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INSIDE

Los Alamos NATIONAL LABORATORY EST. 1943

One of Paul Koehler's numerous endeavors is heading the redesign of the Lujan spallation target. Koehler, who recently rejoined the Laboratory after a more than 20 year hiatus, is shown inside the flight path 13 cave at the Lujan Neutron Scattering Center.

Photo by Richard Robinson (XIT-TSS)

Paul Koehler

Applying nuclear physics expertise to a range of scientific challenges

By Kris Fronzak, ADEPS Communications

> *"The design is really important for getting the most 'bang' per proton. But it's a challenge—the same source has uses in nuclear physics and materials science, which have very different parameters."*

As a youngster, Paul Koehler built his own telescope and was determined to study astronomy in school. His resolve paid off. Koehler launched his career as a Los Alamos Director's postdoctoral research associate in Physics Division and developed some of the first nuclear astrophysics research at the Los Alamos Neutron Science Center (LANSCE)—the results aiding understanding of nucleosynthesis in stellar and explosive environments.

Now returned to the Laboratory after a more than 20-year hiatus, Koehler (LANSCE Weapons Physics, P-27) is diving headfirst into numerous projects that support the Laboratory's national security science mission.

For the Detector for Advanced Neutron Capture Experiments (DANCE) he is using improved neutron resonance data on neodymium and samarium isotopes to test random-matrix theory (RMT). He's leading the planning committee charged with redesigning the spallation target the Lujan

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"Congratulations to all!"

From David's desk . . .

Every couple of months when I sit down to write this column, I remain impressed with the awards that Physics Division staff have received. We just heard that two teams that include Physics staff have been awarded 2016 R&D 100 Awards. These awards are sponsored by *R&D Magazine* and were announced at the Nov. 3 awards banquet in Washington DC.

Ray Newell (Applied Modern Physics, P-21) led a multi-institutional team, including Glen Peterson (P-21) that received the award for the Entropy Engine. It is a random number generator, based on quantum mechanical principles, that addresses a key fundamental flaw in modern crypto systems—predictability. The invention strengthens the foundation of computer security by producing an inexhaustible supply of pure random numbers at speeds of 200 million bits per second. (See page 8 for more information.)

Rashi S. Iyer (Information Systems and Modeling, A-1) led a team, which included Pulak Nath, David Platts (ret.), and John Avery William Neal (former student) (P-21), that developed the Pulmonary Lung Model (PuLMo). It is a miniature, tissue-engineered lung developed to revolutionize the screening of new drugs or toxic agents. PuLMo has the potential to enable screening of new drugs more effectively by improving the reliability of pre-clinical testing and saving time, money, and lives.

Qiuguang Liu, Charles Taylor, and Walter Sondheim (Subatomic Physics, P-25) were awarded a 2015 Small Team Distinguished Performance Award for the commissioning of the Mini- Cryogenic Apparatus for Precision Tests of Argon Interactions with Neutrinos (CAPTAIN).

Chris Frankle (Neutron Science and Technology, P-23) was a member of the Mighty Saber Team that received a 2015 Large Team Distinguished Performance Award. The team supported a multiagency, post-detonation nuclear forensics exercise held during the summer of 2015 to demonstrate the U.S. government's capabilities in nuclear forensics.

John L. Kline (Plasma Physics, P-24) was awarded Fellowship in the American Physical Society, with a citation for "seminal contributions to the understanding and development of hohlraum drivers for inertial confinement fusion and their use for radiation transport, hydrodynamic, and ignition science experiments." (see page 6 for more information.)

Congratulations to all!

Outreach in STEM fields is an important part of our future pipeline. Kun Liu (P-25) represented LANL at the National Society of Black Physicists workshop October 27–29 at Fermilab (see photo at right). More than 100

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Kun Liu at the National Society of Black Physicists workshop at Fermilab.

John Kline, Liz Merritt, Kirk Flippo, and Tiffany Desjardins at the LANL booth at the APS Division of Plasma Physics Plasma Expo.

(Courtesy Glen Wurden)

Koehler cont.

Neutron Scattering Center uses to produce neutrons for basic and applied research benefitting national security, nuclear energy, and academia.

“The design is really important for getting the most ‘bang’ per proton,” Koehler explained. “But it’s a challenge—the same source has uses in nuclear physics and materials science, which have very different parameters.”

