

NUCLEAR ENGINEERING

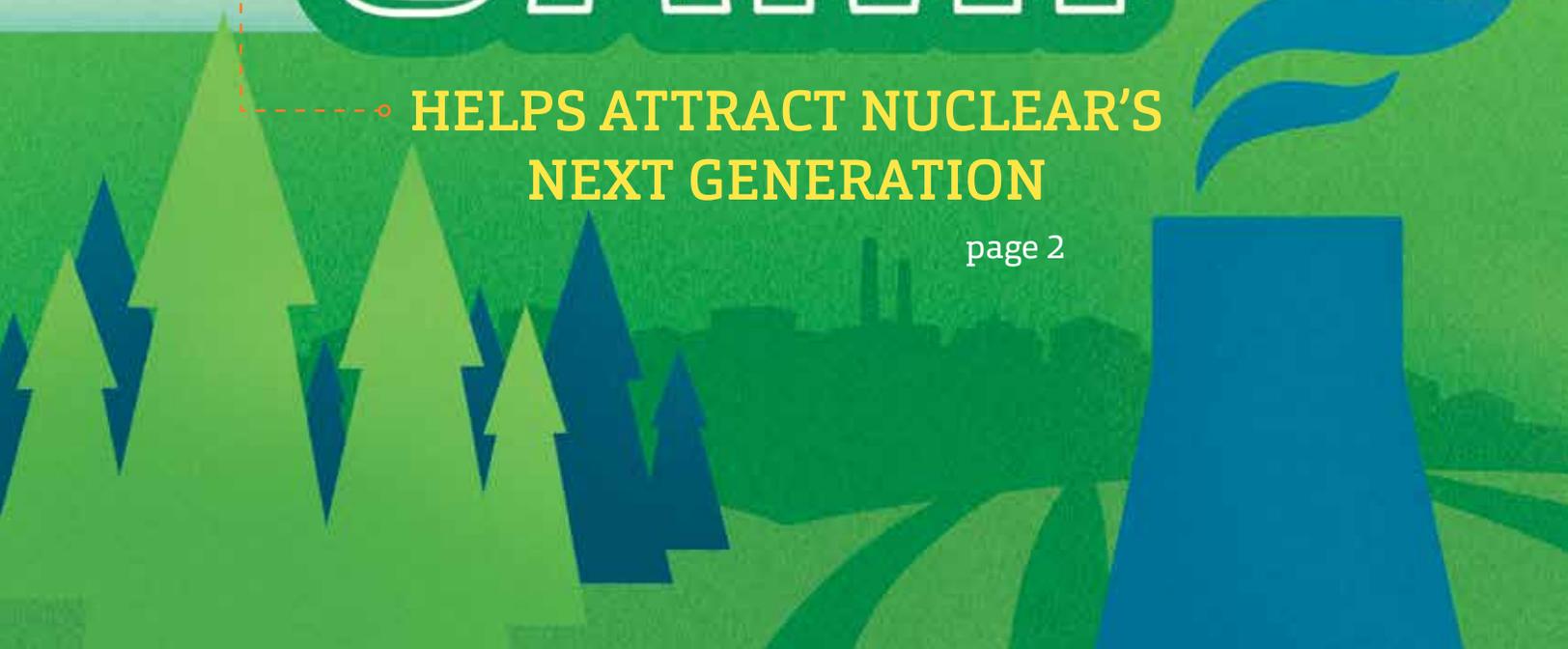
Missouri S&T | Fall 2018



SUMMER CAMP

HELPS ATTRACT NUCLEAR'S
NEXT GENERATION

page 2



A STRONG ENERGY BOND

BEGINS WITH YOUR SUPPORT

Every nuclear engineer knows the importance of a strong energy bond inside the nucleus of an atom.

But there's another kind of energy bond with the power to transform — the possibilities unleashed by academic opportunity.

Your annual support of the nuclear engineering program is helping to create the kind of strong energy bond that drives innovation and next-generation leadership. Because every dollar you contribute supports scholarships for freshmen and research funding for young faculty members.

