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 MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014B0008 実験課題名 Title of experiment Feasibility of time-of-flight prompt gamma-ray analysis for radioactive waste at Fukushima Daiichi and nuclear waste management 実験責任者名 Name of principal investigator Yosuke Toh 所属 Affiliation Japan atomic energy agency	装置責任者 Name of responsible person Yosuke Toh 装置名 Name of Instrument/(BL No.) ANNRI / BL04 実施日 Date of Experiment 16/Apr/2015 – 19/Apr/2015

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.
Tc-99 78mg,54.7mg (TcO2) Pd-107 21mg Ru 176mg Rh 39.4mg Pd 78.8mg Ad 11.8mg

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.
<p>In this study, we used the Ge detector array, a combination of two cluster-Ge detectors, eight large coaxial-Ge detectors and BGO anti-Compton shields surrounding cluster-Ge and coaxial Ge detectors, is installed at the flight path length of 21.5 m in ANNRI. For improvements of the accuracy and sensitivity, we have developed a novel non-destructive multi-elemental analytical technique which combines prompt gamma-ray analysis with time-of-flight technique (TOF-PGA) in J-PARC ANNRI [1]. A key advantage of the developed method is that five types of spectra can be obtained simultaneously, namely, PGA, TOF, MPGA, TOF-PGA, and TOF-MPGA spectra. A PGA spectrum shows gamma-ray counts at a given energy. In contrast, a TOF spectrum shows has three dimensions and plots the energy of the gamma-ray on the X axis, the time-of-flight on the Y axis, and gamma-ray counts at the time of the flight of the neutron that is captured in a sample.</p>

2. 実験方法及び結果(つづき) Experimental method and results (continued)

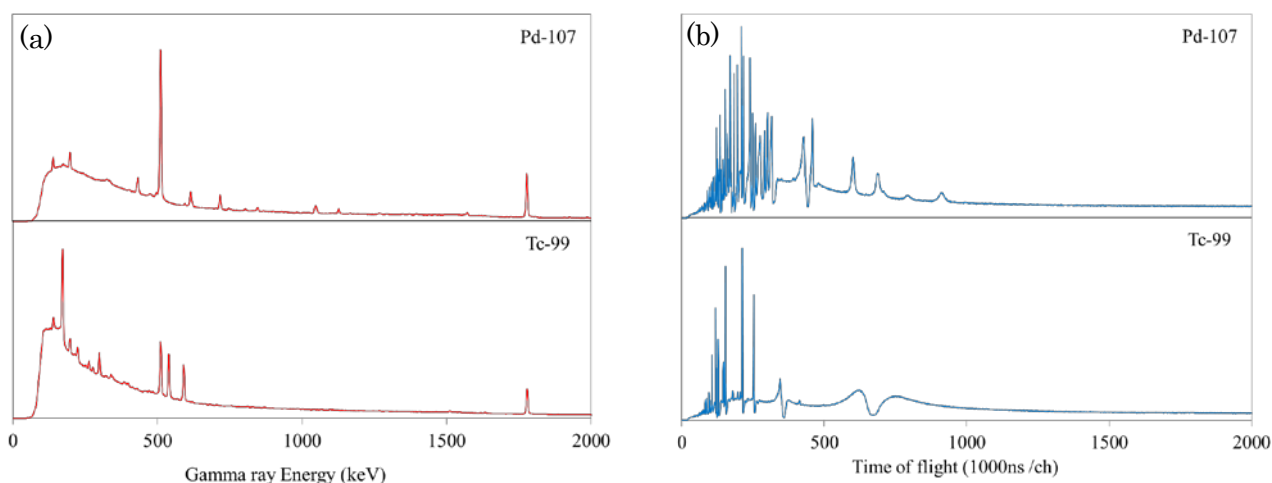


Fig.1. PGA and TOF spectra are shown in (a) and (b), respectively.

The TOF-PGA spectrum has three dimensions and plots the energy of the gamma-ray on the X axis, the time-of-flight on the Y axis, and the number of counts on the Z axis. An MPGA spectrum, which is also a three dimensional spectrum, is constructed with events comprising a pair of prompt γ rays. The SNR values of these spectra depend on the element (or nucleus) which has a specific multiplicity of a prompt gamma ray and specific energies of resonance peaks.

The platinum-group metals (PGEs) generated from four-group partitioning process including radioisotopes Tc-99 and Pd-107 are irradiated by a pulsed neutron for approximately for 3 or 6 hours. The figure 1 (a) shows the PGA spectra of Pd-107 and Tc-99. We observed several strong prompt gamma-ray peaks from Pd-107 and Tc-99 in the spectra. TOF spectra of Pd-107 and Tc99 is shown in the fig.1(b). The neutron capture resonance peaks of Tc-99 only are clearly shown. On the other hand, in the TOF spectrum of Pd-107, the resonance peaks of Pd-107 as well as trace impurity elements are observed. We also measured the simulated sample of four-group partitioning process. In this case, severe peak overlaps occurred in both PGA and TOF spectra because most of nuclei emits many gamma rays and have a large number of resonance peaks. By contrast, TOF-PGA method allows us to eliminate or at least to greatly suppress the interference from the other elements. Thus we reasonably conclude that the developed method allows significant improvements in the SNR values and provides correspondingly more accurate results. The results will be also submitted to a peer reviewed journal in the near future.

[1] Y. Toh et al., Anal.Chem. 2014,86,12030-12036