Production of K^{*0} in Au+Au collisions at 19.6 GeV from RHIC BES-II

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Outline

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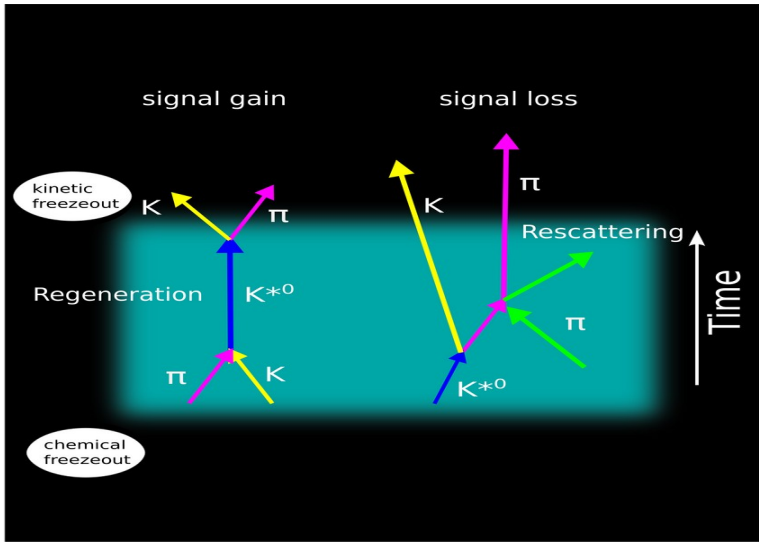
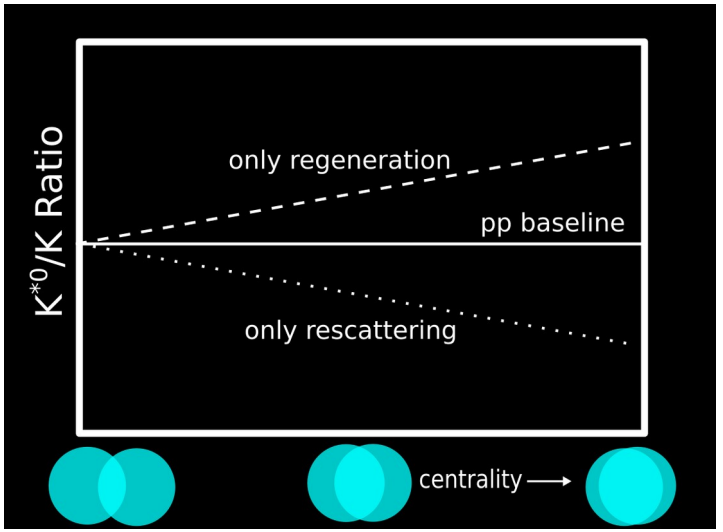
- The STAR detector
- Signal reconstruction
- Results
  - p_T spectra
  - p_T integrated yield (dN/dy)
  - K^{*0}/K ratio
  - Hadronic phase lifetime
- Summary

Motivation

Rescattering and Regeneration:



