

# Technology for Disarmament Verification

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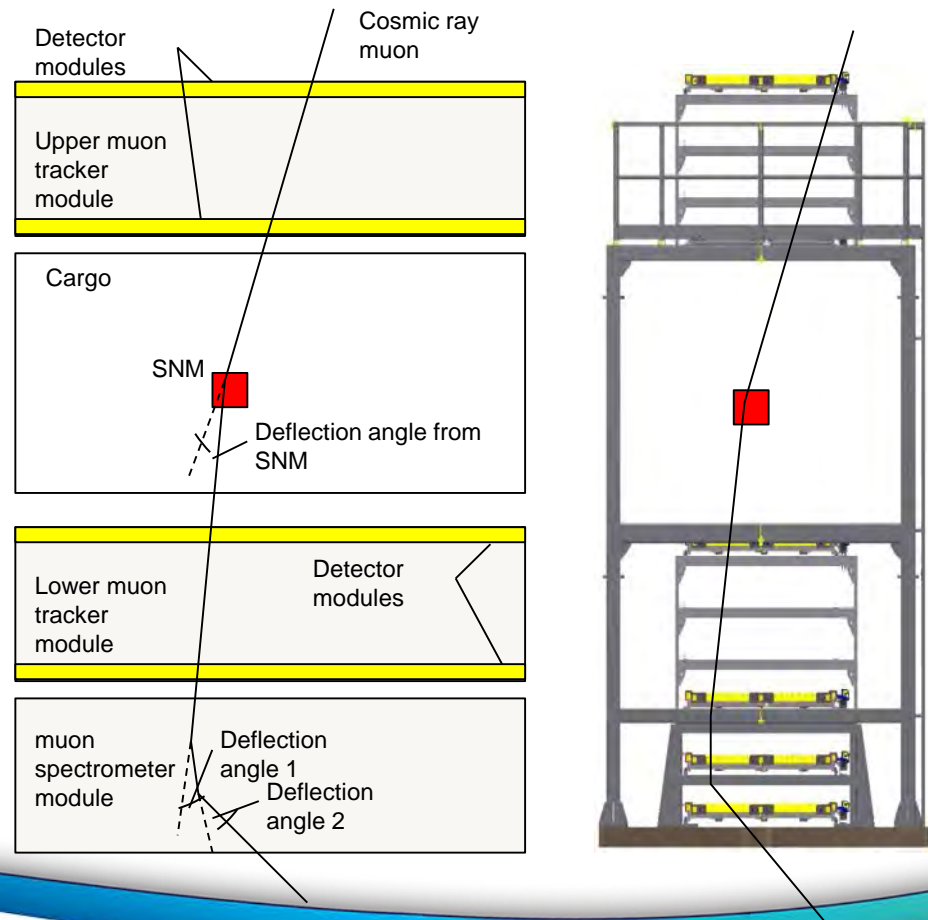
IPNDV WG3 Meeting, Geneva, 2016 Feb 18-19



