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Feasibility Simulation of Spin-Controlled Radioactive Ion Beams Production for g-factor measurement at HIRIBL, HIAF.

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The High-Intensity Heavy-Ion Accelerator Facility (HIAF), developed by the Institute of Modern Physics (IMP), is scheduled to operate by the end of 2025. HIAF comprises a superconducting linac, a booster ring, a spectrometer ring, and a High-rigidity Radioactive Ion Beam Line (HIRIBL) connecting these two rings [1]. HIRIBL is an in-flight projectile fragment separator designed to produce purified radioactive ion beams (RIBs) through a two-stage separation process: a pre-separator and a main separator [2]. The upstream accelerator complex provides HIRIBL with a $^{238}U^{35+}$ beam at an energy of 833 MeV/u with an intensity of 1×10^{11} particles per pulse (PPP).
This facility makes it possible to produce spin-controlled RIBs by a two-step projectile fragmentation (PF) mechanism [3], providing unique opportunities for g-factors measurement. Measurements of g factors can help to assign or confirm the spin and parity of a nuclear state, especially in far-from-stability regions, where such assignments are often based on systematics and theoretical predictions.
Since it is the first time to perform such an experiment at the new facility, a simulation work is demanded and important to evaluate the feasibility of producing polarized RIBs at HIRIBL. To do the simulation, LISE++ and MOCADI are employed. A $^{238}U^{35+}$ primary beam is designed to impinge on a Carbon target. The pre-separator of HIRIBL is used to separate the fission products and select ^{132}Sn, which subsequently undergoes projectile fragmentation on a wedge-shaped Aluminum target to produce spin-aligned ^{130}Sn. LISE++ is used to calculate the transmission and yields of fragments produced and collected, including the optimization of the primary target thickness, degrader thickness, and slit width [4]. Additionally, it provides rapid estimations of the transmission efficiency and yield of various isotopes based on first-order beam optics transfer matrices. The MOCADI program is also employed to perform transport calculations of RIBs, incorporating third-order transfer matrices generated by the GICOSY program. This allows for detailed tracking of beam particle properties at any point within the optical system and provides a more realistic representation of particle beam dynamics compared to LISE++ [5].
The simulation results show that the obtained ^{130}Sn yield achieves the expected goals, confirming the feasibility of producing spin-controlled RIBs at HIRIBL and providing valuable guidance for experimental design.

Reference

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