Energy Education and Workforce Development

Dean Evasius
Director of Science Education
ORAU

ORAU

Outline

- **Trends in Energy Education**
  - Multidisciplinary Training
  - The Role of Computation
  - Partnerships between Academia, Government, and Industry
  - The Need for Diversity
- **Selected Workforce Studies**
  - Assuring a Future U.S.-Based Nuclear and Radiochemistry Expertise
  - Nuclear Engineering Enrollments and Degrees
  - DOE Office of Science Assessment of Workforce Needs

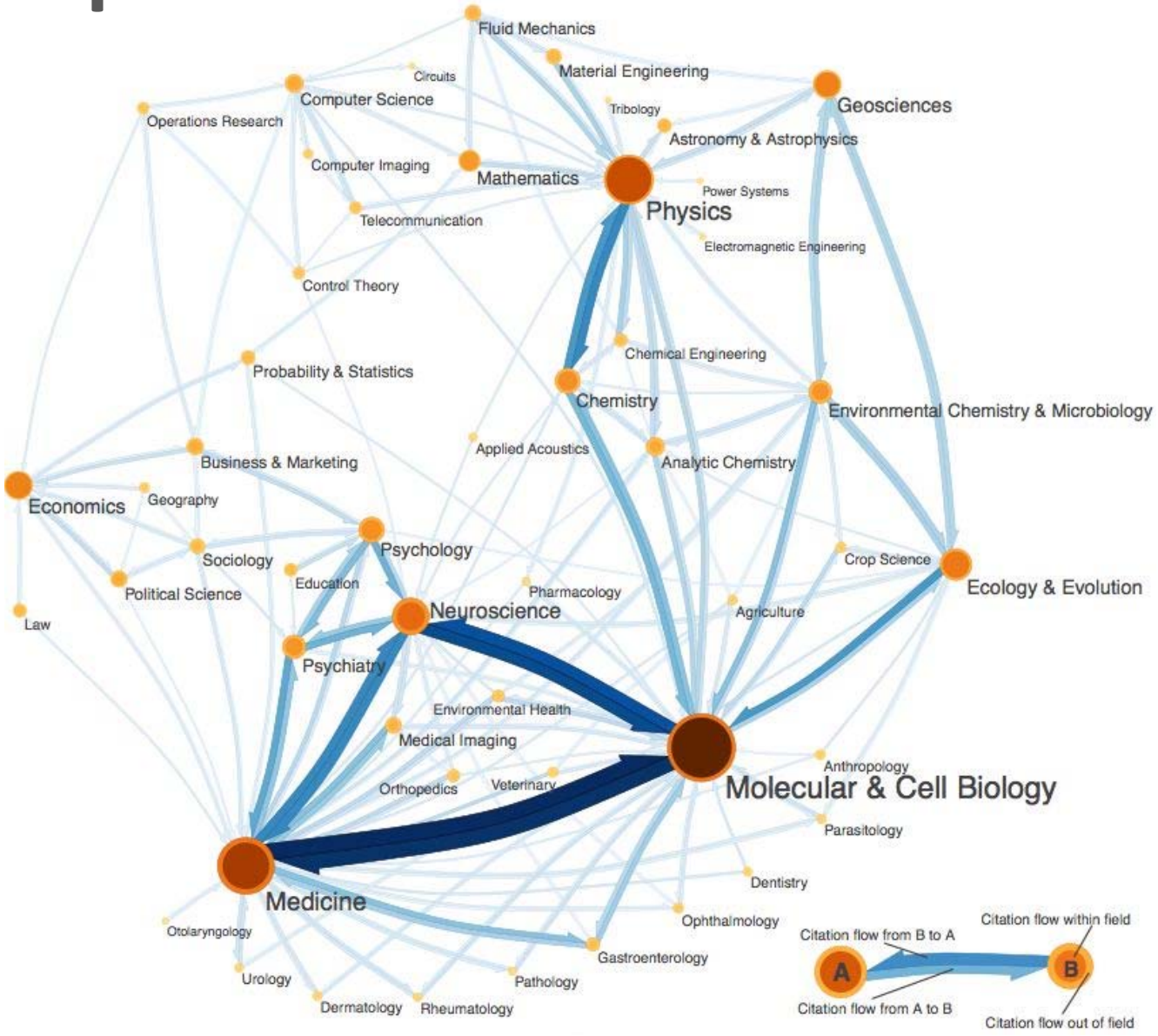
Multidisciplinary Training

We are moving towards problem-inspired education that involves boundary-spanning work at the interface of research and practice.