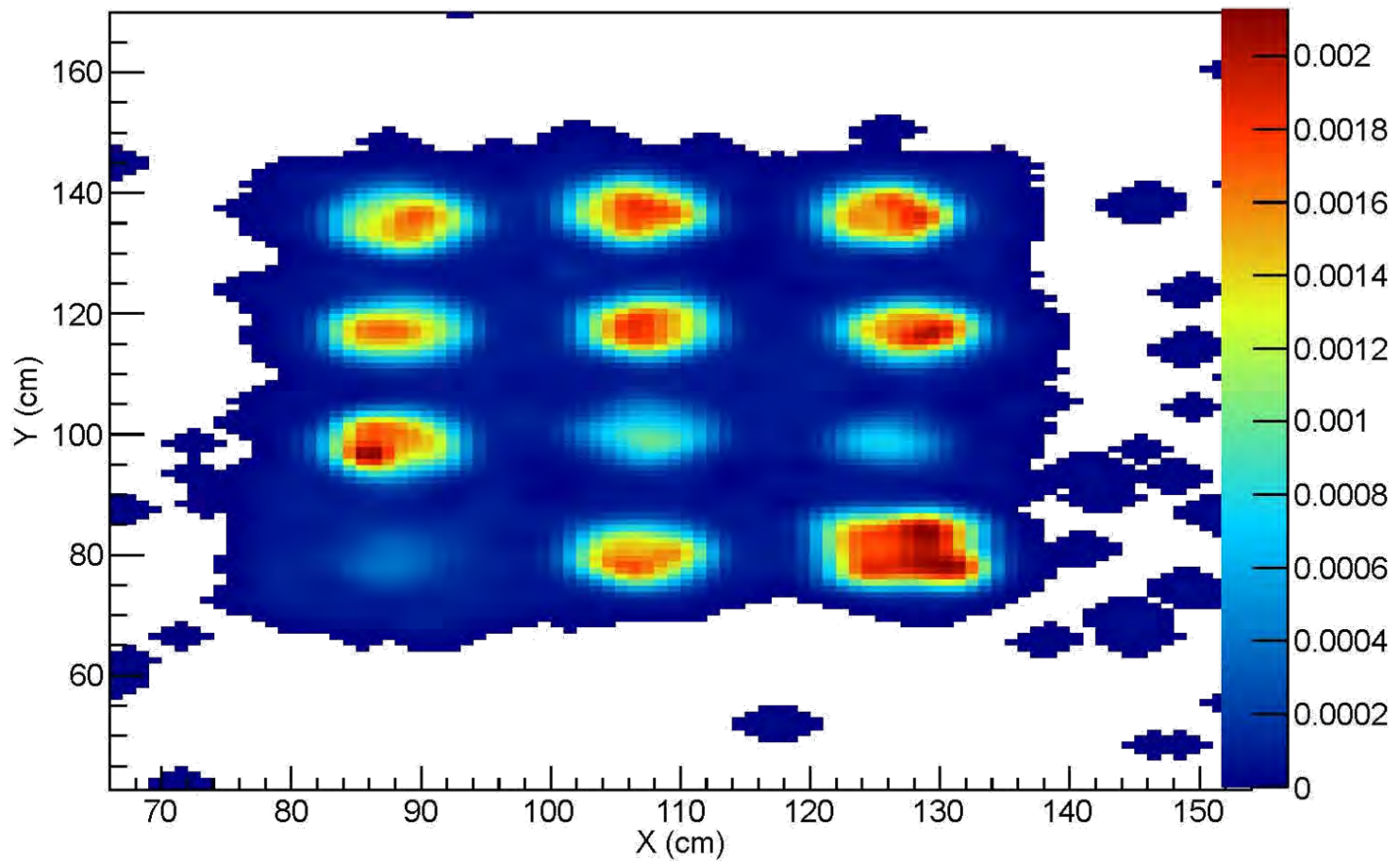
Reference: V. Anghela et al, "A plastic scintillator-based muon tomography system with an integrated muon spectrometer", Nuclear Instruments and Methods, vol. 798, 21 October 2015, pp. 12–23

# 1. Muon Tomography

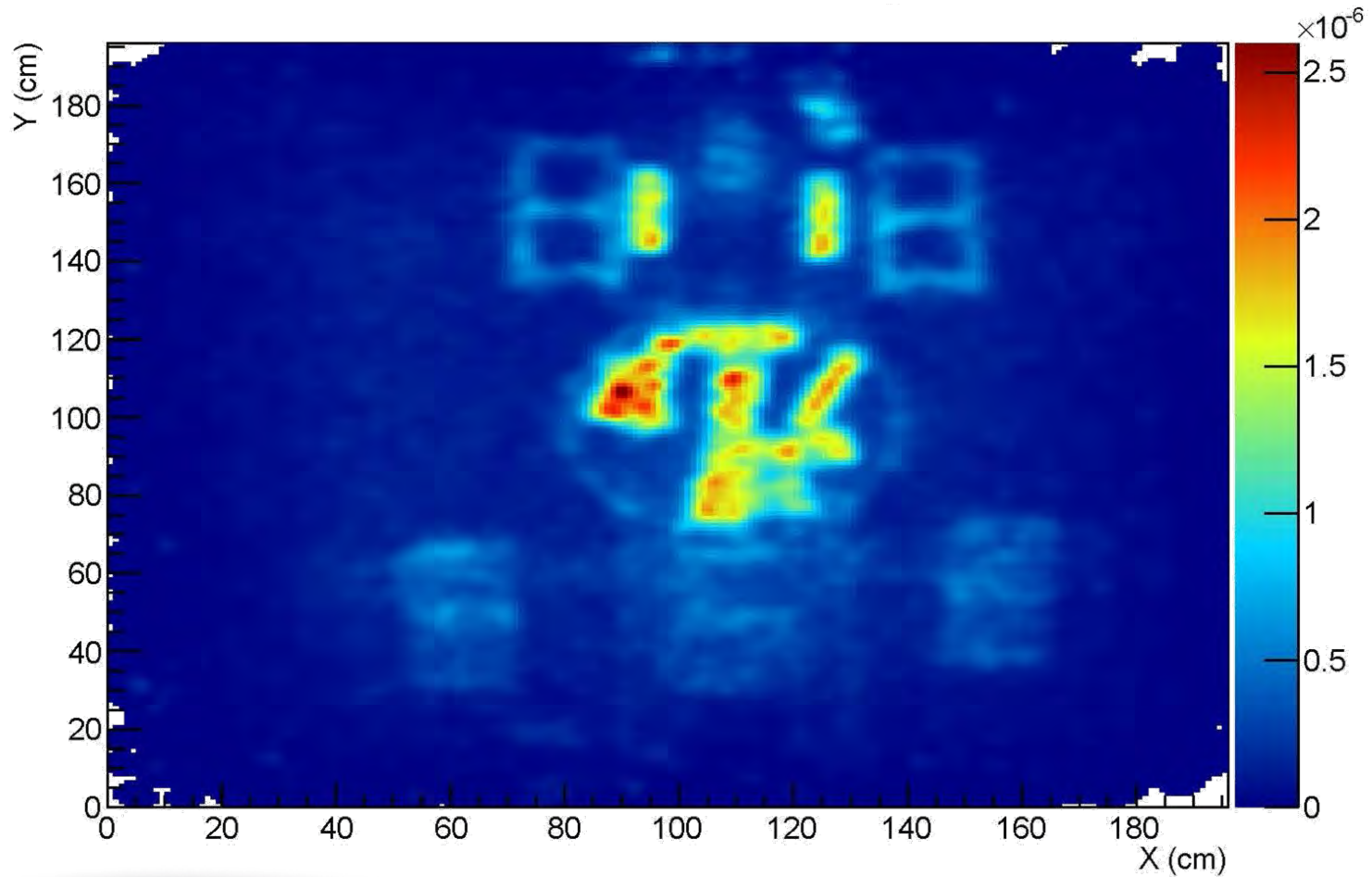
- Usage: verification of storage of nuclear material, or non-nuclear material.
- Utilizes muon flux from upper atmosphere: available at any location, essentially unshieldable.
- Verifies presence of high-Z material, geometry (resolution dependent upon collection time)
- Prototype stage – can be made portable