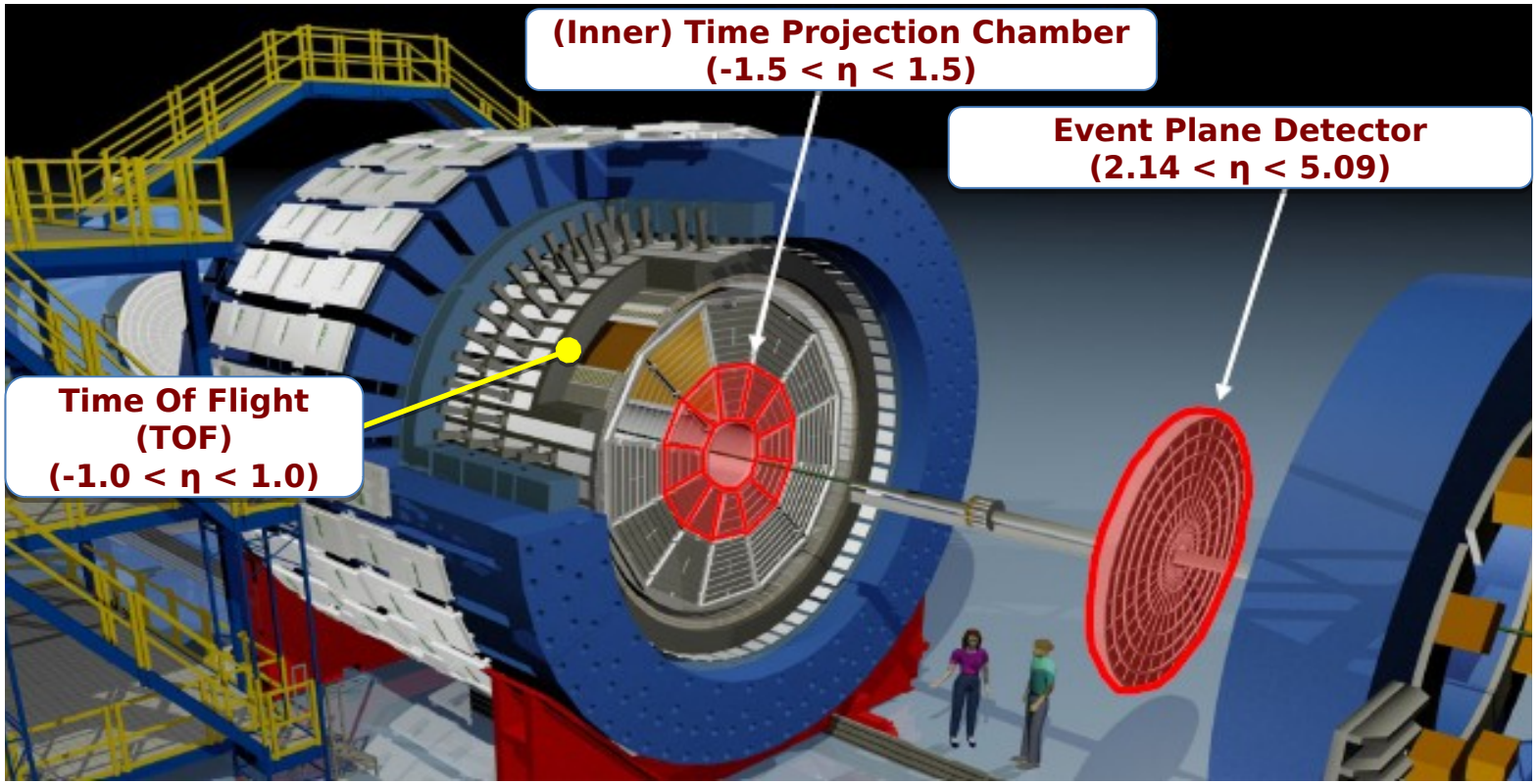


Resonance	Quark content	Decay Channel	t (fm/c)
K^{*0} (896)	$d\bar{s}$	$\pi^- K^+$ (B.R= 0.66)	4.16

- K^{*0}/K ratio can be used to probe the effect of rescattering and regeneration in heavy ion collision.

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

The STAR Detector and Data Set



Tracking: TPC

Particle Identification: TPC & TOF

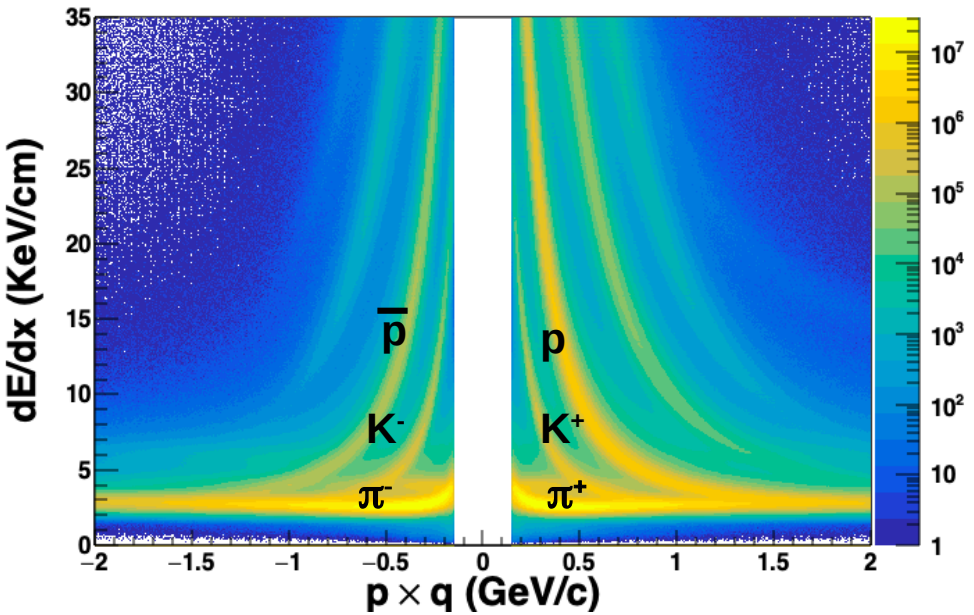
Data Set :

System: Au+Au 19.6 GeV (BES-II)

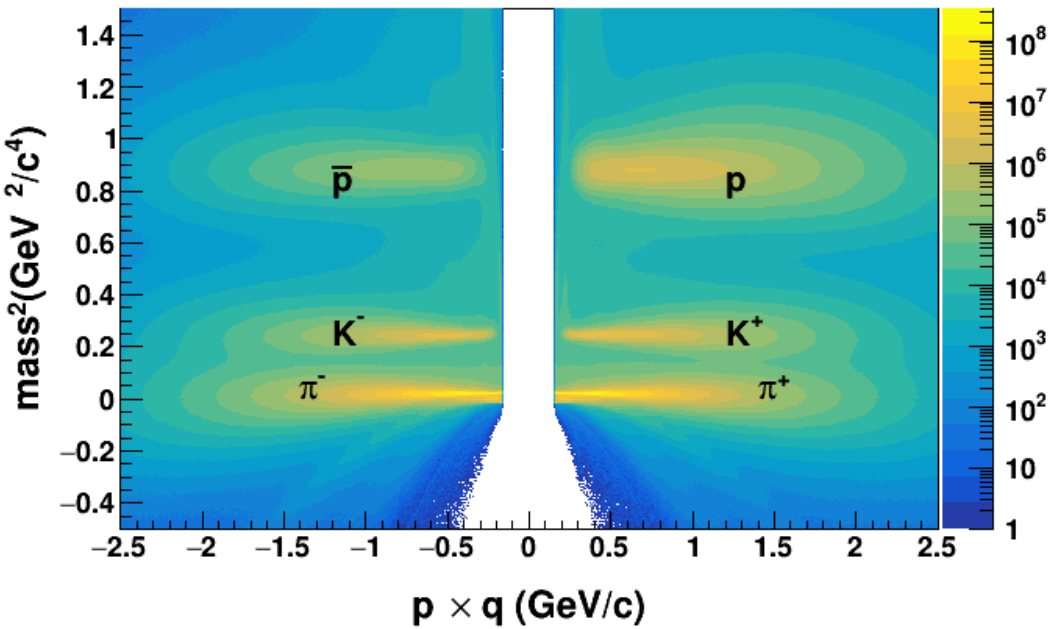
# of events : ~710 M

Particle Identification

Au+Au 19.6 GeV



(Using TPC)



