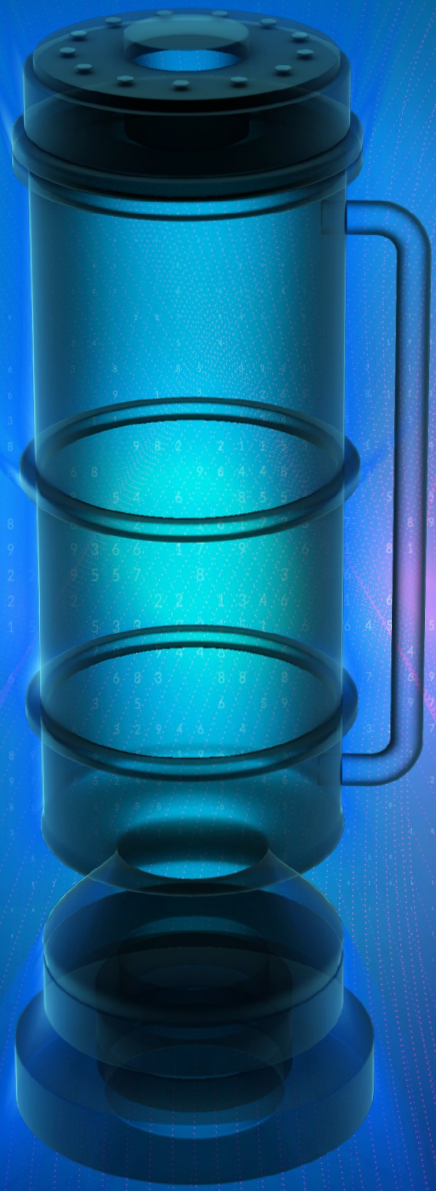
UNIVERSITY *Directory*



GAIN Gateway for Accelerated Innovation in Nuclear

TABLE OF CONTENTS

INTRODUCTION

The GAIN University Directory features a sample of universities engaged in the development of advanced nuclear technologies and should not be considered a comprehensive list of universities. All universities have participated on a voluntary basis and are responsible for the information provided. Inclusion of a university does not indicate endorsement by GAIN.

ACKNOWLEDGMENT

The GAIN University Directory was created by the Gateway for Accelerated Innovation in Nuclear (GAIN).

GAIN
Gateway for Accelerated Innovation in Nuclear

The mission of the GAIN initiative is to provide the nuclear energy industry with access to the technical, regulatory, and financial support necessary to move advanced nuclear technologies toward commercialization, while ensuring the continued reliable and economic operation of the existing nuclear reactor fleet. GAIN offers a single point of access to the broad range of capabilities across the Department of Energy (DOE) national laboratory complex. DOE has invested billions of dollars to build and maintain its nuclear research expertise and infrastructure. This vast capability is being leveraged via GAIN to support commercialization of new advanced nuclear technologies.

GAIN is operated through Idaho National Laboratory and works in partnership with Argonne National Laboratory and Oak Ridge National Laboratory.

If you have questions regarding the directory or other GAIN related activities please contact GAIN at GAIN@inl.gov.

UNIVERSITIES

Idaho State University

Location: Pocatello, ID
Website: www.isu.edu
Department: Department of Nuclear Engineering and Health Physics
Department Website: www.isu.edu/ne
Point of Contact: Chad Pope, PhD., PE
popechad@isu.edu
208-282-2875

Located primarily in eastern Idaho, Idaho State University (ISU) possesses one of the few ABET-accredited B.S. nuclear engineering programs in the midwestern and western United States. ISU maintains a set of nuclear research facilities on its Pocatello campus, including a fully-functional nuclear reactor (AGN-201) that is licensed by the U.S. NRC. These facilities have been and are currently used for experimental and training purposes, including numerous campaigns with both industrial and governmental clientele, in the past several decades

Idaho State University

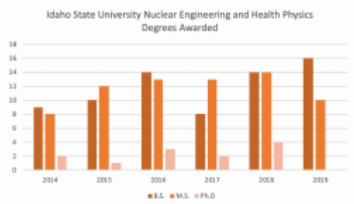
Nuclear Engineering and Health Physics

RESEARCH AREAS

- Nuclear fuel cycle, radioactive waste management and materials development
- Nuclear and criticality safety
- Experimental and analytical reactor physics
- Plasma physics
- Thermal hydraulic experiments and modeling
- Computational fluid dynamics of heat transfer
- Fuel systems, fuel testing, performance modeling
- Health effects of low level radiation
- Internal dosimetry - biokinetics and radioactive material translocation
- Radiation detection and measurement
- Environmental health physics
- Computational nuclear sciences

RESEARCH FOR FY 2019

- $1.4 million in research expenditures



RESEARCH CENTERS

- AGN-201M 5W Reactor Laboratory
- Enviornmental Assessment and Monitoring Laboratories
- Idaho Accelerator Center
- Center for Advanced Energy Studies (CAES)
- Component Flooding and Evaluation Laboratory (CFEL)

PARTNERSHIPS

- Idaho National Laboratory (INL)
- US Nuclear Regulatory Commission (NRC)
- US Department of Energy (DOE)
- State of Idaho

FACULTY AND STAFF

- 6 tenured/tenure-track professors
- 8 adjunct professors
- 3 support staff members

AWARDS AND DISTINCTIONS

- ABET accredited programs
- Dr. Mary Lou Dunzik-Gougar, associate professor, is the 2019 president-elect of the ANS
- Local student section of ANS is 50 years old

Nuclear Engineering and Health Physics | (208) 282-2902 | isu.edu/ne

Idaho State University

Massachusetts Institute of Technology

Location: Cambridge, MA
Website: http://web.mit.edu
Department: Department of Nuclear Science and Engineering
Department Website: http://web.mit.edu/nse
Point of Contact: Jacopo Buongiorno
jacopo@mit.edu
617-253-7316

The Department of Nuclear Science and Engineering (NSE) at MIT provides educational opportunities for undergraduate and graduate students interested in advancing the frontiers of nuclear science and engineering and in developing applications of nuclear technology for the benefit of society and the environment. We prepare our students to make contributions to the scientific fundamentals of our field; to the development and engineering of nuclear systems for energy generation, security, health care, and other applications; and to the integration of nuclear systems into society and the natural environment.

Our mission is to help develop the next generation of technical leaders of the global nuclear enterprise and to provide technical leadership in energy and non-energy applications of nuclear technology.NSE has a vibrant portfolio of fission research activities, which are conducted under the coordination of the Center for Advanced Nuclear Energy Systems (CANES), presently directed by Prof. Jacopo Buongiorno. CANES aims to hasten the development of new and transformative technologies, materials, and methods that will make nuclear fission more affordable, and more rapidly and securely deployable.

NSE
Nuclear Science and Engineering

science : systems : society

NSE has a vibrant portfolio of fission research activities, which are conducted under the coordination of the Center for Advanced Nuclear Energy Systems (CANES), presently directed by Prof. Jacopo Buongiorno. CANES aims to hasten the development of new and transformative technologies, materials, and methods that will make nuclear fission more affordable, and more rapidly and securely deployable.

Research projects range from innovations in LWR technologies to new reactor concepts, from development of new nuclear materials and fuels to research on novel approaches to spent fuel disposal, from fundamental studies of thermal-hydraulic phenomena and in-reactor fuel/materials behavior, to advanced methodologies for reactor physics and CFD analyses.

