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Photos by Sandra Valdez, NIE-CS

In his first five months on the job, Physics Division Leader David Meyerhofer (right) has been visiting teams in the organization. Here, he discusses R&D for the Los Alamos neutron electric dipole moment experiment with Subatomic Physics members Takeyasu Ito (left) and Zhaowen Tang (center) at the Los Alamos Neutron Science Center. When not at the Lab, Meyerhofer, a New Jersey native can be found on the local hiking trails, continuing a hobby he developed as a child visiting his Swiss grandparents. Come spring, he plans to test the theory that a golf ball flies farther at high altitude than at sea level.

“

We need to be looking out 5-10 years—what do we want the Physics Division to look like, what do we want to and should be doing—and put the planning in place to make it happen.

”

David Meyerhofer

Connecting people, raising awareness of capabilities, and not just ‘business as usual’

By Karen Kippen, ADEPS Communications

“Reinvigorating” is how Physics Division Leader David Meyerhofer described the opportunity to learn new physics—the kind performed in one of Los Alamos National Laboratory’s three original technical divisions.

“What attracted me to Los Alamos, and the Physics Division in particular, was the breadth of physics done in the division,” said Meyerhofer, who after 14 years as experimental division director of the University of Rochester’s Laboratory for Laser Energetics (LLE) (and 28 years at the university), was “fundamentally” ready for something different.

Since arriving in August, he has set for himself the challenge of understanding the physics in each of the division’s 25 teams “so I can be an advocate for each of them.” To aid that endeavor, Meyerhofer is meeting with research teams in their experimental areas. “Physics Division has a lot of really bright people, a lot of enthusiastic people,” he said.

Developing new challenges to engage them is central to how Meyerhofer sees his role as division leader. “I want to ensure a professional and collegial work environment, one

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“

I have enjoyed meeting some of you through different venues, including the series of brown bag meetings, both general and focused. I will continue to hold those meetings in the future. I greatly value hearing your thoughts and suggestions. ”

David

From David's desk . . .

By the time you read this, I expect to have completed my initial visits with each of the division's teams. It has been an incredible pleasure to learn about the myriad of science research that is carried out in the division, from quantum cryptography to turbulence in fluids and high-energy-density plasmas to muon and proton radiography to precision fission cross-section measurements. And I could go on and on. While most of the meetings have been on site, I had the pleasure of spending a day at U1a as the team was preparing for a sub-crit., seeing the many areas where the Physics Division contributes to this important programmatic effort. I thank all of you for taking the time to tell me about what you are working on and having the patience to answer my questions.

I have enjoyed meeting some of you through different venues, including the series of brown bag meetings, both general and focused. I will continue to hold those meetings in the future. I greatly value hearing your thoughts and suggestions.

I attended two national meetings where the Physics Division had significant scientific and organizational roles. Scott Wilburn was the chair of the local organizing committee for the APS Division of Nuclear Physics meeting, held in Santa Fe in October. It went off without a hitch. Stefano Gandolfi and Steven Elliot gave invited talks. I enjoyed seeing a number of the LANL talks and also seeing how the division's contributions were important in other talks, for example the research that was using the PHENIX vertex detector.

I was program committee chair for the APS Division of Plasma Physics meeting, held in Savannah, Georgia, in November. I had help on the program committee from Leslie Welsler and Hui Li. Los Alamos made more than 100 presentations (out of ~1,800). David Montgomery presented a tutorial talk. John Kline and Fan Guo gave invited talks. Now that the meeting is over, I will spend the next year as chair of the division, with help on the executive committee from newly elected John Kline.

I hope you enjoyed the interview that Karen Kippen and Chad Olinger conducted with me (in this issue). I am looking forward to continuing to learn about the division's activities and to begin to plan for the future. I wish all of you a safe, secure, and productive New Year.

Physics Division Leader David Meyerhofer

Meyerhofer cont.

encompassing collaboration across the division to develop new opportunities,” he said.

