

K^* Production as a Probe of Final-State Hadronic Interactions in High Baryon Density Regimes at RHIC BES-II Energies

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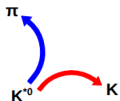
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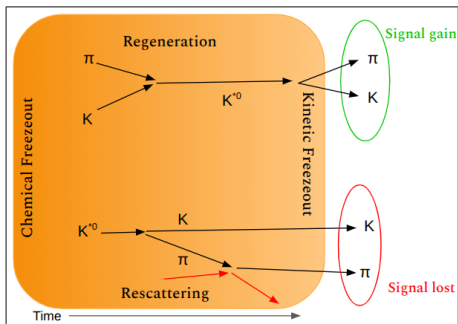
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- 1 Motivation
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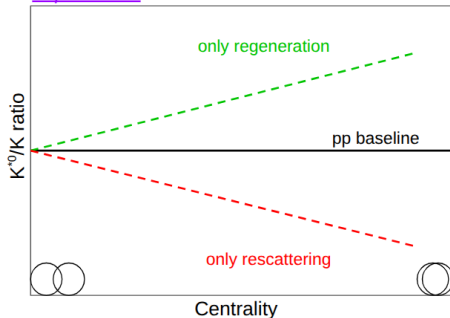
Why do we study K^{*0} ?



Particle Species	Quark Content	Mass (GeV/c ²)	Lifetime (fm/c)
$K^{*0}(K^{\bar{*}0})$	$d\bar{s}(\bar{d}s)$	~ 0.896	~ 4.16

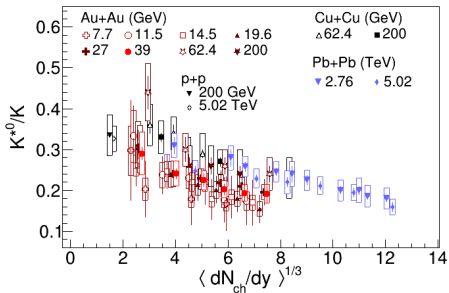


Expectation:



The study of the K^{*0}/K ratio serves as a valuable probe for understanding the interplay between rescattering and regeneration effects in heavy-ion collisions.

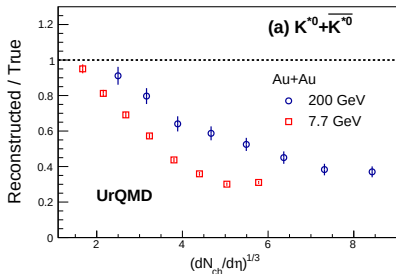
STAR: Phys. Rev. C 66 (2002) 61901



From BES-I measurement:

- $(K^{*0}/K)_{\text{Central}} < (K^{*0}/K)_{\text{peripheral}}$
 $\Rightarrow$ Dominance of hadronic rescattering.
- $(K^{*0}/K)_{\text{BES}} < (K^{*0}/K)_{\text{High-RHIC and LHC}}$
 (Need more precise measurement.)
- Indications of a deviation from multiplicity scaling in the K^{*0}/K ratio at lower collision energies.

STAR: Phys. Rev. C 107, 034907 (2023)

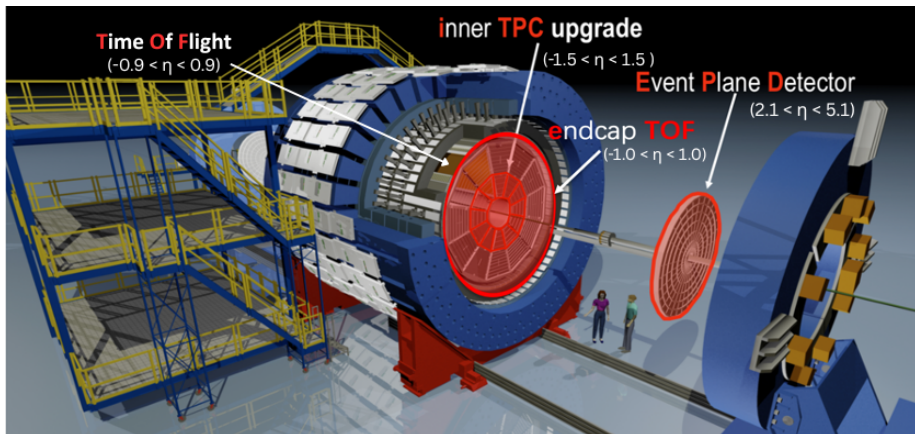


From Transport Model Study:

The loss of resonance yields is more significant at lower collision energies as compared to higher collision energies.

