Southwest Research Institute®

Spring 2016

Technology Today

Hidden Structures Revealed

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AVIATION FUEL TESTING

To meet the needs of the Department of Defense, the Energy Institute, and the aviation industry, SwRI maintains facilities to qualify fuel filters, develop new test methods, and enhance aviation fuel technology. The coalescer-separator shown removes dirt and water contaminants from fuel in both commercial and military fuel handling systems. SwRI works with industry organizations to develop and improve quality standards. The Institute also helps industry develop advanced sensing technologies and fuel handling equipment.

AVIATION FUEL FILTRATION

AVIATION FUEL MONITORS

AVIATION FUEL COALESCERS

AVIATION FUEL ADDITIVES

WATER MAPPING TEST

JET FUEL ELECTRONIC SENSOR

MIL PRF 52308J

ELECTRONIC SENSORS

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D021911

ON THE COVER

Flight control surfaces include the flaps, tabs, and spoilers that allow a pilot to adjust and control an aircraft's flight attitude. Using the Institute's recently aquired powerful CT scanner, SwRI engineers imaged the aluminum honeycomb control surface to visualize its internal structure. This 3-D visualization shows a bonding layer running through the structure.

EMPLOYMENT

Southwest Research Institute is an independent, nonprofit, applied research and development organization. The staff of nearly 3,000 employees pursues activities in the areas of communication systems, modeling and simulation, software development, electronic design, vehicle and engine systems, automotive fuels and lubricants, avionics, geosciences, polymer and materials engineering, mechanical design, chemical analyses, environmental sciences, space science, training systems, industrial engineering, and more.

SwRI is always looking for talented technical staff for its San Antonio facilities and for locations elsewhere in the United States. We welcome your referrals. Check our employment opportunities at **jobs.swri.org**.

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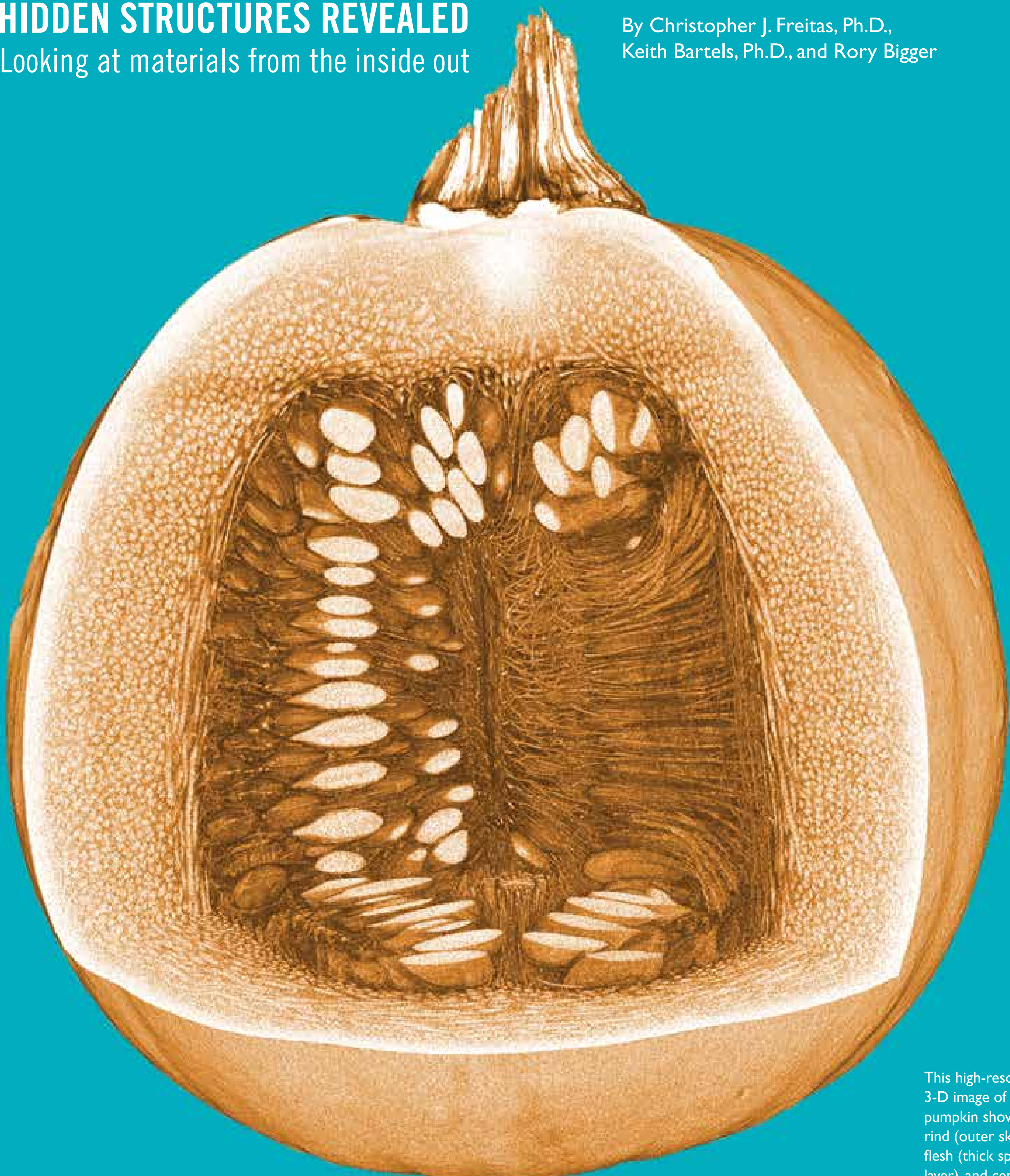
HIDDEN STRUCTURES REVEALED
Looking at materials from the inside out

By Christopher J. Freitas, Ph.D., Keith Bartels, Ph.D., and Rory Bigger



This high-resolution 3-D image of a pumpkin shows the rind (outer skin), flesh (thick spotted layer), and central seed region, including supportive connective fibers.

D021925

D021792_8856

Dr. Christopher Freitas (front right), a program director in the Mechanical Engineering Division, develops computational techniques and experimental methods ranging from fluid flow to terminal ballistics and blast. Dr. Keith Bartels (left) is a staff electrical engineer with more than 30 years of experience in signal and image processing, particularly in medical and nondestructive evaluation applications. Rory Bigger (back right) is a mechanical and aerospace engineer focused on computational mechanics, scientific visualization, and gas dynamics.

Computed tomography or CT imaging is best known for diagnosing medical conditions. Southwest Research Institute is exploring its use in engineering and physical science applications. SwRI recently acquired one of the most powerful industrial CT imaging machines in the state of Texas. This equipment can create three-dimensional volumetric reconstructions of high- and low-density objects, from fabrics and composites to ceramics and metals.

SwRI's CT machine uses high-power X-rays to create a two-dimensional (2-D) projection of each cross-section image. These 2-D images are combined into a 3-D volumetric image that can reveal minute details of the object, from its surface to its core. During actual data acquisition and analysis, the computer images can be rotated in real time, allowing engineers to see and investigate the hidden anatomy, framework, and texture of complex materials and components.

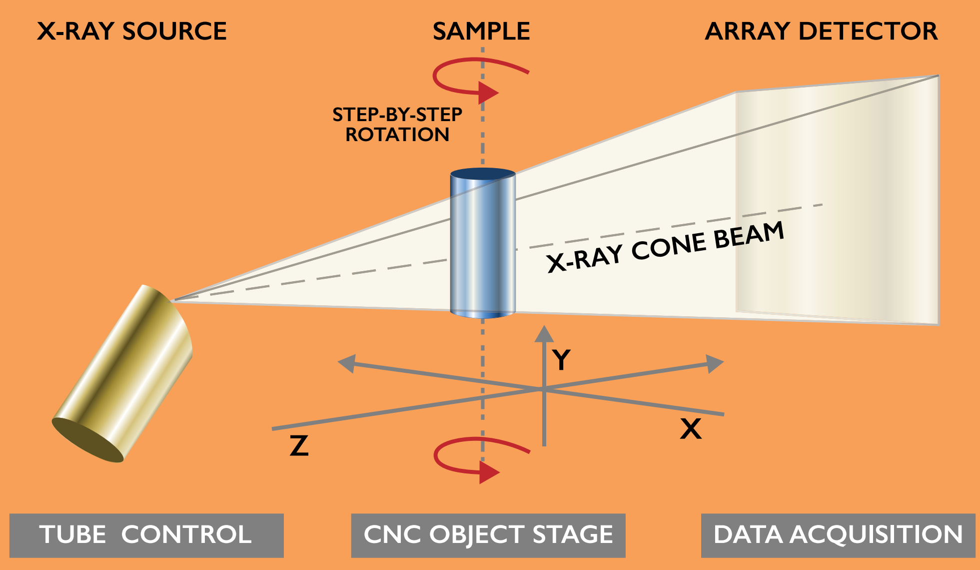
MILITARY APPLICATIONS

Initially, SwRI engineers used CT scanning to diagnose potential problems with military-grade armor and helmets, known as personal protection equipment (PPE). People have been using armor and shields for thousands of years. Protective animal hides and wooden helmets evolved into

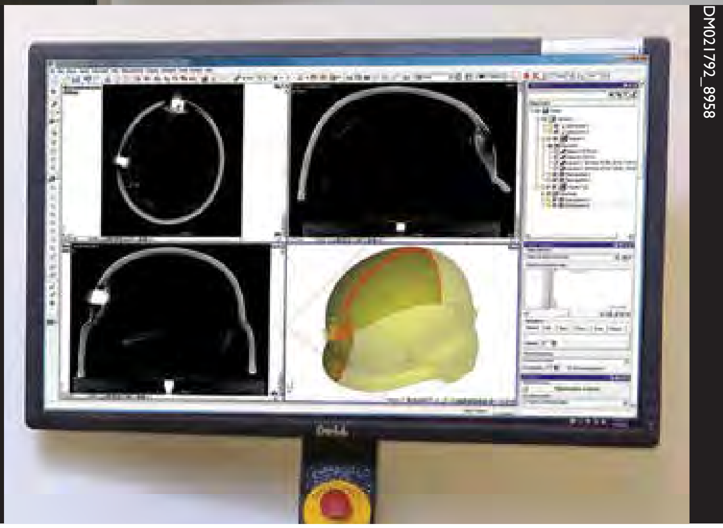
D021912

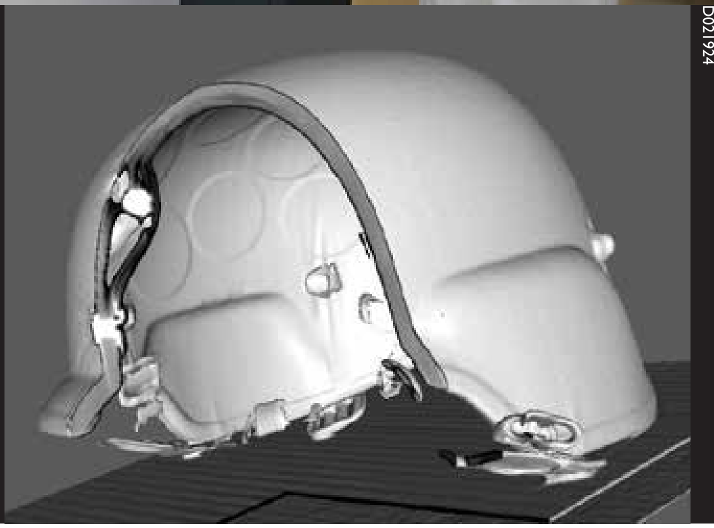
DETAIL

Computed tomography processes and combines many X-ray images taken from different angles to produce cross-sectional images — virtual slices — of specific areas of a scanned object. CT allows you to peek inside a 3-D object.



COMPUTED TOMOGRAPHY / VOLUME RECONSTRUCTION





The CT imaging process collects 2-D X-ray projections and reconstructs (bottom left) and visualizes them as a 3-D volumetric data set (bottom right). The CT image of the helmet shows where a projectile impacted and was halted by the composite material of the helmet.

thin sheets of metal fashioned into increasingly effective, elaborate suits of armor. The development of cannons and guns in the 1500s allowed projectiles to penetrate traditional armor. Increasing metal thickness improved survivability, but eventually metal armor proved too heavy and cumbersome for practical use. In the 1960s, the first lightweight, bullet-resistant materials were developed.

Today's higher velocity and armor-piercing munitions led to reinforcing PPE with complex, multilayered inserts. These plates — with a ceramic face and composite fabric backing — absorb and dissipate a projectile's kinetic energy and momentum, reducing the likelihood of fatal injuries. As a projectile strikes the armor's face, the ceramic and bullet undergo a complex dynamic response. The ceramic plate shatters locally and turns to rubble, which slows, blunts, and potentially fractures the bullet. Then the composite backing spreads the energy of the impact across a larger cross-sectional area and ultimately stops the residual bullet fragments. These complex and layered materials provide effective protection, but are difficult to evaluate for initial manufacturing quality and flaws. They are similarly challenging to evaluate for progressive wear and damage during service.

The Office of Naval Research and Special Operations Command asked SwRI to assess various nondestructive methods to evaluate the quality of, and damage to,

DETAIL

The U.S. Armed Forces began using enhanced inserts in 2005 to provide protection from 0.30-06 M2 armor-piercing rounds with a steel or tungsten penetrator. These enhanced plates are more complex and come with 50 percent cost markup.

DM021792_8818

SwRI developed ESPReSo to automatically evaluate armor components for flaws. A stoplight report indicates if armor is sound (green), has flaws (red), or should be evaluated further (yellow).

ESPReSo AUTOMATED NONDESTRUCTIVE EVALUATION ANALYSIS

INPUT DATA FROM CT HARDWARE

Projection Images (2-D X-rays)

Projection Resolution in Pixels

Detector Pixel Size in Microns

Detector to Object-Center-of-Rotation Distance

Detector to X-ray Source Distance

Rotation-axis to Detector

Center Offset Information

CT RECONSTRUCTION SOFTWARE

Projection Data Read into System Memory

Filter Projections

Backproject Each Filtered Projection

Sum Backprojections

Write Sum to Disk as the Output Data

RECONSTRUCTED OUTPUT DATA

Image Stack of 3-D Data

Voxel Size in Microns

Automated Flaw Detection

STOPLIGHT Report to User/Analyst

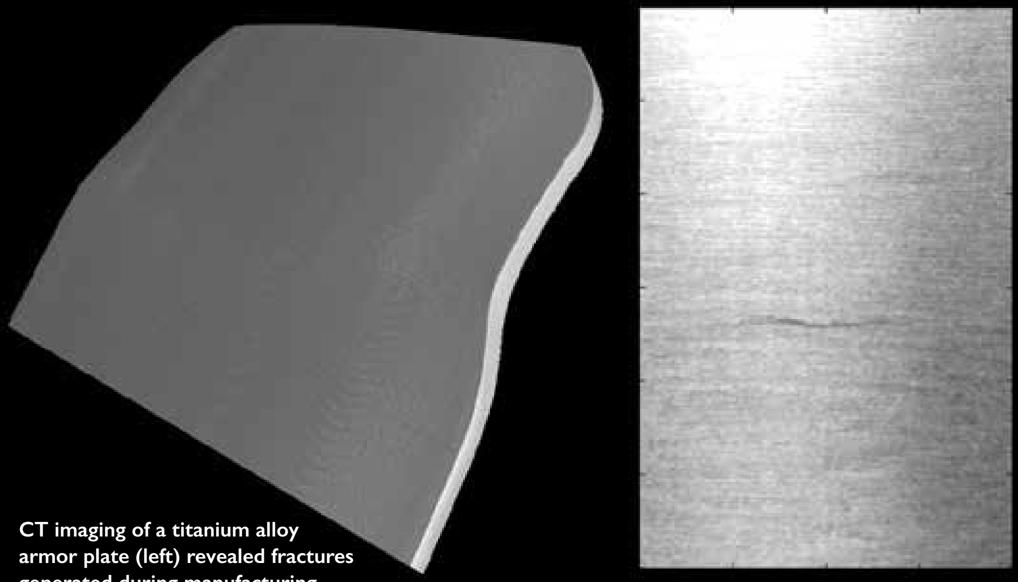
body armor plates and combat helmets. SwRI engineers studied how to assess the quality of enhanced small arms protective insert (ESAPI) plates at delivery and over time, as the equipment was stored and used. Flaws or damage in armor plates can include cracks in the ceramic, flaws in the layer bonding the ceramic with the composite, and voids and delamination in the composite backing material. Combat helmet flaws typically occur in the composite material or the bond layers between the different composite materials used in a specific helmet design — for example, between the carbon outer shell and the polyethylene inner shell. Currently, the military uses 2-D X-ray inspection techniques, which require a technician to manually review images to identify cracks in the ceramic strike face.

