Re-Establishment of the Nuclear Engineering Program at Virginia Tech

Eugene F. Brown
Alireza Haghighat
Mark Pierson

presented by
Leigh Winfrey

Nuclear Engineering Program

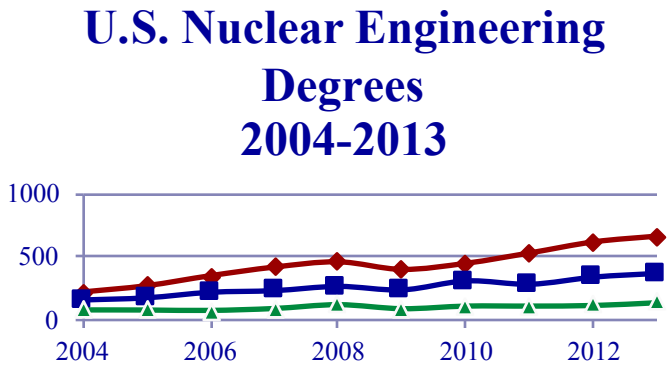
Mechanical Engineering Department

July11, 2014
Virginia Tech

VirginiaTech
Invent the Future

Virginia Tech Nuclear Engineering Program

History & Motivation

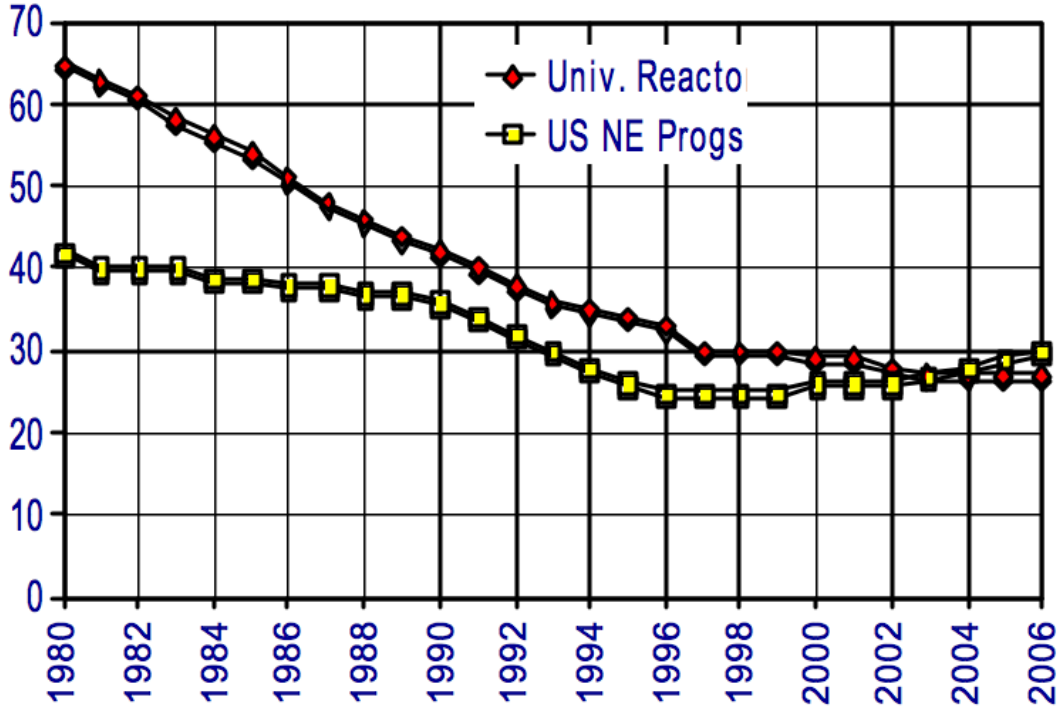


Curriculum

Future Vision

VirginiaTech
Invent the Future

In 1980's and 1990's, the number of NSE university programs at undergraduate and graduate levels in the US shrank from 42 to about 25 before rising back to 29 by 2006



American Nuclear Society, *Nuclear's Human Element*, La Grange Park, IL, 2006.

