

Dear SURF Readers,

Welcome to the January 2016 Sanford Underground Research Facility (SURF) monthly newsletter. The newsletter is posted online; a pdf copy is available as well. You can read recent and archived newsletters at our website -- 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

February 9-11: LZ Directors Review – LBNL, Berkeley
February 26-29: MJD Collaboration Meeting & Workshop – Lead, SD

MAJORANA DEMONSTRATOR Electroforming Lab

The decommissioning of the first science lab constructed on the 4850 Level at SURF will take place in 2016. The 12- by 40-foot “snap together” lab—the Electroforming Lab—has been in place since 2011. Led by Cabot-Ann Christofferson (Figure 1), liaison to Sanford Lab for the MAJORANA DEMONSTRATOR (MJD) experiment, and Chemistry and Applied Biological Sciences Instructor at South Dakota School of Mines & Technology (SDSMT), MJD researchers have been machining ultra-pure copper there.



Figure 1: Cabot-Ann Christofferson prepares chemicals for electroforming baths

In total, the Electroforming Lab will have churned out 3100 kg of ultra-low background copper to be used to help construct the detectors of MJD—a colossal effort to detect neutrinoless double-beta decay to further understanding of the role neutrinos played in how the universe formed and behaves.

In the summer of 2011, *Pacific Northwest National Lab (PNNL)* began construction of the Electroforming Lab along with a group from SDSMT. Once complete, the lab became home to 10 large-scale electroforming baths, each capable of holding a 33-cm diameter and 91-cm long cylinder (a mandrel) made of 316 stainless steel. Over the course of 14 months each, copper was electroformed onto the mandrels—a controlled process that consists of the continuous forming of single-atom-depth layers of copper. That’s an average growth rate of a mere 1 mm per month or 0.033 mm a day, which is substantially lower than the growth rate of the hair on one’s head.



Figure 2: A mandrel being maintained, inspected and measured, and machined

The excruciatingly precise, careful, and tedious efforts within the Electroforming Lab had a single goal: to produce ultra-low background copper that does not interfere with the signal that MJD is looking for. To that end, after the copper was removed from the mandrel (by heating the mandrel to 300°C and then slowly submerging it into a bath of water, causing the mandrel and the copper to expand at different rates and thus separating) the copper is then machined into various hardware, vessels, and shielding to be used in the construction of the Germanium (Ge) detector arrays within vacuum cryostats (Figures 2-3). In total, 1400 kg of ultra-low background copper was incorporated into the MJD detector.

The last mandrel is slated to be set into its acid bath in February. Six of ten baths are occupied, with the remainder in some state of decommissioning. SURF personnel are assisting with copper recycling efforts.



Figure 3: Member of MAJORANA DEMONSTRATOR collaboration installs one of the inner copper shield boxes

By the end of 2015, 20 kg of Ge detectors went online; the final 20 kg is expected to go online before summer 2016. The goal of the MAJORANA DEMONSTRATOR, as its name suggests, is simply to “demonstrate” that the design of the experiment is feasible to detect neutrinoless double-beta decay events at a larger scale. If successful, the next phase of the experiment will begin with the construction of the “one-tonne” experiment: a massive scaling up of the detector mass to increase the likelihood of detecting the hypothesized, extremely rare process. The temporary electroforming lab having served its purpose, a new round of electroforming will begin.

SURF in Review: 2016



Figure 4: The Sanford Lab Homestake Visitor Center opened in June 2015. The Raymond Davis Jr. Memorial sculpture (right of the Visitor Center), designed by artist Dale Lamphere, was dedicated in August.

Incredible progress was made at SURF in 2016, reports SDSTA Executive Director Mike Headley. This was largely due to strong partnerships with scientists around the world, including the science collaborations at Sanford Lab, Lawrence Berkeley National Laboratory, which oversees SURF operations for the Department of Energy (DOE), and Fermilab, the lead DOE laboratory for the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment (LBNF/DUNE) project. Support from the State of South Dakota and the SDSTA

(South Dakota Science and Technology Authority) can also be credited.

