Measurement of $\overline{\Lambda_c}^- / \Lambda_c^+$ ratio in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV with the STAR experiment

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Abstract

The yield ratios of strange anti-baryons to baryons have been measured in heavy-ion collisions and exhibit a trend that is getting closer to unity with increasing number of valence strange quarks. This ratio has, however, never been measured for charm baryons, and it is important to establish if they exhibit a similar amount of baryon-to-anti-baryon enhancement as strange baryons. Λ_c is the lightest baryon containing a charm quark and, as such, presents a unique probe to study the hadronization of charm quarks in the hot and dense QCD medium created in ultra-relativistic heavy-ion collisions. Λ_c has, however, an extremely short lifetime ($c\tau \sim 60$ μm) which makes the reconstruction experimentally challenging. The Heavy Flavor Tracker, installed at the STAR experiment between the years 2014 – 2016, has shown a high efficiency and an unparalleled track-pointing resolution that can facilitate the Λ_c reconstruction in heavy-ion collisions. In this poster, we present the reconstruction of Λ_c baryons via hadronic decays and the studies on the measurement of the yield ratio of $\overline{\Lambda_c}^- / \Lambda_c^+$ utilizing the high-statistics data samples of Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV, recorded with the STAR experiment in 2014 and 2016, including a statistical error projection.

Motivation

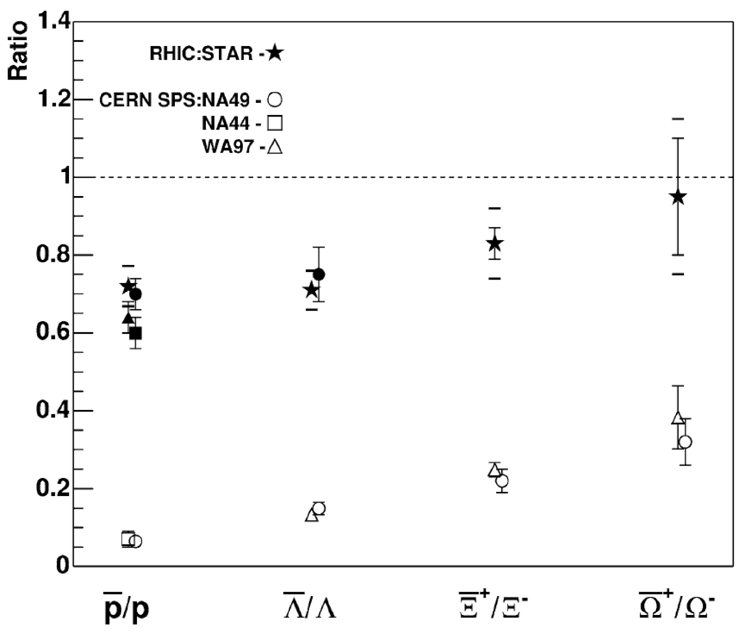

Figure 1: Ratios of anti-baryons to baryons [1].

- Ratios of strange anti-baryons to baryons grow towards unity with increasing number of strange valence quarks in the baryon.
- This ratio has never been measured for charm baryons and anti-baryons in heavy-ion collisions.
- $\overline{\Lambda_c}^- / \Lambda_c^+$ can bring important inside into the hadronization of charm quarks.

