

Dear SURF Readers,

Welcome to the December 2014 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

January 27-29: LZ CD1 review – Berkeley, CA

February 27-March 1: MJD Collaboration meeting – Lead, SD

March 18-20: Low Radioactivity Techniques 2015 – University of Washington, Seattle

May 17-21: Conference on Underground Science - South Dakota School of Mines and Technology, Rapid City, SD

LUX Search for Dark Matter

LUX is searching for dark matter again. Already, on October 30, 2013, the LUX collaboration had released the result of its first dark matter search run. Based on 85 days of accumulated live statistics, it established a new world record for sensitivity to WIMP spin-independent interactions over a wide range of possible particle masses. In particular, it probed possible WIMP models at very low masses (below 10 GeV) by a factor x20 beyond existing sensitivities. By the end of 2014, this result had reached the highest echelon of most-cited HEP papers published for the year, garnering more than 500 citations as measured on the popular physics community database *inSPIRE*.

This result was based on fairly conservative assumptions about the response of the detector at very low energy. In the last quarter of 2013, LUX performed extremely precise calibrations of the detector response to both electronic recoils and nuclear recoils at low energy, using two innovative techniques: injection of tritiated methane as a source of low-energy betas for electronic recoils, and an

entirely new kinematic measurement of nuclear recoil energies from internal multiple scattering of neutrons provided by a D-D neutron generator. The analysis of this calibration data has allowed the collaboration to push its analysis threshold down, with preliminary performance presented at conferences in 2014. A re-analysis of the 2013 WIMP search data is currently being completed to take advantage of this new knowledge, and will be released publicly very soon. (See Figure 1.)



Figure 1: LUX scientists observe real time quality monitoring for the new WIMP search data coming in on December 11, 2014. From left to right: C. Ignarra (SLAC), J. Balahthy (UMD), T.J. Whitis (SLAC)

At SURF, LUX spent the first half of 2014 performing significant upgrades to the detector system for increased stability and performance. Data-taking has resumed since the summer, including runs to finalize the next dark matter run parameters, taking ultra high-statistics calibrations for both electron recoil and nuclear recoil responses, and preliminary dark matter search data for quality assessment. The LUX experiment has begun its new dark matter search in earnest. The collaboration expects to collect over 300 live days of WIMP search data, and make further calibrations, extending the running into mid-2016. They expect to be able to release new search results from these data in late 2016.

Search for Gravity Waves – Part I

Einstein's Theory of General Relativity predicts that gravitational waves travel across the universe at the speed of light. Understanding these waves would help scientists better understand the history of the universe. Researchers believe that gravitational waves exist: the Deep Underground Gravitational Laboratory (DUGL) is one of the experiments underway with the aim to test and prove this theory.

The DUGL experiment supports basic research in both gravitational-wave physics and seismology. For gravitational-wave physics, this experiment will provide background data to assess the feasibility of the future deployment of next generation gravitational-wave detection instruments underground. The low amplitude of ground motion (seismic noise) deep underground provides a unique environment for such an instrument. There are, however, large gaps in fundamental knowledge of the depth dependence of seismic noise in the frequency band of interest to gravitational-wave physics, which this array is expected to address. The experiment thus is also of great interest to seismology. In addition to fundamental work on the nature of seismic noise, the experiment will provide unprecedented new data on two fundamental problems in seismic wave propagation: (1) scattering seismic waves from the Earth's free surface, and (2) wave propagation in an anisotropic medium.

Vuk Mandic, Principal Investigator for DUGL and Professor of Physics at the University of Minnesota, said detecting gravitational waves is one of the highest priorities in astrophysics. "Understanding these waves would allow scientists to observe the universe entirely differently." The waves were created by the merging of neutron stars or black holes, through the collapse of stars, or perhaps when the Big Bang occurred.

Members of DUGL are currently deploying a unique three-dimensional seismic array at Sanford Lab and the surrounding area (see Figures 2-3).