A new expanded science campus will open soon near the Ross Shaft on the 4850 Level. Ross Shaft refurbishment is more than 65 percent complete, while the Yates Shaft team installed 20,000 linear feet of lumber and handled 2900 separate loads in support of science, operations, engineering, and contractors.

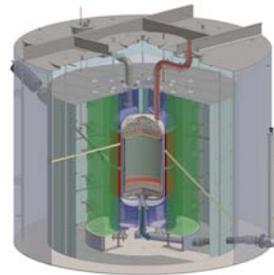


Figure 5: LZ facility design (Image Courtesy of LZ)

The MAJORANA DEMONSTRATOR is operating its first cryostat, Module 1, inside its lead shield and is building strings of germanium detectors for Module 2. Large Underground Xenon (LUX) researchers improved the sensitivity of their dark matter detector by a factor of 20 using a new set of calibration techniques. They recently completed more than half of a 300-day data-taking run. LUX-ZEPLIN (LZ) facility designs have advanced enough to begin construction in 2016 for planned underground experiment installation in 2018 (Figure 5). LBNF/DUNE preliminary facility designs and major project reviews were completed, including the Critical Decision 1 Refresh (CD-1R) and Critical Decision 3a (CD-3a) reviews. The international DUNE collaboration grew to nearly 800 members from 145 institutions.



Figure 6: The CASPAR Facility on the 4850 Level

The CASPAR facility was completed near the Ross Shaft on the 4850 Level (Figure 6). The collaboration completed initial accelerator equipment installation in efforts to study processes in stars that create the heaviest elements in the universe. The BHSU Underground Campus was completed on the 4850 Level. Several low background counters have

been installed and are taking data to support characterization and installation of future experiments like LZ.

Forward Momentum 2025, a 5-year strategic plan based on a 10-year vision for the Sanford Underground Research Facility, was released by the SDSTA. In their introduction, Mike Headley and Casey Peterson, Chairman of the SDSTA Board of Directors, write, "It is our pleasure to present *Forward Momentum 2025*, a strategic plan designed to lead the South Dakota Science and Technology Authority (SDSTA) and the Sanford Underground Research Facility (Sanford Lab) into a bold future."



DUNE News

The United States and CERN have formally agreed to partner on DUNE (Deep Underground Neutrino Experiment). On December 18, in a ceremony at CERN, US Ambassador to the United Nations Pamela Hamamoto and CERN Director-General Rolf Heuer signed five formal agreements. One of these directly affects SURF. The agreement will enable scientists and engineers working at CERN to participate in the design and development of technology for DUNE. DUNE will be a dual-site experiment. The facility for the experiment, the Long-Baseline Neutrino Facility (LBNF) will consist of the world's highest-intensity neutrino beam from Fermilab and provide the infrastructure necessary to support massive, cryogenic *far detectors* installed deep underground at SURF, 800 miles away. LBNF will be responsible for the facilities to house the experiment's *near detectors* on the Fermilab site.

REPORTS/PAPERS AVAILABLE

Forward Momentum 2025, a 5-year strategic plan based on a 10-year vision for SURF: www.sanfordlab.org/sites/sanfordlab.org/files/.../Forward_Momentum.pdf

Improved WIMP scattering limits from the LUX experiment, (LUX collaboration), [arXiv:1512.03506](https://arxiv.org/abs/1512.03506) December 11, 2015.

[The Sanford Underground Research Facility at Homestake \(SURF\)](#). (K.T. Lesko, Phys.Procedia 61 (2015) 542-551.)

[P5 report \(Print quality\)](#) The full Particle Physics Project Prioritization Panel report as accepted by the High Energy Physics Advisory Committee

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

NPR.org: [A Physicist Dreams of Catching Dark Matter in the Act](#) (Joe Palca, January 1)

Scientific American: [Last Call: Will WIMPs Show Their Faces in the Latest Dark Matter Experiment](#) (Clara Moskowitz, February 1)

Symmetry: [CERN and US increase cooperation](#) (Sarah Charley, December 18)

[Deck the halls with Nobel physicists](#) (Kathryn Jepsen, December 16)

[Physics books of 2015](#) (Mike Perricone, December 15)

