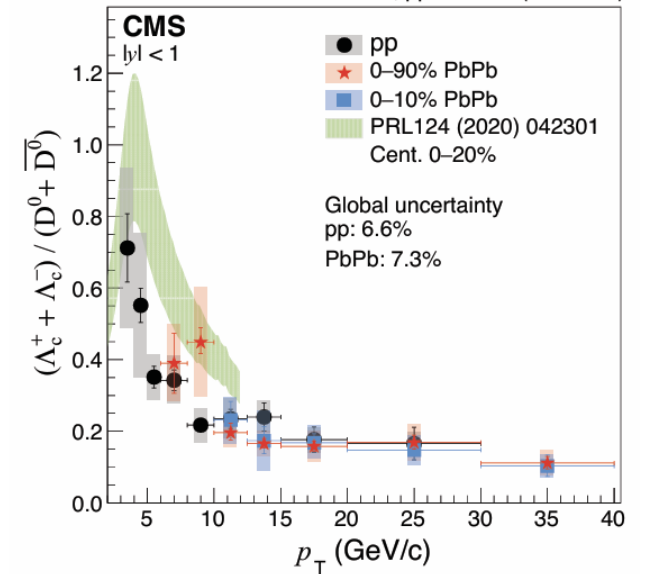
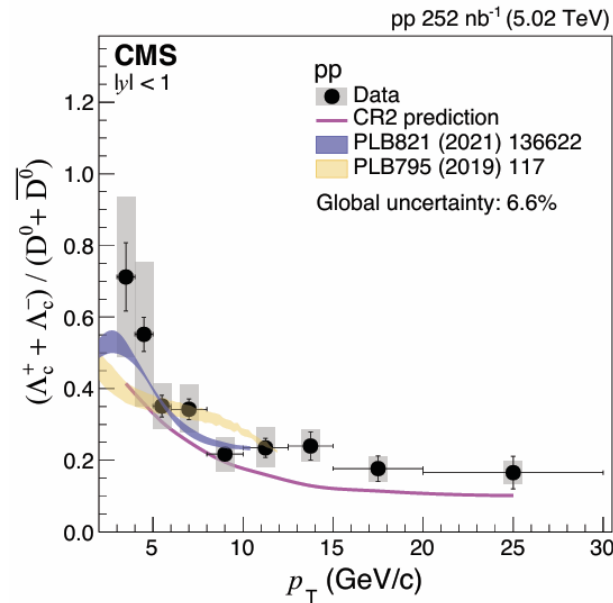
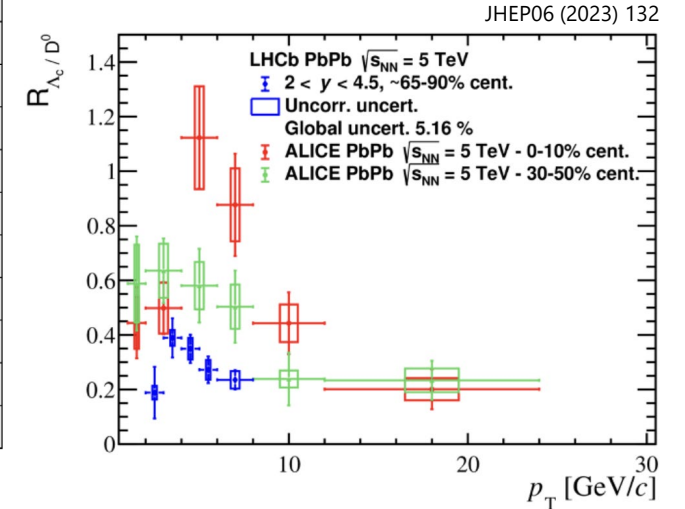
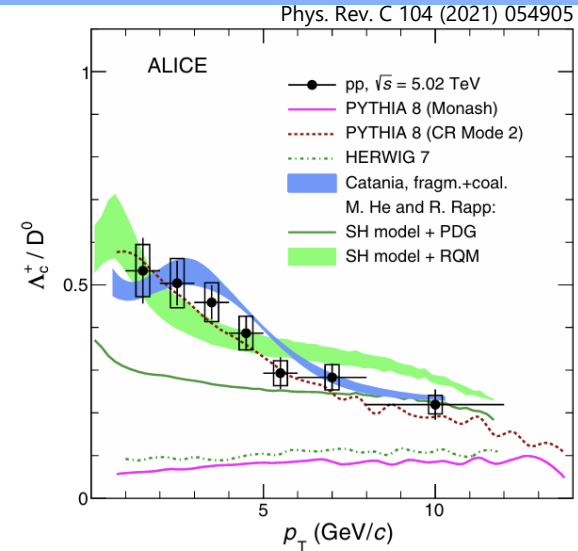


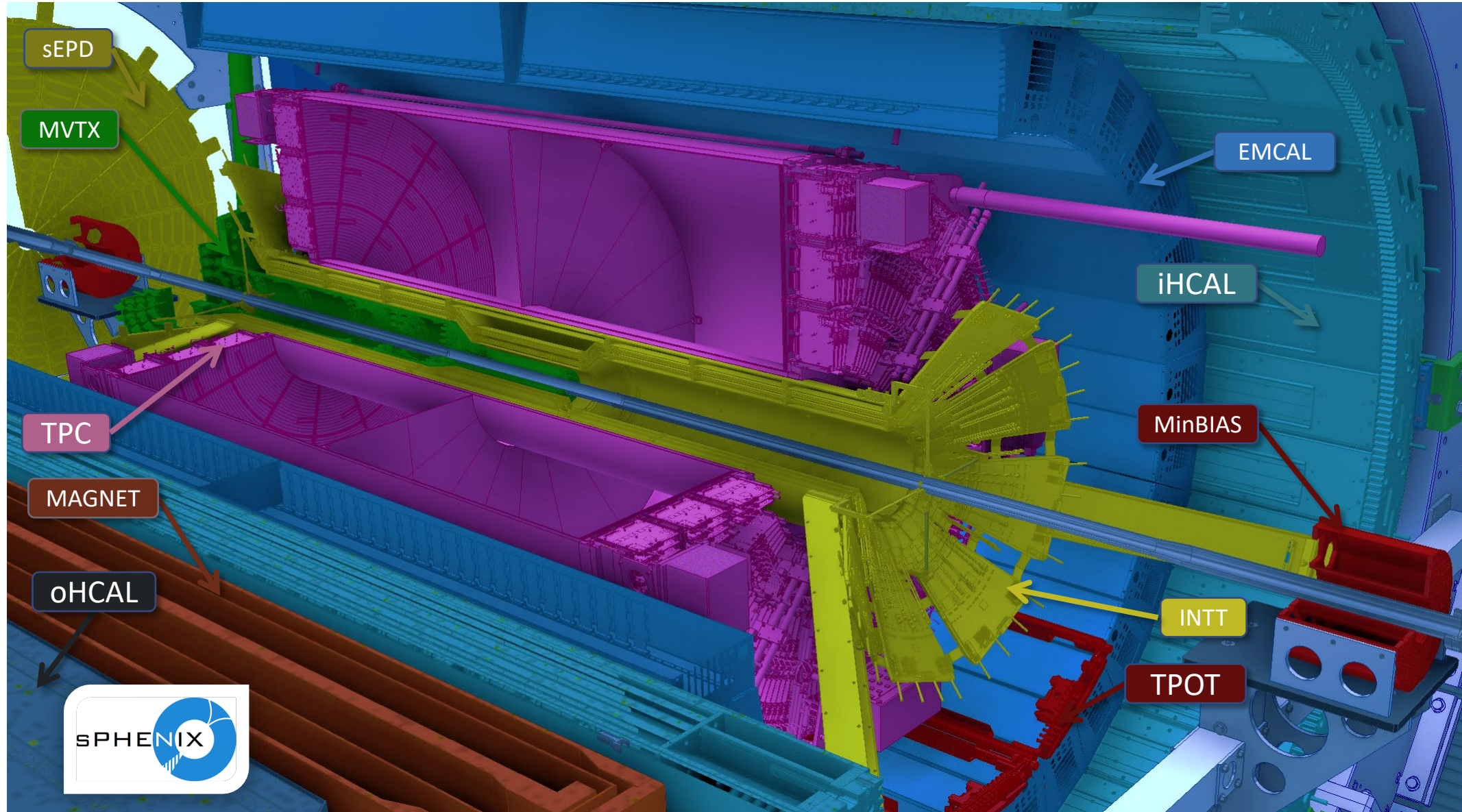
Progress Towards an sPHENIX Measurement of Open-Charm Baryon-to-Meson Ratios in p+p Collisions at RHIC

