Consortium for Monitoring, Technology, and Verification (MTV)

MTV Kickoff Meeting
May 20, 2019

Sara Pozzi, Ph. D.
Professor of Nuclear Engineering and Radiological Sciences
Professor of Physics
Director, Consortium for Monitoring, Technology, and Verification
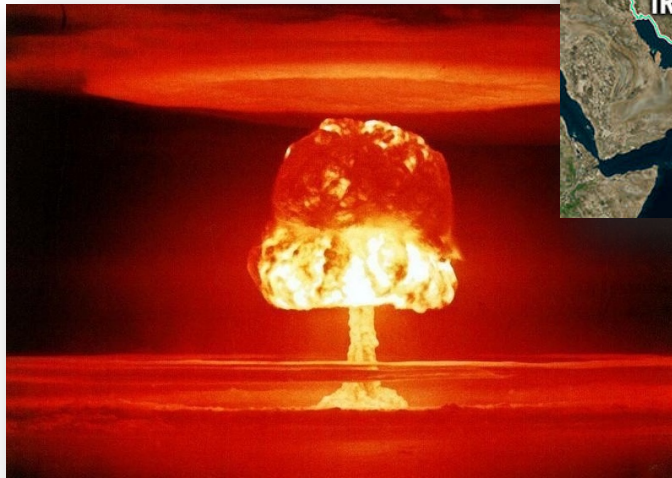Director, Consortium for Verification Technology
Department of Nuclear Engineering and Radiological Sciences
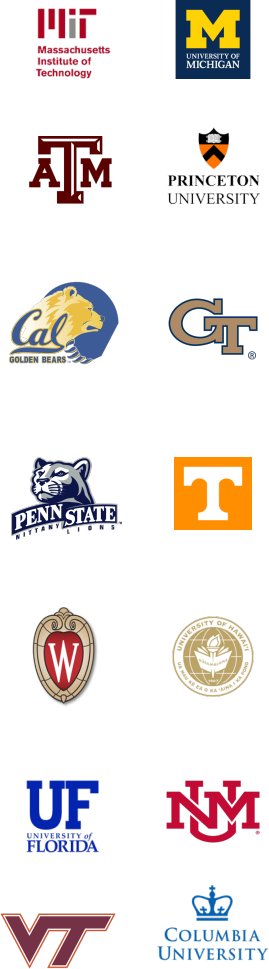University of Michigan

Motivation and Mission

- Prevent the spread of nuclear weapons

- Ensure timely detection and understanding of the signatures of nuclear proliferation; detect activities not in compliance with current treaty obligations

