sPHENIX experience with KFParticle

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EPIC reconstruction meeting

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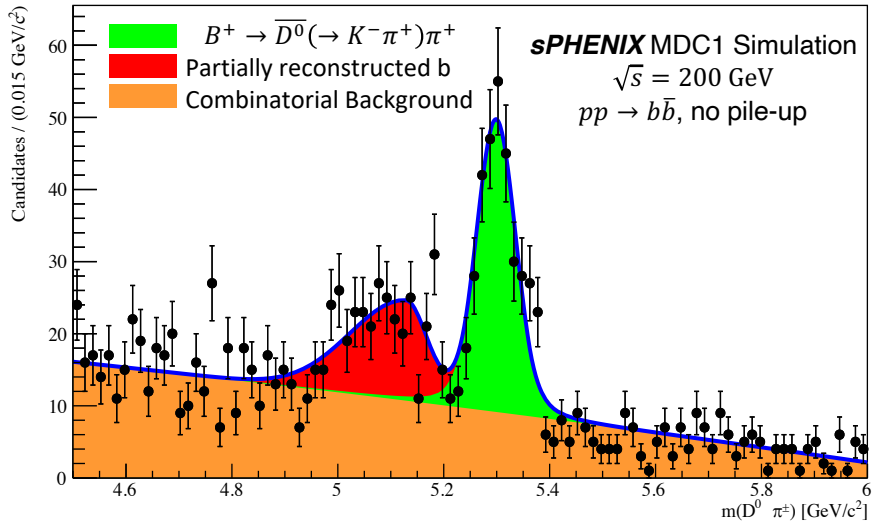
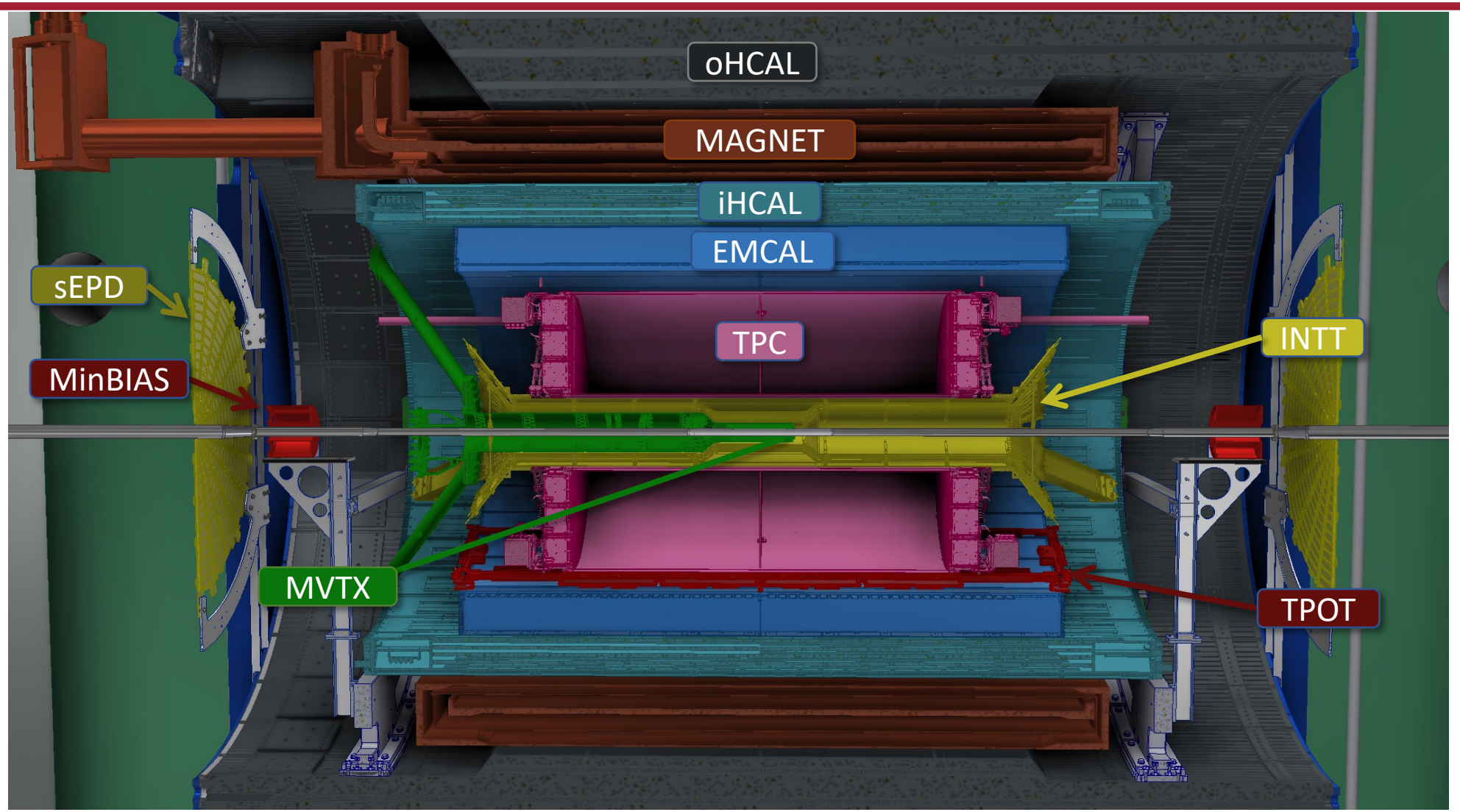
Overview

