Effects of primary vertex reconstruction on D^0 topological variables

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May 6, 2025

D^0 topological variables

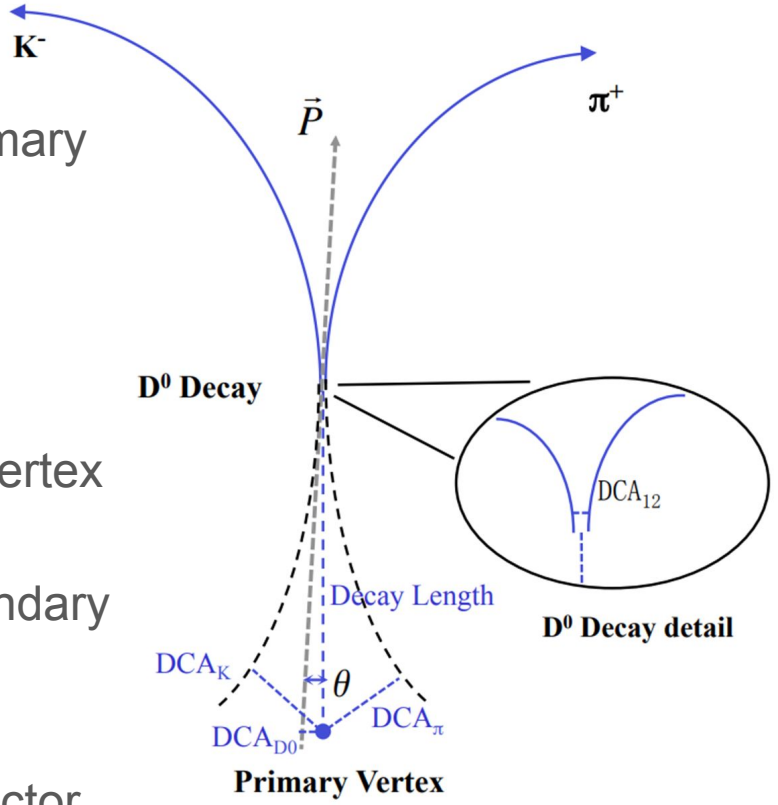
DCA_π and DCA_K : distance of pion/kaon to primary vertex

DCA_{12} : distance between pion and kaon pair

DCA_{D0}: distance of parent particle to primary vertex

Decay length L: distance from primary to secondary vertex

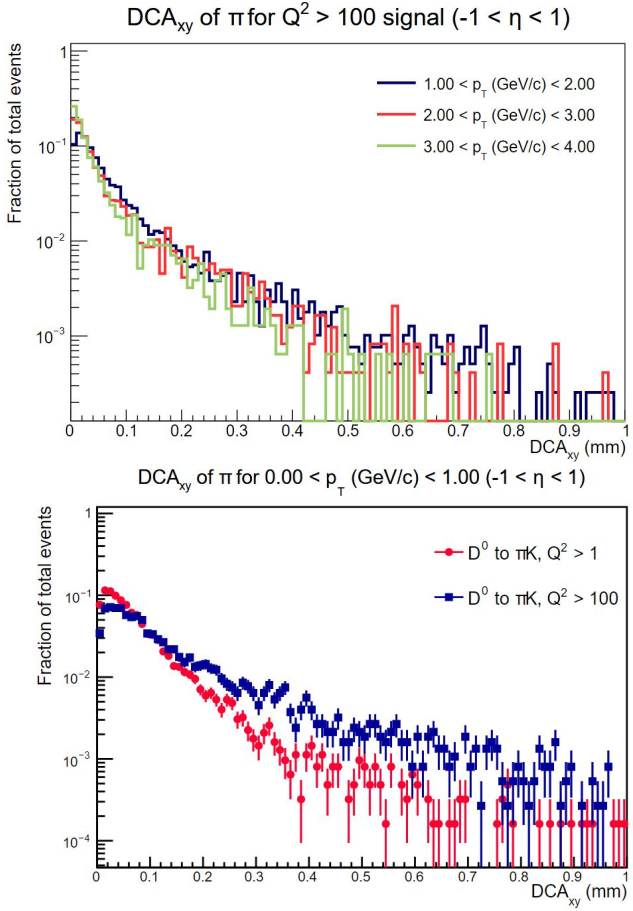
θ: angle between D^0 momentum and vertex vector



Goals

Compare top. variable distributions with respect to Monte Carlo (MC) vs. reconstructed (Reco/RC) primary vertex.