One way he is doing that is by connecting people and raising awareness of capabilities, to prevent the “missed opportunities” that occur when researchers are unaware of each other’s work. “Finding ways to get broader communication both within the Physics Division and with the other divisions at Los Alamos is something I continue to work on,” he said.

A committed effort to envisioning the Physics Division of the future, through strategic planning on the part of staff and management, is another way. “We need to be looking out 5-10 years—what do we want the Physics Division to look like, what do we want to and should be doing—and put the planning in place to make it happen,” he said.

The work of a national security science laboratory is not new to Meyerhofer, who has a PhD in plasma physics from Princeton University. As former member and chair of the Predictive Science Panel, he worked with Livermore and Los Alamos national laboratories’ predictive weapons physics programs. At LLE he was point-of-contact for the non-ignition aspects of stockpile stewardship research for the Inertial Confinement Program.

Meyerhofer became interested in energy research as an undergraduate physics student at Cornell University shortly after the 1970s U.S. gas crisis. A summer job at the Princeton Plasma Physics Laboratory introduced him to spheromaks, a particular form of plasma configuration, and to some of his

now Los Alamos colleagues. Scientific highlights included early work on high-field atomic physics and high-energy physics experiment at SLAC National Accelerator Laboratory that produced electron-positron pairs from a vacuum.

In welcoming him to the Experimental Physical Sciences Directorate, Associate Director Mary Hockaday said Meyerhofer “has a demonstrated ability to develop synergies between weapons and basic science, and to promote research activities that deliver on mission while enabling scientific creativity.”

For example, while at LLE, he worked on developing the science case for a new laser system that allowed scientists to expand the scope of their research. The addition of a new capability, the OMEGA EP, was the result of user input gleaned during a workshop series, “which allowed people to think about the different kind of physics they could do beyond the OMEGA laser system,” he said.

To early-career Physics researchers looking to make an impact, Meyerhofer said, “You need to take the opportunity to learn what other people in this division are doing.” To staff who are familiar with the status quo, he said, “Ask the question why we’ve done something this way forever—is this the optimal way to do this?”

The aim, he said, is “a culture where everyone is heard, where we get new ideas, and it’s not just business as usual.” It’s a principle Meyerhofer himself follows: “I like to say my door is always open.”



Clockwise from top left, Physics Division Leader David Meyerhofer with Wanchun Wei; Leah Broussard; Scott Currie (all Subatomic Physics, P-25), and with team members in front of the Area A staging area at the Los Alamos Neutron Science Center.

