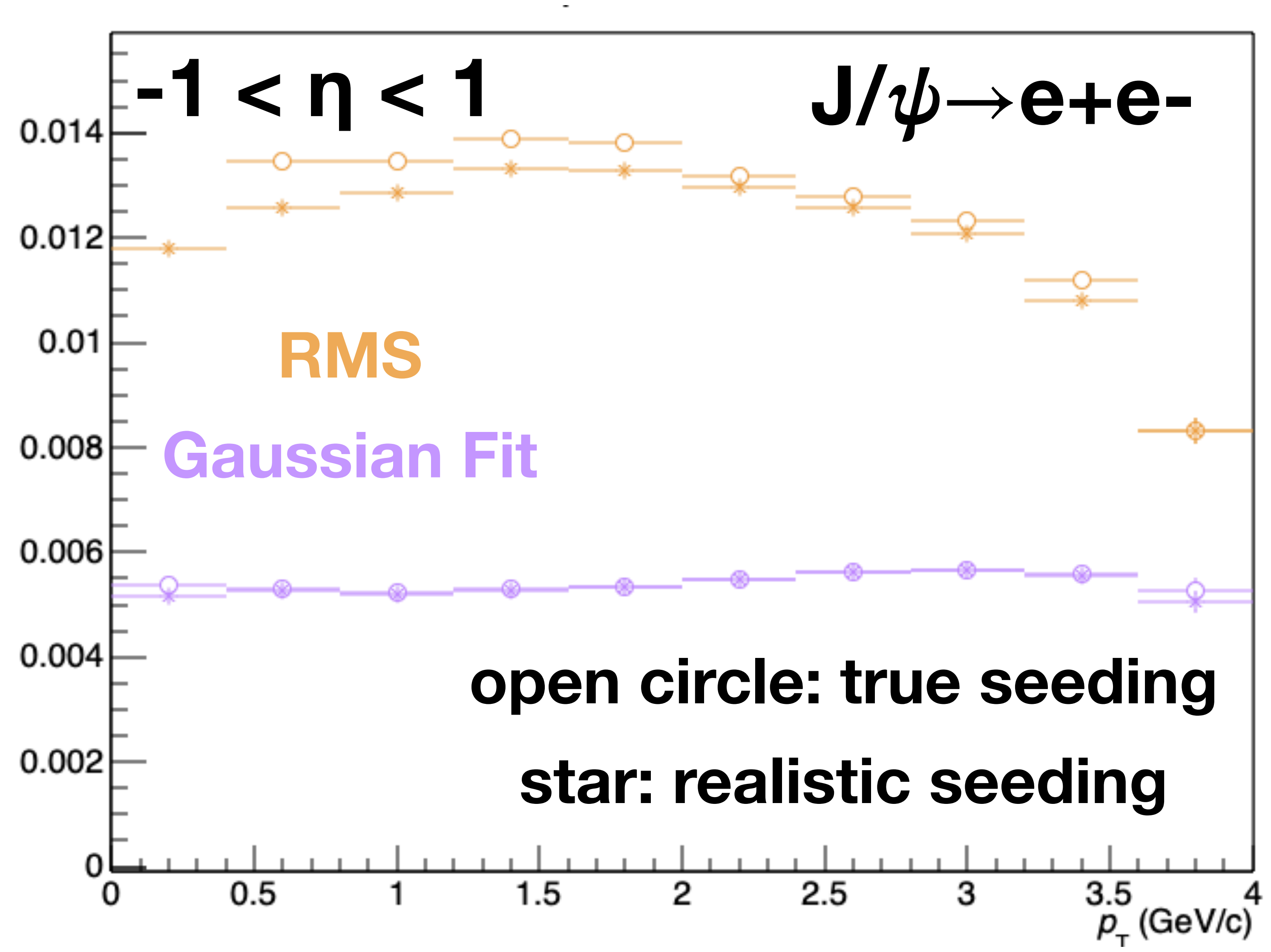
Tracking performance for ePIC

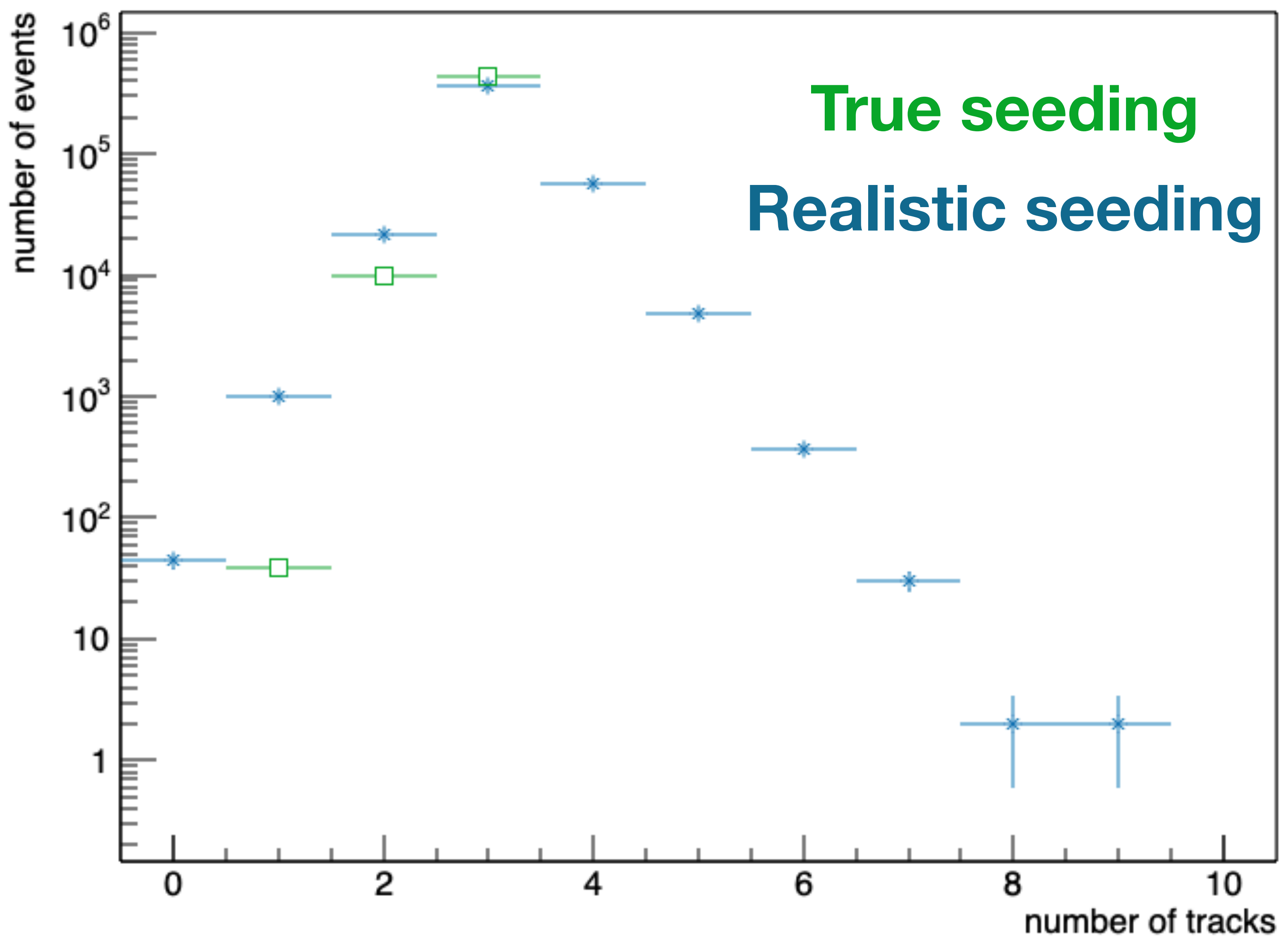
UC-EIC meeting
01. Dec. 2023 (Fri.)

Minjung Kim (UC Berkeley)

Tracking in ePIC software framework

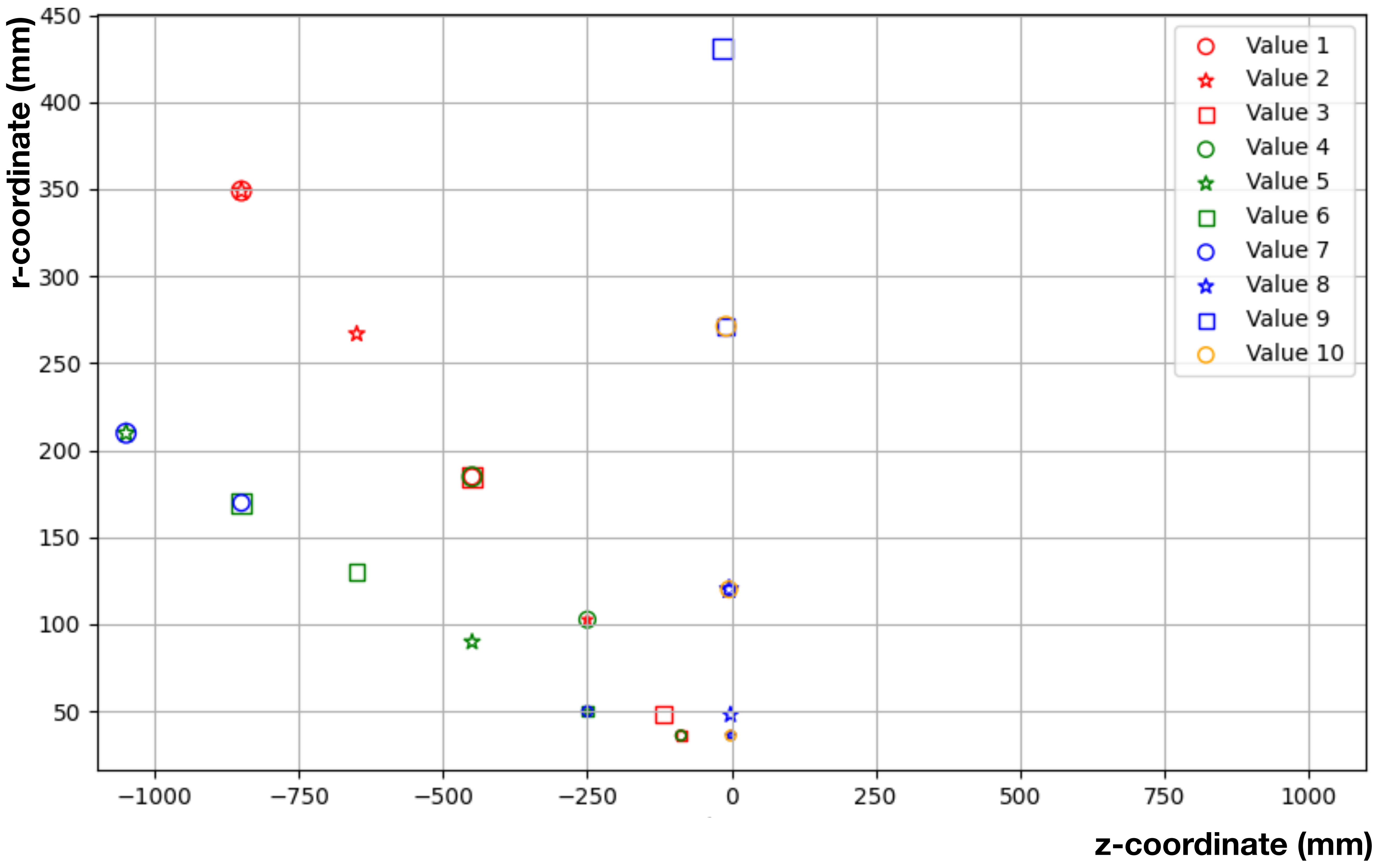
- Latest tracking geometry implemented including MPGD and TOF detector
- Support true seeding and realistic seeding
  - Developed and validated based on single particle gun
  - Track momentum resolution was studied in exclusive photoproduction; fulfilling YR requirement in central barrel
  - Known issue: **Duplicate tracks in realistic seeding algorithm**

