BERKELEY LAB
Bringing Science Solutions to the World

U.S. DEPARTMENT OF ENERGY
Office of Science

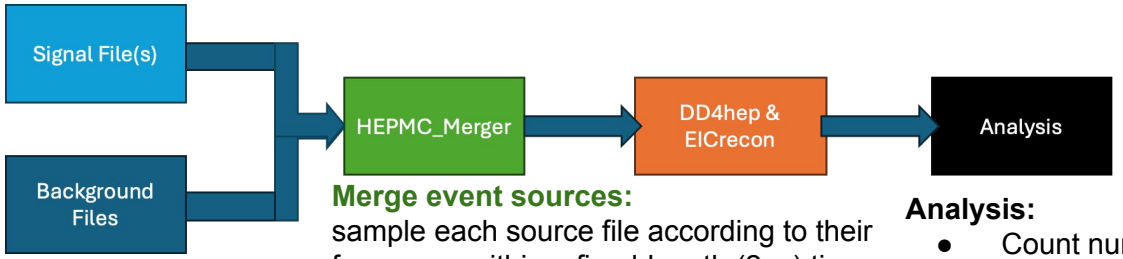
Background Analysis Update

Shujie Li

ePIC Tracking++ Meeting

09.10. 2025

Signal+Background Event Samples



Merge event sources:
sample each source file according to their frequency within a fixed-length (2us) time window

Analysis:
- Count number of digitized hits on STV per area per time

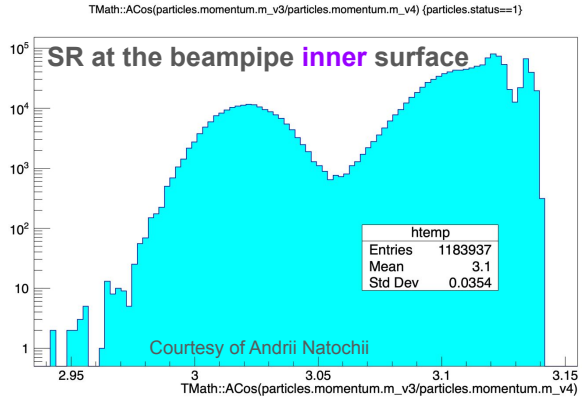
One event = one collision → (merged) One event = one 2us time slice that contains (in this presentation):
- One $Q^2>1$ GeV^2 NC DIS events
- Beam background at calculated freq. (new SR, new electron Bremsstrahlung, Coulomb, Touschek, proton beam gas)

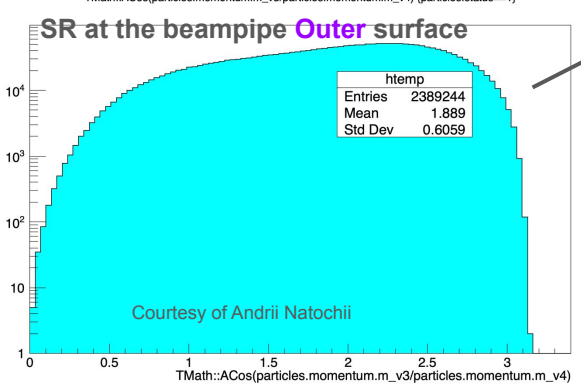
rates in kHz	10x275 GeV	18x275 GeV
	2.5A@10kAhr	0.227A@10kAhr
DIS eA	/	/
electron Synchrotron Radiation	/	3324 MHz
electron beam gas (Bremsstrahlung scatterings)	3177.25 kHz	316.94 kHz
electron beam gas (Coulomb losses,)	29 kHz	1.3 kHz
electron intrabeam (Touschek losses)	240 kHz	0.72 kHz
hadron beam gas	32.6kHz	22.5kHz

- Electron beam-gas rates consider larger region of -5 to +15 meters along the IP, hadron beam-gas rates consider region of -5.5 to +5 meters.
- For more details on background sources, check the ePIC wiki and also

