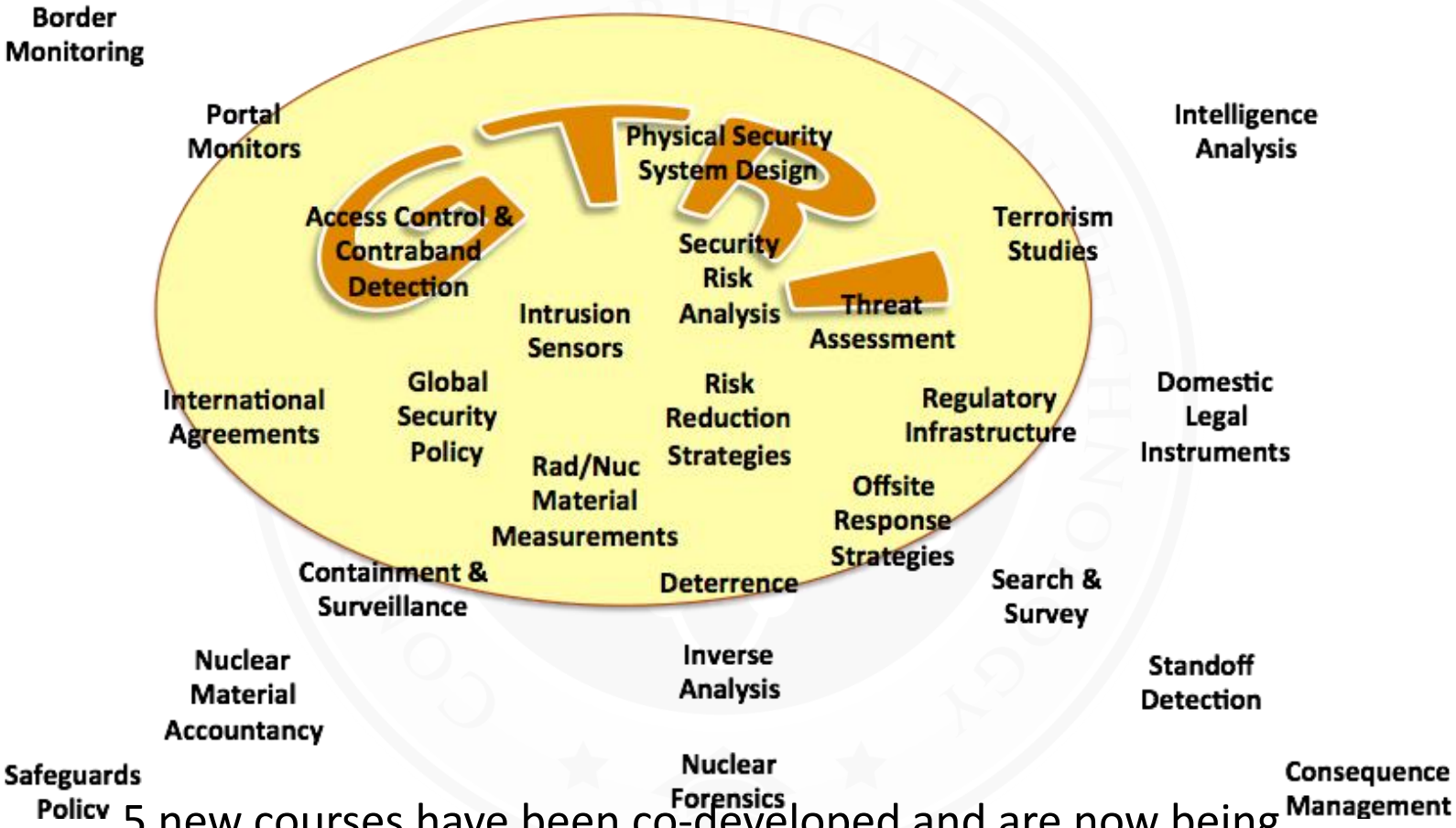
University Programs

Igor Jovanovic

Penn State University

National Nuclear Security Administration

The TAMU-PSU-MIT collaboration has been supported by NNSA - GTRI



5 new courses have been co-developed and are now being offered at the three partner universities.

