

SCIENCE

Gene discovery raises hopes of cheaper cellulosic ethanol

Scientists at ORNL have achieved a breakthrough that could improve conversion of cellulosic plants into advanced biofuels.

Authors of a paper in the on-line *Proceedings of the National Academy of Sciences* have identified a gene within the microorganism *Z. mobilis*, which could make it easier and cheaper to use microbes in the biofuels conversion process. The gene allows the *Z. mobilis* to flourish even when exposed to the chemicals used to pretreat cellulosic feedstocks.

“Microbes have been breaking down plant material to access sugars for millennia, so plants have evolved to have very sophisticated cell structures that make accessing these sugars difficult,” says Steven Brown, staff microbiologist in the Biosciences Division and one of the inventors of the improved *Z. mobilis* strain. Currently, biomass materials like corn stover and switchgrass must undergo a series of pretreatments to loosen the cellular structure enough to extract the sugar from cellulose. Brown said these treatments add new challenges because, although they are necessary, they create

a range of chemicals known as inhibitors that stall or stop microorganisms like *Z. mobilis* from performing the fermentation.

“There are two ways to combat recalcitrance, or the difficulty created by the inhibitors,” Brown says. “One way is to remove the inhibitors, but this method is very expensive and would not help biofuels become cost-competitive with gasoline. The second way is what we

do, which is to develop microorganisms that are more tolerant of the inhibitors.” The non-mutated strain of *Z. mobilis*, for instance, cannot grow in the presence of one of the predominant inhibitors, acetate. However, when gene *nhaA* is over-expressed by inserting a slice of DNA containing the gene into the non-mutated strain, the bacterium can withstand acetate in its environment.

Brown and lead author Shihui Yang did not stop with *Z. mobilis* but looked at related genes in other microorganisms and found that the method translates into different organisms. “We took this gene and integrated it into a strain of yeast, and the improvements carried over into the yeast,” Yang says.

Brown says this method of processing biomass for ethanol has the potential to become a “tool kit” — a combination of mutant genes that reduces the impact of specific inhibitors. The tool kit could expand quickly, too, as scientists now have more advanced DNA sequencing technology available to identify and resequence genes. “The DNA sequencer we used was unavailable as recently as five years ago, and it has unprecedented sequencing capabilities. It is 4,000 times more powerful than the machine that finished sequencing the human genome almost a decade ago,” Brown says.

ORNL microbiologists are currently sequencing other microorganisms used in biofuels production that could also be advantageous if genetically altered to resist different types of inhibitors. “By looking at the behavioral response to the genetic changes in this bacteria, *Zymomonas*, we can then look forward to improving other bacteria,” Yang says.

—Katie Freeman 



Steven Brown (left) and Shihui Yang, researchers in ORNL's Bioenergy Research Center, have developed a strain of microorganism with an improved ability to convert wood products to biofuel.

“We used a computer 4,000 times more powerful than the one that finished sequencing the human genome almost a decade ago.”



Table of Contents

Gene discovery raises hopes of cheaper cellulosic ethanol	1
1954 was a great year for Dick Raridon	2
ORNL family opens its heart to Haitian daughter	3
Club ORNL events	3
Community news	4
Living well	5
Treasures from the archives	6
Thom's thoughts	7
VULCAN helps scientists pinpoint stress and strain	8

1954 was a great year for Dick Raridon



Dick Raridon, second row from the back on the far right, was a graduate student from Vanderbilt in 1954 and part of a group of graduate fellows sponsored by the Atomic Energy Commission working at ORNL that summer. At front center is Mona Marie Herndon. Dick and Mona married two years later.

“I enjoy volunteering because it keeps me close to the activities taking place at the Oak Ridge facilities.”

Reporter is published for retirees of ORNL, which is managed by UT-Battelle for the U.S. Department of Energy.

Deborah Barnes
Editor
 (865)576-0470
 barnesds@ornl.gov

Bill Cabage
Contributing Editor
 (865)574-4399
 cabagewh@ornl.gov

Dick Raridon arrived in Oak Ridge in 1954 and found three things he loved: Mona Marie Herndon, the city of Oak Ridge, and the Lab. That summer, Dick was a graduate student from Vanderbilt and part of an Atomic Energy Commission-sponsored fellowship program in health physics. There was only one female in the program—Mona Marie Herndon, the girl of his dreams. They married two years later.

