

Dear SURF Readers,

Welcome to the September 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

Science and the Homestake Mine

After enjoying the smooth ride down in the Yates cage and stepping into the glistening laboratories of Sanford Lab's Davis Campus 4850 Level, it is easy to forget that these facilities are not at the surface, but in fact 4850 feet underground (see Figure 1). Many surface laboratories lack windows, so it is easy to overlook this amenity. The reality, however, is that the Davis Campus is built in solid rock under extremely high stresses, and the laboratories share many of the same challenges that the historic mining operation faced. The *Homestake Mining Company*, which owned and operated the mine, also needed to preserve the infrastructure in these circumstances, to control water inflow, ensure ventilation, and to maintain the utilities expected and needed for scientific installations and mining. Fortunately, Homestake, and then Sanford Lab, enjoyed the benefits of a long record of leadership in the development of mining technology. Steve Mitchell in his excellent book (*Nuggets to Neutrinos*, 2009) describes many of the innovations in which Homestake was at the forefront during its long history.



Figure 1: The Davis Cavern in 2009 (upper); Physicist Jeremy Mock, right, and other LUX researchers work on the top floor of the LUX experiment, 2012 (lower)

The economic importance of the gold production from the world-class Homestake Mine resulted in a rich literature describing the occurrence and production from the rocks of the northern Black Hills and the mining practices used to produce and process the ore. This literature showed steady progress in the understanding of the formation of the mineral deposits. Over 175 publications on the geology and engineering have been produced since the establishment of the first mines in the area. The close association between Homestake and academic institutions was not an accident, and both science and the company benefited by the relationship. Much of this progress was driven by the interests of a young geologist from Harvard. Donald McLaughlin (shown in Figure 2) was a protégé of Phoebe Hearst, the wife of George Hearst, the original owner of Homestake. Dr. McLaughlin travelled to Lead, South Dakota, and saw the opportunities for scientific investigations that could help both the mine and the study of mineral deposits. The geologic investigations conducted by McLaughlin and his students resulted in real economic improvements in Homestake's bottom line. Dr. McLaughlin later moved to the University of California, Berkeley to become the Dean of the College of Engineering, and work with the formation and distribution of mineral deposits continued. Homestake had prospered during the pre-WWII

years due to the high price of gold and the market assured by the U.S. government. When the restriction on gold production was lifted after the end of WWII in 1945, the synergy between science and economics was recognized, and Dr. McLaughlin was chosen to be Homestake's President and CEO. Subsequently, he served as Chairman of the Board from 1961 to 1970, and later, two of his students followed him in the role of Homestake President.



Figure 2: Donald McLaughlin

Sketch portrait courtesy of College of Engineering, UC Berkeley

Today's link between geology and physics at Homestake was first established by the solar neutrino experiment in 1964. (This experiment was headed by physicist Raymond Davis Jr., who jointly won the Nobel Prize in Physics in 2002.) According to Ken Lande, physicist at the University of Pennsylvania, a geologist on the Homestake Board told the Board and the CEO that this was a good experiment and should be supported. The CEO at the time was John Gustafson, who had done his dissertation in Geology at Homestake under Dr. McLaughlin. It is clear that science was well represented in the upper management. Once the Board and the CEO agreed, progress was rapid and Homestake gave BNL a great price, about \$100k, for the required excavation where the LUX experiment is now located. This is around \$750,000 in 2013 dollars. Hoist trip costs amounted to about \$5k or so per year or about \$35,000 in present-day funds.

In the time since the mine closed and subsequently reopened as a laboratory, geologic studies have been reinvigorated, although they have slowed significantly in recent years. They now tend to be directed toward geomechanical work instead of primarily mineral deposits. The work associated with the preparation of the laboratories on the 4850 Level and the planning for the larger experiments produced a wealth of geotechnical information, however. The need to ensure a safe and stable working environment remains a primary

consideration. Geotechnical studies have resulted in dissertations and publications dealing with geomechanical concepts, geohydrology, geophysics, and geomicrobiology. The core archive donated by Homestake (see Figure 3) is being used more extensively recently, especially since it has undergone organization and cataloguing, although more work of this sort is needed. Much of the work with the core from the archive is related to ore deposits because Homestake is still seen as the foremost representative in the world of this type of gold deposit.



Figure 3: Jeff

Steadman studies Homestake core samples. About 75 miles of samples like these are stored in the former Homestake machine shop on the Sanford Lab surface campus.