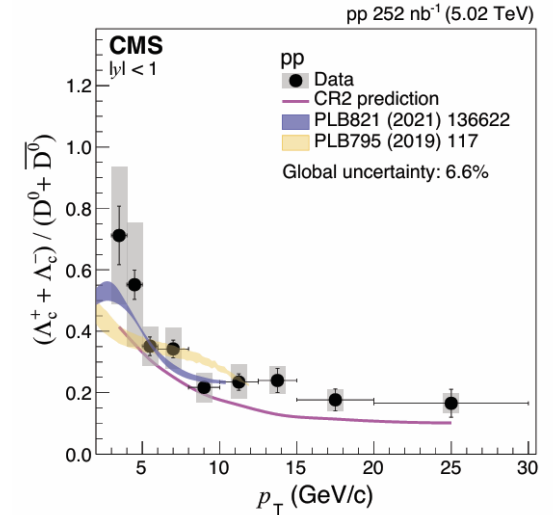
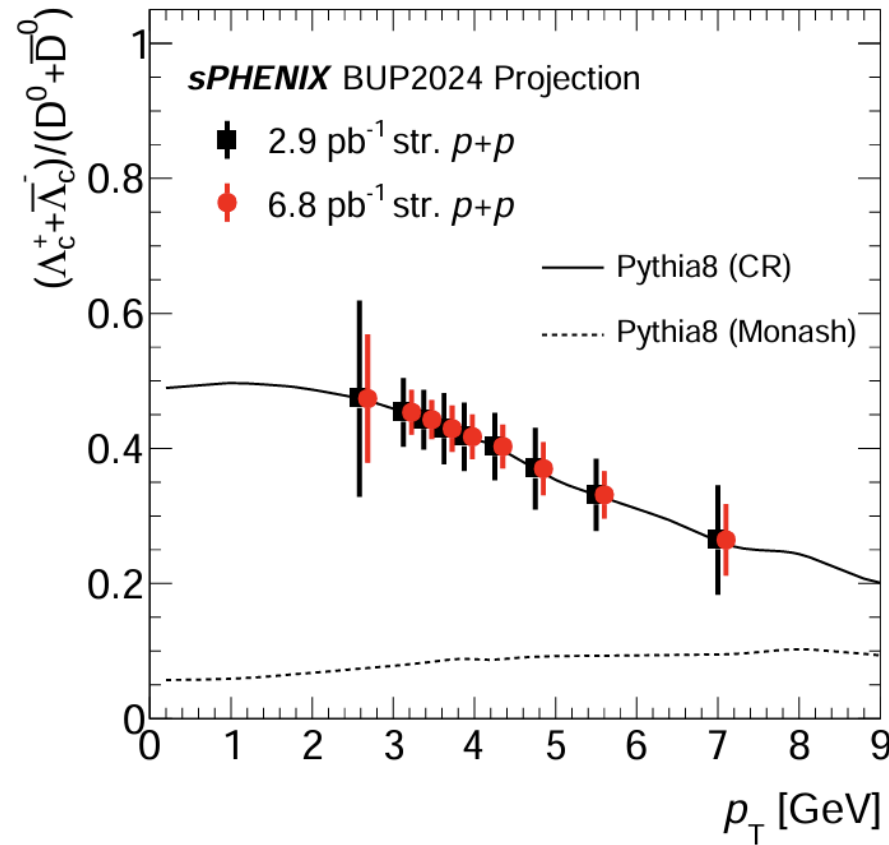
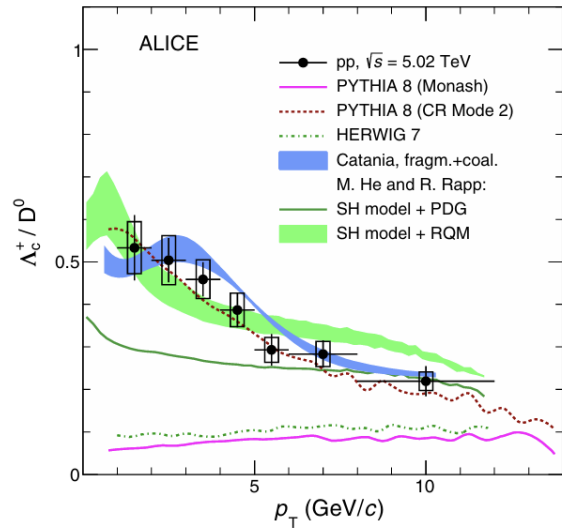
Michael Peters
on behalf of the sPHENIX Collaboration
Initial Stages 2025
Sept. 9, 2025



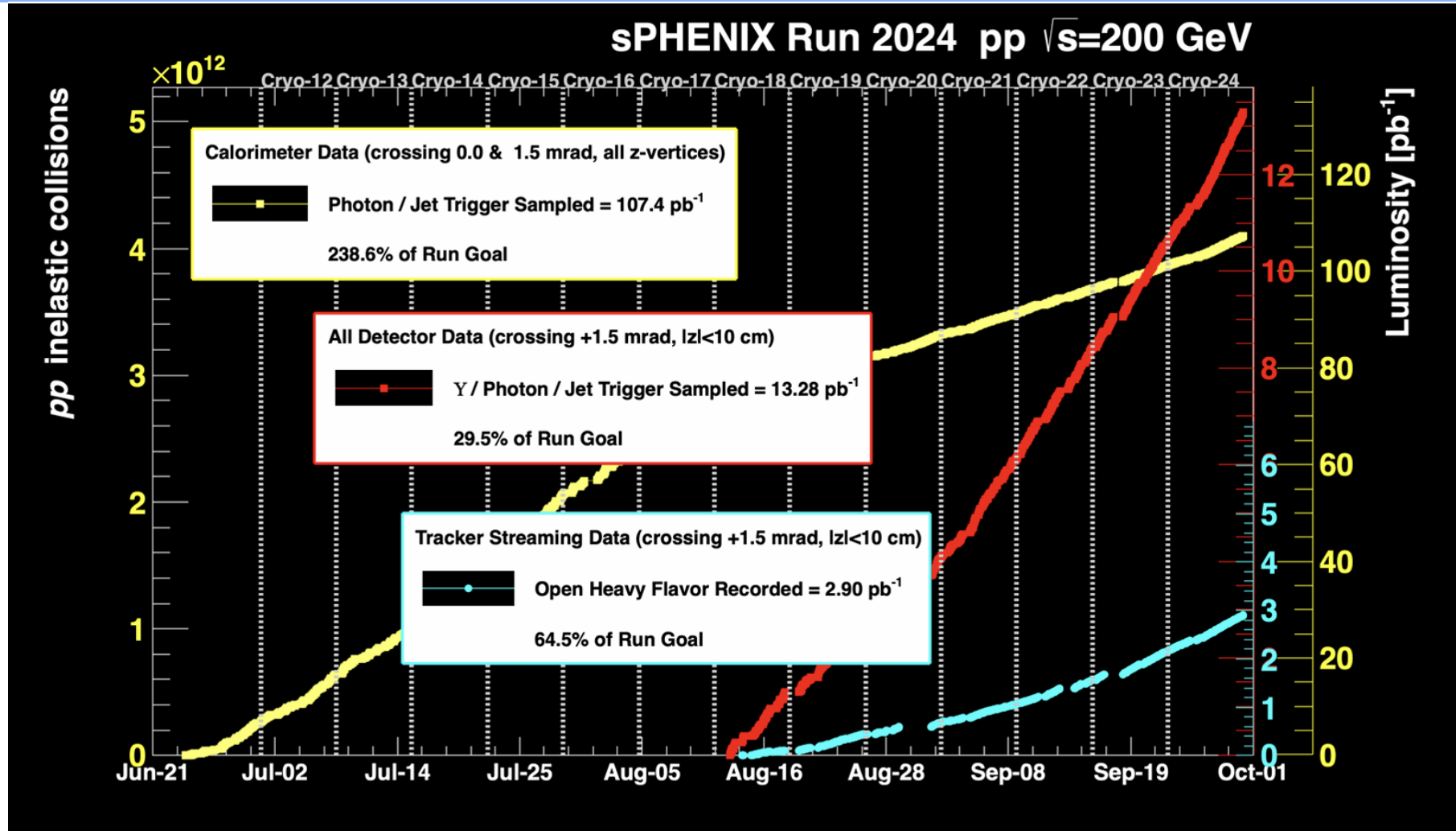
- Open-charm baryon-to-meson ratios impose a powerful constraint on hadronization models in p+p
- Centrality dependence of ratio in heavy-ion collisions under active investigation
- Large uncertainties, particularly at low p_T , indicate plenty of room for unique contribution to measurement space





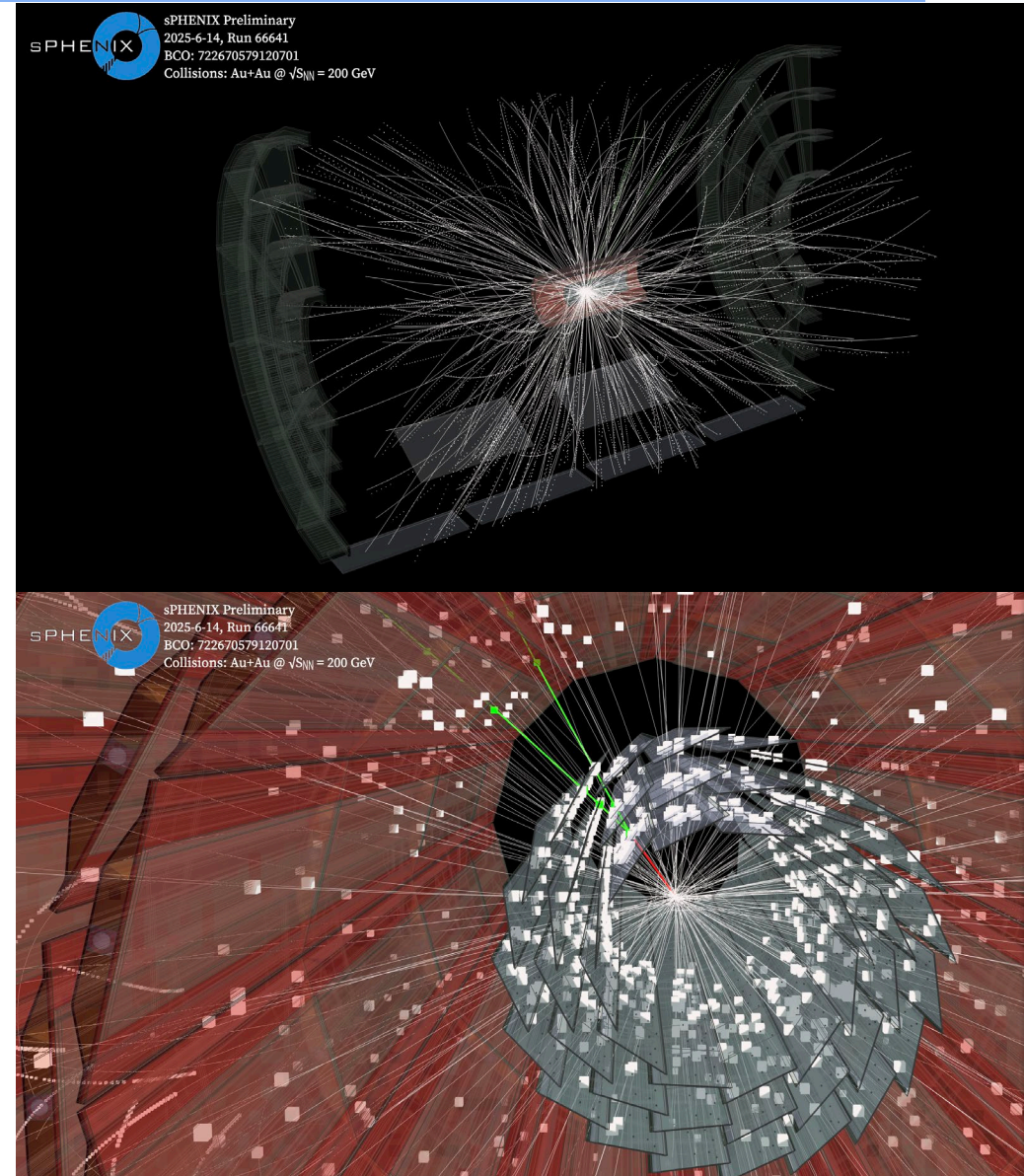


- Streaming-readout tracking (at ~200kHz) allows for unbiased, large open-charm dataset

