

# National Synchrotron Light Source II

## Project Progress Report

May 2012



Photo early on May 31 shows exterior finish work underway at Lab–Office Building 2. Most Project activity is indoors.

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**Steve Dierker**  
NSLS-II Project Director

**Brookhaven National Laboratory**  
Upton, New York 11973



## OVERALL ASSESSMENT

The National Synchrotron Light Source II Project continued to make excellent progress with satisfactory cost and schedule performance. The cumulative cost and schedule indices are 1.0 and 0.95, respectively, both well within the acceptable range. At the end of May, the Project was 77% complete with 43% of contingency and management reserve for the remaining Budget at Completion (BAC).

While the overall safety performance for the Project continues to be satisfactory, a beam miss-steering excursion occurred during the linac commissioning. Although no personnel exposure or equipment damage occurred, a causal analysis team has been appointed to conduct a thorough review and formulate complete corrective action items. Initial corrective action items have been identified and are being implemented. Linac commissioning activities have been and will continue to be significantly limited until corrective actions have been satisfactorily implemented.

The conventional construction continued to be on budget and slightly ahead of schedule. The ring building contractor continued to work on punchlist items. All five of the lab-office buildings (LOBs) continued to make excellent progress.

Healthy progress continued for the accelerator systems, resulting in a positive schedule variance of \$1.5M (schedule performance index of 1.27) in the month of May. The production and installation of magnets, booster, vacuum, RF, power supplies, and cryogenic systems continued to make excellent progress. Installation of booster components is progressing as scheduled and magnet production and magnet-girder integration and installation continued to meet goals. In total, 53 magnet girders are now installed in the storage ring tunnel. The design reviews for the in-vacuum undulators were successfully held.

Good progress continued with hutch installation at the ring building experimental floor. The walls and roof of the CSX hutch are in place and the doors and other elements inside the hutch are being installed. Installation of the HXN hutch has started, and procurement work for the Project beamline components continued. Mitigation actions for the schedule delays in hutch installation and beamline component procurements are being formulated.

The early completion date remains at June 2014, with 12 months of schedule float in respect to the Project's CD-4 milestone date. The schedule refinement for accelerator and beamline installation will continue over the next few months.

Activities funded by ARRA (American Recovery and Reinvestment Act) are now more than 97% complete and continue to be on schedule and on budget.

## UPCOMING EVENTS

FMB-Oxford Preliminary Design Review (PDR) Part 1	Jun 13
FMB-Oxford Preliminary PDR Part 2	Jun 21
Associate Lab Director (ALD)'s Status Review-ABBIX Project	Jun 26-27
ALD's Preliminary Design Review of NEXT Project	Aug 7-9
DOE CD2 review of NEXT Project	Sep 11-12

## ACCELERATOR SYSTEMS

**Injector.** Linac commissioning is nearing completion. Acceptance testing is planned for the third week of June. These are the demonstrated beam parameters at the end of May:

- Energy >200 MeV
- Energy spread <0.5% rms
- Emittance 70 nm rad
- Charge single bunch: 0.5 nC, multi-bunch 12 nC

An unforeseen combination of linac parameters caused an unexpected radiation dose in a controlled part of the booster tunnel. For more information, see the paragraph at the left of this one or the "Environment, Safety and Health" section of this report (p. 6).

Magnetic measurements of the dipole magnets at BINP are now complete. About half of the magnet girders have been received at BNL. All power supplies for the quadrupole, sextupole, and corrector magnets have been received. Most of the supplies needed a small modification to meet code, which was done prior to installation. A new booster schedule was established, with the Accelerator Readiness Review to be during the first week of Dec 2012 and beam commissioning in Jan 2013. The schedule was communicated to, and agreed upon by, BINP. The installation of booster components is progressing very well. The first unit of the storage ring injection kicker has been built and testing of the unit has begun.

**Magnets and girders.** The quadrupole production lines at BINP and Buckley are complete and the remaining units are being shipped to BNL. The first article for the 30 corrector magnets with the modified skew quadrupole coil has been delivered to BNL. The sextupole production at Buckley is completed as well. IHEP has completed the final units, which will be shipped in June to BNL. Dipole production has reached 11 units per month and is proceeding without technical issues. The quadrupole production at Tesla is somewhat slower than planned but able to keep track with magnet girder production. Fifty-three girders had been installed in the tunnel by the end of May.