Figure 2: A DUGL monitoring site on the 2000 Level of SURF



Figure 3: Jamey Tollefson, Industrial Technician, and Tanner Prestegard, University of Minnesota grad student, connect fiber optics for the seismometers on the 4850 Level

DUGL is a project supported by the National Science Foundation's *INtegrated Support Promoting Interdisciplinary Research and Education* (INSPIRE) program. With research taking place at Sanford Lab, DUGL consists of a collaboration among the University of Minnesota, California Institute of Technology, and Indiana University. --*To be continued*



Congratulations to Alan Poon

Alan Poon was recently selected as an American Physical Society (APS) Fellow. APS Fellows are elected by their peers for "exceptional contributions to the physics enterprise; e.g., outstanding physics research, important applications of physics, leadership in or service to physics, or significant contributions to physics education." Poon's selection was as cited, "For significant contributions to understanding fundamental neutrino properties through solar neutrinos, reactor neutrinos, beta decay, and neutrinoless double-beta decay experiments and for the resulting discoveries of physics requiring significant modification of the standard model." (Nominated by Division of Nuclear Physics)

Poon is the LBNL group leader for the MAJORANA Collaboration and the Karlsruhe TRitium Neutrino (KATRIN) collaboration. The MAJORANA Collaboration is constructing the DEMONSTRATOR (MJD), an array of germanium detectors, to search for neutrinoless double-beta decay of germanium-76 at SURF (see Page 3). The MJD was recently profiled in the October 8 edition of *Physics World*. Poon received his BSc (1991) and PhD

(1998) from the University of British Columbia; he has been a Staff Scientist at LBNL since 2001.

Reports/Papers Available

[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

Scientific American: [U.S. Particle Physics Program Aims for the Future](#) (Don Lincoln, November 25)

Phys.org: [SIMP v. WIMP: Novel thermal relic mechanism for dark matter creation in the early universe](#) (Stuart Dambrot, December 2)

National Geographic: [Week's Best Space Pictures: A Star Dies, Mars Cracks, and Neutrinos Are Born](#) (John Raoux, AP, November 14)

SDPB: [Deep Underground Cavity Lab Hunts Mystery Waves](#) (Charles Ray, December 4)

Keloland TV: [Researchers take on dark matter search again](#) (Associated Press, November 24) (also in *Argus Leader*, *The Washington Times*, *News OK*, *KDLT news*)

Rapid City Journal: [5 things to know about Daugaard's budget plan](#) (Staff, December 4) [Researchers take on dark matter search again](#) (Associated Press, November 25)

Black Hills Pioneer: [5 things to know on SD pieces in fed spending plan](#) (AP, December 11)

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



European Researchers' Night

Since 2005, Gran Sasso National Laboratory in L'Aquila, Italy has hosted *European Researchers' Night*. The event offers science activities, guided tours of the research labs normally closed to the public, interactive science shows, hands-on experiments, and various workshops. The event is shared by videoconferencing in more than 300 European cities. Matthias Junker, a scientist at Gran Sasso, said that an estimated 15,000 people attended the event.

This year on September 26, Sanford Lab joined in the videoconference. SURF Executive Director Mike Headley spoke to more than 150 people in L'Aquila, sharing news of the science taking place at SURF.

MAJORANA DEMONSTRATOR Update

The MAJORANA DEMONSTRATOR (MJD) experiment is composed of thousands of parts and pieces, including connectors, copper shields, and cryostats produced underground in order to minimize exposure to cosmic rays. In October, two sections of the cryostats (shown in Figure 4) were brought to the surface and driven 1200 miles from Lead to *Electron Beam Welding Associates* (EBWA) in Indianapolis for a special weld.



Figure 4: One of the cryostats used in MJD. The final e-beam weld is on the top side of the image, right before the crossarm tube goes into the big copper plate wall

Matthew Busch, R&D Engineer at Duke University / Triangle Universities Nuclear Laboratories drove the pieces to their destination. There, the hoop and crossarm sections underwent three high-quality welds using an electron beam (e-beam) welder, before being returned to Sanford Lab a week later.

The welds were done in a vacuum chamber, and no filler material was used in the weld. Only members of MJD touch the copper. "We load the material into the welder," said Busch. "When it cools, we pull it out, put it back in the box and drive it back to Sanford Lab."

Bringing the cryostat to the surface exposed it to higher levels of cosmic radiation. "The copper can be on the surface for a maximum of 60 days," Busch said. He is willing to drive the copper to Indiana to ensure that it remains in the hands of people who understand its value. He is usually accompanied by postdocs or grad students. So far, he has made the trip to Indianapolis three times (more on Busch's travels in a future SURF newsletter). The next scheduled trip will take place sometime in December. In the end, each cryostat will have undergone nine welds for a total of 18 welds.

