2017 RESEARCH ANNUAL REPORT

WASHINGTON STATE UNIVERSITY

Advancing Research Impact and Supporting the WSU Research Community

2017 was a year devoted to advancing research impact. The year was highlighted by exciting achievements, including consistent growth in research and development expenditures, increasing licensing revenue, and significant external recognition of outstanding research faculty. Through it all, the Washington State University Office of Research provided strategically focused support for WSU researchers that enabled them to achieve results of significance and lasting benefit for communities throughout the world.

WSU's research accomplishments in 2017 demonstrate the university's commitment to the Drive to 25, led by WSU President Kirk H. Schulz. The university's faculty and staff conducted leading-edge creative activities, research, and scholarship, and applied knowledge gained from these efforts to real-world challenges. Coupled with a commitment to outstanding educational experiences for students, our research accomplishments set WSU on the path to become one of the nation's top 25 public research universities by 2030.

The Office of Research actively supported the Drive to 25 in 2017. We provided services to researchers at WSU, including supporting individual investigators, as well as multidisciplinary research projects. In collaboration with the Vice President of Finance and Administration, safety – our first priority – was a key area of emphasis in 2017. The Office of Research also continued to provide key services including research grant development and proposal submission; review, approval and oversight of animal and human subject experiments; operation of core instrumentation facilities; and support for commercialization and industrial engagement.

The Office of Research also continued to invest in developing new research capabilities and hiring new faculty in the areas of the WSU Grand Challenges. These investments, known as the Strategic Research Investment Program and launched in 2016, are paying dividends. Four projects were funded, including:

- **Functional Genomics Initiative**: Implementing CRISPR/Cas9 gene-editing technology in livestock species to generate traits that will improve public health and food supply world-wide
- **Health Equity Research Collaborative (HERC)**: Partnering with communities to better understand health disparities and develop culturally sensitive and scalable interventions
- **Green Stormwater**: Implementing new practices and providing the scientific foundation for policies that will keep fish, other aquatic species, and humans healthy
- **Nutritional Genomics and Smart Foods**: Identifying connections among modern agricultural innovations, food production, and health outcomes in diverse communities.

As a result of the strategic investments, 11 new faculty members have been hired with expertise that spans from health and mortality disparities to the economics of water. The new faculty are not only outstanding in their fields, they also complement the strength of other WSU researchers among varying colleges and fields of study at WSU. The result is multi- and inter-disciplinary research that addresses complex problems that cut across traditional disciplines and drives scientific innovation.

During 2017, we celebrated the selection of the first group of students for the Pacific Northwest National Lab-WSU Distinguished Graduate Research Program. The program adds a new dimension and ever-expanding scope to WSU and PNNL's long partnership, which includes joint faculty appointments and research projects. The students have already been accepted into WSU graduate programs and are pursuing research related to clean energy, smart manufacturing, sustainability, national security, and technology. The students will complete their coursework at WSU and then collaborate with nationally recognized PNNL scientists on their dissertation projects.

One of 2017's most exciting accomplishments was the selection of WSU to lead a nationwide consortium of U.S. universities and industry partners in a five-year, $30 million joint research project with university and industry partners in India to advance the development of the power grid in both countries. The consortium demonstrates both the U.S. and Indian commitments to ensuring access to affordable and reliable energy and supporting continued grid innovation that advances and promotes economic growth and energy security at home and abroad.

This year also marked notable achievements in WSU faculty recognition. Four WSU faculty, Amit Bandyopadhyay, Susmita Bose, Douglas Call, and Jonathan Yoder, were elected to the Washington State Academy of Sciences. Katrina L. Mealey, WSU associate dean for research and professor in the College of Veterinary Medicine, was elected a fellow of the National Academy of Inventors. Pizhong Qiao, professor in WSU's Department of Civil and Environmental Engineering, was named a fellow of the American Society of Civil Engineers' Engineering Mechanics Institute. Jean-Sabin McEwen and Steven R. Saunders, assistant professors in the Gene and Linda

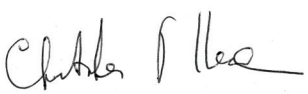
Voiland School of Chemical Engineering and Bioengineering, and Dae Hyun Kim, assistant professor in the School of Electrical Engineering and Computer Science, received early career awards from the National Science Foundation (NSF) and the Defense Advanced Research Program Agency (DARPA). And, Don Dillman, WSU Regents Professor, received the Warren J. Mitofsky Innovators Award from the American Association for Public Opinion Research for designing a new survey method that is now used in censuses around the world.

This report highlights other significant and impactful examples of WSU research, including:

- WSU scientists addressing growing global concern about the spread of antimicrobial resistance in Africa to prevent the spread of antibiotic resistant bacteria to the U.S. and other parts of the globe,
- WSU researchers receiving a $1.57 million grant from the National Institutes of Health to understand the molecular-scale mechanisms that cause cardiomyopathy,
- WSU researchers' discovery of "negative mass," wherein a fluid was observed to accelerate in the opposite direction in which it was "pushed." This was one of the top-cited articles on the physics.org website for 2017.

Commercialization efforts also saw steady growth, with 152 patent applications and $2.2 million in royalty revenue.

To learn more about the life-changing research unfolding at WSU, please read on. Stay up to date on all WSU research and services offered by the Office of Research by visiting research.wsu.edu.



Dr. Christopher Keane
Vice President of Research

GRAND CHALLENGES

Washington State University's Grand Challenges

For over 125 years, Washington State University has remained rooted in its land-grant mission to offer practical, accessible education and to use science to benefit the state of Washington and beyond. WSU's research and education transforms lives every day and betters society in remarkable ways.

To aid in enhancing our research efforts, WSU leadership worked with faculty and staff to develop the WSU Grand Challenges. The Grand Challenges team WSU researchers with scholars around the world—as well as federal and state agencies, national laboratories, business and civic leaders, and philanthropists—to target critical national and global problems. By capitalizing on our institution's research strengths, the Grand Challenges focus WSU's research, innovation, and creativity in specific areas to achieve broad societal impact. Enhancing multidisciplinary research associated with the Grand Challenges is an important element of the research goals for the Drive to 25, an initiative aimed to position WSU to be recognized as one of the nation's top 25 public research universities by 2030..

The Grand Challenges leverage WSU's research strengths and expertise in fundamental and applied sciences, humanities, and social sciences. At their core, the Grand Challenges build on the strength of our individual faculty and research staff. These individuals are the "bedrock" of our research enterprise.

The Grand Challenges are:

Sustaining Health: the Uncompromising Pursuit of Healthier People and Communities

- Deepening our understanding of health and the onset and progression of disease
- Changing the course of disease
- Promoting individual health and wellness
- Promoting healthy communities and populations

Sustainable Resources for Society: Food, Energy, and Water

- Enhancing food production systems and products
- Water safety and sustainability
- Meeting energy needs while protecting the environment
- Assessing societal perspectives and government policy

Advancing Opportunity and Equity

- Identifying the causes and consequences of unequal opportunity
- Promoting equity for individuals and communities
- Furthering economic, educational, and social policies that impact opportunity, societal cohesion, and engagement
- Improving formal and informal education throughout the lifespan

Improving Quality of Life through Smart Systems

- Further development of smart and sustainable infrastructure, systems, and smart grid
- New foundational and emergent materials
- Increasing the power of computing, data, and technology
- Addressing the economic, social, and policy dimensions of technology

Fundamental Research in Support of National Security

- The study of matter at extreme conditions and its application to fundamental science and U.S. nuclear security
- Advancing nuclear nonproliferation and safeguards through basic research
- Increasing the quality of life in developing countries through a community-based approach to improved agriculture and education
- Disease detection, prevention, and response in developing areas to promote global health security

WSU RECEIVES NIH GRANT TO STUDY HEART PROBLEMS AT MOLECULAR LEVEL

Sustaining health

The uncompromising pursuit of healthier people and communities

WSU receives NIH grant to study heart problems at molecular level

Washington State University researchers have received a $1.57 million National Institutes of Health grant to understand the molecular-scale mechanisms that cause cardiomyopathy, or heart muscle disease.

