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# ANNUAL REPORT OF RESEARCH ACTIVITY

OFFICE OF THE VICE PRESIDENT FOR RESEARCH / FISCAL YEAR 2017



**PennState**  
Vice President for Research

## PENN STATE RESEARCH EXPENDITURES REACH AN ALL-TIME HIGH

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Penn State's research expenditures reached a record high of **\$863 million** for the 2016-2017 fiscal year, **an increase of \$27 million** over the previous year. That total included **\$534 million in federal funds**.

A few examples will highlight the breadth of expertise that is one of our hallmarks. The National Science Foundation is funding a national user facility for the development of two-dimensional crystals at University Park, one of only two such platforms in the U.S. for sparking innovation in new materials. A grant from the National Institutes of Health will establish the Center for Healthy Children as a major national resource for the prevention and treatment of child abuse. And investigators at Hershey Medical Center received an award from the U.S. Army to miniaturize a fully implantable heart-assist pump for patients with congenital heart disease.

While federal dollars accounted for over 60 percent of our funding, increases from non-federal sources played a major role in reaching the record-breaking total. In all, Penn State received **\$329 million** from a combination of private funders, the Commonwealth, and university sources, including **\$75 million** from the Commonwealth of Pennsylvania, a **4 percent increase**; and **\$91 million**, a **10 percent increase**, from industry, foundations, and other sponsors. As prime examples of our commitment to industry, UK-based Morgan Advanced Materials and the Pittsburgh-based RJ Lee Group have announced the opening of major new facilities in Penn State's Innovation Park.

Finally, consistent with prior years and with Penn State's peers among other top research universities, the university's own investment in its research enterprise makes up 19 percent of the total, or **\$163 million**. This includes the non-recoverable research expenses required to create the vibrant research environment needed for success.

The record level of expenditures is further testament to our tenacious, world-class faculty, whose bright ideas place our university among the world's best.



NEIL SHARKEY  
*Vice President for Research*





310

INNOVATION  
BOULEVARD

“17”

Two industry leaders in materials will soon occupy the new 30,000 square-foot building at 310 Innovation Boulevard in Innovation Park. Their presence heralds a new era of industrial partnerships for Penn State.

Morgan Advanced Materials, a U.K.-based global leader in engineered carbon and ceramic materials, will establish a **Carbon Science Center of Excellence**, its first such research-and-development center in North America. RJ Lee Group, a leader in industrial forensics headquartered in Pittsburgh, will open an analytical laboratory in the same building.

“The additions of Morgan Advanced Materials and RJ Lee Group to our local industry ecosystem, and their collaboration with Penn State’s advanced materials community, reinforces that this area is quickly becoming a vibrant hub for advanced materials and additive manufacturing innovation,” said Jeff Fortin, associate vice president for research and director of the Office of Industrial Partnerships.

Jeff Fortin

Photo by Michelle Bixby





2-D

NATIONAL USER  
FACILITY FOR  
2-D MATERIALS



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In 2016, the National Science Foundation announced the award of \$17.8 million over five years to Penn State to fund one of only two Materials Innovation Platform national user facilities in the country. These MIP awards are the first of what will become a national infrastructure to support key scientific research areas.

Called the **Two-Dimensional Crystal Consortium (2DCC)**, the new facility at Penn State will foster the growth of a national community of users who develop new materials for next-generation electronics -- devices that are faster, use less energy, and can be built on flexible substrates, as well as other applications.

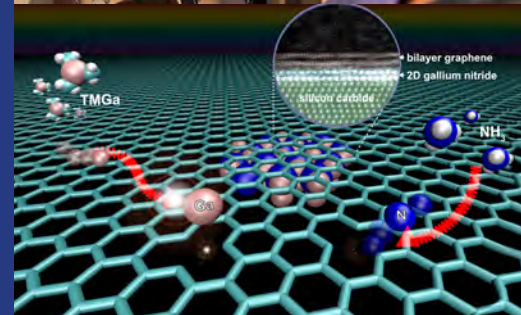
"This major award from NSF provides further proof of Penn State's continuing leadership in materials research," said Penn State Vice President for Research Neil Sharkey. "That our Materials Research Institute was chosen to house one of only two national MIP platforms speaks to the innovative skills of our faculty and the robust infrastructure for materials research at Penn State. This new platform demonstrates the confidence NSF has in our ability to develop novel 2D materials at scale, with the ultimate aim of deployment in devices not yet imagined."

Joan Redwing, professor of materials science and engineering, chemical engineering and electrical engineering, leads the 2DCC. "Our focus will be on two-dimensional materials that are only a few atoms thick, and specifically on materials called chalcogenides, which are layered compounds that contain elements such as sulfur, selenium and tellurium," Redwing said.

