

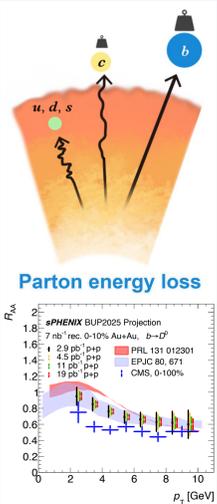
Xudong Yu, Peking University, for the sPHENIX Collaboration

Abstract

sPHENIX is a state-of-the-art experiment at the Relativistic Heavy Ion Collider (RHIC), dedicated on the study of heavy-flavor and jet physics. Its novel streaming-readout-capable, precision tracking system allows for heavy-flavor measurements through high-statistics, unbiased data samples with exceptional precisions. During the 2024 run, sPHENIX was fully commissioned, collecting a sample of 100 billion unbiased p+p collisions and a further sample of minimum-bias Au+Au collisions. The ongoing 2025 run is further enhancing the dataset with high-statistics Au+Au collisions. This extensive p+p collision sample enables heavy-flavor physics measurements in p+p collisions with orders of magnitude more statistics than that previously available at RHIC. Notably, there has been no prior measurement of the Λ_c^+/D^0 baseline in p+p collisions at RHIC energies. The large sPHENIX dataset now enables the first exploration of key open questions, such as the hadronization mechanism of baryons and the strange-to-light flavor meson ratio. We will present the status of the first measurements of the Λ_c^+/D^0 ratio and the similarly unexplored D_s^+/D^+ ratio in p+p collisions.

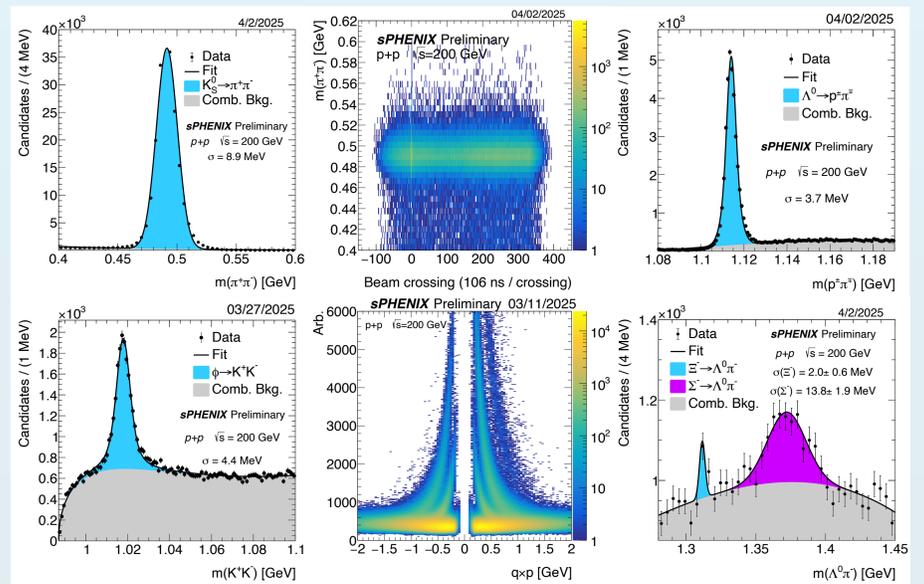
Open heavy flavor physics program

- One of the cornerstones of sPHENIX scientific program
- Heavy quarks (charm and bottom) are excellent probes for Quark Gluon Plasma (QGP)
- $m_{b,c} \gg \Lambda_{QCD} \rightarrow$ pQCD prediction of initial production
- $m_{b,c} \gg T_{QCD} \rightarrow$ No thermal production; conserved from the initial hard scatterings & experience full QGP evolution
- Explore the parton energy loss mechanism and study the collective behavior in medium by varying the mass/momentum of the probe
- Two popular & crucial observables for QGP studies: Collective flow v_n & Nuclear Modification Factor R_{AA}
- Investigate hadronization mechanism via ratio of production yields between various hadron species, which is the initial physics program of sPHENIX
- Baryon/meson ratio Λ_c^+/D^0
- strangeness enhancement D_s^+/D^+



Reconstruction toolkit and light flavor reconstruction

Using KFPARTICLE package, the light flavor resonances are reconstructed from data to show the capability. TPC dE/dx information helps suppress combinatoric background at low momentum.

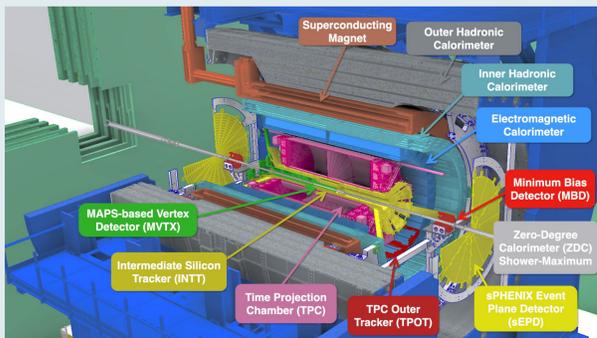


sPHENIX detector

The sPHENIX detector consists of high precision tracking (MVTX, INTT, TPOT, TPC), large acceptance electromagnetic (EMCAL) and hadronic calorimeters (iHCAL, oHCAL), minimum bias detector (MBD) and event plane detector (sEPD)

