

Dear SURF Readers,

Welcome to the July 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

August 10-13: LUX-ZEPLIN (LZ) Collaboration Meeting – Oxford, UK

September 12-15: DUNE Collaboration Meeting - Fermilab

LUX Completes Search

The Large Underground Xenon (LUX) dark matter experiment, which operates at SURF, has completed its search for the missing matter of the universe (Figure 1).

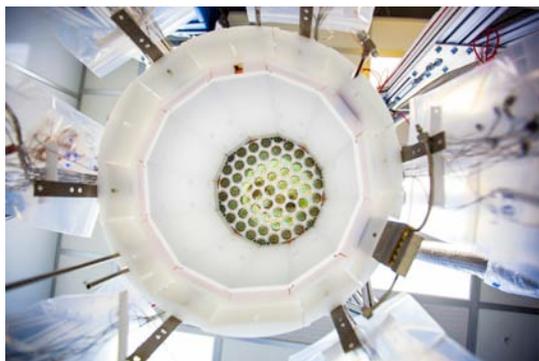


Figure 1: View inside the LUX detector

On July 21, at an international dark matter conference (IDM 2016) in Sheffield, UK, LUX scientific collaborators presented the results from the detector's final 20-month run from October 2014 to May 2016. The new research result is also described with further details on the LUX Collaboration's website: <http://luxdarkmatter.org>.

To read more on LUX, see *SURF in the News* link on Page 3; also May and June 2016 SURF monthly newsletters.

MAJORANA DEMONSTRATOR (MJD) Recycling

The MAJORANA DEMONSTRATOR (MJD) project began growing, or rather electroforming copper at Sanford Lab in 2011. During the process, stainless steel mandrels surrounded by copper nuggets that had been triple-etched in nitric acid are lowered into dilute sulfuric acid baths. The sulfuric acid breaks down the copper, freeing uranium, thorium, and radioisotopes like Cobalt-60, which stay in the solution. Since 2011, 6,600 pounds of copper have been electroformed on 33 mandrels, the last of which was removed March 31, 2015.

The copper was used to build the MAJORANA DEMONSTRATOR, a project that is on the hunt for neutrino-less double-beta decay, that rare form of radioactive decay.

Mid-June, the team shut down the copper production in order to reclaim the copper left behind in the acid baths. This process is called electro-winning. An anode, a thin copper plate, is placed inside the sulfuric acid solution. A current runs through the anode, attracting the remaining copper ions, which then begin to grow onto the anode (Figure 2).



Figure 2: A barrel of copper nuggets with sulfate, ready to be recycled. Once the copper is mixed with sulfuric acid, it takes on a blue color.

"It's a common industrial practice that removes metals from solution," said Cabot-Ann Christofferson, South Dakota School of Mines and Technology (SDSMT) liaison at Sanford Lab for the MJD collaboration.

Now that the detection apparatus has been built, there will be no further need for copper. Colter Dunagan, an undergraduate student at SDSMT, and member of the cleanup crew, says, “Basically, we have to decommission everything now, and one part of that is to remove all of the copper nuggets and dissolved copper from the baths.” The nuggets can simply be removed, but the dissolved copper requires more work (Figure 3).



Figure 3: Colter Dunagan holds a thin copper plate or anode, which is used to extract copper ions

Jared Thompson, a research technician with SDSMT, has been working with the MJD project for several years. “This allows us to reclaim the copper for recycling,” said Thompson. But there’s more to it than just recycling the copper. Copper sulfate is toxic to plant life. According to the Environmental Protection Agency, the allotted amount for heavy metals in liquid is 2 parts per million. MAJORANA can get the liquid to nearly 0 ppm by using the electro-winning method. “By removing the metal from the baths, we eliminate a hazard to the environment as well,” Thompson said.

“It’s the responsible thing to do,” Christofferson added.

Once the copper has plated onto the anodes, it is put into recycling bins and sold to *Pacific Steel* of Rapid City.

Microbial life at SURF

Black Hills State University (BHSU) researchers are searching for life in microbial communities at SURF’s underground. The team initially began collecting data on eukaryotic microbial diversity in 2007. New data collection began in March and includes samples from the 800, 1700, 2000, 4100, and 4800 levels (Figure 4).