Flagship projects include:

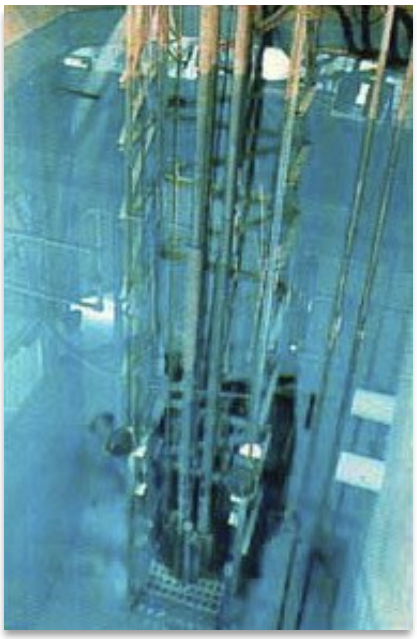
- The recently completed Future of Nuclear Energy in a Carbon-Constrained World study, sponsored by grants from the Sloan Foundation, Shell, EDF, General Atomics, and the Packard Foundation (led by Prof. Jacopo Buongiorno and involving 6 MIT faculty and students, one Harvard Faculty and several external consultants)
- Three large, multi-faculty contracts with DOE-NE:
  1. The Consortium for Advanced Simulation of LWRs (led by Prof. Kord Smith),
  2. The Integrated Research Program on Salt Cooled Reactors (led by Dr. Charles Forsberg)
  3. The Integrated Research Program on Accident Tolerant Fuels (led by Prof. Koroush Shirvan).

CANES' research volume is >$10M/ year. About 70% is from DOE and its laboratories and NSF, while 30% comes from industry, foreign labs and private foundations and donors. The non-DOE share of our fission portfolio is higher than that of any other nuclear engineering department in the US. An additional $700K/year in revenues come from professional education courses offered by CANES faculty, such as the Nuclear Safety Course (MIT's oldest running professional course), the Reactor Technology Course for Nuclear Utilities Executives, and the Risk-Informed Operational Decision Making course. The latter two courses are offered jointly with the Institute for Nuclear Power Operations (INPO).

Missouri University of Science and Technology

Location: Rolla, MO
Website: https://www.mst.edu/
Department: Department of Nuclear Engineering
Department Website: https://nuclear.mst.edu
Point of Contact: Hyoung (Hank) Lee
leehk@mst.edu
573-341-4747

We have nine dedicated full-time faculty with diverse research areas in nuclear engineering and related areas. We have received several research grants from U.S., Department of Energy, U.S. Department of Education, Nuclear Regulatory Commission, Army Research Lab, U.S. Defense Advanced Research Projects Agency, etc. The research areas include thermal-hydraulics, reactor physics, fuel cycle, small modular reactor design, nuclear waste disposal, nuclear materials, radiation detection and measurements, radiation shielding, nuclear forensics, radiochemistry, and radiation imaging.



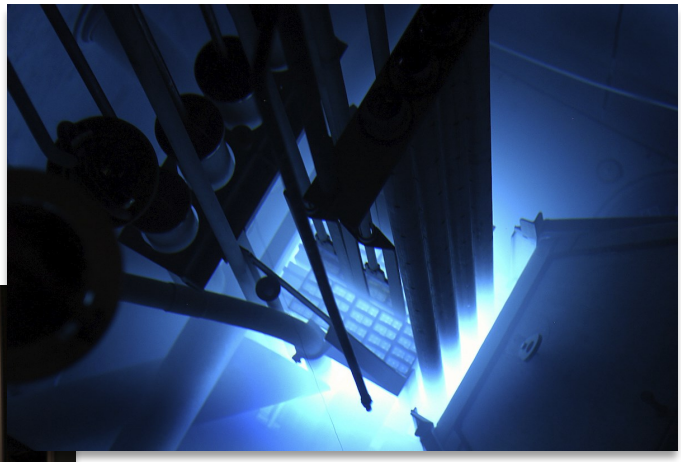
We have a 200 kW nuclear reactor and a fusion of deuterium atoms (D+D) neutron generator as well as several research labs including radiation measurement and spectroscopy lab, nanotechnology, nuclear forensics and radiochemistry lab, two-phase and multi-phase flow lab, hydrogen and mass spectrometry lab, nuclear materials lab, radiation imaging lab, and high-performance computer lab.

NC STATE UNIVERSITY

Location: Raleigh, NC
Website: https://www.ncsu.edu
Department: Department of Nuclear Engineering
Department Website: www.ne.ncsu.edu
Point of Contact: Lisa Marshall
lisa.marshall@ncsu.edu
919-515-5876

Our faculty, professional staff as well as undergraduate and graduate nuclear engineering students are multidisciplinary in scope and possess skill sets in the follow research areas:

- Nuclear Power Design and Safety Analysis
- Radiation Science and Engineering
- Plasma Science and Engineering
- Nuclear Materials, Waste Forms and Storage
- Nuclear Security and Non-Proliferation
- Nuclear Computational Science



NC State University

The Ohio State University

The Ohio State University

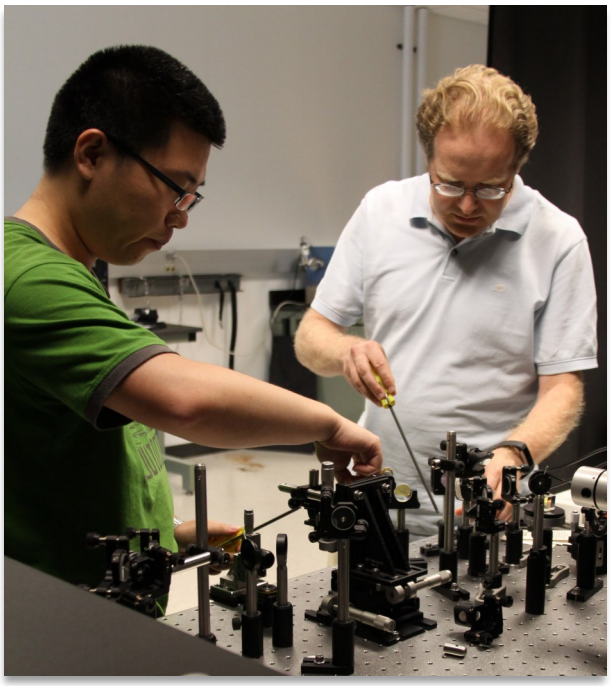
Location: Columbus, OH
Website: https://www.osu.edu
Department: Nuclear Engineering Program, Department of Mechanical and Aerospace Engineering
Department Website: https://mae.osu.edu/nuclear
Point of Contact: Joanne Holland
holland.129@osu.edu
614-292-3204

The Nuclear Science and Engineering application area covers research in a number areas including the application of radiation, radioactive materials and nuclear fission in the areas of nuclear power, nuclear non-proliferation, radiation safety, and environmental management.

Research topics include: Risk, Reliability, and Safety Analysis (Aldemir, Smidts, Wang) includes nuclear reactor safety, probabilistic safety/risk assessment (PSA/PRA) of large engineering systems, non-linear system diagnostics and prognostics, reliability analysis, nuclear power plant severe accident analysis modeling, dynamic methods of PRA, uncertainty quantification in dynamic systems, and fire risk assessment.

Reliability and Risk Research @ Ohio State University with GSE for the GPWR Full Scope Simulator

Applied Nuclear Physics and Radiation Science (Blue, Cao, Khafizov, Sinha, Vasques) is concerned with the interaction of different forms of ionizing radiation with materials and the modeling and simulation of radiation transport. Applications include the development of novel sensors to detect radiation, nuclear reactor kinetics, advanced nuclear instrumentation and measurement



methodology, the damage caused by radiation on material properties, use of neutrons, gamma- and X-rays as an interrogation or probing tool to study advanced materials or to characterize special nuclear materials, radiography, radiation therapy, and the mathematical modeling and numerical simulations of neutron and photon transport problems.

Nuclear Instrumentation and Control (Aldemir, Smidts, Sinha) covers instrumentation and control systems, software reliability modeling, automated software testing, human reliability analysis, digital systems reliability and risk assessment, advanced nuclear reactor instrumentation.

Nuclear Materials, Fuel Cycles, Waste Management Radiation Transport, Reactor Physics, and Thermal Hydraulics (Vasques and Wang) encompasses the mathematical modeling and computational methods development of radiation transport through matter, reactor physics, and reactor thermal hydraulics. Research includes the fields of neutron and photon transport, reactor core physics and kinetics, thermal hydraulics modeling and simulation, advanced reactors design, radiation shielding, nuclear security and non-proliferation, radiography, and radiation therapy, to name a few.

