



# Track Cut Study: Update

sPHENIX Tracking Meeting

March 22<sup>nd</sup>, 2023

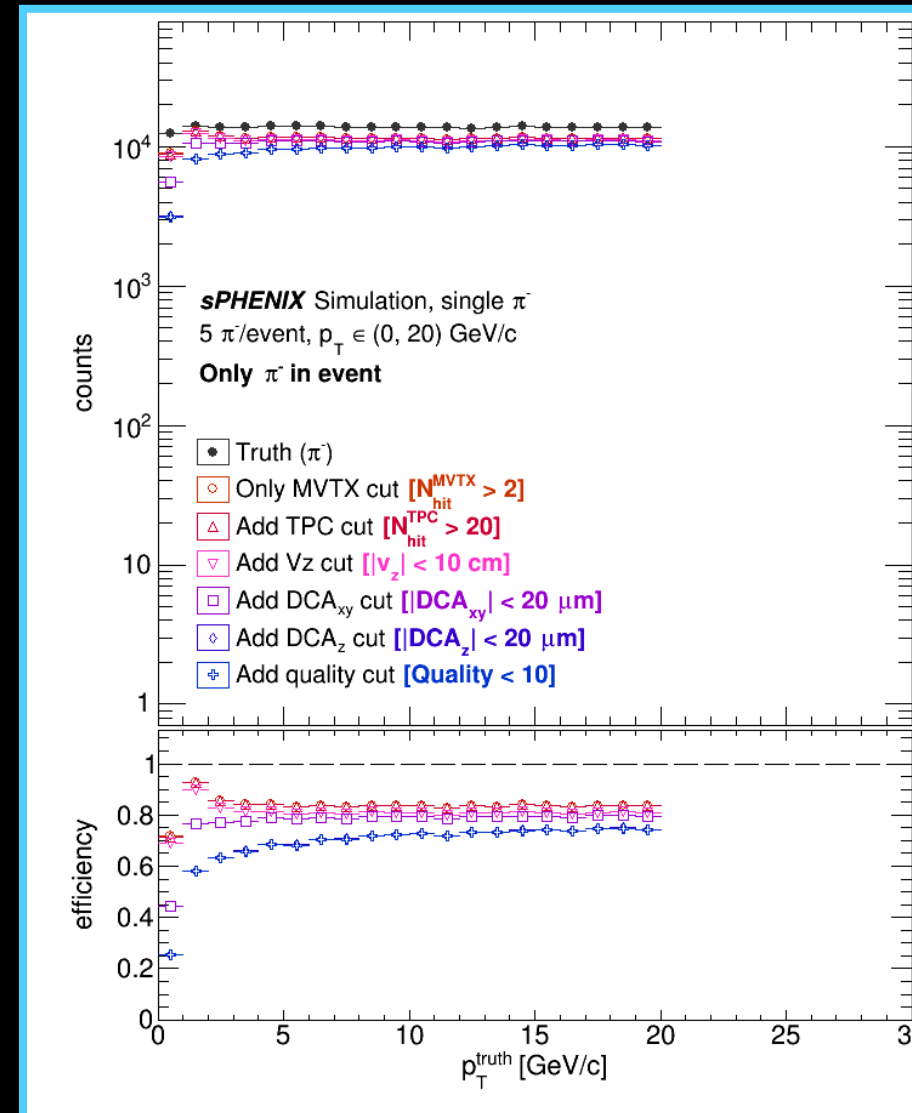
Derek Anderson



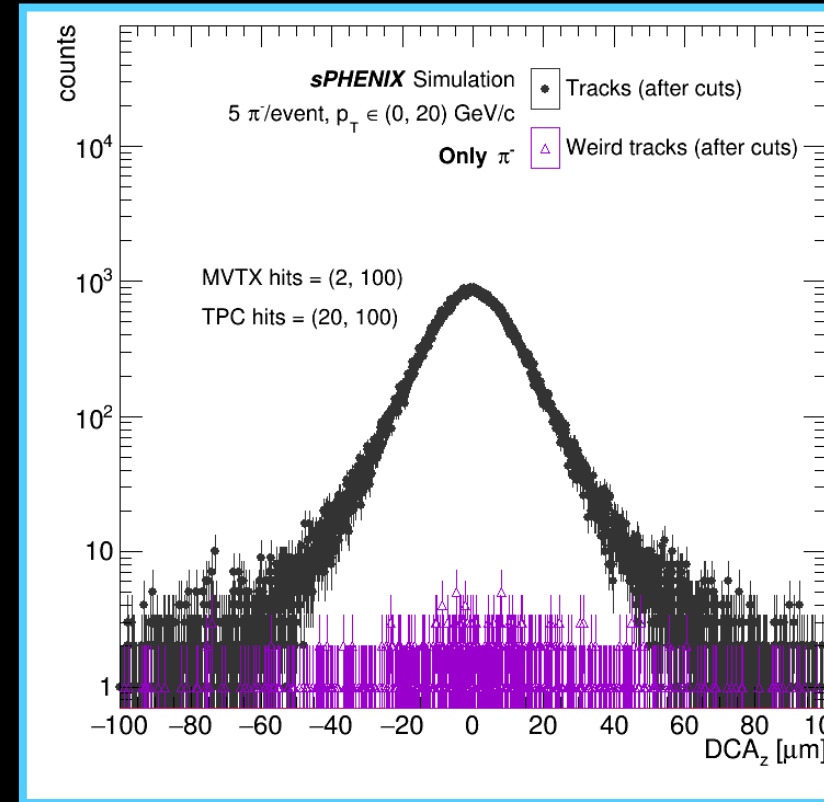
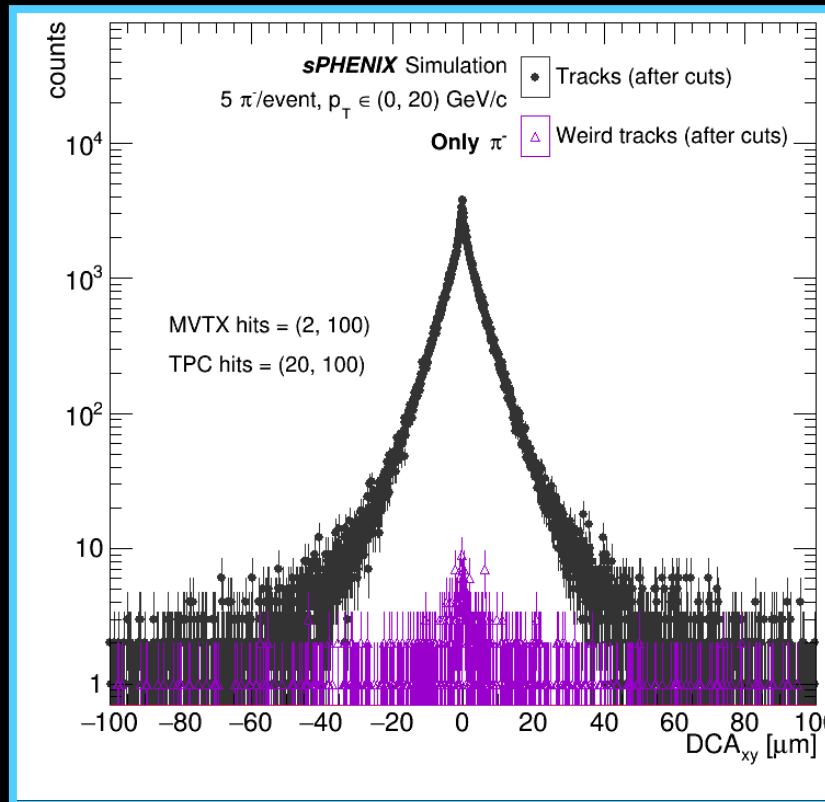
# Tracking Efficiency vs. Cuts



- **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  $\pi^-$ -only events
  - Only 5  $\pi^-$ /event
  - ☞ Now working on events with more  $\pi^-$



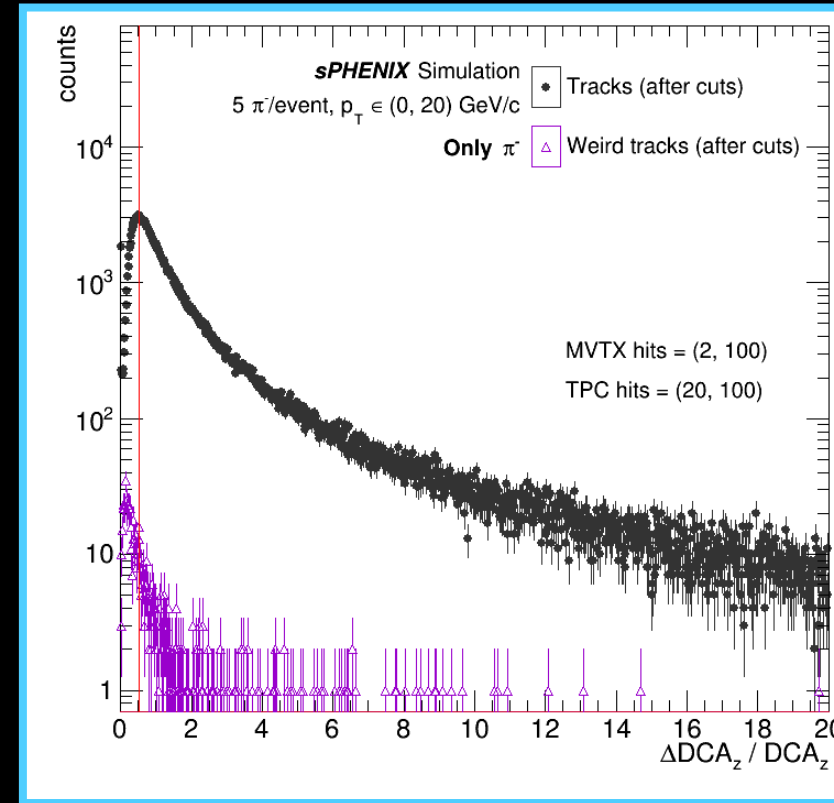
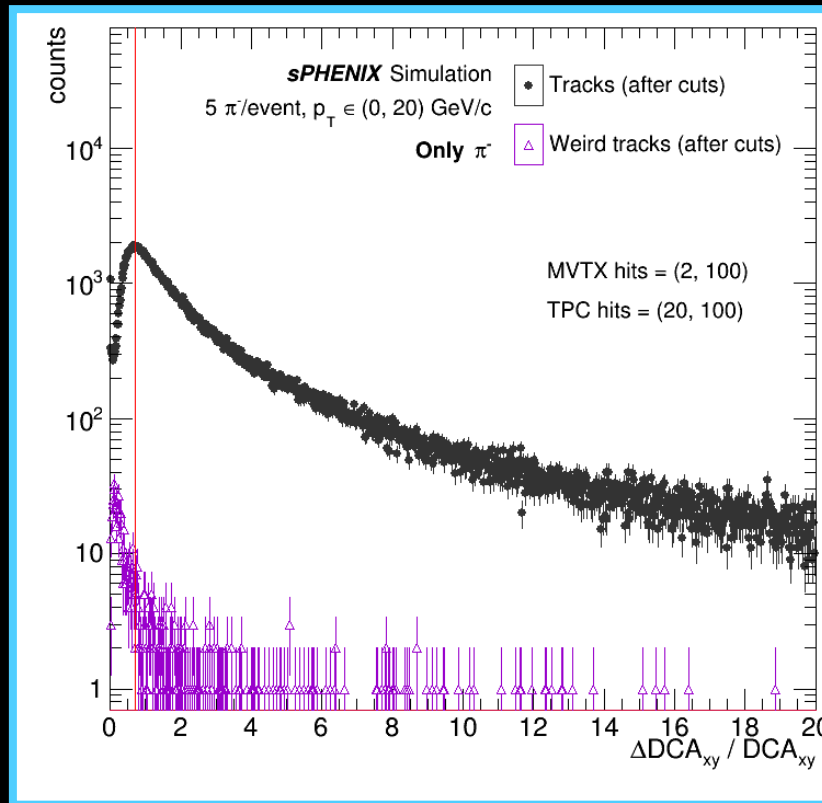
# Track DCA Distributions



- **Left:** track DCA<sub>xy</sub> distribution
- **Right:** track DCA<sub>z</sub> distribution
- ☞ Only for 5  $\pi^-$ /event

