NSAC Workforce Subcommittee Report
NSAC Meeting

June 30, 2014

Jolie A Cizewski

Workforce Charge: Tasks

- Identify disciplines that need more workforce training at graduate & postdoc levels for DOE/SC mission needs
- Things to consider
  - Disciplines not well represented in academic curricula
  - Disciplines in high demand => difficulties in recruitment and retention
  - Disciplines where DOE national labs may play a role in providing workforce development
  - Specific recommendations for graduate student & postdoc programs to address discipline-specific workforce development needs
- Letter report on findings and recommendations by June 30, 2014
  - To guide future activities and investments

Workforce Development in DOE/SC

- Science Undergraduate Laboratory Internships (SULI)
- Community College Internships (CCI)
- DOE Office of Science Graduate Fellowship (SCGF) Program
- Albert Einstein Distinguished Educator Fellowship (AEF) Program
- Visiting Faculty Program (VFP) at DOE Laboratories
- DOE National Science Bowl® (NSB)
- Laboratory Equipment Donation Program (LEDP)
- Outreach
- ONP only
  - Early Career Awards
  - Nuclear Chemistry Summer Schools

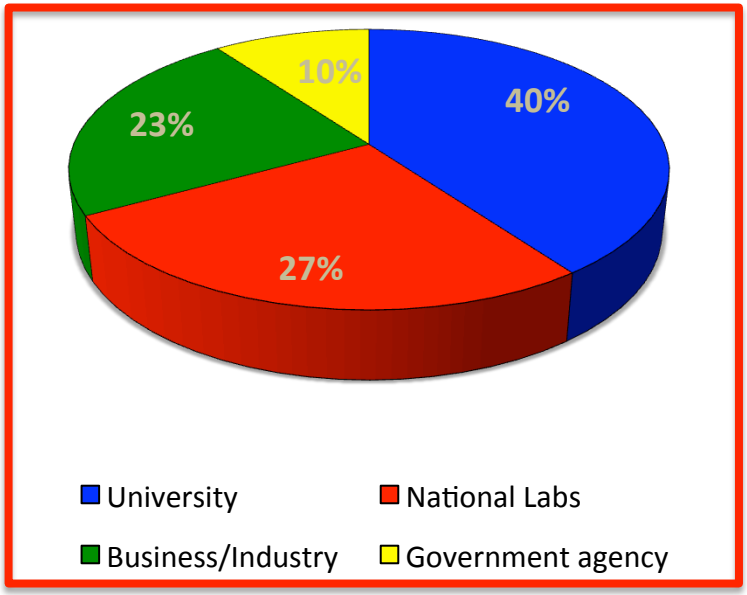
http://science.energy.gov/wdts

NSAC subcommittee

Jolie Cizewski (chair)	Rutgers	Low energy exp
Hari Areti	JLab	Accelerator physics; app
Joe Carlson	LANL	Computational, theory
William Barletta	MIT	Accelerator physics
Ed Hartouni	LLNL	Applications; NNSA
Andrew Hutton	JLab	Accelerator physics; apps
Silvia Jurrison	Missouri	Radio/nuclear chemistry
Eric Norman	UC Berkeley	Nuclear engineering, low E
Michael Thoennessen	MSU	Low energy exp; education
Sherry Yennello	TAMU	Low energy exp; education
Don Geesaman	ANL	Ex-officio

Setting the Context

- Nuclear physics is a vital scientific enterprise
  - Discovery: Fundamental nature of subatomic matter
  - Impact:
    - Enhancing innovation and economic growth
    - Applications in technology, medicine, energy and national security



