Evaluating Proton and Charged Track Reconstruction in 2x2

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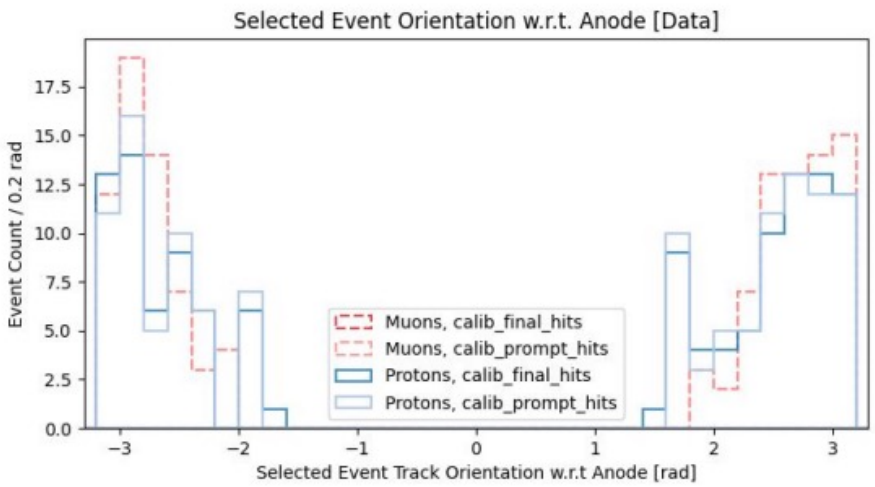
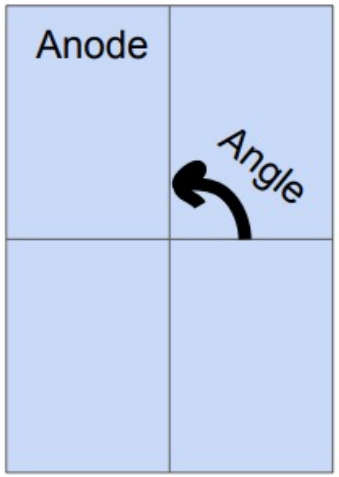
Previous Work → January Workshop

- At January Workshop, we showed preliminary particle kinematic data/MC comparisons for hand-scanned proton-like and muon-like track samples from Bern Module data and simulation flow files
  - **Benchmarking charged, track-like particle reconstruction is essential** for the CC $\bar{\nu}_\mu$-Ar mesonless cross section analysis and the charged track multiplicity analysis