**Power supplies.** The testing of power supply components is ongoing. The 24 first-article units of the DC corrector power amplifiers have been delivered and tested. Some assembly errors were identified and communicated to the manufacturer before full production could begin. To speed installation we have elected to repair the early units in house.

All one-wire interface chassis have been delivered. A simple test system and final traveler have been finished. Testing of the three units that are needed for a cell takes less than a day. Work continues on the new thermistor-based 1-wire temperature monitoring system. Pre-production sensors have been delivered and prototype boards are in-house awaiting assembly.

The AC input modules for 75% of the storage ring have been modified with the new interface board and have been tested. The last procurements for interconnection cables, harness, and mounting hardware are being finalized. Initial pre-production procurements are being used to work out the

final design for interconnection cables. We used these procurements for cell 25 cables. Purchase orders have been submitted for the full complement of storage ring cables. The new rear panels that interface to the magnet thermal switches have been awarded to a vendor. Some production cables have started to come in; in another month the bulk of interconnection cables will be in full production. In the meantime, we fabricate any necessary cables.

Power supply installation work continues in pentants (P) 1 and 2. This involves installing shelves, brackets, and power converters. We have finished installing all components needed for cells 25 and 26. Electrical installers are finishing cell 26 interconnection cables. We are working on cells 23 and 24 as components become available. The new test station gauge in building 740 is nearly operational.

**Electrical utilities.** All cable trays for the booster have been installed except for the tray to be mounted on the girder. The tray for the booster RF is finished in the service building. The second uninterruptible power supply for the injector complex has been installed. Cable pulling is finished for the tray on the inside wall of the booster tunnel. We optimized the design of the tray and cables for the low voltage cables to make better use of available space. Electricians have finished installing AC power in P3 and the PPS conduit for P2. We have added another crew to the storage ring work as the injector work wraps up. All temperature control chassis (“low-precision”) units have been delivered and tested. The first article for the high-precision temperature controller chassis (for BPM racks) also has been received and tested.

**Insertion devices.** All pole modules for the first-article damping wiggler (DW) have been assembled with side magnets, and sorting of main magnets is well underway.

Testing of the control systems for all DWs has been completed. Assembly of the remaining production DW units is progressing well; they are expected to ship from Nortemecanica to Danfysik in June. Danfysik reports that the final measurement will take place the first week of July.

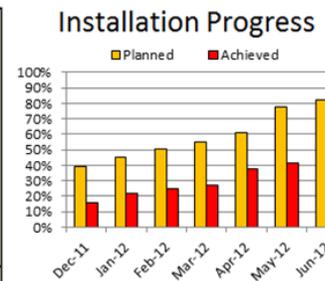
The final design report for the in-vacuum measurement system has been approved, and fabrication has begun. Punchlist items for the integrated field measurement system have been resolved by ADC engineers. Seal tests of the 4 m vacuum chamber continue, with a high-temperature bakeout test. The preliminary design reviews for IVUs 20 and 21 are scheduled for early June. The conceptual design review for IVU22 (the device for the Inelastic X-ray Scattering beamline, IXS) was held with Danfysik.

**Vacuum.** Fifteen Day-1 straight section chambers were received from the Advanced Photon Source; six were assembled and tested. Eight multipole girders and three dipole girders were completed, baked at the 902 Annex, and installed in the tunnel. Cell 29 vacuum assembly is completed and is being checked for leaks. The drift pipe drawings for the BST and the booster RF straight were released to BNL Central Shops for an estimate. All 22 booster girder chambers were assembled with ion pumps and vacuum tested. The undulator absorber drawings were sent to Central Shops for fabrication. More than 60% of the flange absorbers, 20% of the stick absorbers, and 10% of the crotch absorbers are in house and

undergoing inspection. All RF bellows housings have been received, and the internal fingers and sleeves are at various stage of fabrication. All high-voltage booster-rack cable terminations are installed. Most vacuum cables for P1 and P2 have their tunnel-end terminations in place.

**Installation** of magnet girders in the first quarter of the booster tunnel was completed. The booster RF transmitter is nearing completion. All installation of cable trays and cable in the booster tunnel is complete. Equipment enclosures have been installed in P4. AC cabling in P3 is complete and AC cabling in P4 is well underway. Vacuum installation on the mezzanine was completed in P2 and is under way in P3.

