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Towards a Fieldable Atomic Mass Spectrometer for Safeguards Applications: Sample Preparation and Ionization

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The International Atomic Energy Agency's (IAEA) long-term R&D plan calls for the development of new methods to detect misuse at nuclear fuel cycle facilities such as reprocessing and enrichment plants. At enrichment plants, for example, the IAEA's contemporary safeguards approaches are based on a combination of routine and random inspections that include collection of UF6 samples from in-process material and selected cylinders for subsequent destructive analysis (DA) in a laboratory for isotopic characterization, and environmental sampling (ES) for subsequent laboratory elemental and isotopic analysis (both typically by MS). One area of new method development includes moving this kind of isotope-ratio analytical capability for DA and ES activities into the field. Reasons for these developments include timeliness of results, avoidance of hazardous material shipments, guidance of additional sample collecting, etc. However, there are several reasons why this capability does not already exist, such as most lab-based chemical and instrumental methods rely on laboratory infrastructure (highly trained staff, etc.) and require significant amounts of consumables (power, compressed gases, etc.). In addition, there are no currently available, fieldable instruments for atomic or isotope ratio analysis. To address these issues, Pacific Northwest National Laboratory (PNNL) is studying key areas that limit the fieldability of isotope ratio mass spectrometry for atomic ions: sample preparation and ionization, and reducing the physical size of a fieldable mass spectrometer. PNNL is seeking simple and robust techniques that could be effectively utilized by non-technical inspectors. In this report, we present and describe the preliminary findings for three candidate techniques: atmospheric pressure glow discharge, laser ablation/ionization MS at atmospheric pressure, and matrix assisted laser desorption ionization MS. Potential performance metrics for these techniques will be presented, including: detectability, response, isotope ratio accuracy and precision, and ease of use.

Country or International Organization

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Primary author: BARINAGA, Charles (Pacific Northwest National Laboratory / Battelle Memorial Institute)

Co-authors: MANARD, Benjamin (Clemson University); KOPPENAAL, David (PNNL); HART, Garret (PNNL); HAGER, George (PNNL); MARCUS, R. Kenneth (Clemson University); JONES (HARRIS), Sarah (Clemson University)

Presenter: BARINAGA, Charles (Pacific Northwest National Laboratory / Battelle Memorial Institute)

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