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STUDY OF HIGH-p_T PION PRODUCTION WITH CBM AT SIS100 ENERGIES

T. A. Vasiliev [1], *V. P. Ladygin, A. I. Malakhov*

Joint Institute for Nuclear Research, Dubna

Transverse momentum spectra of $\pi^{\pm}$ and the π^{+}/π^{-} ratios are obtained for the Au + Au central collisions at the energies of 6, 8, and $10A$ GeV. The particles identification has been done using the time-of-flight information from RPCs. The pions with large values of the transverse momentum can provide the information on the coexistence phase even in the energy domain of SIS100.

Представлены результаты моделирования для выхода $\pi^{\pm}$ и отношение выхода π^{+}/π^{-} для центральных столкновений Au + Au при энергиях 6, 8 и $10A$ ГэВ. Процедура идентификации частиц основана на измерении времени пролета с использованием RPC. Пионные спектры с большими значениями поперечного импульса могут быть чувствительны к переходной фазе в плотной ядерной материи уже при энергии SIS100.

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INTRODUCTION

One of the most interesting features discovered at the BNL Relativistic Heavy Ion Collider (RHIC) is the suppression of particle production at high transverse momenta in central nucleus–nucleus reactions relative to peripheral ones as well as to p + nucleus and to $p+p$ collisions [1–5]. This is generally interpreted as a sign of parton loss in hot and dense strongly interacting matter. In the experiment [6], there were measured invariant yields of $\pi^{\pm}$, p, anti-p, $K^{\pm}$ particles in Pb + Pb reactions at $\sqrt{s} = 17.3$ GeV collision energy around midrapidity as a function of transverse momentum up to 4.5 GeV/c, with overall systematic errors below $\approx 5\%$. Using these spectra and the previously published $\pi^{\pm}$ yields in $p + p$ collisions, the nuclear modification factor R_{AA} for $\pi^{\pm}$, p, anti-p, $K^{\pm}$ was studied. The hard probes can provide the information on the coexistence phase even in the energy domain of SIS100 [7]. The first step of such investigations at CBM can be the study of high transverse momentum spectra of pions, because high-energy single partons forming the secondary particles are valuable probes of hot dense matter.

SIMULATION OF HIGH-p_T PION DATA AT CBM SETUP

The standard STS geometry and the magnetic field for this release have been used. The Kalman filter (L1-STS procedure) procedure for the particles momentum reconstruction in STS has been used. The particles identification has been done using the time-of-flight

[1] E-mail: tavasiliev@jinr.ru

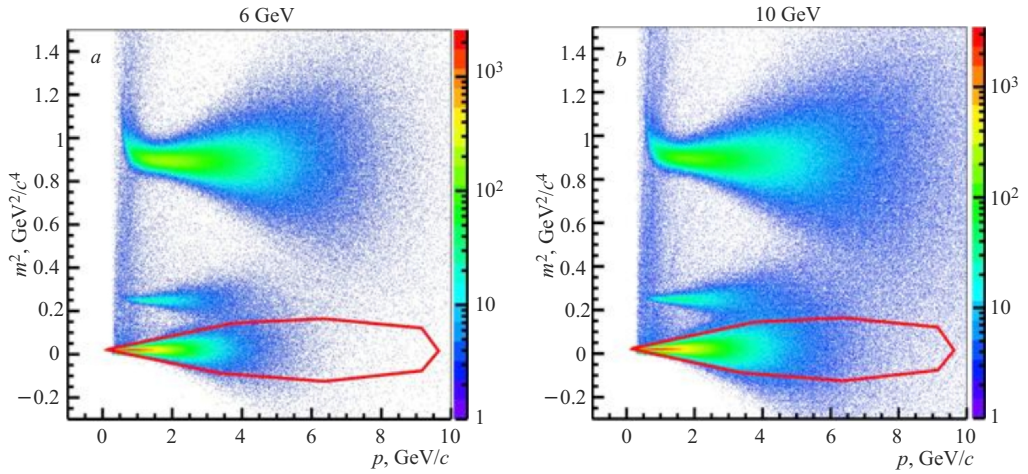

Fig. 1. The $m^2 : p$ correlation for Au + Au UrQMD central events at 6 and $10A$ GeV. The lines are the graphical cuts used for the pion selection

information from RPCs and the momentum information from STS. The time resolution of RPCs is assumed to be 80 ps. The length l (for primary tracks) and the time-of-flight τ provides the velocity β. The momentum p from the track fit in STS combined with β gives the value of squared mass ($m^2 = p^2(1/\beta^2 - 1)$).

Two-dimensional plot $m^2 : p$ was used for the identification of the hadrons in CBM. Pions were selected using the contour on the $m^2 - p$ correlation as presented in Fig. 1. A good separation of protons and kaons from pions is visible up to momenta values of 2.5 GeV/c. The same graphical cut was used to select both negatively and positively charged pions. The investigation of the high-p_T pion production in Au + Au collisions was performed from 6 up to $10A$ GeV for the electron version of the setup. One can see that with the rising of the energy from 6 to $10A$ GeV, the fraction of misidentified K^+ and protons increases. Especially, it is visible that the spots of the positive kaons and pions overlap each other at $10A$ GeV.

