High p_T Spectra of Identified Particles Produced in Pb+Pb Collisions at 158 GeV/nucleon Beam Energy

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ABSTRACT

Transverse momentum spectra of $\pi^{\pm}$, p, $\bar{p}$, $K^{\pm}$, K^0_s and Λ at midrapidity were measured at high p_T in Pb+Pb collisions at 158 GeV/nucleon beam energy by the NA49 experiment. Particle yield ratios (p/π, K/π and Λ/K^0_s) show an enhancement of the baryon/meson ratio for $p_T > 2\,\mathrm{GeV/c}$. The nuclear modification factor R_{CP} is extracted and compared to RHIC measurements and pQCD calculations.

1. INTRODUCTION

One of the most interesting features discovered at RHIC is the suppression of high p_T particle production in central nucleus-nucleus reactions relative to peripheral ones or p+p collisions. This is generally interpreted as a sign of parton energy loss in hot and dense nuclear matter. Additionally, an enhancement of baryon/meson ratios above unity at high p_T was observed and can be explained in the context of quark coalescence models. The aim of this analysis is to investigate the energy dependence of these effects by studying nucleus-nucleus reactions at top SPS energy ($\sqrt{s_{NN}} = 17.3\,\mathrm{GeV/nucleon}$) (see: [1, 8]).

2. DATA ANALYSIS

Centrality selection is based on a calorimetric measurement of the energy observed in the projectile spectator region of phase space (see [3]). Charged particle spectra ($\pi^{\pm}$, p, $\bar{p}$ and $K^{\pm}$) in the center of mass rapidity interval $[-0.3, 0.7]$ are analyzed in the centrality ranges (0-5)%, (12.5-23.5)%, (33.5-80)% of the total inelastic cross section. The tracking efficiency for single tracks is above 95% and an efficient fake track rejection is applied. The particle identification is done by unfolding the energy loss spectra measured in different phase-space bins. The typical $\frac{\mathrm{d}E}{\mathrm{d}x}$ resolution varies between 3 and 6%. The $\pi^{\pm}$ and p, $\bar{p}$ yields were not corrected for feed down from the decay of K^0_s and hyperons; furthermore the $K^{\pm}$ yields were not corrected for decay loss.

Neutral strange particles were analyzed in the centrality range (0-23.5)%. They are identified via the topology of their weak decay into the channels $K^0_s \to \pi^+\pi^-$ (BR = 68.95%) and $\Lambda \to p\pi^-$ (63.9%). For the V0-candidates, selected by geometrical criteria, the invariant mass of the daughter particles is calculated as a function of p_T and the yields of K^0_s and Λ are extracted on a statistical basis. The shown results are for the rapidity interval $[-0.5, 0.5]$ and corrected for acceptance and reconstruction inefficiency. The Λ yields are not corrected for feed down from the decay of heavier hyperons.

3. PHYSICS RESULTS

The proton/pion and the kaon/pion ratios are shown in Fig. 1. These ratios exhibit a monotonic increase with p_T and centrality at high p_T. The kaon/pion ratios show a

saturation tendency at high p_T, particularly the K^-/π^- ratio.

