SPRING 2026

SOUTHWEST RESEARCH INSTITUTE®

TECHNOLOGY TODAY®

Southwest Research Institute's new Center for Accelerating Materials and Processes (CAMP) is investigating new materials and additive manufacturing (AM) techniques to produce high-speed engines in a considerably shorter amount of time than current production timelines. These advanced 3D printing processes offer unique and exciting capabilities for producing metal parts and components. While many traditional methods of fabrication selectively remove materials to produce a part, AM involves the selective "addition" of material, layer-by-layer, to build or "grow" a part. AM revolutionizes the design space, allowing the design and fabrication of complex parts, such as the SwRI logo shown as a wire cutter creates thin metal slices. CAMP is currently procuring and installing additional manufacturing processing and testing equipment. For more information see story on page 27.

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TECHNOLOGY TODAY

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ON THE COVER

Southwest Research Institute is investigating faster, cheaper and more effective ballistic testing through innovative uses of lasers and microscale projectiles. Engineers improved and expanded Laser-Induced Particle Impact Testing (LIPIT), using larger 0.3 mm impactors to pierce the inner metal square, to improve LIPIT data correlations with conventional ballistics testing, shown in foreground.

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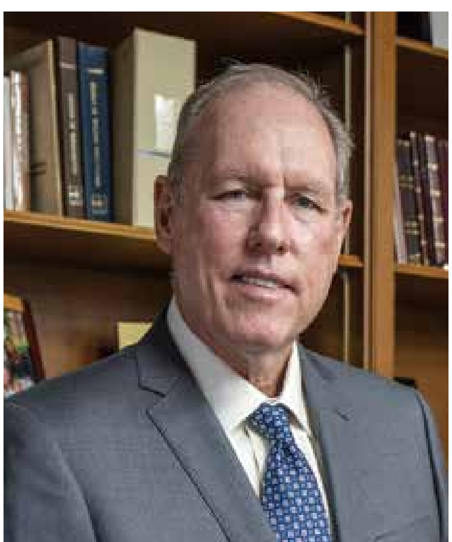

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IN THIS ISSUE

As Southwest Research Institute approaches eight decades in the innovation business, we remain laser-focused on what's next.

In this issue of Technology Today, the cover story discusses how SwRI engineers took a new laser-based ballistics test and made it faster and more efficient while providing better correlation to conventional ballistics testing. A new internal research program is exploring additional improvements by increasing projectile speeds and use cases, all with a goal of accelerating the innovation pipeline for protective armor materials.

The second feature details how a brainstorming session in our automation group led to new ways to address the challenges of using robots in space. Using internal research funding, the team developed a new class of robot motion planning algorithms and validated them in a new Space Robotics Center that mimics in-space microgravity using a novel reverse-air-hockey-table testbed.

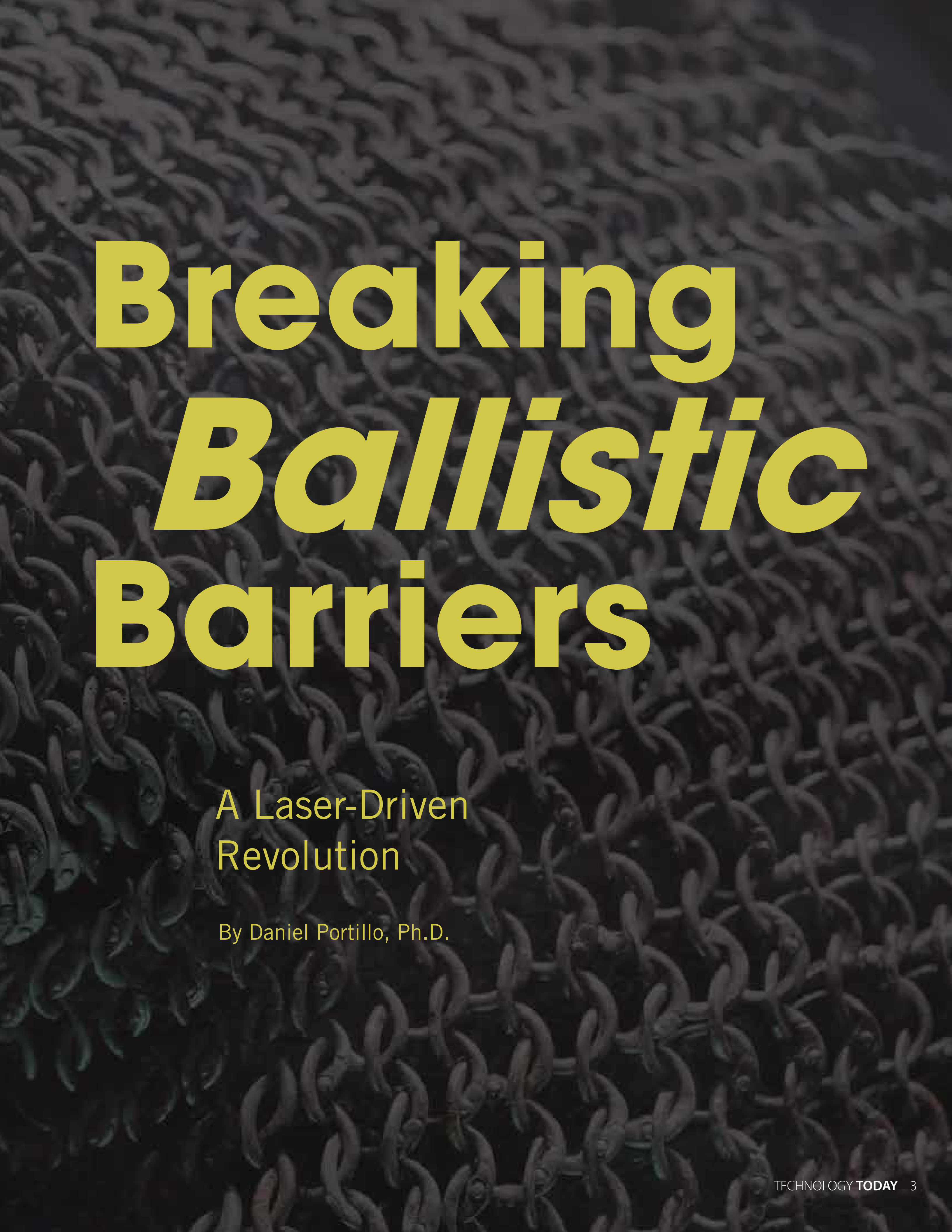
The NEXTCAR feature explores how SwRI engineers leapfrogged the incremental improvements to vehicle efficiency typically made through hardware improvements. With funding from the Department of Energy and the Advanced Research Projects Agency-Energy (ARPA-E), a multidisciplinary team leveraged rapid advances in driver assistance technologies, vehicle connectivity and automation to reach lofty goals of 30% improvements in vehicle efficiency.

Continue reading to learn more about how SwRI takes today's advances and turns them into tomorrow's innovative solutions.

Dr. Ben H. Thacker, P.E.
Chief Operating Officer

A small square 0.1 mm thick metal target is punctured with 25 holes from 0.3 mm projectiles fired during a novel laser-induced particle impact test (LIPIT).

Warriors have armored themselves against the weaponry of their day for thousands of years. Early Sumerian soldiers used copper helmets while ancient Greeks employed bronze breastplates and shields, and medieval knights wore chainmail, all designed to protect them from their enemies. The rise of gunpowder gradually reduced the effectiveness of traditional armor, as metal shielding strong enough to resist bullets proved too heavy to wear.



Breaking *Ballistic* Barriers

A Laser-Driven Revolution

By Daniel Portillo, Ph.D.

SwRI improved prior LIPIT methodologies, which used a high-intensity laser to blast microprojectiles 0.1 mm in size at velocities close to the speed of sound at a target material. SwRI's enhancement uses larger 0.3 mm microprojectiles, which can enhance correlation to standard ballistics testing.

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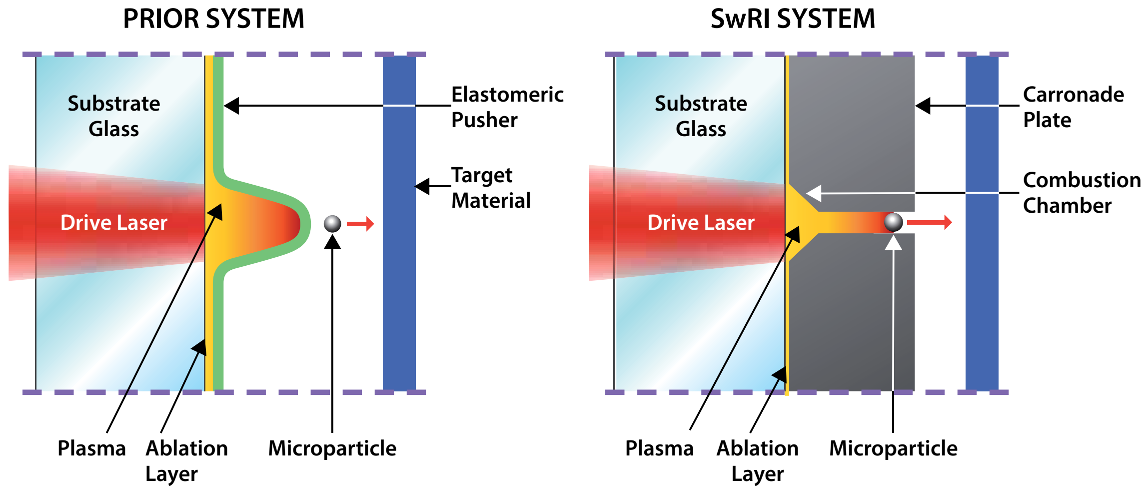


Modern armor emerged in the mid-20th century with steel helmets in World War I and eventually composite and ceramic armor to protect individuals and vehicles from increasingly accelerated impacts and innovative projectiles. The focus of modern armor is reducing weight while increasing ballistic protection through nanotechnology, advanced ceramics and smart materials.

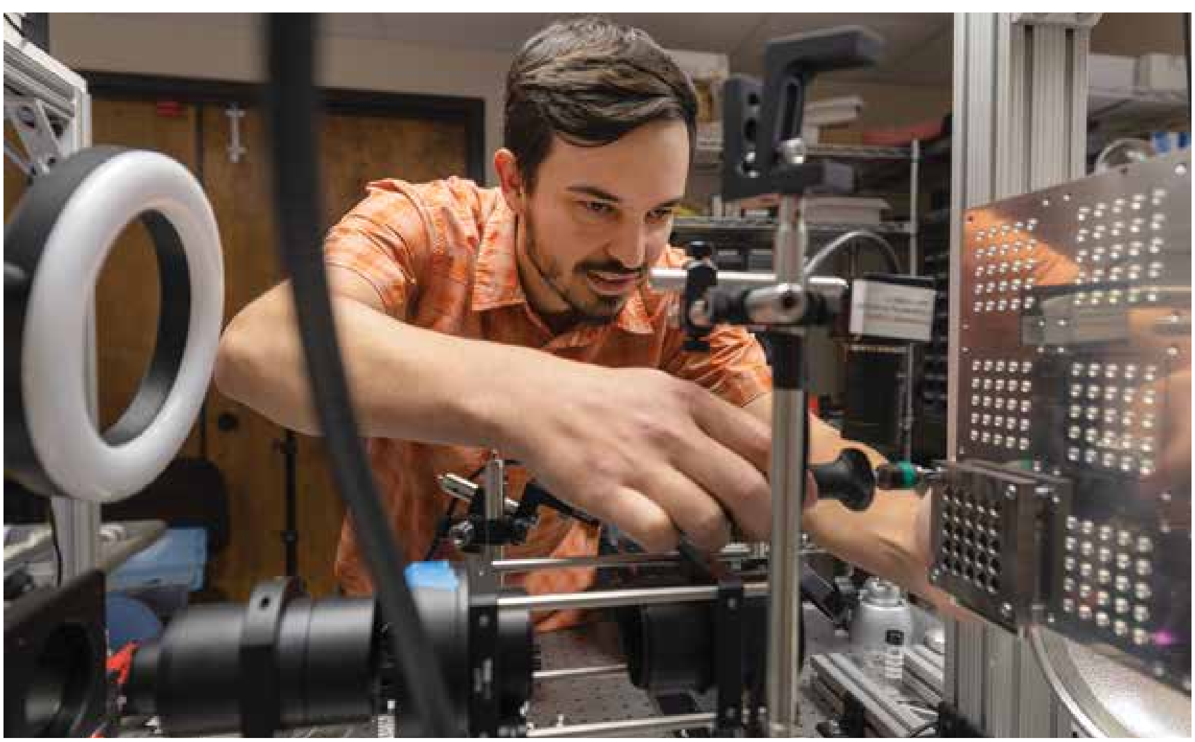
The goal is to improve mobility and comfort while providing superior protection. Today, we can imagine a world where materials no thicker than fingernails can protect soldiers as well as spacecraft and even everyday vehicles from high-speed impacts.

But to get there, industry needs the ability to test the protective qualities of these advanced materials rapidly, using small samples of materials and producing relevant data. This vision is rapidly becoming a reality thanks to Laser-Induced Particle Impact Testing (LIPIT), a groundbreaking technique Southwest Research Institute recently improved.

UNLOCKING LASER TESTING

An SwRI team has opened new avenues for faster, cheaper and more effective ballistic testing through innovative uses of lasers and microscale projectiles. This research has astounding implications for a variety of industries. Researchers are tackling the hurdles to fully unlock its potential, essentially bridging the gap between LIPIT and conventional ballistics testing. The technique launches larger projectiles than previous LIPIT processes allowed — and at a higher rate. Previously, LIPIT launched microspheres 0.1 mm in size, and normal conventional ballistics programs conducted 30 to 40 tests a day. SwRI's technique uses 0.3 mm microspheres and automates the process to conduct 200 tests in an hour.

Protecting soldiers, spacecraft or critical infrastructure relies heavily on materials rigorously tested for their ability to resist high-speed impacts. Traditional ballistic resistance testing is essentially a



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DETAIL

SwRI has decades of experience in ballistics, explosive loading, structural response and scale modeling. Ballistic capabilities range from small arms testing to hypersonics research.

Senior Research Engineer Dr. Daniel Portillo developed facilities to scale up a LIPIT, which generates data that better correlate to conventional ballistics testing. His team then automated the process to allow hundreds of tests an hour.

war zone in miniature: Guns fire bullets into targets, and researchers meticulously measure how materials hold up — or fail — under stress. These tests typically use large pieces of material, such as steel plates. But scaling these tests to evaluate new formulations can quickly devolve into a logistical and resource nightmare.

In many cases, manufacturers have only small quantities of newly developed materials. This limits testing options because firing full-size bullets at very thin or small samples is pointless. The situation becomes even more impractical when rapidly trying to evaluate tens or hundreds of candidate materials.

LIPIT flips the script by scaling everything down, using lasers to launch microscopic particles — think sand grains but shinier and faster — at scaled-down targets. This allows researchers to emulate real-life ballistic impacts without the need for bulky weapons systems, extensive safety precautions or large material samples.

LIPIT LOGISTICS

LIPIT testing is an elegant combination of physics and cutting-edge technology. A high-powered, nanosecond laser provides the punch needed to propel microscopic metallic spheres — 300 micrometers in diameter, roughly the width of a sewing needle — to speeds exceeding 500 meters per second, well beyond the speed of sound. The spheres are loaded into a miniature high-precision barrel system, and when the high-energy laser hits the barrel substrate, an explosion of plasma launches the spheres at a target.

Traditional ballistic testing relies on bullets propelled by the explosive force of ignited gunpowder. LIPIT swaps out chemical energy for photonic energy, using lasers to generate the gas pressure required to accelerate particles. This is where the magic happens. Because the lasers are so precise and repeatable, much of the process can be automated, allowing analyses for batches of test samples in rapid succession.

This time savings is just part of the equation. Testing smaller-scale targets also requires proportionally smaller quantities of material. LIPIT may need only one-tenth of the material normally required for a conventional experiment. This advantage is especially beneficial when working with exotic or experimental materials that are prohibitively expensive to produce.

SMALL TESTS, BIG IMPLICATIONS

Despite its advantages, LIPIT has faced skepticism. The research community has questioned whether miniature impacts really predict how full-scale materials perform in life-or-death scenarios. The SwRI team

SwRI has expanded and advanced LIPIT testing to make data more applicable to full-scale ballistics testing. The system launches larger projectiles, 0.3 mm verses 0.1 mm in size, shown here with a needle for scale.

