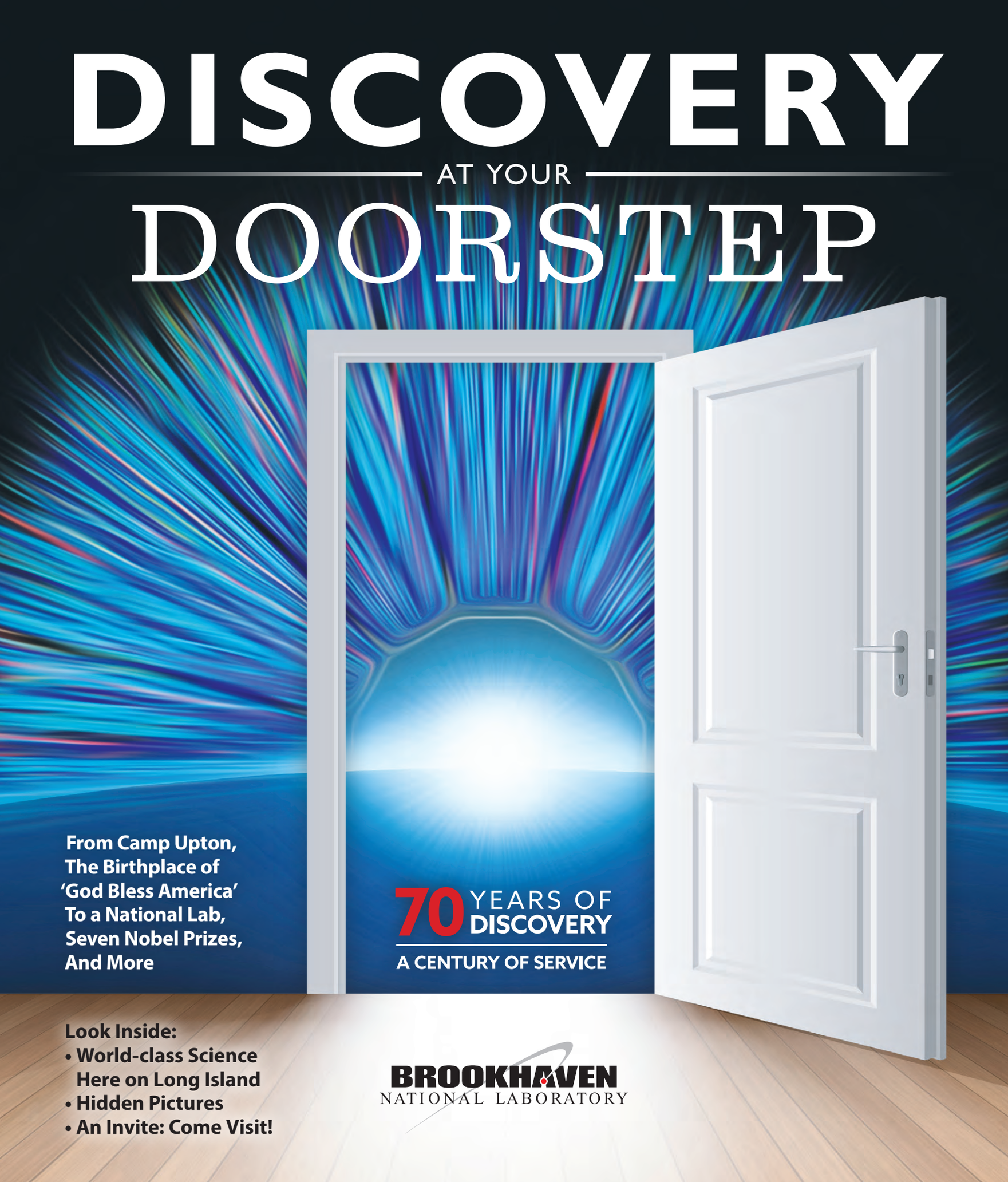
DISCOVERY AT YOUR DOORSTEP



From Camp Upton, The Birthplace of 'God Bless America' To a National Lab, Seven Nobel Prizes, And More

Look Inside:
- **World-class Science Here on Long Island**
- **Hidden Pictures**
- **An Invite: Come Visit!**

BROOKHAVEN NATIONAL LABORATORY

70 YEARS OF DISCOVERY

A CENTURY OF SERVICE

From an Army training camp and birthplace of 'God Bless America' to world-leading discovery science

2017 is special for the U.S. Department of Energy's (DOE) Brookhaven National Laboratory. Seventy years ago, Brookhaven Lab became the nation's newest home for discovery science. At the same location on Long Island where the Laboratory operates today, the U.S. Army's Camp Upton was founded as a training camp a century ago in the months after the United States entered World War I. From 1917 to 1947—when Brookhaven Lab's gate opened and its history of discovery began—hundreds of thousands of men spent time during their military service at Camp Upton.

From soldiers, barracks, and Irving Berlin writing "God Bless America" to renowned scientists, seven Nobel prize-winning discoveries, and countless technological advances, much has changed in here over the past century—and the Laboratory still proudly serves our country today!

Stroll through the years to see just some of the milestones from 100 years of history at this site. The expanded timeline of discovery science at the Laboratory is available online (**www.bnl.gov/70timeline**).

Camp Upton

1917 The U.S. Army's Camp Upton is founded in the Pine Barrens of central Long Island, months after the nation enters World War I.

1918 One of the soldiers at Camp Upton, Irving Berlin, writes "God Bless America."

1944 Camp Upton is converted into a convalescent and rehabilitation hospital for treating wounded veterans returning from World War II.

A New Era of Discovery Science on Long Island

1947 The U.S. War Department transfers Camp Upton to the Atomic Energy Commission, the U.S. Department of Energy's predecessor, for the founding of Brookhaven National Laboratory.

1957 Brookhaven Lab's first of seven Nobel Prize-winning discoveries: Parity Violation

1958 The World's First Video Game? Years before "Pong," Brookhaven scientist William Higinbotham unveils "Tennis for Two."