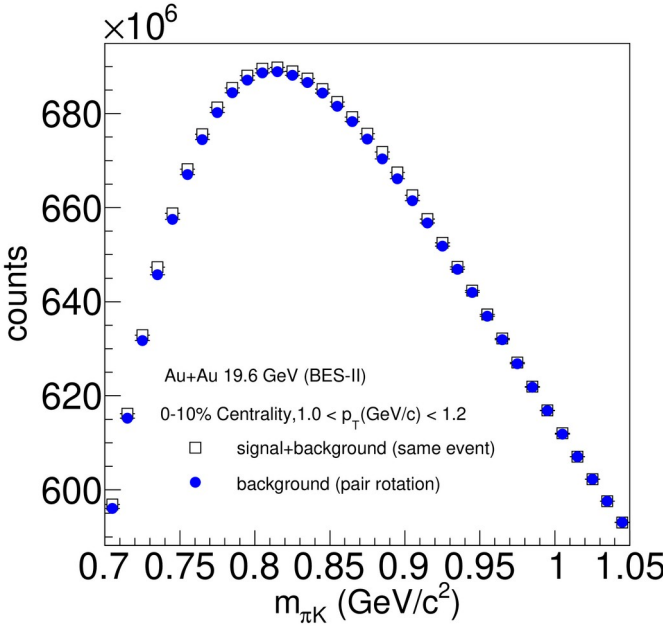
(Using TOF)

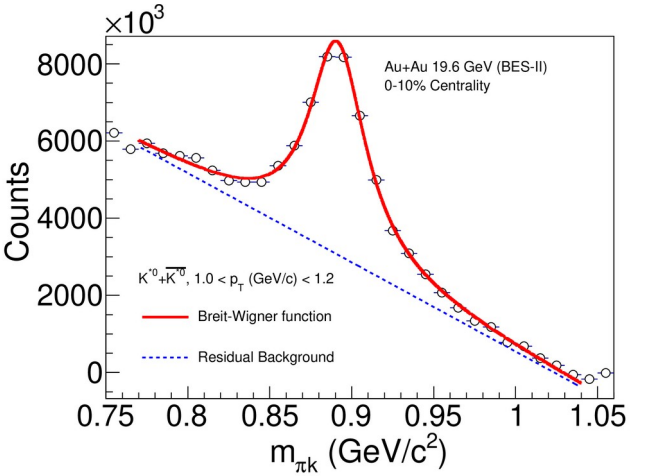
Signal Reconstruction

- 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.

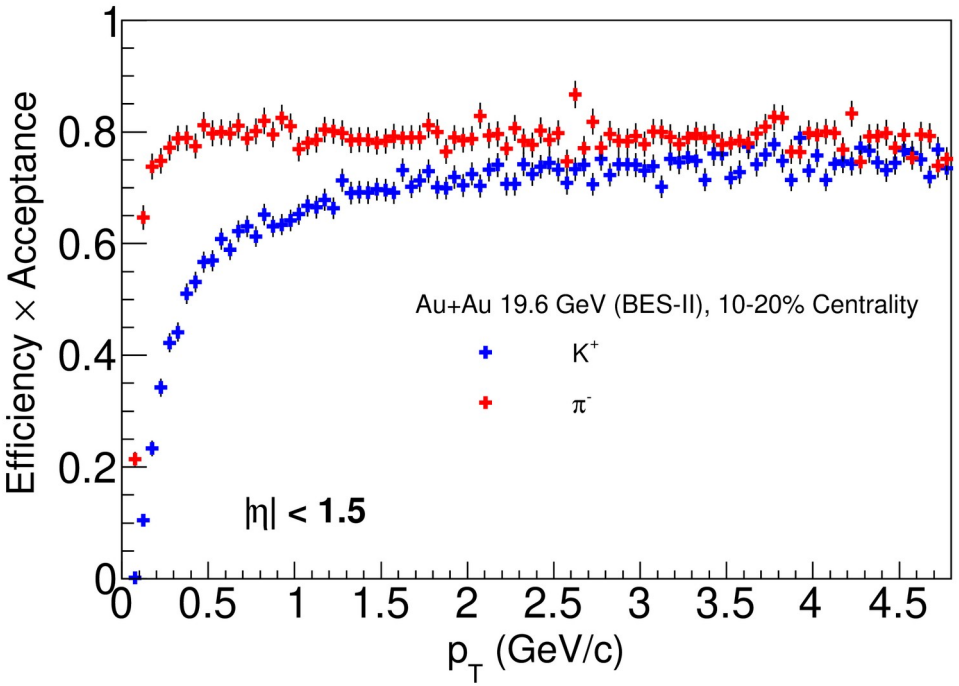
- Fitting function: $\frac{Y}{2\pi}\times[\frac{\Gamma_0}{(M-M_0)^2+\frac{\Gamma_0}{4}}]$ + residual background (1st order polynomial)