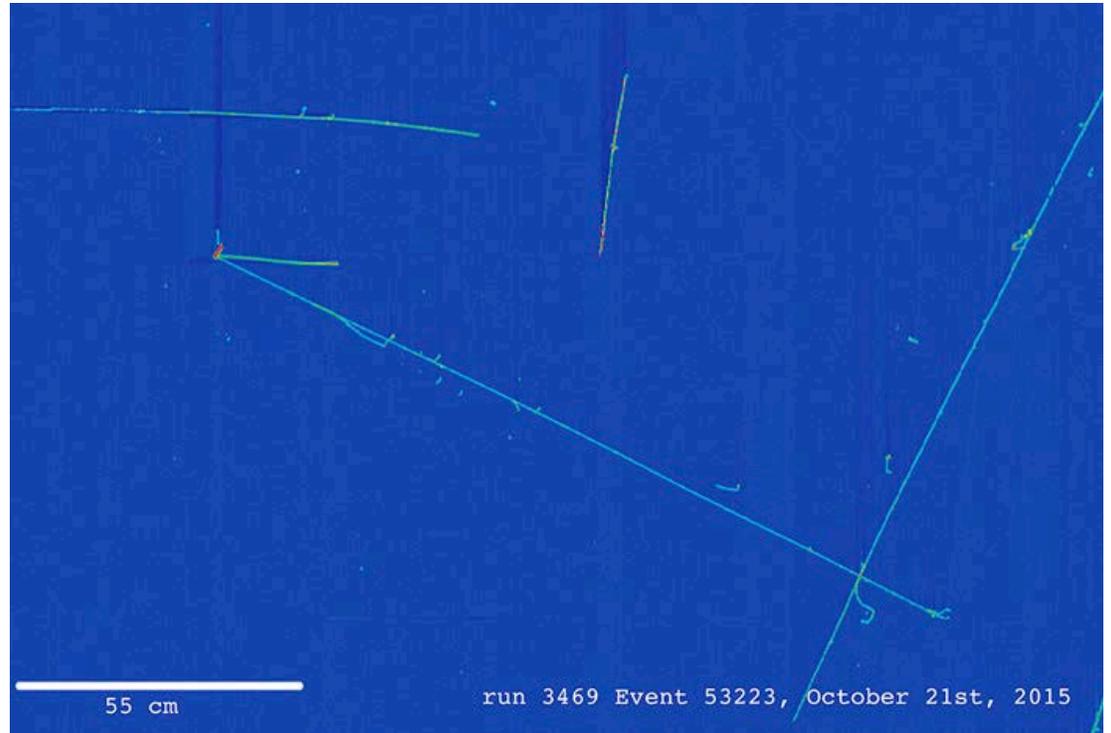


Los Alamos aids in MicroBooNE's first neutrino sightings

MicroBooNE, a neutrino detector, recently observed its first neutrinos—building blocks of matter that are difficult to study because they have no electrical charge. Los Alamos expertise in target fabrication, accelerator beamline operations, and data acquisition systems has been important for the newly commissioned, multi-laboratory experiment at Fermi National Accelerator Laboratory.

MicroBooNE's purpose is to confirm or deny the existence of a hypothetical particle known as the sterile neutrino. Three types of neutrinos have been detected, and the detection of a fourth type would be a major contribution to modern particle physics. MicroBooNE will search for sterile neutrinos by measuring how neutrinos mix and change from one type into another, a process called neutrino oscillations that occurs because neutrinos have mass.

Geoff Mills and Gerald Garvey (Subatomic Physics, P-25) were responsible for the construction of the Booster Neutrino Beamline beryllium target and, working closely with Fermilab staff, they, together with Richard Van de Water (P-25), were heavily involved in the monitoring and debugging of various elements of the beamline during its 10 years of running



An accelerator-born neutrino candidate, spotted with the MicroBooNE detector.

Image courtesy Fermilab.

for MiniBooNE, a related project at Fermilab. Former Los Alamos scientists Wesley Ketchum and Zarko Pavlovic (now at Fermilab) also contributed substantially to the beamline and to the data acquisition system.

The Booster Neutrino Beamline, part of the Accelerator Complex at Fermilab, produces protons with energies as high as 8 GeV. These protons impinge on the beryllium target and produce a secondary beam of pions that decay into muons and neutrinos. It is these neutrinos that are detected by MicroBooNE.

Mills, through a Laboratory Directed Research and Development-funded project, also led the HARP-MiniBooNE collaboration, which produced well-measured pion yields that improved neutrino flux estimates for the MicroBooNE beamline. These flux calculations were used to develop preliminary oscillation and cross section analyses.

The work supports the Lab's Nuclear and Particle Futures science pillar and is an example of physics beyond the standard model research to understand the deeper theory of the fundamental forces that define our universe. The U.S. Department of Energy Office of Science funds the work.

Technical contacts: Bill Louis and Richard Van de Water

New single-stage gas gun at Trident enables 10-nanometer-scale surface height variation measurements of dynamic friction

With unprecedented accuracy, experiments at Los Alamos National Laboratory's Trident Laser Facility have measured shock-induced surface height variations in materials that were blasted by projectiles launched from a single-stage gas gun. Evolving surface height variations, telling signs of interface friction known from previous experiments, are important for understanding the properties and behavior of dynamic materials used in the nation's nuclear weapon stockpile.

