Track Cut Study: Update

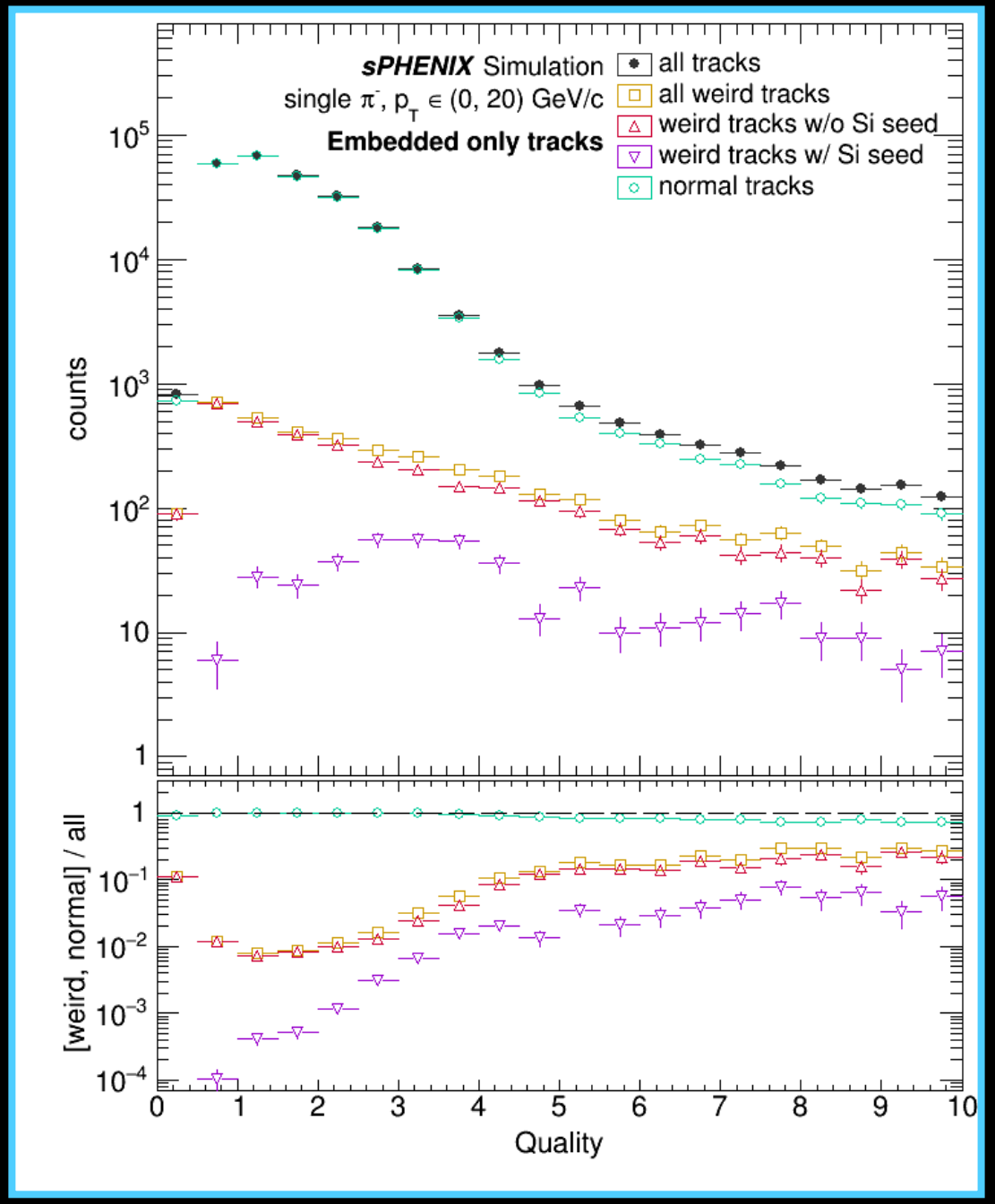
sPHENIX Tracking Meeting

February 1st, 2023

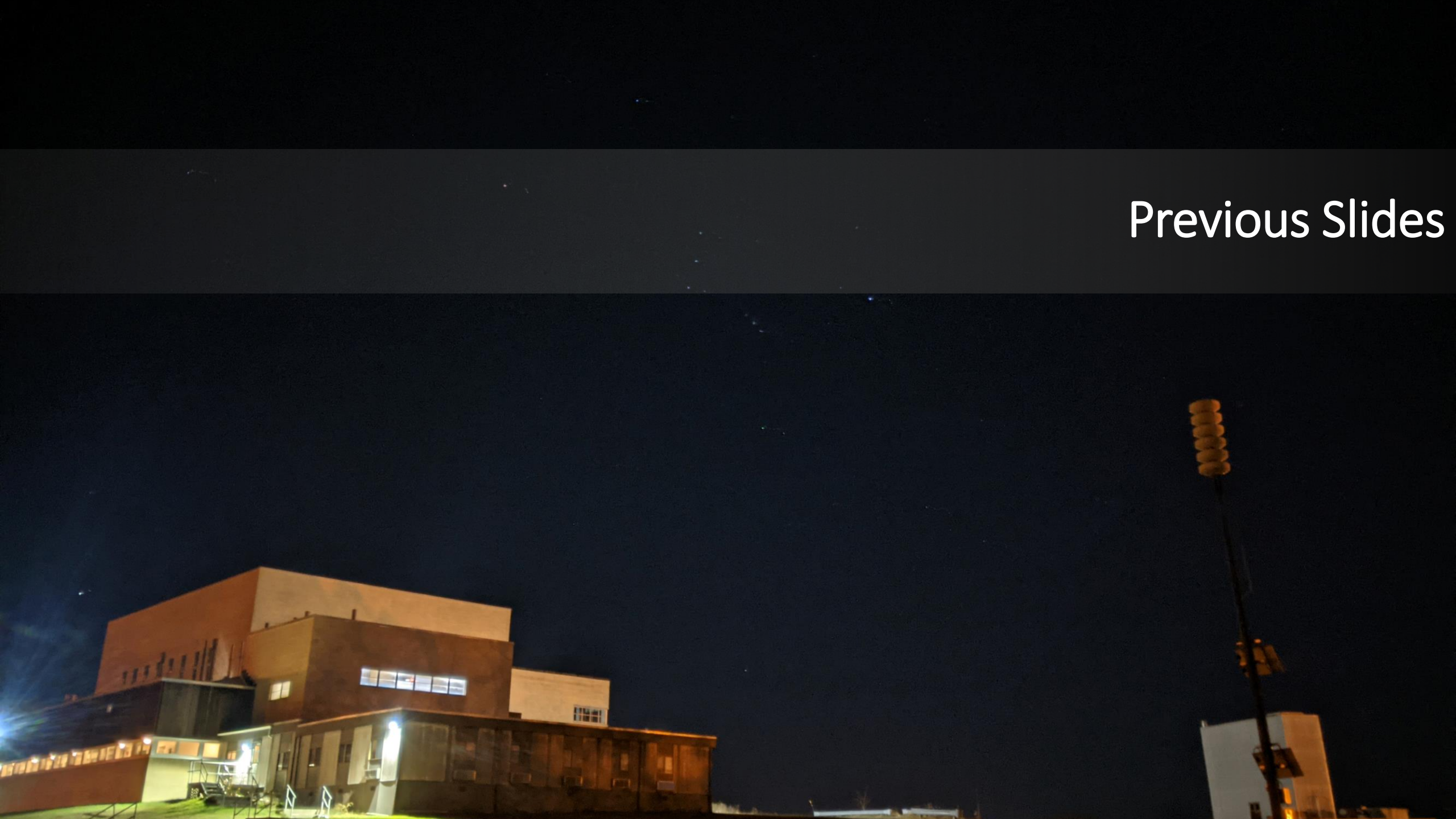
Derek Anderson

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 ⇒ $p_T^{reco}/p_T^{true} \in (0.2,1.20)$



Previous Slides



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

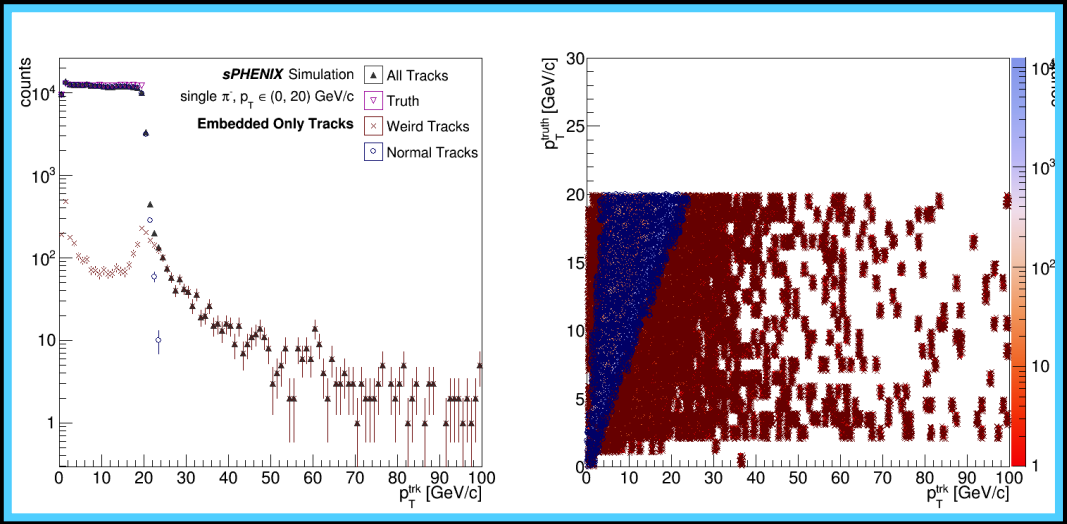
- p_T^{trk} distribution is bimodal (slide 4)
- Majority seem to lie at sector boundaries in phi (slide 5)
- Majority have large DCAxy values (slides 6 and 7)
  - › Show no correlation in DCAz (slides 8 and 9)
- χ^2/ndf distribution is falling (slide 10)

Weird Tracks w/ Silicon Seeds

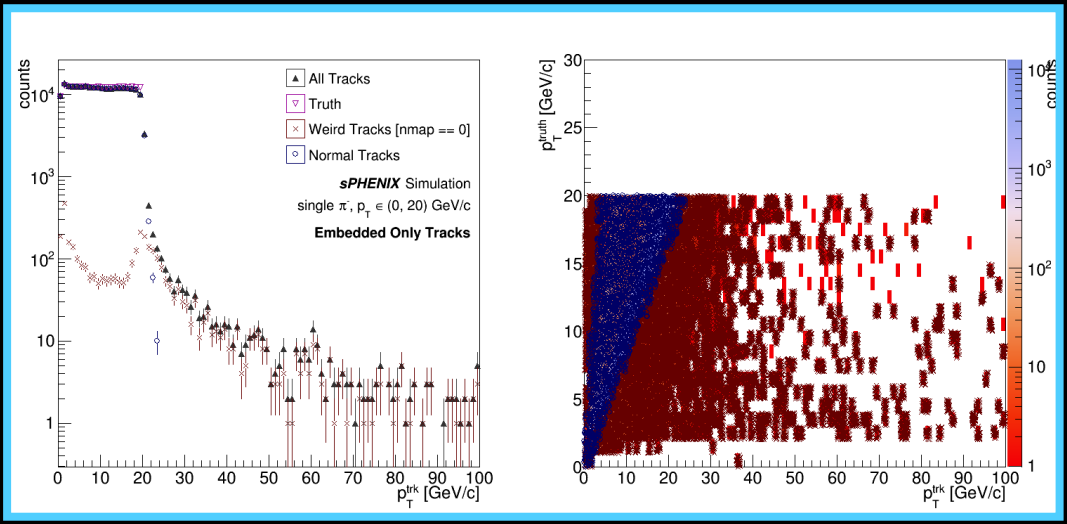
- p_T^{trk} distribution is unimodal (slide 4)
- No correlation in phi (slide 5)
- χ^2/ndf distribution is roughly flat (slide 10)

Track Pt

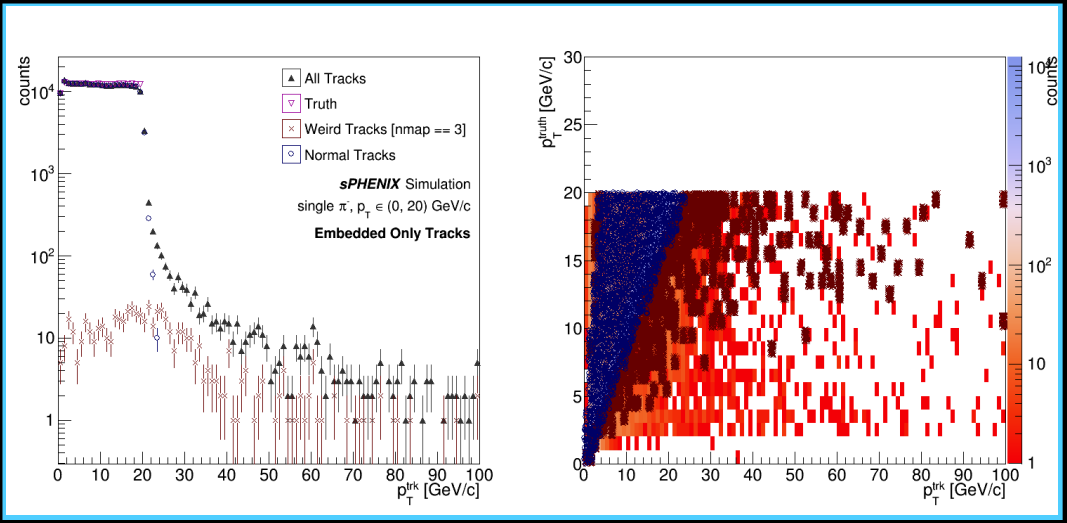
All Weird Tracks



Weird Tracks w/o Silicon Seeds



Weird Tracks w/ Silicon Seeds

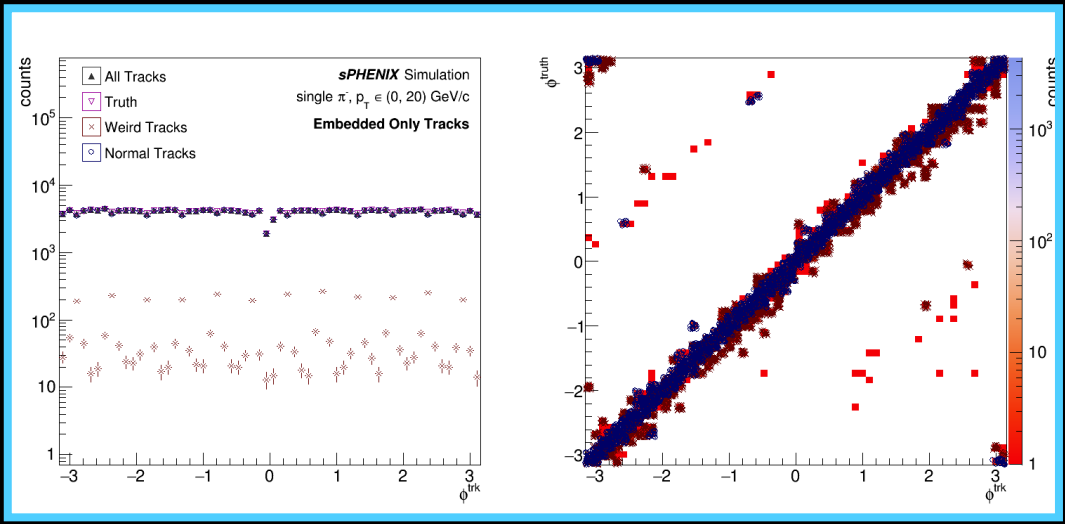


- Reconstructed and truth p_T
  - reco. p_T (left panels)
  - reco. vs. truth p_T (right panels)
  - **pt vs. gpt** leaves of ntp_track tuple

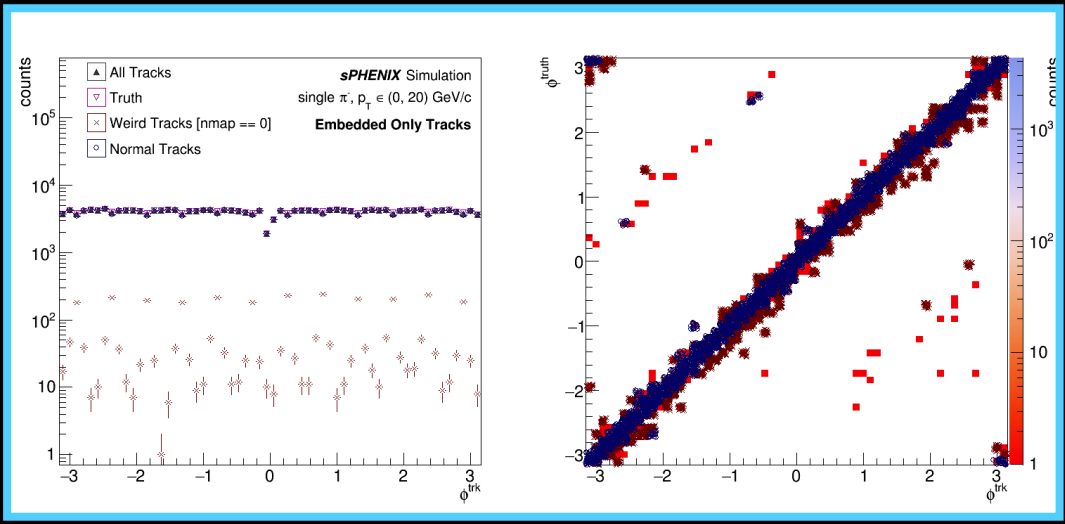
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Track Phi

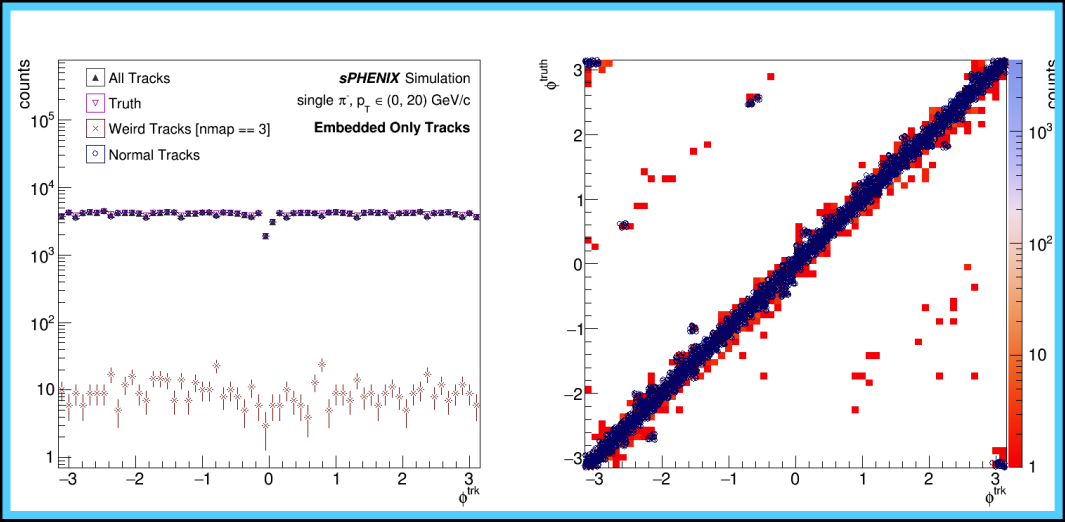
All Weird Tracks



Weird Tracks w/o Silicon Seeds



Weird Tracks w/ Silicon Seeds

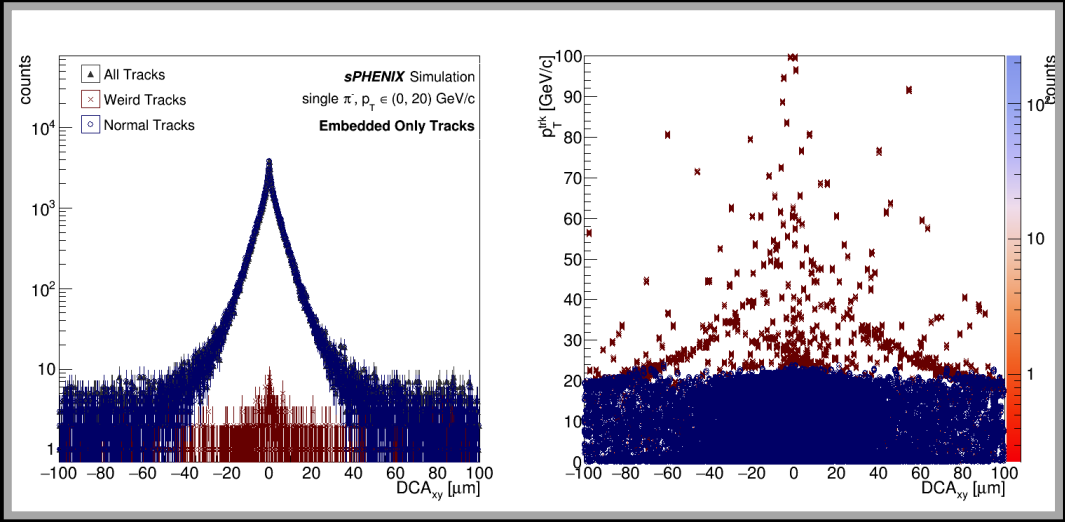


- Reconstructed and truth phi
  - reco. phi (left panels)
  - reco. vs. truth phi (right panels)
  - **phi vs. gphi** leaves of ntp_track tuple

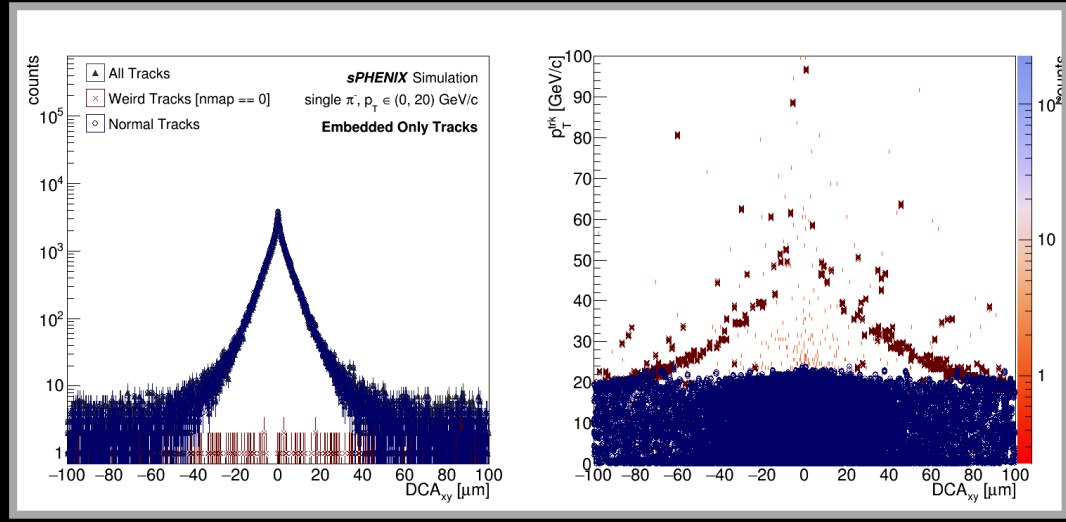
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Track DCAxy

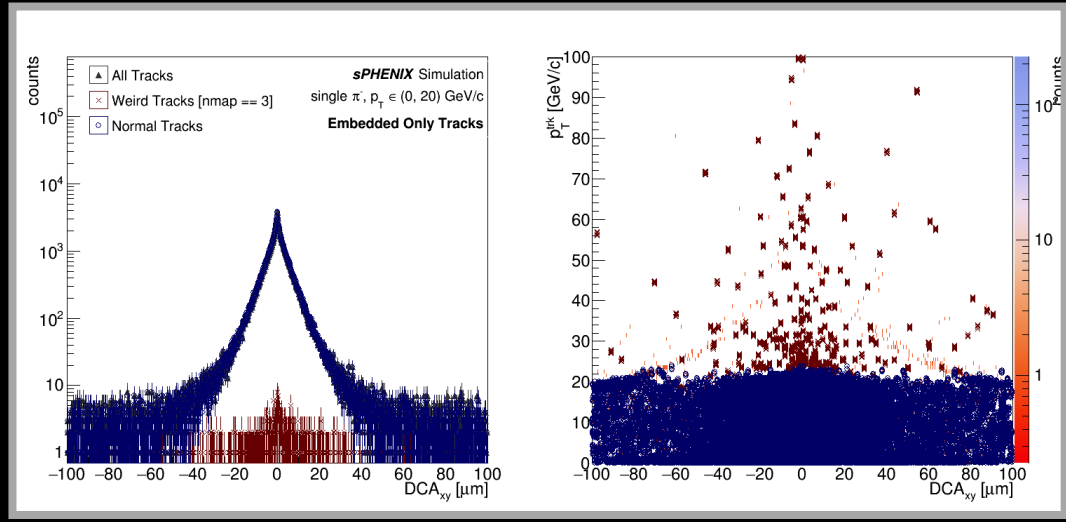
All Weird Tracks



Weird Tracks w/o Silicon Seeds



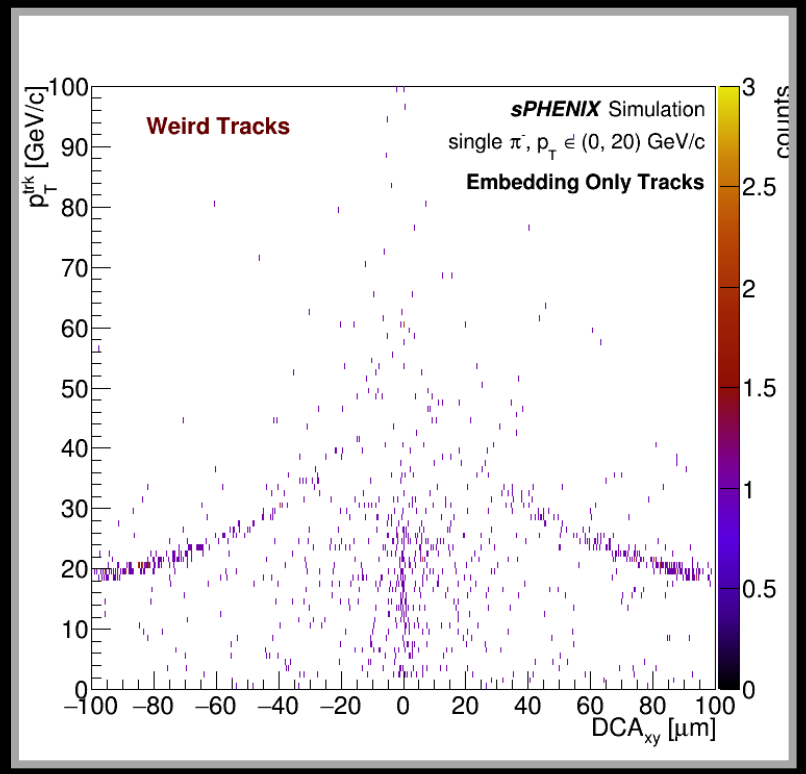
Weird Tracks w/ Silicon Seeds



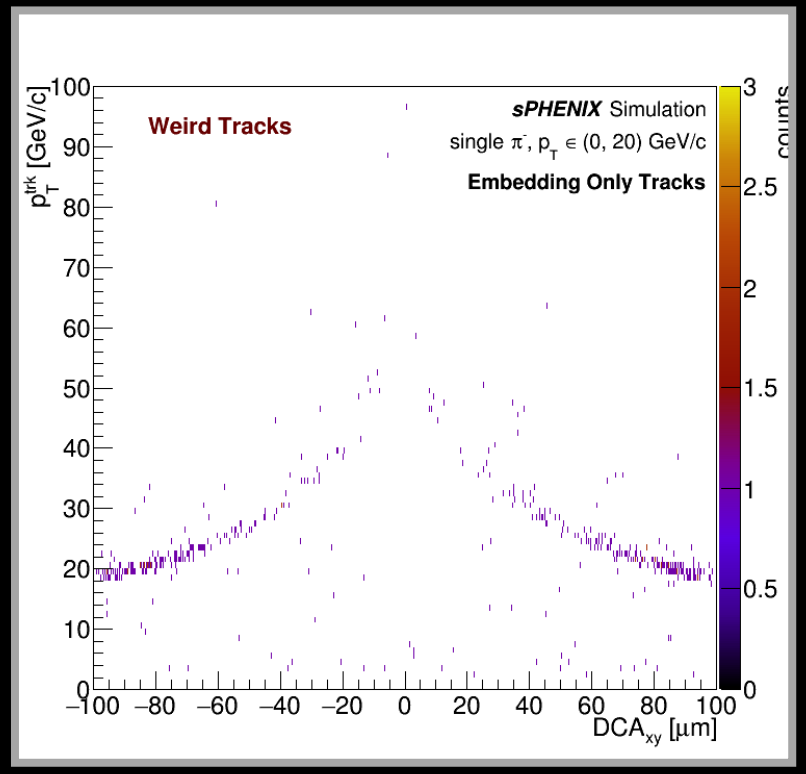
- Track DCAxy
  - Track DCAxy (left panels)
  - DCAxy vs. p_T^{trk} (right panels)
  - **dca3dxy vs. pt** leaves of ntp_track tuple