Career Paths of PhDs – NSAC13

Setting the Context

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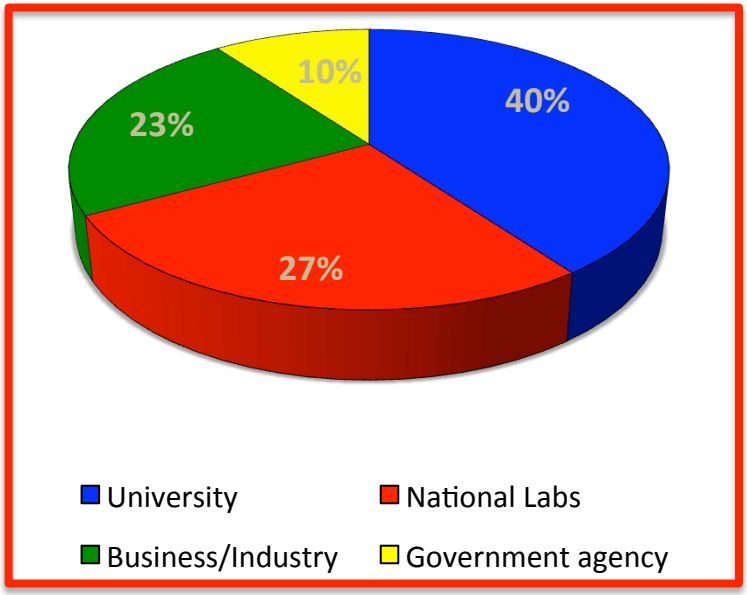
  - Discovery: Fundamental nature of subatomic matter
  - Impact:
    - Enhancing innovation and economic growth
    - Applications in technology, medicine, energy and national security
- DOE NP responsibilities - Primary funding agency for nuclear physics
  - Fundamental research
  - Training students and postdocs for careers in fundamental & applied nuclear science
  - Infrastructure to realize this research
    - Accelerators & large-scale instruments
  - Applications
    - Accelerator science & technology,
    - Isotope developments



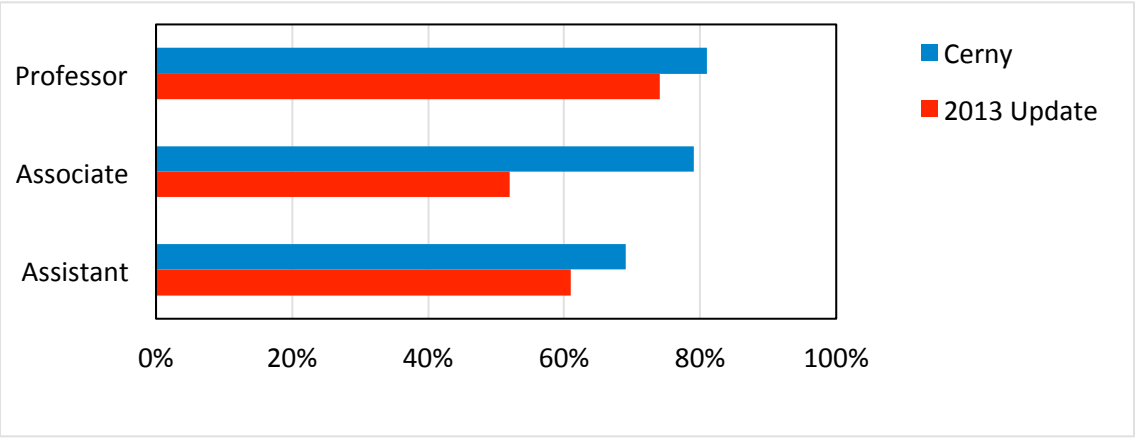
Career Paths of PhDs – NSAC13

Findings Outline

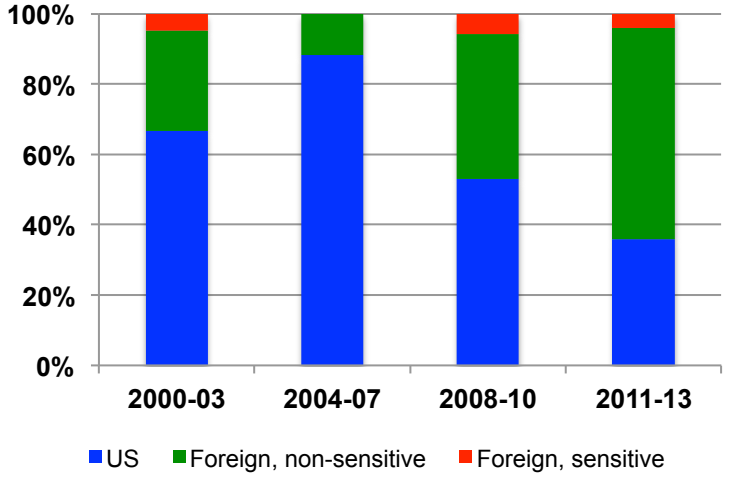
- Challenges in attracting and training the leaders in fundamental nuclear science and technology.
- Challenges in attracting best and brightest for Ph.D. study in nuclear science.
- Challenges in attracting and developing a talented U.S. workforce in accelerator science and the associated technologies
- Challenges in attracting, training and retaining a talented U.S. workforce in high-performance computing and simulations for nuclear science and its applications
- Challenges in recruiting and retaining a highly talented workforce for DOE laboratories, especially U.S. citizens.
- Challenges in attracting U.S. students for fundamental and applied studies in nuclear science and related fields.

