Project Progress Report

National Synchrotron Light Source II

July 2013 Activity

Clouds dance above the synchrotron complex on the last day of July 2013.

report due date:
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OVERALL ASSESSMENT

The National Synchrotron Light Source II Project continued to make satisfactory progress with the current-month schedule performance index (SPI) of 1.30 (+$2M). The cumulative cost and schedule indices are 0.99 and 0.97. The project is 87% (90%) complete with 42% (57%) of contingency and management reserve for the remaining EAC (BAC) after the inclusion of the recently approved scope additions for future beamlines. The project has 77% (10 months) of schedule contingency for the remaining duration of 13 months before the projected completion date of August 2014.

The DOE Independent Project Review (IPR) was conducted by the Office of Science on July 16-18. The committee concluded that the project has made impressive progress on all fronts and has been properly managed. The committee noted that the end game planning is in high gear with appropriate attention given to all areas but achieving early finish date of June 2014 for accelerator delivering x-ray beam appears to be very optimistic.

Accelerator Systems continued to make good progress on installation of the storage ring and integrated testing. The monthly SPI for Accelerator Systems in July was 1.75, +$1.12M, with the cumulative SPI of 0.94. Extended Integrated Testing of the entire injector complex, including transfer lines, continued. Installation of Accelerator Systems is over 92% complete. Installation of transferlines between booster and storage ring is making excellent progress. Delivery and testing of the insertion devices continued, and the installation of front end hardware and infrastructure for the insertion devices are also progressing well.

Experimental Facilities made good progress on delivery and installation of major beamline components, resulted in the monthly SPI for Experimental Facilities of 1.23 (+$0.72M). The hutch installation was completed and excellent progress was made in utility installation. Factory acceptance tests for a number of major components produced for various beamlines were successfully completed. Of HXN beamline components received in 13 crates in May, about 90% had been installed by the end of July.

Based on the production and delivery schedule of remaining insertion devices, the status for the preparation of the authorization basis documents and revised schedules for various readiness reviews for accelerator commissioning with beam, the project schedule continued to be optimized. The storage ring installation, except for 2~3 IDs is expected to be completed in November 2013. The critical path of the project has not changed since June and runs through approvals of revised authorization basis documents, successful readiness reviews for commissioning, booster commissioning followed by the SR commissioning and integrated testing of some of beamlines.

The Project continues to strive to complete all necessary activities to enable initial commissioning of the beamlines with beam by June 2014. However, schedule optimization has been already implemented and all built-in schedule floats are exhausted. Achieving delivery of x-ray beam to all beamlines on June 2014 is still doable but challenging.

ACCELERATOR SYSTEMS

Injection systems. All local shielding required for booster commissioning has been installed and relevant documentation is being handed over to ESH for configuration control.

Figure 1. Storage Ring Injection Straight (SR-IS) installation.

Installation of the storage ring transfer line (Fig. 1) is progressing well. All BST-II and SR-IS (Storage Ring Injection Straight) tables (Fig. 2) have been installed and aligned, except for the SR-IS flag stand and the injection septum support. The DC septum and the BST-II magnets have been installed. All cables for these magnets have been pulled. Cable pulling for the SR-IS will begin shortly. The SR-IS racks at cell 29 of the SR mezzanine are in place. The installation of the Injector PPS as well as the P1/P2 PPS hardware is complete, and functional tests are underway.

(cont. next page)

Figure 2. SR-IS tables installed.

UPCOMING EVENTS

DOE CD-2 Review of NEXT Beamlines Project	July 30–Aug 1
NSLS-II First Experiments Workshop	Aug 12–13
BAT meetings for HXN, CSX-1, CSX-2, and SRX beamlines	August
XPD BAT meeting	September

Work on the storage ring injection straight has increased pace. The two production units of the BST-II correctors have been assembled and will soon be tested and magnetically measured at Bldg. 902. The "first article" unit was magnetically measured earlier in July and results looked good. A pre-survey of the two SR Injection Septa (production and spare) is underway, including detailed measurements of the three vacuum flange interfaces. Once the measurements have been accepted, the first septa will be ready for installation.

