

## Dear Homestake Collaboration,

Welcome to the March 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 the Collaboration, employment opportunities, and other highlights relevant to our shared goal.

### Important Dates

**April 13-15:** DOE Office of Science Review of Options for Underground Science

**April 13-15:** Cosmogenic Activities and Backgrounds Workshop - Berkeley

## Sanford Lab measures Japan earthquake

Japan's catastrophic earthquake was detected on two tiltmeters at the 2000 Level at the Sanford Underground Laboratory. Science Liaison Jason Van Beek, a geology graduate student at South Dakota School of Mines & Technology, provided the data. Van Beek reported that the Transparent Earth tiltmeter registered the first signal from the Honshu quake about 12 minutes after the event began. The surface wave took about 45 minutes to reach Sanford Lab. This sensor measures rock movement as degrees of tilt; it is looking for movement associated with dewatering the Sanford Lab.

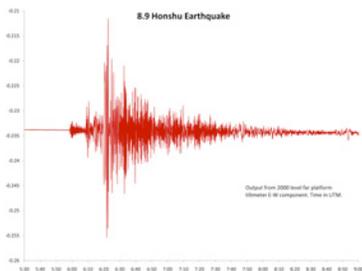


Figure 1: Upper: The Honshu 8.9 quake registered on the Transparent Earth Tiltmeter. X axis = time, Y axis = angle of tilt in microradians. Lower: Earthquake as recorded by the GEOX™ tiltmeter



Figure 2: Jason Van Beek inspects Transparent Earth tiltmeter

Jim Volk of Fermilab, of the GEOX™ (Geological optical extensometers and tiltmeter monitoring) experiment, is also measuring ground movement associated with dewatering. Three sets of GEOX™ tiltmeters measure differences in elevation at sensors many meters apart. The sensors are connected by water-filled plastic tubes. Please note the two graphs in Figure 1. The Transparent Earth tiltmeter records data once per second, while the GEOX™ tiltmeter records data once a minute.

## Deformation Monitoring at DUSEL Using Fiber-Optic and Water-Level Sensors

On February 1-3, 2011, researchers from the GEOX™ experiment visited Sanford Laboratory.

GEOX™ is a multidisciplinary and multi-institutional collaboration that uses fiber-optic strain sensors and water-level sensors to measure and monitor deformation within the laboratory underground. The first tiltmeters of the Hydrostatic Level System were installed in January 2009 to establish baseline measurements. Those arrays were Tevatron-style tiltmeters developed by Jim Volk. In January 2011, a crew consisting of Sanford Lab Geologist Tom Trancynger, Josh Roberts and Dante Fratta of the University of Wisconsin, Jason Van Beek of SDSMT, and Jim Volk changed electronic components on the 2000 Level (Figure 3). Another array on the 2000

Level is a Budker-style tiltmeter, developed at the Budker Institute for Nuclear Physics in Novosibirsk, Russia. GEOX™ will eventually include arrays on three levels: 2000, 4100 and 4850.



Figure 3: Tiltmeter crew at the 2000 Level in January 2011



Figure 4: Wall mounted Budker style tiltmeter (foreground); Pedestal mounted Tevatron style tiltmeter (background)

The GEOX™ research team is developing a new method for measuring deformation and temperature in intact rock. Their measuring devices are called FROSTS (Fiber optically instrumented ROck Strain and Temperature Strips). Each consists of a 6 foot-long strip of stainless steel that has fiber optic strain and temperature sensors attached at 1-foot intervals. The FROSTS are grouted into boreholes drilled into the rock mass. Strain and temperature are measured using a laser light signal sent down the fiber optic cable to the Fiber Bragg Grating (FBG) sensors.

The GEOX™ team installed two prototype FROSTS in an old powder alcove near the Ross Shaft on the 4100 Level where they already have a large array of fiber optic strain and temperature sensors. Braving minus 30° F temperatures at the surface, they worked with SDSTA staff to drill holes, prepare, position, and grout-in the FROSTS. After connecting the 40+ fiber optic strain and temperature sensors to the laser interrogation box, the group is currently collecting data from all of the sensors at one-second intervals.

During the February 1-3 underground trip, other members of the GEOX™ team were able to perform reconnaissance work using nondestructive ultrasonic testing techniques to determine how well a rock bolt is attached to the rock mass. Typically, rock bolts are tested using pull out tests, where the rock bolt is literally pulled out of the rock mass. The

group is developing a method where an ultrasonic pulse will be sent down the bolt from the surface, and the strength and shape of the reflected signal from the end of the bolt can be used to determine how well the rock bolt is grouted into the rock mass, and whether or not the surrounding rock mass is fractured.