Solenoidal Tracker at RHIC: 2π acceptance in azimuth

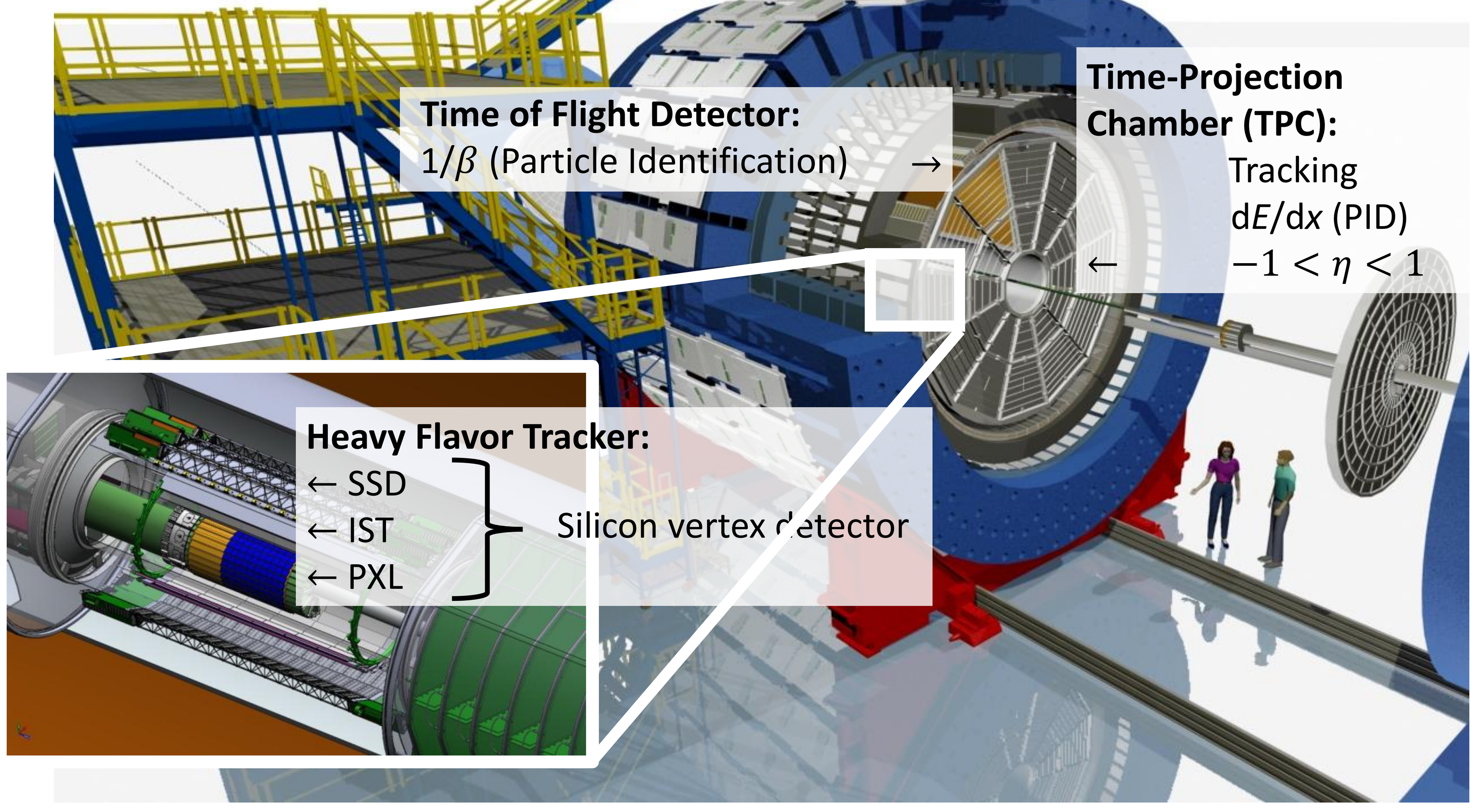

Figure 2: The STAR experiment and subdetectors used in the Λ_c analysis.

Signal extraction

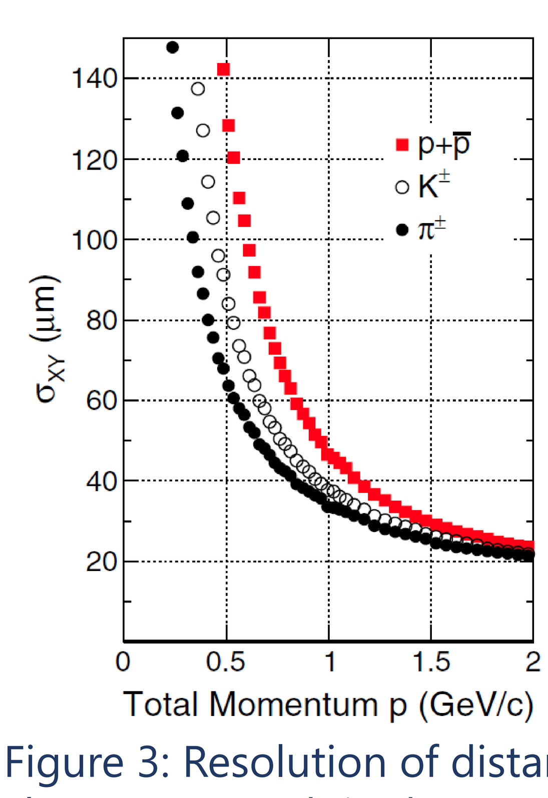

Figure 3: Resolution of distance of closest approach in the transverse plane of identified tracks to the primary vertex with the HFT [2].

