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Advancing the Measurement of Short-Lived Nuclei via Flowing Sample Neutron Activation for Elemental Analysis and Fission Yield Studies

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Neutron activation analysis of short-lived radionuclides offers numerous advantages including high sensitivity, rapid turnaround, and minimal sample handling, making it an invaluable tool for various applications. To leverage these strengths, our team at ETRR-2 has developed Flowing Sample Neutron Activation Analysis (FS-NAA), a continuous-flow system that circulates liquid samples between a neutron irradiation port and a high-purity germanium detector, enabling in-line measurement of radionuclides with half-lives from seconds to hours.

Key achievements of FS-NAA include:
•Detection of short-lived isotopes (e.g., In-116m2, F-20, Al-28, Na-24, V-52, Se-77m) using 252Cf source.
•Enhanced sensitivity under reactor irradiation, enabling measurement of low-cross-section nuclides such as O-19 (via O-18(n,γ)O-19).

Operational advantages of FS-NAA:
Simplicity: It relies on a straightforward pump and tubing loop with standard irradiation and detection components, where no complex pneumatic lines, motorized changers, or specialized shielding. This arrangement minimize the installation time, cost, and maintenance.
Stability of Detector Dead Time: Continuous sample renewal maintains a nearly constant count rate, virtually eliminating dead-time fluctuations and reducing the need for post-acquisition corrections, thus improving quantitative accuracy and reproducibility.
Flow-Rate Adjustability: Tunable pump speed optimizes the irradiation and counting times: high flow-rates minimize decay losses for ultrashort-lived nuclides, while slower flow maximizes buildup for longer-lived species, making FS-NAA adaptable across a broad half-life spectrum.

Concurrently, we are conducting an evaluation of U-235 fission yields under the IAEA CRP F42007 project; our findings are under review at Physical Review C. Building on FS-NAA's versatility, future work will apply this technique to the real-time measurement of very short-lived fission fragments in aqueous media, opening a novel experimental pathway for characterizing neutron-induced reactions on isotopes with sub-minute half-lives.

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