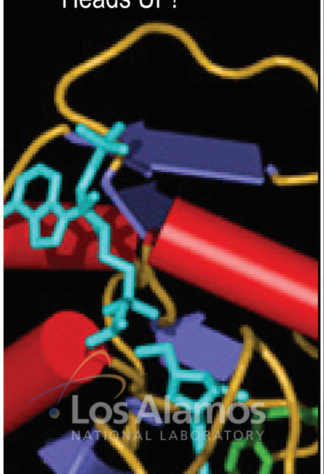
AOT & LANSCE The Pulse

November 2010

INSIDE



Hye Young Lee

Putting together pieces of the nuclear astrophysics puzzle

By Francisco Ojeda
ADEPS Communications

As a nuclear astrophysicist, Hye Young Lee has discovered that her research is like finding the right pieces to the puzzle.

"Personally it is a great feeling when my data can rule out or narrow down some theoretical uncertainty, so it could make the theoretical calculations fit better with the observables; as if we just found the last piece in the big puzzle game," Lee said.

A postdoctoral researcher in Nuclear Science (LANSCE-NS) at the Los Alamos Neutron Science Center (LANSCE), Lee performs fundamental research that helps advance understanding of the physics behind nuclear reactions and provides critical information for several applications.

"I am an experimentalist so I like being in the lab," she said. "I want to provide information for a larger scale, not just for one section of research. One cross section can change a lot of stories. It's exciting to provide the right measurements to theorists to improve modeling in astrophysics."

Lee came to the United States from her home country of South Korea because, she said, she wanted to conduct research with some of the world's most renowned nuclear physicists. She is doing just that at Los Alamos National Laboratory.

"I am at a place where I am able to do what I have always wanted to do and work with some of the most talented nuclear physicists," said Lee, who joined the Laboratory in 2009. "LANSCE is a great place to provide all kinds of neutron beams with well-equipped detector systems. I am getting to research and learn new and fascinating things."

continued on page 3

From Alex's Desk

Colleagues,

First, please join me in congratulating John Erickson as the new AOT division leader. John brings a great amount of knowledge that will be important now—for the LINAC Risk Mitigation Plan—and for the future—setting the stage for MaRIE. We plan to continue working in close collaboration with John, and I'm particularly looking forward to working and passing him on my way to work (he will know what I mean).

Another busy month; we have hosted the LAB (LANSCE Advisory Board). The following members were able to attend: Arthur Kerman (Yale University), Ian Anderson (Oak Ridge National Laboratory), Ka Yee Lee (University of Chicago), Gabrielle Long (Argonne National Laboratory), Raymond Juzaitis (Texas A & M University), John Peoples (Fermi National Accelerator Laboratory), and Nancy Hess (Pacific Northwest National Laboratory, representing the LANSCE User Group). We had a very productive discussion with LAB members and we have a great opportunity to feature our excellence in science throughout our presentations.

Even though the LAB visit report is not yet available, I would like to report that overall, we continue to do well, and we had a lot of great news to feature this year (see my last "From the Desk"). Once again, thank you to all the participants, presenters, and a special thank you to Ginger Grant, Clay Dillingham, and Barbara Maes for organizing a successful venue and assisting and formatting all presentations and posters. Great job to all!

This month, we also hosted a tour for DOE Under Secretary for Science Steven Koonin (on November 17), and on November 9 we also had the opportunity to host a tour for Fermi Laboratory Director Oddone. These two targeted tours featured our people and our capabilities.

'We had a very productive discussion with LAB members and we have a great opportunity to feature our excellence in science throughout our presentations.'

Some additional updates: The LANSCE User Office just issued the call for proposals for experiments to be carried out at the Proton Radiography Facility (pRad) during fiscal year 2011. The Web link lansce.lanl.gov/prad/ has additional information, including details about the proposal, the call submission form, and an overview of pRad experimental capabilities.

We have also extended the deadline for the 23rd Louis Rosen Prize. The Prize of $1000 and a plaque is awarded for the outstanding PhD or MS thesis based on experimental or theoretical research performed at LANSCE. To be eligible, the thesis must have been completed between April 1, 2007 and October 1, 2010. To nominate a thesis for the Rosen Prize, the following information must be received by December 20: (1) a PDF of the thesis, (2) the student's curriculum vitae, (3) a one-page statement from the student describing his or her contribution to the research, an assessment of the importance of the research, and publications resulting from the research, and (4) a statement from the student's research director describing the student's role in the research and its scientific impact. Submissions should be emailed to: Aundrea Espinosa, LANSCE User Office, e-mail aundrea@lanl.gov.

