



PennState

**20
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Annual Report of Research Activity

OFFICE OF THE SENIOR VICE PRESIDENT FOR RESEARCH

Navigating the pandemic – year two

Despite curtailed hiring, limited equipment purchases, and restricted travel, we have maintained a solid and impressive research portfolio. In addition to advancing research related to the pandemic, we have been actively growing research in areas of national priority, including artificial intelligence, 5G, climate change, national security, health & wellness, and additive manufacturing. Thanks to the resilience, passion, and overall excellence of our faculty, we hardly paused in our efforts.

Our research expenditures reached **\$993.1 million**, including **\$610 million** in federal funding from all 15 federal research funding agencies. Funding from the Department of Health and Human Services rose by **\$2.7 million** to top **\$145 million**, and that from the National Science Foundation rose by **\$2.3 million** to a total of **\$69 million**. Funding from Department of Defense agencies other than the Navy, Army, and Air Force rose by **\$8 million**, to **\$21.5 million**.

Among our academic units, three fared exceptionally well last year, with the College of Engineering experiencing a **\$28 million** increase in research funding, to a total of **\$181.5 million**; the College of Medicine's funding rising by **\$24 million**, to **\$127.6 million**; and the College of Education enjoying a **\$6.5 million** increase, to **\$16 million**. Among the Commonwealth campuses, Penn State Erie, The Behrend College more than doubled its research funding, to a total of **\$8 million**.



LORA G. WEISS
Senior Vice President
for Research

I'm happy to report that as of the last published data, Penn State remains first among Pennsylvania public institutions in industry sponsored research, with a total of **\$29.9 million** across all our campuses (FY20 NSF HERD data).

I would like to recognize President Eric Barron for his tireless efforts as a champion of Penn State research. To cite a single, high-profile example, Dr. Barron's vision in launching the extremely successful Invent Penn State initiative demonstrates the tremendous impact of innovation on economic development. Over the last five years, Invent Penn State has assisted **4,976** entrepreneurs and aided in the start of **218** new Pennsylvania companies.

As Dr. Barron enters on a well-earned retirement, we welcome with excitement his successor, Dr. Neeli Bendapudi, and look forward to many more years of research innovations and scholarly excellence. As we advance our research portfolio, we are not just solving problems; we are anticipating the hardest challenges, creating new knowledge, and fielding impressive prototypes. Thanks to everyone for your unyielding commitment to advancing scholarly and scientific research.

SHAPING THE FUTURE

The future of research requires curiosity across multidisciplinary teams, and our interdisciplinary research institutes are pushing the boundaries, making impactful discoveries and advances. We consistently seek approaches to forge research partnerships to advance knowledge, in collaboration with faculty and industry, to commercialize inventions, to transition innovations to applications, and to spawn economic development. As the research and development landscapes change, our stakeholders look to us for new ideas; we are known for developing solutions well in advance of others recognizing the problems. We are recognized for our breadth and depth of research and our academic excellence, founded on a community of exceptional and uniquely collaborative talent driven by curiosity that is on full display in all our research endeavors.

Highlights for this year include **\$20.1 million** in renewed National Science Foundation funding for Penn State's Two-Dimensional Crystal Consortium, one of four Materials Innovation Platform national user facilities in the United States, as well as an **\$18 million** renewal for the Center for Nanoscale Science, a National Science Foundation Materials Science and Engineering Center, and a **\$25 million** renewal from the National Institutes of Health for our Clinical and Translational Science Institute.

In terms of return on investment, 2021 yielded the first round of returns on COVID seed-grants from 2020, with follow-on external funding in excess of **\$13 million and counting**. And David Hughes, Huck Chair in Global Food Security, was awarded a USAID Feed the Future grant for up to **\$39 million** on the strength of his PlantVillage Project, which grew out of a **\$100,000** investment by the Huck Institutes in 2012.

The "Evidence-to-Impact Podcast," produced by the Social Science Research Institute, presented conversations between Penn State researchers and government partners to translate research insights into real-world solutions on issues such as poverty, criminal justice, and healthcare, and our Applied Research Laboratory demonstrated and delivered groundbreaking technological capabilities in response to emerging sea, land, air, space, and cyber threats.

