

Dear SURF Readers,

Welcome to the March 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 new 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

**April 3-6: MAJORANA (MJD) collaboration meeting
– Lead, South Dakota**

**April 19-20: LUX Collaboration meeting – Lead,
South Dakota**

LUX Fills its Detector – Part II

For the past few months, researchers at Case Western Reserve University (CWRU) in Cleveland, Ohio have been working in concert with their LUX collaboration colleagues at the University of Maryland on a process to cleanse xenon gas of its krypton impurity for the LUX detector now operating at SURF's 4850 Level Davis Campus.

CWRU Physics Professor Dan Akerib and colleagues, including graduate student Chang Lee, set up the method by which to remove krypton, following a careful process, drop by drop, using about 60 kilograms of charcoal in a column slightly shorter than the 6.5-foot high LUX detector.

The LUX experiment uses 370kg of xenon as a target to detect dark matter particles known as WIMPs. The xenon has to be free of krypton at the level of one part per trillion. The usual "off-the-shelf" xenon gas might contain as much as 100 parts per billion, much more of an impurity than the sensitive LUX detector can tolerate. Both xenon and krypton are collected as byproducts when liquefying air to separate oxygen and nitrogen in a cryogenic distillation column. Liquid oxygen is mainly produced on an industrial scale for steel manufacture. Because both xenon and krypton are very inert, it is

difficult to separate them through standard chemical reactions. Subsequent distillation can separate krypton and xenon by their slightly different boiling temperatures. Beginning from 1:10 Kr / Xe mixture, distillation can produce xenon that contains only one krypton per hundred billion xenon molecules: it is sold as research-grade xenon.

While this is impressive separation, that xenon is still hardly clean enough for LUX. To avoid overwhelming the dark matter signal, the krypton level in xenon has to be lowered by another fifty thousand. To meet this goal, the LUX group at CWRU built a system to process xenon further down to "dark matter" grade.

Their method was "adsorption chromatography". "Chromo" means "color" in Greek. The name came from the early use of the technique to separate colored pigments from plants. A common example is the spreading of marker ink on paper on rainy days. As the water soaks into the paper, it moves, carrying the pigments inside the ink. Because each pigment sticks to the paper with different strength, the distances they are carried varies, which results in a set of distinct bands (examples are shown in Figure 1). The same principle is used very widely in chemistry and biology to separate different species of gas or segments of DNA.

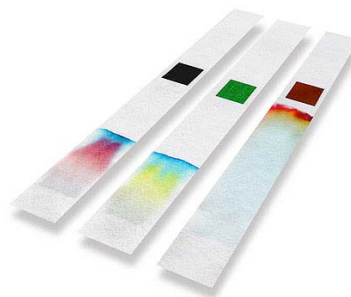


Figure 1: Examples of paper chromatography show the separation of color dyes, carried by water that moves through wicking action in the fibers of the paper

In their "Krypton Removal" system (shown in Figure 2) at CWRU, charcoal and helium were used to separate xenon and krypton. Charcoal has a great deal of surface area and is lightly conductive. That allows polarizable atoms, e.g. xenon and krypton, to stick to it with different "stickiness". However, these bonds are tenuous, so that a wind of helium pumped through a charcoal column will separate the different species. Krypton makes the weaker bond and it travels through the charcoal column faster than

xenon, which being a bigger atom bonds more strongly, and exits the column later.

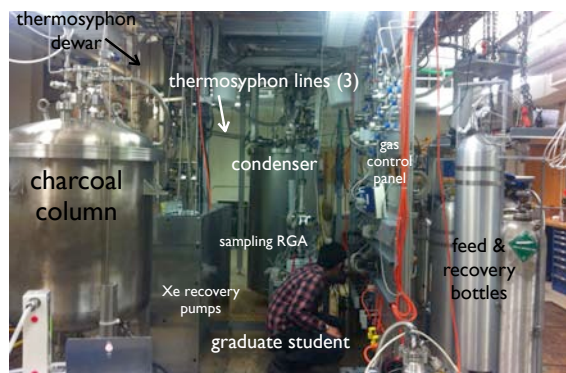


Figure 2: The krypton removal system at Case Western with all of the key elements highlighted (including one of the authors!)

