Workforce Development

P5 Town Hall - Brookhaven National Laboratory

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Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

@BrookhavenLab

The history of science, technology, engineering, and mathematics in the US

- Morril Act of 1862: created land grant universities to promote agricultural science (later established engineering programs)
- World War II, Cold War, NASA (moon landing)
- Acronym (SMET) created in 2001 by the NSF
  - Introduced standards for educators to teach K-12 students
  - Same year: AZ and 6 more states secured public and private grant funding to support STEM education; No Child Left Behind Act
- 2009 Educate to Innovate Initiative
- 2015 STEM Education Act and Every Student Succeeds Act
- Suggestions to introduce arts and humanities >> STEAM

Science and Engineering Higher Education in the United States

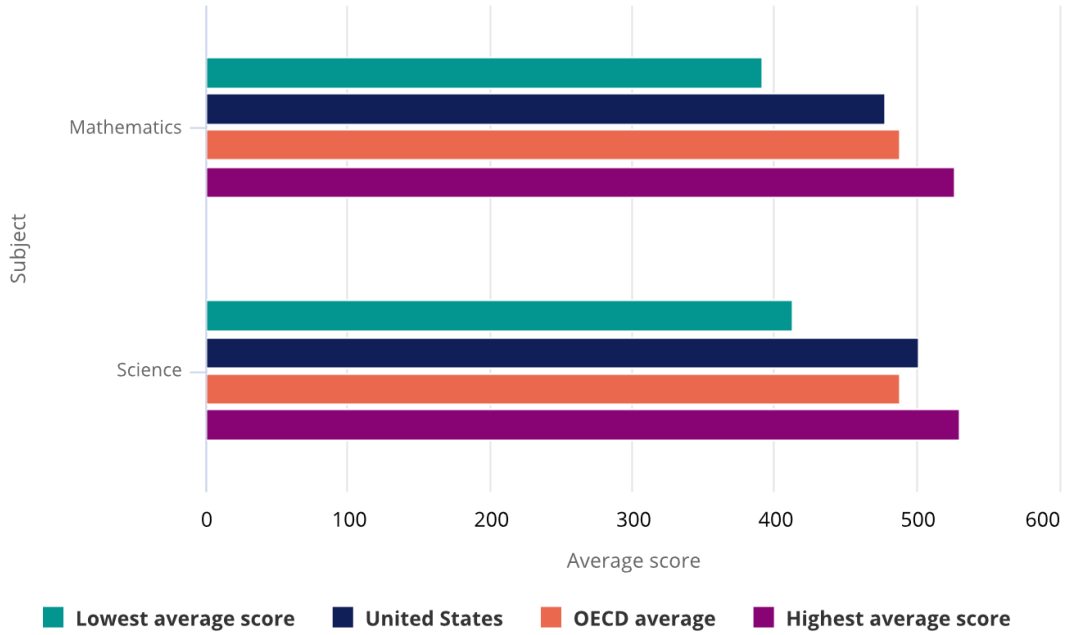
STEM workforce depends heavily on higher education degrees

- 2000-2019 increase in percentage share of S&E degrees from 24% (561,000) to 27% (1,087,000)
- Increases in the cost of undergraduate education, concerns about affordability of higher education
- Community college path to higher education:
  - Two-fifths of students who completed high school in 2018 and enrolled in college
  - Community colleges awarded most (65%) of the 258,000 certificates awarded in S&E technologies in 2019
- Bachelor's degrees ~ 70% of all S&E degrees awarded (#1 social sciences)

National Center for Science and Engineering Statistics | NSB-2022-1

Figure 1

Average scores of 15-year-old students on the PISA mathematics and science literacy scales, by OECD education system: 2018



Note(s):
OECD is Organisation for Economic Co-operation and Development. PISA is Program for International Student Assessment.

Source(s):
OECD, PISA, 2018.