The SwRI team reviewed a broad range of nondestructive evaluation methods, including ultrasound, thermography, eddy current, 2-D X-ray, and interferometry, as well as optical coherence and electrical resistance tomography. CT scanning provided the best balance between ease of use, measurement accuracy, maturity of technology, and usage costs.

Using CT image data, SwRI engineers developed a suite of software tools to automatically assess the quality of ESAPI plates and combat helmets. After a few simple keystroke inputs, the software system automatically reconstructs the images and analyzes the 3-D volume. The outcome is displayed as a stoplight plot. Green indicates no detected flaws, red highlights detected flaws, and yellow suggests further data review. In this new process workflow, a technician is no longer required to visually inspect each ESAPI plate or combat helmet. The SwRI-developed software suite is called Enhanced SwRI Projection Reconstruction Software or ESPReSo. As part of this software system, supplemental software automatically detects cracks in the ceramic, voids in composites, and delamination at bondline interfaces.

THE CASE FOR CT INSPECTION

Once SwRI demonstrated the effectiveness of CT imaging to evaluate armor plates and combat helmets, researchers realized these tools could be used for other personal protection equipment and components.



CT imaging of a titanium alloy armor plate (left) revealed fractures generated during manufacturing (right). The fracture shown has a depth of 0.035 inch. These flaws were not detected by 2-D X-ray imaging.

D021913

Based on interest from military clients, SwRI set out to acquire a new, high-powered CT machine.

SwRI's high-resolution machine has a microfocus, variable-power X-ray tube capable of imaging materials at the micron level. Maximum voltage and power are 240 kilovolts and 320 watts. The 16-inch square surface image plate offers high-definition resolution at speeds of 8 frames per second. The machine accommodates samples up to 20 inches wide, 31 inches high, and 110 pounds. A high-speed, multi-GPU workstation provides quick reconstruction of image data. The dual CPU workstation has 128 GB of RAM, supplemented by a parallel GPU processing subsystem with more than 5,000 processors. Powerful graphics cards and visualization software support tools for metrology as well as porosity and inclusion analyses. The software automatically generates surface and volume data. A free version of the visualization components of the software is available for clients.

BROADER APPLICATIONS

Since October 2015, SwRI has imaged a range of objects beyond the original application of personal protection components. The imaging team has scanned and analyzed a range of components, including automobile cylinder heads, canister filters, medical devices, electronic circuit boards, multi-ply fabrics, and soil samples. Engineers anticipate using CT image data analysis to diagnose material characteristics and potential maladies for a wide range of applications, supporting almost any project requiring detailed analysis of internal structures.

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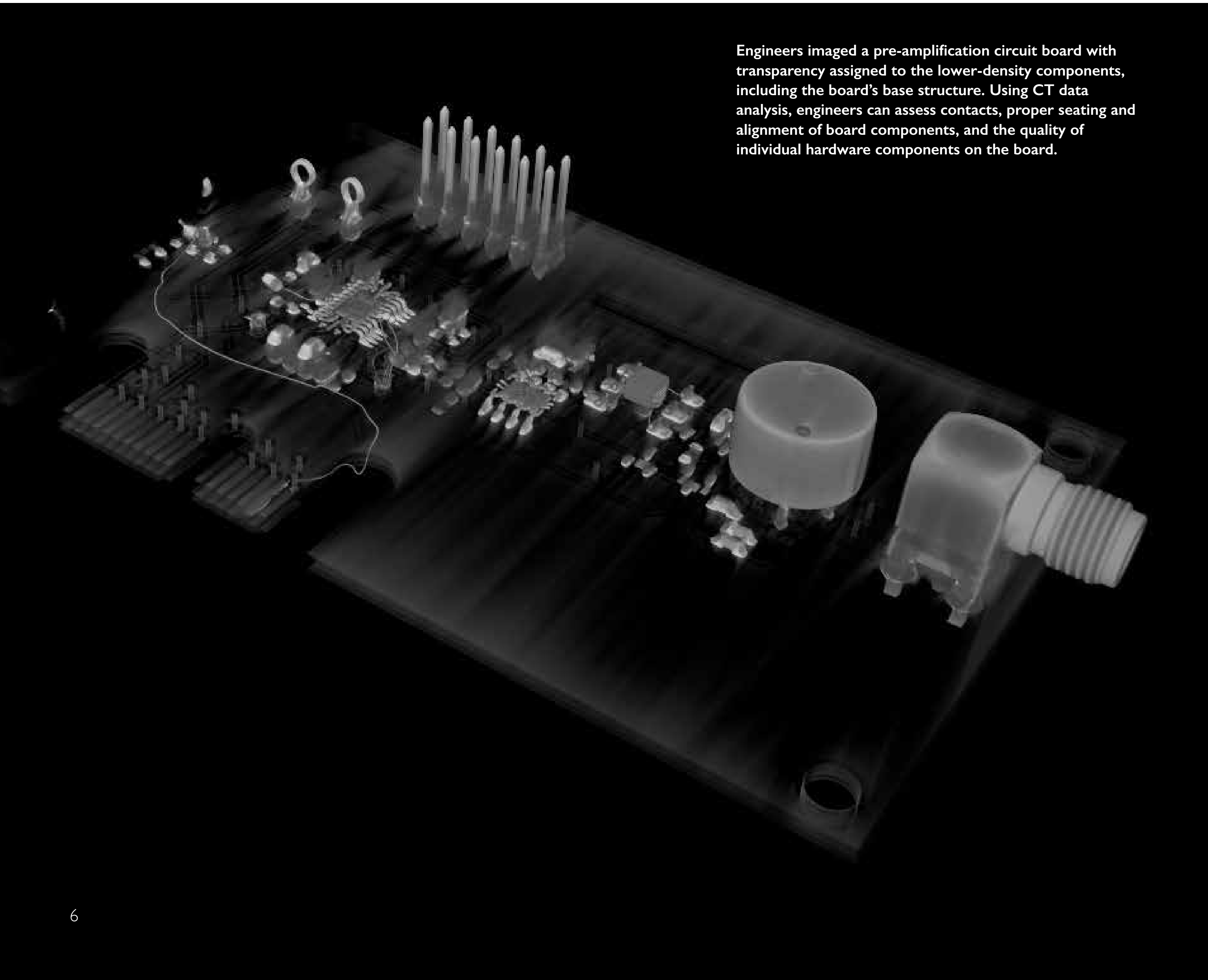


Engineers imaged a pre-amplification circuit board with transparency assigned to the lower-density components, including the board's base structure. Using CT data analysis, engineers can assess contacts, proper seating and alignment of board components, and the quality of individual hardware components on the board.

D018049_9284

Above: Laboratory-scale plants allow SwRI to perfect and prove chemical processes.

Right: SwRI's multi-place tester simultaneously evaluates multiple catalysts under a matrix of test process conditions.

D019770_7675

CRACKING THE PROCESSING CURVE

In SwRI's Chemical and Refining Process Labs, technology breakthroughs help clients stay ahead of the competition. SwRI chemical engineers have extensive hands-on expertise in pilot plant design, from bench-scale to large demonstration units.

Using packed- and fluidized-bed reactors, SwRI develops pilot plants for hydrotreating and hydrocracking hydrocarbons. Batch reactors support chemical processing and continuous distillation. Computer-based process simulation and analytical capabilities accurately determine chemical composition of feed and products.

SwRI's innovative gas-to-liquid technology offers superior carbon efficiency compared to the standard Fischer-Tropsch processes. The Institute develops novel hydroprocessing techniques to upgrade crop and algae oil and other bioderived feedstocks.

Promising new technologies include accelerated catalyst life testing, sulfide agent catalyst assessments, and optimized lubricant production. SwRI expertise includes producing specification-grade products from waxes and liquids, high octane gasoline from lignin, and jet fuel from alcohols.

chemeng.swri.org

Large-scale pilot plants allow engineers to scale-up processes and demonstrate real-world performance.

D018422

SwRI HELPED SHAPE THE BIGGEST SCIENCE STORY OF 2015

NASA's New Horizons mission was a top science story last year and elevated Pluto into the pop culture zeitgeist with the first high-resolution images of a frozen world with active geology and eccentric spinning moons.

"We're only getting started learning about Pluto's geology and atmosphere as we seek to improve our understanding of this fascinating planet," said Dr. Alan Stern, the principal investigator of New Horizons and an associate vice president at Southwest Research Institute (SwRI).

In a year of major space discoveries — including potential liquid water on Mars — the closest Pluto flyby stood out as the historic space exploration achievement of this decade. After traveling over nine years and 3 billion miles, the spacecraft buzzed past Pluto on July 14, 2015, flying within 7,750 miles of its icy surface.

The successful exploration of Pluto by New Horizons earned over 20 awards in 2015 and 2016, including the National Space Society Pioneer Award for Science and Engineering, the American Astronautical Society (AAS) Neil Armstrong Space Flight Achievement Award, the Air and Space Medal of the National Air and Space Museum, the Goddard Trophy of the National Space Club, and the John L. "Jack" Swigert Jr. Award for Space Exploration of the Space Foundation.

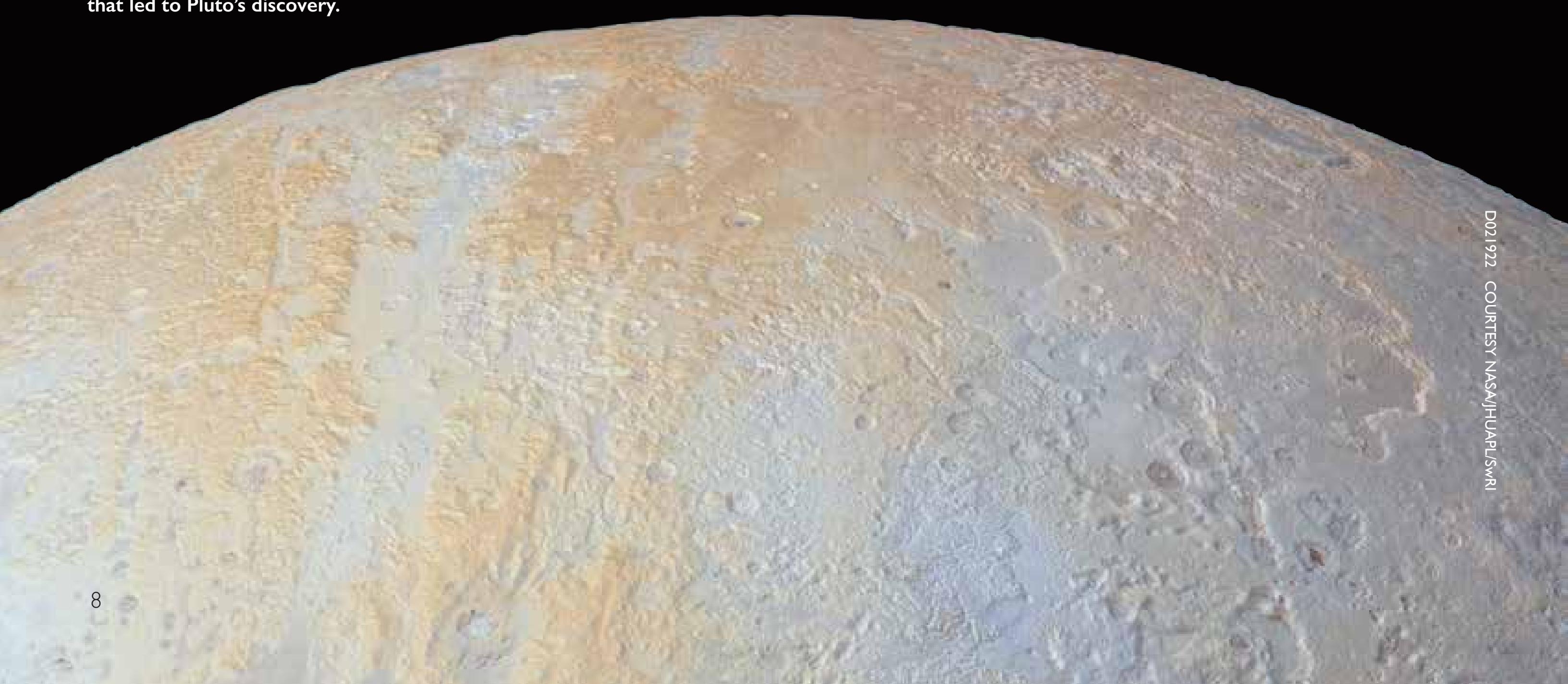
Among many results, the New Horizons science team has already discovered two potential cryovolcanoes on Pluto, measured the pressure of Pluto's atmosphere, and shown evidence of large ice flows that may be shaping the planet's geology. Over the next several months, the New Horizons team will continue to study the composition and structure of Pluto's atmosphere as well as the geology, morphology, and temperature of its surface and its five satellites.

Led by SwRI, the mission team includes the Johns Hopkins University Applied Physics Laboratory, NASA's Goddard Space Flight Center, University of Colorado, Stanford University, and Ball Aerospace & Technologies Corp.

The piano-sized spacecraft has collected over 50 gigabits of Pluto system data with the seven instruments aboard New Horizons. The scientific payload includes the Ralph infrared multi-spectral imager, the Alice ultraviolet spectrograph, the Solar Wind Around Pluto (SWAP) detector, the Long-Range Reconnaissance Imager, twin Radio Science Experiments, the Pluto Energetic Particle Spectrometer Science Investigation, and the Student Dust Counter.

The Alice instrument, developed and built at SwRI, measured how quickly molecules escape Pluto's atmosphere. Measurements by the SwRI-built SWAP instrument revealed that the region where the planet's escaping atmosphere and the solar wind interact is

Long canyons run vertically across Pluto's north polar area — part of the informally named Lowell Regio. Percival Lowell initiated the search that led to Pluto's discovery.



