2016 RESEARCH ANNUAL REPORT

WASHINGTON STATE UNIVERSITY

Accelerating the drive to discovery

2016 was a year of change and opportunity for Washington State University. WSU welcomed a new president with a bold vision, launched the Elson S. Floyd College of Medicine, and continued its strong record of accomplishment in research, scholarship, and creativity. It is my pleasure to share with you some of the University's research achievements and plans for the future.

A highlight this year was the arrival of Dr. Kirk H. Schulz as WSU's 11th president. Under his leadership, WSU embarked on an effort to be recognized as one of the nation's top 25 universities by 2030. Called the Drive to 25, this initiative advances two primary WSU goals:

- Offer a transformative educational experience for students
- Accelerate the development of a preeminent research portfolio

The Drive to 25 emphasizes the importance of the WSU Grand Challenges, research priorities that target critical societal problems. The Grand Challenges form the University's multidisciplinary research agenda and unite teams of outstanding faculty, students and staff. In 2016, WSU funded six interdisciplinary initiatives in support of the Grand Challenges:

- **Functional genomics**: Implementing CRISPR/Cas9 gene-editing technology in livestock species to generate traits that will improve public health and food supply worldwide.
- **Green stormwater infrastructure**: Implementing new practices and providing the foundation for policies that will keep fish and people healthy.
- **Addressing health disparities**: Partnering with communities to better understand health disparities and develop culturally-sensitive and scalable interventions.
- **Community health analytics**: Developing tools and training in computational and analytics-based health care to better inform doctors and patients.
- **Nutritional genomics**: Identifying connections among modern agricultural innovations, food production, and health outcomes in diverse communities.
- **Smart city technologies**: Paving the way to smarter cities by developing a framework to monitor, predict, and control energy and air quality in an urban environment.

This five-year, $22.6 million effort will yield results that enhance the University's research reputation and external funding opportunities, and benefit the citizens of our state and nation.

One of 2016's most significant examples of WSU research benefiting the public was the first cross-country commercial flight powered by biofuel derived from forest residuals. The Alaska Airlines flight was the culmination of work by the WSU-led Northwest Advanced Renewables Alliance, a coalition of 32 organizations in industry, academia, and government. The flight is one of many outcomes from this USDA-supported work.

Events like the biofuel flight are enabled by advances in fundamental research, where WSU also excels. One example was this year's dedication of the Dynamic Compression Sector (DCS) at the Advanced Photon Source, Argonne National Laboratory. Developed and led by the WSU Institute for Shock Physics, DCS will enable researchers worldwide to probe the atomistic behavior of materials in real time at high pressures and temperatures, similar to those found in the center of planets.

Throughout this report you will find more examples of WSU research impact, including efforts to understand global disease spread, manage resources in the Columbia Basin, develop novel solar cells, and preserve indigenous traditions.

In 2016, WSU researchers garnered $219 million in awards, a significant increase over last year. Commercialization efforts continued to grow as well, with royalties reaching nearly $2 million and the number of patents and licenses increasing substantially.

The Office of Research made organizational changes to benefit WSU researchers. It started a department that supports development of large team proposals, and it also plays a leading role in a new safety initiative.

WSU anticipates continued growth and innovation in its research portfolio. The new Elson S. Floyd College of Medicine represents an exciting research opportunity. WSU will also grow collaborations with partner institutions, including the Pacific Northwest National Laboratory.

To learn more about life-changing research unfolding at Washington State University, please read on—and visit research.wsu.edu.

