Spring 2004

# ON TARGET

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY • A DEPARTMENT OF ENERGY FACILITY

Anthony (Tony) W. Thomas
JLab Chief Scientist and
Theory Group Head

## Anthony Thomas is JLab's new Chief Scientist, Theory head

Anthony (Tony) W. Thomas has assumed the mantle of Jefferson Lab Chief Scientist, bringing his 30+ years of experience in nuclear and particle physics to the Lab.

"Tony's interests and expertise in nuclear theory make him an ideal choice for Jefferson Lab's Chief Scientist. He deeply understands the vital connections between experiment, theory, and advanced computation and simulation, and he will be instrumental in bringing this vision to its full development," says Christoph Leemann, Jefferson Lab Director. Jefferson Lab has been without a Chief Scientist since Nathan Isgur's death in 2001.

Dr. Thomas has held positions at CERN, TRIUMF and the University of British Columbia. In his most

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# 12 GeV on the horizon

## *Department of Energy approves 'mission need' for upgrading CEBAF*

Deputy Secretary of Energy Kyle McSlarrow traveled to Jefferson Lab April 19 to announce that the Department of Energy had established a "mission need" for upgrading the Lab's Continuous Electron Beam Accelerator Facility (CEBAF) and its experimental capabilities. During an All Staff Meeting that morning, McSlarrow told Lab employees, visiting officials and members of the news media that DOE had approved the Critical Decision Zero — or CD-0 — document for the proposed CEBAF 12 GeV Upgrade.

The proposed Upgrade at Jefferson Lab would double the energy of the CEBAF electron beam from its current level near 6 GeV to 12 GeV (billion electron volts), build a fourth experimental hall, and upgrade detector capabilities in the three existing experimental halls.

"Approval of CD-0 for the CEBAF Upgrade is an important and critical step in building Jefferson Lab's future," said Lab Director Christoph Leemann. "With the 12 GeV Upgrade, Jefferson Lab will be firmly anchored as a world leader in the field of hadronic physics for many years to come."

"Today marks a special day for all of those within the Lab, among our scientists, at our universities and in our

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Deputy Secretary of Energy Kyle McSlarrow announced the Department of Energy's approval of Jefferson Lab's Accelerator Upgrade at an All Staff meeting held April 19 at the Lab. Listening as Deputy Secretary McSlarrow makes his announcement is (left to right) Congresswoman Jo Ann Davis, Congressman Robert C. "Bobby" Scott, Senator John Warner, and Lab Director Christoph Leemann.

# JLab welcomes Tony Thomas as new Chief Scientist...

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recent position, at the University of Adelaide, he was the Elder Professor of Physics in the Department of Physics and Mathematical Physics, where he also served as Director of the Special Research Centre for the Subatomic Structure of Matter, Director of the Australia National Institute for Theoretical Physics, Physics Department Chair and Associate Dean of the Faculty of Science.

"If you ask where we are getting new information on the structure of matter, this is the key place. Jefferson Lab is elucidating the structure of hadronic matter using the electromagnetic interaction — this is experimental science at its best. Especially with the opportunity to move to higher energies, it's an exciting time to be here," he says.

As Chief Scientist, Thomas will guide JLab's experimental program, providing guidance on the direction of the Lab's experimental and theoretical programs. "I'm working with the user community and theorists to make the scientific program the very best it can be. In these times, even this lab has limited resources, and so they have to be devoted to the science that's really cutting edge," he notes.

Some of the topics Thomas thinks are most important to the Lab include further research on how the complex dance of quarks and gluons inside atoms constitutes nucleons; establishing the existence of the pentaquark, its properties, and other possible pentaquark states; searching for hints of changes in the structure of bound protons and neutrons, a precursor to the "melting" of protons and neutrons into a quark-gluon plasma at high densities; and searching for exotic mesons.

Another of Thomas' top priorities is laying the groundwork for the experimental program that will be made possible by the 12 GeV Upgrade. "Amongst the many exciting possibilities, we are looking for new insights into proton structure through the measurement of virtual Compton scattering and generalized parton distributions," he says.

Thomas also acknowledged the practical benefits in applied science that have been made possible by the basic science program. "The Lab also has a broader program in applied science. And part of my job is to encourage the things that are really first rate in applications of deep ultraviolet light at the FEL or Terahertz radiation, in biology and condensed matter physics, and other programs. So it's not just nuclear physics, though that's clearly the main mission of the Lab," he explains.

Thomas is also Jefferson Lab's new Theory Group Leader. "The theory group at a lab like this is very important. It provides intellectual leadership for the experimental program. When it comes to judging a Lab's scientific program, it's a balance between technology, the questions that interest the experimenters, and what is best able to be interpreted theoretically — what will give theory the next kick forward. So the theory group has many roles," Thomas notes.

One major goal Thomas has for the Theory Group is the establishment of the Excited Baryon Analysis Center (EBAC). The Center will study the many states of the pentaquark, and other baryons, that the quark model predicts are possible. "The Center was one of the things that was proposed just before I arrived, and I hope to see

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Dear Colleagues:

Building on the significant scientific accomplishments in the Nuclear Physics program, our unique core competencies and the advances we have made in areas such as superconducting radiofrequency (SRF), the Spallation Neutron Source (SNS) and the Free-Electron Laser (FEL) we are beginning an exciting new chapter in the life of Jefferson Lab. A large part of preparing for the future is developing a vision that is consistent with the Office of Science and Department of Energy's goals, and putting the people and systems in place to attain that vision. We have made progress in several of those areas and I want to use this column to update you on these developments.

Jefferson Lab's Institutional Plan, the document that describes long range plans for the Lab and its programs, is reviewed by DOE to ensure alignment with DOE's mission. Dr. Ray Orbach, Director of the Office of Science, during a recent visit to Jefferson Lab expressed support for the Lab's vision of the future and complimented the Lab on its alignment of program plans with the 20-year plan for the Office of Science. He recognized the Lab's excellent relationships with our local and regional communities and the Virginia delegation and noted the positive influence these relationships have had in securing Jefferson Lab's future.