Figure 5: GEOX™ personnel Rich Barry, Steve Gabriel, Branko Glisic, Alan Turner, and JoAnn Gage preparing the FROSTS for installation on the 4100 Level



Figure 6: Inserting the FROSTS into the ceiling of the alcove

Steve Gabriel is a high school physics teacher at Spearfish Schools in South Dakota, and a member of the GEOX™ collaboration. Steve uses data from the fiber optic sensors collected underground to explain the concepts of lasers, light waves, and reflections to his students. His portion of the research project entails using distributed fiber optic temperature sensing cable to monitor temperature in different parts of the laboratory underground.

GEOX™ personnel who participated in the February trip include Herb Wang, JoAnn Gage, Matt Kogle, and Andres Tascon (University of Wisconsin–Madison), as well as Steve Gabriel (Spearfish Schools), Alan Turner (Micron Optics Inc.), Rich Barry (Crazy Horse), and Branko Glisic (Princeton University). Other support included Tom Trancynger, Jaret Heise, and Jason Van Beek.



Figure 7: Matt Kogle and Steve Gabriel collect ultrasonic velocity data from rock bolts in the wall of the alcove

## CUBED Progress

The September and December 2010 issues of the DUSEL newsletter reported on Dr. Dongming Mei and other CUBED (Center for Ultra-Low Background Experiments at DUSEL) collaborators from USD, SDSMT, SDSU, and Sanford Lab, who are working on the development of techniques to manufacture ultra-pure crystals underground that may be used by experiments proposed for DUSEL. This project is funded by the DOE EPSCoR Program and the State of South Dakota through the 2010 Research Center. The collaboration continues to make progress toward its goal of producing high purity germanium crystals.

High quality crystals are being pulled on a weekly basis at the surface growth facility located on the USD campus. The USD Crystal Growth group has developed a process and the necessary skills to consistently produce high quality crystals.

Preliminary characterization of the grown crystals demonstrates that the impurity levels are one to two orders of magnitude away from the needed impurity level for detector-grade crystals. The table and graphic in Figure 8 show the resistivity measurements for a recently grown crystal at several positions along its length as identified in the photo. Please note that these are preliminary results.

	Resistivity ( $\Omega \cdot \text{cm}$ )		<sup>60</sup> Carrier Concentration ( $\text{cm}^{-3}$ )	
	~300 K	77 K	~300 K	77 K
Slice #1	73.28	1873.38	$2.9 \times 10^{13}$	$8.3 \times 10^{10}$
Slice #2	71.92	2017.38	$3.0 \times 10^{13}$	$7.7 \times 10^{10}$
Slice #3	64.94	17.944	$3.3 \times 10^{13}$	$7.9 \times 10^{12}$

\*Using assumed mobility



Figure 8: Table and graphic indicate resistivity measurements for a recently grown crystal

The next step for the groups at SDSMT, SDSU, and USD will be to use zone-refining equipment to improve the purity of the starting materials before beginning the growth process. With an increase in purity due to the zone refining, the group expects to grow high-purity crystals by the end of 2011. Ultimately, the growth facility will move underground at Sanford Lab; the 4850 Level is being evaluated as a permanent home for the growth facility. The final design for the facility along with a permanent location will be settled in the near future.

## DuRA Survey and DuRA Charter

The DUSEL Research Association Executive Committee (DuREC) is conducting a survey among members of DUSEL.org to see if they wish to become voting members of the DUSEL Research Association (DuRA). (You may have already received your request.) Membership in DuRA is open by request; all are welcome. Given the research-specific focus of DuRA, emails regarding DuRA business may not be of interest to all and this underlies the upcoming membership request from DuRA. The request will come in the form of a brief survey. Responding to the survey will automatically establish membership. For more info on the DuRA survey:

<https://spreadsheets.google.com/viewform?formkey=dEZyUWhNQTJEb2RDMFFTdU15YTB0UHc6MQ>

DuRA Charter: [http://www.dusel.org/PDFs/dura-docs/DuRA\\_charter\\_20101202.pdf](http://www.dusel.org/PDFs/dura-docs/DuRA_charter_20101202.pdf)



## Workshop News

**A Radon and Radioactivity Workshop** teleconference took place on February 17, 2011. About 20 designated members from the S4 experiments and other interested parties participated in the phone call. The primary goal of the meeting

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was to initiate communication between DUSEL/Sanford Lab and potential site occupants regarding local radon and underground rock/shotcrete radioactivity issues.

