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on

Innovation Through Collaboration: The Department of Energy's Role in the U.S. Research Ecosystem

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Overview

Chairman Lucas, Ranking Member Lofgren, and Members of the Committee, thank you for the opportunity to appear before you today to discuss the National Science Foundation's (NSF) partnerships with the Department of Energy (DOE), which contribute to our shared goals to spur nationwide innovation, train the next generation STEM workforce, and secure global leadership in emerging technologies. I am Dr. Sean Jones, Assistant Director for NSF's Mathematical and Physical Sciences Directorate (MPS).

Established by the National Science Foundation Act of 1950 (P.L. 81-507), NSF is an independent federal agency charged with the mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF is unique in carrying out its mission by supporting research across all fields of science, technology, engineering, and mathematics, and at all levels of STEM education. NSF investments contribute significantly to the economic and national security interests of the nation, and to the development of a future-focused science and engineering workforce that draws on the talents of all Americans and creates new businesses, new jobs, and more exports.

Meeting Today's Global Challenge

Today, the United States faces challenges to our global leadership in science, engineering, and technology as other nations seek to replicate our success to control the future of key technologies. That is why it is critical that we foster the nation's capacity to produce breakthroughs, to innovate, and to power our country forward. Our economic and national security depend on our ability to invest heavily not only in the technologies of today, but to support new discoveries that will become the foundation for technologies of tomorrow. That essential mission requires planting the seeds of innovation *everywhere* — by building ecosystems of innovation in every region of the country.

Over the past 73 years, NSF has funded research and researchers, innovations and innovators, and world-class infrastructure that has garnered incredible benefits to the nation. The Internet, 3D printing, and many of the technologies and industries that are the drivers of national competitiveness today—artificial intelligence, quantum information science, advanced manufacturing, and advanced wireless and biotechnology, to name a few—are rooted in sustained NSF investments in research at the frontiers of science and engineering over multiple decades.

With the passage of the CHIPS and Science Act of 2022, Congress put in place a roadmap for accelerating and expanding the Nation's research enterprise and creating opportunities for innovation in communities throughout the country. The new law positions the federal research agencies to capitalize on the American research ecosystem that is comprised of academia, private industry, the federal government, and other partners to quickly translate research into impacts that benefit the Nation. These partnerships are a central pillar of NSF's mission, and they will be critical to our collective success in achieving the goals of the CHIPS and Science Act and securing the future.

Interagency Partnerships

Inter-agency partnerships and collaborations are a critical part of the federal S&T ecosystem.

Through the Office of Science and Technology Policy's National Science and Technology Council, the federal research agencies work together to coordinate across priority areas and to leverage investments and expertise to tackle national challenges. For example, NSF co-chairs the NSTC's Select Committee on Artificial Intelligence. Through this committee, member agencies focus on policies to prioritize and promote AI R&D, leverage Federal data and computing resources for the AI community, and train the AI-ready workforce. Agencies also partner directly on programmatic priorities, on place-based research and through the use of multi-user research facilities.

Another example is the Subcommittee on Quantum Information Science (SCQIS), which NSF and DOE co-chair along with the National Institute of Standards and Technology (NIST) and the Office of Science and Technology Policy (OSTP). This subcommittee coordinates Federal research and development in quantum information science (QIS) and related technologies. Further responsibilities of the subcommittee are legislated through the National Quantum Initiative Act (NQI Act), which was signed into law in December 2018. The NQI Act aims to accelerate quantum research and development for the economic and national security of the United States. Advances in quantum physics have created some of the 21st century's critical tools such as lasers and broadband communications. New discoveries in quantum physics promise faster computers and more secure communication networks. The diverse scientific fields of physics explore the fundamental workings of our universe, from the smallest quantum-scale phenomena to entire galaxies. From space flight to GPS, physics provides the foundation for countless innovations woven into the fabric of modern life.

