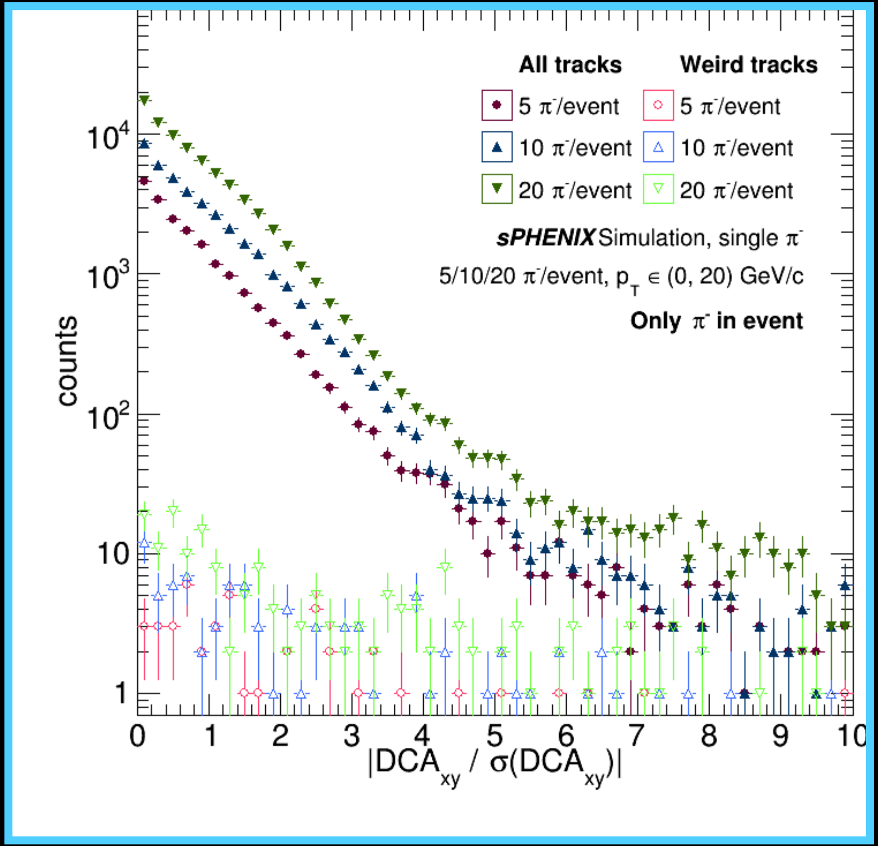
Track Cut Study: Update

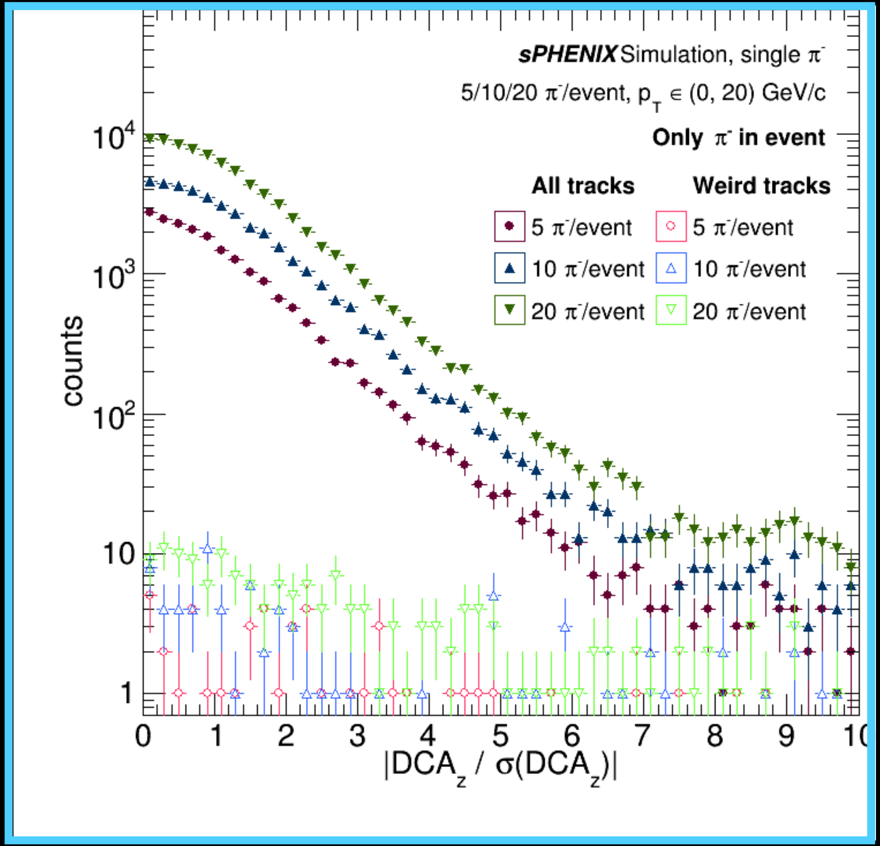
sPHENIX Tracking Meeting

March 29th, 2023

Derek Anderson

How does DCA/σ(DCA) look?



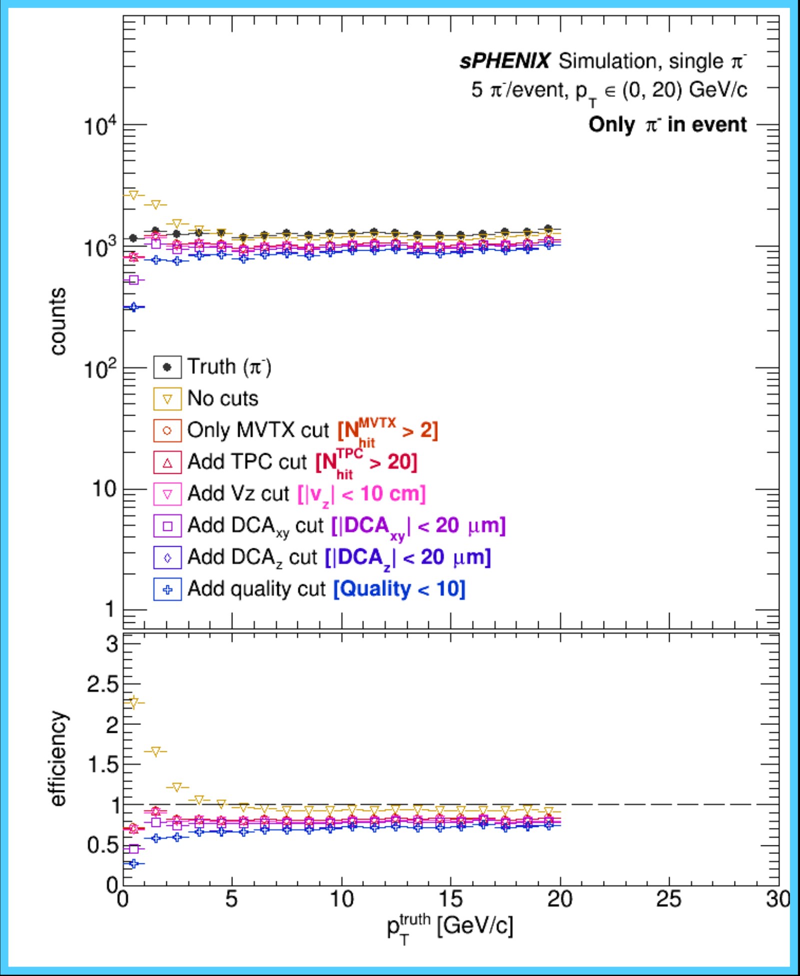


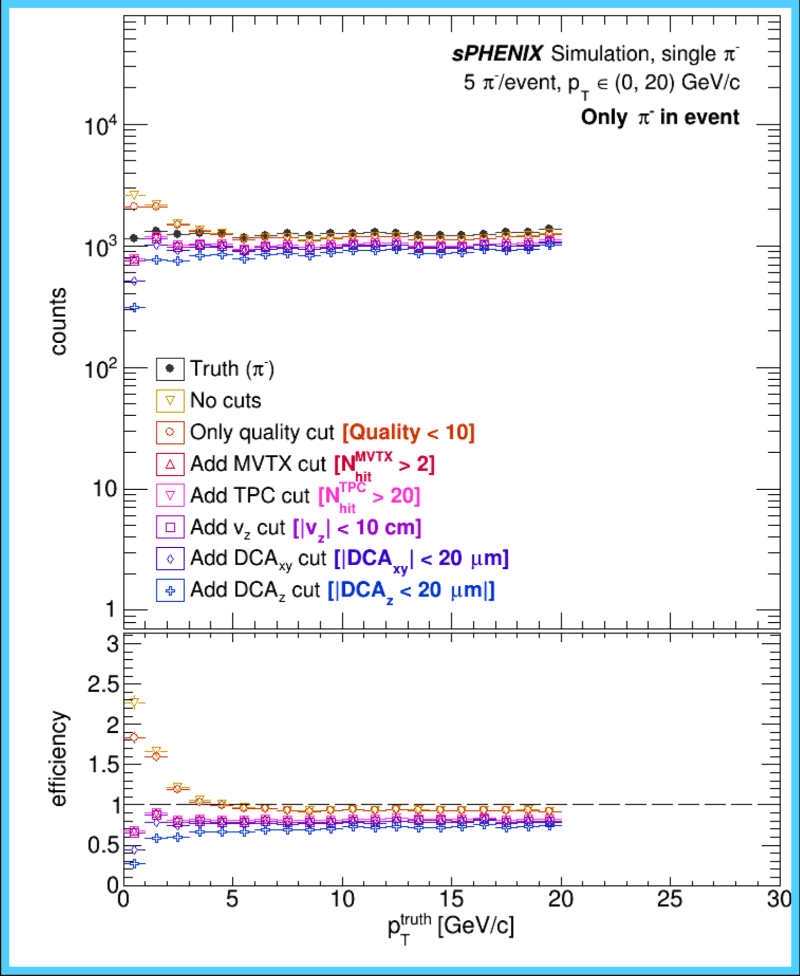
- **Shown:** DCA/σ(DCA) for DCAxy (right) and DCAz (left)
  - Shown for $N_\pi = 5$ **(red)**, $N_\pi = 10$ **(blue)**, and $N_\pi = 20$ **(green)** events
  - ($N_\pi = 50$ and $N_\pi = 100$ events in progress…)

How does changing cut hierarchy affect efficiency?

- **Shown:** How reco. efficiency evolves as cuts are added
  - **Left:** quality cut applied last
  - **Right:** quality cut applied first
  - ☞ Quality cut (< 10) on its own doesn't remove many tracks

- For π^--only events
  - Only 5 π^-/event
  - (20 π^-/events in backup)





What happens when N_{hit}^{TPC} is varied?

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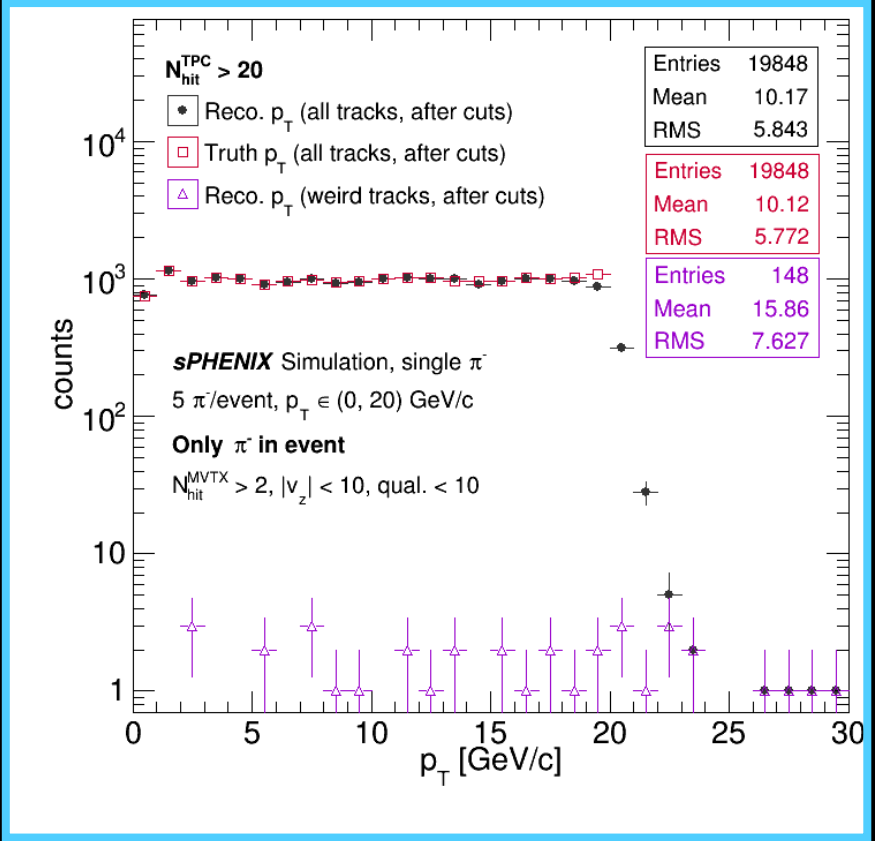
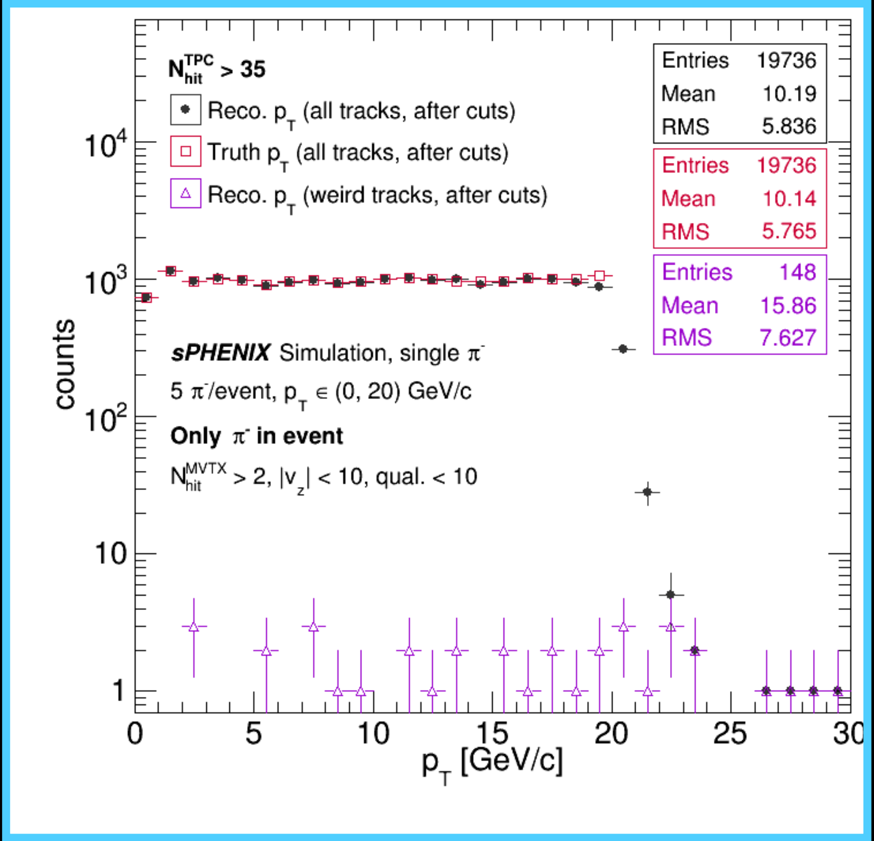
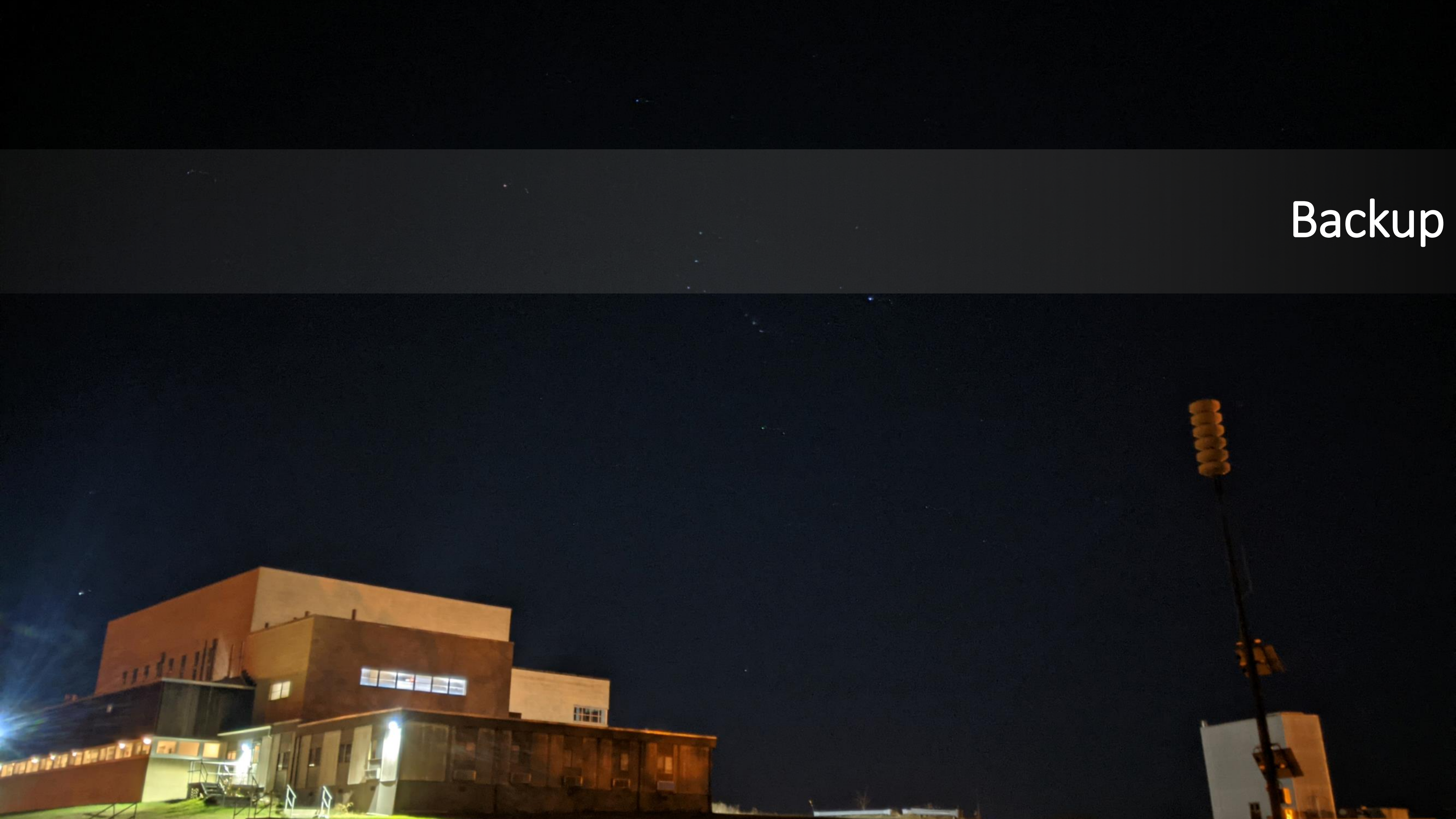




