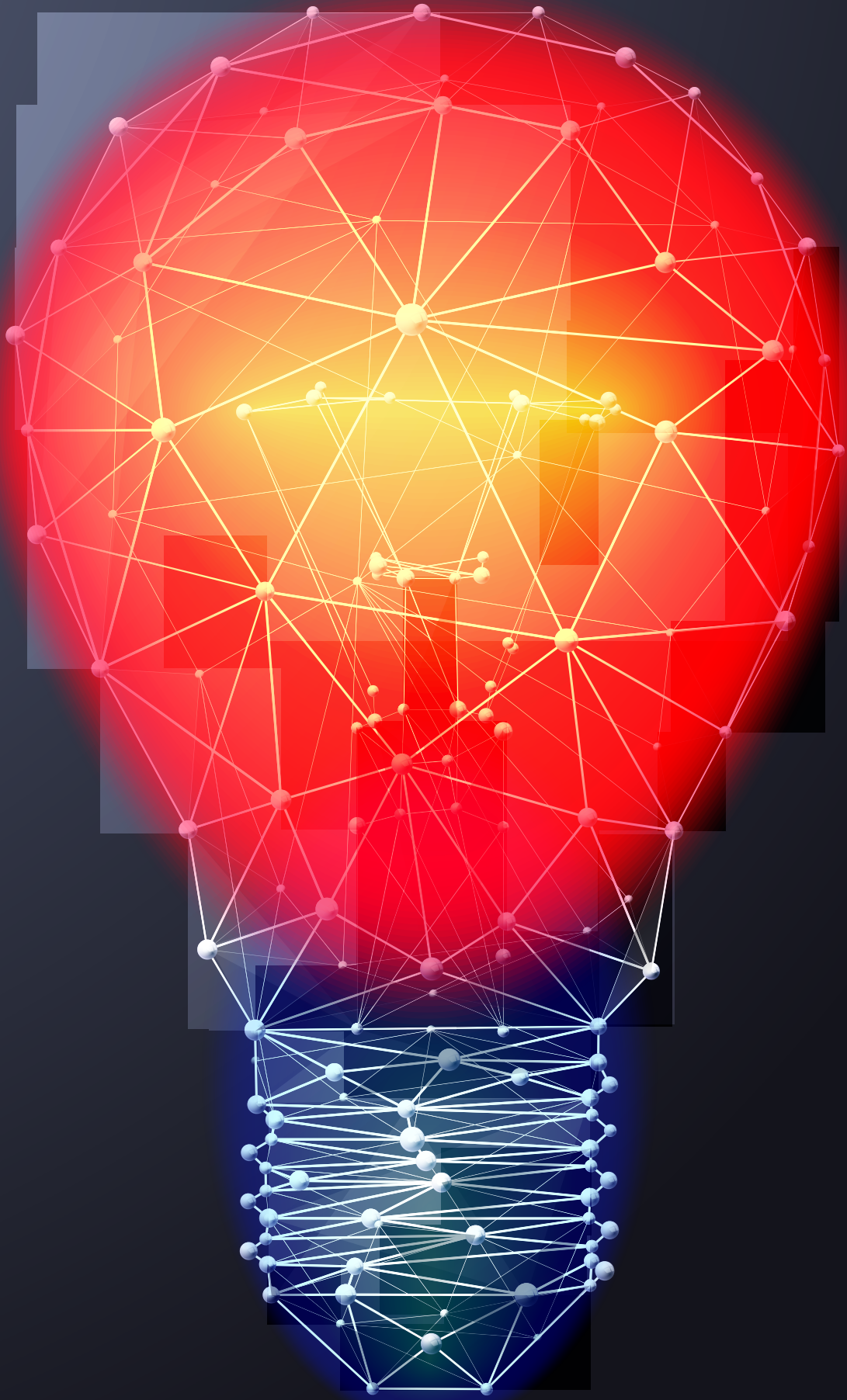




SANDIA LABS
**ACADEMIC
ALLIANCE**
2019
COLLABORATION REPORT







► Sandia's academic alliances establish strategic partnerships to solve science and technology problems of national importance

Sandia's Academic Alliance (SAA) program takes a deliberate approach to building partnerships with universities that combine strengths in key academic disciplines, contain sizable portfolios of relevant research capabilities, and demonstrate a strong institutional commitment to national security.

The SAA Program aims to solve significant problems that Sandia could not address alone, sustain and enrich Sandia's talent pipeline, and accelerate the commercialization and adoption of new technologies.

The Value of Sandia's Academic Alliance Program

University partnerships play an essential role in sustaining Sandia's vitality as a national laboratory. The SAA is an element of Sandia's broader University Partnerships program, which facilitates recruiting and research collaborations with dozens of universities annually.

The SAA program has two three-year goals. SAA aims to realize a step increase in hiring results, by growing the total annual inexperienced hires from each out-of-state SAA university. SAA also strives to establish and sustain strategic research partnerships by establishing several federally sponsored collaborations and multi-institutional consortiums in science & technology (S&T) priorities such as autonomy, advanced computing, hypersonics, quantum information science, and data science.

The SAA program facilitates access to talent, ideas, and Research & Development facilities through strong university partnerships. Earlier this year, the SAA program and campus executives hosted John Myers, Sandia's Senior Director of Human Resources (HR) and Communications, and senior-level staff at Georgia Tech, Illinois, Purdue, UNM, and UT Austin. These campus visits allowed for a history of the partnerships via briefings from the university leadership, tours of research facilities, and discussions of ongoing technical work and potential recruiting opportunities. These visits also provided valuable feedback to HR management that will help Sandia realize a step increase in hiring from SAA schools.

SAA Partners

The Georgia Institute of Technology ▶ *Georgia Tech*

Purdue University ▶ *Purdue*

The University of Illinois Urbana-Champaign ▶ *Illinois*

The University of New Mexico ▶ *UNM*

The University of Texas at Austin ▶ *UT Austin*

The 2019 Collaboration Report

The 2019 Collaboration Report is a compilation of 2019 accomplishments from SAA and Sandia's valued SAA university partners. To learn more about the SAA program, visit www.sandia.gov.



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A C C O M P L

Building the critical skills pipeline

Throughout the past year Sandia co-hosted multiple university events and piloted innovative on-campus internship opportunities to build the skills of students and expose them to the nature of the work conducted at the Laboratories—all with an emphasis on the computer science and cybersecurity disciplines. For example, about 200 students participated in Space Blimp Coding Challenges at Purdue, Illinois, and UT Austin, where space blimps served as simplified substitutes for satellite constellation arrangement, positioning, tracking, tagging, and locating. Students from Georgia Tech, Purdue, North Carolina A&T State University, and Clark Atlanta University also participated in Tracer FIRE (Forensics Incident Response Exercise) Cyber Competitions. The students learned how to analyze a real-world cyberattack on a power grid caused by malware known as CRASHOVERRIDE, which is the second-ever known case of malicious code purpose-built to disrupt physical systems. Beyond the challenge events, innovative programs at Illinois and Purdue provided more than 20 interns with the opportunity to work for Sandia while remaining on campus.

Pictured: Sandia sponsored eight of the 70 teams attending the U.S. Department of Energy's (DOE) fourth collegiate CyberForce Competition in December.



I S H M E N T S

Enabling Sandia's mission campaigns

Sandia formed the AutonomyNM academic research coalition as part of Autonomy for Hypersonics (A4H)—a seven-year, \$35M initiative started in 2017 and funded through the Laboratory Directed Research and Development (LDRD) program. The Sandia-led collaboration seeks to research and develop autonomous systems technologies that will enhance the warfighting utility of hypersonic flight systems. The A4H and AutonomyNM efforts helped attract a related but separate UNM-led, five-year, \$5.5M grant from the National Science Foundation (NSF) to design autonomous systems that are responsive to humans. SAA faculty collaborators also contributed to the development of an autonomous mission-planning solution that generates flight plans in minutes, enhancing the warfighting capability of hypersonics and retaining U.S. leadership in this critical national security area. AutonomyNM collaborators are Sandia, Georgia Tech, Purdue, Illinois, UNM, Stanford University, Texas A&M University, UT Austin, and Utah State University. In addition to UNM, NSF grant collaborators are Purdue, UT Austin, University of Colorado Boulder (UC Boulder), and Sandia.

Pictured: Sandia flies a drone at dusk. Humans might see their roles throughout aviation and aerospace shift if Sandia can simplify manual tasks with artificial intelligence.



A C C O M P L



Facilitating research networks

Sandia initiated the New Mexico Research Spotlight Forum series with UNM, the New Mexico Institute of Mining & Technology (NM Tech), and New Mexico State University (NMSU) to facilitate collaborations between the New Mexico schools and the out-of-state schools in the SAA program. The

bi-monthly event increases faculty knowledge of Sandia program areas and provides Sandia staff the opportunity to learn more about faculty expertise and university capabilities and facilities.

Research Spotlight Forums have focused on topics such as artificial intelligence (AI) and machine learning, engineering mechanics and dynamics, advancing resilience for space systems, quantum information sciences, cybersecurity, and resilient infrastructure.

Pictured: Justin Newcomer briefs attendees on the integral role of technology in Sandia's mission delivery at a 2019 Research Spotlight Forum event.

I S H M E N T S

Exercising leadership in collaborative research

Sandia is participating in numerous joint projects with academia to conduct mission-relevant research for various sponsors. For example, Georgia Tech is leading a consortium of 12 universities and 10 national labs, which received a five-year, \$25M grant to develop enabling technologies to support the DOE/ National Nuclear Security Association (NNSA) nonproliferation mission to detect and characterize nuclear materials production. Sandia received additional funds to support this endeavor and met with Georgia Tech regarding further technical collaborations.

Pictured: Sandia supported the first NNSA Nuclear Security Enterprise Day on March 25, 2019 at Georgia Tech, which sparked great conversations with students about career opportunities available at the national labs.



