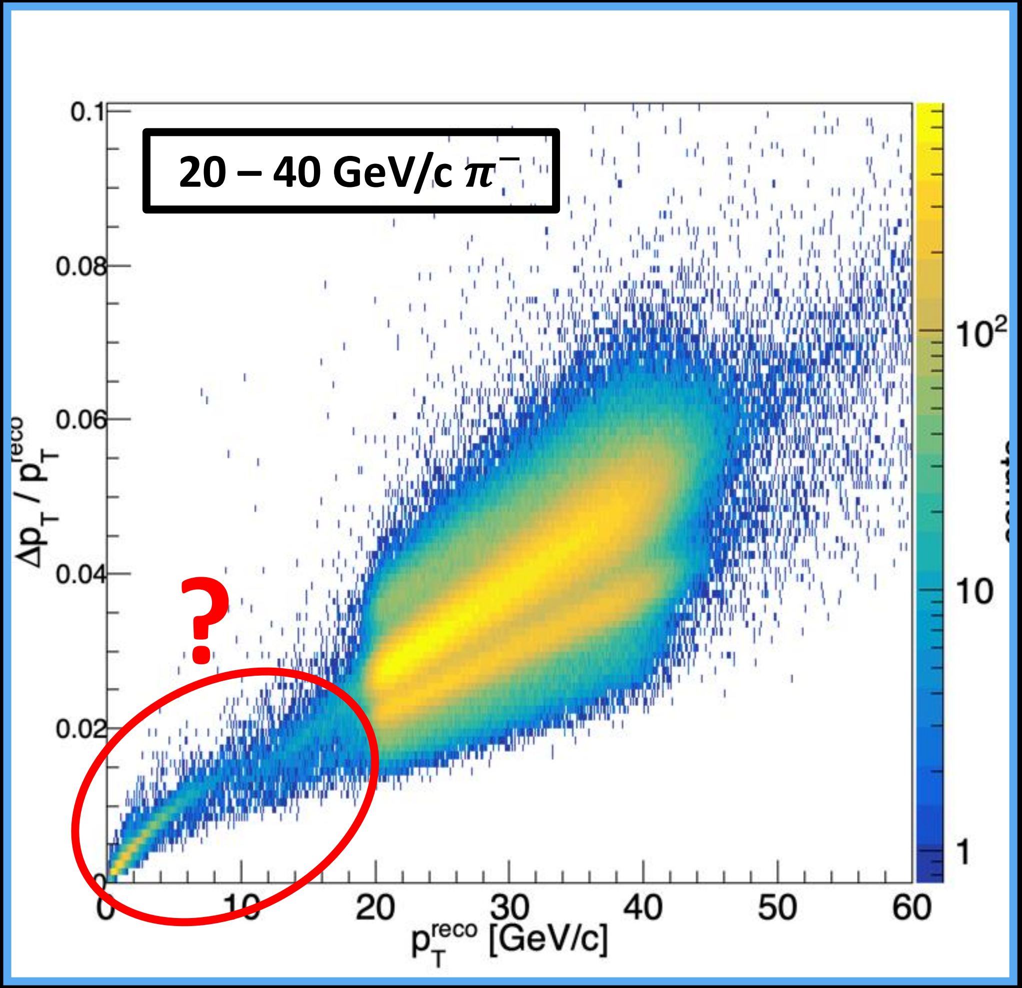
# Track Cut Study: Follow-Up

sPHENIX Tracking Meeting

May 12th, 2023

Derek Anderson (ISU)

# Summary | some observations

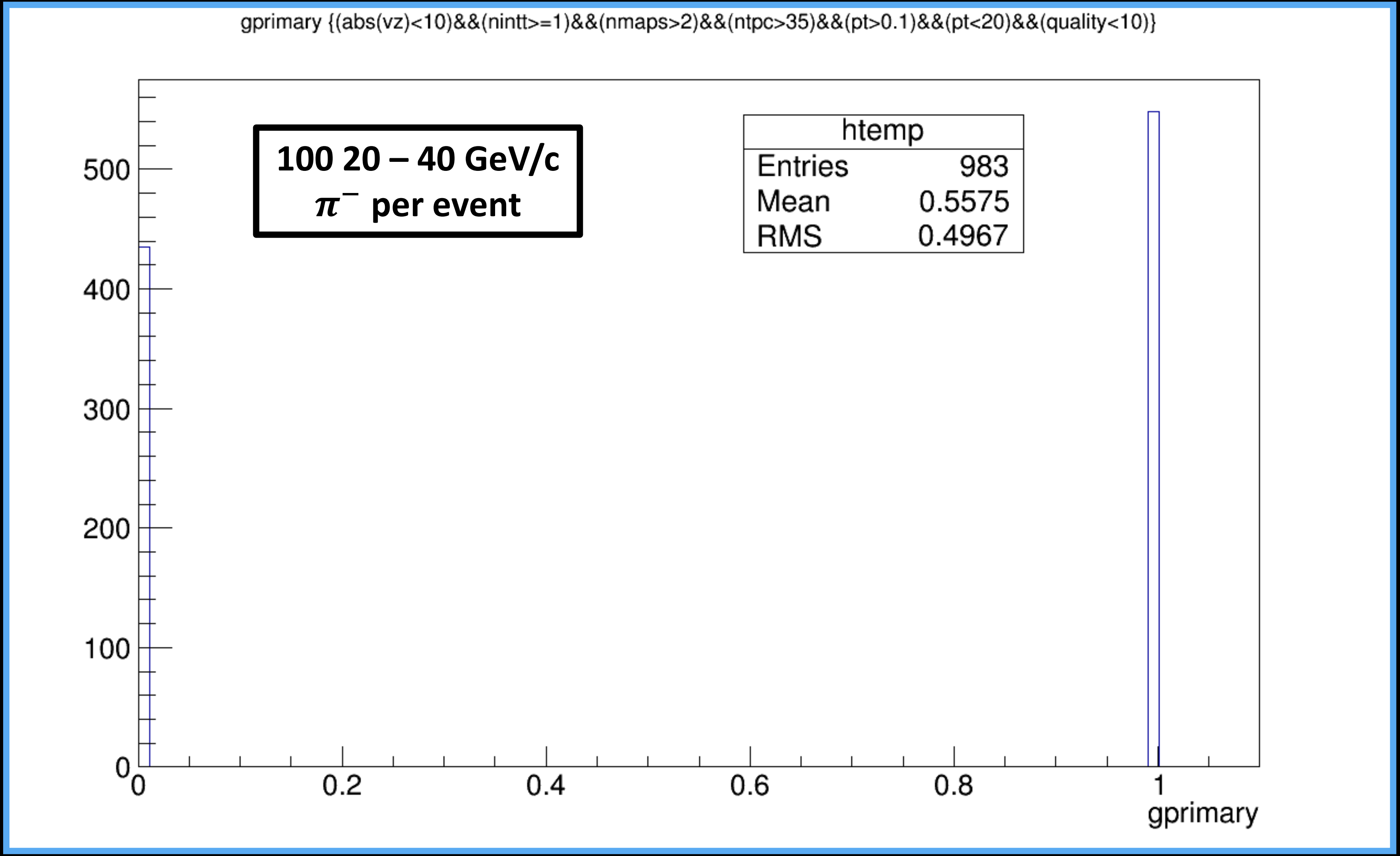



- Was looking at the percent error on $p_T^{reco}$* for tracks in events with 100 20 – 40 GeV/c $\pi^-$
  - ☞ **Noticed large population of tracks with $p_T^{reco} < 20$ GeV/c which survived the cuts listed on slide X**
  - * i.e. deltapt/pt from the evaluator

- After digging into this population, here are a few observations:
  1) < 20 GeV/c tracks made up of both primaries and secondaries **[slide 3]**
  2) Primaries clustered near $p_T^{reco} \sim 20$ GeV/c while secondaries near $p_T^{reco} \sim 0$ GeV/c **[slide 4, 6, 7]**
     - › As we would hope…
  3) Secondaries have significantly larger spread in reco vs. truth vertices than primaries **[slides 10 - 12]**
  4) There seem to be cases where secondaries are assigned INTT or MVTX hits when they shouldn't be **[slides 15 - 18]**

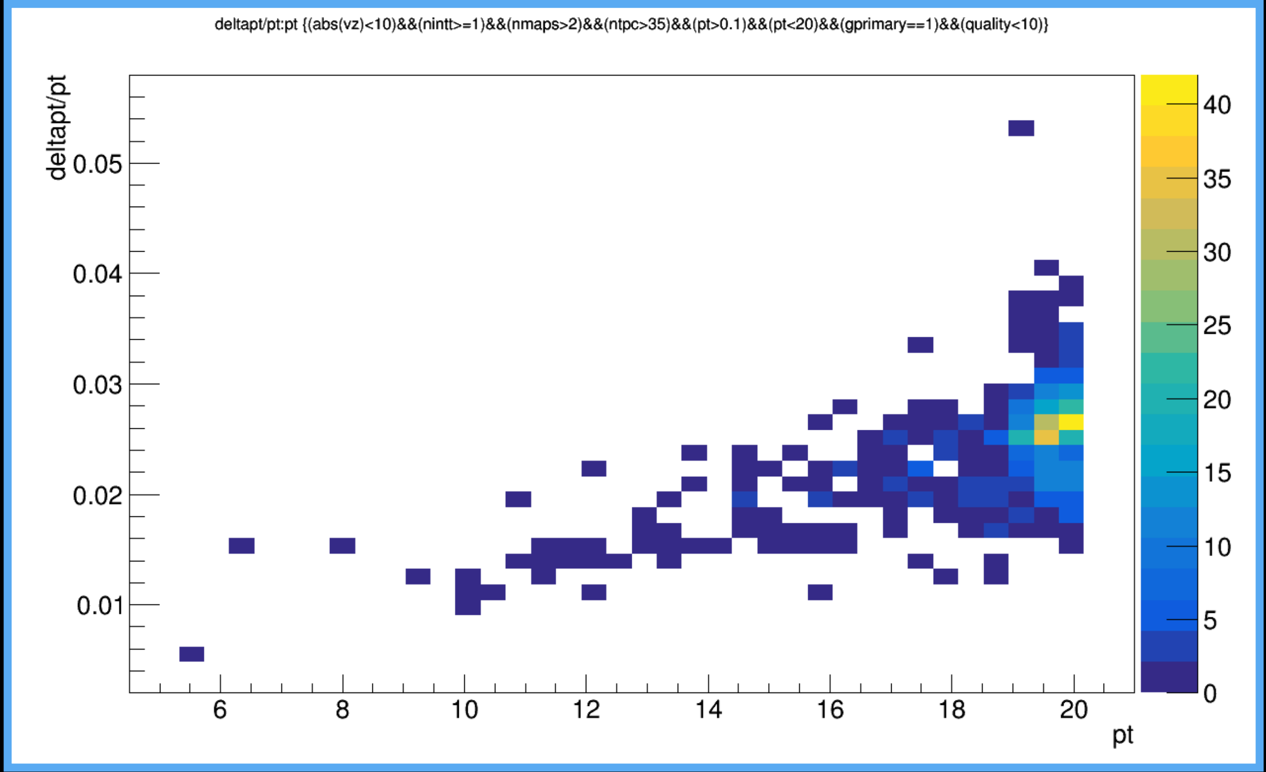
☞ **Will be following up with the same checks for > 20 GeV/c tracks**

# < 20 GeV/c Tracks | gprimary

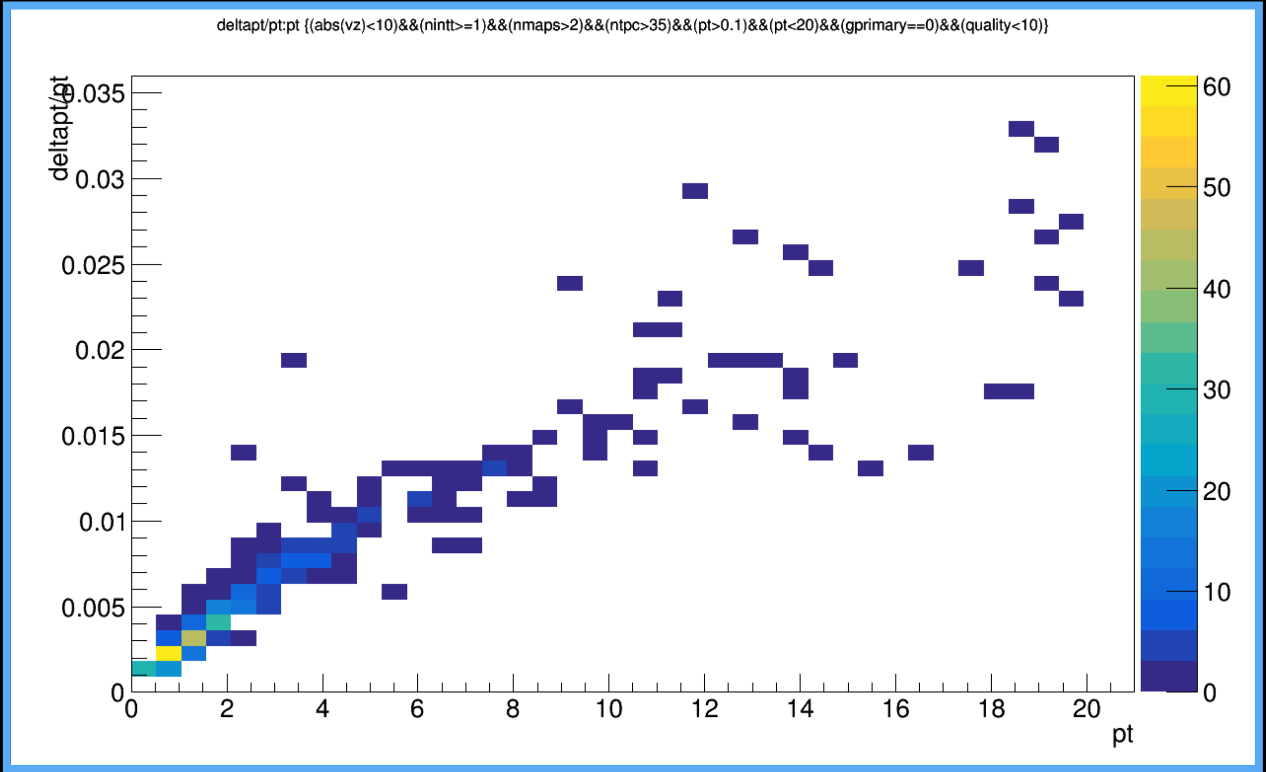


# < 20 GeV/c Tracks | deltapt/pt vs. pt

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



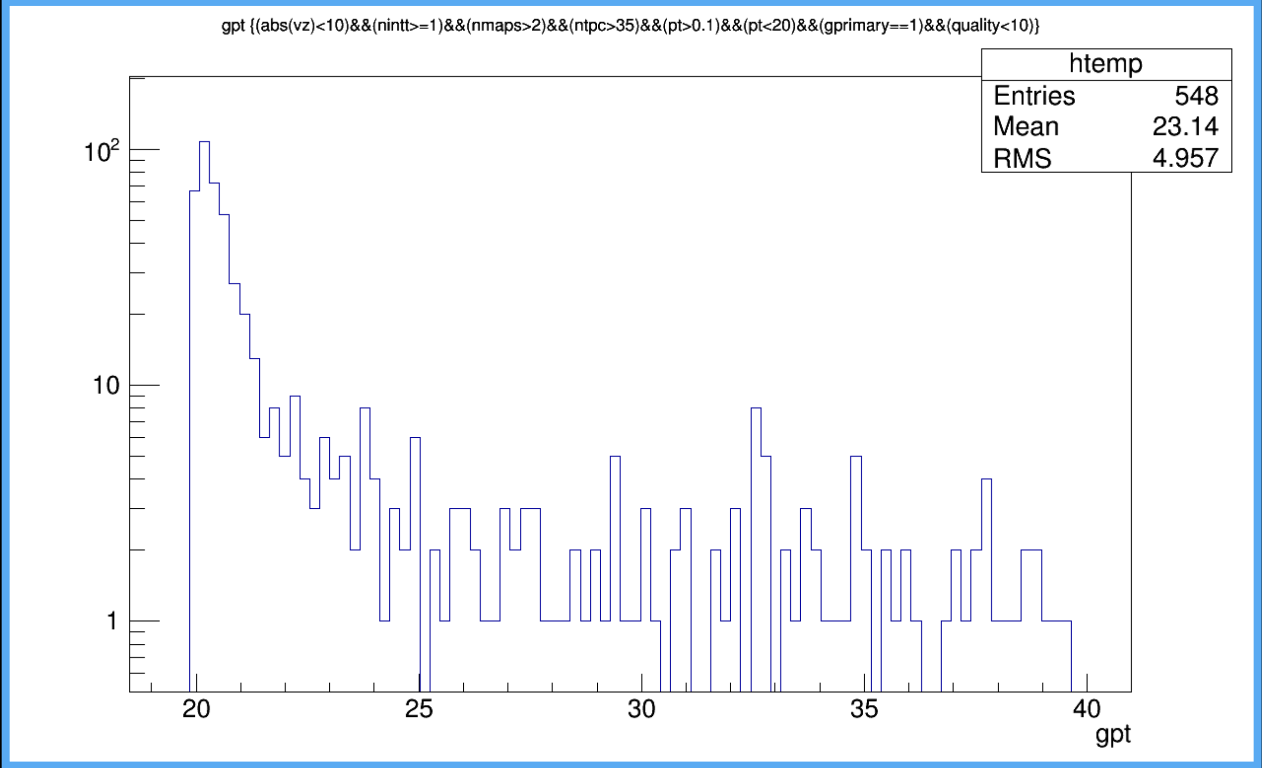

**Primaries (gprimary = 1)**

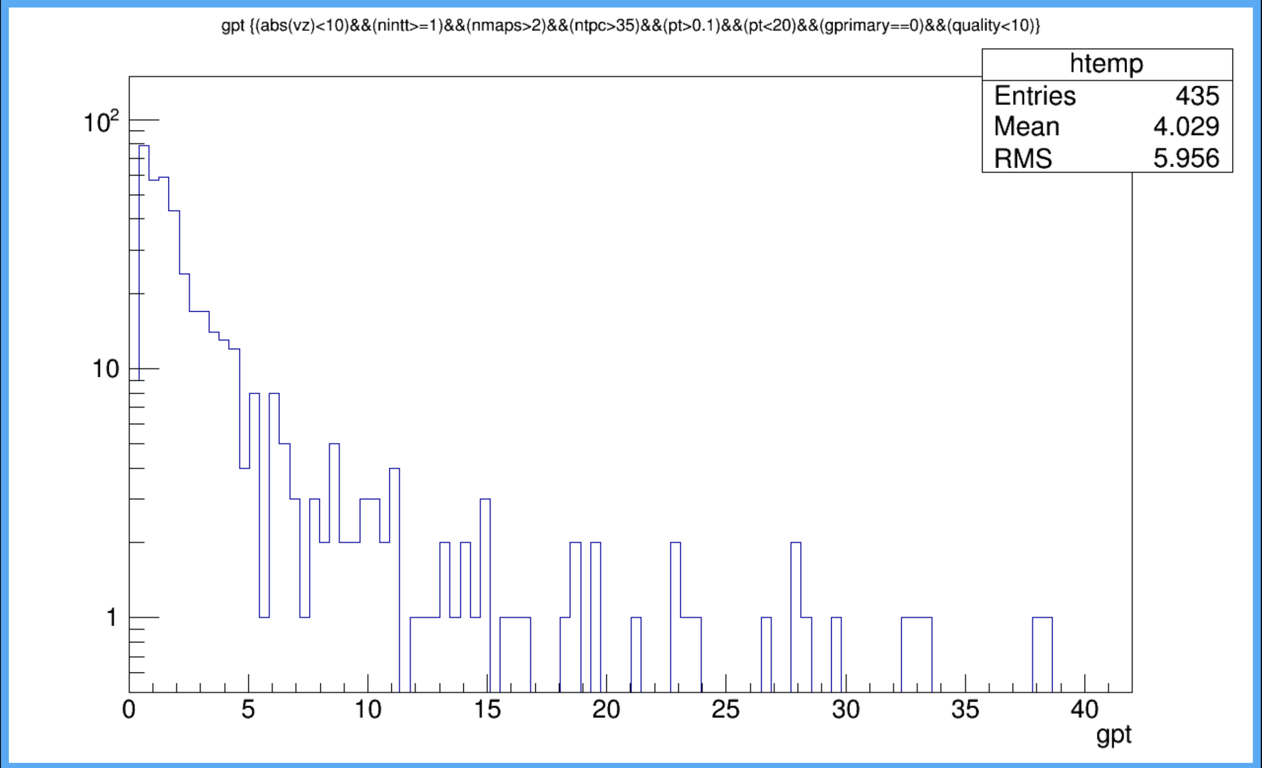



**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gpt

**100 20 – 40 GeV/c $\pi^-$ per event**



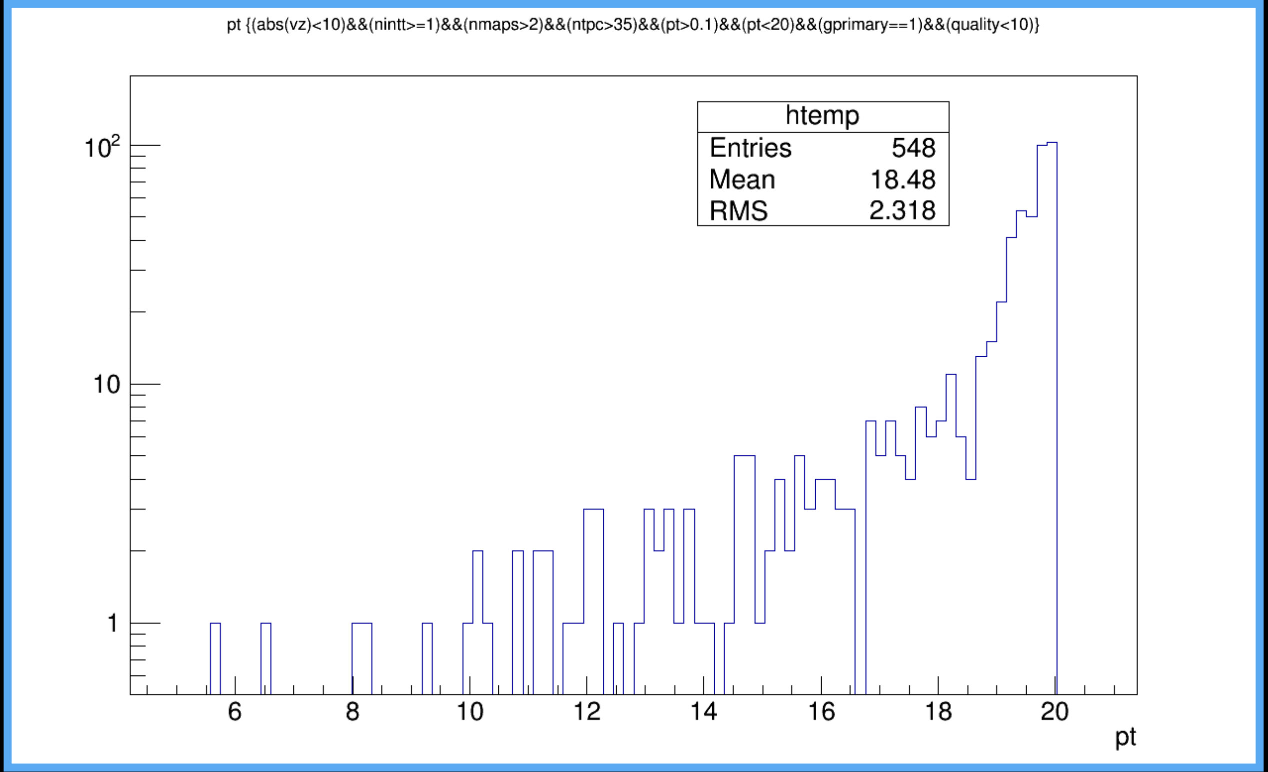



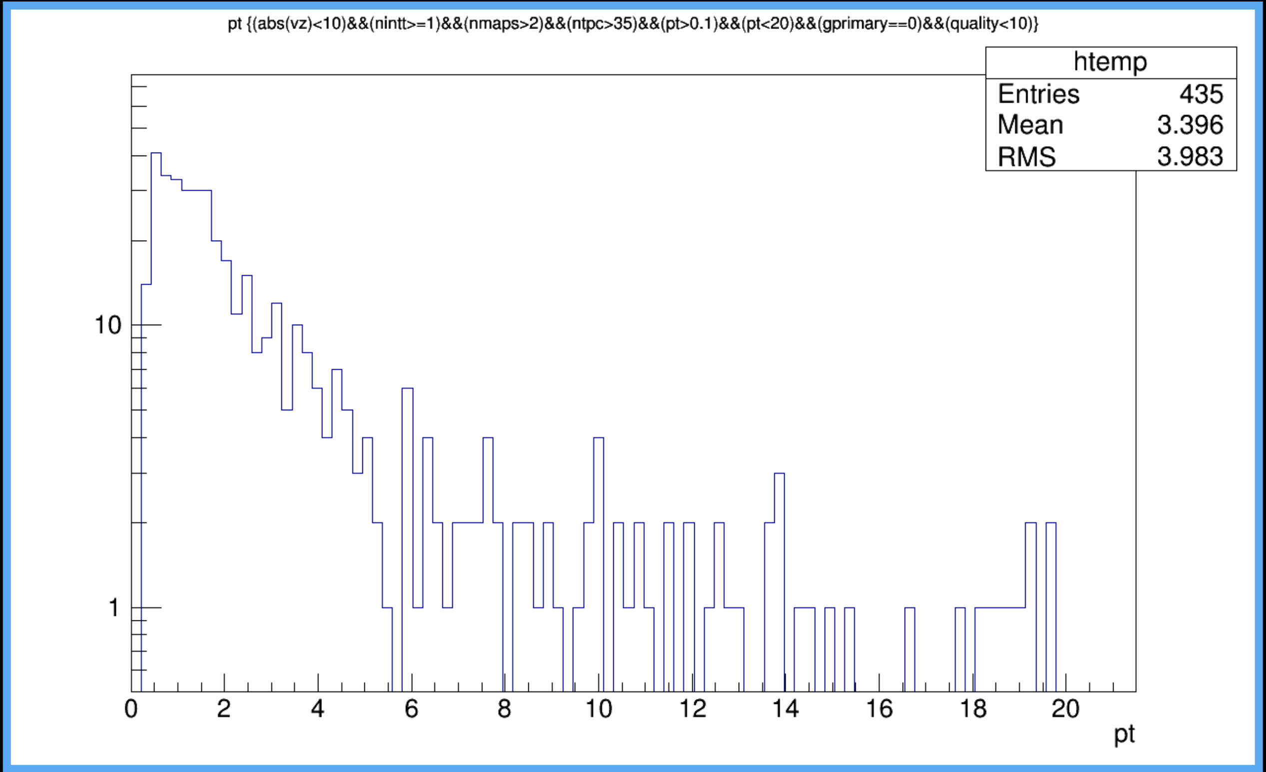

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | pt

**100 20 – 40 GeV/c $\pi^-$ per event**




**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gpt vs. pt

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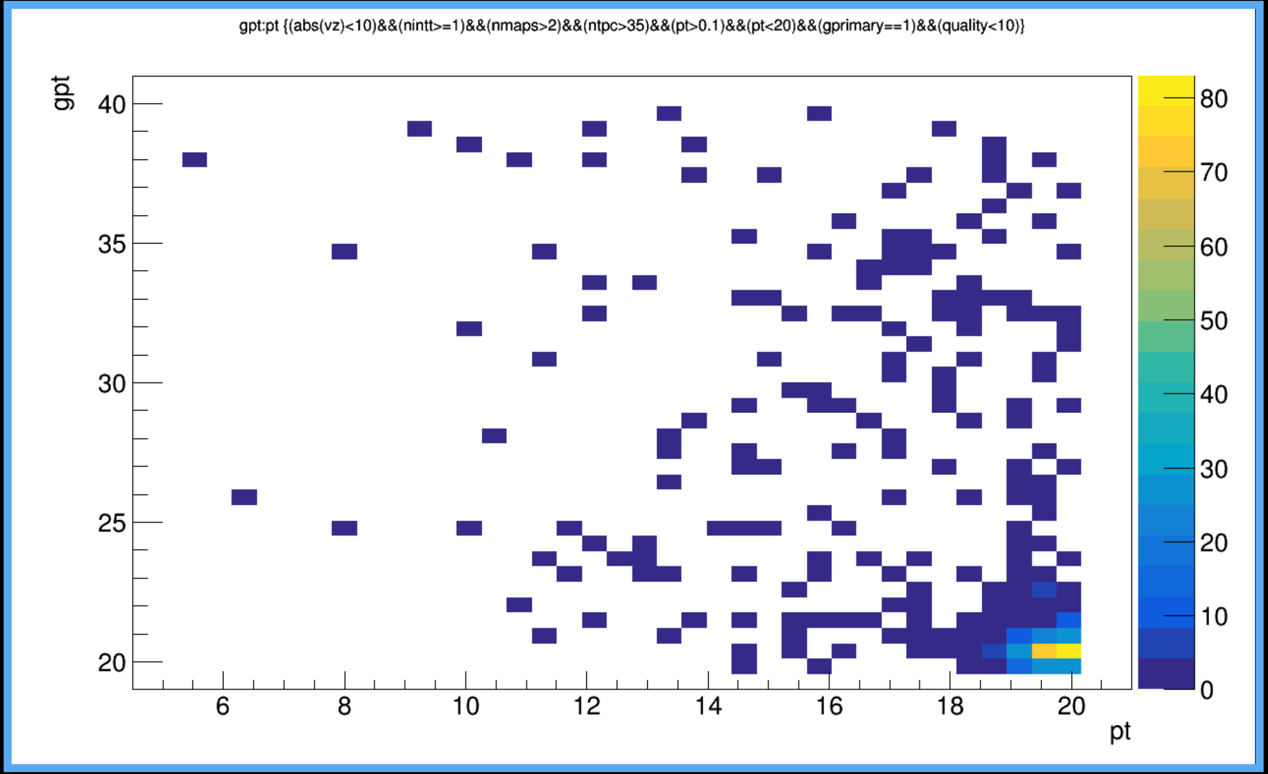
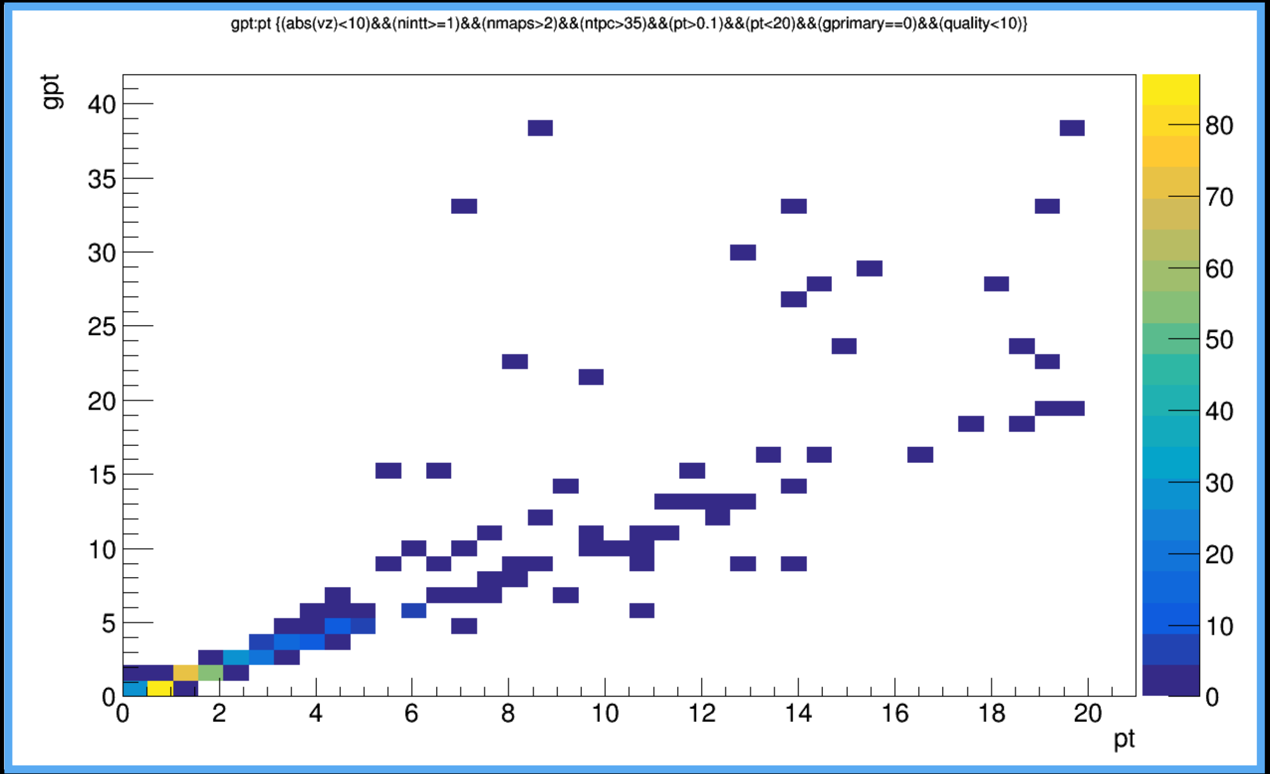
**100 20 – 40 GeV/c**
**$\pi^-$ per event**



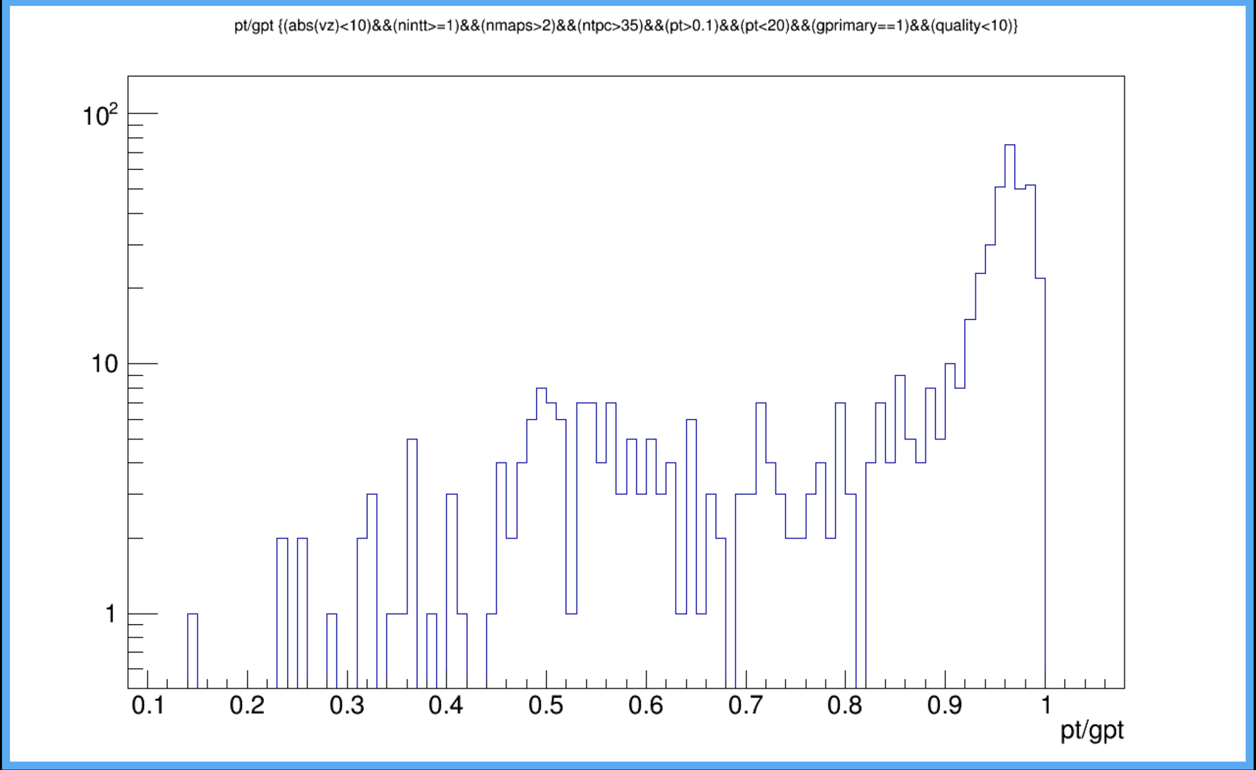



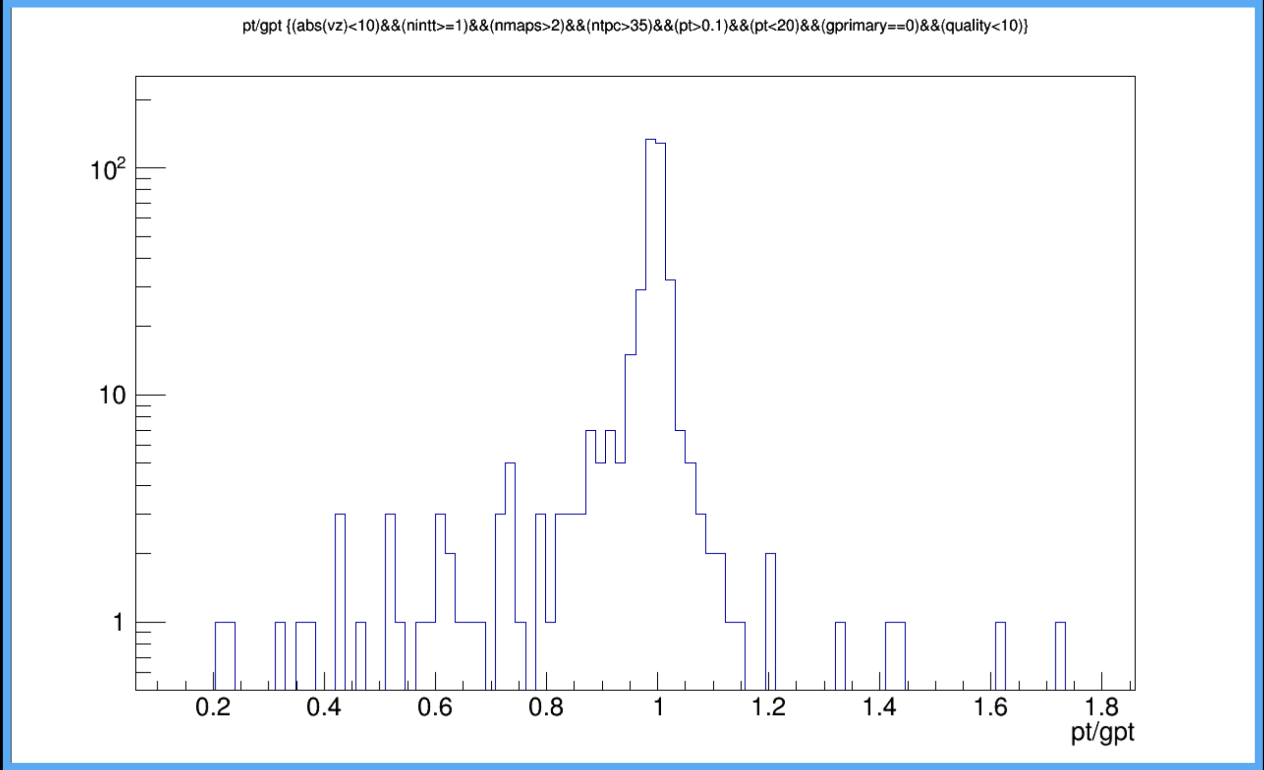

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | pt/gpt

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



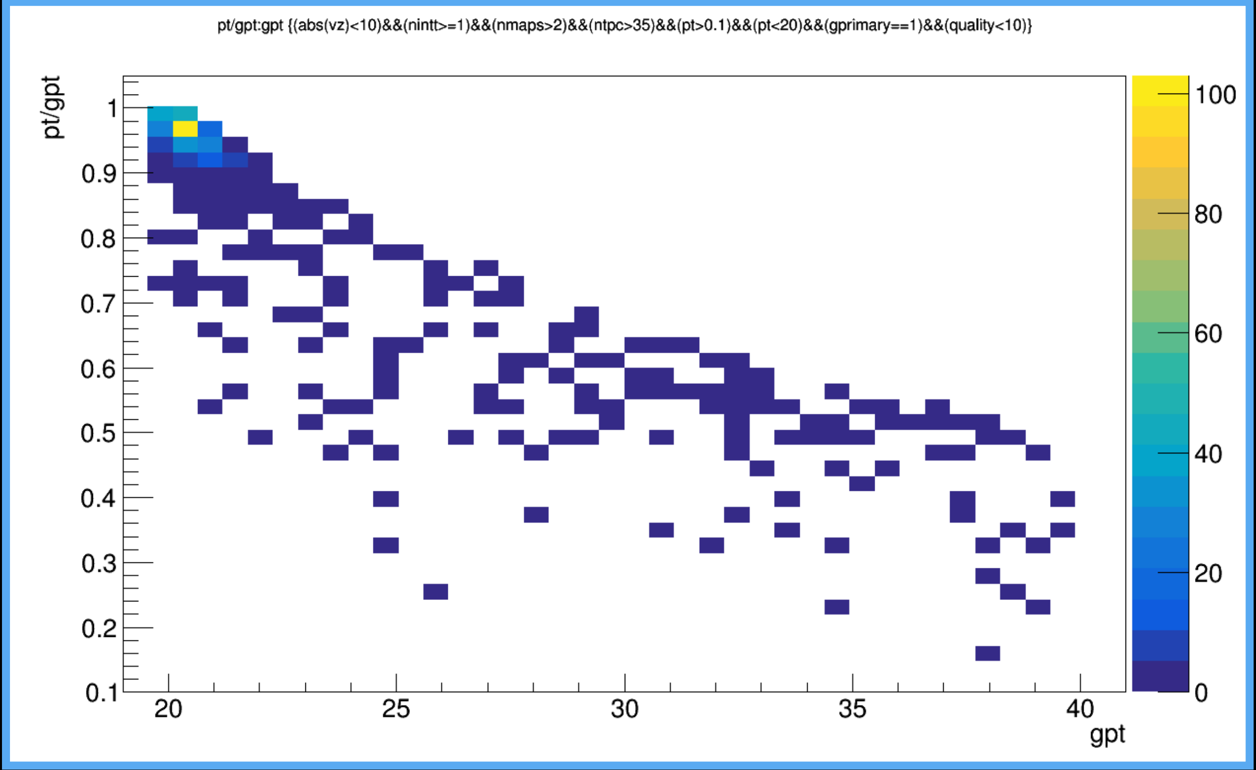



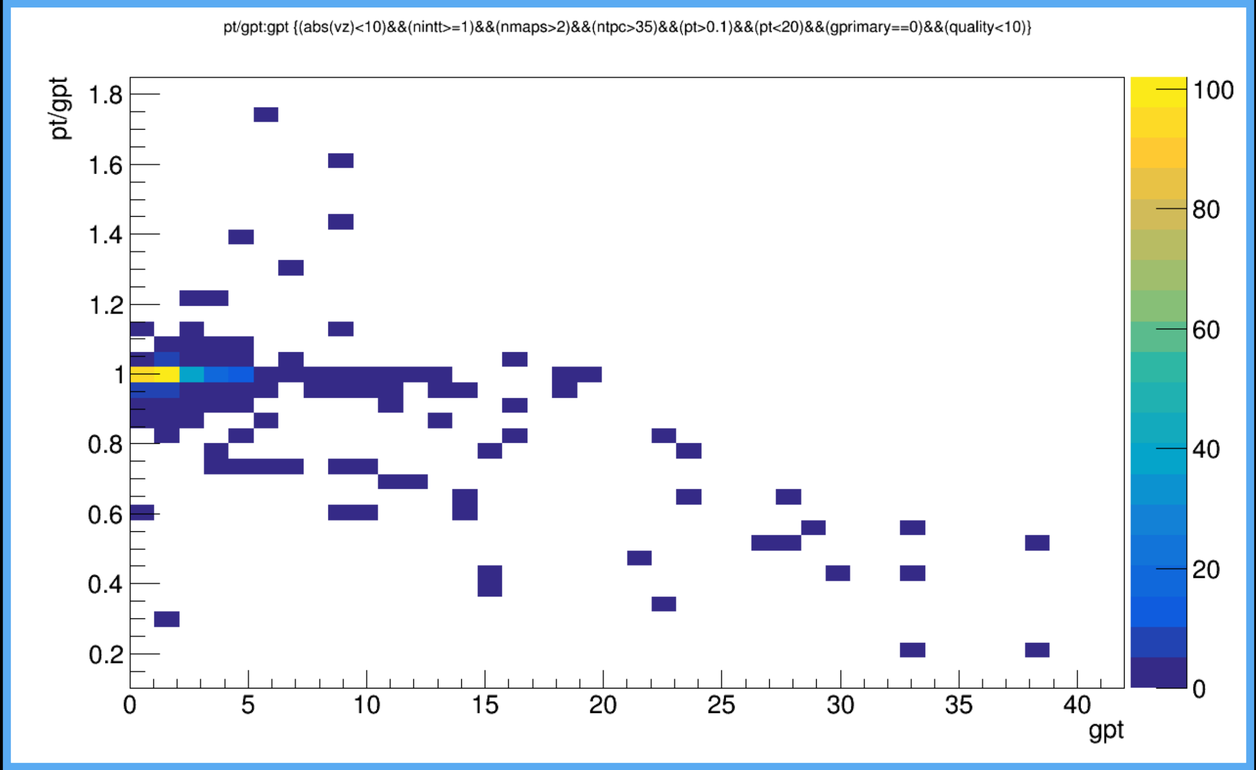

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | pt/gpt vs. gpt

**100 20 – 40 GeV/c $\pi^-$ per event**



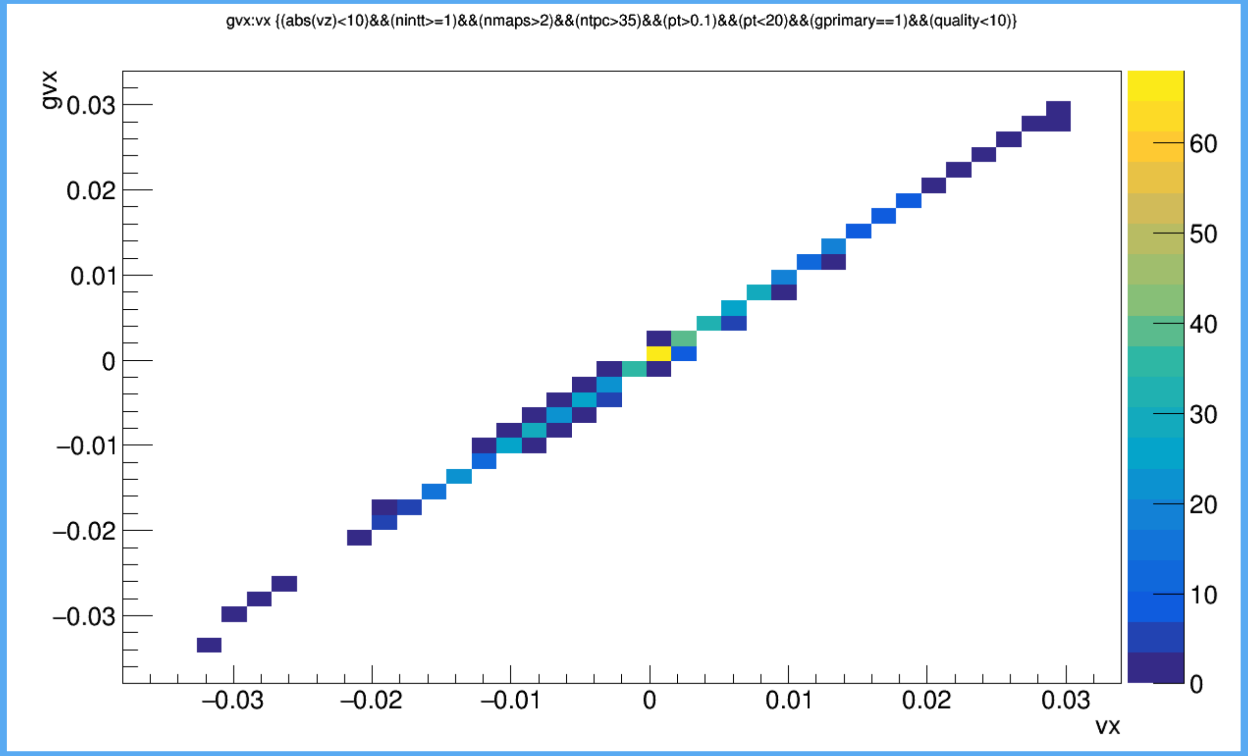



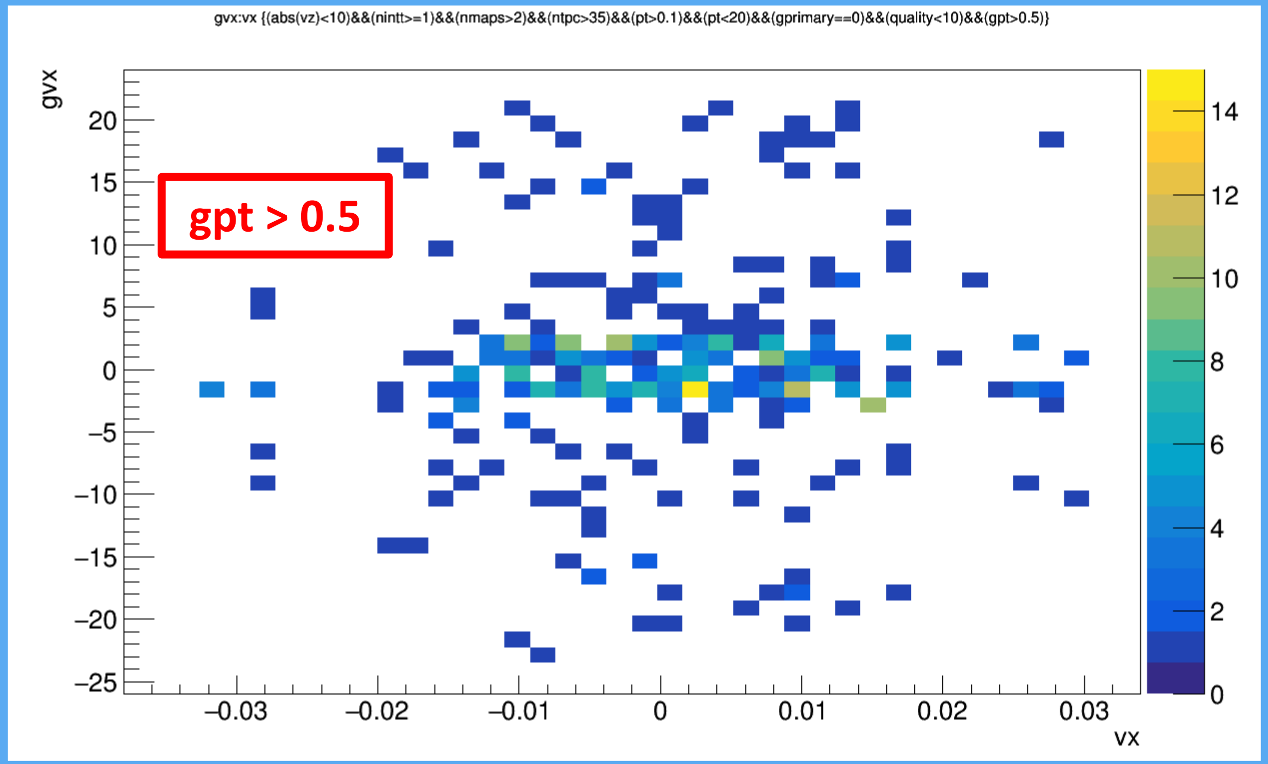

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gvx vs. vx

**100 20 – 40 GeV/c $\pi^-$ per event**



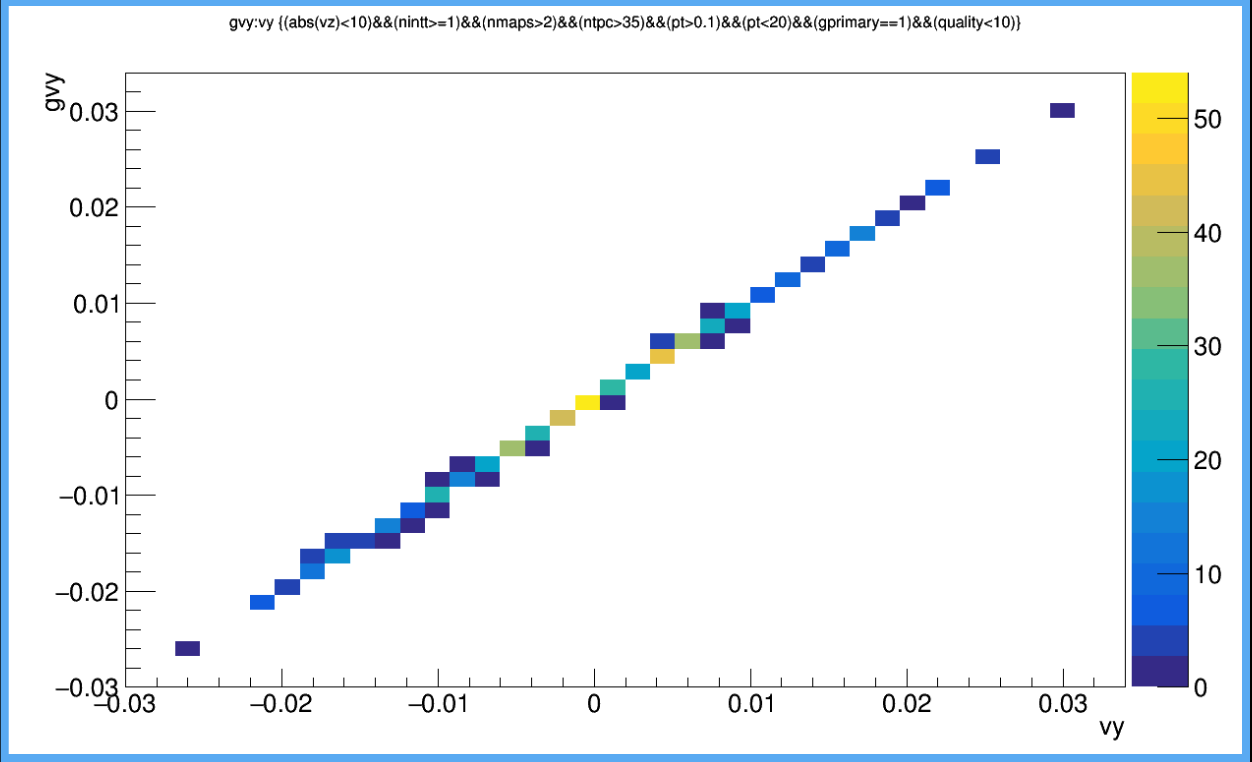




**Primaries (gprimary = 1)**

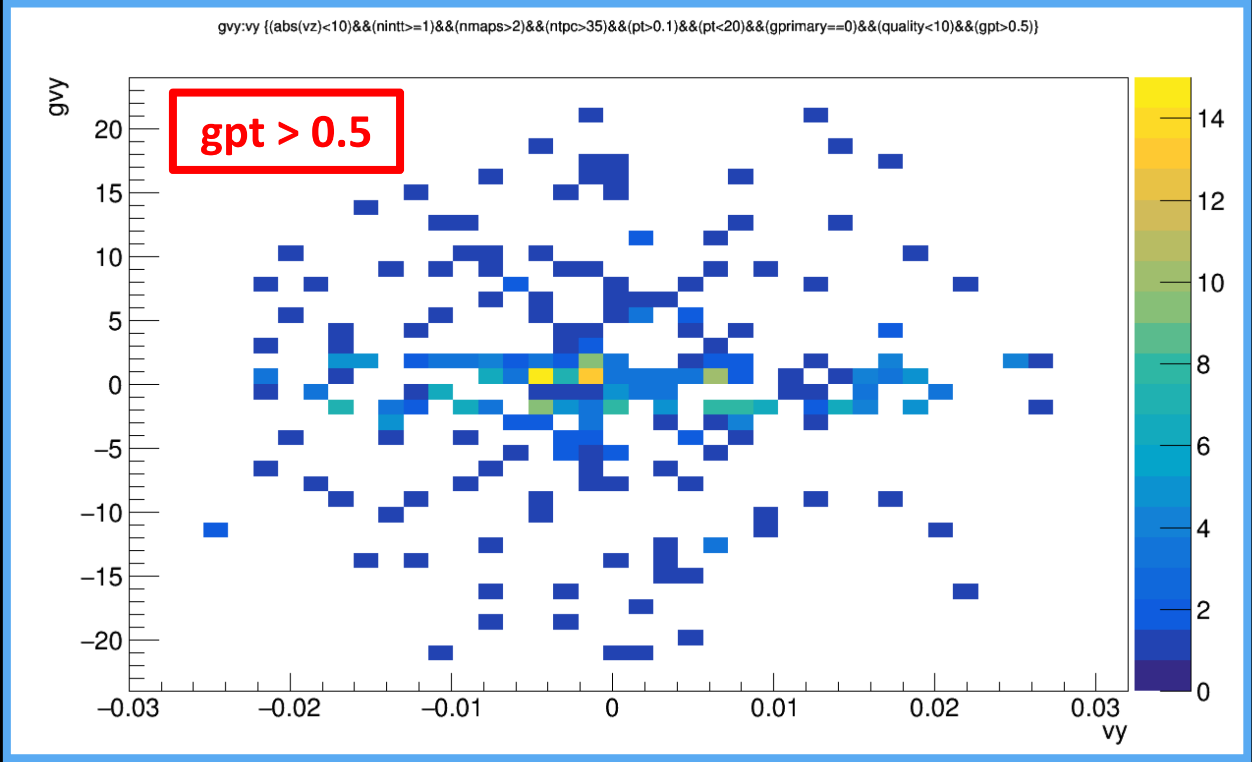
**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gvy vs. vy