Koehler is part of a team examining aging effects on nuclear weapons as part of the Neutron Diagnosed Subcritical Experiment in Nevada. He and Shea Mosby (P-27) developed the data acquisition and analysis systems for an upcoming experiment on a subcritical object at the Device Assembly Facility.

“There’s so many ways he can contribute to our programs,” said P-27 Group Leader Aaron Couture. “That diversity is one of the reasons we brought him back.”

Koehler’s diversity of experience was gained at a variety of institutions, but the common threads are providing data of importance to basic and applied physics, as well as testing and improving nuclear models.

As a research scientist at Oak Ridge National Laboratory, Koehler developed expertise in neutron spectroscopy, radiation detection techniques, data acquisition hardware and software, and nuclear astrophysics. He served as a guest researcher at Norway’s University of Oslo and division chief for the Air Force Technical Applications Center in Florida. From 2013 to 2014, as a LANSCE Rosen Scholar, Koehler explored new and improved experiment capabilities for weapons science and discovered significant deviations between LANSCE data and RMT.

In his spare time, Koehler has been probing RMT, which underpins nuclear theories used in weapons physics and astrophysics and was first proposed about 50 years ago—and now largely accepted. But some of the data he’s collected over the years at Oak Ridge and Los Alamos tell a different story. “We have the world’s best data on a number of nuclear reactions, and they don’t agree with the theory. [RMT] is based on several fundamental assumptions that could very well be wrong,” he said.

He’s published articles challenging RMT, and subsequent researchers have posited modifications to the theory to fit the contrary data. Koehler has his own conjectures. Chief among them is resonance internal conversion, wherein a de-exciting nucleus releases energy to the atom and causes electrons around the nucleus to gain energy.

Koehler is working with theorist Toshihiko Kawano (Nuclear and Particle Physics, Astrophysics and Cosmology, T-2) to determine whether another existing model might explain the phenomenon. “The problem is, the whole idea is somewhat crazy,” Koehler said. “But if it’s there and everyone’s ignored it for so long, it would change the way we look at everything.”

Paul Koehler’s favorite experiment

What: Measured the most accurate neutron capture and total cross sections for molybdenum-95 and obtained the best neutron resonance data ever.

Why: To improve understanding of the origin of the elements in red giant stars, to resolve a long-standing puzzle in molybdenum isotopic anomalies in primitive meteorites, and to provide the most detailed test of the nuclear-statistical model and random-matrix theory to date.

When: Fall 2006 and winter 2012/2013

Where: Oak Ridge Electron Linear Accelerator (ORELA) and the University of Oslo (UiO)

Who: Paul Koehler, Ann-Cecilie Larsen, Magne Guttormsen and Sunniva Siem (UiO); and Klaus Guber (Oak Ridge National Laboratory)

How: Experience gained through years of research at different facilities and fortuitous connections among different groups working on different parts of the same problem all came together to yield results far beyond what was previously possible.

The “a-ha” moment: After a successful experiment using the DANCE detector at LANSCE and talking to Norwegian colleagues at an international meeting, I realized that a small change in our apparatus at ORELA combined with data from an experiment at UiO might result in much better data and tests of theory than ever before.

Novel liquid helium technique to aid highly sensitive search for a neutron electrical dipole moment

A multi-institutional team at Los Alamos has constructed a device measuring the electrical breakdown of liquid helium, thus demonstrating a novel technique enabling a highly sensitive search for the non-zero electrical dipole moment (EDM) in the neutron. For 60-some-years scientists have been searching for a signature of the neutron EDM, whose effects are influenced by the strength of the applied electric field. By successfully showing that liquid helium can be used to create an electric field much larger than in previous experiments, the team's technique could aid experiments aimed at explaining the universe's apparent imbalance of matter and antimatter.

The team's technique will be used during the upcoming hunt for a neutron EDM at Oak Ridge National Laboratory's Spallation Neutron Source, which leads the search.

The accomplishment was featured by the Department of Energy Office of Science as a highlight on its website. An article in *Review of Scientific Instruments* describes the apparatus's design, construction, and operational experience, as well as initial results.

