RIBF experimental program in TRIP project

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RIKEN Transformative Research Innovation Platform of RIKEN platforms (TRIP) project began from FY2023. RIKEN will build a next-generation research DX platform by accumulating and integrating high-quality data to connect all platforms of RIKEN. Through new initiatives, RIKEN will pioneer the "prediction and control science for the future" beyond the boundaries of individual fields and facilitate for social change within the broader domestic and international community.

The TRIP use case "Prediction and control of the transmutations of elements" is aimed at the social implementation of unstable nuclear physics, particularly in medical RI and nuclear waste, through acquisition of RI Beam Factory (RIBF) experimental data and theory development. This use case comprises three tasks: automation of accelerator experiments, acquisition and share of experimental data, and development of unstable nuclear theory. The automation of accelerator experiments, involves the digitization of instruments and efficient operation of accelerators and experimental devices using a feedback control based on machine learning. For acquisition and share of experimental data, we plan to systematically measure nuclear reactions at RIBF and consequently share the data with users. AI techniques and quantum computers will be used to develop unstable nuclear theory in the RI-beam region. This report is focused on the task of acquisition of experimental data.

In the TRIP use case "Prediction and control of the transmutations of elements," we plan to perform the following experimental programs: measurement of elastic scattering anytime anywhere any-beam (MESA), symbiotic systematic and simultaneous cross-section measurements for all over the nuclear chart (S^3CAN), and gamma-ray tracking in R5 for germanium clusters array (GT-5). These experimental programs are complementarily related, and information such as optical potential and nuclear radius will be obtained by performing each measurement on the same nuclei. The measurements will be systematically performed on nuclei that are relatively close to the stable line. A brief description of each program is given below.

MESA: The elastic scattering of RI beams in inverse kinematics will be measured. In particular, reaction data with protons, deuterons, α-particles to unstable nuclei will be systematically obtained. For proton and deuteron elastic scattering, a new ΔE-ΔE-E type telescope array will be used.[1)] However, for α elastic scattering, a time-projection-chamber will be newly installed.

S^3CAN: The interaction cross section of the RI beam will be measured. As targets, hydrogen, deuterium, and carbon targets will be used. The measurement method is similar to that presented Ref. 2).

GT-5: A new tracking-type germanium detector will be installed to obtain data on bound excited states of unstable nuclei. The Ge detector is a quad-type 36-fold segmented detector, which is the same type of detector as that used in the HiCARI campaign.[3)]

For conducting these experimental programs, cryogenic target systems will be installed to obtain data with a good signal-to-noise ratio. In addition, the data acquisition system of RIBF is being upgraded for highly efficient measurements. The first TRIP experiment is scheduled in March 2024.

References

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