Quark Matter 2017

February 5-11, 2017
US - Chicago

Measurements of Λ_c^+ and D_s^+ production in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV from STAR

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STAR

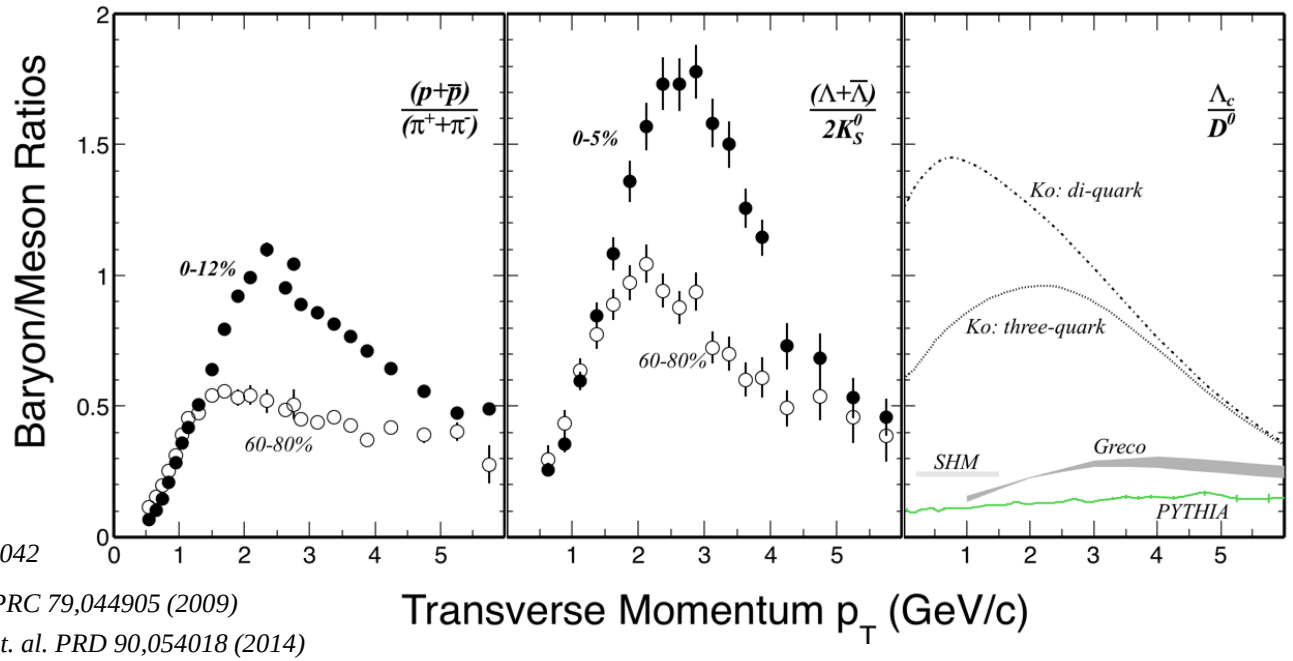
Motivation: Λ_c^+

- Significant enhancement in baryon-to-meson ratio observed in central A+A collisions for light hadron and hadrons containing strange quarks

V. Gerco, et. al. PRL 90,202302 (2003)
V. Gerco, et. al. PRC 68,034904 (2003)

  - Coalescence mechanism well describes the observation

- Enhancement of Λ_c^+/D^0 ratio depends on the degree of charm quark thermalization and coalescence mechanism implementation



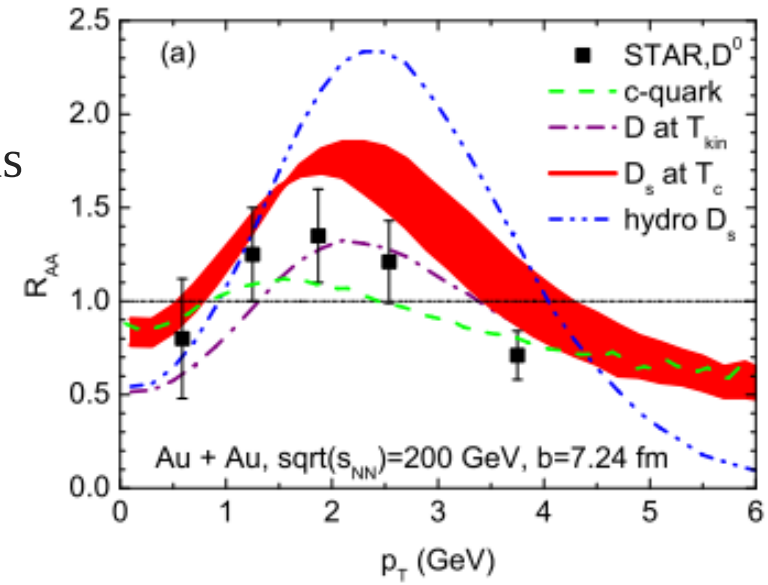
STAR arXiv:nucl-ex/0601042

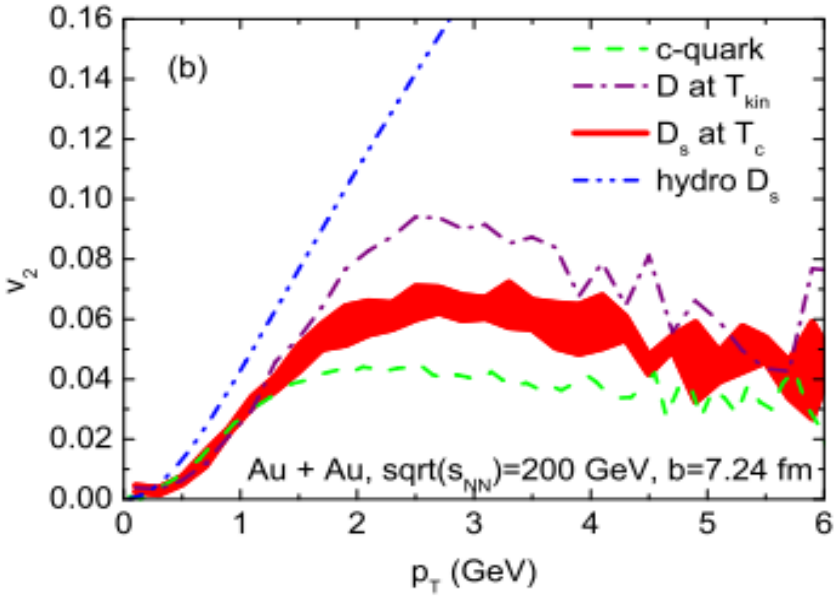
Ko model : Y. Oh, et.al. PRC 79,044905 (2009)

Greco model : S.Ghosh, et. al. PRD 90,054018 (2014)

Motivation: D_s^+

- Study hadronization mechanism
  - Strangeness enhancement in A+A collisions
  - $R_{AA}(D_s^+) > R_{AA}(D)$, D_s^+/D^0 enhancement due to coalescence hadronization

