Annual report

High-resolution spectroscopy of Θ^+ via $K^+p \to \pi^+\Theta^+$ reaction at E559 experiment

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After the E522 experiment, which reported the upper limit of production cross section via $\pi^-p \to K^-\Theta^+$ reaction to be 3.9 μb, an experiment to search for the Θ^+ via the $K^+p \to \pi^+X$ reaction was performed at the K6 beam line at KEK 12 GeV Proton Synchrotron (KEK-PS E559) in order to give a conclusive information on the existence of the Θ^+. Naively the production cross section via $K^+p \to \pi^+\Theta^+$ reaction is expected to be larger than that via $\pi^-p \to K^-\Theta^+$ reaction, because K^+ beams already include $\bar{s}$ quark. One of the most important purpose is the determination of the width of the Θ^+ by utilizing spectrometer system, SKS and K6 beam line, with the excellent missing mass resolution of 2.4 MeV/c^2 (FWHM). We used K^+ beams of 1.2 GeV/c and total 6.1×10^9 kaons were irradiated. Figure 1 shows the experimental setup around the target. As a target, a 12.5 cm-long liquid hydrogen target was used.

For the Θ^+ search, rejection of 3 body decay of K^+ such as $K^+ \to \pi^+\pi^+\pi^-$ or $K^+ \to \pi^+\pi^0\pi^0$ is essential. In decay events, one or three charged particles were emitted to a forward angle, whereas in a hadronic reaction such as Δ production or Θ^+ production, two charged particles were emitted with a large scattering angle. Therefore we installed a large acceptance chamber just downstream of the target to detect the charged particles. We selected two charged particle events to reject decay events in offline analysis. To improve S/N ratio by detecting K^+ from the decay of Θ^+, we also installed a range counter system at the downstream of this chamber.

Let us now describe the present analysis status of the (K^+, π^+) data. The momenta of incident and outgoing particles are analyzed well, since the Σ^+ is clearly reconstructed with almost expected resolution using the $\pi^+p \to K^+X$ reaction taken for the calibration. The vertex distribution after the rejection of decay events is shown in Figure 2 together with the distribution of the empty target data (blue-hatched histogram). The 12.5 cm liquid hydrogen image is clearly observed. We took approximately 15,000 and 10,000 events of $K^+p \to \pi^+X$ reaction in the first and second run, respectively. However, there are still background events which is shown in the hatched histogram. These events might be the contaminations of the K^+ decay events and reaction events at the timing counter upstream of the target (BH2). The analysis of the $K^+p \to \pi^+X$ reaction is in progress.

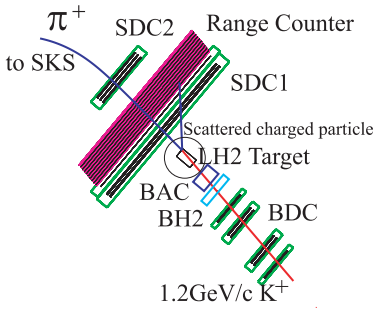

Figure 1: Experimental setup around the LH_2 target.

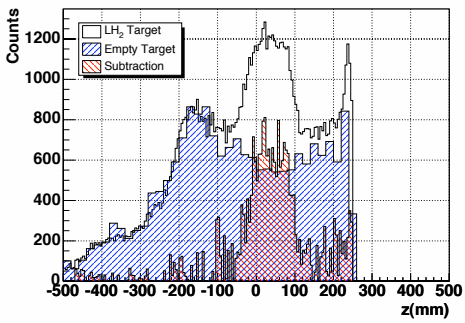

Figure 2: Vertex distribution of $K^+p \to \pi^+X$ reaction obtained from first run.