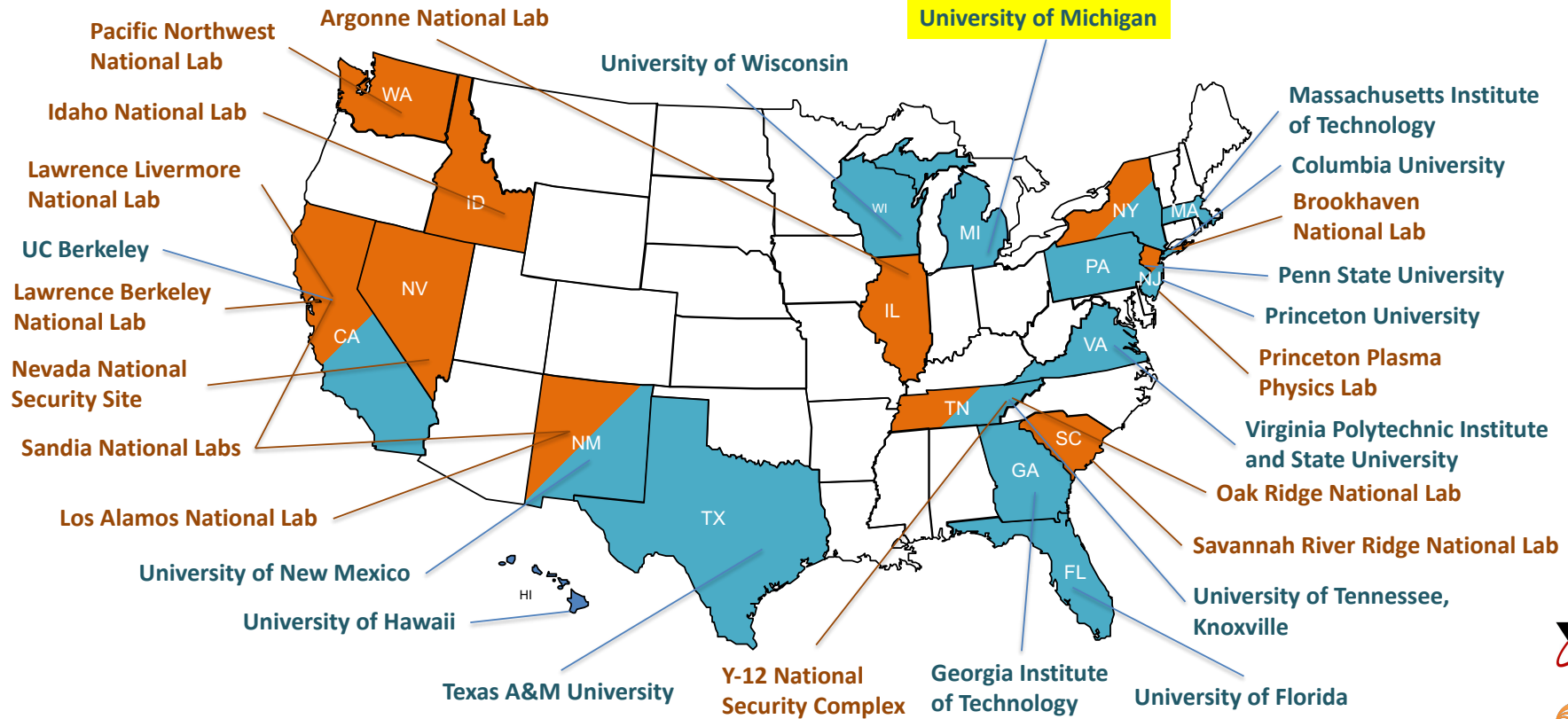- Advance our ability to detect and characterize nuclear explosions, should they occur

IRAN

MTV Team

14 Universities

13 National Labs

Map labels:
- Pacific Northwest National Lab
- Argonne National Lab
- University of Michigan
- University of Wisconsin
- Idaho National Lab
- Massachusetts Institute of Technology
- Columbia University
- Brookhaven National Lab
- Lawrence Livermore National Lab
- UC Berkeley
- Penn State University
- Princeton University
- Lawrence Berkeley National Lab
- Princeton Plasma Physics Lab
- Nevada National Security Site
- Virginia Polytechnic Institute and State University
- Sandia National Labs
- Oak Ridge National Lab
- Savannah River Ridge National Lab
- Los Alamos National Lab
- University of Tennessee, Knoxville
- University of New Mexico
- University of Hawaii
- Texas A&M University
- Y-12 National Security Complex
- Georgia Institute of Technology
- University of Florida

Consortium for Monitoring, Technology, and Verification

1. Fundamentals of Nuclear and Particle Physics

a. Reaction Theory and Modeling
b. Novel Imaging Techniques
c. Antineutrino-Based Methods

2. Signals and Source Terms for Nuclear Nonproliferation

a. Isotopic Science
b. Spatial/Temporal Spectroscopic Analysis
c. In Situ Natural Monitoring (biota)
d. Nuclear Fuel Cycle Process Modeling
e. Radiation Transport

3. Nuclear Explosion Monitoring

a. Infrasound
b. Seismology
c. Environmental Fate and Transport of Radionuclides
d. Radionuclide
e. Methodologies for Wide Area Environmental Sampling
f. Radiation Background Monitoring

A. Modeling and Simulation

B. Nuclear Policy

C. Education and Outreach

Over 100 Ph. D. and M. S. students
Over 100 undergraduate students
Over 1000 elementary, middle, and high school students at outreach events
New science and technologies in nuclear nonproliferation and security

