Brookhaven Town Supervisor John Jay LaValle Visits BNL

January 9, 2004

To learn more about research being done at BNL, which is one of Brookhaven Town's largest employers, Brookhaven Town Supervisor John Jay LaValle visited the Lab for the first time on December 15, 2003.

Laboratory Director Praveen Chaudhari welcomed LaValle and his office staffer Christopher Nuzzi, who both also met Michael Holland, DOE's Brookhaven Area Office Manager; Marge Lynch, Assistant Laboratory Director for Community, Education, Government & Public Affairs (CEGPA); and Jeanne D'Ascoli, CEGPA Community Relations Representative.

The visitors then toured part of the Lab, with a first stop at the National Synchrotron Light Source (NSLS). There, Associate Laboratory Director for Light Sources and NSLS Chair Steven Dierker gave an overview of how Lab scientists and some 2,500 researchers from across the nation and overseas who visit BNL annually use x-rays and ultraviolet and infrared light to make discoveries in biology and physics, chemistry and geophysics, materials science and medicine.

At beamline U10B at the National Synchrotron Light Source, researcher Lisa Miller explains to Brookhaven Town Supervisor John Jay LaValle how she uses infrared light to study bone composition in osteoporosis.

At the next stop, Bill Christie of the Physics Department talked about the massive STAR detector, where about 450 researchers are among the approximately 1,000 scientists, engineers, and technicians from the U.S. and abroad who work at the Relativistic Heavy Ion Collider to replicate conditions at the dawn of time to gain a better understanding of how the universe evolved.

Then, at the Positron Emission Tomography (PET) facility, the visitors learned from scientist David Schlyer of the Chemistry Department about BNL's work in probing the brain chemistry of addiction, mental illness, and aging, and recent work to find effective treatments.
—Liz Seubert

Brookhaven Lab Expects $30 Million to Support Life Sciences

February 12, 2004

The Biology Department at Brookhaven National Laboratory announced that it expects to receive more than $30 million over the next five years, which will renew financing to support structural biological research, including studies of disease and genomics.

The funding, administered by the Office of Biological and Environmental Research within the U.S. Department of Energy's (DOE) Office of Science and by the National Center for Research Resources within the National Institutes of Health, will support a group of six beamlines at the (NSLS).

"The large size of the grant is a tribute to the strong infrastructure within the NSLS and Brookhaven Lab," said Robert Sweet, a structural biologist in the Biology Department at Brookhaven and spokesperson for the research group that maintains the beamlines. "It also reflects how valuable we are to a large number of powerful Northeastern U.S. research groups that use our facility."

For example, researcher Roderick MacKinnon of The Rockefeller University received the 2003 Nobel Prize in Chemistry for his research, performed in part at the NSLS, on how nerve signals are propagated through the body.

"We're very proud of our ability to identify and support Nobel-quality projects like MacKinnon's work," Sweet said. "These funds will allow other important projects to move forward."

A research group from Yale University has used NSLS light to study the structure of ribosomes – cellular "machines" that assemble the proteins cells need to function. Also, scientists from Harvard University determined the structure of a type of tiny opening on the surface of cells that allows proteins to pass in and out of the cell. Their results may provide valuable insight into several basic cellular activities. The grants will also further the work of scientists from local Long Island institutions, such as Stony Brook University and Cold Spring Harbor Laboratory.

Ari Patrinos, Associate Director of Science for DOE's Office of Biological and Environmental Research within the Office of Science, welcomed the renewal of funding for the beamlines. "The Brookhaven scientists are addressing two major objectives of the Lab's structural biology program: developing state-of-the-art technologies for solving the most difficult molecular structure problems, and providing access to this major facility, which is used by more than 2,500 scientists each year," he stated.

This type of research is part of a field of biology called macromolecular crystallography, which uses x-rays to determine the structure of various proteins and nucleic acids, the molecular engines that control the functions of all living cells. Because abnormalities and malfunctions in macromolecules, especially proteins, are often the root of many diseases, an important step toward developing drug treatments is learning about these molecules' structures.

The funds will cover the expenses of improving and maintaining the beamlines, which is carried out by Sweet's research group – a team of nine scientists and fourteen engineers and technicians. It also will cover the costs of training and assisting researchers in performing their measurements.

