

Consortium for Verification Technology (CVT) Overview

October 19, 2016

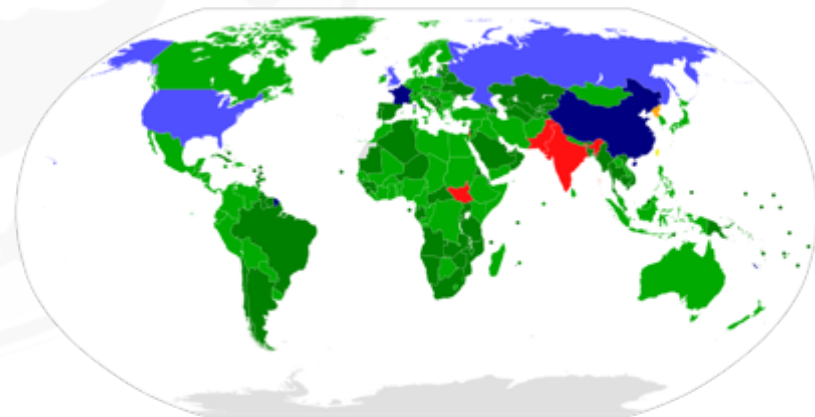
Sara A. Pozzi

University of Michigan



CVT: Background and Motivation

- Preventing the spread of nuclear weapons is a top priority for our nation and the world
- The fast-growing expansion of nuclear capabilities of the 1950's and 60's was ultimately countered by the Nuclear Nonproliferation Treaty (NPT)
- There are states inside and outside this treaty that may be pursuing elements of an overt or covert nuclear weapons program
- Several other treaties (Fissile Material Cutoff Treaty, Comprehensive Test Ban Treaty, and disarmament treaties) have been negotiated to limit and then stop nuclear weapons testing, and to reduce the nuclear arsenals of the Soviet Union/Russia, the United States, and other states
- ***We need new technologies for the verification of existing and proposed nuclear treaties***