The four-year project could lead to improved diagnostics and new treatments for hereditary heart conditions. Cardiomyopathy affects as many as one in 500 people around the world and can often be fatal or have lifetime health consequences.

Alla Kostyukova (left), assistant professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering, and researchers will study mutations in three important proteins that play a key role in healthy heart function.

Heart muscle is made of tiny thick and thin filaments of proteins. With the help of electrical signals, the rope-like filaments bind and unbind in an intricate and precise architecture, allowing heart muscle to contract and beat. The thin filaments look like beaded necklaces and are made of actin, the most abundant protein in the human body. Tropomysin, another protein, wraps itself around the actin filaments. Tropomyosin together with two other proteins, tropomodulin and leiomodin, at the end of the actin filaments act as a sort of cap and determine the filament length.

In families with cardiomyopathy, genetic mutations result in the formation of filaments that are either too short or too long. Those affected can have significant heart problems that cause disability, illness and death.

The researchers will use state-of-the-art approaches to make the key proteins and study them at the molecular and cellular level. The work entails designing the molecules, constructing them at the gene level in a plasmid, and then producing them into bacterial or cardiac cells. The researchers hope to identify the components and molecular mechanisms that regulate thin filament architecture, whether diseased or healthy.

The WSU multidisciplinary group will use nuclear magnetic resonance tools to study the proteins and mutations at the atomic level.

Rewards Improve Alcohol Abuse Treatment

WSU researchers have shown that offering prizes can be an effective, low-cost treatment for alcohol abuse, one of the leading preventable causes of death. Findings from the NIH-funded study, which appeared in the American Journal of Psychiatry, could expand treatment options for an estimated 15 million U.S. adults who abuse alcohol.

Conducted in collaboration with the University of Washington, the study led by Michael McDonell, an associate professor in WSU's Elson S. Floyd College of Medicine, followed 79 participants with serious mental illness at a Seattle-area community mental health center. About half received a 12-week reward-based intervention known as contingency management, which offered prize drawings for addiction treatment attendance and negative urine alcohol test results.

The other half were in a control group that was allowed to draw prizes regardless of test results and treatment attendance. Prizes varied from necessities such as shampoo, soap, clothing, and gift cards to DVD players, microwaves, and digital media players.

Results showed that reward group participants were three times less likely to test positive for alcohol use than control participants, which persisted throughout the study's three-month follow-up period. Surprisingly, they also had reduced tobacco and cocaine use.

The findings suggest that contingency management is a feasible approach for people with alcohol problems and may be particularly effective in those with serious mental illness, a high-cost and difficult-to-engage population.

The intervention requires little investment or training and could be administered anywhere. It could help streamline care for those with mental illness who abuse alcohol—most of whom typically receive separate treatments—as well as increase addiction treatment access in rural areas and low-resource settings.

Researchers develop novel wound healing technology

A Washington State University research team has successfully used a mild electric current to beat drug-resistant bacterial infections, a technology that may eventually be used to treat chronic wound infections.

Led by Haluk Beyenal, the team used an antibiotic in combination with the electric current to kill all of the highly persistent Pseudomonas aeruginosa PAO1 bacteria in their samples. The team used an "e-scaffold," a sort of electronic bandage made out of conductive carbon fabric, along with an antibiotic to specifically tackle these persistent cells.

Beyenal's team determined the conditions necessary for the electrochemical reaction to produce hydrogen peroxide. The current has to be carefully controlled to assure the correct reaction at an exact rate. Their method does not damage surrounding tissue, and the bacteria are unable to develop resistance.

RESEARCHERS FEED, BREED, AND HELP BEES SURVIVE WINTER

Sustaining resources for society

Supplying food, energy, and water for future generations

Researchers feed, breed, and help bees survive winter

Gathering last-minute sips of nectar and pollen, bees at the Washington State University Teaching Apiary made the most of an unusually warm, 60-degree November day.

So did bee breeder Steve Sheppard (left), professor and department chair of entomology, who helped winterize dozens of WSU research hives before the cold returned.

Winter is a tough time for bees. In addition to frigid temperatures, honey bee colonies must battle disease and parasites. WSU researchers are trying to help bees fight off these threats and survive until spring.

Sheppard moved from hive to hive, lifting lids to check the bees for disease and hefting the double-decker wooden boxes to gauge their weight. A healthy hive contains at least 80-90 pounds of stored honey for the winter.

To help underweight hives, Sheppard and WSU entomology students placed feeders full of thick sugar syrup inside. Once the temperature drops, bees aren't able to easily access feeders.

"Winter bees," born with higher levels of fat and protein reserves, look the same as their summer siblings but far outlast hard-working summer bees, who only live as long as six weeks.

Sheppard also ensured that every hive is raised off the ground and every entrance angles downhill to drain rainfall and prevent rotting. He installed wire mesh screens in the entrances to ensure mice can't come inside and removed the entrance reducers that protected the hive from wasp predators in late summer.

WSU entomologists keep more than 200 hives on the Pullman campus and on surrounding properties in Washington and Idaho.

Sheppard's program has broken ground in incorporating controlled climates for better overwintering. Bees are kept in rooms with elevated carbon dioxide concentrations. The bees aren't harmed by the CO2 but there is evidence that it can help control mites.

$2M grant funds continuing WSU research of organic quinoa

Washington State University scientists determined the best varieties of organic quinoa for Pacific Northwest farmers over a four-year study. A new grant will help researchers assess crop yields, prices and more to help those growers turn a profit.

Kevin Murphy, WSU assistant professor and breeder of barley and alternative crops, and several colleagues received a nearly $2 million grant from the U.S. Department of Agriculture Organic Agriculture Research and Extension Initiative for another four years of research on quinoa, an increasingly popular, nutritious seed crop native to South America.

Quinoa contains all the amino acids needed by humans, making it the only seed crop that's also a complete protein. The WSU program is helping grow this super-food in developing countries such as Rwanda and Malawi.

The researchers tested varieties for taste and what they can be used for, as well as heat tolerance, mildew resistance and other traits.

The new grant will support an economist to help farmers determine economic impacts of the crop. It also supports partnering researchers in Minnesota and Maryland as quinoa growth expands eastward.

The scientists are developing new varieties that farmers can use in different regions of the country. The scientists are figuring out the best times to plant, how to plant, and how it grows in different soils.

Although the grant addresses organically grown quinoa, the research program involves both organic and non-organic farming.

WSU GRAD STUDENT ZEROES INTO 2016 ELECTION MAP NEIGHBORHOODS

Opportunity and equity

Promoting an informed and equitable society

WSU grad student zeroes into 2016 election map neighborhoods

A Washington State University graduate student has created what's believed to be the first map to burrow into the most localized voting results of the 2016 U.S. presidential election.

Not only did economics student Ryne Rohla (left) gather voting data from 175,000 precincts nationwide, but he did it on his own time, with no aid or outside funding.

The detailed interactive map probes deeper than red and blue states, and reveals red and blue neighborhoods. It's so popular that the web page crashed within an hour of being posted. Rohla continues to field requests from researchers in the U.S. and abroad to use his data.

Scientists—from Stanford University, UCLA, Carnegie Mellon University, and the University of Bristol—hoping to get a head start on social issues and policy research have been contacting Rohla since the map went public.

Organizations ranging from the Democratic Congressional Campaign Committee to the AARP, the advocacy group for Americans 50 and over, have also approached him.

