January 2011

Los Alamos National Laboratory Advancing National Security Through Scientific Inquiry

why

we may be closer than ever to an HIV vaccine

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Los Alamos NATIONAL LABORATORY EST.1943

About this issue—and distribution of future ones

Scientist Bette Korber recently told the *Santa Fe New Mexican*, "We're in the evolutionary fast lane studying HIV. As soon as the body makes an immune response, HIV wiggles out of it." The team Korber leads at Los Alamos has been hard at work, racing the clock, designing a vaccine to back the deadly virus into a corner. Our cover story explains how—and why it's so crucial to Korber.

Your feedback on the premier issue of *Why* (October 2010) was overwhelmingly positive, with several comments cropping up repeatedly: "excellent," "interesting," "like the content," "like the format," "looks great." A number of readers criticized *Why*'s coverage of technical topics in light of other Lab publications such as *1663*, *Actinide Research Quarterly*, and *National Security Science*.

Several readers praised our plan to meet your preferences—and save trees—by only mailing future issues to subscribers and, of those, only sending printed paper copies to individuals who expressed that preference.

Although we plan to limit distribution to only those who subscribe, feedback from you indicates that we need more time to familiarize our audience with this new periodical. We plan to move to a strict subscription-based delivery come April. Please help us achieve this goal by subscribing online at www.lanl.gov/whysubscribe. If you've already done so, thank you.

Why *magazine is a quarterly publication primarily for employees and retirees of Los Alamos National Laboratory. We welcome comments, suggestions, questions, and corrections. Please send them to why@lanl.gov.*

www.lanl.gov/news/pubs.html

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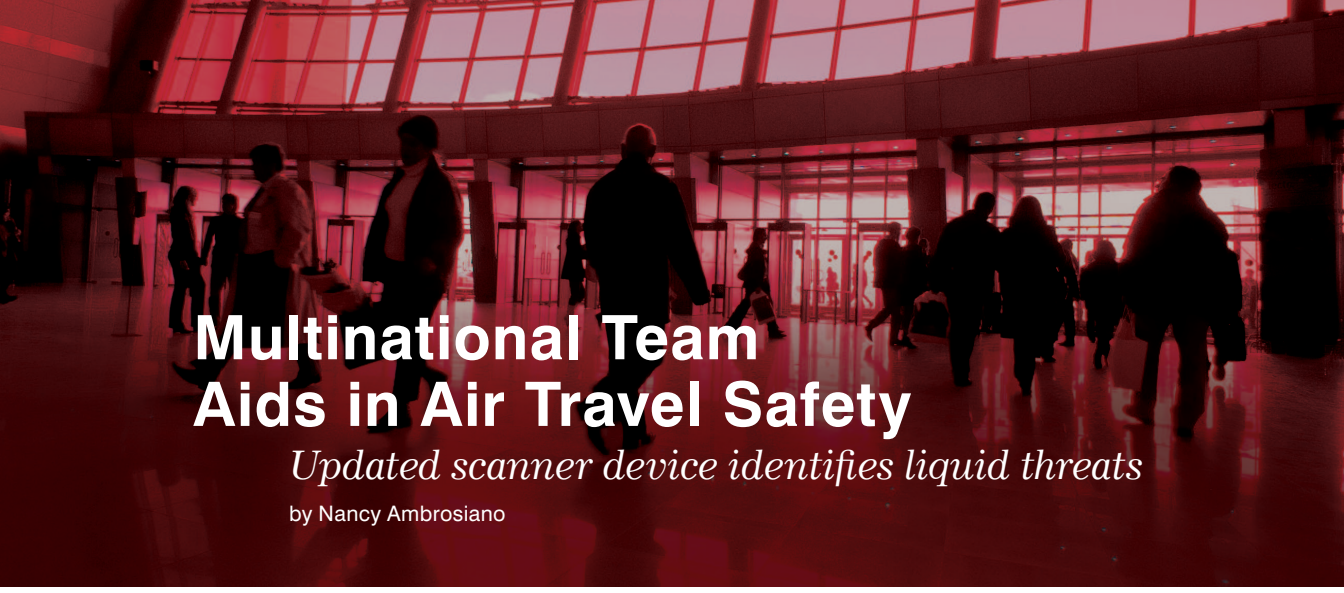


Multinational Team Aids in Air Travel Safety

Updated scanner device identifies liquid threats

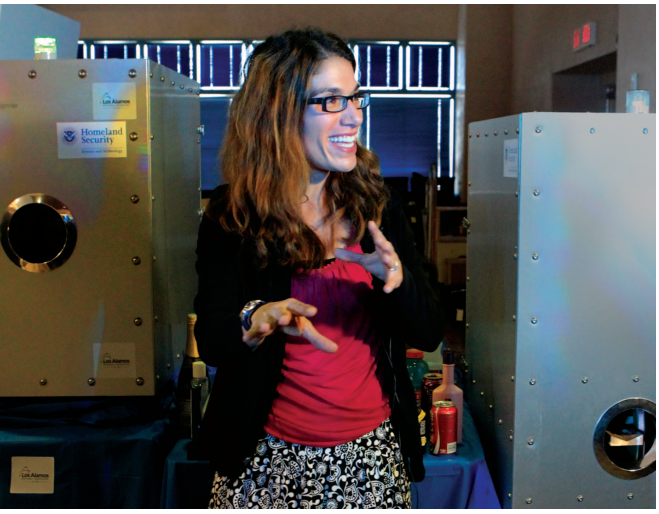
by Nancy Ambrosiano

Photos by LeRoy N. Sanchez

Milestone one: Invent a device that sees into all sorts of packaging at busy airports and divines what liquids are inside. Make it inexpensive, speedy, transportable, and foolproof. Look into bottles and juice boxes and tell us what they're hiding. A *Star Trek* tricorder would be nice.

Milestone two: Take the one you made and make it smaller, faster, simpler, smarter, and, yes, foolproof. Again with the tricorder thing.

Response from LANL's Applied Modern Physics (P-21) team: "You got it."



Project leader Michelle Espy explains the advantages of CoilViz during a demonstration at Albuquerque International Sunport.

Well, not the tricorder part so much. But with the advent of the MagViz Bottled Liquid Scanner system, the Department of Homeland Security (DHS) project made giant steps toward a tabletop device that could speed airport travelers on their way.

Unveiled at Albuquerque International Sunport last October, the new version of the MagViz project took the original nuclear magnetic resonance concept, shrank it down, and simplified it. The new model, "CoilViz," got rid of the superconducting quantum interference devices (SQUIDs), dumped the liquid nitrogen requirement, and STILL looked deep into bottles and told truth to power. Red light = bad liquid. Green light = OK liquid.

"The prototype . . . seems to offer great promise for discriminating threat materials and liquids, and the design seems amenable to commercial adoption," said Stephen Dennis of the DHS Advanced Research Projects Agency.

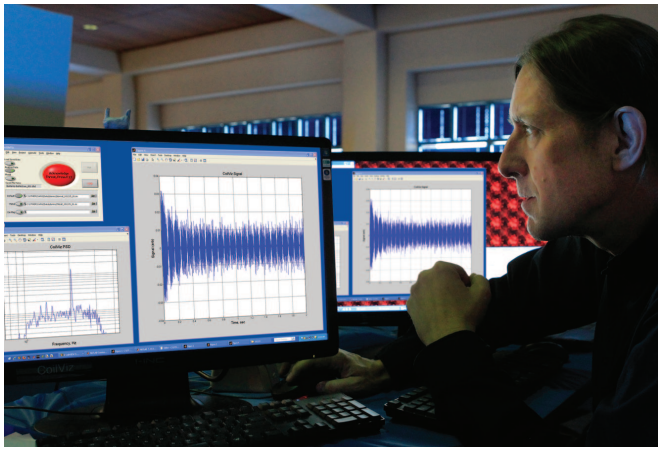
The system, roughly the size of a college-dorm refrigerator, has a simple light on top and a bottle-sized hole in the front, and it is a dramatically different package from that unveiled in December 2008 (see illustration, opposite page).