This is the first time Los Alamos researchers have combined gas guns with transient imaging displacement interferometry (TIDI), a high-resolution (5 μm), two-dimensional surface displacement (10-nm-scale) interferometer that tracks the evolution of surface heterogeneities during high-velocity impacts. TIDI uses a series of laser pulses and fast optical camera recording. TIDI is a diagnostic unique to Trident and measures behavior from laser-driven shocks, which have predictable timing. Gas gun timing is less predictable. The challenge was to synchronize the TIDI pulsed probe laser to the impact from the gas gun. Using two independent trigger signals and repeatable gas gun performance, the research-

ers obtained a total TIDI frame-to-shock event timing jitter of 100 ns, which is primarily due to a 5% shot-to-shot variation in impact velocity.

Using the newly installed gas gun at Trident, Eric Loomis, Tom Shimada, and Randall Johnson (Plasma Physics, P-24) measured shock uniformity in polymethylmethacrylate targets with extreme sensitivity. This is a first step towards future dynamic friction experiments. With this gas gun they plan to extend the dynamic friction measurements in beryllium-copper to impact velocities of 600 m/s, accessing important physical regimes of interface sliding while constraining friction models with unprecedented accuracy.

In their previous laser-driven experiments¹(without gas guns), the limit was 200 m/s. By examining the effects of constrained interface sliding on local deformation near the boundary, researchers learn more about how the interfaces possessing finite frictional strength under high-dynamic pressures and shear can affect the behavior of materials.

The DOE Office of Fusion Energy Sciences funded installation of the Trident gas gun and the research, which supports the Lab's stockpile stewardship mission and Materials for the Future science pillar.

Technical contact: Eric Loomis

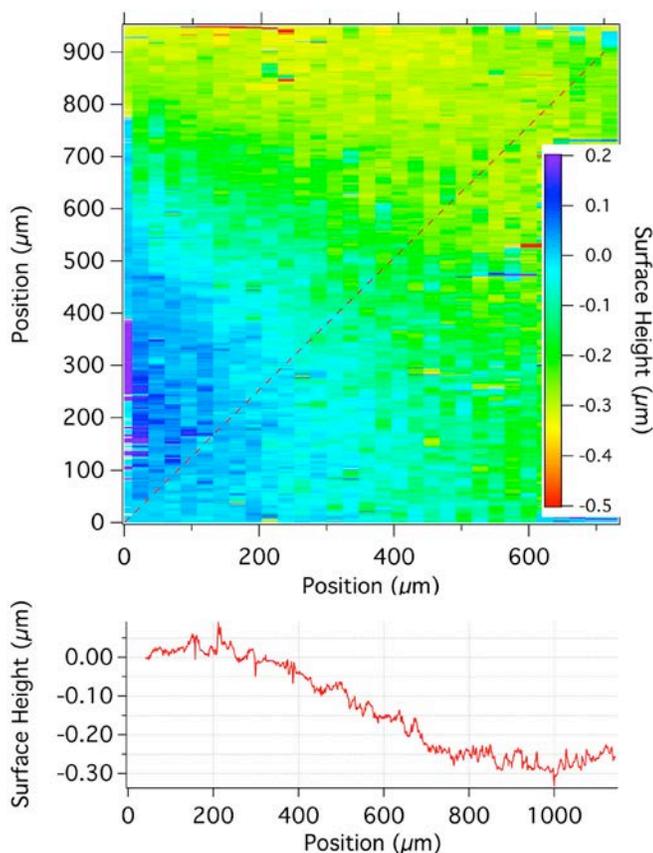
¹E. Loomis, J. Hammerberg, J.C. Cooley, T. Shimada, R.P. Johnson, P. Peralta, R. Olson, G.T. Gray III, "High-resolution measurements of shock behavior across frictional Be/Cu interfaces," *J. Appl. Phys.* **117**, 185906 (2015)

⁶³Ni (*n, γ*) cross sections measured with DANCE

Recent Los Alamos Neutron Science Center (LANSCE) measurements on a radioactive isotope of nickel with the Detector for Advanced Neutron Capture Experiments (DANCE) at the Lujan Center shed new light on how copper and zinc are made in stars.