Most revealing about the Rohla election map is the intensity of the nation's town and country split, with Donald Trump winning easily in rural areas and Hillary Clinton in the cities.

The map also pinpoints clusters of third-party votes among precincts where colleges are located. Green Party candidate Jill Stein performed strongly near Western Washington University, the University of Oregon, California State-Chico and UC-Santa Cruz. Libertarian Gary Johnson did best near the University of Idaho, Eastern Washington University, New Mexico State and Oklahoma State.

Also clustered in university areas were write-ins for Bernie Sanders.

Because no single source exists for precinct-level data, Rohla sent emails, made phone calls and submitted public record requests.

Rohla will use his much sought-after data in two of his three doctoral papers at WSU. The map also is used for a variety of purposes, including a July 2018 article in the *New York Times*.

$1.5M NSF grant funds project to teach real-world math

A Washington State University professor is part of a project awarded $1.5 million from the National Science Foundation to teach mathematical modeling in elementary school as it applies to real-world cultural and community contexts. The goal is to determine strategies that teachers across the nation may use in their own classrooms.

Amy Roth McDuffie, professor of mathematics education in the College of Education, is helping to connect math to kids' own community and culture so they can use it to make sense of their world. It's not enough that they answer a math problem; the whole process of problem solving is important.

Mathematical modeling—using graphs, diagrams, equations and more to predict patterns and provide solutions to real-world issues—historically has been taught in high school and college. But recent Common Core State Standards require elementary students to meet benchmarks too.

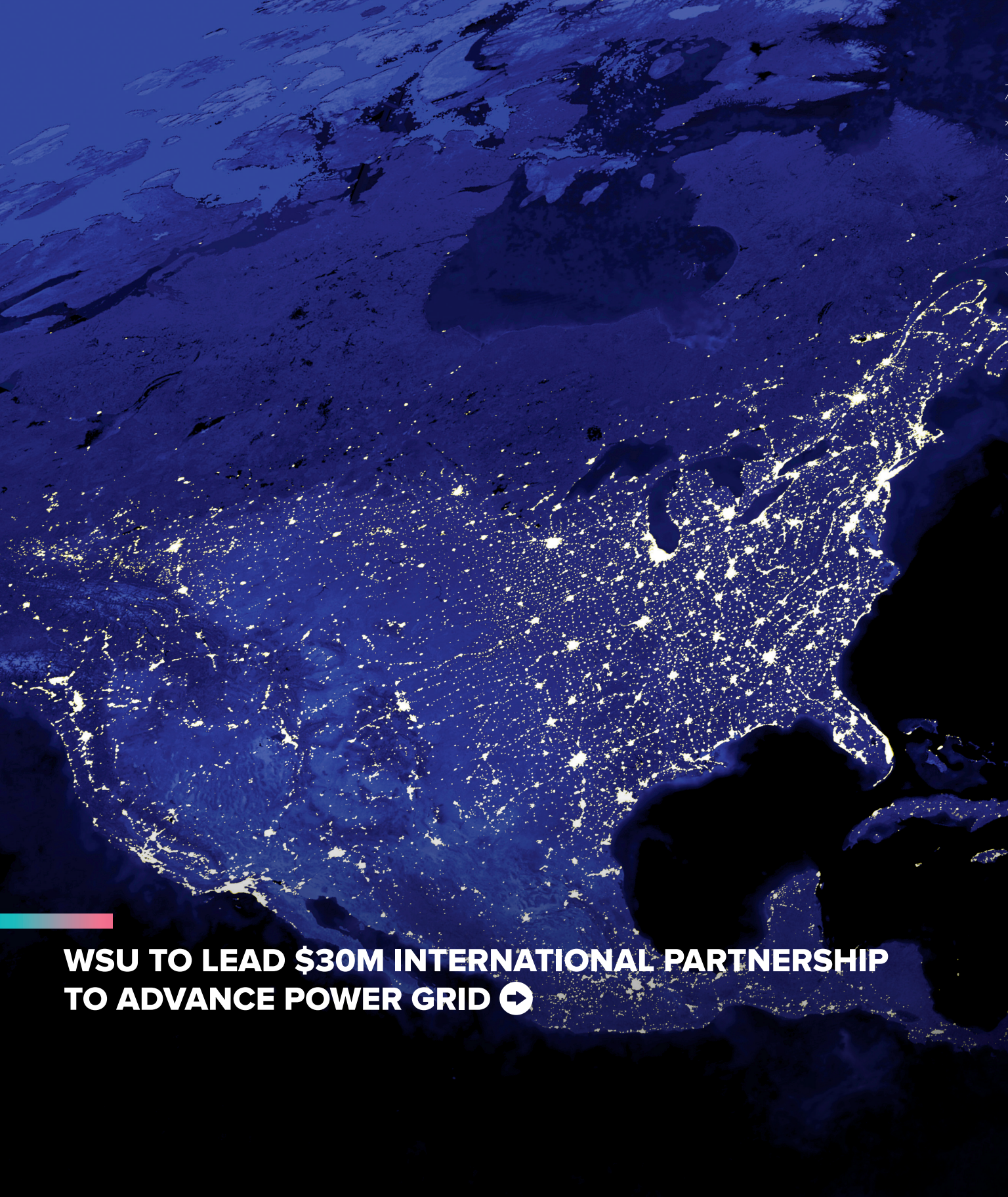
Unlike upper level mathematical modeling, such as weather prediction, students will use grade-level appropriate math tools, such as counting, multiplying, dividing and making graphs.

Elementary teachers recruited in the Northwest and Southwest will meet monthly to use existing research to refine established strategies and develop new ones. They will apply the strategies in their own classrooms, then revise and refine them to achieve what works best.

Throughout the process, teachers will collect data through classroom observation and tests, as well as state testing, to determine student comprehension and retention. Findings will be published so other teachers can implement the ideas.

Grant funds will support stipends for the university researchers and graduate students, elementary teachers and for compilation and review of project data.

Joining Roth McDuffie in the study are: Erin Turner, associate professor of teaching, learning and sociocultural studies at the University of Arizona; Julia Aguirre, associate professor of mathematics education at the University of Washington Tacoma; and Mary Foote, professor of mathematics education at Queens College, City University of New York.



WSU TO LEAD $30M INTERNATIONAL PARTNERSHIP TO ADVANCE POWER GRID

Smart systems

Harnessing technology to improve quality of life

WSU to lead $30M International partnership to advance power grid

WSU will lead a nationwide consortium of U.S. universities and industry partners in a five-year, $30 million joint research project with India to advance the development of the power grid there and in the United States.

The initiative, supported by the Department of Energy Office of Electricity Delivery and Energy Reliability, builds on the department's efforts to foster the reliable, resilient, and secure delivery of electricity needed for U.S. national security, economic growth, and global leadership. The pact also furthers DOE's collaboration with India under the U.S.-India Partnership to Advance Clean Energy.

Noel Schulz, professor in the School of Electrical Engineering and Computer Science (EECS) and WSU First Lady, is the principal investigator for the U.S. team. Anurag Srivastava, EECS associate professor, is the U.S. technical leader and the co-principal investigator. Other co-principal investigators at WSU are Anjan Bose and Adam Hahn from EECS, and Christine Horne in the Department of Sociology.

The new consortium brings together experts from academia, DOE national laboratories, and industry in India and the U.S. to evolve and advance the future electric power grid distribution systems. The effort will allow the continuing increase and integration of distributed energy resources, such as solar, wind, storage, and electric vehicles, advancing the goal of creating a sustainable electricity system.

The project will allow experts to conduct research and deploy new smart grid and energy storage technologies that will modernize the grids of both nations to make them "smarter," while increasing resilience and reliability.

The U.S. team will contribute its expertise and capabilities as India expands energy access to its remote areas, improves its grid reliability and resilience, and strengthens its energy security. In turn, U.S. participants will gain insight from India's grid modernization efforts and grid operational experience.

