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Z machine probes super-Earth atmospheres

A step in the search for other life in the galaxy

By Neal Singer

Researchers are using the huge forces generated by Sandia's Z machine to replicate the gravitational pressures on so-called "super-Earths" to determine which might maintain atmospheres that could support life.

Astronomers believe that millions of super-Earths — collections of rocks up to eight times larger than Earth — exist in our galaxy.

"The question before us is whether any of these superplanets are actually earthlike, with active geological processes, atmospheres and magnetic fields," said Sandia physicist Joshua Townsend.

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SUPERWORLDS — An artist's conception of the gravity-supported magnetic fields of selected super-Earths examined by Sandia National Laboratories' Z machine. Magnetic fields deter cosmic rays from destroying planetary atmospheres, making life more likely to survive.

Illustration by Eric Lundin, based on a photo of Z by Randy Montoya

From airplanes to cell phones: Sandia device finds the flaws in everything

By Michael Ellis Langley

Tim Briggs has built a career at Sandia tearing and breaking things apart. Now, he's developed a fracture-testing tool that could help make everything from aircraft structural frames to cell phones stronger.

Tim has filed a patent for a device associated with bonded structural composite materials that carries the deceptively mundane title "Mode I Fracture Testing Fixture."

The device, a small set of two hangers no larger than the human hand, fits into two precise holes drilled through a piece of metal or two materials bonded together. The hangers then attach to a traditional machine designed to push or pull the sample apart to measure how stiff or strong it is. Before Tim's innovation, conducting a series of such tests might take days or even weeks longer.

"We pull the fracture specimens apart in a very controlled manner," said Tim, who works in Sandia's Lightweight Structures Lab.

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VACCINES

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Sandia National Laboratories

Albuquerque, New Mexico 87185-1468

Livermore, California 94550-0969

Tonopah, Nevada | Nevada National Security Site

Amarillo, Texas | Carlsbad, New Mexico | Washington, D.C.

Jim Danneskiold & Darrick Hurst, Editors 505-844-0587
Meagan Brace, Digital Editor 505-844-0499
Taylor Henry, Production 505-373-0775
Randy Montoya, Photographer 505-844-5605
Paul Rhien, California Site Contact 925-294-6452

CONTRIBUTORS

Michelle Fleming (milepost photos, 505-844-4902),
 Neal Singer (505-846-7078), Stephanie Holinka (505-284-9227),
 Kristen Meub (505-845-7215), Michael Baker (505-284-1085),
 Troy Rummier (505-284-1056), Manette Fisher (505-844-1742),
 Valerie Alba (505-284-7879), Luke Frank (505-844-2020),
 Michael Langley (925-294-1482), Mollie Rappe (505-844-8220)

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LABNEWS Notes

EDITOR'S NOTE: We've stopped printing the *Lab News*, but will continue to publish every two weeks. We want you to remain in our community of readers, so please send your comments and suggestions for stories or for improving the paper. *Lab News* welcomes guest columnists who wish to tell their own "Sandia story" or offer their observations on life at the Labs or on science and technology in the news. If you have a column (500-800 words) or an idea to submit, contact *Lab News* editor Jim Danneskiold at jddanne@sandia.gov.

Sandia radiation expert leads health physics organization

By **Kristen Meub**

Charles "Gus" Potter, a certified health physicist at Sandia, was elected president of the American Academy of Health Physics, an organization that supports certified health physicists and the profession's certification process.

Gus previously served as the organization's parliamentarian for three years, and as president, he plans to update and streamline the profession's recertification process.

Gus is an internationally recognized expert on the measurement and impact assessment of radiation doses to humans. He serves as the vice chairman for the HPSN13 standards committee, which develops radiation protection standards, and participates in three working groups for the International Organization for Standardizations focused on measuring external radiation exposure, radiation exposure through inhalation or ingestion, and also monitoring radiation dose exposure for large groups of people following an adverse event.

At Sandia, Gus studies the effects and consequences of nuclear and radiological terrorism and develops system solutions for national security challenges. He recently worked on a study that considered how emerging technologies may be used to either aid or prevent radiological terrorism. The team compared and ranked technologies based on how they might be used by adversaries to access and steal radiological materials and then considered how they could also help mitigate threats and enhance security.