Today there are about 32 NSE programs

Virginia Tech was no exception

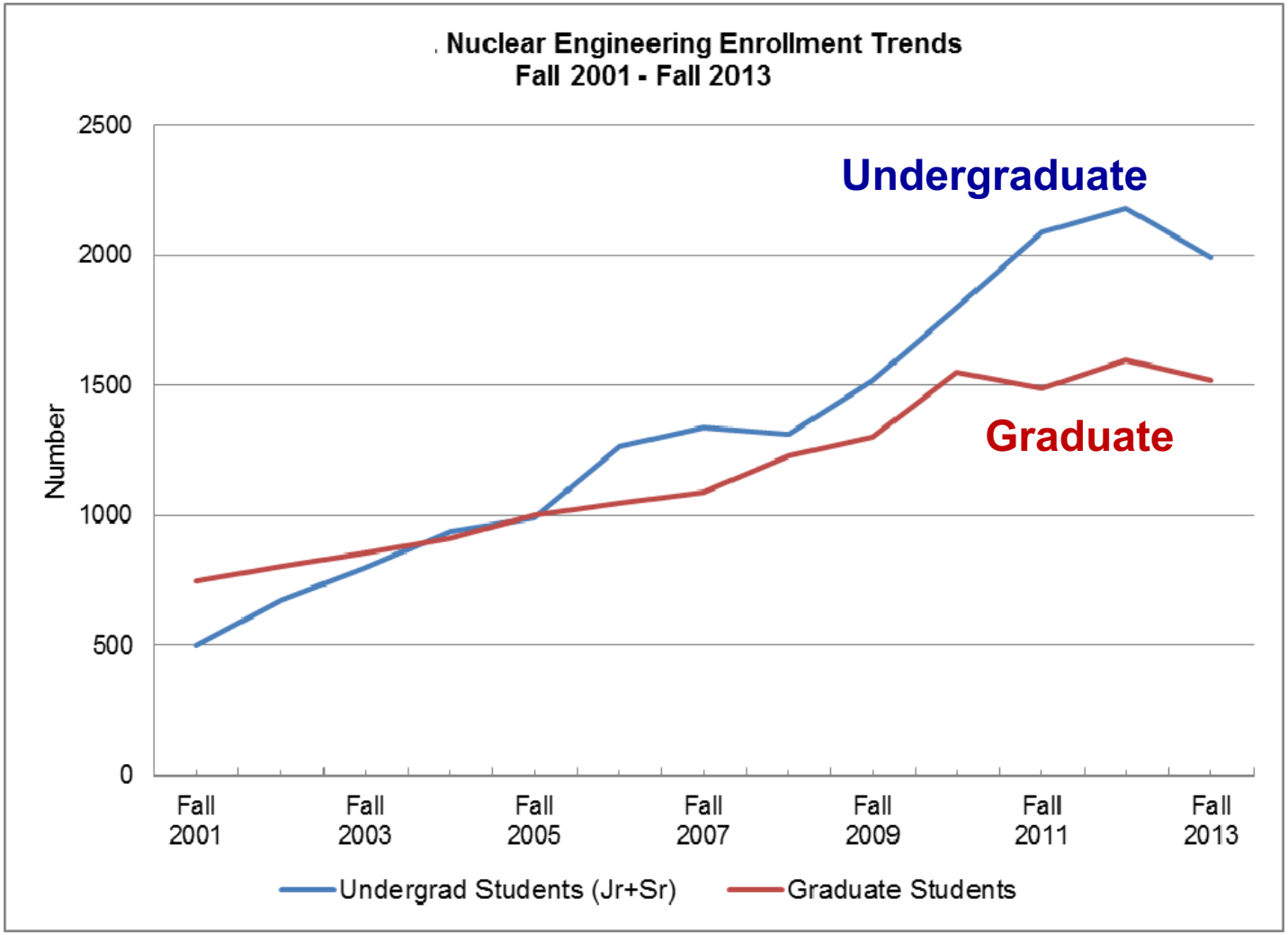
- 1956 - nuclear physics program established in the physics department
- 1960 - 10 kW research reactor installed in physics building, later upgraded to 100 kW
- Mid 1970's - program moved to mechanical engineering department and re-named nuclear engineering
- 1985 – nuclear engineering program terminated
- 1990 - research reactor decommissioned and removed

