Physics Flash

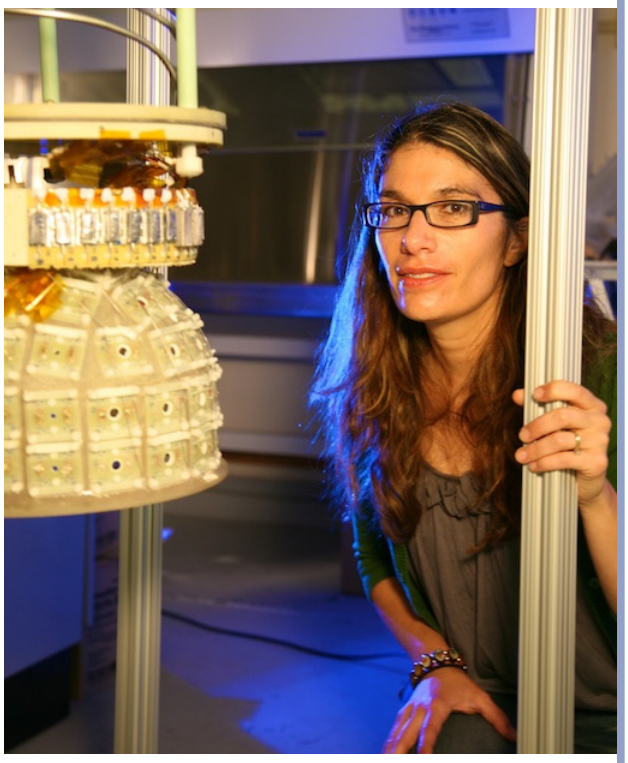
May 2012

INSIDE

Michelle Espy

Using her brain (literally) to detect new applications for SQUIDs

By Diana Del Mauro
ADEPS Communications



Michelle Espy with a sensor array for combined MEG/MRI (magnetoencephalography/magnetic resonance imaging) of the brain, used as part of an LDRD-DR (Laboratory Directed Research and Development Directed Research) project to image functional dynamics in the human brain.

Like a neuron firing up one connection after another, Michelle Espy is an inspired researcher who likes talking to people and knows how to make things happen.

Her inspiration might come from a simple conversation with a scientist in another discipline or a surgeon in a hospital. Then, if she thinks the tool at her disposal might help solve the problem, she dives in. "Rather than having one esoteric piece of science we want to follow to the bitter end, we are always looking for something new where we could pitch in," Espy said.

As Superconducting Quantum Interference Device (SQUID) team leader in Applied Modern Physics (P-21), her tool of choice captures and labels magnetic fields emitted from the brain. SQUIDs are the most sensitive detectors of magnetic fields known to science. In the mid-1980s, Los Alamos National Laboratory began investigating using SQUIDs for imaging brain function and the Lab continues to be one of the few places in the United States devoted to the field of SQUID applications.

While Espy's team uses the technology to solve quite different problems—from detecting the brain tissue causing epilepsy to studying how a plant dies during drought—the underlying scientific principles are the same.

Espy has amassed "an integrated theme of research," said Don Tucker, a University of Oregon psychology professor and her collaborator for more than 10 years. What Espy learned from designing MagViz, a scanner that recognizes hazardous liquids in sealed containers, later spurred researchers to consider using the same ultra-low field magnetic resonance imaging (MRI) for breakthrough medical applications, he noted.