Gus is the lead author on 17 scientific articles on operational radiation dosimetry, biological research and national security. He is also a fellow of the Health Physics Society and a founding member of the DOE Laboratory Accreditation Program's Radiobioassay Oversight Board, which reviews all applications to accredit DOE laboratories to test human waste for radiation. He also has worked with the International Atomic Energy Agency and other organizations on radiological security.



HEAD HEALTH PHYSICIST — Charles "Gus" Potter is the new president of the American Academy of Health Physics, an organization that supports certified health physicists and the profession's certification process.

Photo by Randy Montoya

Gus is an adjunct professor at the University of New Mexico Department of Nuclear Engineering, where he teaches a graduate-level course on internal radiation dosimetry.

Gus holds a bachelor's in physics from Trenton State College, now named the College of New Jersey. He received a master's and doctorate in radiation health from the University of Massachusetts Lowell.

He began his term Jan. 1. 

COVID-19 vaccination underway



FEELING NO PAIN — Deputy Labs Director Dori Ellis gets her COVID-19 vaccine at the Sandia/NM Medical Clinic.

Photo by Bret Latter



TOOLS OF THE TRADE — From actual vaccine, to vials, to syringes, Sandia Medical Clinic makes sure COVID-19 vaccines are administered safely.

Photo by Bret Latter

By **Paul Rhien**

C OVID-19 vaccination is underway for Sandia's New Mexico workforce. Authorized by the state of New Mexico as a vaccination site, Employee Health Services began vaccinating medical personnel, first responders and emergency management on Jan. 11.

With limited vaccine supply from the state, Sandia/NM expects to have administered about 500 first doses and fully vaccinated about 200 staff by Friday, Feb. 12.

In California, Sandia is coordinating with Lawrence Livermore National Laboratory Health Services to ensure Sandia's workforce is included in their vaccination planning. Vaccination of the California workforce has not yet begun, as both labs await vaccine supply from Alameda County.

Addressing common vaccination questions

On Jan. 20, a panel of experts from the Labs' pandemic response team, scientists and health providers recorded a forum about Sandia's strategies for vaccination phases, safety concerns and on-site procedures following vaccination. The **panel**



MIKE ROLLS UP — Sandia/NM recently moved its vaccination clinic outdoors, where Mike Burns, associate Labs director for National Security Programs, cruised in for his scheduled COVID-19 shot.

Photo by Bret Latter

discussion was based on questions solicited from the workforce.

In opening remarks, Deputy Labs Director Dori Ellis addressed the importance of vaccination in helping reduce COVID-19-related illness, and the role the vaccine will play in returning to normal on-site operations.

"We are doing everything we can to help end this pandemic," Dori said. "Not only do we want all of our employees to stay healthy and to really thrive in their community, but our work hasn't changed. We're a national security laboratory, and we've got to continue to execute on that mission."

Dori thanked the cross-functional team, led by Pandemic Response Team Leader Bradley Dickerson and Employee Health Services Director Renee Holland, for their work.

“This has been a major effort,” Dori said. “The [vaccination team] has been working diligently behind-the-scenes trying to make sure that we’re prepared, and we’ve done everything we need to do to be able to deliver the vaccines.”

Remain vigilant, get vaccinated

In the forum, panelists urged members of the workforce to continue diligently

following COVID-19 safety measures as the vaccination effort rolls out.

“Pandemic fatigue is real, and for many months we have worn our masks, washed our hands, socially distanced, postponed travel and worked from home when we can,” said Dr. Claire Escamilla, Sandia Medical physician.

“Now that the COVID vaccine is here, we can’t let up. Let’s stay vigilant with our pandemic precautions,” Claire said. “We’re going to continue to offer COVID testing, contact tracing, quarantine and travel guidance while we safely and efficiently roll out this COVID-19 vaccine to the workforce.”



PAPERWORK — To reduce risks during the initial round of vaccines, required vaccine paperwork took place outdoors on the south side of the Sandia/NM Medical Clinic, thanks to Michael Palmer, James Blea and Rocio Jaramillo of the Emergency Management team.



ARMED AND READY — Syringes with COVID-19 vaccine await the arms of Sandians during the initial vaccination campaign.

Photos by Bret Latta

A closer look at vaccine research

In a separate [town hall](#) hosted on Jan. 21 by Sandia’s Science & Technology Division and National Security Programs, virologists Brooke Harmon and Oscar Negrete offered greater depth on how the COVID-19 vaccines were developed and provided beneficial information on vaccine safety and efficacy.