A team of scientists from LANSCE Weapons Physics (P-27), Nuclear and Radiochemistry (C-NR), Goethe University of Frankfurt, and University of Vienna published its results in *Physical Review C*. This work was part of the PhD thesis of Mario Weigand, an experimental nuclear physicist from the Goethe University of Frankfurt.

The DANCE instrument, located at flight path 14 in the Lujan Center, is a 160-element barium fluoride scintillator array designed to perform measurements on small samples of rare isotopes. The high segmentation combined with the high efficiency of the instrument has allowed measurements on a wide range of isotopes for programs ranging across national security, nuclear forensics, nuclear energy, nuclear structure, and nuclear astrophysics.



Surface height variation of Al-coated polymethylmethacrylate, 300 ns after shock breakout. Static surface of target has been removed. Lineout taken diagonally across top image shows 0.3 mrad of non-planarity.

continued on next page

DANCE cont.

In this study, a sample of ~350 mg of isotopically enriched nickel-62 was irradiated at a reactor, converting 11% of the stable nickel-62 into unstable nickel-63. Nickel-63 is a radioisotope with a 101-year half-life, decaying via emission of a 67-keV electron. The inherent sample activity was 80 GBq, or 2.2 Ci. After the sample was produced, it was brought to LANSCE, where the DANCE experiment was completed.

The elements heavier than iron are primarily produced through neutron capture processes in late stellar evolution of stars somewhat and significant more massive than the sun. Both a slow and rapid neutron capture process can contribute to their production. The slow, or *s* process, evolves along the line of beta stability, with neutrons being sequentially captured until an unstable isotope is created. If it is short-lived (<1 year), it will decay before another neutron capture can take place. If it is long-lived (>1000 years), it will capture another neutron. Isotopes with lifetimes between these extremes are called “branch-point” isotopes, as they split the reaction flow, including both neutron capture and beta decay. Nickel-63 is one such isotope.

Precise knowledge of the neutron capture cross section on branch points allows them to be used to determine stellar conditions at the *s*-process site. Before this work, there was only one measurement of the neutron capture cross section on nickel-63, which differed from theoretical estimates by almost a factor of 2.

The differential measured cross section is shown in Figure 2 (upper) and extends up to 500 keV. For stellar nucleosynthesis calculations, a Maxwellian-averaged cross section (MACS) is needed at 8, 25, and 90 keV. The mea-

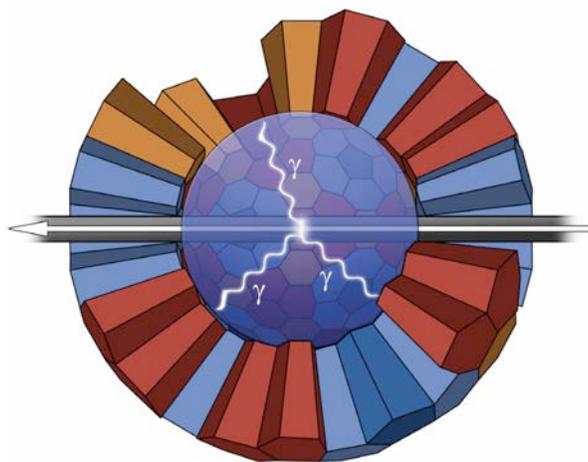


Figure 1. A schematic model of part of the DANCE array is illustrated above. Different crystal shapes are indicated in different colors. Gamma rays are shown coming from the sample position. The sphere at the center represents the ${}^6\text{LiH}$ sphere placed at the center of DANCE to absorb scattered neutrons.

sured MACS together is shown in Figure 2 (lower), together with the previous evaluation and the measurement from neutron time of flight (nTOF).

The excellent agreement between the DANCE and nTOF results lends confidence to adopting the increased cross section relative to the theoretical estimate. This is particularly important as the nickel-63 branching controls the production of both copper-63, which is primarily made in the *s* process, and zinc-64, which is exclusively made in the *s* process. Because nickel-63 will capture more neutrons than previously expected, the reaction flow will bypass the production of both copper-63 and zinc-64 in these environments, leading to a roughly 30% reduction in the expected yield of these isotopes in massive stars.

