National Synchrotron Light Source II

Project Progress Report

August 2012

Early on August 30, landscape prep is underway northwest of LOB 5.

report due date:
September 20, 2012

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BROOKHAVEN NATIONAL LABORATORY

OVERALL ASSESSMENT

The National Synchrotron Light Source II Project made good progress in August, maintaining its satisfactory cost and schedule performance with cumulative cost and schedule indices of 1.0 and 0.95, respectively. At the end of August, the Project was 81% complete with 46.4% of contingency and management reserve for the remaining Budget at Completion, or 38.4% of contingency and management reserve for the remaining Estimate at Completion.

Conventional construction continued to wind down, as three of the Lab–Office Buildings are essentially complete and LOBs 4 and 5 are expected to be completed by the end of this year. Conventional construction continued to be on budget and on schedule, but due to work previously completed ahead of schedule, the current month schedule performance index for conventional construction was reported as 0.70.

Monthly schedule performance for both accelerator systems and experimental facilities showed significant improvement, with schedule indices of 1.03 and 1.16, respectively. Together with conventional construction, the monthly schedule performance index for the overall project was 0.95.

The production and delivery of major contracts including magnets, booster, power supplies, vacuum, RF and cryogenic systems, superconducting RF cavity, and insertion devices continued to make excellent progress. Installation of the booster and storage ring continued to meet goals. All arc magnet girders are now installed and aligned in the booster tunnel and a total of ninety-three magnet girders are installed in the storage ring tunnel. Linac maintenance work was completed while corrective actions from the beam mis-steering excursion event are being formulated and implemented. With an emphasis on heightened safety awareness, some installation activities are being stretched out.

Excellent progress continued with major procurements for beamline components, and a number of successful design reviews for various fabrication contracts were conducted in August. Installation of the hutches was temporarily halted while some safety issues are being addressed.

June 2014 remains the early completion date, with 12 months of schedule float (35% schedule contingency) with respect to the Project's CD-4 milestone date. The schedule refinement for accelerator and beamline installation and the annual project-wide comprehensive Estimate at Completion review continued.

Activities funded by the American Recovery and Reinvestment Act are now more than 99% complete and continue to be on schedule and on budget.

UPCOMING EVENTS

Final Design Review for XPD Beamline Components	Sep 4–7
DOE CD2 review of NEXT Project	Sep 11–12
Rock and Cell Workshop	Sep 17–18
Preliminary Design Review - M3A	Sep 20–21
Preliminary Design Review – CSX Monochromators	Sep 25–26
NSLS-II Beamline Science Readiness Planning Review	Oct 25–26
DOE mini-Review of NSLS-II Project	Nov 19

ACCELERATOR SYSTEMS

Linac. Maintenance work in the linear accelerator was completed. High-power conditioning of RF accelerating structures after venting was postponed.

Booster. All arc magnet girders are installed and aligned. All dipoles cables have been terminated. The quadrupole cables are being trimmed to length and will be terminated soon. The second large main power supply for the booster's combined-function magnets has been delivered. The first booster arc-section was evacuated and vacuum conditions were satisfactory, with no detectable leaks.

Kicker testing is complete. Several of the kickers and kicker pulsers have been moved to Bldg. 740. Testing of septa is ongoing and there are no issues. The first (injection) septum has been tested and found to be vacuum-tight. The booster magnets will be shifted slightly to match the storage ring circumference.

The booster orbit correction procedure and software are being finalized. The algorithms were tested and simulated successfully.

The Agreement on Coordination and Safety of Joint BNL – BINP Activities on booster installation, testing, and commissioning was signed and sent to BINP.

Transport lines. Installation of the linac-to-booster transfer line began in the booster. A work planning meeting was held to define the reconfiguration of the lead bricks in the shielding wall of the linac cave. The permit is being circulated for approvals. There are no issues with the magnet delivery from Stangenes (see status table below). Quadrupole magnets have been measured and analyzed, and there are only minor issues. Transfer line support tables have been delivered to Bldg. 740.

Table 1. Stangenes magnet delivery status.