- **Black** points are all tracks, **purple** points are weird tracks

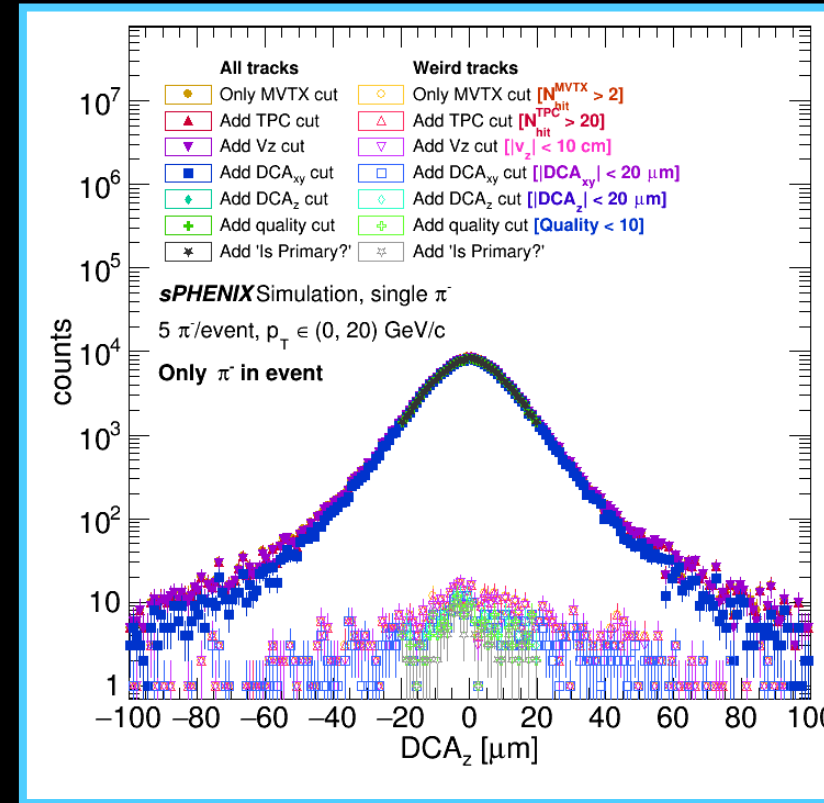
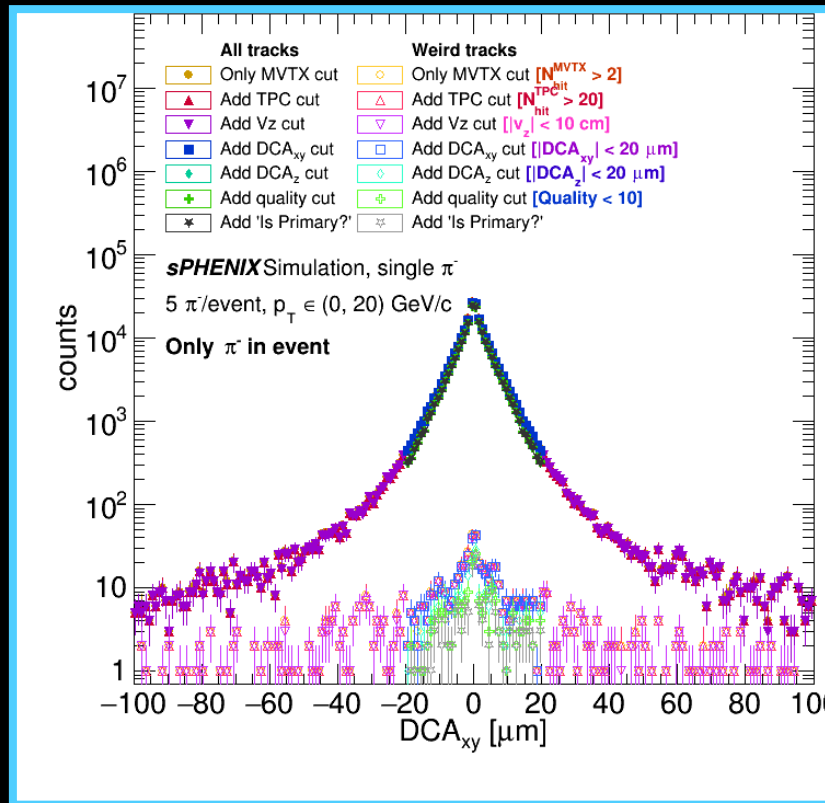
# Track $\sigma_{DCA}/DCA$ Distributions



- **Left:** track DCAxy distribution
- **Right:** track DCAz distribution
- Only for  $5 \pi^-$ /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

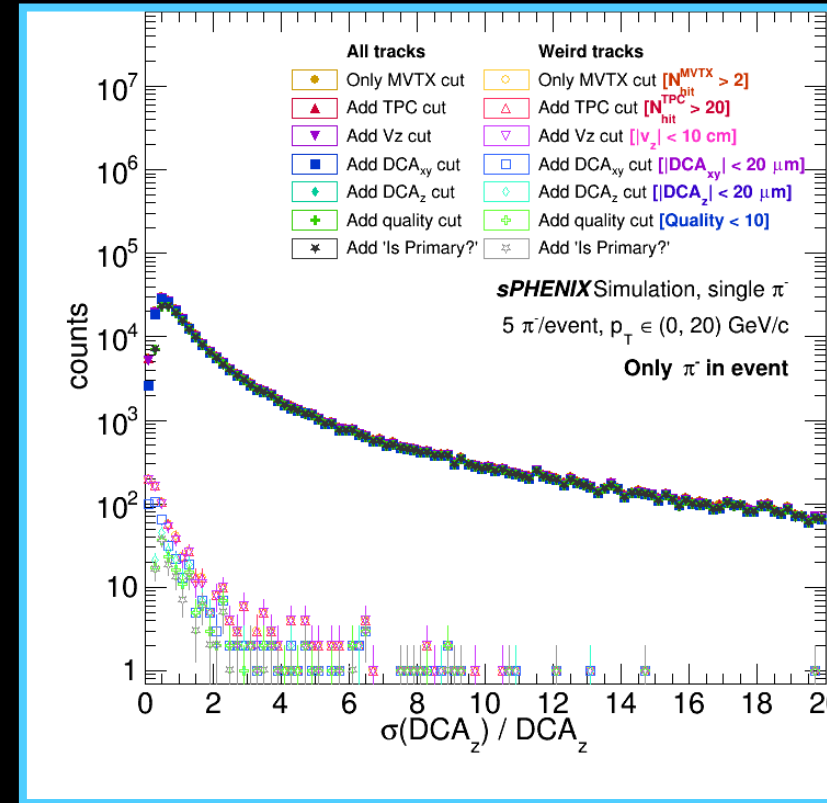
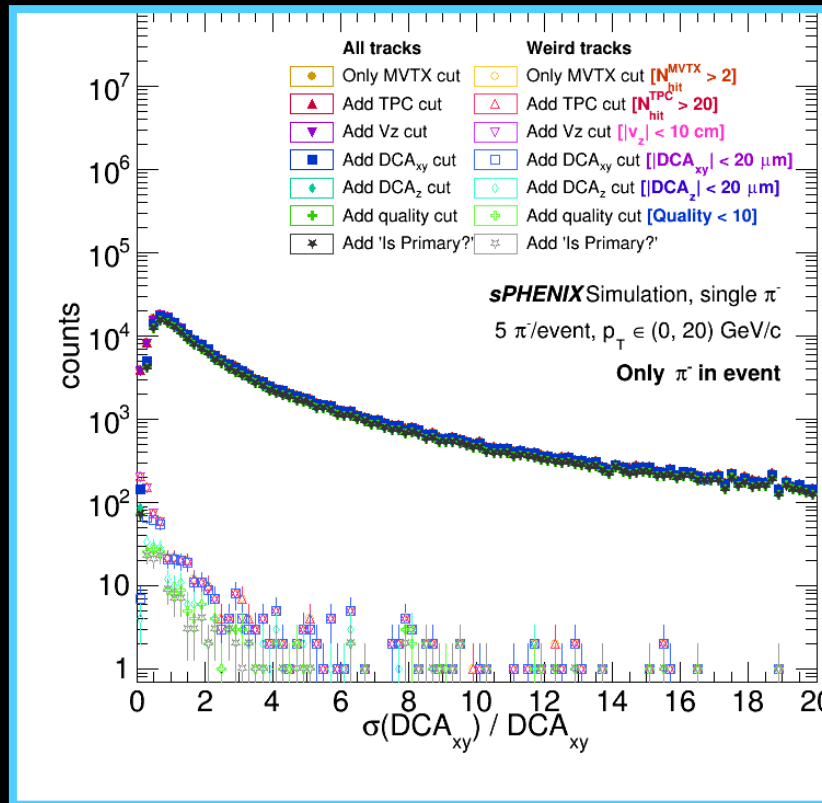


- **Left:** track DCA<sub>xy</sub> distribution
- **Right:** track DCA<sub>z</sub> distribution
- ☞ Only for 5  $\pi^-$ /event

- **Closed Markers:** all tracks
- **Open Markers:** weird tracks



# Track $\sigma_{DCA}/DCA$ vs. Successive Cuts



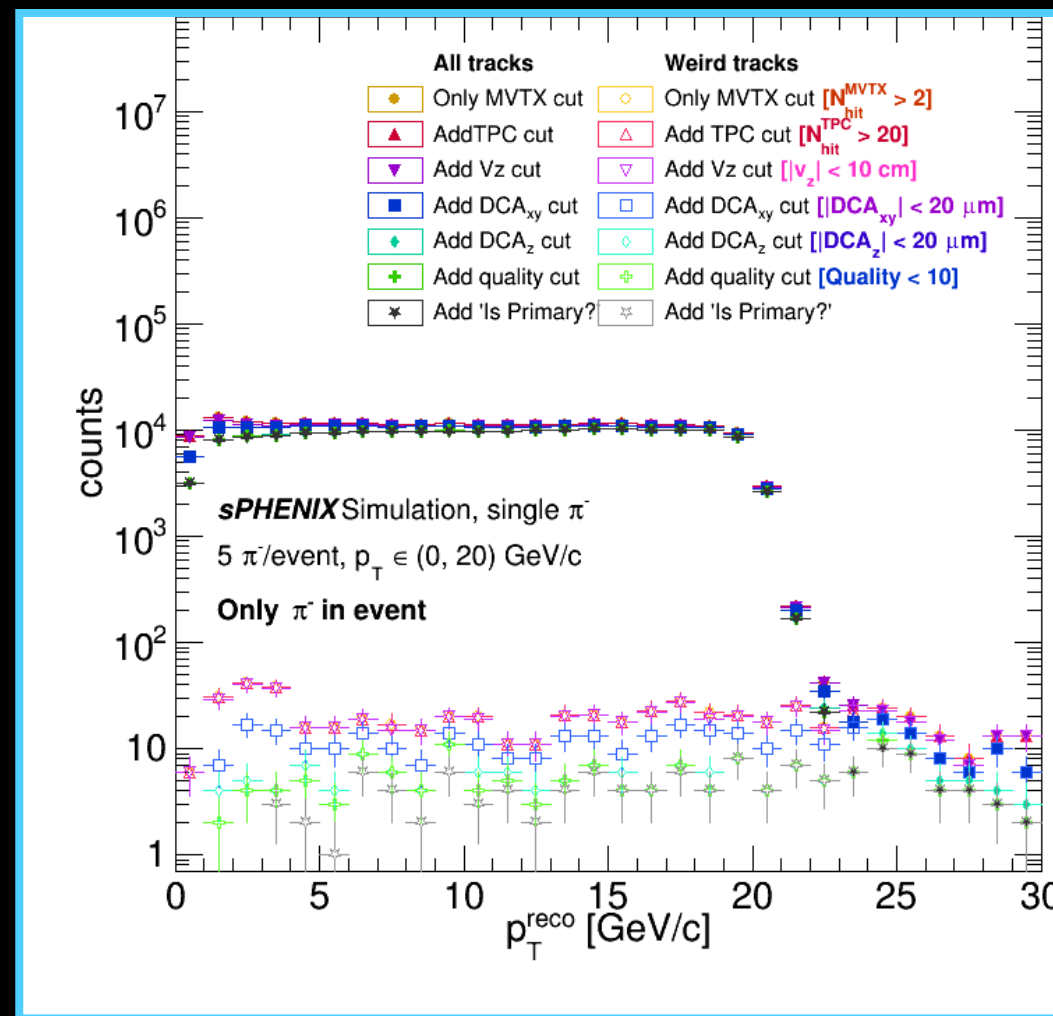
- **Left:** track DCA<sub>xy</sub> distribution
- **Right:** track DCA<sub>z</sub> distribution
- ☞ Only for 5  $\pi^-$ /event

- **Closed Markers:** all tracks
- **Open Markers:** weird tracks

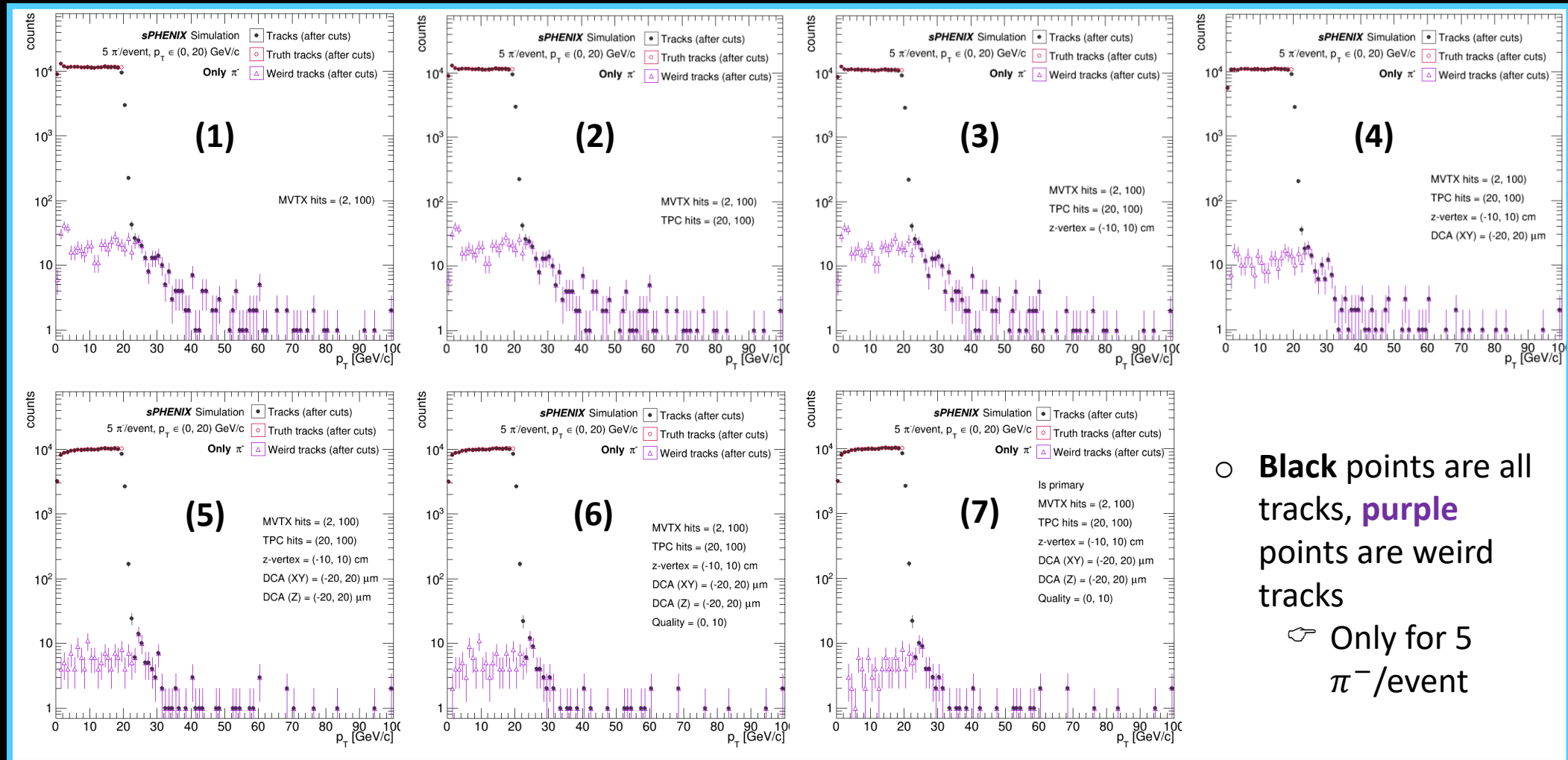
# Track $p_T$ vs. Successive Cuts | 1 panel



