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PARTICLE SPECTRA NEAR MID-RAPIDITY STUDIED WITH CHERENKOV-COMPLEX SYSTEM IN 14.5 AGEV SI + AU COLLISIONS

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Hiceki HAMAGAKI

E802 Collaboration

T. ABBOTT[j], Y. AKIBA[e], D. ALBURGER[b], D. BEAVIS[b], R.R. BETTS[a], L. BIRSTEIN[b], M.A. BLOOMER[h], P.D. BOND[b], C. CHASMAN[b], Y.Y. CHU[b], B.A. COLE[h], J.B. COSTALES[h], H.J. CRAWFORD[i], J.B. CUMMING[b], R. DEBBE[b], E. DUEK[b], J. ENGELAGE[g], S.Y. FUNG[j], L. GRODZINS[h], S. GUSHUE[b], H. HAMAGAKI[e], O. HANSEN[b], S. HAYASHI[e,*], S. HOMMA[e], H.Z. HUANG[h], Y. IKEDA[f], S. KATCOFF[b], S. KAUFMAN[a], K. KIMURA[f], K. KITAMURA[d], K. KURITA[c], R.J. LEDOUX[h], M.J. LEVINE[b], Y. MIAKE[b,**], R.J. MORSE[b], S. NAGAMIYA[c], J. OLNESS[b], C.G. PARSONS[h], L.P. REMSBERG[b], M. SARABURA[h], A. SHOR[b], P. STANKUS[c], S.G. STEADMAN[h], G.S.F. STEPHANS[h], T. SUGITATE[d], M. TANAKA[b], M.J. TANNENBAUM[b], M. TORIKOSHI[e], J.H. VAN DIJK[b], F. VIDEBAEK[a], M. VIENT[j], P. VINCENT[b], V. VUTSADAKIS[n], W.A. WATSON III[b], H.E. WEGNER[b], D.S. WOODRUFF[n], Y. WU[c], AND W. ZAJC[c]

[a] Argonne National Laboratory, Argonne, IL 60439, USA
[b] Brookhaven National Laboratory, Upton, NY 11973, USA
[c] Columbia University, New York, NY 10027, and Nevis Laboratory, Irvington, NY 10533, USA
[d] Hiroshima University, Department of Physics, Hiroshima 730, JAPAN
[e] Institute for Nuclear Study, University of Tokyo, Tokyo 188, JAPAN
[f] Kyushu University, Department of Physics, Fukuoka 812, JAPAN
[g] Lawrence Livermore National Laboratory, Livermore, CA 94550, USA
[h] Massachusetts Institute of Technology, Cambridge, MA 02139, USA
[i] University of California, Space Science Lab., Berkeley, CA 94720, USA
[j] University of California, Riverside, CA 92507, USA
[*] JSPS Fellowship for Japanese Junior Scientist
[**] On leave of absense from University of Tokyo

The Cherenkov Complex system (CC-system) in the E-802 experiment at AGS was successfully operated in the heavy ion running at AGS. Brief description of the system is given. Preliminarily obtained particle spectra for pions, Kaons, and protons near mid-rapidity region in 14.5 A·GeV Si + Au collisions are presented. The spectra shape and the relative yields are compared with those in p + 'N' and p + Au collisions.

1. INTRODUCTION

Main purpose of E802 experiment at AGS is to study mechanism of particle productions at high baryon and/or energy density expected in heavy ion collisions, through semi-inclusive measurement of particle spectra using magnetic spectrometer. The main spectrometer was designed to cover the momentum region below ~5 GeV/c, and the higher momentum region with enough overlap was supposed to be covered by the so called Cherenkov Complex system (CC-system)[1].

Detailed description of the system is omitted in this paper[2]. The CC-system is placed behind the main spectrometer, with a rather small solid angle of ~0.5 msr. It was designed to handle only single tracks. The system

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consists of (1) two sets of scintillator hodoscopes, S1 and S2, set at the front and rear end of the buggy, respectively, for particle identification by time-of-flight in the low momentum region, (2) three sets of drift chambers, T5, T6 and T7 to ensure a track passing through the system, and (3) three threshold-type gas-Cherenkov counters, CC1, CC2 and CC3.

2. DATA TAKING AND ANALYSIS

2.1. Run Conditions.

The data was taken with 14.5 A·GeV Si beams incident onto a Au target with ~3 % interaction length. The beam intensity was $3\sim4\times10^5$ particle per spill, with spill length of ~0.5 sec. The field strength of the spectrometer magnet was chosen as 0.9 Tm. The CC-system was oriented so that acceptance of the system was maximum for particles emitted at θ_{Lab} = 16° with bending angle of -3°, which corresponds to p_{Lab} = 5.2 GeV/c. To measure positive and negative charged particles, polarity of the bending magnet was changed.