Magnet type	Required for booster commissioning	Delivered	Being measured	On route to BNL
LBT 48mm dipoles	2	3	2	
LBT 52mm quads	8	10		
BST 52mm quad	9	5		4
BST 35mm dipole	2		1	1

Injection straight. The detailed design meetings for the storage ring injection straight section are progressing as planned. An internal final design review is planned for October. Work on kicker waveforms is ongoing. Full kicker voltage has been achieved. The conclusion so far is that the RMS jitter of the kicker amplitude is 0.5%, within expected values. The pulser board was tested for jitter at the working current and voltage and the jitter has been measured in sub-nanosecond time frame. Testing of the sample ceramic vacuum chamber is complete with the result that the coating yields a field waveform reduction of 8%. The functionality of the kicker control board has been tested successfully.

Vacuum. All thirty-nine long straight-section chambers were received, assembled, baked, and are ready for installation. Straight-section chambers at cell 26 were successfully

installed. Cells 24 and 29 were assembled, baked, and reached 10–11 Torr. Assembly of cell 04 has started. Development of RF straight layouts has begun. All booster-arc vacuum chambers were connected and the ion pumps installed. The installation of booster straight section chambers has started (Fig. 1).

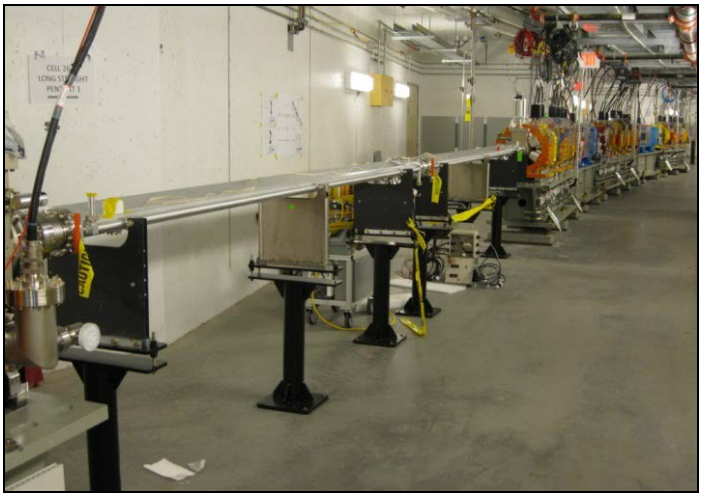


Figure 1. First installed straight section chamber.

At BNL Central Shops, the booster-to-storage ring transfer line B3 bending magnet chamber has been completed, the production of crotch absorbers and undulator absorbers continues, and fabrication of the B4 bending magnet chamber and drift pipes has begun. The order for damping wiggler absorbers has been placed with Hi-Tech in Chicago. The injection kicker ceramic test chamber was measured with a 4-point probe and had a 1 μm-thick titanium coating, thus meeting the acceptance requirement.

The **RF** group continued efforts to obtain approval for the liquid helium and liquid nitrogen distribution plants from the BNL Safety Committee. Low-power testing of the booster RF cavity in the blockhouse of the RF Bldg. was completed and high-power testing started.

Power supply installation was completed for pentant 1, and installation is well advanced for the booster-to-storage ring transfer line. The last power supply production line, the so-called DC-powered amplifiers (for corrector magnet polarity switching) is proceeding well.

Insertion devices. The first article damping wiggler has been shipped, along with the first pair of racks, cabling, and ancillary components. The equipment is expected at BNL on October 3, 2012. Acceptance will require several tests and measurements onsite, per the SOW. The Acceptance Test Plan for all damping wigglers has been reviewed and edited.

The mechanical, electrical, and controls part of the first elliptically polarizing undulator unit is completed and tested at the manufacturer's facility. A preliminary design review for the EPU vacuum chamber was held with the supplier, FMB Inc.; several issues have been raised and resolved.

A draft final design review report for SRX-IVU and U20-IVU has been received. The final design review will be held at BNL in late September. The SRX requires colder cooling water than is typical. Design work is underway to incorporate a heat exchanger that will use processed chilled water.

The request for quotes for the canting magnet was prepared and sent to three potential U.S. bidders.

The company ADC has characterized and assembled the six permanent magnets for the damping wiggler to be inserted into the three-pole wiggler. ADC brought their 3PW, which had been constructed for the original magnets, to BNL for fit-up on the girder. A misalignment of that 3PW with respect to the girders and a need for adjustment relative to the base plate were identified (horizontal adjustment screws are bottomed out on the even cell configuration). These issues have been corrected in the design and the new design was approved.

Magnets. Magnet production for the NSLS-II storage ring is coming to an end. The double-coil quadrupole and the 35-mm dipoles are the last production lines still active. All remaining magnets will be completed in September 2012 and the last shipment is expected to be received in November 2012. Seven hundred twenty-one of the 826 storage ring magnets have been received. Fast corrector first article coils and mountings are complete and inspection by the electrical group is underway.

