College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

FALL 2025 NEWSLETTER

DEPARTMENT OF
NUCLEAR ENGINEERING & ENGINEERING PHYSICS

Nuclear is growing on every front in Wisconsin!

This fall, the department's incoming class has grown again with nearly 50 new nuclear engineering students and 20 new engineering physics students from around the state and across the country. With three years of rapid growth, class sizes are growing, and we are thinking about important lab renovations to help us ensure the outstanding educational experience that our students have come to expect. Since many of those students arrive with an excitement for exploring fusion energy, we are launching a new fusion plasma focus area. Students following this pathway will swap three courses to better align their course plan with this fusion interest.

We also have a growing faculty cohort, welcoming Sébastien Philippe this semester and JungHyun Bae in January 2026. Together, these faculty will give our department a new presence in radiation detection with applications in arms control, international safeguards and nuclear fuel cycles. Combined with the recent tenure and promotion of Juliana Pacheco Duarte, Benedikt Geiger and Yongfeng Zhang to associate professors, we are well positioned to continue our excellence across a diverse research portfolio.

Some of our new student interest may correlate with growing interest in nuclear energy among Wisconsin policy makers. In July, Wisconsin Gov. Tony Evers signed two pieces of bipartisan legislation aimed at helping the state catch up to many others in exploring nuclear energy. One bill calls on the state's Public Service Commission to conduct a siting study, identifying potential sites for new nuclear energy facilities in the coming years. The other asks the Wisconsin Economic Development Corporation to host a global nuclear energy summit. Both place an emphasis on how Wisconsin's manufacturing sector can develop a role in the nuclear supply chain and consider both fission and fusion energy in their scope.

It's an exciting time for nuclear energy in Wisconsin, and NEEP is rising to the challenge!

On, Wisconsin!

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On the cover: Cole Evered, a PhD student in Professor Adrien Couet's research group, works on a new in situ molten salt corrosion/irradiation cell that he designed, tested and validated for the left beamline in the UW-Madison Ion Beam Laboratory. Photo: Lili Sarajian.

FOCUS ON NEW FACULTY

Sébastien Philippe aims to reduce the risk of nuclear war

Early in his academic career, Sébastien Philippe realized the potential for his work to have a major societal impact. His research on the consequences of French nuclear weapon testing in the South Pacific led him to co-author the book *Toxique*, published in 2021.

Using hundreds of declassified French government documents, on-the-ground interviews in France and in Polynesia, and countless hours of advanced computer simulations, the book revealed that the human and environmental aftermath of the nuclear weapon tests conducted between 1966 and 1996 was much more damaging and far-reaching than had been believed based on existing government studies. *Toxique* received numerous awards and led French President Emmanuel Macron to publicly recognize that France owed a debt to French Polynesia, to improve victims' compensation and open government archives.

"That experience was eye-opening. It showed me how I could draw on my technical expertise and scholarly training to generate real-world policy changes that benefit people and society," says Philippe, who joined the department in August 2025 as an assistant professor and an affiliate of the La Follette School of Public Affairs.

In his research, Philippe focuses on technical and policy solutions to assess, manage and reduce the risks to international peace and security associated with nuclear weapons and emerging technologies. He works across fields, partnering with social scientists and journalists, to make his research more impactful and bring his findings to policymakers and diplomats.

His work involves developing methods for monitoring nuclear weapons and verifying international agreements. These methods harness technologies such as commercial satellite imagery, drones, radiation detection, cryptographic protocols and artificial intelligence to enable remote inspections of nuclear facilities and activities, overcoming verification challenges.

Philippe also develops models of the effects of nuclear weapons, and he has used his models to reconstruct and analyze past nuclear weapon activities. By combining models of a radioactive mushroom cloud with models of atmospheric transport and dispersion, along with historical weather data, Philippe and his co-authors were the first to model the fallout of the 1945 Trinity test across the United States, an advance that garnered coverage by the *New York Times*.

