Measurements of ϕ production in Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6, 14.6 GeV with STAR

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Abstract

ϕ has relatively small hadronic interaction cross sections and it can be used to study the physics at the early stage. The multi-strange baryon-to-meson ratio $\Omega(sss)/\phi(s\bar{s})$ is proposed to be a sensitive probe to study the onset of deconfinement. The STAR Beam Energy Scan II program offers us a great opportunity to investigate collision energy and system size dependence of ϕ production in heavy-ion collisions.

In this poster, we present new measurements on transverse momentum (p_T) spectra, centrality dependence of ϕ production yields (dN/dy), resonance to non-resonance yield ratio (ϕ/K^-) and nuclear modification factor (R_{CP}) in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.6 and 19.6 GeV. Physics implications of these measurements will be discussed.

Motivation

- ϕ has relatively small hadronic interaction cross sections and it can be used to study the QGP dynamics with partonic degrees-of-freedom.
- ϕ/K^- ratio and its energy dependence: Differentiate between grand canonical vs. canonical ensembles
- Yield: Measure strangeness enhancement and probe the onset of deconfinement
- R_{CP}: Study the nuclear medium effect in the reaction process

Detector setup, dataset and ϕ reconstruction

- iTPC upgrade: Larger rapidity and lower p_T coverage & better PID
- Events: 19.6 GeV ~ 711M & 14.6 GeV ~ 390M
- Reconstruction: $\phi \to K^-K^+$
- Background: Event-mixing method
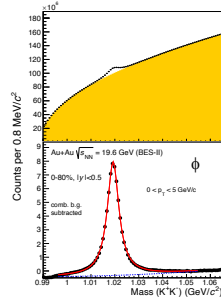
p_T spectra in Au+Au $\sqrt{s_{NN}}$ = 19.6 and 14.6 GeV

- p_T integrated dN/dy is obtained by summing the data points in the measured region and the integral of the fit functions in the unmeasured region
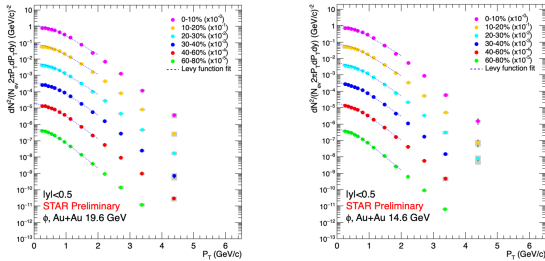

Nuclear modification factor (R_{CP})

- BESII result is consistent with BESI with greatly improved precision
- $R_{CP}(\phi) > R_{CP}(K_S^0)$ at $2 < p_T < 4$ GeV/c
- $R_{CP} < 1$ for higher p_T at 200 GeV → Partonic energy loss in the QGP medium
- $R_{CP} > 1$ for higher p_T at 19.6 GeV and lower energies → Cronin-type interactions, radial flow and/or coalescence hadronization
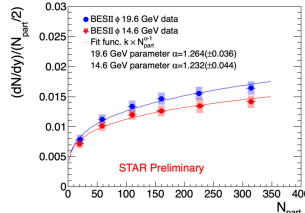
ϕ/K_S^0 BESI: Phys. Rev. C102 (2020) 034909 ϕ 200 GeV: Phys. Rev. Lett. 99 (2007) 112301
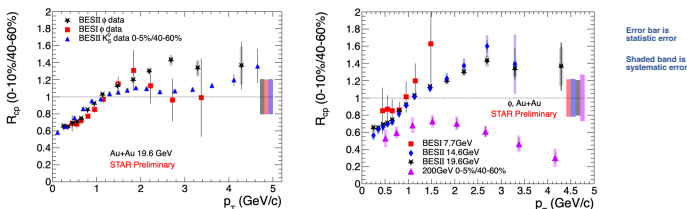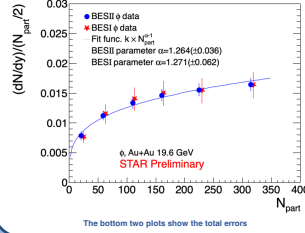

Centrality dependence of ϕ yields (dN/dy)

- α parameter for ϕ is consistent with that for Λ, K at 19.6 GeV → Common centrality dependence for ϕ, Λ, K production.
- From 3.0 GeV to 39.0 GeV, hadronic transport model UrQMD qualitatively describes the trend

Y. Zhou, SQM2022
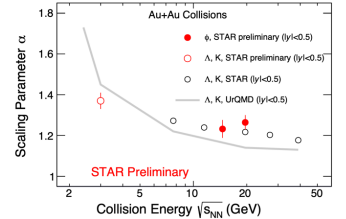
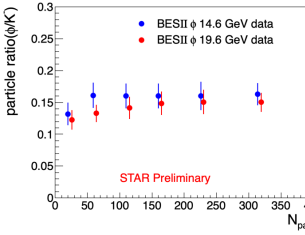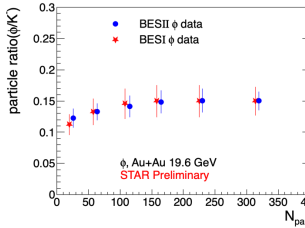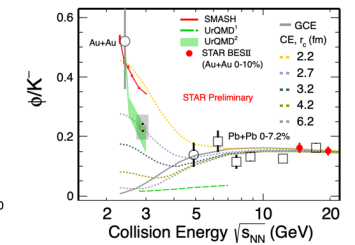## Centrality and Energy dependence of ϕ/K^- ratio.

- ϕ/K^- ratio keeps flat with the increasing centrality
- ϕ/K^- ratio of 19.6 GeV is consistent within errors with 14.6 GeV
- ϕ/K^- ratio reaches the GCE limit at 14.6 and 19.6 GeV

STAR: Phys. Rev. C 96 (2017) 044904
STAR: Phys. Rev. C 101 (2020) 024905
STAR: Phys. Lett. B 831 (2022) 137152

Summary

- Centrality dependence of ϕ production yields (dN/dy) has been presented. From 3.0 GeV to 39.0 GeV, hadronic transport model UrQMD qualitatively describes the trend
- ϕ/K^- ratio are similar at 14.6 and 19.6 GeV. Both GCE and CE calculations agree with data at 14.6 and 19.6 GeV
- Nuclear modification factor (R_{CP}) shows possible nuclear medium effect in the reaction process

Outlook

- The rapidity dependence of ϕ production yields (dN/dy) will be studied
- The measurements in other BESII datasets need to be conducted