

Dear SURF Readers,

Welcome to the November 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

December 6-9: MJD Collaboration meeting – Lead, SD

December 12-14: LZ Technical workshop – LBNL, Berkeley

First results from LUX

Last month, physicists from the Large Underground Xenon (LUX) dark-matter detector experiment announced first-run results after more than three months of operation at the Sanford Underground Research Facility (SURF). On October 30, at a media event at Sanford Lab, co-spokespersons Rick Gaitskell of Brown University and Dan McKinsey of Yale (shown in Figure 1), spoke on behalf of the LUX collaboration. South Dakota’s Governor Dennis Daugaard offered congratulations to the LUX researchers.



Figure 1: Dan McKinsey, left, and Rick Gaitskell pose on the top deck of the LUX experiment, 4850 feet underground

“LUX is blazing the path to illuminate the nature of dark matter. This is the best dark matter detector

result out there right now,” said Gaitskell. “This is only the beginning for LUX,” added McKinsey. “Now that we understand the instrument and its backgrounds, we will continue to take data, testing for more and more elusive candidates for dark matter.”

The report was picked up by over 50 media outlets around the world. Some of the reports are listed in SURF in the News on page 3. In the weeks following, for physicist specialists, LUX collaboration members followed with additional details at seminars held at various laboratories and universities. The LUX collaboration includes 17 research universities and national laboratories in the United States, Great Britain, and Portugal.

LUX, with the world’s most sensitive dark matter detector, was installed at SURF in the summer of 2012 (see Figures 2 and 3). It consists of a 6-foot high titanium tank filled with almost a third of a ton of liquid xenon, cooled to minus 150°F. Light detectors at the top and bottom of the tank (see Figures 4 and 5) detect photons produced in the xenon by charged particles.



Figure 2: LUX researchers, seen here in a clean room on the surface at the Sanford Lab, work on the interior of the detector before it is inserted into its titanium cryostat



Figure 3: The LUX dark matter detector suspended in its protective water tank. The detector is a titanium cryostat—that is, a vacuum thermos—that will keep xenon cool enough to remain a liquid, at about minus 150°F.

LUX finished its first dark matter search run at the 4850 Level in SURF this past summer. The run consisted of 85 live days of data collection. During the run, the experiment recorded more than 83 million particle interactions. Of those interactions, only 160 passed energy selection criteria and were identified as having taken place in the inner part of the detector, a virtual enclosure called the "fiducial volume" that has the lowest background activity. The surviving 160 interactions, or "events", are consistent with the background-only hypothesis of having no Weakly Interacting Massive Particle (WIMP) dark matter interactions throughout the 85-day exposure with a probability of 35%. The experiment's performance exceeded expectations with respect to its light detection efficiency (14%) and its low activity rate from background sources, which on average yielded a little fewer than 2 background particle interactions per day in the dark matter energy region of interest. For comparison, a human being produces about 10,000 nuclear decays every second, mostly from radioactive potassium-40 and carbon-14.



Figure 4: White Teflon lines the interior of the LUX detector, to better gather faint signals of light that will be recorded by the photomultiplier tubes (center).

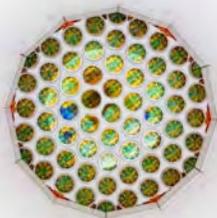


Figure 5: Close-up of photomultiplier tubes

The LUX results not only place the world's most stringent limits on the WIMP dark matter cross-sections (probability of interaction), but also rule out earlier hints of dark matter signals at low masses (<10 GeV) from at least four other experiments. LUX, having high sensitivity to photons, would have

expected to see more than 1500 nuclear recoils from dark matter interactions in the fiducial volume in 85 days to be consistent with the CDMS-II experiment's silicon result from earlier this year.

The LUX collaboration will continue calibrating the detector with greater precision and preparing for a 300-day dark matter search run (planned for 2014), which will increase the sensitivity to dark matter interactions by another factor of 5. If WIMP dark matter interaction rates are close to the current detection limits, LUX is poised to be the first to see them.

