Prototype Demonstration of Gamma-Blind Tensioned Metastable Fluid Neutron / Multiplicity / Alpha Detector - Real Time Methods for Advanced Fuel Cycle Applications

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ABSTRACT

The importance of the nuclear fuel cycle continues to rise on national and international agendas. The U.S. Department of Energy is evaluating and developing advanced methods for safeguarding nuclear materials along with instrumentation in various stages of the fuel cycle, especially in material balance areas (MBAs) and during reprocessing of used nuclear fuel. One of the challenges related to the implementation of any type of MBA and/or reprocessing technology (e.g., PUREX or UREX) is the realtime quantification and control of the transuranic (TRU) isotopes as they move through the process. Monitoring of higher actinides from their neutron emission (including multiplicity) and alpha signatures during transit in MBAs and in aqueous separations is a critical research area. By providing on-line realtime materials accountability, diversion of the materials becomes much more difficult.

Since 2008, investments from the U.S. Department of Energy, U.S. Department of Defense, and the National Science Foundation have enabled proof-of-principle demonstrations for a novel, transformational mode of monitoring for special nuclear materials. The Tensioned Metastable Fluid Detector (TMFD) is a transformational technology that is uniquely capable of both alpha and neutron spectroscopy while being "blind" to the intense gamma field that typically accompanies used fuel – simultaneously with the ability to provide multiplicity information as well. The TMFD technology was proven (lab-scale) as part of a 2008 NERI-C program and it is time to engineer prototype detectors to develop and evaluate applications in real-world fuel cycle scenarios.

The goals of this project are:

1. ***Design and Establish*** prototype TMFD systems that will be capable of real time neutron/alpha/multiplicity signature measurements for special nuclear materials (SNMs) in general and in process fluids in a reprocessing stream.
2. ***Characterization*** of the performance of TMFD prototypes against known standards and procedures to quantify their performance in comparison to alternative measurement techniques.
3. ***Demonstrate*** the efficacy of these systems for measuring SNMs from their neutron, multiplicity and alpha signatures at available facilities to ascertain their transformational impact on improvements over the state-of-art safeguards/security methods; these facilities may include university radiation laboratories and research reactors, US-DOE laboratories, commercial nuclear installations, and/or a reprocessing plant such as that operated in La Hague, France.