CVT Workshop

Advanced Safeguard Tools for Accessible Facilities (Thrust Area #3)

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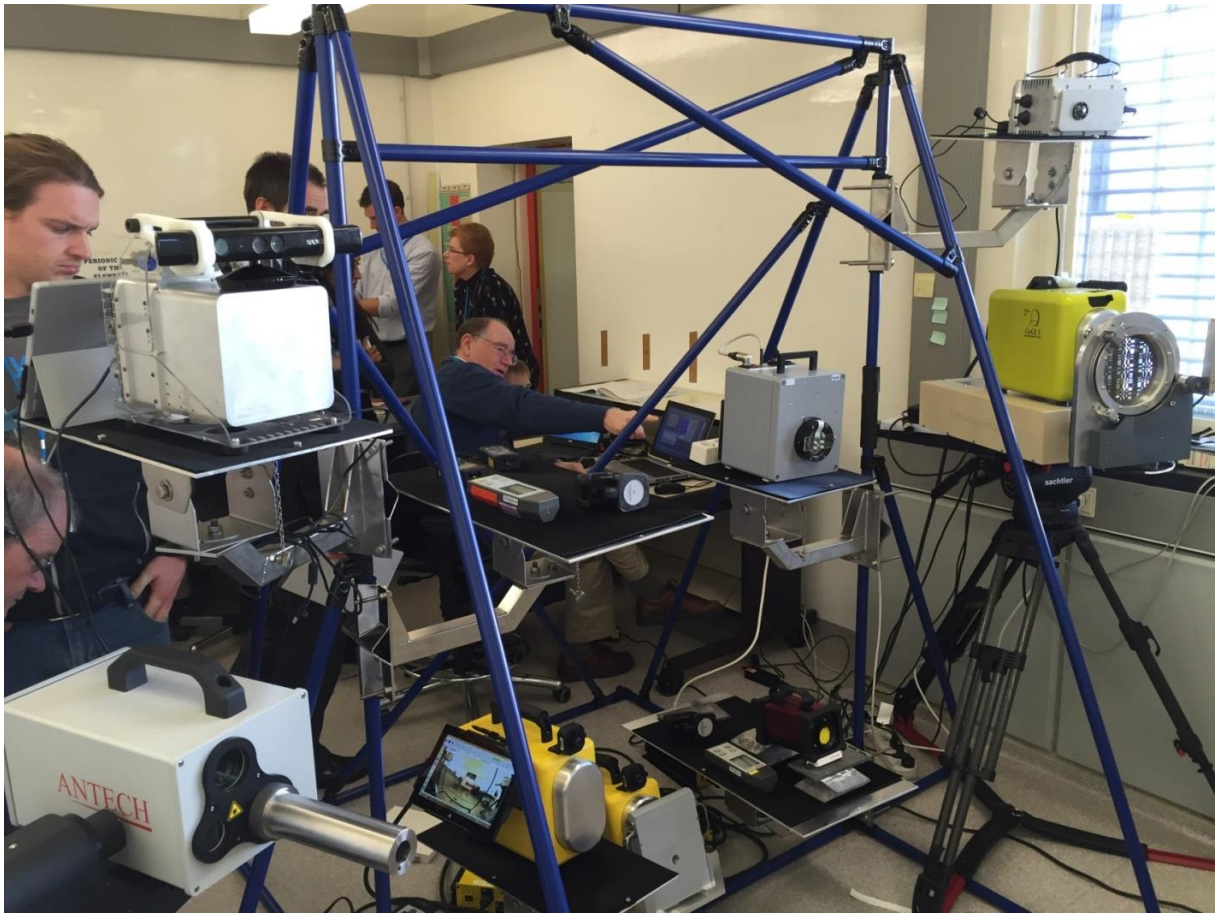
Zhong He
University of Michigan

