Dear Homestake Collaboration,

Welcome to the June 2011 monthly newsletter for Homestake DUSEL and South Dakota's Sanford Laboratory. We gladly receive your input on news, links to news articles, upcoming workshops, conference notices, scientific updates, information concerning DUSEL, employment opportunities, and other highlights relevant to our shared goal.

Important Dates

Week of June 27: Dry runs for PDR Review

July 9: Neutrino Day - Lead, So. Dakota *(more details on page 6)*

July 19-21: Final PDR review - Lead, So. Dakota

Response to the Marx Report

-- Kevin Lesko, Principal Investigator

I am very pleased with the Report of the Committee Assessing Options for Underground Science, which was first revealed at the HEPAP meeting on June 23. The assessment team, which was expertly led by Jay Marx and Mark Reichanadter, was first rate, and they worked diligently and under extreme time pressure to answer the questions posed by the Office of Science.

I am gratified to see that the Committee was able to receive, readily understand, and make use of our advanced estimates and designs for the Homestake site. It is a testament to the DUSEL/SDSTA team's hard work and attention to detail that we could effectively communicate our detailed Plans B and C in essentially a morning session in mid-April. In the assessment process, the Committee repeatedly recognized the quality of the DUSEL/SDSTA team and our work.

Essentially all of our major points are well-represented in the report including the benefits of a single facility to integrate and share the design, construction, and operations functions, the value to the US physics programs to have, using Jay's words, "the home field advantage" for these critical experiments, the importance of having a deep facility to host these experiments, and our ability to phase facility improvements and stage infrastructure additions as the experiments require them, rather than having to create them all at once.

In making a comparison between the facility costs for our Plan B and SNOLab, I believe the Committee was presented with a particularly challenging task. The Plan B estimate was based on specific experiments and collaborations and importantly, their experimental design requirements. These are the experiments specifically indicated in the Committee's charge. The SNOLab comparison had to be extrapolated from the SNOLab expansion project, which was planned in early 2000 and executed mid-decade. The levels of experimental support, safety infrastructure, type and freedom of access, size of cavities, and experimental needs beyond the physical detector had to be estimated from an existing facility, and quickly extrapolated to accommodate substantially larger and more complex experiments. The Committee recognized the difficulty in performing this comparison and calls for the cost differential to be validated. At HEPAP, I volunteered that the DUSEL team was very willing to assist in developing a detailed comparison.

The phased creation of the Plan B/C facility will result in significant cost savings and an overall funding profile much more appropriate for the austere economic environment we are currently in.

To help distinguish between the NSF's comprehensive multi-disciplinary laboratory, DUSEL, with its full suite of experiments, and the significantly reduced scope and phased facility, we have now named Plan B/C to the **Sanford Underground Research Facility or SURF@Homestake.** This renaming of the facility was also motivated by concerns in Washington about DOE taking on the responsibilities of a major new laboratory. Rather than indicating that DOE should immediately investigate alternative sites, in fact the same Bill includes language to maintain the **Homestake site** while the DOE assesses options for the experiments. We understand this language to caution against the creation of another independent National Laboratory, something that the DOE cannot easily consider at this time. We envision that **SURF** will operate as an extension of an existing national laboratory and not represent the massive investment implied by the NSF's DUSEL.

We anticipate that the National Research Council will complete its assessment of DUSEL's science by mid-July and will strongly endorse the critical importance of neutrino studies and dark matter searches to the national physics program. In closing, I would again like to recognize the DUSEL/SDSTA team for your efforts in developing strong facility options that allow for the pursuit of compelling science at **SURF** in a phased approach that will be acceptable to the DOE. *Well done!*

LUX and Dark Matter – Part II

Figure 1: The LUX experiment will be housed in the Davis Cavern. At its center, a water tank (8m diam. x 6m high) will serve as a shield against external backgrounds for the LUX detector

Why at DUSEL?

Part I of this article outlined the scientific purpose for a dark matter experiment as well as elements of detector design used to guard against background radiation. This is a necessity when one is looking for very rare events such as dark matter particle interactions with ordinary matter. Some backgrounds are much harder to shield against than are others. At the surface of the Earth, cosmic rays from outer space constantly bombard us with a flux of about 100 per square meters per second. Those very high energy, charged subatomic particles are extremely penetrating, so the only way to protect against them to the degree that is required for a rare event search such as a dark matter experiment is to put kilometers of material between them and the detector. This makes a project such as DUSEL particularly attractive. At one mile underground, the flux of cosmic rays is reduced by a factor of one million compared to that at the surface. That makes them just manageable.

