Defense Science *Quarterly*

News about the Science Campaign — Summer 2009

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Message from the Director
Chris Deeney, Defense Science Division

One of the bumper stickers for the Science Campaign reads "Putting the Science in QMU." QMU is the Quantification of Margins and Uncertainties, the language by which we communicate certification and assessments. The bumper sticker phrase is based on the need to move from reliance on just the underground nuclear test (UGT)-era data to a more integrated view of weapons, based on both the UGT-era data and an accurate set of physics-based models and fundamental data. This becomes a sustainable stewardship program without any future UGTs. To achieve this grand scientific challenge will require very accurate data. A key theme of this issue of *Defense Science Quarterly* is the quest for accuracy.

The articles on JASPER and DARHT show the progress in obtaining percent level accuracies in fundamental data experiments to large-scale integrated implosions. Often, I joke that as a high energy density plasma (HEDP) physicist, I don't even know my name to 10% accuracy. Well, the paper by NSTec on the accreditation of their calibration facilities is a major first step in obtaining very accurate data in the HEDP regime.

All of these types of measurements will be required to solve grand challenges like Boost. The article by the tri-laboratory points of contact for our National Boost Institute (NBI) discusses the progress and excitement around the recent NBI workshop, including the active participation of academics from the JASON team that reviewed Boost last year and university centers.

Another key advance to address in addition to Boost is the National Ignition Facility (NIF). Congratulations to Ed Moses, Scott Samuelson, and their teams for the successful completion and dedication of NIF (see photograph from the NIF dedication ceremony below).

Progress in stewardship relies fundamentally on the quality of the teams doing the work. Our highlights of recent papers indicate we have great scientists in our program. To ensure a pipeline of great staff, our academic programs fund work in key areas and are designed to draw new generations of talent into our community. We highlight two Stewardship Graduate Fellows and two recent undergraduate student awardees. Of course, the funding ensures only that there are distinguished professors and academic staff in the universities around the country to draw eager students into important scientific fields.

We have lost one of those distinguished scientists. It is with great sadness that we say goodbye to Professor Malcolm Nicol of the University of Nevada, Las Vegas, who died in May. Malcolm was a great leader in the high pressure field and a wonderful colleague. We extend our deepest condolences to his family, colleagues, and students.

Distinguished national leaders at the dedication ceremony of the National Ignition Facility held May 29, 2009.

Density Measurement Errors at DARHT – Quantifying a Decade of Progress

by Scott Watson, Steve Balzer, Chris Gossein (LANL HX-4); Chris Tomkins, Barry Warthen (LANL P-Division)

A major goal of modern hydrotesting facilities is to determine the material density distributions of imploded metal with sufficient accuracy to derive inferred criticality and, therefore, yield. Quantitative radiography of hydrotest experiments used to certify the US stockpile has historically proven difficult due to the fast-moving, highly-opaque objects being studied [i]. Numerous sources of error combine to make this task extremely challenging, including: quantum statistics of the radiographic source and detector; x-ray scatter from the object and shielding; and spot-size, motion, and detector blurring of the radiographs. Nonetheless, a fundamental understanding of these measurements is crucial if one hopes to quantitatively assess weapon performance from flash radiographic machines like those at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility.

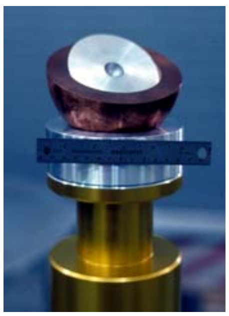


Figure 1. The test object consists of a 1 cm-radius cavity void surrounded by a 4.5 cm radius surrogate fissile material of tungsten, tantalum, or depleted uranium. This sphere is surrounded by a 6.5 cm-radius copper sphere. At its thickest point, the tantalum test object has an areal density of 180 g/cm^2, equivalent to 9" of steel.

Work at Los Alamos National Laboratory's Hydrodynamic Experimentation (HX) and Physics (P) divisions focuses on quantifying measurement errors using the test object shown in Figure 1. Our radiographic system includes DARHT's flash radiographic source (1.5 mm spot, 60 ns pulse, and 500 R @ 1 m), the newly implemented Bucky Grid camera[ii], the Dual-Axis-Confinement System (DACS[iii]) (see Figure 2) and the Bayes Inference Engine (BIE[iv]) analysis technique. These improvements, owed largely to the Science Campaign in Advanced Radiography, result in a state-of-the-art measurement system highly optimized for the task of quantitative, late-time, gas-cavity radiography. We demonstrate that this system delivers approximately 1 percent absolute density measurement.