Analyze Q^2 dependence seen in $DCA_{\pi/K}$.



Data samples and signal selection

Data samples

- PYTHIA8, ep, $Q^2 > 1$ and $Q^2 > 100$
- 50 runs for each Q^2
- ~26500 total events each
- D^0 enriched

(root://dtn-eic.jlab.org//volatile/eic/EPIC/RECO/24.12.0/epic_craterlake/SIDIS/D0_ABCONV/pythia8.306-1.1/10x100/q2_1(100)/hiDiv/)

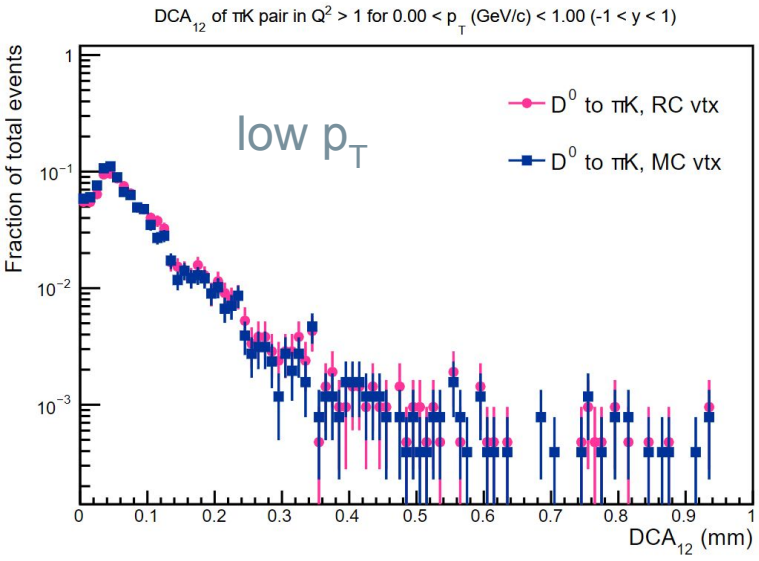
Signal selection

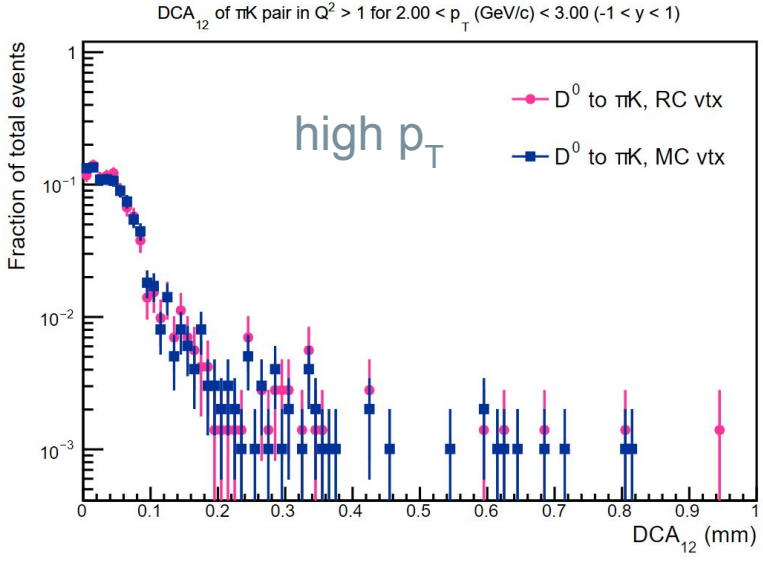
From all pions and kaons:

- dist > 10^{-4} mm from MC primary vertex (non-primary)
- D^0 parent
- Reco πK with matching assoc. ID
- DCA_{π} , DCA_{K} > 0.02 mm
- πK pair with opposite charges

