INTERACTION POINT

SLAC

November 7, 2003

First Evidence that Black Holes Lack Surfaces

By Heather Rock Woods

Looking for bright x-ray bursts in space, a research team headed by SLAC, the E.O. Hulburt Center for Space Research at the Naval Research Laboratory and the NASA Ames Research Center has nailed down a distinctive quality of black holes.

Black holes have fascinated astronomers since Einstein predicted them in his General Relativity theory. Since then, scientists have accumulated limited evidence for their existence. But until now, astronomers still took it on theoretical faith that black holes have 'event horizons' (the point of no return for matter falling into a black hole) but no solid surfaces.

The research team greatly strengthened the evidence that black hole candidates indeed do not have surfaces by looking for telltale signs of a surface—huge thermonuclear x-ray bursts created on the surfaces of other large, gravity-intense objects like neutron stars. A methodical search of celestial objects revealed that black hole candidates do not display these type I bursts, indicating the lack of a surface. The results appeared in the October 1 issue of The Astrophysical Journal.

"We have strong evidence that black hole candidates do not burst the way neutron stars do and that black hole candidates are indeed black holes," said Derek Tournear (EK), a Stanford graduate student in physics and the lead author of the paper.

One of the main ways astronomers distinguish neutron stars from black holes has been the presence or absence of type I x-ray bursts observed from the object. This classification method had never been systematically tested. To check the method's validity, the researchers classified their objects using other approaches, including mass and differences between how neutron stars and black hole candidates have been observed to release x-ray radiation (non type I). Neutron stars emit radiation that has more rapid variability than black hole candidates do. Only black hole candidates with a measured mass were used in the study. Their minimum mass is greater than the mass of neutron stars.

Photo by Diana Rogers

Derek Tournear (l) and Elliott Bloom (both EK), with Erica Raffaut, a Stanford graduate student who worked on the project.

The team then collected data on bursts from two space-based x-ray timing telescopes, the Unconventional Stellar Aspect (USA) Experiment— built jointly by the Naval Research Laboratory and SLAC—and the NASA Rossi X-ray Timing Explorer (RXTE). Both telescopes devoted a large fraction of their lifetimes to observing black hole candidates and neutron stars.

If stellar-mass black holes (roughly 10 times the mass of our sun) had surfaces, calculations published last year by Ramesh Narayan and Jeremy Heyl of the Harvard University Center for Astrophysics show they would also emit type I x-ray bursts at about the same frequency as neutron stars. Tournear and his colleagues couldn't find any bursts coming from black hole candidates, although they saw many coming from neutron stars. In addition to backing up black hole theory, this confirmed that bursts are

(See BLACK HOLES, page 2)

Visitors from White House Office of Science and Technology Policy

Photo by Diana Rogers

Michael Holland, a Senior Policy Analyst, and Kathie Olsen, Associate Director for Science, of the White House Office of Science and Technology Policy, visited SLAC on October 28.

Vacuum Group is an Integral Part of SLAC's Successes

By Anna Gosline

Researchers at SLAC work tirelessly to illuminate the mysteries of our universe, but it takes the hard work of the SLAC Vacuum Group to keep things crystal clear. Proper functioning of the linear accelerator and PEP-II requires pressures a billion times lower than atmospheric pressure and a spotlessly clean vacuum vessel. With over 20 miles of vacuum chambers, there is a constant need for maintenance and improvement. Thanks to the hard work of Vacuum Group technicians, physicists and supervisors, particle beams can speed their way unhindered to new discoveries in high energy physics.

Creating optimal pressures along the linac and PEP-II requires an intimate knowledge of the entire system. Physicists in the Vacuum Group are constantly looking for new technologies to improve and customize vacuum conditions, a search that has contributed to the outstanding beam luminosity achieved by PEP-II. "We make sure the vacuum system does not limit the beam lifetime," says Daniel Wright (AMS), who has been working with vacuums at SLAC for the past 26 years. From turbo-molecular pumps that mechanically draw out air to

(See VACUUM, page 3)