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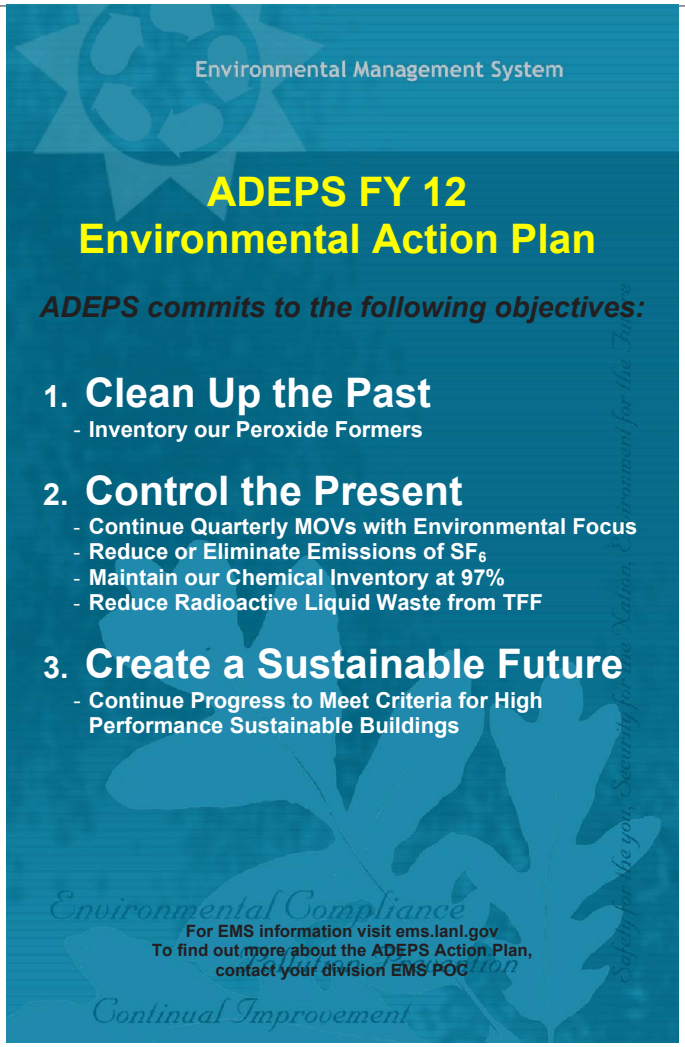
From Steve's Desk

It's time to come up to speed on the Directorate's implementation of the FY12 Environmental Action Plan (EAP) that was developed in support of the Lab's Environmental Management System. The ADEPS team responsible for developing and disseminating the plan includes Steve Glick from P Division (also serves as the Directorate Point of Contact), Jim Coy from MST, Cathy Padró from MPA, and Frances Aull from LANSCE.

Our 2012 Environmental Action Plan addresses our impact on the environment. You have seen the poster: we will attack this from three angles—the past, the present, and the future.

Let's look at our objectives, and the specific targets we have developed to meet the objectives. These objectives parallel the LANL institutional objectives, with the targets fine-tuned to fit our Directorate's needs.



Objective 1 – Reduce Environmental Risks from Historical Operations, Legacy, and Excess Materials and Other Conditions Associated with Activities No Longer a Part of Current Operations (CLEAN UP THE PAST). Last year, we worked with the Lab's Environmental Team to understand our chemical waste generation profile so that we can establish long-term waste-reduction goals. Our focus this year is peroxide formers—we will perform a focused inventory of out-of-date peroxide formers to ensure proper testing and to identify potential disposal pathways.

Objective 2: Control and Reduce Environmental Risks from Current, Ongoing Operations, Mission, and Work Scope (CONTROL THE PRESENT). Managers will continue to emphasize environmental aspects during MOVs, we will conduct an annual chemical inventory, and we will disseminate information on the EAP using posters, group briefings, and e-mails. In addition, we are specifically targeting reduction or elimination of SF_6 releases. SF_6 is an extremely potent greenhouse gas and reducing or eliminating emissions is an institutional goal associated with the Site Sustainability Plan. Finally, MST Division was in line to receive institutional funding to reroute non-RLW (rad liquid waste) discharges at Target Fab Facility that currently go to the RLW Treatment Facility, but the project is on hold due to the funding being withdrawn.

Objective 3 – Reduce Environmental Risk from Customer Expectations and Regulatory Requirements Associated with Future Conditions, Managing these in Alignment with Short- and Long-Term Planning, Work Scope Projects, etc. (CREATE A SUSTAINABLE FUTURE). We will continue to work towards the requirements for High-Efficiency Sustainable Building recognition for the MS-OB (03-1415), including additional tenant education and the formation of a Green Team.