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



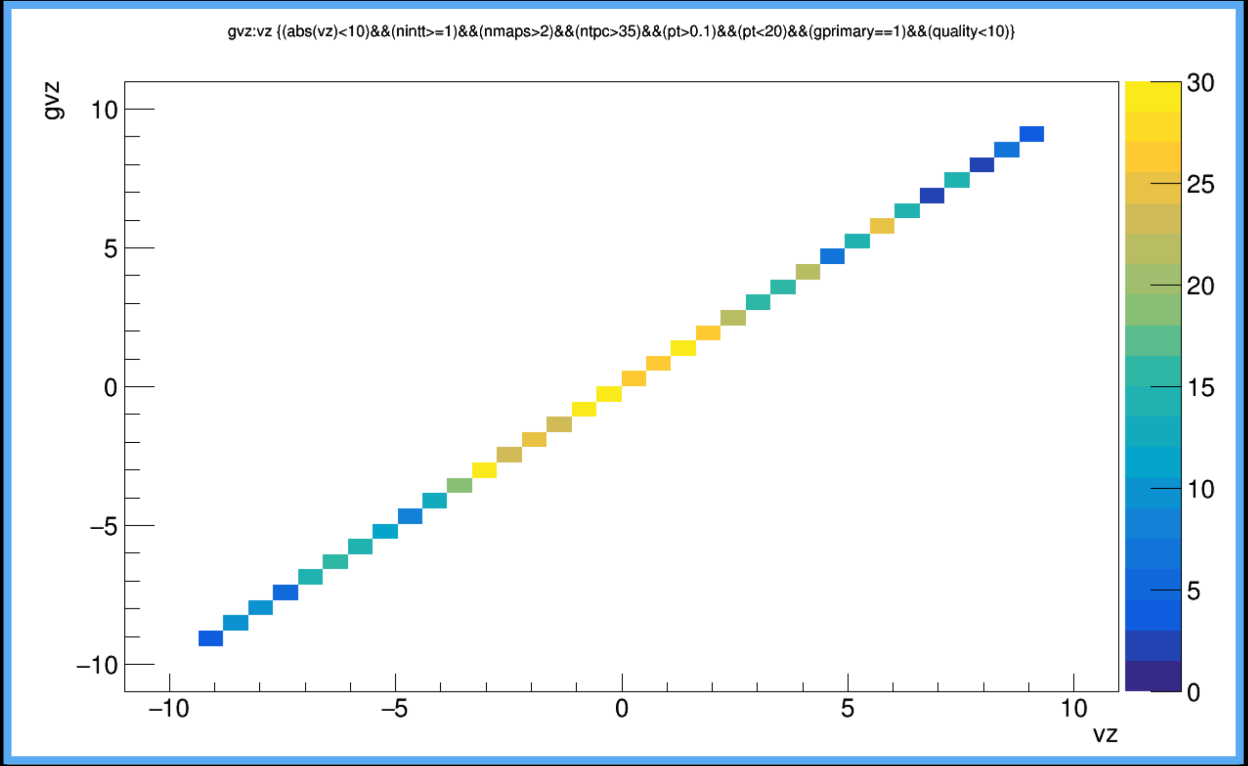

**Primaries (gprimary = 1)**

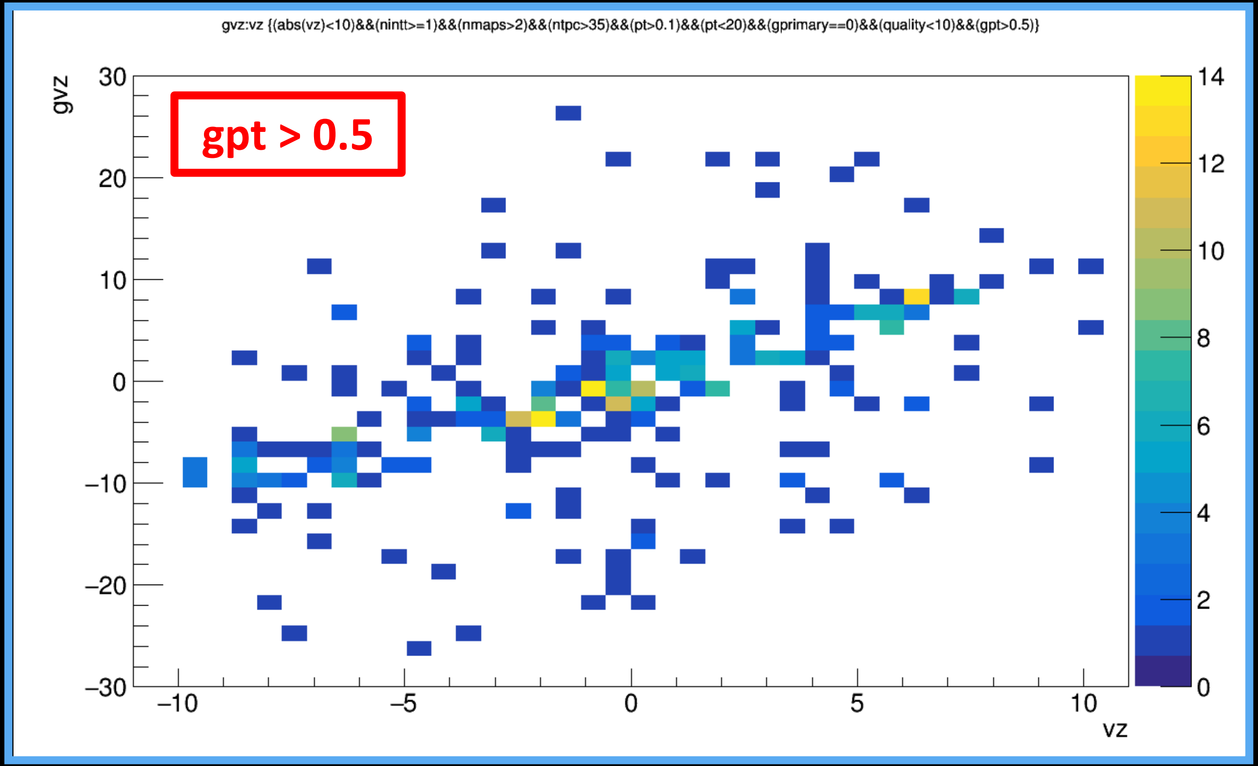



**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gvz vs. vz

**100 20 – 40 GeV/c $\pi^-$ per event**



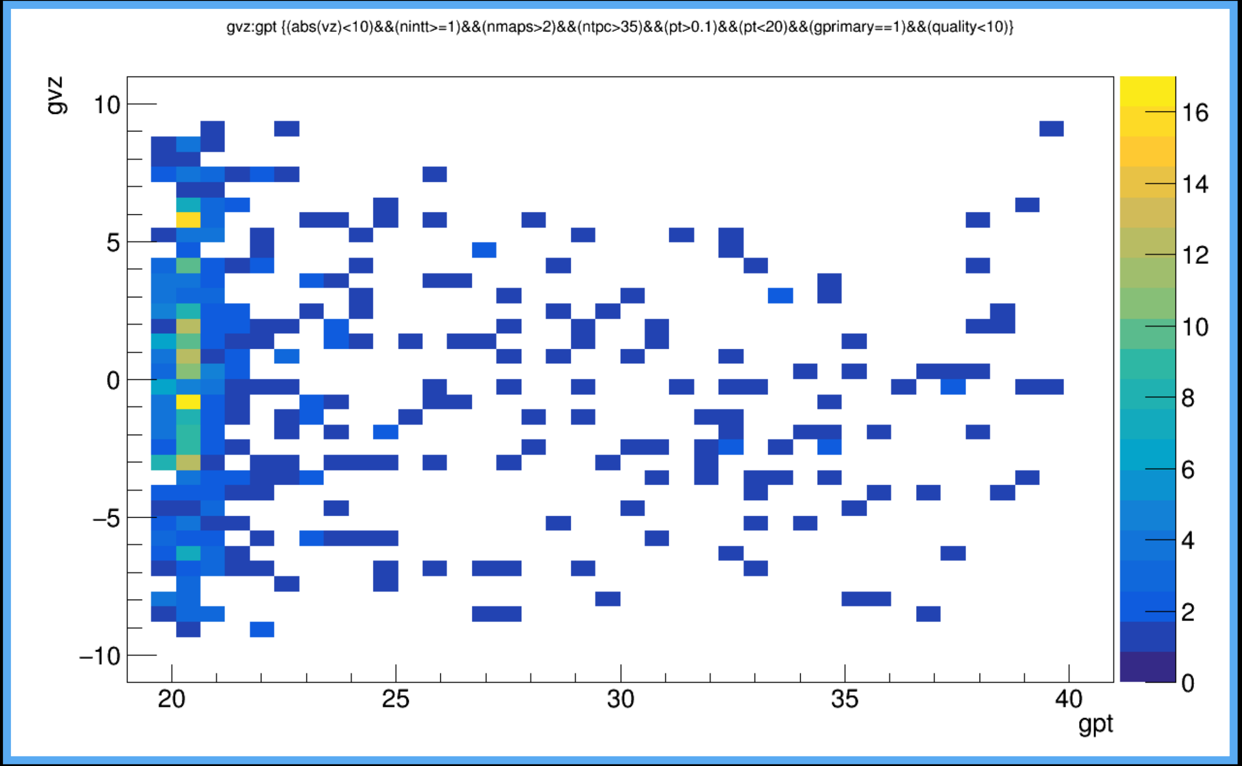




**Primaries (gprimary = 1)**

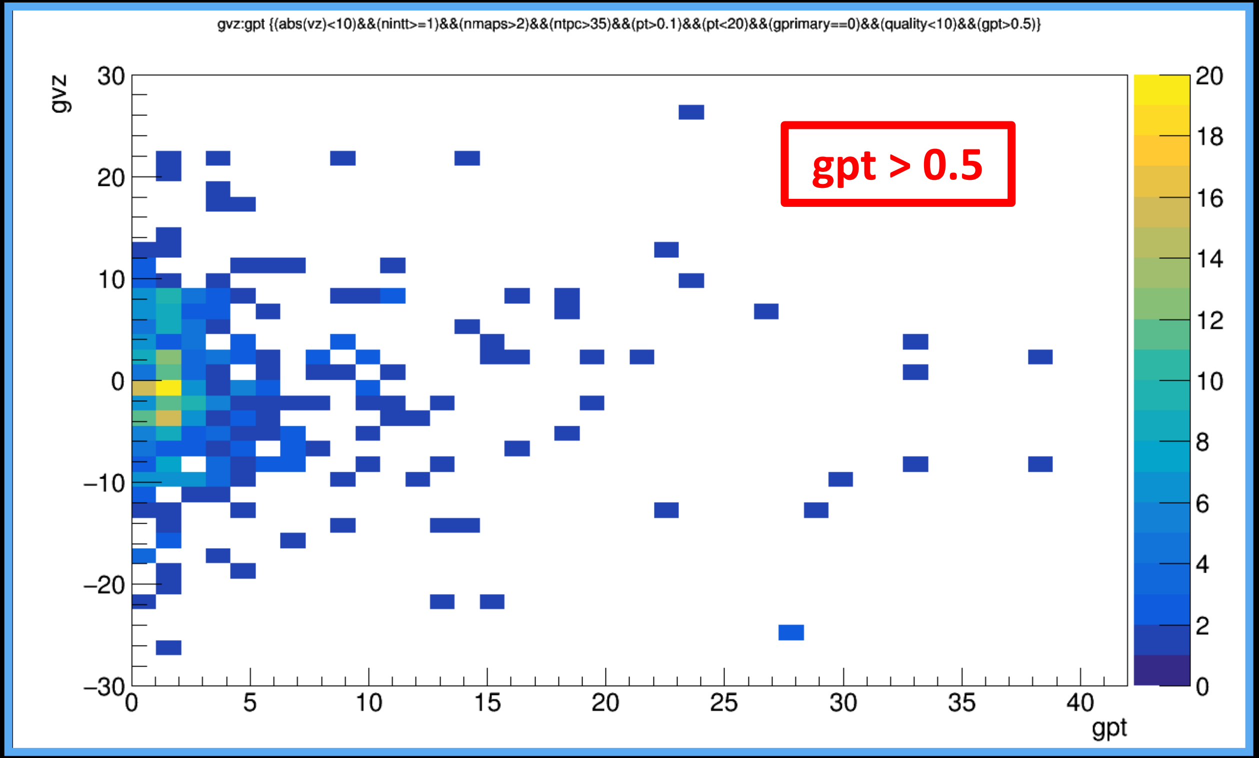
**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gvz vs. pt

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



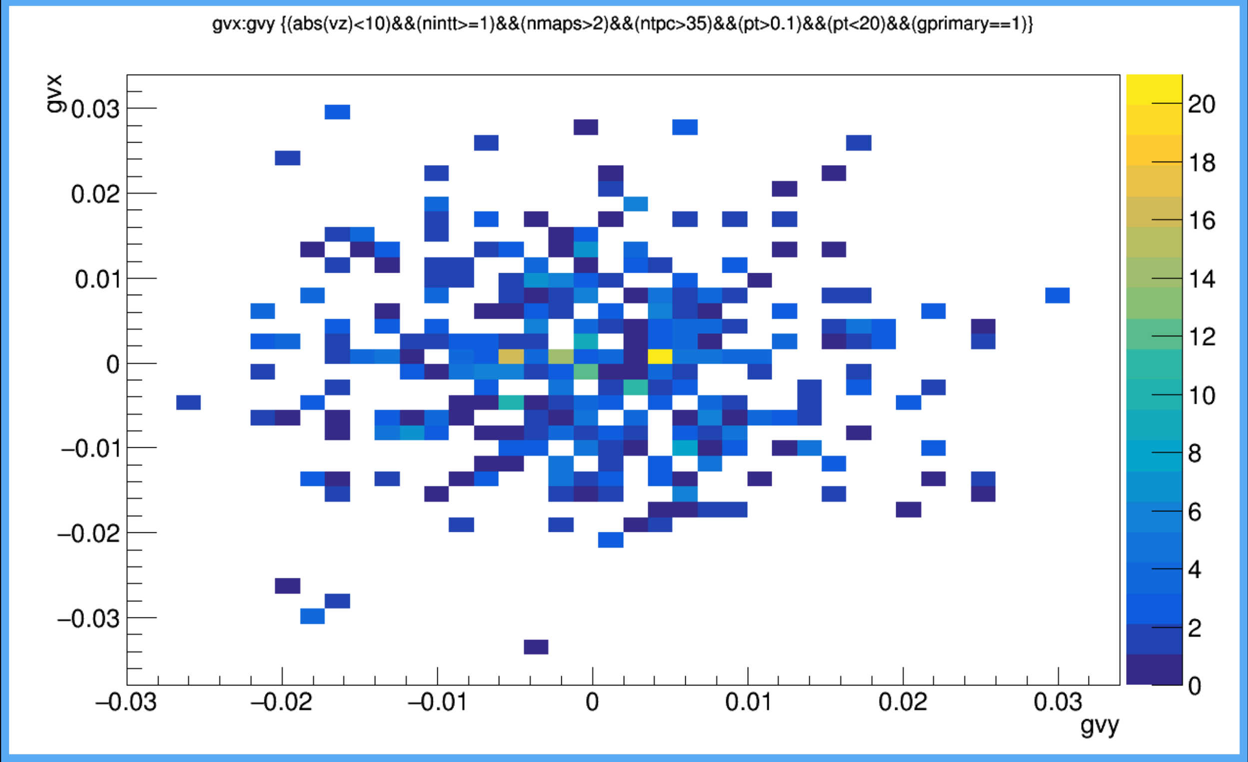

**Primaries (gprimary = 1)**

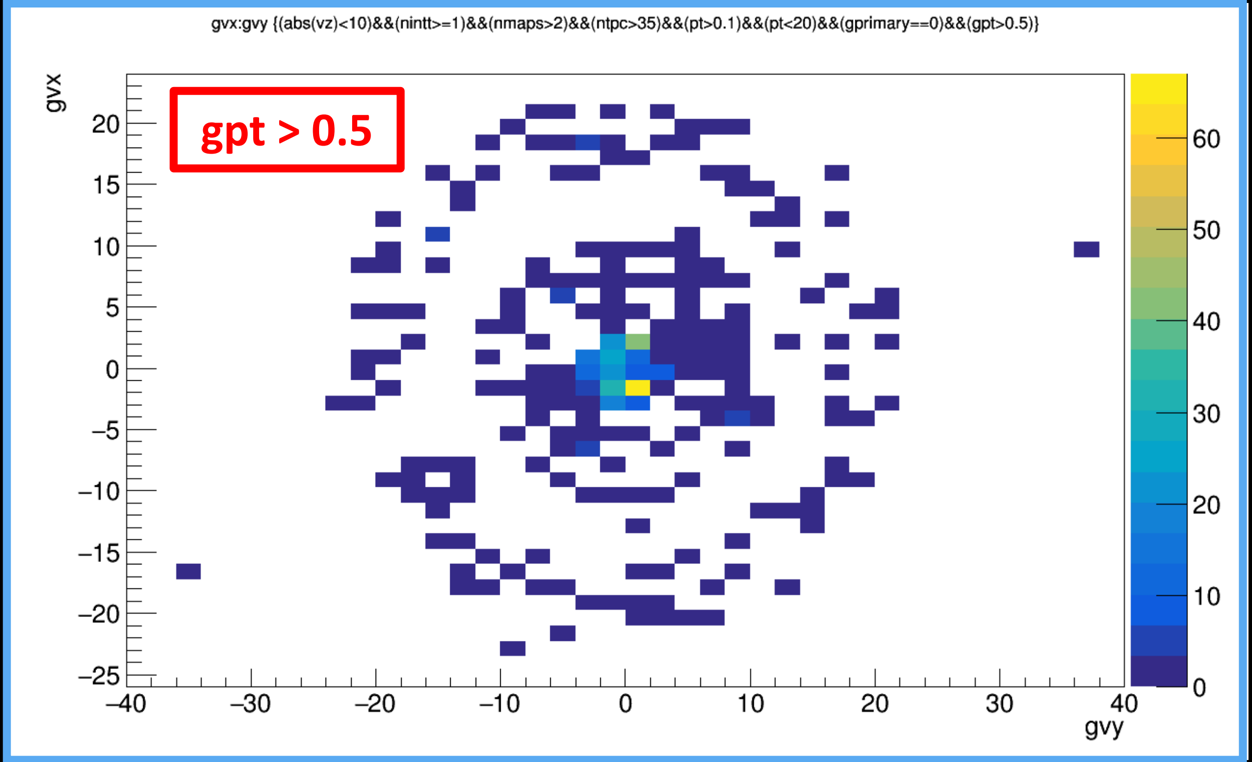



**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gvx vs. gvy

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



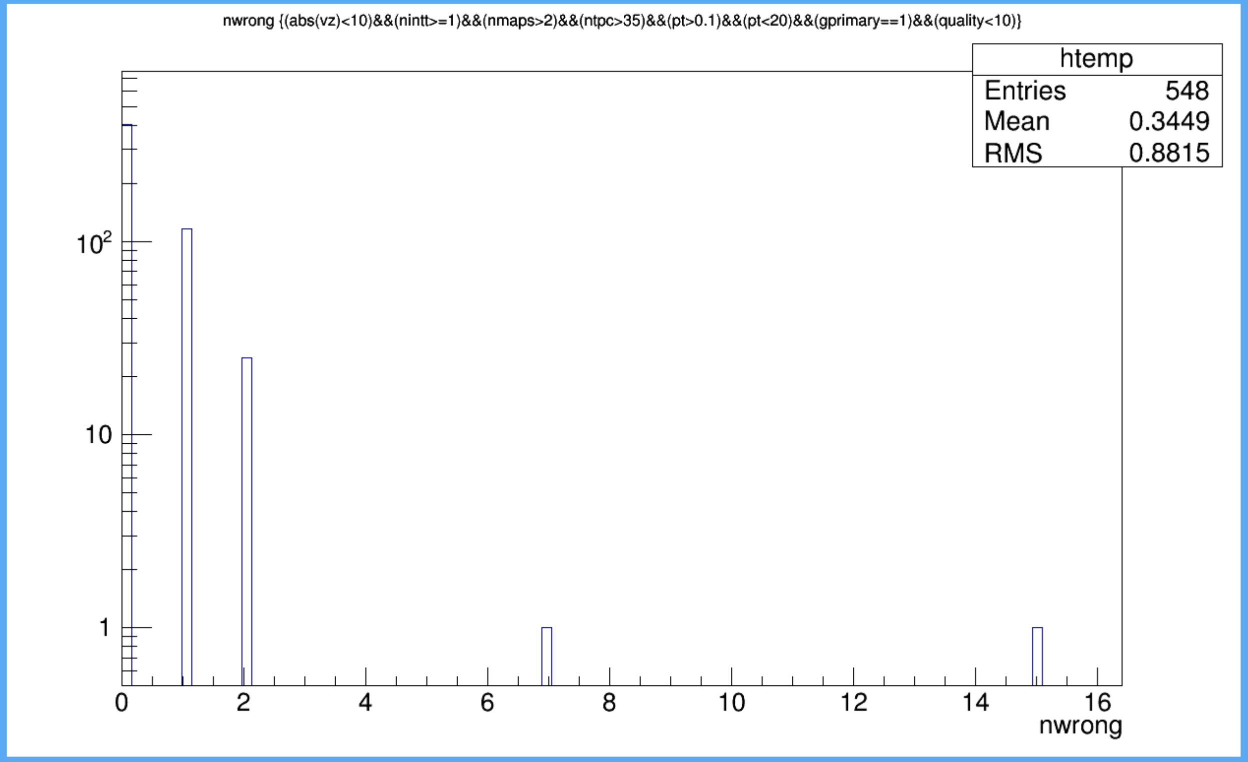



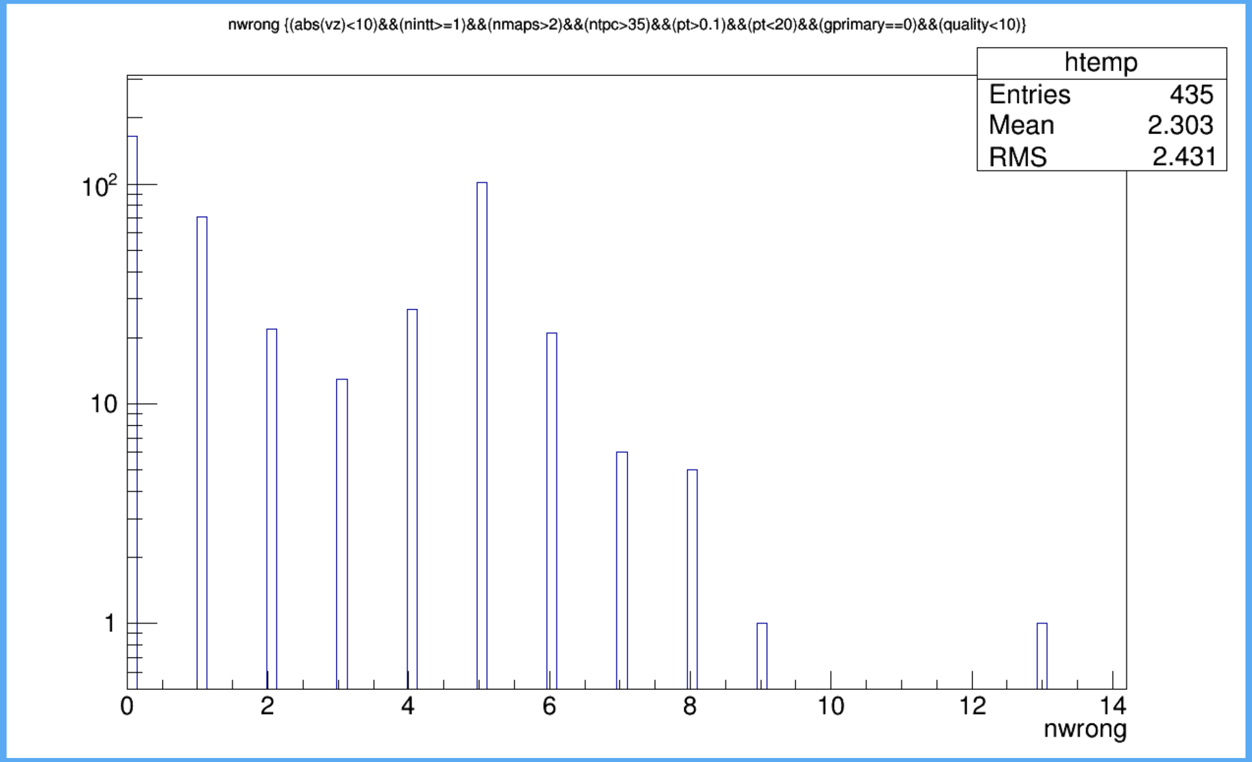

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | nwrong

**100 20 – 40 GeV/c $\pi^-$ per event**



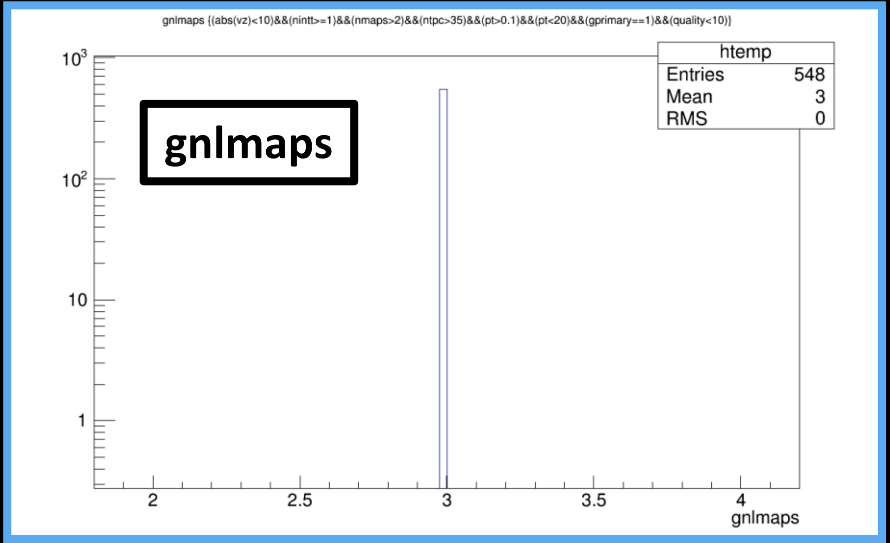

**Primaries (gprimary = 1)**

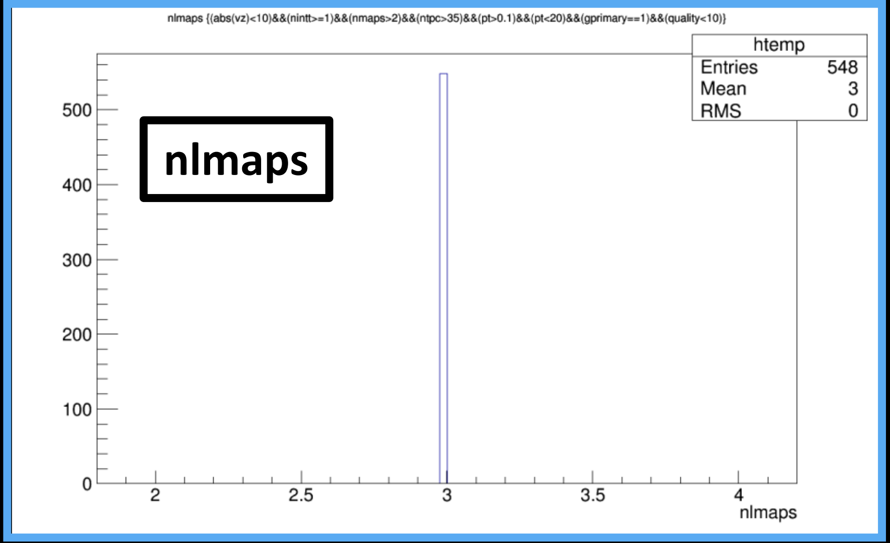
**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gnlmaps and nlmaps

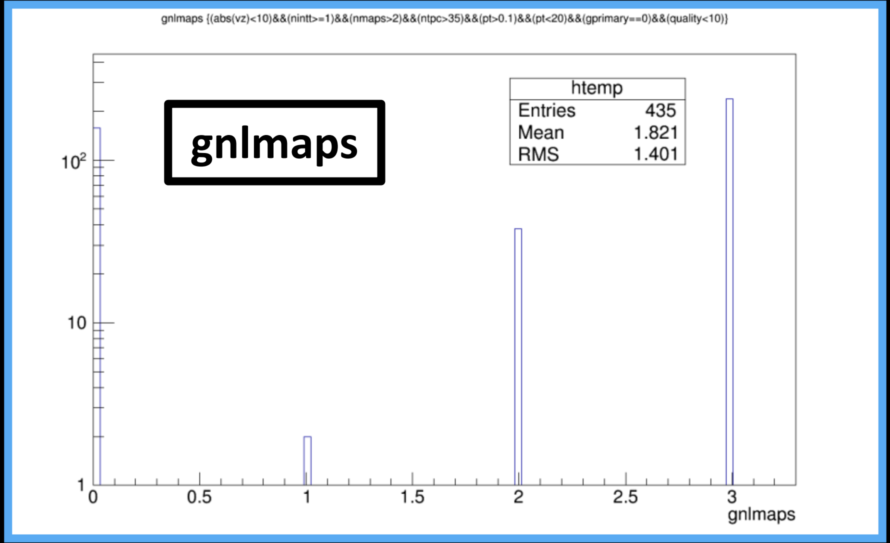
**100 20 – 40 GeV/c $\pi^-$ per event**

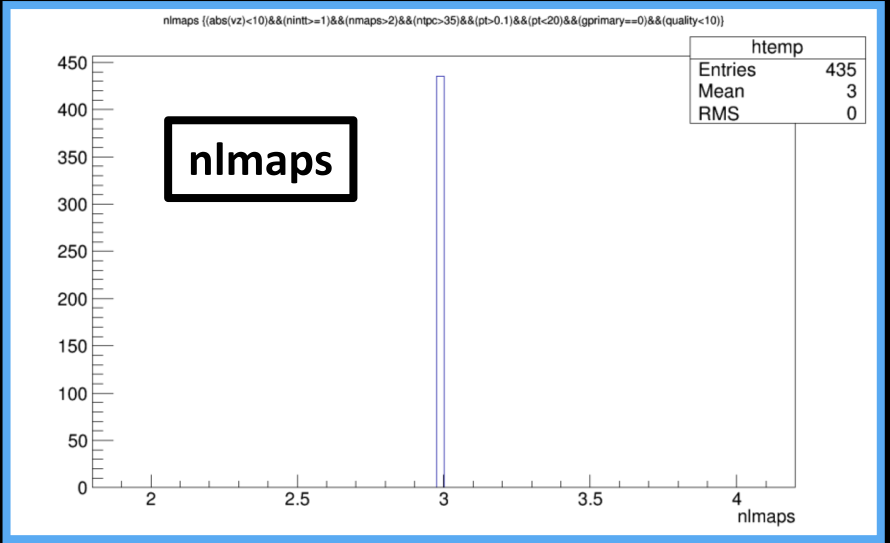
**Primaries (gprimary = 1)**




**Secondaries (gprimary = 0)**

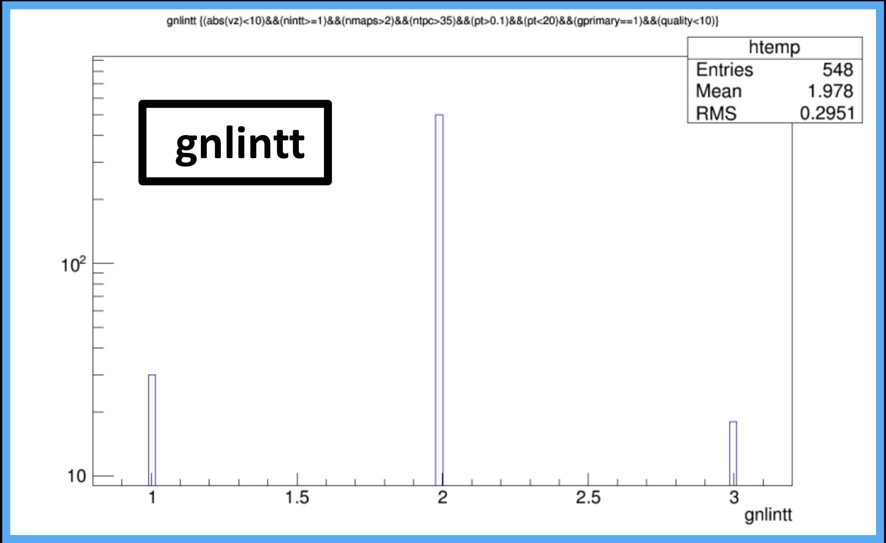


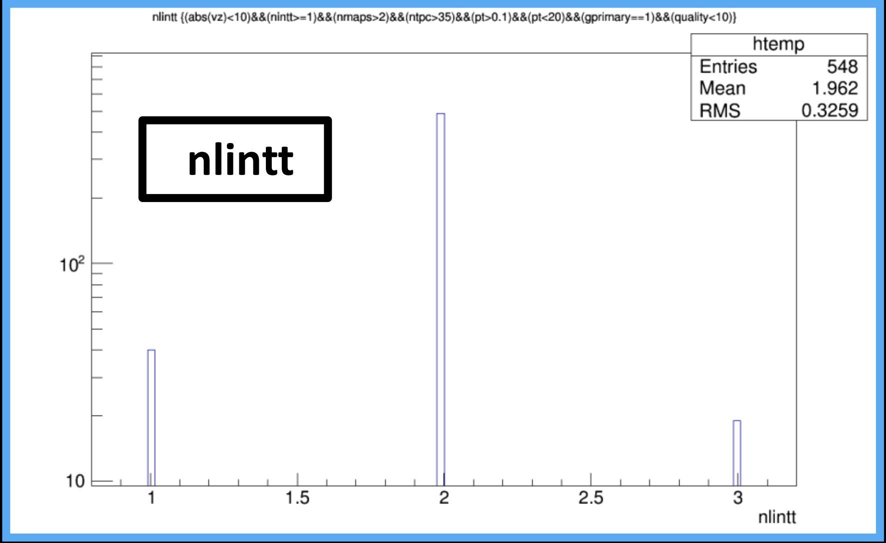



# < 20 GeV/c Tracks | gnlintt and nlintt

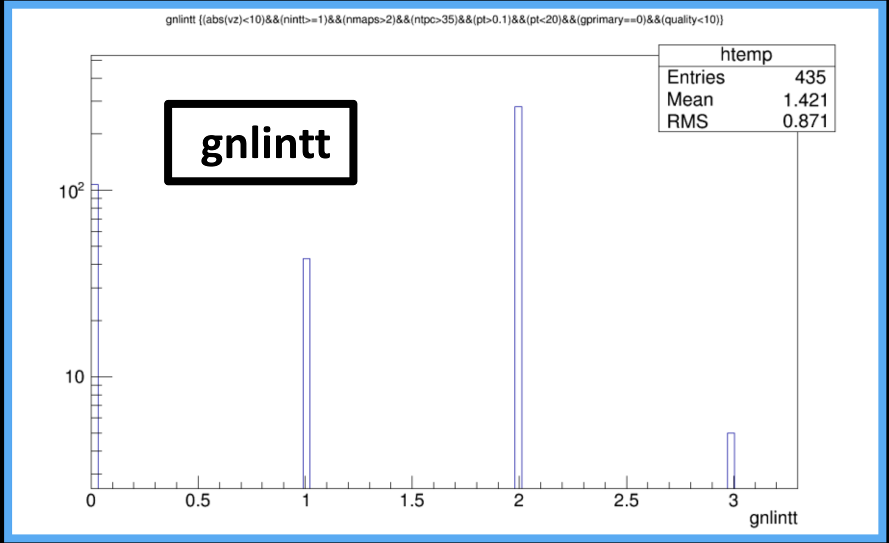
**100 20 – 40 GeV/c $\pi^-$ per event**

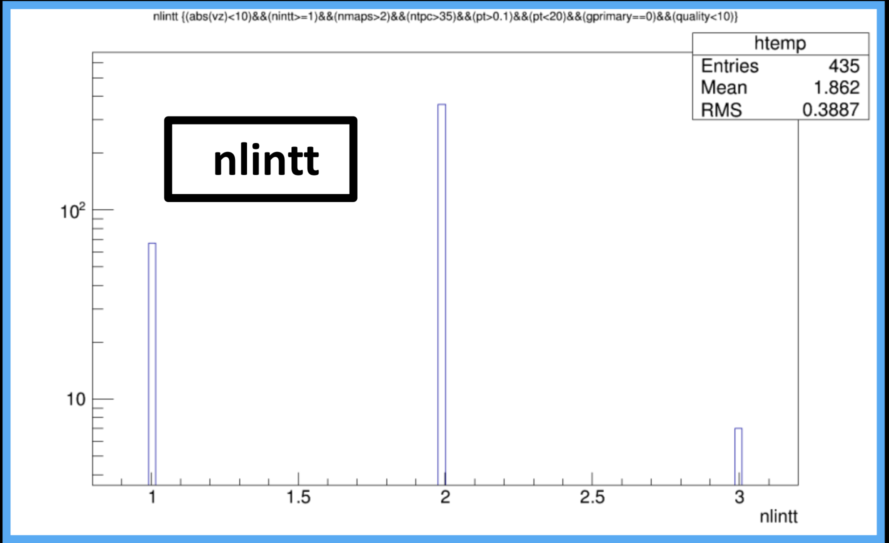
**Primaries (gprimary = 1)**




**Secondaries (gprimary = 0)**



# < 20 GeV/c Tracks | gnltpc and nltpc

**100 20 – 40 GeV/c $\pi^-$ per event**

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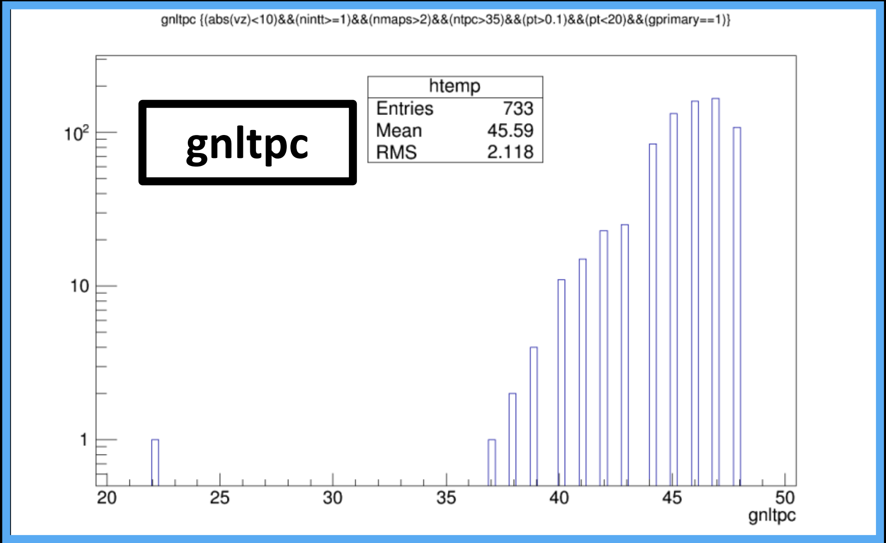
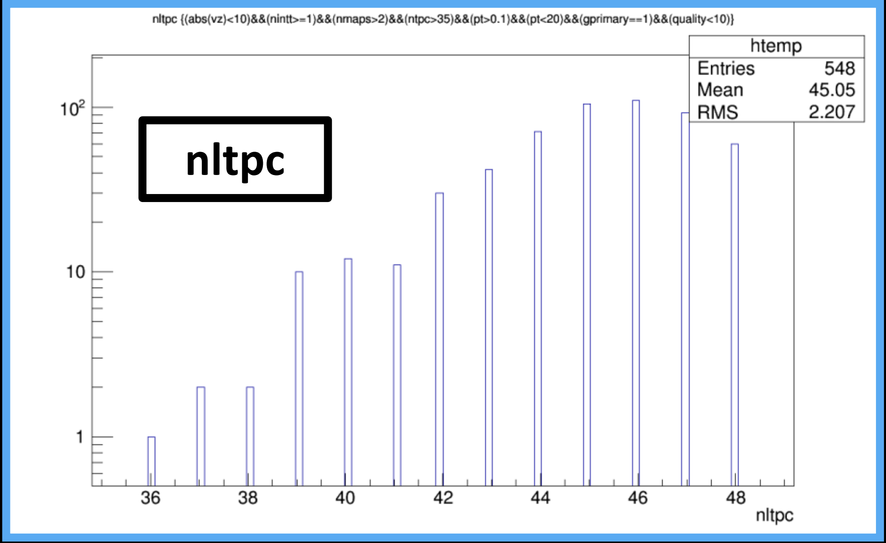
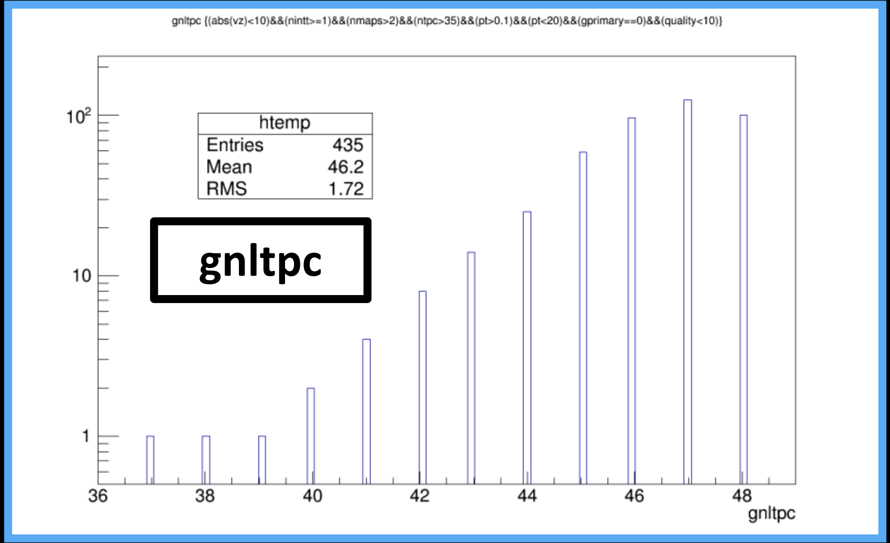
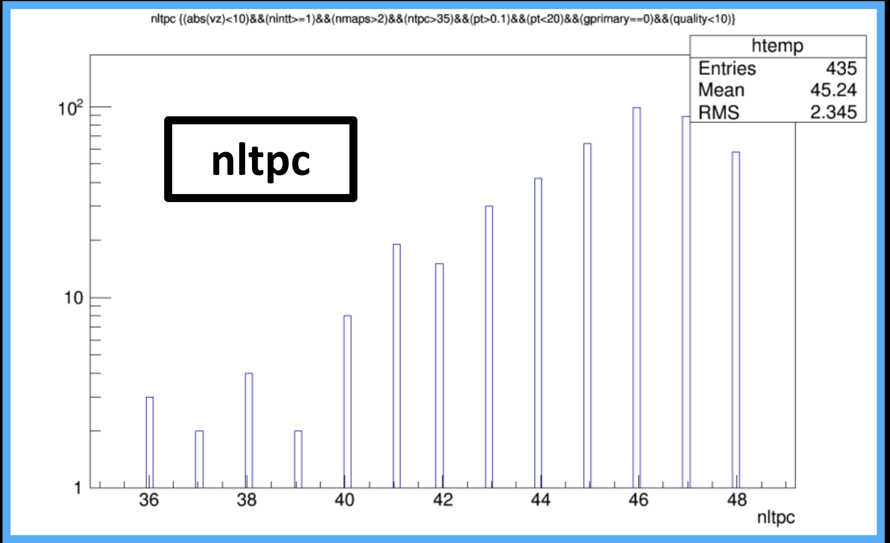
**Primaries (gprimary = 1)**



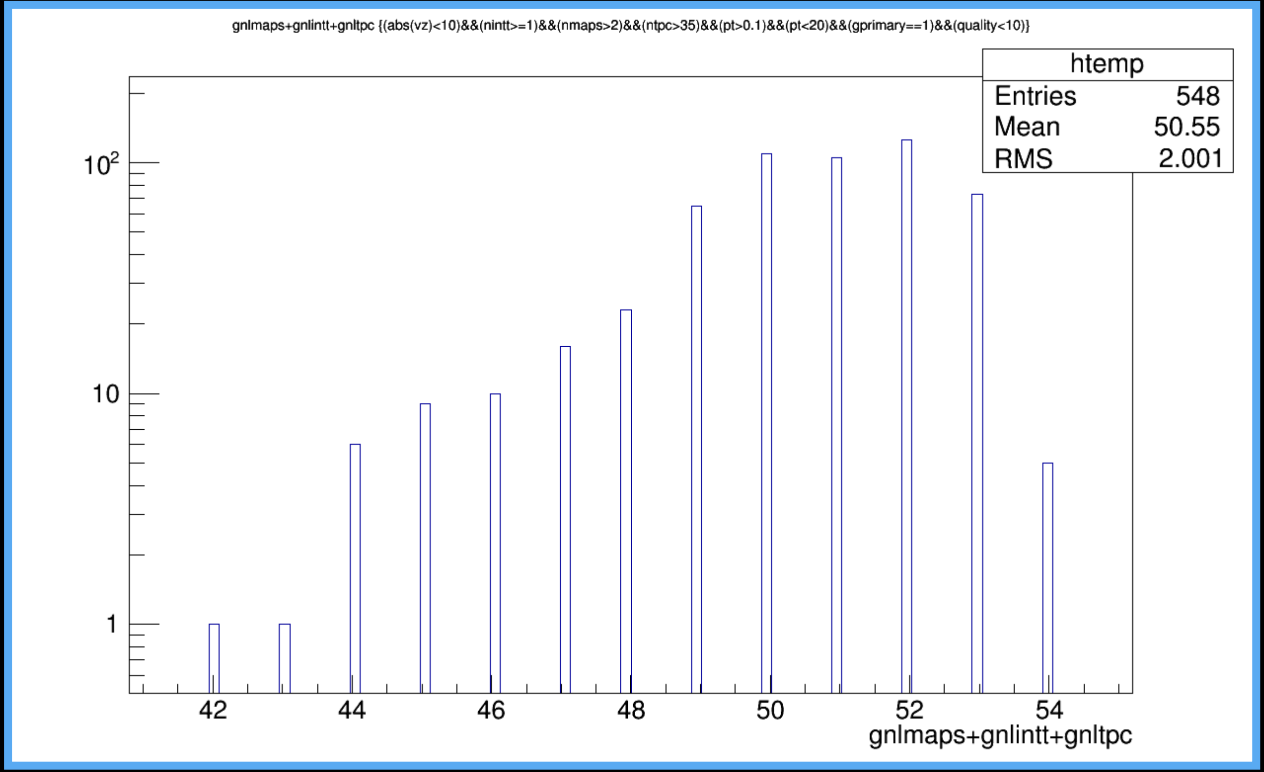

**Secondaries (gprimary = 0)**

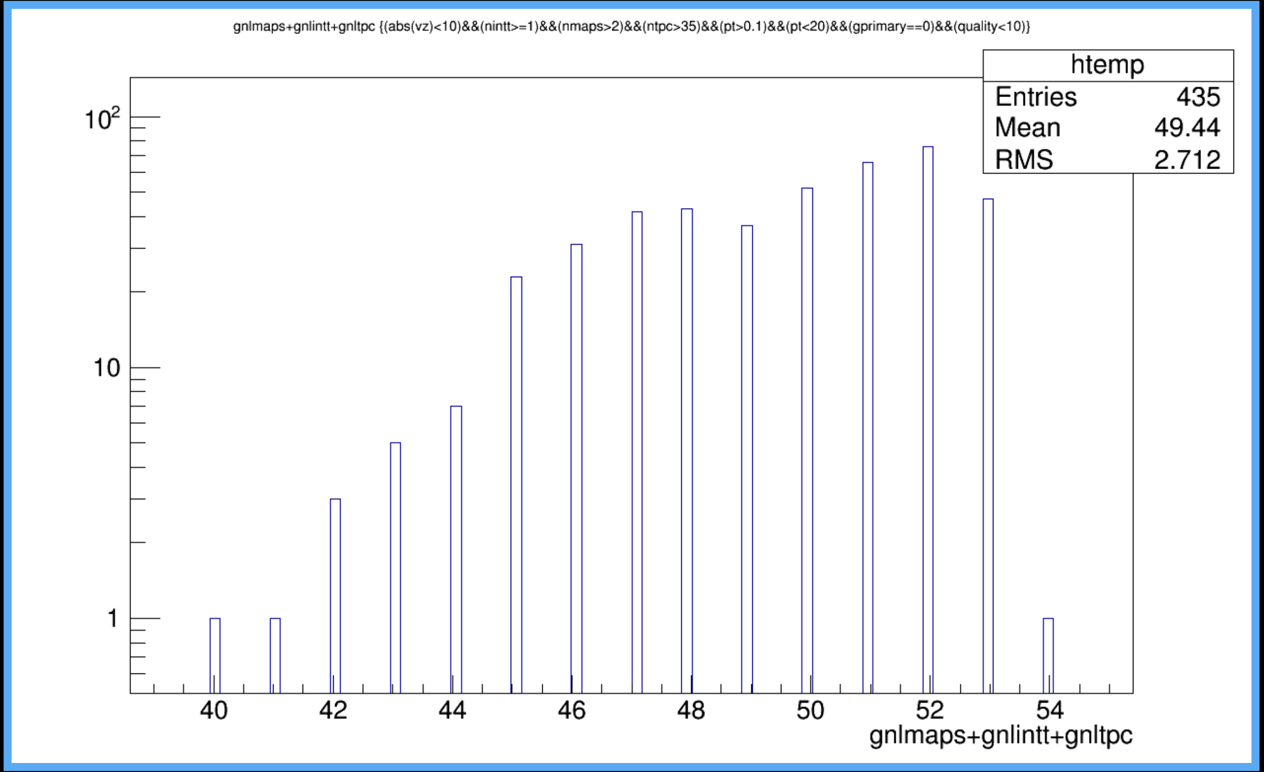


# < 20 GeV/c Tracks | gnltot = gnlmaps + gnlintt + gnltpc

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



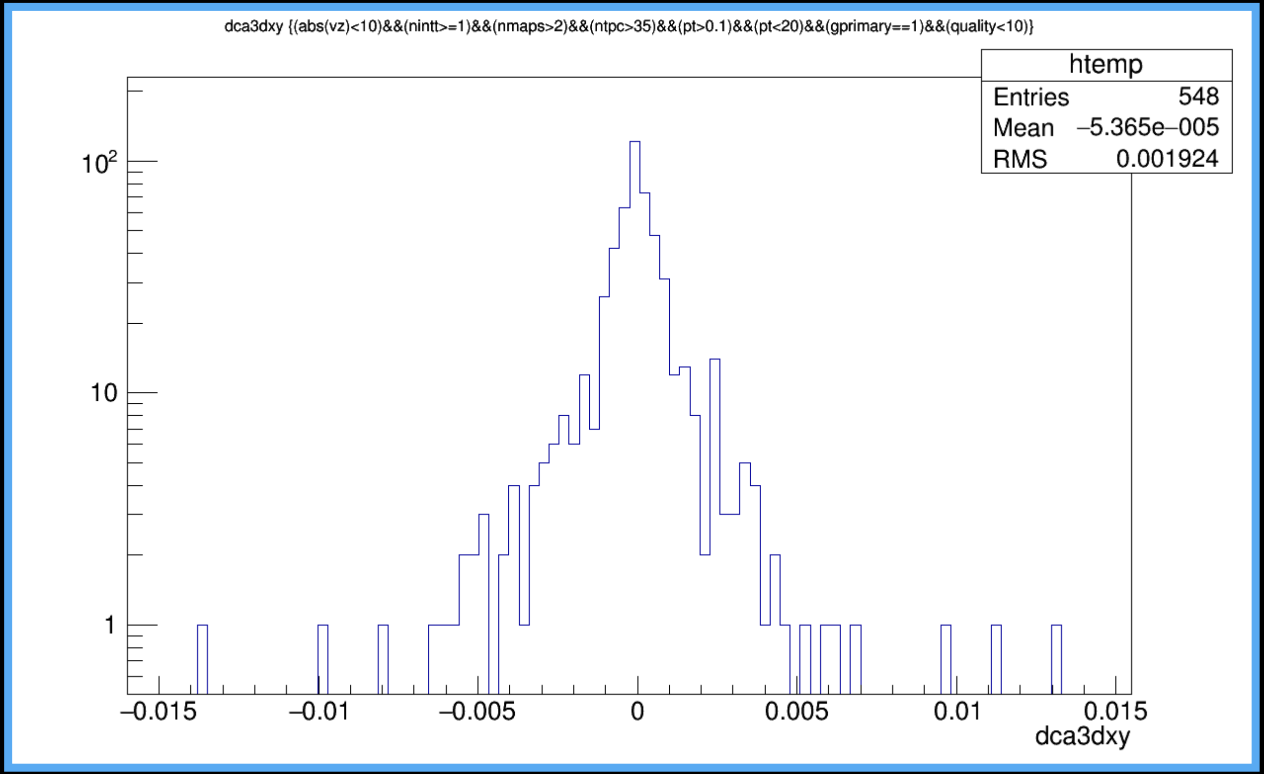




**Primaries (gprimary = 1)**

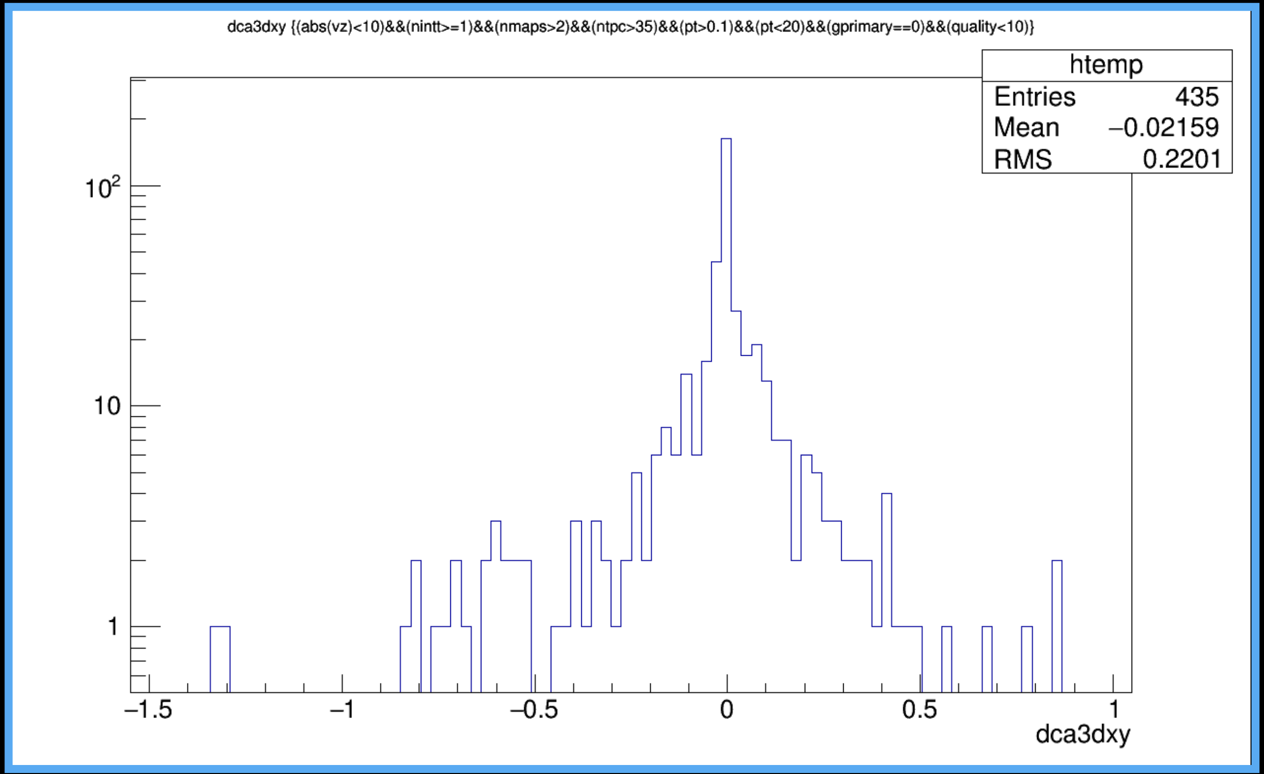
**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | dca3dxy