- sPHENIX is a dedicated heavy-ion experiment at RHIC
  - Assume most people are familiar with sPHENIX so will only highlight key features
  - All trackers capable of streaming readout
  - Calorimeters don't stream
  - No PID (in initial design)
- KFParticle has been integrated into sPHENIX framework
  - Most of the work done during the start of the pandemic in 2020
  - Core mechanics remains the same
  - sPHENIX wrapper to account for no PID

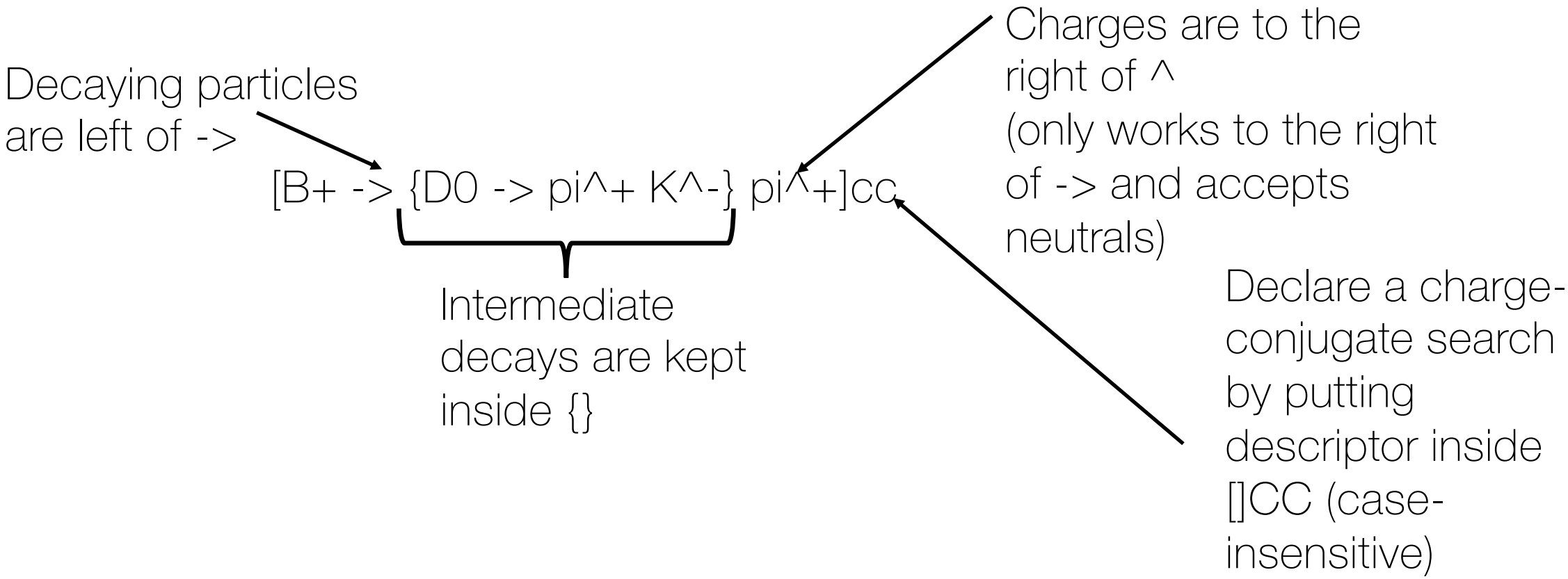


Simulated b-hadron reconstruction with KFParticle at sPHENIX

The sPHENIX detector

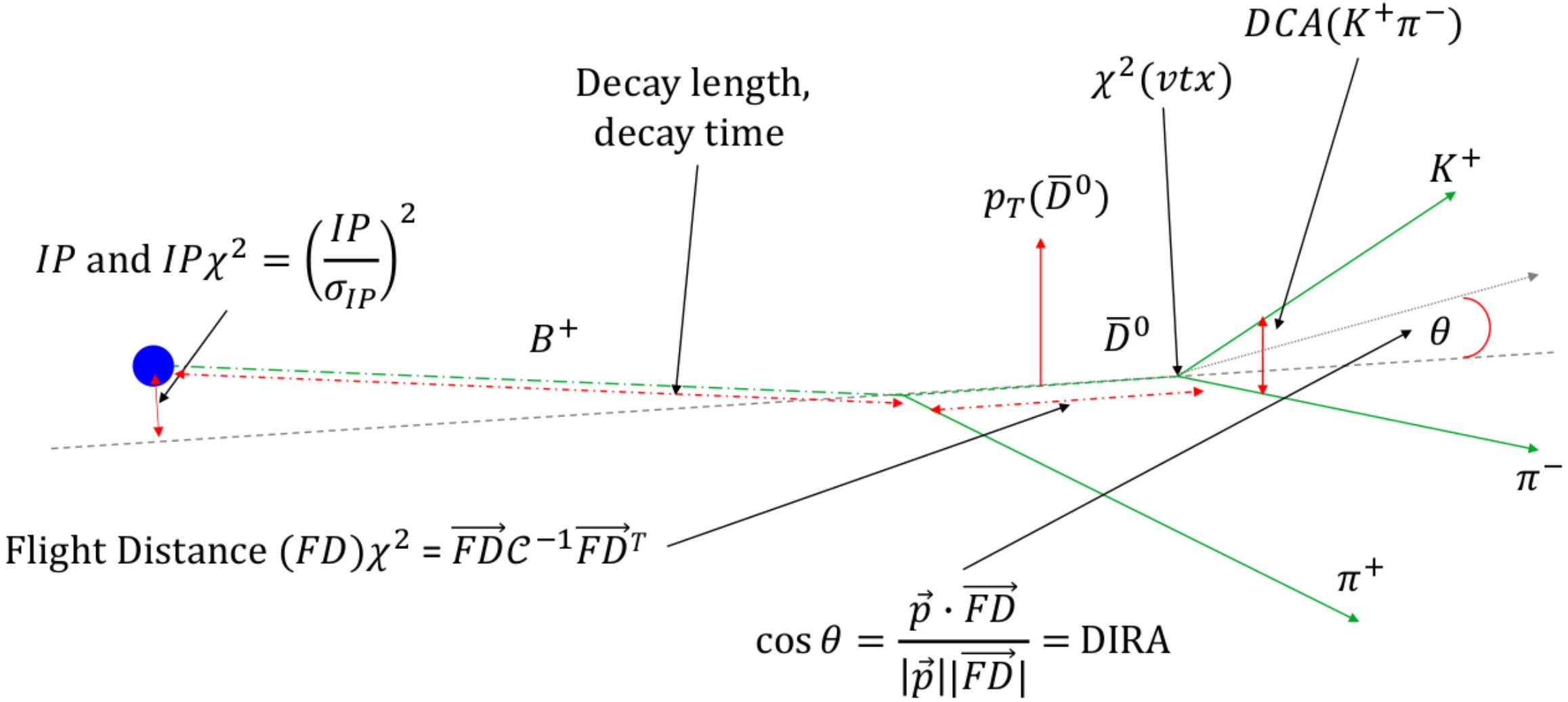


Decay Parser



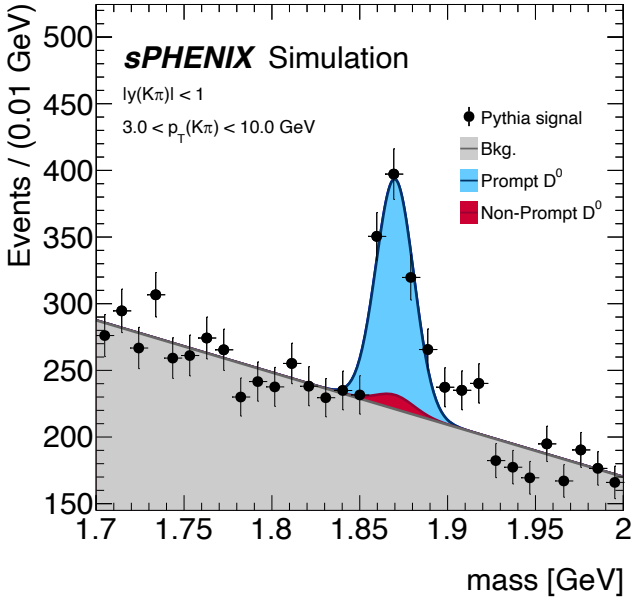
Parser uses TDatabasePDG table, anything ROOT understands, we can understand!

