E546/E567 Precise Measurement of Electronic X rays from pionic atoms

In this research, we measured electronic X-rays (eX-rays) and pionic X-rays emitted from pionic atoms for the purpose of understanding the electronic structure of the pionic atoms.

Because a negative pion strongly screens the nuclear charge, the eX-ray energy emitted from the pionic atom is similar to the eX-ray energy emitted from Z-1 atom, where Z is the atomic number of the pionic atom. In general, this energy is influenced by the electronic structure. So we can investigate the electric structure of pionic atom by measuring the difference of eX-ray energy between Z-1 atom and πZ atom (we call this difference "energy shift"). In 2005-1 and 2005-4 cycles, we measured the energy shifts for the 19 elements ranging from Cu to U. Each eX-ray spectrum was fitted with three components corresponding to the eX-rays emitted from Z atom, πZ atom and Z-1 atom. The Z-1 atom is produced by the nuclear reaction between a negative pion and Z atom. Figure 1 shows an example of the analysis for eX-ray spectrum. In addition, we are reanalyzing the spectra measured previously in our experiments by using this fitting method. Though the analysis is in progress, the energy shifts show the atomic number dependence which is shown in Fig. 2.

In 2005-4 cycle, the energy shifts for actinide elements (Th, U) were measured for the first time. The measured energy shifts are larger than those of more light elements. This result is consistent with the result of the previous experiments for muonic atoms.

Fig, 1
Electric K_α X-ray spectrum of Gd target together with its fitting lines. The red lines correspond to eX-rays emitted from Gd, the yellow lines to eX-rays emitted from Eu and the blue lines to eX-rays emitted from πGd. The two headed arrows indicate the energy shift.

Fig, 2
Atomic number dependence of the energy shifts. It seems that the energy shift becomes larger with increasing atomic number