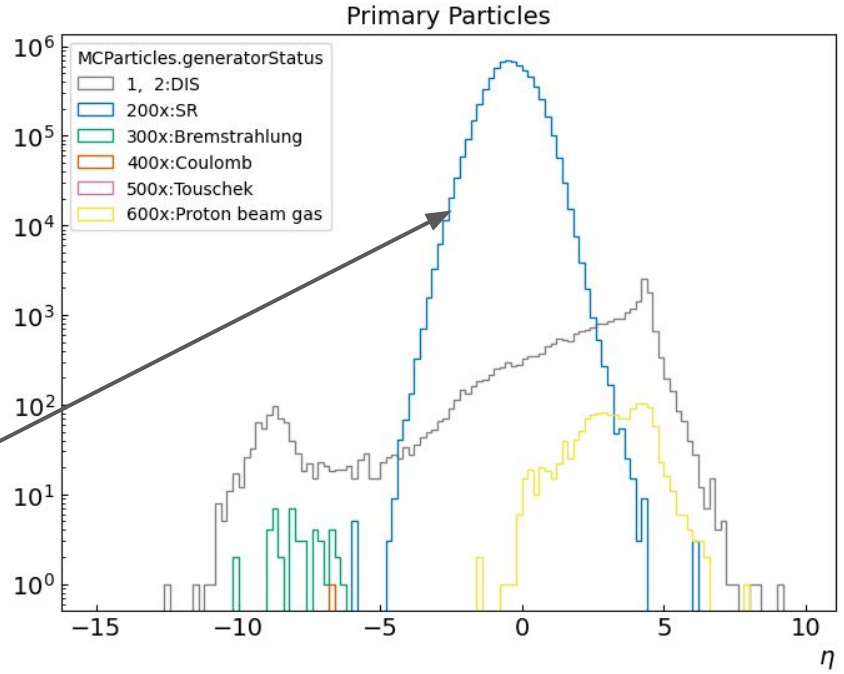
Signal+Background Event Samples

Theta distribution



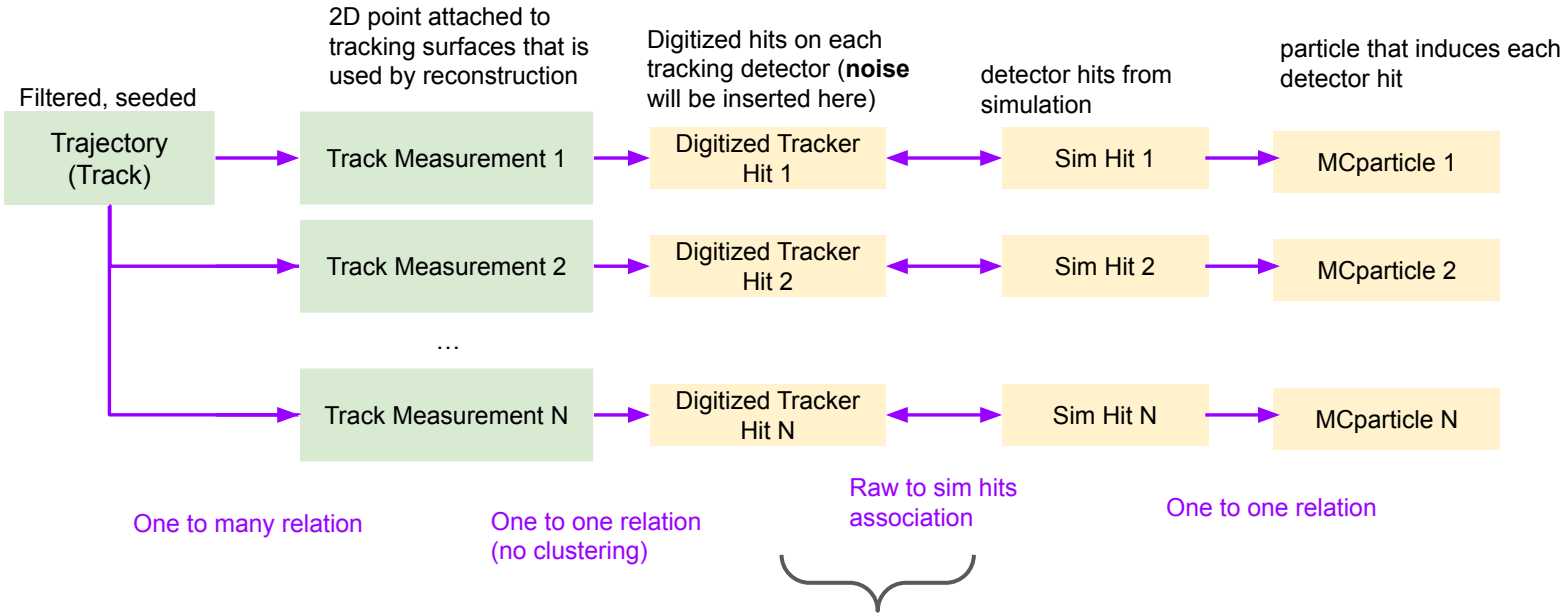


eta distribution, 18x275, 1000 time slices