Preliminary Comparisons: μ vs. p, final vs. prompt hits



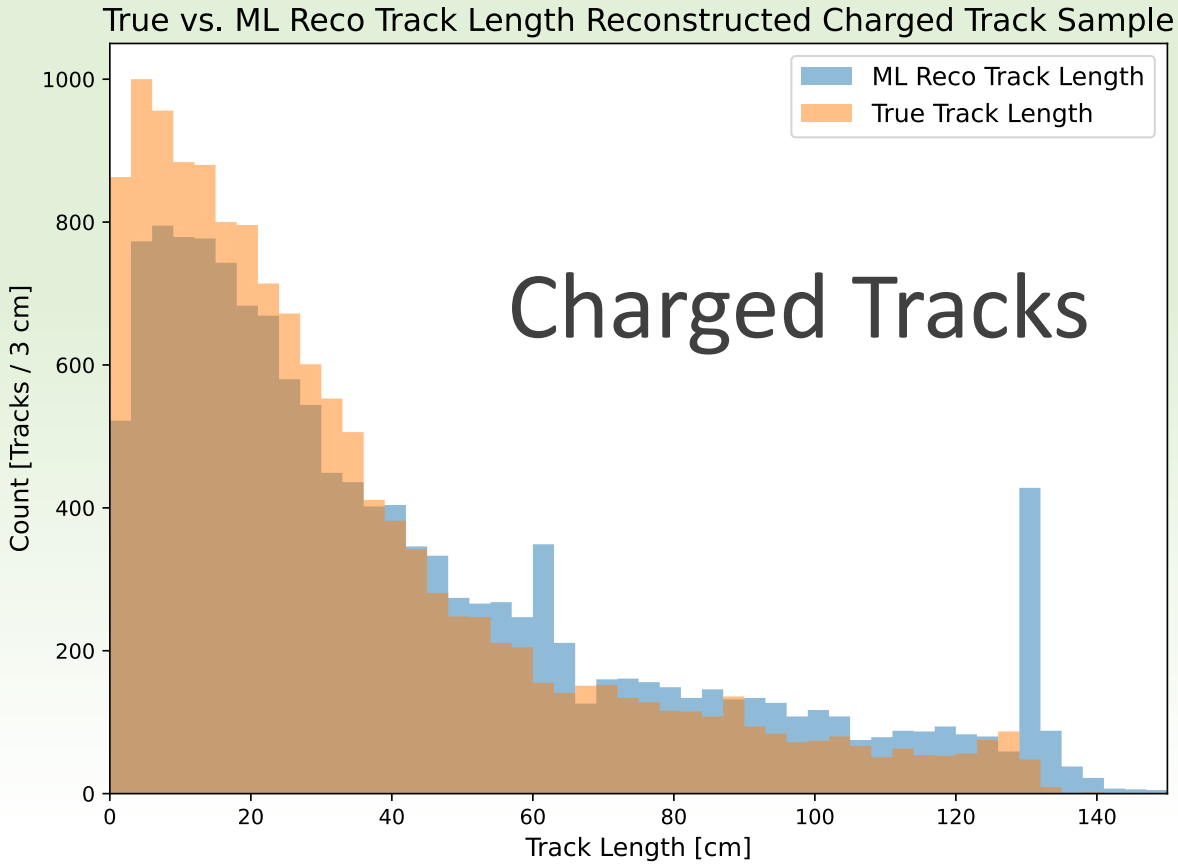


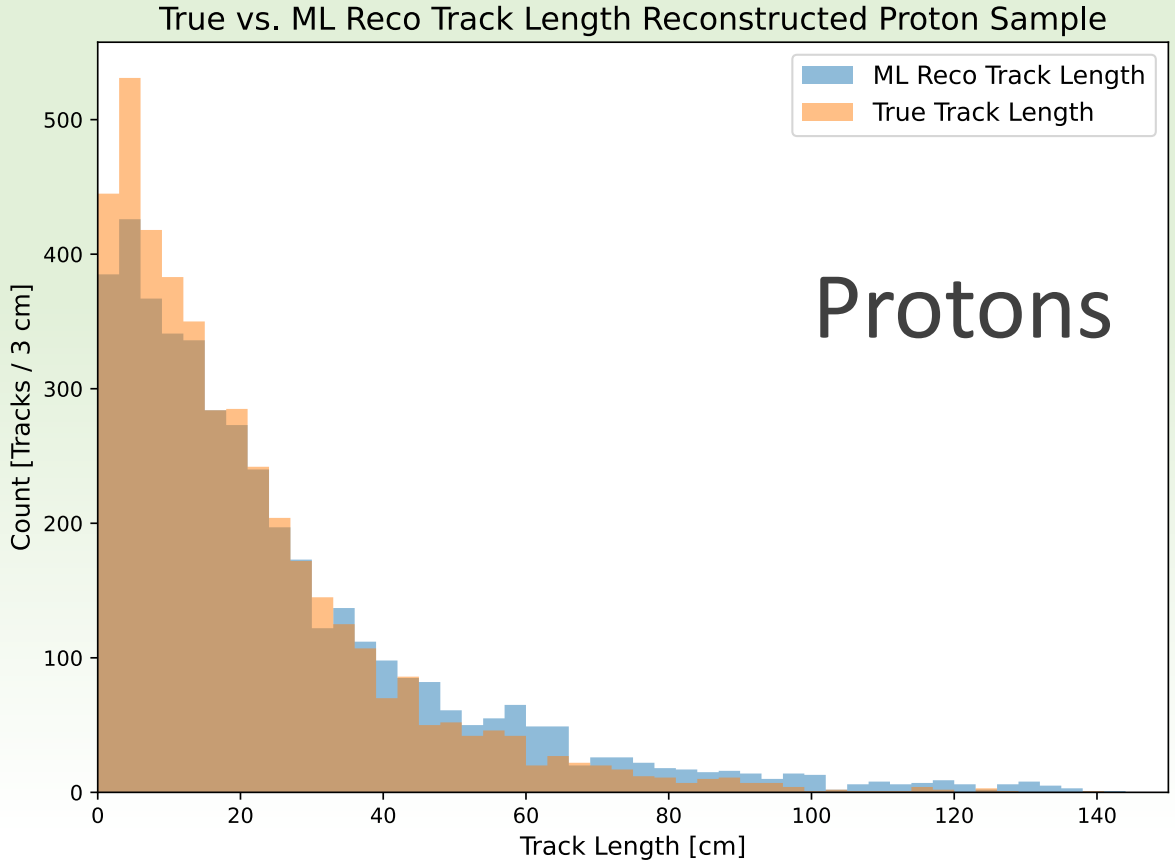
- Small differences in proton angles in prompt vs. final hits datasets
- Indicates difference in how tracklets are formed using the two datasets

Current Work – Full Reco Benchmarking

- Still want to look at calibration-file-level comparisons of data/MC using Bern Module data and simulation (see my presentation yesterday for update on Bern module cosmics simulation status)
- Also want to investigate **full proton reconstruction using CAFs** by comparing reco and true particle kinematics
- As CAFs currently only contain **ML Reco** information, this is the reconstruction I'm evaluating
- **Sample:** MiniRun4.5 Beta 2 CAFs (300 files)
- As ML Reco has some known PID issues, I look at all **reconstructed** charged track-like particles and also just **reconstructed** protons in comparison to **best match true particles**
- Cut on ML Reco "Overlap" variable such that **require reco/true match to have >=0.5 overlap**

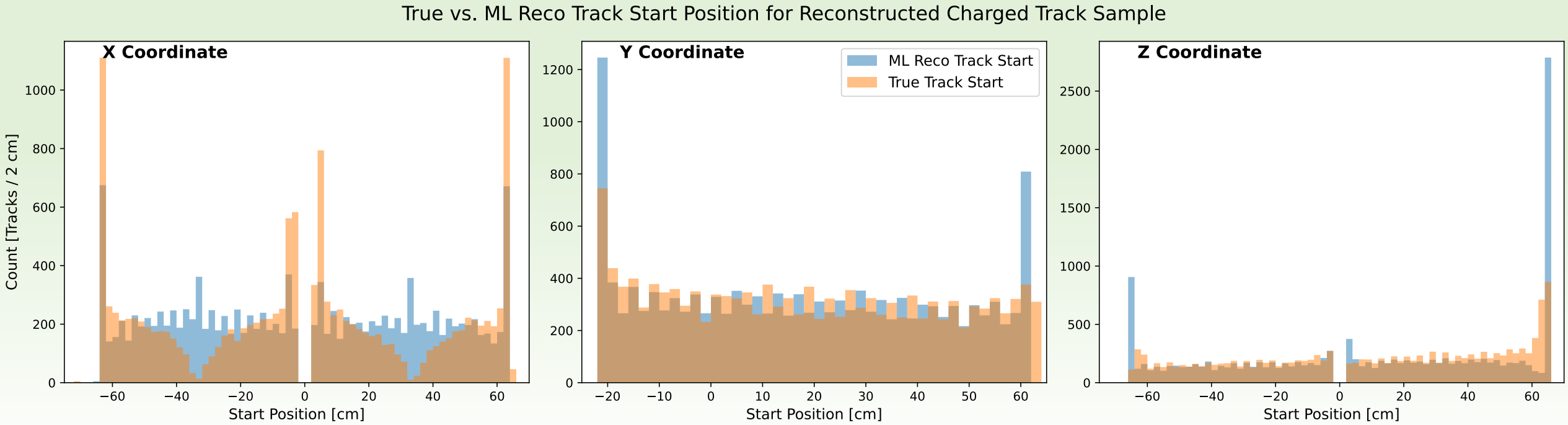
Charged Track and Proton Length





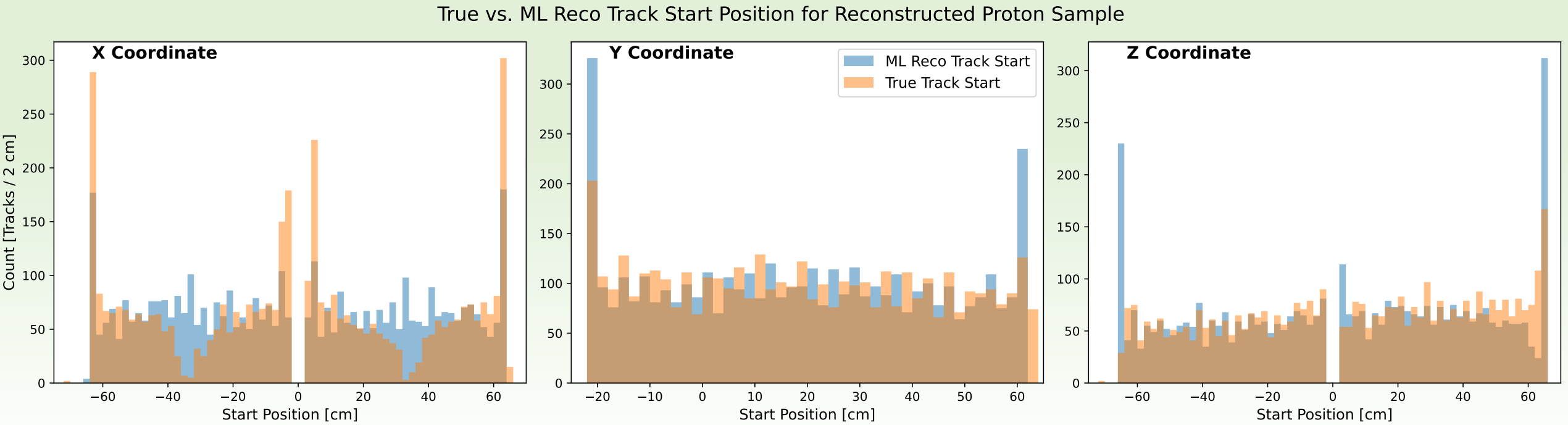
- Longer tail on ML Reco track length distributions
- More short true tracks