Dr. Orbach was very upbeat about Jefferson Lab's future, stating that the 6 GeV experimental program will position the Lab at the forefront of nuclear physics for several more years and the 12 GeV Upgrade will address key scientific questions in the coming decades beyond the reach of the current machine. Orbach also recognized Jefferson Lab's SRF capability and the Lattice Quantum Chromodynamics (QCD) collaboration as critical enablers for the future of science in our nation. He reiterated the important contribution Jefferson Lab is making to the SNS project and emphasized that the schedule must be held, given the high profile the project has both with the scientific community and in Congress. Pat Dehmer, Program Manager for Basic Energy Sciences, was impressed with the scientific and technical accomplishments of the FEL facility, but stated that for the Lab to become a DOE/BES user facility "overwhelming national user interest and program need" must be demonstrated.

During a lengthy discussion on the Lab's safety performance, Dr. Orbach expressed his concern over the Lab's safety record, which is among the poorest of all the national labs. He and other DOE managers view the Lab's high number of safety incidents and near-misses as indicators of inattention that could lead to potential serious injury. Lab management is working with specialized teams to assess the issues, identify causes and develop approaches that will improve safety performance. Reports on these initiatives will be the subject of future columns as we progress in these efforts.

Another noteworthy event in the context of Jefferson Lab's future was the April 19 signing of the CD-0 for our 12 GeV Upgrade, attended by DOE Deputy Secretary Kyle McSlarrow, Senator John Warner and Representatives Jo Ann Davis and Bobby Scott. This is the critical milestone needed for the Lab to proceed in preparing a Conceptual Design Report (CDR) for the project. The 12 GeV Upgrade will extend the scientific reach of Jefferson Lab, allowing us to continue producing world-class scientific research well into the third decade of this century. We have assembled an initial project team, with Dr. Allison Lung serving as Interim Project Director.

Another important milestone has been the recent hiring of a Chief Scientist. Dr. Anthony W. Thomas, from the University of Adelaide, has joined us at Jefferson Lab and his enthusiasm for our programs and strong leadership will play a critical role in shaping the scientific future of Jefferson Lab. Working with the scientific leadership team, Tony will help to ensure that we are pursuing and delivering the best science and taking full advantage of our unique capabilities and facilities. We are indeed fortunate to have attracted a scientist of his international reputation.

With these recent developments, and the talented and dedicated staff we have here, Jefferson Lab is well-positioned to provide leadership in science and technology to our nation and the world for decades to come.

Christoph Leemann
Jefferson Lab Director

*Major events set stage for Lab's future; highlight areas needing work*

# From the Director

# DOE approves mission need for JLab's 12 GeV Upgrade...

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state and local community, who have worked so diligently toward this point," he continued. "I am confident that with the 12 GeV Upgrade, this facility will continue to produce ever more fascinating science."

The Upgrade will allow Jefferson Lab to pursue with even greater precision its primary mission of studying the basic building blocks of matter: quarks and gluons. In simplest terms, these elementary particles combine to form protons and neutrons, which, together with electrons, make up all the atoms in the universe. By studying the properties of these fundamental particles, how they interact to form matter and what forces mediate these interactions, future 12 GeV experiments will make significant contributions to the fundamental understanding of matter beyond current theory.

During his announcement, Deputy Secretary McSlarrow called Jefferson Lab "superb." He said, "You have every reason to be extremely proud of what has been built here… and the people who work here, as innovators and leaders in fundamental nuclear physics research without parallel."

He discussed DOE's 20-year facility plan, unveiled in November 2003 by Secretary Spencer Abraham and the need for future U.S. scientific-research facilities. Then on behalf of Secretary Abraham, McSlarrow announced that DOE had approved the formal mission need for the upgrade of the Continuous Electron Beam Accelerator Facility. "CEBAF will be in the future — as it is today — one of the premier nuclear physics machines in the world," he said.

DOE's facilities plan, *Facilities for the Future of Science: A Twenty-Year Outlook*, identified the CEBAF 12 GeV Upgrade as a near-term priority and listed it seventh in a field of 28 projects.

CD-0 is the first of five "critical decisions" that govern construction of DOE facilities and projects. While this level of approval does not guarantee acceptance of the Lab's plan, it does allow Lab managers to proceed with conceptual design of the Upgrade and to submit an acquisition plan and project execution plan with a projected budget.

A CD-0 for a DOE scientific user facility construction project is only authorized following a rigorous review of the justification for a mission need for the facility and a management strategy for acquiring it. The purpose of the phased critical decision process is to provide structured management review of project readiness prior to each major step in project acquisition.

If JLab receives final approval from DOE, the Upgrade would represent an investment of more than $200 million and would bring 40 permanent jobs to the Lab.

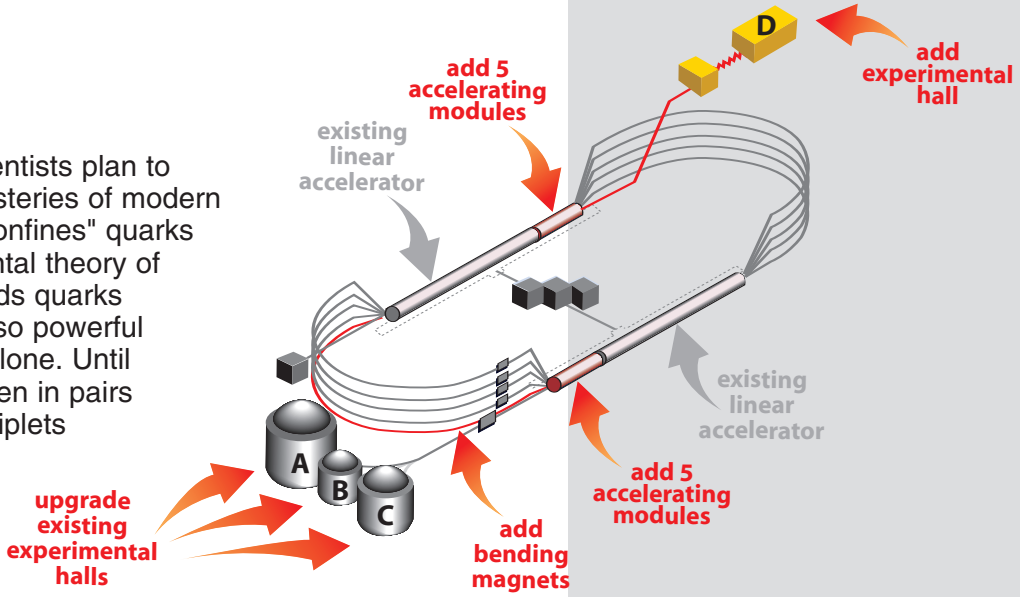
Then, on May 7, Lab Director Christoph Leemann announced his appointment of Assistant Director Allison Lung as the 12 GeV Upgrade Interim Project Director. "With the April signing of CD-0 for the 12 GeV Upgrade, the Lab can officially launch this exciting project," he said. "I am delighted that Allison Lung has agreed to serve as Interim Project Director. She has full authority and responsibility to develop and implement the Lab strategy for successfully meeting the scientific and technical goals of the Upgrade."