Magnet-vacuum girder integration. By the end of August, twenty-six dipole girders and sixty-seven multipole girders had been installed in the accelerator tunnel. The magnet girder installation is complete in pentant 1 (Fig. 2) and is well advanced in pentants 2 and 3. High-precision alignment of multipole girders continues, with two girders aligned per week. All floor plates are grouted and installed except those in front of the large door in pentant 4. All girders have been delivered.

Figure 2. Magnet girder installation in pentant 1.

Instrumentation. BNL Central Shops has fabricated the remaining strip line electrodes, tapered chamber components, and beam position monitor chamber components. We have received the chambers for the tune monitor strip lines, and secondary supports for the strip line chambers have been fabricated. The synchrotron radiation protection issue for the BPM chambers and absorbers needed in C16 has been settled:

the absorber will be set at 20 mm from beam centerline. Detailed drawings for this chamber will be released by the end of September.

High-stability BPM stands and chambers are in progress. The Invar delivery for the stands is due at the end of September. The procurement of all synchrotron light monitor components is 90% complete; we have received roughly 20%.

Hutch procurement is progressing steadily and the vendor is compliant with our requirements. The procurement documents for the X-BPM head have been drafted and the vibration test on the prototype assembly has been completed. There was significant amplification in the horizontal direction. The SR flag design is complete and detailed drawings are being prepared. Drawings for the brazed chamber should be released shortly. Two vendor drawings for the YAG screen and custom bellows are in progress.

A new type-N feed-through has been fabricated to replace the damaged BINP Faraday Cup. The copper center conductor has been repaired and features are being added to the tail end to accept the center conductor of the feed-through. We will be performing final assembly as soon as we get the copper center conductor back from Central Shops. It will then be sent back for a welding procedure, after which it will be ready.

Front ends. The photon shutter bodies are machined and being prepared for brazing. All ray tracings and mask bodies are released. All safety shutters are released or in final checking. All front-end top assembly drawings are in process. Invar stands for XY-slits on all front ends are in process.

Mechanical utilities. Storage ring tunnel deionized water headers are complete. The thirteen pump skid systems are 60% complete and are expected to be completed by the end of the calendar year.

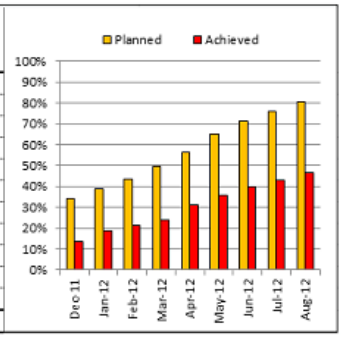
Controls. Remote controls were developed for the booster and storage ring transmitters and for the master oscillator. Work to develop controls for the LLRF board continues. Alarm system controls for the radiation monitors in the booster and linac areas were tested and commissioned, including audible alarms in the control rooms. The commissioning of ICT, including soft interlock with the electron gun to limit total charge per second, is completed as well as commissioning of the fast current transformer, flags, and energy slit in the linac and phase 1 of the linac to booster transfer line. The network infrastructure and timing systems for pentant 1 were provisioned, installed, and tested. All network infrastructure for pentant 1, the linac, and the transfer line is ready for operations. The input-output controller and network servers in pentant 1 are complete.

Installation. The magnet girder installation in pentant 1 is complete. In total, ninety-three multipole and dipole girders (close to two-thirds) are installed in the accelerator tunnel. The installation of booster arc girders is complete. Pentant 1 power supply installation is done, and overall, 21% of the power supplies are complete. Installation of the second part of the linac-to-booster transfer line has started. Table 2 shows an overview of installation progress.

Table 2. Installation progress as of August 2012.