Labs and Centers:

- Reliability and Risk Laboratory
- Nuclear Computing Group
- Nuclear Reactor Laboratory
- Nuclear Analysis and Radiation Sensor Laboratory (NARS)

Oregon State University

Location: Corvallis, OR
Website: https://oregonstate.edu
Department: School of Nuclear Science & Engineering
Department Website: www.ne.orst.edu
Point of Contact: Wade Marcum
wade.marcum@oregonstate.edu
541-737-3018

Oregon State University is uniquely positioned with infrastructure which is capable of supporting advanced reactor testing and experimental work. Oregon State University has and utilizes numerous large-scale thermal hydraulic test facilities which support nuclear reactor license applications and technology qualification processes through the Department of Energy and Nuclear Regulatory Commission.

Location: Norwich, CT
Website: https://www.threerivers.edu
Department: Nuclear Engineering
Department Website: https://www.threerivers.edu/academics/degrees-certificates/nuclear-engineering-technology
Point of Contact: James Sherrard
jsherrard@trcc.commnet.edu
860-215-9472

This is the only program of its kind in New England, one of three in the country, and considered the best in the nation. Through classroom, laboratory, and simulator instruction, this program will educate you in the theories underlying the safe operation of nuclear power generating stations. Additional "hands-on" experience may be gained through 12 weeks of summer co-op employment at Millstone Station's nuclear power plants. This program operates in cooperation with Millstone Station to prepare you as an entry-level technician primarily for the commercial nuclear power industry. This career path involves further training by the utility and successful completion of a license examination administered by the Nuclear Regulatory Commission. For many students, the Associate Degree in Nuclear Engineering Technology is but one step in their academic career as they move on to pursue higher degrees upon graduating from Three Rivers.

University of Idaho - Idaho Falls

University of Idaho
Idaho Falls

Location: Idaho Falls, ID
Website: https://www.uidaho.edu/idaho-falls
Department: College of Engineering, Department of Nuclear Engineering and Industrial Management
Department Website: www.uidaho.edu/engr/departments/neim
Point of Contact: Dr. Indrajit Charit
icharit@uidaho.edu
208-757-5550

The University of Idaho's Idaho Falls Center is uniquely positioned to offer outstanding research and educational opportunities to students. The university has had an educational contract with the Department of Energy's Idaho National Laboratory (INL) to deliver programs and services for more than 65 years. The first courses were offered in 1954 and since then students have earned more than 1200 degrees. Located near INL and home for the Center for Advanced Energy Studies (CAES), U of I Idaho Falls is a premier graduate, research and development center. Students from around the world attend classes and earn degrees at our campus.

U of I Idaho Falls is currently addressing state and national energy needs in partnership with INL. We provide diverse research-based graduate science, engineering and technology programs with a limited number of undergraduate degree programs. A new masters program in cybersecurity will begin in Fall 2021. The Idaho Falls location's existing Reconfigurable Attack-Defend Instructional Computing Laboratory (RADICL) will be joined by a cyber-physical systems lab that is under development.

Students can also earn graduate academic certificates in areas such as Nuclear Criticality Safety, Emergency Planning and Management, Critical Infrastructure Resilience, Nuclear Decommissioning and Used Fuel Management and Nuclear Technology Management. The Nuclear Technology Management certificate is one of just a dozen such certificates in the world and was developed in collaboration with the International Atomic Energy Agency.

In Summer 2021, the installation of the U of I/NuScale reactor plant simulator has been completed. The virtual nuclear power plant control room located in CAES provides the ability to observe nuclear power plant behavior. The facility will be used for research, education, K-12 outreach and public advocacy regarding nuclear power and small modular reactor (SMR) technology.

In partnering with INL, CAES and other state universities, U of I Idaho Falls delivers advanced education and research programs that promote excellence in scholarship, leadership and critical thinking to enhance today and prepare f or tomorrow.

University of Illinois at Urbana-Champaign

Location: Urbana, Illinois
Website: https://illinois.edu
Department: The Grainger College of Engineering Department of Nuclear, Plasma, and Radiological Engineering
Department Website: http://npre.illinois.edu
Point of Contact: Susan Mumm
s-mumm@illinois.edu
217-244-5382

Nuclear, Plasma, and Radiological Engineering at the University of Illinois focuses research in these areas: materials, nuclear power, plasma physics and fusion, radiological science, and reliability and risk.

Materials research includes mechanical properties of cladding and other structural components, and heat exchanger materials. Advanced microanalytical analysis techniques are employed to perform nano-scale interrogation of deformation, precipitation, and chemical segregation studies. Ion beam bombardment of materials runs concurrent with these techniques to simulate fast neutron displacement cascade damage. Fuel performance modeling, molecular dynamics, and kinetic Monte Carlo simulations complement these experimental activities. NPRE researchers study nuclear fuel such as urania, including mass transport and mechanical property studies. Tangentially related work exists in studying hydrogen in metals, including hydride phase formation and solute dislocation pipe diffusion. Research also includes materials far from equilibrium and in extreme environments, such as extreme properties of liquids, various glassy materials, and soft materials.

Included are application of both advanced materials characterizations using neutron and synchrotron light at the national laboratories and atomistic modeling and simulation.

Nuclear power research covers all aspects of nuclear power generation, including reactor physics, thermal-hydraulics, safety, reliability and risk, instrumentation and control, training and education, human factors engineering, reactor materials, nonproliferation, etc. Safety and continued operation of existing reactors and new reactor designs are explored. Cross-cutting areas of research include multi-physics and multi-scale modeling and simulation, high performance computing, reliability and risk, validation and verification, and uncertainty analysis.

Plasma physics/fusion research themes cover magnetic and inertial nuclear fusion as well as plasma engineering. The five research themes that span this work are: fusion materials, plasma-material interface (PMI) diagnostics, plasma-edge and PMI modeling, plasma nanosynthesis and plasma sources and processing.

Radiological sciences research focuses on developing techniques that use ionizing radiation for detection for homeland security and nuclear safeguards, as well as for biomedical research and healthcare. Researchers develop gamma-ray, x-ray and neutron detectors and imaging detectors, and algorithms for analyzing data. NPRE researchers develop advanced diagnostic imaging and radiation-induced therapeutic approaches to address critical healthcare-related issues.

Reliability/Risk research focuses on Probabilistic Risk Assessment (PRA) for the risk-informed nuclear regulatory framework. Work includes developing multidisciplinary PRA and a common vocabulary within diverse engineering and social science domains to enhance prevention of catastrophic accidents and protect the environment.

University of Maryland

Location: College Park, MD
Website: https://www.umd.edu
Department: Department of Mechanical Engineering, Center of Risk and Reliability
Department Website: https://crr.umd.edu
https://radiationumd.edu
Point of Contact: Katrina Groth
kgroth@umd.edu
301-405-5215

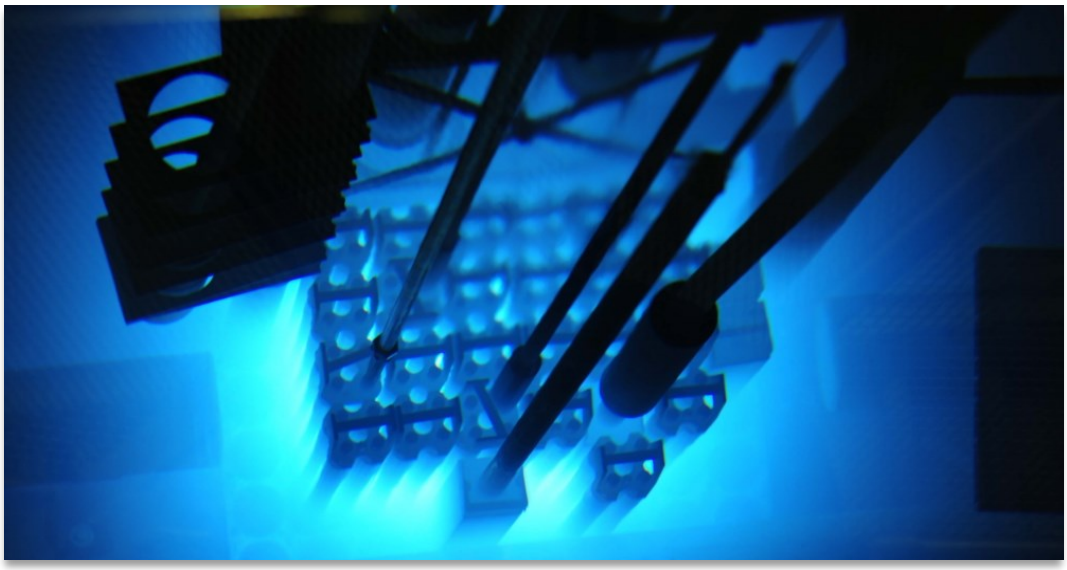
The University of Maryland's A. James Clark School of Engineering conducts research in the areas of nuclear safety, risk and reliability, materials engineering, and radiological science. UMD research occurs throughout the Clark school, with major emphasis in the Center for Risk and Reliability (housed in the Department of Mechanical Engineering), and the Radiation Facilities (housed in the Department of Materials Science and Engineering)