The TAMU-PSU-MIT Nuclear Security Education Program

- Nuclear Security - Threat Analysis and Assessment
- Nuclear Security - Detector and Source Technologies
- Nuclear Security - Applications of Detectors/ Sensors/ Sources for Radiation Detection and
- Nuclear Security - Global Nuclear Security Policies
- Nuclear Security - Design and Analysis of Security Systems for Nuclear Reactors and Fuel Cycle Facilities

In the press…

National Nuclear Security Administration

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Press Release

First Graduates of Nuclear Security Education Program Announced

May 28, 2013

NNSA-established curriculum at MIT, Penn State University, Texas A&M University addresses growing need for trained nuclear security professionals

WASHINGTON, D.C. – The National Nuclear Security Administration (NNSA), the Massachusetts Institute of Technology (MIT), Pennsylvania State University and Texas A&M University have announced the first graduates of their new nuclear security program. This graduate-level program, which began in 2011, aims to develop and educate the next generation of personnel with careers in the nuclear and radiological security fields with both domestic and international focus.

NNSA, through its Global Threat Reduction Initiative (GTRI), collaborated with these three universities to design and develop curricula, course material and laboratory activities. The program provides a comprehensive education in nuclear security, primarily for nuclear engineering graduate students, and allows students to earn a nuclear security specialization for a Master of Science degree in a nuclear engineering program. Students can also receive a stand-alone graduate certificate in nuclear security.

"Developing the next generation of nuclear security experts is fundamental to the long-term security of our nation," said NNSA Deputy Administrator for Defense Nuclear Nonproliferation Anne Harrington. "Investing in the scientific and technical underpinnings of nuclear security helps to accomplish President Obama's vision of a safer world. These well-respected universities, and especially today's graduates, are to be commended for their efforts to enhance global peace and security."

"Penn State is pleased to participate with our partner universities in developing a nuclear security program that trains professionals at the graduate level who can advance nuclear security in the United States and beyond," said The Harold and Inge Marcus Dean of Engineering David N. Wormley.

"The Department of Nuclear Engineering is proud to be part of GTRI's education initiative in providing unique classroom and laboratory opportunities for the next generation of nuclear security professionals," said Dr. Yassin Hassan, department head and Sallie & Don Davis '61 Professor of the Department of Nuclear Engineering at Texas A&M University.

"Nuclear security research projects in MIT's Nuclear Science and Engineering Department are selected for their relevance to current policy problems, their multidisciplinary context, and their need for advanced levels of technical understanding," said Professor Richard Lester, head of the MIT Nuclear Science and Engineering Department. "The new GTRI-sponsored curriculum is helping to prepare our students to carry out this research and to pursue careers in the vitally important fields of nuclear and radiological security."

A set of five courses was developed for the nuclear security education program, with each school organizing one or two of the following: Threat Analysis and Assessment; Detector and Source Technologies; Applications of Detectors/Sensors/Sources for Radiation Detection and Measurements; Global Nuclear Security Policies; and Design and Analysis of Security Systems for Nuclear and Radiological Facilities.

GTRI and its university partners began cooperation to develop the curriculum and course material for this program in 2010, entering into a formal agreement to share all course material, as well as the workload and cost associated with development and implementation. The universities will continue to offer the courses at their own expense and to share the curriculum with other interested universities.

GTRI's mission is to reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide. GTRI achieves its mission by converting research reactors and isotope production facilities from the use of highly enriched uranium to low enriched uranium; removing excess nuclear and radiological materials; and protecting high priority nuclear and radiological materials from theft. Together these efforts provide a comprehensive approach to preventing terrorists' access to nuclear and radiological materials.

A fact sheet on NNSA's Global Threat Reduction Initiative is available online here.

