Physics Flash
June 2012

INSIDE

Physics Division students find the dose of reality they need before graduate school

Despite its name, the Undergraduate Student Program at Los Alamos National Laboratory isn't just for students pursuing an associate's degree or a bachelor's degree. As part of the program's post-baccalaureate category, every year about 100 college graduates, who have not yet been accepted into a graduate school program, receive one-year appointments at the Laboratory.

Some scientists start college with a clear-cut idea in mind and study nonstop until they attain their doctorate. Others, however, find great benefit in taking a break between earning their bachelor's degree and entering graduate school. They want real-world experience, a chance to test the waters, and help to mull over what their next steps will be. Los Alamos offers that opportunity.

For Undergraduate Student Program participants, as they prepare for graduate school acceptance, being mentored, building contacts, and making money are added perks. For more information on the program, please see www.lanl.gov/education/undergrad/about.shtml.

Read below about how three post baccalaureates in the Physics Division found a new sense of direction while engrossed in exciting scientific studies ranging from experimental fluid mechanics to brain imaging.



From left, Laura Jin Mazzaro, Jesse Resnick, and Brenna Fearey.

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From Doug's Desk

In this month's column, I want to provide an update on the financial health of the Division. This fiscal year (FY) has been one of the most interesting years that I can remember in my 27 years at the Lab – interesting in the sense of that apocryphal curse, "May you live in interesting times!" Last FY, the Division had total funding amounting to $105M. We started out this FY with less than $80M. This problem was not unique to Physics Division as most of the line organizations within the Lab had financial difficulties. The result was, of course, the Voluntary Separation Program, where Physics Division lost 15 people to retirement or new opportunities. Given the choices made by the weapons program then to realign the mission, losing these people did not immediately fix our financial problems. However, over the last few months, we have made significant progress in all areas. New money has come in and the weapons program has restored funding for areas that are important to it – significantly pRad and Trident operations, our two facilities. We are now at a total funding in the Division of approximately $90M. Our number of unfunded people has dropped from a high of six full-time equivalents (FTE) in April to less than 1 FTE now and it is projected to continue to decline Many people have actively and successfully looked for short-term activities that have kept them funded while we have tried to repair our larger long-term programs. I wish to personally thank everyone who has gone the extra mile to help us all out.

"...all of the Division continues to perform excellent work of importance to the nation. I am very proud of that and I hope that you are as well."

We are still struggling with the travel and procurement restrictions that were created to maximize funding to pay people's salaries. It is unavoidable that we have to curtail our attendance at conferences and workshops. I and all of the Division Leadership Team are acutely aware of how important these meetings are to your professional development and your standing in the community. With funding still tight, we have not secured relief from these restrictions yet. We are getting relief from the original mandate to curtail all travel by 20%. The institution has listened to our arguments that new projects like HAWC in Mexico or Majorana in South Dakota, or ongoing projects at Fermilab, Livermore, CERN, Rochester, the Test Site, and others require travel to meet our programmatic goals. If we can reduce our conference and workshop travel, we can do the necessary programmatic travel. By making these points in a professional manner I believe that we will be successful in garnering support from upper management.

Even with all of these financial constraints, the Division continues to make impressive progress on many fronts. HAWC appears on schedule to develop a new, more sensitive ultra-high energy cosmic ray detector in Mexico. MiniBooNE continues to refine its measurements of an intriguing anomaly that may well totally revise our understanding of physics in the neutrino sector. We are making impressive progress towards a new, very high priority experiment in Nevada called Gemini. Our High Energy Density Physics campaigns at the National Ignition Facility in Livermore and at the Omega laser in Rochester have yielded important results that benefit three of the Science Campaigns: C1, C4, and C10. With support from LANSCE, we just had an incredibly successful run at Trident demonstrating a new record for laser-generated neutron production. There are many other success stories in the Division and I apologize for not mentioning them all here. The point, of course, is that all of the Division continues to perform excellent work of importance to the nation. I am very proud of that and I hope that you are as well. Next year promises to be challenging as well. Given the state of political discourse in the nation at large, a compromise and a budget seem unlikely. Another continuing resolution is the most likely near-term outcome and we will have to deal with whatever circumstances come our way. Given how you all have risen to the occasion this year, I am confident that we will continue to provide excellent scientific results and important programmatic results for the Laboratory and the nation.