The original MagViz, nearing a Humvee in size, was brilliant at identifying liquids, but all agreed that a smaller, faster device would be needed to satisfy the real-world needs of airport security. The team spent untold hours over the course of several months devising an updated version that took the smarts of the big system and put it into a to-go box.

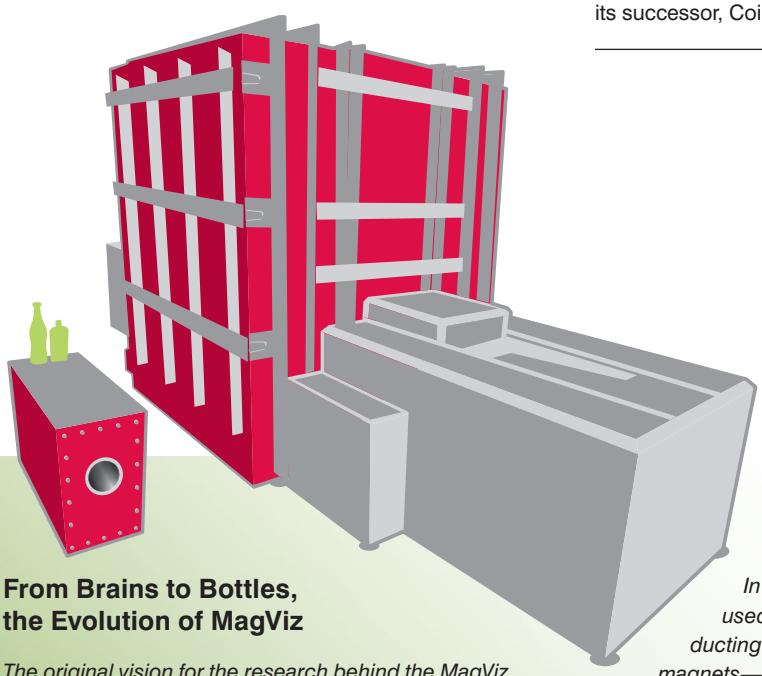
"A few years ago, this sort of nuclear magnetic resonance was barely possible with a sensitive device like a SQUID," said Michelle Espy, the project's leader. "It is really amazing that we have been able to come so far so fast."

The team behind this remarkable and speedy series of successes, known as the "SQUID team" in honor of its many applications using the device, is a varied and interesting bunch from all parts of the globe. Espy credits their diversity as a key ingredient in their system's success.

"Our team combines the best and the brightest," Espy said, "and they come from all over: Russia, Ukraine, Sweden, Canada, Turkey, and Bangladesh, as well as the blended Northern New Mexico culture. . . . And we've even got a guy from Oklahoma," she joked. Two team members have recently earned their U.S. citizenship, and at least one more staffer is midway through the application process. Espy notes, "I'm glad that America is collectively going to be a lot smarter." ■



Bob Kraus, deputy director of the Laboratory-Directed Research and Development program, knows MagViz and its successor, CoilViz, inside out.



The original MagViz system dwarfs the new CoilViz system (far left, with bottles shown for scale).

From Brains to Bottles, the Evolution of MagViz

The original vision for the research behind the MagViz Bottled Liquid Scanner system and its successor, CoilViz, was not related to screening the belongings of airplane passengers. It was intended to adapt a powerful medical tool, magnetic resonance imaging (MRI) technology, to a smaller, less complex device that could be used in regular doctors' offices.

Bringing the device size and magnetic field levels down to a more portable, flexible level would reduce medical costs and provide better diagnostic tools for more people.

In the course of devising a machine that used sophisticated software and superconducting devices—instead of vastly powerful magnets—to see body tissues, the team opened the door to a new use in the airport security world. And after the 3-1-1 rule mandated limitations on the amount of liquids air travelers could carry, the Department of Homeland Security went hunting for a solution. But advances in the security world may well pay off on the medical side as well.

"Just as this machine could make a difference for portable magnetic resonance imaging for an airport, I think it would make a real difference for emergency rooms, for battlefields, for people who can't get high-magnetic-field MRIs," said LANL's Michelle Espy, the project leader.

Interview

Mark Barth

Associate Director for Business Services

Photo by LeRoy N. Sanchez

Mark Barth is associate director for Business Services, which provides Labwide support for people, training, material, supply chain, records, and process improvement.

Barth came to Los Alamos in 2009 from Bechtel National, Inc., where he was the business development manager for Department of Energy and National Nuclear Security Administration programs. Previously he served Bechtel ventures in management roles at the Y-12 Complex in Oak Ridge, Tennessee, and at the Nevada Test Site.

He has a master's degree in business administration from Auburn University, a bachelor of science degree from the United States Naval Academy, and is a registered professional engineer.

You oversee the Business Services directorate (ADBS) at a Lab known for its scientific prowess. How does the operations side of the Lab complement the programmatic role?

Have you ever seen the BASF commercials? They show people using all kinds of products—cleaning their homes, getting new tires—and their motto is, "We don't make a lot of the products you buy. We make a lot of the products you buy *better*."

That's how I think of ADBS. The government doesn't fund this institution so that we can provide people benefits, so that we can train people, so that we can gather or safeguard records—none of those things. Yet none of the good stuff, the certification of the weapons stockpile or Earth-changing innovations, would occur if they did not have the "BASF" that is Business Services. Employees expect to be compensated and they expect to have benefits that are competitive. It's pretty important stuff.

Then, in a way, is ADBS the backbone of the Lab?

No. It is strictly an enabler. If I could figure out a way to allow the weapons work and science to happen without business services, I would do it. I should be trying every single day to figure out ways to be less visible while providing greater service.

What ADBS people do is critically important and it helps every other Lab function. But it's not the job of the Laboratory.

People may think they could do without, or could do with less than what we provide. It is the *how* that gets tricky. It's not so easy because we have regulations and expectations and in some cases our skill sets don't move at the same pace as the expectations.

In the 18 months you've been at the Lab, what has been your biggest challenge?

Overcoming perceptions about ADBS when the basis was either unclear or unfounded. Early on, I'd hear comments or criticism that Acquisition Services couldn't get something done, or HR did something they shouldn't have. I would get out my pen and take notes. I'd always start with, "In order to help I need to clearly understand what the problem is." Often I found it was perception alone—a "problem" with little or no basis.

Perceptions are not the only reality, but they are a reality.

Is one of those perceptions the difficulty of performance reviews?

Performance evaluations are hard no matter the tool. My personal perception and experience tells me that it's easy to tell the top performers how they are doing. You look forward to those discussions. It's pretty darn difficult from the middle on down to tell somebody, "More people do your job better than you do." But, half of the people need to hear that message. I do not care what tool you use, that's a hard thing to do. It is what makes a manager, being able to do that in a way that motivates someone instead of discourages.

"Perceptions are not the only reality, but they are a reality."

"The director is committed to providing competitive benefits and we always have. Doing that costs increasingly more money."

Photo by Sandra Valdez

Do I think our tool is perfect? No. Is that the reason that people label it as difficult? I don't think so. I think it is what comes with it, which is a really, really hard thing to do.

Have you worked to address a perception that the procurement process is difficult?

I think that having people out in the field who know how it works, know who to call within all parts of Acquisition Services, and having them local to our customers is huge. People are going to get frustrated. We buy a lot of very special stuff here. We have customers in their laboratories develop a vision for what they need and convey that in a discussion to a designated procurement representative or a buyer. We need to manage those expectations—how much and how quickly can we move on something like that? We are getting there.