Learning
distributed across time and space where students make use of what they learn to actively engage with their world

Problem-Inspired Education

Scholarship built on knowledge networks that make new connections between disciplines



The MIT Energy Initiative

Our students:

- **Study the entire energy system**, with an emphasis on innovations in technology, institutions, policy, and behavior.

- **Acquire knowledge of multiple perspectives on energy:** science, technology, and social science.

- **Experience hands-on engagements in classrooms and laboratories,** as well as in the field, through:

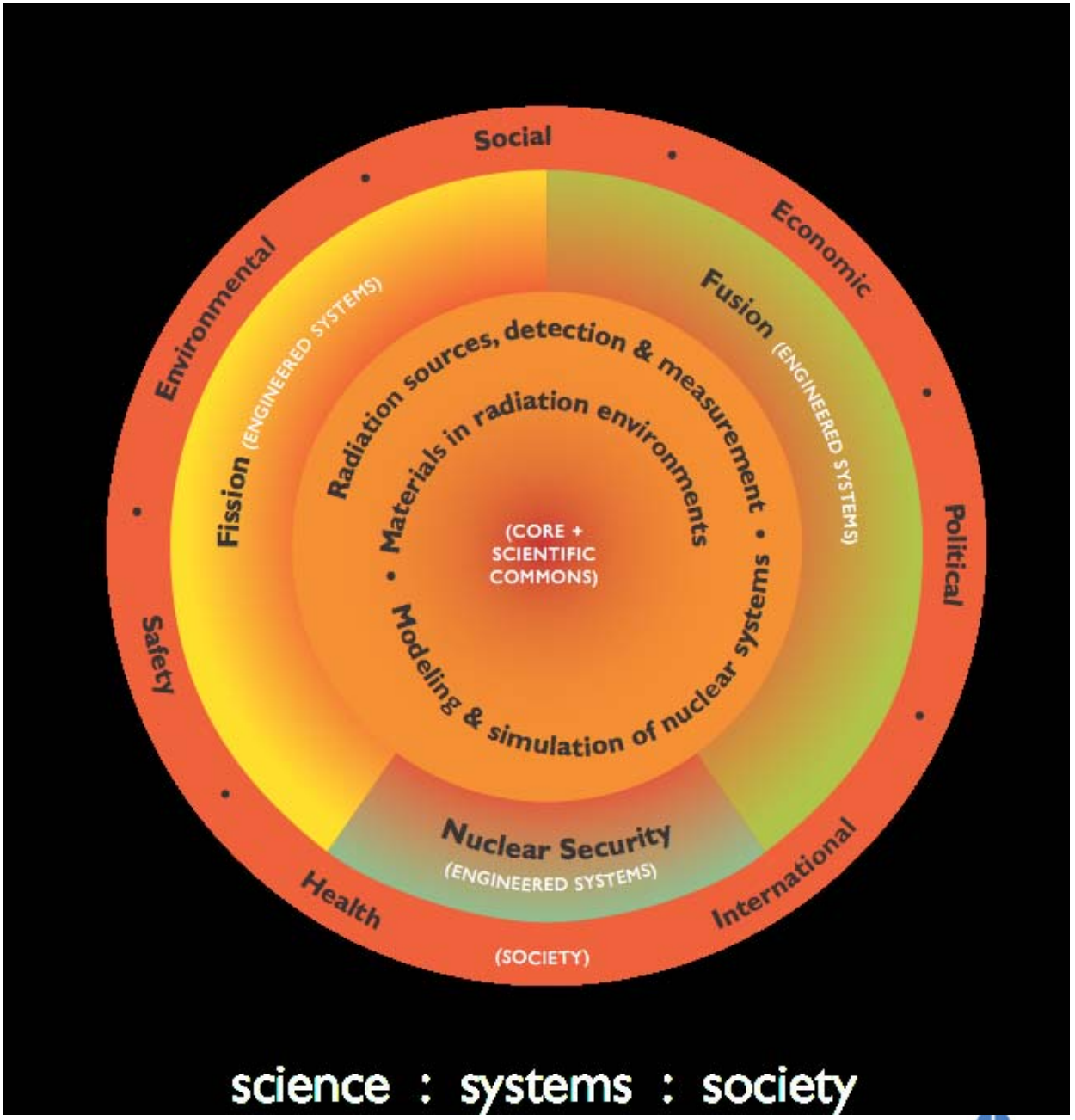
MIT Energy Initiative

NSE
Nuclear Science and Engineering

science : systems : society

"We're developing a more integrated view of world-class education in nuclear science and engineering, with a simultaneous focus on Science, Systems, and Society,"