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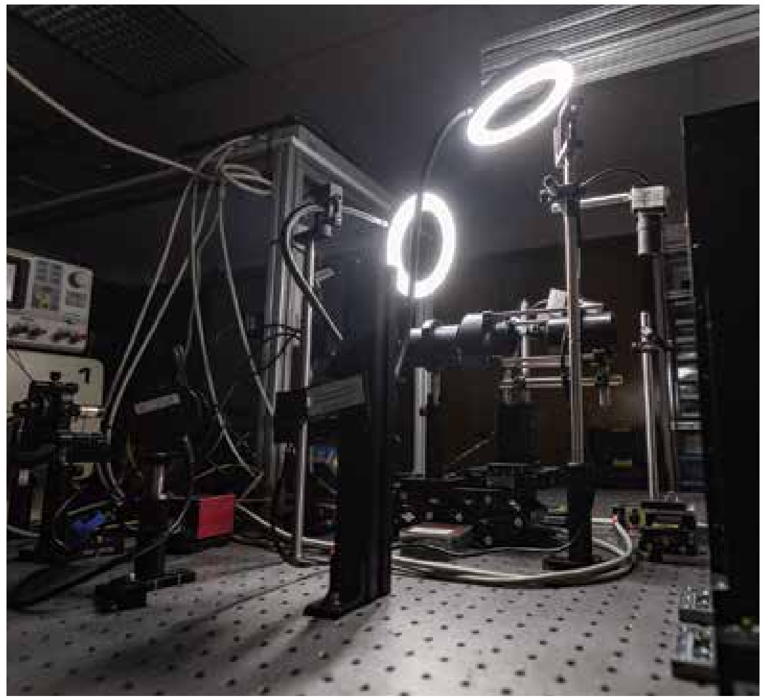

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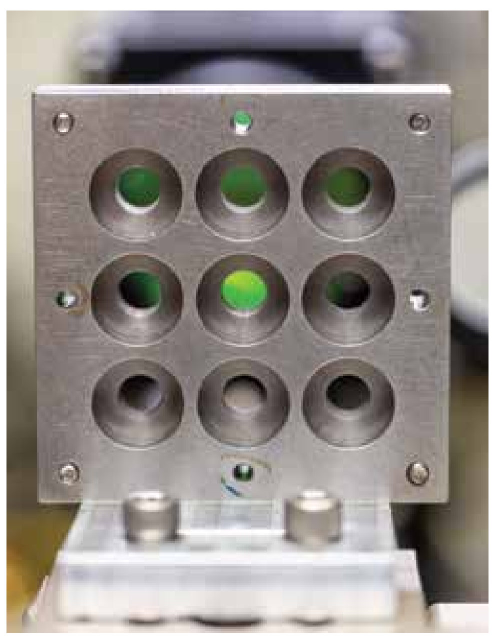

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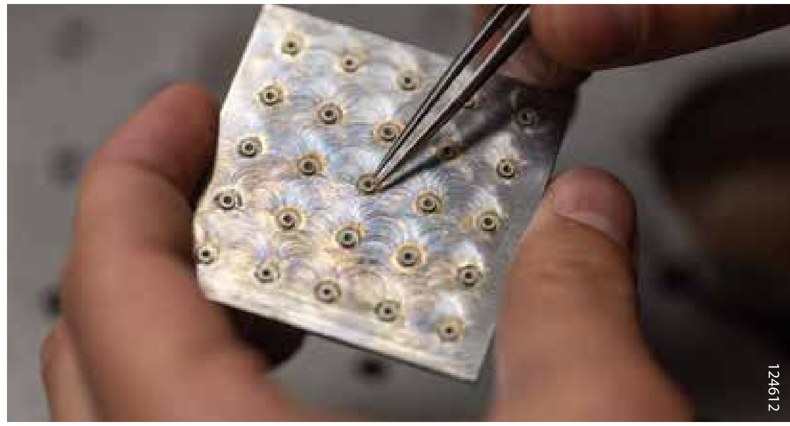
SwRI developed a test system that bounces high-energy laser light around the bench to precisely hit the barrel substrate, causing an explosion of plasma to launch the spheres at a target.



The SwRI method allows batch testing. Microspheres loaded into this miniature series of "barrel" holes allow the system to automatically fire them in rapid succession.

addressed this concern head-on, conducting rigorous scaling studies to validate the reliability of their method.

SwRI collaborated with industry consultants to pit different materials against 300-micrometer projectiles. The targets ranged from high-performance aluminum alloys to ultra-high molecular weight polyethylene (UHMWPE) to Kevlar, all common materials for military helmets and aerospace applications.

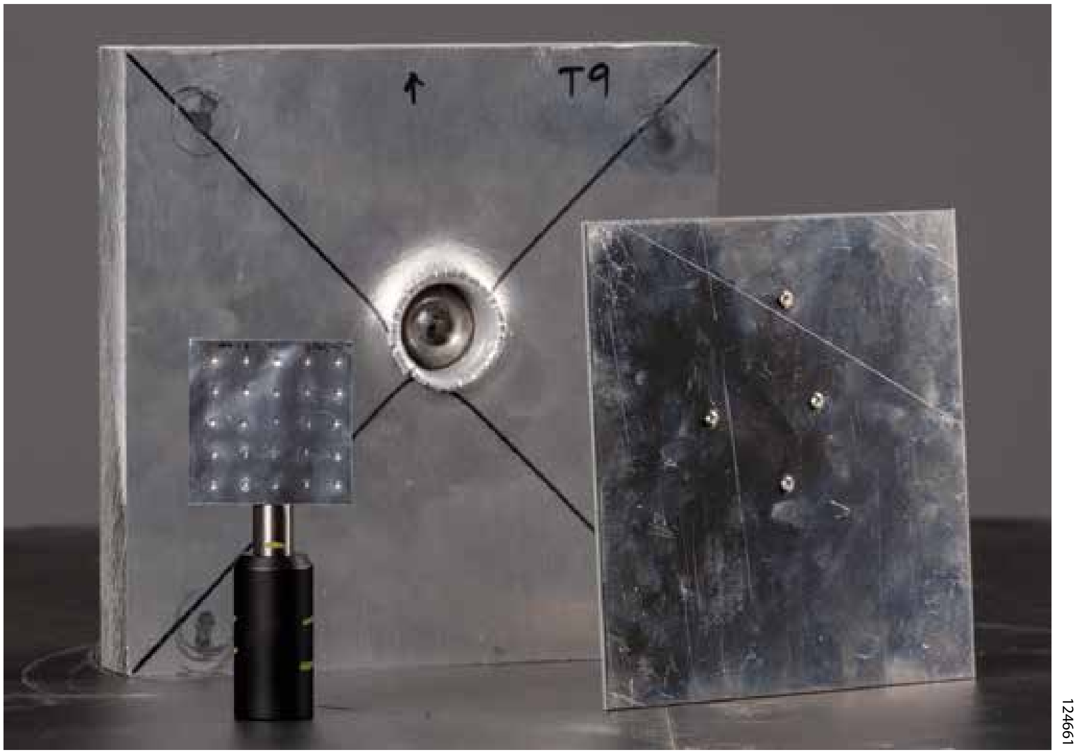
Interestingly, metals like aluminum demonstrated solid scalability, meaning that their performance in LIPIT tests could reliably predict their performance in real-world scenarios. UHMWPE showed similar promise, but Kevlar and other woven fabrics proved trickier — possibly due to the millimeter-scale structures of their yarns, which couldn't be scaled down in a way that mimicked the real-life conditions of full-scale impacts. While these challenges remain, the successes with metals and UHMWPE opened the technology to an expansive array of applications.

FASTER PATH TO BETTER ARMOR

The potential to accelerate the innovation pipeline for protective materials is among the most exciting implications of the SwRI advancement. Researchers are refining methods to close the gap between miniature modeling and full-scale testing. By using larger projectiles with LIPIT, SwRI researchers have created scaled targets that retain meaningful thicknesses and material properties.

The technique has also sparked interest outside the realm of traditional ballistics. For instance, testing could be adapted to understand micrometeoroid impacts on spacecraft hulls or to contribute to the design of impact-resistant consumer products.

SwRI compared LIPIT experiments (foreground) with conventional ballistics tests (background) to demonstrate correlation. The SwRI technique punctured a small 0.1 mm thick metal target (left) with 25 holes from 0.3 mm projectiles fired using novel LIPIT and a 2 mm thick metal target punctured by 3 mm projectiles (right).



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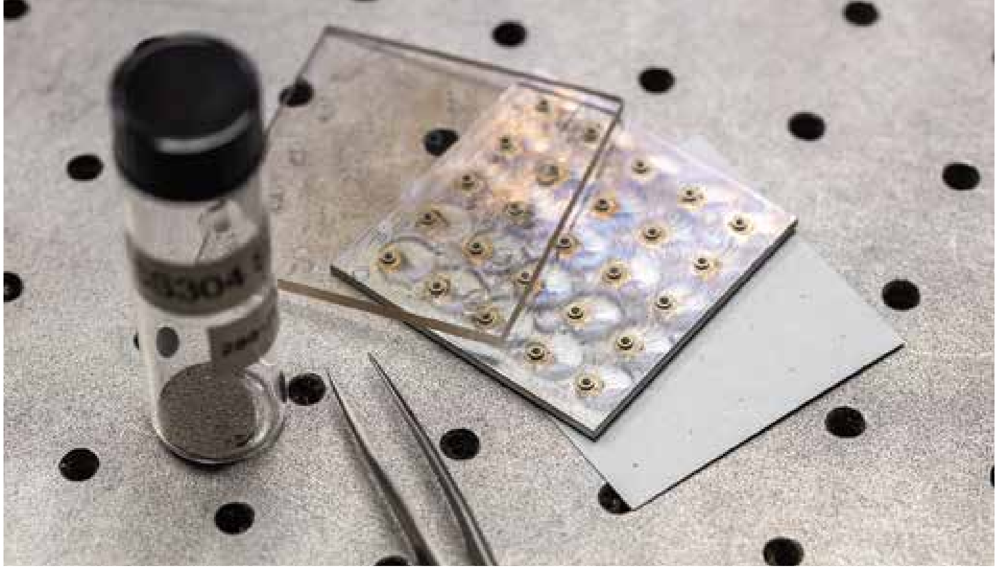

The thousands of microscale impactors in the vial allow SwRI to conduct LIPIT experiments and understand the ballistics response of materials rapidly on a small scale. The goal is to make ballistic testing faster, safer and smarter as well as ultimately expand and improve the innovation pipeline for protective materials.

This method allows us to test materials and scenarios that were previously inaccessible due to time and cost restrictions. This accessibility could be game-changing for industries ranging from automotive engineering — where crash-resistant components are in high demand — to nanotechnology, where researchers are exploring ultra-tough, lightweight materials for energy storage devices. The possibilities are vast.

CHALLENGES, COLLABORATIONS AHEAD

While LIPIT brings obvious benefits, obstacles remain. The scalability issues with fabrics highlight the need for more nuanced approaches when dealing with complex, multilayered materials. Additionally, researchers are working to push the limits of the system even further, investigating whether even larger projectiles could be launched at higher speeds to more closely mimic the ballistics of real-world scenarios.

These challenges underscore the importance of interdisciplinary collaboration. The U.S. Army's SBIR/STTR Program has supported the research, which has involved participation from multiple institutions and other private labs. This collaborative ecosystem around LIPIT allows for continuous learning — building on what works and refining what doesn't.

To encourage knowledge sharing, the team presented their findings at major symposia, including the International Symposium on Ballistics and MACH Conference, where their work has already gained significant recognition.

BRIGHTER, SAFER FUTURE

The LIPIT narrative is the story of relentless innovation. It's about harnessing the precision of lasers and the physics of microscale impacts to solve real, human-sized problems. From saving lives on the battlefield to enabling safer cars and spacecraft, the SwRI team's work is proving that sometimes smaller really is better.

As laser technology advances and researchers refine their methods, the speed of progress will only accelerate. Materials once thought too delicate to fabricate, let alone test, are now entering the realm of practical application. And despite challenges, one thing is clear: The door to high-throughput ballistic testing is wide open, and it's propelled by the quiet hum of a high-powered laser.

SwRI's ultimate goal is simple: making ballistic testing faster, safer and smarter. And with LIPIT, that goal is undoubtedly within reach.

Questions about this story? Contact Dr. Daniel Portillo at (210) 522-4688 or daniel.portillo@swri.org.

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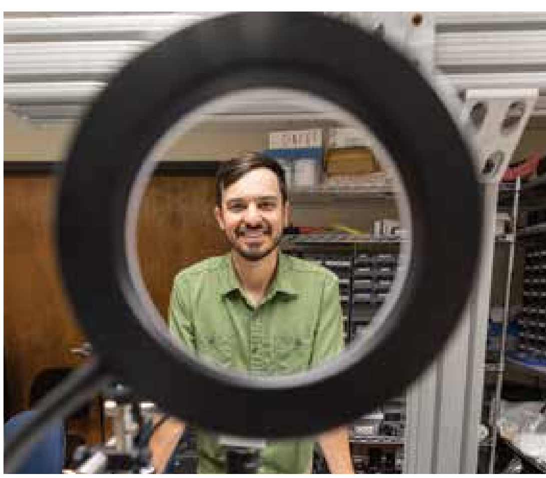


ABOUT THE AUTHOR: Senior Research Engineer Dr. Daniel Portillo joined SwRI in 2022 as a research engineer after receiving his bachelor's, master's and doctorate in mechanical engineering from the University of Texas at San Antonio. Last year, Portillo was lead author of a paper titled "High-Throughput Ballistic Limit Testing Using Laser-Induced Particle Impact Tests," which earned the Rosalind and Pei Chi Chou Young Author Award at the 34th International Symposium on Ballistics in Jacksonville, Florida.

The author acknowledges the contributions of Institute Engineer Dr. Sidney Chocron and Senior Research Engineer Dr. Michael Heim to the development of SwRI's improved LIPIT capabilities.

UNIQUE OBSERVATIONS OF INTERSTELLAR COMET

As the 3I/ATLAS comet zipped through the inner solar system in late 2025, SwRI scientists leveraged rare opportunities to study this interstellar interloper.

3I/ATLAS is just the third object scientists have identified as originating outside of our solar system. SwRI took advantage of some exclusive opportunities, with the PUNCH (Polarimeter to Unify the Corona and Heliosphere) mission tracking the comet from its unique perspective, and SwRI's Ultraviolet Spectrograph aboard NASA's Europa Clipper studying the comet's coma and tail.

PUNCH PERSPECTIVE

"Since its launch in March 2025, PUNCH has achieved major accomplishments with images providing a unique view on the pageantry of the planets and other objects while revealing the grandeur of our Sun in the cosmos," said SwRI's Dr. Craig DeForest, PUNCH mission principal investigator. "And we've discovered some incredible bonus science that PUNCH performs, tracking comets and other objects. We tracked 3I/ATLAS as it traveled through the inner solar system while bright sunlight rendered it invisible to many other telescopes and space assets."

PUNCH's four small suitcase-sized spacecraft have synched to act as a single virtual instrument 8,000 miles across. The mission's wide-field imagers can track objects for long periods as they move across the inner solar system.

As SwRI's Dr. Kevin Walsh and Dr. Simon Porter initiated an internal research and development project to use PUNCH data to search the solar system for previously undiscovered asteroids, 3I/ATLAS was discovered.

"We checked its predicted trajectory and realized it would spend almost two full months in the PUNCH field of view," Walsh said. "For several weeks, the comet was behind the Sun as seen from Earth, where it was basically unobservable for everything except PUNCH. This is the beginning of a whole new field of study. It gives us a chance to study cometary bodies — the building blocks of planets and potentially the building blocks of life in other places across the galaxy."

ULTRAVIOLET OBSERVATIONS

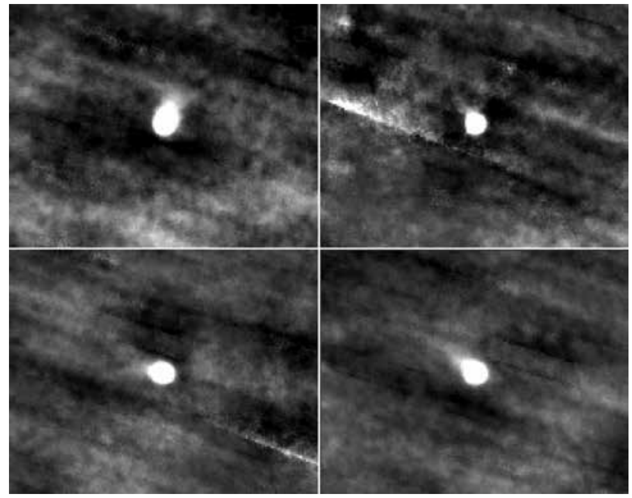
PUNCH observations were complemented by those made by Europa-UVS.