In January, NSF and DOE's Office of Science signed a memorandum of understanding that will continue our longstanding collaboration on scientific and engineering research and enable increased partnerships to address the most important challenges of the 21st century. This MOU builds upon previous NSF and DOE research partnerships, such as collaboration on large physics experiments, quantum information sciences and technologies, and access to scientific user facilities. The MOU also provides opportunities for collaboration on biotechnology, quantum information science and engineering, artificial intelligence and machine learning. Growing a diverse, inclusive STEM workforce is also a priority for both agencies. This MOU will help NSF and DOE facilitate fulfilling engagements that will increase the impact of research and development funding.

Additionally, NSF and DOE's Office of Energy Efficiency and Renewable Energy (EERE) signed a separate MOU in March of last year, this one focused specifically on decarbonization and accelerating clean energy technology research and implementation. Among other things, the partnership aims to create advanced new materials to accelerate solutions to the nation's toughest materials challenges in the energy sector. The partnership will build upon previous collaborative activities and could include bioenergy, building and water treatment technologies, hydrogen and fuel cells, and renewable energy technologies, as well as agriculture, critical minerals and materials, and manufacturing, as well as the social, behavioral and economic aspects of new technologies and energy-related policies. Collaboration could extend to research infrastructure, university-industry partnerships, education and workforce development, and activities supporting diversity, equity, and inclusion.

NSF and DOE's robust partnership includes access to various NSF- and DOE-managed multi-user facilities around the globe. One recent success from that partnership is the NSF-supported work of researchers at the University of South Carolina who collaborated with the DOE's Sandia National Laboratories. The researchers have created a new type of porous material with unique nanoscale properties that can potentially enable superior hydrogen storage solutions — an innovation that would be useful for fuel cells used in vehicles, backup power supplies and other applications.

Other examples include the Large Hadron Collider (LHC), which is an international project at the European Organization for Nuclear Research, CERN, laboratory in Geneva, Switzerland. It is the most powerful particle accelerator ever constructed and has the highest energy particle beams ever created, making it the premier facility in the world for research in elementary particle physics. It consists of a superconducting particle accelerator, about 16.5 miles in circumference, providing two counter-rotating proton beams. Four large particle detectors collect the data delivered by the LHC. Researchers use the data to search for new particles and forces. CERN is responsible for meeting the overall LHC project goals and coordinating international participation. The U.S., through a partnership between NSF and DOE, is a major contributor to the construction and operation of two of the largest particle detectors: A Toroidal LHC ApparatuS, ATLAS; and the Compact Muon Solenoid, CMS. A major international effort is underway to upgrade the luminosity of the particle beam at the LHC to increase the intensity of the high-energy particle collisions and unleash a torrent of data for research in elementary particle physics. NSF is one of more than 45 funding agencies contributing to this effort. The upgrade effort, like LHC operations, is being closely coordinated with DOE.

In the field of astronomy, NSF's National Optical-Infrared Astronomy Research Laboratory (NOIRLab) is the U.S. center for ground-based optical and infrared astronomy and operates several observatories where both NSF and DOE research takes place. Two examples of multi-user facilities where NSF and DOE work in tandem include the Vera C. Rubin Observatory and the Nicholas U. Mayall 4-meter Telescope at Kitt Peak National Observatory.

The Rubin Observatory is led by NSF in partnership with the DOE Office of High Energy Physics. DOE is providing the observatory's world-leading digital camera and is contributing to design, development, installation, commissioning, operations, and scientific research support. The Rubin Observatory will become NSF's flagship optical survey instrument, consisting of an 8-meter wide-field ground-based telescope, a 3.2-gigapixel camera — the largest ever made — and an automated data processing system. It will conduct an unprecedented, decade-long survey of the visible sky and will enable new science in four main areas:

- Understanding the nature of dark matter and dark energy;
- Cataloging the Solar System, to help reveal how it originally formed and to protect Earth from hazardous, near-flying asteroids;
- Exploring the changing sky, including cosmic events that are only visible for short periods of time; and
- Probing the Milky Way's structure and formation.