Related Links

Press Releases

Headlines

May 28, 2013
First Graduates of Nuclear Security Education Program Announced

May 9, 2013
Statement on FY14 Budget Request Before the House Committee on Armed Services Subcommittee on Strategic Forces

May 8, 2013
Statement on FY14 Budget Request Before the Senate Committee on Armed Services Subcommittee on Strategic Forces

May 7, 2013
New Program Review and Analysis Office to Improve NNSA's Budgeting and Planning Capabilities, Increase Accountability

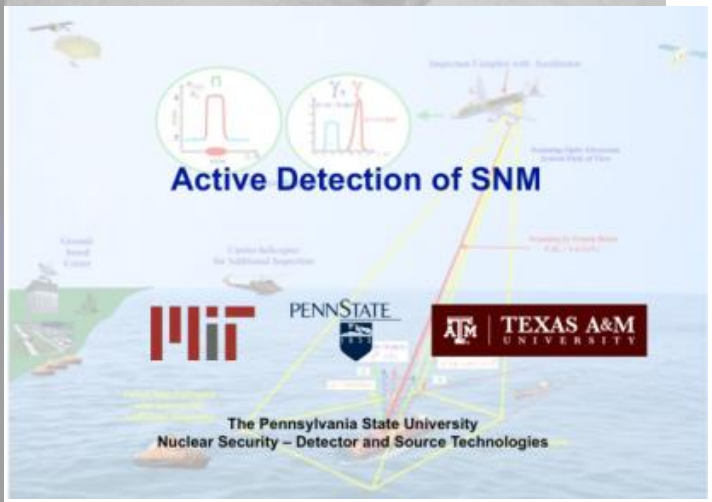
View All >

Timeline

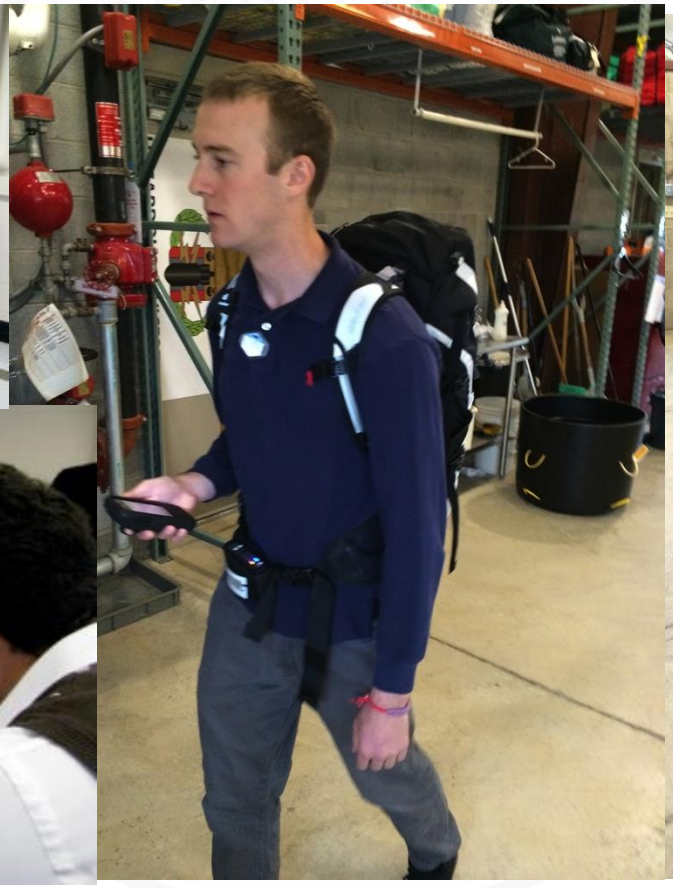
Curious about NNSA history? Check out our interactive timeline to learn about our historic accomplishments!