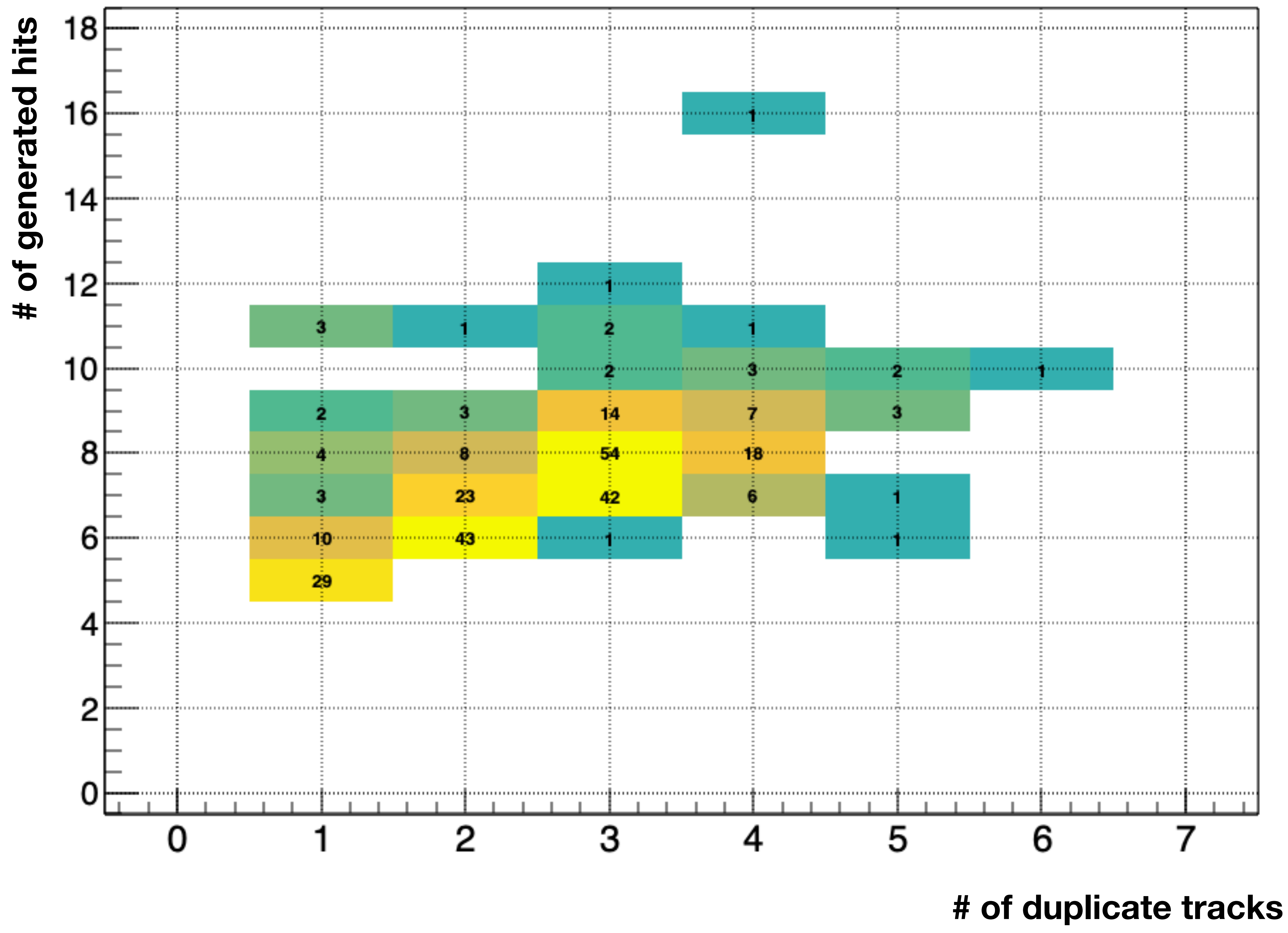




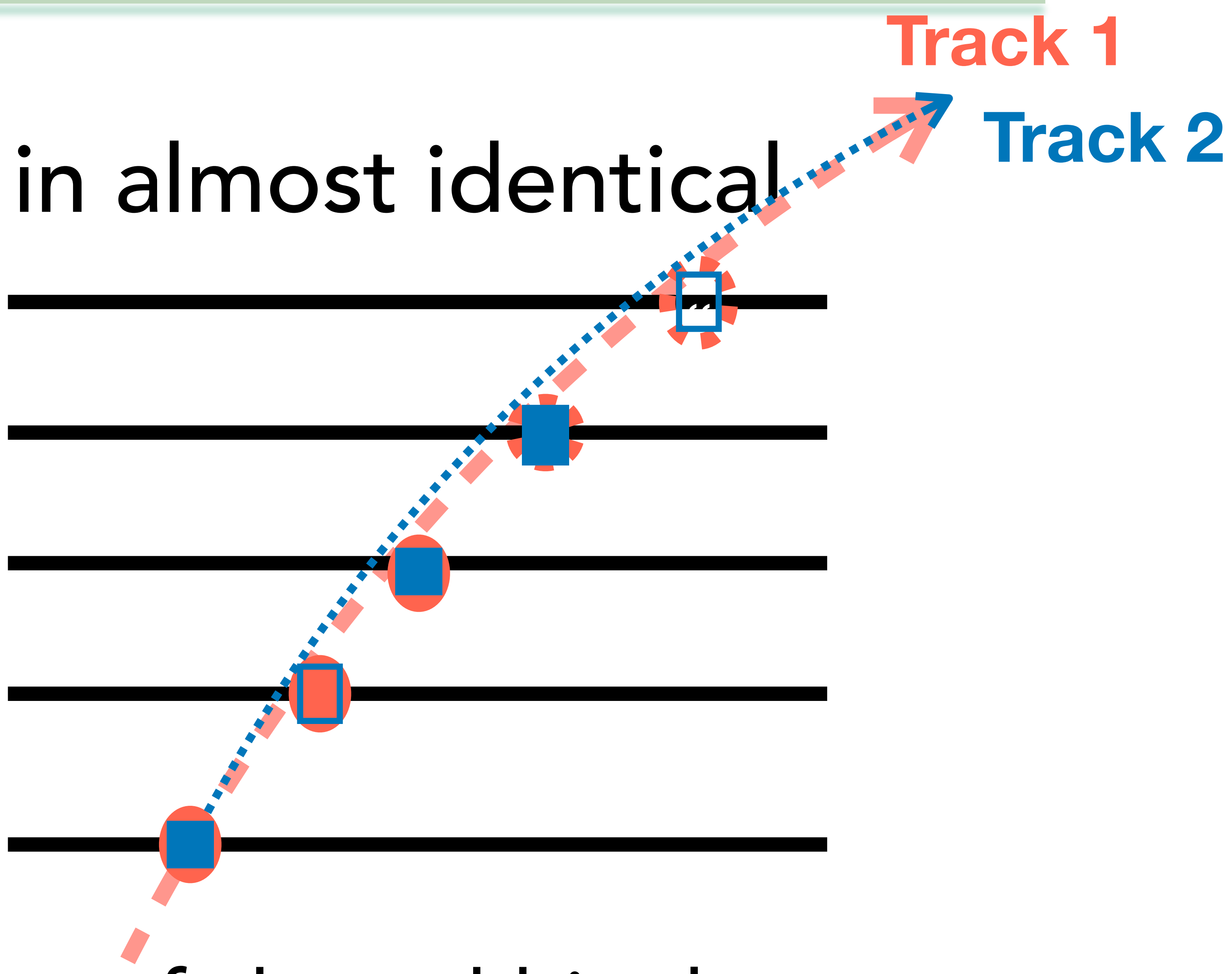
Duplicate tracks in realistic seeding

- Seed is made with 3 hits → several seeds can be found along one trajectory; propagating to duplicate tracks leading positive correlation between # of generated hits and # of duplicate tracks