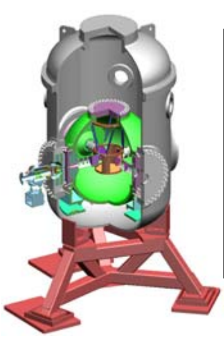


Figure 2. – The Dual-Axis Confinement System (DACS). The green vessel is a 6' diameter blast confinement vessel. The gray vessel provides containment of hazardous materials, and radiation shielding. The experiment is aligned using the orange basket.

Our experimental geometry is identical to the experimental geometry used on recent gas-cavity hydrotests[v]. The test object is carefully aligned within DACS, 1.33 m downstream from the Bremmstrahlung converter. The Bucky Grid gamma-ray camera is located 5.25 m downstream. In an analysis process that is similar to the one used on actual hydrotests, model radiographs generated using the BIE are compared with actual radiographs and optimized to determine material density and material boundary locations. The analysis assumes no prior knowledge of either. Because the static object is "known", we can use the differences between the modeled object and the actual object to derive estimates of the corresponding measurement errors on the unknown positions and material densities in actual hydrotests.

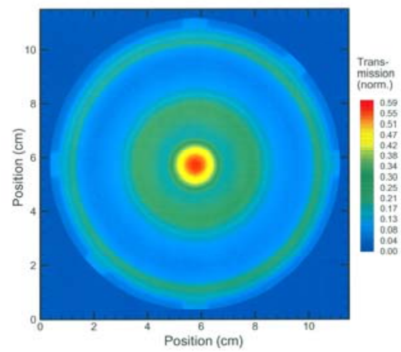


Figure 3. DARHT radiograph of the test

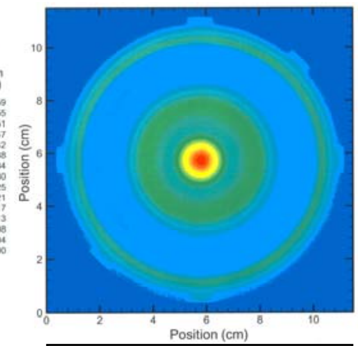


Figure 4. BIE transmission model

The DARHT radiograph and the associated BIE transmission model used to derive the material density are illustrated in Figures 3 and 4. Even in false color, the small differences between the data and the BIE model are difficult to see; a 150 micron-wide lineout of both the radiograph and the BIE model are shown in Figure 5 to illustrate the low noise and excellent agreement. The fractional density error in the tantalum shell is illustrated in Figure 6. We note that the rms error is approximately 1 percent and tends to increase toward the axis of symmetry. Finally, a histogram of the measured density distribution is shown in Figure 7 closely centered on the true tantalum density (16.654 g/cm^3).

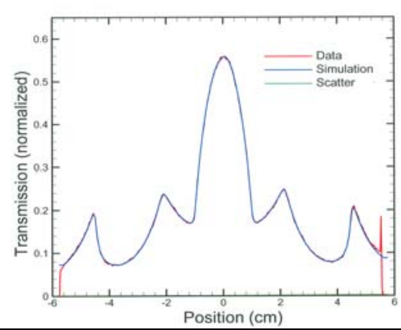


Figure 5. 150 micron-wide lineout of data (red) and BIE model (blue) and low scatter background using the Bucky Grid (green at bottom), showing low noise, reduced scatter and excellent overall agreement

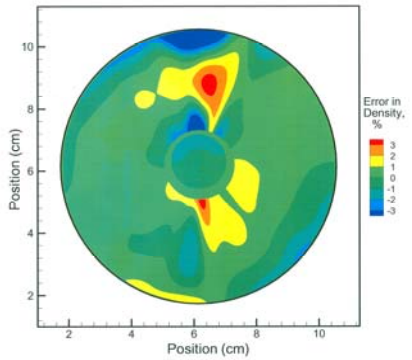


Figure 6. Fractional density error as a function of tantalum position in the test object

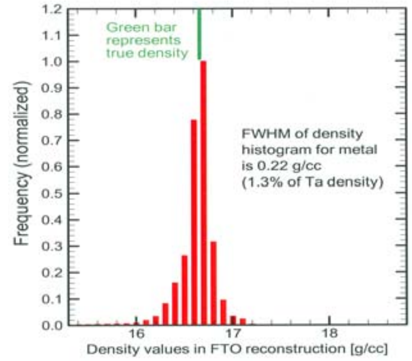


Figure 7. Histogram of measured (red) and actual (green) density using 150 micron x 150 micron material cross-sections

These encouraging results, which are the culmination of more than a decade of work, indicate that for objects of this scale, the DARHT radiographic system can achieve density reconstructions accurate enough to derive an inferred criticality and, ultimately, model device performance of stockpiled systems.