Physics Division Leader Doug Fulton

Students . . .

Who: Brenna Fearey, Superconducting Quantum Interference Device team, Applied Modern Physics (P-21)

Mentor: Team Leader Michelle Espy

Education: Bachelor's of science in psychobiology, 2011, State University of New York

Los Alamos projects: During the past year, Fearey learned core physics concepts and a variety of experimental techniques as she participated in such projects as using EEG (electroencephalography) to understand how the brain recognizes objects, improving the sensitivity of nuclear magnetic resonance-based liquid explosive bottle scanners (for use in airport security), working with phantoms that mimic brain tissue for imaging techniques, and assisting with microfluidics for magnetic algal separation.

Highlight of her experience: "My time at LANL has taught me that, while understanding fundamentals is all well and good, creativity and innovation (are) what truly make an impact in the world," she said. Pulak Nath, a SQUID team scientist, demonstrated creativity when he recognized that some algae are naturally magnetic and devised a way to separate them in a microfluidic system, she said.

Future plans: Fearey arrived on the scene at P-21 with an undergraduate degree in psychobiology behind her and plans for a career in cognitive psychology ahead of her. But after Espy taught her how to run EEG experiments, she changed her mind and applied for graduate programs in neuroscience. This fall, she will start a master's degree in neuroscience and cognition at Utrecht University, Netherlands.

Who: Laura Jin Mazzaro, Extreme Fluids team, Neutron Science & Technology (P-23)

Mentor: Team Leader Kathy Prestridge

Education: Bachelor's of science in engineering, 2011, University of Illinois

Los Alamos projects: "During my time at LANL I was assigned a project to design and build an experimental system. My group is building a new laboratory that will have a vertical shock tube. The shock tube will be filled with air, except for the bottom, which is filled with a much heavier gas. My job has been to design a system that will let us produce different types of waves on the surface of the heavier gas. On the final setup, a shock will be produced by filling up a vessel with air at very high pressure and then suddenly opening it. This will produce a shock wave, which will travel down the tube and hit the waves. When the shock hits the waves, it will initially deform them and then mix the heavier gas with the air. We will study the structures that form while the waves are deforming, as well as how the two gases mix afterwards," Mazzaro said. "Our group works on very fundamental research. We study mixing in flows under different conditions, as well as flow particle transport. However, the results from these experiments can be applied to better understand other phenomena. For example, the work on the new vertical shock tube will help to understand mixing of gases in inertial confinement fusion, as well as supernovas, amongst other things."

Highlight of her experience: "I have learned to do all sorts of things, from designing different devices, to writing computer programs to control motors or the flow of gases. This would have been a very intimidating project if I had been at a university, since professors and other students are always very busy working on their own projects. Getting anyone to help me would have been difficult," Mazzaro said, "But at LANL our entire group is a team, there is a lot of collaboration, and finding support is always easy. This has to be my favorite part about working here."

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Students . . .

Future plans: "The reason why I decided to come here for a year was to gain more experience before committing to a PhD program. I wanted to try more projects in different environments before deciding where I wanted to go and what kind of work I wanted to do. I finally applied to eight different PhD programs all over the country, and was accepted into five of them. Working at LANL was a great boost for my graduate school applications, as well as a wonderful way to get in touch with people that I wanted to work with in grad school. I have decided to start a PhD in environmental engineering at UC Berkeley in the fall, where I will continue working on experimental fluid mechanics." Mazzaro said.