D021922 COURTESY NASA/JHUAPL/SwRI

much smaller than expected. Imagers aboard New Horizons found distinct global haze layers stretching high over Pluto's surface that the atmosphere team, led by SwRI's Dr. Randy Gladstone, are still trying to understand.

"This is a world-class team effort from so many talented SwRI scientists and partner organizations," said Dr. Jim Burch, vice president of SwRI's Space Science and Engineering Division. The mission was also named 2015's top science story at Discover Magazine, Discovery.com, Science News, and Astrobiology, and it earned recognition from Scientific American and Nature. It was also a banner year for Stern, who led the New Horizons mission from its inception as a proposal 15 years ago. TIME magazine recently named Stern to its 2016 list of the 100 most influential people — for the second time since 2007. Stern also earned the AAS Carl Sagan Memorial Award, the American Ingenuity Award by Smithsonian magazine, and he was named an Honorary Fellow of the Royal Astronomical Society. He also took first place in Space News Leaders Making a Difference for 2015.

Located more than 3 billion miles from the Sun, Pluto has captivated the interest of scientists and school children since astronomer Clyde Tombaugh discovered it in 1930. Widely considered a binary planet, Pluto and its Texas-sized moon Charon are locked in orbit together around one another. Four smaller moons orbit the binary.

MOONS & GEOLOGY

Pluto's moons have provided some of the most intriguing findings to date. New Horizons revealed that Charon also has experienced extensive resurfacing and extensional tectonics (stretching of the crust) and has somehow acquired a dark, red stain at its north pole. The flyby also showed that the smallest moons — Styx, Nix, Kerberos, and Hydra — actually behave like spinning tops.

Earth's moon and most moons in our solar system do not spin in this way. Instead, they are locked in synchronous rotations, i.e., with one face always toward the parent body. Hydra, the farthest moon from Pluto, was observed rotating 89 times every time it circled Pluto. Those spin rates may actually vary with a force exerted by Charon. Nix and Hydra also have surface reflectivities that are higher than Charon's.

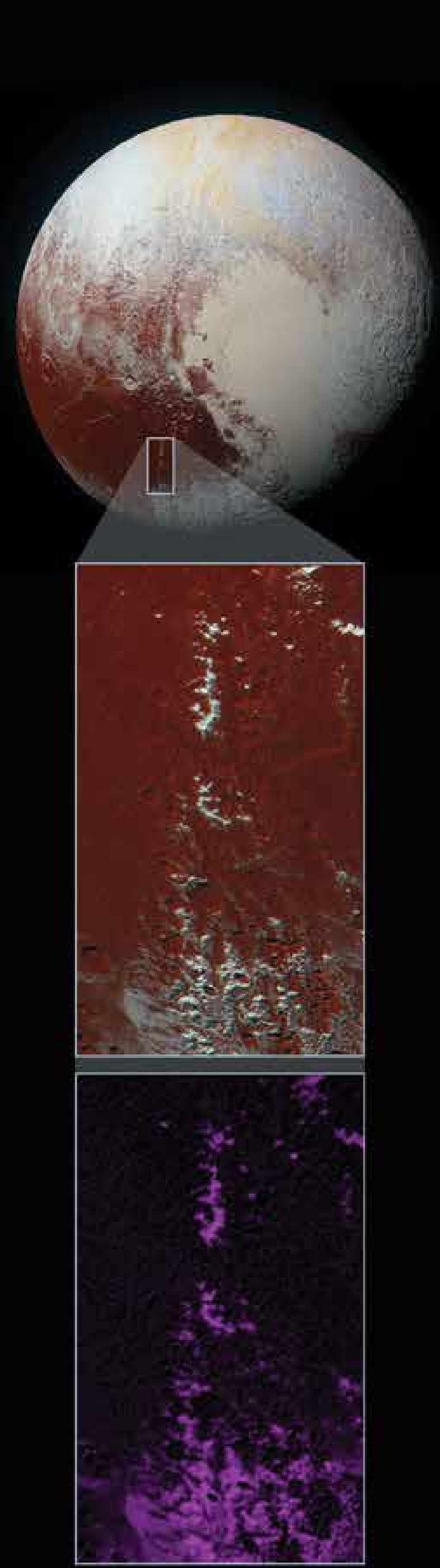
In addition to its already known nitrogen and methane ices, Pluto's surface was discovered to also have widespread water ice. Scientists observed flowing glaciers of solid nitrogen ice with large "floating hills" or "icebergs" of water ice in the informally named "Sputnik Planum" area. New Horizons geologists have presented 3-D maps indicating that two large mountains on Pluto could be cryovolcanoes, or ice volcanoes that may emit water ice, nitrogen, ammonia, or methane.

The scientists are trying to determine the ages of different surface areas on Pluto through the density of impact craters. SwRI researchers have mapped more than 1,000 craters. The estimated surface ages range from 10 million to 4 billion years, meaning that Pluto has been active throughout its over 4 billion year history — a surprise that has delighted scientists.

WHAT'S NEXT?

The New Horizons team hopes to extend the mission deeper into the Kuiper Belt, an area of icy objects at the far reaches of the solar system. Pending approval from NASA, the spacecraft would travel nearly 1 billion miles beyond Pluto to fly by a small (~19 miles wide) Kuiper Belt Object (KBO) known as 2014 MU69 on New Year's Day in 2019.

"As we continue analyzing data from Pluto and its moons, and then explore the distant Kuiper Belt Object, we can glean a better understanding of how Pluto and other small planets formed in our solar system," Stern added. "We really know very little about KBOs. They are going to help us connect the dots to understand how planets form. And the great thing about the Kuiper Belt is that it's colder than anywhere else in our planetary system, so it's a wonderful environment to preserve chemical and geological information about the origin of the solar system. Going to the Kuiper Belt is like an archaeological dig into the history of the solar system," Stern said.



D021914 COURTESY NASA/JHUAPL/SwRI

A chain of methane snow-capped mountains stretches across the dark expanse on Pluto informally named Cthulhu Regio. The region known as Cthulhu (pronounced "k-thu-lu") extends nearly halfway around Pluto's equator and is a little larger than Alaska, covering more than 700,000 square miles.

THE METHANE DETECTORS CHALLENGE

SwRI researchers are evaluating a new generation of low-cost sensors to mitigate greenhouse gas emissions

By Shane Siebenaler

DM02829_0310

In late 2015, the Paris climate meetings brought climate change back into the national media spotlight. What's driving climate change and the actions needed to address it are complex and varied. There is no silver bullet, and activity in a number of areas is needed.

Shane Siebenaler is manager of the Fluid Dynamics Section in SwRI's Mechanical Engineering Division. He oversees research and evaluation related to leak detection, product qualification, erosion, and flow performance mapping primarily for clients in the oil and gas industry.

The effect of greenhouse gases on the environment is of paramount concern, and one area of emphasis is reducing methane emissions. Methane is the dominant molecule in natural gas, a significant energy source in the United States. Methane emissions are a byproduct of industrial operations, landfills, and agricultural processes. While methane is a valuable commodity, it also is a powerful greenhouse gas. On time scales of hundreds and thousands of years, carbon dioxide has a greater impact because it stays in the atmosphere longer than methane. However, in the shorter term (tens of years), methane has a far greater per-unit impact on the climate. Over a 20-year span, the global warming potential of methane is 84. This measure expresses the heat-trapping potential of a gas relative to carbon dioxide, meaning that methane traps 84 times as much heat per molecule.

Many studies indicate that dampening the rate of increase in global temperatures over the next 100 years requires substantial cuts in both methane and carbon dioxide emissions.

For the past year and a half, Southwest Research Institute (SwRI) has played a key role in the Methane Detectors Challenge (MDC), a multi-organizational collaboration aimed at curbing methane emissions in the gas-producing sector. The Environmental Defense Fund (EDF) initiated the MDC to expedite the development and commercialization of low-cost continuous detection technologies. The MDC is a collaborative, multi-stakeholder partnership to improve the speed and cut the costs associated with methane detection from natural gas facilities to reduce overall methane emissions. The program leverages a unique collaboration among an environmental advocacy group, seven oil and gas operators, and a number of independent reviewers from industry, government, and academia.

METHANE AND THE OIL AND GAS INDUSTRY

So how significant are methane emissions from the oil and gas sector? In 2015, the Environmental Protection Agency (EPA) estimated annual methane emissions from oil and gas operations in the United States at 7.3 million metric tons, about the same greenhouse effect as the carbon emissions from 129 million cars.

Another way to look at this problem is to assess what it would take to remove this amount of emitted methane. Forests naturally soak up methane from the atmosphere. How much forest would be required to remove this amount? The U.S. would need about 500 million acres of forest — equivalent to the entire combined land surface of Texas, California, Arizona, Oklahoma, Louisiana, and New Mexico.

D021486_1821

A "two-gun" laser system detects methane concentration of long distances. This sensor technology detects changes along the entire path as opposed to a stationary "point" sensor.

Studies show that a small number of sites account for the majority of emissions releases. These events often result from equipment failure or operators failing to close valves or hatches on tanks. Not all methane leaks are unintentional. In the oil and gas industry, some methane is vented deliberately to remove pressure during maintenance or other operations. But emissions from undetected leaks comprise a significant portion of all emissions.

Any lost product reduces the value of the total produced gas. So, independent of the significant environmental cost of methane emissions, there is an economic incentive for companies to rapidly detect and mitigate such leaks.

Detecting a large outlet of emissions requires continuous monitoring. Traditionally, emissions detection for well pads and compressor stations is conducted through infrequent surveys with relatively expensive instrumentation. These factors highlight the need for low-cost technologies that can detect emissions around the clock and can be deployed at every well pad, compressor station, and other unmanned facility. Reducing large-scale emissions could be achieved by a two-state (leak, no leak) sensor that operates much the same as a household smoke detector. The methane detector would then prompt personnel to visit the site and investigate the possible emissions source.

THE METHANE DETECTORS CHALLENGE

SwRI's role in the MDC began in 2014 with laboratory testing of five sensor technologies selected from a pool of more than 20 applicants from industry and academia. Four of the five technologies were selected for further development and assessment in a follow-up effort at SwRI in 2015. Additional development required outfitting the core sensors with solar panels and rugged data acquisition systems in a period of just a few months.

Because of the vast number of unmanned sites, these sensors need to be relatively low cost ($1,000 per site at production scale). They also need to measure methane concentrations at orders of magnitude lower than the explosive limit of the gas, which is the target for many off-the-shelf sensors. Candidate technologies ranged from sensors used in cars to prevent inebriated drivers from starting them to laser-based monitors used to detect the buildup of harmful gases in coal mines.

The U.S. would need about 500 million acres of forest – equivalent to the entire combined land surface of Texas, California, Arizona, Oklahoma, Louisiana, and New Mexico – to remove the estimated annual oil and gas methane emissions from the atmosphere.

SwRI designed and conducted tests to evaluate the ability of the candidate technologies to find realistic leaks. The first series of tests used a chamber designed and built by SwRI to accurately control the background concentrations of the atmosphere in the chamber to simulate very small changes in the methane concentration. Additional tests assessed whether or not elevated levels of other contaminants such as ethane and carbon dioxide affected sensor performance. Testing also included various temperature and

Research Engineer John Edlebeck installs a set of solar-powered electro-chemical sensors that detect small changes in background methane concentration.

humidity levels to quantify how extreme environmental conditions affected sensor performance. This was crucial because the sensors must withstand environments that range from the harsh winters of North Dakota to the blistering summers of south Texas.

Testing showed that some technologies could quantify methane levels in a static (i.e., not windy) environment down to one part per million, which is as accurate as sensors costing more than $50,000. SwRI conducted iterations of these tests to allow developers to improve their technologies as performance data became available.

The focus of the technology assessment was to release methane outdoors in conditions that would mirror actual well pads and compressor stations. Over a span of several months, researchers conducted tests at two outdoor SwRI facilities. During testing, the technologies had to be powered by solar panels and batteries. Two of the technologies communicated to data acquisition computers through wired connections, and two used wireless routers.

Testing involved methane releases as small as 0.5 standard-cubic-feet-per-minute at distances up to 130 feet between the leak source and the sensors. A key aspect of such leaks, both in this testing and at real locations, is that the concentration of methane is highly variable as wind moves around the gas plume. Thus, the sensors must be able to respond almost instantaneously to "peaks" of methane to accurately gauge whether or not an unplanned release is present.

Two sensors detected most (and in one case, all) leaks without generating any data that would be interpreted as a false alarm. The testing also demonstrated that the technologies could withstand harsh outdoor climates and run unattended for long periods of time.

While there are opportunities for these technologies to be further improved, this challenge demonstrated that these relatively low-cost technologies can be used as continuous monitoring devices in a "hands-off" manner.

FUTURE WORK

SwRI is working with EDF to conduct field testing of two of the technologies at a handful of sites across the United States. Testing is expected to begin sometime this year.

ACKNOWLEDGEMENTS

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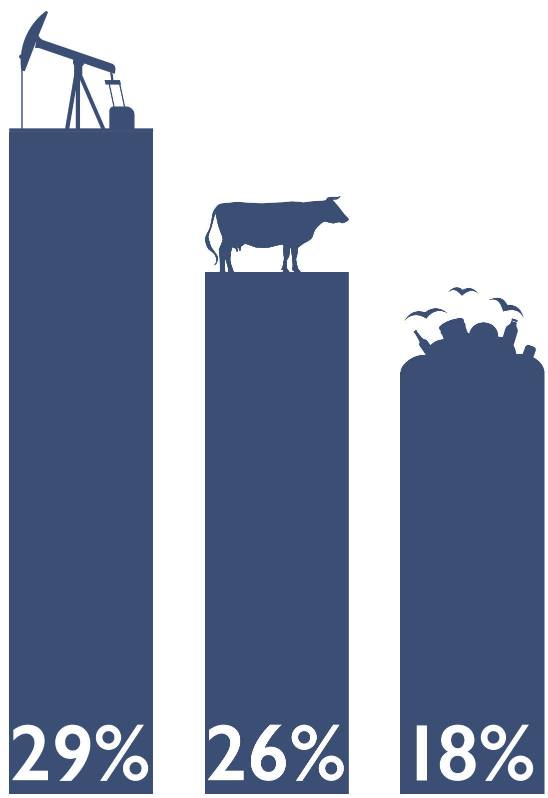
Questions about this article? Contact Siebenaler at (210) 522-5758 or shane.siebenaler@swri.org.

D021503_7799

Methane is a colorless, odorless gas. So why do we smell something akin to rotten eggs? An odorant called mercaptan is added to the gas so we can detect it. Mercaptan contains sulfur, which accounts for the distinctive odor.



According to the U.S. Environmental Protection Agency, the three largest sources of methane are from natural gas and petroleum systems, domestic livestock, and landfills.

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AHEAD LAUNCHED

SwRI is forming a new consortium to advance automotive cylinder head designs. The four-year Aluminum Head Evaluation, Analysis, and Durability (AHEAD) consortium seeks to reduce the weight while improving the durability of aluminum cylinder heads — increasingly important as materials and components are pushed to their limits in modern engines.