[i] Hawkins, D., et al. *Manhattan District History Project Y The Los Alamos Project*. Los Alamos National Laboratory, LAMS-2532 (Vol. I). 1961.
[ii] Watson, S., et al. *Design, Fabrication and Testing of a Large, Anti-Scatter, Grid for Megavolt X-Ray Imaging.* Nuclear Science Symposium. 2005
[iii] Rodriguez, E., et al. DynEx Program: Confinement Vessel Design Philosophy. Los Alamos National Laboratory, DX-ER-0008. 2000.
[iv] Hanson, K., and Cunningham, G. *The Bayes Inference Engine*. Proc. Maximum Entropy and Bayesian Methods. 1995.
[v] Watson, S. Using the DynEx, Dual-Axis Confinement System (DACS) for DARHT Gas-Cavity Hydrotests – Shots 3643, 3628, 3649, and 3627 (U). Los Alamos National Laboratory Report LA-14372. 2008.

2nd Annual BoostFest by Frank Graziani (LLNL), Bob Reinovsky (LANL) and Dawn Flicker (SNL)

The National Boost Initiative (NBI) held its second annual BoostFest at Sandia National Laboratories on April 7-9, 2009. Nearly 100 scientists actively engaged in research in boost physics attended. BoostFest is a Tri-Lab meeting intended to provide a forum where scientists involved in boost physics interact, communicate the latest research advances and establish areas of collaboration. BoostFest is a technical conference that primarily brings together colleagues from the US Department of Energy nuclear weapon laboratories and the UK Atomic Weapons Establishment (AWE) to discuss cross-cutting issues surrounding boost physics. Highlighted during the three-day meeting were new drivers for NBI, constraints provided by test history data, analytic approaches, initial conditions, high energy density physics (HEDP), warm dense matter and the new discoveries/ advances high performance computing is providing.

The first day focused on the integration elements of NBI. After a state of the program talk, the morning was devoted to a series of talks by Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and AWE on the various Directed Stockpile Work requirements driving NBI. The afternoon focused on the future with discussions about alternative data that inform our understanding of boost followed by talks devoted to analytic approaches to understanding boost. The afternoon finished with a very active poster session. The second day was devoted to initial conditions and included presentations on a variety of material science and hydrodynamic topics. The day concluded with an outbrief by Lars Bildsten on the JASON summer study that was followed by a vigorous discussion session. The morning of the last day featured two parallel sessions devoted to HEDP and high resolution simulations. Each parallel session was followed by discussion sessions led by a moderator. The meeting ended with a plenary session focusing on a variety of topics of general interest, including radiochemistry, the Z Machine and warm dense matter. There was also an outbrief on the morning parallel sessions by the moderators, Charlie Nakhleh and Des Pilkington.

Several members of academia who are associated with the national laboratories were also in attendance. They include Yogendra Gupta from Washington State University, Jolie Cizewski of Rutgers who presented a poster, and Lars Bildsten from the University of California, Santa Barbara. We look forward to broadening the level of participation to a wider group of academic partners in future years.

It is clear after this year's BoostFest that this topic continues to engage a growing variety of scientists. Real progress has been made in a variety of areas, including initial conditions, plasma physics, analytic studies and radiochemistry.

Nevada Test Site Awarded Prestigious Certificate of Accreditation for HEDP Calibration Labs **by Christopher Silbernagel, National Security Technologies, LLC**

National Security Technologies (NSTec) Livermore Operations has become the first nationally accredited calibration laboratory to perform pulsed laser power and energy measurements in the US—an achievement of two years of effort.