The first two storage ring injection kicker ceramic chambers have been tested and are being integrated with the rest of the kicker parts at Bldg. 832. Some assembly components are out for painting and are expected to be ready for installation in mid-August. The SR-IS flag was assembled and performed as expected.

During July we iterated details of the kicker pulser design, testing the improved design and modifying the pulsers accordingly. The four pulsers required for operation are completely assembled and ready for testing with the kicker magnets. Machining of the major components of the kicker bus work has been completed in BNL Central Shops. The spare septum (magnet, vacuum chamber and support, no PS) has been delivered and passed the tests at BNL.

Vacuum. Six straight sections were successfully baked in July, making a total of 20 straight sections completed. Cell C22 with x-ray diagnostics diamond windows was assembled and is being baked. The connection of water cooling lines to header drops in P2 and P3 is complete. The cooling lines for 20 straight sections were connected to the cell lines and are being pressure tested. Cell-to-cell PLC cables and other additional vacuum cables are being installed.

Power supplies and electrical utilities. The installation of the two Main Dipole power supplies for the storage ring has been completed. Both low- and high-current testing are being finished for the first power converters, and the second power converter is ready for testing. Testing spare alignment corrector power amplifiers has been accomplished. First-article production of AC-powered amplifiers has started. Power supply installation has been completed in all pentants, except for fast corrector supplies, which are still in production.

Electricians finished the installation of tunnel cable tray for the damping wigglers. Installing of the AC power needed for the DW control racks is underway. Transport line power supply installation is continuing for BSTL phase 2. Components (PSC, PSI, and regulators) needed for installation have been tested and delivered to Bldg. 740.

Instrumentation. The BPM Oscillator tests were completed and replacement of oscillators is underway. Installation of the RF-BPM infrastructure is complete. The first scraper has been installed (Fig. 3) and the remaining scrapers are well advanced, with projected finish dates by mid-August.

The production of loss monitors is well advanced, with completion due in August. All strip-line monitors have been installed and instrumentation cables are in place. The production of the XBPM first article is nearing completion. Installation of the SLM beamline is well advanced and optical components are being installed in the SLM hutch. The stepping motors of the x-ray-diagnostics beamline motor system are being tested. The installation of the DCCT beam current monitor system is in progress and completions is foreseen in August.

Figure 3. Vertical scraper assembly.

Insertion devices. Four DWs are now in-house at BNL. The first will be moved to the ring upon safety approval of the associated "To-Ring Critical Lift Plan." The fifth and sixth DWs are now being prepared for measurement at the supplier. ID cable tray installation in the ring is complete for all cells. Spare cables and connectors have been received for DWs and EPUs. Completed tasks for Cell 28 are: survey per our 3D coordinate file, delivery of vacuum stands/DW base plates, anchor drilling/stud installation, floor scarification, and form construction. Grouting of vacuum stands has begun.

Both EPUs are expected to arrive in port in mid-August. Procurement of the permanent magnet Phasing/Canting Magnet has been processed with a revised layout depicting important alignment tolerances. Solutions to the issues with NEG-coating for the EPU Vacuum Chamber are being investigated; consultants from ESRF/CERN will assist FMB. Provisions to conduct in-vacuum measurement on IVU21 (for the SRX beamline) using the IVMM are being made in the new lab A of Bldg. 832.

Delays had occurred in shipment of steel from New Zealand for the SS-Canting Magnets but all the laminations are now on hand, and assembly of yokes is in progress. Eight pairs of yokes have already been stacked, pressed, oven-cured, and crated ready for shipment to the machine shop. The laser-cut edges of the laminations appeared very clean with no burrs or burn marks.