NSLS-II Accelerator Installation Progress

Achieved	Mar-12	Jul-12	Aug-12
Mechanical Utilities	43%	50%	51%
Electrical Utilities	37%	69%	72%
Magnets	42%	65%	68%
Vacuum	7%	14%	15%
Power Supplies	11%	22%	27%
Instrumentation	20%	38%	36%
Frontends	0%	0%	0%
RF	14%	33%	35%
Inje Straight	0%	0%	0%
LINAC+Booster	9%	42%	55%
Total	24%	43%	46%



Experimental Facilities

During August, active project management of contracts continued, including the preliminary design review for the CHX optics package. Work continues with the XPD hutches. The CSX and HXN optics hutches are awaiting modifications to the hutch doors prior to completion; this is now scheduled for late September since work was temporarily halted due to contractor concerns over lead contamination. Safety concerns over the use of emergency egress ladders from hutch roofs were addressed and stairs will now be used as an alternative. Detailed planning of common system for the beamlines continued, with bottoms-up schedules by task completed for utilities, PPS, EPS, vacuum components, and controls installation. Utilities installation work will start as soon as the CSX hutch is handed over and we have the necessary parts in house. The shutters bid will be released to potential bidders as soon as an internal design review is completed. The shielded transport pipe request for proposal documentation will follow.

CHX. The CHX team worked closely with Bruker ASC to finalize the preliminary design for the beamline optics package. Much attention was devoted to the design of critical elements such as the horizontally deflecting mirror and double-crystal monochromator. The formal preliminary design review for this procurement was held August 23 and 24.

CSX. In August we had kickoff meetings for the monochromator and toroidal mirrors for the CSX beamline, and are preparing for their preliminary design reviews in September. The M1A and M3B package proposals are under final revision and close to being awarded in the next weeks. Information exchange has been initiated for M3A and soon we will have that kickoff meeting. The first optics from the beamline (substrates for the monochromator gratings) are back from metrology and ready for shipping to vendors for grating fabrication. Progress also has been made in the vacuum design and calculations for the beamline vacuum elements, chopper, pinhole system, and white beam slits.

HXN. The final design of the HXN optical components was completed when the team assembled the multilayer Laue lens module of the HXN x-ray microscope (Fig. 3). This

module is designed to be compact, to minimize position drift due to environmental factors such as temperature, and also to increase mechanical stiffness. The purpose of this initial assembly is two-fold: first, to resolve unanticipated dimensional issues and cabling management. Second, it enables extensive performance tests of stability and long-term drift. Testing is planned for the next two months.

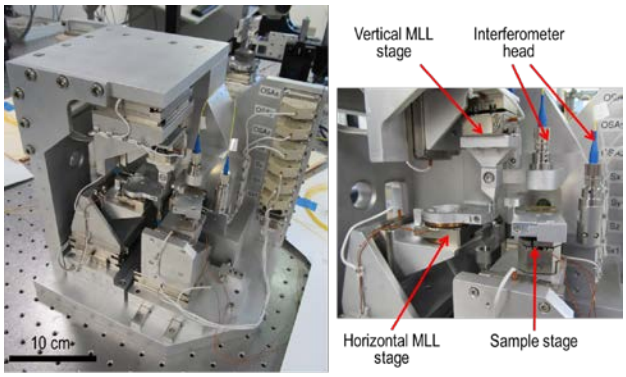


Figure 3. Multilayer Laue Lenses (MLL) module of the HXN x-ray microscope, assembled and ready for extensive performance tests. It is one of the two main modules of the HXN microscope.

IXS. The contract for the IXS KB Mirror System was awarded to Toyama Co., with mirrors and bender mechanism subcontracted to WinlightX. The kick-off meeting with both suppliers is scheduled for Sept. 5. RFP documentation prep for the vacuum chambers of the HRM is in the final stage. The high-precision motion stages will be procured via vendor quotes. In optics development, experiments performed at APS on the multilayer collimating mirror yielded excellent results. The collimated beam divergence was determined to be 103 μrad with the mirror fully illuminated using a scatter source of 25 μm, corresponding to an angular acceptance of more than 10 mrad (Fig. 4). Integrated reflectivity was measured as 47%. These results meet the performance required to deliver the expected baseline performance for the analyzer system of the IXS spectrometer for NSLS-II.

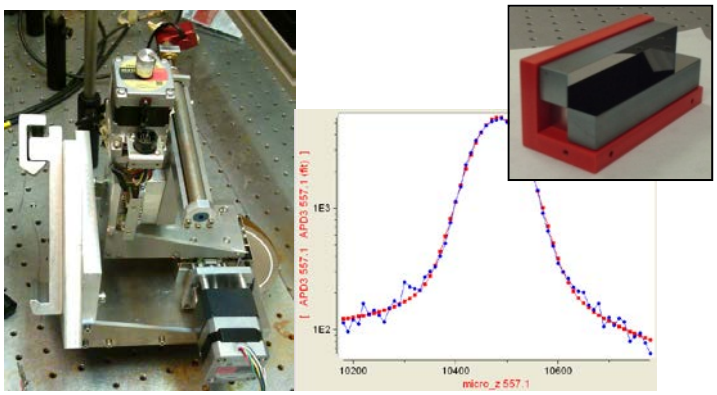


Figure 4. Divergence analyzer (left) developed by the IXS team for measuring the divergence of the collimated beam from the multilayer mirror (right). The collimation as determined was 103 μrad with the mirror fully illuminated from a scattered source with a 25 μm pinhole.

