Probing hadronic rescattering via K^{*0} resonance production at RHIC

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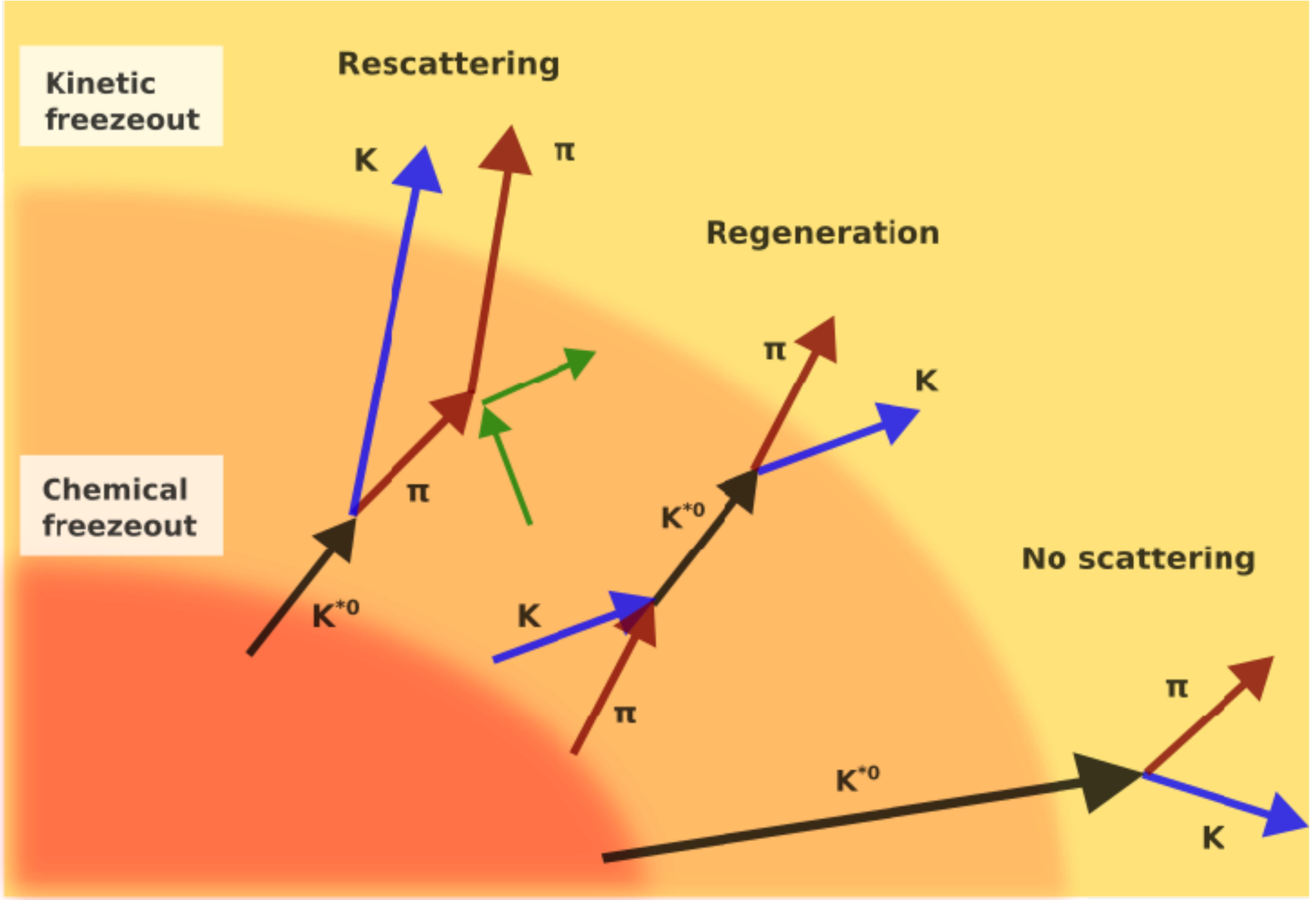
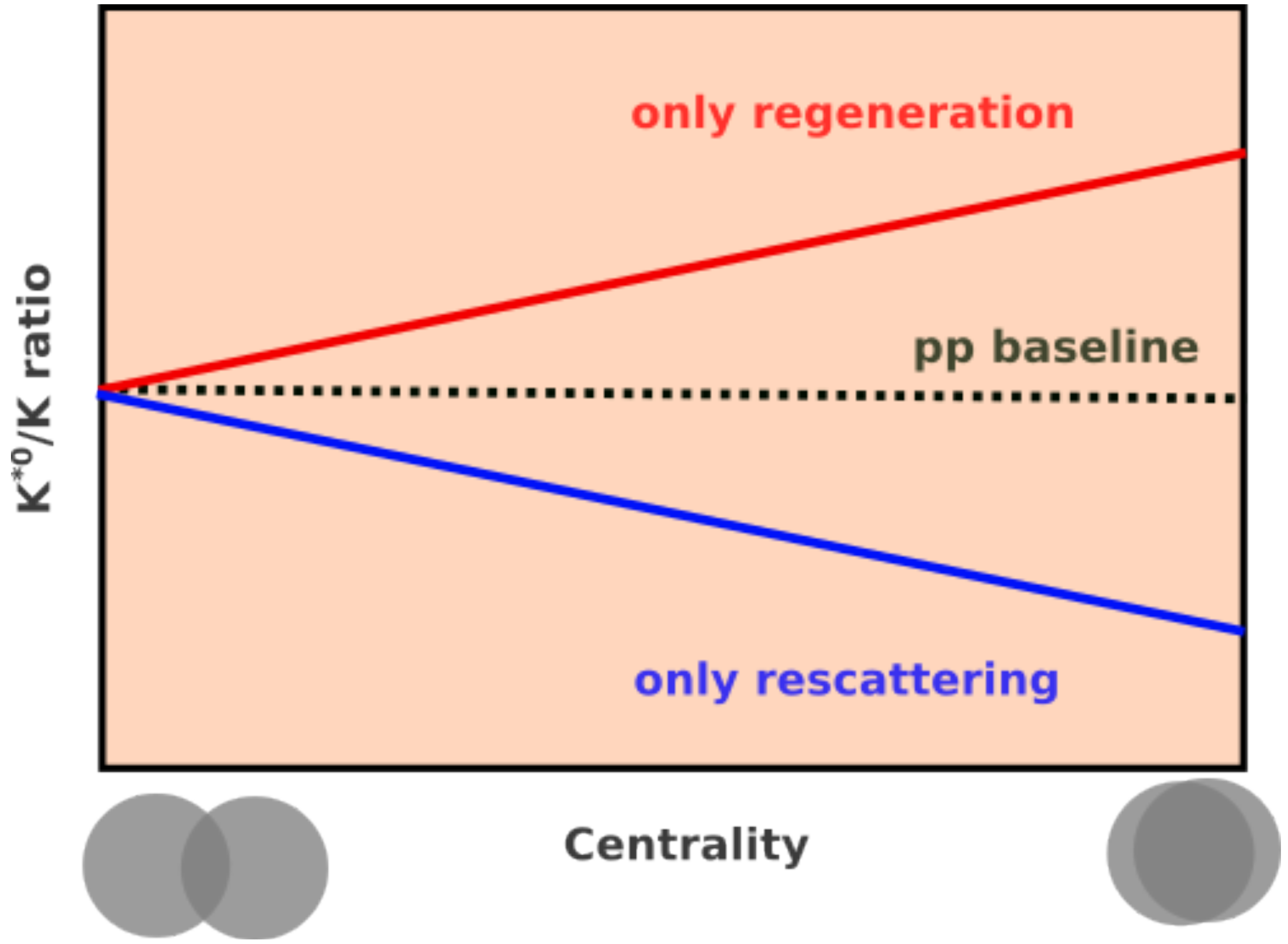
Motivation





