Dear SURF Readers,

Welcome to the October 2013 Sanford Underground Research Facility (SURF) monthly newsletter. The newsletter is also posted online, and a pdf copy is available. You can read recent and archived newsletters at our website at www.sanfordlab.org. We are glad to receive your input on news, links to news articles, upcoming workshops, conference notices, scientific updates, information concerning SURF, employment opportunities, and other highlights relevant to underground science.

Important Dates

October 23-26: APS DNP meeting – Newport News, VA

November 15: INPA 20th anniversary – LBNL, Berkeley

NASA Astrobiology Institute Project Launches at SURF

Duane Moser, Professor in the Division of Earth and Ecosystem Sciences at Desert Research Institute (DRI) in Las Vegas, Nevada shares a report of recent research at the Sanford Underground Research Facility. Dr. Moser is a microbial and molecular ecologist focused on life in the terrestrial deep subsurface, lakes and oceans, and arid lands.

After a successful reconnaissance trip in September, members of the *Life Underground* team of the NASA Astrobiology Institute (shown in Figure 1) were back at Sanford Lab in mid-October for additional underground sampling and their annual Co-Investigators' Meeting. In September, the team surveyed most of Sanford Laboratory's footprint on the 300L, 800L, 1700L, 2000L, and 4850L for water-producing exploration holes left over from mining days, or from more recent rock surveys. These holes will serve as early sites for microbiological experimentation in support of an ambitious five-year program. Candidate holes were located on all levels surveyed, and initial analyses for microbiology, aqueous, and gas geochemistry are underway. The October visitors to the site included all members of the September Reconnaissance Team: Principal Investigator Jan Amend, along with graduate student Lily Momper and postdoc Maggie Osburn (both of University of Southern California (USC)), along with Professor Duane Moser and graduate student Kait Hughes from the Desert Research Institute (DRI)/UNLV), and Cynthia Anderson of Black Hills State University. Additional team members who visited the site for the first time in October included: Victoria Orphan (Caltech), Moh El Naggar (USC), and Rohit Bhartia (Jet Propulsion Laboratory). Team members Yuri Gorby (Rensselaer Polytech) and Ken Nealson and Katrina Edwards (USC) were unable to attend, but remain integral to the future success of this enterprise.

Figure 1: September Reconnaissance Team at Sanford Lab's Kirk Adit (300L) prior to their first entry of the Sanford Lab facility. Left to Right: Duane Moser, Maggie Osburn, Lily Momper, Jan Amend, Kait Hughes

Life Underground is a unique $6.7 million project that combines expertise from the marine and continental sub-disciplines of deep life study and joins it into a single unified framework. The program is tasked with developing approaches for the detection and characterization of microbial life in deep rock-hosted environments, especially from near the limits of life. Among the team's objectives is the adaption of emerging-life detection technologies (e.g. deep UV microscopy and redox-controlled chips) for deployment within the narrow confines of diamond-drilled exploratory holes. With safe and reliable long-term access to a three-dimensional block of the continental deep subsurface, Sanford Lab represents a unique opportunity for the testing and deployment of sensitive instrumentation within the continental lithosphere. Thus, a driving vision of *Life Underground* is the perfection of technologies for ultimate deployment in very difficult environments, such as the deep ocean and extraterrestrial settings. Additional goals of *Life Underground* include the characterization of deep life and biomarkers from little-studied metamorphic endolithic habitats, genome-guided cultivation of "intraterrestrial life" (*in situ* and in the laboratory),

and the development of numerical models for the prediction of microbial metabolisms based on environmental chemistry. All of these can be effectively addressed at SURF.

Figure 2: USC graduate student Lily Momper collecting water for microbial analysis

To achieve its goals, *Life Underground* plans to proceed in a staged approach, with Phase I involving groundwater sampling (as shown in Figure 2) and the installation of natural mineral substrates (e.g. from cores) for *in situ* cultivation/colonization of indigenous microorganisms. Second Stage experimentation will involve piggybacking upon existing exploration drilling programs in the Sanford Lab facility, and a final phase will involve the drilling of some of the first custom holes for microbiological research ever developed in the continental subsurface. Once completed, these resources will be fitted with inert outlet and downhole seals and are envisioned as long-term resources, not only for the *Life Underground* program, but the research community as a whole. As these initial activities draw to a close, the members of *Life Underground* are working with Sanford Lab on an *Experimental Planning Statement* detailing the way forward.