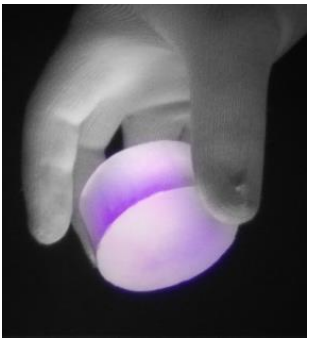
Learning the needs of IAEA

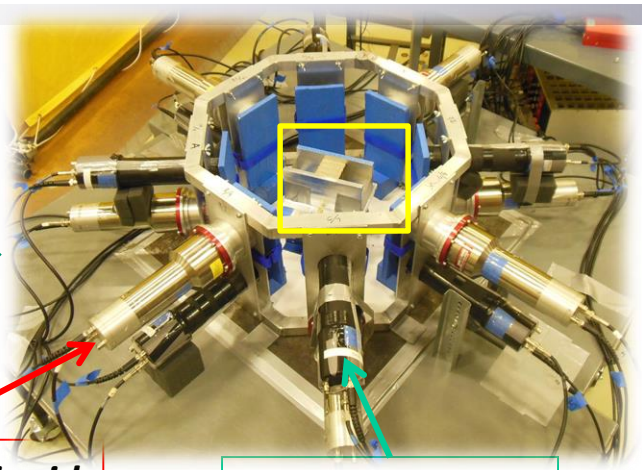
IAEA γ-Ray Imager Workshop during Oct. 19 – 23, 2015
Conf. on Nuclear Security and Safety during April 4 – 8, 2016