But now there is a promising future

"*The growing use of nuclear medicine, the potential expansion of nuclear power generation, and the urgent needs to protect the nation against external nuclear threats, to maintain our nuclear weapons stockpile, and to manage the nuclear wastes generated in past decades, require a substantial, highly trained, and exceptionally talented workforce*."

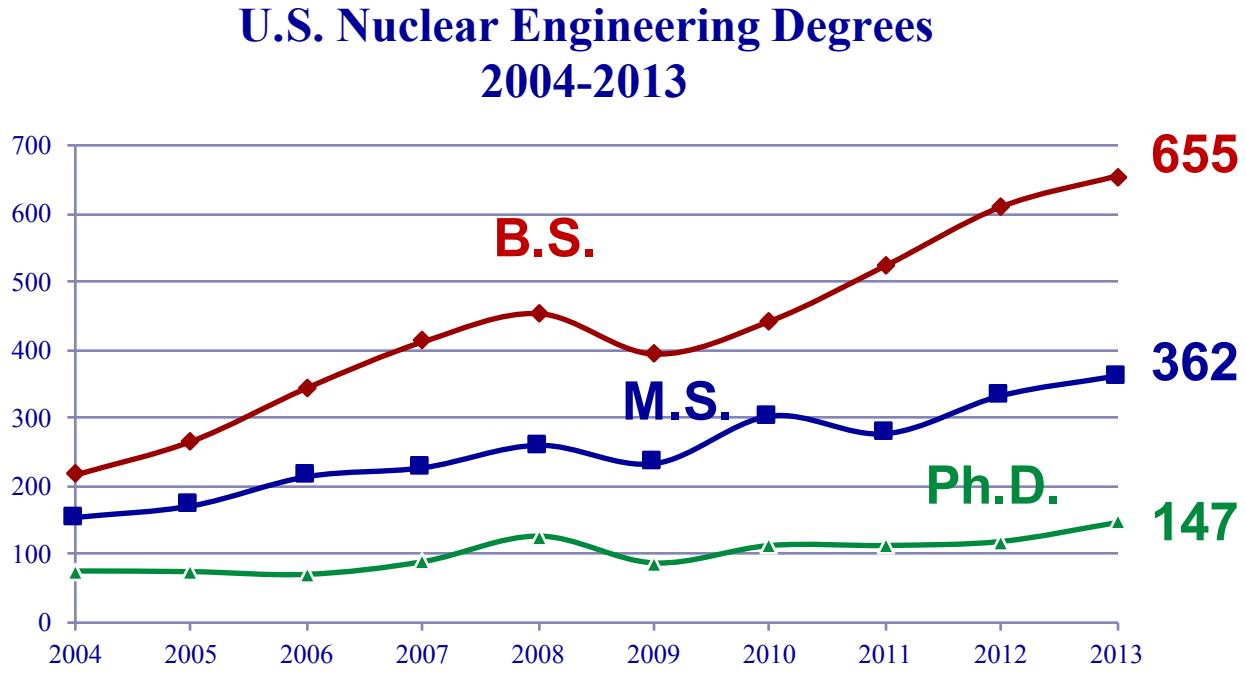
Executive Summary, *Assuring a Future U.S.-Based Nuclear and Radiochemistry Expertise*, National Academies Press, 2012

Most Recent US Nuclear Engineering Enrollment Trends



ORISE, *Nuclear Engineering Enrollments and Degrees Survey, 2013 Data*, Oak Ridge, TN, 2014