Preliminary field measurements for IVU20 results have been obtained. Trajectory and phase errors look satisfactory; however, multipole determination seems to have too much noise to be accurate. Most action items from the IVU22 PRR have been satisfactorily addressed and production will start soon.

Accelerator physics. Work continued on tracking studies needed to determine radiation shielding requirements. Specifications were written for software required for storage ring commissioning activities. Progress was made on development of a data base for lattice information. Radiation safety issues

for the visible synchrotron light monitor beamline were considered by the PS Radiation Safety Committee.

Installation and integrated testing. Overall, accelerator installation was 92% complete at the end of July and continued to make excellent progress toward complete SR installation by November. Installation of the front ends and preparing for ID installation is also progressing well. The accelerator schedule for installation and commissioning is being continuously optimized, based on the latest information on the remaining production deliveries. Integrated testing is currently in process throughout on power supplies, vacuum equipment, and diagnostics.

The P5 copper DI header has been tied-in to the DI system. The P5 copper pump skid and P3 & 5 aluminum pump skids need some PLC programming work before acceptance testing can be completed. Installation of the P4 aluminum DI drops is complete. Installation of the P5 aluminum DI drops is in process. The installation of the P1 make-up water system/polishing loop for the aluminum skid is complete (excluding controls); the system for P2 is now starting. The capillary tubing installation is in process at cell 23.

The AC power work for the damping wiggler racks is in process. Other electrician work in the RF building will start in mid-August, which includes the AC tie-in of the back-up compressor, LN2 equipment, and cleanroom; running UPS cables, ODH PPS installation, and re-installation of cable tray and lights. Installation of the router piping for the tunnel wireless network is in process.

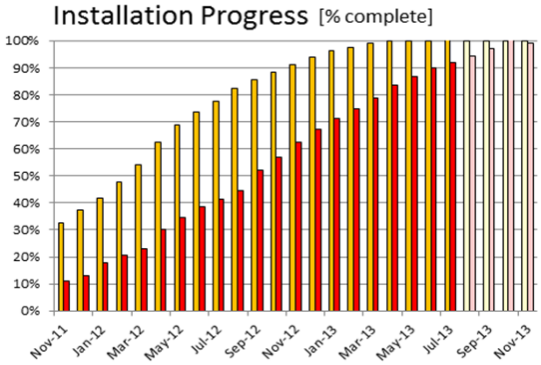
Installation of insertion devices. The floor at the cell 28 damping wiggler straight has been prepared by scarification; the vacuum stands and floor plates will be installed in mid-Aug. The first DW will be brought over to Bldg.740 in late August. Critical lift documents for the DW & EPU are being finalized.

Installation of front ends. Cable pulling documentation for cell 23 is complete and cable pulling is in process, with cell 28 to follow. Plumbing work is in process at cell 23. Bellows are scheduled to be delivered at the end of August. Beamline-specific drawings for the ratchet wall collimators are in process.

Electronics/cable pulling. SR dipole power supplies are ready for testing, but are waiting for the completion of roof deck rework in late Aug. High-current multi-pole power supply testing is complete in P1–P3. Low-current power supply testing is in process in P4. In P5, the power supply installation is complete.

Table 1. NSLS-II Accelerator installation progress at the end of July 2013.

	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13
Mechanical Utilities	68%	73%	74%	78%	80%	88%	91%	92%
Electrical Utilities	91%	95%	96%	99%	99%	100%	100%	100%
Magnets	93%	99%	100%	100%	100%	100%	100%	100%
Vacuum	39%	44%	53%	65%	82%	84%	86%	93%
Power Supplies	48%	54%	65%	70%	81%	87%	95%	99%
Instrumentation	58%	63%	66%	74%	80%	83%	85%	89%
Frontends	6%	6%	11%	15%	23%	32%	34%	36%
RF	47%	49%	52%	57%	59%	64%	75%	77%
Inje Straight	0%	0%	0%	0%	0%	1%	4%	27%
LINAC+Booster	95%	96%	97%	97%	99%	100%	100%	100%
Total	**67%**	**71%**	**75%**	**79%**	**84%**	**87%**	**90%**	**92%**