MTV Timeline and Expected Outcomes

MTV Phases

Phase I: Startup

MTV kickoff workshop. Recruit the best talent for graduate, undergraduate, and post-doctoral MTV fellowships. Introduce fellows and associates to the research activities.
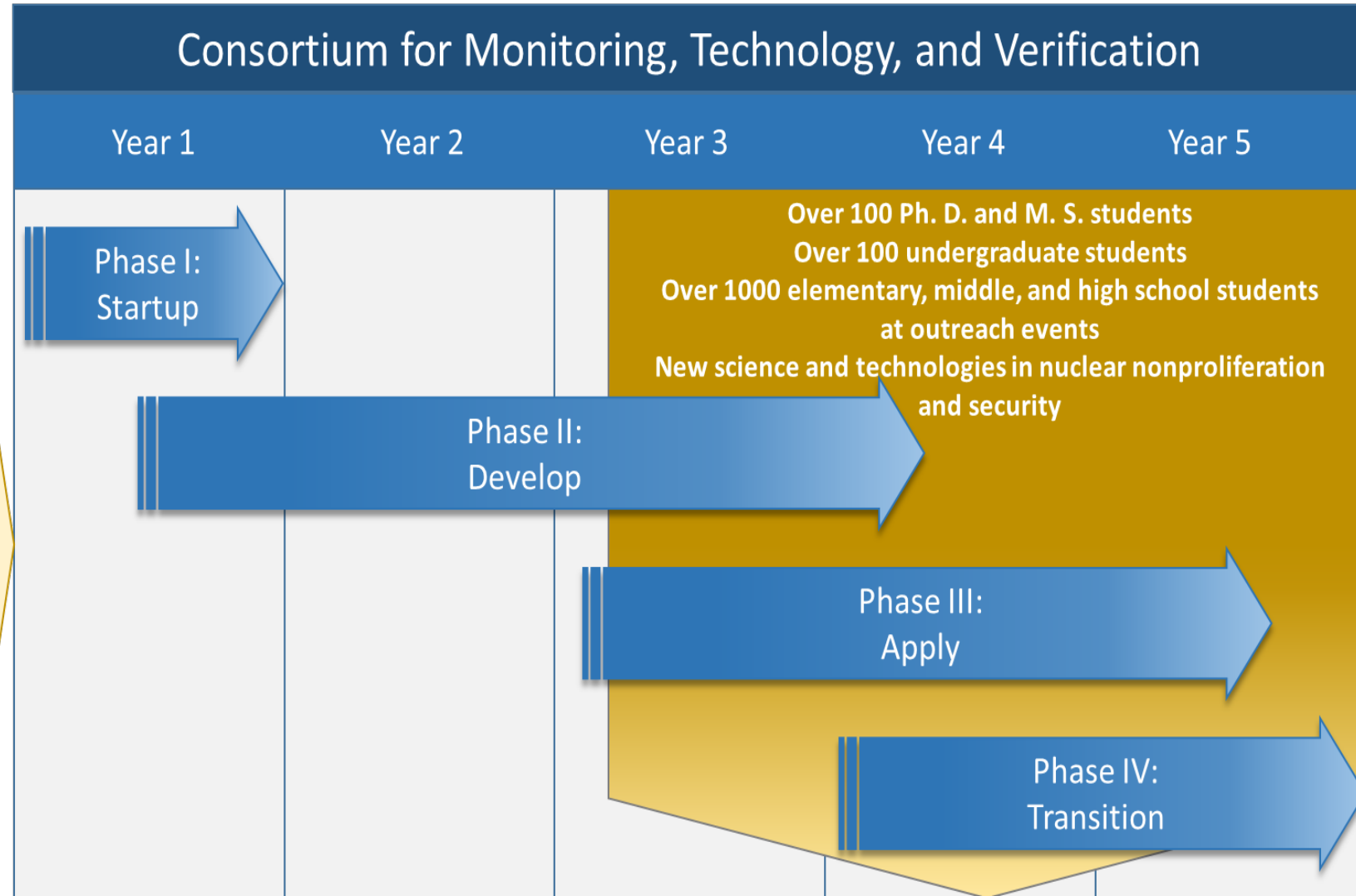
Phase II: Develop

Advance the state-of-the-art in nuclear nonproliferation technologies in the three technical thrust areas. Establish cross-pollination of the research activities. Implementation of MTV travel fellowships to national labs.

Phase III: Apply

Conduct application experiments for each of our projects using the newly-developed technologies. Research results will be disseminated in peer-reviewed journal publications.