Bacteria, archaea, fungi, and eukaryotes live in microhabitats that are ecologically isolated. They

face nutritional limitations and extreme geochemical and physical conditions—a perfect environment for extremophiles. They have also been shielded from the effects of cosmic rays and fluctuating temperatures, all of which have an impact on the microorganisms.



Figure 4: Oxana Gorbatenko (BHSU research assistant) collects a sample from growth on a cavern wall at the 17 Ledge on SURF’s 4850 Level

The eukaryotes are of particular interest to the BHSU group. “Up to now, little research has been done on them,” says Cynthia Anderson, Associate Professor of Biology at BHSU. The group wants to better understand the effect of human activity on these ecosystems, characterize their composition, monitor changes in the communities, and look for novel metabolic products that have potential uses as antibiotics, or in processes such as cellulose degradation.

“New DNA sequencing technology will allow us to obtain a more detailed picture of the eukaryotic diversity present in various habitat types,” said Bethany Reman, BHSU undergraduate.

In the past, samples had to be taken to the surface, then to a lab at BHSU. Now, with the Black Hills Underground Campus and its biology component, once the samples are collected, researchers are now able to assess them soon afterward. “It is possible that the collected samples and living things in them could be highly sensitive to being disturbed, and we want to view them while they are still living,” Anderson said.

Using phase contrast and dark field microscopy, the team can watch light waves travel through the specimen, creating variations in brightness and making the specimen more visible.

Other microbiology groups are also studying extreme life underground. Rajesh Sani, an Associate

Professor of Biology at the South Dakota School of Mines and Technology, leads a research group which has collected samples from levels all the way down to 5000 feet, catalogued them, and written papers about them for nine years (Figure 5).



SURF IN THE NEWS



Figure 5: 2011 photo of Rajesh Sani collecting samples from the 5000 Level

REPORTS/PAPERS AVAILABLE

Special DUNE News: All four volumes of the Deep Underground Neutrino Experiment (DUNE) for Conceptual Design Report DUNE/LBNF are now available on arXiv: Vol. 1. Overview 1601.05471. Vol. 2. Physics 1512.06148, Vol. 3. LBNF 1601.05823, Vol. 4. DUNE detector 1601.02984. <http://arxiv.org/>

The Sanford Underground Research Facility at Homestake. Jaret Heise, J.Phys.Conf.Ser. **606** (2015) no. 1, 012015; [arxiv: 1503.01112](http://arxiv.org/abs/1503.01112) (2015)

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

The Sanford Underground Research Facility at Homestake (SURF). (K.T. Lesko, Phys Procedia **61** 542 (2015)

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 Sanford Lab Visitor Center on Facebook: <https://www.facebook.com/sanfordlabhomestake/>

Today at Berkeley Lab: [World's Most Sensitive Dark Matter Detector Completes Search](#) (Dan Krotz, July 21)

Philanthropy Roundtable: [Interview with Denny Sanford](#) (Summer 2016)

SDPB.org (radio): [Dakota Midday: Neutrino Day Preview](#) (Cara Hetland, July 5)

KEVN Black Hills Fox: [Neutrino Days takes over Sanford Lab Homestake Visitor Center](#) (Staff, July 9)
[Sanford Lab Homestake Visitor Center celebrates 1st anniversary](#) (Taylor Perez, June 30)
[School of Mines receives grant from NASA](#) (Robert Grant, June 23)

NewsCenter1: [NASA could reach Mars by 2030, according to Neutrino Day keynote](#) (July 8)
[Sanford Underground Lab ready to celebrate Neutrino Day](#) (Associated Press, July 1) (Also in *PressofAtlantic City*; *Herald Courier*; *Clay Center Dispatch*)

C&G Partners: [Fresh Award: Sanford Lab Homestake Wins 2016 SEGD Global Design Award](#) (June 13)

Rapid City Journal: [Sanford Lab ready to celebrate Neutrino Day 2016](#) (Staff, July 1)
[Pathways Sanctuary a world away from strife](#) (Tom Griffith, June 22)

[Mines researchers getting hundreds of thousands in grant funds](#) (Mike Anderson, June 23)
[BHSU receives NSF grant for undergraduate research at Sanford Lab](#) (Staff, June 22)
[DUNE will be SD's largest project ever](#) (Tom Griffith, June 13)

Black Hills Pioneer: [Lead celebrates Neutrino Day](#) (John Higgins, July 11)
[Sanford Lab purchases 1.8 million liters of xenon](#) (Jaci Conrad Pearson, July 9)
[Sanford Lab ready to celebrate Neutrino Day 2016](#) (Associated Press, July 1)

DURA

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

Safety Matters

Safety is an ongoing concern for Sanford Lab and all of its experiments. To that effort, researchers and others work to create and support a culture of safety while working underground.

