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# Charged Hadron Distributions in 200 GeV/A S+Au Collisions: A Look at Stopping

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# Charged Hadron Distributions in 200 GeV/A S+Au Collisions: A Look at Stopping

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# Charged Hadron Distributions in 200 GeV/A S+Au Collisions: A Look at Stopping

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The first measurement of rapidity distributions obtained by subtracting positive hadrons from negative hadrons are presented for central 200 GeV/A S+Au collisions. The measurements are made near beam rapidity in order to determine the extent of nuclear stopping in these collisions.

## 1. INTRODUCTION

An important measurement necessary for the understanding of the dynamics of ultrarelativistic heavy ion collisions is that of the extent of nuclear stopping. This measurement can be achieved by observing the nucleon rapidity distribution, particularly in the region near beam rapidity. Before the collision, all of the nucleons exist exclusively at the target and beam rapidities. This observation persists for a completely transparent collision scenario, with an excited, baryon-free region existing at the center-of-mass rapidity. In a completely stopped scenario, the target and projectile nucleons will be shifted in rapidity towards the participant center-of-mass rapidity. Nucleon rapidity distribution measurements performed for 14.6 GeV/A Si+Pb [1], and 11.6 GeV/A Au+Au [2] collisions are indicative of a completely stopped scenario. Recent models predict that a stopped system will persist in 200 GeV/A nucleus-nucleus collisions [3]. We present the first measure of "proton" rapidity distributions near beam rapidity in order to investigate the extent of stopping at these higher energies.

## 2 EXPERIMENTAL APPARATUS

The measurement was obtained with the NA35 Time Projection Chamber (TPC) [4], whose center was 6.8 meters from the target. A 1.5 T analyzing magnet was situated between the target and the TPC. The 2.4 x 1.2 x 1.08 meter TPC was oriented to provide up to sixty position measurements along each straight line track. The charge of each particle was identified by determining its bend direction within the magnet. The data were taken with a central event trigger selecting the upper 6% of the interaction cross section. The trigger was realized by examining the amount of energy deposited into a calorimeter covering angles less than 0.3 degrees about the beam axis.

## 3 DATA ANALYSIS

### 3.1 Corrections

The TPC was positioned with the beam passing through its center in order to measure charged particles near beam rapidity. The transverse momentum and rapidity coverage of the TPC for pions and protons is shown in Figure 1. All data have been corrected for acceptance efficiency as a function of rapidity and $p_t$ in the region where the correction is less than a factor of 3.

The combination of the high track densities seen near beam rapidities in these collisions and the two-track resolution of 2.5 cm for the NA35 TPC make corrections for the track density necessary. This has been done by examining the track density predicted by a model that closely resembles that of the data, namely VENUS [5], version 4.02. VENUS is used to predict the track distribution in the TPC at its mid-plane for an event. All track pairs for the event are examined individually. If a pair of generated tracks lie within 2.5 cm of each other, they would have merged into a single track in the TPC, therefore one of these close tracks is randomly chosen and eliminated. The rapidity and $p_t$ of the eliminated track are recorded. From this information, the percentage of tracks lost due to the track density is determined as a function of rapidity and $p_t$, and these values are subsequently used to correct the data. These corrections range from below 5% near mid-rapidity to about 25% at beam rapidity assuming the proton mass.

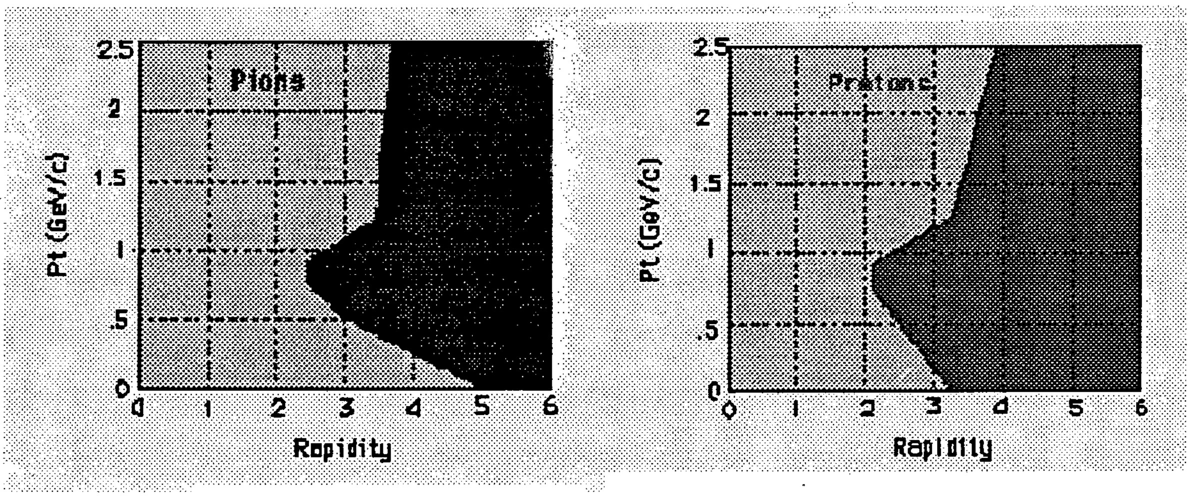

Figure 1. Geometrical acceptance of the NA35 TPC for charged particles as a function of rapidity and transverse momentum assuming the pion and proton masses. The shaded areas show the TPC measurement region. The beam rapidity is 6.