Potential areas of concentration include, but are not limited to, advances in:

- Casting processes
- Structural design
- Analysis procedures
- Material characterization
- Aluminum alloy materials for high-temperature resistance
- Measurement and prediction of residual stresses

"As fuel economy and greenhouse gas regulations drive the need for lighter-weight engines, cylinder heads and their components will need to change," said SwRI Manager Douglas Eberle. "AHEAD offers a cost-effective way for manufacturers to develop new technologies that stand up to the heavy demands of modern engines."

CHEDE CONTINUES

In other consortia news, SwRI is launching the seventh phase of the industry's longest-running diesel research consortium, Clean High-Efficiency Diesel Engine VII (CHEDE-VII). Building on more than 24 years of experience, CHEDE-VII develops pre-competitive diesel engine technology initiatives to address the needs of industry five to 10 years into the future.

"We will suggest a number of research areas that we think are important for the consortium membership to investigate. The members, though, will determine the direction of the research over the four years," said Dr. Charles Roberts, who leads the consortium. Over the past 25 years, membership in the consortium has included major diesel engine manufacturers as well as electronics, fuels and lubricants, and other affiliated systems suppliers.

AC²AT STARTS SECOND YEAR

The Advanced Combustion Catalyst and Aftertreatment Technologies (AC²AT) consortium is focusing on four research projects in its second year. The joint-industry program is evaluating engine emissions and developing tools to improve advanced engine technologies through the application of catalysts.

"In the first year, we've made progress in our understanding of the complex nature of emissions from today's high-performance, high-efficiency gasoline and diesel engines," said Dr. Cary Henry, who leads the AC²AT consortium. "This year we will focus on specific projects to improve aftertreatment and fuel efficiency strategies for these engines."

SwRI has a long history of managing successful consortia for the automotive industry. Other ongoing programs include the the Advanced Engine Fluids (AEF) and the High-Efficiency Dilute Gasoline Engine (HEDGE) consortia. HEDGE developed the Dedicated-EGR® technology now being integrated into production engines. Members benefit from the collective funding of consortia like these, enabling substantially more pre-competitive research than is typically possible with funding by a single client.

The initial research focus of the new AHEAD consortium will be on aluminum cylinder heads like these, used for both gasoline and diesel engines.

New Views Reveal Changing Landscapes

Dr. Marius Necsoiu, a remote sensing scientist, has been analyzing aerial and satellite imagery to reveal how a warming climate impacts everything from Romanian rock glaciers to permafrost in the arctic tundra.

The most recent study, published in Nature Geoscience in March, used analyses of aerial and satellite images to help an international team of 19 researchers identify widespread changes to the arctic tundra. Thawing underground ice is degrading permafrost formations known as ice wedges. This study is the first to determine that rapid melting has become widespread throughout arctic regions in Alaska, Canada, and Russia. Necsoiu compared historical aerial photos and satellite images from 1948 to 1990 with recent images taken from 2005 and 2012. Combined with field observations, the team's analyses showed that deep troughs formed in the landscape as ice wedges melted.

Necsoiu is also studying how a warming climate is affecting permafrost regions in Europe. National Science Foundation-funded analysis reveals changes to rock glacier movements and alpine lakes in the Southern Carpathian Mountains of Romania. Both projects received attention in mainstream media and the scientific community. In March and early April, the scientific social media site ResearchGate.com ranked Necsoiu as the most popular SwRI researcher by reads.

"That was a nice little feather in our cap for this extremely important field of work," noted Dr. Wesley Patrick, SwRI's vice president of Geosciences and Engineering.

D021915 COURTESY GEORGE BURBA

A new study reveals rapid melting of ice and permafrost is altering Alaska, Canada, and Russia.

D021916

SwRI HELPING FIREFIGHTERS ADOPT DRONES

First responders are looking at aerial drones as useful tools for search-and-rescue missions, but it's difficult to know which drone's capabilities will match a particular need.

Under the ASTM E54 technical committee on Homeland Security Applications, SwRI is leading a worldwide team of robotics experts developing drone testing and training standards for first responders.

"The principles of flight are the same for hobby aircraft as they are for tactical drones, so first responders don't have to spend a lot of money to learn how to fly," said SwRI's Senior Research Engineer Andrew Moore. "When the time does come to make a purchase, our test bed will help them to better understand each drone's performance and make informed purchasing decisions."

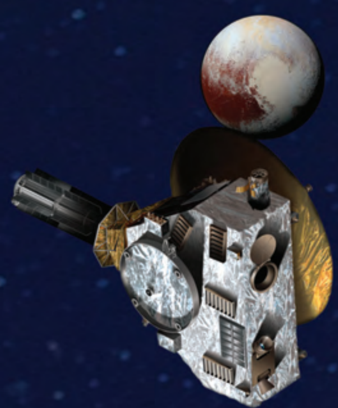
On Jan. 27, members of the Austin Fire Department and San Antonio Police Department visited SwRI to learn more about the project — and test their flying skills. They operated quad-copters equipped with cameras to conduct visual tests to determine camera visibility in tight conditions.

SwRI's current test facility is 16 feet by 24 feet, and includes a bank of 16 fans to simulate windy conditions and obstacles to test tight maneuvers. Constructed of wood, it is covered in netting to help protect operators. Over the next several months, committee members will test a variety of drones as they develop standards. A prototype test facility is scheduled to be delivered to the Austin Fire Department this spring.

2015 | PLUTO FLYBY

NEW HORIZONS MISSION

Helping us understand worlds at the edge of our solar system by making the first reconnaissance of Pluto and its moons



Launch: 19 January 2006
Pluto Closest Approach: 14 July 2015
Top Speed: 52,000 mph
Mass at Launch: 1,054 lbs
Power: Radioisotope thermoelectric generator

Alan Stern
Principal Investigator
NEW HORIZONS
SwRI Boulder

Scott Bolton
Principal Investigator
JUNO
SwRI San Antonio

- Closest point of flyby: 7,750 miles above Pluto
- When New Horizons visited Pluto, it set the record for the most distant object ever visited by a spacecraft
- Payload includes the first student-built instrument ever to fly on any planetary mission
- New Horizons carries some of the ashes of Clyde Tombaugh, the discoverer of Pluto

Earth = 1/11th the diamenter of Jupiter
Pluto = 1/6th the diameter of Earth

Launch: 5 August 2011
Jupiter arrival: 4 July 2016
Top Speed: 165,000 mph
Mass at Launch: 7,992 lbs
Power: Over 650 square feet of solar arrays

- Closest planned orbit: 3,100 miles above Jupiter
- Broke the record to become humanity's most distant solar-powered explorer
- Upon arrival at Jupiter, will be the fastest human-made object in history
- Payload includes JunoCam, NASA's first public outreach camera, to provide the first-ever glimpse of Jupiter's poles, and three space-grade aluminum LEGO® figures of the Roman god Jupiter, his wife Juno, and Galileo Galilei, the first astronomer to observe Jupiter through a telescope

Revealing the history of the solar system by studying the origin and evolution of the giant planet Jupiter

JUNO MISSION

JUPITER ARRIVAL | 2016

IMAGES COURTESY NASA

FROM THE SMALLEST TO THE LARGEST

SwRI WINS TWO 2015 R&D 100 AWARDS

SwRI took home two prestigious R&D 100 Awards. R&D Magazine recognized SwRI's CAsed Pipeline COrrosion Model (CAPCOM) and Ranger localization technology as being among the 100 most significant innovations for 2015.

CAsed Pipeline COrrosion Model (CAPCOM)

CAPCOM allows engineers to evaluate corrosion conditions of cased pipeline sections, where product-carrying pipes are encased within an outer shell of protective piping. The software also allows engineers to evaluate the effectiveness of cathodic protection systems under the complex geometrical, electrical, and environmental conditions associated with cased pipeline segments at highway, railroad, and river crossings.

"These assessments are vitally important for evaluating the thousands of cased crossings estimated by the U.S. Department of Transportation to be located nationwide, many in high-consequence areas," said lead developer Dr. Pavan Shukla. "Pipeline corrosion is a big issue, a big challenge. CAPCOM helps make pipeline infrastructure safer by providing a tool to analyze the corrosion conditions of the pipeline in this complicated environment."

Ranger

Ranger is a patented approach to vehicle localization, providing precise position and orientation measurements using a ground-facing camera and localization algorithms. Ranger images the unique "fingerprint" of road surfaces, allowing precise automated driving within 2 centimeters, similar to the most accurate GPS systems. Ranger, however, can operate in areas or environments where GPS has poor performance or fails completely.

"Localization for automated vehicles is a significant challenge," said Ranger lead developer Dr. Kristopher Kozak. "GPS is very good; it's ubiquitous, everybody has GPS on their phones, but it's not always as accurate as you need it to be for autonomous and automated vehicle localization. Ranger is a low-cost, high-precision localization system that overcomes a lot of problems affecting GPS systems."

Two other SwRI research initiatives were among the finalists. The **Dynamic Crevice Sampling System** allows researchers to sample gases and fluids present inside an engine's combustion chamber at a precise point in the engine cycle. This tool allows a better understanding of the physics and chemistry of in-cylinder processes in engines, ultimately allowing the industry to develop more efficient and cleaner engines.

The **FOCAS® Hot Gas Transient Reactor (HGTR)** is a unique emissions research tool for diesel engine catalyst evaluation and calibration. It is the first fully transient, full-sized, continuous reactor rig, allowing engineers to evaluate full-sized catalysts independent of the actual engine and its operating constraints.

"Since 1971, SwRI has won 40 R&D 100 Awards, considered the 'Oscars of Invention,'" said SwRI President Adam L. Hamilton, P.E. "We're pleased our work has been recognized in such a well-respected forum." R&D 100 Awards are selected by an independent panel of judges and editors of R&D Magazine to honor the top technology products of the year.

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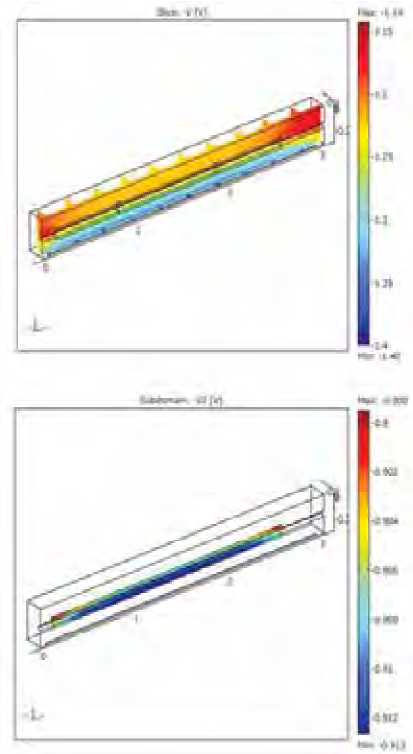


CAPCOM allows engineers to predict corrosion conditions in difficult-to-inspect cased pipeline segments, where a carrier pipe is protected by a casing pipe. CAPCOM models the conductive properties outside (top) and inside the casing (bottom).

D021921

This image shows 10 automated vehicle loops around a slalom course. With Ranger, vehicle position (in green) varied by less than 5 centimeters, compared to GPS measurements (in yellow), which varied by as much as 2 meters. Ranger provides precise position and orientation measurements for automated vehicles using a ground-facing camera and localization algorithms.

D021917 COURTESY NASA/JPL-CALTECH

MATERIAL DIFFERENCES

SwRI scientists combined dynamical, thermal, and chemical Moon formation models to explain key differences between the composition of lunar rocks and those on Earth. Moon rocks are more depleted of volatile elements such as potassium, sodium, and zinc, which tend to have lower boiling points and vaporize readily.

"Explaining the Moon's volatile depletion has been a long-standing mystery, and yet it is a key piece of evidence about how the Earth-Moon system formed," said SwRI Associate Vice President Dr. Robin Canup, a lead author of a Nature Geoscience paper detailing the findings.

Scientists think the Moon formed from an Earth-orbiting disk of vapor and molten matter produced by a giant impact between Earth and a Mars-sized body approximately 4.5 billion years ago. Previously, scientists had considered that volatiles vaporized by the impact might have escaped before the Moon formed.

"However, few volatiles may have actually been lost because the velocity needed to escape the Earth's gravity is quite high," said Canup. "The new research suggests instead that as the Moon completed its growth, volatile-rich melt was preferentially deposited onto the Earth, rather than onto the growing Moon."

Canup's team included researchers from SwRI, Dordt College, and Washington University. The paper, "Lunar Volatile Depletion Due to Incomplete Accretion Within an Impact-generated Disk," was published online in Nature Geoscience. This work was funded in part by the NASA Solar System Exploration Research Virtual Institute (SSERVI).

SwRI, CU Boulder Collaborate to Boost Graduate Education

A new collaboration between SwRI and the University of Colorado Boulder will allow graduate students to more easily contribute to SwRI's planetary and space science programs.

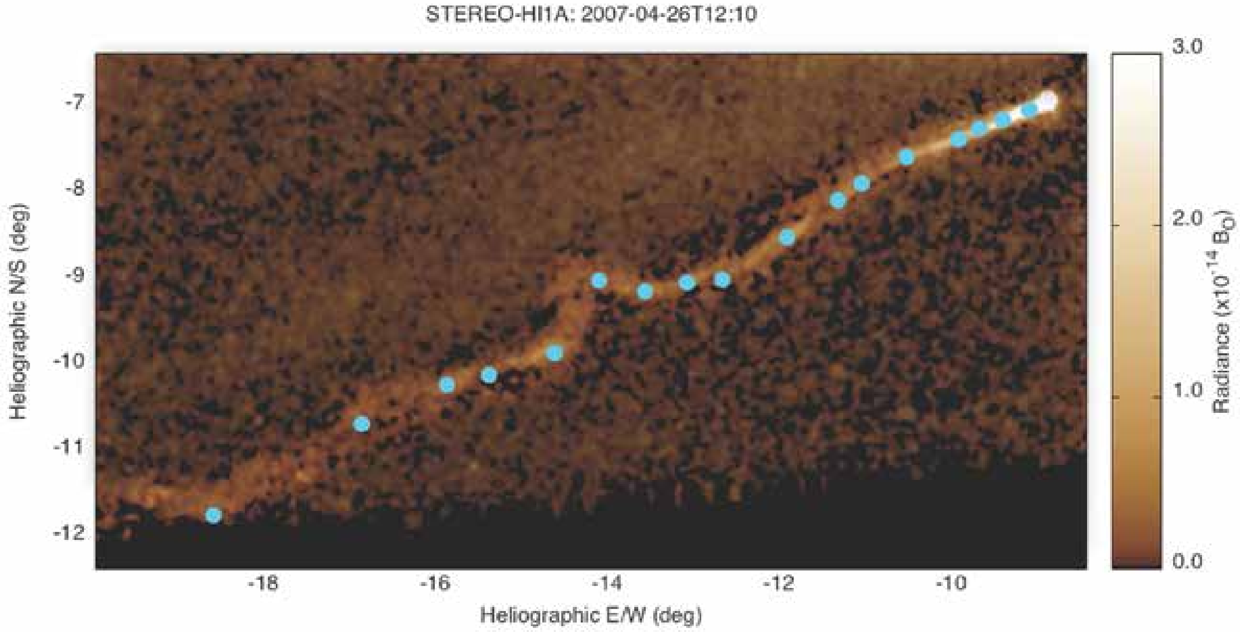
CU's Laboratory for Atmospheric and Space Physics (LASP) will oversee the program, which will facilitate students contributing to SwRI projects. Staff at LASP and SwRI often collaborate on NASA-funded missions to build spaceflight instruments and conduct space science studies. The agreement not only allows SwRI staff to serve as adjoint faculty members and thesis advisers but also facilitates integrating students into SwRI research projects.