The medium-scale high voltage (MSHV) test apparatus was constructed to study electrical breakdown in liquid helium, which can withstand a higher electric field than any man-made vacuum. It showed DC electrical breakdown at temperatures as low as 0.4 K and at pressures between the saturated vapor pressure and ~600 Torr, which means liquid helium can be used to apply an electric field several times bigger than that of previous neutron EDM experiments.

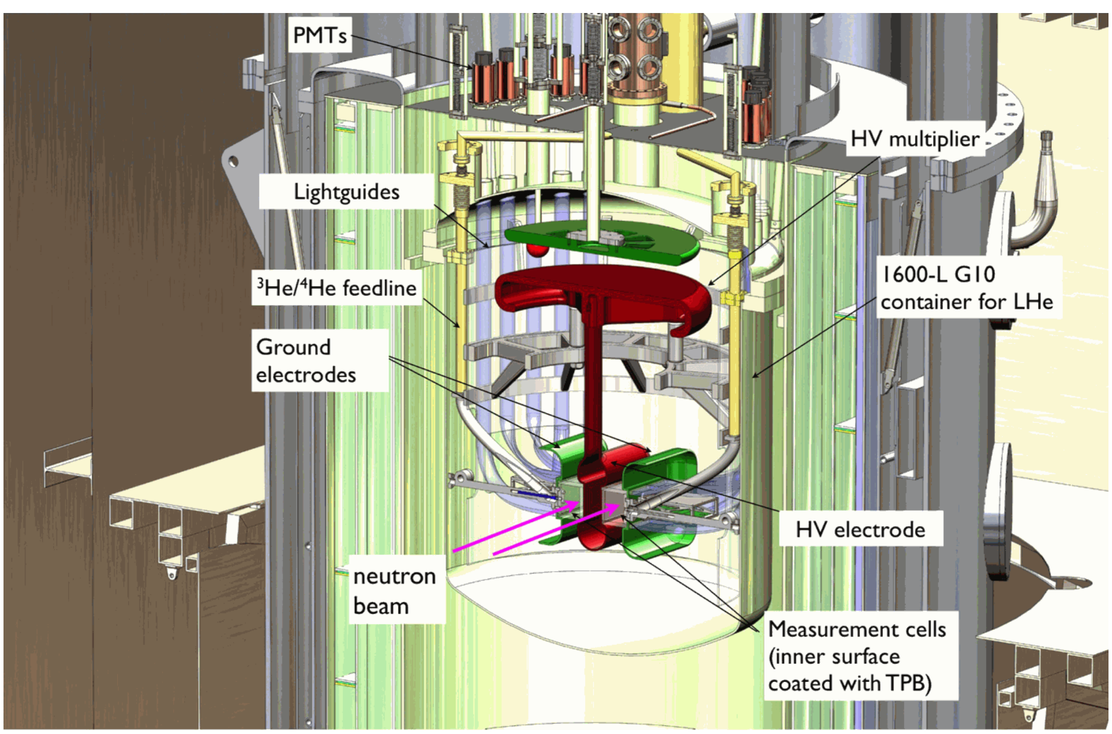
Reference: "An apparatus for studying electrical breakdown in liquid helium at 0.4 K and testing electrode materials for the neutron electric dipole moment experiment at the Spallation Neutron Source," *Review of Scientific Instruments*, **87**, 045113 (2016).

Authors: T. M. Ito, J. C. Ramsey, S. M. Clayton, S. A. Currie, M. Makela, Z. Tang, and W. Wei (Subatomic Physics, P-25); W. C. Griffith (former P-25 postdoctoral researcher, now with the University of Sussex); V. Cianciolo and W. Yao (Oak Ridge National Laboratory); S. E. Williamson and D. H. Beck (University of Illinois); D. Wagner and C. Crawford (University of Kentucky); B. W. Filippone and R. Schmid (California Institute of Technology); and G. M. Seidel (Brown University).

The DOE Office of Science Office of Nuclear Physics and the National Science Foundation funded the project.

This fundamental science project supports the Laboratory's core missions and the Nuclear and Particle Futures and Science of Signatures science pillars by developing experimental techniques relevant to applied scientific work, expertise, and capabilities in cryogenics, high voltages, particle detection, and precision measurements.

Technical contact: Takeyasu Ito



A representation of the MSHV apparatus.

