

# Baryon-Strangeness Correlations in $\sqrt{s_{NN}} = 3$ GeV Au+Au Collisions from RHIC-STAR

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## Abstract

Fluctuations of conserved quantities are proposed as a powerful observable to search for the QCD critical point. Recently, proton cumulants from central Au+Au  $\sqrt{s_{NN}} = 3$  GeV collisions were reported. The results imply that hadronic interactions are dominant at  $\sqrt{s_{NN}} = 3$  GeV and the QCD critical point could exist at higher collision energies. The baryon-strangeness correlation is expected to deviate from the QGP expectation at high baryon-chemical potential, which can be a signature for turning-off of the QGP. We report the second-order baryon-strangeness correlation using proton,  $K^\pm$ , and  $\Lambda$  in Au+Au collisions at  $\sqrt{s_{NN}} = 3$  GeV from the fixed-target program at the STAR experiment. Physics implications of the results as well as comparisons with model calculations are discussed.

## Introduction

**Baryon-strangeness correlation coefficient:**  
$$C_{BS} = -3 * \frac{\langle BS \rangle_c}{\langle S^2 \rangle_c} = -3 * \frac{\langle BS \rangle - \langle B \rangle \langle S \rangle}{\langle S^2 \rangle - \langle S \rangle^2}$$

The  $B$  and  $S$  are number of baryon and strangeness, respectively. The subscript  $c$  indicates ( $\cdot$ ) is cumulant.

- Sensitive to the onset of deconfinement [1]
- Previous STAR measurements on mix-cumulant (using  $p$ ,  $K^\pm$  and their antiparticles) are far away from theoretical prediction [2]
- This work tests the turning-off signal of QGP in 3 GeV Au+Au collisions

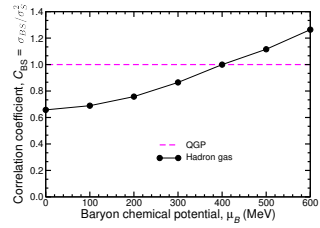
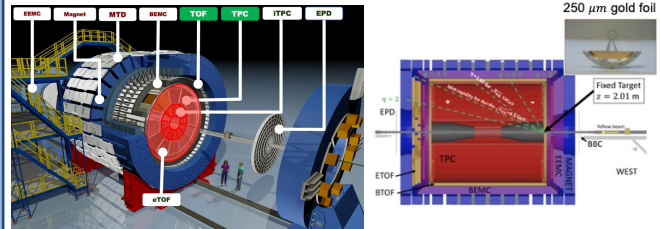
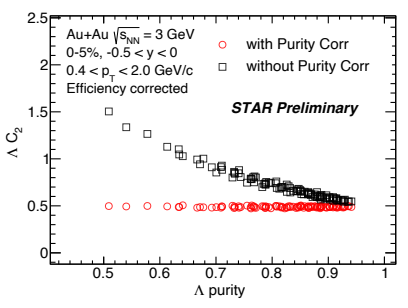
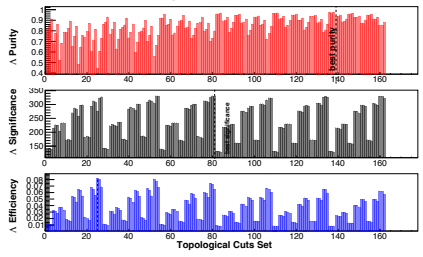
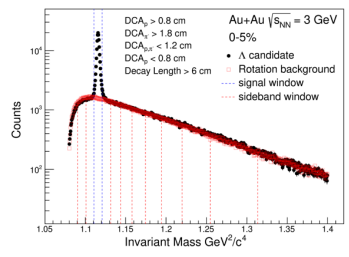


Figure from [1]

## STAR Detector & Fixed-Target Setup

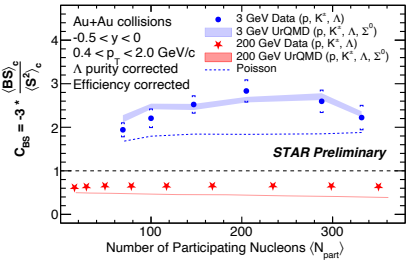
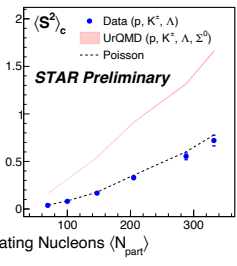
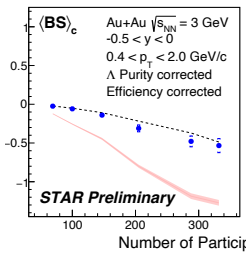


## Analysis Details



- $\Lambda$  reconstruction is done for various topological cuts combination.
- Higher  $\Lambda$  significance means both higher  $\Lambda$  purity and reconstruction efficiency.
- A purity correction method [3] which supposes background in signal region is equivalent to sideband, is used to statistically remove background effect.
- Black rectangles are purity uncorrected results.
- The  $\Lambda C_2$  (variance) are flat and stable with purity correction (red circles).

## Results



- The negative  $\langle BS \rangle_c$  in all centralities indicates negative correlation between baryon and strangeness.
- The  $\langle BS \rangle_c$  and  $\langle S^2 \rangle_c$  values show deviations from Poisson baselines within  $2\sigma$  uncertainties while they show larger deviations from UrQMD calculations.
- The  $C_{BS}$  ratio of 3 GeV data is well described by UrQMD calculation while 200 GeV data [4] is under-estimated by UrQMD.
- The consistency between 3 GeV data and hadronic transport model calculation supports the conclusion that hadronic interactions are dominant in 3 GeV Au+Au collisions.

## Summary

- We report the centrality dependence of  $C_{BS}$  ratio in 3 GeV Au+Au collisions from RHIC-STAR.
- The  $C_{BS}$  ratio of 3 GeV data is well described by UrQMD calculation.
- STAR results support the conclusion that hadronic interactions are dominant in 3 GeV Au+Au collisions.

## References

- [1] V. Koch, A. Majumder, and J. Randrup, PRL 95, 182301 (2005)
- [2] STAR, PRC 105, 29901 (2022)
- [3] T. Nonaka, NIMA 1039,167171 (2022)
- [4] T. Nonaka, ISMD2023

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The STAR Collaboration  
<https://drupal.star.bnl.gov/STAR/presentations>