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Production of K^{*0} in Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6 GeV from STAR BES-II

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STAR

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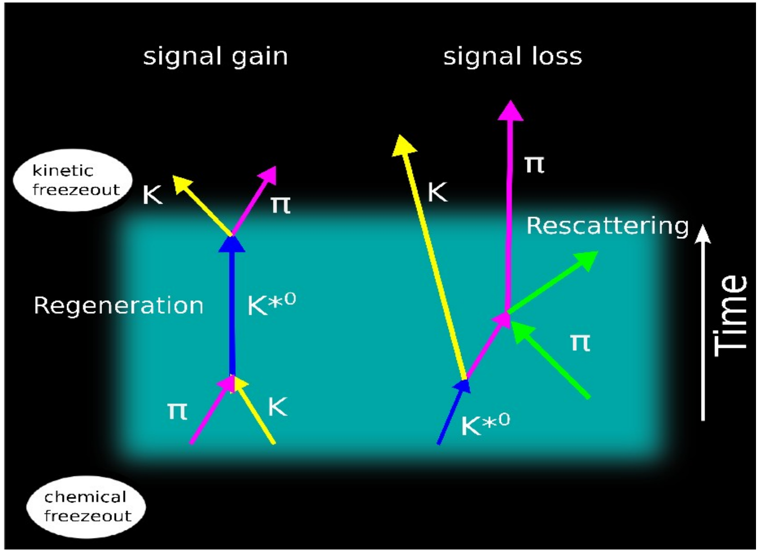
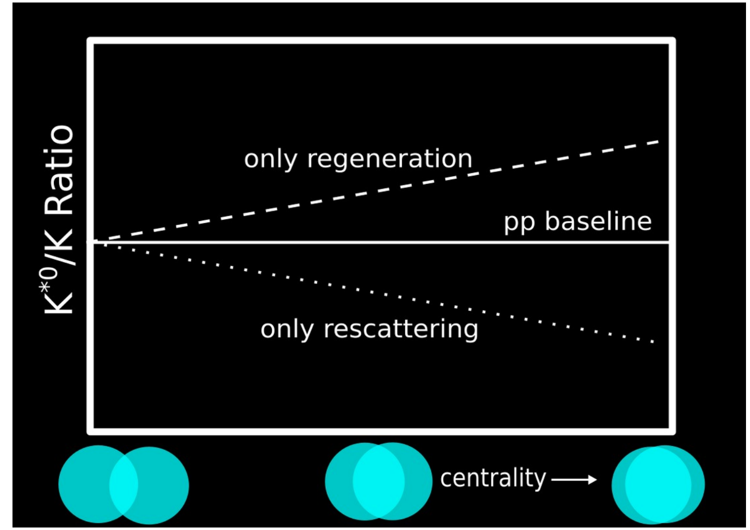
Outline