"We're helping to train the next generation of scientists," said SwRI's Dr. Joel Parker. "If we offer positive experiences for student researchers, they might one day become SwRI or LASP researchers. That's significant at a time when it has been difficult to recruit graduates to work in the sciences."

Six students have been identified to transfer into the program from several academic departments, including astrophysical and planetary sciences, atmospheric and oceanic sciences, physics, aerospace, and engineering.

"These are scientists and engineers at the birth of their careers with an energy, fresh perspective, and curiosity that can bring a significant spark and helpful hands to any project," Parker said.

D021920 COURTESY NASA/SwRI



In this highly processed image of Comet Encke, individual clumps of tail material (indicated by blue dots) bob and twist in the turbulent solar wind. An SwRI/University of Delaware team measured these clumps to determine the flow of the solar wind.

Comet's Tail Sheds Light on Solar Wind

Turbulence explains heat, variability

While we can't see the wind, we can observe things that it blows about. By that same measure, an SwRI-led team studied movements of a comet's tail to understand more about the solar wind, the supersonic outflow of electrically charged gas emitted by the Sun.

Scientists used NASA's Solar and Terrestrial Relations Observatory (STEREO) to study Comet Encke's tail. They found that the solar wind flows through interplanetary space much as the wind blows on Earth, with gusting turbulence and swirling vortices. That turbulence can help explain two of the wind's most curious features — its variable nature and unexpectedly high temperatures.

"The solar wind at Earth is about 70 times hotter than one might expect," said Dr. Craig DeForest, a solar physicist at SwRI's Boulder, Colo., location. "The source of this extra heat has been a mystery of solar wind physics for several decades."

Based on analysis of the comet tail motions, the researchers calculated that large-scale turbulence provides sufficient kinetic energy to drive the high temperatures observed in the solar wind. Turbulence may also explain solar wind variability.

D021560_3202

SwRI SUPPORTS UTSA

SwRI donated $5,000 to The University of Texas at San Antonio Formula Racing Team in support of UTSA's Formula SAE (Society of Automotive Engineers) car. Student-teams compete each year against other university teams. In 2015, the UTSA team placed 17th out of 85 teams. The 2016 event will be held June 15-18 in Lincoln, Neb. Formula SAE promotes careers and excellence in engineering as it encompasses all aspects of the automotive industry.

On behalf of SwRI, Vice President Daniel Stewart (right) presents a $5,000 check to Amanda McCombs and Jacob Hiller, members of The University of Texas at San Antonio Formula Racing Team.

JUNO SETS SOLAR POWER RECORD

Spacecraft burns for Jupiter

D021918 COURTESY NASA

In January 2016, the Juno spacecraft broke a record, becoming humanity's most distant solar-powered emissary. A month later, the NASA spacecraft successfully executed a maneuver to adjust its flight path as it closes in on Jupiter. The spacecraft's thrusters fired for 35 minutes to refine its trajectory, helping set the stage for Juno's arrival at the solar system's largest planet in July.

"Juno is all about pushing the edge of technology to help us learn about our origins," said SwRI's Dr. Scott Bolton, Juno principal investigator. "We use every known technique to see through Jupiter's clouds and reveal the secrets Jupiter holds of our solar system's early history. It just seems right that the sun is helping us learn about the origin of Jupiter and the other planets that orbit it."

Juno launched on Aug. 5, 2011. The spacecraft will orbit the Jovian world 33 times, skimming to within 3,100 miles above the planet's cloud tops every 14 days. During the flybys, Juno will probe beneath Jupiter's obscuring cloud cover and study its aurorae to learn more about the planet's origins, structure, atmosphere, and magnetosphere.

Juno's name comes from mythology. The god Jupiter drew a veil of clouds around himself to hide his mischief, and his wife — the goddess Juno — was able to peer through the clouds and reveal Jupiter's true nature.

NASA's Jet Propulsion Laboratory in Pasadena, Calif., manages the Juno mission for Bolton, who is an associate vice president of SwRI's Space Science and Engineering Division. Juno is part of NASA's New Frontiers Program. Lockheed Martin Space Systems, Denver, built the spacecraft.

DETAIL

Juno is the first spacecraft to have a radiation vault using titanium to shield the electronics from Jupiter's harsh radiation.

D021557_9898

SwRI INNOVATORS AWARDED

Three SwRI staff members received a World LPG Association (WLPGA) 2015 Innovation Award for their paper titled "Direct Injection Liquid Propane." The paper discusses using a propane gas in a modern downsized and boosted direct-injected engine.

Gregory Hansen, Dennis Robertson, and Mark Walls (left to right above) teamed up to investigate using new technologies and alternative fuels for improved fuel economy and lower carbon dioxide emissions. The team converted a Ford EcoBoost engine to run on liquefied propane gas without making engine hardware changes. Propane's anti-knock properties suit direct injection engine applications and show potential to improve efficiency. They demonstrated how propane-specific engine calibration could allow increased compression ratios.

The project was funded through the Propane Education & Research Council, which promotes the use of propane in applications ranging from garden tractors to heavy-duty on-road vehicles. Walls presented the paper at the Global Technology Conference during the 27th World LPG Forum. The award was presented during the 28th World LPG Forum in Singapore.

CYGNSS Constellation Completed

NASA's Cyclone Global Navigation Satellite System (CYGNSS) mission has reached a milestone in its goal of improving hurricane forecasting. SwRI has completed assembly of the eight microsatellites. Scheduled to launch in Fall 2016, CYGNSS will study the inner core of hurricanes in greater detail to better understand their rapid intensification.

Assembly of the microsatellites began in August 2015. The body of each satellite measures roughly 20×25×11 inches, which is slightly larger than a standard carry-on suitcase. When fully assembled, the satellites will each weigh about 64 pounds. With solar panels deployed, each microsatellite will have a wingspan of 5.5 feet.

"We're thrilled to have met an important project milestone," said John Scherrer, CYGNSS project manager at SwRI. "We are now conducting thermal testing in a new vacuum chamber; it's exciting to see this mission come together. Help for the hurricane forecast community is now just around the corner."

The goal of CYGNSS is to improve hurricane intensity forecasts. The constellation of eight microsatellites will measure surface winds in and near the inner core of hurricanes, including regions beneath clouds and intense inner rain bands that could not previously be measured from space.

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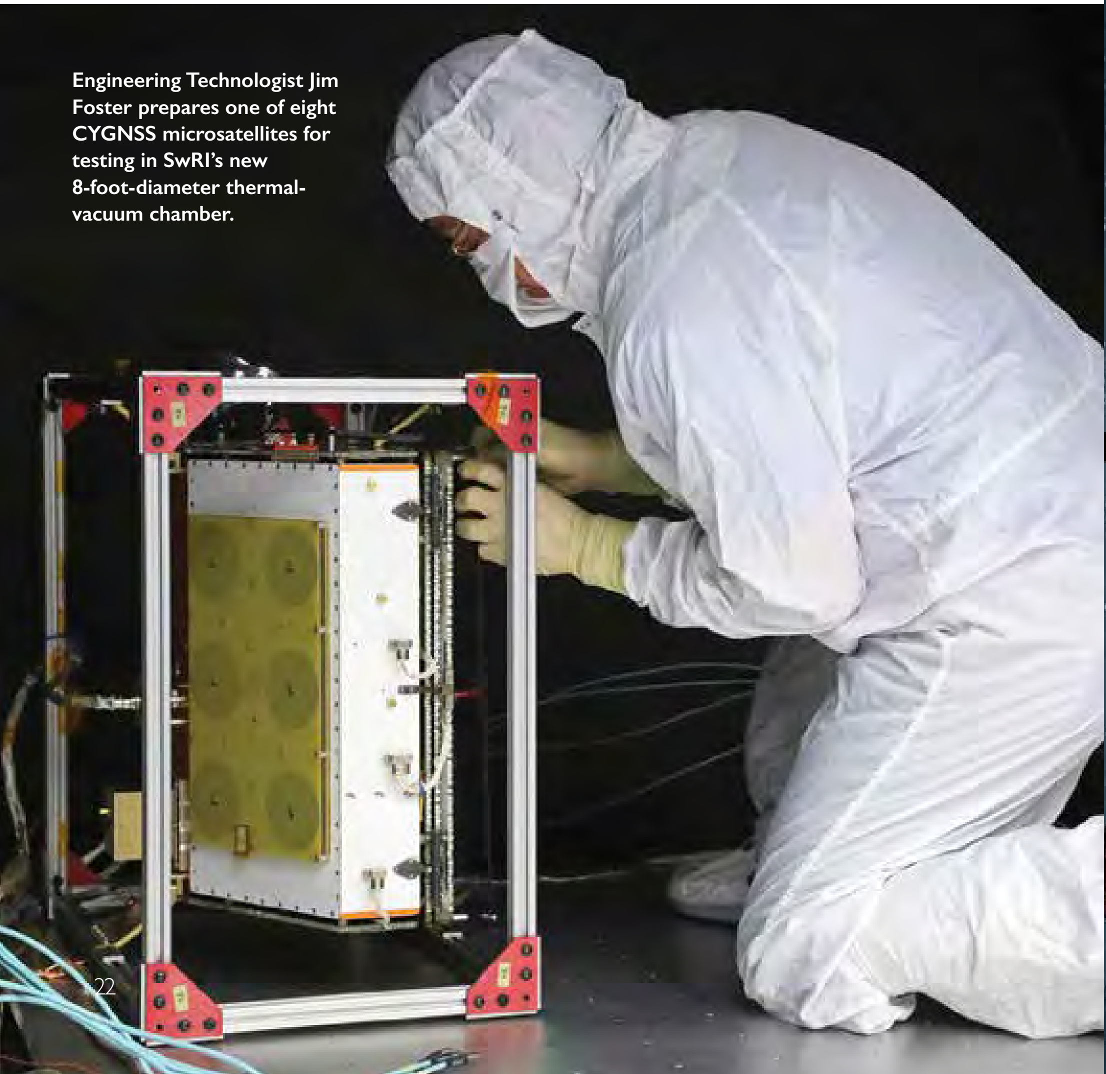


Engineering Technologist Jim Foster prepares one of eight CYGNSS microsatellites for testing in SwRI's new 8-foot-diameter thermal-vacuum chamber.

SwRI AWARDED $3 MILLION NASA CONTRACT

A proposed 11-year mission to study the Trojan asteroids near Jupiter is a once-in-a-lifetime opportunity for an SwRI planetary scientist.

Dr. Harold F. Levison, from SwRI's Boulder office, is the principal investigator for Lucy, a proposed NASA science mission. Lucy would probe primitive asteroids left over from the formation of the outer gas giants. The mission is among five science investigations selected as a possible future mission under NASA's Discovery Program.

Levison will develop concept design studies and analyses for the mission that would study these five space relics. If selected, "Lucy, Surveying the Diversity of Trojan Asteroids: The Fossils of Planet Formation," would launch in 2021 with a final encounter in 2032.

"Because the Trojan asteroids are remnants of that primordial material, they hold vital clues to deciphering the history of the solar system," Levison said. "These asteroids are in an area that really is the last population of objects in the solar system to be visited." The project is named Lucy in a nod to the name given to one of the influential human fossils found on Earth.

The spacecraft would include a sophisticated suite of remote-sensing instruments to study geologic, surface, reflective composition, thermal, and other physical properties of the asteroids. Dr. Catherine Olkin, a manager in SwRI's Space Science and Engineering Division, is the mission's deputy principal investigator.

Team members include Goddard Space Flight Center and Lockheed Martin. Lucy and the four other potential missions that NASA selected are among 27 proposed. NASA is expected to fund up to two missions by September 2016.

D021926 COURTESY NASA/JPL-CALTECH

ROS-INDUSTRIAL: DOES IT BLEND?

Metal fabrication processes — casting, machining, and welding — will often leave weld splatter and other surface-finish defects on parts. The ROS-Industrial Consortium (RIC) led by SwRI is developing robotic solutions to remove defects with Scan-N-Plan™ open-source software.

The goal is to devise a solution that combines the flexibility of manual blending with the repeatability and safety of a robotic system. The manual processes available include sanding, grinding, bead blasting, and vibratory polishing. In high-mix, low-volume applications, however, manual processing can present ergonomic or safety hazards. Moreover, operator-to-operator inconsistencies result in variations in product quality, excessive use of consumables, and other inefficiencies.

"In the third phase, we optimized robotic blending software to work about 1,000 times faster than in phase 2," said SwRI's Paul Hvass, who manages RIC-Americas. The consortium provides cost-shared applied research and development for advanced factory automation.

In the next phase, RIC members will incorporate higher-resolution sensing and integrate process planning and quality assurance steps to create a closed-loop, sensor-driven process. These refinements will accommodate the complex surfaces found on real parts and improve overall finish quality.

DETAIL

ROS-Industrial is an open-source project initiated by SwRI to extend the advanced capabilities of the Robot Operating System (ROS) software to manufacturing.

ROS™ industrial

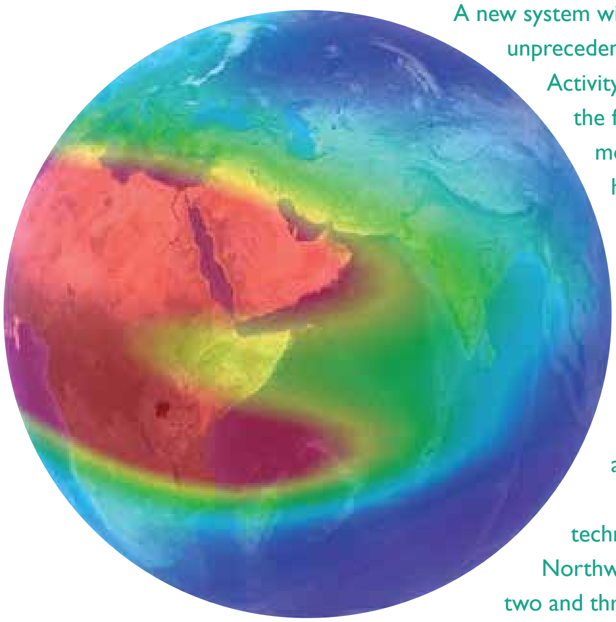
D021575_9930

Novel Geolocation Technology on the Horizon

The U.S. Air Force has awarded a $9.4 million contract to an SwRI-led team to develop novel geolocation technology. A new system will detect and locate communications and other high-frequency (HF) signals with unprecedented accuracy. The program, funded by the Intelligence Advanced Research Projects Activity (IARPA), will integrate a high-fidelity ionospheric model with a geolocation system for the first time to achieve this level of precision. Signals intelligence (SIGINT) applications monitor HF communications and other radio frequency emissions, such as over-the-horizon radar, to identify strategically important signals of interest and then use direction finding and other techniques to map the source of the signal.