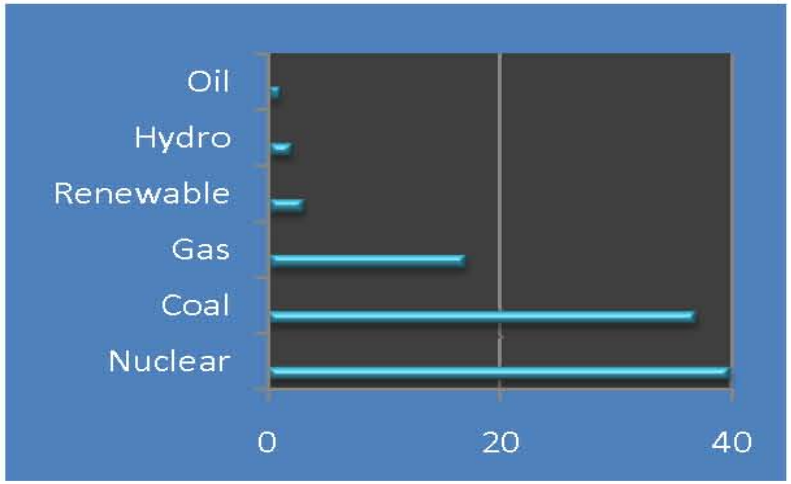
Most Recent US Nuclear Engineering Graduation Trends



- Most B.S. degrees in 2013 since 1984
- Most M.S. degrees in 2013 since 1980
- Most Ph.D. degrees in 2013 since 1972

ORISE, *Nuclear Engineering Enrollments and Degrees Survey, 2013 Data*, Oak Ridge, TN, 2014

Virginia is a “Nuclear State”



Almost 40 percent of electricity generated in Virginia from nuclear energy

AREVA NP, Inc.
B&W Nuclear Operations Group
B&W Generation mPower
CAER (Center for Advanced Engineering and Research)
Dominion Power
Flowserve Industries
Mitsubishi Nuclear Energy Systems (MNES)
Newport News Shipyard
Toshiba American Nuclear Energy

Nuclear companies in Virginia

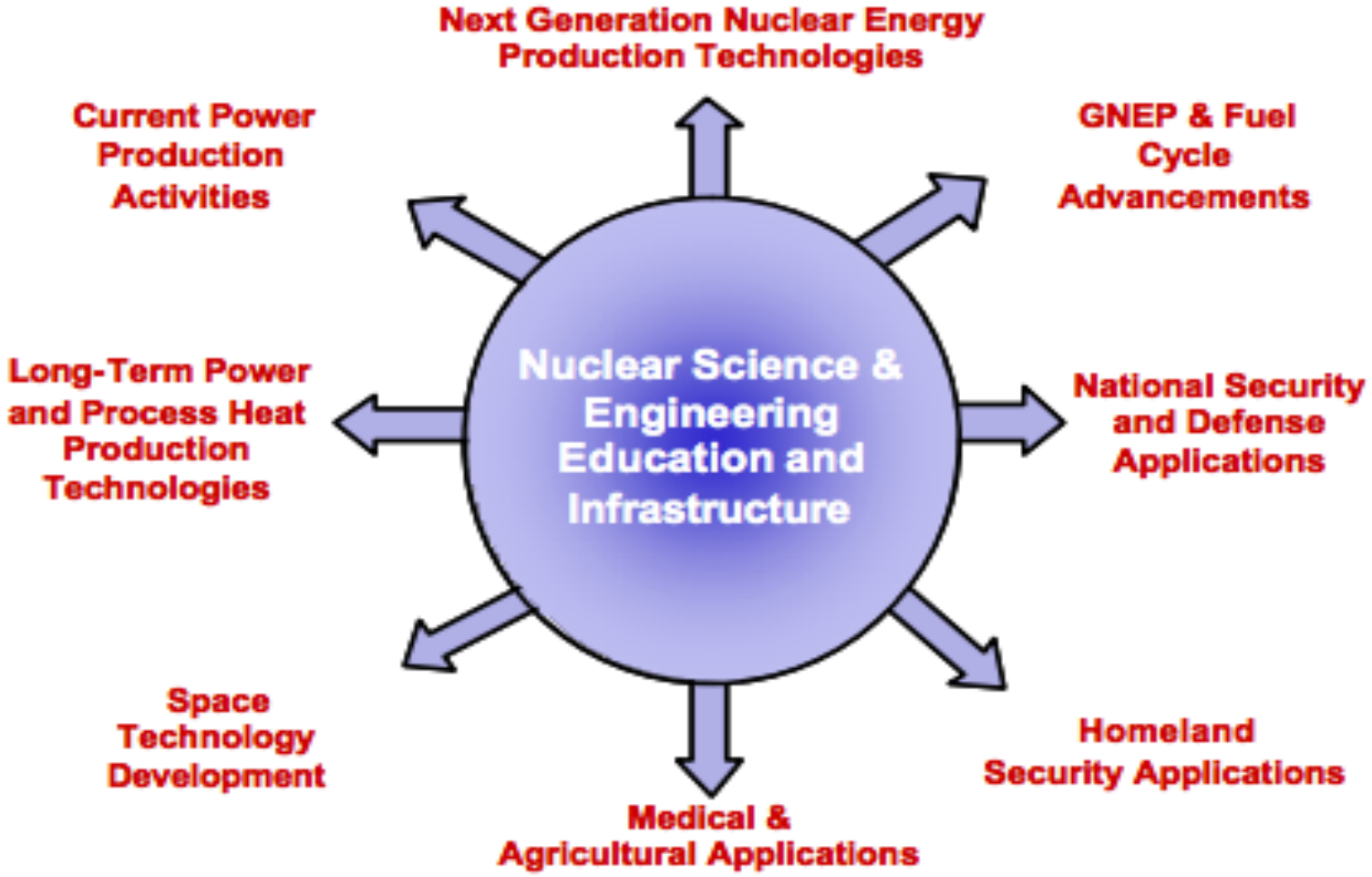
And at Virginia Tech . . .