The MAJORANA DEMONSTRATOR (MJD) experiment has an impenetrable shield made up of six layers of various materials designed to block out minute traces of radiation. Extra care needs to be taken with the last layer--12 inches of polyethylene, a combustible material that requires a defense-in-depth fire protection plan to mitigate fire hazards (Figure 6).



Figure 6: Physics undergraduate student Brady Bos steadies a sheet of poly shielding material while Research Technician Jared Thompson rips it to size

Vince Guiseppe, Assistant Physics Professor at the University of South Carolina and researcher with the MJD experiment, helped create a fire prevention plan to cover all aspects of potential hazards.

"Every prevention measure added is a significant increase in fire protection," said Kathy Carney from Oak Ridge National Laboratory and MJD's Environmental, Health and Safety Manager. "We took a look at all potential failure modes, and from that analysis developed an in-depth fire protection defense."

"We believe that our defense-in-depth strategy minimizes the risk of fire as much as possible," Guiseppe said. "The redundant nature of our fire protection strategy ensures that the risk is low, even if some of our protection systems are lost or not in service. Our strategy is to prevent a fire from occurring inside the shield, rather than just relying on fire suppression should one start."

They came up with a five-step plan:

1. Purge the enclosed areas of oxygen using nitrogen gas. Without oxygen, a fire can't survive.
2. Cool the enclosed area to prevent thermal overload.
3. Encase the poly shield with aluminum.
4. Add redundant heat and smoke detection units in the enclosed area.
5. Place equipment in such a way as to reduce likely ignition sources.

"Once fully enclosed, the detector is physically inaccessible, yet it contains vital systems to operate the experiment," Guiseppe said. "By implementing our fire and thermal management plan, we have confidence that the system can run safely without the risk of a thermal overload or a fire event. This plan is one of many detector safety and hazard mitigation strategies employed for long-term operation of the MAJORANA detector."

Visitor Center celebrates anniversary

On June 30, the Sanford Lab Homestake Visitor Center celebrated its one-year anniversary. A live broadcast, food and drinks, \$1 golfing into the Open Cut, and trolley rides were among the activities.

EDUCATION AND OUTREACH

Neutrino Day



Figure 7: Kaelei Kapust, third place "We are Star Stuff" winner (Grades 3-5)

Sanford Lab kicked off another successful Neutrino Day on Friday, July 8 with a live broadcast on South

Dakota Public Broadcasting (SDPB) from SURF's 4850 Level. The Education and Outreach Department organized the hands-on activities for kids and adults alike. Throughout the day, the "We are Star Stuff" Art Show was on exhibit at Lead Deadwood Art Center (Figure 7).

In the evening, keynote speaker Jason Crusan, of NASA, presented at Lead's Historic Homestake Opera House. On Saturday, he was also the featured guest for SDPB Science Café at Lead's Lotus Up Café. Crusan discussed the 2030 Mission to Mars and the details about NASA's efforts to build habitats for living in space, and later took questions from the audience.

On Saturday, Sanford Lab hosted SDPB's "Science" Steve Rokusek, introducing children to advanced science with his "wild science" demonstrations (Figure 8). These included making clouds out of nitrogen and bubbles, which helps kids learn about the complicated physics of natural phenomenon. Other events at SURF included displays, experiments, and hoistroom tours.



Figure 8: "Science" Steve Rokusek of SDPB presents a "wild science" demonstration



Figure 9: David Vardiman engages with Neutrino Day visitors about the geology of the northern Black Hills and the transition from mining to excavating rock for large science experiments

David Vardiman, SURF geotechnical project engineer, gave a geology demonstration at the

Sanford Lab Homestake Visitor Center (Figure 9). He focused on the differences between mining for gold and building large caverns for major science experiments. "The children loved seeing the fossils, gold samples, and geotechnical cores," he said. "That was really the highlight of the demonstration."

