Probing hadronic rescattering via resonance production in Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6 GeV from STAR BES-II

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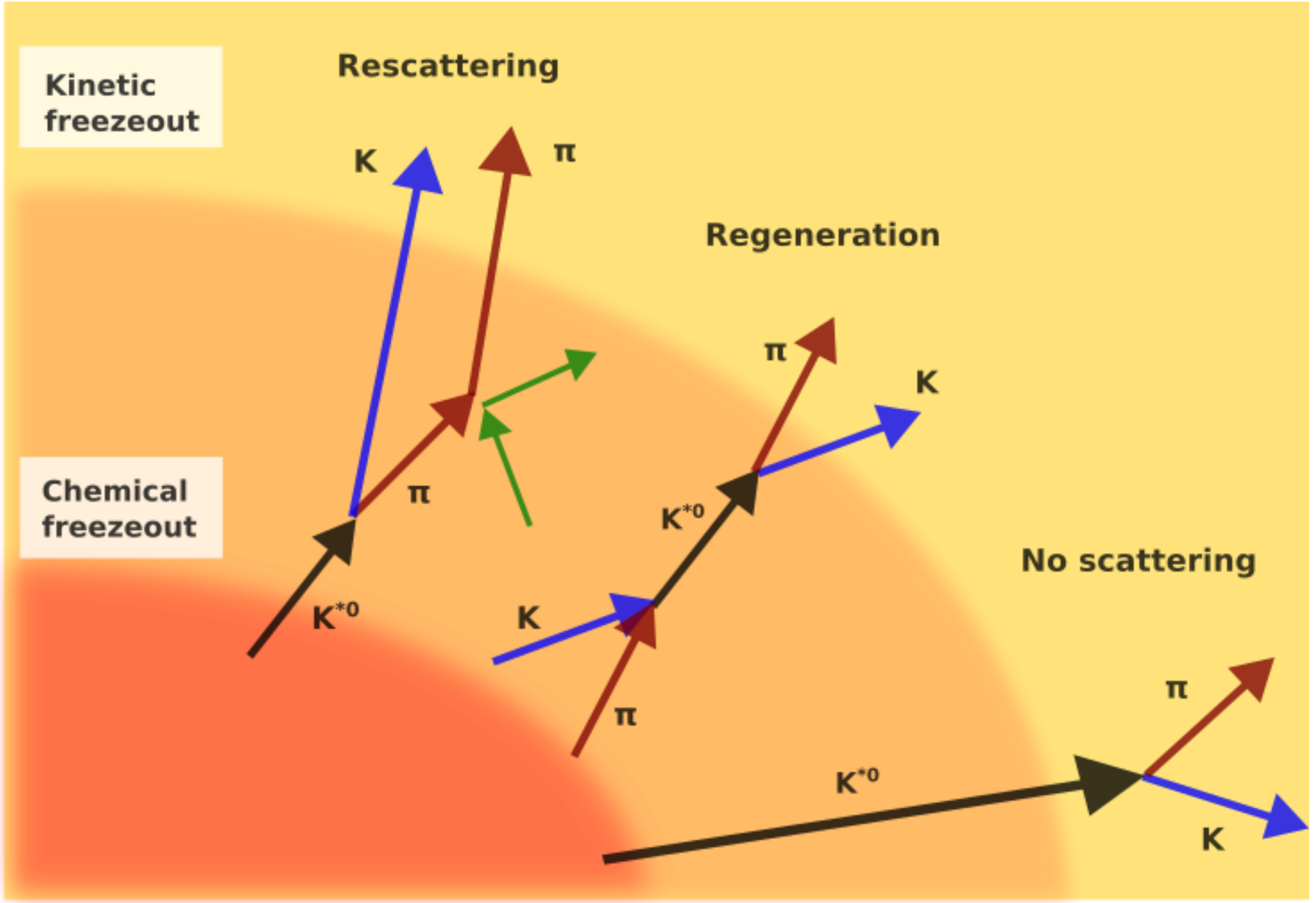
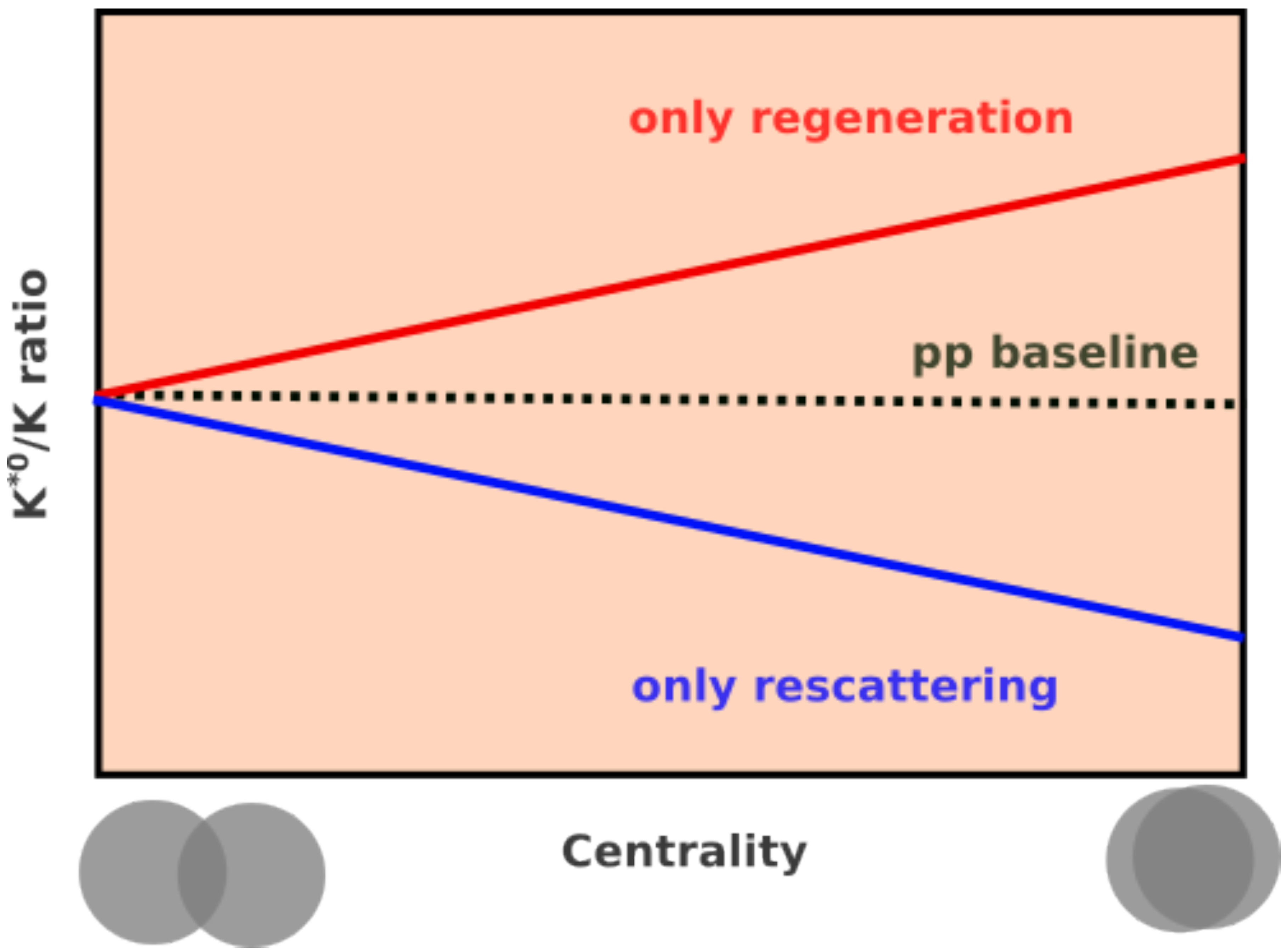
Outline