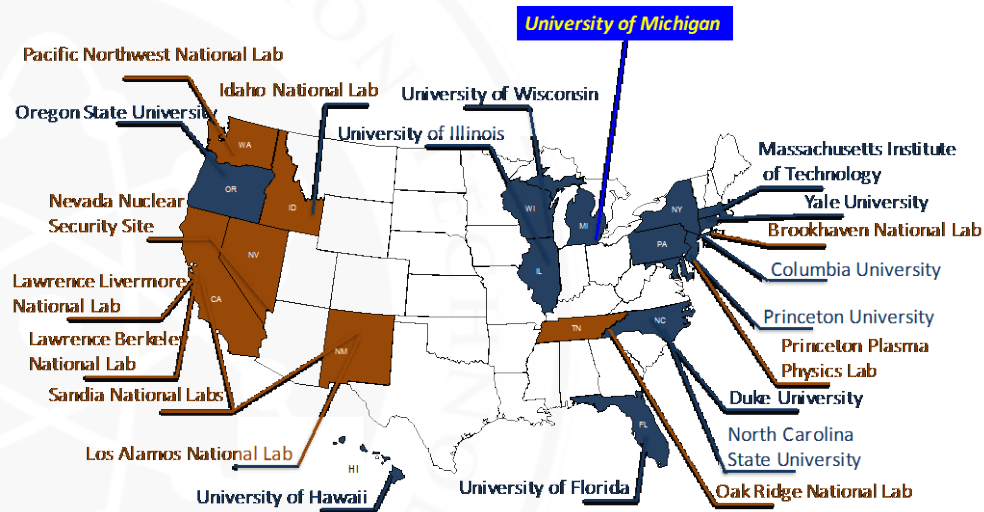


CVT: Mission and Expected Outcomes

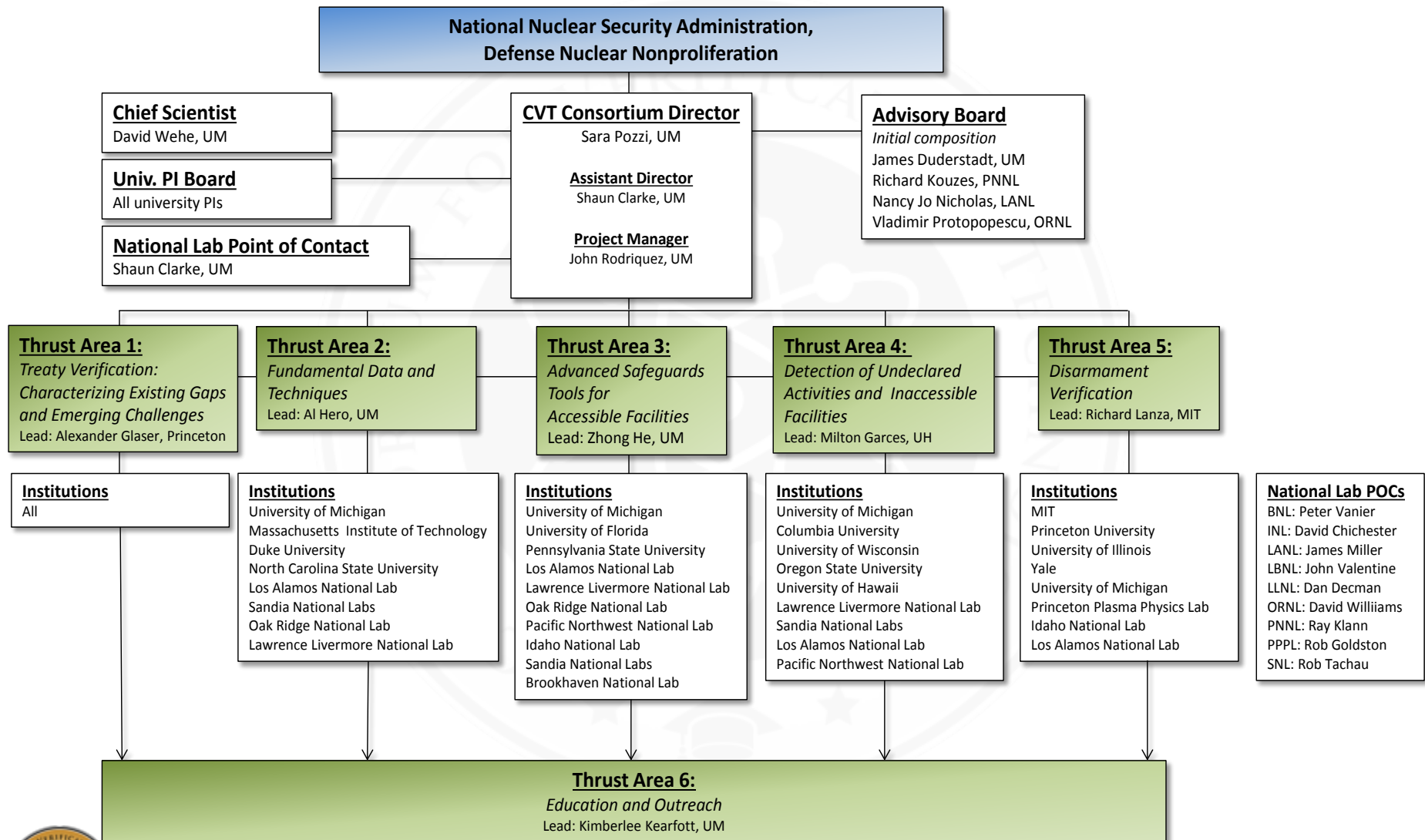
The CVT's mission is the advancement of the state-of-the-art in technologies and policies related to the verification of nuclear treaties and training the next-generation of nuclear professionals.

Expected outcomes:

1. A deep understanding of the policy and technical requirements of nuclear treaty verification
2. Next-generation set of algorithmic and computational capabilities
3. New, more sensitive, accurate, and reliable experimental capabilities for treaty verification
4. More than 80 B.S., M.S., and Ph.D. graduates with talent, training, and commitment in the fields of nonproliferation and safeguards, with strong ties to industry and the national laboratory system



CVT Organizational Chart



CVT: Thrust Areas

Thrust Area 1: *Treaty Verification: Characterizing Existing Gaps and Emerging Challenges*

Thrust Area 2:
*Fundamental Data
and Techniques*

Thrust Area 3:
*Advanced Safeguards Tools
for Accessible Facilities*

Thrust Area 4:
*Detection of Undeclared
Activities and Inaccessible
Facilities*

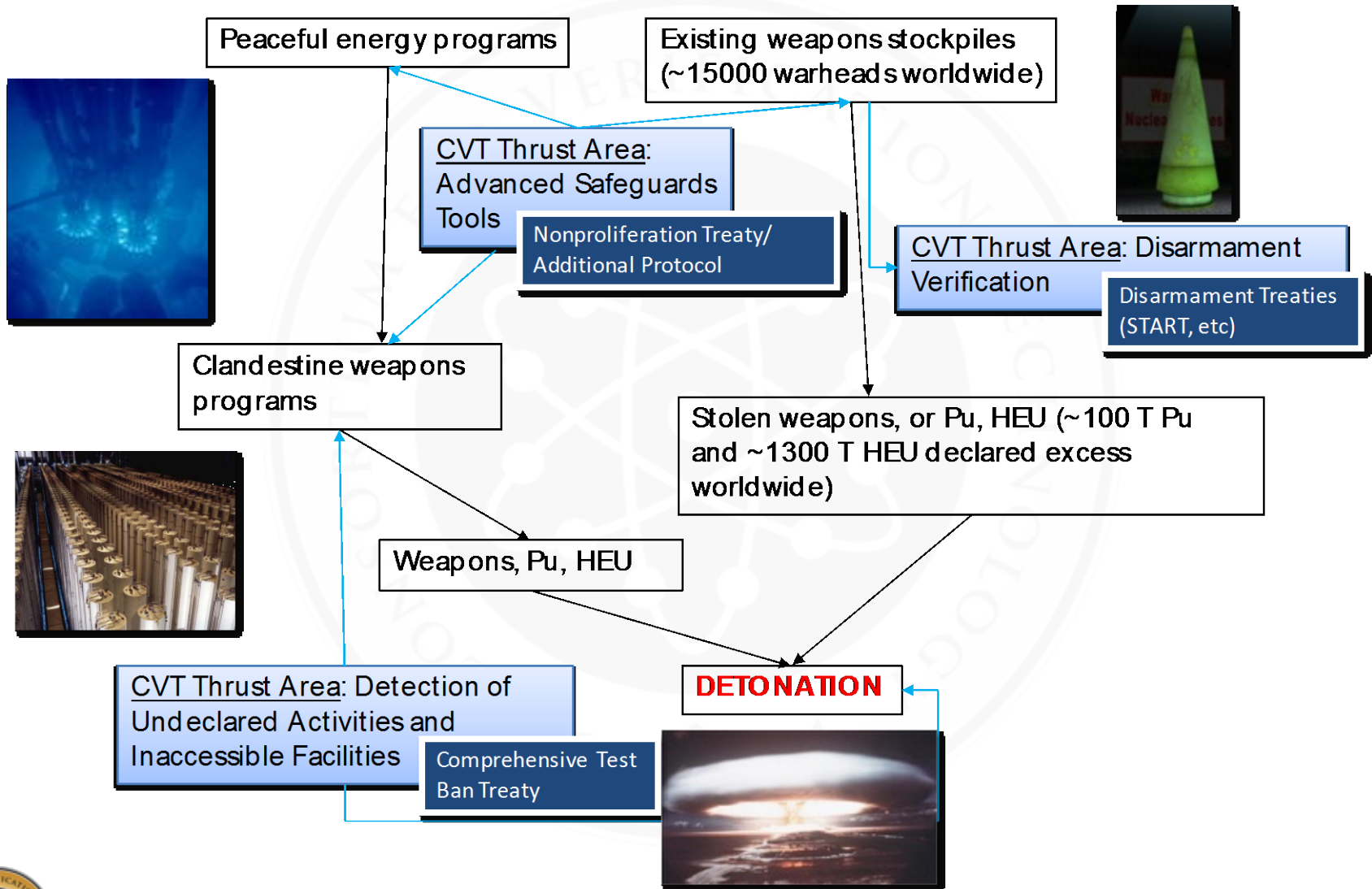
Thrust Area 5:
*Disarmament
Verification*

