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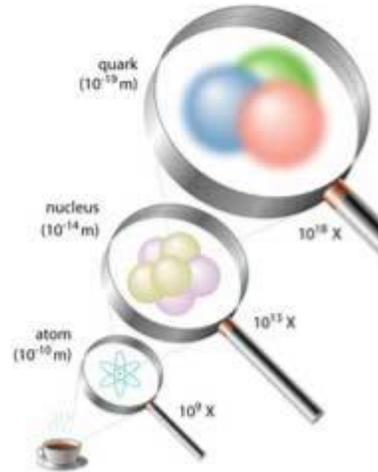
Thirty Years of Quarky Nuclear Physics

By Heather Rock Woods

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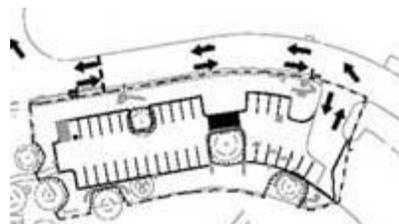
Like ecologists who want to understand the behavior and ecological niche of a newly discovered species, a SLAC user group formed by the late Benson Chertok (American University) began using high-energy electron beams to learn about quarks in their natural habitat—protons, neutrons and combinations of protons and neutrons that form the nucleus of an atom.

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By Shawne Neeper



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By Doug Kreitz

Attendees at the 3rd annual Safety and Security Briefing held on September 22 reacted enthusiastically to the revised format and solid content of the talks.

Staff comments from the 2003 event influenced the topics and helped shape the overall format this year—fewer speakers, timely and concise information and more interesting visuals. We are pleased to report that, based on 400 staff surveys returned, many felt this year's program was the most valuable one they had attended to date.

[See whole story...](#)

Trim That V: Drive

By Shawne Neeper

You probably received the e-mail sent out August 30 with the subject heading: Quotas Now Implemented on Windows Disk Space. It announced new limits on space usage in SLAC's Windows network drives. Your individual 'user' drive, usually mapped as the Z: drive, has an initial limit of 500MB, or six

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parking to support the future Kavli Institute for Particle Astrophysics and Cosmology (KIPAC), and it is nearly finished. Next will come Phase II—construction of the three-story building, which will require occasional closures of the Loop Road.

The current work extends the existing parking lot to the east and downhill from the Cafeteria.

[See whole story...](#)

percent greater than your existing usage, whichever is greater. The 'group' or V: drive gets the larger of 10GB or 10 percent greater than current usage.

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Staff comments from the 2003 event influenced the topics and helped shape the overall format this year—fewer speakers, timely and concise information and more interesting visuals. We are pleased to report that, based on 400 staff surveys returned, many felt this year's program was the most valuable one they had attended to date.

Safety and Security Topics Covered

Jack Hahn (ESH) led off by illustrating that common sense actions related to walking (look where you are going), stair safety (use the handrail) and material handling (wear gloves) could be valuable in reducing our accidents, based on an analysis of recent events. These three simple steps were considered to be related causes to over 20 percent of recent accidents. Hahn also covered ladder and electrical safety. Everyone attending passed the 'pop quiz' he gave at the end of his talk.

Teresa Downey (SCS) followed with an informative presentation on 'Phishing', with examples of 'spoofed' e-mails and fraudulent websites designed to fool recipients into divulging personal financial data. She gave information on how to protect computers, both at work and at home, from virus attacks.

Lauren Schoenthaler (Stanford Office of the General Counsel) spoke about the consequences of the illegal downloading of copyrighted material (movies, songs, articles, etc.) and the laws regarding posting copyrighted material on the Web.

Rick Yeager (BSD) gave helpful tips and reminders about Site Safeguards and Security and the importance of protecting the site's wildlife (SLAC is a nature preserve).

Top Ten Take-Away Countdown

10. Expect the unexpected when you travel overseas
 9. Respect SLAC's wildlife
 8. Follow the posted speed limits on site
 7. Think before you click—watch out for 'spoofed' e-mail and fraudulent Web sites
 6. Protect your computer at home and at work from viruses
 5. Copyrights extend to the Web—link to Web site, don't copy content
 4. Choose the right ladder for the job
 3. Use the handrails on stairs
 2. Walk safely—look where you are going
- And the number one take-away is:
1. Integrate both Safety and Security into how

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Steve Minnear (DOE Office of Counterintelligence) provided you approach your work insights and tips on travel overseas for both business and pleasure. He shared excerpts from several of our colleagues' trip reports to illustrate that while overseas travel is still safe, you should always expect the unexpected.