- Motivation
- The STAR detector
- Signal reconstruction
- Results
  - Transverse momentum spectra
  - p_T integrated yield (dN/dy)
  - K^{*0}/K ratio
  - Lower limit of hadronic phase lifetime
- Summary

Motivation



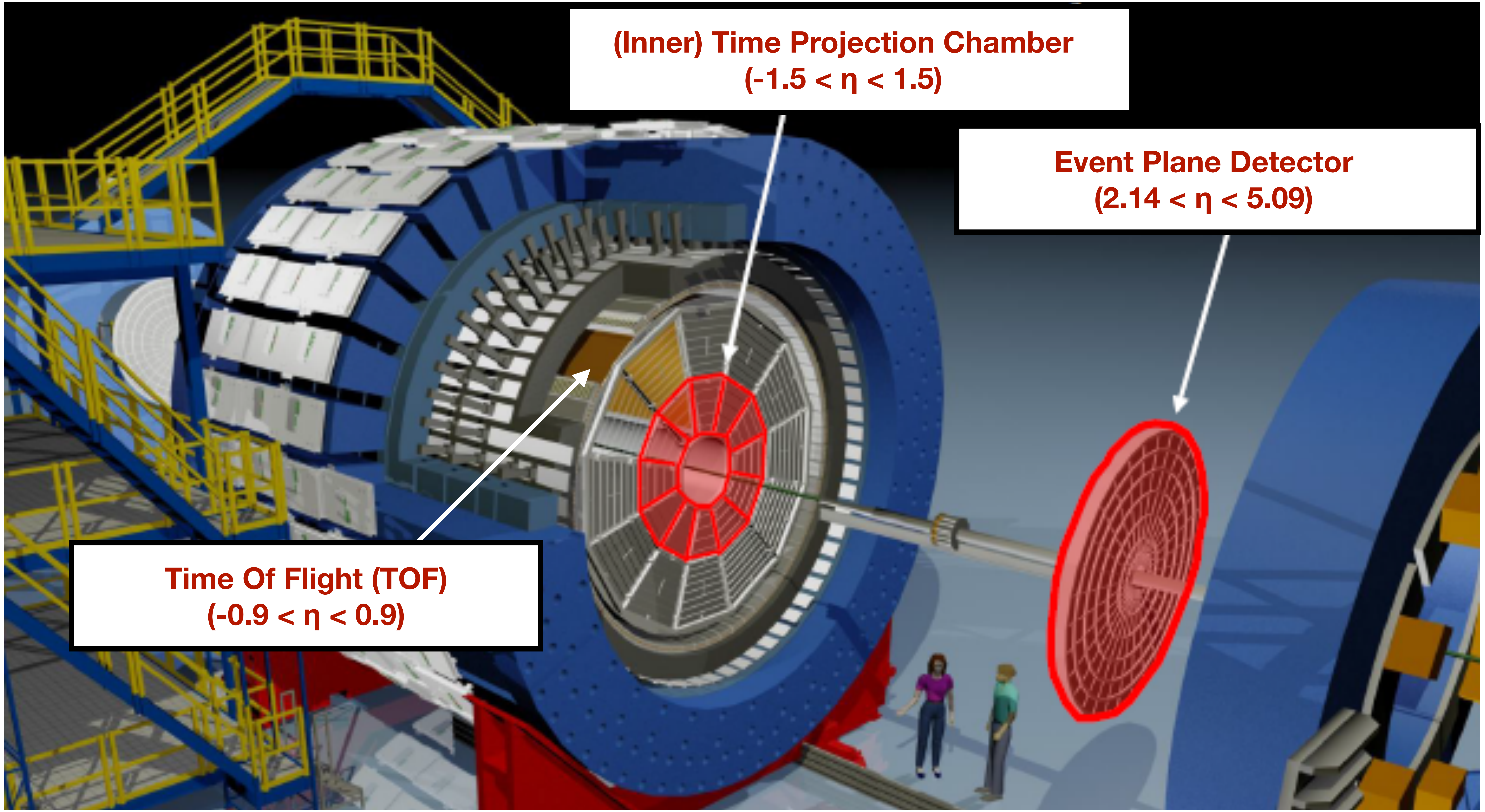


Lifetime of K^{*0} ~ 4.16 fm/c

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

The STAR detector