A C C O M P L

Motivating international engineering education

Sandia provided strong support for the UNM-hosted World Engineering Education Forum – Global Engineering Deans Council (WEEF–GEDC) international conference held in Albuquerque in November 2018. Sandia furnished conference sponsorship, technical leadership panel speakers, an interactive technology demonstration exhibit, Sandia tours for participants, and an SAA Partnerships reception for participants. The theme of the conference was peace engineering — envisioning and working towards a world where prosperity, sustainability, social equity, entrepreneurship, transparency, community voice and engagement, and a culture of quality thrive. The conference was hosted by UNM’s School of Engineering, the Ibero-American Science and Technology Education Consortium, and the Global Innovation Network for Entrepreneurship and Technology. The conference welcomed almost 500 engineering educators, leaders, students, industry representatives, governmental organizations, and non-governmental organizations from 39 different countries to learn, share, and build fruitful and long-term collaborations.

Pictured: Susan Seestrom, Sandia’s Associate Labs Director of Advanced Science & Technology (left), and Nancy Hayden, from Sandia’s Strategic Futures & Policy Analysis team, explore Sandia’s interactive technology demonstration exhibit at the WEEF–GEDC conference.



I S H M E N T S

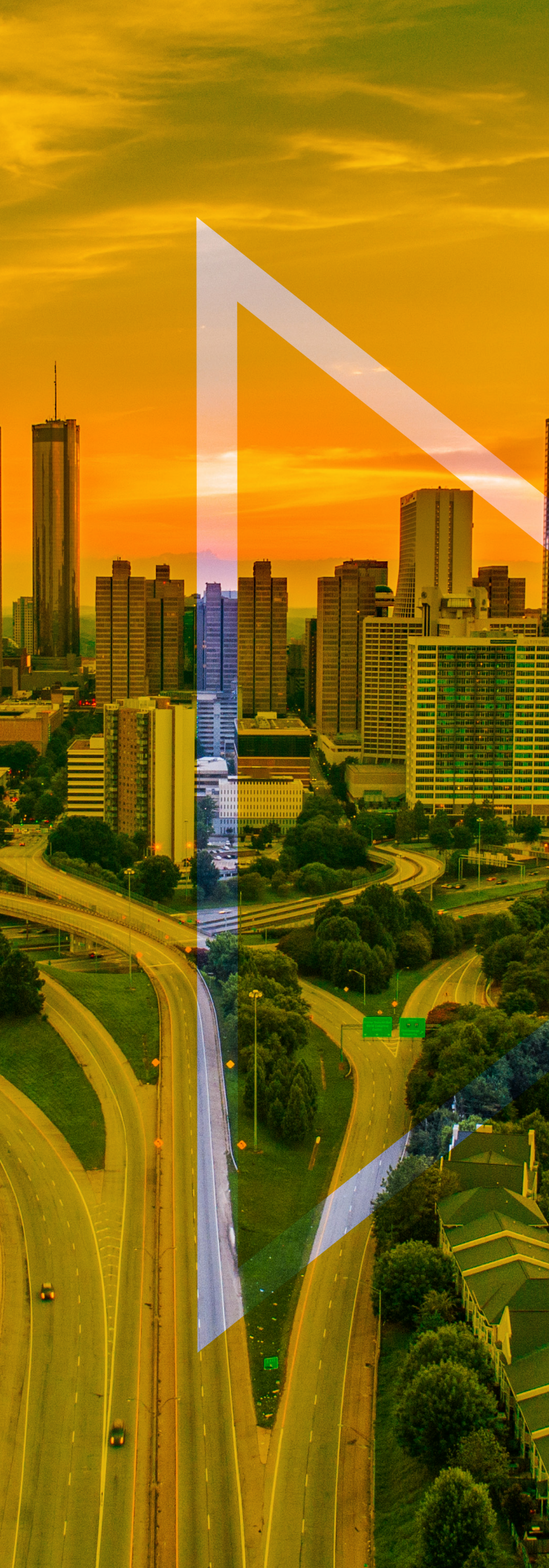
Presidential Early Career Award for Scientists and Engineers given to Sandians and SAA faculty

In 2019, four Sandia employees and sixteen SAA faculty received the Presidential Early Career Award for Scientists and Engineers (PECASE). The PECASE is the highest honor bestowed by the U.S. Government to outstanding scientists and engineers beginning their independent research careers and showing exceptional promise for leadership in science and technology. Former U.S. Secretary of Energy Rick Perry noted, "I am honored to congratulate all of this year's winners as they continue to embark in careers that will maintain America's position as a leader in scientific development and advance the breakthrough technologies of tomorrow."



***Pictured:** A group of distinguished researchers was honored as recipients of the Presidential Early Career Award for Scientists and Engineers in Washington, D.C. on Thursday, July 25, 2019.*





GEORGIA TECH

ATLANTA, GA



Sandia career and research opportunities highlighted at Georgia Tech

During 2019, Georgia Tech students received multiple glimpses into exciting career opportunities at Sandia Labs and across NNSA at large.

On January 17, 2019, Georgia Tech faculty, researchers, and graduate students met at the Marcus Nanotechnology Building for a half-day event to learn about the SAA Program. This unique opportunity, hosted by the Office of Industry Collaboration, was the first event of its kind at the university. It illustrated what the strong program with Georgia Tech brings to both institutions and the technical research areas they have in common (materials/nanotechnology, quantum information sciences, radio frequency photonics/electronics, cyber and information security, and data science and advanced computing). Attendees walked away understanding more about what Sandia's LDRD program could offer in the way of research collaborations and the

many student internship/postdoc/regular positions available.

Last March, Georgia Tech students attended panel discussions and presentations and met one-on-one with staff from the NNSA. At the Nuclear Security Enterprise (NSE) recruitment event that Sandia helped to organize, students learned about missions across the enterprise and current federal and contractor career opportunities. Frank Lowery, NNSA Associate Administrator for Management and Budget, presented on behalf of NNSA and attended meetings with the Executive Vice President for Research and faculty from the Georgia Tech Government and Employee Relations Office, the College of Engineering, the College of Computing, and the Sam Nunn School of International Affairs.



\$1.36M joint DOE award allows for focus on downhole sensing and exploratory well drilling

Sandia Labs and Georgia Tech were awarded \$1.36M for their joint proposal, Downhole Sensing and Event-Driven Sensor Fusion for Depth-of-Cut-Based Autonomous Fault Response and Drilling Optimization. Sandia and Georgia Tech are focused on using the award from the DOE Office of Renewable Energy and Energy Efficiency to

utilize novel mechatronic designs, sensing, and algorithms to enhance the performance of geothermal exploratory well drilling. The effort brings together Sandia's unique expertise in rock mechanics, drilling control, and high-consequence automation and Georgia Tech's novel mechanism design, sensor fusion, and machine learning.



.....▶ A large group from Georgia Tech and Sandia organized the successful NSE event last August at Georgia Tech, which helped to educate students about nuclear security enterprise career opportunities.

Students learn how to hold up under (Tracer) FIRE

Tracer FIRE (Forensic Incident Response Exercise) is a program originally developed by Sandia and Los Alamos National Laboratories to educate and train cyber security incident responders and analysts in critical skill areas for the DOE. Sandia now uses Tracer FIRE for educational outreach to students. On Sept. 6-7, 2018, students from Georgia Tech, North Carolina A&T State University, and Clark Atlanta University were provided with hands-on experience into how cyber incident response teams operate, helping them to

identify adversary trends and strategies. The 26 students, hosted by Sandia and Assistant Professor Brendan Saltaformaggio of Georgia Tech's School of Electrical and Computer Engineering, were exposed to real-world cyber campaigns utilizing malware to help them learn more about adversary trends and strategies. Exercises like Tracer FIRE allow laboratory technical staff to connect with interested students and address the shortage of qualified staff across the DOE complex, other government agencies, and industry.



▶ This group of students responded to a mock cyber event at the Tracer FIRE.

Georgia Tech and Sandia Labs are on the front lines of nuclear science, security, and nonproliferation

A consortium of 12 universities and 10 national labs, led by Georgia Tech Associate Professor Anna Erickson, is focused on improvements and innovative concepts for enabling technologies that support the nonproliferation mission to detect and characterize nuclear materials production. “We will be developing new enabling technologies to address not only the current challenges, but also those we might anticipate in the future,” said Erickson, who is an Associate Professor in Georgia Tech’s Woodruff School of Mechanical Engineering and principal investigator for the Consortium for Enabling Technologies and Innovation (ETI).

Sandia is one of the 10 national laboratory partners in the Consortium for ETI, which is responsible for the nation’s nuclear stockpile and for preventing the spread of nuclear weapons and materials worldwide. This is a significant challenge as new technologies – including additive manufacturing, also known as 3D printing – enable possible manufacturing in many more locations. “We need to look at securing the technologies of the future,” said Erickson.

This \$25M grant from NNSA will be utilized to increase technical readiness levels and hopefully transfer more than 40 graduate students and 20 undergraduate students to the national labs over the next five years. “These grants will foster development of concepts and technologies that keep the United States at the forefront of nuclear monitoring and verification capabilities and allow us to nurture tomorrow’s nonproliferation experts,” said Brent K. Park, NNSA’s Deputy Administrator for Defense Nuclear Nonproliferation.



► *Georgia Tech Associate Professor Anna Erickson positions a new radiation detector prototype in the Varian Clinac beam to study radiation damage.*

Working backward (reverse engineering of computer programs) to protect the national computer infrastructure going forward

Protecting our national computer infrastructure from attackers often requires manual vulnerability analysis and reverse engineering of compiled (binary) computer programs. This analysis is extremely challenging when considering data inputs and data flow. An interdisciplinary Sandia-Georgia Tech team enabled visual analytics for this binary data flow analysis, creating visualizations for representing data flow. While still complex, these visualizations help human analysts to interact intuitively with data flow, reducing the human time burden for binary vulnerability analysis and reverse engineering. The Sandia team derived visualization requirements by applying human factors techniques to binary analysis, modifying the techniques as needed. By representing the limited

number of important data flow primitives and relationships identified in these requirements, the team developed revolutionary user-centric visualizations of data flow. These visualizations enable novel code navigation, information presentation supporting rapid decision-making, and information sharing between human analysts and automated binary analyses. Georgia Tech collaborators John Stasko, Alex Orso, Ravi Mangal and Alex Godwin proved out some of these capabilities, creating a proof-of-concept automatic data flow fact generator and a proof-of-concept visualization supporting interactive exploration, annotation, and update of such graphs. Michelle Leger and Karin Butler are the Sandia principal investigators teaming on this project.

