

**Dear Homestake Collaboration,**

Welcome to the August 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**

**TBD (Fall): Annual DuRA meeting – Fermilab, Batavia, Illinois** – See p. 5 for more details

**PAC meeting: December 2011**

**Neutrinos and Double-beta Decay in Ge-76:  
Part II**

In the July 2011 issue, readers learned that the MAJORANA DEMONSTRATOR is an experiment that will search for neutrinoless double-beta decay in the isotope Germanium-76. If neutrinoless double-beta decay were observed, it would tell us that neutrinos are their own antiparticles, and the measured decay rate would help narrow down the masses of neutrinos.

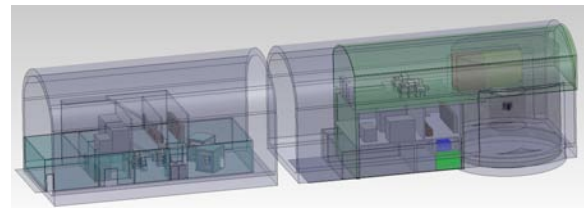
Worldwide, there are two efforts underway searching for neutrinoless double-beta decay in Ge-76: the DEMONSTRATOR, which will begin taking data at Sanford Lab in 2013, and the GERMANIUM DETECTOR ARRAY (GERDA) at Gran Sasso National Laboratory in Italy. Both will have about the same amount of target mass, and therefore similar sensitivities to neutrinoless double-beta decay.

The two experiments are testing two radically different approaches for shielding the detector from external radiation. In the DEMONSTRATOR, the Ge diodes are enclosed in a vacuum vessel made of electroformed copper surrounded by a shield of copper, lead, and plastic. Several other experiments have successfully used a similar compact, layered shield in the past. In GERDA, the Ge diodes are directly immersed in a large volume of liquid argon. The liquid argon is surrounded by a large tank of water. Together, the water and liquid argon provide the necessary shielding from naturally occurring

radioactivity in the rock of the underground cavern. The GERDA approach is rather unconventional, but could have certain advantages if successful. The liquid argon can be purified to achieve a very high radiopurity, and thus reduce the amount of background originating in the shielding materials. GERDA should also be less sensitive to cosmic ray backgrounds, and can be sited at a shallower depth.

Both experiments aim to show that an ultra-low background can be achieved: more than a factor of 100 lower than in previous experiments and low enough to justify building a larger experiment with up to a ton (~1000 kg) of Ge. The more target mass an experiment has, and the lower the rate of background it can achieve, the greater its reach to ever smaller values of neutrino mass and longer half-lives for neutrinoless double beta decay.

The goal posts for neutrinoless double-beta decay searches have been set by other experiments. Neutrino oscillation experiments have indicated that neutrino mass lies above a certain value, while cosmological observations and tritium beta-decay experiments reveal that the neutrino mass is below a certain value. To explore the lower part of that range would require a ton-scale experiment and background rate of less than one count per ton of target mass per year in the energy region where the neutrinoless double-beta decay signal is expected.



*Figure 1: Conceptual layouts of two possible shield configurations for a ton-scale neutrinoless double-beta decay experiment at SURF: a compact shield similar to the MAJORANA DEMONSTRATOR (left) and a cryogenic shield similar to GERDA (right)*

MAJORANA and GERDA are in a competitive race, but it is a friendly one. The two collaborations have close ties, and share resources and knowledge. Building a ton-scale experiment would be expensive, and would have to be an international effort, so the two collaborations have agreed to work together to build a single ton-scale experiment in the future. Such an experiment would combine the best technical aspects of both experiments.

Preliminary conceptual work toward a ton-scale experiment is already underway, but scientists won't know exactly what it will look like until the results come in from GERDA and the DEMONSTRATOR. Depending on those results, large-scale efforts on the ton-scale will probably commence around 2016, and such an experiment might turn on around 2019.

### Deep Underground Science at LBNL

During this summer, the Nuclear Science Division (NSD) at Lawrence Berkeley National Laboratory (LBNL) hosted students and faculty through various programs organized by the laboratory's Center for Science and Engineering Education (CSEE). These visitors participated in research projects in the division, including those involving science at deep underground facilities.

Several NSD research groups teamed up to provide their visiting students and faculty with a new seminar series entitled "The Pizza Talks". These lunchtime seminars were given by division staff, postdocs, and visiting faculty to give students a broad view of the field. The setting was purposely informal so that students felt comfortable asking questions. As an additional incentive, free pizza was provided to the students.