The Kitt Peak National Observatory (KPNO) supports the most diverse collection of astronomical observatories on Earth for nighttime optical and infrared astronomy. KPNO operates several telescopes including the Mayall 4-meter Telescope, which specializes in dark energy science. The Dark Energy Spectroscopic Instrument (DESI) is an international science collaboration managed by DOE's Lawrence Berkeley National Laboratory with primary funding for construction and operations from DOE's Office of High Energy Physics. DESI is installed at the Nicholas U. Mayall 4-meter Telescope at Kitt Peak National Observatory; DOE contracts with NSF's NOIRLab to operate the Mayall Telescope for the DESI survey.

DESI has broken through all previous records for three-dimensional galaxy surveys and has created the largest and most detailed map of the Universe ever. The DESI Legacy Imaging Survey published a new data release just recently, expanding even further upon the largest two-dimensional map of the sky ever created. Over one billion galaxies blaze bright in the colossal map of the sky that was just released, which was made with data from NSF's NOIRLab telescopes at KPNO and Cerro Tololo Inter-American Observatory in Chile. One of the main purposes of this map is to identify roughly 40 million target galaxies for the five-year DESI Spectroscopic Survey, which is aimed at understanding dark energy by precisely mapping the expansion history of the Universe over the last 12 billion years.

Another example of close coordination between DOE and NSF is the orderly transition of NSF's National Superconducting Cyclotron Laboratory (NSCL) to DOE's Facilities for Rare Isotope Beams (FRIB), located at Michigan State University. For 40 years, NSCL served as the Nation's premier user facility for rare isotope beams, which are key to understanding rare nuclear processes and how elements heavier than iron came to be. In 2022, building on NSF's initial investment at NSCL, the DOE Office of Nuclear Physics inaugurated the next-generation facility FRIB, which will keep the U.S. at the frontier of rare isotope science for years to come. This transition would not have been possible without close coordination between DOE and NSF.

Public-Private Partnerships

In addition to our partnerships with other federal agencies, NSF is also focused on developing long-lasting partnerships with industry to help meet the challenges of today and tomorrow. NSF's new Directorate for Technology, Innovation and Partnerships (TIP) — which was codified in the CHIPS and Science Act of 2022 — helps position the agency to capitalize on the uniquely American research ecosystem that includes academia, private industry, the government, and other partners to quickly translate research into impacts that benefit the Nation.

In the past six months, the TIP Directorate has announced new programs and partnerships with companies such as Intel Corporation and Micron Technology, Inc., to develop bold, potentially transformative solutions to address semiconductor manufacturing challenges and also advance opportunities for equitable science, technology, engineering and mathematics (STEM) education.

Last September, NSF announced a new $10 million partnership with Intel to provide funding to support the development of a high-quality manufacturing workforce at all levels of production and innovation. This builds upon a previously announced 10-year collaboration between NSF and Intel that will, over time, invest $100 million to address semiconductor design and manufacturing challenges and workforce shortages around the country.

In October, it was announced that NSF and Micron will each invest $5 million in support of research, education, infrastructure capacity building, and workforce development for semiconductor design and manufacturing. Both of these partnerships will improve and make more equitable STEM education at two-year colleges and four-year universities, including minority-serving institutions.

Just last month, NSF announced a cross-sector partnership with Ericsson, IBM, Intel, and Samsung to support the design of the next generation of semiconductors as part of our Future of Semiconductors (FuSe) initiative. Investments through this public-private partnership will help spur research and innovation leading to breakthroughs in semiconductor and microelectronics technologies, aiding the myriad applications that rely upon these devices.

Summary

NSF has made partnerships a pillar in our strategy for meeting the challenges of today and laying the groundwork for the research enterprise of tomorrow. These examples provide only a small sample of the many collaborations NSF is undertaking both within the federal government and with other partners to leverage resources and provide the best possible return to the American people, now and into the future.

Our partnerships with the DOE and other federal partners are a vital part of these efforts and the research agencies will continue to work together to bring about advances in key technologies that are critical to our economic and national security.

Thank you for the opportunity to appear before the Committee today.