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

Motivation

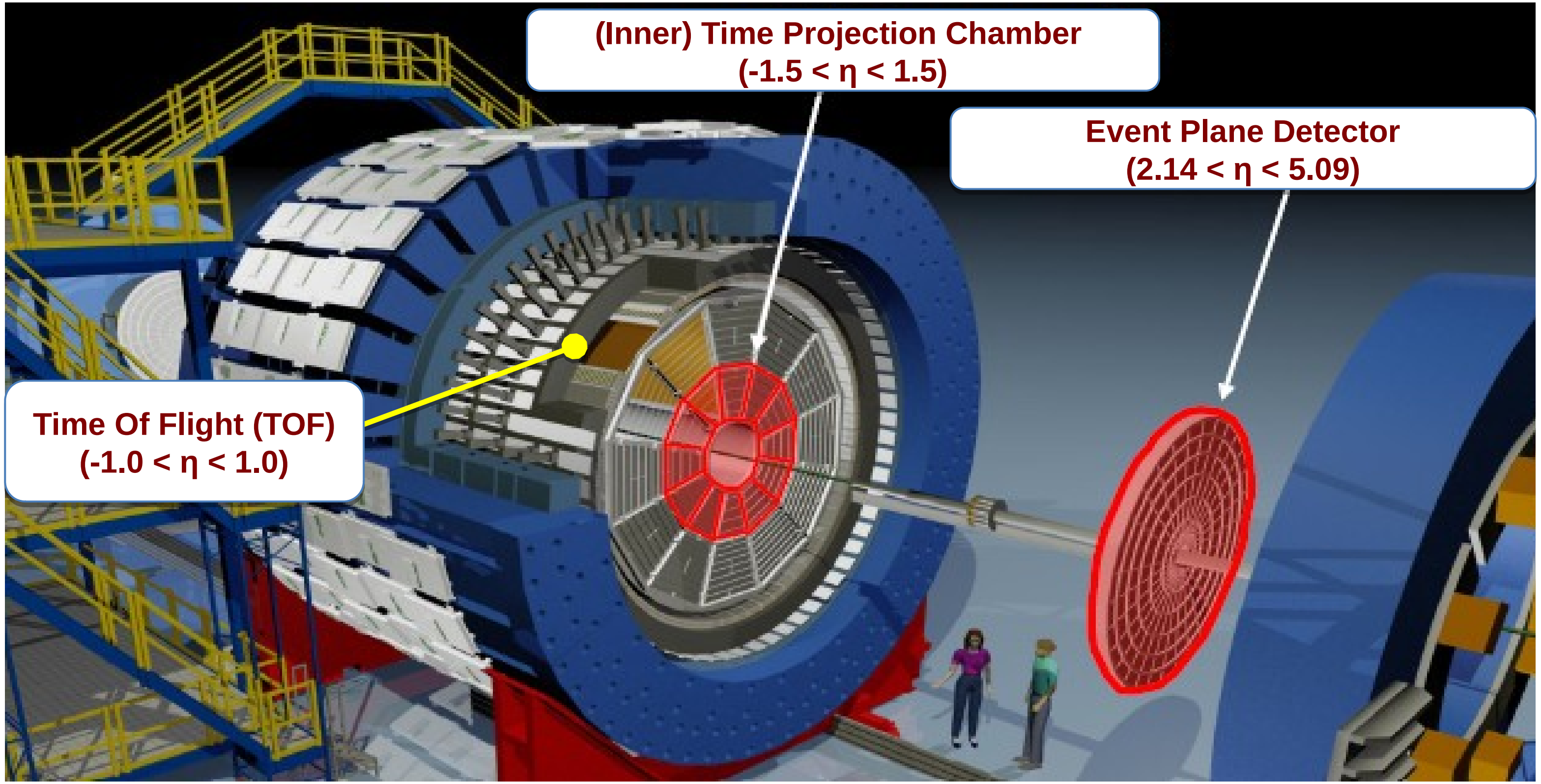




Resonance	Quark content	Decay Channel	t (fm/c)
K^{*0} (896)	$d\bar{s}$	$\pi^- K^+$ (B.R= 0.66)	4.16

- Lifetime comparable to that of the hadronic phase of the QCD medium created in heavy-ion collisions
- Study of K^{*0} can help to probe the interplay of rescattering and regeneration

The STAR Detector and Data Set



Data Set : 19.6 GeV (BES-II)