Presentations Available On-line

For streaming media of the talks and copies of the presentations, see: https://www-internal.slac.stanford.edu/bsd/ISSM/safety_security04.htm

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Isn't Disk Space Cheap?

Disk space is cheaper every year, so many of us have developed the habit of keeping any file that might some day prove useful. It can also seem daunting to comb through many years' accumulation to sort the needed from the unnecessary. As a result, the use of storage space for personal and group files has doubled every year for the last six years, according to Richard Mount (SCS), associate director for computing services. "Even if you imagine that the current rate of hardware price decreases will continue," Mount said, "with storage doubling every year, we will be spending the entire SLAC budget on this in 20 years."

"Another reason [for the quotas]," Mount explained, "is that we have run out of space." SLAC's Windows network storage consists of two big boxes containing more than 100 hard drives each, plus about a half-dozen Dell computers that serve the data. There is no more money in this year's budget to increase that storage space, so SCS devised the quotas to encourage SLAC computer users to delete unnecessary files. "If somebody fills up the disk then a large number of people can't work," Mount said. "The quotas are keeping us from disaster."

Windows Space Request

Take heart. Those who need more space can get it. You will receive e-mail notices as your usage approaches its quota. When you reach 100 percent, you will be able to save any open files, but will need to clear space in order to add files to the server. If you have removed unnecessary files but require more space, fill out the Windows Space Request form on the Web: http://www2.slac.stanford.edu/comp/helprtrak/Public/STsubmit2_remedy1.asp?Catg=Windows&CItem=Space%20Request

Windows network storage for SLAC 'user' and 'group' drives currently requires devices costing a few hundred thousand dollars per year, Mount said. The equipment, and salary for the six employees who maintain this and other network services, are currently funded by indirect cost money—overhead taken from the Lab budget that supports the telephone system, basic site network and e-mail, as well as Windows disk storage.

"While disk usage was small, using Lab overhead money was appropriate," Mount said. However, as disk usage increases, it will be desirable to fund project-related storage through direct costs—money associated

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with projects and science. SCS is working on a proposal that will ask SLAC employees to separate project data from files related to individual work, such as letters and CVs—items that would not normally be passed to a job successor.

Under the new proposal, individuals' files belong on the user's home directory, the Z: drive, which is expected to use relatively little space. Project work requiring vast amounts of data storage will reside on the group drives. The cost of the large-scale storage would be shared by the divisions using the space. "The beauty [of this approach] is that we get some money to provide space, and avoid having a committee deciding who gets what," Mount said. "So we begin to tie the really large use of space for science into the projects." The final definition of the proposal is pending, and will require approval of all SLAC division leaders.

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On the heels of discovering quarks 35 years ago, SLAC pioneered a new field called high-energy nuclear physics to delve into the quirky behavior of quarks.

Like ecologists who want to understand the behavior and ecological niche of a newly discovered species, a SLAC user group formed by the late Benson Chertok (American University) began using high-energy electron beams to learn about quarks in their natural habitat—protons, neutrons and combinations of protons and neutrons that form the nucleus of an atom.

This small field produced rich results vital to both high-energy physics and lower-energy nuclear physics. "The recipe for our experiments was always the same: use the unique SLAC capabilities to do brand new things to learn about how quarks and gluons work," said long-time group leader Ray Arnold (UMass).

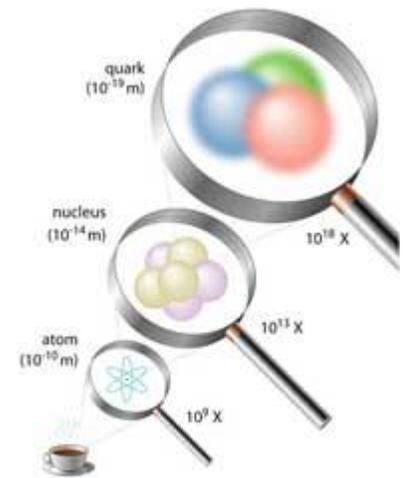
The group switched from American University (AU) to the University of Massachusetts, Amherst (UMass) about five years ago. The core group consisted of Arnold, Steve Rock, Zen Szalata and Peter Bosted. During its 30-year tenure, the group observed where quarks reside in the nucleus, how much momentum quarks carry and how quarks interact with each other and with gluons—the particles that carry the strong force. The strong force holds three quarks inside each proton and neutron and keeps the nucleus intact.