1964 Scientists discover the omega-minus particle, one of eight subatomic particles discovered by Brookhaven scientists.

1982 The National Synchrotron Light Source (NSLS) is dedicated. During more than 30 years of operations, NSLS becomes one of the world's most widely used scientific facilities for many advances, two Nobel Prize-winning discoveries, and nine R&D 100 Awards—the "Oscars of Innovation."

1998 The world's fastest non-commercial supercomputer at the time debuts at the RIKEN BNL Research Center at Brookhaven Lab.

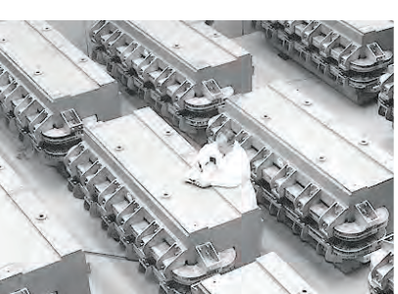
2008 The U.S. Army retires the 77th U.S. Army Regional Readiness Command—the infantry division that began its distinguished 91-year history at Camp Upton.

2011 "All systems are go" at the Long Island Solar Farm at Brookhaven Lab, currently the largest photovoltaic solar array in the United States east of the Mississippi River.

2012 Brookhaven scientists join collaborators in announcing discovery of the particle later identified as the Higgs boson at the Large Hadron Collider at CERN in Europe.

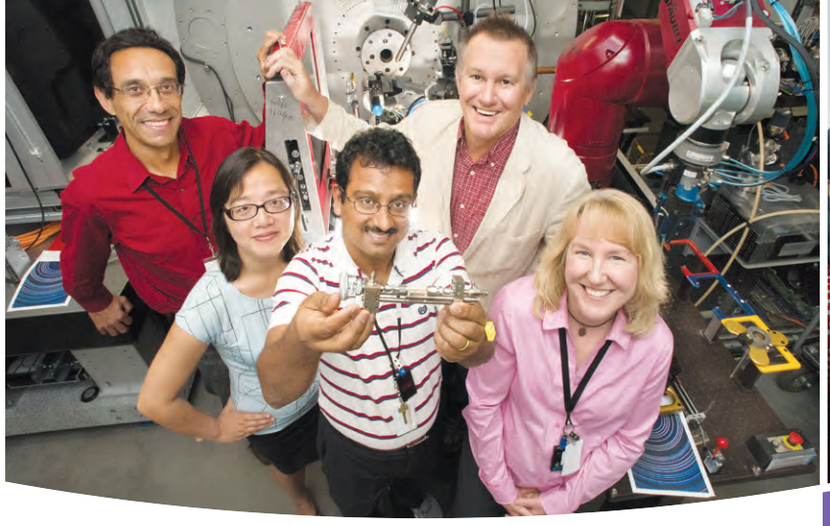
2015 A project team at Brookhaven reaches a major milestone in building a 3,200-megapixel camera sensor for the Large Synoptic Survey Telescope.

2016 Scientists' latest data from proton collisions at RHIC indicate that "wimpy" gluons have a big impact on proton spin. Large uncertainties remain—one reason why nuclear physicists need an electron ion collider to probe the internal structure of the proton even more directly.



Jillian Pesce of Smithtown High School East was honored during the Long Island STEM Hub celebration, hosted at Brookhaven Lab on April 18, for winning an essay contest to recognize the two milestone anniversaries in 2017. Students from high schools across Long Island entered the contest, including Joe McInnis of Greenport High School, who earned second place, and Izzy Schlichting of Mineola High School, who took third. Read Pesce's essay, inspired by the photo at left from the Lab's archive: https://www.bnl.gov/newsroom/news.php?a=212194

Samuel L. Stanley Jr., M.D.
BSA Board Vice Chair
President, Stony Brook University



Lab Director Doon Gibbs presents keys to a family from Habitat for Humanity of Suffolk

INNOVATION & INSPIRATION

The U.S. Department of Energy's (DOE) Brookhaven National Laboratory is at the frontiers of discovery science and just north of the Long Island Expressway at Exit 68. Scientists at Brookhaven Lab lead and collaborate with some of the world's brightest minds, making the Laboratory an asset for innovation and inspiration in support of DOE's mission to ensure America's security and prosperity by addressing its energy, environmental, and nuclear challenges through transformative science and technology solutions.

Powering Discovery Science

Brookhaven Lab is home to seven Nobel Prize-winning discoveries and countless other advances. Those have been powered by the expertise and capabilities that Lab scientists, engineers, and support staff develop while leading and collaborating in pioneering research. The applied and "basic" fundamental research at Brookhaven is often extremely complex, and can lead to new opportunities for innovation and improve the quality of life for generations to come.

Guest researchers travel to Brookhaven's 5,320-acre site from across the United States and around the world for DOE Office of Science User Facilities, including the Relativistic Heavy Ion Collider (see page 9), National Synchrotron Light Source II (page 10), and Center for Functional Nanomaterials (page 11). These large "user facilities" house tools that researchers in academia and industry need, but are too large and too complex for them to build and operate alone. Other research facilities at Brookhaven are not as big, yet they too are vital in powering discovery.

Thanks to more than 26,000 staff who have worked at Brookhaven since 1947—and their collaborators—scientists have pursued exciting adventures to explore the unknown. They identified particles that danced undetected for billions of years. They also helped shape our understanding of the atom and the universe, while advancing medical imaging techniques and research in microbiology, Earth's ecosystems, energy storage, and more. With important challenges and new capabilities—including "big data" and high-throughput computing—their adventures continue today.

The Laboratory is managed for DOE's Office of Science by Brookhaven Science Associates (BSA), a partnership between the Research Foundation for the State University of New York on behalf of Stony Brook University and Battelle. BSA also engages six of the world's premier research universities—Columbia, Cornell, Harvard, the Massachusetts Institute of Technology, Princeton and Yale—in the governance and oversight of the Laboratory.