EXPERIMENTAL FACILITIES

In July, the Experimental Facilities continued to make good progress with a monthly SPI of 1.23 and cumulative SPI of 0.91. The experiment and optics hutches were essentially completed with only punch-list items and new additional stairs to be completed. Utility installation crews were busy with electrical and mechanical utilities, and installing PPS conduit on all beamlines. The electronics racks began to arrive and installation started at 23-ID. Attention on the cable routing (pulling) and termination has now started for vacuum and motion control cabling at several beamlines. Deliveries of beamline optics and components continued in July. FMB-Oxford returned to NSLS-II to continue beamline component installation for XPD in 28-ID-A, 28-ID-B and 28-ID-C. It was recognized that additional design effort would be needed to complete the utility and beamline designs, so steps have been taken to supplement the design room staffing to support all the project beamlines.

CHX. The factory acceptance test (FAT) for the CHX diffractometer has been completed successfully at Huberr GmbH. The instrument is being shipped to BNL and is scheduled to arrive in mid-August, with installation in the CHX endstation to occur at the end of August.

The evaluation process of the SAXS table has proceeded, with best and final offers from two bidders. Following this procedure, a best value proposal has been identified and the formal contract award process has started. The mirror substrate, which is a part of the CHX Optics Package, has been received by the NSLS-II metrology lab. Metrology tests are scheduled for the month of August.

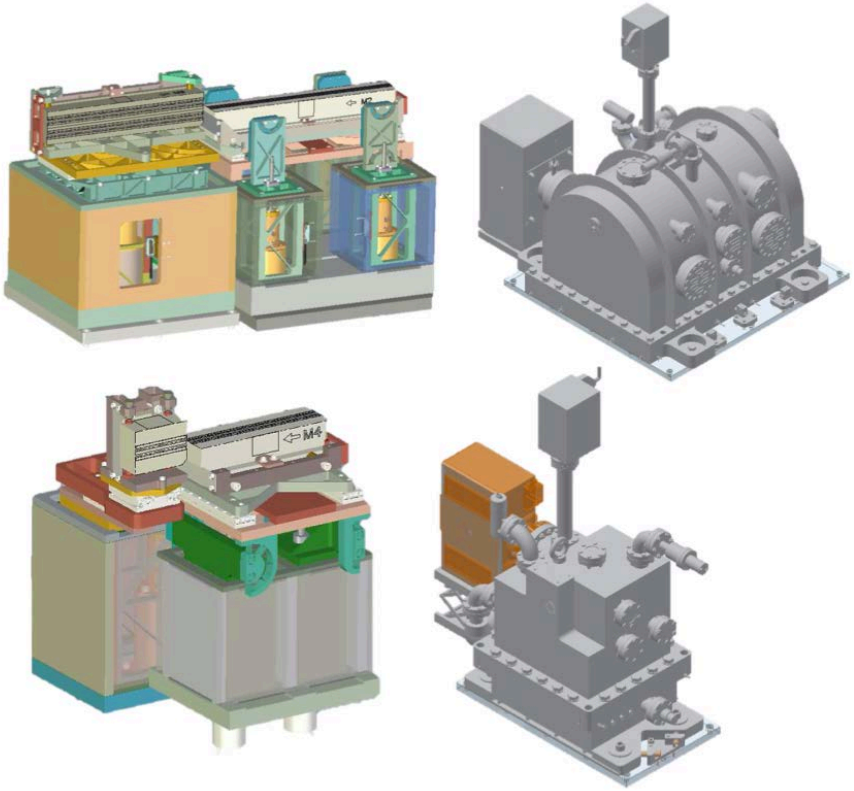
Finally, the CHX hutches have been completed and accepted and the installation of utilities has begun in the B hutch of the CHX endstation.