Among other highlights, the biotech company Gamma Bio signed a 10-year **\$8 million** lease in Innovation Park, our Diversity, Equity, & Inclusion efforts resulted in creation of a Social Justice Research Council, and our Institutional Review Board processed nearly **10,000 submissions** for human subjects research, despite the ongoing pandemic.

From fundamental discovery to innovative applications, knowledge creation, sustainable implementation, economic development, and national security, Penn State research is having a transformative impact on the Commonwealth of Pennsylvania, the nation, and the world.



CANCER INSTITUTE

Penn State Cancer Institute strives to reduce the burden of cancer in central Pennsylvania and beyond through compassionate cancer care, education, innovation and collaborative research. In the past year, the Institute launched multiple clinical trials and invested in state-of-the-art equipment to conduct innovative research and patient care. From identifying genetic mutations that cause worse cancer outcomes in minority populations to studying how factors like geography and social influences affect access to preventive and therapeutic treatments, institute researchers focused on underserved communities, especially residents in rural Appalachian communities. Through all its research endeavors, the Cancer Institute works to understand the origins of cancer, identify and overcome barriers to care, and develop and test next generation therapeutics.



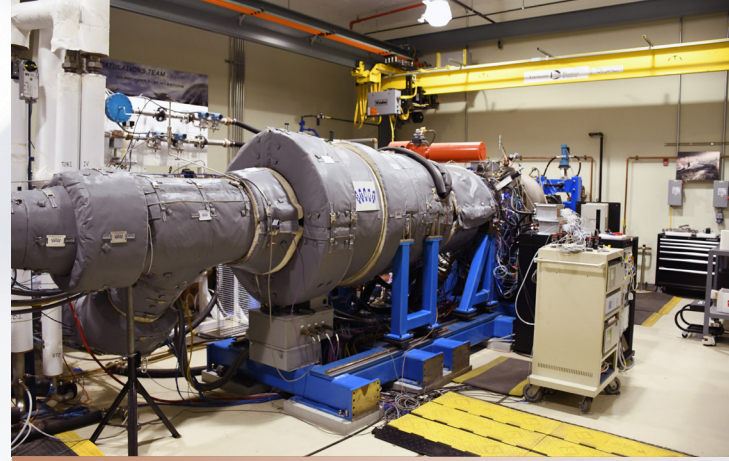
CLINICAL AND TRANSLATIONAL SCIENCE INSTITUTE

With renewed support from the National Institutes of Health, Penn State Clinical and Translational Science Institute secured more than \$25 million in funds to expand community partnerships, improve access to clinical trials, and develop and study new medical and behavioral treatments and interventions. The Institute will continue its efforts to eliminate health disparities by partnering with Sharon, Pa.-based Primary Health Network, Pittsburgh-based Allegheny Health Network and other organizations to understand the impact of social and economic factors on health in rural communities, the Commonwealth and beyond. The Institute also plans to support development of a division of clinical informatics within Penn State College of Medicine where computer and data scientists will advance new ways to use data and health informatics to enhance scientific discovery.



INSTITUTE FOR COMPUTATIONAL AND DATA SCIENCES

Artificial intelligence is accelerating research and transforming many facets of both the public and private sectors. ICDS leads strategic initiatives on research and computing that will help to cement Penn State's AI leadership. By focusing on building interdisciplinary collaborations and making strategic investments, ICDS will help to connect and expand Penn State's AI research in several key areas, including scientific applications, cyberinfrastructure, industry partnerships, and law and policy. Investments include support for new University research centers, faculty co-hires, seed grant funding, AI computational support personnel available to the University community, and the cyberinfrastructure needed to conduct AI research. Through these investments, ICDS is supporting Penn State's mission to empower science and society through digital innovation.



INSTITUTES OF ENERGY AND THE ENVIRONMENT

IEE addresses science-based solutions through interdisciplinary research that improves our society and planet. Our researchers also work with government and industry on technology, law, and policy to reduce climate change impacts and improve responses to climate-related emergencies. We are developing efficient turbine designs for air travel, next-generation solar, wind, and bioenergy systems, high-performance buildings, and battery storage. In 2021 IEE's EnvironMentors program expanded to three campuses, attracting underrepresented high school students to STEM through environmental research. IEE also hosted two distinguished speakers, Robert Bullard, the father of the environmental justice movement, and Shalanda Baker, the Deputy Director for Energy Justice at the U.S. Department of Energy.