In August 2008, the National Institute of Standards and Technology (NIST) notified NSTec that it had met the requirements of the National Voluntary Laboratory Accreditation Program on-site assessment and was granted accreditation in the field of optical radiation. This body, associated with NIST and the US Department of Commerce, verifies a laboratory's competency through assessment against the international standard ISO 17025 standard. The NSTec team successfully became the first calibration laboratory outside of NIST that is accredited to perform laser pulsed power and energy measurements (Range: 0.8 mJ - 1.2 mJ; Wavelength: 532 nm; Pulse Length: 100 ns).

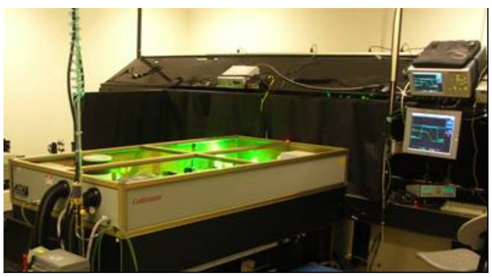


Figure 1. Long pulse laser lab with 10 – 100 nsec flat-top pulse for optical and x-ray streak camera and gated imager diagnostic testing

A current focus of Stockpile Stewardship is on the development of improved predictive capabilities for weapons physics. NSTec's on-going developments in metrology are a key element of the "responsive infrastructure" required to perform primary and secondary assessments with quantified confidence by providing uniform and verifiable calibration methods on instrumentation needed by the Stockpile Stewardship Program. In response to an NNSA FY 2008 Level 2 milestone, NSTec has been working with the national labs to implement uniform and verifiable calibration methods on instrumentation needed by the Stockpile Stewardship Program in its Quantitative Margins and Uncertainties approach to weapon certification. The major achievement during this exercise was not in actually making the measurements but in putting together a quality system that meets the requirements of ISO 17025 and the NIST Handbook 150 which the assessors use to evaluate calibration facilities. Now that the system is in place, it's being leveraged to expand the scope of accreditation in additional areas of laser power and energy, x-ray energy, and spectral work.

During FY 2009, the scope of accreditation is being expanded to include pulsed laser measurements made in the ultraviolet (213 nm) as well as measurements made from 200 nm to 1100 nm, with a spectrometer system for optical filter and fiber optic calibrations.

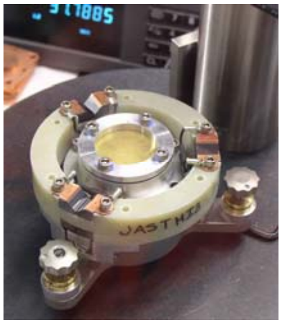
Figure 2. X-ray laboratory for x-ray streak camera, x-ray gated imager, and x-ray component characterization

NSTec currently operates, manages, and maintains a combination of six x-ray (400 eV - 100 keV non-pulsed), laser (1064 nm - 200 nm @ 100 ns - 100 fs pulse duration), and optical sources (spectrometers and pulsed light sources) that service the calibration needs of the national laboratories' HEDP platforms such as NIF, Z, Omega, and others. These needs include, but are not limited to, the calibration of streak cameras, micro-channel plate-based gated imagers, CCD cameras, x-ray optics, image plates, and various optical components. In addition, NSTec services high bandwidth digitizers and is equipped to diagnose electromagnetic pulse and radio frequency issues at various diagnostic locations on present and near-term HEDP experimental platforms.

Figure 3. CCD calibration laboratory for flat field, dynamic range, spectral response, and sensitivity measurements

Update on the JASPER Program by N.C. Holmes, LLNL

The Joint Actinide Shock Physics Experimental Research (JASPER) mission is to make precise, fundamental measurements of the properties of plutonium at high pressures in dynamic experiments. Located at the Nevada Test Site (NTS), the JASPER facility features a two-stage light-gas gun capable of launching 25 gram projectiles at up to 7.5 km/s (nearly 17,000 mph) onto plutonium samples. Upon projectile impact, a shock wave of many Mbar (a million times atmospheric pressure) is generated and passes through a sample in less than a millionth of a second, which is plenty of time to make the measurements NNSA depends on for its stockpile stewardship mission.



A JASPER sample ready for installation into the target assembly in the Primary Target Chamber. The gold surface is the gold coating on a plutonium sample used to determine the properties of aged Pu from the US stockpile. The V-shaped parts mate to JASPER's target alignment system.

