

Proton induced subthreshold pion pair production in nuclei

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In recent years, experimental results of the in-medium properties of hadrons are hotly discussed in picture of the chiral symmetry breaking and its restoration. The in-medium modification of the two pion invariant mass spectrum are reported by pion induced [1] and photon induced [2] reaction. It is argued that this change is came from the modification of the spectrum function of σ meson($f_0(600)$, $J^\pi = 0^+$, $I = 0$) due to the partial restoration of the chiral symmetry breaking in nuclear medium.

For further understanding of the phenomena, we are preparing the proton induced $\pi^+\pi^-$ pair production experiment. we will use the 416 MeV proton beam at RCNP Ring Cyclotron. Although this is subthreshold energy for two pion production for free nucleon target, we can access the most interested region with nuclear targets, where the enhancement of invariant mass distribution have been observed (mass region from $2m_\pi$ to about $350 \text{ MeV}/c^2$). The experiment is performed with Osho magnetic spectrometer at the WSS beam line. This spectrometer system covers about 2.4π solid angle and its acceptance is about 60% for the two pion production process. We will use several kinds of nuclear targets and measure the mass number dependence of $\pi^+\pi^-$ invariant mass distribution to examine the medium effect. The cross section of two pion production is estimated about 1nb order and very small compared to that of proton scattering, which is a few 10mb order. The intelligent event selection at trigger level is needed. We have developed a trigger system quite sensitive to negative charge particles. Using this trigger system, the trigger rate was reduced by roughly 2.5 order of magnitude with keeping the trigger efficiency high for the negatively charged particles. The trigger system is also useful to measure $\pi^+\pi^-$ production reaction.

To improve π^+ detection efficiency and distinguish π^+ from proton well, we are planning to install new plastic hodoscopes additively. These counters can catch up some low energy π^+ s which could escape existing counter system by geometrical reason. With these counters, the time and energy resolutions are expected to be improved. A part of new counters were installed and its properties were tested. The two dimensional scatter plot of dE/dx and momentum is shown in Fig. 1. The Loci of proton and pion are clearly separated. With effective trigger system and new counters, the feasibility of the experimet was confirmed. Further analysis concerning $\pi^+\pi^-$ event are in progress.

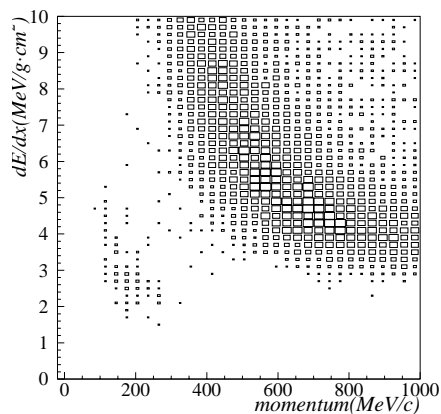


Figure 1: dE/dx versus momentum scatter plot for positive particles. Most events at upper right are protons and lower left are π^+ s.

References

- [1] F. Bonutti, *et al.* [CHAOS Collaboration], Nucl. Phys. **A677**, 213 (2003)
- [2] J. G. Messchendorp, *et al.* [TAPS Collaboration], Phys. Rev. Lett. **70**, 222302 (2002)