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INL and the Consortium for Verification Technology

INL Support in FY2016 and Capabilities and Resources for Future Support

October 2016

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Nuclear Nonproliferation Division
National & Homeland Security Science and Technology Directorate

Idaho National Laboratory

Our Mission

Discover, demonstrate and secure innovative nuclear energy solutions, other clean energy options, and critical infrastructure.

INL
Idaho National Laboratory

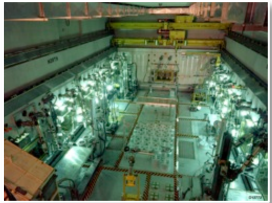
Our Vision

INL will change the world's energy future and secure our critical infrastructure.

Idaho National Laboratory

- ~4000 employees
- 890 square miles
- 111 miles of electrical distribution lines
- 579 buildings
- 177 miles of paved roads
- 14 miles of railroad lines
- 4 reactors
- Mass transit system
- Protective security force
- Multiple irradiated-
  fuel storage pools
- Dry-cask fuel storage
  research testbed

AFC Advanced Fuels Campaign



LWRS Light Water Reactor Sustainability

INL Wireless TEST BED

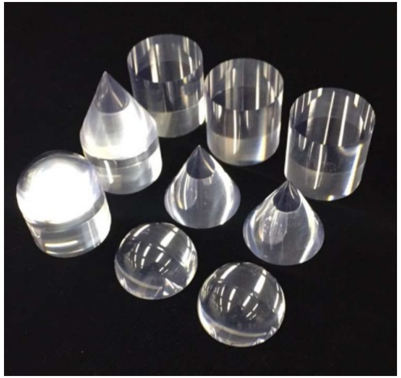
NSUF Nuclear Science User Facilities

NGNP Next Generation Nuclear Plant

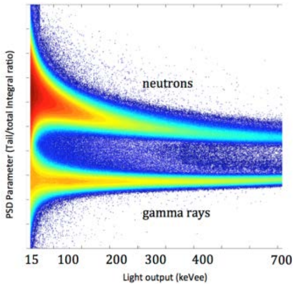
CVT Summer Intern at INL

Charles Sosa

- U. Michigan
- Optimization of organic scintillator detectors to improve neutron/gamma-ray pulse shape discrimination (PSD)
- Evaluation of optimal waveform digitization parameters to maximize PSD performance of organic scintillators

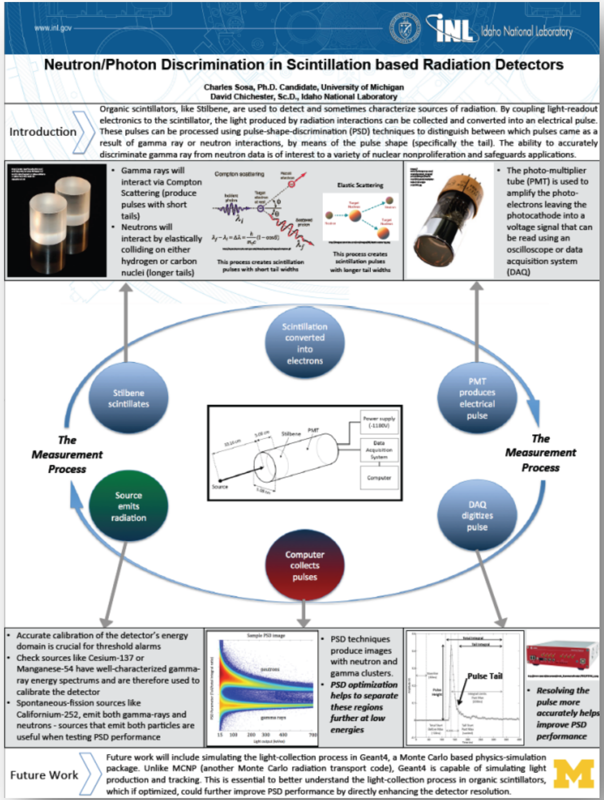


Candidate organic scintillator geometries



PSD-focused optimization aimed at further separating neutron and gamma-ray signals

Right circular cylinder under ultraviolet illumination

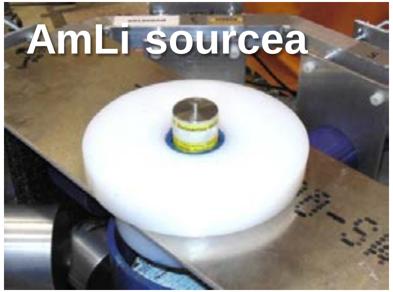


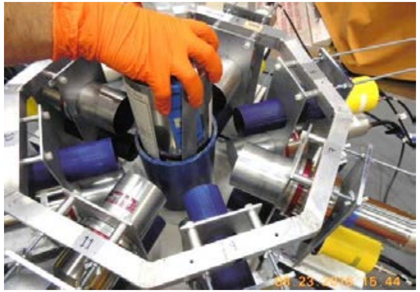
Summer 2016 intern poster at INL

CVT Activities at INL – Fast-Neutron Multiplicity Analysis

We hosted Dr. Angela Di Fulvio and Tony Shin (U. Michigan) for a week-long experiment campaign at INL's ZPPR facility in August