One of the beamlines supported by the grants is brand-new, and will produce the brightest x-ray light at the NSLS. Another, the beamline where MacKinnon performed his research, will be upgraded to produce even brighter light. Lonny Berman, an NSLS physicist, will manage the upgrade.

Above are the staff of the Protein Crystallography Research Resource (PXRR), the Biology Department and National Synchrotron Light Source (NSLS) Department scientists, engineers, machinists, and technicians who operate six NSLS beamlines for macromolecular crystallography.

In addition, Sweet's group will use the funds to develop techniques that allow experimenters to work more quickly and efficiently. They have already pioneered a sophisticated service managed by Howard Robinson, a biophysicist, which allows crystal samples to be sent to NSLS researchers through the mail. In another project, managed by biophysicist Dieter Schneider, they are building a robot that will automatically change the specimens that are studied during NSLS experiments.

—Laura Mgrdichian

The DUV-FEL Workshop

February 19-20, 2004

The Deep Ultra Violet Free Electron Laser (DUV-FEL), a laser linac facility at Brookhaven National Laboratory, is the world's only facility dedicated to laser-seeded FEL research and development (R&D) and its applications. To explore opportunities for future experiments on free electron laser and beam physics at the DUV-FEL, the DUV-FEL Beam Physics and FEL Research and Development Workshop was held on February 19-20, 2004.

Representatives from seven countries and 14 institutions – including Lawrence Berkeley National Laboratory, the Massachusetts Institute of Technology, BESSY, and Pohang Accelerator Laboratory – participated in the workshop. More than 20 talks were presented, covering a broad spectrum of beam physics and FEL topics, such as cascaded high-gain harmonic generation (HGHG) FEL, ultra-short FEL generation techniques, electron-beam optimization, bunch compression, and femtosecond electron-beam instrumentation. The presentations revealed that the seeded FEL, especially the HGHG type, will play a critical role in the proposed x-ray FEL facility.

Brookhaven's Xijie Wang and Li Hua Yu began the workshop with presentations on the DUV-FEL facility and its current FEL R&D program. The facility's main components are a high-brightness electron accelerator, a HGHG FEL, a chemical science endstation, and sophisticated electron and photon beam instrumentation.

The DUV-FEL accelerator system consists of a 1.6 cell photo injector driven by a Ti:Sapphire laser system, and a four-section 2856 MHz SLAC-type traveling wave linac that is capable of producing a 200 MeV electron beam. The facility's magnetic chicane bunch compressor produces sub-picosecond-long electron bunches with a peak current of a few hundred amperes. The high-brightness electron beam travels down the 10 meter-long undulator to generate UV light with a fundamental wavelength of 266 nm.

Past DUV-FEL Activity

One of the most important milestones at the DUV-FEL last year is the initialization and completion of the first DUV-FEL user experiment by Arthur Suits and his collaborators from BNL's Chemistry Department.

This first chemical science experiment – on ion pair imaging – used the HGHG's third harmonic beam (89 nm) to study the super excited states of methyl fluoride, a highly flammable gas. Velocity-mapped ion images of the fluoride ion, obtained using intense, coherent, sub-picosecond pulses of 86-89 nm light, revealed a low translational energy, implying a very high internal excitation in the molecule's methyl cation cofragment [W. Li et al, PRL 92, 083002-1 (2004)].

An enthusiastic group of DUV-FEL workshop attendees, (from left) Xijie Wang (BNL), June-Rong Chen (NSRRC), Gwo-Huei Luo (NSRRC), Bill Weng (BNL), Li-Hua Yu (BNL), Rene Bakker (Trieste), and Jong Oh (PAL), enjoying dinner after a successful workshop.

In response to the requests of many users to study chemical science at the facility, the DUV-FEL linac is being upgraded from 200 to 300 MeV to enable the HGHG FEL to produce 100 μJ pulses of 100 nm light. This will help establish the DUV FEL as a premier user facility for ultraviolet radiation, and will enable state-of-the-art gas phase photochemistry research.