Hit-based Tracking Study Workflow

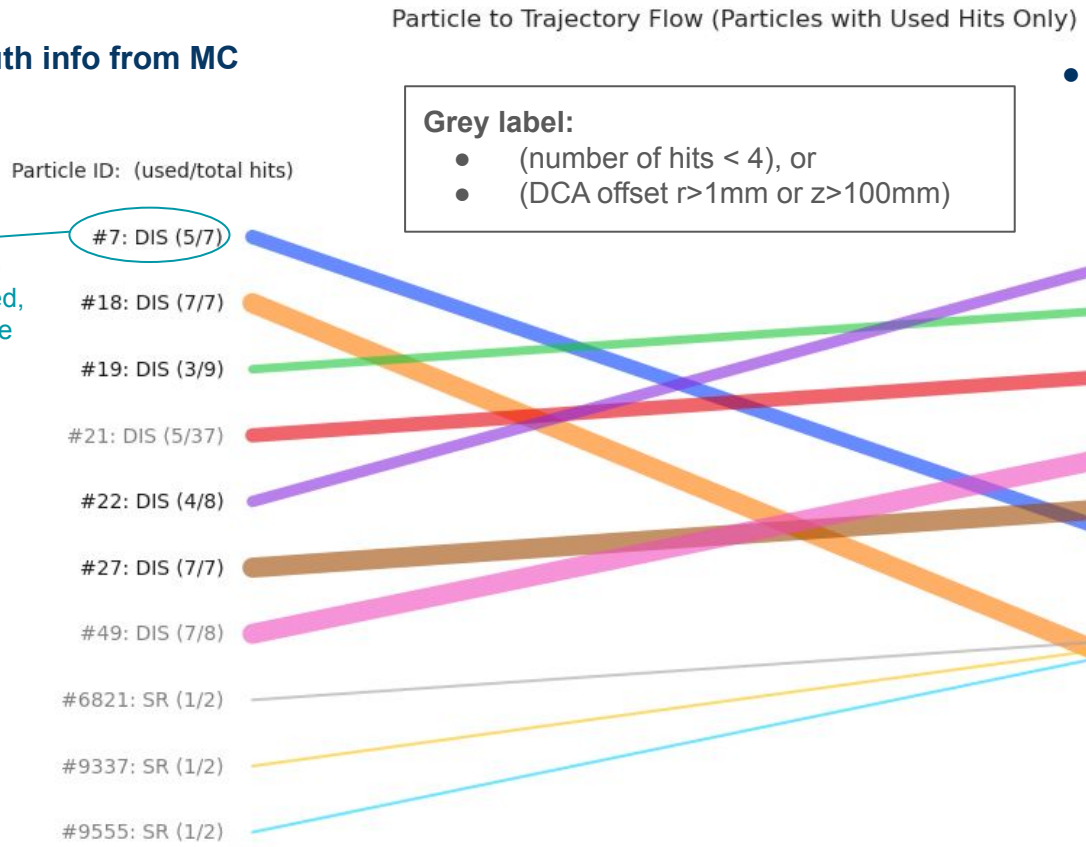
- **Match trajectory, detector hits, and simulated particles**