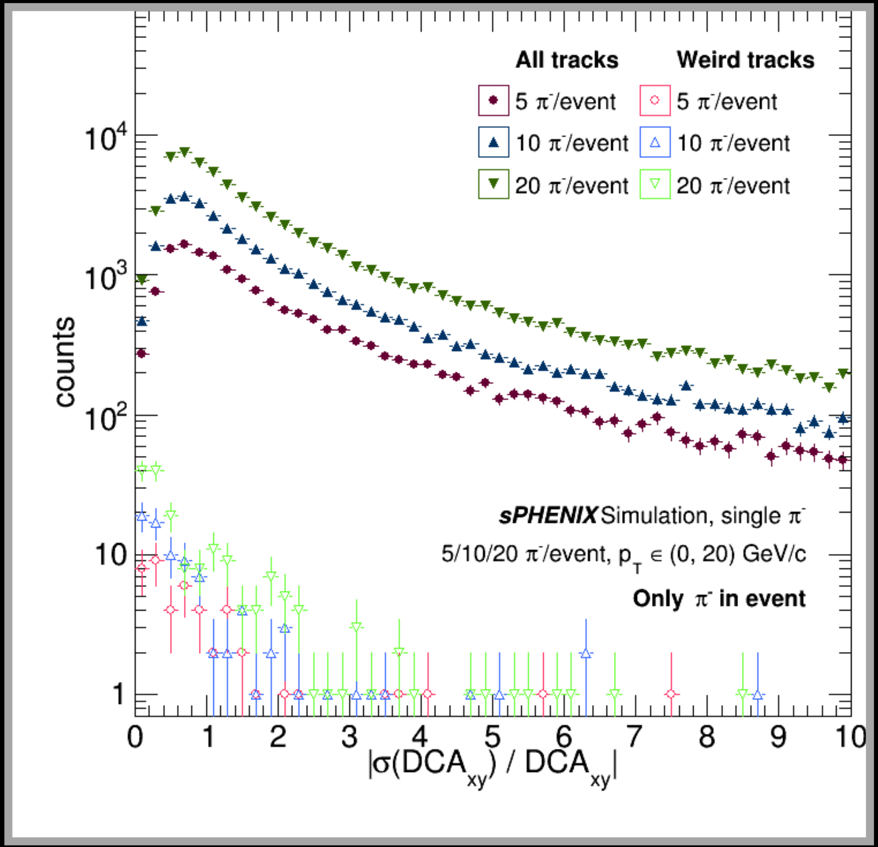
- **Shown:** Reconstructed (black and purple) p_T vs. true p_T **(red)**
  - Left: $N_{hit}^{TPC} > 20$ cut applied
  - Right: $N_{hit}^{TPC} > 35$ cut applied
- **Varying N_{hit}^{TPC} cut makes little impact**

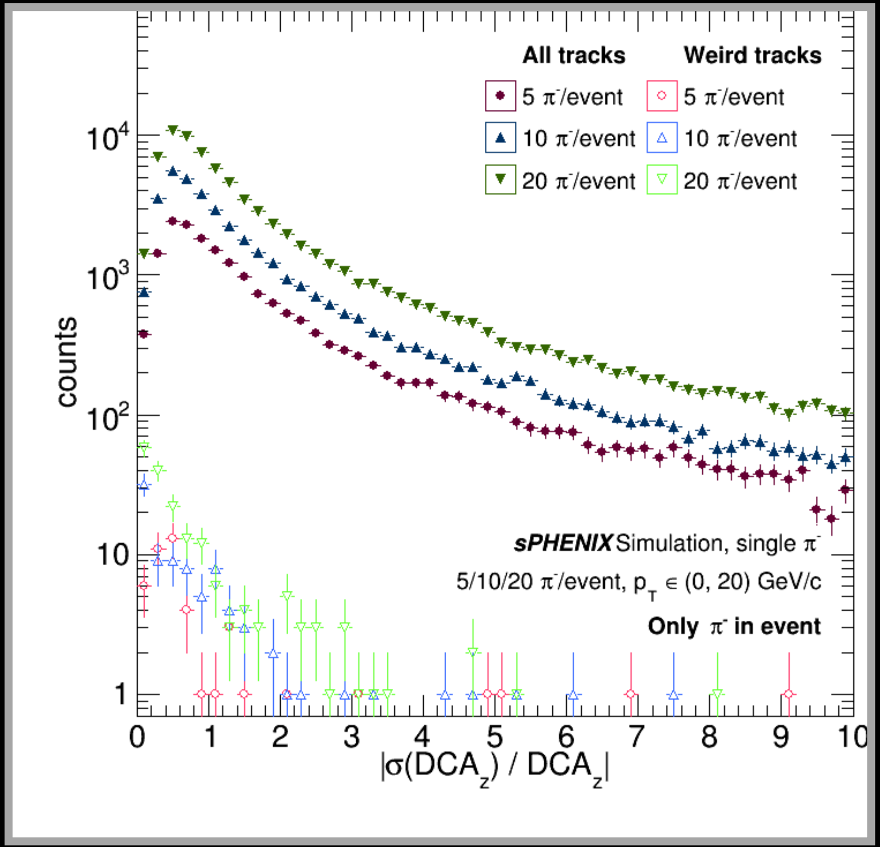
- **Note:** cuts on N_{hit}^{MVTX}, v_z, and quality also applied
- Only 5 π^-/events
  - (10, 20 π^-/events in backup)

Backup



Backup | σ(DCA)/DCA vs. N_{π}

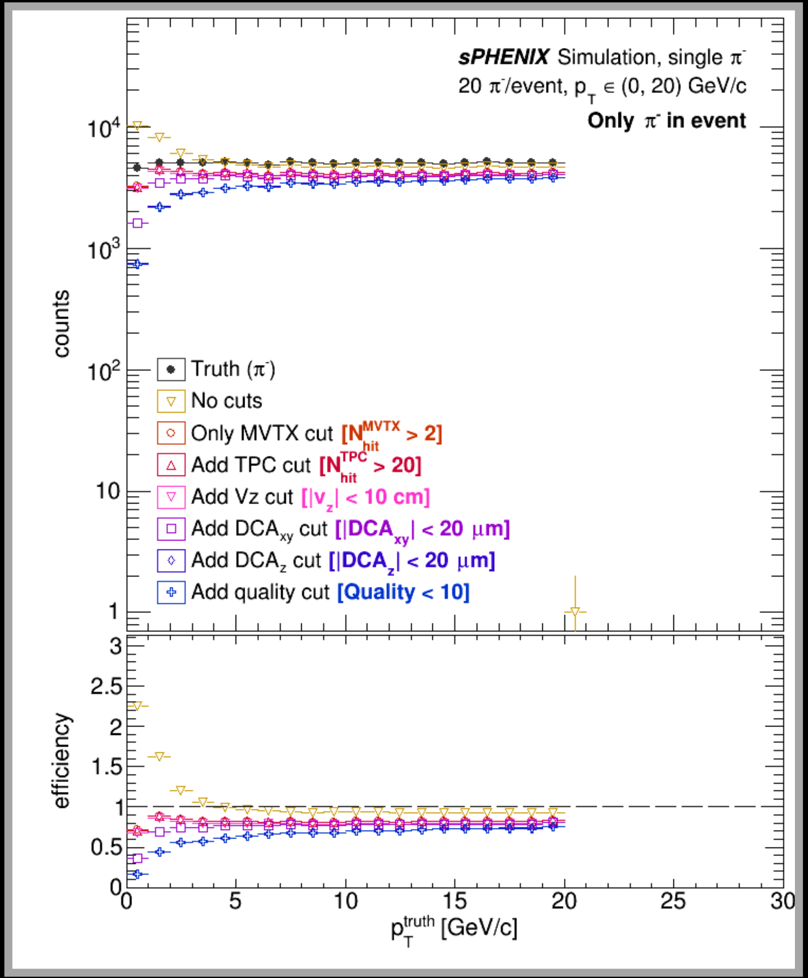


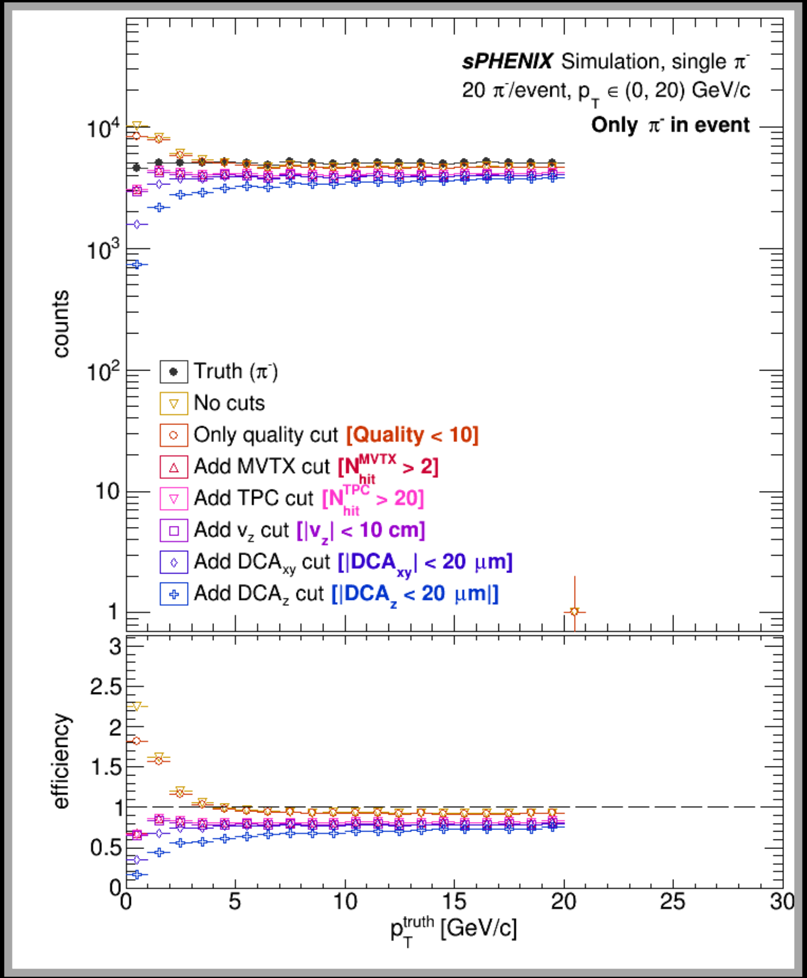


- **Shown:** σ(DCA)/DCA for DCAxy (right) and DCAz (left)
  - Shown for $N_{\pi} = 5$ **(red)**, $N_{\pi} = 10$ **(blue)**, and $N_{\pi} = 20$ **(green)** events

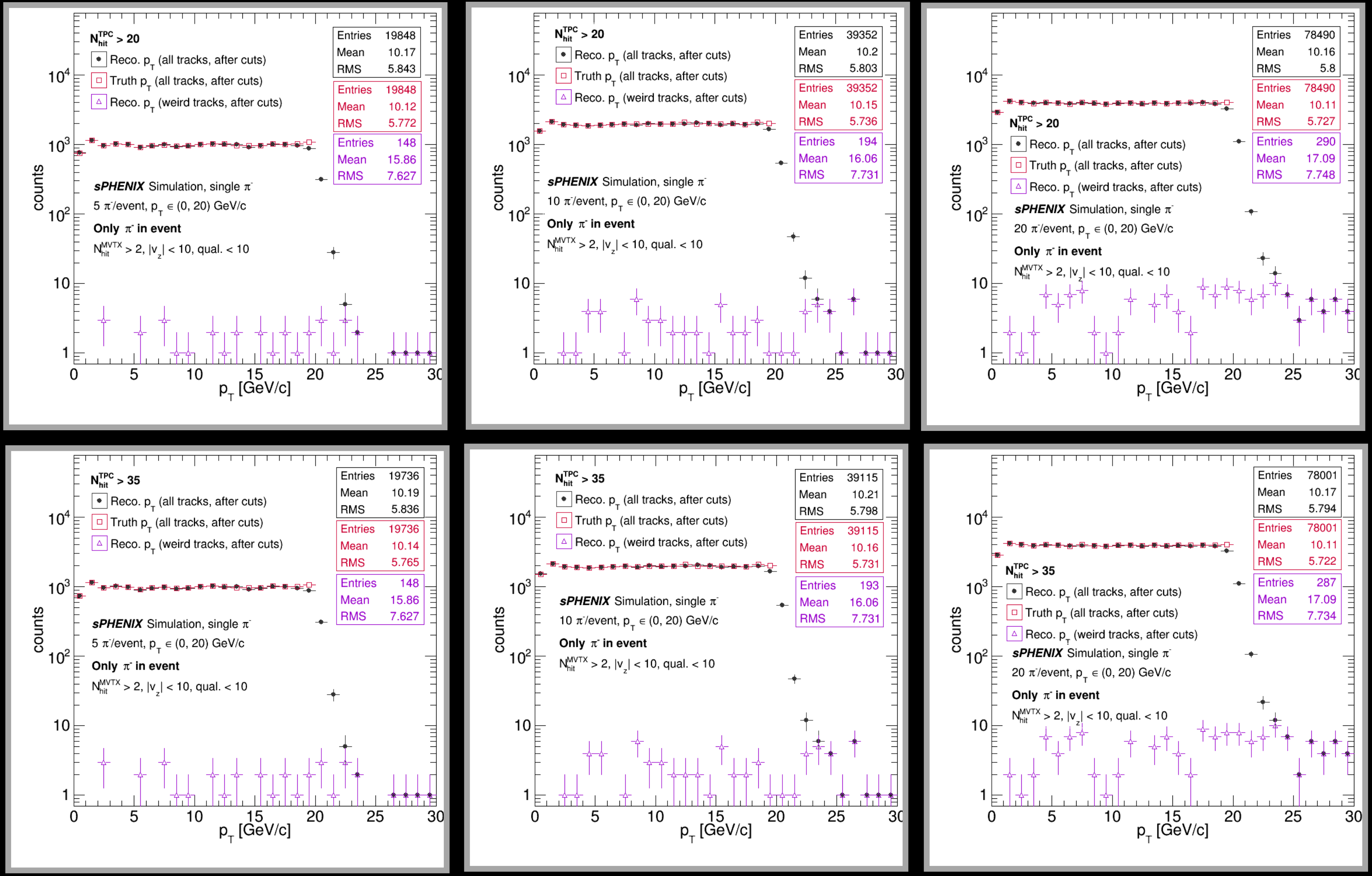
Backup | cuts vs. efficiency for 20 π^-/event

- **Shown:** How reco. efficiency evolves as cuts are added
  - **Left:** quality cut applied last
  - **Right:** quality cut applied first
  - ☞ Quality cut (< 10) on its own doesn't remove many tracks
- For π^--only events
  - 20 π^-/event

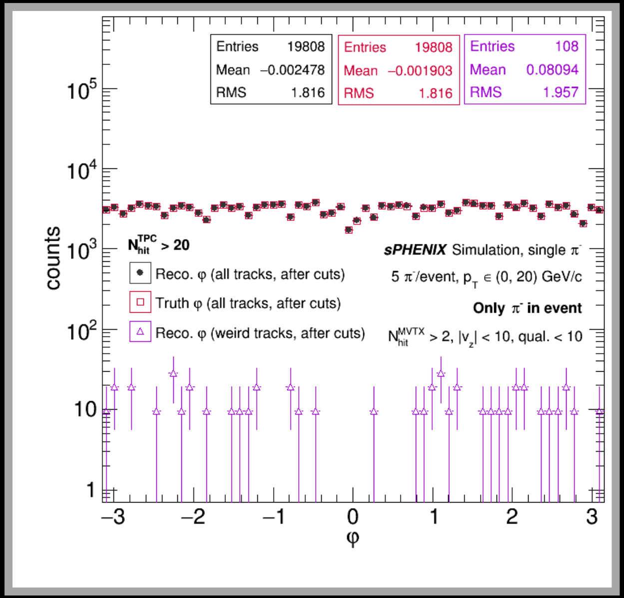


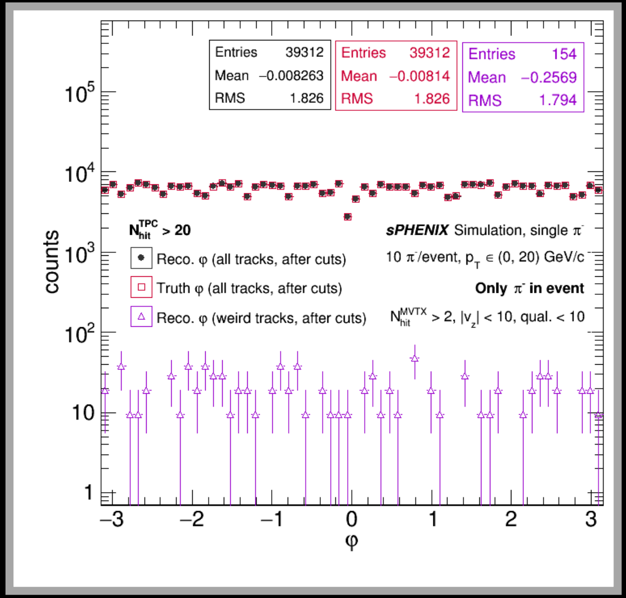


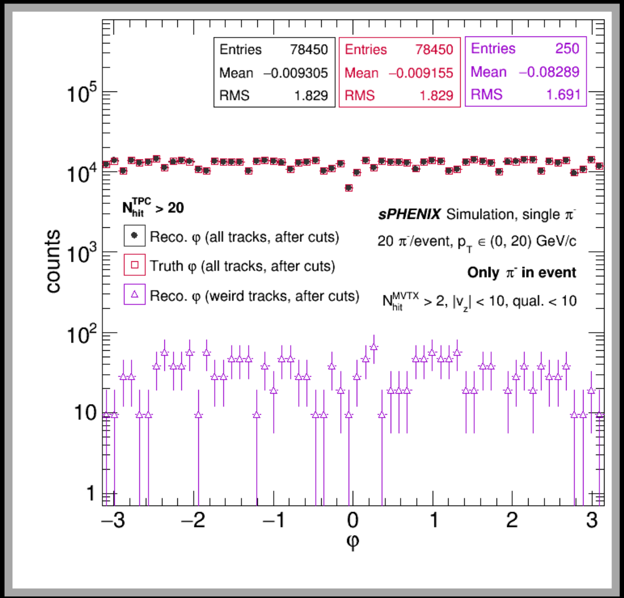
Backup | varying N_{π} and N_{hit}^{TPC}