▶ *Matthew Reno, Sandia engineer and Georgia Tech alumnus, helped develop new software that performs faster quasi-static time series analyses to show how rooftop solar panels interact with the electrical grid throughout the year.*



STUDENT SPOTLIGHT

Marisa Cepeda

Some people like to see the big picture. Georgia Tech PhD candidate Marisa Cepeda sees the big picture through a small lens focused on even tinier things—bacteria. Specifically, Marisa is working with Sandia on the Probiotic Optimally Selected, Specifically Engineered (POSSE) bacteria for supporting microalgae cultures for biofuel. Reducing the cost of algal biofuels is an essential step in bringing a domestically produced alternative fuel technology to commercial reality. One solution is to improve the ability of algal biofuel crops to resist pathogens or microscopic predators that feed on algae.

Marisa is working with Carolyn Fisher, a postdoc at Sandia, and Todd Lane, Sandia principal investigator, to conduct joint research on natural methods of protecting algal biofuel ponds. The findings point to factors that should be considered when developing algal biofuel strains, and demonstrate the power of joint Sandia-academic research in solving U.S. energy security challenges. Based on their LDRD work, Marisa successfully defended her thesis project for her PhD candidacy exam in the School of Chemistry & Biochemistry and presented a poster of her work at the International Society of Chemical Ecology (ISCE) this past June. A Georgia Tech undergrad, Hailey Loehde-Woolard, is also working on the LDRD project and successfully defended her undergraduate honors thesis based on her project work.



Marisa Cepeda
PhD Candidate
Georgia Tech, School of
Chemistry & Biochemistry

Speaking about her experience with Sandia, Marisa stated, “Collaborating with researchers at Sandia National Laboratories has far exceeded my expectations. While working on developing natural methods to protect algal biofuel ponds, the skills I’ve learned and the connections I’ve made are invaluable. Not only do I get to work on a project I’m passionate about, but I also feel that the work is both meaningful and impactful to the biofuel industry.”



KEY LEADERSHIP

Georgia Tech

Chaouki Abdallah
*Executive Vice President for
Research*

Olaf Westerstahl
*Associate Director Strategic Industry
Collaborations, Sandia Research
Engagements*

Remi Dingreville
*Adjunct Assistant Professor,
Mechanics of Materials (Based at
Sandia National Labs)*

Rob Butera
*Associate Dean for Research and
Innovation, College of Engineering*

Sandia National Laboratories

Rebecca Horton
*Senior Manager in Center 1900,
On-campus Manager*

Andre Claudet
Manager in Center 5200, Recruiting Lead





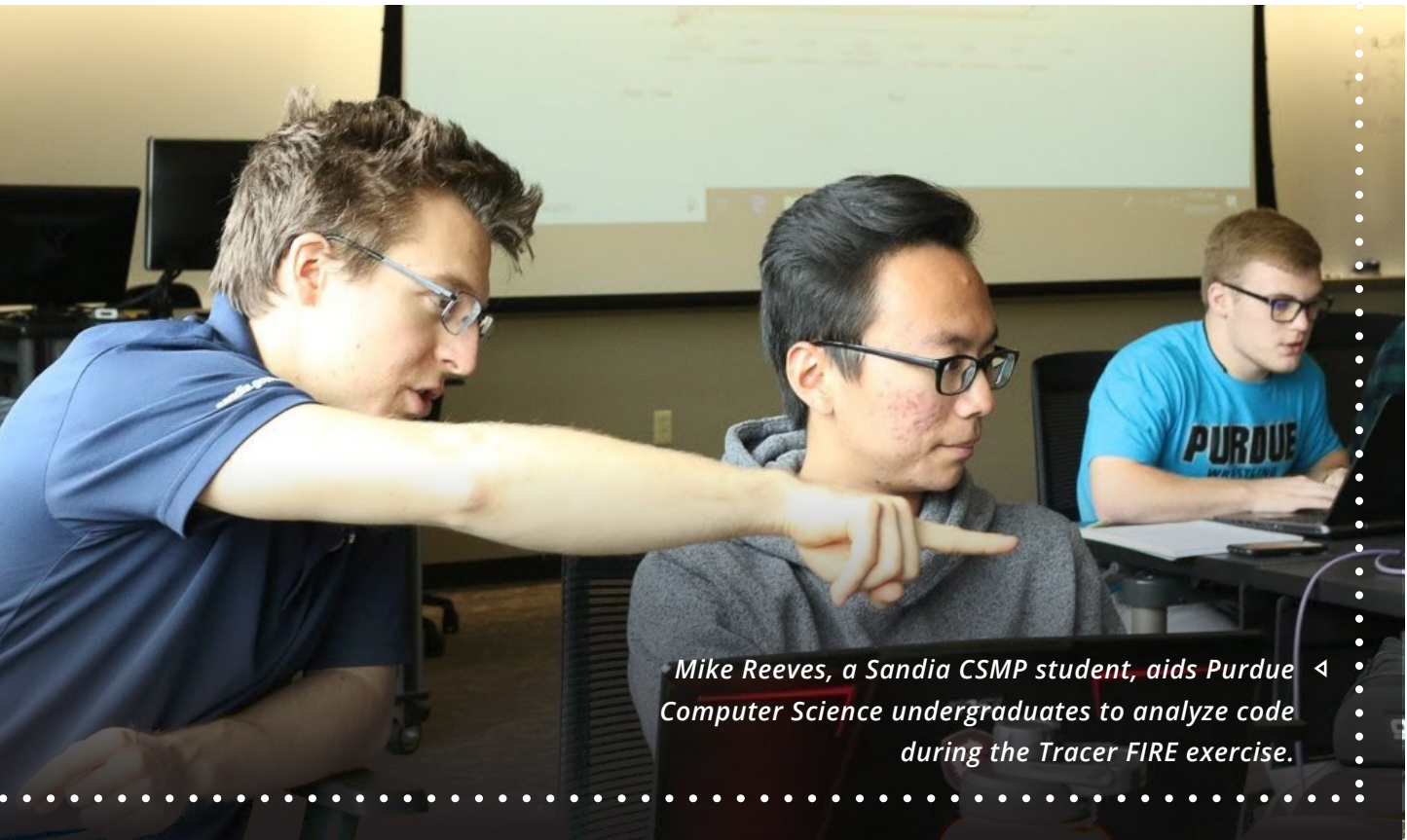
PURDUE
WEST LAFAYETTE, IN

Creating cyber defenders at Purdue

CRASHOVERRIDE. It's a nasty malware framework that wreaks havoc across the world by infiltrating computers, deleting files and processes off the running system, and leaving them vulnerable for a destructive attack so powerful that it can take down entire power grids. CRASHOVERRIDE is the second-ever known case of malicious code purpose-built to disrupt physical systems, and can launch simultaneously across multiple targets.

Enter the Avengers — or in this case, the cyber defenders. Thirty-five students at Purdue and North Carolina A&T University

experienced this malware firsthand and used the unique analyzation training offered in the Tracer FIRE competition to up their skills in cyber defense. This exercise, funded by DOE and co-sponsored in this instance by Sandia Labs and Purdue, improves cybersecurity education and will help NNSA build strong relationships and recruit those in this critical field to help defend the U.S. in years to come. • • • •

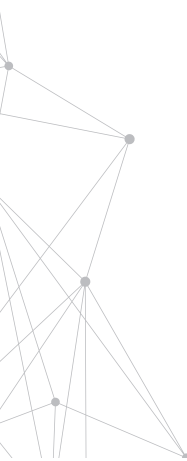


Dedicated space at Purdue enables year-round engagements with student interns

The Sandia Extended National Security Externship (SENSE) space at Purdue brings together year-round interns in the areas of cybersecurity and computer science to work on Sandia projects. The benefits to the externship program are readily apparent. It allows eleven year-round interns to get paid, have flexible work hours around classes, team with PhD researchers, learn new skills, work with technical mentors and principal investigators, and obtain an amazing experience with a national lab. The on-campus SAA manager, Ken Patel, provides oversight and direction as needed. "The SENSE space is much more than a location on campus at Purdue. It facilitates a stronger connection with the Labs, provides a computer network dedicated to remote login, and enables a place for real collaboration to occur between the students and Sandia experts."

At the Center for Education and Research in Information Assurance and Security (CERIAS) Symposium 2019 in April, Purdue