View NNSA Timeline

PSU: Detector and Source Technologies for Nuclear Security



PSU: Laboratory Nuclear Security Course and Field Search Exercise



Regular trips to ORNL / Y-12 for enrolled students

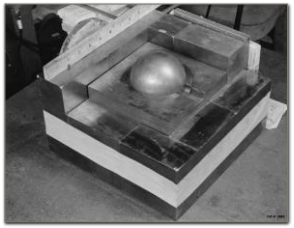
PSU – Fall 2014

Nuc E 597A • Fall 2014

Detector and Source Technologies for Nuclear Security

Prof. I. Jovanovic and Prof. K. Ünlü

MW 1:25 pm – 2.45 pm • Breazeale Nuclear Reactor • 3.0 credits

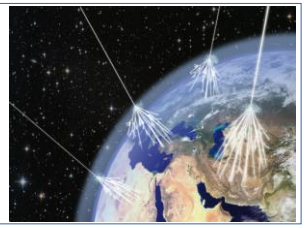


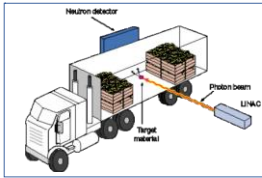
COURSE OBJECTIVES

The primary goal of this course is to educate the student on the theory behind radiation detection systems, sensors, and source technologies. It is expected that the student will develop a deep understanding and working knowledge of radiation detection instrumentation, systems, and measurement techniques, with a specific focus on detection of nuclear and radiological materials relevant for nuclear security and nuclear nonproliferation. By developing this understanding the student will able to identify and quantify the advantages and challenges of radiation detection technologies, including those used in the field.

TOPICS

- Radiation background and sources of radioactivity
- Measurement statistics and detection limits
- Signatures of nuclear materials and proliferation
- Passive detection of nuclear materials and proliferation
- Active detection of nuclear materials and proliferation
- Radiation portal monitors
- Field deployable radiation detection systems
- Analysis of environmental samples and nuclear forensics
- Radiation detection and remote sensing technology





COURSE MATERIALS AND TEXTBOOKS

In-class instruction will be supplemented with the handout material. Since the field is rapidly evolving, students will be exposed to those new developments. Students will carry out a project, typically an in-depth study of one of the detection systems or methodologies.

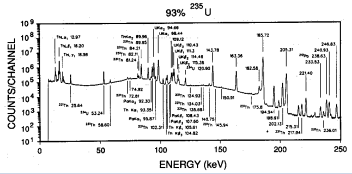
Recommended textbooks include:

Knoll: "Radiation Detection and Measurement"

Tsoulfanidis: "Measurement and Detection of Radiation"

PREREQUISITES

Undergraduate coursework in nuclear structure and radiation interactions and basic radiation detection is desirable. Completing the PSU Nuc E 450 course meets those requirements. For any specific questions on the adequacy of background preparation, please contact the instructors.



Nuclear Security Education Program

Nuc E 579B Fall 2014

Global Nuclear Security Policies

Prof. Kenan Ünlü
Director of Radiation Science and Engineering Center

Mr. Andrew Bieniawski
Vice President for Material Security and Minimization, Nuclear Threat Initiative

The primary goal of this course is to introduce students to the policies and laws that are intended to provide a secure environment for the pursuit of legitimate nuclear activities. After completion of the course, students should understand:

- The origins and history of controlling nuclear materials.
- Implications of increased civilian use of nuclear technology.
- The role of present and future technologies in the development of policies.
- How US and international strategies, policies and laws interact to promote global nuclear security.
- The roles and responsibilities of various agencies both national and international and the regulated parties in nuclear security.
- The strains imposed on the existing framework by the increased risk from non-state adversaries and possible approaches to better control these risks.
- Approaches to reduction of nuclear material and radioisotope inventories.

Students with a nuclear background should understand the political and economic basis for policies; those with a non-technical background should understand the technical limitations of policies and how they may change with changing technology. This course is graduate credits and can count as a Nuc E Technical Elective. Graduate students from other fields and Nuc E senior undergraduate students who are eligible for graduate courses can take this course. Please contact Prof. Ünlü at 865-6351 (kxu2@psu.edu) if you have any questions.