'Big Data' leads to better trees via $3 million grant

Scientists at Washington State University are harnessing the power of "big data" to help growers create the next generation of healthy, sustainable forests and tree crops.

Dorrie Main, professor in the WSU Department of Horticulture, is leading a $3 million effort, funded by the National Science Foundation, to create cyber-infrastructure that helps researchers and breeders share and use tree data.

Scientists are generating a wealth of data on tree genomes, genetics and breeding. The problem is making sense of it all – especially once environmental and geographic data are added in.

To help people use big data, Main and her colleagues aim to unify access to information through a network of community-driven databases, data mining and analysis tools, and educational modules. Such a network would allow scientists, students and tree breeders to share, filter and use data in meaningful ways, from basic discoveries to new varieties.

Over the past decade, her team has created seven public, open-source databases for 25 crops, such as the rose family (including almond, apple, cherry, peach, pear, raspberry and strawberry), citrus, cotton, cacao, legumes and blueberries. Those online databases act as clearinghouses for information on genomics, genetics, and breeding.

This grant will build a unified system of tree databases, help people build their own databases and then connect them. These resources could help breeders more quickly create new, more adaptable varieties.

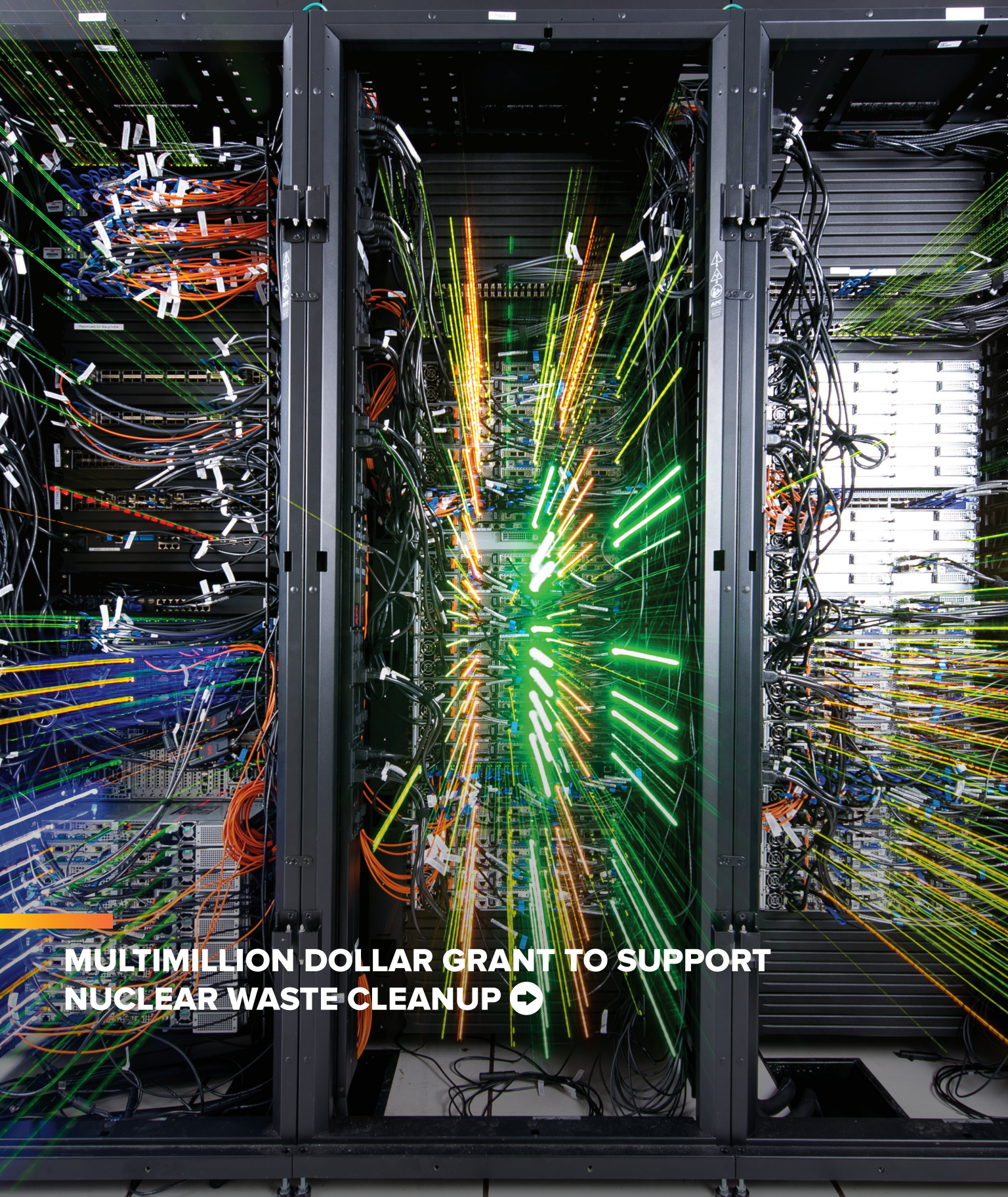
Main's team includes Sook Jung, associate research professor; Stephen Ficklin, assistant professor of horticulture; and colleagues at the universities of Connecticut, Tennessee and Kentucky. The project will use servers in Main's lab as well as WSU'S Kamiak, a high-performance computing facility at WSU.

Smart sensors developed at WSU for assessing bridge health

A WSU research team is building smart sensors to assess the health of aging bridges.

Led by Pizhong Qiao, a professor in WSU's Department of Civil and Environmental Engineering, the researchers received an $80,000 grant from the U.S. Department of Transportation through the Pacific Northwest Transportation Consortium to develop small sensors that will be affixed to bridges. The sensors will send ultrasonic waves through concrete to identify cracks or degraded material, without the need to drill into the concrete.

Qiao's team will affix the sensors directly on the surface of the concrete. They hope that the information they gather from the sensors will help them establish a database to better understand which materials and bridge sections are most vulnerable and how cracks and damage most commonly develop. They are developing and testing their sensor in a laboratory with the idea of eventually testing it on real bridges.



MULTIMILLION DOLLAR GRANT TO SUPPORT NUCLEAR WASTE CLEANUP

National security

Research worldwide to protect America

Multimillion dollar grant to support nuclear waste cleanup

Safe management of nuclear waste is vital to national security and a primary mission of the U.S. Department of Energy (DOE). Approximately 300 million liters of highly radioactive wastes are stored in underground tanks at the Hanford Site in Washington and the Savannah River Site in South Carolina.

To gather knowledge needed to find new methods for safely disposing radioactive wastes, the DOE is tapping the expertise of radiochemists at WSU and Pacific Northwest National Laboratory (PNNL).

The DOE awarded $12 million to establish an Energy Frontier Research Center at PNNL, one of 36 such centers nationwide that conduct fundamental research to build a scientific foundation for energy technologies of the future—and one of four centers established in 2016. Called the Interfacial Dynamics in Radioactive Environments and Materials (IDREAM), the PNNL center is led by WSU Regents professor and PNNL scientist Sue Clark.

PNNL leads IDREAM in partnership with WSU, Oak Ridge National Laboratory, and three other universities. The team collaborates to study chemical reactions in radiation environments and other extreme conditions that cause nuclear waste to change over time.

IDREAM aims to provide new knowledge about molecular interactions caused by radiation in extreme environments. This knowledge will enable the development of waste management technologies, as well as ways to predict how wastes will behave decades from now.

As deputy director of IDREAM, WSU chemistry professor Aurora Clark will work with theorists at PNNL and other research institutions, including the University of Washington, to create realistic simulations of interactions that occur among chemical species in the highly radioactive waste environment.

The simulations will provide the roadmap for investigations by experimentalists like Sue Clark—work that will aid in the design of new waste collection, processing, and storage methods.