This work supports the Laboratory’s Nuclear and Particle Futures (NPAC) science pillar, with particular impact on the NPAC goals of Cosmic Explosions: Origins to Ashes and the Origin, Evolution, and Properties of Atomic Nuclei. This work directly answered questions of the nucleosynthesis of copper and zinc. The DOE Office of Science, Nuclear Physics and Los Alamos’s Laboratory Directed Research and Development program provided support for the Los Alamos investigators.

Los Alamos researchers are T.A. Bredeweg (C-NR), A. Couture (P-27), M. Jandel (C-NR), J.M. O’Donnell (P-27), and J.L. Ullmann (P-27). Reference: “ ${}^{63}\text{Ni}$ (n, γ) cross sections measured with DANCE,” *Phys. Rev. C* **92** (045810) 2015.

Technical contact: Aaron Couture

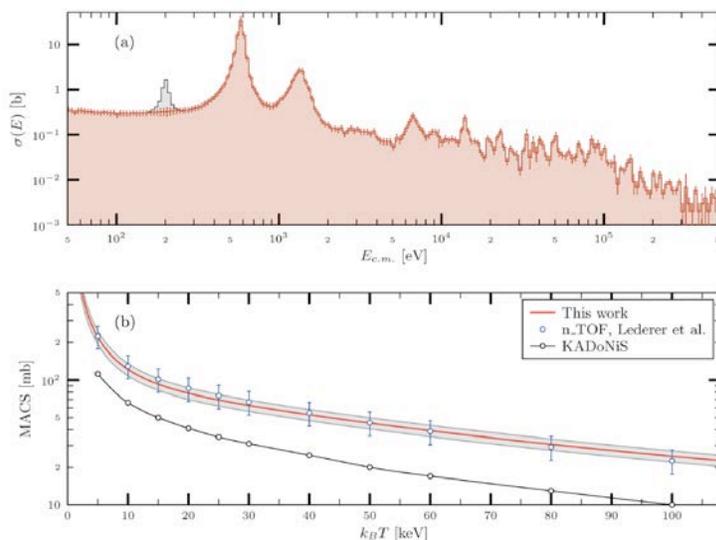


Figure 2: Shown in red in the upper panel is the measured differential neutron capture cross section on nickel-63. Shown in grey is a resonance from a contaminant. The lower panel compares the MACS from DANCE and nTOF measurements, which are in excellent agreement.

Plasma research shows promise for future compact accelerators

A transformative breakthrough by Los Alamos researchers in controlling ion beams allows small-scale laser-plasma accelerators to deliver unprecedented power densities. That development offers benefits in a range of applications, including nuclear fusion experiments, cancer treatments, and security scans to detect smuggled nuclear materials.

Laser-plasma accelerators shoot a high-energy laser into a cloud of plasma, releasing a beam of ions, or electrically charged particles, in a fraction of the distance required by conventional accelerators. The laser generates electromagnetic fields in the plasma.

Using the computer simulation code vector-particle-in-cell (V-PIC), the team developed a scheme enlisting the electromagnetic fields so the beam essentially contains itself, reducing the energy spread, making the beam more efficient, and concentrating more energy on its target. The team confirmed the simulation through experiments on the Trident laser.

High-energy ion beams from plasma accelerators can be used for ion fast-ignition in nuclear fusion, but overcoming power loss resulting from large energy spread is a challenge despite a decade-plus effort. The breakthrough addresses this problem and may contribute to improved next-generation particle accelerators.