I would like to end with a quick safety note. Please be aware of pedestrians crossing the roads around the TA-53 mesa. On several occasions I have personally witnessed folks not stopping for pedestrians even on well-marked and visible crossings. Please be aware of pedestrians and please be courteous.

—LANSCE Deputy Division Leader
Alex Lacerda

Lee ... Pieces of the puzzle

One puzzle piece Lee provides is data for the upgrade of the Fast-Neutron-Induced Gamma Ray Observer (FIGARO) array of gamma ray and neutron detectors. FIGARO is part of the Chi Nu project, which studies fission-induced neutron output at the Weapons Neutron Research facility at LANSCE.

"[FIGARO] will improve data quality and help create potentially numerous applications," Lee said.

For example, FIGARO will contribute to advances in fission physics as well as fast reactor design, development of accelerator-driven systems for transmutation of nuclear waste, and homeland security applications.

For FIGARO, Lee reconfigures the electronics for calibration measurements using neutron tagging and for testing the Lithium-6 glass detectors for detecting fission neutrons below 1 million electronvolts (MeV). She also interprets data analysis codes and develops data analysis software.

FIGARO "is her first experience with nuclear physics and she picked it up quickly," said FIGARO Principal Investigator Bob Haight (LANSCE-NS). "I depend on her for data analysis."

Lee will also put her puzzle solving and data analysis skills to use as part of a team that recently received funding to develop a gamma ray detector array to be constructed for use inside the Helical Orbit Spectrometer (HELIOS) at Argonne National Laboratory. As part of HELIOS, which studies proton reactions with radioactive beams in inverse kinematics, the Array for Photon Observing LanL Output (APOLLO) will provide additional data in the gamma-ray spectrum that will advance understanding of nuclear astrophysics, energy, and fission.

Coming to a new country

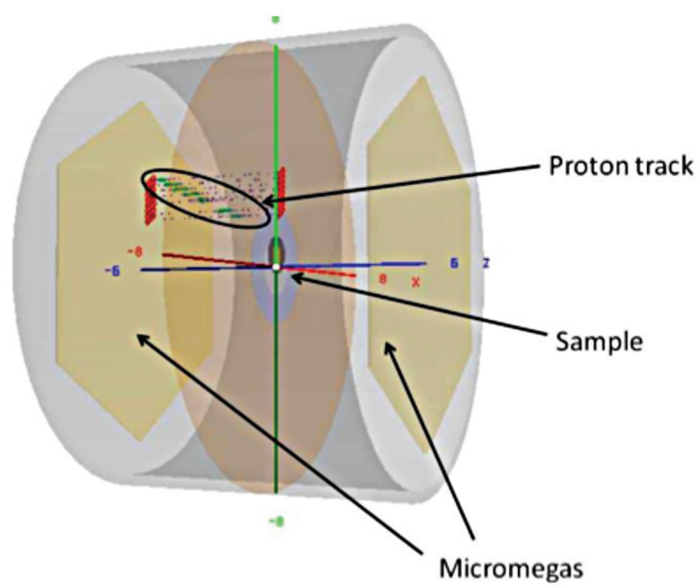
During her graduate studies at Ewha Womans' University in Seoul, Lee worked at the Korea Cancer Center Hospital of the Korea Atomic Energy Research Institute. There she helped design and test the penning ionization gauge ion source for negative ions, a device used in the 13-MeV positron-emission-tomography cyclotron for nuclear medicine and radiation therapy applications.

In 2000, Lee enrolled at the University of Notre Dame, where she received a PhD in physics in 2006. Before joining Los Alamos, she was a postdoctoral researcher at Argonne National Laboratory primarily working on the development of HELIOS and transferring reaction studies on radioactive beams using the spectrometer. "Hye has excellent insight into problems," said Aaron Couture (LANSCE-NS), who has worked with Lee since the two were doctoral students at Notre Dame. "This is invaluable in helping create solutions to further experiments. She has very good technical skills and is very dedicated in the projects she is involved in."

First beam tests with the Time Projection Chamber

Nuclear cross sections are fundamental in modeling the behavior of nuclear systems in weapons and nuclear power reactors. In certain cases, uncertainties in some key cross sections limit the predictive power of simulations. In these cases, sensitivity studies are used to identify cross sections where greater accuracy is needed. As part of the Laboratory's national security mission, scientists determined that the ^{239}plutonium fission cross-section should be known to within 1% uncertainty or less.