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



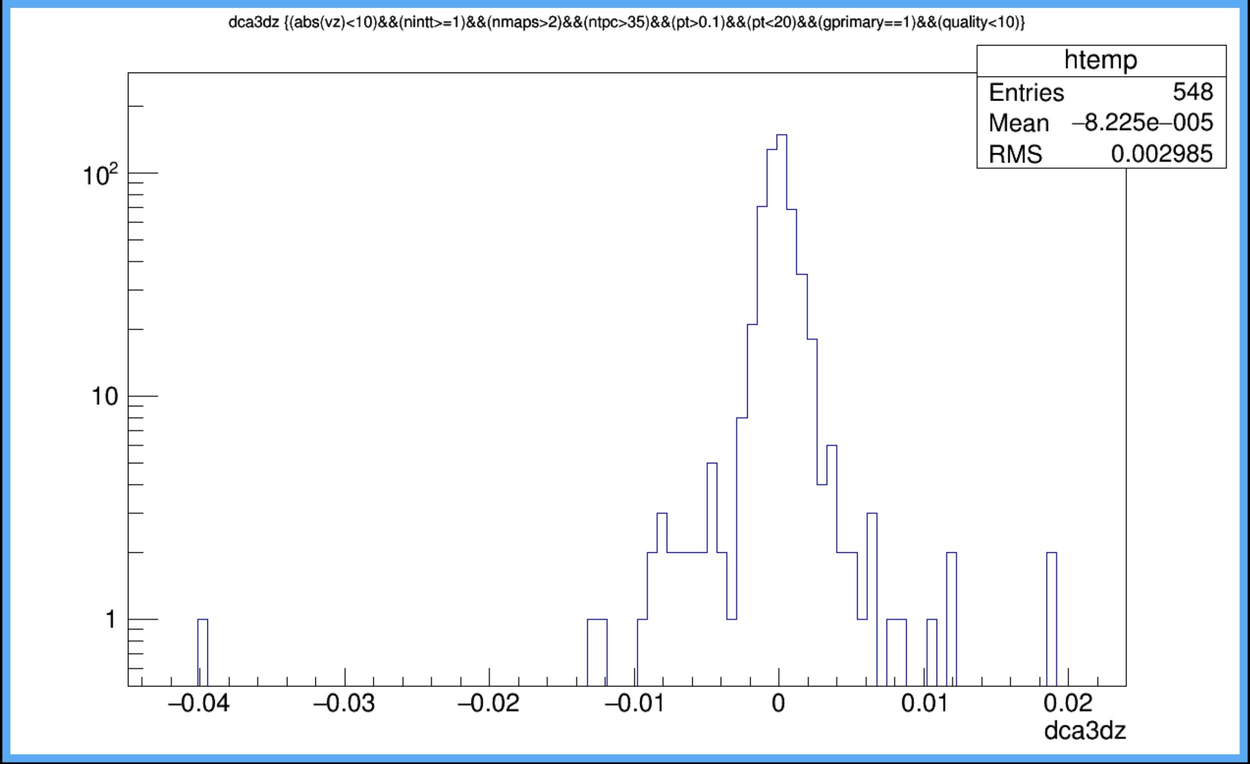

**Primaries (gprimary = 1)**



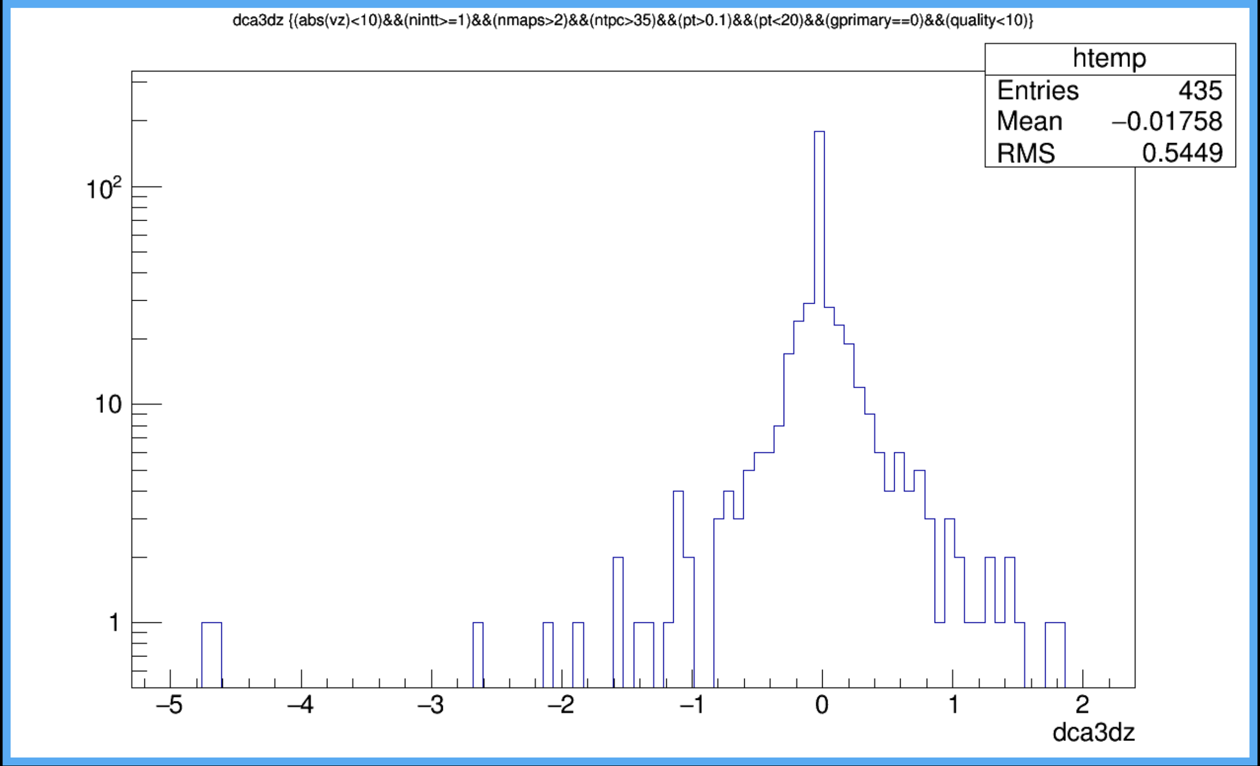

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | dca3dz

**100 20 – 40 GeV/c $\pi^-$ per event**



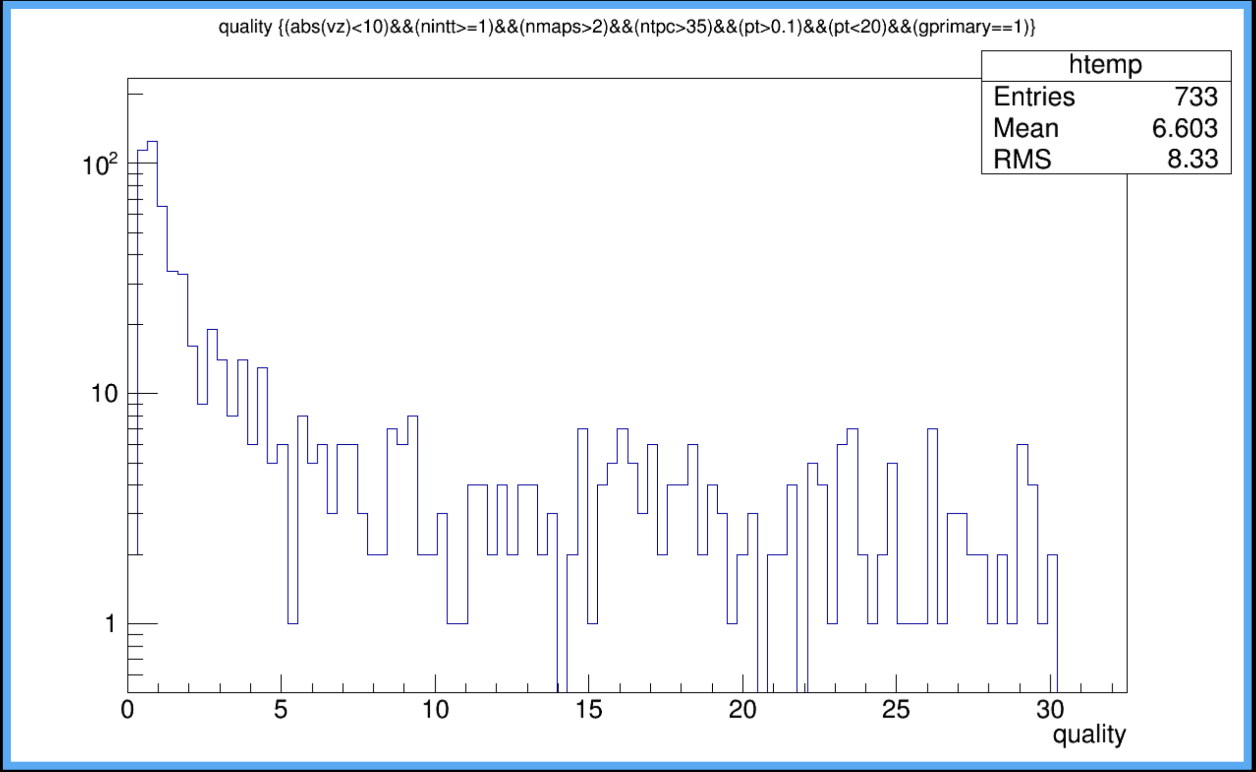

**Primaries (gprimary = 1)**



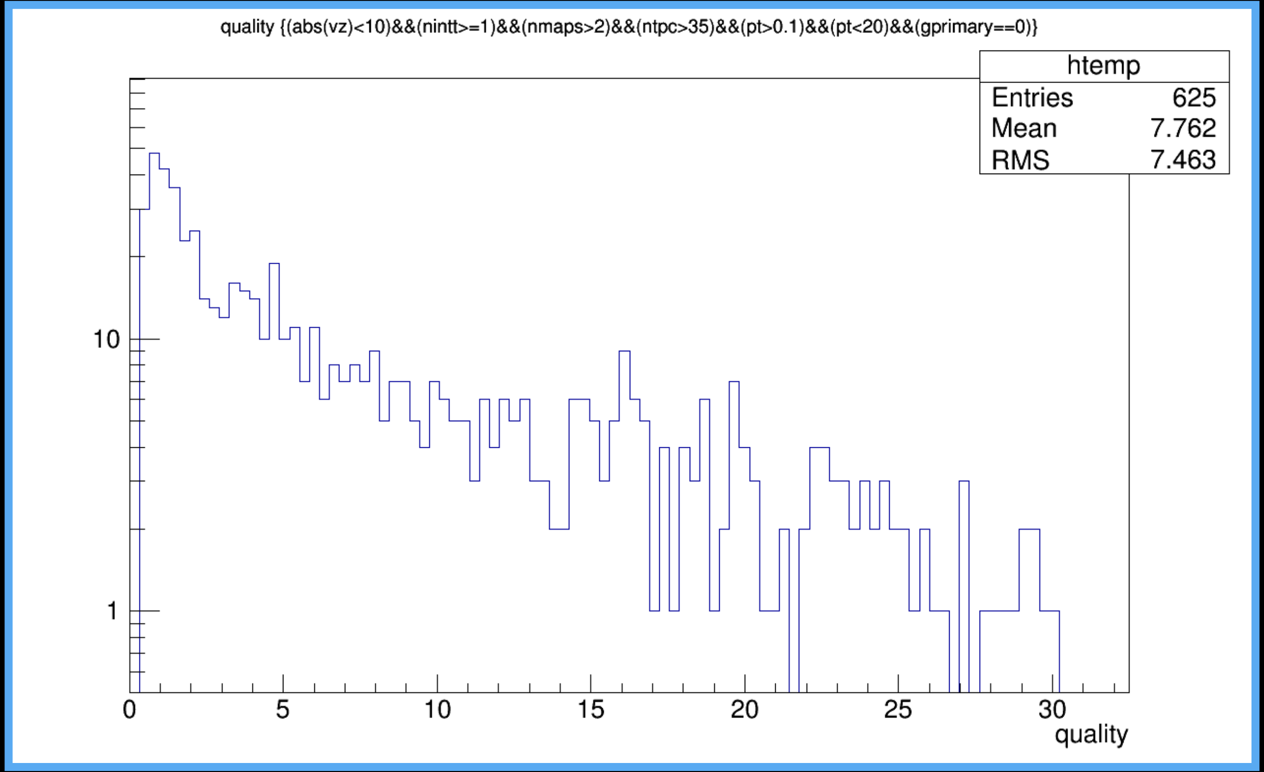

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | quality

**100 20 – 40 GeV/c $\pi^-$ per event**



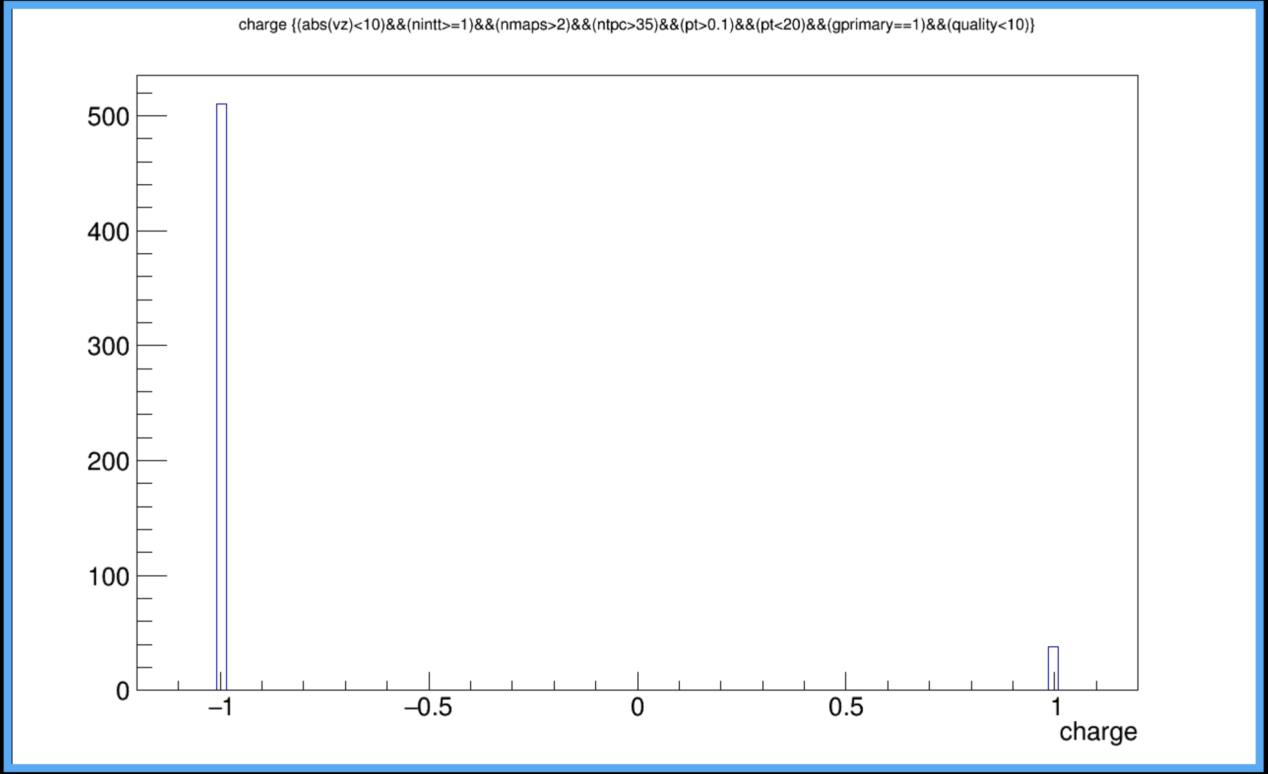

**Primaries (gprimary = 1)**

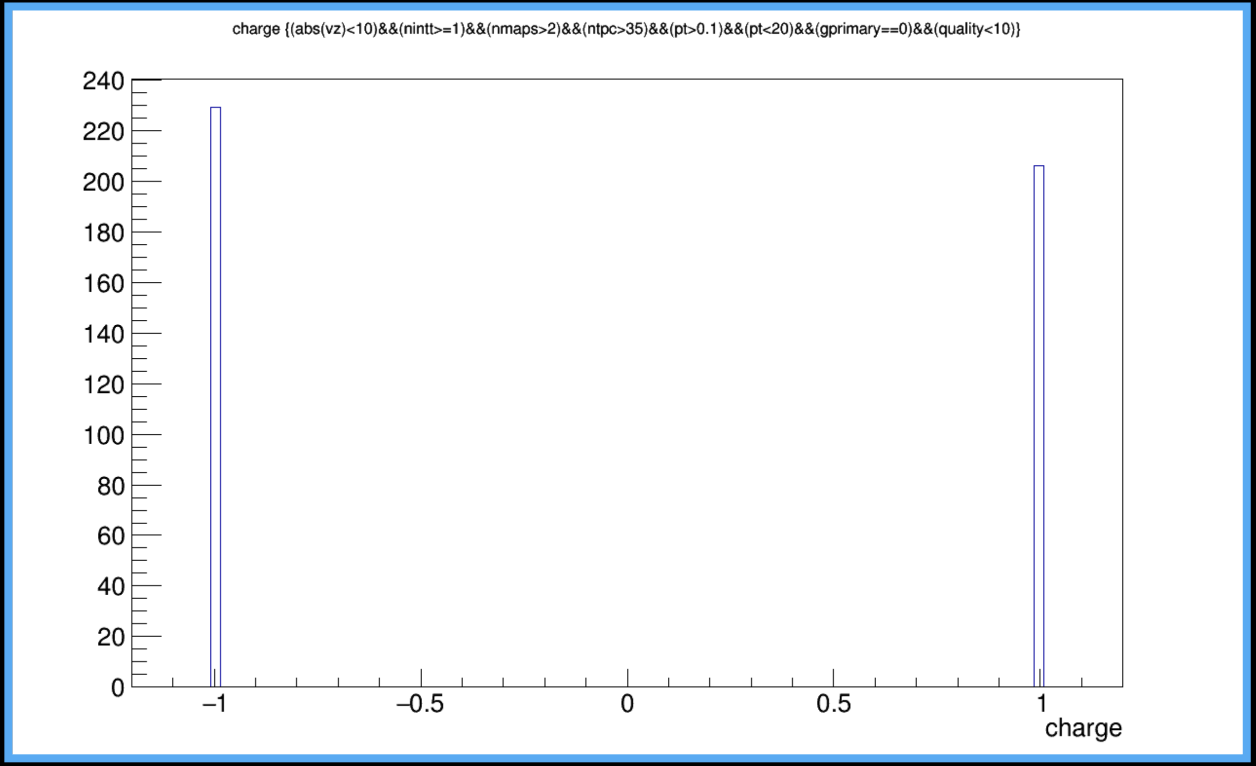



**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | charge

**100 20 – 40 GeV/c $\pi^-$ per event**



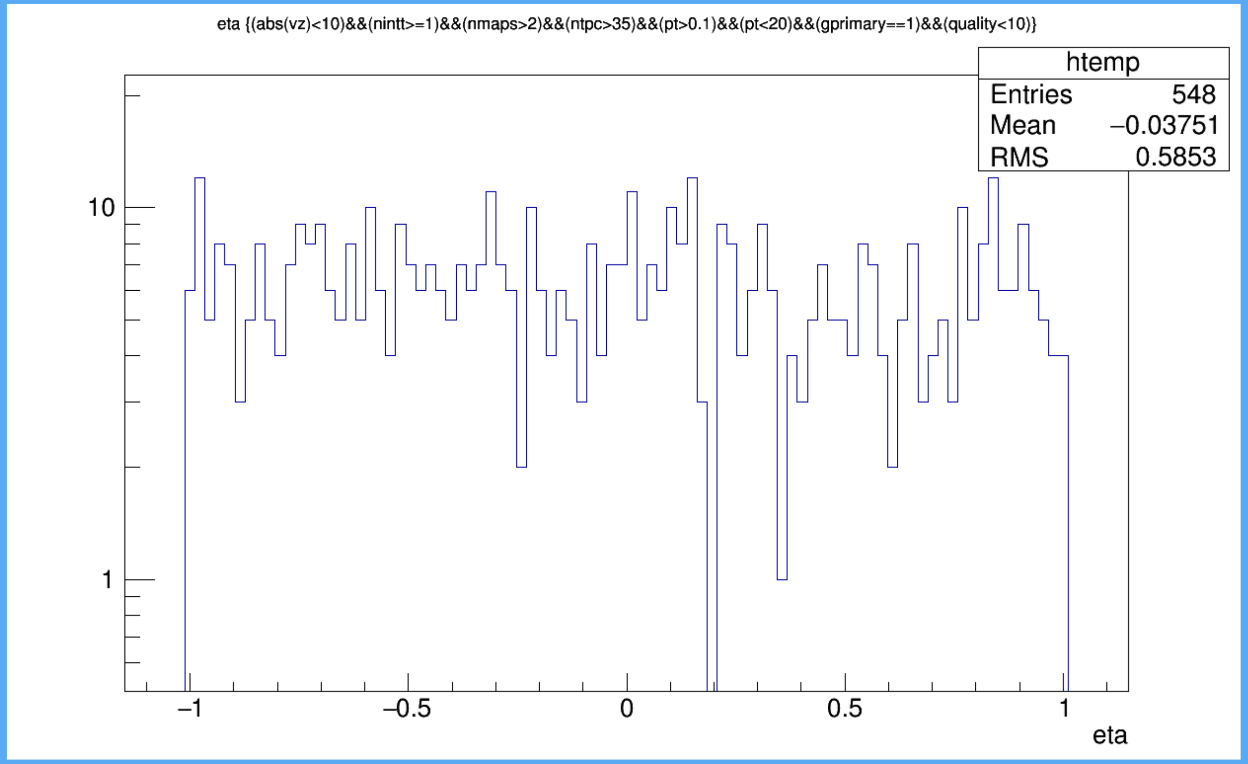



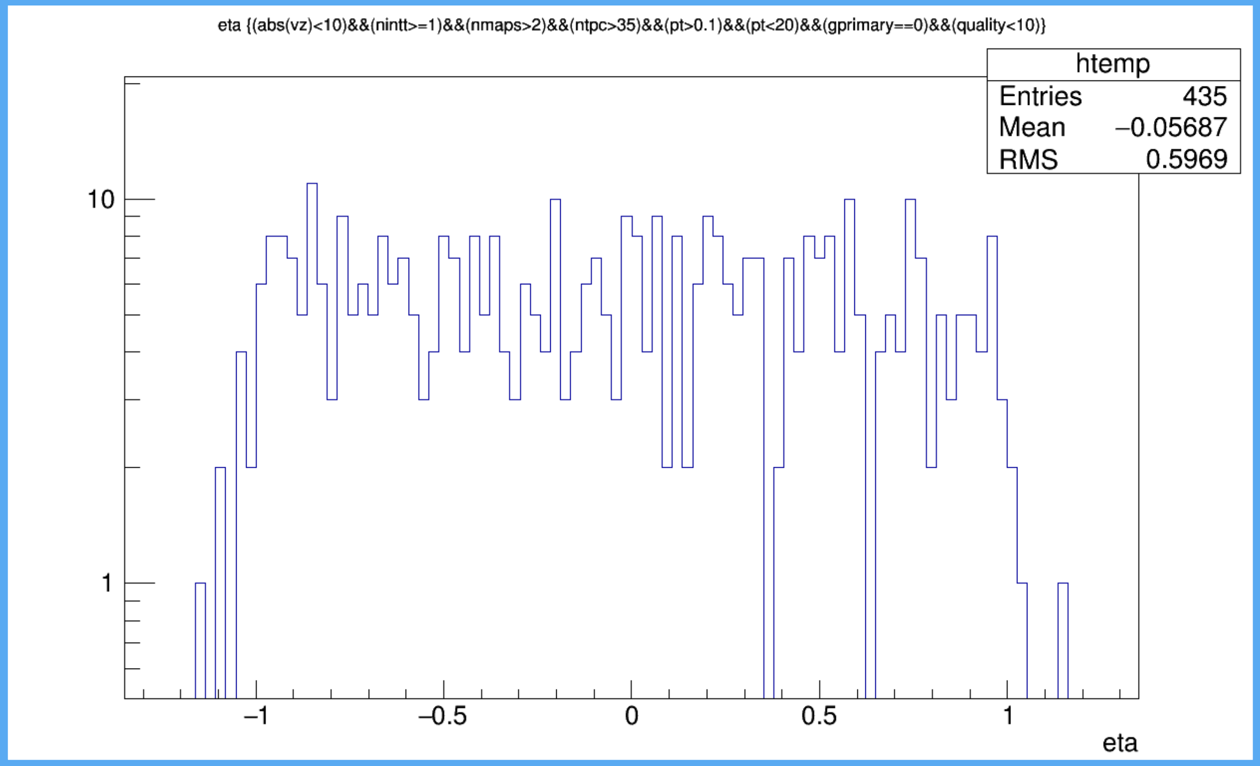

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | eta

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



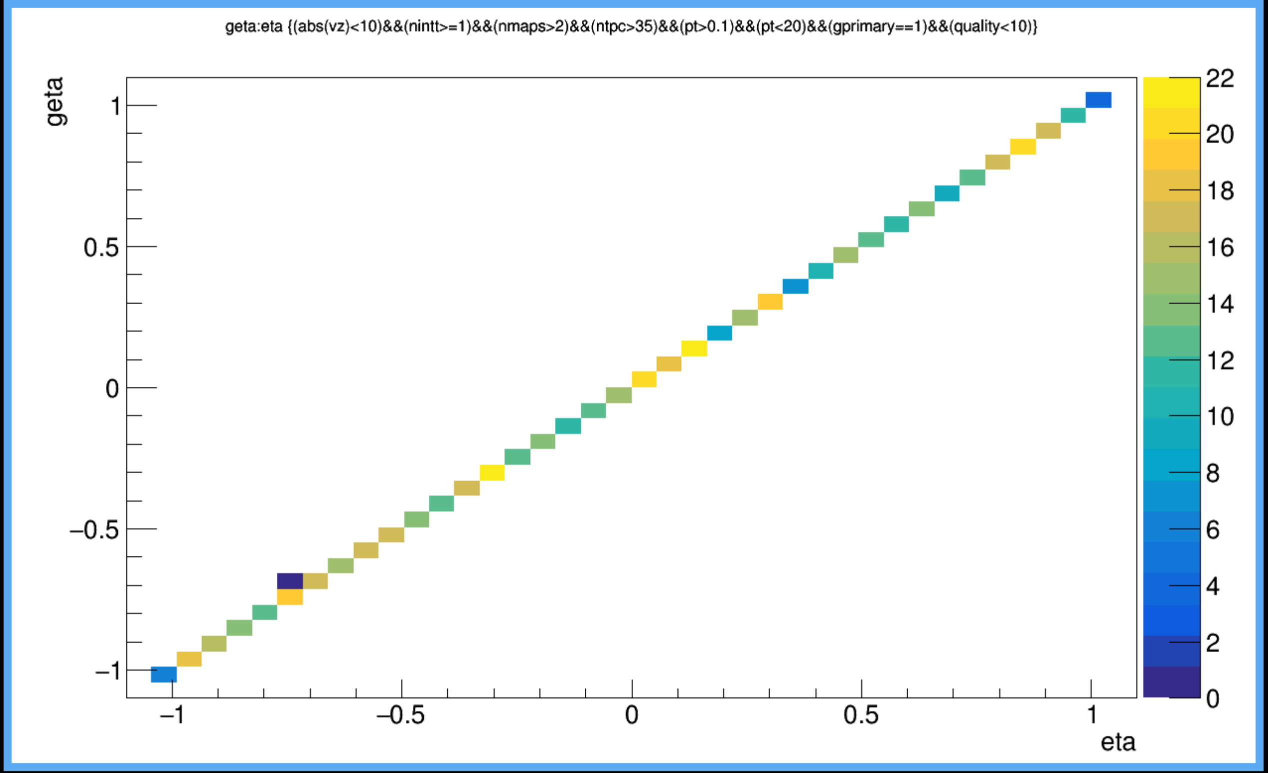



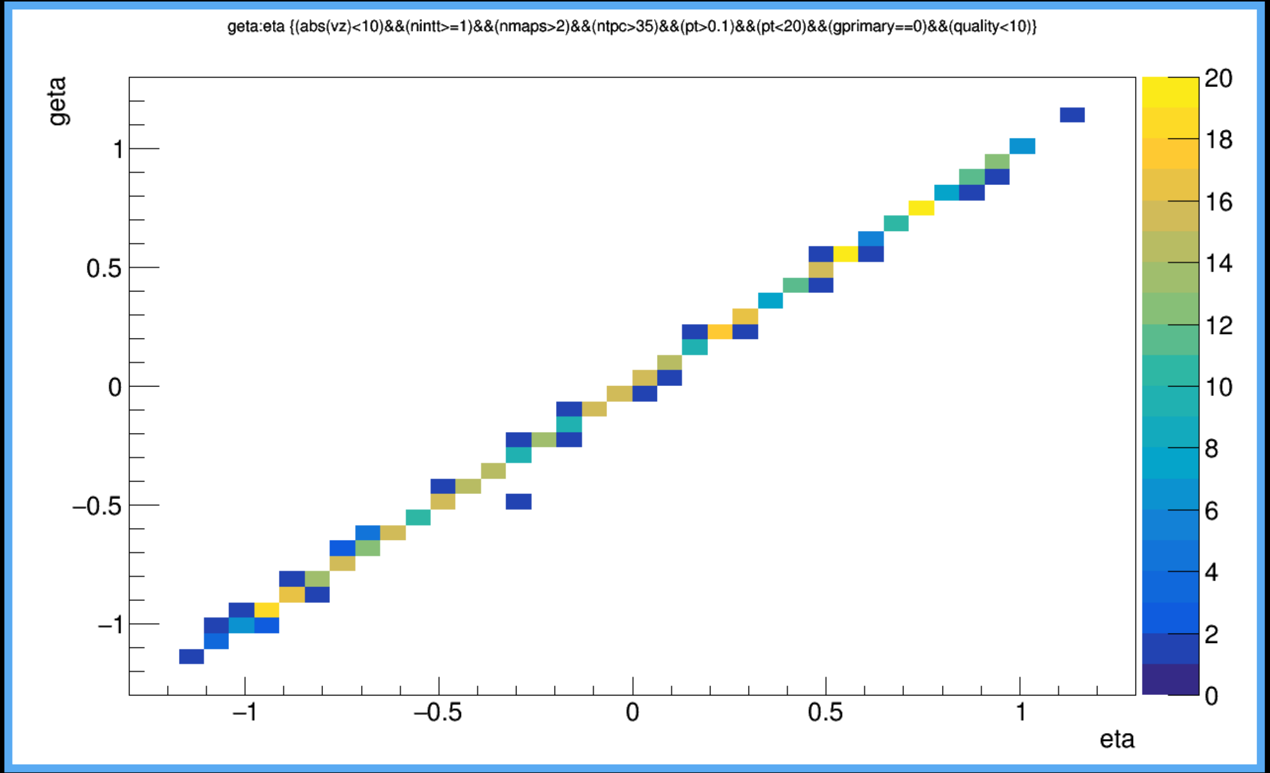

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | geta vs. eta

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



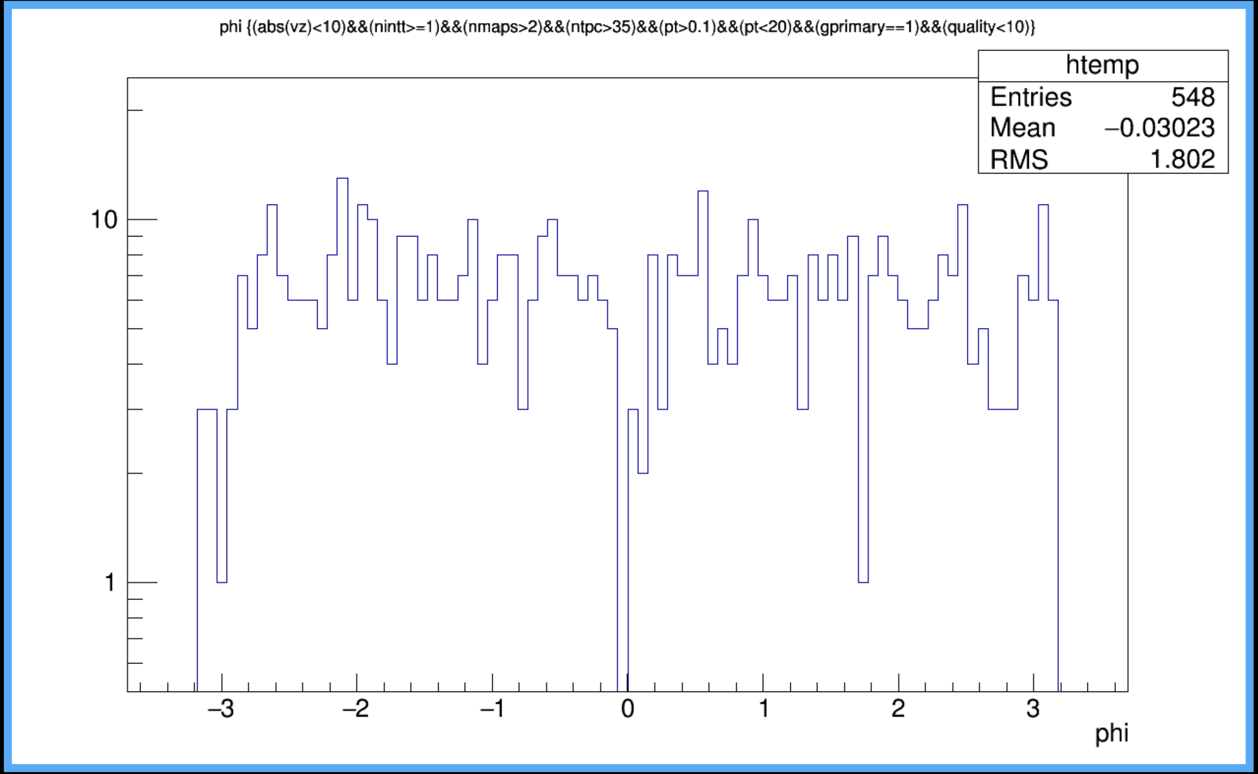



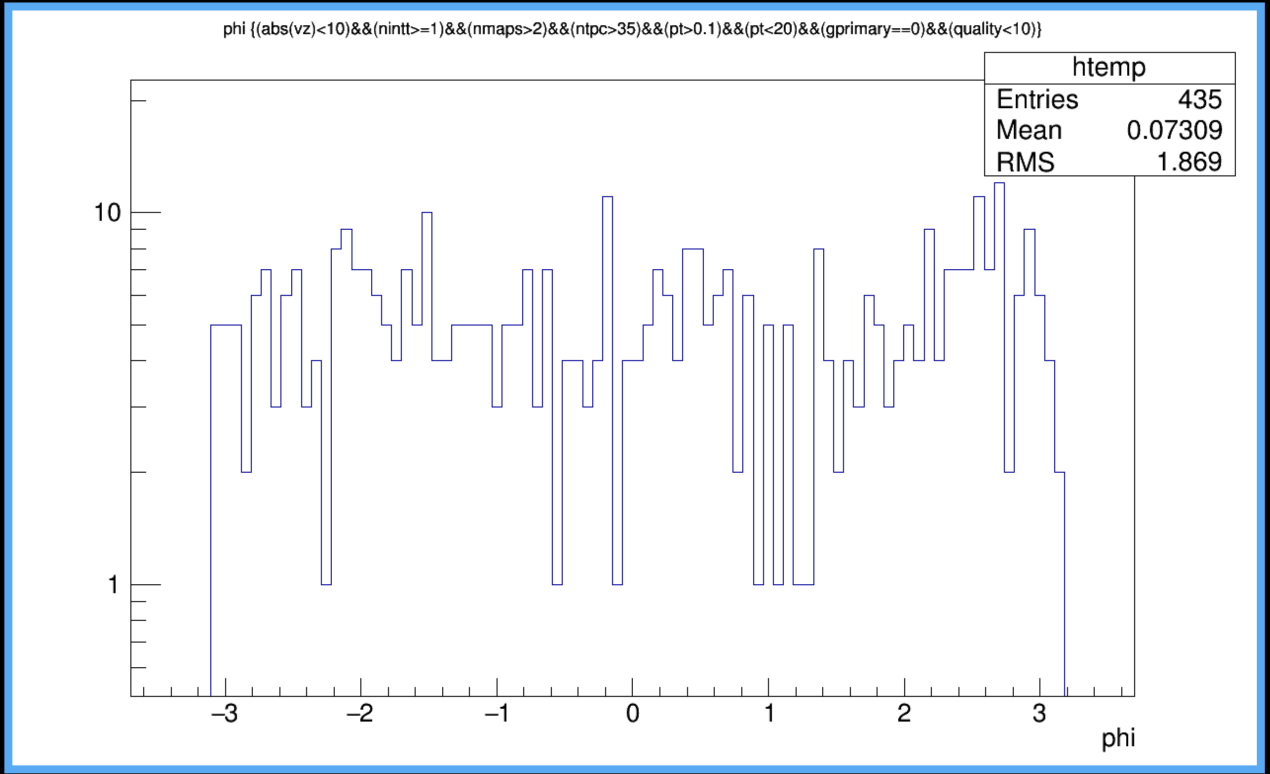

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | phi

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



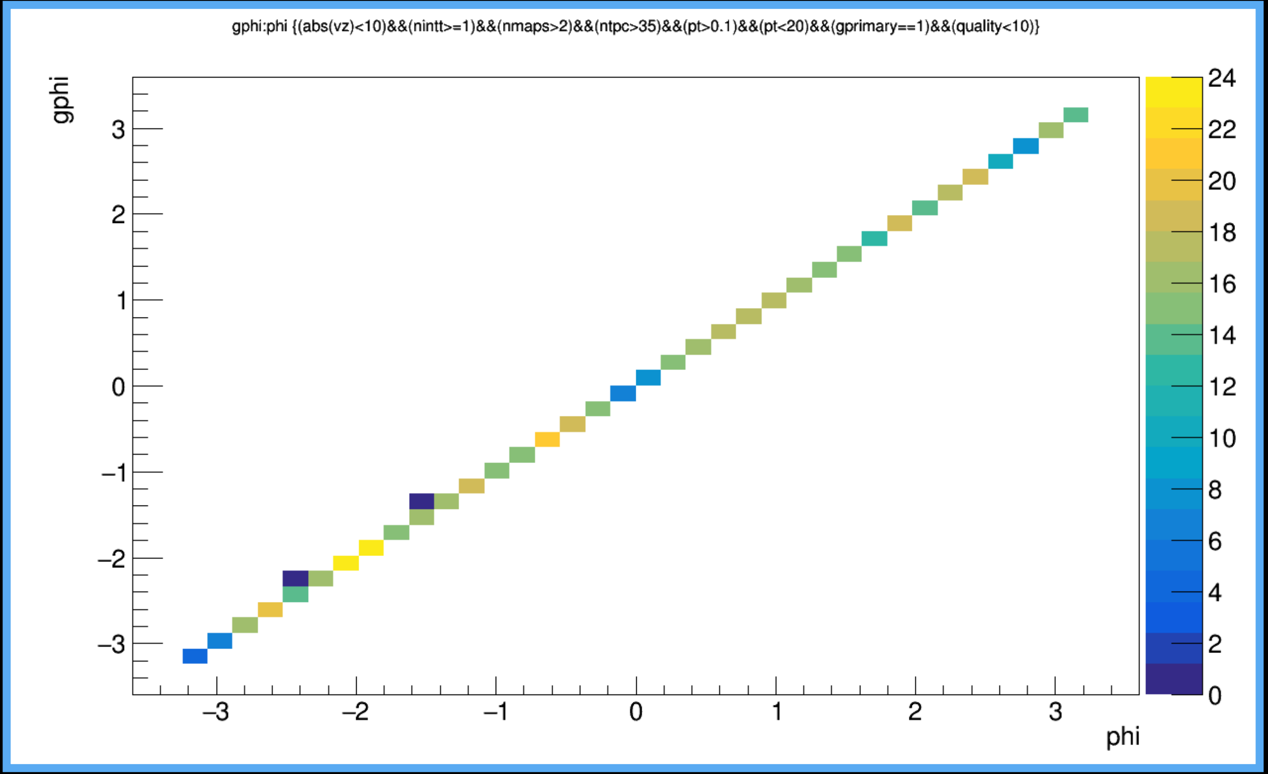



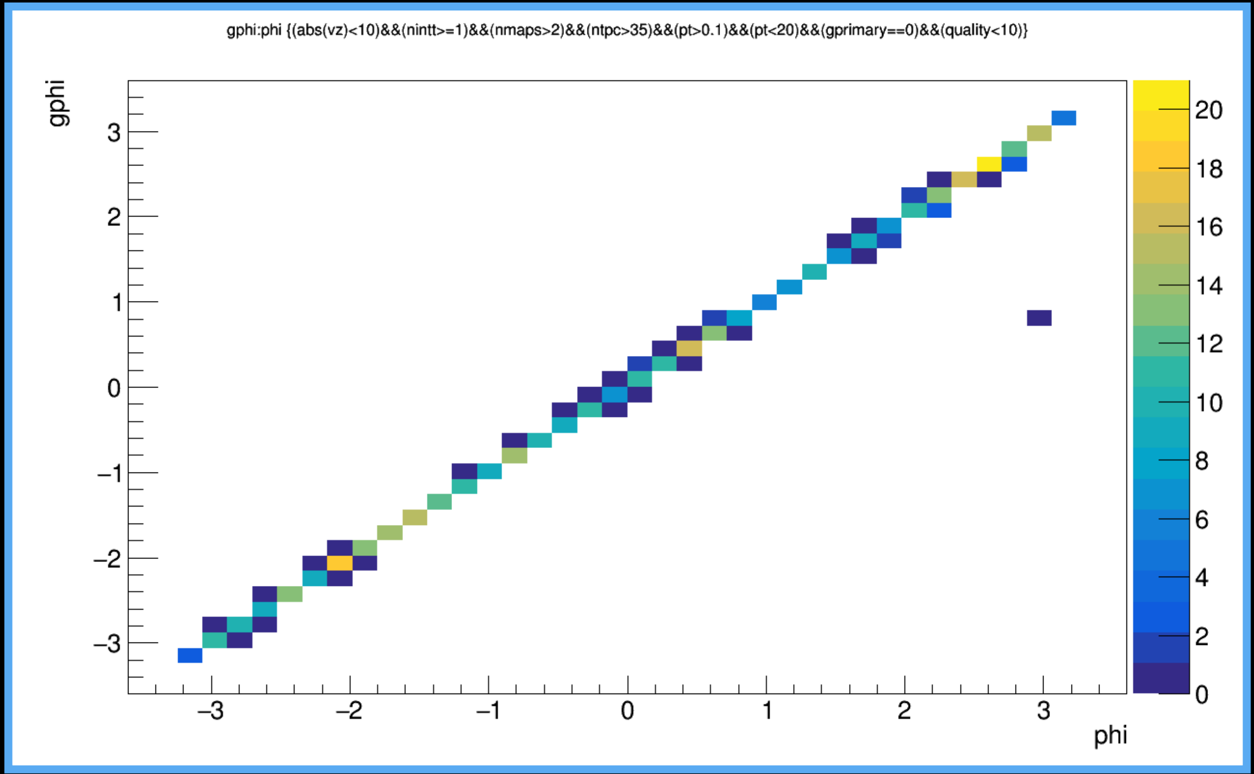

**Primaries (gprimary = 1)**

**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gphi vs. phi

**100 20 – 40 GeV/c**
**$\pi^-$ per event**



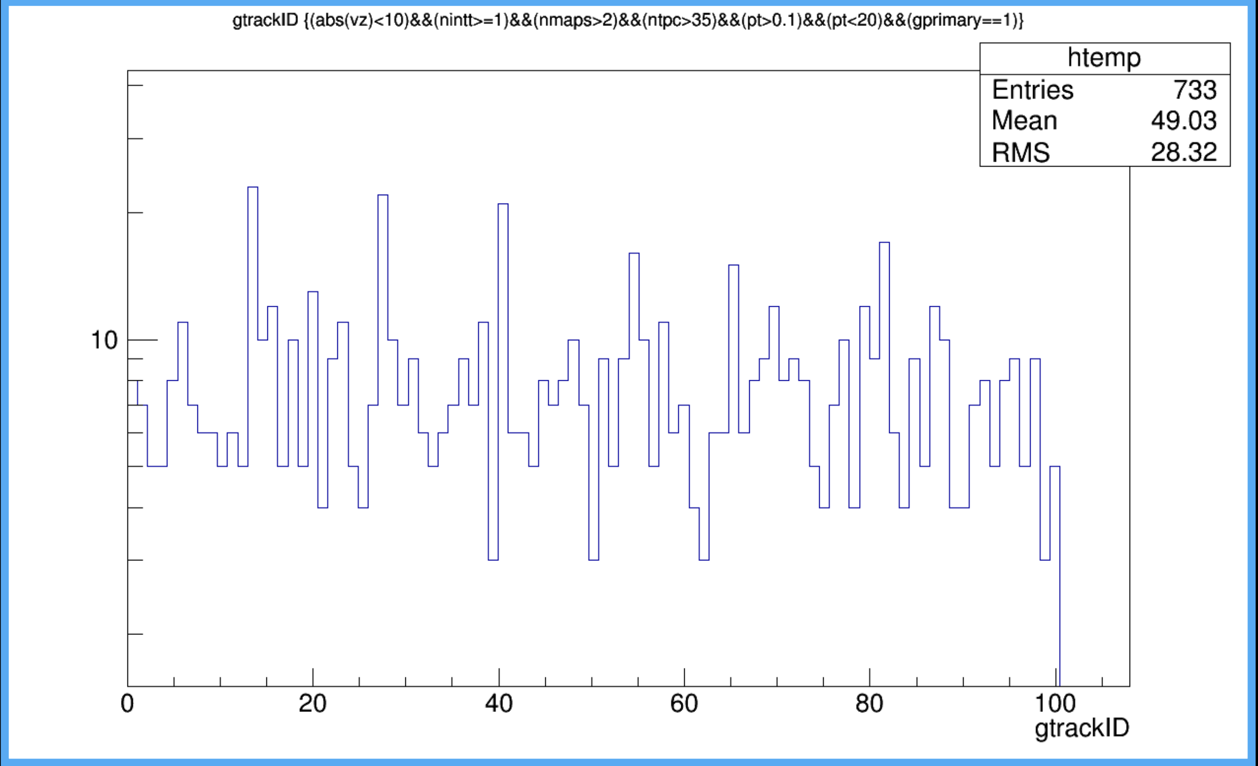




**Primaries (gprimary = 1)**

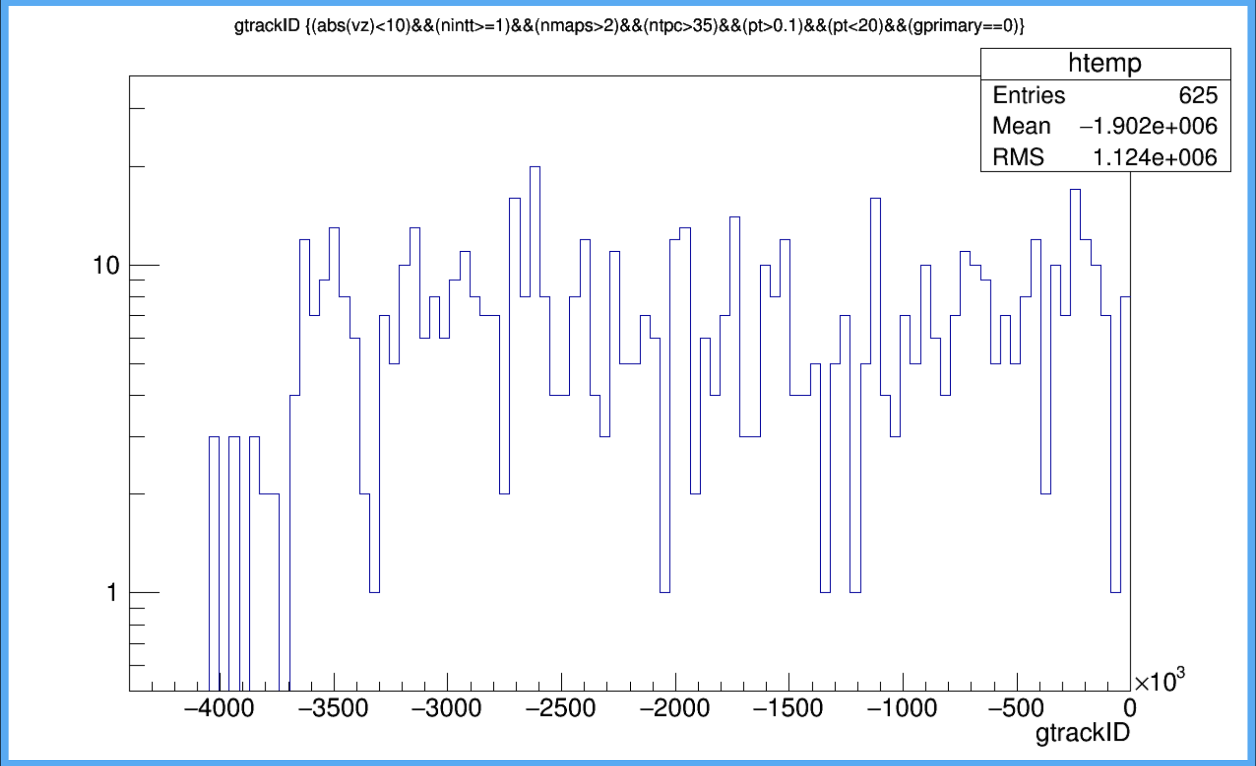
**Secondaries (gprimary = 0)**

# < 20 GeV/c Tracks | gtrackid

**100 20 – 40 GeV/c $\pi^-$ per event**

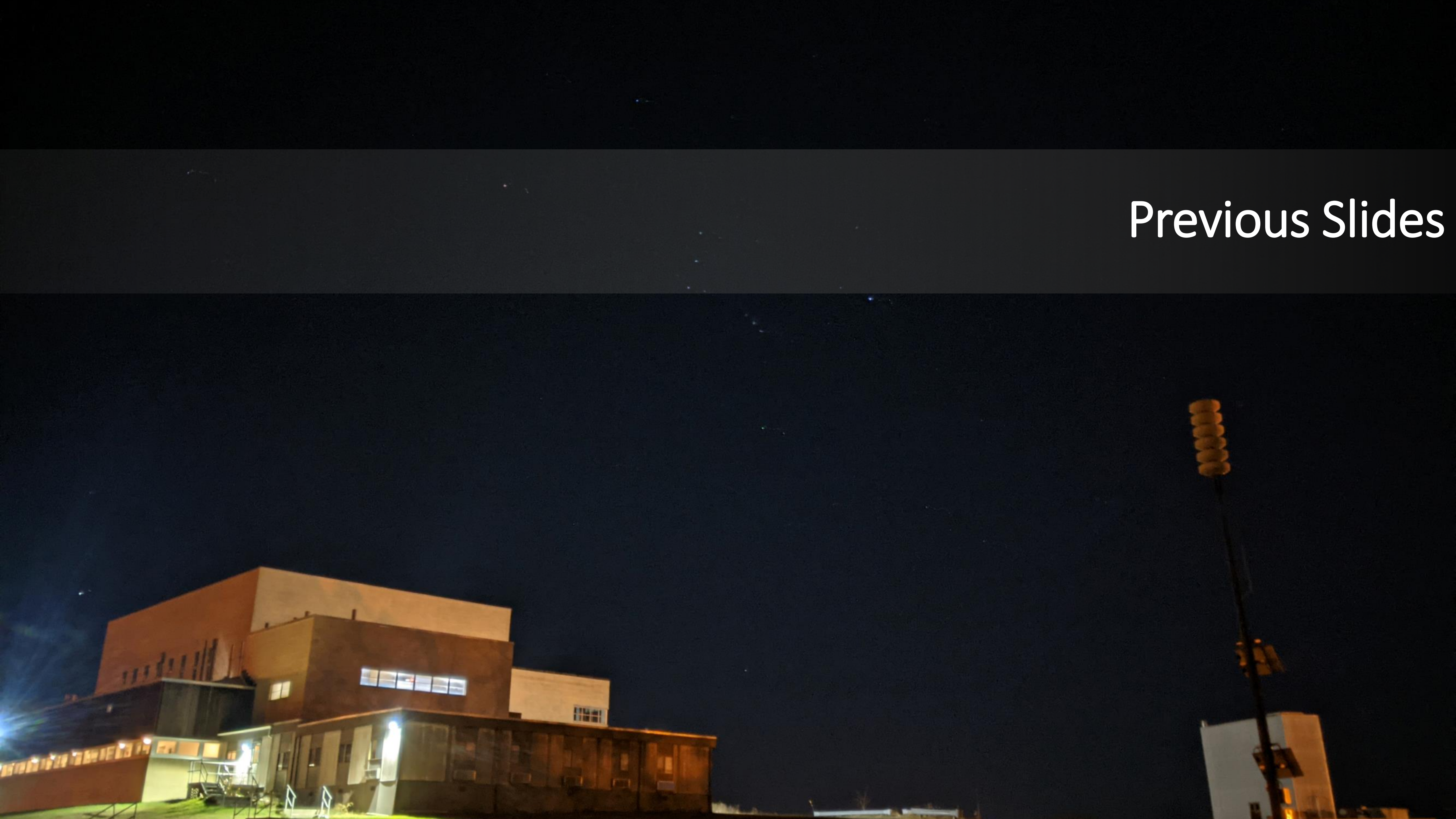