Thrust Area 6: *Education and Outreach*

Cross-cutting, transformational
technologies

Next-generation professionals
in nonproliferation and
safeguards

Nuclear Energy, Weapons Stockpiles, and the Nuclear Threat



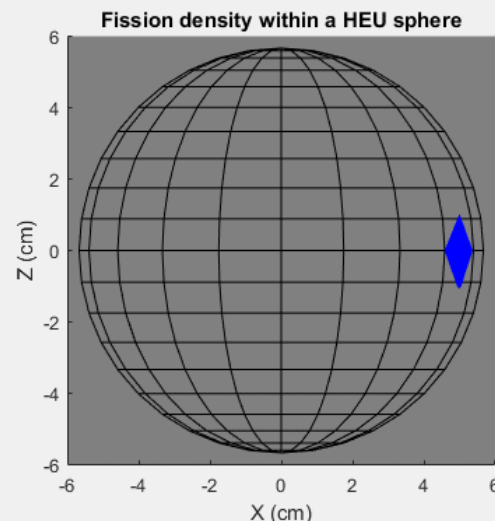
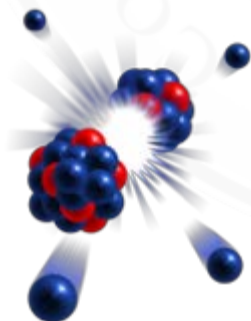
Technical Highlight 1:

Fundamental Physics and Data

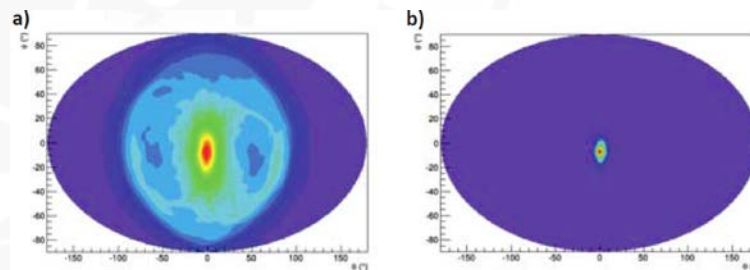
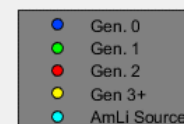
- Addressing the cross-cutting needs in nuclear treaty verification, we developed new algorithms and models for:
 - emissions from nuclear fission
 - correlation-based anomaly/diversion detection
 - data acquisition and signal processing for emerging radiation detection technologies
 - Advanced image reconstruction

National lab collaborators: LANL, ORNL, LLNL, SNL, PNNL, LBNL

Modeling correlated emissions from fission



Modeling fission chains in subcritical assemblies



Simulated Cf-252 backprojection (a) and MLEM (b) images from a single volume scatter camera

Technical Highlight 2:

Advanced Safeguards Tools

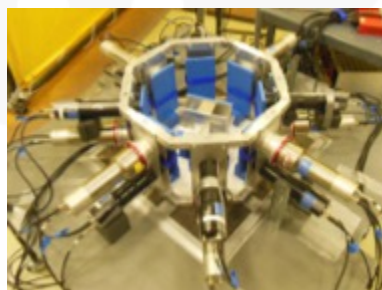
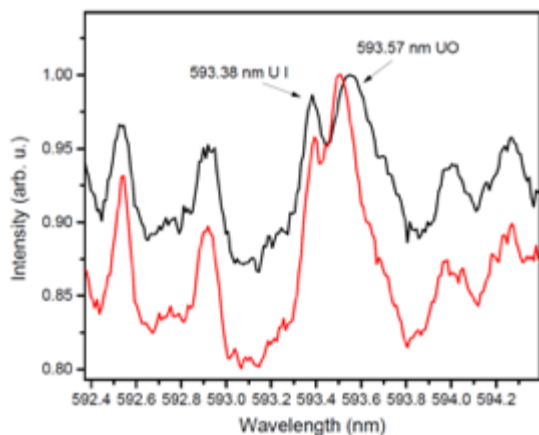
- Conducted successful university-led experiments with Cat-I special nuclear material at the Device Assembly Facility (July 6 – 9, 2015)
- Demonstrated first remote observation of uranium-oxide molecules using femtosecond laser filaments
- Coordinated with the IAEA to understand their needs and target our technology development