Because conventional techniques for measuring fission cross sections are limited to 3-5% uncertainty, scientists proposed a new approach–a Time Projection Chamber (TPC)–to meet the uncertainty requirement. The Neutron Induced Fission Fragment Tracking Experiment (NIFFTE) collaboration, which includes Lawrence Livermore National Laboratory, Los Alamos, Idaho National Laboratory, and six university partners; is developing the detector.



Particle track observed with the fission TPC. The Los Alamos Neutron Science Center/Weapons Neutron Research facility's neutron beam interacts with the chamber gas, resulting in proton recoils. The TPC uses a type of gas ionization detector known as Micromegas for readout.

The time projection chamber was invented in the late 1970s, and is used in high-energy physics. The NIFFTE TPC is unique because it is the first ever used for fission studies. A TPC uses segmented readout pads and drift time information to generate three-dimensional images of particle tracks within the active volume of the

continued on page 4

First beam tests . . . detector. This tracking information can greatly decrease systematic uncertainties in cross section measurements. The TPC will also reduce the uncertainties by providing excellent particle identification, eliminating the ambiguity between fission and decay background. It will allow the fission cross section to be measured relative to the H(n,p) cross section, which is better known than the ^{235}U(n,f) cross section standard.

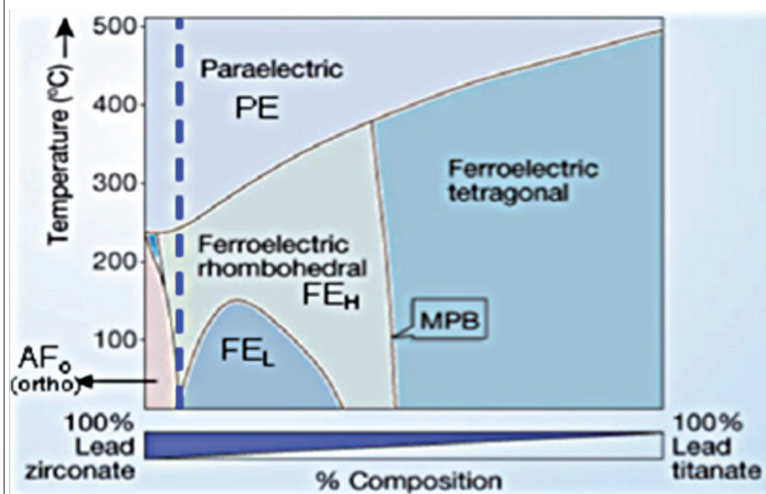
A prototype TPC was shipped from Livermore to Los Alamos in July, and was installed on a beam line at LANSCE. The prototype has two out of 192 segments instrumented, which allows 64 channels to be read out. The first beam data collected in mid-August met a level 2 milestone for the weapons program. The figure depicts an example of a physics event collected at LANSCE. Proton recoil induced by the neutron beam interacting with the gas in the TPC chamber created the measured track. After observing these types of events for the first test, researchers loaded a ^{238}uranium sample into the TPC for fission track measurements.

Following the commissioning of the TPC, a production version will be used to measure ^{239}plutonium fission. This measurement is important both to the weapons program and nuclear energy applications, and a suite of different measurements are expected to follow. In addition to cross sections, the TPC opens new and possibilities for studying the fission process, and it will contribute to a better understanding of this complex nuclear process. Fredrik Tovesson (LANSCE-NS) led the team of Alexander Laptev (LANSCE-NS), and students Lucas Montoya (University of New Mexico), Dana Duke (California Polytechnic State University), Nicholas Fuller (Houghton College), Daniel Pamplin (Abilene Christian University) and Nathan Pickle (Abilene Christian University). NNSA Science Campaign 1 (Robert Reinovsky, LANL Program Manager) and the DOE Nuclear Energy Fuel Cycle R&D program (Stuart Maloy, LANL Program Manager) support the work.
Technical contact: Fredrik Tovesson

As part of the NIFFTE project, two LANSCE summer students, Dana Duke and Nicholas Fuller, won a poster award in the Physics Category at the recent Student Symposium for their research on the TPC gas handling system. The system remotely controls the flow of multiple gas sources into the TPC. Major components of the gas handling system include solenoid valves, pressure transducers, and mass flow controllers.

Discovery of new physics in lead-zirconium-titanium voltage bars

A team of Los Alamos researchers working at the Lujan Center with collaborators from Sandia National Laboratories and academia has discovered important new physics in lead-zirconium-titanate (PZT) ceramic voltage bars that scientifically underpins reliable operation of neutron generators. Among the new insights is a neutron-diffraction-based crystal structure that unexpectedly overturns decades of x-ray studies. The increased body of knowledge established through neutron scattering experiments substantially decreases the risk in Sandia Labs' neutron generator production.