**Primaries (gprimary = 1)**




**Secondaries (gprimary = 0)**

# Previous Slides



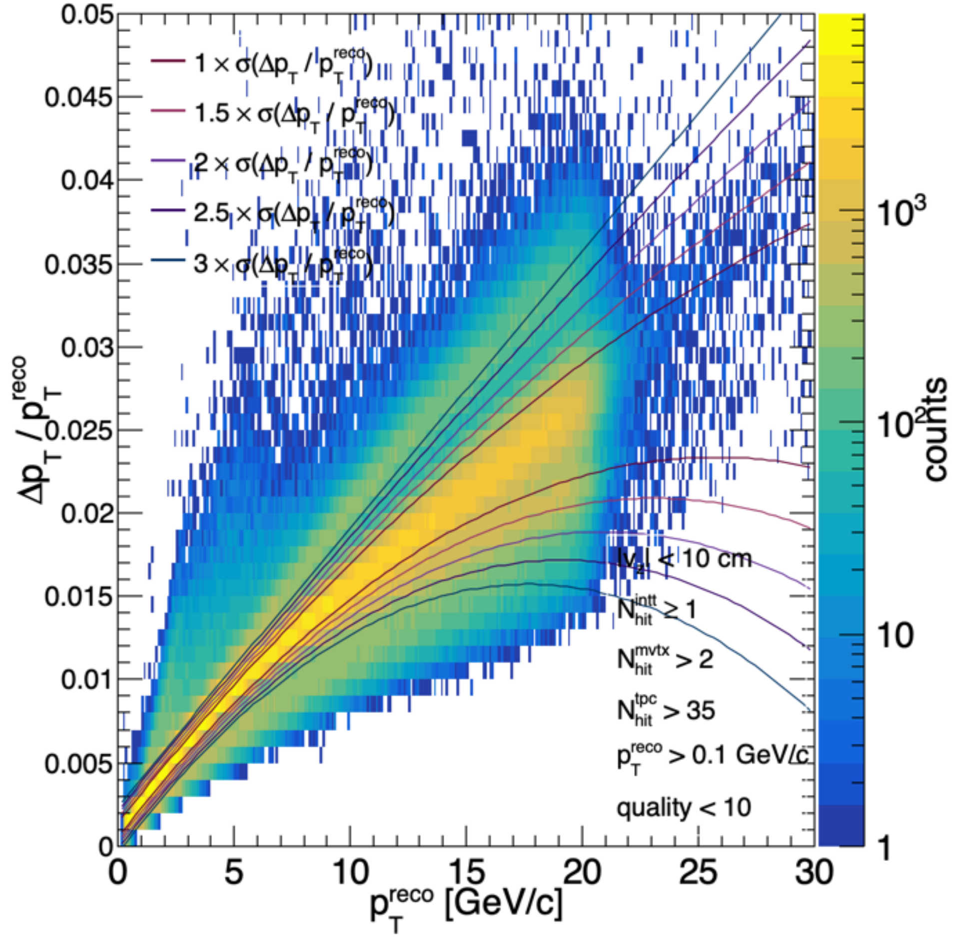
# Performance Cut Strawman

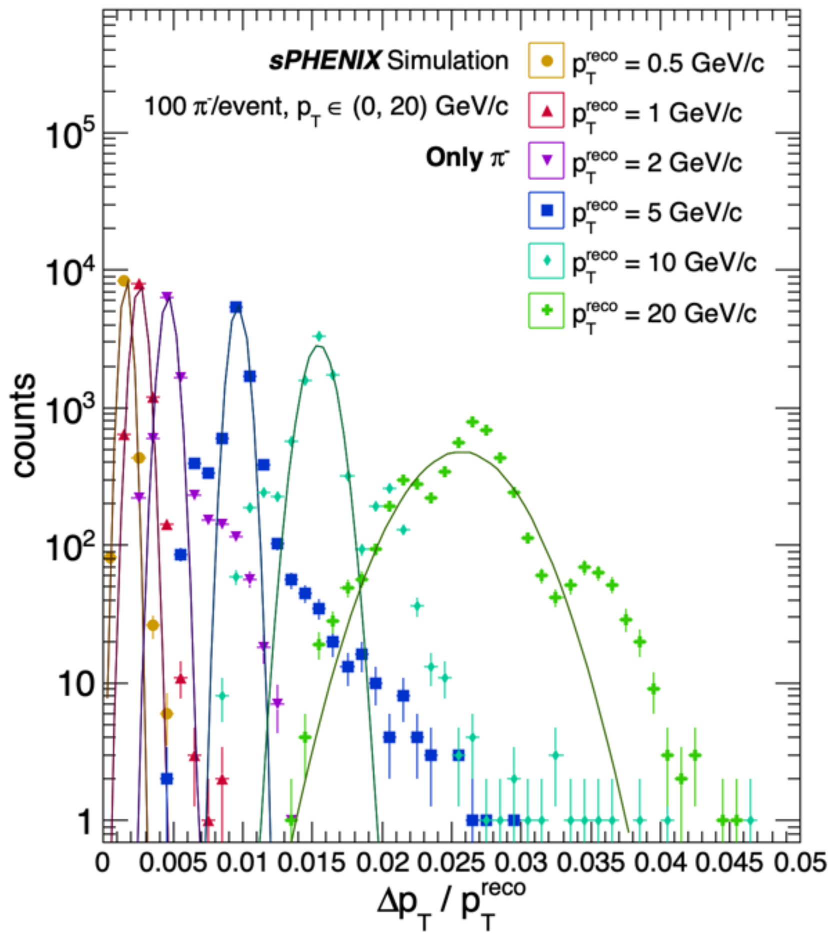
1) $|v_z| < 10$ cm
2) $N_{hits}^{intt} \geq 1$
3) $N_{hits}^{mvtx} > 2$
4) $N_{hits}^{tpc} > 35$ (24?)
5) $p_T^{reco} > 0.1$ GeV/c
6) $\Delta p_T / p_T^{reco} \in ?$ **
7) $(\sigma(DCA_\star)/DCA_\star < ?)$ *

* Need to explore in heavy-ion environments first…

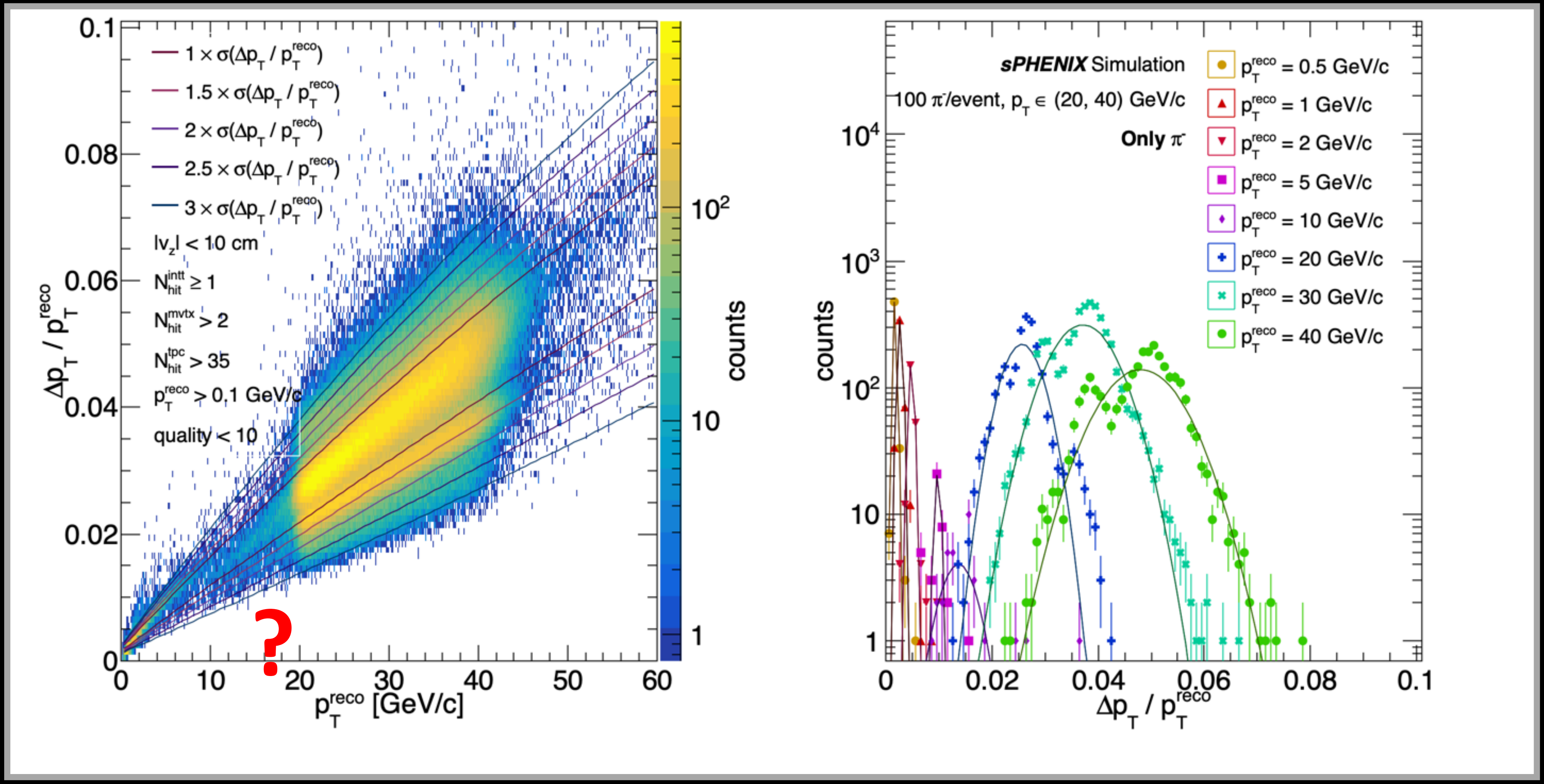
** Looking into now…

# Percent Error over $p_T^{reco}$ | 0 – 20 GeV/c

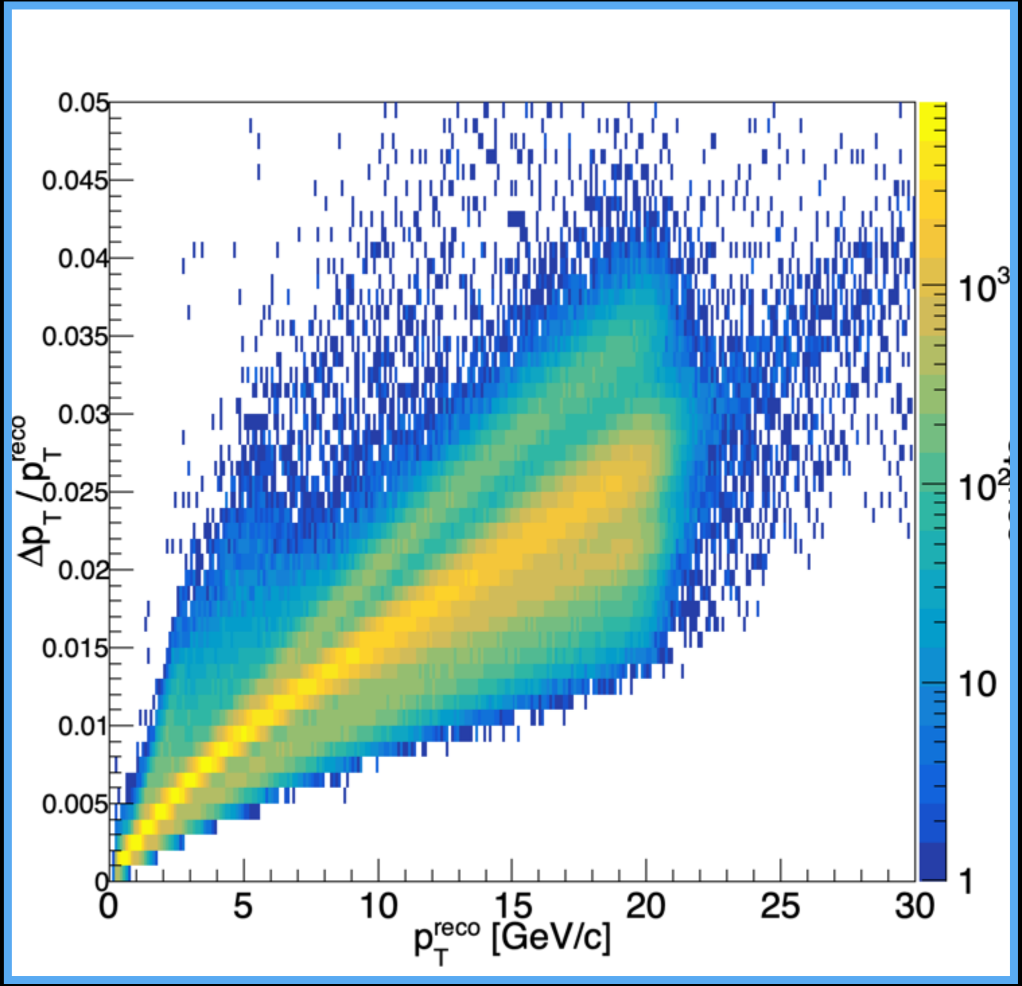


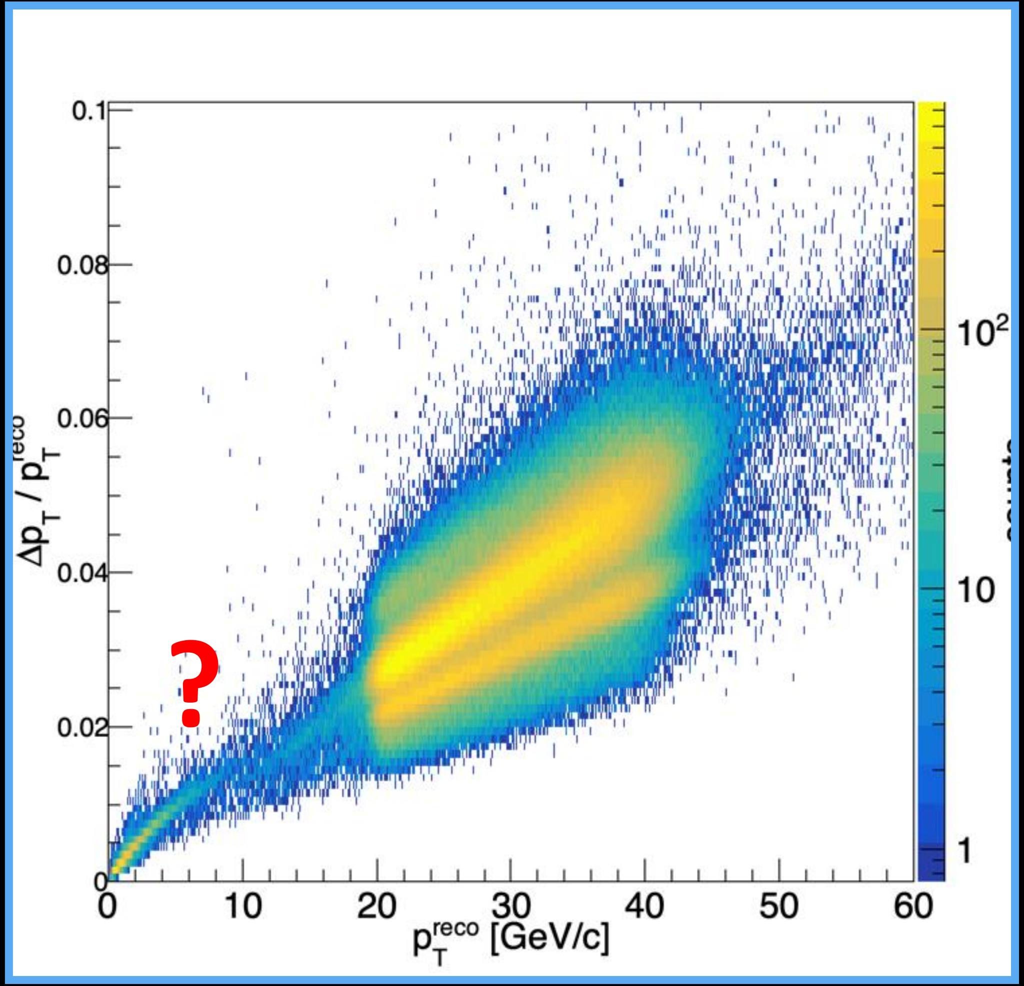



# Percent Error over $p_T^{reco}$ | 20 – 40 GeV/c



# Percent Error over $p_T^{reco}$ | 0 – 20 vs. 20 – 40 GeV/c

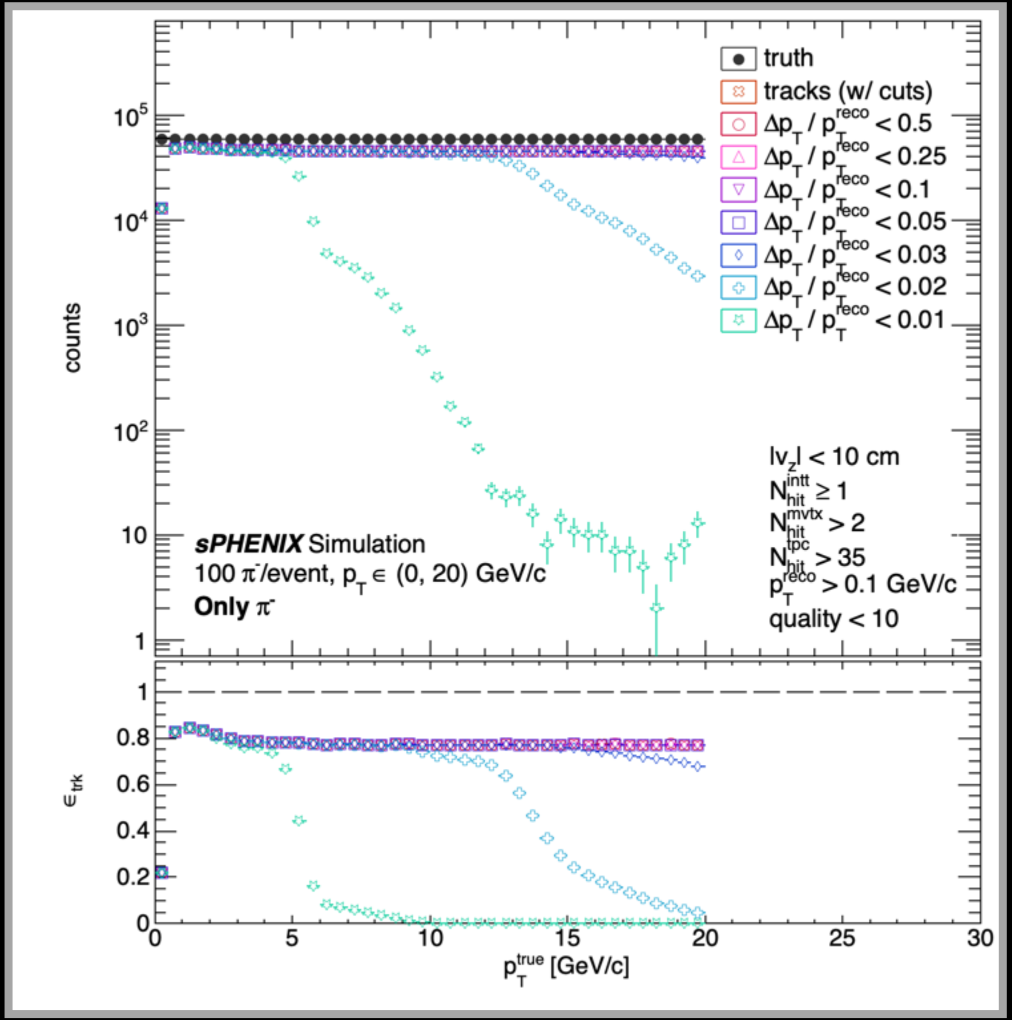


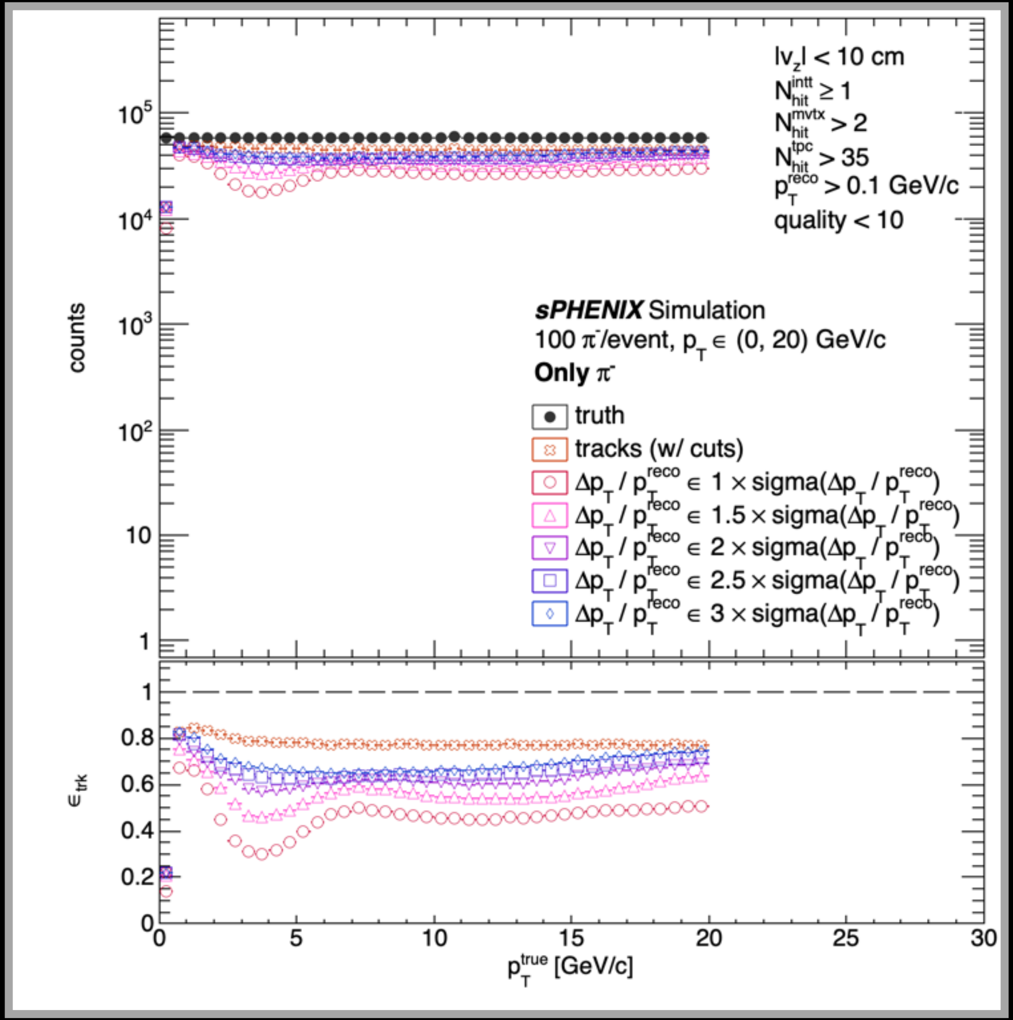

**0 – 20 GeV/c**

**20 – 40 GeV/c**

# $p_T^{reco}$-Dependent Cut | efficiencies (0 – 20 GeV/c)

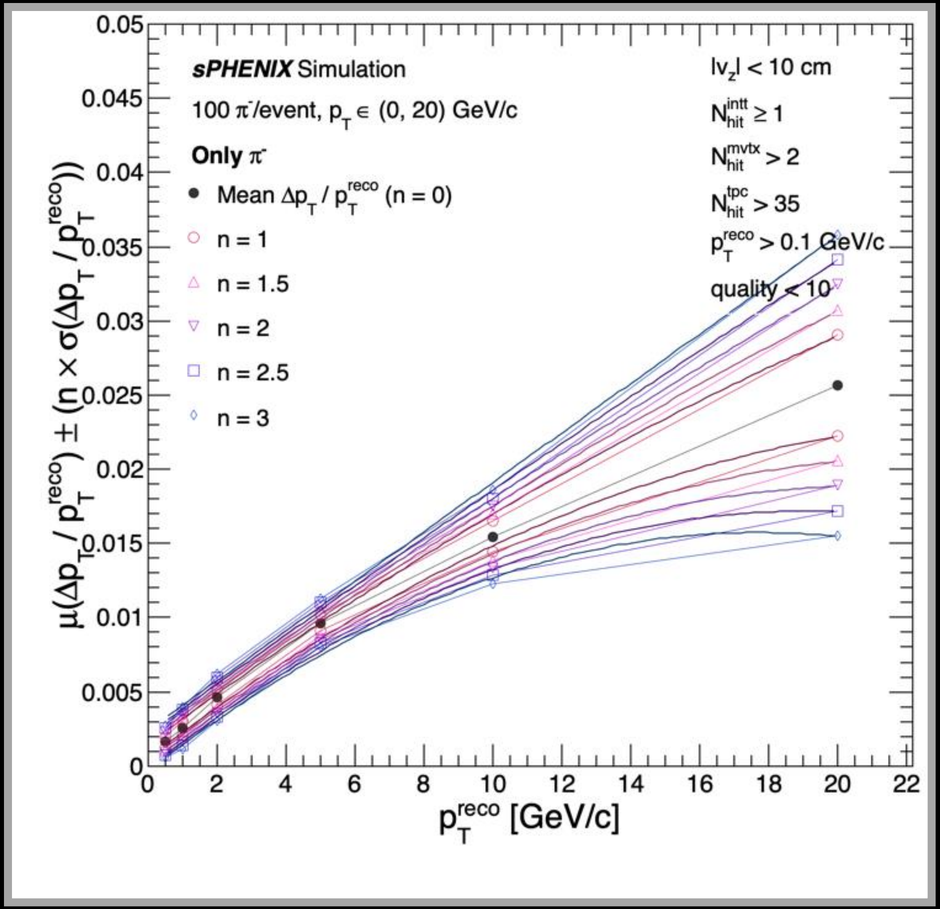


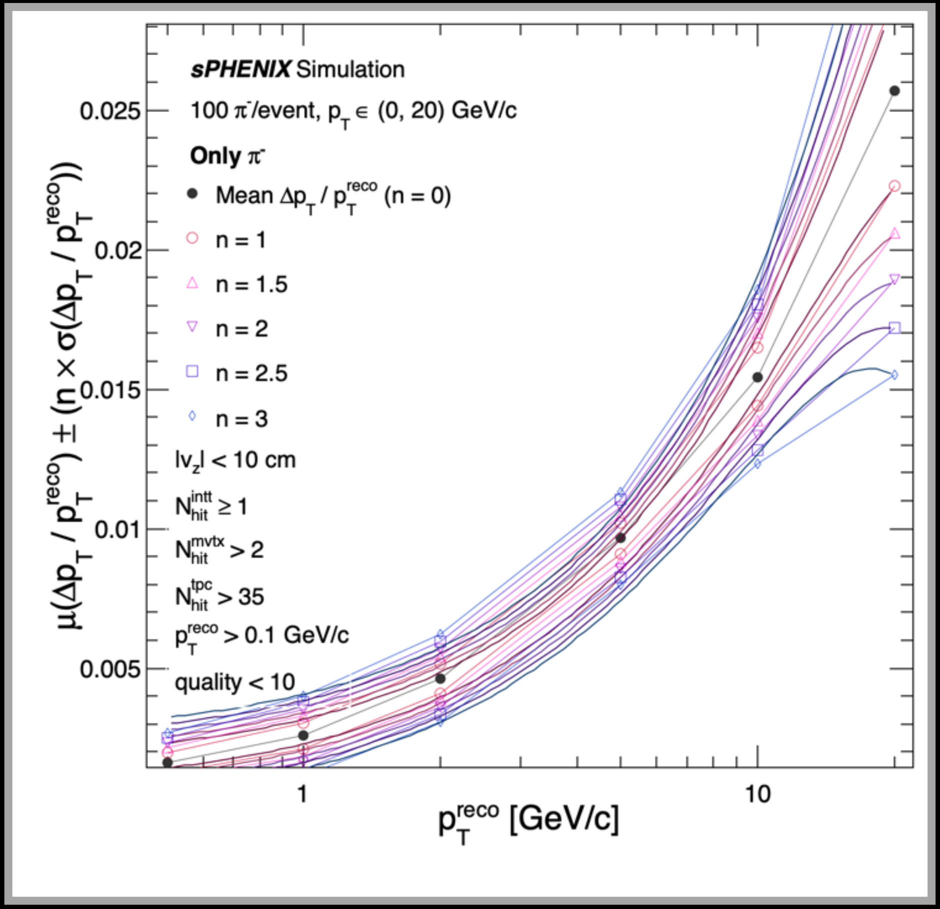

**Flat Cuts**



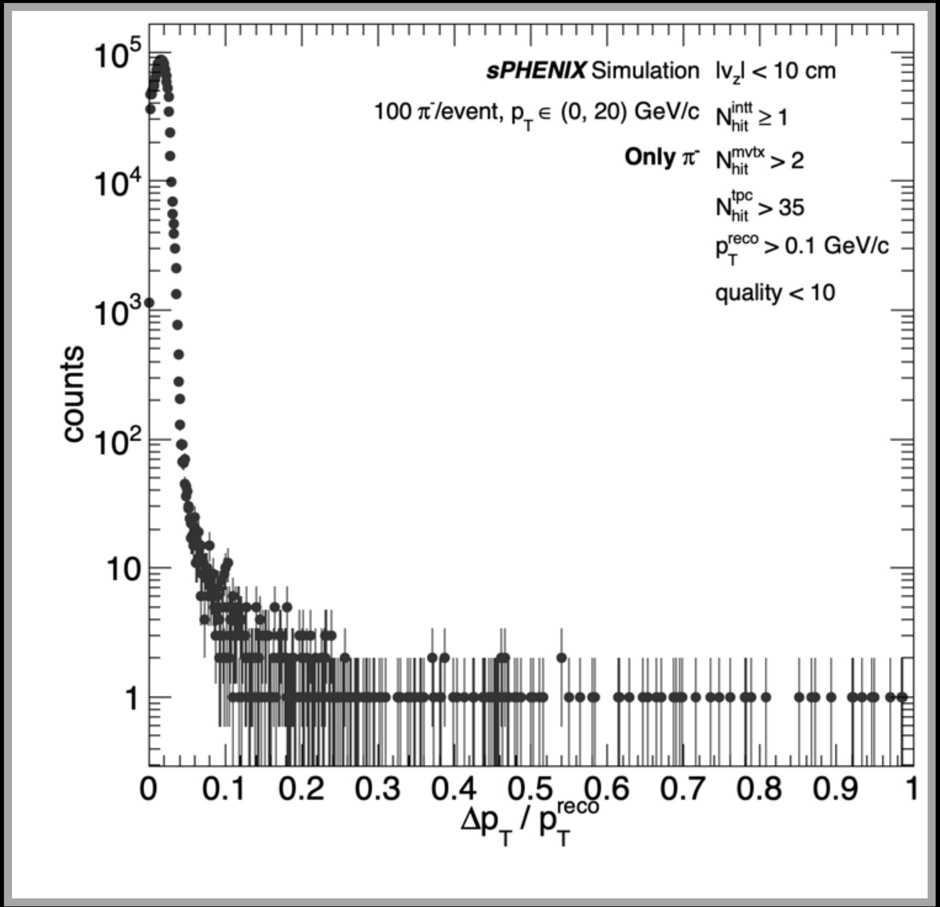

**pT-Depdendent Cut**

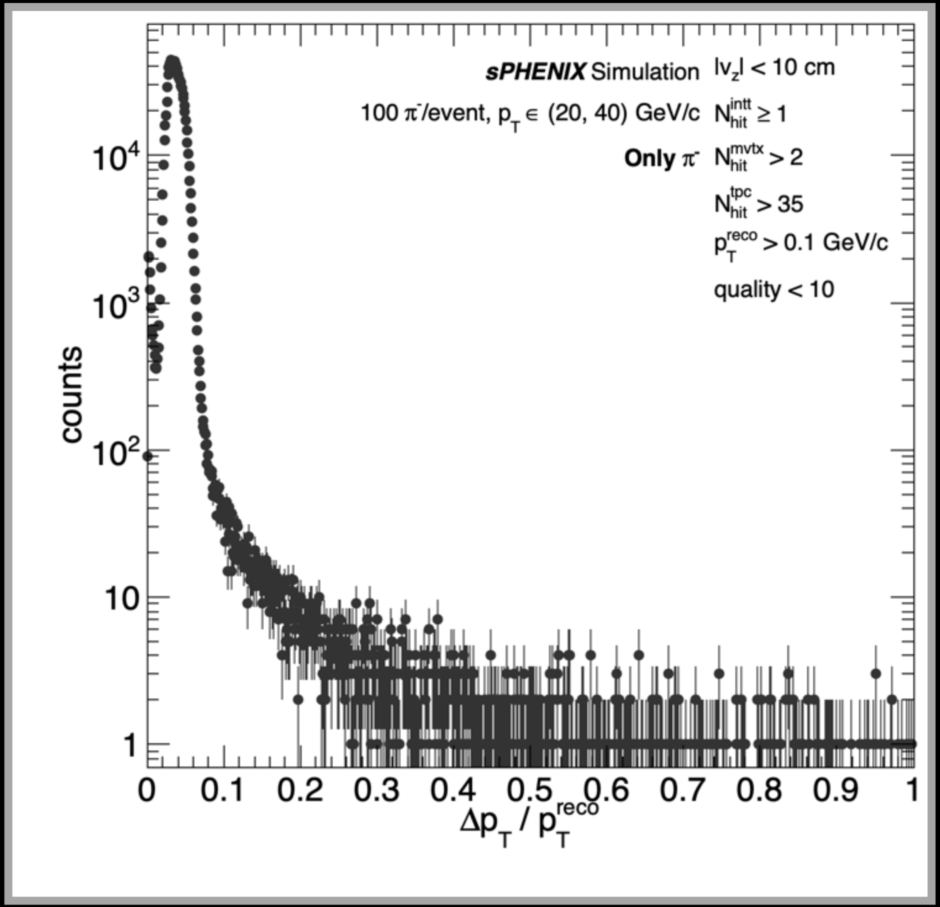
# $p_T^{reco}$-Dependent Cut | extracted $\mu \pm n\sigma$ (0 – 20 GeV/c)



# Backup | 1D Percent Error over $p_T^{reco}$



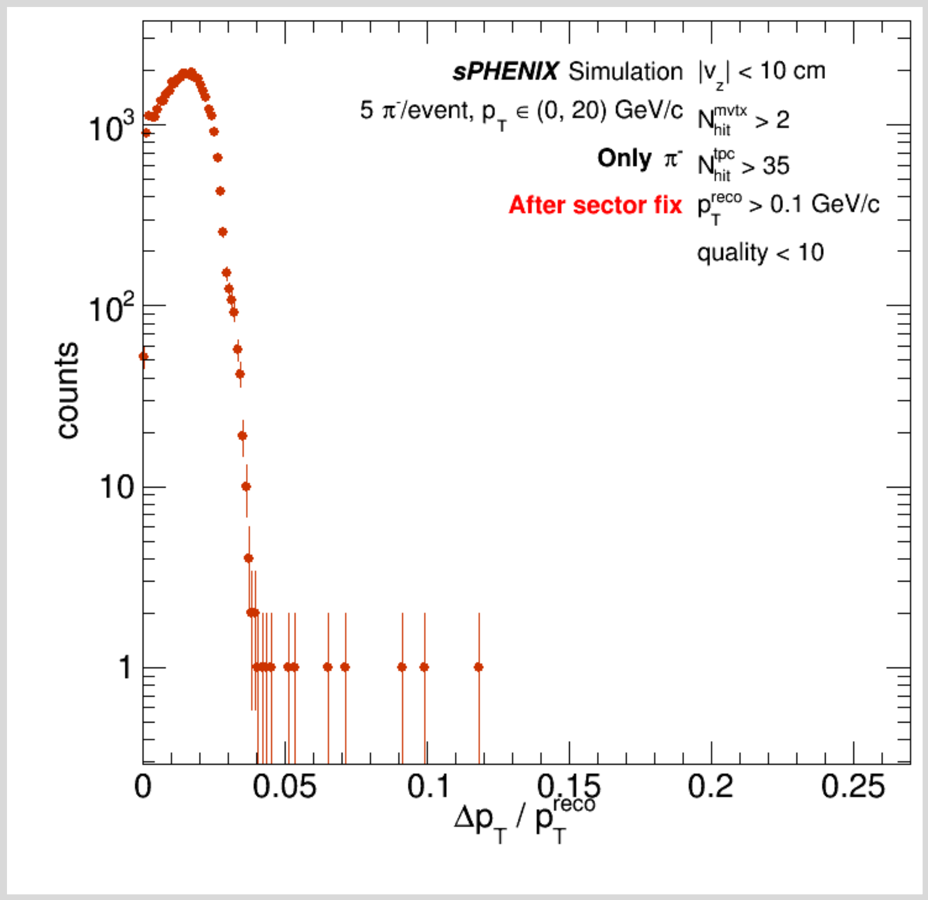



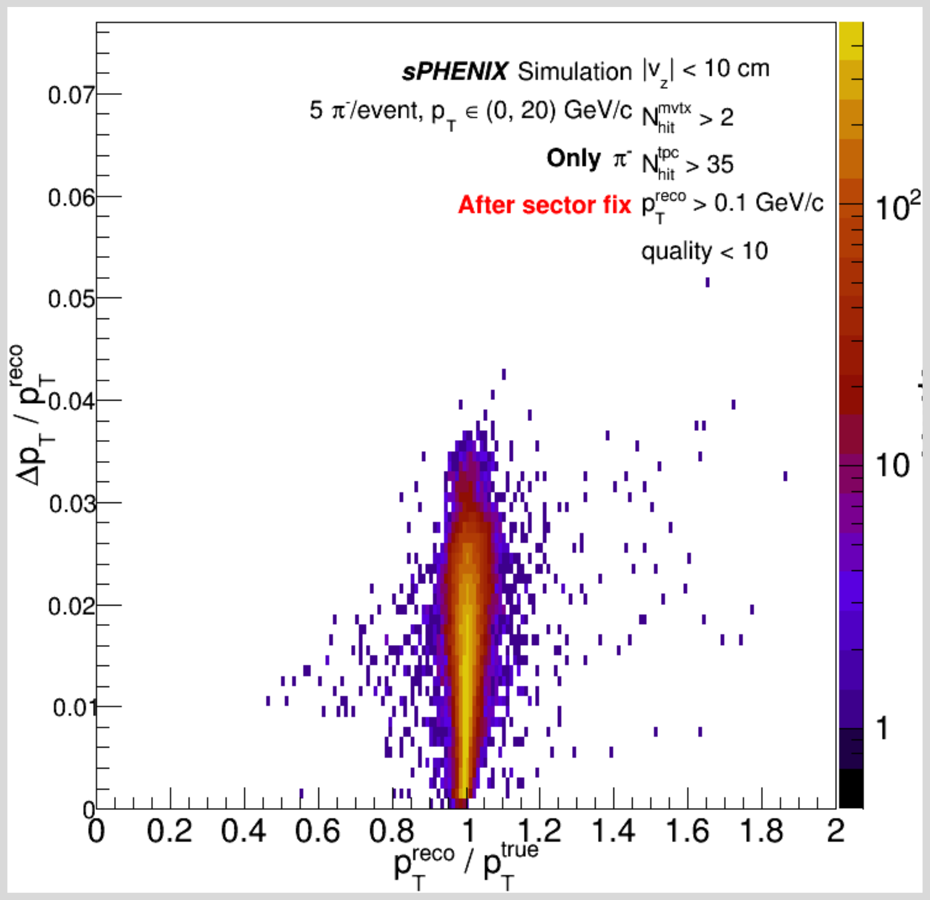

**0 – 20 GeV/c**

**20 – 40 GeV/c**

# Track Percent Errors

W/ SECTOR FIX

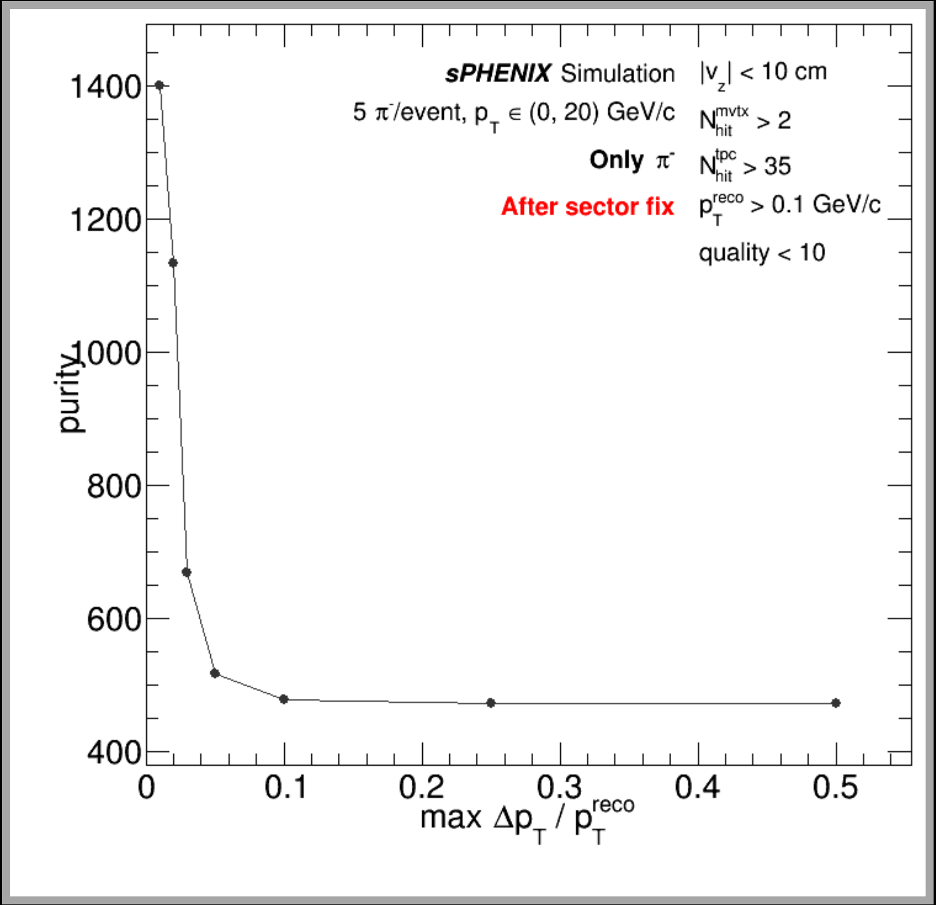


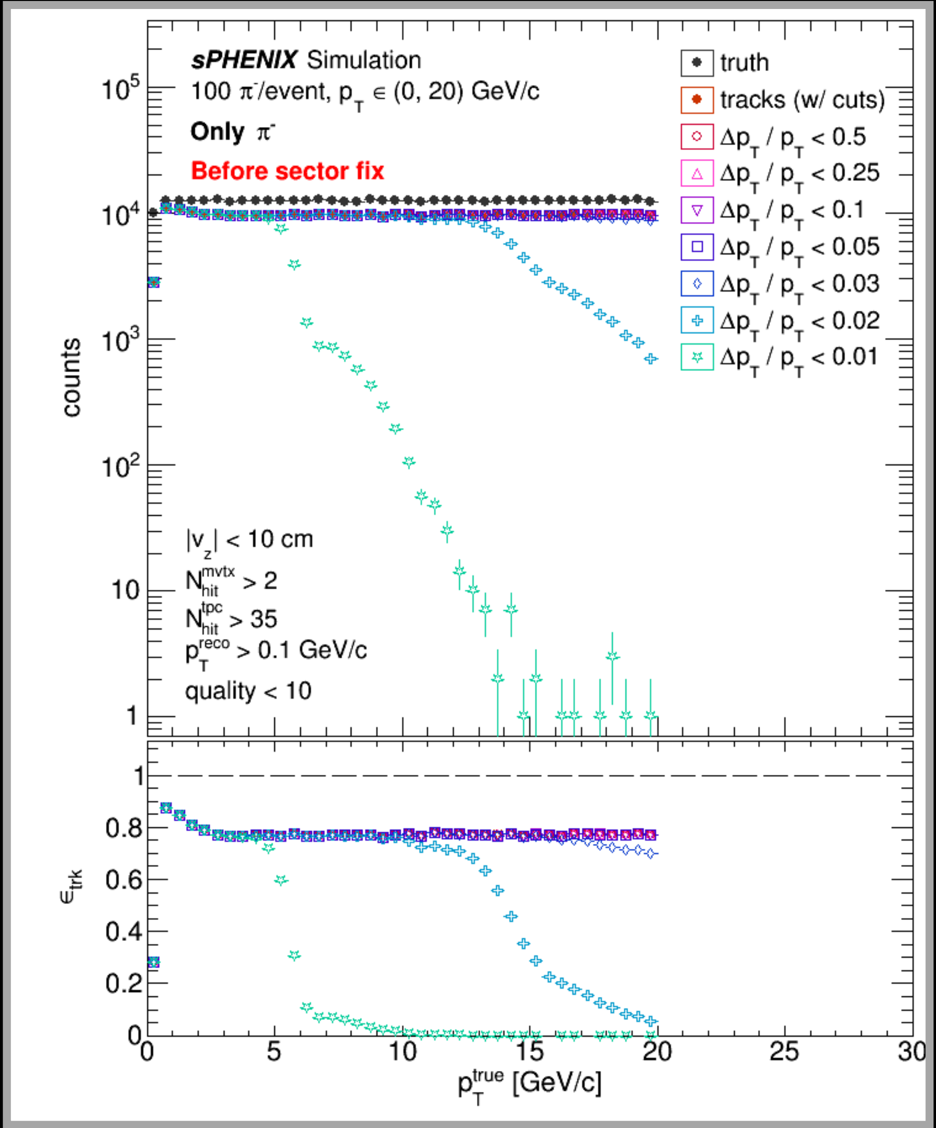




- **Shown:** %-errors on track $p_T$
  - 1D distribution (left) and Vs. $p_T^{reco}/p_T^{true}$ (right)
  - For $N_\pi = 5$ events

# Track Efficiency and Purity

W/ SECTOR FIX

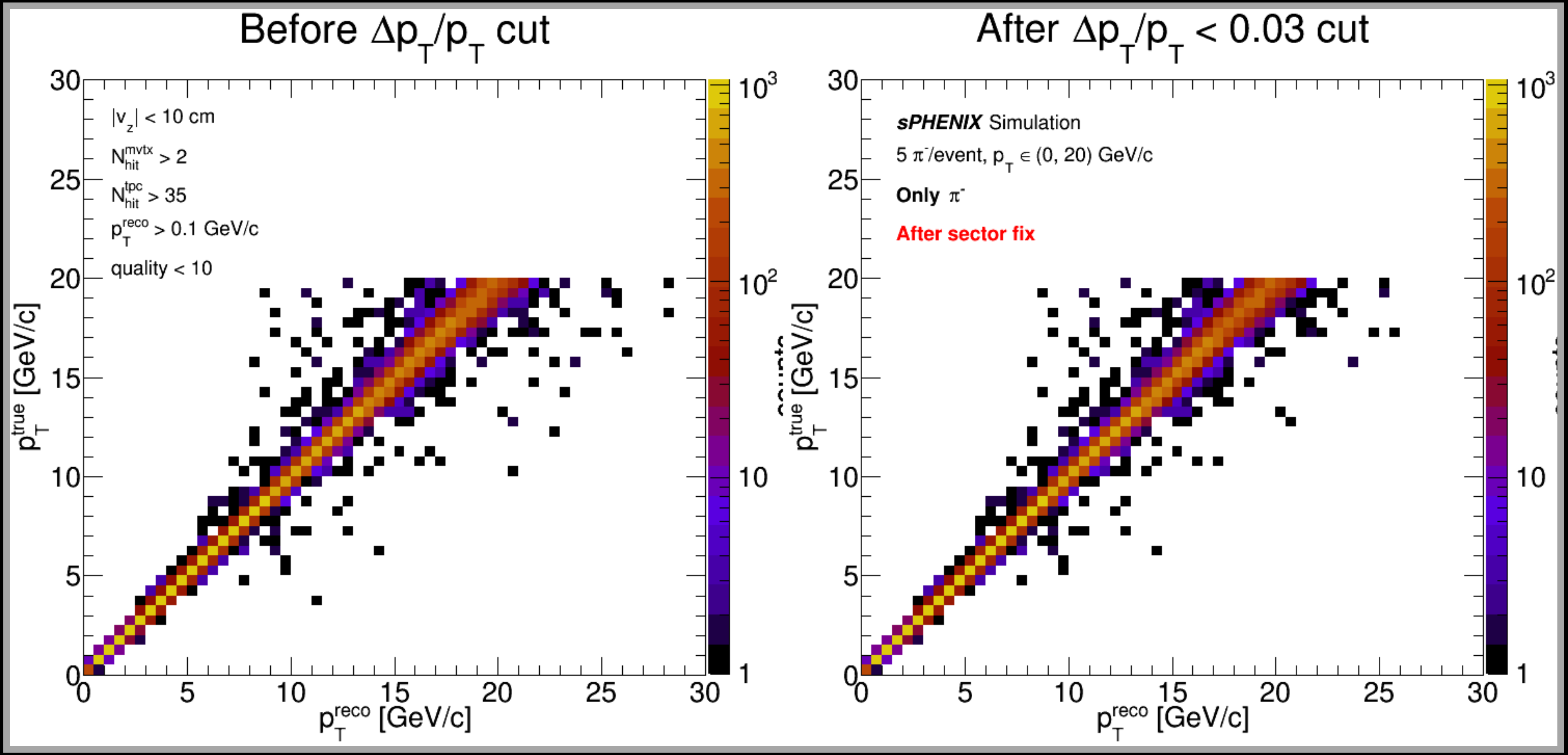



- **Shown:** purity (left) and efficiency right) vs. $\Delta p_T / p_T^{reco}$ cuts
  - For $N_\pi = 5$ events