After successfully lasing at 266 nm with 800 nm laser seeding in late October 2002 [L.H. Yu et al, PRL 91, 074801-1 (2003)], experiments were carried out at the DUV-FEL to further characterize the properties of the HGHG FEL and to demonstrate its stability and controllability. The narrower spectrum and better stability of the HGHG, compared to a Self-Amplified Spontaneous Emission (SASE) FEL, were observed. Both the second and third harmonic HGHG FEL beams were experimentally characterized using a vacuum monochromator. The pulse energy for both harmonics (133 and 89 nm, respectively) was measured to be about 1 μJ, which is about one percent of the fundamental value at 266 nm.

A two-photon absorption auto-correlator with 100 femtosecond (fs) resolution was developed to characterize the HGHG output pulse length. It was experimentally demonstrated that the HGHG can produce output pulses with lengths from one picosecond down to 250 fs by varying the seed laser pulse length.

Experiments to investigate a chirped HGHG FEL were also initialized in 2003. The preliminary results are very promising, and the chirped FEL could lead to even shorter HGHS output pulses. The possibility of achieving HGHG output tuning via electron beam energy chirping was discussed by Timur Shaftan of BNL. Brian Sheehy, also of BNL, discussed various FEL output manipulation techniques and their limitations.

DUV-FEL in the Future

One of the main goals of FEL R&D at the DUV-FEL is to continue developing key technologies for a future x-ray FEL that will be based on the HGHG. For example, a cascaded HGHG and a higher harmonic (n>5) HGHG are critical for the realization of the HGHG x-ray FEL. Additionally, multi-laser electron beam synchronization and timing jitter reduction are very important technologies that will enable ultra-fast science at all future x-ray FEL facilities.

Paul Emma of SLAC discussed a technique that uses an emittance spoiler to achieve ultra-short FEL pulses. Computer simulations have shown that, by using a cleverly placed piece of slotted foil, the Linac Coherent Light Source (LCLS) at SLAC will be able to produce brilliant x-ray pulses that are extremely short – a few femtoseconds. This pulse length, which is more than 200 times shorter than the LCLS baseline design, will dramatically increase that facility's x-ray time resolution, giving scientists the ability to study the movement of matter at atomic scales and observe the structural changes that occur when chemical bonds are made or broken. To test the feasibility of an emittance spoiler at the DUV-FEL, Emma proposed a demonstration experiment. This could reduce the FEL output pulse length by a factor of four.

Beam physics during the electron-beam bunch compression was extensively discussed during the workshop. Zhirong Huang of SLAC gave an overview on microbunching instability during electron-beam compression and its impact on the future x-ray FEL. The LCLS proposes using a laser heater or superconducting undulator to mitigate microbunching instability. Michael Borland of the Advanced Photon Source discussed the latest developments in electron-beam bunch compression simulation. Experimental investigation of microbunching instability and validation of computer predictions will be the major part of beam physics R&D at the DUV-FEL.

To take advantage of the DUV-FEL's unique capabilities, other possibilities in beam physics and FEL R&D will continue to be explored, such as coherent terahertz generation and a femtosecond electro-optical bunch detector.

The workshop ended with a lively discussion on the possible future FEL and beam physics experiments at the DUV-FEL. The workshop participants ranked possible future experiments according to the following criteria:

1. What are likely critical beam physics and FEL experiments for future linac-based light sources? Can the DUV-FEL make an impact?
2. What is the best way to carry out those experiments? How can we take advantage of the unique features of the DUV-FEL?

—Xijie Wang and Laura Mgrdichian

NSLS-II Workshop Lights Brookhaven National Laboratory

March 15, 2004

On March 15, 2004, approximately four hundred registered attendees participated in the NSLS-II Workshop at Brookhaven National Laboratory to support the proposed facility, a world-leading synchrotron that will facilitate cutting-edge research in the biological, material, chemical, environmental, and physical sciences.

The current National Synchrotron Light Source (NSLS) is one of the world's most widely used scientific facilities. Each year, about 2,400 researchers from more than 400 universities, government laboratories, and companies use its x-rays, ultraviolet light, and infrared light for research. The scientific productivity of the NSLS user community is very high and has widespread impact, with approximately 800 publications per year, of which some 130 appear in so-called premier scientific journals.