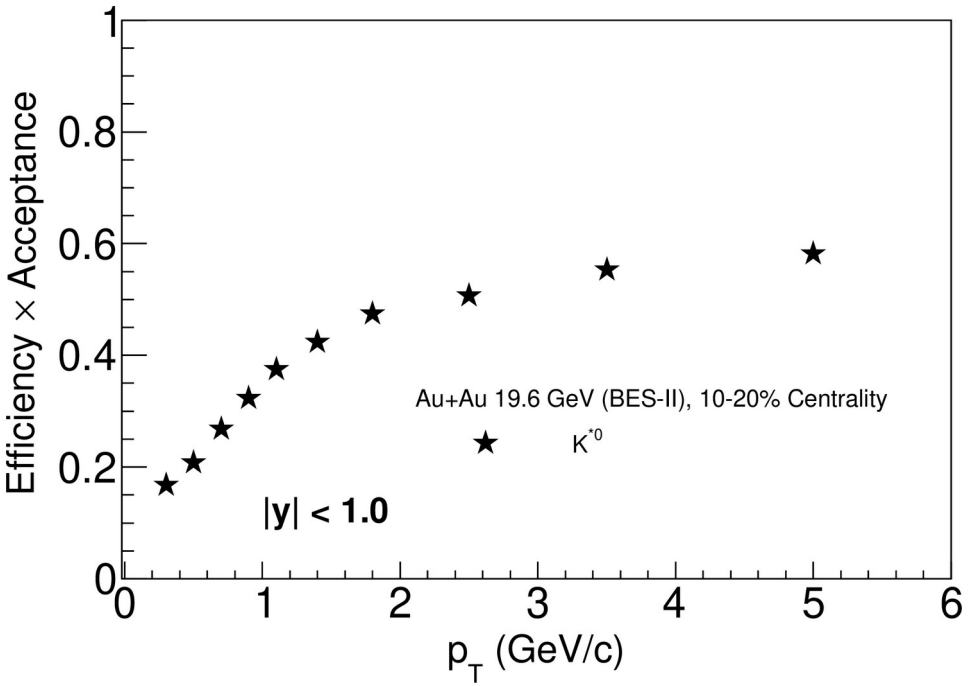




0-10% centrality , 1.0 < p_T (GeV/c) < 1.2	
19.6 GeV	S/√(S+B)
BES-I	2
BES-II	10

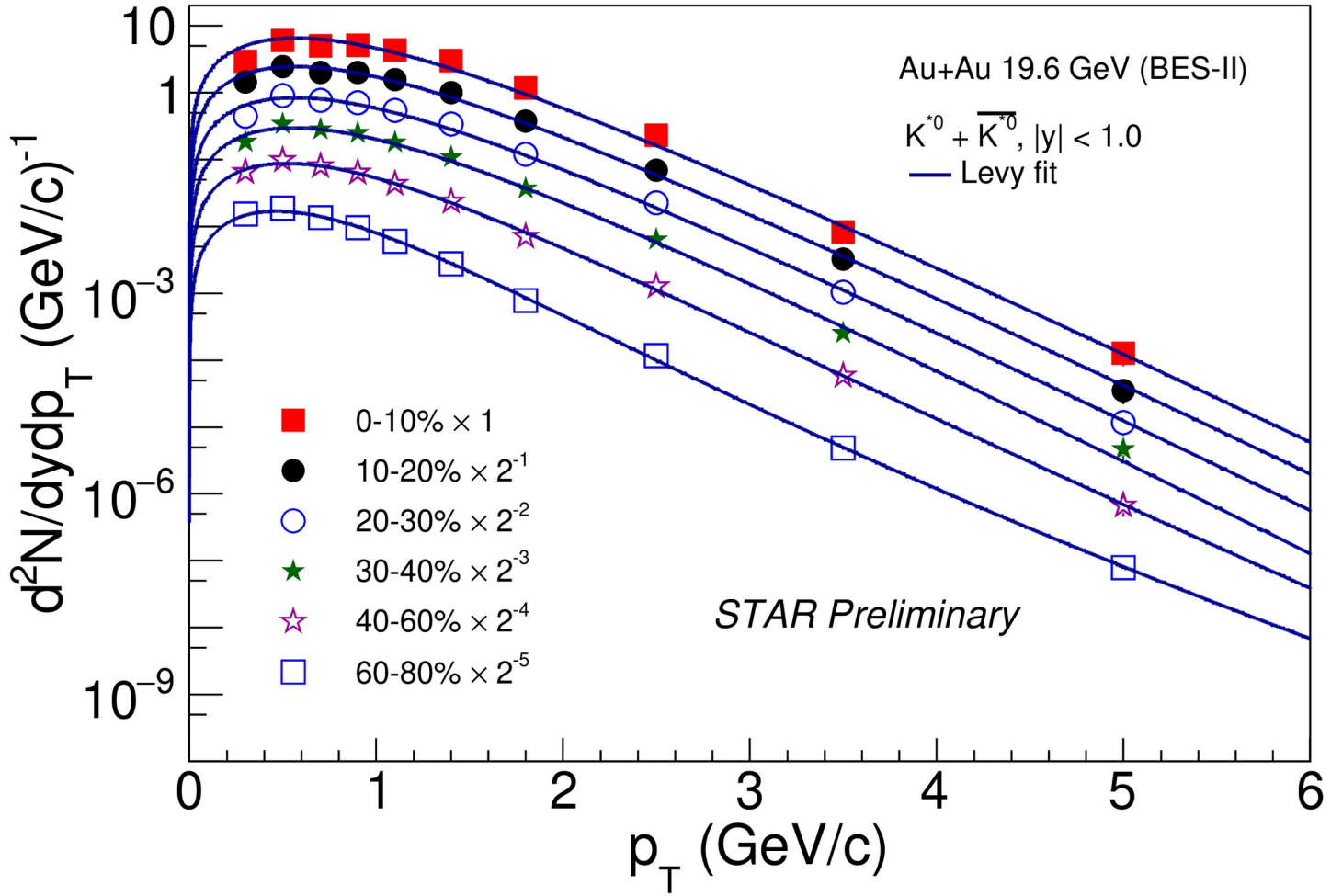
Efficiency × Acceptance





- K^{*0} reconstruction efficiency is estimated based on single particle efficiency