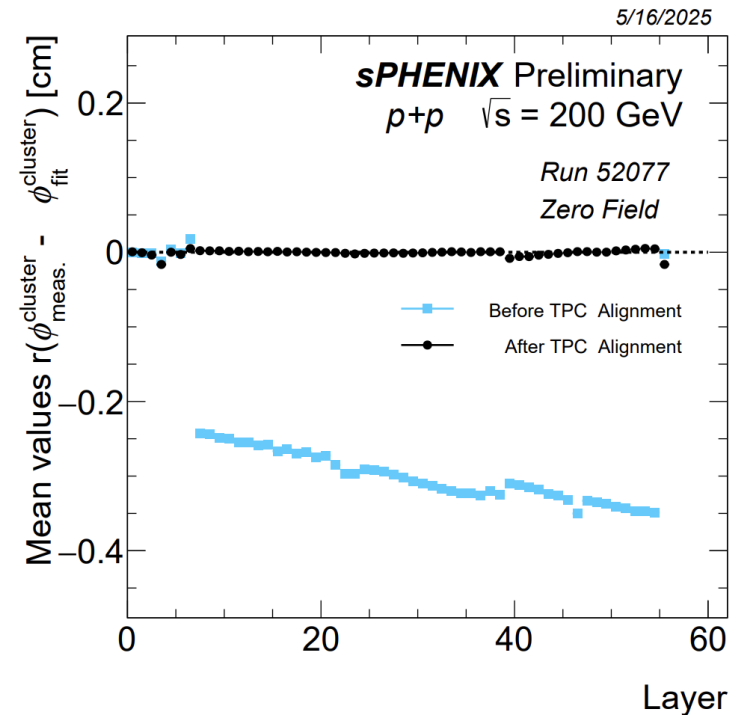
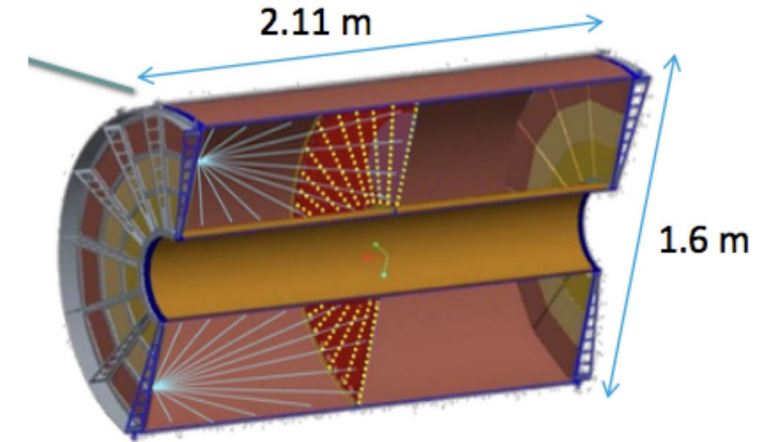


- Delivered luminosity for p+p data-taking in RHIC Run 24 compatible with statistically-viable measurement of baryon-to-meson ratios

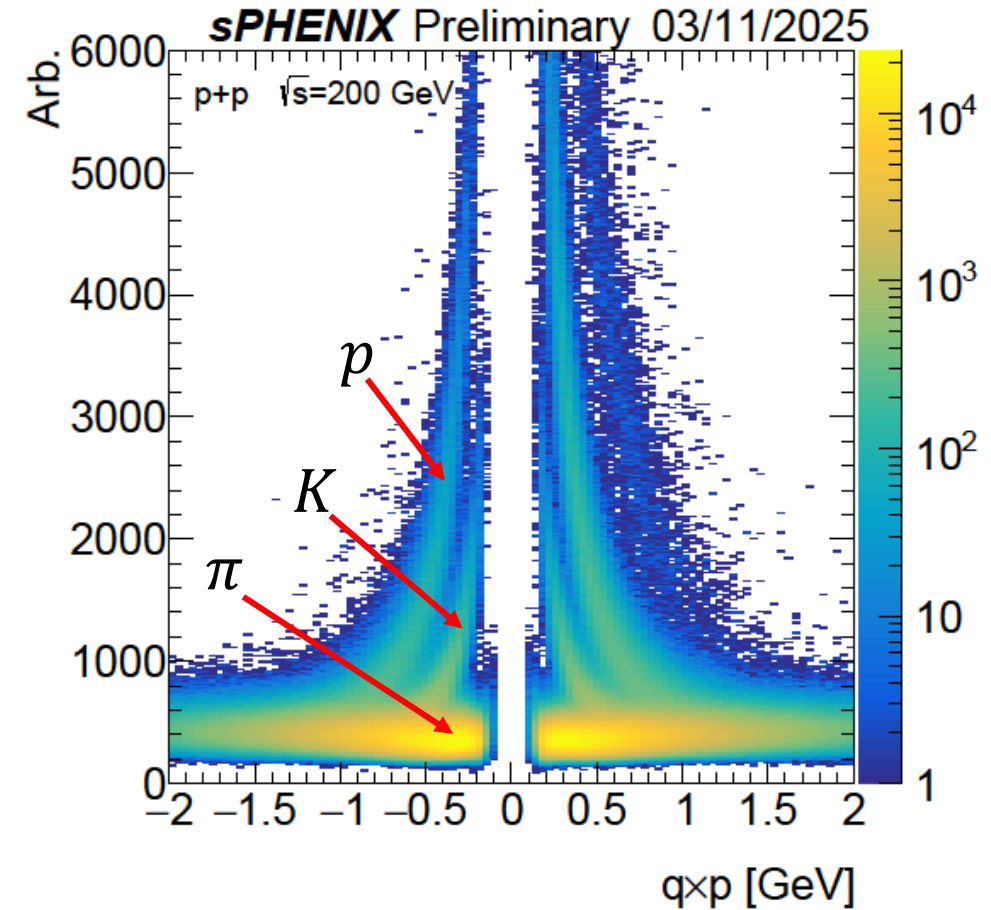
- 55 layers of tracking sensors:
 - 3 layers of MAPS pixel sensors for vertex determination (MVTX)
 - 2 layers of silicon strips for bunch-crossing determination (INTT)
 - 48 layers of TPC pads
 - 2 layers of MicroMegas for TPC calibration (TPOT)
- Seeding done separately in silicon and TPC, matched afterwards
- Matched seeds fitted using A Common Tracking Software (ACTS) Kalman filter
- Streaming-readout data taking ($\sim 200\text{kHz}$) in p+p collisions