So next time you receive a phone call from a nuclear engineering student eager to share what's happening in our program and on campus, we hope you'll take time to connect and catch up. We also hope you'll help to create a chain reaction of opportunity by giving back.

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DEAR ALUMNI, COLLEAGUES AND FRIENDS

I am delighted to share our activities and achievements from the past 12 months. Student enrollment is strong, with 162 undergraduates and 42 graduate students enrolled in fall 2017 (the fall 2018 semester will be underway by the time you read this).

Thirty students received bachelor of science degrees in the 2017–18 academic year, while two students (**Wayne Brewster** and **Joshua Rhodes**) earned master of science degrees and three students (**Thaar Aljuwaya**, **Rami Saeed** and **Ashish Avachat**) earned Ph.D.s.

The year also brought the departure of several valued colleagues, along with some new arrivals. Reactor manager **Bill Bonzer** retired this past year after a 25-year career at the university. He followed into retirement reactor secretary **Maureen Henry** (who never lost her Boston accent despite 17 years on campus). We wish both our best, and have begun the process of looking to fill the reactor manager’s position.

As for the additions, **Michele Warren** is our new office manager, joining us from the mechanical and aerospace engineering department. She replaces **Stephen Casey**, now a senior academic advisor in our home department of mining and nuclear engineering.

We also welcome two new faculty members, **John Gahl** and **Haiming Wen**. You can read more about their backgrounds on p. 3–4.

On behalf of the faculty, students and staff of nuclear engineering I would like to thank you for your support for the NE program, and would greatly appreciate your continued help.

Thank you and God bless you all!

Hank Lee, Ph.D.
Associate Professor and Associate Chair
of Mining and Nuclear Engineering



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SUMMER CAMP

HELPS ATTRACT NUCLEAR'S NEXT GENERATION

John Hayes Haff is a natural tinkerer — enough so that his parents built an outdoor shed to house his homemade science lab rather than risk a wayward chemical reaction from behind his bedroom door.

So when the northeast Arkansas teen, who goes by his middle name, heard about Missouri S&T's hands-on summer camps from a distant relative (and alumnus) in St. Louis, he soon enrolled in the 2018 nuclear engineering camp. Haff was hooked.

Missouri S&T now sits atop the high school senior's college list, even if it means first attending a nearby state university before transferring or moving in with a different relative in Missouri to establish residency.

Now in its 18th year, the weeklong camp is designed to introduce high school students to everything nuclear engineering, from energy sources to medical tools.

That said, the up-close exposure to S&T professors (and counselors who double as the program's graduate students and undergrads) pays unmistakable recruiting dividends, says lead counselor **Wes Tucker**, NucE'16, a current Ph.D. student.

Among this year's participants, every student who completed a post-camp evaluation indicated that they either planned to apply to Missouri S&T or had already done so.

As usual, the daylong trip to Ameren's Callaway Nuclear Plant was a highlight, what Tucker calls the "shining moment in most of the kids' week" for the chance to see the concepts and systems they studied on campus in action at the state's only commercial nuclear power plant near Fulton, Mo.

Other activities included a tour and half-life experiment at the campus research reactor, a Nuclear Expo, group research projects, expert panels with both current students and faculty members, and a screening of the movie *Pandora's Promise*, a documentary that features interviews with former environmentalists and anti-nuclear activists who now advocate for its use.

Participants also toured the Delbert Day Cancer Institute at Phelps County Regional Medical Center.

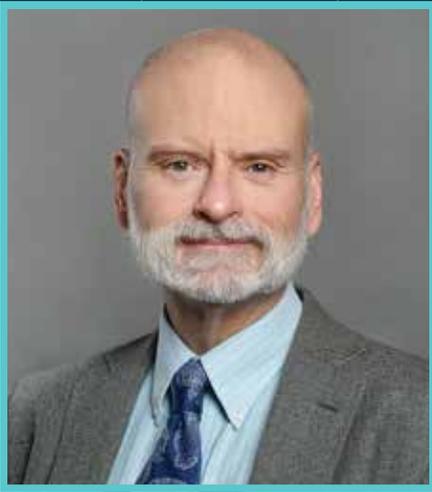


MATERIALS SCIENCE PROFESSOR RECEIVES JOINT APPOINTMENT IN NUCLEAR ENGINEERING

Haiming Wen, an assistant professor of materials science and engineering at Missouri S&T, has formally joined our program, thanks to a joint appointment with his home department.