Why LUX?

There are many additional design features one can employ to improve a dark matter detector's sensitivity; several technologies have been explored over the past 20 years. Currently, the LUX dark matter detector is being operated at the surface level of Sanford Laboratory, and will move underground to the Davis Cavern in Spring 2012 once outfitting is completed. LUX is a time-projection chamber, a traditional detector design dating back to the 1970s which provides 3D positioning of interactions occurring within its active volume. LUX uses as its target 350 kilograms of liquefied ultra-pure xenon, which is a scintillator; interactions inside the xenon will create an amount of light proportional to the amount of energy deposited. That light can be collected on arrays of light detectors sensitive to a single photon, lending the LUX detector a low enough energy threshold to stand a good chance of detecting the tiny bump of a dark matter particle with an atom of xenon.

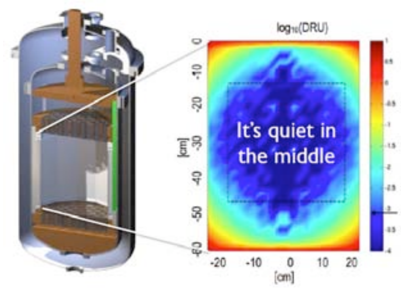


Figure 2: Left: Cross-section of the LUX detector. 350 kg liquid xenon volume delimited at top and bottom by two arrays of photo detectors (dark grey). The detector is composed of two concentric Titanium shells, the inner one at liquid xenon temperature (165 K or -162 F), and the outer one providing vacuum thermal insulation. Right: Results of background simulation showing the center of the detector at four orders of magnitude quieter than its edges. By identifying and selecting only events occurring in the center of the detector, LUX gets of rid of much background and increases chances of observing rare dark matter interactions.

Because the xenon is very pure, the amount of intrinsic background radiation originated within the target itself remains limited. Because xenon is three times as dense as water, it can stop a great deal of the radiation that originates outside the detector before it can reach its center. Combined with the 3D positioning capabilities of a time-projection chamber, this allows the definition of a very quiet region in the middle of the target to look undisturbed for those rare dark matter interactions. Because the LUX detector is larger than any other similar detector currently in operation, it can make maximum use of this "self-shielding" feature while retaining sufficient active detector mass to accumulate statistics rapidly.

This is a key feature for current and future dark matter detectors. Since the early 1990s, detectors have been constructed to be larger and more sensitive. As dark matter continues to elude scientists, physicists are forced to look for more tenuous interactions. To reach the degree of sensitivity required for dark matter detection, an experiment must be able to pick out a few events per year in hundreds of kilograms of material. Without targets built at least on that scale, the amount of time required to allow a very unlikely chance of even seeing even one event is unrealistically excessive.

Once it is turned-on underground, LUX will only need a few days of data taking to catch up to the international competition. After a year of continuous running, it will have explored a significant fraction of new parameter space, setting a new world record and, potentially, finally seeing dark matter interactions.

Biosampling at the 4850 Level

Researchers from Black Hills State University (BHSU) and the South Dakota School of Mines and Technology (SDSM&T) are currently conducting research on microbial communities at the 4850 Level of the Deep Underground Science and Engineering Laboratory (DUSEL).

From BHSU, two associate professors, David Bergmann and Cynthia Anderson, and a research technician, Oxana Gorbatenko, are involved in this project. The group from SDSM&T includes Professor Sookie Bang and three graduate students: Rebecca Pinkelman, Jason Koch, and Adrian Holzer.

Figure 3: BHSU biologist David Bergmann samples water

BHSU is also conducting two smaller, related projects on microbial communities in DUSEL. An undergraduate student, Alicia Brakke, is assembling a library of ribosomal rRNA genes from microbial slime from water on the 4850 Level of DUSEL, which will provide a detailed picture of the presence and abundance of different taxonomic groups of microbes. Another student, Kelli Brunson, is using scanning electron microscopy to study the structure and elemental composition of microbial cells on surfaces at various sites on the 4100 and 4850 Levels of DUSEL.

