Proton induced subthreshold pion pair production in nuclei

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According to the QCD, most part of hadron masses are come from the spontaneous breaking of the chiral symmetry, and it is expected to be changed in hot and/or dense matter where the chiral symmetry is partially restored. CHAOS and TAPS collaboration measured the pion pair invariant mass distribution with the targets from nucleon to nuclei and reported the mass number dependent modification in the $I = J = 0$ channel [1], [2], which could be explained by the in-medium modification of the σ meson spectrum function as suggested in [3]. However, in Crystal Ball experiments, there are not clear evidence [4] and the situation seems to be not clear still.

We have prepared a experiment to measure the $\pi^+\pi^-$ invariant mass distribution in another reaction, A(p,$\pi^+\pi^-$)X, at RCNP for further understanding of the phenomena. Though available proton beam energy at RCNP Ring Cyclotron is lower than the threshold energy of two pion production for nucleon target, we can investigate the $\pi^+\pi^-$ invariant mass region from $2m_\pi$ to about 350 MeV/c^2 for nuclear target thanks to the fermi motion of nucleons in nuclei, and the mass region is where explicit enhancement are seen in CHAOS experiment [1].

The estimated $\pi^+\pi^-$ production cross section is so tiny, about 10^7 lower than the total hadron cross section, that a quite effective event selection in the trigger level is needed. With the FPGA based logic module, We developed a trigger to select two-track event including negative charged particle by requiring the characteristic hit pattern of hodoscopes. Thus we can reduce trigger rate about 5×10^{-3} of the most inclusive trigger(proton scattering event). We also updated DAQ system to reduce dead time by introducing a double buffer system.

The test experiment has been performed at the RCNP WSS course using 416 MeV proton beam with Cu target. Preliminary results is shown in Fig.1. We can see the $\pi^+\pi^-$ production events. From the experimental results, we estimated that the expected yield of $\pi^+\pi^-$ events are about 250 events/day and we will have four days experiment in 2006.

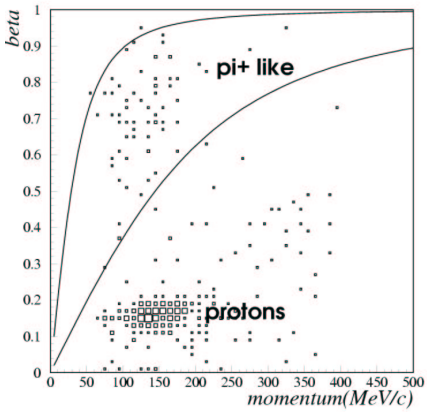

Figure 1: Momentum vs Beta distribution for positive particles which accompanied with π^-. dE/dx cut are applied to select pions for both positive and negative charged particles. Though protons are still remained, π^+s are clearly seen.

References

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