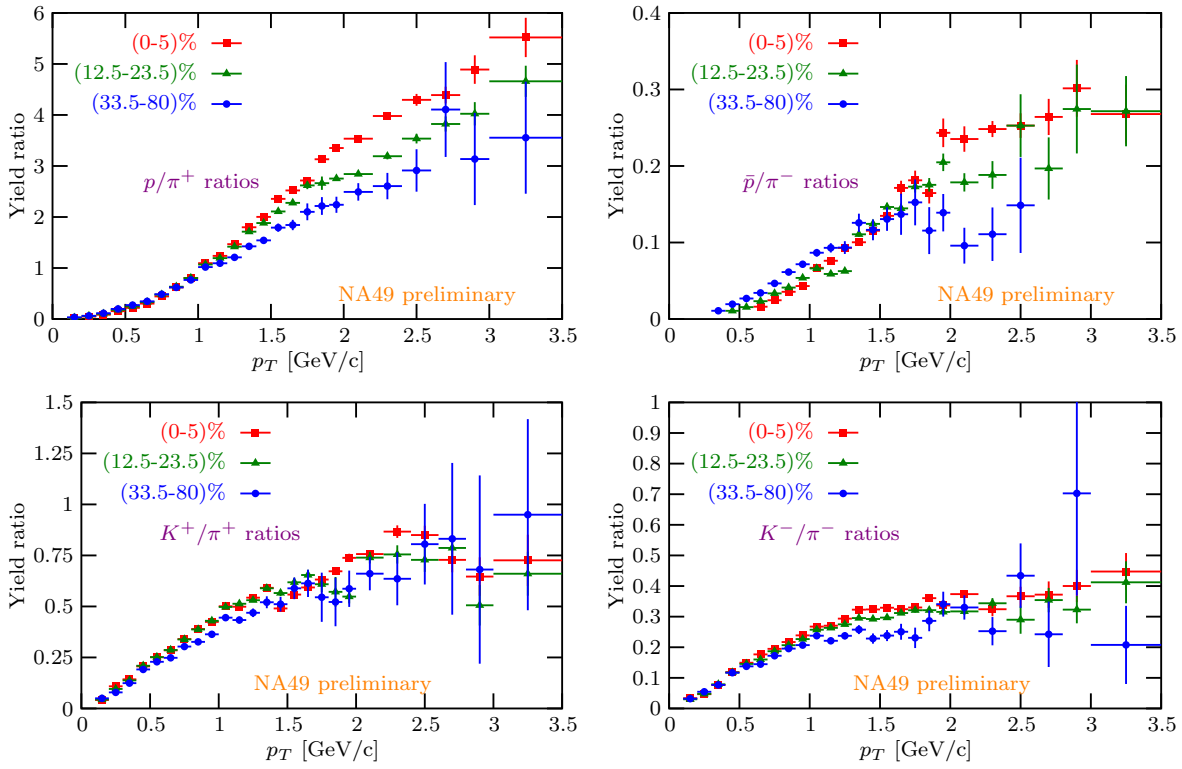

Figure 1. Proton/pion (upper panels) and kaon/pion (lower panels) ratios vs. p_T and centrality.

In the left panel of Fig. 2, our measurement of proton/pion ratio is compared to RHIC data. The shape of these curves is approximately energy independent. The right panel of Fig. 2 shows NA49 baryon/meson ratios, compared to a Blast-Wave (BW, see [7]) parametrization of m_T spectra and radius parameters from Bose-Einstein correlations of pions, fitted simultaneously at low p_T. The BW model curve does not describe the data at high p_T.

The nuclear modification factor R_{CP} is defined by $R_{CP} := \frac{N(\text{Peripheral})}{N(\text{Central})} \cdot \frac{\text{Yield(Central)}}{\text{Yield(Peripheral)}}$. Here N can be either the number of binary collisions or the number of wounded nucleons obtained from model calculations in the given centrality range. The upper panels of Fig. 3 show the energy dependence of R_{CP} vs. p_T of pions with binary collision and with wounded nucleon scaling. At high p_T there is a strong energy dependence with both scalings, however at low p_T wounded nucleon scaling makes R_{CP} energy independent. A similar phenomenon was pointed out for unidentified particles in [6]. The lower panels of Fig. 3 show the comparison of our data to pQCD calculations (see [10]). R_{CP} is consistent with the pQCD calculation at $p_T > 2\,\text{GeV/c}$. However, the pQCD prediction for the antibaryon/meson ratio is very far from the data below $4\,\text{GeV/c}$.

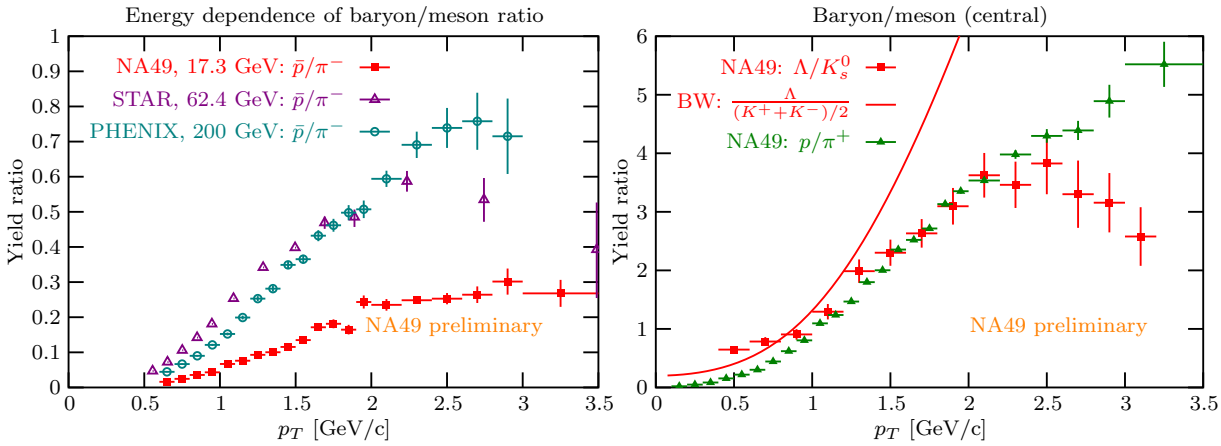

Figure 2. The energy dependence of proton/pion ratios (left panel), and a comparison of the baryon/meson ratios at top SPS energy to a Blast-Wave parametrization (right panel).

4. CONCLUDING REMARKS

First NA49 results on particle yields around midrapidity in the range $2\,\mathrm{GeV/c} \leq p_T < 4.5\,\mathrm{GeV/c}$ were presented from a study of 158 GeV/nucleon beam energy Pb+Pb collisions.