Nuclear physics is concerned with the nucleus; it has always been unclassified research and has nothing to do with weapons research. The small group conducted more than 20 experiments, trained legions of students and created and ran a separate injector for the linear accelerator. Their experiments, along with theoretical work done at SLAC, were among the important motivations for building a laboratory dedicated to nuclear physics—the Thomas Jefferson National Accelerator Facility (JLab) in Newport News, Virginia.

The Strength of Quarks

The group started by challenging the conventional wisdom at the time, which said quarks were inert building blocks whose behavior did not influence a nucleus' properties. That's true when you look at the nucleus as a whole at low energies, where individual quarks are not visible.

However, the traditional rules don't apply when looking at shorter distances (inside the nucleus) at high



Three quarks make up each proton and each neutron. Protons and neutrons form the nucleus of an atom.
(Graphic by Alan Chou)

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Many of the participants in the E-101 experiment are shown in this photo circa 1977. Top row (left to right): Richard Zdarko, Steve Rock, Ivan Schmidt, Benson Chertok. Bottom row (left to right): Bernhard Mecking, Ray Arnold, Zen Szalata. (Photo courtesy of Ray Arnold)

energies. For this scale, physicists were developing a set of equations called Quantum Chromodynamics (QCD) that describes strong force interactions. "We hit the quarks as hard as we can with high-energy electrons and see how they behave," Arnold said. It turns out quarks exert a surprisingly strong effect, influencing nuclear structure—including the ability of the struck nucleus to stay intact—through electric, magnetic and spin properties.

In their first experiment, E-101, the group looked for an extremely rare event: deuterium nuclei (composed of one proton and one neutron) that remained in one piece even under heavy electron fire. It took from hours to days to catch each event. "More commonly, the electrons knocked a proton or neutron out of the nucleus," said Rock.

However, the rare case—intact deuterium—occurred more often than expected by traditional nuclear physics. It followed the pattern predicted by dimensional counting rules, newly developed by theorists Stan Brodsky (THP) and Glennys Farrar (New York University) and extended to electron-deuterium scattering by Brodsky and Chertok.

The rules, an approximation for QCD at short-distances, say that the more quarks in the nucleus, the lower the probability that the nucleus will stay intact. For example, a hydrogen nucleus (one proton, three quarks) is much more likely to stay together than a helium-4 atom (two protons, two neutrons, 12 quarks). Like trying to keep sheep moving in the same direction after lightning has struck, the more sheep, the harder it is to keep the herd together.

What keeps the nucleus unexpectedly whole is the interaction between quarks and gluons. A proton stays intact when its three quarks keep their momentum pointed in the same direction through exchanging gluons. When an electron strikes a proton, it knocks the quarks' momentums into new (and usually separate) directions. Only when the two gluons exchanged between the three quarks have exactly the right kinematics, the right alignment—like a flawless baton pass on a three dimensional racetrack—does the proton stay cohesive.

"They were the first to say you could see quark and gluon degrees of freedom controlling the physics of the nucleus," Brodsky said. "The quarks and gluons actually make a difference."

Picture the proton as a fuzzy ball of stuff, a smear, with particles coming and going. In the quantum smear, quarks constantly exchange gluons with each other.

—Ray Arnold

Fixed Target Experiments

Working with scientists from many other institutions, the AU/UMass group made prolific use of End Station A to do electron scattering experiments. Over the years, the electron beam smashed into fixed targets of deuterium, helium-3, helium-4, other nuclei, electrons, and polarized protons and neutrons. Some of the

targets were very complicated and difficult to work with, like high-pressure gas targets kept near a temperature of absolute zero (Kelvin).

"It was a technical tour de force making the helium-3 target," said Rock, referring to an early experiment. He still has an early aluminum prototype, about a foot long, with a hole blasted through it from a pressure test.

