Update on PDK Analysis

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Outline

- Update on pre-selection

- BDT input, stats, results

- A few words on track reconstruction failure

Pre-selection

- Require at least 2 reco tracks

- With a common vertex — ends of tracks no further than 5 cm

- If multiple pair candidates, disambiguate

  - using a pair with the longest long track
  - if longest track shared among multiple pairs, then pair with longer track going away from the common vertex (direction determined by comparing dE/dx of 6 points on each end of the long track)
  - if still multiple candidates, pick the pair with the longest short track

- Result is a pair of long and short track — muon/pion and kaon candidates

Particles in Selected Track Pairs
Signal

- in **Kmu2** sample:

  - long is mu 98.5% (1.3% is assigned to K)

  - short is K 81.2% (7.7% proton, 5% positron, 6% muon)

- in **K2pi** sample:

 - long is pi 81% (1.9% K)

  - short is K 64.5% (rest pi+, proton,…)
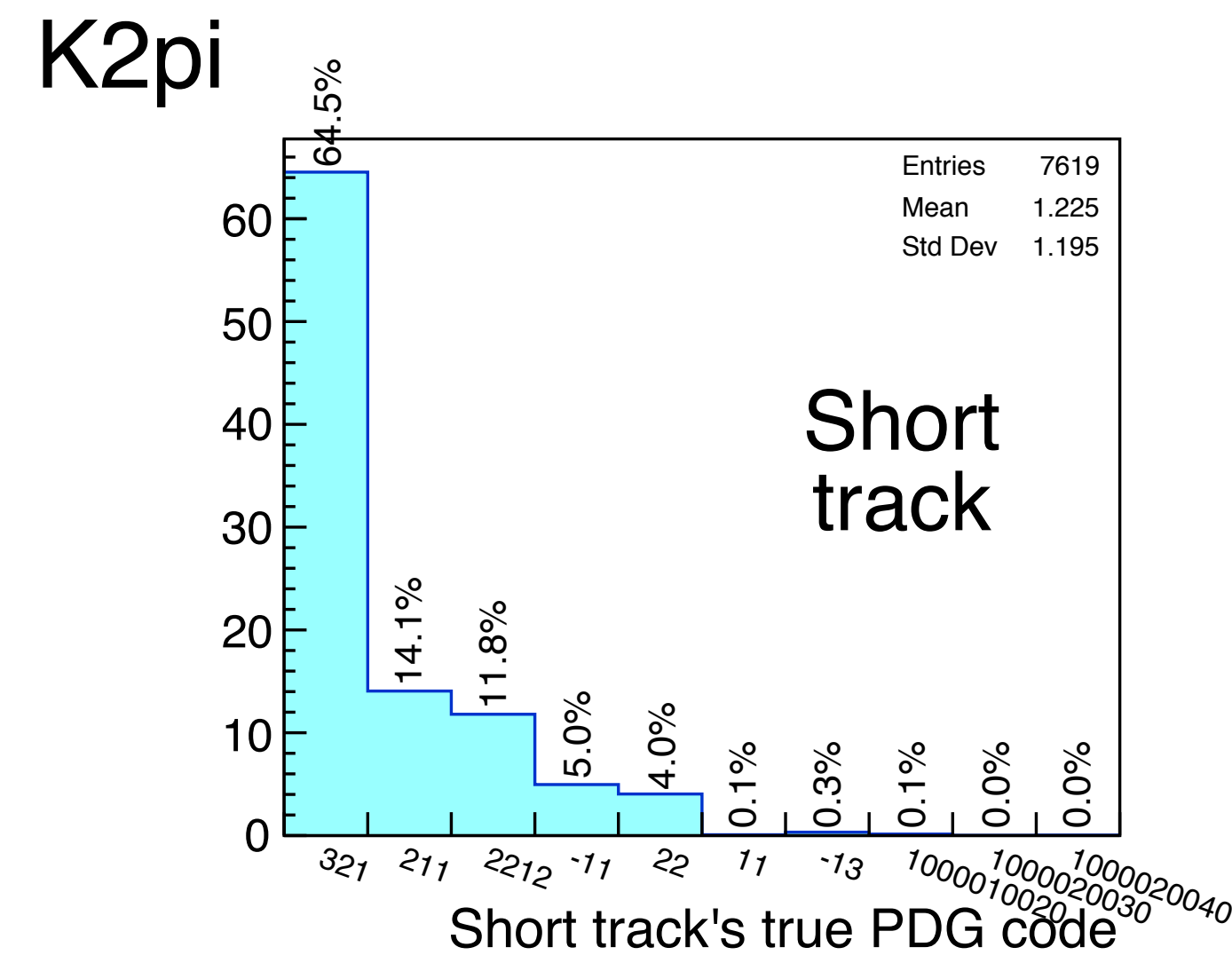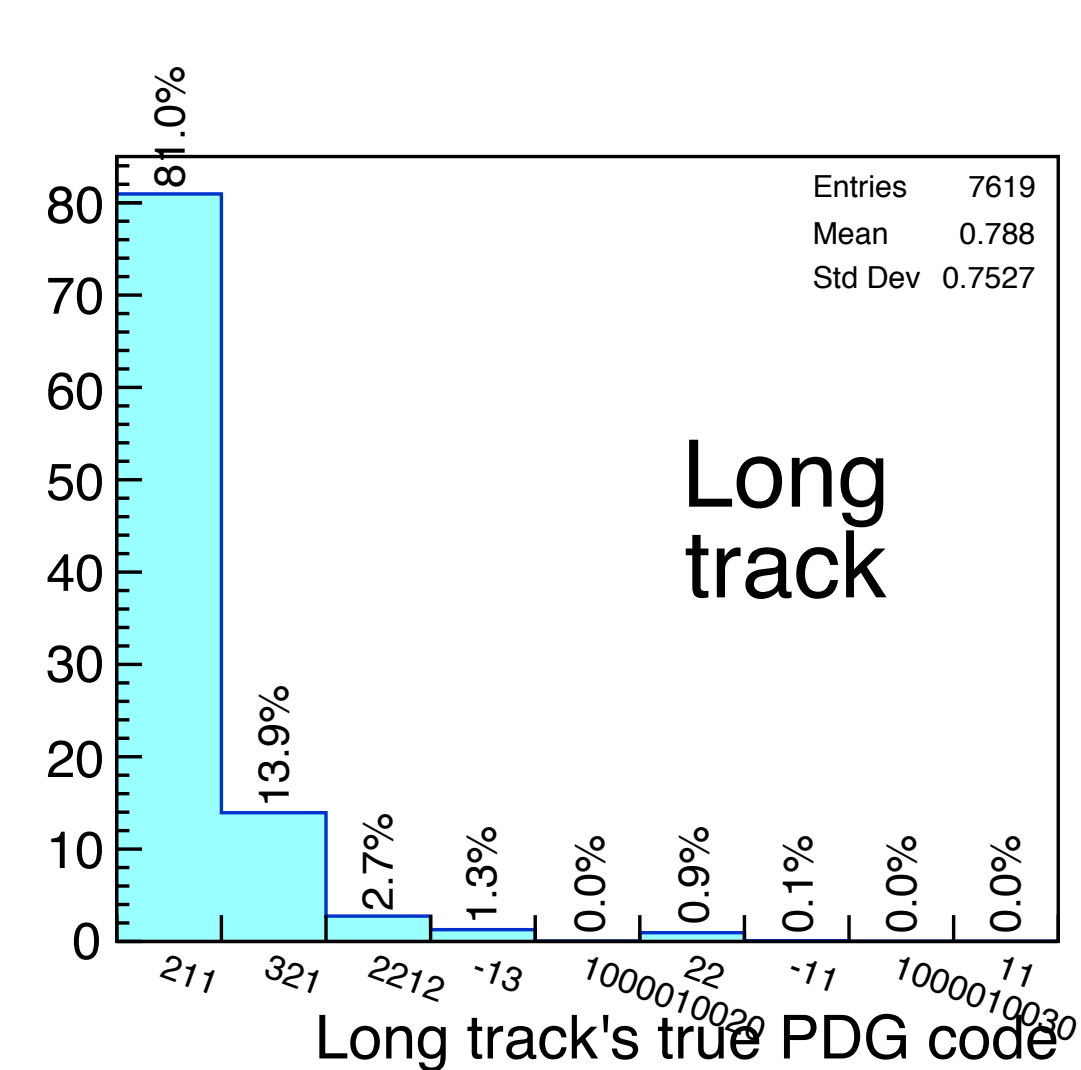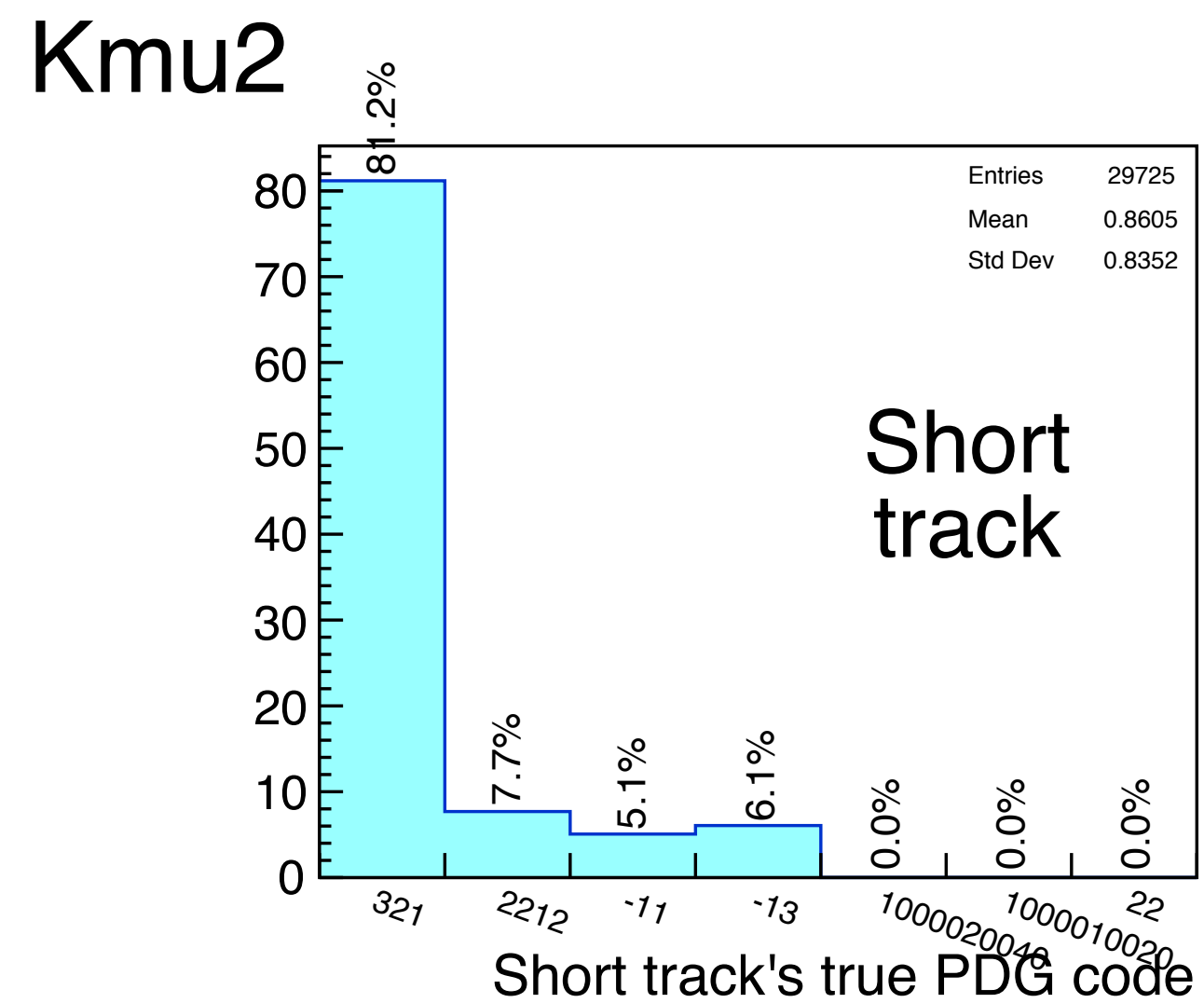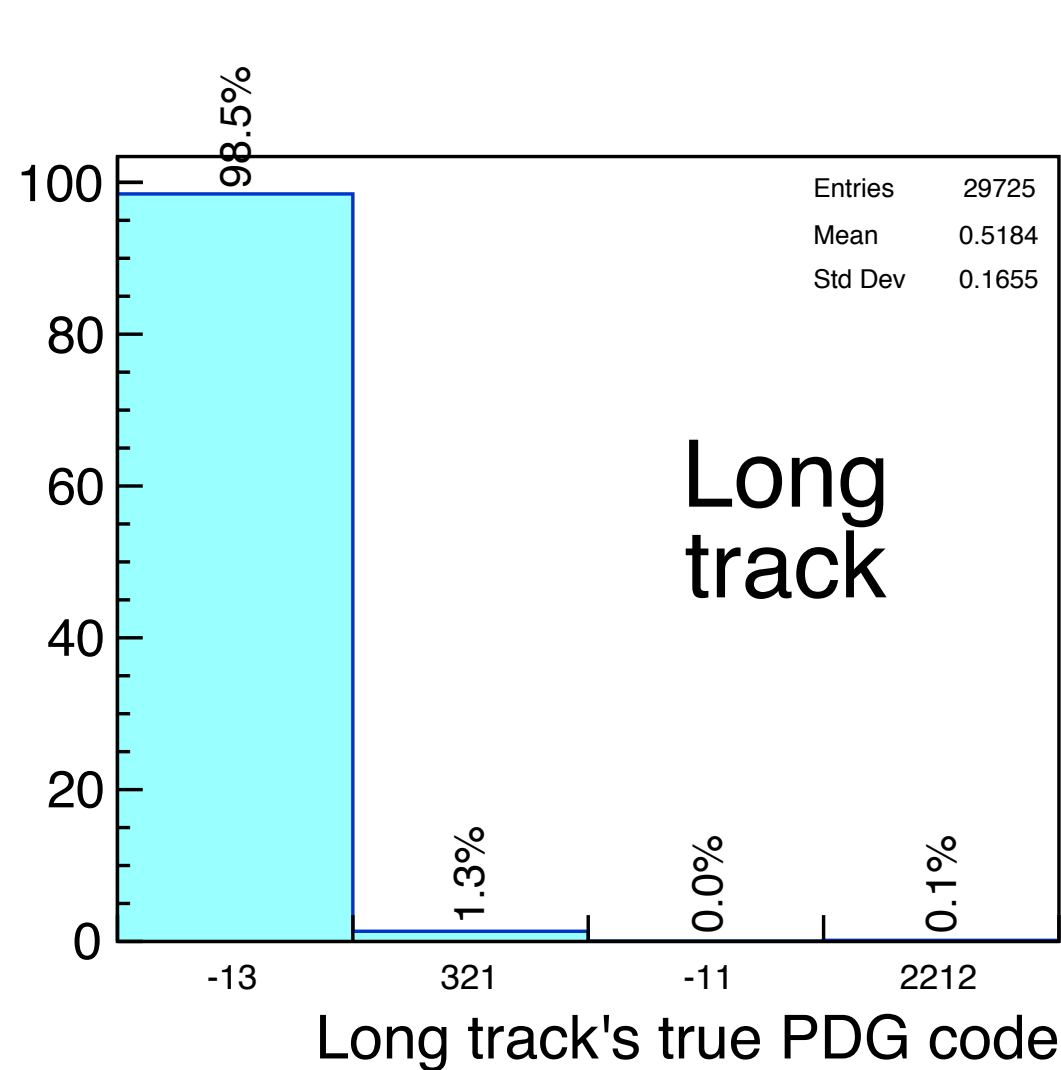
Note: true particle association with a track done by total energy contributing to the track's hits