(github.com/marrbnl/ePIC/tree/main/HF_reco/helix/analysis.cxx)

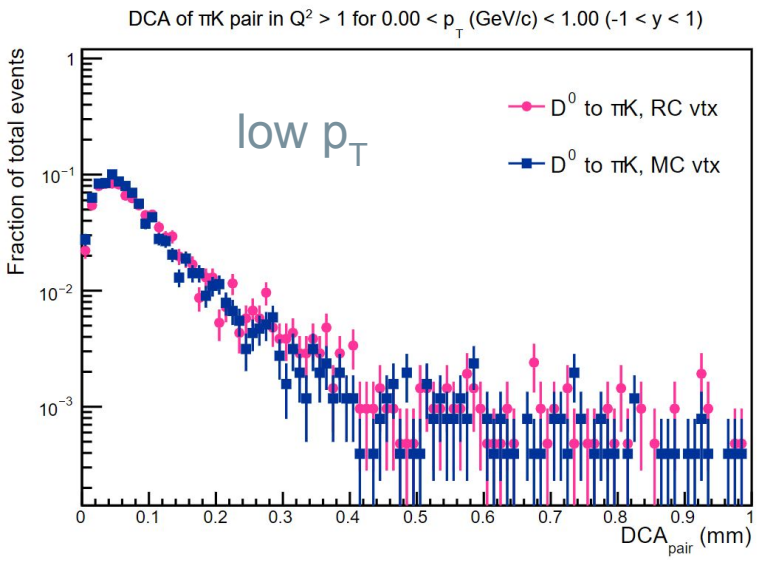
MC vs. Reco primary vertex for DCA_{12}

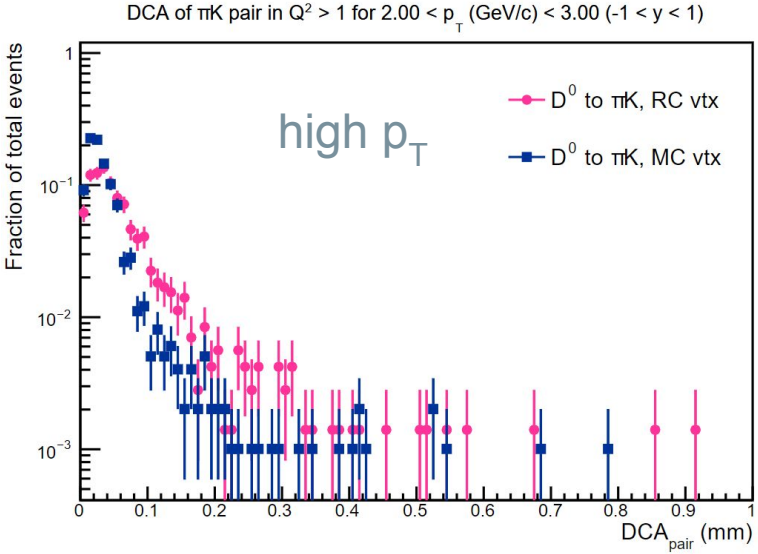




DCA_{12} does not depend on primary vertex location.