Wen joined the university in fall 2017 from Idaho State University, where he was an assistant research professor and staff scientist at Idaho National Laboratory. He holds a Ph.D. in materials science and engineering from the University of California, Davis.

Wen serves on the editorial board of the journal *Materials Science and Engineering: A*. His research focus includes nuclear fuels and structural materials designed for current and next-generation nuclear reactors and the application of advanced materials in energy, transportation and defense.



PROGRAM DIRECTOR AT MIZZOU JOINS S&T THROUGH JOINT APPOINTMENT

John Gahl, a professor of electrical and computer engineering at the University of Missouri-Columbia and director of its nuclear engineering program, is also joining our program through a joint appointment.

Gahl joined the Mizzou faculty in 2000 after previous faculty positions at Texas Tech University and the University of New Mexico. He remains director of the Columbia campus' nuclear engineering program and also oversees the materials science program at the University of Missouri Research Reactor, the nation's largest university-based research reactor.



MELTON PARHAM: NUCLEAR HEALING

Melton Parham, NucE'18, is still in his first semester of the Ph.D. program in medical physics at the University of Oklahoma Health and Science Center. But odds are pretty good that he already has a leg up on his fellow grad students.

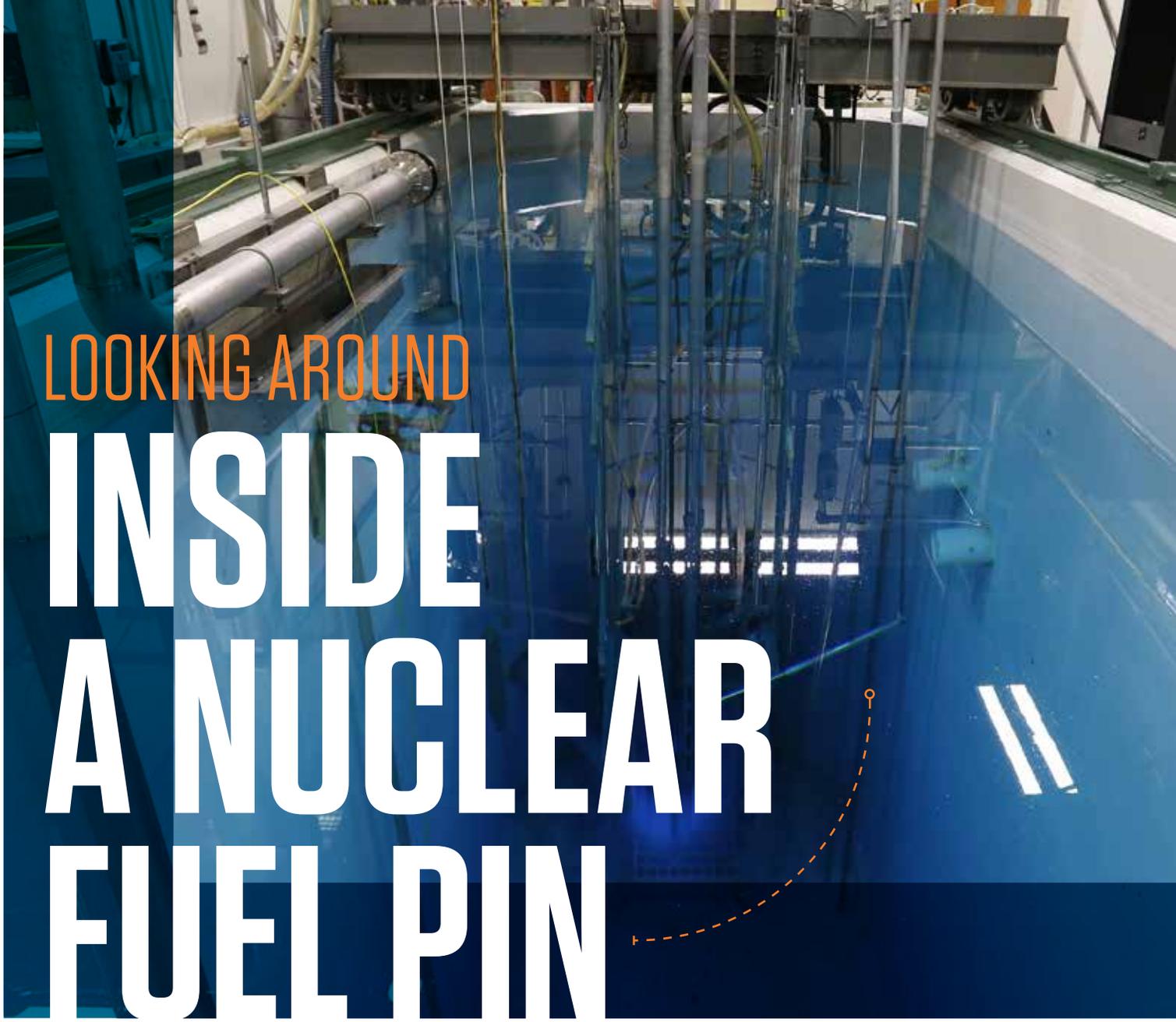
Parham, a native of Midwest City, Okla., says his S&T degree won't lead directly into the medical physics field, but it has given him a firm knowledge of the way atoms work and how they relate to radiation.

