July/August 2005

ON TARGET

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY • A DEPARTMENT OF ENERGY FACILITY

Congratulations FEL group on winning R&D 100 Award

JLab's Free-Electron Laser (FEL) and the nine scientists and engineers who created it, were recently selected for one of R&D Magazine's R&D 100 Awards for 2005. The FEL was one of R&D Magazine's picks for the 100 most technologically significant new products of 2005. Story to follow in the September 2005 *On Target.*

JLab Users discuss scientific results, 12 GeV science, ongoing budget concerns at annual meeting

Nuclear Science research budget concerns and an exciting list of agenda topics brought more than 200 Users to the Jefferson Lab Users Workshop & Annual Meeting, June 20-22. "The Challenges of QCD and the Opportunities of the 12 GeV Upgrade" was the theme for this year's event, which kicked off with Paul Stoler (Rensselaer Polytechnic Institute), outgoing Users Group Board of Directors (UGBOD) chair, installing incoming chair, Gordon Cates (University of Virginia), and handing over the "meeting bell."

JLab Director Christoph Leemann welcomed an auditorium filled to capacity; he mentioned some research highlights being presented at the

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At right: Gordon Cates (UVA), JLab's new Users Group Board of Directors chair, listens to a question from a user during the annual meeting.

Below: JLab's auditorium was full to capacity at the Town Meeting during the users annual meeting and workshop.

Improving environmental stewardship

JLab moves closer to implementing Environmental Management System

JLab's EMS implementation and self-audit team members

Management Representative
Mary Erwin

Debra Brand
Dave Buckle
Kelly Dixon
Dennis Dobbins
Linda Even
Carter Ficklen
Tom Hassler
Charles Hightower
Patty Hunt
Dave Kausch
Walter Kellner
John LeRose
Danny Lloyd
Debbie Magaldi
Jim Murphy
Phil Mutton
Dena Polyhranakis
Sandy Prior
Tim Rothgeb

Previous Participants
Bill Chronis
Rebecca Yasky

Jefferson Lab has always worked to be an environmentally safe workplace for its employees and users, as well as for the larger Hampton Roads community. And in that spirit, over the last 15 months, it has accomplished major milestones toward becoming an even better steward of the environment as it conducts world-class physics experiments.

The Lab is well on its way to becoming an ISO 14001 compliant research laboratory. ISO 14001, Environmental Management System (EMS), is one of the most widely known standards set forth by the International Organization for Standardization. More than 37,000 organizations from well over 100 countries worldwide are already certified as meeting its requirements. ISO 14001 provides a framework to help businesses and organizations of all types to better manage the impact of their activities on the environment and to demonstrate sound environmental management. It does this by providing a structure through which an organization can identify and put in place a process that helps to minimize harmful effects on the environment caused by its activities, and to pursue and achieve continual improvement of its environmental performance.

In achieving the criteria required for ISO 14001 compliance, Jefferson Lab will also meet the federal government's requirement to develop and institute an EMS in accordance with Executive Order (EO) 13148, Greening the Government through Leadership in Environmental Management. This order mandates that JLab and all other Department of Energy facilities develop and implement an EMS. The EMS will provide environmental management oversight demonstrating that these government facilities are formally addressing all of their operations and activities that have or could have a significant impact on the environment, and that specified objectives and targets have been set to reduce those impacts.

"Since May 2004, the EMS implementation team has spent a significant amount of time setting objectives and targets, characterizing environmental aspects from one end of the Lab to the other, identifying any corrective actions needed to address significant aspects, and most recently writing or updating the Standard Operating Procedures that manage those aspects," says Mary Erwin, JLab's Chief Financial Officer and EMS management representative. "Recently an EMS self-audit team was chosen and trained. The team conducted a self-assessment Aug. 3 – 12. The next step will be to address any corrective actions, perform a final management review and the Lab will then be ready to self declare its compliance with EO 13148."

"I'm very confident that we will have completed the implementation process by the Dec. 31, 2005 deadline," Erwin continues, "We have not discovered any significant problems. The SOPs that the implementation team are working on, provide the documentation that addresses what we do and how we go about ensuring that we'll be able to keep the environment around us safe as we work and conduct experiments. The EMS will tie together the many parts of the Lab's environmental protection activities into a comprehensive, measurable program."

The EMS is designed to provide the same type of Lab-wide integration, oversight and quality assurance to the Lab's environmental protection activities and plans that the Integrated Safety Management System (ISMS) provides to the Lab's safety program. A short, on-line (initial) training program is currently underway; all employees and students are currently taking it. An annual refresher will be required, and the plan is to add the EMS refresher to the Lab's annual security/safety refresher training.

"I want to thank the implementation team, our safety professionals and the many other individuals around the Lab who have worked many hours — in addition to their day-to-day work — developing Jefferson Lab's EMS. We couldn't have done it without them," Erwin comments.

From the Director

12 GeV Upgrade Independent Project Review goes very well

Christoph Leemann
Jefferson Lab Director

Dear Colleagues:

I would like to take this opportunity to follow up on my All Staff email announcing the very successful completion of the Department of Energy's recent Independent Project Review of Jefferson Lab's planned 12 GeV Upgrade. Congratulations to JLab's 12 GeV Upgrade team for the tremendous work it has accomplished over the last two years! I extend my deepest thanks to the team and the many people who supported the team as it prepared for the Independent Project Review. I am very proud of the group — Allison Lung, Claus Rode, Leigh Harwood, Will Brooks, Rebecca Yasky, their Assistant Project Managers and Senior Team Leaders and the many people working on the 12 GeV Upgrade project. They have worked hard, setting a standard for high quality as they've steadily progressed through a series of ever more rigorous reviews that started late last year.

This review was conducted by the DOE Office of Science (SC) Director of Project Assessment as a prerequisite for submitting the 12 GeV Upgrade project to Ray Orbach, Director of the Office of Science, for CD-1 approval. The review took place at the request of Dennis Kovar, Associate Director of the Office of Science for Nuclear Physics, who oversees JLab and the other SC nuclear physics laboratories. The Office of Project Assessment provides independent advice to Dr. Orbach, regarding activities essential to constructing and operating major research facilities. Daniel R. Lehman, Director of the Office of Project Assessment, conducts technical, cost, schedule and management peer reviews, often referred to as Lehman Reviews, of Office of Science construction projects and large experimental equipment. These reviews gained international acknowledgment after a review of CERN's Large Hadron Collider (LHC) in April 1996.

