Prompt-D0 and non-prompt D0 DCA distribution

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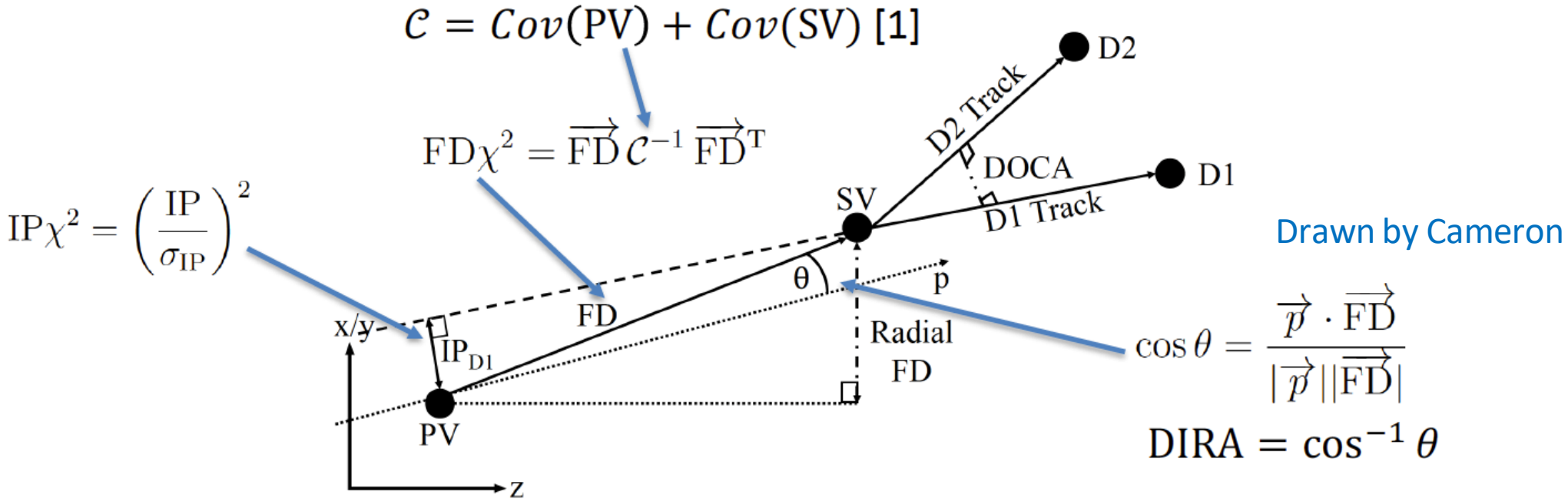
Data sample

- **MC sample:**
  - $c\bar{c} \rightarrow prompt\ D_0 \rightarrow \mathrm{K}\pi$ (DST_HF_CHARM_pythia8-0000000001)
  - $b\bar{b} \rightarrow non-prompt\ D_0 \rightarrow \mathrm{K}\pi$ (DST_HF_BOTTOM_pythia8-0000000001)

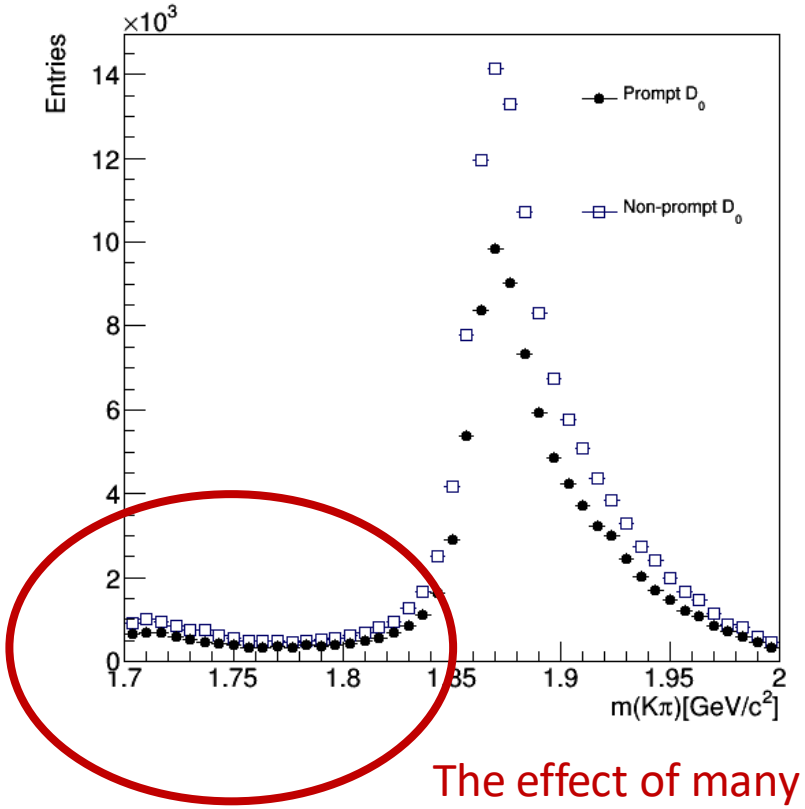
    /sphenix/sim/sim01/sphnxpro/MDC1/HF_pp200_signal/data