Fridays 1:30 to 4:30 pm

Location: Breazeale Nuclear Reactor Classroom

PENNSTATE

National Nuclear Security Administration

RADIATION SCIENCE & ENGINEERING CENTER

Radiochemistry Teaching at PSU

Six course have been developed:

- To familiarize students with the essential chemistry of the nuclear fuel cycle
- To meet the training needs for nuclear engineers and chemists in the nuclear workforce

Semester	Level	Module
1	**Introductory**	**Introduction to Actinide and Lanthanide Chemistry**
		Introduction to the Nuclear Fuel Cycle
2 (or 3)	Advanced	Nuclear Fuel Chemistry
		Nuclear Fuel Reprocessing and Separations Chemistry
3 (or 2)	Advanced	Radioactive Waste Management
		Environmental Actinide Chemistry

Radiochemistry Teaching at PSU

For nuclear engineers and chemists

Fundamental concepts and techniques:

- Nuclear counting
- Ion exchange chromatography
- Solvent extraction
- Tracer/dilution chemistry
- Environmental processes

Laboratory Experiments in Applied Nuclear and Radiochemistry

Program in Nuclear Nonproliferation at UM

- Responds to the urgent need of trained professionals in the area of nuclear nonproliferation and homeland security
- Goal: Attract the best students, from the U.S. and abroad, to study and conduct research at UM → *develop future leaders in the field*
- Graduate program at the MS and PhD level to include:
  - Radiation detection for nuclear materials identification and characterization
  - Fundamentals in nuclear engineering and nuclear science
  - Nonproliferation policy issues
- Student internships in world-class experimental facilities with subject-matter experts
- Build and expand collaborations with international institutions
  - ORNL, INL, SNL, LBNL, LANL, JRC Italy, JRC Belgium, Chalmers University of Technology, Sweden

Nuclear Measurements

Courses at UM

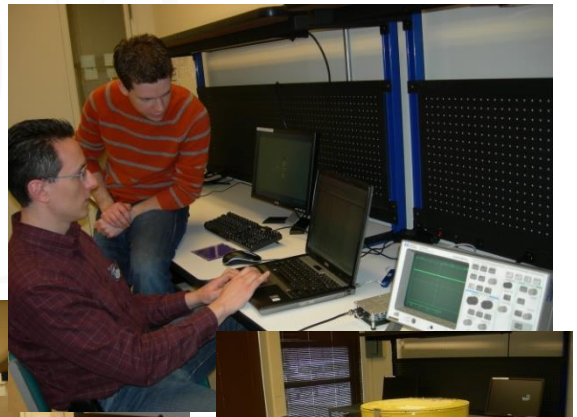
- Core Courses
  - NERS 515: *Nuclear Measurements Laboratory*
  - NERS 481/580: *Engineering Aspects of Radiation Imaging*
  - NERS 518: *Advanced Radiation Measurements*
  - NERS 590: *Monte Carlo Methods*
  - NERS 425: *Applied Nuclear Radiation Laboratory*
  - NERS 311/2: *Atomic and Nuclear Physics*
  - NERS 590: *Detection Techniques for Nuclear Nonproliferation*
  - NERS 590: *Nuclear Safeguards*
- Popular Courses
  - EECS 456: *Digital Signal Processing*
  - EECS 516: *Medical Imaging Systems*
- Courses Relevant to Particular Research Areas
  - EECS 423: *Solid State Device Laboratory*
  - NERS 576: *Charged Particle Accelerators*
  - EIH 694/695: *Radiation Dosimetry/Biology*
  - NERS 425: *Applied Nuclear Radiation*
  - NERS 554: *Radiation Shielding Design*