Particles in Selected Track Pairs
Background

- Long
  - mu- 36.6%
  - proton 39.3%
  - mu+, pi-, pi+ ~7% each
- Short
  - proton 74.7%
  - mu- 6.6%, pi+ 7.4%, pi- 5%

- After 10 cm threshold cut on longer track
- Long
  - mu- 39.3%
  - proton 35.2%
  - mu+, pi-, pi+ ~7% each
- Short
  - proton 73.3%, mu- 7%, pi+ 8%, pi- 5%

BDT input

Templates

- # of tracks

- **track length** of long and short track

- **# of hits** with calorimetric info

- **template LL** of dE/dx vs res.range for short track

- **PIDA** for short and long track

- **# of showers**

- total **energy in tracks**

- total **energy in showers**

- 13 input variables in total
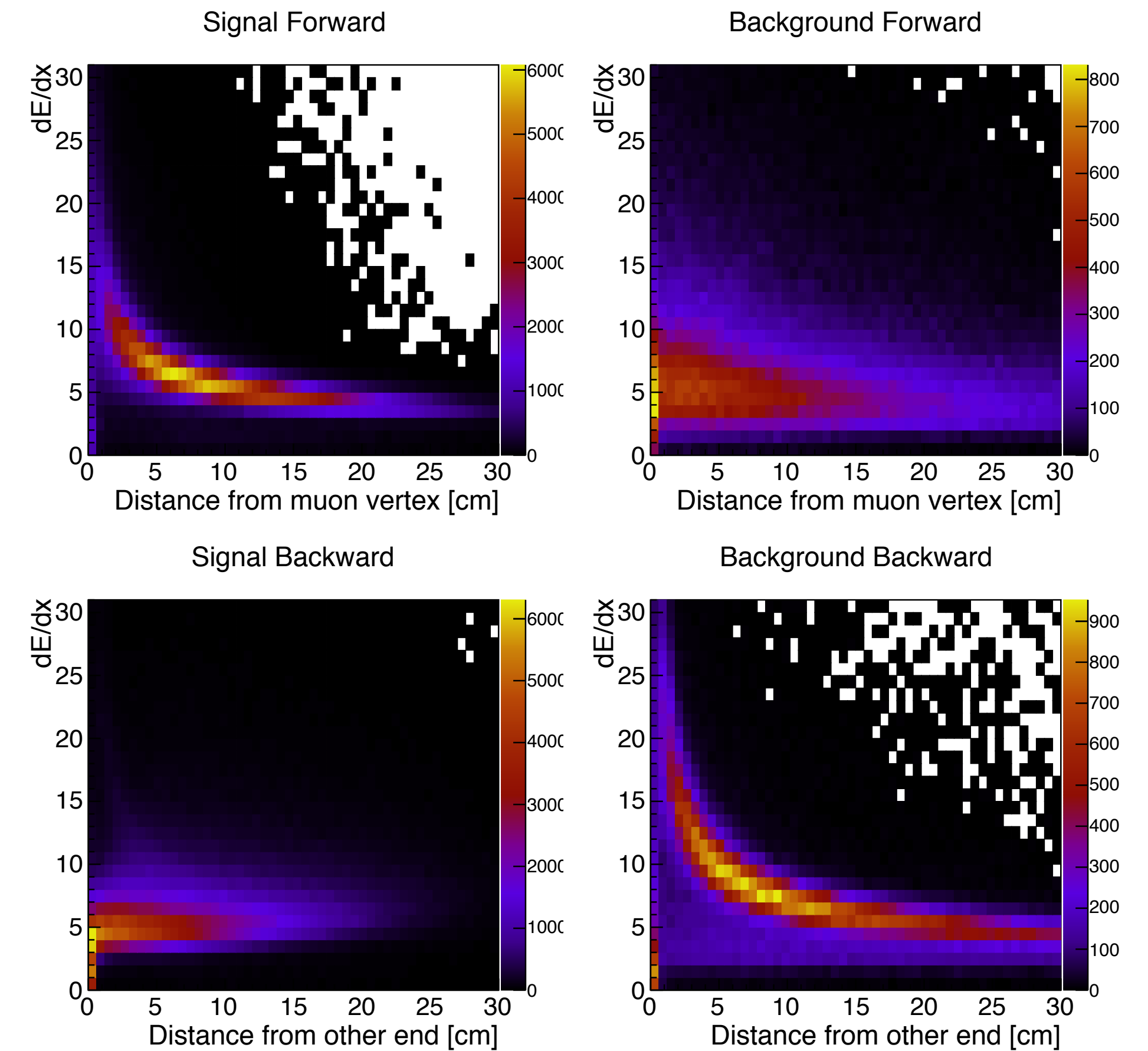
BDT Training and Testing Sample