Charged Track Start Position



- Significant differences in x-coordinate distribution
- Large spikes at edges for ML Reco

Proton Start Position



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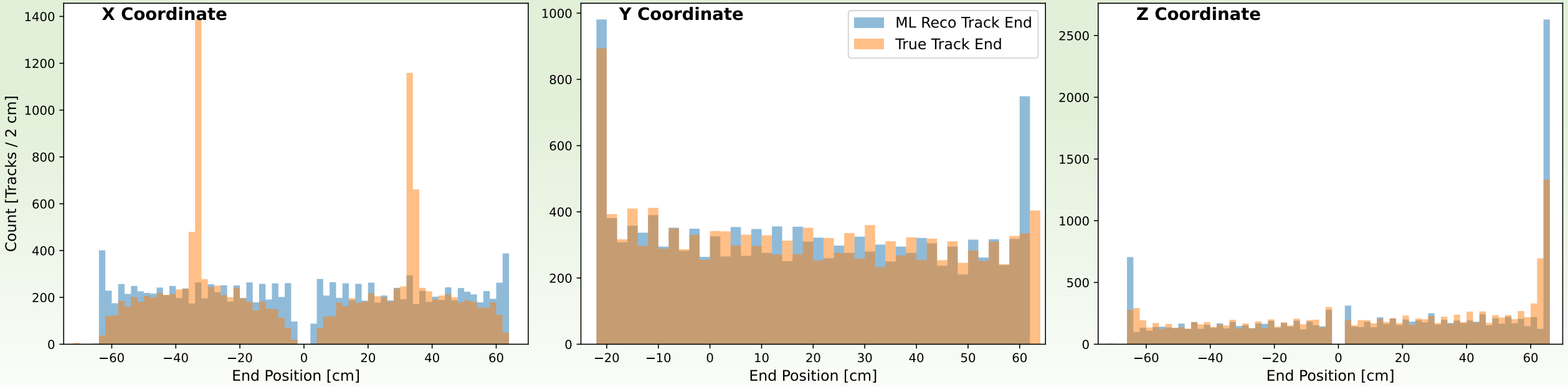
Charged Track End Position

True vs. ML Reco Track End Position for Reconstructed Charged Track Sample



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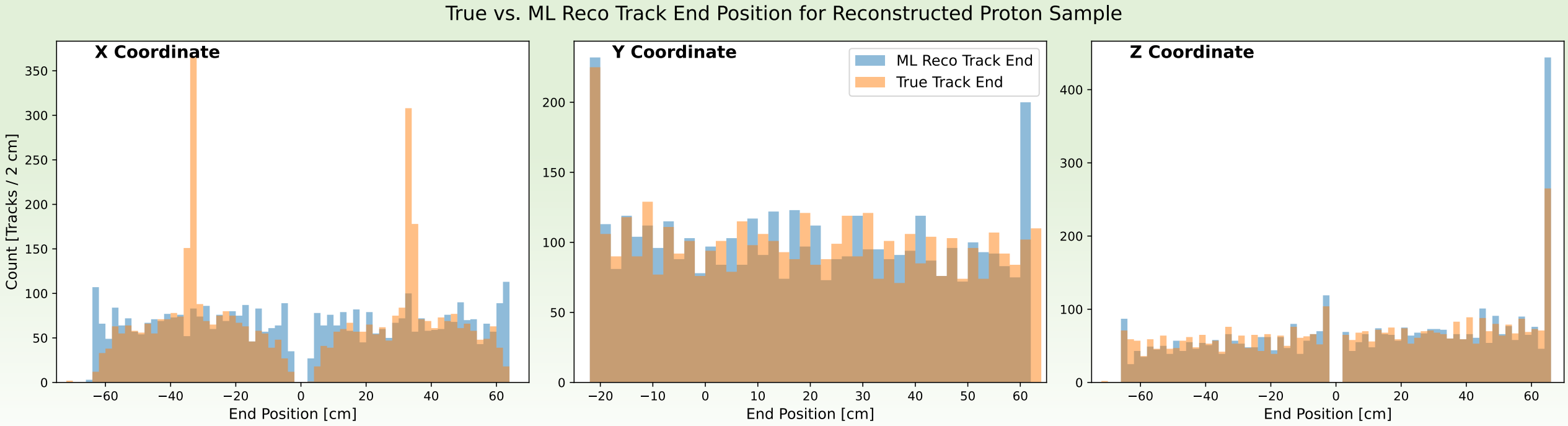
Proton End Position