- **We saw the need to re-establish our nuclear engineering program, largely at the urging of the nuclear sector companies in Virginia**
  - **2007: nuclear engineering courses again offered by the Mechanical Engineering department**
  - **2008-2013: five nuclear engineering faculty hired**
  - **2013: approval granted by the state of Virginia to offer Master's and Doctorate degrees in Nuclear Engineering**

How do we see the demand for future nuclear engineers in Virginia → Interdisciplinary!

Group 1 – Scientific and Engineering
• Multi-physics simulation and visualization for nuclear systems
• Medical physics, health physics and nuclear medicine
• Nuclear fuels, materials and waste
• Nuclear science and digital nuclear instrumentations
• Nuclear power (fuel cycle, design, control, safety, risk, and security)
• Nondestructive detection and imaging
• Radiochemistry
Group 2 – Societal and Political
• Nuclear safeguards and non-proliferation
• Nuclear regulations, policy and public engagement
• Nuclear emergency preparedness, response, and recovery

And in the U.S. → Interdisciplinary!



American Nuclear Society, *Nuclear's Human Element*, La Grange Park, IL, 2006.

Nuclear Engineering Curriculum at Virginia Tech

- Undergraduate Minor in Nuclear Engineering
  - Under development (Spring 2015)
  - Used as a feeder to graduate program
- Graduate Certificate in Nuclear Engineering
- Master of Science/Master of Engineering in Nuclear Engineering
- Doctorate in Nuclear Engineering

Graduate Certificate in Nuclear Engineering

- Designed for non-nuclear engineers who want to work in the nuclear sector
  - 60% of engineers hired in nuclear sector are mechanical engineers
- Requires 3 courses for 9 credit hours
  - NSEG 5114 Nuclear Engineering Fundamentals is required
  - Plus any two graduate level nuclear engineering courses (NSEG)
- Can be completed completely online from anywhere in the world

Master's Degree in Nuclear Engineering

- **Master of Science (30 credit hours)**
  - **Four required courses:**
    - **NSEG 5124 Nuclear Reactor Analysis**
    - **NSEG 5204 Nuclear Fuel Cycle**
    - **NSEG 5424 Reactor Thermal Hydraulics**
    - **NSEG 5604 Radiation Detection & Shielding**
  - **Plus a mathematics course and any two other graduate level courses**
  - **Thesis and Research credits**
- **Master of Engineering: a non-thesis option for the nuclear industry**