The principle is simple, but the implementation is not. Complex sets of gas panels, vessels, tubes, cryogenic condensers, liquid nitrogen thermosyphons, and pumps were designed, purchased, built, and installed by the team at CWRU. Researchers recorded data from various test runs in which the xenon amount and feed rate were varied, as was the helium flow rate and pressure. Eventually, the group arrived at a suitable set of operating parameters, which were programmed into an automated control program so that the system could operate around the clock without human intervention for days at a time.

They began construction in the summer of 2011 but it took almost a year before they were able to begin full-scale test runs. Benchmarking followed on the heels of construction. A mixture of xenon with 1% krypton was used so that both gases would be visible to the test equipment. As they developed the process, LUX collaborators at the University of Maryland (UMD) led by Carter Hall assayed samples from the CWRU runs. The UMD team had developed a technique that was remarkably sensitive to trace gases in xenon – with a single liter of the CWRU output xenon, the researchers at UMD could measure down to a part per trillion of krypton, which is perfectly suited to the LUX goal. After the UMD team confirmed that the xenon was clean enough, the CWRU group attempted to go into steady running.

With 400 kilograms to process, and the experiment schedule bearing down, production was a complicated mixture of joy and sorrow, under

constant time pressure. The system seemed to run smoothly initially, yet the krypton level in the product went up gradually. CWRU researchers discovered that the “raw” source xenon was contaminating the product xenon through a leaky crossover valve. In another case, oil inside a booster pump broke out of its chamber and destroyed two pumps. The final challenge was the mysterious death of heaters inside the cryogenic condenser. The condenser, which is used to freeze the purified xenon to separate it from the helium carrier gas, needs to be heated at the end of a batch so that the solid xenon ice is melted and can be recovered into a clean storage bottle. It took the CWRU team a while to realize that this required the xenon to pass through the low-pressure regime where the 115 Volts powering the heaters would break down and arc.

The entire process involved days of constant challenges and hard work. By the middle of January, CWRU researchers heard from UMD that the last production batch was at spec. The bottles were picked up from Cleveland the very next day, and arrived at SURF a week later. Now, all that xenon lives inside the LUX detector, clean and cold, just as pure as it should be.

Kevin Lesko in Korea

Kevin Lesko, Head of SURF Operations, was an invited speaker for the first symposium of the Institute for Basic Science held at Ewha Womans University in Seoul, South Korea on March 18. Dr. Lesko spoke to *The Symposium on Particle Physics with Underground Experiments* on “Underground Facilities”. Other speakers for this session included Steve Elliot of Los Alamos National Lab, Young-Kee Kim from Fermilab/University of Chicago, and Laura Baudis from University of Zurich. The entire symposium, which covered a broad range of scientific topics, took place over five weeks from February 14 to March 21.

Reports/Papers Available

Paper: [“The Large Underground Xenon \(LUX\) Experiment”](#) has been published in *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, Vol. 704, 11 March 2013, pp. 111–126.

The second in the series of SURF Newsletter Supplement articles, “The MAJORANA

DEMONSTRATOR Project at the 4850 Level Davis Campus” is available at:
<http://www.sanfordlab.org/lbnl/1198>

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

New York Times: [Particle Physicists in U.S. Worry About Being Left Behind](#) (Dennis Overbye, March 4)

Nature.com: [Dark-matter hunt gets deep](#) (Eugenie Samuel Reich, February 21)

Symmetry.com: [Long-Baseline Neutrino Experiment](#) (Kurt Riesselmann, February 14)

LBNL news: [In the Black Hills, Heinemann Tells the Story of the Higgs](#) (Today at Berkeley Lab, February 22)

LiveScience.com: [Scientists Hunt Weird Antimatter Beneath Earth](#) (Tia Ghose, March 13)

Capital Journal (Pierre, SD): (with Allison Jarrell):
[Finding Dark Matter](#) (February 22)
[Mining bright metal](#) (February 22)
[Homestake project shows the importance of research](#) (Editorial, February 22)

KDLT News: [Shedding Some Light On Dark Matter](#) (Jeff Rusack, March 4)

KNBN Newscenter 1: [Local Construction company Receives National Award](#) (March 13)

Native Sun News: [Energy Department Requests Tribal Comments](#) (Talli Nauman, March 4)

Argus Leader (Sioux Falls): [S.D. lab unlikely to lose funding](#) (Steve Young, March 4)

Rapid City Journal: [Construction award](#) (March 17)
[Lead physicist to dish details on hunt for mysterious particles](#) (March 13)

[BHSU photographer professor honored with Distinguished Faculty Award](#) (March 9)

Black Hills Pioneer: [Innovations inspire high school girls to become next generation of female innovators, change the world through STEM](#) (BHP staff, March 4)

DURA Annual meeting

The annual DURA meeting was held on March 5 at SLAC in Palo Alto, followed by the *Cosmic Frontier Meeting and Workshop* on March 6-8. Sixty-five people attended the DURA meeting, in addition to ten who joined by teleconference. The meeting showcased important scientific questions being addressed by researchers at underground labs. The meeting also helped to promote communication between the various groups and organizations involved in U.S. underground science.