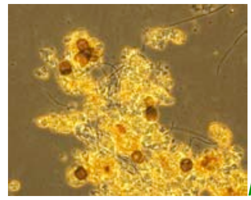


Figure 4: Under the microscope: one microbial biofilm sample from the 4850 Level

The microbial communities here are interesting because they represent the interface between two very different habitats: surface water, which is relatively cool and contains considerable oxygen, and deep aquifer water, which is anaerobic and relatively hot. For this reason, it is possible that microbial communities in water and on surfaces in the lower levels of the mine are unique. The goal of this research is to collect microbial DNA from four sites in the mine (two water samples and two samples of microbial slime on surfaces) and sequence about 60 million base pairs of DNA in each sample. This will produce a large collection of microbial genes from the more abundant microbial species in the community (referred to as a metagenome), some of which may be difficult or impossible to isolate in pure culture in the laboratory. From the list and DNA sequence of genes from each community, it will be possible to draw inferences about what kind of metabolism, such as anaerobic respiration with sulfate or energy generation by oxidizing hydrogen sulfide or ferrous iron, may be important for survival in each mine habitat. The DNA sequence of genes will also provide information about what taxonomic groups of microbes are present in mine habitats.

Figure 5: Sanford Lab geologist Tom Trancynger (left), SDSMT graduate student Becky Pinkelman (center) and BHSU biologist Cynthia Anderson collect a sample growing on timbers

One microbial community underground--microbial slime on rotting wood--will be examined for genes and microbial species that may be important in breakdown of lignocellulose. These genes and the microbes possessing them may be useful in the production of fuels, such as ethanol, from plant material rich in cellulose, including waste-products from wood and crop residue. The presence of other genes, such as those for tolerance of high concentrations of metals, resistance to antibiotics, or production of antimicrobial compounds, may be important for survival in some mine habitats.

A surface habitat--water in Whitewood Creek above the mine--will also be sampled for sequencing of microbial community DNA. This community, unlike those in the mine, has extensive production of organic material by photosynthesis, and should provide information about which genes are required for survival in terrestrial habitats versus deep underground.

John Marks, who has been a mine ventilation consultant with the South Dakota Science and Technology Authority since 2002, recently received an award from the Idaho Academy of Engineers. Mr. Marks has also served as adjunct professor for the South Dakota School of Mines and Technology in Rapid City, South Dakota, and has taught seminars at many western mining schools. To read more about John Marks: http://www.uidaho.edu/engr/about/academyofengineers/marks

PDR Submitted

DUSEL submitted the 800-page Preliminary Design Report (with appendices) to The National Science Foundation on May 26. A defense of the PDR will take place in Lead, South Dakota on July 19-21.

DuRA Survey and DuRA Charter

The DUSEL Research Association (DuRA) Executive Committee (DuREC) is conducting a second email survey among members of DUSEL.org to ratify its Charter. For colleagues who are not yet DuRA members, please take the DuRA survey to become voting members. Membership in DuRA is open by request, and all are welcome. Given the research-specific focus of DuRA, emails regarding DuRA business may not be of interest to all and this is the reason for the separate membership request from DuRA.

DuRA Charter survey: https://spreadsheets.google.com/spreadsheet/viewform?formkey=dDZ3cjRGdS1DY3ViYmFrekIzNnFnS1E6MQ
DuRA Charter: http://www.dusel.org/PDFs/dura-docs/DuRA_charter_20101202.pdf

DUSEL IN THE NEWS

Nature.com: *Underground lab getting a new parent with the Energy Department?* (June 23, Eric Hand) blogs.nature.com

Discover Magazine (online): *A Giant Mine's Glorious Second Life as a Physics Lab* (June 14, Steve Babbitt) discovermagazine.com

KELO News: *Progress Continues On Lead Underground Lab* (June 17, Erich Schaffhauser)

KOTA Territory News: *Five thousand feet deep at the Sanford Underground Lab* (June 17, Shonti Tager)

Black Hills Pioneer: *Scientists working with DUSEL team to reduce experiment costs* (May 7); *Scientists reach lab milestones* (May 24); *Lead Live!* (June 7) - Wendy Pitlick; *Science on display* (June 18, Mark VanGerpen)

The first Lead Live! event took place on Saturday, June 7, 4-8 PM. Vendors, musicians and others filled Lead's Main Street with music, dancing, art, fresh produce, and science. The Black Hills Mining Museum and Sanford Lab organized hands-on activities for kids. Lead Live! will be held the second Saturday of every month until September.