LUX has a peak sensitivity at a WIMP mass of 33 GeV/c² with a sensitivity limit three times greater than any previous experiment. LUX also has a sensitivity of more than 20 times greater than previous experiments of low-mass WIMPs.

Dark matter, so far observed only by its gravitational effects on galaxies and clusters of galaxies, is the predominant form of matter in the universe. WIMPs are the leading theoretical candidates for dark matter.

Planning for the next generation dark matter experiment at Sanford Lab is already underway. LUX-ZEPLIN (LZ) would have a 7-ton liquid xenon target inside the same 72,000-gallon tank of pure water used by LUX. LZ will be a thousand times more sensitive than the LUX detector.

Lawrence Berkeley Lab Physicist Kevin Lesko, who oversees Sanford Lab operations stated, "LUX's first result is a great reward for the Department of Energy's leadership of the Sanford Underground Research Facility." He also commended the collaborations and staff for their determination and hard work.



Kevin Lesko presents his question at this summer's Snowmass Community Summer Study meeting in Minneapolis (Courtesy of Symmetry Magazine)



In Memoriam - Alberto Lemut

--a message from Kevin Lesko

I have some extremely sad news to report this month. Our friend, colleague, and steadfast supporter Alberto Lemut passed on suddenly the morning of Thursday, 21 November. Alberto was a youthful 37 years old.

Alberto's consuming interest was nuclear astrophysics – understanding how the atomic elements are synthesized in stars. Alberto received his PhD in 2005 from Università degli Studi di Genova in his home country of Italy. From 2005 to 2009, he pursued postdoctoral studies at Genova, first at the University and then at INFN. Alberto joined the Nuclear Science Division at Lawrence Berkeley National Laboratory in 2009, working at the 88-inch cyclotron and continuing his studies in nuclear astrophysics. Early in the NSF-sponsored DUSEL process, we identified Alberto as an excellent spokesman for nuclear astrophysics. He served on the DUSEL team as the science liaison with the DIANA project, promoting an underground accelerator center to reproduce the conditions that take place in the center of stars and to measure in the laboratory the precise details of how most of the elements heavier than Lithium are created in the universe. Alberto was the perfect candidate for the job; he knew the science extremely well, having worked measuring several critical nuclear reactions at the Italian version of DIANA, called LUNA. In 2010, Alberto was promoted to project scientist at LBNL. He was the Principal Investigator for the DIANA group at LBNL, and worked with the accelerator physicists to design most of the hardware for the DIANA project. Alberto was at ease working with the physicists and the engineers. He was soft-spoken, but had an air of confidence and cooperation in all of his interactions with me over the years that we developed the Preliminary Design Report (PDR), to which he contributed very substantially to the science chapters.

We were thrilled when Alberto applied for and took a faculty position at the South Dakota School of Mines and Technology in August 2013. This was a good fit

for Alberto. He was a natural educator and an excellent scientist. The School of Mines is close to the Sanford Underground Research Facility – the future home of CASPAR and DIANA.

This winter please join me in looking up at the bright night stars, remembering Alberto and his drive to understand what powers those points of light, and wishing him peace and comfort.

Reports/Papers Available

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

The Economist: [Absence of evidence, or evidence of absence?](#) (October 31)

Scientific American: [Dark Matter Still Hiding: Latest Experimental Sweep Comes Up Empty](#) (Clara Moskowitz, October 30)

Wall Street Journal: [Underground Lab Yields Clues to Dark Matter](#) (Caroline Porter, 10/31)

BBC News: [LUX results: Dark matter hunt nears final phase](#) (Rebecca Morelle, October 30)

New York Times: [Dark Matter Experiment Has Found Nothing, Scientists Say Proudly](#) (Dennis Overbye, October 30)

The Times (UK): [Physicists left in the dark as matter goes undetected](#) (Hannah Devlin, 10/31)