During Lehman's visit to JLab, July 12-14, he led a team of more than two dozen scientists, engineers and project specialists on a thorough review of our 12 GeV Upgrade plan. The reviewers vigorously engaged JLab's project team; provided the Lab with good insights; and gave our project team and their work high marks. With an internal DOE review remaining, I anticipate hearing good news on CD-1 approval this fall — the next critical milestone on the way to realizing the world-class science of the 12 GeV Upgrade.

Projects such as the Upgrade must undergo many such rigorous reviews and follow exacting procedures for execution. The Upgrade team is carefully adhering to Department of Energy Order 413.3, Program and Project Management for the Acquisition of Capital Assets. This order governs the construction of DOE scientific user facilities and includes a tightly scripted set of milestones — called Critical Decisions — through which all projects such as JLab's must pass. You will remember that we achieved the first of these milestones in March 2004 — Critical Decision Zero (CD-0) — determination of Mission Need for the Upgrade to 12 billion electron volts (GeV) of JLab's Continuous Electron Beam Accelerator. A Critical Decision (CD) is a formal determination at a specific point in a project phase that allows the project to proceed to the next phase. CDs are required during the planning and execution of a project and proceed as follows: CD-0, Approve Mission Need; CD-1, Approve Preliminary Baseline Range; CD-2, Approve Performance Baseline; CD-3, Approve Start of Construction; and CD-4, Approve Start of Operations. And I'm delighted to share with you that according to the DOE Independent Review team, all requirements have been completed and are adequate for the next step — CD-1 approval.

The combination of outstanding results from the 12 GeV Science Review and the outstanding 12 GeV Upgrade Project Lehman Review sets the foundation for a very strong JLab future. A compelling scientific case for the Upgrade has been made, and we've worked diligently to gain the support of the larger scientific community, as well as gaining and sustaining government support for the project. Science and scientific developments are a key

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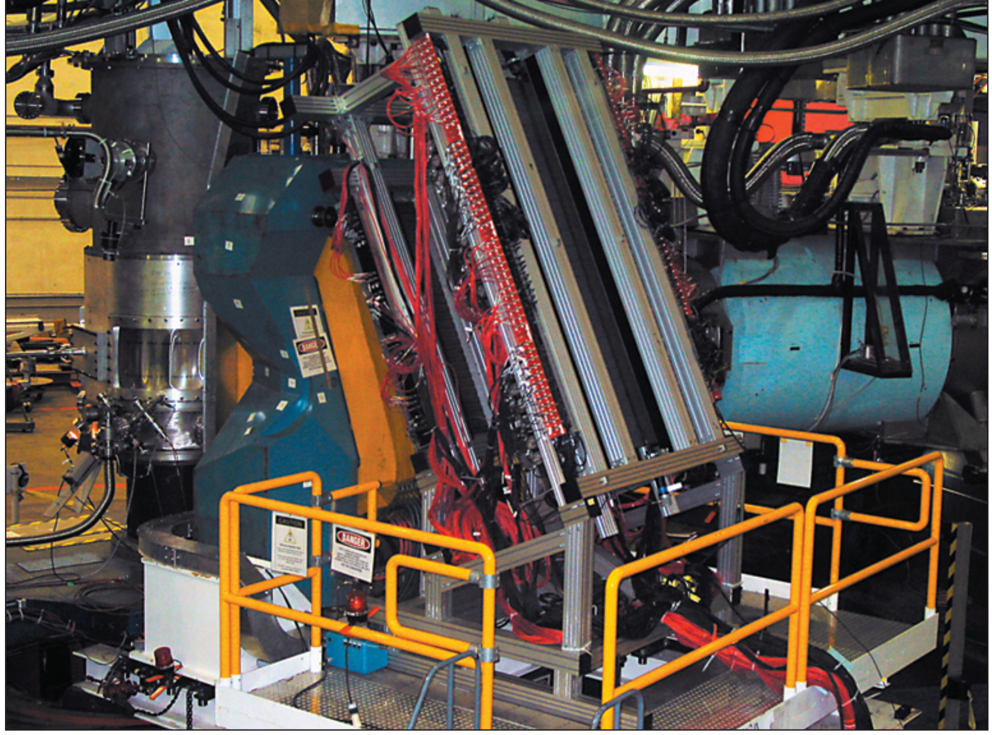
BigBite does its stuff

Spectrometer helps pick pairs out of a crowd



Though small by Hall A standards, BigBite weighs about 18 tons. Visible in this photo, BigBite is sandwiched between the silver, cylindrical scattering chamber and the angled proton detector that consists of multiple layers of scintillators. The stand the detector package is sitting on is movable and will be used during subsequent experiments using BigBite.

by Kandice Carter

Jefferson Lab's core mission is to study the heart of ordinary matter: the nucleus of the atom. Now Hall A has a new magnet and detector system designed to help physicists look at the nucleus in a whole new light. "BigBite" has debuted in its first experiment at Jefferson Lab.

BigBite is a spectrometer that was originally built in 1995 for nuclear physics experiments at NIKHEF, the National Institute for Nuclear Physics and High Energy Physics in the Netherlands. Kees de Jager, Hall A Leader, led several research programs at NIKHEF before coming to Jefferson Lab. He was the program leader of Internal Target Physics at NIKHEF, which built and used BigBite to explore the electric charge distribution in the neutron and the shape of the deuteron (a form of the hydrogen atom containing one proton and one neutron in its nucleus). "BigBite was used as a spectrometer for the internal target, which was inside the storage ring at NIKHEF," de Jager notes.

After he came to Jefferson Lab, de Jager arranged for BigBite to be shipped to JLab once its planned experiments at NIKHEF were complete. Here, BigBite is used to complement Hall A's two High Resolution Spectrometers (HRS).

According to Doug Higinbotham, one of the NIKHEF Ph.D. students that originally used BigBite and the Hall A staff scientist responsible for BigBite's current experimental program, BigBite is very useful for what physicists call triple-coincidence measurements. In these experiments, physicists need to measure three particles. Two particles are detected by Hall A's resident High Resolution Spectrometers, while BigBite detects the third.

"It's a giant microscope. So with the HRS, you see things really, really well, but you can only see some tiny part of the slide," he explains, "BigBite can see the whole slide, but it can't zoom in." However, what BigBite lacks in precision, it makes up with acceptance — the size of the area where it can detect particles. Physicists sometimes refer to a detector's acceptance as its bite.

"The HRS have a very small bite, on the order of a degree; BigBite has a huge bite — almost 10 degrees," Higinbotham explains, "So for some

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experiments, you'd like to have high resolution detectors [like the HRS] detecting interacting particles and another large bite or large acceptance spectrometer [BigBite] detecting recoil particles."