Inspiring the Scientists, Engineers of Tomorrow—and Their Teachers

The Laboratory is a gateway for science, technology, engineering, and math education and development. Each year, more than 30,000 students, teachers, and professors to visit the Science Learning Center on site and take on real research projects with Lab scientists (see page 5).

Neighbors Helping Neighbors

Brookhaven Laboratory takes great pride in being part of the Long Island community. The Laboratory hosts "Summer Sundays" open houses and public lectures that are free to attend. Lab staff work with valued members of the Community Advisory Council. They also participate in volunteer efforts, including helping people on Long Island recover after Superstorm Sandy, sending care packages to troops overseas, and supporting the United Way of Long Island and Habitat for Humanity.

SCIENCE AND NATIONAL SECURITY

Brookhaven scientists contribute important expertise to help make the nation safe. In 2013, Lab staff teamed with the New York City Police Department (NYPD) for the largest-ever urban airflow study to better understand risks posed by airborne contaminants—including chemical, biological, and radiological weapons—to optimize emergency response. In 2014, the Radiological Assistance Program (RAP) team based at Brookhaven Lab went to Super Bowl XLVIII in New Jersey—not to cheer, but to monitor for potential radiological threats.

DISCOVERY PARK AND UPTON SQUARE:
A New Vision for a Historic Apartment Area To Benefit Science and the Local Economy

When scientists from around the world travel to Long Island for the unique research facilities at Brookhaven Lab, many stay in a historic apartment area on site. Discovery Park is a transformative vision for that apartment area, the Laboratory, Long Island, and the New York region. Upton Square would be at the heart of Discovery Park and named after the former Army camp founded at the same location 100 years ago. By leveraging federal investment in the tools at Brookhaven and creating a public-private partnership—among New York State and Long Island local governments, nonprofits, and private industry—Discovery Park is envisioned to support collaboration for developing new technologies, increasing the impact of science education, and promoting economic development in the region.

AN INSIDE LOOK AT WORLD-LEADING DISCOVERY SCIENCE ON LONG ISLAND

A Conversation with Brookhaven Lab Director Doon Gibbs

Doon Gibbs has led the U.S. Department of Energy's Brookhaven National Laboratory and its broad research portfolio since 2013. A Utah native, he moved to Long Island and joined Brookhaven Lab in 1983, after earning a Ph.D. in physics at the University of Illinois at Urbana-Champaign. Gibbs' early science career focused on using x-rays to study materials using synchrotron radiation. He was later instrumental in overseeing design and construction of the Center for Functional Nanomaterials (see page 11) and had significant roles advancing other major projects, including the National Synchrotron Light Source II (NSLS-II, see page 10). With approximately $1 billion of investment and 10 years for design, construction, and commissioning, that facility was delivered on time and under budget.

What do scientists at Brookhaven actually do?

Discovery science at Brookhaven Lab is about finding solutions to some of the biggest questions of our time, from understanding the conditions of the early universe to inventing new technologies that can power and secure our nation's future—and using what we learn to make the world a better place. Science is an exciting cycle that starts with asking big questions, finding answers, and then tackling inevitable new questions. Whether I'm hosting guests at the Laboratory or talking to other parents at my kids' soccer games, I love telling people about the world-class science that is happening right here on Long Island.

What is special about Brookhaven—our national lab on Long Island?

Brookhaven builds and runs big machines for discoveries that deepen our understanding and drive innovation. These are facilities that a university or a company could never build on its own—they require the federal government. For example, we're home to the only particle collider in the nation and the brightest light source of its kind in the world. We've also developed new capabilities for high-performance computing and have the second largest scientific data archive in the United States, the fourth largest in the world.

Each year, thousands of academic and industrial researchers come from across the country and around the world to use our machines to advance science and technology. So far, research at Brookhaven has led to seven Nobel Prize-winning discoveries, and countless advances and benefits to society. This gives us a remarkable opportunity to partner with Long Island and New York State enterprises on a range of problems in energy, biotechnology, and computing, to name just a few. Stony Brook University is the single largest user of our facilities.

What are some real game changing, exciting projects today?

Brookhaven is a multi-purpose lab, with a focus in several areas: understanding the origin and properties of visible matter; energy science, including batteries, the grid and bio-energy; big data; national security; and much more.

Some recent examples: We're developing new sources of renewable biofuels. We produce half the nation's strontium-82 for generators to assess heart health and, thanks to our particle accelerator infrastructure for the Relativistic Heavy Ion Collider (see page 9), we make other radioisotopes for medical diagnostics that can't be produced commercially. We're also targeting research to image, treat, and win against cancer with radioisotopes for personalized treatment.

Our researchers are working with superconductors that conduct electricity with no resistance and developing the world's largest camera sensor—3,200 megapixels—for a giant telescope being built on a mountaintop in Chile. Our scientists are studying Earth's ecosystems and working on national security challenges while helping prevent the spread of nuclear weapons, and more.

Managing data is essential for driving growth in many industries. Can you describe the Lab's work for advanced computing?

High-throughput computing has had a major role in discovery and Brookhaven has been a leader for decades. We create new ways to process huge amounts of data to help scientists with experiments in real-time—that's a game changer. We're home to the second largest scientific data archive in the United States—100 petabytes of data cataloged, searchable, and ready for analysis. That's equivalent to the amount of data you'd use to stream high-definition video 24 hours a day, seven days a week for 340 years!

Are national laboratories part of a national strategy?

The Department of Energy, which is led by Energy Secretary Rick Perry, has 17 national labs, including Brookhaven. The national labs are uniquely positioned to pull together teams of scientists and engineers to address the nation's hardest problems in energy security, national and nuclear security, and environmental management—key elements of the Department's mission. Collectively, the DOE labs are a national treasure—a science-based network that drives the discovery and innovation on which our economic growth and national security depend.

Who owns Brookhaven Lab?