In 1957, the happy couple returned to the Lab, and Dick spent 1957-58 working on his doctoral thesis. Dick recalls, “I worked on ion exchange equipment in a laboratory not far from the present location of the ORNL history room.”

After Dick earned his doctorate, the Raridons headed to Memphis where Dick spent the next four years teaching general physics at Memphis State University. However, when the opportunity to return to ORNL occurred in 1962, Dick and Mona jumped at the chance to come home.

“I worked on the water research program in the study of reverse osmosis,” Dick says. “This program studied economical ways to produce cleaner water from unusable water. Some of this research paved the way for modern technology to purify water.”

In 1970 Dick joined the Center for Environmental Education, an environmental awareness program under the direction of the Oak Ridge Schools. “We promoted recycling at a time when Earth Day and other public environmental initiatives were starting,” Dick says. “We convinced 30,000 students in six states to go through their family trash for one week and tell us what was in it. The Lab did a study on the findings, and some of that information helped in the development of public recycling programs that exist today.”

Dick returned to ORNL in 1972, working in the computer division. He was back in water research, using computers to analyze water flow through the Walker Branch watershed. His later research included air quality studies for the Environmental Protection Agency at TVA’s Kingston and Bull Run steam plants. He helped conduct similar studies at Y-12’s steam plant and power plants near Portsmouth, Ohio.

Moving to the fusion energy division in 1984, Dick ran ion beam modeling programs at Y-12’s fusion facility before retiring in 1992. He returned as a consultant for the next eight years before leaving for good in 2000.

Although Dick has been retired for 18 years, Oak Ridge and ORNL are still very much a focus of his life. He serves on the boards of directors of Clinch River Home Health and the UT Arboretum. Dick also coordinates volunteer tour guides for the DOE Oak Ridge public tour, works with the Secret City Excursion Train, mans the front desk at the American Museum of Science and Energy and volunteers in the Laboratory’s history room.

“I enjoy doing all of these things because it keeps me close to the activities taking place at the Oak Ridge facilities,” Dick says. “Working at ORNL and Y-12 took up most of my work life. Retirement didn’t stop me from being part of everything that still takes place out there. The fact I can still contribute knowledge to the public about Oak Ridge—especially now when a lot of new and exciting things are taking place—excites me, and I want to share that excitement with others.” 🌱

ORNL family opens its heart to Haitian daughter

As the island nation of Haiti continues to experience crisis after the January 2010 earthquake, an ORNL employee and his family have brought one Haitian girl into their hearts and home.

John Stout, who works in the Neutron Sciences Directorate at the High Flux Isotope Reactor, and his wife Carol recently adopted Islande, an 11-year-old Haitian girl who has lived in an orphanage in the village of Coq Chante, Haiti most of her life.

Islande arrived into the Stouts' care with the help of Humanitarian Parole on Jan. 23, less than two weeks after the 7.0 magnitude earthquake killed about 220,000 people and left 1 million homeless.

"The front end of the orphanage had collapsed, and one little girl was killed," Carol said. "When Islande came into our house and went back to her new bedroom, she started knocking on all the walls to make sure they were solid, that they weren't going to fall down."

The Stouts, along with five other families at their local church White Stone, were each in the process of adopting a child from the Coq Chante orphanage when the earthquake struck.

"We were about maybe a year away from getting Islande, but then it all happened so fast," Carol said.

Neither John nor Carol are fluent in Islande's native Creole, but they have communicated the last three months through a limited but expanding Creole vocabulary and help from more fluent members in their church, which has long worked to visit and provide funds for the Haitian orphanage.

"Just this past week, I've noticed Islande naturally using more English words, especially when asking for food or things like that," John said.

Carol said she carries her Creole translation book with her everywhere and that Islande is beginning to pick up on words at school; but sometimes it is still hard to understand how Islande is feeling about her move and new family.

"There's so much I can't wait for her to share with me," said Carol.

The transition was difficult at first as Islande learned to use hot and cold tap water and take baths, as opposed to the bucket baths she was accustomed to at the orphanage.