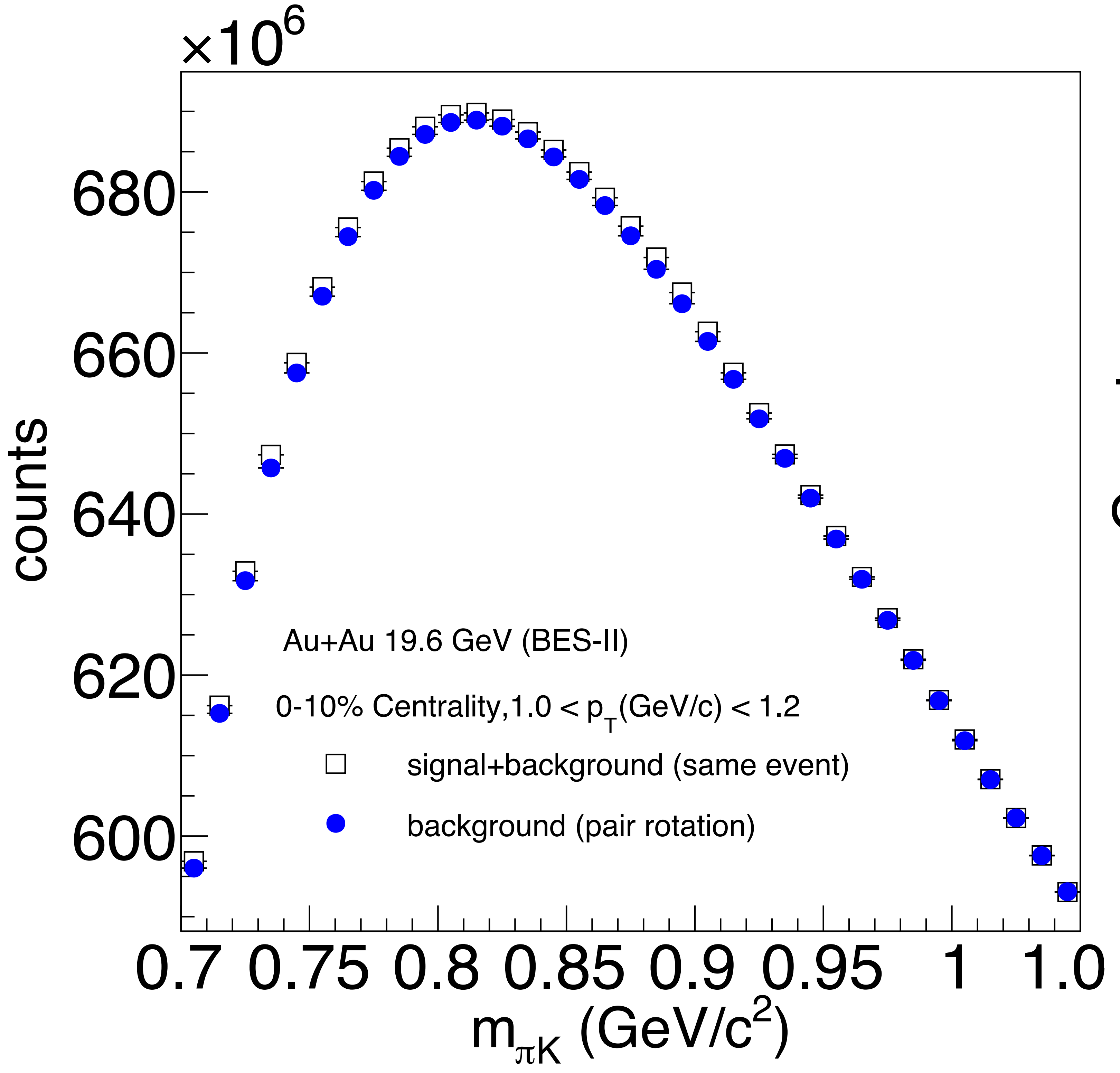


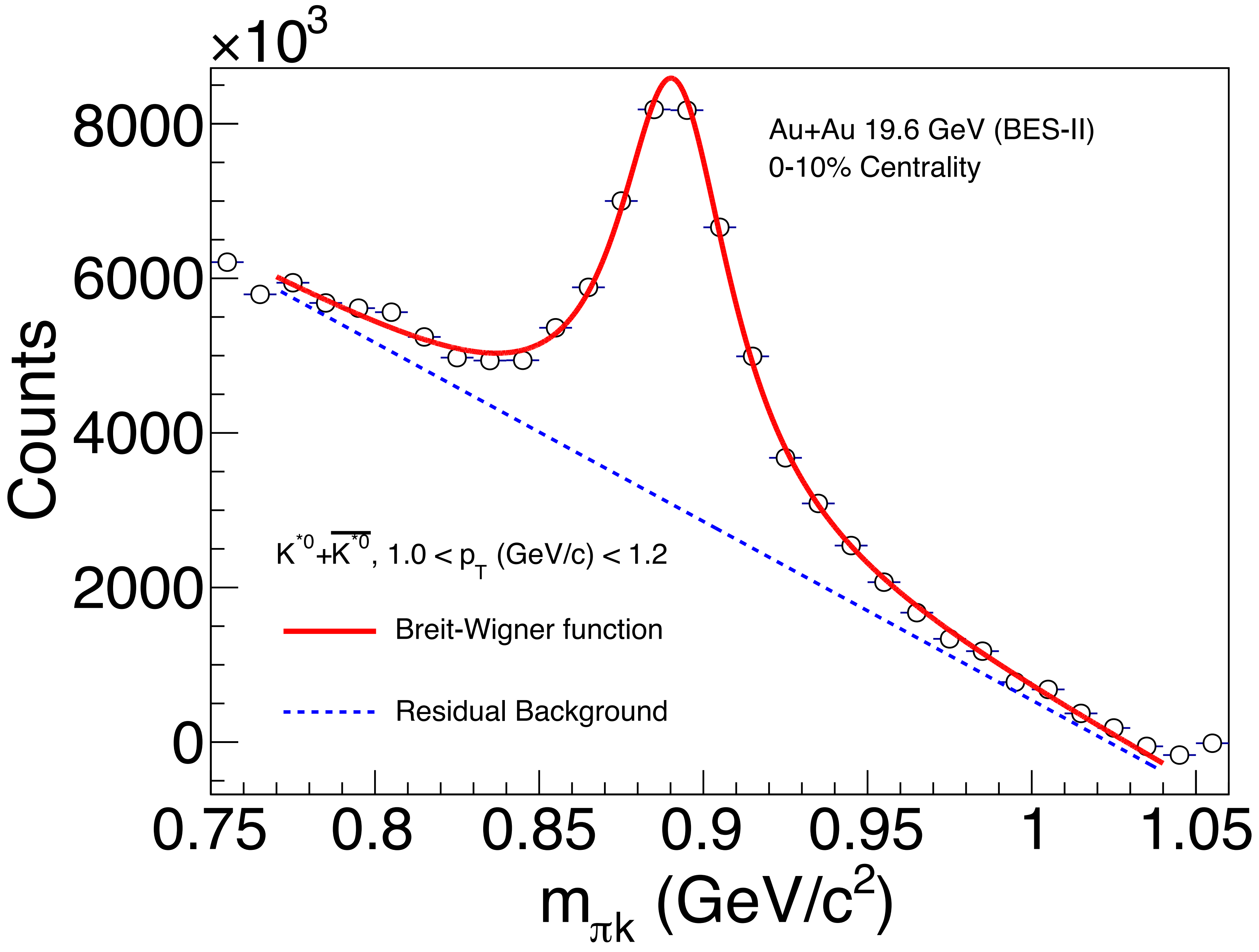
Data Set:
Au+Au 19.6 GeV (BES-II)

Tracking: TPC

Particle Identification:
TPC & TOF

K^{*0} signal reconstruction



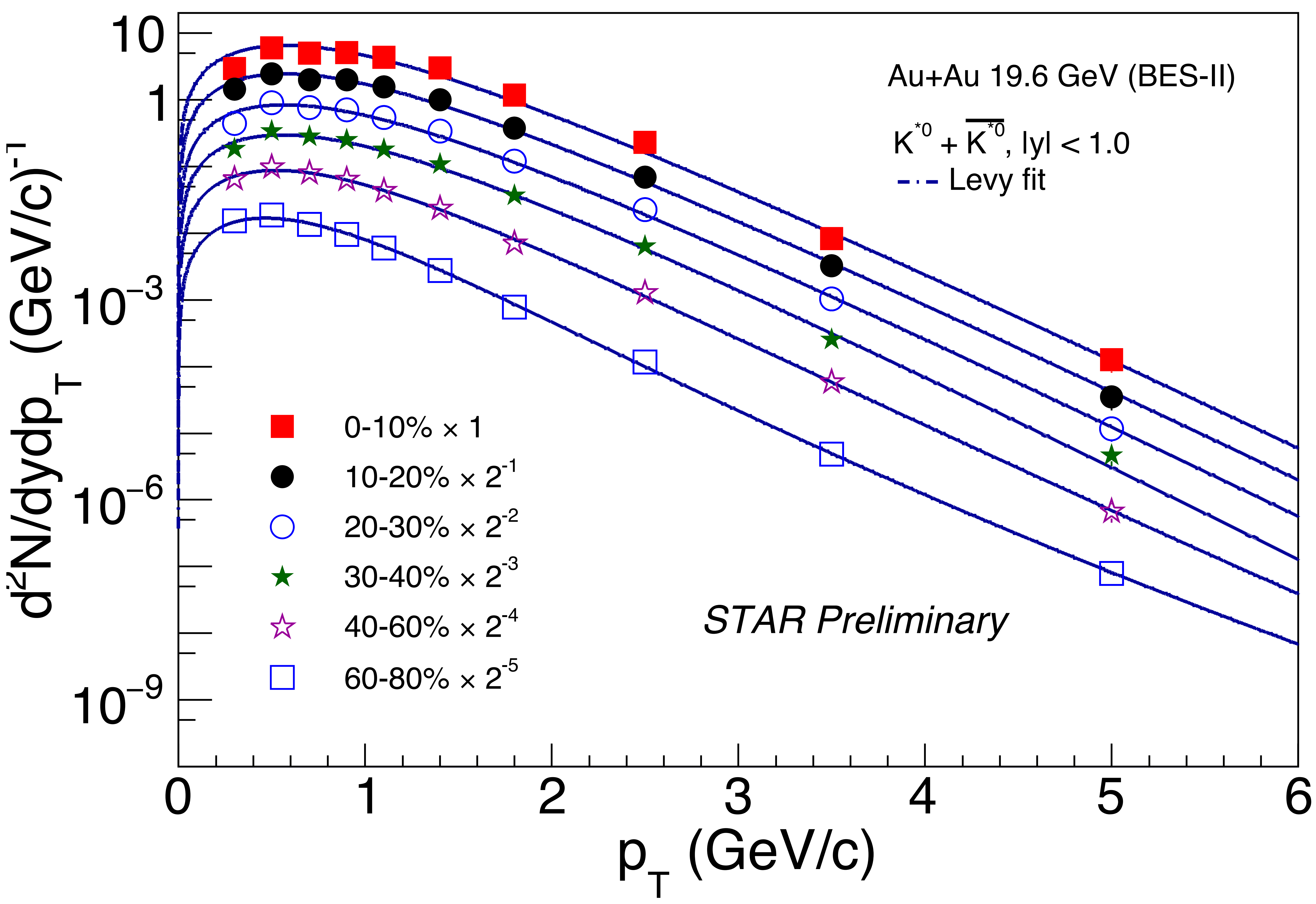


- Decay channel: $K^{*0}(\overline{K^{*0}}) \rightarrow K^{\pm}\pi^{\mp}$ *(B.R ~ 66%)*
- Signals are extracted using the invariant mass method.