A fast-level trigger was constructed simply using the logic outputs from the S1 and S2, in coincidence with the 'minimum bias interaction trigger' (see Ref.3).

2.2. Acceptance of the System

Geometrical acceptance of the CC-system is completely determined by the two hodoscopes, S1 and S2. Acceptance raises sharply around p_{Lab} ~ 3 GeV/c, and is rather flat around 5 GeV/c, and gradually drops in the higher momentum region. Phase space in (y, p_T) plane, for π, K and p, is illustrated in Fig. 1. Although the rapidity region covered by each particle species is slightly different in the low p_T region, we assumed that the spectral shape does not change significantly with such a small variance of rapidity.

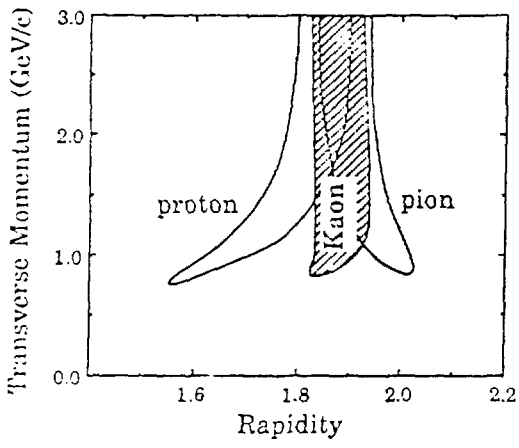

Fig.1 Phase space for π, K and p covered by the CC-system

2.3. Particle Identification in the CC-system

Momentum region planned to cover in the particular runs was below ~9 GeV/c. Particle identification in the CC-system was performed using time-of-flight (TOF) between the beam counter and the S2 hodoscope (flight path ~ 20 meters), and three gas-Cherenkov counters with different indices of refraction.

TOF resolution of the CC-system was σ ~ 100 psec, so that separation between π and K (K and p) was possible up to 4.2 GeV/c (7.3 GeV/c) with 4σ

separation. In the original design, we assumed TOF resolution of 150 ps, with which separation between π and K (K and p) was up to ~3 GeV/c (~5 GeV/c).

Index of refraction of the two Cherenkov counters, CC1 and CC3, was set to the same value, n = 1.00169, which corresponds to γ_{th} = 17.2. Setting value for CC1 is different from the designed one[1]. The setting value was chosen so as to achieve the redundant π-K identification in the momentum region from 2.4 to 8.6 GeV/c. Index of refraction of CC2 was chosen as n = 1.0060, corresponding to γ_{th} = 9.2. The pulse height information from CC2 was used to make positive identification of Kaons in the momentum region between 4.6 GeV/c and 8.6 GeV/c. Since there were a few momentum regions where both TOF and Cherenkov counters worked for particle identification because of better TOF resolution than expected, we could comfortably take this advantage for checking performances of the Cherenkov counters.

3. RESULTS and DISCUSSIONS

It should be noted first that the results shown below are to be taken as preliminary.

The invariant cross sections as a function of p_T in 14.5 A·GeV Si + Au collisions are shown in Fig. 2 for π^+, K^+ and p. Absolute scale of the cross sections, common to all particles, are still under evaluation. Although it is not shown, the spectral shape of π^- is very similar to that of π^+.

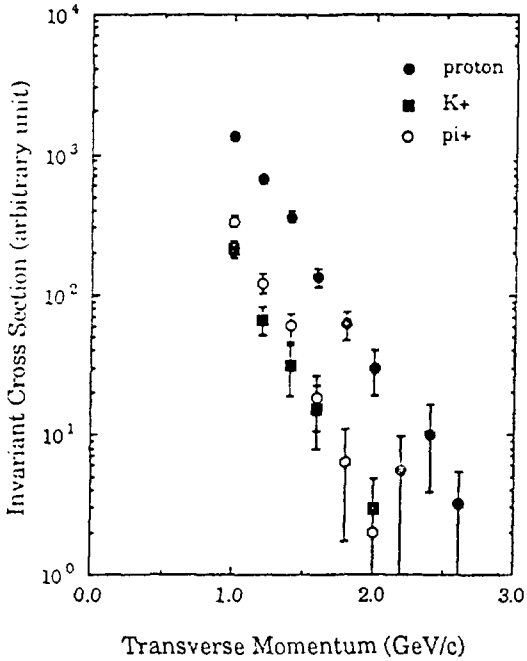

Fig.2. Invariant cross section for π^+, K^+ and p as a function of p_T near mid-rapidity in 14.5 A·GeV Si + Au collisions.

