

Determination of Kaon and Pion Source rapidities in C + Au Collisions at 1.0 A·GeV and 1.8 A·GeV^{B,G}

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The extraction of information on in-medium properties of hadrons from heavy-ion collisions requires a quantitative understanding of the production and propagation mechanisms of the particles under investigation. Of particular interest is the source of strange mesons produced at beam energies close or below threshold energies [1],[2]. An approach to the determination of particle source velocities is to study asymmetric nucleus-nucleus collisions. We have measured the production of kaons and pions in C+Au and Au+C collisions at beam energies of 1.0 and 1.8 A·GeV at laboratory angles of 44 and 70 degrees. The experiments were performed with the Kaon Spectrometer (KaoS) at SIS/GSI. The phase-space region covered by the measurement of K^+ mesons at 1 A·GeV is shown in figure 1 by the full symbols as function of transverse momentum and rapidity.

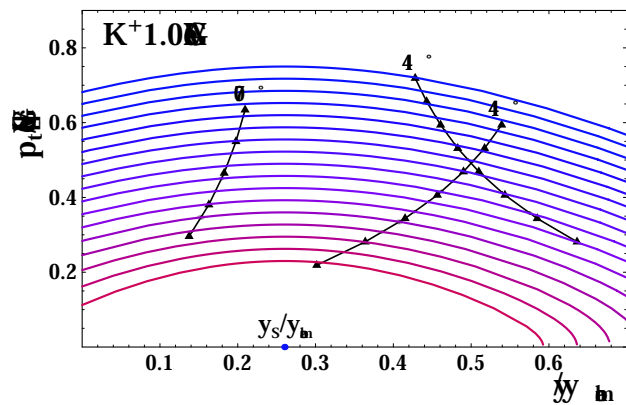


Figure 1: Fit to invariant cross-sections of K^+ -mesons from C→Au and Au→C collisions at 1.0 A·GeV.

The extraction of source rapidities from these data is based on the assumption that the invariant production cross sections can be parameterized by

$$\sigma = (1 + a_2 \cdot \cos^2(\Theta_{CM})) \cdot E_{CM} \cdot C \cdot e^{-\frac{E_{CM}}{T}} \quad (1)$$

This parameterization describes a source of a given temperature emitting particles asymmetrically. The solid lines in figure 1 represent lines of constant cross sections fitted to the data, the fit parameters are the temperature T , the asymmetry parameter a_2 and the source rapidity y_S/y_{beam} . Figure 1 contains the K^+ spectra measured in inclusive C+Au collisions at 44 and 70 degree and in Au+C collisions at 44 degree. In this case the resulting source rapidity is $y_S/y_{beam} = 0.26 \pm 0.01$ and the anisotropy is $a_2 = -0.3 \pm 0.3$ (which is compatible with isotropy). When calculating the source rapidity based on a geometrical picture of a central C+Au collisions one obtains as the num-

ber of participants $A_{part} = 12 + 43$ corresponding to a source rapidity of $y_S/y_{beam} = 0.24$.

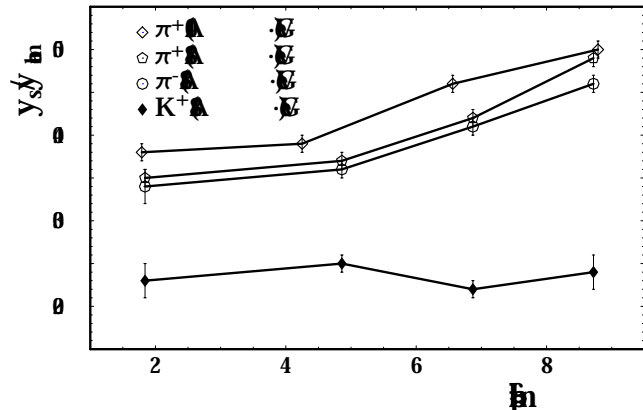


Figure 2: Normalized source rapidity y_S/y_{beam} of K^+ and π^\pm at different energies as a function of average impact parameter $\langle b \rangle$.

A similar analysis has been performed for different collision centralities. Figure 2 presents the pion and kaon source rapidities determined for C+Au collisions at 1.0 and 1.8 A·GeV as function of impact parameter. The averaged impact parameter b was determined by a geometrical model based on the charged particle multiplicity measured between $\Theta_{lab} = 12^\circ - 48^\circ$. It turns out that the K^+ source rapidity has a value of about $y_S/y_{beam} \approx 0.24$ independent of b . The pion source rapidities are by more than a factor of 2 larger and increase with increasing b approaching $y_S/y_{beam} = 0.5$ for the most peripheral collisions. Note that this value corresponds to the nucleon-nucleon center-of-momentum system.

In summary, we found that the source of kaons is located at much smaller rapidities than the pion source. This observation indicates that the production of kaons at beam energies close to threshold is due to multiple collisions involving more nucleons from the target than from the projectile nucleus.

References

- [1] W. Cassing, E. Bratkovskaya *Phys.Rep.* **308**, 65 (1999)
- [2] F. Laue et al., *Eur. Phys.* **397**, JA9 (2000)