Starting in fall 2025, Philippe will contribute his modeling expertise at the United Nations. Philippe and 20 other scientists were recently appointed by UN Secretary-General António Guterres to form an independent scientific panel on the effects of nuclear war. The panel will examine the physical effects and societal consequences of nuclear war at local, regional and planetary scales from the first days to decades after and will present its findings to the UN General Assembly in 2027.

"We're almost on the verge of a new nuclear arms race. A driving force for my work is to better inform policymakers and the public and help prevent it."

"I'm deeply honored and thankful for the opportunity to contribute to the panel's work," Philippe says. "It has been more than three decades since the United Nations last conducted a study on the consequences of nuclear war, and this new effort comes at a pivotal time. Amid growing geopolitical tensions, there has been an unraveling of international agreements in recent years, and the risks and threats of nuclear weapon use have also been increasing. We're almost on the verge of a new nuclear arms race. A driving force for my work is to better inform policymakers and the public and help prevent it."

Philippe earned his PhD in mechanical and aerospace engineering in 2018 from Princeton. Previously, he was a Stanton Nuclear Security postdoctoral fellow at the Harvard Kennedy School's Belfer Center for Science and International Affairs; an associate faculty member in the Nuclear Knowledges Program at Sciences-Po, Paris; and a nuclear safety engineer for strategic deterrent systems in the French Ministry of Armed Forces. Prior to joining UW-Madison, Philippe was a research scholar at Princeton University's Program on Science and Global Security in the School of Public and International Affairs.

A faster, cheaper way to restore stainless steel's corrosion resistance

Found in everything from kitchen appliances to sustainable energy infrastructure, stainless steels are used extensively due to their excellent corrosion (rusting) resistance. They're important materials in many industries, including manufacturing, transportation, oil and gas, nuclear power and chemical processing.

However, stainless steels can undergo a process called sensitization when subjected to a certain range of high temperatures—like during welding—and this substantially deteriorates their corrosion resistance. Left unchecked, corrosion can lead to cracking and structural failure.

"This is a major problem for stainless steels," says Professor Kumar Sridharan. "When stainless steel gets corroded, components need to be replaced or remediated. This is an expensive process and causes extended downtime in industry."

Sridharan and his collaborators have demonstrated a new approach for restoring stainless steel's corrosion resistance that could be much faster and potentially less expensive than conventional high-heat remediation methods.

To fundamentally understand why their approach was so successful at restoring corrosion resistance, the researchers harnessed an advanced technique called atom probe tomography in collaboration with Madison-based company CAMECA Instruments Inc. (AMETEK), which has ties to UW-Madison.

For their approach, the researchers used a technology called "ultrasonic nanocrystal surface modification" on a sample of sensitized stainless steel. In this process, a hard pin taps the steel's surface at extremely high frequencies.

"We showed that ultrasonic nanocrystal surface modification can restore the corrosion-resistant state of the stainless steel, without needing any heat treatment, which is a really big deal," Sridharan says.

While ultrasonic nanocrystal surface modification is not readily scalable, Sridharan says this research could open a door to similar, more scalable surface modification methods to optimize the performance of stainless steels.

UW-Madison's connection to CAMECA, a world-leading manufacturer of atom probe tomography equipment, played a key role in this breakthrough. The precursor to CAMECA's atom probe tomography business was Imago Scientific Instruments Corporation, a company founded in 1998 by Tom Kelly, a former professor of materials science and engineering at UW-Madison. In 2010, Imago was acquired by AMETEK and incorporated into the CAMECA business unit.

New computational tools enable better understanding of TRISO nuclear fuel 'health'

As advanced nuclear reactor designs move forward in commercial development, many of them will use TRISO particle fuel, a highly robust uranium fuel that can withstand extreme temperatures without melting. TRISO fuel includes pyrolytic carbon, which is a graphene-based material with a disordered atomic structure.

When subjected to harsh mechanical stresses and irradiation in an advanced reactor, the fuel material's microstructure will change or evolve, often causing undesirable changes in the overall properties and degrading the fuel's performance.