Phase diagram for PZT ceramic showing the 95/5 composition line (blue dashes). The ferroelectric-to-paraelectric transition is similar to the pressure-driven transition that releases charge in neutron generators.

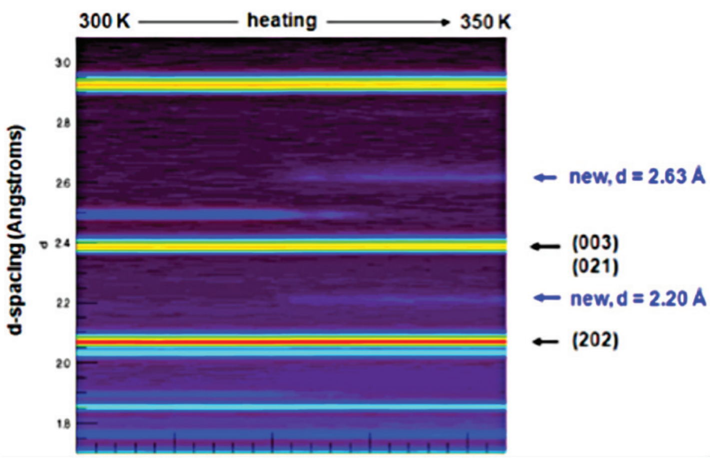
PZT voltage bars in neutron generators are small prisms of ferroelectric ceramic in which substantial electrical energy can be "frozen" into a low-pressure ferroelectric phase. They are used as an ultra-long-life battery that can be called upon reliably to deliver high voltage and large current on split-second demand under extreme environmental conditions at any time over more than a decade. This voltage accelerates deuterons in the neutron tube—a vacuum tube inside the neutron generator—to high enough energy to produce deuterium-tritium fusion in a tritium-loaded target. The fusion reaction produces copious neutrons. These single-use neutron generators are activated by an explosively driven shock wave propagating along the ceramic bar. At a certain pressure in the shock, the ferroelectric phase transforms to paraelectric and releases massive charge.

As part of nuclear reconfiguration, Pinellas-based neutron generator production was moved to Sandia. Meeting annual production goals of Sandia's new low-voltage neutron tube relies on synthesis of

continued on page 5

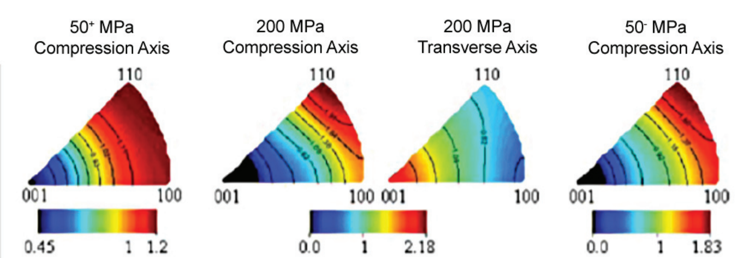
New physics. . . qualified PZT material. High voltage breakdown, resulting from materials flaws, can degrade the voltage pulse and leave the neutron flux outside design margins.

The research team used neutron scattering to determine the true crystal structure for doped and undoped PZT. The scientists detected a doubling of the unit cell, which for decades had eluded researchers who used only x-ray scattering to study the material. It is essential to know the precise chemical structure of material in manufacturing.



Niobium-doped PZT 95/5 shows new neutron diffraction peaks when heated through the phase transition, an unsuspected cell doubling. The newly discovered structure of the high temperature phase revises decades of data from x-ray studies.

The team determined the fraction of ferroelastic strain—as opposed to lattice strain—in the PZT phase transition that develops charge in operation. They accomplished these measurements via a unique neutron scattering experiment under load. The scientists also measured non-ideal lattice strain owing to ceramic grain alignment and intergranular stresses. This is the first time that neutron scattering of samples under load, combined with texture analysis, was used to examine ferroelectrics. The team validated the texture description of ferroelectric ceramics by comparing and consolidating measurements with x-rays and neutrons.



Selected tetragonal inverse pole figures (stereographic projection) from neutron scattering are shown of the compression axis and transverse directions. Intensity reflects the diffraction pole density and helps determine the degree of ferroelastic strain.

These insights inform both operation and production of neutron generators in DOE systems. The impact of this research underpins accelerated design and development of future implementations of this important limited-life component. More specifically, the risk in synthesizing batches of PZT is decreased by knowing the chemical structure and materials microstructure of qualify-able material.