Drawn by Cameron

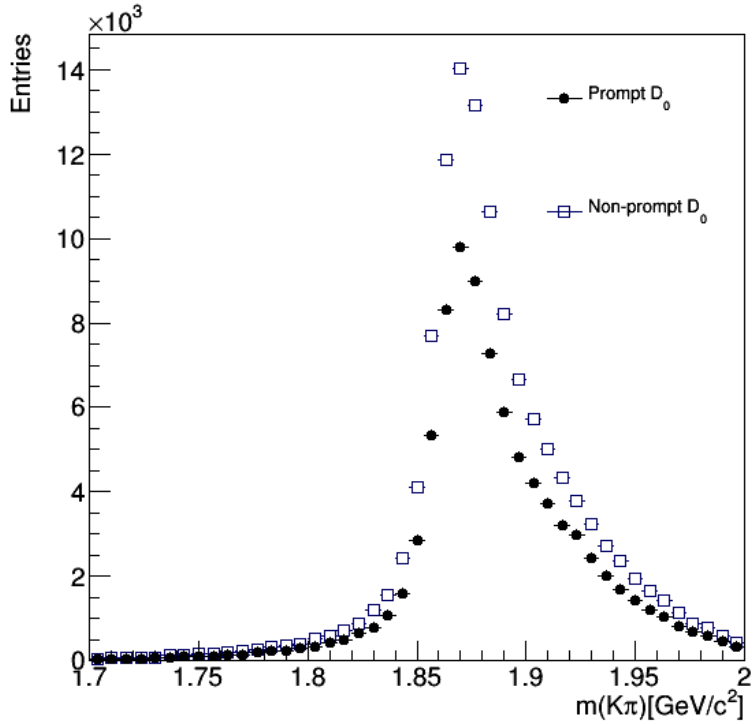
Reconstructed invariant mass

- **Truth matching cuts:**
  - Truth vertex positions matching
  - Track truth ID matching track PDG ID
  - Parent ID = 421



The effect of many particles decay?

- **Truth matching and Gen mass cuts:**
  - Truth vertex positions matching
  - Track truth ID matching track PDG ID
  - 1.864854 < Gen mass < 1.864860
  - Parent ID = 421