Lifetime of K^{*0} ~ 4.16 fm/c

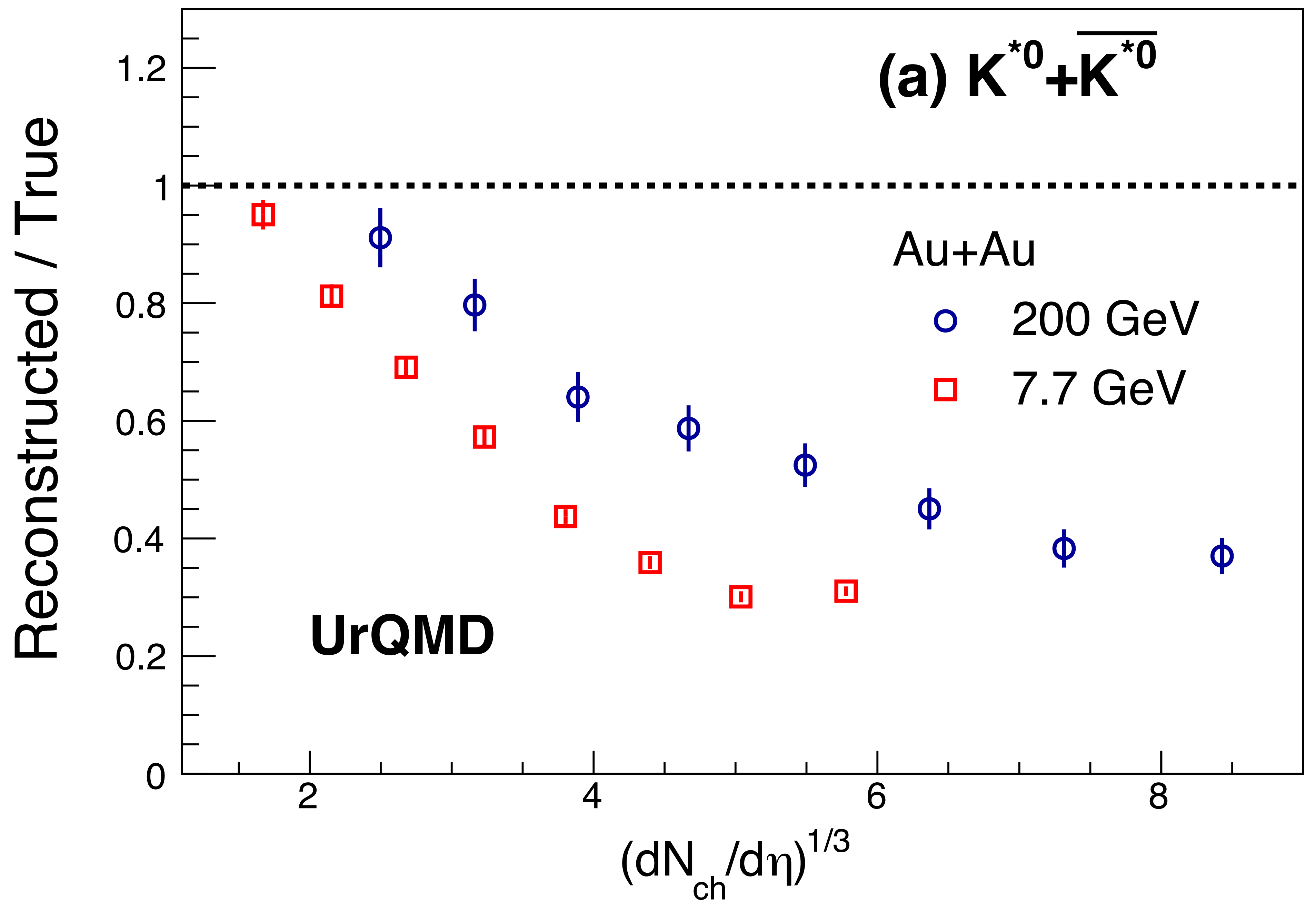
Study of K^{*0} can help to probe the interplay of rescattering and regeneration effects in heavy-ion collisions