The advantage of impact-driven shock compression methods, like JASPER uses, is that a proven, simple relationship exists between the properties of the target (its density and the velocity of the shock wave) and those of the projectile (its physical properties and velocity). This relationship allows us to determine the final pressure, density, and energy in the sample at these very high pressures to very high accuracy—providing of course, that the target samples and measurements meet extremely high standards of accuracy and resolution. JASPER also uses a multi-stage containment system to control the hazard of any release of plutonium into working areas or the environment. Read the *JASPER Contamination Incident* for an update on the recent contamination issue.

During the past year, JASPER responded to being reclassified from a Radiological facility to a Category 3 nuclear facility. This transition is still in progress; it is expected to be completed in early FY 2010. Meanwhile, JASPER has continued to make experimental progress under a formal Justification for Continued Operation.

Perhaps the most important milestone JASPER performed recently is the completion of a measurement of the Hugoniot of delta-phase plutonium over the range 0.2—5 Mbar. The Hugoniot is simply the set of final states for shocks of varying strength starting from the same initial condition, in this case the same starting density, pressure, and temperature. This is significant for several reasons. First, the data are very accurate impedance matching measurements that do not require modeling or interpretation to find the properties we measure. Second, the data are of unprecedented accuracy, with a typical uncertainty in pressure, for example, of about 0.5 percent. This is possible only because the experimental, target fabrication and diagnostic teams have left nothing to chance in an effort to provide the best data possible. Improved theoretical models of plutonium at high pressure are now in much better agreement with JASPER data than the models previously used. Third, these data provide an experimental baseline for more advanced material property measurements, and the design of future experiments. In the past, we used these capabilities to successfully compare the properties of new and aged samples of plutonium on the same experiment.

Experiments were begun on JASPER to measure the properties of hot, low-density states of plutonium, as they are a sensitive test of our understanding of the thermal properties of plutonium. These experiments involve impacting a plutonium sample on which is attached a layer of very low-density silica called aerogel. A measurement of the shock velocity in the aerogel allows us to calculate, again without the use of simulation or models, the expanded state of plutonium. The relationship between the initial and final states is what we test in a JASPER experiment, and is the test sought by theorists. These particular tests turned out to be so challenging at the initial pressures we needed, that an entirely new target design and fabrication technology for silica aerogel had to be developed. Two of these experiments were successfully executed at JASPER last year and more are scheduled.

JASPER will continue new experiments on compression of plutonium, this time starting out in the so-called alpha phase. We will later use those data to interpret measurements of sound velocity in alpha-plutonium. For FY 2009 through FY 2011, we expect increased use of complex dynamic loading paths in JASPER experiments via advances in graded-density impactor technology.

JASPER Contamination Incident
by Robert Hanrahan

On February 25, 2009, JASPER shot 86, the second shot using alpha-phase plutonium, was conducted. After the shot, passive air sample filters indicated radioactive contamination inside the secondary containment chamber (SCC). No contamination was found outside the boundary of the SCC. The SCC did act as intended, a defense in depth to prevent exposure to workers and the public; but it may be a challenge to decontaminate.

The recovery is being conducted in a deliberate manner to preserve forensic evidence that may lead to a determination of the root cause of the contamination. Consequently, all efforts at JASPER since shot 86 have been devoted to planning and execution of the SCC reentry, target assembly recovery, and eventual decontamination. In addition to the root cause determination, the planned implementation of the operation of JASPER as a Category 3 nuclear facility will be implemented before restart approval is granted. As of mid June, the reentry process is on track and evidence of possible causes of the contamination has been identified. More information will be provided in the next issue of *Defense Science Quarterly.*

Publication Highlights

This section highlights recent publications in high-impact scientific journals of research supported by the NNSA Science Campaigns.

Even Superheavies Need a Little Protection J.C. Pei, W. Nazarewicz, J.A. Sheikh, A.K. Kerman, Accepted to Phys. Rev. Lett; arXiv:0901.0901

How heavy can the periodic table go? Scientists have long had the capability to create new, "superheavy" elements by fusing lighter nuclei. The existence of a system formed in a heavy-ion fusion reaction is often brief, however, because the nucleus heats up in the process and must find a way to shed energy and cool back down to a more stable state. Often, this is accomplished through fission, where the nucleus simply breaks apart.