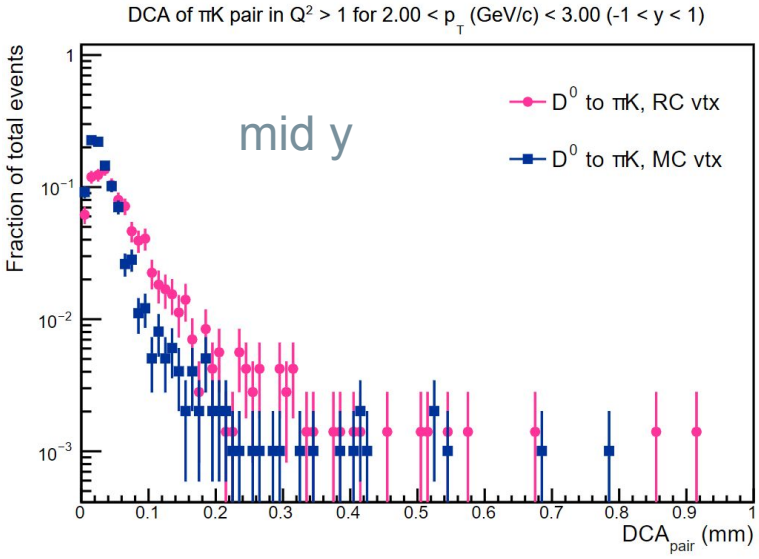
MC vs. Reco primary vertex for DCA_{D0}

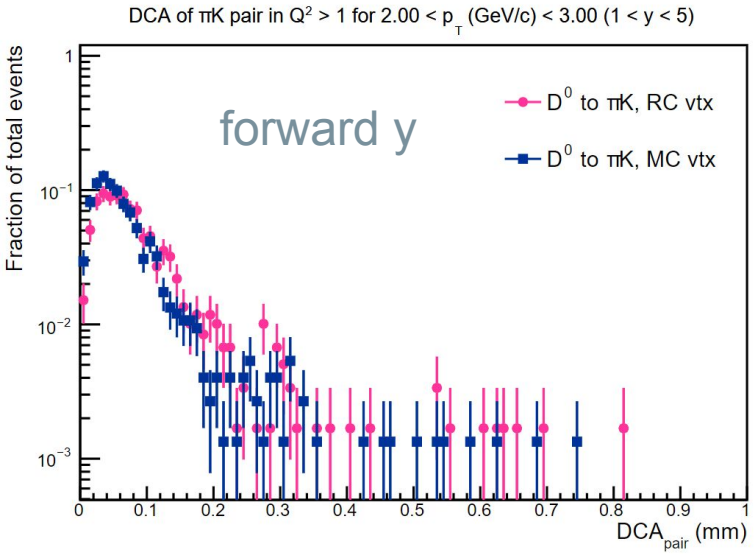




Reco is wider due to limited primary vertex resolution.