- **Left:** track DCAxy distribution
- **Right:** track DCAz distribution
- **Closed Markers:** all tracks
- **Open Markers:** weird tracks



# Track $p_T$ vs. Successive Cuts | 7 panels





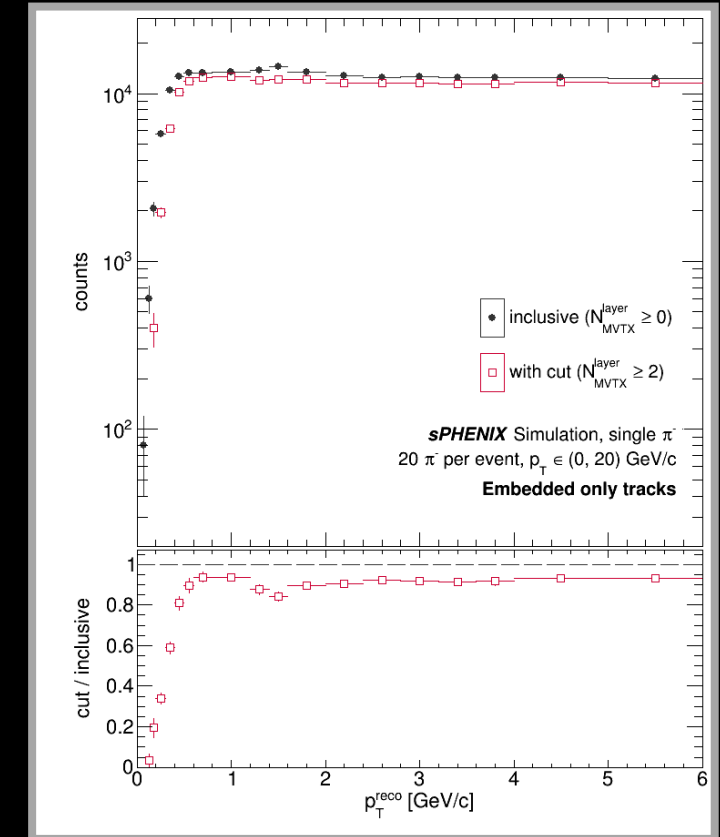
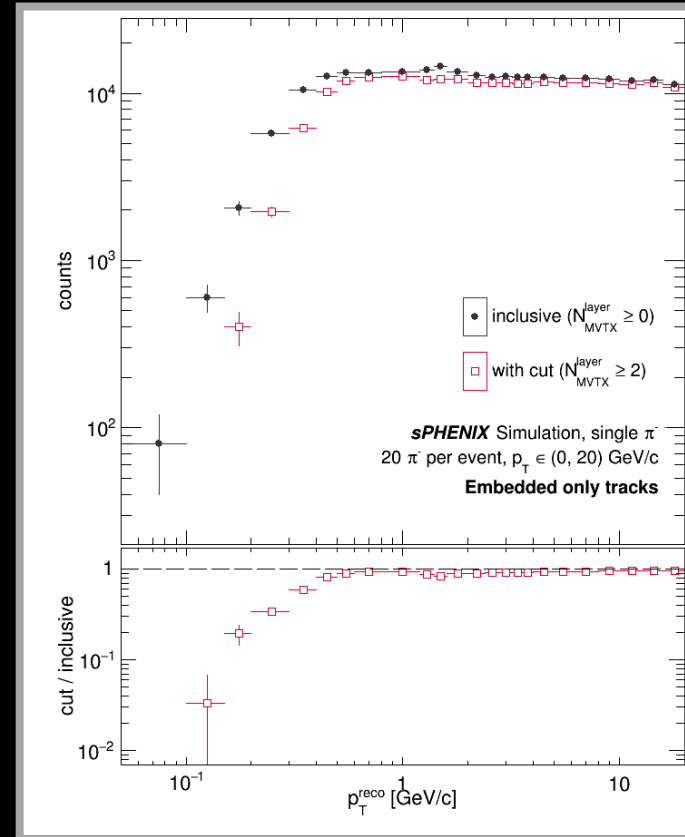
Previous Slides

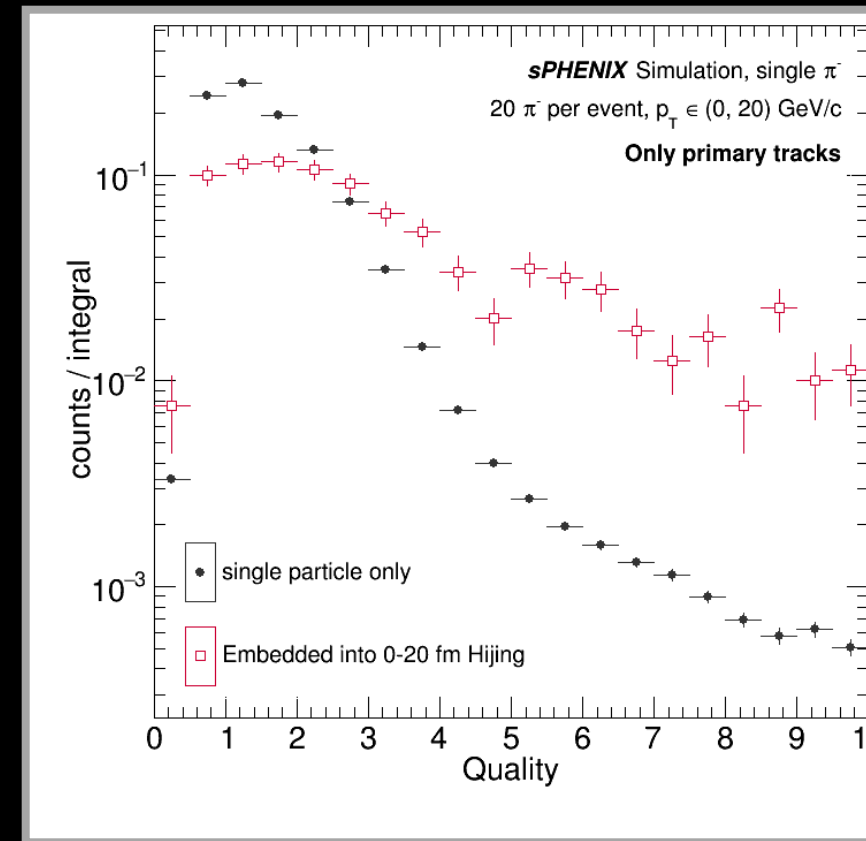
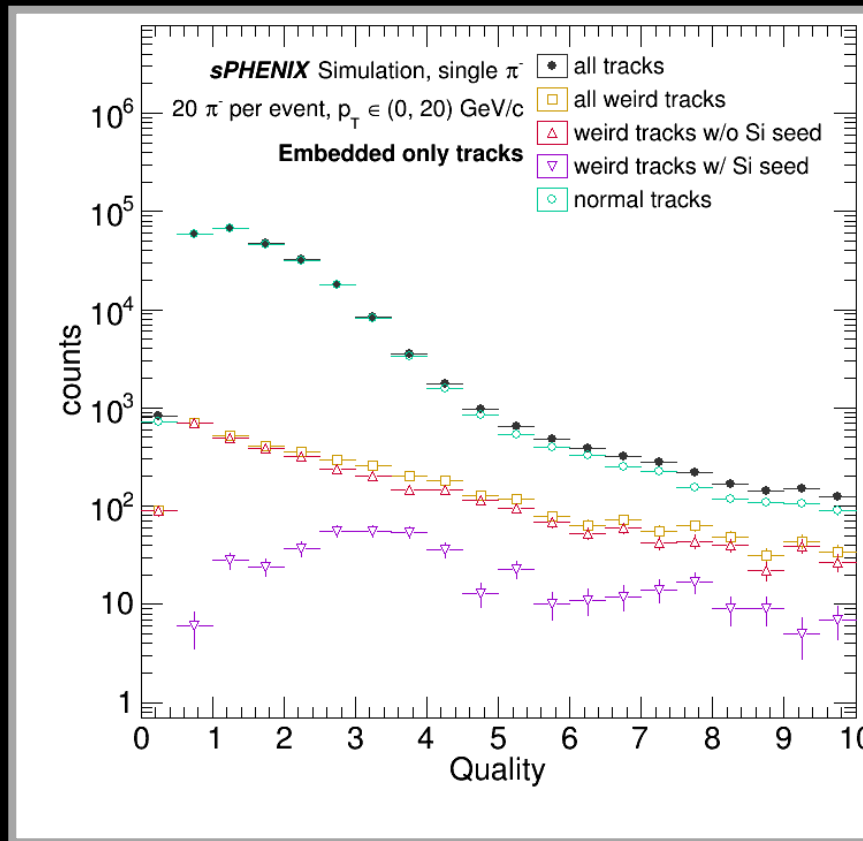


# MVTX Hits $\geq 2$ vs. Inclusive



- 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- $p_T$  region
  - Left: log x-axis
  - Right: linear x-axis



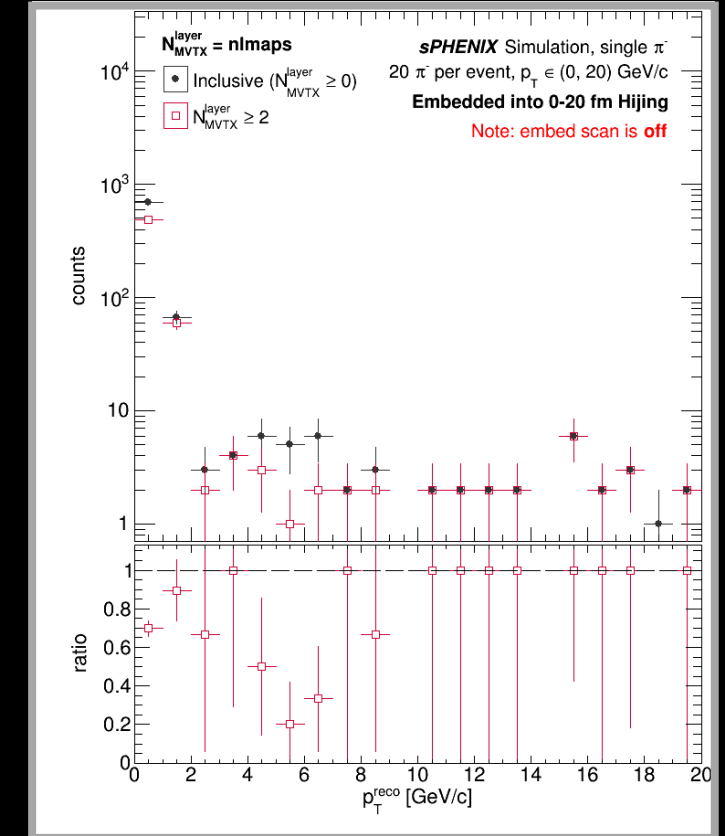
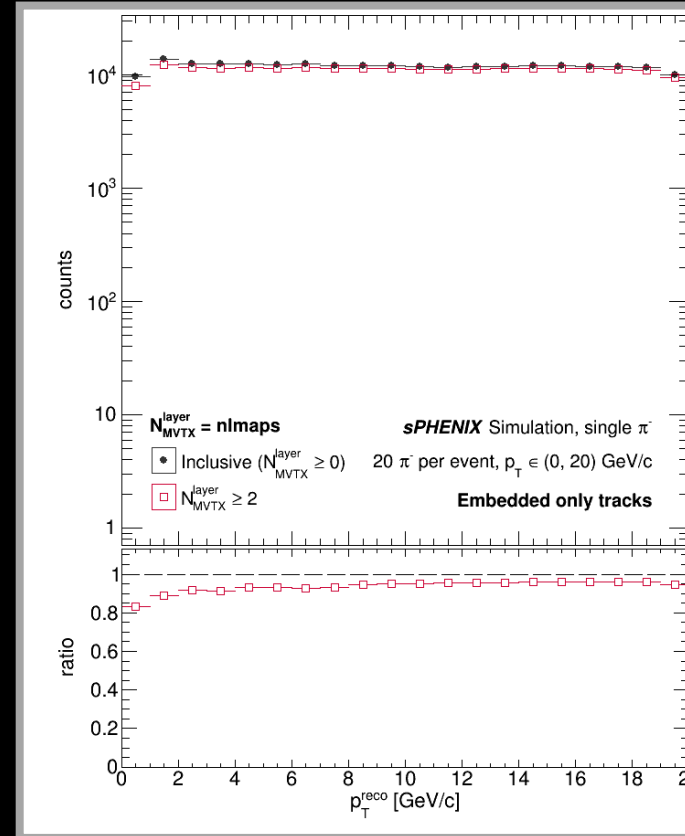