Total sample size:

- Signal: 185k

- Atmospheric neutrinos: 383k (~1.3 Mton-yr exposure)

Pre-selection cuts down to:

- Signal: 81k (44%)

- Atm.v: 76k (20%)

Signal further divided to Kmu2 and K2pi:

- **Kmu2**: total 116k, pres-selected **59k (51%)**
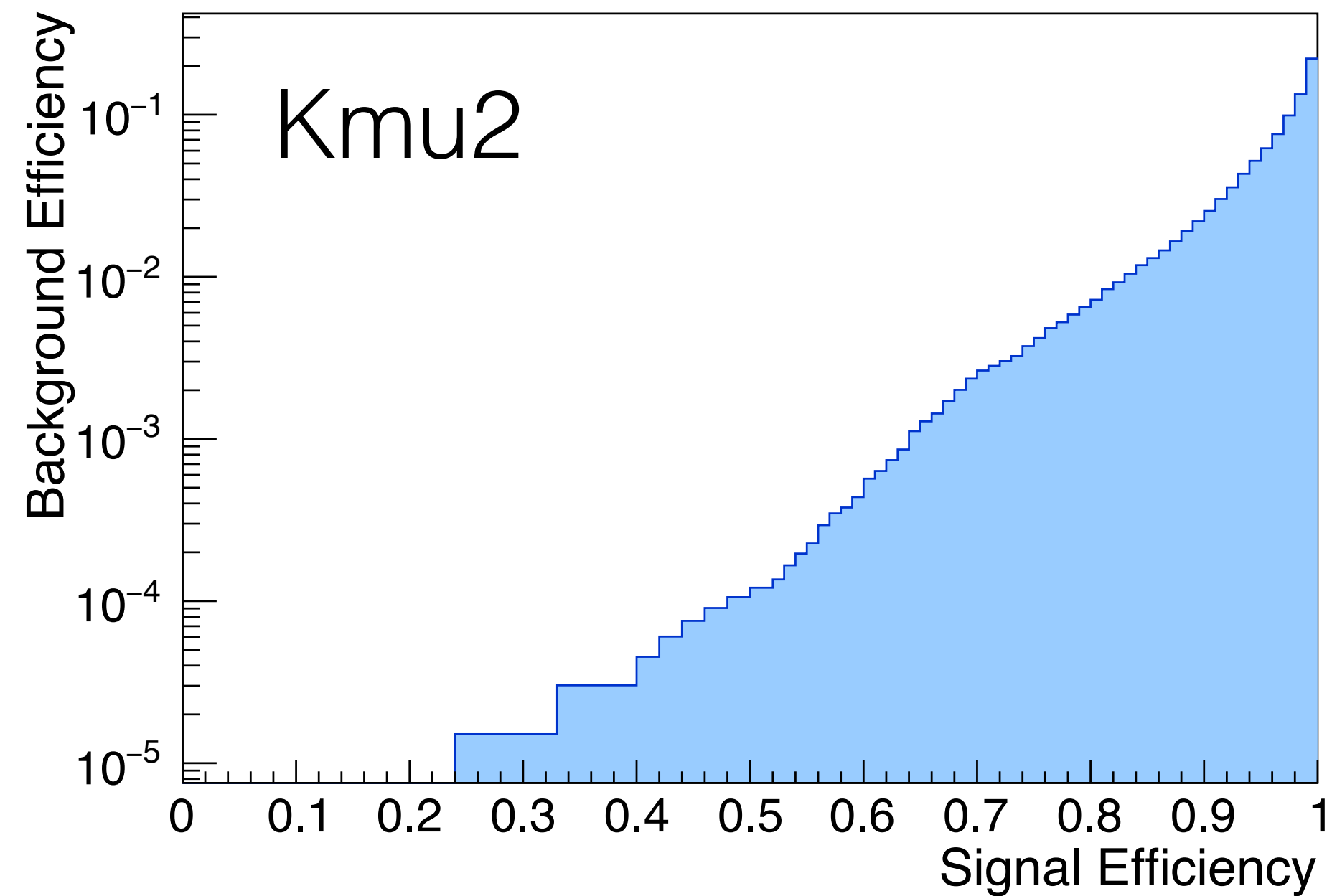
- **K2pi**: total 37k, pre-selected **15k (40.5%)**