While much progress has been made in recent years, it's still a challenge to find the optimal combination of beam and target, as well as the kinematic conditions, to maintain the structural integrity of the superheavies and lead to the formation, at reasonable rates, of new elements. This is due in part to the relationship between fission barriers and excitation energy, the energy difference between the ground and excited state. The conventional wisdom has been that fission barriers, which stabilize the nucleus, tend to disappear at higher excitation energies.

Using microscopic density functional theory, J.C. Pei and colleagues made calculations showing that fission barriers of excited superheavy nuclei vary rapidly with particle number, pointing to the importance of shell effects even at large excitation energies. The results are consistent with recent experiments where superheavy elements were created by bombarding an actinide target with 48-calcium; yet, even at high excitation energies, sizable fission barriers remained. Not only does this reveal clues about the conditions for creating new elements, it also provides a wider context for understanding other types of fission, such as that used in reactors to provide energy.

Free-surface optical scattering as an indicator of the shock-induced solid-liquid phase transition in tin G.D. Stevens, P.A. Rigg, et. al., J. App. Phys., **104**, 013525 (2008)

The development of simple-to-use and unambiguous diagnostic techniques for identification and characterization of phase changes in shock wave experiments is a high priority activity within the DOE/NNSA and was the impetus for an National Security Technologies/Los Alamos National Laboratory collaboration. Researchers undertook an effort to develop a diagnostic which would corroborate the occurrence of a dynamic phase change in shock wave experiments in metals in order to support the development of advanced models for multi-phase equation-of-state studies. The emphasis was on tin because it has relatively well documented phase transitions that are easy to obtain with common shock wave techniques using gas guns or explosives. Tin exists in its tetragonal β state at standard temperature and pressure, transforms to a body-centered tetragonal γ state at 9.4 GPa, and melts at 49 GPa. Melt can also be achieved by shocking tin to above roughly 22 GPa and allowing the shock to release into air or vacuum.

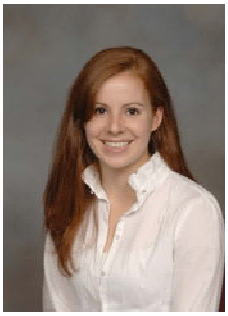
When highly polished metal surfaces melt upon release after shock loading, they exhibit features that suggest significant surface changes accompany the phase transition. The reflection of light from such surfaces changes from specular (pre-shock) to diffuse upon melting. A familiar manifestation of this phenomenon is the loss of signal light in VISAR measurements which occurs at pressures high enough to melt the free surface. Unlike many other potential material phase-sensitive diagnostics (e.g., reflectometry, conductivity), that show relatively small (1–10 percent) changes, the specularity of reflection provides a more sensitive and definitive indication of the solid-liquid phase transition. Using simple photon Doppler velocimetry (PDV) fiber probes located at selected off-axis positions, researchers simultaneously measured the change in surface velocity and the amplitude of light backscattered from shocked metal samples. Both the velocity distribution and the amplitude of light scattered from high angles were found to be strong indicators of the phase change. Using this technique in a series of explosive experiments, researchers were able to readily detect the melt on release point for shocked tin.

Shock-Wave Exploration of the High-Pressure Phases of Carbon M. D. Knudson, M. P. Desjarlais, and D. H. Dolan, Sandia National Laboratories, Science **322,** pp. 1822-1825

The high energy density behavior of carbon, particularly in the vicinity of the melt boundary, is of broad scientific interest and of particular interest to those studying planetary astrophysics and inertial confinement fusion. In the latter field, novel target designs with diamond as the ablator material have been proposed, sparking interest in its melt properties and other characteristics at the high pressures (in the range of hundreds of gigapascals) and densities achievable through compression by large-amplitude shock waves. Previous experimental data in the pressure range of interest, particularly near the melt boundary, has not been sufficiently accurate to allow more than qualitative comparison with theoretical predictions. This paper reports data acquired in experiments on Z using magnetically driven flyer plate techniques developed at Sandia National Laboratories. The relatively large lateral area of the flyer plates, coupled with the ability to precisely measure impact velocity, enabled order of magnitude improvements in accuracy that have allowed quantitative comparison with theory. Among other things, this has provided evidence for the existence of a diamond-bc8-liquid triple point on the melt boundary.

Highlights from the Stewardship Science Graduate Fellowship Program

A DOE/NNSA Stewardship Science Graduate Fellow is exploring technology that could help realize the promise of power from magnetic confinement fusion.