Doctoral Degree in Nuclear Engineering

- **90 credit hours of which 30 credits are from graded course work**
  - Same four required courses as the Master's degree
  - Two mathematics courses
  - At least two 6000-level advanced nuclear engineering courses
  - At least two other graduate level courses as specified by the Advisor
  - Dissertation and Research credits
- **Emphasis also placed on enhancement courses and other graduate certificates for career placement**

Program Benchmarks: Master's Degree

- A minimum target enrollment of 22 full/part-time Master's students in 2019
- A strong record of retention and completion rates in which 75% of initially enrolled Master's students obtain their degrees in 2 years
- Graduation rates of 12 Master's students per year in 2019
- Continuation of at least 40% of M.S. graduates into Ph.D. program

Program Benchmarks: Doctoral Degree

- After 5 years, achieve an average enrollment of 30 Ph.D. students
- Graduation rates of 7 Ph.D. students per year in 2019
- A strong record of retention and completion rates in which 70% of initially enrolled students obtain the Ph.D. degree in 5 years
- A record of 90% of graduates accepted for publication in a peer-reviewed journal within one year of graduation

Immediate Plans

- Recruit top-notch students to expand the nuclear engineering program at Virginia Tech
- Develop an online Master of Nuclear Engineering degree that is accessible worldwide by Fall 2015
- Hire additional nuclear engineering faculty members to support strategic program growth
- Expand program resources, laboratories and facilities

Vision and future of the program

- **Nuclear Science and Engineering (NSE) is an enabling science that is interdisciplinary and facilitates many disciplines**
  - **Involves the integration of engineering, science, medicine, and liberal arts and human sciences**
  - **Requires understanding of nuclear physics, radiation effects on materials, national security, and international relations**
  - **There is no academic unit at Virginia Tech that addresses aforementioned broad spectrum of disciplines**

) ***Need for comprehensive and multidisciplinary educational and research experience***

But we lack the *administrative structure*

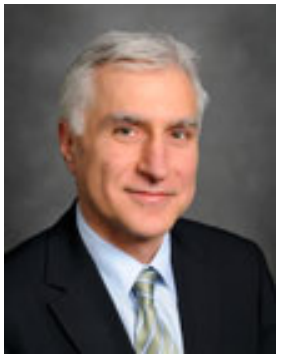
- **For example at VT, we envision a program involving several colleges, institutes/schools, and research units:**
  - College: Engineering, Science, Liberal Arts and Human Sciences, Veterinary Medicine,
  - School: Biomedical Engineering and Sciences
  - Institute: Carilion/Virginia Tech School of Medicine and Medical Research Institute
  - ICAM: Interdisciplinary Center for Applied Mathematics
  - ICTAS: Institute for Critical Technology and Applied Science
  - VBI: Virginia Bioinformatics Institute
  - Visionarium

We propose to establish of a university-level School of Nuclear Engineering and Science (SNES)

- **SNES enables:**
  - **Attracting quality faculty and graduate students**
  - **Education of NSE engineers and scientists with unique skills:**