Indicators 2022: K–12 Education

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https://ncses.nsf.gov/pubs/nsb20221/u-s-and-global-stem-education-and-labor-force

Science and Engineering Higher Education in the United States

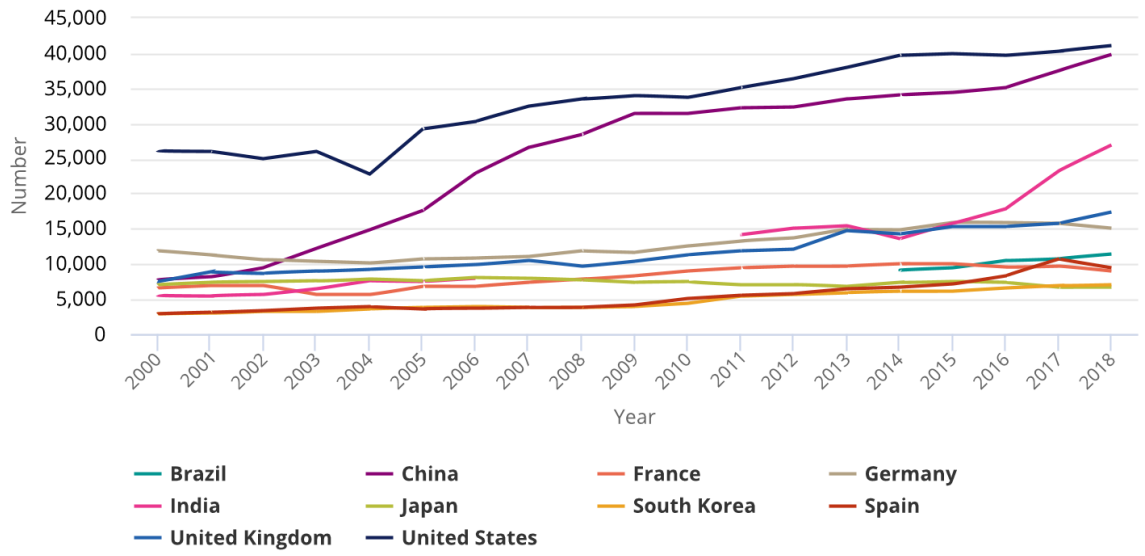
STEM workforce depends heavily on higher education degrees

- Number of master's degrees more than doubled from 2000 to 2019
  - Most pronounced in computer sciences and engineering, largely driven by students on temporary visas
- In 2019 accounted for 65% of doctorates conferred by U.S. universities
  - Largest percentage increases since 2000 occurred in engineering, computer sciences, and medical sciences
- 18% of international students worldwide come to the United States (more than to any other country)
  - More likely than U.S. citizens and permanent residents to study S&E: 49% versus 35%

National Center for Science and Engineering Statistics | NSB-2022-1

Figure 5

S&E doctoral degrees, by selected countries: 2000–18



Note(s):
Data are not available for all countries for all years.

Source(s):
Educational statistics of OECD; Eurostat; MEXT (Japan); NBS and MOE (China); MHRD (India).

Indicators 2022: Higher Education

Brookhaven National Laboratory

https://ncses.nsf.gov/pubs/nsb20221/u-s-and-global-stem-education-and-labor-force