Brookhaven Lab is owned by the Department of Energy and largely funded by the Office of Science. But, ultimately, the Lab is paid for by U.S. taxpayers, so it's "all of ours." The Lab is managed under a contract with the DOE by Brookhaven Science Associates, a company founded by the Research

Foundation for the State University of New York on behalf of Stony Brook University and Battelle. Our partnerships with Stony Brook and with New York State have been one of the most important ingredients of our success nationally.

What does Brookhaven Lab mean to parents and children on Long Island?

Summer is an especially exciting time of the year, as hundreds of interns, from high school to grad school, come to Brookhaven from Long Island and across the country to do real science with real scientists. These guests are diverse, with a variety of backgrounds, and they ask simple yet hard questions that often make us re-think assumptions. This re-thinking helps us push science forward.

More than 30,000 students from first to twelfth grades visit the Laboratory annually. We work with local schools, encouraging students to explore careers in science, technology, engineering, and math (STEM). That's critical for developing tomorrow's workforce—for Brookhaven, Long Island, and the nation.

In July and August, we open our doors for you to tour our big facilities and the Science Learning Center—our longstanding tradition, called Summer Sundays. It's great fun and I hope you'll join us.

Do you have anything to add?

Safety and respect for the environment are our core values at Brookhaven. As the challenges we face become increasingly complex, collectively, we will need a greater diversity of perspectives to tackle challenges, so at Brookhaven, we are striving for a more diverse, inclusive workplace. We must to reach farther than we have before to succeed. Together our scientists and support staff share a passion for discovery. When the Laboratory makes a breakthrough we all share in it, and can feel that we are contributing to making the word a better place. This is really inspiring, and is shared by all of our partners, including DOE, academia, industry, other national laboratories, and especially New York State. These are exciting, challenging times, and we have an opportunity to drive tremendously positive impacts for Long Island, the nation, and the world.

STUDENTS TODAY, SCIENTISTS TOMORROW

Students—many of whom will become the nation's next generation of scientists and engineers—get to do research with world-leading scientists at world-class facilities at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory. Exploring physics, advanced energy systems, nanoscience, scientific computing and coding, and Long Island's natural ecosystems, students, teachers, and professors participate in fun, hands-on research opportunities in science, technology, engineering, and math (STEM) offered through the Lab's Office of Educational Programs (OEP).

Science in Classrooms, Labs, and Long Island's Great Outdoors

Each year, more than 30,000 diverse Long Island students in grades 1 to 12 learn about the scientific method and discovery science through visits to the Lab's Science Learning Center. Many more participate in events, including DOE's National Science Bowl, the bridge-building contest, and the High School Research Program. Teachers from across Long Island are invited to STEM workshops, and together with students and Lab scientists, use facilities at Brookhaven for real research projects. Recently, students in the Lab-sponsored Open Space Stewardship Program studied samples with scientists using the National Synchrotron Light Source II (NLSL-II, see page 10).

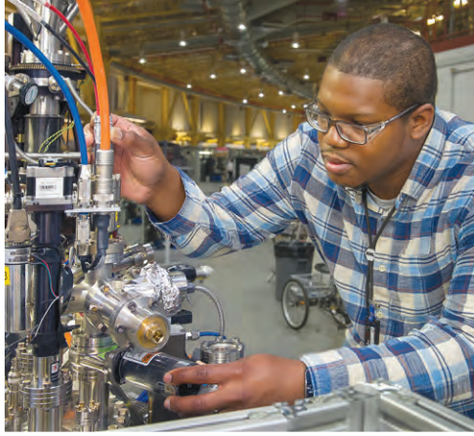
The Long Island STEM Hub—led by Brookhaven Lab and Northwell Health with collaborators at regional universities, school districts, museums, and industry—also introduces and inspires students to pursue STEM careers on Long Island.

Through the "Day in the Life of a River" program, students collect data such as water clarity, biodiversity, and population patterns for fish to develop complex snapshots of river ecosystems. Students and teachers explore, document, and track Long Island's flora and fauna using DNA through the Barcode Long Island program—a collaboration among Brookhaven Lab, Cold Spring Harbor Laboratory, Stony Brook University, and the American Museum of Natural History, funded by the National Institutes of Health. Students from the William Floyd School District, participating in the DNA barcoding project, recently discovered an earwig with a DNA sequence never observed before.

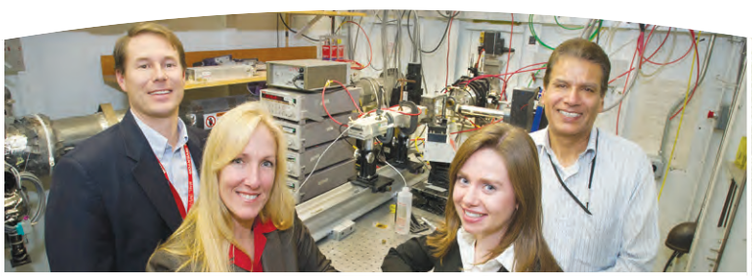
Propelling University Students and Professors to the Frontiers of Discovery

More than 350 students and professors from universities across the country participate in research through internships, tours, and workshops at Brookhaven each year. With funding from DOE's Office of Workforce Development for Teachers and Scientists, the Laboratory supports a sustained pipeline of well-qualified diverse students pursuing careers in STEM. These participants join Brookhaven scientists for research projects at the Relativistic Heavy Ion Collider, NSLS-II, Center for Functional Nanomaterials—all DOE Office of Science User Facilities (see pages 9, 10, and 11)—and other laboratories across Brookhaven's site.

Many of these participants are students and professors of groups underrepresented in STEM who arrive at Brookhaven through DOE-sponsored programs and others, including the New York State Collegiate Science and Technology Entry Program (CSTEP), Interdisciplinary Consortium for Research and Educational Access in Science and Engineering (INCREASE), and the National Science Foundation's Louis Stokes Alliance for Minority Participation (LSAMP) and Alliance for Graduate Education and the Professoriate - Transformation (AGEP-T). Through these relationships, internship program participants comprise approximately 34 percent minorities and 50 percent women.

