Kaon and Antikaon Production in Proton-Nucleus Collisions[B,C]

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Recent experiments on K-meson production in nucleus-nucleus at SIS energies found that the K^-/K^+ ratio is enhanced by about 2 orders of magnitude as compared to proton-proton collisions at proton beam energies close to threshold [1]. Within transport calculations, this enhancement is explained by (i) a reduced in-medium mass of K^- mesons and (ii) multiple step processes like strangeness exchange reactions $\pi Y \rightarrow K^-N$ with $Y = \Lambda, \Sigma$ [2]. The investigation of K^- mesons in proton-nucleus collisions will help to disentangle these two effects because (i) the effective K^- mass is expected to be reduced by about 25% in nuclear matter at saturation density whereas (ii) strangeness exchange reactions are negligible.

Using the Kaon Spectrometer at SIS/GSI we have performed the first measurements of K^- production yields in proton-nucleus collisions at proton energies below 4 GeV. The heavy ion synchrotron delivered protons beam with energies of 1.6, 2.5 and 3.5 GeV with intensities up to 10^{10} protons/sec impinging on C and Au targets of 7 and 2 mm thickness, respectively. A trigger based on the kaon time-on-flight and tracking reduced the data rates to about 5 kHz. The K meson momentum distributions were measured at laboratory angles between Θ_{lab}=32-64 degrees.

Figure 1 presents preliminary double differential production cross sections of K^+ and K^- mesons measured in p+C and p+Au collisions at 2.5 and 3.5 GeV at $\Theta_{lab}=40^o$ as function of the laboratory momentum. The data taken at 3.5 GeV beam energy are not yet corrected for the tracking trigger efficiency. This might be the reason for the structure in the spectra around p_{lab}=700 MeV/c. The smooth spectra measured at 2.5 GeV proton energy were taken at reduced beam intensities without tracking trigger.

Figure 2 shows the K^-/K^+ ratio for p+C and p+Au collisions at a beam energy of 3.5 GeV obtained from the spectra as presented in figure 1. The maximum values of the ratio are about 0.04 and 0.03 for p+C and p+Au, respectively. The corresponding value calculated from inclusive cross sections measured in p+p collisions at 3.5 GeV is about 0.033. Before drawing conclusions on in-medium effects from these values, inclusive K meson production yields have to be extracted from the proton-nucleus data by analyzing the measured polar angle distributions. Moreover, in-medium effects should be more visible in the data measured at 2.5 GeV which is the threshold energy for antikaon production in proton-proton collisions.

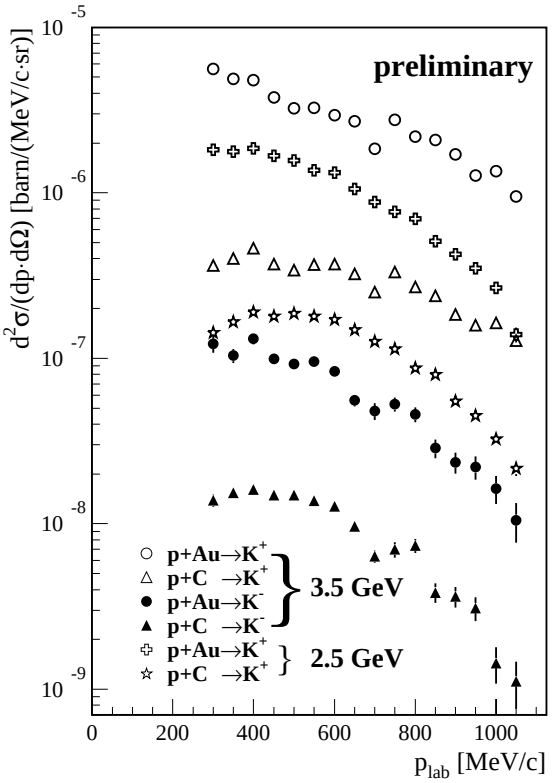

Figure 1: Double differential K^+ and K^- production cross sections measured in p+C and p+Au collisions at 2.5 and 3.5 GeV bombarding energy at a laboratory angle of $\Theta_{lab}=40^o$ as function of laboratory momentum.

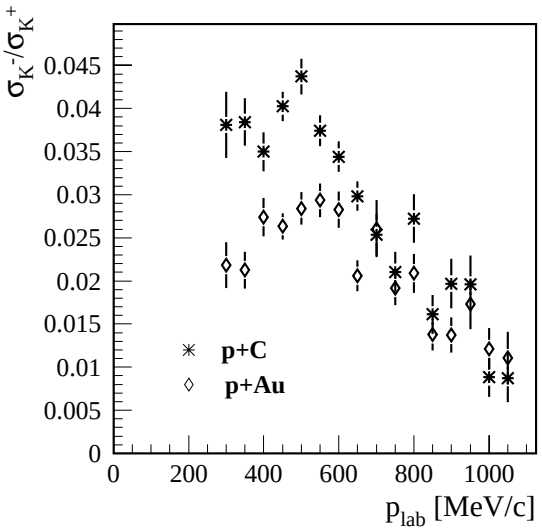

Figure 2: Preliminary K^-/K^+ ratio measured in p+C and p+Au collisions at 3.5 GeV bombarding energy at a laboratory angle of $\Theta_{lab}=40^o$ as function of laboratory momentum.

References

[1] F. Laue, C. Sturm et al., Phys. Rev. Lett. 82 (1999) 1640

[2] W. Cassing and E. Bratkovskaya, Phys. Rep. 308 (1999) 65