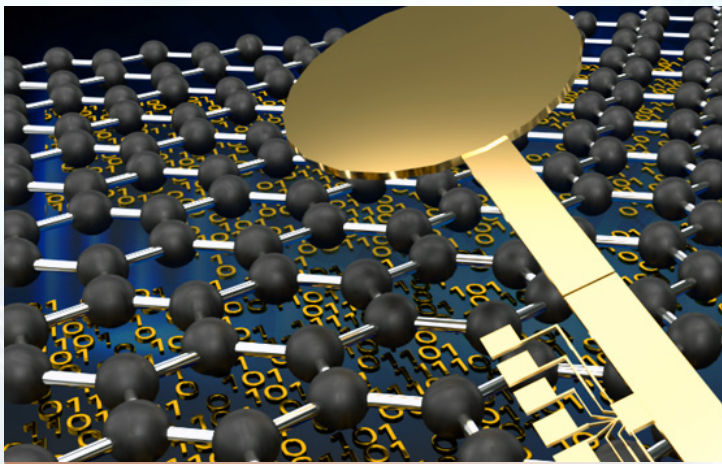
HUCK INSTITUTES OF THE LIFE SCIENCES

In spite of the ongoing pandemic, Huck had an incredibly busy and eventful year. 2021 yielded the first round of returns on COVID seed-grants from 2020, with follow-on external funding in excess of \$13 million and counting. International biotech company Sartorius gifted Huck with new cutting-edge instrumentation to open a Cell Culture Facility. Patricia and Stephen Benkovic chose Huck as their vehicle to invest significantly in new high-risk Penn State research at the interface of chemistry and the life sciences. And Huck Chair in Global Food Security David Hughes was awarded a USAID Feed the Future grant for up to \$39 million on the strength of his PlantVillage Project, which grew out of a \$100K investment by the Huck Institutes in 2012.



SOCIAL SCIENCE RESEARCH INSTITUTE

SSRI fosters research addressing critical human and social problems, including innovative, interdisciplinary research projects led by Penn State's social and behavioral scientists. SSRI supports research consortia, such as the Child Maltreatment Solutions Network, to develop new approaches to complex problems. Network researchers worked with advocates, practitioners, and policy makers to create and implement policies and programs to address child maltreatment across the state. Similarly, the Consortium to Combat Substance Use and Addiction engaged researchers, educators, and practitioners from multiple Penn State campuses working on the prevention and treatment of addiction. New this year was the "Evidence-to-Impact Podcast," presenting conversations between Penn State researchers and government partners to translate research insights into real-world solutions on issues such as poverty, criminal justice, and healthcare.



MATERIALS RESEARCH INSTITUTE

The Materials Research Institute focuses on interdisciplinary materials research that has profound societal impact. Penn State annually ranks first in the nation for materials science and second in materials engineering as per 2020 National Science Foundation research expenditure rankings. MRI partners with industry and government on multiple initiatives. One example is \$20.1 million of renewed funding for the 2D Crystal Consortium, one of only four NSF Materials Innovation Platforms in the country. Penn State has more than 350 tenured faculty across 8 colleges and more than 30 departments with strong interdisciplinary interactions enabled by MRI's infrastructure. Minority-serving university collaborations were initiated via participation in the NSF's Partnerships for Research and Education in Materials program.