Nuclear Physics Highlights

Here are some highlights from three decades of collaborative work at the high-energy frontier of nuclear physics:

- Measured the electric and magnetic properties of quarks in neutrons and protons.
- The Nuclear Physics at SLAC (NPAS) program—an independent injector near the end of the linac that operated for six years in the 1980s. Arnold directed this program, which had its own program committee to select among novel experiment proposals from multiple user groups. The AU/UMass group conducted experiments at NPAS and also provided technical support to other users.
- Demonstrated that quarks have completely different behavior in different elements of the periodic table—a radical and surprising finding. In heavier nuclei, such as iron, quarks tend to share or overlap momentum, making it harder to find a quark at high momentum (high-energy) than in lighter nuclei. The group tested this effect on elements including carbon, aluminum, silver, gold and iron.
- In the 1990s, worked in collaboration with other groups to measure the spin structure of protons and neutrons, finding that quarks carry less than half that spin. "More spin is being carried by gluons and transitory quark-antiquark pairs than we first expected," Arnold said of the results.

Outstanding Experimental Research

"It was an era of great accomplishments," said Brodsky.

Arnold received the Bonner Prize in Nuclear Physics in 2000 from the American Physical Society for outstanding experimental research. He was awarded: 'For his leadership in pioneering measurements of the electromagnetic properties of nuclei and nucleons ... that addressed the fundamental connection of nuclear physics to Quantum Chromodynamics and motivated new experimental programs.' (See <http://www.aps.org/praw/bonner/00winner.cfm> for complete details.)

One program, NPAS, was explicitly funded by DOE as a feeder program to stimulate physics ideas and help train students and post docs who could move on to JLab when it began running experiments in 1994.

The high energies at SLAC provided an experimental region where one could both make theoretical calculations and take measurements to test the theory.

—Steve Rock

The SLAC-JLab connection is strong. Bosted, a long-time AU/UMass physicist now works at JLab, as well as many students who trained with the group, including Allison Lung, now JLab's assistant director.

"Some of the first experiments done at JLab repeated and extended measurements beyond those from our earlier SLAC data," Arnold said. JLab can achieve better

precision but uses lower energies, which limits some types of experiments (like how gluons carry spin), while allowing many other types of experiments not possible at SLAC.

Budgets for high-energy nuclear physics—which falls between lower-energy nuclear physics and very high-energy particle physics—have dried up. “The experiments we did at SLAC were the first glimpses of what was in there, but there are a billion more questions,” Arnold said.

For more information on End Station A, see <http://www2.slac.stanford.edu/vvc/experiments/esa.html>

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The current work extends the existing parking lot to the east and downhill from the Cafeteria. The new parking area lies inside the northeast bend of the Loop Road—after entering SLAC from Sand Hill Road, make a left turn onto the Loop Road from the Main Gate.

During construction, traffic re-routing will continue to vary depending on what operations are needed, explained Jerry Jobe (BSD). For instance, the construction contractors will close the east side of the Loop Road when they need to move heavy equipment and dirt. Jobe asked that everyone stay alert for either a flag man or traffic.

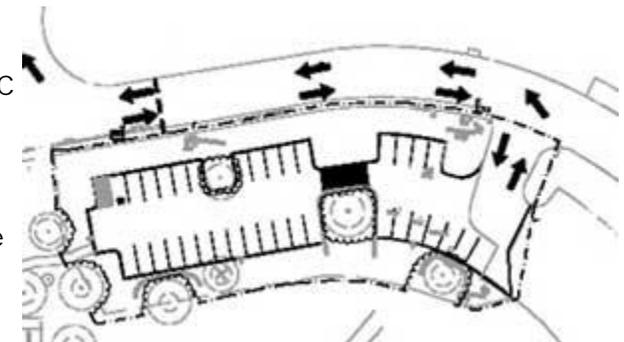
Parking lot construction began September 13 and is expected to last until mid-October—approximately five weeks total. “At the end of that, we should have a new parking area that will accommodate about 35 cars,” Jobe said. It will be open just in time to replace a portion of the Visitor’s Lot that will be needed as a construction staging area when work begins on the Kavli building.

“Provided some hurdles can be overcome, and pending approval from the Stanford Board of Trustees, the building construction will probably start in mid-October,” Jobe said. Milpitas-based Devcon Construction, the general contractor who built the SLAC Guest House, has nearly completed the parking lot and is expected to finish the building in about one year.

“During building construction the Loop Road will be closed going the other direction from time to time,” Jobe said, and there will be construction vehicles and equipment moving around the site. “People will need to be more alert driving around the Loop Road.”