Third-year fellow Laura Berzak, a doctoral student in plasma physics at Princeton University, is studying magnetic properties of the lithium tokamak experiment (LTX) at DOE's Princeton Plasma Physics Laboratory (PPPL). LTX is investigating the use of liquid lithium inner walls for magnetically confined toroidal plasma. Liquid lithium offers potential benefits for fusion reactor operation, including providing a self-replenishing first wall to reduce vessel neutron damage and activation concerns. Lithium is also a key component in the tritium breeding cycle. As such, liquid lithium could simplify reactor design by integrating the lithium tritium-breeding blanket and the inner wall of the vacuum vessel itself. Lithium also retains deuterium, leading to pumping of hydrogenic species and reductions in plasma-cooling particle recycling, thereby yielding improved plasma performance.

LTX is the first experiment to study a fully liquid lithium first wall. By using a heated, in-vessel shell conformal to the plasma's last closed flux surface, Li will coat more than 90 percent of the reactor's plasma-facing surfaces. Berzak's research focuses on designing and using magnetic diagnostics to study the effects of the Li wall on the equilibrium magnetic flux surfaces and to examine changes Li introduces to recycling and the energy confinement time.

LTX is equipped with more than 120 magnetic diagnostics designed to withstand heat and incidental Li contact. The instruments include poloidal flux loops, Mirnov coils, three Rogowskii coils and a diamagnetic loop, all specifically located to account for the presence of the heated shell, which provides a secondary conducting surface.

Berzak is collecting and interpreting diagnostic measurements, both with and without a liquid lithium wall. She'll combine two computer codes. i.e., Leonid Zakharov's Cbc2e tokamak calibration code and the Equilibrium and Stability Code, to perform magnetic reconstructions of LTX equilibrium, constrained by data from the diagnostics. The reconstructions will be used to examine changes in the current profile with the reduced recycling condition. She'll also study confinement time and its scaling with parameters such as plasma current, toroidal field, density and temperature. The reconstructions will lead to comparisons between experimental data and theory, furthering understanding of transport processes affected by the lithium wall and, possibly, permitting development of a first-principles transport model.

Berzak's 2007 practicum at Sandia National Laboratories in New Mexico fit well with her LTX research. Under Dr. Richard Nygren, Fusion Technology Department Manager, she assisted with development of a liquid lithium diverter for PPPL's National Spherical Torus Experiment (NSTX). Berzak worked on an experiment to study the wetting of molybdenum mesh by liquid lithium and was involved in designing and preparing a vacuum chamber and diagnostics.

NNSA Stewardship Science Graduate Fellow Dylan Spaulding is helping develop new tools to understand the ultra-high temperatures and pressures generated in laser-driven dynamic compression experiments. The experiments are a means for him to pursue his main interest in the nature and dynamics of planetary interiors.

Spaulding is a third-year fellow and doctoral student at the University of California, Berkeley (UC Berkeley), majoring in geophysical and planetary science. In recent work, he's focused on developing diagnostic tools to measure the thermal and optical properties of materials in laser-driven shock and ramp compression experiments.

With colleagues at UC Berkeley and Lawrence Livermore National Laboratory (LLNL), Spaulding built and calibrated a streaked optical pyrometry (SOP) system. In a paper for the 2007 American Physical Society (APS) Topical Conference on Shock Compression of Condensed Matter[i], the group reported on experiments using Janus, a two-beam Nd:glass laser at LLNL's Jupiter Laser Facility. They report a time resolution of ~100 ps and the ability to observe temperatures below 4000 K, more sensitive than the best available pyrometer then in use on laser-driven compression experiments. Spaulding has used the SOP system to examine insulator-metal transitions and melting of geophysical materials.

The APS paper also outlined a temporally resolved broadband reflectivity diagnostic to probe electronic structure of condensed matter. This novel approach uses high-intensity nonlinear pumping of a standard optical fiber to produce a bright white-light source for high energy density (HED) measurements on nanosecond time scales. This broadband light source provides more information about electronic structure than traditional approaches that measure reflectivity at a single wavelength. Spectral broadening of up to 300 nm was achieved with a pulse width of 3-5 ns and with an efficiency more than adequate to study material properties on the nanosecond timescales that characterize laser-driven compression experiments. These high-quality metrics address a weakness in the SOP diagnostic by determining the sample's wavelength-dependent emissivity and absorptive behavior, factors that can lead to erroneous temperature values.