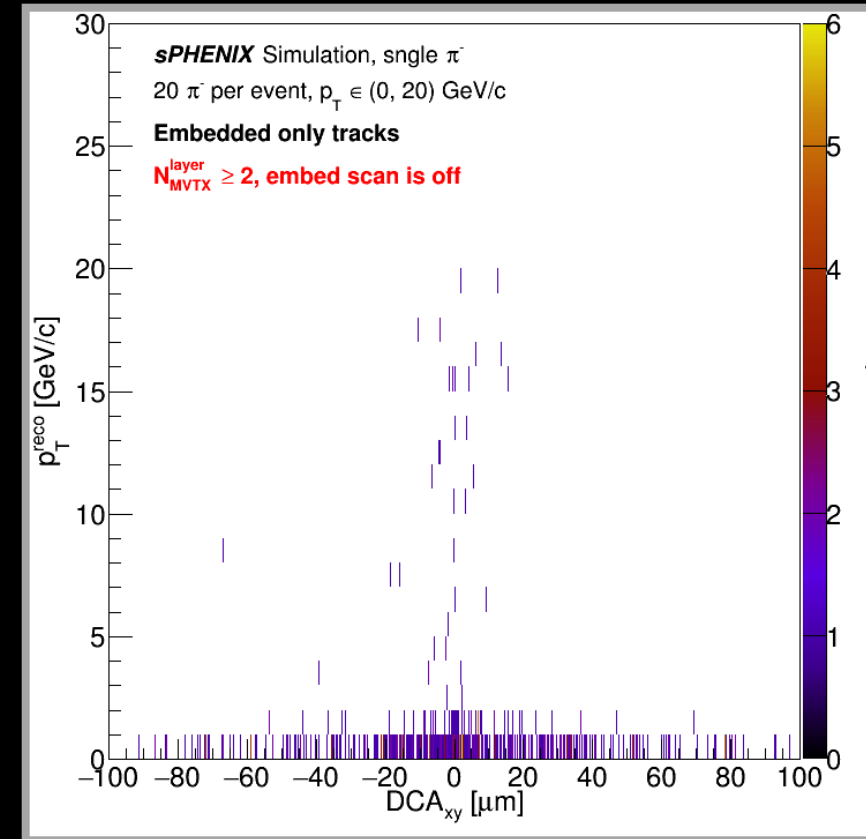
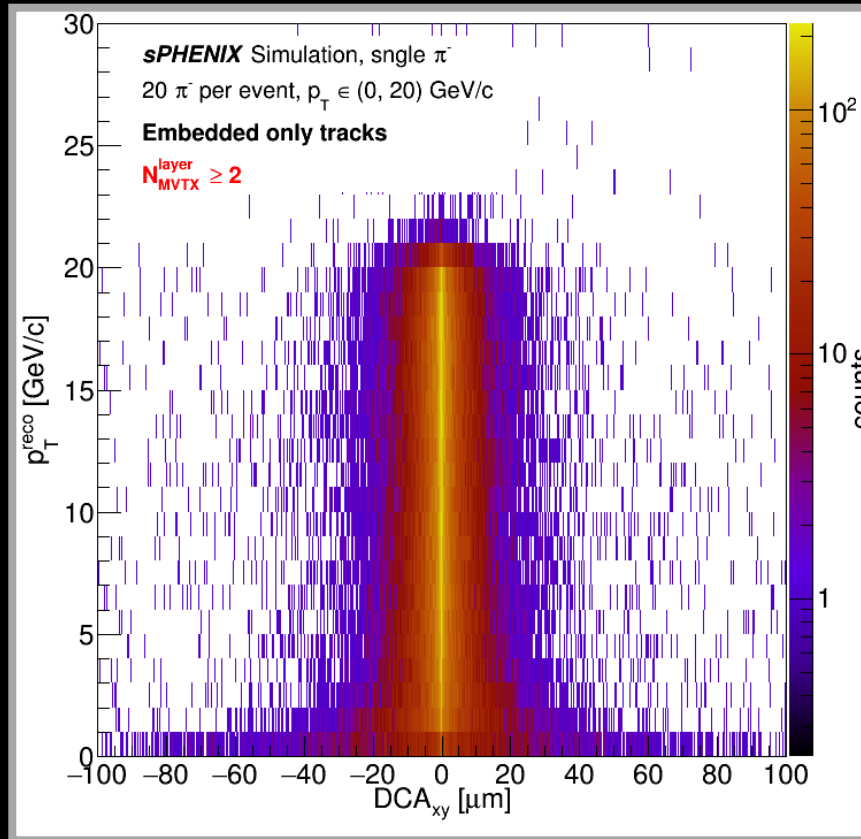
- Ratio of weird/normal (primary) tracks to all (primary) tracks as a function of quality
  - Left: single particle only
  - Right: single particle vs. embedded into Hijing

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



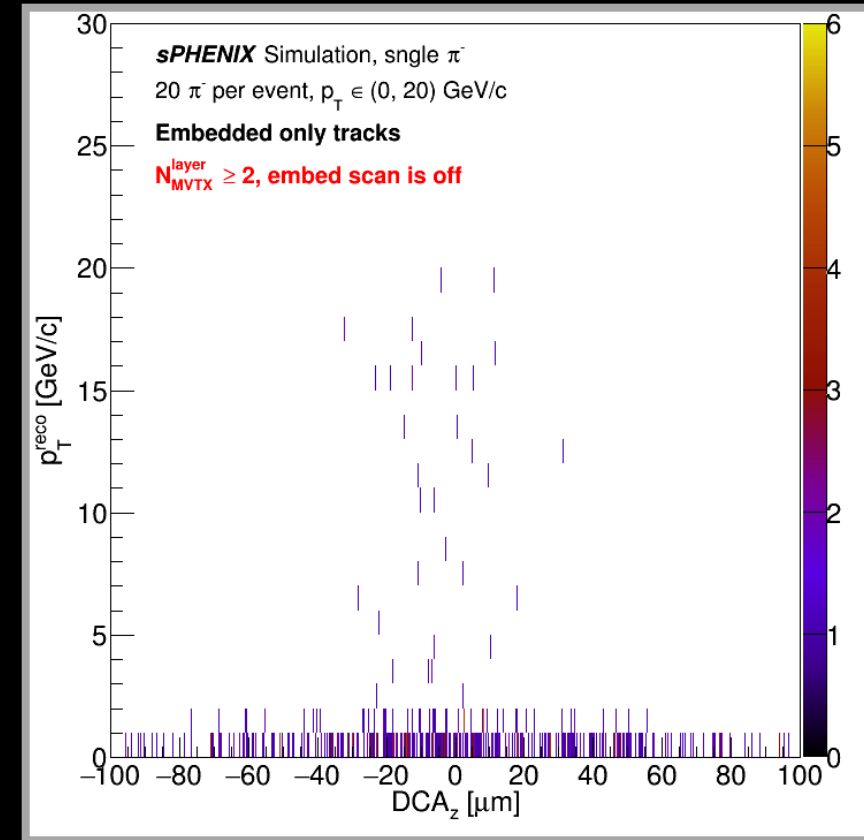
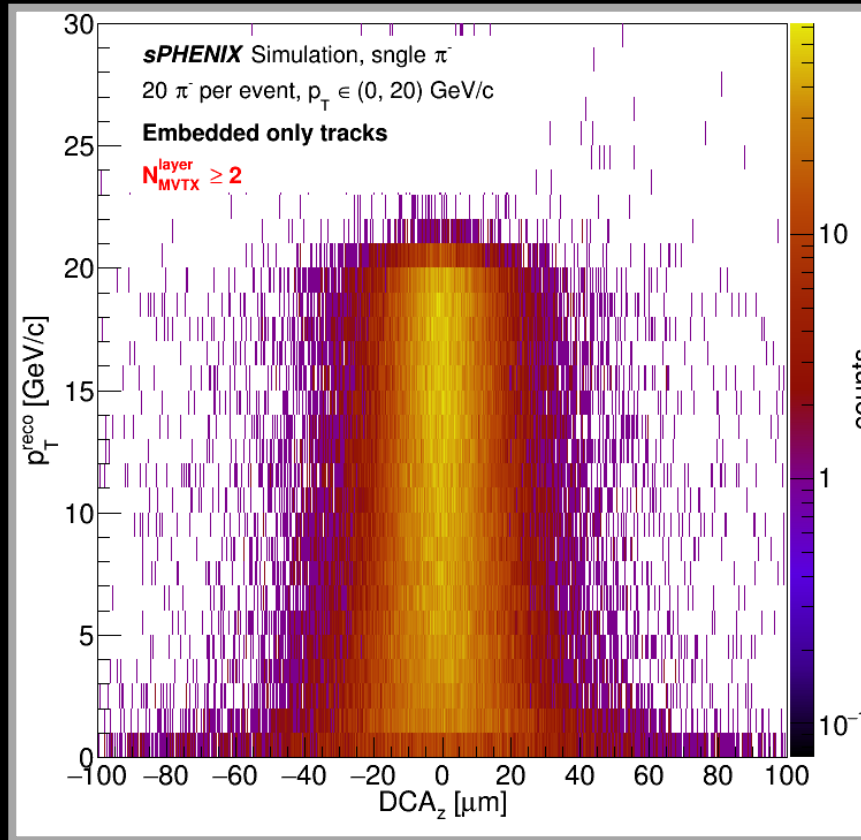
- Reconstructed track  $p_T$  of primary tracks w/
  - $N_{MVTX}^{layer} \geq 2$  (red) vs.
  - Inclusive (black)
- **Left:** single particle only  
**Right:** single particles embedded into Hijing  
 ⇒ Not enough stats for embedded tracks!





- Primary track DCA<sub>xy</sub> for primary tracks w/  $N_{MVTX}^{layer} \geq 2$

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



- Primary track DCAz for primary tracks w/  $N_{MVTX}^{layer} \geq 2$

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



## Plots to Make:

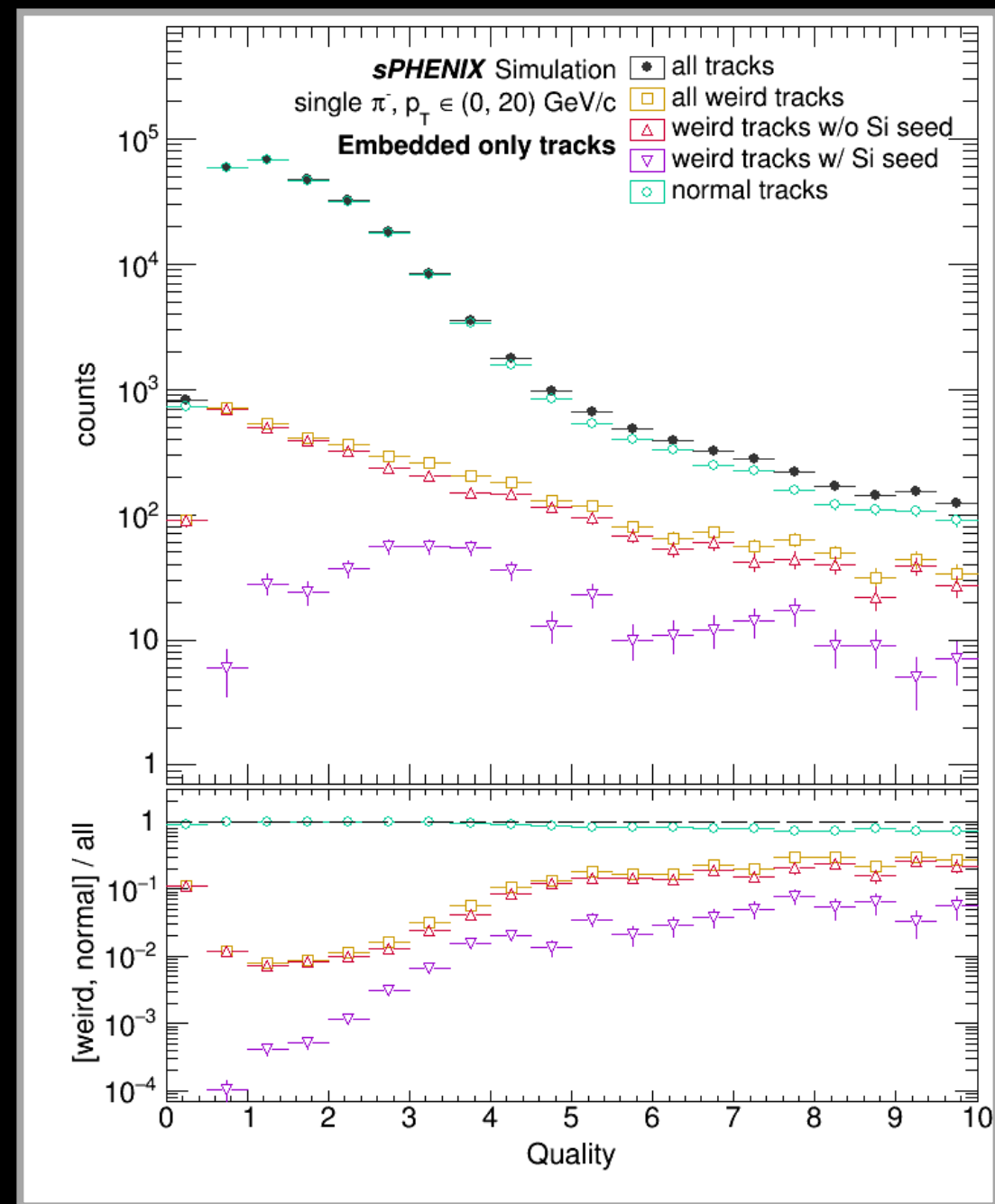
- Quality (and other track quantities) vs.  $N_{TPC}^{hit}$
- Average cluster size for weird tracks vs. normal tracks
  - ☞ Do we have access to that in the evaluator?