Though the current NSLS has been continually updated since its commissioning in 1982, today the practical limits of machine performance have been reached. In order for the productivity of its user community to continue, and in order to tackle the 'grand challenge' scientific problems of tomorrow, plans to upgrade the NSLS are under way. The centerpiece of the proposed NSLS-II will be a state-of-the-art, medium-energy electron storage ring designed to deliver world-leading x-ray brightness and flux, more than 10,000 times brighter than the current NSLS. This facility, which will also include full-energy injection for constant intensity as well as a dedicated infrared ring, is expected to have profound impact on a wide range of scientific disciplines and initiatives and lead to many exciting discoveries in the coming decades.

Speakers at the NSLS-II Workshop at BNL included: (from left) BNL Director Praveen Chaudhari; Battelle President and CEO and current BSA Chair Carl Kohrt; Nobel Prize-winner Roderick MacKinnon of Rockefeller University; DOE Brookhaven Area Office Manager Michael Holland; DOE's Office of Basic Energy Sciences Associate Director Patricia Dehmer; Associate Laboratory Director for Light Sources and National Synchrotron Light Source Department Chair Steven Dierker; and IBM Senior Vice President and Director of Research Paul Horn.

Associate Laboratory Director for Light Sources and NSLS Chair Steve Dierker enthusiastically welcomed the workshop participants and speakers.

The NSLS-II workshop kicked off with opening remarks from Steve Dierker, the Associate Laboratory Director for Light Sources, Chair of the National Synchrotron Light Source (NSLS), and the workshop's host. "The design of NSLS-II has surpassed anything that has ever been built," said Dierker, setting the tone for the enthusiasm and interest that NSLS-II has generated. "The science that will come out of this will be very, very exciting."

Dierker then introduced the morning's first speakers: Brookhaven Lab Director Praveen Chaudhari and the Department of Energy's Brookhaven Area Office Manager, Michael Holland, who matched Dierker's enthusiasm for the days ahead. The stage was then turned over to the workshop's invited distinguished guests.

Addressing a packed auditorium, the morning speakers at the workshop – including NY Congressman Sherwood Boehlert, Chairman of the House Committee on Science, Patricia Dehmer, Associate Director of the DOE Office of Basic Energy Sciences, NY Congressman Tim Bishop, and Battelle President and CEO Carl Kohrt – praised and pledged their support for the proposed NSLS-II facility.

In addition, the two scientific speakers, the 2003 Nobel Prize in Chemistry recipient, Professor Roderick MacKinnon of Rockefeller University, and Dr. Paul Horn, the Vice President for Research and Development at IBM, gave stimulating talks that hinted at the new, exciting science NSLS-II will enable.

Their enthusiasm was shared by Boehlert, the keynote speaker, who said, "One doesn't need a degree in physics to understand the value of a scientific tool that furthers human understanding of matter while answering practical questions in materials science and biology; a tool that is of use to both academic and industrial researchers; a tool that attracts the best researchers from throughout the world."

"The U.S. simply must invest to upgrade its capabilities in this area, building on the expertise that Brookhaven and the researchers who use its facilities have developed over the last few decades," he continued.

"NSLS-II is something we need to do," Dehmer agreed in her talk. "I want you to know that I give you my commitment that NSLS-II will happen. Never doubt my resolve, never doubt your own power, never doubt the power of a great idea."

Bishop imparted a similar message. "We have such confi-

NY Congressman Sherwood Boehlert, Chairman of the House Committee on Science, the workshop's keynote speaker and distinguished guest.

dence in what this Lab can do and what the scientists in this Lab can do. And the best scientists in the world deserve the best equipment," he said.

Kohrt, who is also the Board Chair of Brookhaven Science Associates, the company formed by Battelle and Stony Brook University to manage Brookhaven Lab, also spoke enthusiastically about the new facility. "Thank you to the DOE and the visionaries that started this," he said of NSLS-II. "The journey has just begun."

But Boehlert also reminded the workshop participants of some very real issues, including the financial constraints that are involved. His main message: Nothing is certain in politics, and the realization of NSLS-II largely depends on the ability of its potential users to express why the facility is necessary. "I will do everything I can to help you, but I can't do it alone," he said. "Lawmakers need to hear from you, and especially from those of you in industry and your CEOs, why a light source, or any other piece of equipment or area of research, is important. They - we - need to learn from you what the nation will actually be giving up if you aren't able to succeed."

