BROOKHAVEN
NATIONAL LABORATORY

Brookhaven National Laboratory: Current and Future Priorities

Brookhaven National Laboratory is one of four national laboratories managed or co-managed for the U.S. Department of Energy by Battelle. Established in 1947, Brookhaven has a long, distinguished history as one of the top research labs in the nation, if not the world. Six Nobel Prizes have been awarded for work carried out at Brookhaven, the most recent being the 2003 Nobel Prize in chemistry awarded to Rockefeller University scientist Rod MacKinnon.

For over 50 years, researchers at Brookhaven have been able to successfully visualize, construct, and operate large and unique scientific facilities, then use the data generated to drive advances in many fields. Looking to the future, Brookhaven plans to continue this progress through new facilities and programs that will help in exploring the remaining mysteries of the universe.

From Colliders To Computational Biology

Many of Brookhaven's "big machines" were built to help us understand the basic structure of matter. Our Relativistic Heavy Ion Collider, for example, is helping us to see what the universe may have looked like in the first few moments after its creation. What physicists learn from these collisions may reveal more about why the physical world works the way it does, from the smallest subatomic particles to the largest stars.

Along these lines, Brookhaven has built a supercomputer (called Quantum Chromodynamics on a Chip, or QCDOC), that can help us study the "dark matter" and "dark energy" that appears to make up most of the matter in the universe. The 10,000 processors in this supercomputer each contain their own memory and the equivalent of a 24-lane superhighway for communicating with one another in six dimensions.

IBM has now modified the QCDOC architecture to develop the "Blue Gene/L" supercomputer. When completed in early 2005, IBM expects Blue Gene/L to lead the Top500 supercomputer list. It will be six times faster, consume 1/15th the power per computation and be a fraction of the cost of today's fastest supercomputers — such as the Japanese Earth Simulator.

Although originally developed to simulate elementary particles in high-energy physics, the QCDOC architecture also enables studies in the growing field of computational biology by helping scientists determine the structures and functions of proteins. Structural information will help scientists better understand proteins' role in disease, and may lead to new diagnostic tools and therapeutic drugs.

The Laboratory is collaborating with IBM and expects to develop a computational biology program at Brookhaven. Brookhaven's staff is well-suited to lead such an effort; 10 percent of our biology researchers are in the National Academy of Sciences or the National Academies' Institute of Medicine. If such a facility were located at Brookhaven, we believe researchers around the country — ranging from those at small companies to others at our partner labs, Pacific Northwest and Oak Ridge — and the nation itself would benefit.

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Work at the Interface Of Life & Physical Sciences

The intersection of scientific disciplines is often where the most significant advances in science occur. Several of Brookhaven's current and future facilities will help support research in these overlapping areas and stimulate cross-disciplinary advances.

The proposed National Synchrotron Light Source-II (NSLS-II), one of the projects in the Department of Energy's 20-year plan, is an advanced third-generation, medium-energy electron storage ring that will produce x-rays 10,000 times brighter than Brookhaven's current National Synchrotron Light Source (NSLS). The unprecedented brightness of NSLS-II will lead to many advanced experimental capabilities in a wide range of scientific disciplines including materials and nanoscience, life sciences and chemistry, geosciences, and more.

Standing next to the NSLS-II will be Brookhaven's Center for Functional Nanomaterials (CFN), one of five nanotechnology centers that have been approved by the Department of Energy. The CFN will provide researchers with state-of-the-art capabilities to fabricate and study nanoscale materials. The Center's focus is to achieve a basic understanding of how these materials respond when in nanoscale form. Nanomaterials offer different chemical and physical properties from those of bulk materials, and have the potential to form the basis of new technologies.

The juxtaposition of these two facilities would offer a unique opportunity to researchers — the ability to develop new nano-based materials at the CFN, then explore their characteristics at the NSLS-II — much as Oak Ridge will be able to use its Center for Nanophase Materials Sciences in tandem with its High Flux Isotope Reactor.

Together, the NSLS-II and CFN present opportunities for Brookhaven researchers and facility users to achieve breakthroughs at the interface of the life and physical sciences. Exploring this interface is seen as a key to future advances.

Brookhaven has historically explored this interface in other research areas as well. Our cutting-edge brain imaging work on obesity, addiction, and aging is based on the use of physical tools, like magnetic resonance imaging (MRI) and positron emission tomography (PET). Earlier research in the physical sciences led to the discoveries of the radioisotopes technetium-99m, now used to diagnose heart disease and other ailments in more than 11 million people annually, and thallium-201, now used in hundreds of thousands of heart stress tests each year. These are just a sample Brookhaven's medical discoveries; others include synthetic insulin, the use of L-dopa to treat Parkinson's Disease, and the development of gamma-vinyl-GABA (GVG, vigabatrin), a drug that holds promise as a pharmacological treatment for cocaine addiction.

Homeland Security

Brookhaven is an invaluable counter-terrorism planning and implementation resource for the New York metropolitan area, because of its proximity to New York City and the Department of Homeland Security's (DHS) Plum Island and Environmental Measurements Laboratory facilities, and its scientific and technical expertise and experience.

Brookhaven has built close working relationships with city, state, and regional counter terrorism and emergency response agencies. Brookhaven researchers have also developed an extensive portfolio of homeland security technologies in areas that include safeguarding nuclear materials; developing sensors for detection of nuclear weapons, dirty bombs, toxic chemicals, biological pathogens, and explosives; and designing tools and approaches for identifying, characterizing, and managing risk in various environments.

The Laboratory is working closely with DHS on a number of projects that aim to protect both urban and rural areas.

Working Together

While the majority of our funding comes from the Department of Energy's Office of Science, the Laboratory has reached out to other organizations to foster collaborative efforts. Brookhaven has long-standing collaborative projects with the National Institutes of Health, particularly related to addiction research.

One recent success was the construction of the joint Brookhaven/NASA Space Radiation Laboratory (NSRL). The NSRL is one of the few places in the world that can simulate the harsh cosmic and solar radiation environment found in space.

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