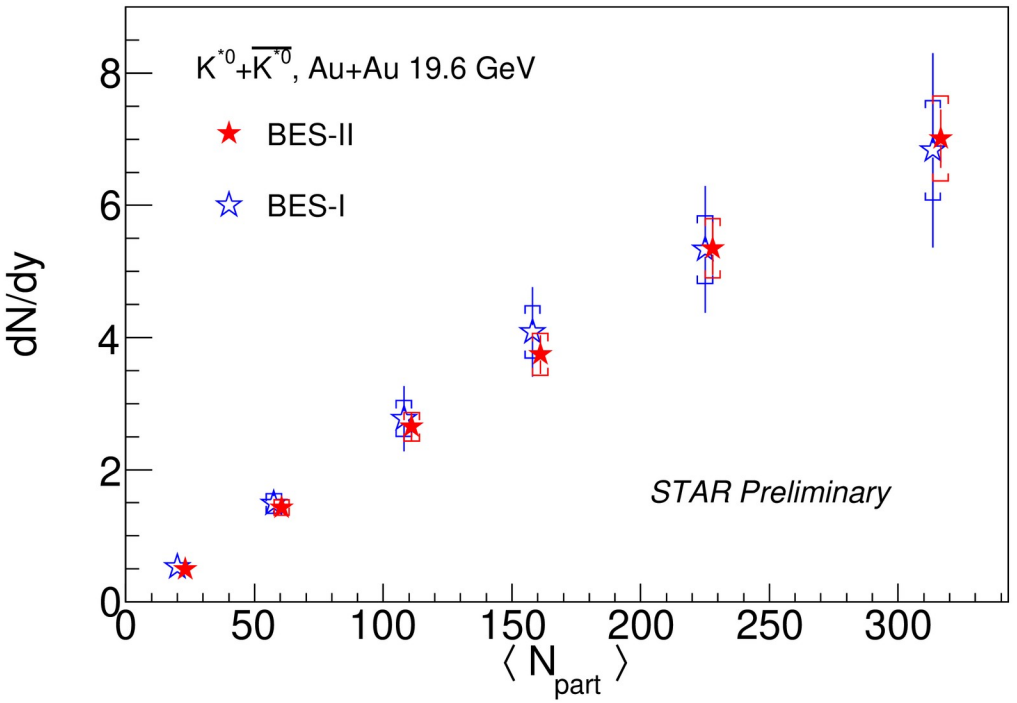
p_T Spectra

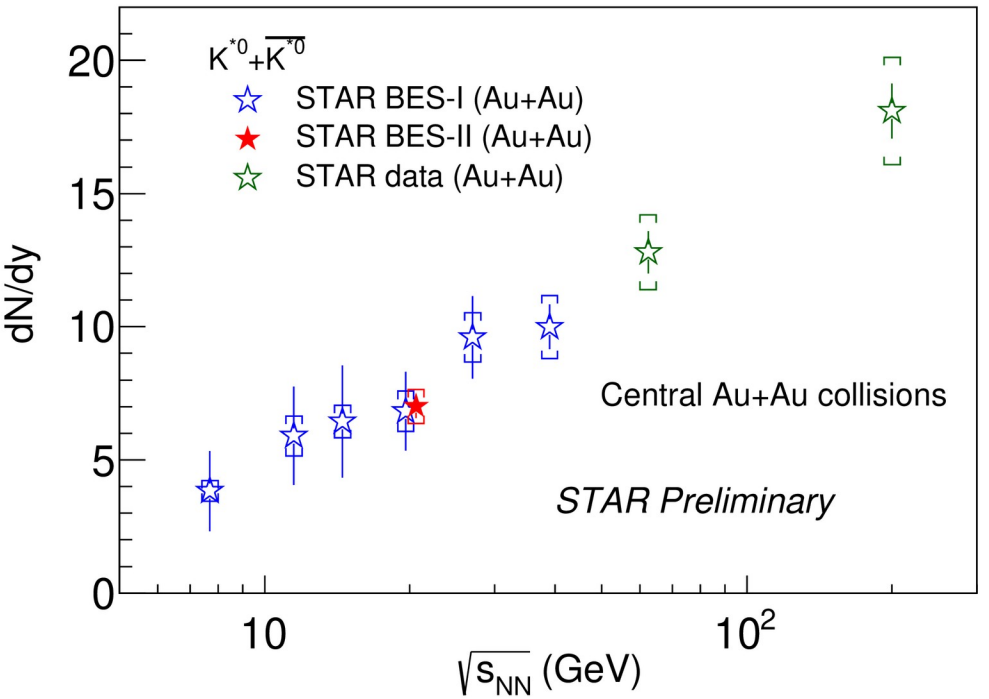


- Levy Tsallis function is used to extrapolate yield at low and high p_T regions.