Brooke’s presentation focused on research and outlined the process vaccines must go through to receive FDA approval. She addressed a common concern about vaccine safety, based on the unprecedented speed with which currently approved vaccines moved through R&D and clinical trials to emergency use authorization.

“The fact that we were able to go from sequence in January (2020) to a vaccine in people by the end of December has a lot more to do with funding and technology advances than anything having to do with shortcuts in safety,” Brooke explained. “There were no shortcuts taken in safety. In fact, I would say that these vaccines were under even more scrutiny than a vaccine normally would be because we’re all watching.”

Brooke discussed how the scientific community is closely examining information that vaccine manufacturers are submitting to the FDA and pointed out that experts have been very confident in the data that they’re reviewing.

Other topics covered in the presentation included how vaccines develop an immune response in the human body, how mRNA vaccines differ from traditional vaccine technologies and potential allergic reactions to vaccines. Brooke and Oscar also addressed the next vaccine candidates in the R&D pipeline and how effective vaccines will be at protecting against emerging virus variants.

Bradley reflected on the layered approach adopted over the course of the past year to keep the workforce safe and deliver on mission-essential national security priorities.

“During the pandemic, we’ve done an exemplary job at Sandia of implementing recommended public health measures,” Bradley said. “The last and most important part of this journey, though, is the vaccine. Once we are vaccinated, that is the highest level of defense we can get, and we’re looking forward to moving into that.”

With limited vaccine supply, the vaccination team’s goal is to move as many Sandians through the vaccination process as possible.

All employees are strongly encouraged to participate in a COVID-19 vaccination program at their earliest opportunity, whether delivered through the Labs or their health care provider.

“This week, I’m scheduled to get my second dose of the vaccine,” Dori said. “I would encourage you very strongly to consider getting this vaccine and helping us as we’re trying to end this pandemic.”

For more details on Sandia’s vaccination plan, including facts and questions, visit the [Coronavirus information page](#). 



PROTECTING THE BOSS — Labs Director James Peery is vaccinated at Sandia Medical.

Photo by Renee Holland



SHOT IN THE ARM — Sandia Medical Clinic Manager Susan Jurica gives a first dose of COVID-19 vaccine into a member of Sandia’s medical team.

Photo by Bret Latter

UNM, Sandia to develop first NM master’s program for project management

By **Kerri Dufault**

The University of New Mexico’s Anderson School of Management this fall will begin formally accepting applicants for the state’s first master’s degree program in project management, a critical component of the school’s memorandum of understanding with Sandia.

In mid-December, the New Mexico Higher Education Department provided final approval of the degree program, fulfilling a major goal of the 2-year-old agreement between UNM and Sandia that

set out their joint plans for collaboration on project management education and professional development.

UNM will become one of only a handful of U.S. universities in the country to offer the project management master’s degree.

“We appreciate UNM’s partnership and believe this will greatly benefit UNM, Sandia and the state,” said Krista Smith, Sandia director for project management.

“This is an extraordinary benefit for the Labs,” Krista said. “As a Federally Funded Research and Development Center, Sandia delivers essential science

and technology to resolve the nation’s most challenging security issues. Because of the national security implications and use of taxpayer resources, it’s imperative that Sandia deliver on its mission on time and on budget. Formal project management provides the expertise and tools to accomplish this,” she said.

As the number and complexity of projects and product development efforts continue to grow, so does the critical need for highly skilled project management professionals, Krista said. Sandia currently employs nearly 500 project management



MANAGING PROJECTS WITH UNM — In this UNM file photo from a 2018 ceremony, Craig White, Dean of the University of New Mexico’s Anderson School of Management, left, and Scott Aeilts, associate Labs director for Mission Services, sign a memorandum of understanding that pledges both institutions’ support for project management education and professional development. **Photo courtesy of UNM**

professionals, and 58 percent of those are UNM graduates.

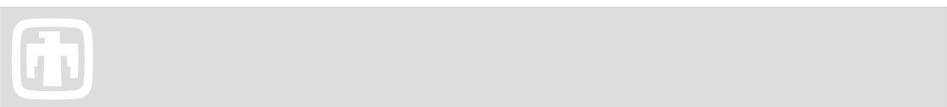
“When you look at the demand that came from the multiple nuclear deterrence modernization projects, strategic partnership projects and upcoming capital construction projects, it’s clear the need for project management is not going away,” said Tristan Walters, a Sandia manager in project management.