The research is supported by Kamiak (left), a high-performance computing facility at WSU.

WSU looks for practices to thwart antimicrobial resistance

WSU scientists are addressing growing global concern about the spread of antimicrobial resistance in Africa by identifying practices that lead to bacterial transmission. Their work could help save lives and prevent the spread of antibiotic resistant bacteria to the U.S. and other parts of the globe.

Doug Call, a professor in WSU's Paul G. Allen School for Global Animal Health, Robert Quinlan, a professor in the Department of Anthropology, and Mark Caudell, a postdoctoral fellow, are lead authors of a study in PLoS One investigating how human behavior, cultural context and living conditions in Tanzania affect the transmission of antimicrobial resistant bacteria from livestock to humans.

The frequent and unregulated use of antibiotics on livestock is a potentially significant contributor to the transmission of antimicrobial resistance. The practice is widespread and understudied in low-income African nations.

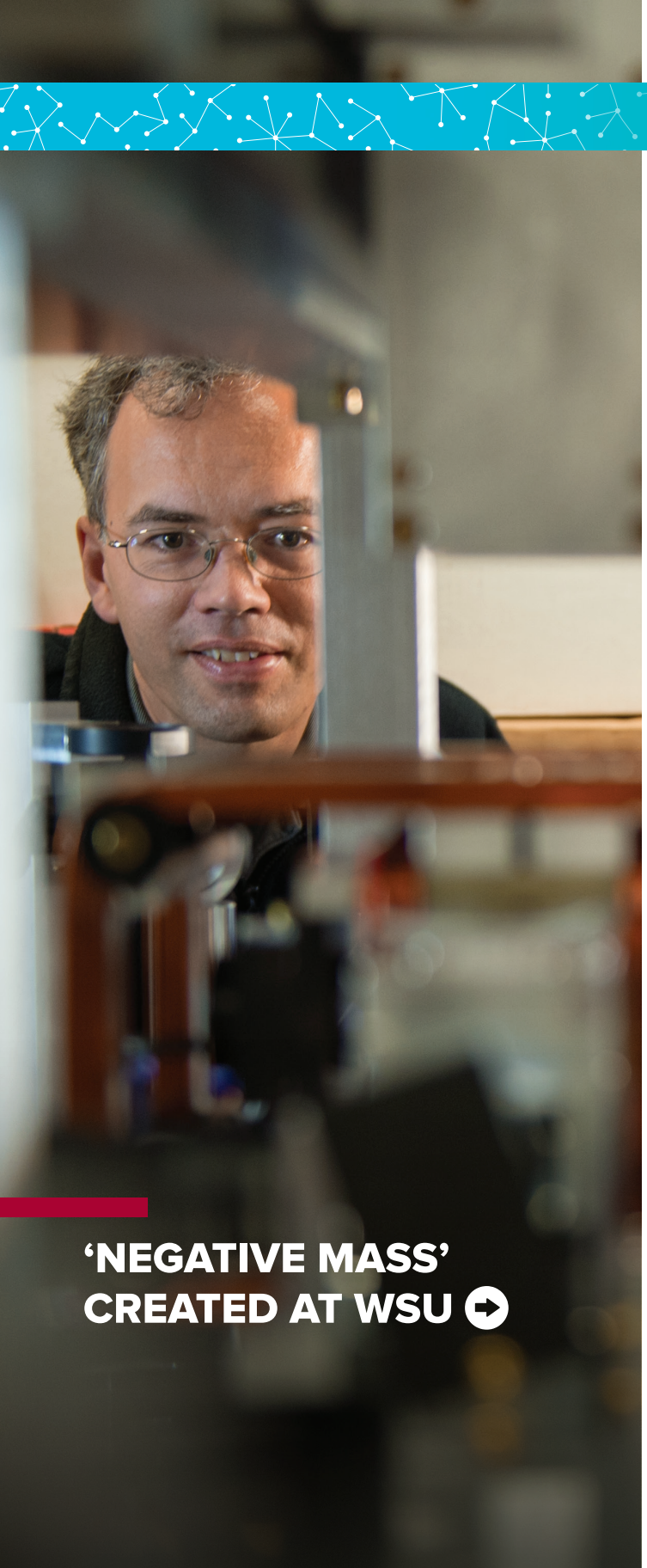
The researchers surveyed members of three indigenous groups, the Maasai, the Arusha and the Chagga, to determine how 200 different socio-economic variables impacted both the use of antimicrobial drugs and whether a withdrawal period was being observed before the consumption of meat and milk from inoculated animals.

They found the Maasai were far more likely than the other groups surveyed to administer antimicrobials without the assistance of professional veterinarians. Only 7 percent of the Maasai households reported withdrawing from meat and milk consumption during and following antimicrobial treatment.

In comparison, 72 percent of the Arusha and 96 percent of the Chagga observed the withdrawal period.

Quinlan and Call analyzed bacterial isolates from people, livestock, poultry and dogs from the majority of the interviewed households, as well as from wildlife. Their dataset includes over 50,000 bacterial isolates that will enable them to link the prevalence of antibiotic resistant E. coli and other bacteria to specific practices.

In a new study, Call, Caudell, and assistant professor Murugan Subbiah are examining the genetic overlap of over 70,000 bacterial isolates from people, livestock, poultry, dogs, and wildlife in Tanzania. By assessing the magnitude of overlap between these groups, they hope to identify those cultural practices and behaviors that drive transmission between people, animals and the environment.



Research excellence stories

‘Negative mass’ created at WSU

WSU physicists have created a fluid with negative mass. Push it, and unlike every physical object in the world we know, it doesn’t accelerate in the direction it was pushed. It accelerates backwards.

The phenomenon is rarely created in laboratory conditions and can be used to explore some of the more challenging concepts of the cosmos.

Hypothetically, matter can have negative mass in the same sense that an electric charge can be either negative or positive.

WSU researchers created the conditions for negative mass by cooling rubidium atoms to just a hair above absolute zero, creating what is known as a Bose-Einstein condensate. In this state, particles move extremely slowly and, following the principles of quantum mechanics, behave like waves. They also synchronize and move in unison as what is known as a superfluid, which flows without losing energy.

Led by Peter Engels (left), WSU professor of physics and astronomy, researchers created these conditions by using lasers to slow the particles, making them colder, and allowing hot, high energy particles to escape like steam, cooling the material further. Michael Forbes, a WSU assistant professor of physics and astronomy, provided theoretical analysis for the research.

The lasers trap the atoms as if they were in a bowl measuring less than a hundred microns across. At this point, the rubidium superfluid had regular mass. Breaking the bowl allows the rubidium to rush out, expanding as the rubidium in the center pushes outward.

To create negative mass, the researchers apply a second set of lasers that kick the atoms back and forth and change the way they spin. When the rubidium rushes out fast enough, it behaves as if it has negative mass.

The technique used by the WSU researchers avoids some of the underlying defects encountered in previous attempts to understand negative mass.

This heightened control gives researchers a new tool to engineer experiments to study analogous physics in astrophysics, like neutron stars, and cosmological phenomena like black holes and dark energy, where experiments are impossible.

WSU physicists contribute to gravitational waves detection

For the first time, scientists have observed ripples in the fabric of space-time called gravitational waves, which arrived at the earth from a cataclysmic event in the distant universe. This confirms a major prediction of Albert Einstein's 1915 general theory of relativity and opens an unprecedented new window into the cosmos.

Gravitational waves carry information about their dramatic origins and about the nature of gravity that cannot otherwise be obtained. Physicists have concluded that the detected gravitational waves were produced during the final fraction of a second of the merger of two black holes to produce a single, more massive spinning black hole. This collision of two black holes had been predicted but never observed.