"It's important to understand the extent of those changes in the material because that will determine how long the fuel can be used," says PhD student Raphaëlle David. "For instance, if the material's properties change dramatically within two months, that fuel won't work well for a nuclear reactor."

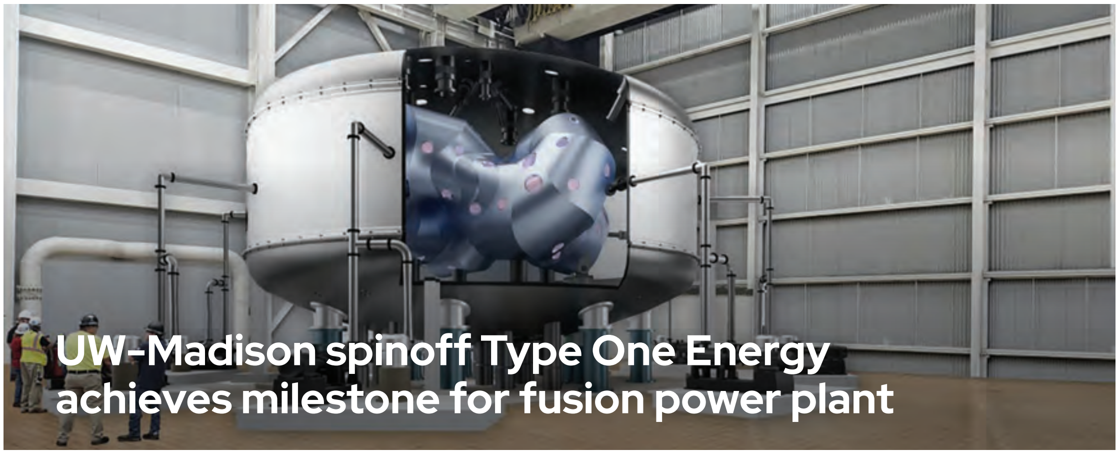
However, it has been challenging to sufficiently characterize how pyrolytic carbon evolves over time in extreme conditions. "There has been a huge gap in the tools that we need to describe the material's evolution," David says.

To address this problem, David and Associate Professor Yongfeng Zhang have developed new computational tools that provide a much better description of the complicated microstructure of pyrolytic carbon materials across multiple length scales. These tools will allow researchers to understand how the material changes over time.

David and Zhang detailed their results in a paper published in the journal *Carbon* in May 2025.

"I really enjoy studying things at very small scales with computational models because it leads to fundamental knowledge than can have wide-ranging applications," David says. "For example, our framework and new tools can also enable improved characterization and analysis of a broad class of carbon materials derived from graphene—materials that are used extensively for many applications in diverse areas and industries beyond nuclear power."

PhD student Raphaëlle David. Submitted photo.



UW–Madison spinoff Type One Energy achieves milestone for fusion power plant

A conceptual design for Type One Energy's fusion plant. Credit: Type One Energy.

UW-Madison spinoff company Type One Energy has published a comprehensive and robust physics basis for a practical fusion pilot power plant. The advance is an important and promising milestone that brings fusion power closer to reality.

This groundbreaking research was presented in a series of six peer-reviewed scientific papers in a special issue of the prestigious *Journal of Plasma Physics,* published in March 2025.

The articles serve as the foundation for the company's first fusion pilot plant project, which Type One Energy is developing. The company is partnering with the Tennessee Valley Authority utility as a probable partner in this endeavor. Fusion energy, the process that powers the sun and stars, is a long-sought-after way to produce limitless clean and safe energy.

The new physics design basis for the pilot power plant is a robust effort to realistically consider the complex relationship between challenging, competing requirements that all need to function together for fusion energy to be possible. Those requirements include plasma performance, power plant startup, construction logistics, reliability, and economics using actual power plant operating experience.

"With this work, we showed there are no showstoppers for Type One Energy's pilot power plant," says Professor Chris Hegna, who's also vice president of stellarator optimization for Type One Energy. "We demonstrated that our design optimization procedure simultaneously satisfied all the requirements without any notable shortcomings. For every kind of plasma physics question that might arise, we had a good answer for how to handle it."

