BRIKEN measurements of P_n-values and half-lives for understanding the formation of the r-process rare-earth peak: progress on the Ce to Nd region

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The Rare-Earth Peak (REP) is a distinctive local maximum observed around mass $A \sim 160$ in the elemental abundance distribution of the rapid-neutron capture process (r-process). Because the REP is formed after neutron exhaustion,[1)] it provides a unique probe for studying the late-time environmental conditions of the r-process site.[2)] According to theoretical models, β-decay rates ($T_{1/2}$) and delayed neutron emission probabilities (P_n-values) play important roles in the formation of the REP.[3)] The region of nuclei with the most significant impact on the formation of the REP has been determined via sensitivity studies.[4)] Most of the $T_{1/2}$ on this region have already been measured by the EURICA collaboration.[7)] However, the experimental determination of P_n-values is yet to be achieved.

The NP1612-RIBF148 experiment exploits the unique capabities of the BRIKEN setup[5,6)] for the measurement of β-delayed neutrons. This experiment attemps to study P_n-values and $T_{1/2}$ for the nuclei which are important to REP formation.[4)] In the 2018 experimental run, a 60-particle-nA ^{238}U beam, with 345 MeV/nucleon, hitting a 4 mm thick Be target was used to produce the secondary radioactive beam. The neutron-rich fragments were filtered out by the BigRIPS fragment separator and the ZeroDegree spectrometer. The beam setting was centered on ^{165}Pm.

Here, we report preliminary results from the 2018 experimental run. Figure 1 shows the measured beta-decay half-lives in the region from Ce to Nd isotopes. The experimental results are compared with previous measurements performed by the EURICA collaboration,[7)] and with FRDM + QRPA theoretical calculations.[8,9)] The BRIKEN experimental data agree well with the previous measurements. In addition, our results exhibit an improved precision for the heavier nuclei region. Based on the current status of the data analysis for this experiment, we expect to obtain at least one new $T_{1/2}$ per atomic number on the heavier isotopes from the Ce to Nd region. These results will be reported in the future.

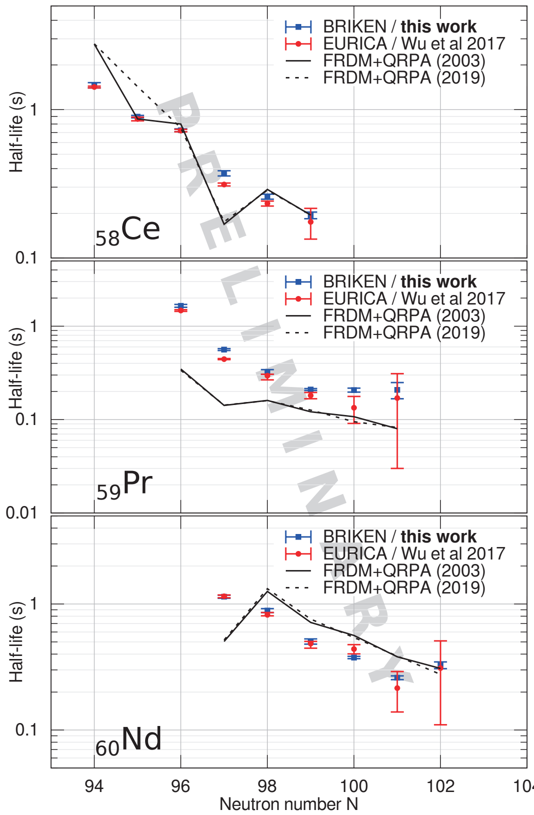

Fig. 1. Systematic trends in BRIKEN results of β-decay half-lifes (blue) compared with previous measurements (red),[7)] and theoretical calculations.[8,9)]

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