SSRL Sees Why Airplane Blades Fail Sooner than Expected

By Heather Rock Woods

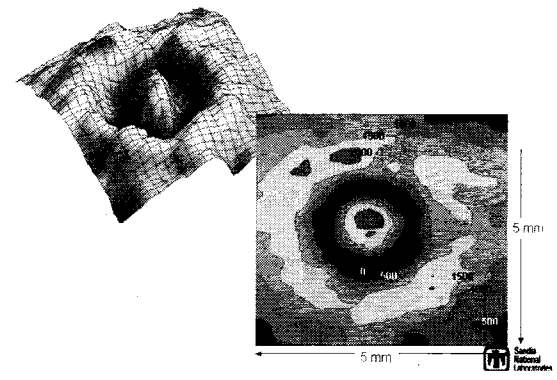
Aircraft turbine engines are prone to ingesting pebbles and other debris that can damage jet engine turbine blades, dramatically reducing the longevity of the components, sometimes catastrophically.

Failures associated with such 'foreign object damage' cost the aerospace industry an estimated $4 billion a year. Studies at SSRL have helped show how and why turbine blades—which normally experience significant stresses during flying—will fatigue more than 100 times sooner than expected from foreign object damage.

"The results of our study are important for people on the tarmac inspecting the blades, looking for damage and deciding whether that pinhead-size ding has damaged the blade catastrophically," said SSRL scientist Apurva Mehta (ESRD).

Working with principal investigator Brad Boyce (Sandia), Mehta and collaborators simulated the damage by firing small hardened steel balls onto a titanium alloy commonly used in turbine blades. At LLNL, these ball bearings were fired at 200 meters per second (m/s), or 450 miles/hour, and at 300 m/s, the typical velocities at which runway debris encounters turbine blades when planes take off and land.

At SSRL, the team examined the resulting damage with the unique abilities of synchrotron mesodiffraction (x-ray diffraction in the sub-millimeter scale); in this case, 0.3 mm to match the size scale of the damage.



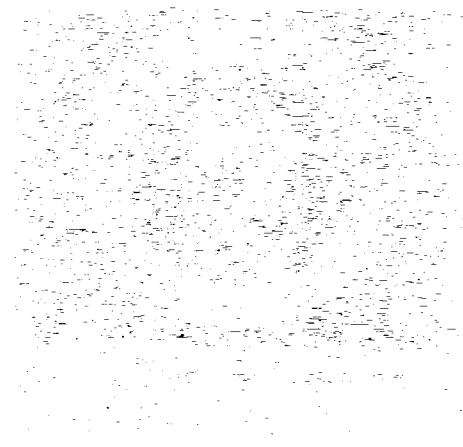
Graphic Courtesy of Apurva Mehta

Apurva Mehta and colleagues mapped the strain in the crater made by a steel ball fired at turbine blade material at 200 m/s. The central cone represents tension, the valley around the cone is under compression, and the strain levels out to normal beyond the crater.

"We wanted to see how things fail, the physics behind what happens. At 300 m/s the mode of failure is qualitatively different, and we wanted to understand why," Mehta said.

The x-ray images revealed the magnitude and distribution of

(See SSRL, page 2)



Director's Corner

By Jonathan Dorfan

Photo by Diana Rogers

One of my most important goals when I became director of SLAC was to accentuate the importance of a respectful workplace, one that is exemplified by a civil, courteous and supportive atmosphere. Having made this a priority in the workplace has had positive and tangible benefits for the Laboratory. Many of you have commented on the effectiveness of the respectful workplace policy in improving the quality of life at SLAC. At no time has the spirit of cooperation and mutual respect at SLAC been more visible than in this past year.

At the beginning of 2003 we were faced with a dismal prospect. The HEP budget was so constrained that it seemed inevitable that we would be forced to make large staff cuts through involuntary layoffs and to reduce the scientific program of the Lab. The Save Our Science/Staff plan was a possible solution, but it meant that the staff would have to make personal sacrifices to guarantee that none of their colleagues lost their jobs and that SLAC's science program could remain robust. It meant that each HEP-supported employee would have to take four days of unpaid leave, and would have to take the full allocation of vacation for 2003. It was a lot to ask and I hope I will never again have to confront you with making such deep and personal sacrifices for the health of our laboratory.

Your response was overwhelming support, and your willingness to sacrifice ensured that there were no involuntary layoffs and that we completed a successful year of research, maintaining SLAC's position as one of the world's great research laboratories. It was not easy and many of you had to make major adjustments in your life to meet the challenges. Because of your actions, mutual respect and mutual support is yet more deeply woven into the fabric of SLAC. Our approach to last year's hardship is admired both on campus and in the other national laboratories.

