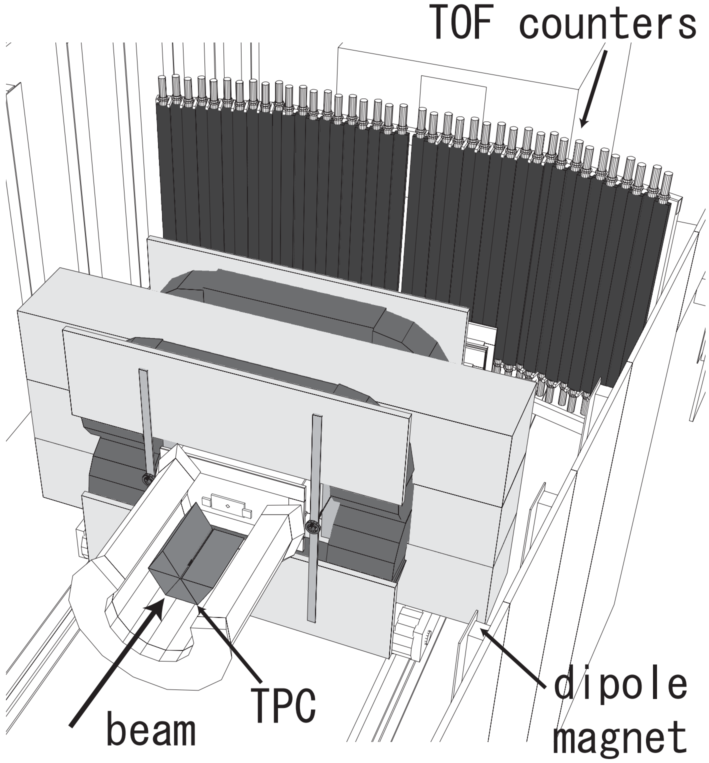

Figure 1: Experimental setup of LEPS spectrometer with the time projection chamber

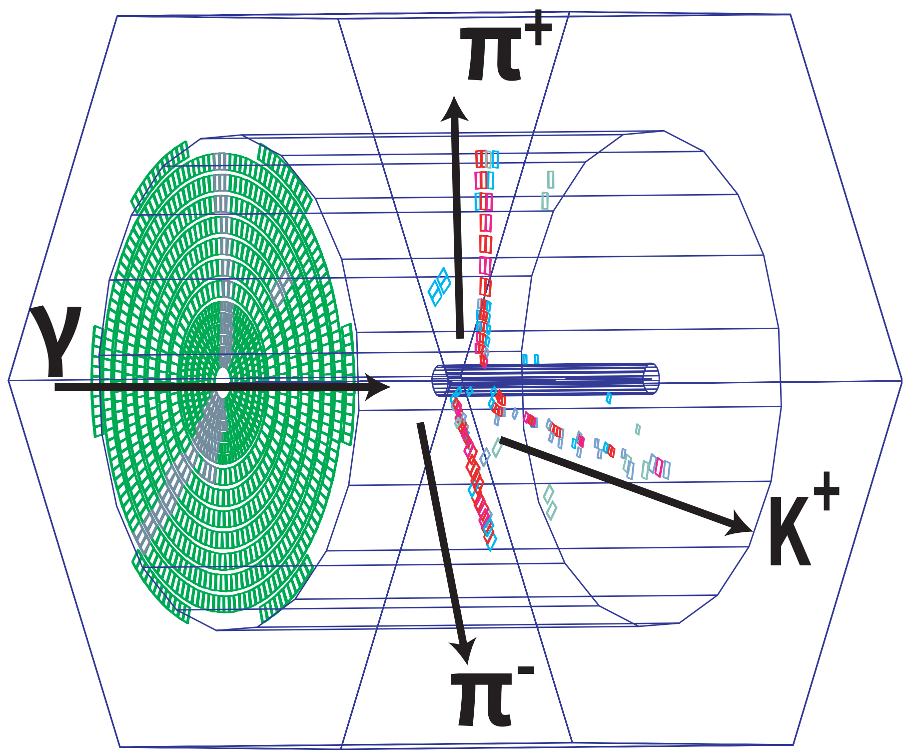

Figure 2: Candidate of $\gamma p \to K^+\Lambda(1405) \to\to K^+\Sigma\pi \to K^+\pi^+\pi^-n$ event obtained in the beam time in the year 2004. Tracks of charged particles are detected by the TPC and displayed in the 3D view.