JLab's first experiment using BigBite — Experiment E01-015 — was inspired by an original measurement at Brookhaven National Lab. Scientists there were trying to measure Short Range Correlations (SRCs). The nucleus is built of one or more nucleons (protons and neutrons). Studying how nucleons interact tells physicists something about how they're glued together. A SRC occurs when two nucleons interact very strongly with one another via the strong force, the force that glues them together in the nucleus.

Think of the strong force as being like a spring. It keeps nucleons at just the right distance from one another. Should one stray a little far, stretching the strong force spring out, the force works to pull the nucleons back together. At the same time, when nucleons push a little too close together, squeezing the strong force spring in, it pushes the particles apart again.

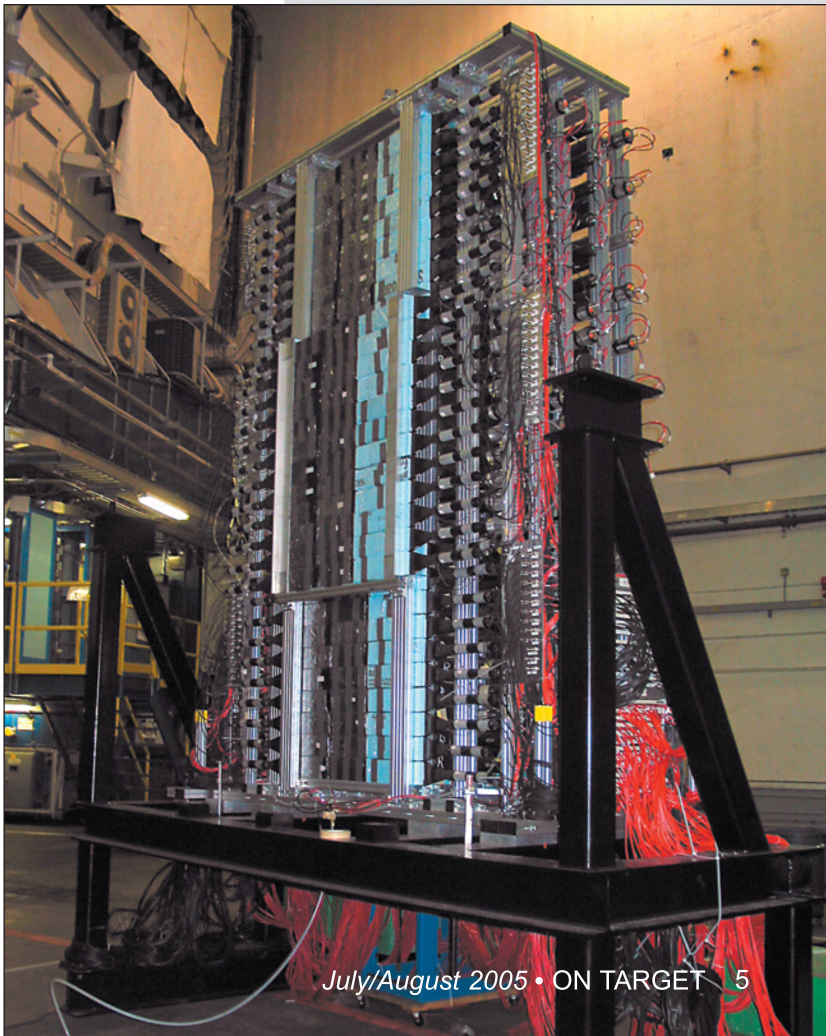
Hall A's E01-015 aims to spot SRCs by catching the strong force in the act of pushing nucleons apart. According to Steve Wood, a spokesperson on the experiment, "You really have to understand every part of the force between nucleons. And part of that force is what's happening at a short distance. The force between nucleons gets very repulsive at short distances." So in that moment, the nucleons each have extra momentum, or energy, pushing them in opposite directions.

If an electron from CEBAF's beam strikes one of the nucleons as they're being pushed apart by the strong force, the scientists can calculate that extra momentum. The researchers are specifically looking to hit protons that are interacting with other protons or neutrons in SRCs. So the HRSs were set to detect the electron from CEBAF and the proton it struck. Meanwhile, BigBite and an accompanying neutron detector were set to detect the proton or neutron that the struck proton was interacting with. "We detect a high energy electron and a high energy proton, and we use the standard Hall A spectrometers for that. Then we look with BigBite and the neutron detector at the place where we expect a recoil from the reaction from the two particles we hit," Wood says.

Post-experimental analysis of the data from the High Resolution Spectrometers, BigBite and the neutron detector will reveal what momentum the two nucleons had at the moment the electron struck the proton. From that, the researchers can get a more complete picture of SRCs, including perhaps a better idea of how nucleons interact via the strong force and how often SRCs occur. Experiment E01-015 looked at SRCs inside a carbon nucleus. Data-taking wrapped up in mid-April, and analysis is underway.

To date, seven experiments have been approved for BigBite. The next experiment is scheduled to begin installation in December.

The neutron detector was positioned vertically and sat several yards behind the proton detector. Components for BigBite's detector packages for this experiment were from Tel Aviv University, Glasgow University, Indiana University and Hampton University. The scattering chamber was funded through a "major research initiative" grant by the University of Virginia.



G-Zero update

Ghostly strange quarks influence proton structure

by Kandice Carter

In research performed in Hall C, nuclear physicists have found that strange quarks do contribute to the structure of the proton. This result indicates that, just as previous experiments have hinted, strange quarks in the proton's quark-gluon sea contribute to a proton's properties. The result comes from work performed by the G-Zero collaboration, an international group of 108 physicists from 19 institutions, and was presented at a Jefferson Lab physics seminar on June 17.

Protons are found in the heart of all matter: the nucleus of the atom. Physicists have long known that protons are primarily built of particles called quarks, along with particles called gluons that bind the quarks together. There are three permanent quarks in the proton that come in two "flavors": two "up" and one "down". Up and down quarks are the lightest of the possible six flavors of quarks that appear to exist in the universe.

In addition to the proton's three resident quarks, the peculiar rules of quantum mechanics allow other particles to appear from time to time. These ghostly particles usually vanish in a tiny fraction of a second, but it's possible that they stay around long enough to influence the structure of the proton. Nuclear physicists set out to catch some of these ghostly particles in the act. They determined that the next-lightest quark, the "strange" quark, would be the most likely to have a visible effect.