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

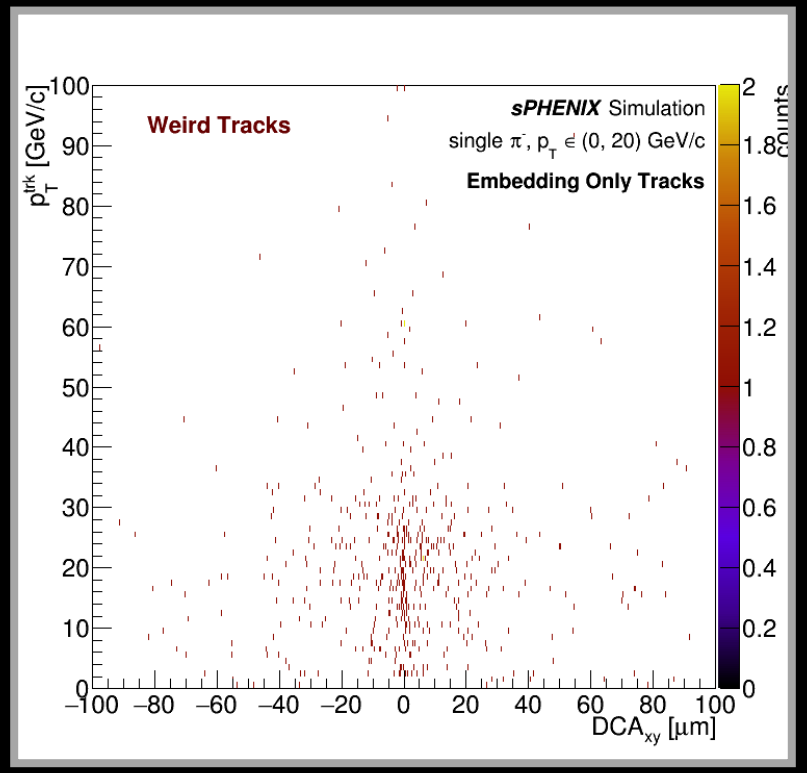
Weird Track DCAxy



All Weird Tracks



Weird Tracks w/o Silicon Seeds

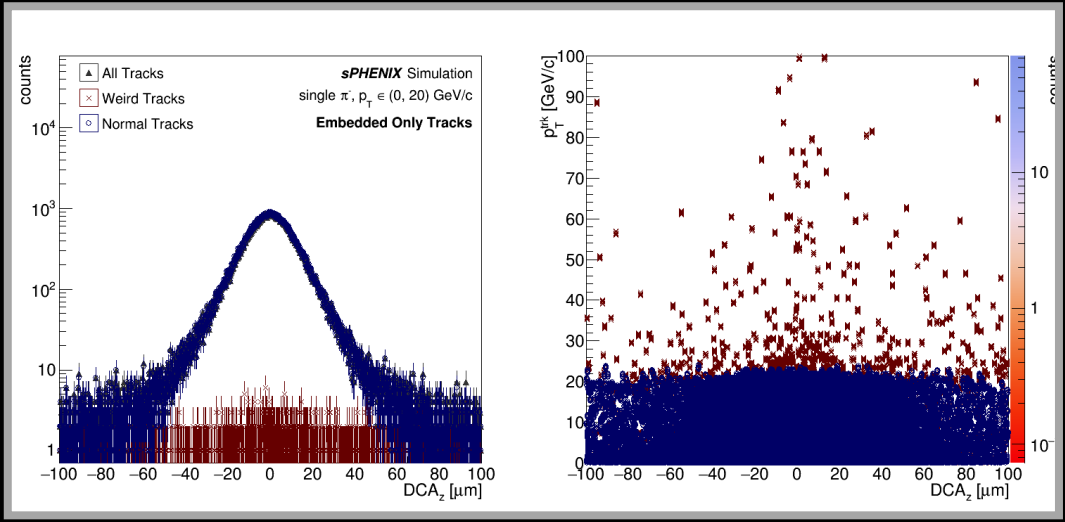


Weird Tracks w/ Silicon Seeds

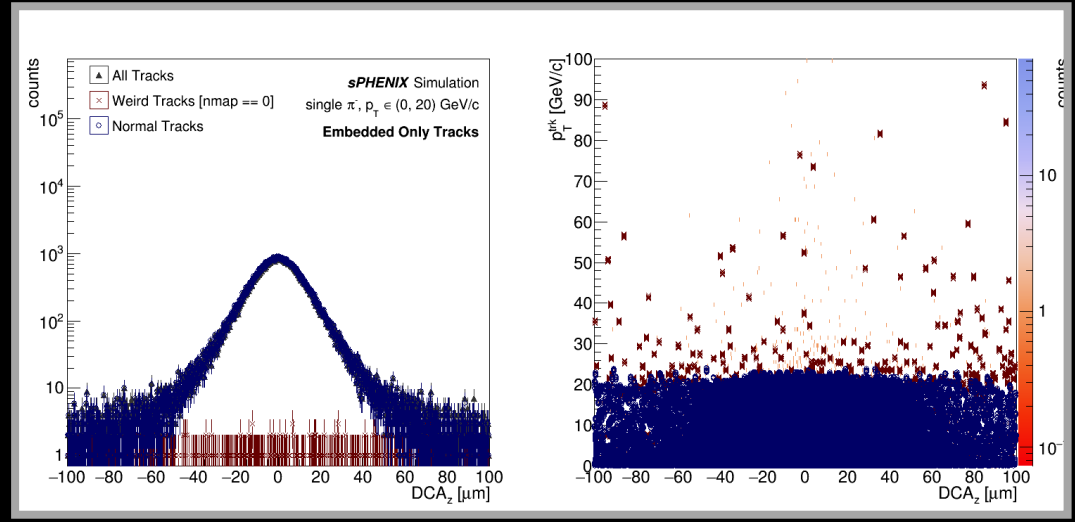
- Weird track DCAxy
  - **dca3dxy** leaf of ntp_track tuple for only weird tracks
- **Note:** z-axes are **not** scaled
  - z-axis range changes between plots (apologies!)

Track DCAz

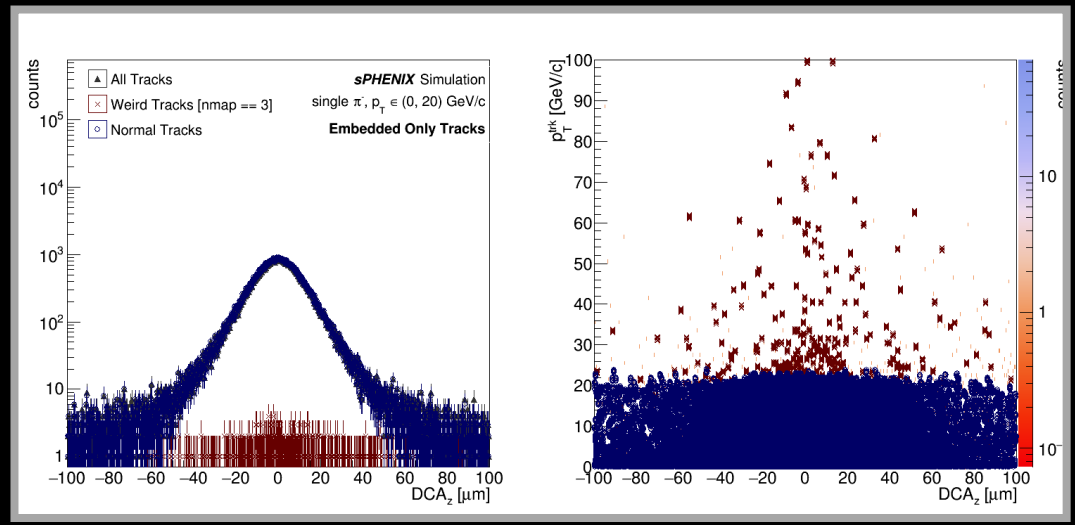
All Weird Tracks



Weird Tracks w/o Silicon Seeds



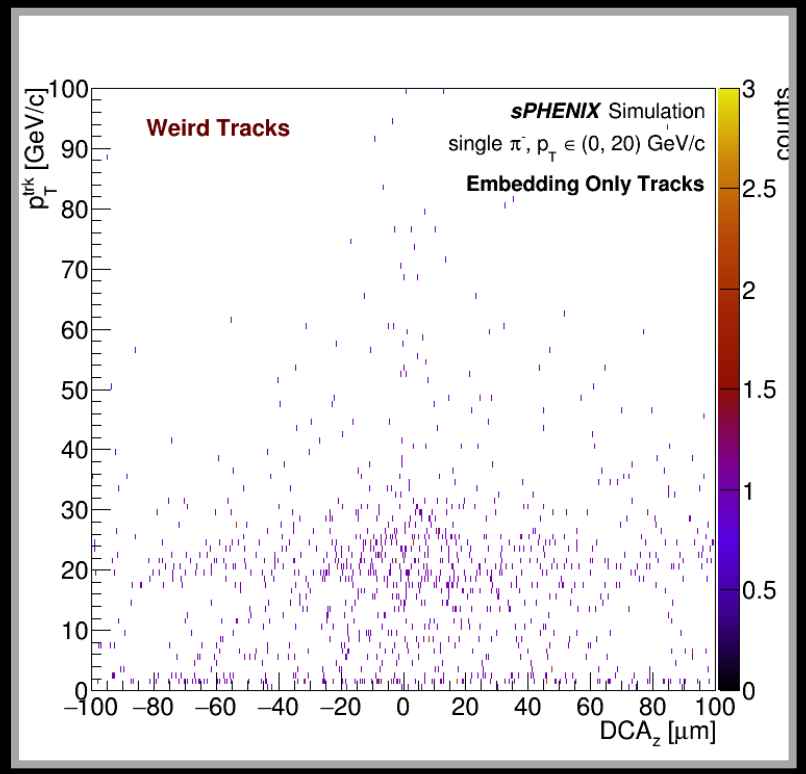
Weird Tracks w/ Silicon Seeds



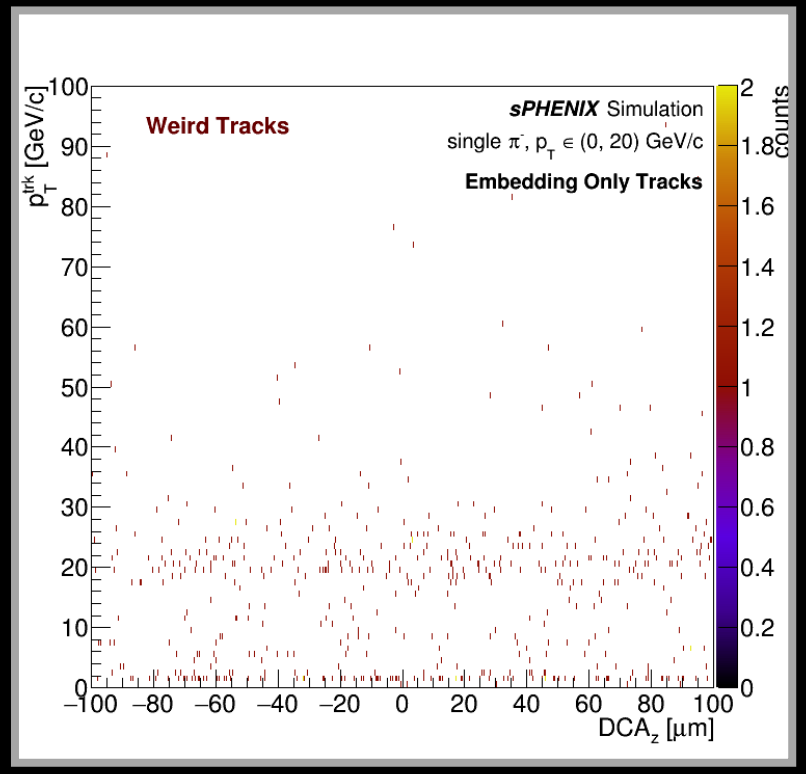
- Track DCAz
  - Track DCAz (left panels)
  - DCAz vs. p_T^{trk} (right panels)
  - **dca3dz vs. pt** leaves of ntp_track tuple

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

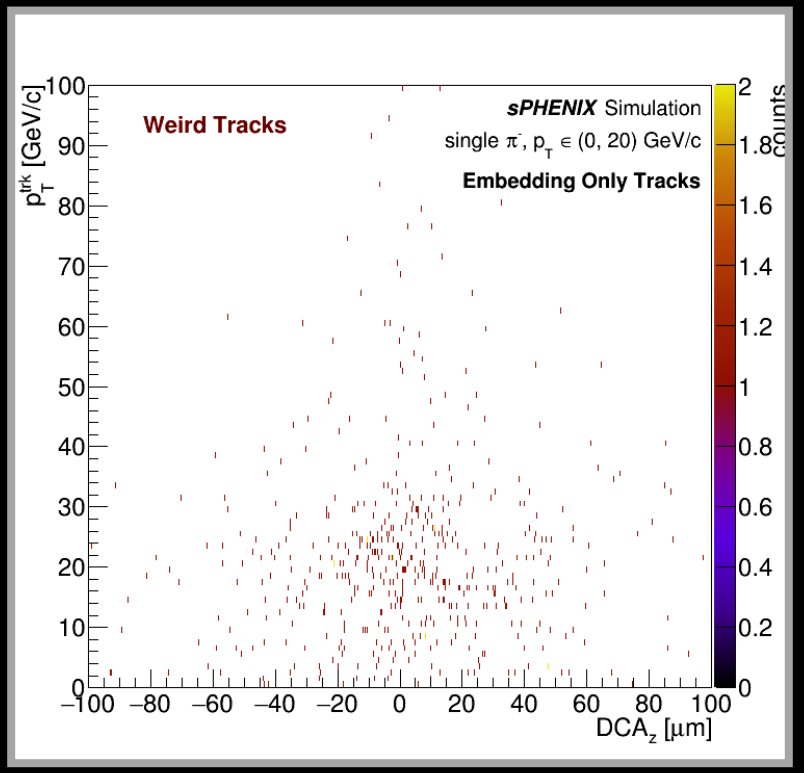
Weird Track DCAz



All Weird Tracks



Weird Tracks w/o Silicon Seeds

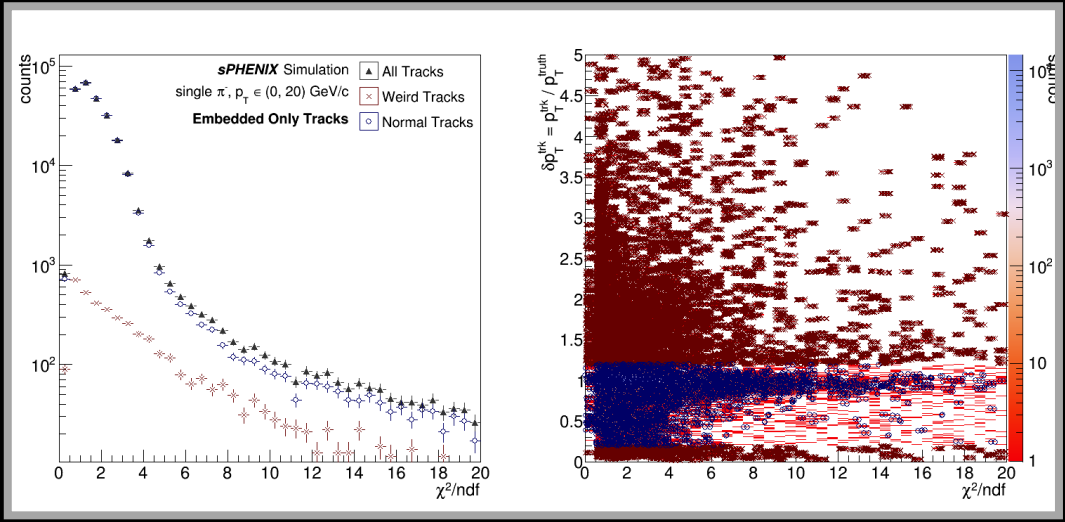


Weird Tracks w/ Silicon Seeds

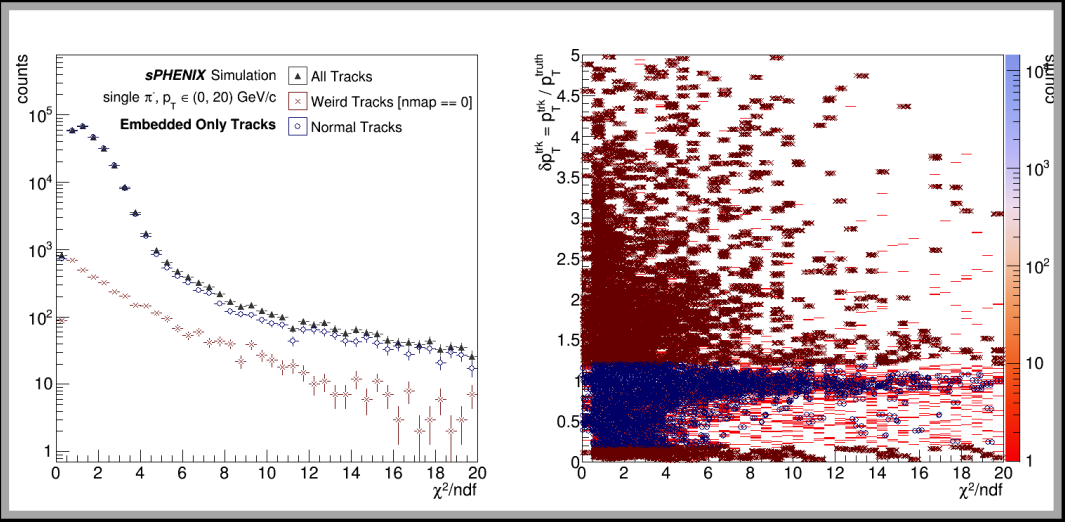
- Weird track DCAz
  - **dca3dz** leaf of ntp_track tuple for only weird tracks
- **Note:** z-axes are **not** scaled
  - z-axis range changes between plots (apologies!)

Track Quality

All Weird Tracks



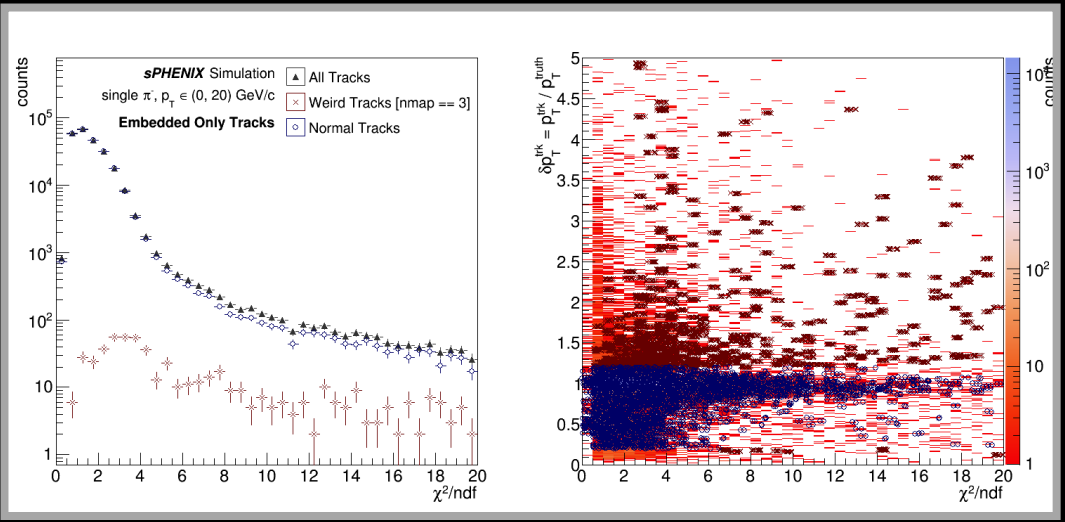
Weird Tracks w/o Silicon Seeds



- 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

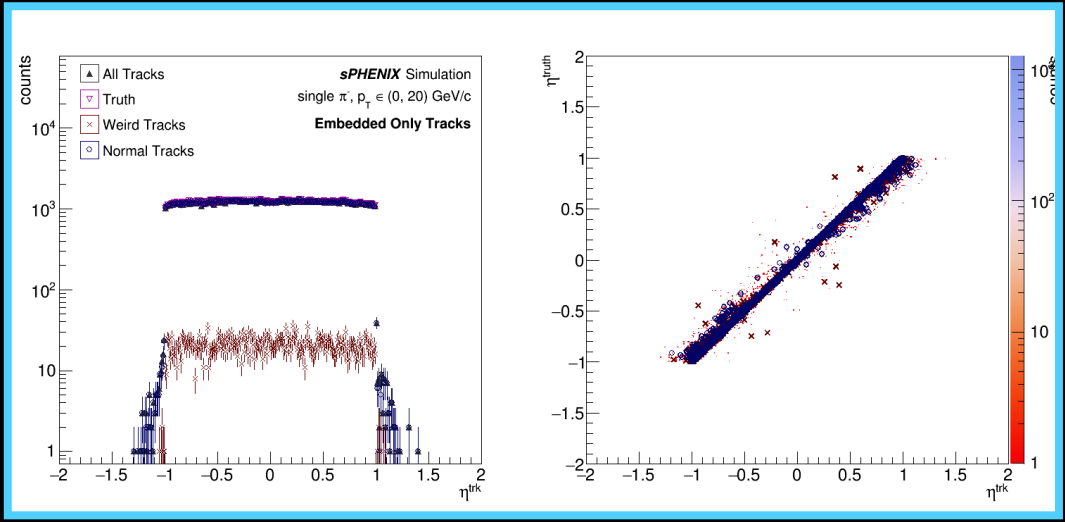
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Weird Tracks w/ Silicon Seeds

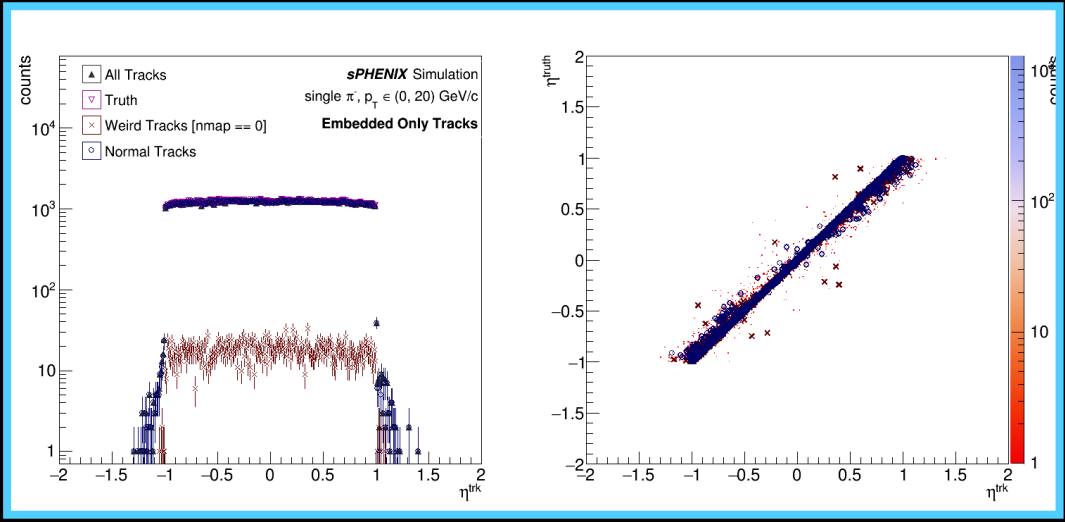


Track Eta

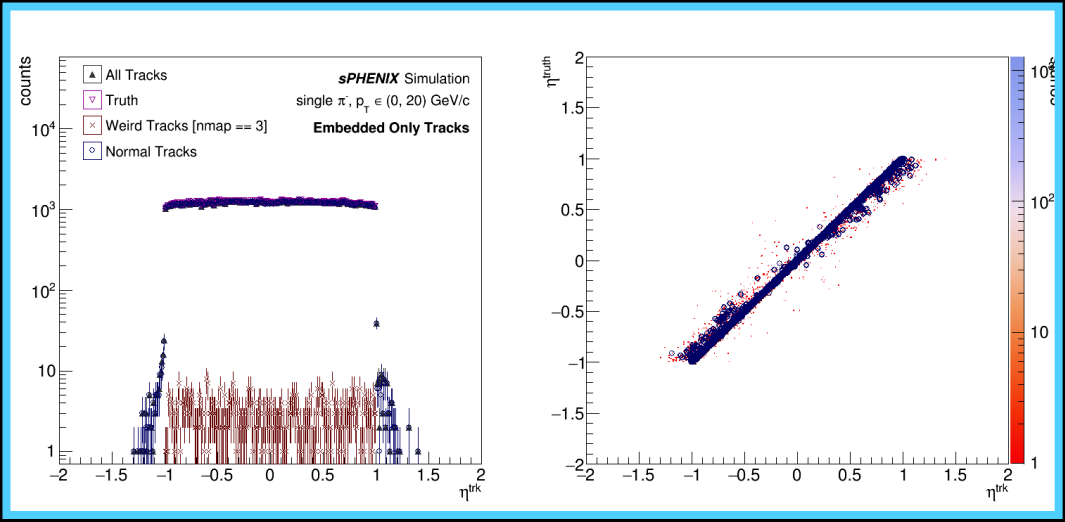
All Weird Tracks



Weird Tracks w/o Silicon Seeds



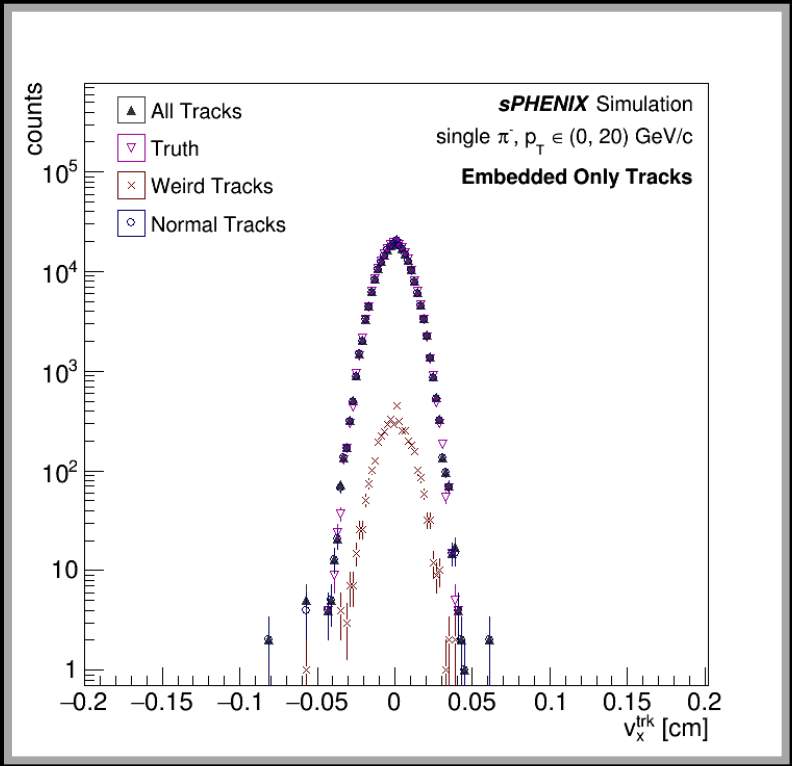
Weird Tracks w/ Silicon Seeds



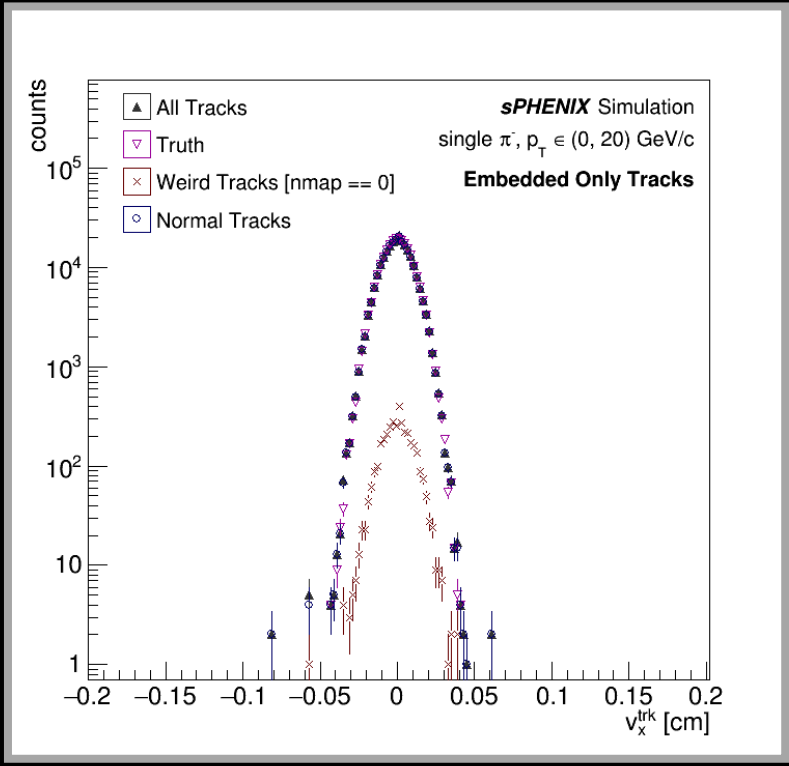
- Reconstructed and truth eta
  - reco. eta (left panels)
  - reco. vs. truth eta (right panels)
  - **eta vs. geta** leaves of ntp_track tuple