Discover Magazine: [World's Most Sensitive Dark Matter Detector Gets a Boost](#) (Jeffrey Wilkerson, January 22)

Physics Central: [Nobel Neutrinos](#) (Staff, Dec. 31)

Today at Berkeley Lab: [UC names Mike Witherell to head Lawrence Berkeley National Laboratory](#) (Jon Weiner, January 21)

Livermore Independent: [New Results from Experimental Facility Deepen Understanding of Dark Matter](#) (January 7)

University at Albany News: [Bringing Dark Matter to Light](#) (December 15)

Ars Technica: [The search for dark matter heats up](#) (Chris Lee, January 21)

Business Insider India: [Most of the universe is missing – here are 5 ambitious experiments that might find the rest](#) (Kelly Dickerson, January 14)

KOTA news: [Sanford Lab's hunt for WIMPs hits new mark](#) (December 14)

NC1: [Women in Physics Conference](#) (Anya Mueller, January 13)

Vimeo: [Nobel Day talk with Jaret Heise](#) (December 11)

How Stuff Works Now: [What Kind of Technology Could Dark Matter Research Lead To?](#) (Patrick Kiger, January 11)

Daily Herald: [Fox Valley's top stories of 2015](#) (Elena Ferrarin, December 23)

Hackaday.com: [LUX searches in the deep for dark matter](#) (Mike Szczys, January 14)

Argus Leader: [State of the State: What the Governor Said](#) (Dan Haugen, January 12)

Rapid City Journal: [BHSU hosting conference for women in Physics](#) (Tom Griffith, January 16)

[Gov. Daugaard's State of the State Address](#) (Gov. Dennis Daugaard, January 13)

[Lead zip line would rank among tallest in the world](#) (Tom Griffith, December 12)

Black Hills Pioneer: [Project beefs up lab fire suppression system](#) (Constance Walter, December 30)

[Lead adopts chamber-designed community brand](#) (Adam Hurlburt, December 23)

DURA News

To comment on DURA, please contact its 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

Water system upgrade

Completion of the Black Hills State University Campus (BHUC) and the CASPAR cavern at the Ross Campus in the summer of 2015 added nearly 1425 square feet to the SURF underground, thus

increasing the need for industrial water underground. An upgrade of the water system that supplies water for drilling, cooling, and fire suppression was carried out. A reservoir was built on the 4100 Level with the installation of about 3000 feet of pipe (Figure 7).

SURF Facility Engineer Andrew Brosnahan developed the concept, which involved building a dam in a drift on the 4100 Level that feeds water through a series of pipes down the Yates Shaft and over to the Ross Campus. The reservoir, which increases the capacity for the Ross Campus, is over 500 feet long, with 65-inch walls on both ends and a concrete slab that spans the first 10 feet. An 18-inch middle wall prevents silt from spilling into the industrial water, while pass-through pipes isolate reservoir water from natural mine inflow water.



Figure 7: (Left) Bill Geffre prepares rock bolts for installation; (Right) Pipe installed in the West Drift runs from the Yates to the Ross Campus

Safety Matters

In 2015, SURF reached a significant safety milestone: 13 months without a workplace-related injury. This can be attributed to SURF's safety culture and a safety focus on the part of SURF staff and visiting researchers. Other safety highlights are:

Evacuation drills: The ESH team at SURF conducts a quarterly evacuation drill "to make sure that everyone working underground can get to the surface safely," said Emergency Response Team (ERT) Lead John Emick. The team follows guidelines set by the Mine Safety and Health Administration (MSHA), and at the end of each drill, ESH does an evaluation to determine whether any procedures need to change.

"We want to keep everyone trained and aware of their roles during an emergency and understand the

best way for them to exit the facility,” added Noel Schroeder, ESH Director.

Water treatment: Every minute, 700 gallons of water are pumped from the SURF underground, amounting to more than a million gallons daily. “The water contains suspended solids--mostly iron--and other impurities,” said Waste Water Treatment Plant Foreman Ken Noren. The water is treated before being released into nearby Gold Run Creek which empties into Whitewood Creek.