"Ionospheric uncertainties are always the most significant source of error in HF geolocation," said Brandon Nance, the project lead in SwRI's Defense and Intelligence Solutions Division. He explained that space weather in the ionosphere — including sunspots, the solar wind, and day/night cycles — can change how a signal is reflected back to Earth and affect accuracy. "By integrating a high-fidelity system that corrects for real-time ionospheric activity, we expect to improve geolocation accuracy significantly."

Phase one of IARPA's High Frequency Geolocation (HFGeo) program examined the technology improvements needed to achieve IARPA's goals. SwRI will collaborate with Northwest Research Associates, Lowell Digisonde International, and YarCom Inc. on phases two and three of HFGeo to develop and test this new technology. Both phases will be completed by January 2018.



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Chambers, D., J. Gassaway, C. Goodin and P. Durst. "Simulation of a Multi-spectral, Multi-camera, Off-road Autonomous Vehicle Perception System with Virtual Autonomous Navigation Environment (VANE)." Presented at the Society of Photo-optical Instrumentation Engineers (SPIE) Remote Sensing/ Security + Defense 2015 Conference, Toulouse, France, September 2015.

Chirathadam, T.A., B.A. White, E.L. Broerman, T. Tavares, J. Esmaeel and S. Meshram. "Case Study: Design and Performance Verification Testing of a Screw Compressor Discharge Silencer." Presented at the GMRC Gas Machinery Conference, Austin, Texas, October 2015.

Chocron, I.S. "Transitioning a Unidirectional Composite Computer Model from Mesoscale to Continuum." Presented at the 11th International DYMAT Conference, Lugano, Switzerland, September 2015.

Chocron, I.S. and **A.J. Carpenter.** "Mesoscale Simulations of Ballistic Impact: From Woven Fabrics to Unidirectional Composites." Presented at the ACS 30th Technical Conference, Lansing, Mich., September 2015.

Christian, E.R., **M.I. Desai, F. Allegrini, J.-M. Jahn,** S. Kanekal, **S.A. Livi,** N. Murphy, **K. Ogasawara** and N. Paschalidis. "The CubeSat Mission to Study Solar Particles (CuSP): An Interplanetary CubeSat." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Dannemann, K.A. "Impact: The Dynamic Behavior of Materials." Presented at the Hartford Chapter of ASM International, Hartford, Conn., September 2015.

Dannemann, K.A., R.P. Bigger, N.L. Scott, A.J. Carpenter and **C.E. Weiss.** "Comparison of High and Low Strain Rate Deformation for Aluminum 5083 Fusion and Friction Stir Welds." Presented at the Materials Science and Technology Conference and Exhibition (MS&T'15), Columbus, Ohio, October 2015.

Dayeh, M.A., M.I. Desai, R.W. Ebert and G.M. Mason. "Properties of the Suprathermal Population Near 1 AU During Solar Cycles 23 and 24." Presented at the Advanced Composition Explorer (ACE) Science Team Meeting, Laurel, Md., November 2015.

Dayeh, M.A., S.A. Fuselier, J.R. Dwyer, M. Uman, D. Jordan, F.L. Carvalho, D.A. Kotovsky and H.K. Rassoul. "Acoustic Properties of Return Strokes and M-components from Rocket-triggered Lightning." Presented at the AGU Fall Meeting, San Francisco, December 2015.

De la Rosa, J., **P.W. Roming** and C. Fryer. "Modeling Type IIn Supernova Light Curves." Presented at the 227th American Astronomical Society (AAS) Meeting, Kissimmee, Fla., January 2016.

Delgado-Garibay, H.A. "Troubleshooting Gas Turbine Blade Failures." Presented at the GMRC Gas Machinery Conference, Austin, Texas, October 2015.

Demajistre, R., P. Janzen, **F. Allegrini, M.A. Dayeh, D.J. McComas** and N. Schwadron. "Fine Structure Energetic Neutral Atom (ENA) Sources Beyond the Termination Shock: Observational Constraints and Detection Limits." Presented at the AGU Fall Meeting, San Francisco, December 2015.

Desai, M.I., F. Allegrini, M.A. Dayeh, H.O. Funsten, **S.A. Fuselier,** J. Heerikhuisen, **D.J. McComas,** N.V. Pogorelov, N.A. Schwadron and G.P. Zank. "Latitude, Energy, and Time Variations of Energetic Neutral Atom Spectral Indices Measured by IBEX." Presented at the AGU Fall Meeting, San Francisco, December 2015.

Desai, M.I., G.M. Mason, **M.A. Dayeh, R.W. Ebert, D.J. McComas,** G. Li, C.M.S. Cohen, R.A. Mewaldt, N.A. Schwadron and C.W. Smith. "Systematic Behavior of Heavy Ion Spectra in Large Gradual Solar Energetic Particle Events." Presented at the First Joint Solar Probe Plus-solar Orbiter Workshop, Florence, Italy, September 2015.

Ebert, R.W., M.A. Dayeh, M.I. Desai, G. Li and G.M. Mason. "Multi-spacecraft Analysis of Energetic Heavy Ions and Interplanetary Shocks in Energetic Storm Particle Events at 1 AU." Presented at the AGU Fall Meeting, San Francisco, December 2015.

Edwards, S.M., J. Nicho and **J. Meyer.** "The Descartes Planning Library for Semi-constrained Cartesian Trajectories." Presented at the Robot Operating System (ROSCon) Conference 2015, Hamburg, Germany, October 2015.

Evans, P.T. "Future Trends in Robotics for Manufacturing Applications." Presented at the South Central Texas Chapter of the American Production and Inventory Control Society (APICS PDM) professional development meeting, San Antonio, October 2015.

Evans, P.T. "Industrial Robots for Manufacturing Applications." Presented at the Computer Engineering Program at the Erik Jonsson School of Engineering and Computer Science, University of Texas at Dallas, Richardson, Dallas, February 2016.

Evans. P.T. "Initiatives for Applying Smart Manufacturing to the Continuous Processing Industries." Presented at the South Texas Local Section – American Institute of Chemical Engineers (STS-AIChE) Meeting, Houston, January 2016.

Evans, P.T. "RIC – Americas Update." Presented at the 2016 ROS-Industrial Consortium – Europe Annual Meeting, Stuttgart, Germany, January 2016.

Fanick, E.R. and **S. Kroll.** "Dilute Sampling System Investigation for the Determination of Semi-volatile Organic Compounds (SVOC) Emissions from Heavy-duty Diesel Engine Exhaust." Presented at the Emissions 2015 Global Automotive Management Council (GAMC), Troy, Mich., June 2015.

Ferrill, D.A., R.N. McGinnis, A.P. Morris, K.J. Smart, Z.T Sickmann, M. Bentz, D. Lehrmann and M.A. Evans. "Mechanical Stratigraphic Controls on Bed-restricted Jointing and Normal Faulting in the Eagle Ford Formation, South-Central Texas, U.S.A." Presented at the Houston Geological Society 2015 Mudrocks Conference, Houston, February 2015; 2016 AAPG Distinguished Lecture presented at Binghamton University – the State University of New York, January 2016; and 2016 AAPG Distinguished Lecture presented at the Central Connecticut State University in New Britain, January 2016.

Ferrill, D.A., A.P. Morris, K.J. Smart and **R.N. McGinnis.** "Mechanical Stratigraphy and Normal Faulting." 2016 American Association of Petroleum Geologists (AAPG) Distinguished Lecture presented at the University of Minnesota Duluth, January 2016, and at Central Michigan University, Mount Pleasant, January 2016.

Ferrill, D.A., S. Wigginton, K.J. Smart, R.N. McGinnis and **A.P Morris.** "Influence of Tectonics and Mechanical Stratigraphy on Borehole-scale Deformation in the Permian Basin (Texas, USA)." Presented at the West Texas Geological Society Meeting, Midland, Texas, October 2015.

Flannigan, W.C. "3-D Sensing for Industrial Robotics." Presented at the 2015 RoboUniverse Conference & Expo, San Diego, December 2015.

Flannigan, W.C. "Open-source Robotics and the Implications for Robot Safety." Presented at the National Robot Safety Conference 2015, Pittsburgh, October 2015.

George, D. "Compressed Natural Gas Filling Station Sampling and Fuel Quality." Presented at the Natural Gas Technology Sampling Conference, New Orleans, January 2016.

Grava, C., K.D. Retherford, D.M. Hurley, P.D. Feldman, **G.R. Gladstone, T.K. Greathouse, J.C. Cook, S.A. Stern,** W.R. Pryor, J.S. Halekas and **D.E. Kaufmann.** "Lunar Reconnaissance Orbiter-Lyman Alpha Mapping Project (LRO-LAMP) Observations of Lunar Exospheric Helium." Presented at the AAS 47th Annual Meeting Division for Planetary Sciences (DPS), Washington, D.C., November 2015.

Grosch, D.J. "Overview of SwRI Test Capabilities." Presented at the Systems Fire Protection Information Exchange, Aberdeen Proving Grounds, Md., October 2015.

Guerra, C. "Modeling Ground Support Equipment Health for Strategic Procurement and Sustainment of Maintenance Functions." Presented at the National Defense Industrial Association (NDIA) 6870 – 18th Annual Systems Engineering Conference, Springfield, Va., October 2015.

Guerra, C. and **C. Camargo.** "Aircraft Support Equipment Roadmap Improves Aircraft Availability." Presented at the Institute of Electrical & Electron Telescope (IEEE) Auto Test Conference, National Harbor, Md., November 2015.

Hardwell, J. "A Simple Flash File System For Embedded Space Applications." Presented at the 2015 Workshop on Spacecraft Flight Software (FSW-15), Laurel, Md., October 2015.

Hedrick, J. "Locomotive Exhaust Emission Regulations: Is Tier 5 Next?" Presented at the Locomotive Maintenance Officers Association (LMOA) 77th Annual Meeting, Minneapolis, Minn., October 2015.

Holmquist, T.J. and J. Bradley. "The Response of Polymethyl Methacrylate (PMMA) Subjected to Large Strains, High Strain Rates, High Pressures, a Range in Temperatures, and Variations in the Intermediate Principal Stress." Presented at the 11th International DYMAT Conference, Lugano, Switzerland, September 2015.

Hubbard, B., **D. Hooper** and J. Mars. "Analysis of Landslide, Debris Flow and Flood Hazards Surrounding the Salton Sea, Southern California: Results Using Hyperspectral Infrared Imager (HyspIRI) Preparatory Imagery, Field Spectral Data and Observations." Presented at the 2015 HyspIRI Science and Application Workshop, Pasadena, Calif., October 2015.

Hubbard, B., **D. Hooper** and J. Mars. "Field, Laboratory and Imaging Spectroscopic Analysis of Landslide, Debris Flow and Flood Hazards in Lacustrine, Aeolian and Alluvial Fan Deposits Surrounding the Salton Sea, Southern California." Presented at the 2015 AGU Fall Meeting, San Francisco, December 2015.

Hubbard, B., J. Mars, R. Kokaly and **D. Hooper.** "Mineral Mapping of Alluvial Fan, Aeolian and Lacustrine Deposits Around the Salton Sea, California Using MICA: A New Tool for Rapid Classification of Hyperspectral Infrared Imager (HyspIRI) VSWIR Imagery." Presented at the 2015 Geological Society of America (GSA) Annual Meeting, Baltimore, November 2015.

Hue, V., F. Hersant, T. Cavalié and M. Dobrijevic. "Photochemistry, Mixing and Transport in Jupiter's Stratosphere Constrained by Cassini." Presented at the AAS 47th Annual Meeting Division for Planetary Sciences (DPS), Washington, D.C., November 2015.

Jensema, R., M.I. Desai, T. Broiles and **M.A. Dayeh.** "Abundance and Source Population of Suprathermal Heavy Ions in Corotating Interaction Regions." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Johnson, J. "Cybersecurity and Connected Vehicles." Presented at the Texas Department of Transportation Texas Technology Task Force, Austin, Texas, December 2015.

Kurz, R. and **K. Brun.** "On Test Uncertainties in Field Performance Tests." Presented at the American Society of Mechanical Engineers (ASME) Turbine Technical Conference and Exposition (Turbo Expo 2015), Montreal, Canada, June 2015.

Lamm, R. "Automated Driving – The Hype." Presented at the 22nd Intelligent Transportation Society (ITS) World Congress, Bordeaux, France, October 2015.

Lamm, R. "Perception and Localization Technologies for Automated Driving." Seminar presented at the 3rd International Symposium on Future Active Safety Technology Towards zero traffic accidents (FAST-zero'15) Symposium at the SAFER – Vehicle and Traffic Safety Centre at Chalmers, Gothenburg, Sweden, September 2015.

Lee, P.M. "Advanced Tribology and Lubrication of Engine Components." Presented at the 20th International Colloquium on Tribology – Industrial and Automotive Lubrication, Stuttgart/Ostfildern, Germany, January 2016.

Lee, P.M. "Using the Full Range of Tribology Tools to Cost Effectively Reduce Fuel Economy in Engines." Presented at the 20th International Colloquium on Tribology – Industrial and Automotive Lubrication, Stuttgart/Ostfildern, Germany, January 2016.

Light, G.M. "Use of Guided Waves for Detection of Hidden Corrosion in Double Shell Tank Floors and Walls." Presented at the American Society for Nondestructive Testing (ASNT) Annual Conference 2015, Salt Lake City, October 2015.

Liljedahl, A., J. Boike, R. Daanen, A. Fedorov, G. Frost, G. Grosse, L. Hinzman, Y. Iijima, J. Jorgenson, N. Matveyeva, **M. Necsoiu,** R. Raynolds, V. Romanovsky, J. Schulla, K. Tape, D. Walker, C. Wilson and H. Yabuki. "Ice Wedge Degradation: Why Arctic Lowlands are Becoming Wetter and Drier." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Livadiotis, G. "Approaching Kappa Distributions: Statistical Background, Theoretical Developments, and Applications in Space Plasma Physics." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Livadiotis, G. "Kappa Distributions: Connection with Non-extensive Statistical Mechanics." Presented at the International Latin American School and Workshop on Foundations of Complexity – Nonadditive Entropies and Nonextensive Statistical Mechanics, Rio de Janeiro, Brazil, October 2015.

Livadiotis, G. "Kappa Distributions: Theory and Applications in Space Plasmas." Presented at the National & Kapodistrian University of Athens, Physics Department, Athens, Greece, July 2015.

Livadiotis, G. "Rankine – Hugoniot Jump Conditions Incorporating Kappa Distributions." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Livadiotis, G. "Revealing a New Quantization Constant." Presented at the University of New Hampshire, Durham, N.H., November 2015.

Livadiotis, G. "Theory of Kappa and Flat-top Distributions." Presented at the International Space Science Institute (ISSI) Team 347 Meeting, Bern, Switzerland, February 2016.

Livadiotis, G. "What is a Kappa Distribution and Why is it Fundamental for Modern Physics?" Presented at the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, Athens, Greece, July 2015, and at the University of New Hampshire, Durham, N.H., November 2015.