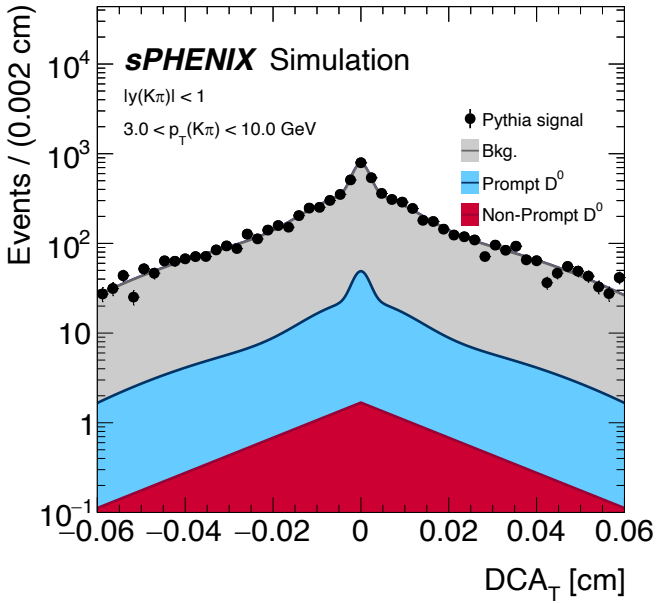
Decay Topology

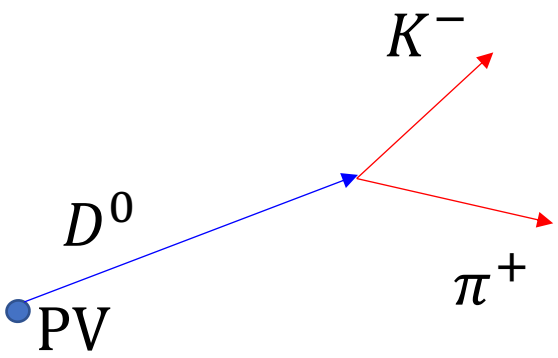


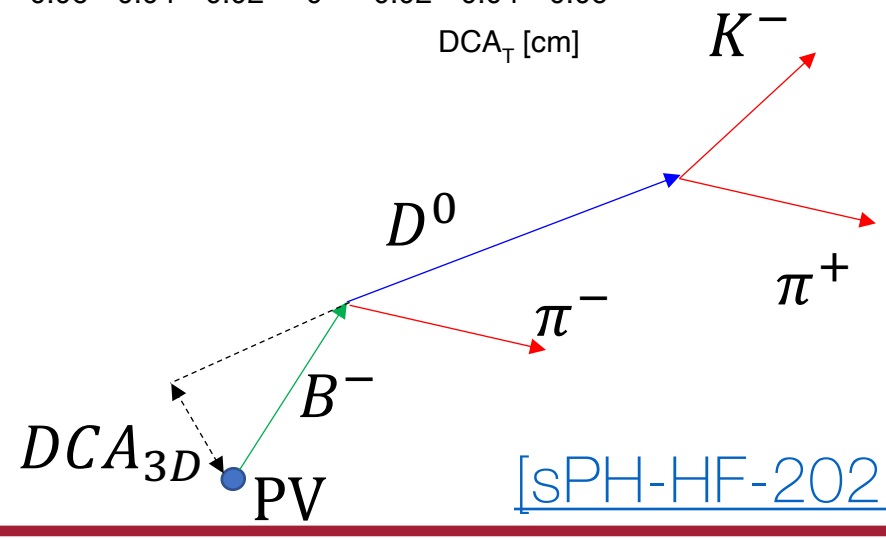
Prompt/non-prompt separation

- Automatic calculation of DCA and 2D DCA allows for prompt/non-prompt separation