While on a practicum under Dr. Bruce Remington, HED program group leader at LLNL, Spaulding worked on a proposal to apply the reflectivity diagnostic to quantify the effect of tamping windows (often made of LiF, MgO, SiO2 or similar material) commonly used in laser-driven HED experiments. Optical diagnostics observe the sample through this window, but its effect on the measurements often is difficult or impossible to quantify. Spaulding is working on integrating these optical diagnostics for regular use at the Jupiter Laser Facility and continues to apply them to his studies in geophysics.

The Stewardship Science Graduate Fellowship supports students pursuing doctorates in areas of interest to stewardship science, including high energy-density physics, low-energy nuclear science and properties of materials under extreme conditions. When the new fellows enroll this fall, the program will have 19 students in seven states.

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[i]Spaulding, D.K., D.G. Hicks, R.F. Smith, J.H. Eggert, R.S. McWilliams, G.W. Collins, R. Jeanloz, "New Optical Diagnostics for Equation-of-State Experiments on the Janus Laser". Shock Compression of Condensed Matter, edited by M. Elert, M.D. Furnish, R. Chau, N. Holmes, and J. Nguyen, © 2007 American Institute of Physics, 1071.

In Remembrance — Malcolm Nicol, 1939-2009

Malcolm Nicol, widely known for his many contributions to high pressure research, passed away on May 7, 2009. This sad event represents a significant loss for the high pressure community.

Nicol earned his Ph.D. in Chemistry from the University of California (UC), Berkeley in 1963. He was a professor at UC, Los Angeles until 1999, and he played a key role in the development of the use of Raman spectroscopy in the diamond cell. Later, he joined the faculty of the University of Nevada, Las Vegas (UNLV). Most recently, he served as Director of the High Pressure Science and Engineering Center (HiPSEC) at UNLV, which brings together scientists from many fields of research, including the shock compression groups from the national labs. He was also a founding member of the High Pressure Collaborative Access Team (HPCAT) consortium at the Advanced Photon Source and was instrumental in bringing about the cutting-edge high pressure techniques pioneered by the HPCAT staff. As a supporter of the International Association for Advancement of High Pressure Science and Technology, he served four terms as treasurer, from 1999 – 2007.

Through the decades, Nicol made numerous significant contributions to the expansion of the oxygen phase diagram and pioneered the study of reaction kinetics of organic materials in shock experiments. We shall all miss this great leader.

Awards

Fulbright Scholarship Award

A National High Magnetic Field Laboratory (Magnet Lab) Research Experiences for Undergraduates student has been awarded a Fulbright Scholarship to build solar-powered water-filtration systems in Ghana this summer.

Amanda Lounsbury, a senior condensed matter physics major at Occidental College in Los Angeles, participated in the 2008 summer research program at the Magnet Lab's Tallahassee headquarters, where she was supported by Stan Tozer's grant from DOE/NNSA. Lounsbury worked with Eric Palm on helium mixtures and fabricated capacitive thermometers to extend measurements to the highest fields available in the resistive magnets at the Magnet Lab.

The summer research experience did not mark Lounsbury's first trip to the Magnet Lab. During the summer of 2007, she accompanied Professor George Schmiedeshoff on a research trip to the lab for initial investigations into the thermal expansion and magnetostriction of a dilute mixture of 3He in liquid 4He. The work is being published in Philosophical Magazine.

Lannutti Award for Undergraduate Research

Kristen Collar took first place in the Florida State University (FSU) Physics Department's undergraduate poster symposium, for which she received the Lannutti Award for Undergraduate Research and $750. The award is named for Joseph E. Lannutti, who was a pioneering professor of physics at FSU.

Collar first came to the Magnet Lab as a freshman through FSU's Women in Math, Science and Engineering program. Her research, conducted under Stan Tozer and funded by DOE/NNSA, focuses on the flux growth of Ce-based crystals and their characterization.

After her first year at FSU, Collar applied for an Undergraduate Research and Creative Endeavors Scholarship and received a $1,000 award; she also was accepted to the Magnet Lab's Research Experiences for Undergraduates program at the lab's Los Alamos branch. She worked at MST-6 with Jason Cooley and at the Pulsed Field Facility with Chuck Mielke. Some of this work was published in Physical Review B.