New experiment starts, such as that championed by Jan Amend of the University of Southern California (USC) and Duane Moser of the Desert Research Institute (DRI), are encouraging. In September 2013, a five-member team visited SURF to scout for locations that can serve as test beds for a new a geomicrobiology initiative. (The team will report on their findings in a future issue of the SURF monthly newsletter.) In addition to Amend and Moser, the team included USC and UNLV/DRI graduate students (Lily Momper and Kaitlyn Hughes) and USC Postdoc Magdalena Osburn. The work of the team will support the *Life Underground* node NASA's Astrobiology Institute. This five-year project, conceived as perhaps the first coordinated research program ever uniting marine and continental deep life study, focuses on instrument development for *in situ* life detection and factors that control the activity and distribution of indigenous life deep underground. The program utilizes a range of windows into the deep biosphere, including boreholes from the Nevada National Security Site, Death Valley, and marine settings via the Ocean Drilling Program (ODP). Sanford Lab is envisioned as its primary underground research site and equipment testing facility. Thus, a new link between the Black Hills

and large questions about the function of the Universe may have been forged through this NASA program at SURF.

CETUP*

Two years ago, the theory community (based at Dakota State University) started a new initiative: the Center for Theoretical Underground Physics and Related Areas (CETUP*), in response to an increasing interest in experiments conducted at deep underground facilities around the world. Studies of neutrino physics and dark matter are of high interest to particle and nuclear physicists as well as astrophysicists. Research with the ongoing and proposed dark matter and neutrino experiments is expected to unveil answers to critical questions asked by scientists for the last few decades. CETUP* programs take place on a yearly basis, starting on a small scale in 2011. In 2012, a three-week long CETUP* program was organized, consisting of a one-and-a-half week-long focus session on current theoretical and experimental status of dark matter discussions, and another one-and-a-half week session focusing on neutrino physics, nucleon decay, and unification. The latest status of theory and experiments were reviewed over detailed discussion sessions which made all the participants want to return for future CETUP* programs. Many of these discussion sessions gave rise to a large number of papers as is evident from the 20 publications with CETUP* preprint numbers for 2012. In addition, the AIP (American Institute of Physics) Proceedings titled *CETUP* 2012 – Workshop on Dark Matter, Unification and Neutrino Physics* was published.



Figure 4: CETUP program attendees take an excursion to the Crazy Horse Memorial in the Black Hills*



Figure 5: CETUP 2013 program attendees pose for a group photo*

The CETUP* 2013 workshop was even more interesting and productive. In addition to all-day talks and discussion sessions held at the Lead/Deadwood Middle School, program events also included a tour of SURF, excursions to the Black Hills and Badlands National Park, and a visit to Mt. Rushmore, Crazy Horse, and Custer Park (see Figures 4-5). A major international conference, entitled PPC (VIIth International Conference on Interconnection between Particle Physics and Cosmology) was co-hosted at a nearby venue at *The Lodge* in Deadwood for six days during the time between the dark matter and neutrino workshops. PPC involved about 70 international participants. The program began at Texas A&M University in 2007 and has since travelled to many places including Geneva, Turin, and Seoul over the last five years. Some of the participants from the earlier PPC conferences also participated in the CETUP* workshop, making it a true international event. In addition, the month-long CETUP* workshop (two-week long session on Dark Matter and two-week long session on Neutrino Physics and Astrophysics) allowed the international group of more than 60 physicists to flesh out the details of several ideas involving all three frontiers (Energy, Intensity, and Cosmic) of physics before the final presentation for this year's Snowmass community planning meeting in High Energy Physics.

The objectives of CETUP* and PPC in 2013 were to analyze the connection between dark matter and particle physics models, discuss the connections among dark matter, grand unification models and recent neutrino results, explore predictions for ongoing and forthcoming experiments, develop a theoretical understanding of the three-neutrino oscillation parameters, provide a stimulating venue for exchange of scientific ideas among experts in these areas, communicate the importance of underground science research in dark matter,

neutrino physics, unification and proton decay to the general public and support of investment in science education. The results of the CETUP* workshop and PPC conference will be summarized in the American Institute of Physics (AIP) Proceedings.

For more information about the past and future CETUP* programs, contact the organizer, Dr. Barbara Szczerbinska from Dakota State University at Barbara.Szczerbinska@dsu.edu.

New South Dakota Physics doctoral program

This fall, two of South Dakota's new physics doctoral students, Chris and Angela Chiller, attended classes at Sanford Lab's Davis Campus 4850 Level (shown in Figure 6). They took time out from their work underground on the LUX experiment to use the videoconferencing unit available in the Common Corridor. University of South Dakota (USD) physicist Dongming Mei was teaching group theory and physics beyond the Standard Model, lecturing from Vermillion, about 450 miles east of Lead. Both recently earned master's degrees in Physics from USD, and are now continuing in South Dakota's new physics doctoral program.