Dr. Christopher Keane
Vice President of Research

Facts & figures

Total research and development expenditures

FY 2015

$333,134,000

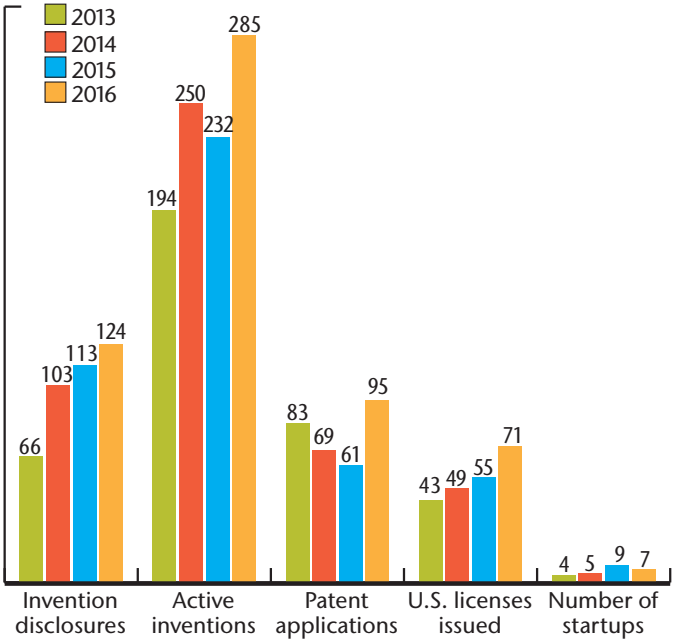
Sponsored project expenditures

FY 2016

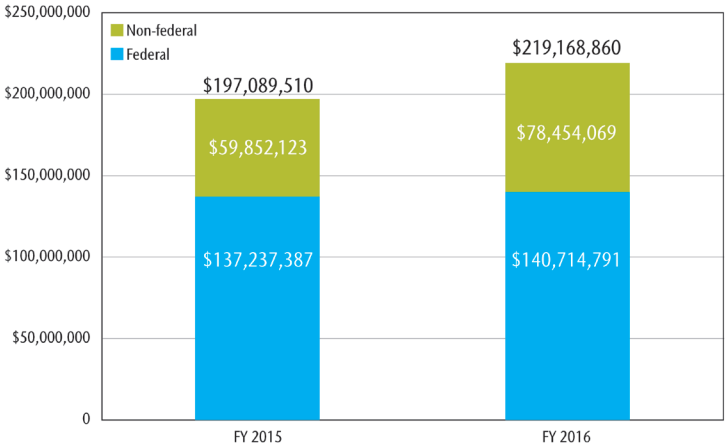
Federal: $129,345,965

Non-federal: $61,878,140

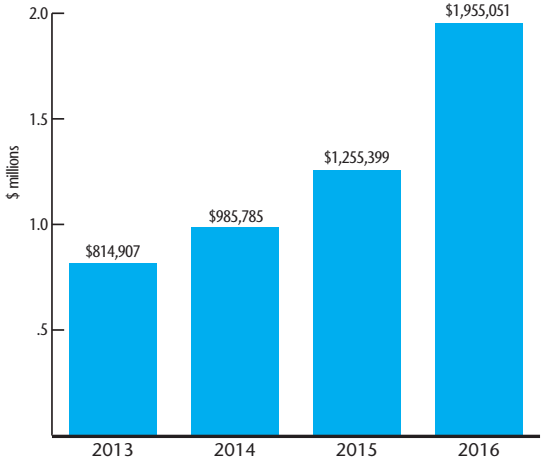
Commercialization activity



Sponsored project awards received



Royalty revenue



GRAND CHALLENGES

Grand Challenges: Addressing the problems of the 21st century

WSU research unites the best minds across disciplines to address the Grand Challenges: critical regional, national, and global problems.

The University's researchers team with scholars worldwide, as well as with federal and state agencies, national laboratories, business and civic leaders, and philanthropists. Together they work to achieve significant, lasting benefits for communities on every continent.

Examples on the following pages illustrate research addressing each challenge:

Sustaining health

The uncompromising pursuit of healthier people and communities

Sustainable resources

Supplying food, energy, and water for future generations

Opportunity and equity

Promoting an informed and equitable society, expanding individual opportunity, and advancing social justice

Smart systems

Harnessing technology to improve quality of life

National security

Fundamental research to protect America

ADDRESSING HEALTH DISPARITIES AND PREVENTING DISEASE

Sustaining health

The uncompromising pursuit of healthier people and communities

American Indian, Alaska Native, Native Hawaiian, and Pacific Islander communities experience elevated rates of hypertension, cardiovascular disease, and stroke. These communities are historically underserved when it comes to health care. Little research has been conducted to better understand and address their health care needs.