Photo-production of hyperon resonances at SPring-8/LEPS

M. Niiyama[1], D. S. Ahn[2], J. K. Ahn[3], S. Ajimura[4], H. C. Bhang[5], W. C. Chang[6], J. Y. Chen[6], O. Dmitry[6], T. Emori[1], H. Fujimura[1], S. Fukui[7], H. Funahashi[1], T. Ishikawa[8] K. Imai[1], K. Hicks[9] K. Horie[2], T. Hotta[2], Y. Kato[2], K. Kino[2], H. Kohri[2], S. Makino[10], T. Matsumura[12] T. Mibe[9], M. Miyabe[1], K. Miwa[1], N. Muramatsu[2], M. Nakamura[10], T. Nakano[2], Y. Nakatsugawa[1], T. Ogama[4], N. Saito[1], T. Sawada[2], Y. Sugaya[4], M. Uchida[13], T. Yorita[11] and M. Yosoi[1]

[1] *Department of Physics, Kyoto University, Kyoto, 606-8502, Japan*

[2] *Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

[3] *Department of Physics, , Pusan National University, Pusan 609-737, Korea*

[4] *Department of Physics, Osaka University, Toyonaka Osaka, 560-0043, Japan*

[5] *School of Physics, , Seoul National University, Seoul 151-747, Korea*

[6] *Institute of Physics, Academia Sinica, Taipei, 11529, Taiwan*

[7] *Department of Physics, Nagoya University, Nagoya, Aichi 464-8602, Japan*

[8] *Laboratory of Nuclear Science, Tohoku University, Sendai, Miyagi 982-0826, Japan*

[9] *Department of Physics, Ohio University, Athens, Ohio 45701, USA*

[10] *Wakayama Medical College, Wakayama, Wakayama 641-0012, Japan*

[11] *Japan Synchrotron Radiation Research Institute, Sayou, Hyoto, 679-5143, Japan*

[12] *National Defense Academy in Japan, Yokosuka, Kanagawa, 239-8686, Japan*

[13] *Department of Physics, Tokyo Institute of Technology Meguro, Tokyo, 152-8551, Japan*

The structure of $\Lambda^*(1405)$ is a long standing question in hadron physics. The mass of $\Lambda^*(1405)$ is 1406.5 MeV/c^2 and 30 MeV/c^2 below Kaon-Nucleon threshold. The spin and parity of $\Lambda^*(1405)$ are not measured directly but assigned as $J^P = \frac{1}{2}^-$ [1]. In the quark model $\Lambda^*(1405)$ is the spin-multiplet partner of $J^P = \frac{3}{2}^-$ $\Lambda^*(1520)$, but its mass difference is too large to be explained by the LS force between quarks. Therefore $\Lambda^*(1405)$ has been interpreted not as a pure three quark state but a meson baryon molecular state. Nacher *et al.* [2] suggest that the $\Lambda^*(1405)$ can be dynamically generated by ten meson-baryon coupled channels in the context of chiral unitary model, and predicted that the lineshape of $\Lambda^*(1405)$ is different in $\Sigma^+\pi^-$ and $\Sigma^-\pi^+$ channels. The recent lattice QCD calculation also suggests such a molecular state for $\Lambda^*(1405)$ [3]. Recently some theorists predict the modification of mass spectrum of $\Lambda^*(1405)$ in nuclear matter [4, 2, 5] from the point of view of meson baryon states. Therefore, the measurement of the $\Lambda^*(1405)$ invariant mass distribution is crucial to test these model predictions. But no experimental data of $\Lambda^*(1405)$ production from nucleus is available up to now.

Since the $\Lambda^*(1405)$ hyperon lies close to $\Sigma^*(1385)$ in mass, we need to distinguish these two hyperons to obtain clear event samples of $\Lambda^*(1405)$. The $\Lambda^*(1405)$ decays into $\Sigma\pi$, while $\Sigma^*(1385)$ decays mainly into $\Lambda\pi$. Thus we can identify $\Lambda^*(1405)$ by tagging Σ hyperon. We have constructed a Time Projection Chamber (TPC) as the 4π detector to detect decay topology of hyperons. The active volume of the TPC is cylindrical shape of 700 mm in length and 350 mm in diameter. The TPC is immersed in a solenoidal magnetic field of 2 T. Signals from the TPC are read out through 1055 cathode pads which are arranged in 14 circular rows. The electric field for drift electrons are made by copper strips embedded on the inner and outer side of field cage (Fig. 3). The three dimensional coordinates of a track of a charged particle can be reconstructed from the center of gravity of the induced charge on pads and drift time of electrons. Figure 2 shows a candidate of $\gamma p \to K^+\Lambda(1405) \to K^+\Sigma\pi \to K^+\pi^+\pi^-n$ reaction obtained from CH_2 target run in the year 2004.

