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Research on Time-Resolved Prompt Gamma Neutron Activation Analysis Based on Back-n Facility

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Time-Resolved Prompt Gamma Neutron Activation Analysis (T-PGAA) is an innovative nuclear analytical technique that combines the advantages of Neutron Resonance Capture Analysis (NRCA) and Prompt Gamma Activation Analysis (PGAA). It exhibits high sensitivity and exceptional isotopic resolution capabilities. T-PGAA holds significant potential in diverse fields such as lunar soil analysis, nuclear leakage tracking, and cultural heritage archaeology. However, the technology remains in its developmental stage, with challenges persisting in data analysis methodologies and system optimization. The Back-n beamline at the China Spallation Neutron Source (CSNS) provides a neutron beam characterized by a broad energy spectrum, high flux intensity, and superior energy resolution, making it an ideal platform for T-PGAA research. In December 2023, an experiment was conducted using a natural lutetium (Lu) target irradiated by neutrons from the Back-n beamline. High-purity germanium detector (HPGe) were employed to measure prompt gamma rays emitted from neutron-induced interactions. By correlating neutron energy derived from time-of-flight (TOF) measurements with characteristic gamma rays and neutron resonance signatures, the isotopic composition and quantitative analysis of the target were achieved. The experimental data underwent systematic processing, including detector calibration, identification of characteristic nuclides, and content analysis. The results confirmed the relative abundance of two isotopes in the Lu target, thereby validating the feasibility of T-PGAA methodology on the Back-n beamline. Additionally, the performance of the detector and data acquisition systems was rigorously tested. This study establishes a foundational framework for analyzing T-PGAA experimental data and paves the way for refining analytical methods.

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