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

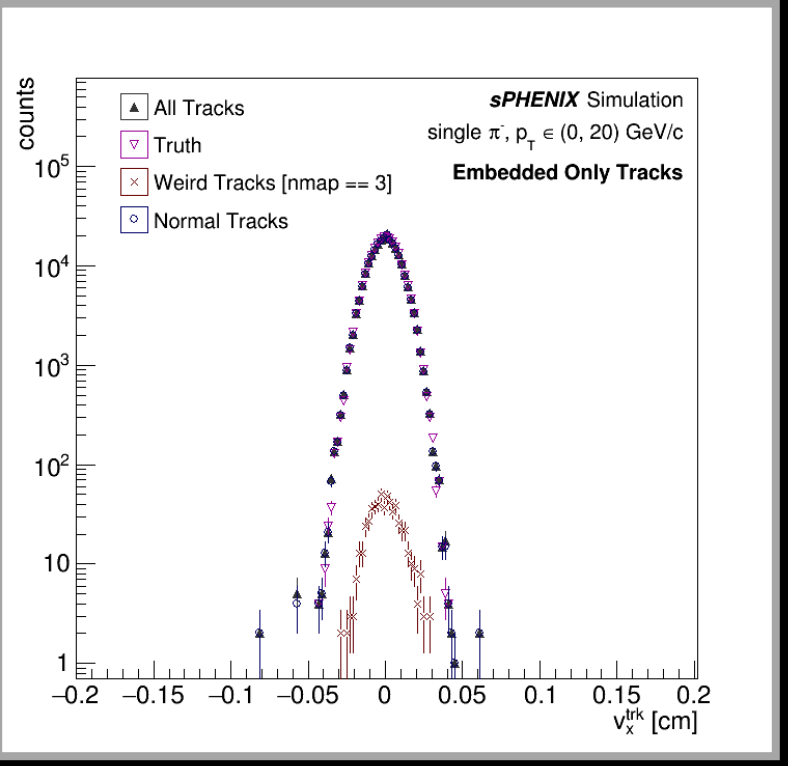
Track X-Vertex



All Weird Tracks



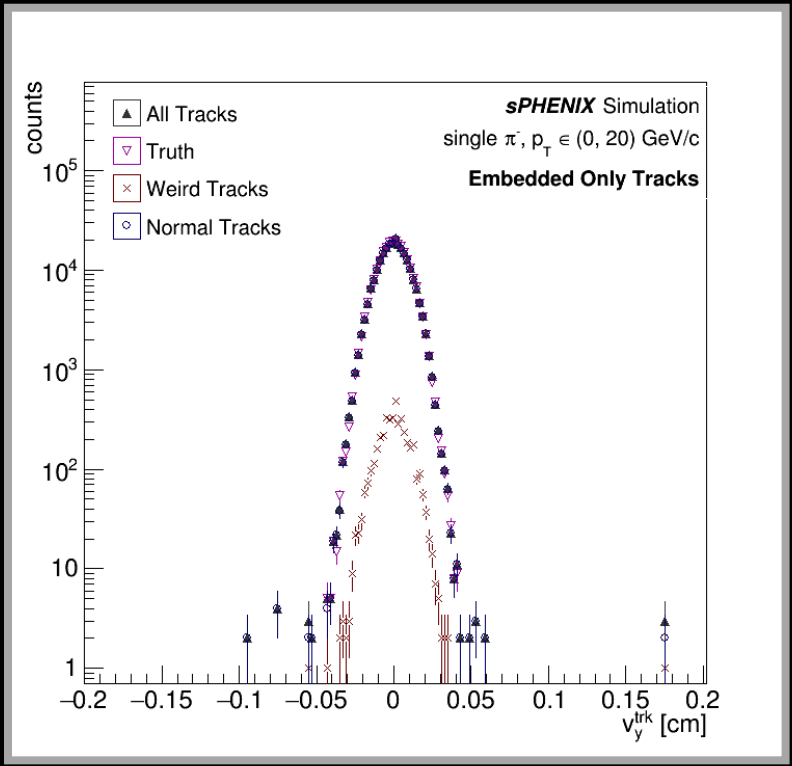
Weird Tracks w/o Silicon Seeds



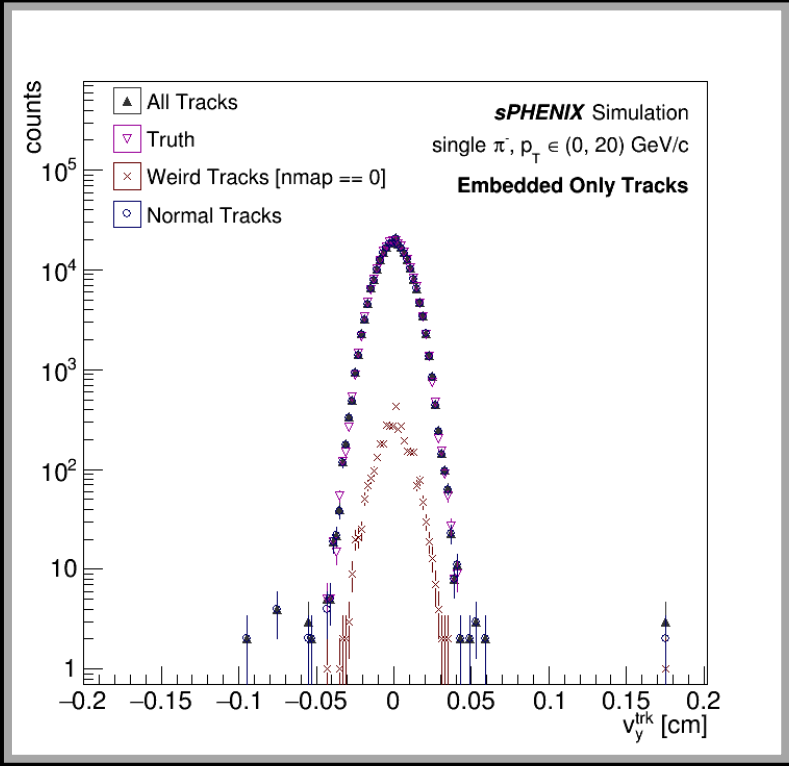
Weird Tracks w/ Silicon Seeds

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

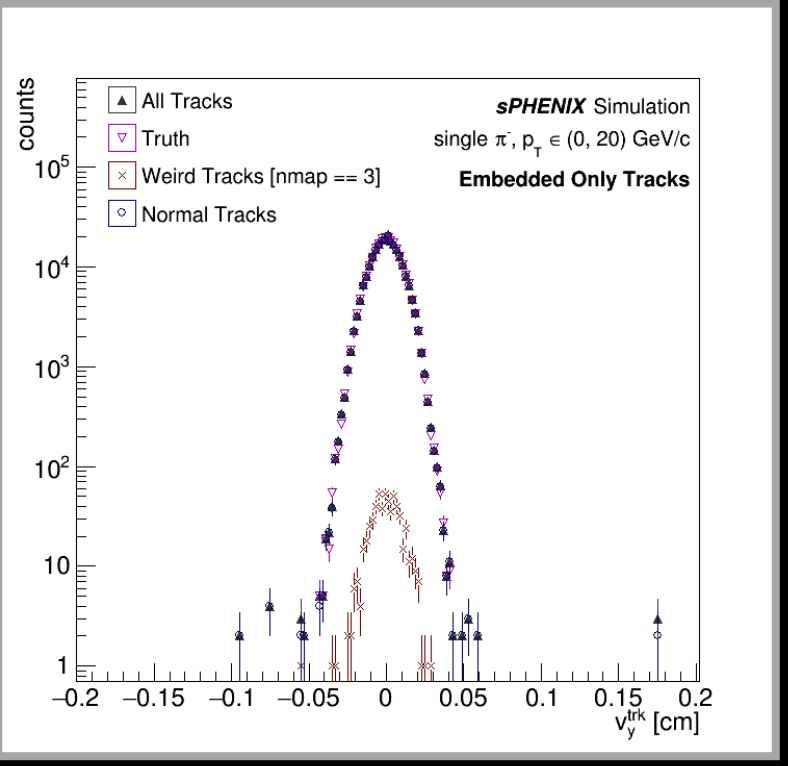
Track Y-Vertex



All Weird Tracks



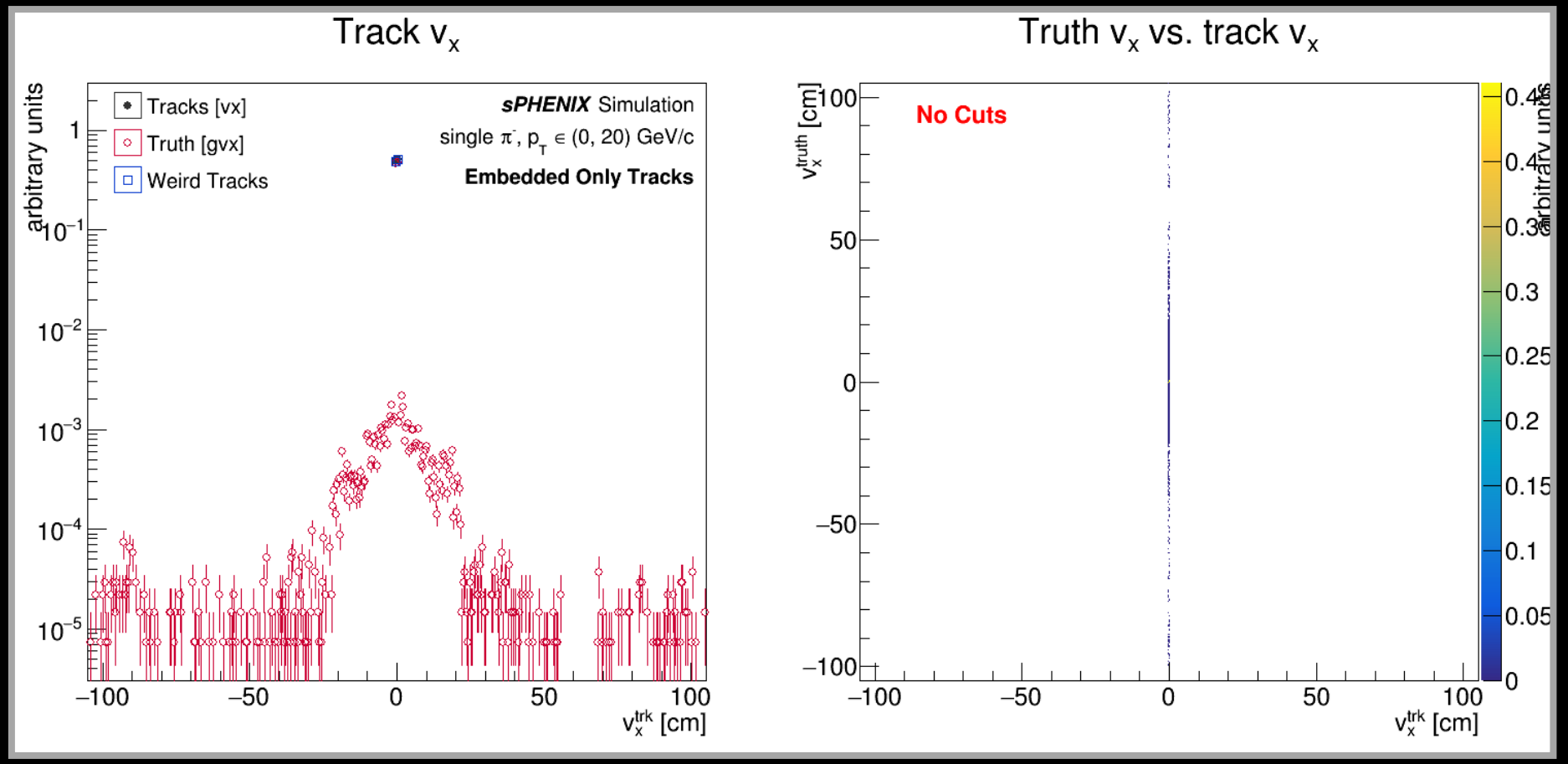
Weird Tracks w/o Silicon Seeds



Weird Tracks w/ Silicon Seeds

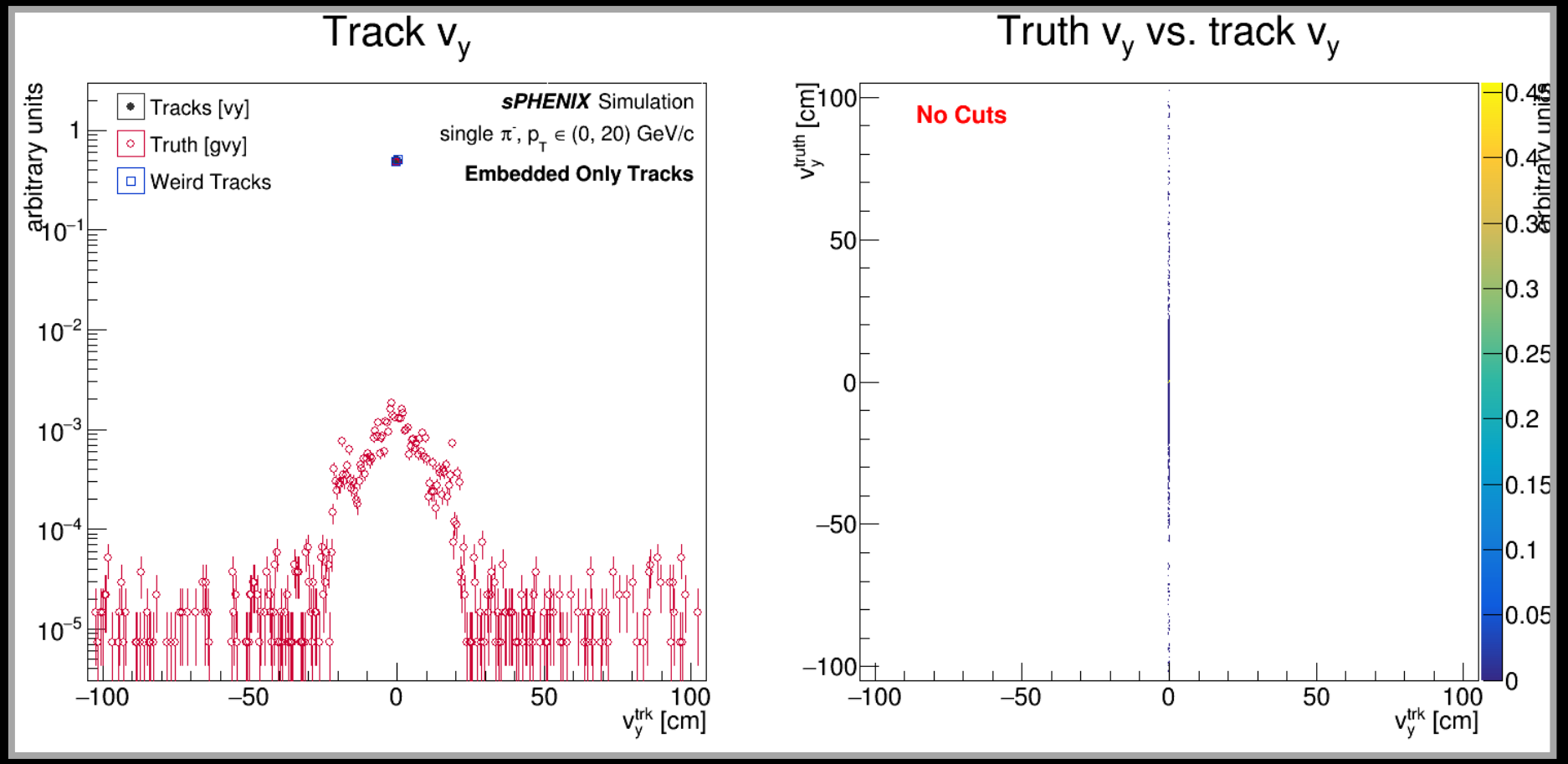
- Y-component of reconstructed vertex
  - **vy** leaf of ntp_track tuple
- **Note:** y-axes are **not** scaled
  - y-axis range changes between plots (apologies!)

Workfest Follow-Up | Reco. vs. Truth Vx



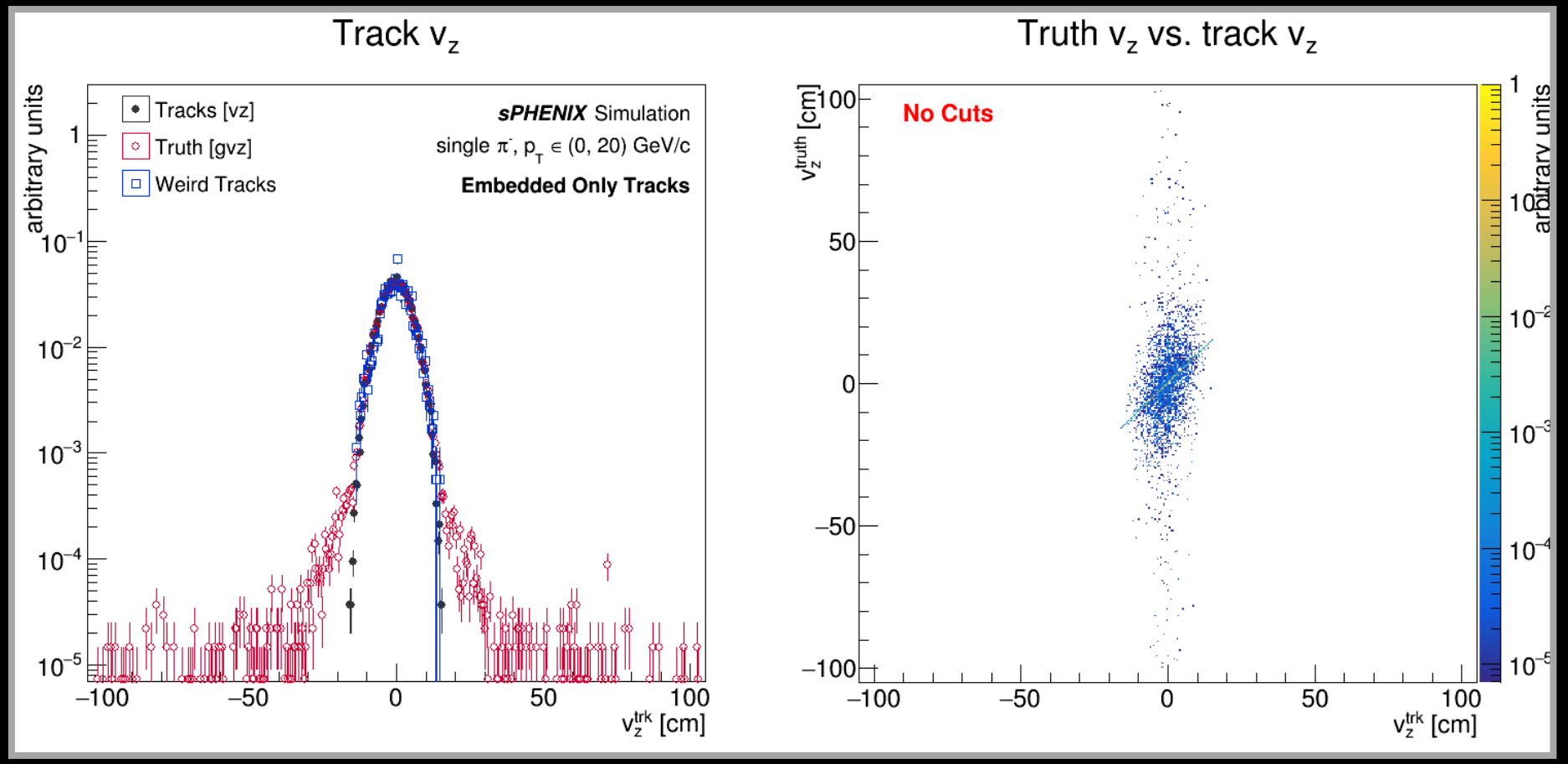
- Only cuts applied are to select "weird tracks"
  $\Rightarrow p_T^{reco}/p_T^{truth} \notin (0.2,1.2)$
- **Note:** distributions scaled by integral

Workfest Follow-Up | Reco. vs. Truth Vy



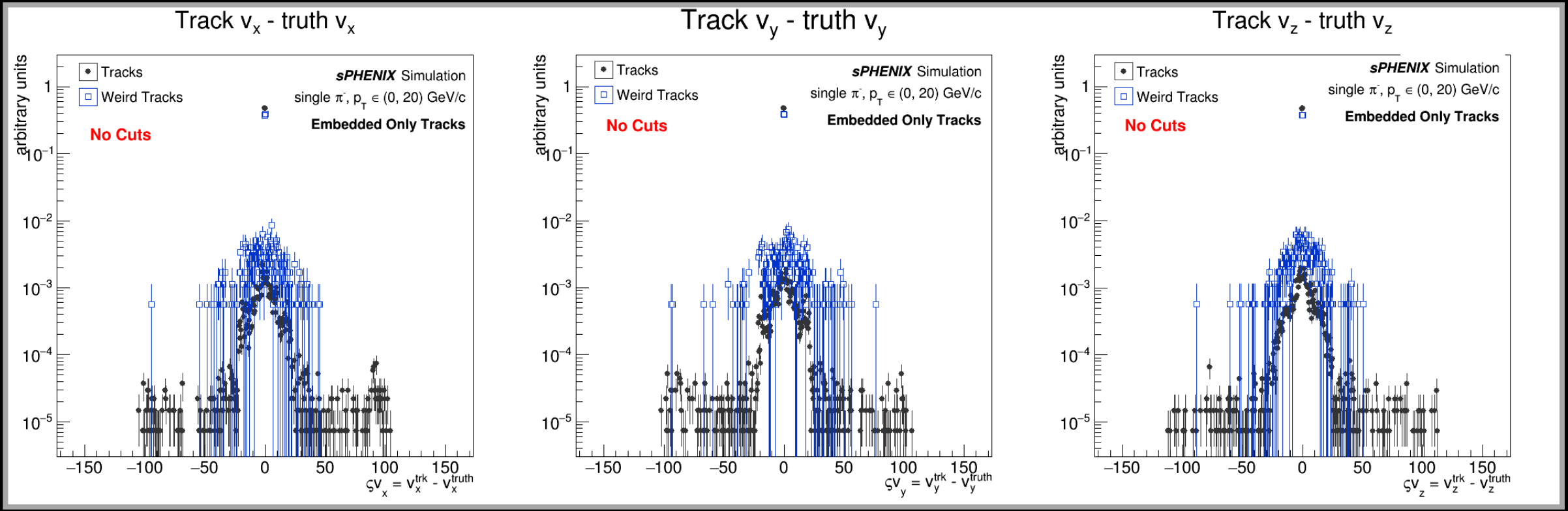
- Only cuts applied are to select "weird tracks"
  $\Rightarrow p_T^{reco}/p_T^{truth} \notin (0.2,1.2)$
- **Note:** distributions scaled by integral

Workfest Follow-Up | Reco. vs. Truth Vz



- Only cuts applied are to select "weird tracks"
  $\Rightarrow p_T^{reco}/p_T^{truth} \notin (0.2,1.2)$
- **Note:** distributions scaled by integral

Workfest Follow-Up | Difference Between Reco. vs. Truth Vtx

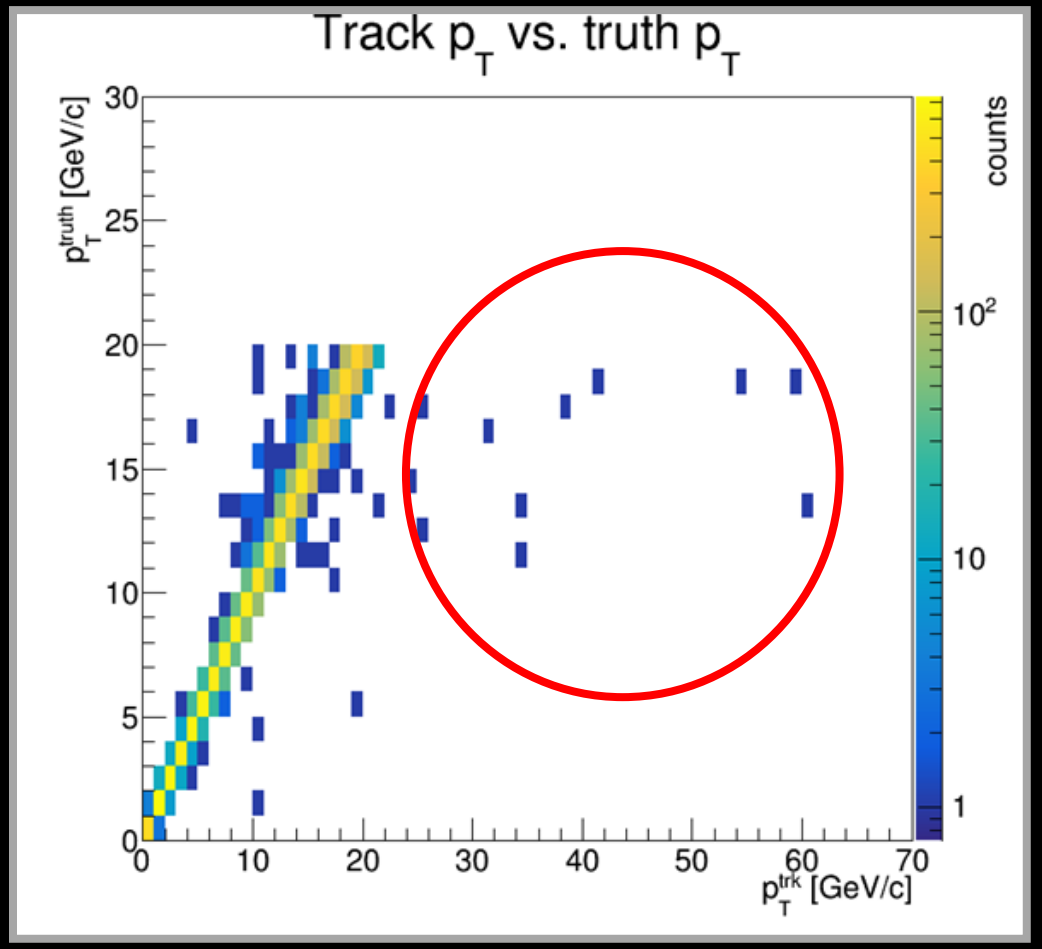


- Only cuts applied are to select "weird tracks"
  $\Rightarrow p_T^{reco}/p_T^{truth} \notin (0.2,1.2)$
- **Note:** distributions scaled by integral

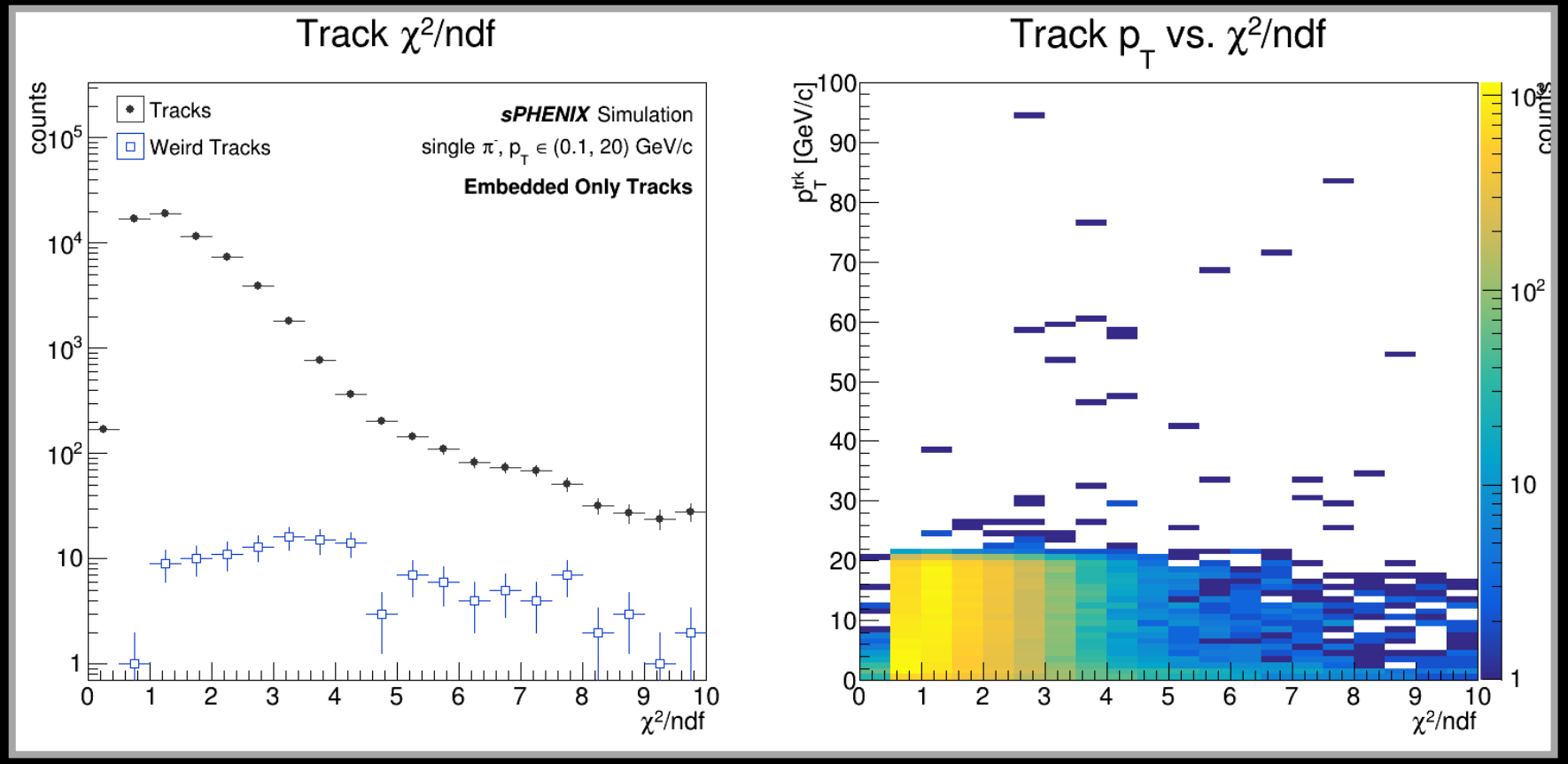
What Did I do?