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

p_T Integrated Yield



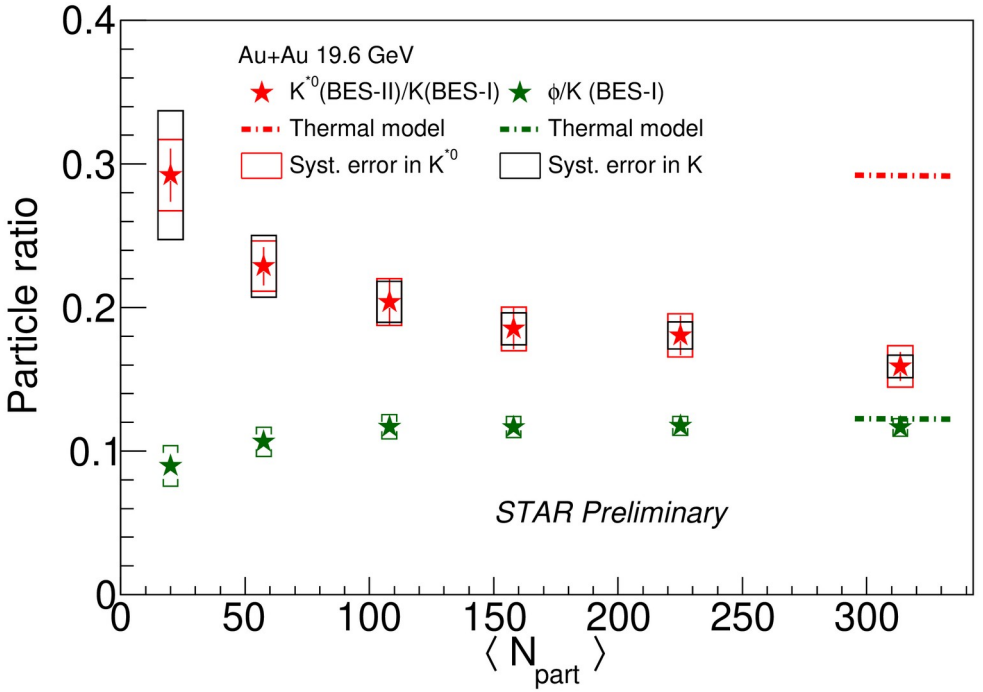


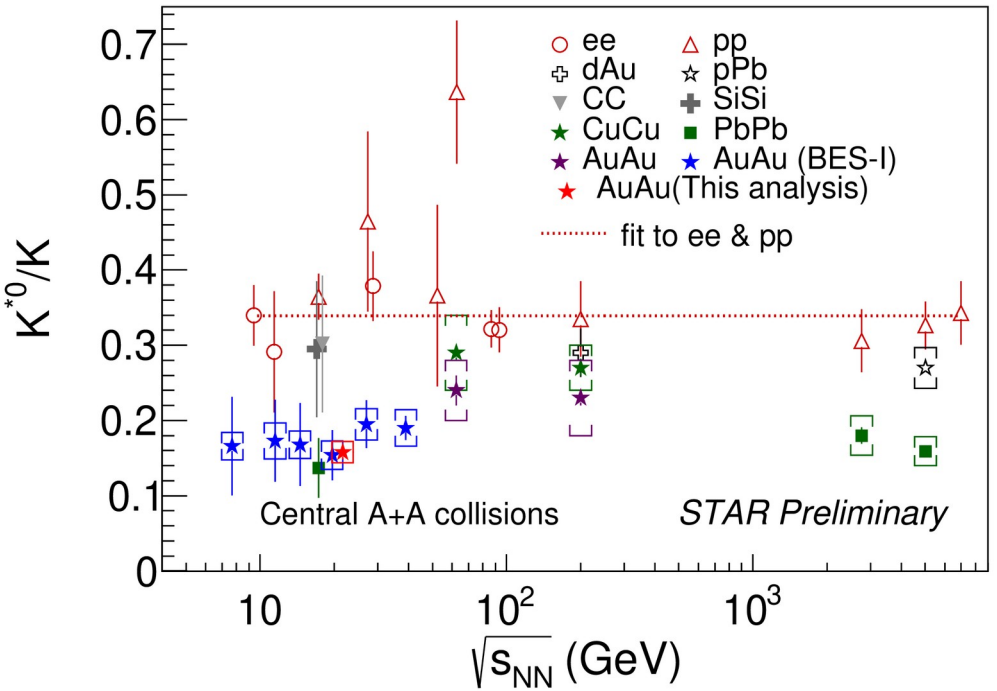
STAR. Phys.Rev.C 84 (2011) 034909 (62.4 and 200 GeV)

dN/dy increases with centrality and collision energy

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

K^{*0}/K Ratio





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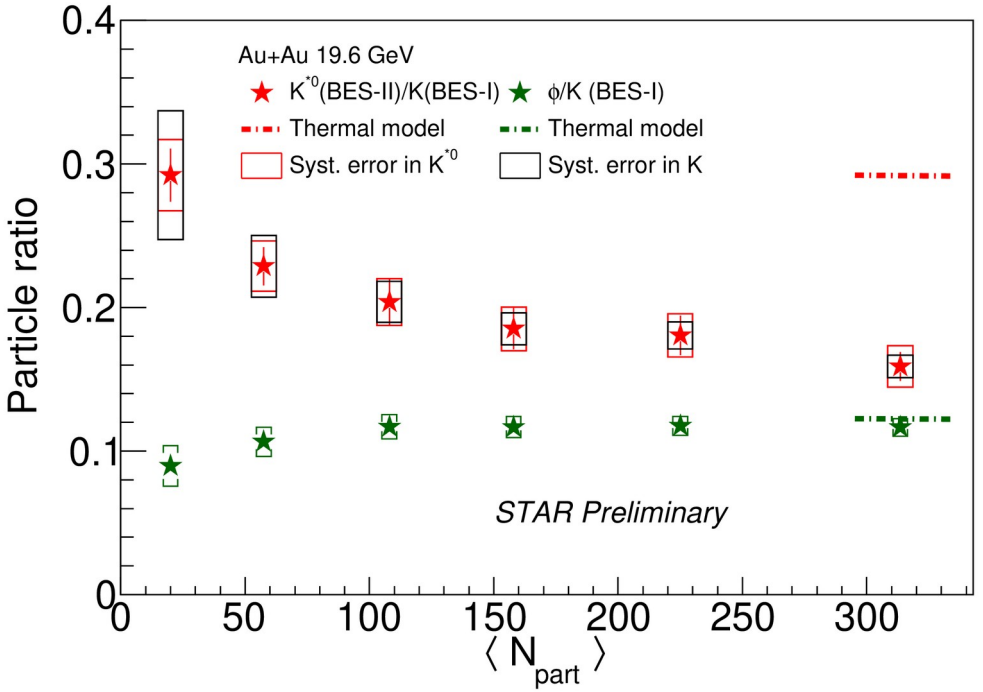
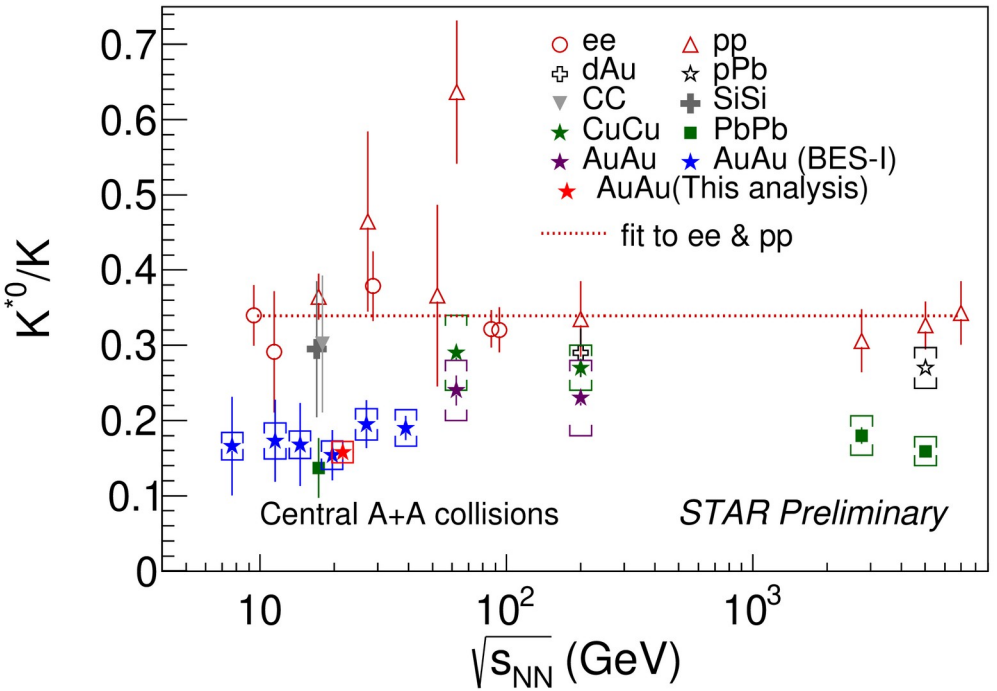
ALICE. Eur. Phys. J. C, 76(5):245,(2016) (p+Pb)