Dr. Dedra Buchwald of the WSU Health Sciences Spokane campus hopes to equip these communities with powerful tools to improve blood pressure control, and ultimately cardiovascular disease and stroke. With a $10 million grant from the National Institute on Minority Health and Health Disparities, Dr. Buchwald will work with a Southwest tribe, an Alaska Native health care organization, and three Native Hawaiian and Pacific Islander community-based organizations to reduce health risks related to high blood pressure.

Taking aim at chronic disease

The grant is part of the National Institutes of Health (NIH) Transdisciplinary Collaborative Centers for Health Disparities Research Program (TCC), which focuses on priority areas in minority health and health disparities. Dr. Buchwald will create one of two TCC centers that target chronic disease prevention. The other center will be based at Michigan State University.

A community partnership

Dr. Buchwald and fellow Principal Investigator, Dr. Spero Manson of the University of Colorado Denver, plan to engage community members in all aspects of the research process. The leaders of the Center's three intervention projects are all American Indian or Alaska Native, and all are former mentees. The Center also includes teams of personnel who represent the spectrum of National Institute of Minority Health and Health Disparities staff, academic institutions, and health care systems and agencies that play a role in serving minority communities. In addition, Drs. Buchwald and Manson will foster new scientific collaborations with local and regional partners. Scientifically rigorous and culturally informed, their investigations will respond to community needs while honoring community values.

HELPING THE COLUMBIA BASIN WITHSTAND CLIMATE CHANGE

Sustainable resources

Supplying food, energy, and water for future generations

In Washington's Columbia River basin, climate change has diminished snow storage, a significant source of summer water for the region. At the same time, population growth is escalating demand for water.

The basin is home to farms and ranches that feed the state. Hydropower generates more than half of the Pacific Northwest's electricity, most coming from the Columbia River.[1] Resources must be deftly managed to develop the region's resilience to climate change.

Population growth and climate change strain interdependent food, energy and water systems. WSU researchers have long studied each of these systems alone. A recent $3 million grant from the National Science Foundation and U.S. Department of Agriculture unites the researchers' efforts.

