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When You Think of New York....  
Think Technology and Science  
Brookhaven's National Synchrotron Light Source II  
(NSLS-II) Project

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When you think of New York City and the metropolitan area non-residents characteristically think of it as a major finance hub with high-power financial brokers, Broadway theater, advertising industry and mass media, and institutions of higher educational. And, they are right. The city is home to offices of 20 of the top 25 foreign branches of international banks and five of the country's 10 largest insurance companies. New York City has 145 studios and stages and 35 radio stations. More than 200 newspapers have offices here, and 350 consumer magazines are headquartered in the city.

The city's professional services industry includes the headquarters of the 10 largest US-based consulting firms, 6 of the world's top 10 securities firms, 3 of the Big Five accounting firms' headquarters, and 219 international banks. But, the city is much more diverse. It is also home to 20,000 not-for-profit businesses of all types, has more than 10,000 manufacturing and industrial firms that employ over a quarter of a million people. The high-tech and new media is a \$9.2 billion industry in New York City alone, and it continues to grow, with approximately 4,000 companies representing that sector.

One of our clients, the US Department of Energy, has a science laboratory just over 60 miles from New York City - Brookhaven National Laboratory. Brookhaven is one of ten national laboratories overseen and primarily funded by the Office of Science of the U.S. Department of Energy (DOE), Brookhaven National Laboratory conducts research in the physical, biomedical, and environmental sciences, as well as in

energy technologies and national security. Brookhaven Lab also builds and operates major scientific facilities available to university, industry and government researchers. Brookhaven is operated and managed for DOE's Office of Science by Brookhaven Science Associates, a limited-liability company founded by the Research Foundation of the State University of New York on behalf of Stony Brook University, the largest academic user of Laboratory facilities, and Battelle, a nonprofit, applied science and technology organization.



This article spotlights on one of Brookhaven's mega projects: The National Synchrotron Light Source II Project (NSLS II)

## A Brief History of Brookhaven's NSLS Project

### Birth of the synchrotron

In 1945, the *synchrotron* was proposed as the latest accelerator for high-energy physics, designed to push particles, in this case electrons, to higher energies than could a *cyclotron*, the particle accelerator of the day. An accelerator takes stationary charged particles, such as electrons, and drives them to velocities near the speed of light. In being forced by magnets to travel around a circular storage ring, charged particles tangentially emit electromagnetic radiation and, consequently, lose energy. This energy is emitted in the form of light and is known as synchrotron radiation.

The General Electric (GE) Laboratory in Schenectady, New York built the world's second synchrotron, and it was with this machine in 1947 that synchrotron radiation was first observed. Radiation by orbiting electrons in synchrotrons was predicted by, among others, John Blewett, then a physicist for GE who went on to become one of Brookhaven's most influential accelerator physicists, working on both the Cosmotron and the Alternating Gradient Synchrotron.

For high-energy physicists, performing experiments at an electron accelerator, synchrotron radiation is a nuisance which causes a loss of particle energy. But condensed-matter physicists realized that this was exactly what was needed to investigate electrons surrounding the atomic nucleus and the position of atoms in molecules. So, in the early days, the two branches of physics worked together in so-called "parasitic" operation, where synchrotron light illuminated the condensed-matter physicists' experiments while particle physicists used the electron beam.

## **The light spectrum**

The part of the electromagnetic spectrum that the human eye can see is called visible light. In order of decreasing wavelength and increasing frequency, it is known to school children as "ROY G. BIV," for red, orange, yellow, green, blue, indigo and violet. The region with wavelengths shorter than violet is the ultraviolet and, overlapping and going beyond it, the x-ray region. Meanwhile, on the other side of red, with longer wavelengths, is the infrared region. The shorter the wavelength, the higher the frequency and the more "energetic" the light.

While it cannot be seen by the human eye, when used in certain ways and viewed by appropriate detectors, this light can reveal structures and features of individual atoms, molecules, crystals, cells and more, especially when the wavelength and corresponding energy of the light are matched to the size and energy of the sample being viewed. Because synchrotron light is very intense and well collimated, it is preferred to light produced by conventional laboratory sources.

## **Decision to build the NSLS**

When the U.S. Department of Energy's Office of Basic Energy Sciences recognized the need for "second generation" electron synchrotrons dedicated to the production of light, it budgeted construction funding for Brookhaven's National Synchrotron Light Source (NSLS), beginning in fiscal year 1978. Ground was broken for the NSLS on September 28, 1978, and the vacuum ultraviolet (VUV) ring began operations in late 1982, while the x-ray ring was commissioned in 1984.

## **The Chasman-Green lattice**

Before the light at the NSLS was turned on, however, the two inspired scientists responsible for the ingenious design of the two storage rings had died. The late Renate Chasman and G. Kenneth Green had designed the "double focusing achromat," or what is more commonly known as the Chasman-Green lattice. The lattice is the periodic arrangement of magnets that bend, focus and correct the electron beam, and their simple yet elegant design included straight sections for the insertion of equipment.

When special magnets are inserted into two straight sections in the VUV ring and five straight sections in the x-ray ring, the electron beam "wiggles" and, therefore, emits even more intense synchrotron radiation. Chasman and Green's inclusion of these devices in their design of the storage rings enables the NSLS to deliver world-class beams of light today.