Workplace health is a hot topic nationally. How will the new Blue Cross Blue Shield wellness initiatives affect the individual employee's insurance?

The director is committed to providing competitive benefits and we always have. Doing that costs increasingly more money.

We have to reduce the amount of medical services that people use. Wellness has a role to play. It's about getting people to realize that living a healthier lifestyle means you go to the doctor less. That means that both the institution and the employee pay less, our insurance provider does not have to reimburse those costs, and it snowballs.

The new initiatives include online member accounts with recipes, health news and weight management programs. There are also discounts for preventative care like YMCA memberships, health spas, and massage therapy. Here at the Lab, we encourage people to spend time at the Wellness Center.

Keep in mind it's like turning an aircraft carrier. It is not like tomorrow everyone is going to go run at lunchtime. But, if people make better dietary choices, if people are more active, if people do watch their weight more carefully, it really would have a big impact.

Part of a healthy lifestyle is having a life outside of work, a hobby. I heard your hobby is maintaining a '63 Corvette.

Yes, but it's not terribly cardiovascular.

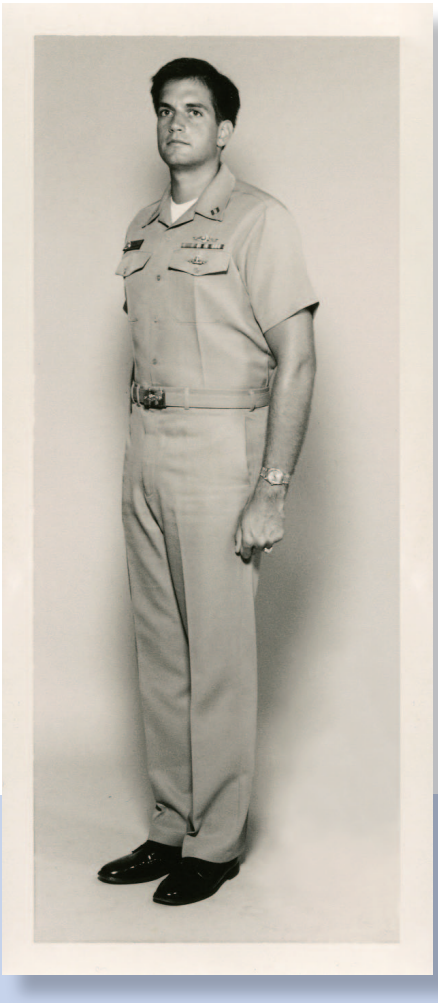
Maybe it's a mental exercise.

It really is. I am not happy unless it is perfect. It is all original and I take great pride in the fact that it runs better than my 2009 Jetta. I am pretty good mechanically and it is fun, though completely impractical.

Does your quest for perfection with the Corvette carry over to your job?

I would like to think not. Of course, my job is to find things to improve. I can't sit back and say it is quiet and everything is working so let's not do anything. On those days I say "what about this, what about that, what is the feedback from our customers?"

Remember what I said before: if I could snap my fingers and have business services go away and all those science and weapons folks continue to do everything they want to do, I would do it. That is not realistic. Am I a perfectionist? I don't know. My wife would tell you *yes*, I know that. ■



More about Mark Barth

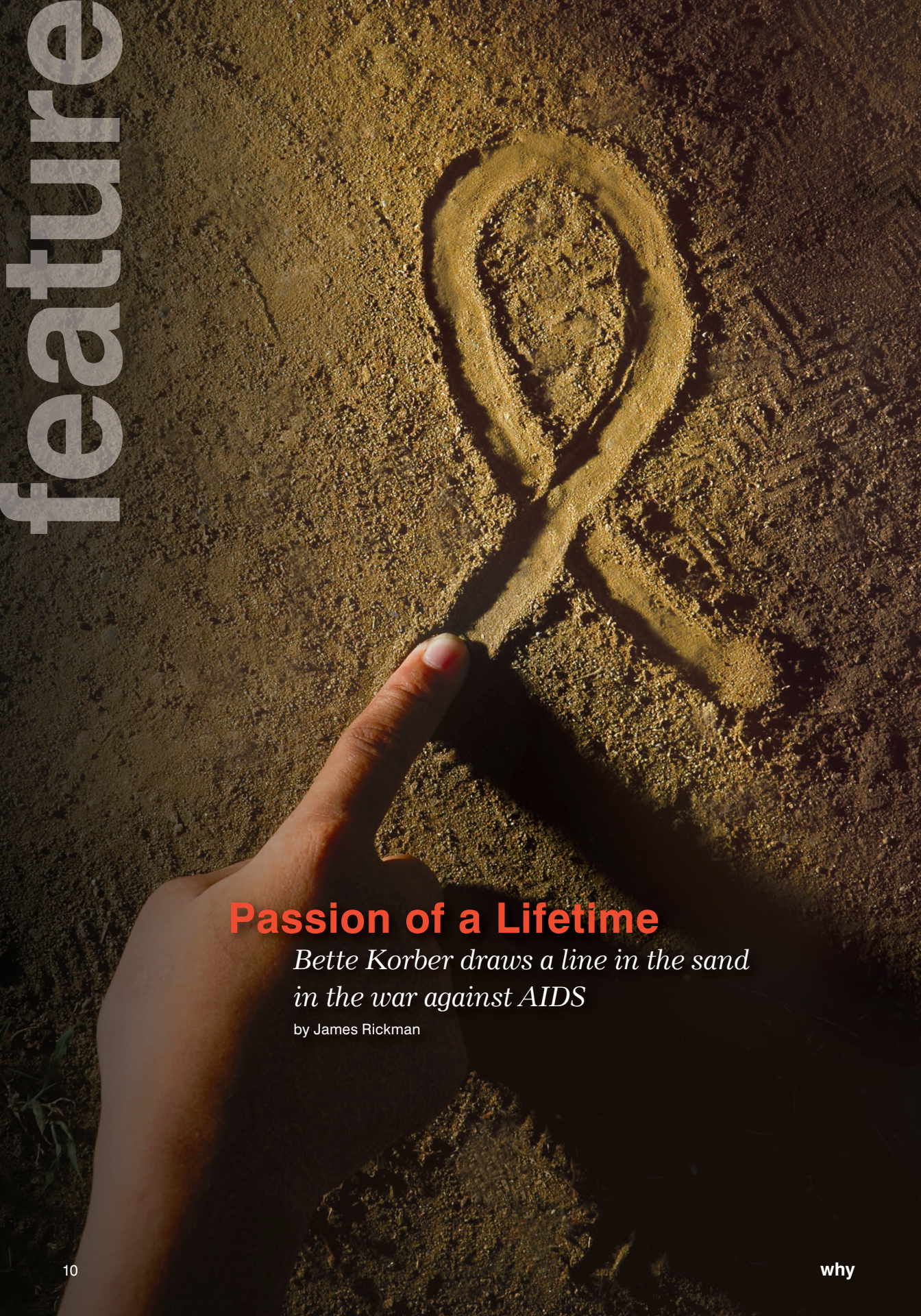
Imagine eating, sleeping, and working in a three-story building with more than 100 coworkers in cramped quarters with no windows, submerged in the ocean for months at a time….

Before Bechtel, Barth served as an officer in the United States Navy, and spent much of his time on a ballistic missile submarine.

Barth has experience with nuclear weapons. While on the submarine, part of his officer requirements included crawling into the missile access hole, not much bigger than a piece of paper, and closing out each level of the missile after routine maintenance.

"Getting in wasn't so bad, but getting out was not easy," the 6'4" Barth recalls. "I'd position my shoulders just right and they'd have to pull me out."