Silverleaf: Prototype Red Sage experiments performed at Q-site

The Red Sage campaign is a series of subcritical dynamic plutonium experiments designed to measure ejecta. Nightshade, the first Red Sage series scheduled for fiscal year 2019, will measure the amount of ejecta emission into vacuum from a double-shocked plutonium surface. This data is required to develop and calibrate ejecta models used in codes to predict device performance.

To fully diagnose the ejecta emission, the project will field a complex suite of diagnostics, including velocimetry, momentum measurements, and radiography. To maximize data returns, a number of targets will be driven at the same time. This complexity is a major technical risk to the Nightshade subcritical experiment.

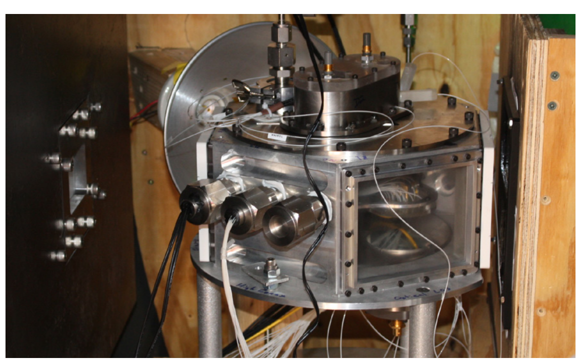
To address this technical risk, a series of four experiments (called the Silverleaf series) was executed at Los Alamos National Laboratory's Q-site. These experiments demonstrate a prototype design of the Nightshade package. This package succeeded in meeting the constraints for fielding at the Nevada National Security Site U1a facility. All the diagnostics functioned well and excellent data was obtained. The assembly and data quality improved with each experiment.

As a result of the Silverleaf series, a number of design improvements have been identified for the Nightshade experiments. These improvements cover many aspects of the design—from diagnostic improvements to manufacturing and assembly methods—that will result in a more efficient and higher quality experiment.

This work was funded by the NNSA under Science Campaign 2: Subcritical Experiments lead by Michael Furlanetto. The success of the Silverleaf experiments was the result of a large team of people working across the National Laboratories, including, from Los Alamos National Laboratory: Bob Gentzlinger (Technology Applications, A-3); David Oschwald (Physical Chemistry and Applied Spectroscopy, C-PCS); Daniel Creveling, Dean Doty, Steve Gilbertson, and Michael Shinas (DARHT Experiments and Diagnostics, J-4); Ray Guffee, Daniel Naranjo, and Steve Rivera (Experiments Integration Office, J-8); Chris Campbell and Angelo Cartelli (Explosive Applications and Special Projects, M-6); Derek Schmidt (Engineered Materials, MST-7); Matt Briggs, Billy Buttler, Jeremy Danielson, Dana Duke, Pat Harding, Tymothy Mangan, Ruben Manzanares, Patrick Medina, Pete Pazuchanics, Jeremy Payton, Danny Sorenson, Benjie Stone, Lenny Tabaka, and Patrick Younk (Neutron Science and Technology, P-23); Daniel Aragon, Ernie Aragon, Martin Herrera, Vince Hesch, Tony Martinez, Louis Montoya, and Jose Olivas (Prototype Fabrication, PF); Roger Hall and Gary Liechty (Detonator Technology, Q-6); Rueben Roybal (Gas Transfer Systems, Q-7); Craig Cunico, Robert Gonzales, Rudy Originales, Morgan Tompkins, and David Villareal (Weapons Product Definition, W-5); Amy Bauer, Mike Furlanetto, Carl Hagelberg (X Theoretical Design, XTD); from National Security Technologies: Brandon Lalone, Jerry Stevens, Stuart Baker, Andrew Corridor, Abel Diaz, Al Lopez, Dane Morgan, Dave Phillips, Duane Smalley, Andrew Smith, Ed Daykin, Mike Hanache, and Mike Pena; from Lawrence Livermore National Laboratory: Corey Bennett, Steve Compton, Louis Ferranti, Adam Lodes, Jose Sinibaldi, and Paul Steele.

"Nightshade Prototype Experiments (Silverleaf)," Sept 2016; LA-UR-16-27510.

Technical contacts: Jeremy Danielson and Amy Bauer



Silverleaf package installed at the Q-site firing point.