SANFORD UNDERGROUND LABORATORY NEWS

Dewatering Levels

Figure 6: Progress of dewatering at Sanford Lab

The Figure 6 graphic indicates the dewatering progress made in the past three years at Sanford Lab. As of June 6, the water level dropped below 5600 feet. The high water mark was reached in August 2008 at 4350 feet underground. Since that time, DUSEL equipment has pumped 1.5 billion gallons of water from underground and the water level has dropped 1070 feet.

4850 Level Updates

Figure 7: Scientists don cleanroom attire inside the MAJORANA cleanroom

MAJORANA scientists returned to Sanford Lab during the first week of June to ready the 4850 Level lab. The team also worked with Sanford Lab technicians to move three pallets of copper and 20 pallets of lead to the new storage room on the 4850 Level.

The lead will eventually be used to shield the MAJORANA detector. The copper is currently in the form of cylindrical nuggets about an inch long and an inch in diameter. As part of the purification process, the nuggets will be dissolved in acid baths and electroformed into pure copper.

Members of the LUX Collaboration have been working on the surface level, warming up their detector after its first testing at cold temperatures. The LUX team took two weeks to cool the detector down to approximately minus 100 degrees Celsius (-148 F). The detector was cooled with liquid nitrogen. Sanford Lab Science Liaison Director Jaret Heise notes that the detector performed well in this test.

The detector was filled not with xenon but with argon gas. “It has a lower liquefication point so it doesn’t go liquid,” reported LUX Principal Investigator Rick Gaitskell. “We want to be able to test all the systems without the additional risk associated with having the target liquefy.” Risks include rapid pressure increases, but the LUX collaboration worked closely with the Environment, Health and Safety Department to develop a gradual, staged testing process.

Hydroseeding at Sanford Lab

Figure 8: Hydroseed solution applied in Kirk Gulch. A pipeline on the bridge was installed in Fall 2010 to transport water from Grizzly Gulch tailings dam to the wastewater treatment plant.

Environmental Manager John Scheetz recently directed a project to hydroseed 10 acres of Sanford Lab property. The contractor was Jensen Hydroseeding of Belle Fourche, South Dakota. The land had been disturbed by the installation of a 12-inch pipeline that connects the Grizzly Gulch tailings impoundment with Sanford Lab’s wastewater treatment plant.

Hydroseeding is a two-step process than can quickly plant grass over a large area. The seed mix included seven species of grass native to western South Dakota. Scheetz said the new grass would help keep Sanford Lab in compliance with its storm-water permit as well as help reclaim past disturbances.

EDUCATION AND OUTREACH

Early Education Activities

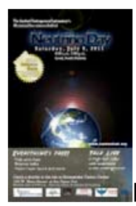
Sanford Laboratory hosted students from two summer programs with the goal of increasing the number of American Indian students who are considering and entering careers in Science, Technology, Engineering and Mathematics (STEM).

The first activity--a four-day summer camp for middle school students--was organized in partnership with the University of Nebraska Medical Center (UNMC), located in Omaha, NE, and Black Hills State University (BHSU). UNMC has been running a successful outreach program for several years with schools on reservations in Nebraska and South Dakota. The program, funded by the National Institute of Health through a Science Education Partnership Award (SEPA) is a partnership between UNMC, the Aberdeen Area Tribal Chairmen's Health Board, and K-8 schools. A key component is a summer camp for middle school students that focuses on both health science education and more general STEM education and opportunities. This year, Sanford Laboratory and BHSU partnered with UNMC to host the summer camp at BHSU from June 5-9. Twenty-one students and their sponsors came from schools on the Omaha Nation Reservation, the Northern Ponca and Winnebago tribes of Nebraska, and the Yankton Sioux and Crow Creek tribes in South Dakota. The students spent Monday at BHSU at biology and health activities with BHSU biology faculty as well as scientists from *Sanford Health* in Sioux Falls. They spent Tuesday touring science-related sites in the Black Hills, including Wind Cave, the Mammoth Site, and the Journey Museum, where they received a presentation on ethnoastronomy. In the evening, they built their own telescopes and used them to look at Saturn and the moon. On Wednesday, the students spent the day at Sanford Laboratory where they toured the Waste Water Treatment Plant, the LUX lab and the Hoist Room and did water filtering and radiation activities. Thanks to Jim Whitlock and the crew at the WWTP, James Verbus and other students at LUX, Ben Sayler, KC Russell, Julie Dahl, Jaye Conrad, Bill Harlan and everyone else who helped make Sanford Laboratory Day a success, and special thanks to Julie Dahl for her excellent overall organization of the camp.