Hegna is a co-founder of Type One Energy along with ECE Professor Emeritus David Anderson, who served for decades as the director of the Helically Symmetric eXperiment (HSX), a stellarator fusion reactor that's now led by NEEP Associate Professor Benedikt Geiger. Anderson and Hegna are building upon major research advances from HSX as they develop Type One Energy's power plant design.

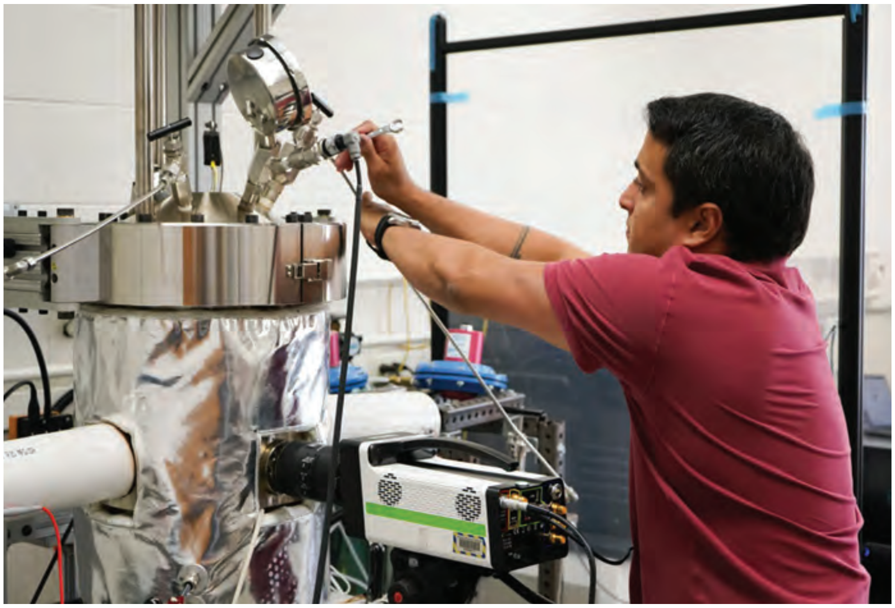
The new physics solution makes use of the operating characteristics of highly optimized stellarator fusion technology using modular superconducting magnets. A stellarator is a type of fusion reactor that uses complex, helical magnetic fields to confine the plasma, thereby enabling scientists to control it and create suitable conditions for fusion. This technology is already being used with success on the world's largest research stellarator, the Wendelstein 7-X, located in Germany, but the challenge embraced by Type One Energy's new design is how to evolve the design for use as a pilot plant.

Led by Hegna, widely recognized as a leading theorist in modern stellarators, Type One Energy performed high-fidelity computational plasma physics analyses to substantially reduce the risk of meeting the pilot power plant's functional and performance requirements.

This research was developed collaboratively between Type One Energy and a broad coalition of scientists from national laboratories and universities around the world, including UW-Madison, which is one of the world's top-ranked fusion energy research universities. Professor Paul Wilson and members of his research group are co-authors on two of the *Journal of Plasma Physics* papers, contributing expertise in neutronics and fuel-cycle modeling.

"One of the joys of being at UW-Madison is that we have lots of world-class experts in many different areas walking around our hallways, and Type One Energy is able to work closely with them and benefit from their expertise through collaborative research agreements," Hegna says.

The company made use of a spectrum of high-performance computing facilities, including access to the highest-performance U.S. Department of Energy supercomputers such as the exascale Frontier machine at Oak Ridge National Laboratory, to perform its physics simulations.



To study critical heat flux, PhD student Bruno Serrao sets up his custom pool boiling experiment to monitor how material surface characteristics impact heat transfer. Photo: Lili Sarajian.

Next-gen nuclear safety: From fission to fusion

From advancing small modular reactor concepts to developing new accident progression tools for fusion systems, the Heat Transfer and Safety Analysis (HEATS) Laboratory, led by Associate Professor Juliana Pacheco Duarte, is at the forefront of nuclear systems design and safety analysis.