We have carried out hyperon photo-production experiment at SPring-8/LEPS with polyethylene, carbon and copper target. The energy range of the backward compton scattering photon was 1.5 - 2.4 GeV. Figure 1 illustrates the setup of experiment. The forward spectrometer system was used to detect particles going at forward angle. TPC was utlized to momentum-analyze particles going backward. Figure 4 is a photograph of the detector in the experimental hatch of SPring-8/LEPS. We analyzed events in which a K^+ was detected by the forward spectrometer. Figure 5 shows the missing mass spectrum of $p(\gamma, K^+)X$ reaction for CH_2 target assuming a proton is at rest. The third peak around 1.4 GeV/c^2 accounts for $\Lambda^*(1405)$ and $\Sigma^*(1385)$. The invariant mass of $\Lambda^*(1405)$ will be reconstruct by detecting $\Sigma\pi$ using TPC. Detailed analysis such as momentum calibration and particle identification by TPC is underway.

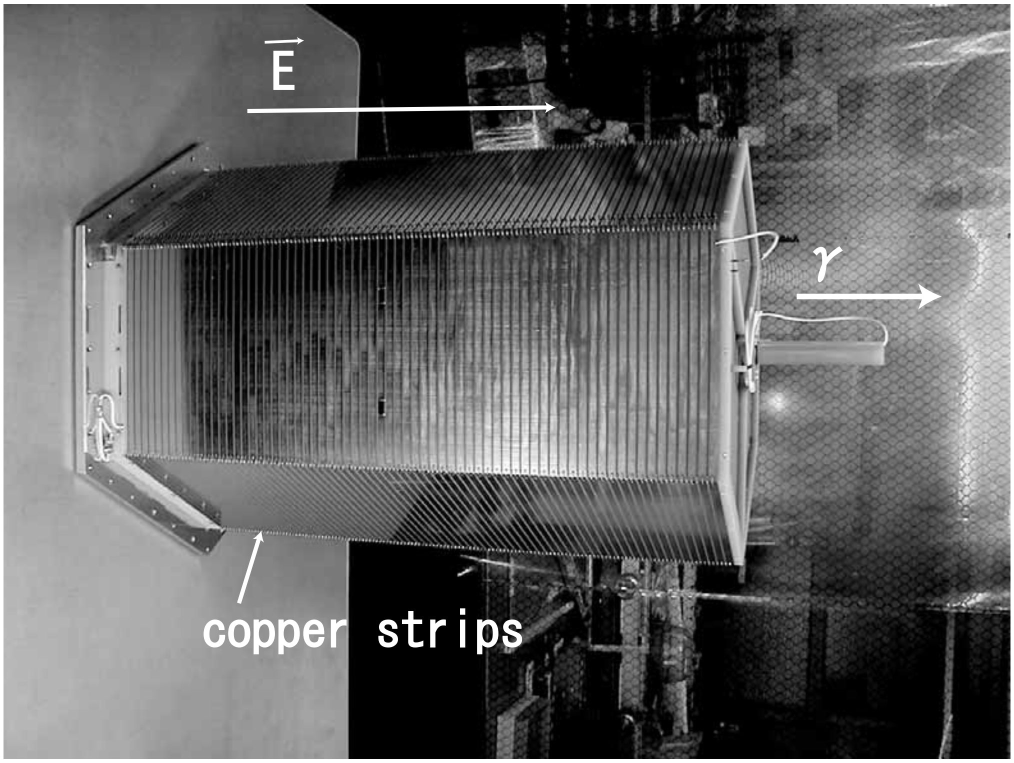

Figure 3: A picture of the drift cage. Copper strips make the drift field in the active volume. A nuclear target is installed in the active volume. The photon beam goes through from left to right.