Safety, risk and reliability research in the Center for Risk and Reliability (CRR) draws expertise from 15 faculty spanning the Clark School's various departments. CRR provides research leadership in the development of fundamental risk and reliability science and new frontiers in safety, security, risk and reliability studies that includes probabilistic risk assessment, data analytics, machine learning, prognostics and health management, complex engineering systems and structures, human reliability analysis, cybersecurity, and resilience engineering.

CRR's laboratories include System Risk and Reliability Analysis (SyRRA), Cybersecurity Quantification (CQ), Hybrid Systems Integration and Simulation (HSIS), and Probabilistic Physics of Failure and Fracture (PPoFF) laboratories. CRR is the research arm of UMD's reliability engineering educational program, largest and most comprehensive M.S. and Ph.D. degree granting reliability engineering program in the U.S.

UMD's Radiation Facilities house the Maryland University Training Reactor (MUTR), a panoramic Co-60 irradiator, and an electron linear accelerator (LINAC). The MUTR is a very early model 250 kW General Atomics low enrichment uranium TRIGA reactor that was installed in 1970 as an upgrade from a 10 kW HEU Materials Testing Reactor previously installed in 1960. The UMD NRC license is #70 (Docket R -70). The facilities support teaching, research, and service for UMD as well as many collaborators including many national laboratories and other prestigious institutions. The Dry Cell Gamma Irradiator allows for the irradiation of a wide variety of sample sizes with dose rates that range from just a few krad/hr to over one Mrad/hr. The LINAC is a modified Varian Clinac-6 (V7715) with a variable electron beam energy from 2 to 10 MeV, which provides 1 kW of beam power through moderating the beam current. Experimental activities include gamma and neutron irradiation in the reactor, high dose rate gamma or electron irradiations, a thermal neutron imaging station, and neutron activation analysis.

A major focus of UMD's Radiation Facilities educational efforts is preparing undergraduate students for the safe and reliable operation of our training reactor. A reactor and radiation measurements class is offered as part of the nuclear engineering undergraduate minor.



University of Massachusetts-Lowell

UMASS LOWELL

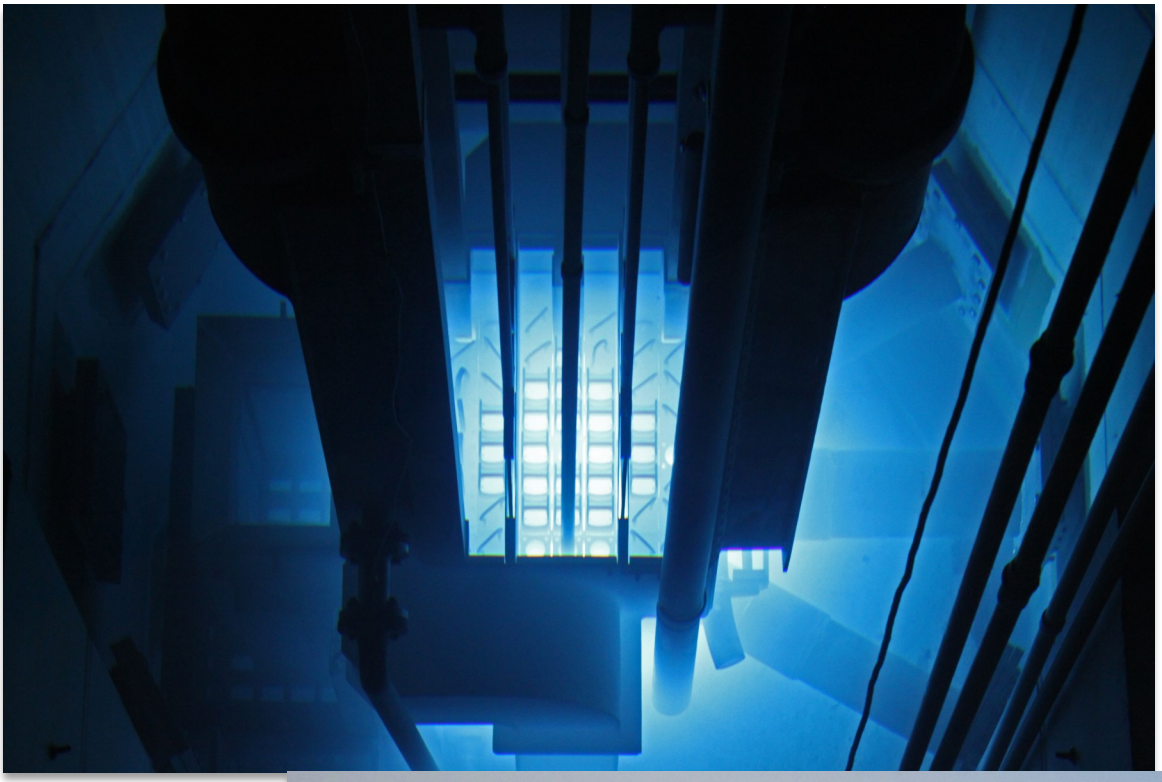
Learning with Purpose

Location: Lowell, MA
Website: https://www.uml.edu
Department: Department of Chemical Engineering, Nuclear Engineering Program
Department Website: https://www.uml.edu/nuclear
Point of Contact: Sukesh Aghara
nuclear@uml.edu
978-934-3115

The academic program in Nuclear Science and Engineering (NS&E) education at UMass Lowell has been established since 1960's. UMass Lowell offers Bachelors (ABET accredited), Masters, and a Doctorate programs with focus in NS&E.

The Nuclear Engineering track resides in the Francis College of Engineering and the Radiological Science track resides in the College of Sciences. The NS&E program is delivered by ~ 16 faculty members. The NS&E has several well established research groups in nuclear fuel cycle, thermal hydraulics, advance separations, reactor kinetics and advanced detectors.

The radiation laboratories house 5.5 MeV Van de Graaff accelerator, 1 MWt GE open pool type research reactor, advanced detection laboratory, Integrated Nuclear Security and Safeguards Laboratory (INSSL), Cybersecurity Testbed, Nuclear Reactor Thermal-Hydraulics Lab and several other facilities.



The University has funded research from DOE, NEUP, NRC, NNSA, DoD, IAEA, DOE national laboratories and industry partners.