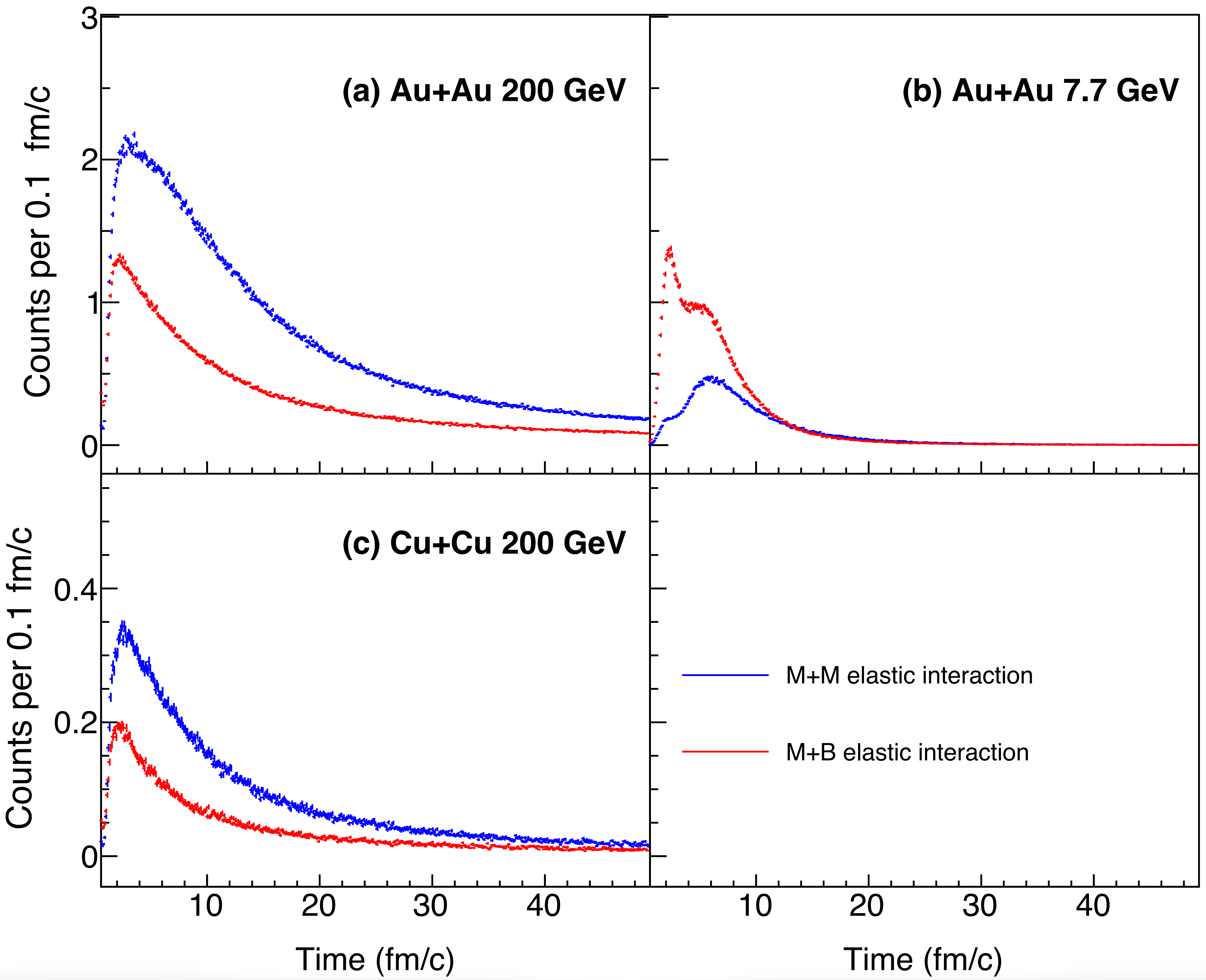
STAR. Phys. Rev. C 66 (2002) 61901

Motivation

A.K. Sahoo, ATHIC 2025

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

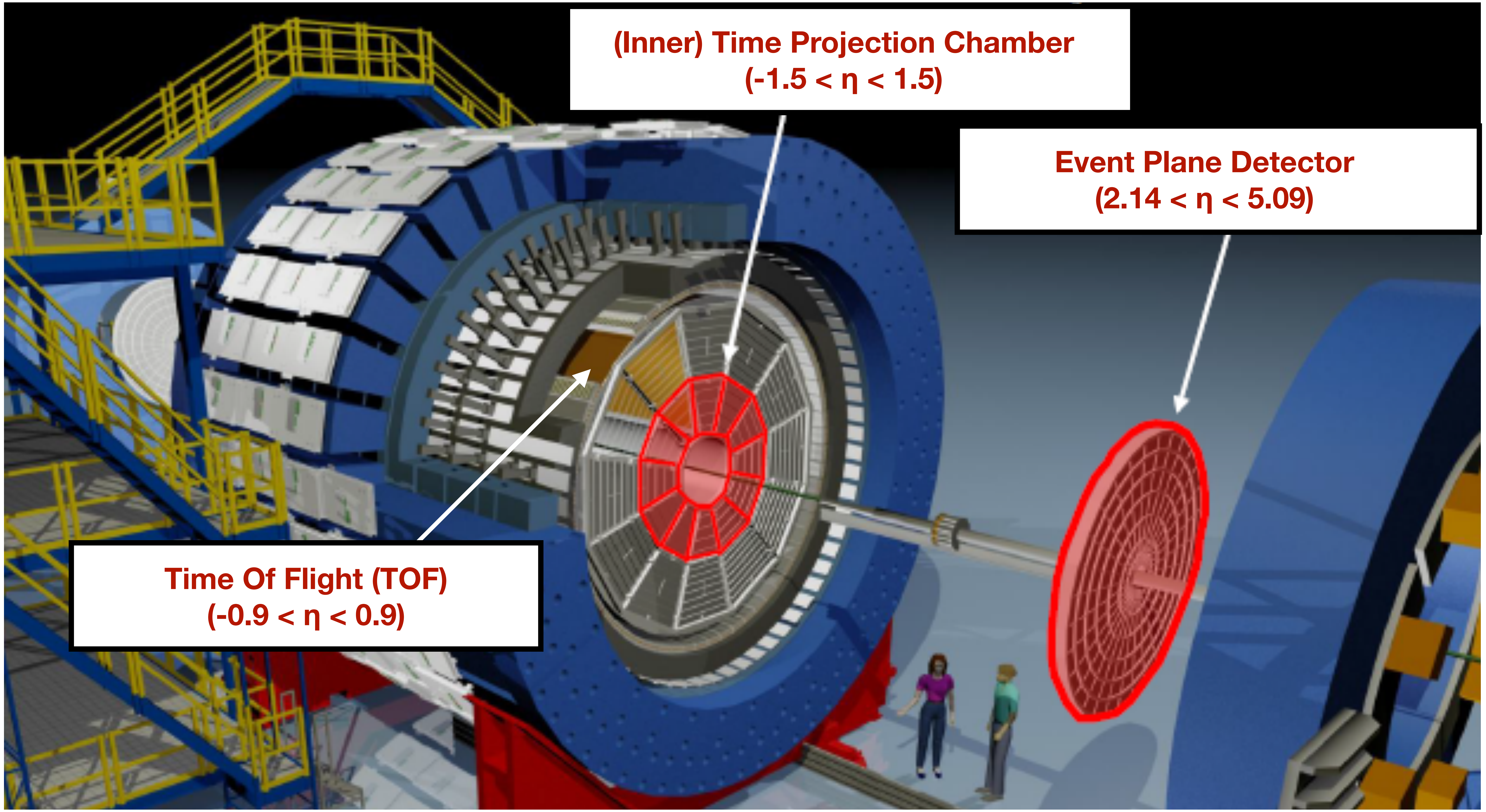




- The loss of resonance yields is more significant at lower collision energy as compared to higher collision energy

- Meson-baryon elastics interaction dominates over meson -meson interaction at lower energy regime.

The STAR detector



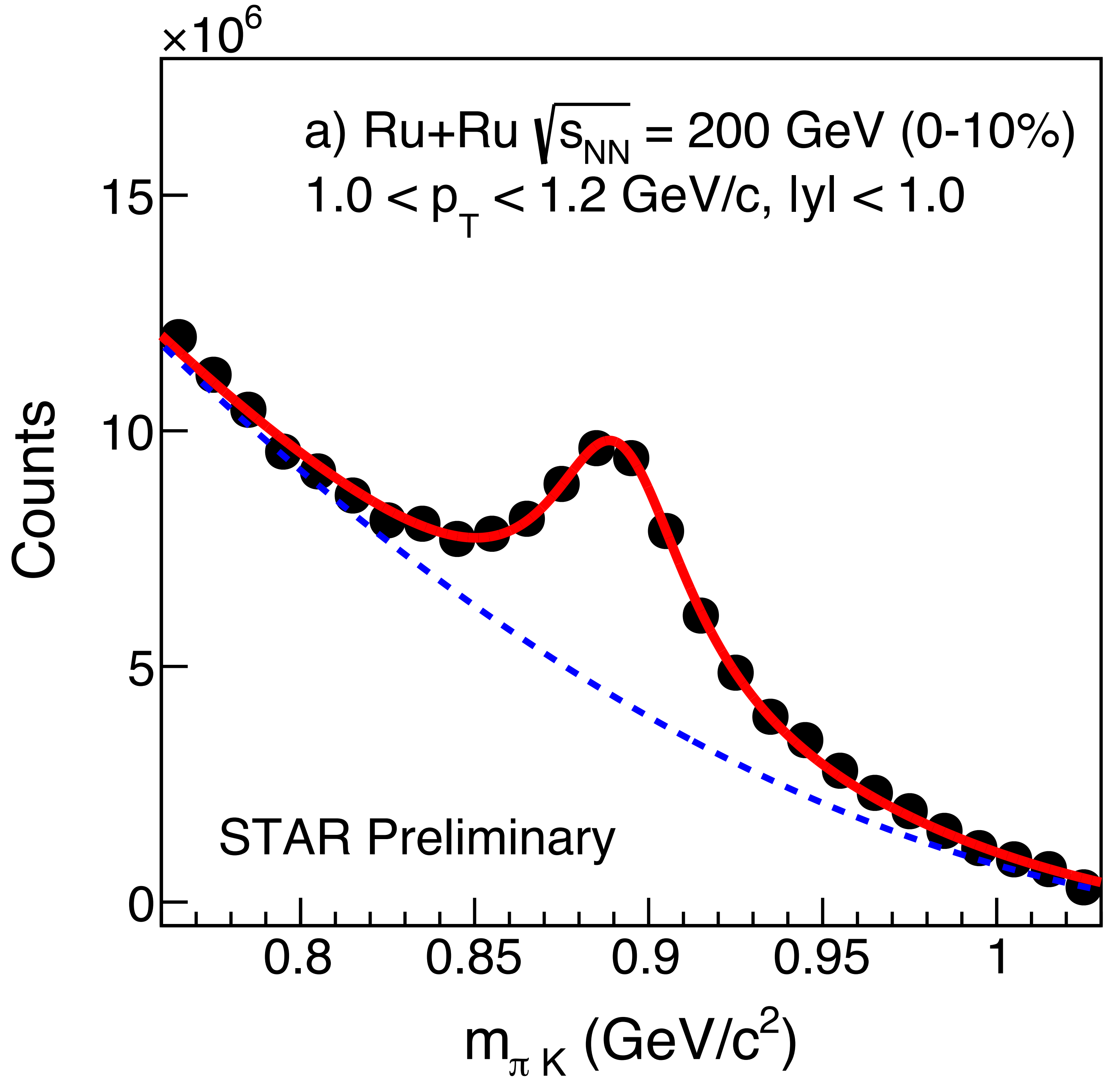
Data Sets:
Ru+Ru, Zr+Zr
$\sqrt{s_{NN}}$ = 200 GeV