  - Can also be used with other variables (decay length, pointing angle) to improve purity









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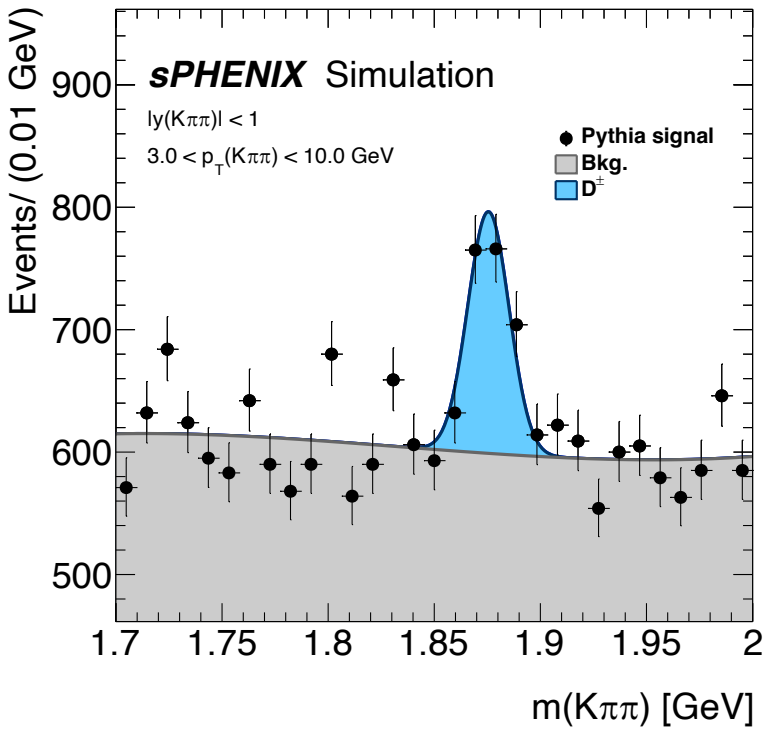
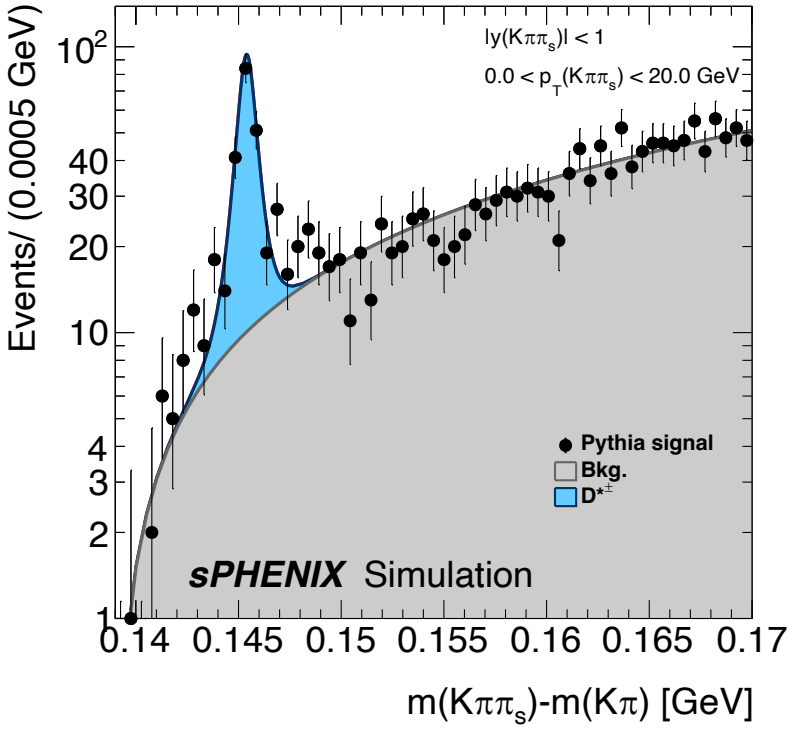
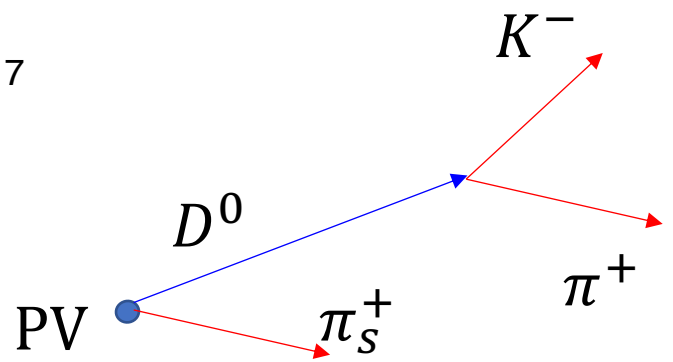
Resonance tagging