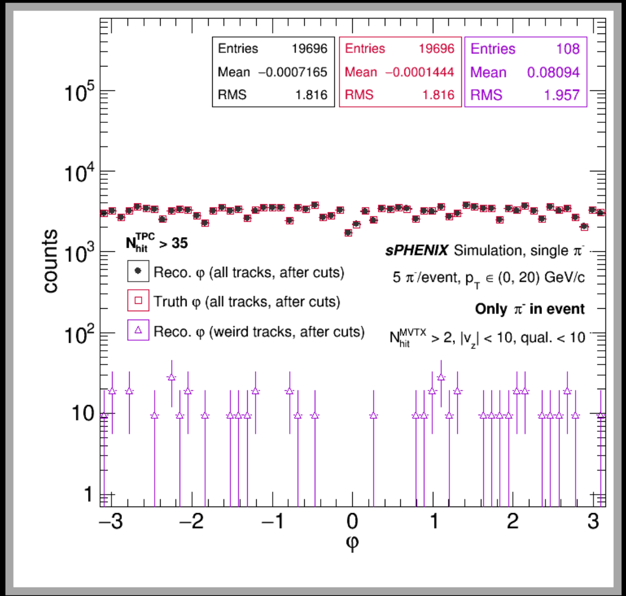


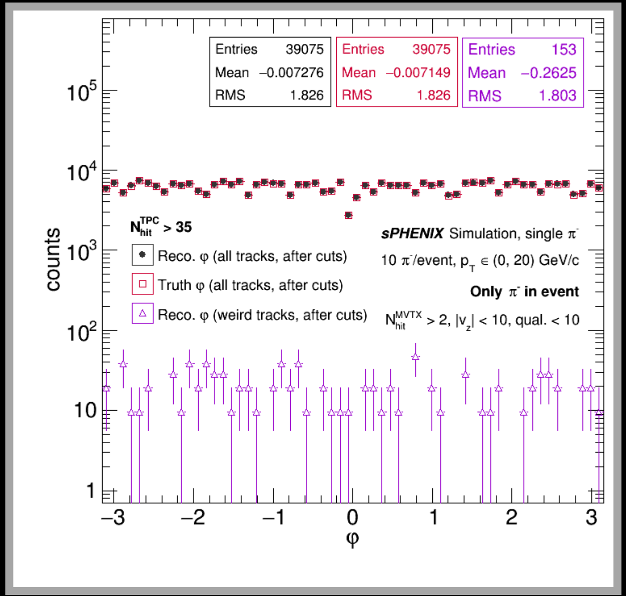
Backup | varying N_{π} and N_{hit}^{TPC}

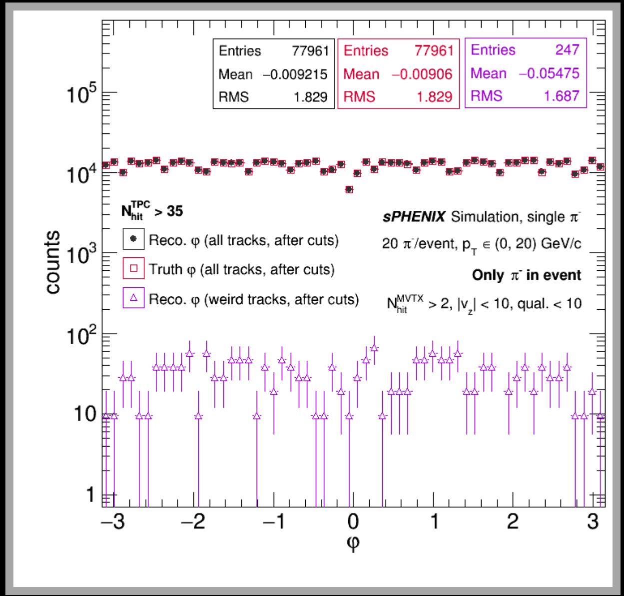








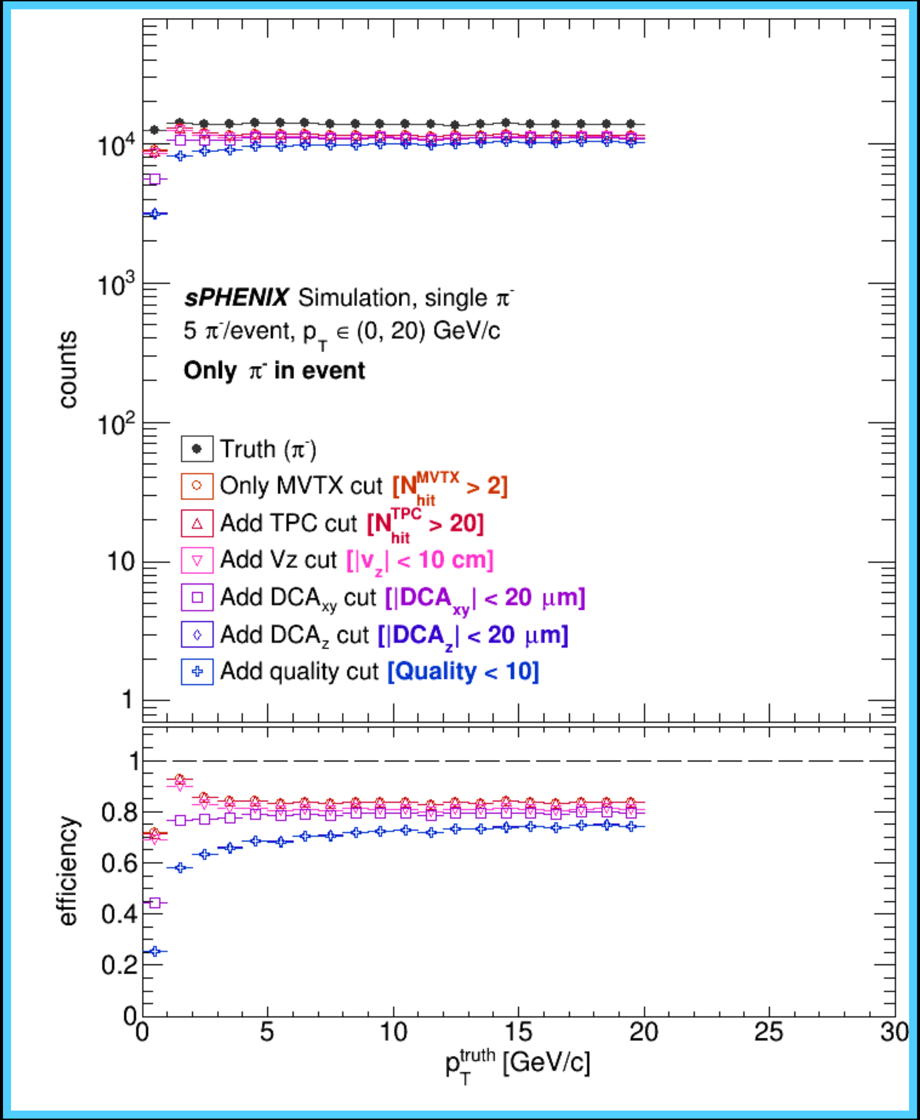




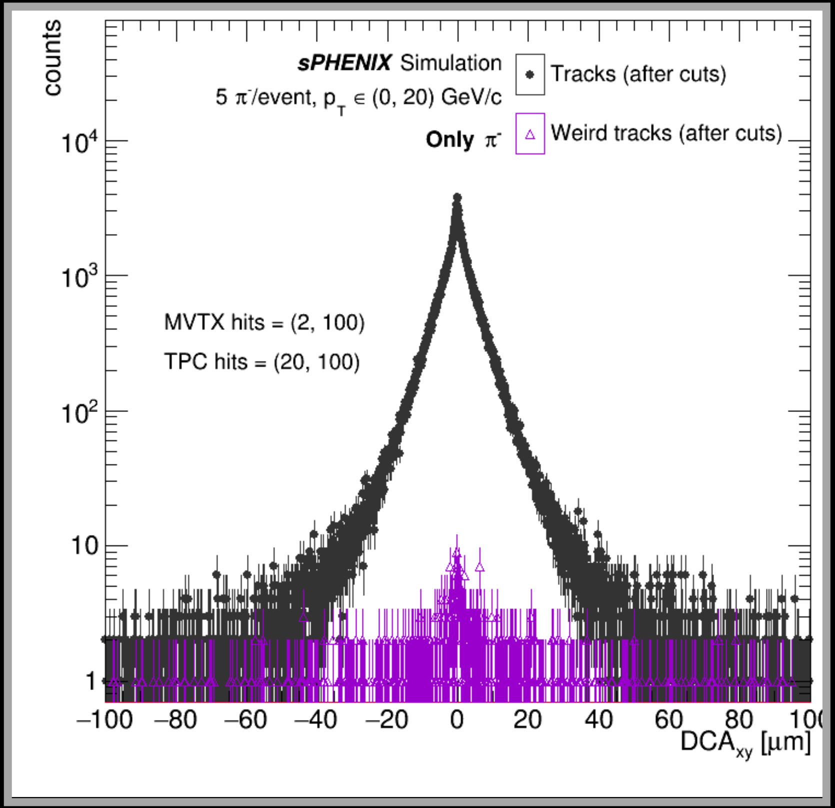
Previous Slides

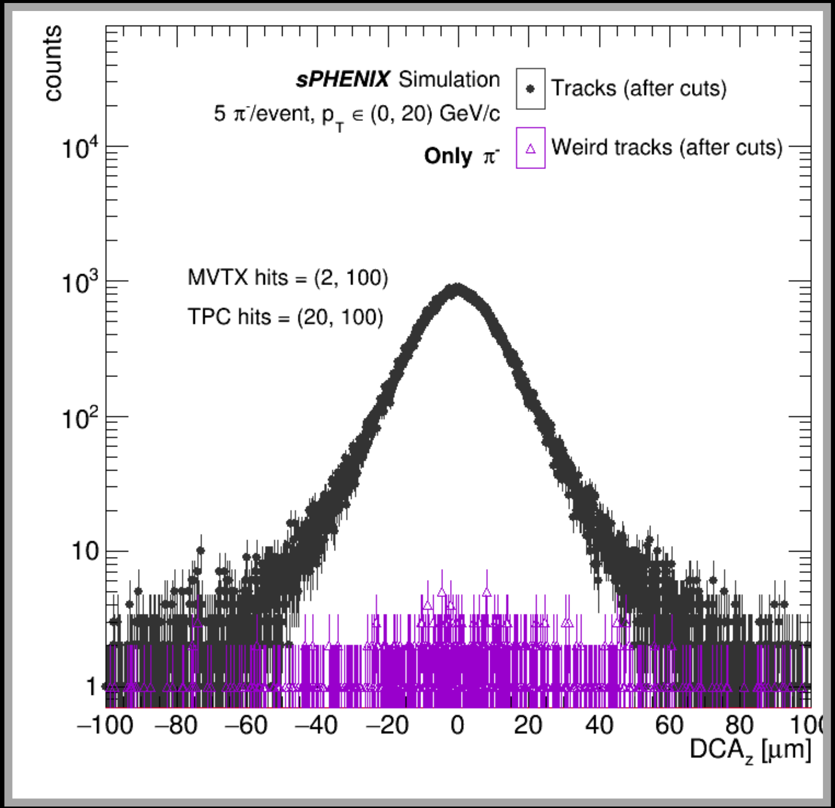
Tracking Efficiency vs. Cuts

- **Shown:** How reco. efficiency evolves as cuts are added
  - Biggest effects are due to DCA…
  - **Note:** “Add quality cut” and “Add DcaZ cut” points are on top of each other
- For π^--only events
  - Only 5 π^-/event
  - ☞ Now working on events with more π^-



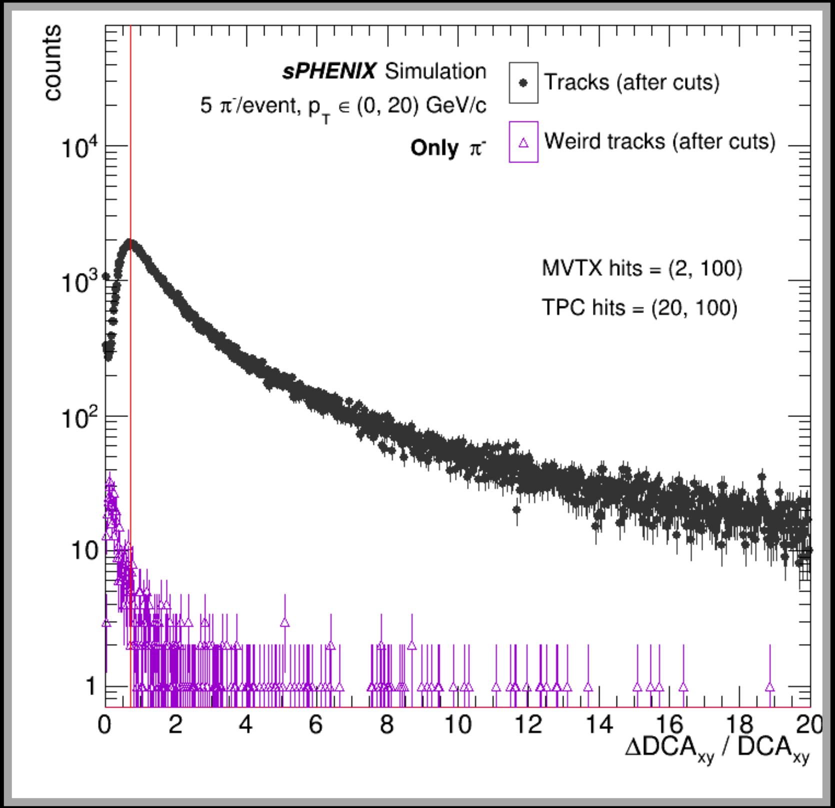
Track DCA Distributions

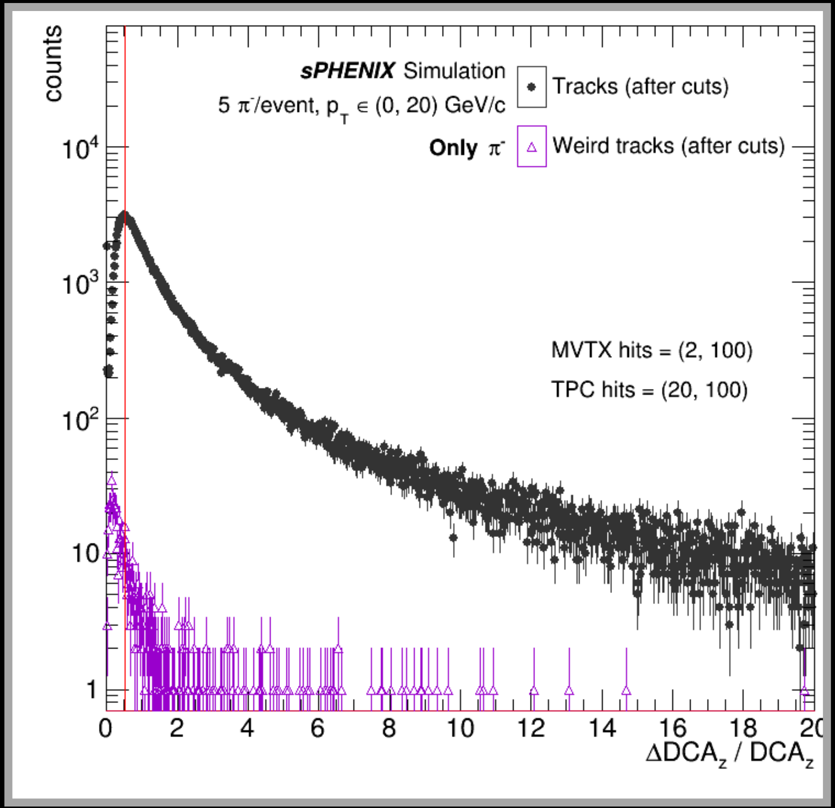




- **Left:** track DCAxy distribution
  Right: track DCAz distribution
  ☞ Only for 5 π^-/event
- **Black** points are all tracks, **purple** points are weird tracks

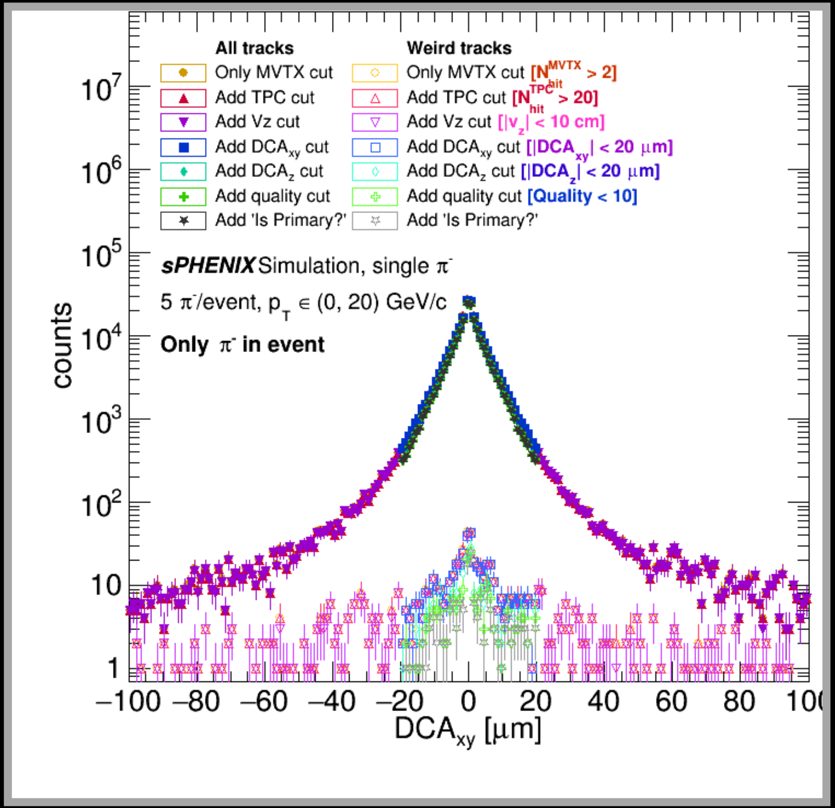
Track σ_{DCA}/DCA Distributions

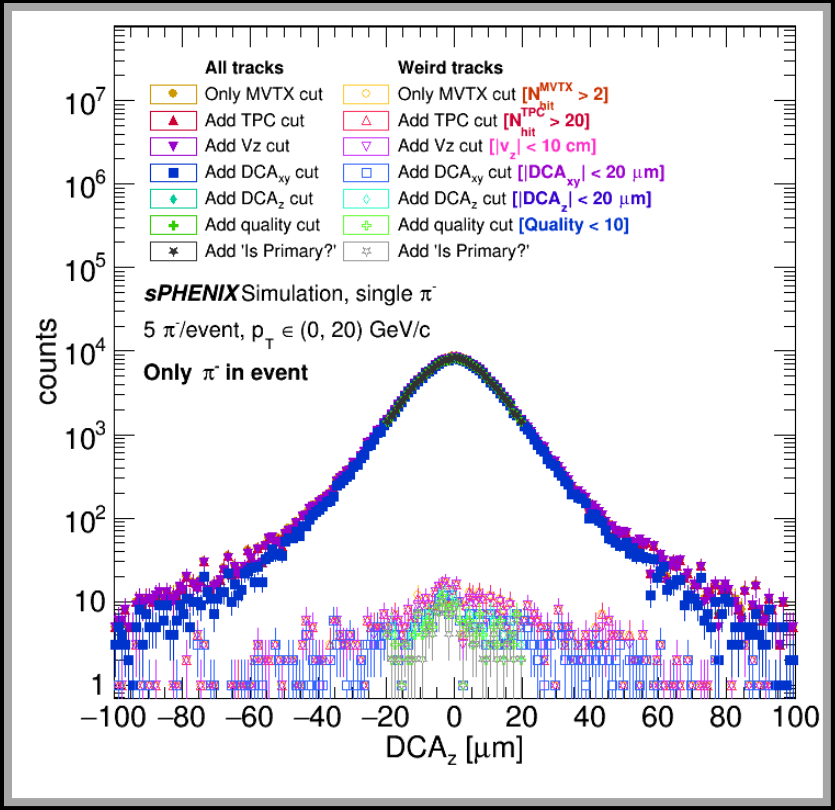




- **Left:** track DCAxy distribution
  Right: track DCAz distribution
  - ☞ Only for 5 π^{-}/event
- **Black** points are all tracks, **purple** points are weird tracks
- **Red** lines indicate maxima of distribution for all tracks