K^{*0}/K Ratio

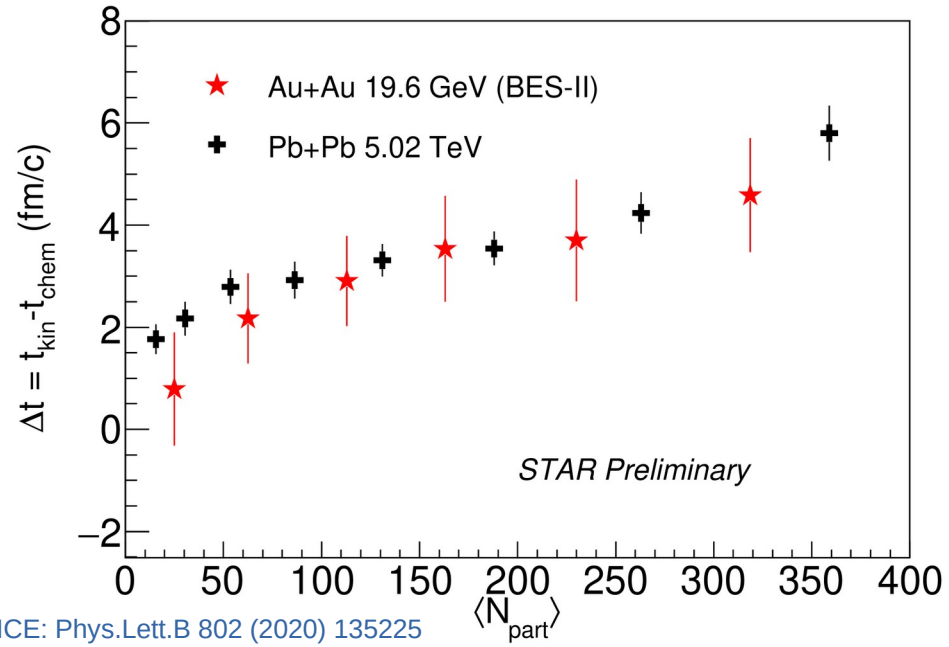




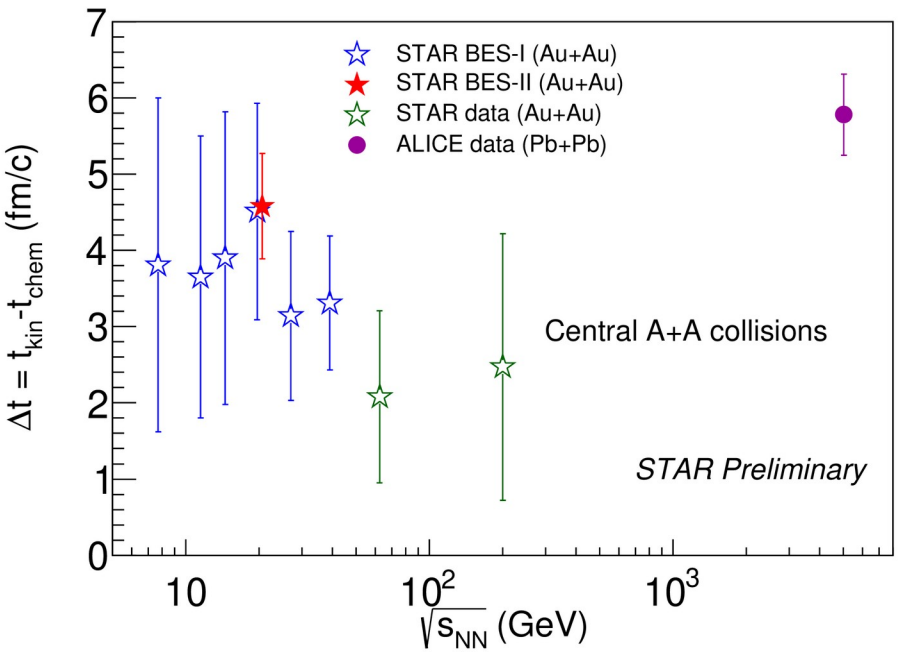
- $(K^{*0}/K)_{central} < (K^{*0}/K)_{peripheral}$
- $(K^{*0}/K)_{central} < (K^{*0}/K)_{pp/ee\text{-}reference}$
- (ϕ/K): independent of centrality
- Themal model explains the ϕ/K, but overpredicts the K^{*0}/K in central collision