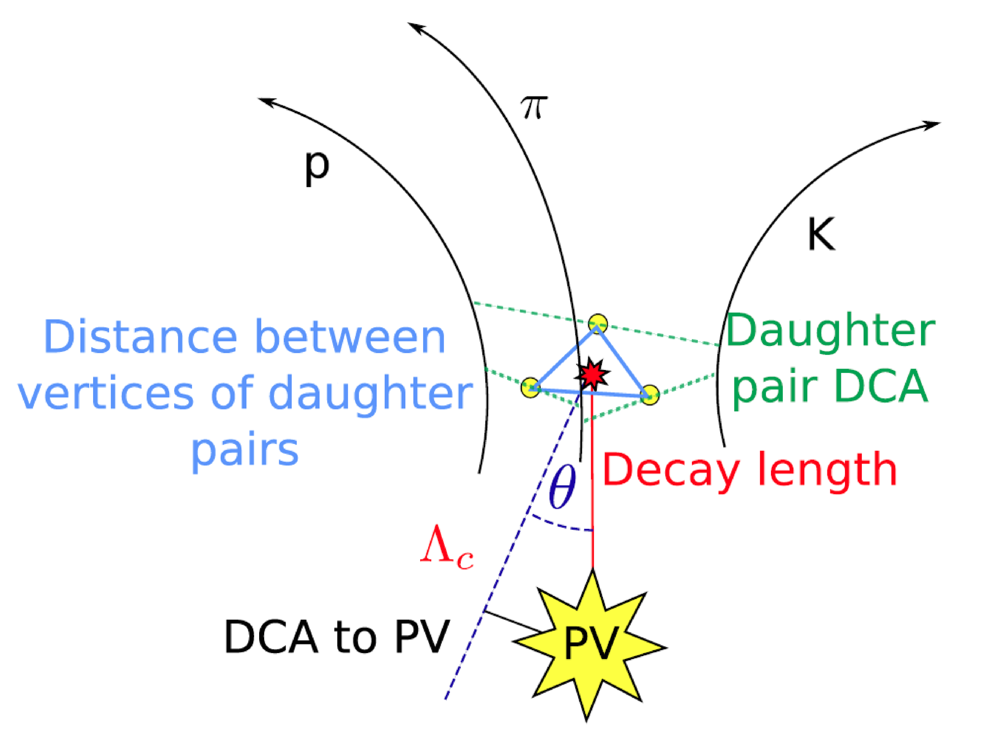

Figure 4: Topological reconstruction of the Λ_c secondary vertex.

- Short life time of $c\tau = 60$ μm.
- Three-body decay channel $\Lambda_c^\pm \to \pi^\pm K^\mp p^\pm$ used.
- Topological reconstruction thanks to the excellent tracking resolution of the HFT.
- Cuts on topological variables optimized via the Toolkit for Multi-Variate Analysis (TMVA – [3]) package, using rectangular cuts method.

