industrial and government institutions. For example, NSLS has been used by researchers to explain how a class of proteins help to generate nerve impulses – the electrical activity that underlies all movement, sensation, and perhaps even thought. This work was awarded the Nobel Prize in Chemistry in 2003. Work conducted at NSLS also led to the 2009 Nobel Prize in Chemistry, shared by visiting researchers Venkatraman Ramakrishnan (Cambridge University) and Thomas Steitz (Yale University) for investigating the structure and function of the ribosome. The NSLS has also been used by researchers from IBM to develop materials processes required to use copper instead of aluminum in integrated circuit interconnects – leading to faster, lower-power computer chips.

The NSLS allows scientists to "see" the tiny molecular structures of many substances and specimens. With this capability, scientists can make many fascinating discoveries, like:

- Revealing a potential explanation for superconductivity, a little-understood phenomenon that may revolutionize computers and electronics
- Studying the chemical composition of bones, which may aid in the understanding of arthritis and osteoporosis
- Determining the structure of a section of genetic materials known as RNA, which may lead to new ways to prevent or treat genetic disorders
- Using plants to clean up environmental contaminants, a technique known as phytoremediation
- Producing the first images of HIV, the virus that causes AIDS, attacking a human cell
- Determining a new way to use x-rays to study carbon nanotubes, tiny cylindrical carbon molecules with exceptional strength, conductivity, and heat resistance
- Studying how the structure and properties of various materials change when subjected to extremely high pressures and temperatures, leading to new, safer reactor designs.

The superior capabilities of NSLS-II will advance this work and open new avenues for scientific discovery.

The 2003 Nobel Prize in chemistry was shared by NSLS visiting researcher Roderick MacKinnon for his work exploring how one class of proteins helps to generate nerve impulses.

The 2009 Nobel Prize in chemistry was shared by visiting researchers Venkatraman Ramakrishnan and Thomas Steitz for investigating the structure and function of the ribosome.

U.S. DEPARTMENT OF ENERGY

BROOKHAVEN NATIONAL LABORATORY

4/23/14

Brookhaven National Laboratory

The National Synchrotron Light Source II

A New Light on the Horizon

The National Synchrotron Light Source II

A New Light on the Horizon

A new light shines on the horizon at the U.S. Department of Energy's Brookhaven National Laboratory. A cutting-edge new user facility will soon illuminate the path to discoveries in fields ranging from energy to medicine.

Major advances in energy technologies — increasing the efficiency of solar panels, developing new, longer-life batteries for electric vehicles, or designing the next generation of nuclear power systems — require scientific breakthroughs in developing new materials with desired properties. Synchrotron light sources are non-destructive tools that give researchers the ability to "watch" the system dynamics of a wide range of materials with nanoscale resolution — on the order of just billionths of a meter.

To delve even deeper into the nanoworld, Brookhaven National Laboratory designed and built the National Synchrotron Light Source II (NSLS-II), a light source with exquisite sensitivity and x-rays 10,000 times brighter than the currently operating National Synchrotron Light Source (NSLS). Scheduled for completion in 2015, NSLS-II will allow scientists to study and quantify the atomic and electronic structure, chemical composition, and magnetic properties of materials in a wide range of temperatures and environments. NSLS-II will help researchers explore solutions to the grand energy challenges faced by the nation, and open up new regimes of scientific discovery that will pave the way to discoveries in physics, chemistry, and biology — advances that will ultimately enhance national security and help drive the development of abundant, safe, and clean energy technologies.

"No synchrotron anywhere in the world – either currently operating, under construction, or in design – enables scientists to image and characterize materials with resolution down to a billionth of a meter, the scale at which key properties and phenomena emerge. Brookhaven National Laboratory built NSLS-II to address this need."

A Giant Microscope

NSLS-II has a medium-energy storage ring designed to deliver world-leading brightness and flux. Like an extremely powerful microscope, NSLS-II will provide scientists with the world's finest capabilities for x-ray imaging, and will be ideal for a wide range of disciplines and scientific initiatives in the coming decades, including new studies of small crystals in structural biology, development of nanometer-resolution probes for nanoscience, coherent imaging of the structure and dynamics of disordered materials, greatly increased applicability of inelastic x-ray scattering, and properties of materials under extreme conditions. Such a high-brightness light source will also foster research in structural genomics and drug design. In the area of biological and medical imaging, NSLS-II will extend studies of early disease detection.

A Legacy of Breakthroughs

Work at NSLS-II will build on a foundation of important scientific discoveries made by some of the thousands of visiting researchers who come to Brookhaven every year. The new machine will replace the original National Synchrotron Light Source (NSLS), which began operations in 1982. NSLS provides essential scientific tools for scientists from academic,

(continued on back)

Visiting Researchers

NSLS is one of the busiest scientific facilities in the world, each year hosting more than 2,300 researchers from approximately 400 universities, laboratories, and corporations. These scientists come to the NSLS from around the world, performing experiments using its bright beams of x-ray, ultraviolet, and infrared light to learn about the unique structures and properties of proteins, polymers, metals and minerals, and many other materials. About 60 percent of these researchers are from either the life or materials sciences, but many also conduct research in chemistry, geosciences and ecology, and applied science and engineering. The remaining users perform research in optical, nuclear, and general physics, or other fields. All told, these user scientists publish, on average, more than 900 papers each year based on advances they make using NSLS, with more than 125 appearing in premier journals such as Science and Nature.

Much of this work will transfer to NSLS-II when it begins operations in 2015, and its new beamlines and capabilities have been designed with input from this active community of users. When fully built out, NSLS-II will accommodate more than 60 beamlines that will allow researchers to push back the frontiers of science and will empower industry with new, advanced capabilities for innovation.