Phase IV: Transition

Technology and MTV graduate transitions to national laboratories, industry, and academia.

Consortium for Verification Technology

Foundational Experience & Technical Expertise

Consortium for Monitoring, Technology, and Verification

Year 1	Year 2	Year 3	Year 4	Year 5

Phase I: Startup

Phase II: Develop

Phase III: Apply

Phase IV: Transition

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Over 100 undergraduate students
Over 1000 elementary, middle, and high school students at outreach events
New science and technologies in nuclear nonproliferation and security

Thrust Area 1: Fundamentals of Nuclear and Particle Physics

1. ## Reaction Theory and Modeling

   - *University Leads: Sara Pozzi, UM; Chris Perfetti, UNM*
   - *National Laboratory Collaborators: Patrick Talou, Rian Bahran, Jesson Hutchinson, and Michael Rising, LANL; Ramona Vogt, LLNL; Jorgen Randrup, LBNL; Michael Smith, Vladimir Sobes, Cathy Romano, Dorothea Wiarda, and Brad Rearden, ORNL; Alejandro Sonzogni, BNL*

2. ## Novel Imaging Techniques

   - *University Leads: Zhong He and David Wehe, UM; Adam Hecht, UNM*
   - *National Laboratory Collaborators: Chris Morris, Elena Guardincerri, and Matt Durham, LANL; Peter Marleau and Erik Brubaker, SNL; David Chichester, INL; Martin Williamson, Y-12; Jesse Bonner, NNSS*

3. ## Antineutrino-Based Methods

   - *University Leads: Igor Jovanovic, UM; Anna Erickson, GIT; Patrick Huber, VT; John Learned, UH*
   - *National Laboratory Collaborators: Adam Bernstein, Jingke Xu, Nathaniel Bowden, and Sergey Pereverzev, LLNL; Chris Bryan, ORNL; Alejandro Sonzogni, BNL*

Steppers

MURA mask

CdZnTe

Controller

Measurement   Mask

Reconstruction
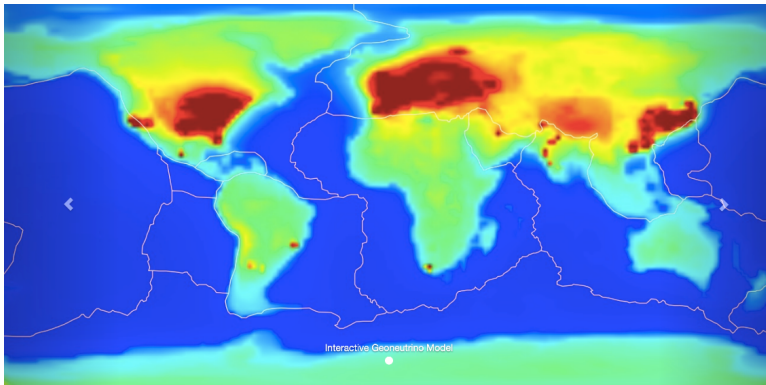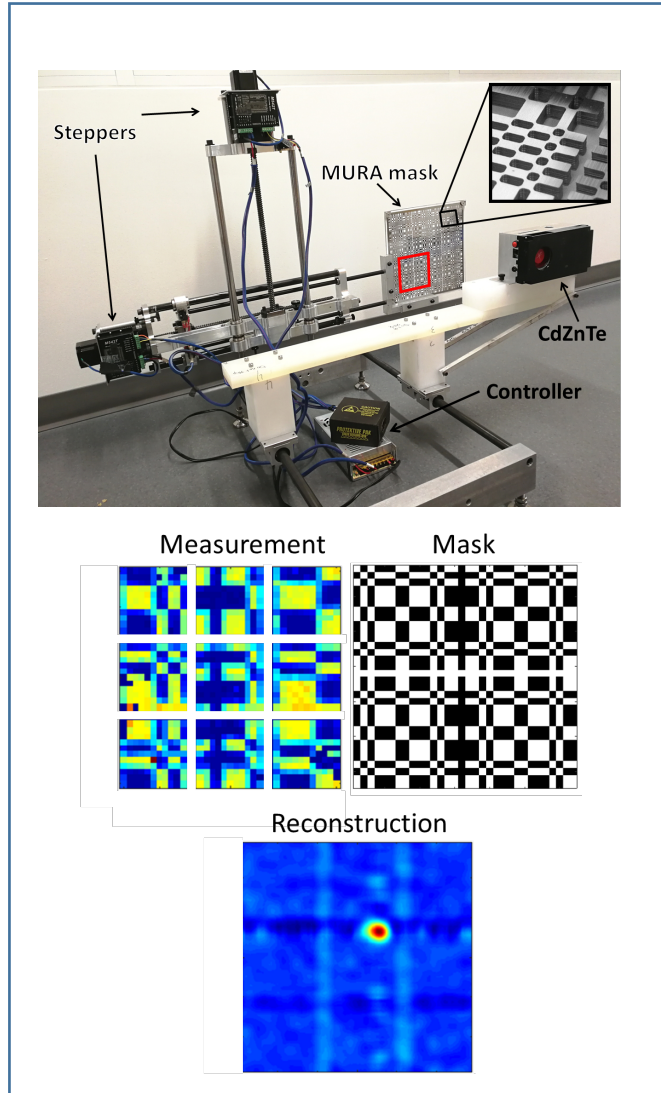
Barna, A.M. and Dye, S.T., "Web Application for Modeling Global Antineutrinos," (2015).
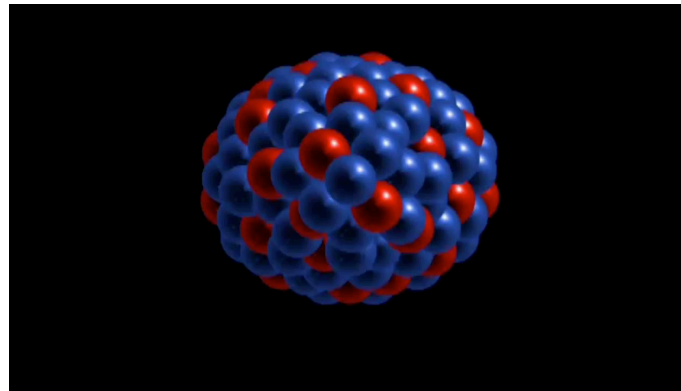
Thrust Area 2: Signals and Source Terms for Nuclear Nonproliferation