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

During the last week of February, members of the MJD collaboration, including MAJORANA Principal Investigator Professor John Wilkerson (University of North Carolina) and Physicist Brandon White (Oak Ridge National Lab), went underground to the MAJORANA lab to test the electronic performance of their first batch of enriched germanium. Five germanium detector crystals had been delivered to the Davis Campus 4850 Level at Sanford Lab earlier in February. Each detector was individually packaged in a cylindrical stainless steel transport cryostat. Wilkerson (shown in Figure 3) reported that the testing indicated the detectors are in good working order. MAJORANA will eventually use about 40 kilograms of germanium crystals in their search for neutrinoless double-beta decay.



Figure 3: John Wilkerson (left) adjusts a transport cryostat in the MJD Lab; Brandon White monitors electronic signals



Figure 4: Electronic signals from a germanium detector

Ross Shaft Construction Update

Construction crews have been replacing steel in the Ross Shaft since August 2012. Eventually, they will replace all the steel in the 5000-foot shaft, a process expected to take several years. At this point, they have refurbished 464 feet of the shaft, down to the 300 Level. Foreman George Vandine has been supervising four crews of four, plus two toplanders - working 12-hour shifts, seven days a week.



Figure 5: The Ross Shaft as seen from the station at the 300 Level. Suspended at the upper corner, is a blue Sky Climber lift.

Early work in the Ross Shaft included start-up tasks, where crews installed new work decks in the cage and north skip compartments, as well as two small cranes and a Sky Climber® ascender (shown in Figure 5), a type of suspended scaffolding.

Safety at Sanford Lab

Senior Safety Specialist Jaime Hopmeier, who began working at Sanford Lab in January, has been preparing an employee Safety sheet called *Safety Loop*. Each sheet focuses on a different aspect of safety at Sanford Lab. Here are a few safety tips on how to prevent overexertion injuries:

One solution is to become better fit for work. Athletes train to improve their skill, strength, and flexibility. They warm up before performing strenuous actions. Athletes also personally benefit from training, and you can too. Study after study has shown that increased physical fitness can lead to a better quality of life—in and out of the workplace.

If your job is physically demanding, stretch and warm up first. Cold muscles and soft tissue are vulnerable to injury. Slow down and pay attention. Slowly build up to your required pace. Watch for your body's warning signs such as pain, discomfort or pressure. Frequent regular breaks for exercise (shown in Figure 6) can reduce fatigue and prevent repetitive motion injuries.



Figure 6: Hopmeier demonstrates on a rowing machine in the Yates Hoist Room, installed for hoist operators who sit at their hoist controls for 12-hour shifts

EDUCATION AND OUTREACH

Recent Activities:

K-12 Outreach

The Belle Fourche Middle School Eighth grade Science and Math Club visited Sanford Lab on March 1. Students received an overview talk, took part in a workshop on radiation, and toured the Hoist Room. The Pennington County 4H club also visited Sanford Lab on March 9, where a mixture of students and adults participated in the *Move the Lux* engineering challenge and toured the Hoist Room.

The Quarknet Center at Black Hills State University (BHSU), under the direction of Kara Keeter, held a master class for high school students on March 12 at the university in Spearfish, South Dakota. Four Quarknet teachers brought 26 students to analyze data from the ATLAS experiment at the Large Hadron Collider at CERN. Joining the South Dakota Quarknet teachers were two teachers and several students from Newcastle, Wyoming. An additional master class will be held on March 23.