"The 12 GeV Upgrade presents a tremendous opportunity for Jefferson Lab to continue producing world-class scientific research well into the third decade of this century. Achieving this goal, while maintaining our high standards for the present research program, will require the focused dedication and commitment of every member of our staff and user community. I have every confidence that under Allison's leadership, the Jefferson Lab community will rise to the challenge required for success."

Visit Jefferson Lab's web site for additional information: http://www.jlab.org/div_dept/dir_off/public_affairs/news_releases/2004/04upgrade.html.

Near the end of their tour on April 19, Deputy Secretary of Energy Kyle McSlarrow (left to right), converses with Lab Director Christoph Leemann and Senator John Warner.

# More about the science behind the 12 GeV Upgrade




With the 12 GeV Upgrade, scientists plan to address one of the great mysteries of modern physics — the mechanism that "confines" quarks together. According to a fundamental theory of particle physics, the force that binds quarks together — the strong force — is so powerful that no quark can ever be found alone. Until recently, quarks had only been seen in pairs (particles called mesons) and in triplets (particles called baryons: protons and neutrons are baryons). But other quark combinations are theoretically possible. For instance, recent experiments have shown evidence of a five-quark particle (dubbed the pentaquark).

The new experimental hall (Hall D) aims to produce exotic or hybrid mesons. These exotic mesons are produced by exciting the gluons, the strong force or “glue” that binds quarks together. Though predicted by theory, many of these exotic mesons have never been seen before, and identifying them and their properties will provide information on the strong force and how it confines quarks.

The Upgrade will also enable scientists to research the fundamental structure of protons and neutrons (collectively called nucleons). By the mid-1970s, scientists knew that nucleons were made up of three quarks held together by gluons. We now know that a more complex system exists, with both quarks and gluons moving at nearly light speed and quarks and anti-quarks popping in and out of existence. The higher energy and new detectors of the 12 GeV Upgrade will allow scientists to probe how all of these particles interact to determine a nucleon’s basic properties — its mass, spin and how it interacts with other particles around it.

Another physics puzzle of the atomic nucleus is how protons and neutrons bind together to form the nucleus. One idea is that, when nucleons are close together, the strong force binding quarks together inside a nucleon is so strong that it can leak out, binding it to other nucleons. Another idea is that protons and neutrons swap quarks, and this exchange binds nucleons together. The Upgrade will allow scientists to further study how nucleons interact and determine the mechanism that binds them together.

An upgraded CEBAF will also allow physicists to study the limits of the “Standard Model,” a theory that describes fundamental particles and their interactions. So far, tests of this model have shown that it’s accurate. The Upgrade will open new opportunities for probing the model’s limits. Discovering where it fails will allow physicists to develop ever more accurate and inclusive theories of matter, giving them insights into the fundamental particles that comprise the world around us.

These experiments, and others, contribute to Jefferson Lab’s goal to push the knowledge of nuclear physics beyond current theory by studying the properties of fundamental particles, how these particles interact to form matter and what forces mediate these interactions. Upgrade plans call for a continuation of the research programs in the Lab’s three existing experimental halls (Hall A, Hall B and Hall C), as well as the building of a fourth hall (Hall D).

# On-Site Review

*DOE visits JLab; discusses range of activities from scientific program to long-range planning*

Jefferson Lab management received very positive feedback on the Lab's long-range vision, research program, effective use of SciDAC (Scientific Discovery through Advanced Computing) funding, and its strong relationships with partner universities and the local and regional communities, during the Department of Energy's On-Site Review held here April 2. There were also frank comments about JLab's poor worker safety record.

Presiding over the review was Dr. Ray Orbach, Director of the Office of Science. He and other DOE officials and visiting review panel members were impressed with JLab and its scientific research program and Long Range Plan. At the outset of the review, Orbach announced that Deputy Energy Secretary Kyle McSlarrow would come to the Lab later in April to sign Critical Decision Zero for the 12 GeV Upgrade "to give JLab the attention and respect it deserves." (See CD-0 event story beginning on page 1.)

The review agenda included sessions for senior Lab management to discuss a wide range of topics with Orbach, and senior Office of Science managers including: Dennis Kovar, Associate Director of Nuclear Physics; Robin Staffin, Associate Director of High Energy Physics; Ed Oliver, Advanced Scientific Computing Research; and Pat Dehmer, Associate Director of Basic Energy Sciences.

Briefings and topics of discussion included JLab's nuclear physics vision for research at 6 GeV (billion electron volts), the 12 GeV Upgrade and science at the higher energy, and the research JLab could potentially move into with an electron ion collider in the more distant future. Orbach and Kovar encouraged Lab leadership to actively pursue a strong international user collaboration for the 12 GeV science program.

The Lattice QCD (Quantum Chomodynamics) efforts earned praise, with Staffin saying he "greatly appreciates the work JLab is doing in LQCD."