Sydney De Vries, DUSEL Underground Infrastructure Construction Manager, discussed present and future air ventilation options for the laboratory, which could have an effect on the final airborne radon level underground. Sanford Lab's Science Liaison Director Jaret Heise reported preliminary data from radon level studies at several underground monitoring locations, carried out by Sanford Lab staff and members from USD. A comprehensive compilation of radiometric assay results for rock samples from underground and concrete samples provided by construction vendors (work primarily done by William Roggenthen (SDSMT professor and DUSEL Co-PI) and A.R. Smith (LBNL)) was also reported. Priscilla Cushman (University of Minnesota), AARM Collaboration summarized the general radon requirements for the S4 experiments based on information gathered from previous FAARM collaboration meetings.

The agenda of the meeting and some of the presentations can be found at: <https://docs.sanfordlab.org/docushare/dsweb/View/Wiki-86/Agenda>

The local DUSEL Radon Task Force, consisting of Yuen-Dat Chan, Rohit Salve, and Jaret Heise, intends to maintain a TWiki page to keep track of relevant radon and radioactivity information of interest to the community at: [https://docs.sanfordlab.org/docushare/dsweb/View/Wiki-86/Radon\\_and\\_Rock\\_Radioactivity\\_Information\\_at\\_Homestake](https://docs.sanfordlab.org/docushare/dsweb/View/Wiki-86/Radon_and_Rock_Radioactivity_Information_at_Homestake)

Further follow up meetings and discussions will take place between DUSEL and the S4 experiments about radon mitigation issues, such as radon scrubbers, etc.

**A workshop on the status of the Davis campus and Ross area** at Sanford Laboratory and of the DUSEL laboratory module design was held on March 2-4, 2011. About 30 participants attended. Presentations were made on the schedule for completion of the Davis campus for the LUX and MAJORANA Demonstrator experiments, and on the nearly completed clean-room facility in the Ross area to house copper electroforming for the MAJORANA demonstrator apparatus. The current

design of the DUSEL laboratory modules was described in detail, including recently developed alternative options and plans. Representatives from dark matter, neutrinoless double-beta decay experiments, and low-background assay facility presented their plans for experimental layouts and infrastructure. This information and follow-up interactions will help guide the future DUSEL facility design work. Presentations and additional information are at:

<https://docs.sanfordlab.org/docushare/dsweb/View/Wiki-152>



### DUSEL IN THE NEWS

#### Watch Videos

*Vacuum tubes implode in the name of Physics* – (Wired Science) - “We are planning to build a gigantic underground detector to understand a key property that may have caused an imbalance in favor of matter,” says particle physicist Milind Diwan of Brookhaven National Laboratory. Fermilab would shoot the world's most intense neutrino beam toward DUSEL about 800 miles away. To design stronger vacuum tubes for a proposed high-stakes physics experiment, researchers first need to understand their weaknesses — so they blew up the devices in an old torpedo test chamber. The destructive tests, seen in the video link below, support the development of a planned \$1 billion experiment to detect neutrinos. To watch the implosion:

<http://www.wired.com/wiredscience/2011/02/neutrino-photomultiplier-tubes/>

*Pop Goes the Photomultiplier Tube* (Scienceblogs) – Fifty thousand multiplier tubes are planned to coat each of two massive detectors in the proposed LBNE experiment. To watch another version:

[http://scienceblogs.com/brookhaven/2011/02/pop\\_goes\\_the\\_photomultiplier\\_t.php](http://scienceblogs.com/brookhaven/2011/02/pop_goes_the_photomultiplier_t.php)

#### Read DUSEL news items:

Star Date: [Underground Astronomy IV](#), (March 4)

Science Insider: *NSF and Energy Department agree to keep pumps on for underground lab site* (February 22, Adrian Cho and Jeffrey Mervis)

Rapid City Journal: *Dept. of Energy to assist Sanford Underground Lab* (February 16)

DUSELwatch.com: *LUX reaches milestone; Clearing science hurdles* (Wendy Pitlick)

[www.sanfordlab.org](http://www.sanfordlab.org) - Check out "Twitter updates" in lower left hand column

## SANFORD UNDERGROUND LABORATORY AT HOMESTAKE

### Russian Professors visit Sanford Lab



In February, ten Russian professors from G.V. Plehkanov Saint Petersburg State Mining Institute and Technical University visited Sanford Lab. The group represented the fields of mining, metallurgy, minerals, electronics, economics, and eco-geology.

SDSMT faculty members signed a Memorandum of Understanding and hope to collaborate on future student exchanges, technical conferences, joint research proposals, and exchanges of mineral samples.