- **Task:** characterize outlier tracks
  - **Result:** Made progress and have a lead (see next slide)…

- **Note:** Also would like to determine cuts to remove pileup tracks
  - Made progress along this front as well:
    - 👍 Figured out how to embed in hijing: now successfully running jobs
    - 👍 Made necessary edits to code to characterize pileup tracks



A Possible Lead



- Outlier tracks generally look similar to normal tracks…
  - **Except:** The chi2/ndf of the track fit…
  - Will be following up at tracking meeting at on Tuesday

Update Details

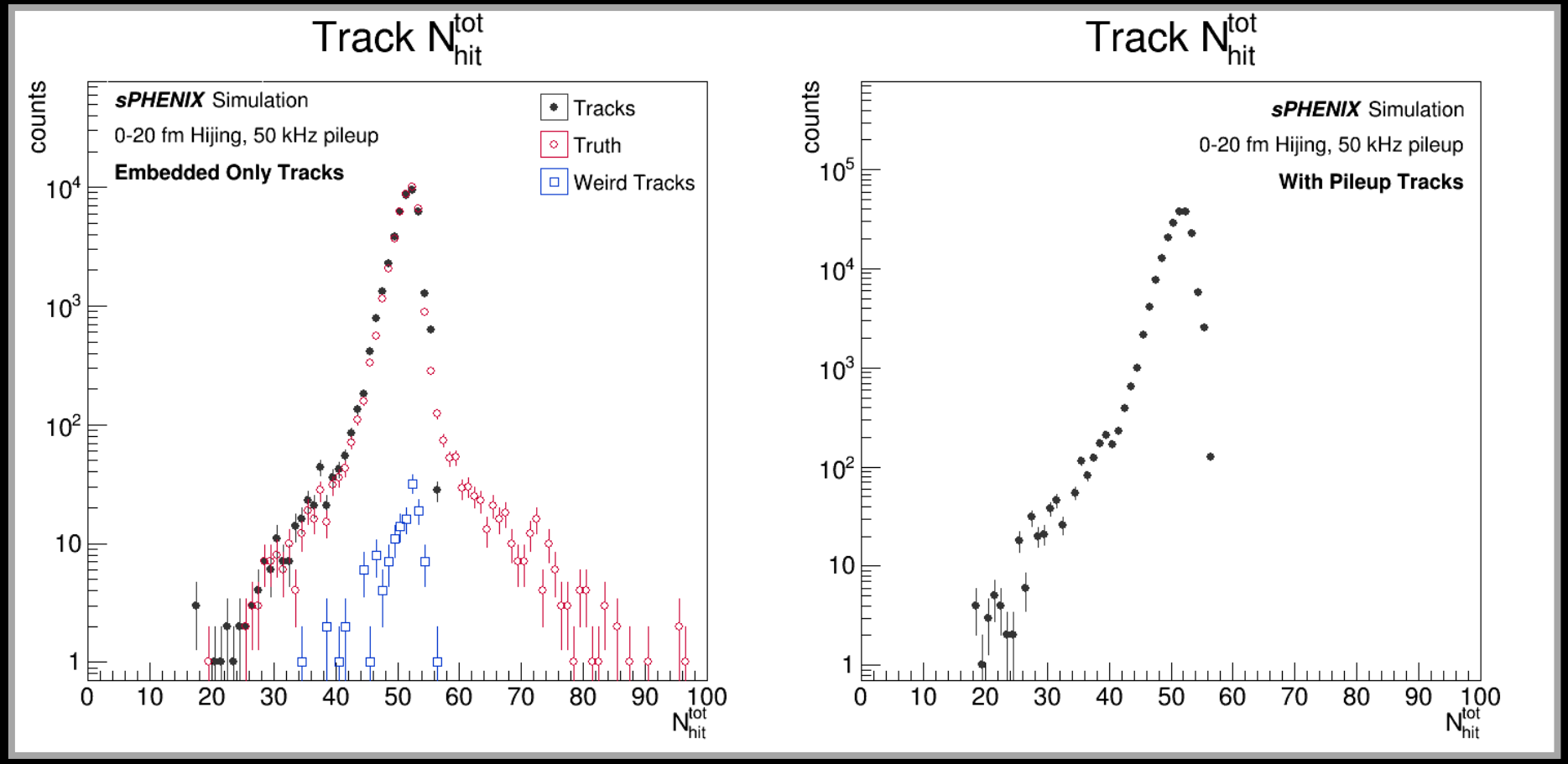
- Currently running over larger sample
  - 0 – 20 fm Hijing **(type = 4)**
  - 50 kHz pileup **(pileup = 1)**
  - ☞ **41700 embedded tracks shown here** (12868 last time)

- **Pileup tracks included this time:**
  - Plotted all entries from ntp_gtrk (excluded NAN entries)
  - ☞ **Should I be looking at only entries with gprimary = 0?**

- **Plots shown here:**
  - Nhits, DCAxy, DCAz, η, ϕ, and p_T for reco., truth, "weird", and pileup tracks
  - The %-errors on DCAxy, DCAz, η, ϕ, and p_T

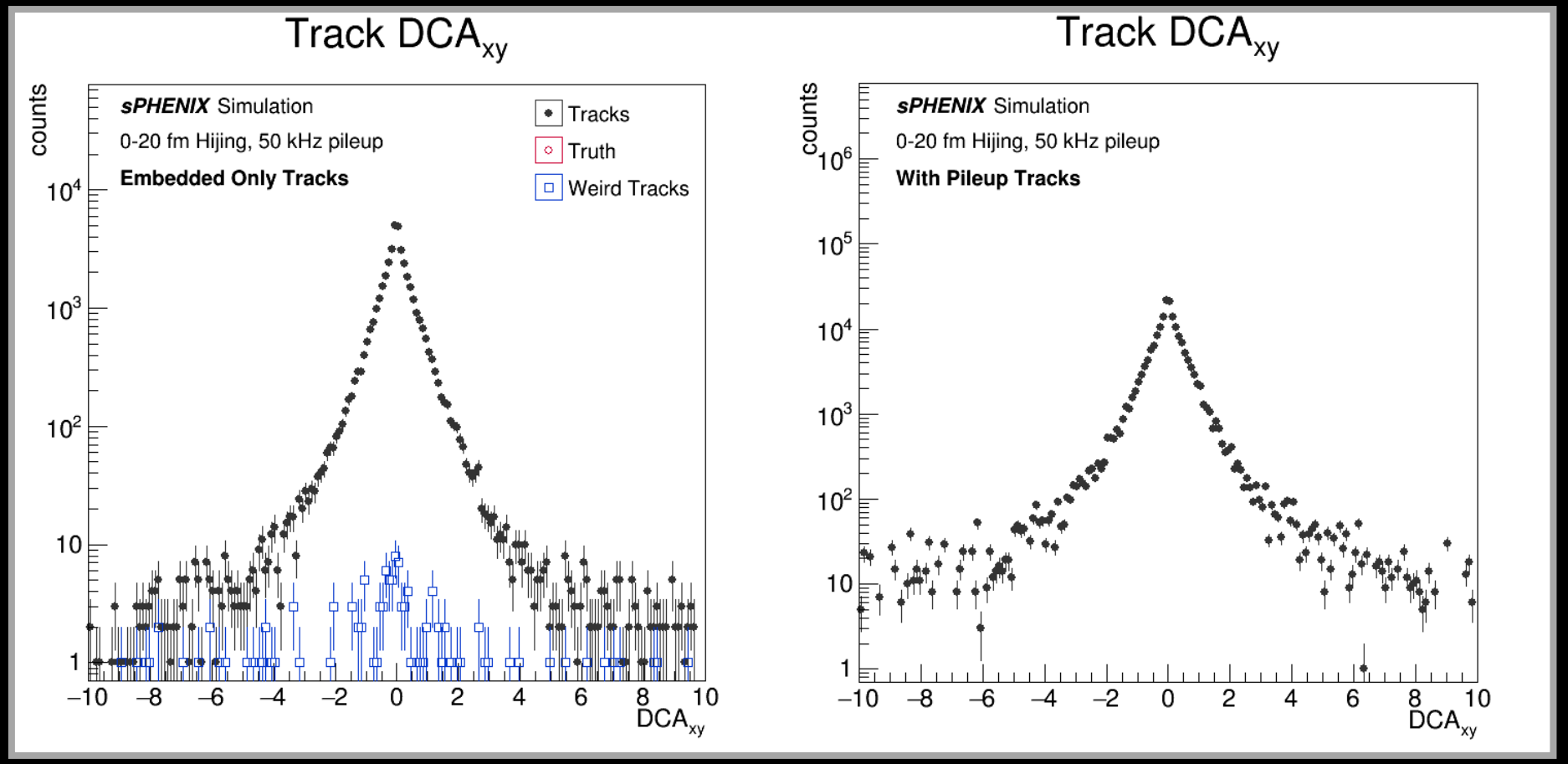
- **"Weird Tracks:"** tracks w/ unusually large or small p_T^{trk}/p_T^{true}
  - ☞ **< 0.2 or > 1.2**

Embed Only vs. With Pileup | Track NHits



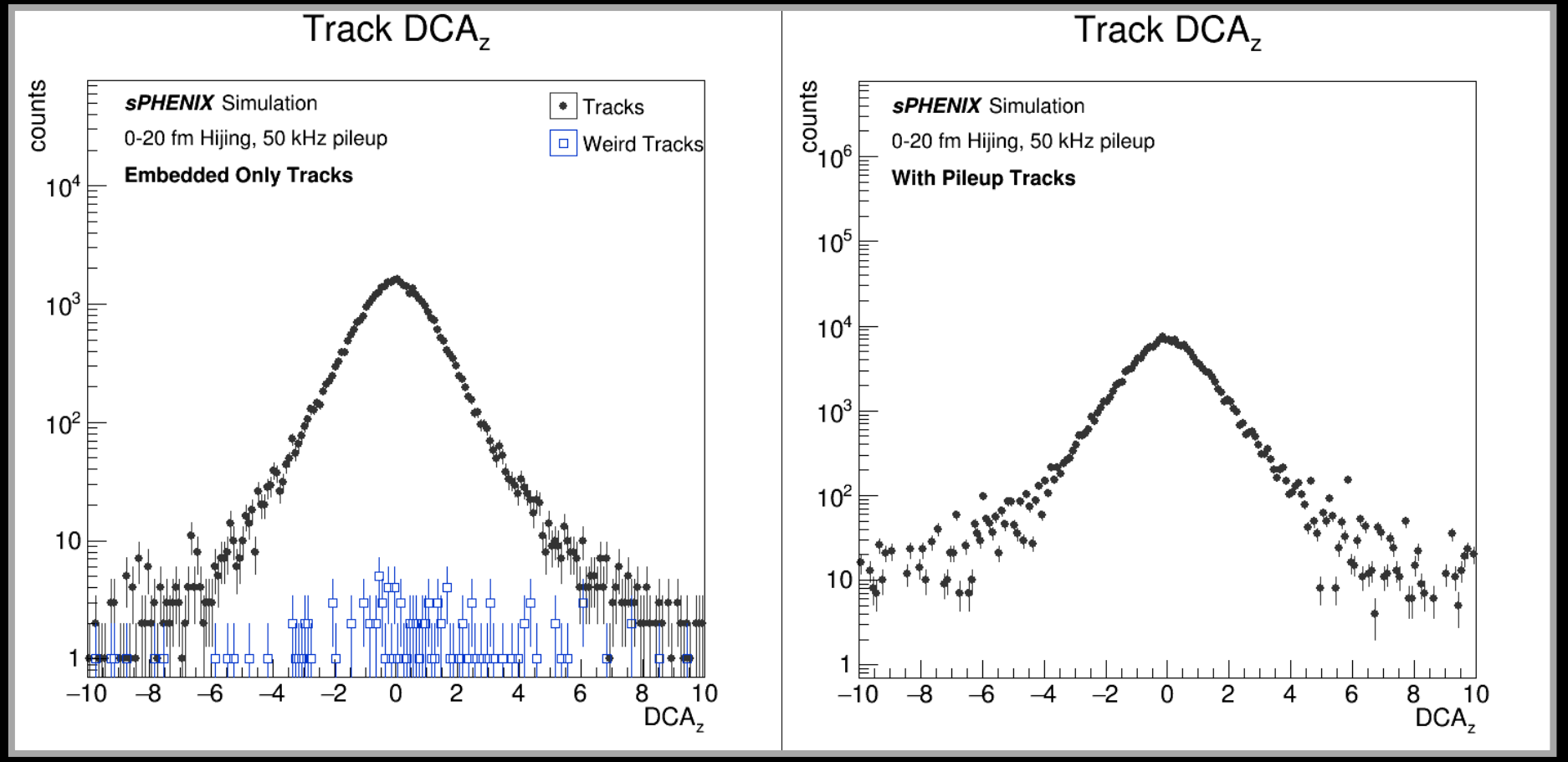
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup | Track DCAxy



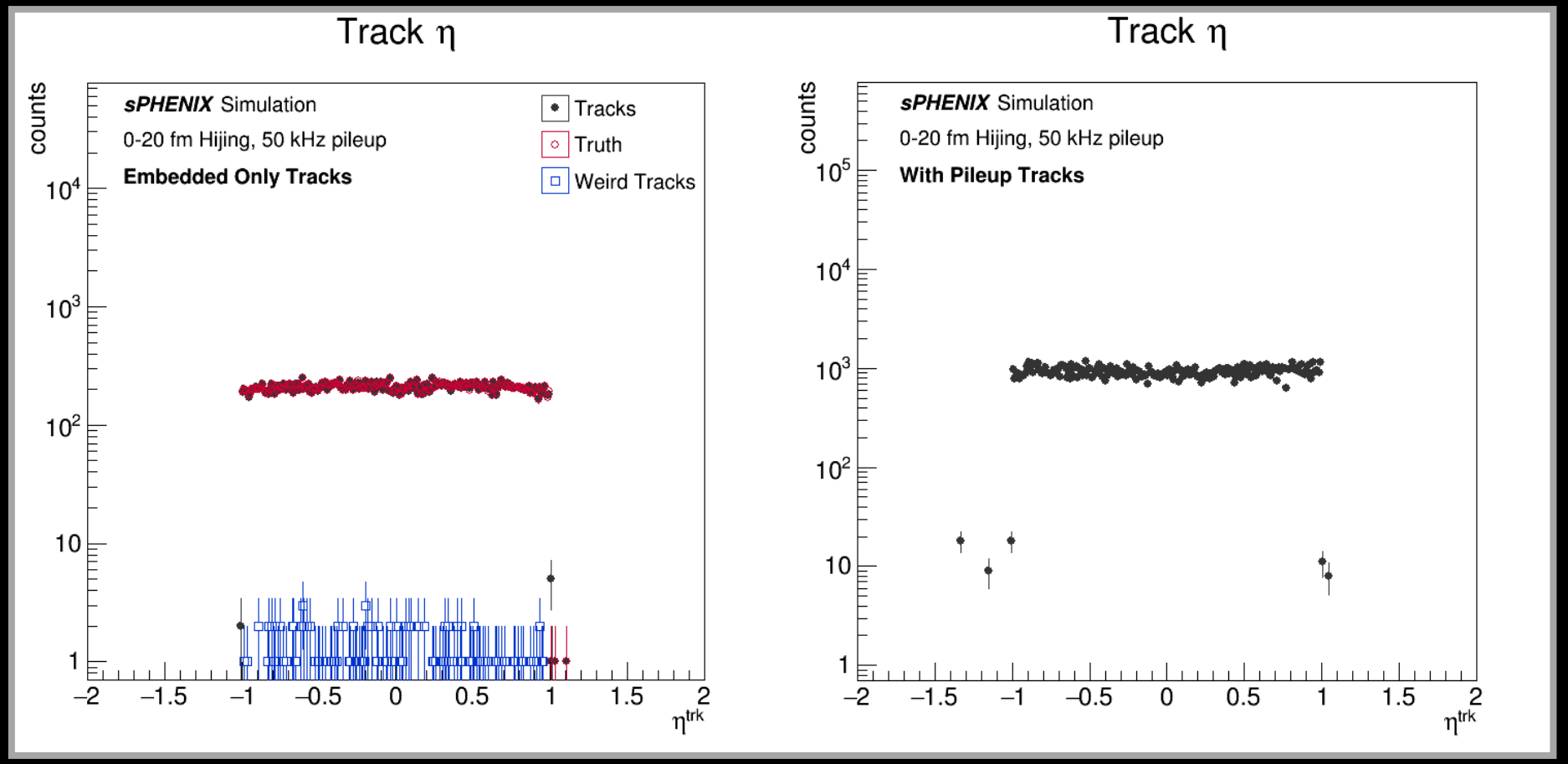
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup | Track DCAz



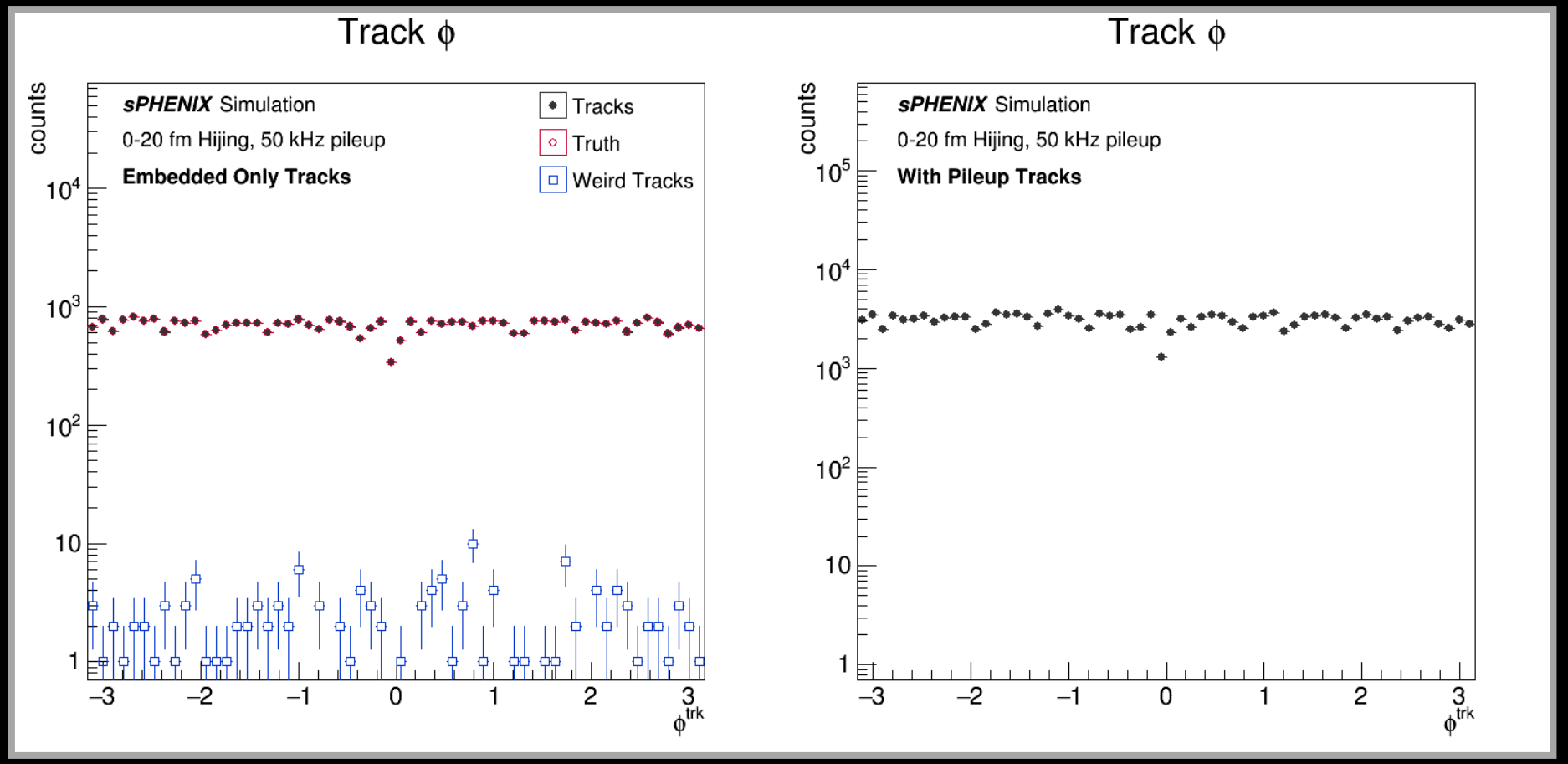
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup | Track η



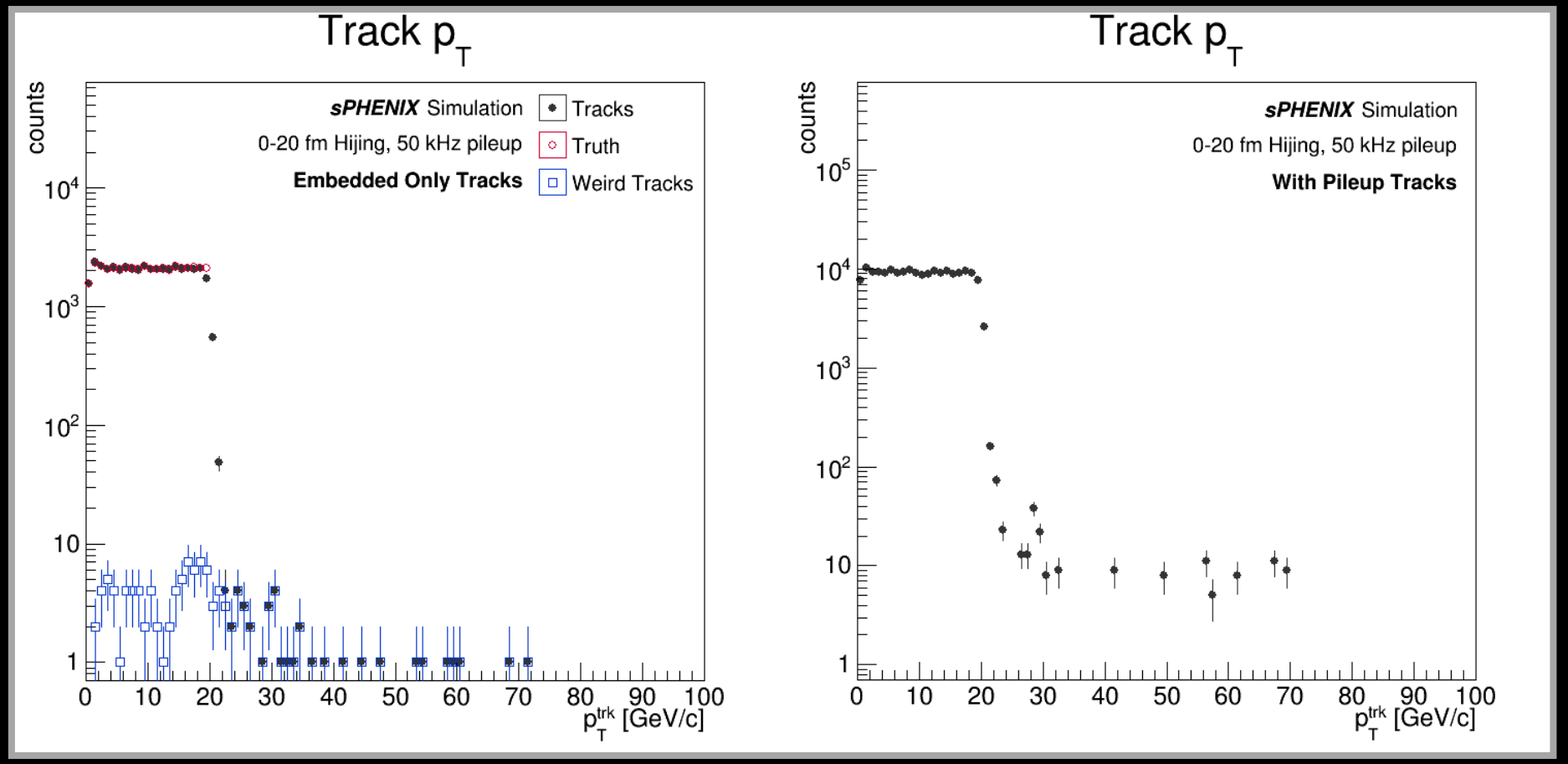
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup | Track ϕ