The Lab's vision for its core competencies were discussed, including superconducting radiofrequency technology and the upgraded Free-Electron Laser. The review team strongly encouraged the Lab to continue building on its core competencies in order to ensure that these capabilities will be available for future DOE projects. At the request of Orbach, JLab presented a proposal for the Lab to become the U.S. Center of Excellence for SRF capabilities. The phased approach would allow the Lab to develop the technical capabilities needed to successfully realize DOE's 20-year facilities plan.

Dehmer described JLab's phased approach to developing the SRF technology as "a good approach that looks reasonable." Kovar commented that Jefferson Lab is a primary center for SRF and should coordinate a national effort to develop the technology. He also spoke of the need to continue building on the nation's investment in SRF technology.

The panel complimented the Lab's work in support of the Spallation Neutron Source. They emphasized the Lab's need to hold to its SNS cryomodule production schedule. The project is highly visible to stakeholders around the nation and its success in delivering performance on cost and schedule will impact future DOE projects.

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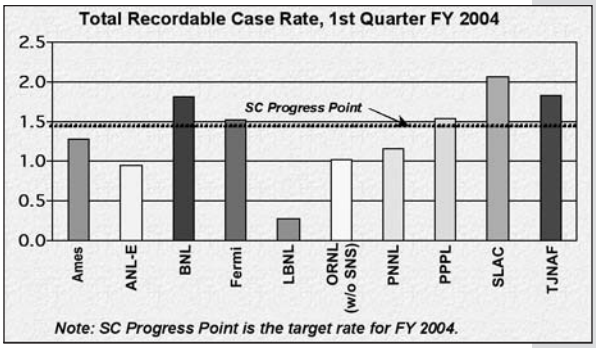
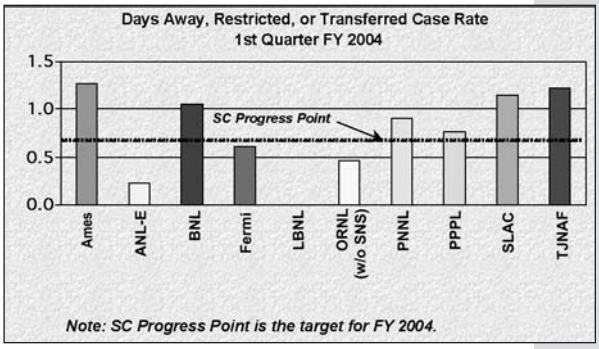
Ray Orbach, Director of DOE's Office of Science (left to right), comments during the recent On-Site Review. Office of Science managers Dennis Kovar, Associate Director of Nuclear Physics, and Robin Staffin, Associate Director of High Energy Physics, also participated in the review.

# TRC and DART:

## *Tracking JLab's safety performance*




Creating a productive, yet safe, work environment is one of JLab's highest priorities. But according to JLab's safety statistics, TRC and DART, the Lab has a long way to go before realizing this goal. What are TRC and DART?

TRC (Total Recordable Case Rate) is the number of recordable accidents per 200,000 hours worked. A recordable accident is one that requires more than basic first aide treatment (this is defined by OSHA and includes a list of 14 measures). Two hundred thousand hours is the average work-time per year put in by 100 people working 40 hours a week, 50 weeks a year.

DART (Days Away, Restricted or Transferred Case Rate) is the number of incidents per 200,000 hours worked that result in lost work days, restricted work days (the worker cannot perform all of his/her normal duties) or days in which the worker is transferred to alternate duties to accommodate an injury.

DOE's Office of Science uses these statistics to rate the safety performance of its facilities. In the first quarter of fiscal year 2004, JLab's TRC was 1.8, and the Lab's DART was 1.2, placing Jefferson Lab next to last among Office of Science facilities in safety performance.

The DOE Office of Science goal is for all of its laboratories to have TRC and DART numbers that fall into its "outstanding" rating level. TRC and DART rating categories are presented in detail on JLab's Intranet Insider page.

## On-Site Review. . .

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The FEL earned praise from Dehmer, "The facility is superb," she said. "JLab talent and Department of Defense funding resulted in a wonderful partnership." She added that energy-recovery linac technology is critical for future-generation lasers. She hopes to invest in a small program to develop ERL technology across agencies. While impressed with the scientific and technical accomplishments of the FEL, she said that in order to receive BES funding, the Lab would need to "demonstrate enormous national user interest and program need."

Safety was the significant topic discussed during the session on management challenges and operational/business issues. Jefferson Lab has recorded a number of minor mishaps and near misses over the last two years. Currently, Jefferson Lab's safety numbers fall below DOE's goals and the Lab is ranked in the bottom third for safety of the 10 Office of Science laboratories.

Safety is a high-priority issue for DOE and the national labs, and plans are underway within the Office of Science to begin weighting laboratory safety metrics within the laboratories' annual performance rating system. Ray Orbach emphasized that "cutting corners results in safety problems and impacts performance," and that small events — such as what JLab has been experiencing — if left unresolved, eventually become serious events.

Other topics during this session included infrastructure, maintenance, information technology, human capital and security.

Jefferson Lab's senior leadership participated in the On-Site Review briefings and discussions. Pictured here are (right to left): Lab Director Christoph Leemann, Assistant Director Allison Lung, Chief Scientist Tony Thomas, Chief Financial Officer Mary Erwin and Chief Technology Officer Fred Dylla.

# Congratulations to JLab's newest APS Fellows

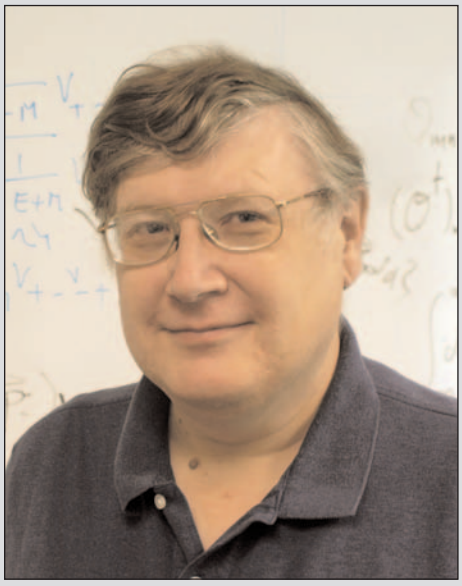
In December 2003, two JLab staff members and one user were informed that they were among the 215 individuals newly elected to Fellowship within the American Physical Society. Fellowship is considered one of the highest peer honors in the physics world.