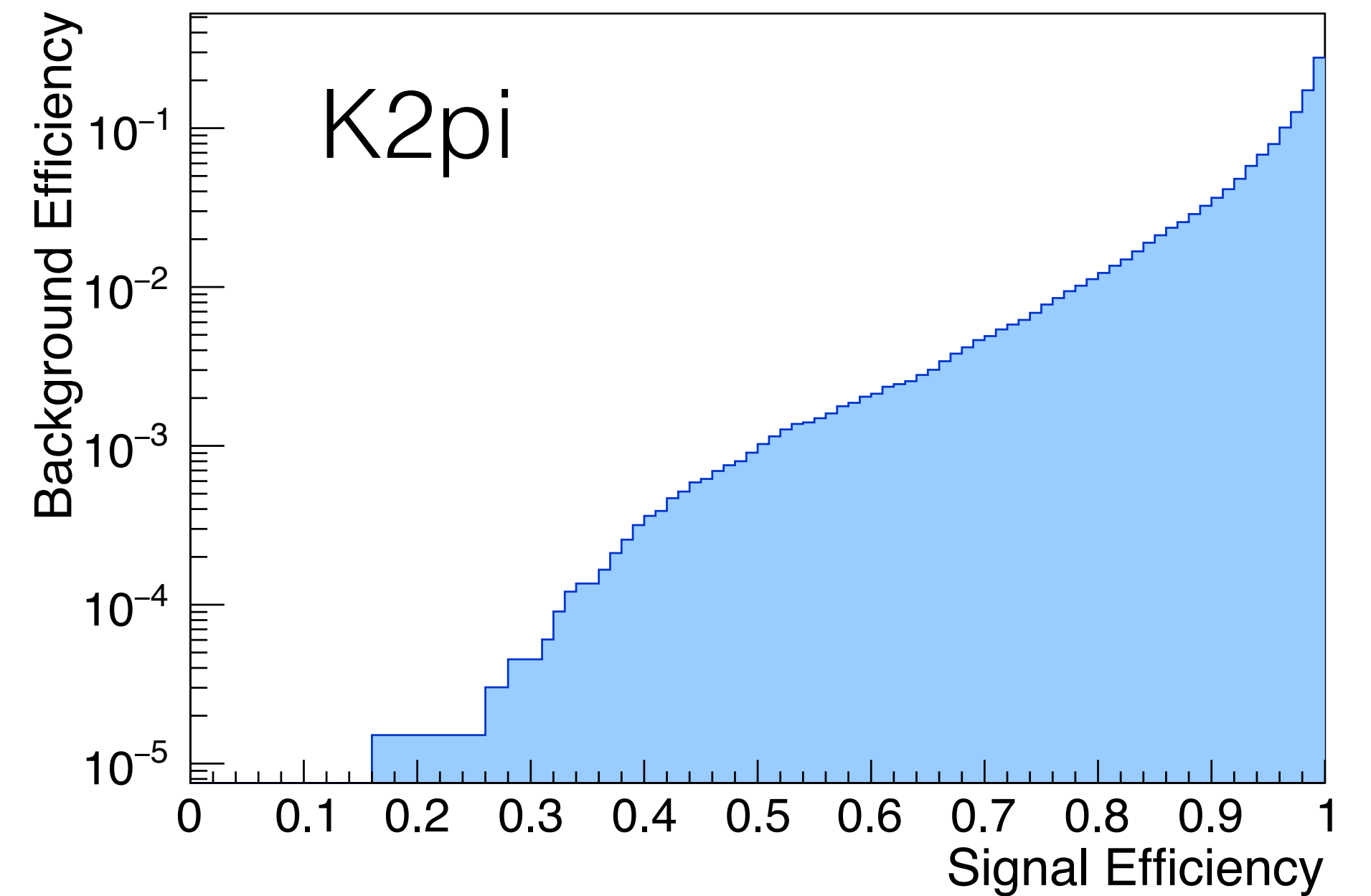BDT trained on:

- Amt.v: 10k

- Signal: 30k Kmu2, 10k K2pi

BDT tested on:

- Amt.v: 66k after pre-sel. **~1.14 Mton-yr** exposure

- Signal: 29k Kmu2, 5k K2pi

BDT Results

- ~47% @ 10^{-4} Bg

- Considering pre-selection: **24% @ 2x10^{-5} Bg**

- ~5.8 bg events per Mton-yr

- ~34% @ 10^{-4} Bg

- Considering pre-selection: **14% @ 2x10^{-5} Bg**

Reconstruction Failures

- Large hit on PDK signal efficiency comes from inefficient reconstruction of kaon track

- Scanned through some events, there are often recognisable K tracks

- Some reasons of reconstruction failure seem to be:

  - tracks span across 2 TPCs/tracks cross APA

  - overlapping trajectories

  - track perpendicular to wire plane

- K tracks with:

  - L > 5 cm & are primary & DAR (58%)

  - & has a reco track: 46% (46%/58% = **79.3%** of above) — poor efficiency

- for L > 14 cm still only **85.8%** efficiency
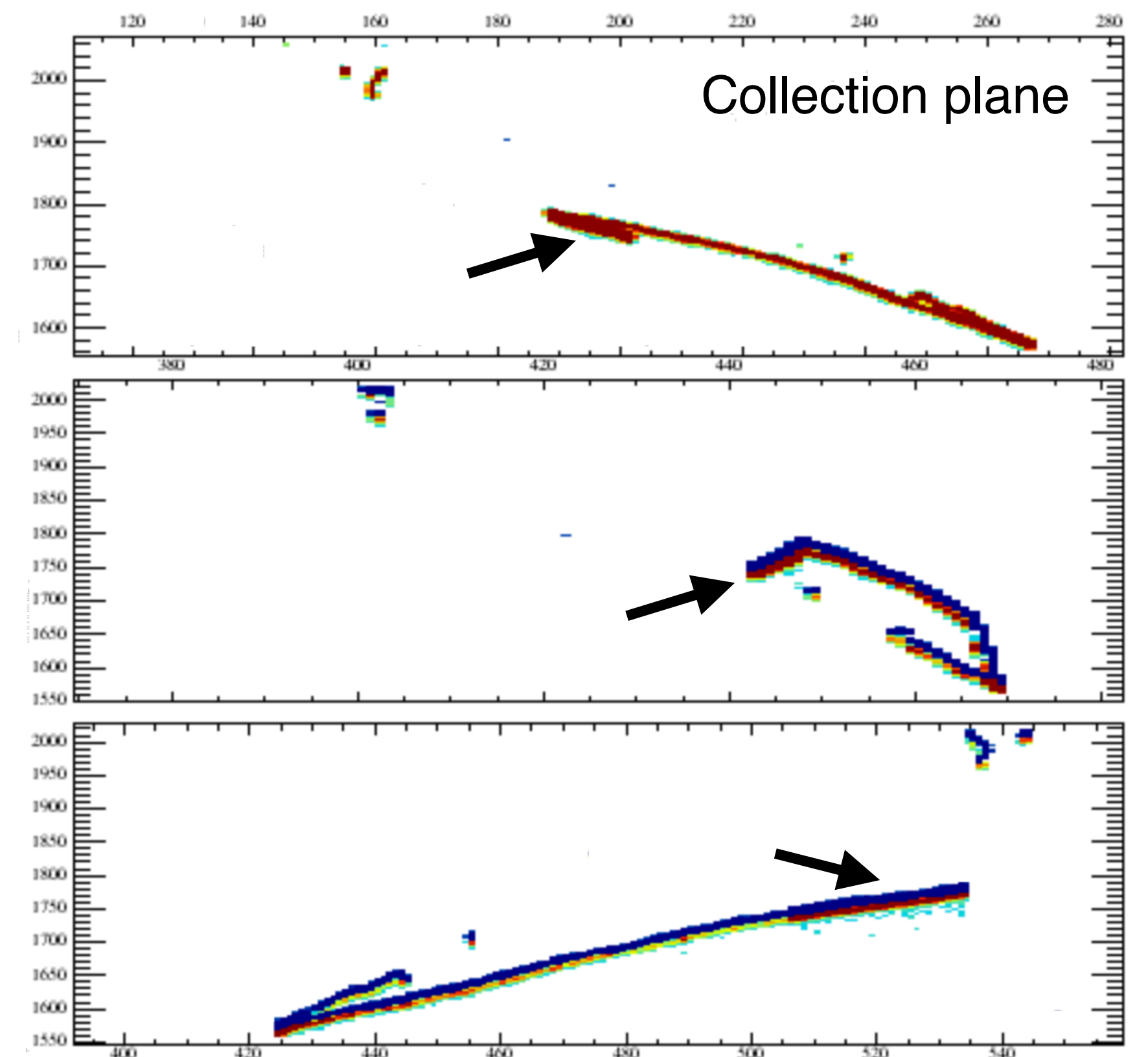
Primary K which DAR