1. ## Isotopic Science
   - *University Leads: Steven Biegalski, GIT; Areg Danagoulian, MIT; Marek Flaska, PSU*
   - *National Laboratory Collaborators: David Chichester, INL; Bruce Pierson, and Christine Johnson PNNL; Jennifer Matzel, and Chris Carson, LLNL*

2. ## Spatial/Temporal Spectroscopic Analysis
   - *University Lead: Igor Jovanovic, UM*
   - *National Laboratory Collaborators: Sivanandan Harilal, and Mark Phillips, PNNL*

3. ## In Situ Natural Monitoring (biota)
   - *University Leads: Terry Hazen, UTK; Eric Alm, MIT; Adam Arkin, UCB; Henrietta Dulai, UH*
   - *National Laboratory Collaborators: David Graham, ORNL; Paramvir Dehal LBNL; Chris Henry, ANL*

4. ## Nuclear Fuel Cycle Process Modeling
   - *University Leads: Paul Wilson, UW; Sunil Chirayath, TAMU; Alex Glaser, Princeton*
   - *National Laboratory Collaborators: Terry Todd, and Jack Law INL; Benjamin Cipiti, SNL; Rob Goldston, PPPL; Andrew Worrall, ORNL*

5. ## Radiation Transport
   - *University Leads: Brian Kiedrowski, UM; Anil Prinja, UNM*
   - *National Laboratory Collaborators: Rian Bahran, and Avneet Sood, LANL; Manoj Prasad, LLNL*
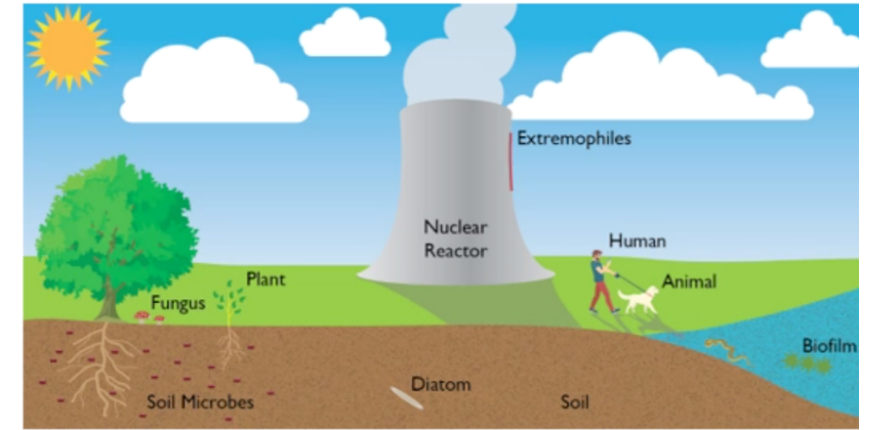
Source: Nuclear working group, 2019
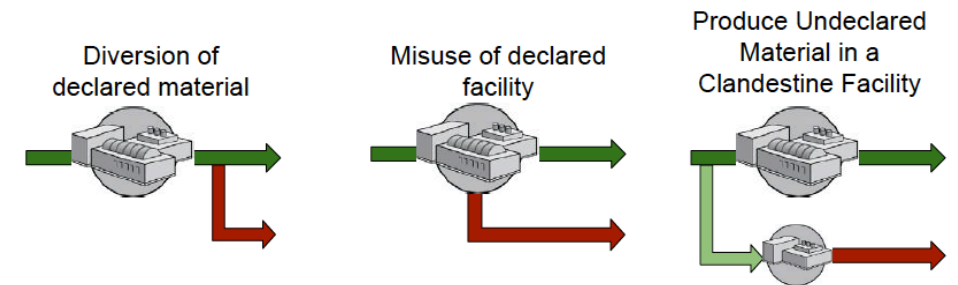
Source: Paul Wilson, U. Wisconsin, 2019

Thrust Area 3: Nuclear Explosion Monitoring

1. ## Infrasound
   - *University Lead: Milton Garcés, University of Hawaii*
   - *National Laboratory Collaborators: David Chichester, INL; A. Rodgers, K. Kim, J. Gaylord and Steven Magana-Zook, LLNL; David Bowman, SNL*

2. ## Seismology
   - *University Lead: Göran Ekström, Paul Richards, Won-Young Kim, Columbia University*
   - *National Laboratory Collaborators: Bill Walter and Mike Pasyanos, LLNL; W. Scott Phillips, LANL; Chris Young, SNL*

3. ## Environmental Fate and Transport of Radionuclides
   - *University Lead: Andreas Enqvist, UF*
   - *National Laboratory Collaborators: Mitch Myjak, PNNL; Rebecca Detwiler, PNNL*

4. ## Radionuclide
   - *University Lead: Sara Pozzi, UM*
   - *National Laboratory Collaborators: Natalia Zaitseva, Steve Payne, Nerine Cherepy, LLNL; Michael Foxe, Matthew Cooper, Ted Bowyer, PNNL*

5. ## Methodologies for Wide Area Environmental Sampling
   - *University Lead: Kyle Hartig, UF*
   - *National Laboratory Collaborators: Sivanandan Harilal, Mark Phillips, and Brian Brumfield, PNNL; Kristian Myhre, ORNL; Sam Clegg, LANL*

6. ## Radiation Background Monitoring
   - *University Lead: Kim Kearfott, UM*
   - *National Laboratory Collaborators: Karen Miller, LANL; Jared Johnson, ORNL*