CASPAR

The rehabilitation of the space for Compact Accelerator System Performing Astrophysical Research (CASPAR), including ground support and shotcrete, is being performed by the SDSTA hazard mitigation crew (see Figure 5). Shotcrete application began November 26, with expectations to be completed in early January. Researchers from University of Notre Dame (UND), South Dakota School of Mines and Technology (SDSMT), and Colorado School of Mines will soon collaborate on underground research, with CASPAR's low power accelerator allowing scientists to validate background radiation simulations.



Figure 5: Shotcrete will soon cover these rock walls to make the area safe for the CASPAR experiment. (SURF Photographer Matt Kapust used battery-powered LED light to illuminate the cavern over a long exposure.)

Safety at Sanford Lab

On Wednesday, November 12, Sanford Lab conducted a drill to evacuate the underground laboratory. Its purpose was to test the nine oxygen sensors at the Davis Campus.

Most of the experiments at Sanford Lab require the use of cryogenics, including liquid nitrogen, to purify workspaces and cool materials used in detectors. When liquid nitrogen is released rapidly in an enclosed space, it can replace oxygen, creating a hazard.

Over time, sensors can drift up to a half of a percent yearly. "We regularly calibrate oxygen sensors to ensure they are operating as they should," said Jaret Heise, SURF Science Liaison Director. "More importantly, we want to ensure personnel are safe."

If oxygen levels reach 19.5 percent, a local alarm broadcasts within earshot, said Dana Byram, SURF Experiment Support Scientist (shown in Figure 6). At 18 percent oxygen, a facility alarm would alert staff to evacuate the area.

Sanford Lab also conducts bi-weekly drills designed to walk people through the correct action in case of emergency.



Figure 6: Left: Facilities Tech Shane Heydon prepares oxygen sensor in the MJD liquid nitrogen alcove for calibration; Right: Dana Byram uses a handheld gas tester to check oxygen concentration of calibration gas



Info on Travel to Lead

Construction on Deadwood's Highway 85 began in November with an anticipated completion date of September 2016. Expect closures and delays

throughout this time period. You are encouraged to take the Central City route to and from Sanford Lab instead of Highway 85.

EDUCATION AND OUTREACH

SDSMT Women in Science and Engineering (WISE)

Ten undergraduates and two faculty members from the SDSMT WISE organization made a trip underground on December 2 to tour the Davis Campus and its environs with SURF E&O Deputy Director Peggy Norris. The students are studying in various majors including physics, geology, industrial hygiene, and several disciplines of engineering. The group went down on the lunchtime cage at the Davis Campus and met with scientists and graduate students over a pizza lunch. They then toured the LUX experiment with LBNL Staff Scientist Vic Gehman and learned about the MJD experiment with SDSMT Chemistry Instructor Cabot-Ann Christofferson. After talking about the importance of an ultraclean environment for the experiment, the students took measurements of particulates in and around the Davis Campus. Finally, cage operator Ricky Allen took them for a ride on the *man car* down a *drift*. Overall, the day gave the students an appreciation for the complexity of operation of the Sanford Underground Research Facility, and the multiple engineering and science disciplines necessary to make it a success. Additional students will tour in January.

Black Hills Area Home School Educators

On December 12, the largest and most diverse group visited Sanford Lab thus far (aside from Neutrino Day). *Black Hills Area Home School Educators*, a home school cooperative, brought almost 50 students and 27 parents to the event from within a hundred mile radius to spend 4.5 hours at the Lab (see Figures 7-8). Students ranged in age from four to seventeen, with the largest group at ages 9-11. To make the event possible, Education and Outreach staff--Tom Campbell, Julie Dahl, Peggy Norris, Bree Reynolds, and Ben Sayler--were supplemented by the Science Department's custodian Robyn Varland and, from underground, SURF Experiment Support Specialist Dana Byram.



Figure 7: A young scientist looks at the world through diffraction glasses

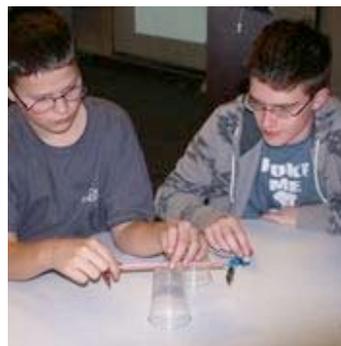


Figure 8: Older students make a spinning compass as a model of how accelerators work

Before lunch, the younger students took part in two hands-on workshops. The first, *Properties of Matter* (Ben, Bree, Julie, and Robyn), introduced students to light and magnetism. The second, *Earth and Space* (Bree, Tom, and Robyn), introduced them to some astronomy. Students had fun with activities that Bree and Tom have been piloting with younger students in after-school programs in Lead-Deadwood and Spearfish.