Our Human Resources Department is doing tremendous work to underpin this ethic of mutual support. The New Employees Orientation program and the excellent Certificate in Supervision program, now in its third year, come readily to mind. I take particular joy in the Employee Recognition Awards, better known as the 'Globies', which allows us to recognize colleagues who have demonstrated support for their coworkers, kindness and the desire to help others, qualities which build great organizations as much as the more obvious technical and professional skills.

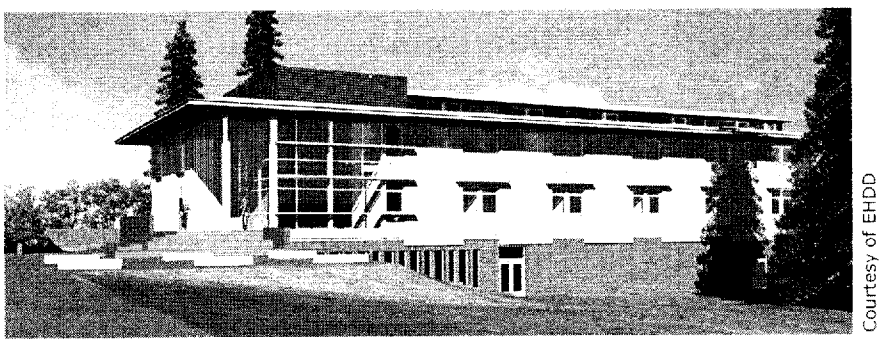
This year the Department of Energy asked me to write a vision statement for the Laboratory. I finished with this paragraph: "SLAC should not be assessed by its programs and facilities alone. The excitement and identification of the staff with the mission of the Laboratory are SLAC's most important assets. The staff has driven the success of the Laboratory, and their current commitment is a guarantee for future strength."

It gives me great pleasure to be able to write such a statement; I thank and congratulate you all.

KIPAC Holds Kick-off Event

By Linda DuShane White

The Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) held a Kick-Off Party on October 18, an event designed to introduce Kavli to the astrophysics community. About 100 scientists attended from both local universities and local DOE labs. "It was quite a success all around," said KIPAC Director Roger Blandford. "We had large contingents from LBNL and Livermore. We can complement each other in various ways." On the agenda were nine science talks as well as a Round Table discussion on future collaborations.



Courtesy of EHDD

An artist's rendition of the Kavli Institute, with Panofsky Grove to the right.

Inauguration of KIPAC took place on March 17. While the building is still in the planning stages, there are a great many things happening already with KIPAC.

Funded by the philanthropic physicist Fred Kavli, the new Institute will concentrate on current developments in astrophysics, high energy physics and cosmology, as well as collaborative work with other institutions and scientists. Blandford and Deputy Director Steven Kahn have offices in the Central Lab Annex (Bldg. 84) as well as at Stanford.

The KIPAC building is partway through the several stages of its design. "We had approval from the Board of Directors in October 2003," Blandford said. "We will do detailed design in February and groundbreaking in May 2004 with completion planned for 2005." He added, "At the moment it seems like it's going very well. We're very happy with it. It's meant to blend in with the SLAC central campus."

EHDD Architecture of San Francisco is designing the new facility. There will be a mid-size auditorium, seating about 150, and around 100 offices. Incorporated into the building's lobby will be an information center. The final design is still under discussion. Blandford has a vision for scientific meeting space, "On the top floor there will be a nice large conference room which I see being used for international meetings."

The new building will be situated between the Research Office Building (ROB) and Panofsky Grove. Great care is being taken not to disrupt the Grove. "In fact", said Blandford, "The landscaping is being taken quite seriously, and will be quite nice. There will be new trees, including new redwoods."

Jennifer Formichelli, Administrative Associate for Kavli added, "Large windows and a balcony are planned to take advantage of the view of the Bay."

For information see: http://www.ehdd.com/ and http://www-group.slac.stanford.edu/kipac/

Black Holes

(continued from page 1)

a useful way to differentiate neutron stars from black hole candidates.

The researchers can't completely rule out bursts from black hole candidates because they can't constantly observe the objects. However, their results show with 95 percent confidence that they would have seen bursts, even if black hole candidates burst at only 1/20th the rate of the neutron stars they observed. "We set good limits on whether black hole candidates have surfaces and we gave some teeth to the assumption that they do not," said co-author Elliott Bloom (EK).