Charge dependence of the reconstruction efficiency

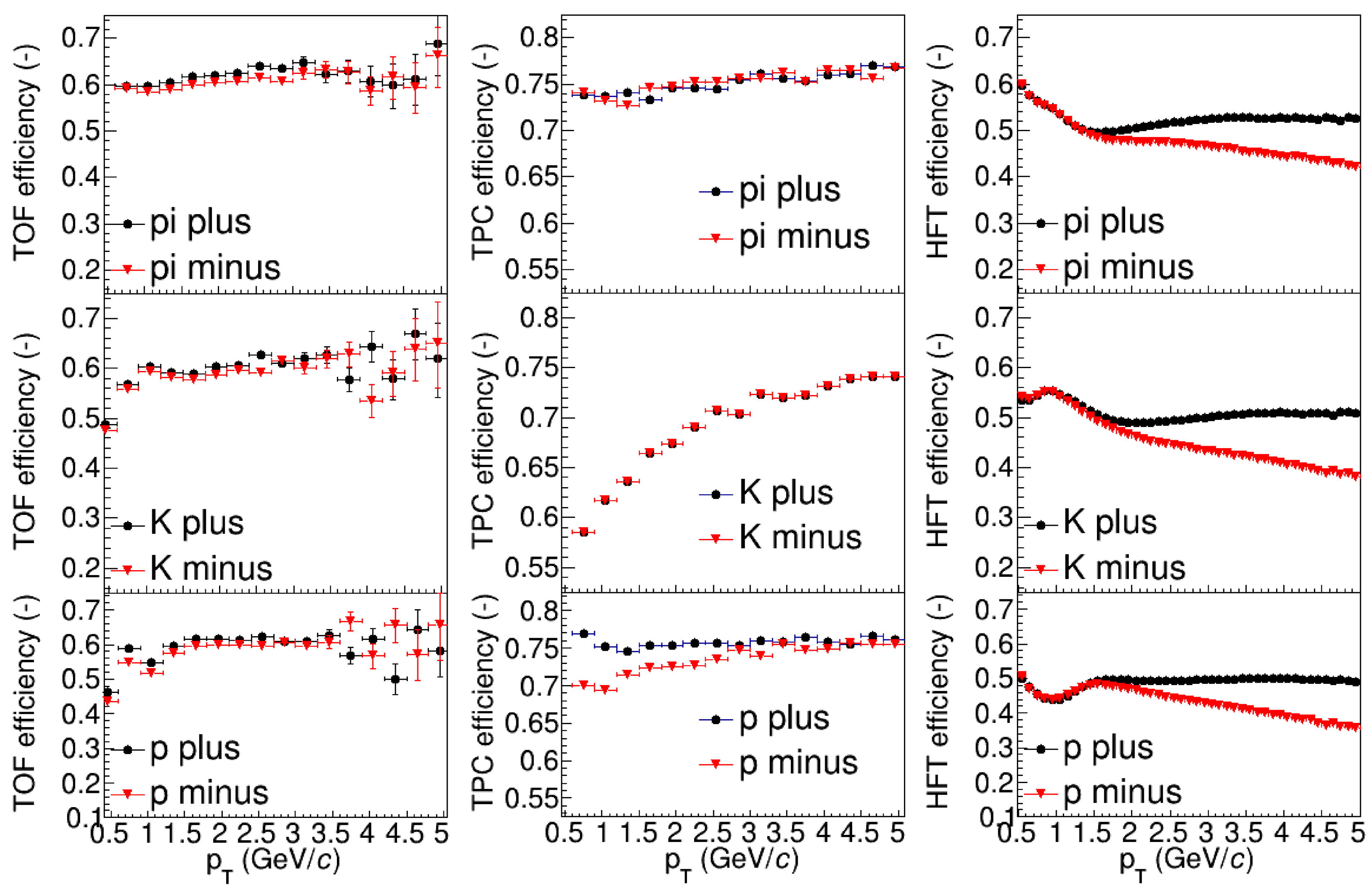

Figure 4: Difference in the TOF-matching efficiency.

Figure 5: Difference in the TPC efficiency.

Figure 6: Difference in the HFT-matching efficiency.

- HFT- and TOF- matching efficiencies obtain from real data.
- TPC efficiency obtained from embedding of simulated tracks in real data.
- There is an observable charge dependence in the detectors – currently under study.

$\overline{\Lambda_c}^- / \Lambda_c^+$ efficiency ratio

- The efficiencies were extracted separately for Λ_c^+ and $\overline{\Lambda_c}^-$, using a data-driven simulation:
  - The Λ_c were decayed, using the EvtGen simulator [4].
  - The positions of the daughter particles were smeared according to the DCA distribution extracted from the data.
  - Momenta are smeared according to detector simulation.