A. K. Sahoo *et al.*, J. Phys. G: Nucl. Part. Phys. 52, 015101 (2025)

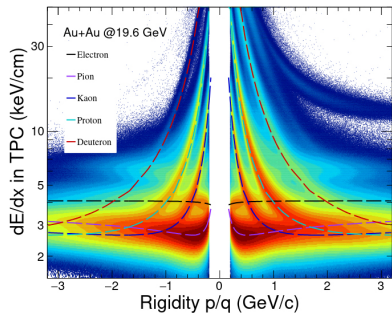
The STAR Experiment



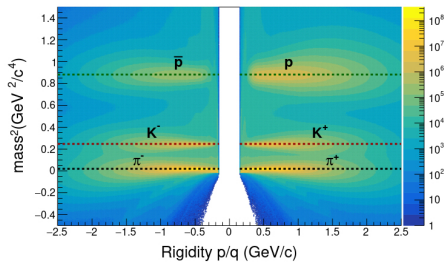
- Uniform acceptance, full azimuthal coverage, excellent PID capability.
- iTPC: Charged Particle Tracking.
- iTPC & TOF: Particle Identification.

Data sets: Au+Au (BES-II), $\sqrt{s_{NN}} = 7.7, 11.5, 14.6, 19.6, \text{ and } 27 \text{ GeV}$.

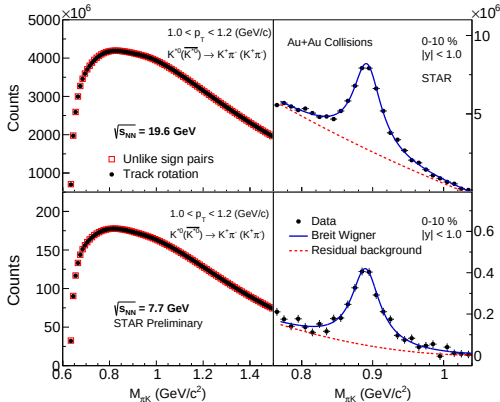
Au+Au 19.6 GeV



Using TPC



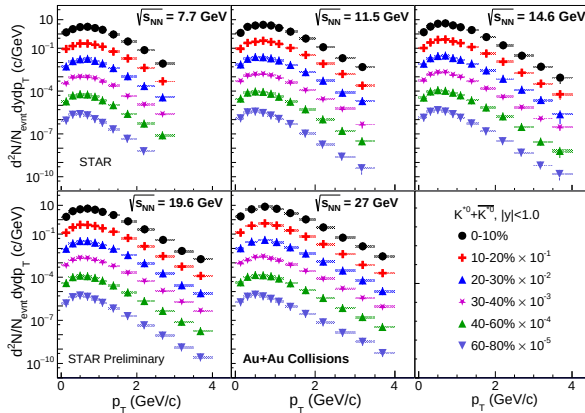
Using TOF



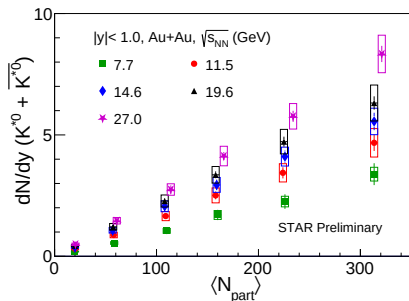
- Decay channel: $K^{*0}(K^{*0}) \rightarrow K^{\pm}\pi^{\mp}$ ($B.R \sim 66\%$)
- Signals are extracted using the invariant mass method. Invariant mass:

$$m_{inv}^2 = \sum_i E_i^2 - \sum_i \vec{p}_i^2$$
 where, $E^2 = (E_{\pi} + E_K)^2$
 and $\vec{p}^2 = (\vec{p}_{\pi} + \vec{p}_K)^2$
- The combinatorial background is estimated using the pair rotation method.
- Fitting function:

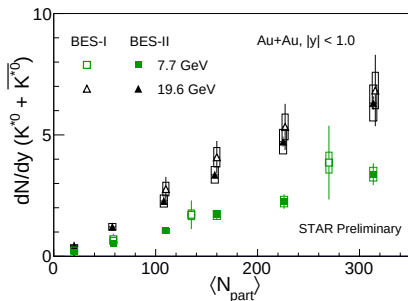
$$\frac{Y}{2\pi} \times \left[\frac{\Gamma_0}{(M-M_0)^2 + \frac{\Gamma_0^2}{4}} \right] + \text{2nd order polynomial for residual background.}$$



- $(K^{*0} + \bar{K}^{*0})$ p_T spectra at mid rapidity ($|y| < 1.0$) in various centralities in Au+Au collisions at $\sqrt{s_{NN}} = 7.7, 11.5, 14.6, 19.6$, and 27 GeV.
- The lowest p_T bin is $0.0 - 0.2$ GeV/c , hence no low p_T extrapolation needed for p_T -integrated yield.



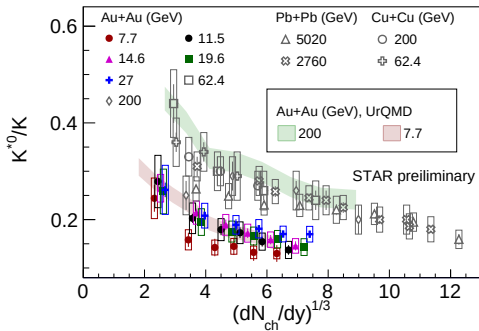
K^{*0} yield increases with centrality and collision energy.



The statistical errors are reduced by a factor ~ 3 in BES-II measurement as compared to those in BES-I.

For BES-I : STAR: Phys. Rev. C 107, 034907 (2023)

Multiplicity Dependence of the K^{*0}/K Ratio



- $(K^{*0}/K)_{\text{BES}} < (K^{*0}/K)_{\text{Top RHIC and LHC}}$

-A deviation from multiplicity scaling is observed at BES energies.

- The trends observed at both top RHIC and BES energies are qualitatively reproduced by the UrQMD model.

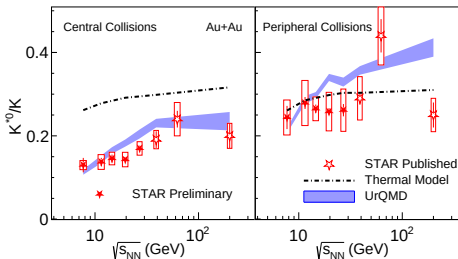
STAR: Phys. Rev. C 84, 034909 (2011)

STAR: Phys. Rev. C 95, 064606 (2017)

STAR: Phys. Lett. B 802, 135225 (2020)

A. K. Sahoo et al., J. Phys. G: Nucl. Part. Phys. 52, 015101 (2025)

Model Comparison:



- Thermal model overpredicts K^{*0}/K in central collisions but agrees with peripheral data.
- UrQMD qualitatively describes the data in the central collision.

-Dominant hadronic rescattering effects in central collisions.

T_{ch} , μ_B , μ_S are taken from STAR BES-I spectra analysis.

STAR: Phys. Rev. C 96, 044904 (2017)

A. K. Sahoo *et al.*, Phys. Rev. C 108, 044904 (2023)

STAR: Phys. Rev. C 107, 034907 (2023)

STAR: Phys. Rev. C 84, 034909 (2011)

- The STAR measurement of K^{*0} resonance production is presented for Au+Au Collisions at BES-II energies $\sqrt{s_{NN}} = 7.7, 11.5, 14.6, 19.6,$ and 27 GeV.
- The ratio of resonance to non-resonance particles, along with comparisons to model predictions, suggests that hadronic rescattering dominates over regeneration in central AA collisions.
- At BES energies, the K^{*0}/K ratio deviates from the universal multiplicity scaling observed at top RHIC and LHC energies. This deviation suggests a suppression of the K^{*0} yield at lower collision energies, likely resulting from increased hadronic rescattering effects in the later stages of the collision.

Thank you !!!