LEPS experiment using new liquid hydrogen target with thickness of 150 mm at SPring-8

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Reactions of GeV photons are characterized by the process that a photon converts into a vector meson and the vector meson is scattered diffractively by Pomeron exchange [1]. The Pomeron exchange can be understood as the multi-gluon exchange process, which describes various hadronic cross sections at high energy [2]. In the low energy region, photoproduction of ϕ meson is a unique reaction for studying the gluon exchange process because meson exchange processes are strongly suppressed by OZI rule. We expect that precise measurement of cross section will clarify the glueball contribution [3]. In LEPS experiment at BL33LEP of SPring-8, we have been mainly studying the photoproduction of the ϕ meson on proton by using polarized photon beam with the maximum energy of 2.4 GeV. Measuring the parity asymmetry of K^+K^- decay of the ϕ meson with linearly polarized photon makes it possible to study the strength of natural parity (including the glueball exchange) and unnatural parity exchange processes [4].

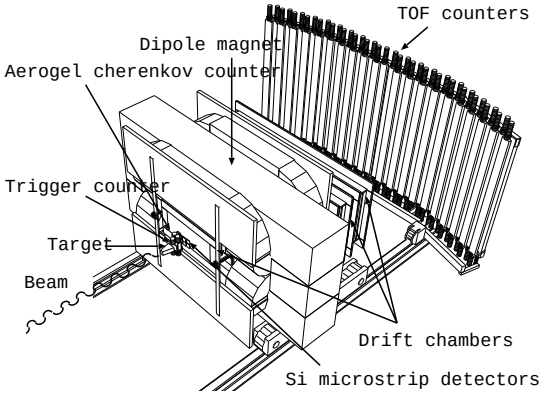

Figure 1: Detector System.

A detector system is optimized for the forward photoproduction measurement [5] as shown in Fig.1. It consists of a dipole magnet spectrometer in the beam direction, Si microstrip detectors and multi-wire drift chambers for particle tracking, and time of flight (TOF) counters. The energy of the incident beam is determined with about 15 MeV resolution by measuring recoil electron with a tagging counter (not drawn in the figure). In December 1999, we started taking data by using a LH_2 target system with a 50 mm-thick target cell. After about the six months data taking, we started to construct a new system with a thicker target. The new system with a 150 mm-thick target cell was completed in May 2002.

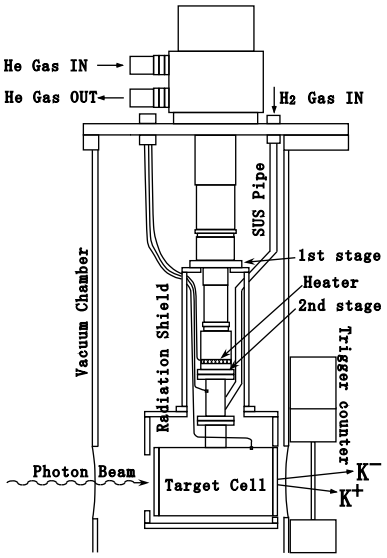

Figure 2: New liquid hydrogen target system.

Figure 2 shows the new LH_2 target system which is in the vacuum chamber during cooling. The refrigerator (Daikin UV204SCL) has cooling ability of 18 W at the first stage (80 K) and 9 W at the second stage (20 K). It takes about 15 hours to change the gas hydrogen to the LH_2. During the experiment, the heater ($\sim$3 W) on the second stage controls the temperature of the LH_2 stably. We use two silicon diode temperature sensors to measure temperatures of the LH_2 at different points. Typical temperatures are 16.0 at the extension of the second stage and 20.5 K at the target cell. The inner size of the cell is about 660 cm^3 and the large acceptance of $|\theta_x|$ <20° and $|\theta_y|$ <11° is achieved even in the most upstream.

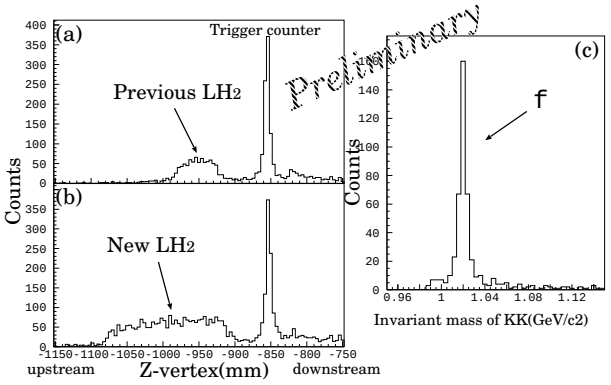

Figure 3: Z-vertex distributions reconstructed from two charged particle tracks, (a) 50 mm-thick target, (b) new 150 mm-thick target. (c) is the invariant mass spectrum of the K^+K^- pair.

We identifies the ϕ meson by reconstructing an invariant mass from a K^+K^- meson pair. Figure 3(a) and (b) show Z-vertex distributions reconstructed from two charged particle tracks. Bumps observed upstream of -900 mm correspond to the previous(a) and new(b) LH_2 targets. The new LH_2 target enables us to take data with roughly three times higher speed than the previous one. Sharp peaks at -850 mm are due to a trigger counter which is used to determine the timing of the TDC start and the ADC gate. Particles generated in the LH_2 target can be easily distinguished from others. The invariant mass spectrum of the K^+K^- meson pair is shown in Fig.3(c). A sharp peak which corresponds to the ϕ meson can be clearly observed.

We have already taken data with several thousands ϕ mesons. The data analysis will be finished in the near future. We are planning to carry out an experiment to study coherent photoproduction of the ϕ meson on deuteron using a liquid deuterium target.

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