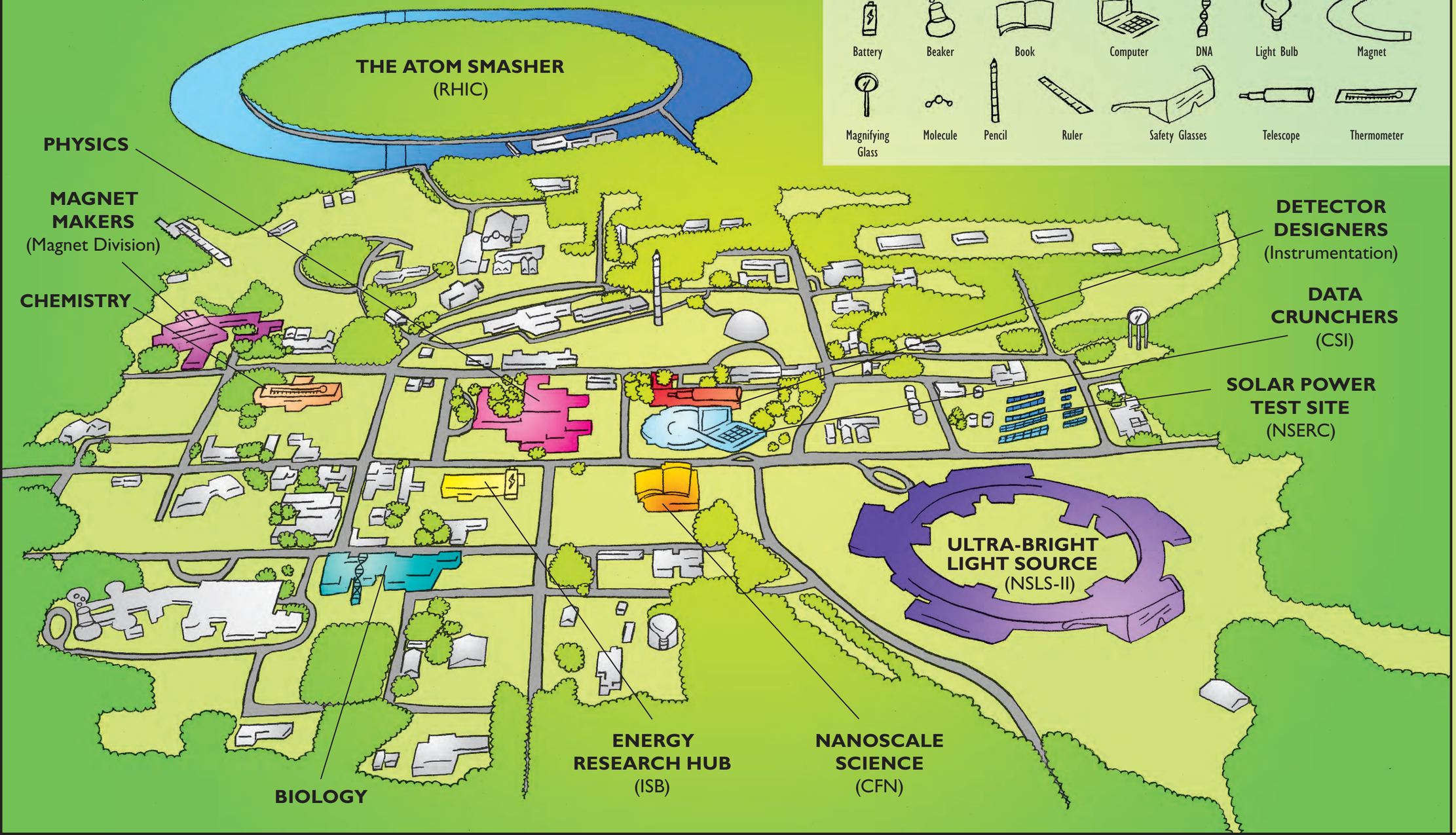


After earning his master's and Ph.D. at Stony Brook University, Rockville Centre native Robert Palomino now works at the National Synchrotron Light Source II through the AGEP-T program to study the structure and properties of catalysts that increase the rate of chemical reactions.



BROOKHAVEN NATIONAL LABORATORY

UPTON, NEW YORK



HIDDEN PICTURES!

Can you find these tools for discovery among the world-class facilities at Brookhaven Lab?

FACILITIES KEY

CFN:
Center for Functional Nanomaterials
(see pg. 11)

CSI:
Computational Science Initiative

ISB:
Interdisciplinary Science Building

NSERC:
Northeast Solar Energy Research Center

NSLS-II:
National Synchrotron Light Source II
(see pg. 10)

RHIC:
Relativistic Heavy Ion Collider (see pg. 9)

Brookhaven Lab is managed for the U.S. Department of Energy by Brookhaven Science Associates, a company founded by Stony Brook University and Battelle.

BROOKHAVEN NATIONAL LABORATORY

summer sundays

Experience hands-on discovery // **Meet** the scientists
Tour our world-class facilities // **Enjoy** science talks & shows

Family Fun Day
A fabulous day of hands-on family fun with the Science Learning Center.

Exploring the Ultra Small
Tour the Center for Functional Nanomaterials.

Brilliant Light, Dazzling Discoveries
Visit the National Synchrotron Light Source II.

Atom-Smashing Fun*
Explore the Relativistic Heavy Ion Collider.
*Facility tour appropriate for ages 10 and over

70 YEARS OF DISCOVERY
A CENTURY OF SERVICE

BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

FREE!