Parham wants to work on the clinical side of medical physics — using analytical and applied scientific techniques to assist healthcare workers in the safe diagnosis and treatment of patients.

"The main job is to help others," he says. "We collaborate with a variety of experts in clinics, mainly in radiation and oncology, using a variety of analytical, computer-aided bioengineering techniques. Our work includes radiotherapy, X-ray imaging, ultrasound, tomography, radiology, nuclear magnetic resonance imaging and lasers."

Parham says one of the most valuable lessons he's learned is how to handle failure.

"I work hard with anything I perform now," Parham says. "I've learned every action I do deserves my best effort with an even better attitude. I no longer think failing is a bad thing. I know now that with every failure, success is to follow."



LOOKING AROUND

INSIDE A NUCLEAR FUEL PIN

The search for safe and environmentally friendly renewable energy sources is one of the biggest challenges currently facing humanity. One improved renewable energy source under development is the next generation of nuclear reactors and, along with them, new types of fuels.

To test the performance of these new fuels in a usable timeframe, researchers must develop new methods to investigate the fuel's structural, thermodynamic and chemical characteristics. **Joseph Graham**, assistant professor of nuclear engineering, and **Hank Lee**, program director, have developed a mobile platform the size of a microwave that can X-ray the spent nuclear fuel using gamma radiation.

"It is hard to see what reactions are occurring within a fuel pin that is actively engaged in a nuclear reactor," says Graham, who is also the director of Missouri S&T's nuclear reactor. "Current measurement capabilities are limited to removing an active fuel rod, waiting for it to cool within a radioactive pool of water and then scanning it to see residue effects that are taking place."

Once fuel is used up, it is removed from the reactor. However, that fuel is still radioactive and must be kept submerged in water to cool for a period of time that can vary from weeks to years. By lowering

their new measuring device into a containment pool, researchers can begin to measure the fuel's reactions and their locations within the pin almost as soon as it is removed from active use.

"This device will allow us to look at the fuel 'right out of the oven,' so to speak," says Graham. "The work relies on the pins still being active and not decaying for too long. The fuel is like a house — at night with the lights on you can see into it, but once the lights are turned out it all becomes dark."

"This device will allow us to look at the fuel 'right out of the oven,' so to speak."



NRC GRANTS BOOST FACULTY RECRUITMENT, SCHOLARSHIPS

A pair of federal grants totaling \$650,000 will aid the program with faculty recruitment as well as undergraduate scholarship support.