  Invariant mass: $m^2_{inv} = \Sigma_i E^2_i - \Sigma_i p^2_i$, where $E^2 = (E^2_\pi + E^2_K)$ and $p^2 = (p^2_\pi + p^2_K)$
- The combinatorial background is estimated using the pair rotation method.

- Fitting function: $\frac{Y}{2\pi} \times \left[\frac{\Gamma_0}{(M - M_0)^2 + \frac{\Gamma_0}{4}}\right]$ + 1st order Polynomial (residual background)

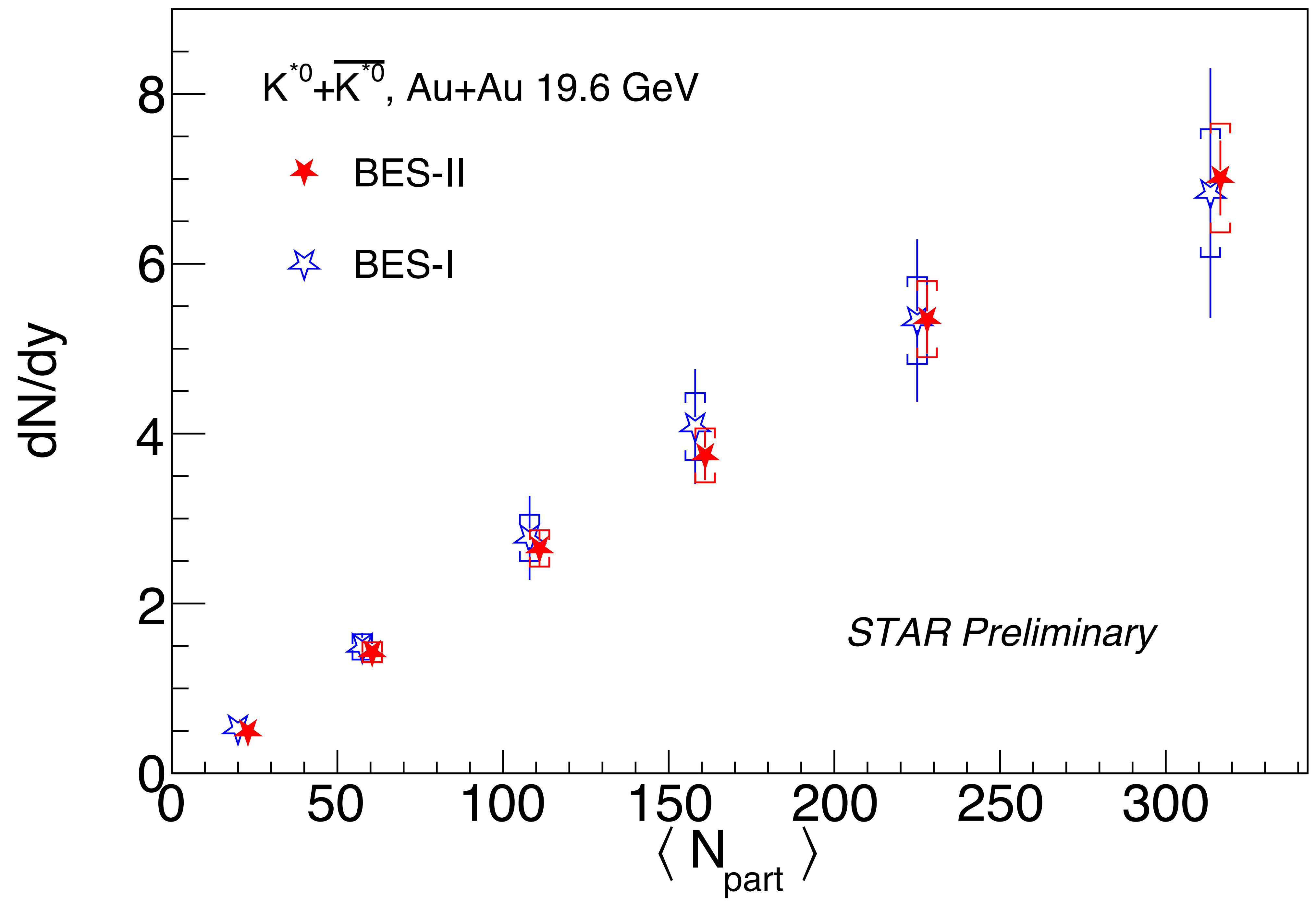
Transverse momentum spectra



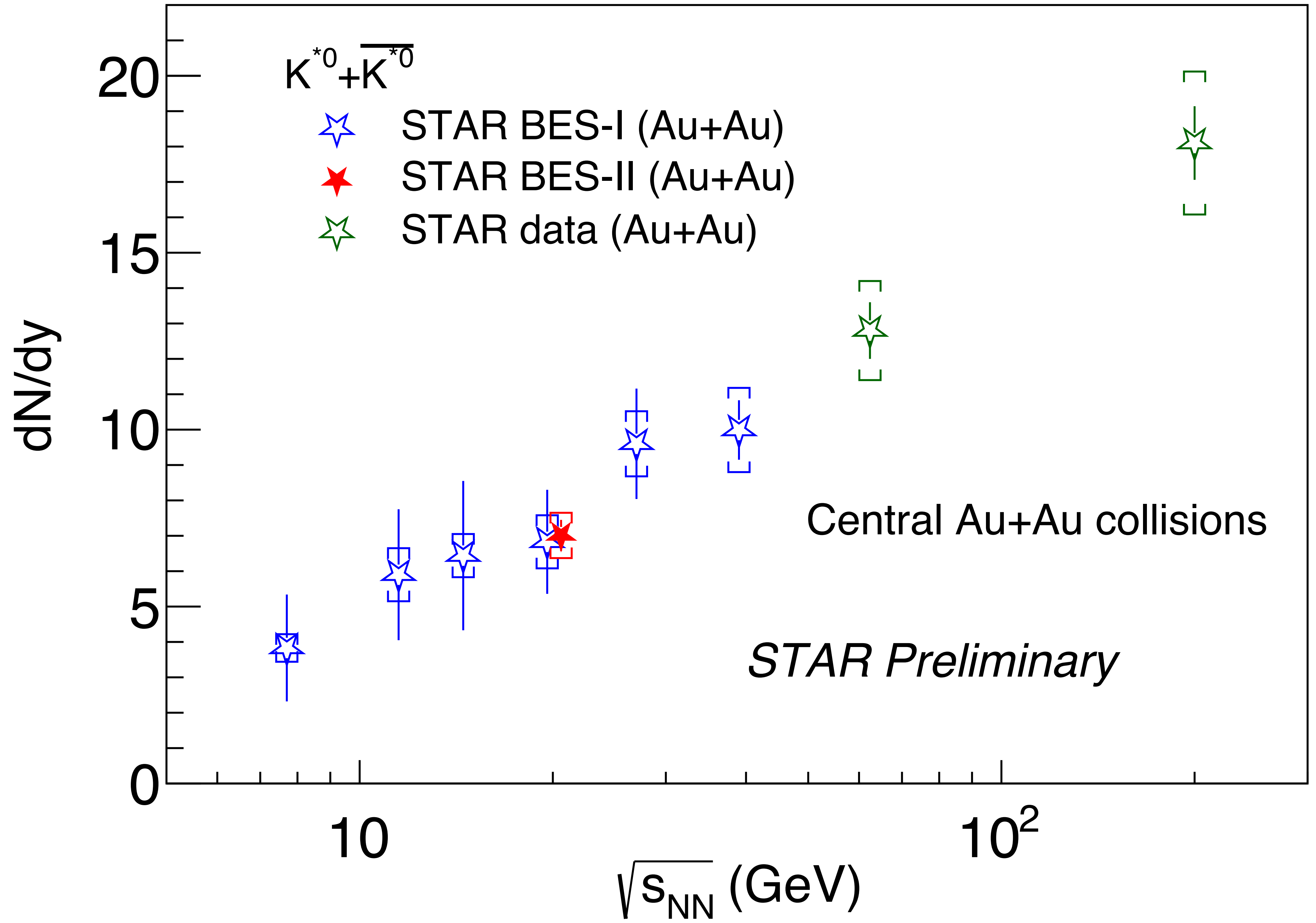
Levy Tsallis function is used to extrapolate spectra to unmeasured regions.