Challenges in attracting and training the leaders in fundamental nuclear science and technology.

- Delicate balance
  - Attracting best & brightest from around the world for graduate studies in nuclear science & technologies
  - Developing and supporting US students on paths to leadership in nuclear science & technologies
- Delicate balance may no longer be the case
  - Country of PhD of Early Career Award recipients
  - Country of PhD of current faculty members



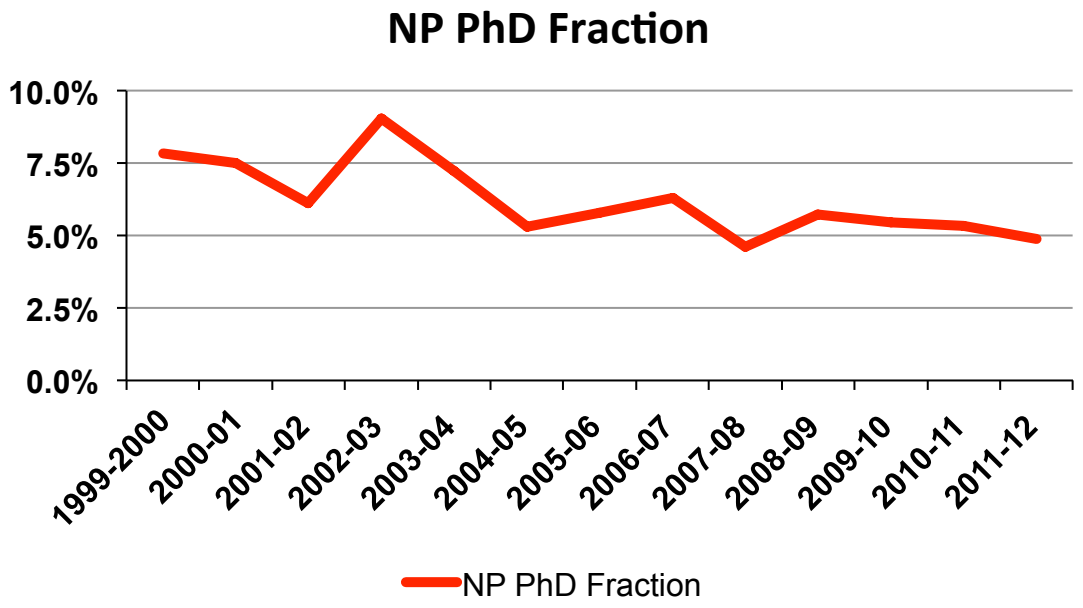
Percent NP physics faculty with US PhD



Country of PhD degree

Challenges in attracting best and brightest for Ph.D. study in nuclear science

- Smaller % of physics PhDs are in nuclear physics



NP Workforce Survey & AIP Degree reports

Challenges in attracting best and brightest for Ph.D. study in nuclear science

- Smaller % of physics PhDs are in nuclear physics
- Very few grad student fellowship recipients in nuclear science
  - NSF GRF: 0.06% of (6 in 5 years)
  - DOE GRF: 5% (8 out of 150 in 2010 and 2 out of 50 in 2012)
  - Stewardship Science GRF (NNSA): – about 1/3 (out of 5-6/year)
  - Computational Science GRF (DOE): – almost none