The team, in front of the Trident laser target chamber at Los Alamos National Laboratory, includes (back, from left) Tom Shimada, Sha-Marie Reid (Plasma Physics, P-24); Adam Sefkow (Sandia National Laboratories); Miguel Santiago, Chris Hamilton (Engineered Materials, MST-7); (front, from left) Russ Mortensen (P-24); Chengkun Huang (Applied Mathematics and Plasma Physics, T-5); Sasi Palaniyappan, Juan Fernández, Cort Gautier, Randy Johnson (P-24); and (not pictured) Rahul Shah, Raymond Gonzales (P-24); Lin Yin (Plasma Theory and Applications, XCP-6); Brian Albright (XTD Primary Physics, XTD-PRI), and Christian Kreuzer (Ludwig-Maximilian University).

The Los Alamos discovery will benefit basic science, since the more powerful ion beams can flash-heat materials to create warm, dense matter similar to that found in stars and planetary cores.

The Laboratory Directed Research and Development program funded the work, which supports the Lab's national security mission and Nuclear and Particle Futures science pillar. The research benefited from the use of the Trident laser, which is funded by the Inertial Confinement Fusion campaign (Program Manager Steve Batha) and NNSA Campaign 4 (Secondary Assessment Technologies, Program Manager John Scott). Simulations were run using the Lab's Institutional Computing and Advanced Simulation and Computing program allocations.

Reference: "Efficient quasi-monoenergetic ion beams from laser-driven relativistic plasmas," *Nat. Commun.* 6:10170 doi: 10.1038/ncomms10170 (2015).

Technical contact: Sasi Palaniyappan

Los Alamos Northern New Mexico IEEE Section wins two excellence awards

The Los Alamos Northern New Mexico (LANNM) Institute of Electrical and Electronics Engineers (IEEE) Section has received 2015 Outstanding Small IEEE Section awards for excellence in local activities, which are mostly run by volunteers from Los Alamos National Laboratory. LANNM section activities include technical talks open to the public (about 6-10 per year), professional development training, students and high school events promoting science and engineering, and recruiting gatherings.

After winning the award in the Southwest Area of Region 6, the Los Alamos Northern New Mexico Section advanced to the Region 6 competition, where it was again a winner, competing with other small sections with up to 500 members. The IEEE consists of 10 regions worldwide, of which Region 6 in the United States is the largest covering western states where high-tech companies abound.

IEEE professional interests have expanded, covering practically all science and technology, including nuclear, photonic, power, software engineering, and biotechnology. IEEE serves as an umbrella organization for many professional societies of a more precisely defined scope of interest, the largest of which is the Computer Society. The LANNM Section includes some of these local chapters.

From Los Alamos National Laboratory, LANNM volunteers include Section Chair Hanna Makaruk (Applied Modern Physics, P-21), Section Vice-chair Bruce Carlsten (Accelerator and Operations Technology, AOT-DO), Signal Processing Society Chapter Chair David Izraelevitz (Space Data Systems, ISR-3), Computer Society Chapter Chair Michael Ham (P-21), Nuclear & Plasma Sciences Society Chapter Chair Nathan Moody (Accelerators and electrodynamics, AOT-AE), Women in Science and Engineering Affinity Group Chair Heather Quinn (ISR-3), Young Professional Affinity Group Chair Charles Weaver (Space Electronics and Signal Processing, ISR-4), and Section Historian and former long-time Chair Teri Roberts (Data and IT Quality Management,

Celebrating service

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

| | |
|---------------------------|----------|
| Robert Haight, P-27 | 45 years |
| Julie Canepa, P-24 | 30 years |
| Jeffrey Griego, P-24 | 25 years |
| Constantine Sinnis, P-27 | 25 years |
| Donald Gautier, P-24 | 15 years |
| Garrett Kenyon, P-21 | 15 years |
| Christopher Tomkins, P-21 | 15 years |
| Aaron Couture, P-27 | 10 years |
| Keith Rielage, P-23 | 10 years |
| Joshua Tybo, P-23 | 5 years |



LANNM Section volunteers celebrate the Outstanding Small Section Award at a social gathering in Los Alamos on IEEE Day. From left: Robert Owczarek (University of New Mexico), Bruce Carlsten (Los Alamos National Laboratory), Gregg Giesler (COMPA Industries), Peter Clout (Vista Control Systems Inc.), Heather Quinn, David Izraelevitz, Christopher Brislawn, Hanna Makaruk, Zack Backer, Michael Ham, Randy Roberts, and Teri Roberts (all Los Alamos).