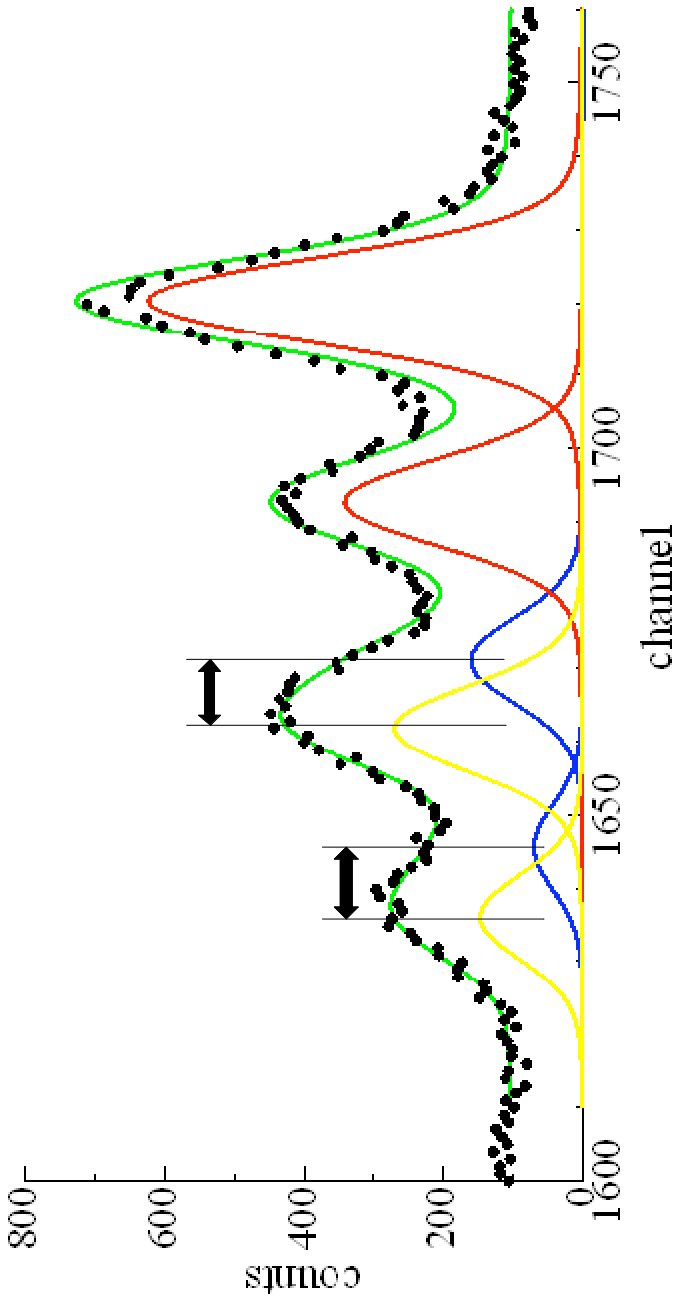

Figure 1

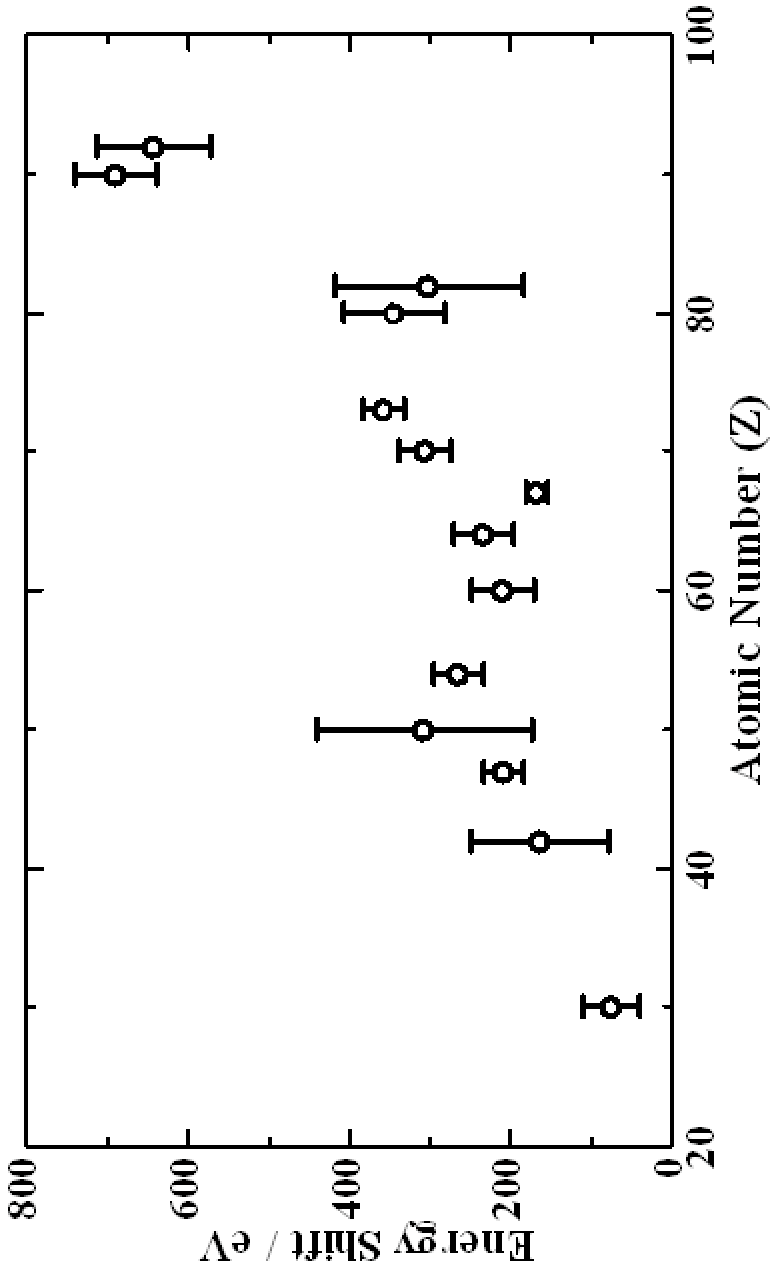
Energy Shift / eV
0
200
400
600
800
20
40
60
80
100
Atomic Number (Z)

Figure 2