# Track vs. Truth $p_T$ Before and After $\Delta p_T$ Cuts

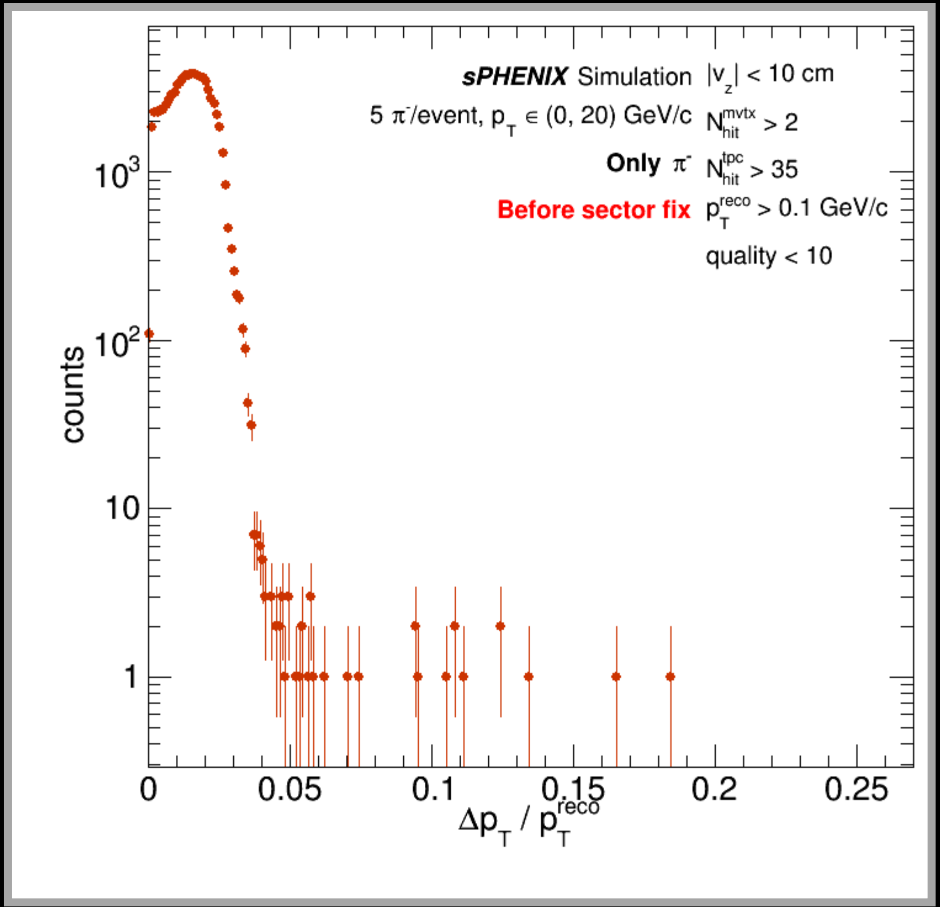
**W/ SECTOR FIX**

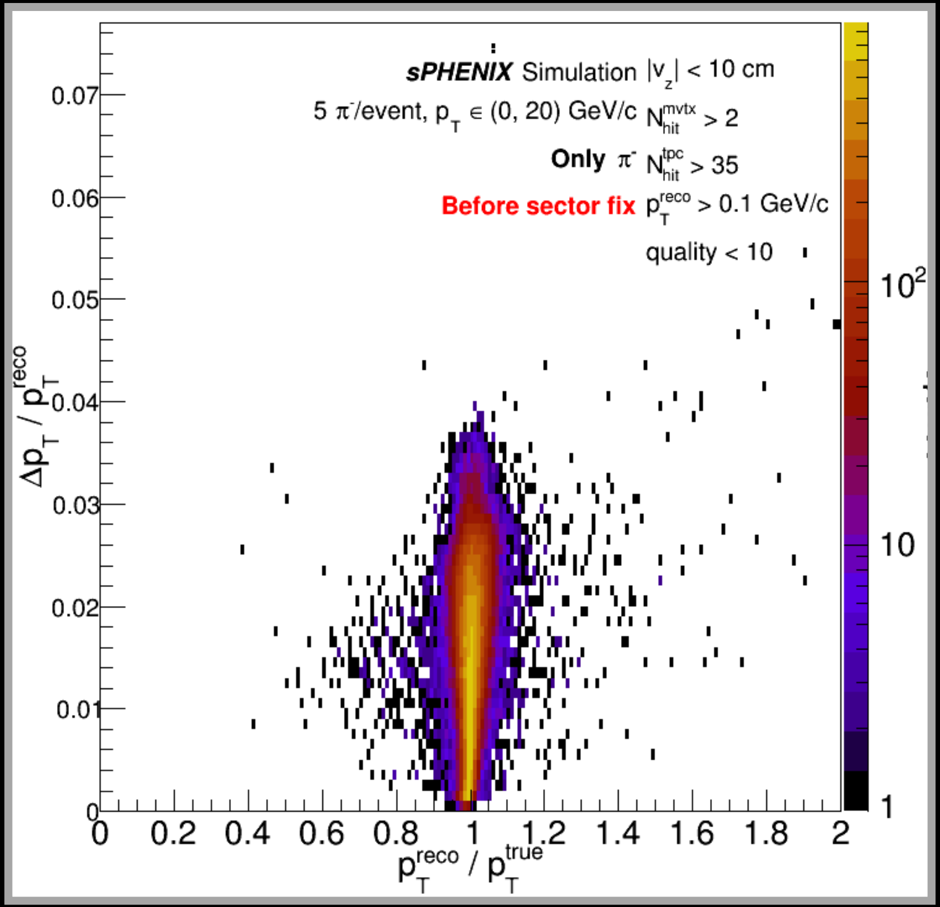



- **Shown:** 2D distribution of truth vs. reconstructed $p_T$
  - No $\Delta p_T$ cut (left) and w/ $\Delta p_T$ (right)
  - For $N_\pi = 5$ events

# Backup | Track Percent Errors (Before Fix, $N_\pi = 5$)

**NO SECTOR FIX**

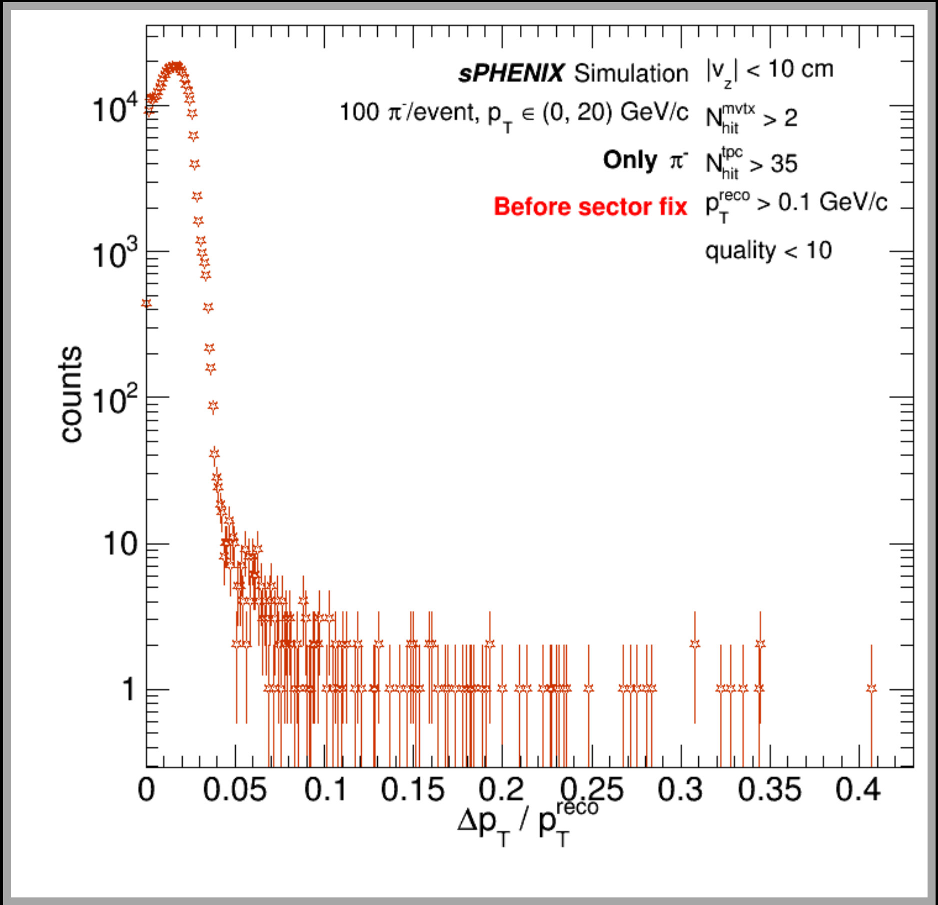


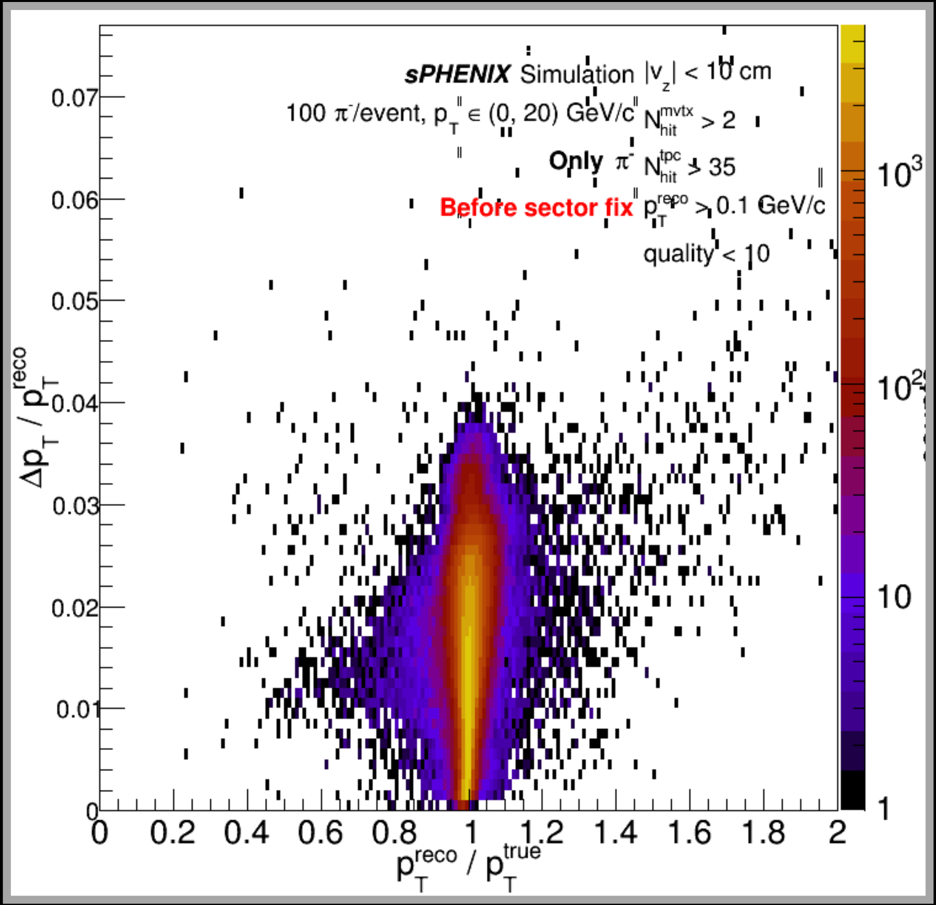




- **Shown:** %-errors on track $p_T$
  - 1D distribution (left) and Vs. $p_T^{reco}/p_T^{true}$ (right)
  - For $N_\pi = 5$ events

# Backup | Track Percent Errors (Before Fix, $N_\pi = 100$)

**NO SECTOR FIX**

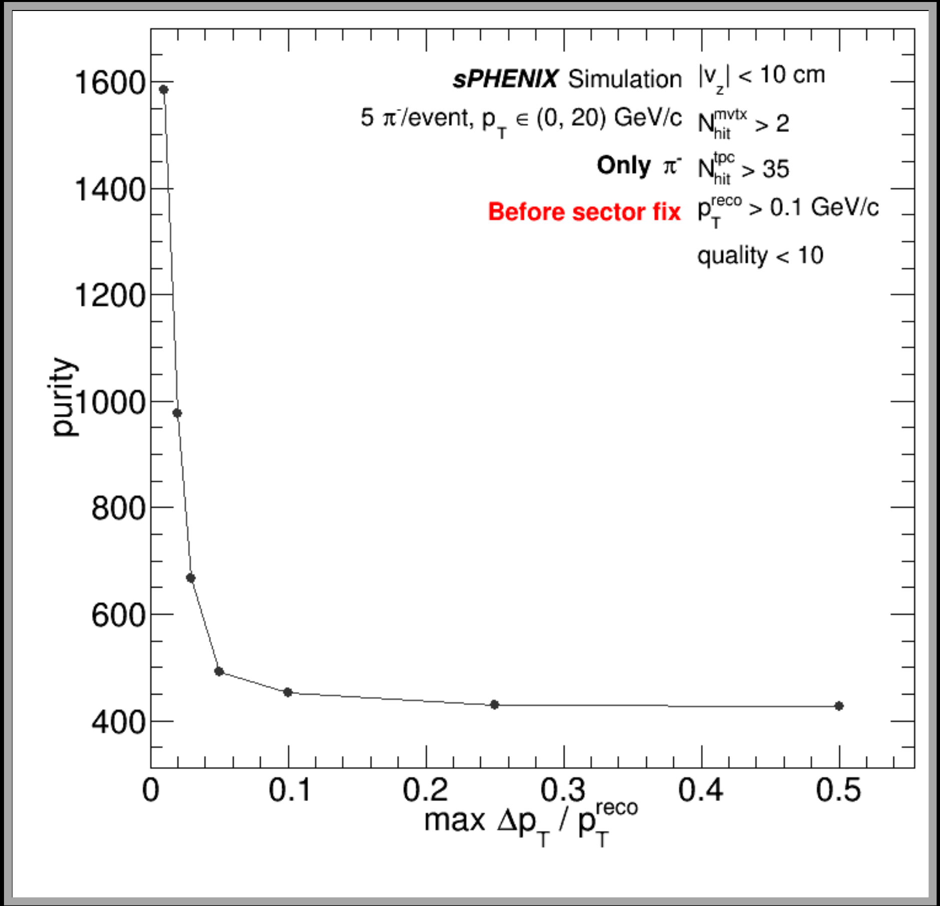


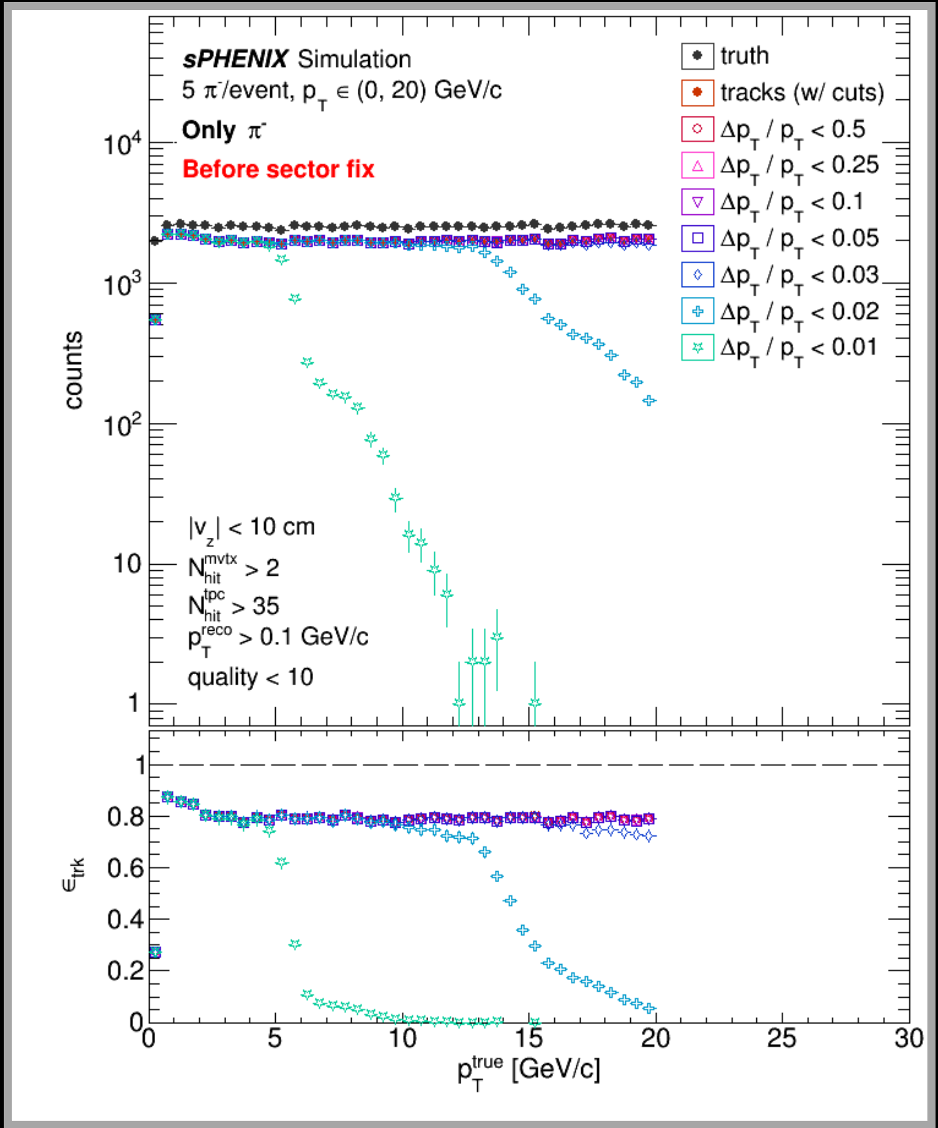




- **Shown:** %-errors on track $p_T$
  - 1D distribution (left) and Vs. $p_T^{reco}/p_T^{true}$ (right)
  - For $N_\pi = 100$ events

# Backup | Track Efficiency and Purity (Before Fix, $N_\pi = 5$)

**NO SECTOR FIX**

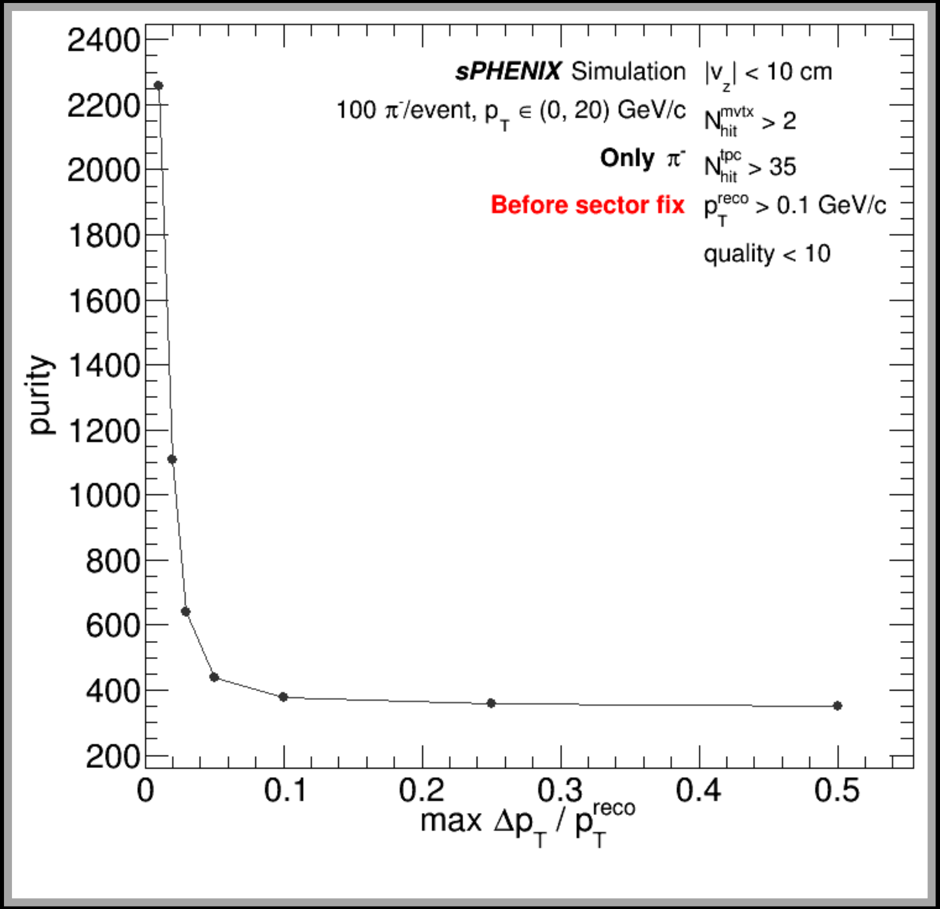


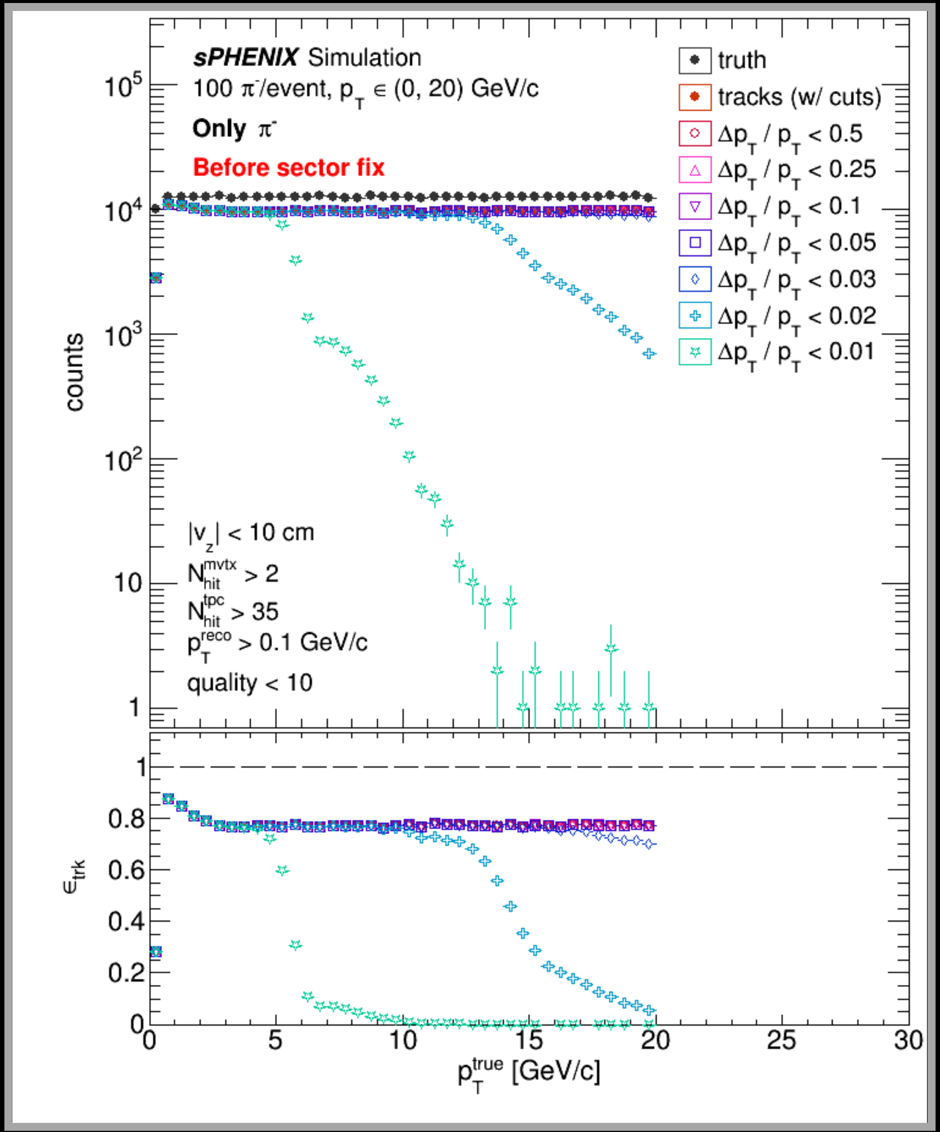




- **Shown:** purity (left) and efficiency right) vs. $\Delta p_T / p_T^{reco}$ cuts
  - For $N_\pi = 5$ events

# Backup | Track Efficiency and Purity (Before Fix, $N_\pi = 100$)

**NO SECTOR FIX**

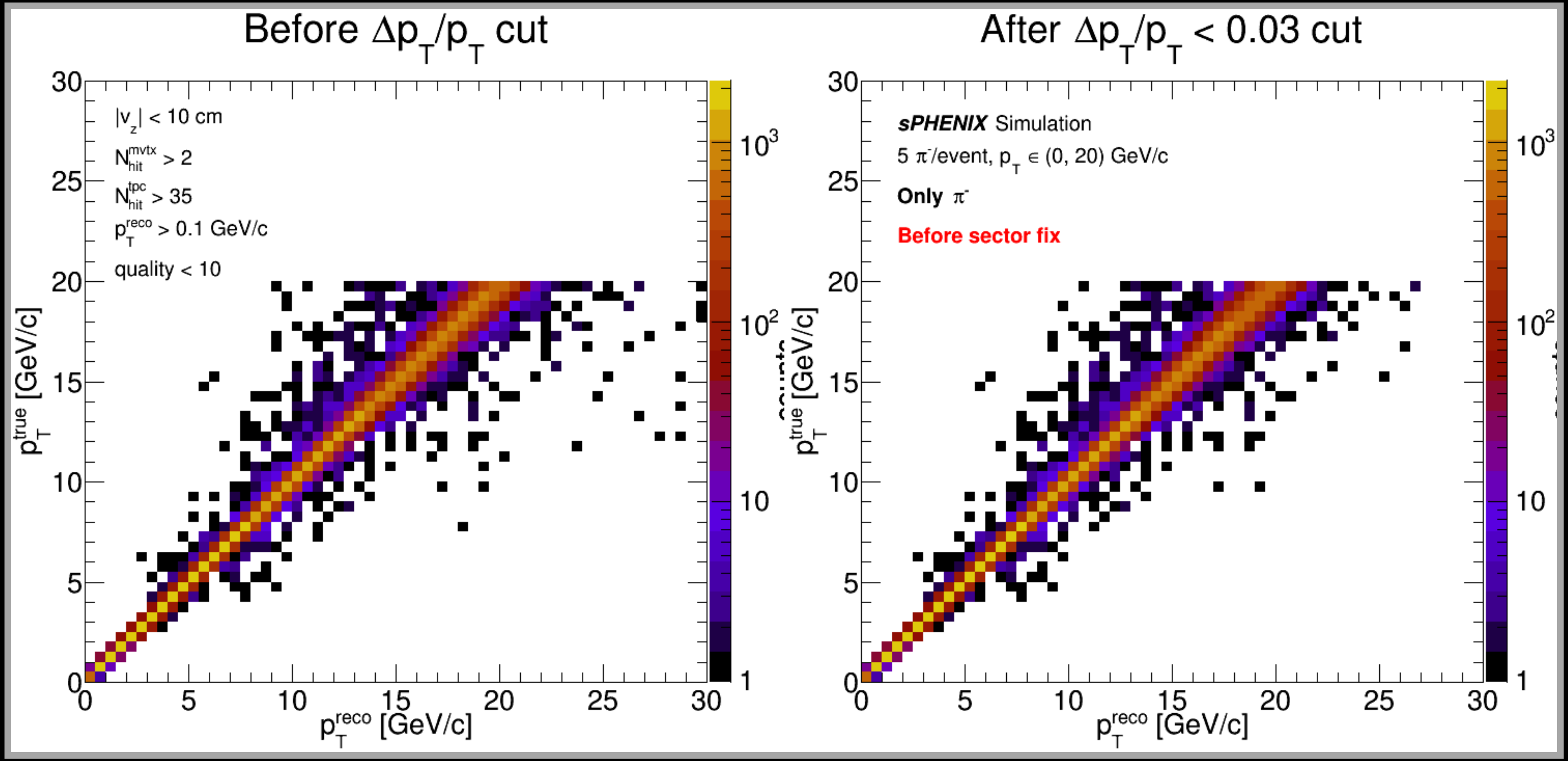



- **Shown:** purity (left) and efficiency right) vs. $\Delta p_T / p_T^{reco}$ cuts
  - For $N_\pi = 100$ events

# Backup | Track vs. Truth $p_T$ (Before Fix, $N_\pi = 5$)

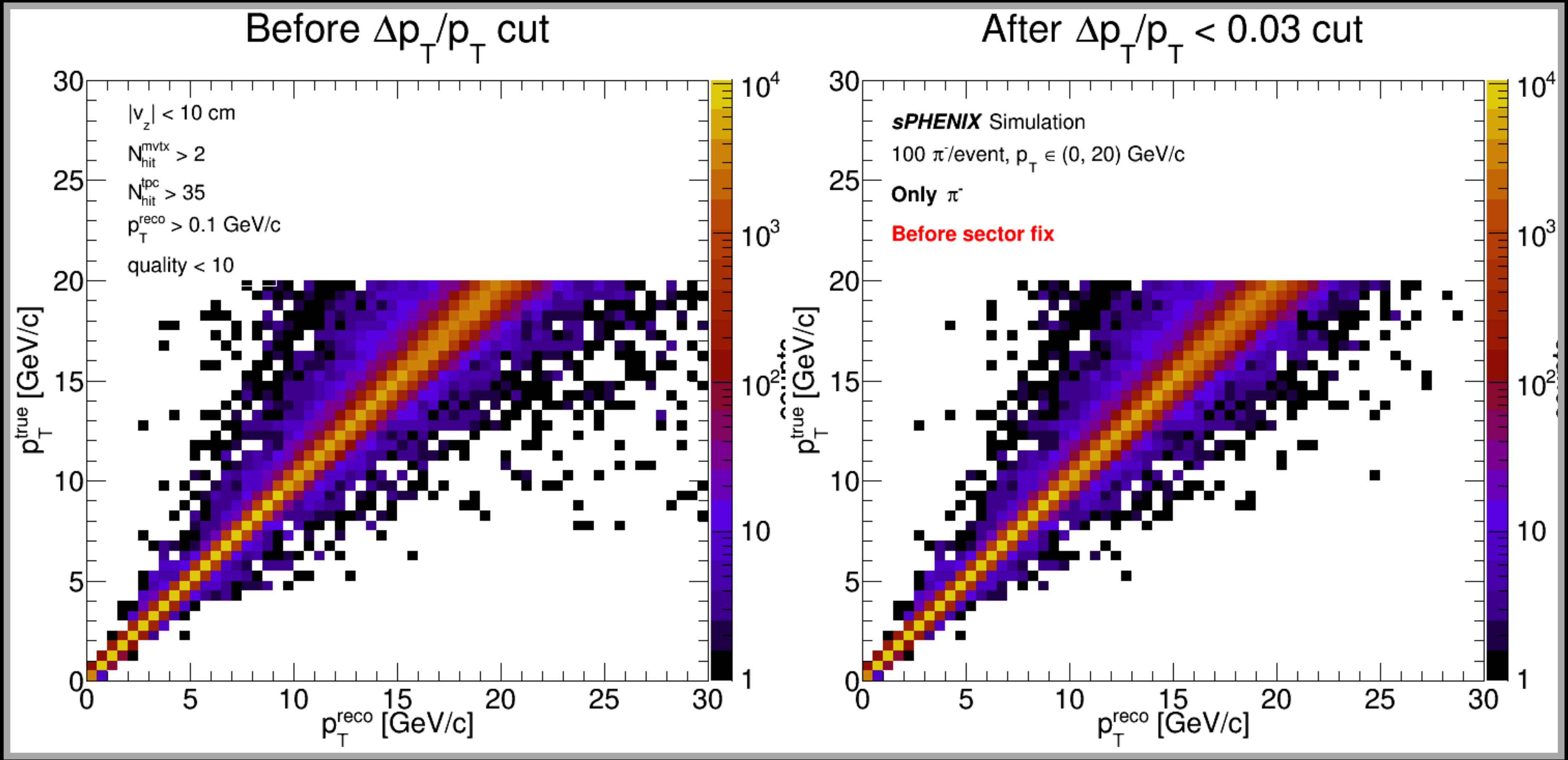
**NO SECTOR FIX**




- **Shown:** 2D distribution of truth vs. reconstructed $p_T$
  - No $\Delta p_T$ cut (left) and w/ $\Delta p_T$ (right)
  - For $N_\pi = 5$ events

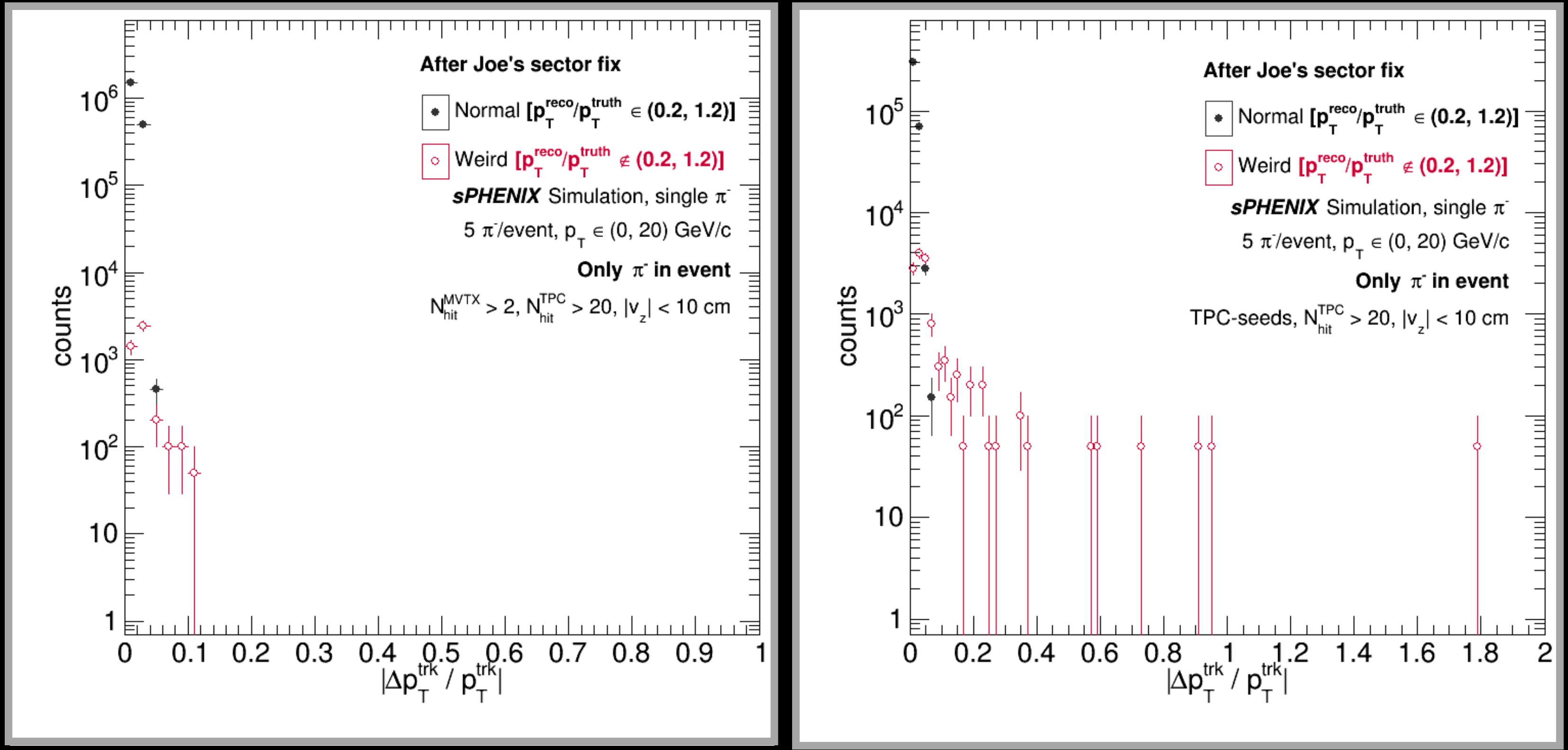
# Backup | Track vs. Truth $p_T$ (Before Fix, $N_\pi = 100$)

**NO SECTOR FIX**




- **Shown:** 2D distribution of truth vs. reconstructed $p_T$
  - No $\Delta p_T$ cut (left) and w/ $\Delta p_T$ (right)
  - For $N_\pi = 100$ events

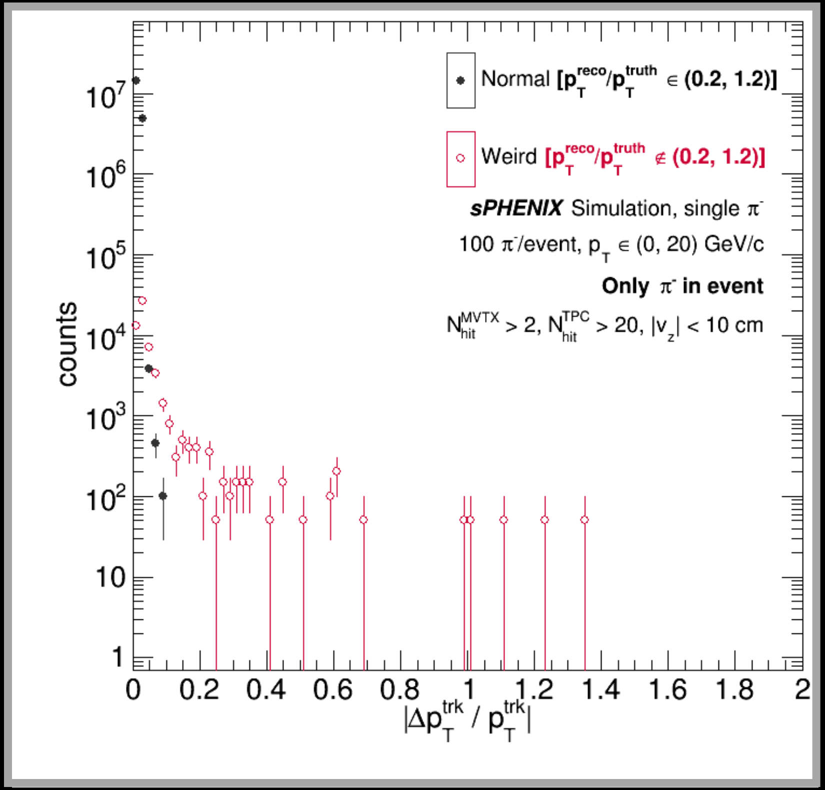
# Track Percent Errors | TPC-Seed vs. w/ MVTX After Sector Fix

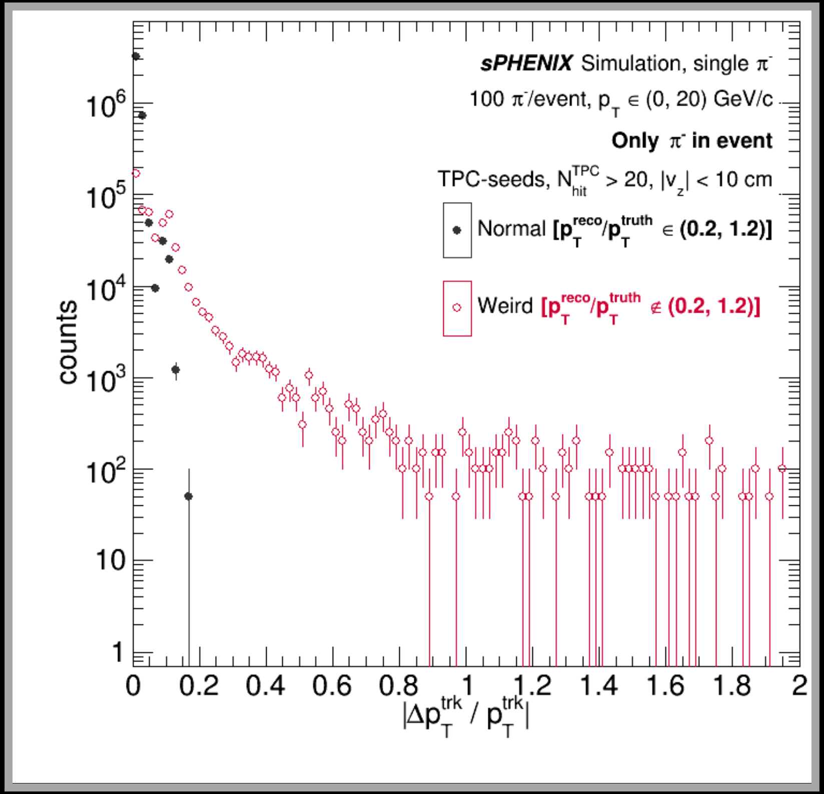



**W/ SECTOR FIX**

- **Shown:** %-errors on track $p_T$
  - W/ MVTX hits (left) vs. TPC-Seeds (right)
  - For $N_\pi = 5$ events

# Track Percent Errors | TPC-Seed vs. w/ MVTX



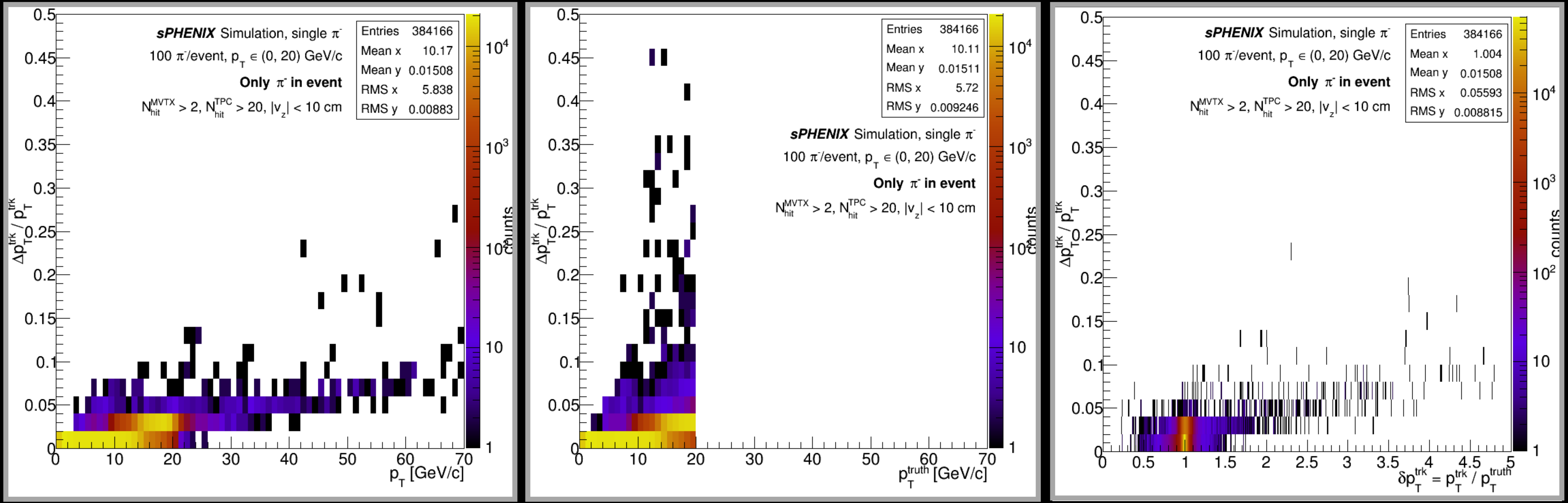




**NO SECTOR FIX**

- **Shown:** %-errors on track $p_T$
  - W/ MVTX hits (left) vs. TPC-Seeds (right)
  - For $N_\pi = 100$ events

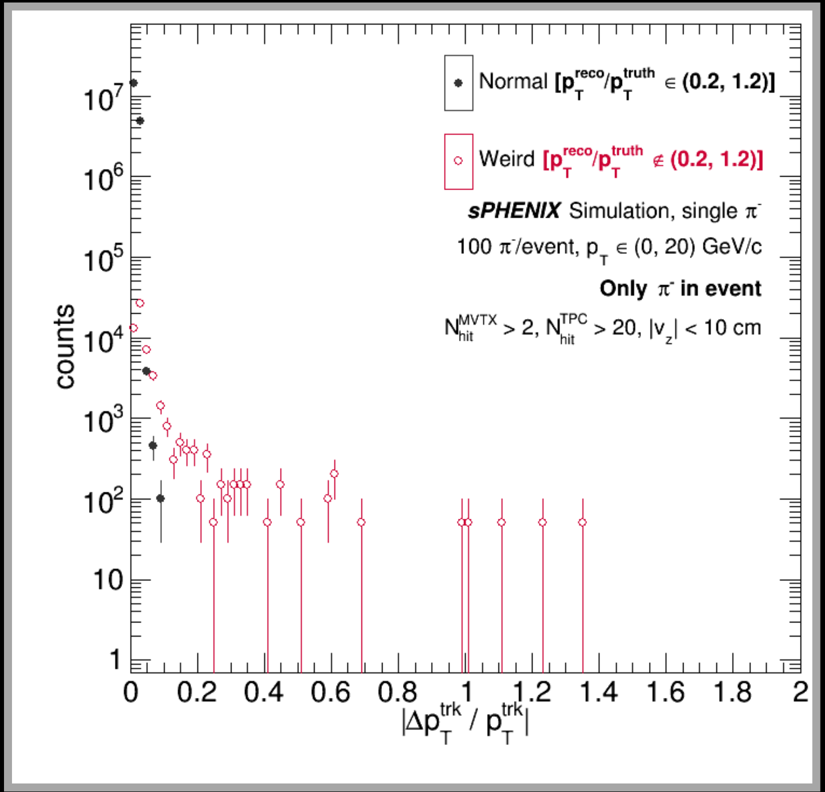
# Track Percent Errors | Percent-error vs. $p_T$

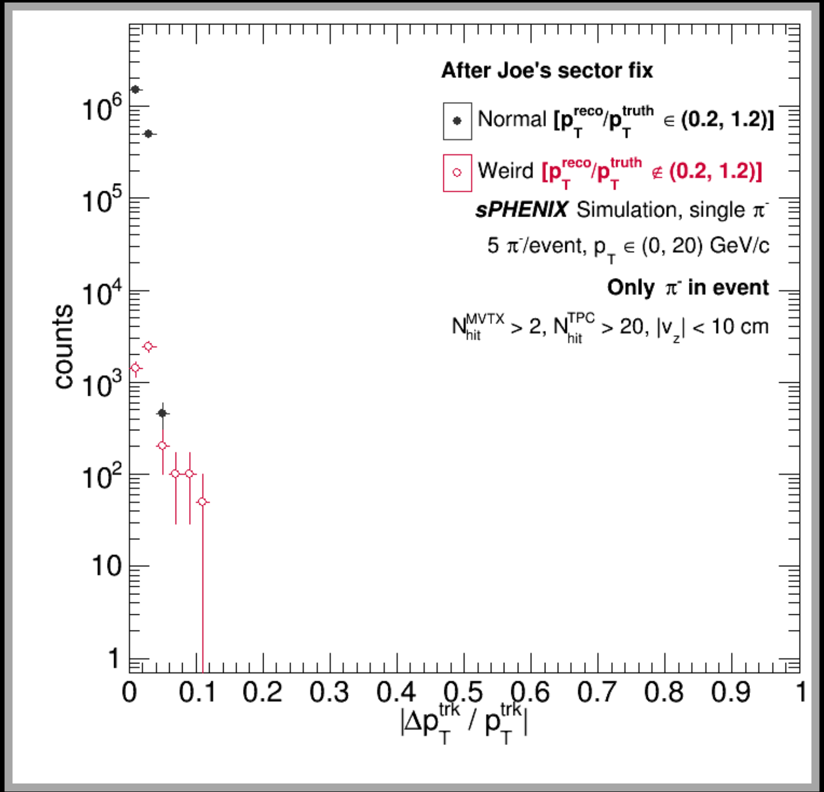
**NO SECTOR FIX**




- **Shown:** %-errors on track $p_T$ vs. reco (right), truth (center), and fractional (left) $p_T$
  - W/ MVTX hits
  - For $N_\pi = 100$ events

# Track Percent Errors | Before vs. After Sector Fix



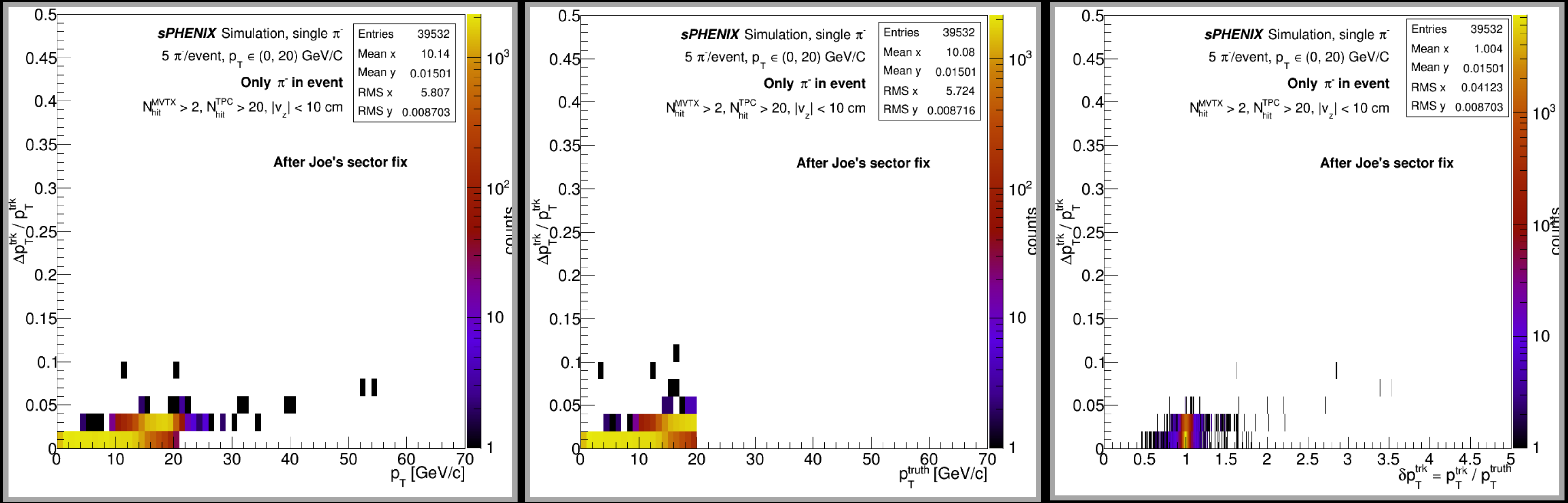

**NO SECTOR FIX**

**W/ SECTOR FIX**

- **Shown:** %-errors on track $p_T$
  - W/ MVTX hits
  - For $N_\pi = 100$ (left) and 5 (right) events

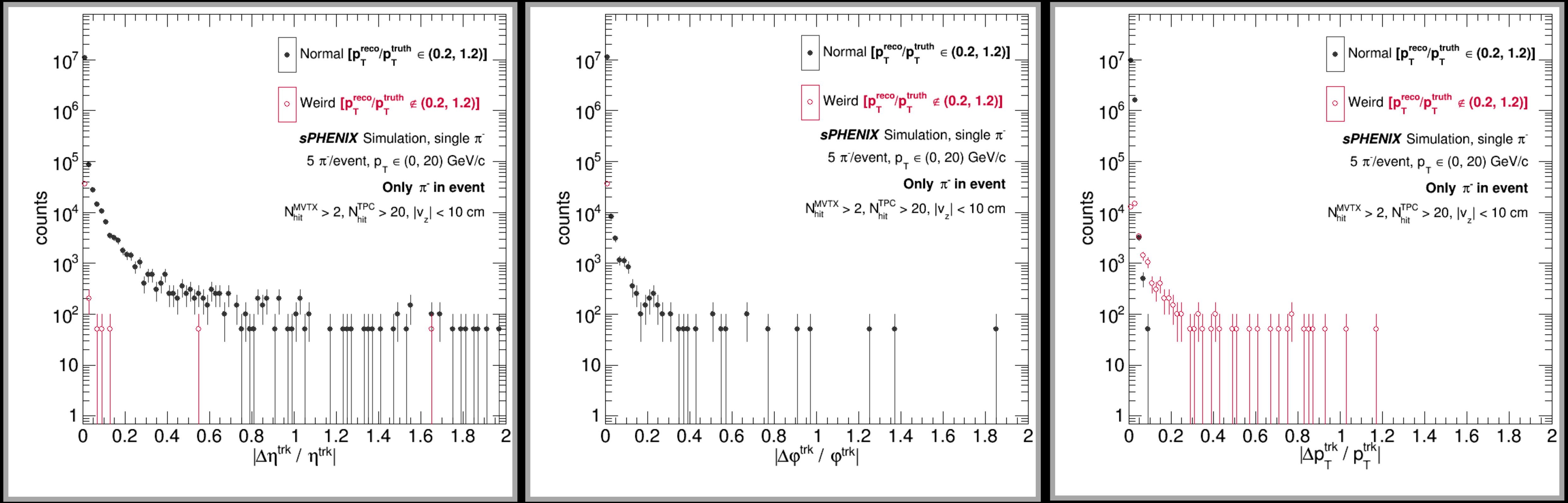
# Track Percent Errors | Percent-error vs. $p_T$