Seismic Analysis of DPRK Nuclear Testing
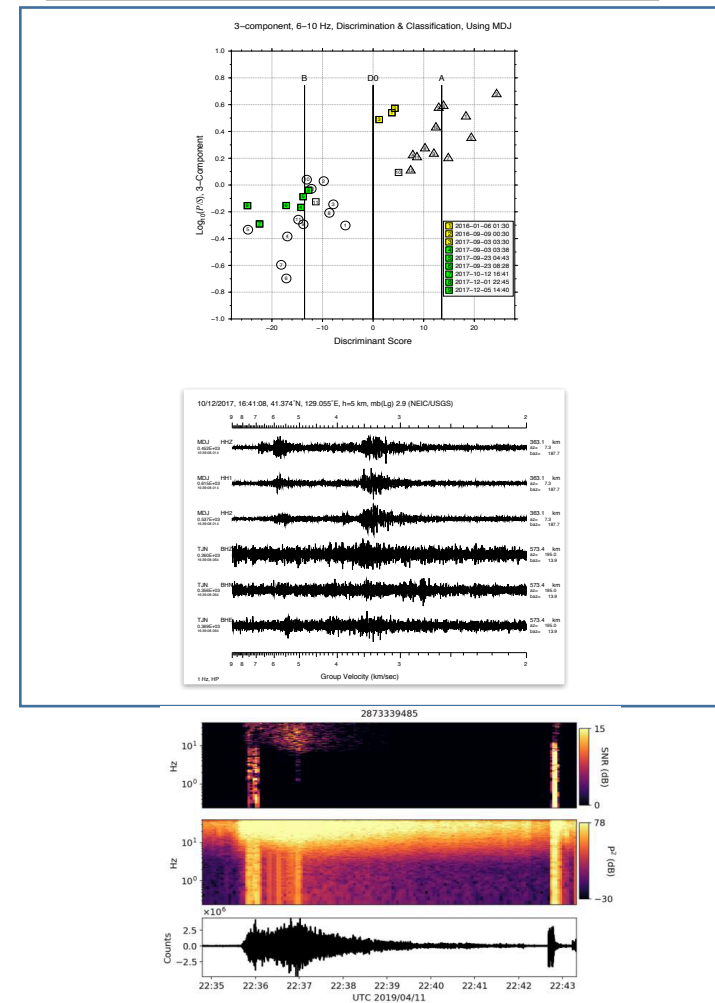
Falcon Heavy 11 April 2019, http://redvox.io/@/7d2b

Cross-cutting Thrust: Modeling and Simulation

- Develop and apply mathematical models, numerical and analytical methods, simulation tools, statistical techniques

- Four broad cross-cutting subject areas:
  - Environmental species transport modeling
  - Nuclear fuel cycle simulation
  - Radiation physics and transport
  - Statistical and data analysis methods
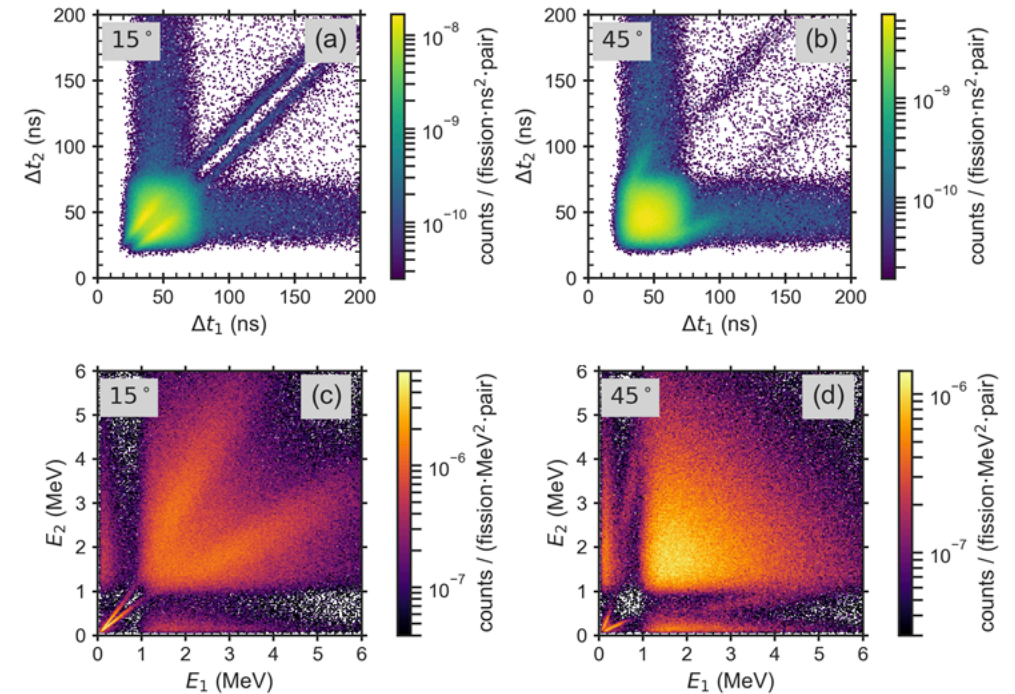


