Identified Particle Production in Au+Au Collisions at $\sqrt{s_{NN}} = 14.5$ GeV in STAR

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Introduction

The main objectives of high - energy heavy-ion collisions are to explore the Quantum Chromodynamics (QCD) phase diagram and to study the properties of the hot and dense matter formed.

The fireball formed in high - energy heavy-ion collisions thermalizes as it expands and hence cools and gradually the particles cease to collide among themselves. The temperature (T_{ch}) at which the inelastic collisions between the particles cease is called chemical freeze-out. On further expansion of the system and drop of temperature, the elastic collisions between the particles cease and the particles momenta gets fixed. This is called kinetic freeze-out characterised by the temperature T_k. The study of the bulk properties of the system like dN/dy, mean p_T, particle ratios and freeze-out parameters, sheds light on the evolution of the system formed in high energy heavy-ion collisions.

Data Analysis

The data analyzed in this work were recorded by the STAR detector at RHIC in 2014, at center of mass energy $\sqrt{s_{NN}} = 14.5$ GeV, which is the left - over point in the RHIC Beam Energy Scan (BES) programme. The minimum bias triggered events with a primary collision vertex position along the longitudinal beam direction (V_z) within 30 cm from the center of the detector, are selected for this analysis with an additional radial vertex cut for the transverse position of the primary

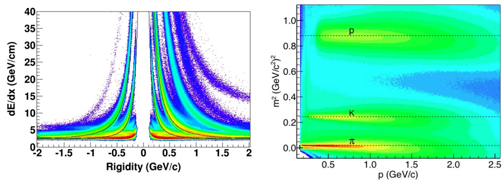

FIG. 1: The dE/dx as function of charge×momentum (Rigidity) and m^2 as function of momentum in Au+Au collisions at $\sqrt{s_{NN}} = 14.5$ GeV.

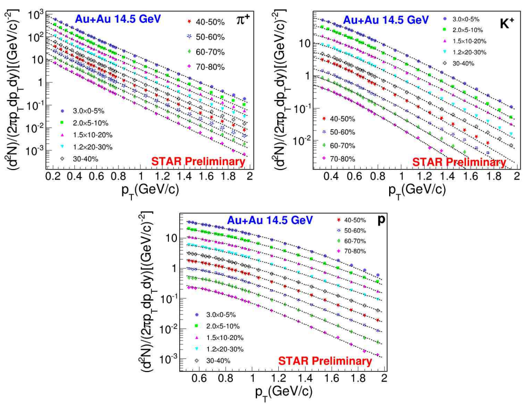

FIG. 2: Centrality dependence of the invariant yields of π^+, K^+ and p in nine different centralities as a function of p_T produced in the Au+Au collisions at $\sqrt{s_{NN}} = 14.5$ GeV.

vertex ($V_r < 1$ cm) from the center of the beam pipe. The number of events obtained after all these cuts are ~ 14.6 million. Mainly the Time Projection Chamber (TPC) and the Time Of Flight (TOF) detectors are used for particle tracking and identification.

The raw yields are extracted using TPC by using Ionization energy loss of the charged

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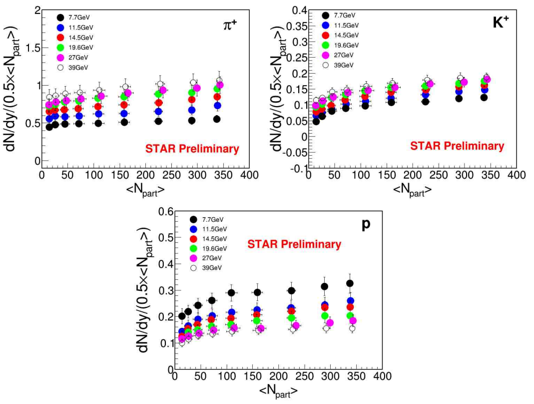

FIG. 3: $< dN/dy >$ of π^+, K^+ and p scaled by $< 0.5 \times N_{part} >$ as a function of $< N_{part} >$ in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5 GeV along with other BES energies.

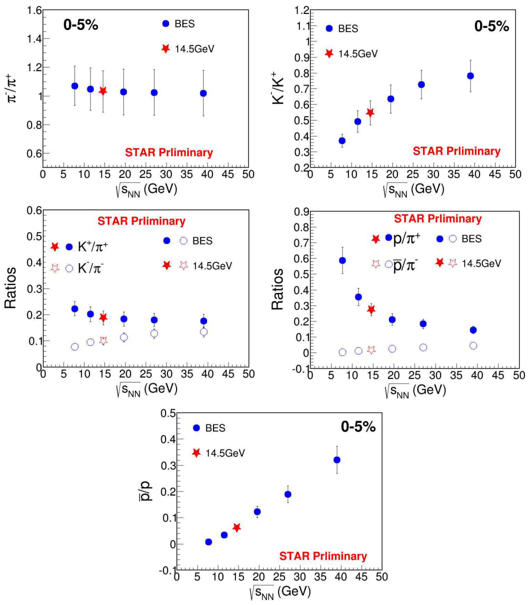

FIG. 4: Different particle ratios as a function of $\sqrt{s_{NN}}$ in Au+Au collisions at $\sqrt{s_{NN}} = 14.5$ GeV along with other BES energies.

particles while traversing the TPC volume, i.e. from the dE/dx information of individual particles using a multi - gaussian fitting method. The raw yields using TOF are obtained using timing measurements and by fitting the m^2 distributions for individual particles[1]. Figure 1 shows the relevant plots for particle identification in TPC and TOF which are the dE/dx as a function of charge×momentum (rigidity) and m^2 as a function of momentum in Au+Au collisions at $\sqrt{s_{NN}} = 14.5$ GeV respectively.

The yields of the produced particles as a function of p_T are corrected for tracking efficiency, matching efficiency between TPC and TOF and for background contribution to the yields of pions and protons[1].

Results

Figure 2 shows the transverse momentum spectra obtained in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5 GeV in nine different centralities and are fitted with various functions to extract p_T integrated particle yields in each centrality. For pion, the fit function is Bose - Einstein (BE), for kaon, it is m_T - exponential and for proton (anti-proton), it is double exponential. Figure 3 shows the centrality dependence of dN/dy in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5 GeV for π^+, K^+ and p in comparision with other Beam Energy Scan (BES) energies (7.7, 11.5, 19.6, 27, 39 (GeV)). Figure 4 shows different particle ratios for $0-5\%$ centrality in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5 GeV along with other BES energies as a function of $\sqrt{s_{NN}}$. We observe that the results obtained in 14.5 GeV are in the same trend as in other BES energies[2,3].

In addition to the transverse momentum spectra for $\pi^\pm, K^\pm, p(\bar{p})$ and their yields, we will also present the average transverse momentum and freeze-out parameters obtained in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5 GeV. A comparative study with other BES energies will be discussed.

References

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