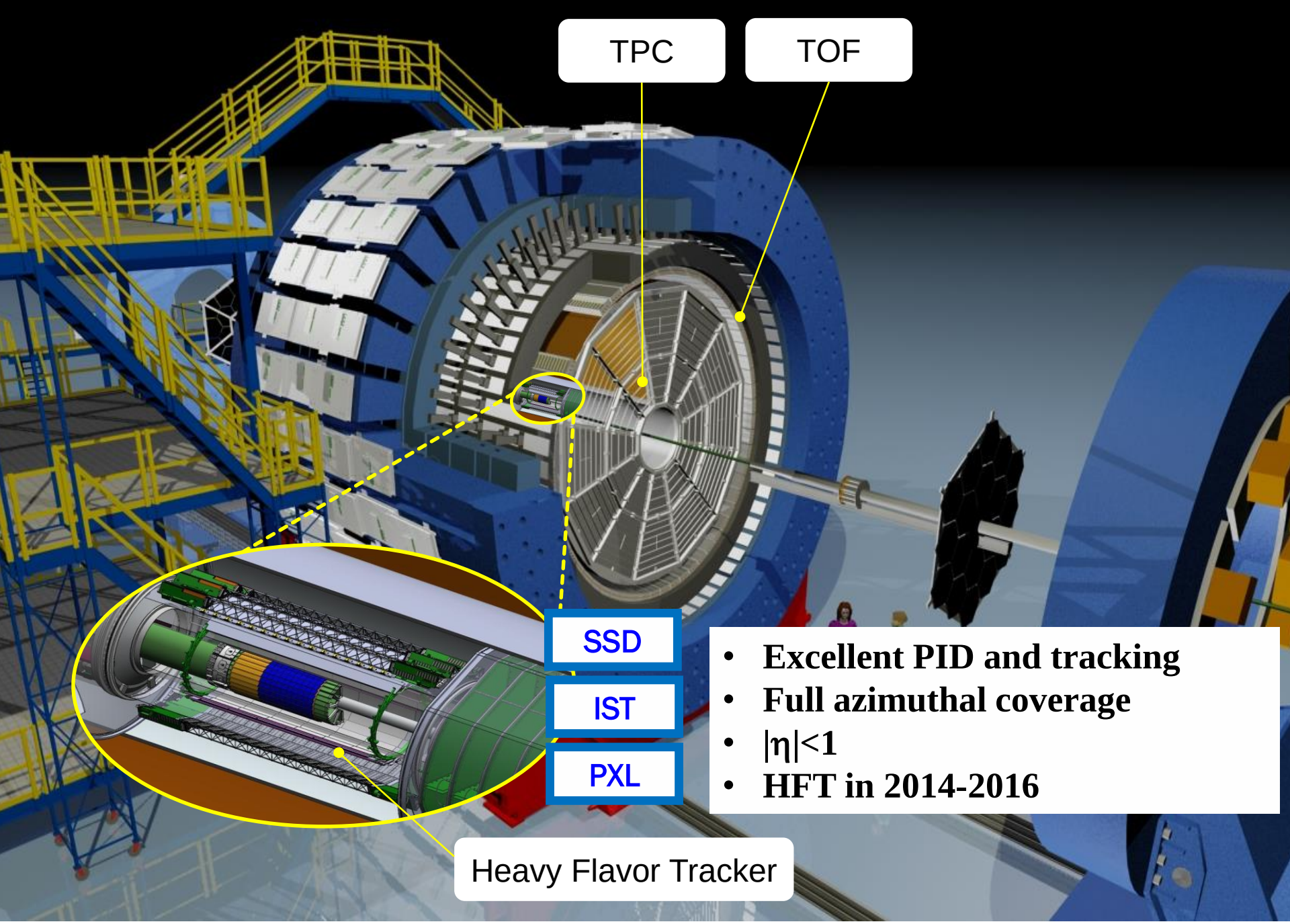




H. Min et al. PRL 110,112301 (2013)

- More sensitive to properties of Quark Gluon Plasma
  - $v_2(D_s^+) < v_2(D)$ due to earlier freeze-out of D_s^+

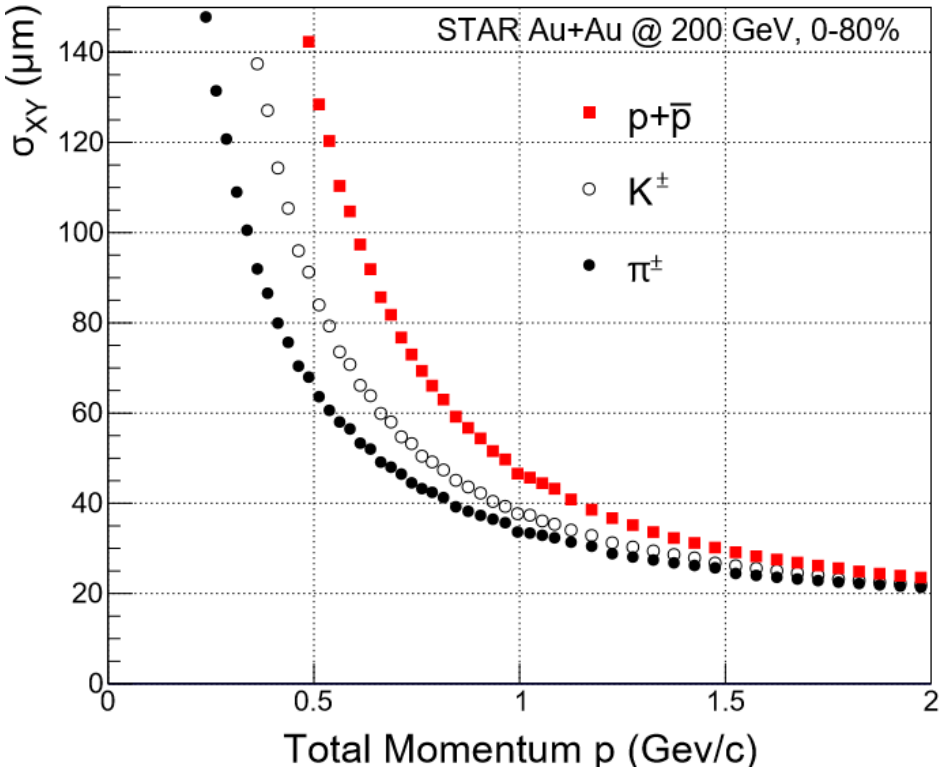
- Measurements of Λ_c^+ and D_s^+ can help constrain the total charm yield



- **Excellent PID and tracking**
- **Full azimuthal coverage**
- **$|\eta|<1$**
- **HFT in 2014-2016**

Λ_c^+ and D_s^+ reconstruction

- Dataset
  - Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV recorded in 2014
  - About 900M minimum bias events
- Reconstruction efficiency
  - Data-driven approach