"This opportunity to view another target on the way to Jupiter was completely unexpected," said SwRI's Dr. Kurt Retherford, the principal investigator for Europa-UVS. "Our observations have allowed for a unique and nuanced view of the comet."

Europa-UVS's unusual sunward viewpoint obtained a unique downstream view of the comet's two tails, viewing largely from "behind" the tails and looking back toward the comet nucleus and coma, the cloud of gas surrounding it.

Europa-UVS detected oxygen, hydrogen and dust-related features, supporting the preponderance of data indicating that comet 3I/ATLAS underwent a period of high outgassing activity during the period just after its closest approach to the Sun. The instrument readily measures the fundamental transitions from atoms and molecules, visualizing gases emitted and water molecules breaking down into hydrogen and oxygen atoms.

"Understanding the composition of the comet and how readily these gases are emitted can give us a clearer view of the comet's origin and how it may have evolved during transit from elsewhere in the galaxy to our solar system," said SwRI's Dr. Tracy Becker, co-deputy principal investigator of Europa-UVS. "What are the chemical processes at play, and how can we unravel the comet's origin in its own star system? Were those processes similar to how we believe our solar system formed? Those are big questions."



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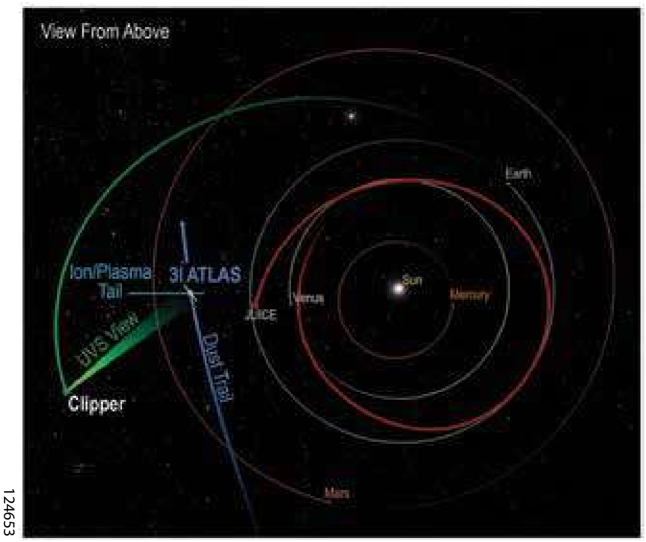
An SwRI project used data from NASA's Polarimeter to Unify the Corona and Heliosphere (PUNCH) spacecraft to track the interstellar comet 3I/ATLAS. PUNCH tracked the comet for many weeks when it was behind the Sun as seen from Earth, making it difficult for other telescopes to follow it. The comet is visible in these images created by PUNCH between Oct. 30, 2025 and Nov. 2, 2025.



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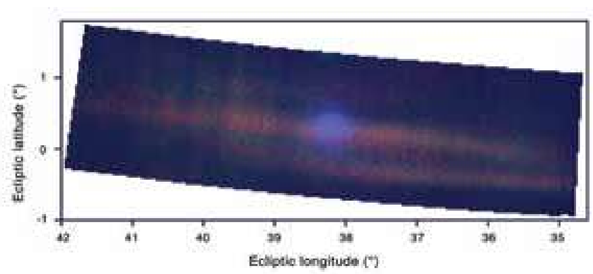
At the same time that the PUNCH spacecraft was tracking the comet, the SwRI-led UVS aboard NASA's Europa Clipper spacecraft made valuable observations of it from a different vantage point. During a period when it was difficult to observe from Earth, Europa Clipper was able to view its two tails from between their downstream directions.



The SwRI-led Europa-UVS instrument captured this composite image of Interstellar comet 3I/ATLAS on Nov. 6, 2025, from aboard NASA's Europa Clipper spacecraft.

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IMAGES COURTESY NASA/JPL-CALTECH/SwRI

SwRI-TRINITY CONDUCT COLLABORATIVE BIOMEDICAL RESEARCH

SwRI and Trinity University have launched a new grant program to support collaborative research. Three unique biomedical research projects were funded in 2025, the program's inaugural year.

"We are proud to launch this new focused grant program to grow Trinity and SwRI collaborations, provide opportunities for Trinity students and advance medical breakthroughs that may one day improve and even save lives," said Dr. Joe McDonough, vice president of SwRI's Chemistry and Chemical Engineering Division.

STABILITY STUDIES

One project is studying Thermus thermophilus, a bacterium with highly stable proteins, to advance understanding of stability mechanisms that could pave the way for advanced treatments for diseases such as Alzheimer's, ALS and cancer. The bacterium is extremely heat tolerant and produces thermostable enzymes and proteins. Dr. Jonathan Bohmann, a staff scientist at SwRI, and Dr. Laura Hunsicker-Wang, a chemistry professor at Trinity University, will explore the structure of these stable proteins.

"For SwRI's part, we're working to determine a baseline for how mutations or changes in a protein can degrade stability," Bohmann said. "Nearly any structural change will affect the stability of a protein, but some mutation sites are more relevant than others. We want to understand those changes and if small molecules could bind to those sites to restore stability."

TARGETING PTSD

Another project is developing an intranasal drug-device combination to treat post-traumatic stress disorder (PTSD). Researchers are screening formulations and delivery methods for oxytocin, a hormone that plays a critical role in human bonding and stress mitigation. The project expands on prior collaborative research with Trinity University that explored treating alcoholism and relapses with oxytocin. SwRI successfully packaged oxytocin using liposomes, or nanosized protective spheres made of organic compounds, to ensure targeted delivery in the body.

"Intranasal delivery of liposomes can bypass the blood-brain barrier and allow the treatment direct access to the central nervous system. In addition, the intranasal delivery has commercial precedents with other Food and Drug Administration-approved liposome-drug combinations, making future advancements more feasible," said SwRI Staff Scientist Dr. Mike Rubal.

PRODRUG PROMISE

A third project seeks to improve a prodrug, a compound activated in the body, to mitigate tissue and organ damage associated with heart attacks, strokes and traumatic injuries. It will address both the initial lack of blood and the rush of blood that follows treatment.

"Protein misfolding during cellular stress is a key driver of tissue damage, so the new prodrug will target that," said SwRI's Dr. Christopher Dorsey, who will synthesize the new formulation. "Once we figure out the synthesis route, we will train Trinity students to carry out our new technique. That's the exciting part of this collaboration, the opportunity to give back and pass along what we learn to a team of future scientists."

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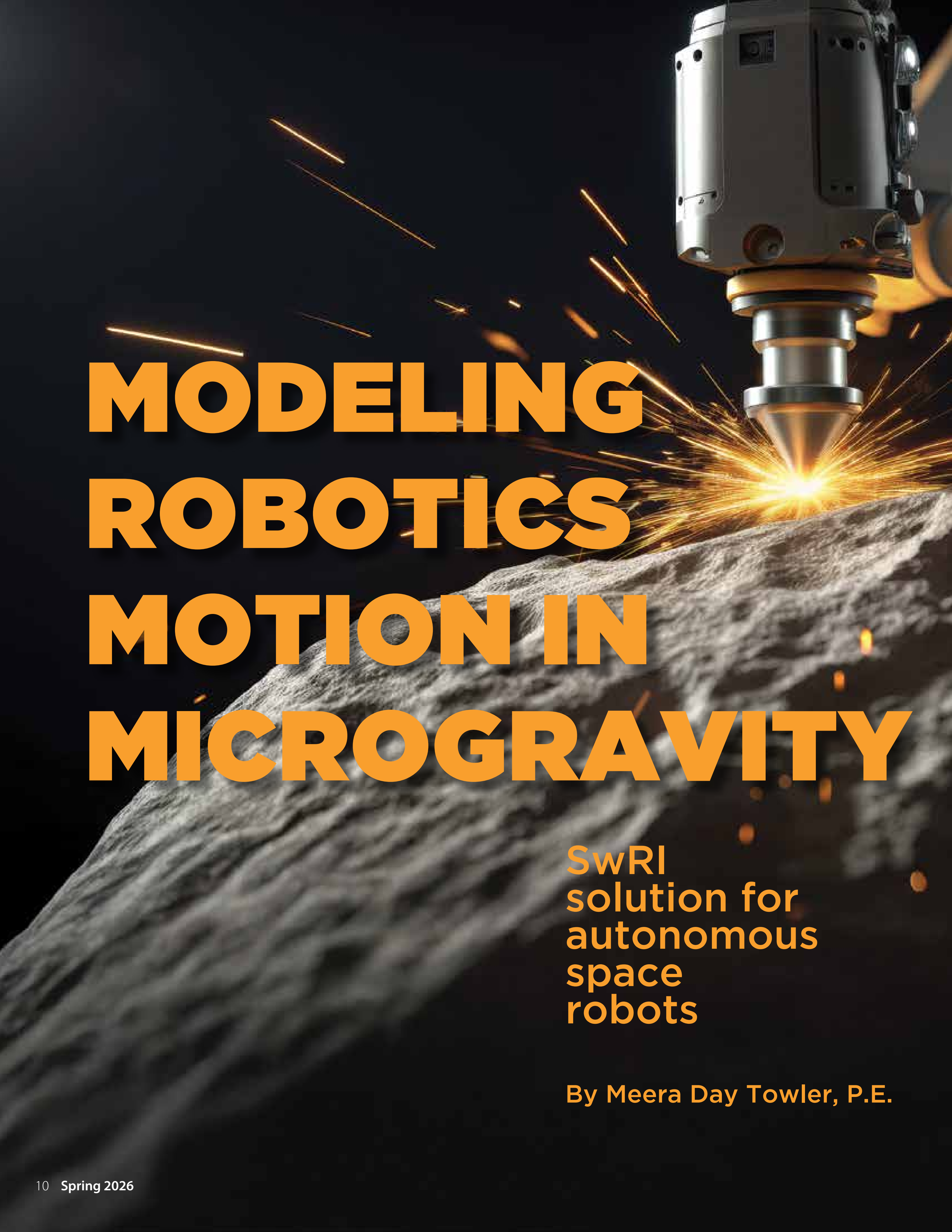
SwRI is collaborating with Trinity University to develop a prodrug to mitigate tissue and organ damage in patients treated for heart attack, stroke and other injuries. The team includes (from left) SwRI Senior Research Scientist Christopher Dorsey, Trinity students Cesar Perozo and Hrithik Patel, and Trinity University Associate Professor Christina Cooley.



MODELING ROBOTICS MOTION IN MICROGRAVITY

SwRI solution for autonomous space robots

By Meera Day Towler, P.E.

ROBOTS have been assisting humans in space for decades, extending the reach of human ingenuity and exploration. Robotics have been crucial for space exploration from the beginning, starting with uncrewed spacecraft that use automation technology to perform orbital missions, flybys or exploration of the solar system and beyond. Robots have also supported and maintained orbital infrastructure. In 1993, a robot arm helped astronauts repair the Hubble Space Telescope. Robot arms were also used to construct the International Space Station and deploy payloads from the space shuttle. Most of these early robotics applications were either teleoperated or hard-coded and pre-planned before launch.

ABOUT THE AUTHOR: Meera Day Towler is a program manager focusing on business development, project management and strategy coordination for a highly successful space robotics program area. She is currently focused on transitioning SwRI's terrestrial robotics and autonomy technologies for use in space.

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Today, preparations for the next generation of robots in space are using artificial intelligence and novel, high-performance computing to enable advanced automation. By leveraging capabilities from industrial automation and automated vehicles, NASA and the U.S. Space Force are pursuing similar robotic technologies that can operate in microgravity.

The commercial space sector alone could grow by 41% in the next five years, making space a new frontier for both exploration and economic development. Future space exploration will leverage robotics and automation to enable in-space servicing, assembly and manufacturing (ISAM) in orbit and on other planets. Both government and industry have a vested interest in on-orbit testing, transportation, refueling and manufacturing. Managing all this activity will require complex systems and interoperable technologies. Simply put, the future of space depends on robotics.

Southwest Research Institute has a long and successful history of implementing robotic technology in challenging environments from performing aircraft maintenance to verifying the integrity of tanks holding nuclear waste. Today, SwRI is developing several solutions within the emerging ISAM ecosystem. In 2022, SwRI launched the Maturing Adaptable Space Technologies (MAST) initiative, focusing on robot motion planning for challenging operations in space. MAST builds on nearly two decades of autonomy research, leveraging technologies from advanced automation for manufacturing robots, ground vehicles, aerial drones and more.

ADAPTING TERRESTRIAL TECHNOLOGIES

Typical terrestrial motion planning involves waypoint planning, a preplanned series of robot motions to accomplish work, usually from a fixed position on a work bench or table. For industrial applications, SwRI has pioneered flexible and adaptable dynamic path planning algorithms for commercial off-the-shelf robotic arms coupled with advanced vision systems.

As opposed to waypoint planning, dynamic path planning uses sensor data about a robot's environment to plan motion and execute tasks without collisions. When changes occur in the task or environment, the robot dynamically adjusts its motion planning. With a long history of successfully applying dynamic path planning to numerous challenging terrestrial tasks, researchers are now applying these same concepts to space.

However, the parameters for dynamic motion planning in space are different from those on Earth. Through collaboration with researchers and scientists across the Institute, SwRI developed a list of these parameters and constraints governing path planning for a free-floating space system.

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For nearly 50 years, SwRI has developed large-scale robot systems to perform aircraft maintenance. This system, designed to robotically "depaint" the F-22 stealth aircraft, was the largest fully robotic system of its kind when it was installed at Hill AFB in 2011.

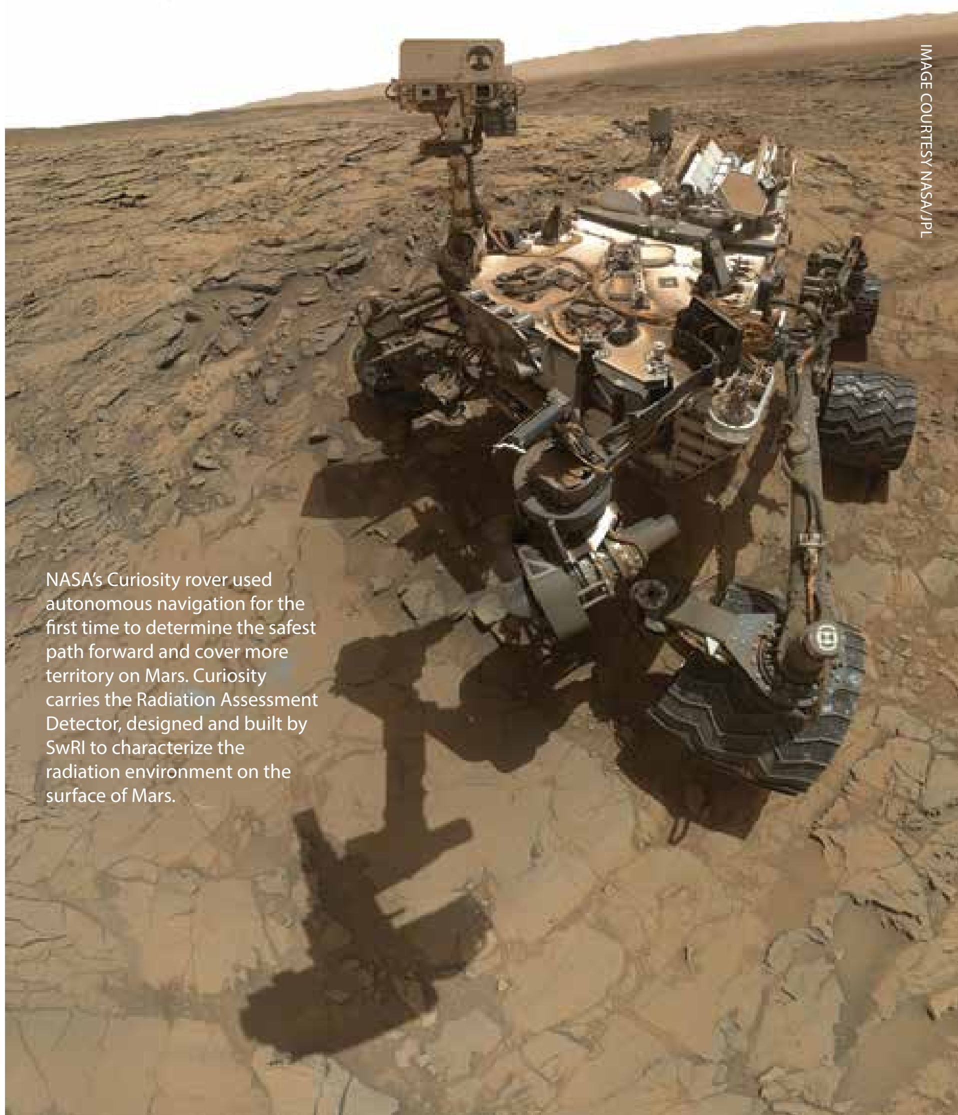

IMAGE COURTESY NASA/JPL

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NASA's Curiosity rover used autonomous navigation for the first time to determine the safest path forward and cover more territory on Mars. Curiosity carries the Radiation Assessment Detector, designed and built by SwRI to characterize the radiation environment on the surface of Mars.