Patricia Dehmer, Associate Director of the Office of Basic Energy Sciences, gave an inspiring and positive speech in support of NSLS-II.

Seeming to answer this challenge, Horn gave examples of how his company would benefit from NSLS-II. In his presentation on nanoscience, Horn discussed why progress in improving the performance of silicon transistors has slowed, and how NSLS-II could open doors to new materials that may replace silicon transistors.

NY Congressman Tim Bishop spoke about the importance of NSLS-II to Brookhaven Lab and the scientific community.

The silicon transistor, Horn explained, has developed into a nanodevice. But any further miniaturization has all but halted because researchers can't solve the problem of transistor cooling. As a result, technology development companies have moved in a different direction, and are trying to gain better transistor performance without scaling them down. This involves researching new materials, which, Horn said, is where NSLS-II would step in as a valuable research tool.

"We are at a paradigm shift, where the physics that comes from synchrotrons like NSLS-II is absolutely critical," he said. "We can use x-rays to look at new materials and their features at an incredibly fine scale."

Carl Kohrt, the President and CEO of Battelle and the current chair of Brookhaven Science Associates, also offered his support for NSLS-II.

Horn hailed NSLS-II as a gateway into cutting-edge nanoscience research, a field that is expected to become a major engineering discipline that will integrate many fields – physics, materials science, chemistry, and biology – reduce the cost of manufacturing, ultimately reducing costs for the consumer, and generally revolutionize the information technology and electronics industries.

In his talk, MacKinnon also clearly explained how NSLS-II would further his work, which he said would be "impossible" with the current NSLS. He described his Nobel prize-winning research involving the structural determination of cell membrane proteins called ion channels, which was performed, in part, at the existing NSLS.

IBM Vice President for Research Paul Horn, who gave an excellent talk on how NSLS-II could help revive the silicon transistor industry.

In the meantime, however, there are still many other membrane proteins to study, which, according to MacKinnon, make up between 25 and 30 percent of all proteins. "We know almost nothing about this important class of proteins," he said, and emphasized the role that NSLS-II would play in changing that fact. "There is no other way to study these proteins at the level a synchrotron allows."

"We're behind," he added. "Our need is getting severe."

MacKinnon also stressed the importance of the facility's location in the northeastern United States. NSLS-II would service the many research institutions in the re-

Roderick MacKinnon, winner of the 2003 Nobel Prize in Chemistry, discussed how NSLS-II would enable further research on ion channels.

gion, he said, and it is essential for researchers whose work requires frequent visits to have local access to the facility.

During the afternoon, the workshop participants divided into seven breakout sessions, giving them a chance to provide input and feedback on the design and parameters of NSLS-II. The topics were spectroscopy, scattering, small angle x-ray scattering and x-ray photon correlation spectroscopy (SAXS/XPCS), nanoprobe/imaging, macromolecular crystallography, infrared, and inelastic x-ray scattering.

—Laura Mgrdichian

Cullie Sparks: In-Memoriam

March 19, 2004

Cullie Sparks, a charter member of the NSLS users group and one of the first Chairmen of the Users Executive Committee, died March 19, 2004. Dr. Sparks made major contributions to materials science, x-ray physics, and synchrotron science that continue to have a worldwide impact. He was a particularly enthusiastic supporter of synchrotron radiation and threw himself wholeheartedly into developing beamline X14 at the NSLS when the NSLS was still on the drawing board.

After earning a metallurgical Ph.D. from the University of Kentucky, Sparks joined Oak Ridge National Laboratory in 1957. In the mid 60's Sparks and his group leader, Bernard Borie, used symmetry to interpret variations in the weak so-called diffuse x-ray scattering from crystalline alloys. By quantitatively studying patterns in the diffuse x-ray scattering, they found that local structural fluctuations could be measured with unprecedented sensitivity. This early research explored the tendency for some materials to have a long-ranged average structure but with important nanoscale fluctuations about the average. Later this research led to elegant experiments at the NSLS that measured chemically specific bond distances to less than a tenth of a picometer (<0.001 Å).