Greedy ambiguity resolution solver

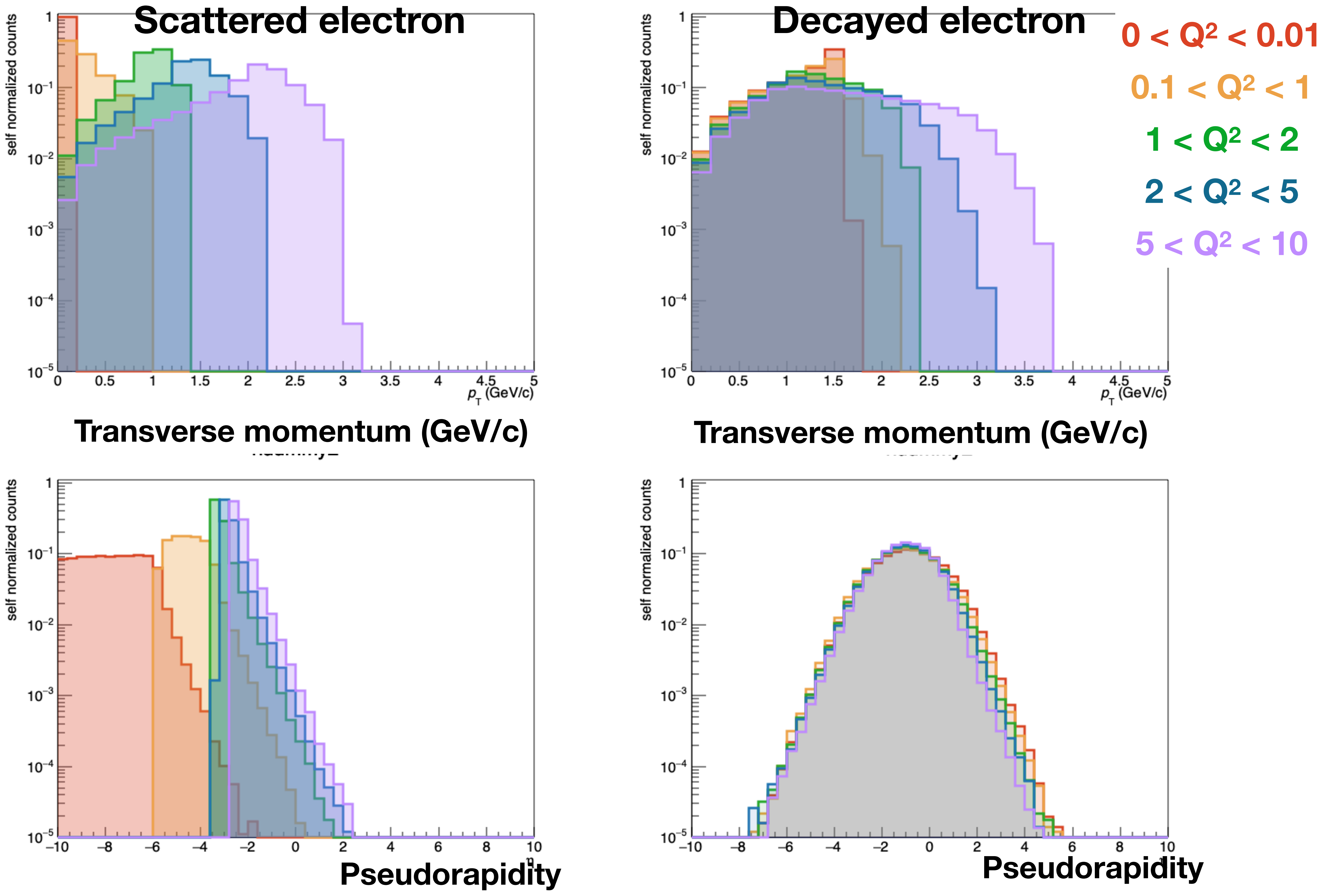


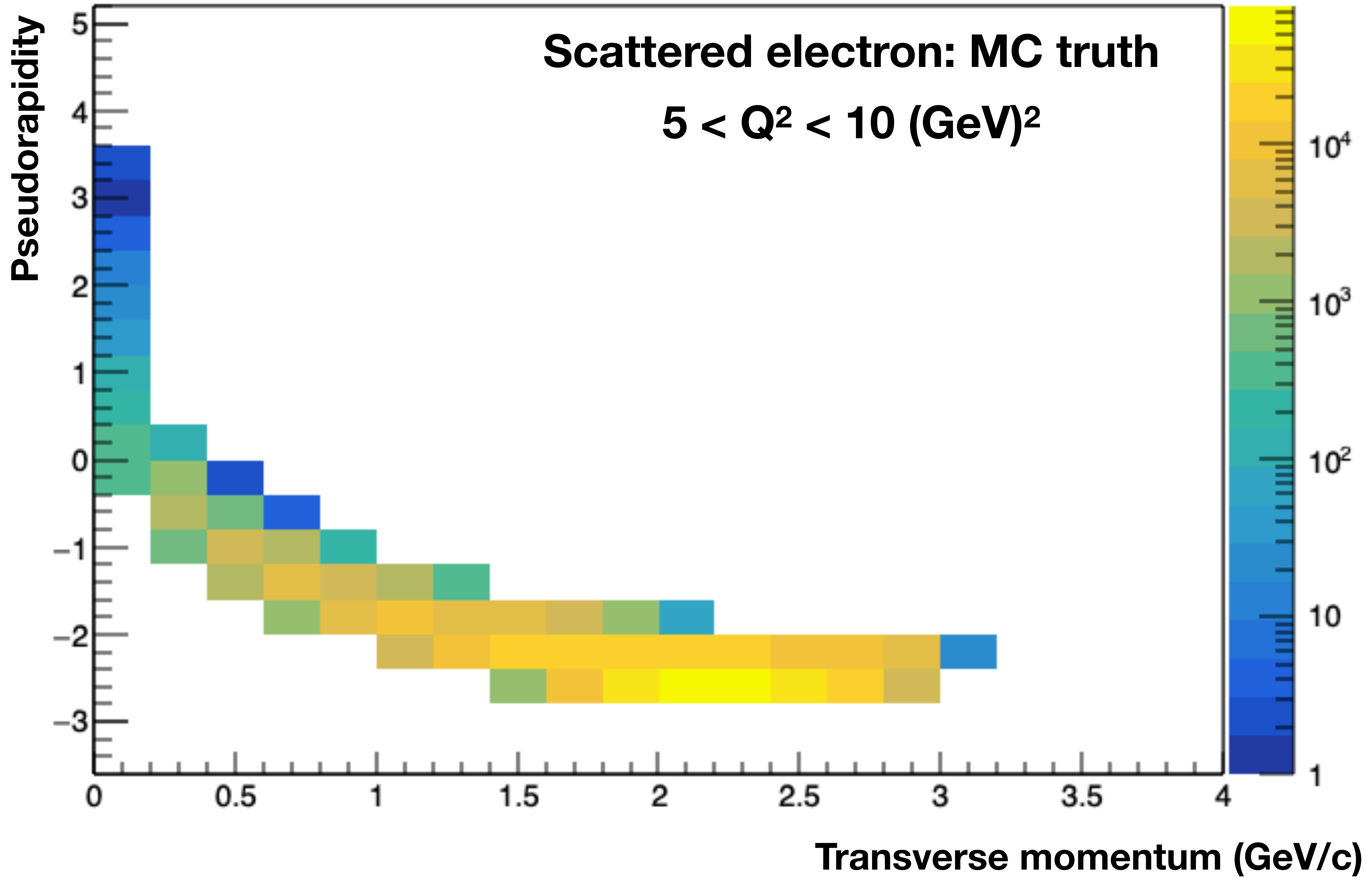
- After tracking, seeds originated from same particle result in almost identical reconstructed tracks
  - More or less similar reconstructed kinematic variables
  - Almost same sets of associated hits
- Greedy ambiguity resolution solver:
  1. Iterate trajectories and find the trajectory having number of shared hits larger than certain threshold
  2. Find the competetors and keep better quality trajectory only
  3. Repeat till you have trajectories having shared hits below certain threshold

➡ **Native support in ACTS,** not implemented in official EICrecon yet

Reminder: J/ψ photoproduction in EIC

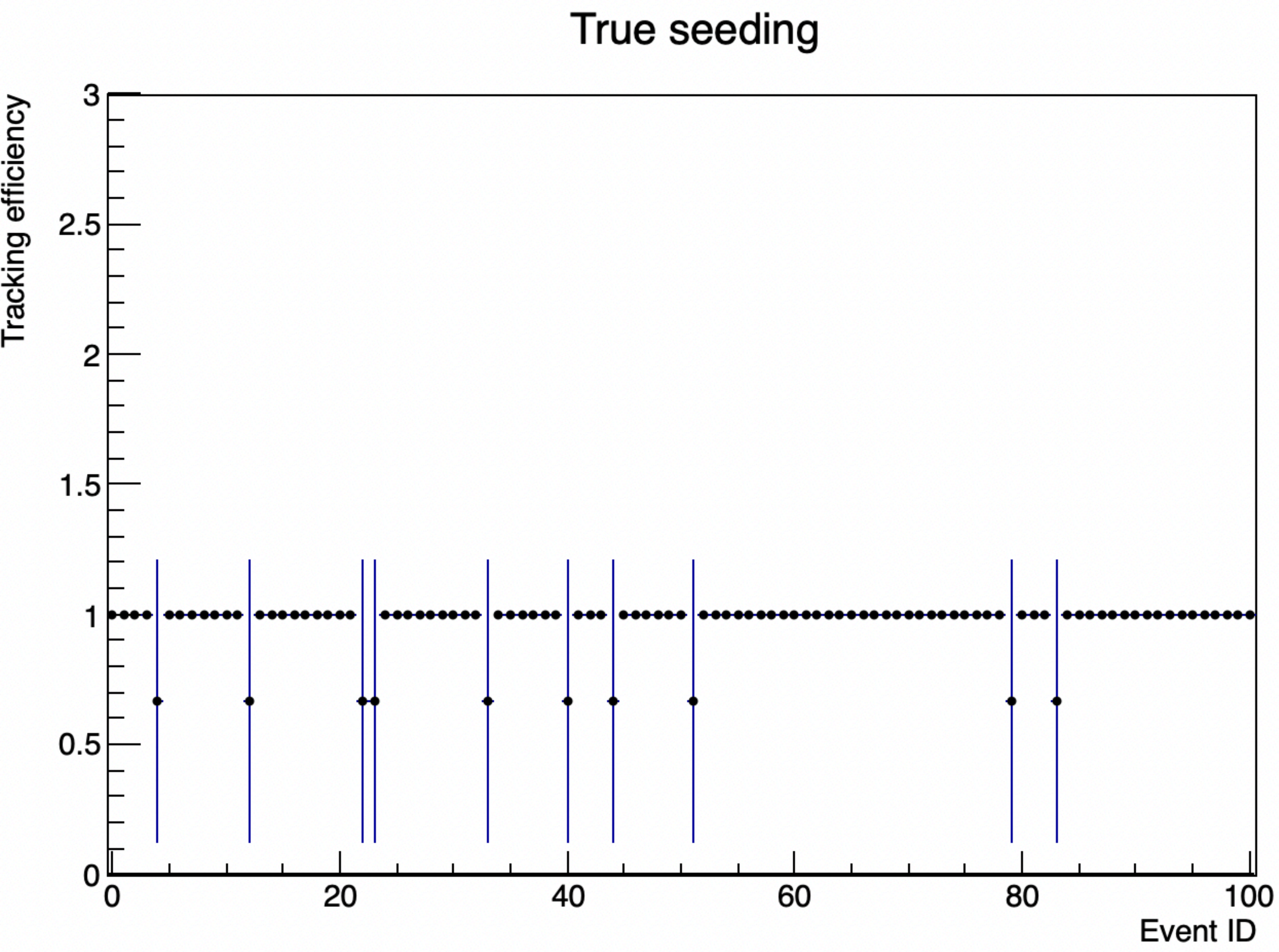
- Coherent production of eA→eA′J/ψ→e(e+e-)A′ with eSTARLight
- Final state particle kinematics are well constrained; most of cases 3 electrons