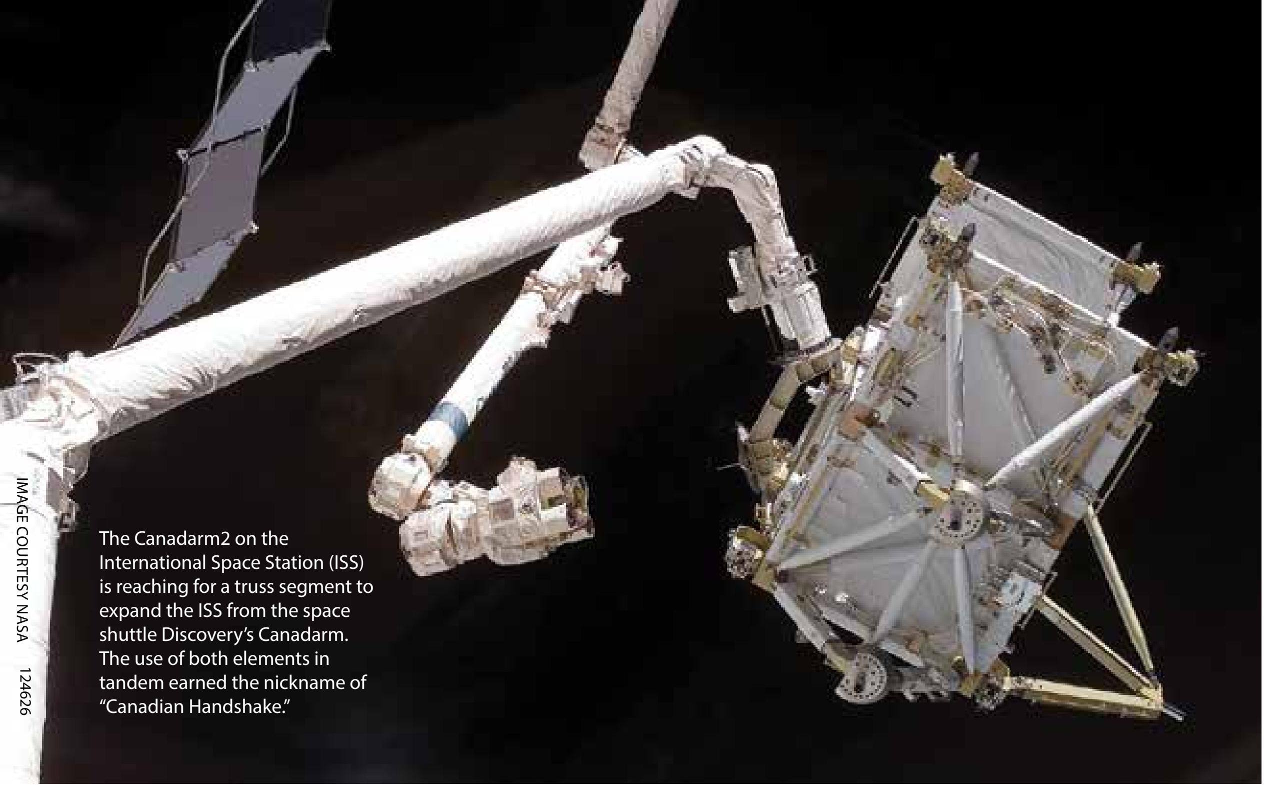


IMAGE COURTESY NASA 124626

The Canadarm2 on the International Space Station (ISS) is reaching for a truss segment to expand the ISS from the space shuttle Discovery's Canadarm. The use of both elements in tandem earned the nickname of "Canadian Handshake."

124668

SwRI developed a Vision for Off-Road Autonomy (VORA) tool, a passive camera system to perceive objects, model environments and simultaneously localize and map while navigating off-road environments — including exploring planetary surfaces, as demonstrated here at an analogous Earth setting.

DETAIL

Underactuated robots have fewer independent control inputs than total degrees of freedom, and consequently, their control systems cannot follow arbitrary trajectories.

Traditional motion planning techniques are ineffective in the microgravity environment of space, given the dynamics of free-floating systems. If a robot arm is mounted to a relatively small spacecraft, as the robot arm moves, the base will also shift due to basic physics associated with equal and opposite reactions. This means that motion planning in space needs to account for this opposite reaction and intelligently plan for it.

That's where MAST makes a difference.

MAST: MATURING ADAPTABLE SPACE TECHNOLOGY

Over the last three years, SwRI investigated motion planning in a simulation environment and using physical hardware. SwRI engineers selected Drake, a physics-based open-source simulation environment, to model the robotic systems and surrounding environment, which offers "real world" physics similar to what you experience playing a video game. Drake also connects to an optimizer, allowing software to optimize parameters according to a set of weights and constraints.

Because sustained microgravity cannot be replicated on Earth, SwRI researchers needed a practical way to physically validate the models and motion plans generated under MAST. To simulate microgravity conditions, SwRI commissioned its Space Robotics Center, which features a platform that floats using air bearings on a flat surface — like a giant air hockey table — to simulate low-gravity conditions. It enables a mock spacecraft with a robotic arm to "float" on the surface of the table, freely rotating and moving along the surface of the table. The facility also features a motion capture system and controllable lighting to improve video capture of the robotic arm and better mimic the harsh lighting conditions in space.

When the MAST software generates trajectories, the first step is to set a seed trajectory, a terrestrial plan of how to move from the start to end states, as well as a set of optimization parameters. For example, a common use case limits the motion applied to the spacecraft a robot is mounted on, possibly including returning it to its starting location. Then, MAST runs the optimization using Drake's physics engine to plan motions that account for and constrain the motion of the entire system, i.e., a robot arm mounted on a spacecraft.

SwRI developed a completely different class of planning algorithms for MAST in comparison to those used on Earth. These algorithms must consider the dynamics

SwRI Senior Research Engineer Michael Ripperger validates MAST motion plans in the Space Robotics Center, using this 600-pound simulated robot that glides over the granite slab, much like a puck on a giant air hockey table, enabling three-axis motion that includes vertical rotation through the robot-platform center of mass, getting the robot end effector tool close to a target.

124626

SwRI addressed the small movements needed to position the robot exactly where it's needed to use real-time visual feedback from cameras to position a robot arm controller. This enables smaller movements key to the grasping and mating capabilities needed for space applications.

124638

To address orbital clean-up of the estimated 100 million pieces of space debris, ranging from 1 millimeter to over 10 centimeters and weighing more than 9,000 metric tons, SwRI developed techniques to address the challenges of space, including shiny objects that could stymie many computer vision systems.

124662

of the full system. They are designed to plan higher-speed motions for underactuated systems while simultaneously constraining the induced motion on the host platform, such as momentum minimization, orientation disturbance, etc.

MAST offers two different modeling environments to generate robot trajectories — an in-space microgravity simulation environment and the Space Robotics Center, which has gravity but allows the robot to "float" along the the surface of the table. SwRI can take trajectories generated in the simulation environment and implement them using hardware to demonstrate and assess performance in the Space Robotics Center.

During the final phase of the MAST program, SwRI improved its Space Robotics Center capabilities to address the small movements needed to position the robot exactly where it's needed. Terrestrial robotics address this with visual "servoing," which uses real-time visual feedback from cameras to position a robot arm controller. SwRI modified the technique to enable smaller movements key to grasping and mating capabilities needed for space applications.

SPACE ROBOTICS LAUNCH

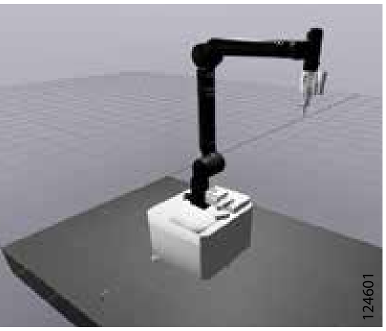
MAST played a key role in launching SwRI's space robotics program. Over the past several years, MAST has grown from an internal research program into a larger effort with external collaborations, including projects tackling technical challenges with the government and commercial clients. SwRI has leveraged nearly two decades of research and development in machine vision, industrial robotics and automated systems, applying proven Earth-based autonomy technologies — such as those used in industrial robotics and driverless vehicles — to the unique demands of space applications.

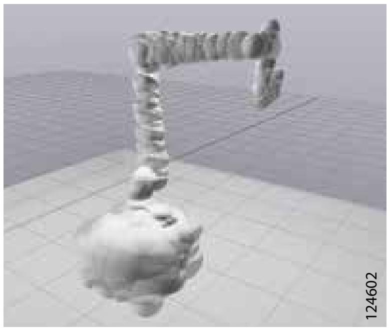
SPACE ASSEMBLY

Manufacturing and assembling structures in space is an inevitable necessity. Building larger structures in space eliminates the limitations imposed by launch vehicle size and weight constraints, allowing for the construction of larger, more complex systems. Additionally, in-space assembly reduces the risks and costs associated with launching preassembled large structures or deployable structures, enabling a more efficient use of launches and innovative designs. Robotics and automation are key to this future. Given that robotic manufacturing and assembly have been used terrestrially for decades, there are a lot of existing capabilities that the space industry can leverage.

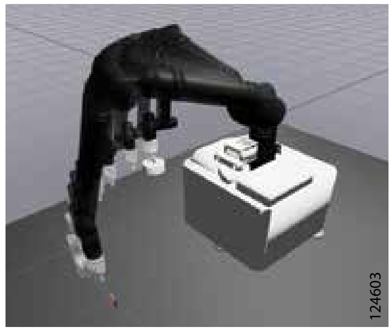
ON-ORBIT REFUELING

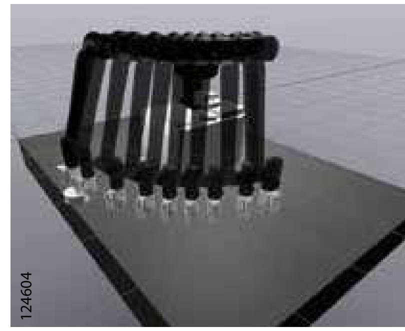
In-space refueling is another critical capability designed to extend the operational lifespan of satellites and





Using Drake simulation software, SwRI develops a visual model to plan robot motion. The platform verifies the model in terms of visual and collision geometry as well as kinematic structure before progressing to true simulation.





SwRI developed this robot manipulator tool to operate on three axes, indicated by red, blue and green arrows, to visualize motion planning optimization.

other space assets, particularly high-value spacecraft in geosynchronous orbit. Autonomous systems use cameras and image processing algorithms to accurately assess the orientation and motion of the target satellite, allowing the servicing spacecraft to dock or grapple the client spacecraft. Once the rendezvous is complete, the docking mechanism or robotic arms can connect refueling hardware. Performing this process autonomously reduces the risk of human error and enhances the safety and reliability of in-space refueling operations. Once refueling becomes a routine operation, autonomous robotic systems equipped with cutting-edge computer vision technology will play an essential role in preserving the functionality of high-value space assets. These operations could significantly lower operational costs, paving the way for more sustainable space exploration and commercialization.

SPACE JUNK CLEANUP

Robotics will also be key tools for cleaning up space junk, defunct human-made objects orbiting the Earth, including old launch vehicles, spent rocket stages and fragments from collisions. Autonomous systems equipped with cameras and image processing software can detect and track space debris in orbit. These robots use computer vision to navigate the complex space environment, identifying debris movements for careful approach. Robotic arms can then grasp the debris for collection or deorbiting to prevent collisions with operational satellites, reducing the need for human interventions while helping mitigate the growing issue of space debris and ensuring safer, more sustainable space operations.

MAST MOVING FORWARD

With the MAST internal research project wrapping up, the team is looking for ways to test the software pipeline in microgravity and starting a range of externally funded programs advancing aspects of the software. This research has positioned SwRI to meet the emerging needs of the space sector, for NASA, USSF and the commercial market.

The future of space operations will depend on robotics that can adapt, perceive and respond in environments where humans can't — or can't easily — go. Through the MAST program, SwRI has matured trusted terrestrial technologies for sensing, perception and manipulation for transition to space. This research directly supports emerging ISAM needs and reflects a heritage in advanced manufacturing. The goals focus on delivering robotic solutions ready to perform in dynamic, unstructured environments to support the next generation of space exploration missions. These goals will support a sustainable human presence in space, on the Moon and Mars, and beyond.

Questions about this article? Contact Meera Day Towler at (210) 522-6339 or meera.towler@swri.org.

IMAGE COURTESY ASTROSCALE U.S.
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DETAIL

SwRI is helping a client develop spacecraft for satellite maintenance by designing, building, integrating and testing two servicing spacecraft. One spacecraft is designed to extend the life of in-orbit client satellites by docking with them and performing propulsive maneuvers intended to either return them back to service or move them to a disposal orbit beyond the crowded geostationary orbit. A refueler spacecraft, funded by the U.S. Space Force, is designed to dock with other satellites, delivering fuel to refuel client vehicles in geostationary orbit.

SwRI's novel CoDICE instrument maintains operational reliability and longevity with its unique design. The half of CoDICE that will always face the Sun has a shiny gold surface to deflect heat energy, while the opposite side has a matte black surface to absorb as much heat as possible.

NOVEL IMAP INSTRUMENT DELIVERS FIRST-LIGHT DATA

SwRI's novel Compact Dual Ion Composition Experiment (CoDICE) instrument aboard NASA's Interstellar Mapping and Acceleration Probe (IMAP) spacecraft has successfully collected first-light data. IMAP launched in September 2025 to help researchers better understand the boundary of the heliosphere, the magnetic bubble that surrounds and protects our solar system.

As a modern-day celestial cartographer, IMAP will chart the boundaries of the heliosphere encapsulating our entire solar system to understand how it interacts with the local galactic neighborhood beyond.

In addition to providing CoDICE, SwRI also managed IMAP's mission payload, overseeing the development and delivery of all 10 IMAP instruments from multiple institutions. All have successfully recorded their first-light observations as the spacecraft journeys to its final observational post.

"IMAP features the next generation of instruments designed to give us a more complete picture of the interaction between the interstellar medium and the solar wind," said SwRI's Susan Pope, the mission's payload manager. "This will provide a better understanding of our place in the universe."

CoDICE measures the distribution and composition of interstellar pickup ions, particles that make it through the "heliospheric" filter. The instrument will also characterize solar wind ions as well as the mass and composition of highly energized solar particles associated with flares and coronal mass ejections.

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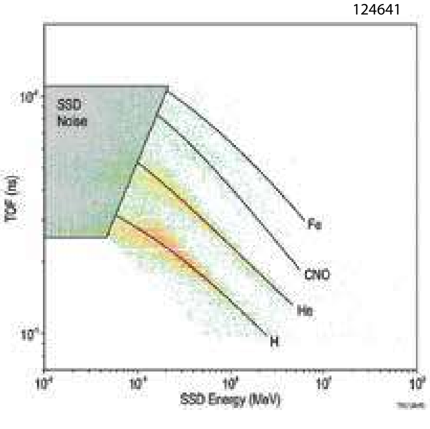

The SwRI-developed CoDICE instrument aboard IMAP collected first-light data that included these higher-energy measurements of hydrogen, helium, carbon, nitrogen, oxygen and iron. At least two separate instruments are typically required to make these types of measurements. CoDICE makes them on its own.

"The CoDICE instrument performed as expected, identifying particles from different origins by measuring protons as well as rarer ion species, such as interstellar helium ions, and solar wind oxygen and iron ions," said Dr. Mihir Desai, an IMAP co-investigator and part of the CoDICE leadership team.

The heliosphere is created by the constant flow of particles from the Sun known as the solar wind, which separates our solar system from the interstellar medium, the ancient cast-off winds of other stars. IMAP instruments will collect and analyze particles that make it through the barrier. The mission will also examine the fundamental processes that accelerate particles throughout the heliosphere and beyond. These energetic particles and cosmic rays can harm astronauts and space-based technologies.

"Initially developed through the Institute's internal research and development program and then matured through the IMAP mission, CoDICE combines the capabilities of multiple instruments into one patented sensor," said SwRI's Dr. Stefano Livi, who led its development. "The 22-pound instrument is about the size of a 5-gallon paint bucket and has a unique and beautiful thermal management design."

With all of IMAP's instruments up and running, the mission has completed its commissioning stage and moved into the science demonstration phase.