- D^{*+} decays promptly
- Requires good handle on PV, SV and tracking
- In PDG: $\mathrm{m(K\pi\pi_s)} - \mathrm{m(K\pi)} = 145.426(2)$
- Easily handled by KFParticle



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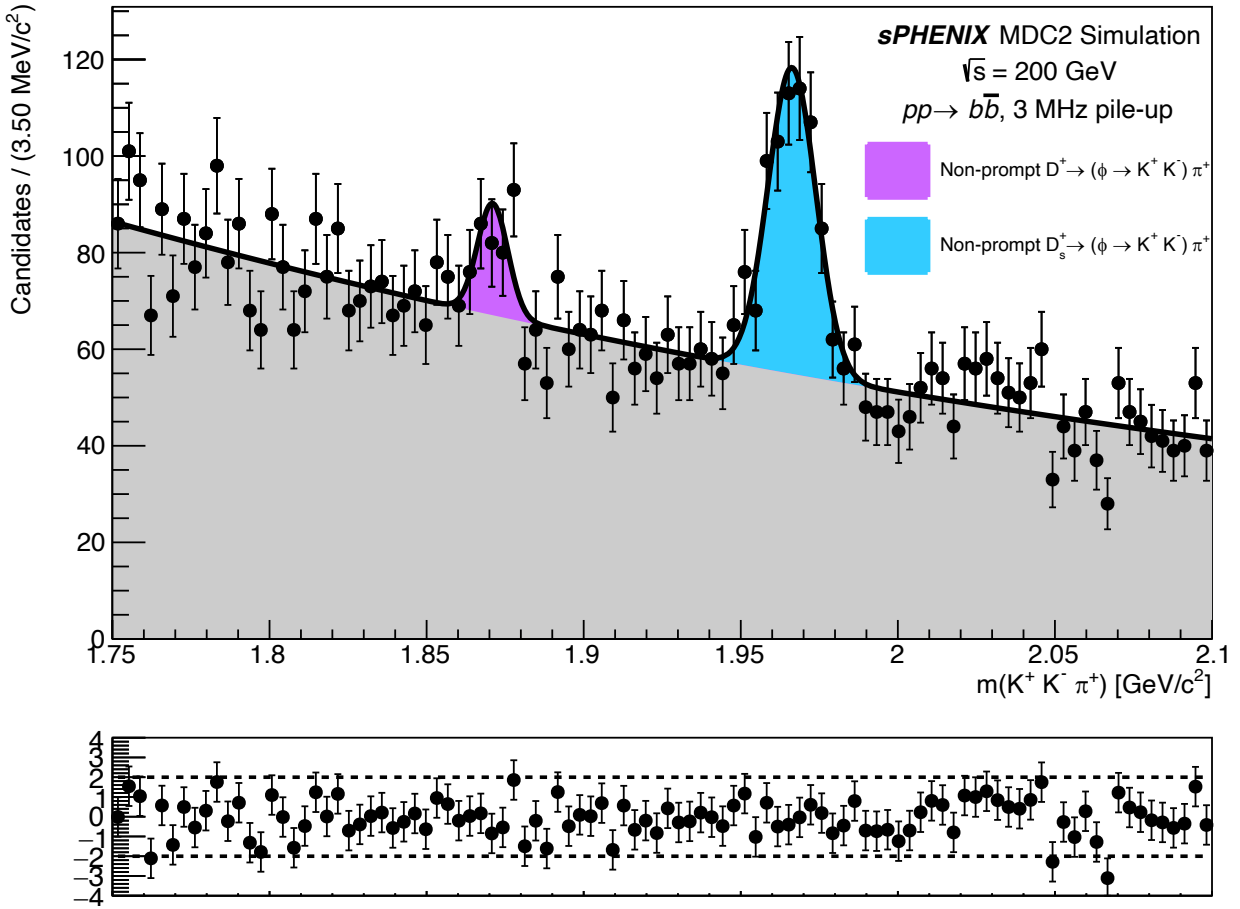
Mass resolution