According to Doug Beck, a professor of physics at the University of Illinois at Urbana-Champaign and the spokesperson for the G-Zero collaboration, one way to see these strange quarks is to measure them through the weak interaction. "If we look with photons via the electromagnetic interac-

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The G-Zero installation includes a 100,000-pound, 14 feet in diameter, doughnut-shaped superconducting magnet that was designed and tested by physicists at the University of Illinois, and eight pie-shaped detector segments from France. The components stand together on a large moveable framework

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tion, we see quarks inside the proton. And then, if we do it with the weak interaction, we see a very similar, yet distinctly different view of the quarks. And it's by comparing those pictures that we can get at the strange quark contribution," Beck says.

Since the hydrogen nucleus consists of a single proton, G-Zero researchers sent a polarized beam of electrons into a hydrogen target. They then watched to see how many protons were "scattered," essentially knocked out of the target, by the electrons. Throughout the experiment, the researchers alternated the electron beam's polarization (spin).

"We run the beam with polarization in one direction, and we look to see how many protons are scattered. Then we turn the beam around, in polarization at least, and measure for exactly the same amount of time again and look to see how many protons are scattered. And there will be a different number by about 10 parts per million," Beck says. That's because the electromagnetic force is mirror-symmetric (the electrons' spin will not affect the number of protons scattered), while the weak force is not (electrons polarized one way will interact slightly differently than electrons spinning oppositely).

"The relative difference in those counting rates tells us how big the weak interaction piece is in this scattering of electrons from protons. We compare it to the strength of the electromagnetic interaction between electrons and protons, and that gives us the answer that we're looking for," Beck explains.

What the researchers found was that strange quarks do contribute to the structure of the proton. In particular, Beck says the collaboration found that strange quarks contribute to the proton's electric and magnetic fields — in other words, its charge distribution and magnetization.

"All quarks carry charge, and one of the things we measure is where the strange quarks are located in the proton's overall charge distribution," Beck explains, "And then there's a related effect. There are these charged quarks inside the protons, and they're moving around. And when charged objects move around, they can create a magnetic field. In G-Zero, we also measure how strange quarks contribute to the proton's magnetization."

G-Zero allowed the researchers to extract a quantity representing the strange quark's contribution to a combination of the proton's charge and magnetization. "The data indicate that the strange quark contributions are non-zero over the entire range of our measurements," Beck says, "And there are a couple of points that overlap other measurements. They agree, so that's a good thing."

However, by itself, the G-Zero result does not yet allow the researchers to separate the strange quark's contribution to the charge from its contribution to the magnetization. "There's another G-Zero run coming up in December, and that will help us to try to disentangle this combination of the contribution to the charge and the magnetization. So that will give us one more measurement that will allow us to look at those quantities separately," Beck notes.

G-Zero is a multi-year experimental program designed to measure, through the weak force, the strange quark contribution to proton structure. G-Zero was financed by the U.S. Department of Energy and the National Science Foundation. In addition, sig-

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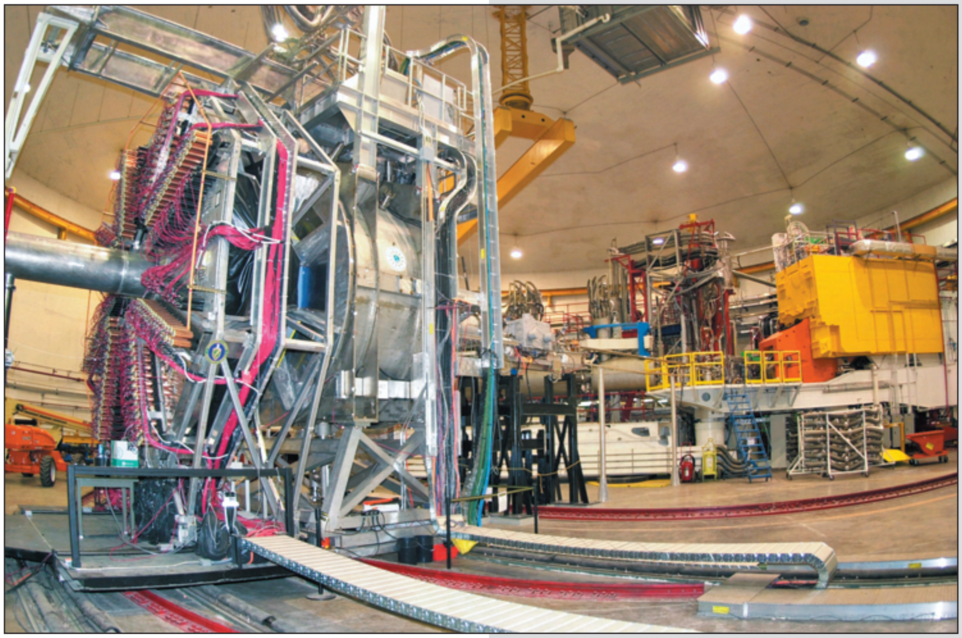
The G-Zero experimental program is funded by the National Science Foundation, the Department of Energy, the French National Center for Scientific Research (CNRS) and the Natural Sciences and Engineering Research Council (NSERC) in Canada.



Young scientists' work recognized at Users meeting...

Above: Dennis Kovar, DOE's Associate Director of the Office of Science for Nuclear Physics, takes a question from the audience during JLab's recent Users annual meeting and workshop.

Below: JLab users discussed research highlights, budget concerns and new scientific challenges and questions during a poster session at the annual meeting.

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meeting and described the nuclear physics field as "strong," but with an ongoing problem with funding. "We must demonstrate the need for our field and make a concerted effort to communicate our field's scientific accomplishments and the value of what we do here," he said.

He stressed that at every opportunity, each of us must communicate — in language that can be grasped and understood by the intended audience — the compelling nature of JLab research to the public, to Congress and to funding agencies.

He went on to discuss the latest efforts toward making JLab's planned 12 GeV Upgrade a reality and commented on the several reviews that the project has gone through since last year. (See page 3 for more information on 12 GeV reviews.) The Upgrade team has been working very hard and doubly hard since Critical Decision-0 was approved in 2004, Leemann noted. He anticipates the project achieving CD-1 this fall.

In opening comments new UGBOD chair, Gordon Cates, noted, "Preliminary registration indicates a fantastic turnout for this Users Group meeting. We have a large and exciting meeting ahead of us with a wonderful and diverse program including new discussions in nuclear physics, and how JLab's Free-Electron Laser is becoming an increasingly important part of technological capabilities here. The depth and breadth of our field is incredible. We are part of an exciting time in an exciting field. While great stuff is behind us, I believe the best is yet to come. The physics we can reach out to now is incredible — unlike anything we could do in the past."