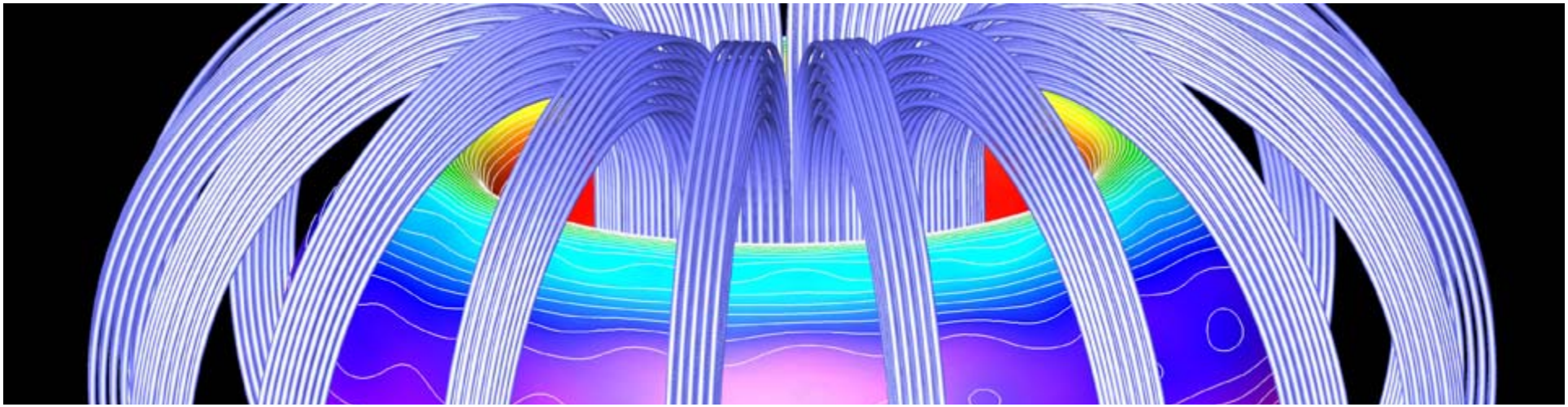
Professor Richard Lester



THE BREDESEN CENTER

for Interdisciplinary Research and Graduate Education

Seeking to create opportunities for exceptional students to engage in interdisciplinary research and education, the Bredesen Center offers doctoral fellowships to candidates pursuing studies in **energy science and engineering.**

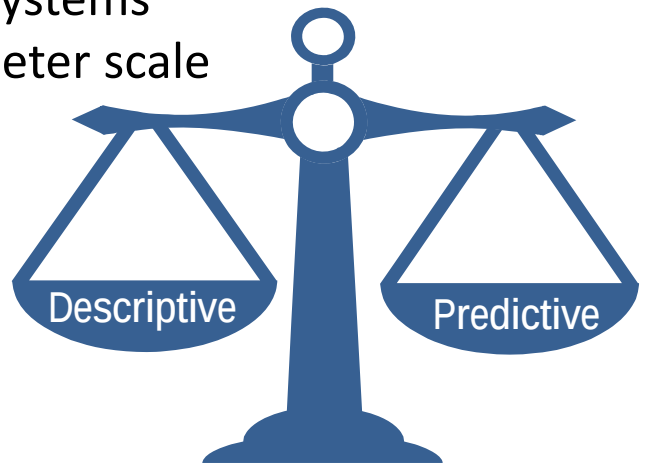


The Case for Simulation Science

- Computational capability increases by factors of 10^3 to 10^6 every decade

- Exascale systems can address timescales and numbers of particles that can transform science
  - First principles calculation of nanoscale systems
  - Integrated climate modeling at the kilometer scale

- We do not have the resources or time to do all experiments or build/test multiple configurations of large-scale energy systems



We are at the tipping point for predictive capability

Computational and Data-Enabled Science and Engineering

- **The goal of the CDS&E program** is to identify and capitalize on opportunities for major scientific and engineering breakthroughs through new computational and data analysis approaches.