ADVANCING NOVEL HYDROGEN ENGINES

SwRI has upgraded its hydrogen-powered heavy-duty internal combustion engine (H_2-ICE) with a state-of-the-art turbocharger and developed a reliable testing methodology to study stochastic pre-ignition (SPI) in H_2-ICEs.

In 2023, SwRI converted a traditional natural-gas-fueled internal combustion engine to run solely on hydrogen fuel with minimal modifications, which was integrated into a Class-8 truck. Developed through SwRI's Hydrogen Internal Combustion Engine consortium, the H_2-ICE demonstration vehicle offers the long-haul trucking market a zero-greenhouse-gas option.

TURBOCHARGING

SwRI created specifications for a new turbocharger unit to improve the H_2-ICE truck's already solid performance, increasing peak torque from 1,494 to 1,760 foot-pound (ft·lb) and peak power from 370 to 440 hp.

"Upgrading to a mechanically driven turbocharger gave us the airflow needed to continue improving engine performance," said Chris Bitsis, assistant director of SwRI's Powertrain Systems Engineering Department. "For instance, in addition to the torque and horsepower gains, the engine's peak efficiency was also improved to 44%, which is class leading for a spark-ignited engine. The torque and power ratings are comparable with diesel trucks focused on fuel economy currently on the road with the bonus of near-zero tailpipe emissions."

Hydrogen engines often struggle to maintain the airflow needed during fast acceleration to eliminate pre-ignition and minimize NOx emissions. SwRI addressed this challenge by working with a commercial supplier that engineered the new turbocharger to SwRI's specifications. The turbocharger shaft is mechanically linked to the crankshaft through a variable drive, allowing it to provide the necessary boost pressure on demand.

PREIGNITION PREDICTION

SwRI also recently developed a tool to identify and predict pre-ignition challenges associated with hydrogen fuel and advanced clean engine technologies. When this abnormal combustion state is initiated, it can lead to knocking, which can be detrimental to engine performance and durability. Hydrogen's low minimum ignition energy threshold combined with conditions conducive to lubricant droplet autoignition are believed to contribute to SPI in H_2-ICEs.

"While H_2-ICEs experience pre-ignition at higher frequencies than spark-ignited gasoline engines, these events are typically mild compared to the intense SPI events observed in gasoline engines, which can cause severe mechanical damage," said Dr. Vickey Kalaskar, a lead engineer in SwRI's Powertrain Systems Engineering Department. "Lubricant oil volatility and compression ratio are a driving influence for hydrogen-fueled pre-ignition events."

Through this research, SwRI engineers developed new testing methods that provide insight into lubricant-initiated SPI in H_2-ICEs while supporting further work, such as refining SPI quantification methods, exploring mitigation strategies and evaluating commercial lubricants. SwRI is also collaborating with the University of Texas at San Antonio to integrate machine learning and AI for real-time pre-ignition detection in H_2-ICEs.

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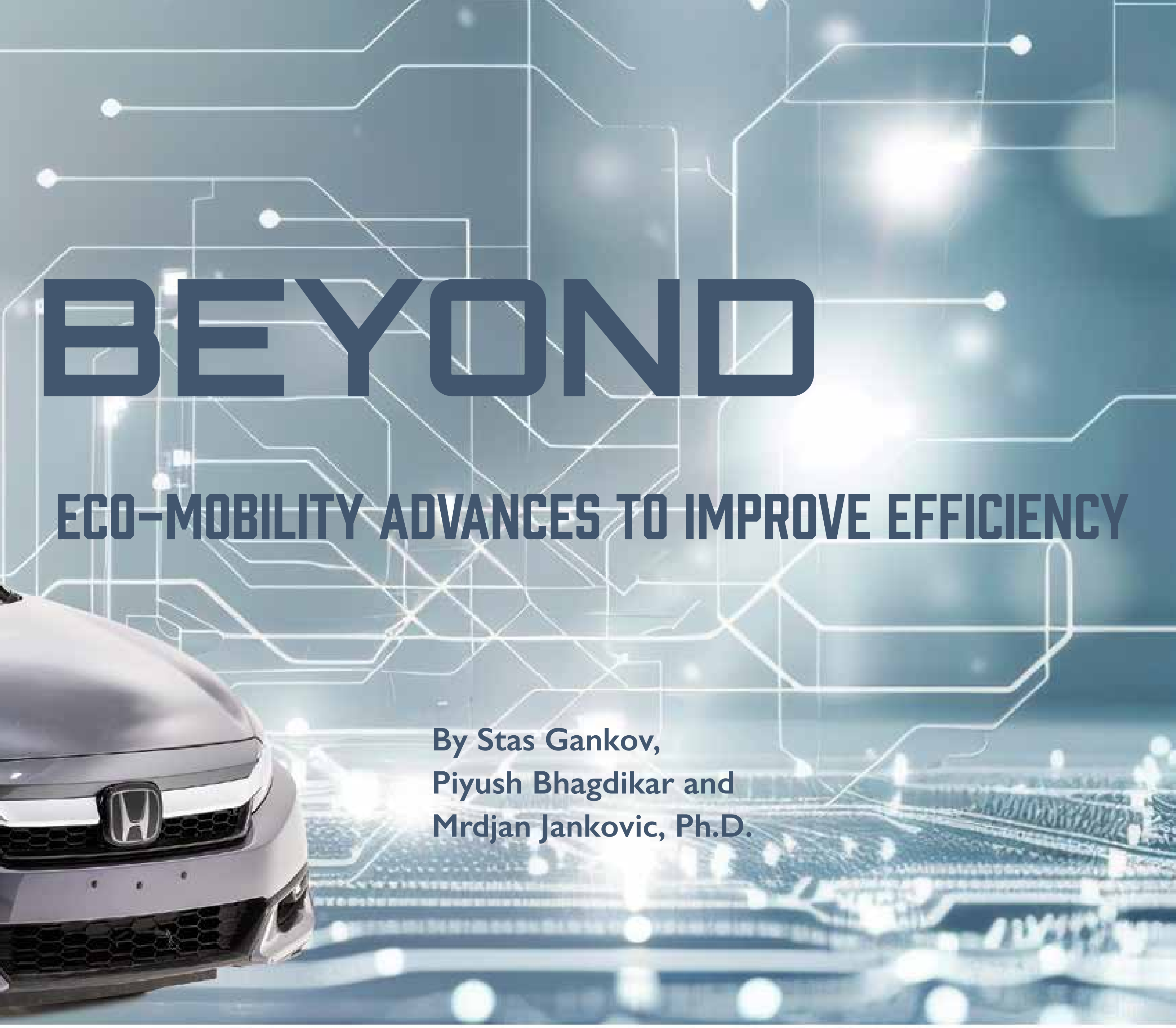
SwRI has modified and successfully demonstrated a heavy-duty natural gas-fueled engine to run on 100% hydrogen fuel and continues to research, design and innovate H_2-ICE technology. SwRI's multidisciplinary hydrogen energy research team uses the engine to explore decarbonization technologies across a broad spectrum of industries.

NEXTCAR &

Traditionally, automotive efficiency improvements have relied on incremental hardware upgrades, but these increases are becoming more difficult to achieve. The last big jumps occurred when automakers switched from V-8 engines to turbocharged four- and six-cylinder options that can deliver the same power while burning less fuel and with the introduction of electrified powertrains. And over the last five years, smaller, more efficient models have lost market share to larger SUVs.



BEYOND

ECO-MOBILITY ADVANCES TO IMPROVE EFFICIENCY

By Stas Gankov,
Piyush Bhagdikar and
Mrdjan Jankovic, Ph.D.

New ways to address efficiency are imperative. Over the last decade, the Department of Energy and the Advanced Research Projects Agency - Energy (ARPA-E) sought to leverage rapid advances in driver assistance technologies, vehicle connectivity and automation to explore creative ways to improve the efficiency of future vehicle fleets. The NEXTCAR program, short for NEXT-Generation Energy Technologies for Connected and Automated On-Road Vehicles, sought out enabling technologies that use connectivity and automation to optimize vehicle dynamic controls and powertrain operation to reduce energy consumption. These controls — implemented on a single vehicle basis, across a cohort of cooperating vehicles, or across the entire vehicle fleet — could significantly improve transportation efficiency.

Conventional powertrain control is reactive, with drivers and vehicle systems responding to events after they happen. Powertrain control technologies developed under the NEXTCAR Program have the potential for predictive and anticipatory control. Connected and automated vehicle (CAV) technology previously prioritized for safety and navigation is now aiming at maximizing efficiency.

In 2016, ARPA-E awarded Southwest Research Institute and 10 other research teams around the country with funding to use CAV technologies to achieve a monumental 20% efficiency improvement. 2025 capped off an ambitious, eight-year effort to use a multidisciplinary team of SwRI experts to develop technologies to help passenger vehicles operate more efficiently, reduce energy consumption and stem the rise of greenhouse gas emissions.

DETAIL

The software, algorithm and testing suite developed during NEXTCAR Phase I, collectively known as Eco-Mobility with Connected Powertrains, won an R&D 100 Award in 2021, recognizing it as one of the most significant innovations of that year.

SOFTWARE-DRIVEN STRATEGY

For Phase I, SwRI efforts focused on using CAV data to anticipate the operating environment and integrate and optimize dynamic controls and powertrain operation in real time. This strategy targets software-driven gains rather than powertrain changes, offering a path for immediate adoption in current fleets while serving as a powerful complement to future hardware innovations. Crucially, these gains are achieved without compromising emissions, safety or drivability. In Phase I, SwRI developed and demonstrated the technology using a highly efficient Plug-in Hybrid Electric Vehicle as the platform.

As a proven leader in automotive engineering and intelligent systems, SwRI was well positioned to tackle the NEXTCAR challenge. For years, SwRI has conducted ongoing research to improve the efficiency and range of hybrid and electric vehicles as well as lowering emissions of internal combustion engine vehicles. The Institute has also been in the forefront of developing intelligent transportation systems, cooperative systems and automated driving.

The SwRI technology developed during NEXTCAR Phase I successfully accomplished the 20% reduction goal. The resulting suite of control algorithms uses vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and vehicle-to-everything (V2X) technologies to optimize vehicle route, speed and power. V2X, which includes V2V and V2I, provides access to richer information about the driving scenario.

The algorithms optimized hybrid-electric system performance by efficiently coordinating power distribution across the battery, electric motor, gasoline engine and other powertrain components while also reducing overall power demand. The team achieved these results while maintaining normal human-like driving behavior and normal traffic flow.

This success led to a new three-year Phase II contract in 2021, challenging SwRI to demonstrate an additional 10% energy savings. SwRI was one of only four teams from Phase I to advance to Phase II. In this phase, the team integrated SAE Level 4 (L4) automated driving systems, enabling highly precise control over eco-mobility maneuvers. The completed Phase II automated vehicle met its ambitious 30% energy reduction goal and showcased fully autonomous,

NEXTCAR technologies leveraged enhanced situational awareness to optimize system operations, equipping the research vehicle with an onboard V2X radio and tablet PCs and controllers.

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DETAIL

SAE International is a nonprofit association for aerospace, automotive and commercial vehicle engineers, developing technical standards, fostering lifelong learning and connecting experts to improve mobility technology.

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Through the extensive testing on SwRI's CAV-enabled test track, SwRI demonstrated how its NEXTCAR vehicle and the CAV technology could function in real-world scenarios, realizing the breadth of applications the technology could facilitate. For example, synchronized operation could optimize real-world efficiency, which could be applied to fleets, heavy-duty transportation and even unmanned aerial vehicles, such as drones.

driverless vehicle operations. SwRI developed the entire software stack, eco-mobility algorithms, drive-by-wire interface and control systems in house.

SwRI's NEXTCAR platform combines several unique CAV technologies together to create truly innovative connected vehicle solutions. SwRI-developed drive-by-wire technology that automatically operates the vehicle's accelerator, brake pedals and power steering system. The NEXTCAR vehicle combined conventional sensing technologies, such as lidar, with SwRI's patented Ranger localization technology. Ranger uses a ground-facing camera and localization algorithms to navigate automated vehicles. The specialized algorithm suite includes cooperative control capabilities as well as smart lane merging and changing functionality.

NEXTCAR APPLICATIONS

- Eco-driving leverages V2V and V2I information from nearby vehicles and traffic signals to minimize accelerations and generate an energy-efficient speed profile.
- Eco-routing fuses a powertrain dynamics layer on top of existing off-the-shelf navigational services to present energy optimal routes specific to vehicle powertrain and driver behavior.
- Power-split optimization improves hybrid vehicle energy consumption using predicted route data and a high-fidelity vehicle model to select the most efficient powertrain operating mode.
- Driver speed advisory provides a scalable framework to inform drivers about how speed affects economy, which can be integrated with a navigation system or mobile application.
- Augmented by traffic simulators,SwRI's NEXTCAR chassis dynamometer assesses fuel economy, emissions, CAV algorithms and new technologies.
- Powertrain-centric solutions incorporate advanced hybrid powertrain control for engines and transmissions as well as ultra-low NOx solutions for heavy-duty trucks.

From left, Research Engineer Kartik Adsule, Manager Stas Gankov and Senior Research Engineer Piyush Bhagdikar integrated prototype equipment to enable SwRI's NEXTCAR eco-mobility capabilities. The vehicle combines CAV technology and SAE Level 4 automation to demonstrate up to 30% energy savings compared to traditional hybrid vehicles — without modifying the powertrain.

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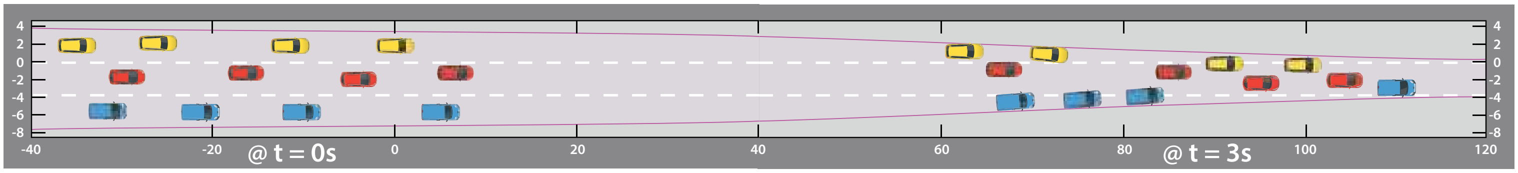

This graphic shows how SwRI's merge algorithm manages interchange lane swaps at 55 mph, showing how the 12 vehicles effectively merge after 3 seconds.

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The merge-assist algorithm emulates race-car driving, providing excellent situational awareness through V2V, decentralized operation and no prioritization, predicting the actions of other drivers to quickly adjust to their movements. A lean computational footprint offers low energy consumption and predictability with respect to merging ahead or behind another vehicle and provides a more comfortable ride. Predictability improves robustness and agility over other control algorithms.

SwRI's eco-mobility technology developed under NEXTCAR includes different applications that can be used together or individually. The technology could potentially revolutionize the transportation industry while helping reduce energy consumption and emissions. The technology can generate measurable savings, even in scenarios with limited or no connectivity to connected vehicle information, relying solely on the sensing capabilities of existing modern production vehicles.

MERGE-ASSIST ALGORITHM

Through the NEXTCAR II program, SwRI developed a special merge assist algorithm. Merging lanes and highway interchanges are challenging for human drivers and even more so for automated systems. These scenarios often require split-second negotiations. These safety-critical maneuvers can be affected by many factors, including road configuration, vehicle size and visibility. Current automated-merge software often relies on established priorities, such as a first-in-first-out (FIFO) order, and on long-range V2V communication and a roadside coordinator. FIFO applications have the potential for string instability, where each subsequent merging vehicle brakes a bit later and harder than the preceding one.