- No reservations needed
- Gates open 10 a.m. to 3 p.m.
- All activities are available on a first-come, first-served basis
- Visitors 16 & older must bring a photo ID
- Handicapped accessible
- 1 ½ miles north of LIE Exit 68

Summer Sundays Brookhaven

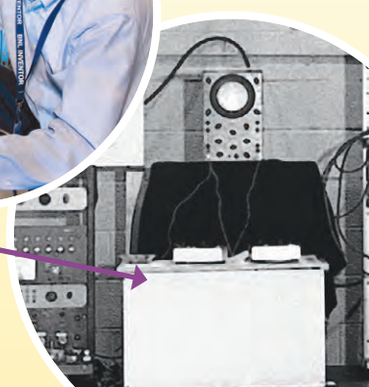
CALL **631-344-2651** OR VISIT **BNL.GOV/SUMMERSUNDAYS**

BILLION-DOLLAR IMPACTS FROM BROOKHAVEN LAB INNOVATIONS

Brookhaven Lab's Office of Technology Commercialization & Partnerships encourages the spirit of entrepreneurship and actively promotes the formation of start-up companies around technologies developed at the Laboratory. The Laboratory also grants licenses and takes equity in new ventures arising from the Lab's discoveries.

Some of the innovations from research at Brookhaven Lab have led to billion-dollar impacts. During our 70-year history, Lab scientists:

- Designed corrosion-prevention coating for metals using newly revealed properties of nanoparticles
- Sequenced the T7 virus genome to create a highly efficient system for producing proteins used in biomedical research, diagnostics, and treatment
- Patented MagLev, the principle of superfast magnetically-levitated transportation
- Developed cleaner-combusting oil burners, saving consumers approximately $25 billion in fuel costs and keeping 160 megatons of carbon dioxide out of Earth's atmosphere
- Created the first successful positron emission tomography (PET) scan radiotracer, ^{18}FDG, which is now used to study the nervous system and image cancer
- Synthesized human insulin, replacing animal insulin to treat diabetes
- Developed Technetium-99m, the most widely used radioisotope for imaging diseased organs
- Developed Levodopa (L-dopa), the gold standard for treating Parkinson's disease
- Invented "Tennis for Two" in 1958—often called the world's first video game—which led to a multi-billion–dollar industry



SMASHING ATOMS @ RHIC

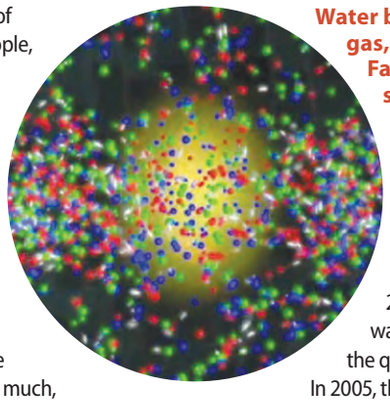
Unlocking Mysteries of Matter and Mass, and Why the Universe Works the Way It Does

Everything we see in the universe is made of atoms—from tiny nanoparticles to water, people, planets, and stars. We know those atoms bond together to form molecules, and that protons and neutrons form the heart of an atom's nucleus. But scientists have major questions about the subatomic quarks and gluons inside those protons and neutrons, how they interact, and why.

One of the best ways to figure out how something works is to break it down to its smallest pieces. For the visible universe, the "building-block" quark and gluon particles are held together by the "strong force"—which is much, much, much stronger than gravity. The only way to break them apart, watch how it happens, and learn more about the "strong force" is by smashing them together. The Relativistic Heavy Ion Collider (RHIC) at Brookhaven Lab is the only machine of its kind in the United States where scientists can do this.

RHIC is a U.S. Department of Energy Office of Science User Facility, two-and-a-half miles around, and visible from outer space. Atoms stripped of their electrons—called ions—race around RHIC faster than 671 million miles per hour, 99.995 percent the speed of light. RHIC contains two separate, intersecting "storage rings." Ions in one ring travel one direction and ions in the other ring travel the opposite direction and, where the rings intersect, the ions CRASH!

Large detectors several stories tall filled with special sensors and electronics then capture signals from the particle "wreckage" and convert them into data for 1,000 scientists and scientists-in-training in more than 30 countries.



Water boils, changing from a liquid to gas, when it's heated to 212 degrees Fahrenheit. The quark-gluon plasma scientists discovered at RHIC (pictured left) measures 7 trillion degrees Fahrenheit—7 followed by 12 zeroes—yet it is a liquid. Even at that high temperature, quark-gluon plasma isn't "boiling hot!"