LA Times: [LUX Dark matter detector finds no WIMPs, so why are scientists happy?](#) (Amina Khan, October 30)

Deutsche Welle: [Dark matter detector LUX fails to spot particles, still a success](#) (November 1)

Washington Post: [Physics experiment deep in abandoned gold mine fails to find any sign of elusive dark matter](#) (Associated Press, October 30)

Physics World.com: [LUX dark-matter search comes up empty](#) (Hamish Johnston, October 31)

The Register (UK): [Dark Matter](#) (Richard Chirgwin, October 31)

The Guardian (UK): [Dark matter stays hidden](#) (Ian Sample, October 30)

LBNL news: [Sanford Underground Lab Announces First Results from LUX](#) (October 31)
[First Results from LUX, the World's Most Sensitive Dark Matter Detector](#) (Paul Preuss, 10/30)

Physics.org: [First results from LUX dark matter detector](#) (October 30)

High Country News: [Cosmic Prospecting in Lead, South Dakota](#) (Marshall Swearingen, November 11)

Rapid City Journal: [Sanford lab officials say search for dark matter advances](#) (Tom Griffith, October 31)
[Search for dark matter](#) (Seth Borenstein, Chet Brokaw, October 30)
[Results of 1st research at Lead lab to be released](#) (Associated Press, October 25)

Black Hills Pioneer: [Shedding light on the darkness](#) (Adam Hurlburt, November 12)
[Dakota DeLUX](#) (Adam Hurlburt, October 31)
[Dark matters](#) (Adam Hurlburt, October 30)

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

The MJD experiment continues to add bricks for the lead shield that will surround its detector to block out radioactive backgrounds from the lab and the rock walls (see Figure 6). Vince Giuseppe, Assistant Professor of Physics at the University of South Carolina, is supervising the shield construction.



Figure 6: Stacked lead bricks will help shield the sensitive MJD experiment

Before the bricks enter the clean environment of the MJD lab, they undergo a rigorous cleaning, or etching. Research Technician Jared Thompson, of South Dakota School of Mines and Technology, says, "Basically, the etching removes the outer layer of the brick, which removes all but the most minute traces of radiation."

The etching begins with an acetic acid bath. Each brick is soaked for ten to fifteen minutes to remove debris. The bath is followed by two rinses in deionized water. In the next step, the bricks are placed in a nitric acid and hydrogen peroxide bath, also followed by two water rinses. The bricks are dried with a disposable cloth and isopropyl alcohol in the third step. Finally, each brick is bagged in succession in three plastic bags that are heat-sealed to keep out impurities.

Once underground, the plastic bags are removed one step at a time on their way to the MJD clean room (see Figure 7). One bag is removed in the cart wash, the second in the clean-room annex, and the third bag inside the clean room, just before the brick is added to the shield.



Figure 7: Josh Harris, Black Hills State University student, etches the lead bricks while BHSU Technician David Coleman dries them

Once completed, the lead shield will form a box 18 inches thick, as part of the overall 9-foot high detector structure. So far, 570 bricks are in place. Only 4630 more bricks to go!

Sanford Lab upgrades

Sanford Lab recently has had some server upgrades. They include a new cable management system, new power distribution units, power over Ethernet units, and Uninterruptable Power Supplies (UPS) (see Figure 8). The generator is located in the Yates Admin Building. Prior to this, Sanford Lab did not have a backup generator and the two small UPS systems protected only the servers, not the network gear. The UPS holds constant power so there will be no interruption in the power status, should a power failure occur.



Figure 8: Jason Rath, Facilities Tech in black shirt, and Industrial Electrician Warren Weller install cable for new electrical services in the server room. Note the open cabinet that houses the UPS.

Installation of the generator and UPS units began in July and was completed on October 23. The process included laying a concrete pad for the generator to rest, plumbing natural gas to the generator, running conduits to the transfer switch, installing new electrical panels and conductors, and

transferring the loads from the old panel to the new panel, one server at a time.