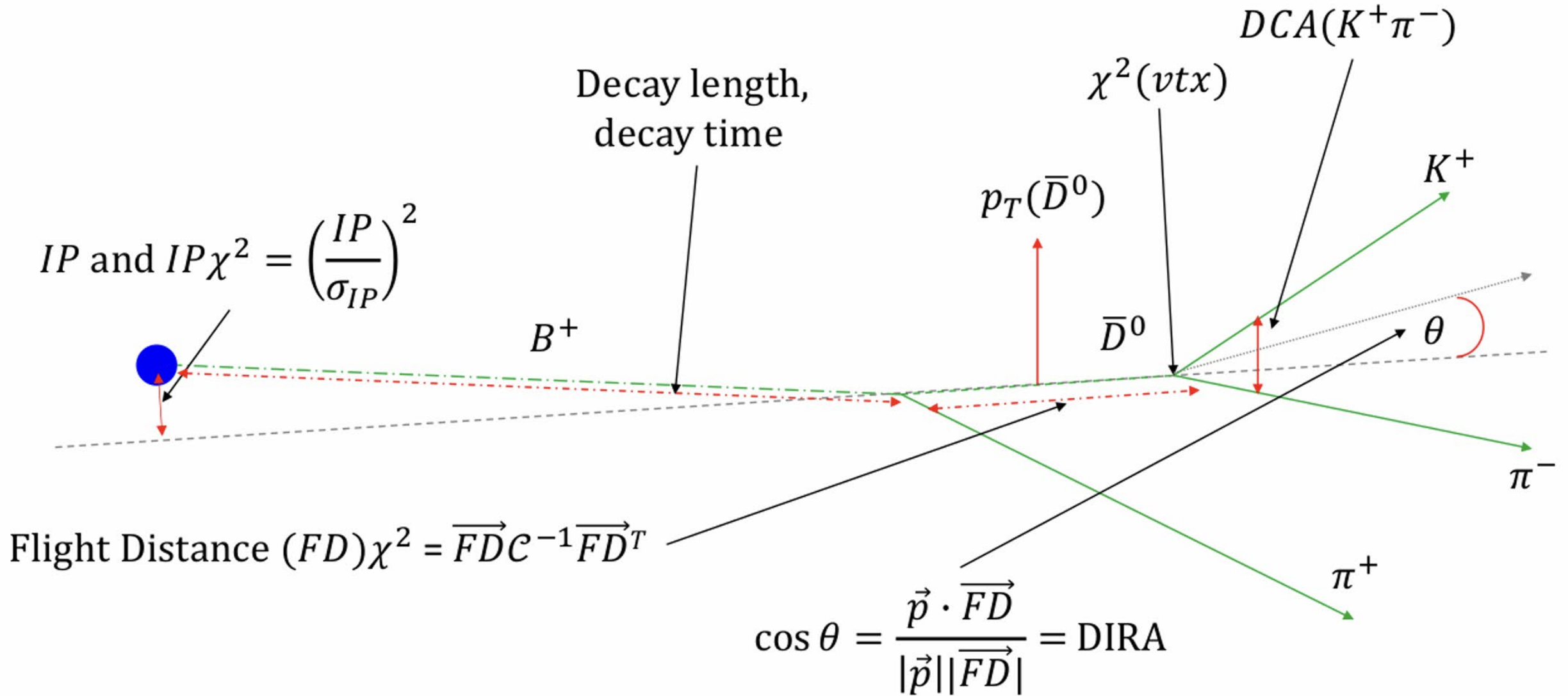


- In parallel with ongoing data-taking, calibration efforts for all tracking detectors:
 - Alignment of all detectors using cosmic tracks and collision data
 - Measurement and correction of distortions in TPC using:
 - Residuals using silicon and TPOT space points
 - Laser flashes (line and diffuse)
 - Digital current fluctuations
 - TPC gain calibration
 - MVTX threshold tuning
 - INTT ADC and timing calibration
 - Identification of dead regions
 - Masking of hot channels
- Continual efforts to improve our understanding of the detector and quality of track reconstruction



- Decay reconstruction accomplished using KFParticle
 - Given specified decay mode, finds secondary vertex and parent candidate properties using Kalman-filter-based method
- Output tree includes both parent candidate information and daughter track properties
- TPC dE/dx measurements used to further reduce background
 - dE/dx vs. p spectrum fitted, p , K , π bands extracted
 - Cut on whether dE/dx is within $N\%$ of band center for given track p





Light-Flavor Decays

$$K_S^0 \rightarrow \pi^+ \pi^-$$

$$\Lambda^0 \rightarrow p^\pm \pi^\mp$$

$$\phi \rightarrow K^+ K^-$$

$$\Xi^- \rightarrow [\Lambda^0 \rightarrow p^\pm \pi^\mp] \pi^-$$

$$\Sigma^{*-}(1385) \rightarrow [\Lambda^0 \rightarrow p^\pm \pi^\mp] \pi^-$$

Heavy-Flavor Decays

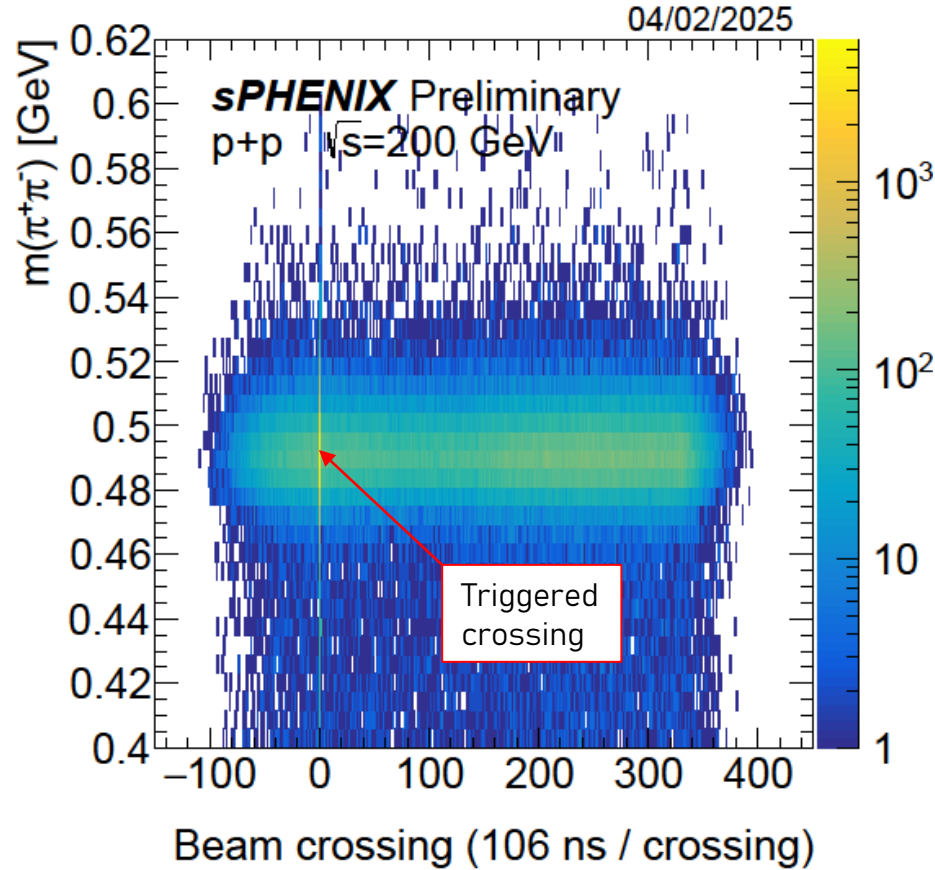
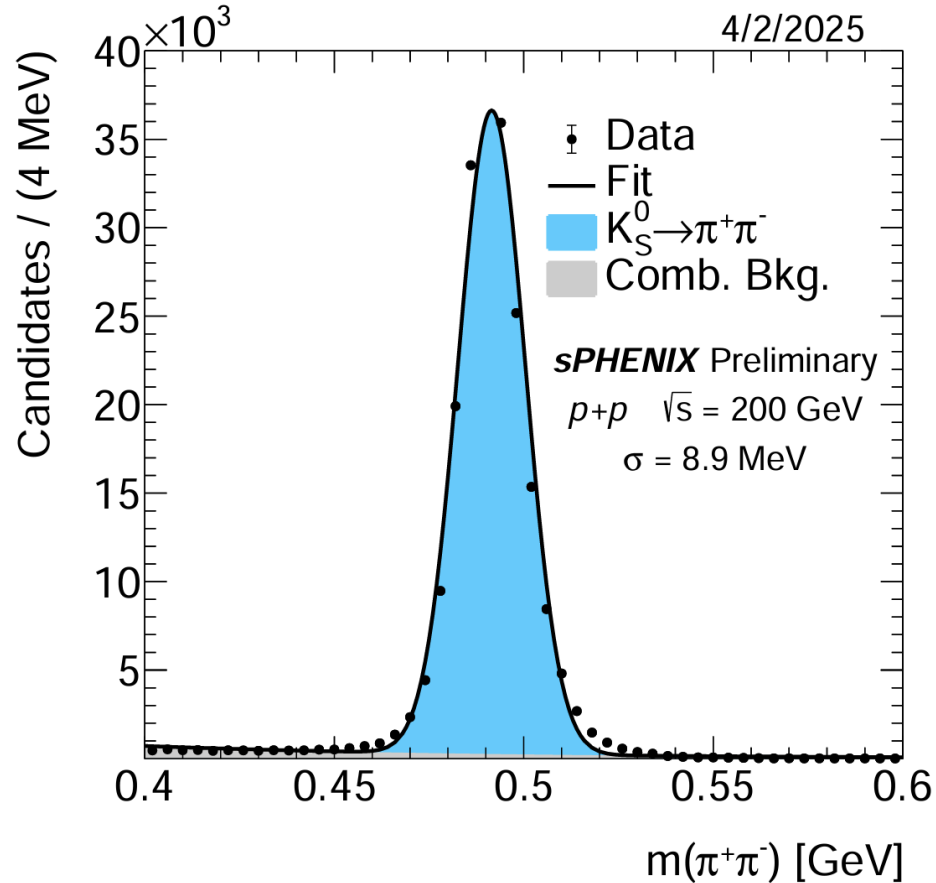
$$D^0 \rightarrow K^\pm \pi^\mp$$

$$\Lambda_c^\pm \rightarrow p^\pm K^\mp \pi^\pm$$

$$D^\pm \rightarrow K^\mp \pi^\pm \pi^\pm$$

First at
RHIC in
p+p!