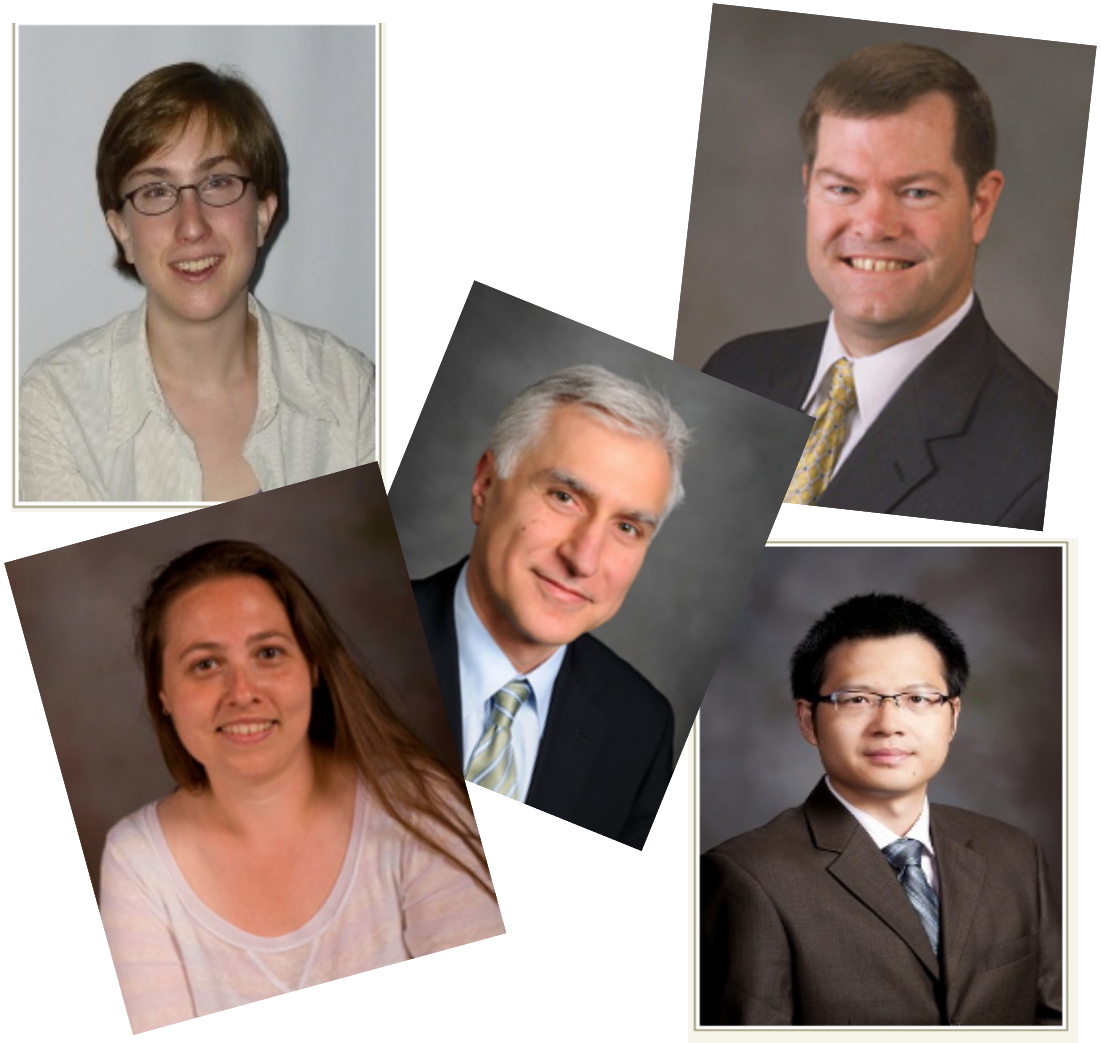
    Knowledge of computational and experimental methodologies and tools to address grand challenges of our time including: energy, health, and environment

Virginia Tech Nuclear Engineering Faculty


- **Mark Pierson, Ph.D. Mathematics, Virginia Tech (2005); Associate Professor, Program Director**
- **Alireza Haghighat, Ph.D. Nuclear Engineering, University of Washington (1986); Professor, Director Nuclear Science & Engineering Lab, Arlington, VA**
- **Celine Hin, Ph.D. Materials Science, Institut Polytechnique de Grenoble and Commissariat a l'Energie Atomique, France (2005); Assistant Professor**
- **Leigh Winfrey, Ph.D. Mechanical Engineering, minor in Nuclear Engineering, North Carolina State University (NCSU) (2010); Assistant Professor**
- **Yang Liu, Ph.D. Nuclear Engineering, Purdue University (2008); Assistant Professor**

We welcome your questions



VirginiaTech
Invent the Future