Research is constantly ongoing aboveground in order to more efficiently treat the water, reduce the amount of chemicals, and the amount of water sent to the City of Lead, South Dakota sewer. Underground water flows into a reservoir and then is mixed with water from Barrick’s Grizzly Gulch tailing dam. One step in the treatment process involves moving the water through Yardney multimedia filters, which use garnets, rock, and anthracite coal to clean the water. The filters leave behind backwash, which is sent to the sludge tank to remove iron.

As the backwash empties into the sludge tank, a coagulant is added to neutralize the charge of the micron-sized iron particles. A mixer stirs the water for a few moments before a flocculant (floc) or clarifying agent is added, causing the iron to form into clumps that settle to the bottom of the tank (Figure 8). The sludge layer is pumped to a dewatering bag.



Figure 8: Left: Water Treatment Plant Foreman Ken Noren holds a bottle of flocculent mix. Right: Flocculent mixed with water causes iron to clump together and settle at the bottom of the tank

Over seven years ago, 100 gallons of liquid floc were used each week in the treatment process. Over time, that amount has been reduced. In the last few months, the WWTP operators experienced a breakthrough when they began using a new powder mixture that decreases the consumption of floc to about 7 grams per week. Not only is this a huge

savings, but the new process has improved the quality of the water by eliminating the use of phosphoric acid and soda ash, which is much better for the environment. Noren pointed out that the water is so clean that it meets drinking standards.

Traffic: Check for detours through Deadwood en route to Lead: <http://www.highway85lead.com/traffic>

EDUCATION AND OUTREACH

APS Conference

On January 15-17, more than 1400 students attended (virtually or in person) the American Physical Society (APS) Conference for Undergraduate Women in Physics (Figure 9). The Conferences are connected to nine sites around the country including Black Hills State University (BHSU), and co-sponsored by BHSU and Sanford Lab. The conference is design to support women who are seeking a career in physics. For a joint keynote address, all nine sites participated together; for the other events, each site operated independently.



Figure 9: Attendees of the Women in Physics Conference, held at Black Hills State University, heard national speakers, attended panel discussions, and participated in workshops

This year marks the first time the conference encompassed a nine-state region, and the first time it was held at such a small university.

“Many university departments have few female faculty and students,” said SURF Deputy Director of Education and Outreach Peggy Norris. “The women who do go into physics often feel isolated. This conference offers them networking opportunities and a chance to meet role models.”

Students heard several speakers and participated in panel discussions, including one panel which focused on gender equity. Panelists stressed that hard work and perseverance will make the difference in their physics career and job seeking. Women were encouraged to think positively about their abilities.

The final panel of the conference featured four female graduate students and focused on what students can expect from graduate school. The panelists were: Elizabeth Boulton, Yale, with the Large Underground Xenon (LUX) experiment; Meg Millhouse, Montana State University, LIGO; Emily Dvorak, South Dakota School of Mines & Technology, with the IceCube Neutrino Experiment; and Megan Stark, SDSMT, working with LUX-ZEPLIN (LZ).

The conference is so important to young women, said Brianna Mount, research assistant professor at BHSU, because they gain a broader understanding of the value of continuing to pursue a career in physics.

The event was also sponsored by several other organizations and institutions: SDMST, the University of South Dakota, Dakota State University, the Board of Regents, EPSCoR, South Dakota Space Grant Consortium, GenPro Energy, and the American Astronomical Society. Nationally, the National Science Foundation and the Department of Energy support the conferences through a grant to the APS.

Deep Talks

Deep Talks takes place the second Thursday of each month at Sanford Lab, and will continue through May. On January 14, SURF Laboratory Director Walter Weinig led the discussion on a behind-the-scenes look at what happens to make big science experiments work in an underground environment. A reception preceded the talk, with free craft beer samples provided by Crow Peak Brewing, along with appetizers.

Dr. Barbara Billington

E&O hosted a speaker on January 15 at SURF. Dr. Barbara Billington (University of Minnesota), a national expert on strategies for increasing the number of women in science and engineering,

discussed the issue of gender inequity and strategies for making improvements in the South Dakota area.