Exploring connections among food, energy, and water

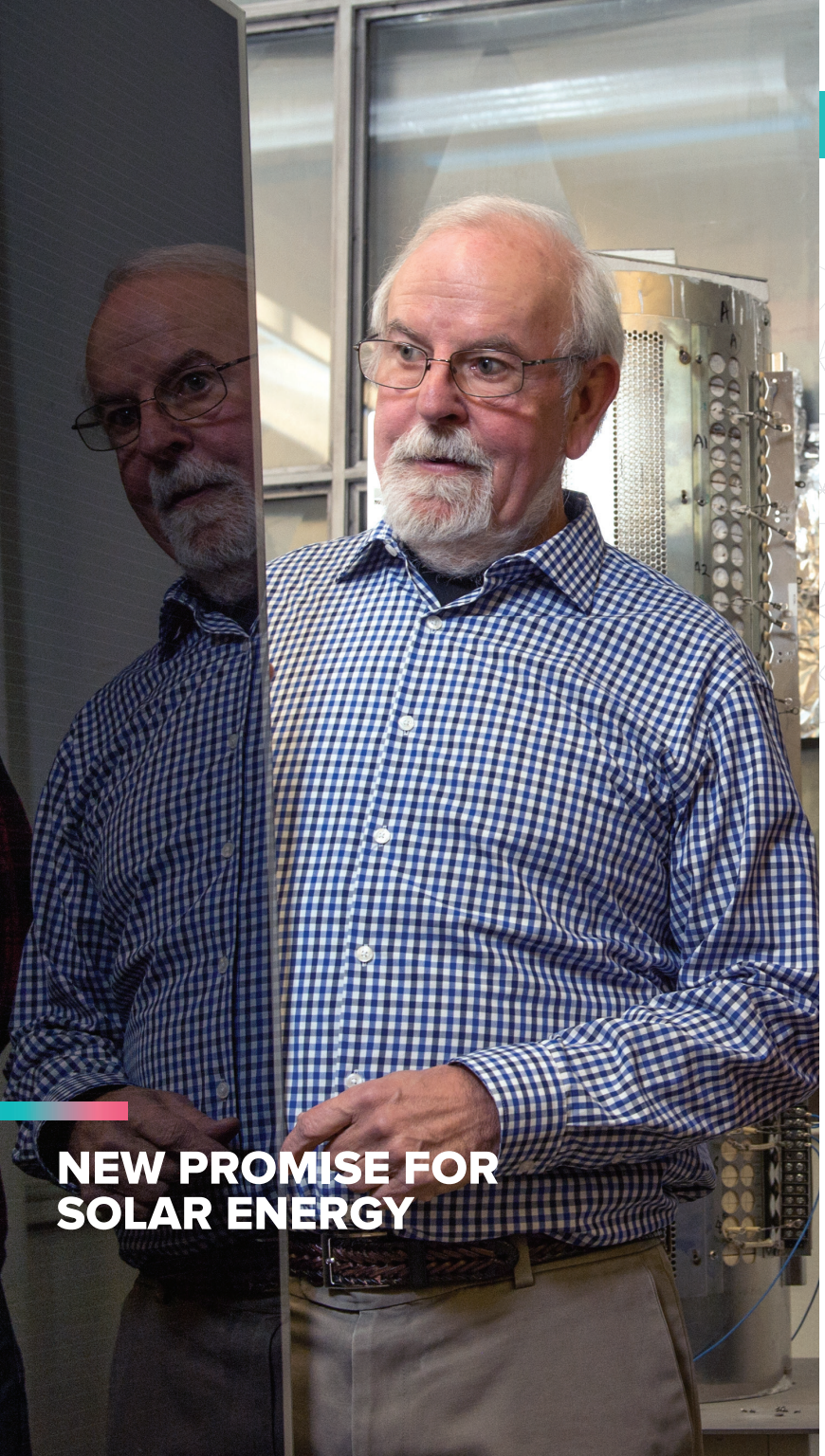
Jennifer Adam (left) and Julie Padowski are co-leading an interdisciplinary team that explores how food, energy, and water systems interact. Dr. Adam is associate director of the State of Washington Water Research Center, where Dr. Padowski is a clinical assistant professor. Dr. Padowski is also affiliated with WSU's Center for Environmental Research, Education and Outreach.

Creating a roadmap for an uncertain future

Researchers will identify ways to optimize resource management under rapidly changing conditions. They will integrate existing models to better understand complex interactions throughout the basin. They also plan to evaluate how technological innovations, such as precision agriculture or energy storage batteries, might help mitigate effects of the shifting climate.

The team spans the WSU Pullman and Vancouver campuses, as well as University of Idaho, University of Utah, Utah State University, and the Pacific Northwest National Laboratory. Faculty from WSU's Center for Sustaining Agriculture and Natural Resources also participate.

1. Bonneville Power Administration, www.bpa.gov/PublicInvolvement/CommunityEducation/ValueoftheRiver/Pages/Hydropower.aspx



NEW PROMISE FOR SOLAR ENERGY

Smart systems

Harnessing technology to improve quality of life

A breakthrough by WSU researcher Kelvin Lynn could help solar energy compete with fossil fuels for generating electricity.

Commercial success of solar technology has been constrained by the cells' performance and cost. Key to addressing both concerns are the materials from which solar cells are made.

Seeking an alternative to silicon

Silicon solar cells represent 90 percent of the solar cell market. Because silicon is a costly material to use in manufacturing, it keeps the price of solar cells high. A low-cost alternative is cadmium telluride (CdTe), which outperforms silicon in real-world conditions, such as low light and hot, humid weather. CdTe also boasts a lower carbon footprint. The downside: Its performance is limited.

