

Proposal Title

Active Interrogation using Photofission Technique for Nuclear Materials Control and Accountability

Final Technical Work Scope Identification

Work Scope FC-5: Materials Protection, Accountancy, and Controls Technologies

Proposed Scope Description

Innovative systems with increased sensitivity and resolution are in great demand to detect diversion and to prevent misuse, in support of nuclear materials management for the U.S. fuel cycle. Nuclear fission is the most important multiplicative process involved in non-destructive active interrogation. This process produces the most easily recognizable signature for nuclear materials. In addition to thermal or high-energy neutrons, high-energy gamma rays can also excite a nucleus and cause fission through a process known as photofission. Electron linear accelerators (LINAC) are widely used as the interrogating photon sources for inspection methods involving photofission technique.

In photofission reactions, four types of radiation can be used as signature signals for material identification and quantification: prompt photons, prompt neutrons, delayed photons and delayed neutrons. Although prompt signals are much stronger than the delayed signals, it is difficult to quantify them in practical measurements. The reason is that they tend to be buried by the much more intense probing radiation. Delayed signals are emitted seconds or even minutes after the photon irradiation, thus much easier to be distinguished from the interrogating radiation. LINAC-based, advanced inspection techniques utilizing the delayed signals after photon induced fission have been extensively studied for homeland security applications. Previous research also showed that a unique delayed gamma ray energy spectrum exists for each fissionable isotope. Isotopic composition measurement methods based on delayed gamma ray spectroscopy will be the primary focus of this project. The overarching objectives of this project are the following:

- Study active interrogation methods based on delayed photons emitted after photon induced fission; Investigate the feasibility to utilize photofission technique for direct plutonium measurement in spent fuel
- Design and set up an active interrogation system based on photofission technique; optimize the design with guidance from simulation study
- Develop and test high throughput spectroscopy systems using innovative signal processing techniques
- Evaluate the performance of the developed interrogation system with nuclear material samples; Contribute to the photofission database using high accuracy measurement results