The degree program not only will help students enter the workforce with the foundation and analytical skills they need to succeed immediately, but it also provides a more direct path for students who want a project management career at Sandia or in other industries, he said.

“Sandia will have a great pipeline of students to recruit from,” Tristan said. “Additionally, it will save Sandia significant costs because the Labs will only need to provide program-specific training.”

Current students will be able to transfer credits from existing UNM project management courses toward the new degree. 

Mileposts



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Super-Earth

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The current work at Z is described in the [Feb. 9 issue](#) of Nature Communications. Researchers in Sandia's Fundamental Science Program, working with colleagues at the Carnegie Institution for Science in Washington, D.C., used the forces available at Sandia's uniquely powerful Z machine to apply the equivalent of huge gravitational pressures to bridgmanite, also known as magnesium-silicate, the most abundant material in solid planets.

The experiments gave birth to a data-supported table that shows when the superplanet's interior would be solid, liquid or gaseous under various pressures, temperatures and densities, and in what predicted time spans. Only a liquid core — with its metals shifting over each other in conditions resembling those in an earthly dynamo — produces the magnetic fields that can shunt destructive solar winds and cosmic rays away from a planet's atmosphere, potentially allowing life to survive.

Planetary cores revealed

Such critical information about magnetic field strengths generated by the core states of different-sized super-Earths was unknown: cores are well-hidden by the bulk of the planets surrounding them, and thus invisible to remote viewers. For researchers who preferred earthly experiments rather than long-distance imaging, sufficient pressures weren't available until they got help from Z.

Yingwei Fei, the study's corresponding author and senior staff scientist at the Carnegie's Earth and Planets Laboratory, is known for his skill in synthesizing large-diameter bridgmanite using multiton presses with sintered diamond anvils.

"Z has provided our collaboration a unique tool that no other technique can match, for us to explore the extreme conditions of super-Earths' interiors," Fei said. "The machine's unprecedented high-quality data have been critical for advancing our knowledge of super-Earths."

Further analysis of the state of gaseous and dense materials on specific super-Earths produced a list of seven planets

possibly worthy of further study: 55 Cancri e, Kepler 10b, 36b, 80e, and 93b, CoRoT-7b and HD-219134b.

Said Sandia manager Christopher Seagle, who with Fei initially proposed the Z experiments, "These planets, which we found most likely to support life, were selected for further study because they have similar ratios to Earth in their iron, silicates and volatile gasses, in addition to interior temperatures conducive to maintaining magnetic fields for protection against solar wind."

Joshua said the team focused on super-sized, rather than small, planets because large gravitational pressures mean atmospheres are more likely to survive over the long haul.

"Because Mars was smaller, it had a weaker gravitational field to begin with," Joshua said. "Then as its core quickly cooled, it lost its magnetic field and its atmosphere was subsequently stripped away."

Z pulses slam plates into bridgmanite

For the experiments, the Z machine, with operating conditions of up to 26 million amps and hundreds of thousands of volts, creates magnetic pulses of enormous power that accelerate credit card-sized pieces of copper and aluminum called flyer plates.

The pulses propel the flyer plates much faster than a rifle bullet into samples of bridgmanite, the Earth's most common mineral. The extreme, near-instantaneous pressure creates longitudinal and transverse sound waves in the bridgmanite that reveal whether it remains solid or changes to a liquid or gas, said Sandia researcher