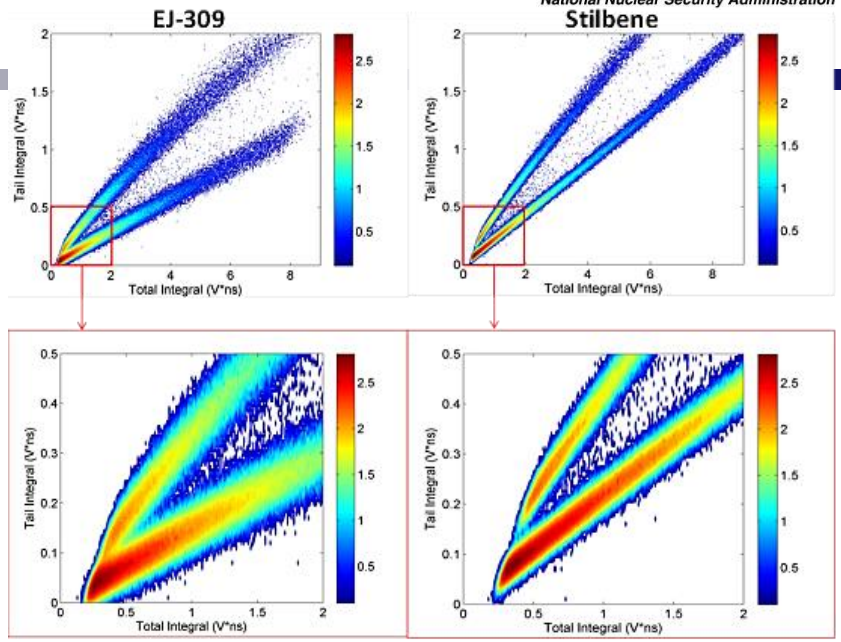


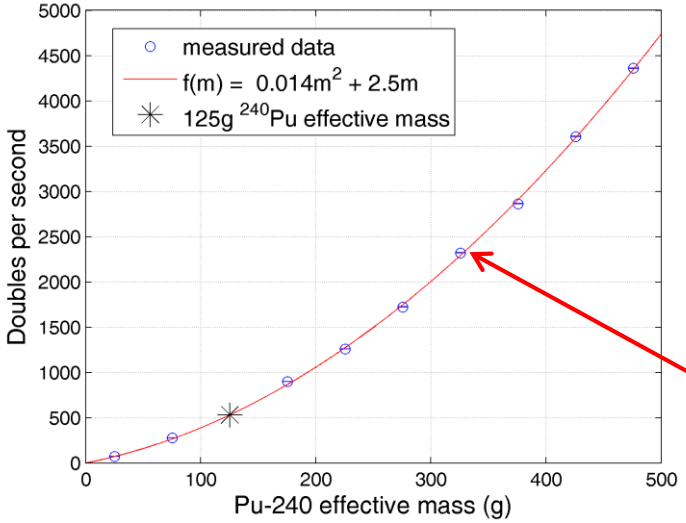
Fast-Neutron Multiplicity Counter

Stilbene crystal







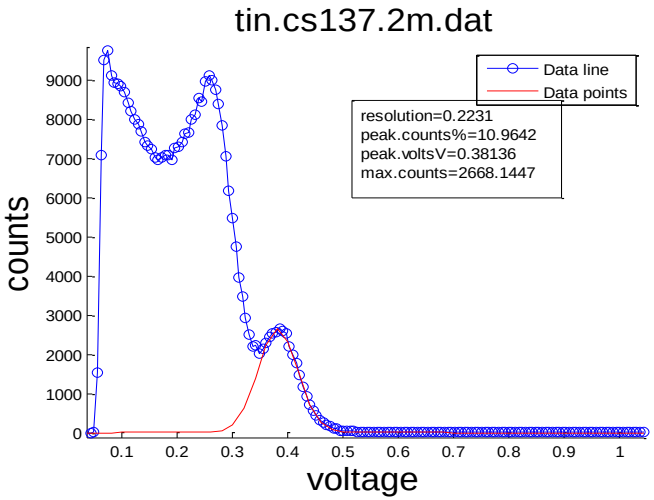


- Gamma-neutron discrimination (PSD) possible at lower thresholds (≈400 keV recoil proton energy) – **higher efficiency**
- Higher multiplicative samples yield a higher doubles count rate per unit single count rate – **more accurate measurement on Pu mass**
- Statistic uncertainty lower than 1% in 3 min (50g < ^{240}Pu mass < 500g) – **Faster measurement**
- Pu-240 mass estimated for unknown sample with max 2% 1SD combined uncertainty

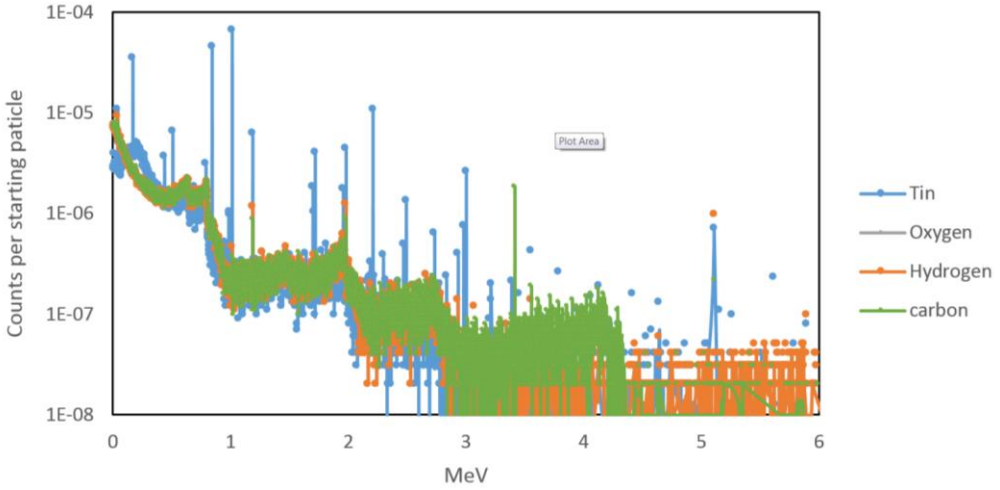
IAEA plans to replace He-3 based detectors with liquid scintillator FNMCs.

Capabilities for Shielded Nuclear Material Detection

- New detector compounds for detection of shielded nuclear material is being tested.
- Using Tin in organo-metallic compounds in a liquid scintillator allows for particle discrimination, photopeak behavior and eventually detector of low counts of fast neutrons, thermal neutrons and high-energy gamma rays that might escape shielded material.
- Gadolinium used for thermal neutron captures.