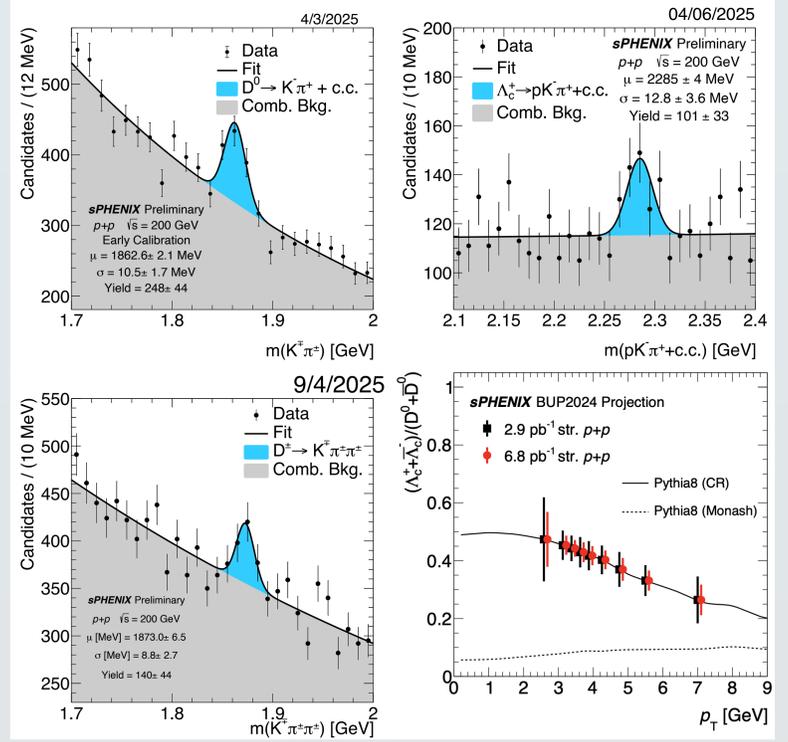
Tracking detectors for heavy flavor reconstruction

- MVTX:
 - Three layers silicon pixel detector
 - 5 um position resolution
 - Allows vertex reconstruction for HF
- INTT:
 - Two layers silicon strip detector
 - Short integration time allows single bunch identification to mitigate pile-up
- TPC:
 - 48 layers GEM continuous readout
 - ~1% momentum resolution @ 1 GeV
 - dE/dx information for particle ID
- TPOT:
 - Micromegas based detector with partial coverage
 - Facilitates calibration for TPC distortions



$\Lambda_c^+/D^0/D^+$ reconstruction from real data

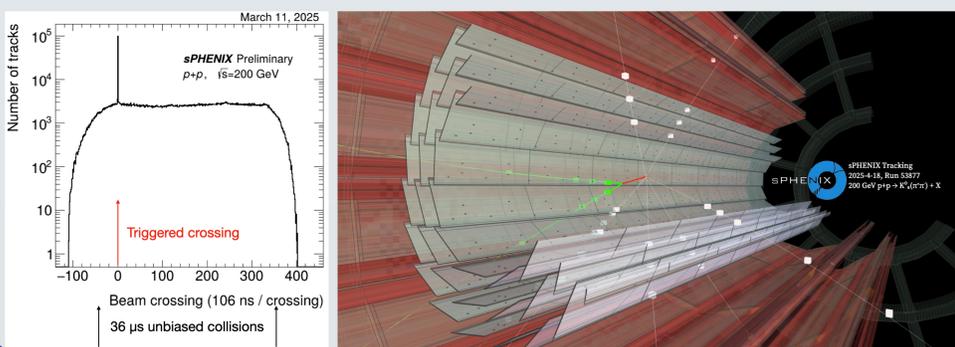
- First D^0 invariant mass peak at sPHENIX has been identified!
- First measurement of Λ_c^+ at $\sim 3\sigma$ confidence level in p+p at RHIC!
- First measurement of D^+ at $\sim 3\sigma$ confidence level in p+p at RHIC! Working towards D_s^+/D^+ ratio
- Statistically limited in ~ 1 hour of data – more to come
- Using early calibrations
 - MVTX alignment with field off data
 - TPC static distortion corrections from simulation and space charge distortion corrections only in ϕ direction using lamination fitting
- Ongoing efforts to improve early calibrations \Rightarrow Optimizing reconstruction efficiency, yields and better background suppression



Streaming DAQ system and tracking reconstruction

In pp collisions, with streaming DAQ capability, we record data for 14 us (TPC drift time) + 36 us (extended readout). In the normal data-taking mode of Run24, a 20% streaming rate can increase the minimum bias (MB) sampling rate to 200 kHz, which is 20 to 50 times higher compared to the pure MB trigger mode. Over the entire Run24, sPHENIX collected 100 billion streaming events that can be used for open heavy flavor physics analysis.

sPHENIX tracking software uses 4D detector information for track reconstruction. A Common Tracking Software (ACTS) is implemented. Full reconstruction workflow split into 4 steps: clustering hits, full track seeding, final track fitting and vertexing



Summary and outlook

- sPHENIX tracking detectors with streaming readout collected a large sample of unbiased p+p collisions in Run24, allowing for measuring open charm Baryon-to-Meson ratios.
- Using the KFPARTICLE package, we reconstruct the open-charm resonances $\Lambda_c^+/D^0/D^+$, as well as several light flavor resonances ($K_S^0, \Lambda, \phi, \Xi, \Sigma^{*+}$) in real data by leveraging track momentum information and primary vertex positions from the sPHENIX tracking software.
- Ongoing efforts on improving tracking performance including alignment and distortion corrections which is essential for an accurate determination of Λ_c^+/D^0 and D_s^+/D^+ ratios.