To succeed, we need everyone to "up" their awareness and take action. Turn off lights in offices, conference rooms, hallways, and labs when not in use. Get that leaking faucet/toilet/urinal fixed (contact your facilities coordinator). Turn off computer peripherals when not in use. Alter your purchasing habits–Purchase GREEN. Use the blue and green recycling bins. Share chemicals, minimize chemical inventories, purchase safer alternatives, recycle and dispose properly. Salvage all unnecessary or unused (and not needed) equipment. Nominate a deserving colleague for a P2 (Pollution Prevention) Award!!

Document, Record & Report all significant environmental actions that you take that positively affect the environment. Remember, if it's not recorded, it didn't happen. Please send your environmental action reports (e-mails are fine) to your Division contact: jcoy@lanl.gov for MST; padro@lanl.gov for MPA; aull@lanl.gov for LANSCE, and sglick@lanl.gov for P Division. This will ensure that our efforts continue to get the deserved recognition for our environmental efforts.

Steve Glick, ADEPS EMS point of contact

Espy . . . This low-cost alternative to conventional MRI is now Espy's biggest passion. "I think ultra-low field MRI could bring an entirely new class of diagnostic equipment to the world," she said.

Espy is now developing the physics for a new portable MRI device, with funding she secured from the National Institutes of Health. Tucker, also chief executive officer of Electrical Geodesics, hopes to commercialize the portable MRI. In addition to filling the need to detect brain injuries in battlefield soldiers, the portable MRI could serve civilians in developing countries.

From neuroscience to explosives detection and back

With a PhD in nuclear physics from the University of Minnesota, Espy imagined she would spend her days probing the nucleus. Instead, following a friend's suggestion, she became a postdoctoral researcher on the SQUID team in 1996. Espy jokes that she is among the few people in the world who can actually tell that their co-workers have brain activity. To further her research, she has crawled inside the MRI machines in her laboratory dozens of times, and her colleagues do the same.

SQUID was a "quiet brain-imaging team," she said, until 2006 when it demonstrated the first ultra-low field MRIs of a human brain, opening the door to new applications.

In the wake of a London terrorist plot, the SQUID team wondered if ultra-low field MRI might help foil such plots in the future and constructed "something only a mother could love," Espy said: a scanner made of wood, fiberglass, and boat batteries. Capable of identifying explosives in packaged liquids at airports, it brought a flush of Department of Homeland Security funding to the team.

In 2007, as Espy arose as SQUID team leader, the team grew from about 10 to 20 members due to the liquid detection project and the focus shifted away from fundamental neuroscience. "It has been hard in some ways," she said. "But overall, it's been good for the team and good for the science."

Arcing back toward its original charter of unlocking the secrets of the brain, the SQUID team is currently in a race with a European consortium to build an MRI system around a magnetoencephalography machine, providing both spatial and temporal resolution of the brain's anatomy and function.

Espy holds three patents and four research awards, including an R&D 100 for the liquid scanner, which Florida-based Field Forensics is preparing to deploy at courthouses, concert halls, and cruise ships.

She said a decade-plus of studying the world's "most amazing piece of hardware" has made her a better listener. "Often I am not even close to the smartest person in the room," she said.

Michelle Espy's favorite experiment

What: Measuring my son's heartbeat with magnetocardiography (MCG) when I was eight months pregnant with him.
Why: To assess our technical capability to use SQUID-based techniques in our laboratory to record the fetal-MCG signal. It is impossible to measure fetal electrical heart activity after the first trimester using anything but fetal-MCG.
When: May 2003
Where: SQUID laboratory
Who: Myself and Andrei Matlashov (P-21)
How: I was expecting my first child and Andrei somewhat jokingly mentioned that now was our chance to see if we had the technical ability to measure fetal MCG. I thought it was a great idea, so we went before the Institutional Review Board (for human subject approval) and they agreed that it was no-risk to do. Fetal MCG is a somewhat well-established method, but we hoped that we could demonstrate that our instrumentation was sensitive enough. It was first and foremost a benchmarking experiment. But of course I was keenly interested to see my son's MCG.
The "a-ha moment:" The experiment is entirely passive, so I just sat in the shielded room with the cryostat near my belly. I recall that Andrei sat with me (I was pretty pregnant and he was probably worried I would go into labor or not be able to ever get back up). The whole thing took about 10 minutes. When we came out we quickly looked at the data and saw Hank's heartbeat in amongst mine (the maternal MCG signal is always much larger). After appropriate analysis we could see Hank's heartbeat sticking out even more clearly. It was great to see our method worked, and to get to "see" the baby!