"By controlling the growth of these materials on an atomic scale, we will create materials with unique properties and exotic quantum states that offer the potential to revolutionize future electronic technologies. Once we solve the science problems of learning how to deposit these materials over large areas, we will work with industry to commercialize the technology and spark innovation."

MIPs seek to substantially increase the rate at which new materials and new materials phenomena are discovered. The 2DCC at Penn State will follow the "materials by design" concept, combining synthesis, characterization and modeling to speed up new discoveries.

Top to bottom: Hybrid Molecular Beam Epitaxy system, Thin Film Synthesis Facility; Illustration of a process to stabilize two-dimensional nitride semiconductors; Chemical vapor transport system, Bulk Crystal Growth facility; Angle resolved photo emission spectrometer, Davey Lab.  
Photos (4) by Patrick Mansell. Image by Z. Al Balushi and Stephen Weitzner / Penn State MatSE





Thinkstock



Photo by Patrick Mansell

Jennie Noll



Thinkstock

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Roughly two million children experience maltreatment each year in the U.S., facing the possibility of a lifetime of mental, emotional, behavioral and physical health difficulties. With more than \$124 billion spent on child maltreatment-related costs, the importance of mitigating damaging outcomes for victims cannot be overstated. There is a critical need for new research to identify solutions, mobilize public investment in prevention and treatment, accelerate science to practice, and spark system-wide change.

Recognizing this need, the Eunice Kennedy Shriver National Institute of Child Health and Human Development, part of the National Institutes of Health (NIH), recently selected Penn State to establish the **Center for Healthy Children**. The award of \$7.7 million over five years will support a national resource for child maltreatment research and training. To further this effort, Penn State has committed \$4.4 million in funds, to total more than \$12 million.

"Maltreatment is a critical issue requiring tangible solutions. There needs to be a heightened focus on raising the bar for research in this area so we can develop specific ways to prevent maltreatment and promote health and well-being for survivors," said Jennie Noll, principal investigator of the NIH award, professor of human development and family studies, and director of the Child Maltreatment Solutions Network. "We don't yet have a comprehensive understanding of exactly why maltreatment leads to such dire consequences for some, while others may exhibit remarkable resilience. It is vitally important that we identify the mechanisms involved in these disparities."

The knowledge generated will allow scientists, advocates, and practitioners to develop and implement novel, targeted and optimized interventions that will impact lives and have relevance nationwide and throughout the world.

This Center grant augments Penn State's initial investment in 2012 to create and support a network of researchers to solve the complex problem of child maltreatment. Through this investment, the network hired nine faculty members across five colleges in a unique trans-disciplinary effort.

"We continue our commitment to work on this critical issue by contributing \$4.4 million in support of the new NIH center," said Penn State President Eric J. Barron. "The expertise, passion and dedication of our researchers are unparalleled and this grant exemplifies our strength in successful interdisciplinary collaborations, involving leading experts from across the University."



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FIRST NATIONAL  
CENTER FOR CHILD  
MALTREATMENT  
STUDIES

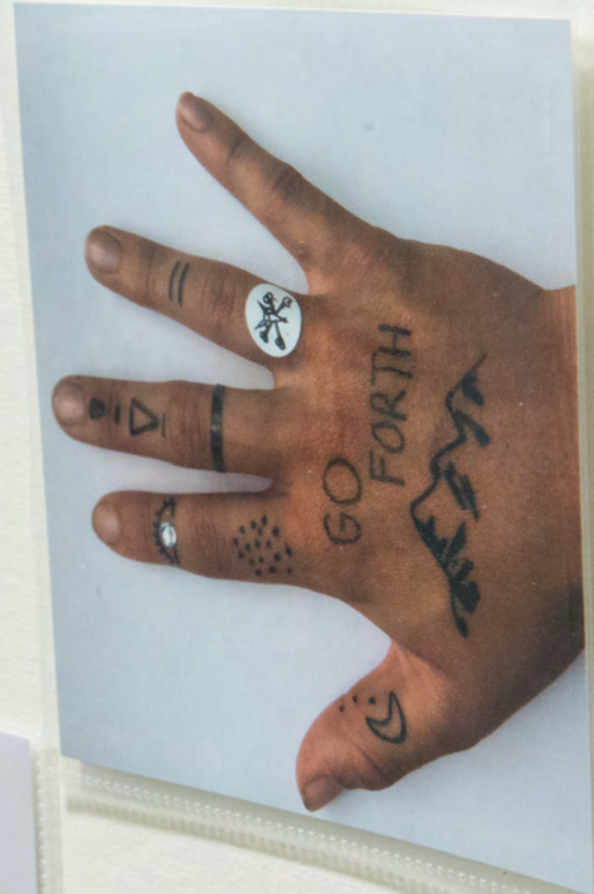
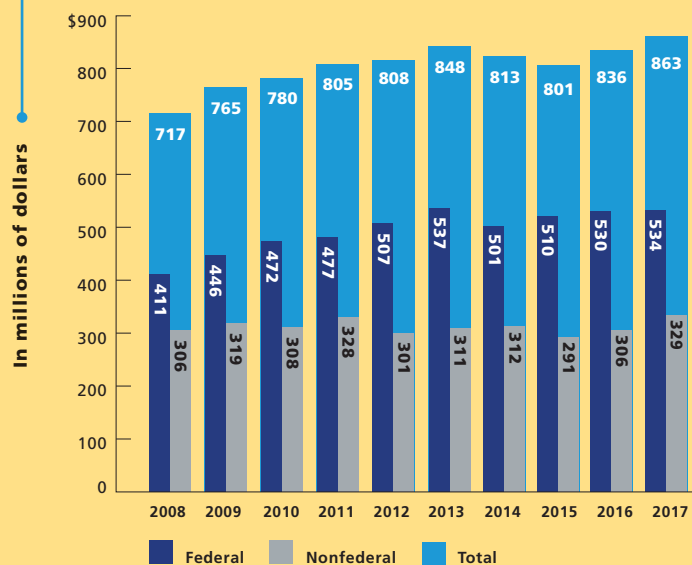