DCA distributions

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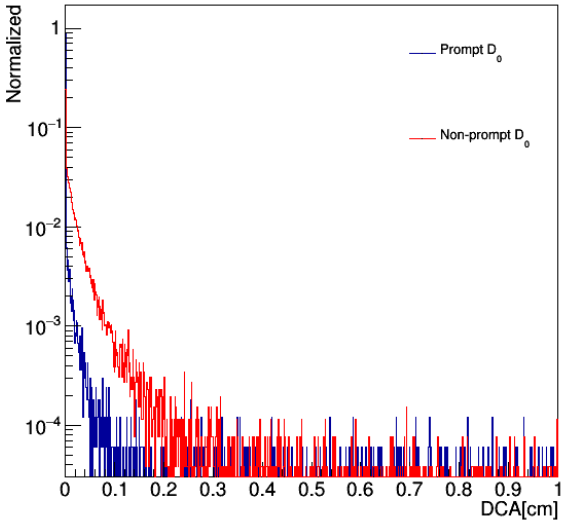
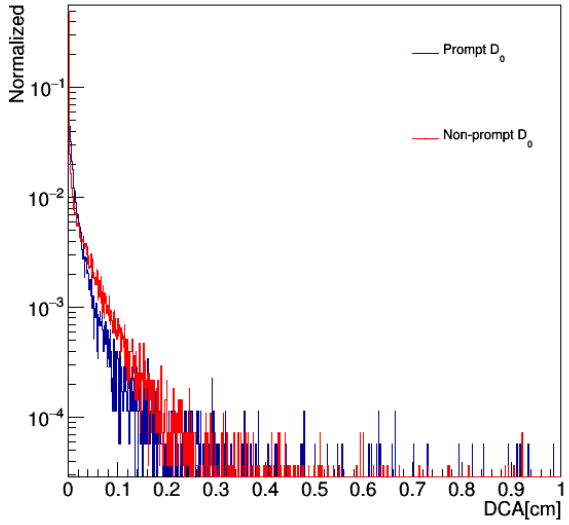
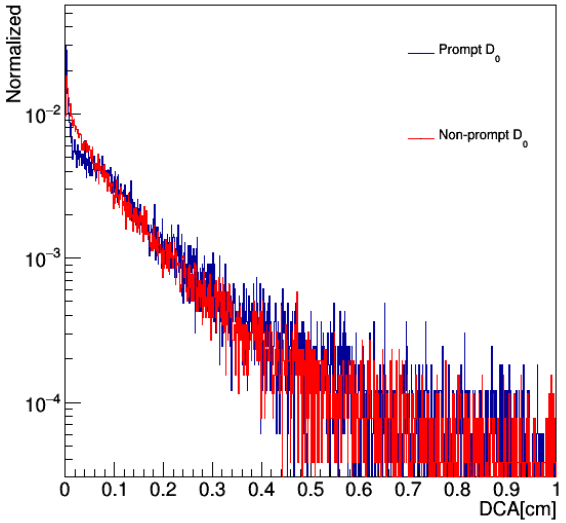