- **The CDS&E program crosses multiple Divisions** within the Directorate for Mathematical and Physical Sciences (MPS), the Directorate for Engineering (ENG), and the Division of Advanced Cyberinfrastructure (ACI) in the Directorate for Computer and Information Science and Engineering (CISE).

Office of Science FY 2015 Budget Request to Congress

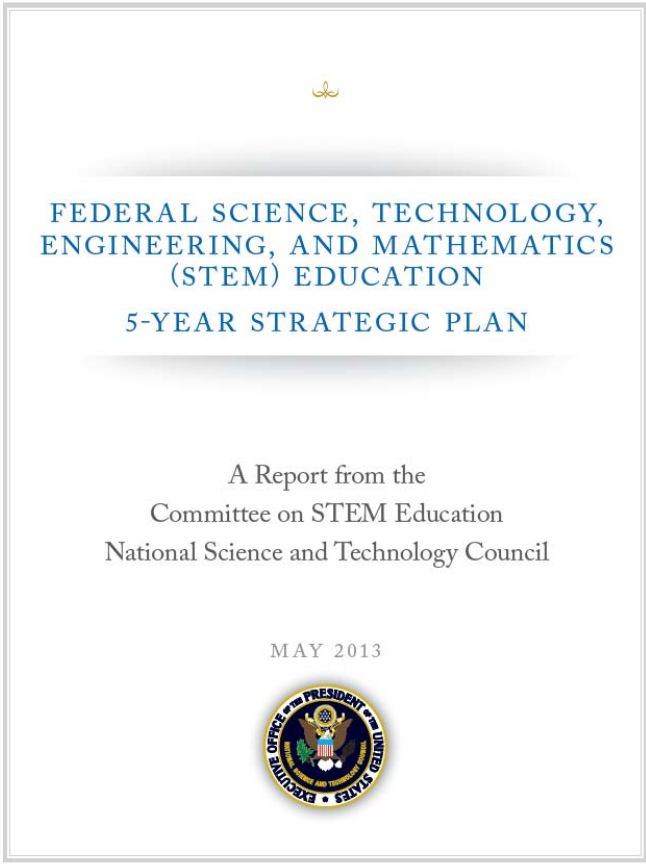
(Dollars in thousands)

	FY 2013 Current (prior to SBIR/STTR)	FY 2013 Current Approp.	FY 2014 Enacted Approp.	FY 2015 President's Request	FY15 President's Request vs. FY14 Enacted Approp.	
Advanced Scientific Computing Research	417,778	405,000	478,093	541,000	+62,907	+13.2%
Basic Energy Sciences	1,596,166	1,551,256	1,711,929	1,806,500	+94,571	+5.5%
Biological and Environmental Research	578,294	560,657	609,696	628,000	+18,304	+3.0%
Fusion Energy Sciences	385,137	377,776	504,677	416,000	-88,677	-17.6%
High Energy Physics	748,314	727,523	796,521	744,000	-52,521	-6.6%
Nuclear Physics	519,859	507,248	569,138	593,573	+24,435	+4.3%
Workforce Development for Teachers and Scientists	17,486	17,486	26,500	19,500	-7,000	-26.4%
Science Laboratories Infrastructure	105,673	105,673	97,818	79,189	-18,629	-19.0%
Safeguards and Security	77,506	77,506	87,000	94,000	+7,000	+8.0%
Program Direction	174,862	174,862	185,000	189,393	+4,393	+2.4%
Subtotal, Office of Science	**4,621,075**	**4,504,987**	**5,066,372**	**5,111,155**	+44,783	+0.9%
Small Business Innovation Research/Technology Transfer	...	176,208	...	...	...	...
Use of Prior Year Balances	...	...	...	...	...	...
Total, Office of Science	**4,621,075**	**4,681,195**	**5,066,372**	**5,111,155**	+44,783	+0.9%

The Need for Diversity

Implementation Roadmap:

Better Serve Groups Historically Underrepresented in STEM Fields



IMPACT STATEMENT: Increase the number of underrepresented minorities that graduate college with STEM degrees in the next 10 years and improve women's participation in areas of STEM where they are significantly underrepresented.