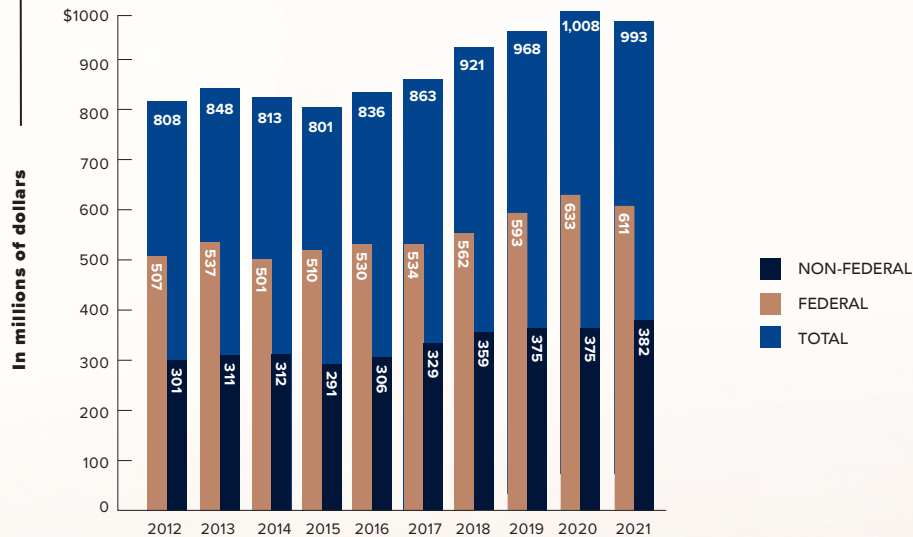


APPLIED RESEARCH LABORATORY

The Applied Research Laboratory, established at Penn State in 1945 at the request of the United States Navy, is a designated University Affiliated Research Center. ARL's broad research portfolio seeks revolutionary advances in basic science and applied research, and our focus on rapid prototyping and in situ demonstration result in real and immediate advances in capability. In 2021, ARL demonstrated and delivered groundbreaking technological capabilities in response to emerging sea, land, air, space, and cyber threats, supporting federal sponsors across the defense, homeland security, law enforcement, and intelligence communities. Our continued focus on collaborative research and development creates innovative new technologies with revolutionary impact, ensuring the Laboratory will continue its proud history of supporting our nation's security.

TOTAL RESEARCH EXPENDITURES, 2012-2021

(Federal and Nonfederal)



SOURCES OF RESEARCH FUNDING

1 Federal \$610,676,000

2 University \$239,932,000

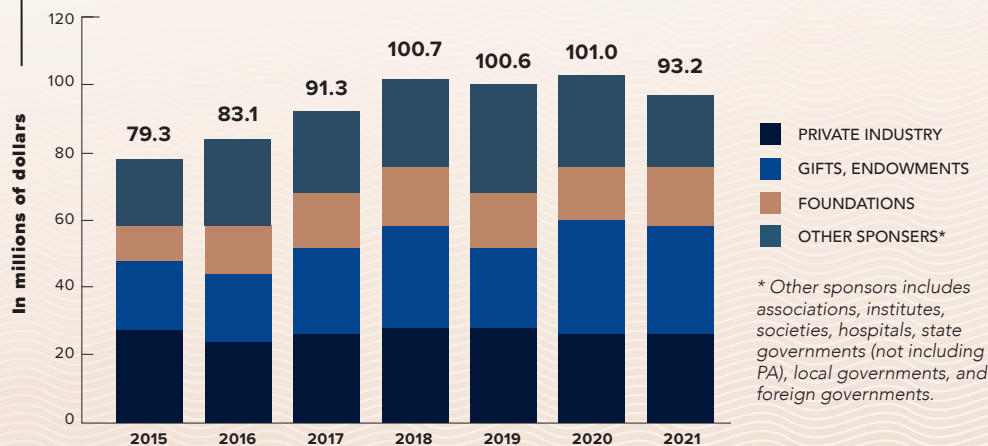
3 Industry and other \$93,153,000

4 Commonwealth of Pennsylvania \$49,375,000

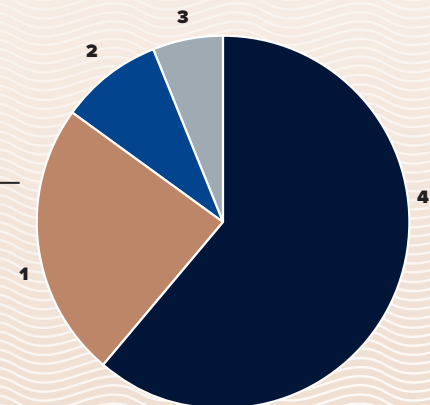
TOTAL \$993,136,000

INDUSTRY, FOUNDATIONS, AND OTHER SPONSORS

(excluding Federal, Federal flow-through, Commonwealth of PA, and internal PSU funds)



* Other sponsors includes associations, institutes, societies, hospitals, state governments (not including PA), local governments, and foreign governments.