With the current digi algorithm, multiple sim hits can be associated with one raw hit. For this study, use only 1 hit per cell per particle

- **Truth info from MC**

- **Reconstructed tracks**



Grey label:
- (number of hits < 4), or
- (DCA offset r>1mm or z>100mm)

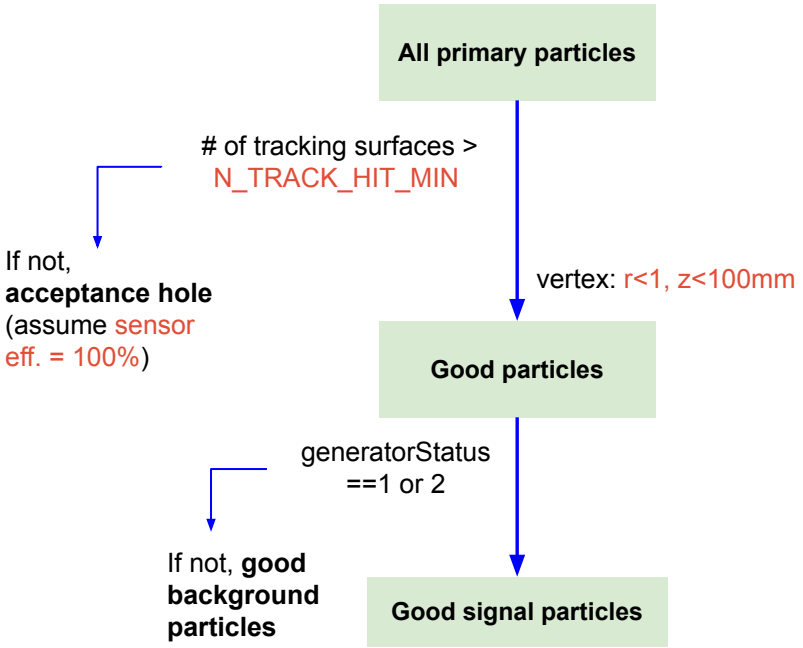
Good quality particle that are reconstructed, though not all hits are identified in tracking

A good track with all hits from a single signal particle

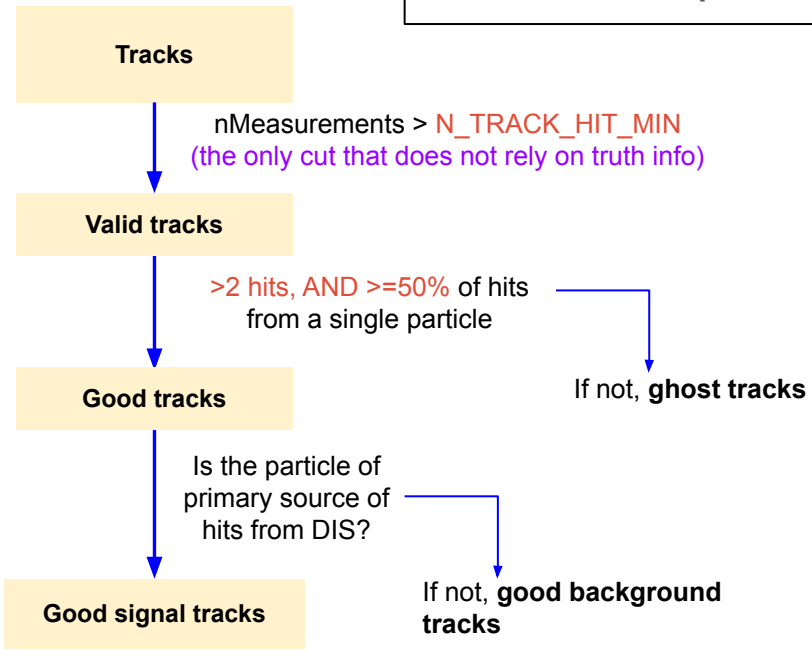
3 hits from 3 SR background. Ghost track.