	Mar-12	Apr-12	May-12
Mechanical Utilities	50%	58%	59%
Electrical Utilities	49%	73%	81%
Magnets	42%	43%	50%
Vacuum	11%	13%	15%
Power Supplies	11%	12%	15%
Instrumentation	20%	23%	27%
Frontends	0%	0%	0%
RF	14%	31%	27%
Inje Straight	0%	0%	0%
LINAC+Booster	10%	16%	30%
Total	27%	37%	42%



**Integrated testing.** After completion of vacuum components in tunnel cells 27 and 29, the vacuum system in these cells was pumped and leak tests have been performed.

## Experimental Facilities

The month of May was very busy, with the NSLS-II Users’ Meeting, a review of NSLS-II Operations plans, and our first beamline components Final Design Review, for HXN. Installation work on the CSX optics hutch is progressing well with finishing tasks in progress. Work has commenced on the HXN hutches.

**CHX.** The CHX team worked with the contractors on the two major procurements already awarded, the optics package and diffractometer, making sure that the projects stay on schedule. The team worked on several other procurement packages, including a high precision positioning system for an optical table and a focusing system (the “transfocator”) using beryllium compound refractive lenses. The first CHX Beamline Advisory Team (BAT) meeting of 2012 took place May 10, with all BAT members onsite. Discussions focused on establishing and prioritizing experimental capabilities needed for the early science program of the beamline.

**CSX.** The walls and roof of the CSX FOE hutch are in place. The final CSX optical components packages, for M1A and M3B mirror mechanics, were solicited; responses are expected in June. The monochromator package has been awarded and the contract was signed. Two more procurement packages, for toroidal mirrors and the bendable mirror evaluation, are close to being finalized. The beamline team is preparing the procurement packages for different non-optical beamline components, such as vacuum component, detectors, and diagnostics.

**HXN.** The HXN team received the final design report for the beamline component package from FMB-Oxford in the second week of May, and held the final design review (FDR) meeting for three days in the final week of May. Four technical BSA panels (beamline team, engineering & quality assurance, safety, and radiation safety) were formed and reviewed the final design package, logging minor comments. The Contractor will submit a revised design report in June.

**IXS.** Contract negotiation for the IXS KB mirror system proceeded well, resulting in a 4-month improvement of the delivery schedule. The contract is expected to be awarded in June. The specification and statement of work (SOW) documents for the IXS spectrometer are in final review by procurement staff, with release for proposals expected in June.

The IXS team completed another successful test run of the high-resolution optics at PETRA III (Fig. 1). The ultrahigh resolution trapezoidal flexure stages designed for the IXS 4B monochromator were tested for angular stability and repeatability during energy scans; the yielded angular repeatability of 70 nrad corresponds to an energy width of 0.2 meV. The total energy resolution of the 4B-CDW as measured was improved to less than 0.9 meV. Tests involving the multilayer collimating mirror were not possible due to insufficient flux density at the PETRA III beamline. The IXS team plans to perform the test after the PETRA III team has installed a pair of focusing mirrors at the beamline to improve flux density.



Figure 1. meV IXS prototype system setup installed at PETRA III P01 beamline.

**SRX.** Teleconference discussions with Bruker-ASC and WinlightX have begun regarding progress in the design process for the optics package and the KB mirror system, respectively. The NSLS-II Users' Meeting presented a forum for discussions with vendors about stages, detectors, and the necessary laser interferometers. In parallel, experiments aiming for early science studies with SRX have been performed at the Advanced Light Source in Berkeley and at the ESRF in Grenoble, France.

**XPD.** Weekly teleconference meetings are taking place with the prime Contractors for the double Laue monochromator, beamline components package, and vertical focusing mirror. The SOW and specification for the XPD diffractometer have been sent to the procurement office.

The XPD scientific staff and representatives of COMPRES went for a tour and inventory of the high pressure equipment at NSLS X17. The XPD staff and BAT held a one-day meeting on May 10. The agenda included presentations and discussions on installation and commissioning, the beamline readiness plan, an update on side branch and X17A operation, high pressure planning, baseline sample environments, detectors, software, and early science planning.

**Optics fabrication.** An extensive series of multilayers were grown to characterize the effects of differing nitrogen concentration during reactive sputtering. Twenty multilayers were grown, from 0% nitrogen to 20%, in 2% increments—two growths at each nitrogen concentration to unambiguously extract growth rate information for each material. Following this effort, an examination of film stress versus nitrogen concentration will be investigated, to select the optimum parameters for the next multilayer Laue lens growth series.