"Also, the first few weeks, she didn't stop eating. She was just constantly eating.

Then I think she learned that we could always go to the store, and the food wasn't going to run out," Carol said.

Islande and the other Coq Chante children now living in Knoxville, Tenn., spend a lot of time together. John and Carol said they enjoy watching DVDs in French, a language that many people in Haiti speak moderately, and singing to their families and each other.

"The girls do each other's hair. Hair is a woman's pride in Haiti," Carol said.

Even though John works at ORNL during the day, he's been teaching Islande to ride a bicycle on weekends, and the church families have taken the children ice-skating. Islande is also interested in music and is about to begin guitar lessons.

The Stout couple has three children, all in their 20s, and Carol said the decision to adopt Islande was a careful one. She visited Coq Chante three times last year, and John visited in 2008. They said they know they have done the best thing for Islande.

"I've heard Haitian people say of Haiti 'there's no possibilities, no possibilities,'" Carol recalled.

Islande was placed in the fifth-grade in Knoxville, despite not being able to speak English, and she is expected to learn enough of the language to continue on in school.

—Katie Freeman 🌿



Adopted daughter, Islande, and her mother, Carol Stout, at the Coq Chante orphanage in Haiti where Islande grew up.



Islande during her first trip to the pool after moving to the U.S. with adoptive parents, John and Carol Stout.

"When Islande came into our house, she started knocking on all the walls to make sure they were solid and weren't going to fall down."

Club ORNL events

Get the details and latest news online via <https://info.ornl.gov/sites/clubornl>. Request an XCAMS account, which will allow you to participate in these events or contact Lara James at 576-3753 or jamesla@ornl.gov.

July 17 White Water Rafting

July 24 IJAMS Nature Center

August 14-15 Fall Creek Falls Overnight

Walking for a Cure



Honorary Chair Dr. Thom Mason signals the start of the walk with a snip of the tape.

Every hour of every day, someone is diagnosed with Type 1 diabetes. Last December, that day came for ORNL employee Tina Carter, her husband and seven-year-old son, Brett, who was diagnosed with juvenile diabetes.

“It came as a real surprise to us, considering we did not have any family members with Type

1 diabetes,” said Tina. The diagnosis was life-altering.

Diabetes (medically known as diabetes mellitus) is the name given to disorders in which the body has trouble regulating its blood glucose, or blood sugar, levels. Of the two major types of diabetes, Type 1, also called juvenile diabetes or insulin-dependent diabetes, is a disorder of the body’s immune system. People with this diagnosis must undergo a regimen of multiple daily injections, a calculated diet and rigorous blood sugar checks (by lancing a finger) as much as six or more times a day. You can’t outgrow the disease – only minimize the life-threatening complications with insulin.

“My motivation is young kids diagnosed with Type 1 diabetes. I try to be an example and let them know they can live a long, healthy and fulfilling life.”

—ORNL employee Roger Jones, who lost his left leg in 2004 due to diabetes-related complications

Families like the Carters depend on the Juvenile Diabetes Research Foundation (JDRF) for support and research. While using the JDRF website, Tina learned of the local JDRF Walk to the Cure in downtown Knoxville.

On Saturday, May 15, Tina and her family were among 113 registered ORNL walkers, including employees, family and friends. Lab director Thom Mason served as this year’s honorary chair and challenged employees to raise money for research by participating in the walk. Thom and his son led the walk.

Fellow participant and ORNL employee Kahra Gilley has family members with Type 1 and 2 diabetes.

“I have seen their struggles over the years and decided to start participating in the walk eight years ago,” said Kahra. “When I realized how passionate everyone was in helping to find a cure for this life-long disease, I was hooked, and I’ve been walking ever since.”

Type 1 diabetes is generally diagnosed in children, teenagers or young adults. Scientists do not yet know exactly what causes the disease, but they believe that autoimmune, genetic, and environmental factors are involved. While there is still no cure, the JDRF relies on financial contributions and passion of its volunteers to support research.

After tallying the totals, UT-Battelle was the largest walking team and raised more than all registered corporate teams. The total catapulted to over \$18,000, including a \$5,000 sponsorship from UT-Battelle. It was a banner day for the Lab.