The gravitational waves were detected on Sept. 14, 2015, at 5:51 a.m. Eastern Daylight Time (09:51 UTC) by both of the twin Laser Interferometer Gravitational-wave Observatory (LIGO) detectors, located in Livingston, La., and Hanford, Wash.

The LIGO observatories are funded by the National Science Foundation, and were conceived, built and are operated by Caltech and MIT.

WSU scientists contributing to the discovery are professor Sukanta Bose, postdoctoral researcher Nairwita Mazumder and graduate students Bernard Hall and Ryan Magee – all physicists; and astrophysicists Fred Raab and Greg Mendell, who are WSU adjunct faculty working at LIGO at Hanford.

Bose and his collaborators and students laid the foundation for combining data from multiple detectors to increase the chance of discovering a gravitational wave signal. They also worked on the method for searching gravitational-wave signals from black hole mergers, aided by prior research by WSU theoretical physicist Matt Duez.

Mazumder, Hall and Magee contributed to a better understanding of the detector's behavior, helping it see deeper into the universe.

Study aims to improve work for students with disabilities

Marcus Poppen, assistant professor of special education at WSU, received the Switzer Research Fellowship to document and evaluate vocational support services provided to young adults with disabilities while they are enrolled in school.

Upon completion of the project, researchers and practitioners will have more information about the availability of transition services that lead to more positive post-secondary outcomes for students with disabilities. They will be able to use this information to develop new strategies that ensure these services are offered to those who need them.

The $70,000 award from the National Institute of Disability, Independent Living and Rehabilitation Research will fund Poppen's study of the relationship between pre-employment transition services and vocational rehabilitation (VR) outcomes for young adults with disabilities, and the development of a new measurement tool to evaluate the availability of coordination of these services.

Pre-employment transition services include things like job exploration, work-based learning, counseling on post-secondary enrollment options, workplace readiness instruction, and instruction in self-advocacy.

Poppen will collaborate with the Oregon Department of Vocational Rehabilitation, University of Oregon and 235 Oregon high schools to research existing data of almost 4,500 young adults with disabilities who received and completed services from Oregon VR between 2003 and 2013, and collect new data on the availability and coordination of pre-employment transition services.

GROWING WSU RESEARCH REQUIRES INVESTMENT IN WSU'S RESEARCH STRENGTHS

Strategic Research Investment

Growing WSU research requires investment in WSU's research strengths. In 2016, WSU furthered its mission by strategically investing resources into research, academic, and student success programs with the potential for a wide societal impact. The research component, referred to as the Strategic Research Investment Initiative, identified specific investments to be funded over the period FY2017-FY2021. A similar program, now known as the Transformational Change Initiative (TCI), identified critical efforts necessary to enhance student success. These investments will support the Drive to 25 and help establish WSU as a distinguished public research university, focused on improving the quality of life for the people and communities we serve.

Investments in Success

The Strategic Research Investment currently funds four projects:

- Functional Genomics Initiative
- Health Equity Research Collaborative (HERC)
- Green Stormwater
- Nutritional Genomics and Smart Foods

New Faculty Hires

As a result of the Strategic Research Investment Initiative, 11 new faculty members have been hired with the following areas of expertise:

Dr. Pablo Monsivais
Associate Professor in Nutrition and Exercise Physiology. Dr. Monsivais studies social and behavioral determinants of diet and obesity to help inform policies to reduce health inequalities.

Dr. Justin Denney
William Julius Wilson Distinguished Professor in Sociology. Dr. Denney's expertise provides a bridge between translational studies of the social determinants of health and intervention studies designed to address health disparities.

Dr. Robert Danielson
Assistant Professor in Educational Psychology. Dr. Danielson's expertise is in pedagogy and learning strategies to improve health education.

Dr. Mina Park
Assistant Professor in the Murrow College of Communications. Dr. Park will contribute health communication expertise and experience in working with disadvantaged communities and community intervention research.

Dr. Anna Zamora-Kapoor
Assistant Research Professor in College of Arts and Sciences and Elson S. Floyd College of Medicine. Dr. Zamora-Kapoor serves as Community Liaison for the Health Equity Research Center and contributes community-based research on populations with health disparity.

Dr. Samantha Noll
Assistant Professor in the School of Politics, Philosophy, and Public Affairs. Dr. Noll's expertise is bioethics related to animals and animal biotechnology.

Dr. Ryan Driskell
Assistant Professor in the School of Molecular Biosciences. Dr. Driskell's expertise is in tissue regeneration and wound repair.

Dr. Joe Cook
Associate Professor in the School of Economic Sciences. Dr. Cook's expertise includes stormwater and green infrastructure, benefit-cost analysis, environmental and natural resource economics, and water resource economics.

Dr. Jennifer McIntyre
Assistant Professor in School of the Environment. Dr. McIntyre's expertise is in aquatic ecotoxicology, including the impacts of anthropogenic contaminants on aquatic ecosystems, developing fish, and Pacific salmon; and green-infrastructure approaches to prevent toxicity to animals from urban stormwater and runoff.

Dr. Courtney Gardner
Assistant Professor in the School of Civil and Environmental Engineering. Dr. Gardner's expertise includes stormwater and environmental research.

Dr. Ofer Amran
Assistant Professor in College of Veterinary Medicine/Elson S. Floyd College of Medicine. Dr. Amran's expertise is in spatial epidemiology (GIS). He studies the relationship between space, place and health outcomes, particularly how individual, contextual and environmental factors impact disease rates and clinical outcomes and how access to health services affects health outcomes and service utilization.

Faculty Recognition

Veterinary professor named Fellow of National Academy of Inventors

Katrina L. Mealey, associate dean for research; professor; and Richard L. Ott endowed chair in small animal medicine and research has been elected a fellow of the National Academy of Inventors.

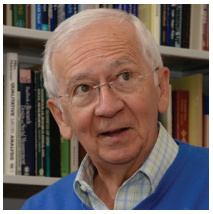
She discovered a potentially fatal gene mutation in dogs, developed a test for it and has established a unique program at WSU of individualized medical treatment for pets. Her nine national and international patents, licensed on four continents by eight different companies, have generated more than $1 million in royalties and licensing fees for WSU.

VCEA professor named Engineering Mechanics Institute Fellow

Pizhong Qiao, professor in WSU's Department of Civil and Environmental Engineering, was named a fellow of the American Society of Civil Engineers' Engineering Mechanics Institute (EMI).

Qiao was recognized for his significant contributions to civil engineering research, particularly in structural composites and mechanics, and his commitment and participation within the EMI. He has conducted research in the areas of smart structural health monitoring, impact-resistant materials and high-performance green concretes.

Innovative WSU approach ignites survey industry, earns national award



WSU Regents Professor **Don Dillman** and a team of former graduate students received the Warren J. Mitofsky Innovators Award from the American Association for Public Opinion Research for designing a new survey method that is now used in censuses around the world.

The WSU team used the U.S. Postal Service to obtain 98 percent of household addresses, providing access to virtually all adults in the U.S. Dillman and the team developed a method for people to take an online survey through a postal mall code using a small cash incentive.

Researchers receive early career awards

Jean-Sabin McEwen, assistant professor in chemical engineering and bioengineering, received approximately a $500,000 Faculty Early Career Development Program from the National Science Foundation (NSF). McEwen is developing a model for predicting behavior of low-temperature exhaust catalysts in real-world conditions. In collaboration with Tufts University researchers, the WSU team will use a comprehensive model they developed to predict exhaust gas reactions.

Steven R. Saunders, assistant professor in chemical engineering and bioengineering, received a $500,000 Faculty Early Career Development Program from NSF. Saunders is developing better methods of preparing catalysts so they are more efficient and last longer. Saunders' team is working with molecules that can be switched on or off through physical or chemical stimuli, such as through heating or the introduction of carbon dioxide, as a way to control the shape, size, synthesis and deposition of metallic nanoparticles to be used as catalysts.