Cullie Sparks aligning a sample on beamline X14.

Their Borie-Sparks method for analyzing diffuse x-ray and neutron scattering is still used worldwide to interpret diffuse neutron scattering and forms the basis for modern diffuse x-ray techniques. Research based on their pioneering work continues at major Department of Energy facilities including the Advanced Photon Source, National Synchrotron Light Source, and ORNL's High Flux Isotope Reactor.

Also in the 60's, Dr. Sparks recognized the potential of artificial graphite crystals for high-performance x-ray and neutron monochromators. He worked with researchers at Union Carbide Corporation to perfect the manufacture and performance of graphite monochromators and became the world's expert on mosaic graphite optics. By combining the natural tendency of mosaic graphite crystals to focus in the plane-of-scatter with out-of-plane focusing based on curved surfaces, he created powerful doubly-focusing crystal optics. Carbide continues to make a range of graphite monochromators that are used worldwide both for x-rays and neutrons.

Armed with a vastly more powerful way to produce intense x-ray beams, Sparks began a systematic search for inelastic x-ray scattering contributions that might have contributed background in his diffuse scattering measurements. His careful research uncovered an unsuspected resonant-inelastic scattering mechanism. Although a respected reviewer from Bell Labs, who specialized in inelastic x-ray scattering, could find no fault in Sparks' 1974 Physical Review Letters paper, the reviewer personally performed definitive synchrotron experiments at Stanford Synchrotron Radiation Laboratory (SSRL) to check Sparks' results—and verified, much to his surprise, that Sparks was correct! Resonant raman x-ray scattering or "Sparks scattering" is still widely used to study the dynamics of x-ray-induced atomic transitions.

In 1976, proton microprobe measurements on monozite inclusions with anomalously large halos in micas from Madagascar indicated the presence of primordial superheavy elements. This "discovery" reverberated throughout the scientific community, as the presence of primordial superheavy elements suggested that the earth might be only a few thousand years old, a compact atomic weapon might be made of these unusual elements, and even the shape of the nucleus might differ from standard materials.

In a crash program to settle the issue, Sparks designed the first synchrotron-based x-ray fluorescence microprobe and led a team of distinguished scientists that installed and executed the critical test at the SSRL. Sparks and his team convincingly showed that primordial superheavy elements do not exist in these micas. As a result, the U.S. and other governments avoided the enormous resources that might otherwise have been expended to understand something for which there is no evidence. This experiment clearly illustrated the critical need for intense synchrotron radiation sources.

In the summer of 1979, during a sabbatical at BNL, Sparks began studying how to focus x-rays with bent perfect crystals. He was motivated by the fact that crystals, with roughly a 20 times larger scattering angle than mirrors, can collect much larger divergences and focus them onto a sample. Although Sparks was greatly challenged by computer programming, he worked with scientists at BNL and ORNL to study ways to utilize the potential of crystal focusing. He discovered that in a nondispersive geometry, the Bragg angle of each ray reflected from a flat crystal is virtually the same off a crystal bent to focus at magnification=1/3. This discovery opened the possibility of dynamically bent sagittal focusing optics. Despite major technical challenges and a general consensus that the method could not work, sagittal focusing optics were demonstrated, paving the way

Cullie (left on banjo) and the Earsore Quartet playing at the 1985 NSLS Users' Meeting.

for beamline X14. Sagittal focusing optics are now installed in multimillion-dollar facilities around the world providing 20 times greater x-ray intensity than alternative focusing methods.

Not only were the sagittal focusing optics widely adopted by the worldwide synchrotron community, but the efficiency and flexibility of sagittal focusing optics on beamline X14 also led to numerous exciting collaborations. First or early measurements included fluorescence tomography, resonant magnetic scattering, multiple wavelength holography, anomalous powder and diffuse x-ray scattering, nuclear resonant scattering, glancing angle scattering from lipids, scattering from liquid crystals, quasi crystals, and other experiments.

In addition to his other contributions at the NSLS, in 1985 Sparks and three associates contributed the after-dinner show at the NSLS users meeting. This legendary performance of bluegrass songs with synchrotron themes was topped off with a round of authentic moonshine for those NSLS users and staff brave enough to try.