He strongly urged the Users community to make a point to attend large, or high profile conferences. "Bring yourselves and your students," he said. "Provide program ideas to the conference planning board; and talk about your science and the experiments you are conducting at Jefferson Lab." He encouraged the scientists to visit the elected officials in their respective districts — yearly if possible — to share their work.

Next on the agenda was Anthony W. Thomas, JLab Chief Scientist and Theory Group Leader, presenting "JLab Physics Moving into the Future." He discussed several of the main areas of nuclear science research that will be enabled by JLab's planned 12 GeV Upgrade.

The Town Meeting followed Thomas' discussion of 12 GeV Science. First on the agenda was Rick Casten, chair of the Nuclear Science Advisory Committee (NSAC), discussing DOE nuclear science budget shortfall concerns and the DOE-requested springtime NSAC subcommittee meeting.

He was followed by Dennis Kovar, DOE's Associate Director of the Office of Science for Nuclear Physics. As overseer of all SC nuclear physics laboratories, he further emphasized DOE's nuclear and high-energy physics budget concerns and emphasized the need to be able to clearly make the case for nuclear physics research. "Our community needs to articulate in

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Karl Slifer (center), UVA, accepts the Southeastern Universities Research Association Thesis Prize from SURA President Jerry Draayer. They are accompanied by JLab user, Zein-Eddine Meziani (Temple University), who was Slifer's advisor at Temple.

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a much better way — in a way policy makers and the public can understand — the benefits of high-energy and nuclear physics research. If we can't communicate the excitement of our science, we will not be supported in the future."

Brad Keister, National Science Foundation (NSF) Program Director for Nuclear Physics, rounded out the Town Meeting by discussing the budget impact on nuclear physics research funded through the NSF. Several high-profile experiments conducted at JLab have or are currently receiving NSF funding.

Highlights from the week included special sessions with Jeff Harvey, University of Chicago, discussing the Connections Between String Theory and QCD; and Bob Austin, Princeton, discussed the groundbreaking microbiology experiment he ran at the Free-Electron Laser. The event schedule was dizzying with workshops on form factors, parity, High-x physics, exotic baryons and mesons, nucleon spin structure, baryon spectroscopy, generalized parton distributions and deeply virtual Compton scattering, Quantum Chromodynamics (QCD) and nuclei, 2-gamma, lattice QCD, quark-hadron duality, and the Roper Resonance.

On the last morning of the meeting, Christoph Leemann and Gordon Cates were on hand to congratulate the Southeastern Universities Research Association (SURA) Thesis and Poster Contest winners with Jerry Draayer, SURA president, presenting the awards. Karl Slifer, UVA, won the $1,500 thesis prize for his submission "Spin Structure of He-3 and the Neutron at Low Momentum Transfer" from research he conducted during Experiment 94-010 in Hall A. "The SURA Thesis Prize is a wonderful tradition," Cates commented. "The money is nice, but the honor of being able to put this on your CV is nice for your entire career."

This was the first year for the poster contest. "Gordon emailed me asking if SURA would support a poster competition. He had my response in five minutes," Draayer said. "This is a great way to engage and energize our young scientists; these students are the future of our field. We can't live without them." Sarah Phillips, College of William & Mary, won first place and $1,000 for her poster on her research on the G-Zero experiment in Hall C; Chris Tennant, W&M, took second place and $750 for his accelerator-research poster; and Tanja Horn, University of Maryland, Hall C, and Peter Monaghan, MIT, Hall A, shared third place and split $500.

At the end of the three-day event, Cates said, it was really wonderful to see the huge turnout at the Town Meeting — the user community's interest in the presentations, their questions, and vigorous discussions.

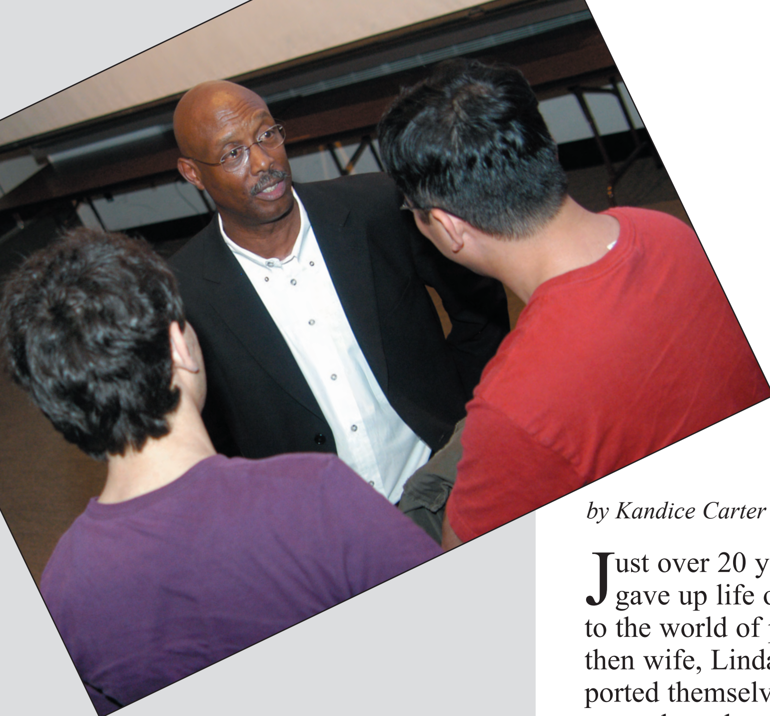
Poster Winners

Sarah Phillips

Chris Tennant

Peter Monaghan

Tanja Horn



Twenty years ago, Warren Buck and his colleagues founded the Hampton University Graduate Studies Summer School (HUGS). Buck is currently Chancellor Emeritus of the University of Washington – Bothell. Here he talks with students who attended his HUGS 20th Anniversary Seminar at JLab.

HUGS celebrates 20 years!

Provides students access to world class JLab physics

by Kandice Carter

Just over 20 years ago, Warren Buck gave up life on a sailboat to return to the world of physics. He and his then wife, Linda A. Horn, had supported themselves by selling their artwork as they sailed around the Bahamas for three years. When Buck returned to physics in 1984, he felt driven to make a difference and to share his excitement for physics. He took a position at Hampton University (HU) and began collaborating closely with CEBAF, which was under construction at that time.

"I had a couple of friends that kept telling me that I should make something of my life," he recently recalled. "I wanted to start something that would help students understand the fundamental reason of why the Lab was being built." Over the next several years, Buck did make a difference. Among other projects, Buck and his colleagues founded the Hampton University Graduate Studies Summer School (HUGS), a program at Hampton University and Jefferson Lab designed for second and third year experimental or theoretical Nuclear/Particle physics Ph.D. students who have completed (or nearly completed) their coursework. The program, which lasts for three weeks and serves as a crash course in JLab physics, achieved a notable milestone this year in successfully reaching its 20th anniversary.