Favors dominant hadronic re-scattering in central A+A collisions

Hadronic Phase Lifetime



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



→ Errors are the quadratic sum of statistical and systematic errors

- $(K^{*0}/K)_{kin} = (K^{*0}/K)_{chem} \times e^{-\Delta t/\tau}$
  where, Δt = 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
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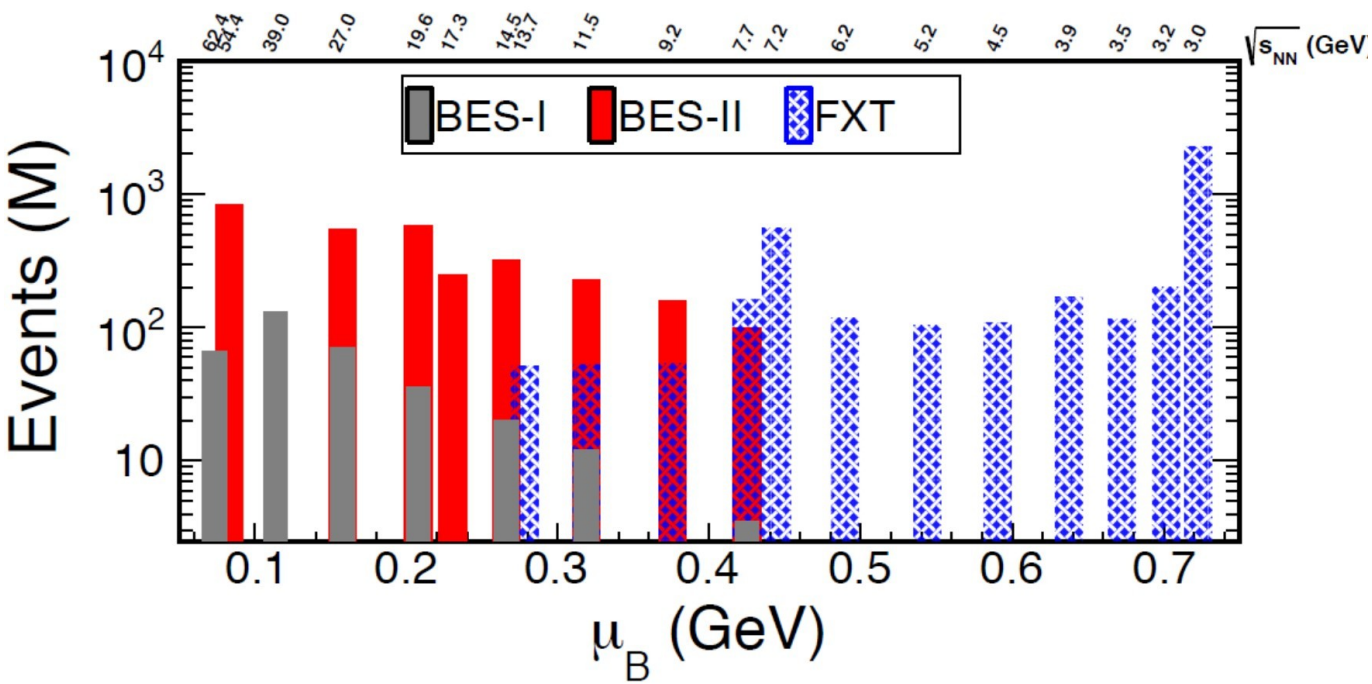
- Here, $(K^{*0}/K)_{pp} = 0.34 \pm 0.01$
- *No clear energy dependence within the current uncertainties for RHIC measurement.*

Summary

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

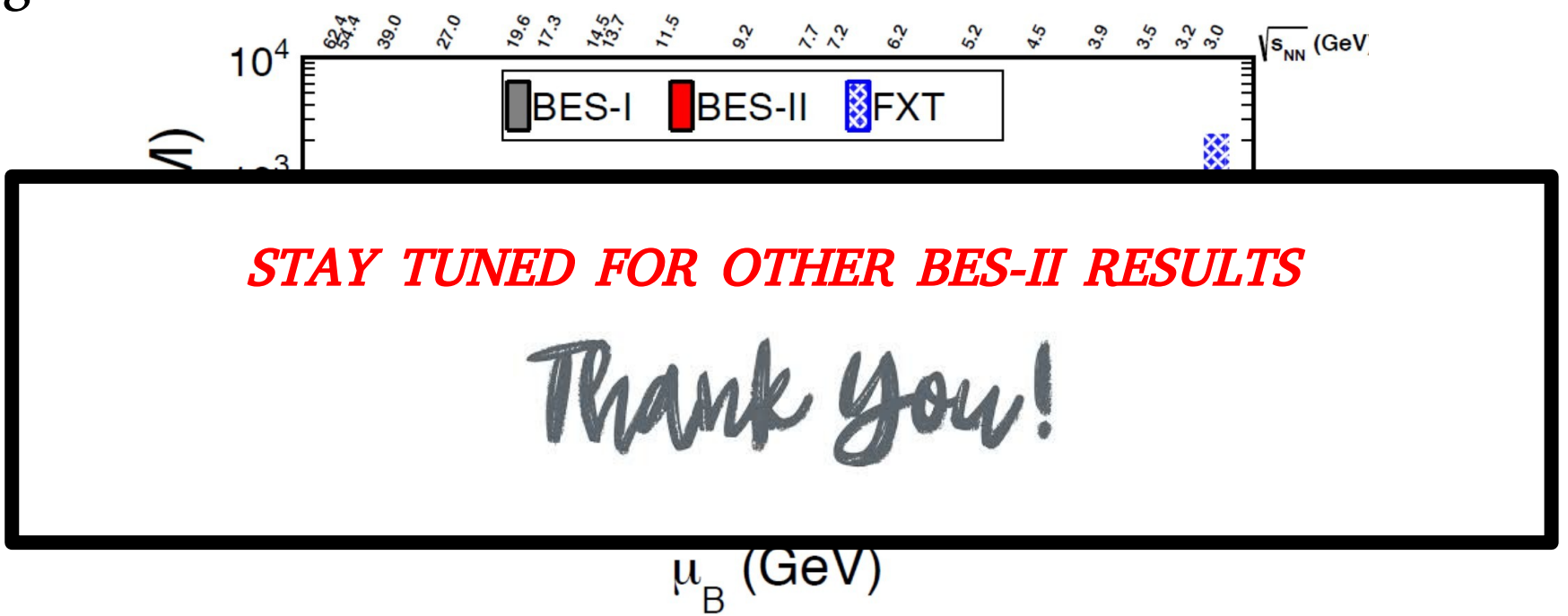
Outlook

- High statistics measurement of K^{*0} resonances in STAR BES-II
- Constraints on the hadronic phase lifetime
- Explore more differential measurements (e.g. rapidity dependence)



Outlook

- High statistics measurement of K^{*0} resonances in STAR BES-II
- Constraints on the hadronic phase lifetime
- Explore more differential measurements (e.g. rapidity dependence) using iTPC



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)