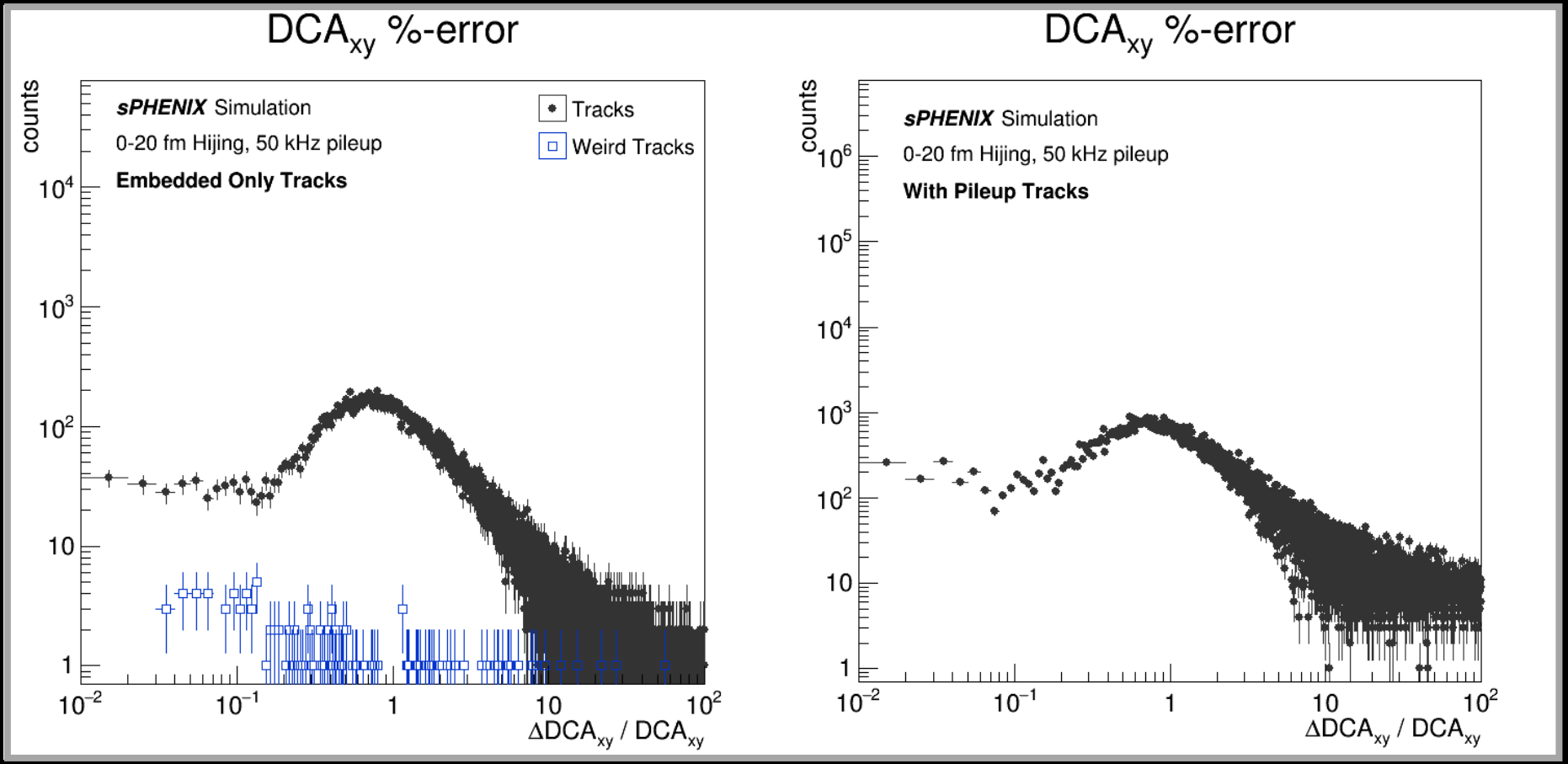
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup | Track p_T



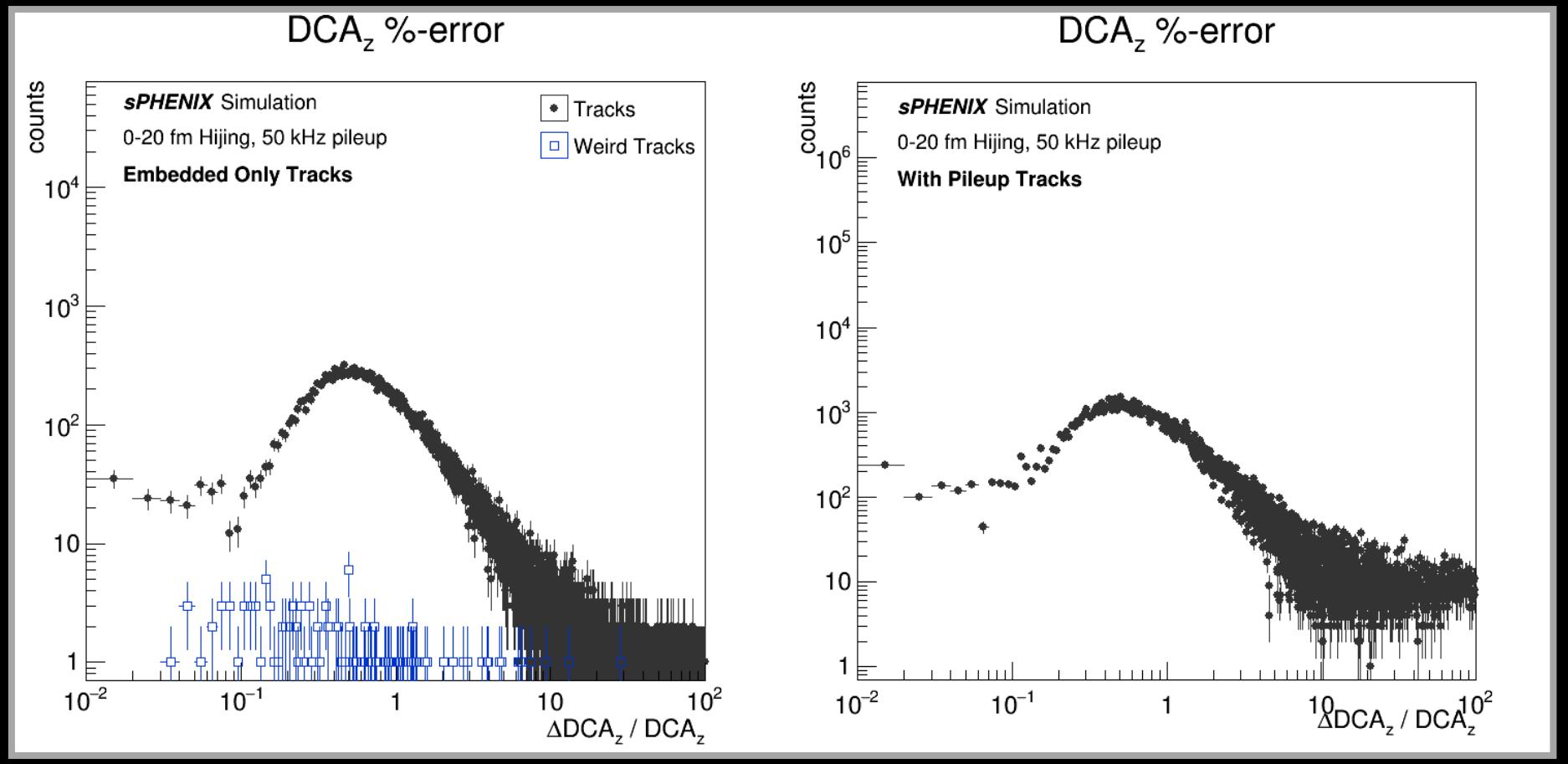
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup %-Error | Track DCAxy



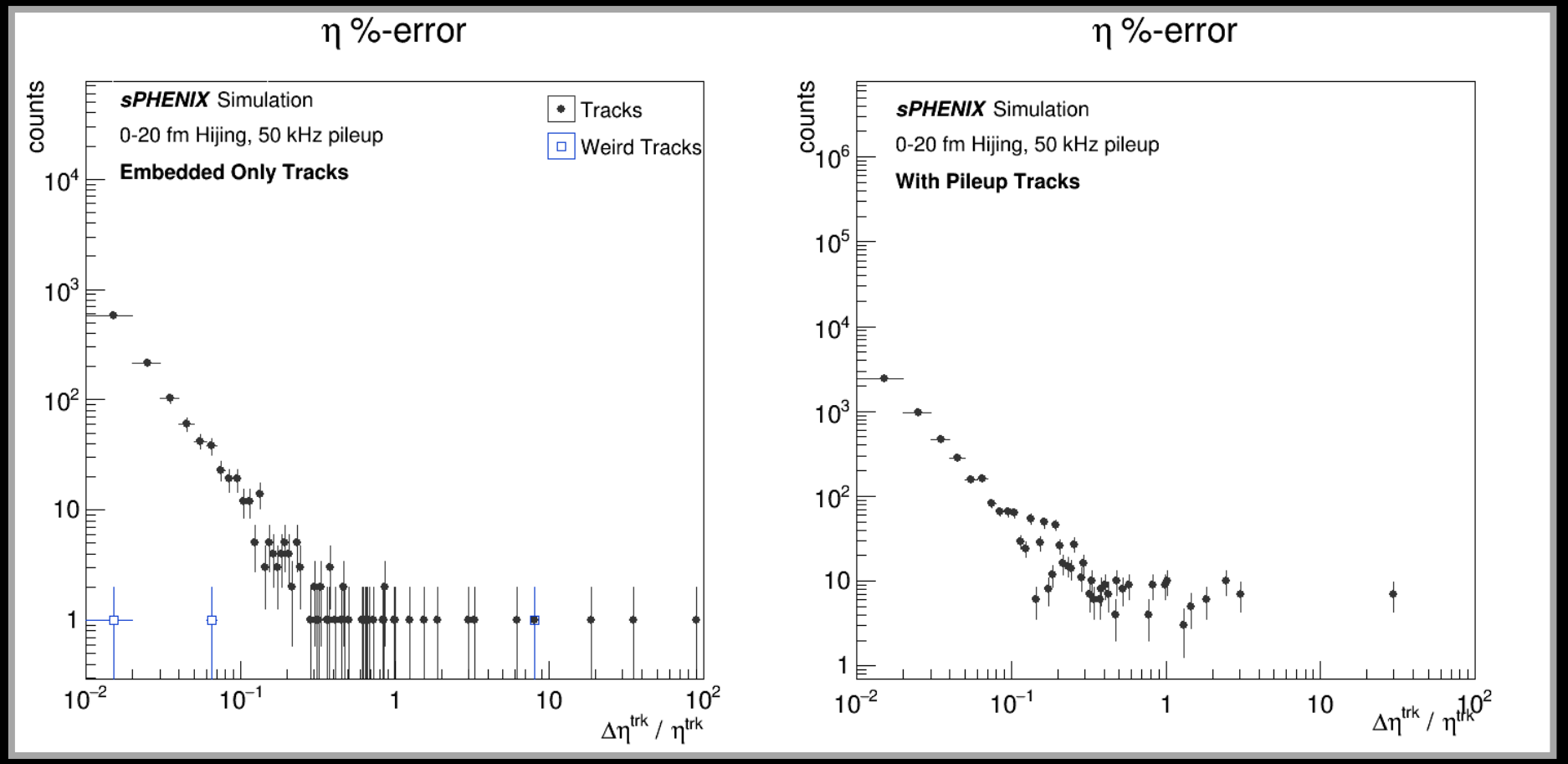
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup %-Error | Track DCAz



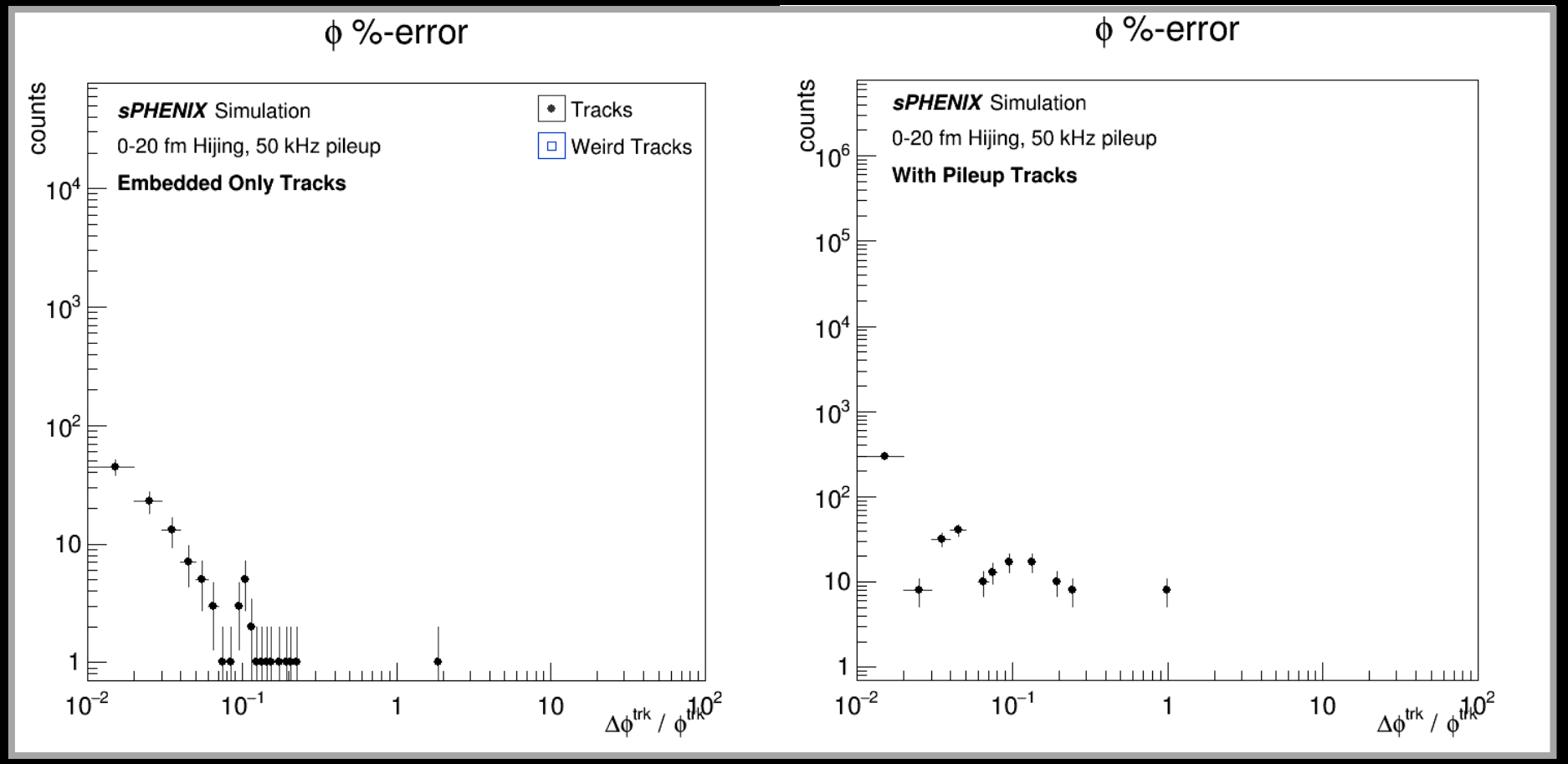
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup %-Error | Track η



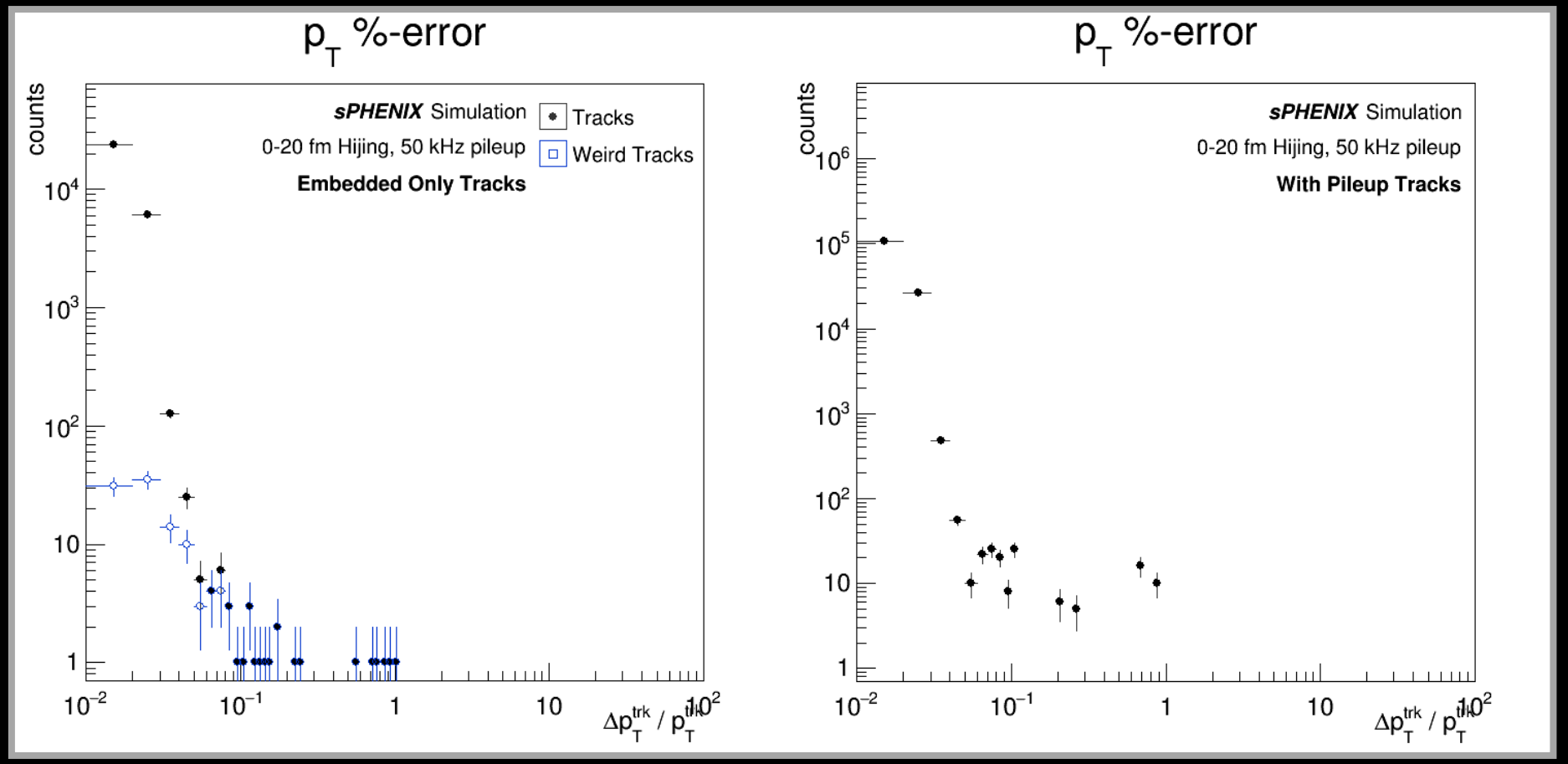
- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup %-Error | Track ϕ



- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Embed Only vs. With Pileup %-Error | Track p_T



- **Note:** y-axis scale changes b/n left and right
  - Will fix next time..

Update Details

- Currently running over larger sample
  - 0 – 20 fm Hijing **(type = 4)**
  - 50 kHz pileup **(pileup = 1)**
  - ☞ **12868 tracks shown here** (4257 last time)

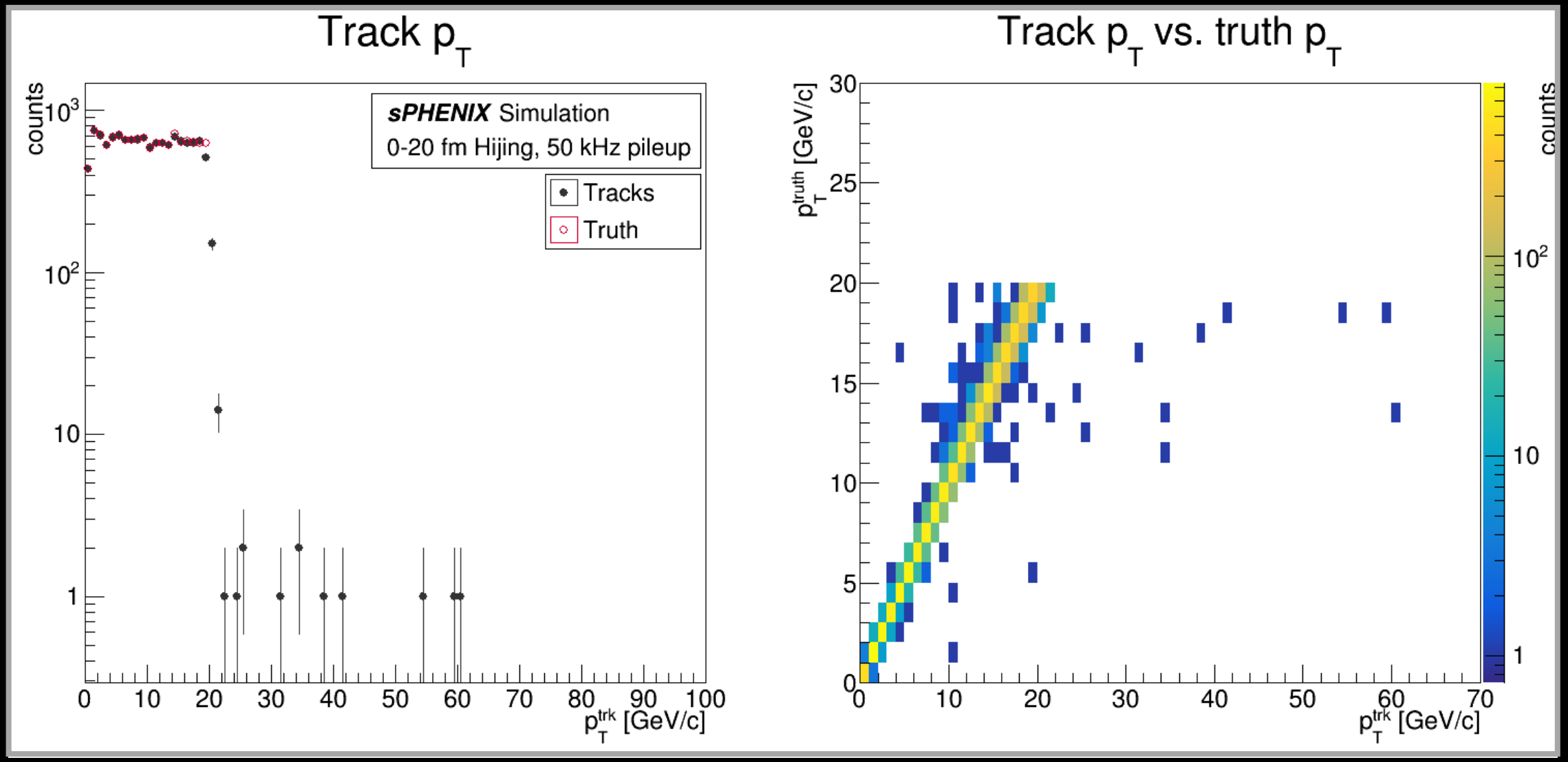
- **Tracks shown are embedded only**
  - Wanted to look at pileup tracks as well, but forgot to run sample
  - Will look at next week…

- **Plots shown here:**
  - Plots from last time w/ more stats, and compared against true p_T
  - A few new quantities (η, ϕ…)
  - Plots of "scaled" quantities, e.g.

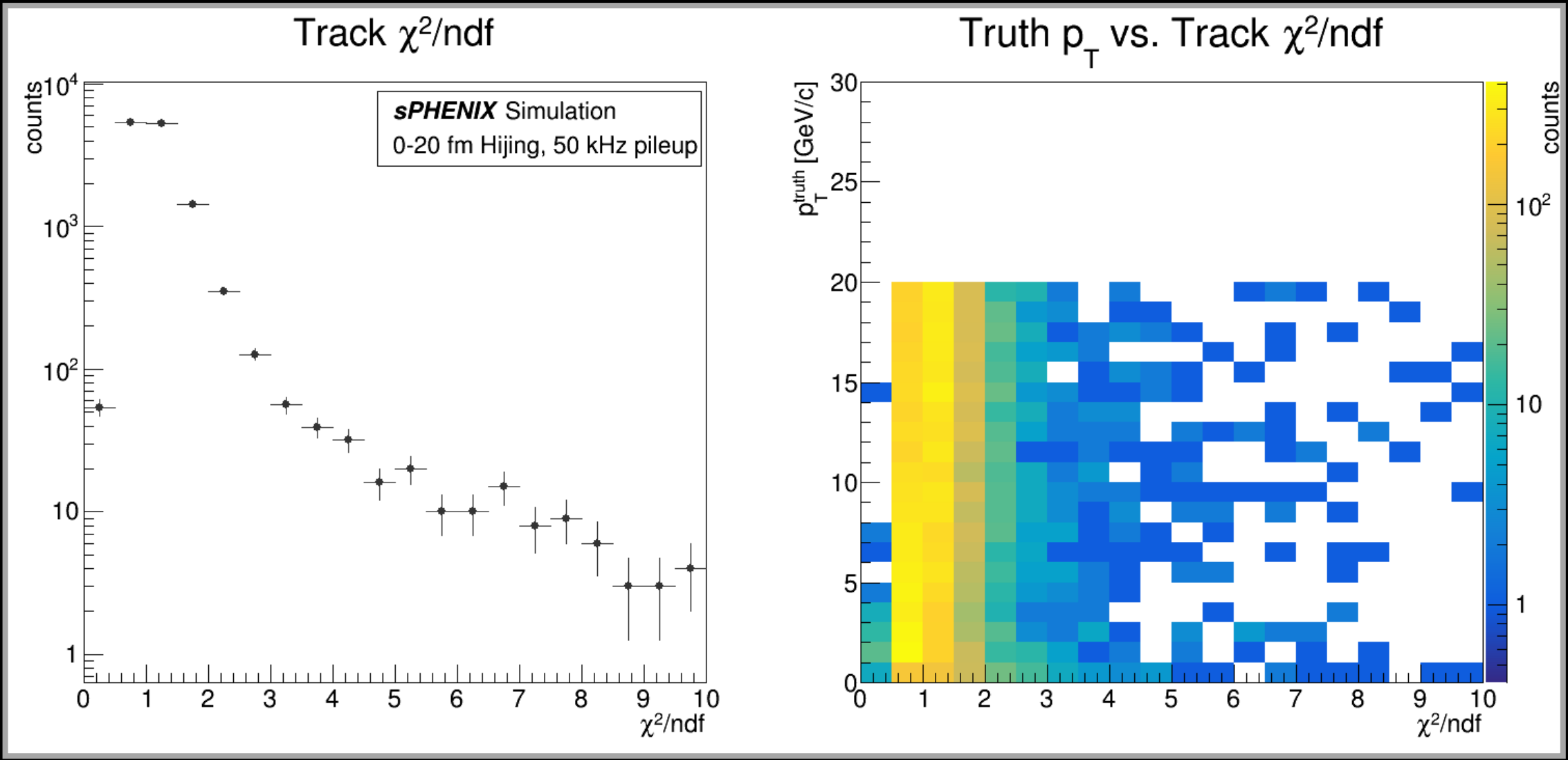
$$p_T / \Delta p_T$$

- **Will look closer at tracks w/ unusually large (or small) p_T^{trk} / p_T^{true} next week**