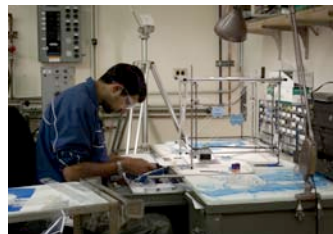
Postdoc Ryan Martin of the MAJORANA DEMONSTRATOR group took the lead in organizing the series with participation from the research groups working on a number of past, current, and planned experiments such as CUORE, NEXT, KamLAND, SNO, KATRIN and leptogenesis as well as some theory basics. The choice of subjects gave the students a good understanding of the field of neutrinoless double beta decay searches and low background physics. The students gave short talks at the end of the series to summarize the work that they had done over the summer. Overall, this series was a success and the students appreciated the opportunity to learn more about the subject.

Some of the summer research projects of these visitors are directly related to the early science program at Sanford Laboratory.

James Mulligan, an undergraduate from the University of Washington, characterized commercial germanium radiation detectors that are of interest to the MAJORANA DEMONSTRATOR project. He performed

a variety of detailed characterizations of two of these detectors that will be useful in building comprehensive models to predict their responses. During his stay, James also had the opportunity to learn a variety of techniques useful in experimental physics, including the operation of electronics, data-analysis, 3-D design, and machining.

Erin Hansen, an undergraduate from Rensselaer Polytechnic Institute, developed a cryostat for testing and developing signal readout electronics for the MAJORANA DEMONSTRATOR project. The DEMONSTRATOR electronics use a novel design, with components and circuitry mounted on small pieces of fused silica wafer. This presented many constraints on the design of the cryostat. It had to make reversible electrical connections with the board that left no contamination on the surface; it had to realistically simulate the interaction of the board with a Ge detector; and have a short thermal cycle to allow many development and testing cycles. Erin successfully completed the project, designing, fabricating and testing modifications to an existing cryostat. This cryostat will be invaluable.



*Figure 2: Ankur Dhar, undergraduate student at UC Berkeley, assembling a 3D printer*

Ankur Dhar, a UC Berkeley undergraduate, worked on two projects on the additive manufacture of insulators for ultra-low-background experiments. One used vapor-deposited parylene, and the other used 3D-printed thermo-plastics. In the parylene project, he developed an ultra-low-background temperature sensor using gold traces deposited onto a parylene substrate. He reconditioned and characterized a parylene machine, manufactured deposition fixtures, designed the sensors, and worked with specialists to deposit and pattern the gold traces. In the 3D-printing project, he identified a suitable entry-level 3D printer for development work, built it from a kit, commissioned it and printed various realistic detector system components for thermal, out-gassing and radiopurity tests. Both projects produced promising leads for future development.



## DUSEL IN THE NEWS

Physics Today: *DOE looks hard at taking over deep underground site* (Toni Feder, Aug 2011)  
<http://dx.doi.org/10.1063/PT.3.1211>

Black Hills Pioneer: *Moving forward with underground science in the US* by Kevin Lesko (August 1); *Daugaard expresses importance of lab, working to ensure success* (August 1); *LUX collaboration going international* (July 26); *Dark Matter! LUX prepares for final tests, on schedule for 2013 operation* (July 25) (Wendy Pitlick)

DUSELwatch.com: *Clearing airport security with technology? Not always easy!*; *LUX scientists on track to take dark matter experiment underground* (Wendy Pitlick, July 25)

For twitter updates see: [www.sanfordlab.org](http://www.sanfordlab.org)

**Report Available:** The National Research Council report *An Assessment of the Deep Underground Science and Engineering Laboratory* can be ordered at: <http://t.co/i3PAfPz>

## SANFORD UNDERGROUND LABORATORY NEWS

### Dewatering Levels

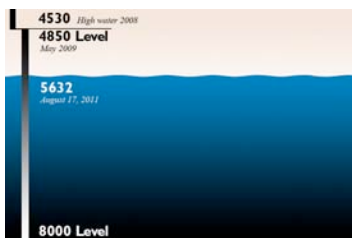


Figure 3: Progress of dewatering at Sanford Lab

The Figure 3 graphic indicates the dewatering progress made in the past three years at Sanford Lab. The high water mark was reached in August 2008 at 4350 feet underground.

Due to routine maintenance and repairs at the water treatment plant, the water level will increase slightly over the next few months. Surface-Operations

Foreman Dan Regan is overseeing valve changes, seal replacement, and maintenance on rotating biological contactors (RBC) channels, which remove trace amounts of ammonia from the water before discharge. Following that, a groundwater development company Hydro Resources will repair a deep-water pump located 7800 feet underground.