After active duty, Barth joined the Navy Reserve and spent his weekdays at Bechtel and his weekends working for the Office of Naval Research, including trips to LANL, Lawrence Livermore National Laboratory, Oak Ridge, and Sandia National Laboratories. He retired from naval service in 2008.



Passion of a Lifetime

Bette Korber draws a line in the sand in the war against AIDS

by James Rickman

Long motivated by the loss of a good friend to AIDS, Bette Korber is part of an international team working to design and implement the first human trial of a novel approach to fighting the HIV virus.

Fifteen years ago, theoretical biologist Bette Korber was carefully eying the branches of a family tree. It wasn't the Korber clan. She was studying the genetic history of the human immunodeficiency virus, HIV, the organism that causes AIDS. Korber sought patterns in a virus that mutates so vigorously that an infected host can harbor thousands of variant strains of the organism just months after initial infection.

Peering into the web-like representation of virus variants catalogued within the International HIV Database, Korber posited a theory.

What if, instead of targeting individual diverse strains of a virus, AIDS vaccine development focused on a consensus or ancestral state of genetic material derived from the vast array of circulating forms of the virus?

The vaccine would be more "central," and so perhaps more likely to trigger immune responses that would cross-react with many strains. This approach would capture the most commonly conserved aspects of HIV proteins, but keep them in a natural context.

The idea provided a potential new strategy in the war against HIV—a virus that has infected more than 30 million people worldwide, including more than a million people in the United States. Each day nearly 5,500 people die of the disease. An estimated 25 million people have died from AIDS-related causes since recognition of the pandemic 30 years ago.

Advancing the consensus-state concept from just an idea to being tested in animals took many years. The first experimental test of the concept in macaques, a necessary step on the road to a human trial, was conducted by a team at Duke and Harvard universities and published in 2008. This provided a glimmer of hope on the otherwise grim HIV battleground. It also prompted Korber at the time to tell a reporter that, perhaps, with any luck at all, she might see development of an effective AIDS vaccine in her lifetime.

In the world of AIDS, where a typical individual is expected to live only 10 to 12 years after becoming infected, Korber's 15 years worth of research may as well be a lifetime. Fortunately, understanding of the virus has evolved significantly, though not as quickly as the virus itself has evolved. And this is where the problem lies.

Because HIV evolution is such a challenging force, effective treatment becomes an enormously daunting task. Drugs that strike at the organism one year may be obsolete the next. An AIDS patient must take up to four drugs all at once, for life, so the virus does not

develop drug resistance. Therefore, a vaccine that prevents infection is desperately needed, particularly in the developing world where the cost of multidrug therapy is prohibitive.

Building on this "central vaccine" idea, Korber obtained directed research funding from LANL to bring together a group of colleagues, including Will Fischer; her husband, James Theiler; Simon Perkins (now at Google); and Tanmoy Bhattacharya, as well as others.

Will Fischer

Together they devised a computational strategy to design a set of proteins they call *mosaic proteins*. When combined, they theorized, mosaic proteins should maximize the vaccine coverage of HIV diversity by including a small number of optimally designed viral proteins instead of just one protein.

But every protein added to a vaccine hugely increases the cost of testing and development, and it is still unknown which approach—the simpler single consensus protein or multiple mosaic proteins—might work better in the context of a human vaccine.

In promising recent studies published in 2010, the mosaic vaccine prototypes were tested in monkeys. The animals made potent immune responses that were able to recognize an even more diverse array of HIV strains than the consensus-vaccinated animals. The results were exciting, for reasons both professional and personal.

Fighting AIDS—and winning—is an obsession that motivated Korber to sign on with the Laboratory back in 1991. During the mid 1980s, while Korber was working toward her Ph.D. in immunology at Caltech, she and her fiancé were housemates with a British doctoral candidate who had become infected with HIV. That was during the time when AIDS was still largely a mystery, and no effective therapies were available.

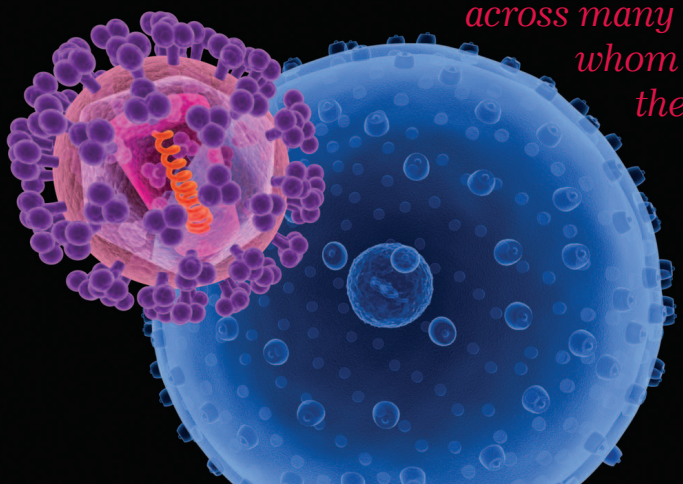
"I watched this brilliant, feisty young man die slowly," Korber recalls. "There was nothing anyone could do for him. I decided maybe I could do something for other people in the same situation. It has been the focus of my life to make a vaccine happen."

Now 20 years after she lost her housemate and started to work on HIV, Korber, together with her old friend and colleague Professor Dr. Barton Haynes of Duke University, along with an international team of researchers, are preparing to begin the first phase of human trials. They will test ideas borne of insights

Barton Haynes

"I love working at LANL because I've had the pleasure of working with excellent theorists across many disciplines, each of whom helped transform these concepts from ideas to reality."

—Bette Korber



The Medical Sciences Research Building, Duke University

drawn from more than two decades of gathering information for the International HIV Database, originally curated by Korber's LANL mentor, Gerald Meyers.

In the phase 1 study, the research team will compare human immune responses to vaccines containing either a natural strain of HIV, a consensus sequence, or three mosaic proteins.

"A human vaccine trial is very difficult, very expensive—and it takes a lot of time," Korber said. "They have to check safety every way they can before a human trial begins. Once they are satisfied that every safety measure has been taken, a small set of volunteers will be selected for the trial. We'll be testing safety as well as their immune responses, to see which vaccine candidate makes the most potent and broadly cross-reactive immune response." If that goes well, either the consensus or mosaic vaccines may go into an efficacy trial.

After focusing on the viral diversity of HIV for 20 years, Korber is cautiously optimistic that staying ahead of the virus through mosaic and consensus vaccines, or through other methods, may allow her to rejoice about a victory against AIDS in her lifetime.

"At this point, because of the results in animal studies, I'm confident this is a good approach that merits testing in humans," she said. "I love working at LANL because I've had the pleasure of working with excellent theorists across many disciplines, each of whom helped transform these concepts from ideas to reality." ■

"It has been the focus of my life to make a vaccine happen."

Bette Korber is a Laboratory Fellow at Los Alamos National Laboratory and an external professor at the Santa Fe Institute.

She earned a Ph.D. in immunology from Caltech in 1988 and was a Leukemia Society postdoctoral fellow in retrovirology at Harvard before joining the Theoretical Biology group at Los Alamos in 1990. At that point she turned from the lab bench to theory and analyses.

Korber has led an HIV sequence and immunology database project at Los Alamos for the past decade. She has coauthored over 190 scientific papers.

