Progress on the decay spectroscopy and measurement of half-lives and P_n values in exotic nuclei near the $N = 50$ shell closure

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β-delayed single- and multi-neutron emission is found in neutron-rich nuclei in which β decay populates states above the neutron separation energy (S_n) in the daughter nucleus. New generations of radioactive ion beam facilities will be able to produce thousands of currently inaccessible neutron-rich nuclei. Delayed neutron emission is expected to be the dominant decay process for these nuclei, with recent papers detailing the importance of β-delayed neutron emission for the r-process.[1,2)]

In 2016, the BRIKEN collaboration constructed and commissioned the world's largest and most efficient β-delayed neutron detector[3,4)] at RIBF to conduct a wide-ranging and systematic study into the decay properties of hundreds of the most exotic neutron-rich nuclei currently available. The BRIKEN detector consists of 140 ^{3}He tubes within a HDPE moderator surrounding the highly-segmented active stopper AIDA and two HPGe clover detectors in close geometry.

The NP1412-RIBF127R1 experiment implemented the BRIKEN detector to measure β-delayed neutron emission probabilities and half-lives, as well as conduct decay spectroscopy studies, around the $N = 50$ shell closure near the doubly-magic ^{78}Ni. This is a region highlighted as sensitive to β-decay properties.[5)] In one of the first papers published from this experiment,[6,7)] R. Yokoyama *et al.* observed two neutron emission in ^{84,85,87}Ga for the first time, and detailed dominating one-neutron emission from two-neutron unbound states in ^{86,87}Ga.

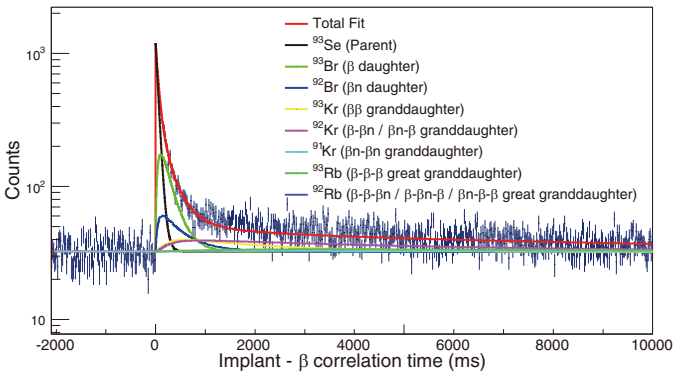

Fig. 1. Preliminary half-life analysis of ^{93}Se, showing the contributions to the total fit from the parent and daughter isotopes.

The analysis efforts based at TRIUMF focus on the $^{91–95}$Se and $^{94–97}$Br isotopes. From these isotopes, half-lives and P_n values are expected to be measured for $^{92–95}$Se and $^{95–97}$Br for the first time. An example decay half-life Bateman fit, considering the contributions to the total fit from each of the daughter nuclei along the decay chain, is shown in Fig. 1. Decay spectroscopy information in the neutron-rich region around $A \sim 90$–100 is sparse and this analysis will allow the extraction of the first decay spectroscopy data for multiple nuclei in this region.

Further analysis of the data is ongoing and expected to yield multiple new P_n values and half-lives. Early publications highlight the potential of the highly efficient BRIKEN detector to expand the systematics of β-decay in exotic neutron-rich nuclei, vital in developing accurate r-process nucleosynthesis models.

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