*Figure 9: Sanford Lab Chief Financial Officer Nancy Geary points to a barite specimen collected on her family's ranch (north of Wasta, SD) probably in the 1960s. The specimen is now in the Mining Institute's collection.*

### Davis Cavern

Bags of shotcrete supplied by LG Everist of Sioux Falls, S.D. are lined up in the Transition Cavern on the 4850 Level. So far, 810 2000-pound bags have been ordered. The hoist lifts the shotcrete bags, which are dumped into a hopper. The shotcrete is mixed with water, then pumped through a hose to

the robotic arm's nozzle. Sanford Lab has ordered low-radioactivity shotcrete to minimize the background noise of cosmic radiation. The Davis Cavern will be the future home of the LUX dark-matter detector.



*Figure 10: (left) Robotic arm in Davis cavern can be operated from the ground to apply shotcrete in hard-to-reach places; (right) Bags of shotcrete with hoist in background*

### LUX Detector

During the week of March 1, LUX researchers began lowering the LUX dark-matter detector toward a water tank, similar to a tank that will be constructed underground. The LUX detector will eventually be installed at the 4850 Level in the Davis Cavern. However, it must first be tested at the surface lab. So far, the detector has been lowered 5 feet.

The core of LUX is a cryostat that will contain 350 kilograms of liquid xenon. The cryostat is protected inside an outer vessel. Liquid nitrogen will cool the xenon gas to a liquid state, about minus 148° F. Before any of this will take place, LUX will undergo a rigorous safety review.



*Figure 11: LUX researchers and Sanford Lab personnel pose with the dark-matter detector being lowered into a water tank*

## EDUCATION AND OUTREACH

### Planning for the Sanford Center for Science Education (SCSE)

The DUSEL/Sanford Lab Education Advisory Committee (EAC) met on March 4, 2011 to review the education and outreach volume for the Preliminary Design Report and to hear about progress in planning for the SCSE. The committee was positive about the progress made to date and the activities and partnerships under development as prototypes. Committee members are:

- Jacquelyn Bolman, Director of Indian Natural Resources, Science, and Engineering Program, Humboldt State University
- Roger Campbell, Director of Indian Education, SD Department of Education
- Willi Chinowsky, Professor of Physics Emeritus, University of California, Berkeley
- Rose Emanuel, Science Teacher, Lead-Deadwood High School
- Bob Jacobsen, Professor of Physics, University of California-Berkeley
- Keith Moore, Director, US Bureau of Indian Education
- Melody Schopp, Secretary of Education, SD Department of Education
- Nigel Smith, Director, Sudbury Neutrino Observatory (SNOLAB)
- Susan Van Gundy, Director of Education, National Science Digital Library
- Jack Warner, Executive Director, South Dakota Board of Regents (represented by Gary Johnson, VP for Research, SD Board of Regents)

### Early Programming

*Undergraduate Education:* KC Russell, Cultural and Diversity Liaison, and Peggy Norris, Deputy Director of Education, visited Sitting Bull College in Fort Yates, North Dakota on February 17. The college serves residents of the Standing Rock Reservation, which straddles the border of North and South Dakota. They spoke to a geology class and met with science faculty to discuss possible workshops on their campus as well as future student visits to Sanford Lab.

Peggy Norris spoke via videoconference to North Dakota faculty members from several universities at the North Dakota CyberInfrastructure Conference on March 3. Topics included planning for the SCSE and its plans for extensive cyberlearning programming.

*K-12 Education:* Connie Giroux (Sanford Lab Science Liaison), Bill Harlan (Communications Director), Peggy Norris, and KC Russell visited Red Cloud Indian School in Pine Ridge, South Dakota on February 28. They toured the school and met with the principal, science faculty, and English faculty. A trip is planned for both science and journalism students to visit Sanford Lab this spring.

Ten students have been chosen for the Davis-Bahcall Scholars program for Summer 2011. The students will spend a week in July at Sanford Lab, and then visit the Soudan Mine, University of Wisconsin, and Fermilab before traveling to Princeton to study in the Physics Department along with students from Italy. Professor Frank Calaprice conducts the Princeton component of the program.

## ENVIRONMENT, HEALTH & SAFETY



### Spring Safety

**Spring break:** Travel. Enjoy sun, sand, and surf. Use sunscreen. Watch your alcohol intake. Eat healthy. Be smoke-free. Read a book. Have fun!

**Spring cleaning:** Store cleaners safely. Climb a ladder, not a box. Use non-toxic pest control. Be careful when lifting.