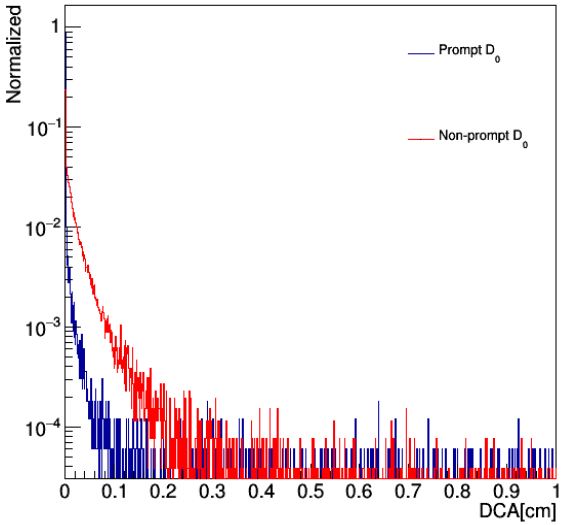
Truth DCA



DCA using True secondary vertices and Reco primary vertices



DCA using Reco secondary vertices and True primary vertices



DCA using True secondary vertices, True primary vertices and Reco momentum

DCA distributions

- **Truth matching and Gen mass cuts:**
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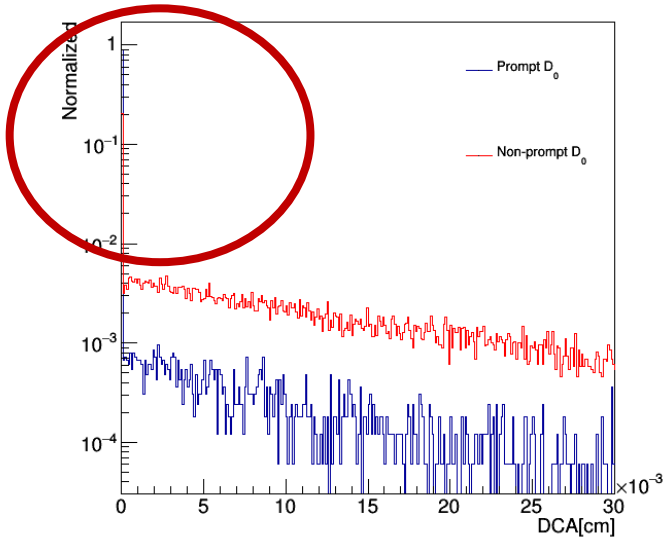
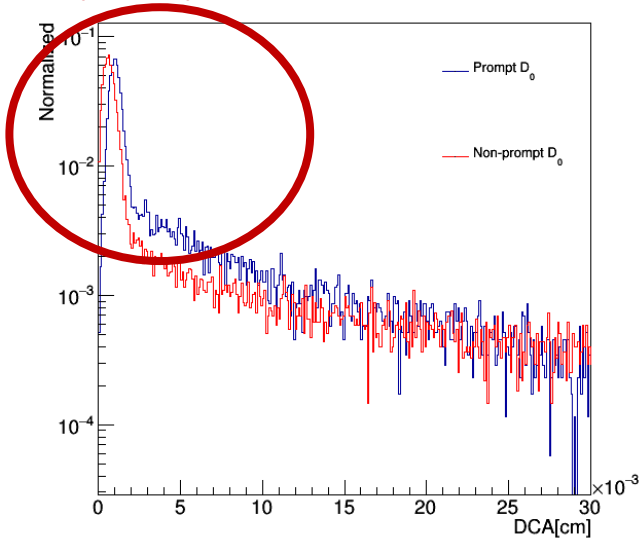
The truth DCA of Prompt D0 has a long tail and Non-Prompt D0 has a peak at 0.

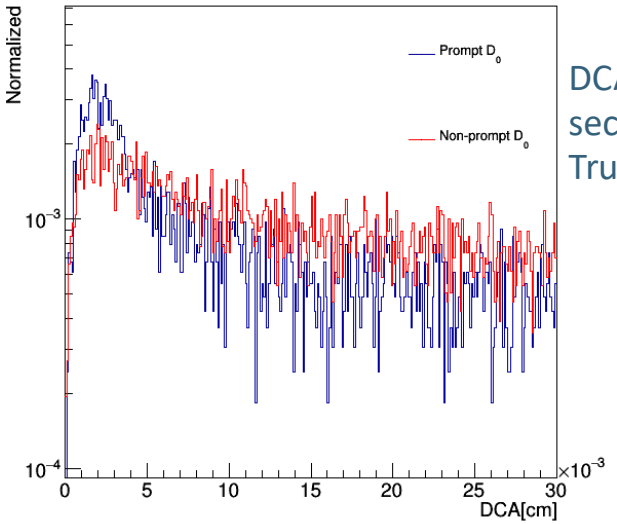


Truth DCA

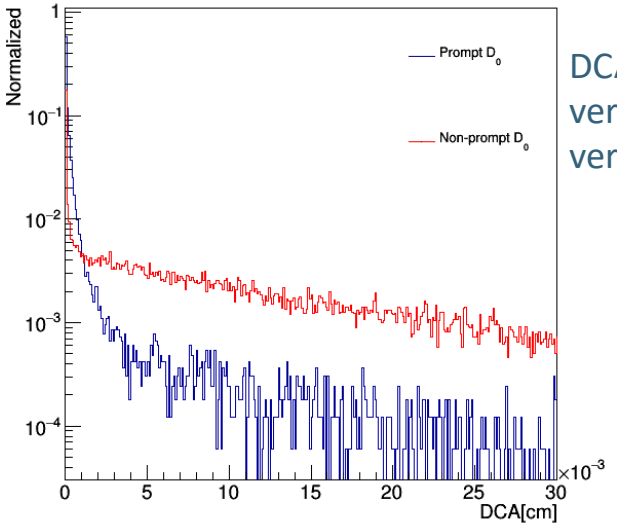
The DCA of Prompt D0 shifts more than Non-prompt D0.
The major issue comes from Reco primary vertices.