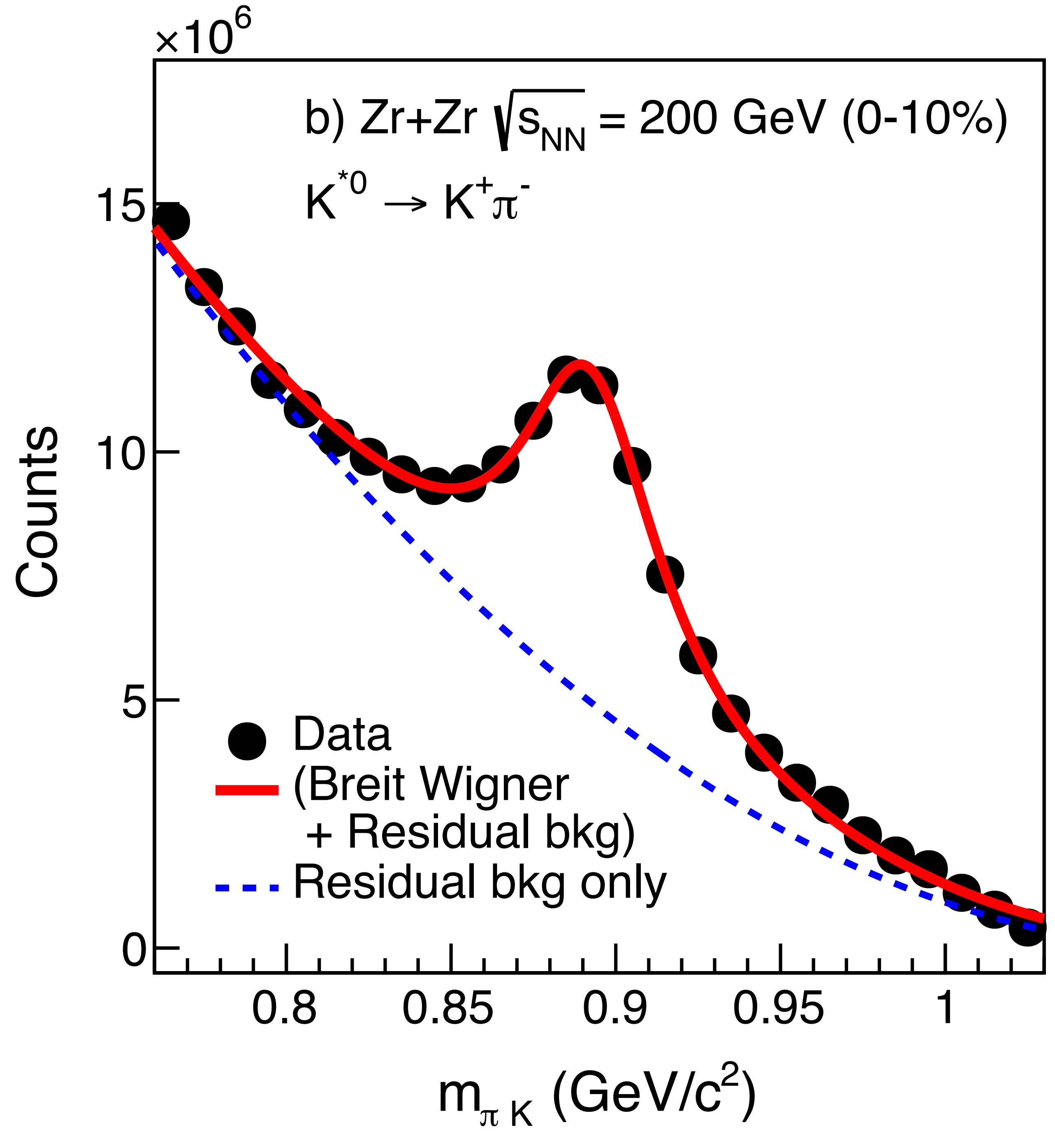
Au+Au (BES-II)
$\sqrt{s_{NN}}$ = 7.7, 11.5, 14.6, 19.6 and 27 GeV