System: Au+Au

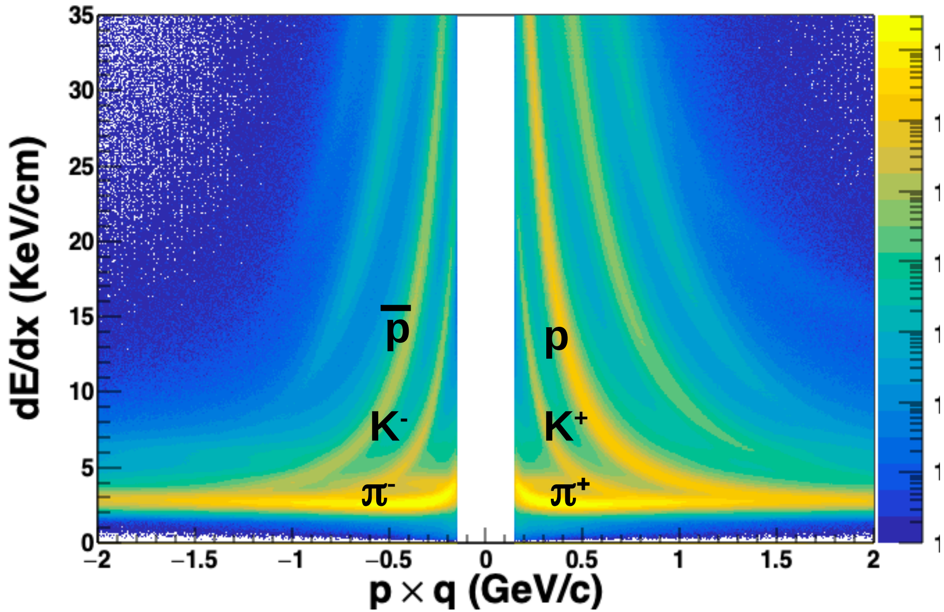
# of events : ~710 M

Tracking:
TPC

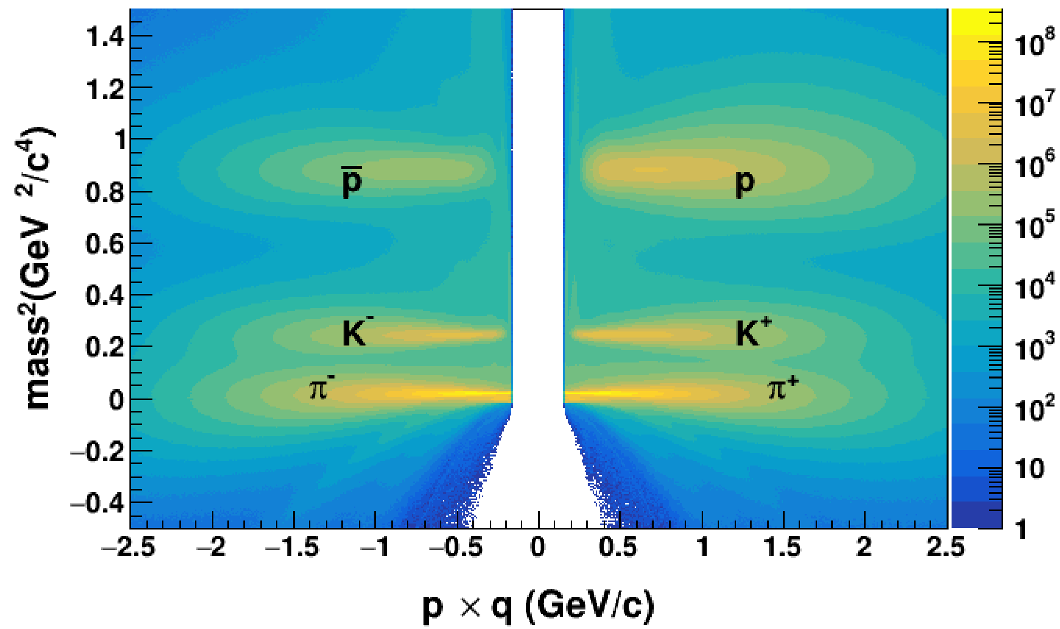
Particle Identification:
TPC & TOF

Particle Identification

Au+Au 19.6 GeV

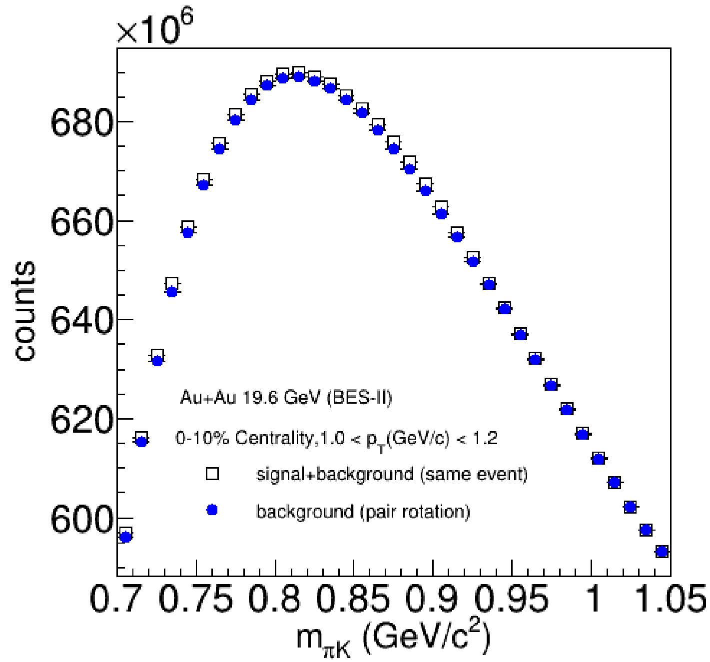


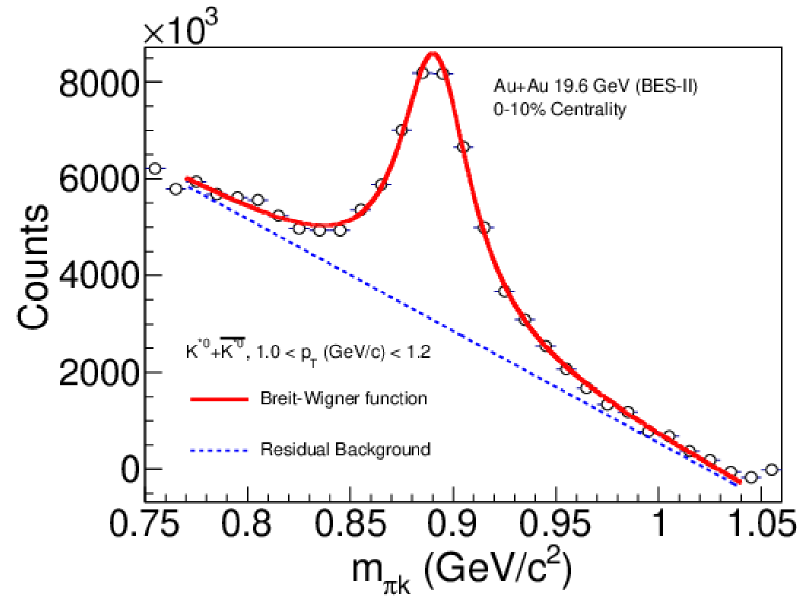
(Using TPC)



(Using TOF)