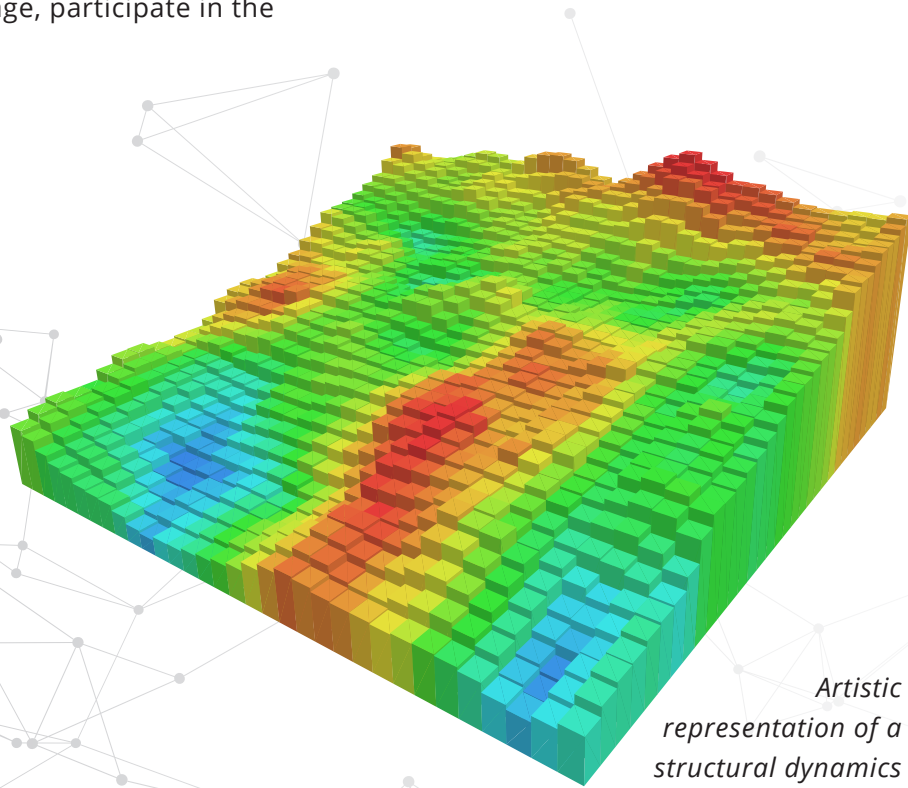
leaders recognized Sandia for its student engagement through SENSE and related cyber security workshops and competitions. Joel Rasmus, managing director for CERIAS, called out some of the accomplishments facilitated by Ken Patel. "Ken had an idea of extending the student intern experience and bringing it to Purdue's campus. This is how the Sandia externship program was established, which led to the CERIAS lab being refitted so Sandia could run their externship out of the CERIAS office. CERIAS had a long relationship with Sandia, but under Ken here on campus, he has been able to foster growing relationships between existing researchers." SENSE is just one more way that Sandia is working to establish a Sandia cohort at Purdue and create in-roads with the talent pipeline of the future.



Predicting structural dynamics damage in rock

On February 20-22, 2019, a group of computational scientists and experimentalists gathered at Purdue's Stewart Center for an exciting event co-sponsored by Sandia. The Damage Mechanics Challenge Workshop brought together experts from Purdue and Sandia, Lawrence Livermore, and Los Alamos national labs to speak on topics related to structural dynamics. The interactive event allowed participants to present their computational approach for numerical simulation of damage, participate in the

design of a challenge problem focused on predicting failure in controlled ways and with increasing complexity, and define repeatable and unbiased metrics to quantitatively assess and measure the quality of the theoretical and data-driven models, given the significant influence of inherent uncertainty and variability on the onset and mode of failures.



Artistic representation of a structural dynamics rendering

SOL4CE and Dr. Eugene Spafford

Automated threat modeling for cyber security analytics and emulation is the focus of a Sandia and Purdue LDRD project. The technical progress made so far resulted in well-received proceedings in the top security conferences. The creation of SOL4CE (Scaled Able Open Laboratory 4 Cyber Experimentation) and a joint expansion of Sandia proprietary virtualization tools to academia is a direct outcome of the project's Emulytics™ work.

This project also paved the way for a 2019 summer Sandia sabbatical for prominent Purdue faculty member, Dr. Eugene "Spaf" Spafford. Spaf is one of the most recognized international leaders in the field of computing on issues of security and intelligence, education, cybercrime, and computing policy. During his sabbatical, he leveraged his decades of expertise to help Sandia stay ahead of threats for effective cyber defense. In partnership with the SAA, Spaf is continuing efforts with Marcus Chang, Sandia Director of Cyber Security & Mission Computing; Han Lin, Sandia

Manager of Cyber Security Initiatives; and Vince Urias, Sandia Cyber Security Initiatives expert, to seek new talent pipeline opportunities. Potential efforts include crafting a master's degree program tailored to Sandia's program goals, developing new platforms and environments for cyber experimentation by students, and sponsoring cyber competitions on behalf of Sandia at Purdue.

During the summer, Spaf hosted a Sandia exchange for Purdue department heads and professors in computer science, electrical engineering, and computer engineering to learn about Sandia's mission and brainstorm new approaches to collaboration work together. Spaf will continue to help Sandia with research and pipeline initiatives for cybersecurity.



► *Purdue's Dr. Eugene Spafford met with visiting Purdue faculty, Saurabh Bagchi, Tom Hacker and others at Sandia's Center for Cyberdefenders suite.*

Marcey Hoover receives 2019 Distinguished Science Alumni Award for Statistics from Purdue

On March 29, 2019, Marcey Hoover, Director of Sandia's Energy and Homeland Security Program Management Center, received the 2019 Distinguished Science Alumni Award for Statistics from Purdue. Hoover is Sandia's Executive Sponsor for the school.

As a doctoral student at Purdue, Hoover didn't have her sights set on working at a national laboratory. "I was sitting in my office one day at Purdue when a Sandia recruiter walked in and asked if I had ever heard of Sandia Labs," Hoover recalled. "The answer was no. They asked me to come out for an interview, and I fell in love with Sandia and Albuquerque after my first visit." Hoover started at Sandia as an applied statistician in 1995, and her career has taken her into multiple areas at the national lab.

Hoover's time at Purdue prepared her well for her career at Sandia. "My degree provided the necessary credentials to hire into a national laboratory, and my time working within the Purdue Statistical Consulting Service provided the practical experience necessary to fulfill the requirements of the assignments," she said.

A photograph of Marcey Hoover, a woman with long brown hair, wearing a black blazer over a grey patterned top. She is standing behind a clear acrylic podium with the Purdue University logo on it. She is smiling and looking to her right. A name tag on her chest reads "Marcey Hoover" and "PURDUE College of Science". A microphone is positioned in front of her. The background is a plain, light-colored wall.

Marcey Hoover
Energy and Homeland Security
Program Management Center
Director at Sandia



KEY LEADERSHIP

Purdue

Theresa Mayer
*Executive Vice President for
Research & Partnerships*

Dan DeLaurentis
*Professor and President's Fellow for
Defense Initiatives*

Dr. Timothée L. Pourpoint
*Professor, School of Aeronautics
and Astronautics*

Sandia National Laboratories

Marcy Hoover
*Director of Center 8100,
Academic Alliance Executive*

Kamlesh Patel
*Manager in Center 1900,
On-campus Manager*

Kim Welch
*Manager in Center 2800,
Recruiting Lead*





ILLINOIS
URBANA-CHAMPAIGN, IL

Applied Research Institute summer internship pilot project

The Applied Research Institute (ARI) is a unit of the College of Engineering located in Illinois's Research Park. Since the fall of 2017, Sandia has leveraged its strategic relationship with the ARI to provide on-campus opportunities for Illinois students to work directly on software development tasks supporting Sandia's space mission. This unique program pilot introduces students to national security careers by allowing them to contribute to actual mission projects. Most recently, 10 undergraduate students across a variety of technical fields worked full-time during the summer at ARI in close collaboration with Sandia project team members.

Eight of the ten undergraduate summer interns visited Sandia in Albuquerque, NM on August 12-13, 2019 to brief their summer project work, meet with Sandia staff, tour facilities, and participate in an internal recruiting open house. Two of the students interviewed for full-time positions at Sandia. Prior to the visit, some students indicated they weren't planning to pursue a graduate degree immediately after graduating. However, after this trip, they said they are reconsidering because of the numerous opportunities they see available to them with graduate degrees.



► A group of ARI summer interns working with Sandia during 2018 gathered for a quick photo.



Critical patch defends against cyberattack on medical diagnostics

After bioinformatics researchers at Sandia identified a weakness in one common open-source software for genomic analysis that left DNA-based medical diagnostics vulnerable to cyberattacks, they partnered with cybersecurity colleagues at Illinois. To find this vulnerability, the Sandia-Illinois team used a platform developed by Sandia called Emulytics™ to simulate the process of genome mapping, imported simulated genetic information, and had two servers send information to Emulytics™. The researchers mapped the sequencing results and compared results with and without an attack to see how the attack changed the final sequence. “Once we discovered this attack could change a patient’s genetic information, we followed responsible disclosure,” said Corey Hudson, a bioinformatics researcher at Sandia who

helped uncover the issue. The researchers contacted the open-source developers, who then issued a patch to fix the problem. They also contacted public agencies, including cybersecurity experts at the U.S. Computer Emergency Readiness Team, so they could more widely distribute information about this issue.

The discovery reveals that protecting genomic information involves more than safe storage of an individual’s genetic information – it requires the cybersecurity of computer systems analyzing genetic data, said Hudson. The research, funded by the LDRD program, continues testing other genome mapping software for security weaknesses.