Mass resolution is very good, easy separation of D^+ and D_s^+

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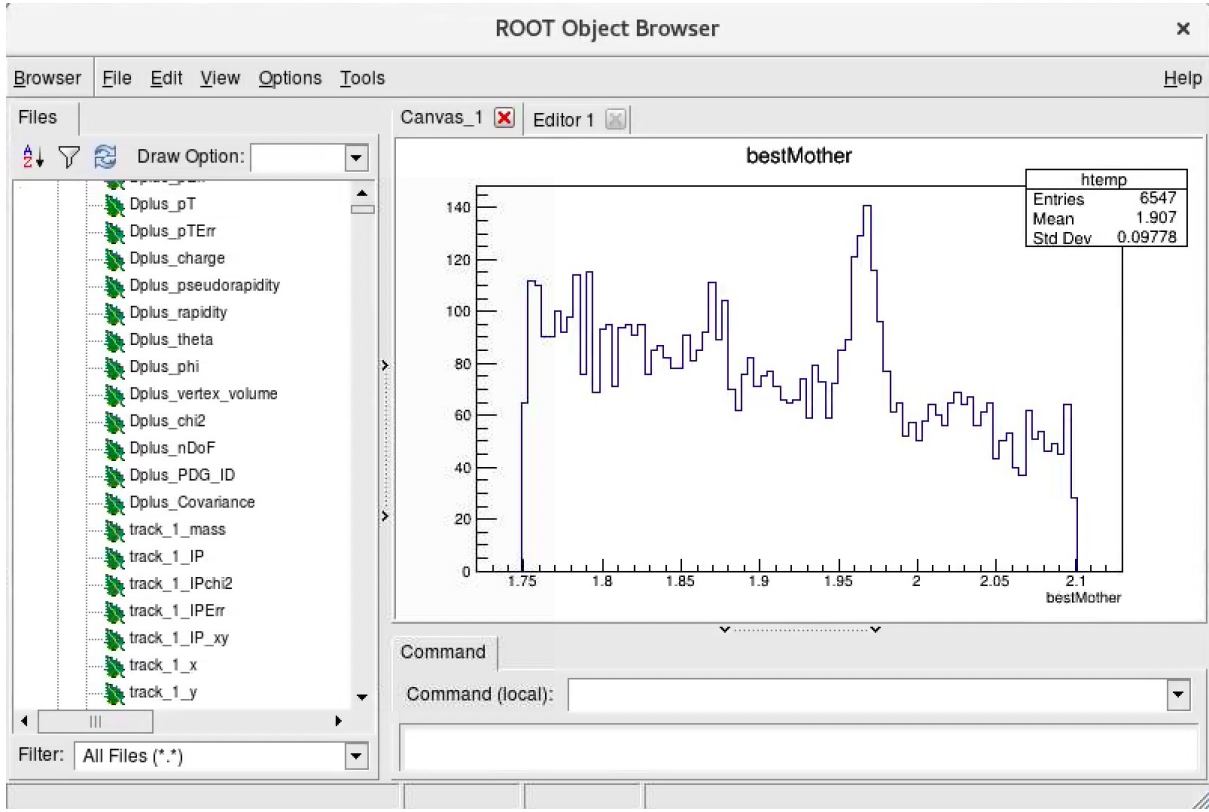
Outputs