K^{*0} Reconstruction

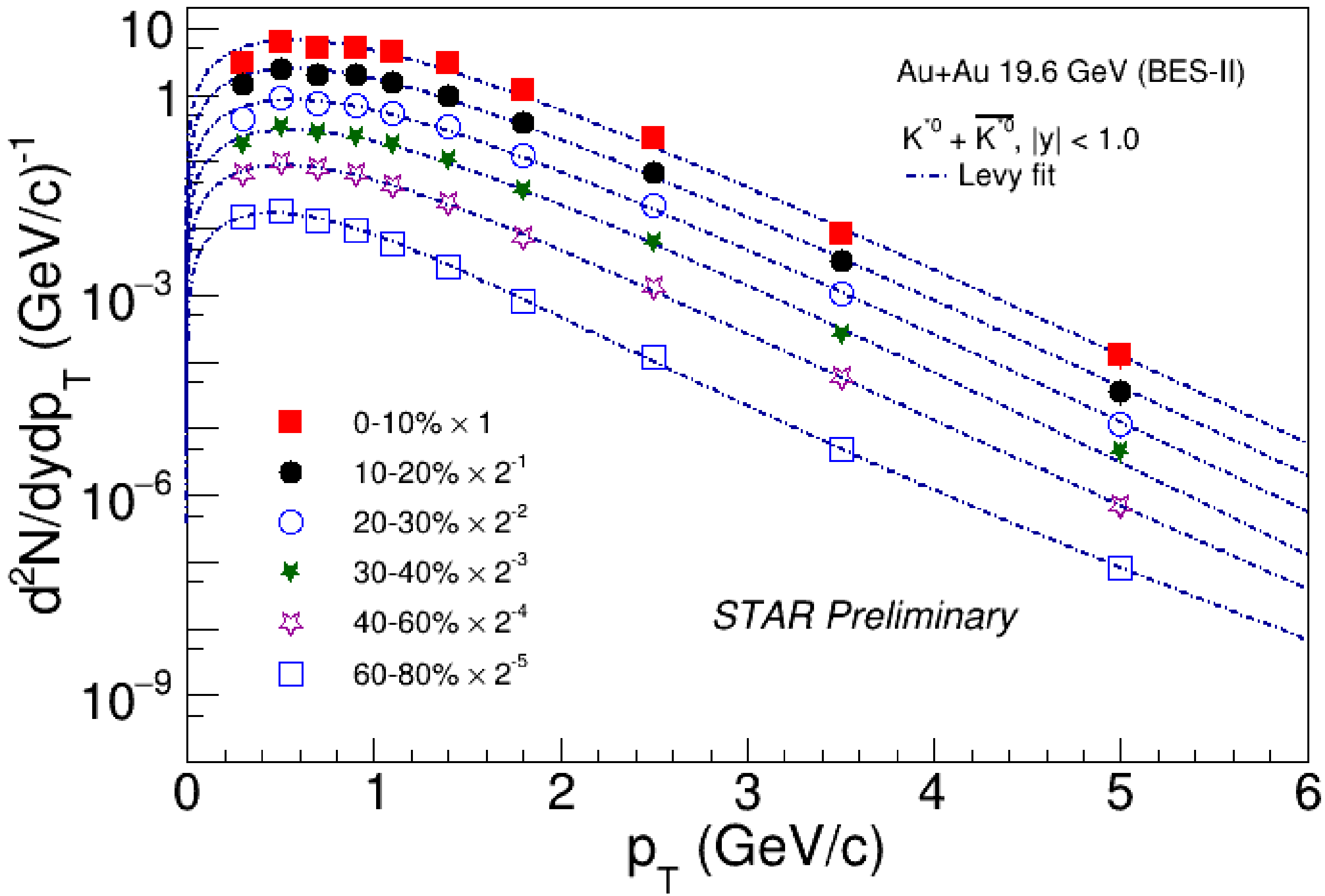




- Signals are extracted using invariant mass method.

  Invariant mass: $m^2_{inv} = E^2 - p^2$ where, $E^2=(E_\pi + E_K)^2$ and $p^2=(p_\pi + p_K)^2$
- Combinatorial background is estimated using pair rotation method.
- Fitting function: $\frac{Y}{2\pi}\times[\frac{\Gamma_0}{(M-M_0)^2+\frac{\Gamma_0}{4}}]$ + 1st order polynomial (residual background)