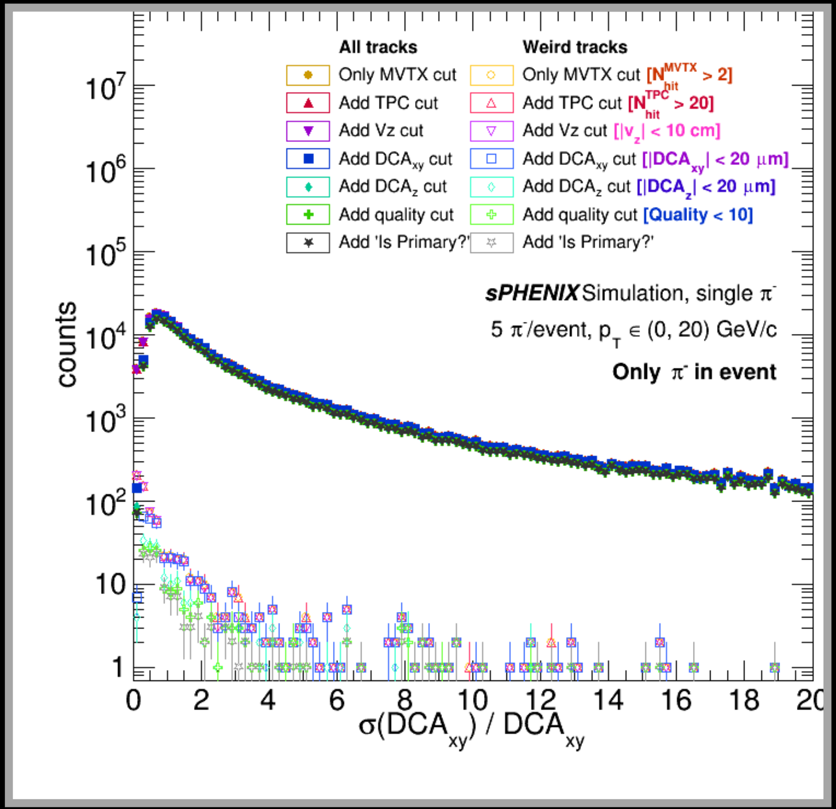
Track DCA vs. Successive Cuts

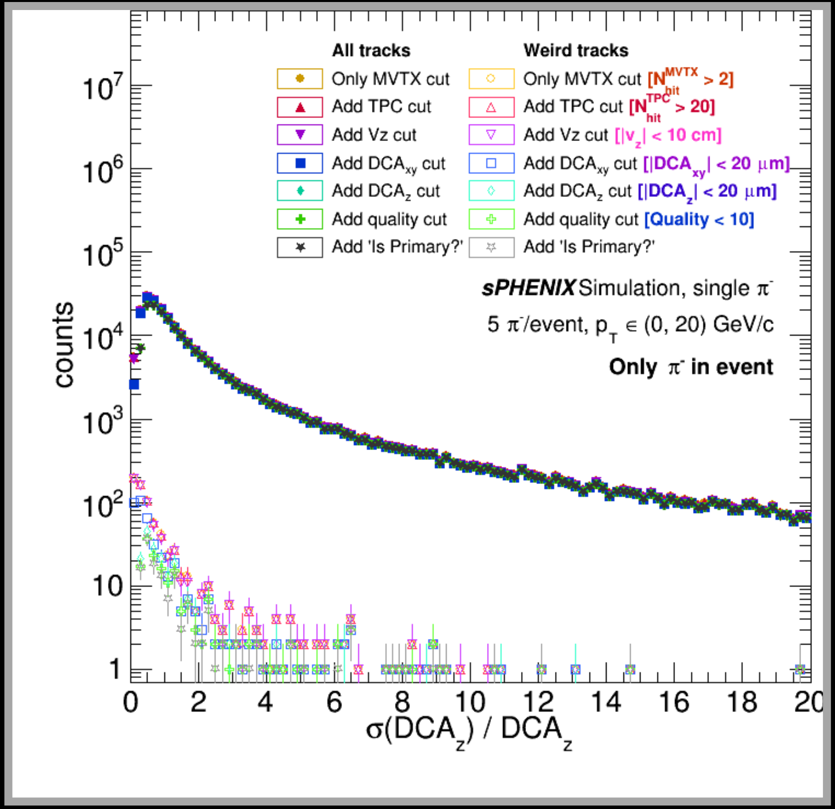




- **Left:** track DCAxy distribution
  Right: track DCAz distribution
  - ☞ Only for 5 π^-/event
- **Closed Markers:** all tracks
  Open Markers: weird tracks

Track σ_{DCA}/DCA vs. Successive Cuts

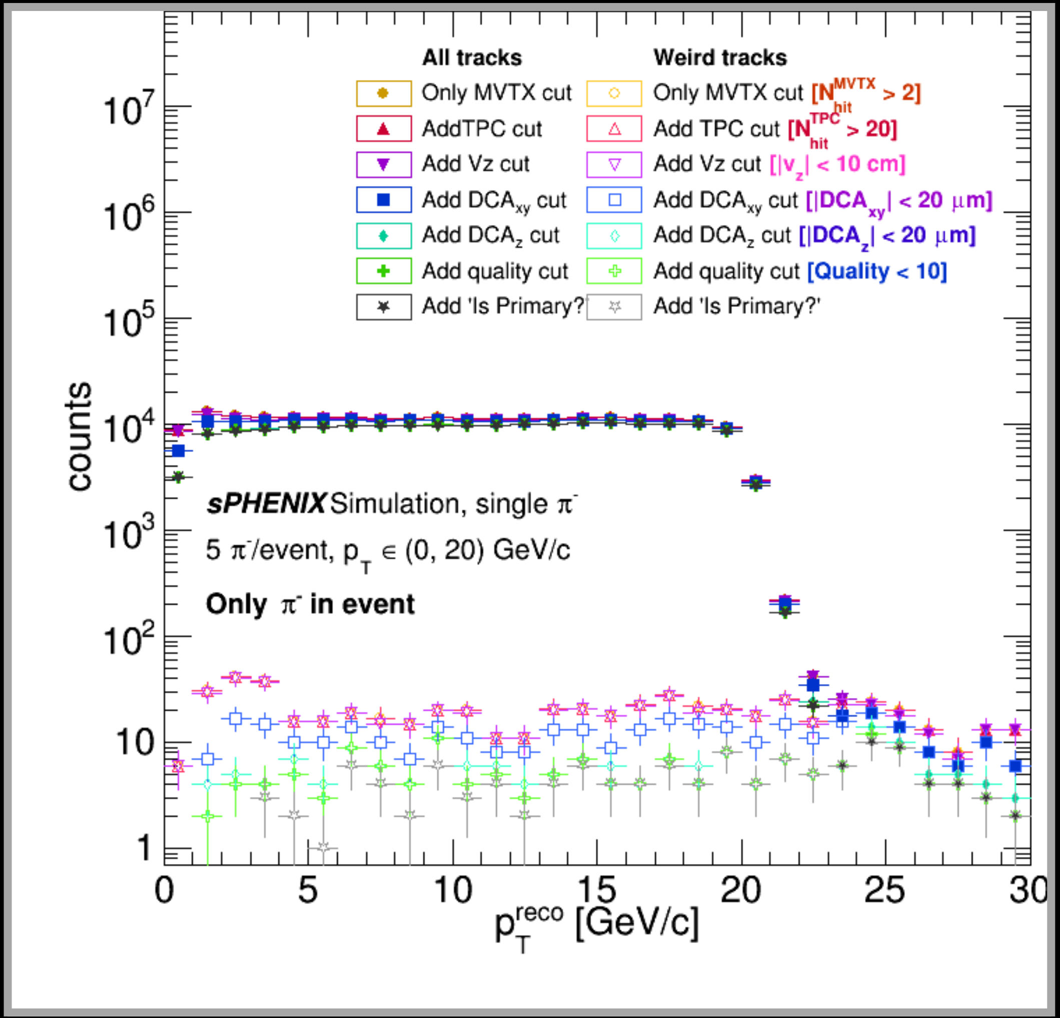




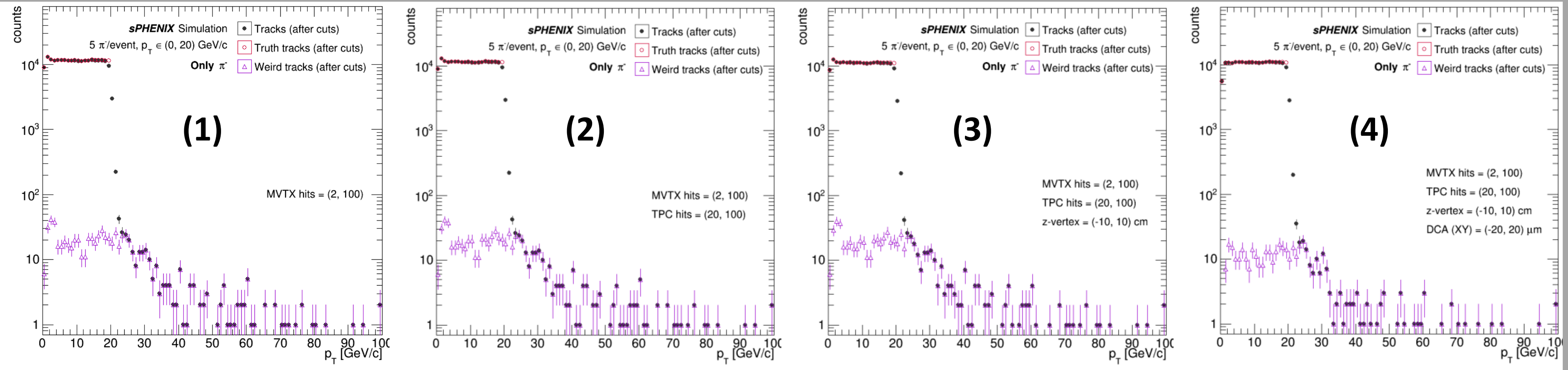
- **Left:** track DCAxy distribution
  Right: track DCAz distribution
  - ☞ Only for 5 π^-/event
- **Closed Markers:** all tracks
  Open Markers: weird tracks

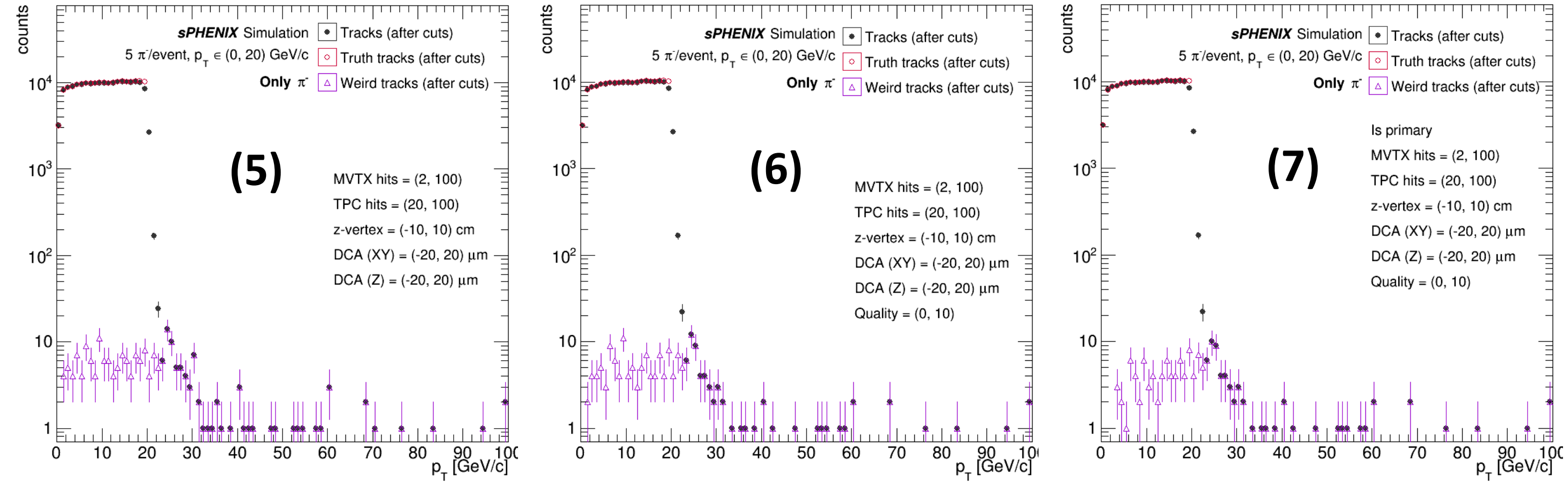
Track p_T vs. Successive Cuts | 1 panel

- **Left:** track DCAxy distribution
  Right: track DCAz distribution
  - ☞ Only for 5 π^-/event
- **Closed Markers:** all tracks
  Open Markers: weird tracks



Track p_T vs. Successive Cuts | 7 panels

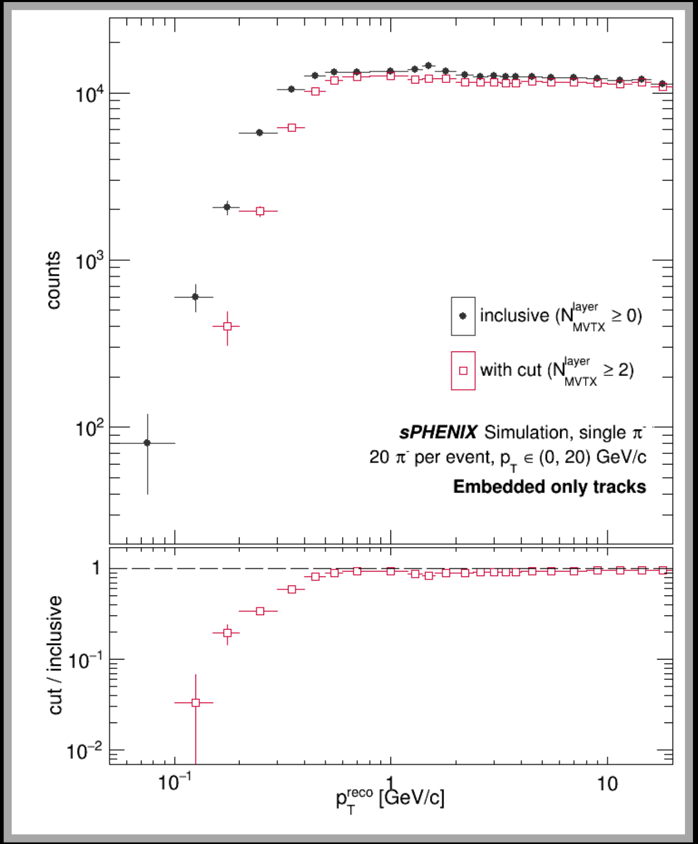


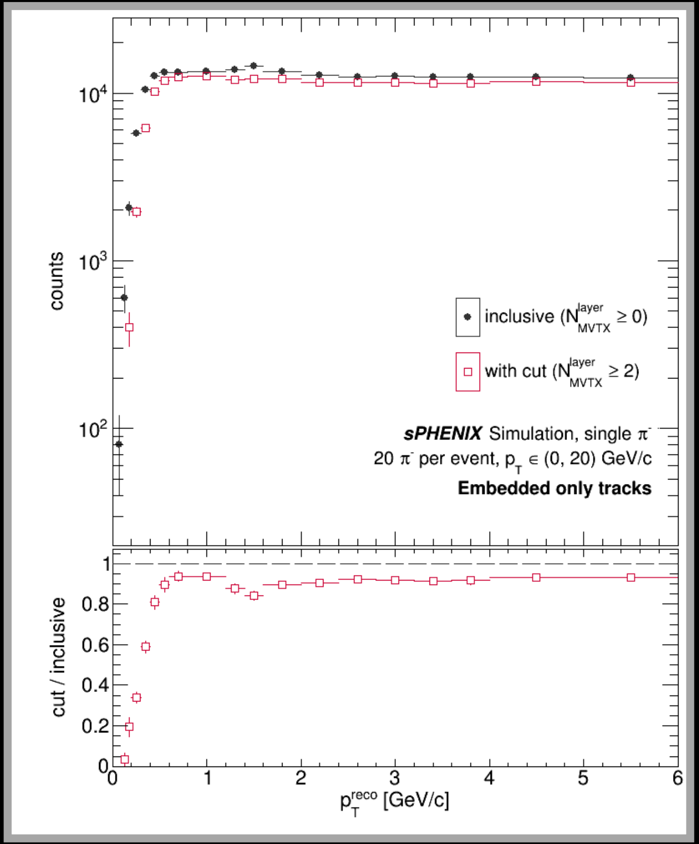


- **Black** points are all tracks, **purple** points are weird tracks
  - ☞ Only for 5 π^-/event