SAE-1). Tom Tierney (Intelligence & Systems Analysis, A-2) is a longtime volunteer and past section chair, currently serving with IEEE-USA Board of Directors as vice president for government relations.

Technical contact: Hanna Makaruk



Published by the Experimental Physical Sciences Directorate.

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

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



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HeadsUP!

ADEPS Environmental Action Plan for FY16

ADEPS remains committed to managing its environmental impacts with forethought and action. Our 2016 Environmental Action Plan was developed from an overarching review of the potential impacts of our work activities and identifies certain, concrete steps we can take to decrease the potential for, and severity of, any environmental damage from our work.



We remain focused on three areas: *Clean the Past*, *Control the Present*, and *Create a Sustainable Future*. These objectives parallel Los Alamos National Laboratory institutional objectives, with the specific targets fine-tuned to fit our directorate.

Clean the Past: Reduce environmental risks from historical operations, legacy and excess materials, and other conditions associated with activities no longer a part of current operations.

Target 1: Continue salvaging and recycling surplus equipment, materials, etc.

Action 1: Reduce, salvage, and recycle

Action 2: Transporter assessment, clean-out, removal

Action 3: Combined effort: MPA/MST clean-up of rad-contaminated vacuum pumps and other legacy items from 03-34

Action 4: Transfer hazardous chemicals from LANSCE to ORNL-SNS and dispose of the rest of the hazardous chemicals from 53-015.

Target 2: Identify and execute ADEPS Footprint Reduction Project

Action 1: Relocate occupants, supplies, and equipment from 53-044, 53-045, 53-046, and 53-047 such that these buildings can be readied for D&D via the LFO-FOD.

Control the Present: Control and reduce environmental risks from current, ongoing operations, missions, and work scope.

Target 1: Annual: One environmental MOV per manager per quarter

Target 2: Annual: Communicate EAP and EMS information to directorate staff

Action 1: Ample use of posters, division newsletter articles, group meetings

Action 2: Integrate ADEPS EMS EAP message with ADEPS WSST Team

Action 3: Host a “zero waste” meeting or event

Target 3: Annual: Maintain control of chemicals

Action 1: Annual chemical inventory with 95% goal for each ADEPS division

Action 2: Utilize LANL chemical re-use resources (ChemDB & Chemicals eStockroom)

Target 4: Submit projects or work improvement activities for P2

Create a Sustainable Future: Ensure mission is entwined with effective environmental stewardship

Target 1: Sponsor or participate on building a “Green Team”

Action 1: Participate on the 03-1415 Green Team

Target 2: Incorporate MaRIE planning to include future potential environmental hazards and mitigations on our 2.10’s and 2.4

Additionally:

Each of us can contribute in small, but important ways, such as turning off lights in areas when not in use, calling attention to a leaking faucet or toilet so it can be fixed, turning off computer peripherals when not in use, and being attentive to purchases to support “green” procurements wherever possible. Other actions to consider are:

- Using the blue and green recycling bins.
- Sharing chemicals, minimizing chemical inventories, purchasing safer alternatives, recycling and disposing properly.
- Salvaging all unnecessary or unused (and not needed) equipment.
- Nominating a deserving colleague for a P2 Award!!

Please remember to let us know of any environmental actions so we can tally them in our end-of-year report. You can send information to any of the ADEPS Environmental Action Plan contacts:

ADEPS – John Gustafson, johngus@lanl.gov

MPA Division – Jeff Willis, jwillis@lanl.gov

MST Division – Dianne Wilburn, dianne@lanl.gov

P Division – Steve Glick, sglick@lanl.gov

The ADEPS plan in greater detail can be found at the LANL EMS web page at int.lanl.gov/environment/ems/index.shtml; then click on Tools - “EMS Action Plans.”

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