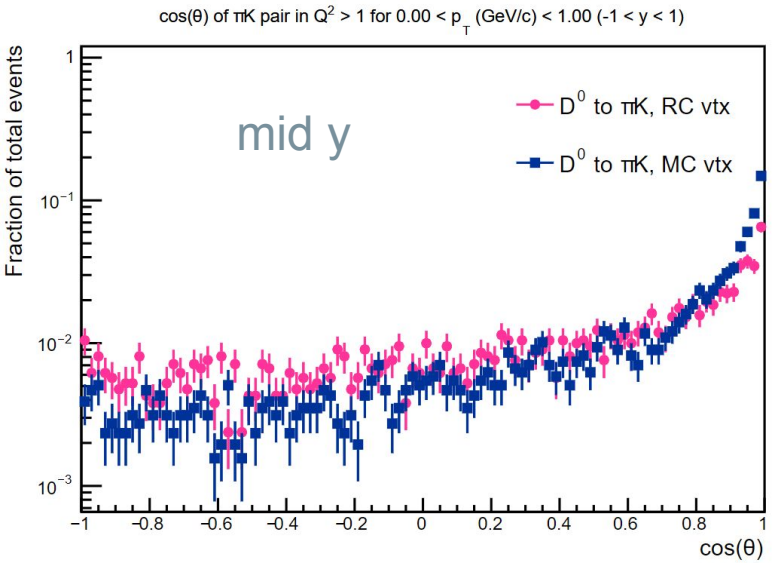
MC vs. Reco primary vertex for DCA_{D0}

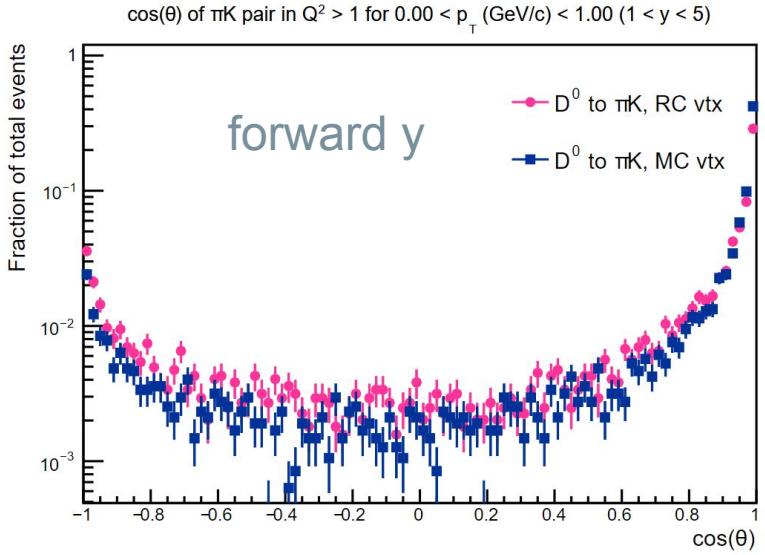




Greatest effect at high p_T and mid y, where track resolution is best.

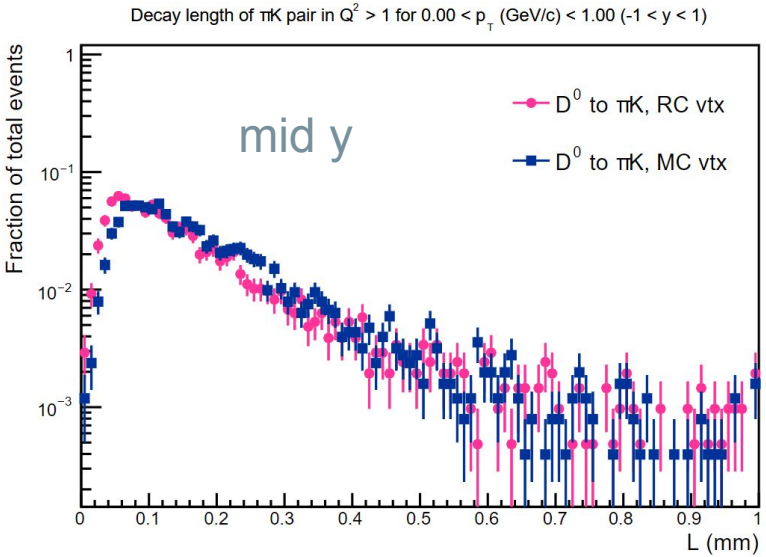
MC vs. Reco primary vertex for cos(θ)

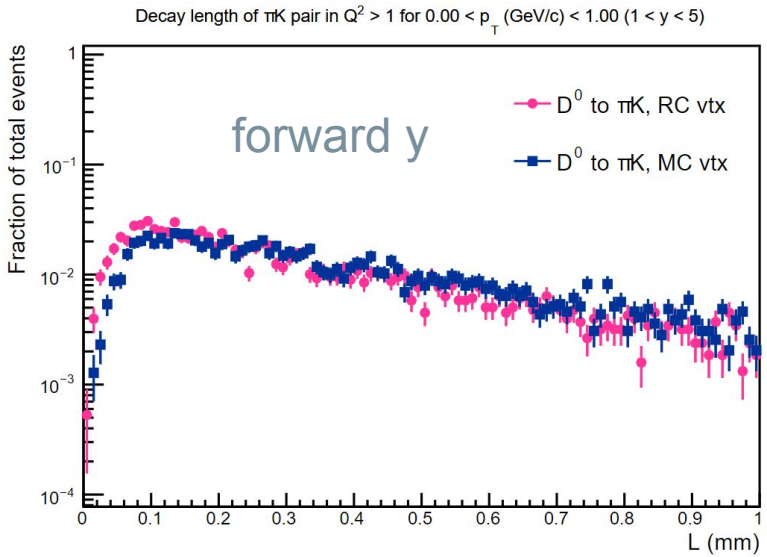




MC is higher near cos(θ) = +1 (also the case at higher p_T).