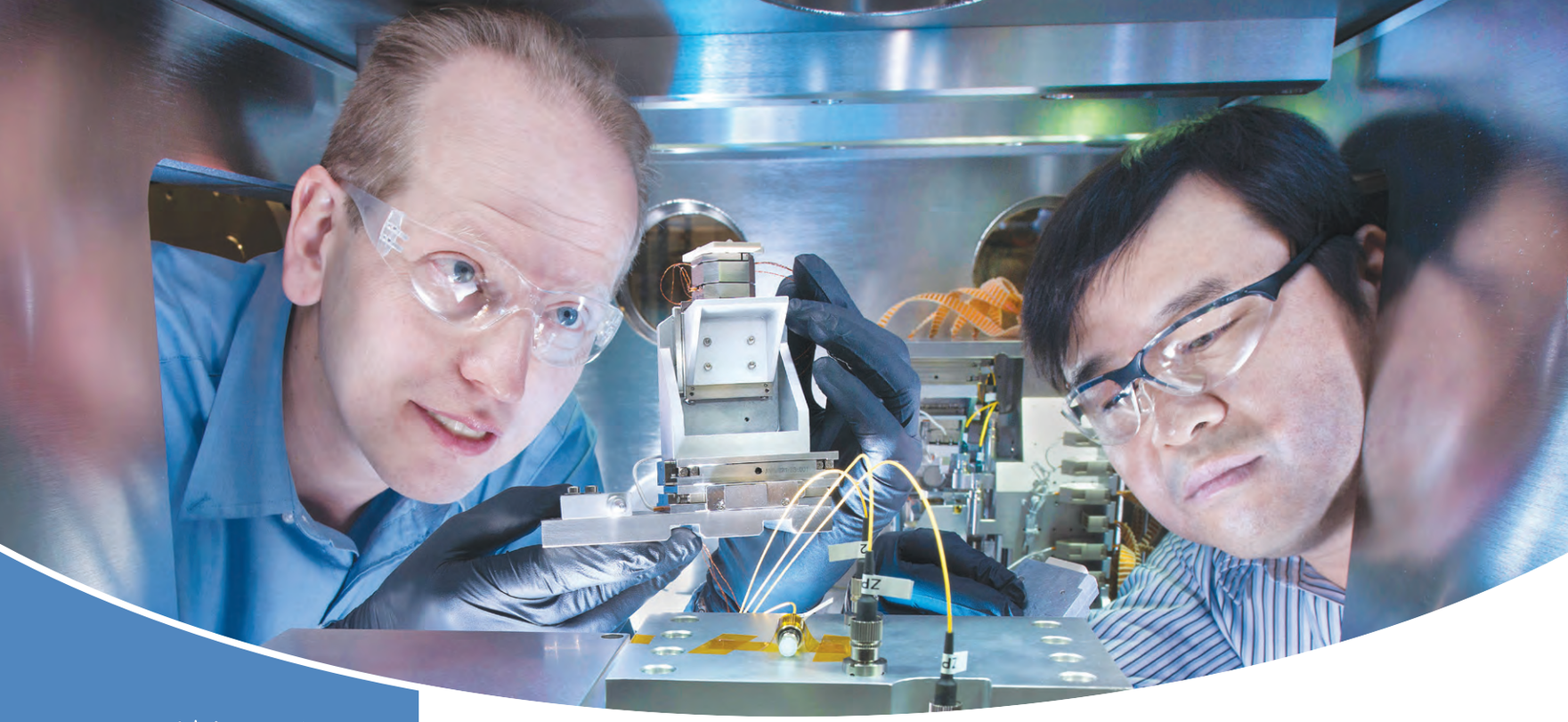
The first particles collided at RHIC in 2000 and, with major upgrades along the way, scientists have continued examining the quark-gluon interactions at RHIC ever since. In 2005, they discovered the "perfect liquid," called quark-gluon plasma, that filled the early universe in its first few microseconds. RHIC is also the only research facility in the world where scientists can collide protons that are "polarized"—aligned like spinning tops with their axes pointing in a specific direction—investigating the great "proton spin crisis" to determine why the proton's whole "spin value" does not equal to the sum of its parts.

For the years ahead, RHIC provides the infrastructure that could be the foundation for an electron-ion collider, a next-generation user facility for decades of exploration into the building-block particles at the heart of all matter in the visible universe. An investment like that would propel decades of future discovery and create new opportunities for future scientists who are students today. It would also help the U.S. maintain its leadership in the field of nuclear physics, accelerator technologies, and more—and it could all happen right here on Long Island.

RESEARCH FOR SPACE TRAVEL, MEDICAL TREATMENTS

The particle accelerators for RHIC provide key infrastructure and capabilities for scientists and students' research at other facilities at Brookhaven Lab. At the NASA Space Radiation Laboratory, its particle beams are used to simulate cosmic radiation and better understand risks before sending astronauts on longer missions in space and to Mars! The accelerator also produces medical isotopes that save lives through cardiac diagnostics and research for new ways to image, treat, and win against cancer.

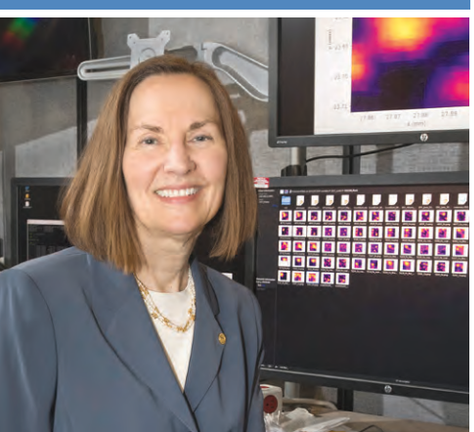
You, your family, and friends are invited to visit RHIC; walk in the tunnel; see the three-story-tall STAR detector; and learn about the science at Summer Sundays!



summer sundays

Meet scientists and see where they do their exciting research at NSLS-II, the brightest light source of it's kind. Sunglasses not required.

Esther Takeuchi is named inventor on more than 150 patents—including several for the battery in the implantable defibrillator. A joint appointment at Brookhaven Lab and Stony Brook University, she is leading research at NSLS-II for next-generation batteries and energy storage.



LIGHT, SO BRIGHT @ NSLS-II

The brightest light source of its kind, for unprecedented capabilities, advances

The National Synchrotron Light Source II (NSLS-II) at Brookhaven Lab is the brightest light source of its kind on the planet for scientists to study samples at the atomic scale in ways not possible before—materials like superconductors and catalysts, geological samples, and biological proteins. A U.S. Department of Energy Office of Science User Facility, this electron accelerator creates ultra-bright X-rays to explore materials for advances in energy, environmental science, and medicine.

NSLS-II is large enough to fit Yankee Stadium inside.

Today, researchers from Brookhaven and around the world—as well as professors, teachers, and students—travel to NSLS-II to use its 19 different "beamlines" for experiments. Each beamline has its own unique capabilities and features. Nine additional beamlines are currently in development and NSLS-II can house 60 in total for thousands of users each year.

Research for Next-generation Batteries, Energy Storage

With the brightness and brainpower at NSLS-II and the Center for Functional Nanomaterials (see page 11), researchers at Brookhaven are developing new capabilities to study processes "*in operando*"—in real-world operating environments instead of pristine vacuum chambers and ultraclean laboratories.

For example, scientists can begin to identify the strengths and weaknesses of components inside a battery as it works and recharges, rather than doing an "autopsy" afterward. This research to improve battery efficiency could have tremendous implications beyond smartphones, laptops, and defibrillators. It could also help electric vehicles travel farther on a single charge and provide major improvements for storing energy from sources like the sun and wind, so more power would available after the sun sets and when the wind doesn't blow.