We have extended the BES-I measurement to both lower and higher p_T regions using BES-II data

p_T integrated yield



BES-I result : arXiv:2210.02909

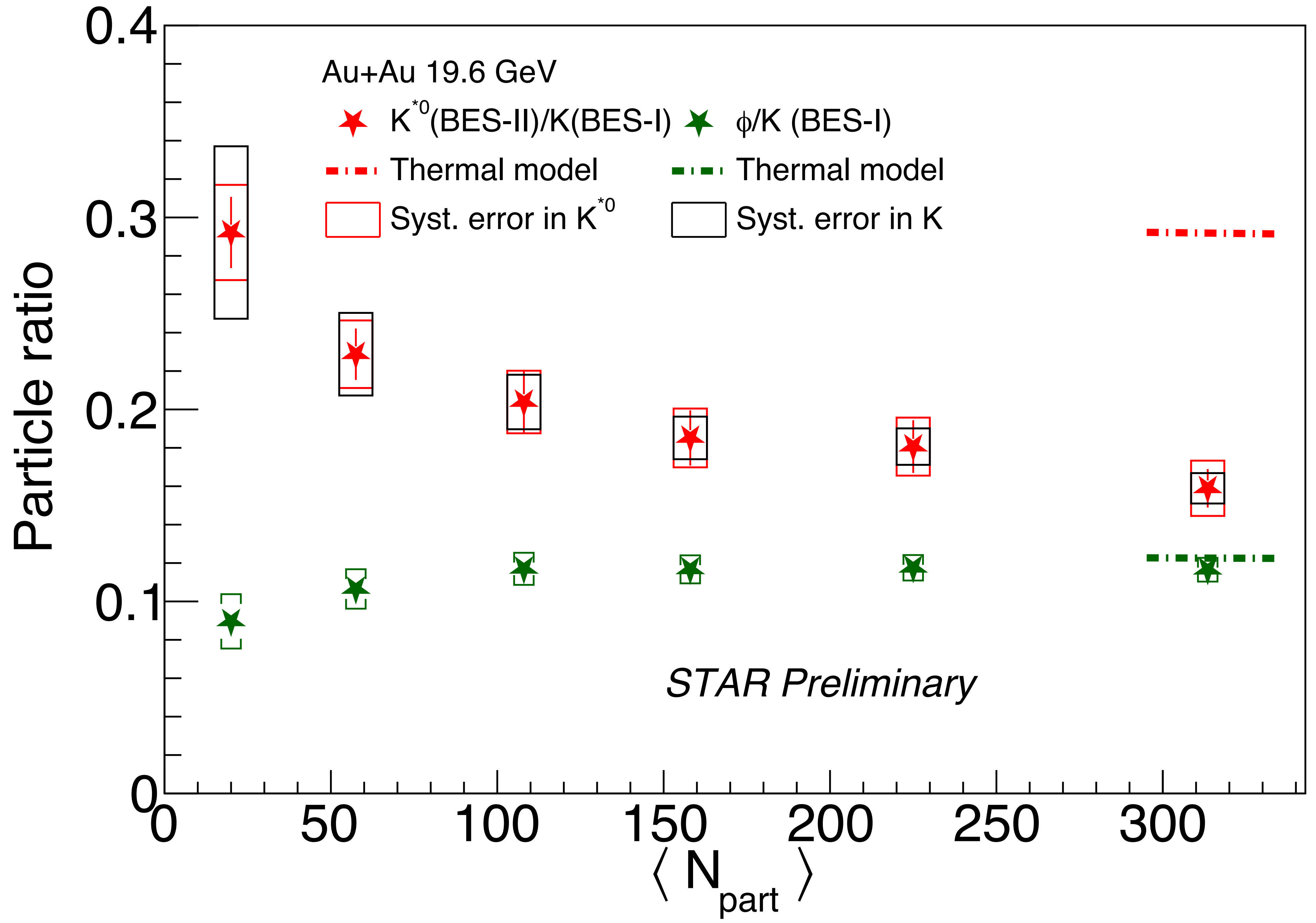


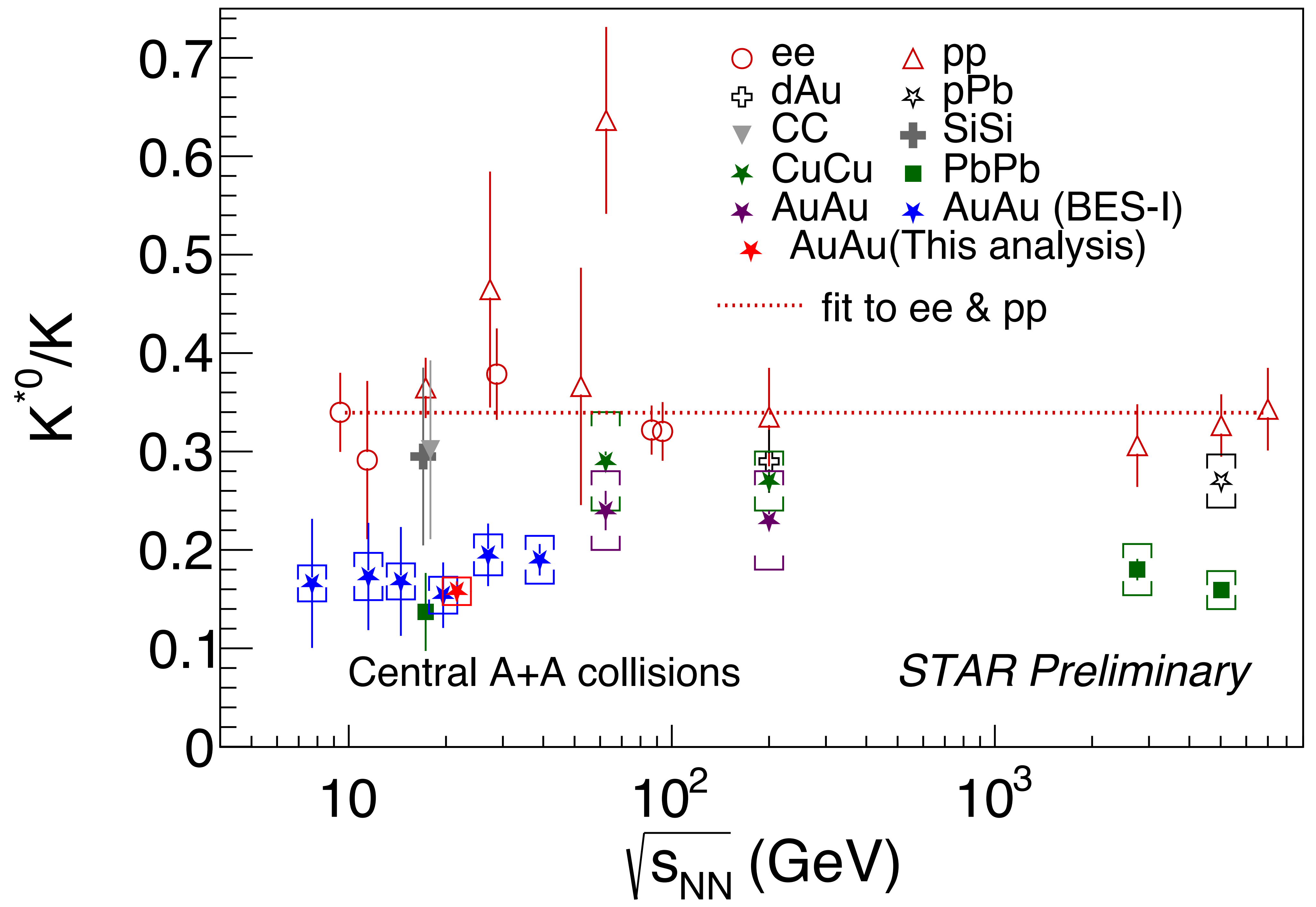
STAR. Phys.Rev.C 84 (2011) 034909 (62.4 and 200 GeV)