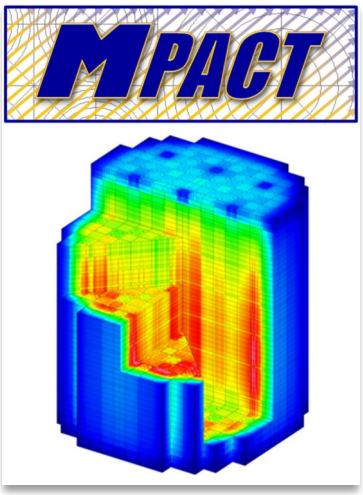
University of Michigan

Location: Ann Arbor, MI
Website: https://umich.edu, https://engin.umich.edu
Department: Nuclear Engineering & Radiological Sciences
Department Website: https://ners.engin.umich.edu
Point of Contact: Brendan Kochunas
bkochuna@umich.edu
734-763-3867

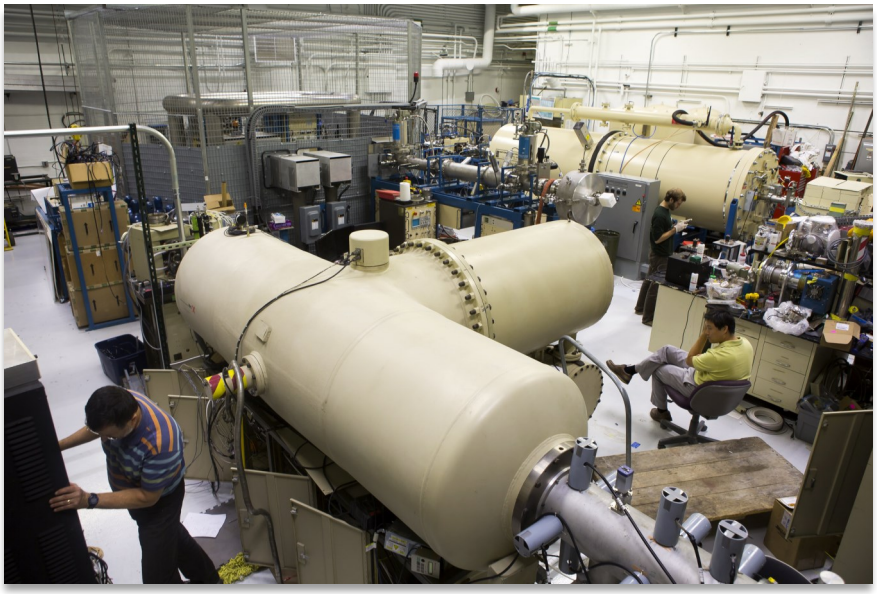
Nuclear Engineering & Radiological Sciences (NERS) at the University of Michigan (U-M) is a community of students and world-renowned faculty working side-by-side to ensure that the benefits of nuclear and radiological technology are used to advance and improve society in the 21st Century. We aim to be the global academic leader in the innovation and evolution of nuclear engineering.

Our research contributes to the advanced reactor community in several areas, including: Detection—The Applied Nuclear Science Group (Jovanovic) has an active research program in advanced optical sensors for nuclear power systems that focuses on the design and use of novel radiation detectors, including antineutrino detectors for safeguards and monitoring of nuclear reactors and other power systems.

Fission/Transport—The Nuclear Reactor Analysis and Methods Group (Downar, Kochunas) develops and maintains the PARCS Nodal Simulator, the primary neutronics auditing tool used by the US Nuclear Regulatory Commission for reactor licensing and evaluation (Downar). The group also developed and maintains the high-fidelity core simulator MPACT (Kochunas). MPACT is an advanced, full core, 3D, deterministic transport solver within VERA. The group has extensive expertise in reactor analysis & design, computational reactor physics methods, safety analysis, multiphysics applications, and numerical methods.



Cliimate/Policy—The Fastest Path to Zero Initiative offers a variety of tools to help communities achieve ambitious climate goals by adopting carbon-zero technology including advanced nuclear reactors. The Initiative also works to connect key nuclear research insights with policymakers.



Materials—To support our wide range of materials research (Was) there are two facilities: the Michigan Ion Beam Laboratory (MIBL) and the Irradiated Materials Testing Laboratory (IMTL). The MIBL is the only triple ion beam facility in the US and also includes the capability to conduct dual ion irradiation in situ in a transmission electron microscope. The IMTL houses five stress corrosion cracking systems for the study of crack initiation and crack growth in neutron-irradiated material in reactor environments.

The MIBL and IMTL are part of NERS's unparalleled portfolio of laboratories—18 in total—which include:
Experimental & Computational Multiphase Flow Laboratory
High-Temperature Corrosion Laboratory
Irradiated Materials Testing Complex
Michigan Ion Beam Laboratory
Neutron Science Laboratory
Nuclear Plant Simulation Laboratory
Radiation Detection Laboratory
Thermal-Hydraulics Laboratory

The College of Engineering at U-M has 11 separate departments spanning a vast range of disciplines, which gives our professors substantial opportunity for cross-disciplinary collaboration. U-M also boasts several relevant, unique institutes/facilities, including:
Michigan Institute for Computational Discovery & Engineering
Michigan Institute for Data Science
Michigan Materials Research Institute
Ford Motor

University of Pittsburgh

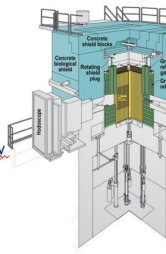
Location: Pittsburgh, PA
Website: https://www.pitt.edu
Department: Nuclear Engineering program, Swanson School of Engineering
Department Website: https://www.engineering.pitt.edu/nuclear/
Point of Contact: Dr. Tom Congedo
tvc9@pitt.edu

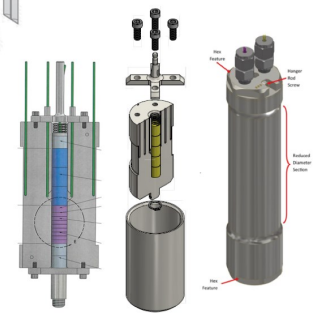
Pitt's Nuclear Engineering program provides in-depth coverage of NE subject areas, and combines them directly into a deeper understanding of nuclear system operations and safety. Our research opportunities cover the MS level in NE, and also the doctoral level in disciplines addressing current leading edge advanced reactor research. Our active research areas currently include: Experiments and Testing to measure Fuel Performance and irradiation effects on fuel Thermal Conductivity; Use of embedded fiber-optic sensors in-situ; Advanced Online Monitoring and Diagnostic Technologies; Materials Degradation in Lead-cooled reactors; Additive manufacturing simulation and production of advanced system components; Cyber Security; and SMR containment response in severe accident conditions. We therefore bring the strengths of the entire Swanson School of Engineering to our development of new solutions for unique new reactors.

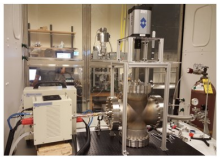
Transient Reactor Experiments for Fuels

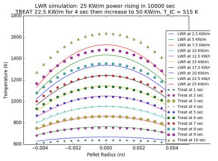
Project Goals

1. **Fuel Fracture**
   - I. Sudden Heating Experiment
   - II. Sudden Cooling Experiment
2. **Cladding Failure**
   - I. Mechanical Test of Hydrided Zircaloy Cladding
   - II. Computational Model Development
3. **Transient Boiling**
   - I. Flow Loop Experiment (Inverted Heating)
   - II. Pool Experiment (Wire Heating)
4. **TREAT Integral Experiment**
   - I. TREAT Fuel Experiment



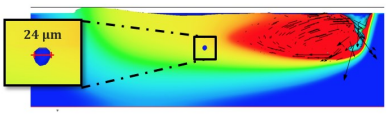


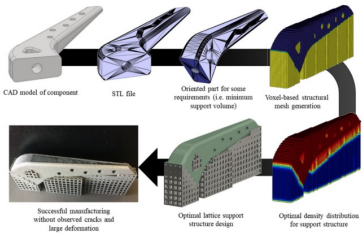


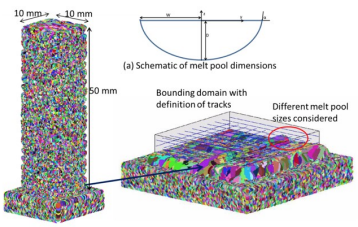


AM Modeling & Simulation Capabilities

- Fast process simulation
- Residual stress/distortion modeling
- AM-oriented topology optimization
- Process-microstructure-property modeling







University of Pittsburgh

THE UNIVERSITY OF TENNESSEE KNOXVILLE

Location: Knoxville, TN
Website: utk.edu
Department: Department of Nuclear Engineering
Department Website: ne.utk.edu
Point of Contact: Dr. Wes Hines
jhines2@utk.edu
865-974-2525

Because of our recent growth to more than twenty full time faculty members, we are currently spread out over several buildings. To meet the sustained expansion of the Departments faculty, teaching, and research; a new engineering complex (pictured) is under construction with a move-in date of 2021. This new 228,000 square-foot facility will triple our current space with 21st Century offices, classrooms, study areas, lounge areas, and twenty-three new state of the art laboratories dedicated to nuclear engineering.

