

Imaging Highly Enriched Uranium Sample with Active Interrogation

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Dual-Particle Imaging System for Standoff Detection of Special Nuclear Material

GOALS & OBJECTIVES

- Detection and imaging highly enriched uranium (HEU) sample at the Device Assembly Facility (DAF) located at the Nevada
- HEU is hard to detect due to low energy gamma rays and low neutron emission rates
- Actively interrogate HEU with neutrons in order to image neutron and gamma ray signal from HEU fissions

MEASUREMENT RESULTS



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DUAL-PARTICLE IMAGING SYSTEM

- The Dual-Particle Imager (DPI) is a combined Compton-scatter and neutron-scatter camera being designed for the detection of SNM.
- Use imaging reconstruction techniques allows for simultaneous reconstruction of images and locationdependent energy spectra.



Fig. 1. Schematic of the DPI with common neutron and photon interaction

Fig. 5. Reconstructed HEU images driven by four AmLi sources: neutron image (left) and photon (right).



Fig. 4. Reconstructed neutron images: DT generator only (left) and HEU (right). Red squares signify the DT location.

paths. Cross-sectional view of the back plane detector pattern is shown on the right.

MEASUREMENT SETUP

- Three different interrogating sources with HEU sample: 1) DT generator, d(t,n)⁴He, 14.1 MeV, ~1×10¹¹ neutrons/second (isotropic) with the HEU sample located at (90°, 85°) (Fig. 2.) 2) DD generator, d(d,n)³He, 2.5 MeV, ~1×10⁸ neutrons/second (isotropic) with the HEU sample located at $(90^{\circ}, 85^{\circ})$
 - 3) HEU sample located at (90°, 85°) surrounded by four $\sim 1 \times 10^6$ neutrons/second AmLi sources (Fig. 3.)
- ~1.5-m standoff for HEU sample
- DT generator: 287,000 photons, and 768 neutrons measured
- AmLi sources: 1,800,000 photons, and 26,000 neutrons measured





CONCLUSIONS

- The DPI was able to detect and locate actively interrogated HEU sample
- Using veto signal from the DT generator give us possibility to distinguish neutrons from HEU fission and DT generator itself
- Clear neutron and photon signal from HEU sample was obtain in the case when it with was driven by four AmLi sources

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 - North Carolina State University: Pete Champan, John Mattingly
 - Oak Ridge National



Fig. 2. Location of the HEU sample and DT generator relative to the DPI.

Fig. 3. Location of the HEU sample and AmLi sources relative to the DPI. Laboratory: Jason Newby

Princeton University: Ben Reimold, Sebastien Philippe, Alex Glaser



Fig. 6. Participating members of 2016 DAF Campaign.



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