Our Work: STEM Programs

U.S. DEPARTMENT OF ENERGY | Office of Economic Impact and Diversity

Alexandria Clark, Intern
Office of Economic Impact and Diversity

energy.gov/diversity

Minority Educational Institution Student Partnership Program (MEISPP)

Offers talented undergraduate and graduate students summer internship positions with the Department of Energy and our National Laboratories, with the goal of reaching underrepresented students in STEM fields, such as women and girls. Positions involve scientific research or a focus on policy, business, and government relations. Deadline for application submission in March.

Mickey Leland Energy Fellowship

The Mickey Leland Energy Fellowship (MLEF), sponsored by the U.S. Department of Energy's Office of Fossil Energy, is a 10-week summer internship program that provides opportunities to students who are pursuing degrees in science, technology (IT), engineering, or mathematics (STEM majors). The goal of the program is to Improve opportunities for minority and female students in these fields, but all eligible candidates are encouraged to apply. Candidates who are selected will have the opportunity to work on focused research projects consistent with the mission of the Office of Fossil Energy. Deadline for application in January.

The Need for Partnerships

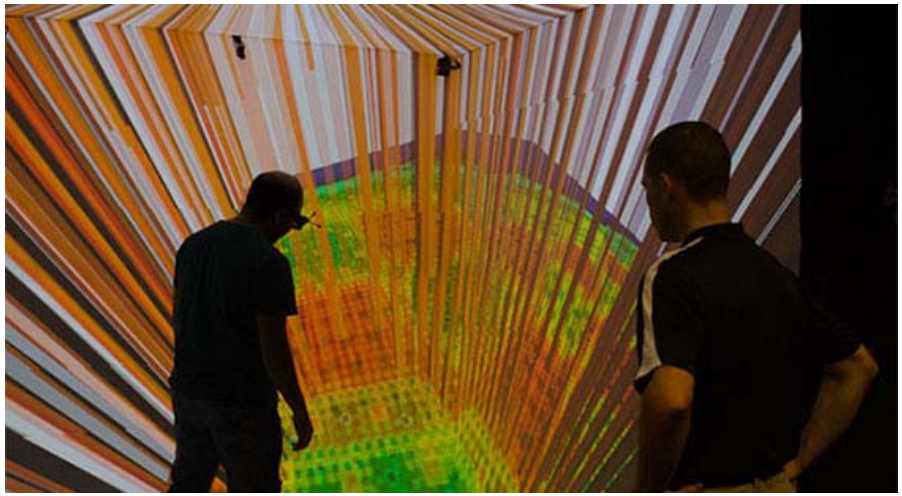
Building a strong "all hands on deck" effort that includes business, non -profits, foundations, and_others:

The President launched the ***Educate to Innovate*** campaign including commitments from more than 100 CEOs; more than 150 organizations are stepping up in response to the President's goal of preparing 100,000 excellent STEM teachers and have formed a coalition called *100kin10* with more than $50 million raised; and more than $100 million in philanthropic investments has been committed to support the President's goal of one million more STEM college graduates.

John P. Holdren
Assistant to the President for Science and Technology
Director, Office of Science and Technology Policy

CASL

The Consortium for Advanced Simulation of Light Water Reactors (CASL) is the DOE Energy Innovation Hub established for the purpose of providing advanced modeling and simulation (M&S) solutions for commercial nuclear reactors.



3D visualization allowing physical walk-through of the top 20% of high-powered rods in a pressurized water reactor core.

Workforce Studies

- Assuring a Future U.S.-Based Nuclear and Radiochemistry Expertise
- Nuclear Engineering Enrollments and Degrees
- DOE Office of Science Assessment of Workforce Needs