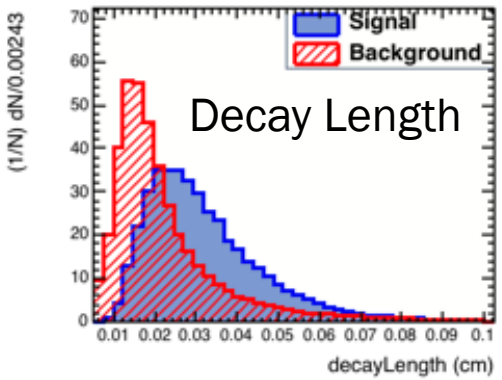


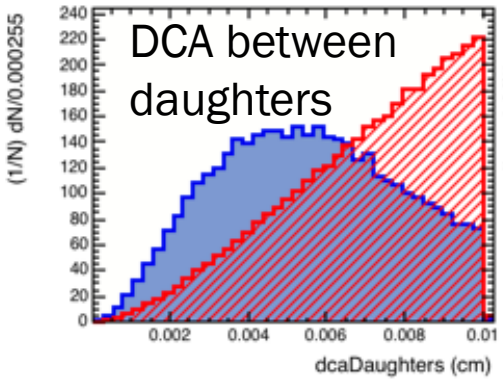
Particle	Mass	$c\tau$	Decay channel	B. R.
D_s^+	1968 MeV/c^2	150 μm	$D_s^+ \to \phi\pi^+ \to K^-K^+\pi^+$	2.32 %
Λ_c^+	2286 MeV/c^2	60 μm	$\Lambda_c^+ \to \pi^+p^+K^-$	6.35%

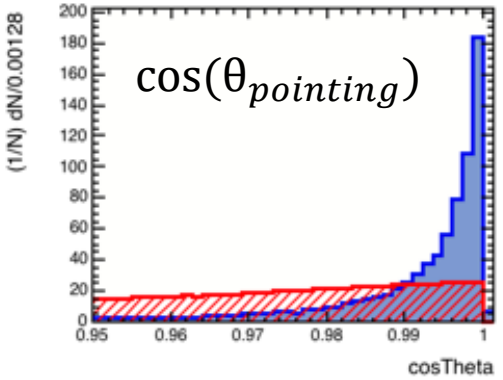
Charge conjugates also measured

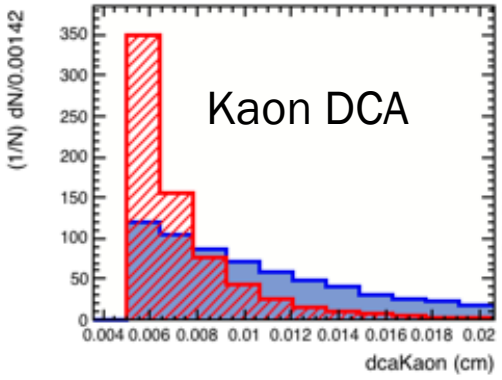
Signal optimization for Λ_c^+

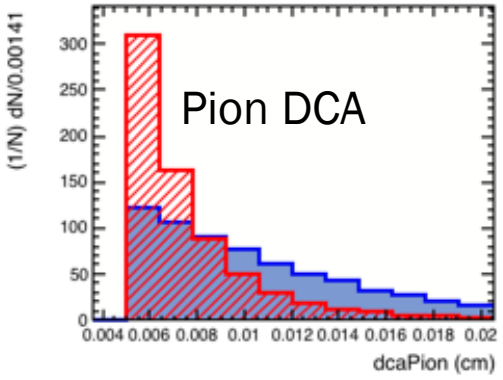
- Topological cut optimized using TMVA package
- Background extracted from real data using wrong-sign method
- Signal simulated with data-driven fast simulation

