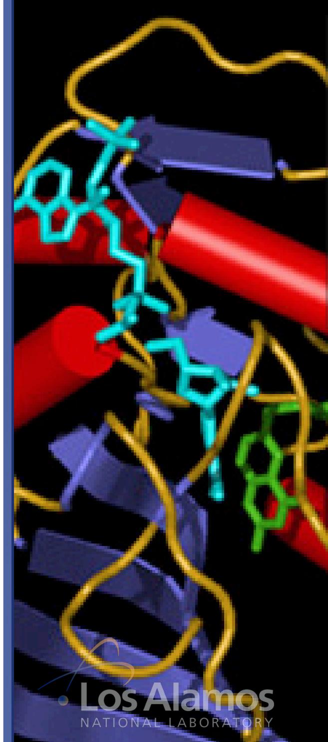
AOT & LANSCE The Pulse

February 2009

INSIDE



First demonstration of 197-MeV protons at LANSCE for isotope production

The Isotope Production Facility (IPF) uses 100-MeV protons from LANSCE to create radioisotopes though nuclear reactions. Staff in Chemistry Division then separate and purify the radioisotopes for medical and research needs. In an effort to produce new radioisotopes for research, scientists performed calculations for radioisotope production using other proton beam energies. Their calculations indicated that ~ 200-MeV protons were optimal to make desired new radioisotopes, such as gadolinium-153.

In December, a cooperative effort between LANSCE, AOT, and C Division personnel enabled the LANSCE accelerator to transport 197-MeV protons to the Blue Room experimental area of the Weapons Neutron Research (WNR) facility. It had been many years since protons at an energy other than 800 MeV had been used in the experimental areas at LANSCE, and never at an energy less than 256 MeV to WNR.

As part of this effort, the LANSCE facility also recovered the ability to transport multiple energy proton beams, 197 MeV and 800 MeV in this case, simultaneously to different experimental areas. The ability

◀ WNR facility at LANSCE; the concrete dome covers the experimental area.

to transport multiple energy proton beams was essential for operating the Proton Radiography and Ultra-Cold Neutron programs at LANSCE while the IPF experiments were ongoing. The ability to change the beam energy from pulse to pulse was built into the original accelerator controls, but the multiple energy controls have not been used in more than a decade. The system functionality with the 197-MeV and 800-MeV beams worked on the first try and only required minor adjustments to achieve production-quality operation.

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From Kurt's desk

In his inaugural speech, President Barack Obama said, "We will restore science to its rightful place, and wield technology's wonders…"

These are words I was delighted to hear. Our nation's scientific and technological infrastructure has been neglected far too long.

For example, at the request of Congress, the National Academies were asked to conduct an assessment of America's ability to compete and prosper in the 21st century—and to propose appropriate actions to enhance the likelihood of success in that endeavor. In 2005 the National Academies published its assessment in a powerful report, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future."

In their report the Academies concluded, in part, "It is the unanimous view of our committee that America today faces a serious and intensifying challenge with regard to its future competitiveness and standard of living. Further, we appear to be on a losing path. We are here today hoping both to elevate the nation's awareness of this developing situation and to propose constructive solutions… Americans, with only 5% of the world's population but with nearly 30% of the world's wealth, tend to believe that scientific and technological leadership and the high standard of living it underpins is somehow the natural state of affairs. But such good fortune is not a birthright. If we wish our children and grandchildren to enjoy the standard of living most Americans have come to expect, there is only one answer: We must get out and compete."

If our nation is to "rise above the gathering storm" of economic downturn, we must once again invest heavily in our science and technology. Science and technology will be key to providing the solutions we need to our challenges in energy, environment, safety, security, and economic growth. With a new administration in Washington an increase in funding for science and technology seems to be on the horizon. This increase in funding would bode well for our national laboratories and their facilities, like LANSCE, that provide cutting-edge research relevant to energy, environment, safety, security, and fundamental nuclear science—all of which fundamentally impact our economy and standard of living.

So, as I look across the LANSCE mesa and ponder our future possibilities, I have to smile and say Happy New Year!

Kurt Schoenberg, LANSCE Facility Director

Michel Barsoum joins LANSCE as sixth Wheatley Scholar

Michel Barsoum, distinguished professor of Materials Science and Engineering of Drexel University, joined LANSCE's Lujan Center as the sixth John Wheatley Scholar. Los Alamos established the Wheatley Scholar program in 1997, in honor of one of its illustrious researchers, John Wheatley.