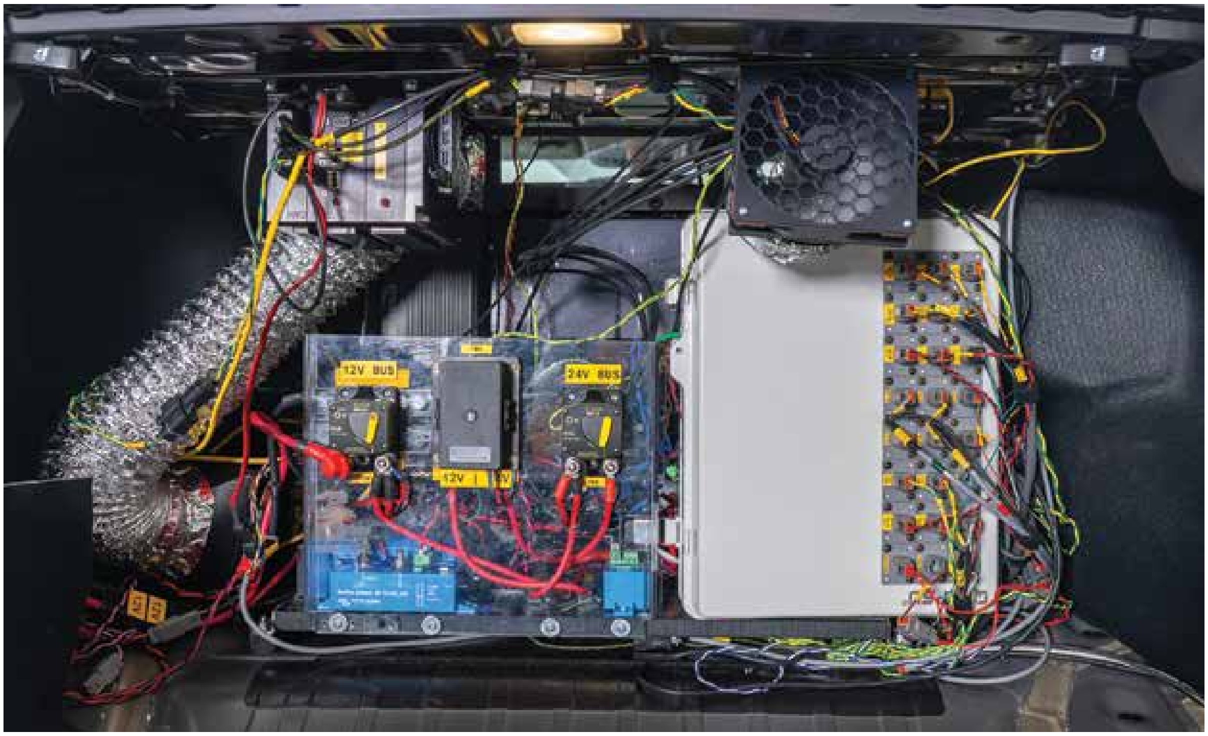
The SwRI solution used a decentralized computational approach that avoids prioritization altogether. Through an internally funded project, the team developed a set of related algorithms that handle lane merges and highway interchanges with high efficiency, using SAE L2+ autonomy, from driver-assisted systems to full autonomy. The decentralized systems allow the vehicles to operate independently but cooperate to optimize merging while improving traffic flow and reducing energy consumption. This new algorithm shows 23% improvements in energy efficiency and a 6% higher average velocity over FIFO algorithms along a 500-meter stretch of roads around the merge point. In a highway interchange case, control barrier functions protect vehicles from collision using predictor-corrector feedback loops to provide agility and enhanced safety. The behavior reacts quickly, like a racecar driver, and has proven more resilient when something unexpected happens, such as a vehicle losing power.

The methodology behind the algorithms optimizes the operation of individual agents, enabling decentralized cooperation among multiple agents and enhancing system-level performance. Based on the observed agility of groups of vehicles controlled by the merge-assist algorithm, the team sees the potential to extend it to unmanned aerial vechicles. Drone-to-drone very-short-range communications require low power and minimize detectability or interference, key points of interest for this application.

NEXT STEPS

In June 2025, years of hard work, innovation and collaboration culminated at an ARPA-E capstone event at the American Center for Mobility in Michigan. SwRI staff from the Powertrain Engineering and Intelligent Systems divisions attended the event along with ARPA-E representatives, stakeholders from the mobility industry and other NEXTCAR teams from around the country. At this ARPA-E field day, SwRI's NEXTCAR vehicle performed highly accurate and repeatable automated driving tasks along a pre-mapped route. The vehicle's eco-driving controller showed spectators optimized speed information in real time. SwRI's NEXTCAR demonstration showcased the benefits CAV technology and automation offer the mobility industry, demonstrating greater efficiency and greenhouse gas emission reductions.

While originally shown using a plug-in hybrid vehicle, both DOE and SwRI internal funding demonstrated that eco-mobility applies to all vehicle powertrains, including pure electric, conventional



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SwRI integrated custom and commercial components to create the "brain" behind NEXTCAR's eco-mobility applications to develop and demonstrate in real time cutting-edge energy-efficient technologies.

combustion engines and conventional hybrid vehicles. The technology would be particularly beneficial for heavy-duty and fleet vehicles. In addition to the primary benefits of safety, efficiency and energy savings, the team is assessing secondary benefits, such as using algorithms to enhance the lifespan of powertrain components to reduce maintenance and repair costs.

The long-term vision for this platform is creating a unified control system architecture for all modes of transportation. This will involve developing new algorithms and creating new validation tests and standardized testing to ensure the high standards.

Additionally, over the last eight years, SwRI collected vast amounts of connected vehicle data associated with traffic simulations, custom high-fidelity vehicle simulators, algorithm refinement and CAV dynamometer testing. At present, the team is looking for collaborators to take advantage of the data and development to continue to innovate advanced CAV algorithms and expand the benefits.

The team is excited about what's next for NEXT-CAR's eco-mobility technology.

Questions about the story? Contact Stas Gankov at 210-522-6206 or stas.gankov@swri.org.

The authors want to acknowledge the contributions of Institute Engineers Dr. Michael Brown of SwRI's Intelligent Systems Division and Dr. Jayant Sarlashkar of the Powertrain Engineering Division to SwRI's NEXTCAR eco-mobility projects.

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ABOUT THE AUTHORS: Stas Gankov, manager of SwRI's Advanced Algorithms Section, leads advanced algorithms and test cell automation system activities. He was the principal investigator of SwRI's NEXTCAR program. Piyush Bhagdikar is a senior research engineer in Advanced Algorithms, focusing on dynamical systems, controls and modeling for CAVs and electrified vehicle systems. Dr. Mrdjan Jankovic, a staff engineer in the Advanced Algorithms section, has extensive experience in power-train engineering, ADAS and nonlinear control theory. He has pioneered fuel-efficient technologies and collision-avoidance algorithms.

MAKING POWER MORE EFFICIENT, COST-EFFECTIVE

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SwRI and 8 Rivers have patented a system that leverages fluctuations in energy demand by using liquid oxygen storage (LOX) to make power plants more cost-effective and efficient. The Institute modified a recently developed power cycle, the Allam-Fetvedt Cycle, which combusts fuel such as natural gas using an oxygen and carbon dioxide mixture. The system also allows complete carbon capture, minimizing greenhouse gas emissions.

The Allam-Fetvedt Cycle requires high-purity oxygen separated from air, which is mostly nitrogen with trace amounts of other gases. This energy-intense separation process consumes 10% of a power plant's output.

"Our idea is to generate oxygen during off-peak hours, when electricity is less expensive because demand is lower," said SwRI Institute Engineer Dr. Jeffrey Moore, one of the new system's inventors. "The oxygen can then be stored in liquid form and converted back into gas for use when energy is in high demand. This boosts plant output while lowering operating costs."

SwRI conducted a techno-economic analysis to ensure that a power plant using this technology would be profitable, modeling both plant performance and hour-by-hour costs over a full year. Studies by Princeton University and the National Renewable Energy Laboratory showed that current price volatility for electricity will continue to increase as more forms of renewable energy come online, indicating that the economic benefits of the application will persist or grow in the future.

"The data show that prices in some regions may stay low for weeks, then spike for long periods, depending on renewable penetration. Right now, the grid is about 10–15% renewables. If that rises to 30%, the problems associated with fluctuations in wind and solar energy production will be exacerbated, making energy storage critical for overall grid reliability," Moore said. "Currently, there's no large-scale energy storage system on the grid, although research is underway."

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SwRI-DEVELOPED PaSTA SUPPORTS SPACECRAFT DOCKING

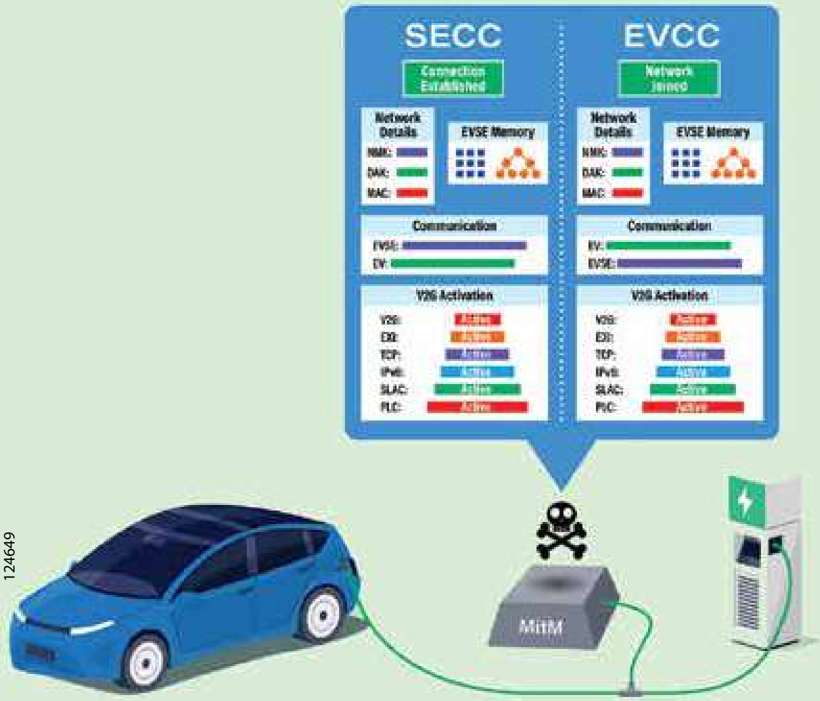
SwRI has developed technology to stiffen deployable structures on spacecraft to enable autonomous spacecraft docking operations. SwRI is currently integrating the Parallelogram Synchronized Truss Assembly (PaSTA) technology with solar arrays on the Astroscale U.S. Refueler spacecraft. The team is also designing two different deployable booms using PaSTA technology for another spacecraft SwRI is developing.

The Astroscale U.S. Provisioner™, a 300-kilogram spacecraft, will provide the first-ever on-orbit refueling operations above geostationary orbit for the United States Space Force (USSF). SwRI is building, integrating and testing the refueler. The precision pointing required to dock the refueler with other vehicles in space requires a stiffened solar array.

"The Provisioner does something that is difficult for spacecraft: autonomously docking with other spacecraft," said Ryan Rickerson, manager of SwRI's Deployable Structures Section and lead mechanical engineer for PaSTA. "That just isn't possible with traditional solar array designs."

PaSTA provides a structural backbone for the solar panels, which extend out four and a half feet from the spacecraft. On the other spacecraft, each array will extend 20 feet and collectively generate 5,000 watts of power for the spacecraft while enabling the same precision pointing as the smaller refueler spacecraft.

PaSTA uses a patented framework of interconnected elements in a truss structure to increase solar array stability and rigidity. As a result, the panels don't bend. Instead, they are stretched or compressed along their length, something known as axial loading.



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EV CHARGING SECURITY VULNERABILITIES

SwRI identified a security vulnerability in a standard protocol governing communications between electric vehicles (EV) and EV charging equipment. The research prompted the Cybersecurity & Infrastructure Security Agency (CISA) to issue a security advisory related to the ISO 15118 vehicle-to-grid communications standard.

Through internal research, a team of SwRI engineers spoofed signal measurements between an EV and EV supply equipment (EVSE), leading to a Common Vulnerabilities & Exposures (CVE) advisory.

"It's important to note that this vulnerability comes from the requirements in an industry standard, meaning it can affect a variety of vehicle manufacturers," said Mark Johnson, who led the research. "We hope this will encourage manufacturers to continue working to adopt ISO 15118-20 as well as public key infrastructure in the EV charging space to better protect consumers."

The research explored vulnerabilities in the Signal Level Attenuation Characterization (SLAC) protocol when identifying the charging station a particular vehicle is connected to within a charger network. This process involves sending a signal from the vehicle to the chargers, which then respond with a measure of signal quality.

After identifying security deficiencies within the SLAC process, SwRI's research team developed a machine-in-the-middle (MitM) attack to test if communications between vehicles and chargers could be compromised. The researchers successfully modeled the attack using simulators before replicating the attack between vehicles and charging stations.

Using the MitM device to tap into the appropriate line in the charger cable, the researchers injected signals that led to full control over the communications channel, demonstrating that the EV charging process could be manipulated or halted using the MitM attack.

SwRI's High Reliability Systems Department performs a variety of cybersecurity services for the automotive industry, helping identify cyberthreats to ground vehicles, transportation infrastructure and automotive embedded systems.

BIOREACTOR REPLICATES VERSATILE STEM CELLS

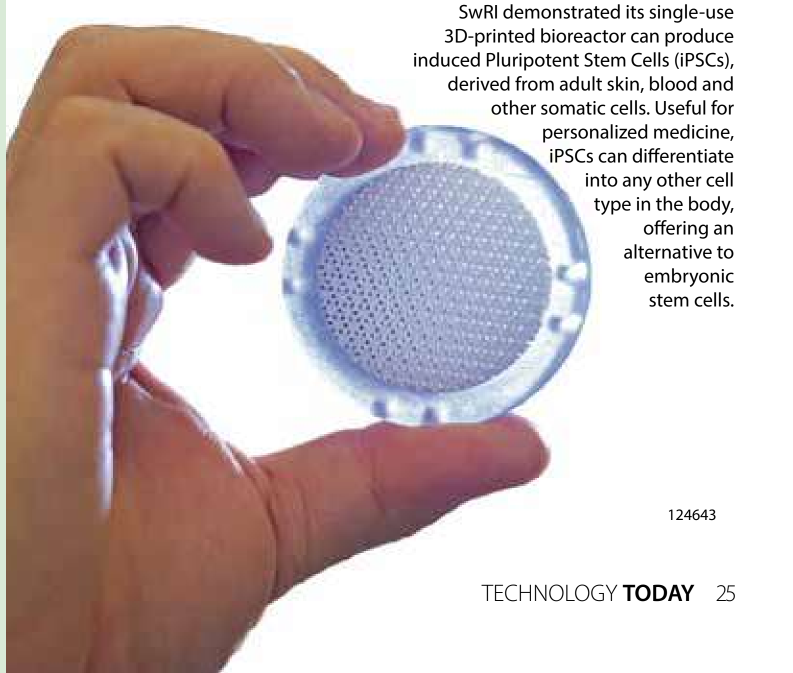
SwRI has demonstrated a new application for its cell-expansion bioreactor to advance tissue engineering and cell-based therapies for treatment of injuries and diseases.

SwRI scientists used the bioreactor to replicate induced Pluripotent Stem Cells (iPSCs) derived from adult skin, blood and other somatic cells. A pluripotent state allows iPSCs to differentiate into any other cell type in the body, much like embryonic stem cells but without their ethical ambiguity. Large quantities of iPSCs are needed for regenerative medicine and individualized health care, but current technology has challenges with scale-up production while maintaining iPSCs' "stemness" properties.

"Using the SwRI-developed single-use 3D-printed bioreactor, we successfully harvested significant quantities of iPSCs," said Senior Research Engineer Nick McMahon, who led the project. "We are working on further differentiating those iPSCs into neural progenitor cells, which could support the regeneration of neurons damaged due to injury. International studies have shown that neural progenitor cells can repair the spinal cord when administered in the first 28 days following a spinal cord injury."

SwRI's 3D-printed bioreactor matrix boasts a larger surface-to-volume ratio compared to traditional 2D cell culture devices such as flasks or dishes, so it can grow more cells using an automated perfusion method. Due to the exceptional geometry of SwRI's bioreactor, cells maintain a monolayer without forming clusters during the cultivation process, minimizing the risk of spontaneous differentiation into the wrong types of cells.

"Since the discovery of iPSCs in the early 2000s, scientists have been exploring their potential to revolutionize medicine by using a patient's own cells to repair or replace damaged tissues while avoiding immune rejection. Unlike embryonic stem cells, iPSCs pose no ethical controversy, making them a promising and responsible path toward personalized medicine," said Institute Engineer Dr. Jian Ling.



SwRI demonstrated its single-use 3D-printed bioreactor can produce induced Pluripotent Stem Cells (iPSCs), derived from adult skin, blood and other somatic cells. Useful for personalized medicine, iPSCs can differentiate into any other cell type in the body, offering an alternative to embryonic stem cells.

124643

AIDING THE SEARCH FOR WATER ON THE MOON

SwRI scientists are collaborating with researchers at UT San Antonio to study how space weathering affects lunar surface materials, using just a few grains of lunar soil collected by the Apollo missions. Understanding how the solar wind and micrometeoroid impacts caused surface materials to evolve over eons will help researchers looking for water on the Moon.

"These Apollo-era samples continue to be a cornerstone of lunar science, providing the most direct link to the Moon's surface processes and evolution, including space weathering," said SwRI's Dr. Ujjwal Raut, the principal investigator of the project.