Llera, K., J. Goldstein, D.J. McComas and **P.W. Valek.** "Opening the Black Box to Low-altitude Emission: Understanding How Near-Earth Ring Current Ions Escape as Energetic Neutral Atoms." Presented at the Second UTSA Astronomy and Space Physics Graduate Symposium, San Antonio, September 2015.

Llera, K., J. Goldstein, D.J. McComas and **P.W. Valek.** "Reconstructing Ion Spectra from Low-altitude ENAs: Moderate to Large Storms." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Martinez, J. "Autonomous Vehicle Security Challenges." Presented at the Florida International University Institute of Transportation Engineers (FIU ITE) Student Chapter Meeting, Miami, November 2015.

Martinez, J. "Autonomous Vehicles State of the Industry and Challenges Facing AV Developers." Presented at the 2015 Intelligent Transportation Society (ITS) of Florida Annual Meeting, Jacksonville, Fla., December 2015.

Martinez, J. "Truck-mounted Attenuators and UAV for Bridge Inspection." Presented at the FIU ITE Student Chapter Meeting, Miami, November 2015.

McClung, A.M., K. Brun and **J.M. Delimont.** "Comparison of Supercritical Carbon Dioxide Cycles for Oxy-combustion." Presented at the ASME Turbo Expo 2015, Montreal, Canada, June 2015.

McComas, D.J. "From the Sun to the Edge of the Solar System." Earth, Planetary, and Space Sciences Distinguished Alumni Lecture presented at UCLA, Los Angeles, October 2015.

Mentzer, C. "Bringing Automation to Markets." Presented at the 22nd ITS World Congress, Bordeaux, France, October 2015.

Moore, J.J., T.C. Allison, N. Evans, J. Kerth and J. Pacheco. "Development and Testing of Multi-stage Internally Cooled Centrifugal Compressor." Presented at the TPS Symposia, Houston, September 2015.

Morris, A.P., D.A. Ferrill, A.M. Price, **G.R. Walter** and **R.N. McGinnis.** "Rapid Evaluation of Induced Seismicity Using Slip Tendency Analysis and Well Hydraulics." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Morris, A.P., D.A. Ferrill, G.R. Walter and A.M. Price. "Slip Tendency Analysis and Risk of Induced Seismicity." Presented at the 2015 Joint

Assembly AGU Conference, Montreal, Canada May 2015.

Morris, R.E., **S.R. Westbrook,** D. Baniszewski and P. Serino. "Naval Research Laboratory Defense Logistics Energy (NRL-DLA) Fuel Forensics and F-76 Investigation." Presented at the 14th International Symposium on Stability, Handling and Use of Liquid Fuels, Inc. (IASH 2015), Charleston, S.C., October 2015.

Necsoiu, M. and A. Onaca. "Detecting Rock Glacier Dynamics in Southern Carpathians Mountains Using High-resolution Optical and Multi-temporal SAR Satellite Imagery." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Newton, T. and **B. Abbott.** "Packet-based Best Source Selector and Other IP-Telemetry Tricks." Presented at ITC, Las Vegas, October 2015.

Nicolaou, G. and **G. Livadiotis.** "Misestimation of Plasma Temperature When Applying a Maxwellian Distribution to Space Plasmas Described by Kappa Distributions." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Noonan, P. and **S. Whittington.** "Constraints Implementation Tools." Presented at ITC, Las Vegas, October 2015.

Ogasawara, K., F. Allegrini, J.L. Burch, M.I. Desai, R.W. Ebert, J. Goldstein, J.-M. Jahn, S.A. Livi and **D.J. McComas.** "A Double-cusp Type Electrostatic Analyzer for High-cadence Ring Current Ion Measurements." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Onaca, A., **M. Necsoiu,** F. Ardelean, F. Sirbu and B. Magori. "Slow Geomorphologic Evolution of Rock Glaciers in Marginal Periglacial Environment of Southern Carpathians (Romania)." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Parra, J.O., U. Iturrarán, J.S. Parra, J.L. Jiménez and H. Carrillo. "Self-organizing Maps with Cokriging Porosity Applied to Sand-shale Reservoirs Using Seismic Techniques." Presented at the Society of Exploration Geophysicists (SEG) International Exposition and 85th Annual Meeting, New Orleans, October 2015.

Randolph, L. "New Technologies for Wrong-way Driver Detection." Presented at the Texas District of the Institute of Transportation Engineers (TEXITE) Fall Meeting, San Antonio, September 2015.

Ransom, D.L. "Challenges in Unmanned Aerial System Propulsion." Presented at the Association for Unmanned Vehicle Systems International 2015 Workshop Series – Unmanned Aircraft Systems Propulsion: Optimization, Technical Challenges and Future Directions, Washington, D.C., October 2015.

Ransom, D.L. "Probabilistic Design Analysis of Bellows Type Pogo Accumulator." Presented at the 18th American Institute of Aeronautics and Astronautics (AIAA) Non-deterministic Approaches Conference, San Diego, January 2016.

Ridens, B.L., A. Garcia-Hernandez, A. Alvarado and **E.L. Broerman.** "The Impact of Changing Gas Composition on Compressor Efficiency and Operating Conditions." Presented at the GMRC Gas Machinery Conference, Austin, Texas, October 2015.

Roming, P. and J. Tobler. "Environments of Gamma-ray Bursts." Presented at the 227th AAS Meeting, Kissimmee, Fla., January 2016.

Roth, L., **K.D. Retherford,** J. Saur, D.F. Strobel, P.D. Feldman, M.A. McGrath, F. Nimmo, **J.R. Spencer, C. Grava** and A. Blöcker. "Europa's Neutral and Plasma Environment Investigated Through FUV Aurora Imaging." Presented at the European Planetary Science Congress 2015, Nantes, France, September 2015.

Rutherford, J. "Protecting Large Organizations and Communities Through the Use of a Honey Community." Presented at the U.S. Department of Homeland Security Secure and Resilient Cyber Ecosystem (SRCD) Industry Workshop, Atlanta, November 2015.

Rutherford, J. "Using an Improved Cybersecurity Kill Chain to Develop an Improved Honey Community." Presented at the Hawaii International Conference on System Sciences, Honolulu, January 2016.

Schwadron, N.A., J.K, Wilson, M.D. Looper, A. Jordan, H.E. Spence, J.B. Blake, A.W. Case, Y. Iwata, J.C. Kasper, W.M. Farrell, D.J. Lawrence, **G. Livadiotis,** J. Mazur, N. Petro, C. Pieters, M.S. Robinson, S. Smith, L.W. Townsend and C. Zeitlin. "Possible Albedo Proton Signature of Hydrated Lunar Surface Layer." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Schwadron, N.A., J.K. Wilson, M.D. Looper, A. Jordan, H.E. Spence, J.B. Blake, A.W. Case, Y. Iwata, J.C. Kasper, W.M. Farrell, D.J. Lawrence, **G. Livadiotis,** J. Mazur, N. Petro, C., Pieters, M.S. Robinson, S. Smith, L.W. Townsend and C. Zeitlin. "Signatures of Volatiles in the Lunar Proton Albedo." Presented (via web) at the Polar Regolith Workshop by NASA Solar System Exploration Research Virtual Institute, December 2015.

Siebenaler, S.P. "Cable-based Leak Detection Retrofit Study." Presented at the 2016 Pipeline Research Council International (PRCI) Pipeline Research Exchange, San Diego, February 2016.

Siebenaler, S.P. "Innovation in Research: Bringing Large Problems to Scale." Presented (via web) at the Rio Pipeline 2015 Conference and Exposition, Rio de Janeiro, Brazil, September 2015.

Siebenaler, S.P. "Liquid Leak Detection Technology Review for Aboveground Facilities." Presented at the 2016 PRCI Pipeline Research Exchange, San Diego, February 2016.

Siebenaler, S.P. "Subsea Fiber-optic Leak Detection." Presented at the Marine Technology Society Subsea Leak Detection Symposium, Houston, November 2015.

Simons, S.B., E.L. Broerman and **K. Brun.** "Development of a Predictive Method for Quantifying Vortex-shedding Pulsation Amplitudes in Compressor Piping Systems." Presented at the ASME Turbo Expo 2015, Montreal, Canada, June 2015.

Simons, S.B., T.A. Grimley and **C.J. Whinery.** "Meter Station Design Considerations." Presented at the GMRC Gas Machinery Conference, Austin, Texas, October 2015.

Simons, S.B., C.J. Whinery and **K. Brun.** "Pulsation Amplitude Effects of Altering Characteristics of Gas-liquid Dampeners." Presented at the TPS Symposia, Houston, September 2015.

Smart, K.J., G.I. Ofoegbu, **A.P. Morris, R.N. McGinnis** and **D.A. Ferrill.** "Geomechanical Modeling of Hydraulic Fracturing: Importance of Mechanical Stratigraphy, Stress State, and Pre-existing Structures." Presented at the 2015 Houston Geological Society Applied Geoscience Conference (2015 HGS AGC) – Geomechanics of Unconventionals, Houston, May 2015.

Suman, A., R. Kurz, N. Aldi, M. Morini, **K. Brun,** M. Pinelli and P. Spina. "Quantitative CFD Analyses of Particle Deposition on a Transonic Axial Compressor Blade, Part I: Particle Zones Impact." Presented at the ASME Turbo Expo 2015, Montreal, Canada, June 2015.

Suman, A., M. Morini, R. Kurz, N. Aldi, **K. Brun,** M. Pinelli and P. Spina. "Quantitative CFD Analyses of Particle Deposition on a Transonic Axial Compressor Blade, Part II: Impact Kinematics and Particle Analysis." Presented at the ASME Turbo Expo 2015, Montreal, Canada, June 2015.

Summerlin, E.J., S. Kanekal, E.R. Christian, G. Crum, **M.I. Desai,** A. Evans, J. Dumonthier, T. Jamison, A. Jones, S.A. Livi, K. Ogasawara, N. Paschalidis and G. Suarez. "CeREs, A Compact Radiation Belt Explorer to Study Charged Particle Dynamics in Geospace." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

Thacker, B.H. "Model Credibility: When to Ask Further Questions and What to Ask." Presented at the 2016 AIAA Sci-Tech 2016 Conference, San Diego, January 2016.

Timme, M. "A Focus on the RF Network Flight Testing and Results." Presented at ITC, Las Vegas, October 2015.

Towler, J. "Mapviz: An Extensible 2-D Visualization Tool for Automated Vehicles." Presented at ROSCon 2015, Hamburg, Germany, October 2015.

Trevino, G. "Electric Vehicle Future." Presented at the Border Energy Forum XXII, San Diego, October 2015.

Vinogradov, S. "Broadband Omni-directional Magnetostrictive Transducer for Transversal Guided Waves in Plates." Presented at the American Society of Nondestructive Testing South Texas Section, San Antonio, November 2015.

Westbrook, S.R. "A Review of Diesel Fuel Stability Test Methods (1930s to Today)." Presented at the 14th International Symposium on Stability, Handling and Use of Liquid Fuels, Charleston, S.C., October 2015.

White, B.A., E.L. Broerman, J.A. Bennett and **A. Garcia-Hernandez.** "Centrifugal Compressors – Dynamic Considerations for Station Design." Presented at the 2016 Gas Electric Partnership, Houston, February 2016.

Wood, P.B. "MMS HPCA Onboard Data Processing." Presented at the 2015 Workshop on Spacecraft Flight Software (FSW-15), Laurel, Md., October 2015.

Wright, M. and **L. Randolph.** "Dallas-Fort Worth Center-to-Center (C2C) Pilot Project: Summary for TACTICS C2C Plugin." Presented at the North Central Texas Council of Governments, Dallas, April 2015.

Wright, N., P. Merritt and **E.R. Fanick.** "Method for Sampling and Analysis of Crankcase Gases." Presented at the 25th Coordinating Research Council (CRC) Real World Emissions Workshop, Long Beach, Calif., March 2015.

Zajac, D. and **N. Carmichael.** "Combined Armament Tester." Presented at IEEE Auto Test Conference, National Harbor, Md., November 2015.

Zirnstein, E., H. Funsten, J. Heerikhuisen, **G. Livadiotis, D.J. McComas** and N. Pogorelov. "The Local Interstellar Magnetic Field Determined from the IBEX Ribbon." Presented at the AGU 2015 Fall Meeting, San Francisco, December 2015.

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Bailey, G. and **C. Wileman.** "Investigation of the Durability of High-Efficiency Gasoline Engines."

Basagaoglu, H., A. Carpenter, K. Gauger, and **M. Juckett.** "Development of a New Numerical Model to Simulate Chemotaxis-Driven Bacterial Transport for Treatment of Tumor Cells and Mitigation of Bacterially-Mediated Pipeline Corrosion Problems."

Blount, J. and **R. Rogers.** "Event Detection with Clustering Algorithms."

Bohmann, J., K. Gauger, T. Reeves, W. Bauta, S. Cabiness, and **Kenneth Lange.** "Development of Beta-Lactamase Inhibitors."

Carson, K. and **X. Cheng.** "Exploration of Encapsulation Methods of Subunit Vaccines."

Cheng, X. "Enhancing the Efficacy of a Chlamydia Subunit Vaccine Through Encapsulation."

Dannemann, K., A. Carpenter, S. Chocron, C. Duffer, and **J. Walker.** "Impact of Carbon Fiber-Reinforced Composites."

Delimont, J. and **D. Ransom.** "Model Based Gas Turbine Health Monitoring, Diagnostics, and Optimization Using Typically Sparse Performance Data."

Enke, B., K. Walsh, D. Durda, and **S. Marchi.** "Massively Parallel SPH Simulation Tools and Process."

Erwin, J. and **M. Medrano.** "An Efficient Circulating Fluidized Reactor Technology Integrated into a Stochastic Model with Biomass Quality Variables for Sustainable Biofuels and Biobased Products."

Ferrill, D., "Distinguished Lecture Series and Invited Review Paper."

Fletcher, G. and **T. Jaeckle.** "Feasibility Study and Definition of Requirements for a Satellite Ground Station."

Furman, B. "Electrophoretic Deposition of Orthotropic Boron Nitride-Polyimide Nanocomposites."

Grant, C. "Proof-of-Concept Development of a Traversing Hot-Wire Anemometer for Natural Gas Applications."

Griffith, L. "Multimedia Assessment."

Grimm, R. "Geophysical Capability Development for the Mars InSight Mission."

Huczek, J. and **Marc Janssens.** "CFD Modeling of Furnished Room Fires in Tall Wood Buildings Including Cool-Down."

Hvass, P., C. Flannigan, and **P. Evans.** "Robotic Product Singulation Testbed."

Kozak, K. "Assessing the Feasibility of Ranger in Kit Form."

Mabey, G. "Efficacy of Spatial Detection."

Noll, J. and **G. Musgrove.** "Stratospheric Compressor for Lighter-Than-Air Vehicles."

Nowicki, K. and **M. Shoffner.** "Laser Nephelometer."

Pickens, K., K. Holladay, and **G. Miller.** "Designing Ion Optics Using High Dimensional Physical Models with Parameter Optimization."

Rigney. M. "Deep Learning System for Robotic Pick Selection."

Rogers, R. and **J. Little.** "Evaluation of SwRI Support for the Global Knowledge Environment (GKE) Architecture of the U.S. Naval Tactical Cloud (NTC)."