## 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  $\Rightarrow p_T^{reco} / p_T^{true} \notin (0.2, 1.20)$
  - Normal  $\Rightarrow p_T^{reco} / p_T^{true} \in (0.2, 1.20)$



# 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  $\pi^-$ 
  - 20  $\pi^-$  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

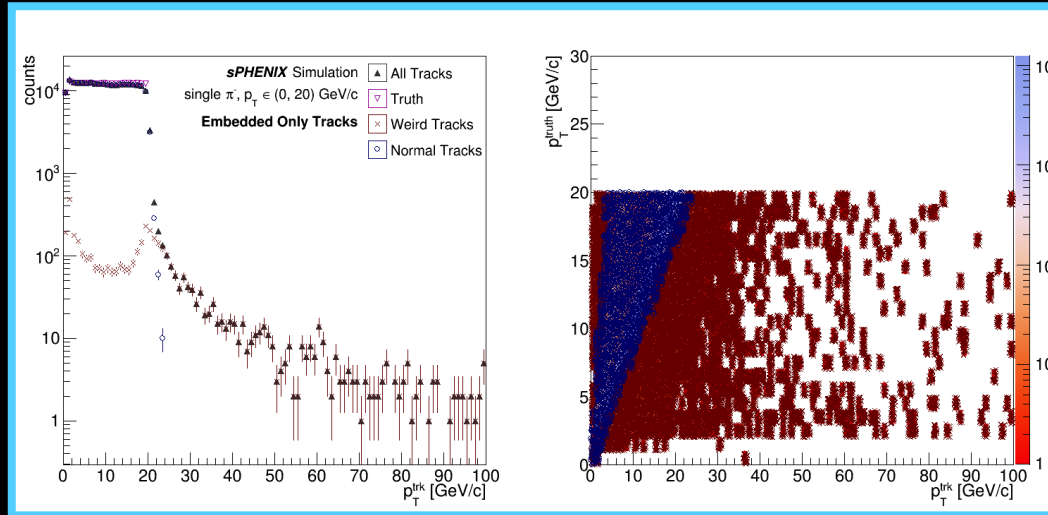
## Weird Tracks w/o Silicon Seeds

- $p_T^{trk}$  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)
- $\chi^2/ndf$  distribution is falling (slide 10)

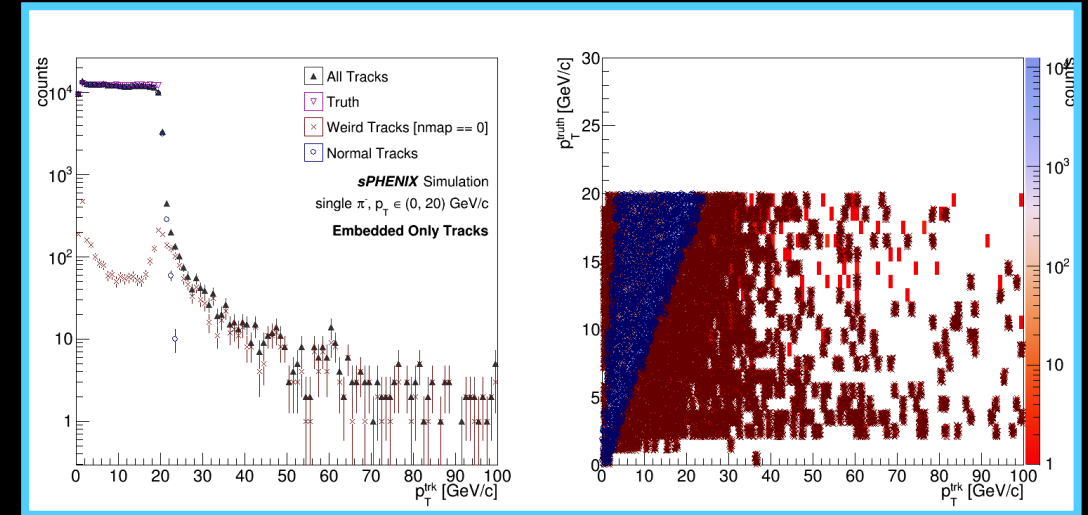
## Weird Tracks w/ Silicon Seeds

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

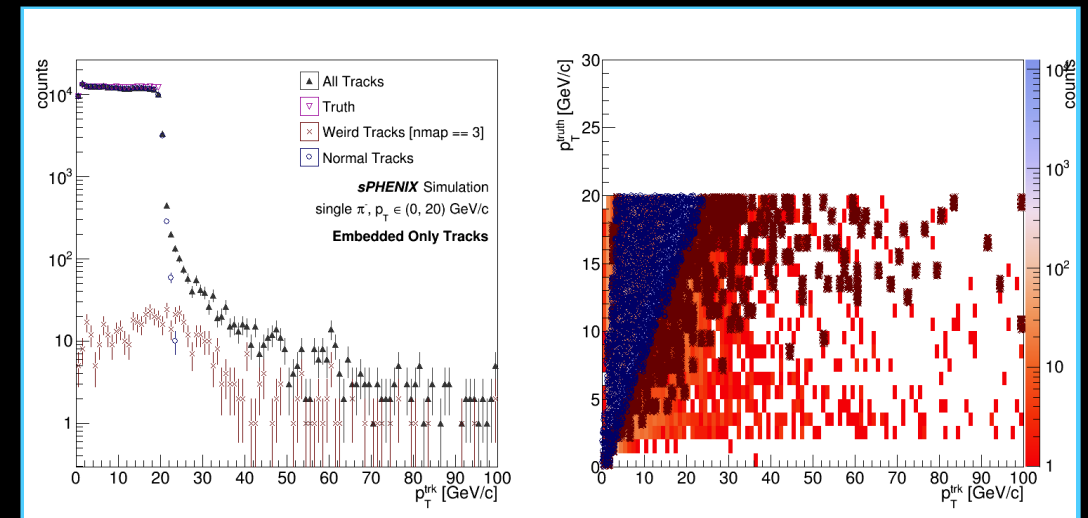
## All Weird Tracks



## Weird Tracks w/o Silicon Seeds

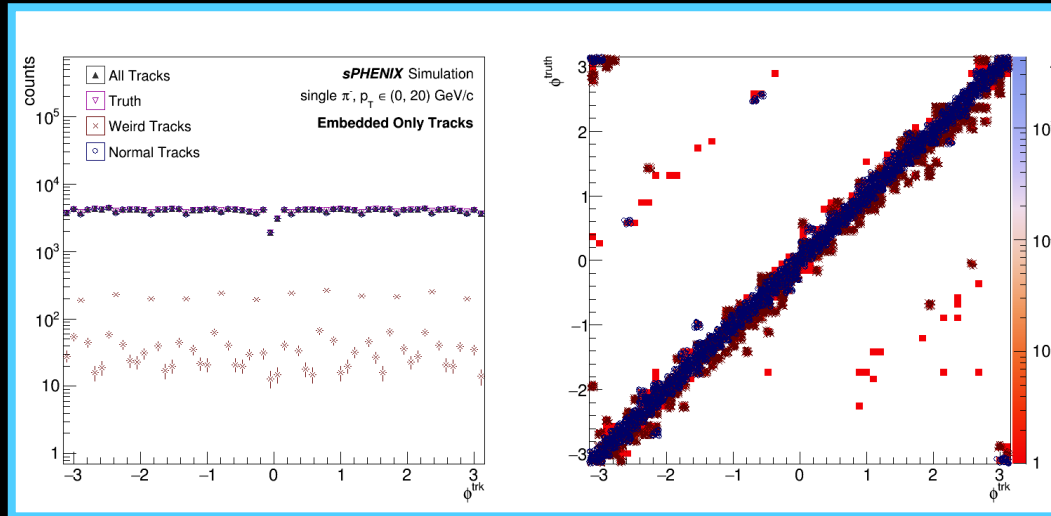


## Weird Tracks w/ Silicon Seeds

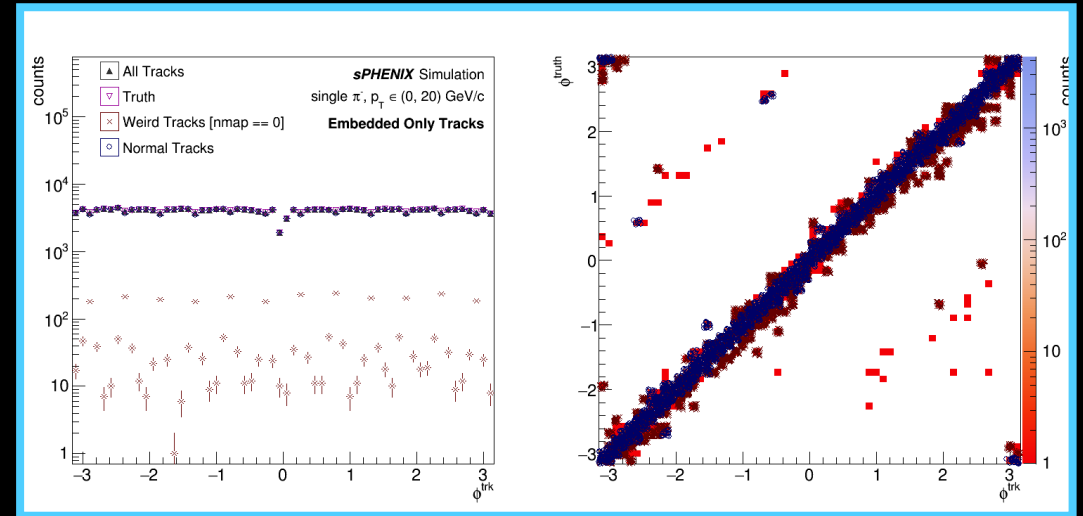


- Reconstructed and truth  $p_T$ 
  - reco.  $p_T$  (left panels)
  - reco. vs. truth  $p_T$  (right panels)
  - **pt vs. gpt** leaves of ntp\_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

