T465 & T480 : Test Experiments for Measurements of Auger Electron Following Pion Capture Process

Our group investigated the pion capture process for molecules in the liquid and gas phases focusing to the behavior of pionic hydrogen atoms, and contributed to understand the mechanism of the process. The experimental results revealed the influence of the valence electrons and chemical structure on the pion capture and pion transfer processes. It is necessary for further understanding the mechanism to observe directly the initial step of the capture process and to investigate microscopically the whole of the capture process. Then we are designing an experiment to measure Auger electrons emitted in the initial step of the pion capture and electronic X-rays (eX-rays) in the coincidence with the pionic X-rays (π X-rays). Here, we report the results of the test experiments to measure the Auger electrons and the eX-rays.

The measurements were performed at the π μ channel of KEK-PS. The electrons were measured with a passivated implanted planar silicon (PIPS) detector, and the eX-rays were measured with a Ge-detector for low-energy photon spectrometry. We carried out two times of the test, experiment-1 (T465) and experiment-2 (T480). At first we carried out experiment-1, as mentioned below.

- Survey of the emitted electron around the target (Ni and Ag foil) during pion irradiation.
- Measurements of the Auger electrons originating from the inner-shell in the coincidence with the π X-rays.
- Examination of the change of the electron spectrum with target thickness, the target atomic number, and the shield.

As a result, we concluded that the measurements for Auger electrons were too difficult in these experimental conditions owing to the secondary electrons and bremsstrahlung. Then we improved the shields and setup to exclude the disturbance. According to the results, we carried out experiment-2.

- Retrial of measurement for the Auger electrons in the coincidence with the π X-rays.
- Survey of the influence of the change of the distance between the target (Ni, Ti and Ag) and the PIPS on the electron spectrum.
- Evaluation of the various kind of shield in this chamber.

Consequently we obtained the best conditions for the shield and the distance. In addition, to reveal rearrangement of inner-shell electrons correlated with the transition of a π X-ray we measured the π X-rays and eX-rays. The eX-rays for (Z-1) atom of the atomic number were observed in the coincidence of the π X-rays, though the statistics were very low. Figure 1 is X-rays observed in the coincidence with the π X-rays.

Now we are designing the shield to lower the influence of the secondary electrons and bremsstrahlung, and we are planning to measure the Auger electrons emitted by the pion capture.

Figure Caption

Fig.1. Electronic X-rays observed in the coincidence with the pionic X-rays of (a) Pb (10-9), (b) Pb (9-8), (c) Pb (8-7) and (d) Pb (7-6). The numbers in parentheses indicate the principal quantum numbers relevant to the transition.