Nuclear Science Education

Nuclear Data 2013, an international conference focused on applications of nuclear science, included two sessions on nuclear science education as part of its tri-annual meeting, which was held in New York City on March 4-8. Peggy Norris, SURF Education and Outreach Deputy Director, gave an invited talk on the South Dakota Davis-Bahcall Scholars program and other efforts to attract high-achieving STEM (science, technology, engineering, and math) students to careers in nuclear and particle physics. Other speakers presented surveys on the public perception of nuclear science in South Africa and Austria, and education research into students' understanding and misconceptions in the areas of radiation, radioactivity and its benefits and risks. The latter included a talk by Andy Johnson of BHSU, who has been teaching a non-science major course on radiation and testing student understanding. Another talk examined women graduate students and their varied paths into physics and astronomy. The conference sessions provided an excellent opportunity to find out what tools and best practices have been achieved in nuclear science education around the world.

Public Talks

Physicist Jose Alonso gave a talk "Switzerland to South Dakota: parallels in front-line physics" on March 14 at the Adoba Eco Hotel for the Rapid City Rotary Club. He spoke about research at the Large Hadron Collider (LHC) at CERN and Sanford Lab, outlining his own work with his colleagues at the LHC. Alonso was Director of the Sanford Lab from 2007 to 2009, and experienced a 30-year career at Lawrence Berkeley National Lab.

LUX physicist Luiz de Viveiros (shown in Figure 7) of the LIP-Coimbra Lab in Portugal spoke to 120 Rotarians in Sioux Falls by videoconference from

the Sanford Lab 4850 Level on March 4. He described the LUX experiment and answered audience questions. SURF Multimedia Specialist Matt Kapust directed the event from Lead, while SDSTA Executive Director Ron Wheeler and Communications Director Bill Harlan were on site at the City Centre Holiday Inn in Sioux Falls to present photos, graphics, and time-lapse videos. Sanford Lab plans to host a similar event with underground scientists in Aberdeen, South Dakota on April 8.



Figure 7: Luiz de Viveiros speaks by videoconference to Sioux Falls Rotary Club

Upcoming Events:

Brown Bag Seminars

A brown bag seminar will take place at 11:30 am on Wednesday, March 27, in the Sanford Lab Yates Education Building Conference Room. The speaker will be Sarah Carlson, Executive Director of the Historic Homestake Opera House in Lead, South Dakota. The 99-year-old performing arts venue, conceived by philanthropist Phoebe Apperson Hearst, with the help of Thomas J. Grier, Superintendent of Homestake Mining Company, hosts community theater, concerts, receptions, weddings, and public presentations. In the past, the building housed a bowling alley, swimming pool, men's lounge, billiard hall, card and social rooms, and a 1,000-seat theater. Come learn more about the building's history and plans for the future. Pizza will be provided by the Pizza Lab in Central City for those who RSVP by March 26 to Julie.Dahl@bhsu.edu.

Public Events

The artist Joe Davis will be on the campus of SDSMT during the first week of April to do an installation in the Apex Gallery. Davis is an artist in the biology department at MIT, and will be featured in the April 2013 issue of *Discover* magazine. The

gallery installation for the Apex is a prototype for one that will be installed in an atrium of Harvard Medical School.

During his visit, there will be a screening of the independent documentary film entitled: *Heaven and Earth and Joe David*: (<http://joedavisthemovie.com/>). The screening will take place at the Dahl Arts Center's John T. Vucurevich Event Center in Rapid City on April 3 at 6 pm.

ENVIRONMENT, HEALTH & SAFETY



Spring Garden Safety

- Wear proper safety apparel: long pants, long-sleeved shirts, heavy gloves, sturdy shoes with rubber soles, and eye protection. Avoid wearing clothes that might get caught in moving parts such as jewelry or long scarves.
- Protect your back and muscles: start the weeding and pruning slowly, take 5 to 10 minute breaks, bend from the knees to lift heavy objects, and stand upright when raking or hoeing.
- Plants toxic to dogs, cats or rabbits: azalea, lily, ferns, foxglove, hyacinth, lily of the valley, iris, rhododendron, crocus, and tulips. Check out the [Pet HealthZone toxic plant chart](#).

If you are visiting South Dakota, contact (605) 722-0002 for road closure and weather information.

STAFF NEWS

Wendy Zawada, Science Integration Engineer, joined the SURF (DUSEL) project in July 2009, and transferred into the Science department about two years ago. She has accepted a position at *OC/ Chemical* as mine engineering supervisor in Green River, Wyoming, and her last day at SURF was March 15. Thanks to Wendy for all her hard work on the SURF and DUSEL project and all best wishes to Wendy in this next phase of her career.