CSX. Design of the vacuum transport for the polarization branch was finalized and submitted to BNL's Central Shops. The monochromators passed all their tests at the factory and

are ready for the FAT, which has been scheduled for the first week in August. All 13 of the 19-in. equipment racks for both branch beamlines were installed by the beamline techs. The Controls group has routed and terminated the fiber optic connections, enabling the beamline to be online for the first time. The racks have been populated with all the motion controllers, vacuum gauge controllers and ion pump controllers needed to service both branch beamlines. Cable pulling started for the vacuum cables for the coherence branch and the FOE. Termination of these cables has been scheduled for August. Finally, the M3A mirror system was "taken off bake" and exceeded the vacuum specifications. Preparations are underway for installing the optic into the mirror system in September after the metrology is performed at SPring-8 in August. July saw the completion of the utilities installation. Both branch beamlines now have electrical power, compressed air, and both DI and PCW systems available, which has greatly accelerated the progress of technical installations on the beamlines.

SRX. The vendors Bruker-ASC and WinlightX continue to make very good progress in fabricating the components for both large optical packages. Figure 4 (below) shows the design for the KB Mirror System, which is under construction now. The SRX team closely monitors the advancements in the work of both suppliers with weekly teleconferences and continuous discussions. The SRX team continues its efforts in the design of the sample stage for the high-resolution setup. As well, the holders for complex sample environments have been developed further, with the collaboration of scientists from BNL, the Beamline Advisory Team and other academic institutions.

Figure 4. Final design of vacuum chambers, mechanics and mirrors for the SRX K Mirror System.



Top: High-flux mode of operation.

Bottom: High-resolution mode of operation.

HXN. Installation of the beamline components in the first optical enclosure is about 90% complete. Installation of the cables for motion system and vacuum components is complete and the cables are being tested. The vendor proposals for the vacuum enclosure for the HXN x-ray microscope are evaluated and the contract is being negotiated. Design of the detector station for the HXN x-ray microscope is completed, and procurement for the components began. Early science investigation using the multilayer Laue lenses on Pt-Ni nano-catalysis (Fig. 5) is featured on the back cover of the journal *Nanoscale* **5**, 7184 (2013).

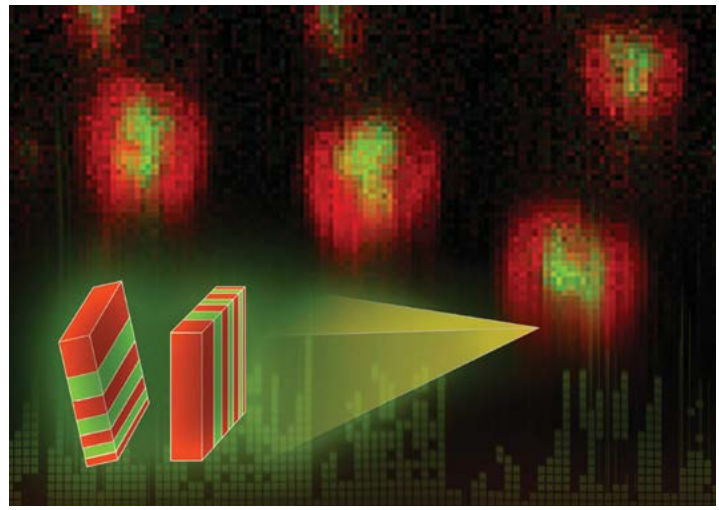


Figure 5. Oxidation process of Pt-Ni catalytic nanoparticles is investigated using a scanning x-ray microscope with multilayer Laue lenses (MLL). The prototype MLL microscope has been used for this early science investigation, in collaboration with scientists from Argonne National Laboratory, Chosun University (Korea) and Gwangju Institute of Science and Technology (Korea).