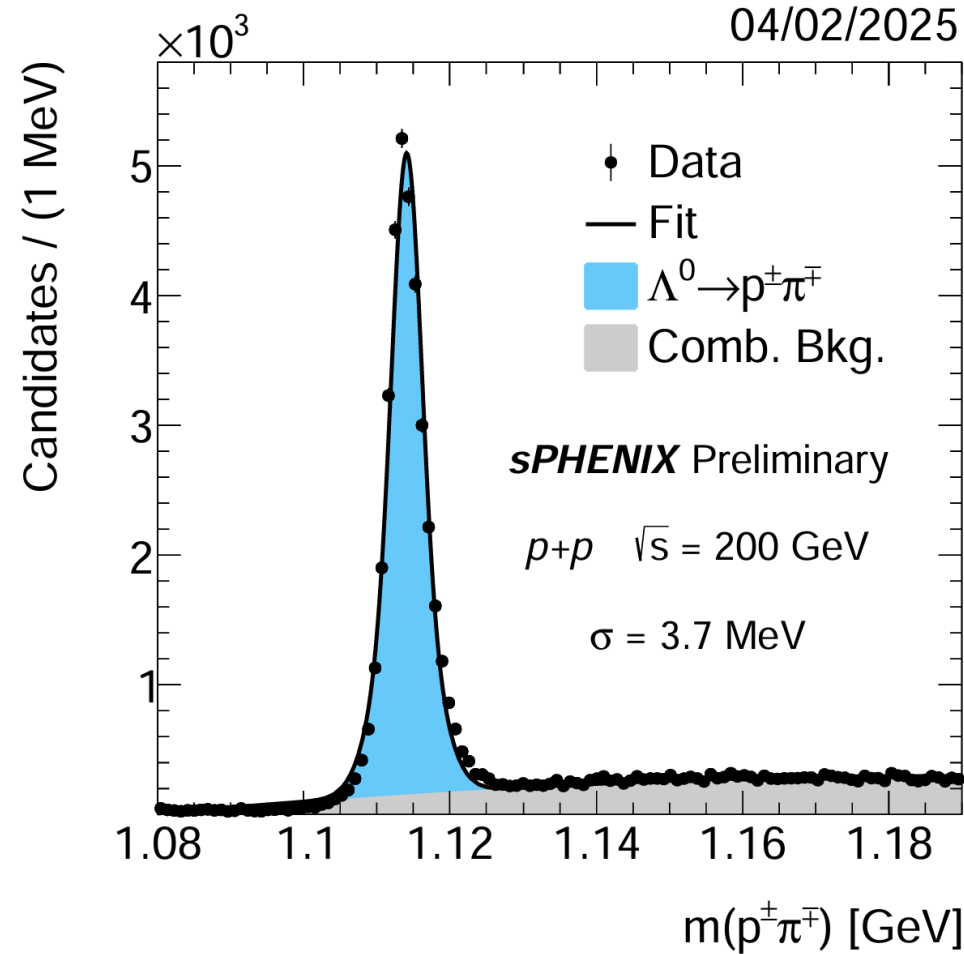
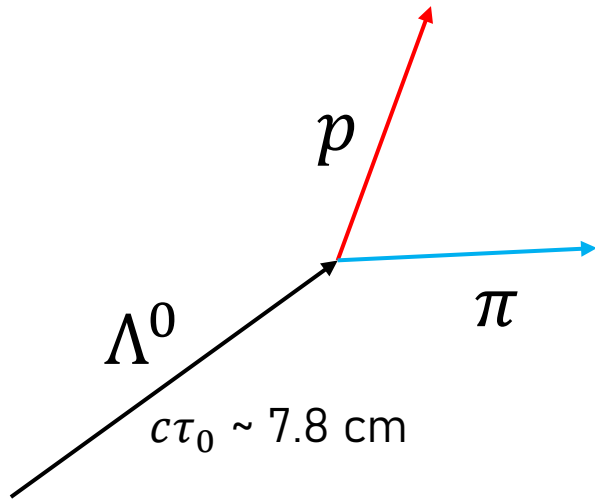
- Decay reconstruction actively under development, much more to come



~1 hour of data!

- Cuts applied:
- Daughter # MVTX clusters
 - Daughter # TPC clusters
 - Daughter PID
 - Daughter χ^2/ndf
 - Daughter IP_{xy}
 - Track-to-track DCA
 - K_S^0 DIRA
 - SV χ^2/ndf

- Significant yield with very little background
- Yield constant as a function of bunch crossing – streaming readout crosscheck successful!

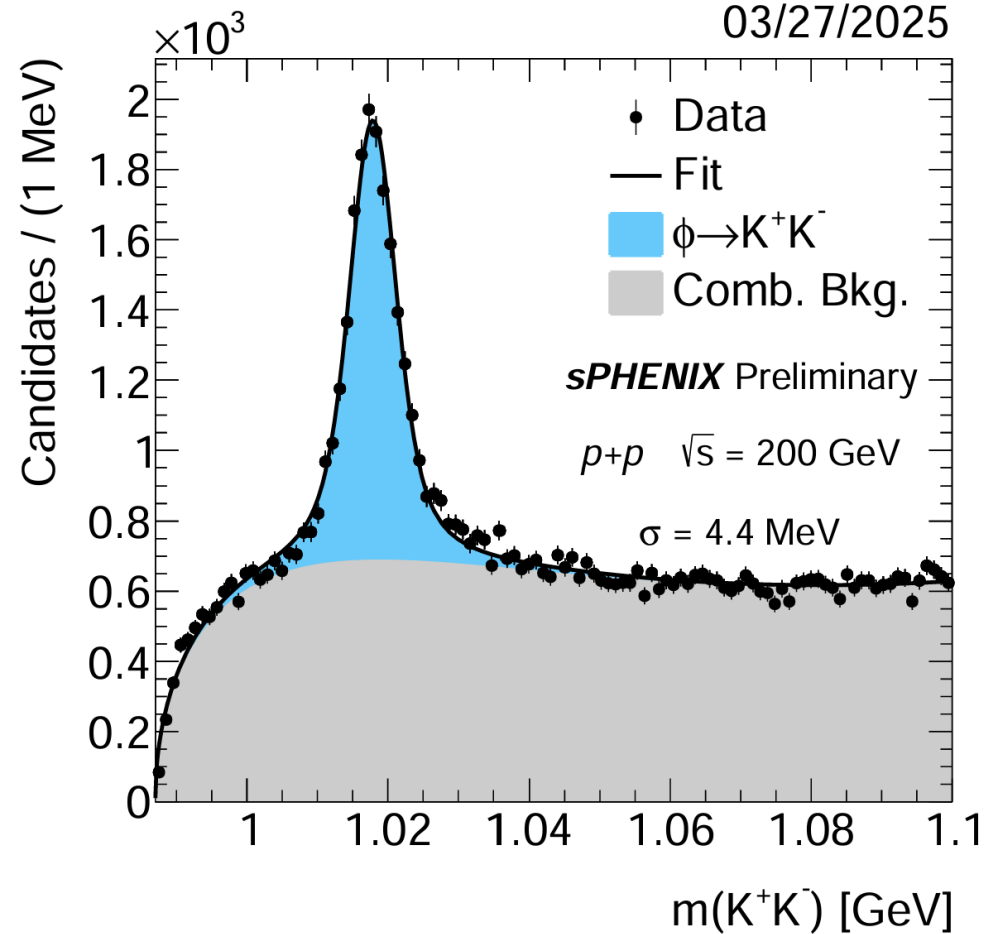
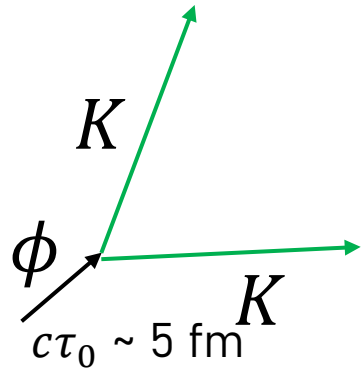


~1 hour of data!

Cuts applied:

- Daughter # MVTX clusters
- Daughter # TPC clusters
- Daughter PID
- Daughter χ^2/ndf
- Daughter IP_{xy}
- Track-to-track DCA
- Λ^0 DIRA
- SV χ^2/ndf

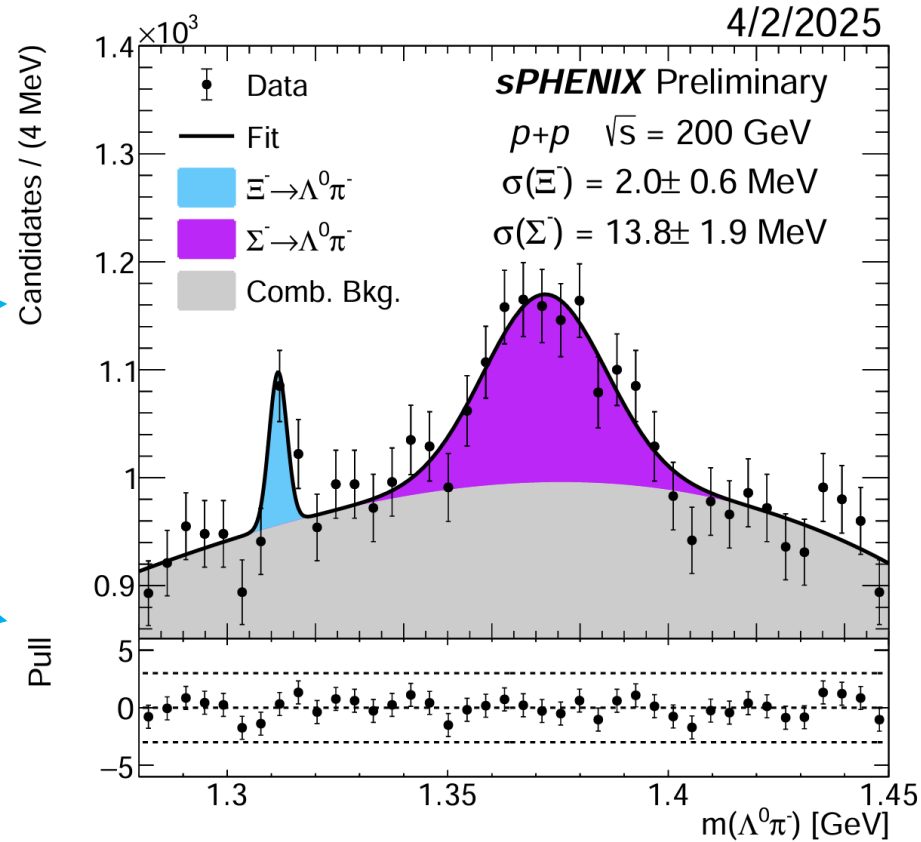
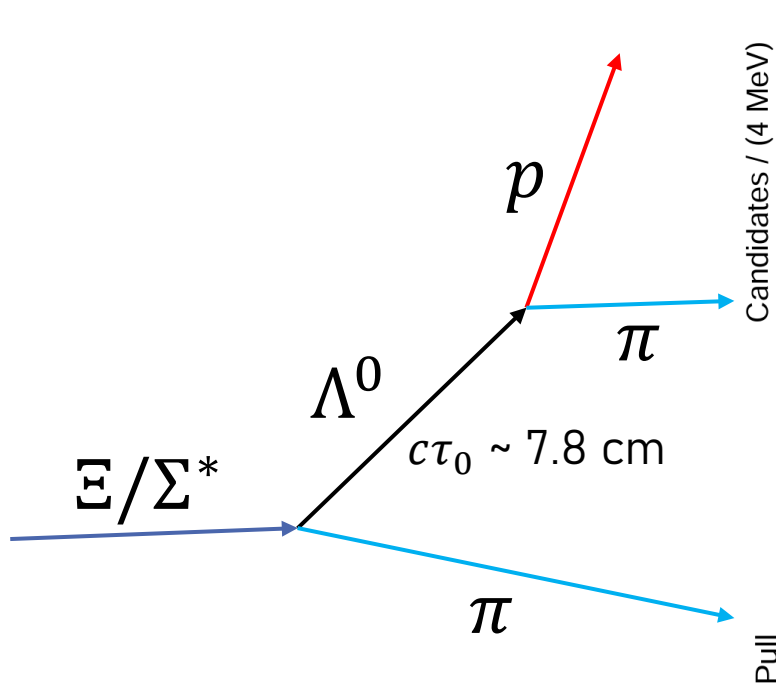
- Proton PID classification via dE/dx cut significantly suppresses background



~1 hour of data!

