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

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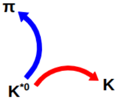
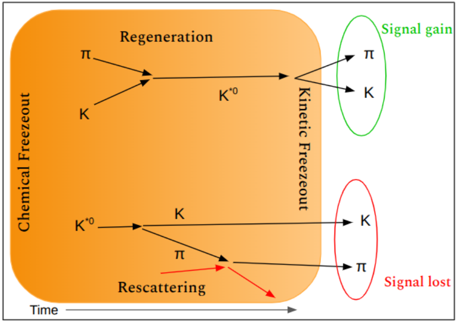
# Outline

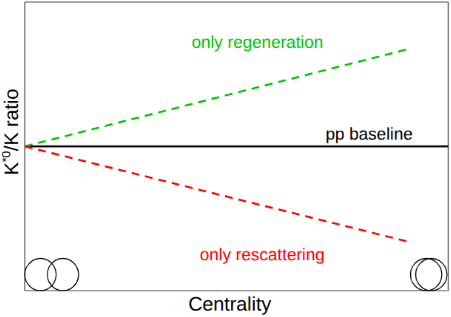
## *Why do we study $K^{*0}$?*




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

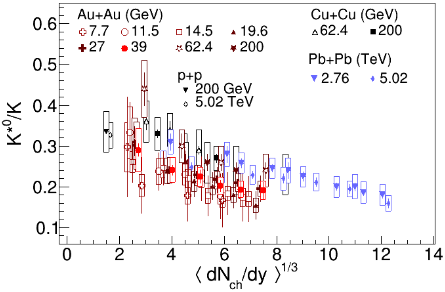



*Expectation:*




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.

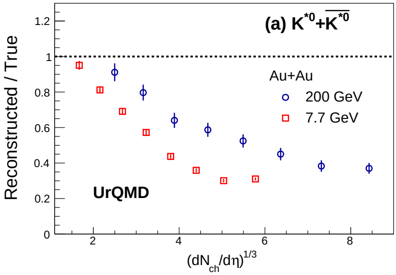
STAR: Phys. Rev. C 66 (2002) 61901




## *From BES-I measurement:*

- $(K^{*0}/K)_{\text{Central}} < (K^{*0}/K)_{\text{peripheral}}$
  $\Longrightarrow$ 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.

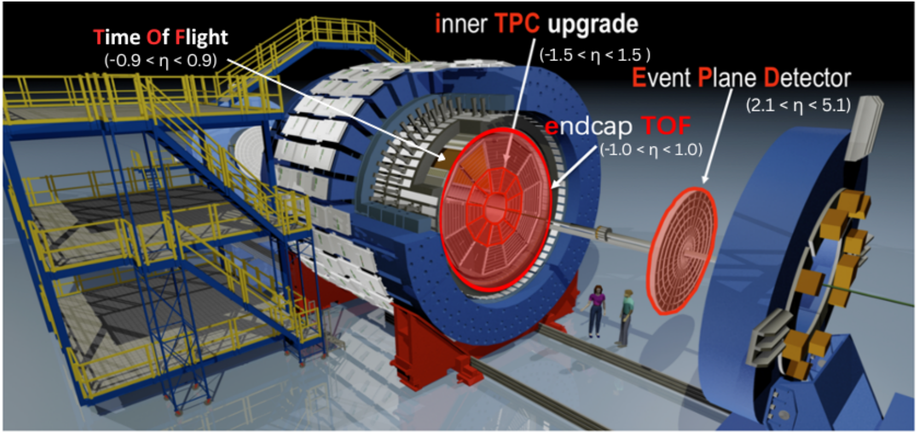
STAR: Phys. Rev. C 107, 034907 (2023)




## *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)

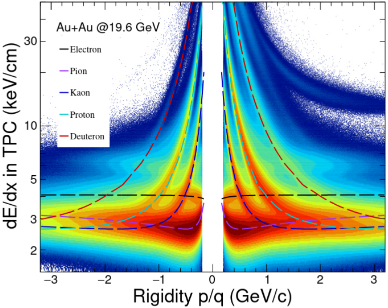



- Uniform acceptance, full azimuthal coverage, excellent PID capability.
- **iTPC:** Charged Particle Tracking.
- **iTPC & TOF:** Particle Identification.

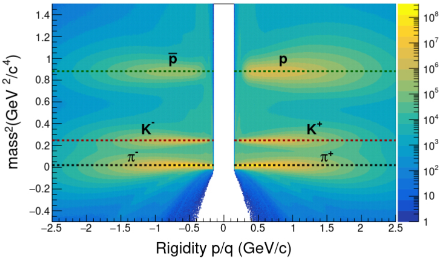
**Data sets:** Au+Au (BES-II), $\sqrt{s_{NN}} = 7.7, 11.5, 14.6, 19.6$, and 27 GeV.