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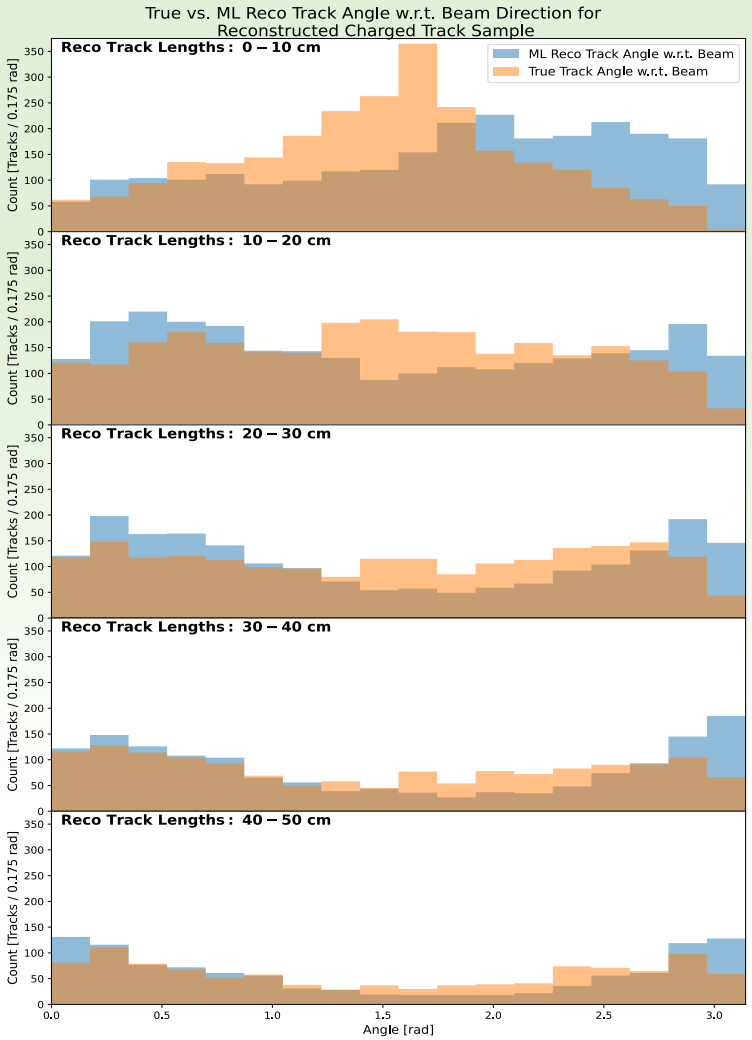
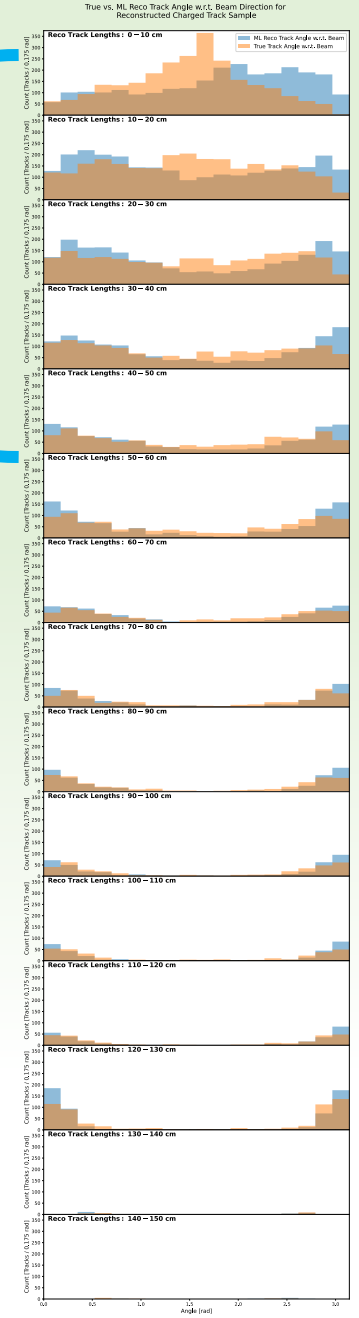
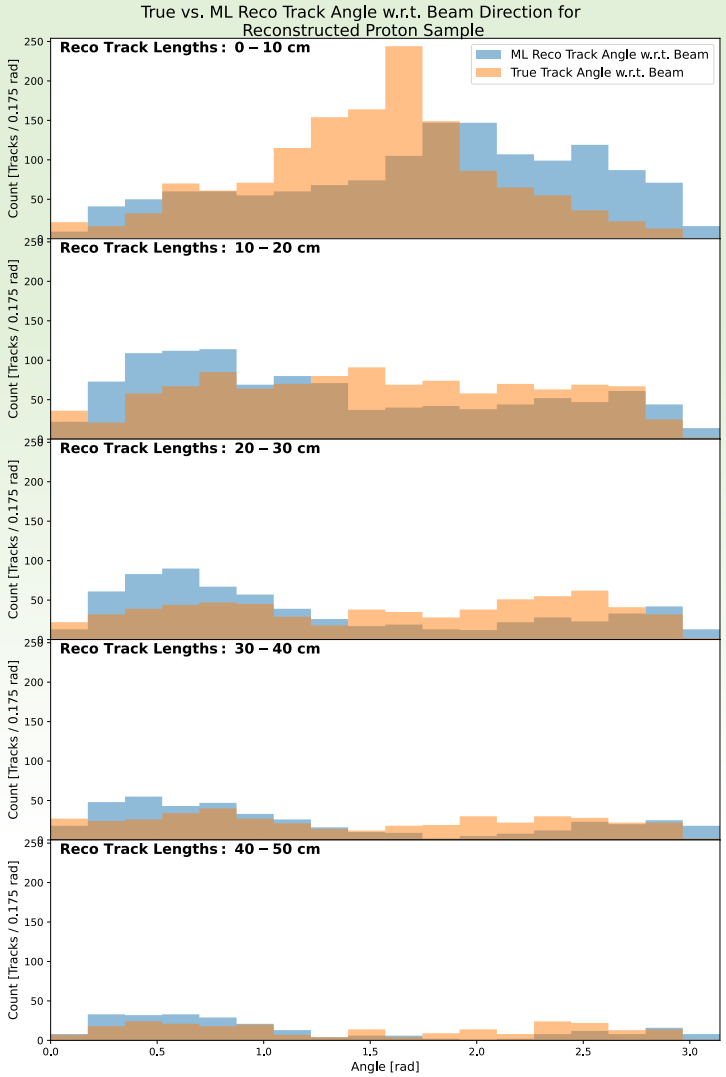
Charged Track Angle w.r.t Beam

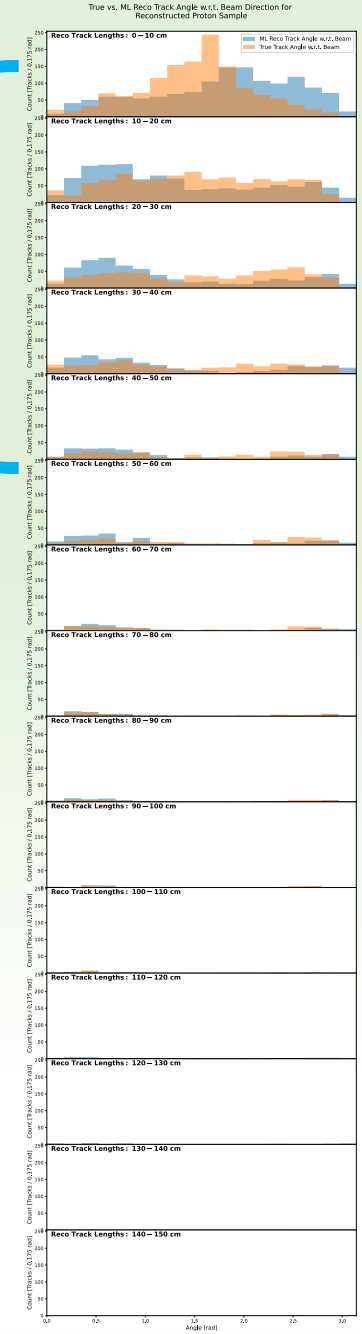




- Binned by reconstructed track length in 10 cm bins
- For shorter tracks, clear difference in true vs. reco distributions