Figure 6: Chris and Angela Chiller work underground and attend classes by videoconference at Sanford Lab

Snowmass 2013

At the DOE/HEPAP Snowmass (on the Mississippi) community planning meeting, held in Minneapolis in July and August, the Physics community discussed issues related to LBNE. Find links to submitted white papers relevant to neutrinos at: <http://www.snowmass2013.org/tiki-index.php?page=Official+Snowmass+White+Papers>

The next step in the process will be to convene a Particle Physics Project Prioritization Panel (P5) charged by DOE and NSF to "develop an updated strategic plan for U.S. high energy physics that can

be executed over a ten-year timescale, in the context of a twenty-year global vision for the field." The report is due May 1, 2014. The full charge can be found at: http://science.energy.gov/~media/hep/hepap/pdf/201309/P5_Charge_2013.pdf

Reports/Papers Available

LBNE report for Snowmass: [Scientific Opportunities with the Long-Baseline Neutrino Experiment](http://arxiv.org/abs/1307.7335). 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

Symmetry: [South Dakota artists explore dark matter](#) (Bill Harlan, September 17)
[Why particle physics matters](#) (August 20)
[Physicists chart path forward](#) (Kelen Tuttle, August 8)

BHSU news: [Sanford Lab and Black Hills State University will partner in new science education center](#) (August 27)

KOTA news: [Sanford Lab partners with BHSU to convert science building](#) (August 21)

The Republic: [Sanford Lab partnering with Black Hills State on \\$4.5M project](#) (Associated Press, August 22)

Argus Leader: [Sanford underground lab project in Lead ahead of schedule](#) (September 6)

Rapid City Journal: [Ross Shaft project ahead of schedule](#) (Tom Griffith, September 6)
[Lead underground lab project ahead of schedule](#) (September 6)
[Sanford Lab, BHSU announce plans for \\$4.5 million science center](#) (Tom Griffith, August 22)
[Sanford U](#) (Tom Griffith, August 21)

Black Hills Pioneer (Wendy Pitick): [Physics doctoral program kicks off](#) (August 23)
[Sanford Lab, BHSU announce \\$4.2M partnership](#) (August 22)

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

MAJORANA DEMONSTRATOR (MJD) update

On August 27, the first two 1-ton pallets of cleaned lead bricks were delivered to the 4850 Level Davis Campus, where MAJORANA researchers are building their experiment, coming from Black Hills State University in nearby Spearfish, SD (shown in Figure 7). Physicists Steve Elliott of Los Alamos National Lab and John Wilkerson of the University of North Carolina were present to direct the activities. By the end of the week, the team had completed most of the first layer of bricks that will shield the MAJORANA detector. The shield will require about 5000 lead bricks, each weighing 26 pounds.



Figure 8: Infrastructure Tech (Kyle Ehnes delivers lead bricks to the top of the Yates Shaft. Infrastructure Tech John Emick waits with the pallet.

Ross Shaft update

Progress continues in the five-year project to replace steel supports in the 5000-foot Ross Shaft (see Figure 8). The top photo shows the old corrugated steel snow shed at the top of the Ross Shaft 800 Level. Historically, snow sheds protected miners waiting at stations for a cage. Unseen loose rock could build up behind the sheds, creating a safety hazard. In the middle photo, Infrastructure Tech James Gregory surveys the station, after the snow shed has been removed. New ground control measures, including rock bolts and welded steel mesh, which allows thorough inspection of rock conditions, have been added. The bottom photo, taken August 23, shows the new 18-foot tubular steel set installed at the station. Currently, 904 feet of steel in the shaft has been replaced. Underground Access Director Will McElroy reports that the team is slightly ahead of schedule.

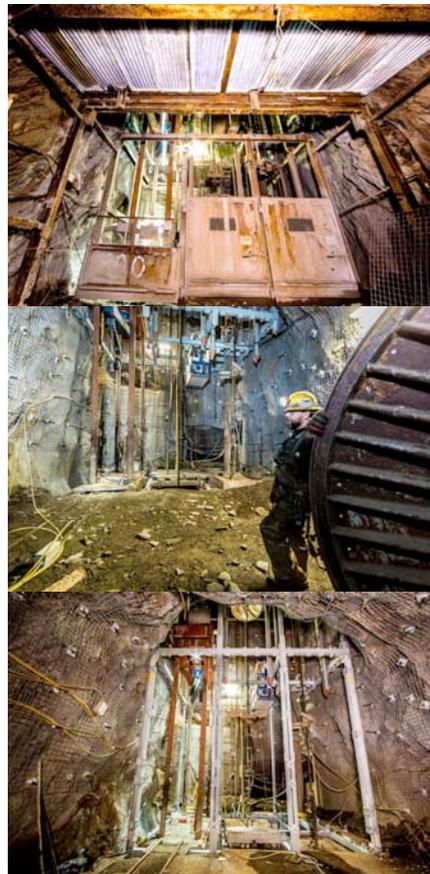


Figure 8: Progress in the Ross Shaft

EDUCATION AND OUTREACH

Cultural Activities

The Black Hills State University (BHSU) "Bridge" program provides an expanded orientation for American Indian freshmen entering BHSU. The Bridge Program helps students transition from high school to college by addressing academic, professional, cultural, and social issues that first-time Native college students may face. For the second year in a row, BHSU's Center for American Indian Studies, which runs the program, brought the students to visit Sanford Lab. SURF Education and Outreach (E&O) Director Ben Saylor, Multi-Media Specialist Matt Kapust, and E&O Deputy Director Peggy Norris presented talks to 29 incoming freshmen and 12 upperclassmen. Students took part in an activity in the parking lot using tiltmeters, took a Hoist Room tour, and listened to talks about Sanford Lab (including job possibilities) and about using tiltmeters to pinpoint the location of earthquakes.