XPD. FMB-Oxford arrived on July 29 to start phase 1 installation of the XPD beamline components (Fig. 6). This includes the End Optical Bench and the High Resolution Monochromator in End Station C, the shielded beam transport in A through C (Fig. 7), and the diamond filter assembly and its support. The rest of the equipment will be delivered by the end of August and will be installed and surveyed through September.

Figure 6. Delivery on 7/30 in front of the XPD beamline of the crates containing the components shipped by FMB-Oxford.

The vertical focusing mirror from Winlight-X was installed and approved. The vertical support table (Fig. 8) for the diffractometer has been assembled and meets specs. Late delivery of the Heidenhain Ring Encoders is delaying the assembly of rotary axes, but the assembly of main shaft elements has begun (Fig. 9).

Figure 7. Installation of the long shielded pipe in 28-ID-B (transport from optical enclosure A to end station 28-ID-C).

Lead/steel enclosures (hutches) at 28-ID-A, B, C, and D are completed, checked, and accepted. Mechanical utilities installation (piping, flow meters, capillary tubes, and transmitters) continues in the First Optics Enclosure. The DI water system has been successfully pressure tested. Electrical utilities at 28-ID-B are installed and at 28-ID-C are now in progress. Lighting installation in 28-ID-D is completed. Routing of power to racks and cable terminations is in progress. PPS conduits are installed in 28-ID-D. Two fully equipped racks have been lifted onto the A-hutch.

XPD is mentoring one Community College summer intern (BNL CCI program) and supporting one undergraduate student from Columbia University: both students are working on the workflow software for handling the XPD data.

Figure 8. RPI diffractometer granite wedge support. The vertical translation is made by a massive in-air wedge jack using a stepper motor driving horizontally along a ball-screw through a planetary gearbox. The load is taken into the granite wedge via a duplex pair of angular-contact bearings. This unit drives the assembly vertically with wedges mounted back-to-back moving along a pair of precision guide rails mounted on ground surfaces.

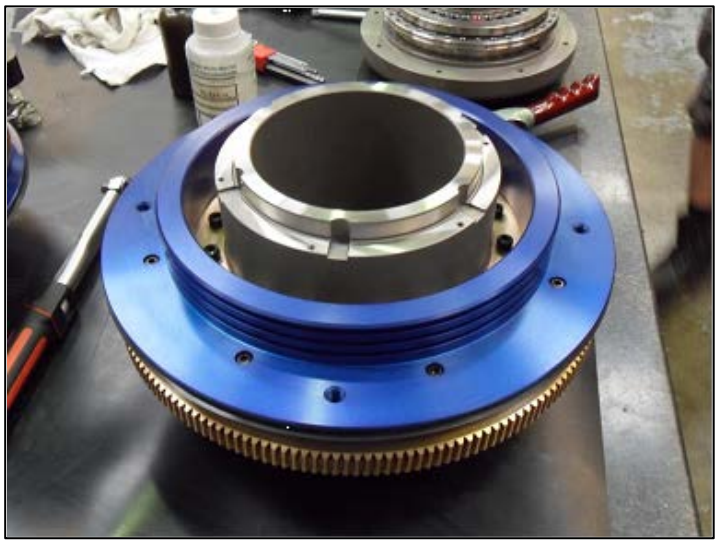


Figure 9. RPI diffractometer spindle axis.

COST/SCHEDULE BASELINE STATUS

The current-period schedule variance (SV) for the overall project is ($1.99M) with an associated schedule performance index (SPI) of 1.30. The improved performance is due primarily to Accelerator Systems ($1.12M) and Experimental ($0.72M). The cumulative SV for the project continues to have green status with an SPI of 0.97 (-$23.8M).

The current-month cost performance index (CPI) for the NSLS-II project was 0.95 (-$0.45M), primarily driven by invoices paid in the Accelerator Systems for the Injection System Booster. The cumulative Project CV (cost variance) continues with green status at 0.99 (-$9.9M).