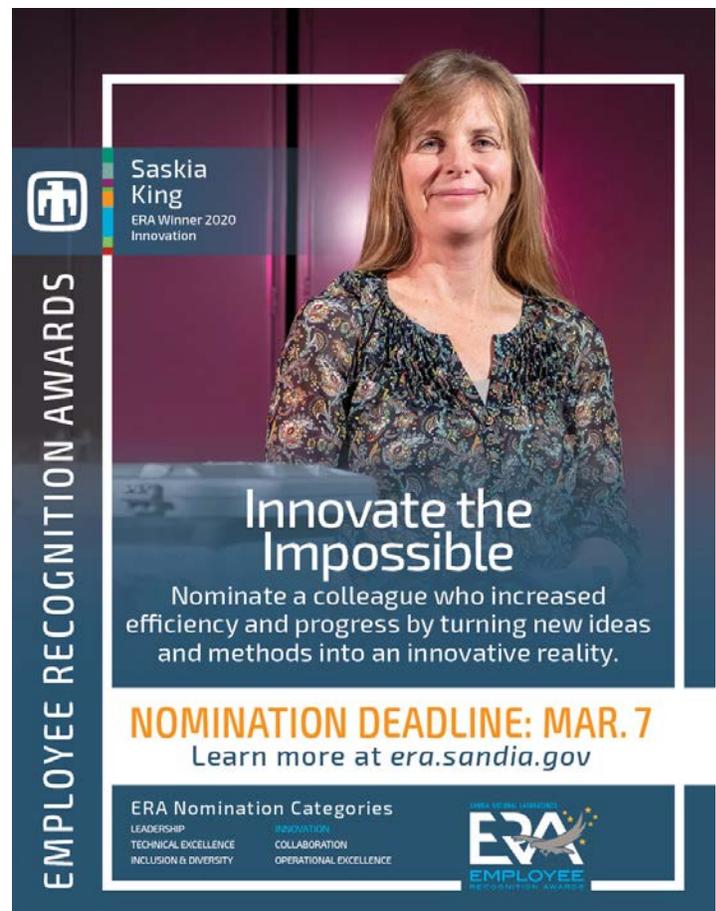
and co-author Chad McCoy. With these new results, researchers were supplied with solid data on which to anchor otherwise theoretical planetary models.

They conclude that the high-precision density data and unprecedentedly high melting temperatures achieved at the Z machine "provide benchmarks for theoretical calculations under extreme conditions."

"Our collaboration with Sandia scientists has led to results that will encourage more academic exploration of exoplanets whose discovery has captured the public imagination," Fei said.

"This work identifies interesting exoplanet candidates to explore further," said Christopher. "Z shock compression plus Yingwei Fei's unique capability to synthesize large-diameter bridgmanite allowed us to obtain data relevant to exoplanets that would not be possible anywhere else."

The work was supported by the National Science Foundation, the Z Fundamental Science Program and a Carnegie Venture grant. 



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Friday, March 19



Nominate great environmental efforts for 2020 EMS awards

By **Dan Ware**

The Environment, Safety and Health program's Environmental Management System is accepting nominations for its annual **EMS Environmental Excellence Awards** to recognize projects accomplished during calendar year 2020.

"Part of our mission is to preserve our natural resources, minimize waste and pollution, and continually reduce the potential negative impact our work has on the environment," said award program coordinator Ben Henning. "These Labwide awards are our opportunity to recognize and applaud the efforts of those Sandians who go above and beyond in their work to help us protect and enhance our surrounding environment."

Both individuals and teams can be nominated.

The categories are:

Greenie Award – The Greenie Award recognizes an individual who goes above and beyond for environmental stewardship outside of their job description.

Grassroots Award – The Grassroots Award is exactly as it sounds. It celebrates a team that took it upon themselves to make small changes that, if we all did the same, would create a significant impact across the Labs.

Resource Conservation Award – The Resource Conservation Award recognizes excellent efforts in conservation.

Above and Beyond Award – The Above and Beyond Award this year recognizes an individual who didn't take the

easy way out, but instead made the extra effort to preserve the environment.

Kaizen Award – This award is for an individual or team whose efforts have continuously improved the environmental impact of processes and/or activities via the permanent implementation of improvements. These improvements should be progressive over time and lead to cost reductions, environmental quality improvement and/or efficiency increases.

Sequoia Award – The Sequoia Award is given to projects that impact the entire Laboratories and have a large reach.

The deadline for nominations is Friday, March 19, and the awards will be announced on Thursday, April 22, in conjunction with Earth Day.

For questions, additional information or help writing and submitting a nomination, contact Ben Henning. 

Fracture testing

CONTINUED FROM PAGE 1

“Then, we’re able to measure the response of the material and quantify the relevant fracture properties, which informs us how cracks might actually grow when used in finished products under various loading conditions.”

In every industry and consumer product, things break. This can lead to property loss, litigation, injuries and loss of life. Sometimes the fracturing happens because a design is engineered without a full understanding of how the materials perform in certain conditions.