John L. Kline named 2016 APS Fellow

John L. Kline (Plasma Physics, P-24) was named an American Physical Society Fellow, nominated by the Division of Plasma Physics. Kline was cited for “seminal contributions to the understanding and development of hohlraum drivers for inertial confinement fusion and their use for radiation transport, hydrodynamic, and ignition science experiments.”

To be selected as a fellow, nominees must have made exceptional contributions to the field of physics, whether by research, important applications, leadership or service to physics, or education contributions.

Kline received his PhD in plasma physics from West Virginia University in 2002, and joined Los Alamos National Laboratory as a postdoctoral researcher later that year. As a postdoctoral researcher, he investigated the physics of laser plasma interactions in the context of inertial confinement fusion (ICF) and the kinetic and the fluid regimes of electron plasma waves driven by stimulated Raman scattering.

In 2008 he became actively involved in the national ICF program, first as an experimentalist at the National Ignition Facility (NIF) and later as a campaign leader. He conducted some of the first experiments on the NIF after the initial completion of the facility studying hohlraum radiation drive. He leads the first campaign to study beryllium capsules for ICF on the NIF, and is a project leader for the LANL ICF program and a team leader for the radiation hydrodynamics team in P-24.

The American Physical Society is a nonprofit membership organization formed in 1899 to advance and spread the knowledge of physics. APS represents more than 51,000 members worldwide and publishes more than a dozen scientific journals, including *Physical Review* and *Physical Review Letters*.

Technical contact: John Kline

Physics students in the news

Remedes and Martinez-Alvarez win Student Symposium awards for research; nine more present

A number of student researchers from Physics Division presented their research at the Laboratory’s 16th Annual Student Symposium held in August. Tyler Remedes (Plasma Physics, P-24) and Adriel Martinez-Alvarez (Applied Modern Physics, P-21) took home awards for their work.

Remedes, a University of Florida graduate student, was recognized for research on “Pulse Dilation Technique on Gas Cherenkov Detectors for application in ICF.” Gas Cherenkov detectors (GCDs) are useful in inertial confinement fusion systems due to a fast timing resolution of about 10 ps, but are limited by photomultiplier tube (PMT) technology that typically has a time resolution of about 100 ps. Remedes’ work involved using pulse dilation to increase the timing resolution of a microchannel plate photomultiplier tube (MCP-PMT), which resulted in an output signal stretched in time from the MCP-PMT with ~10 ps timing resolution. Remedes is mentored by Hans W. Herrmann (Plasma Physics, P-24) and his work was sponsored by the National Nuclear Security Administration.

Adriel Martinez-Alvarez, a Santa Fe Community College undergraduate student, was recognized for research on “Synthesis of Alginate Microspheres in a Microfluidic Platform.” He reported on the fabrication of monodispersed alginate microspheres using droplet-based microfluidics, an efficient method to create monodispersed aqueous droplets in an oil. The research involved optimizing a delayed gelation chemistry of alginate hydrogels for integration into the microfluidic format. The resulting mono-dispersed alginate-based microspheres could be used in applications from cell cultures to injectable cell carriers, according to the research.