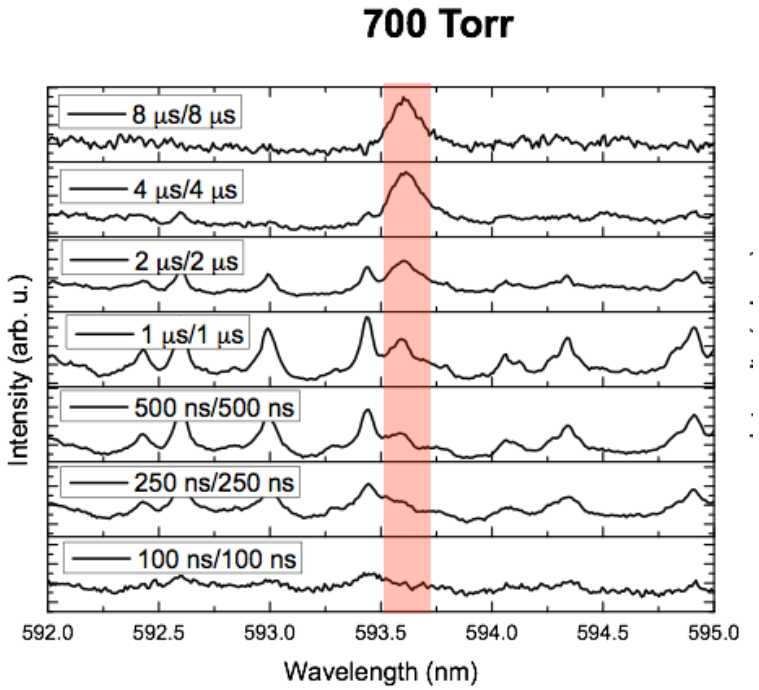
Cs-137 spectra with a moderate tin-loaded liquid scintillator. Photopeak behavior seen and useful for detector resolution characterization.

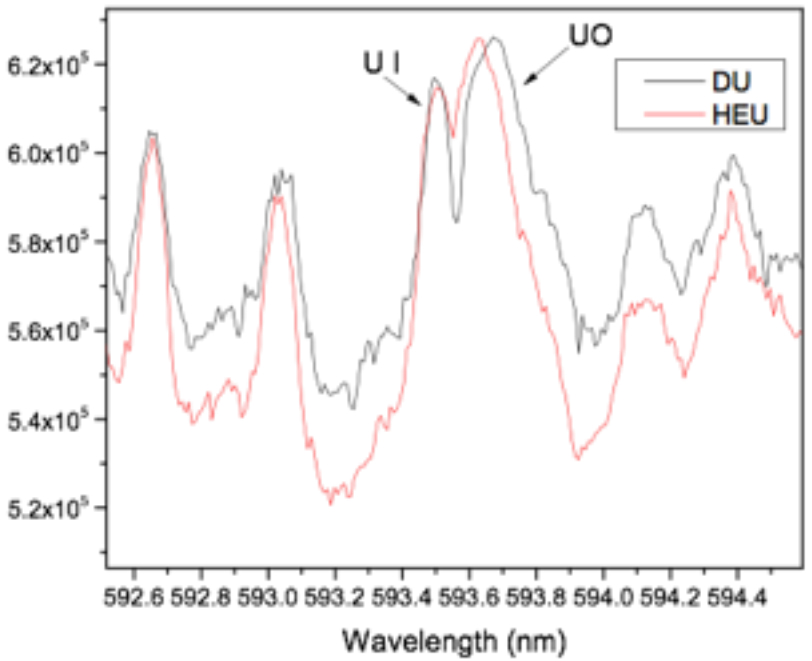


Gamma energy absorbed in a 3x3 cell of only one element. Most of the peaks come from the tin. The biggest peak that the tin detector has in common with ej-309 is the 3.4MeV peak from carbon and tin.