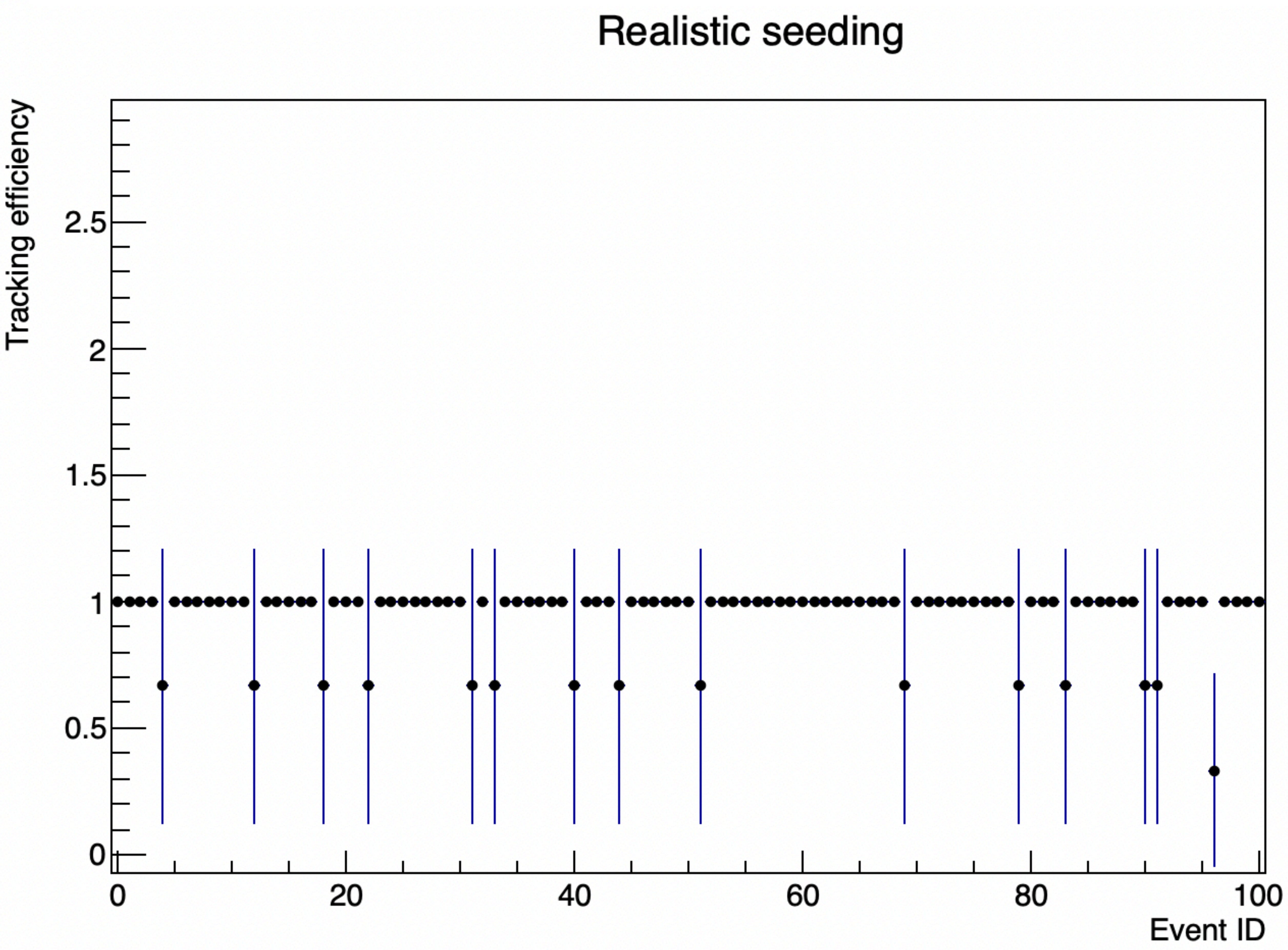




Duplicate track rejection in photoproduction events

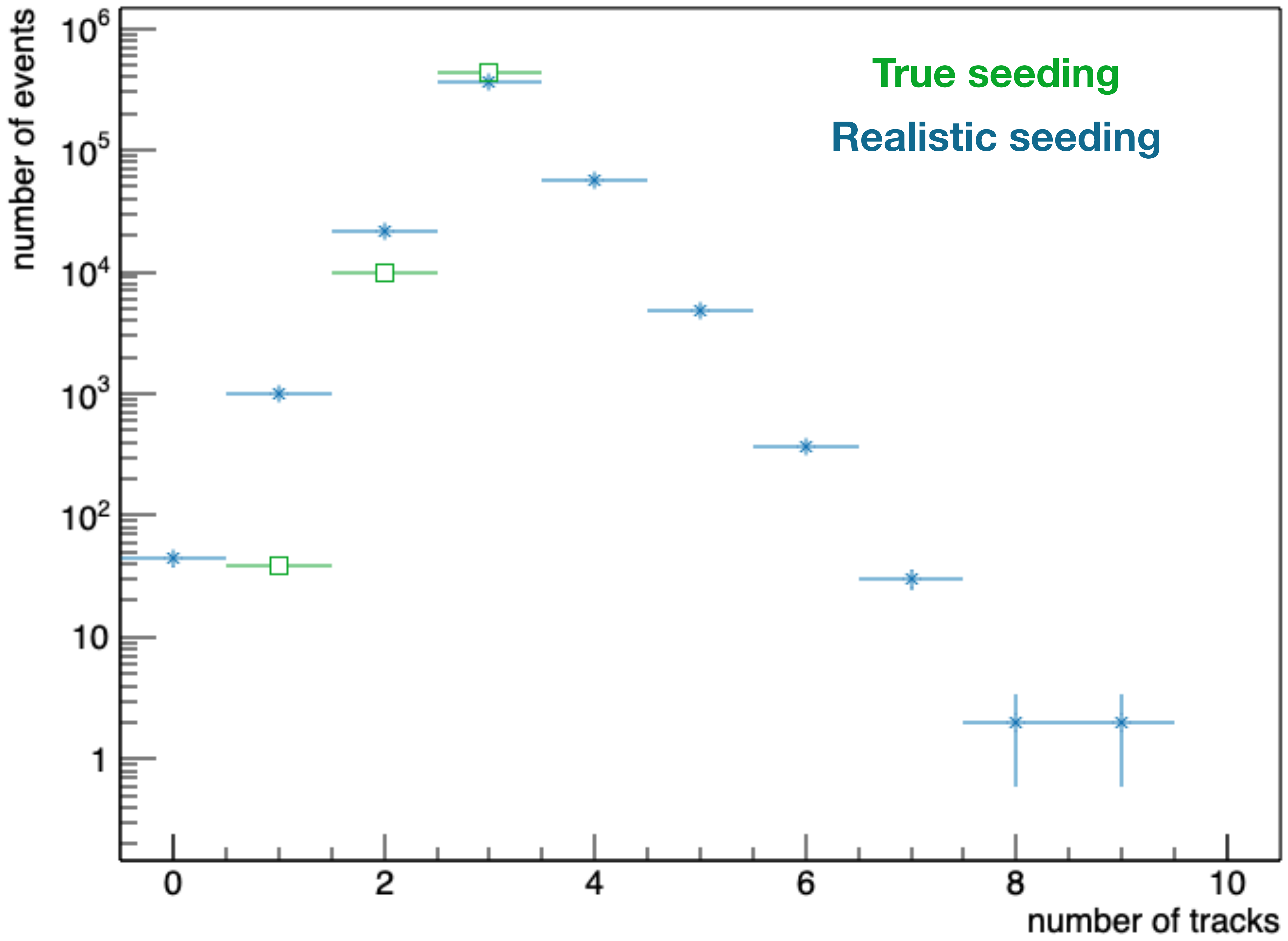
- Event-by-event tracking efficiency estimated: $\dfrac{\text{number of reconstructed tracks}}{\text{number of generated final state particles}}$