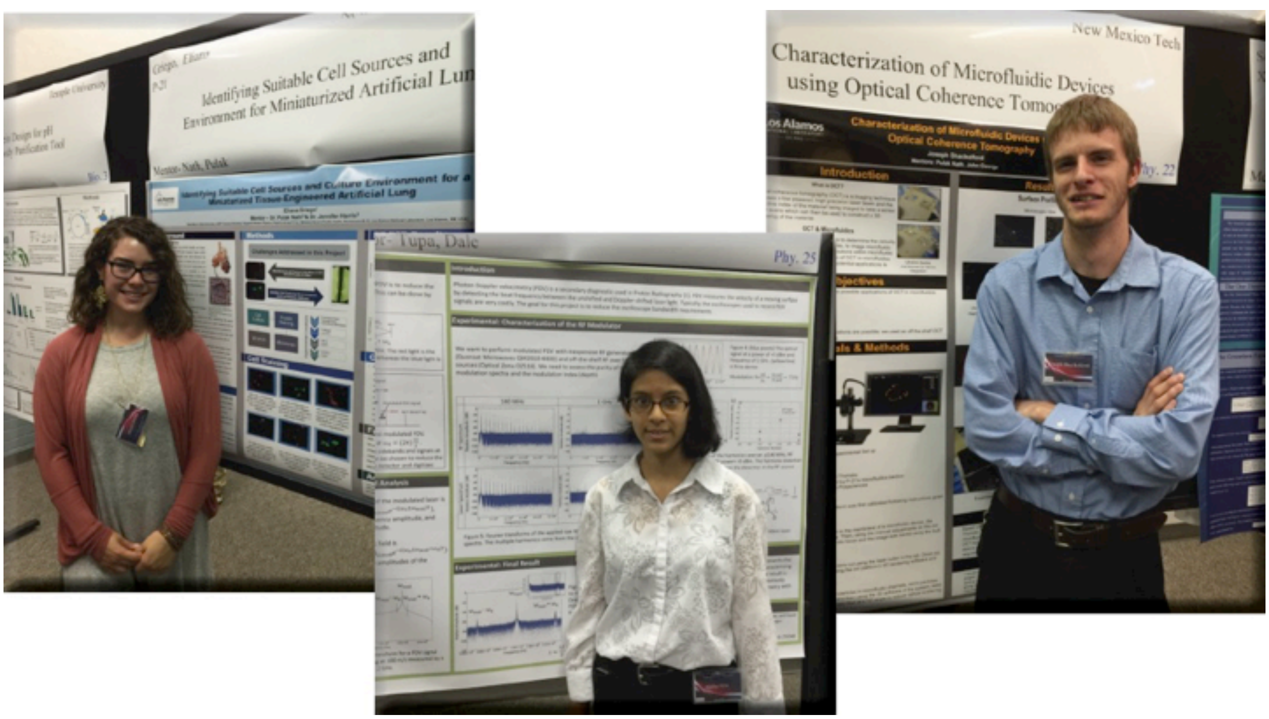
Martinez-Alvarez is mentored by Pulak Nath (P-21). The National Science Foundation sponsored his research.

continued on next page

Students cont.

Other Physics Division student presenters were the following.

- Eliana Griego (P-21) presented "Identifying Suitable Cell Sources and Environment for Miniaturized Artificial Lung." Her mentor is Pulak Nath (P-21).
- Victoria Hypes (P-21) presented "Developing a Lung-on-Chip: Small Molecule Absorption in PU Membranes." Her mentor is Pulak Nath (P-21).
- Brandi Rodarte (P-21) presented "Divide and Conquer: Encapsulation of Small Particles in Microfluidic Droplets." Her mentor is Pulak Nath (P-21).
- Joseph Shackelford (P-21) presented "Characterization of Microfluidic Devices using Optical Coherence Tomography." His mentor is Pulak Nath (P-21).
- Willie Lopez (P-21) presented "A Magnetically Coupled Peristaltic Pump for Microfluidic Applications." His mentor is Pulak Nath (P-21).
- Samantha Burtwistle (P-21) presented "Progress Towards a Potassium BEC Machine." Her mentor is Malcolm Boshier (P-21).
- Tymothy Mangan (Neutron Science and Technology, P-23) presented "A Multipurpose Test Stand for Scintillator Decay Lifetimes." His mentor is Jeremy Danielson (P-23).
- Noah Ratcliff (Subatomic Physics, P-25) presented "Techniques to Improve the Sensitivity of Raman Spectroscopy." His mentor is Zhehui Wang (P-25).
- Alisha Vira (P-25) presented "Assessing Modulated-Laser PDV." Her mentor is Dale Tupa (P-25).



From left: Eliana Griego (P-21), Alisha Vira (P-25), and Joseph Shackelford (P-21).

First Entropy Engine quantum random number generator hits the market

Whitewood Encryption Systems’ quantum random number generator serial number 00001 shipped recently, marking the technology’s debut as a commercial product available for cybersecurity applications.

The technology was also a winner of a 2016 R&D 100 Award, which honor the top 100 proven technological advances of the past year as determined by a panel selected by *R&D Magazine*.

Developed in partnership between the Laboratory and Whitewood, the device is a plug-and-play card that fits network servers and strengthens the foundation of computer security by creating truly random numbers at a rate up to 200 million bits each second. It can deliver these numbers on-demand over a network to existing encryption applications and devices performing cryptographic operations across data centers, cloud computing systems, mobile phones, and the internet of things. Marketed under the name Entropy Engine, it produces random bits with the strongest security assurances and at the highest rates of any hardware random number generator on the market today.