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- Nuclear chemistry – critical need to identify
  - Not tracked by NSF Survey of Earned Doctorates
  - Relatively few chemistry programs have nuclear/radio chem
  - High diversity in funding sources

Challenges in nuclear/radio chemistry training

- Five DOE agencies provide funding
  - NP (Low Energy and Isotope Program & Production), BES (heavy element), BER (radiochemistry, including med schools)
- Faculty in many different departments
  - Chemistry (and Biochemistry), Chemical Engineering, Biology, Medical Schools (Radiology)
  - Faculty in Med Schools face barriers to mentoring students

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- Solution: Nuclear Chemistry Summer Schools
  - Two schools, highly competitive
  - About 50% of recent nuclear and radio chem PhDs are alumni
  - NP has ended support as of FY14

Challenges in accelerator science & technology training

- Few current leaders in accelerator science received training in US
  - 2/3 of US-trained were DOE supported; 1/3 NSF supported
  - ≈30% are HE or NP PhDs who transition to technology
- About 12 US PhD programs include accelerator science
  - UCLA (DOE), MSU (now NSF), Cornell (NSF) – both undergrad & grad, but limited curriculum
  - New: Stony Brook (w/ BNL) and Old Dominium (w/ JLab)
  - Europe: about 75 institutes, grad & continuing education

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- Solution: US Particle Accelerator School (annually)
  - Broad curriculum spanning science, technologies and systems

Challenges in attracting, training and retaining a talented U.S. workforce in high-performance computing and simulations

- High-performance computing & simulations in nuclear science & applications
  - Required to advance science, engineering and technologies
    - Fundamental science, national needs, medicine, industry
    - Especially DOE laboratories
  - Few universities have access to largest computer systems
  - Challenge: competitive pressures from industry when recruit & retain

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  - Challenge: competitive pressures from industry when recruit & retain
- Solutions (partial):
  - Computational Science GRF (partial: Almost none ever in NP)
  - SciDAC and ASC (NNSA): grad student and postdoc training engaged math & computer scientists w/ nuclear physicists
  - TALENT – Training in Advanced Low Energy Nuclear Theory
    - Small computational component

Challenges in recruiting and retaining a highly talented workforce for DOE laboratories, especially U.S. citizens

- Surveyed all DOE Laboratories (SC, NNSA, NE) requesting input on disciplines where challenged in recruiting and training workforce
  - Results summarized in Table 6
  - Need US citizens
    - Especially for national & homeland security
    - Even at multi-purpose labs

Nuclear science	**Accelerator physics & technology**
Nuclear radiochemistry	Beamline physics & engineering
Radiation chemistry	
Computational nuclear science & simulations	
Nuclear non-proliferation	
Actinide science	

Challenges in attracting U.S. students for fundamental and applied studies in nuclear science and related fields

- US undergrad students have limited exposure to nuclear science & technologies at colleges & universities
  - Limited nuclear physics undergrad courses
    - At best shared elective, course
  - Very limited nuclear/radio chemistry undergrad courses
    - 4% of chemistry departments
  - Almost no exposure to accelerator science

Challenges in attracting U.S. students for fundamental and applied studies in nuclear science and related fields

- US undergrad students have limited exposure to nuclear science & technologies at colleges & universities

- Multi-faceted solution
  - Undergraduate research SULI and single-PI (and NSF REU)
  - Nuclear Chemistry and Accelerator Physics Schools
  - Engagement of students and faculty advisors from traditionally under-represented backgrounds
    - SULI
    - Community College Internships
    - Visiting Faculty Program
  - Outreach to school children and communities
    - Example: BEAMS at JLab

Recommendations

We recommend that all stakeholders expand and enhance the training opportunities for undergraduate and graduate students and postdocs

- to attract and develop the leaders in fundamental nuclear science and the technologies that enable it,
- to supply a sustainable workforce of nuclear scientists in critical applications in national and homeland security, medicine, energy, and industry.