Connie Giroux, Science Liaison Laboratory Supervisor, will be leaving Sanford Lab on March 29 to take a job as environmental safety specialist and safety officer with the Indian Health Service in

Bemidji, Minnesota. Connie joined Sanford Lab in 2008 and transferred into the Science Department in June 2009. As a Rosebud Sioux tribal member, Connie has served as a wonderful role model for young people in South Dakota. Thanks to Connie for her dedication to the project, and all the best for the future.



Figure 8: Connie Giroux (middle) and Wendy Zawada (right) at Sanford Lab

Tim Baumgartner joined the SURF Staff on February 19 as Director of the Facility Infrastructure Department. He will oversee Facility Maintenance, Surface Operations, and the electrical-cyberinfrastructure group, leading the latter. Baumgartner worked at Homestake when it was still a mine, as his family had a contract at the water treatment plant. His underground experience also includes work as an underground electrical planner for *Barrick Gold Corp.* in Nevada.

Mark Hanhardt, who received his Master's degree in Physics from South Dakota School of Mines and Technology a few years ago, will be working at SURF as Experiment Support Scientist. While in grad school, he was a member of the LUX collaboration, before working as an experiment support scientist at the Soudan Underground Lab in Minnesota.



Figure 9: Left to Right: Bryan Silvermail, Tim Baumgartner, and Mark Hanhardt



Andrew Brosnahan joins SURF as a Junior Facility Engineer. Previously, he worked summers at Sanford Lab while pursuing an engineering degree from South Dakota School of Mines and Technology. He has also worked at *RESPEC Consulting* in Rapid City.

UPCOMING CONFERENCES AND WORKSHOPS

Workshop in Low Radioactivity Techniques, Laboratori Nazionali del Gran Sasso (LNGS), Italy. April 10-12, 2013. The workshop will examine topics in low radioactivity materials and techniques, and aspects of the development of low background detectors and techniques.
<http://lrt2013.lngs.infn.it>

APS April meeting, Sheraton Denver Downtown Hotel, Denver, Colorado, April 13-16, 2013. Includes Neutrino session on April 15. Particle physicists, nuclear physicists, and astrophysicists will share new results and insights.
<http://www.aps.org/meetings/april/>

Intensity Frontier Workshop, Argonne National Lab, April 25-27, 2013. The Intensity Frontier working group will be holding an all-hands workshop as part of the ongoing 2013 Community Summer Study ("Snowmass").
<https://indico.fnal.gov/conferenceDisplay.py?confId=6248>

INPAC/MRPI General Meeting - New Directions in Nuclear/Particle Astrophysics and Cosmology, Asilomar Conference Grounds, Pacific Grove, CA, April 26-28, 2013. <http://cosmology.berkeley.edu/inpac-mrpi/Main/INPAC-MRPI>

International Symposium: Opportunities in Underground Physics for Snowmass (ISOUP13), Asilomar Conference Grounds, Pacific Grove, CA. May 24-27, 2013.
<http://neutrino.physics.ucdavis.edu/indico/conferenceDisplay.py?ovw=True&confId=0>

SINOROCK Third Symposium, Tongji University, Shanghai, China. June 13-16, 2013. A URL workshop will be held on June 12.
<http://www.sinorock2013.org>

ARMA, 47th US Rock Mechanics/Geomechanics Symposium, Westin San Francisco Market Street, San Francisco, CA. June 23-26, 2013.
<http://armasyposium.org/>

CETUP* workshop, Lead/Deadwood Middle School, Lead, South Dakota. June 24-July 26, 2013. The CETUP* 2013 workshop will address questions in physics, astrophysics, geosciences, and geomicrobiology.
<http://www.dsu.edu/research/cetup/index.aspx>

Community Summer Study 2013 (SNOWMASS on the Mississippi). Minneapolis, MN, July 29-August 6, 2013. Sessions on five particle physics frontiers: cosmic energy, facilities, instrumentation, and intensity.
<http://www.snowmass2013.org>

DPF 2013, APS Division of Particles and Fields Meeting, UCSC, Santa Cruz, CA. August 13-17, 2013.
<http://www.aps.org/units/dpf/meetings/meeting.cfm?name=DPF13>

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>

Underground Science Experiments & Research Seminars (USERS) continue bi-weekly on Thursdays, 1:30-2:30 PM. Alternate sessions will be held at LBNL and UC Berkeley, 325 Old LeConte Hall. If you are interested in attending these seminars please subscribe to this email list for future announcements:
<http://dusel.org/mailman/listinfo/ugsseminars>



JOBS

PhD Graduate Research Assistant in Deep Life Study, DRI Las Vegas and UNLV School of Life Sciences, Nevada. Interface with NASA Astrobiology Institute and Life Underground. Focus on deep drilling programs associated with Death Valley National Park, Nevada National Security site, and other underground locations. Interdisciplinary

team includes USC, Caltech, Rensselaer, and JPL. Duane Moser, Desert Research Institute, 755 E. Flamingo Rd., Las Vegas, NV 819119. Duane.moser@dri.edu.