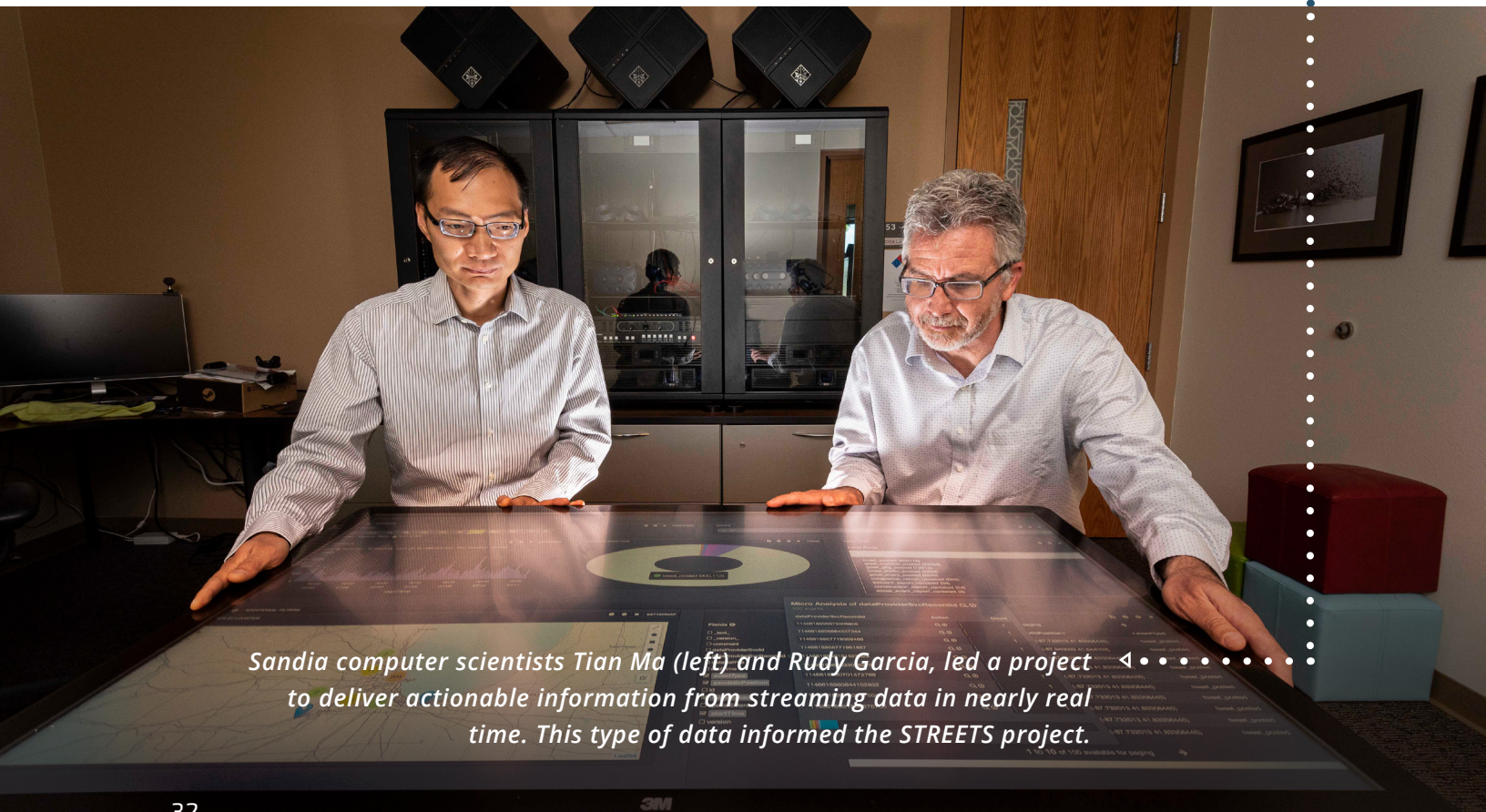


Applying machine learning to understand traffic flow

Partnership in the area of machine learning resulted in “STREETS: A Novel Camera Network Dataset for Traffic Flow” being accepted as the spotlight paper at NeurIPS, a preeminent conference in machine learning. The research was conducted at Lake County Passage by Illinois Professor Minh Do, PhD student Corey Snyder, and Tian Ma, a principal member of the R&D science and engineering staff at Sandia. (Initial work on this project started as part of the ARI internship program.) Tian is recognized as a key expert in detection algorithms and a pioneer in the field of

tracking systems, where he has innovated and delivered state-of-the-art detection and tracking algorithms to these systems. His research solutions are not simply theoretical constructions in literature but have been realized and engineered into real-world applications.

The STREETS project with Illinois was enabled, in part, by a Sandia LDRD project and was presented at the 33rd annual NeurIPS conference Dec. 8-14, 2019 in Vancouver, B.C.



Sandia computer scientists Tian Ma (left) and Rudy Garcia, led a project to deliver actionable information from streaming data in nearly real time. This type of data informed the STREETS project.

Presidential Early Career Award for Scientists and Engineers

On July 2, 2019, the White House announced that year's Presidential Early Career Award for Scientists and Engineers (PECASE) recipients. The PECASE is the highest honor bestowed by the U.S. government to outstanding scientists and engineers who are beginning their independent research careers and show exceptional promise for leadership in science and technology.

In 2019, six Illinois faculty were named recipients of the prestigious research award. Several have recent/current connections with Sandia, including two working on LDRD projects.

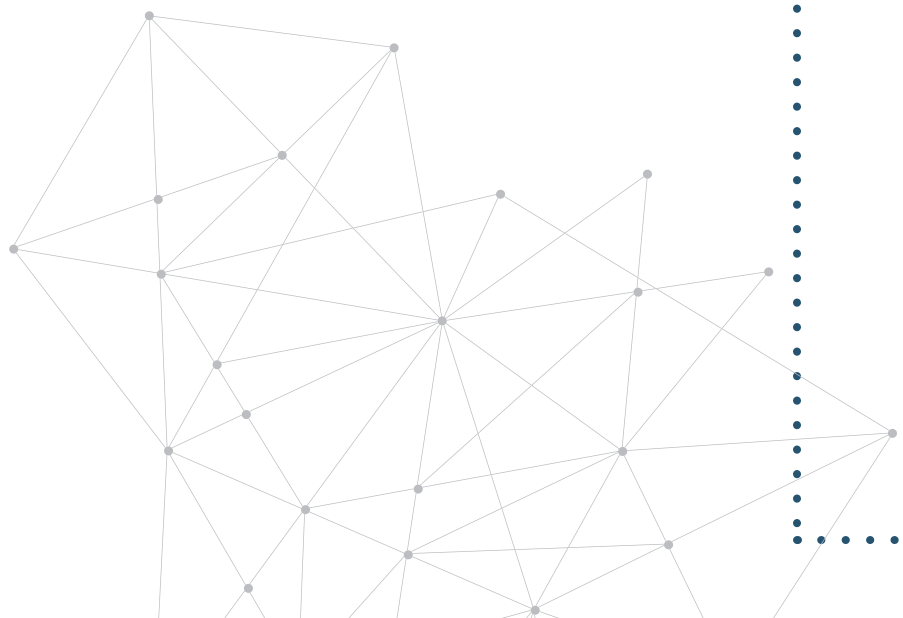
- Pinshane Huang
Illinois, Department of Defense (DOD)
- Prashant Jain
Illinois, National Science Foundation
- Daniel Llano
Illinois, Department of Health and Human Services
- Julia Shelton
Illinois, Department of Energy
- Kelly Stephani
Illinois, National Aeronautics and Space Administration
-



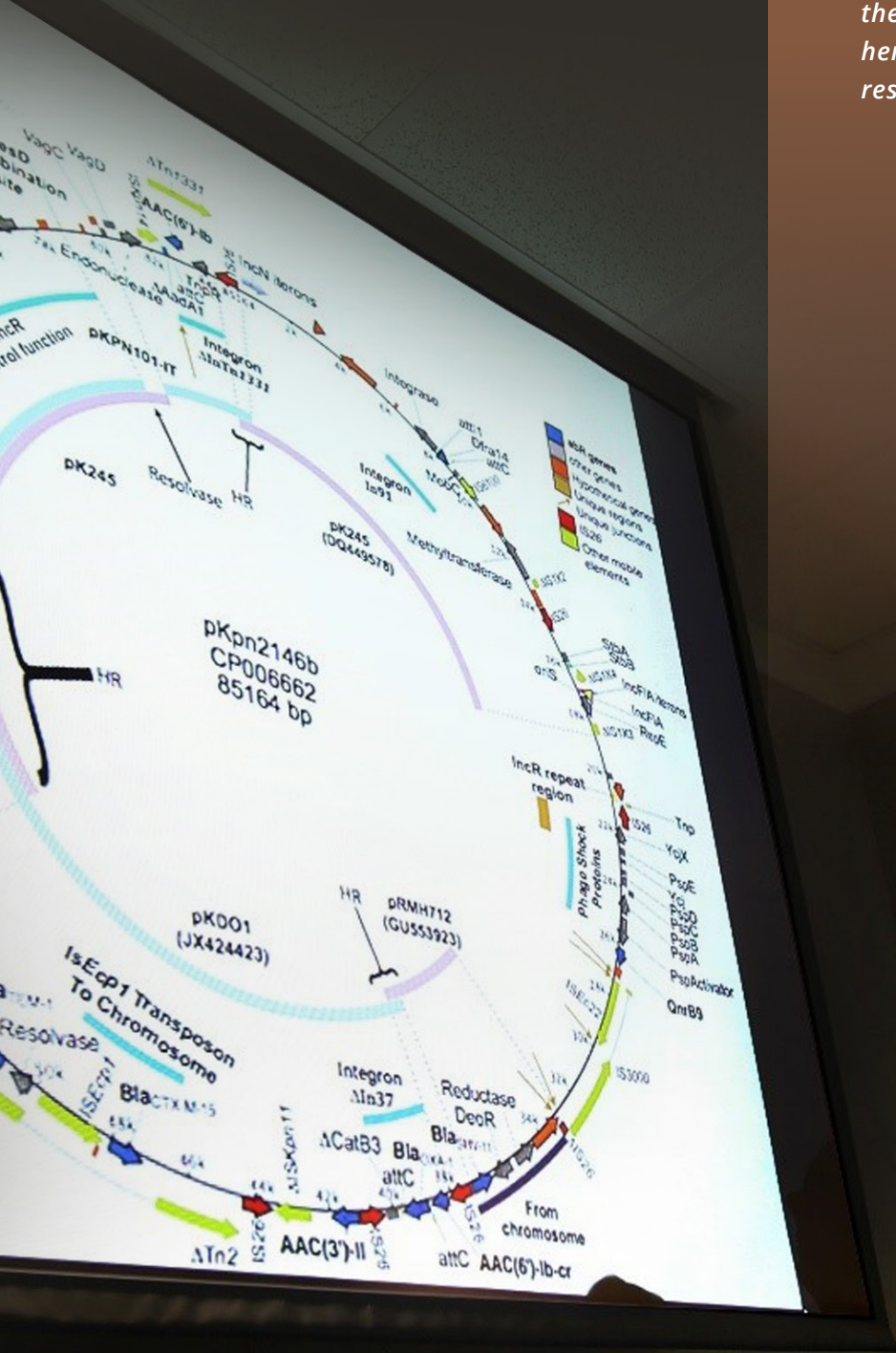
Partnering on computational biotechnology and genomic medicine

Sandia's Dr. Corey Hudson was elected Vice Chair of the Center for Computational Biotechnology and Genomic Medicine (CCBGM) Advisory Board and has been actively involved in the research center with partial support from both the SAA Program and the LDRD program. CCBGM, a National Science Foundation Industry/University Cooperative Research Center, uses the power of computational predictive genomics to advance pressing societal issues that require predictive genomics, such as enabling patient-specific cancer treatment, understanding and modifying microbiomes, and supporting humanity's rapidly expanding need for food by improving the efficiency of plant and animal agriculture.