MC vs. Reco primary vertex for L

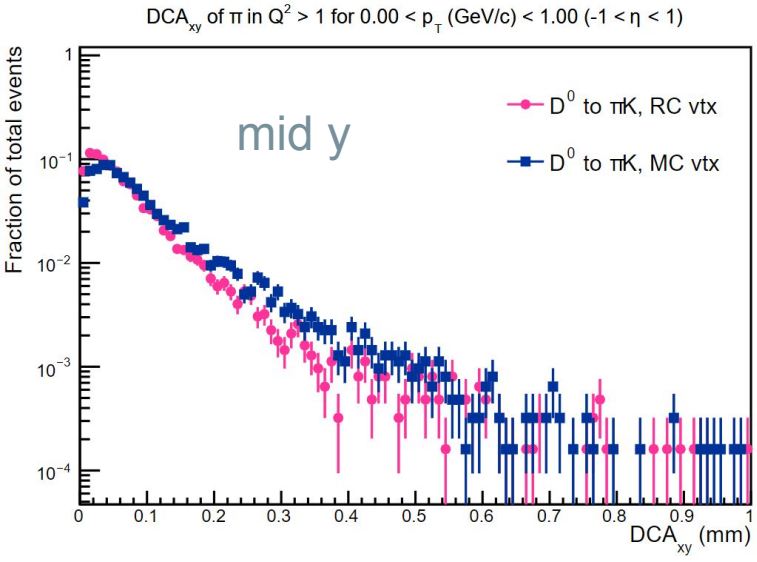


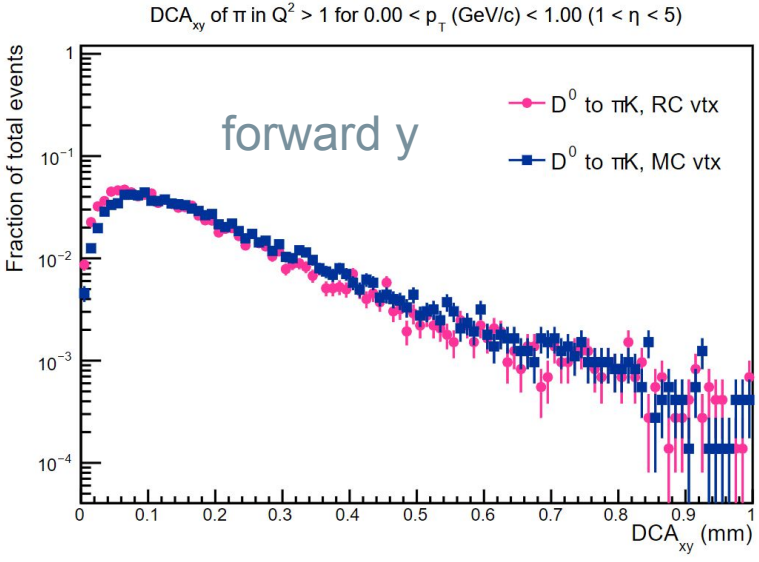


MC is wider than Reco (also the case at higher p_T).

Opposite of what we expect.