National lab collaborators: LANL, LLNL, ORNL, PNNL, INL, SNL, BNL, NNSS, PPPL

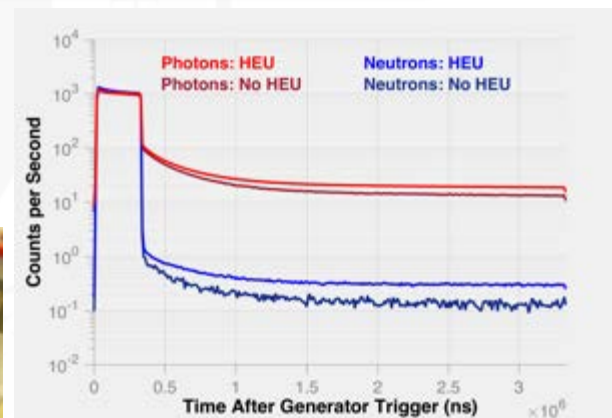


Active detection of HEU at DAF

Isotopic shift for DU and HEU



Fast neutron multiplicity counter prototype

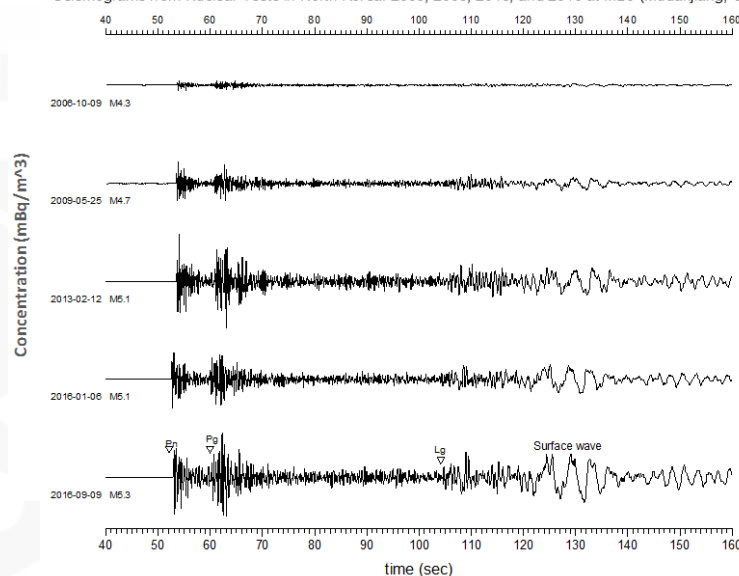


Technical Highlight 3:

Analysis of DPRK Tests

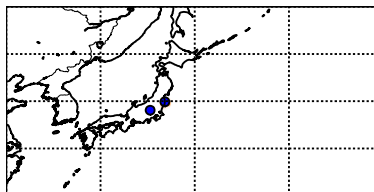
- Analyzed seismic signals from 6-Jan-2016 nuclear event in North Korea
- Determined that the event is comparable in magnitude to those from the May 2009 and February 2013 nuclear weapons tests in North Korea
- Obtained and performed initial analysis of infrasound and radionuclide data from the International Monitoring System

Seismograms from Nuclear Tests in North Korea: 2006, 2009, 2013, and 2016 at MDJ (Mudanjiang, China)



6

National lab
collaborators: LLNL,
LANL, SNL, PNNL



$\times 10^8$

- 2.00

- 1.75

- 1.50

- 1.25

00

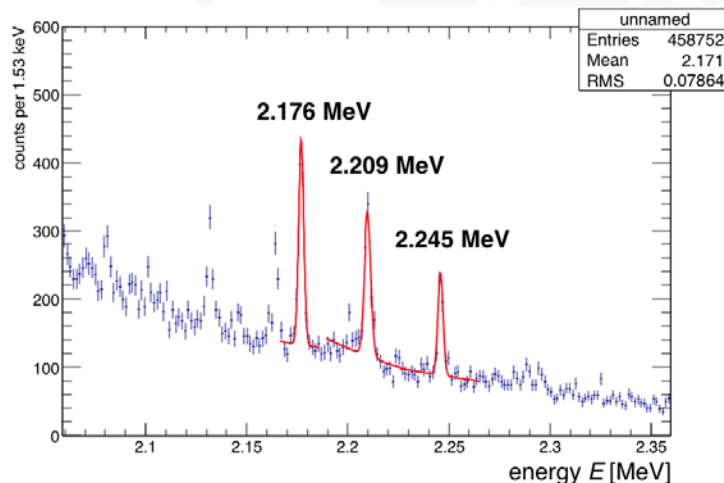
mBq·m⁻³

Technical Highlight 4:

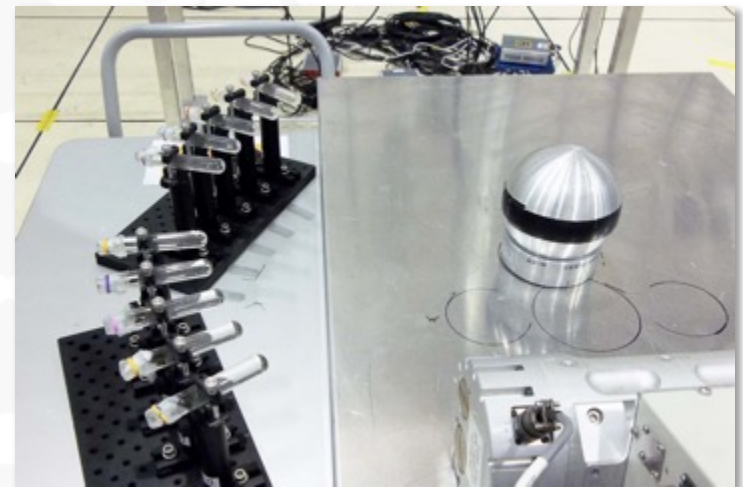
Verification of Future Disarmament Treaties

- Collected nuclear resonance fluorescence data from U-238 at MIT
- Developed prototype system to demonstrate hardware-based zero-knowledge protocols
- Performed neutron interrogation experiments at the device assembly facility with category-I SNM

National lab collaborators: LANL, NNSS, PPPL



HEU measurements using a DD neutron generator

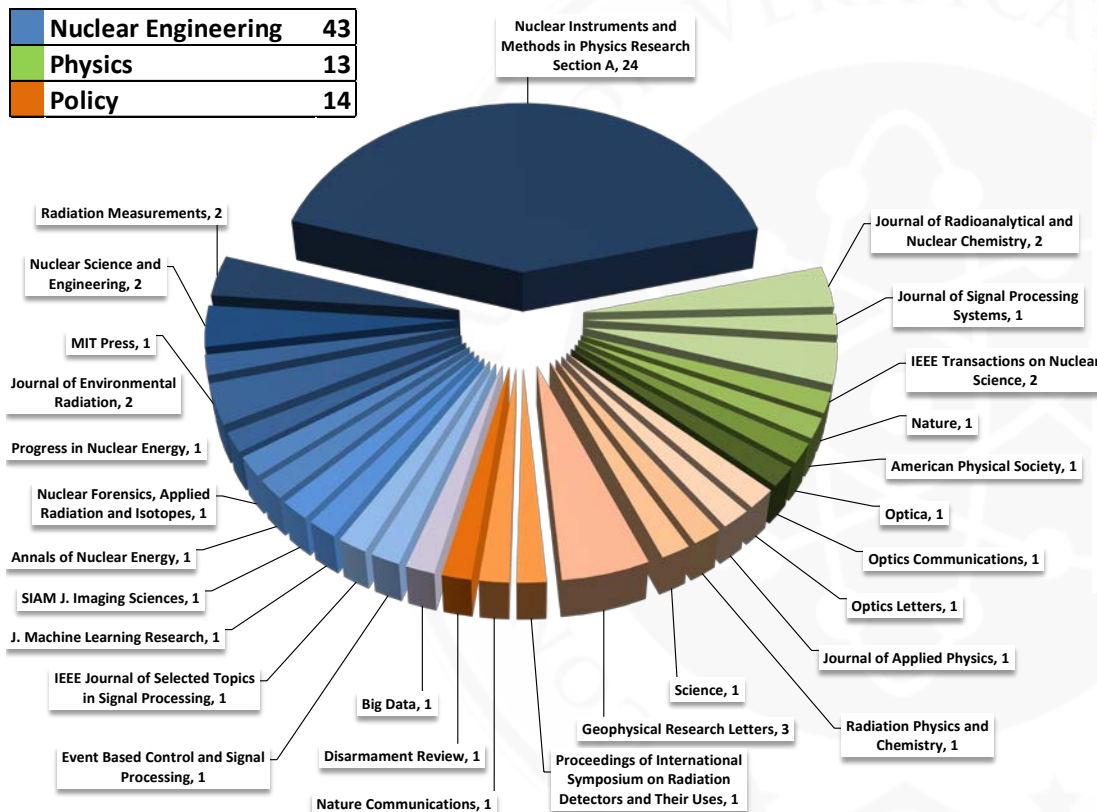


Characteristic nuclear resonances of U-238 can be used for isotopic identification

Publication Highlights

total publications: 70

Nuclear Engineering	43
Physics	13
Policy	14



SECTIONS

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THE NEW YORKER

ELEMENTS

THE VIRTUES OF NUCLEAR IGNORANCE

By Alex Wellerstein, SEPTEMBER 20, 2016



Americans of a certain age are well acquainted with one of Ronald Reagan's pithier maxims: "Trust, but verify." It is a translation of a Russian proverb, and Reagan used it often in his dealings with the Soviet Union over nuclear disarmament, as both countries chipped away tentatively at their Cold War stockpiles. For him, the saying encapsulated the idea that a good treaty would require rigorous inspections, to insure that neither



Alexander Glaser (left) and Sébastien Philippe, of Princeton University, pose with a mockup of a reentry vehicle, the portion of a nuclear missile that contains the warhead.