Ribbons cut for Majorana Demonstrator Laboratory one mile underground

The Majorana Demonstrator nuclear physics experiment recently completed a major milestone with a move to its nearly mile-deep location at the Sanford Underground Laboratory in Lead, South Dakota.

The experiment is designed to discover if neutrinos are their own antiparticles, "Majorana" particles, and help researchers learn more about the fundamental nature of the universe and the standard model of physics. The particles result from neutrino-less double beta decay, a low-energy nuclear decay emitting 2 beta particles, which is extremely rare with a half-life of at least 10^{25} years. A measurement of the decay rate of this extremely rare process would also provide a value for the absolute mass scale for the neutrino.

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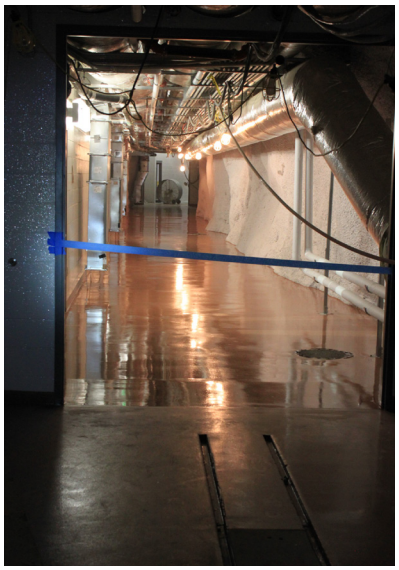
The initial team that worked at the Sanford Underground Laboratory, Davis Campus. From left, Los Alamos postdoctoral researcher David Steele, Los Alamos technician Larry Rodriguez, Los Alamos staff member Steve Elliott, and University of North Carolina graduate student Kyle Snavely.



A tunnel at the Sanford Underground Laboratory, where the MAJORANA DEMONSTRATOR nuclear physics experiment will be conducted.

Majorana . . . Because the half-life is so long and the signal from the decay so weak, the location, at 4,850 feet underground, lessens the amount of background radiation, as does the clean room environment being constructed. A Los Alamos team traveled to Sanford, located in the former Homestake gold mine, in late March for the collaboration's initial work within the underground lab. Its first task was to begin assembly of a small clean room that resides within the larger cleanroom. When finished, it will be converted to a class 2000 clean room.

About 100 scientists from 4 countries and 18 institutions form the MAJORANA collaboration, which has been planning this project since 2000. The experiment will be constructed between 2012 and 2014, with data taking beginning in early 2013 for a fraction of the experiment, and it will continue through 2017.

Los Alamos researchers contributed to the experiment's design and radiation shielding. This includes design and fabrication of the shield and the calibration system for the detectors. LANL played a key role in the purchase and testing of many of the germanium detectors that will be used. LANL also performed a great number of background studies to understand the predicted performance of the apparatus.

LANL scientists will participate in the assembly and operation of the experiment, and they will contribute to the analysis as data becomes available. The DOE Office of Nuclear Physics (Scott Wilburn, LANL program manager), the National Science Foundation, and LANL Laboratory Directed Research and Development (LDRD) fund different aspects of the research. Los Alamos principal investigator is Steve Elliott (Neutron Science and Technology, P-23). Other Los Alamos participants include Keith Rielage, Larry Rodriguez, Melissa Boswell, Mary Kidd, Michael Ronquest, Harry Salazar, and David Steele (P-23). The MAJORANA project is part of the Laboratory's Beyond the Standard Model Grand Challenge.