The Sanford Science Education Center

Two announcements were made in August regarding plans for moving forward on a multi-faceted Sanford Science Education Center with branches at BHSU (for teacher preparation), the Homestake Visitor Center (for the public) and Sanford Lab (for classroom visits, teacher workshops, undergraduate programs, videoconferencing, etc.). (Some illustrations are shown in Figures 9-11.) On August 16, a press release announced that Sanford Lab and the Lead Chamber of Commerce were exploring options for a new building at the site of the current Homestake Visitor Center. On August 21, a press conference was held at BHSU announcing a partnership between BHSU and SDSTA for a \$4.2M renovation of the Jonas Science Building. The event generated extensive media coverage and positive community comments. Both projects have aggressive schedules with construction anticipated to begin in the summer of 2014.



Figure 9: Artist's depiction of proposed conversion of Jonas Science facility at BHSU into a branch of the Sanford Science Education Center



Figure 10: Illustration of proposed new Sanford Lab Homestake Visitor center on Main Street



Figure 11: Proposed remodel of Sanford Lab Yates Administration Building includes a new entrance and a covered walkway

On September 17, Sanford Lab hosted a Chamber of Commerce Mixer and panel discussion as part of the *South Dakota Festival of Books*, which comes to Deadwood on alternate years. The event celebrated the Fiftieth anniversary of Ray Davis' proposal to measure solar neutrinos in the Homestake Mine. Former Homestake employee Steve Mitchell, author of *Nuggets to Neutrinos*, was the featured presenter.

Back to School Supplemental Reading

Steven T. Mitchell: *Nuggets to Neutrinos: The Homestake Story*

Elizabeth Cook-Lynn: *New Indians, Old Wars; A Separate Country*

Paul Hedren: *Ho! For the Black Hills*

Jon Lauck: *The Lost Region: Toward a Revival of Midwestern History*

Merlyn Magner: *Come Into the Water: A Survivor's Story* (on the 1972 Rapid City flood)

Jane Rasmussen: *"Dear Unforgettable Brother": The Stavig Letters from Norway and America, 1881-1937*

Jerry Wilson: *Waiting for the Coyote's Call: An Eco-Memoir from the Missouri River Bluff*

Norma Wilson: *One Room Country School: South Dakota Stories*

All authors listed were presenters at the *South Dakota Festival of Books* in September 2013. All are South Dakota authors or write about South Dakota settings.

ENVIRONMENT, HEALTH & SAFETY



Back to School Backpack Safety

- Choose a lightweight backpack. Canvas packs weigh less than leather ones.
- Don't overload the backpack. It should weigh about 10 to 15 percent of your weight. Multiple compartments can help distribute the weight.
- Use both straps when wearing the backpack. A padded back will increase comfort and protect the back.

UPCOMING CONFERENCES AND WORKSHOPS

EUROCK 2013, ISRM International Symposium, Congress Centre, Wroclaw University of Technology, Wroclaw, Poland. September 21-26, 2013. Rock Mechanics for resources, energy, and environment.
<http://www.eurock2013.pwr.wroc.pl/index.php?id=0>

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>

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>



JOBS

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>

Faculty position, National Superconducting Cyclotron Lab, Michigan State University. Experimental Nuclear Science teaching/research position. Job number 7953. Deadline: 10/15/13.
fac_search2013@nscl.msu.edu
<http://www.nscl.msu.edu/ourlab/employment/1639>

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>

Assistant Professor, Rensselaer Polytechnic, Troy, NY. Tenure-track position in Experimental Particle/Nuclear Astrophysics researching double-beta decay, direct or indirect detection of dark matter. Deadline: 10/20/13. Joan Perras, perraj@rpi.edu
www.rpi.edu/dept/phys/faculty/searches.html

Staff/Assistant Research Scientist, Geobiology Logistics/Laboratory Manager, Desert Research Institute, Las Vegas. In Earth and Ecosystem Sciences, logistical support of NASA's new Life Underground Astrobiology Institute and Lab Manager for DRI's Environmental Microbiology Lab. Review starts 8/1/13 Job No: 0600133
<http://www.jobs.dri.edu>

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