Barsoum is a Fellow of the American Ceramic Society and an Academician in the World Academy of Ceramics. He has more than 200 papers and 16 issued and pending patents. His textbook, *Fundamentals of Ceramics*, is in its second printing. Barsoum discovered and characterized the "MAX" phases in ceramics, a new class of machinable ternary carbides and nitrides with remarkable toughness and thermal properties. His inaugural MAX paper in 1996 has been cited more than 500 times. Recently he reported scientific evidence that parts of the Great Pyramids of Giza have an early form of concrete. His surprising discovery established that Egyptian concrete lasts 45 centuries, compared to two centuries for Portland cement. His neutron scattering studies of ancient Egyptian building materials at the Lujan Center established further details of this finding.

▲ Michel Barsoum (LANSCE-LC)

During his one-year Wheatley Scholar term, Barsoum will help develop programs in neutron scattering instrumentation, particularly for advanced materials, composites, and ceramics. His studies of archaeo-concrete and MAX phases provide good paradigms for exciting new materials topics for neutron scattering.

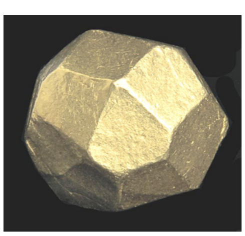
Single crystal diffraction studies of natural gold crystal growth under extreme conditions

Heinz Nakotte (New Mexico State University and the institution's first LANSCE Professor) and geologist John Rakovan [University of Miami (Ohio)], studied a series of extraordinary gold nugget specimens from private and museum collections. The specimens weighed 10 to 20 grams. Only the most extreme conditions can lead to gold crystals of this size, and even more refined conditions give rise to single crystals. Because large single crystals bring a much higher collectors' price, crystal formats and growth habits are used to distinguished authentic natural crystals from forgeries. It is therefore important to understand the characteristic growth habits that arise in nature, such as the "hopper growth" that enhances crystal edges and depresses faces as shown in the 18g Venezuelan specimen shown to the right.

X-ray diffraction studies generally fail to establish whether extreme crystals such as this one are crystalline throughout. Even high energy x-rays cannot both penetrate the sample and diffract from the interior, owing to the strong absorption of a high Z material such as gold. Neutrons are not limited in this way. Within minutes on the LANSCE Single Crystal Diffractometer, the specimen was shown to be a single, large octahedral crystal and, therefore, natural.

By contrast, two samples with bizarre cross-shaped crystal faces were shown to be forgeries, deftly cast with quartz chunks that naturally occur with free gold. Sven Vogel (LANSCE-LC) conducted complementary texture measurements on the High-Pressure Preferred Orientation Diffractometer spectrometer (HIPPO), which verified the powder pattern of these crystals.

Having demonstrated that neutron diffraction is the best non-destructive method to establish gold crystallinity in extreme samples, the team is considering studying the largest example of an alleged single crystal of unusual 24-sided format, shown in the figure to the left. X-rays have determined that this 78g behemoth has disrupted surfaces, which might be alluvial damage from rolling in a stream bed.



▲ Frans Trouw (right), leader of the Lujan Center cryogenics team, and Alan Shapiro (both of LANSCE-LC), examine the new dilution refrigerator recently commissioned at the Lujan Neutron Scattering Center.

Lujan Neutron Scattering Center receives new helium dilution refrigerator

A team from Vericold Corporation in Germany and Oxford Cryogenics in England worked with Lujan scientists to commission the first cryogen-free ^{3}He-^{4}He dilution refrigerator at a United States neutron scattering facility. The refrigerator, designed to reach temperatures of 20 mK, performed flawlessly. The Vericold device is a new design, which uses a closed cycle pulse tube cooling technique to cool the system to approximately 4K, at which point the dilution heat exchanger can take over and reduce the sample temperature to 20 mK. The pulse tube method does not require liquid He as a pre-coolant and thus results in a significant saving in operating costs, compared to conventional He dilution refrigerators. During the commissioning tests the refrigerator exhibited stable long-term operation at 11 mK under no external heat load. The refrigerator was purchased with Los Alamos National Laboratory General and Administrative funds in FY 2006 and is a key initial component in the forthcoming Lujan Enhancement Program to be funded by DOE-BES.