No Worries About the Trees

Construction plans for the building and parking area were designed to accommodate SLAC’s trees, which will provide welcome shade for parked cars. Existing trees appear as circles on the project site plan. “We go



This plan shows the layout of the new parking area. The arrow in the upper-left corner leads to the Main Gate. (Drawing courtesy of Kingston Chan)

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around the trees, and protect them," said Kingston Chan (SEM), the project engineer who helps coordinate with Stanford and Devcon.

Some trees will even be relocated and replanted elsewhere on SLAC grounds. "If it's an oak, we definitely save it," Chan said. One tree, in particular, is slated for special treatment. A commemorative flowering cherry tree, planted in honor of Director emeritus W.K.H. 'Pief' Panofsky (DO), will be moved from its present site near the redwoods in Panofsky Grove to make way for the new building.

The KIPAC inauguration and groundbreaking took place this spring and summer. For more information, see <http://www2.slac.stanford.edu/tip/2003/mar21/kavli-event.htm> and <http://www2.slac.stanford.edu/tip/2004/jul16/kavli.htm>

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New Flea Market Debuts

By Emily Ball

A new on-line Flea Market launched this week on SLAC's Web site. Built on the SLAC Today platform, the redesigned Flea Market has a number of important features:

- Sort listings by date, category or title
- Delete and edit your own ads at any time
- Add a photo and Web link to your ad

As always, ads are reviewed and approved before being posted. Thanks to everyone in TIS, SCS, ES&H and COM who helped put this new system together.

You can find the Flea Market on SLAC Today, or see: <http://today.slac.stanford.edu/fm/>

Date Posted	Category	Title
30 Sep 04	For Sale	Sony Mavica digital camera
30 Sep 04	For Sale	HP Compaq 2400
29 Sep 04	For Sale	1990 Chevrolet Truck
29 Sep 04	Wanted	See details on today.slac.edu. Take advantage of reduced price community!
29 Sep 04	For Sale	HP Gas Refrigerator
28 Sep 04	Free	Shufflers
28 Sep 04	For Sale	12 Pound Simpson Cyclists
26 Sep 04	For Sale	Truck for sale
26 Sep 04	For Sale	1993 Honda 1000
27 Sep 04	For Sale	Agency Romance Books - hundreds
27 Sep 04	For Sale	Crucifixes and Chains
23 Sep 04	Free	1991 Ford Escort

The new Flea Market main screen. (Image courtesy of SLAC)

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Computer-based Safety Training

By Paul Bloom

By now, most of you should be familiar with the EOESH and GERT computer-based training (CBT) offered by the ES&H Training Group at nine satellite computer locations around the SLAC site. The response we have received from you, the SLAC community, has been overwhelmingly positive regarding your experience in taking computer-based versions of these two courses.

Since February 2003, over 2,600 EOESH and GERT courses have been taken using CBT. If you calculate that each CBT course takes about an hour to complete as opposed to sitting half a day in class, the Lab has saved tens of thousands of dollars in employee time alone. We have you to thank for the success of this program.

What you may not be as familiar with are the 15 other safety courses ES&H Training offers by CBT, including courses such as Electrical Safety for Non-Electrical Workers and Lead Safety.

Unlike the EOESH and GERT courses, access to these 15 CBT courses was limited to our training lab in Building 24. For your convenience we have added three more computer stations around SLAC where you can take these courses. You can contact the following people to schedule an appointment for CBT safety courses at any of the four locations.

Location and Contacts

Bldg. 24: Terry Ash (ESH), Ext. 2688, tomboy@slac.stanford.edu

Bldg. 34: Deborah Lilly (ESD), Ext. 3514, dlilly@slac.stanford.edu

Bldg. 44: Mary Regan (KLY), Ext. 3602, mary@slac.stanford.edu

Bldg. 25: Dianna Beebe (MFD), Ext. 4576, dbeebe@slac.stanford.edu

I encourage you to try out our CBT courses at one of these locations. I am sure that you will find them an easy to use—and often fun—way to learn critical safety material. ES&H training will continue to seek out new ways to improve safety training at SLAC in order to make it more convenient to get the training you need to perform your work safely and confidently.

For a complete list of our computer-based courses, please see: www-group.slac.stanford.edu/esh/training/trainops/cbtcourses.html

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Winter Shutdown

By Lee Lyon

SLAC will be closed December 18 through January 2 with the exception of staff members who are requested to work for a critical or programmatic reason and those needed to ensure site safety and security. PEP-II and BABAR will run with a skeleton crew through December 23; GLAST will continue work on some critical path tasks; and SSRL will run SPEAR3 through December 22 and will have a small crew doing installation work. Management in those areas will inform employees of their schedules. Employees not specifically requested to work are asked not to come to the site.

