Introduction and Motivation

• Photon active interrogation can induce photonuclear reactions in HEU to produce more detectable signatures compared to passive detection.
• **Goal:** Develop high-confidence techniques to detect prompt photofission neutrons in active interrogation scenarios.
• **Expected Impact:** This project will demonstrate the ability to use prompt photofission neutron signatures and organic scintillators to detect special nuclear material.

Mission Relevance

• Active interrogation systems support the detection of concealed special nuclear material.
• Increasing the deployability of active interrogation systems will improve the ability to interdict illicit special nuclear material.

Technical Approach

• **Experiments:** Interrogate depleted uranium (DU) with a 9-MeV linear accelerator (linac, Fig. 1), detect prompt photofission neutron signatures with stilbene organic scintillators.
• **Analysis:** Pulse shape discrimination (PSD) by charge integration (Fig. 2) with time-gating to measure only prompt neutrons emitted during a linac pulse.

Results

• **5.08-cm cylinder stilbene:** Detector overwhelmed, causing significant signal loss via pulse pile-up. No defined neutron band in the PSD plot (Fig. 3).
• **0.6-cm cube stilbene:** Pile-ups are successfully cleaned from the collected data. Sparse neutron band (Fig. 4). Net neutron count rate >2σ above active background within 5 minutes of measurement (Fig. 4-5).

Reference:


MTV Impact

• Networked with MTV-associated national lab researchers
• Workshop presentations solicited feedback from subject matter experts
• Organized collaborative experimental campaigns

Conclusions

• Reducing detector size reduces pile-up rate, significantly improving fast neutron detection capability during active interrogation.
• Arrays of small-volume detectors can detect prompt photofission neutrons in the active interrogation environment.
• Next Steps: Analyze stilbene data with machine learning-based algorithm. Investigate silicon photomultiplier arrays use.