At the Homestake Opera House, Elizabeth Worcester, member of the Deep Underground Experiment (DUNE), focused her presentation on neutrinos and how DUNE and the Long-Baseline Neutrino Facility (LBNF) will search for these ghost-like particles. Dan McKinsey, UC Berkeley professor and co-spokesperson for the Large Underground Xenon (LUX) experiment, discussed dark matter and the next generation detector, LUX-ZEPLIN (LZ), which will replace LUX at Sanford Lab.

Nearby Manuel Brothers Park housed a tent for a variety of science activities. The South Dakota School of Mines & Technology (SDSMT) contributed greatly to the program this year. The Geological Engineering Department hosted gold panning in the park, and The Society of Physics Students made liquid nitrogen root beer floats and frozen marshmallows. The Physics Department provided a radiation safety and CASPAR table. Engineering students brought up three of their race cars that were designed for competitions on fuel efficiency. The kids were able to have their pictures taken sitting in the cars. *GenPro Energy* also supported Neutrino Day by bringing a tiny house to the park, totally supported by solar energy. The house was much appreciated when a sudden thunderstorm hit. Food vendors and a National Guard obstacle course were also available in the park.

Other activities included a scavenger hunt to introduce people to the displays at the Visitor Center, an art corner for young children, a Rutherford scattering activity, and engineering activities.

Volunteers who assisted Neutrino Day include:

- Sanford Lab interns Anna Hall, Viet Ho, and Joseph Mammo
- High School students Garret Keifer (Lead), and Hanna Newmiller, Hanna Stadings, and Hanna Young (Spearfish)
- Rapid City teacher. Lynn Arnold and retired Douglas teacher, Kathy Rose

Black Hills State University (BHSU) also assisted greatly with the festival. The Davis-Bahcall Scholars helped with physics activities at Sanford Lab, as did a group of BHSU REU (Research Experience for Undergraduates) students. Camille Griffiths, a biology graduate student from BHSU, brought radio telemetry equipment; and then hid paper turtles and candy around the park so the kids could search for them. Camille is researching the genetics of the box turtle population on the Pine Ridge Reservation that she tracks, using the same equipment.

More than 1100 people attended Neutrino Day events, which also included videoconferences from the underground with members of the Emergency Response Team and the CASPAR experiment (Compact Accelerator System for Performing Astrophysical Research).

Davis-Bahcall Scholars

During the week of June 13, the Davis-Bahcall Scholars spent time at SURF, learning what it is like to be a scientist in a professional setting (Figure 10). Programs like Davis-Bahcall expose students to real-world science and introduce them to scientists around the world. As part of the program, the students will also tour Argonne and Fermi National Accelerator laboratories, the University of Wisconsin and the University of Minnesota in the United States, as well as Gran Sasso and Frascati National laboratories in Italy. They will also visit the *3M Plant* in Aberdeen, South Dakota and *Microsoft* in Fargo, North Dakota.



Figure 10: 2016 Davis-Bahcall scholars (left to right): James Mayclin, Lucas Sternhagen, Trey Waldrup, Sowmya Ragothaman, Alex Wiley, Gina Selig, Hadassah Meyer and Theodore Savinov

“This is a really pivotal time in their career development,” said Dr. Brianna Mount, Research Assistant Professor at Black Hills State University

and adviser to the Scholars Program. “They’re trying to figure out what major they want to pursue. The Davis-Bahcall program is a good opportunity for us to influence their choice.”

In supporting the Davis-Bahcall Scholars Program, Sanford Lab is following its mission to transform education while developing the scientists of the future. As Mount said, contact with the scientists and others can greatly influence them to choose a career in the sciences that they might not otherwise have chosen.

The Davis-Bahcall Scholars Program is sponsored by the *South Dakota Space Grant Consortium* (SDSGC), *First Premier Bank* of Sioux Falls, BHSU, and Sanford Lab. The SDSCG has sponsored Davis-Bahcall Scholars for several years as part of its mission to instill the spirit of exploration and discovery in students, educators, and the general public.