The team consisted of Sven Vogel and Anna Llobet Megias (Lujan Neutron Scattering Center, LANSCE-LC), Mark Rodriguez and Pin Yang (Sandia National Laboratories), Jacob L. Jones (University of Florida), and Mark Hoffman (The University of New South Wales). The team received a Defense Programs Award of Excellence. Jones received a Presidential Early Career Award in Science and Engineering for research on ferroelectric materials, including this work.

Los Alamos lends its scientific expertise to clean energy and carbon sequestration projects

Department of Energy Secretary Steven Chu recently announced that as part of the Department of Energy Fossil Energy Program, the agency is funding large, complementary projects that will focus on clean energy and carbon sequestration. And Los Alamos National Laboratory is deeply involved in two of these projects—the Clean Coal Center and the Carbon Capture and Storage Simulation Initiative.

Clean Coal Center

The Department of Energy is funding the U.S. component of two new U.S.-China Clean Energy Research Centers for a total of $25 million over the next five years. The work is associated with clean coal and clean vehicles. Industrial partners and universities will provide matching funds for research in the United States, while the Chinese government will provide an equal amount of funding for parallel research centers in China. The United States and China will work together to tackle major hurdles for the use of clean-energy technologies and practices.

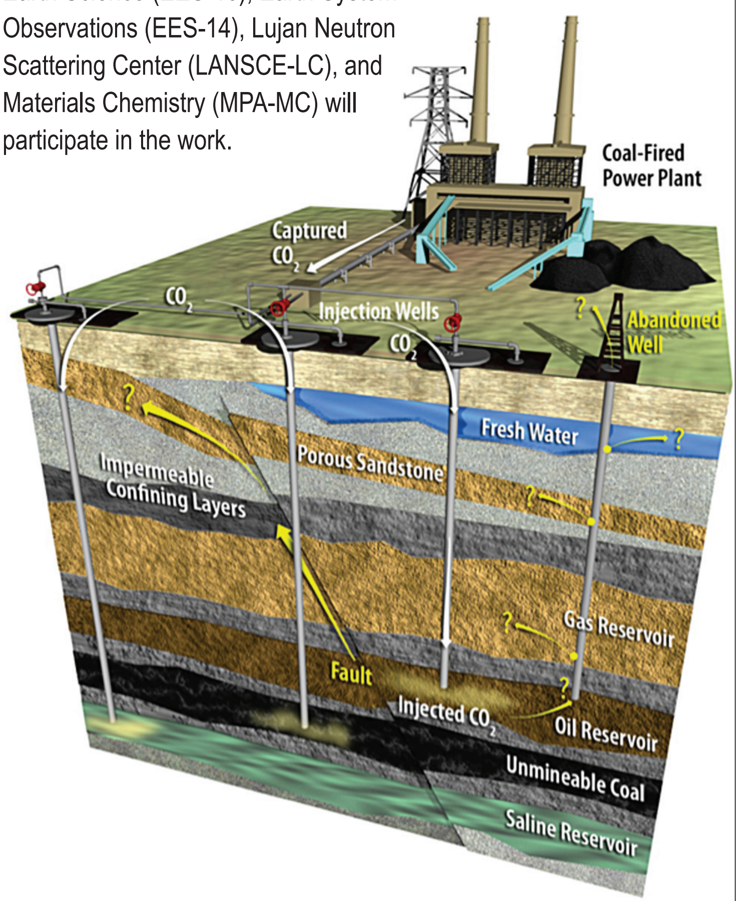
Los Alamos is part of the winning proposal for the Clean Coal Center, named the U.S.-China Advanced Coal Technology Collaboration (U.S.-China ACT). This center is focused on collaboration between the United States and China for the next generation of clean-coal technologies, including carbon capture and storage. West Virginia University will lead a collaboration that includes Los Alamos, the University of Wyoming, University of Kentucky, Indiana University, Lawrence Livermore National Laboratory, National Energy Technology Laboratory, World

continued on page 6

Clean energy . . . Resources Institute, U.S.-China Clean Energy Forum, General Electric, Duke Energy, LP Amina, Babcock & Wilcox, and American Electric Power.

The Clean Coal Center has eight primary research tasks: 1) Site characterization and assessment for geological sequestration, 2) Subsurface simulation of carbon dioxide (CO_2) Injection and coupled processes, 3) Risk assessment and hazard management, 4) Integrated industrial process modeling, 5) Novel capture technology development, 6) Coal conversion and utilization, 7) CO_2 utilization, and 8) International integration and communication.