Proton Angle w.r.t Beam





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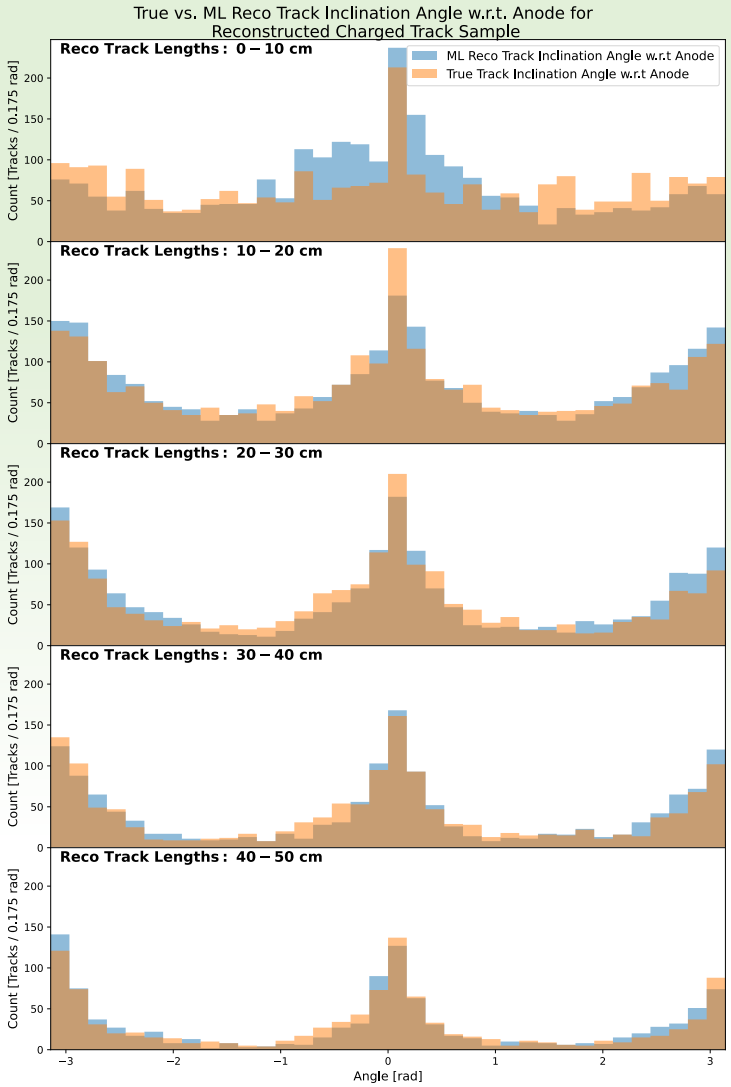
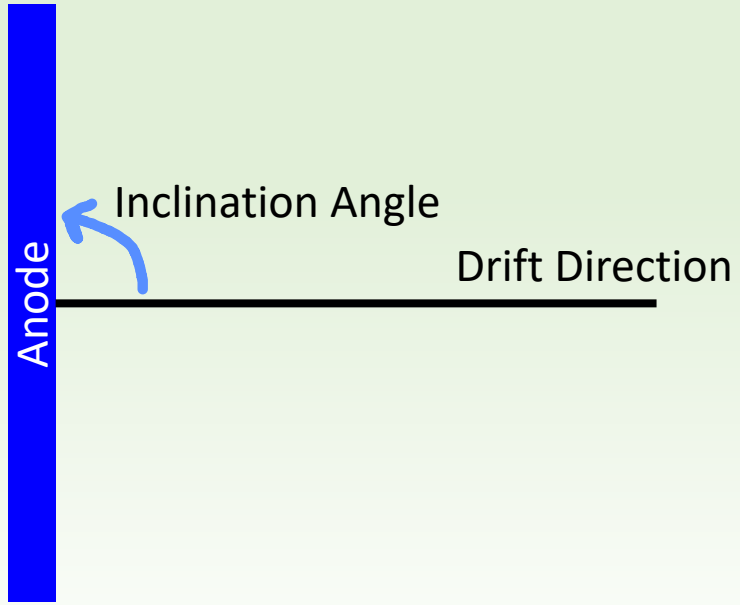
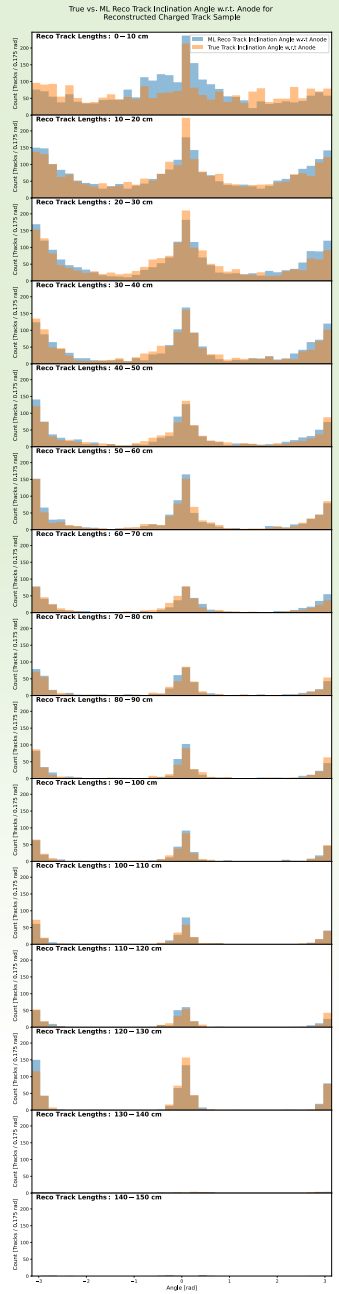
Charged Track Inclination Angle







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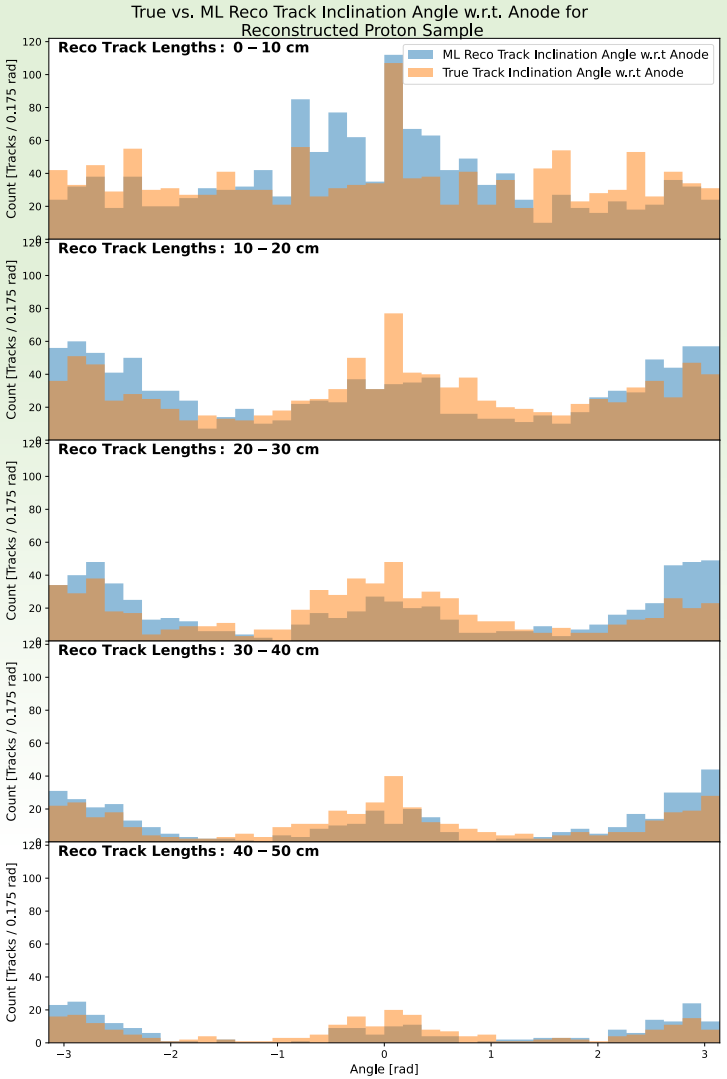
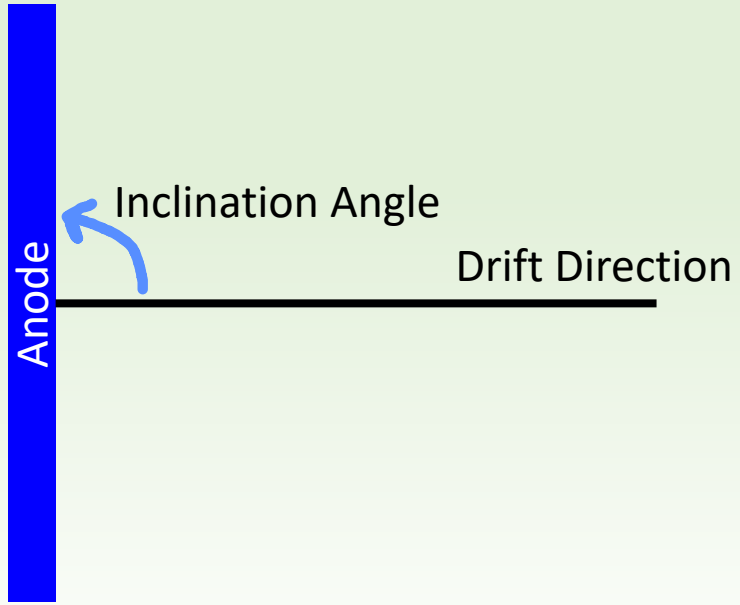
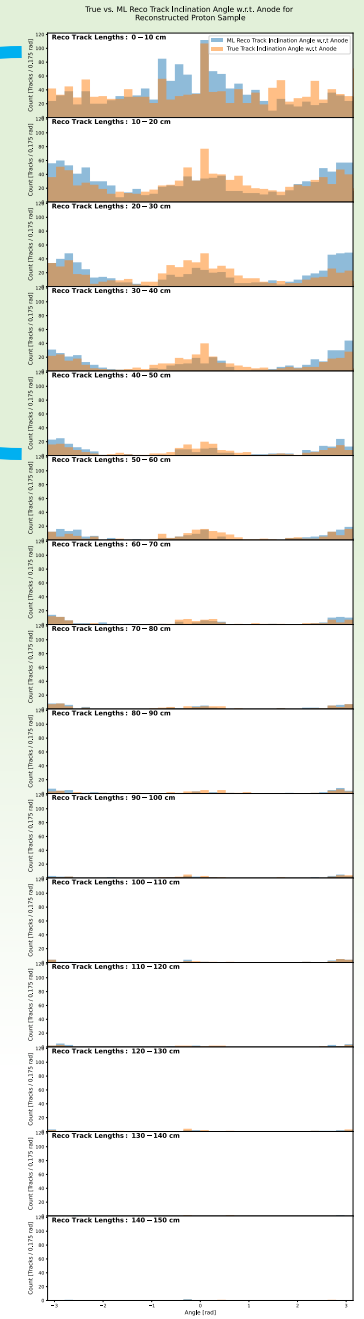
Proton Inclination Angle