Established in 1957, the Department of Nuclear Engineering at the University of Tennessee (UTNE) is the first, and one of the largest and most prestigious programs in the United States, consistently ranked among the top ten in the nation by U.S. News and World Report. It currently is the third largest nuclear engineering program with the most Nuclear Engineering PhD students in the nation.

The department has a strong research program with close collaborations with Oak Ridge National Laboratory (ORNL), the Y-12 Nuclear Security Complex, and several industrial partners. Four of the faculty have joint appointments with ORNL or Y-12 and several ORNL and Y-12 scientists have joint appoints with UTNE. These relationships provide for sharing of specialized laboratories and equipment.

The department has a broad range of research expertise including nuclear reactor fuels and materials, advanced modeling and simulation, nuclear security, nuclear fuel cycle, nuclear fusion technologies, radiological sciences and health physics, nuclear criticality safety, nuclear reactor dynamics and control, reliability and maintainability engineering, nuclear system reliability and risk assessment, radiation transport, and thermal hydraulics.

With respect to advanced reactors, the department has specializations and conducts research in many areas including:

• Advanced Fuels including accident tolerant cladding and ceramic composite TRISO-bearing fuel.

• Computational modeling and measurements of nuclear fuel performance and radiation effects in materials and materials in extreme environments

• Instrumentation and Control including Autonomous Operations

• Monitoring Diagnostics, and Prognostics of High Value Assets

• Advanced Modeling and Simulation of Nuclear Reactor Systems

• Nuclear Reactor Kinetics and Dynamics with an emphasis on the important reactor multi-physics phenomena and its impact on reactor safety performance

• Molten Salt Reactor Modeling and Design

Key partnerships include:

• Oak Ridge National Laboratory, which is the largest DoE science and energy laboratory, which provides exceptional researchers with distinctive equipment and unique facilities to solve some of the nation's most compelling challenges.

• Y-12 Nuclear Security Complex, which is a DoE National Nuclear Security Administration facility located in Oak Ridge and is a premier manufacturing facility dedicated to making the nation and the world a safer place.

The University of Utah

Location: Salt Lake City, UT
Website: www.utah.edu
Department: College of Engineering, Department of Civil and Environmental Engineering, Nuclear Engineering
Department Website: https://www.nuclear.utah.edu
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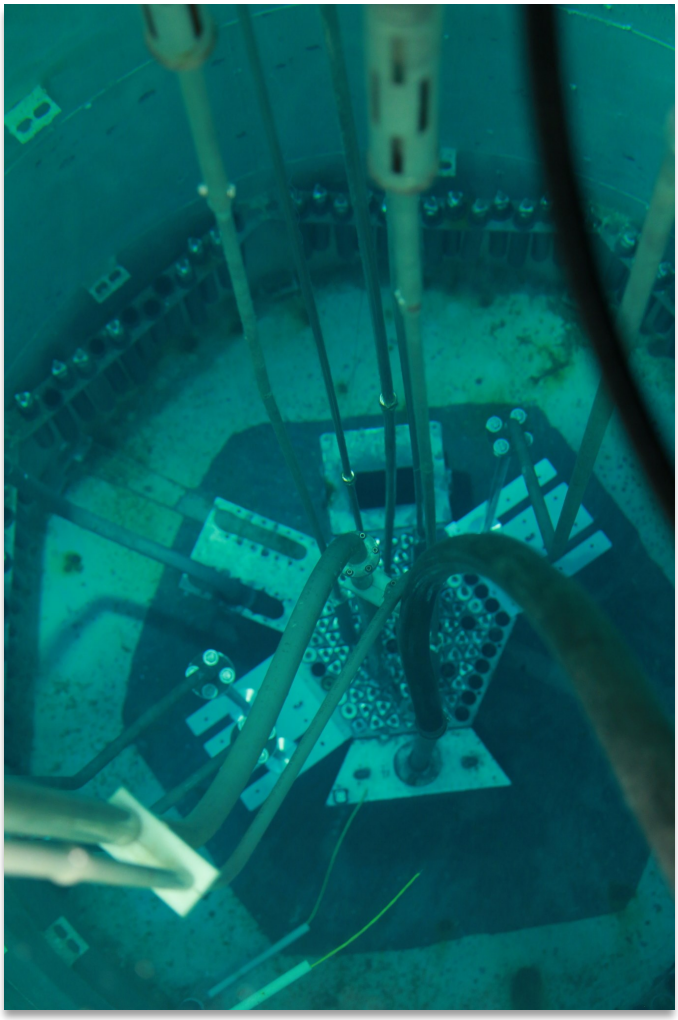
courtney.phillips@utah.edu

Housed within the Department of Civil and Environmental Engineering (CVEEN) at the University of Utah, the Utah Nuclear Engineering Program (UNEP) has two separate graduate degrees (M.S. non-thesis and Ph.D. in Nuclear Engineering) as well as an undergraduate minor. As part of Utah's flagship research university and proud member of the Pac-12 Conference, UNEP is responsible for educating the next generation workforce in critical nuclear engineering fields and developing innovative procedures and technologies for the advancement of nuclear applications.

Our areas of specialization encompass neutron activation, radiation detection, radiochemistry, actinide chemistry, nuclear material performance, numerical modeling of nuclear infrastructure, and isotope production and nuclear medicine.

Our graduates have a well-rounded background in Nuclear Principles and Engineering covering Radiation Interactions, Reactor Physics, Health Physics, Nuclear Instrumentation as well as additional research specific elective classes. We operate a 100 kW TRIGA Reactor with thermal irradiation and fast irradiation ports.

UNEP faculty research is grouped into four areas: nuclear materials and structural analysis, actinide chemistry and radiochemistry, neutron activation and radiation detection, and isotope production and nuclear medicine. The Nuclear Materials and Structural Analysis area collaborates with the structural engineering area within CVEEN.



They have focused research capabilities on seismic assessment and monitoring of nuclear structures, risk assessment of storage and transportation, BISON mechanical capabilities, nuclear fuel synthesis, neutron and gamma damage experimentation, analysis and modelling and post-irradiation sample testing.

The actinide chemistry and radiochemistry research included detonation nuclear forensics, f-element compound synthesis and thermodynamic measurements, synthesis and evaluation of novel resins for separation of actinides and lanthanides, production of high purity targets for heavy actinide production (Am and Pu), radionuclide transportation modelling and remediation strategies.

The third area of neutron activation and radiation detection includes detector development and testing, radiation hardness experimentation, development of electronics for radiation applications, in-situ gamma and neutron testing, radiation transport simulations, and environmental monitoring of trace contaminants.

Isotope production and nuclear medicine is the final area that includes production and separation of radionuclides for imaging and treatment of cancer and other diseases, targeted radiotherapy applications, PET/SPECT imaging applications, and production of actinides including Pa, Np, Pu, and Am.