In short, Sparks was a gifted experimentalist and a good friend of the NSLS. His scientific legacy continues to this day through advanced x-ray optics, new fields of atomic physics, materials, and synchrotron science.

—Gene Ice, ORNL

New Technology Turns Dredged Material into Cement

April 7, 2004

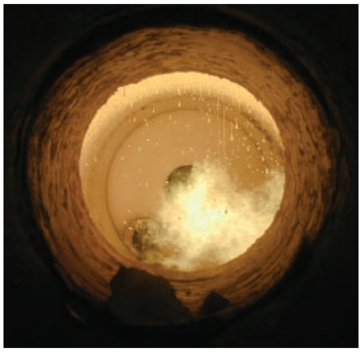
In research performed in part at the NSLS, scientists at Brookhaven National Laboratory have helped develop a new technology that converts material dredged from the bottoms of harbors and waterways into a substance that can be made into construction-grade cement. The technology, called Cement-Lock, was developed in collaboration with the U.S. Environmental Protection Agency (EPA), the State of New Jersey, and other government and public groups.

“This technology will greatly help to increase the health of many U.S. harbors and waterways, such as the Port of New York and New Jersey,” said Keith Jones, an environmental scientist at Brookhaven who took part in Cement-Lock’s development. “These waterways are contaminated by metals and pollutants from many human activities, such as sewer overflow systems and discharges from industrial operations.”

To ensure that the port can continue to service large container ships, which need deep water, it must be dredged regularly, Jones explained. But because the dredged material is contaminated, there are very strict restrictions on where and how it can be disposed of.

“This is one of several promising technologies that have the power to solve the problem of dredged material,” said EPA Regional Administrator Jane M. Kenny at an event in Bayonne, New Jersey on November 24, 2003. “It enables us to treat contaminated material and use it

The kiln in Bayonne, New Jersey



A view into the kiln as it operates

beneficially, instead of adding tons of material to landfills that are already short on space."

According to Eric Stern, the EPA Regional Contaminated Sediment Program Manager, "Sediment decontamination is a component of an overall dredged material/contaminated sediment management strategy. What sets this program apart from typical remediation is that beneficial use products – cement, lightweight aggregates, bricks, and soils – are the end result. These products then serve as economic drivers for the restoration and revitalization of impacted waterways, ports, and harbors around the entire world."

Brookhaven Lab has been involved in the development of sediment decontamination strategies since 1994, when it began collaborating on a decontamination program for the Port of New York and New Jersey, called the New York/New Jersey Harbor Sediment Decontamination Project, led by Stern. The collaboration also includes the EPA, the U.S. Army Corps of Engineers, and the New Jersey Department of Transportation (NJDOT) Office of Maritime Resources, which joined the collaboration in 1998.

Many researchers at Brookhaven Lab participated in that project, and began by performing basic research on contamination chemistry. For example, using x-rays and infrared light at NSLS beamlines U2B, X1A, X26A, and X27A, the scientists closely studied how contaminants are bound to sediment particle grains.

Brookhaven researchers also determined which experimental treatment methods would be tested and selected several technology companies to perform bench and pilot-scale tests, which can treat a few gallons and several cubic yards of sediment, respectively.

Once those test results were completed, the Brookhaven group reviewed the results and selected several treatment methods for full-scale demonstrations. As a result, Brookhaven and the EPA awarded contracts for the construction and operation of two large-scale sediment treatment facilities that can treat thousands of cubic yards of material. The Gas Technology Institute (GTI) in Des Plaines, Illinois, which developed Cement-Lock during the initial testing phases, is one of the two winning companies. GTI is an independent company that develops energy and environmental technologies.

Grains of Ecomelt

"The GTI group developed a process that can treat all types of sediment, and highly contaminated ones, in particular," said Jones, who is also the project's technical manager. "The facility has potential for use on major problem spots in the region."