Meanwhile, the older students participated in a hoist room tour (Ben, Julie, and Tom) and a *Neutrino and Dark Matter* workshop with Peggy. During the workshop, they played the Nucleosynthesis Game (adapted from the *Joint Institute of Nuclear Astrophysics*), which introduced them to isotopes and nuclear decay, talked about the Ray Davis experiment and searches for dark matter, and explored natural radioactivity.

All except the very youngest students participated in the videoconference to the Davis Campus. Dana Byram showed them LUX and the MJD Assembly area, and answered many questions about science at SURF and about working underground.

After lunch, students participated in one more workshop. For the older students, Ben, with help from Peggy, Tom, and Robyn, led activities with permanent and electro-magnets and talked about the Long-Baseline Neutrino Experiment. Julie and Bree did some engineering design activities with the younger students, including building a tower out of spaghetti.



Cultural Diversity

KC Russell works with SURF's Education and Outreach Department as Cultural Diversity Coordinator/Liaison. In this role, he assists Human Resources in promoting diversity and works with South Dakota tribes to develop opportunities in science. He also is the National Environmental Policy Act Coordinator, consulting with the Long-Baseline Neutrino Experiment.

Prior to coming to Sanford Lab, KC Russell served in the military for 38 years (seven in active duty, 13 in the South Dakota National Guard, and 18 as a senior Army instructor). He spent 36 years as Director of Indian Health in a four-state region, served as Senior Policy Advisor to former South Dakota Governor Mike Rounds, and was the National Tribal Liaison with FEMA.

As a Lower Brule (Kul Wacasa) Tribal Member, KC makes it clear that although he consults on projects and issues that affect Native Peoples, he does not speak for everyone. "I don't speak for any ethnic group," Russell said. "I just talk to people and share what I know."

He loves working at Sanford Lab and appreciates the consideration given to Native cultures. For example, the Black Hills, called Paha Sapa, is sacred to many tribes. Sanford Lab volunteered to keep all rock removed from the underground in the Black Hills. "They didn't have to do that. It shows respect for the sacredness of the land."

Russell is involved in the wider community, serving as a Veterans' Commissioner. He and his wife Diane, married for 44 years, have three children and five grandchildren. He also likes to hunt and fish with family and friends, who eat everything they catch.

Summer Internships

Applications are being accepted for Dave Bozied and Chris Bauer Engineering Internships. Contact: Peggy Norris, SURF Deputy Director for Education and Outreach, PNorris@sanfordlab.org, (605-722-5049). Deadline: January 9, 2015.

ENVIRONMENT, HEALTH & SAFETY

EHSOC meeting

The Environmental Health and Safety Oversight Committee (EHSOC) made one of their periodic visits to SURF on November 4-6 to review Sanford Lab's safety program. "They spent most of their time talking to staff," said SURF EHS Director Noel Schroeder. Schroeder said EHSOC was pleased with what they saw at Sanford Lab. "They were impressed with the changes we've made since their last visit such as advancements in how we do work planning. They were also pleased to see that our staff are very engaged in the safety process."

As advisory board for Sanford Lab, EHSOC includes safety professionals from Fermilab, LBNL, SLAC, and the University of Pittsburgh. The purpose of their visit was to better understand the safety culture at Sanford Lab and to offer guidance where needed.

"The committee's feedback was very helpful," said SURF Lab Director Mike Headley. "It provides us additional guidance to shape our safety program improvement plans."



Holiday Safety

- Eat healthy: include fruit and fruit drinks in your holiday party menu
- Keep holiday items out of reach of your pets: poinsettia, holly, mistletoe, tinsel, electric cords.

- Manage stress: reach out to friends, share tasks with family members, take a walk, listen to soothing music, get plenty of sleep.
- Travel safely: be aware of weather changes, buckle up, don't drink and drive.