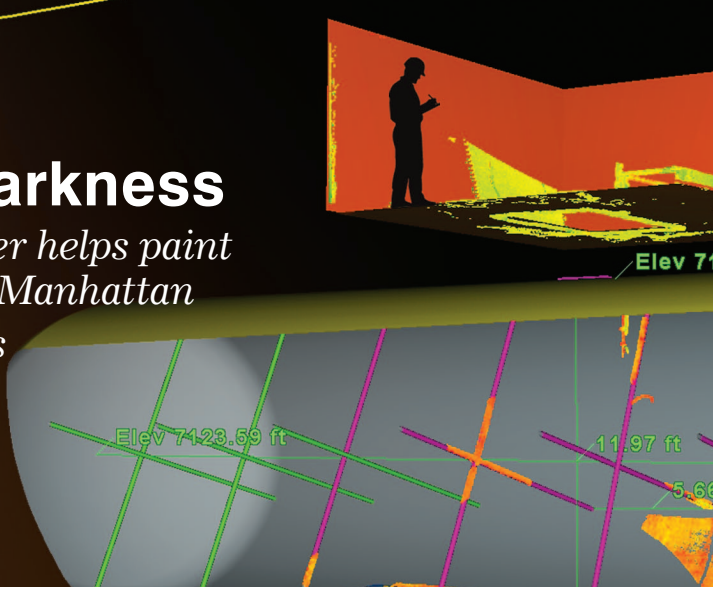
She received the E.O. Lawrence Award, the highest scientific honor from the Department of Energy, for her achievements in the life sciences.

Outside of work, Korber is a drummer in a local Celtic band.

Piercing the Darkness

Cutting-edge imager helps paint a picture of buried Manhattan Project waste tanks

by Fred DeSousa



Los Alamos engineers tasked with cleaning up decades-old waste sites are using cutting-edge technology to get a startling look inside a Manhattan Project relic: a pair of large underground tanks ordered built by General Leslie Groves himself.

Leslie Groves

Groves, along with Robert Oppenheimer, directed the Manhattan Project and ramrodded construction of the original Lab buildings in 1943.

One of Groves's less famous projects was the installation of two 60-foot-long underground "General's Tanks" to store the highly radioactive chemical liquids that came from the plutonium refining process—liquids that Groves hoped would yield even more plutonium later on. The tanks were installed toward the east end of what's now known as Technical Area 21, near the second generation of LANL plutonium labs at the end of DP Road.

Left behind

As technology advanced, scientists discovered easier ways to extract plutonium, and 55,000 gallons of liquid and sludge were left behind after World War II.

"The logbooks stopped in '47," said Bill Criswell, the deputy program director for cleanup at TA-21.

The tanks were pumped out in 1980, but like trying to empty a can of soda, you can never seem to get it all.

The very existence of the tanks was classified until the early 1990s.

Today, as part of the Lab's $2 billion-plus effort to clean up Manhattan Project and Cold War waste, the General's Tanks must be emptied, dug up, and removed.

But there's a catch. The tanks have been sealed since 1980, and no one knew exactly what was inside or how dangerous it was. Speculation ranged from a screaming-hot witches' brew of plutonium, americium, and other nasty chemicals . . . to explosive hydrogen gas . . . to harmless rainwater.

No leakage found

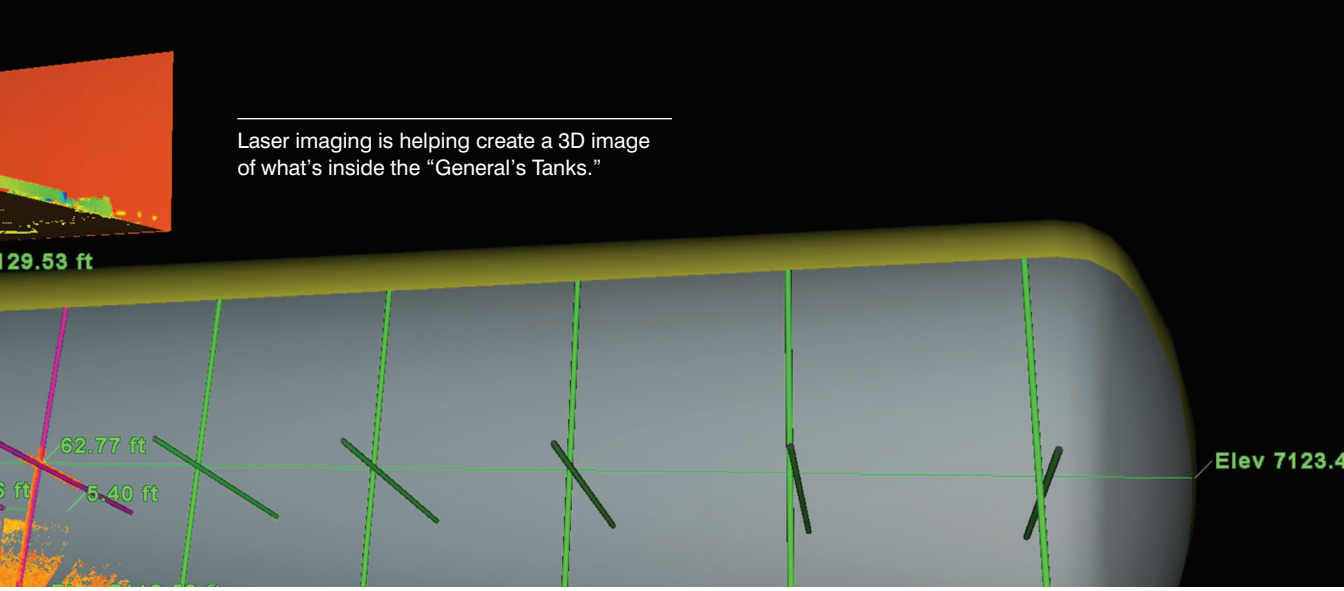
Lab investigations in 2006 using diagonal boreholes found no leakage under the tanks. Ground-penetrating radar was blocked by concrete slabs above.

Nuclear safety rules strictly prohibit anyone—or anything—from entering the tanks. Any investigation of what's really inside must be done unobtrusively and nondestructively, looking into the small access holes used for pumping out contents in 1980.

Photos taken in 2010 after a careful excavation to the pump-out holes showed a brown layer of what appeared to be water.

"That's great, but what's under the water?" said project engineer Harold Gammage.

Enter something straight from an episode of *CSI*: a high-tech laser device that can create a 3D image of nearly anything, accurate to 1/100th of an inch. It sweeps its beam along the surface of any object, detecting shapes and contours, creating hundreds of thousands of data points that can be transformed into a computer model.



Laser imaging is helping create a 3D image of what's inside the "General's Tanks."

The result is an amazingly clear and highly detailed picture of something that hasn't been seen since World War II: the inside of the General's Tanks.

"Protecting the people, gaining data"

"We now know it's a few inches of sludge covered with water, that little bit they couldn't get out in 1980," said program director Paul Huber. "We can now do a stepwise progression to go in, safely package the *heel* material—the chemicals and solids—and develop a plan to remove the tanks. It's about protecting the material, protecting the people, gaining data, and gaining confidence."

"It's just fascinating technology that gave us a lot of data," said Gammage. Data that, for example, will help engineers design a proper tool to navigate the curved bottom of the tanks to first sample and then scoop out, or vacuum, what's left.

"If we only have to do it once, it's a huge savings," added Huber.

The samples will go to a special lab at LANL's Chemistry and Metallurgy Research building—CMR—that is nearly as old as the General's Tanks. Depending on that analysis, the sludge will be mixed with a cement-like material and sent to a licensed low-level waste disposal facility or to the Waste Isolation Pilot Plant (WIPP) in Southern New Mexico.

Final approval of any remediation will come from the state of New Mexico.

Leveraging expertise

Engineers have already lined up underground tank experts from the U.S. Department of Energy's Hanford Site in Washington State for their best practices and lessons learned. Hanford is currently dealing with dozens of larger underground tanks, some of them leaking.