The first award, a three-year Nuclear Regulatory Commission grant for \$450,000, will cover the costs of **Haiming Wen**, who specializes in nuclear materials. The NRC grant requires a \$150,000 match from the university.

Wen's addition is considered a strategic hire under S&T's best-in-class initiative in the signature area of Materials for Extreme Environments. The award acknowledges the department's recent and sustained growth — a 24 percent undergraduate enrollment increase over the past decade, with graduate enrollment growing 180 percent during that same span. The money will allow for Wen to purchase laboratory equipment, travel to professional meetings and provide additional graduate student support.

The second NRC grant of \$200,000 will allow us to provide partial undergraduate scholarships to 26 full-time juniors and seniors annually over two years. Academic merit will be the primary consideration, though financial need will also be considered. Similar scholarship support through a series of NRC grants starting in 2012 have been provided to 117 students, in amounts ranging from \$1,000 to \$3,000 per semester, says program director **Hank Lee**.



ALSHEHRI SHARES PH.D. RESEARCH AT ANS

Doctoral student **Salman Alshehri** traveled to Philadelphia in June to present his research at the annual meeting of the American Nuclear Society.

Alshehri presented two papers at the conference: "Experimental Investigation on Heat Transfer Characteristics with Non-Uniform Heat Flux Distribution under Natural Circulation" and "Experimental Investigation of Plenum-to-Plenum Natural Circulation Heat Transfer in a Prismatic Very High-Temperature Reactor."

He conducts his research under the guidance of **Shoaib Usman**, associate professor of mining and nuclear engineering, and received a travel grant from the university's Council of Graduate Students to attend the meeting.

Along with Usman, Alshehri's co-authors are **Ibrahim Ahmed Said**, MS ChE'15, PhD ChE'17; and **Muthanna H. Al-Dahhan**, chair and Curators' Distinguished Professor of chemical and biochemical engineering.

Alshehri formerly worked as a research assistant in the National Center for Nuclear Technology, King Abdulaziz City for Science and Technology, in Riyadh, Saudi Arabia, then trained in INVAP Co. in Bariloche, Argentina, for 18 months. After earning a scholarship to study abroad, he applied to S&T because the school aligned with his research interests of plenum-to-plenum heat transfer and gas dynamics under natural circulation in prismatic very high-temperature reactors.



AVACHAT NAMED DEAN'S GRADUATE EDUCATOR

A Ph.D. student in nuclear engineering has been recognized for his yeoman classroom efforts by the Missouri S&T College of Engineering and Computing (CEC).

Ashish Avachat (above center), a doctoral student from Pune, Maharashtra, India, was one of 10 doctoral students affiliated with a total of seven academic departments to be named an inaugural Dean's Graduate Educator.

Each student was recognized and honored at an end-of-semester campus reception on Thursday, May 10, along with eight other students named CEC Dean's Ph.D. Scholars for their scholarly contributions.

The award winners were nominated by professors in their home departments, then selected by a department committee or department chair for college consideration. Winners were selected by Vice Provost and Dean **Richard Wlezien** from those submitted by each department.

Hank Lee (above left), Avachat's faculty advisor, lauded his student's contributions in an award nomination letter.

"Ashish not only answers students' questions after regular class and lab sections but also encourages students to consult him whenever they need to go through course material again," Lee wrote. "He clearly goes out of his way to explain the course materials to the students. Ashish's personable disposition, enthusiasm, energy and thorough understanding of the material makes him a well-liked teaching assistant in the program, and an outstanding educator."

FEDERAL GRANT FUNDS REACTOR UPGRADES

A new \$250,000 federal grant will enable the Missouri S&T Research Reactor to both improve safety and enhance our ability to use the facility as a distance learning resource.

The project's principal investigator is associate professor **Ayodeji Alajo**, assisted by co-PIs and faculty members **Xin Liu**, **Joseph Graham**, **Joshua Schlegel**, **Shoaib Usman** and **Hank Lee**.

The needed safety improvements are in fuel handling as well as support for experiments designed for submersion into the reactor pool. A gamma sensitive portal monitor will improve safety standards, as will the installation of a two-ton overhead crane to minimize the effect of fatigue experienced by fuel handlers during core reshuffling and unloading. The new crane will also make it easier to move heavy components such as the core access element and in-pool delayed gamma detector rig.