Los Alamos will lead the risk analysis task and provide scientific support for the subsurface simulation of CO_2 injection and coupled processes, site characterization and assessment for geological sequestration, and novel capture technology development tasks. The Laboratory also will leverage its carbon sequestration expertise, programs, and collaborations, such as DOE's National Risk Assessment Partnership (NRAP) and regional sequestration partnerships. Philip Stauffer (Computational Earth Sciences, EES-16) is the Los Alamos principal investigator for the Clean Coal Center project. Los Alamos researchers from Computational Earth Science (EES-16), Earth System Observations (EES-14), Lujan Neutron Scattering Center (LANSCE-LC), and Materials Chemistry (MPA-MC) will participate in the work.



Schematic of carbon capture and geological sequestration for clean energy from coal. Image by Anthony Mancino of International Research, Analysis, and Development (IAT-1).

Carbon Capture and Storage Simulation Initiative

The Carbon Capture and Storage Simulation Initiative was created with an investment of up to $40 million from the American Recovery and Reinvestment Act. This partnership will bring together national laboratories and regional university alliances to accelerate the development of carbon capture and storage (CCS) technologies from inception to full-scale deployment. Information gained through the partnership will further DOE's effort to develop lower cost, efficient industrial-scale CCS processes. The collaboration builds upon the Administration's goal to overcome the barriers to widespread, cost-effective deployment of CCS within 10 years, while helping position the United States as a leader in global clean energy.

Through the use of advanced modeling and simulation, researchers will develop science-based methods to lower the cost of carbon capture while reducing technical and financial risks associated with its storage. Included in this initiative are the DOE's NRAP and the Carbon Capture Simulation Initiative (CCSI). Los Alamos is providing scientific support for both activities.

Melissa Fox of Applied Energy (SPO-AE) is the Los Alamos program manager for work on these two projects, which support the Laboratory's Energy Security mission area.

Electric-field modification of magnetism in a thin film

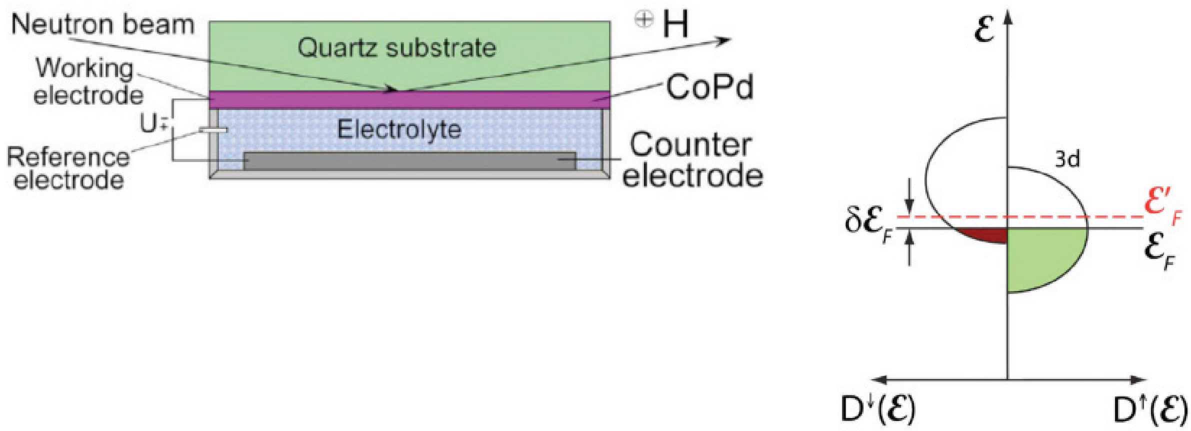
Researchers from Los Alamos and the University of California, San Diego recently used polarized neutron reflectometry to perform depth-resolved measurements of electric field-induced changes of the saturation magnetization in a thin ferromagnetic film. Their results further the understanding of spin electronics, a vibrant field of science and technology due to the strong interplay of electric field and magnetism at nanometer length scales. The findings provide quantitative information to test theoretical models of the magnetoelectric effect.