BCST
BOARD ON CHEMICAL SCIENCES & TECHNOLOGY

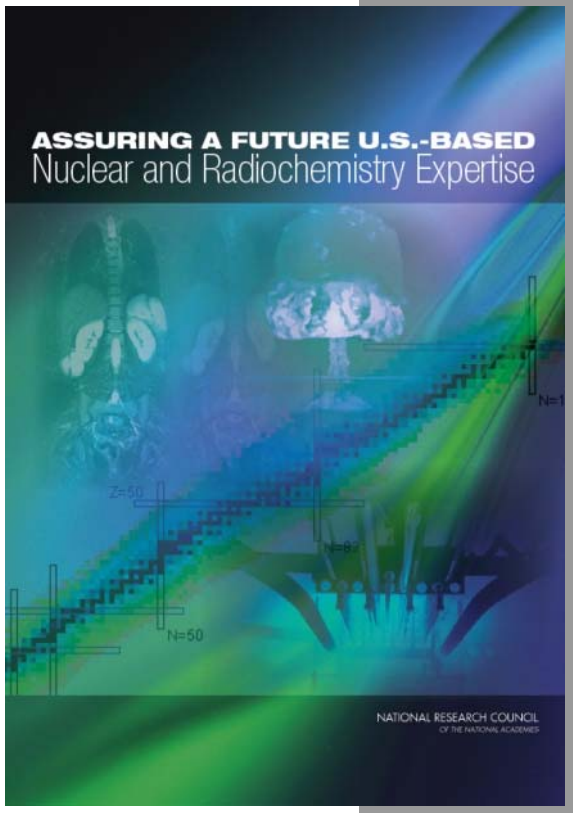
THE NATIONAL ACADEMIES

Assuring a Future U.S.-Based Nuclear and Radiochemistry Expertise

Carolyn J. Anderson, PhD
University of Pittsburgh

69th meeting of ORAU Council of Sponsoring Institutions

March 5, 2014



STUDY CHARGE

Examine supply and demand for nuclear and radiochemistry expertise and discuss possible approaches for ensuring adequate availability of these skills in the future

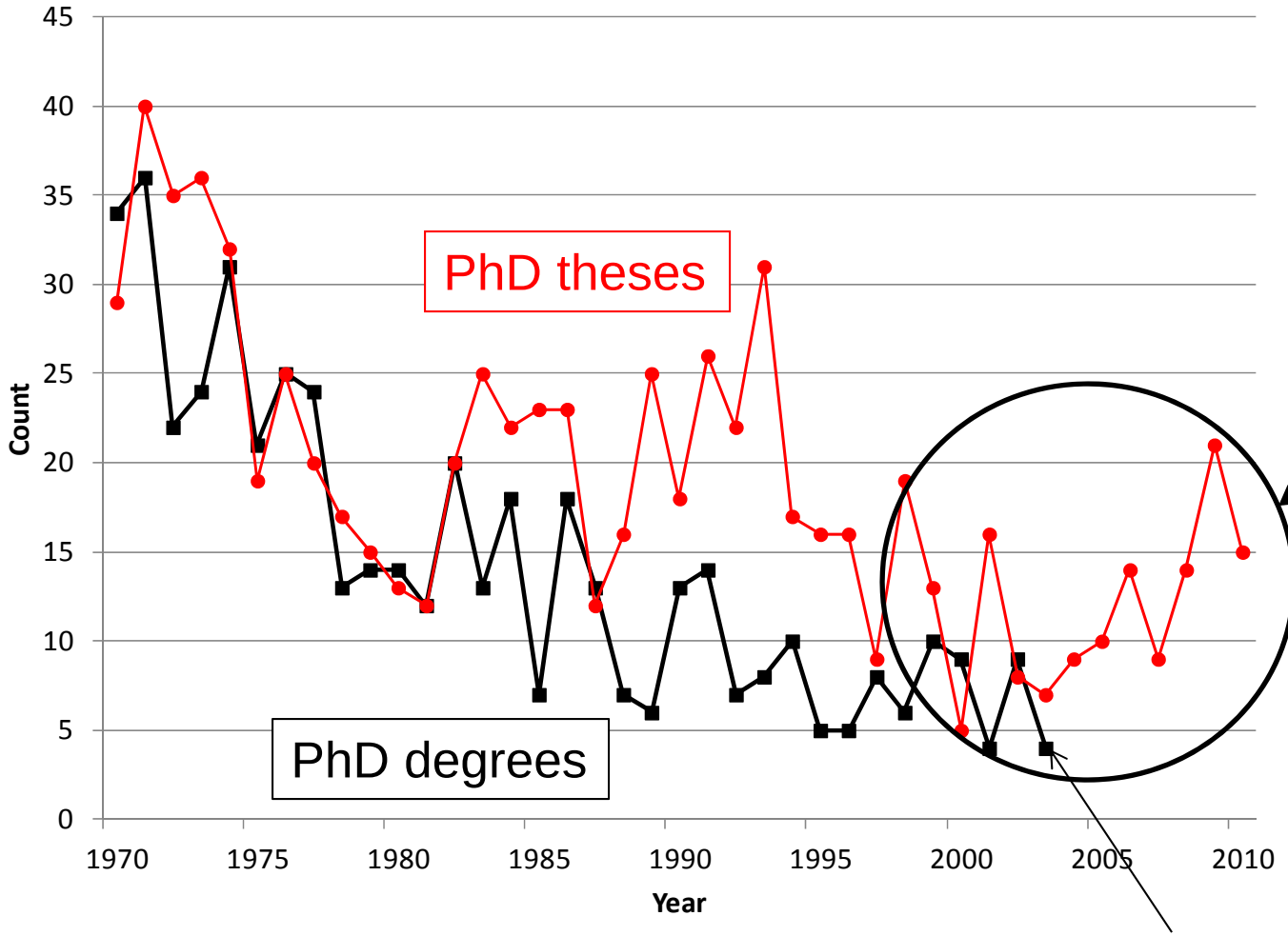
I. Estimate the availability and need for experts