"There was all this speculation and all this mystique through the early '90s," said Criswell. "All those wild stories are kind of gone now. Let's move on and get rid of the tanks." ■

Charles Malone of LANL's Utilities and Infrastructure group uses a 3D laser imager to pinpoint the sludge at the bottom of each tank.

Science Goes Underground

LANL Nevada personnel are expert in nuclear operational discipline

by Kevin Roark

Photos by Richard Robinson

LANL has a rich history of setting up subcritical experiments at the Nevada National Security Site (formerly Nevada Test Site), including the Centaur shot.

The Nevada National Security Site may be just a short drive from Las Vegas, but the people there don't gamble. Not when it comes to their role maintaining the U.S. nuclear deterrent.

A cadre of Los Alamos National Laboratory scientists and technicians work there full time. Their efforts support crucial science that includes subcritical experiments: helping the United States manage its nuclear stockpile without full nuclear explosive testing.

Their job starts at the Laboratory's Technical Area 55 and concludes in a mine deep underground at Nevada National Security Site, or NNSS (formerly known as the Nevada Test Site). Getting the experimental package from TA-55 to the Zero Room, 960 feet below ground at NNSS, is no ordinary journey.

On December 1, 2010, the group supported by staff from the NNSS management and operations contractor, NSTec, successfully completed the second in a series of subcritical experiments, named Bacchus and Barolo. This one is called Barolo A. Bacchus is the name of the Roman god of wine and Barolo is a prized wine-producing region of Italy.

The idea for subcritical experiments, or subcrits, began after the 1992 U.S. moratorium on underground nuclear testing. These experiments examine the behavior of plutonium when subjected to the extreme forces produced by high explosives. Subcrits produce essential scientific data and technical information used to help maintain the safety and effectiveness of the nuclear weapons stockpile.

The experiments are subcritical; that is, no critical mass is formed and no self-sustaining nuclear chain reaction occurs—there is no nuclear explosion.

Los Alamos National Laboratory conducted the first subcritical experiment in Nevada, called Rebound, on July 2, 1997. Laboratory staff permanently assigned to Nevada for supporting the current series of subcritical experiments are primarily part of the Nevada Engineering Operations Group (W-51).

Workers carefully remove the subcritical experimental package from the Device Transport Vehicle.

Because the final assembly of a subcritical experiment contains both explosives and plutonium, moving the experimental package is no simple matter. The experimental package travels about 10 miles from the Device Assembly Facility to the vertical shaft hoist at the entrance to a mine complex dedicated to science that is known as the U1a facility. Moving the package is a well-rehearsed and highly orchestrated endeavor.

Underground overview

Covering 1,350 square miles, an area larger than Rhode Island, the Nevada Nuclear Security Site is one of the largest outdoor laboratories in the United States.

The first aboveground nuclear test in Nevada, "Able," took place there (when it was called the Nevada Test Site) on January 27, 1951. The last nuclear test, underground and called "Divider," was September 23, 1992.

The U1a mine complex used for LANL's recent subcritical experiment was originally excavated in the 1960s for an underground nuclear test that was later cancelled. In 1988, the U1a shaft was built and the "Ledoux" nuclear test was conducted two years later.

The current U1a complex is mined at the base of two vertical shafts equipped with mechanical hoists for personnel and equipment access. A third shaft provides cross ventilation, instrumentation and utility access, and an emergency exit. The underground complex is on one level and consists of horizontal tunnels and alcoves that total about 1.4 miles in length. The complex provides a high degree of safety for workers and the public, exceptional security for experiments, and minimizes environmental impacts.

The detonation takes place deep inside U1a within a chamber called the Zero Room, so named because of the tradition in Nevada of calling all test locations "Ground Zero."

"Nothing is left to chance," said Don Bourcier, W-51 group leader. W-51 is a part of the Laboratory's Weapon Systems Engineering Division. "We use extreme safety and security protocols. Every move is documented and practiced over and over again until it's perfect. For a nuclear activity, formal conduct of operations, or disciplined operations, is mandatory."

Members of the insertion crew wheel the experimental device, still in its shipping container, into the lift at U1a for transport downhole.

The day's activities, when the experimental package is moved, are known as "delivery and insertion." Everything is governed by a massive 500-page checklist that breaks down nearly 20 major events into bite-sized actions.

The checklist for the Barolo A insertion has been in development for two years and went through seven iterations. The checklist activities have been practiced at least that many times, and if the team encounters problems, they make improvements using a formal process. When insertion day comes there is no guessing or figuring things out on the fly.

The rigor of this process is borne out on insertion day. Early in the morning, before the experimental package is allowed to leave the Device Assembly Facility, checklist actions help workers determine an unexpected malfunction. They find that the 9-ton, high-explosive-hardened forklift at U1a used to move the package from its specialized Device Transport Vehicle to a custom cart that will carry the experiment "downhole" isn't working properly.

"There's a procedure for dealing with the unexpected," said Bourcier. "Every path we take is checked to make sure any action falls within all regulations and the safety basis for the activity."

In this case, the crew takes parallel paths consistent with procedures, one to see if the balky forklift can be properly repaired quickly, another to search for a suitable replacement forklift. Once a forklift that meets all the detailed specifications of the job at hand is located, it's quickly moved to U1a. Problem solved.

Another example of the detail in the checklists is evident when the Device Transport Vehicle arrives from the Device Assembly Facility at U1a. One of the first steps in unloading the experimental package is opening the sliding box atop the Device Transport Vehicle's trailer, which includes loosening and tightening bolts. Anytime bolts need to be tightened to a specified torque, the checklist includes a detail where someone checks the setting on the torque wrench not once but twice before the bolts are tightened, just to make sure that the right amount of force is used.

"When you have special nuclear material and high explosives combined, no detail is too small or too trivial to be ignored," said Bourcier.

The Bacchus and Barolo series of tests were conducted inside steel containment vessels that are sealed and entombed to prevent any radioactive contamination.

The steps in the insertion process where those small details matter the most occur during four critical lifts. These are the times when the possibility exists, however remote, that the experimental package could be mishandled and damaged.

- The first crops up when the experimental package is lifted from the Device Transport Vehicle with a forklift and placed on the transport cart prior to going downhole.
- Second is when the lid from the shipping container is removed with an overhead crane just outside the Zero Room.
- The third is when the experimental package itself is lifted from the container and moved to a smaller cart for transport to the Zero Room.
- The fourth is when the experimental package is lifted from the smaller cart into the test containment vessel in the Zero Room.

On insertion day for Barolo A, all four lifts are executed flawlessly.

“Our mantra,” said Bourcier, “is calm, measured, and deliberate.”

On the surface, once the transport cart is loaded, about half of the 40-person Laboratory-NSTec crew goes downhole first. As it drops into the main shaft, the elevator car slowly descends into total darkness that lasts less than a minute. The absence of light is unnerving. As the car nears the bottom the light slowly returns, but it’s an eerie glow of yellowish tones from artificial sources.

At the bottom of the shaft, the transport cart is carefully attached to a small vehicle reminiscent of those used at airports to haul luggage carts. Once the rest of the crew arrives downhole, at a pace that’s like an odd underground parade, the experimental package is driven to its final destination, Zero Room.

Once enclosed in the steel containment vessel inside the Zero Room, Barolo A will never come out again. After completion of the test, the vessel and its contents will be entombed against the far wall of the Zero Room alongside the Bacchus vessel and, eventually, the Barolo B vessel.

The test itself aims to produce a variety of technical data, including surface diagnostics that measure attributes such as velocity and radiographs of the material as it is shocked by explosives. The radiographs, essentially high-powered X-ray images, are produced by two machines called Cygnus 1 and 2.