Tim Baumgartner, Director of Facilities Infrastructure, said that the upgrade will allow for future expansion of the IT systems.

EDUCATION AND OUTREACH

Outreach Activities

Sanford Lab participated in the South Dakota Indian Education Summit on September 29–October 1, interacting with many educators working in Indian country. In addition to an information booth, staffed by Cultural Diversity Coordinator KC Russell and Education and Outreach Deputy Director Peggy Norris, SURF Education and Outreach Director Ben Saylor gave an overview talk about Sanford Lab and its education and outreach program.

Education and Outreach staff participated in the program planning and presentations for two recent Girl Scout STEM events, one in Rapid City (155 girls) and one in Bismarck, South Dakota (30 girls). At the Rapid City event, a Halloween 'Ghouls Ball', Sanford Lab teamed up with Black Hills State University (BHSU). The BHSU effort was organized by Postdoctoral Researcher Brianna Mount.

Planning Activities

Planning is ongoing for the building and exhibits for the Sanford Lab Homestake Visitors Center (at the site of the current Homestake Visitors Center), as well as the renovation of the Jonas Science Building at BHSU, which will house a branch of the Sanford Science Education Center focused on teacher preparation. Construction of both facilities is planned to begin in May 2014.

As part of the planning process, Ben Saylor traveled to Albuquerque, New Mexico on October 20-23 to attend the annual conference of the Association of Science and Technology Centers and to visit four science centers in the region: the Explora Science Center, the New Mexico Museum of Natural History and Science, the National Museum of Nuclear Science and History (affiliated with Sandia National Laboratory), and the Bradbury Science Museum (affiliated with Los Alamos National Laboratory). The conference provided helpful advice about integrating current scientific research into the science center

setting and about communicating complex science to the general public. All four of the science education facilities that Ben visited have interesting design features and programs that are relevant in planning the Sanford Science Education Center. The Bradbury Science Museum at Los Alamos is an especially good example of a science-oriented visitor center that tells an interesting historical story and showcases current scientific research. Explora does an excellent job of involving scientists from nearby Sandia in developing tabletop displays that can be used both at the science center on special days and in surrounding schools.

Multimedia outreach

In mid-October, University of South Dakota graduate students Angela and Chris Chiller (shown in Figure 9) communicated via videoconference from the Sanford Lab Davis underground cavern with an audience attending an event sponsored by the Vermillion Rotary Club on the eastern side of South Dakota.



Figure 9: Angela and Chris Chiller discuss the hunt for dark matter to a Vermillion, SD audience from the Davis cavern

This presentation was part of an evolving multimedia program to connect people from remote locations directly to the science happening at Sanford Lab.

Other recent events include the LUX results webcast (October 30), and a noon luncheon hosted at the Surbeck Center at the South Dakota School of Mines and Technology (November 4).

FY2013 Statistics

The final numbers for the federal fiscal year 2013 (October 2012–September 2013) show that the SURF Education and Outreach Department reached a total of over 6100 students, educators, and science enthusiasts of all ages. This is an increase

of 10% from FY2012. The breakdown is given in the table in Figure 10. These numbers would not have been possible without our friends and partners at Sanford Lab, BHSU, the Lead Chamber of Commerce, and other institutions too numerous to mention. Special thanks are due the members of the LUX and MJD collaborations, who are always willing to pause their work and talk enthusiastically about the science they are pursuing.

	ONSITE	OFFSITE	VIDEOCONF*	
For K-12 Educators	98	299	17	414
For Informal Educators	48	219		267
For K-12 Students	498	1446	26	1970
For Undergraduate students	82	11		93
For Undergraduate faculty and staff	25	2	1	28
For Graduate students, faculty and scientists	27	30		57
For the General Public, Community, Service Groups	1198	828	1250	3276
Total	1976	2835	1294	6105

Figure 10: FY2013 Statistics

** Does not include onsite groups who participated in a videoconference to the underground as part of their visit (93 students and 41 educators)*

ENVIRONMENT, HEALTH & SAFETY



Holiday Safety

The holiday season can be a difficult time. If you are feeling depression, stress, or anxiety, please take care of yourself:

- Reach out to family, friends, and colleagues
- Seek the counsel of a priest, rabbi, or minister

- Do not be afraid to contact a therapist or mental health professional

Have a safe and happy Thanksgiving!