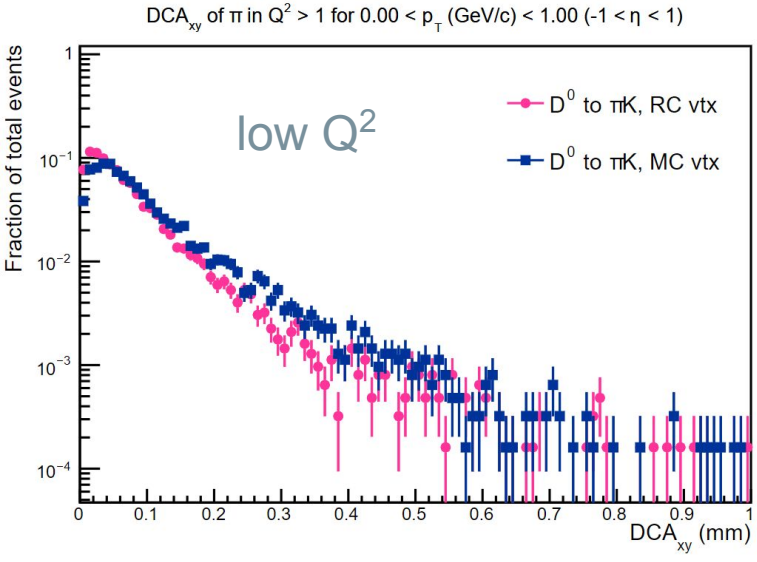
MC vs. Reco primary vertex for DCA_{π}

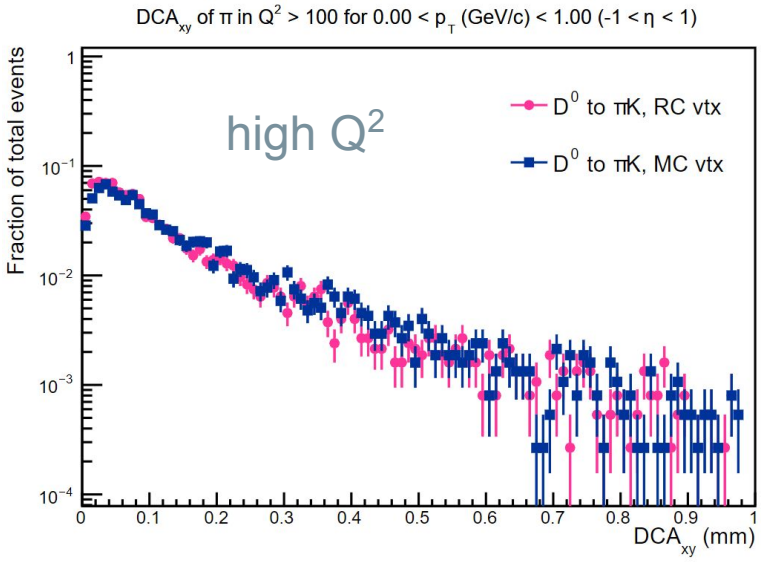




MC is wider than Reco (also the case at higher p_T).

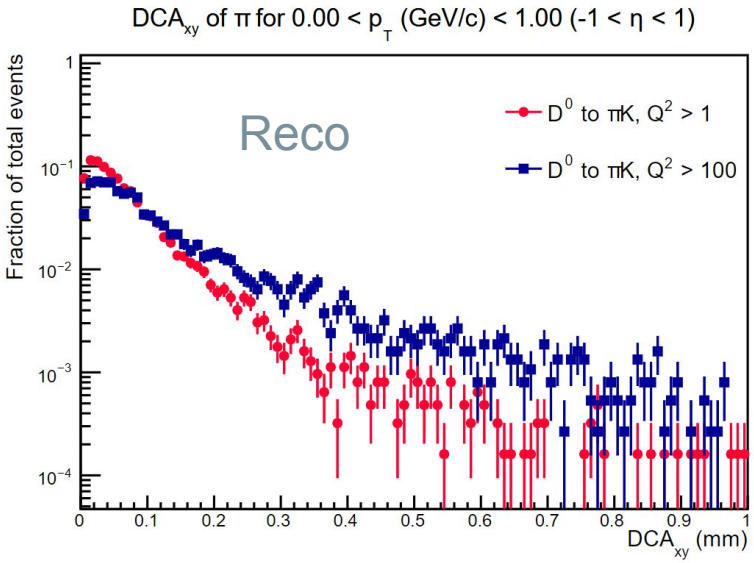
Effects for $Q^2 > 1$ vs. $Q^2 > 100$ for DCA_{π}