Who: Jesse Resnick, Superconducting Quantum Interference Device team, Applied Modern Physics (P-21)

Mentors: Team Leader Michelle Espy and Pulak Nath

Education: Bachelor's of science in chemistry, 2010, Westminster College, Utah

Los Alamos projects: Even with just a little first-hand experience with SQUIDs–the highly sensitive sensors that give this group its name–Resnick learned that magnetic fields can do more than just brain imaging.

TreeViz, for instance, measures the fluid content of trees. A plant biologist could sling the low-budget scanning device over the shoulder and trek into the forest, equipped with a tool that can "non-invasively monitor the physiology of trees over long periods of time," Resnick said.

With Nath, Resnick developed and tested microfluidic devices, which may eventually be a crucial component for medical diagnosis and biofuel production. Resnick learned about a novel manufacturing process called adhesive transfer tape options for microfluidics (ATTOM), which is more conducive to rapid industrial scaling than conventional fabrication methods.

Highlight of his experience: "One of my favorite experiences at LANL was learning how to design homogenous magnetic fields for nuclear magnetic resonance and then translating this theoretical knowledge into a rough prototype for performing measurements on small trees," Resnick said. "I even got to decorate the tree in our system for Christmas…with strictly non-magnetic ornaments, of course."

Future plans: Resnick said the critical-thinking and problem-solving skills he learned as part of P-21 will be valuable as he enters the University of Washington's Medical Scientist Training Program, where he plans to study neurobiology and medicine.

Studies of 4π mix in fusion targets at the OMEGA Laser

LANL's Inertial Confinement Fusion program supports NNSA's goal of creating thermonuclear burn in the laboratory. The 192-beam National Ignition Facility (NIF) at Lawrence Livermore National Laboratory is working towards this, but there are technical hurdles to overcome. One of the difficulties with laser fusion is the mixing of ablator material from the capsule shell into the deuterium-tritium fuel as the capsule is compressed. Such mix may occur due to imperfections in the capsule, inhomogeneous laser drive, Rayleigh-Taylor and/or Richtmyer-Meshkov instability growth. This is called "4π mix." As in all mix, it results in suppression of plasma temperature and fusion burn through radiative cooling and ionization losses. Target defects, such as a braze joint, may cause other mix.

The DIME (Defect-Induced Mix Experiment) team measured 4π mix with 10 shots at the OMEGA Laser, University of Rochester. The researchers imploded thin hydrocarbon (CH) plastic shells with a uniform laser drive. The scientists varied the titanium (Ti) marker layer burial depth to obtain 4π mix data. Neutron measurements and x-ray spectroscopy of the embedded titanium layer in the plastic shell detected the effects of mix.

The team obtained multiple correlations of titanium mix into the compressed core: reduced neutron yield, increased helium (He)-like line emission from the titanium, and increased titanium areal density (ρr) as the burial depth of the titanium was reduced. The ρr is the product of density and thickness of the titanium as it is compressed. It is denser and thicker when initially closer to the gas and absorbs more radiant energy in this case. The Ti that actually mixes with the hot gas radiates more, cooling the gas, and the fusion yield drops as the various radiative losses reduce the probability of the fusion reactions. The data show that the 4π Ti-mix depth is approximately