The use of an electric field (E) to actuate a magnetic response has been limited to materials with low Curie temperatures (Tc) or to low temperatures at which the effect is observable owing to the generally weak interaction between electric field and magnetism. Although Tc of 3*d* transition metals and their alloys can occur well above room temperature, these materials are conductors. Therefore, the influence of E fields on magnetism is severely constrained. Despite these difficulties, control of magnetism with E fields is attractive, because E fields can be localized to nanometer length scales and require less energy to produce than magnetic fields.

continued on page 7

Electric-field . . . An electrochemical cell can be used to influence surface magnetism directly with *E* fields (see figure). Mikhail Zhernenkov, Michael Fitzsimmons, and Jaroslaw Majewski (LANSCE-LC); Jerzy Chlistunoff (Sensors and Electrochemical Devices, MPA-11); I. Tudosa and E. E. Fullerton (University of California, San Diego) modified the magnetization depth profile by applying a large electric field (greater than approximately 108 V/m) to the sample surface using an electrochemical cell filled with propylene carbonate electrolyte. The scientists measured the *E*-induced modification of the magnetic properties of a SiO_2\Ta (4.7 nm)\$Co_{50}Pd_{50}$ (18.5 nm) thin film on the Asterix reflectometer at the Lujan Neutron Scattering Center. The researchers applied a magnetic field of 3 kOe parallel to the sample's surface. They performed the experiment at three values of applied voltage U in the sequence of -0.32 V, -0.15 V, and 0 V. Analysis of the neutron scattering data revealed a linear increase of the magnetization as a function of applied potential within the top 7.2 nm region of the film closest to the surface. The 7.2 nm thickness of the *E*-field-affected-magnetic layer is comparable to the magnetic exchange ("healing") length λ_0 for a wide range of ferromagnets. This result may be a manifestation of the spin-capacitor effect—the change of magnetization due to the accumulation of spin-polarized charges close to the surface. In a ferromagnetic material, the electron density of states near the Fermi surface is spin-polarized. Therefore, the net accumulation of charge due to the applied *E*-field is also spin-polarized. A perturbation to Fermi level may change the net magnetization accordingly (see figure).

Reference: "Electric-field Modification of Magnetism in a Thin CoPd Film," *Physical Review* B **82**, 024420 (2010) and *Virtual Journal of Nanoscale Science & Technology* (August 2 issue). The DOE Office of Basic Energy Sciences funded the work.



(Left): Schematic of the electrochemical cell. (Right): Illustration of the density of states D↑↓ ($\varepsilon_{F)}$ of a ferromagnet near the Fermi level ε_F The difference of D↑↓ ε_F integrated from the bottom of the band to ε_F is the net (spin) magnetization. The integrated densities of the state for spin-up and spin-down electrons are shown by green (right) and red (left) areas. Shift of ε_F to $\varepsilon_{F'}$ changes the green and red integrals differently, thus changing the magnetization. With sufficient electric field E, the Fermi level ε_F and density of states D↑↓ can change the magnetization M.

AOT and LANSCE Division staff awarded Defense Programs Awards of Excellence

AOT and LANSCE Division members were among the recipients of several Defense Program Awards of Excellence, presented by NNSA Deputy Administrator for Defense Programs Don Cook, during a recent ceremony. The annual awards recognize significant achievements in quality, productivity, cost savings, safety, or creativity in support of NNSA's Defense Programs. The awards also demonstrate how the Laboratory's capabilities support the Lab's nuclear deterrence mission. LANSCE and AOT staff were among the members of the LANSCE Operations Team and the Fundamental Materials Science of PZT Voltage Bars in Neutron Generators team.

The LANSCE Operations Team demonstrated extraordinary dedication and commitment to providing beam time to user of the LANSCE facility. The reliability goal for the accelerator beam delivered to the DP users is 85%. Beam reliability at or above 85% is considered world class for a facility such as

continued on page 8

Awards . . . LANSCE. In 2009, beam reliability achieved for the DP users met and often exceeded 85%. Proton radiography was conducted in 36 dynamic shots. LANSCE delivered a record number of 1138.3 beam hours for proton radiography, with a reliability factor approaching 92%.

The Fundamental Materials Science of PZT Voltage Bars in Neutron Generators Team has discovered important new physics in lead-zirconium-titanate (PZT) ceramic voltage bars that scientifically underpins reliable operation of neutron generators. The increased body of knowledge they established through neutron scattering experiments substantially decreases the risk in Sandia National Laboratories' production for DOE systems. PZT voltage bars constitute a long-life battery in neutron generators that could reliably deliver a high voltage and large current on demand with split-second timing under Stockpile to Target Sequence conditions at any time over many years.

