Evolution of collectivity in Ti isotopes towards the $N = 40$ island of inversion

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Over the past decade, significant efforts on both the experimental and theoretical fronts have focused on the development of nuclear collectivity in exotic isotopes around $N = 40$. It was revealed that the new island of inversion, where the intruder configuration is strongly favored in the ground state, at $N = 40$ is centered around ^{64}Cr.[1,2] It is then interesting to question whether this enhanced collectivity established in the region around the Fe and Cr isotopes presents itself in exotic systems with fewer protons, namely, Ti isotopes. Several theoretical calculations[2–6] show the difference in the reduced transition rates, $B(E2; 0^+ \rightarrow 2^+)$ values, for neutron-rich Ti isotopes beyond ^{56}Ti when considering different model spaces. Although the energies for the first 2^+ state are consistent and agree with experimental data, the $B(E2)$ values differ, depending on whether the gd shell is included in the calculations. This suggests that the boundary of the island of inversion is located between ^{56}Ti and ^{58}Ti. To answer these questions, the Coulomb excitation of ^{56,58}Ti was measured.

The experiment was conducted at the RIBF as a part of the HiCARI campaign. A ^{70}Zn primary beam with a maximum intensity of 600 particle nA was accelerated to 345 MeV/nucleon and impinged on a 11-mm-thick ^{9}Be primary target to produce a secondary beam for ^{56,58}Ti. The beam fragments were separated and identified by the BigRIPS using the standard $\Delta E{-}\mathrm{TOF}{-}B\rho$ method. The secondary beam impinged on a 1-mm-thick Au target to induce a Coulomb excitation reaction. A 3-mm-thick Be target was also used to determine the nuclear contribution to the excitation. The reaction residuals were identified by the ZeroDegree spectrometer. De-excitation γ rays were detected by the HiCARI array[7] at the F8 focal plane. The preliminary particle identification plots are shown in Fig. 1. Tails will be removed by further analysis.

Currently, the data are under analysis. The preliminary Doppler-corrected energy spectra show the clear transition peaks at known energies of the first 2^+ state in both ^{56,58}Ti. Moreover, candidates of peaks are found in coincidence with the one-neutron knockout channel from ^{56,58}Ti, which will reveal the configuration of the ground-state wave function of these nuclei.

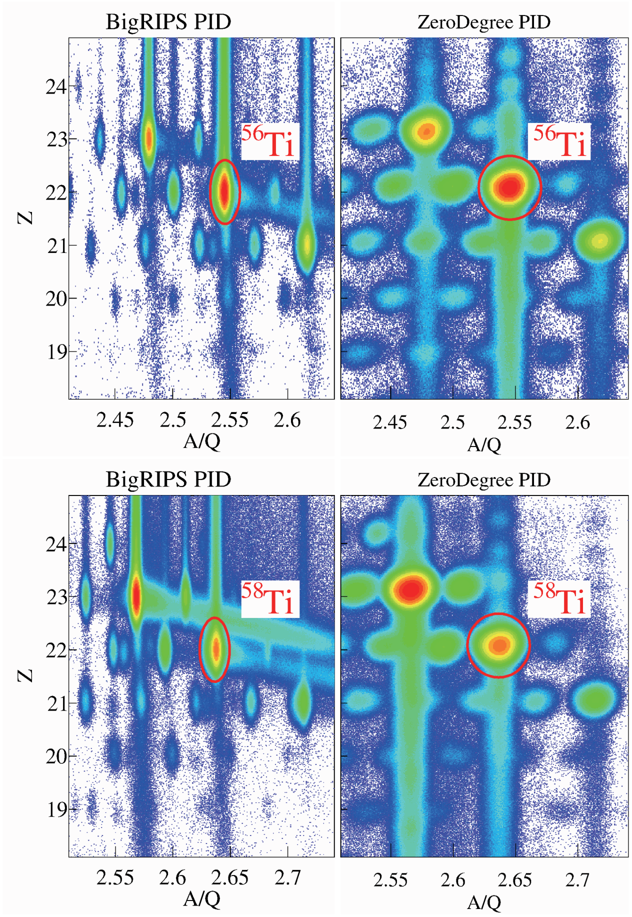

Fig. 1. Particle identification plots for both the incoming beam and outgoing residuals. The top panel shows the ^{56}Ti setting and the bottom the ^{58}Ti setting.

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