For decades, the maximum voltage available from a CdTe solar cell was fixed, making it less energy efficient than silicon-based cells. This practical limit was imposed by the quality of CdTe materials.

Breaking a longstanding barrier

Working with the U.S. Department of Energy's National Renewable Energy Laboratory, Dr. Lynn's team discovered a way to grow CdTe crystals that enabled precise control over purity and composition. His approach enabled fabrication of CdTe solar cells that made them nearly as efficient as silicon-based cells. The innovation establishes new research paths for developing solar cells that are more efficient and provide electricity at lower cost than fossil fuels.

Dr. Lynn's research was funded through the Department of Energy's SunShot Initiative, which aims to strengthen U.S. competitiveness in the solar industry and make solar energy cost-competitive with traditional energy sources.

PRESERVING INDIGENOUS TRADITIONS IN DIGITAL FORM

Opportunity and equity

Promoting an informed and equitable society

A complete picture of U.S. history requires the information held in tribal archives, libraries, and museums (TALMs). While many major libraries and museums now digitize their collections for access and use, many TALMs lack the resources to do so. In addition, traditional content management systems are organized under Western standards, not allowing for local narrations and other cultural practices and protocols important to archiving Native heritage.

Digitally preserving and sharing stories, artifacts, and images from diverse cultures is important in a technologically advancing world. WSU researcher Kim Christen is ensuring that digital history includes Native American voices stored and accessed in culturally responsible ways.

Helping tribal communities build and maintain digital archives

Dr. Christen has partnered with WSU Libraries to train tribal communities in the lifecycle of digital stewardship. Together they are hosting a multi-year Tribal Stewardship Cohort Program, supported by a grant from the Institute of Museum and Library Services (IMLS).

Central to the program is Mukurtu CMS, a content management system that Dr. Christen originally developed several years ago for the Warumungu Aboriginal community in Australia. The sustainable, scalable software platform is now used around the world to help indigenous peoples circulate, manage, and narrate materials following their cultural practices. The cohort program teaches tribal communities how to implement and use Mukurtu in their home institutions.

Taking digital preservation nationwide

Dr. Christen's most recent grant from the IMLS will allow her to launch Mukurtu hubs around the country, in partnership with several universities and libraries. The hubs will provide training and support to TALMs, and ongoing development and deployment of the Mukurtu platform.

Dr. Christen's work on Mukurtu is part of the Center for Digital Scholarship and Curation, which she leads at WSU with co-director Trevor Bond from WSU Libraries.

PREVENTING SPREAD OF DISEASE IN KENYA

National security

Research worldwide to protect America

In Kenya, 42 percent[1] of the population falls below the poverty line. Lack of health care among the impoverished increases the risk of hard-to-control disease outbreaks. Understanding and preventing infectious disease threats among vulnerable populations in rural and urban settings is important to global health security.

Kariuki Njenga addresses these challenges using a "One Health" approach, which recognizes that human health is connected to the health of animals and the environment. With a $3.4 million, five-year grant from the Centers for Disease Control and Prevention (CDC), Dr. Njenga conducts investigations that aim to combat major health challenges in Kenya, including zoonotic diseases that travel from animals to humans.

Launching vaccination programs

Dr. Njenga leads the CDC's One Health Program at the Kenya Medical Research Institute. As part of the current CDC grant, he explores vaccines for diseases that the CDC has monitored and deemed troublesome for vulnerable populations in Western Kenya.

Keeping watch for Zika virus

Dr. Njenga is also investigating the presence of Zika virus in East Africa. He tracks the health of pregnant women in two different regions to watch for emergence of the disease.

Monitoring livestock for disease

With another CDC grant, now in its second year, Dr. Njenga has created the first-ever systematic livestock disease surveillance program in Kenya. Information gathered informs further research and interventions that detect and stop zoonotic diseases.