Caleb Gimar, who recently completed a doctoral degree in physics through the SwRI-UT San Antonio Joint Graduate Program, led the research with support from NASA's Lunar Data Analysis Program.

"We are investigating how space weathering drives physical and chemical changes in grains of lunar soil, largely controlling their far-ultraviolet reflectance," Gimar said. "This research explains why soils with different degrees of weathering vary in brightness and the way they scatter far-ultraviolet light."

These results allow researchers to better interpret remote sensing data from the Lunar Reconnaissance Orbiter Lyman-Alpha Mapping Project (LRO-LAMP), which has been orbiting the Moon since 2009.

"The SwRI-led LAMP instrument was designed to search for signs of water ice by peering into the permanently shadowed polar craters using far-ultraviolet light from stars instead of the Sun," said Dr. Kurt D. Retherford, principal investigator of the LAMP instrument. "Accurately identifying that ice and estimating its abundance depends on understanding the far-ultraviolet reflectance of dry lunar soil."

SwRI collaborated with UT San Antonio to analyze lunar soil samples and determine how space weathering affected their far-ultraviolet reflectance. SwRI measured the reflectance of the Apollo 11 soil sample in SwRI's Slater Crater ultra-high vacuum instrument suite.

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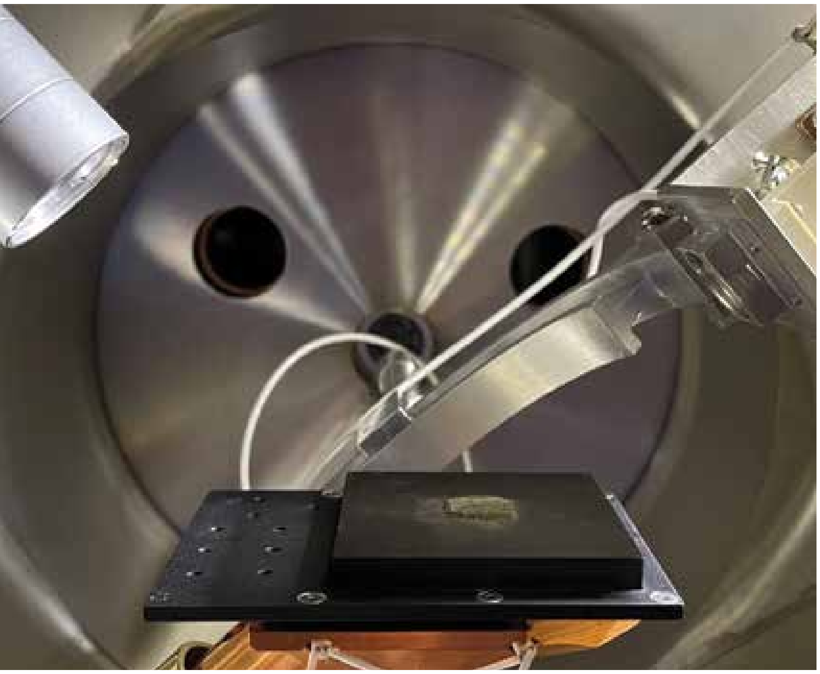

Dr. Danna Qasim is leading efforts to develop SwRI's new Nebular Origins of the Universe Research (NOUR) laboratory to bridge pre-planetary and planetary science and better understand the origins of our universe.

TRACING CHEMICAL ORIGINS OF PLANETARY SYSTEMS

SwRI has created a new space science laboratory to enhance our understanding of the origins of planetary systems. The Nebular Origins of the Universe Research (NOUR) Laboratory will trace the chemical origins of planetary systems.

"We are examining the chemistry of ice, gas and dust that have existed since before our solar system formed, connecting the dots to determine how materials in those clouds ultimately evolve into planets," said SwRI Senior Research Scientist Dr. Danna Qasim, who is leading the lab. "By simulating the physico-chemical conditions of these pre-planetary environments, we can fill key data gaps, providing insights that future NASA missions need to accomplish their goals."

SwRI's Space Science Division is establishing a robust astrochemistry program, connecting early cosmic chemistry to planetary evolution. The new lab focuses on the chemistry of interstellar clouds, vast regions of ice, gas and dust between stars, a largely unexplored area of astrochemistry.

The laboratory launched with two vacuum chambers. One is dedicated to studying dark interstellar cloud chemistry where complex organic molecules are formed. The other simulates stellar irradiation of interstellar ices to study how biologically relevant molecules form. The NOUR laboratory will also include a liquid chromatography-mass spectrometer (LC-MS) to analyze these molecules.

"The irradiation of these ices will produce even more complex molecules, such as components of DNA and RNA, that can be analyzed with LC-MS. We also plan to investigate sample-return materials, such as materials from the Moon, asteroids, comets and Mars, with the LC-MS," Qasim said. "By understanding the chemical inventory of pre-planetary environments, we will be able to help trace the origins of potential biosignatures and determine whether they could have been inherited from earlier cosmic stages."

124622

HIGH-SPEED PROPULSION ENGINE FACILITY

SwRI has built a highly specialized Center for Accelerating Materials and Processes (CAMP), a new facility that will support research and development for tomorrow's high-speed aerospace engines.

"The CAMP facility will strengthen our nation's leadership in aerospace propulsion," said Dr. Barron Bichon, vice president of SwRI's Mechanical Engineering Division. "It's an investment in this country's future competitiveness, helping lay the foundation for transformative aerospace technologies that will have a lasting impact on defense and global mobility."

Global defense, air travel, delivery and transportation are among the market forces driving the demand for high-speed engines. The new CAMP facility will focus on demonstrating faster, more efficient techniques for manufacturing high-speed propulsion systems.

CAMP is a two-story, 33,505-square-foot facility at SwRI's headquarters in San Antonio. Construction began in 2024, supported by a $30 million investment from SwRI. Engineers will evaluate new materials and processes to produce high-speed engines in a considerably shorter amount of time than current production timelines.

"The Center for Accelerating Materials and Processes demonstrates SwRI's dedication to leading-edge research that tackles some of the toughest technical problems of today," said Dr. Ben Thacker, SwRI chief operating officer. "This facility opens the door to new possibilities in what we can create and accelerates how quickly critical propulsion solutions can be deployed."

CAMP is currently procuring and installing manufacturing process test equipment.

URANUS' RADIATION BELT MYSTERY SOLVED?

SwRI scientists believe they may have resolved a 39-year-old mystery about the radiation belts around Uranus.

In 1986, when Voyager 2 made the first and only flyby of Uranus, it measured a surprisingly strong electron radiation belt at significantly higher levels than anticipated. Based on extrapolations from other planetary systems, Uranus' electron radiation belt was off the charts. Since then, scientists have wondered how the Uranian system, with a planet unlike anything else in the solar system, could support such an intense radiation belt.

"We decided to look at the Voyager 2 data and compare it to Earth observations we've made in the decades since," said SwRI's Dr. Robert Allen, lead author of a paper outlining this research.

Based on these new analyses, SwRI scientists theorize that Voyager 2 observations may have more in common with processes at Earth driven by large solar wind storms — massive eruptions of plasma, magnetic fields and electromagnetic radiation from the Sun. Scientists now think a solar wind structure known as a co-rotating interaction region was likely passing through the Uranian system at the same time as Voyager 2.

"In 2019, Earth experienced one of these events, which caused an immense amount of radiation belt electron acceleration," said SwRI's Dr. Sarah Vines, a co-author of the paper. "If a similar mechanism interacted with the Uranian system, it would explain why Voyager 2 saw all this unexpected additional energy."

This new study indicates a space weather event likely caused powerful high-frequency waves, creating the most intense conditions observed over the entirety of the Voyager 2 mission. In 1986, scientists thought that these waves would scatter electrons, but scientists now know that, under certain conditions, those same waves could also accelerate electrons and feed additional energy into planetary systems.

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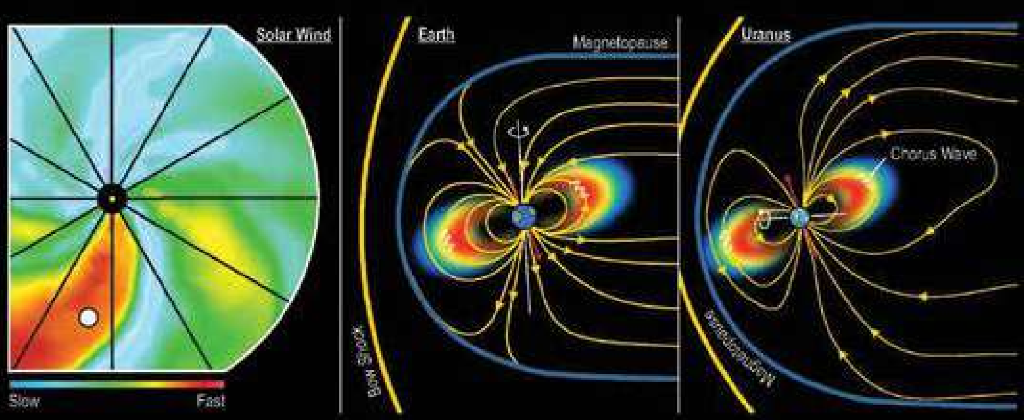


SwRI scientists compared space weather impacts of a fast solar wind structure (first panel) driving an intense solar storm at Earth in 2019 (second panel) with conditions observed at Uranus by Voyager 2 in 1986 (third panel) to potentially solve a 39-year mystery about the extreme radiation belts it found. A solar storm could have caused chorus waves, an electromagnetic emission that could have resulted from the solar storm and accelerated electrons.

DEVELOPING SUSTAINABLE AVIATION FUELS

SwRI produced a batch of blended sustainable aviation fuel (SAF) through a refinery process that started with electrofuels, or e-fuels. Using internal research funding, a multidisciplinary team produced SAF and characterized it along with two other commercially available fuels, collecting emissions and particulate data to support the aviation industry's emissions goals.

"Aviation is difficult to decarbonize due to the fuel density and power required for flight," said Francesco Di Sabatino, a group leader in SwRI's Mechanical Engineering Division. "With this project we're gathering important data for conventional fuel and two different SAFs."

Worldwide, air travel accounts for 2% of all carbon emissions and 12% of all carbon emissions from transportation. Jets running on SAF could help reduce carbon emissions associated with conventional fossil fuels. The team tackled three SAF focus areas — production, characterization and testing.

First, chemical engineers refined e-fuels manufactured with hydrogen produced from electrolysis of water and captured carbon dioxide or carbon monoxide. The team then processed that into a custom SAF meeting aviation fuel standards. Then SwRI's fuels and lubricants specialists characterized this SAF and compared it with traditional jet fuel and a commercially available SAF blend. SwRI's propulsion and energy specialists used a jet engine test stand to collect emissions data.

"We are excited to offer multidisciplinary solutions across all stages of the SAF development cycle," said SwRI's Executive Vice President Emeritus Walt Downing. "This integrated project paired chemical and mechanical engineers with fluids and emissions experts to address several technical challenges."

124637

ASTEROID FEATURES NAMED

The International Astronomical Union has approved official names for features identified by the SwRI-led Lucy mission on the surface of asteroid 52246 Donaldjohanson. The NASA Lucy spacecraft flew past the asteroid on April 20, 2025.

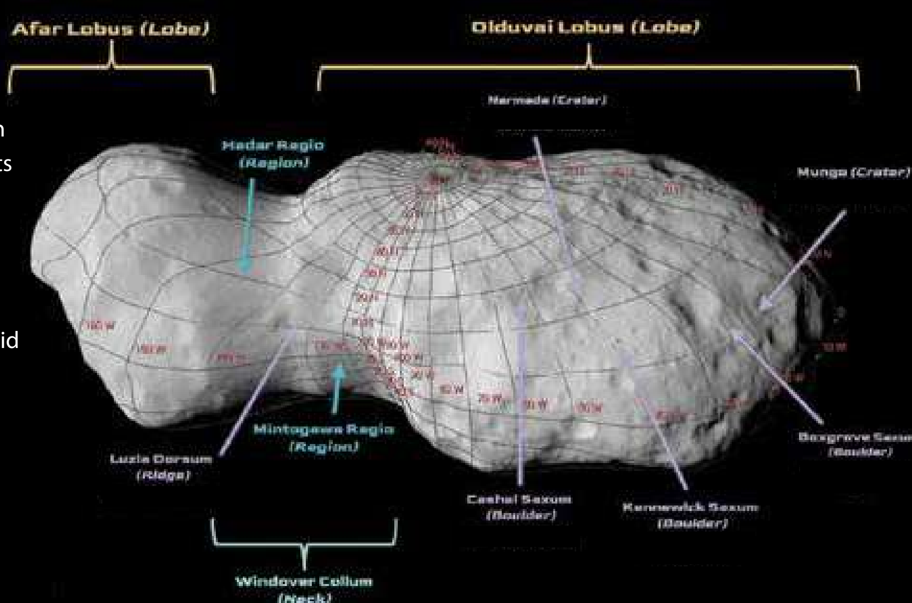
The features are named for significant paleoanthropological sites and discoveries in honor of the asteroid's namesake, Donald Johanson, who discovered the fossilized skeleton of an early human ancestor named Lucy. The Lucy mission, in turn, is named after this discovery as it will explore Jupiter's Trojan asteroids, "fossils" left over from the creation of the solar system.

"Visiting a new world for the first time is very exciting. Just as the explorers used to do here on Earth, when we come upon a new celestial body, we like to map the landscape and name its most interesting features," said SwRI's Dr. Simone Marchi, who serves as deputy principal investigator for the Lucy mission.

Naming features on planetary bodies makes it easier for scientists to model and clearly communicate new discoveries about these objects. Donaldjohanson is a carbonaceous asteroid approximately 8 kilometers (5 miles) long and 3.5 kilometers (2.2 miles) wide. SwRI-led modeling indicates that it may have been formed about 155 million years ago when a larger parent asteroid broke apart.

The asteroid's smaller lobe is called the Afar lobe after the Ethiopian region where Lucy and other human ancestor fossils were found. The larger lobe is named the Olduvai lobe after a Tanzanian river gorge.

The neck connecting the two lobes was named after the Windover Archeological Site near Cape Canaveral, Florida, where Lucy was launched in 2021. Additional features include two smooth regions on the neck named Hadar, the site of the Lucy fossil's discovery, and Minatogawa, where the oldest known hominins in Japan were found.



124647

AUTOMATING CALIBRATION FOR EMISSIONS CONTROL SYSTEMS

SwRI has developed a method to automate the calibration of heavy-duty diesel truck emissions control systems using machine learning and algorithm-based optimization. The latest diesel aftertreatment systems often take weeks to calibrate. SwRI's new method can calibrate them in as little as two hours.

"Manually calibrating selective catalytic reduction (SCR) systems is labor-intensive, often taking six or more weeks of testing and work," said Venkata Chundru, a senior research engineer in SwRI's Advanced Algorithms Section. "By combining advanced modeling with automated optimization, we can accelerate calibration and improve system performance while ensuring compliance with upcoming standards."

New U.S. Environmental Protection Agency and California Air Resources Board (CARB) standards are scheduled to go into effect in 2027, governing the amount of nitrogen oxides (NOx) a vehicle can emit in proportion to energy used. SwRI has completed several projects that improve existing automotive technologies, which meet or exceed the new standards.

As a continuation of this work, SwRI's Powertrain Engineering Division has developed a method to automate calibration of SCR systems for diesel engines. Most SCR systems control engine emissions using ammonia-based solutions, such as urea-based diesel exhaust fluids injected into the exhaust stream. The dosed exhaust interacts with a catalyst, creating a chemical reaction that converts NOx into harmless water and nitrogen.

The project team created a physics-informed neural network machine learning model that integrates data with the laws of physics, providing faster and more accurate results. By running simulations of an active SCR system, the team could fine-tune its urea dosing control to lower overall NOx and ammonia emissions and rapidly identify optimal settings for the engines. The model could then learn to identify these settings and map the calibration processes, allowing for full automation.

124660

124650

ASSESSING F-16 LANDING GEAR RELIABILITY

SwRI has received a seven-year, $9.9 million contract from the U.S. Air Force to predict the life of landing gear components for the F-16 Fighting Falcon fleet. SwRI will leverage its aging aircraft expertise to predict when parts need replacement, determine the root causes of failure and recommend improvements to maintenance practices.

The contract falls under the Comprehensive Landing Gear Integrity Program, a 20-year, $300 million Indefinite Delivery Indefinite Quantity (IDIQ) contract shared among three organizations, including SwRI.

