MLF Experimental Report	提出日 Date of Report 26 Jul 2013
課題番号 Project No. 2012B0178 実験課題名 Title of experiment Measurement of the Mössbauer γ-rays from exotic Fe atoms produced by negative muon capture process 実験責任者名 Name of principal investigator Y. Kobayashi 所属 Affiliation Univ. of Electrro-Commun./RIKEN	装置責任者 Name of responsible person Prof. Y. Miyake 装置名 Name of Instrument/(BL No.) D2 実施日 Date of Experiment 9 Mar – 11 Mar 2013

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

Co metal (5 x 50 x 50 μm)

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

The unusual chemical species and anomalous oxidation states of "exotic atoms" produced by nuclear reactions and nuclear transformation have been investigated by combining nuclear probes and *in situ* characterization technique. It is well known that exotic atoms are produced following negative muon capture as well as hot atoms by neutron capture. Backenstoss *et al*. reported the distributions of excited nuclei formed after negative muon capture process and determined the probabilities for the emission of the number of neutrons, by identification of γ-radiation emitted from the excited states. They succeeded to measure some of the excited sublevels produced by the reaction of ^{59}Co (μ^-, 2n) ^{57}Fe* with a monoisotopic ^{59}Co metal, but could not obtain the first excited level of 14.4 keV that is a Mössbauer transition for ^{57}Fe [1].

The experiment [2012B0178] was performed at D2 port at the MLF Facility in J-Parc. A Co metal foil with a thickness of 5μm was placed at the target position in the end of the beamline. The γ-rays and the muonic X-rays emitted from Co as a result of the μ^- capture process were measured by Ge semiconductor detector, then the

momentum of the negative muon were optimized to be 30 MeV/c. Energy spectra of Co that captured negative muon with the momentum of 30 MeV/c is shown in Fig. 1. It was found that the peak intensities of the 122-keV γ-transition were too weak, and the peak position was overlapped with that of μN(3-1). Since the γ-ray with the energy of 122 keV is a precursor of ^{57}Fe Mössbauer γ-ray of 14.4 keV, it was suggested to be really hard to measure the in-beam Mössbauer spectroscopy in a simple experimental layout. Then, the obtained muonic X- ray

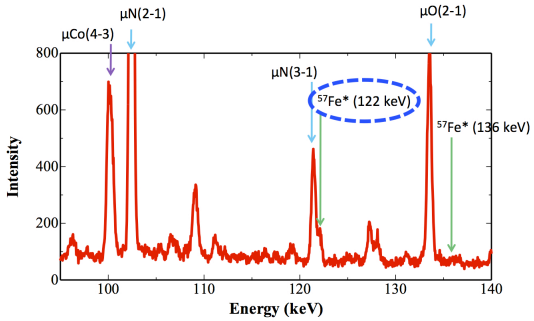

Fig. 1. Energy spectra of Co that captured negative muon with the momentum of 30 MeV/c.

spectrum was analyzed by the delayed components just after pulsed-muon irradiation. Most of the characteristic X-ray peaks were disappeared. However, both γ-transitions of 14.4 and 122 keV could be extracted, since they have the life-times of approximate 100 ns, as shown Fig. 2 (a) and (b).

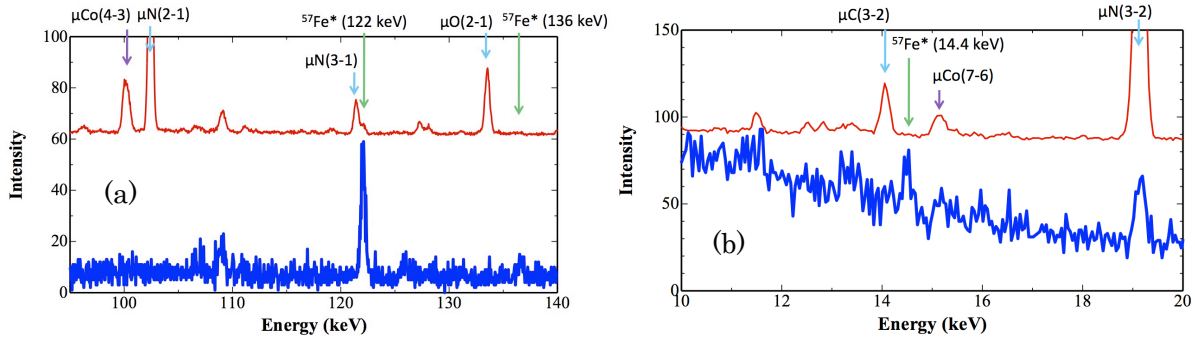

Fig. 2. Delayed X-ray and γ-ray spectra of Co irradiated by negative muon with the momentum of 30 MeV/c.

The experimental configuration including the target layout and the detection system will be optimized and improved further for the in-beam Mössbauer spectroscopy.