LEAD: BRIAN KIEDROWSKI, U. MICHIGAN

Cross-cutting Thrust: Nuclear Policy

- Foster an understanding among the students and postdoctoral researchers of how their technical work connects to policy

- Plan keynote addresses at the annual Consortium workshops by experts who are engaged at the technology/policy interface in nuclear non-proliferation

- Host an annual student non-proliferation policy paper competition, in which MTV-supported students will be encouraged to discuss the opportunities for, and challenges to, adoption of their research

- Encourage MTV students and postdocs to apply to the Center for Global Security Research program that is offered by LLNL

LEAD: PAUL WILSON, U. WISCONSIN

Source: KCNA
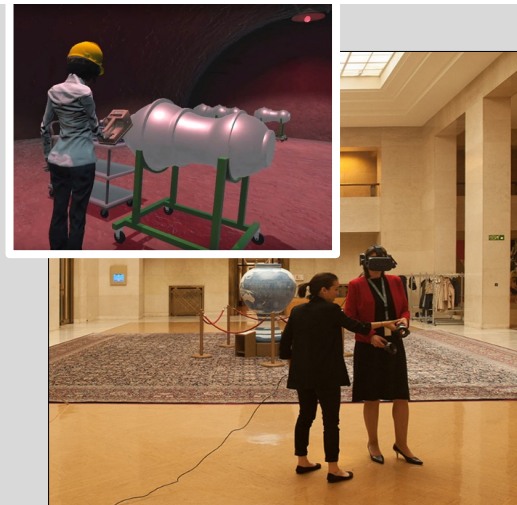
Source: Alex Glaser, Princeton

Source: U.S. Department of Energy

Cross-cutting Thrust: Education and Outreach

- MTV Research Fellowships
  - Undergraduate, graduate, and postdoctoral research fellows
  - Student and faculty national laboratory rotations
- Academic course development and enhancement
- Workshops
  - Annual MTV Workshop
  - MCNP, MCNP-X, GAENT-4, Field Programmable Gate Array Programming
- Early exposure to nuclear science and engineering education
  - Elementary, Junior High, and High School students
  - Presentations at other non-MTV colleges and universities
- Public exposure
  - Peer reviewed journal publications
  - Radiation Weather Station
  - Research presentations at scientific conferences
 - MTV Website and social media presence

Consortium Model Advantages

- Research excellence – through collaboration with other top institutions

  - Publications in top journals in field

- Increased visibility and recognition at the national and international level

  - Hosting high-level multidisciplinary meetings and technical workshops

- Enhanced opportunities for faculty, students and staff

  - Attract outstanding students to UM and partner institutions

- Enhanced outreach opportunities

  - Elementary school through high school students

Expected Outcomes and Impact

- A deeper understanding of fundamental nonproliferation-relevant nuclear physics processes, such as nuclear fission and antineutrino emission and interactions

- Enhanced sensors with capability to detect proliferation signatures from various activities such as enrichment, fuel cycle anomalies, and nuclear testing

- Next-generation set of modeling and simulation capabilities specifically suited to the field of nuclear nonproliferation and verification

- New, more sensitive and robust techniques for monitoring nuclear explosions

- More than 200 B. S., M. S., and Ph. D. graduates with unique training in the field of nuclear nonproliferation and strong ties to government, industry, and the national laboratory system
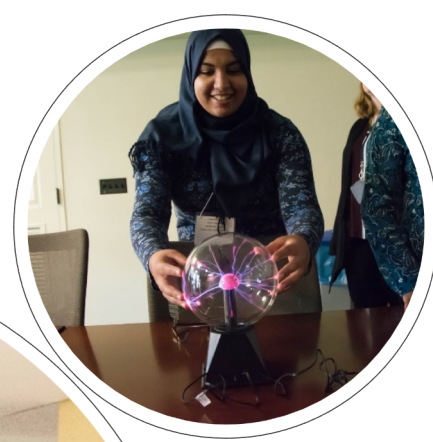
Acknowledgements

The Consortium for Monitoring, Technology, and Verification would like to thank the NNSA and DOE for the continued support of these research activities.