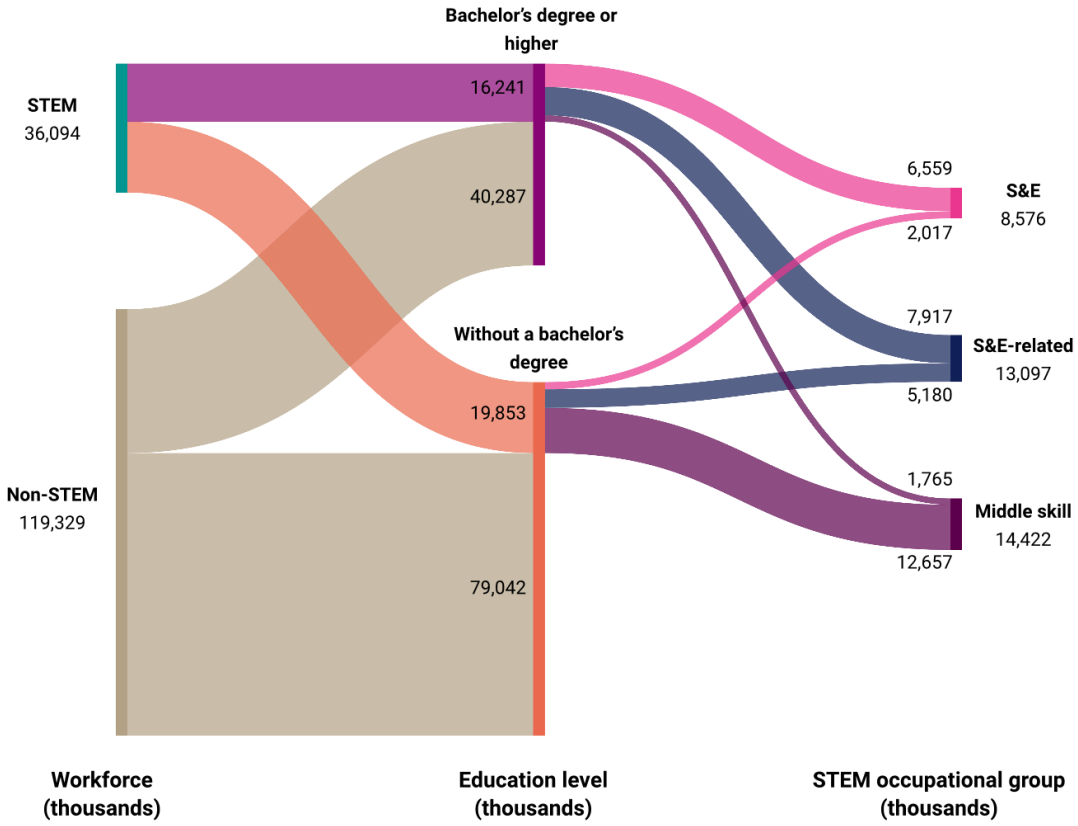
STEM workforce, market and economy

- The U.S. STEM workforce constitutes 23% of the total U.S. workforce (36 million people in diverse occupations that require STEM knowledge and expertise).
- *Science and Engineering Indicators* introduced a new definition of the STEM workforce: now encompasses all workers who use S&E skills in their jobs rather (no longer based mostly on degree level)
  - New definition more than doubles the number of individuals classified within the STEM workforce
- STEM jobs have grown faster than non-STEM jobs since 2010, and many STEM jobs are projected to grow in the future.

National Center for Science and Engineering Statistics | NSB-2022-1

Figure 8

U.S. workforce, by STEM occupational group and education level: 2019



Note(s):
STEM is science, technology, engineering, and mathematics. Numbers are rounded to the nearest 1,000.

Source(s):
U.S. Census Bureau, ACS, 2019.

Indicators 2022: Labor Force

https://ncses.nsf.gov/pubs/nsb20221/u-s-and-global-stem-education-and-labor-force

HEP, Instrumentation Frontier, and Workforce Development

- The instrumentation workforce includes not only the physicists making the connections to the particle physics science mission, but the world-class scientists from other disciplines and the uniquely skilled technical staff that make the enterprise a success.
- Engaging with world-class scientists from other disciplines requires not only funding, but rewards and recognition commensurate with their contributions to the success of the HEP program. This extends to the technical staff without whom no major detector program could be realized.
- There are two cultural hurdles that need to be addressed:
  - The first is embracing scientists from other disciplines as equals.
  - The second is the issue that both the scientists from other disciplines and the technical staff are funded primarily from soft funding streams (e.g. projects).

HEP, Instrumentation Frontier, and Workforce Development

- Skilled workforce to undertake the broad instrumentation program is in short supply.
  - As the complexity of our detector systems have grown, the number and type of specialists needed has increased dramatically.
- In addition, the cyclic nature of detector constructions and upgrades make this problem particularly harsh in specific times when big upgrades happen simultaneously.
  - A way of ameliorating this problem is to promote R&D efforts that allows a steadier work on advancing the new technologies of the future.
- Create a pipeline requires a dedicated effort on different fronts: partnerships, collaborations, internships, hands on trainings
  - To ensure community awareness of the state of the art as new ideas and techniques evolve over the long cycles of detector design and development it will be important to organize specialty meetings that include both presentations and training as well as general instrumentation meetings.
  - Low-cost high-impact online infrastructure: the emergence of the web has been a significant help in the design of our present-day detector systems and can be more intentionally exploited to provide a broad institutional memory.

arXiv:2204.07285v1 [physics.ins-det]

DOE programs: Workforce Development for Teachers and Scientists (WDTS)