Jean Delayen, Accelerator Division, was recognized for his numerous contributions to the physics and technology of superconducting radiofrequency (SRF) linear accelerators.

Jay Wallace "Wally" Van Orden, jointly appointed physics professor at Old Dominion University and JLab Theory Group senior scientist, was cited for his contributions to the understanding of relativistic effects in few- and many-body nuclei with particular emphasis on covariant calculations of the electromagnetic properties of the deuteron.

And Ronald Gilman, Rutgers University and JLab Hall A user, was cited for his studies of the transition region between pion/nucleon and quark/gluon degrees of freedom via recoil proton polarization measurements.

This spring they received their certificates from the APS unit recognizing their achievements. The Fellowship program was created to recognize members who have made advances in knowledge through original research and publication or made significant and innovative contributions in the application of physics to science and technology, or made a significant contribution to the teaching of physics. Each year, no more than one-half of one percent of the current membership is recognized by their peers for election to the status of Fellow in the Society. Each new Fellow is elected after competitive review and recommendation by a committee on the unit level, additional review by the APS Fellowship committee and final approval by the full APS council. Fellowship has existed since the beginning of APS in 1899.



Wally Van Orden

## Van Orden: first to receive joint appointment at Jefferson Lab

Wally Van Orden said he was honored to join the other members of JLab's Theory Group that are APS Fellows. "I was quite pleased when I was notified," he said. "It's always nice to be recognized by your peers."

Van Orden grew up in Utah and attended Utah State University for his undergraduate degree in physics, a field he knew he'd pursue from the time he was a teenager. "I always read a lot," he recalled, "and really enjoyed physics."

He went to graduate school at Stanford, and decided to focus his efforts on theoretical and nuclear physics. While at Stanford he met Dirk Walecka, who was a senior professor there at the time. The two men now share an office at JLab.

He received his Ph.D. in 1978 and went on to the University of Maryland at College Park for three years as a post-doc. At the end of that time, he was appointed to the rank of assistant professor.

Van Orden first came to the Lab in 1988 as a visiting scientist on a one-year appointment; in 1989 he joined the staff and moved to Virginia. In the fall of 1990, he received a joint appointment with Old Dominion University, where he is now a full-time regular faculty member, and JLab purchases half of his time so he can continue his work in the Theory Group. Van Orden was the first person to receive such a joint appointment.

He made the career decision early on to be a theorist rather than an

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# For Delayen, accelerators trump coal mines

For Delayen, "Being elected an APS fellow is very gratifying since it is an acknowledgement by your peers that you have made significant and original contributions to a particular field of physics," said Jean Delayen, the Accelerator Division's newest APS Fellow.

He still has the notebook in which, as a young man, he first took notes on particle accelerators. Accelerator technology, according to Delayen, requires a broad range of skills: the "right combination" of basic and applied science, math and engineering. And, for Delayen it was a ticket out of the coal mines of northern France, where he was the first in many generations not to have to go to work with a pickax and lantern.

Delayen has come a long way from his boyhood home of Auchel, near Calais. Today he is a Fellow in both JLab's Center for Advanced Studies of Accelerators (CASA) and its Institute for Superconducting Radiofrequency Science and Technology, as well as a Principal Scientist, and leader of SRF parameters on the work JLab is doing for the Spallation Neutron Source under construction in Oak Ridge, Tennessee. JLab is part of a team of federal laboratories — including Argonne, Brookhaven, Lawrence Berkeley, Los Alamos and Oak Ridge — assisting in the design, engineering and construction of the $1 billion-plus SNS, which will provide the most intense pulsed-neutron beams in the world for scientific research and industrial development.

Delayen first arrived in the United States in 1970, as a graduate student at the California Institute of Technology. Seven years later he earned a Ph.D. in low-temperature physics. Nine years after that he headed for Argonne National Laboratory outside Chicago, after being in the CalTech superconducting radiofrequency (SRF) program from its beginning until it was terminated. Delayen arrived at Argonne with little more than his expertise and a determination to go beyond what he had accomplished in California. As Argonne's program manager for SRF and accelerator physics in the Technology Development Division from 1987 to 1995, he did just that.

"All I had was a desk," Delayen recalled. "I had to get funding to hire people, buy equipment and do everything from scratch. I was quite successful: after a year I had found about $2 million, and several of the advances that we made during that time are now being incorporated in accelerators that are under development."

Jefferson Lab was Delayen's next professional step. As head of JLab's Accelerator Development Department through 2001, he oversaw the development and refinement of next-generation cryomodules, the heart of the Lab's superconducting accelerator technology. "I looked around. JLab was the most interesting place," Delayen recollected. "It had very good facilities — and very good people."

"A lot of the expertise needed for the future application of technology for accelerators resides here," he added.

As a senior Accelerator Division scientist, Delayen is active in both CASA and the Institute for Superconducting Radiofrequency for Science and Technology. Both centers were established in May 2001 with the goal of enhancing Jefferson Lab's core competencies in the science and technology of particle accelerators and physics of beams of charged particles and photons by integrating the various disciplines.

"At larger, more established institutions, you may have less opportunity to make an impact," Delayen said. "Because Jefferson Lab is small it is specialized, a single-purpose lab. There was, and still is, an opportunity here to shape the future."

Jean Delayen

# CEBAF reaches major milestone

## *100th experiment completes data collection*

A decade after achieving first beam, Jefferson Lab has completed data collection on its 100th experiment.

The experiment, titled "Quark Propagation through Cold QCD Matter," began its run in December 2003 and wrapped up in early March. It probed Quantum Chromodynamics (QCD), a fundamental theory of particle physics that describes the interactions of quarks and gluons — the basic building blocks of matter. A property of QCD, called confinement, states that no quark can ever be found alone. Instead, they combine in pairs (mesons) or triplets (baryons) to make up larger particles. For instance, every proton and neutron contains three basic quarks.