STAFF NEWS

During the month of December over the holidays, SURF lost two valuable staff members: Lea Mathis, Contracts Specialist, and Jim Hanhardt, Technical Support Lead.



Lea Mathis had been with Sanford Lab for seven years, working closely with a variety of companies to develop contracts for SURF projects. A long-time resident of Lead, Mathis was involved with the community and many organizations.



Jim Hanhardt worked for 15 years at Homestake, with nearly six at Sanford Lab. He helped shape operations processes, trained staff to work safely, and was instrumental in helping develop key policies and procedures for daily operations. A motorcycle enthusiast who built his own bike, Hanhardt was very active with his church.

ENVIRONMENT, HEALTH & SAFETY



Winter Driving Safety

- Most accidents occur when roadways are wet, snowy or icy. Other winter hazards are caused by severe cold, flooding, extreme wind, and thick fog. Winter flooding can occur due to snowmelt, ice jams, and storms.
- If you see a flooded area or a barrier, turn around and go back. Do not attempt to drive through or around it.
- Even 6 inches of fast-moving floodwater can knock over an adult; it takes just 12 inches of rushing water to carry away a small car, while 2 feet of rushing water can carry away most vehicles.

UPCOMING CONFERENCES AND WORKSHOPS

Lake Louise Winter Institute, Chateau Lake Louise, February 7-13, 2016. Explore recent trends in particle physics in an informal setting.

<https://uofa.ualberta.ca/physics/research/lake-louise-winter-institute>

UCLA Dark Matter Symposium, UCLA Northwest Auditorium, February 17-19, 2016. Sources and Detection of Dark Matter and Dark Energy in the Universe. Followed by special session on David Cline, February 20.

<https://conferences.pa.ucla.edu/dm16/about.html>

Cosmology 2016 Rencontres de Moriond Conference, La Thuile (Valle d'Aosta, Italy), March 19-26, 2016. Topics devoted to Cosmology and dark matter. For registration and more details:

<http://moriond.in2p3.fr/J16>

APS April meeting 2016, Salt Lake City, April 16-19. **The Cold Universe**, April 25-July 15, UC Santa Barbara.

<http://www.aps.org/meetings/calendar.cfm>

ICHEP 2016 Chicago: 38th International Conference on High Energy Physics, August 3-10, Chicago. Physicists will share latest advancements in particle physics, astroparticle physics, cosmology, and accelerator science. Deadline for abstract submission: Feb. 7, 2016.

<http://ichep2016.org/>



JOBS

Postdoctoral Position, Brown University. Research on LUX-ZEPLIN (LZ) in Astroparticle Physics group led by Rick Gaitskell. Review begins: 12/15/15. Contact: richard_gaitskell@brown.edu

<https://academicjobsonline.org/ajo/jobs/6834>

Lindemann Trust Fellowships, 2016-17. Three grants per year for postdocs to carry out scientific research in the USA. Closing: 2/15/16.

www.esu.org/lindemann

Postdoctoral positions, University of Zurich. Work with Experimental Astroparticle group in GERDA neutrinoless double beta decay experiment. Contact: Prof. Laura Baudis, Physics Institute of the

University of Zurich, Winterthurerstr. 190, CH-8057 Zurich, Switzerland. Closing: 2/29/16.

<http://www.physik.uzh.ch/jobs.shtml>

Tenure-track Faculty position, University of Massachusetts, Amherst. Focus area in non-accelerator physics includes dark matter searches, neutrino physics. Deadline: 1/4/16.

<https://umass.interviewexchange.com/jobofferdetails.jsp?JOBID=65788&CNTRNO=6&TSTMP=1448042882232>

AIP Congressional Fellowship. Scientist position working inside the halls of Congress with American Institute of Physics. Deadline: 1/15/16. Contact: Jennifer Greenamoyer, jgreenamoyer@aip.org

<https://www.aip.org/policy/fellowships/cf>

Tenure-track Professor or Associate Professor positions, Penn State. Research in astroparticle physics, cosmology, particle physics. Apply at:

<https://academicjobsonline.org/ajo/jobs/6395>

<https://academicjobsonline.org/ajo/jobs/6393>

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