The CCBGM brings together two university sites with unique resources in computational and biological sciences, namely Illinois and Mayo Clinic; the University of Chicago, working as an affiliate institution, has expertise in high-performance computing (HPC; through Argonne National Laboratory) and cancer genomics. The CCBGM recently funded a Sandia proposal focused on genomic security and security of the U.S. bioeconomy. The Design and Assessment of Secure Genomic Pipeline is also tightly integrated with Hudson's current LDRD project and other Sandia interests. The LDRD project brought two Illinois interns to work at Sandia the summer of 2019.



► Sandia National Labs' researcher Corey Hudson (right) was elected Vice Chair of the CCBGM Advisory Board. He is pictured here with Kelly Williams, another Sandia researcher.



ALUMNI SPOTLIGHT

Brent Houchens

Illinois alum Brent Houchens is a mechanical engineer who focuses on thermal/fluid science and engineering at Sandia. Houchens, who worked in academia prior to coming to Sandia, appreciates the overall environment Sandia provides to its researchers since the lab allows staff to grow their own skills and portfolios by going to conferences, and contributing to external presentations and publications. He also understands firsthand the importance of Sandia utilizing universities for project work. "Sandia really values interactions with universities that pursue complementary efforts. So, when LDRD funding is awarded to a project, those funds can extend to universities who bring on faculty and students to support really high-risk-, high-reward-type opportunities."

Houchens appreciates the breadth of Sandia's portfolio as it provides staff with opportunities to pursue projects they are passionate about. "I've been interested in renewable energy research for a long time," said Houchens. "Sandia allowed me to combine my background in computational fluid dynamics with developing new wind energy applications. My work with the wind energy group is both advancing fundamental modeling capabilities and providing long-term insight to improve wind farm efficiencies."



Brent Houchens
Illinois Alumni

KEY LEADERSHIP

Illinois

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Vice Chancellor for Research and Innovation

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*Executive Associate Vice Chancellor
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Sandia National Laboratories

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On-campus Manager

Jason Petti
Manager in Center 1300, Recruiting Lead

Rahni Johnson
Program Development Specialist

Stephanie Gallegos
Administrative Staff Associate



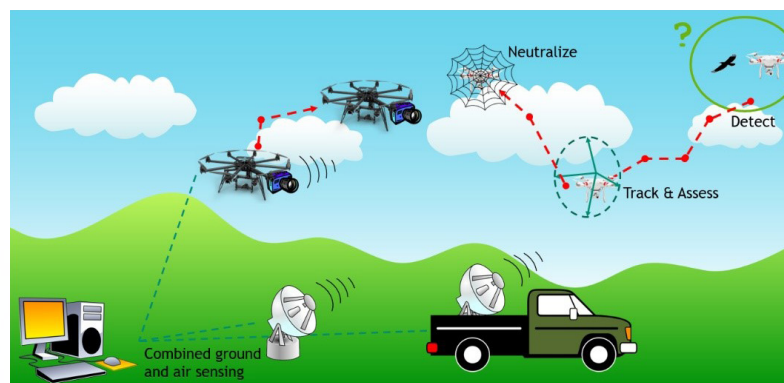


UNM
ALBUQUERQUE, NM

Mitigating unmanned aerial threats

The first award to a Federally Funded Research & Development Center (Sandia) by NATO Science for Peace and Security supports counterterrorism research involving small drones. The \$1.6M award over three years is focused on the development of technology to mitigate the threat of unmanned aerial systems to national security by low, slow, and small threats. The work is led by Sandia's Robotics R&D Manager, Jon Salton, in collaboration with the UNM Electrical and Computer Engineering Department and the Swiss Department of Defence (armasuisse) and Civil Protection. UNM Professor Dr. Rafael Fierro (Electrical and Computer Engineering) was engaged through the contract and will employ two graduate students. Sandia

anticipates hiring two students beginning in summer 2020 with the potential to hire a postdoctoral candidate to split time on this project and others. The NATO programmatic kickoff meeting occurred in the fall of 2019, and the technical kickoff meeting happened the first quarter of fiscal year 2020.



► *This notional concept of operations shows how the drone technology could potentially be used to mitigate the threat of unmanned aerial systems.*

► *Sandia interns built and programmed drones, similar to the quadcopters seen here, to study autonomy and artificial intelligence for hypersonic flight.*

Designing autonomous systems responsive to humans

Autonomous systems, found in everything from manufacturing processes to airplanes, drones, and automobiles, are increasingly common. This technology is becoming more affordable and accessible to the masses. The goal of the five-year, \$5.5M National Science Foundation (NSF) Cognitive Autonomy grant titled “Cognitive Autonomy for Human Cyber-Physical Systems: Turning Novices into Experts” is to design autonomous systems that are responsive to humans. Sandia, acting as an industry partner, is providing advice and student support, and UNM (\$3.25M) and Purdue (\$2.25M) are the primary collaborators; additional academic partners include UT Austin and UC Boulder.

Meeko Oishi, UNM Associate Professor of Electrical and Computer Engineering, will lead the UNM effort to optimize human cyber-physical systems for autonomous hypersonic systems as well as support DOD work in human automation systems. This

proposal builds on work from an SAA LDRD project and Autonomy for Hypersonics. Oishi is interested in building on this new program to create a hub for autonomy research at UNM, ideally in alignment with the major initiatives in autonomy going on concurrently at Sandia Labs and Air Force Research Lab. With a critical mass of faculty and students working on rich and timely problems, she’s excited about what could be accomplished in the next five years.



Meeko Oishi
Associate Professor of Electrical
and Computer Engineering

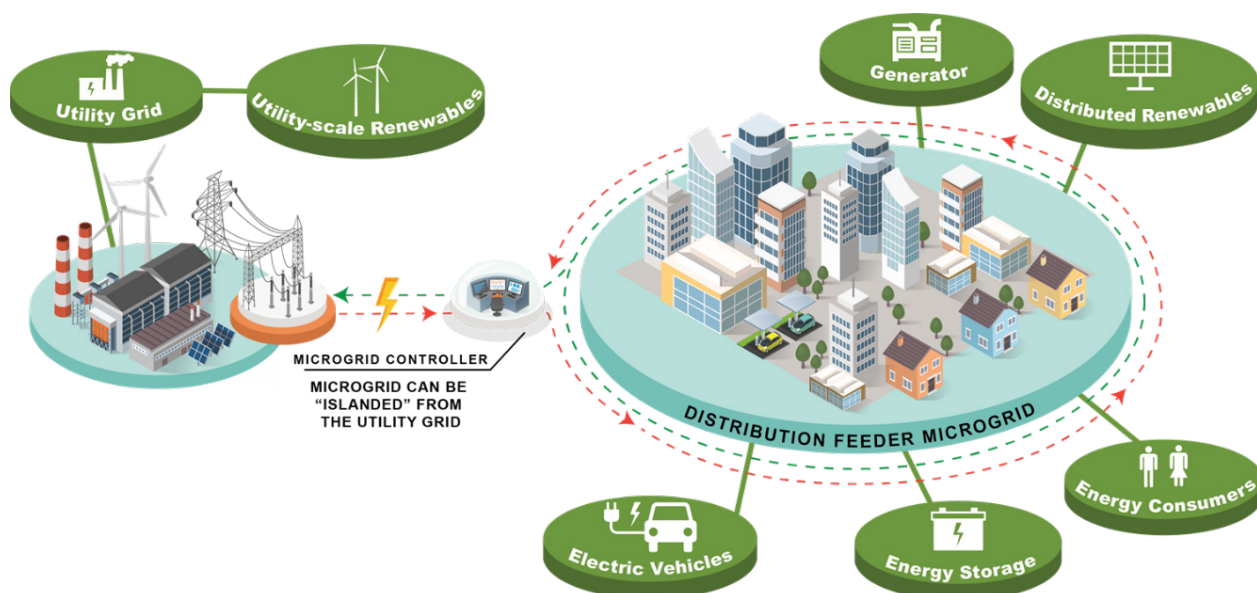


Building a resilient electrical grid

The New Mexico Established Program to Stimulate Competitive Research (NM EPSCoR) is building the state's capacity to conduct scientific research and is training a diverse, well-qualified Science, Technology, Engineering and Mathematics (STEM) workforce. NSF has awarded a "New Mexico SMART Grid Center" Track 1 EPSCoR grant of \$20M over five years, including a partnership between Sandia, UNM, New Mexico Tech, and NMSU. The program seeks to design a future electricity grid that is Sustainable, Modular, Adaptive, Resilient, and Transactive (SMART) utilizing utility and microgrids.

This program's goal is to develop an integrated research and education program that supports a modern electric grid built on the principles of Distribution

Feeder Microgrids, with objectives relating to architecture, networking, decision-support, and deployment. This program also includes collaboration with Los Alamos National Laboratory, Public Service Company of NM (PNM), El Paso Electric, Los Alamos Department of Public Utilities, Microgrid Systems Laboratory, Electric Power Research Institute, NM EPSCoR, NM First, and Santa Fe Community College. According to William Michener, principal investigator for the award and State Director of New Mexico EPSCoR, "Through this grant, we will not only advance research areas of national importance but train a cadre of undergraduate and graduate students in New Mexico to join the STEM workforce." Find more information on the [NM EPSCoR SMART Grid Center](#) online.



Advancing fast reactor licenscing

DOE's Nuclear Energy University Program awarded UNM and Sandia \$800K for three years for "NICSim: Nuclear Instrumentation and Control Simulation for Evaluating Response to Cyberattacks." The NICSim platform aids in investigating the cybersecurity of nuclear power plant instrumentation and control systems by developing and validating a programmable logic controller emulation methodology and developing a reliable, fast running interface that effectively links to a physics-based simulation model within a Matlab Simulink framework.