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

Resonance/Non-resonance ratios





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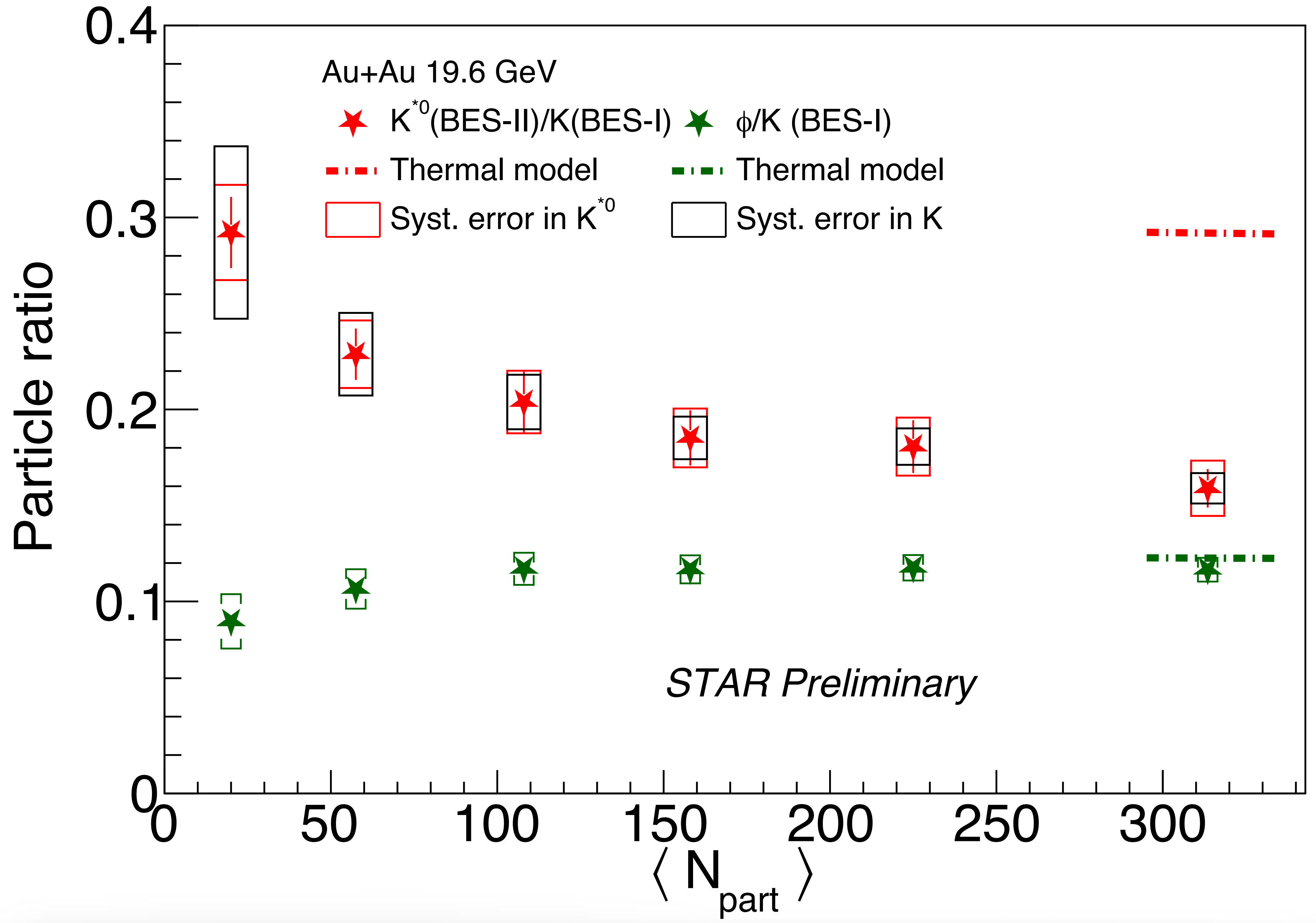
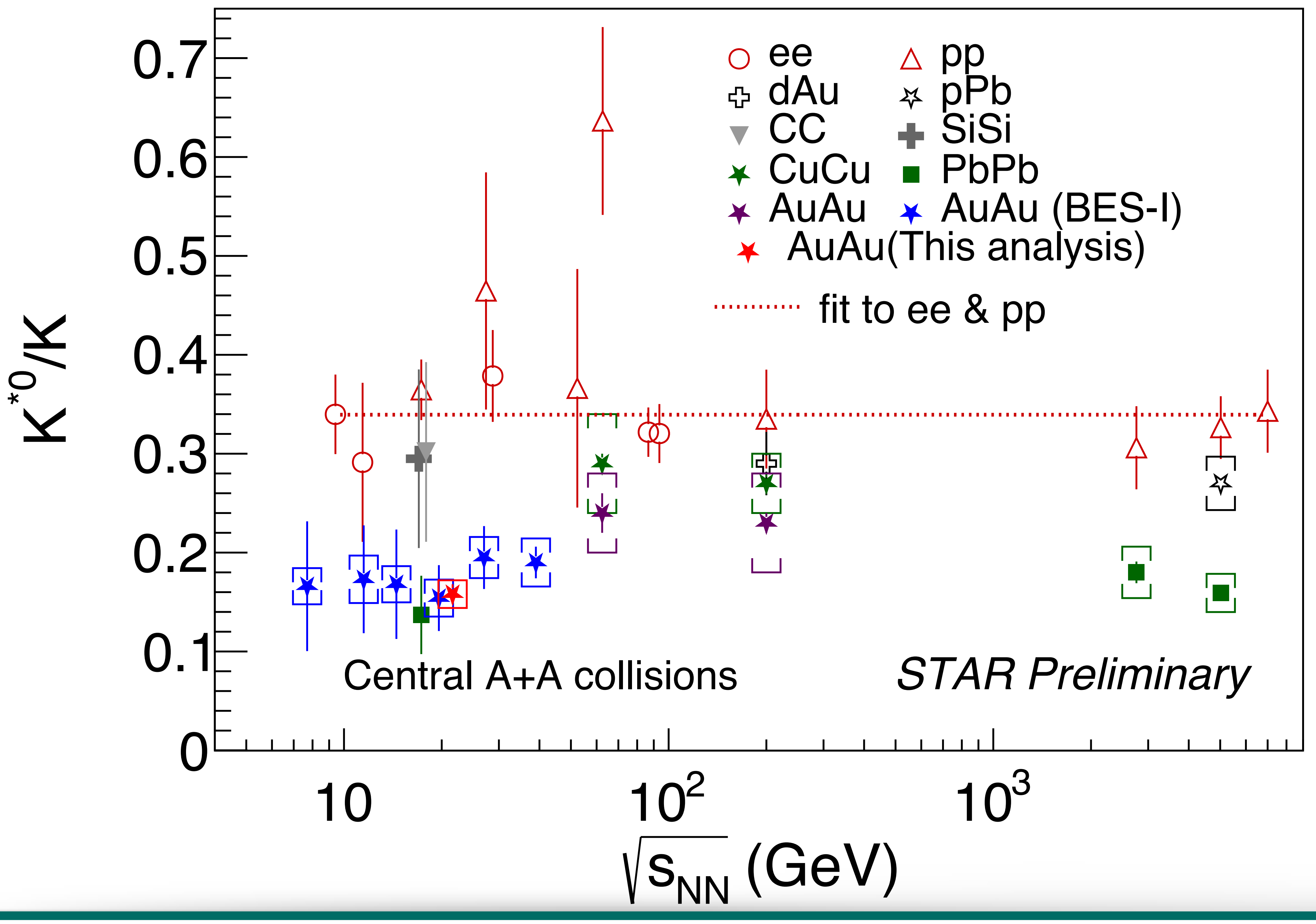
ALICE. Eur. Phys. J. C, 76(5):245,(2016) (p+Pb)