*DAR: decay at rest

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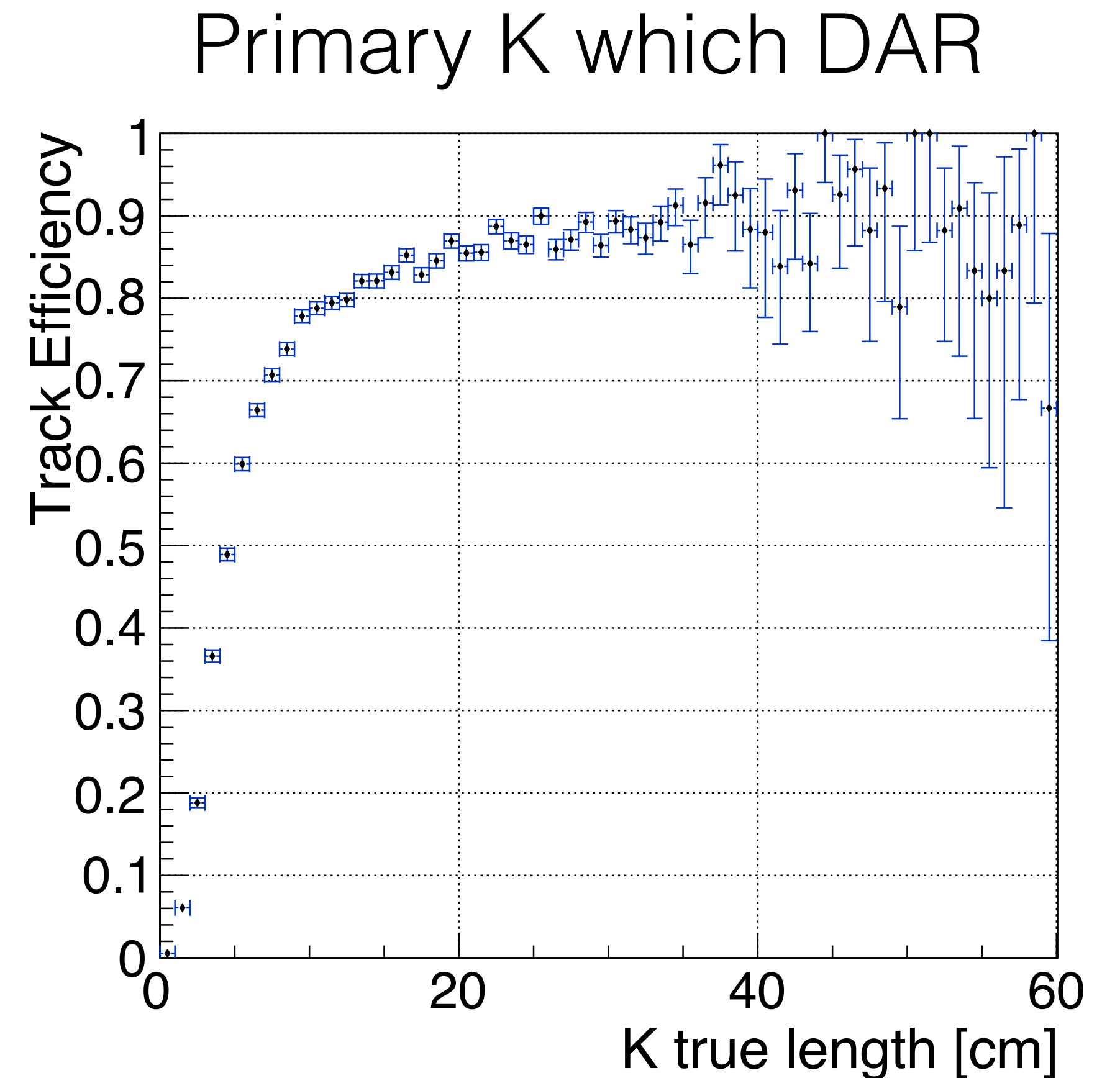
Examples of Failed Reco

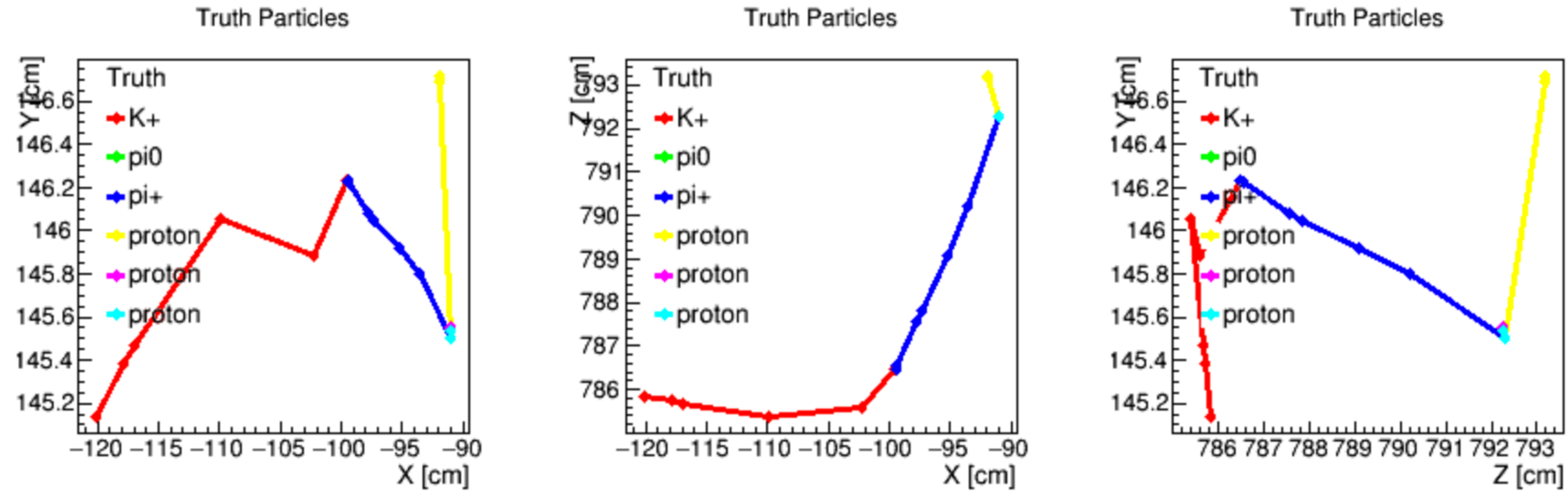- Examples of K trajectories longer than 14 cm
  and not reconstructed
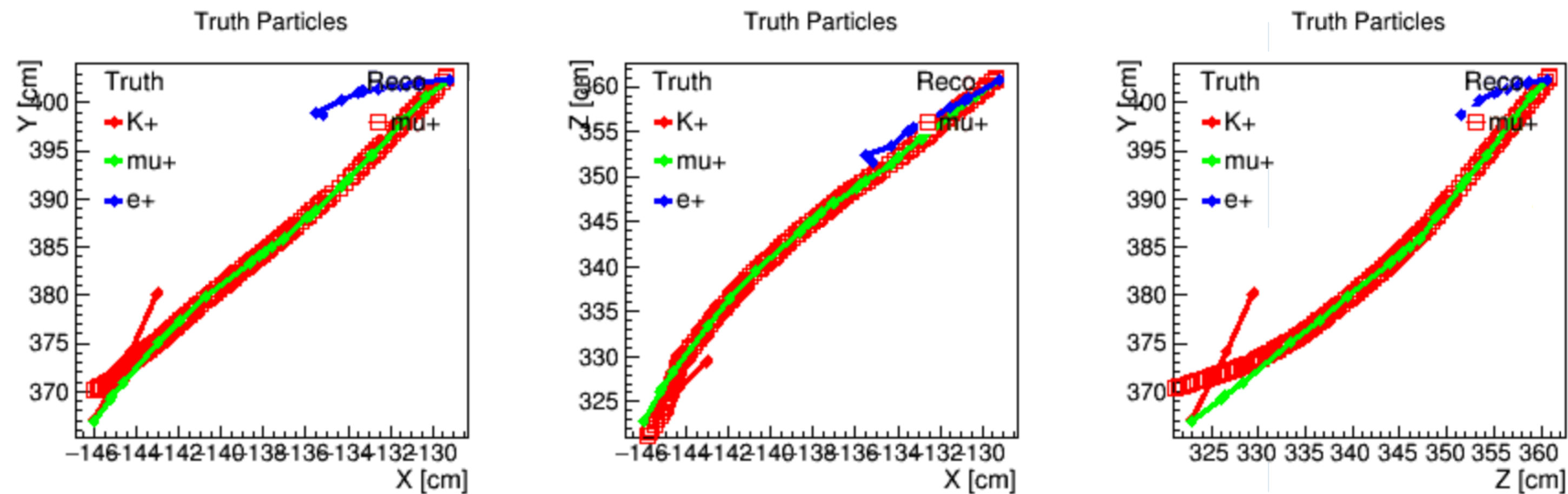
- K overlaps with muon