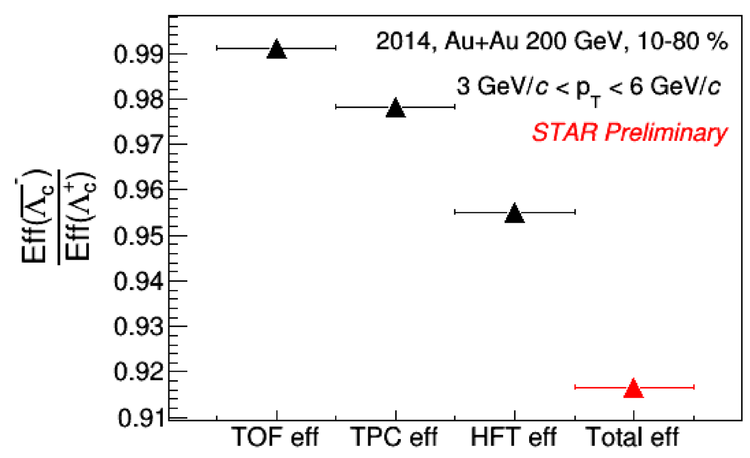

Figure 7: 2014 $\overline{\Lambda_c}^- / \Lambda_c^+$ efficiency ratio.

Statistical error projection of the $\overline{\Lambda_c}^- / \Lambda_c^+$ Yields Ratio

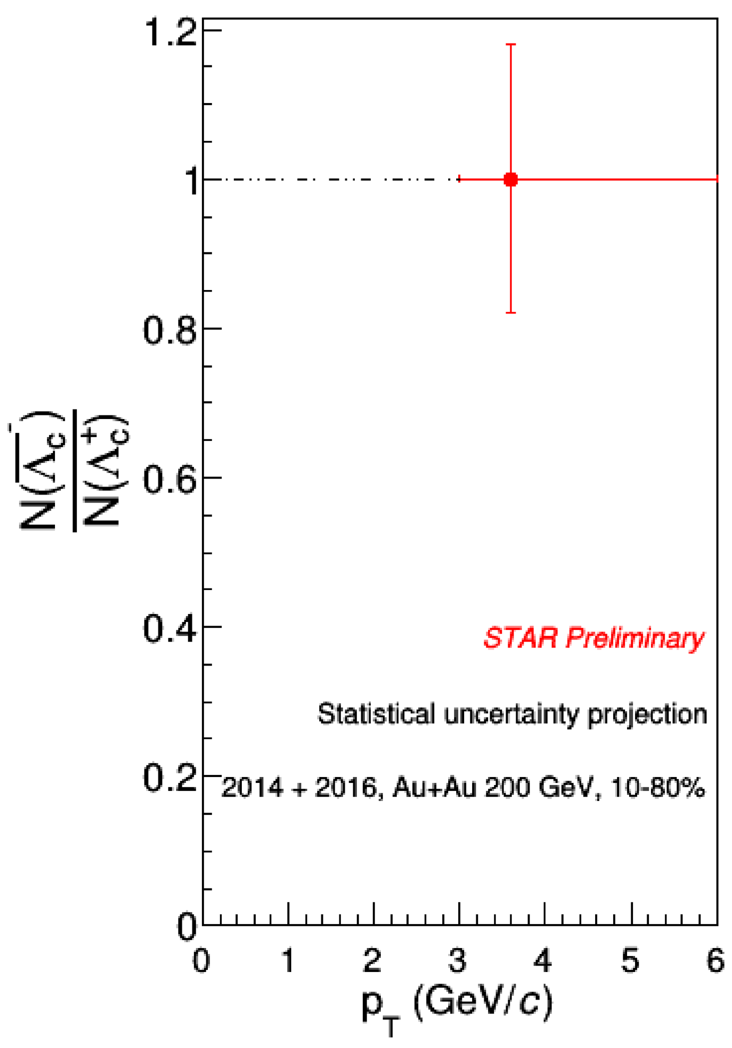

Figure 8: Projection of the statistical error of the $\overline{\Lambda_c}^- / \Lambda_c^+$ ratio, using 2014 – 2016 Au+Au data.

References

[1] J. Adams, et al. (STAR), Phys. Lett. B **567** (2003) 167 – 174.
[2] L. Adamczyk et al. (STAR) Phys. Rev. Lett. **118** (2017) 212301.
[3] L. Hoecker et al., arXiv:physics/0703039.
[4] D.J. Lange, Nucl. Instrum. Meth. A**462** (2001) 152-155.

Acknowledgement

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