The invention addresses a key fundamental flaw in modern cryptographic systems: predictability. Entropy Engine uses the unique properties of quantum mechanics to generate true entropy (random numbers) in a way that makes it immune from external influences. The behavior of the universe at the smallest scale–the quantum level–is fundamentally unpredictable and beyond the influence of any adversary. The new technology supplies a flood of trustworthy, verifiable truly random numbers, making it virtually impossible for even the most sophisticated cyber attackers to break into the assets protected by this technology.

The work, which supports the Laboratory’s Global Security mission area and Nuclear and Particle Futures science pillar, was initially funded through the Laboratory Directed Research and Development program, with later funding by the Defense Advanced Research Projects Activity (DARPA). The Department of Homeland Security’s Transition to Practice program within the department’s Science and Technology directorate helped bring the technology to market.

Researchers: Raymond Newell and Glen Peterson (Applied Modern Physics, P-21), David Guenther (Space Electronics and Signal Processing, ISR-4), with collaborators Richard Moulds (Whitewood Encryption Systems), Jane E. Nordholt and Richard Hughes (retired LANL); Robert Van Rooyen (Summit Scientific Inc.), and Alex Rosiewicz (A2E Partners, Inc.).

Technical contact: Raymond Newell

The final product as it is prepared for shipment.

HeadsUP!

Yellow road striping: radiological controlled area

Bold yellow paint stripes now vividly demarcate roads leading into the four radiological controlled areas on the LANSCE mesa (at the Lujan Center, WNR, and near the RLW/Fraser dome area). The new striping is about three-feet wide and states "Rad Control Area" in black lettering.

Entering such areas requires specialized training and proper dosimetry. "The paint should make people cognizant of the fact that they're going into a controlled area," said Dan Gonzalez, team leader for LANSCE Health Physics Operations (DESHF-LFO). "These prominent visual aids help us do our jobs better and enable individuals to do the right thing." If anyone passing through TA-53 has doubts about whether they should be in an area, the signs should prompt them to turn around and contact their managers, he said. Gonzalez collaborated with the ADEPS Worker Safety and Security Team, which provided funding for the effort.

DESHF-LFO also installed stanchions at the Lujan Center to remind users to scan their hands and feet for radiological contamination at a hand and foot monitor before leaving the facility.

Celebrating service

Congratulations to the following Physics Division employees celebrating service anniversaries recently:

Christopher Morris, P-25	40 years
June Garcia, P-21	30 years
Ronald Nelson, P-27	30 years
Hanna Makaruk, P-21	20 years
Paul Nedrow, P-23	15 years
Larry Schultz, P-21	15 years
Michael Mocko, P-27	10 years
Elena Guardincerri, P-25	5 years
Jennifer Disterhaupt, P-21	5 years

From David's desk cont.

undergraduates, graduate students and early-career faculty attended this workshop to equip themselves with the tools and information they need to advance to the next stage of their careers. Kun thoroughly enjoyed his participation in the event. Liz Merritt and Kirk Flippo (P-24) organized Los Alamos's booth at the Plasma Expo that occurred in conjunction with the 2016 APS Division of Plasma Physics meeting in San Jose the last week of October (see photo page 2). Elementary and secondary school students from neighboring districts come to the Expo to learn about plasma physics. I particularly enjoyed the wet demonstration of the Rayleigh Taylor instability.

The 2016 APS Division of Plasma Physics meeting also marked the end of my term as chair of the division. While being in the chair line is a four-year term, the first three years are the most work, being, in sequence, chair of the fellowship committee, the program committee, and finally the division. I am looking forward to my last year as past-chair, with its reduced workload. Being chair allowed me to see many of the presentations by LANL scientists from P-23 and P-24. It is always so nice to catch up on what is going on.

I hope everyone has a safe and secure holiday season.

Physics Division Leader David Meyerhofer

PhysicsFlash

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To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 505-606-1822, or adeps-comm@lanl.gov.

For past issues, see www.lanl.gov/org/padste/adeps/physics/physics-flash-archive.php

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