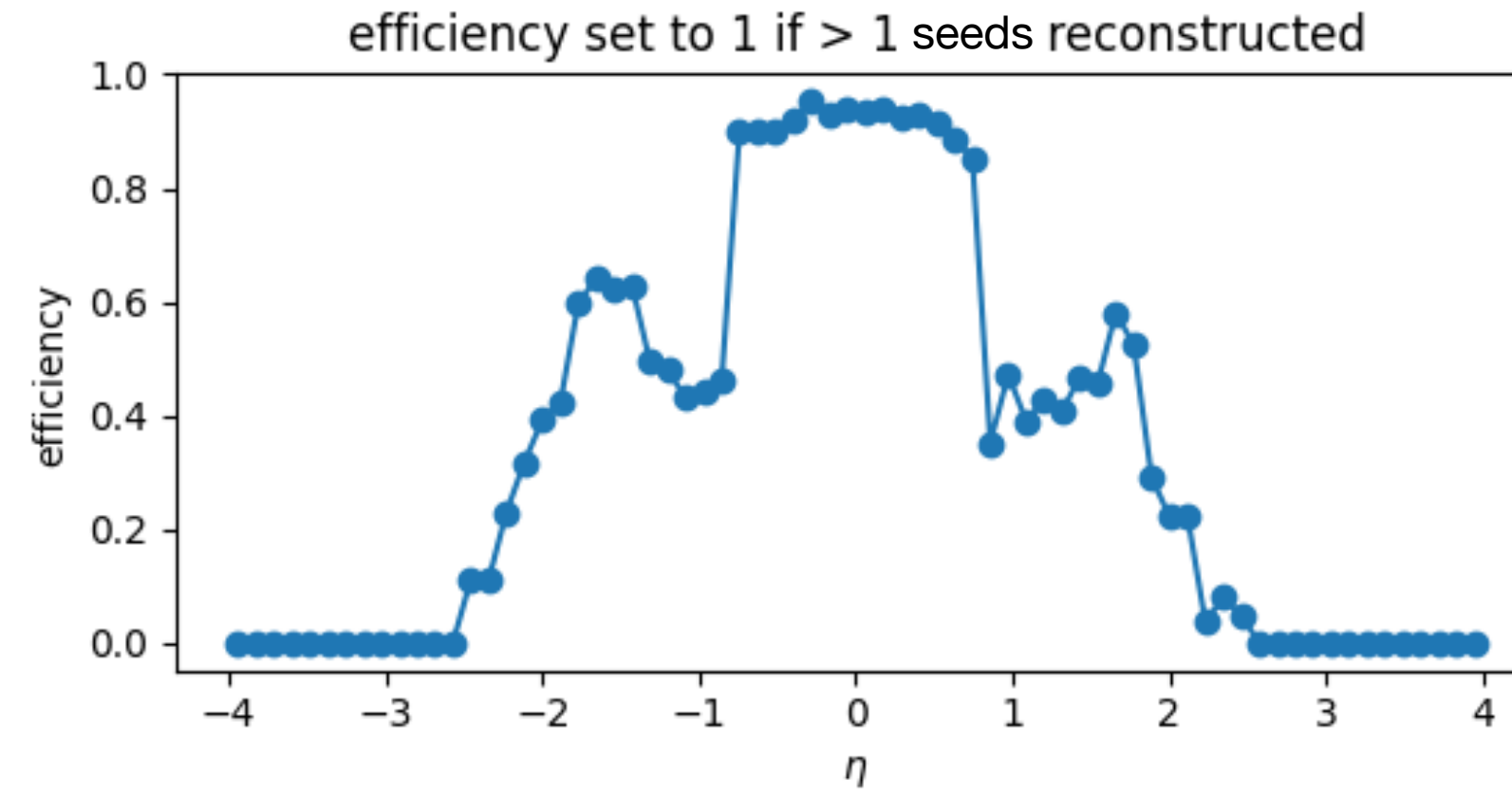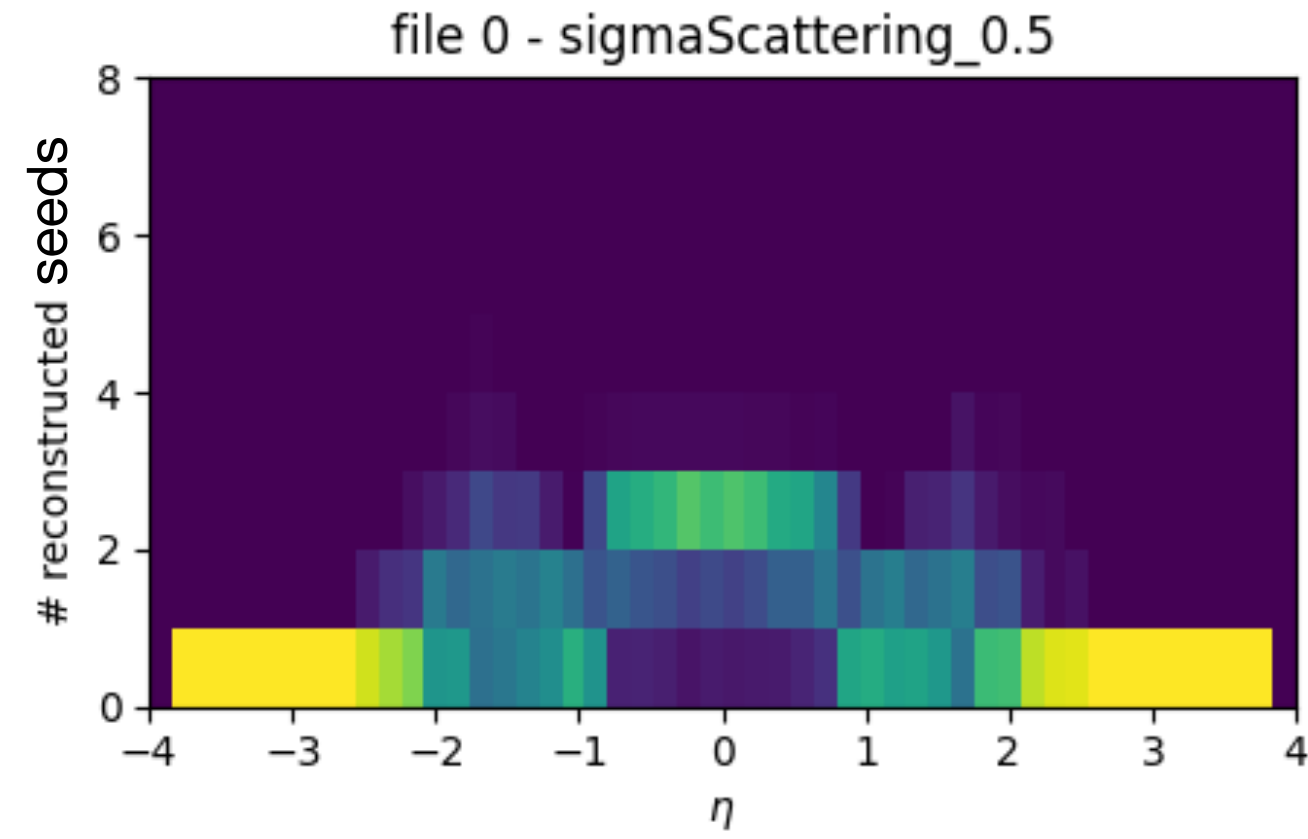
Source (Y.S. Lai's params)

```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;
```

```cpp
/// 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;
```