To read more about moving day for the MAJORANA experiment, please see www.symmetrymagazine.org/breaking/2012/03/28/moving-day-for-experiment-examining-whether-neutrinos-are-their-own-antiparticles/

Technical contact: Steve Elliott

Prestridge featured at Brookhaven Women in Science lecture series

Extreme Fluids Team Leader Katherine Prestridge (P-23) recently gave an invited talk as part of the Brookhaven Women in Science lecture series. Her talk at the New York national laboratory, "Clouds, Waves, and Supernovas: Understanding Fluid Mixing in Extreme Conditions," described fluid instabilities as they occur in everyday life.

"If you have a hot sauce bottle and you turn it upside down, nothing will come out," she said, giving an example, "but once you shake it, you're perturbing it, and the fluid comes out."

Prestridge, who holds a BS in aerospace engineering from Princeton University and a PhD in applied mechanics and engineering sciences from the University of California, San Diego, is the principal investigator for the shock tube and turbulence mixing tunnel projects in P-23. She is the recipient of the 2000 LANL Postdoctoral Publication Prize in Experimental Sciences, a 2008 Los Alamos National Laboratory Star Award for her technical work and her achievements as a mentor, project leader, and deputy group leader, and a 2008 Defense Programs Award of Excellence for the Shock Tube Team.

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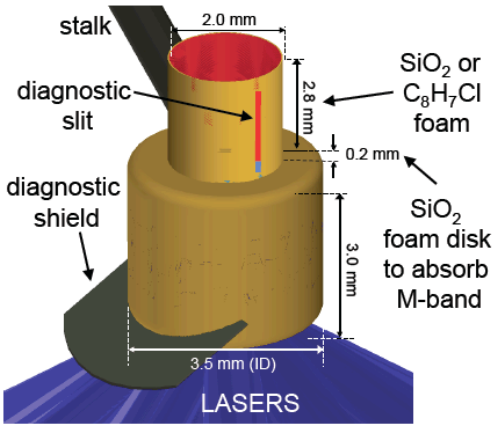
Prestridge . . . The Extreme Fluids team has developed diagnostics that produce the highest resolution images in the world of Richtmyer-Meshkov instabilities, which are driven by shock waves and are commonly found in exploding supernovas. The team's experiments are used to validate the turbulence models in numerical codes at Los Alamos. Simulations from these validated codes aid researchers at the National Ignition Facility in their quest to create a source of fusion energy. One of the biggest obstacles to achieving fusion energy is the mixing, which takes place in the target capsule and contaminates the fuel. The Extreme Fluids team is working to remove that obstacle by aiding scientists' understanding of fluid mixing in extreme conditions.

"If we can get more fusion energy out than we put in with lasers, we will have a new source of clean energy," Prestridge said.

To watch a video of the presentation, please see www.youtube.com/watch?v=xCIWr_gC5gU&feature=player_embedded.

Technical contact: K. Prestridge



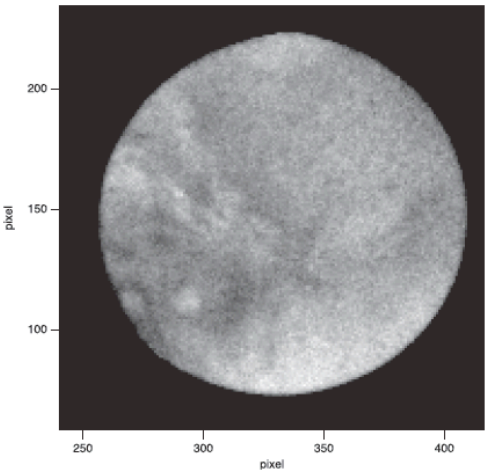
Left: A Pleiades NIF target, showing the foam component –in red–located at the output of a hohlraum, the radiation cavity used to drive the experiment.

