Test of a Prototype Chamber for the New TPC

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The most exciting result in the SPring-8/LEPS experiments so far is the discovery of an exotic baryon resonance state with $S = +1$, which is now called Θ^+ [1]. The LEPS result has been confirmed by more than a dozen of experiments in other facilities and recently it was also observed in the $\gamma d \to \Lambda^*(1520)\Theta^+$ reaction at LEPS. The spin and parity of Θ^+ have, however, not been determined although they are key issues to select various theoretical models. The decay asymmetry of photo-produced vector mesons is one of the observables sensitive to the parity of the exchange particles in the reaction. Thus, the $\vec{\gamma}N \to \overline{K}^*\Theta^+$ (N; p or n) reaction is a good candidate to obtain information on the parity of Θ^+ [2].

In order to detect the decay of the produced $\overline{K}^*(892)$, we need a detector with a wide acceptance, which can be provided by a Time Projection Chamber (TPC) complementary to the LEPS forward spectrometer. We have already constructed and used a TPC, whose main purpose is to measure $\Lambda^*(1405)$ [3]. Unfortunately, this can not be used for the liquid hydrogen or deuterium targets (LH_2,LD_2) because its target region is only less than 25 mmϕ diameter so as to distinguish $\Lambda^*(1405)$ from $\Sigma^*(1385)$ by using their decay topology. Thus, it was planed to construct another new TPC with a bore of 100 mmϕ diameter.

We have adopted a hexagonal shape with six regions for the new TPC. In that case, the acceptance loss due to the support frames at six corners is one of the big problems. Instead of soldering sense and potential wires on the print board, we have tried a new method in which each wire is wound circularly supported by small brass pins with grooves. The pins are plugged into the narrow frames connecting the signal read-out lines. A prototype chamber with such structures has been constructed for several tests, whose schematic view is shown in Fig. 1. Each wire spacing is 2.5 mm and sense wires and potential wires are strained alternatively. The most inner and outer wires are guard wires. The sense wire plane is sandwiched between a ground plate and a shield wire plane with 4 mm gaps. We checked dependence of the gain and energy resolution on the high voltage supplied to sense wires, using ^{55}Fe X-ray source. The electric discharge did not occur below 1.65 kV when the voltage of the potential wire was fixed at 200 V. We found the energy resolution become suddenly worse above 1.56 kV, while the gain still increased smoothly. Since dE/dx is used for the particle identification in TPC, this result is important. The gain slightly decreased near the support insulator, but it was recovered by supplying a proper voltage to the middle electrode on the side surface of the frame.

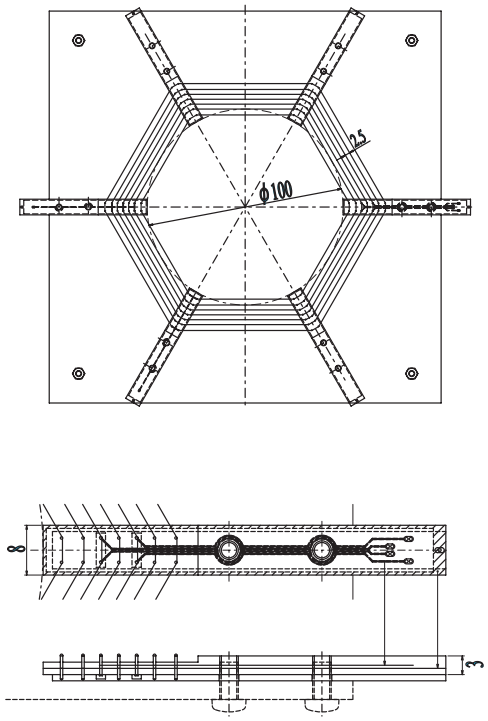

Figure 1: Schematic view of the prototype chamber for the new TPC. The sense wire plane and the expanded view of the support structure are shown.

Based on the test results of the prototype chamber, we have designed the new TPC and it is now under construction, which will be used for the next LEPS experiment together with an energy up-graded photon beam.

References

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