To read more*: Life Underground* (August 1, 2013)
Seeking Life Underground (October 9, 2013)

LUX event

On October 30, physicists from the LUX dark matter detector experiment will announce the first results at an invitation-only event at the Sanford Underground Research Facility. Speakers will include the LUX scientists and South Dakota Governor Dennis Daugaard. Media are welcome to attend the event, which will be webcast live by South Dakota Public Broadcasting, starting at 9 a.m. Go to sanfordlab.org to get a link to the webcast.

Reports/Papers Available

LBNE report for Snowmass: *Scientific Opportunities with the Long-Baseline Neutrino Experiment*. Cornell University Library. http://arxiv.org/abs/1307.7335

Paper: "The Large Underground Xenon (LUX) Experiment". *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment,* Vol. 704, 11 March 2013, pp. 111–126.

Why the US Needs a Deep Domestic Research Facility. (Kevin Lesko, April 1, Cornell University Library, http://arxiv.org/abs/1304.0402)

For news, *twitter* updates, and other features see the SURF website: www.sanfordlab.org
Like SURF on Facebook:
http://www.facebook.com/SURFatHomestake

SURF IN THE NEWS

Physics.org: In former gold mine, scientists lie in wait for dark matter (Eric Gershon, October 17)

Symmetry: The great physics quest (Glennda Chui, September 24)

Fermilab Today: LBNE gains new partners from Brazil, Italy and UK (Anne Heavey, September 26)

Science Magazine: The Unruly Neutrino (Adrian Cho, September 6)

Rapid City Journal: BHSU president announces retirement (John McLaughlin, October 12)

Black Hills Pioneer: BHSU President to retire (Heather Murschel, October 11)
Groundswell (Wendy Pitlick, September 28)
Harlan retires as Sanford's communications director, announces replacement (Adam Hurlburt, September 21)

DURA News

To comment on DURA, please contact chair Richard Gaitskell (Richard_Gaitskell@brown.edu). For Bio-Geo-Engineering matters, contact Bill Roggenthen (William.Roggenthen@sdsmt.edu). For further information on DURA, see: http://sanfordlab.org/dura

SANFORD UNDERGROUND LABORATORY NEWS

LUX update

James Verbus, a Brown University graduate student (shown in Figure 3), is leading the team installing a neutron generator next to the LUX detector's water tank. The detector is suspended inside the tank.

Figure 3: James Verbus points to the cylindrical neutron generator that the LUX team is assembling

Verbus offers a description of how the generator will function, starting with the box at the top of the device, pictured in Figure 3 (right). "Up here you have a microwave generator (a magnetron) similar to what you have in a microwave oven," he said. The microwaves will be funneled down the waveguide (the rectangular column below the microwave generator) into the small box directly above the larger cylinder. The evacuated box is a plasma chamber into which is injected a small amount of deuterium gas.

The microwaves enter the plasma chamber and ionize the deuterium, stripping the deuterium atoms of their electrons, turning them into charged particles. A pinhole is positioned in the top of the large cylinder and a titanium-plated copper target is inside the tube. "We put 125 kV between the target and the top," Verbus said.

The deuterium ions migrate to the target and plate onto the titanium. Subsequent deuterium ions fuse with the plated deuterium, yielding a helium-3 atom and a neutron. The free neutrons will scatter in every direction. Most of them will be stopped by a shield of carbon-rich borated polyethylene. However, a hole in the shield next to the LUX water tank will allow the neutrons to pass through. The neutrons will easily penetrate the stainless steel, but water in the tank would stop them. An empty pipe inside the water tank, which is aligned with the generator, will funnel neutrons into the LUX detector itself.

Because the neutron generator produces particles of uniform energy, LUX researchers will be able to measure the angles between the neutron-xenon collisions to come up with a very precise measurement of the number of photons a WIMP-xenon collision might produce. "You can get an absolute calibration," Verbus says.

Safety reviews of the neutron generator were completed during the first week of October. It will be ready for operation later in October.