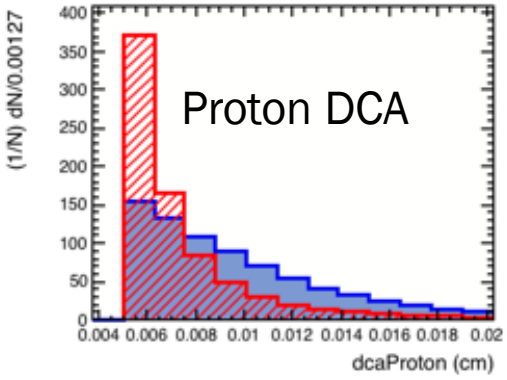




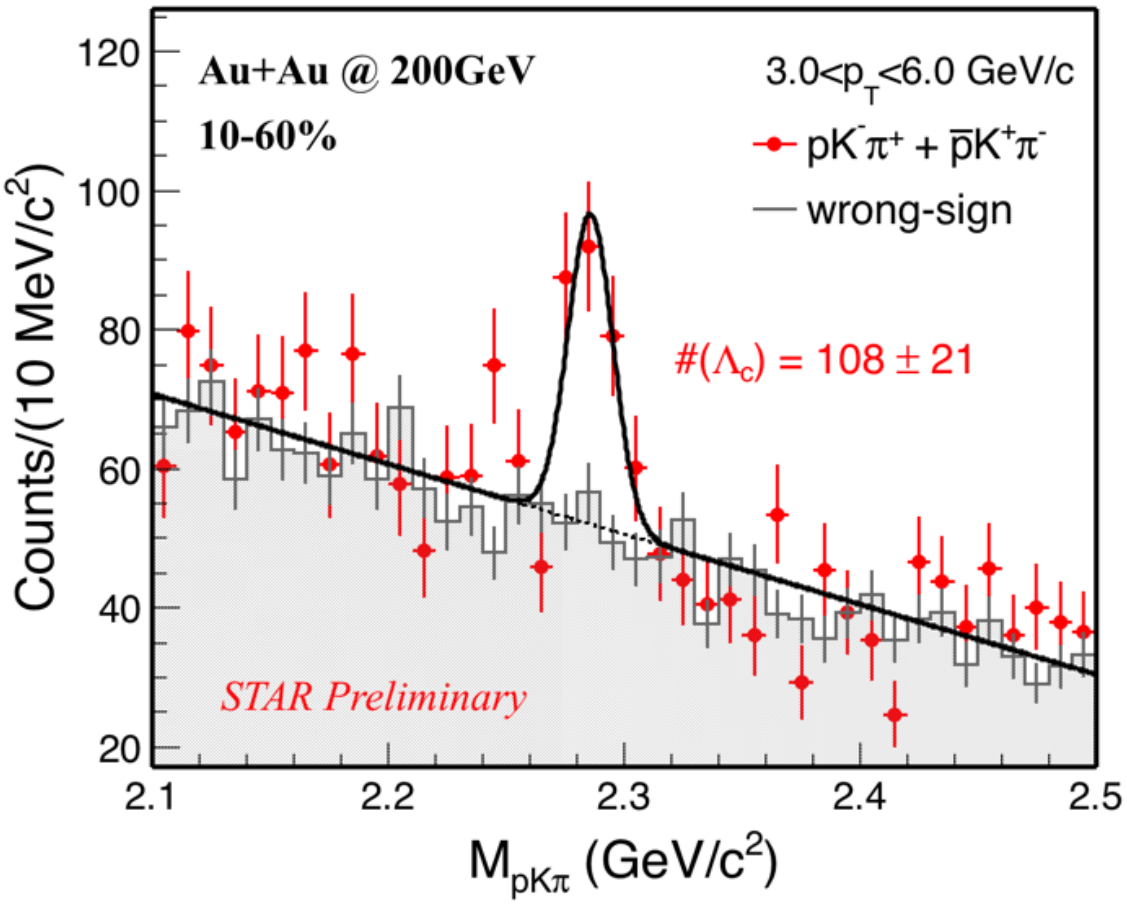








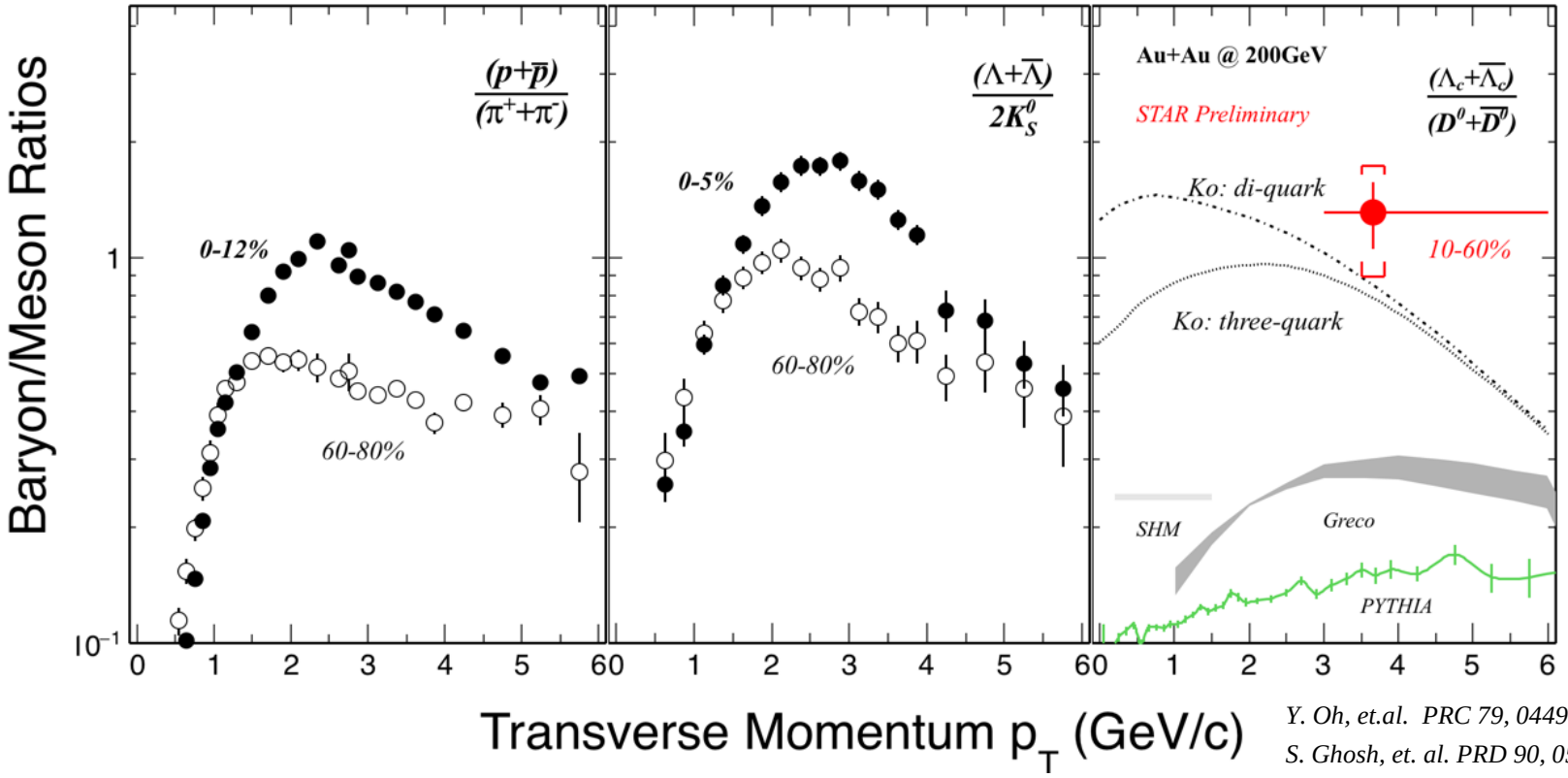
Λ_c^+ reconstruction



Guannan Xie
Board ID: G15

The first Λ_c^+ signal observed in heavy-ion collisions!

Baryon over meson ratio

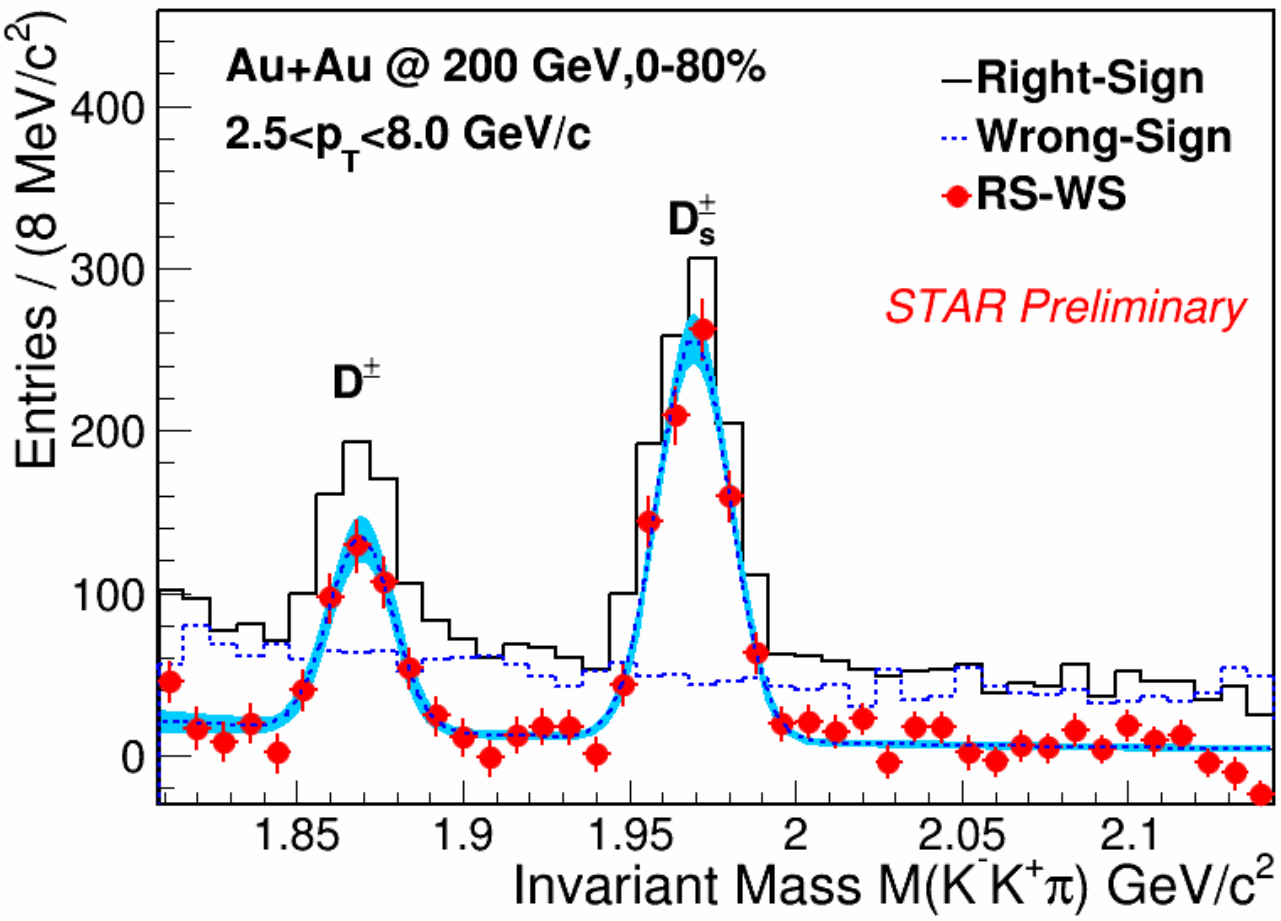


Y. Oh, et.al. PRC 79, 044905 (2009)
S. Ghosh, et. al. PRD 90, 054018 (2014)

- Observed an enhancement of Λ_c^+/D^0 ratio over PYTHIA; similar amplitude to light strange hadrons