These new observations are an important step forward in characterizing the real nature of black holes and confirming that black hole candidates are indeed black holes.

For more information, see: http://www.slac.stanford.edu/grp/ek/index.htm

SSRL

(continued from page 1)

residual stresses in and around the craters made by the ball bearings' impact. For example, the material was under tension in the center of the crater, under compression in a ring around the center, and under normal stress beyond the crater.

In 200 m/s craters, the actual stresses measured in the lab matched calculations from the finite-element models that engineers use to estimate residual stress. This shows that the models are dependable in predicting how much longer the dinged blades should last for impacts at 200 m/s and below. The team was surprised to find that the 300 m/s craters actually showed lower residual stresses than the 200 m/s craters. "It didn't match our intuition or the calculations' predictions at all," said Mehta.

Careful examination of the 300 m/s craters revealed large variations in residual stresses. The regions of lower stress often had micro-cracks created by the impact. Mehta and his colleagues believe these relieve the majority of the residual stress. It also explains the models' off-base predictions at 300 m/s. Micro-cracks, however, are the weak point in the material. Subsequent mechanical tests have shown the material invariably fails (and fails faster) there.

The good news is that not all impacts are harmful. The team found that residual stresses around a 200 m/s crater located in the central part of the blade goes away after a few cycles. However, impacts near an edge or an angle in the blades leads to unrelieved strain on sides, edges and corners that are not relaxed on cycling and become sites of fatigue failure.

"Our study tells maintenance crews to look not only for the size of the impact crater, but for its location and for signs of micro-cracks," Mehta said.

The funders of the study, the Lufthansa Technik AG, the U.S. Air Force and the U.S. Army, were excited about the results. Turbine blades are expensive, and the new data give more clues about which craters are dangerous and which might 'self-heal.'

This new understanding has been incorporated into a mathematical model of failure to help design new blades to prevent failures resulting from foreign object damage.

Boyce shared the results in a workshop last month called "Probing Mechanical Deformation and Failure via Synchrotron X-ray," during SSRL's 30th Annual Users Meeting.

"This example illustrates the utility of a synchrotron x-ray source to solve real-world engineering problems," said SSRL scientist Mike Toney.

Fall Logo-wear Sale

The Friends of the Linear Accelerator are pleased to announce their annual Fall sale of embroidered SLAC logo-wear from Lands' End.

Volunteers will be taking orders in the Main Lobby of the SLAC Guest House during lunch hour (Noon–1:00 PM) the week of November 10–14.

All logo-wear will arrive in plenty of time for the upcoming holidays.

For more information, contact Doug Kreitz at Ext. 4550, dougkr@slac.stanford.edu

Vacuum

(continued from page 1)

specialized ion pumps that charge and bind unwanted molecules, the Vacuum Group has a device to eliminate pretty much anything that comes their way.

Introducing new parts into the vacuum system to upgrade or service the system is, however, a precarious job. Any molecule present in the vessel can interact with the beam and ruin it. "A single fingerprint becomes a huge contamination," comments Dave Bostic (MFD), Operations Engineer. All vacuum parts must go through a rigorous cleaning process. After initial chemical cleaning, parts are assembled in clean rooms and then 'baked out' under high temperature and low pressure to burn off any trace contaminants and speed the release of absorbed air molecules.

Photo by Kelley Ramsey

The vacuum group is an integral part of SLAC.

Immaculately cleaned parts are then installed by field technicians, who must climb down to the belly of the accelerator and expose the delicate vacuum system to a host of contaminants. Portable clean rooms, or air showers, keep the dust and grime out of the vessel while technicians install parts. "The weight of all of our cleanliness effort is on the technicians shoulders at that point. They do an amazing job," says Bostic.

In addition to the daily operations, many technicians and supervisors have spent a sleepless night or two down in the linac or PEP-II, searching for leaks or part failures and fixing them fast. Experiments at SLAC run 24 hours a day and a serious problem with the vacuum system means major losses of data and money. "We've had people down there for three days, round the clock. It gets hard just to find someone for the next shift," says Matt Hayes (MFD), Vacuum Group supervisor.