Cygnus radiography complements the surface diagnostics by providing a more extensive, but time-limited view and penetrating measurements of the internal properties of test materials. Cygnus is a dual-beam radiography source at U1a that makes two images at a 60-degree angle from one another, precisely separable in time as required by the experiment.

The wealth of data produced by Cygnus is essential to stockpile stewardship because the measurements are taken directly from nuclear materials like plutonium, not surrogates. ■

LANL personnel manufacture the components of experimental packages at Technical Area 55 and assemble at the Device Assembly Facility in Nevada, seen here.

Customer Focused, Data Driven

Lean Six Sigma at Los Alamos

by Jennifer Awe

Photo by Sandra Valdez

Lean Six Sigma team members Michael Peters, Natalia Herrera, and Chris Binns (left to right) review data from a recent fuel improvement project.

Is it a new exercise regimen or a secret society? Chances are you've heard the name Lean Six Sigma, and you may know colleagues who are "Yellow Belts" . . . but what is it—and why should you care?

Six Sigma was developed by Motorola in the early 1980s as a business management strategy focused on process improvement and customer needs, primarily in assembly lines. It grew in popularity and is now used throughout the world in many corporate operations. Its practitioners include some of the biggest names in business and technology, such as Raytheon, Dell, 3M, and GE.

The "Lean" part of the program enables participants to reduce waste, and "Six Sigma" focuses on reducing defects. The combined approach provides LANL employees a means to gather and analyze meaningful data to manage and improve process performance, quality, and results. Lean Six Sigma channels these efforts into two main areas: process management and process improvement.

"If process improvement were fire fighting, then process management would be fire prevention," said Michael Peters, a Black Belt working in the Lean Six Sigma office.

Type of Training	Requirements
LSS Overview	2 hrs instruction
Yellow Belt Certification	64 hrs instruction + on the job training + process management system
Champion Certification	12 hrs instruction, exam + on the job training + mentoring of yellow belt
Green Belt Certification	160 hrs instruction, exams + on the job training + 1 certification project
Black Belt Certification	200 hrs instruction, exams + on the job training + 2 certification projects

Belt levels are based on the number of training hours completed. Yellow Belts are the cornerstone of the Lean Six Sigma process because they are embedded throughout the Lab.

Interested in becoming part of Lean Six Sigma? Call (505) 665-5010.

The goal is to use solid data to determine the origin of a problem and seek solutions that cut waste. It boils down to efficiently meeting customer needs.

Who is your customer?

In the world of Lean Six Sigma, the customer is king.

In order to meet a customer's needs, you must first identify the customer. That's not always as easy as it sounds. Lab customers might be, for example, the National Nuclear Security Administration (NNSA) Site Office or headquarters. They could be other Lab divisions, the Department of Energy, the Department of Homeland Security, or senior management within LANL.

Why should you care?

In a slow economy, there is even more competition for available funding and customer demands grow ever-higher. Organizations may face smaller budgets, with little or no change to work expectations.

"Now is the perfect time to streamline our work," said Chris Binns, Lean Six Sigma program manager and Black Belt. "Finding inefficiencies and improving the overall process allows us to do more with less and makes for a satisfied customer."

Binns takes his own advice and uses data from successful Lean Six Sigma case studies to report back to his customers—various Lab divisions and groups. In fiscal year 2010, Lean Six Sigma boasted $46 million in benefits to the Lab. These benefits include reallocating resources and reduced costs.

"The same rules apply here as they do in other industries," Binns said. "Our customers want to see the value of our work."

How do you prove value?

With the Lean Six Sigma approach anyone, anywhere in the Lab can identify an area for improvement. This could be a lingering issue or a new problem.

"It allows us to take the finger pointing out of the equation and use that energy to come up with a solution," said Jack Morrison, a Black Belt candidate working in the Lean Six Sigma office.

A group first comes up with a process improvement project (PIP). They select an area they'd like to improve and determine a baseline performance level. It might be, for instance, increasing furniture reuse or streamlining a procurement process. Then the group determines a desired performance level. A team of subject matter experts and Lean Six Sigma members works together, gathering and analyzing data. The objective: close the gap between the baseline and the desired performance level.

Natalia Herrera is a Black Belt candidate working in the Lean Six Sigma office. She spent months in the field collecting data for a fuel management PIP. Charts and tables line her office walls.

The Lab's fuel crew dispenses fuel to the truck fleet as required by their work orders. The amount dispensed minus the amount used for a specific project should equal what's left in the tank. Each day, the crew conducts dipstick readings to determine the amount of fuel in each truck. Periodically, these reading results and work order totals are reconciled, and that is when the crew noticed large variations.

"We found that the dipstick readings were inaccurate and caused the variation," Herrera recalled. "The readings could be skewed by variables—for example, trucks being parked on a slope. On the other hand, meter readings were accurate, and after benchmarking with several companies we found this was the right way to manage our fuel."

Herrera then worked with the team to develop an implementation plan using the findings. The plan detailed a new testing method and reconciliation process. Using calibrated meters instead of dipsticks would reduce the error rate from plus or minus 560 gallons per day to plus or minus 5 gallons per day.

"The group approaching us owns the problem, and they own the solution," Herrera said. "We are not the experts in their areas. They live it every day. We're there to help with the data and processes that take up time and resources." ■

Photos by LeRoy Sanchez

Joseph Valdez of the Lab's Heavy Equipment, Roads, and Grounds group records fuel levels for the Lab's truck fleet, data that helped reveal discrepancies in measuring methods and led to efficiency improvements.

What do you do?

Jobs around the Lab

by Ed Vigil

Photos by Sandra Valdez

Mike Pacheco works at the Lab's National High Magnetic Field Laboratory. Deployed to that facility as part of LANL's Condensed Matter & Magnet Science group, Pacheco helps build and maintain some of the world's most powerful super magnets. A consortium of LANL, Florida State University, and the University of Florida, the National High Magnetic Field Laboratory is a user facility. It provides researchers from across the globe the opportunity to advance science and technology using high magnetic fields.

What skills do you need to build these monster magnets?

You need to be able to use a variety of machine tools, including lathes and drill presses, as well as shop tools. It helps, too, if you can take a sketch on a napkin or an engineering drawing and make it real. This is really important because we do a lot of prototyping. In fact, a lot of what we do is one-off and one-of-a-kind.

What special training or education do you need?

What got me started was being trained by LANL in a machinist apprenticeship program. Over the past 40 years I've taken additional training in vacuum systems, materials, metallurgy, and electrical. Even after all these years I continue to learn new things in my field.

Why did you choose this field?

In school I took a lot of courses in the vocational arts, graphics arts, shop class, woodworking, and machine shop. Right after high school I went to the Los Alamos campus of the University of New Mexico for a year or so, but I decided that what I really enjoyed was working with my hands—building and creating things. That's when I made up my mind to go into this field.

How long have you had this job?

I've been with the Lab since 1971, and the National High Magnetic Field Lab since 1991. Early in my career I served the Lab's Controlled Thermonuclear Research Division, where I worked on some of the early fusion devices, including the reversed-field pinch Z machines.

What's the best part of your job?

Working on the really challenging projects—the complex ones—and the satisfaction of getting to see them turn out great. I also enjoy the opportunity to try out new materials and processes.

What's the most challenging part?

Most of the time I don't have a set plan for any given day. I can have a lot of things just come up unexpectedly. Another challenge comes from working on several projects at once and being ready to help anyone who walks through the door. That means remaining flexible with your time and schedule.

What do you do on your days off?

I enjoy doing my tinwork, woodcarvings, and paintings. Most of my artwork is southwestern and includes santos, retablos, and stamped and punched tinwork. And, like most people, I work on several projects at a time.

Mike Pacheco enjoys working with his hands to maintain the Lab's super magnets, and to create his punched tinwork.