- Targets
  - DOE/SC Office of Workforce Development (WDTS)
  - Office of Science (SC)
  - Office of Nuclear Physics (NP)
  - Individual investigators at universities & national labs

We recommend that the WDTS increase the number of awards with a practicum opportunity given directly to graduate students to enhance their training, targeted to areas with demonstrated need.

- More than traditional fellowship – training component explicitly linked to SC mission
- Recipients expected to participate in 8-12 week practicum at DOE laboratory or facility
  - Model on Stewardship Science & Computational Science GRF

We recommend that the WDTS, NP and other SC offices work together to increase support for "schools" in areas with critical workforce development needs and sustain their support at viable levels.

- These "schools" provide multi-disciplinary training
  - Complements what colleges & universities can offer
- Nuclear Chemistry Summer Schools
  - Sustain strong full funding for 2 schools
  - Expand to 3rd with sufficient funding
- US Particle Accelerator School
  - Expand offerings to include detector technology
  - Provide professional training to career staff
- Laboratory or discipline specific schools
  - TALENT, HUGS, etc.

We recommend that the DOE and the WDTS create new opportunities for high-performance computational science multi-disciplinary training across SC and in collaboration with NNSA through SciDAC and other initiatives.

- Training brings together nuclear & computer scientists and collaborations between universities & national labs

We recommend that NP and other SC and DOE offices work to reverse the decline in the number of both nuclear and radiochemistry faculty and students at universities.

- Universities are where graduate students are trained
- Faculty support is critical to recruiting, promoting and retaining faculty at universities
- Both nuclear and radio chemistry

We recommend that WDTS in collaboration with discipline-specific offices such as NP establish prestigious postdoctoral training opportunities in areas of demonstrated need and with an opportunity to couple to DOE laboratories or facilities.

- Subfields:
  - Nuclear physics & chemistry
  - High-performance computational science
  - Accelerator science, engineering & technology
- Recipients expected to couple their research to opportunities at DOE labs or facilities
  - Serve as intro to multi-disciplinary research at labs
  - Complement training at home institutions

We recommend that SC and NP sustain Early Career Awards

- Highlight exciting research & technical contributions of recipients
- Inspire students and postdocs
- Enhance training of students and postdocs mentored by ECA recipients

We recommend that the DOE enable students and postdoctoral scholars at DOE laboratories to attend conferences by exempting them from DOE conference travel limitations.

- Conference travel is essential for workforce development
- Restrictions disproportionally negatively impact students, postdocs, early career scientists

Broadening the participation of US students in nuclear science & technologies

- **SULI** - Science Undergraduate Laboratory Internships
- **Outreach activities** hosted by DOE Laboratories
- **Community College Internships** & **Visiting Faculty Program** – students & teachers from minority-serving institutions

We recommend that WDTS work with the hosting laboratories to track the research groups and the careers of SULI participants to obtain a quantitative assessment of the impact of these opportunities and training. These assessments should be used to inform the number of SULI opportunities and target these opportunities to disciplines of demonstrated need.

- Undergraduate research critical part of pathway to nuclear science & technology
- Almost no publicly available tracking data
- Recommendation: track the SULI participants
  - Assessment of the program
  - Inform how to improve effectiveness, especially in areas of SC-mission need

We recommend that WDTS sustain and support outreach activities at DOE labs to introduce school students and teachers to the labs and provide training that complements what is offered in schools.

We recommend that WDTS enhance visibility of DOE/SC labs to students and teachers from minority serving institutions and women, building on efforts in SULI, Community College Internships, Visiting Faculty Program, and outreach activities for students and teachers.

We recommend that WDTS establish dedicated resources to continually assess the current, near term and longer term needs for a highly-talented, diverse workforce to realize the missions of the

- DOE
- Other government agencies
- Private sector

that require a workforce with the skills of individuals trained in DOE-sponsored programs.

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We recommend that the research mentors of undergraduate and graduate students should expand their knowledge of the SULI program and prestigious fellowship and training opportunities for their students and help these students develop competitive applications for these awards.