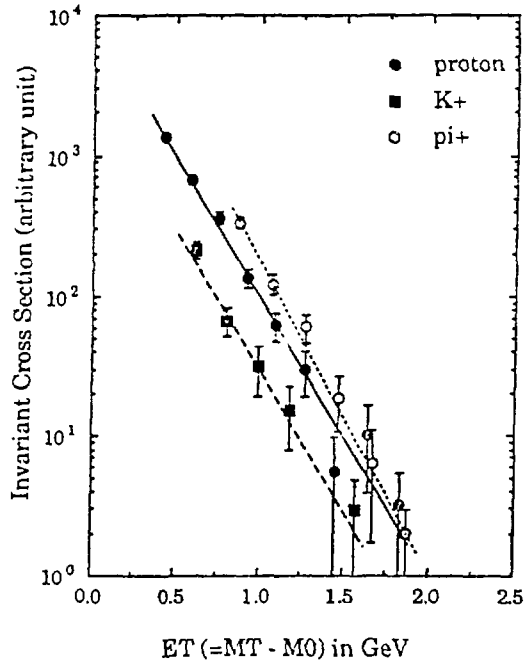

Fig.3. Invariant cross section as a function of E_T (= M_T - M_0). Straight lines are for eye-guides.

Figure 3 shows the cross sections as a function of E_T (= M_T - M_0). The straight lines in the figure are for guiding eyes. Spectra shape for p, K and π are very similar, and can be described by an single exponential with the same slope parameter, although pion's slope looks a little steeper compared to the others.

Figure 4 shows the ratios, (a) K^+ to π^+, and (b) K^+ to p, as a function of p_T, together with the results for p +'N' and p +'Au' collisions[4,*]. It is interesting to see that K^+/π^+ ratio increases with target mass in proton-incident cases, and the ratio in Si + Au collisions is significantly large compared to those in proton-incident ones. The result seems smoothly connected down to the results obtained in the low p_T region[3,5]. Different

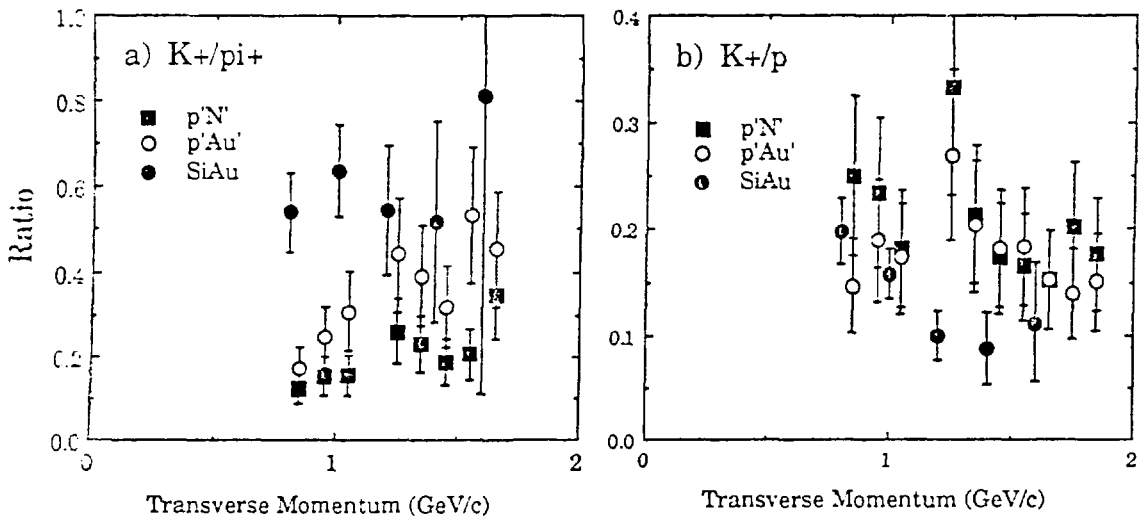

Fig. 4. a) K^+/π^+ and b) K^+/p ratio near mid-rapidity for Si + Au, p + 'N', and p + 'Au' collisions. Proton-incident data were taken from Ref. 4.

features are seen in K^+/p ratio; (1) dependence of the ratio on target mass is very small in proton-incident cases, and (2) the ratio looks similar between Si + Au and p + A collisions at $p_T \sim 1$ GeV/c. It seems to be very important to study the projectile and target mass dependence of the particle yields more systematically.

We would like to mention here that efforts on fixing the absolute scale of cross sections is going on, and the data analyses for Si + Al, O + Al, and O + Au collisions are in progress. We hope we can clarify more or less the mechanism of particle productions in heavy ion collisions in near future.

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* Ref. 3 gives the invariant cross sections for p+'N' collisions, which is extrapolated from the data with Be, Cu and W targets, assuming a functional form $A_T^{(\alpha)}$ for the dependence of the cross section on target mass A_T

4. CONCLUSION

We presented the first, though preliminary, results obtained with the Cherenkov Complex system in the E802 experiment at AGS.

The particle spectra for π^+, K^+, and p near mid-rapidity in 14.5 A·GeV Si + Au collisions were presented. The ratios, K^+/π^+ and K^+/p, were compared with those in p + A collisions.

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