Strange hadron production in d+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV using the STAR detector

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Abstract

Strangeness production has been suggested as a sensitive probe to the early dynamics of the deconfined matter created in heavy-ion collisions. Ratios of particle yields involving strange particles are often utilized to study freeze-out properties of the nuclear matter, such as the strangeness chemical potential and the chemical freeze-out temperature. The d+Au collisions connect between Au+Au and p+p collisions, and supply the baseline for the study of strangeness enhancement in the deconfined matter. The study of nuclear modification factors for strange hadrons in d+Au collisions can also help to understand Cronin-like effects.

In this work, we will present new measurements on the production of strange hadrons (K^0_S, Λ, Ξ, Ω) for different rapidity intervals in d+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV, recorded by the STAR experiment in 2016. We will report transverse momentum (p_{T}) spectra, p_{T} integrated yield (dN/dy), average transverse momentum, yield ratios, nuclear modification factors, and rapidity asymmetry (Y_{asym}) for those strange hadrons. The physics implications of the measurement on the collision dynamics will be discussed.

1 Introduction

Mechanism of particle production in asymmetric system like p+Au, d+Au etc. at RHIC may be different in forward and backward rapidities. In d+Au collisions, radial flow, nuclear shadowing and multiple scattering have different effects on the particle production in the forward (d-going) and backward (Au-going) rapidity regions. A comparative study of particle production at forward and backward rapidity can be carried out using a ratio called the rapidity asymmetry (Y_{asym}), which is defined as

$$Y_{\text{asym}}(p_T) = \frac{Y_B(p_T)}{Y_F(p_T)},$$

where Y_{F} and Y_{B} are forward and backward particle yields, respectively.

2 Analysis Details and Techniques

A successful run of d+Au collisions at $\sqrt{s_{\text{NN}}} = 200$ GeV was carried out in 2016. Total of approximately 100 Million good events have been selected for the reconstruction of K_S^0.

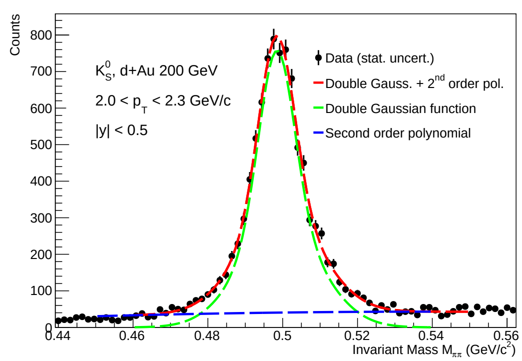
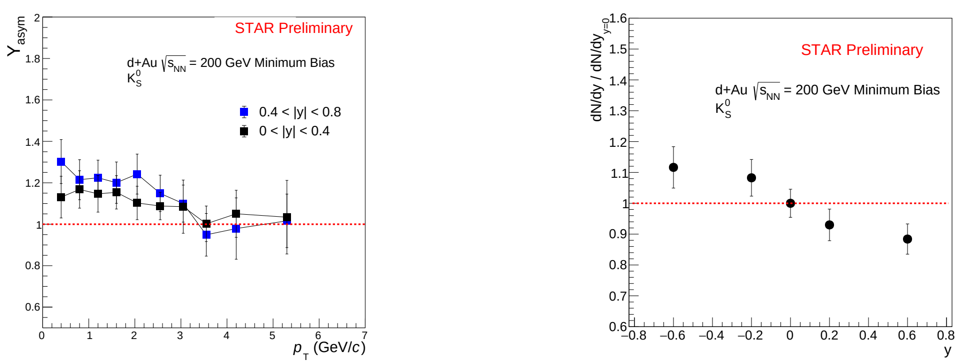


Figure 1: K_S^0 invariant mass distributions at mid-rapidity |y| < 0.5, for different transverse momentum ranges, in d+Au collisions at $\sqrt{s_{\text{NN}}} = 200$ GeV. The distribution was fitted with double Gaussian (for signal peak) plus second order polynomial function (for background), shown as the red line. The blue curve represents the background. The green curve shows the signal peak region.

K_S^0 is a weakly decaying particle. It travels a certain distance ($c\tau = 2.68$ cm) and then decays into stable daughter particles ($K_S^0 \to \pi^+ + \pi^-$). The decay topology of K_S^0 can be used for their reconstruction to suppress the background. We have used double Gaussian and second order polynomial function to depict the signal and background, respectively, as shown in Fig. 1. Raw yield is determined by using the signal counting method under the mass window of $M_0 \pm 3\sigma$, where M_0 is mass of K_S^0 and σ is the width.

3 Results and Discussion

We have measured the transverse momentum dependence (p_T) of Y_{asym} for K_S^0 in two rapidity intervals ($0 < |y| < 0.4, 0.4 < |y| < 0.8$) with minimum bias d+Au collision data. $Y_{\rm asym}$ values deviate from unity at low $p_{\rm T}$ ($<$ 3 GeV/c), suggesting the presence of a rapidity dependence in the nuclear effects. $Y_{\rm asym}$ is consistent with unity at high $p_{\rm T}$, providing a hint that nuclear effects become weaker at high $p_{\rm T}$ as shown in Fig. 2(a). The p_T-integrated yield dN/dy is obtained for each rapidity interval and ratio $(dN/dy)/(dN/dy)_{y=0}$ decreases with rapidity which is shown in Fig. 2(b).



(a) rapidity asymmetry as a function of $p_{\rm T}$ (b) $(dN/dy)/(dN/dy)_{y=0}$ as function of y

Figure 2: Rapidity asymmetry and $(dN/dy)/(dN/dy)_{y=0}$ for K_S^0 in d+Au $\sqrt{s_{\rm NN}}$ = 200 GeV minimum bias. The error bars in both the figures represent statistical errors only.

References

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