Rutherford, J. "Development of a Sensor for Use in Network Threat Awareness."

Sharp, C., C. Webb, and **S. Rengarajan.** "Advanced Model-Based SCR Controller for Multiple Component Catalyst Systems."

Smith, S. "Investigation and Measurement of Balloon Dynamics at the Apex and Base of a Scientific Balloon."

Sturdevant, T. and **R. Fenske.** "Data Classification Capability Enhancement in a Virtualized Environment."

Van Rheeden, D., B. Davidson, and **B. Martin.** "Carrier Phase Estimation for Geolocation."

Waite, H. and **T. Brockwell.** "MASPEX Generation 2."

Funded January 1, 2016

Black, R. and **M. Grantz.** "Blind Discrimination of Modulation Changes within Communications Signal Bursts."

Chiu, J. and **G. Bartley.** "Fast Catalyst Light Off on a Heavy-Duty Natural Gas Engine."

Dannemann, K., A. Carpenter, S. Chocron, and **J. Walker.** "Impact of Carbon Fiber-Reinforced Composites."

Eliason, T., A. Moore, and **C. Scribner.** "Development of Artificial Muscle Actuator for Physical Joint Simulator."

Helffrich, J. and **J. Harrison.** "Zero-Power Sensors."

Hicks, F. "Ultra-Wideband Receiver."

Klar, R. and **Y. Tyler.** "Improved Spatial Resolution for an Earth-Observing Infrared Spectrometer."

Levison, H., C. Olkin, M. Buie, and **J. Andrews.** "Capacity and Infrastructure for Trojan and Flyby Space Missions."

Lu, B., S. Hudak, and **C. Popelar.** "Fundamental Assessment of Sulfide Stress Cracking and Tearing Resistance in Sour Brine Environments."

Megel, A. "Transient Durability Analysis of Aluminum Cylinder Heads."

Moore, T., V. Yakovlev, K. Favela, E. Bryner, and **G. Bartley.** "Integrating Cavity Enhanced Spectroscopy (ICES) Instrument for Continuous Multi-Gas Monitoring of Trace Gases."

Mueschke, N. and **A. Joyce.** "Hydrogen and Methane Gas-Phase Detonations."

Owston, R. and **S. Green.** "Development and Validation of Liquid-Liquid Separation Modeling Techniques."

Roberts, C., J. Miwa, G. Neely, R. Florea, C. Bitsis, and **A. Morris.** "Low-Cost, High-BMEP (Brake Mean Effective Pressure), High Power Density Diesel Engine."

Scribner, C., P. Hvass, and **J. Oxley.** "Large-Scale Additive Manufacturing Using Concrete Composite Materials."

Soto, A., B. Ehresmann, and **K. Neal.** "Development of a Thermal Neutron Sensor for Neutron Spectroscopy."

Wilkes, J., J. Moore, T. Allison, and **K. Brun.** "Field Testing of Rotating Equipment Vibration Modes Using Operational Modal Analysis."

PATENTS

Avery, P.A., S.E. Slocum, and **J.A. Towler.** "Cooperative Perimeter Patrol System and Method." U.S. Patent No. 9,164,514. October 2015.

Bauta, W.E., W.R. Cantrell, and **M.W. Tidwell.** "Reactivators of Organophosphorous Inhibited Acetylcholinesterase." U.S. Patent No. 9,162,983. October 2015.

Burrahm, R.W. "Internal Combustion Engine Having Dedicated EGR Cylinder With Intake Separate from Intake of Main Cylinders." U.S. Patent No. 9,206,769. December 2015.

Carrola, J., W.C. Couvillion Jr., S.M. Porter, D.R. Chambers, and **C.J. Guerra.** "Machine Vision Systems and Methods for Analysis and Tracking of Strain in Deformable Materials." U.S. Patent No. 9,218,660. December 2015.

Feng, M., D.D. Daruwalla, J. Erwin, and **W.K. Gauger.** "Extraction of Lipids from Living Cells Utilizing Liquid CO." U.S. Patent No. 9,217,119. December 2015.

Gukelberger R., and **J.W. Gingrich.** "Internal Combustion Engine Having Dual EGR Loops (Dedicated EGR Loop and Low Pressure EGR Loop) and Dual Cylinder Intake Ports." U.S. Patent No. 9,200,599. December 2015.

Huang, F.Y., "Biogas Purification System and Methods of Use Thereof." U.S. Patent No. 9,217,116. December 2015.

Kwun, H., M. Capps, J. Crane, and **S.M. Walker.** "Apparatus and Method for Inspection of Tubes in a Boiler." U.S. Patent No. 9,146,215. September 2015.

Lewis, C.L., W.C. Flannigan, M.O. Blanton, and **D. A. Brooks.** "3-D Imaging Sensor Based Location Estimation." U.S. Patent No. 9,218,529. December 2015.

Phillips, A.J., C. Engelbecht, J.M. Major, and R.C. Lynch. "Leakage Current Sensor for Suspension Type Insulator." U.S. Patent No. 9,261,549. February 2016

Phillips, A.J., J.M. Major, R.C. Lynch, **K. Hill, S. Harrell,** and **B. Rummage.** "Overhead Conductor Sensor." U.S. Patent No. 9,261,414. February 2016.

Roberts, C.E. "Fluid Bearings with Adjustable Frictional Load Characteristics." U.S. Patent No. 9,181,980. November 2015.

Rossini, J.G. "BMP-2 Upregulating Compounds for Healing Bone Tissue and Screening Methods for Selecting Such Compounds." U.S. Patent No. 9,216,181. December 2015.

Thwing, C.J., J.D. Bartlett, E.C. Laiche, and **D.L. Jones.** "Optical Velocity Tracking for Paint Spray Gun." U.S. Patent No. 9,245,163. January 2016.

Westmoreland, B.E., D.A. McKee, M.C. Megel, M.A. Tussing, T.E. Reinhart, and **D.P. Branyon.** "Hybrid Ceramic/Sand Core for Casting Metal Engine Parts with Passages or Holes Having a Cross Section Too Small for Sand Casting." U.S. Patent No. 9,162,280. October 2015.

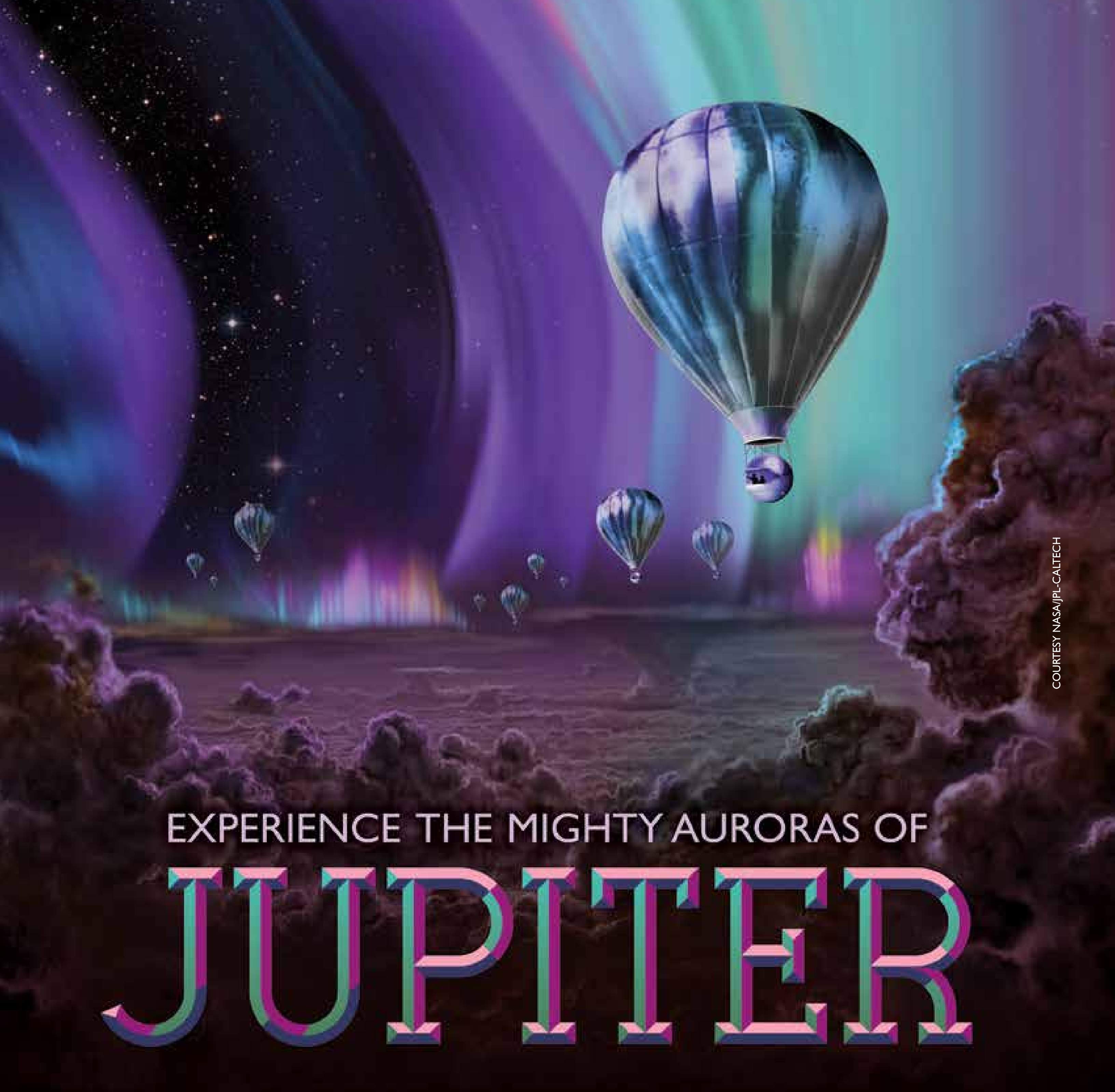
Zwiener, A.M., K.H. Carson, J.A. McDonough, N.L. Cantu, S.J. Drabik, A.P. Clark, P.M. Thompson, and **R.M. Corbett.** "Isoamyl Nitrite Formulations." U.S. Patent No. 9,216,222. December 2015.

DESTINATION JUPITER

NASA's Juno mission, led by SwRI's Dr. Scott Bolton, is arriving at Jupiter on July 4, 2016. The mission will improve our understanding of the solar system's beginnings by revealing the origin and evolution of Jupiter.

This "travel poster" of Jupiter features the Jovian cloudscape, which boasts the most spectacular light show in the solar system. With dazzling northern and southern lights, Jupiter's auroras are hundreds of times more powerful than Earth's. The glowing ring they form around each pole is bigger than our home planet. Revolving outside this auroral oval are the glowing, electric "footprints" of Jupiter's three largest moons. Juno will observe Jupiter's aurorae from above the poles, studying them in ways never before possible.

To download NASA's travel posters, go to **http://www.jpl.nasa.gov/visions-of-the-future/**



COURTESY NASA/JPL-CALTECH

COMING UP

AWARDS

Dr. Alan Stern, associate vice president of the Space Science and Engineering Division and the Principal Investigator of NASA's New Horizons mission to Pluto, received the 2016 Carl Sagan Memorial Award from the American Astronautical Society (AAS). The award recognizes an individual who has "demonstrated leadership in research or policies advancing exploration of the Cosmos."

The AAS also presented its 2015 Neil Armstrong Space Flight Achievement Award to the **New Horizons team** for outstanding achievement as a flight crew. Founded in 1954, AAS is the premier network of current and future space professionals dedicated to advancing all space activities.

Walter D. Downing, SwRI executive vice president, has been elected vice chair of BioMed SA, the nonprofit organization that promotes San Antonio's healthcare and bioscience industries. Founded in 2005, BioMed SA is focused on bringing major biomedical companies to San Antonio. It fosters collaboration among researchers, investors, and elected officials in the local biomedical device business community.

SwRI is among eight organizations and individuals inducted into the inaugural class of the San Antonio Aviation and Aerospace Hall of Fame.

Dr. Stephen Fuselier, executive director of the Space Science Directorate, received the European Geosciences Union Hannes Alfvén Medal for outstanding scientific contributions to understanding plasma processes in the solar system and other cosmic environments. Fuselier is a Fellow of the American Geophysical Union and has published more than 320 papers in scientific journals and conference proceedings. The medal honors Hannes Alfvén, a Swedish physicist who made pioneering discoveries in cosmic physics, including cosmic radiation and the galactic magnetic field.

Dr. William Bottke presented the 2015 Shoemaker Lecture, "The Calm Before the Storm: Exploring the Post Accretionary Doldrums Prior to the Late Heavy Bombardment," at the American Geophysical Union Fall meeting. Bottke examined evidence from asteroids, Mars, Earth, and the Moon to argue that there were two distinct periods of early planetary bombardment. The presentation was one of AGU's series of lectures associated with the William Bowie Medal, its highest honor. Named for medal recipient Eugene Shoemaker, this lecture is presented by an outstanding geologist or planetary scientist selected for contributions to the understanding of impact craters and lunar science.

Dr. Terry Alger, a director in the Engine, Emissions, and Vehicle Research Division and a Fellow of the Society of Automotive Engineers, received two "Excellence in Oral Presentation" awards from the SAE for papers given at the 2015 World Congress. The papers honored were "The Impact of Cooled EGR on Peak Cylinder Pressure in a Turbocharged, Spark Ignited Engine" and "Dedicated EGR: A Cost Effective Solution for the Chinese Market." Alger has received nine such awards to date.

TRADE SHOWS

ISHM, Oklahoma City, OK; May 10-12, 2016

STLE 2016 Annual Meeting, Las Vegas, NV; May 15-19, 2016

TechConnect World Innovation Conference & Expo, Washington D.C.; May 22-25, 2016

Texas Life Science Forum, Houston; May 26, 2016

New Hampshire Aerospace and Defense Conference (NHADEC), Manchester, NH; June 1, 2016

ITS America Annual Meeting, San Jose, CA; June 12-15, 2016

Eurosatory, Paris, France; June 13-17, 2016

AAPG 2016 Annual Convention & Exhibition, Alberta, Canada; June 19-22, 2016

Sensors Expo & Conference, San Jose, CA; June 22-23, 2016

IFT Food Expo, Chicago, IL; July 16-19, 2016

43rd Annual Meeting & Exposition of the Controlled Release Society, Seattle, WA; July 17-20, 2016

30th Annual AIAA/USU Small Satellite Conference, Logan, UT; August 6-11, 2016

Texas Groundwater Summit, San Marcos, TX; August 23-25, 2016

45thTurbomachinery Symposium & 32nd International Pump Symposia, Houston, TX; September 12-15, 2016

IEEE AUTOTESTCON, Anaheim, CA; September 12-16, 2016

American School of Gas Measurement Technology (ASGMT) Houston, TX; September 19-22, 2016

ASNT Annual Meeting, Long Beach, CA; October 24-27, 2016

Automotive Testing Expo North America, Novi, MI; October 25-27, 2016

International Telemetering Conference, Glendale, AZ; November 7-10, 2016

Xponential, Dallas, TX; May 8-11, 2017

Valve World Americas Expo & Conference, Houston, TX; June 20-21, 2017

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