- Cuts applied:
- Daughter # MVTX clusters
 - Daughter PID
 - Daughter p_T
 - Daughter p
 - Track-to-track DCA
 - ϕ decay length

- Kaon PID cut via dE/dx instrumental for background reduction, especially with such short decay length

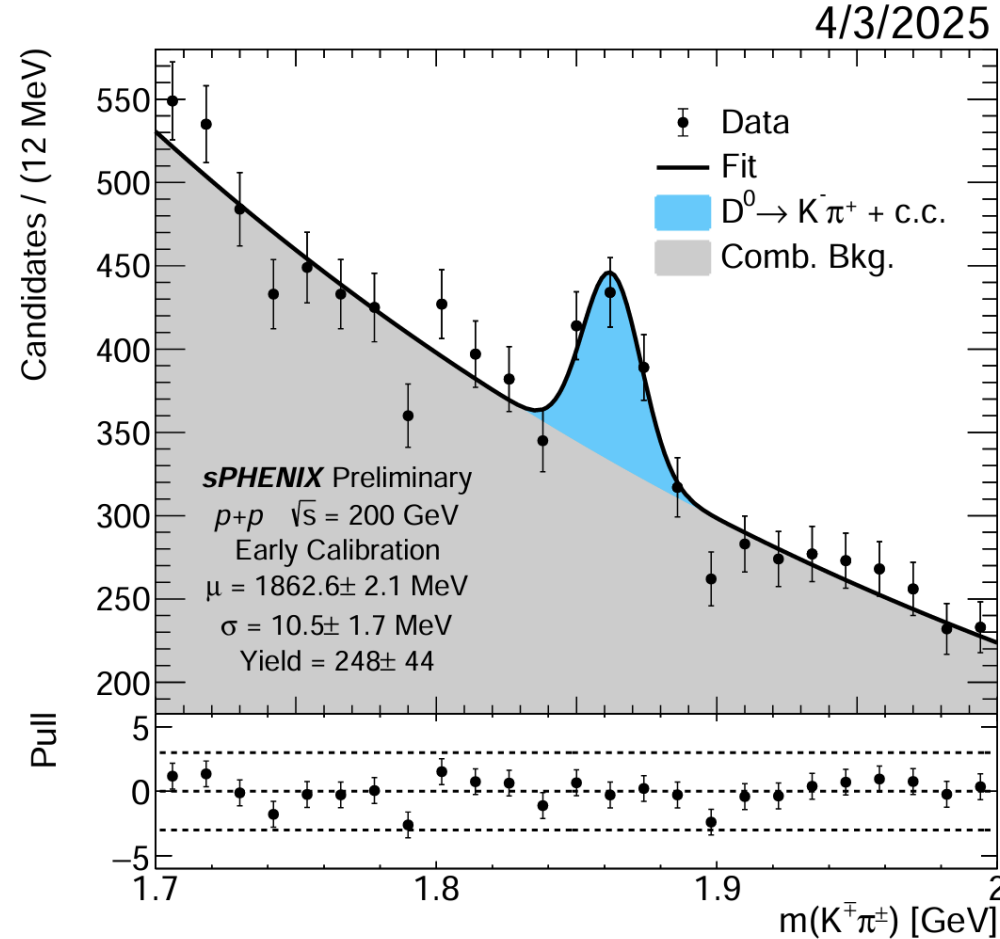
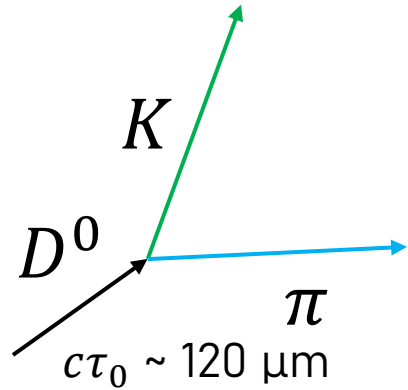


~1 hour of data!

Cuts applied:

- Λ^0 mass
- Daughter PID
- Daughter p_T
- Track-to-track DCA (Λ^0 daughters)
- Track-to-track DCA (Λ^0 to π^-)
- Λ^0 decay length

- Lower cross-section expected for these than K_S^0 or Λ^0 decays, but still clearly visible above background
- Intermediate Λ^0 reconstructed as part of KFParticle candidate determination



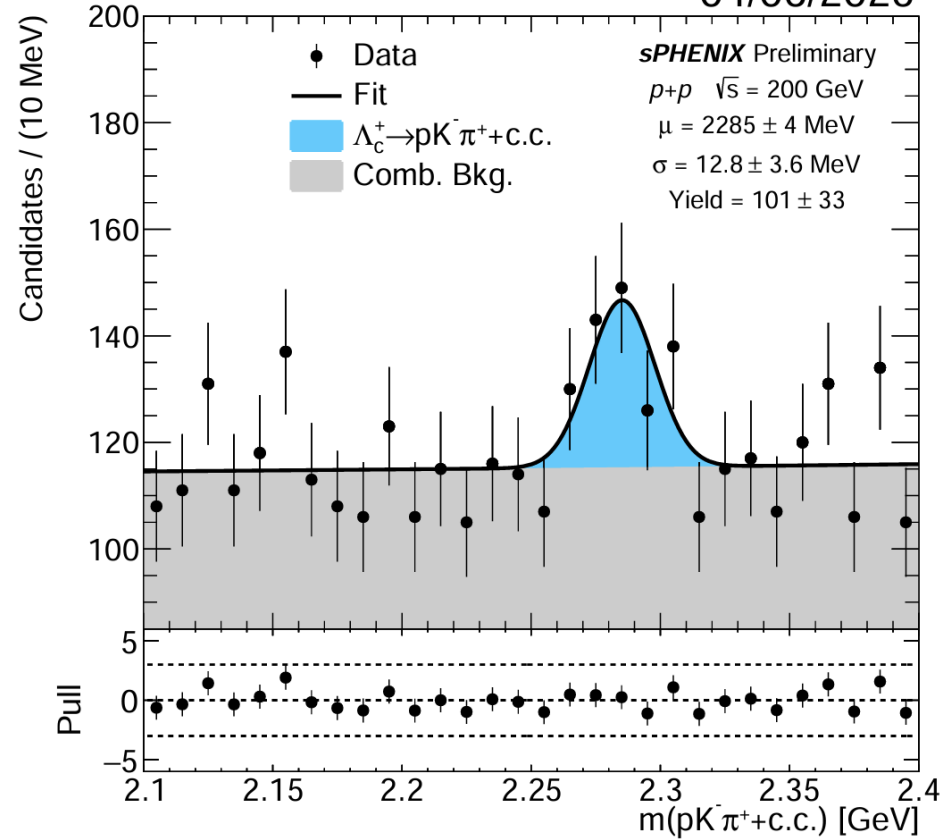
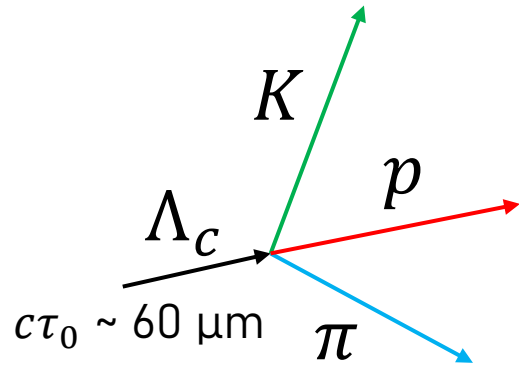
~1 hour of data!

- Cuts applied:
- Daughter PID
 - Daughter p_T
 - Daughter $l_{p_{xy}}$
 - Daughter # MVTX clusters
 - Daughter # INTT clusters
 - Daughter # TPC clusters
 - Track-to-track DCA_{xy}
 - D^0 transverse decay length
 - D^0 transverse decay length significance
 - D^0 DIRA
 - D^0 IP
 - D^0 p_T
 - SV χ^2
 - PV z position

- First heavy-flavor result obtained from sPHENIX!
- Uses only a small fraction of full dataset