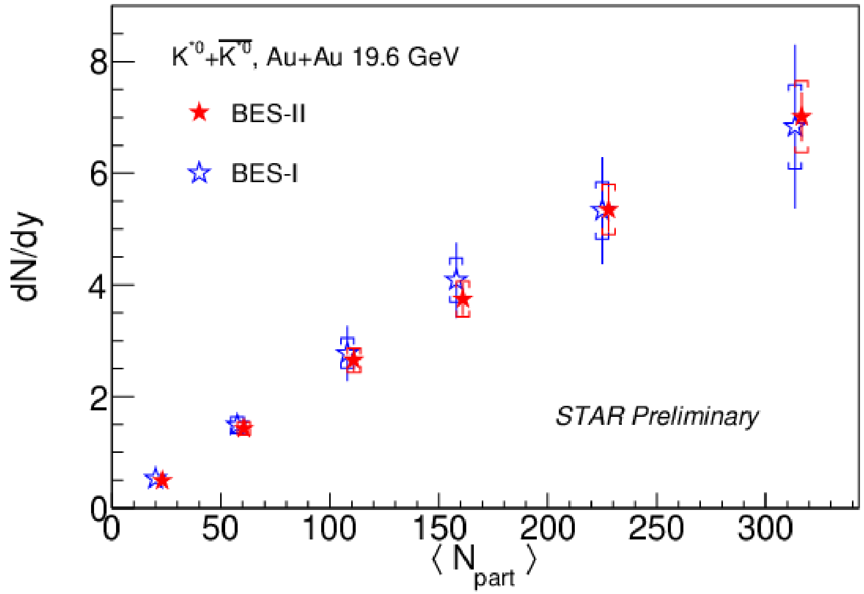
Transverse Momentum Spectra



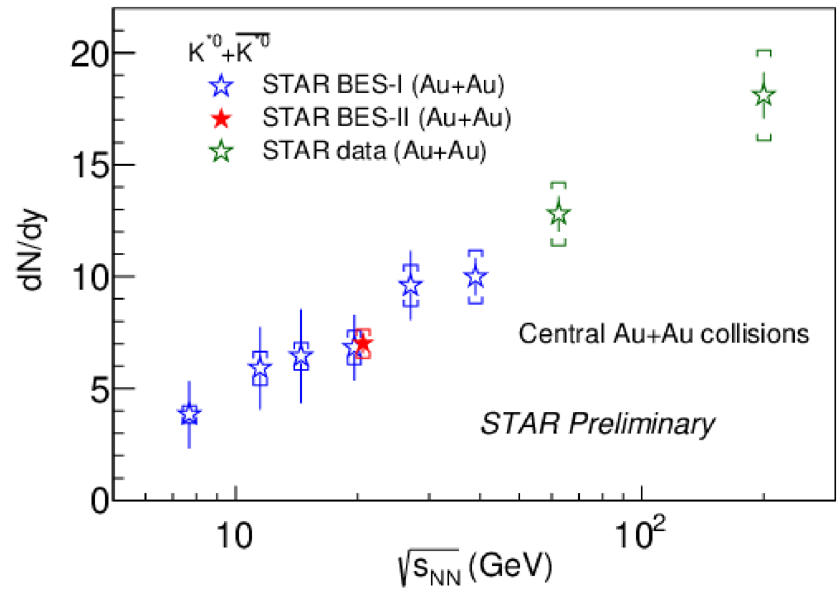
- Extend the BES-I measurement to both lower and higher p_T regions using BES-II data
- Levy Tsallis function is used to extrapolate spectra to unmeasured regions.