II. Estimate the gap between availability and need, and discuss the impact of this gap on the relevant sectors

III. Suggest approaches that could be implemented to assure the U.S. supply of experts is adequate for the next 20 years*

*Note: committee was only able to look out 5 years due to data limitations

Encouraging numbers of new *nuclear chemistry* PhDs



Average of 13 *nuclear chemistry* PhD theses per year 2005-2010

~60 graduate faculty each year since 2005

Last year *nuclear chemistry* listed on Survey of Earned Doctorates

The needs for expertise are barely being met by current supply—and future needs may not be met by future supply

Estimated Supply of and Demand for Nuclear and Radiochemist Degree Holders over the Next 5 Years

	BS	MS	PhD
Currently Employed	416	256	765
Demand for new hires (due to retirements and some growth)	200	93	306
Supply of new degree holders	250	50	65

→ Security & Medicine

Includes academic faculty, government agencies, industry, and national laboratories

The Committee Recommends Actions in Three Main Areas of Need

1. **Institutional**: structural support and collaboration
2. **Educational**: on-the-job training and knowledge transfer and retention
3. **Workforce Data**: data collection and tracking of workforce

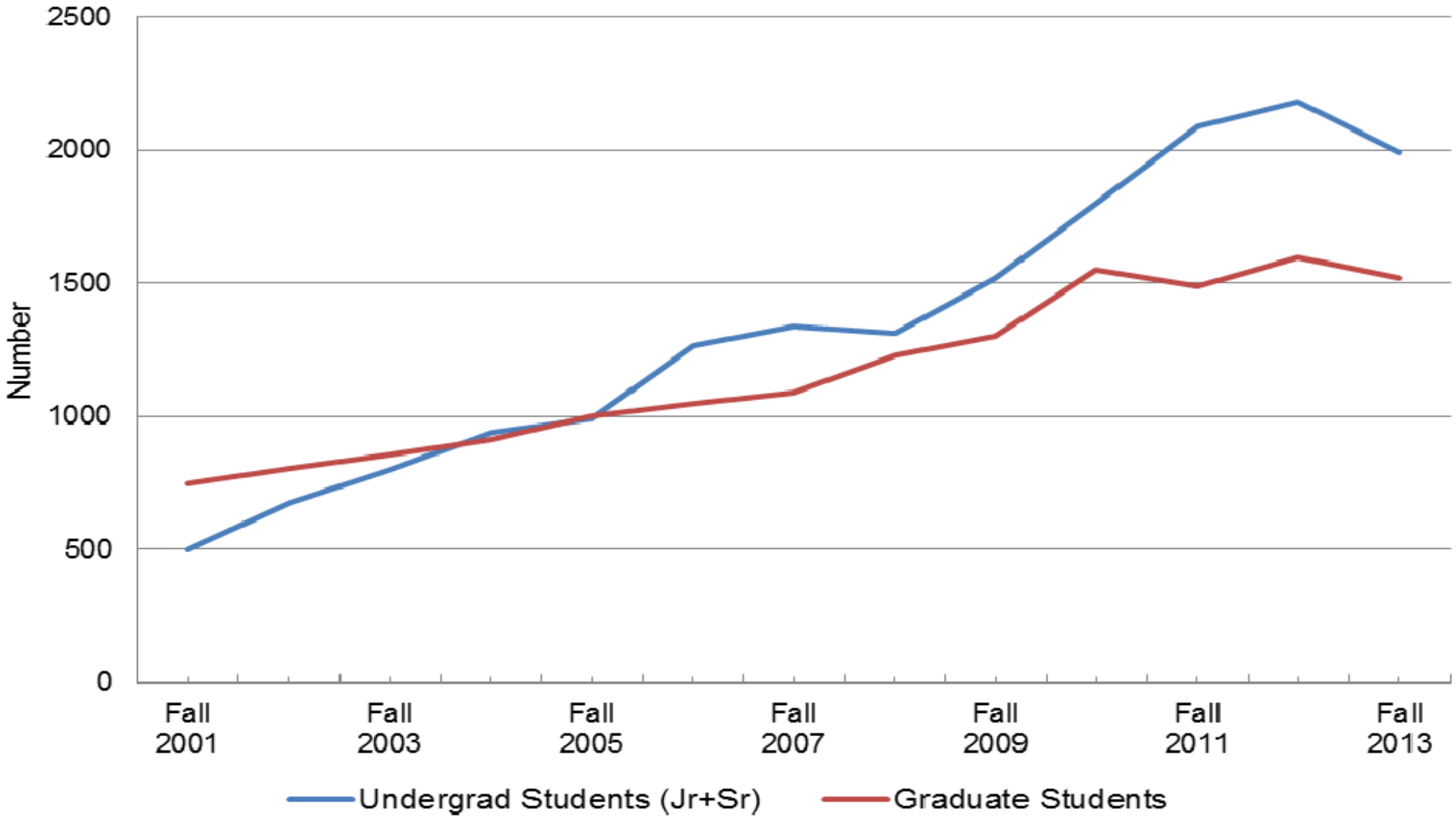
Establish multiple formalized collaborative partnerships for research and education