On the teaching side, the Department of Energy grant will allow a distance reactor laboratory class offered in collaboration with the University of Illinois to provide access to digital recordings of reactor power logs.



DOCTORAL STUDENT INTERNS AT ARGONNE

Kyle Paaren, NucE'16, spent the summer as an intern at Argonne National Laboratory outside Chicago, generating neutron and gamma cross-section libraries based on recent nuclear data.

Paaren's graduate studies involve the development of switchable radioisotopes to be used for gamma and neutron imaging. That radiosopic development will be used in conjunction with nuclear reactor components to test for defects and irradiation damage.

Paaren previously received the Integrated University Program fellowship award through the Department of Energy's Nuclear Energy University Program, as well as the Chancellor's Distinguished Fellowship at S&T.

The suburban St. Louis native says that at Argonne, he used recent nuclear data to "evaluate, verify and validate those cross-section libraries using the neutron transport code PROTEUS, which includes high-fidelity and lower-fidelity (nodal) neutron transport calculation options, and Monte Carlo codes for various nuclear reactor types, including sodium-cooled fast reactors, molten salt reactors and high-temperature reactors."

He also worked on another project associated with non-destructive testing of dry cask storage for spent nuclear fuel through neutron imaging.



WAGNER PENS NEWSPAPER COLUMN FOR NATIONAL ENGINEERS' WEEK

John Wagner, NucE'92, wrote a guest opinion column in *The Post Register* newspaper in Idaho Falls, Idaho, to promote nuclear engineering as a career choice for the next generation of engineers.

Wagner was named associate laboratory director in the nuclear science and technology directorate of Idaho National Laboratory (INL) in October 2017, his second promotion in less than two years of working at the U.S. Department of Energy lab.

Rather than appealing to the "child prodigy types who were taking apart and rebuilding grandfather clocks" by their fourth birthday, Wagner describes an "extremely bright future" at the nation's leading laboratory for nuclear energy research and development for the "many more like me."

"For the next generation of nuclear engineers, this is a land of opportunity," Wagner says. "It's a chance to reinvent an aging industry, and it carries the potential to mitigate climate change and bring power to 1.3 billion people who currently have none.

"At INL, 30 percent of our workforce is at least 50 years of age and approaching retirement," he continues. "We are staring down a critical shortage of scientists and engineers, the people we need to drive innovation and create the clean energy that will power our future."

Wagner further notes how he found his calling in nuclear engineering while studying in Rolla.

DOE AWARDS SECOND \$800K GRANT

The federal Department of Energy has awarded another \$800,000 grant to Missouri S&T through its Nuclear Energy University Program (NEUP), this time for assistant professor **Haiming Wen**, assistant professor **Joseph Graham**, and two investigators from the University of Idaho and Idaho National Laboratory.

Wen, whose home department is materials science and engineering and who holds a joint appointment in our program, will attempt to determine the oxidation behavior of silicon carbide and graphitic materials in oxygen and/or moisture, to accurately measure the kinetic parameters of oxidation, to ascertain the oxidation mechanisms in relation to the microstructures, to determine the effect of irradiation on oxidation behavior, and to provide data and input to the safety analysis of high-temperature gas reactors (HTGRs) under air and moisture ingress accident conditions.

"While HTGRs use pure helium as a reactor coolant, in some accident scenarios significant amounts of moisture or air can be introduced into the helium coolant and reactor core," an abstract of the research proposal states. "The effects of oxidants on TRISO (tri-structural isotropic) fuel integrity are essential considerations that are part of HTGR safety analysis. Data are needed to more accurately understand fuel oxidation and model core behavior."

In 2017, Graham, assistant professor and program director **Hank Lee** and a former graduate student also won a three-year, \$800,000 NEUP grant to develop advanced poolside fuel characterization techniques for nuclear test reactors. The team presented a concept for a compact, submersible, high-resolution gamma-ray tomography system.