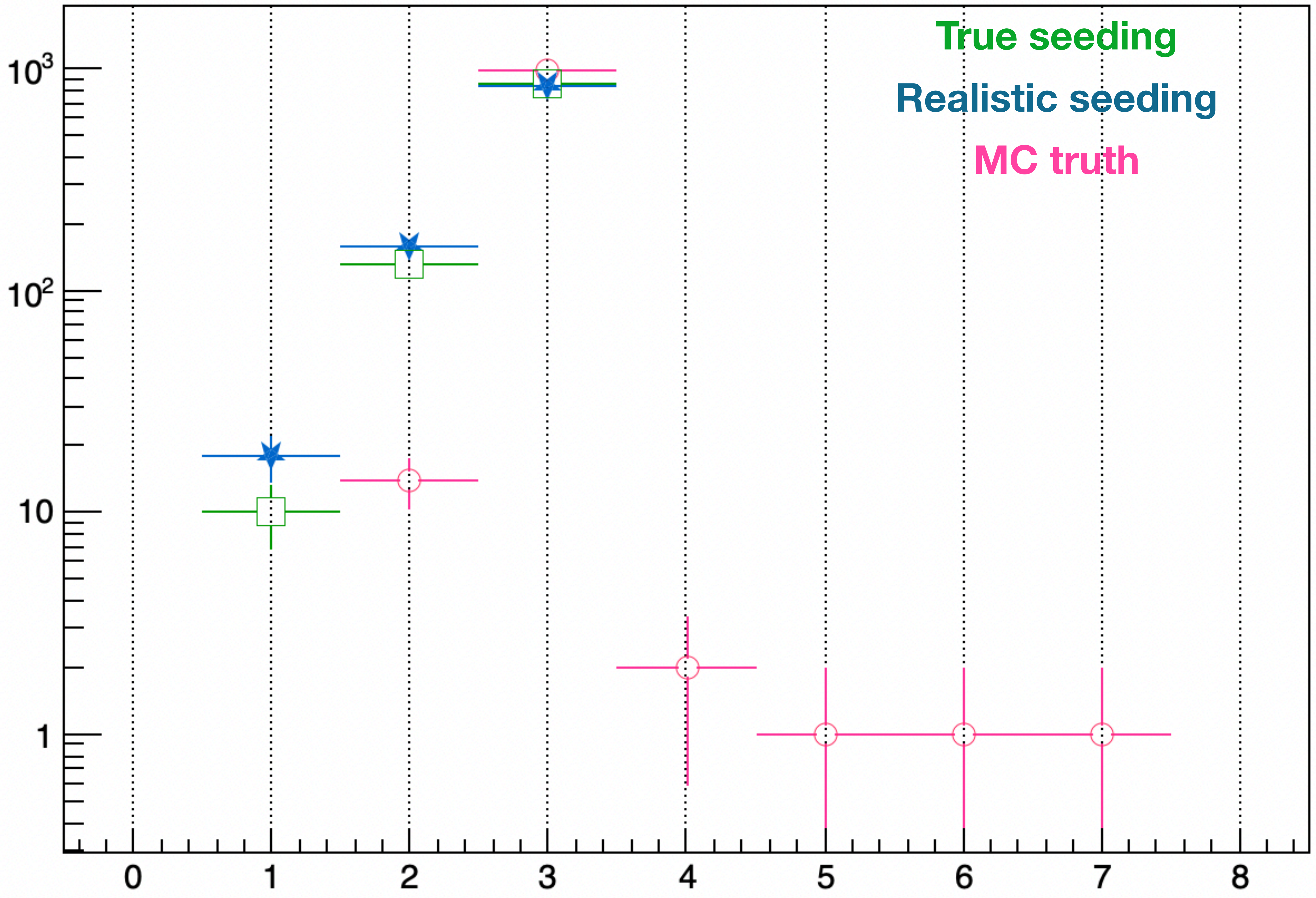




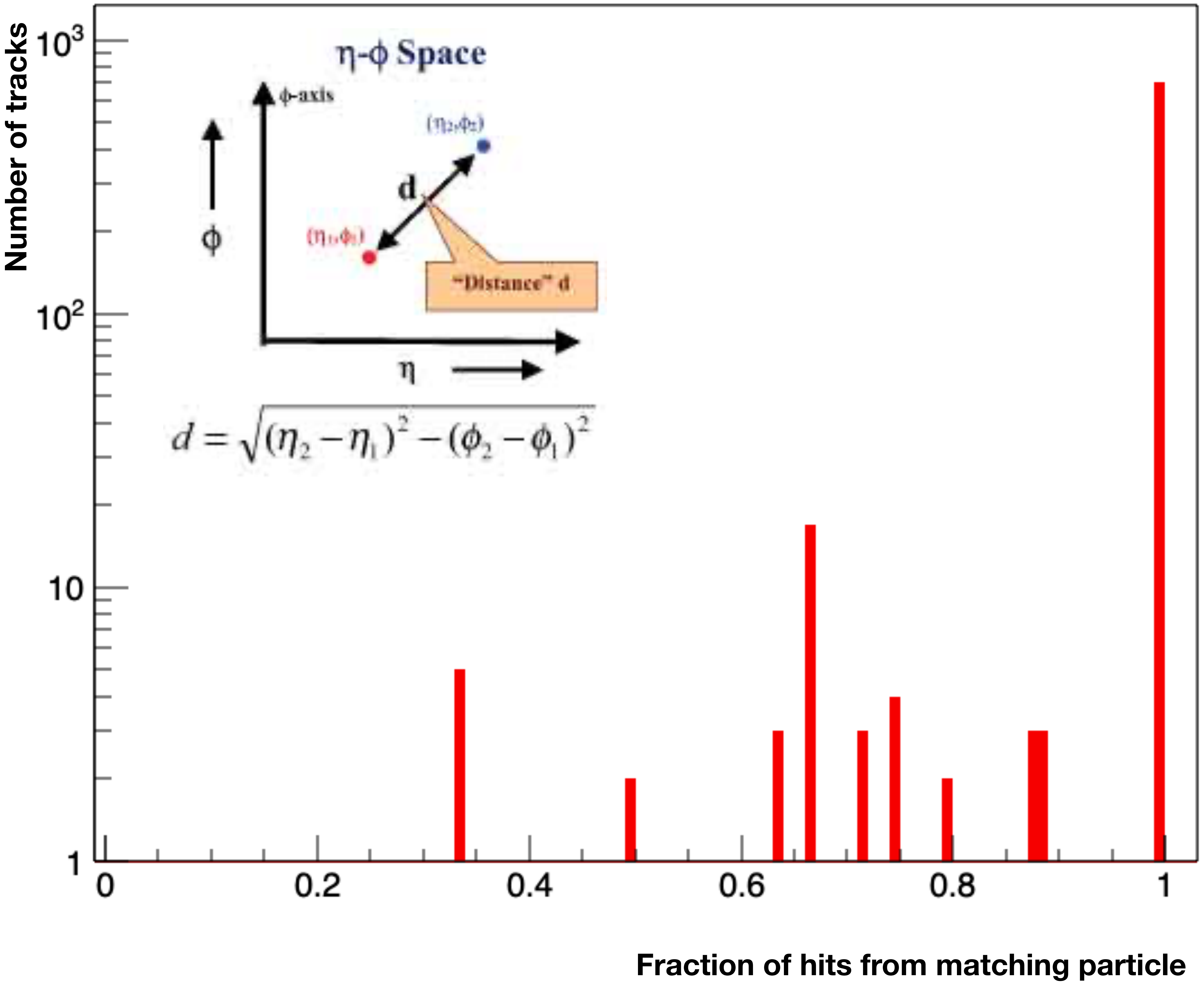
Duplicate track rejection in photoproduction events

- Tracking efficiency of realistic seeding method after duplicate track rejection became closer to true seeding, as well as MC truth info.





Matching between reconstructed track and MC particle

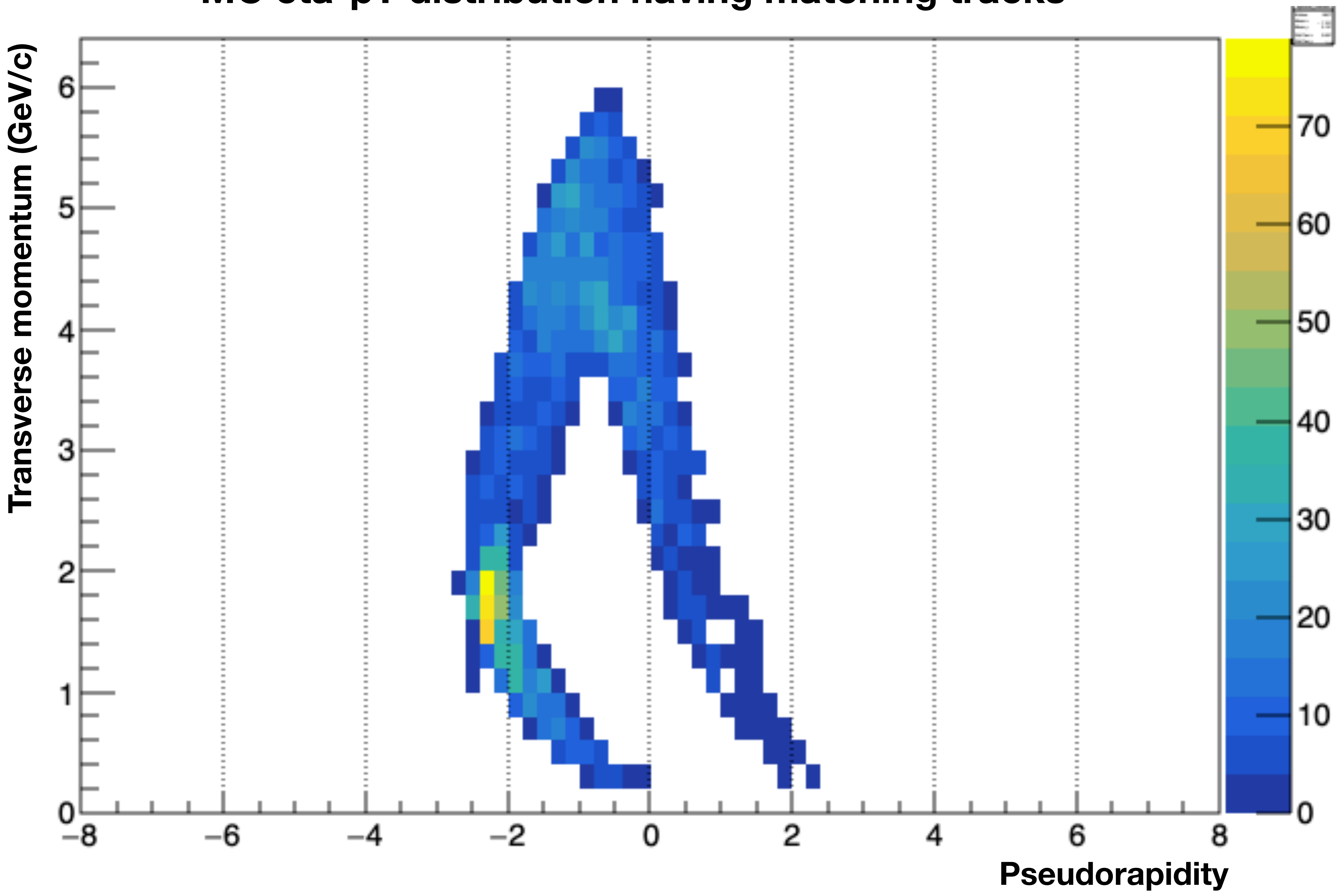


- Two different matching methods were considered:
  - Hit level matching: check the source of hits in the track and matching to the particle giving maximum contribution
  - Angular distance matching: matching reconstructed track with the particle having the closest value of the distance
- Angular distance based matching gives more than 98% consistent result with hit level matching

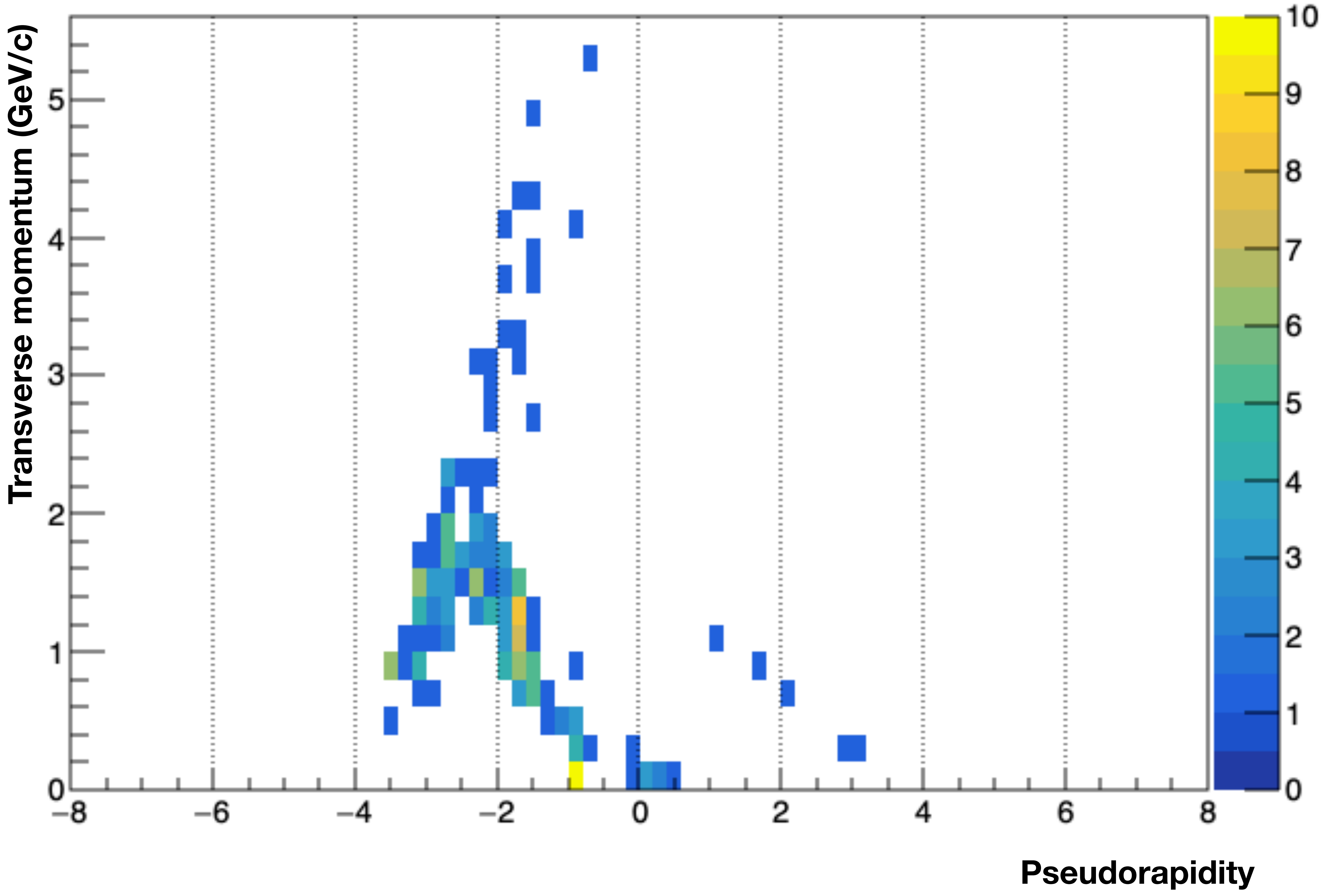
First look of tracking efficiency of the ePIC tracker