DCA using True secondary vertices and Reco primary vertices



DCA using Reco secondary vertices and True primary vertices



DCA using True secondary vertices, True primary vertices and Reco momentum

DCA distributions

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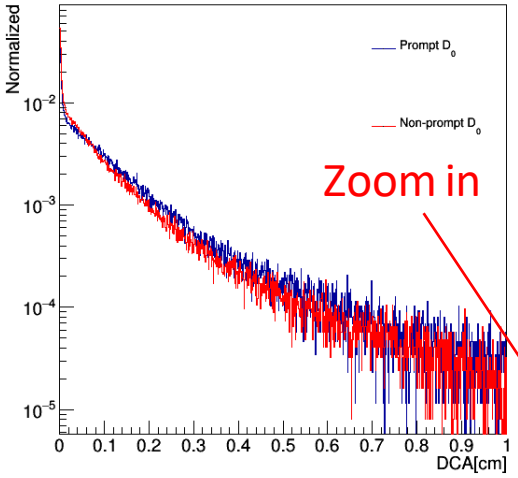
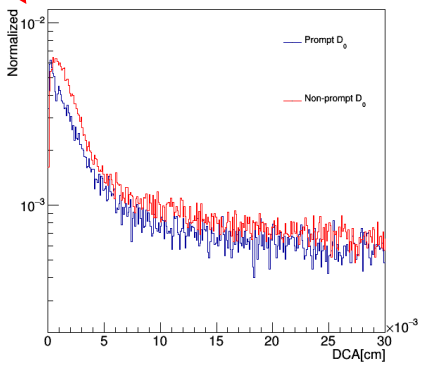
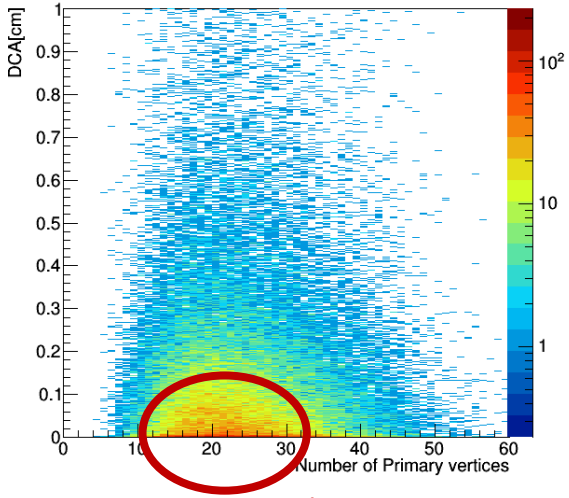


Zoom in

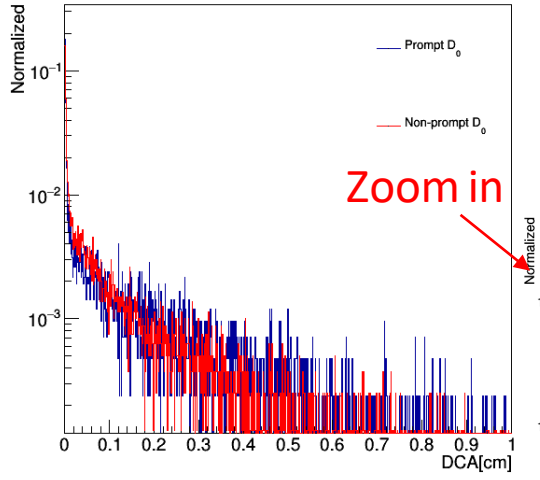


Reconstructed DCA using all number of primary vertices

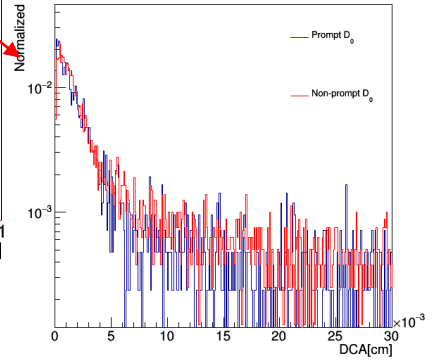


Most events (DCA around zero) have several primary vertices
Is this a bug from core software?

- **Truth matching, Gen mass and Topological cuts:**
  - Truth vertex positions matching
  - Track truth ID matching track PDG ID
  - 1.864854 < Gen mass < 1.864860
  - Parent ID = 421
  - $trk.\chi^2 < 4$
  - $trkIP\ \chi^2 > 1$
  - $\chi^2_D < 2$
  - FD $\chi^2 > 80$



Zoom in



The two distributions look similar

Conclusion

- We saw the effect of many particles decay, compared with invariant mass distributions with and without Gen mass cut
- The number of primary vertices is too large around 20 or so. Is
- The truth DCA of Prompt D0 has a long tail, and Non-Prompt D0 has a peak at 0. Furthermore, if we replace the true primary vertices with Reco primary vertices, the DCA distribution of Prompt D0 shifts more than the Non-prompt DCA does