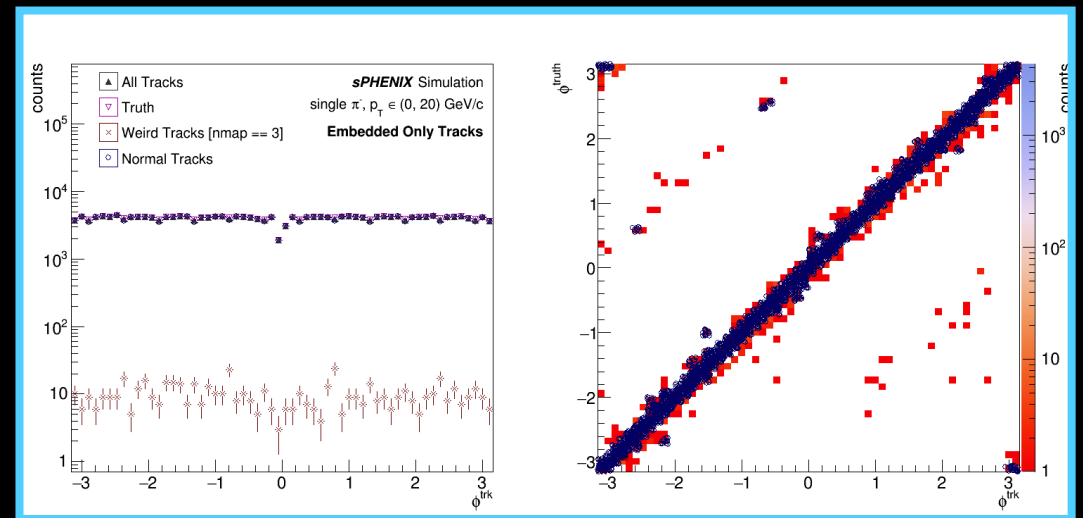
## All Weird Tracks



## Weird Tracks w/o Silicon Seeds



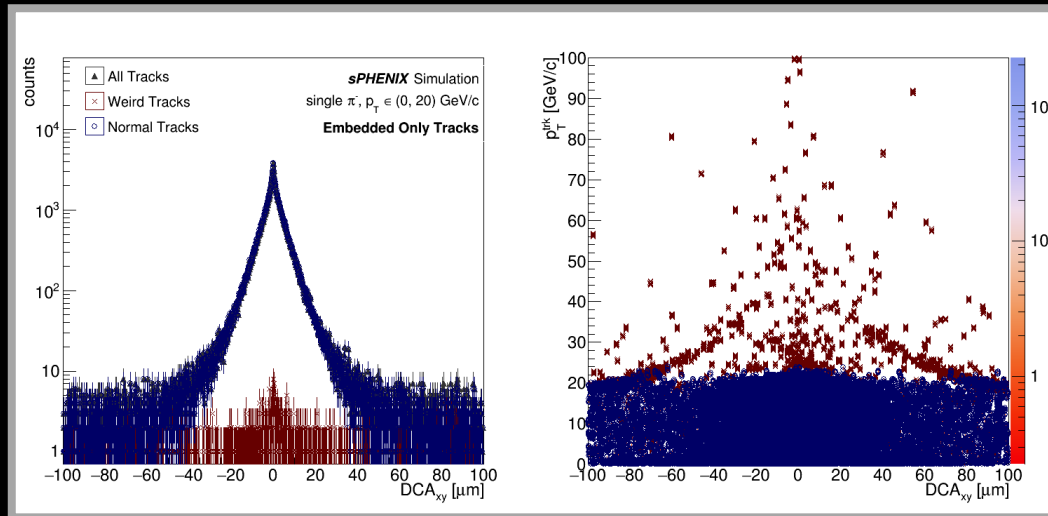
## Weird Tracks w/ Silicon Seeds



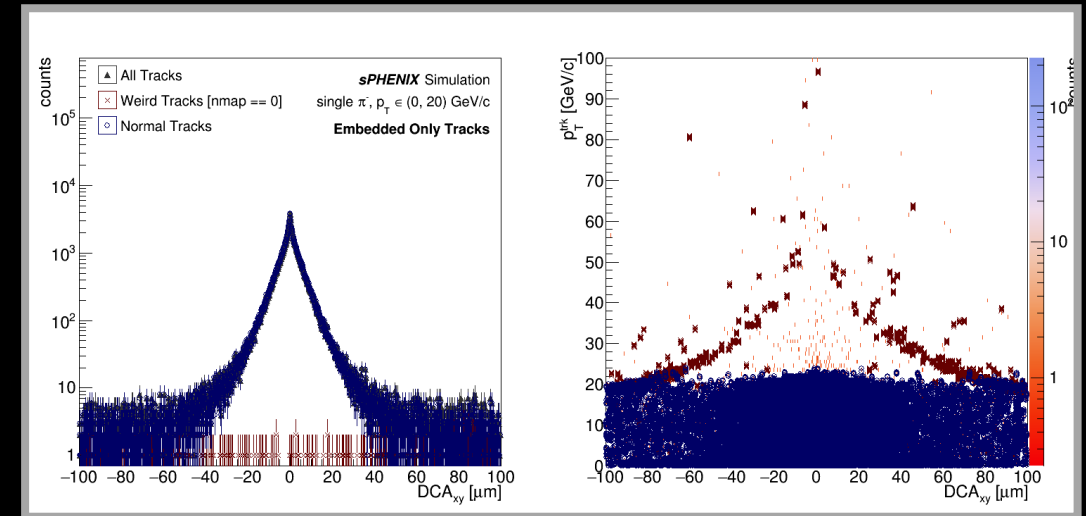
- Reconstructed and truth phi
  - reco. phi (left panels)
  - reco. vs. truth phi (right panels)
  - **phi vs. gphi** leaves of ntp\_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)



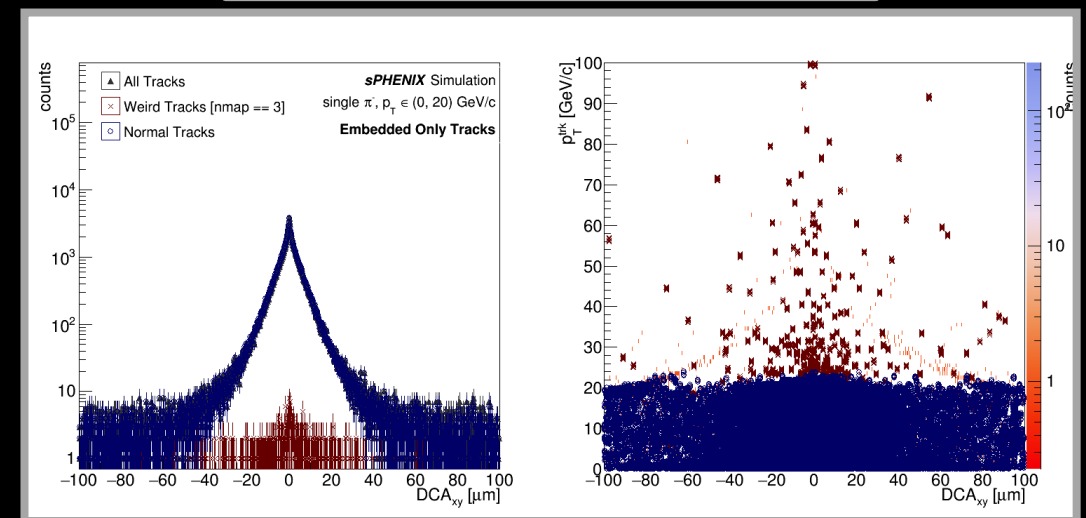
## All Weird Tracks



## Weird Tracks w/o Silicon Seeds

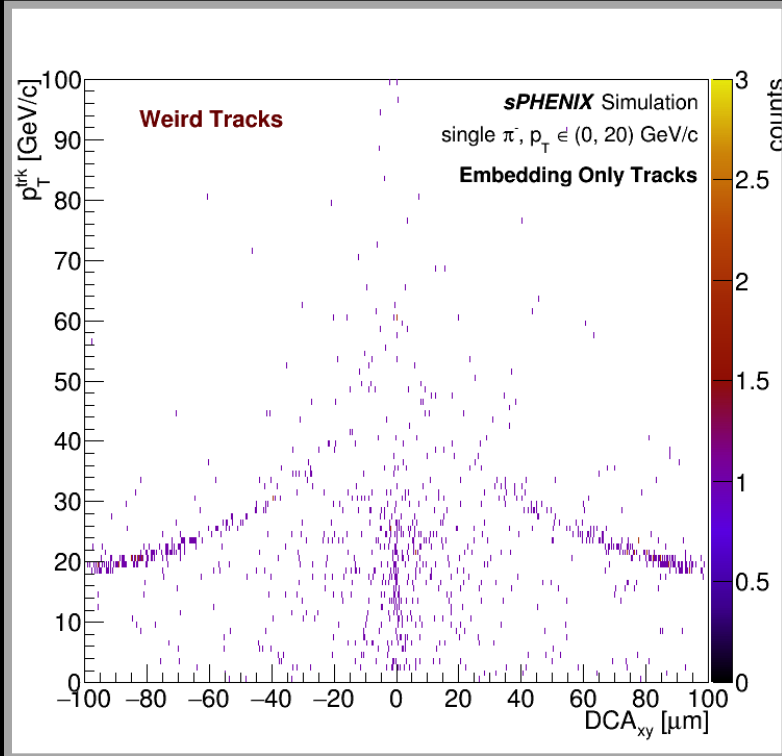


## Weird Tracks w/ Silicon Seeds

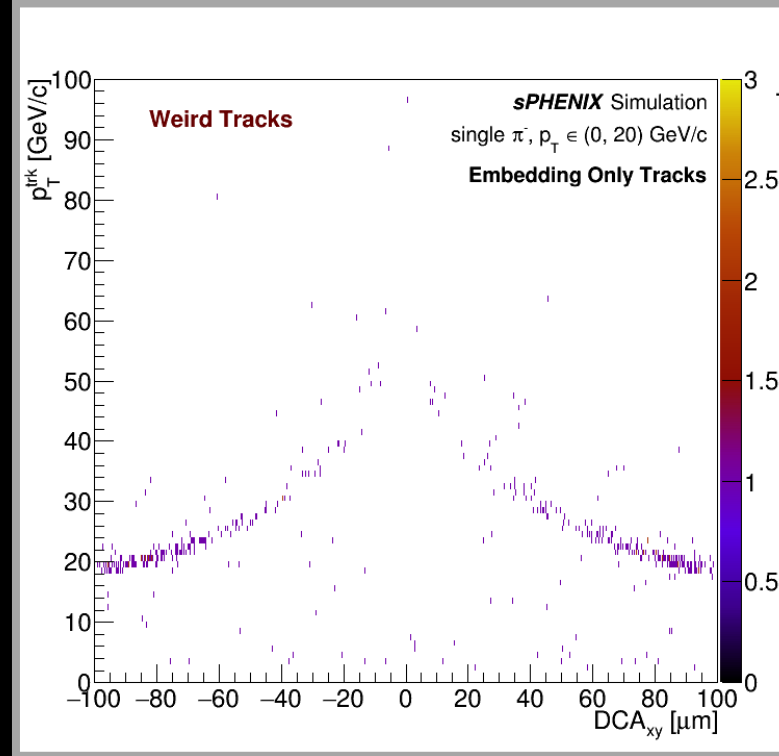


- Track DCAxy
  - Track DCAxy (left panels)
  - DCAxy vs.  $p_T^{rk}$  (right panels)
  - `dca3dxy` vs. `pt` leaves of `ntp_track` tuple
- Note: y-axes are not scaled
  - y-axis range changes between plots (apologies!)

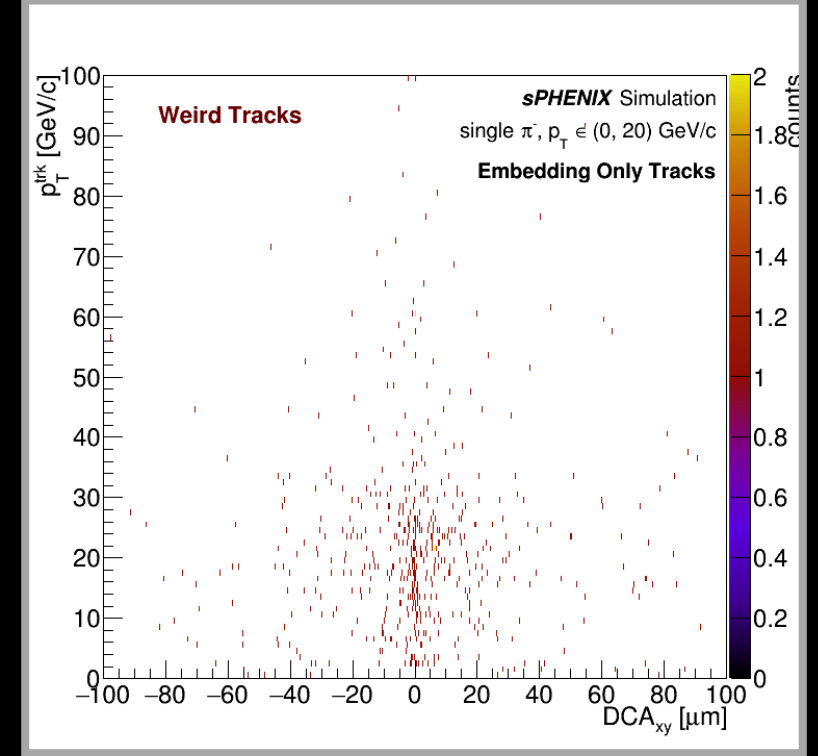
# Weird Track DCAxy



All Weird Tracks



Weird Tracks w/o Silicon Seeds

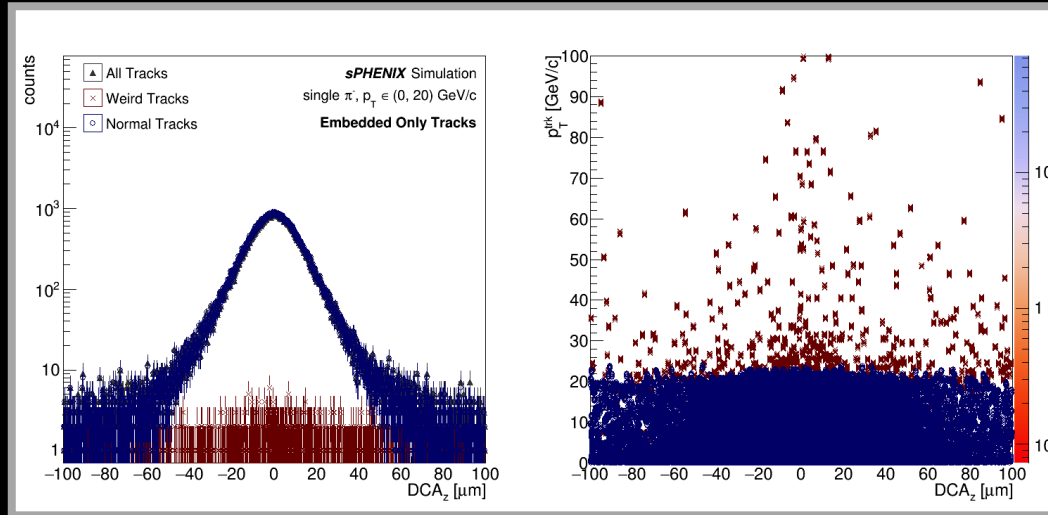


Weird Tracks w/ Silicon Seeds

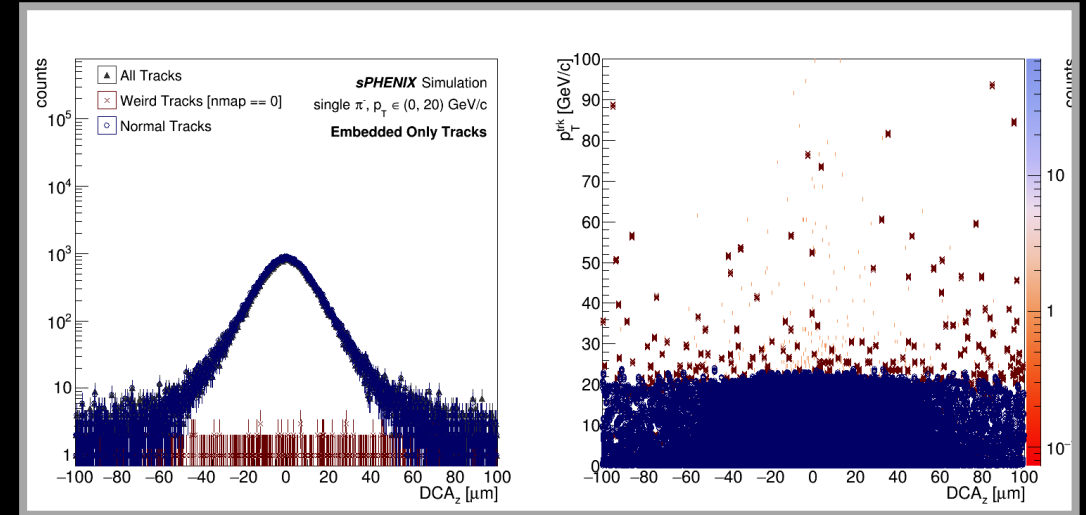
- Weird track DCAxy
  - `dca3dxy` leaf of `ntp_track` tuple for only weird tracks