Despite the long hours and close spaces, the Vacuum Group's commitment to innovation, quality and efficiency has consistently provided excellent vacuum conditions for particle physics research at SLAC. Their work is challenging and rewarding. "This is a fun place to be," says Hayes. Must be something in the air.

Celebration of Light: Diwali

By Sandra Czech

Photo by Diana Rogers

Kay Ganapathi (TD) and Kaustuv (EK) at the annual Diwali Celebration, which was held last month.

The noontime festivities included sumptuous Indian food, music, dancing and a raffle. Diwali falls on the new moon day between October and November and is also known as the 'Festival of Lights.' Ganapathi gave the welcome speech, and noted the celebration "brings the SLAC Community an understanding and appreciation of different cultures through food and music, which has no bounds."

Participants from around the site enjoyed the festival as they learned more about the Indian culture.

Clarification: When to Call 9-911

By Steve Mahaley

The last issue of TIP (October 17, 2003) contained an article that provided guidelines on when to call 9-911, and generated questions that are addressed below.

The 9-911 Service is Here for You

If you ever have any doubt about whether there is an emergency, call 9-911. The operators are trained to recognize what is and is not an emergency. If you can safely move and only have a minor injury, go to SLAC Medical (A&E, Bldg. 41) for treatment (open Monday through Friday, 8:00 a.m. to 4:30 p.m.). If the injury is severe or prevents the victim from moving, call 9-911 immediately. The fire station on site is available 24-hours a day.

9-911 is for Emergency Services

For any situation requiring emergency services, whether it is for ambulance, fire or police service, you do not need to know which service is appropriate. The 911 operator will know once you explain the situation.

Remember—if there is ever any doubt as to the nature of your situation, do not hesitate to call 9-911.

For more information, contact Steve Mahaley, Emergency Management Coordinator (Ext. 2095).

Protect the Environment During Construction

By Mike Hug

Excavating and grading soil can cause sediment and other pollutants to flow into storm drains. The content in storm drains then flows directly into streams and the ocean.

Sediment is Dirty

Sediment is the most common pollutant washed from work sites into storm drains. Once in the water supply it can clog fish gills, block sunlight needed by marine life and increase the ocean's water temperature. These consequences harm sea life and disturb the food chain upon which both fish and people depend.

Furthermore, poorly maintained vehicles or heavy construction equipment can leak fuel and oil. Sediment may soak up these chemicals, as well as other work-site pollutants such as pesticides, cleaning solvents, cement wash and asphalt which increases the potential harm from sediment runoff.

Act Preventively

SLAC personnel can employ simple measures to reduce the amount of sediment pollution.

• During construction, cover all excavated material with plastic or place it in a bin. If covering the piles is impractical, other protective measures can be used with the approval of the ES&H Construction Inspector (Ext. 4512).

• Protect the nearest catch basins with fiber rolls, berms or plastic to keep material from entering the storm drain system.

Photo by Mike Hug

Erosion control blankets cover bare soil and freshly graded surfaces.

• During the rainy season, cover freshly graded surfaces with erosion control blankets to minimize erosion.

• Finally, clean the work site at the end of each day.

Be a Good Soil Steward

Once construction is complete, there are a few steps you can take to further ensure construction activities do not damage the environment.

• Inspect all catch basins in the area of the site and clean if necessary.

• Remove construction debris from the entire site at the end of the project.

• Cover bare soil with seed and erosion control blankets.

• Revegetate the site with fast-growing annual and perennial grasses to bind the soil and prevent erosion.

For information or questions, please contact Mike Hug (Ext. 4042).

Registering and Submitting Documents Benefits Everyone

By Beck Reitmeyer

As Lab Director Jonathan Dorfan recently said, "A research institution's publication record provides an important measure of its success" (TIP, September 5, 2003). Register and submit your documents to the Technical Publications department (TechPubs), and help us give your paper—and the Lab—the attention it deserves.

Once you register and submit your document to TechPubs, they automatically send it through the Tech Transfer office, post it to the Web and include it in the SPIRES literature database. This also helps fulfill a requirement from the Director (All Hands Memo, February 8, 2000) and our mandate from DOE to collect, track and organize all written results of work done at SLAC.

Is it a SLAC Document?

Broadly defined, a SLAC document is a written work authored by a SLAC employee, user, subcontractor or visitor that is produced by using SLAC resources. The resource can be as earth-shaking as a new experimental result or technical breakthrough discovered at SLAC or as mundane as your office space or computer.