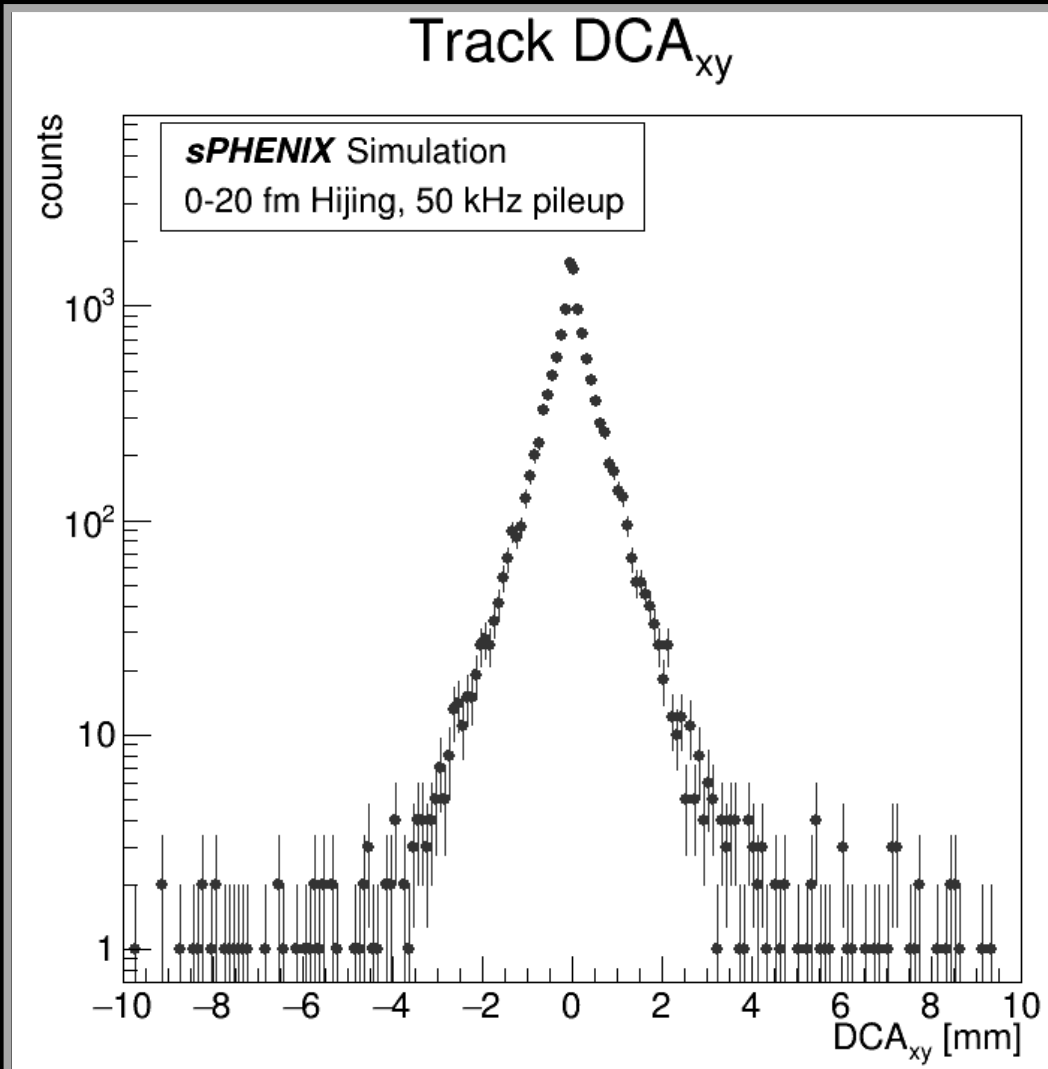
Updated Plots | Track vs. True p_T

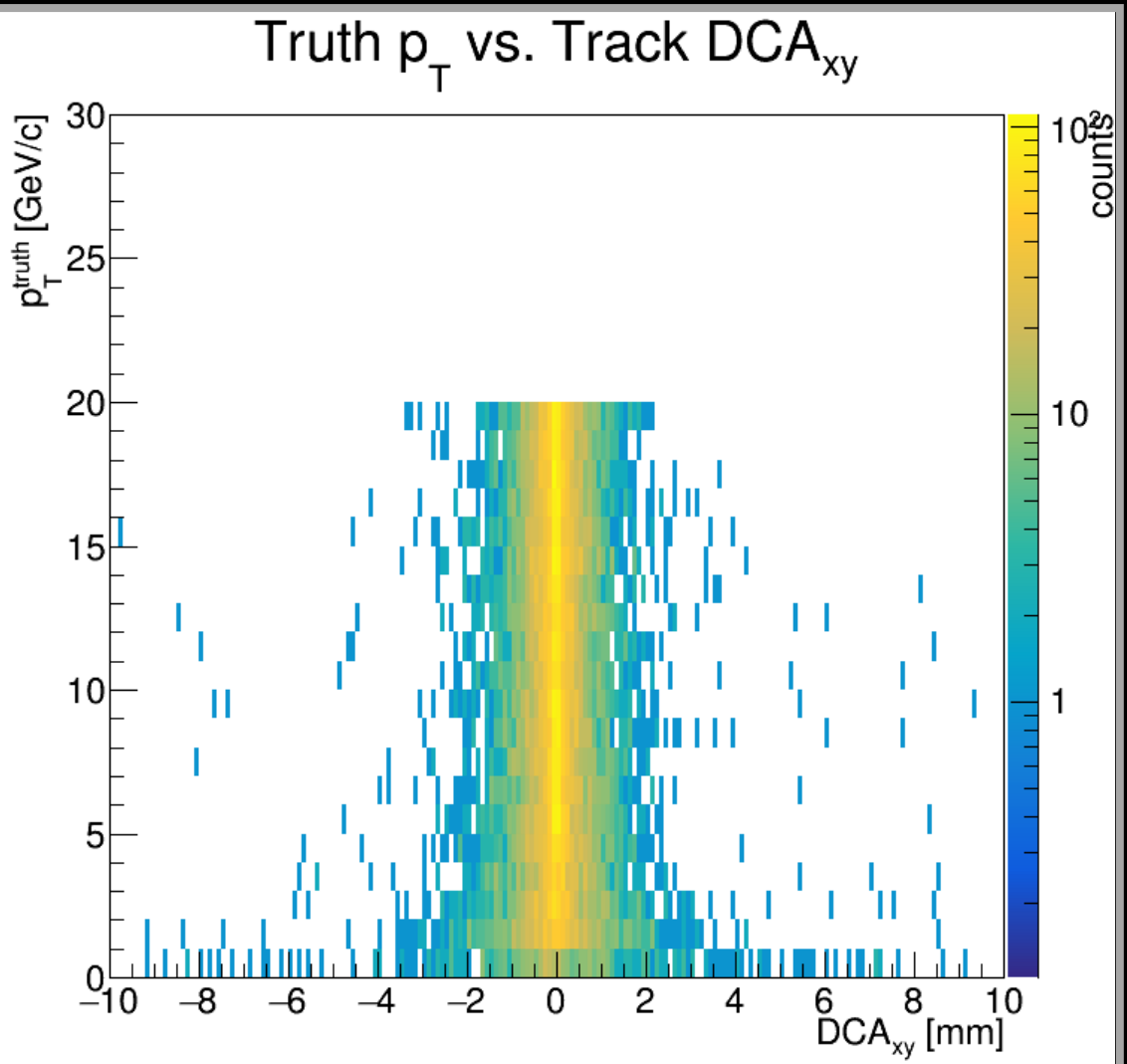


Updated Plots | Track Quality

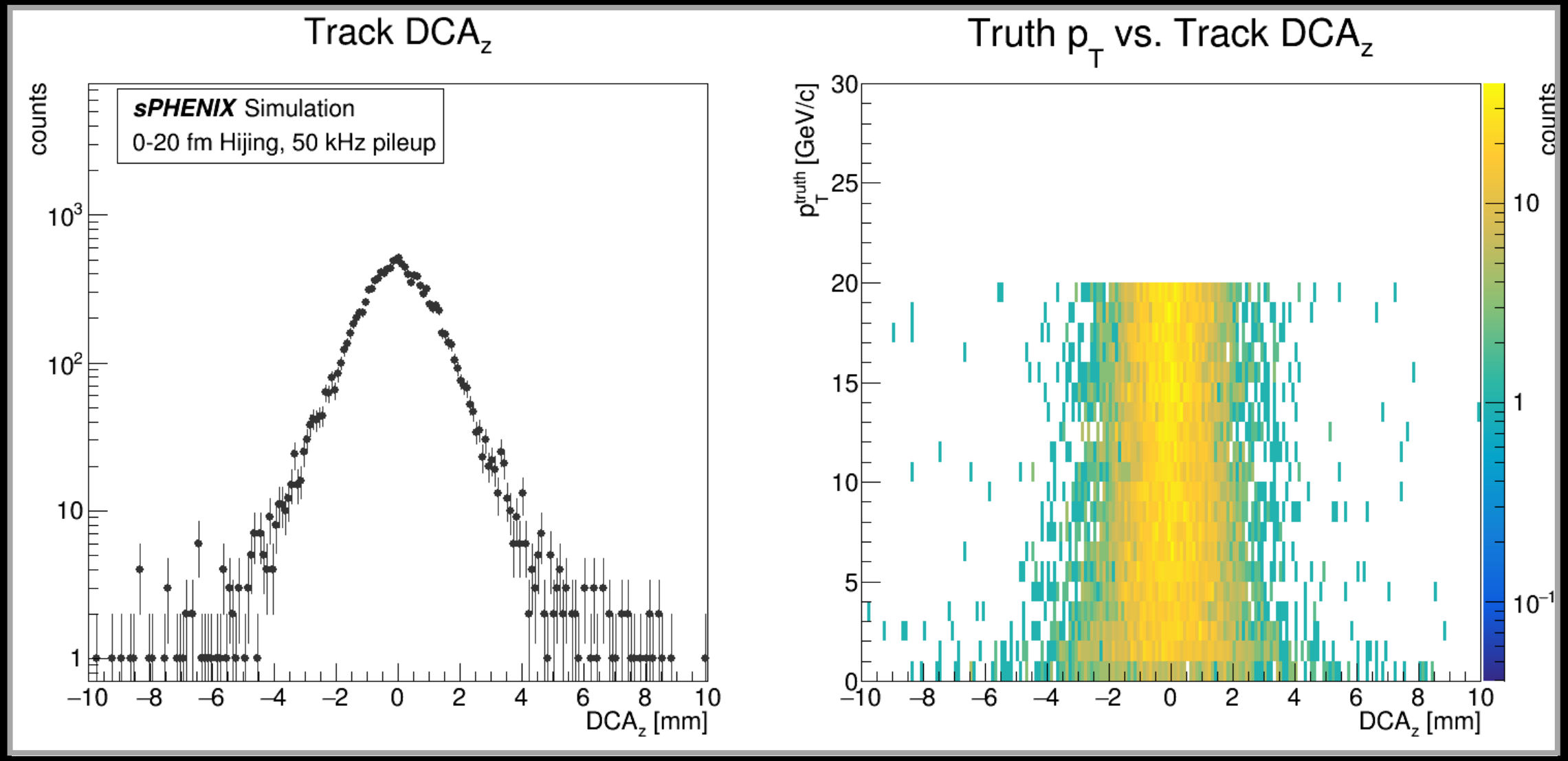


Updated Plots | Track DCAxy

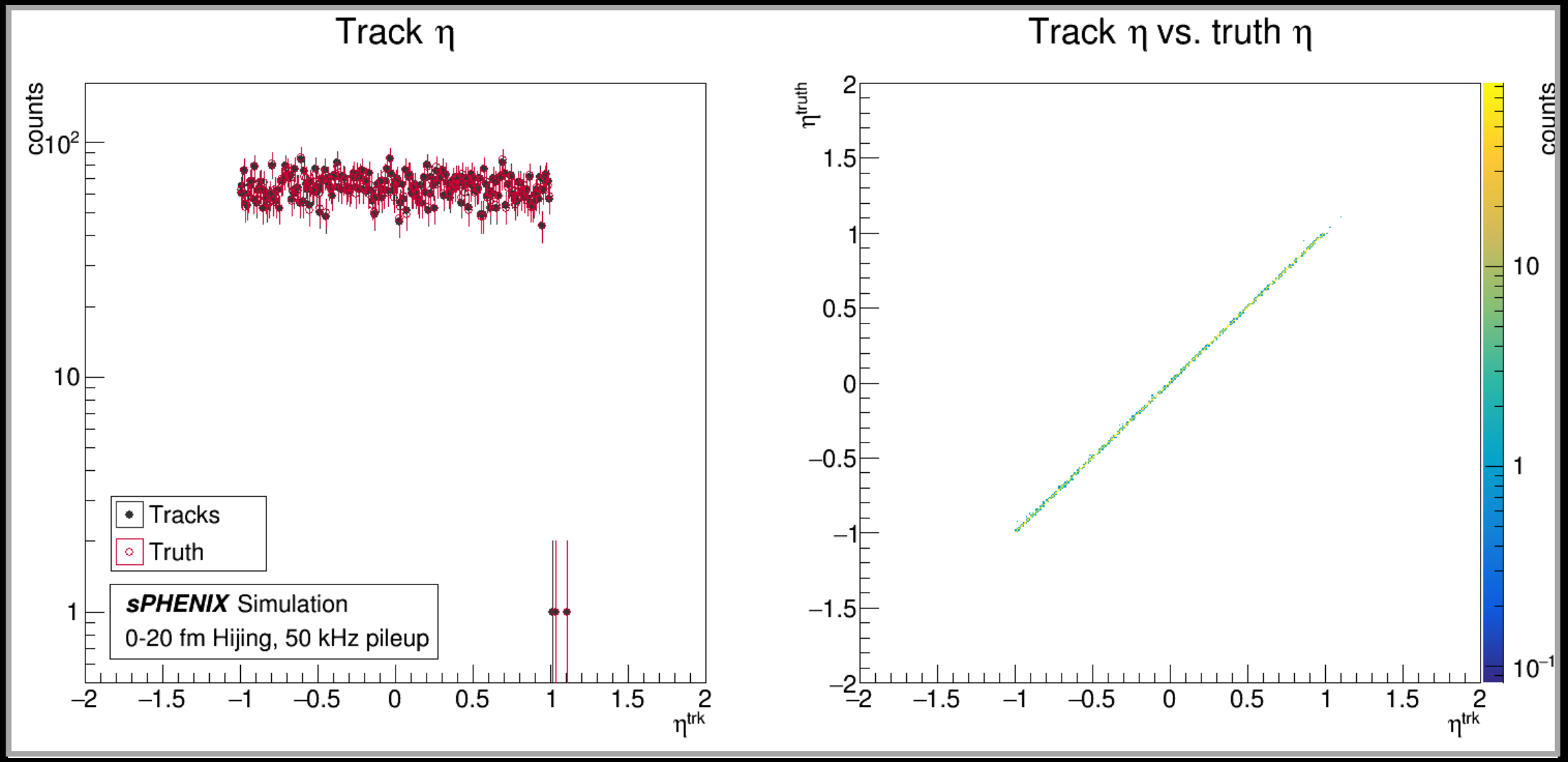




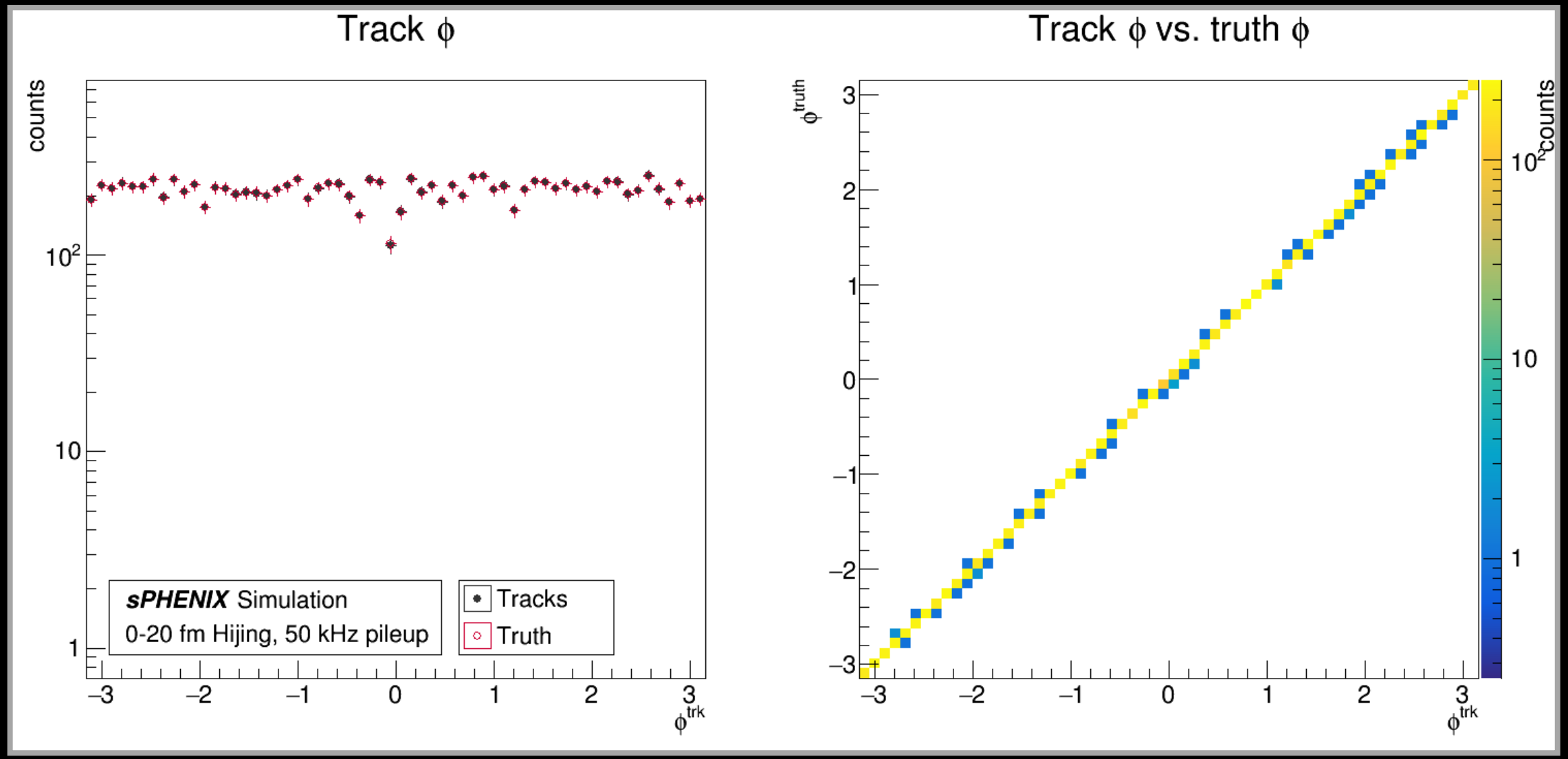
Updated Plots | Track DCAz



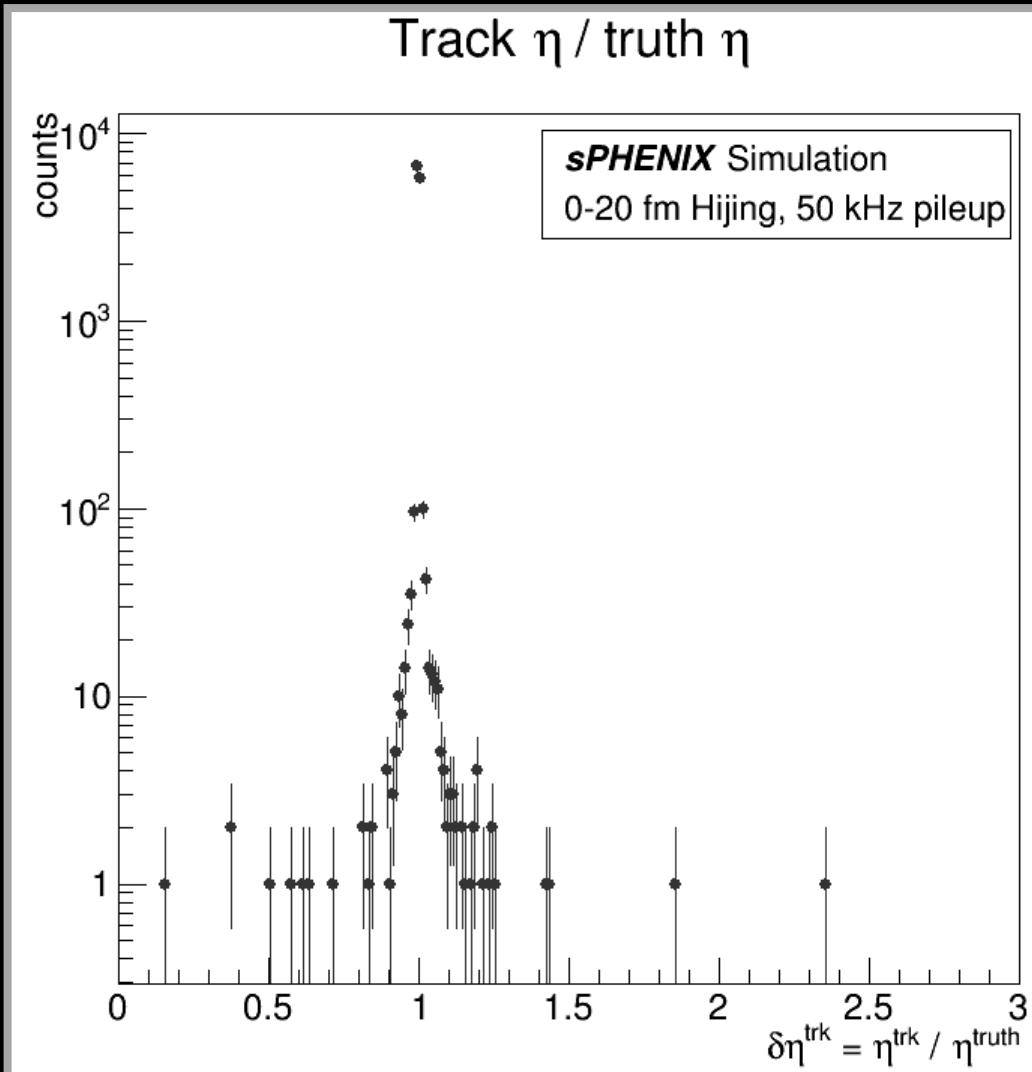
New Quantities | Track vs. True η

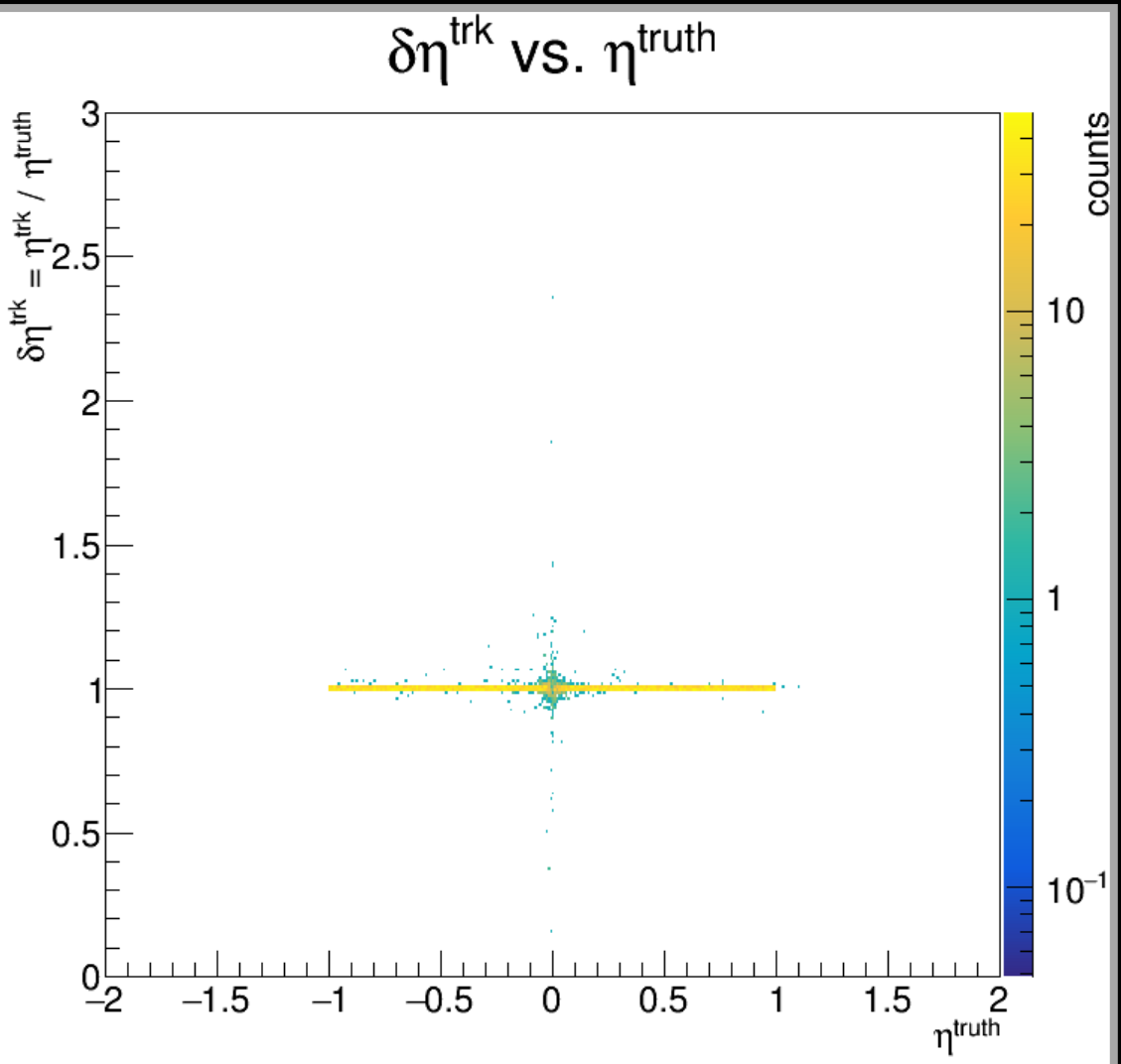


New Quantities | Track vs. True ϕ

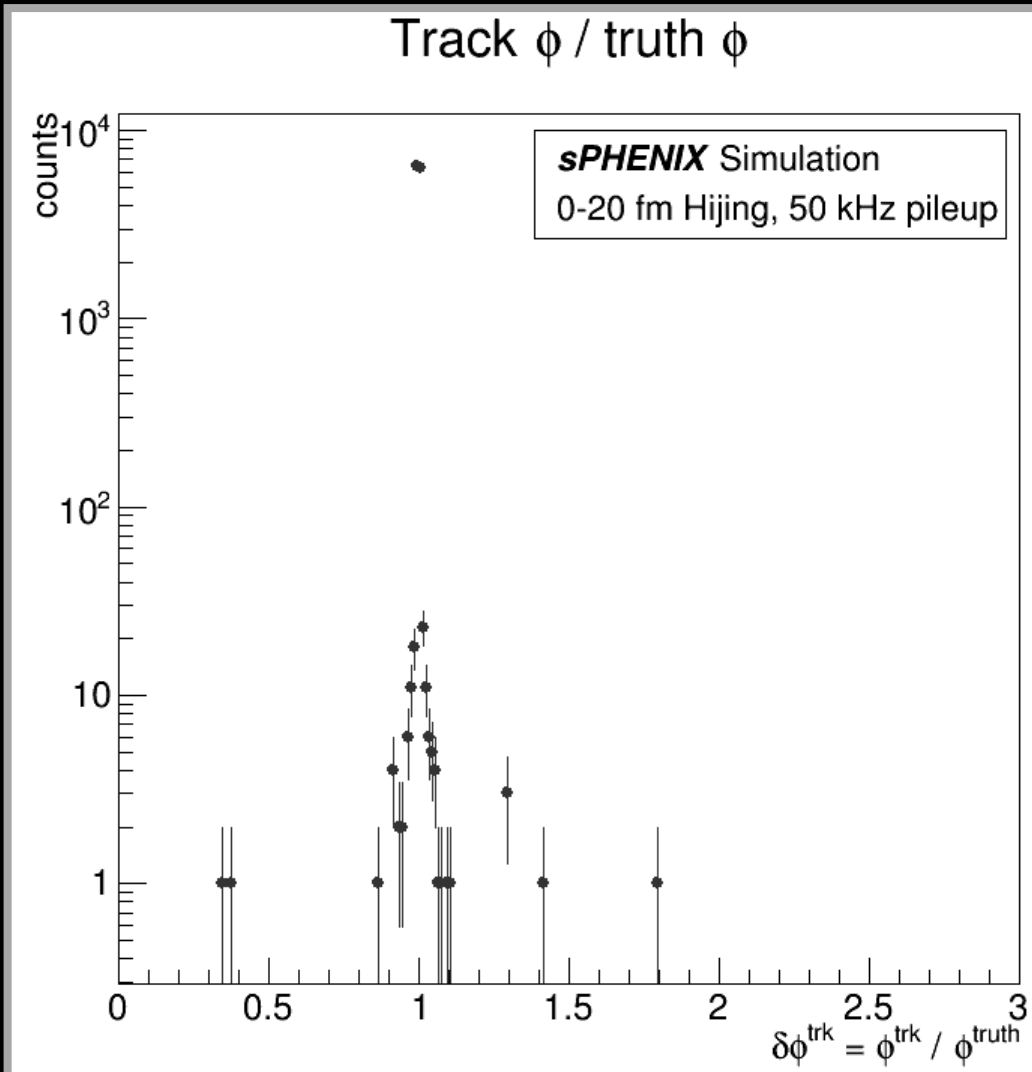


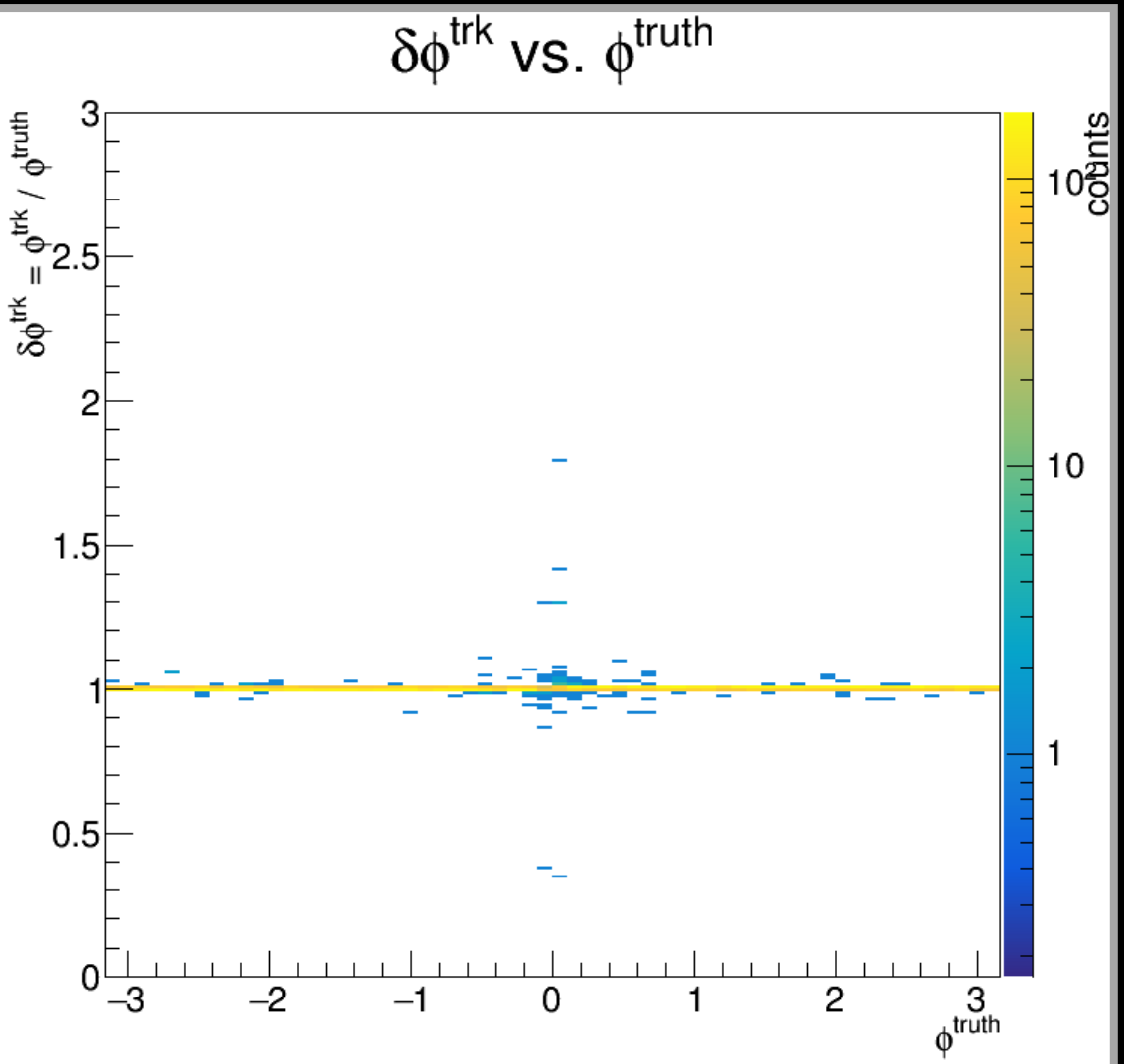
New Quantities | Fractional vs. True η



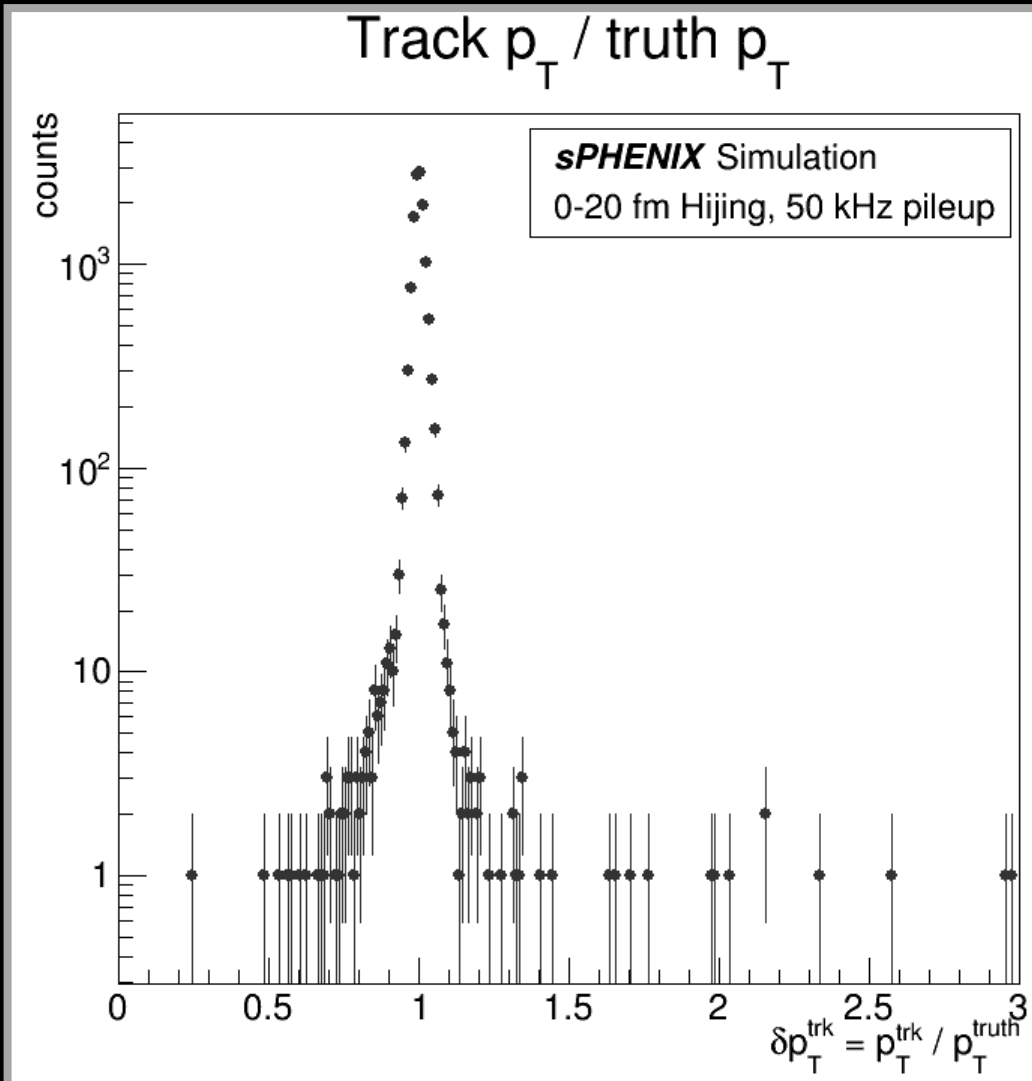


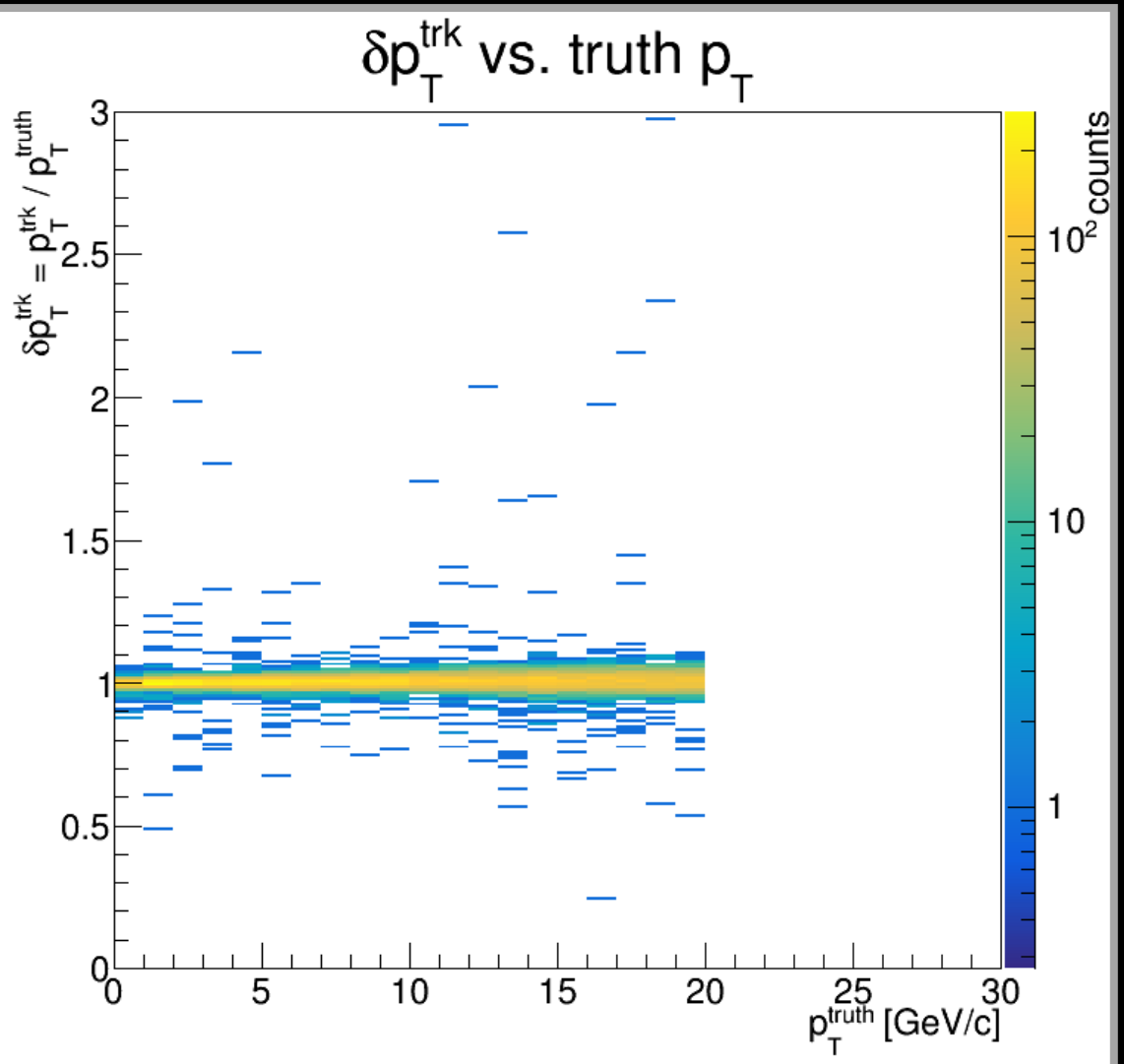
New Quantities | Fractional vs. True ϕ