C. Tsallis, J. Statist. Phys., 52:479–487, 1988

p_T Integrated Yield



BES-I result : arXiv:2210.02909

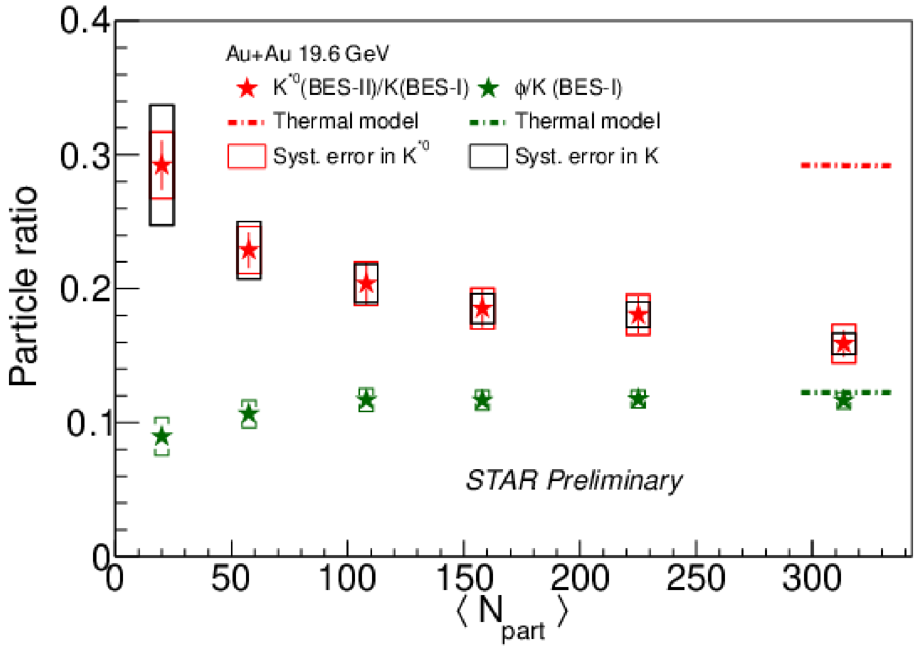


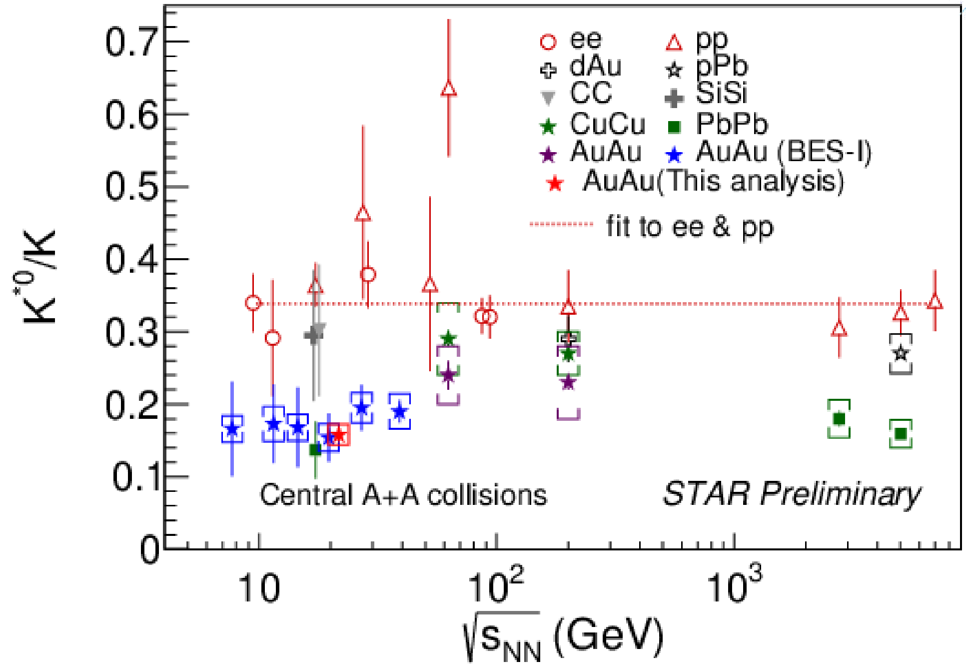
STAR. Phys.Rev.C 84 (2011) 034909 (62.4 and 200 GeV)