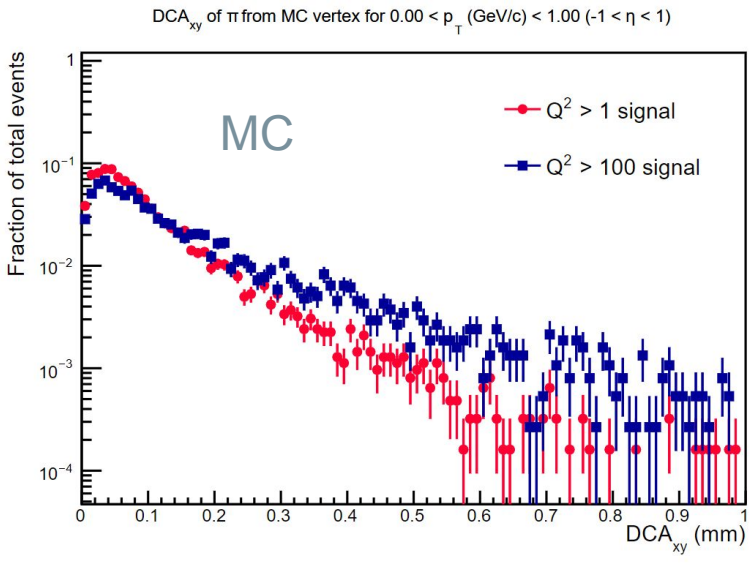




Reco is more similar to MC for $Q^2 > 100$ (for all top. variables).

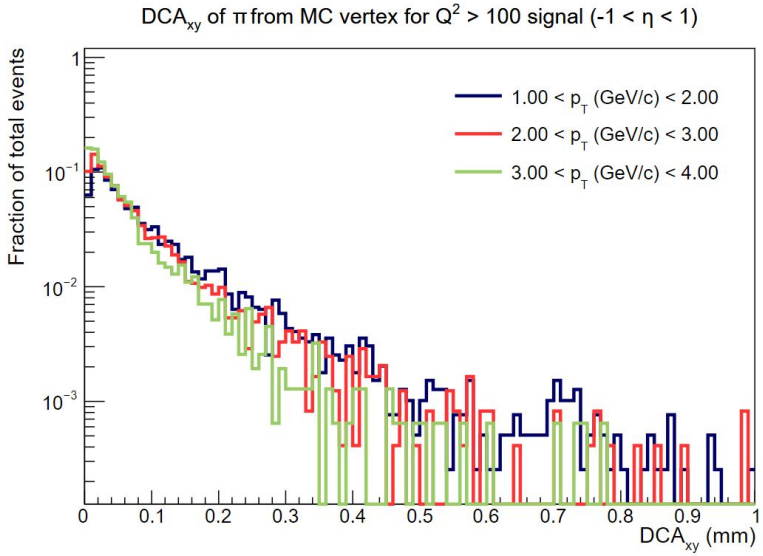
MC vs. Reco primary vertex for DCA_{π}

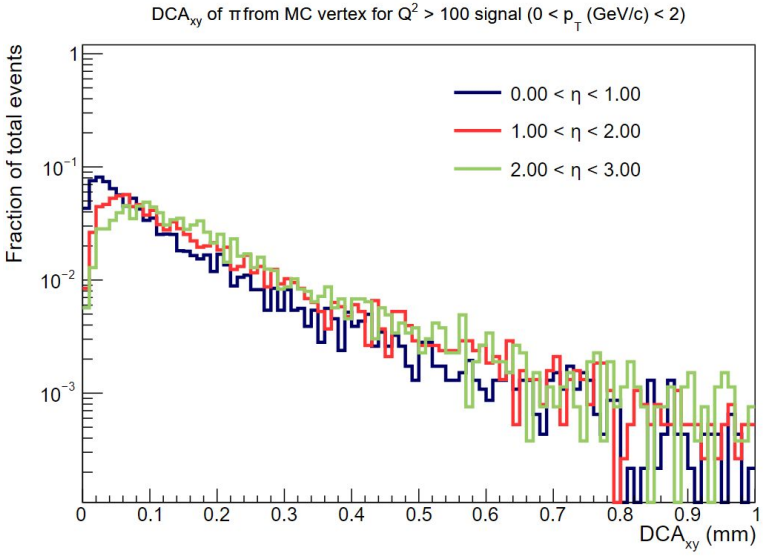




$Q^2 > 100$ is wider than $Q^2 > 1$ for Reco and MC distributions.

p_T and η dependences for DCA_π





Similar dependences as seen in Reco distributions (for all top. variables).

Summary

Reco is wider for DCA_{D0} and cos(θ), as expected.

MC is wider for $DCA_{\pi/K}$ and L, which is opposite as expected.

Reco and MC are most different for high p_T, mid y, and $Q^2 > 1$.