“I was touched by the overwhelming support of my co-workers and proud that my family was able to represent UT-Battelle in support of such a great cause,” said Tina.

To become involved with future Team UT-Battelle events, visit www.ornl.gov/info/news/cco/teamutb.shtml.

—Stephanie Ritchie 🌿



Team UT-Battelle, JDRF volunteers, including captains Kahra Gilley, Nancy Holcombe, Roger Jones, LaRonda Mack and Roxanne Raschke.

Lighter summer favorites

Macaroni Salad

- 1 pound elbow macaroni (use whole-grain pasta to boost fiber & phytonutrients)
- 1¼ c. partially thawed frozen petite peas or lightly cooked shelled edamame (green soybeans)
- 3 celery stalks, thinly sliced
- 4 scallions, white and part of green, thinly sliced diagonally

- 6 oz. lean ham, ¼ inch diced (optional)
- ¾ c. light mayo
- ¾ c. fat-free sour cream (or light)
- 1 tsp. white wine vinegar (or cider)
- 1 tsp. sugar
- ¼ tsp. ground nutmeg
- ¼ tsp. freshly ground salt (optional)
- freshly ground pepper to taste

Bring a large pot of water to a rolling boil. Add macaroni and cook until al dente (7-8 minutes). Drain in colander and rinse with cold water. Transfer noodles to a large bowl. Cover the bowl with plastic wrap or a lid and refrigerate until completely cool. Add peas or edamame, sliced celery, scallions, and ham (if desired) and toss to blend.

In small bowl or 4-cup measure, whisk together light mayonnaise, sour cream, vinegar, sugar, nutmeg, and ¼ teaspoon salt (if desired). Spoon over macaroni mixture and stir to blend. Season with pepper to taste. Cover bowl and refrigerate until ready to serve.



Recipe redo

Hint: Use half light mayo and half fat-free sour cream instead of the full amount of full fat and calorie versions

Per serving:

- 254 calories
- 10 g protein
- 42 g carbs
- 5 g fat
- 6 mg cholesterol
- 2.5 g fiber
- 132 mg sodium

Drivers beware – keep sunscreen handy

July is a busy month for vacations, outdoor activities and road trips. Before you roll down your window and enjoy the breeze, be prepared. According to a recent study published by the Journal of the American Academy of Dermatology, left-sided skin cancer cases are on the rise. Researchers attribute increased cases to a driver's cumulative sun exposure – an effect that may not show up until many years later.

Dr. Scott Fosko, chair of dermatology at the Saint Louis University School of Medicine, led the study. Fosko and his team reviewed information gathered from 1,047 skin cancer patients referred to the university. Of the total, 52.6 percent of the patients had skin cancer on their left side with 47.4 on the right. Of those cases, 74 percent on the left side were malignant with just 26 percent on the right. Of those regularly exposed, 82 percent of the cases were on the head and neck. When arms and hands were factored in, the number catapulted to 92 percent.

Researchers believe the men had a higher rate of left-sided skin cancer because men tend to be in the driver's seat or hold driving professions. In response, doctors recommend a sun block able to protect against both UVA and UVB rays. Contrary to popular belief, tinted windows are not enough protection, as they allow 63 percent of UVA rays to reach your skin. Experts also recommend long sleeves and a hat to cover the neck, ears and face for longer trips.

While skin cancer is one of the most deadly cancers, it is one of the most preventable. Most of the more than 1 million yearly cases of nonmalignant skin cancers in the US are related to sun exposure. The highly-malignant melanoma is most often times a result of cumulative sun exposure for the nearly 12,000 who die of the cancer each year, according to the American Cancer Society.

Regular skin screenings are critical to preventing skin cancer. Most doctors recommend checking your skin on a monthly basis. Check the skin right after a bath or shower while the skin is still wet. Keep a close eye on each mole. If necessary, take pictures to recall differences in between checks. Surging hormones may also play a part in changing moles, such as pregnancy and teen years, as well as going through menopause.

Many websites, such as MayoClinic.com, offer additional tips on mole examination – including warning signs. If you notice asymmetry, irregular edges, changes in color or diameter (larger than a pencil eraser), get checked by your doctor.