SRX. As a followup to the preliminary design review meeting with Bruker about the beamline optics package, the ray tracings have been revisited and updated. Several action items resulting from the preliminary design review meeting have been addressed, such as transport of the granite table for the double crystal monchromator and HFM (Fig. 5) or utilities and controls setup for the DCM cryo-cooler. Much work has been invested into preparation of the early science workshop for the SRX, "Rock & Cell", scheduled for Sept. 17–18. Procurement of the sample stages has progressed. Final design discussions with the supplier, SIOS, are underway.

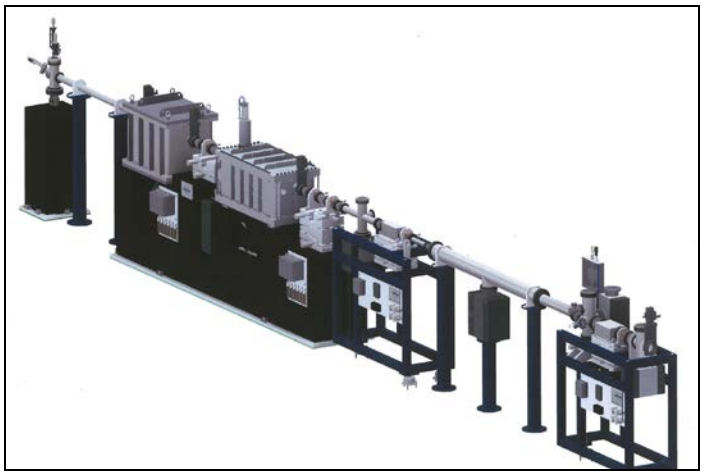


Figure 5. Granite table for the DCM and HFM.

XPD. All twenty-eight ID-A, -B, and -C enclosure walls and roof panels have been delivered and installed (Fig. 6). The Best Value decision has been made for the XPD beamline powder diffractometer. Weekly meetings with the contractors for the XPD beamline component, Laue monochromator, and mirror allow continuous interaction with the manufacturers and monitoring of the work progress. Specification of the XPD pixel array detector is ongoing. Ray tracing and conceptual design of the XPD multi-analyzer channel system have started, based on experimental work done on Laue analyzer crystals at NSLS X7A.

Figure 6. View of XPD hutches, Aug. 23, 2012. Far end, First Optical Enclosure. Center door: XPD-2 endstation. Near door, XPD-1 endstation.

CONVENTIONAL FACILITIES

Conventional construction continued its excellent progress during August as three of the Lab–Office Buildings are nearing substantial completion and readiness for occupancy, while the ring building punchlist work is drawing down. Items identified during beneficial occupancy reviews for LOBs 1 through 3 are nearing completion and beneficial occupancy is expected during September. The ring building contractor has completed basic contract work and continues to work down remaining punchlist items, moving closer to 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 completion of all physical work at the site, demobilization and contract closeout will commence. The contractor has already partially demobilized, removing most field office trailers to enable final site restoration. It is anticipated that the ring building contractor's site presence will end by November 2012, although they will continue to be available for any warranty work.

Construction of the five LOBs continues to make excellent progress. Activities in LOBs 1, 2 and 3 are focused on the completion of pre-occupancy items identified during the beneficial occupancy review in late June. Office area finishes and flooring work are completed, laboratory furniture has been installed, and building plumbing and HVAC are ready for operation. Final acceptance of the fire alarm and communication systems is imminent and will enable progression to beneficial occupancy in September. The LOB 3 HXN beamline extension area, which had previously lagged the LOB 3 progress, is now nearly complete and will undergo a beneficial occupancy review in September (Fig. 7).

Figure 7. HXN beamline extension substantially complete, awaiting BORE.