PHOTOGRAPH COURTESY ALEXANDER GLASER AND SÉBASTIEN PHILIPPE / NUCLEAR FUTURES LABORATORY

Full Article

<http://www.newyorker.com/tech/elements/the-virtues-of-nuclear-ignorance>



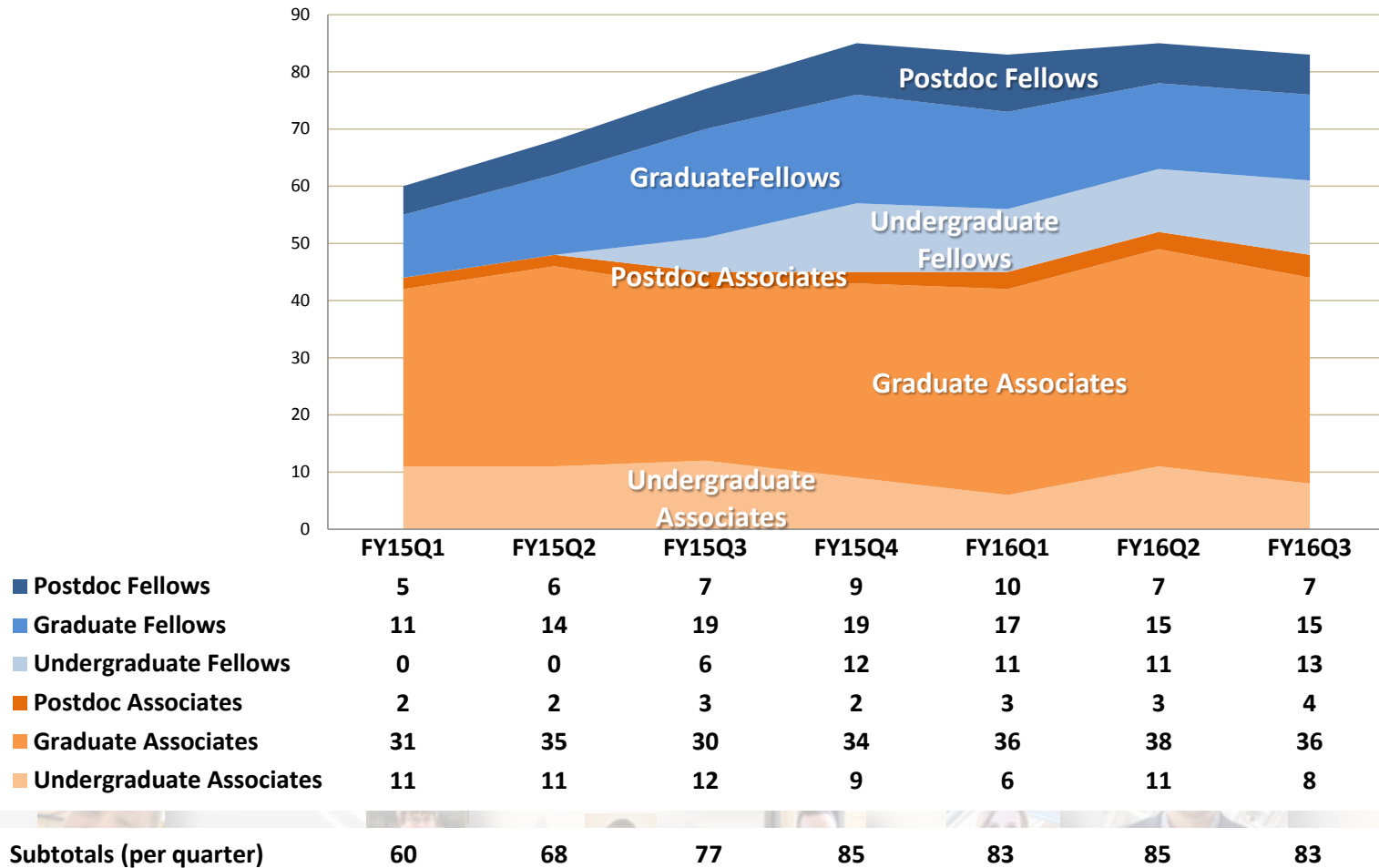
Consortium for Verification Technology



CVT Fellows & Associates*

Student participation by quarter, September 2014 - Present

Number of Students / Postdocs

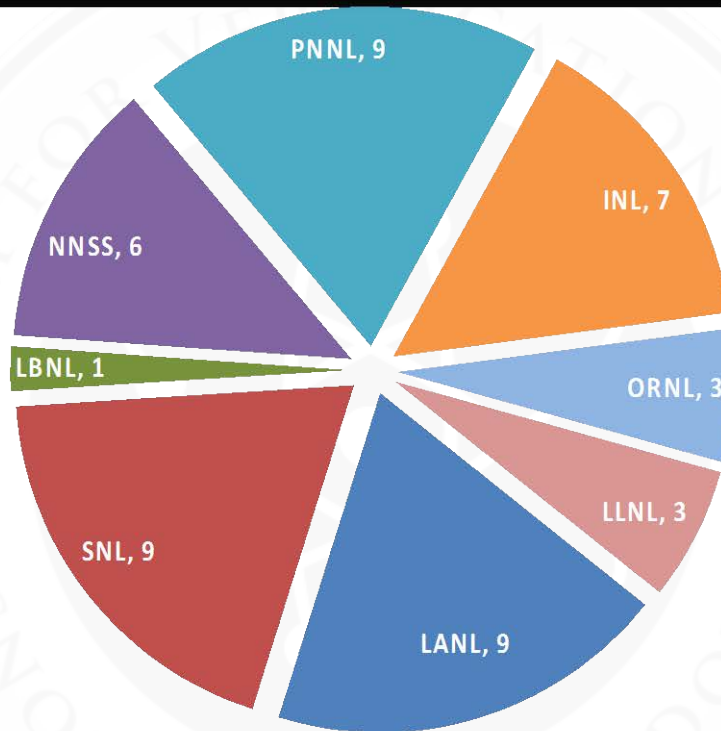


*Fellows: fully funded by CVT grant, *Associates: partially funded by CVT grant



Student to National Lab Internships

47 Internships from 09/01/2014 to present



Ciara Sivels
PNNL, 2016
Mentor: Justin McIntyre



Cameron Miller
LBNL, 2016
Mentor: Cameron Geddes



Jennifer Arthur
LANL, 2016
Mentors: Rian Bahrn & Jesson Hutchinson



Mateusz Monterial
SNL, 2016
Mentor: Peter Marleau



Matthew Mar cath
LANL, 2015
Mentor: Robert Haight



Anthony Christe
LLNL, 2016
Academic Cooperation Project (ACP)



Pin Yu-Chen
PNNL, 2015
Mentor: Sutanay Sidhuri



Angela Di Fulvio & Charles Sosa
INL, 2015
Mentor: David Chichester



UM Nuclear Safeguards
ORNL, 2015
Mentor: Kimberly Gilligan & Ram Venkataraman



National Lab Scientist Fellowship



Thomas Atwood
Sandia National Laboratories
Host: Paul Wilson
University of Wisconsin
Feb 2016



Jorgen Randrup
Lawrence Berkeley National Lab
Host: Sara Pozzi
University of Michigan
March 2016



Ramona Vogt
Lawrence Livermore Nat Lab
Host: Sara Pozzi
University of Michigan
March 2016



Kenneth Jarman
Pacific Northwest National Laboratory
Host: Scott Kemp
Massachusetts Institute of Technology
June 2016



David Mascarenas