Foam density characterization station is operational and benefitting selection of NIF HEDP targets

A new foam density characterization station (DCS) is operational and already impacting selection of National Ignition Facility (NIF) high energy density physics (HEDP) targets. Since the individual foam components used in these targets are too light to weigh, measurements of single parts are not usually possible. And yet, small deviations in foam density dramatically impact radiation propagation and complicate assessment of radiation flow models. The foams, with densities ranging from 30–125 mg/cm^3, are silica aerogel or plastic foams used in targets for HEDP experiments at both NIF and Omega laser facilities. These are the first set of non-ignition related experiments being performed at NIF, and support development and validation of models used in our codes.

For this reason, Plasma Physics, P-24, personnel (J. M. Taccetti, N. Lanier, and R. Aragonez) have designed and, with help from Polymers & Coatings, MST-7, target fabrication personnel (D. Schmidt, B. Patterson, K. Obrey and C. Hamilton) have constructed a dedicated monochromatic x-ray imaging station to measure the density of single component foams. The DCS currently includes a molybdenum Lα (2.3 keV) and a chromium Kα (5.4 keV) soft x-ray source, although plans include adding a copper Kα (8.0 keV) source in the near future. Depending on the size and density of the part in question, the density measurement uncertainty can reach the limiting factor of the cold opacity uncertainty, ~ 1%. This effort is funded by the Science Campaign 4 Program Office (LANL Program Manager Kim Scott).

Right: An image of the line-averaged transmission of a 125 mg/cc C_8H_7Cl foam component obtained on the DCS, clearly showing foam density nonuniformities (this particular target was taken out of the shot cycle).



Celebrating service

Congratulations to the following Physics Division employee celebrating a service anniversary this month:

John Kline, P-24 10 years

Physics Flash

is published by the Experimental Physical Sciences Directorate.
To submit news items or for more information contact Karen Kippen, EPS Communications Team, 606-1822, or kkippen@lanl.gov.
LALP-12-006
To read past issues, please see www.lanl.gov/orgs/p/flash_files/flash.shtml.

HEDP&F Capability Review 2012

The 2012 High Energy Density Plasmas and Fluids (HEDP&F) Capability Review was held recently and featured approximately 75 Laboratory researchers presenting recent HEDP&F-related science and technological accomplishments, either in presentations or during poster sessions.

The review was organized by a steering committee of technical leaders along theme areas. Shown above (left to right) are members Malcolm Andrews, Dana Knoll, Cris Barnes, Manuel Hegelich, and Juan Fernandez (missing from this picture are Steve Batha, Herb Funsten, and Jack Shlachter).

The review committee consisted of esteemed external scientists from academia including the University of California, other DOE laboratories such as Livermore and LLE at Rochester, along with representatives of the University of California Office of the President and the Los Alamos National Security, LLC Science and Technology Committee. Shown below, standing are Robbie Vogt (CalTech), Debra Callahan (LLNL), Oleg Schilling (LLNL), Robert Lucht (Purdue), Harlan Spence (U. New Hampshire), Chan Joshi (UCLA), Carl Sovenic (U. Wisconsin), Jill Dahlburg (NRL, Chair), Roger Falcone (LBL), David Meyerhofer (U. Rochester LLE). Seated are Markus Roth (TU Darmstadt) and Michael Donovan (U. Texas). (Not shown is Raymond Jeanloz, UC Berkeley).

HeadsUP!

Improve workplace skills, reduce stress

Did you know that possessing more tools to handle workplace issues has a stress-reducing benefit? These workplace skills videotapes are available for free viewing at the Ombuds Office:

- Communication skills
- Crucial Conversations
- Digital Communication in the Workplace
- DISC Personal-Profile System
- Management skills
- Decision-Making Styles
- Meeting Management
- Life balance skills
- Priority Management
- Live Out Loud: The Secret Skills of Living Life to the Fullest

Questions about this training? Contact Ombuds Office at 665-2837.

LANL Investigative Services Team

LANL maintains an Employee Concerns Program for Laboratory employees and subcontractors to report employee concerns, without fear of retaliation, and to have those concerns addressed through an independent, objective evaluation. Another avenue to report unlawful acts is through the LANL Investigative Services Team (LIST).

To read more about the LIST, please see the Security Smart at int.lanl.gov/security/documents/security-smart/2012/list412.pdf.