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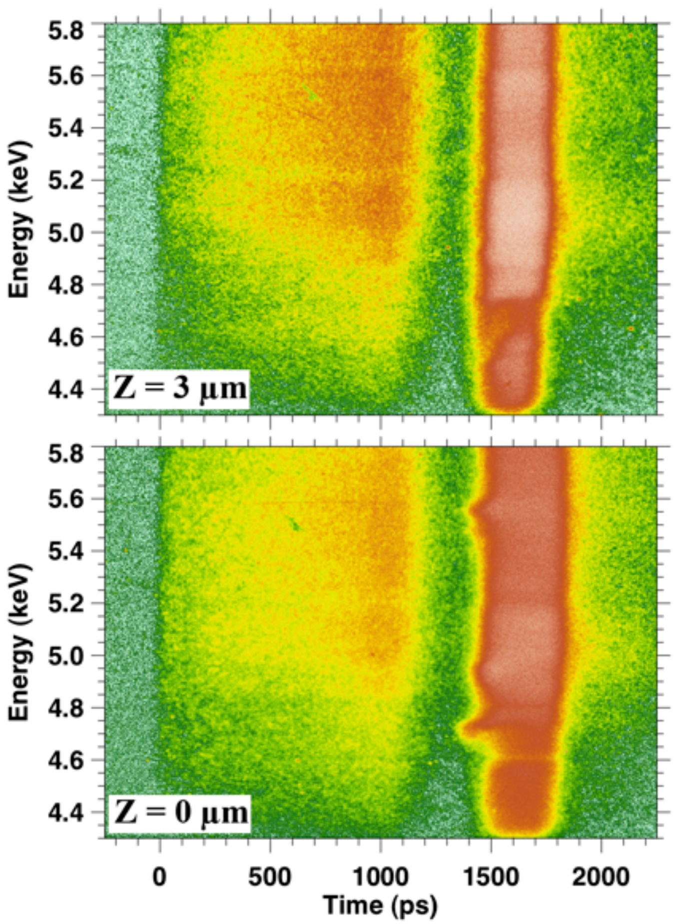
Mix . . . 1.5 μm. The scientists' goal in FY13 is to demonstrate control of polar direct drive by obtaining radially symmetrical capsule implosion. Then researchers can address 4π and defect mix at NIF, where direct drive (laser beams impinging directly on the capsule) is the only option.

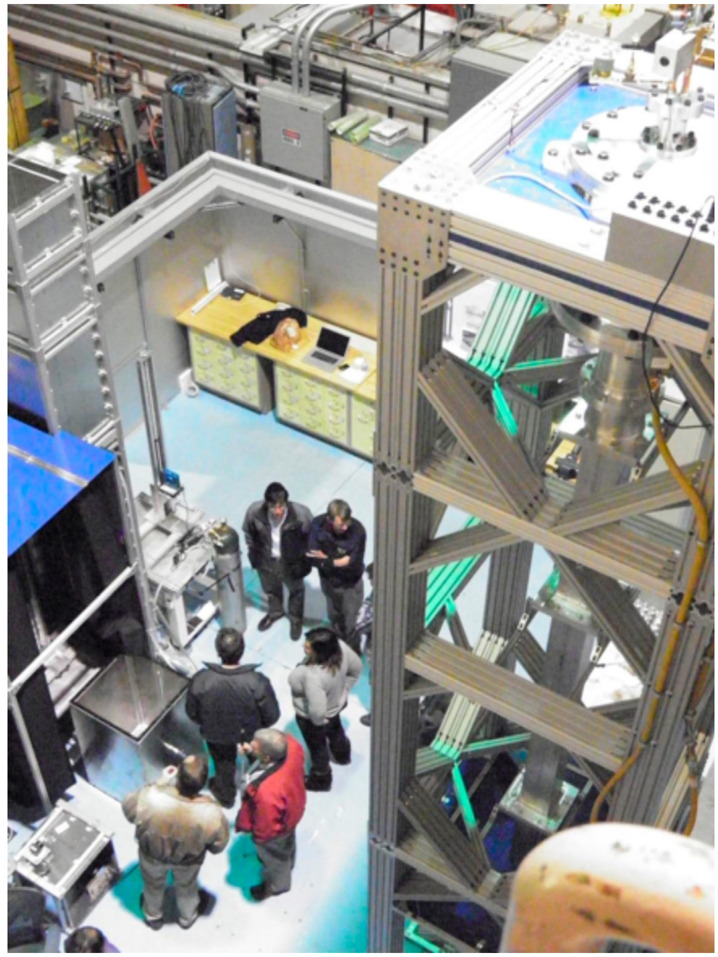
Jim Cobble, Rahul Shah, Scott Hsu, and Tom Murphy (Plasma Physics, P-24); Steve Batha (Physics Division, P-DO); Kim Obrey (Polymers and Coatings, MST-7); Natalia Krasheninnikova, Ian Tregillis, Paul Bradley, and Mark Schmitt (Plasma Theory and Applications, XCP-6) participated in the research. Barukh Yaakobi and Vladimir Glebov (University of Rochester) assisted with plasma diagnostic measurements during the Omega experiments, and General Atomics fabricated the precision targets.

