Photon Sciences Directorate at
Brookhaven National Laboratory

2010 ANNUAL REPORT

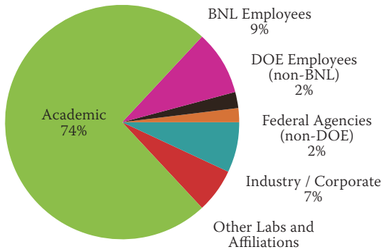
The Photon Sciences Directorate operates the National Synchrotron Light Source (NSLS) and is constructing the National Synchrotron Light Source II (NSLS-II), both funded by the Department of Energy's Office of Science. These facilities support a large community of scientists using photons (light) to carry out research in energy and environmental sciences, physics, materials science, chemistry, biology and medicine, and other disciplines.

FY10 PUBLICATION COUNT

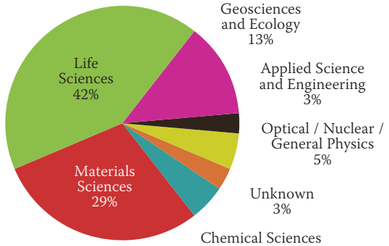
Publication Type	Total	Staff
Total Publications	893	110
Total Journals	747	84
Peer-Reviewed Journals	724	81
Peer-Reviewed Premier Journals	165	21
Conference Proceedings	68	18
Reports: Technical, Formal, Informal	2	2
Books / Book Chapters	18	4
Theses / Dissertations	51	0
Patents	7	2

FY10 USER DEMOGRAPHICS

NSLS Users by Affiliation



NSLS Users by Field of Research



NSLS-II MILESTONES

August 2005
Mission need approved

July 2007
Alternative selection and cost range approved

January 2008
Performance baseline approved

January 2009
Start of construction approved

February 2009
Award for ring building

May 2010
Award for booster system

June 2010
NEXT mission need approved

August 2010
LOB contract awarded

October 2010
"Topping out" ceremony – closing of the ring

March 2011
Beneficial occupancy of 1st section of ring building

October 2013
Start accelerator commissioning

June 2015
Approve start of operations

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

DISCOVERY *at Light Speed*

REFLECTIONS ON THE YEAR

This is a very exciting period for photon sciences at Brookhaven National Laboratory. It is also a time of unprecedented growth for the Photon Sciences Directorate, which operates the National Synchrotron Light Source (NSLS) and is constructing NSLS-II, both funded by the Department of Energy's Office of Science.

Reflecting the quick pace of our activities, we chose the theme "Discovery at Light Speed" for the directorate's 2010 annual report, a fiscal year bookended by October 2009 and September 2010.

The year began with the news that NSLS users Venki Ramakrishnan of Cambridge University (also a former employee in Brookhaven's biology department) and Thomas A. Steitz of Yale University were sharing the 2009 Nobel Prize in Chemistry with Ada E. Yonath of the Weizmann Institute of Science.

Every research project has the potential for accolades. In 2010, NSLS users and staff published close to 900 papers, with about 170 appearing in premiere journals. Those are impressive stats for a facility nearly three decades old, testament to the highly dedicated team keeping NSLS at peak performance and the high quality of its user community.

Our NSLS users come from a worldwide community of scientists using photons, or light, to carry out research in energy and environmental sciences, physics, materials science, chemistry, biology and medicine. All are looking forward to the new capabilities enabled by NSLS-II, which will offer unprecedented resolution at the nanoscale. The new facility will produce x-rays more than 10,000 times brighter than the current NSLS and host a suite of sophisticated instruments for cutting-edge science.