Tracking: TPC

Particle Identification:
TPC & TOF

Signal reconstruction



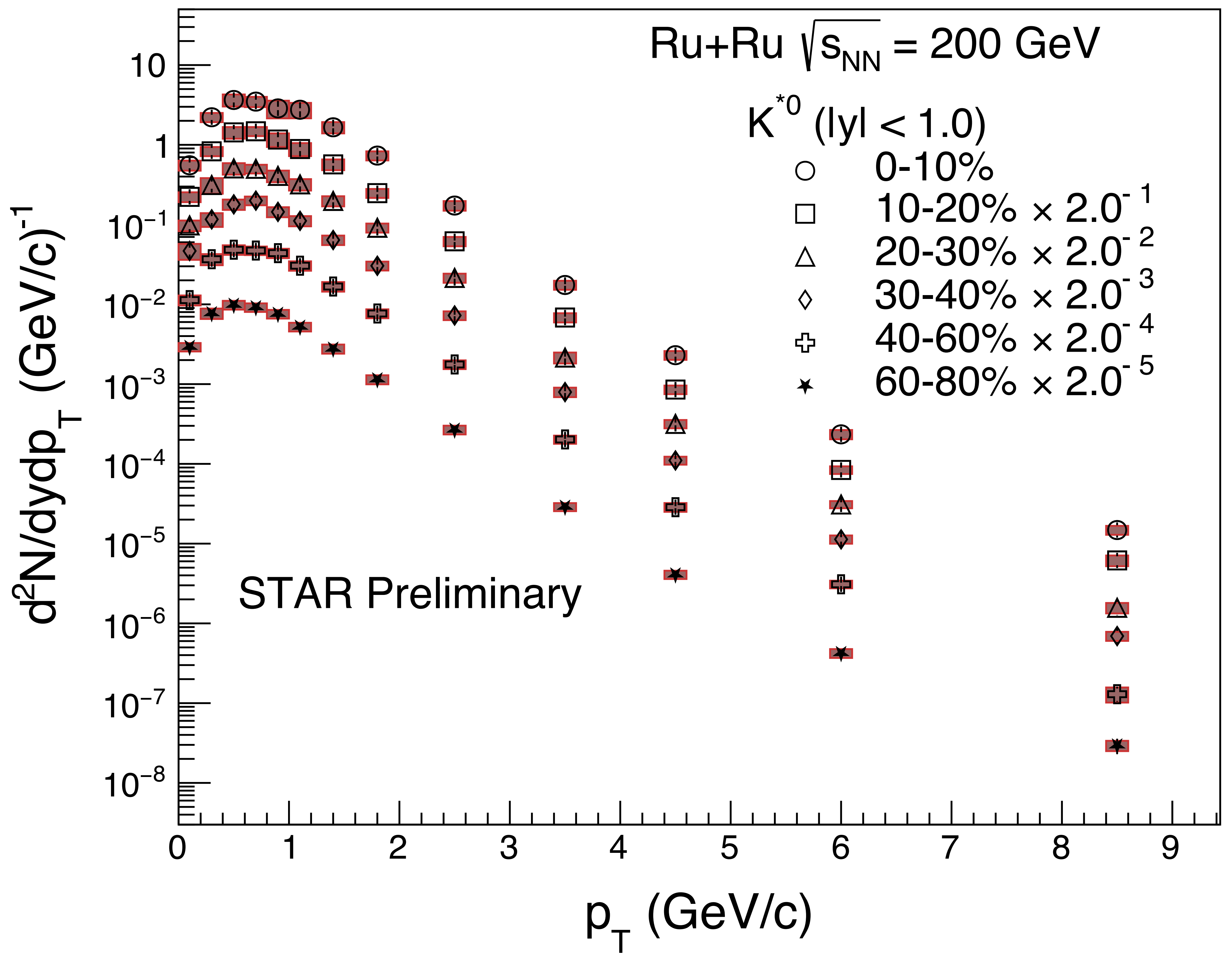


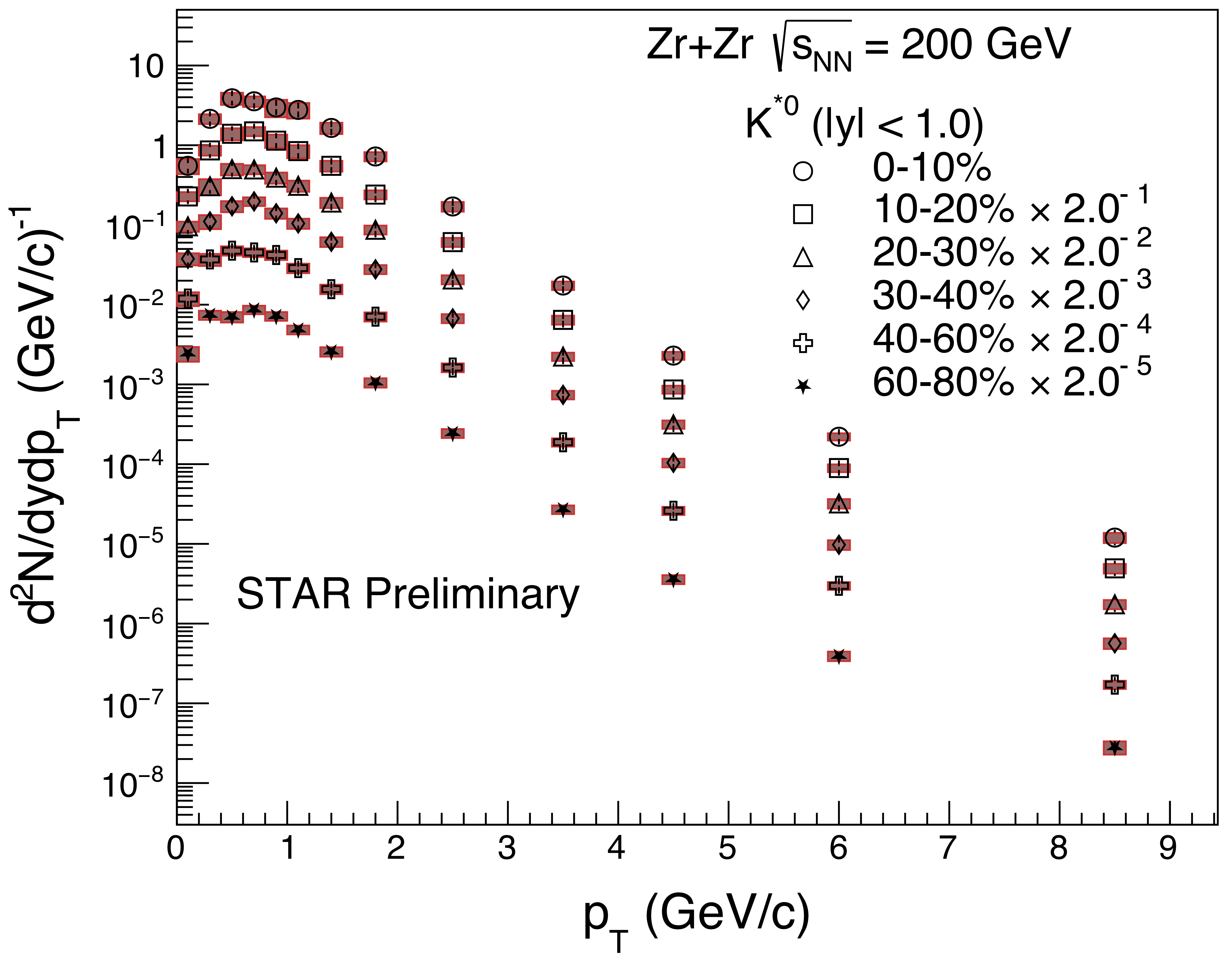
- Decay channel: $K^{*0}(\overline{K^{*0}}) \rightarrow K^{\pm}\pi^{\mp}$ (*B.R ~ 66%*)
- Signals are extracted using the invariant mass method.

  Invariant mass: $m^2_{inv} = \Sigma_i E^2_i - \Sigma_i p^2_i$, where $E^2 = (E_\pi + E_K)^2$ and $p^2 = (p_\pi + p_K)^2$
- The combinatorial background is estimated using the pair rotation method.
- Fitting function: $\frac{Y}{2\pi} \times \left[\frac{\Gamma_0}{(M-M_0)^2 + \frac{\Gamma_0^2}{4}}\right]$ + residual background

Transverse momentum spectra

A.K. Sahoo, ATHIC 2025





- Lowest p_T reach : 0.0-0.2 GeV/c ➞ No low-p_T extrapolation needed for p_T-integrated yield
- The yield for Ru+Ru and Zr+Zr are consistent with each other within uncertainties.