Critical loads

“Think about critical applications like a pressurized aircraft at 30,000 feet with 300 or more souls on board relying on bonded surfaces as part of a critical load path,” Tim said. “That can never fail. But people also don’t want their very benign carbon-fiber hockey stick or mountain bike that they paid hundreds or even thousands of dollars for to break.”

The tool can be applied “to everything in between — medical devices, aerospace, automotive crash worthiness, civil structures, pressure vessels, recreation and sporting. Every structure is likely affected by fracture-based failure mechanisms, and testing is difficult. This new device and approach aim to make it a bit simpler,” he said.

Before he developed his hangers, Tim would have to align and bond hinges to the specimen, which added significant time and cost to the process before he could even set up and perform the experiment.

“As simple as it is,” he said of the new approach using the free-rotation hanger system, “this is kind of the novelty of this device. There’s a beauty and simplicity here.



GETTING A GRIP — Timothy Briggs fashioned this set of hangers to help perform fracture tests, rapidly accelerating the speed of such testing for Sandia. **Photo by Timothy Briggs**



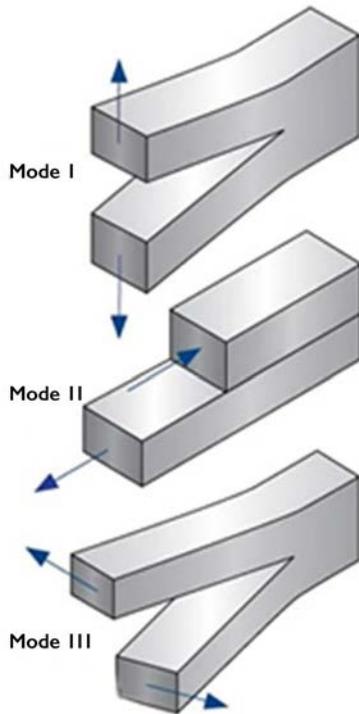
PUSH AND PULL — An example of a traditional fracture test of a metal sample shows how Sandia tests for conditions that will rip apart a material — such as shear and pressure.

Photo by Timothy Briggs



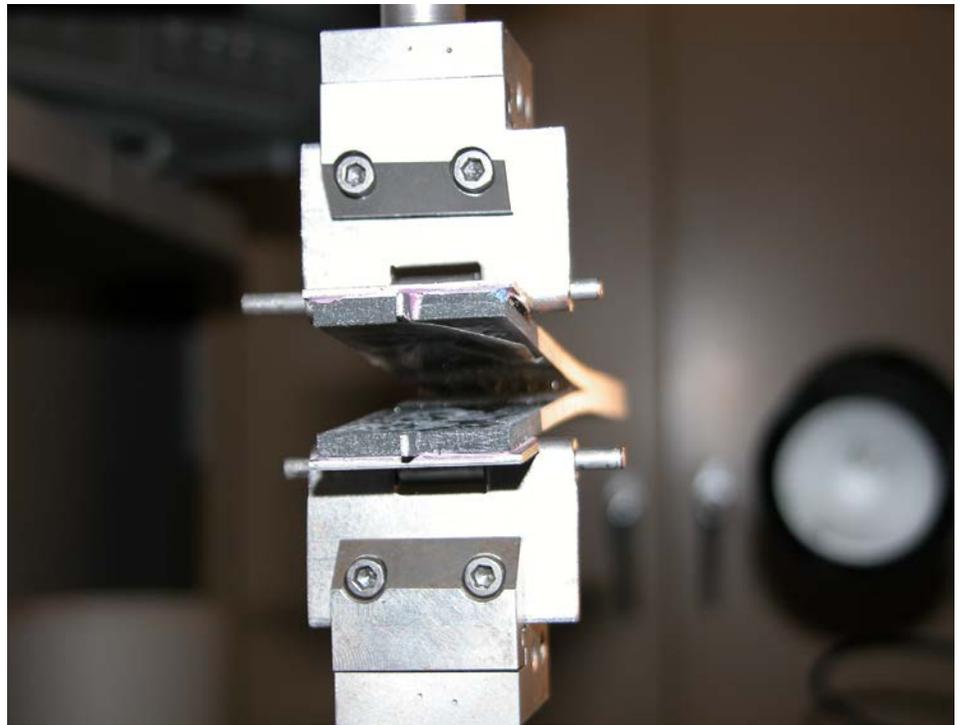
HANG TOUGH — Tests of the strength of a metal sample using the traditional method of bonding hinges to the material, holding the top and bottom pieces in the image, is now easier and more quickly done with hangers developed at Sandia.