Betty Colyer safeguards lives by maintaining the Lab's fleet of defibrillators and teaching CPR classes.

Betty Colyer of Medical Services works in the Laboratory's Occupational Medicine facility as a nurse attending to the medical needs of Lab employees.

What skills do you need to be a nurse at the Lab?

A background and experience in outpatient or emergency patient care, because you do a lot of independent thinking. In addition, a nursing license and such skills as CPR.

What special training or education do you need?

I have a bachelor of science in nursing, so I was able to get certified as an occupational health nurse specialist. This gives you a better background for the field of occupational medicine and includes knowledge of OSHA issues. It also can help you if you choose to move to another company. At Occupational Medicine we currently have four people who are certified.

Why did you choose nursing?

Well, when I was young I used to watch the TV soap opera *General Hospital* at my babysitter's house. And I just thought "Jessie the nurse" had the coolest job. It was something I wanted to do forever.

How long have you had this job?

I've been at the Lab for 13 years. Before coming here I'd been a nurse elsewhere in New Mexico and in southern Colorado.

How did you get your job?

I was working at Los Alamos Medical Center and when it was time to move on I already knew many people at the Lab, including folks with Occupational Medicine, so it seemed sort of natural.

What's the best part of being a nurse here?

The best part is checking on the automatic external defibrillators (AEDs) that we put in place all over the Lab to help save lives. I'm in charge of that program, and I find it really gratifying. I also enjoy my role as the lead on LANL's respirator program and the fact that I can help staff and the program offices meet their safety requirements.

What's the most challenging part?

For the most part they're only good challenges. Like making sure people who work with certain hazardous materials have proper respiratory protection.

What do you do on your days off?

On my days off, I enjoy teaching CPR classes to organizations like the Girl Scouts and church groups. I also enjoy spending time with my grandkids. But the one thing I really do enjoy is "World of Warcraft," an online role-playing game. It gives me the chance to get lost in a world of fun and fantasy with massive numbers of players around the world. ■

Community Matters

The LANL Laces program: ties that bind Lab employees to area children in need

by Tatjana Rosev

Photo by Sandra Valdez

The usually calm shoe store in Española teems with activity. Excited chatter fills the air as tots dart between wobbly stacks of shoes or stand in line, wriggling and giggling, hopping impatiently from one stocking foot to the other as they wait for smiling staff to fit them for new shoes.

It's nearly time for the new school year to start, and these kids can't wait to pick out the shoes they've always dreamed of: pink sneakers with glittery laces for the girls and athletic shoes decorated with pictures of their favorite superheroes for the boys.

Every child deserves new shoes. But hundreds of Northern New Mexico kids would start school without, if it weren't for the generosity of Lab employees who every year donate generously to the LANL Laces program.

Len Valerio of the Lab's Network Infrastructure group, who also is a member of the Española Public School Board, noted that more than 4,300 students attend Española public schools. Of these, close to 3,900 come from low-income households and qualify for free or reduced-cost lunches as part of the federal Supplemental Nutrition Assistance Program (SNAP).

"We have a lot of students in need in our school district, and these types of programs really make a difference to them and their families," Valerio continued. "They make them feel like someone truly cares about them."

The year-round initiative has grown exponentially since its inception in 2005, said program coordinator Tim Martinez of the Community Programs Office.

"Back then, we provided shoes for 60 needy children, and last year, we were able to outfit 300 kids," he noted. Martinez has coordinated the effort for several years now in partnership with area shoe stores, such as Española's Shoe Dept., and loves to attend shoe fittings. "It's a big deal," he said. "You see the school buses pull up, and the little kids come out all excited, knowing they're going to get great new shoes."

When the kids first enter the store, it seems like they're overwhelmed by the selection. "Knowing they can pick out any shoes they want really gets them excited," Martinez said. After fitting the children, staff direct them to the appropriate section of the store, and the kids have fun pulling shoes out of their boxes and trying them on. Afterward, they sit together, grinning and comparing their new footwear. "It just opens my heart to see the smiles on those little faces," Martinez said.

And the smiles spill over into the classroom. "The children's faces say it all," Marilyn McBane, director of bilingual education for the Española Public School District. "I appreciate the work and organization that it takes to coordinate all the resources to help the families. The Lab's dedication to the children of our valley is visible in this effort to get shoes for our most needy."

School Superintendent Janette Archuleta thanked the Lab for making a difference in so many lives. "Our students are very grateful for a program like LANL Laces," she said.

For many employees, giving back to their communities is nothing exceptional. The generosity of the Laboratory workforce is "extraordinary," said Deputy Lab Director Ike Richardson. It means more than just making financial contributions. In addition to providing community members with holiday dinners and presents, it means giving less fortunate students the gift of education. And that ensures they are properly outfitted in time for the new school year. ■

Other Laboratory giving programs

Last year, employees donated more than 15,000 items to the School Supply Drive, filling 780 backpacks.

The Lab's Holiday Drive and Holiday Gift Tag Program has provided children and senior citizens with new clothes and gifts in time for the holidays. Last year, more than 1,400 holiday tags were collected.

Finally, as part of the Thanksgiving Food Drive and Take a Turkey to Work Day, employees last year donated 560 turkeys and thousands of pounds of nonperishable food items to ensure that those less fortunate enjoyed a delicious holiday meal.

observer

Bigfoot

Sizing up, then carefully tearing down, LANL says good-bye to the old Administration Building, a large part of its footprint-reduction effort

Photos by LeRoy N. Sanchez

Photos by LeRoy Sanchez

Former Lab Director Sig Hecker (1986-1997) tours his old office and conference room.

The mammoth structure on the mesa totaled nearly 320,000 square feet, more than a third larger than New Mexico's state capitol building.

Designed by noted architectural firm Skidmore, Owings & Merrill and completed in 1956 at a cost approaching $6 million, the structure, also known a SM-43, was home for most of its life to a thousand employees. Those included seven Lab directors—from Bradbury to Kuckuck—whose quarters appear on the opposite page.

Lab staff occupied the Administration Building until September 2008. Its denizens played host to many distinguished visitors, including Kennedy and Johnson, Gerald Ford, and Bill Clinton. Many presentations and meetings took place in the 600-seat auditorium. ■

Material Recycled to Date*

- 22,000 cu yds concrete
- 6,500 fluorescent tubes
- 3,700 non-PCB ballasts
- 1,900 incandescent bulbs
- 100 EXIT signs
- 1,000 cu yds scrap metal
- 56 furniture truckloads
- 1,000 wooden doors

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Et cetera

Soft fabric does a hard job—channels 20 million electron volts, 1,900 amperes

One of the most fascinating stops on the tour of the Laboratory's Dual Axis Radiographic Hydrodynamic Test (DARHT) facility is the electron source at Axis One. Official visitors peer through a small glass window at the head of a huge accelerator to see the "velvet cathode."

The buttery fabric of ancient origins is part of the massive system that takes X-ray motion pictures of mock nuclear implosions. At some level, validating weapons performance without nuclear testing comes down to a two-inch circle of black velvet.

Held in place by a metal frame, the velvet cathode is the source of Axis One's electrons. When Axis One is fired, the electrons spill from the velvet to form a beam and that hits a metal target at the end of the line. This beam yields the world's most powerful X-rays, used to study extremely dense materials at blinding speeds and searing temperatures.

The velvet is black, but it could be any color. It's a great source of electrons because velvet has a high concentration of straight, vertical, uniform fibers with very sharp tips; this enhances the electric field that starts the release of electrons.

The idea for using velvet dates to the 1970s, but finding the right stuff involved some trial and error. When Axis One came online in 1999, it took several months to figure out that cotton velvet didn't work as well as rayon. ■