Some of the scientific discoveries we anticipate at NSLS-II will lead to major advances in alternative energy technologies, such as hydrogen and solar. These discoveries could pave the way to:

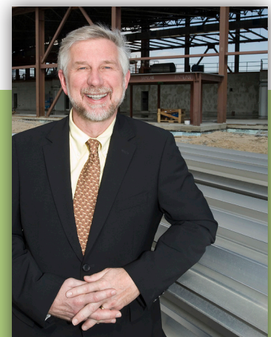
- catalysts that split water with sunlight for hydrogen production
- materials that can reversibly store large quantities of electricity or hydrogen
- high-temperature superconducting materials that carry electricity with no loss for efficient power transmission lines
- materials for solid-state lighting with half of the present power consumption

Excitement about NSLS-II is evident in many ways, most notably the extraordinary response we had to the 2010 call for beamline development proposals for the anticipated 60 or more beamlines that NSLS-II will ultimately host. A total of 54 proposals were submitted and, after extensive review, 34 were approved. Funding from both the Department of Energy and the National Institutes of Health has already been secured to support the design and construction of a number of these beamlines.

FY11 is a challenging and exciting year for the NSLS-II Project as we reach the peak of our construction activity. We remain on track to complete the project by March 2014, a full 15 months ahead of schedule and with even more capabilities than originally planned. The Photon Sciences Directorate is well on its way to fulfilling our vision of being a provider of choice for world-class photon sciences and facilities.

Steve Dierker

Steve Dierker
Associate Laboratory Director for Photon Sciences



A BEAM OF PHOTONS IS A POWERFUL TOOL

Made by accelerating electrons to 99.99 percent of the speed of light, photons help scientists illuminate wide-ranging scientific mysteries, from the inner workings of batteries and the composition of comet dust to the atomic structure of proteins vital for human life. At the U.S. Department of Energy's Brookhaven National Laboratory, scientists perform this work and more at the National Synchrotron Light Source (NSLS) and are preparing to extend their research at the National Synchrotron Light Source II (NSLS-II), now under construction. The 2010 Annual Report of the Photon Sciences Directorate, which oversees NSLS and NSLS-II, details a spectrum of recent achievements made by directorate staff and the large user community it supports. This companion piece highlights our activities for the fiscal year, from October 2009 through September 2010.

View the full report at:
www.bnl.gov/ps/annualreport

Nobel Prize


Photon Sciences Directorate staff


Ned Seeman*


NSLS-II lab-office building


InSynC

Ring closing


NSLS-II construction

IN THE SPOTLIGHT

Nobel for "Pictures" of Protein Factories

Two recipients of the 2009 Nobel Prize in Chemistry have strong ties to NSLS. Venki Ramakrishnan, a former employee in Brookhaven's biology department and long-time NSLS user, now at Cambridge University, and Thomas A. Steitz of Yale University, also a long-time NSLS user, shared the prize with Ada E. Yonath of the Weizmann Institute of Science for their work on the structure and function of the ribosome. In the late 1990s, Ramakrishnan and Steitz used protein crystallography at NSLS and other light sources to solve the high-resolution structures for two ribosome subunits crucial to understanding everything from how the ribosome achieves its amazing precision to how different antibiotics bind to it.

Bringing NSLS into the Classroom

A new program launched at Brookhaven lets high school teachers and their students conduct experiments they devise with a major piece of scientific equipment: NSLS. The program, dubbed InSynC for Introducing Synchrotrons into the Classroom, allocates time on the multi-million-dollar machine to classrooms through a competitive, peer-reviewed proposal process.

Moving Into Production for Accelerator Hardware

We had 14 goals for the year and checked off 11, with "in progress" noted on the balance. Design work on the complex hardware for NSLS-II accelerator systems was completed in 2010. This includes superconducting cavities, RF power sources, vacuum systems, power supplies, magnet systems and insertion devices. In addition, we started the fabrication and assembly of aluminum vacuum chambers, finishing roughly 25 percent of them by year's end. Orders for all vacuum pumps were placed, and about 50 percent of the pumps were delivered.

Boom Gives Birth to Photon Sciences Directorate

Since 2005, the number of employees in the directorate has increased from 180 to more than 450 as our portfolio has expanded from operating NSLS to also include designing and constructing NSLS-II, designing and constructing additional beamlines for NSLS-II and, in coming years, transitioning to NSLS-II operations. To better manage this rapid growth, the Light Sources Directorate spent much of the year planning for a reorganization. In October 2010, the Photon Sciences Directorate was born. The new structure positions the organization well for continued growth and future success in photon sciences.