Don't cancel your summer trips – just play it safe.

Facts source: Journal of the American Academy of Dermatology. 🌿



THE NEWS

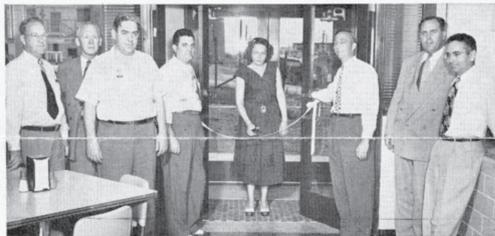
OAK RIDGE NATIONAL LABORATORY

A Publication by and for the ORNL Employees of Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation
 Vol. 2—No. 50 OAK RIDGE, TENNESSEE Friday, June 23, 1950



SCENES TAKEN AT THE NEW CAFETERIA'S PREMIERE TUESDAY OF LAST WEEK—The two pictures above show about two-thirds of the seating space of the Laboratory's new dining facility with a goodly number of ORNLers evidently enjoying the pleasant environment the new cafeteria affords. Below, top picture, depicts ribbon-cutting ceremony which took place at 11:14 a. m. in the formal opening. Doing the honor of cutting the ribbon was Dorothy Cagle, of the Cafeteria staff. Others in the picture are, left to right, L. E. McKeynolds, Oak Ridge manager, J. A. Jones Construction Co.; Dr. D. C. Bardwell, ORNL Building Committee;

S. C. Barnett, Executive Director; W. V. Atkins, Cafeteria Manager; M. V. Firmin, Service Department Supervisor; Dr. C. E. Larson, Director of the Laboratory; and Dr. A. M. Weinberg, Research Director. Bottom picture is a close-up of the serving line taken a few seconds after 11:15 a. m. when the new Cafeteria opened for the first time. Lead-off patron is Miss Alla Brackett, followed by R. E. Oakes, two of ORNL's oldest employees in point of service. Behind the counter, employees of the cafeteria are, left to right, Junior Trammell, L. M. Sutton, Carrie Abernathy, Reba Stephens, Beatrice Robinson and Lillian Wilkerson.



ORNL's New Cafeteria Fulfills Need; Patrons Complimentary

ORNL's new, modern cafeteria, long-needed as a replacement for the obsolete wartime built facility with its cramped and inadequate working and serving quarters, opened its doors for the first time at 11:15 a. m., Tuesday of last week. Approximately 600 were served at noontime that first day—and for the first time patrons were able to really enjoy a cafeteria meal in a pleasant adequate environment. Word of that satisfaction must have spread, for the very next day the number of patrons mounted to about 750, a new high for ORNL cafeteria serving by a wide margin.

New Appointments

Appointments to technical staffs of the Oak Ridge National Laboratory...



Technical Meetings

BIOLOGY SEMINAR at 3:30 p. m., Thursday, June 29, in the Conference Room, third floor, Building 9207, Genes and Enzymes in Neurospora. Dr. Norman H. Horowitz, of California Institute of Technology.

CHEMISTRY SEMINAR at 3:15 p. m., Wednesday, June 28, in the East Lounge of Ridge Hall. The Volkenstein Adsorption Equation. Dr. W. O. Milligan, of Rice Institute.

OAK RIDGE PHYSICS SEMINAR at 4 p. m., Friday, June 30, in the East Lounge of Ridge Hall. Gamma-Alpha Angular Correlation from Fluorine 19 Plus Protons. J. M. Jauch, of Iowa University and a Visiting Investigator with the ORNL Physics Division.

THE OAK RIDGE MATHEMATICS SEMINAR has been discontinued for the summer months. It will be re-convened next fall.

Chemistry Topic On A

"Chemistry and the Atomic Age" will be the topic of a broadcast on the CHEMISTRY program on WATO at 10:30 p. m., June 25. Mrs. E. J. Jen, of Y-12, will be the viewee on the broadcast. The HEADLINE program is an educational feature of the East Tennessee American Chemical Society.