Ross Shaft update

Progress continues on the five-year project to replace steel in the Ross Shaft. On September 27, a failed slip regulator brought the steel replacement to a grinding halt. The mechanism regulates the variation between the rotating magnetic field of the 1750-HP AC motor that powers a motor-generator set with a 40-ton flywheel driving two 1500-HP DC hoist motors, and the rotation speed of the motor (see Figure 4). As Facility Infrastructure Director Tim Baumgartner says, "The slip regulator is like a dimmer light, but a lot bigger. It controls the amount of current that goes into the motor."

Figure 4: The motor-generator set that converts AC power to DC power to operate the hoist.

The failed slip regulator was manufactured in 1948, evidence of the manufacturer's high quality as well as a tribute to regular maintenance. However, this

meant that replacement parts were no longer available. The slip regulator consists of many parts: rubber insulators, bakelite boards, copper rods that serve as electrodes, and three huge clay pots that separate the electrodes. The team was able to track down the raw materials and then fabricate them to fit (shown in Figure 5). One week after the slip regulator's breakdown, team members had completed installation of the newly fabricated parts so that steel replacement could resume.

Figure 5: Facilities Technicians Kevin Ehnes and Chris Huber install electrodes into the clay pots in the slip regulator tank

Blizzard in South Dakota

While California and other West Coast states were basking in 80° weather, Lead, South Dakota received 55 inches of snow between Thursday, October 3 and Saturday, October 5 (see Figure 6). Winds gusted up to 50 mph and left cars, trucks, and homes buried under the snow. Power outages were reported throughout the area. The storm was responsible for the closing of business, schools, and the Sanford Lab (except for "essential personnel.")

Figure 6: Oak Ridge National Laboratory physicist David Radford hikes toward the Yates Shaft on October 5

SURF runs a complex operation that requires certain staff members to be on-site. Exhaust fans provide fresh air to the underground. Water must be pumped, and the water treatment plant must operate to maintain biological treatment systems. All systems require electricity; Sanford Lab's power supply kept running throughout this critical period. Dedicated personnel proved that they were up to the task when their presence was required at Sanford Lab.

On Saturday, October 5, MAJORANA DEMONSTRATOR (MJD) scientists remotely monitoring the experiment noticed a glitch in the liquid nitrogen system. MJD Deputy Project Director David Radford of Oak Ridge National Laboratory and physicists Vince Giuseppe of University of South Carolina and Johnny Goett of Los Alamos National Laboratory set out on foot for Sanford Lab's Yates Shaft from the MJD apartment located about one mile from Sanford Lab. This might normally be a 20-minute walk but in the snow, the trek took them an hour, in some places wading knee-deep in snow.

Hoist Operator Leon Bachand and Infrastructure Technicians Pat Urbaniak and Bryan Johnson, already on duty from the storm's onset, were ready to take the scientists underground.

LUX also experienced a few problems, reported physicist Luiz de Viveiros of LIP Coimbra, but he was able to make repairs remotely. During the closure, LUX and MJD personnel also checked other systems.

Sanford Lab Director Mike Headley thanked the team, especially Surface Operations Foreman Dan Regan and Construction Safety Specialist Tim Eggers. Both men alternated as emergency response coordinators during the blizzard. In addition, the two men also put in volunteer time as Regan volunteers with Lawrence County Search and Rescue, and Eggers with the Lead Volunteer Fire Department.

About thirty others assisted on-site during the blizzard. Sanford Lab opened for normal operations on October 8.

EDUCATION AND OUTREACH

Fifty Years of Neutrinos in the Black Hills

Sanford Lab hosted a Lead Chamber of Commerce mixer on September 18 with a panel discussion celebrating *Fifty Years (almost) of Neutrinos in the Black Hills.* This event also helped to kick off the South Dakota Festival of Books. November 2013

marks the fiftieth anniversary of Ray Davis and John Bahcall's proposal to pursue a deep underground solar neutrino experiment, presented at an international conference. Portions of a video interview with Ray Davis, recorded by *Historical Footprints in the 1980's*, were shown. Steven Mitchell, author of *Nuggets to Neutrinos: The Homestake Story*, Sanford Lab Communications Director Bill Harlan, and Science Liaison Director Jaret Heise also shared their perspectives of the impact of the Davis/Bahcall collaboration on Homestake Mine, the Black Hills, and the neutrino science community. Over the coming two years, there will be further opportunities for celebration of the progress of this seminal experiment.