"You never find a quark by itself, in isolation. That's really a very bizarre thing and a huge mystery. So what happens when you try to get one quark alone?" asks Will Brooks, JLab Staff Scientist and experiment spokesperson.

Jefferson Lab's accelerator is helping physicists answer that question. The electron beam is one of the few tools on Earth that can separate quarks. "You can't pull quarks apart with your fingers, but you can collide something very energetic with a quark and try to knock it out. And we have a rather simple picture of what happens when you do that."

Will Brooks

In this experiment, scientists essentially slam an electron into a single quark, knocking it out of the particle it was bound up in. But it doesn't come out alone — the energy the quark absorbs in the collision is transformed into new clusters of quarks and gluons.

"If you could pull a single quark, the farther away you pull it, the force remains the same, but the energy you're putting into that system is getting bigger and bigger. So the more you pull, the more energy you're stuffing in there. And you get so much energy stored up, that a new particle could be produced, because according to Einstein's $E=mc^2$, energy can be transformed into matter. And so a new particle just mysteriously pops out of the vacuum. And now you've got a brand new particle. And if you pull very hard for a very long distance, you can have many of these new particles appear."

Scientists hope that studying this process of creating new quark-based particles, called hadronization, reveals new information about quark confinement. And by studying the new quarks and gluons, experimenters seek to understand how they were created and what happened before they coalesced into new multi-quark particles.

"Normally, all you measure are the particles that come out, long after that other process [hadronization] is done. So the idea is to use the nucleus as a laboratory. If you knew everything about the nucleus, and then you initiated some process inside one that you want to study, then you could use your understanding of the nucleus to understand what's going on."

To that end, the experiment used five different targets — composed of nuclei with different numbers of protons and neutrons. Deuterium, which holds the simplest nucleus containing both a proton and a neutron, was followed by targets of carbon, iron, tin and lead.

Brooks says now that data collection is complete, the next step is to

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calibrate the data. “Once it's calibrated and processed, we’ll know whether there's something very unexpected. And we’ll have preliminary results around 6 months after that. We might have publishable results one to two years after that. It takes a long time.”

In the meantime, the experimental team, comprised of CEBAF Large Acceptance Spectrometer (CLAS) collaborators, is looking to the future. Brooks says improved beam energies should provide even better data. "The CEBAF 12 GeV Upgrade would be a very fine place to do the ultimate experiment of this kind, and it's in our plans."

In the ideal experiment of this type, experimenters would have an electron beam with enough energy to hit quarks so hard that they fly completely out of the smallest nuclei (like deuterium) in which they reside before hadronization. Performing the same experiment on ever larger nuclei until hadronization once again takes place inside the nucleus would reveal the time scale that the process requires — a vital piece of information in understanding quark confinement.

Brooks says JLab’s 100th experiment was run concurrently with its 101st experiment: “$Q^2$ Dependence of Nuclear Transparency for Incoherent $\rho^0$ Electroproduction,” a search for color transparency, another prediction of QCD. “In Hall B, you can do more than one experiment at a time. For instance, the first Hall B run had 13 experiments.”

According to QCD, quarks have a special kind of extra charge called color. Color charge comes in three varieties: red, blue and green. Quarks can only exist in combinations where their color charges add up to no color. For instance, a baryon, which has three quarks, has a quark of each color, adding up to white (no color). A meson contains a quark and an anti-quark, so if one quark is red, the other is anti-red, once again adding up to no color.

While baryons and mesons have no color, some of the color charge from the individual quarks still leaks out, allowing baryons and mesons to interact with other particles. For instance, this is how baryons like protons and neutrons bind together to make up the nucleus of an atom.

But it’s possible for the quarks in some particles to bind together so tightly, and therefore be so small or compact compared to other particles, that their color charge doesn’t leak out. According to Kawtar Hafidi, spokesperson for the experiment and Assistant Scientist at Argonne National Lab, QCD predicts that these particles can coast along without interacting with other particles. When this happens, it’s said that the medium these particles are traveling through is “color transparent.”

“It's like the particle becomes invisible to the medium. The medium doesn't see the particle, so it flies through the medium without any interaction” Hafidi says.

In the experiment, scientists looked for rho mesons that were created when the electrons slammed into quarks in the nuclei of the target. Some of these rho mesons should have been small enough for the particle to sail out of the nucleus without interacting with other particles.

“If we see the signal that we’re looking for in these results, it will be the first evidence of color transparency ever. It's very important. There are no other theories that can explain the results we’re anticipating without color transparency,” Hafidi notes.

While data collection is complete, the physicists have just begun calibrating their data, a necessary step before they can begin analysis. They expect to have preliminary results as early as December.

Jefferson Lab ran its first experiment in 1995 in Hall C. Titled “The Energy Dependence of Nucleon Propagation in Nuclei as Measured in the (e, e'p) Reaction,” the experiment was completed in December 1995.

## *100th experiment completes data collection...*

In the experimental run, the accelerator slammed electrons into the nuclei of a target element. Pictured here is a close-up view of a sample aluminum target and the target apparatus.

# Plugging in to the professional world of physics

## *JLab intern experience gives Shepherd his first taste of real research*

Matthew Shepherd first came to Jefferson Lab in 1997 as a wide-eyed undergraduate physics intern. He returned on Jan. 30, 2004, confident, calm and ready to present a physics seminar titled "Charmless Semileptonic B Decays at CLEO," the subject of his research work at Cornell University.

After the seminar, he comfortably fielded questions about the CLEO detector, uncertainty calculations and his work at CESR (the Cornell Electron Storage Ring), a high-luminosity electron-positron collider. Shepherd says he wasn't always this confident of his work and he attributes much of his professional development to the mentoring he's received over the years.

Shepherd met Alex Dzierba, a physics professor at Indiana University and a JLab user, in the fall of 1996 when he began his undergraduate studies at Indiana University. "Professor Dzierba taught the first-year physics course at Indiana. He strongly encouraged me to spend the summer at Jefferson Lab," Shepherd recalls.