UPCOMING CONFERENCES AND WORKSHOPS

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>

Dark Matter 2014, UCLA's 11th Symposium on Sources and Detection of Dark Matter and Dark Energy in the Universe, February 26-28, 2014. Northwest Auditorium, Covel Commons, UCLA.
<https://hepconf.physics.ucla.edu/dm14/>

APS April meeting, Savannah, GA, April 5-8, 2014. Particle physicists, nuclear physicists, and astrophysicists will share new research and insights.
<http://www.aps.org/meetings/april/index.cfm>

Neutrino 2014, XXVI International Conference on Neutrino Physics and Astrophysics, Boston, MA, June 2-7, 2014.
<http://neutrino2014.bu.edu/neutrino-2014/>

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, and neutrino physics beyond the Standard Model.
<http://www.kitp.ucsb.edu/activities/dbdetails?acro=neutrinos14>



STAFF NEWS

Meet the new SURF Communications Director: Constance Walter.

Before going to college, Constance worked for many years in the restaurant industry, managing everything from fast food restaurants to hotel dining rooms to her own steak house. Somewhere in the mix, she became the food and beverage director for a restaurant that catered meals for the Far West River Boat in Bismarck, North Dakota. They took folks up and down the Missouri, often dropping them off at different sites downstream. The return trip took several hours and so, in the spirit of Mark Twain, she became an “apprentice” pilot. She never logged enough hours to become a pilot, but she wagers that she can still identify snags and hidden sand bars on the “Mighty Mo”.

Since then, she’s been an entertainment editor at the *Lincoln Journal Star* in Nebraska, communications director for the College of Engineering at the University of Nebraska, assistant director of the Peru State College Foundation in Peru, Nebraska, and director of university relations at Dickinson State University. Most recently, she operated her own marketing consulting firm, working with individuals and businesses, represented a regional entertainer, and produced concerts.

Walter has a BA in English (with a minor in communication arts—basically, theater) and an MS in Organizational Management. She loved her work at UNL because it brought her into contact with many really smart, creative, and innovative people who did some amazing research. She did a pretty good job promoting the research there and hopes that she can do as much for Sanford Lab.

“In all my many years of living, I’ve had the pleasure of working with people from all walks of life,” Connie says. “Most of them just want to be happy and do some good in the world. I like that. It gives me hope for the future of my four children and eight grandchildren.”

Favorite quote: *“Well-behaved women seldom make history.”* –Laurel Thatcher Ulrich, History Professor, Harvard University



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>

Assistant Professor, SUNY Albany, Particle Astrophysics. Tenure-track faculty position in particle astrophysics and cosmology. Deadline: 12/1/13. Jesse Ernst, physics@albany.edu <http://inspirehep.net/record/1261825>

Assistant Professor, Texas A&M University. Tenure-track position in experimental high energy physics or accelerator physics. Deadline: 1/1/14. Walker, facultysearch@physics.tamu.edu <http://inspirehep.net/record/1264576>

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>

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

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>

Postdoctoral position, University of Zurich. Research on XENON dark matter project. Deadline: 12/15/13. 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

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>

Newsletter Editor: Melissa Barclay
Contributors: Kevin Lesko; Connie Walter (Sanford Lab local news); Carlos H. Faham (First results from LUX); Peggy Norris, Ben Saylor (Education and Outreach)

Photo Credits: Figs. 1-5,8,9: Matt Kapust; Fig. 6: Vince Giuseppe; Fig. 7: Jared Thompson; Fig. 10: Education & Outreach

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