Particle yield

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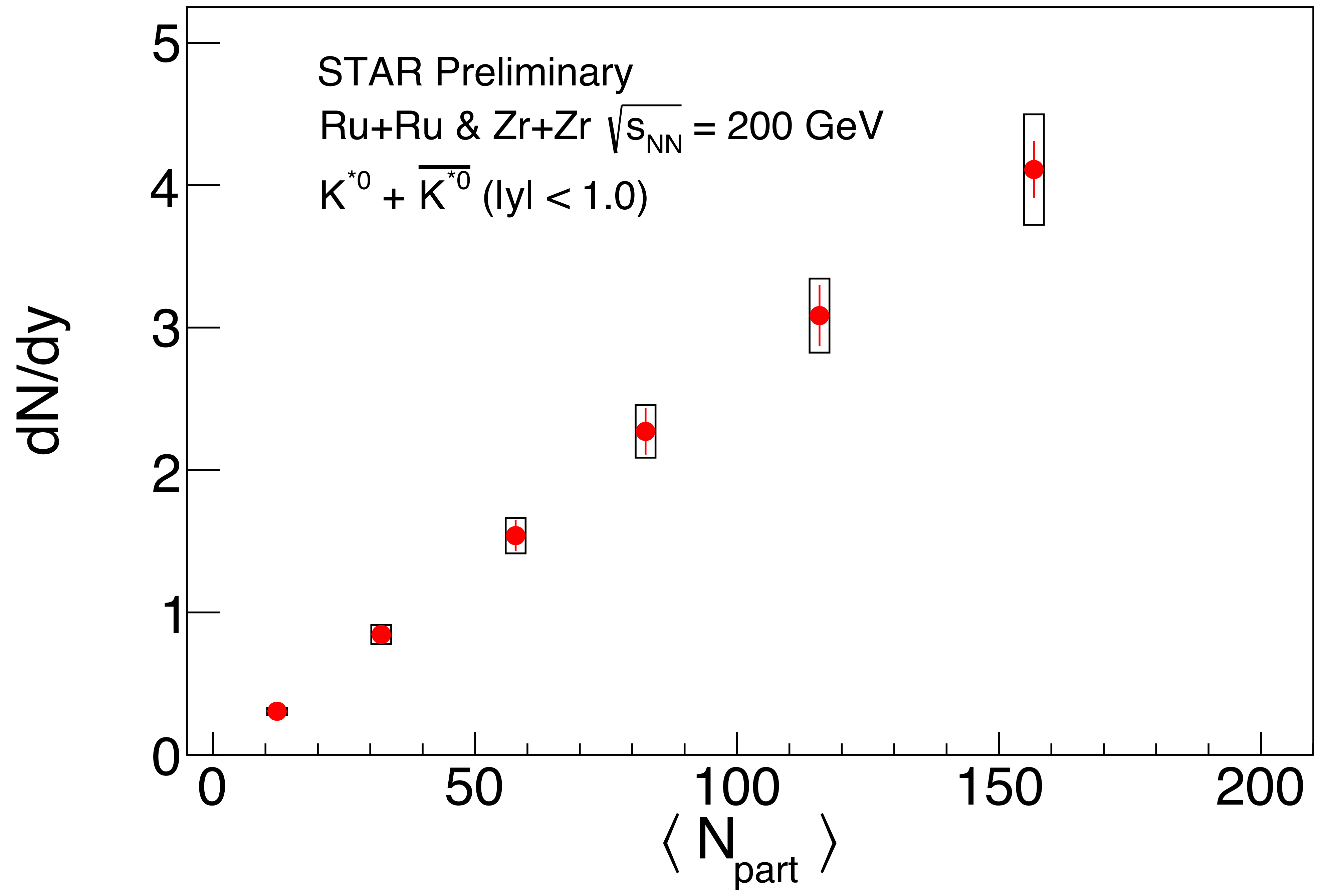