The original goals of the program were to introduce the students to the CEBAF machine design and to the type of physics to be performed when CEBAF came online, to encourage these students to remain in nuclear physics, and to establish an educational program at CEBAF. "The program covered everything, from instrumentation to experimental setup, from data analysis to theory," Buck noted. "And personally, it was another motive for me to learn more physics."

Buck said the first year of the program was very difficult. "Funding was nonexistent," he explained, "So we had to beg, borrow and steal to get people here." Letters to the Mayors of Newport News and Hampton University made $4000 available; and HU and CEBAF gave support by in-kind funds. Since the money came in a little at a time, Buck and his colleagues barely had enough to get the program started.

In the program's first year, 12 students participated; they stayed in the dorms at HU and attended lectures at HU and CEBAF. To shuttle the students back and forth, "In those first few years, I actually drove a bus everyday," Buck said. Students were required to write up notes from the lectures to be published in a Proceedings edited by the lecturers. He still has a copy of the first Proceedings, which was hand written, not typed. The program also allowed the students to perform research while they attended; and they were given the opportunity to share what they had learned. The last week of the program was devoted to student presentations. Buck ran HUGS for 10 years then turned it over to Jose Goity, Theory Group, in 1996. "I ran out of steam, quite frankly. It had been 10 years," he said, looking back. There have been a few changes in the program. Now, each year has a theme. In 2005, the program focused on experimental and theoretical topics of high current inter-

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est in strong interaction physics. Buck is proud that the program has stood the test of time. "It was far more than a summer school. It was a community of scholars, an outreach vehicle for Hampton University physics, and it was used to leverage educational programs at the Lab," he commented during a seminar he presented June 1 on the history of HUGS' first 10 years. The 29 students in the HUGS 2005 class, as well as a number of former HUGS students, Buck's colleagues and JLab staff, attended the seminar.

Buck is now Chancellor Emeritus of the University of Washington - Bothell. He said he was leaving the administrative role he'd held since 1999 with the intention of getting back to physics and other pursuits.

Cynthia Keppel, a former HUGS student (class of 1989) who holds a HU/JLab joint appointment, has led the program since 2001. "It [HUGS] fills a crucial role in providing students access to the state of the art and the most exciting science in a context that they can understand. …world-class experts freely invest their time and effort to share their expertise with students through the program. I think it's a measure for how much the community cares for its students," she added.

"Physics is about people," Buck said during the [June 1 HUGS anniversary] seminar, "and we shouldn't forget that in our striving toward a result." HUGS realizes that philosophy. It brings tomorrow's nuclear/particle physicists together today, allowing them to get to know their peers, interact with senior physicists from around the world and better understand the challenges and opportunities of nuclear physics research. Happy Anniversary HUGS, and many more!

HUGS tidbits

Since 1986, more than 350 students have been through the program.

The largest number of students to participate in any one summer session was 32 in 2003.

The smallest class was five students in 1987.

The HUGS class of 2005 poses for a group photo. They are accompanied by Cynthia Keppel (front, far left), a former HUGS student (class of 1989) who holds a HU/JLab joint appointment and has led the program since 2001; Kim Wilson (to Keppel's left), who provides Hampton University administrative assistance to HUGS; Jose Goity (center left in group), Theory Group, who led HUGS from 1996-2000; Mary Fox (back row, center left), JLab Theory Group administrative assistant and Wilson's HUGS counterpart; Renato Higa (back row, far right), Theory Group and HUGS instructor; and Bob Williams (to Higa's left), former Theory Group post doc who ran HUGS day-to-day classroom activities.

On the leading edge

New cavity production process could reduce costs, provide high performance

by Kandice Carter

The Accelerator Division's Institute for Superconducting Radiofrequency (SRF) Science & Technology is a world leader in SRF accelerator technology research and design. Now the newest idea out of the Institute may revolutionize the way accelerating cavities are produced — making the manufacturing process faster and cheaper, while producing cavities that could potentially outperform any other niobium cavities ever tested.

Superconducting accelerator cavities, such as the ones used in JLab's accelerator to accelerate electrons, are usually made of niobium metal. Like salt crystals, niobium crystals can be grown in a variety of sizes. In accelerator scientist lingo, niobium metal composed of smaller crystals is called fine-grain, while larger crystal material is called large-grain. Ordinarily, accelerator cavities are fabricated from sheets of fine-grain niobium. These sheets are forged from a large chunk of niobium called an ingot and then rolled. The rolling procedure crushes the grains so that each sheet contains grains that are more or less a uniform small size that can be easily stamped into a desired shape. The sheets are then pressed into parts, and the parts are welded together to make a complete cavity.

A JLab team came up with a way to simplify this process. Instead of working to make fine-grain niobium, the process renders pieces with readily available large-grain niobium. The team, led by Senior Staff Scientists Peter Kneisel and Ganapati Myneni, procured standard ingots of large-grain niobium through an industrial partnership with Tadeu Carneiro, spokesperson and manager of Reference Metals Co., Bridgeville, Penn. The JLab team obtained sheets of large-grain niobium by simply slicing them off an ingot using wire electrical discharge machining.

"It's just like slicing up a sausage," Kneisel notes. Instead of rolling the metal to produce a fine-grain sheet, the team used a slice off of the ingot and applied the standard process of deep drawing to coax the large-grain material into parts of the desired shape. They then welded the parts together. "So the only difference between what we are doing now and typically what everybody else does, is that we have a different kind of material — not fine-grain material, but large-grain," Kneisel adds.

The new fabrication process could simplify manufacturing while reducing cost and assembly time. For instance, eliminating the rolling procedure also eliminated related annealing steps, a softening process where the niobium is heated and then slowly cooled. "Intermediate annealing steps are necessary to remove stresses in the material and re-crystallize it. These manufacturing steps have the inherent risk of introducing unwanted impurities in the material," Kneisel explains. These impurities are removed by chemical etching, which entails using acids to strip away the surface layers of the metal. The chemical etching step was kept in the new fabrication process; early tests suggest however that much less etching is required.

The team found they could remove two more steps from the process: an electropolishing step, where the cavity is cleaned by being suspended in acid and exposed to an electric current, and the baking procedure, where the cavities are baked for about two days in an industrial oven. In all, the new fabrication process could result in an estimated 35 percent savings in the cost of producing cavities and less time-consuming quality assurance procedures.