Resonance yield increases with centrality and collision energy

The statistical errors are reduced by a factor of 3 in BES-II compared to BES-I

Particle ratios

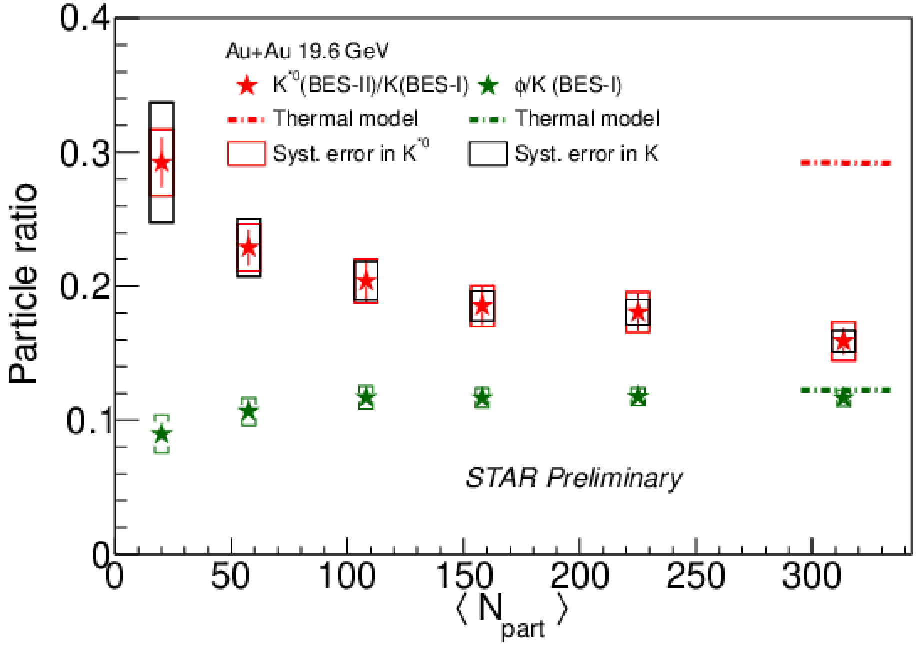


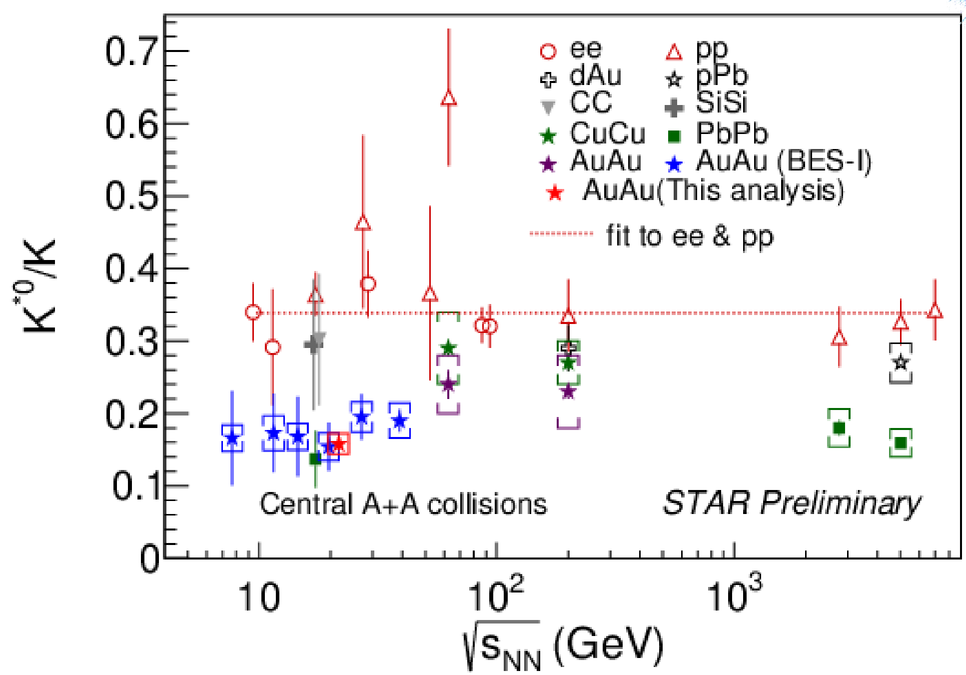


H. Albrecht et al..Z. Phys. C, 61:1–18,1994 (e+e)
Yi-Jin Pei. Z. Phys. C,72:39–46,1996 (e+e)
W Hofmann. Ann. Rev. Nucl. Part.Sci., 38:279–322 1988 (e+e)
K. Abe et al: .Phys.Rev. D, 59:052001, 1999 (e+e)
D. Drijard et al. Z. Phys. C, 9:293, 1981 (p+p)
T. Akesson et al. Nucl. Phys. B, 203:27, 1983 (p+p)
NA49. Phys. Rev. C.84.064909 (2011),
M. Aguilar-Benitez et al. Z. Phys. C, 50:405–426,1991 (p+p)

STAR. Phys. Rev. C 66 (2002) 61901
STAR. Phys. Rev. C.71.064902 (2005)(p+p, Au+Au)
STAR. Phys. Rev. C, 78:044906 (2008) (d+Au,Au+Au)
STAR. Phys. Rev. C, 84:034909 (2011) (C+C,Si+Si)
STAR. Phys. Rev. C, 102(3):034909 (2020) (Au+Au)
ALICE. Phys. Rev. C.91.024609 (2015) (Pb+Pb)
ALICE. Phys. Rev. C.95.064606 (2017) (Pb+Pb)
ALICE. Phys. Lett. B, 802:135225 (2020) (Pb+Pb)
ALICE. Eur. Phys. J. C, 76(5):245,(2016) (p+Pb)