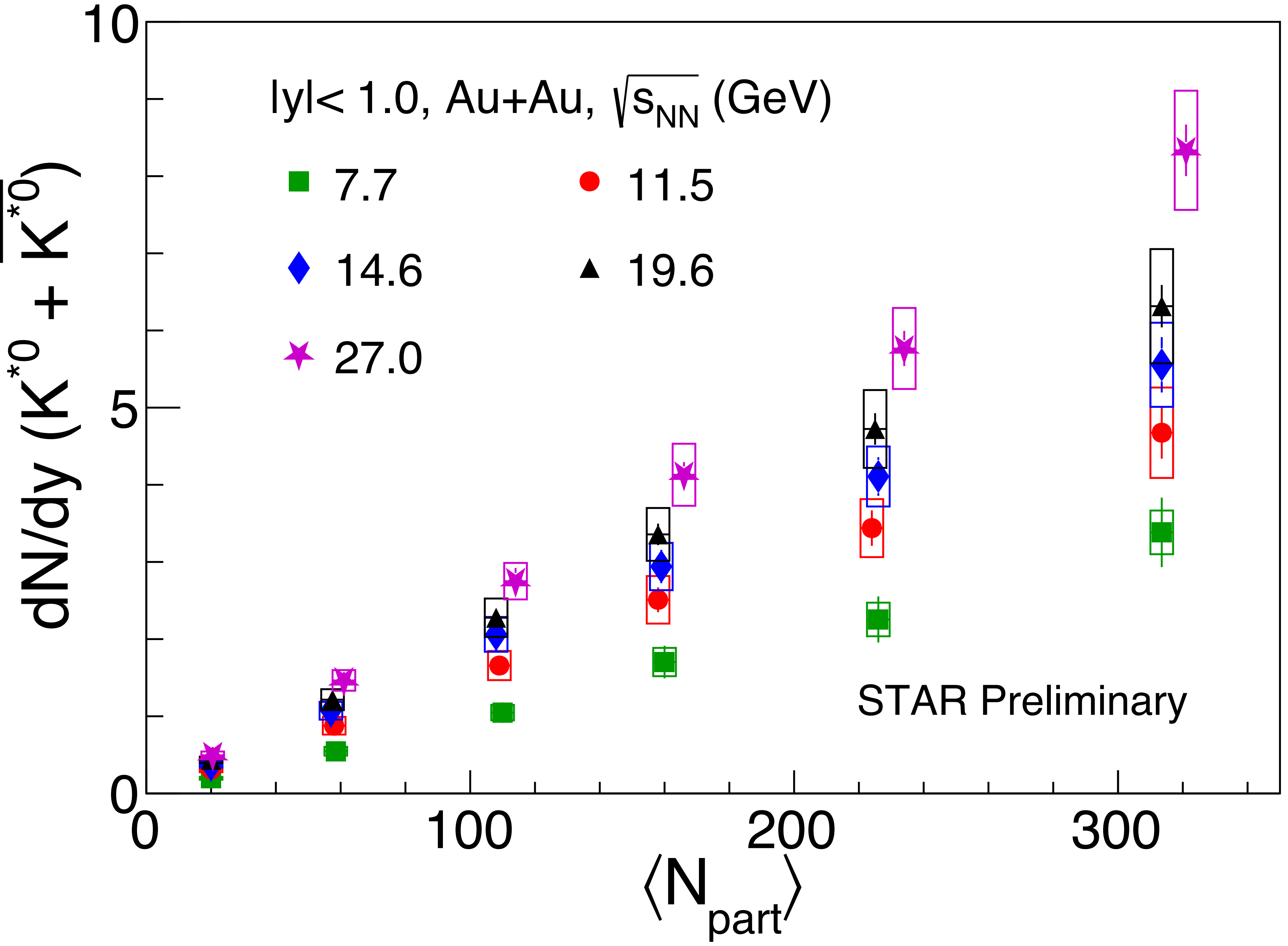
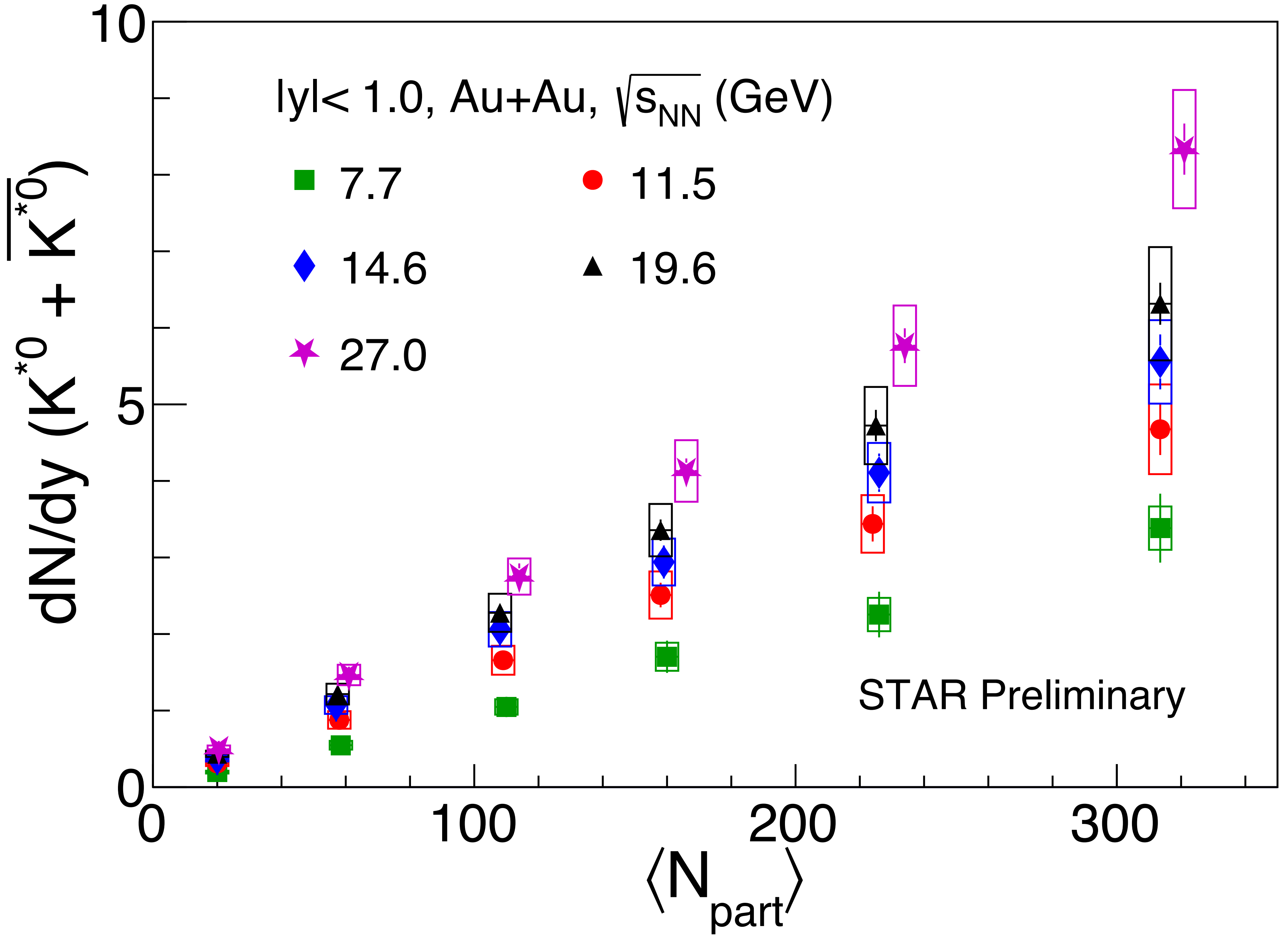
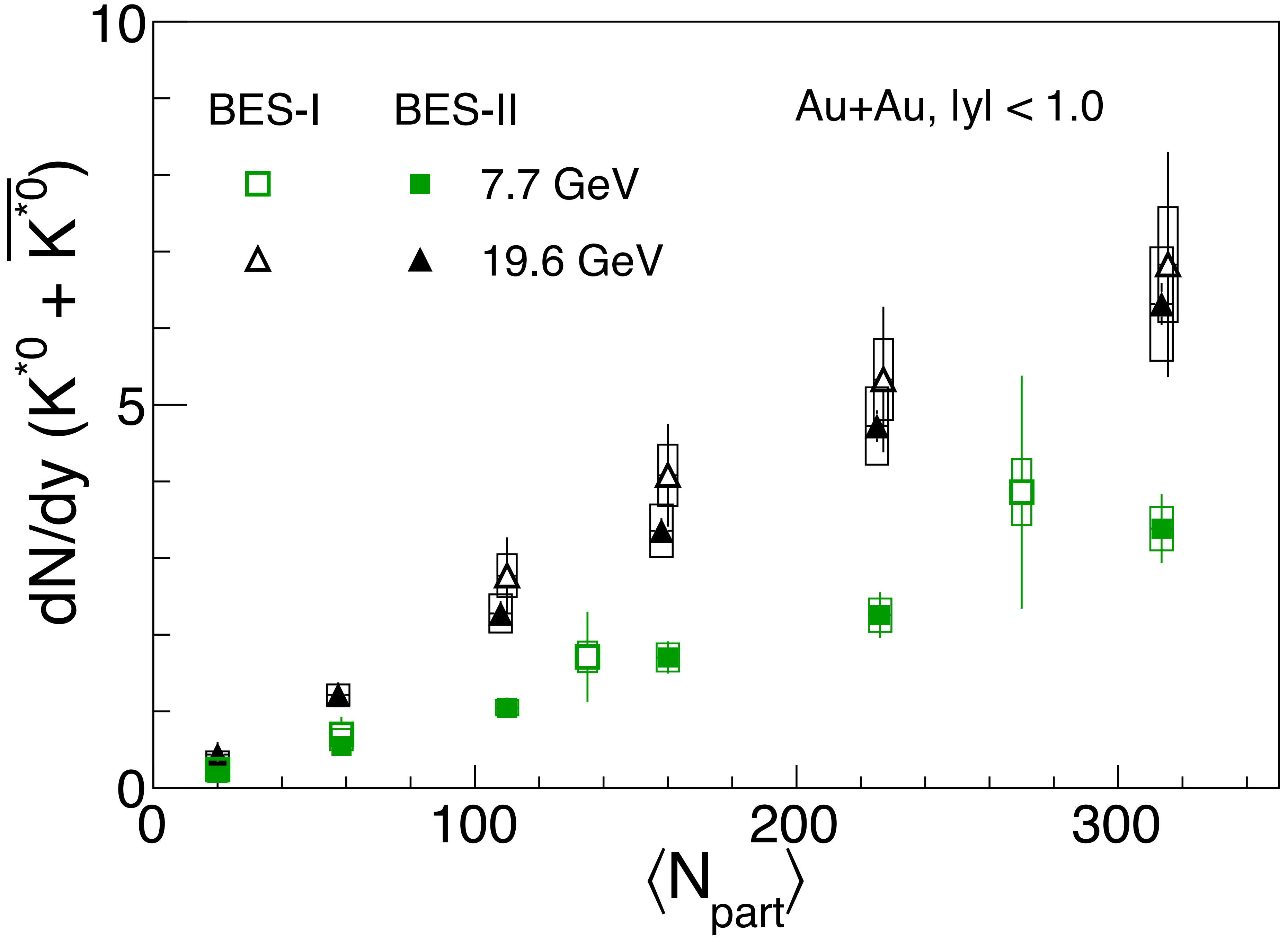