Matthew Shepherd

Here for the summer of 1997, the young intern worked in the Experimental Equipment Lab on a Cerenkov detector — optimizing the electronics for a phototube base on the detector. His group's goal was to simulate and improve phototube performance on the unit. "It was probably my first connection to real research. I enjoyed it and had a great time. And even though, as an undergrad, I couldn't understand everything that was going on, I could begin to appreciate the research."

In addition to the hands-on research work, he also appreciated the personal attention the students received from the Science Education staff. He still remembers Jan Tyler, Science Education program manager, encouraging him to spend at least a little time outside the Lab to take part in organized fun — volleyball games or movie outings scheduled for the students. "These short breaks away from work were important, and after getting back from one, I found that I worked that much harder," he notes.

"After the JLab internship, Alex asked me to start working with his research group," Shepherd adds. The next summer, he worked with other students in Dzierba's group on data analysis from an experiment that had taken place at Brookhaven National Lab. "Alex was careful to make sure we were exposed to real physics. He makes it a practice to hire undergraduates for his group, which is to be strongly commended," comments Shepherd. He stayed with Dzierba's group for the rest of his undergraduate training. "It got me out of the classroom and plugged into the professional world of physics." The work also led to the first paper that Shepherd coauthored, which appeared in *Physical Review D* in 2001.

Though Dzierba kept his lab students busy, Shepherd found time to spend a summer at CERN in 1999. As part of a National Science Foundation sponsored program, he joined more than 150 students from Europe as part

*Continued on next page*

## *New APS Fellow,Van Orden: first to receive JLab joint appointment...*

*Continued from page 8*

experimentalist, he said. For the past 15 years he has been working with relativistic models of the deuteron, and this is the work for which the American Physical Society recently honored him. The results of his work have pleased him.

"I've been very gratified by the outcomes," he said. "Some very nice data has been taken here. It's been of much higher quality than ever before. Our calculations have worked quite well." He has also been applying some of the same techniques for which he was honored to simple quark models, and is working with collaborators at Ohio State University and the University of Utrecht (The Netherlands) on simple quantum mechanical models of duality and scaling.

## *Plugging in to the professional world of physics, intern experiences taste of real research...*

*Continued from previous page*

of the CERN Summer Student Program. He worked on a prototype of the hadron calorimeter for the Compact Muon Solenoid (CMS), and other projects. Experiences like that help young scientists grow a lot culturally, according to Shepherd.

After graduating from Indiana University with a bachelor's degree in physics and mathematics, he headed to Cornell University. His work there has focused on data from the CLEO detector. He expects to complete his Ph.D. in the spring of 2005, and has accepted an offer to start work in August 2005 as an assistant professor in the Physics Department at Indiana University. "I plan to spend a substantial part of my research time working with the GlueX collaboration on an experiment that will go into the proposed Hall D at JLab," he says. "So I look forward to many more trips to JLab in the future."

His time at Cornell has also given him the opportunity to come full circle and mentor young physicists. Shepherd, as part of a group of Cornell researchers, took on a student from the Research Experience for Undergraduates program, which is funded through the National Science Foundation. The group helped the student reach his goal of gaining a better understanding of the electronics in a sophisticated detector like CLEO. Shepherd says he learned a lot through the experience, and plans to be a mentor again.

Reflecting on his education and career, Shepherd is quick to credit his mentors and the research experiences they exposed him to. "There's no substitute for a real research environment," he emphasizes. "I think being exposed to that makes you grow in many ways, because in that environment you have to learn to operate as a physicist. And the sooner you get acclimated to that, the faster your career and research goals will develop."

### CLEO — CESR, CESR — CLEO?

What does CLEO stand for? "It actually doesn't stand for anything at all. It is always written in all capital letters but isn't an acronym for anything. The name comes more from the accelerator, which is called the Cornell Electron Storage Ring — CESR — and pronounced "Caesar." And what would Caesar be without Cleopatra? So there they are: CESR and CLEO."

# Briefs

## Milestones
### for March/April 2004

#### Hello

Anthony Thomas, Chief Scientist/ Theory Group Leader, Directorate

Vihoa Tran, Biomedical Imaging Physicist, Physics Division

Michael Goodliff, Survey Technician, Accelerator Div.

Christopher Humphry, Accelerator Operator, Accel. Div.

Robert Reposa, Hall A Welder/ Fabricator, Phy. Div.

Nancy Hartley, Accounts Payable Clerk, Chief Financial Office

Cynthia Crawford, Residence Facility, Cleaning Associate, Southeastern Universities Research Association

Ruth Woodward, Terahertz Spectroscopist-Post Doctoral Fellow, Accel. Div.

Johnie Banks, Medical Services Administrative Assistant, Administration Div.

#### Goodbye

David Waldman, Staff Engineer, Accel. Div.

Johan Bengtsson, Staff Scientist, Accel. Div.

#### Congratulations

Congratulations to Debra Stitts, Document Control Supervisor, for recently completing an Associate's Degree in Liberal Arts from Saint Leo University.

Stitts becomes the 26th person at Jefferson Lab to earn a degree through the tuition assistance program. She plans to continue her studies at Saint Leo as she pursues a Bachelor's Degree in Business Administration. She is one of 39 people currently participating in the program.

Henry Robertson joined the ranks of college graduates during commencement ceremonies at Christopher Newport University in May. He received a Bachelor's Degree in Information Science with an emphasis in Management Information Systems. Robertson is a Safety Systems Engineer Associate in the Accelerator Division. He becomes the second Tuition Assistance Program (TAP) participant this year to complete a degree program.

Thinking about continuing your education? Jefferson Lab can help. To become eligible for TAP consideration, you must be a regular employee (full or part-time) and have completed 12 months of your probationary period. Contact the Training & Performance Office for details or visit the web at www.jlab.org/div_dept/train.

## *AVS awards Fred Dylla with Honorary Membership*

The American Vacuum Society awarded Honorary Membership to Fred Dylla, JLab's Chief Technology Officer, in recognition of his scientific contributions, and for his service to the Society at their annual meeting.