The Jefferson Lab team used the process to fabricate four single-cell cavities in two designs for testing. Two single-cell cavities were made with large-grain niobium in Jefferson Lab's own 12 GeV Upgrade design. The team also made use of one large grain of niobium to make two more single-cell cavities out of single niobium crystals. One of the single-crystal single-cell cavities was made in the same shape as the low-loss design proposed as an improvement to the baseline for the International Linear Collider (ILC), and the other was built in the 12 GeV Upgrade design.

Kneisel presented results of tests on the single-cell cavities in a poster session at the recent 2005 Particle

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Accelerator Conference in Knoxville, Tenn. The team found that all the cavities performed well in early tests; however, the cavities made with single-crystal niobium were superior performers.

In particular, the ILC-style cavity, though a scaled-down version of what the ILC would require, reached a remarkable accelerating gradient (its ability to transfer energy into particles per unit of cavity length). In preliminary tests conducted at -271 degrees Celsius, the cavity's accelerating gradient exceeded both the ILC specification of 28 MV/m (MegaVolts per meter) and eventual goal of 35 MV/m. After adding a brief, low-temperature bake back into the fabrication process, the cavity achieved an accelerating gradient of 45 MV/m, which is roughly equal to Cornell's current world record of 46 MV/m, when measurement uncertainty and differing experimental conditions are taken into account.

The cavity in the 12 GeV Upgrade design performed even better. It reached a fundamental limit of superconducting niobium in its ability to store an accelerating field. Niobium loses its superconducting properties beyond this limit. Such field levels have never been achieved before in accelerating cavities. The team is now in the process of assembling a large-grain seven-cell cavity in the 12 GeV design, along with a fine-grain version for comparison. They expect to have the results of tests on the two complete cavities by this fall.

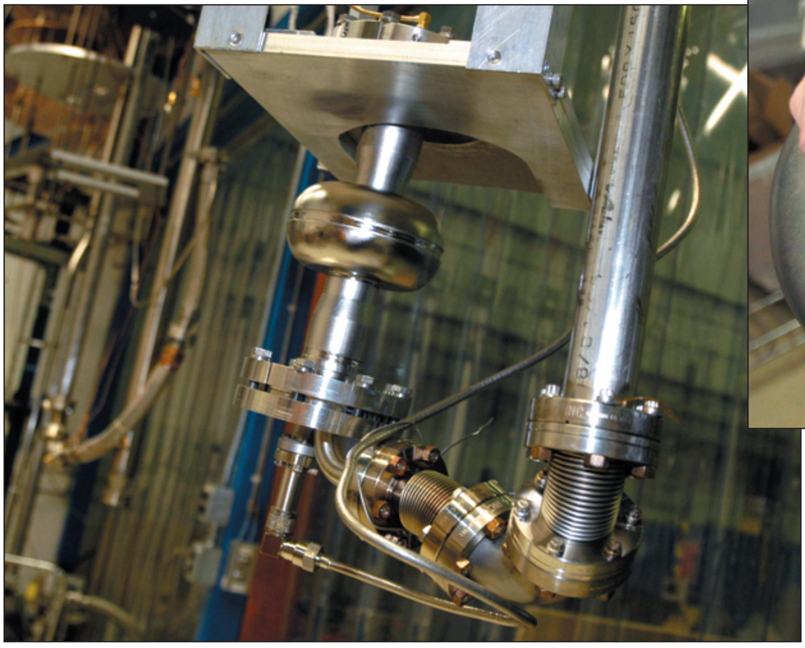
The team who built the cavities and conducted the tests includes Peter Kneisel, Ganapati Myneni, Gianluigi Ciovati, Jacek Sekutowicz (DESY), Larry Turlington, Robert Manus, Gary Slack, Steve Manning and Pete Kushnick. This work is being conducted in the Institute of SRF Science and Technology headed by Warren Funk.

Gary Slack, a senior machinist in the CNC (Computer Numeric Controlled) Machine Shop, shows off the 7-cell, 12 GeV Upgrade cavity design (left) and the low-loss design proposed for the International Linear Collider (right).

Pictured on page 12 is a large-grain, single-cell niobium cavity in JLab's 12 GeV Upgrade design.

Below: One of the JLab-produced single-cell, single-crystal niobium cavities, of the low-loss design proposed for the International Linear Collider, awaits testing in the Vertical Test Area of the Test Lab.

At right: A look inside two single-cell cavities shows the smoother, more reflective surface inside the cavity made with large-grain niobium (on the right) versus the cavity made with fine-grain niobium (on the left) through what has been the standard process.



Milestones
for June/July 2005

Hello

Nilmani Mathur, Post Doctoral Fellow, Theory Group

Goodbye

Constance Creech, Diagnostic System Technician, Accelerator Div.

Mary Eaton, Human Resources Assistant, Administration Division

Sarah Ingels, Public Affairs Specialist, Directorate

John Kennedy, Fire Protection & Security Technician, Admin. Div.

Kisha Owens, Human Resources Assistant, Administration Division

Jarreas Underwood, Hall B Mechanical Technician, Physics Div.

Hugh Williams, Assessment Engineer, Directorate

In Memoriam

Erich Josef Feldl, a retired JLab staff member, passed away May 31, 2005, after a long illness. He worked for several years as a Mechanical Project Engineer in the Accelerator Division before retiring early in 2000.

He is survived by his wife Anna of Newport News, his son Eric and his wife Katy of Newport News, his daughter Nicole Feldl of Boulder, Colo., and two sisters, Marlene Philibert and Chrisa Villard, both from Canada.

He was born in Munich, Germany, and immigrated to the U.S. where he earned his Master's Degree in Nuclear Engineering. He also ran a design and engineering business.

JLab posts updated EH&S policy statement

Lab Director Christoph Leemann recently released an updated JLab Environment, Health and Safety (EH&S) policy statement. New EH&S policy statement posters have been distributed across campus for placement on work-area bulletin boards. The policy statement is also published in Chapter 1100 of the EH&S Manual and is posted online at www.jlab.org/ehs/. Everyone at JLab is encouraged to read and become familiar with the updated policy. The changes made to the statement are part of JLab implementing its new Environmental Management System (EMS). (See page 2 for more information on EMS.)

Printed below is, in part, JLab's new policy on Environmental Protection, Health, and Safety:

Sound environmental protection, health and safety practices are essential elements to the successful execution of JLab's scientific mission and all related activities. It is Lab policy to identify and adhere to all applicable EH&S laws, regulations, and standards, and Department of Energy contractual commitments. JLab considers no activity to be so urgent or important that our standards for environmental protection, health, or safety may be compromised. Demonstrated performance in protecting the environment, including a commitment to the prevention of pollution, and ensuring the health and safety of our colleagues, visitors and surrounding community is paramount among our responsibilities as a national lab.