Dr. Njenga is one of several researchers from WSU's Paul G. Allen School for Global Animal Health who are based in Africa. These experts collaborate with local health organizations and governments to anticipate and foil emerging infectious disease threats.

1. unicef.org/kenya/overview_4616.html

REVEALING SECRETS OF MATERIAL BEHAVIOR AT EXTREME CONDITIONS

First-of-its-kind research capability

While exposing a sample of silicon to extreme dynamic compression–due to the impact of a nearly 12,000 mph plastic projectile–WSU scientists documented the transformation from its common cubic diamond structure to a simple hexagonal structure. At one point, they could see both structures as the shock wave traveled through the sample in less than half a millionth of a second.

WSU led the development of this experimental capability, which allows scientists to watch atomic-level changes unfold in the composition and behavior of materials under extreme conditions. Experiments take place in a facility called the Dynamic Compression Sector (DCS). Experiments utilize tunable, high-energy X-ray pulses to make movies of materials subjected to extreme conditions, and permit scientists to view condensed matter changes at the microscopic level during a shock compression event.

Research facility located at Argonne National Laboratory

WSU developed the DCS at the Advanced Photon Source, a U.S. Department of Energy Office of Science user facility located near Chicago at Argonne National Laboratory. The effort was sponsored by the National Nuclear Security Administration. Contributors to development of the DCS included Argonne, Los Alamos, Lawrence Livermore, and Sandia national laboratories, the Army Research Laboratory, and academic institutions.

Until now, researchers have had to rely on computer simulations to follow the atomic-level changes of a structural transformation under pressure, according to Yogendra Gupta, Regents professor and director of the WSU Institute for Shock Physics. The new method provides a way to measure physical changes and see if simulations are valid. Researchers examined silicon through DCS because they suspected that long-standing assumptions about the material would need to be re-examined.

Capability will accelerate investigations on multiple fronts

DCS will help address energy and national security challenges. It will enable scientists to understand the structure of planetary interiors and to develop lightweight materials for industrial, aerospace, and automotive applications.

Innovation for Washington's signature industry

WSU created a brand new apple variety called **Cosmic Crisp**™, known for its excellent flavor, good texture, and superior storage. Cosmic Crisp™ is a cross between Enterprise and Honeycrisp.

More than 600,000 trees are expected to be planted this spring, and growers have ordered over 5 million trees for 2018. First harvest will be in 2019. Fruit will become widely available to consumers in 2020.

Cosmic Crisp™ is the latest example of WSU's world-class tree fruit breeding program and the University's commitment to the state's tree-fruit industry.

Student research

Every year, reused and infected hypodermic needles cause 1.3 million deaths. Two 2016 WSU bioengineering graduates developed a cost-effective solution.

Emily Willard and **Katherine Brandenstein** designed a sterilizing cap that fits over the opening of a vaccine vial, decontaminating needles to help save lives. Both young women are researchers at heart, but dove into the world of business to turn their discoveries into a technology for commercialization. With help from entrepreneurship experts at WSU, Willard and Brandenstein developed a prototype of their product and launched a company.

The duo won the WSU Business Plan competition and the University of Washington's first Health Innovation Challenge. Willard and Brandenstein are now working to bring their product to market. In 2017 they will visit medical clinics in Tanzania.

Learn more about WSU undergraduate research at **research.wsu.edu/undergraduate**.

Faculty recognition

Newly elected to the Washington State Academy of Sciences

In 2016 four WSU researchers were named to the Washington State Academy of Sciences. By conferring membership, the Academy recognizes these scholars' outstanding record of scientific achievement. It also acknowledges their willingness to work on behalf of the Academy to address issues facing the state of Washington.

Monica Kirkpatrick Johnson

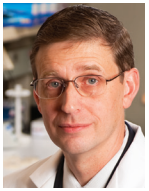
The professor of sociology and Honors College distinguished professor studies work, family, and education across the life course.

Brian Lamb

The Regents professor and Boeing distinguished professor is an atmospheric scientist who leads WSU's Laboratory for Atmospheric Research.