## 8 NU fuel bundles, 3 dummy bundles, 1 lead stack

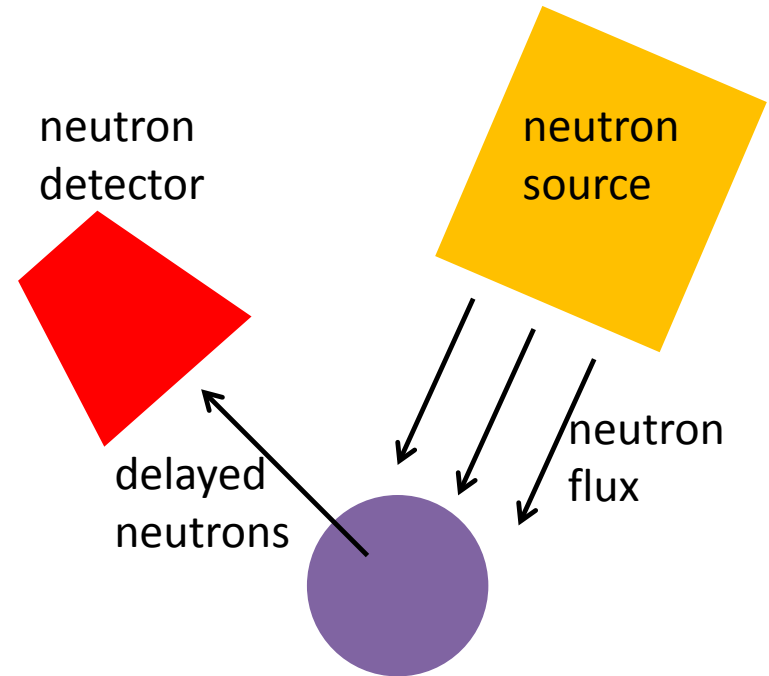


## Drum filled with lead bricks + one NU fuel bundle



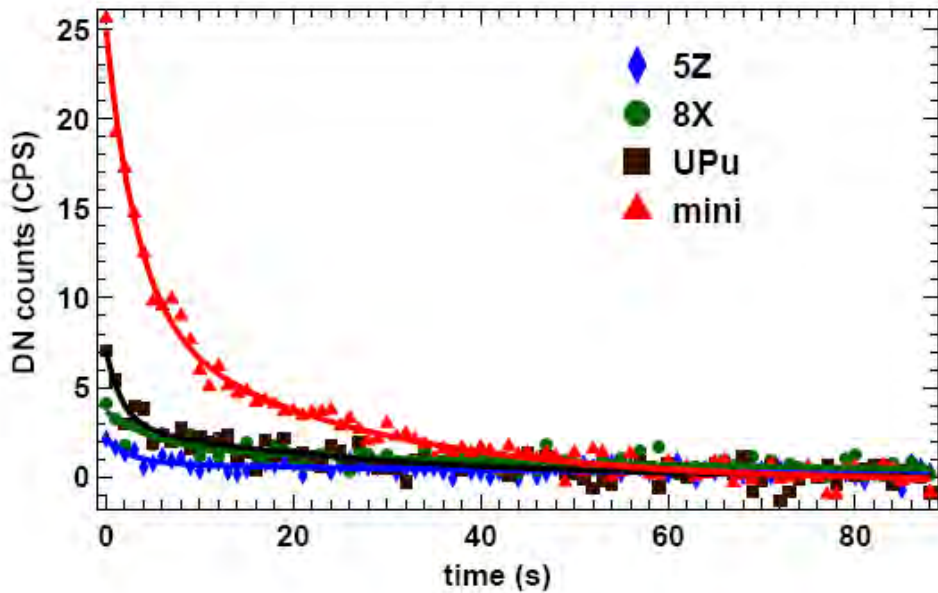
## 2. Active Neutron Interrogation with Delayed Neutrons

- Usage: verification of nuclear material
- Exposes sample to intermittent neutron flux, and records resulting decay of delayed neutrons (if nuclear material present) – works through shielding material
- Sensitivity dependent upon time of irradiation and efficiency of neutron detector – can be limited to elemental analysis only if needed.
- In use at NRU reactor (Chalk River) – can be made portable with neutron source



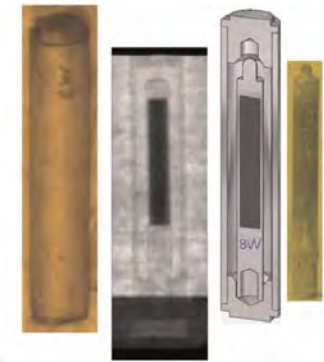
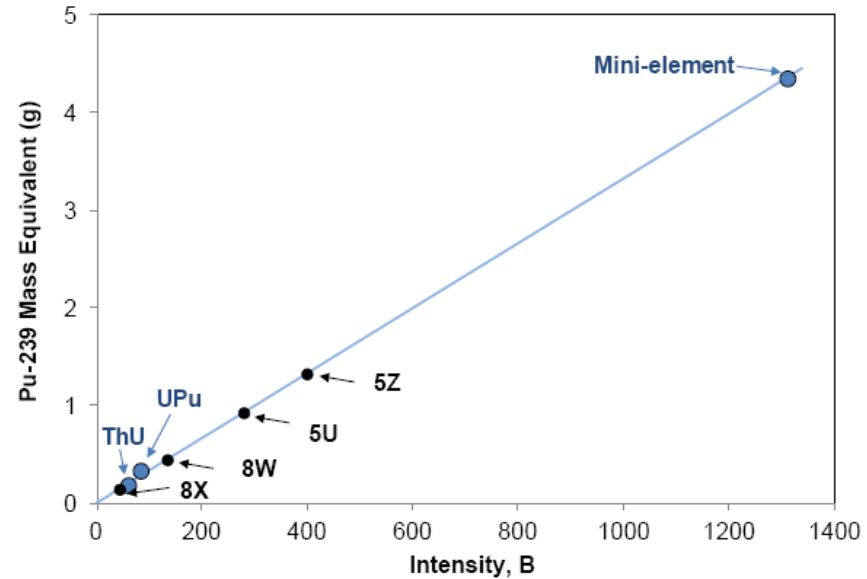


## Decay of delayed neutron source:



Reference: R. B. Rogge, G. Bentoumi, F. (Ike) Dimayuga, R. Flacau, G. Li, L. Li, and B. Sur, "Non-Destructive Examination Using Neutrons: A Nuclear Waste and Orphaned Source Characterization Case Study Applicable to Nuclear Forensics," CNL Nuclear Review, vol. 4, no. 2, December 2015

## Mass correlation:



# 3. Facilities for training, testing: CNL Chalk River Laboratories

- Full-scope nuclear laboratory
- Fuel development, hot cells, range of nuclear material (full range of U enrichment, Pu), radiation protection and dosimetry, nuclear security and response force.
- Wide range of fresh and waste nuclear material in storage, legacy materials, flask geometries
- NRU research reactor, neutron sources, neutron generator
- Expertise in detector modeling, development, testing, exercise development, analysis.