TechPubs offers a variety of document numbers to organize SLAC publications. For example, PUB numbers are used for papers that you can publish as journal articles, conference publications or lectures; R numbers are for technical reports, theses or conference proceedings; TN numbers are for technical notes or papers not being submitted to a journal or conference. To determine which type of number is right for your document, go to the idoc online registration system Web site at http://idoc.slac.stanford.edu/doctypes.htm or ask someone in the TechPubs department (http://www-group.slac.stanford.edu/techpubs).

Since we publish these documents to the Web, your papers quickly become available to colleagues within SLAC and around the world. On-line publishing has also helped us report SLAC's work annually, to the DOE and to win a DOE certificate of achievement "for successfully completing the transition from paper to electronic technical information reporting 3 years ahead of the DOE goal" (DOE Certificate of Achievement, March 15, 2002).

Fulfilling your author responsibilities is easy. Log on to idoc at http://idoc.slac.stanford.edu to obtain a document number and then follow the posted submission instructions to either FTP or e-mail an electronic version of your paper to us—we'll do the rest. Log on to idoc during our first annual Pub Week (November 17-21) to enter a drawing for your choice of prizes – no paper entry is necessary to win.

Remember that registering and submitting the document you've authored as a SLAC publication benefits both you and the Lab.

POLICIES AND PROCEDURES

Scrap Moratorium is Still in Place

In July 2000, DOE directed all its Laboratories to stop releasing certain scrap and salvage materials from their sites. Specifically, any material from radiological areas (RA's) or radioactive material areas (RMA's) needed to be held until the DOE developed new guidelines and procedures to handle this material.

This scrap moratorium (or 'hold') is still in effect, and it could be several more years before SLAC is permitted to release these materials.

To ensure SLAC's compliance with this DOE directive, all property or material going to Salvage needs to be surveyed by Occupational Health Physics (OHP). Call OHP (Ext. 4299) once you have filled out the Salvage Form on the Web. On this form, you will list the material to be salvaged and verify, to the best of your knowledge, if the material has been in either an RA or an RMA since July 2000. The form is available on-line from our Business Information System (BIS) website (http://www-bis.slac.stanford.edu/forms/Salvage_Form.pdf).

A final word. Please do not dump any material around the site. Contact Salvage (Ext. 2329) for detailed pickup and/or delivery instructions.

Contact: Alan Conrad, Assistant Property Manager, Ext. 2329, alanc@slac.stanford.edu

SLAC Run, Walk 'n Roll November 20

Benefits Open Enrollment Underway

Open Enrollment, the annual 3-week-long period for enrolling in next year's benefits programs, began Monday, November 3, and concludes Friday, November 21. Please see http://benefitsu.stanford.edu/pdf/news_fall_2003.pdf for complete information.

Web Inventor Visits SLAC

Photo by Diana Rogers

Web pioneers (l to r) Paul Kunz (EK), Tim Berners Lee (web inventor), and Bebo White (SCS) look at the first web pages published in America.

Traveling Resource Center to Visit Bay Area Again

By Lee Lyon

I want to inform you of another visit to the Bay Area by the Traveling Resource Center associated with the Energy Employees Occupational Illness Compensation Program Act (EEOICPA).

SLAC and DOE wish to inform you that you may be eligible for this important Federal benefits program and to let you know how you can apply or get more information.

As a reminder of this program, during the Cold War, workers employed in the nation's atomic weapons program or other programs may have been exposed to radioactive and toxic substances. In 2000, Congress passed the EEOICPA to provide assistance to those workers who have become ill as a result of employment at atomic weapon facilities or other facilities. Individuals, or their eligible survivors, who were an employee, contractor or subcontractor at a DOE facility, such as SLAC, may be eligible for benefits under this program.

Program Administered by the Department of Labor (DOL)

The federal portion of the EEOICPA, administered by the DOL, was enacted to provide compensation to workers with cancer, beryllium disease or silicosis. Employees, or their survivors, whose claims are approved may receive a lump-sum payment of $150,000 and medical benefits for the covered illness.