This year Christmas falls on a Saturday. The Laboratory, except for a few areas, will be closed from Friday, December 17, at midnight (0:00) through Friday, December 31, at midnight (0:00). University holidays are December 24, 27 and 31. Of the seven remaining normal work days during those two weeks, December 23 and 30 are University paid days off. Staff members who are required to work on the paid days off will have the time added to their vacation balance.

Staff will have to use personal time or vacation time to receive full pay for the other five days. All employees will have five days to cover with leave in order to maintain full pay. Employees may take some or all of the time as leave without pay if they choose.

We will again allow staff to borrow their three Personal Time Off days, their Floating Holiday (formerly Birthday Holiday) and their January vacation accrual from calendar year 2005 to assist with maintenance of pay during this shutdown.

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Special Academic Pricing for SLAC Employees Ends October 15

By Anita Piercey

Did you know that SLAC employees are eligible for Apple's Academic Pricing via the Stanford Bookstore or Apple Education On-line Store?

Through October 15, Apple is running a special promotion called 'Cram and Jam'.

Buy any iBook or PowerBook with an iPod and get \$200 back*; purchase an HP printer and receive an additional rebate up to \$99. For complete rules see: <http://www.apple.com/education/cramandjam> and <http://apple.com/promo/greatlookingdeal>

Visit the Stanford Bookstore Computer Store or visit The Apple Store On-line, see: <http://www.apple.com/education/store> to learn about other Apple special bundles being offered.

A Stanford ID card is required to receive academic pricing.

*Offer excludes the 12-inch iBook with CD-ROM drive and iPod mini. Offer expires October 15, while supplies last.

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TIP Holiday Publication Schedule

Plan your articles now! The Interaction Point will be published on the following days through January 2005:

October 15

November 5

November 19

December 10

January 21

Stories are due 10 days before publication date. For more information, see:

<http://www2.slac.stanford.edu/tip/>

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Get your message out to the SLAC Community!

Post it on

SLAC Today

- Events
- Announcements
- News

<http://today.slac.stanford.edu/>

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MILESTONES

Service Awards

5 Years

Dong, Danning (EE), 10/11
Seryi, Andrei (NLC), 10/9
Siegmann, Hans (ESRD), 10/6
Wachsmann, Alf (SCS), 10/4

15 Years

Albaniel, Francisco (KLY), 10/2
Krauter, Karey (ESD), 10/9

20 Years

Schultz, David (NLC), 10/15
Scott, Joan (PUR), 10/1

25 Years

Benitez, Wilevaldo (MFD), 10/1
Goldsberry, Richard (KLY), 10/8
Onaga, Kazuko (BBR), 10/5

35 Years

Snowberger, Gary (ESD), 10/13
Tilghman, Crystal (TIS), 10/1

Retired

Loens, Ed (SEM), 9/1

To submit a Milestone, see:

<http://www.slac.stanford.edu/pubs/tip/milestoneindex.html>

See Awards and Honors at:

- [HAVE QUESTIONS ABOUT INVESTING YOUR RETIREMENT?](#)
- [Upcoming Events](#)

<http://www.slac.stanford.edu/slac/award/>

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The Stanford Linear Accelerator Center is managed by [Stanford University](#) for the [US Department of Energy](#)

Last update Wednesday September 29, 2004 by [Emily Ball](#)

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Give Blood Today, Save a Life Tomorrow

Wednesday, October 13

8 a.m. to 3 p.m.

Panofsky Auditorium

<http://www-group.slac.stanford.edu/hr/d/blooddrive.html>

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HAVE QUESTIONS ABOUT INVESTING YOUR RETIREMENT?

Representatives from Fidelity, Vanguard, and TIAA-CREF will be holding individual counseling sessions at SLAC. Please contact them directly to set up an appointment:

Fidelity
 October 12
 November 9
 December 7
 call (800) 642-7131

Vanguard
 October 14
 November 15
 December 9
 call (800) 662-0106
 ext. 14500
www.meetvanguard.com

TIAA-CREF
 October 19
 November 17
 December 14
 call (800) 842-2007
www.tiaa-cref.org/moc

All sessions will be held at:
 Building 280, Module A, Room 180

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TIP is available online at:

<http://www2.slac.stanford.edu/tip/>