K^{*0} yield increases with N_{part} and collision energy

Particle yield

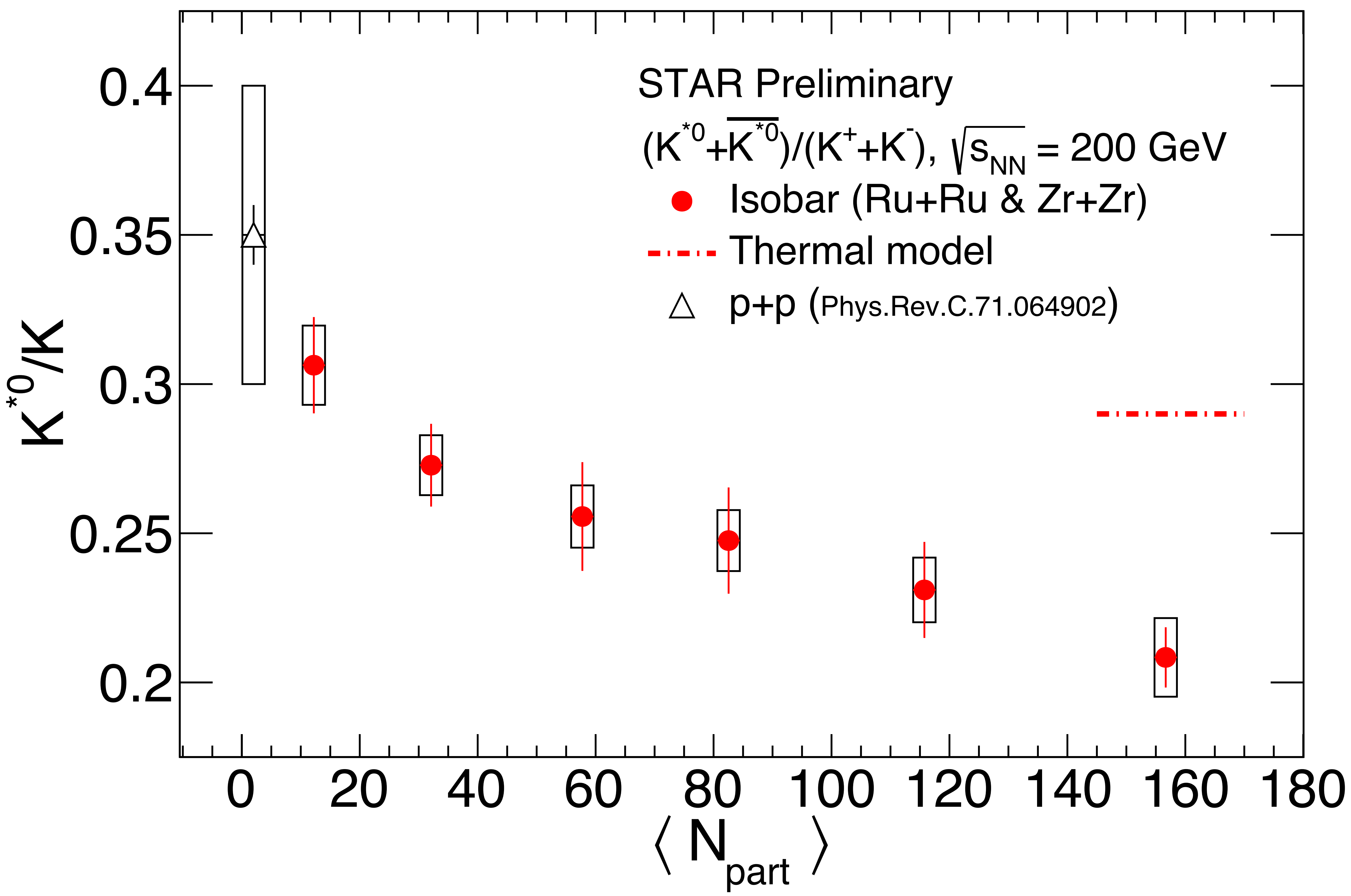




K^{*0} yield increases with N_{part} and collision energy

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

Particle ratio

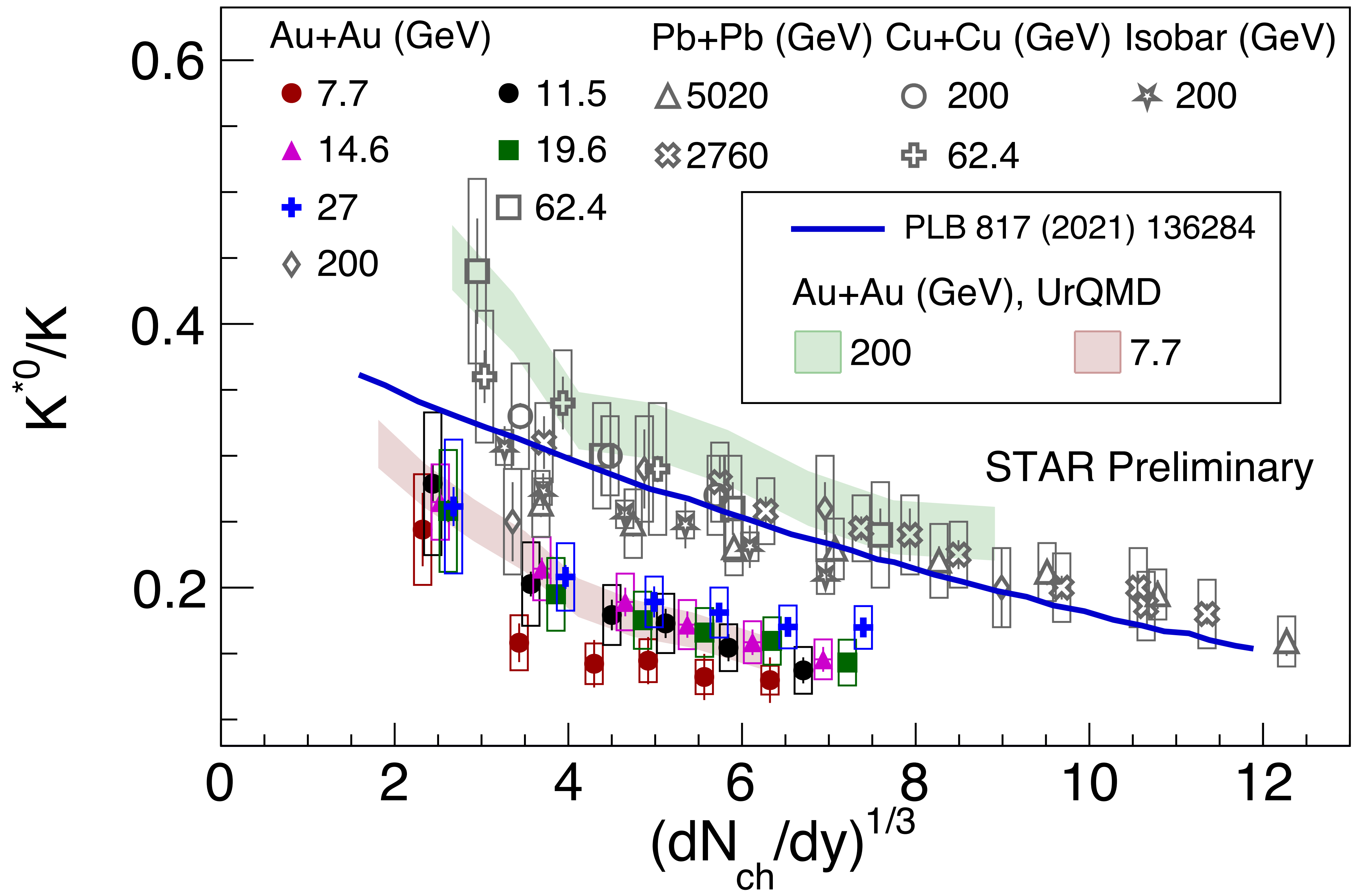


- $(K^{*0}/K)_{central} < (K^{*0}/K)_{peripheral}$
- $(K^{*0}/K)_{central} < (K^{*0}/K)_{pp\ collision}$
- Thermal model overestimates K^{*0}/K ratio in central collisions

  (T=150 MeV, μ_B=20 MeV)

- Indicates that hadronic rescattering is dominant over regeneration in central heavy-ion collisions

Particle ratio

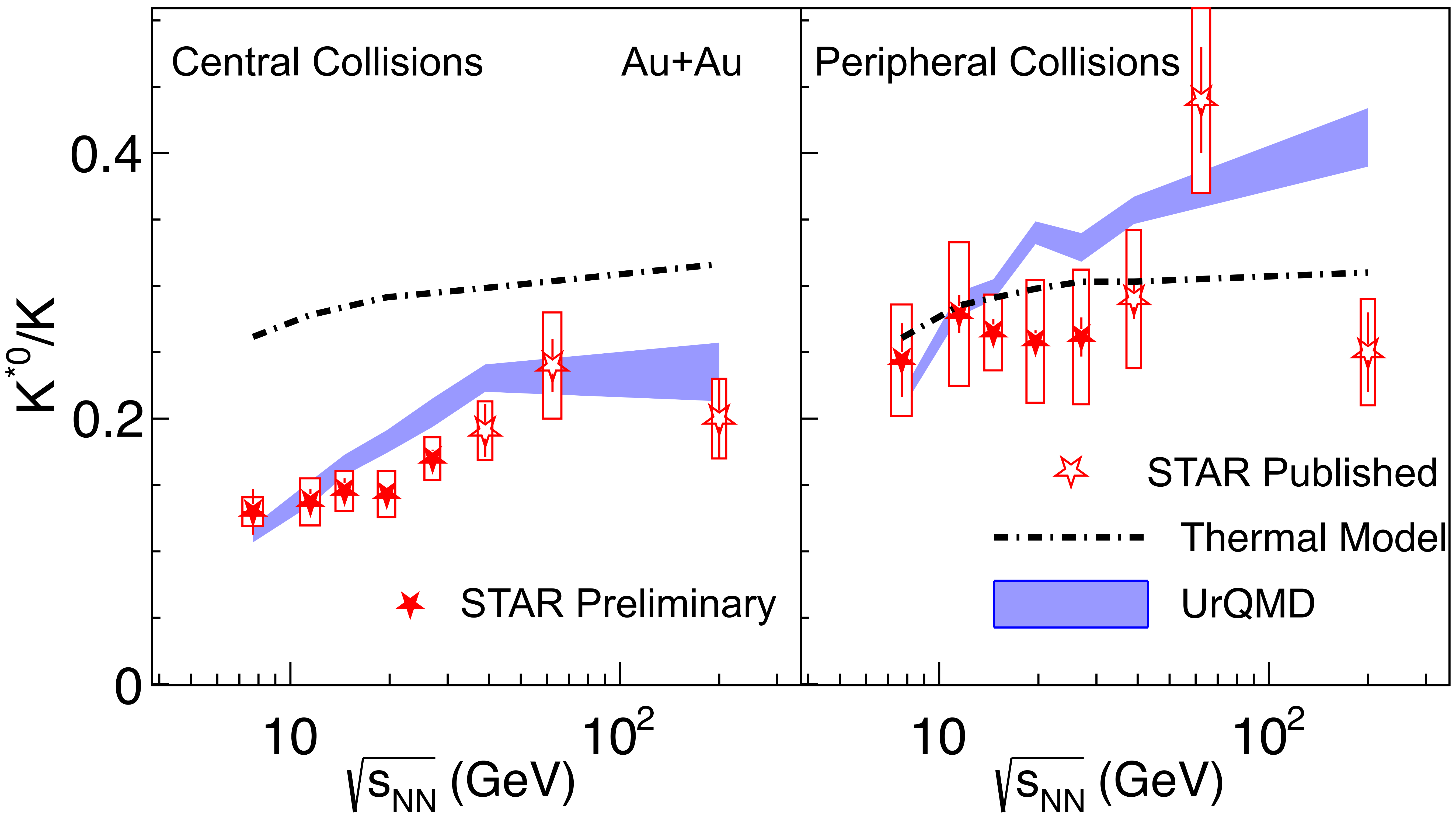


- The $(K^{*0}/K)_{BES} < (K^{*0}/K)_{\text{Top RHIC and LHC}}$

- Multiplicity scaling breaks, Which could be due to stronger meson-baryon interactions at high baryon density region

- Transport model study qualitatively reproduces the trend observed both at top RHIC and BES energies.

Particle ratio



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

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

- Thermal model over estimates K^{*0}/K ratio in central collision, But consistent with the ratio at peripheral collisions. UrQMD model qualitatively explains the results at central collision.

-Dominant hadronic rescattering in central collisions

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

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

Summary

- The STAR measurement of K^{*0} resonance production is presented for Isobar collision at $\sqrt{s_{NN}}$ = 200 GeV and Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7 - 27 GeV.
- The resonance to non-resonance ratio and further model comparison indicates **dominant hadronic rescattering over regeneration in central AA collisions.**
- At BES energies, the K^{*0}/K ratio shows a deviation from the universal multiplicity scaling observed at top RHIC and LHC energies, suggesting **increased suppression of K^{*0} yield at lower collision energies, where meson-baryon interactions dominate over meson-meson interactions.**

Thank you!