With the monthly SPI of 1.23 ($0.72M) in July, the cumulative SPI for the Experimental Facilities, WBS 1.4, improved slightly to 0.91 (-$5.1M).

Conventional Facilities' July SPI performed at a level of 1.32 and maintained the cumulative SPI at 1.0 for the project. The current-month CPI of 0.72 is the direct result of invoices paid for work previously accomplished.

Accelerator Systems, WBS 1.3, achieved another excellent schedule performance in July with a monthly SPI of 1.75 ($1.12M) and the cumulative SPI at 0.94 (-$16.4M). The cumulative CPI continued to be at 0.95 with the current month CPI of 0.72 was a result of invoices paid in the Injection System.

Accelerator Pre-Ops, WBS 1.6, had an SPI of 1.05 for the month, while increasing the cumulative SPI at 0.94 (-$1.6M).

The Project is approximately 90% complete as of July 31, with approximately 57.3% remaining contingency/MR on BAC work remaining. The Project EAC is $894,821K and MR/Contingency is approximately 41.6% of EAC work remaining. Project percent complete is 86.6%, based on EAC work remaining. At the end of July there is approximately $49.8M remaining of Contingency and MR on the Project.

The July critical path remains unchanged from June. There are 10 months of float between the Project's early completion milestone and CD-4.

ENVIRONMENT, SAFETY, AND HEALTH

Actions identified in the Corrective Action Plan (CAP) associated with the beam mis-steering event that occurred at the Linac on May 29, 2012 are approximately 90% complete. Accelerator commissioning with beam will not resume until all necessary corrective actions have been satisfactorily implemented and a successful ARR (Accelerator Readiness Review) has been conducted.

Significant emphasis is being placed on the revision and preparation of the authorization basis documents and procedures necessary to support the Instrument Readiness Review (IRR) and ARR. Revised Linac documents have been reviewed by the Laboratory ESH Committee (LESHC) and forwarded to DOE, and approval is imminent. Injector documents have been completed, vetted through the PS Radiation Safety Committee, and will be reviewed by the LESHC before the end of August. Pre-planning for the IRR and ARR was performed, including preparation of the Instrument Readiness Plan and identification of potential IRR and ARR participants.

All BOREs (Beneficial Occupancy Readiness Evaluations) for the NSLS-II facility have been completed, and work to close out remaining post-occupancy items continues. Operational Readiness Evaluations (OREs) have been completed for the LOB 3 machine shop and have been scheduled for the remaining seven laboratories in LOB 3. These labs are being used to assemble and test beamline components. The BORE and ORE processes ensure that life safety, code compliance, and work planning/controls are in place prior to commencing with laboratory work. Work to complete conventional construction activity punchlist items continues and is nearly complete.