- Between the larger nuclear and radiochemistry programs at universities and national laboratories, and the programs of 2- and 4-year colleges, research institutes, medical facilities, and industry.
- To satisfy both current and future professional and academic needs, including
  - Traditional academic education
  - Internships, fellowships, and on-the-job training opportunities
  - Access to equipped experimental and theoretical facilities;
  - Access to highly qualified and knowledgeable experts to assure knowledge transfer and retention of critical information
- Supported by federal agencies that depend on nuclear and radiochemistry expertise (e.g. DHS, DOD, DOE, NSF, NIH, etc.)

Nuclear Engineering Enrollments and Degrees Survey, 2013 Data

Number 72 *Oak Ridge Institute for Science and Education* 2014

Figure 1. Nuclear Engineering Enrollment Trends
Fall 2001 - Fall 2013



Nuclear Engineering Enrollments and Degrees Survey, 2013 Data

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Table 1. Nuclear Engineering Degrees, 2004-2013

	Degrees		
Year	B.S.	M.S.	Ph.D.
2013	655	362	147
2012[1]	610	333	119
2011	524	277	113
2010	443	303	113
2009	395	233	87
2008	454	260	127
2007	413	227	89
2006	346	214	70
2005	268	171	74
2004	219	154	75

[1]2012 data for five programs estimated by ORISE. See the appendix for more information.

Source: Oak Ridge Institute for Science and Education.

DOE Assessment of Workforce Needs

The Office of Science Federal Advisory Committee will help identify disciplines in which significantly greater emphasis in workforce training at the graduate and postdoc levels is necessary to address gaps in current and future Office of Science mission needs:

- *Disciplines not well represented in academic curricula*
- *Disciplines in high demand, nationally and/or internationally*
- *Specific recommendations for programs to address the needs*

Office of Science: Key Workforce Areas

- Computational Sciences
- Accelerator Science
- Detector Physics
- Actinide Science (Nuclear/radiochemistry)
- Fundamental Electrochemistry
- Crystal Growth
- Materials at the Nano/Meso Scale
- Neutron Scattering

New in FY 2014: Accelerator Science

The acceleration and control of charged particle beams are essential tools for discovery science within the Physics Division: from high to low energy beams, high intensity sources for secondary or tertiary beams (e.g., neutrinos), nuclear physics, nuclear astrophysics.

- We are starting an accelerator science program with the goal of enabling fundamental discoveries and train students and postdocs across disciplinary boundaries
  - Program Description *PD 13-7243: "Accelerator Science"*
  - http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504937
  - Proposal target date: November 29, 2013
- Broader impacts are significant: industrial applications, medical applications, homeland security, light sources
- Program will focus on transformational developments that are likely to come from curiosity-driven research with strong interdisciplinary links
- Program will evolve with the community as new challenges are identified

Thank You!

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