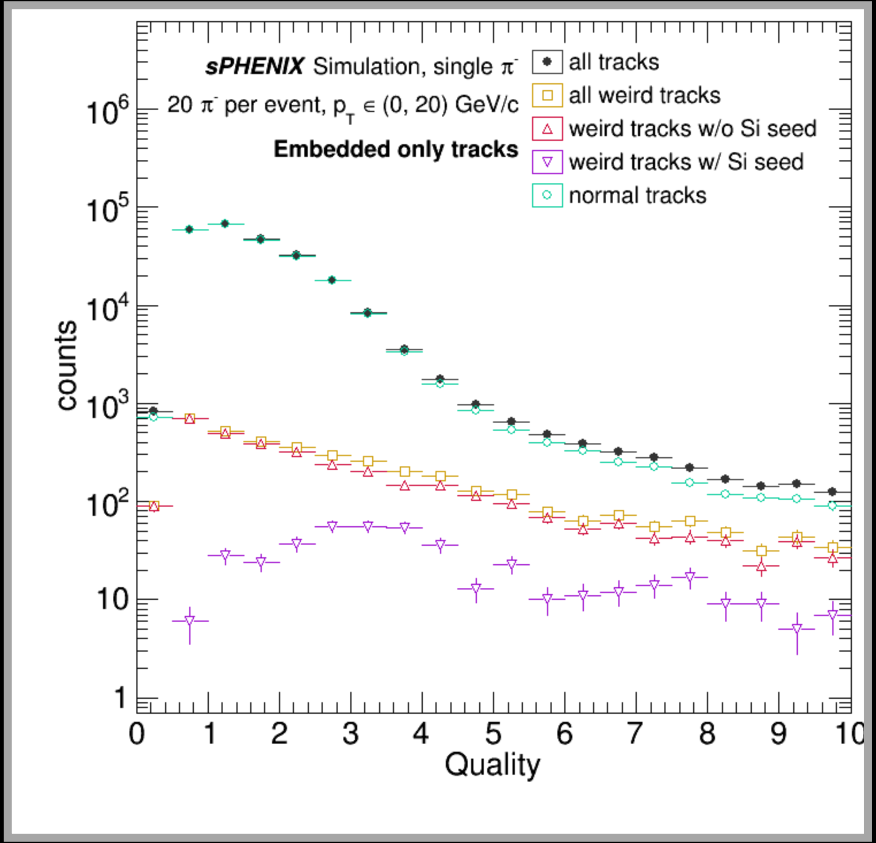
MVTX Hits >= 2 vs. Inclusive

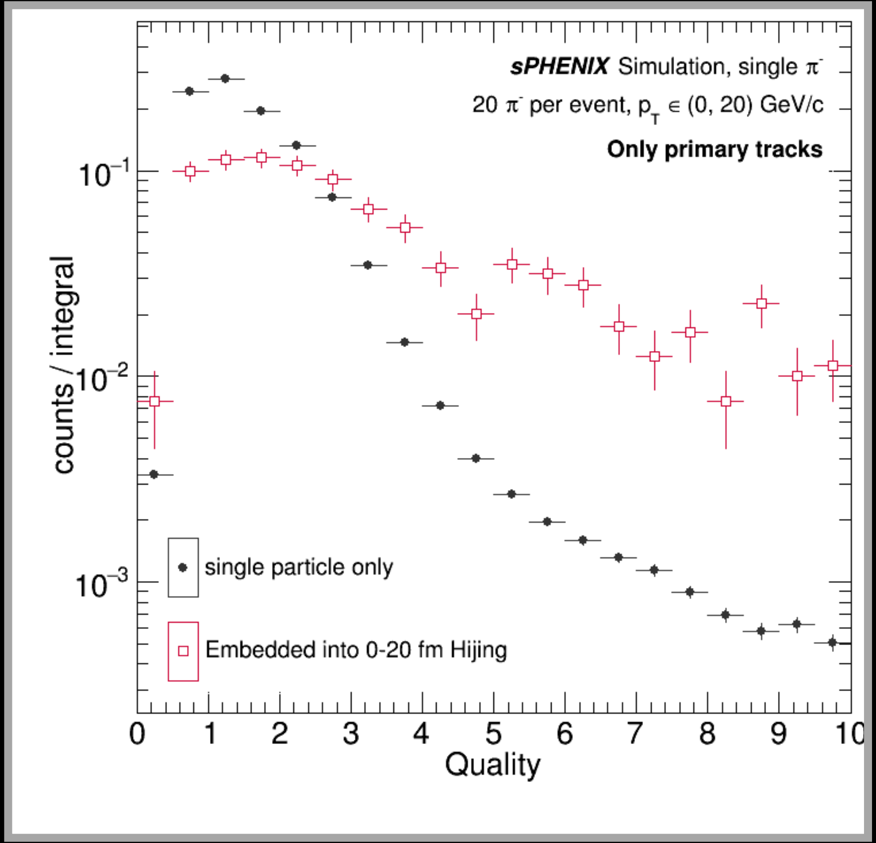
- Reconstructed track p_T of primary tracks w/
  - $N_{MVTX}^{layer} \geq 2$ **(red)** vs.
  - Inclusive **(black)**
- Rebinned left figure on slide 5 to accentuate low-pT region
  - **Left:** log x-axis
  - **Right:** linear x-axis





Track Quality in Hijing



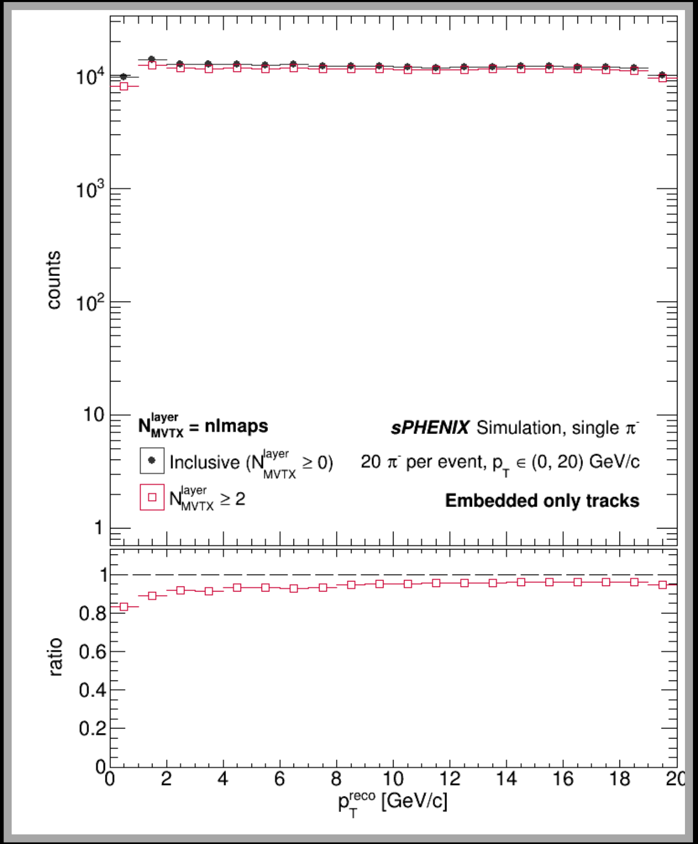


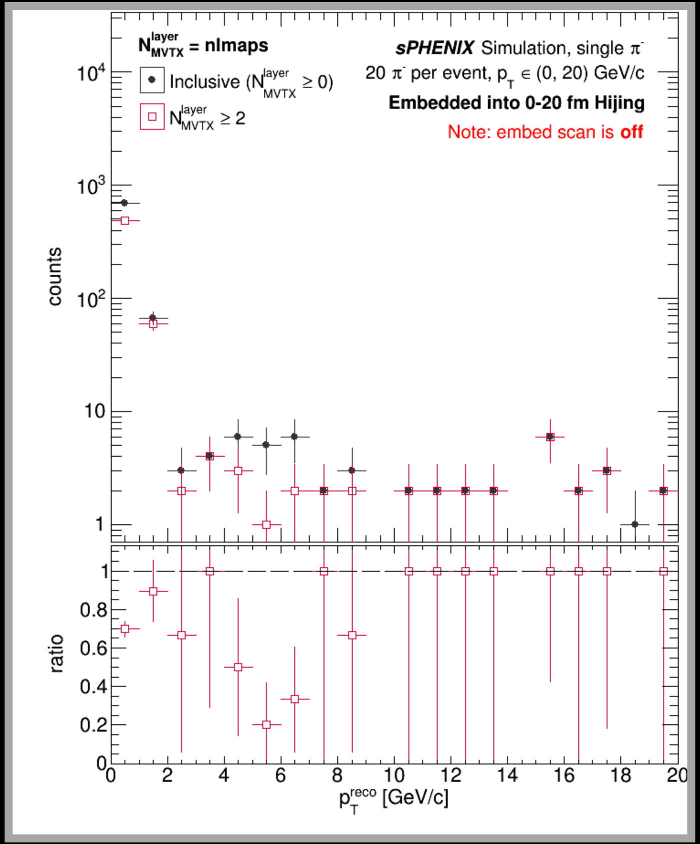
- Ratio of weird/normal (primary) tracks to all (primary) tracks as a function of quality
  - **Left:** single particle only
  - **Right:** single particle vs. embedded into Hijing

- **Reminder:**
  - Weird $\Rightarrow p_T^{reco}/p_T^{true} \notin (0.2, 1.20)$
  - Normal $\Rightarrow p_T^{reco}/p_T^{true} \in (0.2, 1.20)$

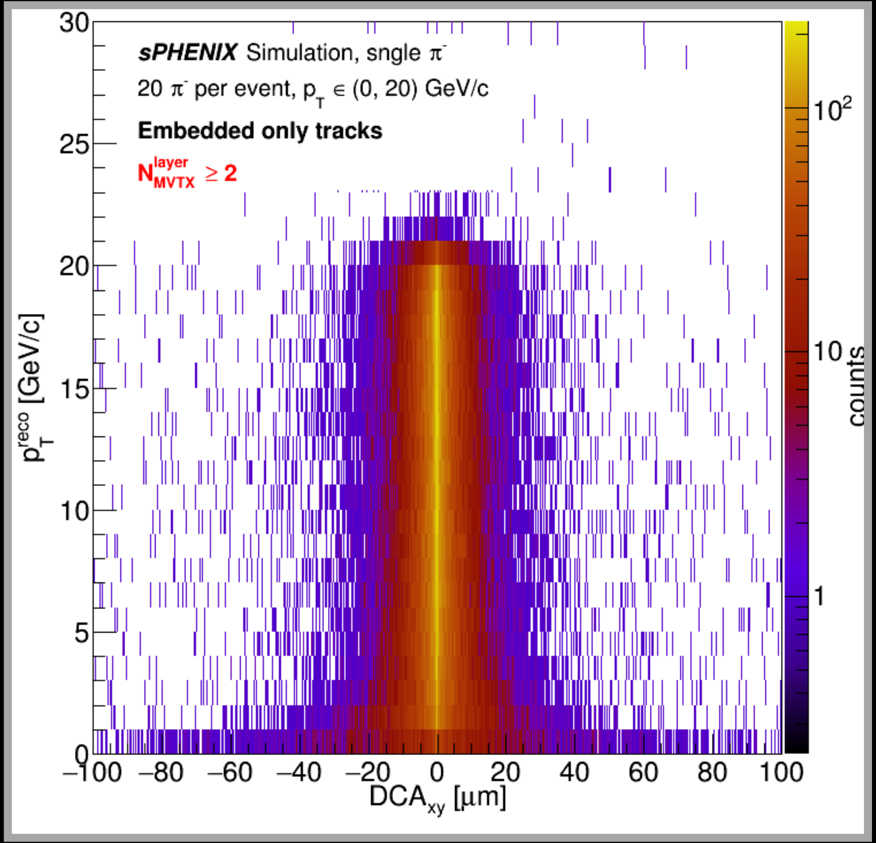
MVTX Hits >= 2 vs. Inclusive | track pT

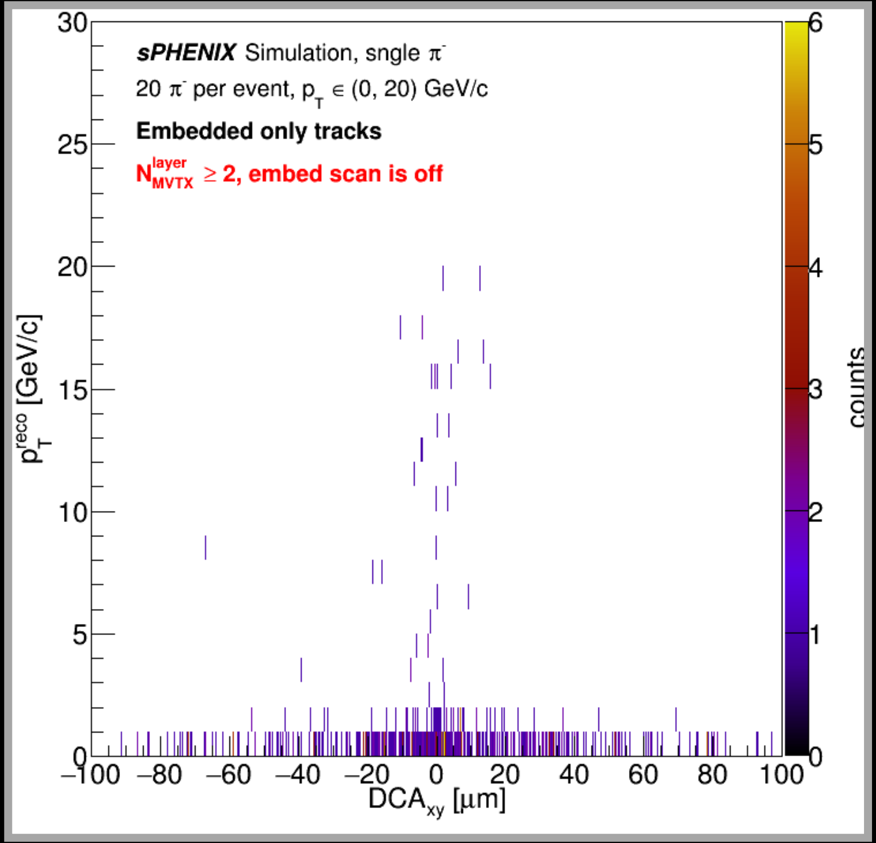
- Reconstructed track p_T of primary tracks w/
  - $N_{MVTX}^{layer} \geq 2$ **(red)** vs.
  - Inclusive **(black)**
- **Left:** single particle only
  Right: single particles embedded into Hijing
  ⇒ Not enough stats for embedded tracks!





MVTX Hits >= 2 | track DCAxy

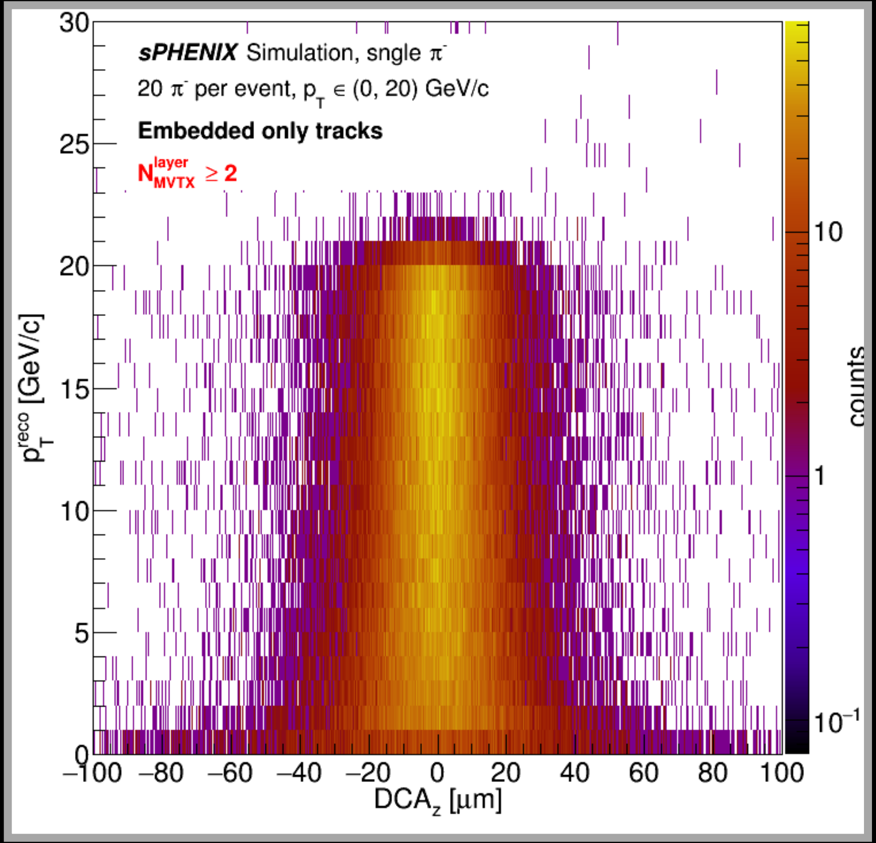


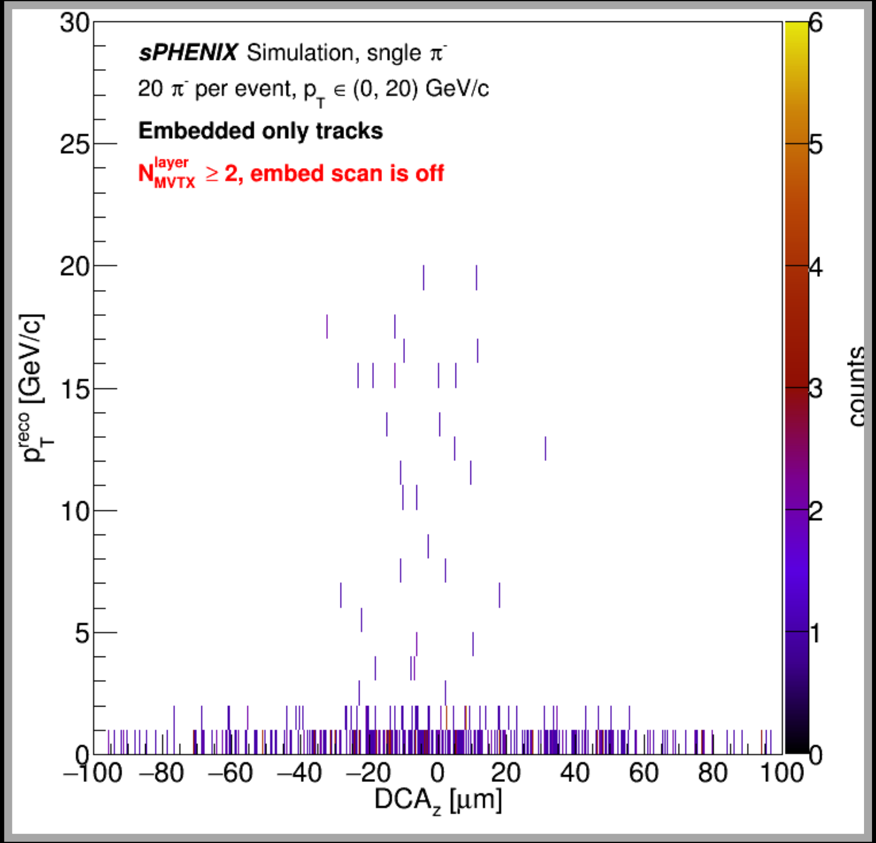


- Primary track DCAxy for primary tracks w/ $N^{layer}_{MVTX} \geq 2$

- **Left:** single particle only
  Right: single particles embedded into Hijing
  ⇒ Not enough stats for embedded tracks!

MVTX Hits >= 2 | track DCAz





- Primary track DCAxy for primary tracks w/ $N^{layer}_{MVTX} \geq 2$

- **Left:** single particle only
  Right: single particles embedded into Hijing
  ⇒ Not enough stats for embedded tracks!

For Next Time

Plots to Make:

- Quality (and other track quantities) vs. N_{TPC}^{hit}
- Average cluster size for weird tracks vs. normal tracks
  - ☞ Do we have access to that in the evaluator?