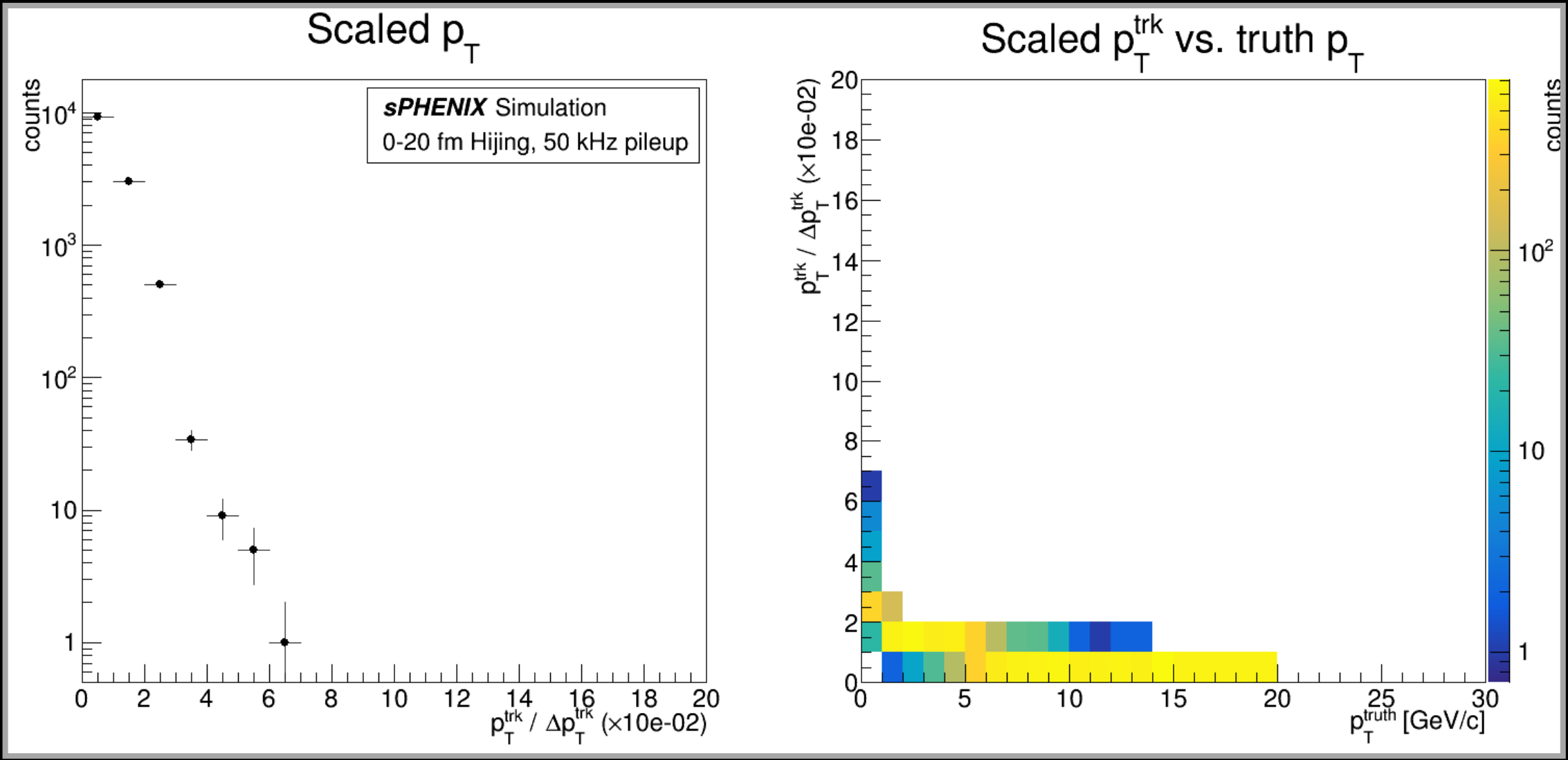


New Quantities | Fractional vs. True p_T

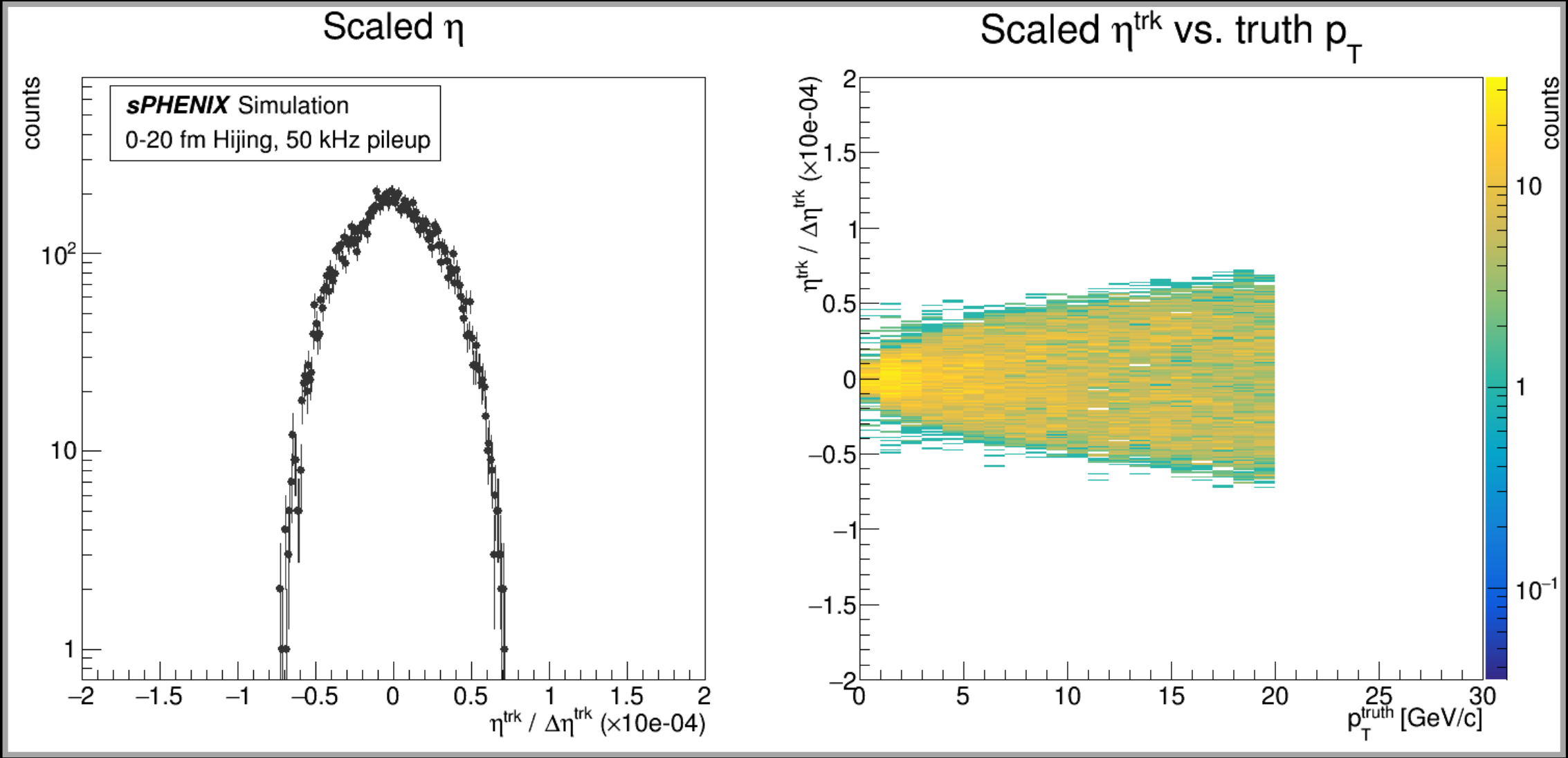




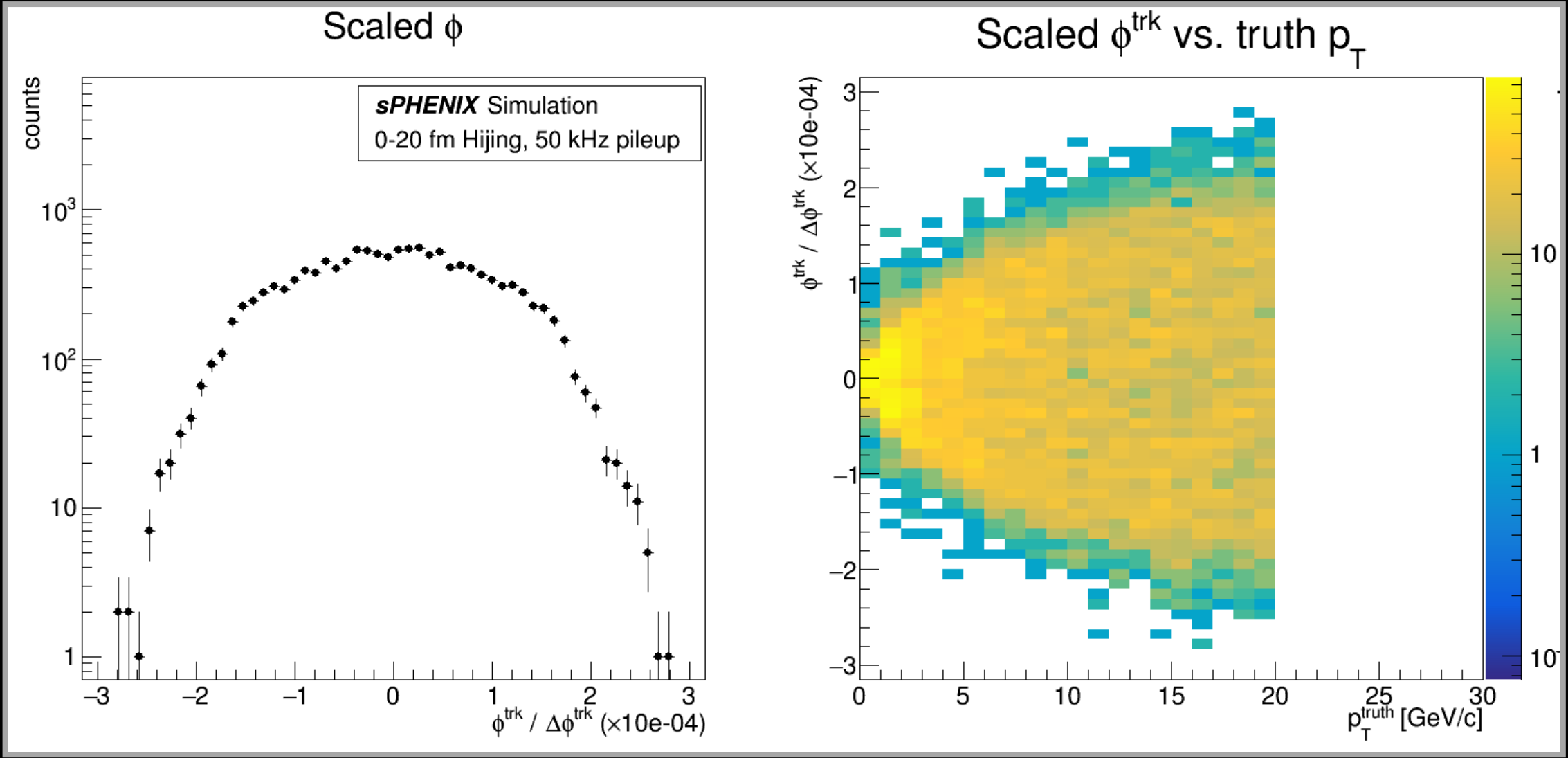
Scaled Quantities | Track p_T



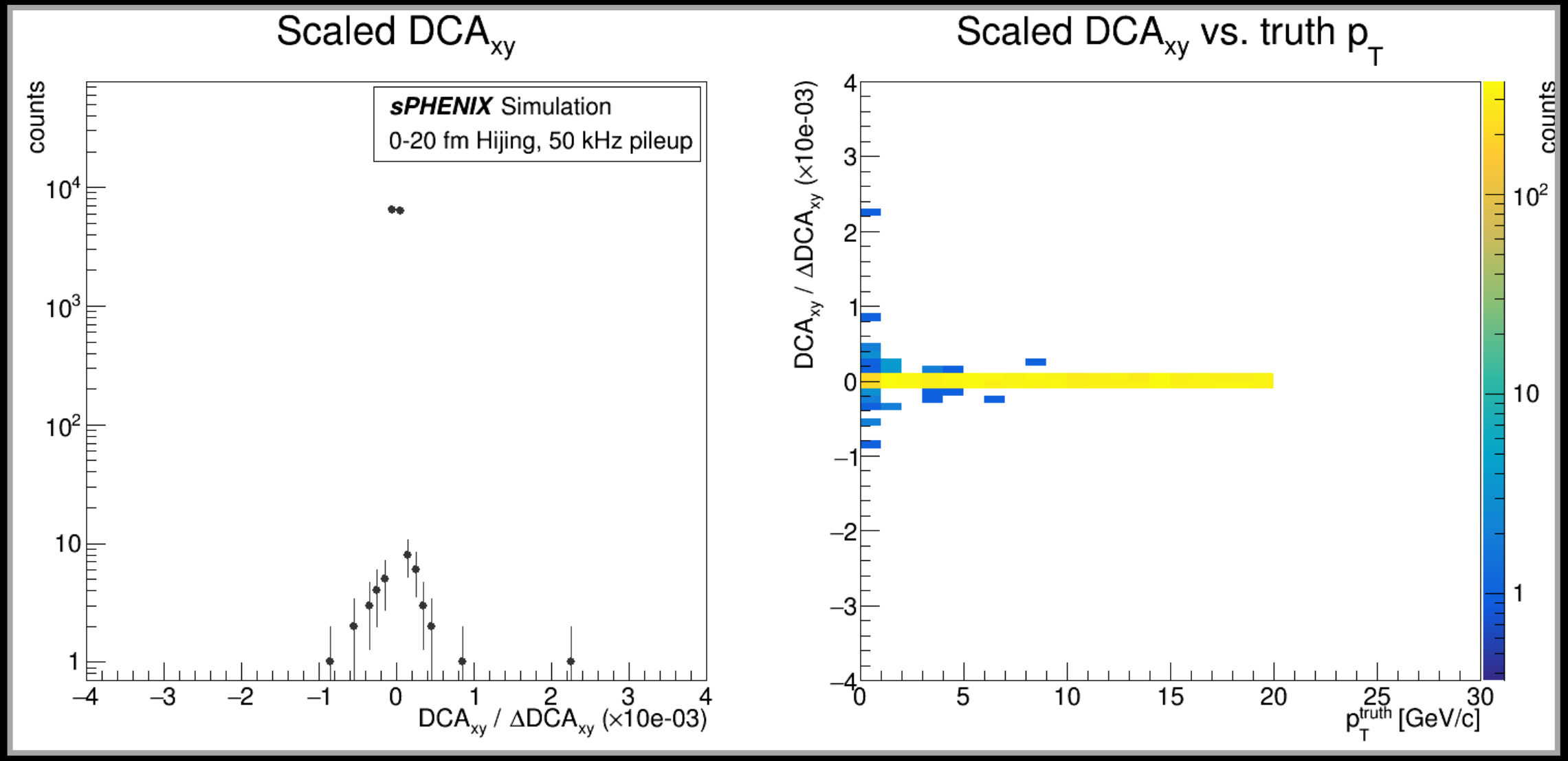
Scaled Quantities | Track η



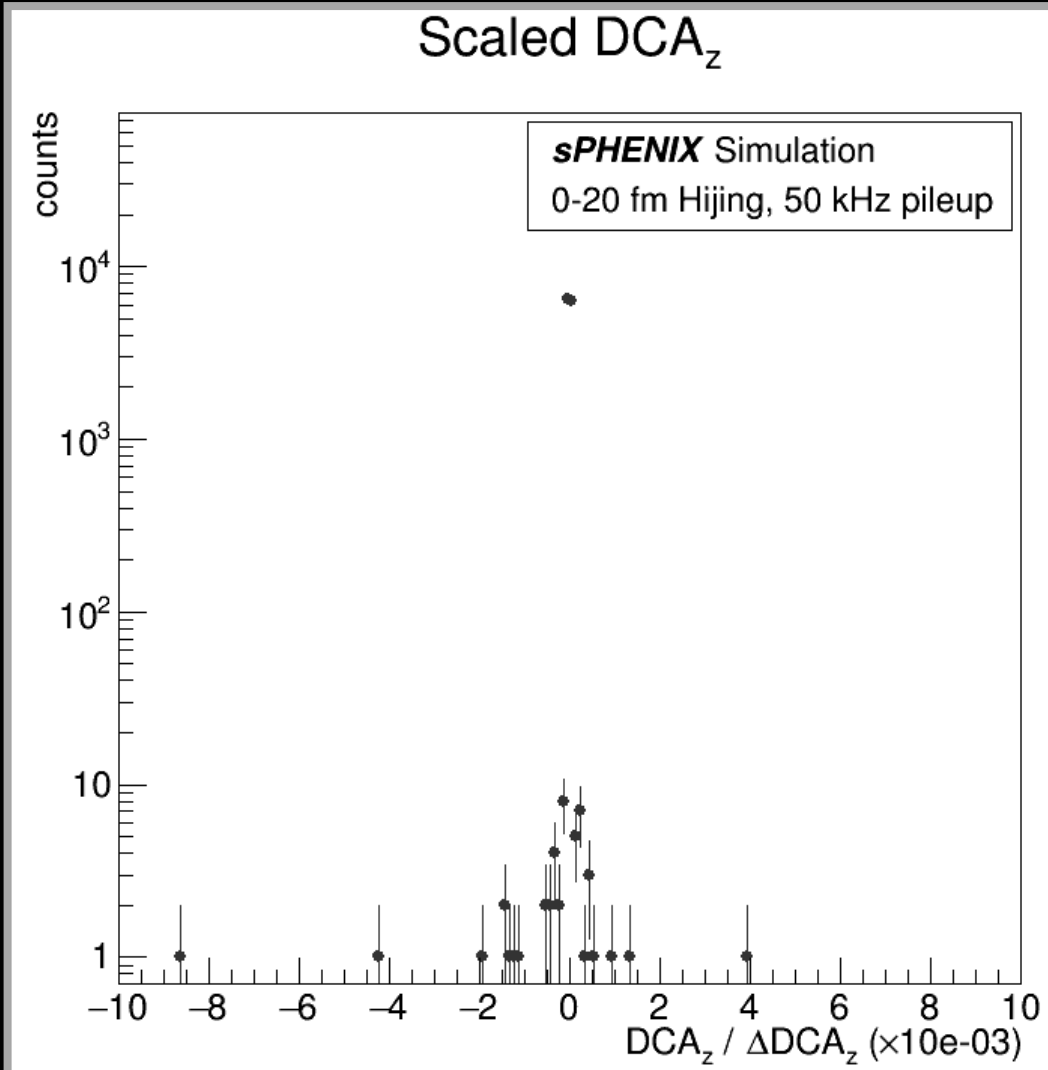
Scaled Quantities | Track ϕ

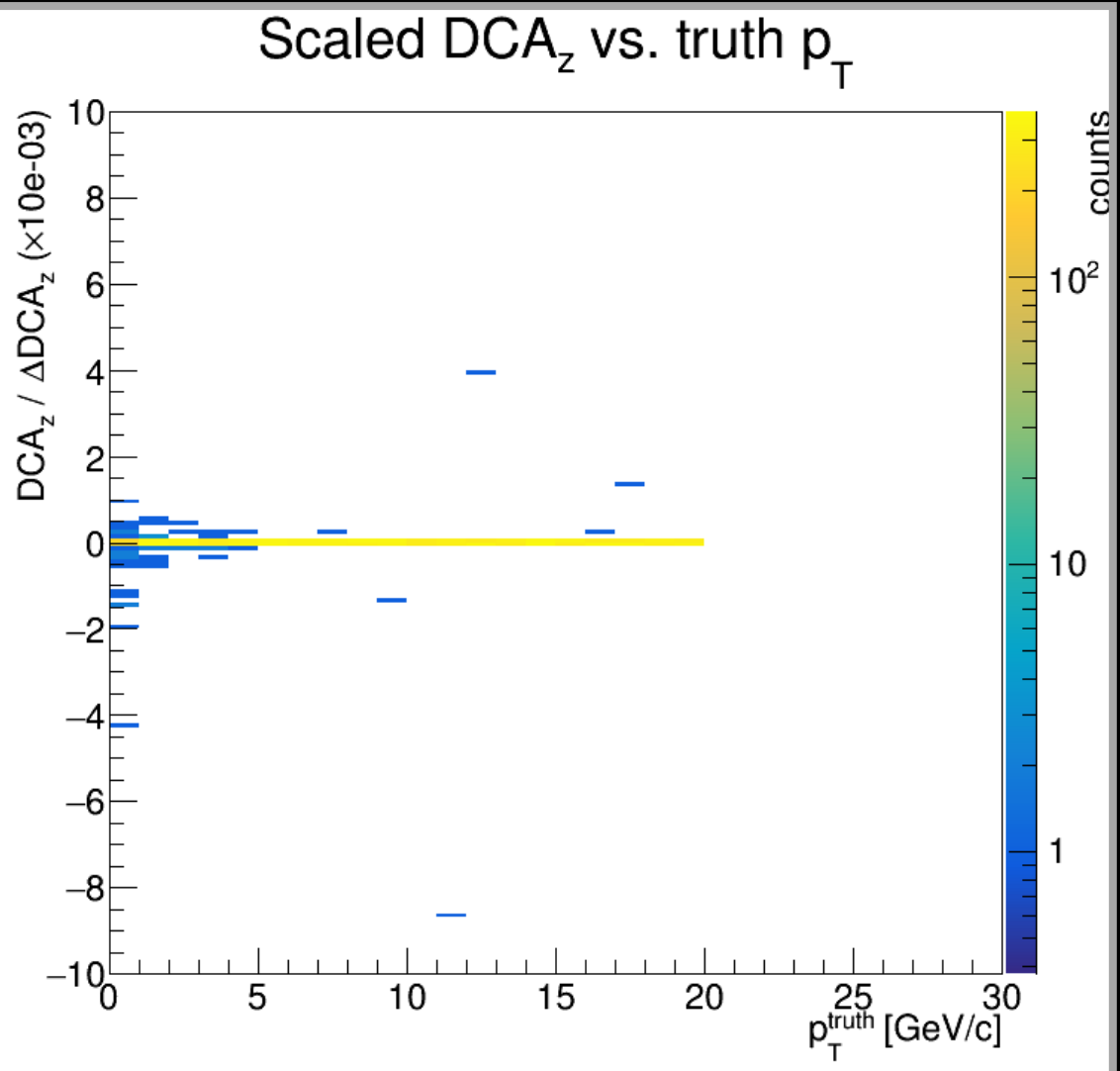


Scaled Quantities | Track DCAxy



Scaled Quantities | Track DCAz



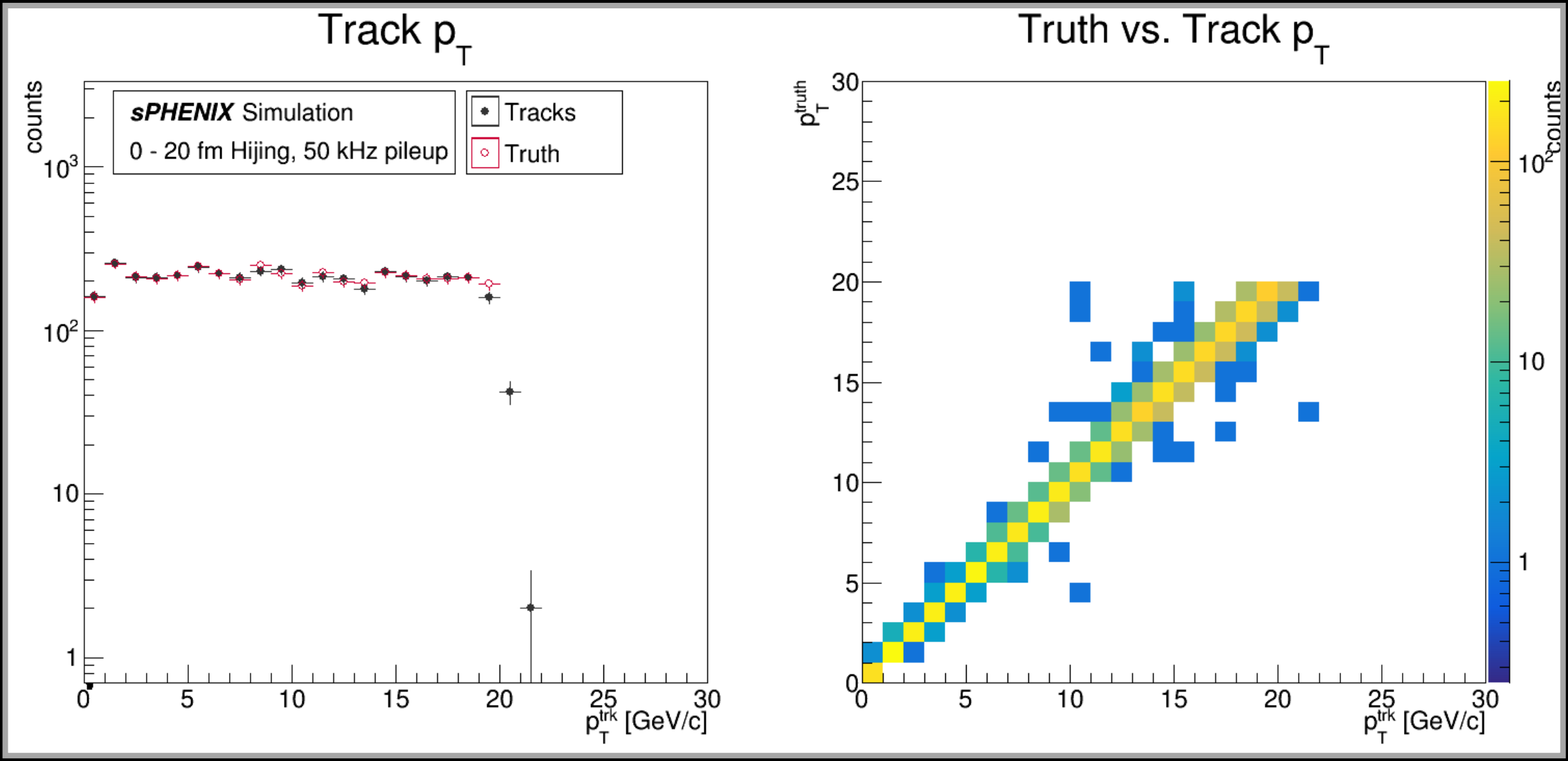


Study Details

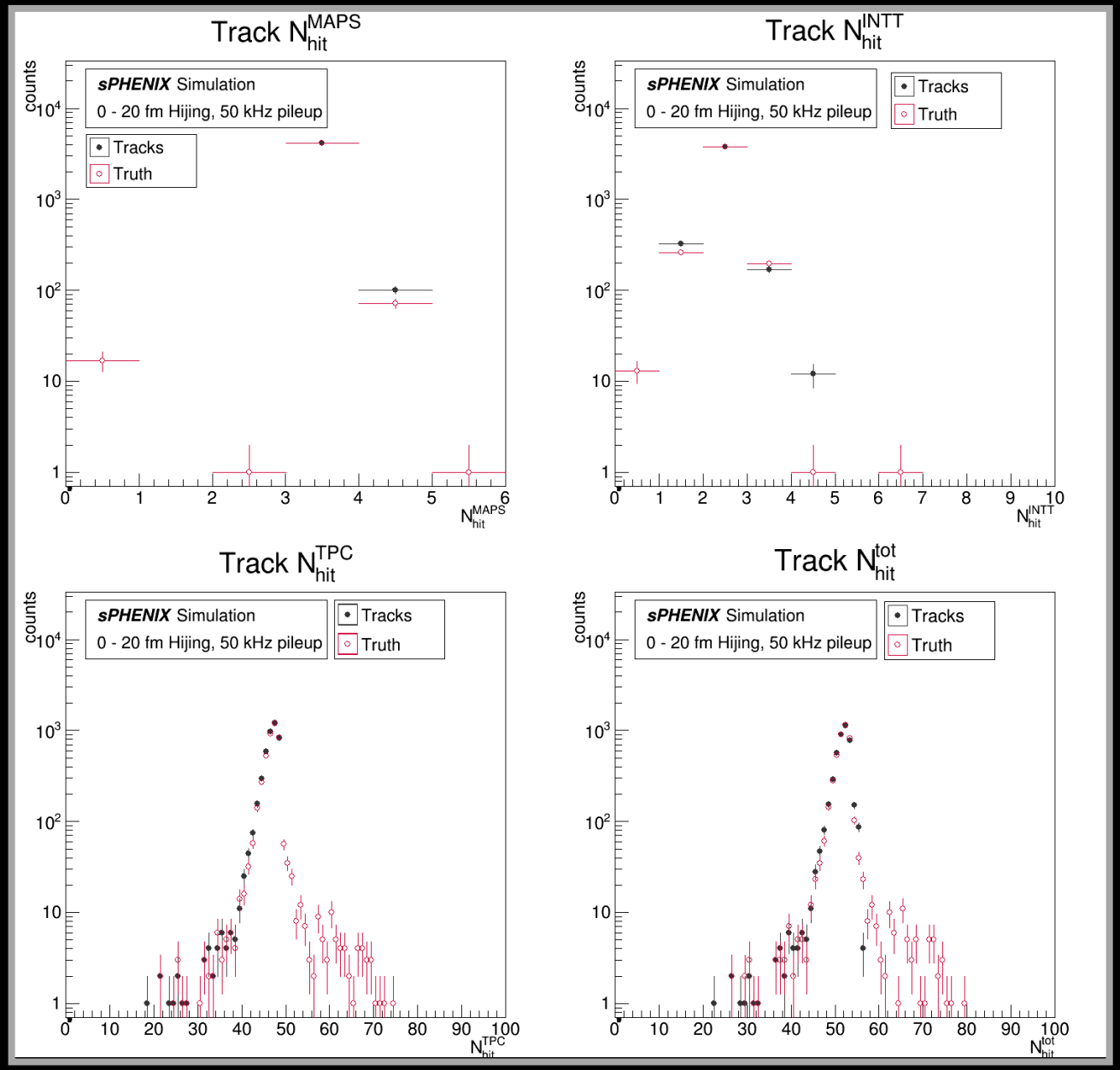
- Ran default Fun4All macro over small set of files to test:
  - 0 – 20 fm Hijing **(type = 4)**
  - 50 kHz pileup **(pileup = 1)**
