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Identified Light and Strange Hadron Spectra at $\sqrt{s_{NN}}$=14.5 GeV and Systematic Study of Baryon/Meson Effect at Intermediate Transverse Momentum with STAR at RHIC BES I

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Abstract

With the recently measured Au+Au collisions at $\sqrt{s_{NN}}$=14.5 GeV, STAR completed its first phase of the Beam Energy Scan (BES) program at RHIC. The main motivation of the BES program is the study of the QCD phase diagram and the search for a conjectured critical point. Amongst the various collision energies of 7.7, 11.5, 19.6, 27, and 39 GeV, that have been previously presented by STAR, collisions at 14.5 GeV will provide data set in the relatively large chemical potential gap between the 11.5 and 19.6 GeV center-of-mass energies. In this contribution, we report new STAR measurements of Au+Au at $\sqrt{s_{NN}}$=14.5 GeV that include identified light particle R_{CP} and spectra, as well as measurements of the strange hadrons (K^0_s, Λ, Ξ, Ω, and ϕ). The spectra from both light and strange particles cover a significant range of the intermediate transverse momentum ($2 < p_T < 5$ GeV/c) in all beam energies. This provides a unique set of data for a systematic study of the baryon-to-meson ratio at intermediate p_T from BES Phase I. We will discuss its physics implications and whether hadronic interactions at late stage dominate the collision dynamics.

Keywords:
BES, Beam Energy Scan, Nuclear Modification Factor, R_{CP}, Strange Hadrons, Spectra, Baryon, Meson, STAR, RHIC

1. Introduction

One of the primary goals of the RHIC Beam Energy Scan (BES) program is to search the QCD phase diagram for the onset of signatures attributed to the formation of a QGP [1]. The recently collected data from Au+Au collisions at $\sqrt{s_{NN}}$=14.5 GeV provides new data in the relatively large baryon chemical potential gap between data collected previously in BES I at $\sqrt{s_{NN}}$=11.5 and 19.6 GeV[2]. In this work, we present new STAR measurements of the light ($\pi^{\pm}$, p, and $\bar{p}$) and strange (K^0_s, Λ, Ξ, Ω, and ϕ) hadron spectra in Au+Au collisions at $\sqrt{s_{NN}}$=14.5 GeV with STAR. These identified particle spectra are used to construct identified particle R_{CP} and baryon-to-meson ratios. These observables, expected to be sensitive to the formation of a QGP medium, are presented for $\sqrt{s_{NN}}$=14.5 GeV. These results are discussed in the context of the results from previous BES I energies.

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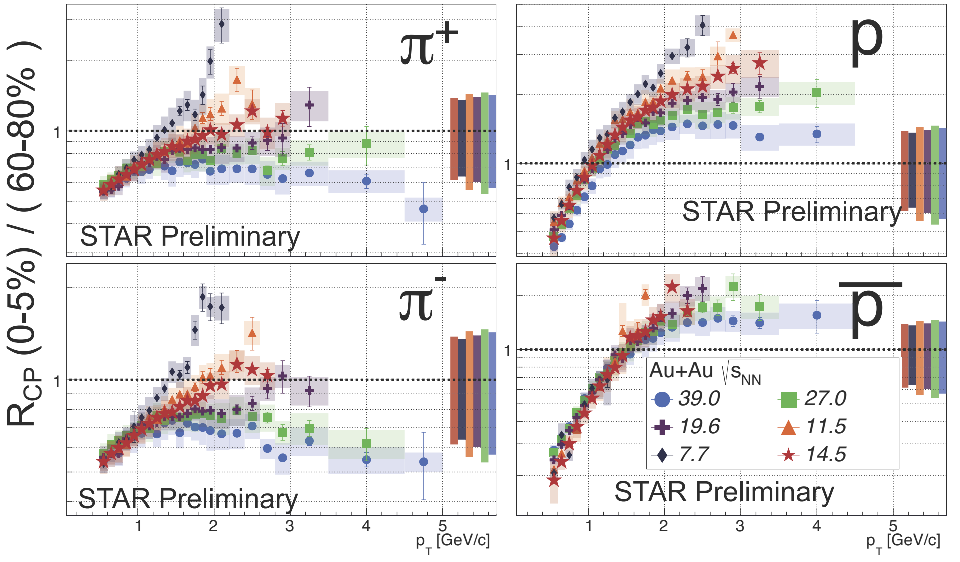

Fig. 1. The R_{CP} for Au+Au at $\sqrt{s_{NN}}$=14.5 GeV for events with a centrality of 0-5% over those with a centrality of 60-80%. The large colored error bars on the right hand side of each plot are the correlated uncertainty due to the MC Glauber calculation of N_{coll} for each $\sqrt{s_{NN}}$ energy. Horizontal bars represent the p_T range used for measuring each point in the spectra. Vertical bars are used to show statistical uncertainty while shaded boxes are used to show systematic uncertainties.

2. Analysis

The Solenoidal Tracker at RHIC (STAR) [3] is used for the measurement of the identified particle spectra. The two sub-detectors of primary importance in this analysis are the Time Projection Chamber (TPC) [4] and the Time Of Flight detector (TOF) [5]. The TPC provides particle track reconstruction, momentum measurement, and specific ionization energy loss (dE/dx) measurement. The TOF provides precise particle velocity (β) measurements.

For the measurement of the light hadron spectra, a novel technique for combining the dE/dx information from the TPC and the β^{-1} information from the TOF has been employed. In this technique the 2D dE/dx vs. β^{-1} distribution is reduced into several complimentary 1D distributions. Two of these distributions are the 1D projections of all tracks on the dE/dx and β^{-1} axes. The rest are formed by applying a cut around each particle's expected dE/dx (β^{-1}) and then projecting on the other axis. The light hadron yields are then extracted by fitting to all of these 1D distributions simultaneously. This technique provides a robust method of measuring the light particle spectra from low p_T out to intermediate/high p_T in the wide range of $\sqrt{s_{NN}}$ energies included in the BES I.

The strange hadrons are identified using the TPC's tracking to reconstruct a secondary vertex. Topological cuts are then applied and the combinatorial background is removed. The yields for the particles of interest are then extracted by fitting to the invariant mass distributions of the charged decay particles. The light hadron spectra are measured in the rapidity region $|y| \leq 0.25$ and the strange hadron spectra are measured in the rapidity region $|y| \leq 0.5$. Both sets of spectra are measured for seven centrality classes, ranging from 60-80% to 0-5% most central, determined using the Monte-Carlo (MC) Glauber model[6, 7].

The light and strange hadron spectra are corrected for acceptance and efficiency. STARSim, a framework based on GEANT [8], is used to simulate particle tracks in the STAR detector. These simulated tracks are embedded into real events and used to calculate the TPC's track reconstruction efficiency and acceptance. The light hadron spectra are also corrected for the matching efficiency of the TOF detector. Some tracks that are reconstructed in the TPC do not get matched to hits in the TOF detector. In order to correct for these effects a data-driven technique has been employed to compute the TOF-to-TPC matching efficiency