# Performance test of the new Time Projection Chamber for liquid targets

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Since the discovery of a candidate of pentaquark $\Theta^+$ at SPring-8/LEPS [1], there have been many experiments, but even the existence of the $\Theta^+$ has not been confirmed. We plan to take new data with the second Time Projection Chamber (TPC-II) which is used for liquid $H_2$ and $D_2$ target in order to further investigate $\Theta^+$, etc. in a wider kinematic region. Maximum photon energy of the BL33LEP becomes about 3.0 GeV by using a 257-nm laser, which is over the threshold of the $\gamma + N \rightarrow \overline{K}^* + \Theta^+$ reaction (2.7 GeV). Since $\overline{K}^*$ is a vector meson, we can determine the parity of the exchanged particle from the decay asymmetry of $\overline{K}^*$, and may get information on the parity of $\Theta^+$ itself. The standard detectors at LEPS have only forward acceptance, decay particles of $\overline{K}^*$ especially $\pi^+$ can hardly be detected without TPC-II.

After the test of the prototype chamber [2], we designed the TPC-II with a hexagonal cylindrical shape. The maximum drift distance is 760 mm, the maximum radial distance of the outer field cage is 557 mm, and that of the inner cage is 115 mm. There are 2 × 27 anode wires strained in a hexagonal shape of each hemisphere with the wire pitch of 5 mm. The pad plane, which is placed at the distance of 4mm under the anode plane, is divided into 6 sectors. Each sector has 224 pads and each pad size is 5.1mm×14.5mm. From a GEANT4 simulation, the acceptance of the TPC-II is about 60% for the $\overline{K}^* \rightarrow K^- + \pi^+$. The result of the simulation shows that the position resolution on the pad plane must be less than 200 $\mu$m, if we want to observe $\Theta^+$ whose width is less than 25 MeV,

First, we tested TPC-II using $^{55}$Fe X-ray source in order to get pad response function (PRF). We found that the better PRF was pseudo-Lorentz function, $1/(p1^2 + (x - p2)^2)^{3.5}$. Secondly, we studied the position resolution on the pad plane by using the high energy electron beam which was obtained from the photon beam at LEPS. Typical data are shown in Fig. 1. Our aim of this test was to know the angle dependence of the position resolution and to determine the optimum value of the high voltage supplied to anode wires. When an avalanche occurs, the position in the direction of the pad row is determined from the pad signals by using the PRF and the position of the vertical to the pad row from the center of gravity of the signals of anode wires.

The results of the crossing-angle dependence was that the position resolution on the pad plane was 133.2±0.2 at 0°, 170.8±0.3 at 12.5 ° and 343.0±1.1 at 25°. We do not still understand the reason of the worse resolution at 25° than that expected. It might be due to the effect of the insulators supporting wires. Further studies will be needed for the case of the large crossing angles. From the results of the HV-dependence test, we found that the best HV of anode wires was 1574 V.

Unfortunately, since the construction of the field cages was not completed yet in the test experiments, the performance test of the drift direction is still remained for the future test experiment.

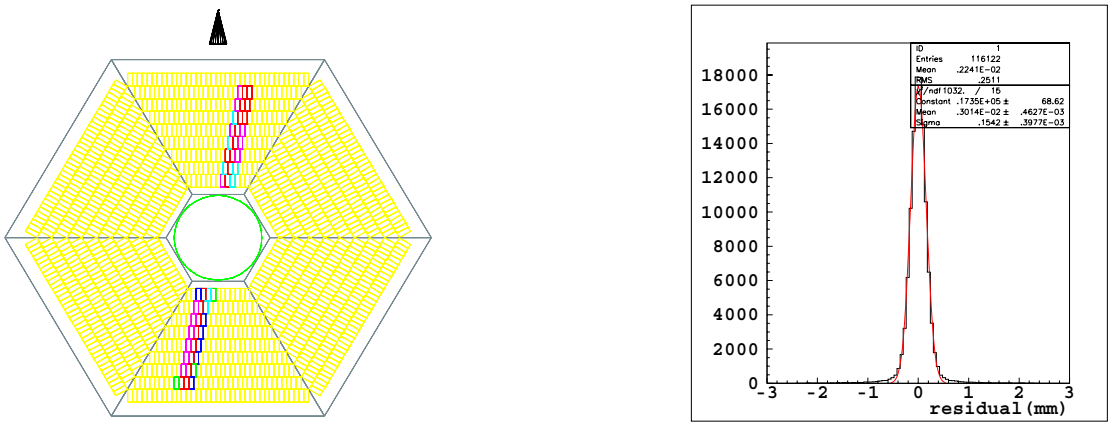


Figure 1: (Left) Event-display at 12.5° crossing-angle. (Right) Residual distribution for 12.5° events.

## References

[1] T. Nakano *et al.*, Phys. Rev. Lett. **91**, 012002 (2003) [arXiv:hep-ex/0301020].
[2] M. Yosoi et al., RCNP Annual Report, 2004, p.84.