Safety Signs

Your Life Has Only 18 Seconds Without a Injury Through

Sixty years ago this month Taken from The ORNL News for June 1950

- ORNL will soon have a new cafeteria with forced ventilation to comfortably seat 300 people.
- A new Health Physics Research building to open soon for study of public health aspects of radioactive waste disposal and removal of radioactive matter from water. This supports efforts directed toward civilian defense of public water supplies and equipping military with potable water.
- A program to study the bioluminescence of fireflies (lightning bugs) is announced and Oak Ridge youngsters are asked to supply 100,000 fireflies (and are paid 25 cents for each 100 fireflies).
- Ground-breaking for a new research building (now 4500S) took place.
- A photo shows Edward Brewster (janitor) with a 15-pound turtle he caught in the creek near the 703 building (3100 area now); he planned to "parboil" it then "fry it in deep fat."
- Harold Urey (1934 Nobel Prize winner in Chemistry) says a "daring approach" is needed in solving atomic energy problems (peacetime as well as military). He cites "less cautious administrators" and "self-starters" in making decisions as necessary.
- Alston Householder, chief of the ORNL Mathematical Panel, reviews ways in which mathematics is helping ORNL research, citing especially biology, health physics, reactor technology and equipment design.

—prepared by ORNL History Room volunteers

From the Lab Director

Congratulations to Doug Kothe and the Center for Advanced Simulation of Light Water Reactors proposal team for their successful bid against tough competition for the Reactor Simulation Innovation Hub. ORNL will lead a host of partners, which includes the Idaho and Sandia national laboratories and TVA, to form a “virtual” light-water reactor that should enable researchers to extend the lifetimes of existing nuclear reactors and help develop the next generation of materials for new reactors. The \$122 million program represents DOE’s first hub award and is a tremendous win for ORNL. Our selection to lead the project is an acknowledgment of the Laboratory’s state-of-the-art capabilities in modeling and simulation and our rich history in nuclear energy research.



Brent Park, our recently appointed Associate Laboratory Director for Global Security, assumes his new duties following the July 4th holiday. Brent has a 25-year background in physics research and research management, including leading the Homeland Security Technologies Division at the Nevada Test Site. Brent’s most recent appointment was as director of the remote sensing lab at NTS. I’d like to thank Dana Christensen for doing double duty in leading Global Security during the search for a new leader.

Brian Wirth has been named the ninth University of Tennessee-Oak Ridge National Laboratory Governor’s Chair. Brian is currently an associate professor at the University of California, Berkeley, which he joined in 2002 following several years as a materials scientist at Lawrence Livermore National Laboratory. We welcome Brian, who will be a great addition to our materials program.

Congratulations to the ORNL supercomputing team on Jaguar’s continued number one ranking in an international field that is becoming increasingly competitive. ORNL will be home to a third petascale machine when the National Oceanic and Atmospheric Administration’s new supercomputer arrives later this month and becomes another of the Laboratory’s assets in climate research.

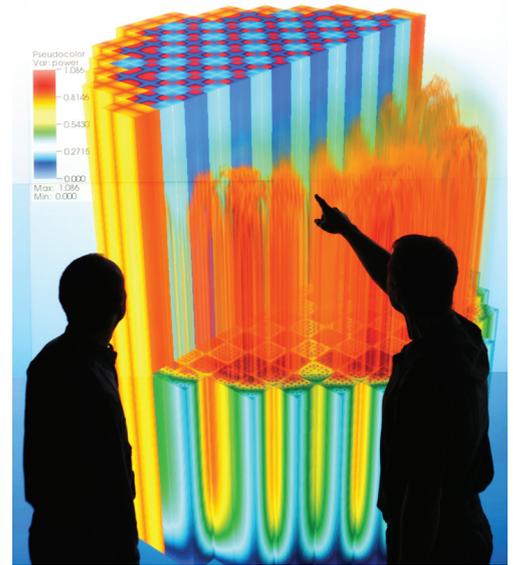
Congratulations also to Small Business Programs Director Keith Joy, who has received the Small Business Administration’s 2010 Dwight D. Eisenhower Award for Excellence in the Research and Development category. In 2005, ORNL was the first Office of Science laboratory to win this award, which recognizes large prime contractors that have excelled in their use of small businesses as suppliers and subcontractors.