Resonance/Non-resonance ratios





- Thermal model explains φ/K, but overestimates K^{*0}/K ratio in central collisions
- $(K^{*0}/K)_{central} < (K^{*0}/K)_{peripheral}$
- $(K^{*0}/K)_{central} < (K^{*0}/K)_{pp/ee\ collisions}$
- φ/K ratio remains almost independent of centrality

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

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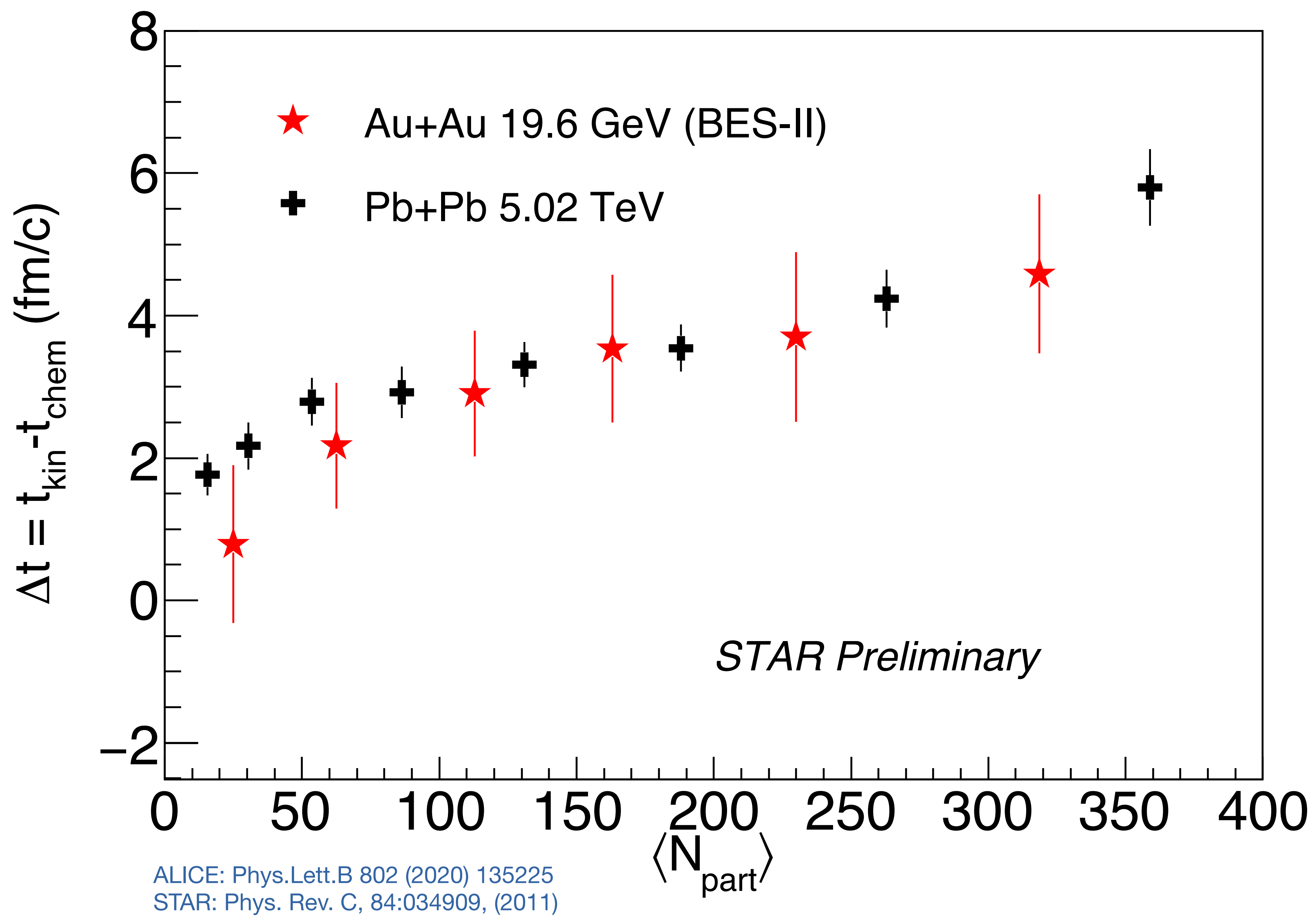
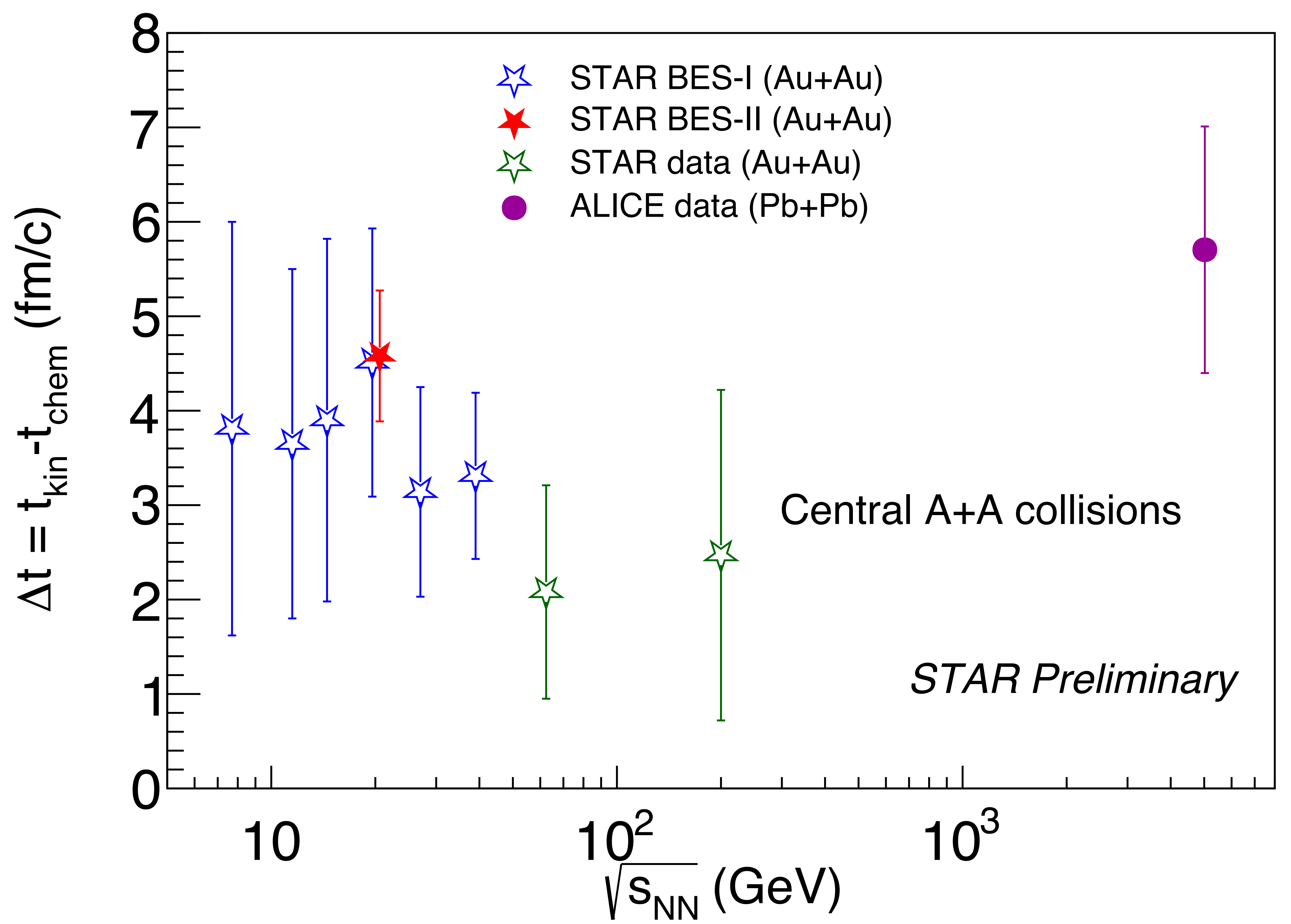
Lower limit of hadronic phase lifetime