LOBs 4 and 5 will be completed as enclosed shells for later fit-out and were scheduled for later completion. They are progressing on or ahead of schedule and are now fully enclosed with steel, concrete, and exterior enclosure work and interior HVAC well advanced. Interior partitions and finishes are just getting underway. Completion of the project scope for LOBs 4 and 5 is on track for December 2012

Sitework for the LOBs and the site overall is nearing completion. All major paving is now in place (Fig. 8). With completion of the building exteriors, the final site grading, topsoil distribution, and seeding can begin. This is scheduled for late August and September, to coincide with the grass planting season. Final coordination of sitework to be performed by the ring contractor and the LOB contractor is now complete and only execution remains. All sitework is expected to be completed by late October.

Figure 8. New parking lots are handy for workers finishing the interior.

COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index for the Project overall is 1.0 and the cumulative schedule performance index is 0.95, both well within the acceptable range. The Project is 80.7% complete, with 38.4% of contingency and management reserve, based on EAC work remaining.

The project's current-period green schedule variance, with a current-month SPI of 0.95 (-$670K), is due to continued positive performance in Accelerator Systems as well as Experimental Systems. The continued deliveries of storage ring magnets and several other components have contributed to the positive picture. The cumulative ASD schedule performance improved slightly from 0.88 to 0.89.

The cumulative Experimental Facilities Division beamlines' schedule performance showed a slight improvement, up to 0.91 from .90 with a positive SV for the month of $294K, SPI 1.16. The cumulative CPI is at 1.02 (green status), $579K.

The Conventional Construction Division schedule performance for August is red, with a SPI of 0.70 (-$717K), due to work previously completed ahead of schedule in the LOBs, including storefront, tiling, painting, piping, HVAC, and metal siding. The cumulative CFD SPI is green at 1.0, $296K.

The current-month CPI for the NSLS-II Project is a negative variance of (-$858K). The project-level cumulative cost performance is 1.00, green status.

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 35% schedule contingency.

ENVIRONMENT, SAFETY, AND HEALTH

Beneficial occupancy readiness evaluations have been completed for Lab–Office Buildings 1, 2, and 3 (including the HXN beamline extension). Pre-start items are being closed out and occupancy is expected in late September. 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 mis-steering excursion that occurred at the linac on May 29 was investigated by an external independent team; this team submitted their final report on August 31. The corrective action plan is being drafted. Linac commissioning activities have been suspended and will not resume until all corrective actions are satisfactorily implemented.

Construction activity continues to wind down, as the ring building is complete and LOBs 1, 2, and 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.

NEWLY HIRED

Peter Galioto – Vacuum Technician – Vacuum Group – ASD

Sebastian Kalbfleisch – Physics Associate – HXN Beamline – XFD

Chris Koleda – Mechanical Technician — XFD

NSLS-II ACRONYMS

3PW	Three-Pole Wiggler
ARRA	American Recovery and Reinvestment Act
ASD	Accelerator Systems Division
BAC	Budget At Completion
BINP	Budker Institute of Nuclear Physics
BORE	Beneficial Occupancy Readiness Evaluation
BPM	Beam Position Monitor
CFD	Conventional Facilities Division
CHX	Coherent Hard X-ray beamline
CPI	Cost Performance Index
CSX	Coherent Soft X-ray beamline
DCM	Double-Crystal Monochromator
DI	Deionized
DW	Damping Wiggler
EAC	Estimate at Completion
EPS	Equipment Protection System
EPU	Elliptically Polarizing Undulator
FDR	Final Design Review
He	Helium
HFM	Horizontally Focusing Mirror
HRM	High-Resolution Monitor
HVAC	Heating, Ventilation, and Air Conditioning
HXN	Hard X-ray Nanoprobe beamline
ICT	Integrated Current Transformer
IXS	Inelastic X-ray Scattering beamline
KB	Kirkpatrick-Baez
LLRF	Low-Level RF
LOB	Lab–Office Building
MLL	Multilayer Laue Lens
DR	Preliminary Design Review
PPS	Personnel Protection System
PS	Power Supplies
RFQ	Request for Quote
RFP	Request for Proposal
RMS	Root Mean Square (also, rms)
SLM	Synchrotron Light Monitor
SOW	Statement of Work
SPI	Schedule Performance Index
SR	Storage Ring, also Synchrotron Radiation
SRX	Submicron Resolution X-ray Spectroscopy
SV	Schedule Variance
XFD	Experimental Facilities Division
XPD	X-ray Powder Diffraction beamline