- **Science Undergraduate Laboratory Internships (SULI)**
  - The SULI program encourages undergraduate students and recent graduates to pursue science, technology, engineering, and mathematics (STEM) careers by providing research experiences at the Department of Energy (DOE) laboratories.
- **Community College Internships (CCI)**
  - The CCI program seeks to support community college students who are interested in pursuing technical careers or furthering their educational aspirations relevant to the DOE mission by providing technical training experiences at the DOE laboratories.
- **Visiting Faculty Program (VFP)**
  - The Visiting Faculty Program (VFP) seeks to enhance the research competitiveness and strengthen the STEM teaching of faculty members from institutions of higher education that are historically underrepresented in the research community to expand the workforce that addresses DOE mission areas. Two Tracks: Research Collaboration and Teaching Initiative
- **Office of Science Graduate Student Research (SCGSR) Program**
  - The SCGSR Program provides supplemental awards to outstanding graduate students to spend 3 to 12 months conducting part of their doctoral thesis/dissertation research at a host DOE national laboratory/facility in collaboration with a DOE laboratory scientist.

DOE programs: Workforce Development for Teachers and Scientists (WDTS)

Workforce Development for Teachers and Scientists (WDTS)

Ensuring a pipeline of skilled STEM talent to support the DOE mission

- Strong support for the undergraduate internships, graduate thesis research, and visiting faculty appointments at DOE labs to help sustain a skilled workforce pipeline, total ~1,400 annually
- Expanding opportunities to underrepresented, underserved groups
- Intentional outreach to Minority Serving Institutions (MSIs) and Underrepresented Groups (URGs)
- Pathways and Activities aiming at attracting and recruiting more diverse and inclusive applicants/participants to DOE workforce training programs

The DOE system of National Laboratories is a unique asset for training and workforce development:

- DOE Labs employ >30,000 scientists and engineers (~14,000 at SC Labs)
- World-class scientific user facilities, capabilities, and resources
- Culture of team science, mentoring, and learning through discovery

Discovery Learning, Mentorship, Competence Building, Accelerated Growth

U.S. DEPARTMENT OF ENERGY | Office of Science

New opportunities

- **Funding for Accelerated, Inclusive Research (FAIR) – launched this year**
  - FAIR aims to build research capacity, infrastructure, and expertise at institutions historically underrepresented in the Office of Science portfolio, including minority serving institutions (MSIs) and emerging research institutions (ERIs).
- **Reaching a New Energy Sciences Workforce (RENEW) – launched in 2022**
  - Building foundations through undergraduate and graduate training opportunities for students and institutions historically underrepresented in the SC research portfolio.
- **DOE Traineeship in High Energy Physics Instrumentation – launched in 2021**
  - To address a workforce shortfall in critical technical topic areas by training graduate students in specific STEM disciplines aligned with workforce needs in the area of instrumentation as they apply to HEP's mission-space.
  - Two examples: HEPIC (High-Energy Physics Integrated Circuits) and TRAIN-MI program (High Energy Physics Instrumentation Traineeship in Michigan)

HEPIC (High-Energy Physics Integrated Circuits)

- **Mission**: give top students exposure to the challenges and exciting work opportunities in the field of radiation detectors before they graduate
- **Goal**: give students an exciting experience in HEP and ”hook” them into the field early
  - Building strong personal networks with promising students will help retain these students in the HEP community as they graduate.
  - Early access is critical as HEP laboratories cannot compete with industry salaries for IC Designers.
- **Implementation**: HEPIC member labs have developed research activities appropriate for graduate students and provides fellowships for these students to experience cutting-edge design work in HEP-targeted ASICs before they reach industry.
  - The intention is that some portion of these students will choose to stay within the HEP ASIC development community.
  - The continual renewal of students is required due to the observed turnover as HEP IC designers migrate to more lucrative industry jobs.
  - In addition to summer research experience in HEP provided by the National Labs, HEPIC also includes an educational component. ASIC design for HEP applications has several unique features and challenges that differentiate it from most industrial design specialties.

IC Design Traineeship Program With Applications In High Energy Physics

The HEPIC Traineeship Program provides graduate students from participating Universities interested in integrated circuit design with an opportunity to learn about the types of experiments conducted at Department of Energy (DoE) national laboratories around the country which work on high energy physics (HEP) including various particle accelerators. It introduces the trainees to the HEP design community, the scientific ASIC design challenges they face, and other students across the country who are part of the same program.