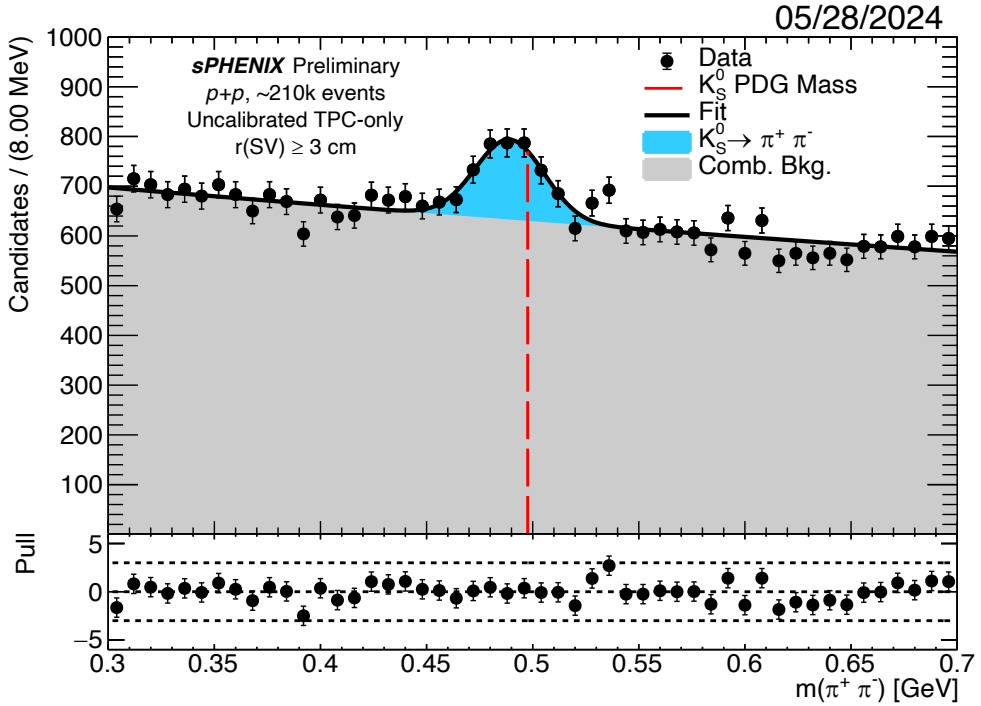
- 2 output options at sPHENIX
  - nTuple, allows for immediate analysis
  - Container creation
- Containers allow us to store candidate for later use
  - Can run during file production
  - Can be used for triggering (by checking the container is not empty)
  - Can interface with down stream analysis (particle flow)
  - Can be passed to QA for run-by-run checks
- All 4 uses of containers have been tested at sPHENIX