- Division of Nuclear Physics of APS
- Division of Nuclear Chemistry and Technology of ACS

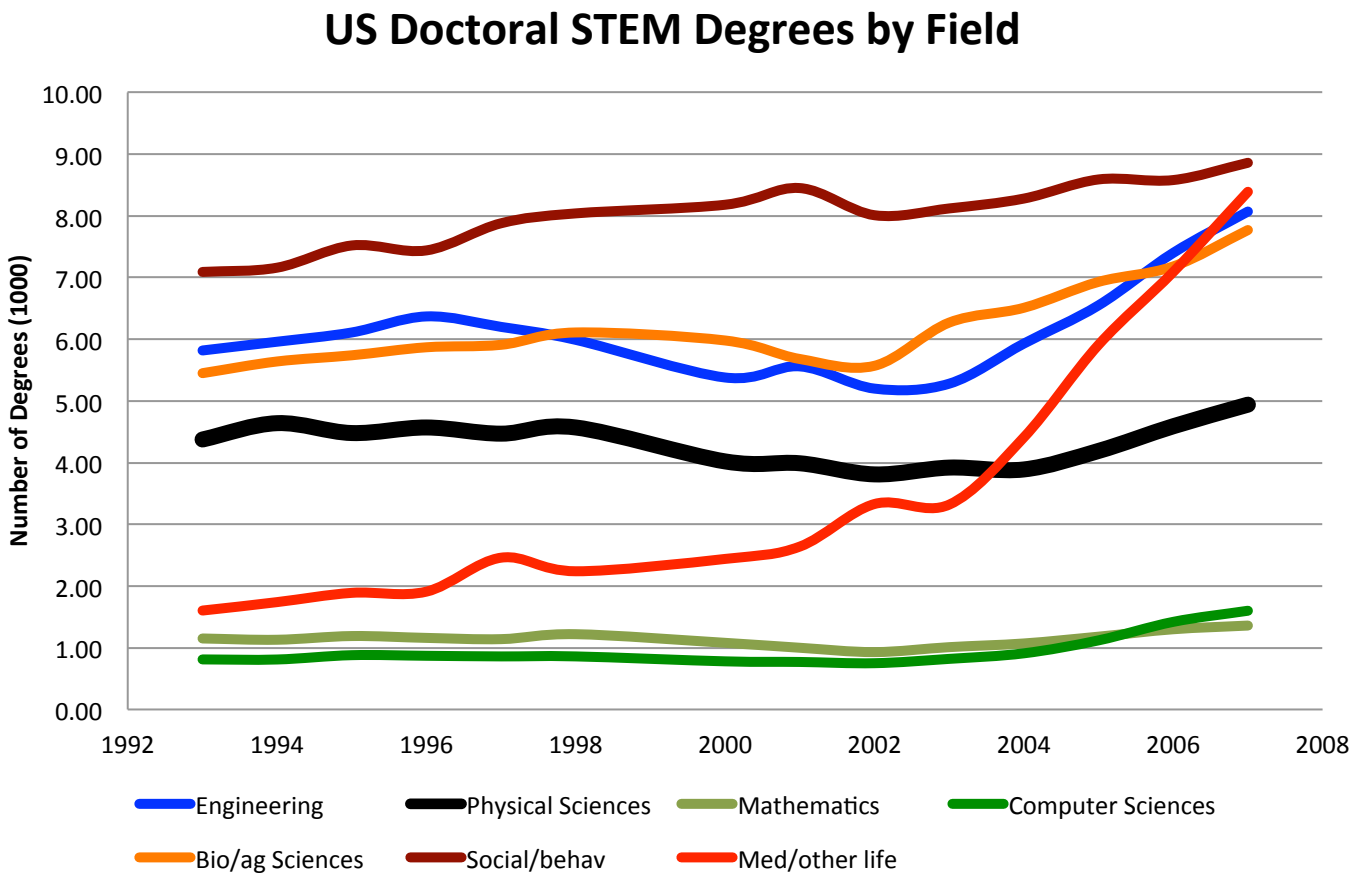
Thank you

Are there any questions?

BACKUP

STEM vs P-STEM

- While 20 years ago 17% of STEM Doctoral degrees were in physics sciences; today only 12%
- NSF Fellowships awards follow percent of applications in a subfield



http://www.nsf.gov/statistics/seind10/figures.htm#c2