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

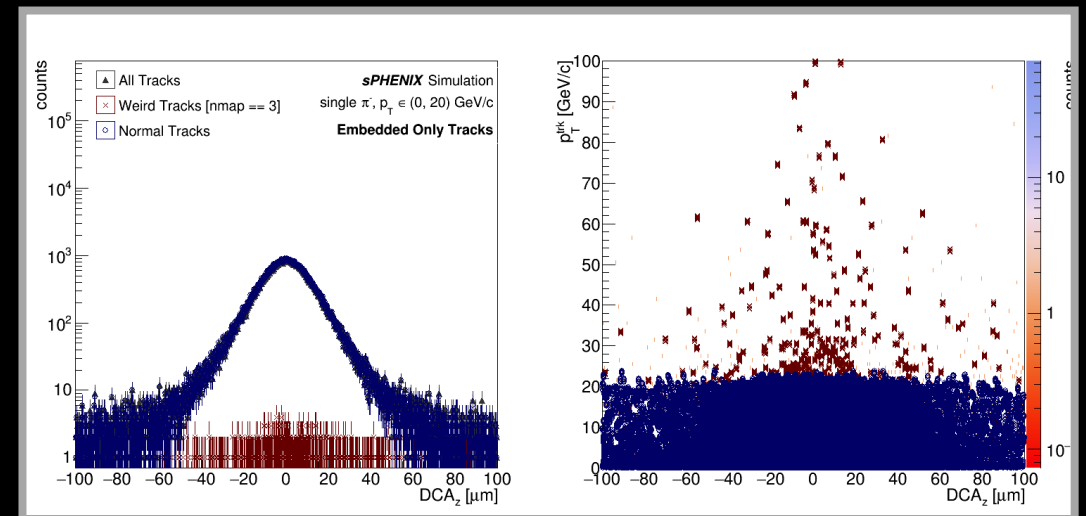
## All Weird Tracks



## Weird Tracks w/o Silicon Seeds

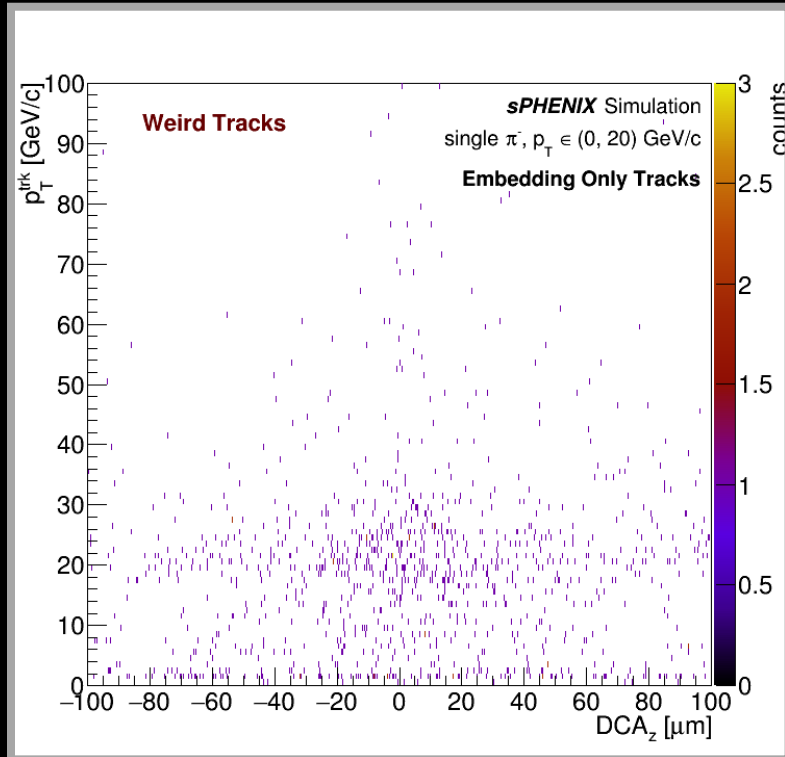


## Weird Tracks w/ Silicon Seeds

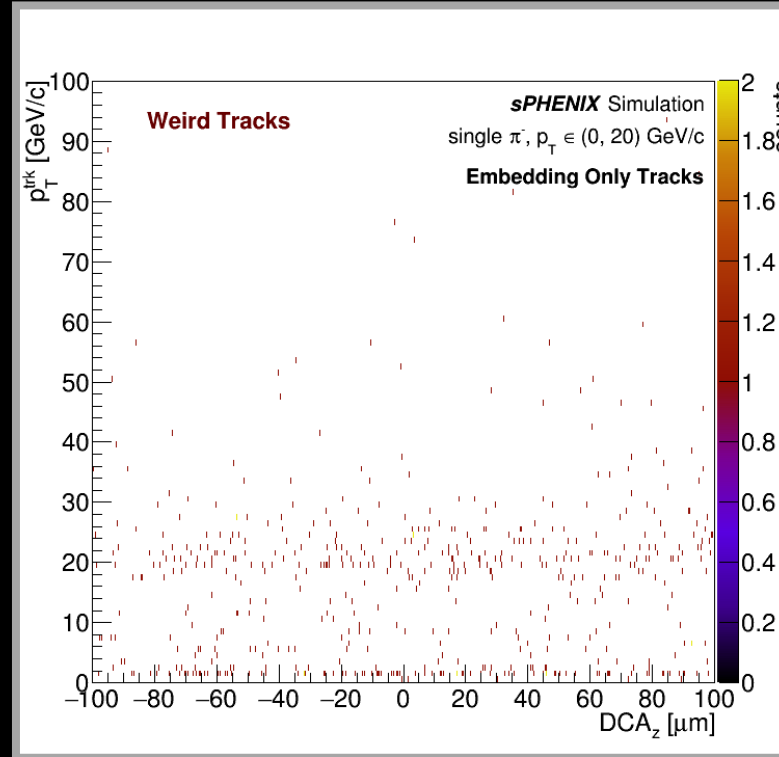


- Track DCAz
  - Track DCAz (left panels)
  - DCAz vs.  $p_T^{trk}$  (right panels)
  - `dca3dz` vs. `pt` leaves of `ntp_track` tuple
- Note: y-axes are not scaled
  - y-axis range changes between plots (apologies!)

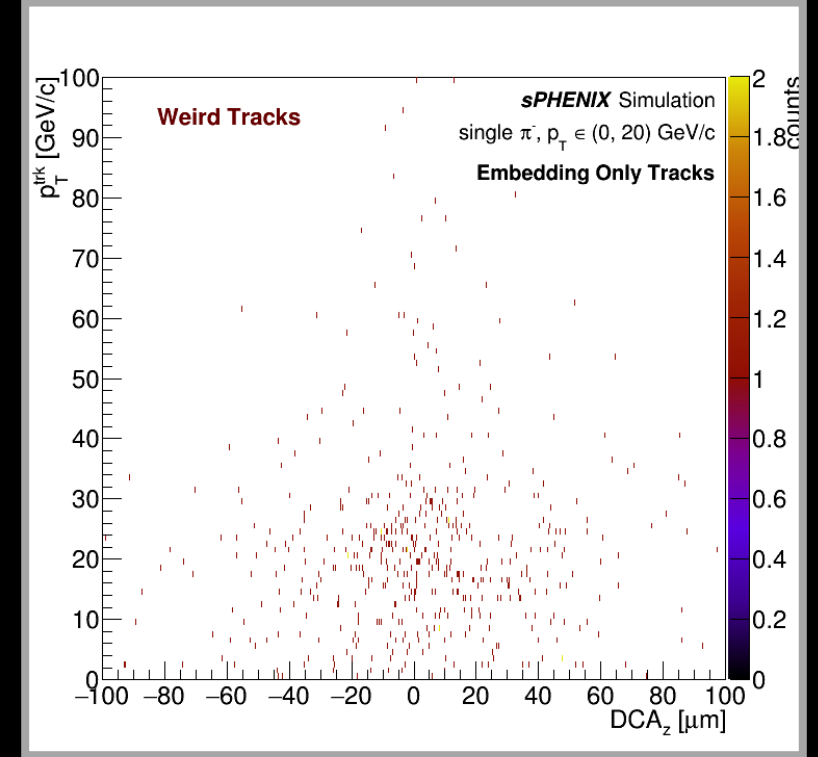
# Weird Track DCAz



All Weird Tracks



Weird Tracks w/o Silicon Seeds



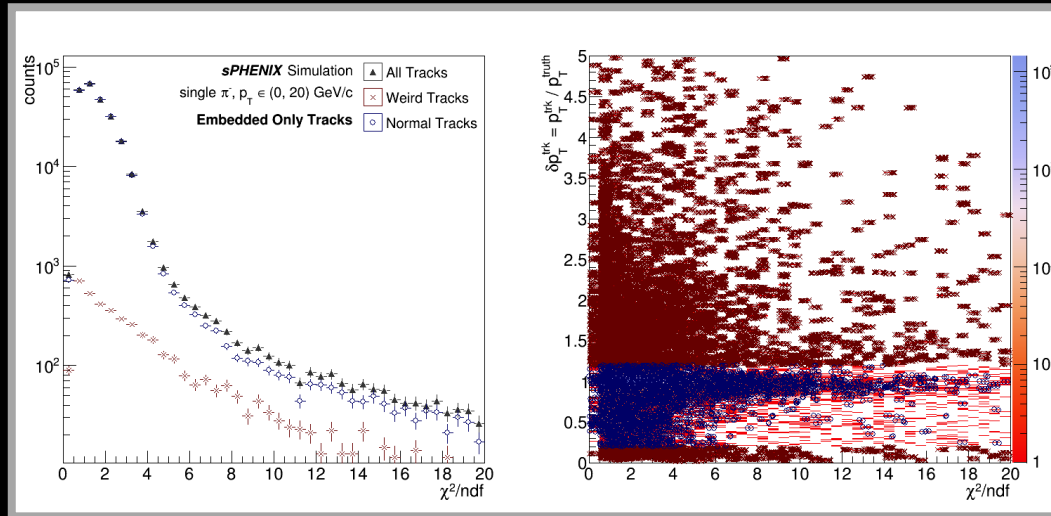
Weird Tracks w/ Silicon Seeds

- Weird track DCAz
  - `dca3dz` leaf of `ntp_track` tuple for only weird tracks

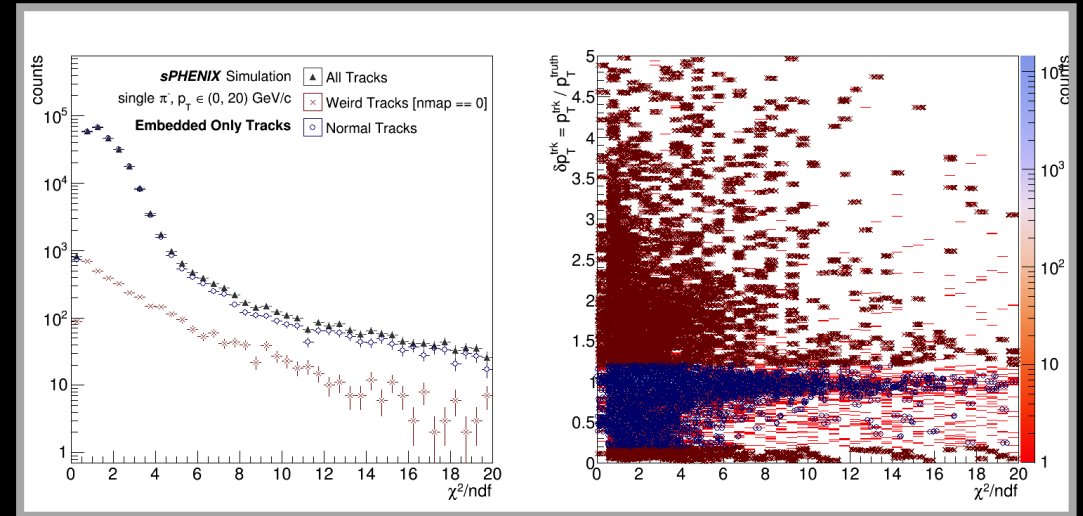
- Note: z-axes are not scaled
  - z-axis range changes between plots (apologies!)