On July 2, 2025, Wisconsin passed legislation calling for a nuclear power siting study to identify opportunities for fission and fusion energy generation in the state, including the development of small modular reactors—a unique technology that could change the landscape of nuclear power.

Small modular reactors are designed to be simpler and smaller in size than current reactors, making them easy to manufacture in high quantities offsite and ship to power plants for assembly. Duarte's lab is investigating methods to further improve the performance of these small modular reactors.

One method of improving safety and efficiency is using accident tolerant fuels in these reactors. Accident tolerant fuels are more resistant to the extreme environments of nuclear reactors, which could provide wider safety margins in an accident scenario. At the same time, these metallic fuels also produce hydrogen gas when they oxidize, and hydrogen buildup can increase the likelihood of a severe accident.

Undergraduate student Priscilla Lee is studying the oxidation of accident tolerant fuels to build a model that can predict how different factors lead to core meltdowns. Lee uses an accident analysis code called MELCOR, developed by Sandia National Laboratory, to simulate accident progression in fission reactors.

"The better we can model an accident scenario, the more we can safeguard against it, and the more we can make our reactors accident resistant," says Lee, who joined the HEATS Lab in summer 2025 through the College of Engineering Summer Undergraduate Research in Engineering program.

Another core area of safety analysis within the HEATS Lab is critical heat flux, or the point at which heat transfer decreases and the surface temperature spikes. If heat flux reaches this critical point, the outer layer of the fuel rods—or cladding—could rupture and release radioactive material.

To analyze critical heat flux, PhD student Bruno Serrao applies machine learning models to predict the maximum boiling point at which it occurs. He designed a custom pool boiling experiment that allows him to monitor the boiling process using a high-speed camera.

His particular focus is investigating how the surface characteristics of different material samples impact heat transfer. He uses samples of a zirconium alloy, a chromium-coated zirconium alloy, and iron-chromium-aluminum alloys—materials commonly used for nuclear reactor fuel cladding—that he sands down or polishes to achieve various textures.

Researchers in the lab often use both experimental and computational techniques, as Duarte encourages students to explore a wide range of methods. Since moving to UW-Madison in 2022, Duarte's group has tripled in size, expanding its research portfolio to include severe accidents as well as safety analysis for fusion machines.

PhD student Anthony Garcia uses a version of MELCOR to study loss of coolant scenarios in fusion reactors. Garcia's background is in thermodynamics and fluids, but he joined HEATS to pursue fusion research.

"I was always interested in fusion," Garcia says. "I want to see it progress to the commercial stage. Climate change has become the issue of our generation, and I want to contribute to this challenging area."

2025 ENGINEERS' DAY HONOREES

Erik Nygaard
Early Career Award recipient

Erik Nygaard (BSNEEP '09, MSNEEP '11) believes strongly in the importance of nuclear technology for modern society, from medical radioisotope products to nuclear reactors that provide nearly 20% of the country's carbon-free electricity. In his role as director of product development for the advanced technologies division at BWX Technologies, he is leading the development of advanced nuclear reactor technologies for military, commercial and space applications. One of those efforts is focused on commercial reactors as part of the U.S. Department of Energy Advanced Reactor Demonstration Program and R&D technologies. Looking back on his time at UW-Madison, he says being a licensed student operator at the UW Nuclear Reactor was a foundational experience in his education and prepared him exceptionally well for success in his career.

Kevin Nordt
Distinguished Achievement Award recipient

During his tenure as the chief financial officer and chief executive officer of the Grant County Public Utility District in Washington from 2011 to 2021, Kevin Nordt (MSNEEP '92) led the development of novel products and services that allowed the company to maintain reliable and cost-effective electric power service to its customers while increasing renewable energy on the grid. Under his leadership, the company built a high-speed broadband internet network that serves all rural areas in its service territory.