  STAR: $1.3 \pm 0.3(\text{stat}) \pm 0.4(\text{sys})$, PYTHIA: 0.1 - 0.15
- Ko model (0-5%) with coalescence and thermalized charm quarks is consistent with data

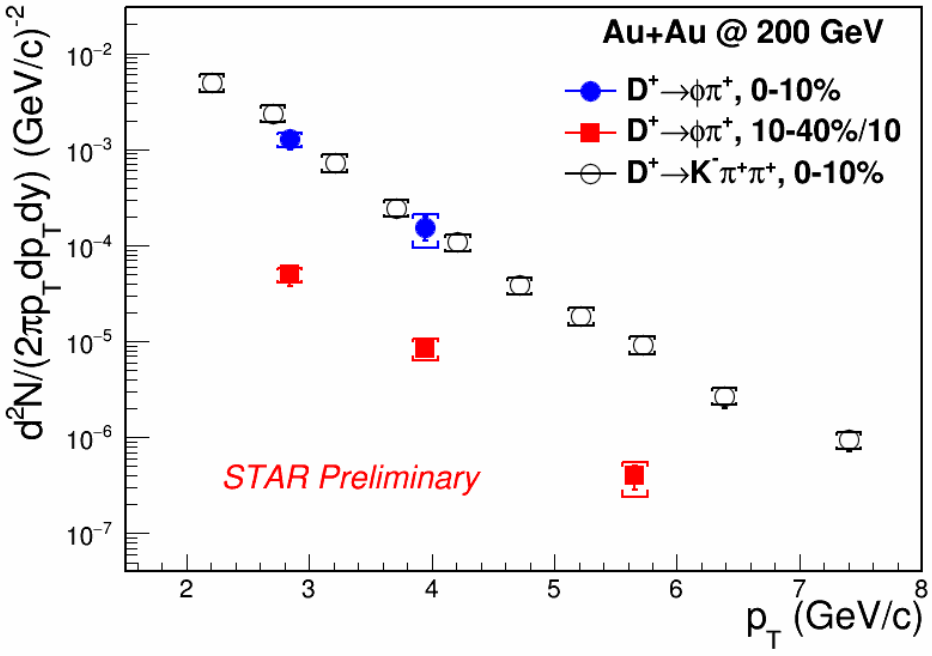
D_s^+ and D^+ reconstruction



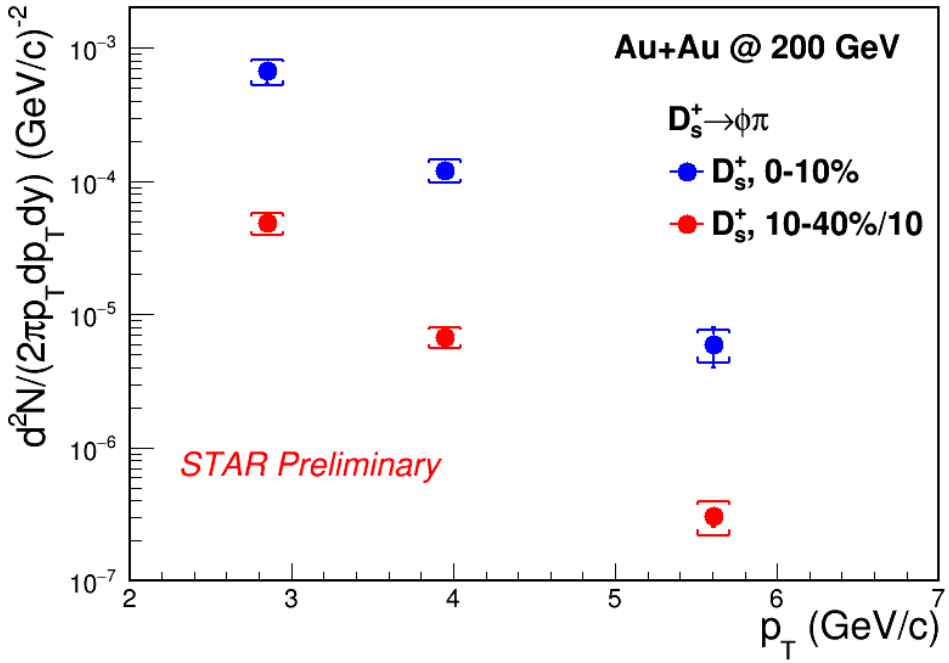
- About a factor 4 improvement in D_s^+ signal significance compared with the results shown at the QM2015