EXPENDITURES FROM FEDERAL AGENCIES

1 Department of Defense \$262,121,000

2 Department of Health and Human Services \$145,078,000

3 National Science Foundation \$68,913,000

4 USDA \$32,121,000

5 DOE \$31,740,000

6 NASA \$15,888,000

7 Other \$54,815,000

Transportation \$8,114,000

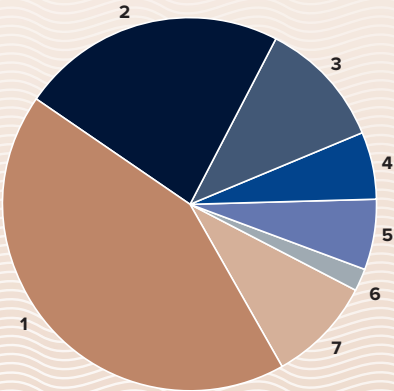
Commerce \$3,506,000

Education \$2,543,000

Interior \$1,533,000

Other Federal \$39,119,000

TOTAL \$610,676,000



EXPENDITURES BY PERFORMING UNIT

1 Agricultural Sciences \$104,865,000

2 Defense Related Research Units \$269,653,000

3 Earth and Mineral Sciences \$64,138,000

4 Eberly College of Science \$108,920,000

5 Education \$16,073,000

6 Engineering \$181,521,000

7 Health and Human Development \$46,054,000

8 Information Sciences and Technology \$11,597,000

9 Liberal Arts \$35,229,000

10 Medicine \$127,567,000

11 Other Campuses \$16,643,000

Altoona College \$1,133,000

Berks College \$515,000

Capital College \$3,916,000

Great Valley \$1,021,000

Penn State Erie, The Behrend College \$8,000,000

Other Commonwealth Campuses \$2,058,000

12 Other Colleges \$10,876,000

Arts and Architecture \$1,838,000

Communications \$975,000

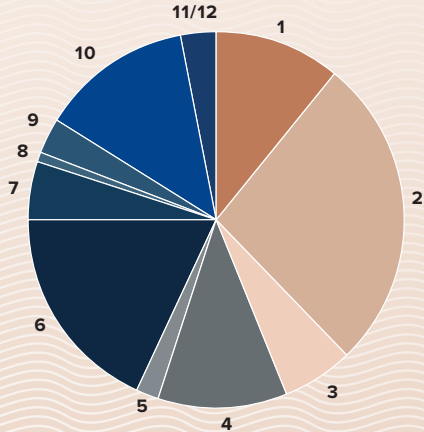
Inter national Affairs \$501,000

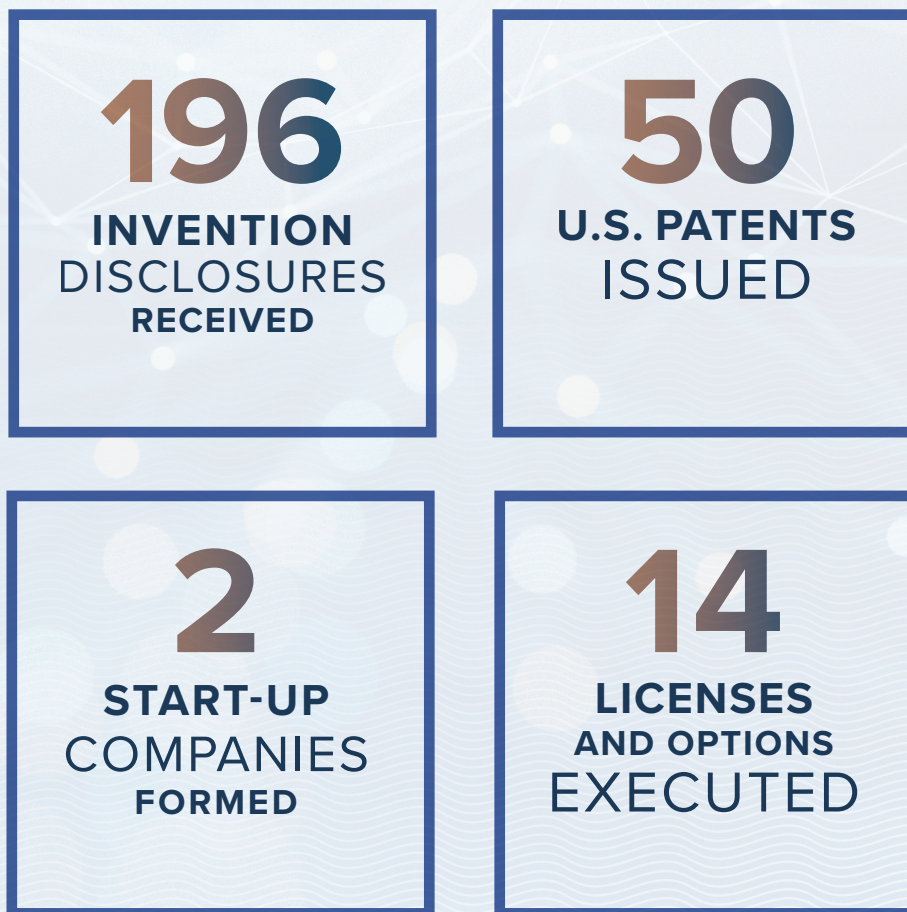
Nursing \$3,817,000

Penn State Law \$277,000

Smeal College of Business \$3,468,000

TOTAL \$993,136,000



PENN STATE TECHNOLOGY TRANSFER AT A GLANCE*Total revenue: \$2.5 million**Technology transfer data are for the period January–December 2020.*

A SAMPLING OF MAJOR AWARDS

2-D CRYSTALS

The National Science Foundation renewed funding for the Materials Innovation Platform national user facility at Penn State's Materials Research Institute, the Two-Dimensional Crystal Consortium, at \$20.1 million over five years.

ENERGY FRONTIERS

A \$10 million Energy Frontier Research Center Award from the U.S. Department of Energy will focus on 3D ferroelectric microelectronics.

BUILDING DIVERSITY