The collaborative project is being by led by Mohamed S. El-Genk, Distinguished and Regents' Professor of Nuclear Engineering and founding director of the UNM Institute for Space and Nuclear Power Studies. Christopher Lamb, a member of the technical staff at Sandia and a UNM research assistant professor, along with UNM research assistant professor Timothy Schriener, with the Institute for Space and

Nuclear Power Studies, are collaborators on the project. The goal of the Nuclear Energy University Program projects is to maintain U.S. leadership in nuclear research across the country by providing top science and engineering faculty and their students with opportunities to develop innovative technologies and solutions for civil nuclear capabilities.



Mohamed S. El-Genk
Distinguished and Regents'
Professor of Nuclear Engineering



Stopping tragic events before faulty subsurface seals can start them

Sandia researchers and partners from UNM, UT Austin, and the Bureau of Economic Geology are collaborating to ensure seal integrity. This joint LDRD project is addressing critical gaps in the fundamental understanding of the conditions and materials required to ensure seal integrity in subsurface applications. The critical

research will help to prevent faulty seals that contribute to tragic events such as the fatal well blowout in the Macondo Deepwater incident in 2010 in the Gulf of Mexico and the Aliso Canyon natural storage well leak in 2015 that lasted for 118 days and released more natural gas than 80,000 homes would in a year.



An umbrella CRADA with UNM fosters numerous technical collaborations

An umbrella Cooperative Research and Development Agreement (CRADA) is a written contract between Sandia and collaborators seeking to partner in a mutual research area. The umbrella CRADA with UNM outlines nine areas for collaboration including quantum information science; computational science and engineering; cybersecurity; data analytics, systems analysis and intelligence science; nuclear engineering and high-energy density science; advanced materials and devices; energy and water; bioscience for national security; and emerging science and engineering capabilities for national security.

The CRADA immediately launched two projects focused on radiation testing and developing particle detector designs for CERN, the European particle physics laboratory. The agreement also builds on partnerships between Sandia and the Center for Quantum Information and Control, co-located at UNM and the University of Arizona (UA); at the Advanced

Materials Laboratory, a research facility jointly operated by Sandia and UNM; and at the New Mexico EPSCoR SMART Grid Center, a project that includes Sandia, UNM, and several other research institutions. This umbrella CRADA model could serve as a model for other SAA partners in the future.



Diane Peebles
New Mexico
Partnership Manager

Edl Schamiloglu
Special Assistant to the
Provost for Laboratory
Relations at UNM

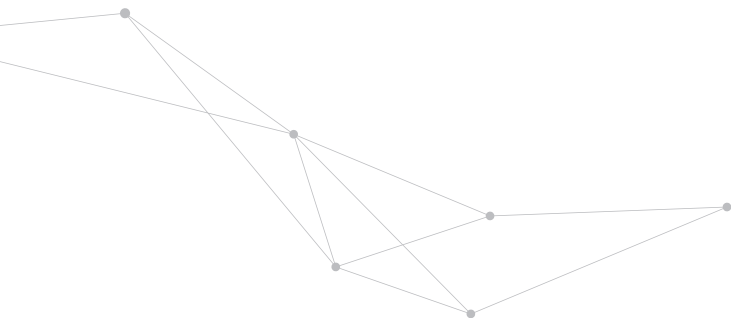


Creating a SUPER collaboration

A new Memorandum of Understanding (MOU) was signed for the Sandia/UNM Pulsed Power Extreme-condition Research (SUPER) Center. This MOU solidifies collaboration between Sandia's Pulsed Power Sciences area and UNM's Earth and Planetary Sciences and Electrical and Computer Engineering departments. The principal goals of the proposed collaboration are threefold: (1) accelerate technical progress broadly in fields relevant to DOE/NNSA, (2) cultivate a pipeline of experts in the fields of high-energy density science and pulsed power, and (3) attract new graduate researchers to targeted STEM programs at UNM.

Sandia anticipates strong growth in pulsed power activities from refurbishment and improvement projects on current pulsed power facilities SATURN, HERMES,

and Z Machine; development of the new intermediate scale driver Thor; and development of a major next generation facility in the near-term future. A long-term goal of the SUPER Center is to grow a vibrant center of excellence that utilizes Thor, a recently developed intermediate-scale pulsed power platform. The SUPER Center will enable joint research initiatives spanning both Sandia and UNM facilities and provide UNM students unique opportunities to conduct geophysics and pulsed power graduate thesis projects utilizing cutting-edge technology to solve outstanding problems.





▶ Sandia technician Eric Breden installs a transmission cable on the new pulsed-power machine's central powerflow assembly.

STUDENT SPOTLIGHT

Maimuna Hossain

Maimuna Hossain is a PhD student in the UNM Department of Mechanical Engineering, pursuing research in structural dynamics and vibrations. She received her bachelor's degree in Mechanical Engineering from Columbia University, and prior to graduate school, worked as a mechanical engineer in the Satellite Communications Branch at the Tobyhanna Army Depot. During the year, Hossain works on an LDRD project focused on finding the dynamic properties of a structure under vibration. The project successfully produced two conference papers and potential journal papers. As she continues her work, this project will become her thesis for dissertation. According to Hossain, "Working with Sandia has expanded my understanding of structural dynamics for aerospace applications. It exposed me to what it is like to work for the Labs and allowed me to meaningfully combine skills in linear algebra, advanced computation techniques, and mechanical and structural engineering in order to solve technical problems."



Maimuna Hossain
PhD Candidate

UNM Department of
Mechanical Engineering

KEY LEADERSHIP

UNM

Gabriel Lopez

*Vice President of Research and
Economic Development*

Edl Schamiloglu

*Special Assistant to the Provost for
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Mark Peceny

Dean of College of Arts and Sciences

Shawn Berman

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Sandia National Laboratories

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UNM Deputy Campus Executive*

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*Manager in Center 9400,
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Nicole Streu

UNM Technical Recruiting Specialist

Cody Steele

*Manager in Center 2200,
UNM Mission Services Talent
Acquisition Team Recruiting Lead*

Antoinette Cummings

*UNM Mission Services Talent
Acquisition Team Recruiting Specialist*





UT AUSTIN
AUSTIN, TX

Establishing a new center for astrophysical plasma properties leveraging Sandia's Z Machine

A new five-year, \$7M grant from DOE/NNSA was awarded to UT Austin to establish a new Center for Astrophysical Plasma Properties (CAPP), which aims to advance astronomy through experimental science. The Wootton Center for Astrophysical Plasma Properties (WCAPP) focuses on the spectroscopic properties of stars and accretion disks using “at parameter” experiments. This means scientists can run experiments conducted under the same extreme temperatures and densities found inside stars, no longer forcing researchers to scale their findings by many orders of magnitude, helping to eliminate discrepancies. Quite literally, they are creating star stuff.

Currently, these experiments use the X-ray output of the Z Pulsed Power Facility at Sandia, the largest X-ray source in the world, to heat plasmas to the same conditions (temperature, density, and radiation environment) as those observed in astronomical objects. The Z Pulsed Power Facility, more casually referred to as the Z Machine, is the largest high-frequency electromagnetic wave generator in the world, used to test materials in conditions of extreme temperature and pressure.

The experiments, led by Distinguished UT Austin Astronomy Professor Don Winget and UT Austin Clinical Researcher of Astronomy and CAPP Deputy Director Mike Montgomery, include measuring (1) density-dependent opacities of iron-peak elements at solar interior conditions, (2) spectral lines of low-Z elements at white dwarf photospheric conditions, (3) atomic population kinetics of neon in a radiation-dominated environment, and (4) resonant Auger destruction of silicon at conditions found in accretion disks around supermassive black holes. Using Sandia's Z Machine, the team will replicate the extreme temperatures and densities of plasma.

The CAPP grant will support four graduate students and two postdoctoral researchers and bring together experts in various areas of astrophysics from UT Austin; the University of Nevada, Reno; and Sandia.



[Listen to Don Winget, UT Austin Astronomy Professor, discuss his work utilizing Sandia's Z Machine](#)



▶ The center section of Sandia's Z machine is prepared for a shot.

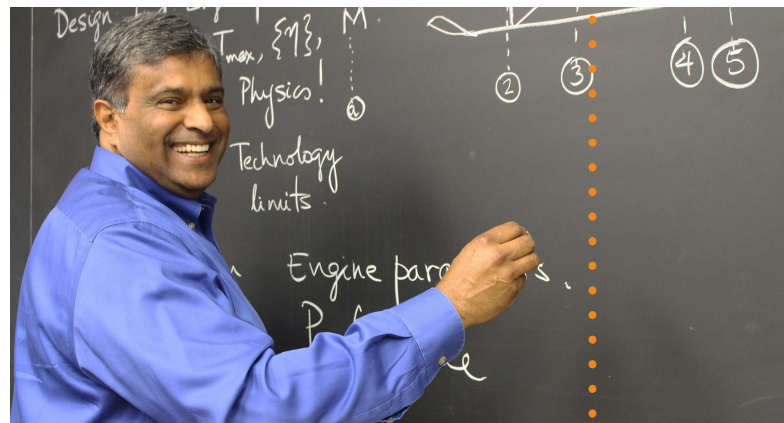
Completing a radical sabbatical at Sandia: Dr. Philip Varghese

Dr. Philip Varghese, UT Austin Distinguished Professor in the Department of Aerospace Engineering and Engineering Mechanics, recently completed a sabbatical at Sandia. Dr. Varghese's research focuses on understanding the basic molecular processes occurring in high speed and high temperature, and non-equilibrium flows. This interdisciplinary field requires a synthesis of physics and chemistry with the more traditional engineering disciplines of fluid mechanics, heat transfer, and thermodynamics. He applies his work to the study of hypersonic and rarefied flows, plasmas, and combustion.

During his sabbatical, Dr. Varghese engaged with Sandia leaders and programs across the Labs, interacting closely with staff in Aerosciences (Justin Wagner), Diagnostics Sciences (Sean Kearney, Caroline Winters), and Plasma Theory and Simulation (Chris Moore). He also networked with experts in a variety of other areas including Computer Science, Hypersonics, Materials, and Monitoring Systems. "At the university," said Dr. Varghese, "we tend to focus on problems that will take a lot of work (and hence a fairly long time) to solve and think of them as fundamental. At Sandia, there

is much more of a focus on important problems that need to be solved urgently."