We Called, You Answered

A remarkable 54 NSLS-II beamline development proposals were submitted in 2010 by nearly 700 proposal team members from around the world, representing both existing and new user communities in a variety of scientific fields. Each proposal was reviewed first by one of seven Science Advisory Committee (SAC) Study Panels and then by the full SAC. More than half — 34 — were approved.

Closing the Ring

Just days into FY11, the structural framework of NSLS-II became a complete, nearly half-mile ring as the final steel beam was bolted into place. The "topping out" ceremony collected the signatures of more than 300 construction workers, Brookhaven and Department of Energy officials, invited guests, and Lab employees on the last steel beam. That beam will be visible to future research teams on the experimental floor.

NSLS User Wins Kavli Prize

For his pioneering advances in the field of DNA nanotechnology, New York University chemist Nadrian C. (Ned) Seeman took home the 2010 Kavli Prize in Nanoscience. Seeman, who shared the $1-million prize with Donald Eigler of IBM's Almaden Research Center, uses NSLS to determine the atomic structures of the specific DNA complexes he builds. With the help of NSLS data, Seeman made a significant breakthrough — the creation of 3D DNA structures.

$34-Million Contract for Lab-Office Buildings

E.W. Howell, based in Plainview, NY, won a $34-million contract to build laboratory-office buildings (LOBs) for NSLS-II. Construction is funded by the American Recovery and Reinvestment Act.

Getting to the Action: Beamlines for NSLS-II

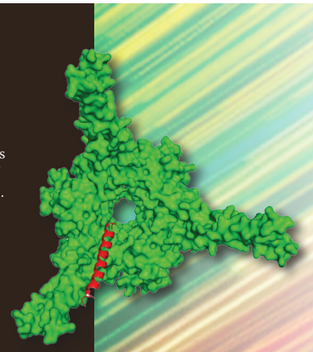
At NSLS-II, all the science action will take place at some 60 beamlines, each one consisting of a suite of scientific instruments where experiments are carried out. Six beamlines are being built by the NSLS-II Project. Preliminary designs for these six "project" beamlines lay out basic details, from the front ends, where the light is siphoned off the main ring, to the hutches, where research is done. Procurement will begin soon on major equipment such as high-precision mirrors and gratings. Planning also is under way for additional beamlines. The U.S. Department of Energy granted CD-0 (approval of mission need) for a Major Item of Equipment Project known as "NSLS-II Experimental Tools," or NEXT. The NEXT Project will design and construct 5-6 beamlines and CD-0 authorized the start of their conceptual design. The National Institutes of Health and the National Institute of Standards and Technology have also committed funds to support design and construction of beamlines at NSLS-II.

*Photo courtesy of The Kavli Prize

TWO OF BNL'S TOP FIVE PAPERS OF THE YEAR

Targeting the Tuberculosis "Recycling Center"

Tuberculosis (TB) infects a third of the world's population. Targeting the system that delivers unwanted proteins to the TB bacteria's "recycling factory" could inhibit the bacteria and treat TB. The catch is that human cells have a similar protein-recycling system that could also be destroyed by inhibitory drugs. Researchers used NSLS to uncover a key difference between the human and TB recycling centers — information that could lead to drugs that disable the bacterial system while leaving human cells intact.



Protecting Platinum for Better Fuel Cells

Platinum is one of the most efficient metals used to drive reactions in fuel cells for electric cars. But in stop-and-go-driving, the precious platinum quickly dissolves. With help from NSLS studies, scientists developed a new electrocatalyst with a palladium nanoparticle core that "protects" a single layer of platinum surrounding the particles. The catalyst minimizes platinum's wear and tear while maintaining high levels of reactivity and could greatly enhance the practicality of fuel-cell vehicles.