K-12 Activities

Newcastle High School brought seventeen physics and advanced chemistry students to Sanford Lab on September 25. The group was preparing for science-fair projects and many had been to Sanford Lab last year. International Cosmic Day was celebrated with a discussion of data analysis and statistics. The group also toured the Hoist Room. Two other school groups scheduled for early October were postponed because of the early snowstorms this season.

ENVIRONMENT, HEALTH & SAFETY

Recycling

- Recycling is vital to the health of our planet. Recycling protects our climate, preserves resources, and reduces our dependence on fossil fuels.
- By recycling paper, plastic, glass, and metal, you help to build a sustainable, healthy world for future generations.
- Do your part. Take your electronics, ink cartridges, batteries, and other recyclables to your nearest recycling center.

UPCOMING CONFERENCES AND WORKSHOPS

Fall 2013 Meeting of the APS DNP, Newport News, VA, Marriott Hotel and Conference Center, October 23-26, 2013.
https://www.jlab.org/conferences/dnp2013/dnp-13.html

High Voltage in Noble Liquids Workshop, Fermilab, Batavia, Illinois. This workshop will provide a forum to discuss current activities aimed toward understanding the behavior of high voltage in noble liquids. November 8-9, 2013.
https://indico.fnal.gov/conferenceDisplay.py?confId=7394

NNN13: International Workshop on Next Generation Nucleon Decay and Neutrino Detectors, Kavli IPMU, Tokyo, Japan, November 10-13, 2013.
http://indico.ipmu.jp/indico/conferenceDisplay.py?confId=17

INPA 20th anniversary event, Lawrence Berkeley National Lab. Over the past twenty years, LBNL's Nuclear Science and Physics Divisions have worked together as leaders in the revolutionary changes in our understanding of neutrinos and cosmology. A celebration featuring short presentations and refreshments will take place at Perseverance Hall from 2-4 p.m.

Present and Future Neutrino Physics, KITP, UC Santa Barbara, September 29-December 29, 2014. Topics include neutrino oscillations, nature of neutrino mass, absolute neutrino mass scale, models for neutrino masses and mixings, and neutrino physics beyond the Standard Model. Application deadline: 11/15/13.
http://www.kitp.ucsb.edu/activities/dbdetails?acro=neutrinos14

APS Conferences for Undergraduate Women in Physics, January 17-19, 2014. Eight conferences aimed at providing women undergraduate students with information and resources to support them as they pursue a career in physics. Held at various locations. Contact: women@aps.org
http://www.aps.org/programs/women/workshops/cuwipapp.cfm

STAFF NEWS

Bill Harlan retires

Sanford Lab Communications Director Bill Harlan will retire in November, after nearly six years on the job.

SURF Director Mike Headley stated, "Bill has played a central role in communicating the creation and operation of the Sanford Lab over the past nearly six years. He's told the story of the lab, its staff, and researchers with dedication, interest, and professionalism. We appreciate Bill's contributions, thank him for his friendship, and wish him all the best on his retirement."

Harlan joined Sanford Lab in March 2008, but his connection with the Homestake gold mine began much earlier. He worked underground briefly in the mid-1960s, then again in the mid-1970s, as a laborer and as a motorman, driving underground trains.

Harlan describes himself as "the worst gold miner in the history of Homestake," but his short stints in the mine helped launch his 29-year career in journalism. His first major project was a three-part magazine series, "Extremely Deep Throat," which chronicled his experiences underground. (*Homestake Mining Co*. later reprinted the series for distribution to new hires.)

Harlan came to Sanford Lab from the *Rapid City Journal*, where his beats included the gold mine and later the proposal to convert it into an underground laboratory. Harlan wrote more than a hundred stories about the project.

Figure 7: Bill Harlan goes underground to research a story about Sanford Lab

During his tenure at Sanford Lab, Harlan produced a half-hour documentary about the project and a safety video for underground visitors, and he directed the creation of the facility's website, sanfordlab.org. He launched the *Deep Science for Everyone* lecture series, which continues today, and the Neutrino Day science festival. This year, the event drew more than 1100 visitors. Harlan also started *Deep Thoughts*, a weekly newsletter that has chronicled the development, construction, and operation of Sanford Lab for the past five years.