The addition of the dilution refrigerator system to the suite of sample environment resources at the Lujan Center will make ultra-low temperatures available on a number of diffraction, reflectometry, and inelastic instruments available to users. Combined with the existing 11T superconducting magnet, this will enable the Lujan Center to address many of the cutting-edge research problems of the condensed matter physics community, especially scattering research in superconducting and other correlated electron systems.

Technical contact: Jim Rhyne

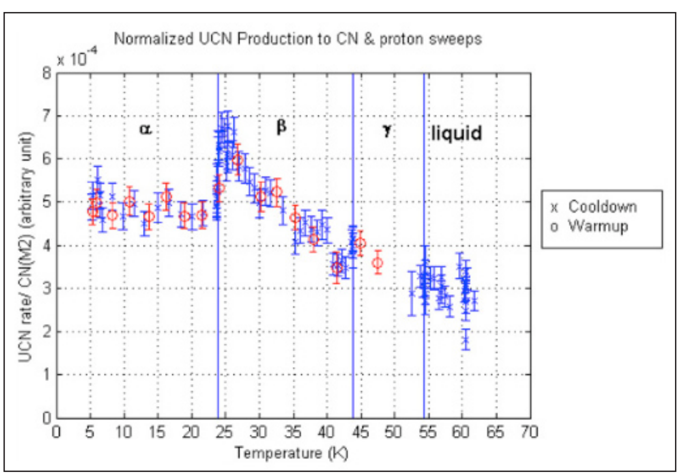
First production of ultra-cold neutrons from solid oxygen at Lujan Center

Principal Investigator Chen-Yu Liu and her team from Indiana University have performed the first successful production of ultra-cold neutrons (UCNs) via inelastic magnetic scattering on a solid oxygen crystal. Los Alamos researchers include flight path scientist Aaron Couture (LANSCE-NS), and Andy Saunders and Mark Makela (P-25) as collaborators. The researchers took advantage of the cold neutron flux available at a LANSCE-NS flight path at the Lujan Neutron Scattering Center.

Most facilities studying UCNs use solid deuterium to produce ultra-cold neutrons. However, the ultimate yield of UCNs is limited by the intrinsic absorption in the UCN production source. Oxygen-16 has a neutron absorption cross-section that is a factor of five smaller than that of deuterium and a zero incoherent cross-section, offering the opportunity to develop significantly larger UCN sources and larger fluxes of UCNs.

The preliminary UCN production is shown in the figure below as a function of the temperature and solid oxygen phase. While the present results are qualitative, ongoing measurements will quantify the UCN production rate on the present solid oxygen crystal in several low temperature phases. In addition, the crystal has been grown inside of a 5.5 T superconducting solenoid. This will enable a detailed study of the magnetic interactions and may lead to the possibility of fine-tuning the production of ultra-cold neutrons through the application of an external magnetic field.

The Nuclear Science User Program supported the Los Alamos work.



▲ UCN count rate normalized to the incident cold neutron flux. Solid oxygen is solidified from liquid under ambient earth magnetic field.

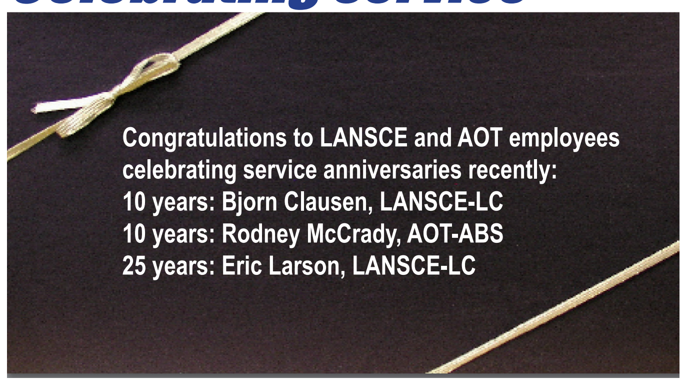
197-MeV protons. . . *continued from page 1*

The 197-MeV beam "tune" supported experiments that C Division's IPF personnel were scheduled to run in the Blue Room at WNR in mid-December. These initial experiments were expected to lead to follow-on activities to develop a unique isotope production capability to complement the existing 100-MeV IPF facility at LANSCE.

Technical contacts: Leo Bitteker and Ron Nelson

February is Wise Health Consumer Month
Wise Health Consumer Month in February provides useful information to help employees make better health decisions. Wise Health Consumer Month is sponsored by the American Institute of Preventive Medicine. Contact wellness@lanl.gov for information on living a healthier lifestyle and to learn about related of health topics.

Celebrating service



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