Hit-based Tracking Study Workflow

- **Truth info from MC**



- **Reconstructed tracks**



RED text: tunable parameters

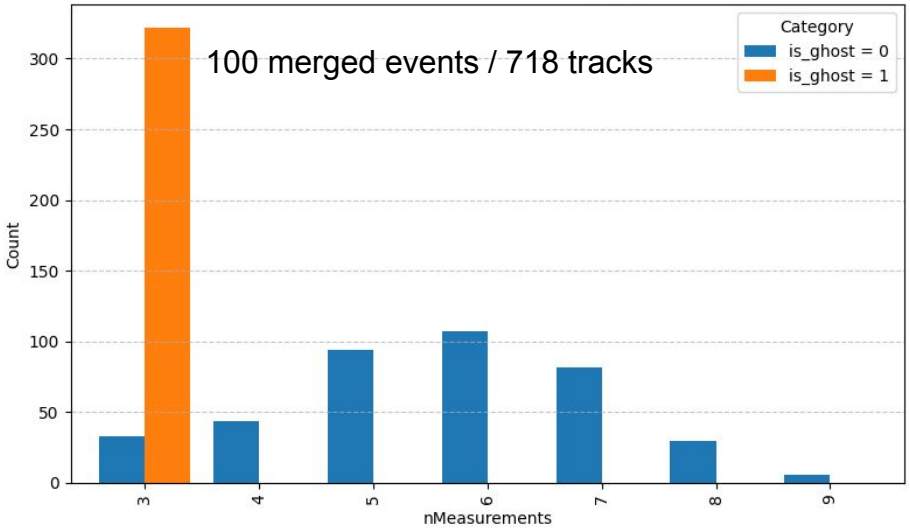
Tracking efficiency:
good signal particle with a good signal track / good signal particles

Tracking Purity:
good signal tracks / valid tracks

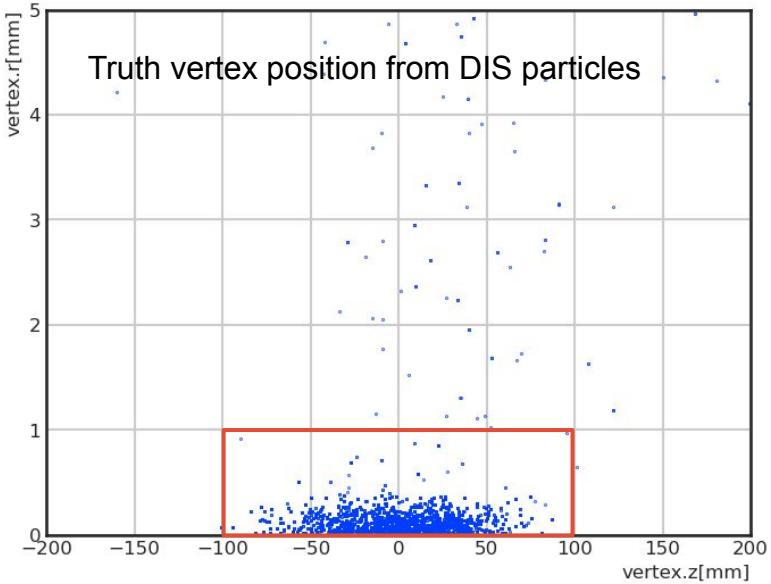
Purity of Track Hits:
In a given valid track, the fraction of hits from the particle of primary source