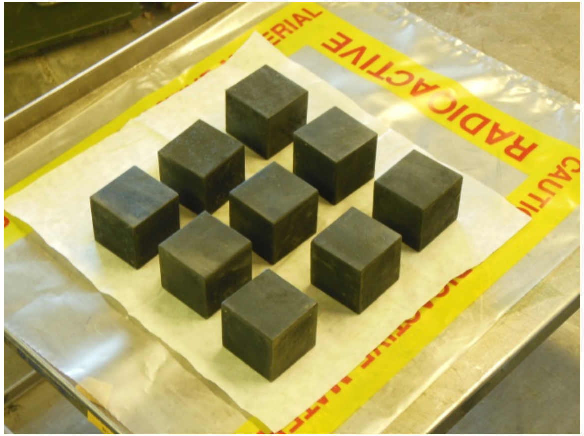
- U Mass standards (6)
  - 0.5 – 4 kg
  - 93% ^{235}U
- U enrichment standards (3)
  - 0.230 kg each (0.690kg)
  - 20%, 53%, 93%
- Clad UO_2 pins (32)
  - 0.080 kg each (2.5 kg)
  - 16.4% ^{235}U

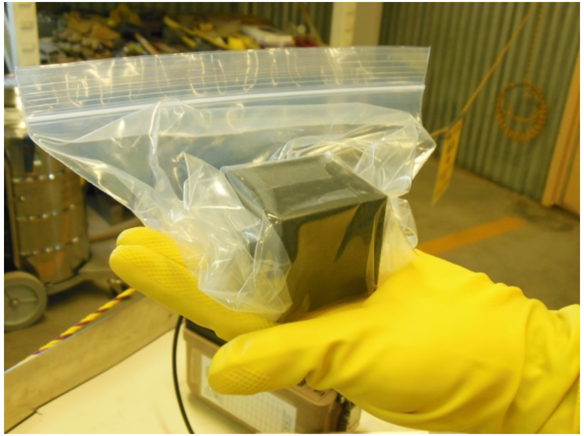




Packaging Depleted Uranium Cubes for Princeton

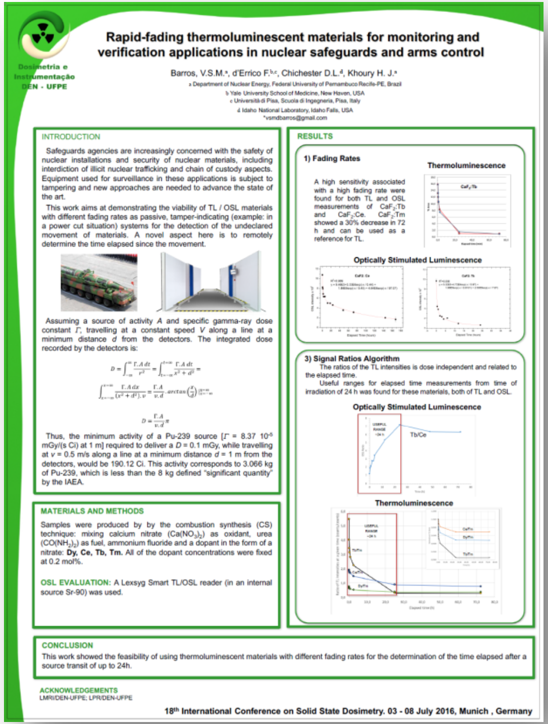
- Conversation with Rob Goldston at the UITI meeting requesting uranium
- INL identified nine depleted uranium cubes (2” × 2” ×2”) and prepared them for shipment to Princeton Plasma Physics Laboratory to support CVT experimental activities at Princeton University (Alexander Glaser)
- Request initiated June 7
- Materials packaged and ready for shipment July 22



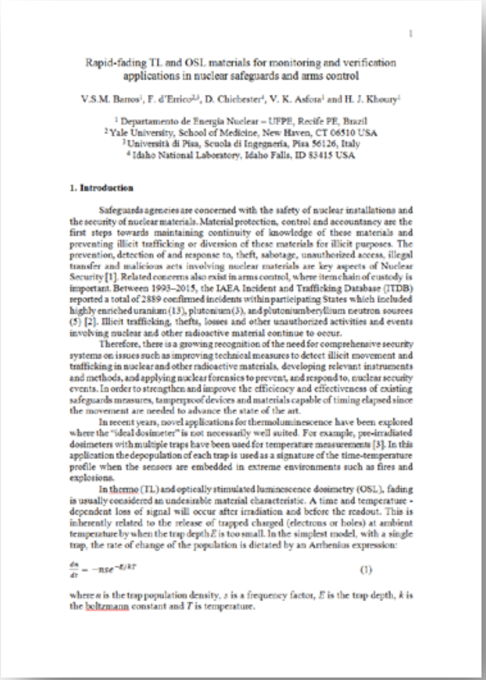


Emerging Collaboration Related to Passive Smart Tags

- Working with Dr. Francesco D'Errico, Yale University
- Exploring ideas for using dosimeters in nontraditional ways to meet safeguards and arms control measurement challenges
  - Use of TL and OSL materials for passive, time-sensitive tags
  - Use of bubble detectors for passive area/portal monitors
- Planning experiments at INL



