Isomer spectroscopy of ^{92,94}Se in the SEASTAR 2015 experiment

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We report on the analysis of the isomer spectroscopy of ^{92,94}Se conducted during the SEASTAR 2015 campaign of experiments.[1)] Neutron-rich nuclei were produced via the in-flight fission of a 345-MeV/nucleon ^{238}U primary beam colliding with a ^{9}Be target. The fragments were selected with BigRIPS, previously tuned to produce a radioactive beam centered around ^{95}Br. This secondary beam impinged on a 99(1)-mm LH_2 target of the MINOS device placed at F8, producing neutron-rich selenium nuclei via knockout reactions. The ejectiles were transported through the ZeroDegree spectrometer, where particle identification was conducted via the TOF-$B\rho$-ΔE measurement to deduce the mass-to-charge ratio (A/Q) and atomic number (Z). The obtained PID histogram is shown in Fig. 1.

The nuclei were implanted on the silicon layers of the AIDA stopper placed at the end of the ZeroDegree spectrometer. The existence and decay of isomeric states of the implanted ions were studied using the EURICA array comprised of HP Ge detectors.[2,3)] The obtained spectra for delayed γ rays are shown in Fig. 2. All the reported transitions for these isotopes[4,5)] were observed. For ^{92}Se, new transitions were found at 67, 353 and 1252 keV. For ^{94}Se, the isomeric state was observed for the first time, with new transitions having energies of 495, 822, 752, and 1180 keV.

Several analysis steps such as add-back reconstruction, background subtraction, efficiency and time-walk correction, and $\gamma\gamma$ coincidences have been conducted to identify the γ rays emitted after the isomeric decay and their placement in the level schemes, which have been extended. In both nuclei, a single isomeric state has been found because the half-lives for the individual transitions, measured from their time spectra, are consistent with each other. The isomeric half-lives were obtained from the exponential fit of the time spectrum obtained after adding events of individual transitions, leading to $T_{1/2} = 15.7(7)$ μs for ^{92}Se and $T_{1/2} = 0.68(5)$ μs for ^{94}Se.

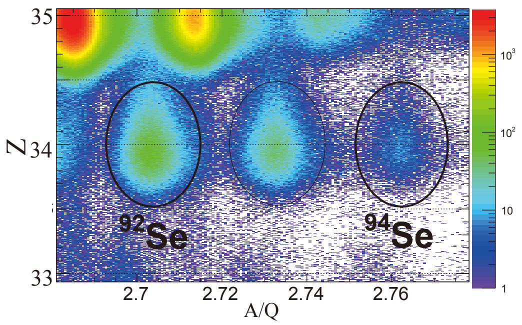

Fig. 1. ZeroDegree PID spectrum and 2D cuts of ^{92,94}Se.

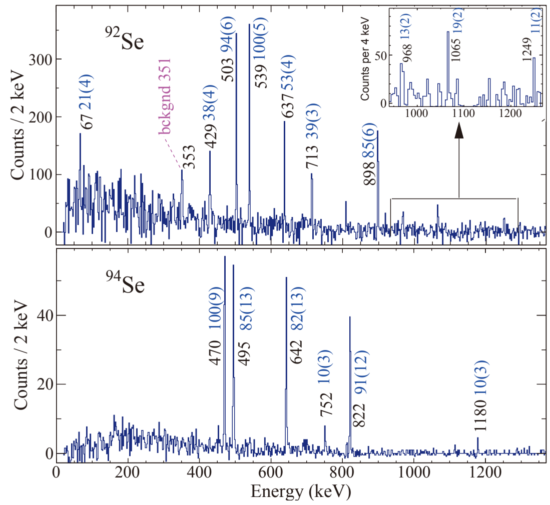

Fig. 2. Delayed γ-rays correlated to ^{92}Se and ^{94}Se. The energy (black) and efficiency-corrected intensity (blue) of the transitions are shown next to the peaks.

For ^{92}Se, the isomeric decay occurs because of an E2 67-keV transition with a decay strength of approximately 1 W.u. The comparison between BrICC calculations and experimental intensities allowed the multipolarity assignment. In the context of Nilsson schemes of state-of-the-art beyond mean-field (BMF) theories, the isomeric decay likely corresponds to a $9^- \rightarrow 7^-$ transition between two oblate quasi neutron states. For ^{94}Se an oblate K-isomer is suggested, decaying via a $7^- \rightarrow 6_1^+$ E1 transition with an energy of 495 keV. The spin quantum numbers were tentatively assigned assuming the simplest high-K quasiparticle couplings near the Fermi surface, in both cases near $\beta \sim -0.24$, involving the 11/2[505] level. A prolate-to-oblate transition between $^{90-94}$Se$_{56-60}$ is predicted by BMF theories recently used for the neighbouring ^{98,100}Kr.[6)] It seems to be supported by the experimental systematics and the decay pattern between the low-lying levels observed during the isomeric decay.

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