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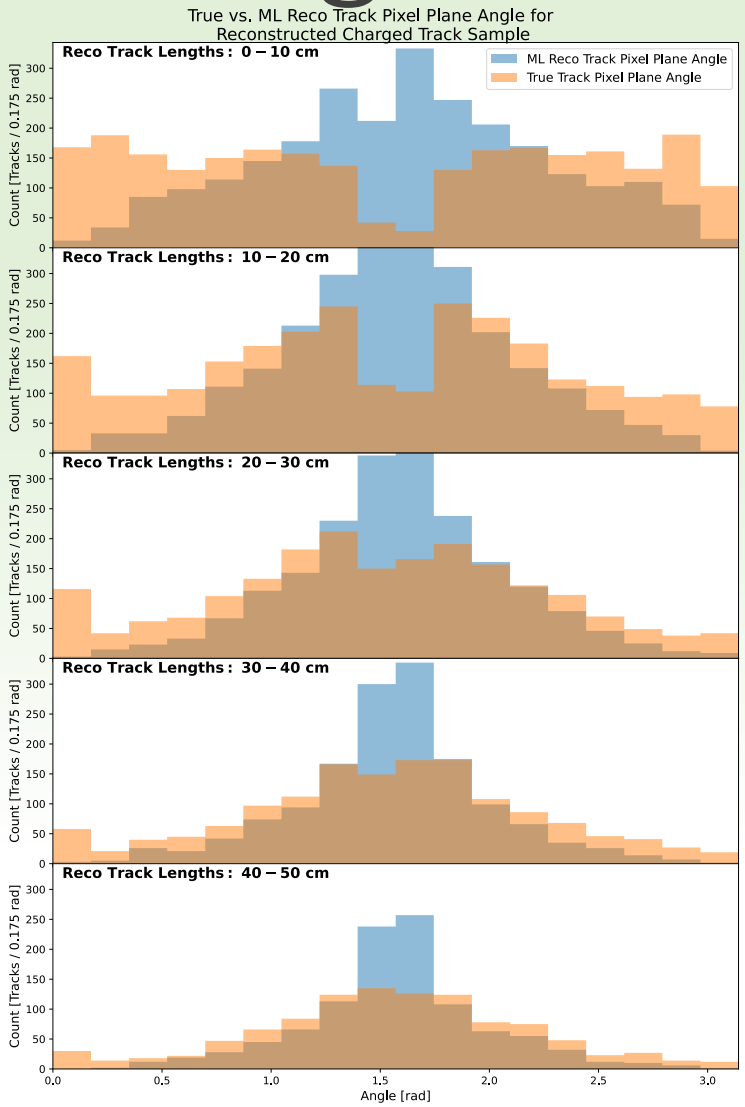
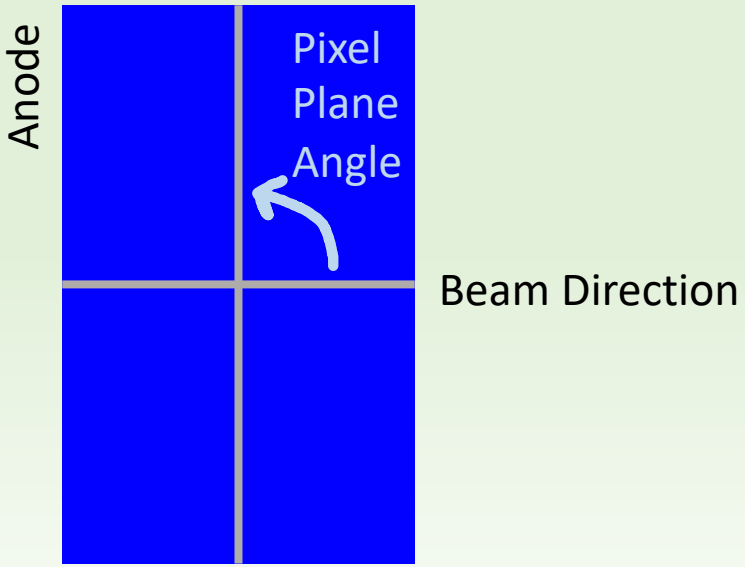
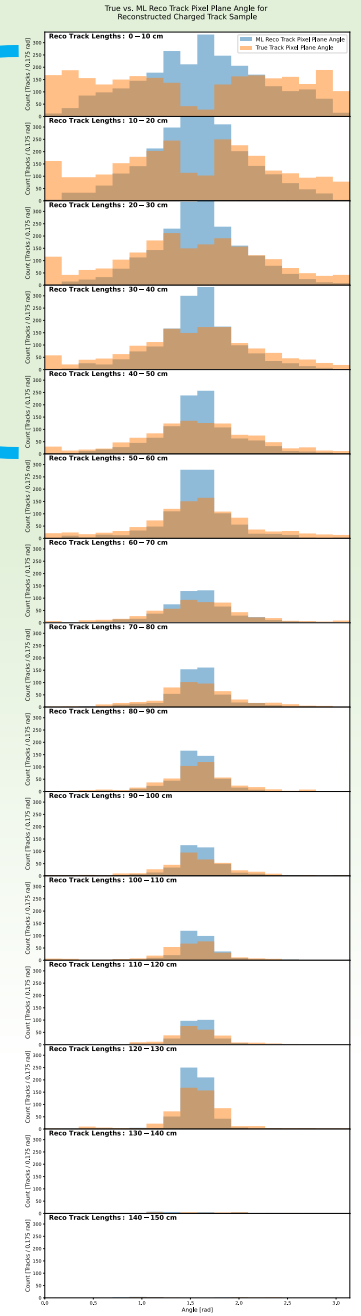
Charged Track Pixel Plane Angle