Studying Proteins, Viruses to Fight Disease

Adding to the advanced imaging tools for biological structures recently completed at NSLS-II, funded by the National Institutes of Health, scientists at NSLS-II are collaborating with partners from Stony Brook University and Cold Spring Harbor Laboratory for future breakthroughs in fighting disease. With funding from New York State, a new tool is on its way to NSLS-II, where researchers will probe biomolecular structures, like proteins and viruses, suspended in thin layers of ice for atomic scale resolution.

This new cryogenic electron microscopy (cryo-EM) instrumentation, to be located at NSLS-II, will help scientists overcome major challenges in biology and the life sciences. The complementary X-ray and cryo-EM tools will enable scientists "solve biomolecular structures" faster to help accelerate designs for new medicines and treatments.

A 10-year Project Completed on Time, Under Budget

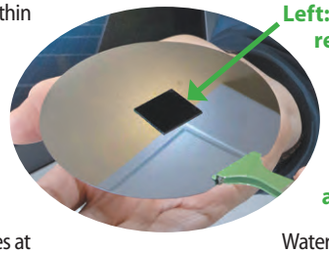
NSLS-II is one of the newest facilities for research at Brookhaven Lab. It was dedicated in 2015, after more than 10 years of design, construction, and commissioning. In 2016, the international Project Management Institute recognized NSLS-II as its Project of the Year, for completing on time and under budget with additional capabilities beyond what was originally planned.

BREAKTHROUGHS @ CFN

Research at the ultra-small nanoscale for big advances in energy, national security, and more

The nanoscale is the fantastically small world within our own—a world measured in billionths of a meter, with individual atoms and unique properties. When scientists design materials with structures at the nanoscale, those materials can do new and exciting things. The Center for Functional Nanomaterials (CFN) at Brookhaven Lab is a U.S. Department of Energy Office of Science User Facility, where scientists are making new discoveries at this ultra-small scale to fundamentally improve what's possible for technology and energy.

The CFN is outfitted with state-of-the-art facilities to make, measure, and understand nanomaterials. Scientists at the CFN advance the field of nanoscience and provide their expertise to hundreds of guest users from other national laboratories, universities, and industry each year to improve our world with more efficient catalysts, batteries, solar cells, and more.



Left: The black square is dark, because it isn't reflecting light, thanks to a nanotextured surface scientists developed at the CFN. Inspired by highly antireflective insect eyes, this coating could dramatically increase the energy solar panels collect. Right: Zoomed in, see the antireflective surface at the nanoscale.

Nanoscience Inspired by Nature for Energy—and Ski Goggles?

Inspired by the structure of some insects' eyes, scientists at the CFN created nanotextured surfaces to dramatically increase the amount of energy solar panels capture. Look at solar panels on a bright sunny day and you'll see the panels reflecting the blue sky and clouds overhead. That reflection is inefficiency. CFN scientists developed nanotextures that mimic moth eyes, which are highly antireflective, helping solar panels reflect much less light to collect much more power.

CFN scientists have made other nanotextures that help solar panels operate under less-than-ideal conditions. Imagine a surface covered with nanometer-scale traffic cones, packed neatly edge to edge. Scientists recently made nanocone-textures like that, which prevent moisture—fog—from accumulating on surfaces.

Water droplets literally jump off. Solar panels coated with these nanotextures would stay dry on dewy mornings, allowing them to capture light beginning at sunrise. Coating ski goggles with these structures could even reduce injuries in the mountains by eliminating fogging!

Nanotextures to Strengthen National Security

Researchers at the CFN can also apply nanoscience discoveries for both national security and medical applications—to create ultrasensitive detector sensors that ignore "noise" while identifying specific molecules from trace amounts of explosive materials, for example. Similar detectors could be optimized to look for indications of the early stages of cancer.

Breaking A World Record at the CFN

Faster computers and better high-resolution televisions and smartphones are made possible, in part, from research and development on the "lithography" processes to create complex materials with specific patterns and compositions. Scientists at the CFN recently became the first to develop and use electron-beam lithography to pattern materials at the size scale of one nanometer—only a few atoms across—breaking a world record and setting the stage for future advances.

summer sundays

Visit the CFN during Summer Sundays to explore the nanoworld, and see how breakthroughs at the nanoscale can create big impacts for technology and energy.

Visit Brookhaven Lab, and Stay in Touch

On Summer Sundays, tour the world-class research facilities and Science Learning Center at Brookhaven Lab. Meet scientists and join in the special activities for children and adults. See details on page 8. No registration is required for these family-friendly events and they're free!

Whether or not you can visit for Summer Sundays, join the staff and collaborators at Brookhaven Lab for an ongoing journey to the frontiers of discovery.

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BROOKHAVEN NATIONAL LABORATORY

70 YEARS OF DISCOVERY
A CENTURY OF SERVICE

DISCOVERY SCIENCE QUIZ

You can find the answers on the pages inside or search our website, **www.bnl.gov**.

- Brookhaven Lab is one of _____ U.S. Department of Energy national laboratories.
- It may sound simple but _____ research is often extremely complex, and can lead to new opportunities for innovation and improve the quality of life for future generations.
- The subatomic particles inside protons and neutrons scientists study at the Relativistic Heavy Ion Collider (RHIC) are called _____ and _____.
- The quark-gluon plasma that scientists discovered at RHIC measures 7 trillion degrees Fahrenheit. At that high temperature, it's not a gas but a _____.
- At the National Synchrotron Light Source II (NSLS-II), researchers use ultra-bright _____ to study materials at the atomic scale.
- Researchers at NSLS-II will use "cryogenic electron microscopy" to study proteins and viruses in thin layers of _____.
- At the Center for Functional Nanomaterials (CFN), scientists explore the ultra-small nanoworld to improve what's possible for technology and energy. A nanometer is one _____ of a meter.
- Scientists at the CFN recently broke a world record, using "electron beam lithography" to pattern materials at the scale of _____ nanometer(s).

Bonus Question

- Today, Brookhaven Lab operates at the site of the U.S. Army's former _____ _____, which opened in _____.