The distribution of the transverse momenta for the $\pi^+(\pi^-)$ primary tracks at $6A$ GeV is represented in Fig. 2. The spectra of input and reconstructured events are presented by solid and dashed histogram. Input events were taken from UrQMD 2.3 generator [9]. Dashed and dotted histograms are the reconstructured data using L1-STS procedure on the transverse momenta p_T of pions identified in two ways. Dashed histograms correspond to the particle identification using Monte-Carlo information of GEANT3 track. Dotted curves correspond to the pion tracks identified via $m^2 : p$ graphical cut. The drop of the dotted histograms (L1-STS PID via ($m^2 : p$)) relative to the dashed ones (L1-STS PID via GEANT3) is connected with the acceptance of the TOF wall.

Obtained π^+/π^- ratios at 6 and $10A$ GeV for the central Au + Au collisions as a function of transverse momentum p_T are given in Fig. 3 in plots a and b, respectively. Open squares correspond to the UrQMD 2.3 data. Open triangles correspond to the L1-STS reconstructured data with using the GEANT3 for particle identification. The solid symbols represent the π^+/π^- ratio when the TOF was used for the PID.

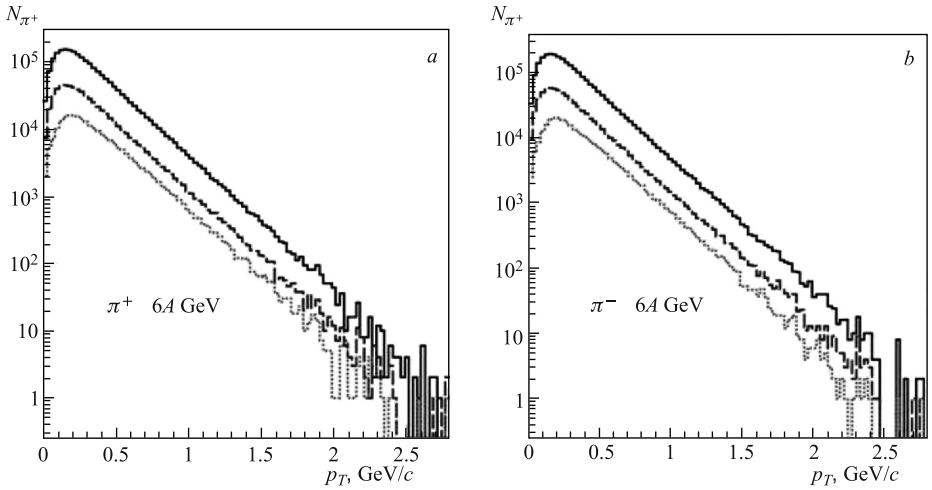

Fig. 2. High-p_T pion spectra for central Au + Au collisions at $6A$ GeV for π^+ (a) and π^- (b)

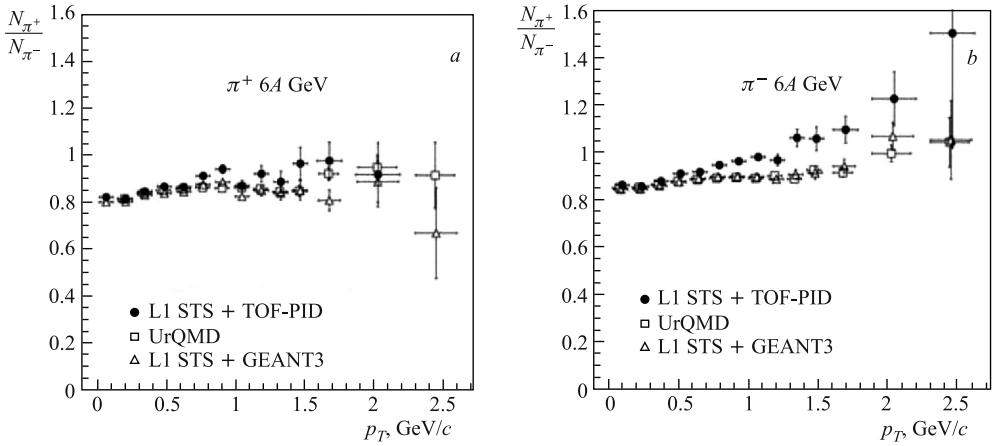

Fig. 3. Ratio of the π^+ to π^- in central Au + Au collisions at 6 GeV as a function of the transverse momentum p_T

The ratio is near to 0.8 and it reflects the value of the proton/neutron fraction in Au + Au system. The ratio data for reconstrucured data using particle identification $m^2 : p$ at $6A$ GeV are slightly upper than the input and are in agreement within the statistical errors. However, the systematical deviation to the higher values is observed at $10A$ GeV. This systematic deviation grows with the increase of p_T. The method of the pion identification by the graphical cut unavoidably leads to the contamination of kaons and protons, especially at high momentum values. To improve the purity of the PID, the modification of criteria was performed in [10]. Since the aim is to study the event-by-event ratios, the graphical cut was modified in the way where the pion border next to kaon was shifted to the left to reach the equivalent numbers of pions and kaons in the bin. The particle identification for π^+ based only on the $m^2 : p$ at high-p_T needs for additional criteria, for instance, the information from RICH.

SUMMARY

Simulation of the high-p_T pion spectra for Au + Au central collision at CBM@SIS100 is performed. It is shown that π^- spectra can be reconstructured with the high purity (98%) using PID from RPC(TOF). The reconstruction of the π^+ spectra requires additional suppression of misidentified K^+ and protons.

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