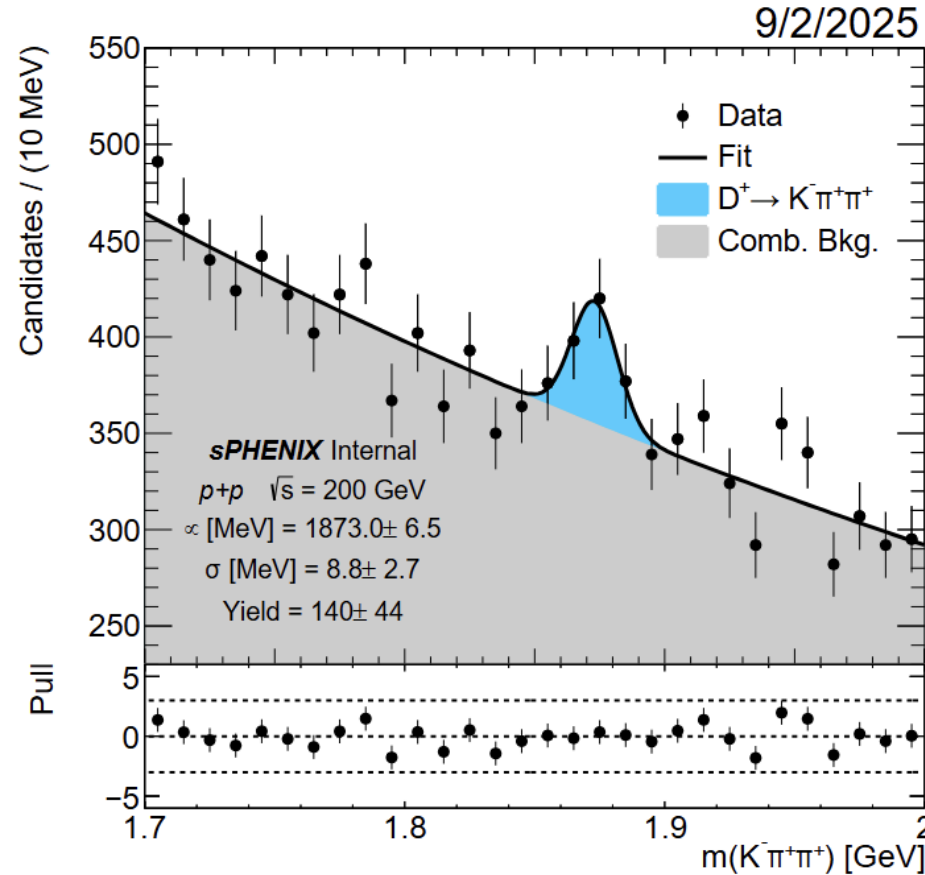
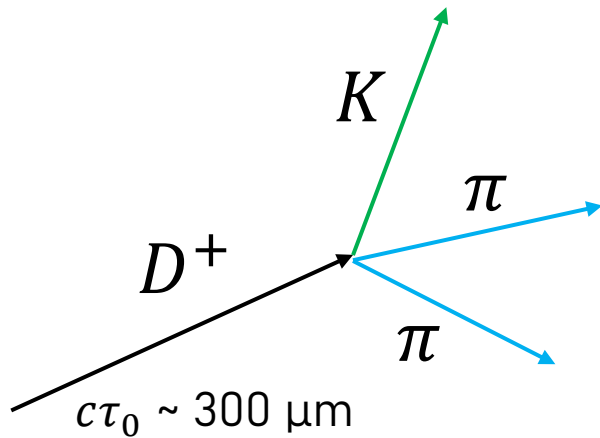
04/06/2025

~1 hour of data!



- Cuts applied:
- Daughter PID
 - Daughter p_T
 - Daughter χ^2/ndf
 - Daughter # MVTX clusters
 - Daughter # INTT clusters
 - Daughter # TPC clusters
 - Track-to-track DCA
 - Λ_c transverse decay length
 - Λ_c DIRA
 - SV χ^2/ndf

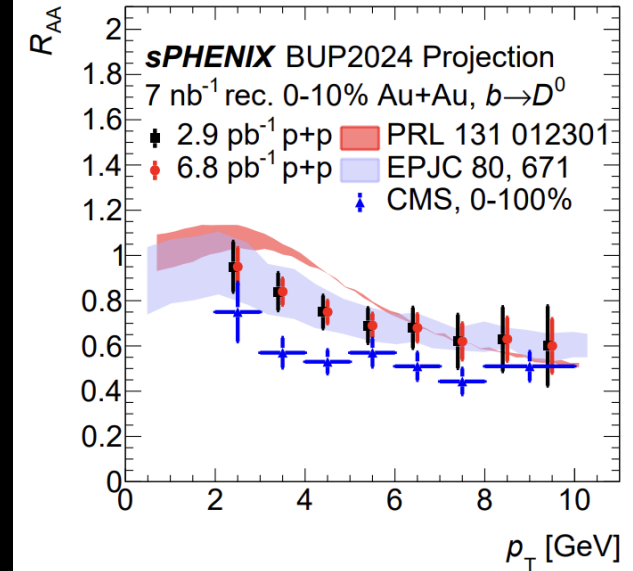
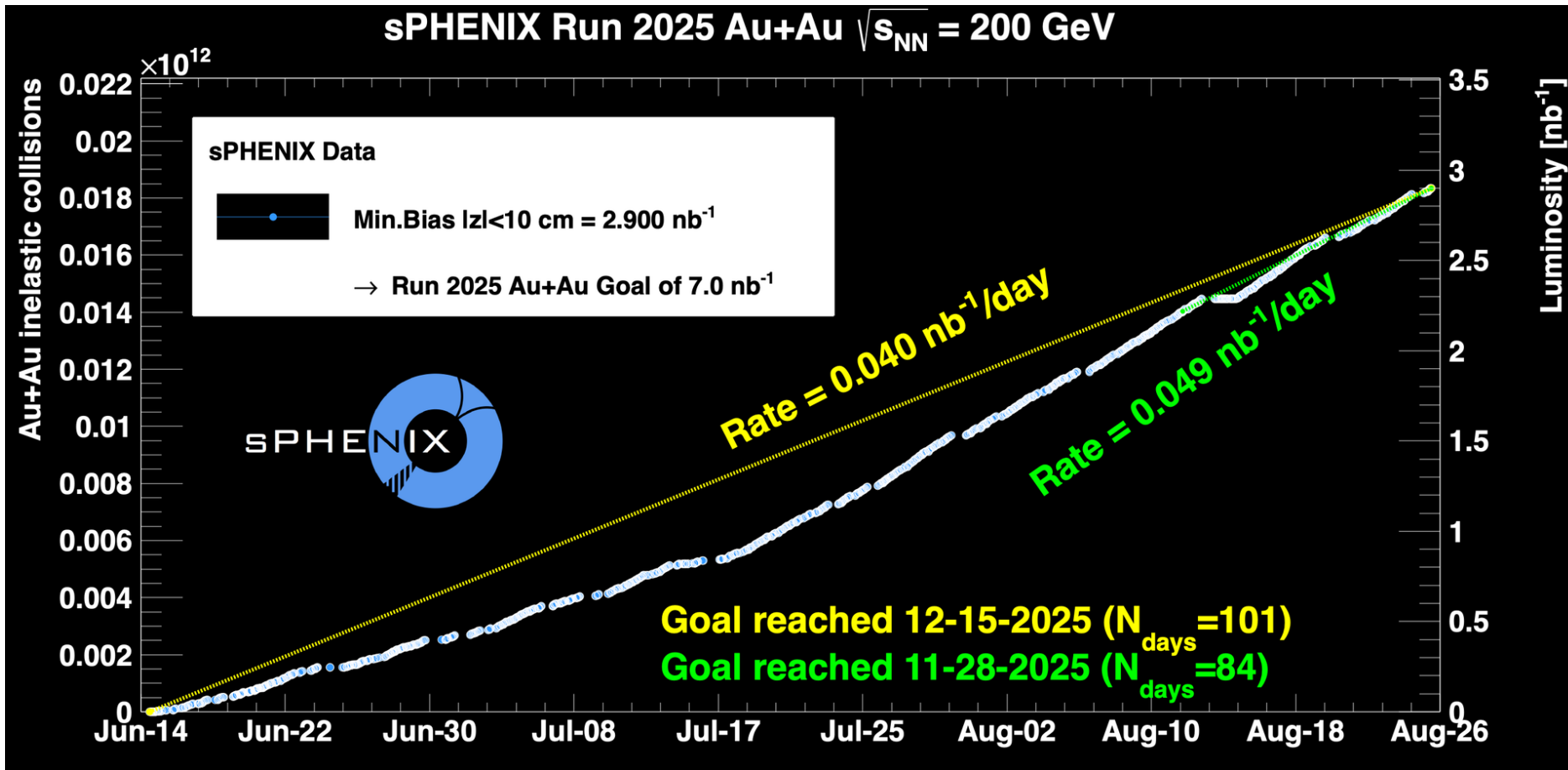
- First measurement of Λ_c^+ at RHIC in p+p!