# Track Quality

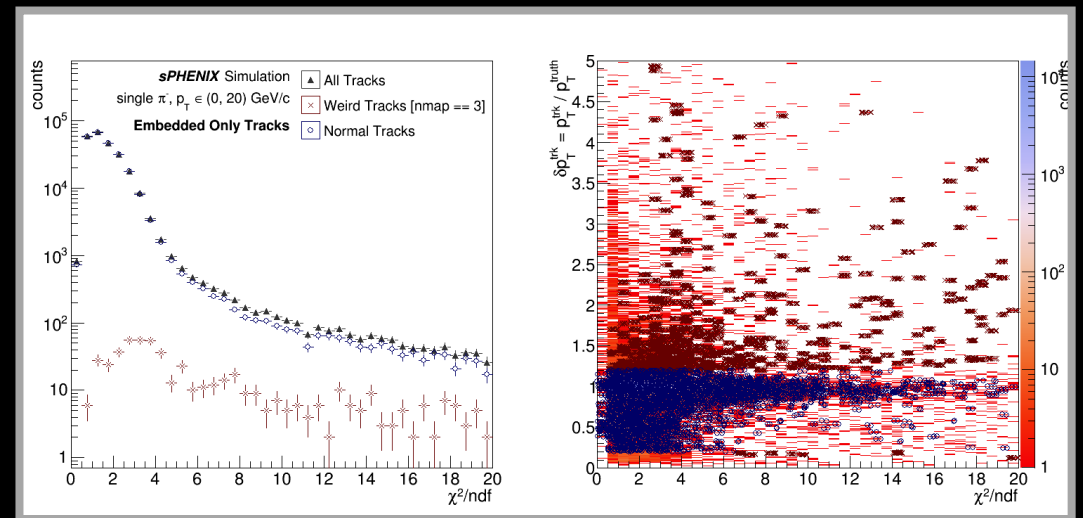
## All Weird Tracks



## Weird Tracks w/o Silicon Seeds

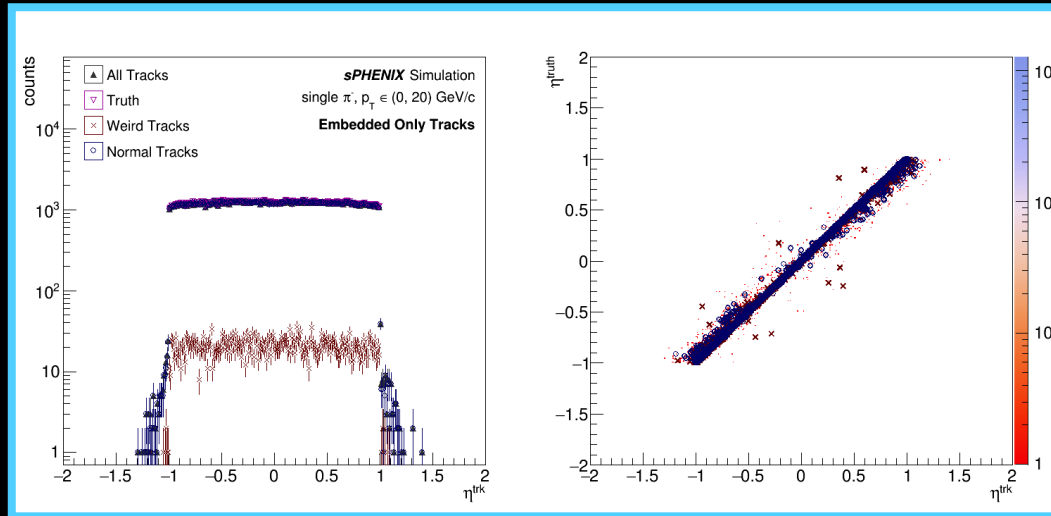


## Weird Tracks w/ Silicon Seeds

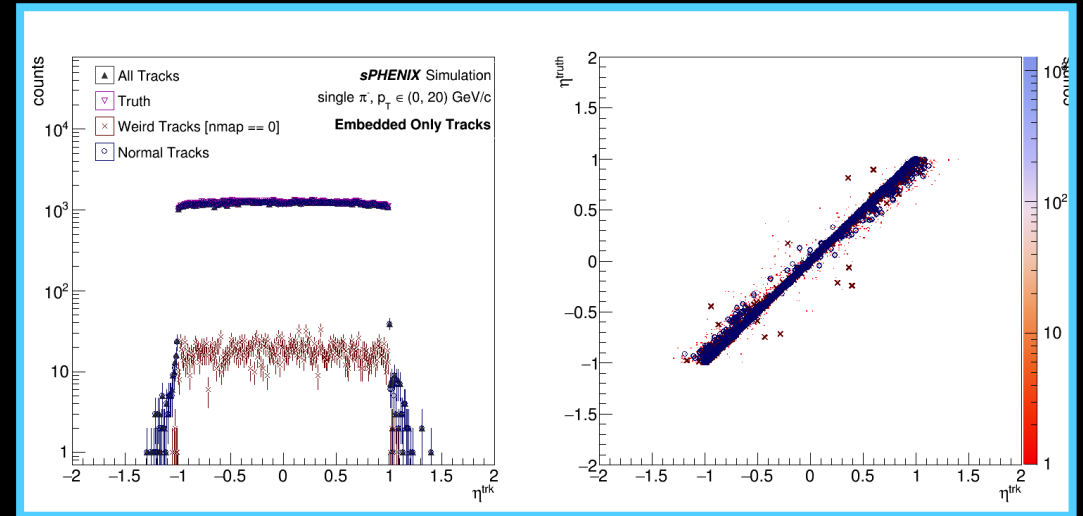


- Track  $\chi^2/\text{ndf}$ 
  - Track  $\chi^2/\text{ndf}$  (left panels)
  - $\chi^2/\text{ndf}$  vs.  $p_T^{\text{trk}}/p_T^{\text{true}}$  (right panels)
  - quality vs. pt/gpt leaves of ntp\_track tuple
- Note: y-axes are not scaled
  - y-axis range changes between plots (apologies!)

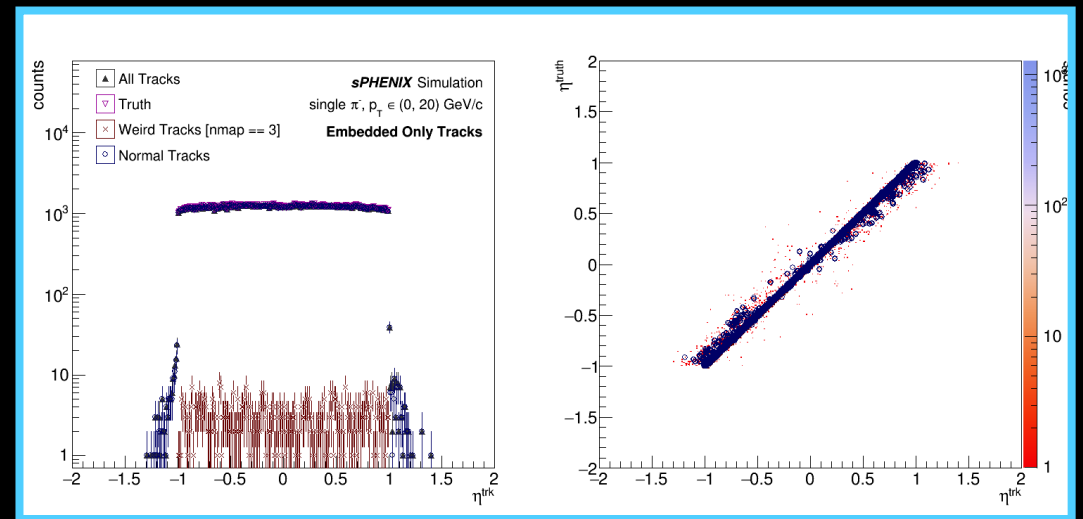
## All Weird Tracks



## Weird Tracks w/o Silicon Seeds



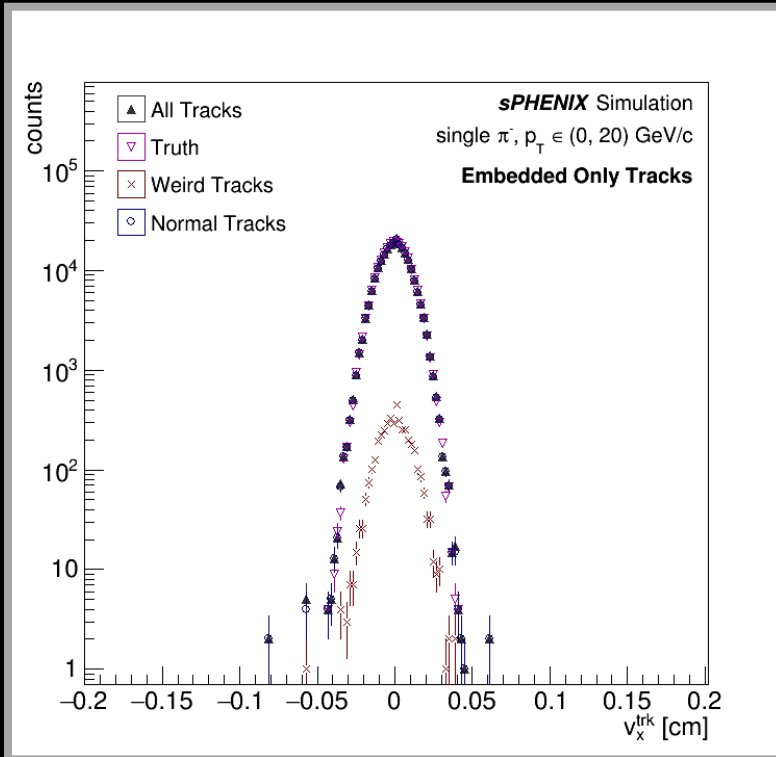
## Weird Tracks w/ Silicon Seeds



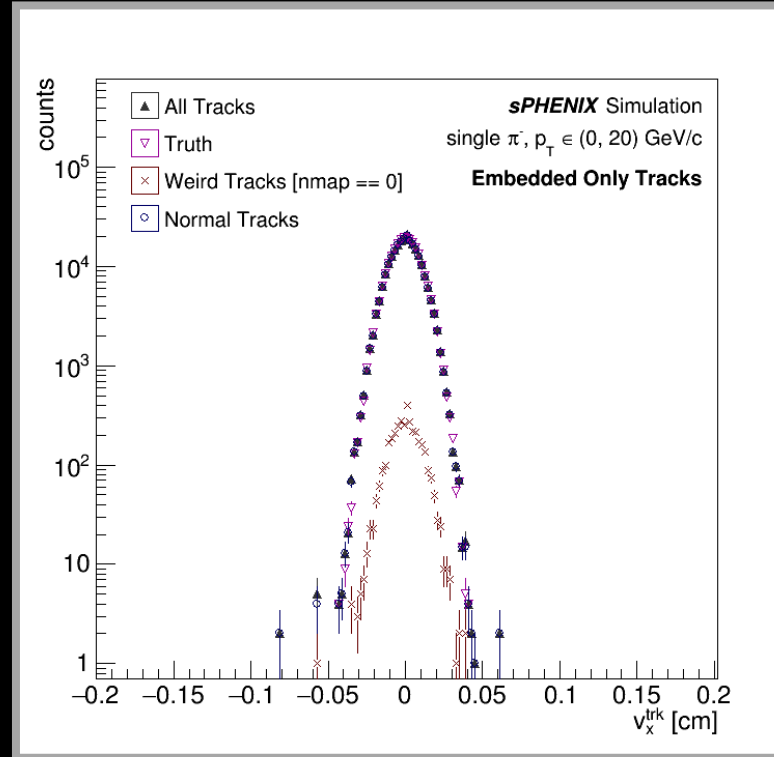
- Reconstructed and truth eta
  - reco. eta (left panels)
  - reco. vs. truth eta (right panels)
  - eta vs. geta leaves of ntp\_track tuple
- **Note:** y-axes are not scaled
  - y-axis range changes between plots (apologies!)



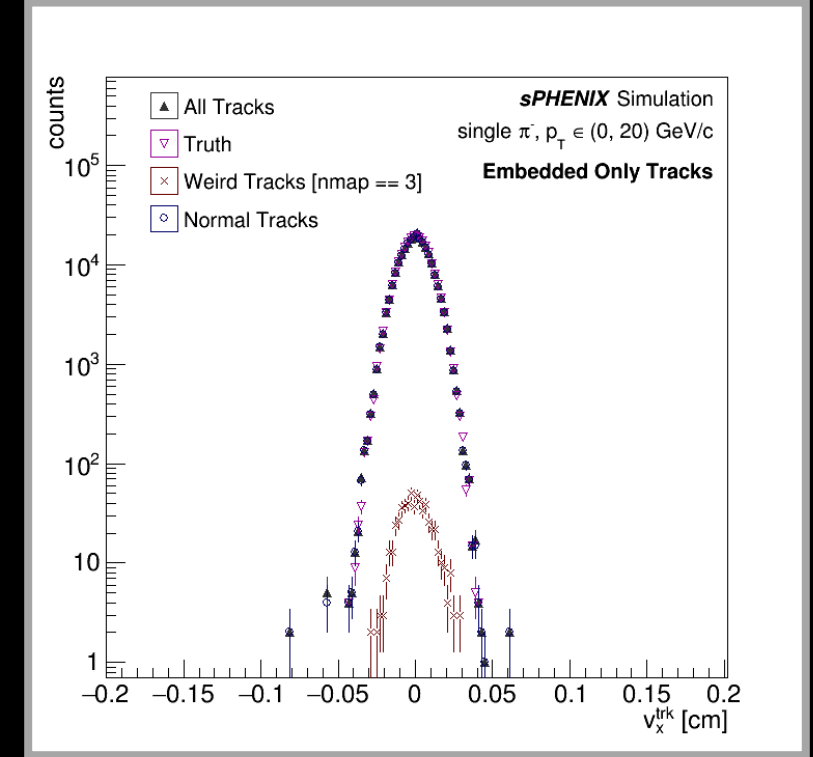
# Track X-Vertex



All Weird Tracks



Weird Tracks w/o Silicon Seeds



Weird Tracks w/ Silicon Seeds

- X-component of reconstructed vertex
  - $v_x$  leaf of `ntp_track` tuple

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