Photo by Michelle Bixby

## TOTAL RESEARCH EXPENDITURES, 2008–2017

(Federal and Nonfederal)



## SOURCES OF RESEARCH FUNDING

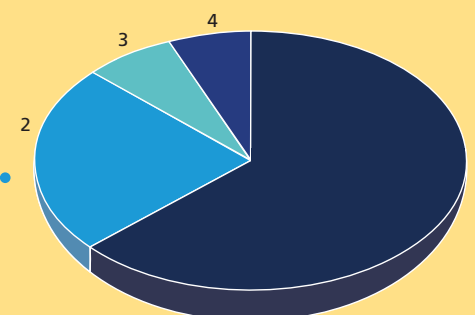
1 Federal \$533,610,000

2 University \$163,270,000

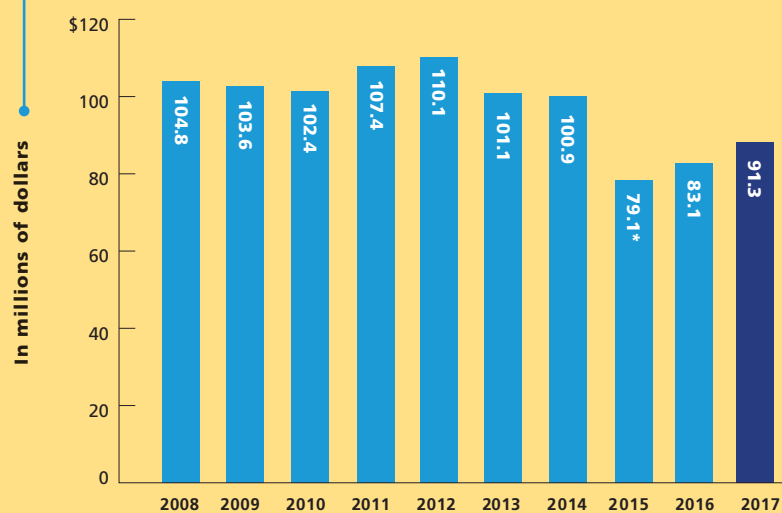
3 Industry and other \$91,340,000

4 Commonwealth of Pennsylvania  
\$74,646,000

**Total \$862,866,000**



## RESEARCH SPONSORED BY INDUSTRY, FOUNDATIONS, AND OTHER SPONSORS, 2008–2017



\* Starting in FY15, federal flow-through dollars were removed from industry awards and allocated back to the prime federal sponsor.



## EXPENDITURES FROM FEDERAL AGENCIES

1 **Department of Defense \$211,615,000**

2 **Department of Health and Human Services \$126,300,000**

3 **National Science Foundation \$73,942,000**

4 **Other \$52,082,000**

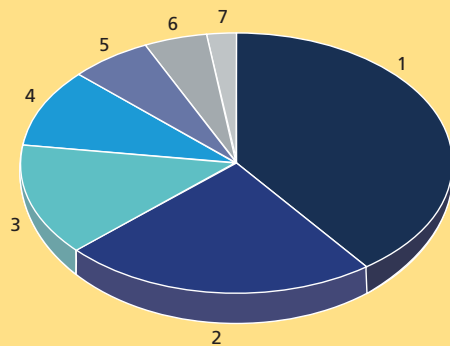
Commerce \$3,650,000  
Education \$4,794,000  
EPA \$903,000  
Interior \$1,879,000  
Transportation \$6,418,000  
Other Federal \$34,438,000