"This has been my dream job," Harlan says. "I love the underground environment; the science is mind-boggling and, most important, the people here are inspiring." Harlan will continue to work part-time for the Sanford Lab on special projects, but he will do it from afar. He and his wife, Marjorie, are moving to Georgia to be closer to family, including a grandson.

Connie Walter will replace Bill Harlan as Communications Director. More on Connie in the November newsletter.

JOBS

Staff Scientist, Lawrence Berkeley National Lab, Physics Division. Work with Particle Data Group. Deadline: 1/3/14. Juerg Beringer, jberinger@lbl.gov.
https://academicjobsonline.org/ajo/jobs/3458

Postdoctoral Fellow, Lawrence Berkeley National Lab, Nuclear Science Division. Work on neutrinoless double-beta decay search in the MAJORANA Experiment. Alan Poon. awpoon@lbl.gov
https://lbl.taleo.net/careersection/2/jobdetail.ftl?lang=en&job=76244

Tenure-track faculty positions, South Dakota School of Mines, Rapid City, SD. Junior and senior faculty openings in South Dakota's new physics doctoral program. Deadline: 1/15/14.
http://inspirehep.net/record/1260920
http://inspirehep.net/record/1260921

Postdoctoral position, Max-Planck-Institut für Physik, Munich. GERDA experiment and possible future large scale experiments. Info: Iris Abt, isa@mpp.mpg.de. Deadline: 11/15/13.
http://cerncourier.com/cws/job/J000007901

Lecturer, University of North Carolina, Chapel Hill, Dept. of Physics & Astronomy. Redesign and teach undergraduate physics/astronomy courses. Laurie McNeil, mcneil@physics.unc.edu. Deadline: 1/15/14.
https://unc.peopleadmin.com/postings/33408

Postdoctoral position, University of Zurich. Research on XENON dark matter project. Deadline: 11/14/13. Submit applications: Carmelina Genovese, Physics Institute, University of Zurich, Winterhurerstr. 190, CH-8057, Zurich, Switzerland. Carmelina.genovese@physik.uzh.ch. Contact: Laura Baudis, lbaudis@physik.uzh.ch

Faculty positions, University of California, Berkeley. Two tenure-track Physics Dept. faculty positions to start July 2014. Deadline: 11/8/13. Sarah Wittmer switt@berkeley.edu
Astroparticle Experiment (direct dark matter detection): https://aprecruit.berkeley.edu/apply/JPF00197
AMO Science (emphasis on theory): https://aprecruit.berkeley.edu/apply/JPF00196

Postdoctoral Fellowships, LBNL, Berkeley. Chamberlain Fellow in experimental particle physics and cosmology. Deadline: 10/15/13.
https://academicjobsonline.org/ajo/jobs/2931

Postdoctoral position, University of North Carolina, Chapel Hill. Research in Experimental Nuclear and Particle Astrophysics. Work with MAJORANA and KATRIN. John Wilkerson. jfw@physics.unc.edu
https://unc.peopleadmin.com/postings/31072

Postdoctoral position, University of Alabama, Tuscaloosa. Work on EXO experiment in nuclear physics group. Closing date: 12/1/13. Andreas Piepke, andreas@bama.ua.edu.
https://facultyjobs.ua.edu/postings/30762

Newsletter Editor: Melissa Barclay
Contributors: Kevin Lesko; Bill Harlan and Connie Walter (Sanford Lab local news); NASA Astrobiology Institute Project Launches at SURF (Duane Moser); Peggy Norris, Ben Sayler (Education and Outreach)

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Lawrence Berkeley National Lab
Kevin T. Lesko: 510-486-7731
KTLesko@lbl.gov
Melissa Barclay: 510-486-5237
mbarclay@berkeley.edu
SDSTA/Sanford Lab
Mike Headley, Executive Director
Mandy Knight, 605-722-8650, x222
MKnight@sanfordlab.org
http://www.sanfordlab.org/

BERKELEY OFFICE

SURF Project Office
Lawrence Berkeley National Lab (LBNL)
One Cyclotron Road
MS 50B-5239
Berkeley, CA 94720