Optical pitch, CMP slurry, new pads, and a series of other consumables have been delivered to begin pitch polishing of the silicon crystals. The pitch polishing setup is underway.

A Technology Maturation proposal titled “Monolithically mounted multilayer Laue lens as a complete x-ray nano-focusing optic” was submitted.

## CONVENTIONAL FACILITIES

Conventional construction continued its excellent progress during May as the first lab-office buildings (LOBs) are nearing substantial completion and readiness for occupancy, while the ring building punchlist work is drawing down. LOBs 1 through 3 are slated for beneficial occupancy reviews in late June. The ring building contractor has completed basic contract work and is working on punchlist items, moving toward contract closeout.

With all areas of the ring building now occupied, the ring building contractor has completed the major work scope. All areas slated for the installation of accelerator equipment have been accepted from the contractor and are now being utilized for installation activities or staging and storing equipment and materials as they are readied for installation. The remaining ring building contractor work includes resolution of all punchlist items, completion of system commissioning and operator training, delivery of remaining operations and as-built documents, and final sitework. Following the completion of all physical work at the site, demobilization and contract closeout will commence. It is anticipated that the ring building contractor's site presence will end by July 2012, although they will be available for any warranty work.

Construction of the five LOBs continues to progress. LOB 1 activity is focused on completion of the exterior siding system, commissioning of mechanical and electrical systems, training O&M staff on equipment operation, and completion of interior finishes in preparation for beneficial occupancy in June (Fig. 2). Office area finishes and flooring work are nearly completed, Laboratory furniture is being installed, and building plumbing and HVAC are ready for operation.



Figure 2. The kitchen area of LOB 1 is ready for appliances.

LOB 3 is slated for full fit-out next, and is progressing right on the heels of LOB 1. The building exterior envelope is nearly complete except for the HXN area, where sheathing is in place and siding installation is still underway. Interior finish work is advancing quickly, as the office areas are nearing completion (Fig. 3), mechanical/electrical and plumbing (MEP) are being commissioned and ready for use, and interior finish of labs is underway.



Figure 3. Built-in furniture in LOB 3, nearly ready for beneficial occupancy.

LOB 2 follows, with roofing, sheathing, and glazing completed and exterior siding nearly complete. Interior partitions and MEP are well advanced and nearly completed. In LOB 4, steel and concrete are complete; interior partition work, mechanical, and electrical work are in progress. In LOB 5, steel and concrete are complete, with roofing and sheathing in progress and interior partition work just getting underway.

Sitework for the LOBs continues to make rapid progress (Fig. 4). Application of the final paving course for the parking lots will begin in June. Finish grading of areas disturbed by LOB construction is now underway, and application of top soil and seeding will begin in June. Much of the sidewalk and curbing work has been completed. Final grading, spreading of top soil, and seeding of areas around the LOBs is now in progress. Areas of finish grading and seeding for the ring building that were impacted by LOB construction will be

finished by the LOB contractor this summer, bringing all site work to completion under the LOB contract by early fall.



Figure 4. Exterior siding is complete at LOB 1. Landscape seeding awaits.

The LOB workforce has been at peak activity levels, with all trades working to varying degrees in each LOB. With completion and beneficial occupancy of LOBs 1, 3, and 2 imminent, the workforce on the site will begin to diminish after June, until LOBs 4 and 5 are completed by the end of December 2012.

The coordination of work between the ring building and LOB contractors, with accelerator installation also underway, continues to progress well with minimal interference or disruption. Any work performed by the contractors in occupied areas is managed by a work permit system, to ensure safety of the workers and minimize potential disruption of the ongoing accelerator installation work.

## COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) for the overall Project is 1.0 and the cumulative Schedule Performance Index (SPI) is 0.95, both well within the acceptable range. The Project is 77% complete, with 38% of contingency and management reserve, based on EAC (estimate at completion) work remaining.

The Project's current-period schedule variance is green, with a current-month SPI of 1.00, \$74K, due to very positive performance in Accelerator Systems (AS), with continued deliveries of storage ring (SR) magnets, positive performance in the damping wiggler insertion device components, and positive performance in the SR RF component fabrication.