The NNSA Science Campaigns (Steve Batha, LANL program manager) funded the research, which supports the Lab's Nuclear Deterrence and Energy Security mission areas and the Materials for the Future science pillar.

Technical contact: Jim Cobble



X-ray streak camera records of target emission show that the Ti line emission disappears when it is buried. Top: with the Ti-impurity layer buried at Z = 3 μm; Bottom: with the Ti in contact with the deuterium gas



Aerial view of the Turbulence Laboratory, with the Vertical Shock Tube on the right and the Turbulent Mixing Tunnel on the left. Pictured from top to bottom are Daniel Israel, Rob Gore, Sergiy Gerashchenko (hidden), Kathy Prestridge, Malcolm Andrews, Steve Batha, and Cris Barnes.

Turbulence Laboratory opens with new Vertical Shock Tube Experiment

The Turbulence Laboratory is a new lab space created by the Extreme Fluids Team in Neutron Science and Technology (P-23) within the Staging Area A at LANSCE. The lab space houses the new Vertical Shock Tube and Turbulent Mixing Tunnel experiments, which are designed to study shocked and variable density mixing flows. The experimental results will help the development of new turbulence models, and the validation of models and codes at LANL and Lawrence Livermore National Laboratory. Team members are Kathy Prestridge, Adam Martinez, Ricardo Mejia-Alvarez, Sergiy Gerashchenko, Laura Mazzaro and Greg Orlicz. The team held an open house early this year to show collaborators the new facilities. Both experiments are being commissioned this fiscal year.

This work is led by Kathy Prestridge (P-23) with funding from the Science Campaign 4.

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Kathy Prestridge discusses the new Turbulent Mixing Tunnel experiment with Rob Gore. The 22-foot-high Vertical Shock Tube is seen in the background.

Celebrating service

Congratulations to the following Physics Division employees celebrating service anniversaries this month:

Joseph Stone, P-23	35 years
David Clark, P-24	20 years
Stephen Glick, P-DO	10 years

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To submit news items or for more information contact Karen Kippen, EPS Communications Team, 606-1822, or kkippen@lanl.gov.
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HeadsUP!

New website for ADEPS Worker Safety and Security Team

The ADEPS WSST has a resource and information page located on the ADEPS internal website:

int.lanl.gov/org/padste/adeps/wsst.shtml

The site includes the team's most recent meeting minutes as well as links to a wide range of related safety and security information, including

- Environment, Safety, Health (ADESH)
- Security and Safeguards (ADSS)
- National Safety Council
- Occupational Medicine
- Occurrence Reporting
- Safety Short
- Voluntary Protection Program (VPP)
- Mesalib

WSST is all about

- Driving worker involvement in resolving issues
- Improving safety and security
- Representing all workers
- Facilitating communication between workers and managers.

The WSST will work hard to address any issue you have. You will get a response from the WSST within a week and will be periodically kept abreast of progress on your issue.

Your ADEPS WSST members are

- ADEPS: Jeff Schinkel
- LANSCE-DO: Howard Nekimken
- LANSCE-LC: Eric Larson
- MPA-CMMS: Michael Torrez
- MPA-MC: Eve Bauer, chair
- MST-6: Erik Luther
- MST-8: Thomas Sisneros
- P-25: Jeff Bacon, co-chair