GTI is now carrying out a large-scale demonstration of the Cement-Lock process with a specially constructed 10-foot diameter by 30-foot long rotary kiln melter that they built for the demonstration in Bayonne. In the process, dredged material and modifying minerals are loaded into the kiln and heated to between 2,400 and 2,600 degrees Fahrenheit, creating a molten material. The high temperature causes some contaminants in the material to break down into environmentally safe components that are vented to the atmosphere, while the contaminants that do not break down are incorporated into the melt. The resulting treated material, called "Ecomelt," is then ground to a powder and blended with cement. The Ecomelt takes part in the hardening process of concrete, which is a mixture of cement, sand, gravel, and water. Further, Ecomelt reduces the quantity of other raw materials that are typically used in cement manufacturing, such as shale.

After the testing phase, which will treat 400 cubic yards of dredged material from New Jersey's upper Newark Bay, EPA and NJDOT will work with GTI to develop a commercial kiln that can treat up to 500,000 cubic yards of sediment per year.

The research is funded by EPA, the NJDOT Office of Maritime Resources, GTI, and Unitel Technologies.

—Laura Mgrdichian

NSLS Hosts More Than 100 Children on "Take Our Sons and Daughters to Work" Day

April 24, 2004

On April 24, more than 100 BNL daughters and sons learned about some of the scientific programs at the NSLS and even performed their own scientific experiments. The one-day visit was part of the national "Take our Sons and Daughters to Work Day."

At the NSLS, the children learned that the facility produces many types of light, from microwaves to x-rays, which have many applications in many fields, including computers,

Some of the participants at the NSLS "Take Our Sons and Daughters Work Day"

catalysis, microscopes, and medicine. Synchrotron light was contrasted with more familiar forms of light as the children played a game that tested their knowledge of everyday light sources, such as laser pointers, cell phones, radios, and TV remote controls.

The daughters and sons then toured the experimental floor, where NSLS Control Room Operator Gary Weiner explained how synchrotron light is made. NSLS scientists Marc Allaire, Lisa Miller, Cecilia Sanchez-Hanke, and Vivian Stojanoff then showed the students a few x-ray and infrared beamlines, where they discovered how synchrotron light is used to study the composition of rocks and minerals and, using protein crystallography, to develop new drugs.

After the tour, the daughters and sons had the chance to perform their own scientific experiments. Marc Allaire, NSLS student Tejas Telivala, and NSLS postdoc Adele Qi Wang demonstrated the refraction of light through a prism, and each child had the opportunity to test their skills with their own prism.

The children observed the effect of vacuum on a marshmallow Peep.

NSLS beamline scientist Randy Smith showed the students how a vacuum is created using a bell jar and vacuum pump. The children observed the effect of vacuum on balloons, a bell, a candle, and soda water. But perhaps the most memorable experiment was the effect of vacuum on marshmallow Peeps candies, which dramatically expanded under vacuum, but then shriveled to half their size when re-exposed to air. Regardless, the final product was still tasty.

—Lisa Miller

2004 RapiData Crystallography Course

April 25-30, 2004

From April 25 to 30, budding crystallographers from around the world gathered at Brookhaven Lab for RapiData 2004, a week-long course run by Brookhaven's Biology and National Synchrotron Light Source (NSLS) Departments. The course introduces students to the field of macromolecular x-ray crystallography by giving them access to advanced equipment, the latest crystallography techniques, and the instruction of experienced crystallographers.

2004 RapiData Crystallography course attendees

The course, "Rapid Data Collection and Structure Solving at the NSLS: A Practical Course in Macromolecular X-Ray Diffraction Measurement," consisted of two days of lectures and tutorials taught by scientists from BNL, industry, academia, and other national labs. This was followed by a marathon sixty-hour data-collection and analysis session at the NSLS, in which the same instructors and volunteers acted as hands-on advisors. Several of the course's 48 students left with solved structures, which will likely result in publications.

The course, which helps to train the next generation of NSLS users, is mostly organized by Bob Sweet and Denise Kranz of Biology, but they emphasize that its success depends on enthusiastic help from most of the twenty members of the PXRR (the Biology and NSLS Macromolecular Crystallography Research Resource), plus a dozen or so outside teachers.

Major funding for the course was provided by the National Institutes of Health through the National Center for Research Resources, and the Office of Biological & Environmental Research within the U.S. Department of Energy's Office of Science. Additional support comes from the NSLS, as well as equipment vendors and drug companies.

—Karen McNulty Walsh and Laura Mgrdichian