Accelerator Systems' schedule performance for the month was positive, with a schedule variance of +\$1.5M and SPI of 1.27. The cumulative AS schedule performance has continued to improve, with a schedule performance index of 0.88, (-\$28.5M), down from (-\$30M) in April. This continues an upward/positive trend. The schedule performance improvement in AS is due to increased production magnet deliveries and progress on SR components.

The cumulative Experimental Facilities (XF) beamlines' schedule performance continues to trend downward, with a cumulative schedule performance index of 0.90 (-\$2.5M), compared to 0.91 in April. The schedule performance trend is

down from previous months due to delayed delivery of the HXN and CXS hutches. The CXS mirrors have also incurred delivery delays, contributing to the negative current-period XF schedule variance of (-\$451K).

Conventional Construction activities have a negative schedule variance for the month of May 2012, with a schedule performance index of 0.88 (-\$721K), due primarily to work completed ahead of schedule in the ring building contract and a small negative schedule variance for LOBs 2 and 4. However, on a cumulative basis, performance for all LOBs is on or ahead of schedule and the cumulative Conventional Construction schedule is ahead of plan with a schedule performance index of 1.00, at \$1.0M.

The Project-level cumulative cost variance is 1.00 CPI, \$1.8M—green status. The current-month CPI for the Project also is green, at 0.95 (\$-747K).

The critical path for the Project remains the same as last month and goes through the installation of power supplies and instrumentation in the racks. The critical path continues through EPU installation, integrated testing, final survey, and commissioning of the Accelerator Systems. The early Project completion date remains at June 2014, which is consistent with the baseline schedule. There are 12 months of float between the Project's early completion milestone and CD-4, with approximately 32% schedule contingency.

## NEWLY HIRED

There were no new hires in May.

## ENVIRONMENT, SAFETY, AND HEALTH

Beneficial occupancy readiness evaluations (BOREs) have begun for the Lab–Office Buildings, beginning with LOBs 1, 2, and 3, which are expected to have occupancy in July and staff moving in by the end of August. LOBs 4 and 5 will be completed in the late-December time frame. The BORE process will ensure that all life safety and code compliance requirements are in place prior to staff occupying the LOBs. Work to close out the remaining post-occupancy items from the ring building continues and is nearly complete.

A beam miss-steering excursion occurred at the linac on May 29. During commissioning activities, the combination of linac electron beam energy and the power supply setting for the dipole bending magnet were such that the resulting beam path extended beyond the downstream shadow shield width and struck the linac shield wall. This resulted in elevated radiation in a radiation-monitored, controlled area within the booster enclosure. No personnel exposure or machine damage occurred. This excursion is under investigation by a causal analysis team. Linac commissioning activities have been and will be continue to be significantly limited until corrective actions have been satisfactorily implemented.