Dae Hyun Kim, assistant professor in the School of Electrical Engineering and Computer Science, received approximately a $500,000 Young Faculty Award from DARPA. Kim is designing a 3-D stacked microprocessor that will be 10-20 times faster than 2-D microprocessors. The researchers are working to stack the microprocessor to reduce the distance between transistors, reduce its signal time and make the processor faster.

Four researchers named to Washington State Academy of Sciences

In 2017, four Washington State University faculty were elected to the Washington State Academy of Sciences. New members are accepted in recognition of their outstanding record of scientific achievement and willingness to work on behalf of the academy in bringing the best available science to bear on issues within the state of Washington.

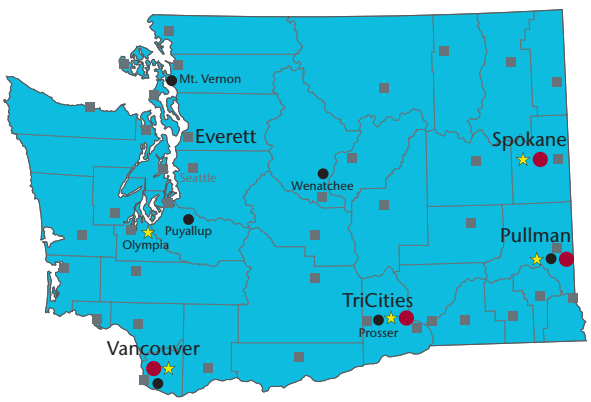
Amit Bandyopadhyay, Herman and Brita Lindholm endowed chair and professor in the School of Mechanical and Materials Engineering. A holder of 15 U.S. patents, Bandyopadhyay is an expert in materials and advanced manufacturing with a special emphasis on additive manufacturing and biomaterials for bone disorders.

Susmita Bose, Herman and Brita Lindholm endowed chair and professor in the School of Mechanical and Materials Engineering. Bose's research combines the fields of chemistry, bioengineering, materials science, and advanced manufacturing, especially 3D printing, and is a leader in the use of technology to improve human health.

Douglas Call, professor of Molecular Epidemiology. Call researches antimicrobial resistance, which is widely considered to be a leading public health challenge of the 21st century. His work is helping clarify how environmental factors contribute to selection and maintenance of this resistance in human and animal populations.

Jonathan Yoder, professor in the School of Economic Sciences and director of the state of Washington Water Research Center. Yoder is an internationally renowned economist whose applied economic approaches provide an evidence-based foundation for environmental and natural resource policy.

Advancing research statewide

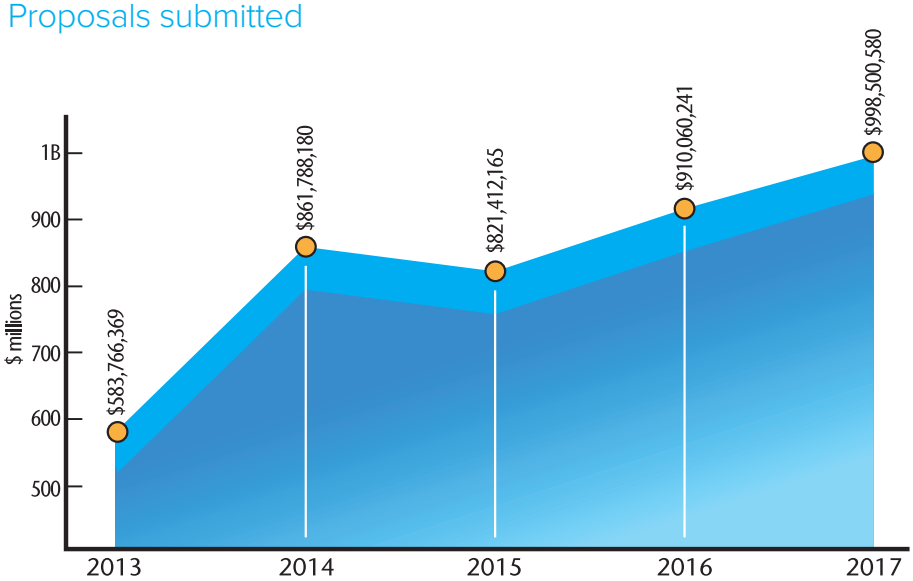


Washington State University faculty conduct research at campuses across the state. Extension offices in each of Washington's 39 counties turn research into action for local industry and communities.

- **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.