# Particle Identification

Au+Au 19.6 GeV

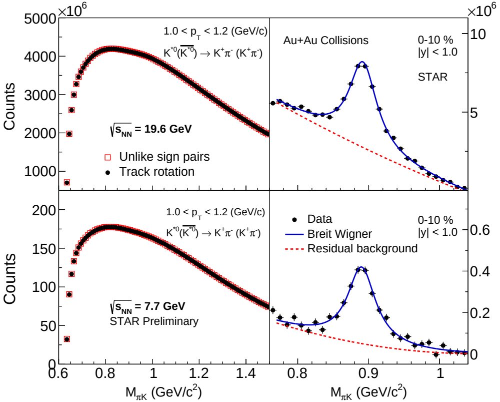



Using TPC



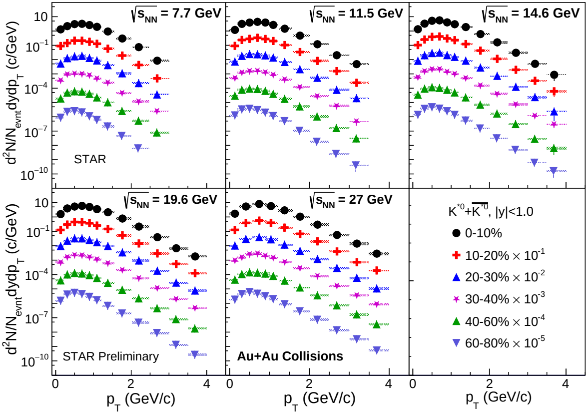

Using TOF

# $K^{*0}$ Signal Reconstruction

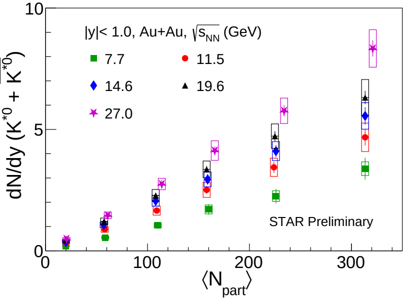


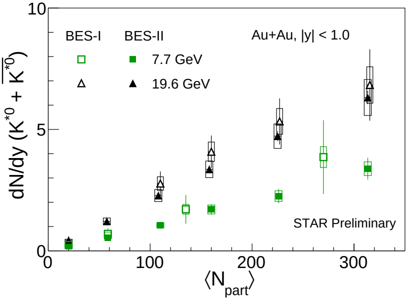

- Decay channel: $K^{*0}(\bar{K}^{*0}) \longrightarrow K^{\pm}\pi^{\mp}$ $(B.R \sim 66\%)$
- Signals are extracted using the invariant mass method. Invariant mass: $m_{inv}^2 = \sum_i E_i^2 - \sum_i \vec{p}_i^2$
  where, $E^2 = (E_\pi + E_K)^2$
  and $\vec{p}^2 = (\vec{p}_\pi + \vec{p}_K)^2$
- The combinatorial background is estimated using the pair rotation method.
- Fitting function:
  $\frac{Y}{2\pi} \times [\frac{\Gamma_0}{(M-M_0)^2+\frac{\Gamma_0{}^2}{4}}]$+ 2nd order polynomial for residual background.

# Transverse Momentum Spectra




- $(K^{*0}+\bar{K}^{*0})$ $p_T$ 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.



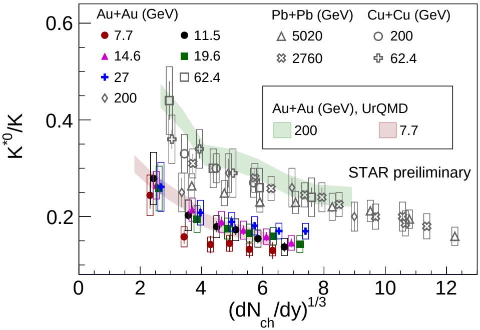




$K^{*0}$ yield increases with centrality and collision energy.

The statistical errors are reduced by a factor $\sim 3$ 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




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

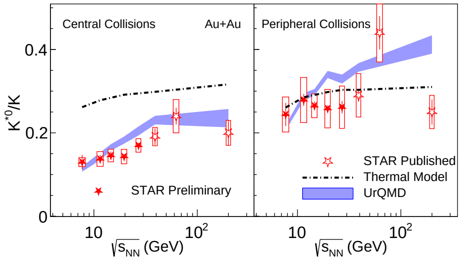
  *-A deviation from multiplicity scaling is observed at BES energies.*

- 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)

# Collision Energy Dependence of the $K^{*0}/K$ Ratio

## *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.*

$T_{ch}$, $\mu_B$, $\mu_S$ 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)

# Summary

- 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 !!!*