In Wen's case, the NEUP grant reunites him with a former colleague at INL, where he worked as staff scientist. He was also an assistant research professor at Idaho State University before joining S&T in 2017.

Missouri S&T has received similar federal grants in every year but one since 2009, totaling nearly \$4 million, for projects ranging from scholarships and fellowships to infrastructure upgrades to the research reactor.

ALMUTAIRI COMPLETES KOREAN FELLOWSHIP



Bader Almutairi, a Ph.D. student in nuclear engineering, spent summer 2017 with a team of international peer students researching nuclear nonproliferation and risk management.

Before pursuing his Ph.D., he was employed at the Kuwait Institute for Scientific Research in his native country. After earning a scholarship to study abroad, he applied to S&T because the school aligned with his research interests of neutron generators, fission sources and detector deadtime correction.

Almutairi has also been elected to lead the university's Council of Graduate Students this academic year after previously serving as the nuclear engineering program's representative.

In addition to his fellowship with the Korea Advanced Institute of Science and Technology, a public research university in Daejeon, South Korea, Almutairi spent a part of summer 2018 as a visiting researcher at the Rhode Island Nuclear Science Center, where he investigated the use of silicon carbide for accident tolerant nuclear fuel cladding applications under the supervision of the center's director and in collaboration with the University of Rhode Island and Brown University.

He also returned to Argonne for a two-week summer school fellowship in 2018 and earned a second fellowship this past summer to attend a 10-day program in Aix-en-Provence, France, jointly organized by the French Atomic Energy Commission and the Karlsruhe Institute of Technology in Germany.

His advisor is **Shoaib Usman**, associate professor of nuclear engineering.

DEPARTMENT UPDATES



STUDENTS CELEBRATE 50 YEARS OF ANS

The Missouri S&T student chapter of the American Nuclear Society celebrated the organization's 50th anniversary with a full year of activities.

ANS president **Bob Coward** joined students, faculty, staff and alumni at our awards banquet. In the spring, our chapter hosted workshops for Boy Scouts seeking to obtain a merit badge in nuclear science. And in April, several chapter members attended the ANS Student Conference in Gainesville, Fla. The chapter's executive board consists of **Monica Gehrig**, president; **Seth Kilby**, vice president; **Kyle Paaren**, secretary; and **Zackary Wetzel**, treasurer. Serving as junior officers are **Kaitlin Samuelson**, historian; **Elizabeth Triller**, webmaster; and **Adam Ligo**, reactor liaison.

The organization is looking using fundraisers to raise awareness about the importance of nuclear power and build a positive relationship between the chapter and local community. The plan is to use funds to help support educational events in the organization, such as hosting speakers, getting supplies for workshops and sending students to present and participate in the ANS annual student conference. For more information about these opportunities, please email ANS student chapter president **Monica Gehrig** at mlgrk6@mst.edu.



ALOB Aidan HONORED WITH STAFF EXCELLENCE AWARD

Tina Alobaidan, an administrative associate in the mining and nuclear engineering department's main offices in McNutt Hall, was among the winners of the 2018 Missouri S&T Staff Excellence Award.

Alobaidan, an S&T employee since 2011 who joined our department in 2013, was honored with the other winners on May 30 during Staff Recognition Day ceremonies. She is pictured above with Staff Council Chair **John Cook** (left) and Chancellor **Chris Maples** (right).

WOMEN IN NUCLEAR CHAPTER TO HOST CAREER FAIR

Our chapter of Women in Nuclear holds an annual Flamingo Flocking fundraiser to raise money for breast cancer research. We move flocks of flamingos with tags featuring nuclear and breast cancer facts to different departments on campus. This year, Women in Nuclear is also working on plans for an upcoming Nuclear Career Fair.



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Kelly Stevens, NucE'18

GRADUATION DOESN'T MEAN GOODBYE.

- It's easy to stay in touch with your department.

Just say hello when a student representative calls from Phonathon or drop us a note at tinaa@mst.edu. Tell us how you're doing with a degree in nuclear engineering so we can feature your accomplishments among our alumni achievement stories. With your support, there's no limit to what we can achieve.