A monotonic increase of baryon/meson ratios and kaon/pion ratios with p_T and centrality was observed at high p_T. The p_T shape of the baryon/meson ratio is approximately energy independent. The measured baryon/meson ratios were compared to a Blast-Wave model: the model predictions exceed the data for $p_T > 1.5\,\mathrm{GeV/c}$.

The nuclear modification factors R_{CP} were also determined from the particle yields for various particle species, as a function of p_T. The measured R_{CP} ratio does not show Cronin enhancement for the mesons at larger p_T when using binary collision scaling. The behavior is qualitatively similar to the p_T shape observed at RHIC. A strong energy dependence of the R_{CP} ratios was observed at high p_T with both binary collision and wounded nucleon scaling. However, at low p_T, the wounded nucleon scaling factorizes out the energy dependence. Results for R_{CP} with binary collision scaling are consistent with pQCD model calculations at $p_T > 2.5\,\mathrm{GeV/c}$. However, the pQCD calculation strongly overpredicts the observed antibaryon/meson ratio for $p_T < 4\,\mathrm{GeV/c}$.

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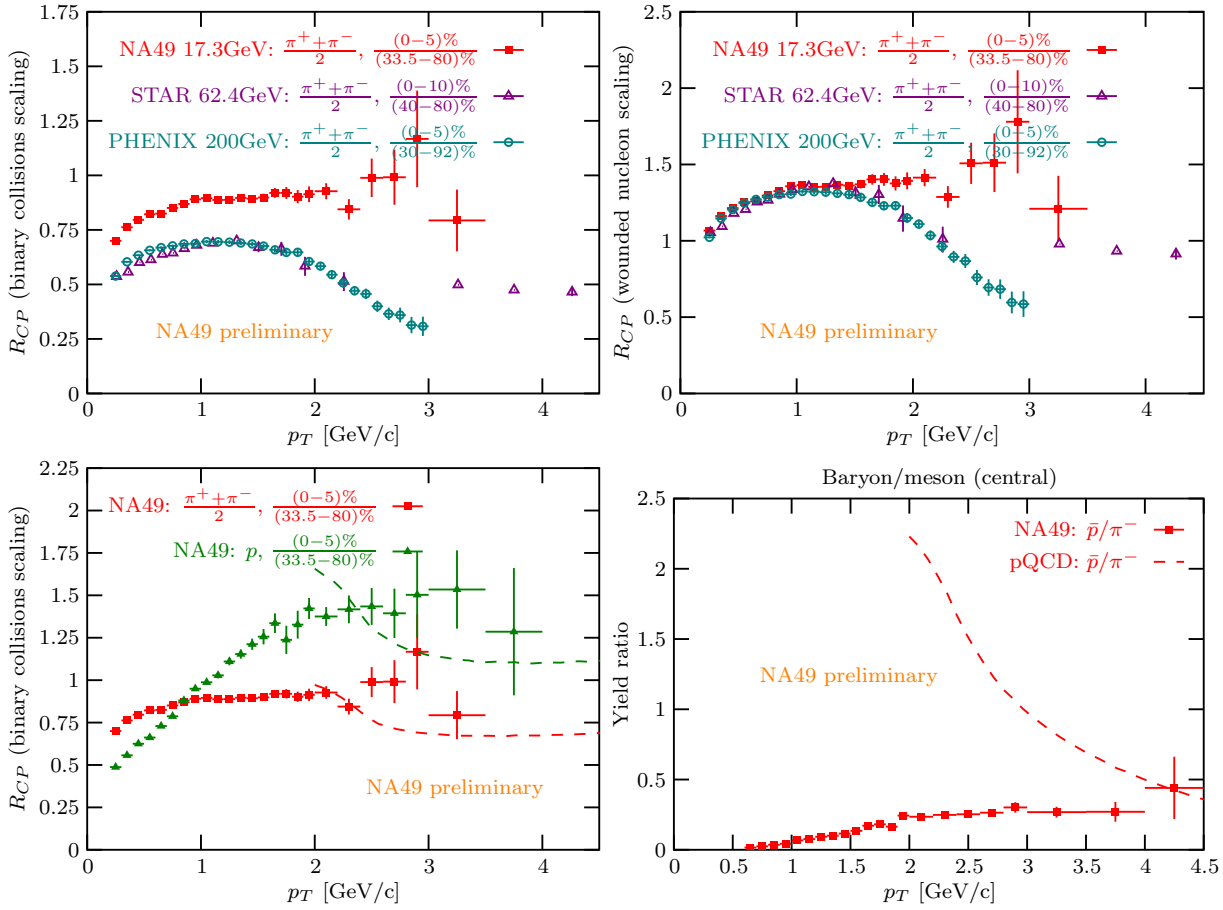

Figure 3. Energy dependence of R_{CP} vs. p_T (upper panels): binary collision scaling (left panel) and wounded nucleon scaling (right panel). Comparison of data to pQCD calculations (lower panels): the nuclear modification factor R_{CP} (left panel) and the baryon/meson ratio (right panel).

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