W/ SECTOR FIX



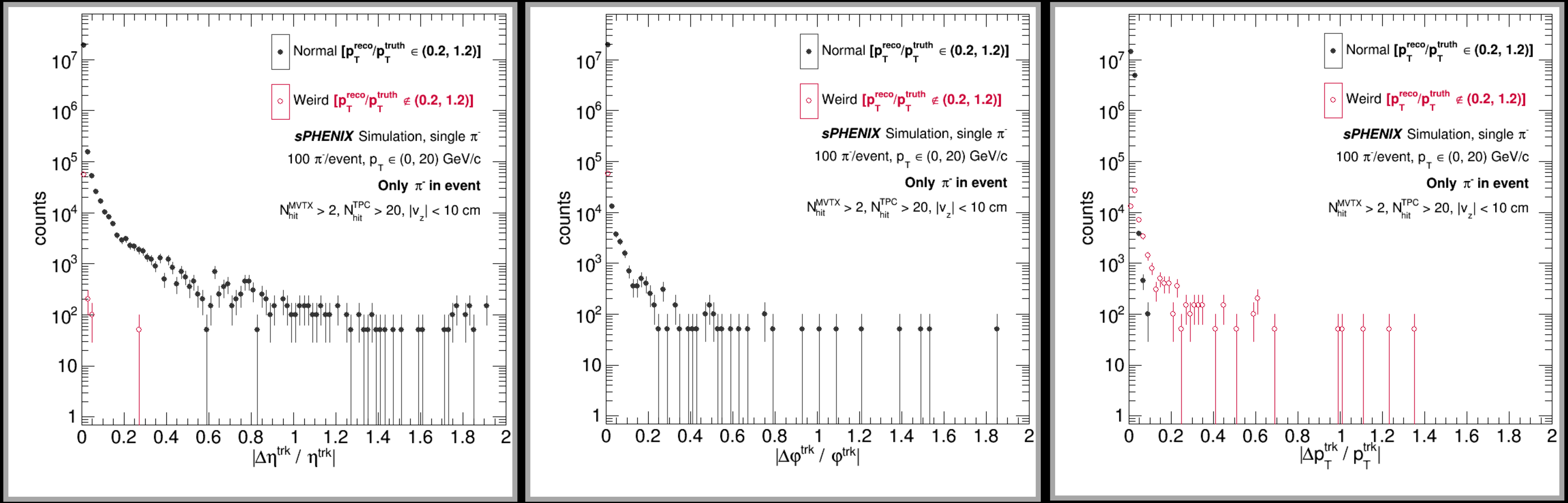

- **Shown:** %-errors on track $p_T$ vs. reco (right), truth (center), and fractional (left) $p_T$
  - W/ MVTX hits
  - For $N_\pi = 5$ events

# Track Percent Errors | $N_\pi = 5$



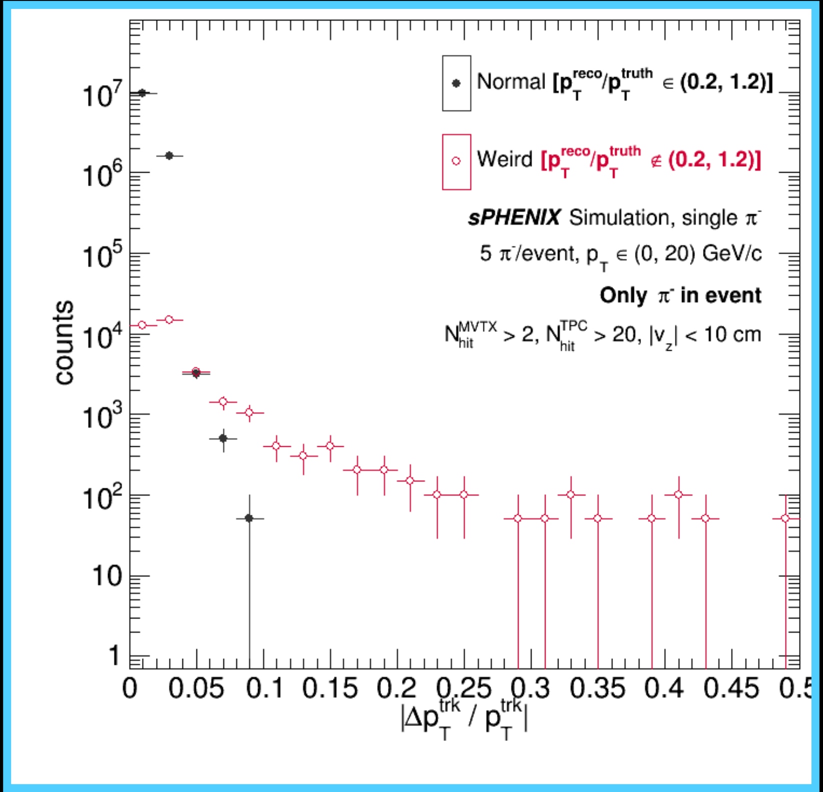

- Shown: %-errors on track $\eta$ (left), $\varphi$ (center), and $p_T$ (right)
  - For $N_\pi = 5$ events

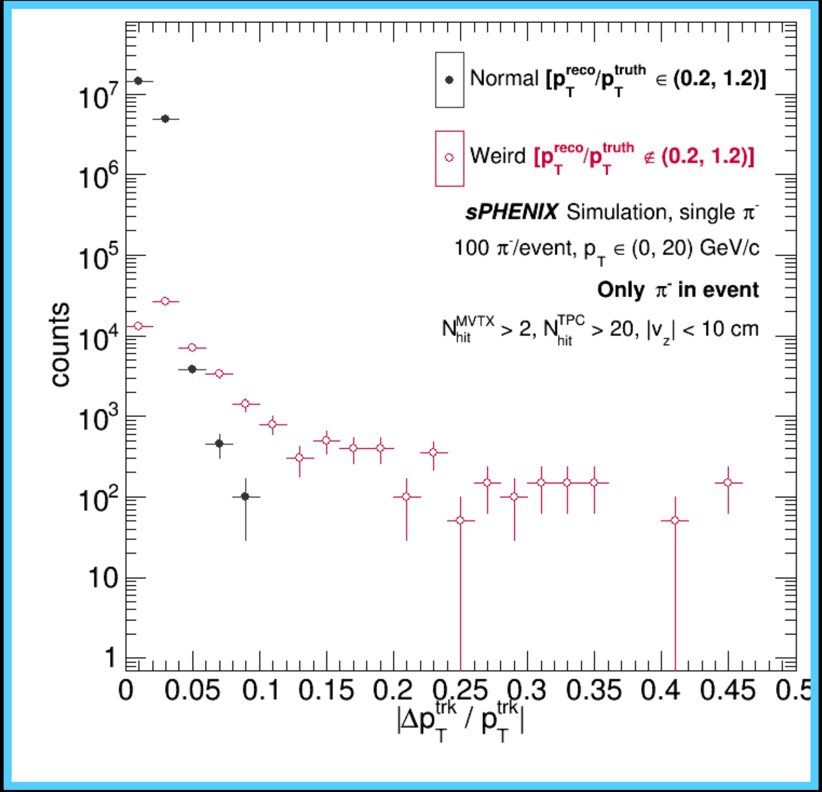
# Track Percent Errors | $N_\pi = 100$




- **Shown:** %-errors on track $\eta$ **(left)**, $\varphi$ **(center)**, and $p_T$ **(right)**
  - For $N_\pi = 100$ events

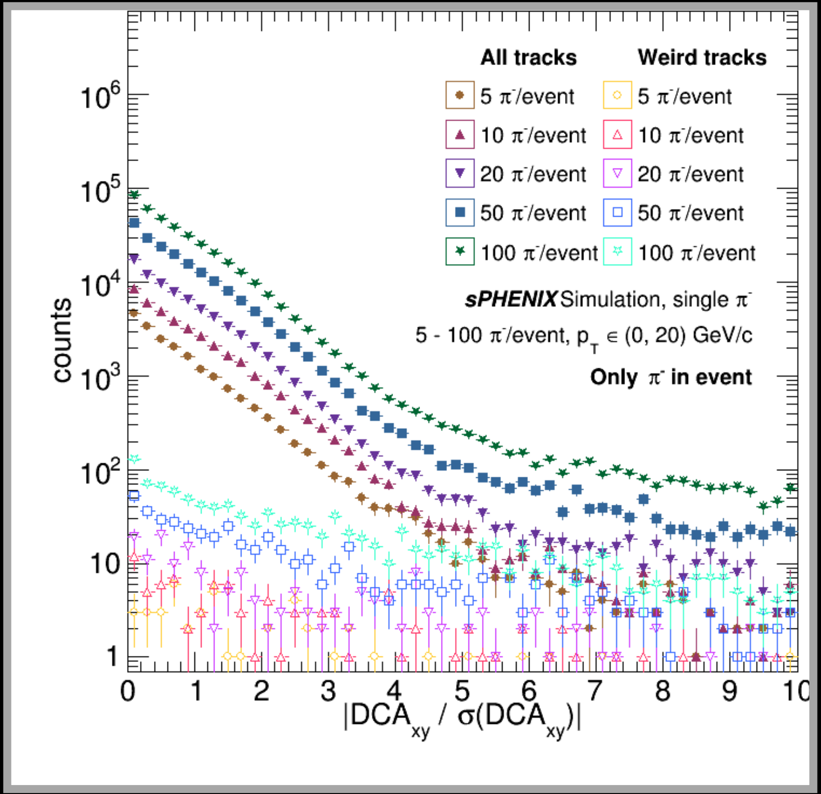
# Track Percent Errors | zoomed-in on x-axis

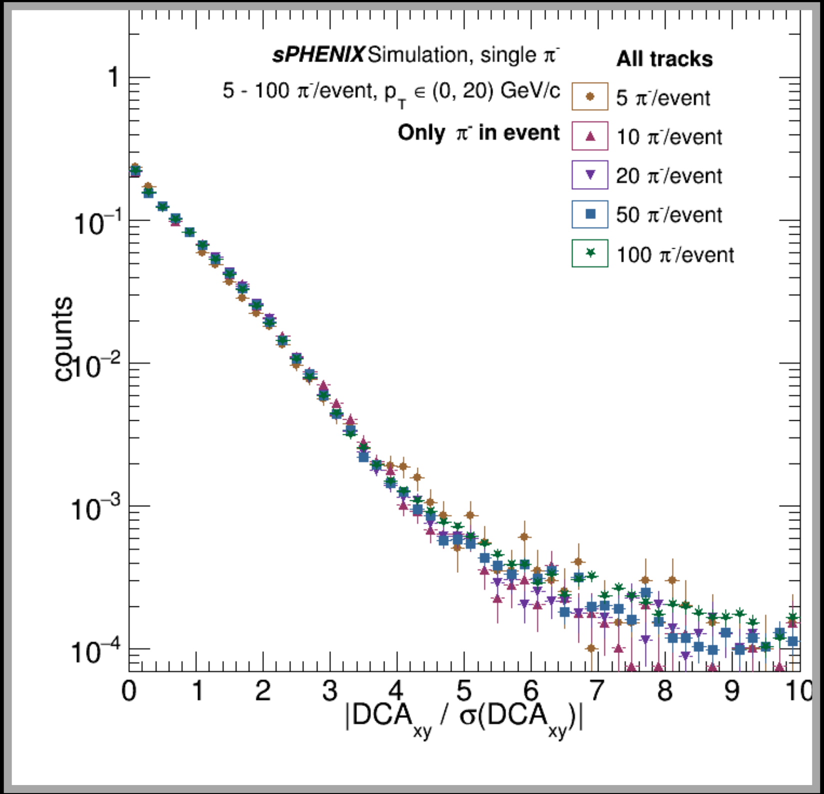


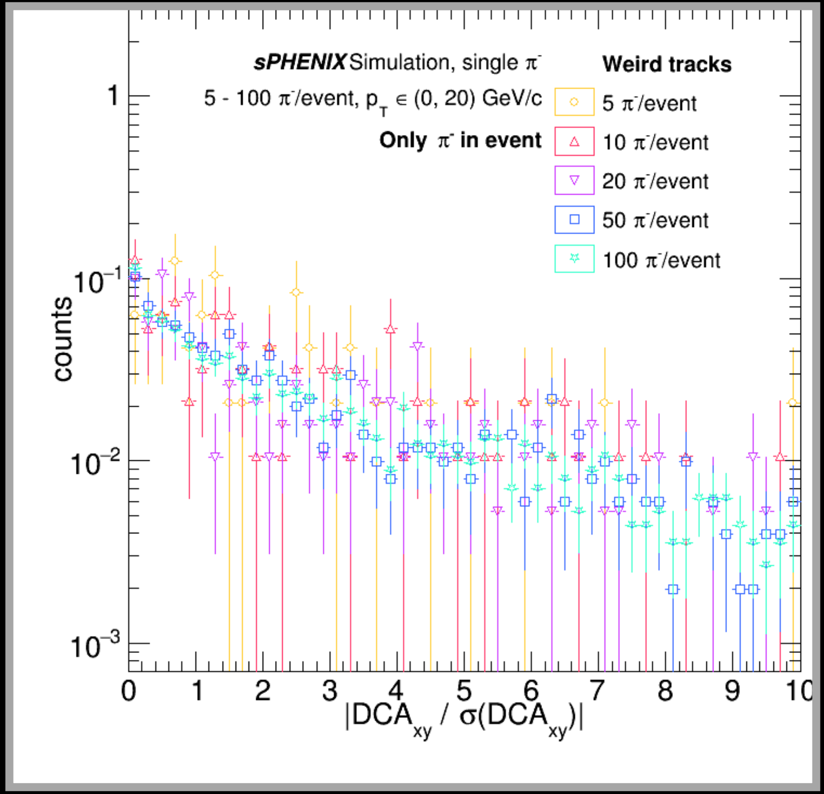




- **Shown:** %-errors on track $p_T$
  - For $N_\pi = 5$ (left) and 100 (right) events

# DCAxy/$\sigma$(DCAxy) vs. $N_\pi$

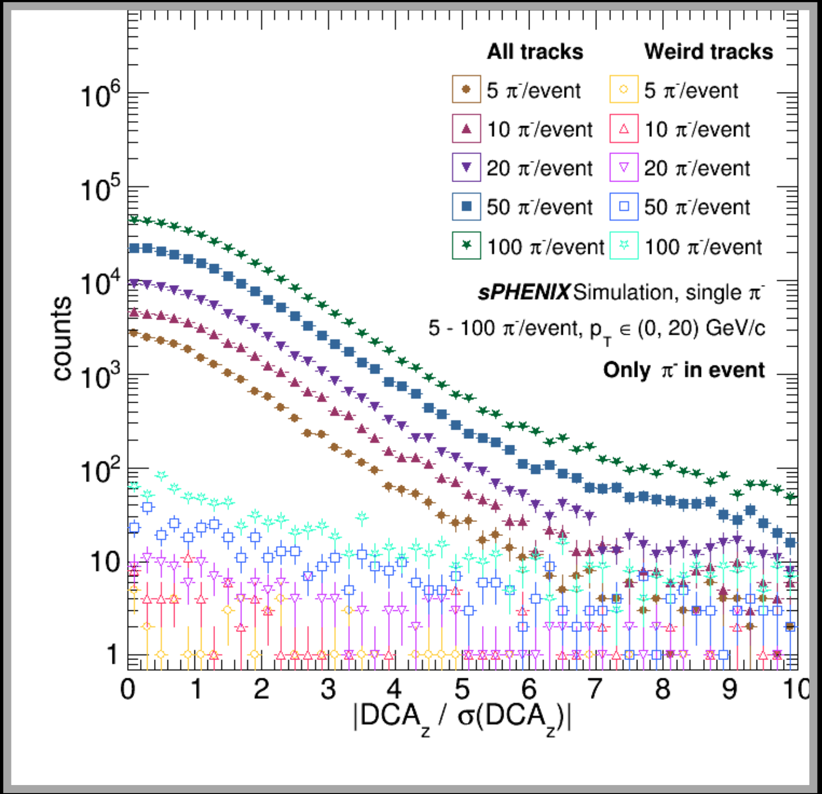


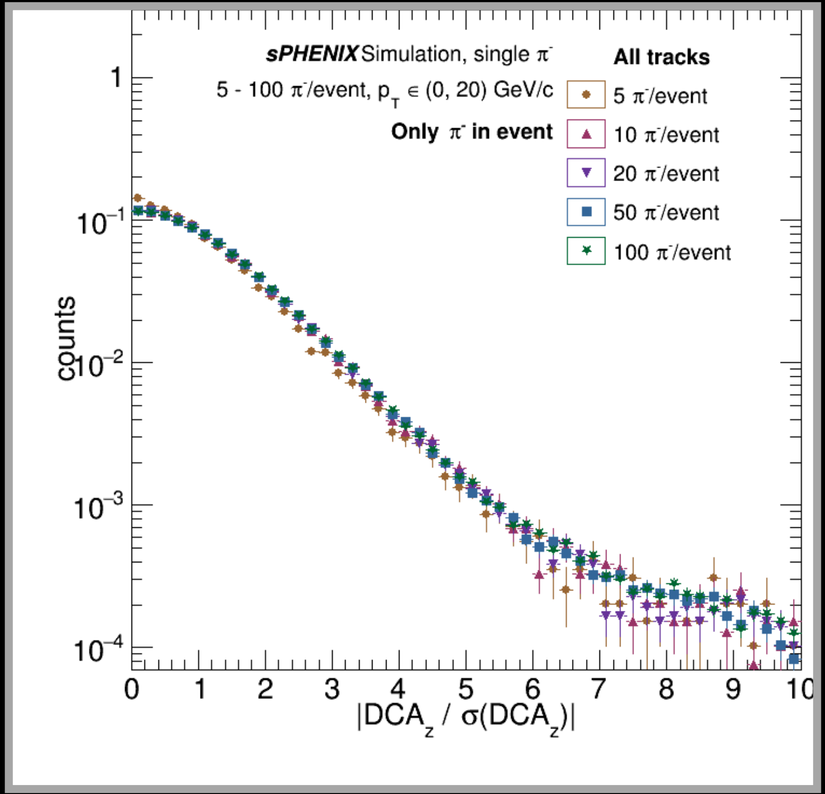



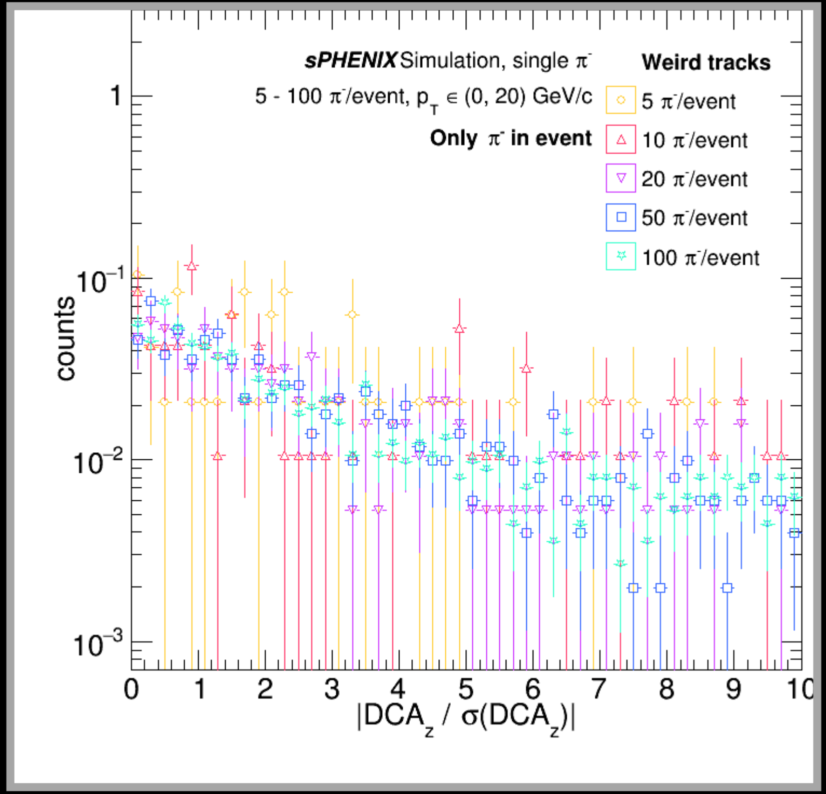




- **Shown:** DCAxy/$\sigma$(DCAxy)
  - Unnormalized **(left)**, all tracks **(normalized, center)**, and weird tracks **(normalized, right)**
  - For $N_\pi = 5$ **(orange)**, $N_\pi = 10$ **(red)**, $N_\pi = 20$ **(purple)**, $N_\pi = 50$ **(blue)**, and $N_\pi = 100$ **(green)** events

# DCAz/$\sigma$(DCAz) vs. $N_\pi$

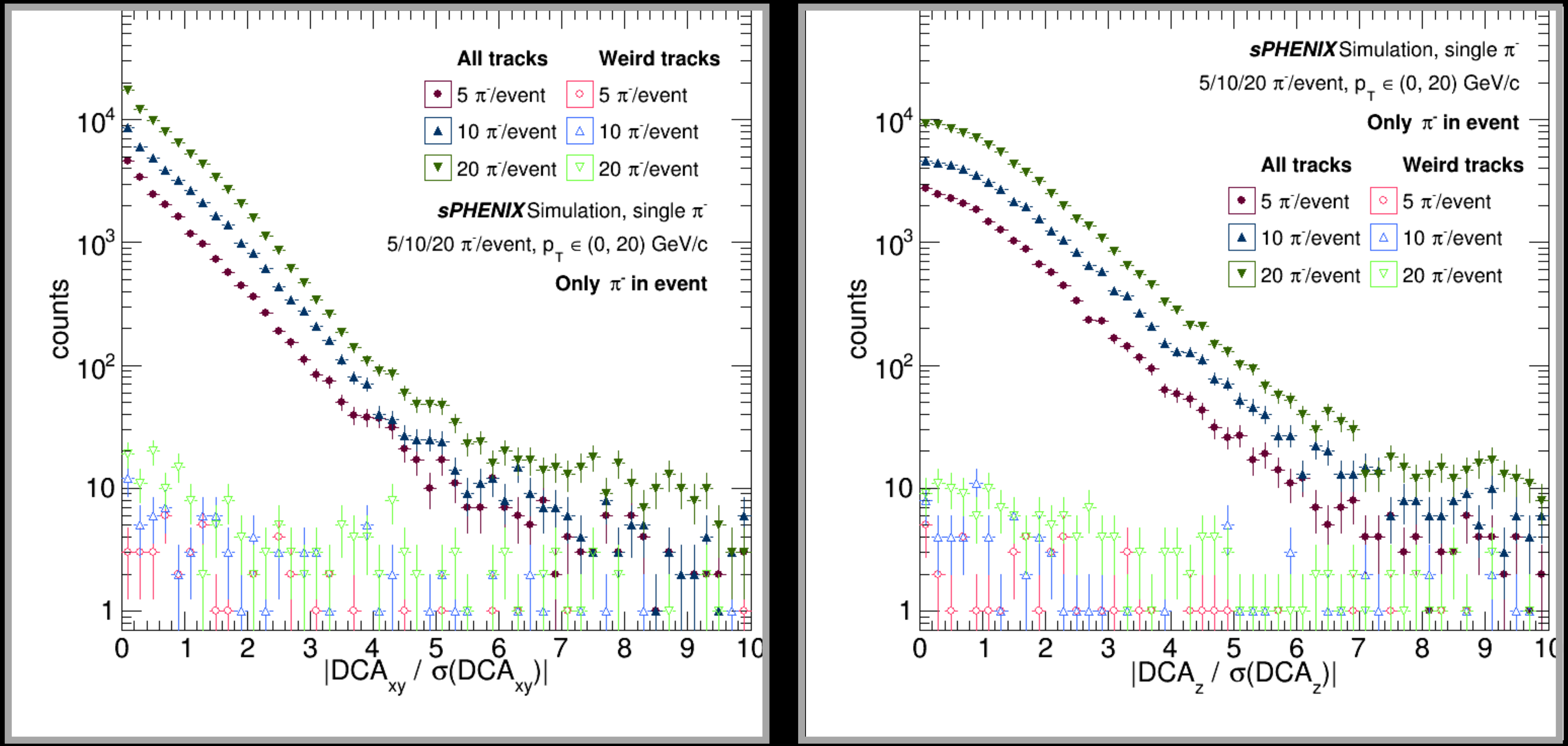



- **Shown:** DCAz/$\sigma$(DCAz)
  - Unnormalized **(left)** , all tracks **(normalized, center)** , and weird tracks **(normalized, right)**
  - For $N_\pi = 5$ **(orange)**, $N_\pi = 10$ **(red)**, $N_\pi = 20$ **(purple)**, $N_\pi = 50$ **(blue)**, and $N_\pi = 100$ **(green)** events

# How does DCA/$\sigma$(DCA) look?

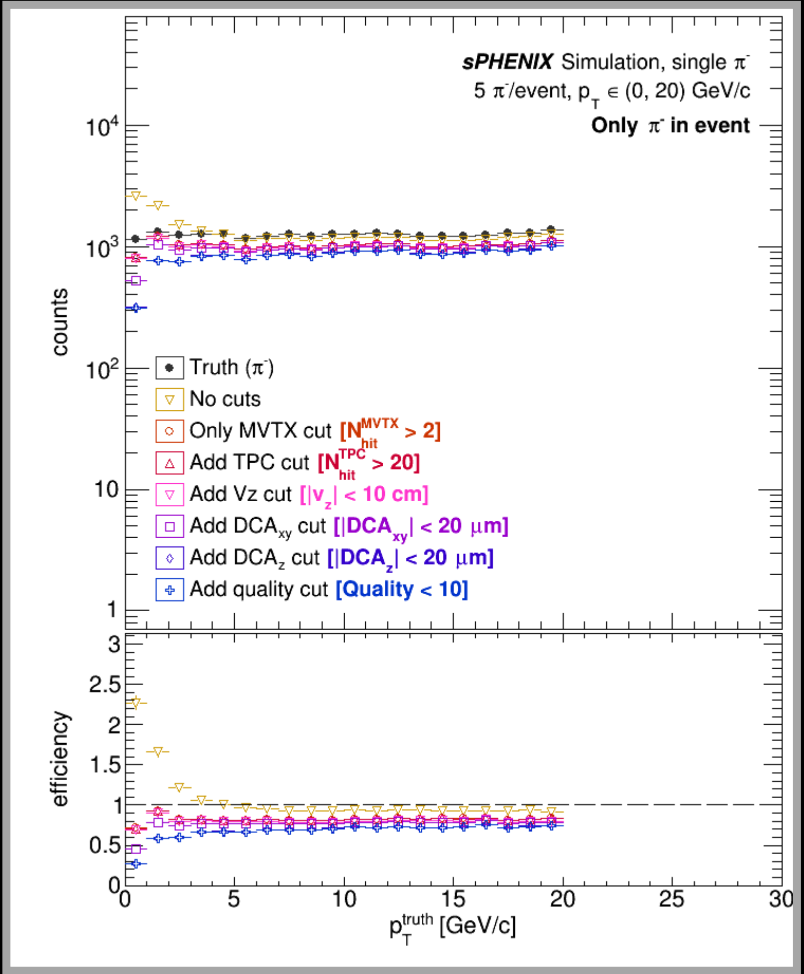


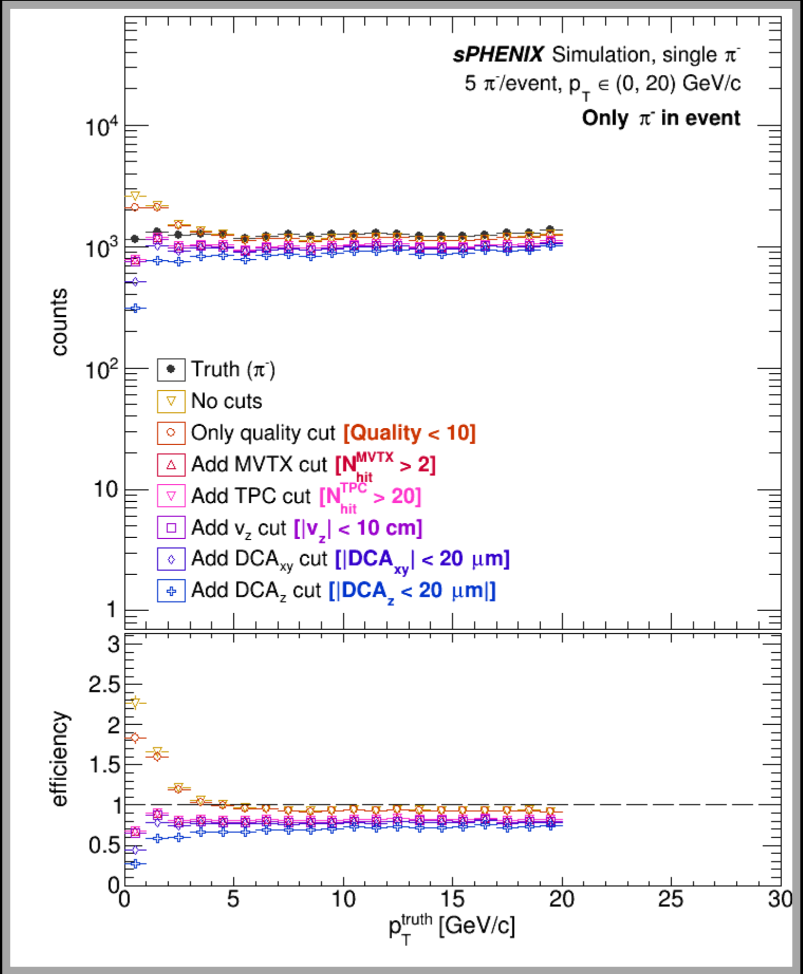

- **Shown:** DCA/$\sigma$(DCA) for DCAxy (right) and DCAz (left)
  - Shown for $N_\pi = 5$ **(red)**, $N_\pi = 10$ **(blue)**, and $N_\pi = 20$ **(green)** events
  - ($N_\pi = 50$ and $N_\pi = 100$ events in progress…)

# How does changing cut hierarchy affect efficiency?

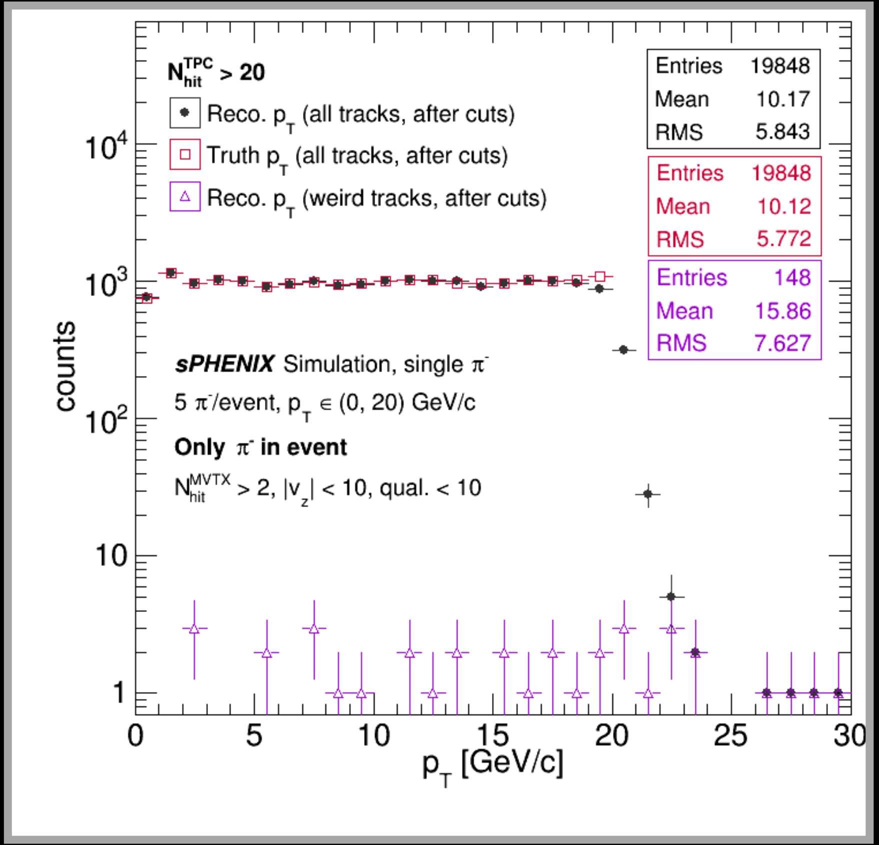
- **Shown:** How reco. efficiency evolves as cuts are added
  - **Left:** quality cut applied last
  - **Right:** quality cut applied first
  - ☞ Quality cut (< 10) on its own doesn't remove many tracks

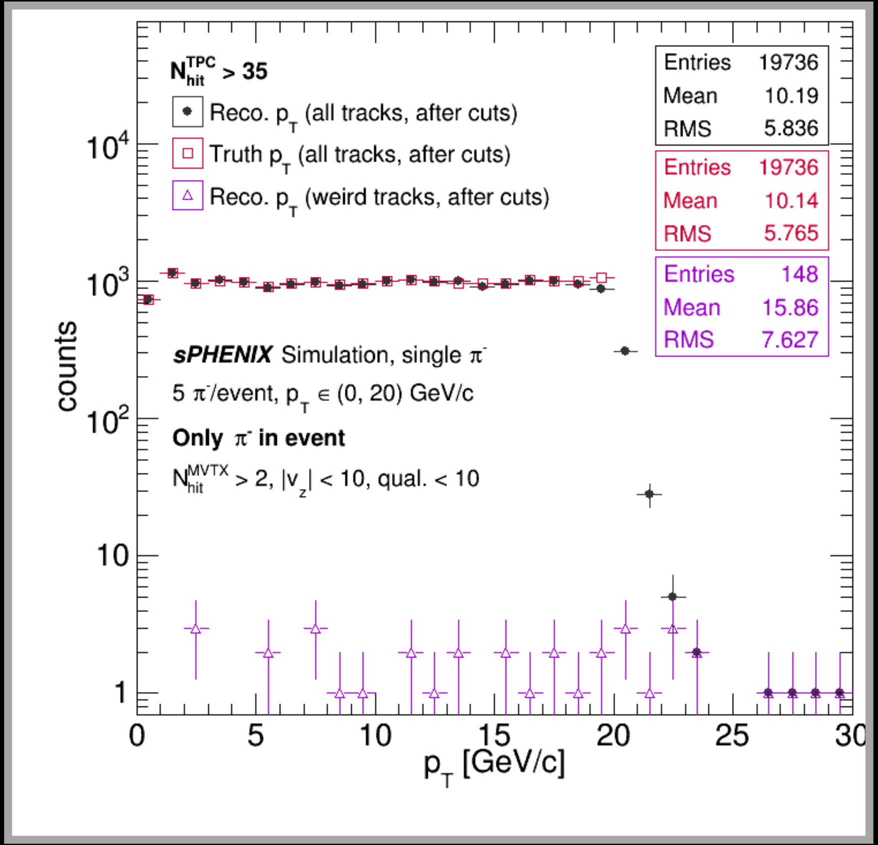
- For $\pi^-$-only events
  - Only 5 $\pi^-$/event
  - (20 $\pi^-$/events in backup)



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



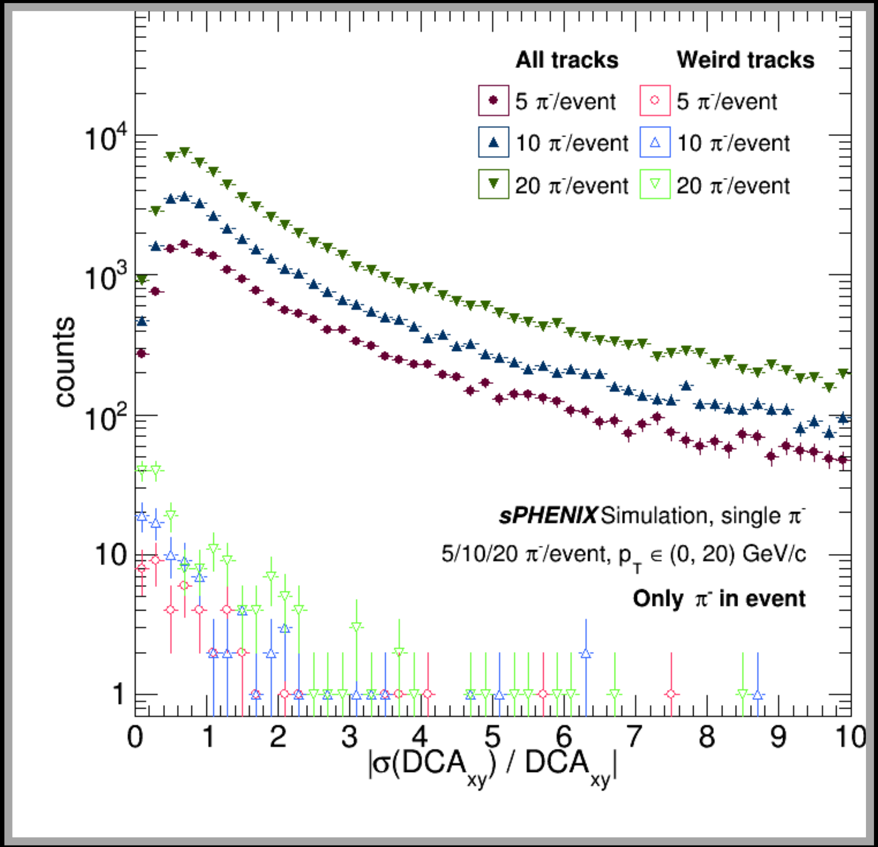



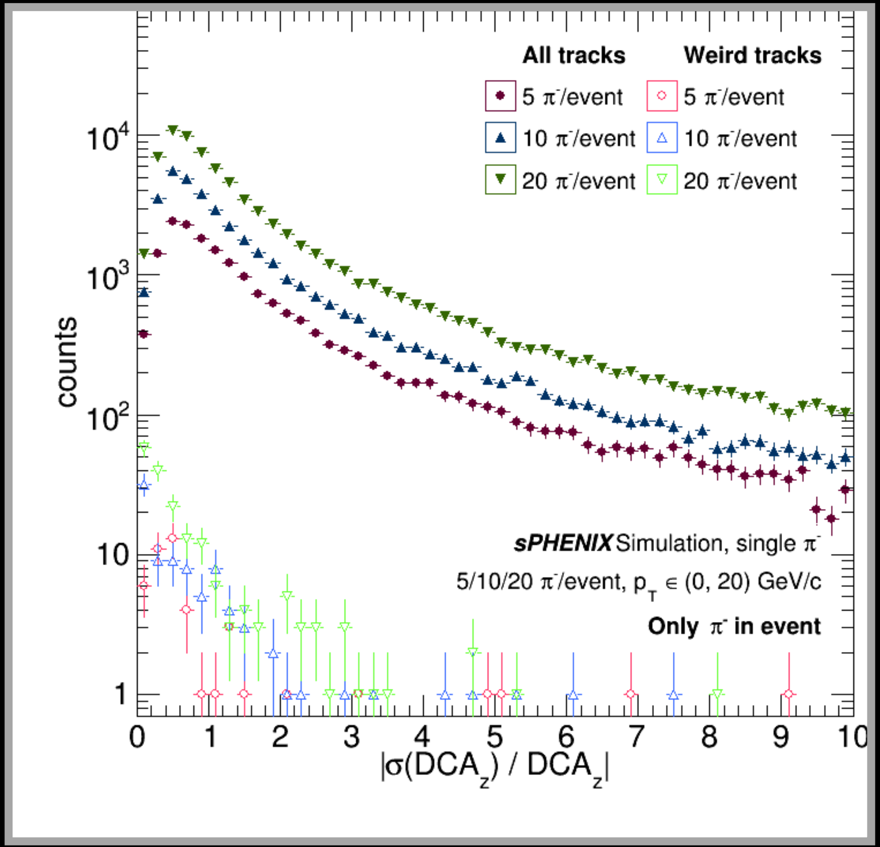

- **Shown:** Reconstructed (black and purple) $p_T$ vs. true $p_T$ (red)
  - Left: $N_{hit}^{TPC} > 20$ cut applied
  - Right: $N_{hit}^{TPC} > 35$ cut applied
- **Varying $N_{hit}^{TPC}$ cut makes little impact**

- **Note:** cuts on $N_{hit}^{MVTX}$, $v_z$, and quality also applied

- Only 5 $\pi^-$/events
  - (10, 20 $\pi^-$/events in backup)

# $\sigma$(DCA)/DCA vs. $N_\pi$

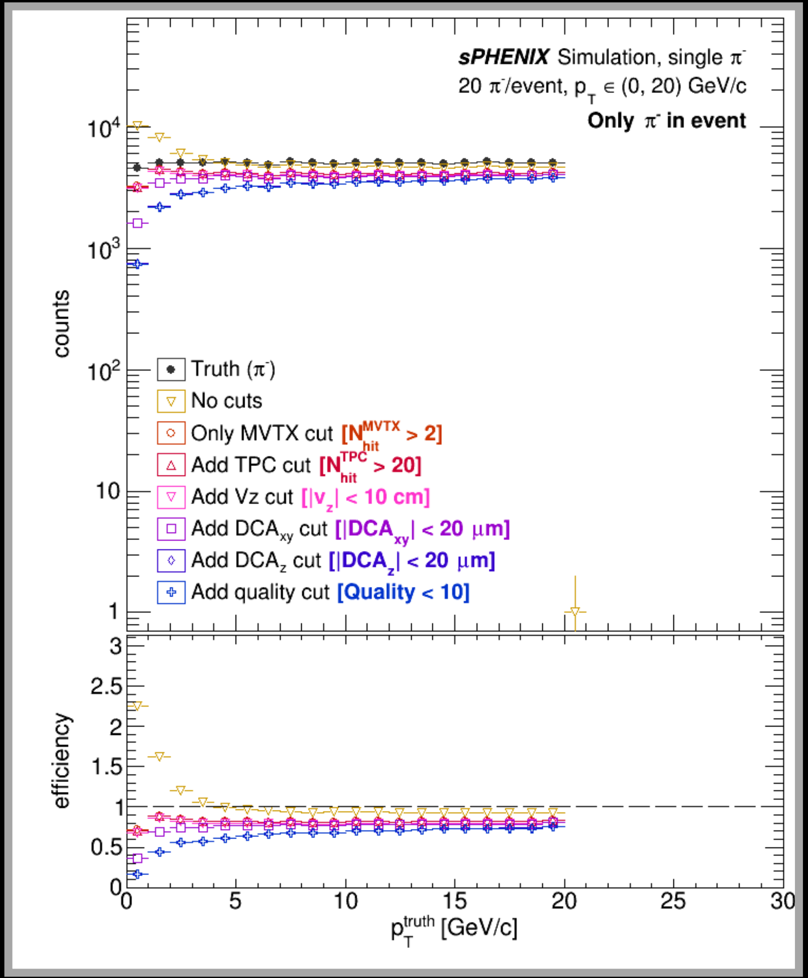


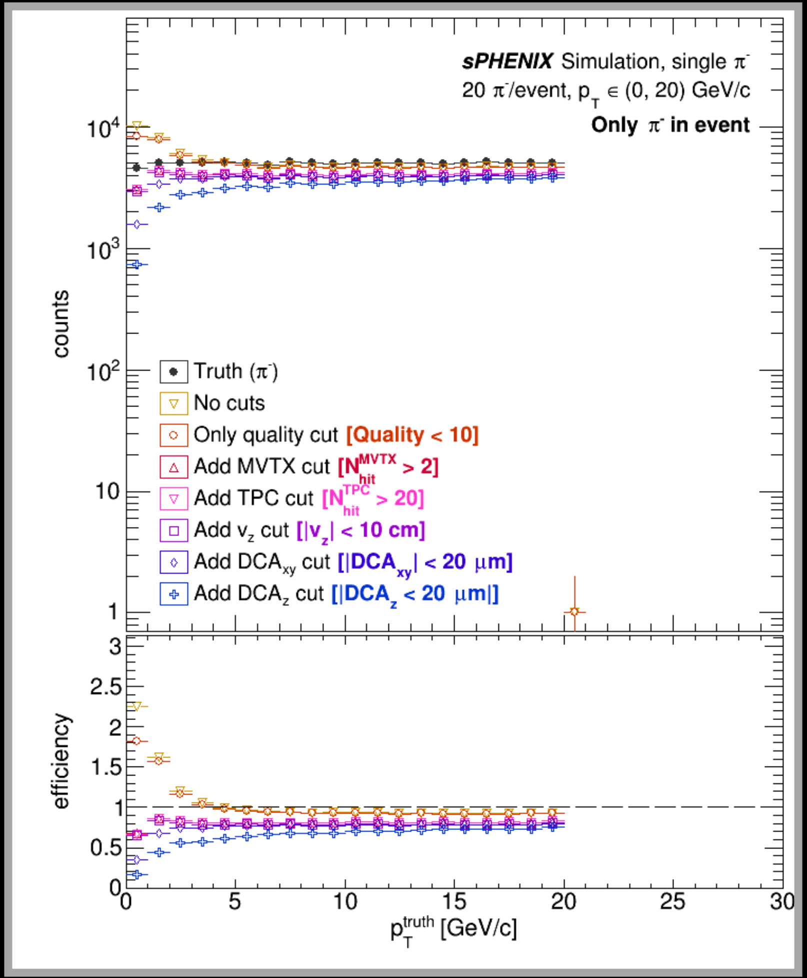




- **Shown:** $\sigma$(DCA)/DCA for DCAxy (right) and DCAz (left)
  - Shown for $N_\pi = 5$ **(red)**, $N_\pi = 10$ **(blue)**, and $N_\pi = 20$ **(green)** events

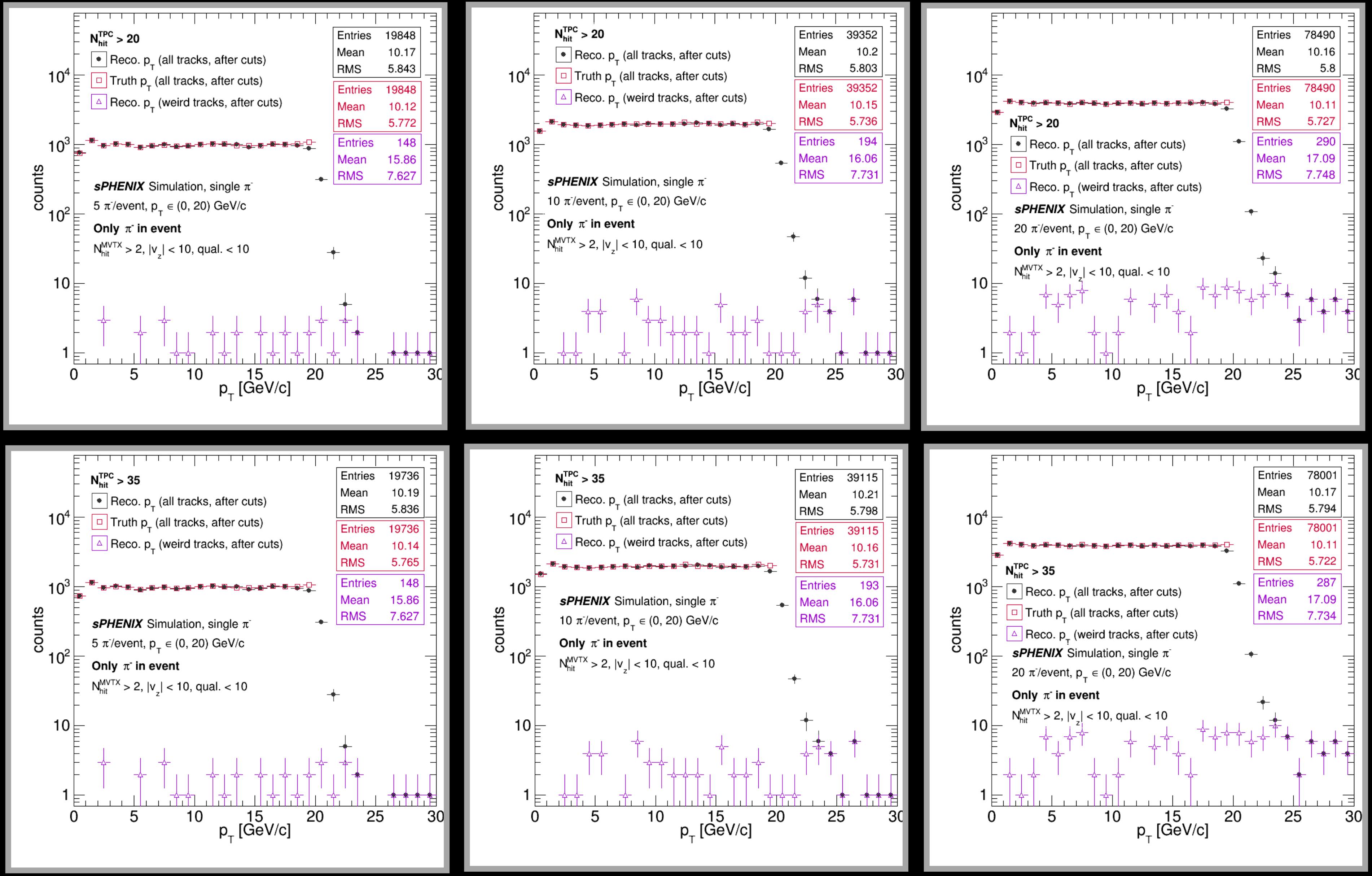
# Cuts vs. efficiency for 20 $\pi^-$/event

- **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 $\pi^-$-only events
  - 20 $\pi^-$/event