D^+ and D_s^+ p_T spectra

D^+

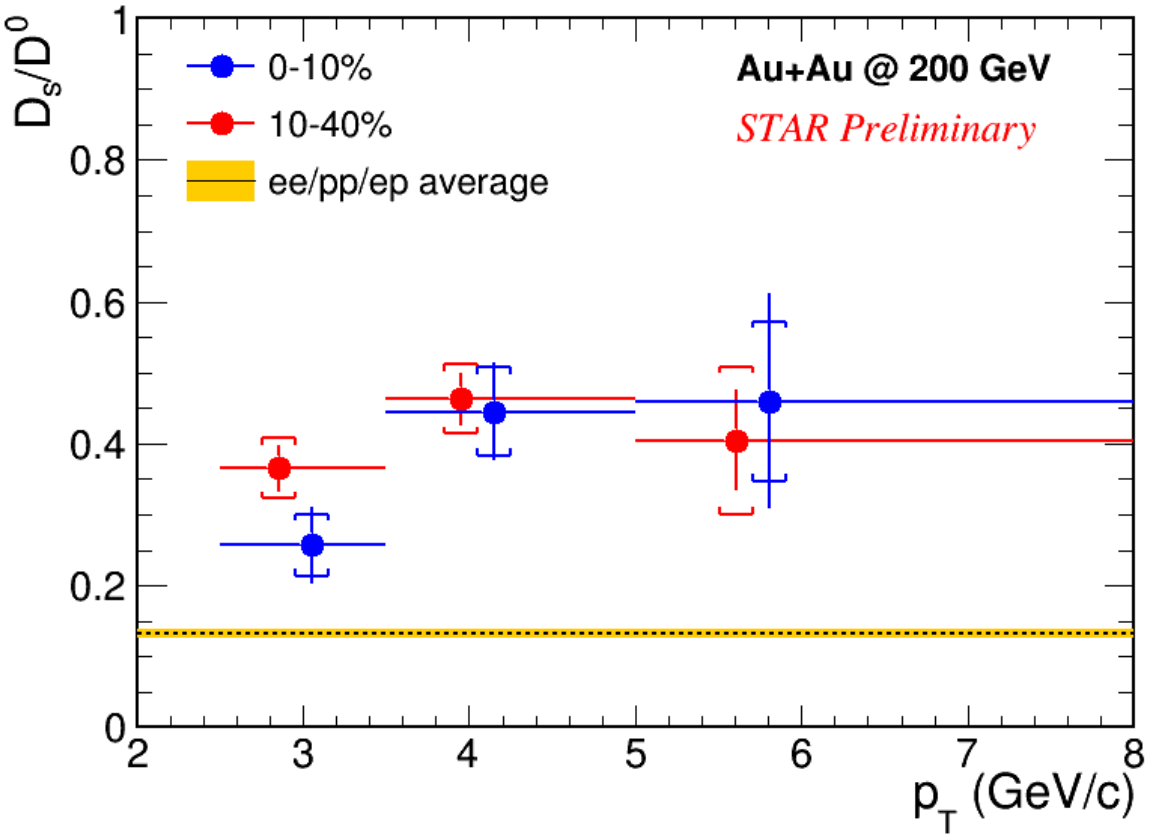


D_s^+



- The D^+ p_T spectra from two decay channels are consistent
  - $D^+ \to \pi^+ \pi^+ K^-$ (B.R. = 9.46%) from Jakub Kvapil (Board ID: I03)
  - $D^+ \to \phi\pi^+ \to \pi^+ K^- K^+$ (B.R. = 0.27%)

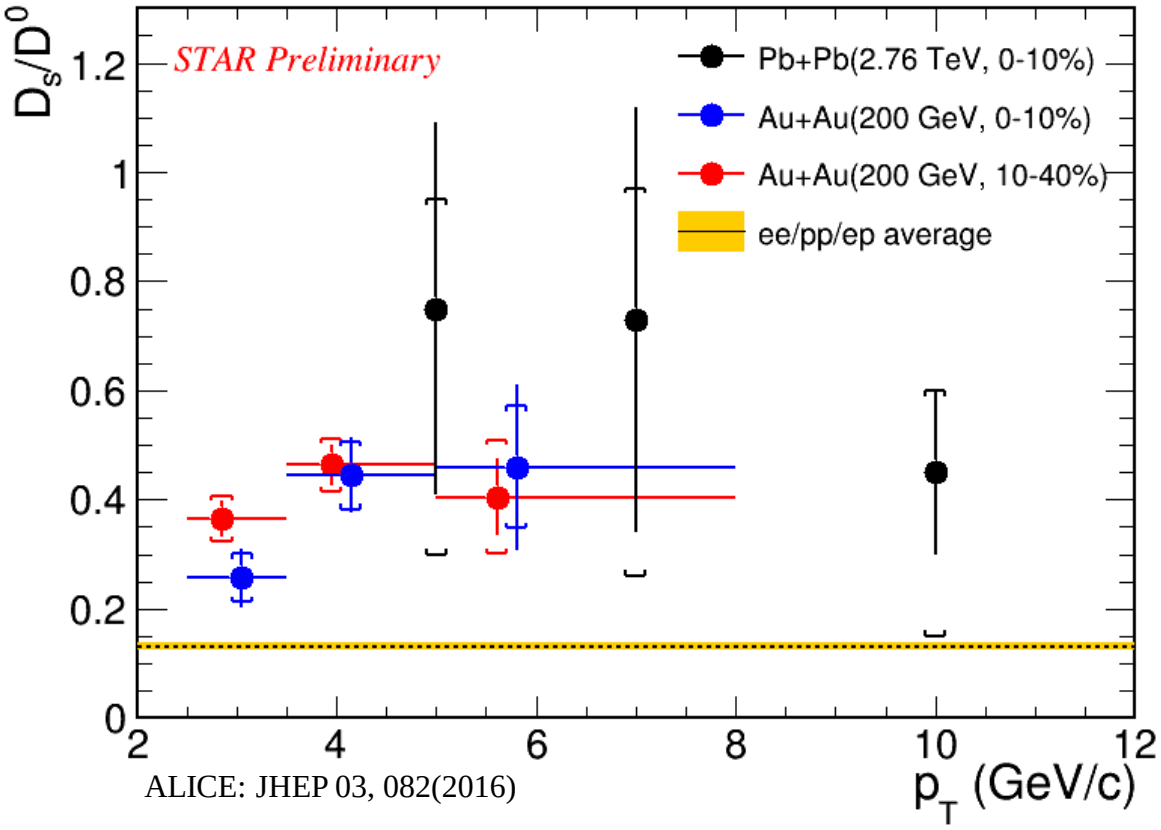
D_s^+/D^0 ratio



0-10% data points shifted to the right for clarity

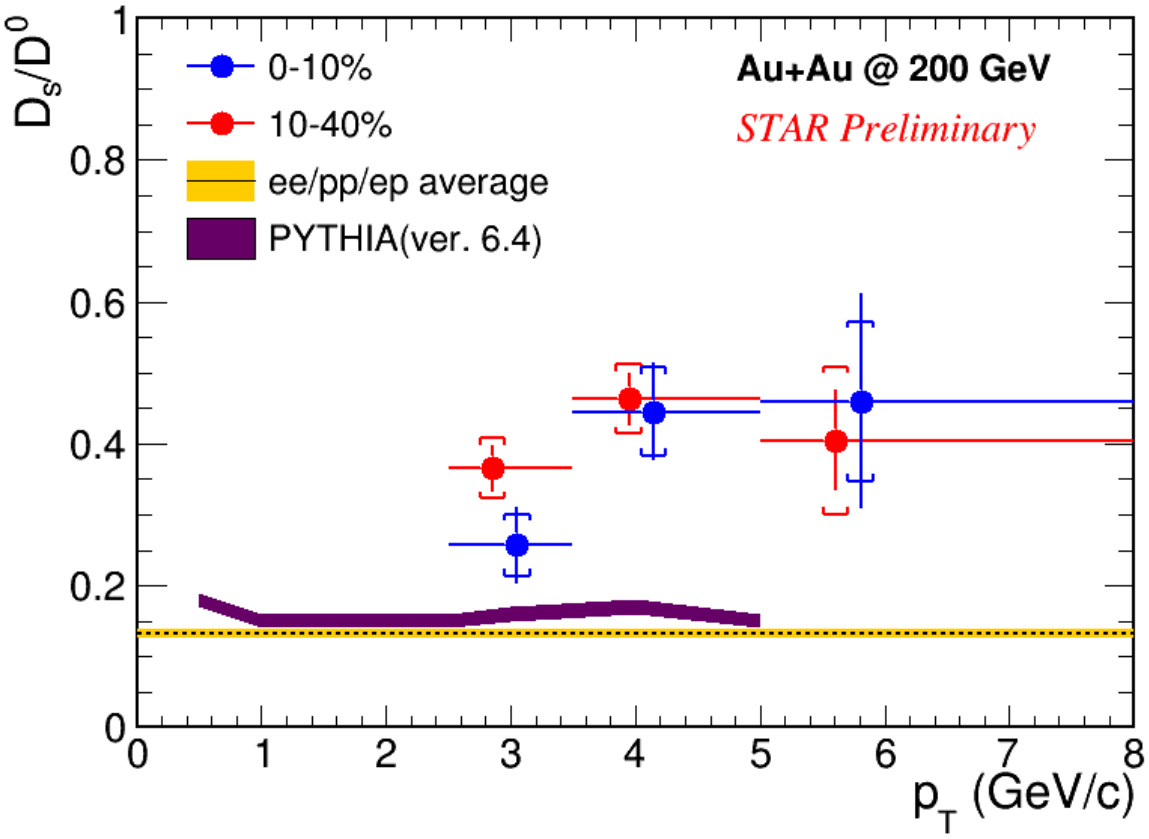
- D_s^+/D^0 ratio significantly larger than fragmentation baseline
  - ee/ep/pp average: 0.132 *M Lisovyi, et. al. EPJ C 76, 397 (2016)*
- Comparable enhancement in 0-10% and 10-40%