ORNL staff members continue to lead in volunteering for the community. More than 100 volunteers came out to the World’s Fair site for the Juvenile Diabetes Research Foundation Walk to Cure Diabetes on May 15, described on page 4. I served as this year’s honorary chair, and was encouraged to see that Team UT-Battelle had the largest corporate group and raised well over \$18,000 toward a worthy cause. Facilities and Operations was the directorate raising the most money, followed closely by Energy and Engineering Sciences, Human Resources, and ITER. Communications and External Relations had the largest contingent of walkers. I encourage you to become involved in similar causes in our community.

Thomas Mason

Thom Mason

“The \$122 million Reactor Simulation Innovation Hub represents DOE’s first hub award and is a tremendous win for ORNL.”



Computer simulation of reactor design is a major element of the CASL project.



The group that developed ORNL’s winning proposal for the Consortium for Advanced Simulation of Light Water Reactors poses on presentation day.



Oak Ridge National Laboratory
Reporter
P.O. Box 2008
Oak Ridge, TN 37831-6266

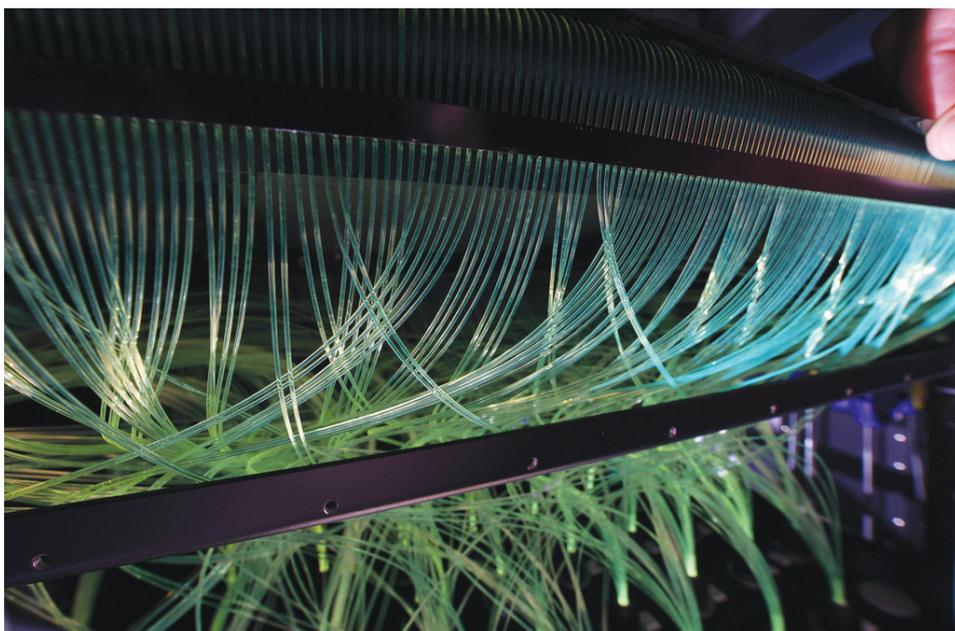
PRSR STD
U.S. Postage
PAID
Permit # 37
Powell, TN

VULCAN helps scientists pinpoint stress and strain

One of the newest and most popular instruments at the Spallation Neutron Source (SNS) is the VULCAN diffractometer. The reasons behind VULCAN's popularity are similar to those that make the SNS so attractive: it's new, and it has unusual capabilities.

VULCAN was built to take measurements on engineering materials (like a turbine blade from a jet engine or the frame of a car) under stress. VULCAN uses a neutron beam to "see" inside materials and make three dimensional maps of the distance between atoms in critical sections. Scientists can look at these maps and determine if the atoms are being squeezed together or pulled apart—signs of stress and strain in the materials.

"VULCAN is also a good example of our efforts to broaden the neutron science user base," says Stephen Nagler, Chief Scientist of ORNL's Neutron Scattering Science Division. Nagler expects the SNS to increase the number of people who are using neutron science for applied materials research like that performed on the VULCAN. "There has been some work of this type in the past," Nagler observes, "but I think the SNS will attract a much broader group of people to the field." 



Optical fibers blooming from a VULCAN detector module. The fibers transmit light signals created by captured neutrons to photo multiplier tubes where the signals are amplified and then sent to a data acquisition system to be recorded.