Cuts Justification

N_TRACK_HIT_MIN = 4 would reject most ghost tracks without hurting the efficiency significantly

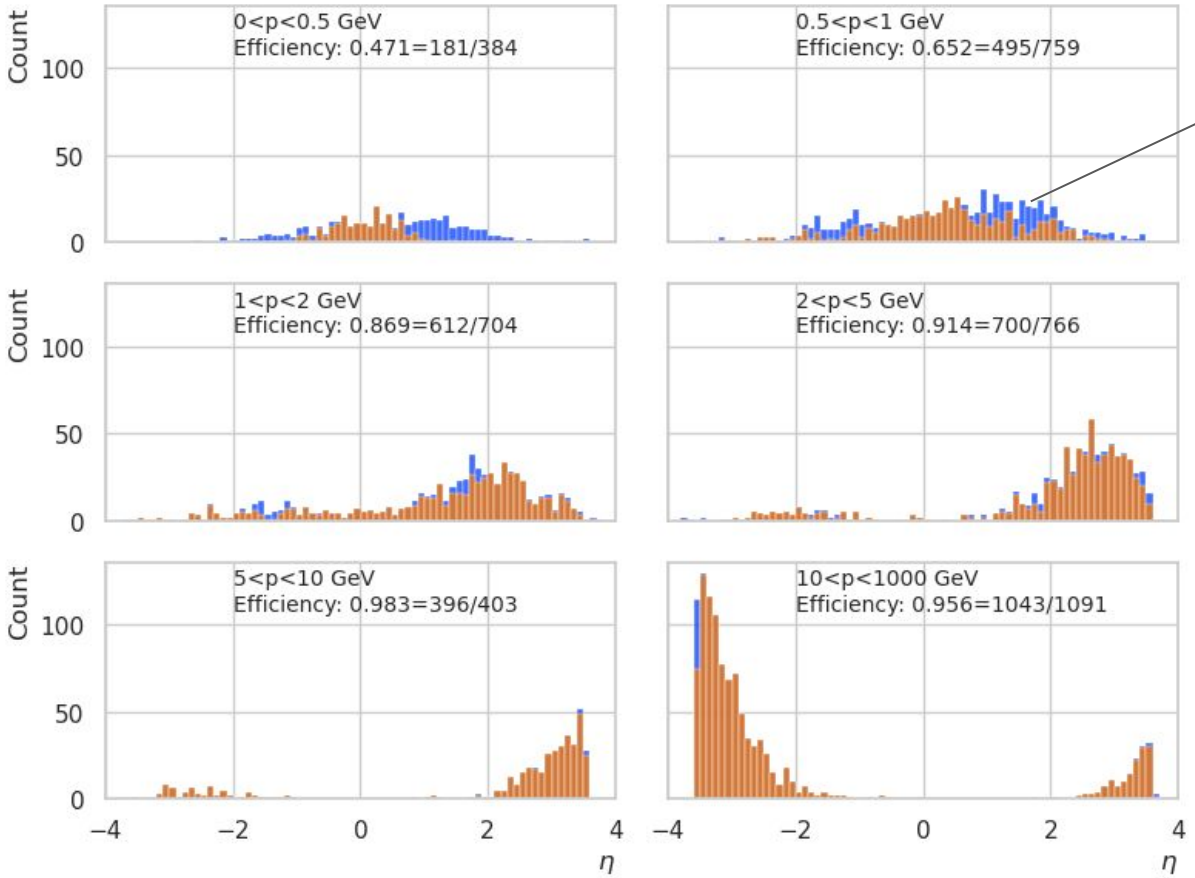


Vertex abs(r)<1mm, abs(z)<100mm seems to be a good sanity cut for DIS events



Tracking Efficiency

Blue: good signal particles **Orange**: good signal particles AND reconstructed



Low momentum inefficiency:

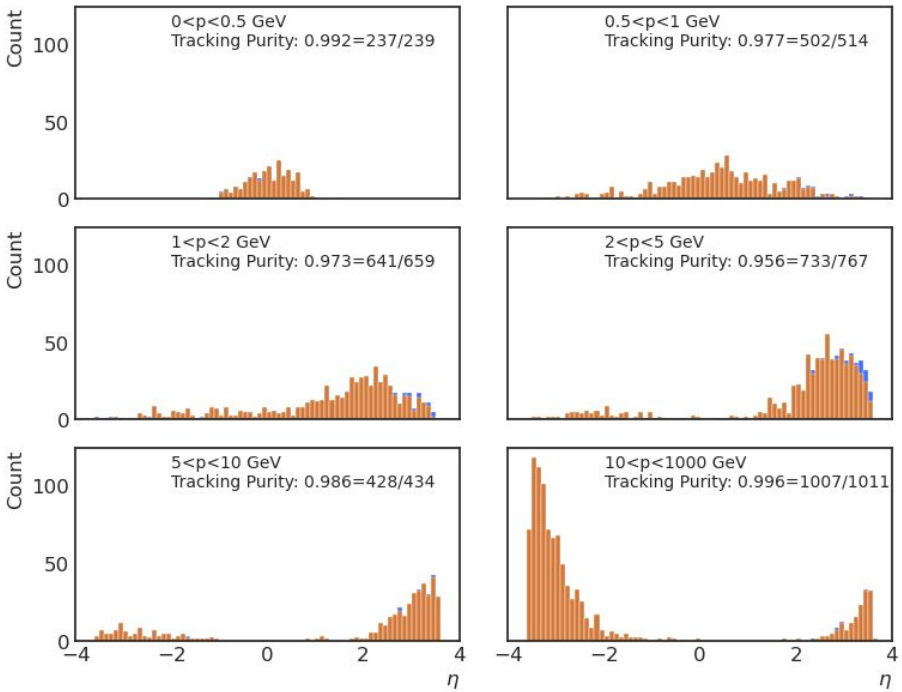
- Consistent with previous study on seeding inefficiency with single particle
- See also Barak's talk today

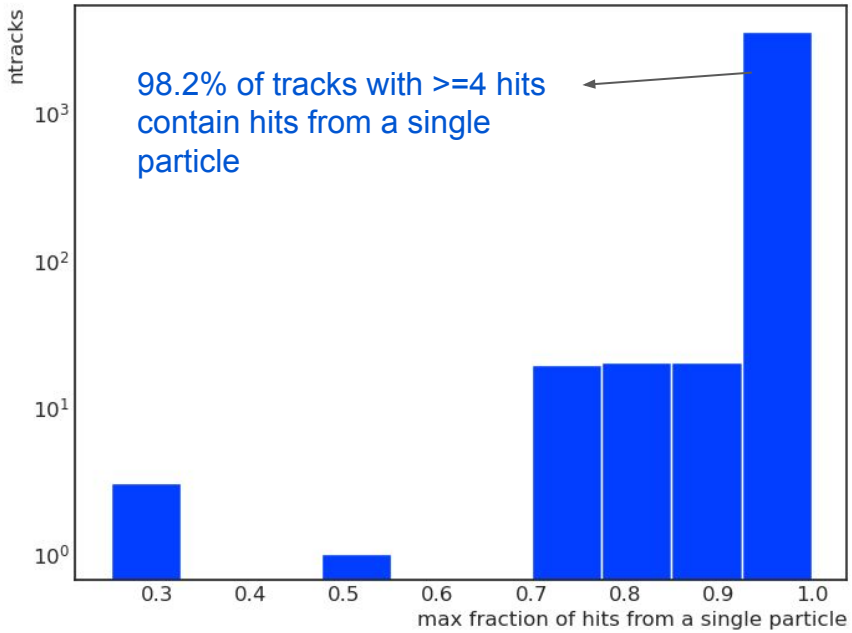
To do:

tune seeding parameters to better handle the geometry transition region

Tracking Purity and Purity of Track Hits

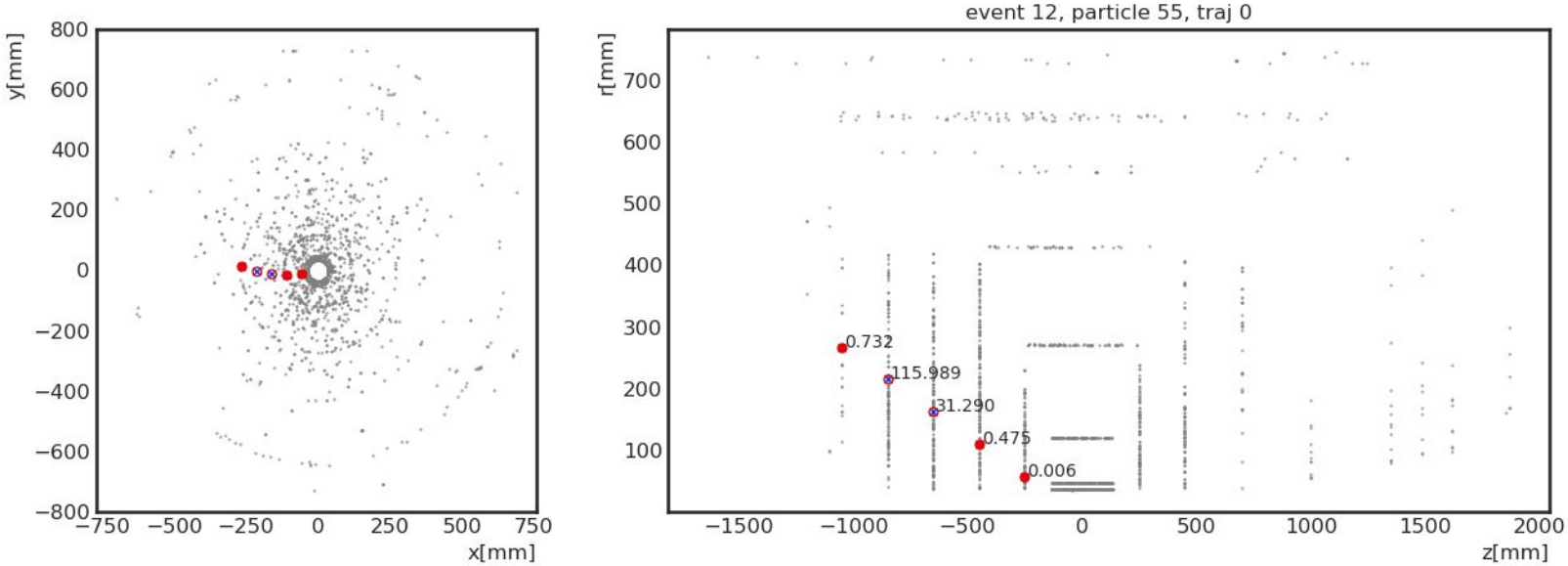
Blue: valid tracks **Orange**: good signal tracks





Example of hits not used in tracking due to Chi2 cut

Red solid circle: hits used in tracking
Red hollow circle: hits saw by CKF but rejected by chi2 cuts
Blue markers : All available hits from the particle
Grey markers: All detector hits from one event



Planned: dedicated study on error propagation, hits residuals, and adjust chi2 cut.

Towards pre-TDR

1. Update the tracking geometry and study the acceptance effect.

2. Improve efficiency with dedicated seeding and chi2 study.

3. Repeat this study with better stats from background simulation campaign, and check dp/p, theta, phi, DCAr resolutions

To do:

- x5 bg frequency to check tracking (regardless of hit rates)
- 5x100 without SR