D_s^+/D^0 ratio: RHIC vs. LHC



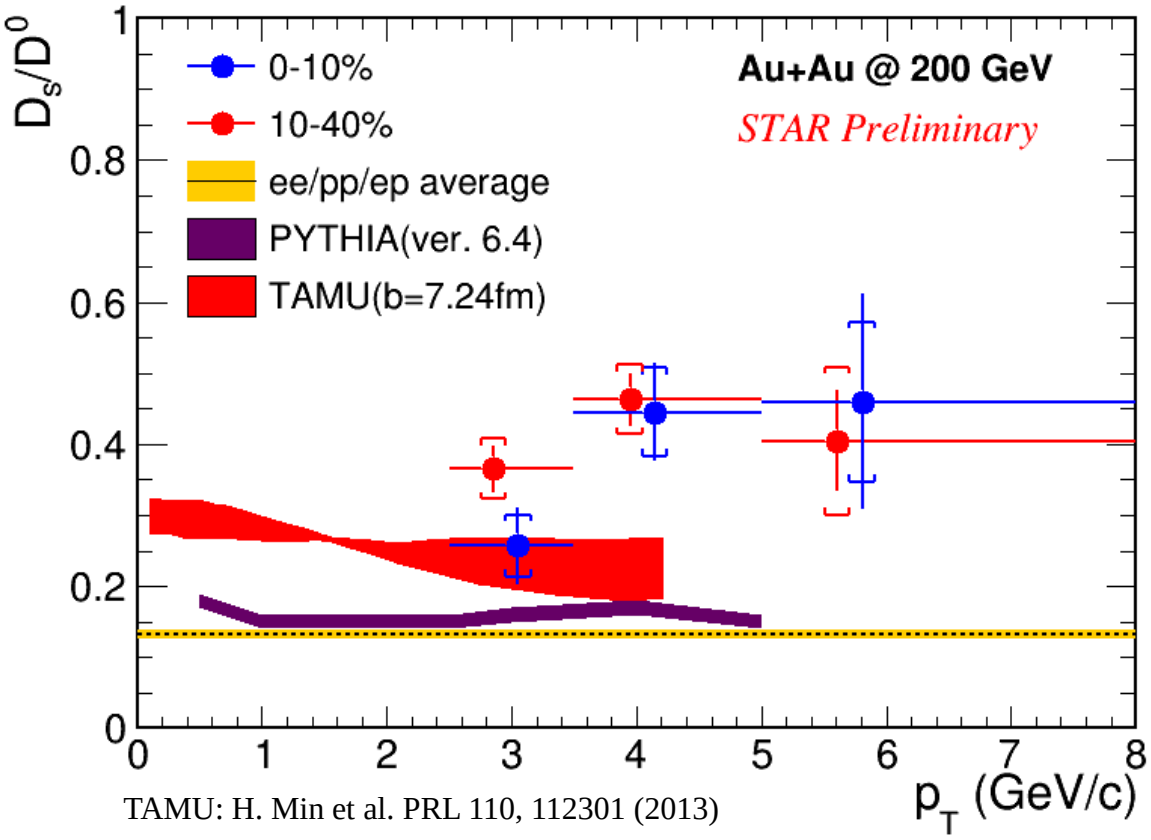
- Comparable ratio between RHIC and LHC in overlapping p_T range

D_s^+/D^0 ratio: data vs. PYTHIA



- Observed strong enhancement with respect to PYTHIA prediction

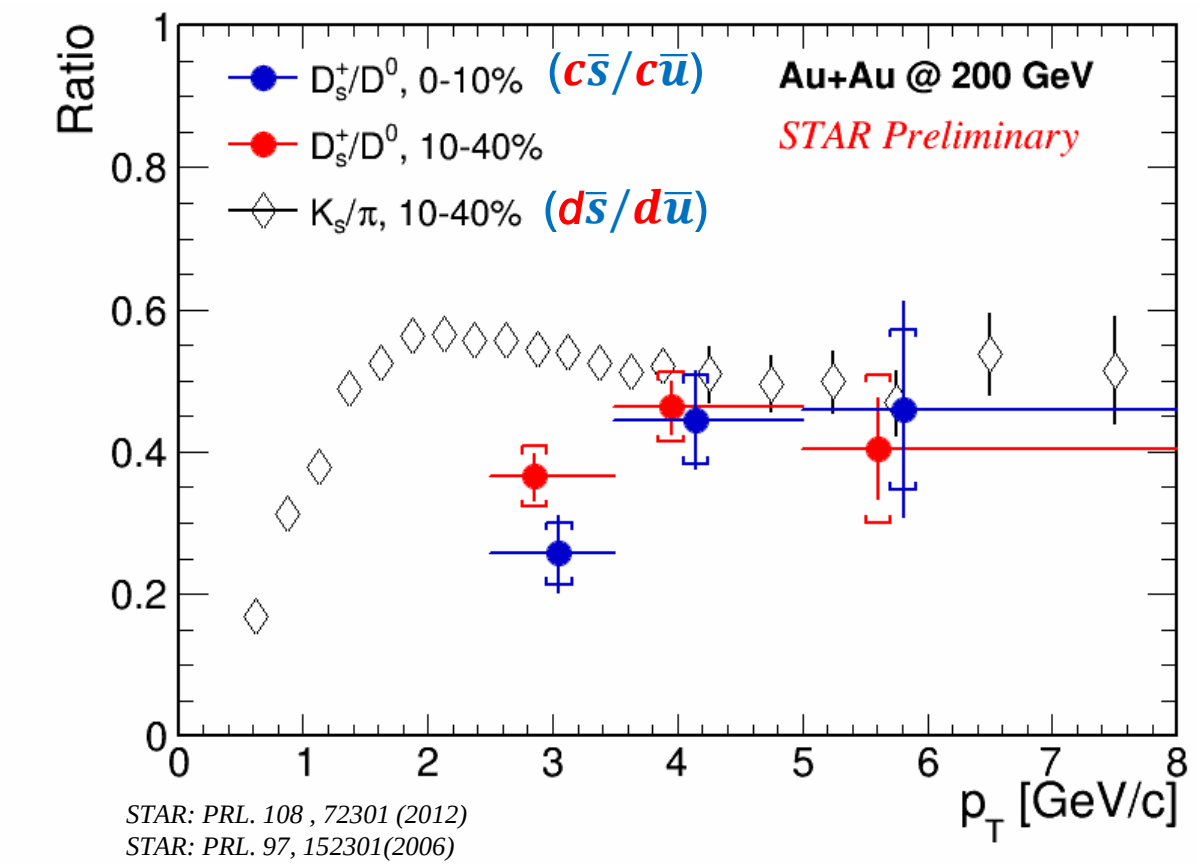
D_s^+/D^0 ratio : Data vs Model



TAMU: H. Min et al. PRL 110, 112301 (2013)