Presentation at the 18th Int. Conf. on Solid State Dosimetry



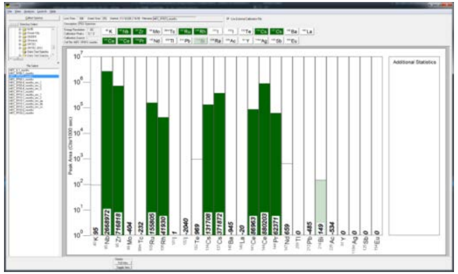
Paper submitted to Radiation Measurements

INL Capability Alignment with the CVT Thrust Areas

Thrust Areas	Sub Areas	INL Staff	INL Resources
1: Characterizing Gaps & Emerging Challenges	FMCT Verification Challenges	✓	✓
	Future Disarmament Treaties	✓	✓
2: Fundamental Physical Data, Data Acquisition & Analysis Techniques	Physics of Fission	✓	✘
	Data Analytics	✓	✘
	Data Acquisition for High-Throughput Radiation Detector Systems	✓	✓
3: Advanced Safeguards Tools for Accessible Facilities	Neutron Multiplicity Counting	✓	✓
	Handheld/Portable Room Temp. Semiconductor γ-Ray Imagers	✓	✓
	Stand-off Meas. using LIBS for Limited Access Areas	✓	✓
	Chain-of-Custody Detectors	✓	✓
4: Detection of Undeclared Activities and Inaccessible Facilities	Seismic Signatures	✘	✓
	Infrasound Signatures	?	✓
	Atmospheric Radionuclide Sensing	✓	✓
	Signatures from Undeclared Fuel-Cycle Facilities	✓	✓
5: Disarmament Verification	Rad. Detection Systems for Arms Control & Treaty Verification	✓	✓
	Warhead Dismantlement Facility & Managed-Access Simulator	✓	✓
	Zero-Knowledge Neutron-based Verification System	✓	✓
	Limited Knowledge Transmission NRF	✓	✓
6: Education & Outreach	Multiple	✓	✓

INL Research Staff Interests Aligned with the CVT

- Automated, information-barrier software for assessing gamma-ray spectra for CTBT on-site inspections
  PI: Gus Caffrey TA: 1, 5, & 6
- Study of nontraditional signatures and observables associated with reprocessing LWR fuel; evaluation of forensic signatures from LWR fuel
  PI: Kevin Carney TA: 1, 4, & 6
- Development of passive and active interrogation methods for characterizing assemblies of SNM for safeguards, arms control, and treaty verification
  PI: David Chichester TA: 1, 2, 3, 5, & 6
- Methods and instruments for ultra-trace mass and radiochemical analyses and the production of reference materials
  PI: Matt Watrous TA: 1, 4, & 6



Screen shot of the OSIRIS user interface, showing results of allowed gamma-ray results

Disassembly of an LWR fuel pin at INL for follow-on radiochemical analyses

Source-assisted multiplicity counting to determine multiplication, M, of an assembly of HEU

Potential INL Resource Support for the CVT

Working with Bulk SNM
(Thrust Areas: 1, 2, 3, 5, & 6)

Active interrogation & multiplicity counting for SNM detection and characterization

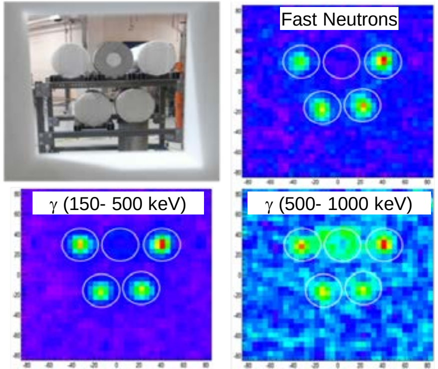
U & Pu Processing Facilities
(Thrust Areas: 1, 3, 4, & 6)

Hot-cell facilities processing irradiated fuel; U and Pu radio-chemistry

Explosives Test Range
(Thrust Areas: 4)

Large explosives test range supporting outdoor RDD detonation events

Radiation Imager Trials
(Thrust Areas: 3 & 5)



Assessing imaging systems for arms control and emergency response (example data from an ORNL system)

PUREX Pilot Plant
(Thrust Areas: 1, 2, 4, & 6)

Engineering-scale solvent extraction pilot plant for non-proliferation R&D

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