UM: Detection Techniques for Nuclear Nonproliferation

- Covers recent techniques for the detection, identification, and characterization of nuclear materials, including the study of Monte Carlo simulations, and measurements with gamma-ray and neutron sources
- Course enrollment
  - Winter 2008 – 17 students
  - Fall 2009 – 11 students
  - Fall 2010 – 19 students
  - Fall 2011 – 21 students
  - Fall 2012 – 22 students
  - Fall 2013 – 17 students
  - Fall 2014 – 19 students
- Course content
  - Nuclear nonproliferation; homeland security
  - Introduction to the physics of nuclear fission
  - Monte Carlo simulations for nuclear nonproliferation applications
  - Passive and active inspection of SNM
  - Detectors and safeguards instruments; digital pulse shape analysis

UM: Detection Techniques for Nuclear Nonproliferation (exercises)

- This course contains five, two-week laboratory exercises
  1. Hands-on use of Monte Carlo codes (MCNP5, MCNP-PoliMi)
  2. Pulse shape discrimination using liquid scintillators
  3. Measurement of coincident fast neutrons and gamma rays with liquid scintillators and a ^{252}Cf source
  4. Enrichment measurements on uranium samples
  5. Active photon interrogation simulations



UM New Course:

Nuclear Safeguards

- Course content
  - History of nuclear safeguards
  - International safeguards policy
  - Nondestructive assay techniques
  - Typical safeguards instruments for neutron and gamma-ray detection
  - Data analysis for nuclear material identification and characterization

- Students enrolled in the course take part in the week-long training offered at the Safeguards Laboratory at Oak Ridge National Laboratory for a hands-on safeguards experience

UM: Science and Energy Policy Courses (Gerald R. Ford School of Public Policy)

- There are numerous course available to our students through Ford School of Public Policy
  - PUBPOL 224 – *Nuclear Proliferation*
  - PUBPOL 481 – *Science, Technology, and Public Policy*
  - PUBPOL 650 – *Introduction to Science and Technology Policy Analysis*
  - PUBPOL 655 – *Energy in World Politics*
  - PUBPOL 654 – *Science and Technology in International Affairs*
  - PUBPOL 673 – *International Security Affairs*

OSU: Nuclear Arms Control and Non-Proliferation

Political Science Program (Fall 2014)

- Instructor: Dr. David Bernell
- Lecturer: Ambassador Thomas Graham Jr.

- Examines the history, politics and current challenges involving nuclear weapons.
- Addresses the Cold War era, including the arms race and the many arms control treaties signed between the US and Soviet Union, as well as the Nuclear Nonproliferation Treaty.
- Looks at contemporary issues such as the problem of proliferation, along with regional issues in South Asia, Iran, and North Korea.

OSU: Introduction to Nuclear Forensics

Department of Nuclear Engineering and Radiation Health Physics (Fall 2014)

Instructor: Dr. Camille Palmer

- Nuclear forensics is focused on obtaining, characterizing, and interpreting data resulting from intercepted nuclear or radioactive materials with the objective of providing technical evidence to support attribution.
- The attribution process can help identify nuclear threats, either state or non-state actors, and ultimately help deter the use of nuclear weapons.
- The course will provide an overview of the nuclear forensics approach touching on relevant technical areas such as nuclear explosive devices, chronometry (age-dating), radiochemical procedures, SNM detection, material fingerprinting and attribution.

Princeton Course: Unmaking the Bomb: The Science and Technology of Nuclear Nonproliferation, Disarmament, and Verification

MAE 354 / MAE 574, Princeton University, Spring 2015
Instructor: Alexander Glaser

Course description: This course covers the science and technology underlying existing and emerging nuclear security issues. Part I introduces the principles of nuclear fission, nuclear radiation, and nuclear weapons (and their effects). Part II develops the concepts required to model and analyze nuclear systems, including the production of fissile materials and the detection and characterization of these materials with radiation measurement techniques. Relevant applications are explored in Part III and include nuclear forensic analysis, nuclear archaeology, and nuclear warhead verification. Such case studies will also be part of the final projects. The course is open to juniors, seniors, and graduate students (with permission of the adviser).