This honor was bestowed for his outstanding contribution in creating the foundation for preserving a permanent legacy of the first 50 years of AVS. Honorary membership privileges include life rights to the society and exemption from all dues and fees.

He is a past President of the American Vacuum Society and has held many other offices within the organization.

## *Manzlak named Tidewater Safety Professional of 2004*

Bert Manzlak, Physics Division deputy safety officer, recently received the American Society of Safety Engineers — Greater Tidewater Chapter — Safety Professional of the Year award.

This honor recognizes Manzlak for his community and professional services. He is the current Peninsula section president and member of the chapter executive board, a past chapter president and former regional examination proctor for the Board of Certified Safety Professionals. Manzlak mentors local safety professionals, and is on the advisory executive committee of safety for high energy physics, in addition to his environmental, health and safety service to the JLab staff and user community.

## *LBNL hosts workshop on Advanced Computational Software Collection*

Lawrence Berkeley National Lab is hosting a four-day workshop on the DOE Advanced CompuTational Software (ACTS) Collection, a set of software tools aimed at simplifying the solution of common and important computational problems. The workshop, "Enabling Technologies for High End Computer Simulations," will be held Aug. 24-27 at Berkeley.

The Department of Energy is sponsoring the workshop, and there is no fee to attend. However, the number of participants is limited and people interested in attending must submit their application by June 25, 2004. The application can be found at http://acts.nersc.gov/events/Workshop2004/application.html.

Developed mainly at DOE national labs, the DOE ACTS Collection has benefited a wide range of scientific codes and industrial applications.

These benefits include improving the efficiency of scientific research in high performing computing environments and enabling computation that would not have been possible otherwise.

As part of this outreach to potential users, DOE will sponsor a limited number of graduate students and postdoctoral fellows to participate in the workshop. This support includes round-trip transportation to and from Berkeley, local transportation, lodging, meals and workshop materials. Applications from other research scientists are also encouraged.

The workshop will include a range of tutorials on the tools (both those currently available in the collection and some deliverables from the DOE SciDAC program), discussion sessions aimed at solving specific computational needs by the participants, and hands-on practices using high performance computers at the National Energy Research Scientific Computing (NERSC) Center.

For more information, contact Tony Drummond at (510) 486-7624 or Osni Marques at (510) 486-5290, or visit http://acts.nersc.gov/events/Workshop2004/.

## JLab recognizes its Outstanding Small Business Contractor for FY 2003

Jefferson Lab recently recognized a local, woman-owned machine shop as its Outstanding Small Business Contractor for fiscal year 2003. Triad Machine Shop was chosen from 107 small disadvantaged or women-owned vendors under contract with the Lab during the previous fiscal year.

Sharon Harrah, owner of Triad Machine Shop located in Newport News, received the Southeastern Universities Research Association (SURA)/JLab Outstanding Small Business Contractor award for FY 2003.

At a reception held in mid-April, Department of Energy Site Office officials, senior JLab management, JLab Machine Shop staff and other Lab employees congratulated Harrah as she received the award plaque from JLab Director, Christoph Leemann.

JLab began using Triad Machine Shop in 1988. For the past seven years the business has been instrumental in handling machining projects that couldn't be completed in-house. During FY 2003, Triad completed 476 workorders valued at $198,000 for the JLab Machine Shop.

According to Machine Shop supervisor, David McCay, 30 percent of the jobs put into JLab's Machine Shop are for "rush" work that is needed the same day or first thing the following day. "Triad Machine picks up and delivers all tasks. The company can be relied on to complete rush tasks within specified delivery times," he notes. Triad Machine representatives have, on occasion, even met with JLab personnel after hours and on weekends to deliver completed tasks, McCay adds.

McCay gives Triad Machine high marks on work quality and being very concerned with customer satisfaction.

Sharon Harrah (center), owner of Triad Machine Shop located in Newport News, Va., receives the award plaque from JLab Director Christoph Leemann (right). Harrah is accompanied by her husband, Ed.

# JLab welcomes Tony Thomas as new Chief Scientist...

*Continued from page 2*

it develop rapidly. In EBAC, theorists will work very closely with experimentalists to extract the most information from the data, and see whether some of these missing states are really there. There are some really challenging questions for theoretical physicists in that analysis," he says.

He also sees the Theory Group as a testing ground for future theorists. In his view, the Lab, in concert with local colleges and universities, is a premier place for training the next generation of theorists. "There couldn't be a more stimulating environment for a student to get a Ph.D. in theoretical physics than in a lab like this," he point out, "and that's one thing that I think is extremely important."

Thomas and his wife Joan arrived in Newport News March 28, and they're taking their time to settle into the area. "There are many challenges in moving to a new country, because many things are done differently. Most of the people here have been very welcoming," he says. During his free time, he likes to take long walks, read and watch sports. (He prefers watching cricket and Australian-rules football, but he's searching for sports that are a little easier to find on American television.)

Joan is a Ph.D. research chemist who studies the extraction of copper ore and environmental problems associated with acid-mine drainage from sulfide minerals — a specialization in the area of surface chemistry. He has two daughters. Alicia, age 26, is a psychologist specializing in human resources management in Adelaide, and Nadine, age 23, has earned a degree in mathematics and will soon also finish up a degree in electrical engineering at the University of Adelaide.

Thomas is already hard at work here, putting his expertise in nuclear physics to good use. He helped establish the theory group at TRIUMF, and he has worked in many different areas of research, including deep inelastic scattering, structure of nuclei, symmetry violation, quark models, lattice QCD and chiral extrapolation problems.

Thomas earned his B.S. (1970) and Ph.D. (1974) from Flinders University. He has authored more than 450 scientific papers. He has served as President of the Australian Institute of Physics and has been elected Fellow of the Australian Academy of Science, the American Physical Society, and the (UK) Institute of Physics. He has received numerous awards, including the Harrie Massey Medal (IoP), the Thomas Ranken Lyle Medal (Australian Academy of Science), a von Humboldt Research Prize (Alexander von Humboldt Research Foundation) and the Walter Boas Medal (AIP).

ON TARGET

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