Figure 4: Concrete blocks stored in the chiller cutout awaiting use in construction of the Davis Campus

### 4850 Level Progress

Construction continues at the 4850 Level. As of August 1, all of the equipment and material needed to construct the Davis Campus had been lowered to the Yates Shaft and was sitting on work decks.

The engineered fill has already been spread over the rock floor of the Transition Cavern. Plumbing and electrical conduits that will run under the completed floor have also been installed. Vapor barriers and a 2-inch layer of fine sand will be laid down before concrete is poured. When finished, the MAJORANA DEMONSTRATOR lab's floor will be one foot thick.



Figure 5: Infrastructure Tech Danny James lowers a bundle of rebar down the Yates shaft

On July 20, scientists started electroplating copper for the MAJORANA DEMONSTRATOR project on the 4850 Level. The process is time-consuming as copper nuggets are added to the outer rings in each of 10 electroforming tubs filled with a sulfuric acid solution. A stainless steel cylinder or mandrel in the shape of a part needed to build the experiment is lowered into each bath. When an electrical current is

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added, the mandrel becomes a cathode and a thin layer of copper begins to form at a rate of about 70 millionths of a meter per day. This means that in five months, about half an inch of copper will have been formed on the mandrel. The result is a pure copper with none of the impurities that would take place on the surface. The temporary cleanroom to make this pure, radiation-free copper will operate for about two years.



*Figure 6: SDSMT grad student Mark Horton washes the surface of copper with deionized water to remove sulfate crystals in the MAJORANA temporary cleanroom*

## EDUCATION AND OUTREACH

### Early Education Activities

The Sturgis Rally marks an end to the busy pace of summer activities of the Education and Outreach program, and an opportunity to pause, review, and reflect on future opportunities and challenges. In total, the program served 783 students, educators and members of the general public since June 1, as summarized in Figure 7.

Program	ONSITE PROGRAMS BY AUDIENCE			Educa-tors	Pub-lic
	Students by grade				
	6-8	9-12	Un-der-grad		
Research Internships		1	4		
SEPA Summer Camp	28		4	5	
BHSU Upward Bound Camp		33		5	
SDSMT Geology Field Camp		22		3	
SDSMT GEAR-UP		24		2	
Neutrino Day					575
Davis-Bahcall Scholars			11	1	
BHSU Quarknet				5	
Subtotals/Onsite	28	80	19	21	575

OFFSITE PROGRAMS BY AUDIENCE					
Unearthing Connections...					33
Journey Into Space (two workshops)					27
Subtotals/offsite					60
2011 Summer total	28	80	19	81	575

*Figure 7: Sanford Lab Education Summer Programs - Shaded programs place special emphasis on serving American Indian students*

*Journey Into Space:* Peggy Norris is the science content Principal Investigator for a three-year NASA grant with Rapid City's Journey Museum to bring astronomy into schools across the region and state. Since the state of South Dakota has only a handful of teachers accredited to teach astronomy and space science, students seldom have the opportunity to take a dedicated course. A goal of the grant is to give teachers the tools and confidence to incorporate topics that address the state space-science standards into other science courses.



*Figure 8: Participants in the Journey Into Space workshop for secondary educators pose outside the Journey Museum with Peggy Norris, Kristin Testin and Dianne Melvin (Journey Museum) and helper Sophia Elia, an intern with the Sanford Lab Education Department this summer*

As part of the first year of the grant, two three-day teacher professional development workshops were held in July at the Journey Museum. The first was for elementary school teachers and the second for middle and high school teachers (Figure 8). Highlights included special lectures. For the elementary teachers, Tom Durkin (SDSMT) talked about what the Hubble Space Telescope has shown us about the universe. For the secondary teachers, Tim Morton, a graduate student at Cal Tech, gave an exciting video lecture on the search for exoplanets and latest results from the NASA Kepler mission. The workshops provided participating teachers the opportunity to work together honing their skills and developing lesson plans around South Dakota space-science standards.

*The Davis-Bahcall Scholars Program at Princeton:* Last month, Education and Outreach reported on the first two weeks of this summer's Davis-Bahcall program. The ten students arrived back in South Dakota in mid-August after three weeks spent studying modern physics (quantum mechanics, special and general relativity, and particle and nuclear physics) with Professors Frank Calaprice and Peter Myers and graduate student Emily Shields (all of Princeton) and Professor Barbara Sczcerbinska (Dakota State University). Twenty students from Italy, sponsored by Gran Sasso Laboratory and the region of Abruzzo, also joined the program, taking their lectures in Italian but participating in laboratories and social activities together with the students from South Dakota. The students also had two lectures from Professor Netta Bahcall and toured the Princeton Plasma Physics Laboratory and the Institute for Advanced Study. The program ended with a closing ceremony on Friday, August 12.



