New liquid hydrogen target with thickness of 150 mm for LEPS experiment at SPring-8

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In the LEPS experiment at SPring-8 we have been studying the photoproduction of the ϕ meson on proton mainly. A liquid hydrogen (LH_2) target with enough thickness had been needed for obtaining high statistics efficiently. Recently we made a new LH_2 target with a thickness of 150 mm, which enables us to take data with about three times higher speed than the previous one.

A LH_2 target system has been developed by Kyushu university group for experiments at the ring-cyclotron of RCNP [1]. The target system has a 1.5 mm-thick cell [1]. Osaka university ($pp\gamma$) group used this system with a 9 mm-thick target cell [2]. In the LEPS experiment, a much thicker LH_2 target is needed to take data efficiently. In December 1999, we started taking data by using the LH_2 target system with a 50 mm-thick target cell. After about the six months data taking, we started to construct a whole system of a new thicker target. The target with a thickness of 150 mm was completed in May 2002.

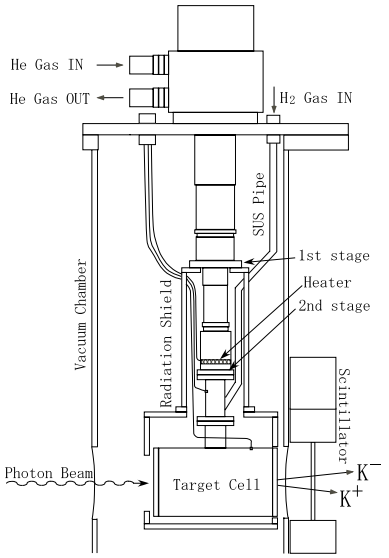

Figure 1: Liquid hydrogen target system.

Figure 1 shows a new LH_2 target system which is in the vacuum chamber during the 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 hydrogen gas to the LH_2. The refrigerator uses the helium gas in the cooling process of the adiabatic expansion. The SUS pipe which is connected to an extension copper of the second stage provides the hydrogen gas from the reservoir. The target cell made of aluminum is also connected to the extension of the second stage. There are aluminum shields to suppress the heat radiation, and they are connected to the first stage. The target cell and the aluminum shields are covered with the aluminized mylar (not drawn in the figure) for suppressing the heat radiation.

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. The accuracy of the temperature sensor is 0.3 K in the LH_2 temperature. The size of the sensor is 2.4 mm in diameter and 6.4 mm in length. A temperature sensor is inserted in a hole on the extension of the second stage and the other is

inserted in a hole on the target cell. Typical temperatures are 16.0 and 20.5 K for the former and the latter, respectively. For good heat conductivity, Apiezon N grease was used in the holes.

Figure 2 shows the LH_2 target cell which is composed of a body, a head, and entrance and exit windows for the beam and particles. In our system, the pressure in the cell is 1.75 atm when the hydrogen is in the gas state, and it decreases to 1.05 atm when the cell is full of the LH_2. For the safety operation, the cell has ability to endure a pressure up to 3 atm. Toray Kapton films, which are hard for radiations, with a thickness of 125 μm are used as window films. The film was attached to a window from inside of the cell by using a Stycast glue which had enough strength even in a LH_2 temperature. The window and the body were glued by using a strongly pressed Indium wire. The Indium also plays an important role for the heat conductivity. The inner size of the cell is about 660 cm^3 and the large acceptance of $|\theta_x| < 20^\circ$ and $|\theta_y| < 11^\circ$ is achieved even in the most upstream.

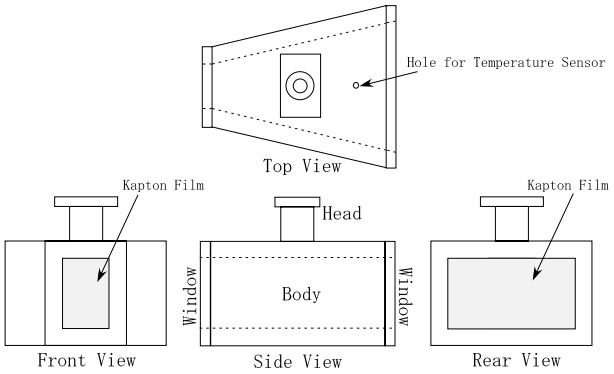

Figure 2: Liquid hydrogen target cell.

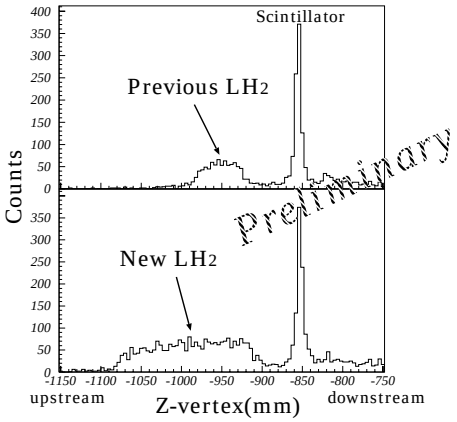

Figure 3: Z-vertex distribution for two track events. The upper and lower histograms show data taken with the previous 50 mm-thick and new 150 mm-thick targets, respectively.

We identifies the ϕ meson by reconstructing the invariant mass from a K^+K^- meson pair. Figure 3 shows preliminary Z-vertex distributions reconstructed from two charged particle tracks. The bumps observed upstream of -900 mm correspond to the previous and new LH_2 targets. We can take data with roughly three times higher speed than the previous LH_2 target. The sharp peaks at -850 mm are due to a scintillator 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. In the near future, we plan to use this target system for a liquid deuterium target, too.

References

[1] T. Yagita *et al.*, RCNP Annual Report 2000.
[2] K. Yasuda *et al.*, Phys. Rev. Lett 82 (1999) 4775.
K. Yasuda *et al.*, RCNP Annual Report 1997.