- Most of efficiency lost in low pT below 200 MeV/c
- Limited kinematic coverage of photoproduction events

MC eta-pT distribution having matching tracks

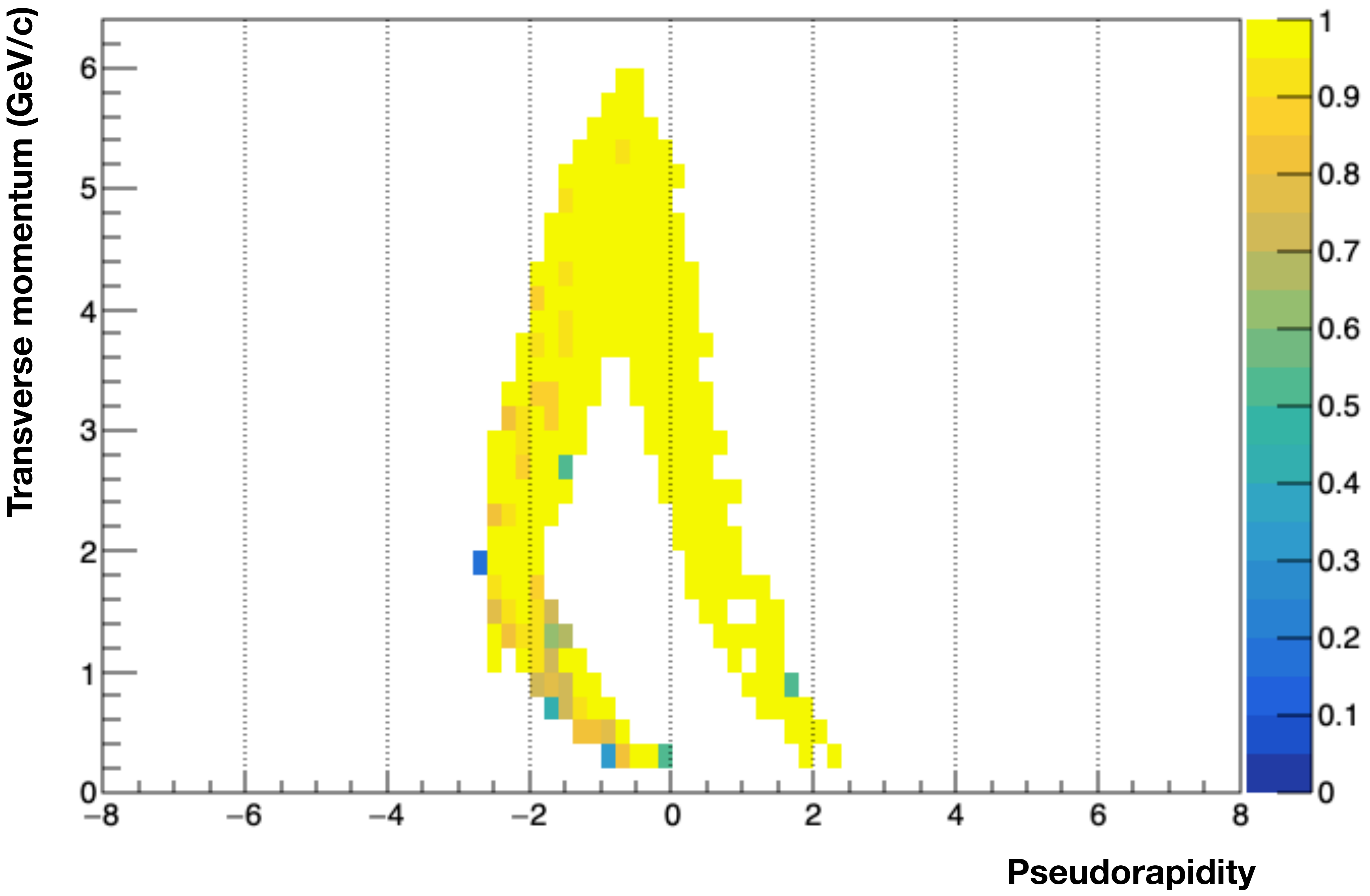


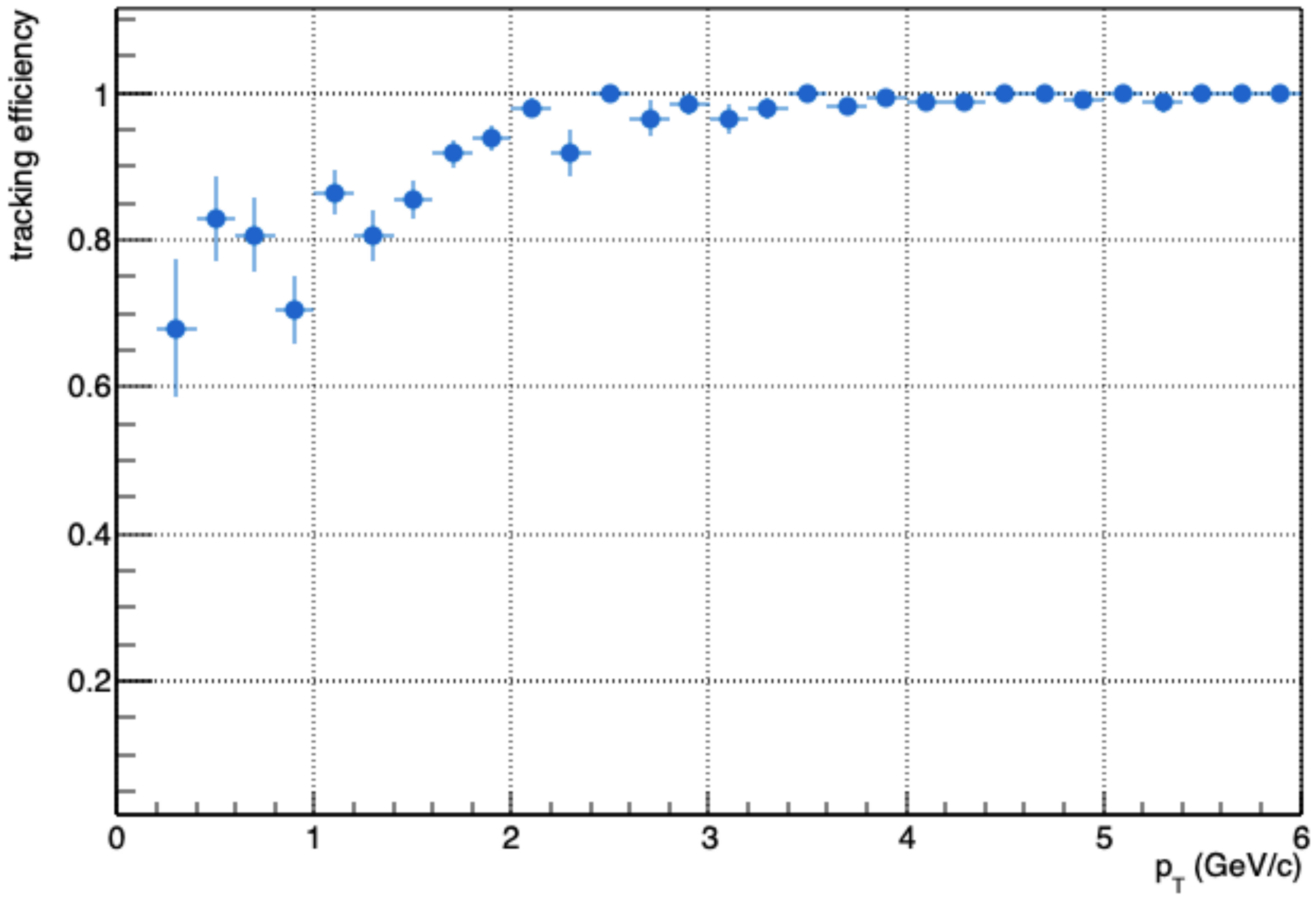
MC eta-pT distribution not having matching tracks



First look of tracking efficiency of the ePIC tracker

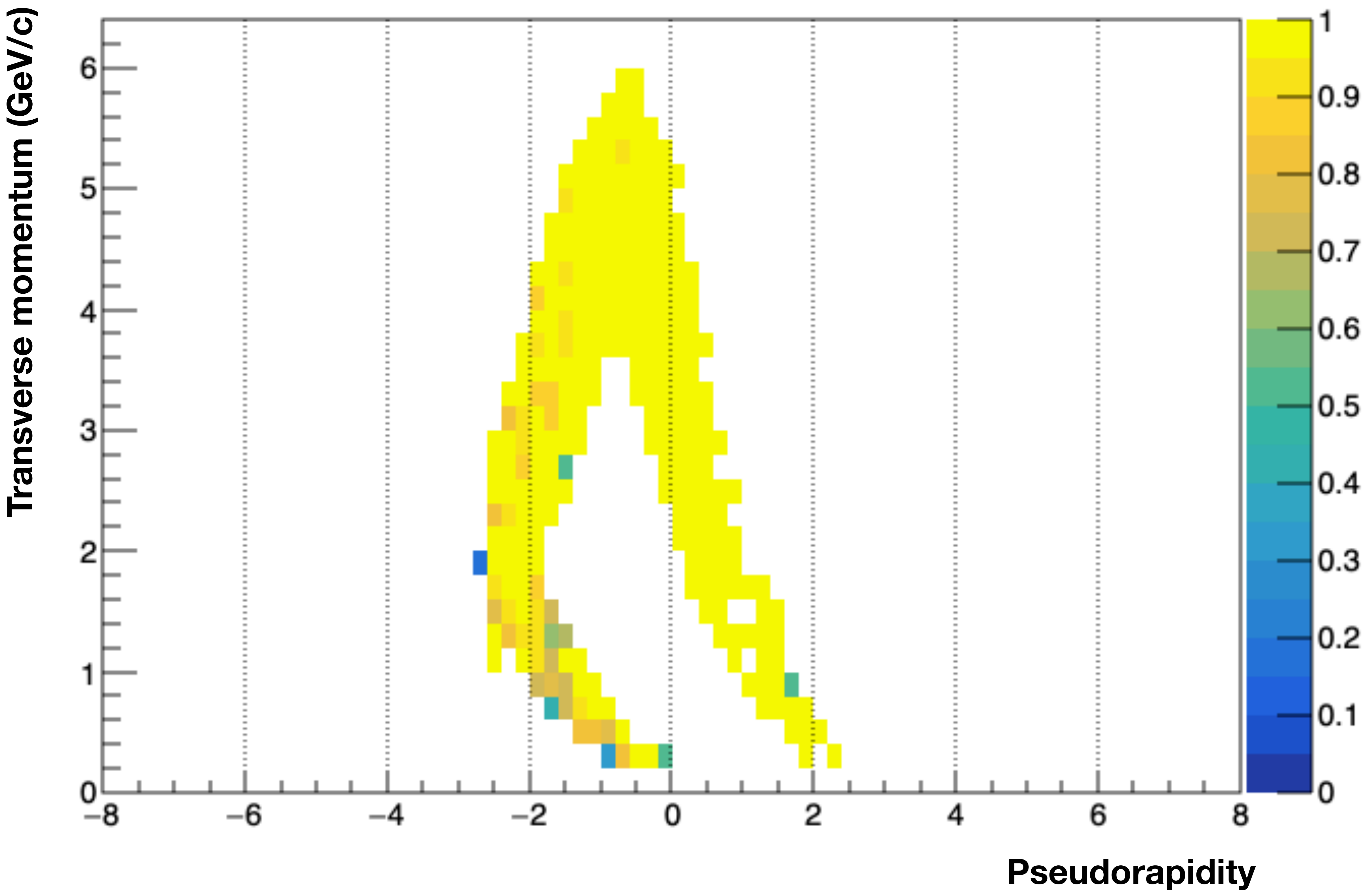
- Most of efficiency lost in low pT below 200 MeV/c
- Tracking efficiency: $\frac{\textbf{number of reconstructed, matched tracks}}{\textbf{number of generated final state particles}}$