Collection plane
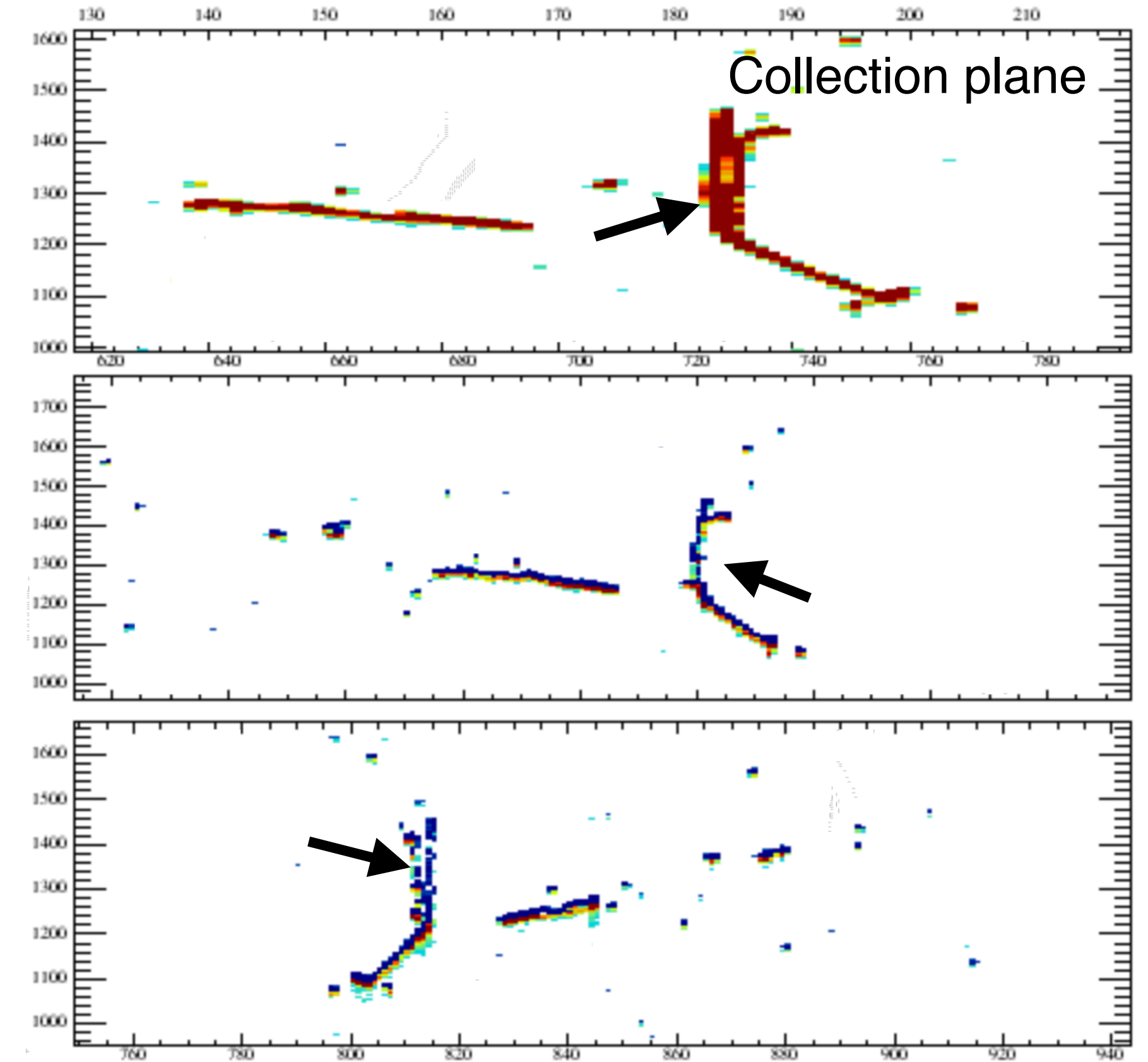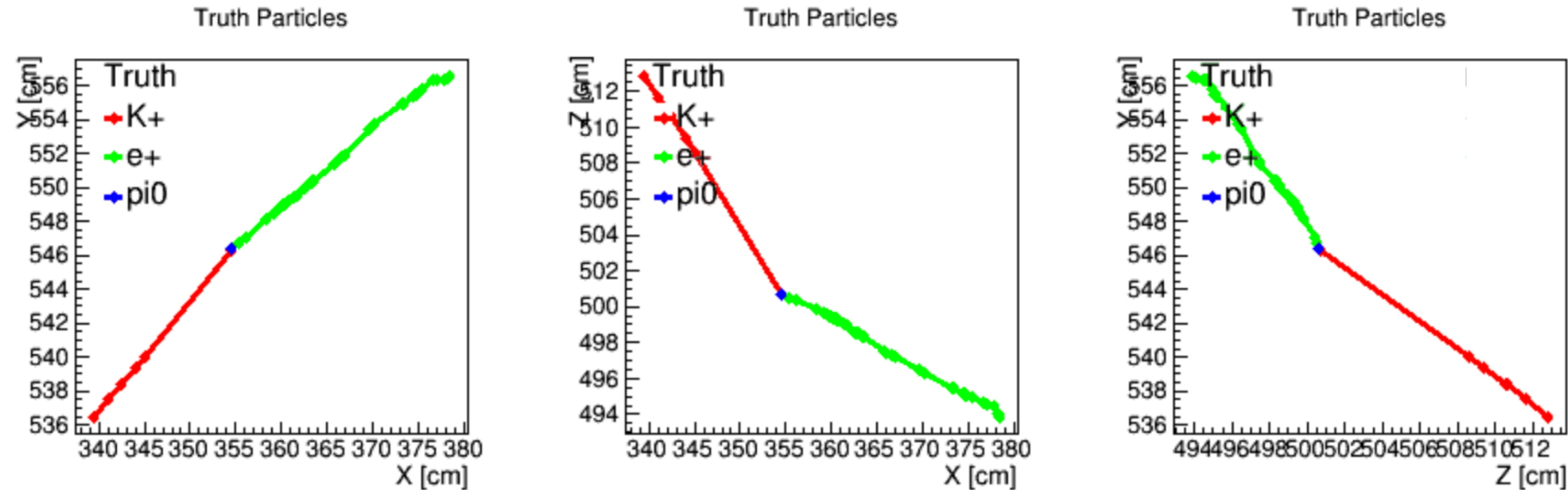
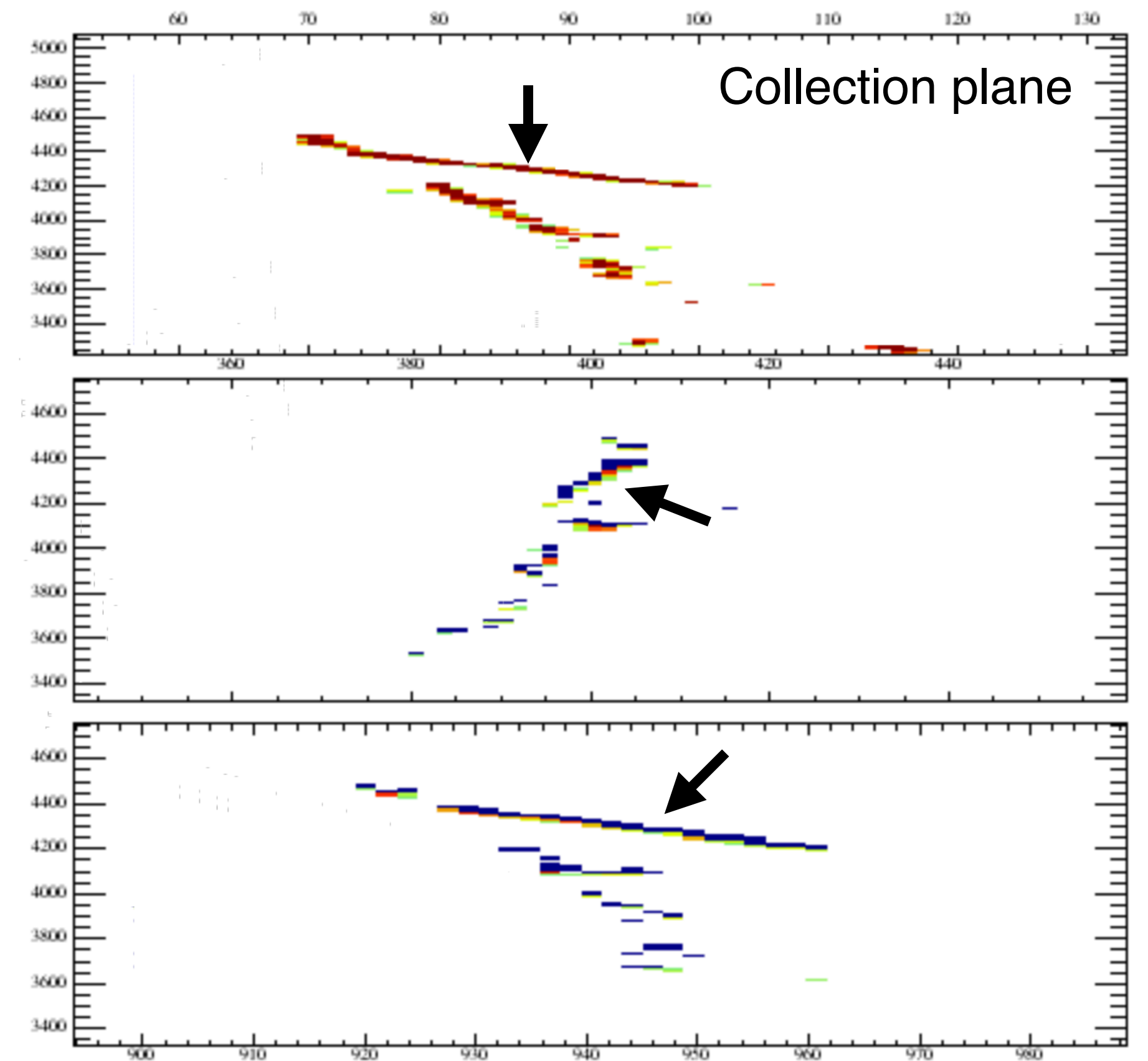# Examples of Failed Reco

- K track perpendicular to the wire plane

Examples of Failed Reco

- K track at shallow angle w.r.t. wires in 2nd plane

- and other activity in the neighbourhood

Collection plane

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Conclusion

- Simple BDT analysis does not give satisfactory results

- In order to have better estimation of low/no background, more atmospheric events needed (factor 10?)

- Big hit in signal efficiency comes from poor reconstruction of kaon tracks

To Do

- Will run cheated Pandora reconstruction — as a workaround for poor recon. efficiency

  - cheated: creates hist clusters based on true particle-hit association

- Will add K-mass estimate into K2pi analysis

- Will try to workaround poor K reco. eff. in a similar way as Dan Pershey has done