Los Alamos National Laboratory
Host: Milton Garces
University of Hawaii
May 2016

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CVT Student Advancement Model



Alexis Trahan



2014, CVT Associate



**2011, Begins UM
Graduate program
in Nuclear Engineering and
Radiological Sciences**



**2007 - 2011
UC Berkeley Undergrad
B.S. in Nuclear Engineering**



2015, LANL Intern



2016, Staff at LANL



2016, PhD defense



2012, LANL Intern

CVT Student Advancement Model



2012, June - June 2013
NNSA Graduate Fellow



2014, CVT Associate

UF UNIVERSITY of
FLORIDA

Assistant Professor,
University of Florida



2011, June
Oregon State University
B.S. Nuclear Engineering

2011, April
OSU Undergrad Awarded
Nuclear Forensics Graduate
Fellowship



2011, August
Begins PhD program at
Penn State

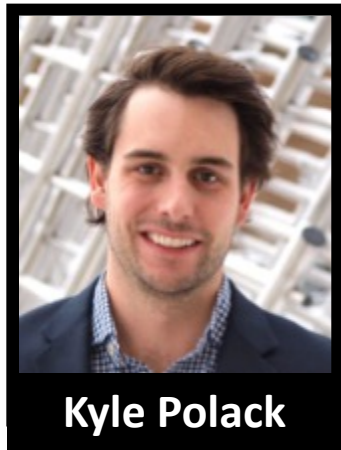
2014, February - October 2014
Seaborg Graduate Fellow at LANL

November 2014 - May 2016
Guest Scientist at LANL

May 2016
PhD Defense, PSU Engineering



CVT Student Advancement Model



2014, U. Michigan, MSE
Electrical Engineering: Systems

2011, U. Michigan, MSE
Nucl. Eng. & Radiological Sciences

2014,
CVT Associate

2016,
CVT Fellow

2016, Senior Staff
at Sandia Natl Labs

2013, Sandia Fellowship

2010, Knolls Atomic Power
Laboratory, Nuclear Data
and Methods Division

2016, PhD defense



Sandia
National
Laboratories



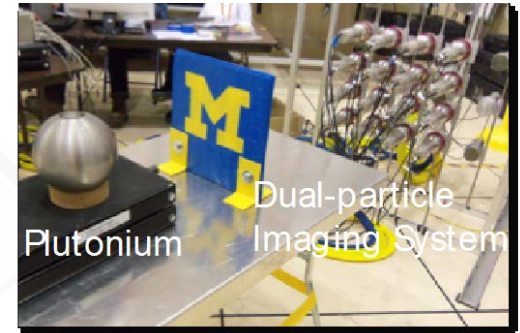
2010, Begins UM
Graduate program
For Nuclear Engineering



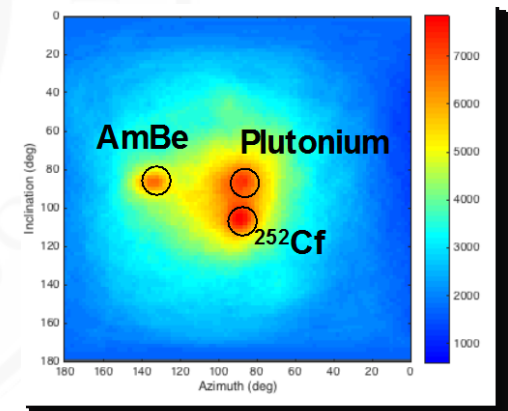
2010, U. Michigan, B.S.
Nuclear Engineering &
Radiological Sciences