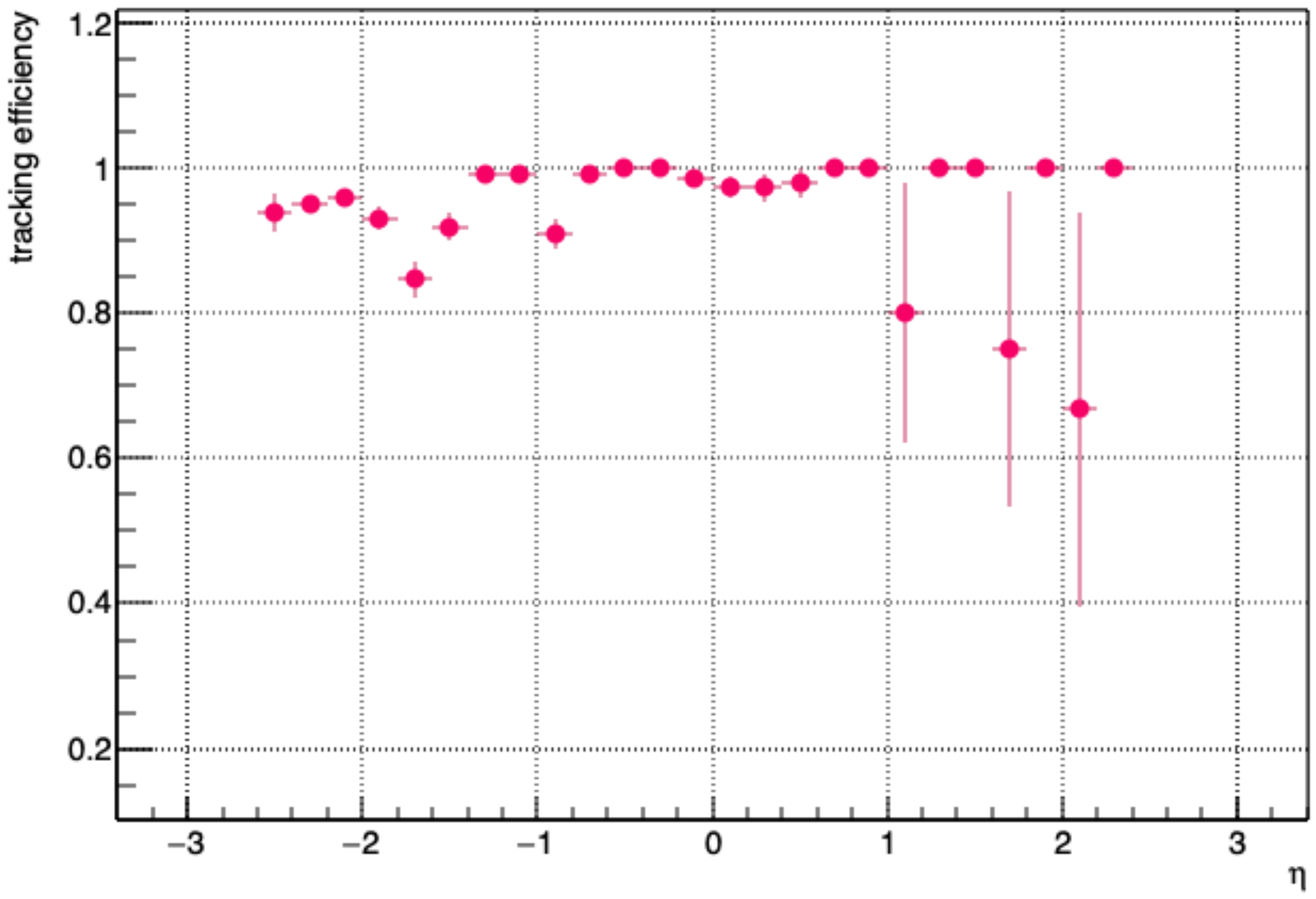




First look of tracking efficiency of the ePIC tracker

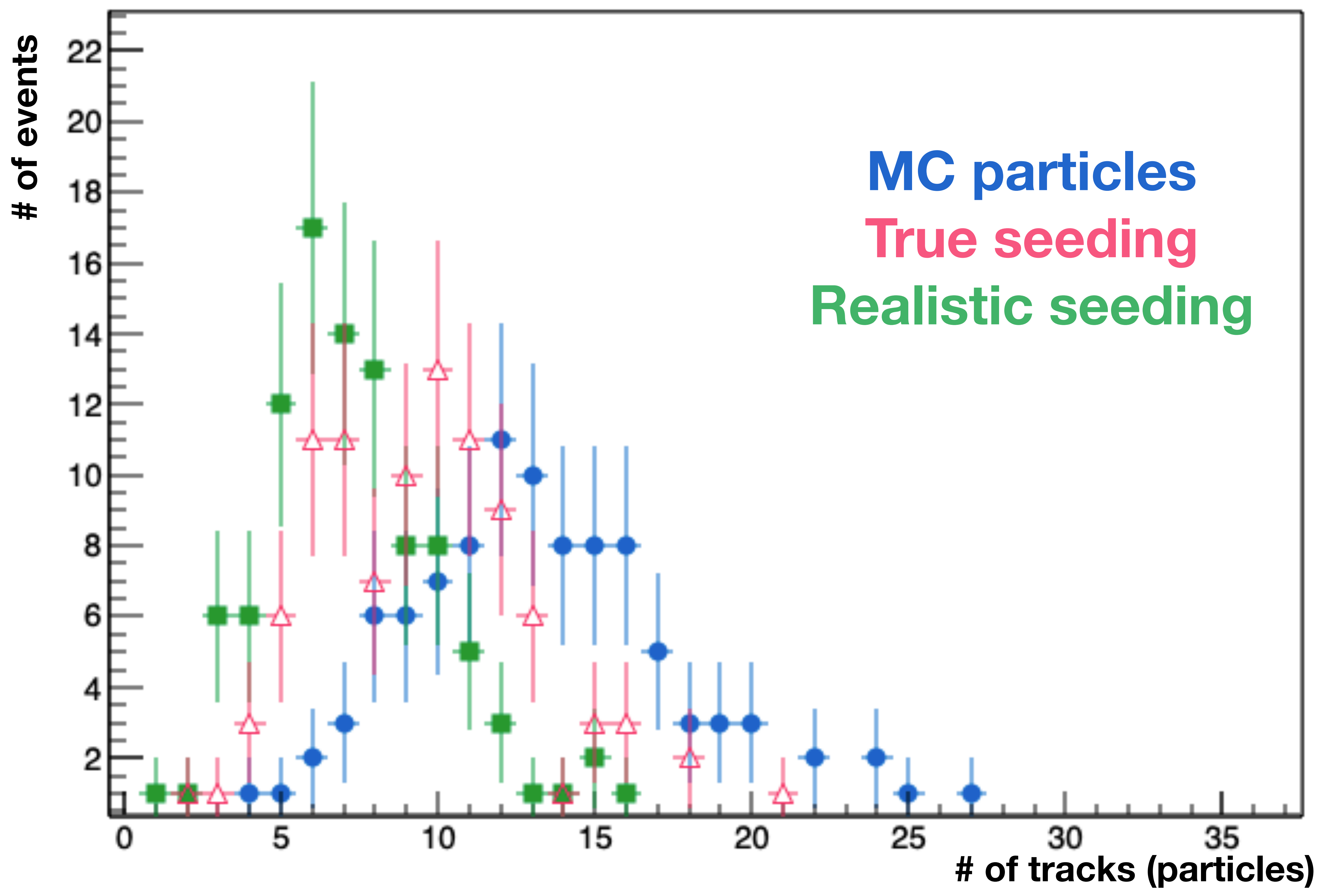
- No trying eta dependence found within -2.5 < eta < 2.5
- Tracking efficiency: $\frac{\textbf{number of reconstructed, matched tracks}}{\textbf{number of generated final state particles}}$

