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NEUTRON MULTIPLICITY DETECTION
AND OTHER UF ADVANCED
SAFEGUARDS CVT CONTRIBUTIONS
Metal Doped Liquid Scintillator

- Organic liquid scintillation based
- Tin-based dopants for high-Z component
- Improved gamma collection
- Increased energy deposition implications for neutron/gamma discrimination?
- Low-cost mass producible material
Tin Doped Liquid Scintillator

EJ-309

Tin ("original")

Tin ("new", alternative dyes)

$^{137}\text{Cs}$ spectrum powered at 1660V

- Small photo-peak behavior shown at <1% tin doping, resolution broadened for small sizes due to tin characteristic X-ray escapes (3-inch diameter shown)
Tin Doped Liquid Scintillator

EJ-309  Tin (“original”)

Cosmic Ray Contributions To Neutron Multiplicity Counting

- Large source of multiplicity background
- Strong MCNP-experiment agreement
- Potential source of semi-isotropic neutrons
- See poster #9 for details
High Throughput Data Processing

- Motivation: Data saturation from $\gamma$’s
- Real world application: spent fuel
- Reject pulses in the digitizer, before data transfer
- Using pulse accumulators in SIS3316-DT 16 channel digitizer:
Algorithm Development and Verification for Aerial Radiation Measurement Systems

- Use pre-existing knowledge of the world and additional real-time sensor information to augment radiation detection data to aid in detection, localization, and tracking of sources from aerial measurement platforms

Gardiner, et al, PNNL-SA-113710
To be presented at DNP 2015, October 28-31, Santa Fe, NM
Algorithm Development and Verification for Aerial Radiation Measurement Systems

- Compare current measurement to an estimate of the background via ratios of counts in large, possibly overlapping energy regions of interest. (NSCRAD)
- Look for statistically significant deviations from background in selected spectral windows
- Especially useful for low-count spectra, regardless of energy resolution
- Improve alarm thresholds (θ) and lower minimum detectable activity through improved ratio techniques

\[ \theta = m - \delta d \]

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CVT Associates & Related Efforts

- Pulse analysis methods for deuterated scintillation detectors
- Anisotropic fast neutron-detector interaction models
- Alternative medical isotope production paths (non-HEU/LEU alternative): C-11 production for PET scans

Simplified experimental setup with a DD-109X generator, a HPGe detector, and a sample control handler.
CVT Associates & Related Efforts (Cont’d)

• Computer vision & radiological sensor data fusion
• Neutron spectrum unfolding using high-density noble gas detectors
• Organic photodetectors as replacements to PMTs and Si-photodiodes
• $\text{BiI}_3$ Gamma-Ray Spectrometers for Enrichment Monitoring

Radiological/3D vision data fusion
Testbed design for organic photodetectors
Upcoming Enhancement to UF Research Capabilities

- LEIDOS SORDS (Stand-Off Radiation Detection System)
- Coded Aperture Imaging
- Mobile Research Platform
- Potential Research
  - Imaging and Detection Algorithms
  - New Detectors, Electronics, Active Masks
  - Image Fusion
  - Detection Limits
  - Variety of Nuclear Security, OSI, Interdiction, Treaty Verification Research

CVT Participants will be given access to this system.

System delivery expected in early 2016

Special Thanks to Rich Vojtech of DHS/DNDO for making this system available to UF
UF Metrics

• 4 students (1 Fellow and 3 Associates) spent summers at national laboratories
  – Robert Weinmann-Smith at LANL – Multiplicity Counters (LANL – Martin Swinhoe)
  – Hannah Gardiner – Aerial Radiation Measurement System Algorithm Development (PNNL – Mitchell Myjak and Cari Seifert)
  – Paul Johns and Christopher Greulich – Organic Photodetectors (PNNL – Warnick Kernan and Mary Bliss)

• Several Posters and Oral Presentations
  – SCINT 2015
  – SPIE
  – INMM
  – DNP
  – IEEE
  – ANS Winter Conference

Papers under preparation for NIMA, Nuclear Technology, and Physical Review