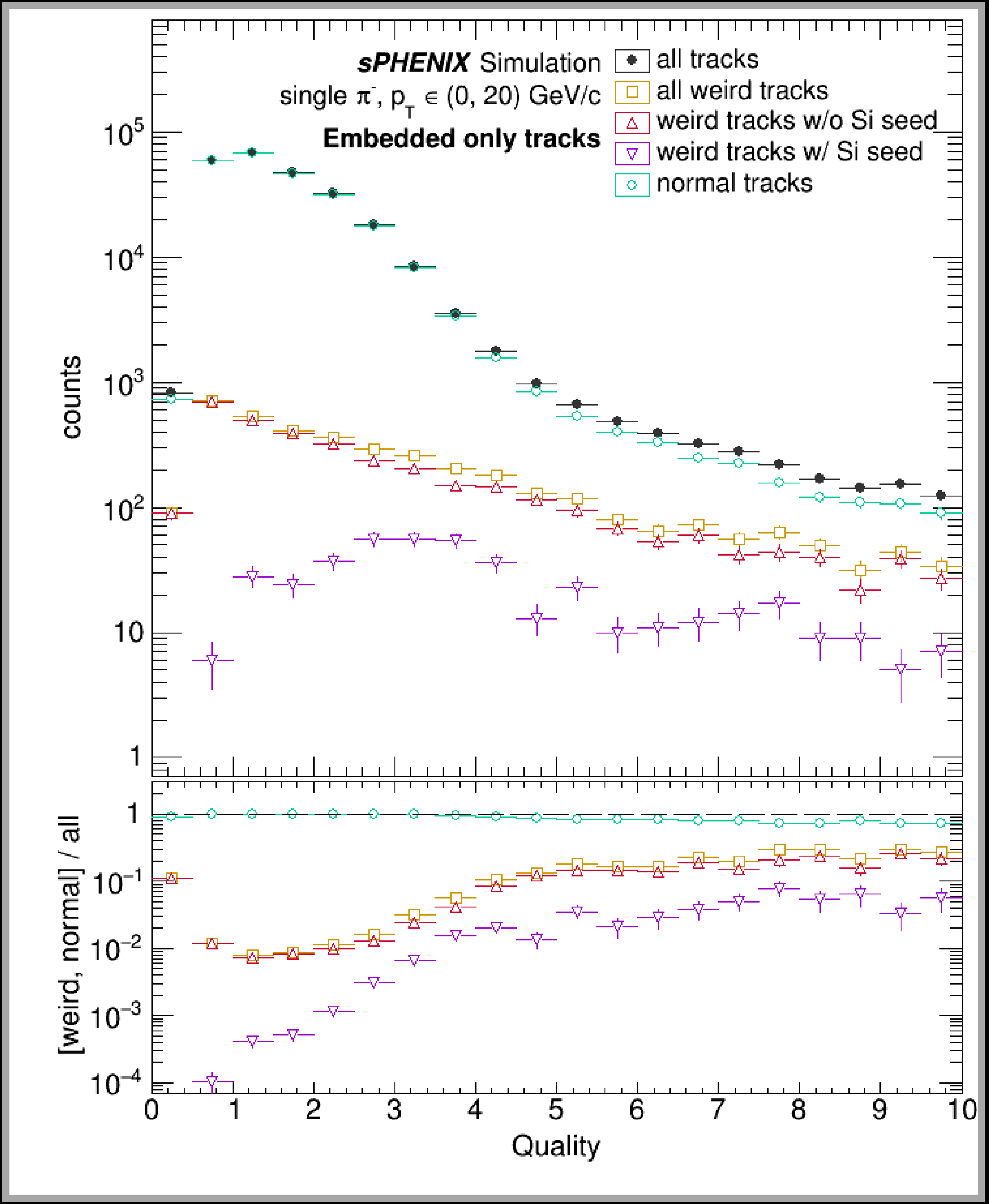
To Take Care Of:

- Finish refactoring code
  - Did not set it up intelligently 😅
  - Became unmanageable as the no. of different populations to look at grew
- Generate more embedded stats

Ratio of Weird/Normal Tracks to All

- Ratio of weird/normal (primary) tracks to all (primary) tracks as a function of quality

- **Reminder:**
  - Weird ⇒ $p_T^{reco}/p_T^{true} \notin (0.2, 1.20)$
  - Normal ⇒ $p_T^{reco}/p_T^{true} \in (0.2, 1.20)$



Details

- **Weird Tracks:** tracks with $p_T^{trk}/p_T^{true} \notin (0.2, 1.2)$
  - Split weird track population into 2 samples:
    - W/o Silicon Seeds: **nmaps == 0**
    - W/ Silicon Seeds: **nmaps == 3**
- **Normal Tracks:** tracks with $p_T^{trk}/p_T^{true} \in (0.2, 1.2)$

- Color scheme:
  - **Black triangles =** primary tracks
  - **Magenta triangles =** truth
  - **Red X's =** weird primary tracks
  - **Blue circles =** normal primary tracks
- In 2D plots:
  - **Color maps =** all primary tracks
  - **Red X scatter plots =** weird primary tracks
  - **Blue circle scatter plots =** normal primary tracks

- Simulated sample of single π^-
  - 20 π^- per event
  - $p_T^{true} \in (0, 20)$ GeV/c
  - Ran w/ scan_for_embed on

- Using larger sample than in previous updates:
  - No. of primary tracks: **244015**
  - No. of weird tracks: **4175**
    - No. w/o silicon seeds: **3582**
    - No. w/ silicon seeds: **578**
    - **15** weird tracks had nmaps == 4
  - No. of normal tracks: **239840**
- Cuts Applied:
  - **gprimary == 1** (select only primary tracks)
  - Cuts to select weird & normal tracks

Some Observations

Weird Tracks w/o Silicon Seeds

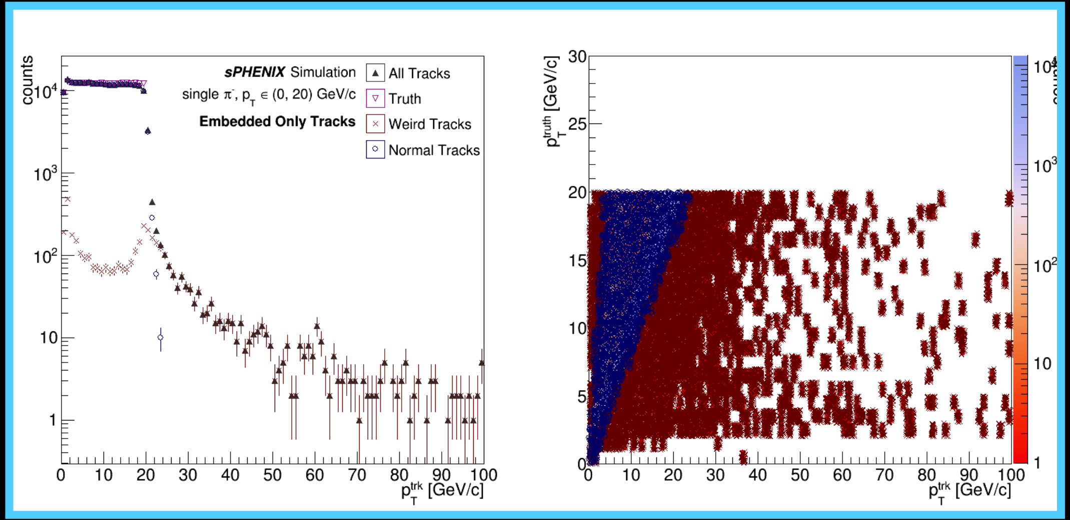
- p_T^{trk} distribution is bimodal (slide 4)
- Majority seem to lie at sector boundaries in phi (slide 5)
- Majority have large DCAxy values (slides 6 and 7)
  - Show no correlation in DCAz (slides 8 and 9)
- χ^2/ndf distribution is falling (slide 10)

Weird Tracks w/ Silicon Seeds

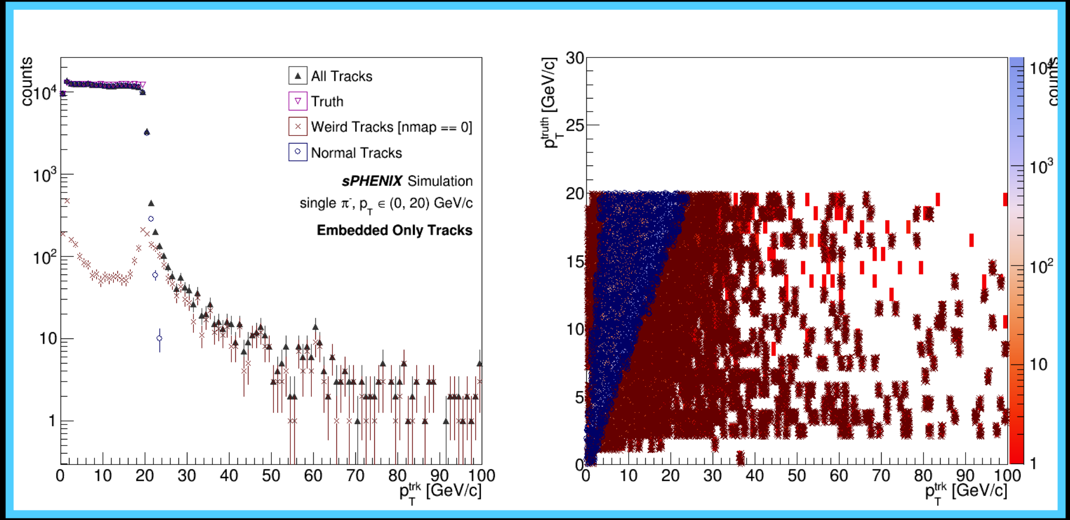
- p_T^{trk} distribution is unimodal (slide 4)
- No correlation in phi (slide 5)
- χ^2/ndf distribution is roughly flat (slide 10)

Track Pt

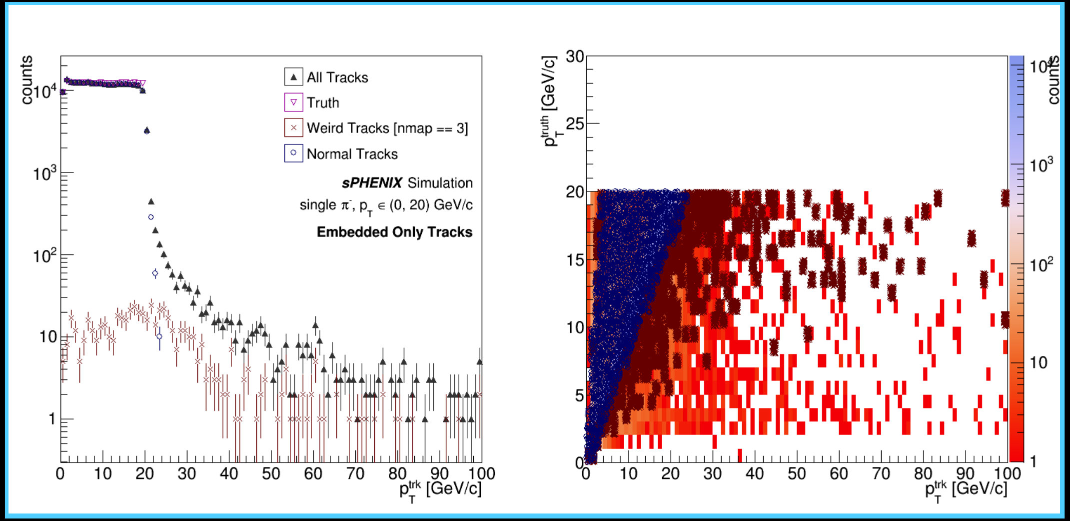
All Weird Tracks



Weird Tracks w/o Silicon Seeds



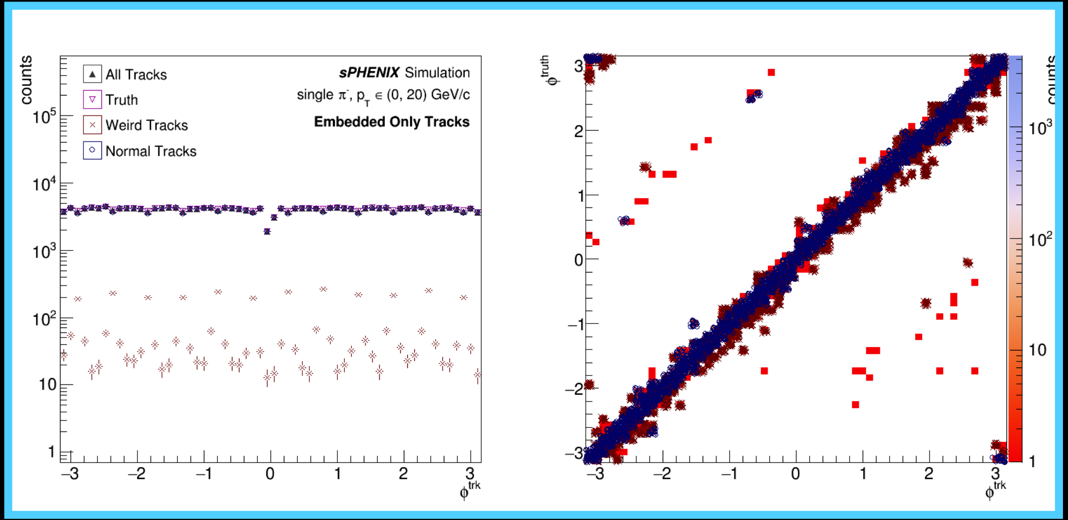
Weird Tracks w/ Silicon Seeds



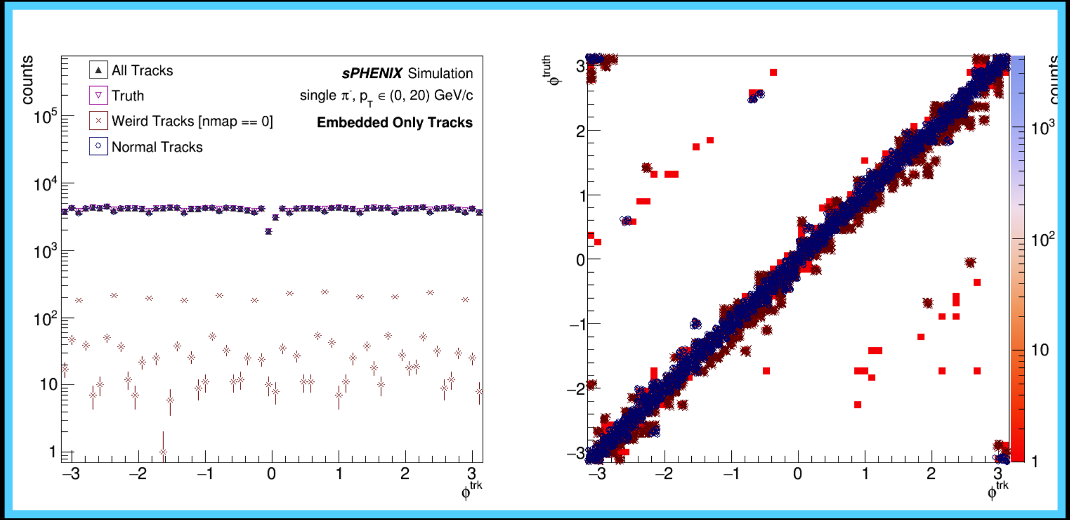
- Reconstructed and truth p_T
  - reco. p_T (left panels)
  - reco. vs. truth p_T (right panels)
  - **pt vs. gpt** leaves of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Track Phi

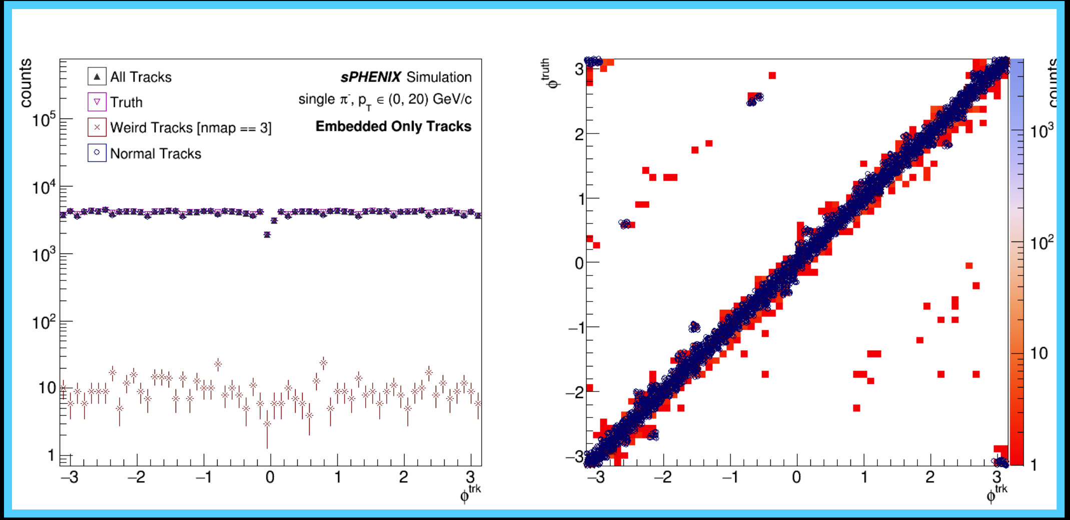
All Weird Tracks



Weird Tracks w/o Silicon Seeds



Weird Tracks w/ Silicon Seeds

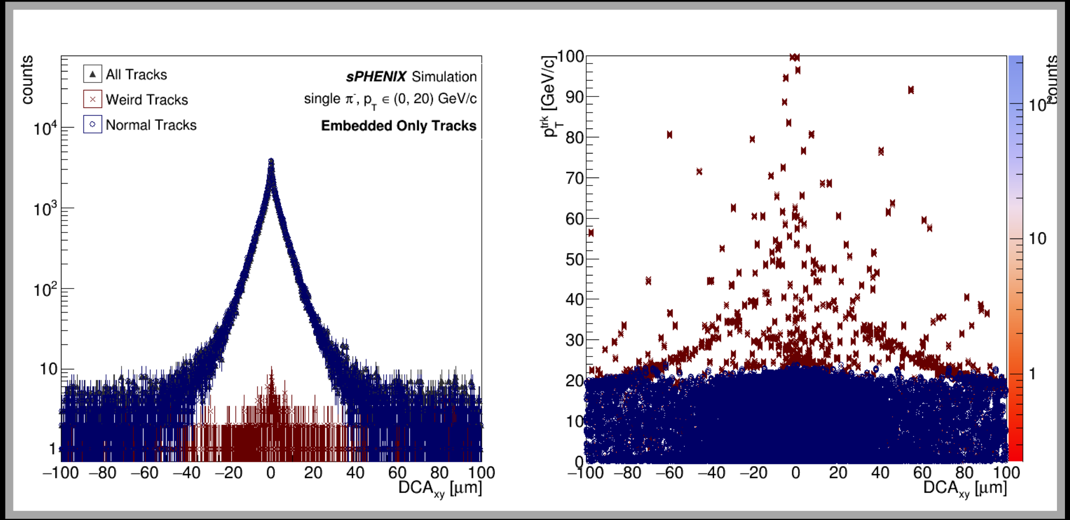


- Reconstructed and truth phi
  - reco. phi (left panels)
  - reco. vs. truth phi (right panels)
  - **phi vs. gphi** leaves of ntp_track tuple

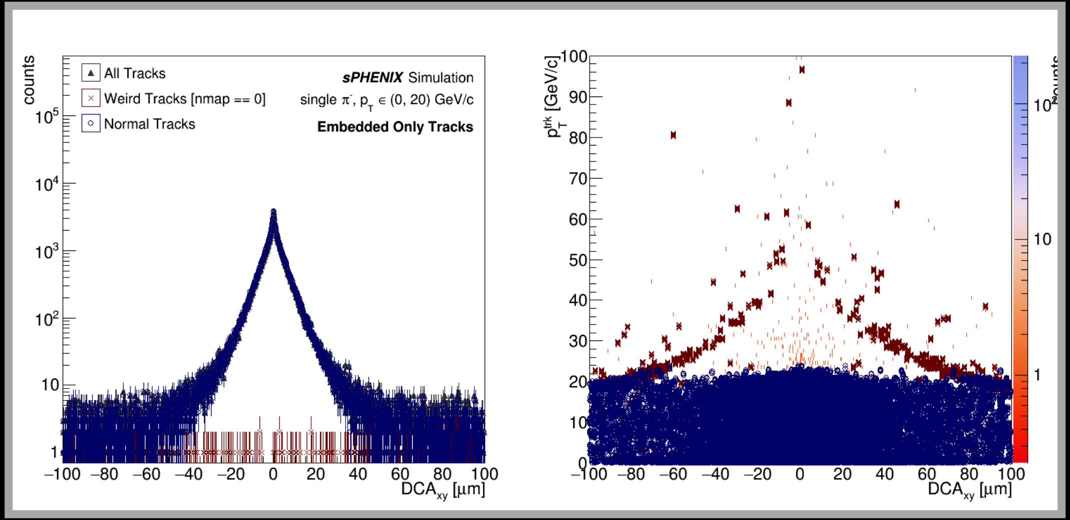
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Track DCAxy