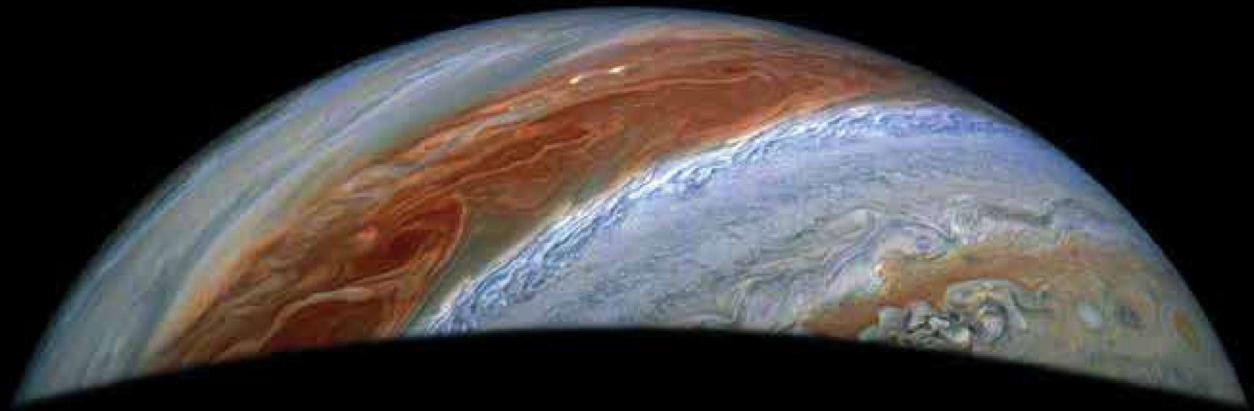
The F-16 is a compact, multirole fighter first introduced in 1978. It's currently the world's largest fixed-wing military aircraft fleet, with more than 2,000 aircraft in active service worldwide.

"Aircraft landing gear experience unique conditions compared to other aircraft components," said SwRI Principal Engineer Laura Hunt, who oversees the project. "We are looking at impact forces during touchdown, stress from towing loads and factors like corrosion and vibration that make the landing gear particularly vulnerable to fatigue and damage over time."

SwRI has provided technical engineering support to the Air Force for several decades under the Aircraft Structural Integrity Program (ASIP) and the U.S. Air Force Academy Center for Aircraft Structural Life Extension (CAStLE). These programs address aging aircraft structures and material degradation. SwRI has developed structural health monitoring systems and specialized inspection probes, as well as the NASGRO® software tool, which analyzes fracture and fatigue crack growth in structures and mechanical components.

SwRI aims to improve the efficiency and accuracy of current methods used to estimate the lifespan of landing gear components by applying the Institute's expertise in flight data recording, full-scale testing, life prediction and probabilistic analysis.

"Our fatigue life prediction experience and probabilistic analysis capabilities set SwRI apart on this work, allowing us to predict the service life of these parts while assessing uncertainties with greater confidence," Hunt said.



JUPITER'S GALILEAN MOON HYDRATION SET AT BIRTH

Io, the most volcanically active moon in the solar system, appears completely dry and devoid of water ice, while its neighbor Europa is thought to harbor a vast global ocean of liquid water beneath its icy crust. A new international study co-led by SwRI and Aix-Marseille University reveals that this striking contrast was established at birth, as they formed around Jupiter, not from later evolutionary processes.

Since the first missions exploring the Jovian system in the late 1970s, scientists have known that Jupiter's moons exhibit markedly different characteristics. Io and Europa provide the most striking example. While Io is a dry and intensely volcanic world devoid of water, Europa is icy and thought to conceal a vast subsurface ocean of liquid water.

"Io and Europa are next-door neighbors orbiting Jupiter, yet they look like they come from completely different families," said SwRI's Dr. Olivier Mousis, second author of an Astrophysical Journal paper detailing these findings. "Our study shows that this contrast wasn't written over time — it was already there at birth."

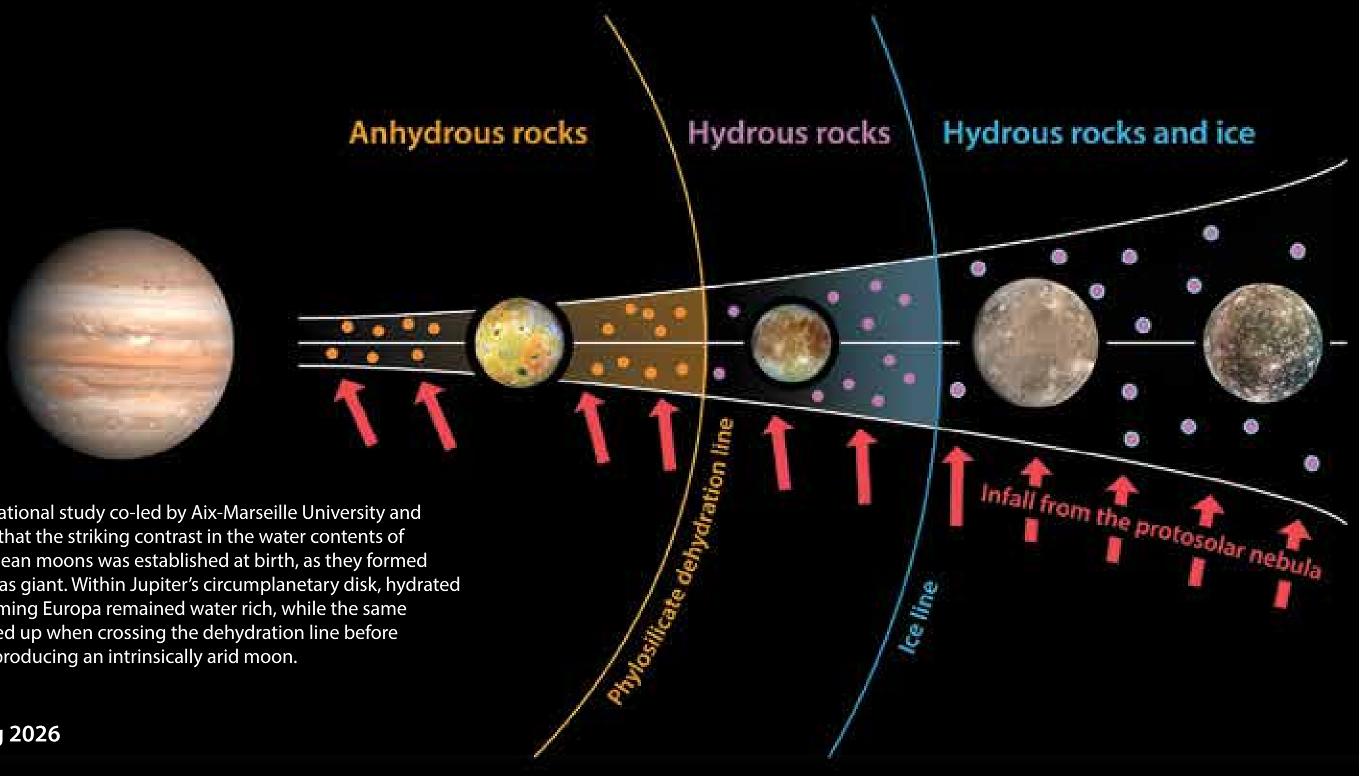
The team tested two main hypotheses to explain the differences. The first suggests that the extreme conditions prevailing close to Jupiter during satellite formation prevented water ice from being preserved, depriving Io of this component from the outset. The second hypothesis proposes that Io and Europa initially formed with similar amounts of water, but Io subsequently lost most of its volatiles over time through atmospheric escape and erosion processes.

The international team reconstructed the earliest evolutionary stages of Io and Europa, assuming that the moons' water originated from hydrated minerals incorporated during formation. Using an advanced numerical modeling framework, the study coupled the internal thermal evolution of the moons with volatile escape processes, accounting for all major heat sources active in the young Jovian system, including accretional heating, radioactive decay, tidal dissipation and Jupiter's intense radiation.

"Io has long been seen as a moon that lost its water later in life," Mousis explained. "But when we put that idea to the test, the physics just refuses to cooperate: Io simply can't get rid of its water that efficiently."

For that matter, Europa would not lose its water either, even under extreme conditions. The findings indicate that Io and Europa were already fundamentally different at birth — Io forming from dry materials and Europa accreting from ice-rich building blocks.

"The simplest explanation turns out to be the right one," Mousis said. "Io was born dry, Europa was born wet — and no amount of late-stage evolution can change that."



A new international study co-led by Aix-Marseille University and SwRI reveals that the striking contrast in the water contents of Jupiter's Galilean moons was established at birth, as they formed around the gas giant. Within Jupiter's circumplanetary disk, hydrated materials forming Europa remained water rich, while the same materials dried up when crossing the dehydration line before reaching Io, producing an intrinsically arid moon.

124669

NMR TECHNIQUE TO ENHANCE DRUG DEVELOPMENT

New upgrades to SwRI's nuclear magnetic resonance (NMR) laboratory identified a robust technique for analyzing organic compounds used in drug discovery and development.

Through internally funded research, SwRI compared quantitative NMR (qNMR) to high-performance liquid chromatography (HPLC) to determine the purity of active pharmaceutical ingredients (APIs). The research confirmed that qNMR is a faster, more cost-effective option to quantify APIs in certain applications.

"When you want to get drugs into trials as quickly as possible, qNMR has the potential to dramatically reduce the time and cost of accurately quantifying APIs and impurities in early phases," said Lead Scientist Dr. Shawn Blumberg, who worked on the project. "For late-stage development, qNMR can complement HPLC, confirming the target compound's weight-for-weight purity — the percentage of a pure substance present in a given sample — and providing more confidence in dose calculations that can lead to a better overall product."

While other studies have shown qNMR can determine the weight-for-weight purity of a variety of organic compounds, publicly available data comparing qNMR to HPLC for pharmaceutical development was sparse. SwRI internal research allowed the team to develop a qNMR technique to accurately analyze and quantify APIs without the high material burden of standard methods while providing direct comparisons to HPLC.

Using large magnets to study the properties of atomic nuclei, NMR techniques can help determine the structures of small-molecule drugs and other chemicals. HLPC is a more complex process requiring multistep experiments and consuming significant amounts of a compound for analysis.

"While HPLC remains the gold standard of quantitative API analysis, the procedure requires significant amounts of material to perform multiple experiments," said Senior Research Scientist Dr. Christopher Dorsey, who served as the project's primary investigator. "HPLC methods must be developed and validated for each compound at each step along the synthetic route. This takes several weeks, increasing product development timelines and expenses and requiring additional synthesis to provide material necessary for assay development."

NMR can identify the product of interest as well as residual solvents and other organic impurities. Using a known amount of a commercially available reference standard, quantitative information about the purity of a compound is possible without using a reference standard of the same compound for comparison.

In SwRI's recently updated facilities chemists compared quantitative NMR (qNMR) to high-performance liquid chromatography (HPLC). The research confirmed that qNMR is a faster, more cost-effective option to quantify APIs in certain applications.

104503

UPCOMING

WEBINARS, WORKSHOPS and TRAINING COURSES HOSTED by SwRI:

Introduction to Propulsion Simulation Using NPSS — Spring Short Course, May 5, 2026, in person

Supercritical Carbon Dioxide Power Cycles, May 6, 2026, virtual

ISO 9001 Internal Auditor, May 11, 2026, in person

Automotive Corrosion Symposium, May 18, 2026, in person

Flow Induced Vibrations (FIV): Reducing the Impact on Piping Systems, May 20, 2026, virtual

Transient Hydraulic Modeling, June 3, 2026, virtual

Wet Gas Compression, June 17, 2026, virtual

TRADESHOWS:

Offshore Technology Conference, Houston, May 4, 2026

Hill Industry Partner Exchange, Ogden, UT, May 5, 2026

7th Annual GCC Innovative Drug Discovery and Development Conference, Houston, May 5, 2026

Holistic Health & Fitness (H2F) Symposium, Hampton, VA, May 12, 2026

Academia, Industry & Military (AIM) Health R&D Summit, San Antonio, May 19, 2026

Microencapsulation Industrial Convention, Valencia, Spain, June 8, 2026

ITS America Conference & Expo, Detroit, June 9, 2026

ChemE Show, Houston, June 9, 2026

Specialty & Agro Chemicals America, Savannah, GA, June 16, 2026

Cyber-Physical Systems Security Summit (CPS3), Rochester, MI, June 16, 2026

Automate, Chicago, June 22, 2026

NSMMS and CRASTE Symposium, Columbia, SC, June 22, 2026

Controlled Release Society Annual Meeting, Lisbon, Portugal, July 6, 2026

Institute of Food Technologists (IFT) First Annual Event & Expo, Chicago, July 12, 2026

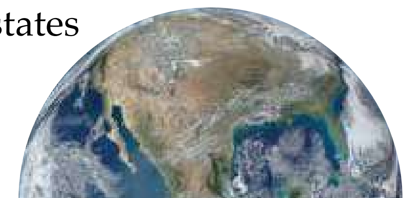
API Inspection and Mechanical Integrity Summit, San Antonio, July 20, 2026

Life Cycle Industry Days (LCID) & Wright Dialogue with Industry (WDI), Dayton, OH, July 27, 2026

BY THE NUMBERS
September 2025–March 2026

34 presentations given in

11 states



& 2 COUNTRIES

18 papers published in **16** DIFFERENT PUBLICATIONS

9 patents awarded

124671

Dr. Barron Bichon has been promoted to vice president of SwRI's Mechanical Engineering Division. He previously served as the director of SwRI's Materials Engineering Department. As vice president, Bichon will lead more than 400 staff members performing research, development, testing and evaluation.

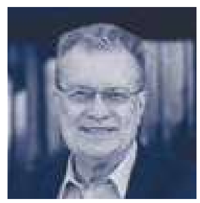
Dr. Pablo Bueno has been named an Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA). Pablo has been AIAA volunteer and was the chair of the AIAA Southwest Texas Section. He is a lead engineer in SwRI's Computational Mechanics Section.

124676

124675

Dr. Michael Davis has been named a Fellow of the Society of Photo-Optical Instrumentation Engineers (SPIE). Davis is an astrophysicist specializing in the design and testing of space instruments, including those used for ultraviolet imaging and spectroscopy. He was named a senior member of SPIE in 2021.

Walt Downing, P.E., has been selected to receive the 2026 IEEE Systems Council Outstanding Service Award for visionary leadership, strong governance, cross-society integration, and advancing systems engineering. Downing is executive vice president emeritus of SwRI.



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Dr. Stephen Fuselier has been appointed as vice president of SwRI's Space Science Division. A noted heliophysicist, He recently served as the co-chair of the National Academies of Solar and Space Physics Decadal Survey. Fuselier joined SwRI in 2011 and served as acting vice president of the division since 2024.

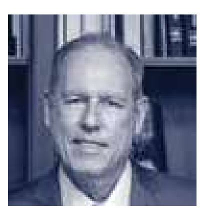
Institute Engineer **Dr. Peter Lee** is the co-editor of a new book titled "Electric Vehicle Fluid Testing." The book focuses on the specialized testing of lubricants and coolants for electric vehicles (EVs), covering new methodologies and critical issues designed to improve EV efficiency and durability.

124674

124712

Dr. Alan Stern has been named a Fellow of the American Astronomical Society (AAS). The honor recognizes his leadership in space science and instrumentation to study the outer solar system. Stern is a planetary scientist and associate vice president in SwRI's Space Sector and the principal investigator of NASA's New Horizons mission.

Dr. Ben Thacker, P.E., has been named chief operating officer of SwRI. Thacker previously served as the vice president of SwRI's Mechanical Engineering Division. In his new role, Thacker directs the operations of the Institute's technical divisions and administers SwRI's internal research program.



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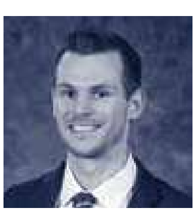

Dr. Chris Thomas has been named an Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA). AIAA Associate Fellows are recognized for overseeing important engineering or scientific work and outstanding contributions to their field. Thomas leads SwRI's Combustion for Defense and Aerospace Applications Group.

TECHNOLOGY
TODAY

Director of Communications
Maria Stothoff

Editor
Deb Schmid

Assistant Editor
Mike W. Thomas

Contributors
Camaron Brooks
Jesus Chavez
Robert Crowe
Joanna Quintanilla

Design
Jessica Vidal

Photography
William Luther
Ian McKinney

Illustration
Bill Livermore

Circulation
Cecilia Novak

Address correspondence to the Editor,
Communications Department,
Southwest Research Institute,
6220 Culebra Road
San Antonio, Texas 78238-5166,
or e-mail **dschmid@swri.org**.
To be placed on the mailing list, visit **update.swri.org**.
To make address changes, call 210.522.2257
or email **solutions@swri.org.**

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