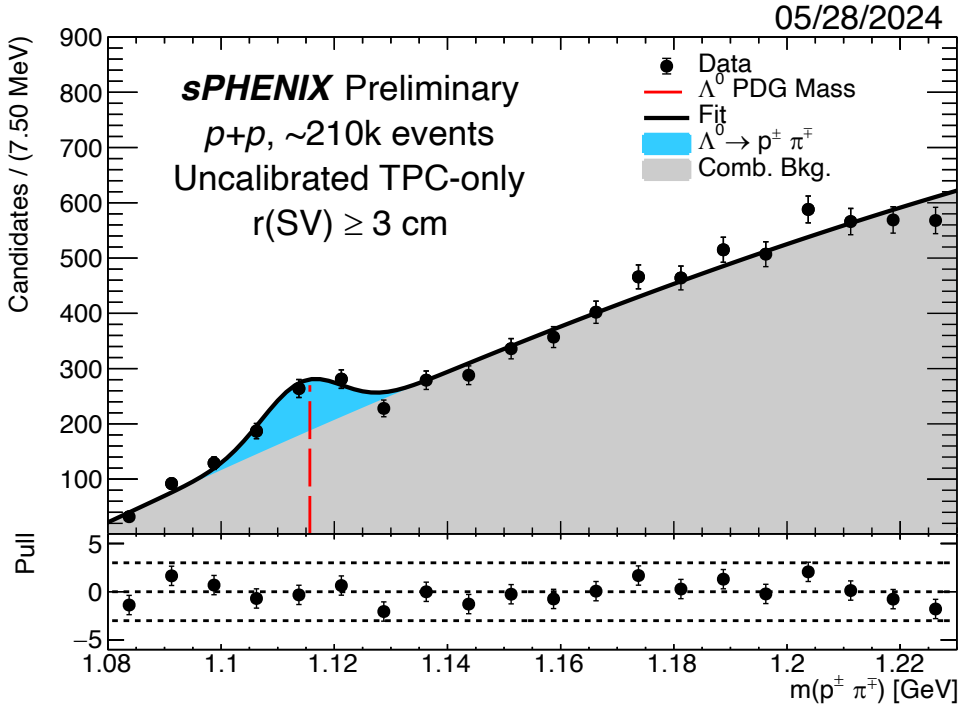


Real reconstruction at sPHENIX

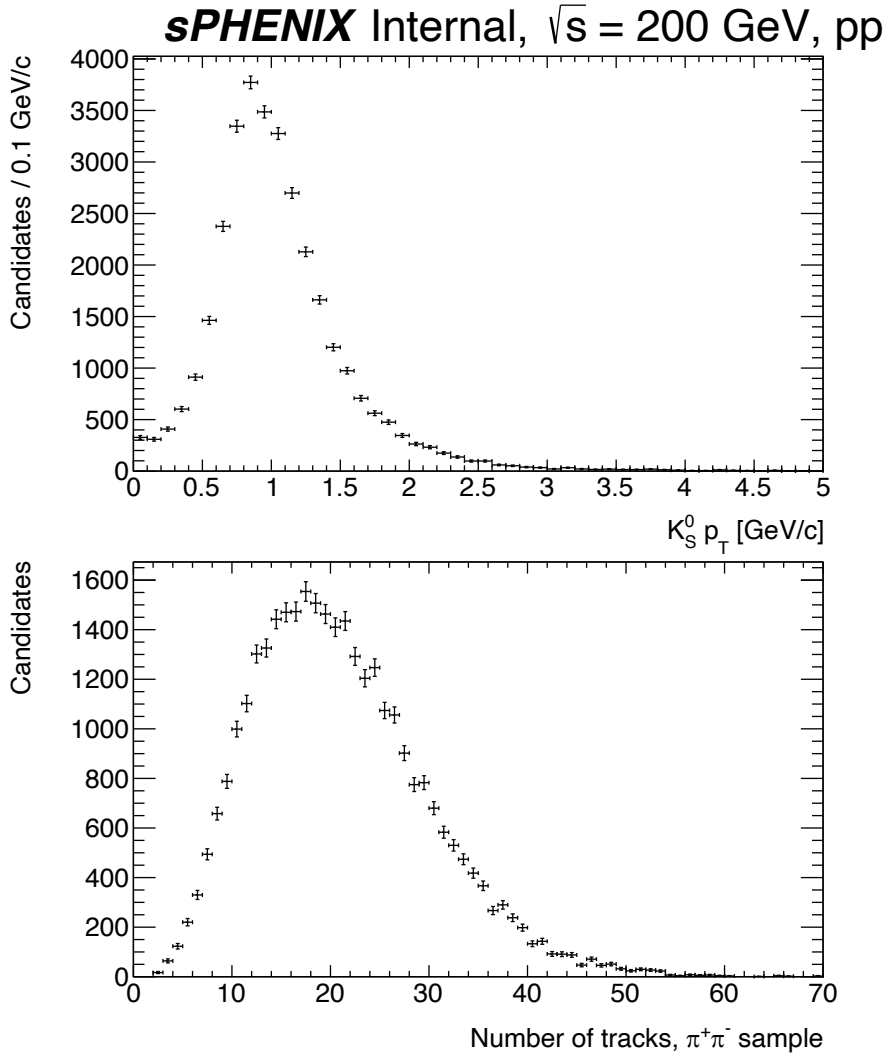
https://www.sphenix.bnl.gov/PublicResults

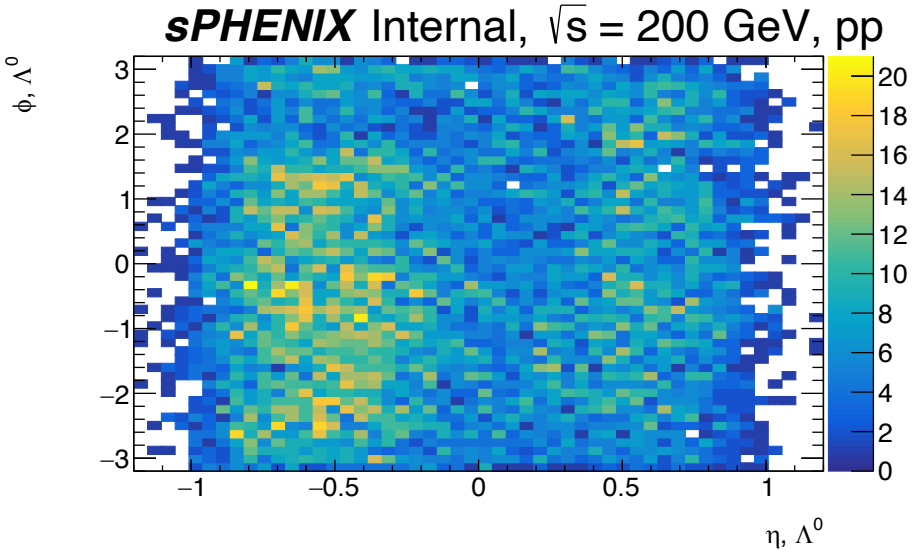
- KFParticle was deployed at sPHENIX on a short run using just our TPC
  - Collected about 210,000 events
  - TPC was uncalibrated
  - No primary vertexing was performed





Real reconstruction at sPHENIX





Top left – Reconstructed $\mathbf{K^0_S}$ pT spectrum
Bottom left – Number of reconstructed tracks per event
Top right - $\mathbf{\Lambda^0}$ η/ϕ distribution

Conclusion

- KFParticle is successfully deployed at sPHENIX
  - Made some interesting wrapper choices to overcome no a priori PID
- General package infrastructure is easy to use
- Next steps:
  - Full charm reconstruction
  - Applying to new areas of our heavy flavor program:
    - Development of a generic secondary vertex tagger
    - Started on Monday
    - Also performs PV reconstruction
    - Requires no exclusive decay information (independent of number of tracks from SV)
    - Preliminary (last night) results: ~95% efficiency for selecting charm decay tracks away from PV
    - Around 10 to 30% rejection of primary tracks (next focus is to improve primary rejection to 80+ %)