Progress of study of $\beta$-decay of neutron-rich nuclei with $Z \sim 60$

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Approximately half of the elements heavier than iron are formed by the rapid neutron-capture process ($r$-process). In the solar $r$-process abundance distribution, the region of rare-earth elements forms a peak around $A = 160$, which may have a different mechanism of formation compared with the other two distinct peaks at $A = 130$ and $A = 195$ relating to neutron-closed shells at $N = 82$ and $N = 126$, respectively. $\beta$-decay half-lives of the elements always play an important role at both the cold and hot $r$-process paths and will be expected to constrain the conditions in understanding the $r$-process nucleosynthesis.

To study the rare-earth peak, a $\beta$-decay experiment with $Z \sim 60$ was performed at the RIBF facility in June 2013. This experiment was carried out using the in-flight fission of a 345 MeV/nucleon $^{238}$U beam colliding with a Be target. The secondary beam, including a cocktail of highly neutron-rich isotopes, was implanted in the $\beta$-decay counting system WAS3ABi$^2$(Wide-range Active Silicon-Strip Stopper Array) for Beta and ion detection), which consists of a stack of five highly segmented DSSSDs (Double-Sided Silicon Strip Detectors). With the help of the high-purity germanium detectors (EURICA)$^3$, $\gamma$ rays with a high production rate emitted from implanted radioactive isotopes or the daughters nuclei fed through the $\beta$-decay can be measured. The $\beta$-decay half-lives could be determined by fitting the distribution of the time difference between the implantations in the WAS3ABi and the following $\beta$-decay events.

In this experiment, approximately 35 half-lives were measured, including approximately 25 new half-lives.