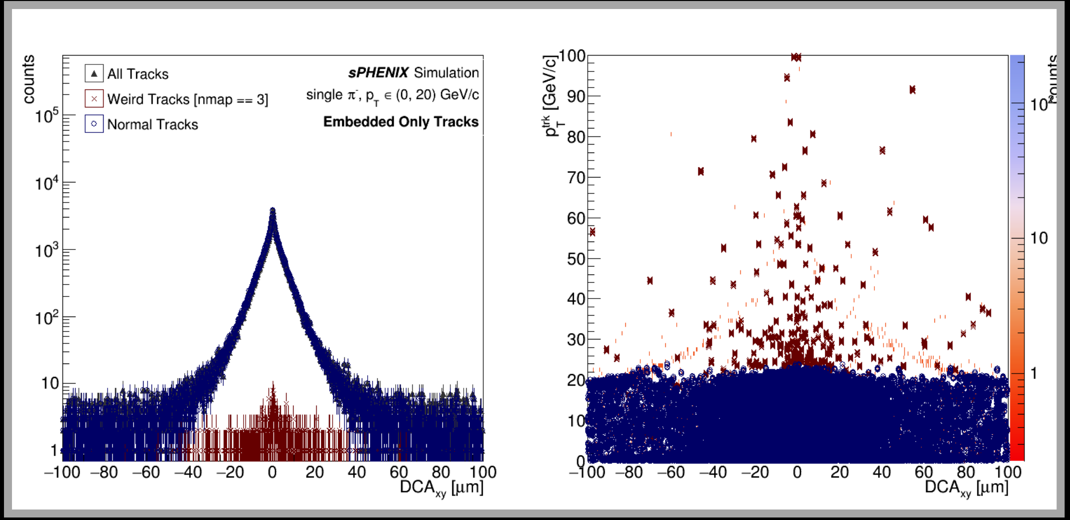
All Weird Tracks



Weird Tracks w/o Silicon Seeds

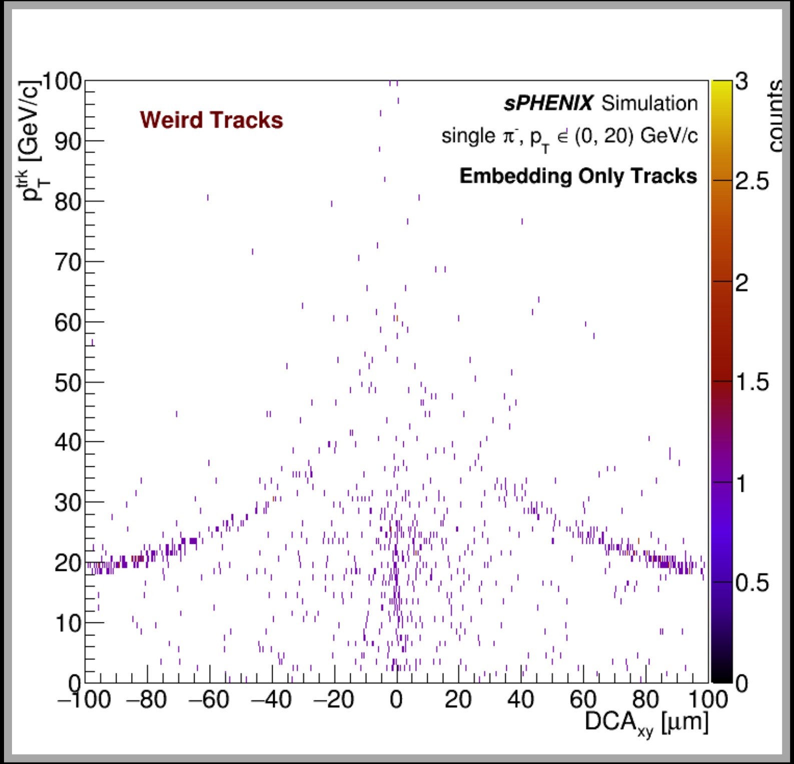


Weird Tracks w/ Silicon Seeds

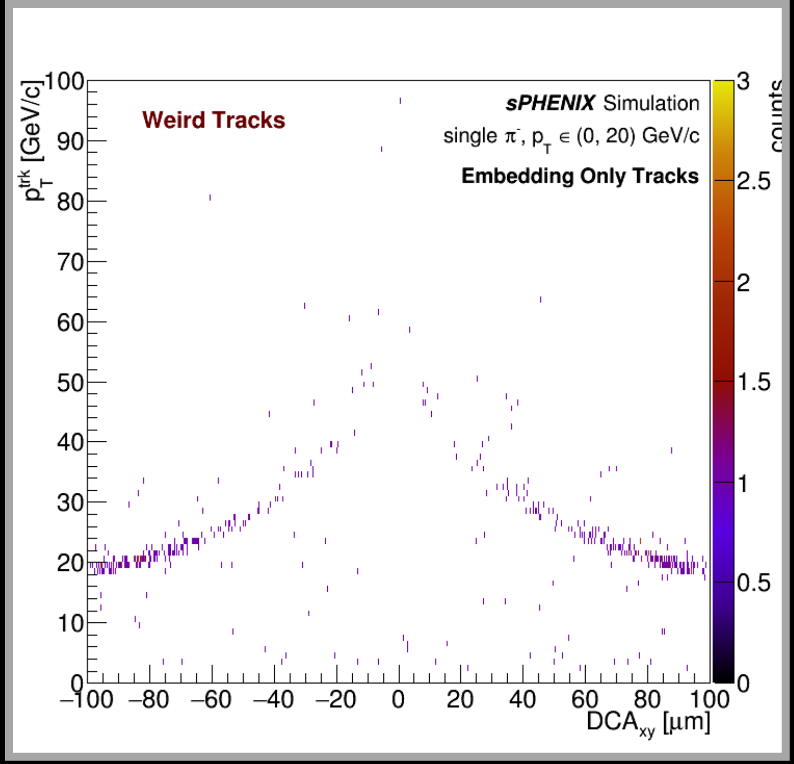


- Track DCAxy
  - Track DCAxy (left panels)
  - DCAxy vs. p_T^{trk} (right panels)
  - **dca3dxy vs. pt** leaves of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

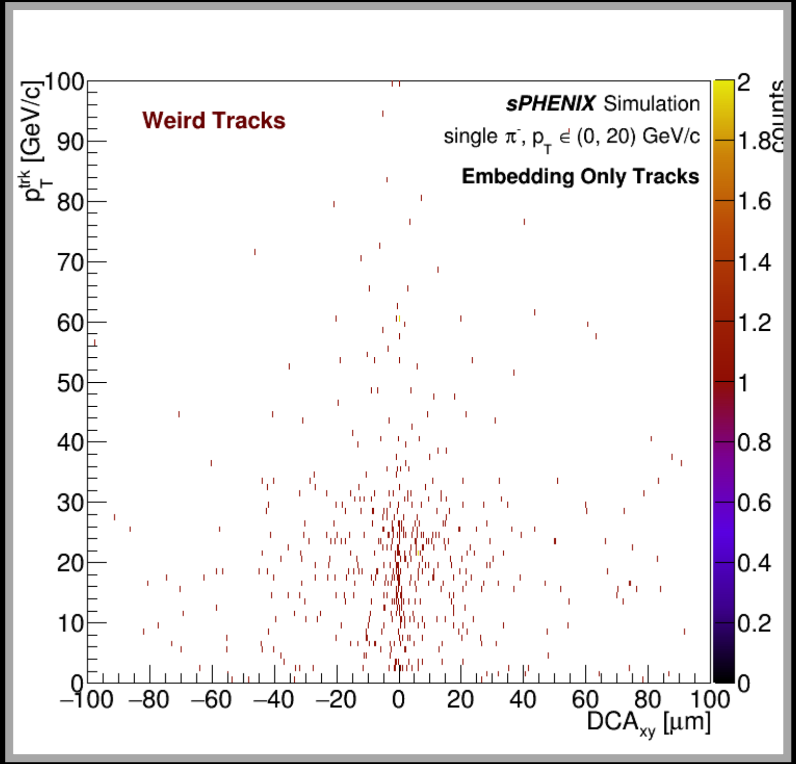
Weird Track DCAxy



All Weird Tracks



Weird Tracks w/o Silicon Seeds

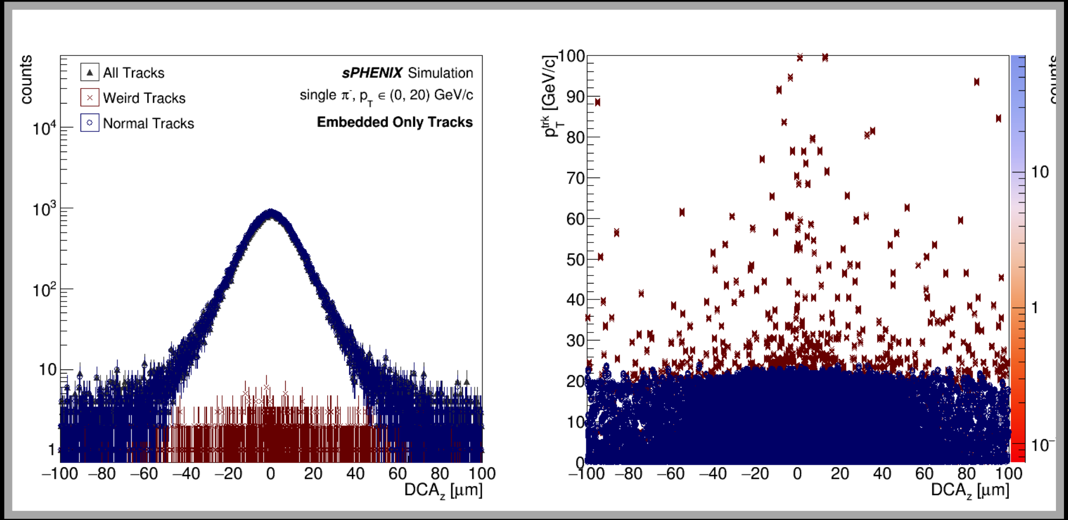


Weird Tracks w/ Silicon Seeds

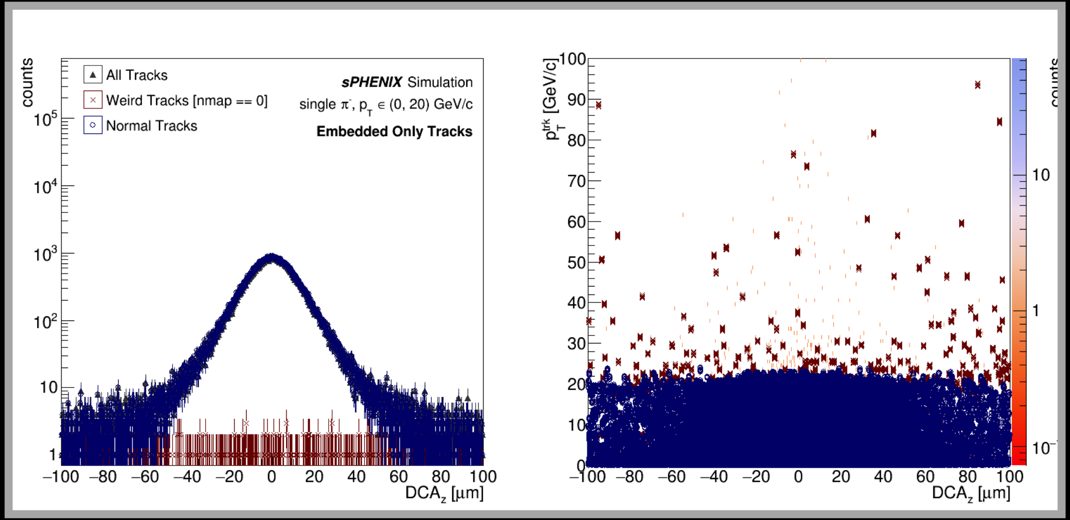
- Weird track DCAxy
  - **dca3dxy** leaf of ntp_track tuple for only weird tracks
- **Note:** z-axes are **not** scaled
  - z-axis range changes between plots (apologies!)

Track DCAz

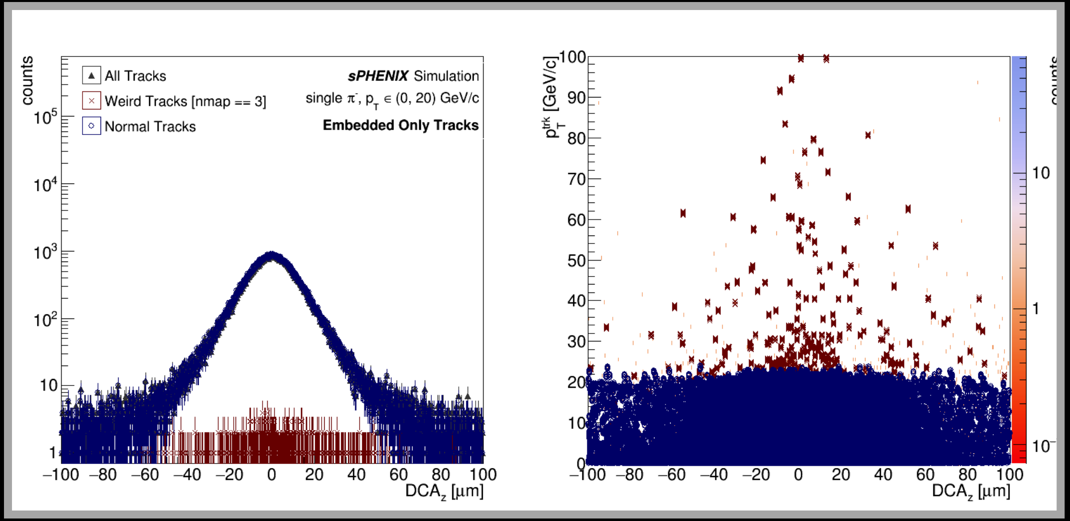
All Weird Tracks



Weird Tracks w/o Silicon Seeds



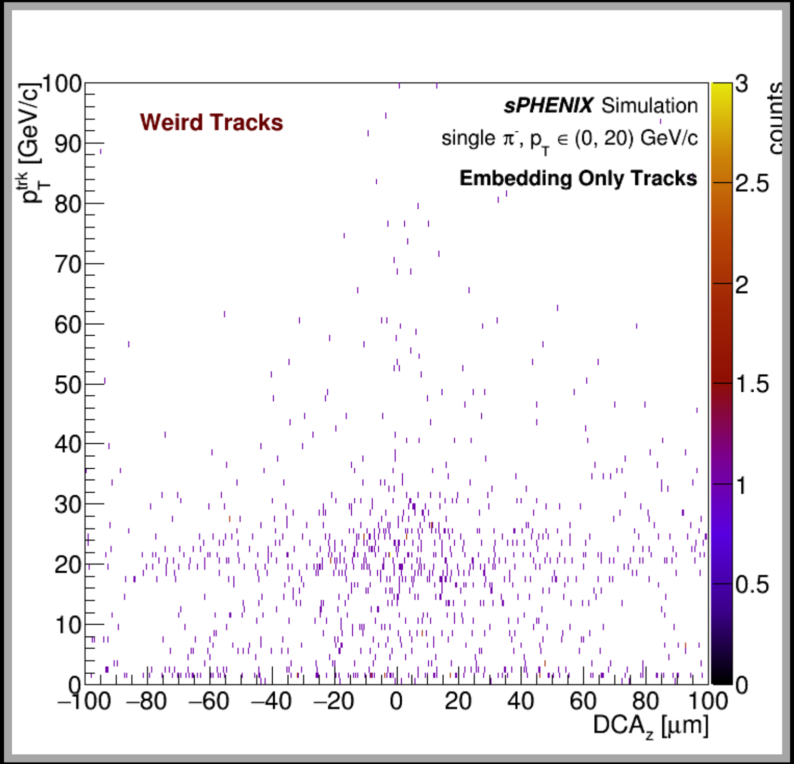
Weird Tracks w/ Silicon Seeds



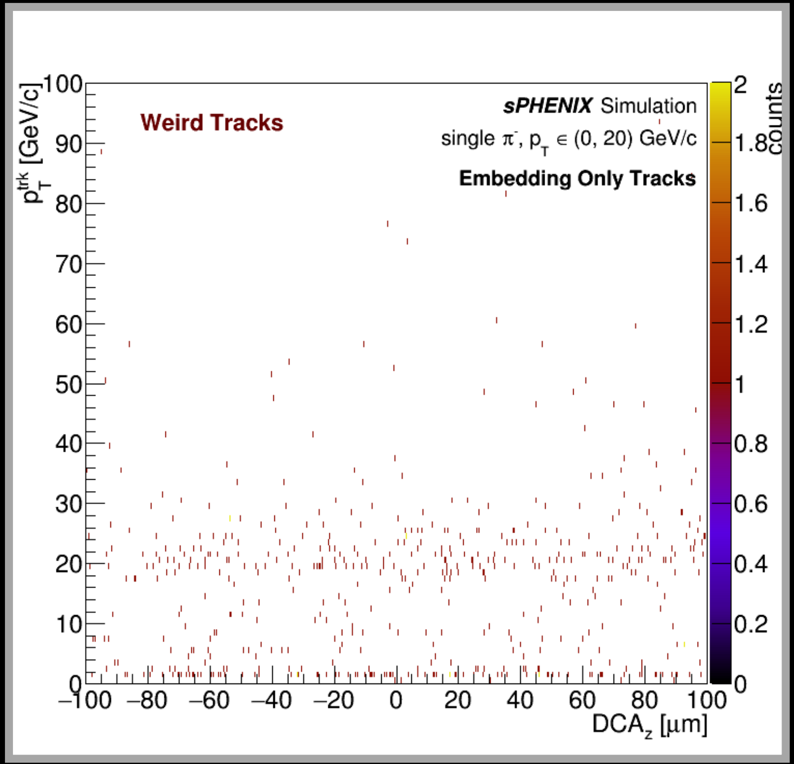
- Track DCAz
  - Track DCAz (left panels)
  - DCAz vs. p_T^{trk} (right panels)
  - **dca3dz vs. pt** leaves of ntp_track tuple

- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

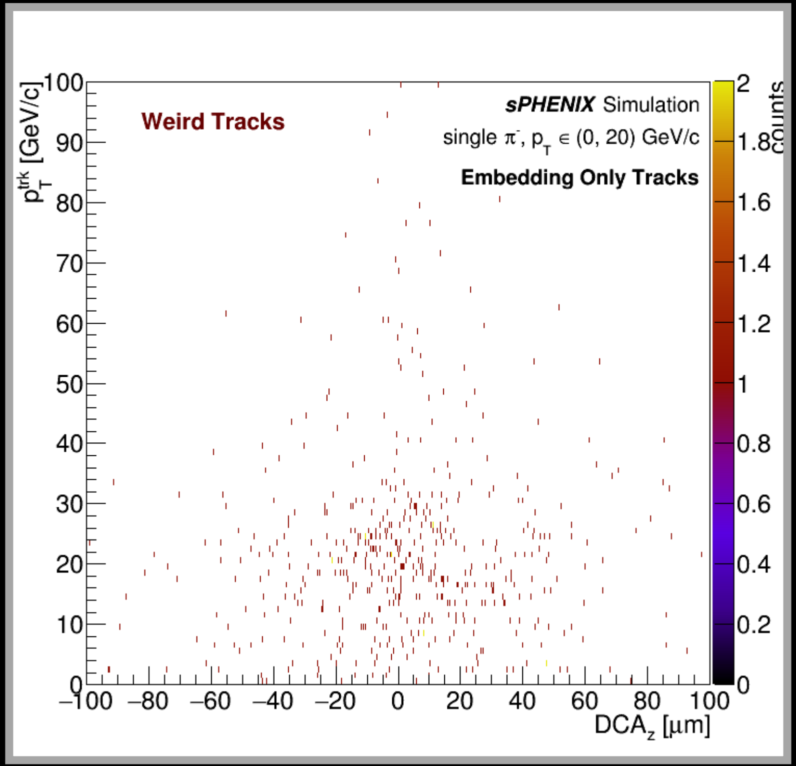
Weird Track DCAz



All Weird Tracks



Weird Tracks w/o Silicon Seeds

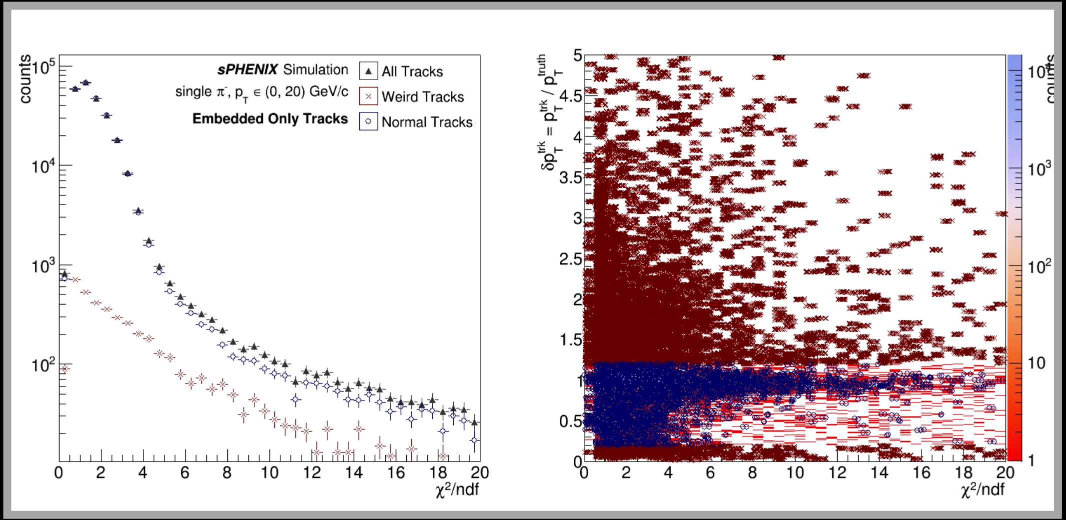


Weird Tracks w/ Silicon Seeds

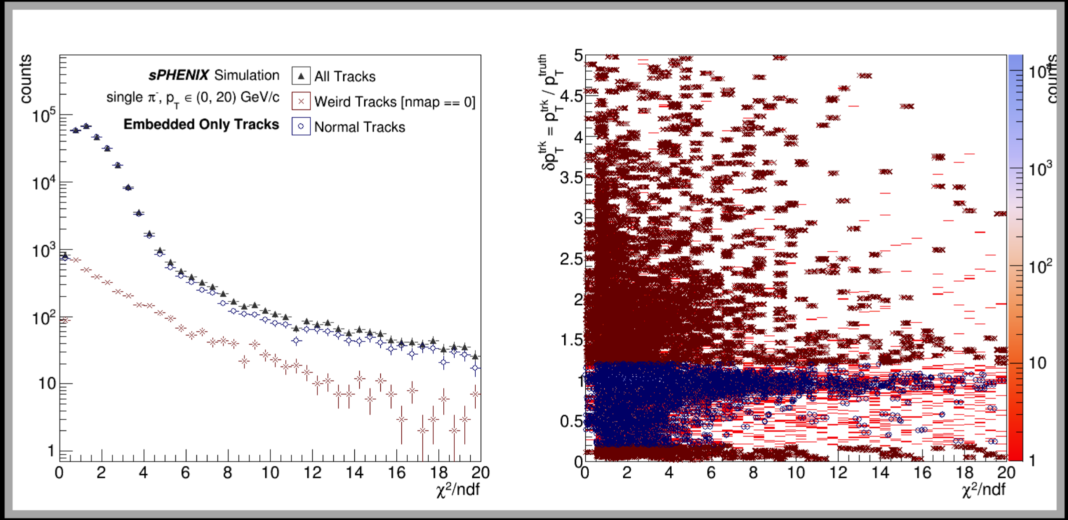
- Weird track DCAz
  - **dca3dz** leaf of ntp_track tuple for only weird tracks
- **Note:** z-axes are **not** scaled
  - z-axis range changes between plots (apologies!)

Track Quality

All Weird Tracks



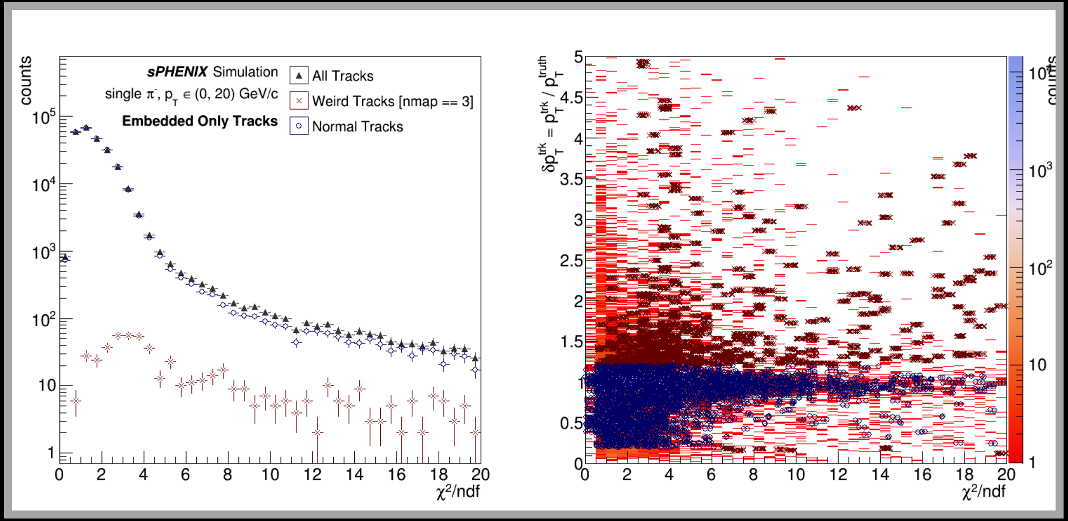
Weird Tracks w/o Silicon Seeds



- Track χ^2/ndf
  - Track χ^2/ndf (left panels)
  - χ^2/ndf vs. p_T^{trk}/p_T^{true} (right panels)
  - **quality vs. pt/gpt** leaves of ntp_track tuple

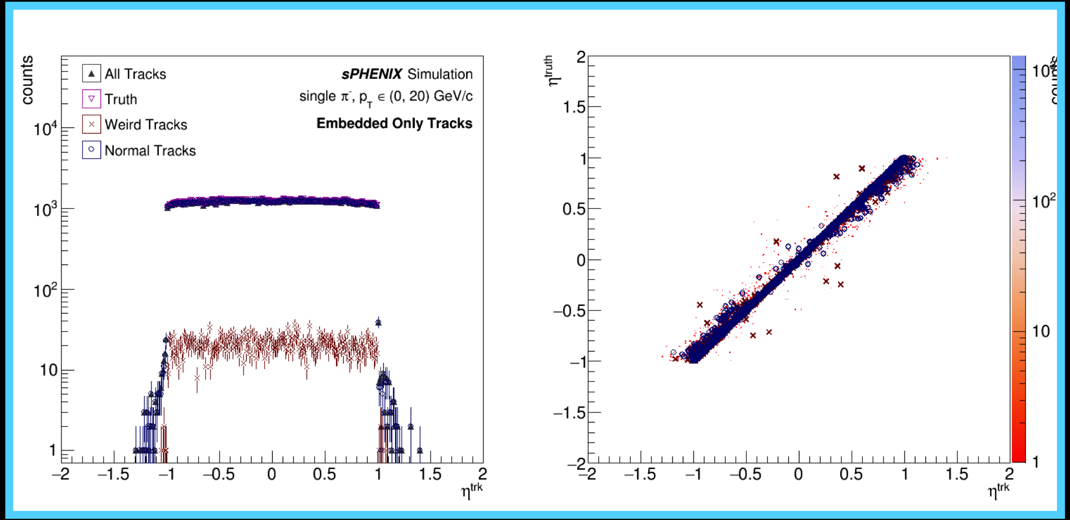
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Weird Tracks w/ Silicon Seeds

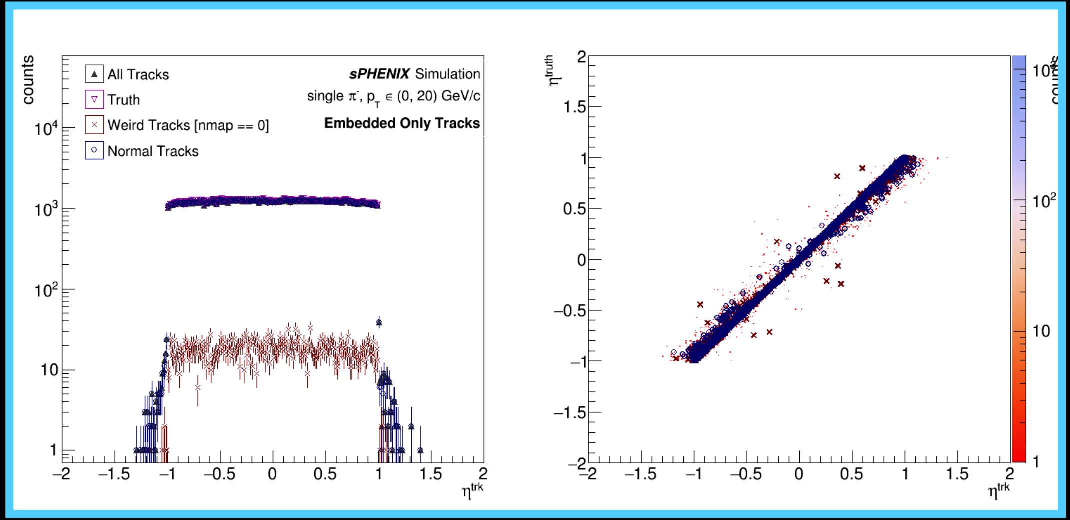


Track Eta

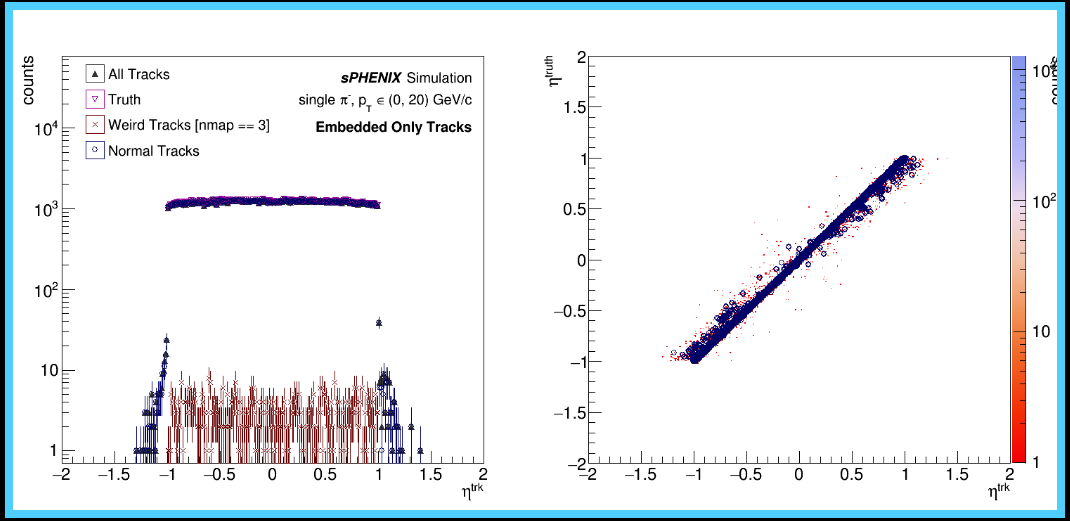
All Weird Tracks



Weird Tracks w/o Silicon Seeds

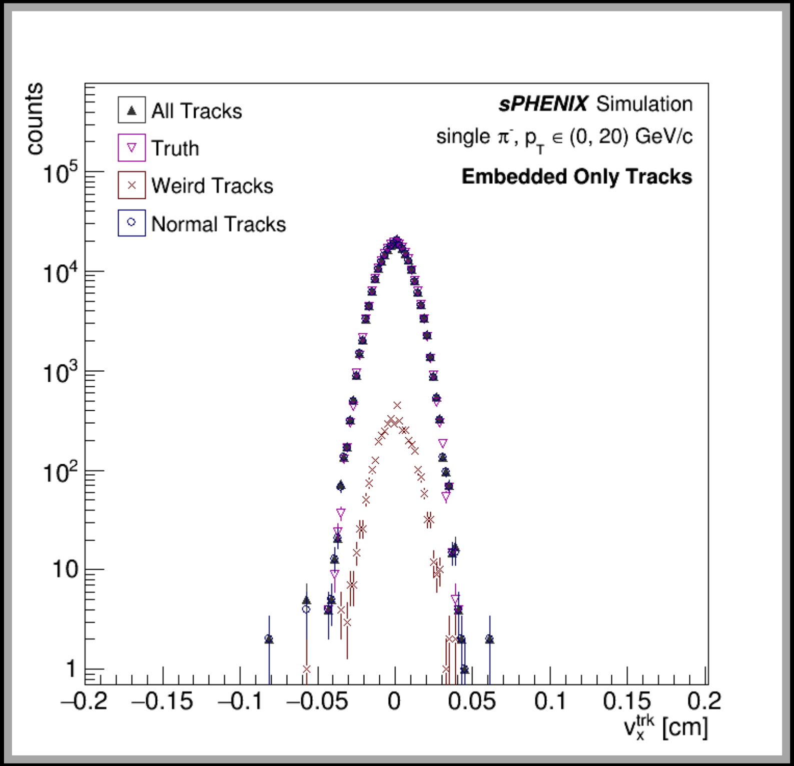


Weird Tracks w/ Silicon Seeds

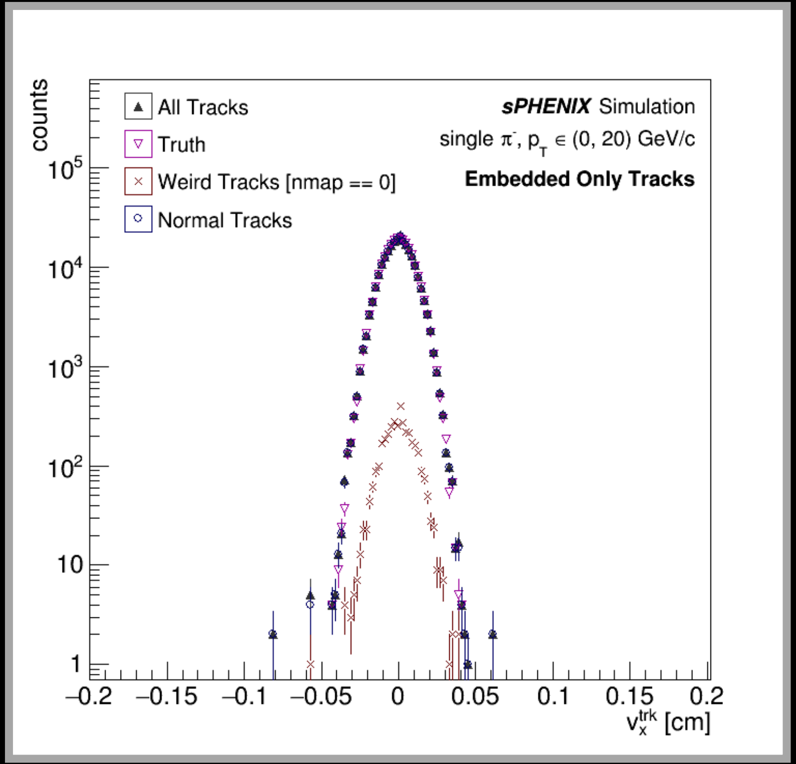


- Reconstructed and truth eta
  - reco. eta (left panels)
  - reco. vs. truth eta (right panels)
  - **eta vs. geta** leaves of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

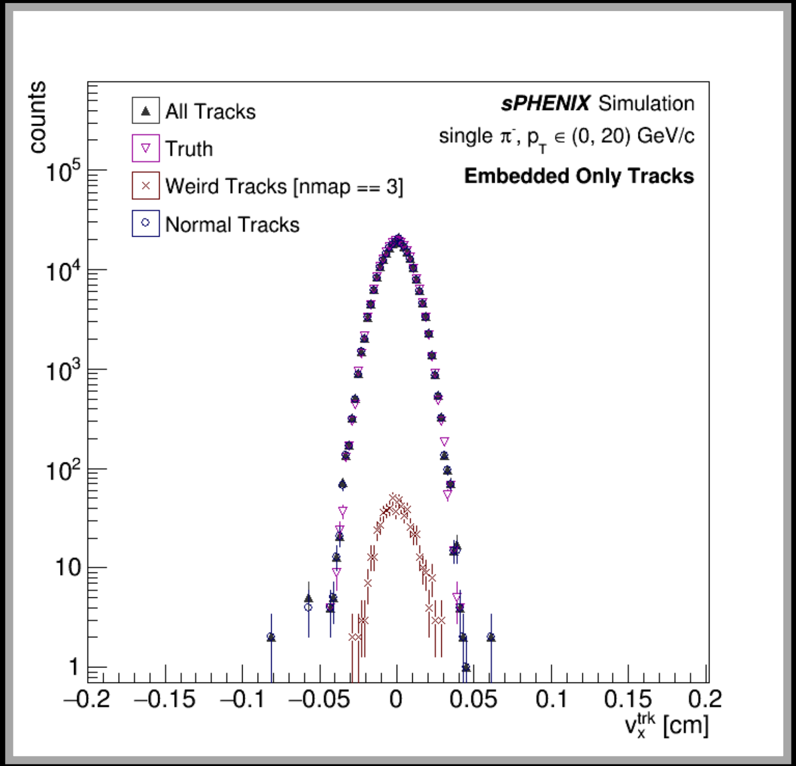
Track X-Vertex



All Weird Tracks



Weird Tracks w/o Silicon Seeds



Weird Tracks w/ Silicon Seeds

- X-component of reconstructed vertex
  - **vx** leaf of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)