The Andrew W. Mellon Foundation has awarded \$3.1 million to build on existing programs in the College of Liberal Arts related to diversity, equity and inclusion, including expanding research initiatives and working toward a more diverse academic community.

COVID CARE

Penn State College of Medicine received \$2.69 million through the Patient-Centered Outcomes Research Institute to establish projects aimed at addressing COVID-19 health disparities among nursing home residents and racial and ethnic minorities.

NANOSCALE SCIENCE

The Center for Nanoscale Science, a National Science Foundation Materials Science and Engineering Center (MRSEC), has again successfully renewed its NSF support at \$18 million for six years. The new iteration of the center encompasses two of NSF's Big Ideas — "Quantum Leap" and "Harnessing the Data Revolution."

BIOMASS FUEL

The U.S. Department of Agriculture's National Institute for Food and Agriculture awarded a five-year, \$10 million grant to a research team led by Iowa State University, Penn State and Roeslein Alternative Energy to develop new methods of turning biomass and manure into fuel.

SUPPORT FOR STEM

A \$4.4 million grant from a leading computer software developer and nearly \$700,000 from the National Science Foundation will support the Youth Engineering Solutions initiative, whose goal is to develop equitable, research-based, and classroom-tested preK-8 engineering and STEM curricula.

LIGO LIFT

A \$3.4 million grant from the National Science Foundation will help develop software and services to allow the Laser Interferometer Gravitational-wave Observatory (LIGO) to discover gravitational waves from black holes and neutron stars in real-time in order to facilitate the detection of prompt electromagnetic counterparts.

SUMMARY OF RESEARCH PROPOSALS AND AWARDS

\$3.08_B

**TOTAL
AMOUNT OF
PROPOSALS**

\$780_M

**TOTAL
AMOUNT OF
AWARDS**

4,919

**PROPOSALS
SUBMITTED**

3,280

**AWARDS
RECEIVED**

1,856

**NEW & COMPETING
CONTINUATION AWARDS
RECEIVED**

2,262

**INVESTIGATORS
RECEIVING
AWARDS**

963

SPONSORS

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