Photo by Timothy Briggs



BREAKDOWN — This graphic illustrates the types of fractures simulated by Sandia.

Illustration courtesy Timothy Briggs



TIME TO SPLIT — Sandia hangers make it easier to test the strength of a metal sample using the traditional method of bonding hinges to the material.

Photo by Timothy Briggs

Toss out the glue pot

“Now you can completely abandon the old, laborious process of bonding hinges to the surfaces of the specimen,” Tim said. “I can’t tell you how much work it was to cut hinges, abrade and clean all the bonded surfaces, mix adhesives, precisely align the hinge to the specimen face, glue the hinge to one side of the specimen, allow it to cure, clean up the mess, then do it all again to the other side. Now it’s literally just, drill a hole and go.”

Tim’s patent-pending device allows for a much quicker and inexpensive turnaround for his team to obtain critical-fracture properties, which allows for much greater insight into the conditions that could cause materials to fracture and fail.

Because the time for testing is significantly reduced, engineers will have an opportunity to make things better by subjecting samples to wider array of environmental and loading conditions, ensuring more predictable performance that will improve reliability and safety while reducing research and development costs.

Businesses not only can make their products safer and more reliable with the new approach, but they also can pass on to the consumer the cost savings realized in more efficient research and development as well as reductions in potential liability litigation.

“Seeing the interest from other Sandia researchers for this device is exciting,” Tim said. “I hope this new approach, and the work it could enable for others, can have a broad reach and impact beyond Sandia’s national security mission, touching people’s everyday lives more visibly in their day-to-day activities.” 



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Heavy-lifting innovation born from intersection of need, collaboration

By **Michael Ellis Langley**

A simple innovation developed at Sandia's California campus and designed to improve hoists may make it easier for people everywhere to work safely on heavy items.

Hoists are used in auto garages, machine shops and manufacturing plants around the world. Their only job — to safely and easily lift heavy and unwieldy objects so that they can be worked on. But once an automotive engine or some other piece of hardware has been lifted into the air, it can't easily be rotated so workers can access hard-to-reach areas, until now.

Researchers Irfan Nadiadi and John Monson collaborated to find a way for environmental test teams to rotate and lift objects safely. When they couldn't find a commercial off-the-shelf solution, they developed a custom, locking side pull hoist ring. It mimics a traditional side pull hoist ring but provides an integrated, removable locking pin to fix the hoist rotation at a desired angle.

"It's such a general tool, a piece of rigging hardware," Irfan said. "You lift the object, you pull out the pin, rotate it while it's suspended and then lock the pin and set it back down. If you didn't have a locking capability, you may have to hold your tool and workpiece at an awkward height, rotated in a difficult orientation."

John added, "Two opposing locking hoist rings must align with the center of gravity. That's what allows you to freely rotate a workpiece and lock it."

When they filed a patent for the novel hardware, both were surprised to find no one else had thought of it.

"Maybe it should have existed," Irfan said. "There's a bunch of potential applications in R&D labs or the aerospace industry."

John said that any industry that uses rigging hardware could benefit from their innovation.



EASIER PICKER-UPPER — The custom, locking side pull hoist ring innovation created by Irfan Nadiadi and John Monson makes it possible to manipulate heavy objects while they are suspended in the air.
Photo by Irfan Nadiadi and John Monson

"In certain applications it improves the safety of lifting operations and reduces the number of people needed to perform those tasks," John said.

He suggested that he and Irfan don't see their innovation as particularly important; they just wanted to solve a problem for their co-workers. He does say the process sparked a new innovative thought.

"One thing Irfan and I talked about was coming up with a family of parts with different load ratings," John said.

As designed, the upper limit of their hoist ring is 300 pounds.

"The design is scalable," Irfan said. "While it's perhaps designed for one weight now, it could easily be scaled up using a bigger fastener. A lot of the different environmental test labs in California and New Mexico really appreciated the added feature of being able to lock the rotation and they've asked if we can build more." [i](#)