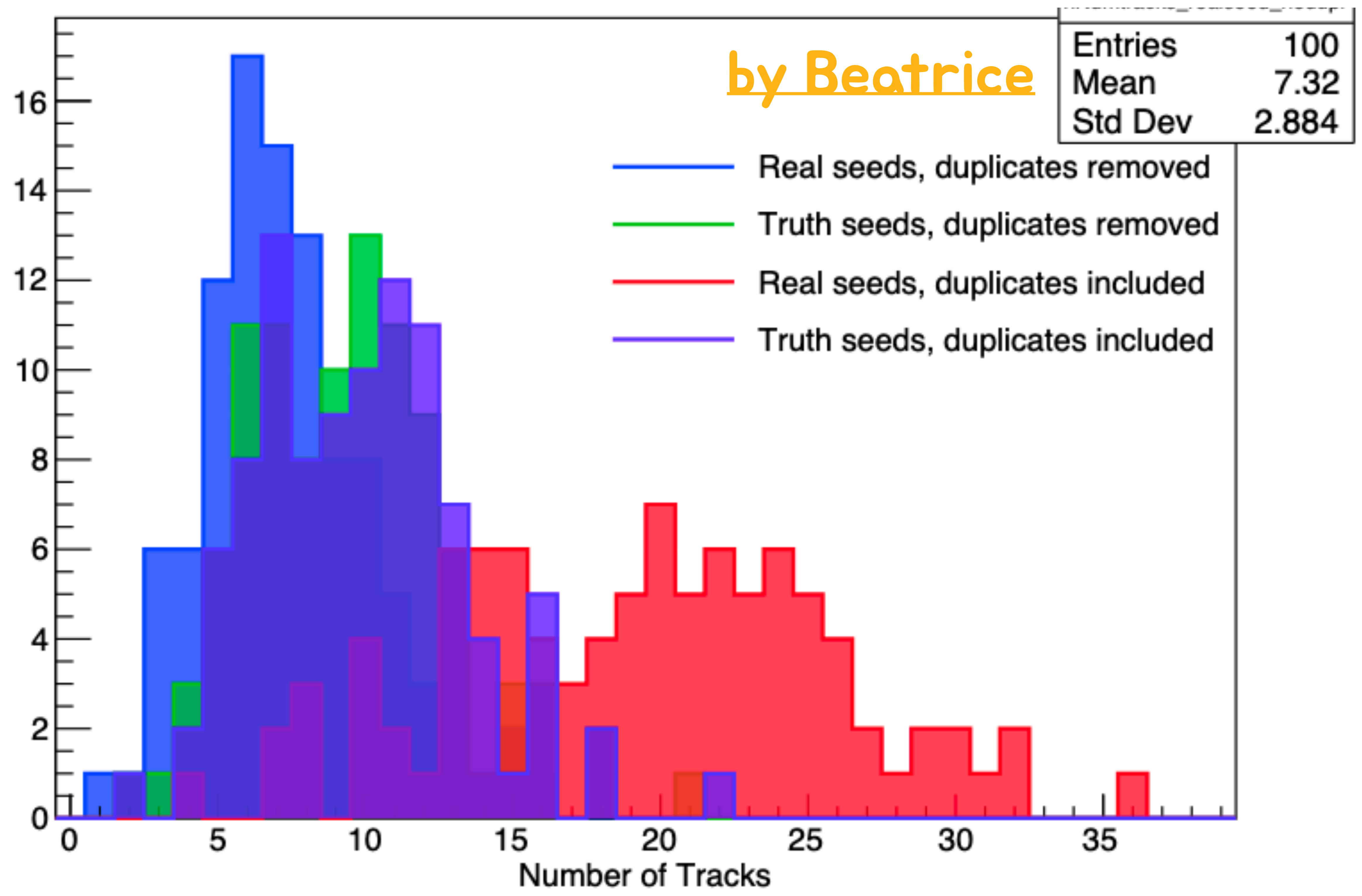




Moving towards complicated environment

- PYTHIA DIS for e-p collisions at 18x275, with minQ2=1000 + beam Effects
- Tracking performance in DIS events seems far worse than in photoproduction → due to abundance of low pT tracks
- Impact of duplicate track rejection for true seeding → detailed studies required!





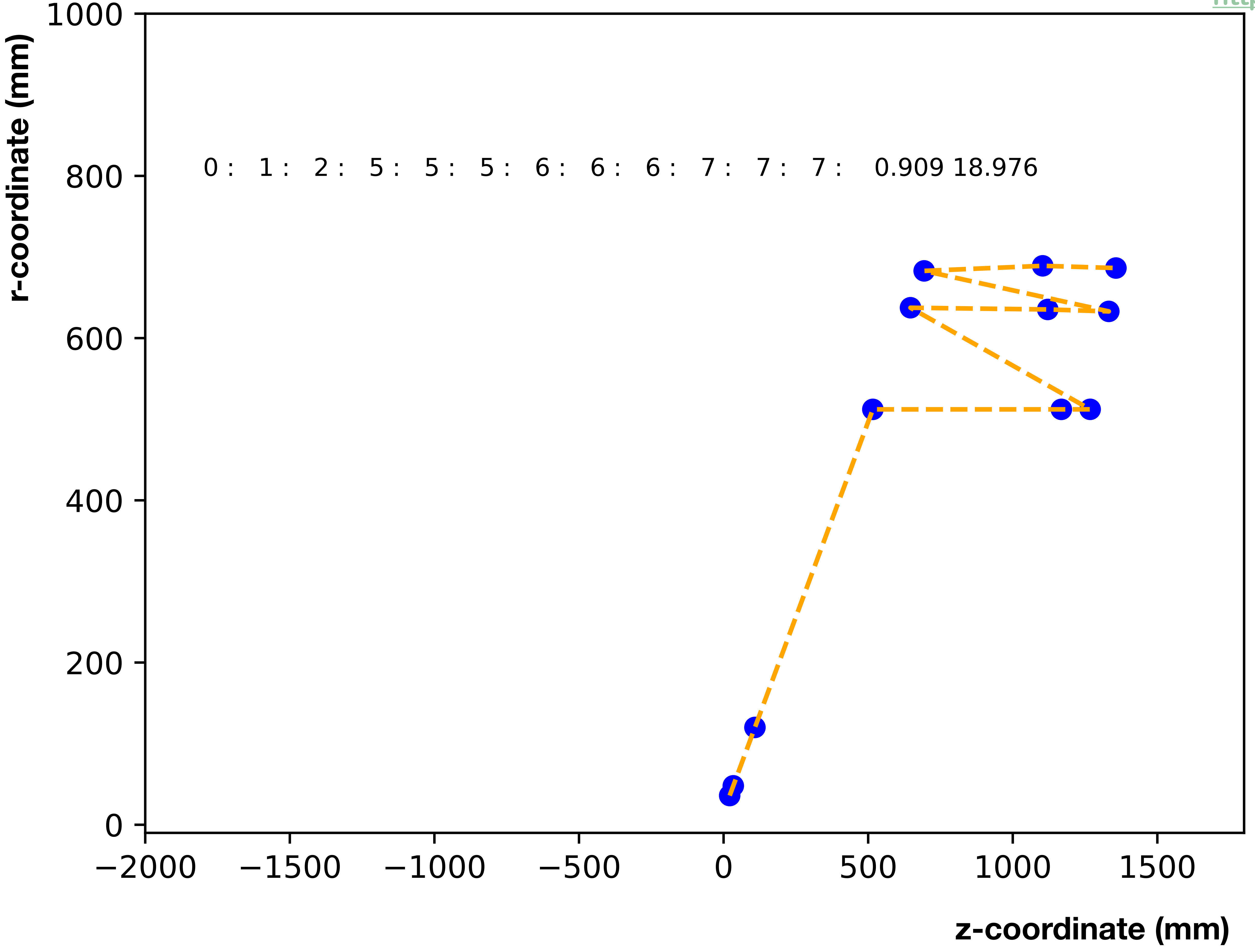
Summary and outlook

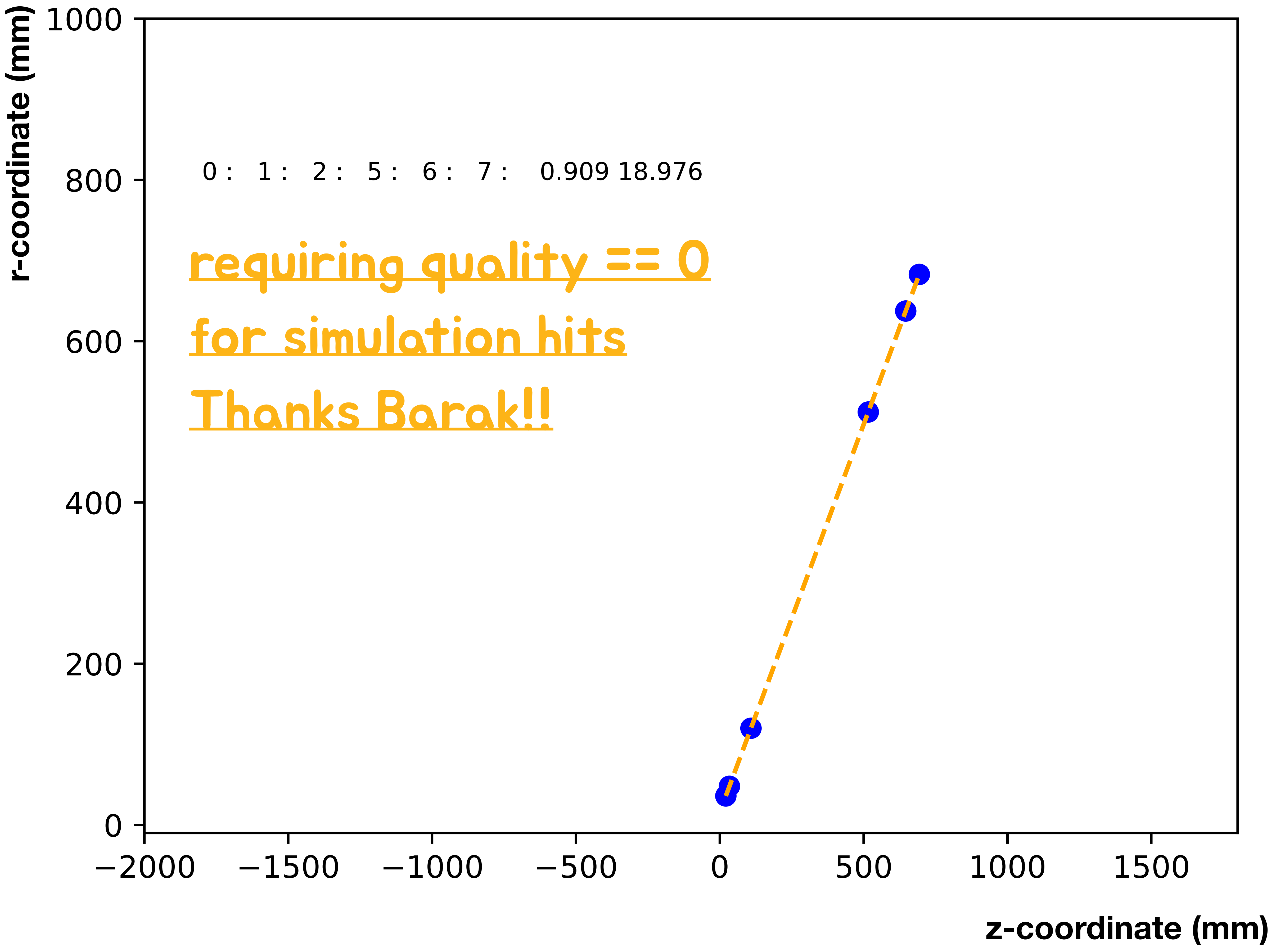
- Duplicate track rejection for realistic seeding
  - Implementation to EICrecon required; directly adopt the methods defined in ACTS
- Tracking efficiency estimated for the first time in photoproduction events
  - Tracking efficiency as a function of pT and eta looks reasonable
  - Increase the statistics to study the edge and the overlap regions between barrel and endcap
  - Impact of MPGDs and TOF in tracking can be quantified
- Start playing with high Q2 DIS events
  - Room for improvement in true seeding: bias from initial parameters - Selection on “trackable” MC particle required!
  - Study tracking efficiency more differentially (ex. as a function of multiplicity)
  - Fake tracks, random associations, …

Multiple generated hits on single layer

- One charged particle generates more than one hit on single layer more pronounced in MPGDs and TOF → random association of hits from secondary particles in Geant4

https://indico.bnl.gov/event/18368/contributions/73607/attachments/46169/78083/tracking_022323.pdf





Short update on DPTS - some features QA plots