Program Administered by DOE

DOE has established independent physician panels of occupational medicine doctors to review whether workplace toxic exposures may have caused or contributed to DOE workers' occupational illnesses. If there is an affirmative finding, DOE will assist the worker in filing a claim with the state workers' compensation program. Toxic-related illnesses could include asbestosis, liver disease, nervous system disorders, non-cancerous respiratory or kidney disease, heavy metal poisoning, certain reproductive disorders, or other diseases.

To Apply or Get More Information

The DOL and DOE are sponsoring a Traveling Resource Center to help current, retired or former SLAC workers file applications or get more information.

When: Tuesday, November 18 and Wednesday, November 19, 8:30 a.m. to 6:00 p.m.

Where: Sheraton Four Points Hotel, 5115 Hopyard Road, Pleasanton (925) 460-8800

You may drop by or make an appointment by calling toll free 1-866-697-0841 between the hours of 8:30 a.m. and 6:00 p.m. PST. You can also get more information or file a claim through this number as well.

For questions or to file an application, visit the Traveling Resource Center in Pleasanton on the dates and at the locations given above.

MILESTONES

Service Awards

5 Years
Bray, Arthur (SCS), 11/1
Brown, Christopher (MFD), 11/2
Tran, Henry (OHP), 11/12

10 Years
McMillen, Kathryn (KLY), 11/15
Wolf, Zachary (MM), 11/15

15 Years
McMahon, Noel (SEM), 11/1
Debarger, Scott (ACC), 11/1
Chan, Andrea (SEM), 11/2

20 Years
Eichner, John Paul (KLY), 11/9

Deceased
Franey, Paul, formerly with PMS (retired 1992), on October 21, 2003

To Submit a Milestone, see: http://www.slac.stanford.edu/pubs/tip/milestoneindex.html

See Awards and Honors at http://www.slac.stanford.edu/slac/award/

Upcoming Events

Mon., Nov. 10, 12:15 p.m.
Stanford University,
Tresidder Union, Cypress Room
Robin Mamlet, Stanford U.
Selective College Admission: What's a Parent to Do?

Mon., Nov. 10, 4:15 p.m.
SLAC, Panofsky Auditorium
(Refreshments-3:45)
SLAC DEPARTMENTAL COLLOQUIUM
Sidney Drell, SLAC
The Gravest Danger: Nuclear Weapons and Their Proliferation

Tue., Nov. 11, 12:30 p.m.
SLAC, Orange Room
SLAC EXPERIMENTAL SEMINAR
Steve Olsen, U of Hawai'i
X (3872) - Belle

Wed., Nov. 12 10:00 a.m.
UCSC, ISB Rm 310
UCSC SCIPP EXPERIMENTAL SEMINAR
Joel Primack/Don Coyne, UCSC
Highlights from the INPAC and Kavli Institute Meetings

Wed., Nov. 12 10:00 a.m.
UCSC, ISB Rm 310
UCSC SCIPP EXPERIMENTAL SEMINAR
Ghazal Geshnizjani, Brown U.
Early Universe

Thu., Nov. 13, 12:30 p.m.
SLAC, Orange Room
SLAC EXPERIMENTAL SEMINAR
Marek Karliner, Tel Aviv U.
Theoretical Interpretation of the Pentaquark

Mon., Nov. 17, 4:15 p.m.
SLAC, Panofsky Auditorium
(Refreshments-3:45)
SLAC DEPARTMENTAL COLLOQUIUM
Robert Full, UC Berkeley
Robotics Geckos etc.

Please send additions to: seminars@slac.stanford.edu
For complete event listings, see: http://www.slac.stanford.edu/grp/pao/seminar.html

The Interaction Point

Editorial Team
Neil Calder
Nina Adelman Stolar
Katherine Bellevin
Vickee Flynn
Ziba Mahdavi

Writers
Heather Rock Woods
Linda DuShane White
Anna Gosline

Photography/Graphics
Diana Rogers
Michael Hyde
Nicolle Rager

Distribution
Crystal Tilghman
Tineke Graafland
Emily Ball (on-line)

The Interaction Point is published twice monthly every first and third Friday. Submissions are due the second and fourth Tuesdays of each month.

Send submissions to tip@slac.stanford.edu, or mail to TIP Editor, MS 58, Stanford Linear Accelerator Center, 2575 Sand Hill Road, Menlo Park, CA 94025.

TIP is available online at: http://www2.slac.stanford.edu/tip/