For most of the last decade, he has served as the chairman of the board for Warm Springs Power and Water Enterprises, an Oregon-based company owned by the Confederated Tribes of the Warm Springs that owns, operates and develops power and water infrastructure to serve the western United States for the benefit of the Tribes.

In 2023, Nordt returned to Wisconsin to start a new role as executive vice president and chief strategy officer for Dairyland Power Cooperative, which includes leading the effort to bring advanced nuclear power to Wisconsin.

Fifteen years after Fukushima: Graduate student gains global perspective

Nearly 15 years have passed since a 9.0 magnitude earthquake, and the 49-foot tsunami it triggered, compromised the cooling systems of three reactors at the Fukushima Daiichi Power Plant in Japan and resulted in a severe nuclear accident.

In summer 2025, PhD student Nick Crnkovich gained firsthand insight into the site's ongoing restoration efforts by participating in the 2025 Nuclear Innovator Cultivation Camp hosted at the Institute of Science Tokyo. The camp fosters international collaboration between early-career researchers, serving as a forum for discussion about further restoration techniques and emerging nuclear technologies.

Crnkovich's cohort included some Japanese students who were in grade school or early high school when the accident happened and are now working in the nuclear industry. He also met employees from TEPCO, the company that owned and operated the Fukushima plant.

"They have a deep sense of personal responsibility and commitment to not just containing it but returning the area to a safe spot," Crnkovich says.

Today, the restricted zone at the Fukushima Daiichi plant has been reduced considerably, but the next major hurdle is removing the contaminated fuel debris—approximately 880 tons—stored at the site. The interior of the containment vessels can only be reached by sending custom-engineered robots through two ports, each just under 20 inches in diameter. Even at the target rate of approximately 660 pounds per day, the process could take several years.

"They aren't wavering or suggesting to simply pour concrete over the area," he says. "They're ready to solve these challenges."

In reflecting on his experience, Crnkovich is reminded that advancing the nuclear field is not just a technical challenge, but also one of building public safety and trust.

"Talking to the people that were around when it happened definitely puts safety back in the forefront for me as we move on to advanced reactor concepts," Crnkovich says.

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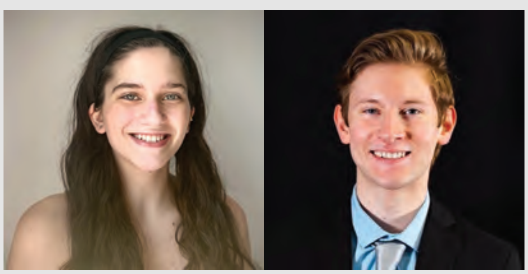

Two graduate students awarded UNLP Graduate Fellowships

Graduate students Isabella Wood and Gabe Dengler-Jeanblanc have received University Nuclear Leadership Program Graduate Fellowships.

Sponsored by the Department of Energy's Office of Nuclear Energy, the fellowships support graduate research relevant to nuclear energy and include a summer internship at a DOE national laboratory.

Wood and Dengler-Jeanblanc are both part of the Reactor Technology Integration Group (ReTI) led by Assistant Professor Ben Lindley.

Wood's research explores unconventional and novel core geometries in pebble-bed high-temperature gas-cooled reactors. Her goal is to develop viable, economical engineering solutions to bring these reactors closer to deployment, particularly in remote communities.

"Being awarded this fellowship is a confidence boost in both my abilities and the potential of my research," Wood says. "It's a meaningful validation that the hard work I've put in over the past few years is recognized."

Dengler-Jeanblanc began his research as a NEEP undergraduate, using software to test potential improvements to the power production of pressurized water reactors while maintaining safety limits. His work aims to improve fuel utilization for a wide range of reactor designs, ultimately providing cheaper electricity.

"This fellowship validates the hard work I have put into receiving my undergraduate degree," Dengler-Jeanblanc says. "Although it has been my intention to continue on to graduate school for many years now, this fellowship helps me confirm that I am on the right path."

These fellowships will allow both Wood and Dengler-Jeanblanc to continue their research without the stress of securing funding, enabling them the freedom to pursue the areas of study that align with their long-term career goals.