Standoff Detection of HEU by Femtosecond Filament Molecular Isotope Spectrometry

- Observation of molecular isotopic shift of U_xO_y produced in interaction of U with atmospheric oxygen
- Molecular isotope shift ~2x larger than the largest atomic isotope shift
- May enable standoff isotopically sensitive detection on kilometer scale

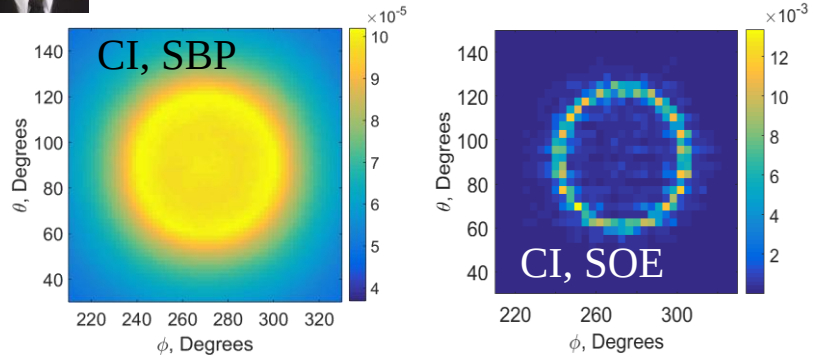




Kyle Hartig, Isaac Ghebregziabher, and Igor Jovanovic

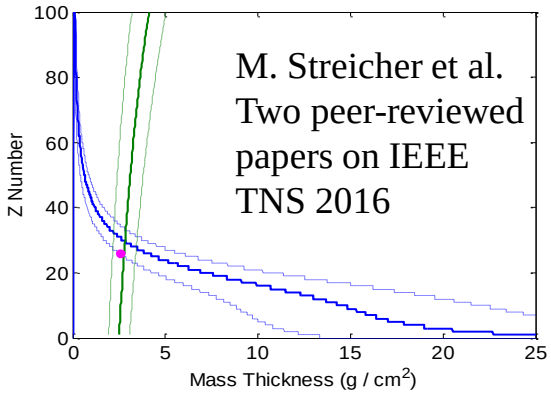
SNM Detection and Characterization using 3-D CZT Gamma-Neutron Detectors

Gamma Imaging in 3D, using Stochastic Origin Ensembles



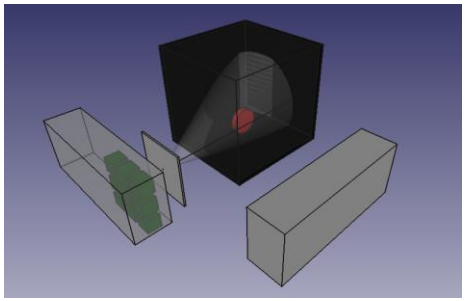
Simulated image reconstruction

Characterize shielding material



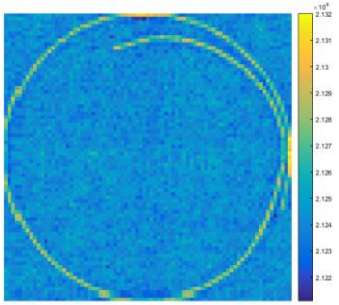
Fast neutron measurement at DAF

Quantitative measurement on SNMs



Measurements at Y-12 to determine UO_2 disk size, mass and enrichment

"Black-Box" Project



Thermal neutron imaging

Summary and Conclusions

- **The IAEA is in need of new systems and techniques to verify compliance with the Nonproliferation Treaty**
- **New techniques have been developed to capture unique signatures of SNMs**
  - Plutonium fuel plates were assayed using fast neutron multiplicity counting
  - HEU was distinguished from DU using LIBS-based molecular spectroscopy
  - Advancement on detection and characterization of SNMs using 3-D CZT high energy resolution imaging detectors
- **These techniques have the potential to improve the state-of-the-art in detection of nuclear material accounting and diversion**