Figure 9: Students and instructors from the SEPA summer camp pose in front of the Yates headframe after their tour

Following on the heels of the SEPA camp, on June 10, the Sanford Lab Education Department hosted 33 American Indian high school students from across the state of South Dakota. These students are attending Upward Bound, a six-week college preparation program at BHSU. The students heard an overview talk about Sanford Lab and STEM careers associated with a multi-disciplinary research laboratory, toured the Hoist Room and the LUX lab, and worked on radiation, cosmic ray and spectroscopy activities. Thanks to Julie Dahl, Ben Sayler, intern Sophia Elia and undergraduate interns at LUX for helping with the day's events.

On June 15, a third camp visit took place with 22 students from across the country who were attending a one-week high school geology camp at SDSM. They toured the Hoist Room and listened to a geology talk by Bill Roggenthen overlooking the Open Cut at the Homestake Visitors' Center. A surprise addition to the agenda was a videoconference Q&A session connecting with scientists at the 4850 Level campus that was part of a test in preparation for upcoming HD videoconferencing events such as Neutrino Day.



Neutrino Day will be held this year on July 9. The highlight will include live videoconferencing to the MAJORANA DEMONSTRATOR site on the 4850 Level. Other events include:

- Thursday, July 7 at 6:30 PM (MDT): South Dakota Public Broadcasting Science Café. Live or online at: SDPB.org/sciencecafe
- Friday, July 8 at 11 AM (MDT): Listen to Innovations program broadcast live from the Majorana electroforming lab on the 4850 Level. www.sdpb.org/

For more information, please go to www.sanfordlab.org or contact Bill Harlan bharlan@sanfordlab.org / (605)722-4025.

Cultural Activities

Ben Sayler and Julie Dahl are members of a statewide task force on diversity in STEM, part of the South Dakota EPSCoR grant that is funding many of the early activities of the Education Department. The second annual EPSCoR Diversity Summit was held on June 1, preceding the annual EPSCoR research meeting. The Summit focused on increasing the diversity in STEM disciplines at universities in the state, particularly among American Indian students. The keynote address was given by Lisa Lone Fight from Montana State University, who spoke on "Seeing Students through the Native Eye: Traditional Native American Culture/Language and Place as a Resource and Platform for Broadening STEM participation".

Planning for the Sanford Center for Science Education (SCSE)

As Education and Outreach staff work with school groups and other education audiences this spring and summer, they are testing and refining new content, and also documenting the questions that students of different ages tend to ask. Through this process, they are developing a research-based collection of the compelling and engaging science and engineering concepts related to the lab and educational activities to go along with them.

ENVIRONMENT, HEALTH & SAFETY

Fireworks Safety

To avoid burns and eye injuries, use fireworks, rockets, and sparklers outdoors. Children should always be supervised.

Keep a water bucket or garden hose handy.

Avoid illegal or homemade fireworks. Attend one of your local fun public fireworks displays instead.

Keep pets indoors on the Fourth of July to avoid fright, noise, stress, or injury.

Safety pages on Sanford Lab website: www.sanfordlab.org - Use the left hand menu to open individual pages

UPCOMING EVENTS AND ANNOUNCEMENTS

Workshops

12th International Conference on Topics in Astroparticle and Underground Physics, Münchner Künstlerhaus (Munich House of Artists), Munich, Germany, September 5-9, 2011. Topics covered by the conference: Cosmology and particle physics, Dark matter and its detection, Neutrino physics and astrophysics, Gravitational waves, High-energy astrophysics and cosmic rays.
For more info: http://taup2011.mpp.mpg.de/

Third International Workshop on Baryon and Lepton Number Violation (BLV-2011), Gatlinburg (Edgewater Hotel), Great Smoky Mountains, Tennessee, September 22-24, 2011. The Workshop purpose is to discuss state-of-the-art of B, L, and B-L violation search, stimulate experimental and theoretical developments in this area, and attract new and young researchers to this field. Other topics will include: proton decay, n-nbar transformations, Majorana neutrinos and their role in physics beyond the standard model and in Cosmology.
For more info: http://www.phys.utk.edu/blv2011/

DuRA Events

Presentations that may be of interest to DuRA members are scheduled in the following meetings:

45th U.S. Rock Mechanics/Geomechanics Symposium with sessions on Geology and Geophysics, Mining Engineering, DUSEL Rock Mechanics, Civil Engineering, and underground construction, San Francisco, CA, June 26-29, 2011. http://www.armasymposium.org/

2011 XXV International Union of Geodesy and Geophysics (IUGG) General Assembly, workshops and business meetings, Melbourne, Australia, June 28-July 8, 2011. http://www.iugg2011.com/

GeoProc 2011 4th International Conference on Coupled THMC Processes in Geosystems, Perth, Australia, July 6–9, 2011. http://www.mech.uwa.edu.au/research/geoproc

Meeting of the Division of Particles and Fields of the APS, Brown University, Providence, RI, August 9-13, 2011. http://www.hep.brown.edu/~DPF2011/

12th International Congress on Rock Mechanics, with workshop WS-5 on Networks of underground research laboratories for international disciplinary innovations, Beijing, China, Oct. 17-21, 2011. http://www.isrm2011.com/page.asp?id=100

AGU Fall Meeting, San Francisco, December 5-9, 2011. http://www.agu.org/meetings/

Please send information regarding upcoming meetings of interest or presentations from DuRA members, as well as other related events to Steve Elliott (elliotts@lanl.gov) or Duane Moser (Duane.Moser@dri.edu).

JOBS

Scientist-2 Position with Weak Interactions Team in Physics Division, P-23, Los Alamos National Lab. Work mostly on MAJORANA, also focus on low-energy neutrino physics/particle astrophysics. Job #: 221444. For more info, contact: Eric Brown (en_brown@lanl.gov) or Steve Elliott (elliotts@lanl.gov).

Visiting Assistant Professor, Dept. of Physics, Univ. of South Dakota. Participate in 2010 DUSEL Research Center (CUBED) activities and DUSEL experiments. Apply at: https://yourfuture.sdbor.edu, contact Chair of Physics Search Committee, Dept. of Earth Science & Physics, Univ. of South Dakota, 414 East Clark, Vermillion, SD 57069 or physics@usd.edu.

Senior Tenured Faculty, Physics Dept., Temple University, in all areas of Astrophysics. Applicants must have a high-quality research program with substantial research funding, and teaching experience. To apply, send CV, research plan, current grant support, statement of teaching philosophy and 5 references to: http://www.temple.edu/physics/news/positions.html or Search Committee, Dept. of Physics, Temple University, 1900 N 13th Street, Philadelphia, PA 19122-6082.

Postdoctoral Fellow with PhD in Microbiology or Geology to work on NSF PIRE-funded project with focus on microbial community structure and diversity, biogeography, and genomics, Tengchong Geothermal Field, Yunnan Province. Send CV and research statement to: Dr Hailiang Dong, Dept of Geology, Miami University, Oxford, OH 45056, or dongh@muohio.edu.

Postdoctoral Position, UC Santa Barbara, Particle Detector Development, Dept. of Physics. Lead detector R&D program, building ultra-high-resolution particle detectors for future neutrino and dark matter detectors. Contact: bmonreal@physics.ucsb.edu, Professor Ben Monreal or http://hep.ucsb.edu/

Newsletter Editor: Melissa Barclay
Contributors: Kevin Lesko (Response to the Marx Report); Bill Harlan (Sanford Lab); Simon Fiorucci (LUX and Dark Matter); David Bergmann (Biosampling at the 4850 Level); Steve Elliott, Derek Elsworth, Joe Wang (DuRA News); Peggy Norris, Ben Sayler (Education and Outreach).

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BERKELEY OFFICE

UC Berkeley
DUSEL Project Office
2440 Bancroft Way, Suite 303
MC 1295
Berkeley, CA 94720-1295
Fax: 510-642-2258

DUSEL CONTACT INFORMATION

University of California at Berkeley
Kevin T. Lesko: 510-642-0147
KTLesko@berkeley.edu
Melissa Barclay: 510-642-2244
mbarclay@berkeley.edu
http://www.dusel.org /
SDSTA/Sanford Lab
Ron Wheeler, Executive Director
Mandy Knight, 605-722-8650, x222
MKnight@sanfordlab.org
http://www.sanfordlab.org/
South Dakota School of Mines and Technology
William Roggenthen: 605-394-2460
William.Roggenthen@sdsmt.edu