Half-lives and β-delayed neutron emission for the most exotic neutron-rich Se and Br isotopes

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The BRIKEN collaboration performed measurements on several neutron-rich nuclei regions across the nuclear chart during the period 2017–2021. Focused on the double magic ^{78}Ni region, the experiment RIBF127 aimed to determine experimental β-decay half-lives, neutron emission probabilities, and γ spectroscopy of isotopes beyond the $N = 50$ neutron shell, which are all important parameters to provide reliable data for models of the astrophysical rapid-neutron capture process. The most neutron-rich isotopes of elements from Fe ($Z = 26$) to Kr ($Z = 36$) were identified using the BigRIPS spectrometer on an event-by-event basis with the $B\rho$–ΔE–ToF method.[1)] At the end of the beamline, the detection setup consisted of the Advanced Impantation and Detector Array (AIDA)[2)] surrounded by the BRIKEN detector.[3)] The AIDA consists of an array of six highly segmented layers of double-sided Si detectors (DSSSD), enabling the detection of the implants of the ions and their β-decays. The BRIKEN array is a high efficiency neutron detector based on 140 ^{3}He counters embedded in a polyethylene matrix to moderate the emitted neutrons, and two HPGe clover γ detectors. It enabled the detection of the neutrons and the γ-rays emitted after the β-decays.

The isotopic species of interest in this study are $^{91-94}$Se and $^{94-96}$Br. They have been implanted in AIDA (see Table 1), and for most of them, the decay properties were determined for the first time. The data analysis is based on the time correlation of the implants and β-decays registered in AIDA, and the neutrons and γ-rays detected with the BRIKEN detector. In addition to the time correlation, spatial correlations between implants and β-decays are studied owing to the DSSSD's segmentation. This allowed us to adjust the best signal-to-noise rate in the correlations.[4)] Using the Bateman equations and corrections due to the physical limitations of the detection systems,[5,6)] the half-life and the β-delayed neutron emission probability, P_{1n}-value, were determined. Figure 1 shows the analysis of ^{91}Se, in which multiple simultaneous fits of implant-β and implant-β-neutron correlation histograms were performed to determine its properties. Preliminary results show slightly shorter half-life and higher P_{1n}-value compared with the literature for ^{91}Se. An upcoming publication will report new half-lives and P_{1n} values in the region, some of them for the first time.

Table 1. Number of implants of the isotopes of interest and available data in the literature.

Nucleus	Number of ions	Previous literature values	
	implanted	half-life (s)	P_{1n} value (%)
^{91}Se	59728	0.27(5)	21(10)[7)]
^{92}Se	340337	-	-
^{93}Se	16631	-	-
^{94}Se	525	-	-
^{94}Br	2627	0.070(20)	30(10)[7)]
^{95}Br	2289	-	-
^{96}Br	159	-	-

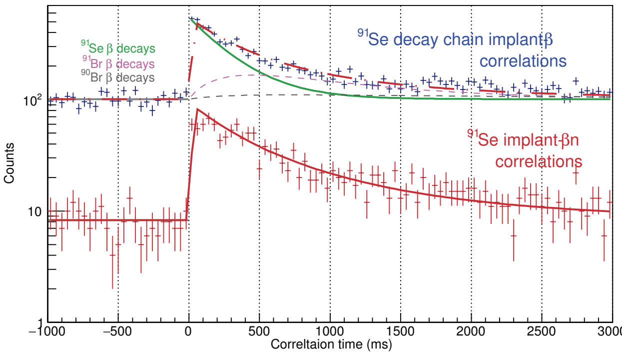

Fig. 1. Implant-β (blue) and implant-β-neutron (red) correlation histograms for ^{91}Se. Fitted curves obtained by simultaneously sharing common parameters, from which the half-life and the P_{1n}-value were determined.

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