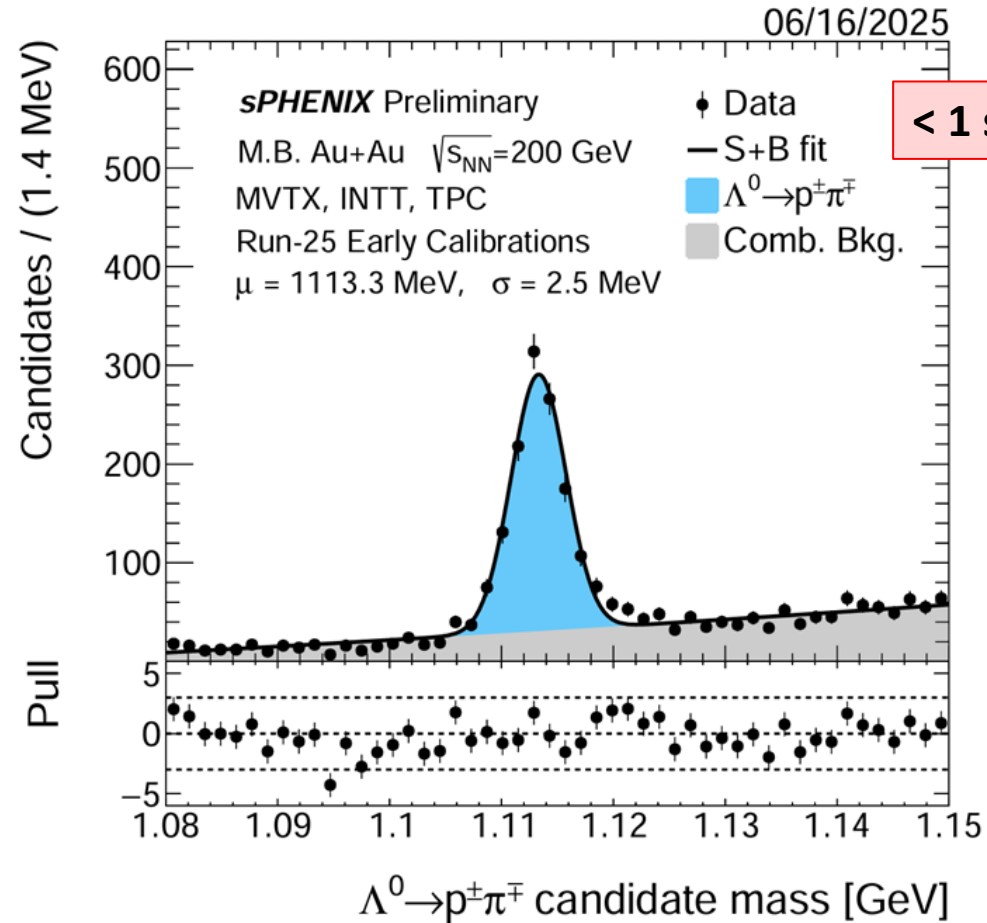
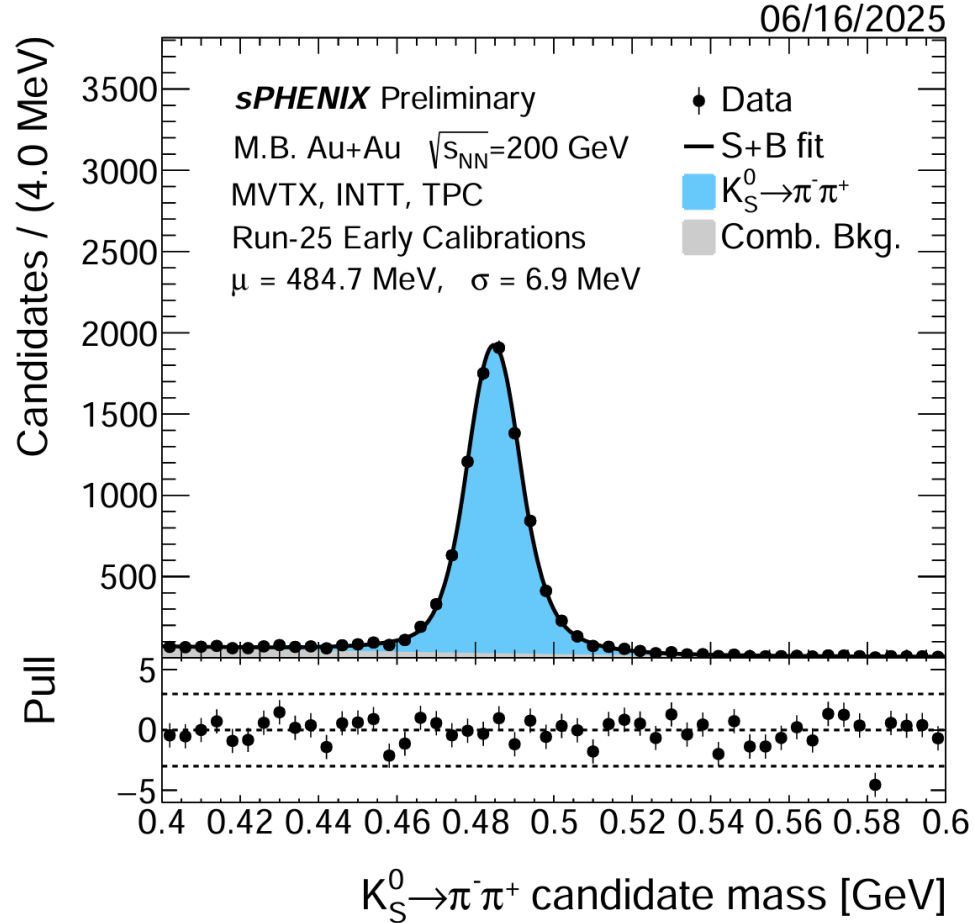
~1 hour of data!

- Cuts applied:
- Daughter PID
 - Daughter p_T
 - Daughter IP_{xy}
 - Daughter # MVTX clusters
 - Daughter # INTT clusters
 - Daughter # TPC clusters
 - Track-to-track DCA
 - D^+ transverse decay length
 - D^+ transverse decay length significance
 - D^+ DIRA
 - D^+ p_T
 - SV χ^2/ndf
 - PV z position

- New for this conference and first in RHIC p+p!
- Working towards D_s^+ / D^+ ratio

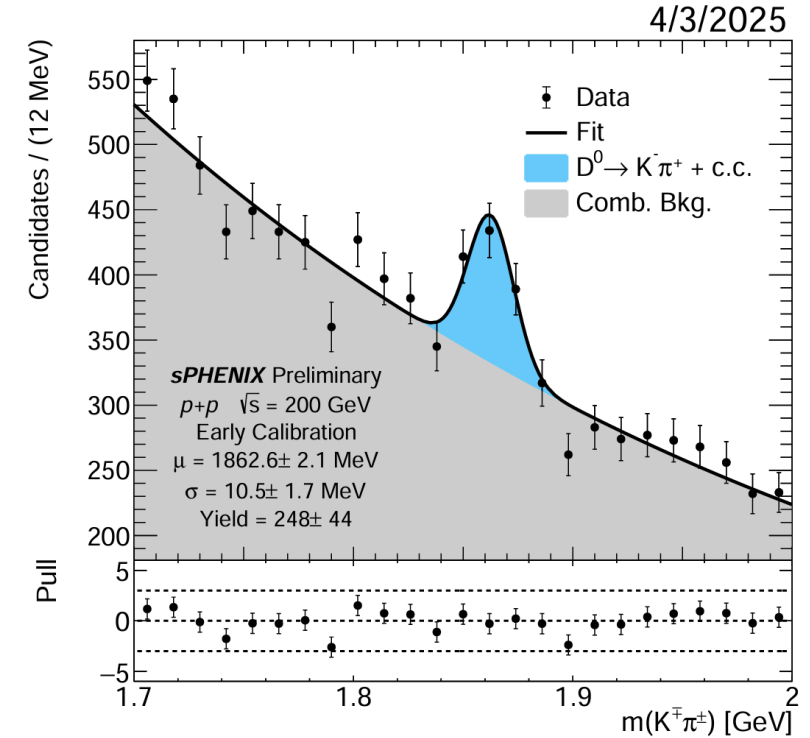
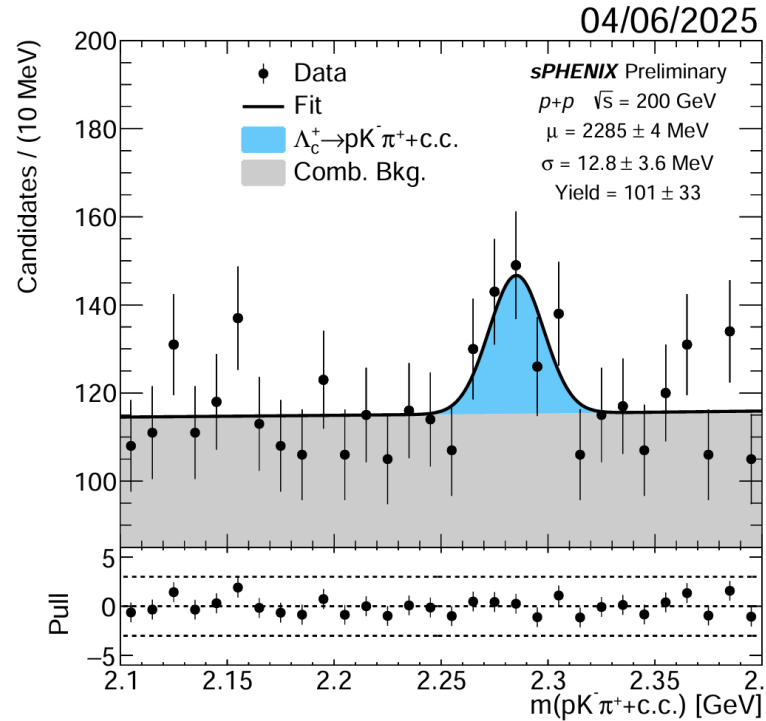
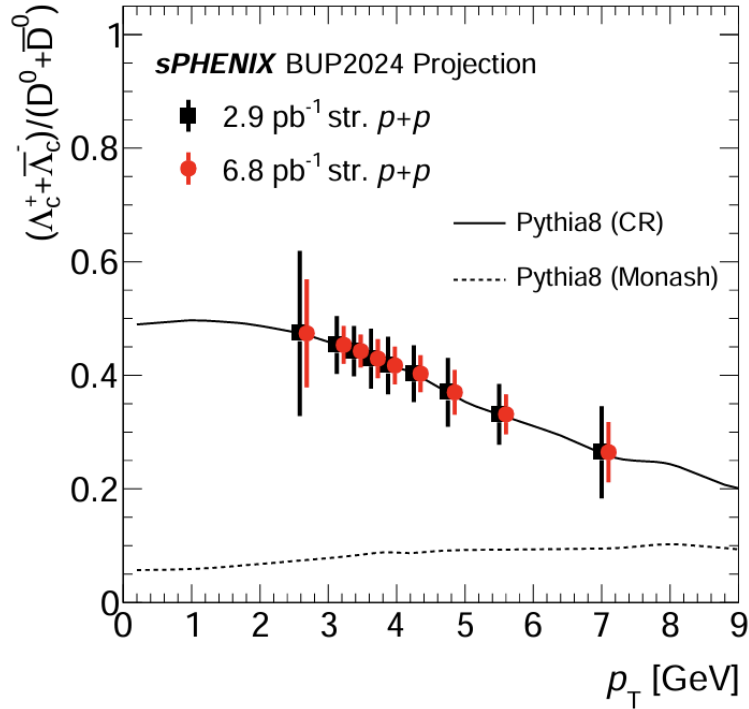


- Continuing to accumulate large Au+Au dataset



< 1 second of data!

- Clear peak, cuts very effective at eliminating background even in busy Au+Au environment
- Very quick turnaround – plots produced within days of first data



- sPHENIX tracking calibration and reconstruction efforts are well underway
- Tuning of all aspects of decay reconstruction in progress, processing of full data sample to meet projections
- First streaming-readout tracking measurements at RHIC will constrain heavy-flavor ratios and models of hadronization