Stanford University

UC SANTA CRUZ

UCDAVIS

Accepting new University members for 2024

PI Contact: Mark Horovitz

SLAC

BERKELEY LAB

Brookhaven National Laboratory

Fermilab

HEPIC Summer Week 2022

Hosted at SLAC, lectures on HEP related IC design topics and hands-on design exercises – open to all students

HEPIC Summer Week 2023 Applications Open

TRAIN-MI instrumentation traineeship

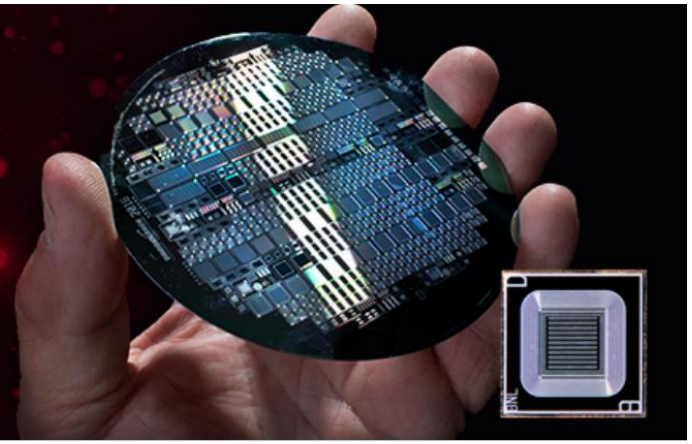
- TRAIN-MI centers around a University-endorsed certification program and joins the existing Accelerator Science and Engineering Traineeship (ASET) at MSU to provide comprehensive training in two undersubscribed subfields of HEP.
  - Students from high energy physics, nuclear physics and related fields, including electrical engineering, are able to take dedicated instrumentation courses to gain a rigorous, broad, and deep understanding of instrumentation.
- The program has the following key objectives:
  - **Curriculum**: Students will learn about detector technologies (scintillators, photon detectors, calorimeters, bolometers, time projection detectors), detector readout and electronics, including ASICs, radiation safety and materials physics. In addition, project management, lab safety and scientific communication will also be covered. Successful completion of the program will result in formal certification. Program assessed by independent panel.
  - **Research opportunities**: Post coursework, students will be paired with research mentors at national laboratories or DOE-supported facilities where they will be able to apply their skills to a research project with a central instrumentation component. An important goal is to build connections and experiences at national laboratories that will enhance students' ability to build careers in instrumentation. The program includes dedicated mentoring and career opportunities to connect students and their skills to employment opportunities and a community of HEP. instrumentation.

arXiv:2204.07285v1 **[physics.ins-det]**

EDIT School 2023

Excellence in Detector and Instrumentation Technologies

Hosted by Brookhaven National Laboratory
October 10–20, 2023



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Purpose

Please mark this event on your calendar. More information to come.

EDIT (Excellence in Detector and Instrumentation Technologies) is a school series that is devoted to young researchers, in their graduate studies or in their first year as post docs, seeking to acquire a deeper knowledge on the major aspects of detectors and instrumentation technologies for particle physics. The school comprises lectures and four courses with hands-on experiments, including beam tests, on silicon sensors, silicon systems, calorimetry and gas detectors.

Local Organizers

- Gabriella Carini (BNL)
- Michael Begel (BNL)
- Hucheng Chen (BNL)
- Sara Capp (BNL)

Sponsors and/or Co-sponsors

- International Committee for Future Accelerators (ICFA)
- Department of Energy (DOE)

EDIT Instrumentation Schools

View Past Schools

Training Information

Dates: October 10–20, 2023

Event ID: 000004865

Venue:
Brookhaven National Laboratory
Upton, NY 11973 USA

Training Coordinator:
Sara Capp

(631) 344-7290
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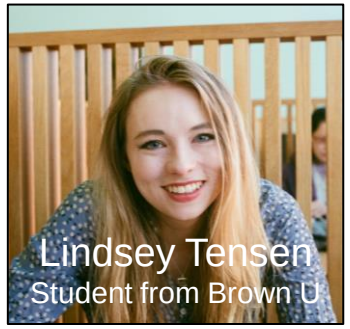
Summary

- We are on the right track but there is a long way ahead
- Complex problem, it requires a concerted effort
- Commitment: each and everyone of us can make a difference, a student at a time

Acknowledgement: thanks to colleagues and DOE for providing input for this presentation

Summer students in Instrumentation Division presenting their final projects in August 2022.



Lindsey Tensen
Student from Brown U

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UCSC HEPIC student

Questions?