NCSU Courses

- NE591: *Nuclear Nonproliferation Technology and Policy*
  - Offered every Spring semester since 2010
  - Supported by NNSA Next Generation Safeguards Initiative
  - Developed in collaboration with ORNL
    - About half the lectures are given by ORNL scientists
    - Students travel to ORNL Safeguards Lab for 1 week
- NE795: *Characterization of SNM*
  - New course created in 2014; offered every other Spring semester
  - Supported by DHS National Nuclear Forensics Expertise Development Program
  - Students characterize an "unknown" source of Category I SNM using low- and high-resolution gamma spectroscopy and neutron multiplicity counting

NCSU: Certificate Program

- The NCSU Nuclear Engineering and Political Science departments are currently developing a graduate certificate in Nuclear Nonproliferation Science and Policy

- The program will consist of 15 semester hours (5 courses) in Nuclear Engineering and Political Science

- Courses will focus on nuclear science and political science contributing to the development of international nonproliferation policy

Columbia - Earth Institute

Mainly, a seismology group (> 20 people) with a Ph. D program that has engaged in all aspects of explosion monitoring since the 1950s

- development of seismometers and building global networks methods for discriminating between earthquake and explosion signals participation of personnel in test-ban treaty negotiations (by Frank Press, Lynn Sykes, Paul Richards)
- joint projects in Russia, Kazakhstan; many regional studies
- Funding from DARPA, US Air Force, DTRA, Dept. of State, now NNSA

- 2003 new course introduced: WMD (85% nuclear WMD) – 50 students/yr
- From this year taught by a Physics faculty member

UF: Related Classes

- ENU 4930 – Introduction to Nuclear Safeguards
  - Tied with visit to ORNL, taught annually
- ENU 6937 – Perspectives on Nuclear Security and Non-Proliferation
  - Topics vary by professor, but has been taught by former and retired national laboratory staff
  - This year's focus has been to detector development and radiation measurements within security and non-proliferation topics
- ENU 4930 – Introduction to Nuclear Criticality Safety

UF: Florida Institute for National Security

- Provides graduate students multi-year scholarships (stipend plus-ups) and signing bonuses for students working on national security related/funded projects
- Consolidates all faculty/research in rad/bio/chem/nuke security research under one flag

PNNL's Nuclear Security Summer School (NSSS)

- Universities that have sent students include
  - UF, Georgia Tech, TAMU, UT-Austin, UT-Knoxville, Wisconsin, WSU, Washington, NC State, UC-Berkeley, Ohio State, Umass-Lowell, CSM, MSU, Penn State
- Lecturers and lab instructors include: Bob Runkle, Mitch Woodring, and Jim Baciak
- Guest Lecturers vary year-to-year, but have included:
  - Arden Dougan, David Beach, David Bowman
  - Eric Smith, Jon Schwantes, Dave Kostorowski, Jason Shergur
- We limit number of students to 12-16

Course Outline & Activities




Week 1 – Foundations

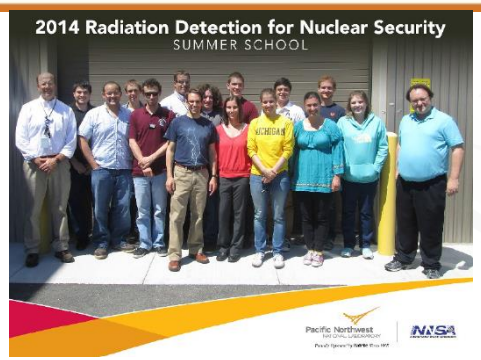
Lectures include
- Fundamentals of Radiation Detection
- Gamma-ray Spectroscopy
- Neutron Multiplicity Counting
- Nuclear Fuel & Enrichment

Activities include
- Modeling Source Terms
- Detector Sensitivity vs. Selectivity
- Neutron Moderation

Week 2 – Applications

Lectures include
- Nuclear Safeguards
- Arms Control & Treaty Verification
- Interdiction
- Emergency Response

Activities include
- Border Guard Training
- Tours of AREVA Fuel Fabrication Plant & Hanford B Reactor



We will be offering the Nuclear Security Summer School again in June 2016. Specific dates will be announced in the fall of 2015.