ENVIRONMENT, HEALTH & SAFETY



Heat Safety

- Wear light-colored clothes, in light fabrics such as linen or cotton. A wide-brimmed hat can shield your face from UV rays.
- Sunglasses prevent harmful ultraviolet rays from damaging your eyes. Use a sunscreen with at least 15 SPF, and lip balm with SPF.
- Drink water, at least 8-10 glasses, throughout the day. Avoid sugary drinks, alcohol, and caffeine. Eat plenty of fresh fruits and vegetables.
- *Have a fun & safe summer!*

UPCOMING CONFERENCES AND WORKSHOPS

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. <http://ichep2016.org/>

INPC2016, International Nuclear Physics Conference, September 11-16, 2016, Adelaide, Australia. <http://inpc2016.com/>

Perspectives of GPU Computing in Science, September 26-28, 2016, Sapienza Università di Roma. Discuss and assess impacts and perspectives of GPU and many-core computing.

<http://www.roma1.infn.it/conference/GPU2016/index.html>

WIN2017, Workshop on Weak Interactions and Neutrinos, June 19-24, 2017, Irvine, CA.

<http://www.physics.uci.edu/WIN2017/>



JOBS

NERSC Data Postdoctoral Fellow, LBNL. Support high-energy experiments, especially LUX-ZEPLIN (LZ) software development and deployment. Closing: 9/1/16.

<https://lbl.taleo.net/careersection/2/jobdetail.ftl?lang=en&job=82724>

Postdoctoral Scholar, University of Chicago. Research in experimental particle physics at KICP; participate in XENON1T program. Closing: 8/1/16.

Luca Grandi, xenon1t_search@uchicago.edu.

<http://inspirehep.net/record/1466582>

Neutrino Physics Scientist 2/3, Los Alamos National Lab. Weak Interactions/Astrophysics

Team: study properties of neutrinos including next generation neutrinoless double beta decay. Job #: IRC50266. Keith Rielage, rielagek@lanl.gov.

<http://www.lanl.gov/careers/career-options/jobs/index.php>

Opening for Grad Student at Niels Bohr Institute, Univ. of Copenhagen, research on

IceCube/DeepCore and PINGU; neutrino oscillation physics. Jason Koskinen, koskinen@nbi.ku.dk.

<http://www.nbi.ku.dk/jobs/phd-scholarship-in-experimental-neutrino-physics/>

Postdoctoral Researcher, LLNL. Research focus on R&D on nEXO neutrinoless double beta decay experiment. Contact: Samuele Sangiorgio, sangiorgio1@llnl.gov. Job ID: 101011.

<http://careers-ext.llnl.gov/jobs/5386296-postdoctoral-research-staff-member>

Postdoctoral researcher, LLNL. Research on fission TPC project in Nuclear and Particle Physics Group. Contact: Samuele Sangiorgio (sangiorgio1@llnl.gov). Job ID: 100894.

<http://careers-ext.llnl.gov/jobs/search?q=100894>

Postdoctoral research scientist, South Dakota School of Mines & Technology, Rapid City.

Research in experimental underground physics, direct dark matter searches. Closing: 8/1/16. Richard Schnee, Richard.Schnee@sdsmt.edu.

<http://inspirehep.net/record/1430055>

Postdoctoral Associate, Dark Matter and Neutrino Physics, Northwestern University. Join

group of Prof. Enectali Figueroa-Feliciano. Research SuperCDMS and other experiments. Closing:

7/31/16. Contact: enectali@northwestern.edu

<http://inspirehep.net/record/1430991>

Lab tech positions, South Dakota School of Mines & Technology, Rapid City. Work with

construction of systems including LZ dark matter experiment at SURF.

<https://www.higheredjobs.com/details.cfm?JobCode=176244745>

Newsletter Editor: Melissa Barclay

Contributors: Kevin Lesko; Constance Walter (Sanford Lab news, MAJORANA DEMONSTRATOR, Microbial life); Robyn Hynes (Davis-Bahcall Scholars); June Apaza, Peggy Norris (Education & Outreach)

Photo Credits: Figs. 1,6,7: Matt Kapust;

Figs. 2,3,10: Robyn Hynes; Fig. 4: Constance Walter; Fig. 5: Bill Harlan; Fig. 8: Samantha Gorder; Fig. 9: Laura Heisinger

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, 605-722-4022

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**