Major research universities have faculty with a very broad range of expertise, and it's quite common to find people working on similar problems in very different disciplines. "There are problems at the Labs that benefit from the complementary expertise and perspectives that universities can provide." Dr. Varghese wants to continue to work with his collaborators on problems of mutual interest. Dr. Varghese stated, "My selection of research problems in the future will certainly be impacted by my improved understanding of the nature of the problems being worked on at the lab."



► *Dr. Philip Varghese, UT Austin Distinguished Professor, appreciates that Sandia explores "interesting" ideas that turn out to be useful for solving some of the world's important problems.*

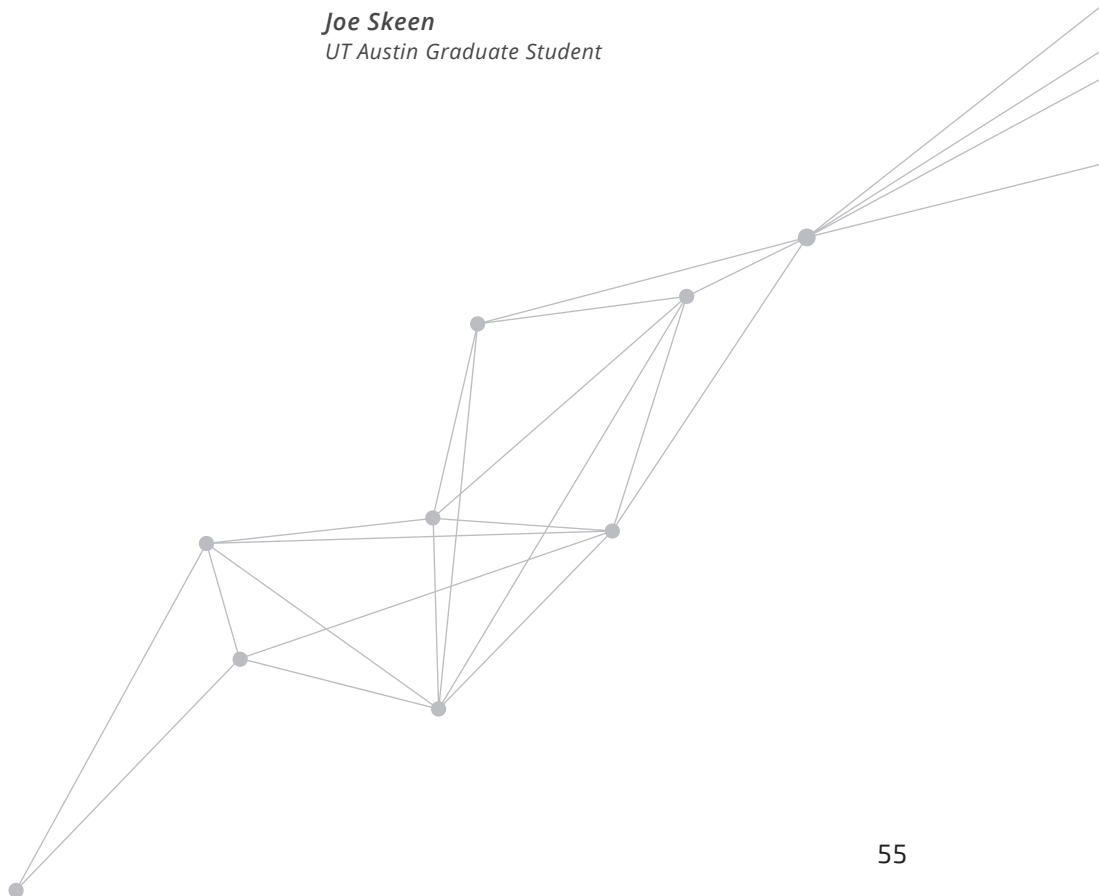
Grad student Joe Skeen is making (acoustic) waves at UT Austin for Sandia

Joe Skeen, a first-year graduate student at UT Austin, is making incredible contributions to the Sandia mission through his design of an acoustic scanner. He received his bachelor's degree in Aeronautical and Astronautical Engineering from Purdue in May 2019 with a specialization in design and structures. Purdue is also where he first became aware of Sandia. Joe is now pursuing a PhD in Aerospace Engineering as a part of the Solids, Structures, and Materials department at UT Austin, and is working with Dr. Michael Haberman in the Department of Mechanical Engineering. "My experience at UT Austin has allowed

me to learn a lot about the ways acoustic waves are modeled mathematically and experimentally," said Skeen.



Joe Skeen
UT Austin Graduate Student



Space Blimp Coding Challenge at UT Austin brings together coders for a friendly competition

On September 13, 2019, approximately 40 students participated in the Space Blimp Coding Challenge event held at UT Austin, making this an extremely popular Sandia recruiting event. Helping to organize the event was Sandia's Computer Science (CS) recruiting team working with Dave Minster, the on-campus SAA manager. Earlier HR recruiting efforts contributed to the high turnout. Coding competitions are quickly becoming a "go to" among top companies engaged in recruiting and hiring for computer science and computer engineering positions. These challenges aren't designed such that participants are focused on finishing, but on finishing as

much as they can in the allotted time. This venue allows the Sandia teams to really observe their skills.

At the end of the competition, Sandia provided direct feedback via presentations showing how each challenge problem related to real work happening at the lab. Discussions around real data resonated and led to many one-on-one conversations with potential student recruits. These events set Sandia apart and leave a more lasting impression on students. At least 17 CS students from UT Austin have now applied for Sandia internships as a result of their Space Blimp experience.

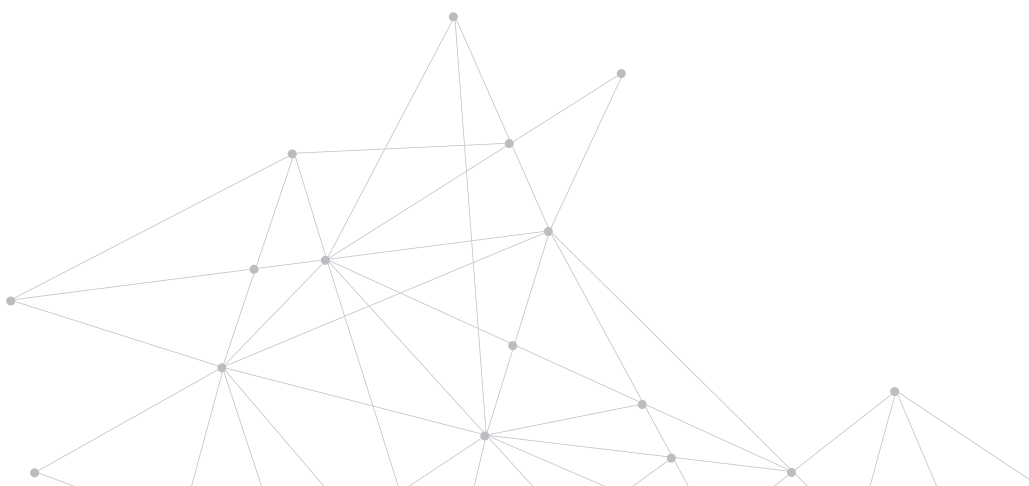


Expanding our relationship with the Army Futures Command at UT Austin

The University of Texas System Board of Regents approved \$20M to support UT Austin's collaboration with the [U.S. Army Futures Command \(AFC\)](#), which is headquartered in Austin and dedicated to modernizing the U.S. Army. UT Austin is the hub for two of its five research programs: Robotics and Assured Positioning, Navigation, and Timing, which develops advanced location tools to help soldiers navigate contested environments.

The U.S. Army initiative provides Sandia a unique opportunity to collaborate on future work and the co-location of the on-campus manager has allowed for continuous dialogue between academia, industry, and government. Recent examples include: Sandia's participation in the U.S. Army's annual [Mad Scientist Conference: Disruption and the Future Operational Environment](#) on April 24-25, 2019 at the Cockrell School of Engineering. The two-day event brought together experts in

areas ranging from robotics to space and explored the individual and convergent impacts of technological innovations on the future of military operations, from present day through 2050. Sandia's Alex Roesler, Deputy Director of the Integrated Military Systems Center, and Gary Polansky, Chief Scientist for Hypersonic Technology Development and Applications, presented Hypersonics and Autonomy in Near Earth Orbit. The SAA on-campus manager, Dave Minster, and Alan Nanco attended the Spring Symposium to pursue joint collaborations with AFC and UT Austin.



Sandia shined at the 2019 Rising Stars Workshop at UT Austin

In April 2019, Sandia and UT Austin's Oden Institute for Computational Engineering and Sciences held the first-ever Rising Stars Workshop focused on computational and data sciences. The top 25 women in the computational and data sciences fields were selected to participate. Rising Stars Workshops are conducted for women

graduate students and postdocs interested in pursuing academic and research careers. The workshops began at the Massachusetts Institute of Technology (MIT) in 2012 and have been conducted in a variety of fields at institutions across the world. Sandia's Tammy Kolda, a distinguished member of technical staff, gave the keynote address.



▶ Participants focused on computation and data sciences gather for the 2019 Rising Stars Workshop at UT Austin.



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UT Austin

Dan Jaffe
Vice President of Research

Jennifer Lyon Gardner
Associate Vice President of Research

John Ekerdt
*Associate Dean of Research,
Cockrell School of Engineering*

Sandia National Laboratories

Justine Johannes
*Director of Center 6600,
Academic Alliance Executive*

Alex Roesler
*Deputy Director in Center 5400
Academic Alliance Deputy Executive*

Dave Minster
*Manager in Center 1900,
On-campus Manager*

Michelle Pang
*UT Recruiting Lead
(20+ person recruiting team)*



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Research Spotlight Forum, UNM
Addendum: Connecting researchers
across institutions

https://www.sandia.gov/working_with_sandia/technology_partnerships/universities/Research%20Spotlight.html



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