### 3.2 Results

The rapidity distributions for negative hadrons are shown in Figure 2a. This spectrum was obtained by fitting the transverse mass distributions of negative hadrons in pion rapidity bins 0.2 units wide to the function

$$f(m_t) = Ae^{-m_t/T},$$

where T is the inverse slope parameter, shown in Figure 2b as a function of rapidity. The rapidity distribution was obtained by integrating under the fitted curve extrapolated from $p_t=0$ to $p_t=\infty$. Also shown in Figure 2 are the predictions of the VENUS 4.02 model. The VENUS predictions were analyzed in the same manner as the data after filtering them through the detector geometry. VENUS is in good agreement with the data, even following the trend of decreasing inverse slope parameter as a function of increasing rapidity seen in the data.

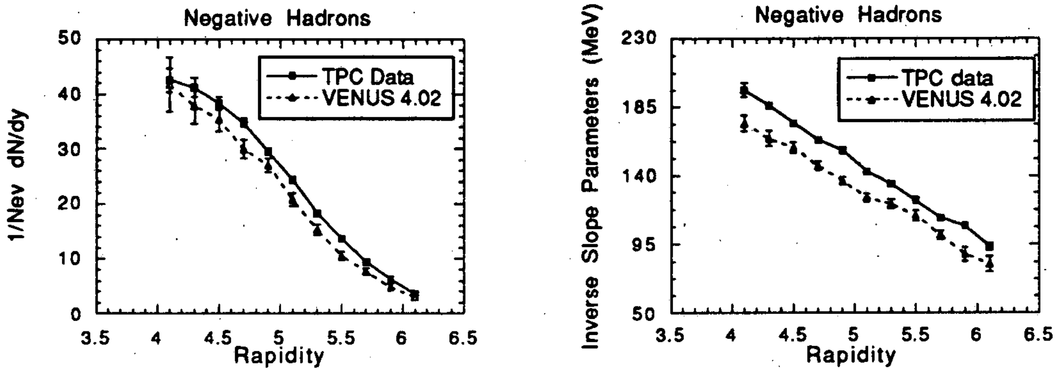

Figure 2.a) Rapidity distribution for negative hadrons. Shown are the TPC data overlayed with VENUS 4.02 predictions. The lines are drawn to guide the eye. b) Inverse slope parameters as a function of rapidity for negative hadrons.

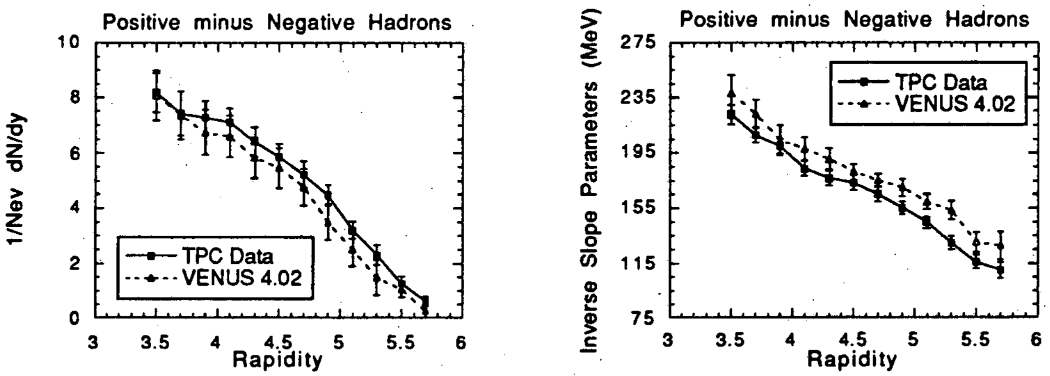

Figure 3.a) Rapidity distribution for positive minus negative hadrons. Shown are the TPC data and VENUS 4.02 predictions. b) Inverse slope parameters as a function of rapidity for "protons".

Representative proton spectra are obtained by subtracting negative hadron distributions from positive hadron distributions, again correcting for geometric acceptance and efficiency as a function of track density. The proton mass is used to determine the rapidity in this case. In addition, these difference distributions are corrected for kaon contamination as estimated by VENUS. The resulting "proton" spectra are fit to the same exponential function as negative hadrons, and the dN/dy and inverse slope parameters are extracted with the same procedure. The results are shown in Figure 3 along with the VENUS predictions, which again closely predict the data.

A useful observable to quantify the "proton" rapidity distribution in terms of stopping is the mean rapidity shift of the projectile protons from their original beam rapidity, $<\Delta y_p>$. The larger this value, the more stopping is present in the system. Extrapolating the "proton" dN/dy curve in Figure 3 until its integral equals the original 16 projectile protons, the mean rapidity shift is determined to be $<\Delta y_p>=1.98\pm0.05$. In order to compare this measurement to those of other systems at different energies, a parameter can be defined as follows:

$$S = \frac{< \Delta y_{\text{projectile}} >}{y_{\text{beam}} - y_{\text{participant center-of-mass}}}.$$

The values of S for two symmetric and two asymmetric systems at CERN and AGS energies are tabulated in Table 1. The NA35 values of this parameter are slightly below, but comparable to those at AGS energies for similar systems, suggestive of a considerable amount of stopping in 200 GeV/A nucleus-nucleus collisions.

Table 1
S Parameter Values

| Experiment | System | S Parameter |
|---|---|---|
| NA35 | 200 GeV/A S+Au | 0.57 |
| E814 [1] | 14.6 GeV/A Si+Pb | 0.61 |
| NA35 [6] | 200 GeV/A S+S | 0.51 |
| E802 [2] | 14.6 GeV/A Si+Al | 0.57 |

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