Jill McCluskey

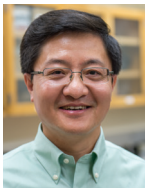
The distinguished professor of sustainability serves as associate director of the school of Economic Science.



John Roll

The senior vice chancellor at WSU Health Sciences Spokane was also recently named associate vice president for health science research. In that position, he will help develop an integrated, university-wide health sciences research agenda.

National Academy of Inventors



Yong Wang

In 2016, Yong Wang was named a fellow of the National Academy of Inventors—a prestigious group of scientists that includes 27 Nobel laureates. Dr. Wang is internationally known for his work in catalysis and reaction engineering for energy and renewable fuels and chemicals. He holds a joint appointment with the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL), where he is a laboratory fellow and associate director of PNNL's Institute for Integrated Catalysis. He was named the PNNL Inventor of the Year twice and holds hundreds of patents around the world.

Research computing

New in 2016, the Center for Institutional Research Computing (CIRC) unites the WSU research community to share and continually improve high-performance computing resources. These resources are essential to accelerating scientific and data-intensive research.

In 2015 WSU acquired a high-performance condo computing cluster called Kamiak, which opened new doors for data-intensive investigations. CIRC supports faculty seeking ways to leverage Kamiak. CIRC and WSU IT Services maintain the system and will acquire new equipment that is responsive to enduring and emerging needs of WSU's research community.

CIRC is one of nearly 40 WSU centers that advance research initiatives. Explore all of the centers, facilities, and capabilities at research.wsu.edu.

2016 visiting lectures

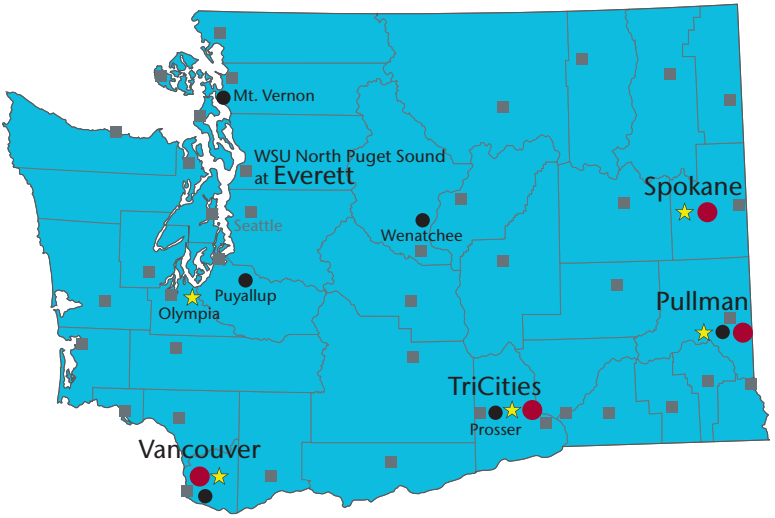
Washington State University thanks the following experts for sharing their knowledge and insights with the research community.

Dimitri Kusnezov *U.S. Department of Energy chief scientist and advisor to the secretary of energy*

Anne Harrington *Deputy adminstrator for defense nuclear nonproliferation, National Nuclear Security Administration*

Advancing research statewide

Washington State University faculty conduct research at campuses across the state. Extension offices in each of Washington's 39 counties turn research into action for local industry and communities.



Research centers, institutes, and core facilities

More than 30 research centers and institutes bridge disciplines to answer difficult questions. Core facilities support investigations with instrumentation and services.

Research and extension centers

Agricultural and natural resource research at four strategically located centers is supported largely by state and federal research grants and contracts. Public investment in these centers yields enormous returns in land productivity, disease-resistant crops, and the conservation and safer use of natural resources.

Libraries

WSU serves the state with eight libraries at five locations: Pullman, Spokane, Tri-Cities, Vancouver, and Olympia.

Extension offices

WSU Extension leverages research to find solutions to local issues.

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