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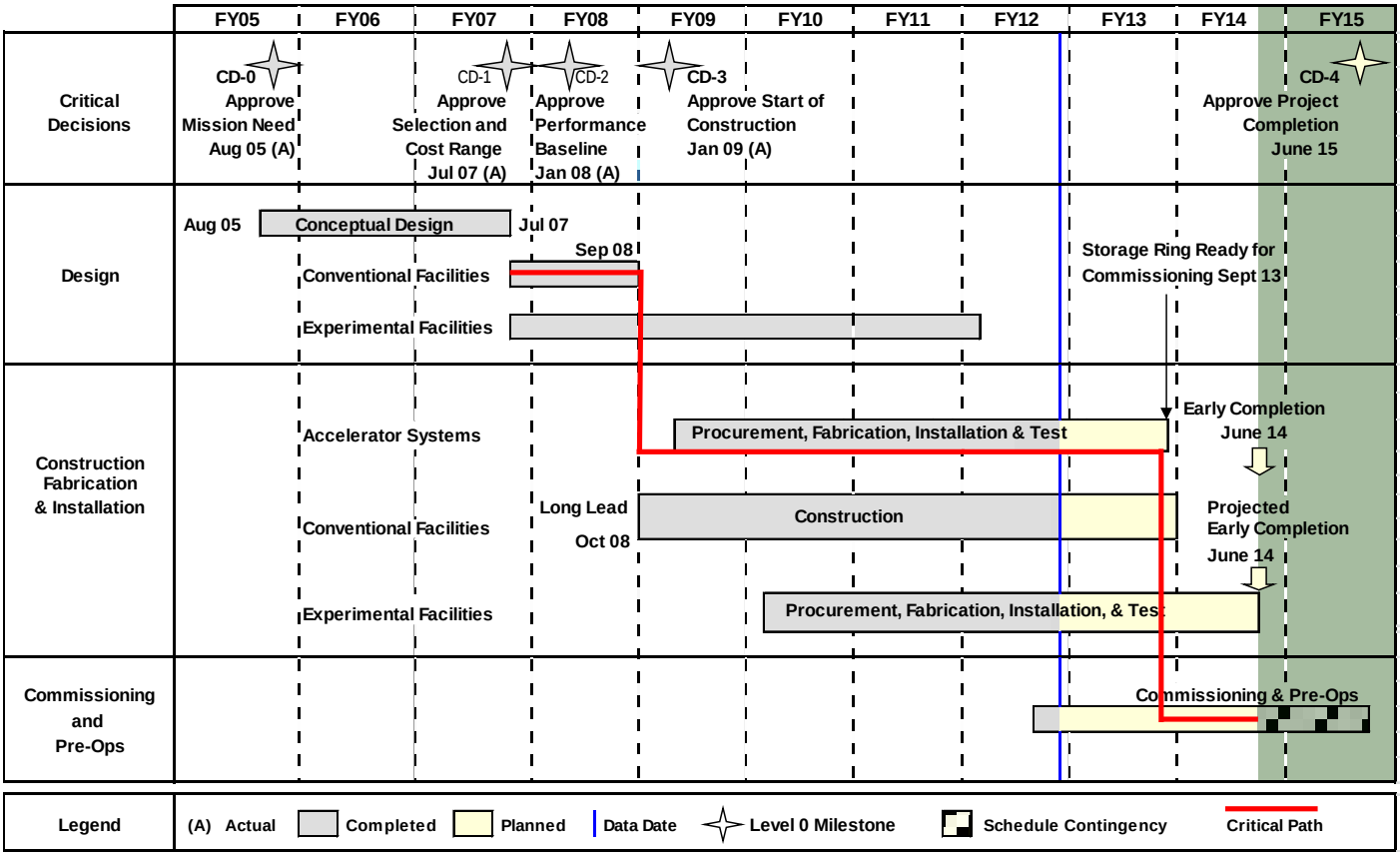
The NSLS-II Project is being carried out to design and build a world-class user facility for scientific research using synchrotron radiation. The project scope includes the design, construction, and installation of the accelerator hardware, civil construction, and experimental facilities required to 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

	NSLS-II Funding Profile ($M)											
Funding Type	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
Total NSLS-II Project	1.0	4.8	25.0	49.7	253.3	141.0	152.8	159.1	71.6	48.7	5.0	912.0

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,

or via mail at: Room 37, Bldg 830M, Brookhaven National Laboratory, Upton NY 119873.