**** Happy Holidays! ****

UPCOMING CONFERENCES AND WORKSHOPS

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>

APS Conferences for Undergraduate Women in Physics (CuWiP). January 16-18, 2015. Three-day regional conferences held in various locations.
<http://www.aps.org/programs/women/workshops/cuwip.cfm>

2015 Physics Teacher Education Conference. February 6-8, 2015, Seattle.
<http://www.aps.org/meetings/meeting.cfm?name=PTEC15>

8th CERN Latin-American School of High Energy Physics, Ecuador, March 4-7, 2015. Targeted particularly for students in experimental HEP who are in the final years of work toward their PhD.
<http://physicschool.web.cern.ch/PhysicSchool/CLASHEP/CLASHEP2015/default.html>

Seventh International Conference on Quarks and Nuclear Physics, Chile, March 2-6, 2015. Topics will include quarks and gluons content of nucleons and nuclei, hadron spectroscopy, effective field theories, nuclear matter under extreme conditions.
<http://indico.cern.ch/event/304663/>

LRT Workshop V (Low Radioactivity Techniques) University of Washington, Seattle, March 18-20, 2015. Topics include dark matter, solar neutrinos, double-beta decay, and long half-life phenomena.
<http://lrt2015.npl.washington.edu>



JOBS

Faculty positions, Queen's University. Canada Research Chair in Theoretical Particle Astrophysics, and Assistant Professor in Experimental Particle Astrophysics. Deadline: 2/15/15.
<http://www.queensu.ca/physics/canada-research-chair-theoretical-particle-astrophysics>
<http://www.queensu.ca/physics/tenure-track-position-experimental-particle-astrophysics>

Postdoctoral Research Associate, Stony Brook University. Openings in Nucleon decay and Neutrino group. Contact: Chang Kee Jung, chang.jung@stonybrook.edu, Clark McGrew, clark.mcgrew@stonybrook.edu. Deadline: 1/15/15. Send CV, research statement, 3 letters of reference: Charise Kelly, cckelly@sbhep.physics.sunysb.edu

Tenure-track faculty positions, South Dakota School of Mines and Technology. Undergraduate/graduate teaching and research in geophysics. Review begins 1/12/15. Contact: Larry Stetler, larry.stetler@sdsmt.edu
<http://www.sdsmt.edu/employment>

Postdoctoral Researcher, SDSMT. Work in Experimental Underground Physics as part of the Cryogenic Dark Matter Search (SuperCDMS), AARM, and LZ collaborations. Richard Schnee, Richard.Schnee@sdsmt.edu
<https://inspirehep.net/record/1315388>

Postdoctoral positions, University of Washington. Work in Experimental Particle-Astrophysics with the ADMX experiment. Leslie Rosenberg, lrosenberg@phys.washington.edu
<https://sharepoint.washington.edu/phys/admin/Pages/View-Position.aspx?pid=41>

Assistant Professor positions, UC San Diego. 1: Experimental particle physics (direct or indirect Dark Matter detection, Neutrino Physics, and experimental Cosmology); 2: open to all research areas in Physics. Deadline: 12/31/14.
<https://apol-recruit.ucsd.edu/apply/JPF00674>
<https://apol-recruit.ucsd.edu/apply/JPF00681>

Postdoctoral Associate, Yale. Research in short and long baseline oscillation experiments underway at Fermilab including MicroBooNE, LAr1-ND,

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LArIAT, and LBNE. Deadline: 12/31/14. Bonnie Fleming, bonnie.fleming@yale.edu
<https://academicjobsonline.org/ajo/jobs/4664>

Faculty position, Rice University. Teaching and research in Astroparticle Physics/Cosmology. Deadline: 1/12/15. Contact: umbe@rice.edu or M. Baring, Dept. of Physics/ Astronomy, MS 108, Rice University, Houston, TX 77005
inspirehep.net/record/131942965

Postdoctoral position, Texas A&M University. Work on SuperCDMS at SNOLab. Opportunities in detector development, cryogenic testing, data analysis, and research project management. mahapatra@physics.tamu.edu
<https://physics.tamu.edu/about/openpositions.shtml>

Postdoctoral researcher, University at Albany, SUNY. Research in direct WIMP detection, work on data analysis, travel to Lead, SD, gaining hands-on expertise on LUX/LZ. Deadline: 2/1/15. Matthew Szydagis mszydagis@albany.edu
<http://albany.interviewexchange.com/jobofferdetails.jsp;jsessionid=C639453CC99065905F7F634461A5BAAB?JOBID=51419>

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>

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