NAI: <https://astrobiology.nasa.gov/nai/>

Life Underground:

<http://www.astrobio.net/pressrelease/5073/seeking-life-underground>

Postdoctoral Researcher, Case Western Reserve University, Cleveland, Ohio. Work on LUX and LZ program in the Dark Matter Group led by Profs. Tom Shutt and Dan Akerib. Deadline: 5/15/13. LUXLZ_postdoc@phys.cwru.edu.

Tenure track position, Chancellor's Fellowship, University of Edinburgh. Teaching and research in nuclear/particle physics. Research in ATLAS or LHCb. Dr. Alex Murphy, a.s.murphy@ed.ac.uk <http://www.ph.ed.ac.uk/chancellors-fellows>

Postdoctoral Researchers, Dept. of Physics, Eng. Physics & Astronomy, Queen's University. Experimental Neutrino Physics, in Particle Astrophysics group, work on SNO+ experiment. Alex Wright, IP Research Scientist & Asst. Professor, Dept. of Physics, Queen's University, Kingston, ON K7L 3N6, Canada. awright@physics.queensu.ca

Postdoctoral Researcher, LLNL, Livermore. Research in Experimental Nuclear Physics (ENP) Group/Nuclear and High Energy Physics. Support of CUORE. Nicholas Scielzo (scielzo1@llnl.gov) https://careers-prd.llnl.gov/psp/careers/EMPLOYEE/HRMS/c/HRS_HRA_M.HRS_CE.GBL?Page=HRS_CE_JOB_DTL&Action=A&JobOpeningId=11017&SiteId=1&PostingSeq=1

Postdoctoral researcher, Experimental Astroparticle Physics, IU South Bend, IN. Work on COUPP direct dark matter search experiment. Prof. Ilan Levine, ilevine@iusb.edu. Dept. of Physics & Astronomy, IUSB, 1700 Mishawaka Ave., South Bend, IN, 46634. Deadline: 3/1/13. <https://www.iusb.edu/academic-affairs/searches.shtml.php-postdoc>

Tenure track faculty position at University of South Dakota. Background in theoretical/computational physics and research including dark matter searches, neutrino experiments, or materials science focused on detectors in an underground environment. Job # 0005098. Review begins 2/1/13. <https://yourfuture.sdbor.edu>

Tenure track faculty positions in Physics at South Dakota School of Mines. New SURF-related research program in particle physics, neutrino physics, dark matter, proton decay, and related research that requires deep underground shielding and low-background counting; also seeking a specialist in computational physics. Job #: 0004996. <http://www.sdsmt.edu/employment>

Postdoc Position, T2K Experimental High Energy Physics, York University, Toronto. Work on T2K neutrino oscillation experiment. Prof. Sampa Bhadra, bhadra@yorku.ca <http://inspirehep.net/record/1203399>

Newsletter Editor: Melissa Barclay

Contributors: Kevin Lesko; Bill Harlan (Sanford Lab local news); Dan Akerib and Chang Lee, CWRU (LUX fills its Detector – Part II); Jaime Hopmeier (Safety at Sanford Lab); Peggy Norris, Ben Sayler (Education and Outreach)

Photo Credits: Fig. 1: Membrane Solutions website; Fig. 2: Dan Akerib; Figs. 3-9: Matt Kapust

Lawrence Berkeley National Lab

Kevin T. Lesko: 510-486-7731

KTLesko@lbl.gov

Melissa Barclay: 510-486-5237

mbarclay@berkeley.edu

SDSTA/Sanford Lab

Ron Wheeler, Executive Director

Mandy Knight, 605-722-8650, x222

MKnight@sanfordlab.org

<http://www.sanfordlab.org/>

**BERKELEY OFFICE
New address**

**SURF Project Office
Lawrence Berkeley National Lab (LBNL)
One Cyclotron Road
MS 50B-5239
Berkeley, CA 94720**