ALICE: Phys.Lett.B 802 (2020) 135225
STAR: Phys. Rev. C, 84:034909, (2011)



- $(K^{*0}/K)_{kin} = (K^{*0}/K)_{chem} \times e^{-\Delta t/\tau}$

  Where, Δt = lower limit of hadronic phase lifetime (t_{kin} - t_{chem})

  τ = lifetime of K^{*0}

- Here We can take

  $(K^{*0}/K)_{kin} \approx (K^{*0}/K)_{AA}$

  $(K^{*0}/K)_{chem} \approx (K^{*0}/K)_{pp}$

STAR. Phys. Rev. C 66 (2002) 61901
Zhangbu Xu.J. Phys. G 30, S325--S334, (2004)
S. Singha, et al. Int. J. Mod. Phys. E 24 (2015) 05, 1550041

Errors are quadratic sum of statistical and systematic errors

- Here $(K^{*0}/K)_{pp}$ for BES energies are taken to be 0.34 ± 0.01
- No clear energy dependence within current uncertainties at RHIC

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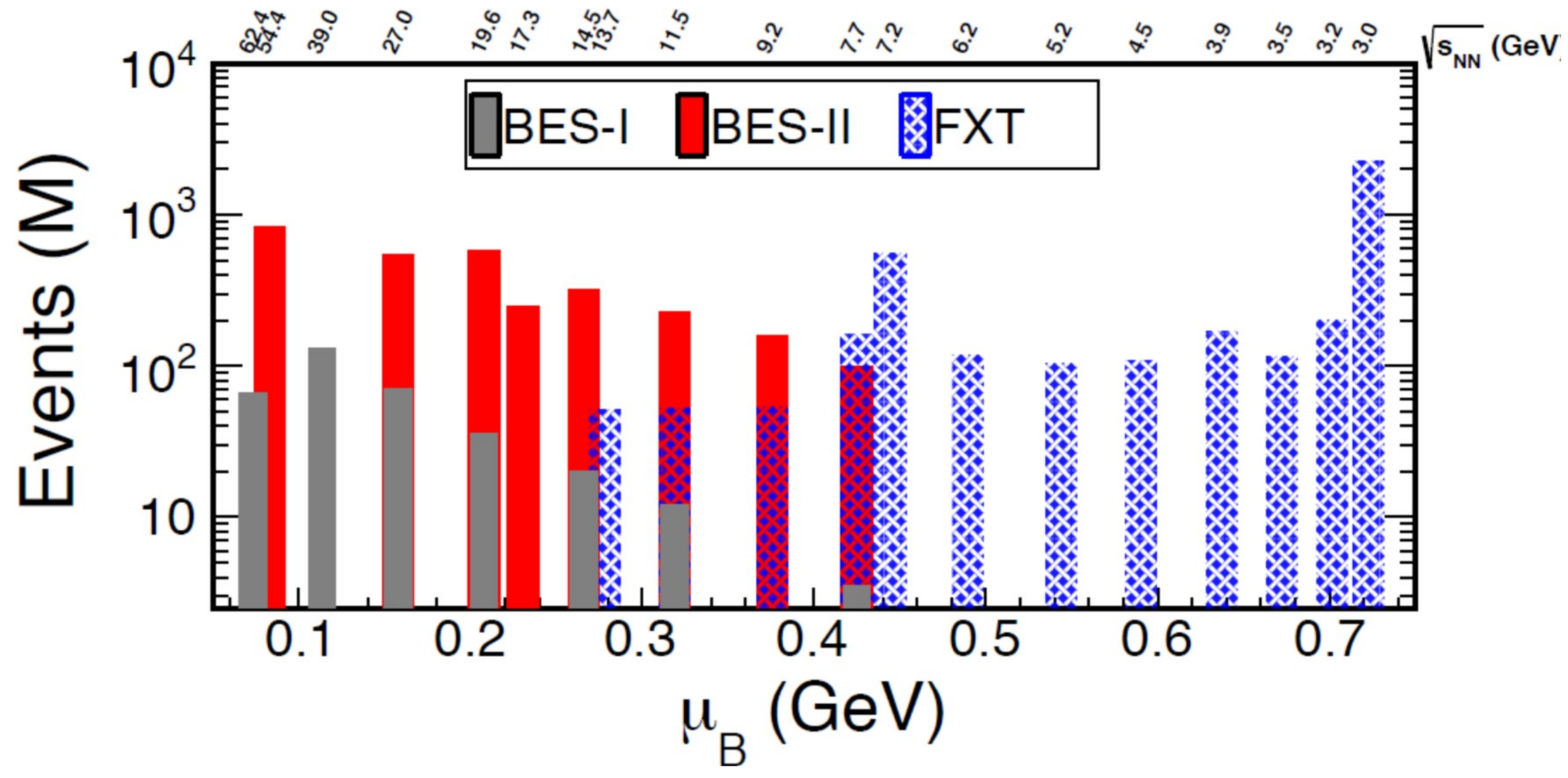
Summary

- We have presented the measurement of K^{*0} resonance production in Au+Au collisions at 19.6 GeV from BES-II.
- The resonance to non-resonance ratio indicates dominant hadronic rescattering over regeneration in central AA collisions.
- The lower limit of hadronic phase lifetime is estimated using a toy model. The hadronic phase lifetime increases with centrality, and no clear energy dependence is observed within current uncertainties for RHIC energies.

Outlook

- K^{*0} resonance measurements at other energies using high statistics data collected in STAR BES-II program.
- It will help us to establish the lower limits of hadronic phase lifetime in those collisions.




Thank you

Backup

- Thermal model parameters : T_{ch} = 153.9 MeV, μ_S = 43.2 MeV, μ_B = 187.9 MeV,

Phys. Rev. C 96, 044904 (2017)