University of Wisconsin-Madison

Location: Madison, WI
Website: https://www.wisc.edu/
Department: Institute for Nuclear Energy Systems, Department of Engineering Physics
Department Website: https://www.engr.wisc.edu/department/engineering-physics/
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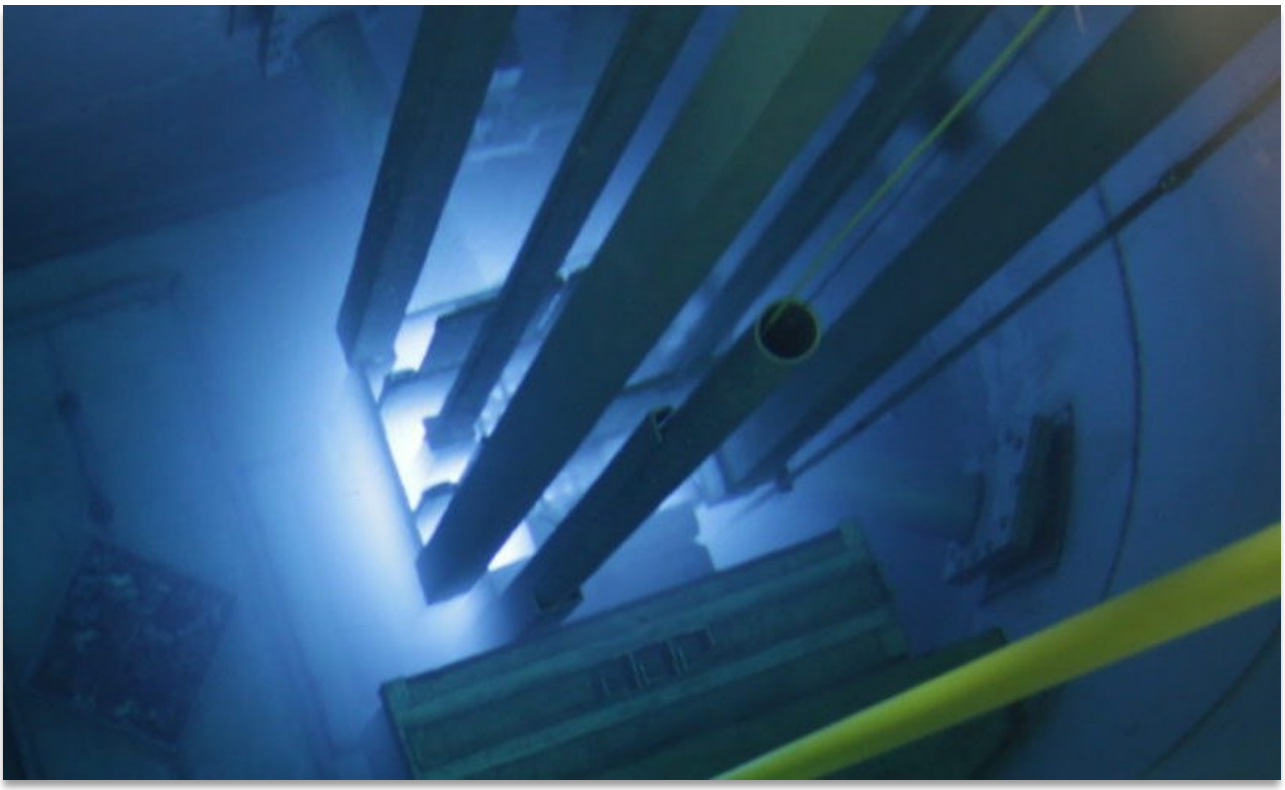
The Institute for Nuclear Energy Systems (INES) is the primary home for all nuclear energy research, teaching, and outreach at the University of Wisconsin-Madison. Based in the Department of Engineering Physics, INES includes researchers from across the College of Engineering and beyond. Through individual and collaborative projects, INES contributes to the advancement of peaceful uses of nuclear science and technology, particularly applications related to low-carbon production of electricity and other energy products. Our multidisciplinary faculty offer expertise in a wide range of topics and many collaboration opportunities for both undergraduate nuclear engineering and graduate nuclear engineering & engineering physics degree paths. Some of our key research programs focus on the following areas:

INSTITUTE FOR NUCLEAR ENERGY SYSTEMS

University of Wisconsin-Madison

Some of our key research programs focus on the following areas:

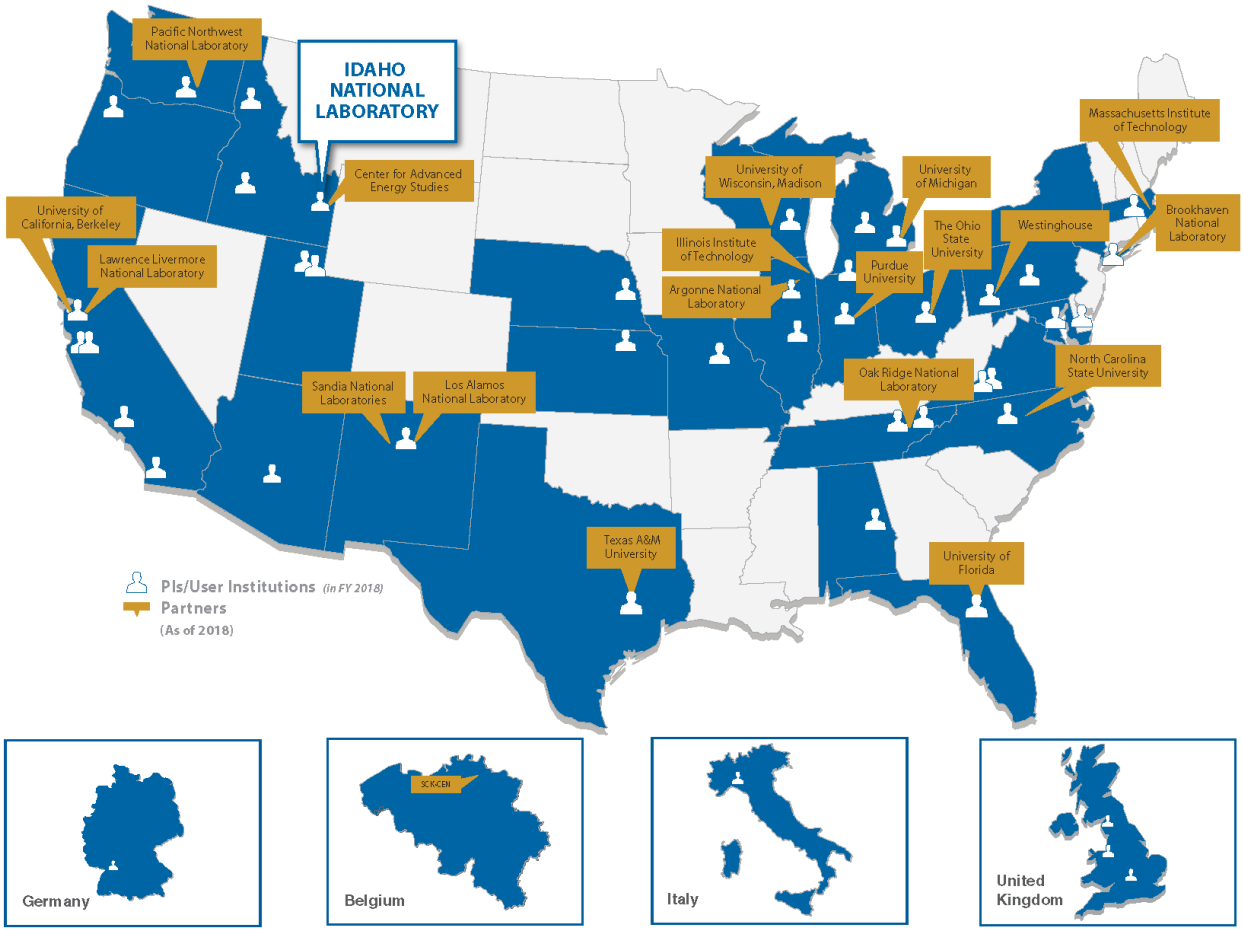
- Current and Advanced Fission Reactor Thermal Hydraulics
- Radiation Transport, Reactor Physics & Nuclear Fuel Cycles
- Integrated Energy Systems
- Nuclear Materials
- Irradiation Effect Studies
- Corrosion Studies
- Nuclear Security Studies