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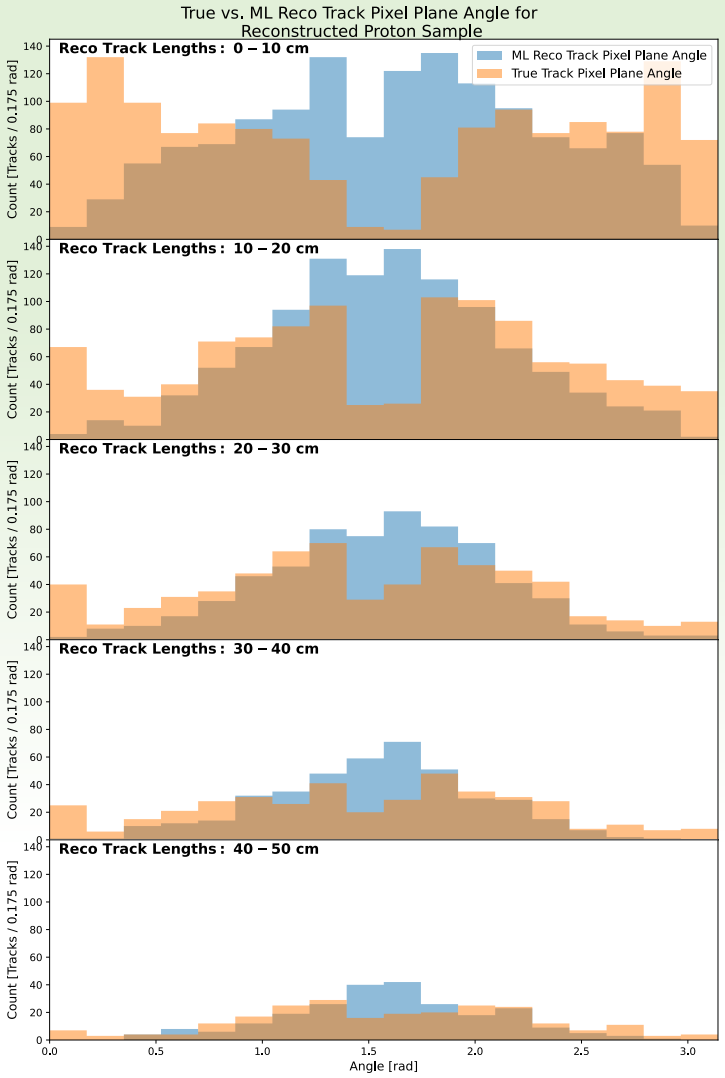
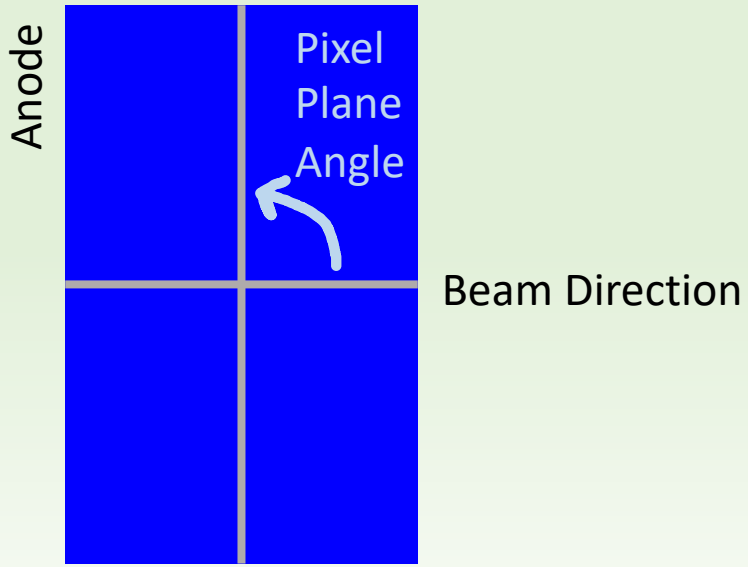
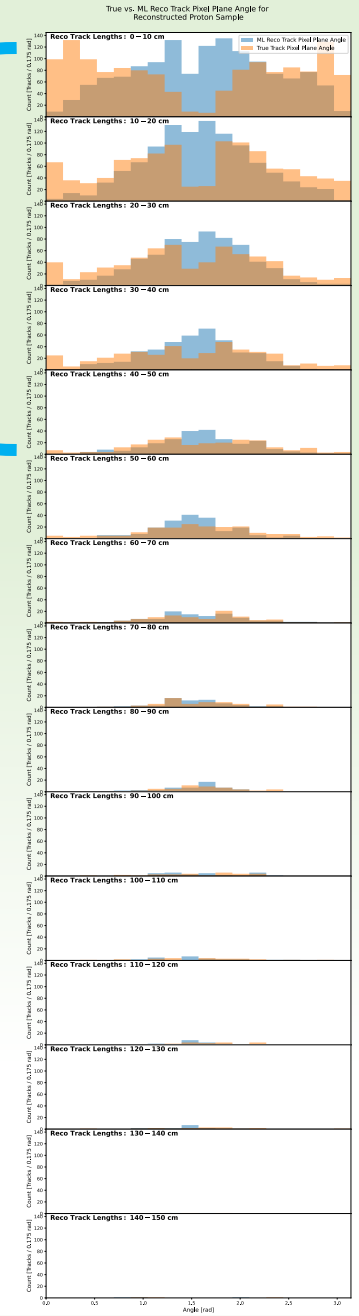
- For all tracks, clear difference in true vs. reco distributions