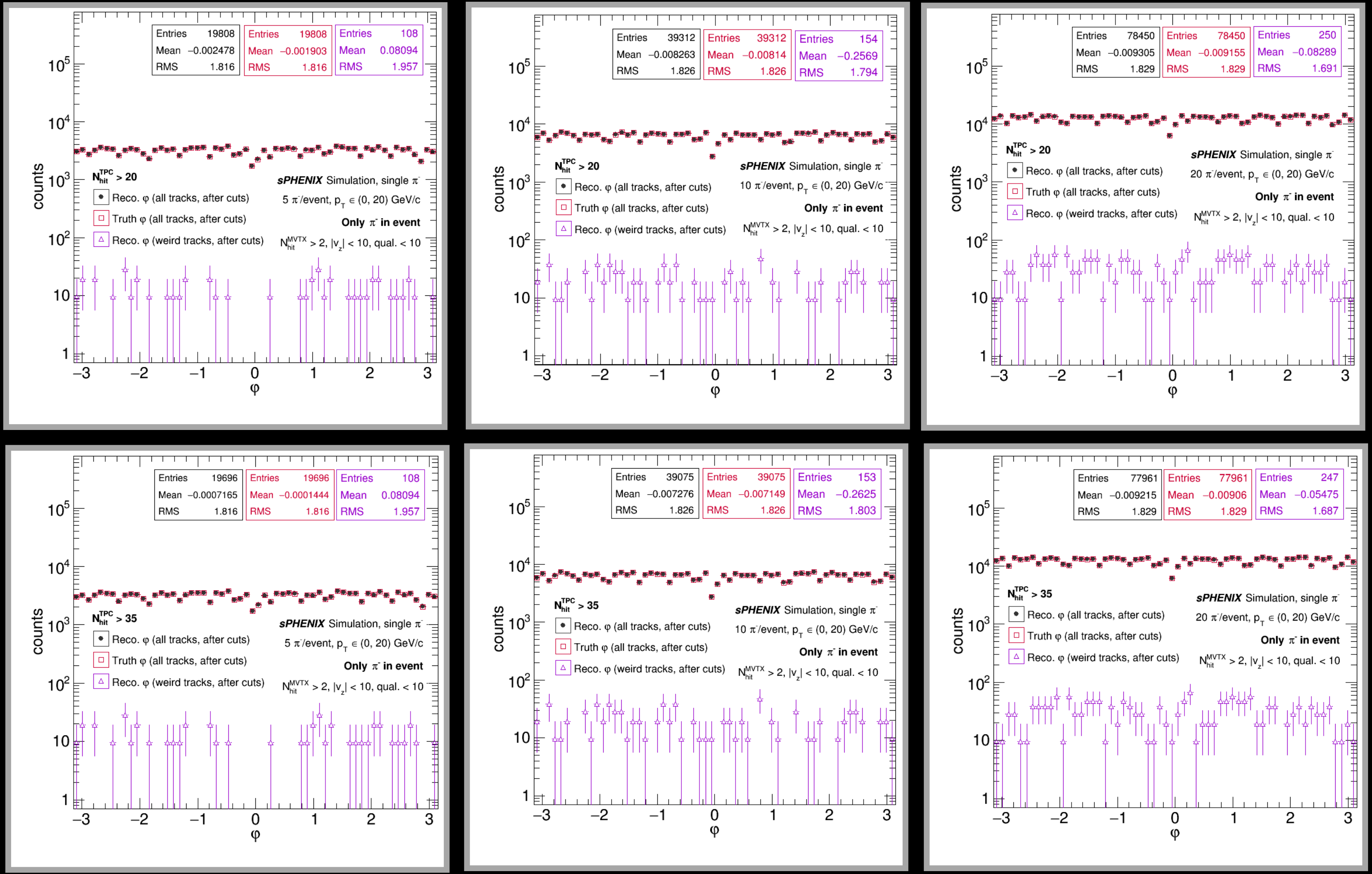


# Varying $N_{\pi}$ and $N_{hit}^{TPC}$



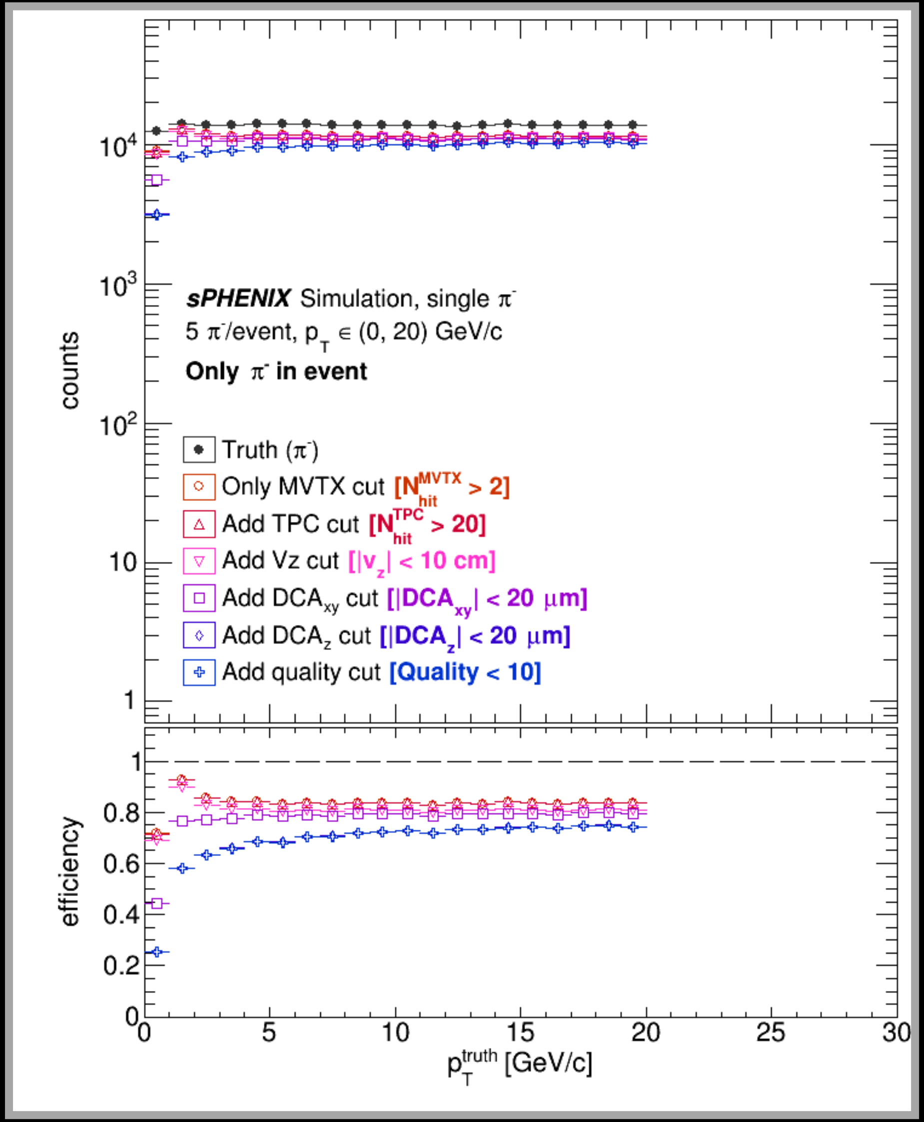
# Varying $N_\pi$ and $N_{hit}^{TPC}$



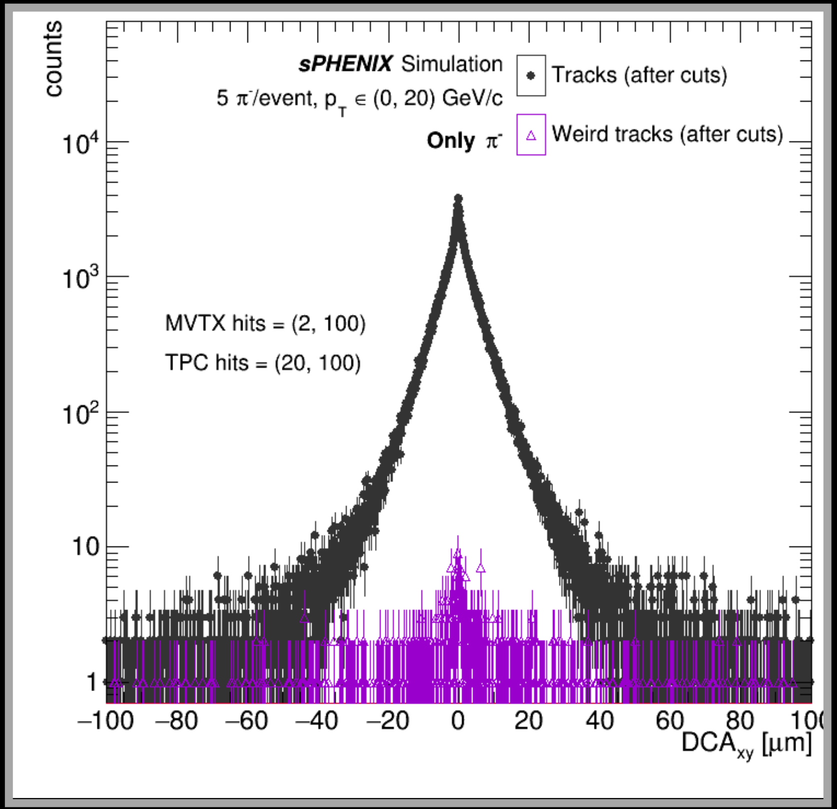
# Tracking Efficiency vs. Cuts

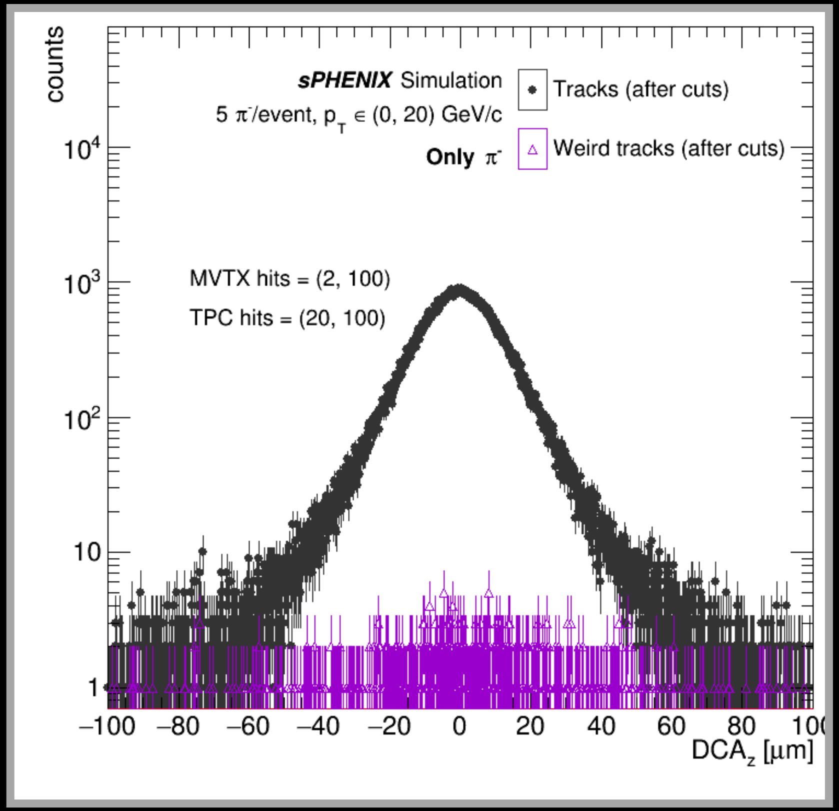
- **Shown:** How reco. efficiency evolves as cuts are added
  - Biggest effects are due to DCA…
  - **Note:** "Add quality cut" and "Add DcaZ cut" points are on top of each other

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



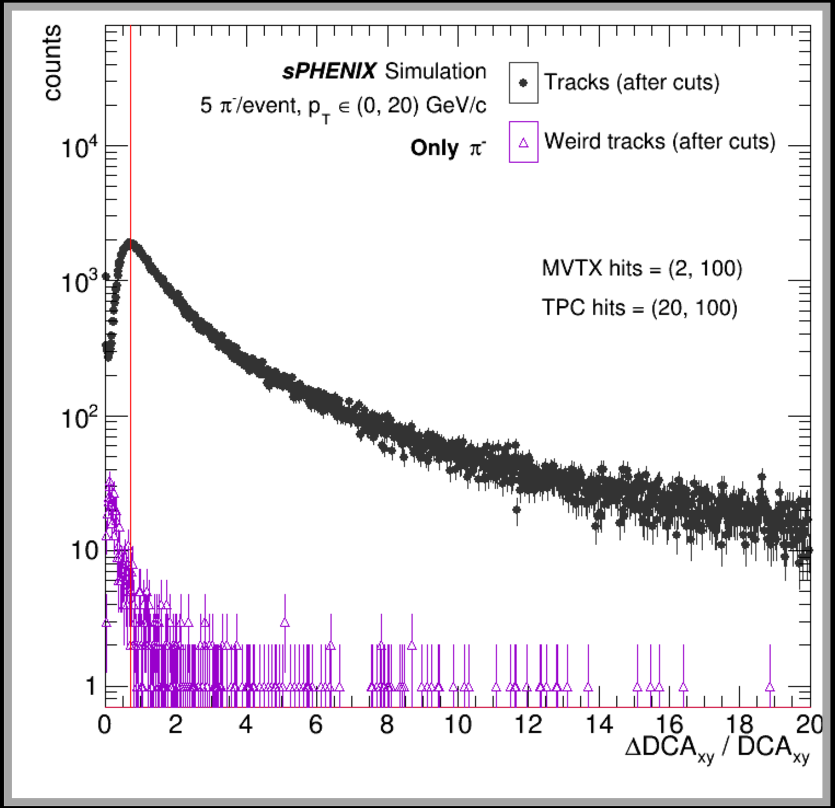
# Track DCA Distributions

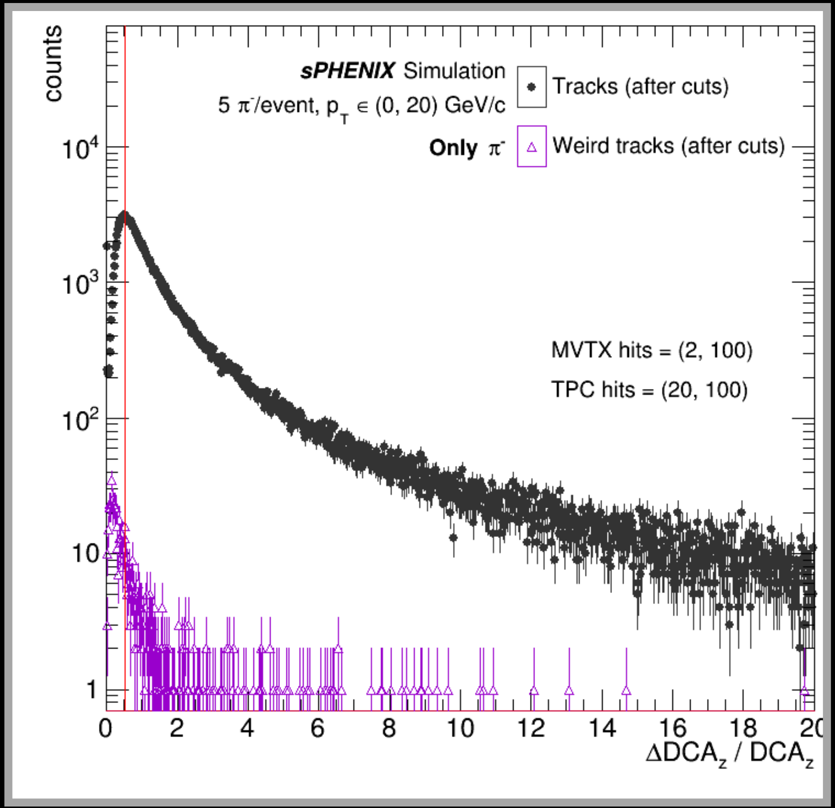



- **Left:** track DCAxy distribution
  **Right:** track DCAz distribution
  - ☞ Only for 5 $\pi^-$/event
- **Black** points are all tracks, **purple** points are weird tracks

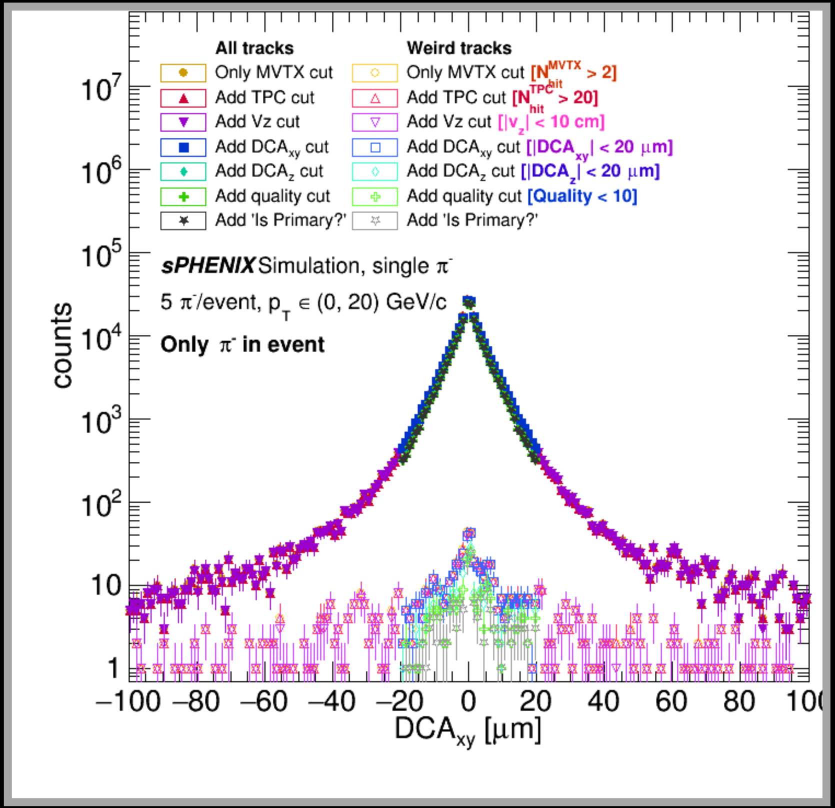
# Track $\sigma_{DCA}$/DCA Distributions

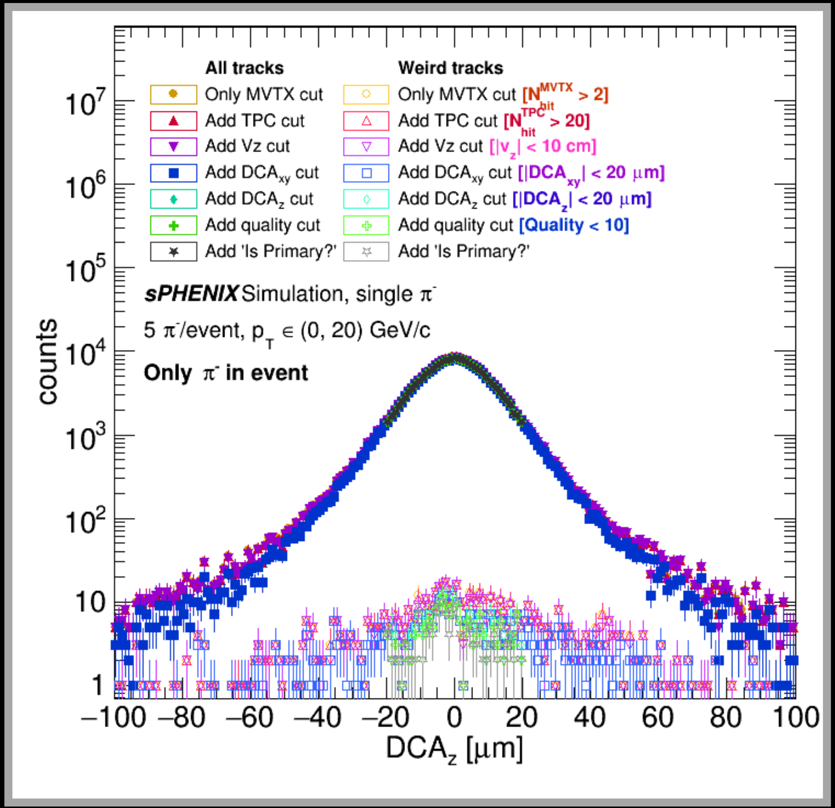



- **Left:** track DCAxy distribution
  **Right:** track DCAz distribution
  - ☞ Only for 5 $\pi^{-}$/event
- **Black** points are all tracks, **purple** points are weird tracks
- **Red** lines indicate maxima of distribution for all tracks

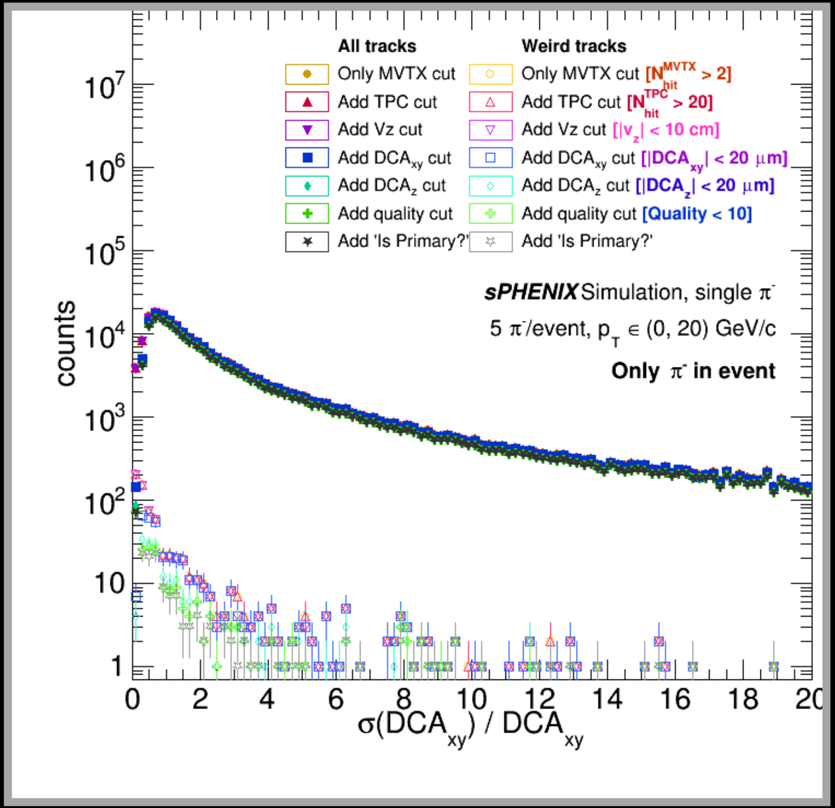
# Track DCA vs. Successive Cuts

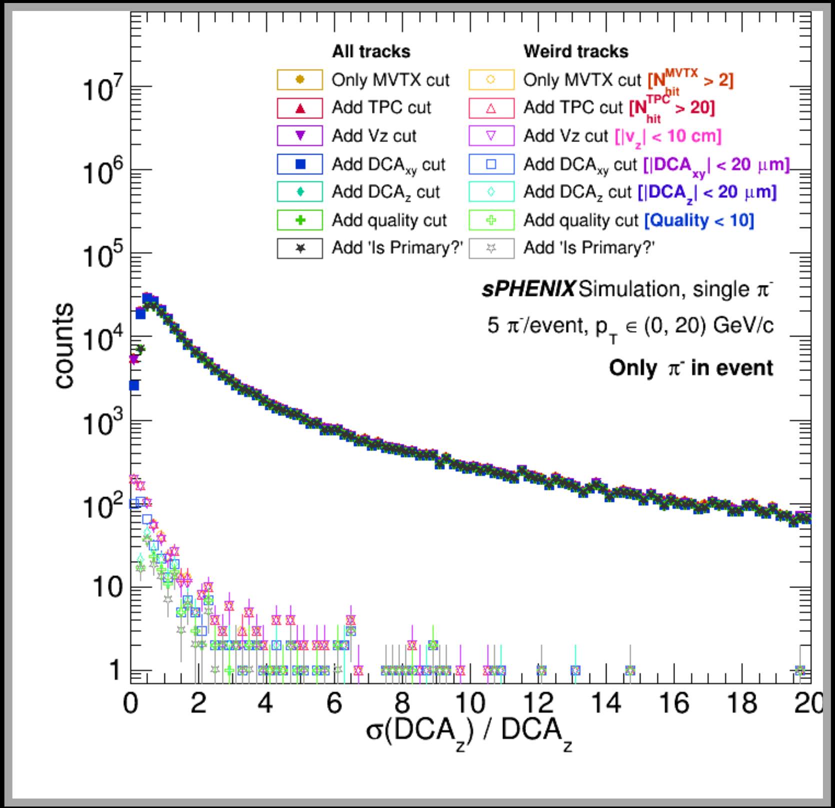



- **Left:** track DCAxy distribution
  **Right:** track DCAz distribution
  - ☞ Only for 5 $\pi^-$/event
- **Closed Markers:** all tracks
  **Open Markers:** weird tracks

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



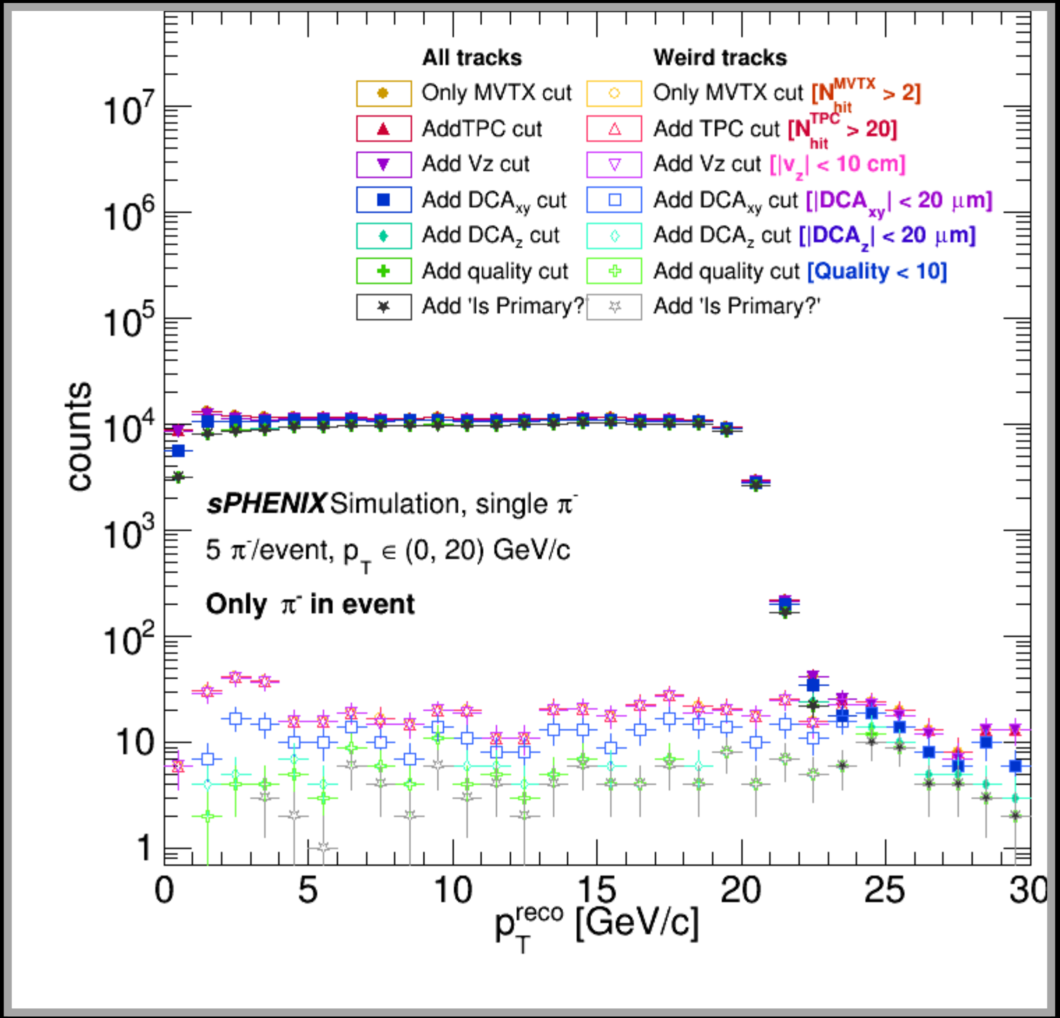




- **Left:** track DCAxy distribution
  **Right:** track DCAz distribution
  - ☞ Only for 5 $\pi^-$/event
- **Closed Markers:** all tracks
  **Open Markers:** weird tracks

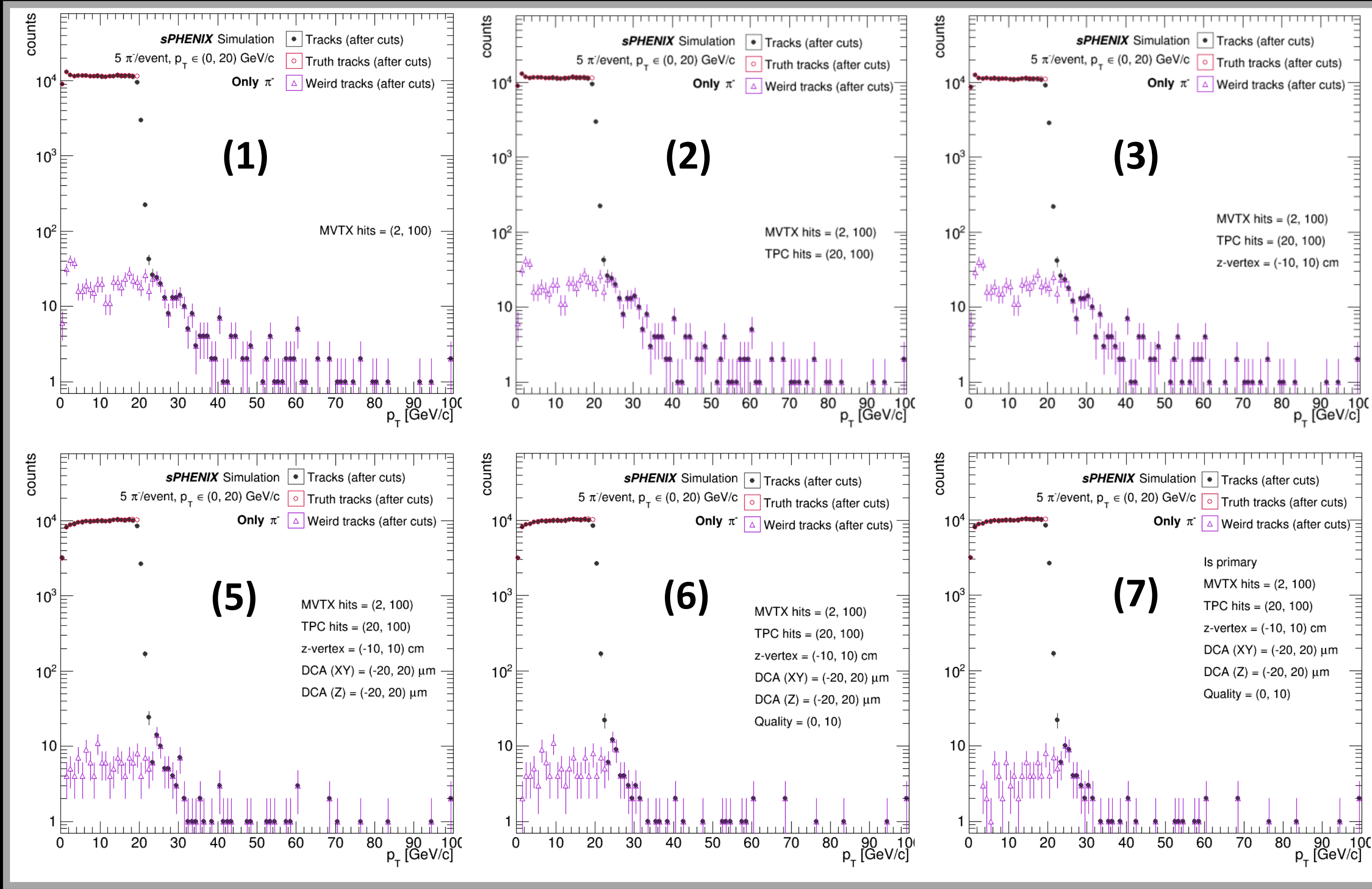
# Track $p_T$ vs. Successive Cuts | 1 panel

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

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



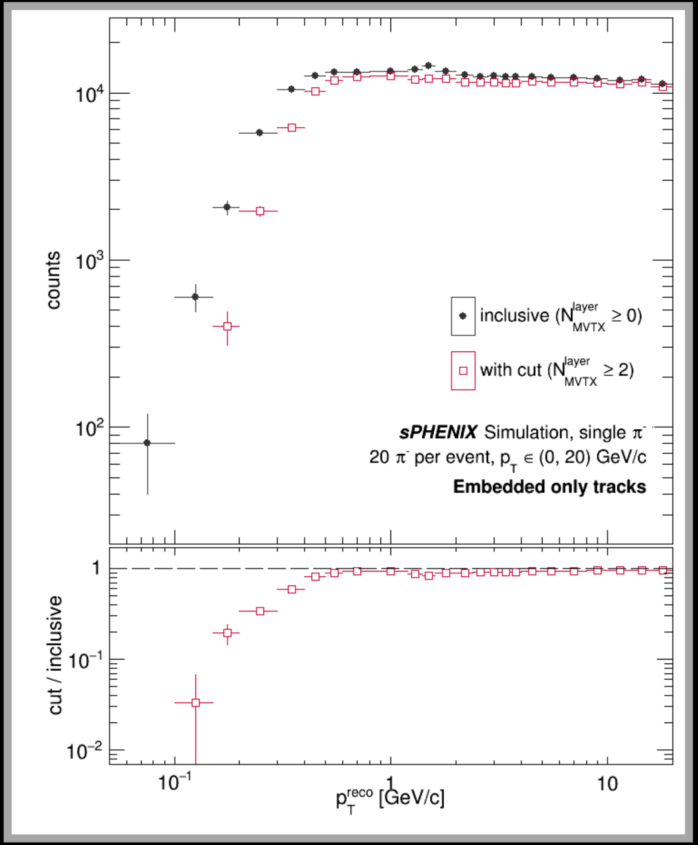
# Track $p_T$ vs. Successive Cuts | 7 panels

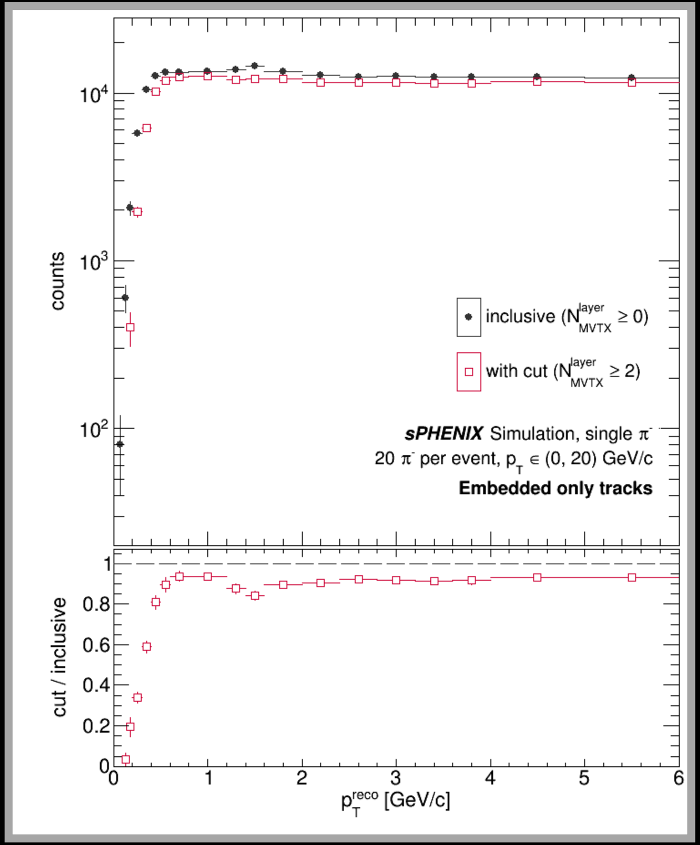



- **Black** points are all tracks, **purple** points are weird tracks
  - Only for 5 $\pi^-$/event

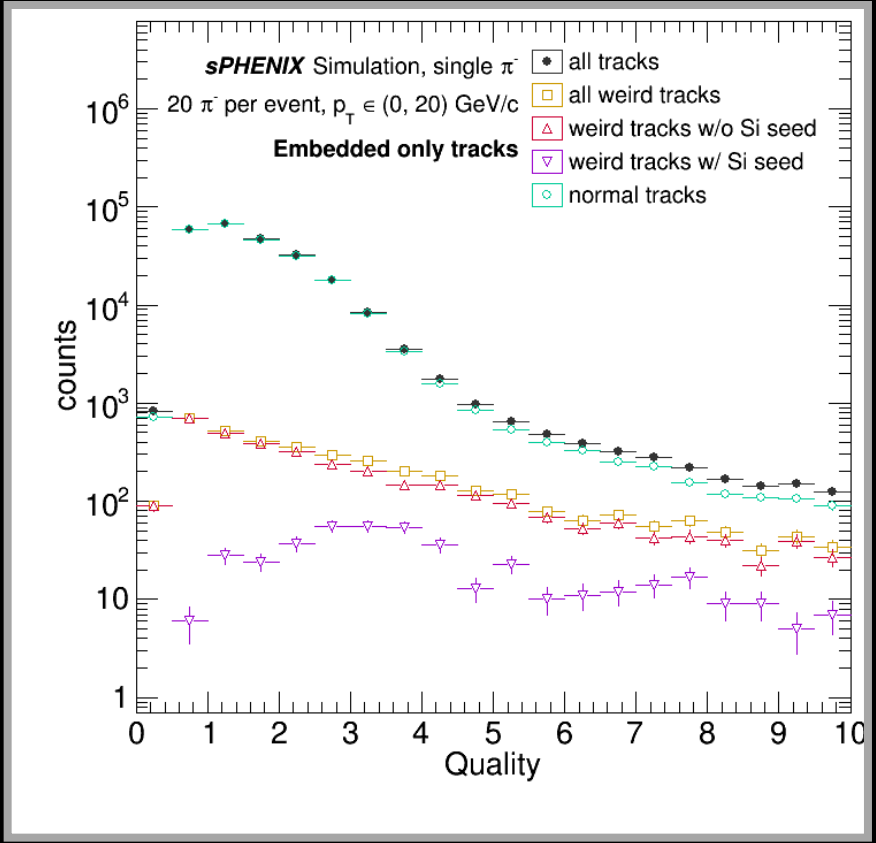
# MVTX Hits >= 2 vs. Inclusive

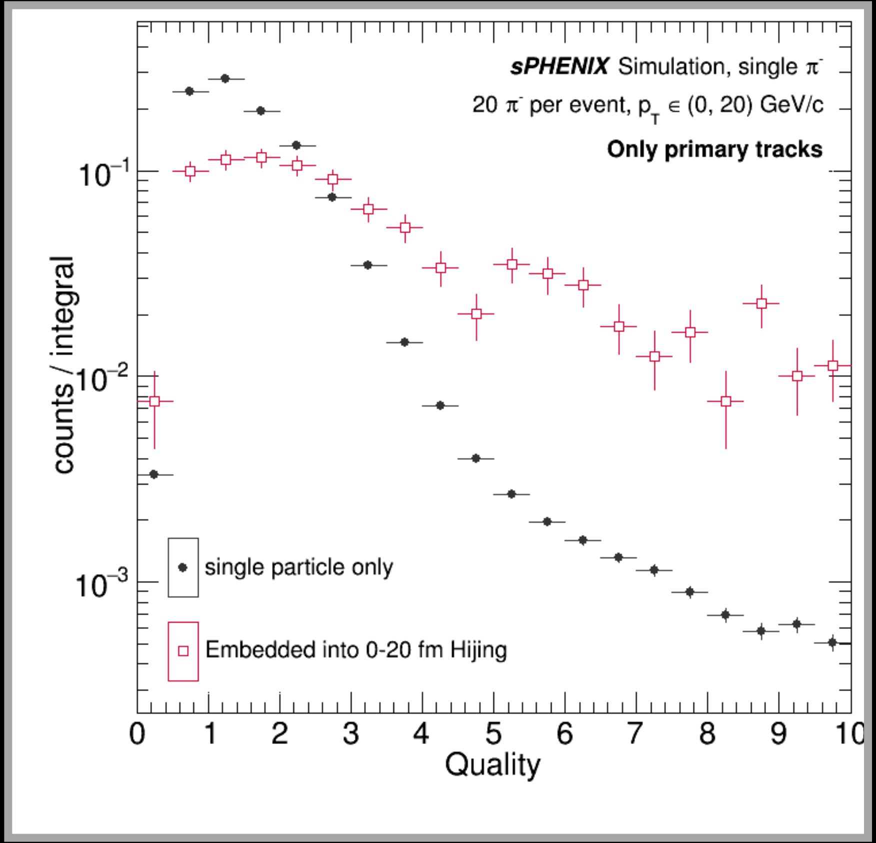
- Reconstructed track $p_T$ of primary tracks w/
  - $N_{MVTX}^{layer} \geq 2$ **(red)** vs.
  - Inclusive **(black)**
- Rebinned left figure on slide 5 to accentuate low-pT region
  - **Left:** log x-axis
  - **Right:** linear x-axis



# Track Quality in Hijing



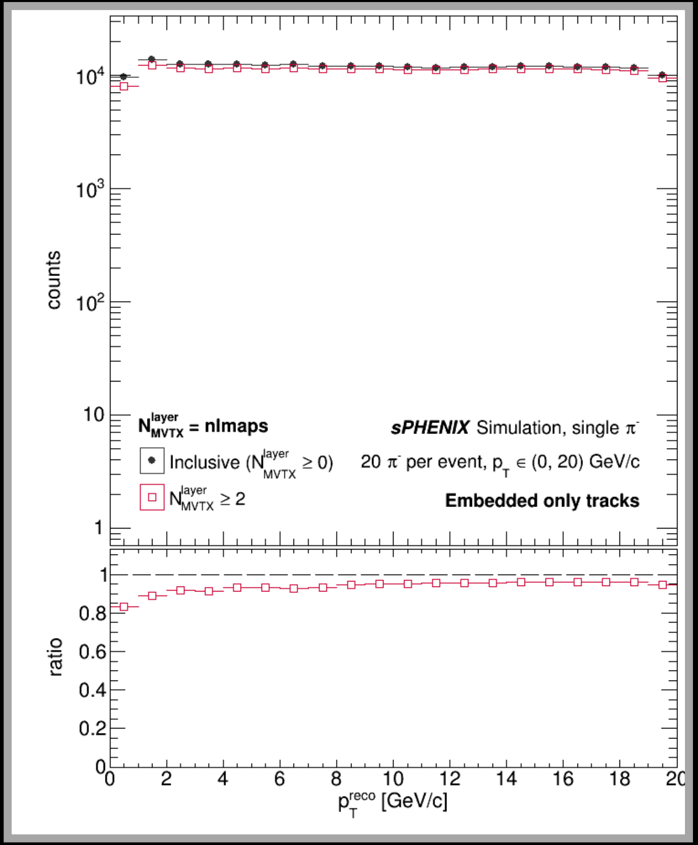

- Ratio of weird/normal (primary) tracks to all (primary) tracks as a function of quality
  - **Left:** single particle only
  - **Right:** single particle vs. embedded into Hijing

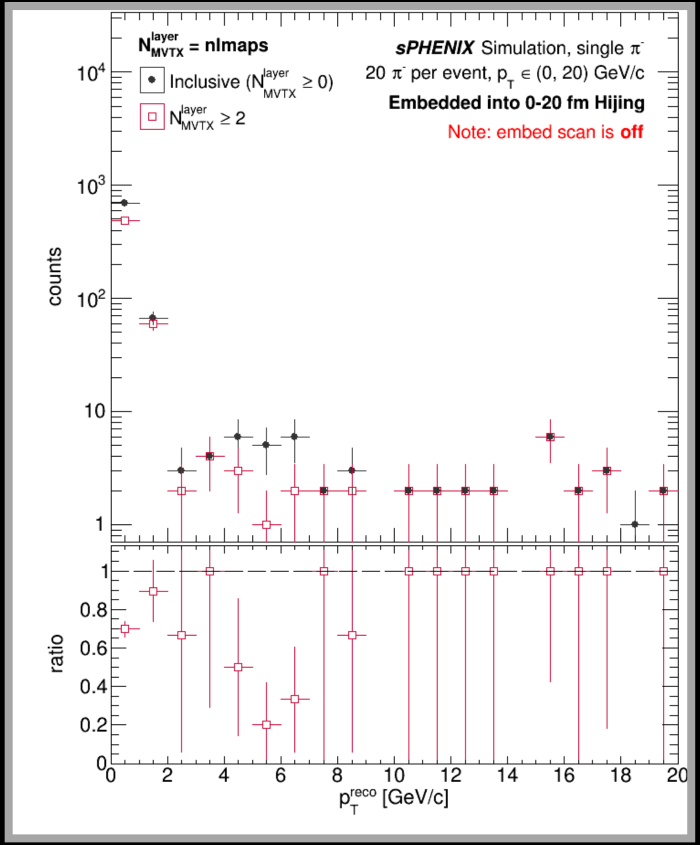
- **Reminder:**
  - Weird ⇒ $p_T^{reco}/p_T^{true} \notin (0.2, 1.20)$
  - Normal ⇒ $p_T^{reco}/p_T^{true} \in (0.2, 1.20)$

# MVTX Hits >= 2 vs. Inclusive | track pT

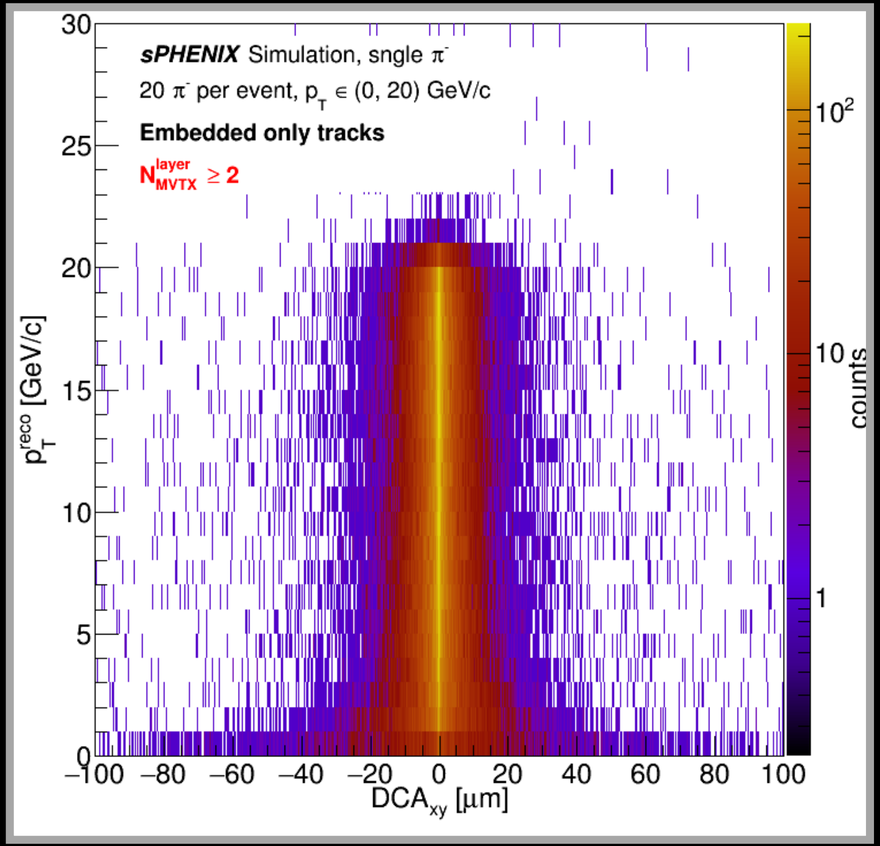
- Reconstructed track $p_T$ of primary tracks w/
  - $N_{MVTX}^{layer} \geq 2$ **(red)** vs.
  - Inclusive **(black)**

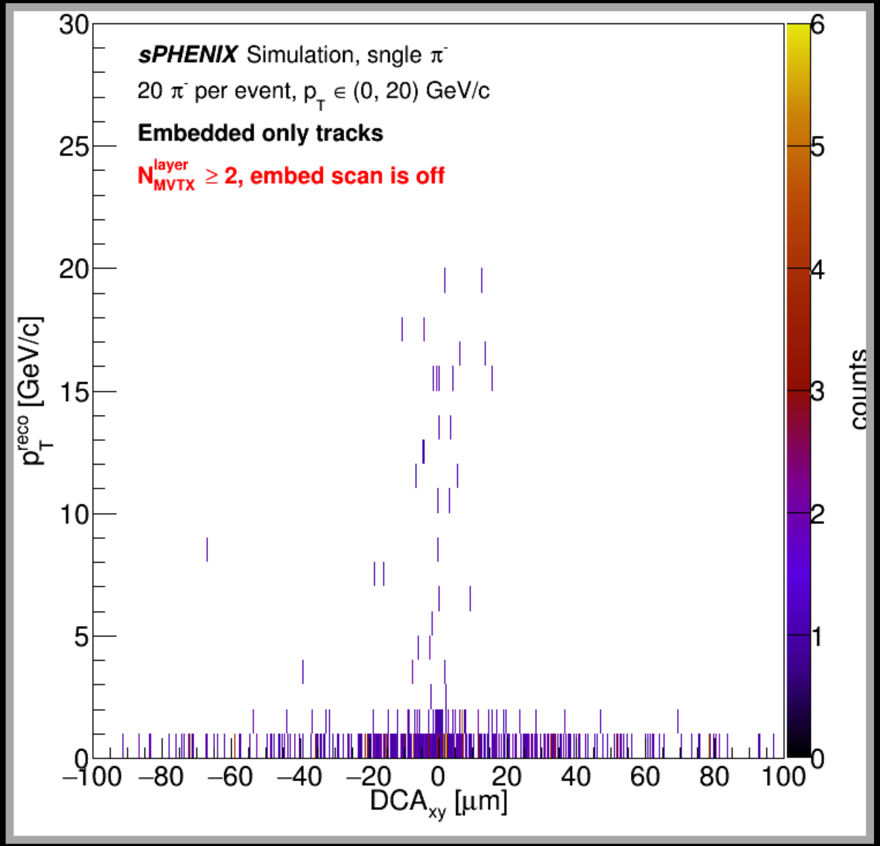
- **Left:** single particle only
  **Right:** single particles embedded into Hijing
  $\Rightarrow$ Not enough stats for embedded tracks!



# MVTX Hits >= 2 | track DCAxy

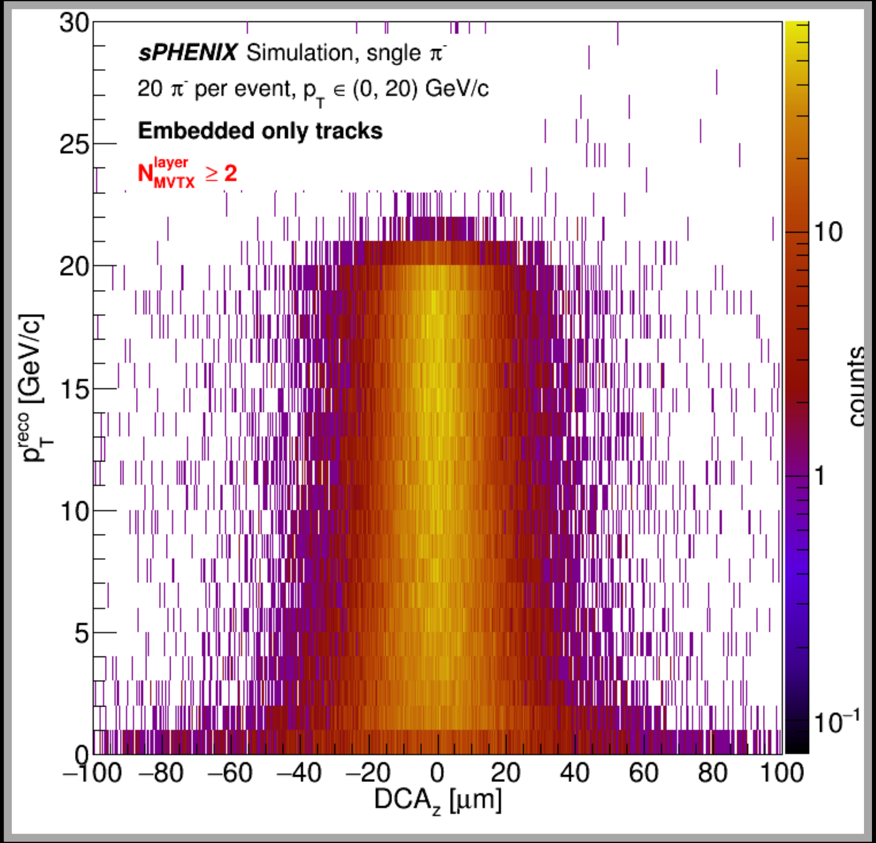


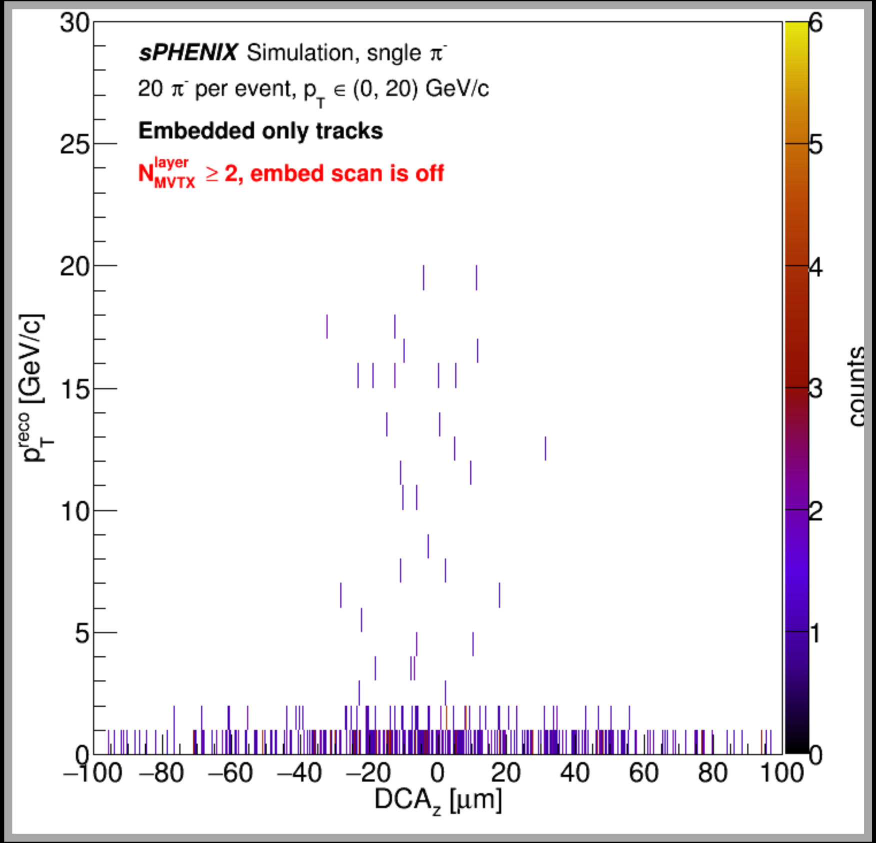




- Primary track DCAxy for primary tracks w/ $N^{layer}_{MVTX} \geq 2$

- **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:**

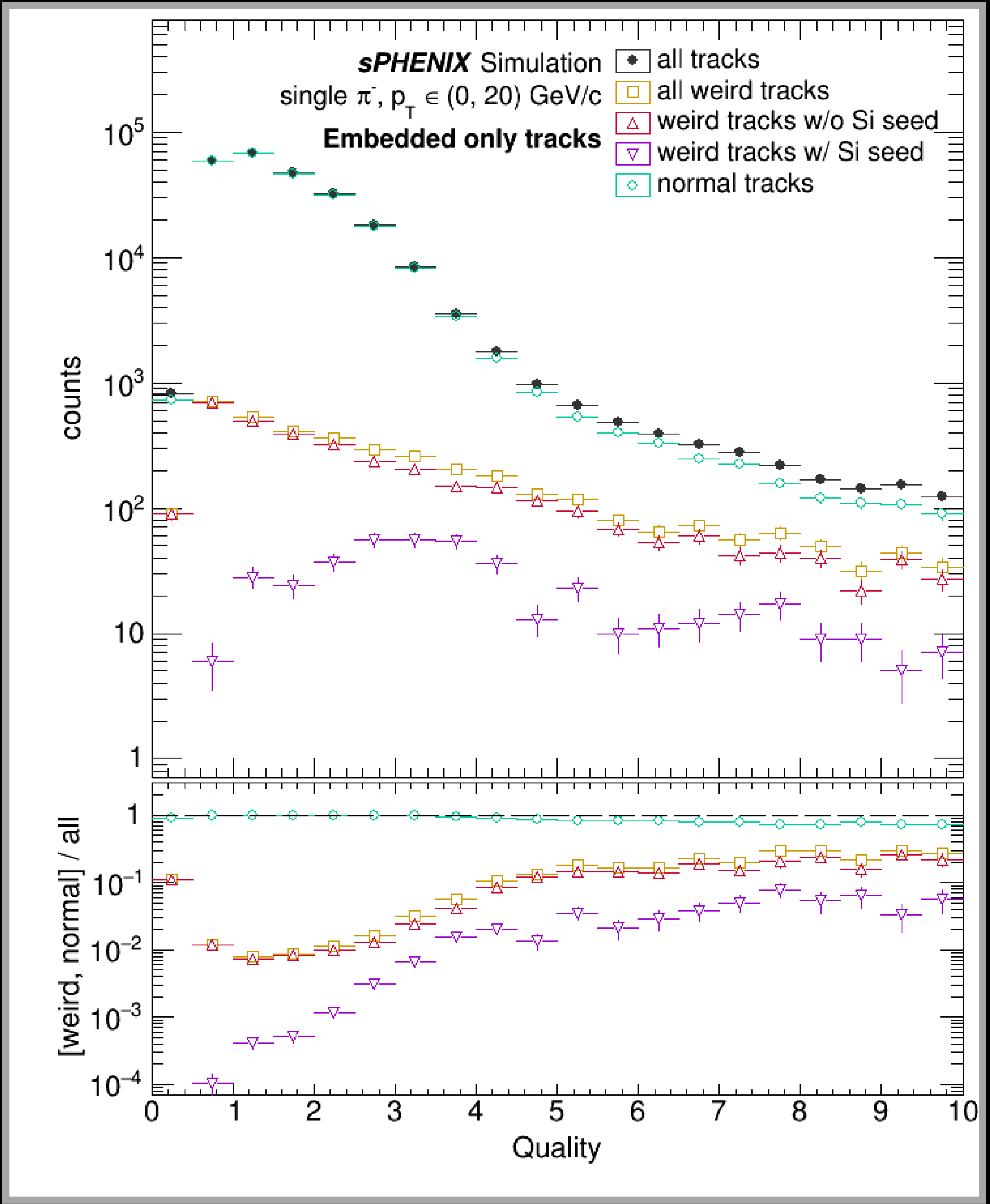
- Quality (and other track quantities) vs. $N_{TPC}^{hit}$
- Average cluster size for weird tracks vs. normal tracks
  - ☞ Do we have access to that in the evaluator?