  - ☞ Next will run over larger sample

- **These slides:** looked at a handful of quantities
  - ☞ This update is mostly to correct any conceptual errors…

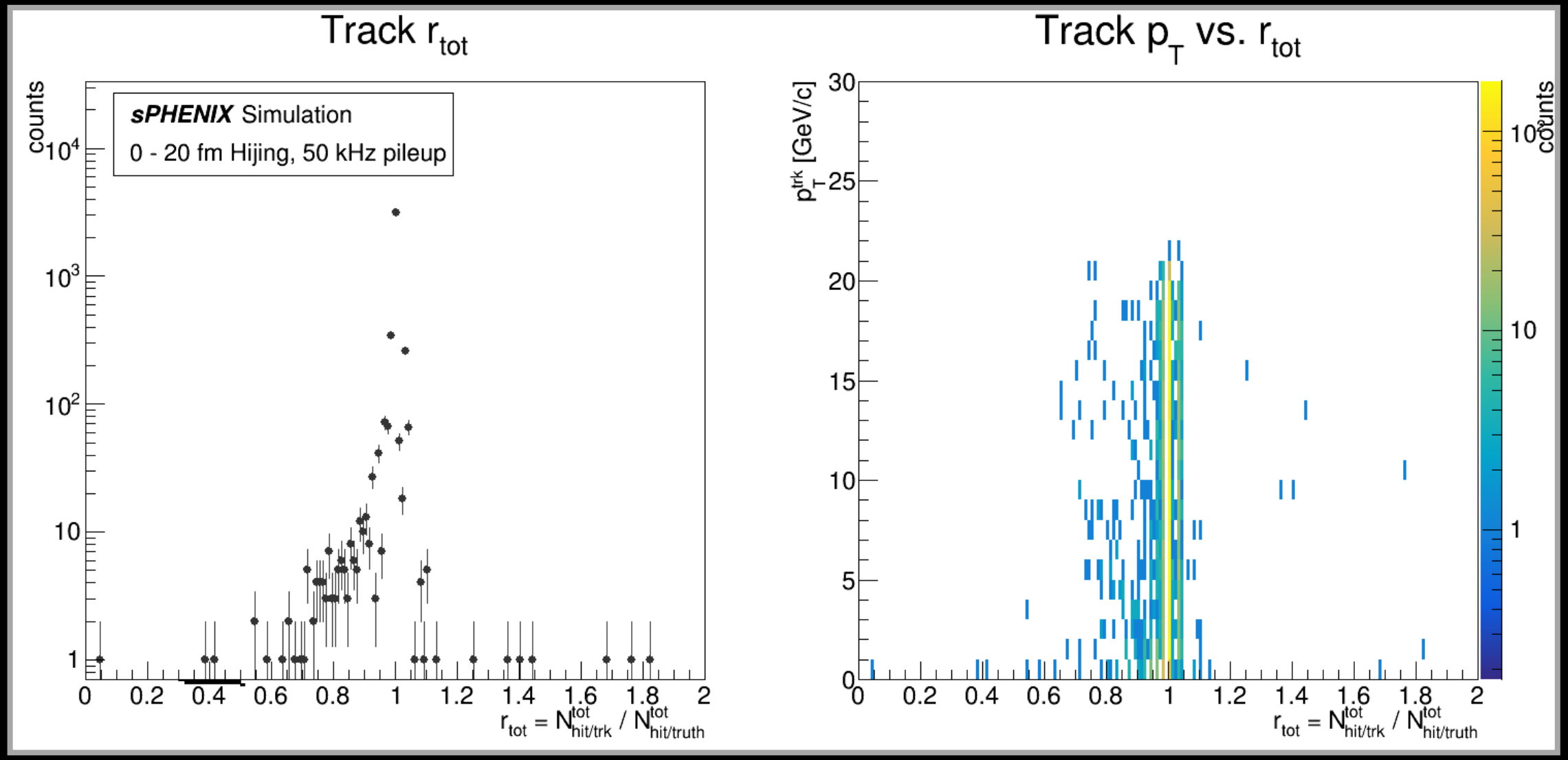
Track vs. True Pt



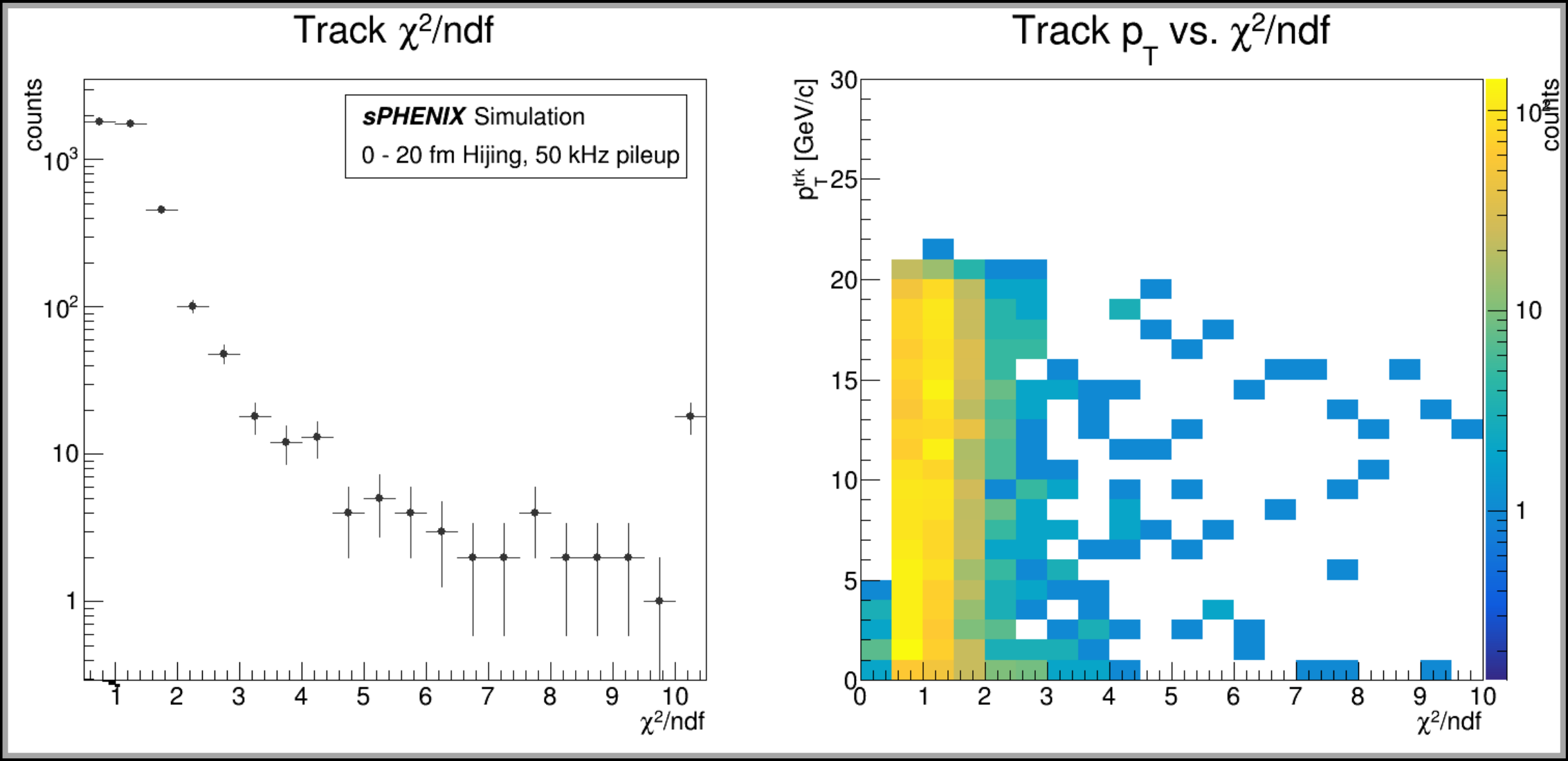
Track vs. Truth Nhits



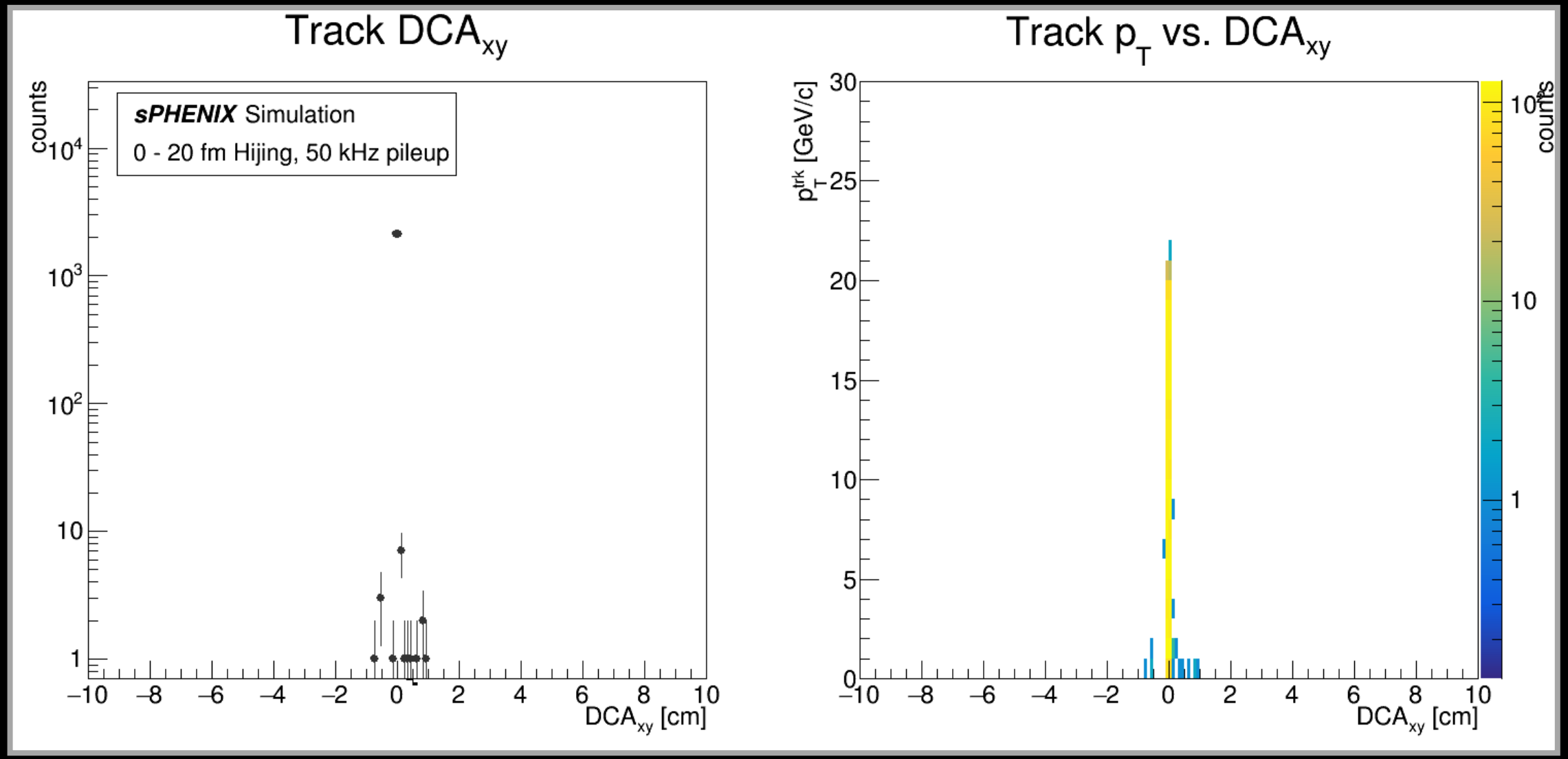
Track/True Nhits



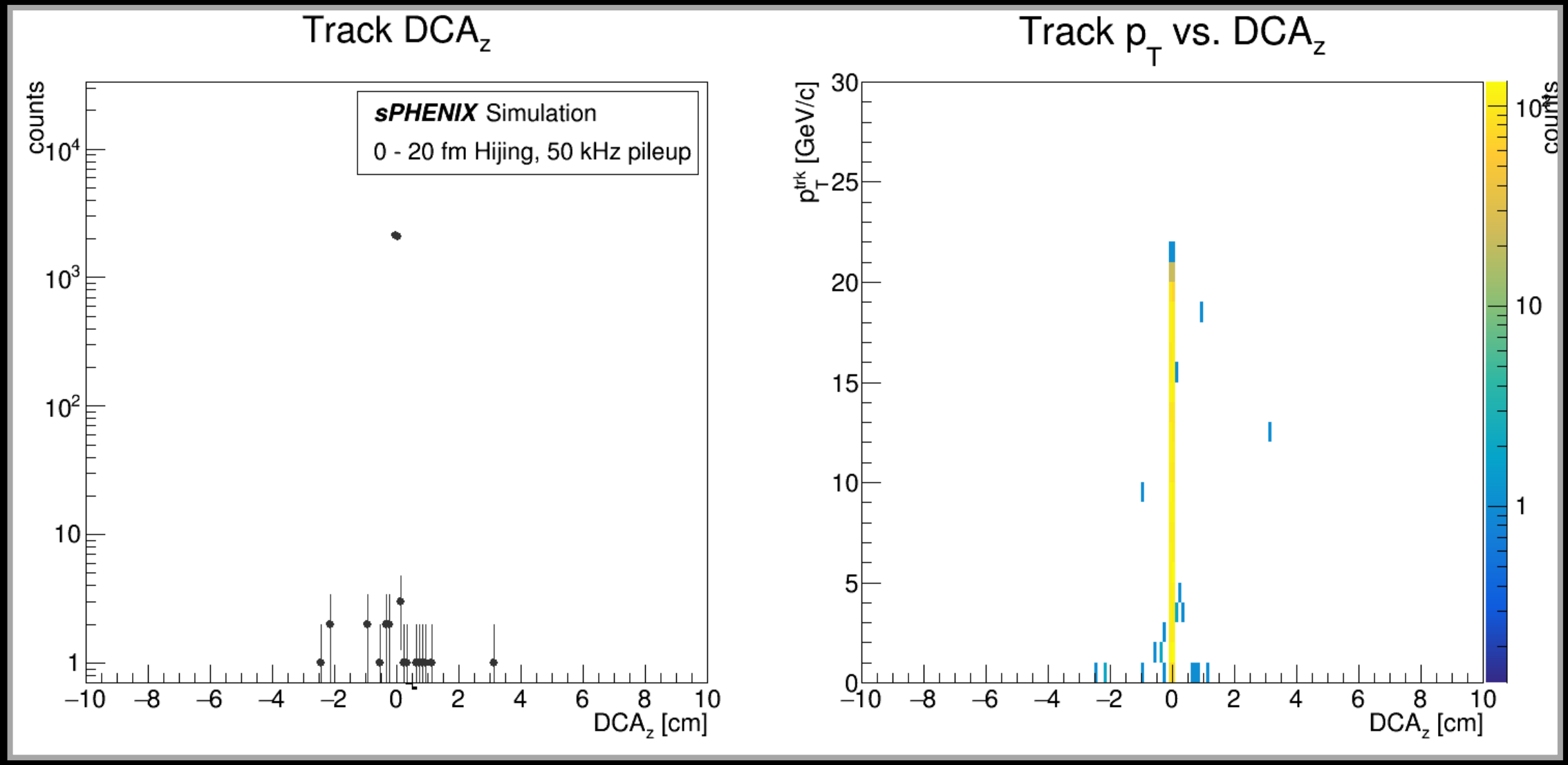
Track Quality



Track DCAxy


Track DCA$_{xy}$
counts
sPHENIX Simulation
0 - 20 fm Hijing, 50 kHz pileup
DCA$_{xy}$ [cm]
Track p$_T$ vs. DCA$_{xy}$
p$_T^{trk}$ [GeV/c]
counts
DCA$_{xy}$ [cm]

Track DCAz


Track DCA$_z$
sPHENIX Simulation
0 - 20 fm Hijing, 50 kHz pileup
counts
DCA$_z$ [cm]
Track p$_T$ vs. DCA$_z$
p$_T^{trk}$ [GeV/c]
DCA$_z$ [cm]
counts