LANSCE-NS researcher among recipients of LDRD Day poster awards

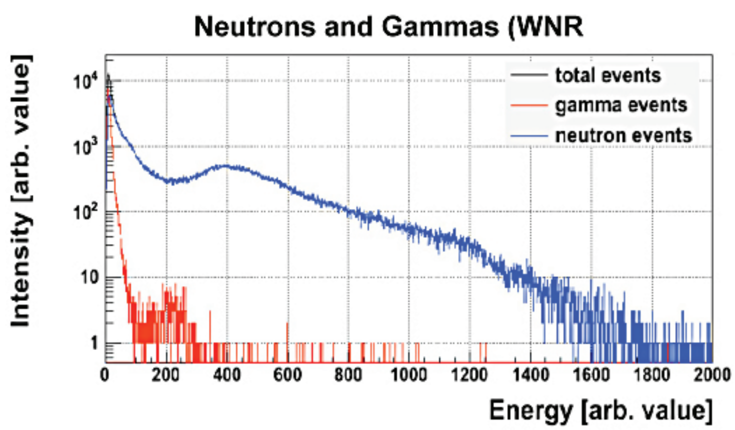
Frederik Tovesson (LANSCE-NS) was among the recipients of a Best Poster Award at the recent second annual LDRD Day event. Tovesson was a co-author of "A Novel Neutron Detector."

Laboratory Directed Research and Development (LDRD) invests in potentially high-payoff projects at the discretion of the Laboratory Director. These investments enable the Laboratory to anticipate and prepare for emerging national security challenges. More than 40 researchers discussed their LDRD-funded research at the second annual LDRD Day at the Buffalo Thunder Hotel in Pojoaque. One of the goals of the event is to present Los Alamos's science to the public in an approachable, understandable manner. Attendees had the opportunity to vote on the best poster, with LDRD Director Bill Priedhorsky presenting two awards, Best Poster and Poster of Exceptional Merit, based on the voting.

The ability to measure neutrons is key to understanding the universe and protecting our borders. Neutron monitors are commonly used for a variety of nuclear physics applications, but these detectors present technical challenges. For example, the worldwide helium-3 shortage makes the development of new neutron detectors critical for global security projects such as nonproliferation verification and nuclear fuel cycle measurements.

The Los Alamos scientists (Ernst Esch, principal investigator, Safeguards Science and Technology, N-1; R. Muenchausen, Polymers and Coatings, MST-7; S. Stange, N-1; I. May and F. Taw, Inorganic, Isotope and Actinide Chemistry, C-IIAC, and F. Tovesson) proposed a scintillating neutron detector, consisting of a liquid scintillator loaded with fissionable material. If the fissionable material is small enough (molecular or nanoparticles), the fission products will leave the non-scintillating particles and deposit their energy in the scintillating matrix. Their research indicates that it is also possible to load nanoparticles of fissionable material into a scintillating matrix. These detectors would have 1000 times more stopping power than fission chambers. This approach has several advantages over conventional techniques: high total neutron interaction cross-section, pulse shape and pulse size discrimination between gammas and neutrons, fast pulse timing to allow high count-rates, and ruggedness.

The researchers developed, characterized, and tested a scintillating neutron detector of the new design. They loaded the detector with nanoparticles of fissionable material in a scintillating matrix, with up to three orders of magnitude higher loading than typical fission chambers. Testing the detector in a neutron beam line demonstrated a significant improvement in neutron sensitivity compared with a conventional fission chamber. This could result in a rugged, cost-efficient detector with high efficiency and short signal rise time. Liquid scintillators with a molecular thorium complex as a fissionable material showed no degradation in optical properties, including radioluminescence.



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HeadsUP!

Hazards related to commonly available laser pointers

Various commonly available laser pointers can emit far more power than their label states, creating serious hazards for users.

Just a few milliseconds of direct exposure to some inexpensive green, blue, or violet lasers can cause permanent eye damage. Green laser pointers are complex optical devices that create green light from a high-power infrared laser. Many inexpensive green laser pointers emit dangerously high levels of the infrared light, far in excess of what the labels are suggesting, because the manufacturer has left out an internal optical filter to absorb the unused infrared light. While blue and violet laser pointers use a much simpler technology, recent experiences have shown that they may also emit dangerously optical powers.

For example, a “10mW Blue Violet Laser Presentation Pointer” that can be purchased at Amazon.com for $25 is labeled as “Power < 10mW” (1mW = one thousandth of a watt). The measured output power, however, is actually above 70mW. This output level is 70 times higher than the power at which the blink reflex, which closes the eye in one quarter of a second upon exposure to intense light, would protect the eye from injury.

The simplest way to avoid these hazards is to use red laser pointers because they do appear to emit in accordance with their labeling. Note that visible laser pointers used at Los Alamos without safety controls must emit less than 5mW and should emit less than 1mW. Those interested in purchasing a green, blue, or violet laser pointer to use at the Laboratory should consult with a laser safety officer (aserlso.lanl.gov/) to ensure that the pointer is both safe and allowed at the Lab without laser safety controls. Be aware of the potential hazards from these devices outside of the Lab as well.