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

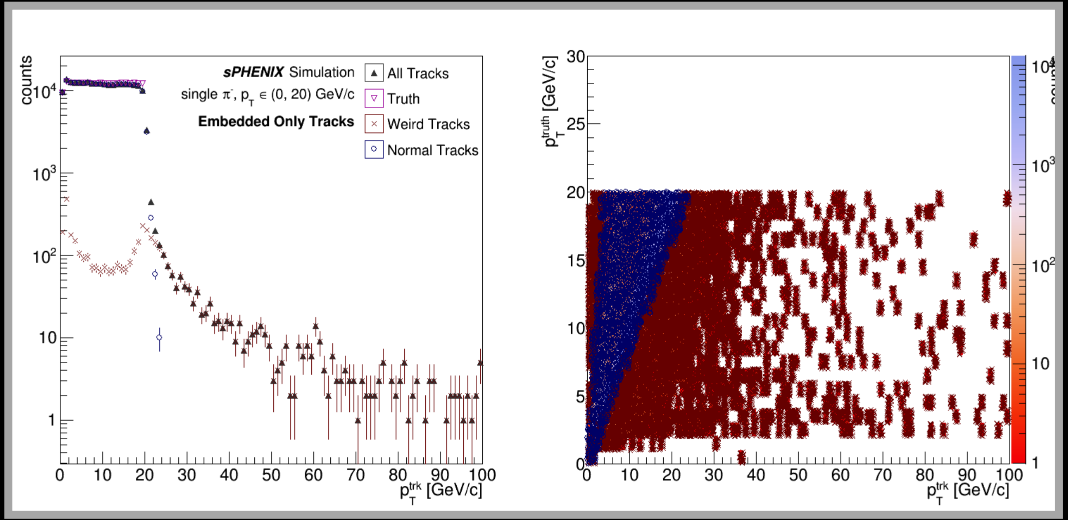
- $p_T^{trk}$ distribution is bimodal (slide 4)
- Majority seem to lie at sector boundaries in phi (slide 5)
- Majority have large DCAxy values (slides 6 and 7)
  - Show no correlation in DCAz (slides 8 and 9)
- $\chi^2$/ndf distribution is falling (slide 10)

**Weird Tracks w/ Silicon Seeds**

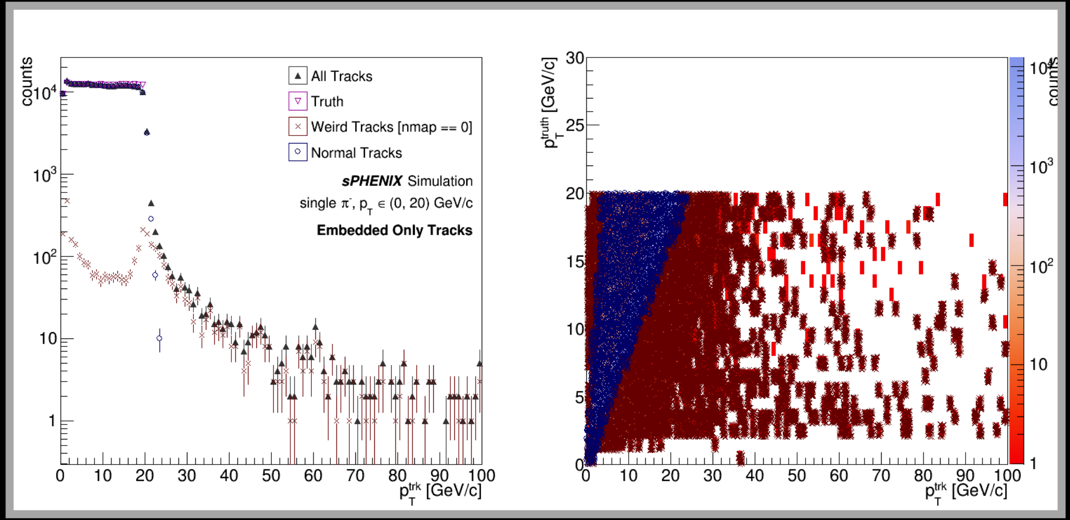
- $p_T^{trk}$ distribution is unimodal (slide 4)
- No correlation in phi (slide 5)
- $\chi^2$/ndf distribution is roughly flat (slide 10)

# Track Pt

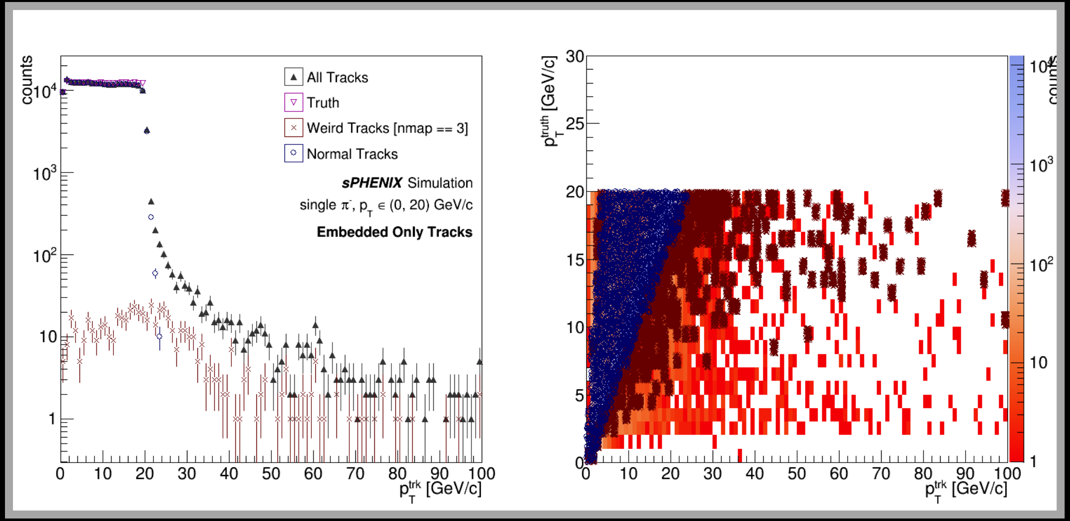
**All Weird Tracks**




**Weird Tracks w/o Silicon Seeds**



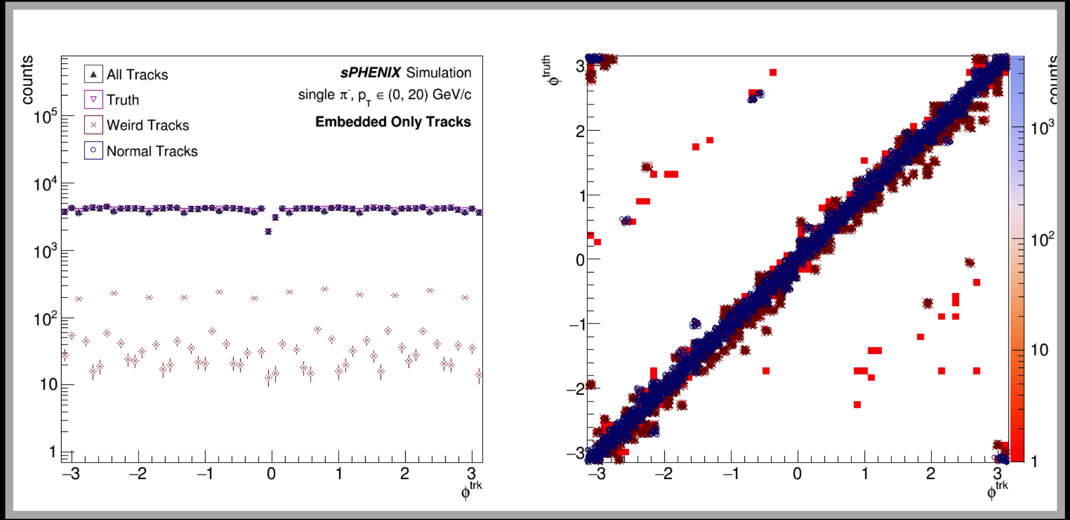

**Weird Tracks w/ Silicon Seeds**



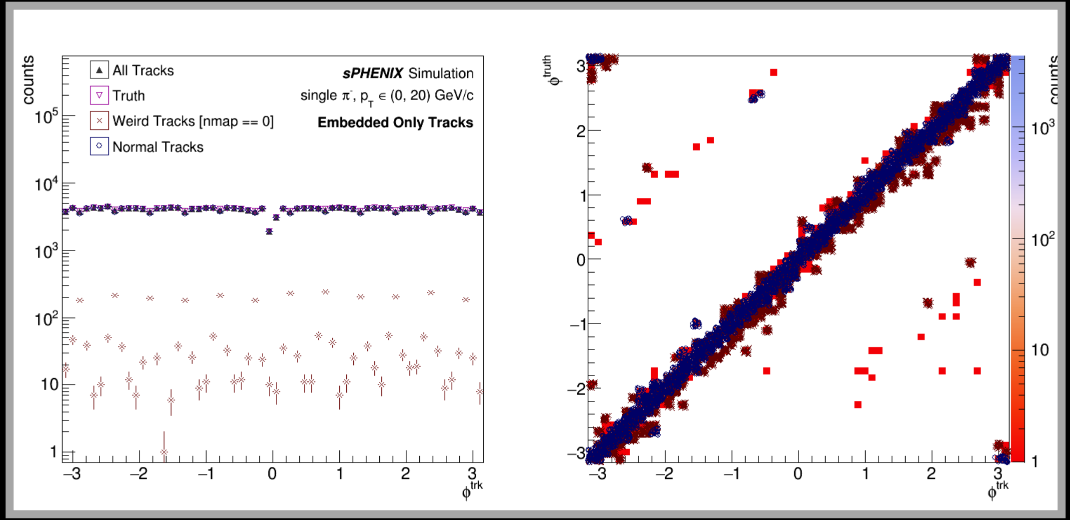

- Reconstructed and truth $p_T$
  - reco. $p_T$ (left panels)
  - reco. vs. truth $p_T$ (right panels)
  - **pt vs. gpt** leaves of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

# Track Phi

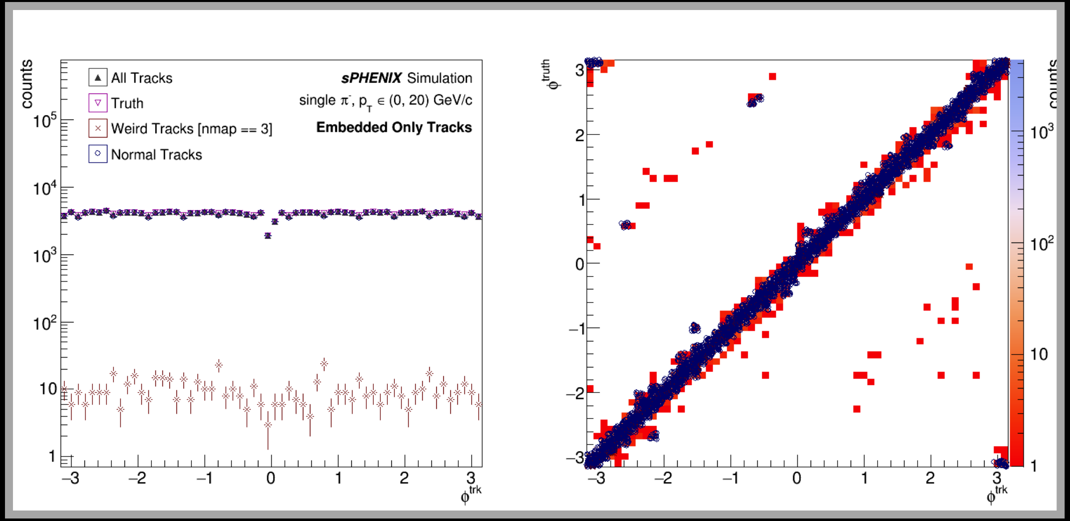
**All Weird Tracks**




**Weird Tracks w/o Silicon Seeds**



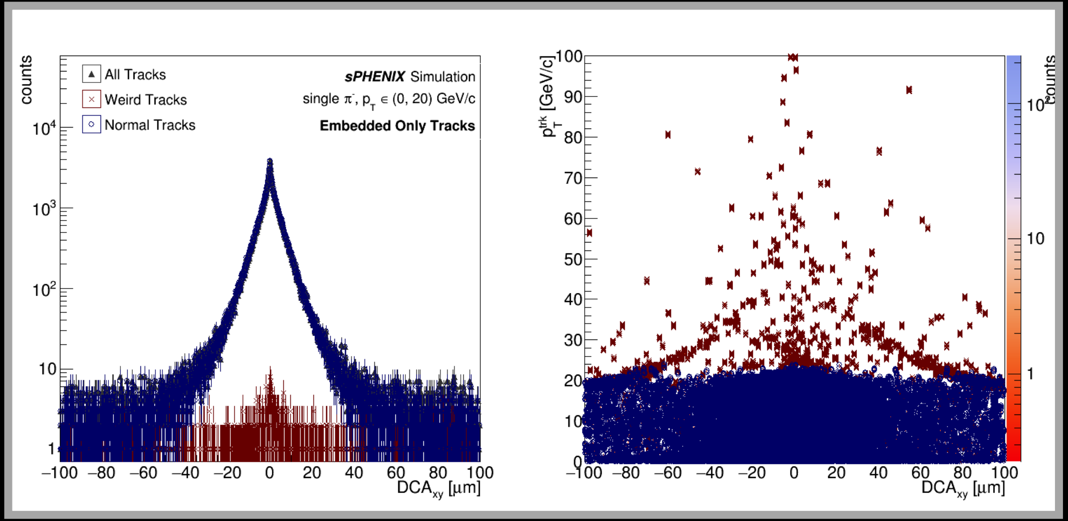

**Weird Tracks w/ Silicon Seeds**



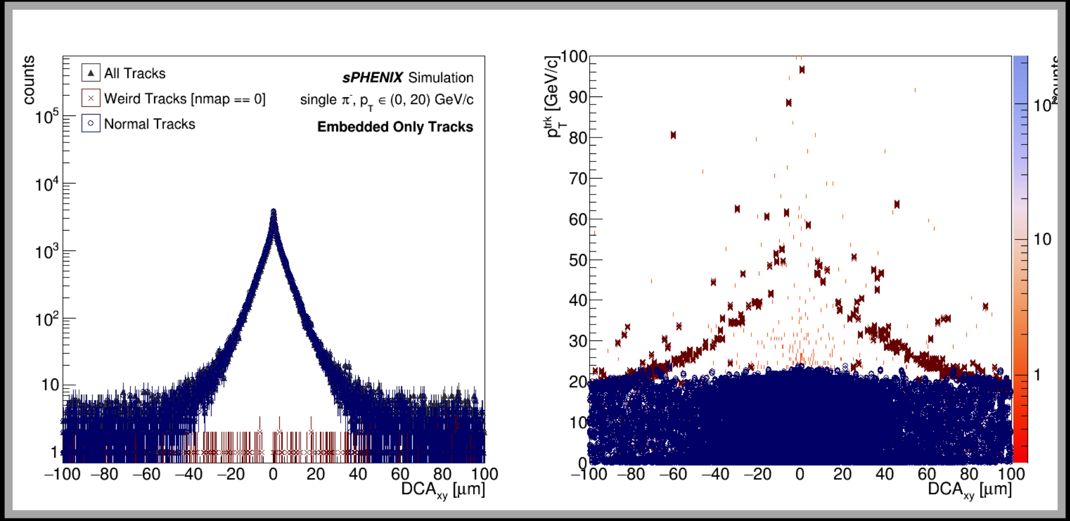

- Reconstructed and truth phi
  - reco. phi (left panels)
  - reco. vs. truth phi (right panels)
  - **phi vs. gphi** leaves of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

# Track DCAxy

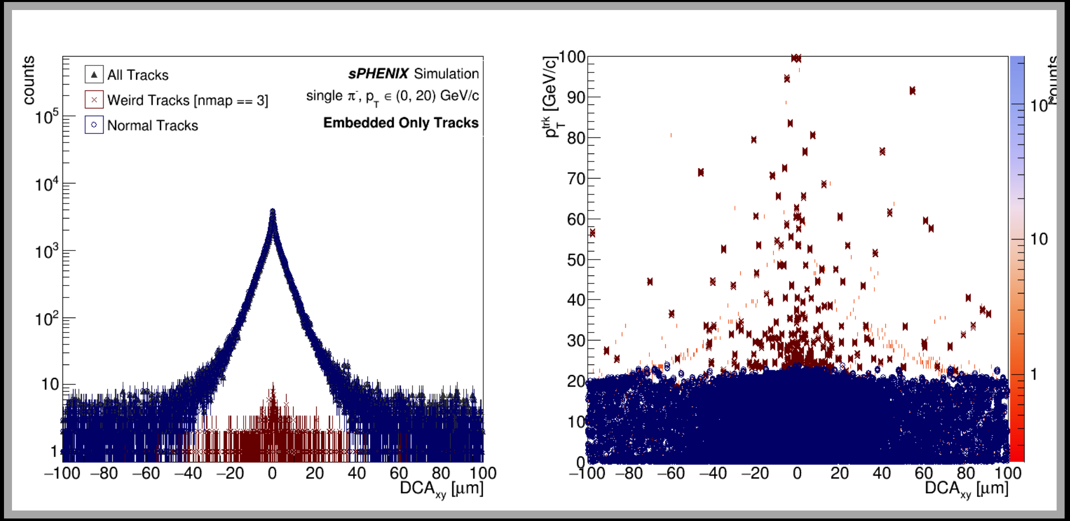
**All Weird Tracks**




**Weird Tracks w/o Silicon Seeds**



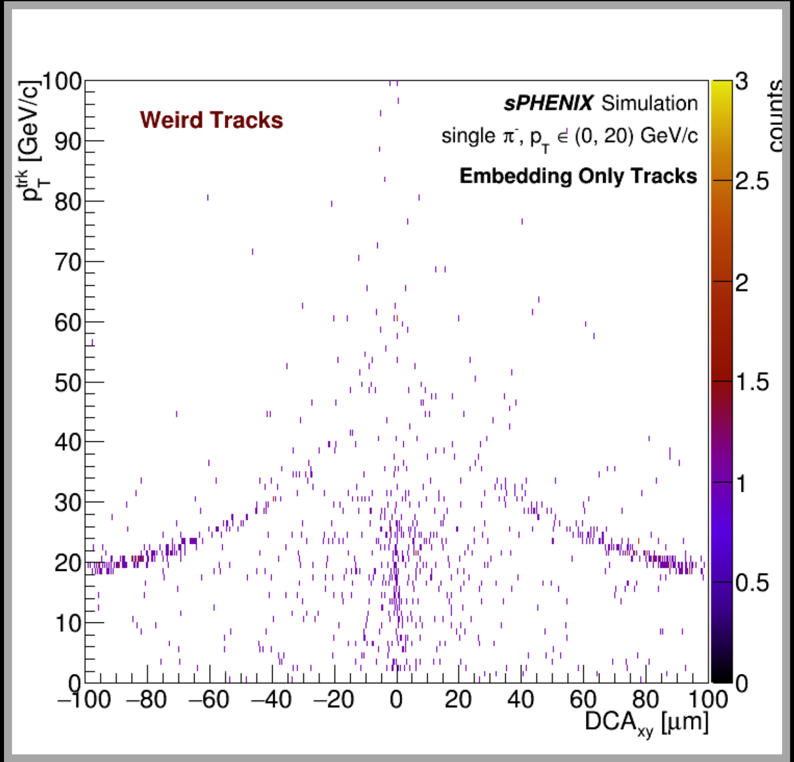

**Weird Tracks w/ Silicon Seeds**



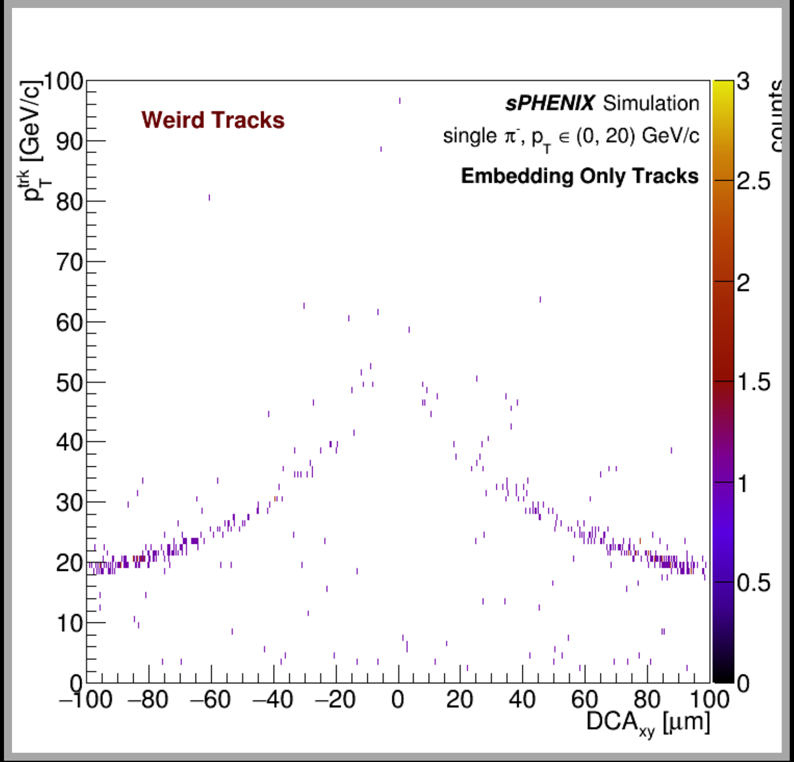

- Track DCAxy
  - Track DCAxy (left panels)
  - DCAxy vs. $p_T^{trk}$ (right panels)
  - **dca3dxy vs. pt** leaves of ntp_track tuple

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

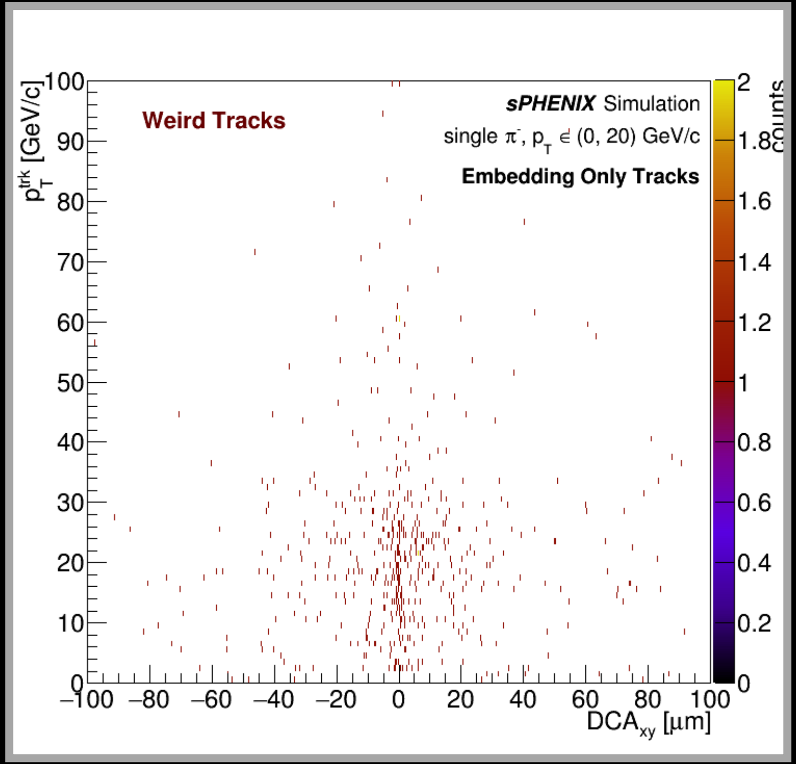
# Weird Track DCAxy




All Weird Tracks




Weird Tracks w/o Silicon Seeds

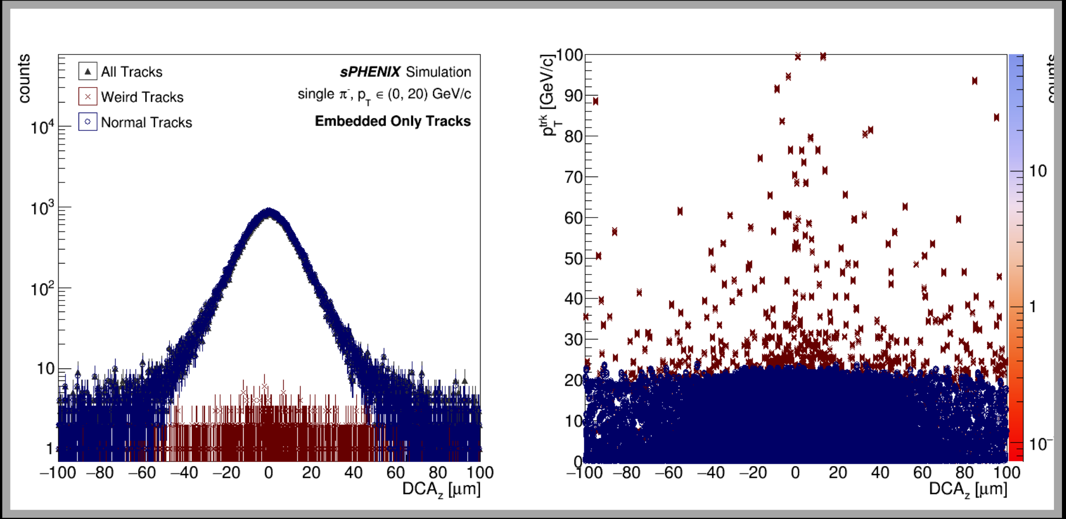



Weird Tracks w/ Silicon Seeds

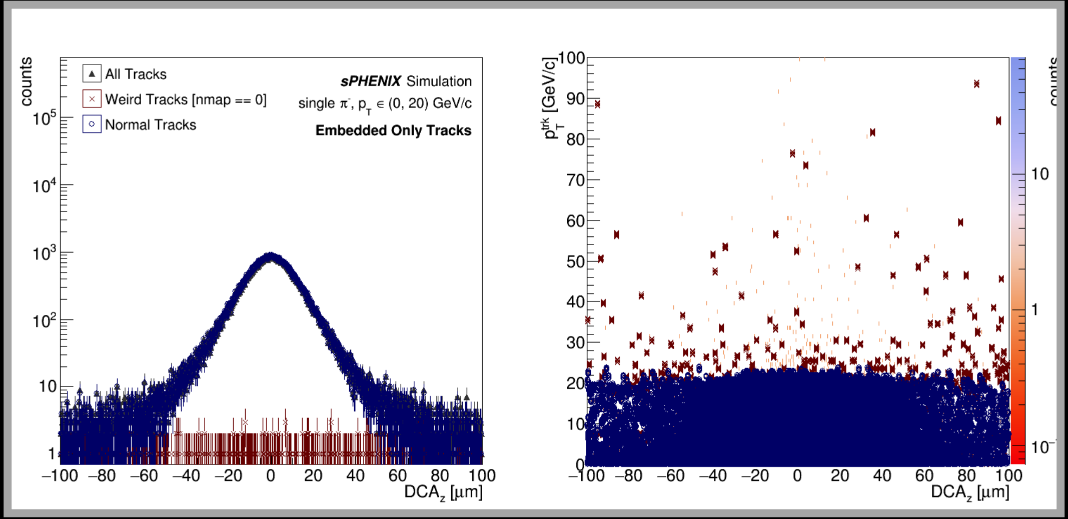
- Weird track DCAxy
  - **dca3dxy** leaf of ntp_track tuple for only weird tracks
- **Note:** z-axes are **not** scaled
  - z-axis range changes between plots (apologies!)

# Track DCAz

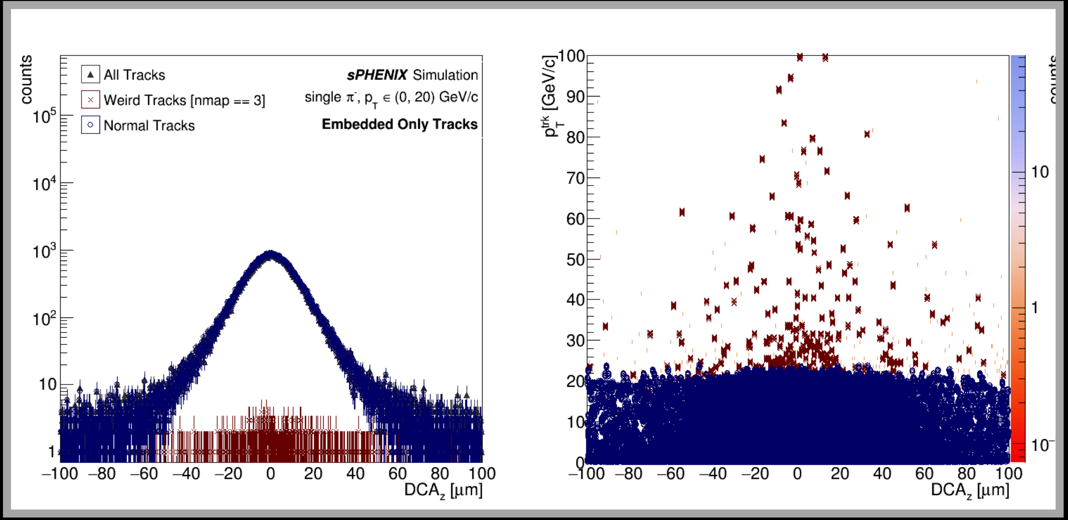
**All Weird Tracks**




**Weird Tracks w/o Silicon Seeds**



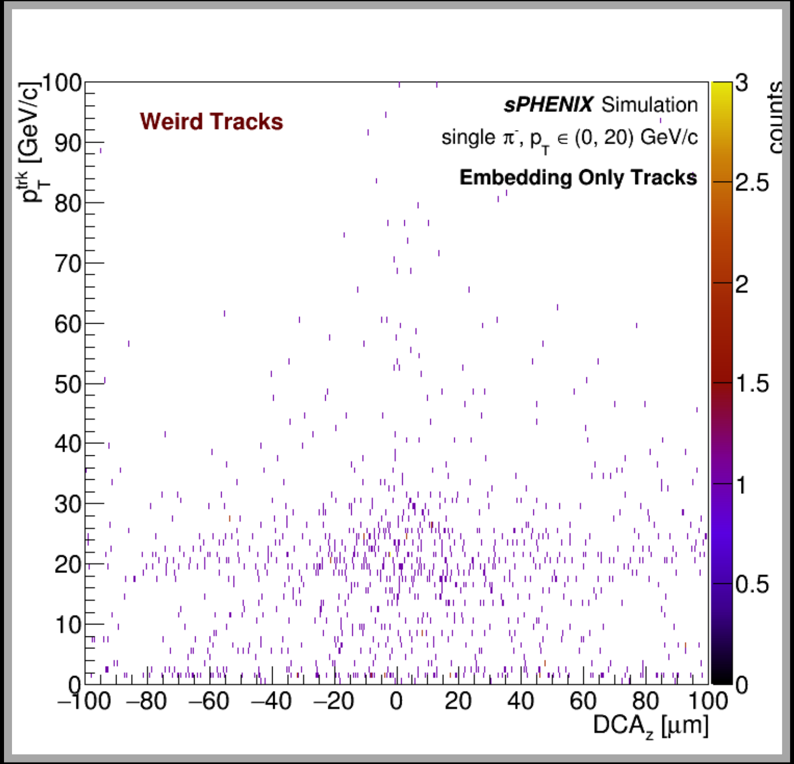

**Weird Tracks w/ Silicon Seeds**



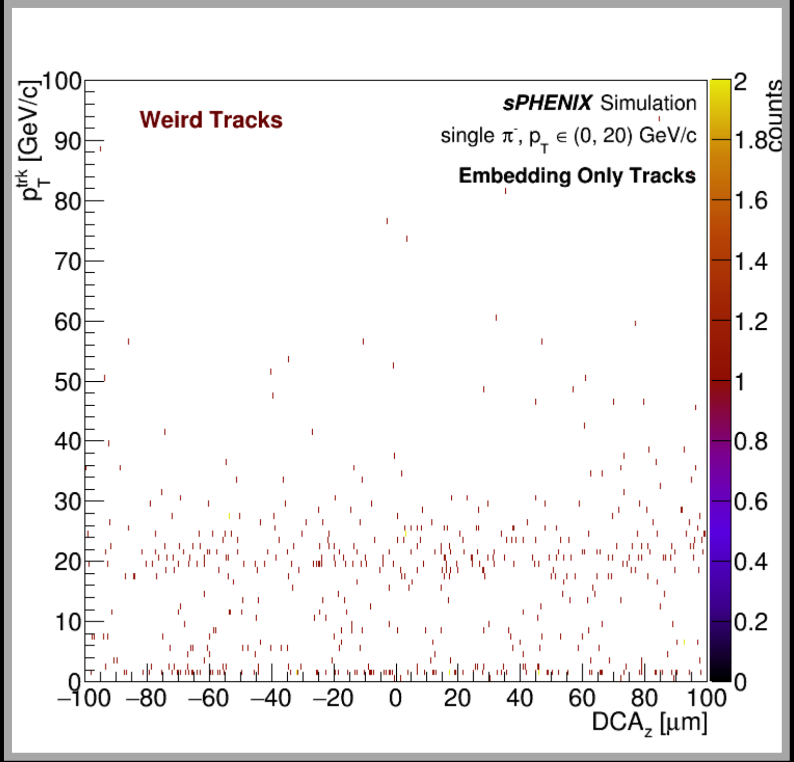

- Track DCAz
  - Track DCAz (left panels)
  - DCAz vs. $p_T^{trk}$ (right panels)
  - **dca3dz vs. pt** leaves of ntp_track tuple

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

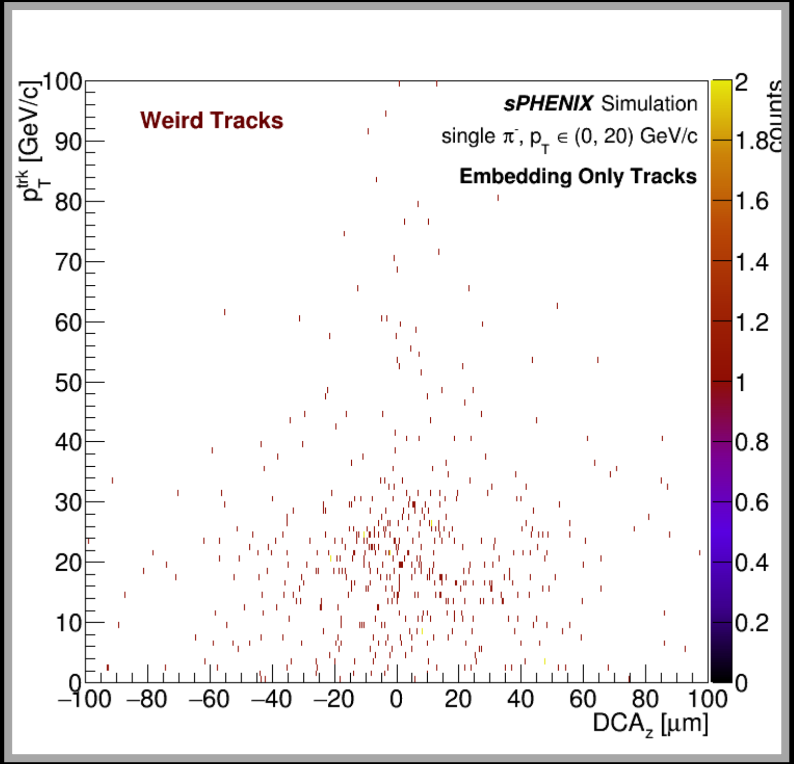
# Weird Track DCAz




All Weird Tracks




Weird Tracks w/o Silicon Seeds

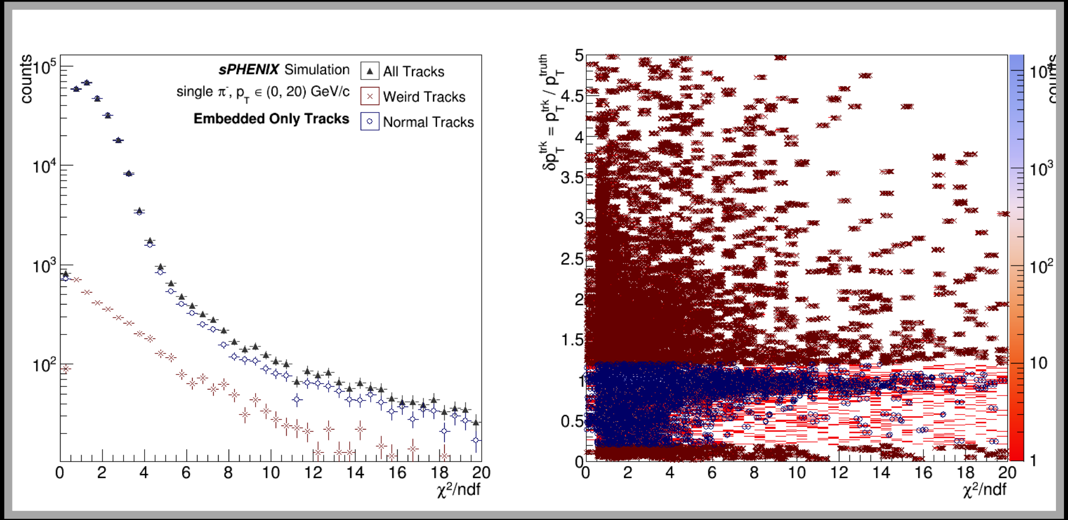



Weird Tracks w/ Silicon Seeds

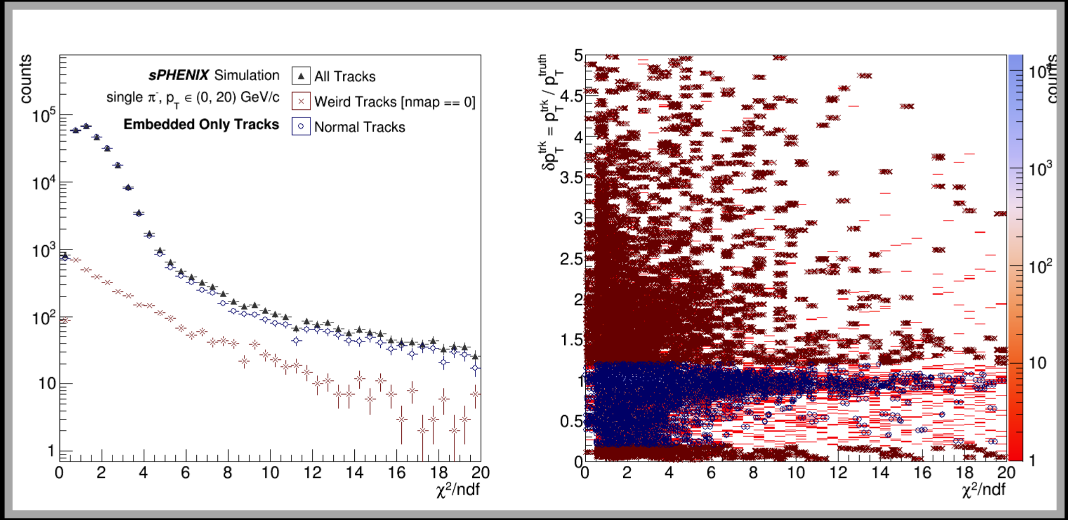
- Weird track DCAz
  - **dca3dz** leaf of ntp_track tuple for only weird tracks
- **Note:** z-axes are **not** scaled
  - z-axis range changes between plots (apologies!)

# Track Quality

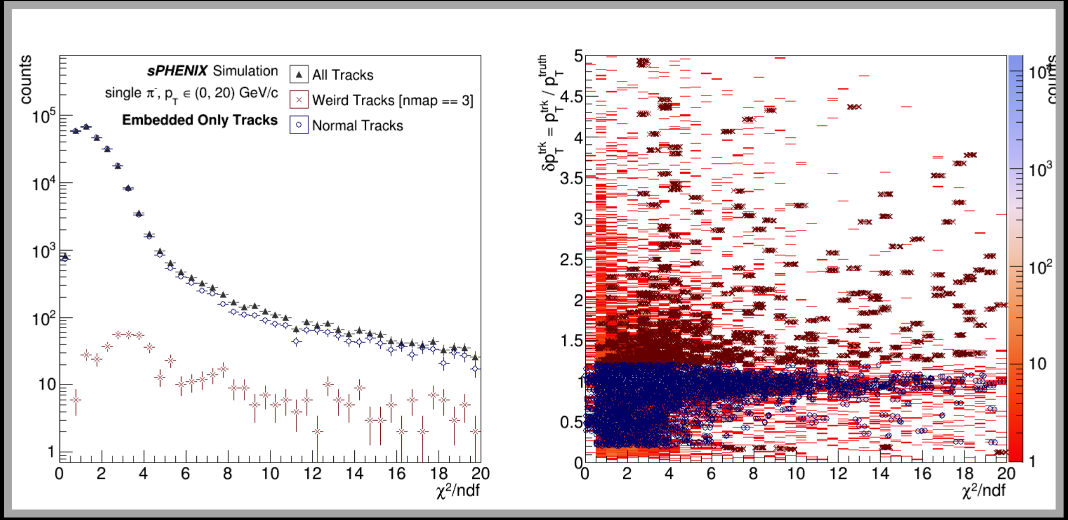
## All Weird Tracks




## Weird Tracks w/o Silicon Seeds




## Weird Tracks w/ Silicon Seeds

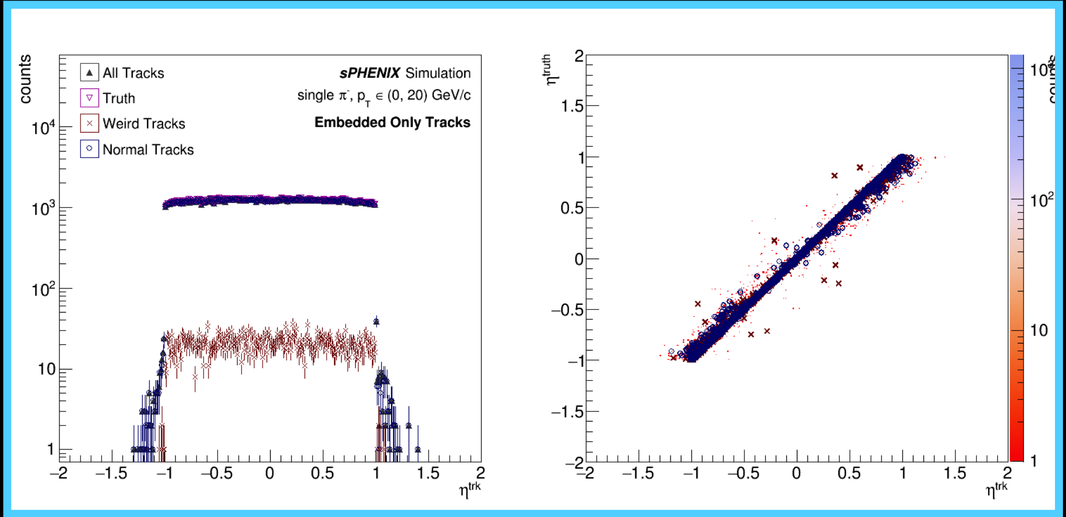



- Track $\chi^2$/ndf
  - Track $\chi^2$/ndf (left panels)
  - $\chi^2$/ndf vs. $p_T^{trk}/p_T^{true}$ (right panels)
  - **quality vs. pt/gpt** leaves of ntp_track tuple

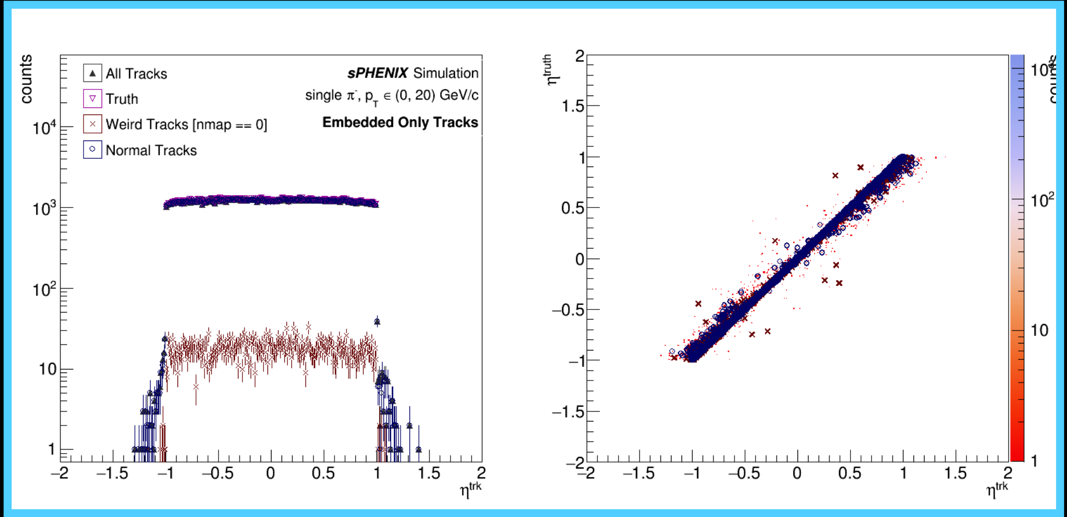
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

# Track Eta

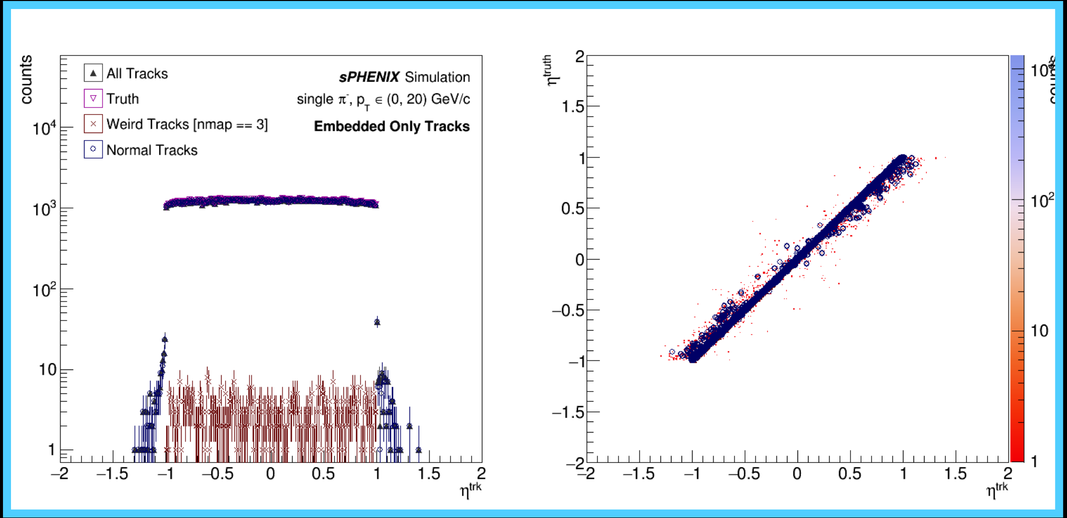
**All Weird Tracks**




**Weird Tracks w/o Silicon Seeds**

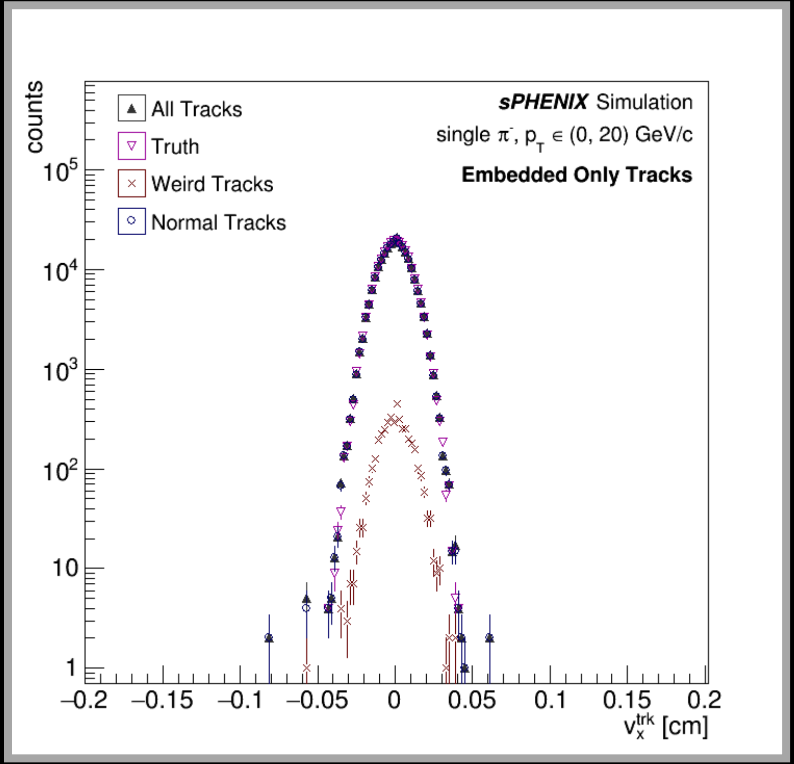



**Weird Tracks w/ Silicon Seeds**

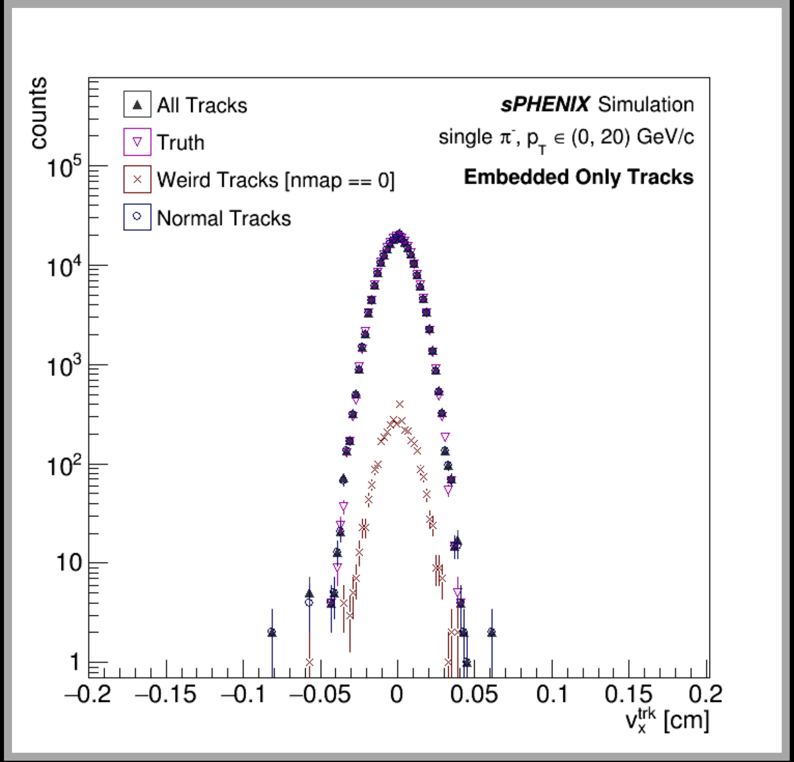



- Reconstructed and truth eta
  - reco. eta (left panels)
  - reco. vs. truth eta (right panels)
  - **eta vs. geta** leaves of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

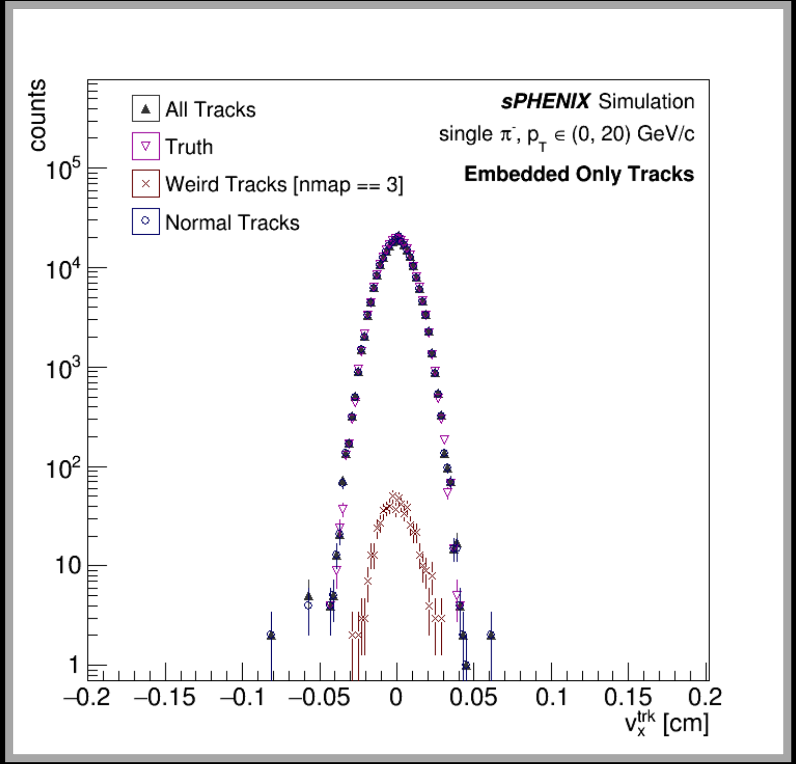
# Track X-Vertex




**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!)