Particle ratios

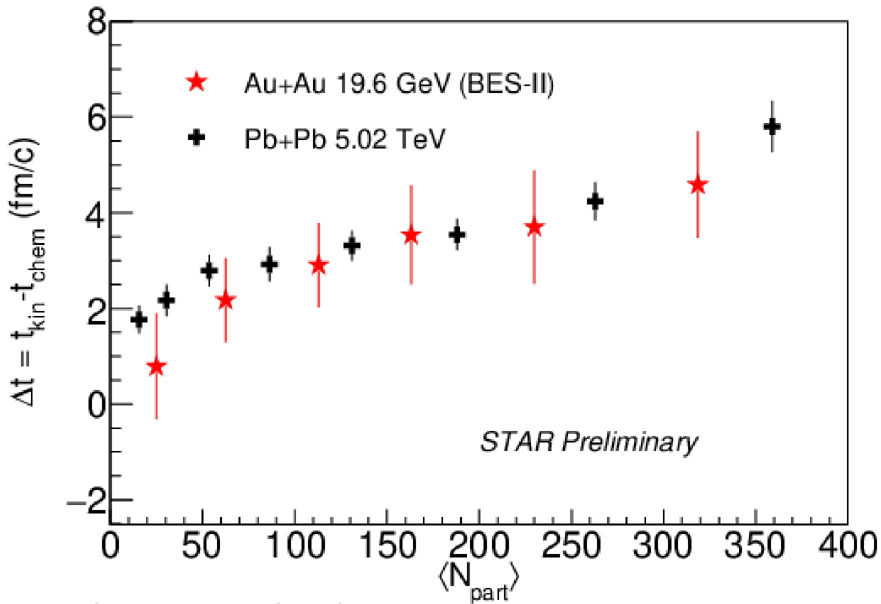


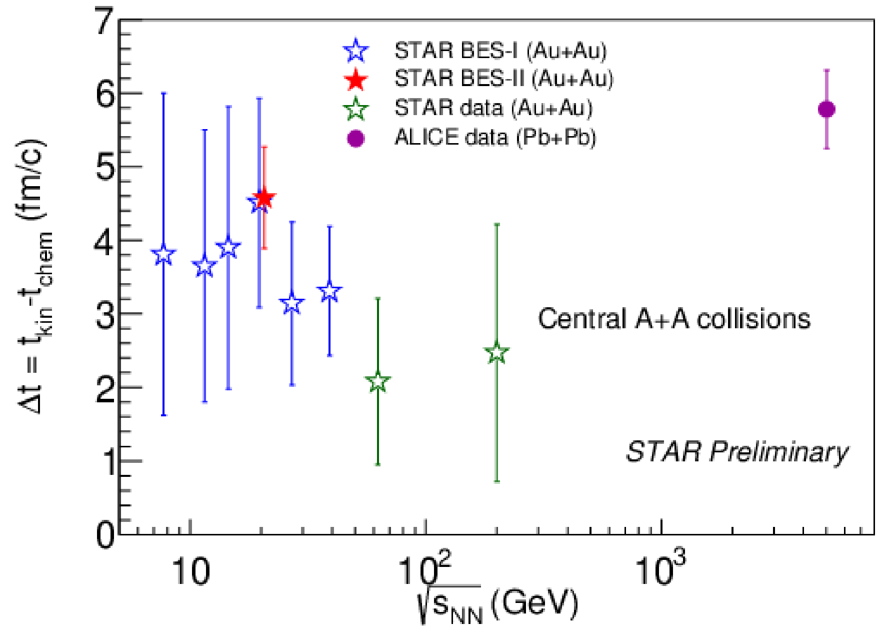


- $(K^{*0}/K)_{central} < (K^{*0}/K)_{peripheral}$
- $(K^{*0}/K)_{central} < (K^{*0}/K)_{pp/ee\text{-}reference}$
- (φ/K): independent of centrality
- Themal model explains φ/K, but overpredicts K^{*0}/K in central collisions

Indicates dominant hadronic rescattering in central heavy-Ion collisions

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

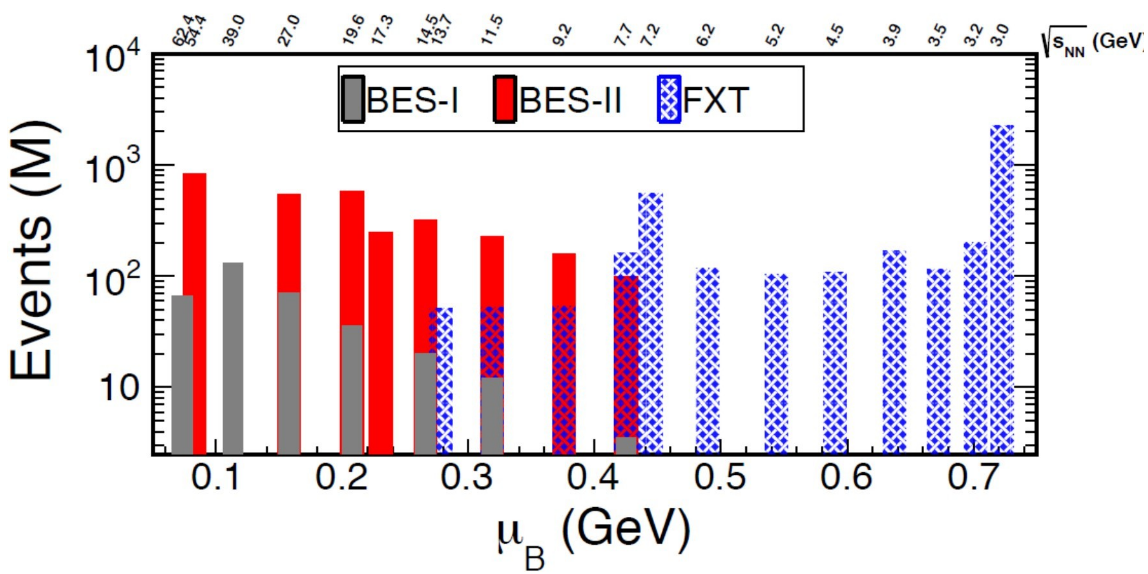
- Errors are the quadratic sum of statistical and systematic errors
- Here, $(K^{*0}/K)_{pp} = 0.34 \pm 0.01$
- No obvious energy dependence within the current uncertainties at RHIC

Summary

- K^{*0} resonance production in Au+Au collisions at 19.6 GeV from BES-II is presented
- K^{*0}/K ratio indicates dominance of hadronic rescattering over regeneration in central Au+Au collisions
- The lower limit of hadronic phase lifetime increases with centrality, and no clear energy dependence is observed within current uncertainities for RHIC measurements.

Outlook

- K^{*0} resonance measurement using high statistics data collected in STAR BES-II program
- Constraints on the hadronic phase lifetime
- Explore more differential measurements (e.g. rapidity dependence)



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)