Facts & figures

Proposals submitted



Total research and development expenditures

FY 2016

$334,082,000

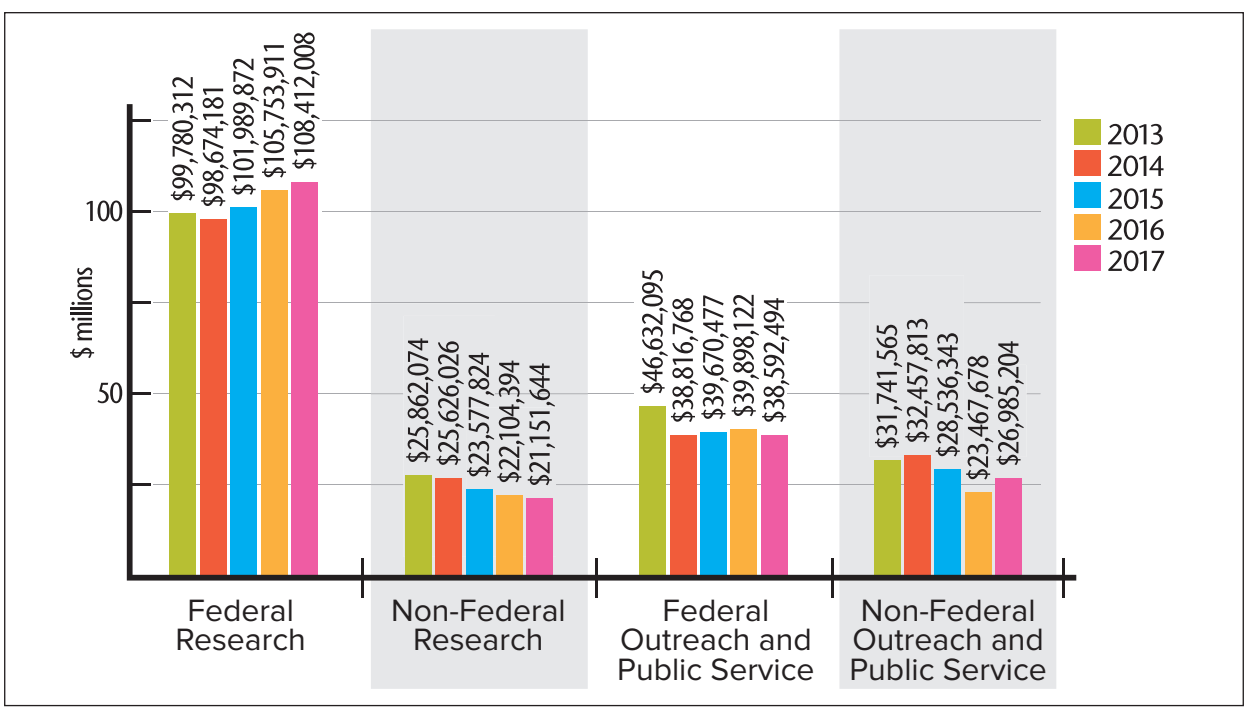
Sponsored project expenditures

FY 2017

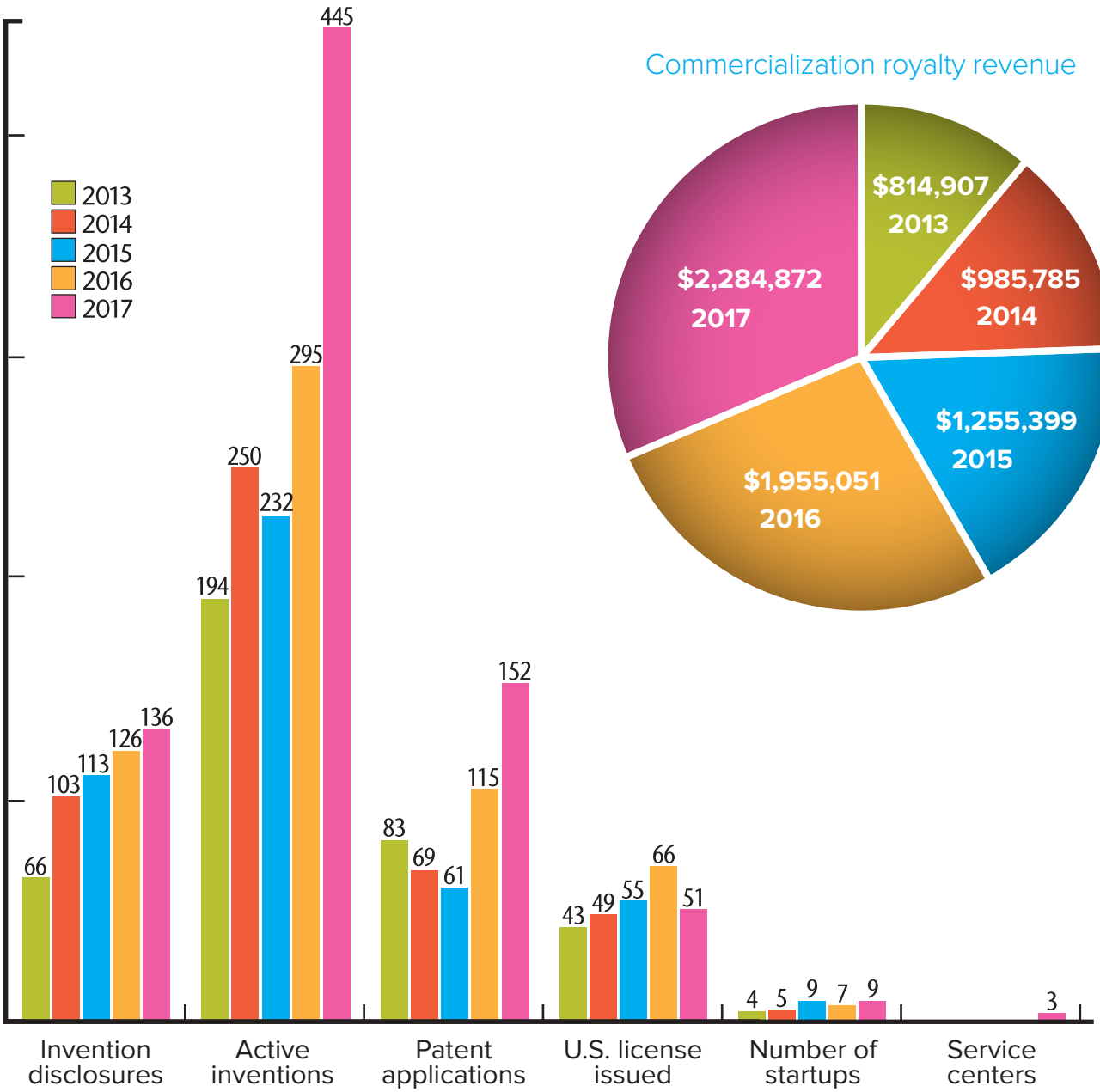
Federal: $131,924,726

Non-federal: $63,216,624

Research vs. outreach and public service



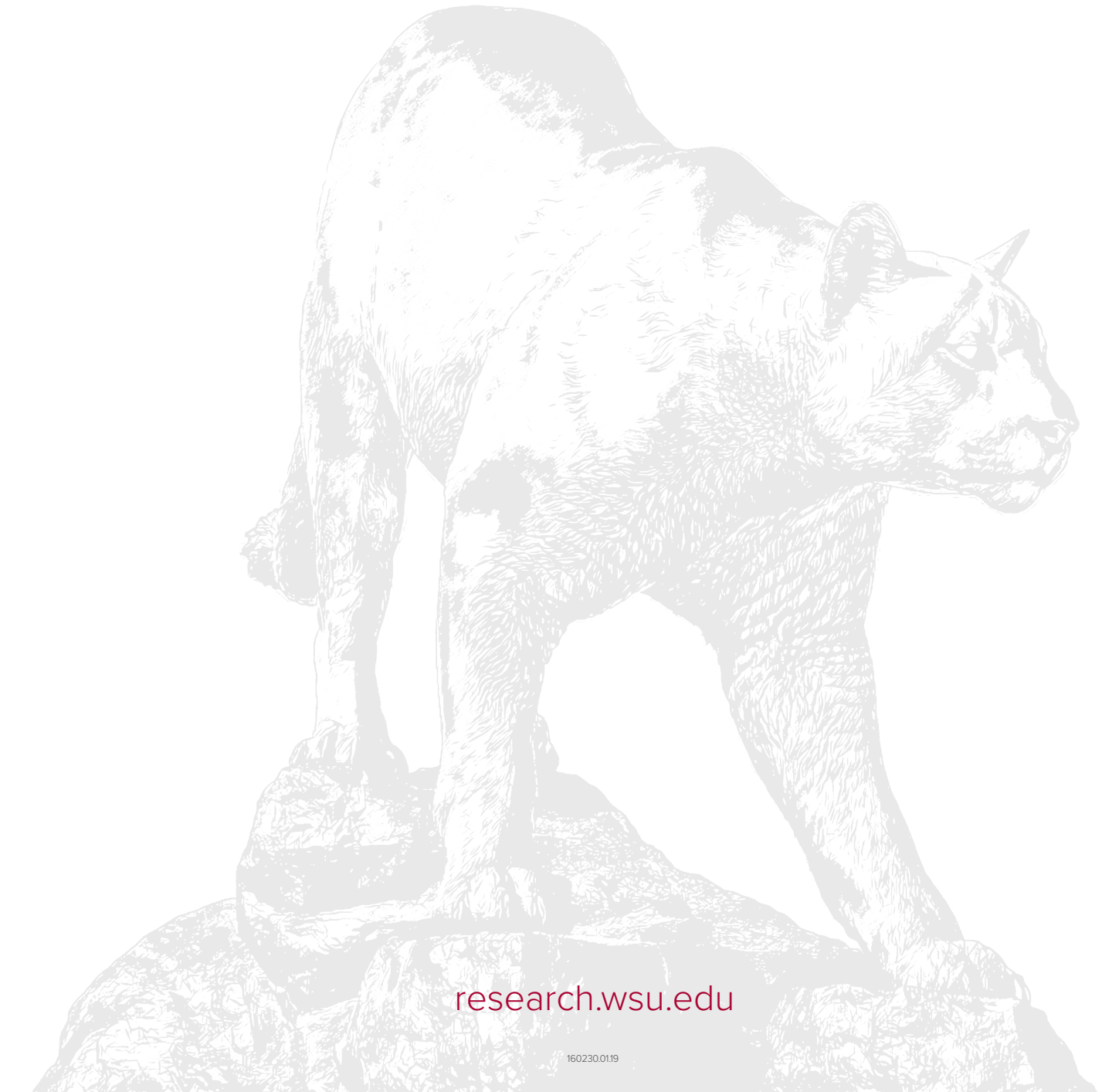
Commercialization activity



Commercialization royalty revenue

WASHINGTON STATE UNIVERSITY

Everett | Extension | Global | Pullman | Spokane | Tri-Cities | Vancouver



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