*Figure 9: Davis-Bahcall Scholars and Gran Sasso Scholars at the closing ceremony together with Princeton faculty*

### Other Activities

Peggy Norris and Ben Sayler took part in two education sessions and a round table discussion organized for the APS Division of Particles and Fields meeting in Providence, Rhode Island on August 9-10. The sessions were designed to bring together people working in education and outreach on the various experiments and facilities in the area of particle physics. Highlights from among the many talks presented included a traveling exhibit on gravity waves (Marco Cavaglia, Mississippi State, representing LIGO), a particle physics website for elementary students, [www.quarked.org](http://www.quarked.org) (Alice Bean, Kansas University), an overview of 30 years of education and outreach at Fermilab (Marge Bardeen), and a talk by high school teacher Mike Fetso (Godwin High School, Virginia) on using CMS data in the classroom. The group also had a fruitful

discussion on ways to share resources and collaborate in the future.

### ENVIRONMENT, HEALTH & SAFETY



#### Summer Safety – *what to do afterward*

Sunburn:

- Use over the counter pain reliever or skin moisturizers, especially those containing aloe
- Apply cold compresses or take cool baths

Contact with poison oak or ivy:

- Immediately rinse with rubbing alcohol or dishwashing soap
- To relieve itching, take antihistamine

Pet overheating:

- Hose down your pet with water or give your pet cool water to drink
- Call your vet

**Safety pages on Sanford Lab website:**

[www.sanfordlab.org](http://www.sanfordlab.org) - Use the left hand menu to open individual pages

### UPCOMING EVENTS AND ANNOUNCEMENTS

#### Conferences and Workshops

Transcriptions of presentations made at the Meeting of the APS Division of Particles and Fields, August 9-13, 2011 have been posted at: <http://www.hep.brown.edu/~DPF2011/>

**12<sup>th</sup> International Conference on Topics in Astroparticle and Underground Physics, München** Künstlerhaus (Munich House of Artists), Munich, Germany, September 5-9, 2011. Topics covered at 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 searches, 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

### Message from Steve Elliott and Rick Gaitskell:

Due to a conflict with the ICFA meeting at CERN requiring the presence of a number of key people who would otherwise attend the DuRA annual meeting, DuRA has decided to change the meeting dates. The dates will be announced soon. We hope that this unfortunate development does not inconvenience anyone.

Presentations of interest to DuRA members are posted in the following meetings:

**12<sup>th</sup> 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](mailto:elliotts@lanl.gov)) or Duane Moser ([Duane.Moser@dri.edu](mailto:Duane.Moser@dri.edu)).



## JOBS

Postdoctoral Research Assistant, Royal Holloway, University of London, Physics Dept. Research on dark matter detection with liquid argon and DEAP/CLEAN experiment. For further details: <http://www.rhul.ac.uk/physics/research/particlephysics/experimentalparticlephysics/darkmattersearches.aspx>

Tenure-track faculty position in Dept. of Physics, Augustana College, Rock Island, Illinois, beginning Sept. 2012. Teach physics courses, conduct research involving undergraduates. More details at:

[http://www.augie.edu/admin/human\\_res/prospective/facultypositions.html - physics](http://www.augie.edu/admin/human_res/prospective/facultypositions.html-physics)

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, China. Send CV and research statement to: Dr Hailiang Dong, Dept of Geology, Miami University, Oxford, OH 45056, or [dongh@muohio.edu](mailto:dongh@muohio.edu).

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**Contributors:** Kevin Lesko; Bill Harlan (Sanford Lab); David Steele (Neutrinos and Double-beta Decay in Ge-76); James Loach, Ryan Martin, Alan Poon (Deep Underground Science at LBNL); Steve Elliott, Rick Gaitskell (DuRA News); Peggy Norris, Ben Saylor (Education and Outreach).

**Photo Credits:** Fig. 1: Matthew Busch; Fig. 2: James Loach; Figs. 3,4: Matt Kapust; Fig. 5: Woody Hover; Fig. 6: Jaret Heise; Figs. 7,9: Peggy Norris; Fig. 8: Casey Peterson

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