To effectively discharge these responsibilities, integrated safety management (ISM) principles and functions fully integrate EH&S requirements into the planning and execution of all work at JLab. ISM principles require that line managers be held accountable for effective EH&S performance within their programs, with each individual at JLab responsible for establishing knowledge and control of the EH&S hazards of all work in which he or she participates. Everyone has the right and responsibility to remedy or to report any practice, situation, or action that endangers people or the environment.

To ensure and improve EH&S performance, EH&S objectives and targets are set and progress is measured against stated goals. Involvement in this process at all levels of the Lab's organization is expected, and commitment is required. Continuous improvement is our goal.

Need a car, van or forklift to do your JLab work?

Facilities Management (FM) maintains a government vehicle fleet and a Material Handling Equipment (MHE) pool to support JLab payroll employees in conducting official JLab business (i.e. carrying out research work, attending authorized events, moving scientific materials, etc.).

The vehicle fleet includes cars and cargo/passenger vans; and the MHE pool includes specialized implements such as forklifts, manlifts, tractors and tow tugs. The vehicle fleet is available on a first-come, first-served basis by calling the FM customer service desk at ext. 7400, weekdays, 8 a.m.-5 p.m. Talk with Dreamie Newsome or Jennifer Barnett about vehicle availability and possible use of fleet vehicles outside of FM. They are also the point of contact for key/vehicle pickup and return. All fleet vehicles have fuel cards and must be returned with a full tank of gas.

Drivers using any vehicle must have a current U.S. driver's license. Off-site drivers must be at least 21-years-old; on-site drivers 18-20 years old must have department manager/group leader approval on file at FM.

To use implements from the MHE pool, contact Manny Nevarez. He coordinates use of MHE and oversees the training needed to operate MHE.

Visit www.jlab.org/fm/ and click on "Vehicles" or "Material Handling Equipment" for more information.

Make hurricane preparedness a priority

As predicted, the 2005 hurricane season has been more active than normal. It is important that severe weather preparations are conducted in a timely manner and not left until the last minute. If you have not already

Continued on next page

Hall C User Tomislav Petković presents a copy of his book “eksperimentalna fizika ¡ sponznajna teorija” to Information Resources Manager Elois Morgan. He was here earlier this summer pulling shifts for Experiment E01-011. Petković, faculty member and current head of the Department of Applied Physics at the Electrical Engineering and Computing University of Zagreb, Croatia, enjoys using JLab’s Library during his visits. Last summer, during his daily visits to the Library, he finished writing the English summary for the physics book he authored. He is one of several scientists organizing a Theory of Relativity & Philosophy symposium in Cres, Croatia, Sept. 26-28, celebrating the 100th anniversary of Einstein’s Special Theory of Relativity. For more information, visit http://core.ecu.edu/phil/ryane/fpconferences.htm.

Continued from previous page

done so, now is a good time to remind yourselves, coworkers, and family members of some useful resources on tropical storm information, notes JLab Emergency Manager John Kelly.

When preparing for a hurricane or any type of severe weather, the 24 hours or so before a storm’s predicted arrival may be too late to buy essentials.

Consult your safety warden or building manager for hurricane preparations for your building or work area. JLab-specific information on all types of major weather events is available in the JLab EH&S Manual, Chapter 3510 Appendix T-4, Severe Weather Procedures at www.jlab.org/ehs/manual/EHSbook-181.html#pgfId-3315.

Consult John Kelly at ext. 7531 or email jkelly@jlab.org with specific questions.

Additional hurricane information may also be found at the links below.
www.jlab.org/intralab/emergency/hurricane/severe.html
www.vaemergency.com/
www.fema.gov/hazards/hurricanes/

Strange quarks influence proton structure...

Continued from page 7

nificant contributions of hardware and scientific/engineering manpower were also made by CNRS in France and NSERC in Canada. To date, more than 100 scientists, 22 graduate students and 19 undergraduate students have been involved with G-Zero. Beck presented the results at a public physics seminar titled “Strange Quark Contributions to Nucleon Structure? Results from the Forward G0 Experiment” on June 17 at Jefferson Lab. A formal scientific paper was submitted for review and publication in Physical Review Letters that day as well.

Several other experiments, including the SAMPLE experiment at MIT-Bates, the A4 experiment at the Mainz Laboratory in Germany, and HAPPEx at Jefferson Lab were also designed to spot strange quarks in the proton.

From the Director...

Continued from page 3

factor in maintaining a healthy economy and play a critical role in maintaining the forefront R&D capabilities of our nation.

Looking forward, we must continue to support the 12 GeV Upgrade team and the Lab’s efforts to make 12 GeV a reality. The Upgrade is an investment in our future. It provides a solid research program in nuclear physics and related topics that will allow us a far deeper and more fundamental understanding of the structure of atomic nuclei. With a strong scientific program and a solid project foundation, we ensure a vital, world-class scientific program at Jefferson Lab for many years to come. In these austere budget times, working together smartly, efficiently and safely will help us achieve this success.

Arrington receives Presidential Early Career Award

John Arrington, an Argonne National Laboratory physicist, received the Presidential Early Career Award for Scientists and Engineers (PECASE) in mid-June, recognizing his contribution to the advancement of science.

He earned the award for his research into the quark distributions of nuclei, which has provided a compelling new look into the short-range structure of nuclei. The research was done at JLab: a combination of his thesis work as a graduate student with the California Institute of Technology, experiments he collaborated on that ran here in 2004, and future plans, according to Arrington.

The Presidential Awards are intended to recognize and nurture some of the finest scientists and engineers who, while early in their research careers, show exceptional potential for leadership at the frontiers of scientific knowledge during the 21st century. The Presidential Award is the highest honor bestowed by the U.S. government on outstanding scientists and engineers who are beginning their independent careers.

"The Department of Energy is proud that these researchers are making important contributions, in a wide range of fields, to innovation and technology for energy, economic and national security," Secretary of Energy Samuel Bodman said. "If the outstanding efforts of these scientists and engineers are any indication of the future, I have no doubt they will ensure America's scientific leadership far into the next century."

Arrington's work is helping to shape scientific understanding of the core of an atom. At one-trillionth of the volume of an atom, the nucleus contains 99.9 percent of the mass. The nucleus is not a calm in the eye of an atomic storm as once perceived, but a violent core with some protons and neutrons moving at more than half the speed of light. Even slower-moving protons must change direction a billion times every trillionth of a second, Arrington said.

ON TARGET

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