## Integrated Project Teaming Approach

DOE uses an integrated project teaming approach for managing the NSLS-II Project. This Integrated Project Team (IPT), organized and led by the NSLS-II Federal Project Director, is an essential element in DOE's acquisition process and is being used during all phases of the project's life cycle. This team consists of professionals representing diverse disciplines with the specific knowledge, skills, and abilities to support the Federal Project Director in successfully executing the project. The IPT for the NSLS-II Project consists of members from both DOE and the contractor, Brookhaven Science Associates (BSA). The team membership is changing as the project progresses from initiation to closeout to ensure the necessary skills are always represented to meet the project's needs.

The IPT is grouped into three areas (Executive, Core, and Support) with specific responsibilities.

### Executive members include:

- **Patricia Dehmer**, Associate Director of the DOE SC Office of Basic Energy Sciences (BES)
- **Michael Holland**, Manager of the SC Brookhaven Site Office (BHSO)
- **Samuel Aronson**, Director of Brookhaven National Laboratory (BNL)

### Core members include:

- **Frank Crescenzo**, NSLS-II Federal Project Director and IPT Lead, BHSO
- **Joseph Eng**, NSLS-II Deputy Federal Project Director, BHSO
- **Thomas Brown**, NSLS-II Program Manager, BES
- **Steve Dierker**, NSLS-II Project Director, BNL
- **James Yeck**, NSLS-II Deputy Project Director, BNL

The Support members are involved in the daily activities of the NSLS-II Project and have functions in project management, project controls, field execution, safety oversight, and/or business operations that are integral to the NSLS-II Project. Because of the progressive and dynamic nature of the project, the personnel skill and knowledge mix will change throughout the project's life cycle.

<b>NSLS-II</b>	<b>Project</b>	<b>Schedule</b>
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Major Milestone Event	Preliminary Schedule
CD-0 (approve Mission Need)	4th quarter, FY2005

CD-1 (approve Alternative Selection and Cost Range)	4th quarter, FY2007
CD-2 (approve Performance Baseline)	2nd quarter, FY2008
CD-3 (approve Start of Construction)	2nd quarter, FY2009
CD-4a (approve Start of Initial Operations)	4th quarter, FY2012
CD-4b (approve Start of Full Operations)	3rd quarter, FY2015

**Critical Decisions**

The five Critical Decisions are major milestones approved by the Secretarial Acquisition Executive or Acquisition Executive that establish the mission need, recommended alternative, Acquisition Strategy, the Performance Baseline, and other essential elements required to ensure that the project meets applicable mission, design, security, and safety requirements. Each Critical Decision marks an increase in commitment of resources by the Department and requires successful completion of the preceding phase or Critical Decision.

**CD-0, Approve Mission Need**

The Initiation Phase begins with the identification of a mission-related need. A Program identifies a credible performance gap between its current capabilities and capacities and those required to achieve the goals articulated in its strategic plan and/or in the DOE Target Enterprise Architecture for IT capital asset projects. A Mission Need Statement is the translation of this gap into functional requirements that cannot be met through other than material means. It should describe the general parameters of the project, how it fits within the mission of the Program, and why it is critical to the overall accomplishment of the Department mission, including the benefits to be realized.

The mission need is independent of a particular solution, and should not be defined by equipment, facility, technological solution, or physical end-item. This approach allows the Program the flexibility to explore a variety of solutions and not limit potential solutions. Approval of CD-0 formally establishes a project and begins the process of conceptual planning and design used to develop alternative concepts and functional requirements. Additionally, CD-0 approval allows the Program to request Project Engineering and Design funds for use in preliminary design, final design, and baseline development.

**CD-1, Approve Alternative Selection and Cost Range**

CD-1 approval marks the completion of the project Definition Phase, during which time the conceptual design is developed. This is an iterative process to define, analyze, and refine project concepts and alternatives. This process uses a systems methodology that integrates requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration to evolve a cost-effective, preferred solution to meet a mission need. Approval of CD-1 provides the authorization to begin the project Execution Phase and allows Project Engineering and Design funds to be used. For design-build projects, Project Engineering and Design funds may be used to develop a Statement of Work/Request for Proposal. Additionally, long-lead procurements may be approved during this phase, provided National Environmental Policy Act documentation is prepared, where applicable.

**CD-2, Approve Performance Baseline**

Completion of preliminary design is the first major milestone in the project Execution Phase. Preliminary design is complete when it provides sufficient information for development of the Performance Baseline in support of CD-2. The Performance Baseline is developed based on a mature design, a well-defined and documented scope, a resource-loaded detailed schedule, a definitive cost estimate, and defined Key Performance Parameters. Approval of CD-2 authorizes submission of a budget request for the total project cost. For projects with design periods less than 18 months, a budget request may be submitted prior to CD-2 approval as part of tailoring.

**CD-3, Approve Start of Construction**

With design and engineering essentially complete, a final design review performed, all environmental and safety criteria met, and all security concerns addressed, the project is ready to begin construction, implementation, procurement, or fabrication. CD-3 provides authorization to complete all procurement and construction and/or implementation activities and initiate all acceptance and turnover activities. Approval of CD-3 authorizes the project to commit all the resources necessary, within the funds provided, to execute the project.

**CD-4, Approve Start of Operations or Project Completion**

CD-4 marks the achievement of the completion criteria defined in the Project Execution Plan and approval of transition to operations. This decision is predicated on the readiness to operate and/or maintain the system, facility, or capability. Transition and turnover does not necessarily terminate all project activity. Rather, it marks a point at which the operations organizations assume responsibility for operation and maintenance.

All projects must have a project transition/closeout plan that clearly defines the basis for attaining initial or full operating capability or meeting performance criteria as required for project closeout, as applicable. The key attributes in turnover are the Government's readiness to operate, the ability to assume operational responsibility, and the acceptance of the asset.



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