Proton Pixel Plane Angle







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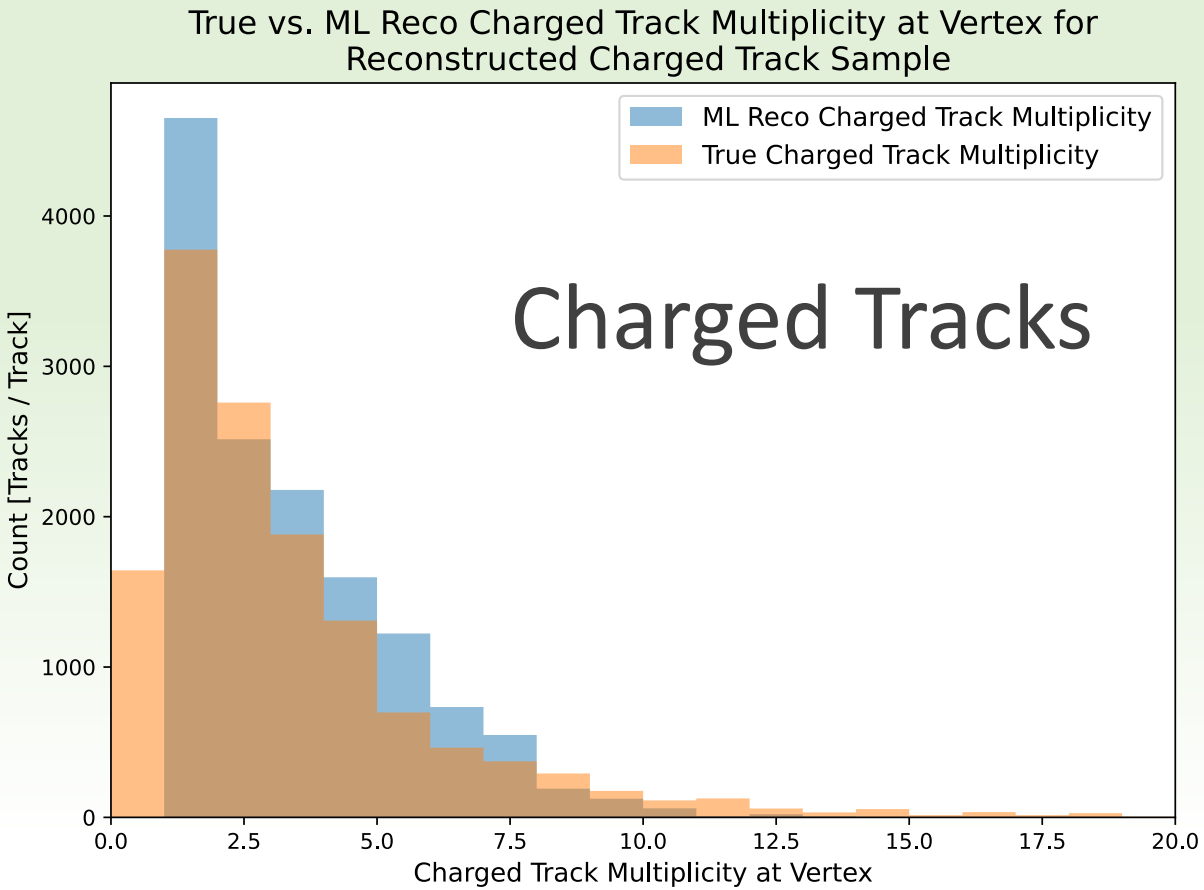
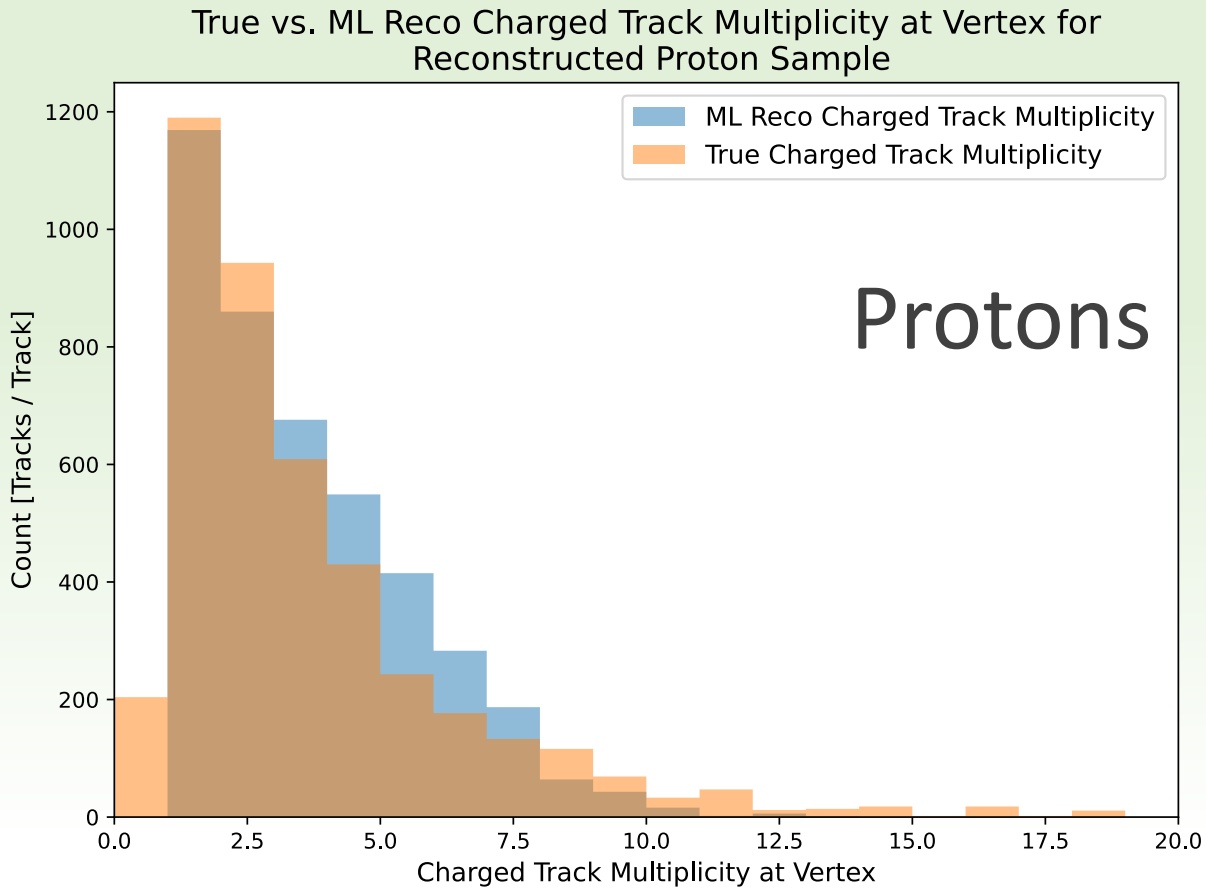
Track Multiplicity at Vertex





- First bin may be cases where true particle match is shower-like
- In the future, will look at kinematics by true track multiplicity at vertex to get a better understanding of reconstruction fidelity in high activity environments

Summary + Future Studies

- Starting to study proton and charged track reconstruction (ML Reco) using CAFs
- **Some unexpected features in true vs. reco distributions, especially for pixel plane angle**
- Future areas of investigation:
  - Break down some of the plots I showed in terms of different variables (e.g. by charged track multiplicity at the vertex, by start/end position, etc.) to **identify specific failure modes**
  - Similar studies with reflowed Bern data/new Bern cosmics samples run through ML Reco