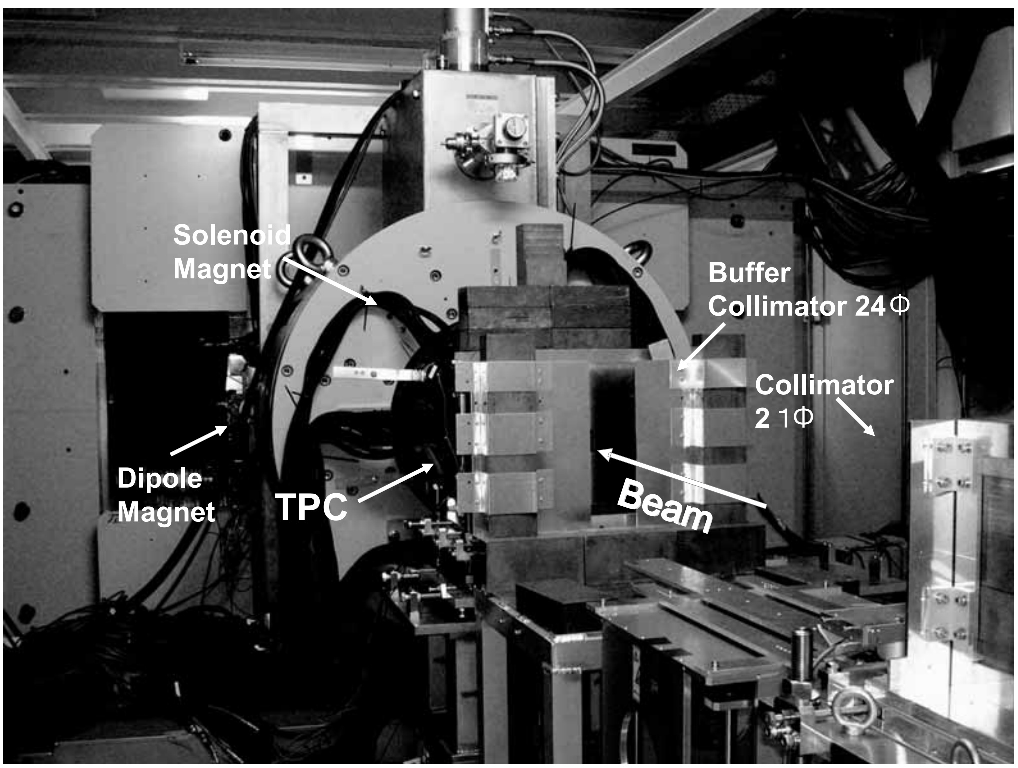

Figure 4: Photograph of the inside of experimental hatch of SPring-8/LEPS. The photon beam goes through from right to left in the picture. The TPC is installed in the super-conducting solenoid magnet. The dipole magnet and drift chambers are located downstream of the TPC.

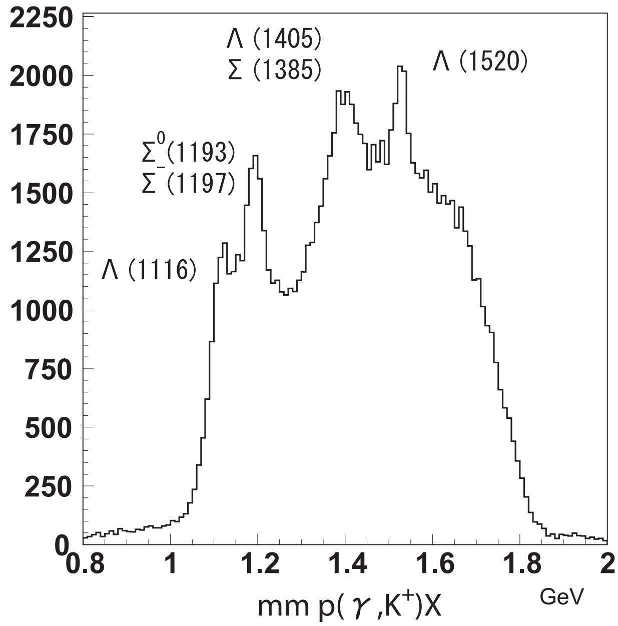

Figure 5: Missing mass spectrum for $p(\gamma, K^+)X$ reaction assuming proton at rest in CH_2 target. An unresolved peak corresponding to $\Lambda^*(1405)$ and $\Sigma^*(1385)$ is seen around 1.4 GeV/c^2.

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