**Spring allergies:** Trees are a main source of pollen in early spring. Sources include oak, olive, elm, birch, maple, and juniper/cypress. Pets can also suffer from seasonal allergies. If conditions are severe, consult your doctor (or a vet).

*For info on Lead, South Dakota road and weather conditions: Call (605) 722-0002*

**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

### Workshops

**Cosmogenic Activities and Backgrounds Workshop**, Lawrence Berkeley National Laboratory, April 13-15, 2011. This DUSEL-sponsored workshop will explore key experimental measurements and theoretical models of cosmogenic activity and backgrounds, discuss the challenges in interpreting the data and matching models to experiment, and lay out a roadmap for future experimental activities and modeling efforts. The workshop scope includes neutron spallation and subsequent interactions, isotope production, electromagnetic and hadronic showering, muon-incident interactions and propagation, and other related topics.

<https://docs.sanfordlab.org/docushare/dsweb/View/Wiki-141/HomePage>

**Fourth IUPAP International Conference on Women in Physics**, Stellenbosch, South Africa, April 5-8, 2011. Conference goals: provide an opportunity to view and analyze current status of, and progress in promoting women in physics in each country and internationally; provide an arena for women in physics to share their scientific accomplishments and create international scientific collaborations; and build capacity in each participating country to design and implement changes to improve the participation and advancement of women in physics.

For more info: <http://www.uswip.org/>

**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:

**Symposium on Experiments on the Cosmic Frontier: Astrophysical Studies of Matter, Energy, Space and Time**, Fermilab, Batavia, Illinois, March 23-26, 2011.  
<http://astro.fnal.gov/events/Conferences/cosmic/Home.html>

**2011 APS April Meeting**, Anaheim, California, April 30-May 3, 2011.

<http://www.aps.org/meetings/april/index.cfm>

**45<sup>th</sup> 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/>

**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/>

**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>

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)).

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## JOBS

Postdoctoral Position in neutrino physics, LHEP, University of Bern. EXO experiment searching for the neutrinoless double beta decay in the  $^{136}\text{Xe}$  isotope. Send letter, CV, publications list, and two reference letters to: Dr. Razvan Gornea, Laboratorium für Hochenergiephysik, Universität Bern, Sidlerstrasse 5, 3012 Bern (Switzerland). For more info: [gornea@lhep.unibe.ch](mailto:gornea@lhep.unibe.ch)

Visiting Assistant Professor, Dept. of Physics, Univ. of South Dakota. Candidate will participate in 2010 DUSEL Research Center (CUBED) activities and in the planned DUSEL experiments. Apply at: <https://yourfuture.sdbor.edu> or submit materials to Chair of Physics Search Committee, Dept. of Earth Science & Physics, University of South Dakota, 414 East Clark, Vermillion, SD 57069 or to [physics@usd.edu](mailto:physics@usd.edu).

Senior Tenured Faculty, Physics Dept., Temple University, in all areas of Astrophysics particularly experimental/observational. Applicants must have his/her own high-quality research program with substantial research funding, and teaching experience. To apply, send CV, pubs list, research plan, current grant support, statement of teaching philosophy and 5 references, or for more info: <http://www.temple.edu/physics/news/positions.html> or Search Committee, Dept. of Physics, Temple University, 1900 N 13<sup>th</sup> 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, genomics and related research in China, Tengchong Geothermal Field, Yunnan Province. To apply send CV and research statement, or for more info: Dr Hailiang Dong, Dept of Geology, Miami University, Oxford, OH 45056, or [dongh@muohio.edu](mailto: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. Assist KATRIN neutrino experiment and at UCSB Nanofabrication Facility. Contact:

[bmonreal@physics.ucsb.edu](mailto:bmonreal@physics.ucsb.edu), Professor Ben Monreal or <http://hep.ucsb.edu/>

Postdoctoral Position, Syracuse University, Direct Dark Matter Detection. Experimental particle astrophysics group working with Cryogenic Dark Matter Search (SuperCDMS), AARM, and DEAP/CLEAN. Further info: <http://cdms.syr.edu/> Apply: <https://www.sujobopps.com/> (Job # 026971)

**Newsletter Editor:** Melissa Barclay

**Contributors:** Kevin Lesko, Bill Harlan (Sanford Lab); Yuen-Dat Chan (Radon workshop report); Milind Diwan (Video news); Steve Elliott, Derek Elsworth, Joe Wang (DuRA News); JoAnn Gage, Herb Wang (Deformation Monitoring at DUSEL Using Fiber-Optic and Water-Level Sensors); M. Gilchriese (Davis campus workshop report); Dongming Mei (CUBED Progress); Peggy Norris, Ben Sayler (Education and Outreach).

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