Development of Time Projection Chamber at SPring-8/LEPS

M.Niiyama[a], J.K.Ahn[b], D.S.Ahn[b], W.C.Chang[e], T.Ishikawa[a], K.Imai[a], H.Kohri[c], K.Miwa[a], M.Nakamura[a], T.Nakano[c], D.S.Oshuev[e], Y.Sugaya[d], and M.Yosoi[a]

[a]*Department of Physics, Kyoto University, Kyoto, Kyoto 606-8502, Japan*
[b]*Department of Physics, Pusan National University, Pusan 609-735, Korea*
[c]*Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*
[d]*Department of Physics, Osaka University, Toyonaka, Osaka 560-0043 Japan*
[e]*Institute of Physics, Academia Sinica, Taipei 11529, Taiwan*

We have constructed a Time Projection Chamber (TPC) as the 4π detector for hadron photoproduction experiments at SPring-8/LEPS. The specific feature of this TPC is to detect the tracks as close from the target as a few millimeters. The nuclear target of 12.5 mm in radius is mounted on the center of the active volume, and pad rows span from 13 mm in radius, as shown in Fig.1 . This configuration enables us to detect short life particles like Σ which decays in a few centimeters.

A purpose of the TPC is to measure the invariant mass of $\Lambda^*(1405)$. To obtain a clean invariant mass spectrum, it is important to distinguish $\Lambda^*(1405)$ from $\Sigma^*(1385)$ by the decay topology. $\Lambda^*(1405)$ decays into $\Sigma\pi$, on the other hand $\Sigma^*(1385)$ decays into $\Lambda\pi$. A big advantage of TPC is high detection efficiency for decay topology because of its multi-track separation capability, which enables us to separate $\Lambda^*(1405)$ from $\Sigma^*(1385)$ by detecting Σ.

The active volume of the TPC is 700 mm in length and 350 mm in diameter. And it is installed in a solenoid magnet. The signals are read out with 1055 cathode pads and digitized by flash ADCs of 10 bits 40 MHz .

There are two different pad configurations. The inner section has a denser pad configuration, which consists of 6 pad rows with 4×7 mm^2 pad. The outer section has 8 pad rows of 8×13 mm^2. The denser pad configuration is also useful to detect Σ.

We studied the basic performance of the TPC such as the drift velocity, the spatial resolution and the resolution of dE/dx measurement with cosmic rays. The FADC modules of 8 bits 20 MHz are used for this measurement.

As shown in Fig. 2, a linear correlation between drift length and drift time was confirmed. The drift velocity is estimated as 5.2 cm/μsec with the electric

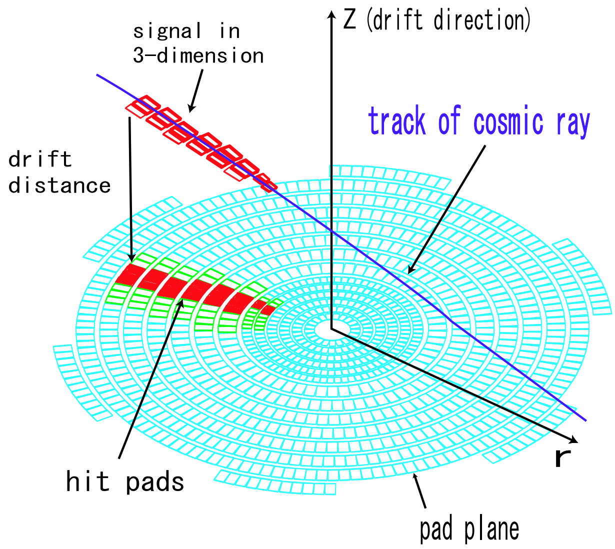

Figure 1: The three dimentional event display of the TPC. Signals and reconstruced track of a cosmic ray are shown.

field of 180 V/cm in P10 gas. This is consistent with the typical value for P10 gas. From the cosmic ray track we obtained the position resolution for drift direction as 770 μm. And further improvement can be expected by increasing frequency of flash ADCs.

The dE/dx measurement is important for the particle identification. We used 6 layers of large pads for the measurement of dE/dx of minimum ionizing particles (MIPs). The resolution of dE/dx measurement is 16% for MIPs.

We used solenoid magnet of 1.7 T to reduce the transverse diffusion effect. The spatial resolution for the large pads is 640μm and 440 μm for the small pads. Further improvement will be achieved by the calibration of readout electronics.

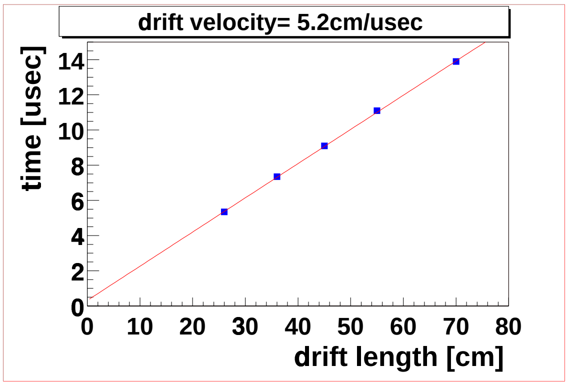

Figure 2: The drift time as a function of drift length. Linear correlation can be confirmed.

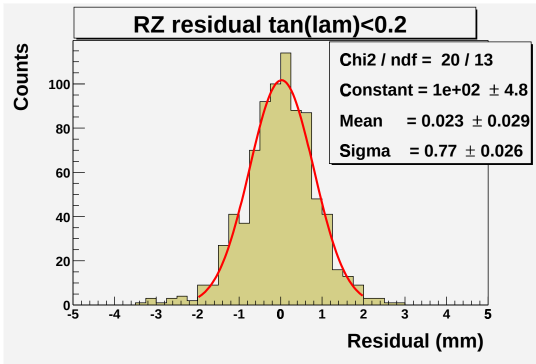

Figure 3: The residual plot for the drift direction is shown. The spatial resolution for the drift direction is 770 μm.

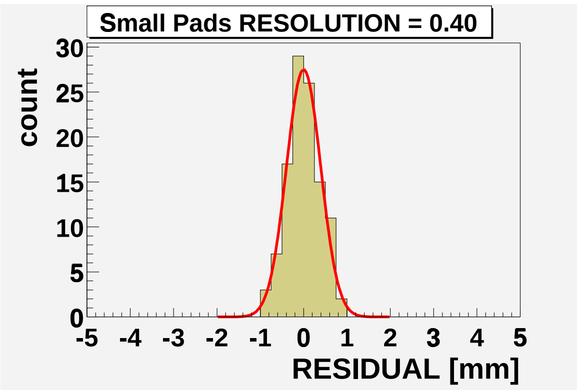

Figure 4: The position resolution for small pads is 400 μm