- Observed strong enhancement with respect to PYTHIA calculation
- Measured ratio is also larger than TAMU model (~10-40%) prediction
  - D_s^+/D^0 for TAMU: $R_{AA}^{TAMU}(D_s^+)/R_{AA}^{TAMU}(D)$*0.1869

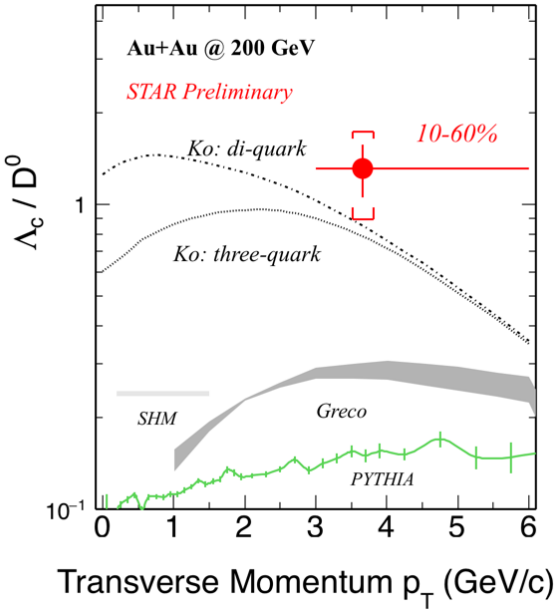
D_s^+/D^0 ratio: charm vs. light quark

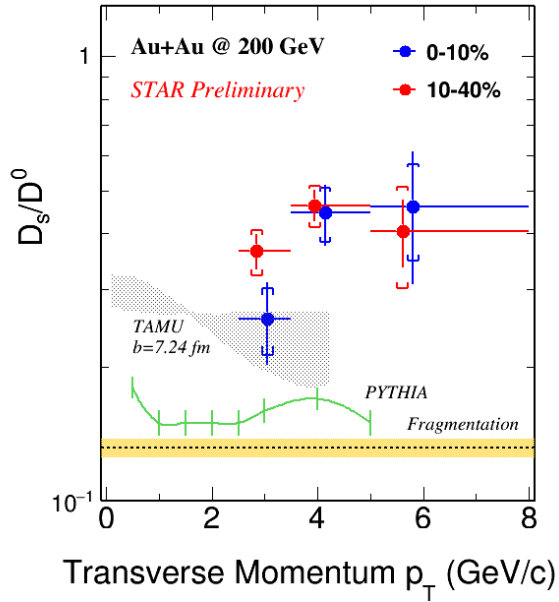


- Similar amplitude as light hadron at 3.5-8 GeV/c, but smaller enhancement at 2.5-3.5 GeV/c.

Summary

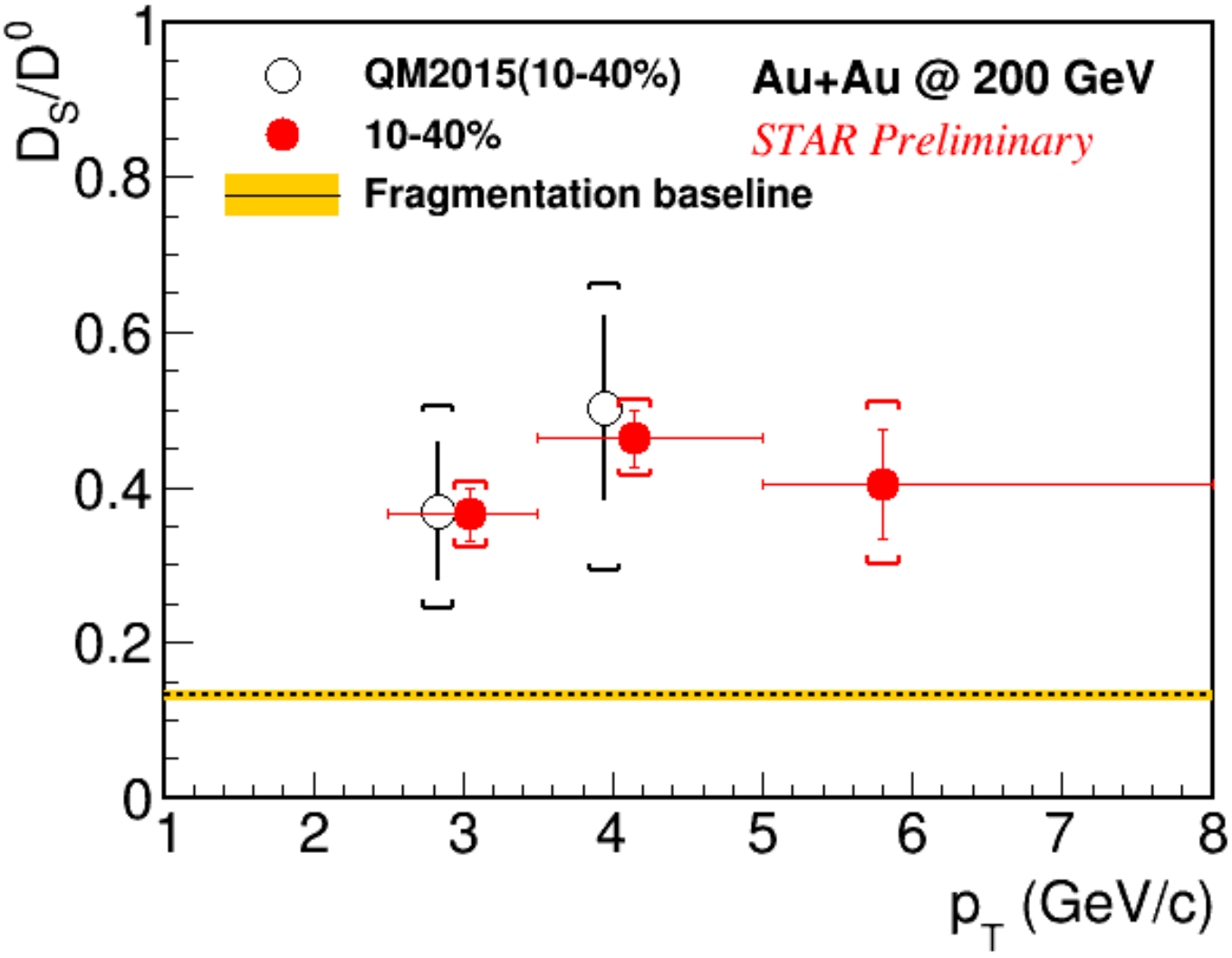
- First measurement of Λ_c^+ production in heavy-ion collisions
  - $\Lambda_c^+/D^0 = 1.3 \pm 0.3(\text{stat}) \pm 0.4(\text{sys})$, PYTHIA 0.1-0.15
  - Ko model with coalescence hadronization and thermalized charm quarks consistent with our measurement
- Enhancement of D_s^+/D^0 ratio with respect to PYTHIA prediction
  - TAMU model underestimates the enhancement in 10-40% centrality
- Observed Λ_c^+/D^0 (3-6 GeV/c) and D_s^+/D^0 (3.5-8 GeV/c) ratios comparable with light hadrons
- Outlook
  - In 2016, STAR collected 2 billion Au+Au events
  - More precise measurements of Λ_c^+ R_{cp} and D_s^+ v_2 are underway.





Thanks

Compare with QM2015



Strangeness enhancement