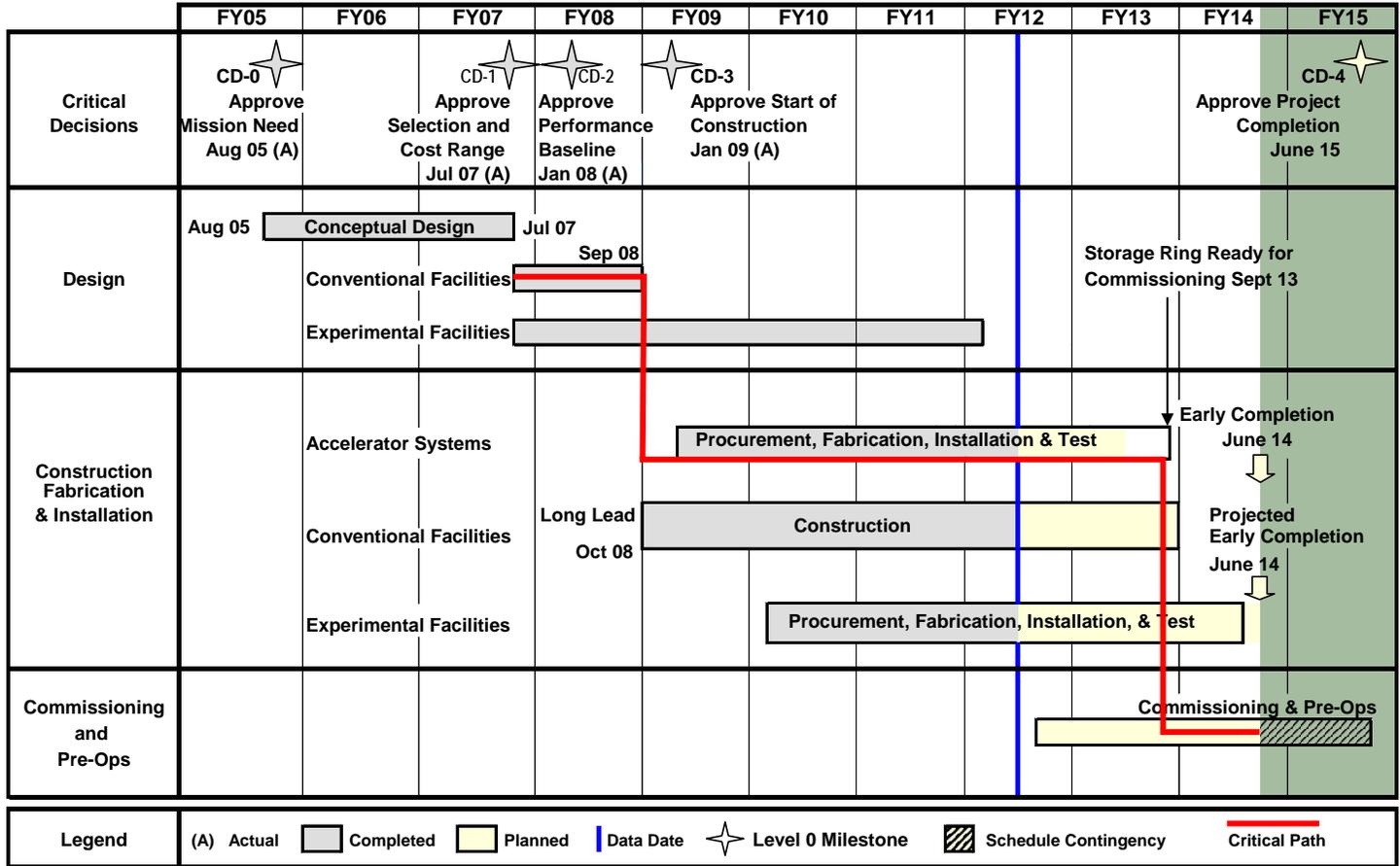
Construction activity continues to wind down, as the ring building is complete and LOBs 1 to 3 are essentially complete. The focus of construction is now at LOBs 4 and 5 and on finished site work. Increased emphasis is being given to safety as the contractor demobilizes. Historically, this phase of a construction project results in increased injuries and claims. Enhanced communications and job planning are being implemented to minimize this risk.



Figure 5. Doors open to the future.

The NSLS-II Project is being carried out to design and build a world-class user facility for scientific research using synchrotron radiation. The project scope includes the design, construction, and installation of the accelerator hardware, civil construction, and experimental facilities required to produce a new synchrotron light source. It will be highly optimized to deliver ultra-high brightness and flux and exceptional beam stability. These capabilities will enable the study of material properties and functions down to a spatial resolution of 1 nm, energy resolution of 0.1 meV, and with the ultra-high sensitivity necessary to perform spectroscopy on a single atom.

DOE Project Milestone Schedule



Funding Profile

Funding Type	NSLS-II Funding Profile (\$M)											
	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	TOTAL
R&D			3.0	20.0	10.0	2.0	0.8					35.8
OPC	1.0	4.8	19.0									24.8
PED			3.0	29.7	27.3							60.0
Construction					216.0	139.0	151.3	151.4	47.2	26.3		731.2
Pre-Ops							0.7	7.7	24.4	22.4	5.0	60.2
<b>Total NSLS-II Project</b>	<b>1.0</b>	<b>4.8</b>	<b>25.0</b>	<b>49.7</b>	<b>253.3</b>	<b>141.0</b>	<b>152.8</b>	<b>159.1</b>	<b>71.6</b>	<b>48.7</b>	<b>5.0</b>	<b>912.0</b>

The NSLS-II Project Progress Report is prepared monthly for submission to the Department of Energy. This condensed version is available to the public at the NSLS-II website in PDF format. For questions or comments contact the editor, Kathleen Robinson, at [krobinson@bnl.gov](mailto:krobinson@bnl.gov), or via mail at: Room 37, Bldg 830M, Brookhaven National Laboratory, Upton NY 119873.