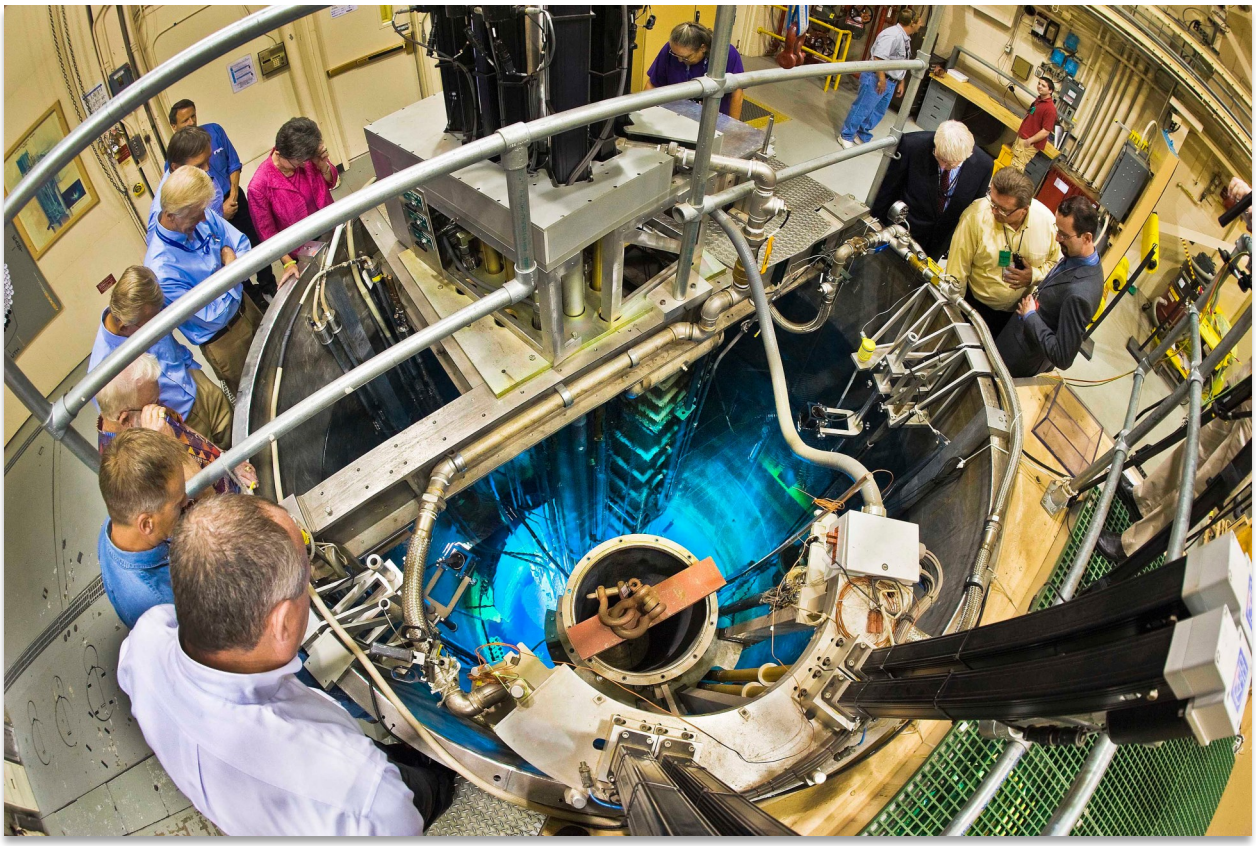
UNIVERSITY RESOURCES

Nuclear Science User Facilities

The Nuclear Science User Facilities (NSUF) offers unparalleled research opportunities for nuclear energy researchers. Users are provided access (at no cost to the researcher) to world-class nuclear research facilities, technical expertise from experienced scientists and engineers, and assistance with experiment design, assembly, safety analysis and examination.



Location: Idaho Falls, ID
Website: www.nsuf.inl.gov
NSUF Director: Rory Kennedy
Point of Contact: Tiera Cate
Tiera.cate@inl.gov
208-403-8844

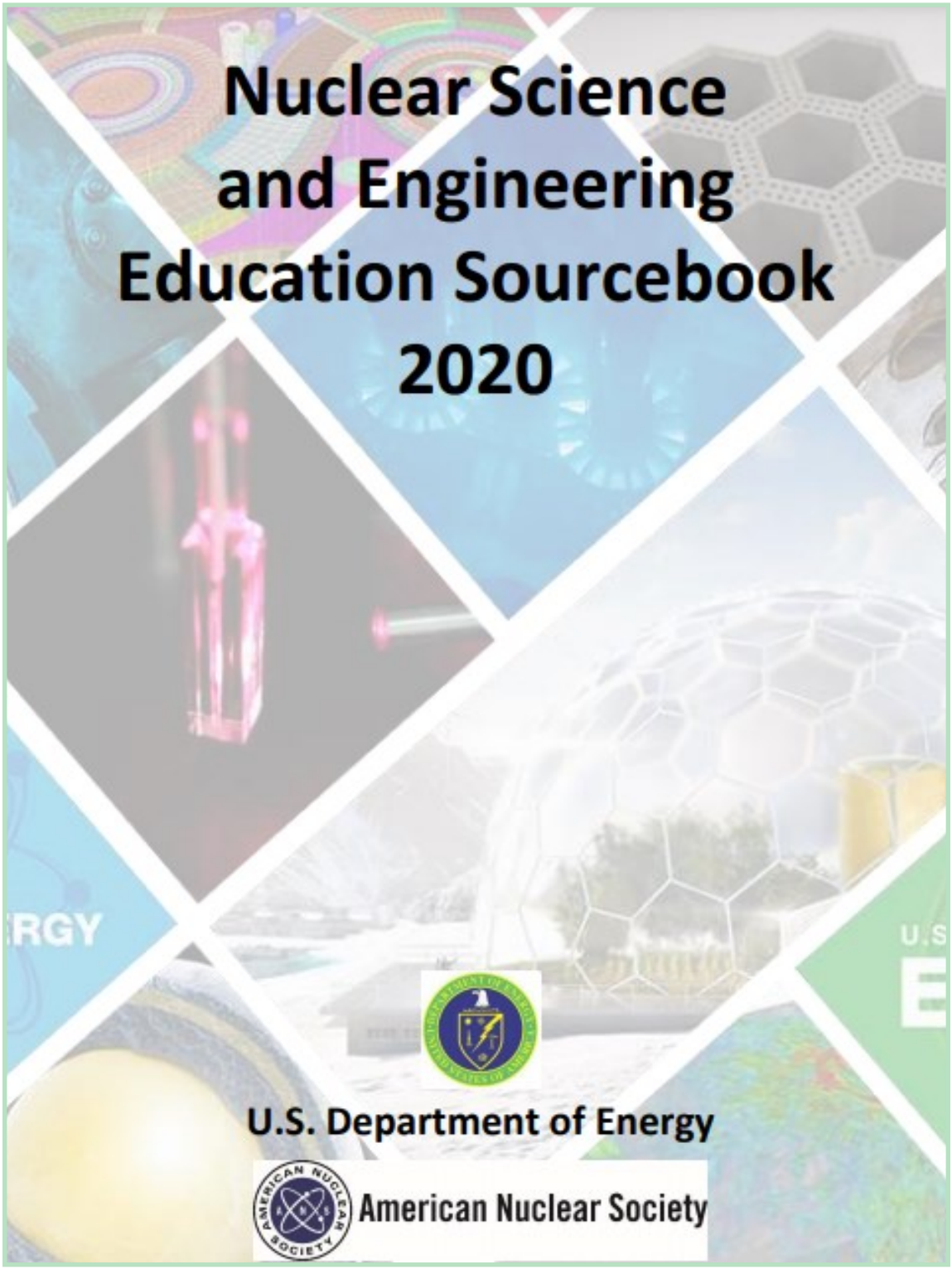


Sandia Annular Core Research Reactor

Access to NSUF's 49 facilities at 21 partners institutions is awarded through two competitive peer-reviewed processes, Consolidated Innovative Nuclear Research (CINR) and the Rapid Turnaround Experiment (RTE). NSUF staff is available to help any researcher who desires to submit a proposal. Submitted proposals should be consistent with the DOE-NE mission and its programmatic interests. These include light water reactor sustainability, fuel cycle research and development, advanced modeling and simulation, and advanced reactor technology programs. All NSUF research must be non-proprietary and results are expected to be published.

Nuclear Science and Engineering Education Sourcebook 2020

Nuclear Science and Engineering Education Source Book 2020



Cover Photo - Graphic from U.S. Department of Energy Office of Nuclear Energy Website

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GAIN Gateway for Accelerated Innovation in Nuclear

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