5 **USDA \$32,536,000**

6 **DOE \$25,123,000**

7 **NASA \$12,012,000**

**Total \$533,610,000**



## EXPENDITURES BY PERFORMING UNIT

1 **Agricultural Sciences \$112,858,000**

2 **Defense Related Research Units \$218,128,000**

3 **Earth and Mineral Sciences \$64,373,000**

4 **Eberly College of Science \$117,213,000**

5 **Education \$9,317,000**

6 **Engineering \$123,792,000**

7 **Health and Human Development \$47,497,000**

8 **Information Sciences and Technology \$8,355,000**

9 **Liberal Arts \$33,647,000**

10 **Medicine \$105,265,000**

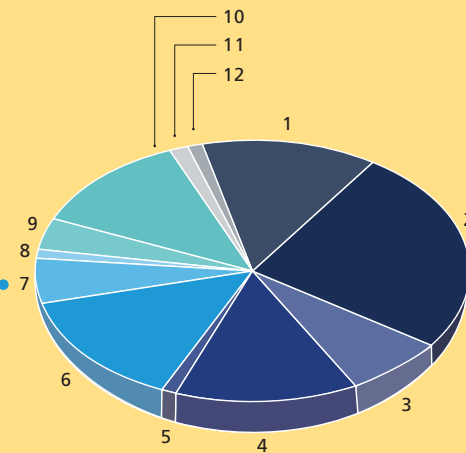
11 **Other Campuses \$13,167,000**

Altoona College \$1,242,000  
Behrend College \$4,386,000  
Berks College \$600,000  
Capital College \$1,894,000  
Great Valley \$288,000  
Other Commonwealth Campuses \$4,757,000

12 **Other Colleges \$9,254,000**

Arts and Architecture \$1,601,000  
Communications \$479,000  
International Programs \$522,000  
Law \$961,000  
Nursing \$1,766,000  
Smeal College of Business \$3,925,000

**Total \$862,866,000**



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**PENN STATE TECHNOLOGY TRANSFER AT A GLANCE**

*Total revenue: \$8.4 million*

**154**

**INVENTION  
DISCLOSURES  
RECEIVED**

**38**

**U.S. PATENTS  
ISSUED**

**6**

**START-UP  
COMPANIES  
FORMED**

**23**

**LICENSES  
AND OPTIONS  
EXECUTED**

*Technology transfer data provided by Penn State's Office of Technology Management are for the period January–December 2016.*



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## A SAMPLING OF MAJOR GRANTS AND AWARDS

### TRANSLATION HUB

The National Center for Advancing Translational Sciences, a division of the National Institutes of Health, awarded \$3.7M to Penn State's Clinical and Translational Science Institute, to serve as a regional hub for translational research.

### VIROME ECOLOGY

The National Science Foundation has provided \$2.35M to a team of Penn State researchers to learn how viruses interact and flow between mice and ticks, to help scientists understand transmission patterns of emerging diseases.

### GLOBAL RELIGIONS

Promoting Research and Discovery on Global Religions, a project supported by a \$1.7 million grant from the John Templeton Foundation, is developing data and tools to track international trends in religion and spirituality over time.

### CACAO IMMUNITY

The National Science Foundation awarded Penn State \$2.4 million to study the plant immune system in cacao, an important cash crop in many developing countries. The comprehensive study will identify genes important for disease resistance and establish an approach that can be adapted to other crops.

### IMPLANTABLE HEART PUMP

Investigators at Hershey Medical Center received \$2.8 million from the U.S. Army Medical Research and Development Command to further develop and miniaturize a fully implantable and reliable heart-assist pump for congenital heart disease patients.

### FUEL ECONOMY

Under a \$3 million grant from the U.S. Department of Energy's Energy Advanced Research Projects Agency, investigators are developing a predictive control system that will use vehicle connectivity to reduce fuel consumption for heavy duty diesel vehicles.

## SUMMARY OF RESEARCH PROPOSALS AND AWARDS

\$2.24<sub>B</sub>

TOTAL  
AMOUNT OF  
PROPOSALS

\$650<sub>M</sub>

TOTAL  
AMOUNT OF  
AWARDS

4,247

PROPOSALS  
SUBMITTED

3,414

AWARDS  
RECEIVED

2,078

NEW & COMPETING  
CONTINUATION AWARDS  
RECEIVED

1,989

INVESTIGATORS  
RECEIVING  
AWARDS

1,027

SPONSORS



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