CVT: Summary of Accomplishments

- A successful CVT Annual Workshop was held on October 15 and 16, 2015 at the Campus Inn in Ann Arbor, MI: 84 representatives from 13 collaborating universities and 9 national laboratories were present, including 15 CVT fellows and 19 associates
- A successful UITI conference was held in June, 2015 in Ann Arbor, MI with nearly 300 attendees
- 7 workshops (MCNPX-PoliMi (2015 & 2016), CVT (2014 & 2015), CAEN, Nuclear Verification at Low Numbers, Geant 4)
- 47 student laboratory internships and 5 lab scientist fellowships
- 5 outreach events and more than 13,000 visits to our CVT website
- 127 students and postdocs (61 fellows, 66 associates) are engaged in CVT research.
- Successful experiments on category-I special nuclear material, including students (DAF 2015, 2016, INL 2015, 2016, etc.)
- Technical findings published in 70 journal articles and 108 conference papers, and presented in 71 invited talks



CVT-led experiments at the Nevada Nuclear Security Site

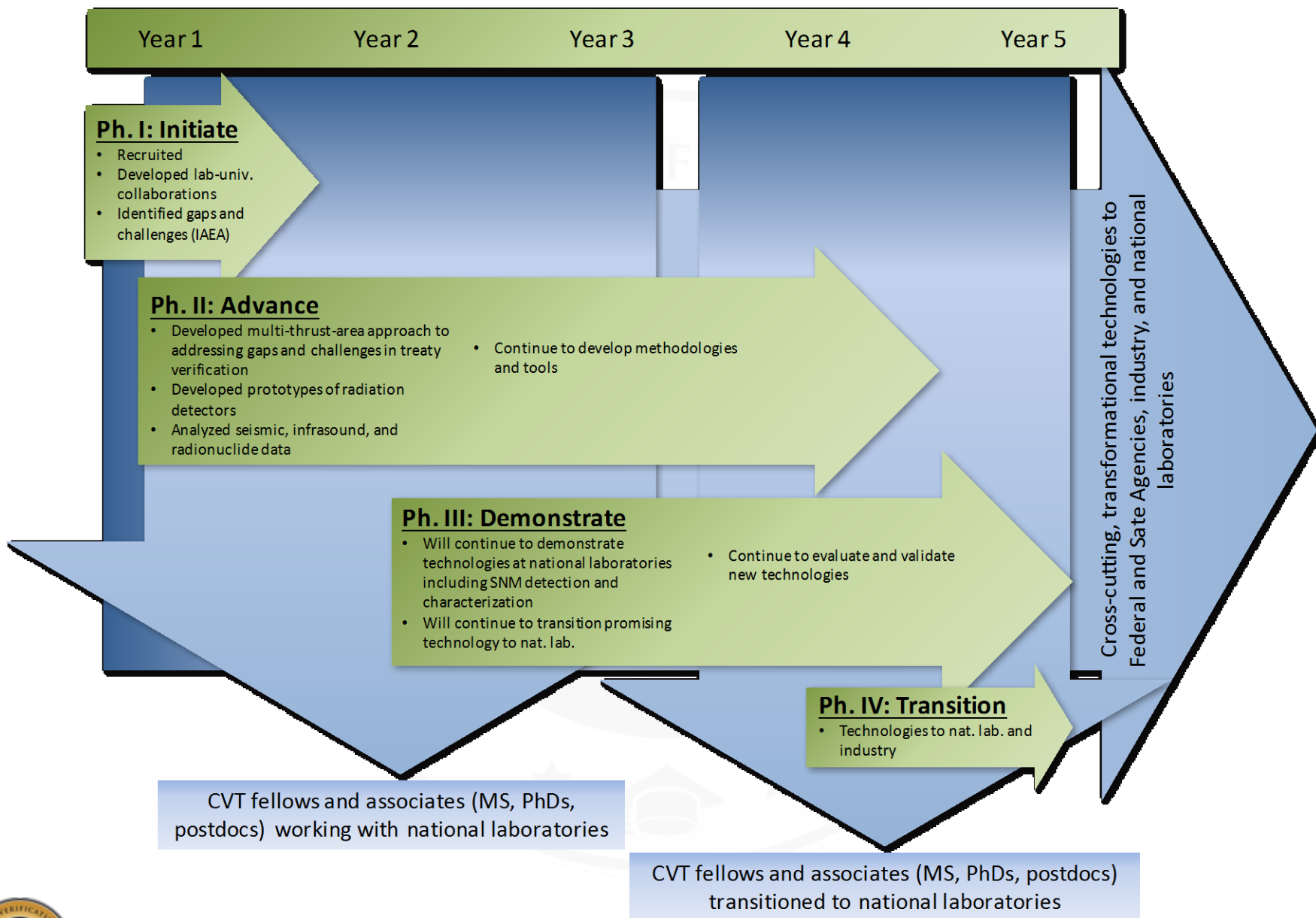


Detecting and characterizing nuclear material at large distances



CVT outreach activities

CVT: Timeline and Outcomes



Acknowledgement

This work was funded by the Consortium for Verification Technology under Department of Energy National Nuclear Security Administration award number DE-NA0002534

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<http://cvt.engin.umich.edu>



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