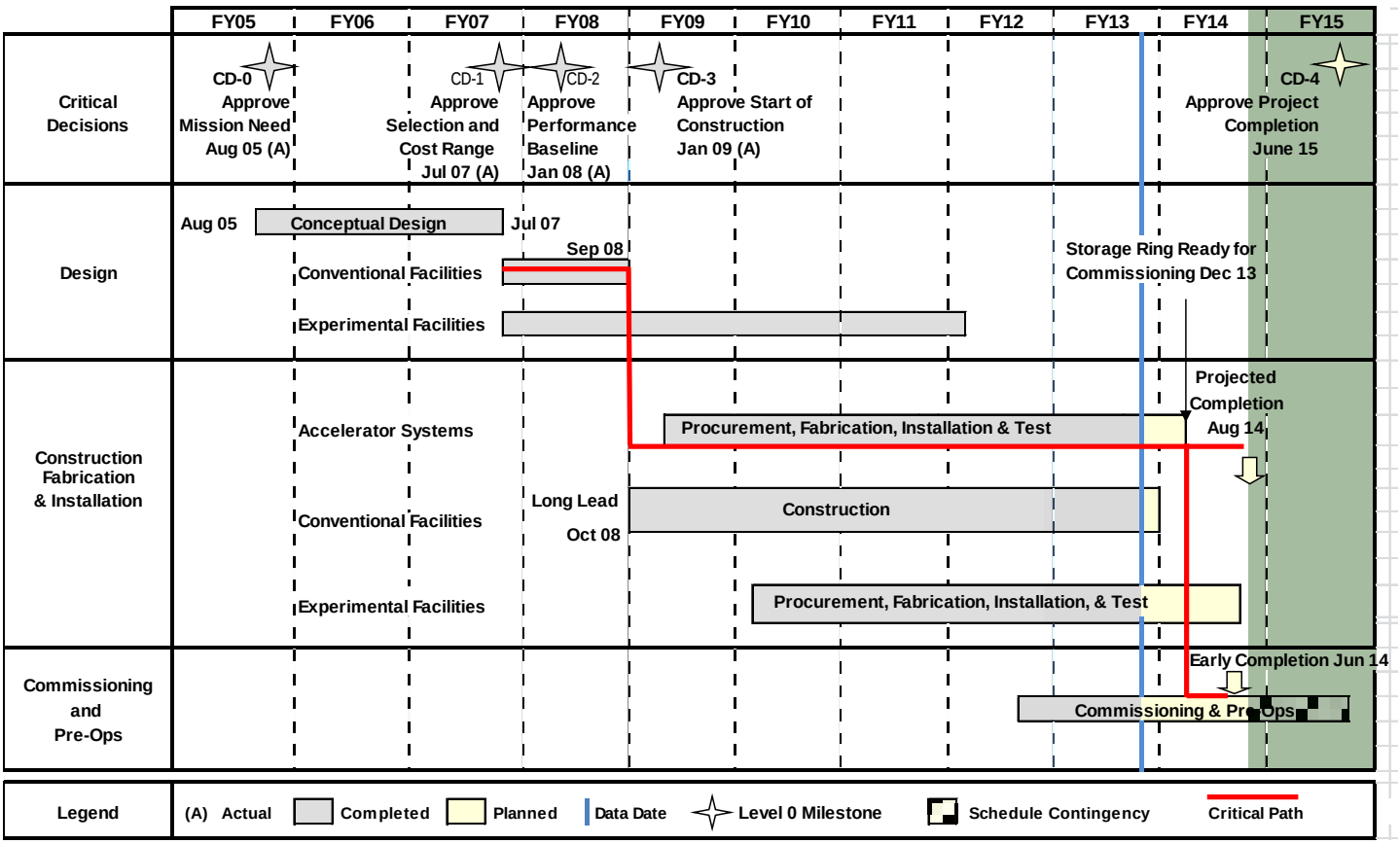
Installation of experimental hutches is nearing completion. The hutches and the experimental facilities will be reviewed using the IRR process. The reviews will be performed to ensure that safety requirements have been met.

ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ARR	Accelerator Readiness Review
ARRA	American Recovery and Reinvestment Act
BAC	Budget At Completion
BORE	Beneficial Occupancy Readiness Evaluation
BPM	Beam Position Monitor
CAP	Corrective Action Plan
CHX	Coherent Hard X-ray beamline
CPI	Cost Performance Index
CSX	Coherent Soft X-ray beamline
CV	Cost Variance
DI	Deionized
DW	Damping Wiggler
EAC	Estimate at Completion
EPU	Elliptically Polarizing Undulator
ESH	Environment, Safety and Health
EVMS	Earned Value Management System
FAT	Factory Acceptance Test
FDR	Final Design Review
FOE	First Optics Enclosure
HVAC	Heating, Ventilation and Air Conditioning
HXN	Hard X-ray Nanoprobe beamline
ID	Insertion Device
IRR	Instrument Readiness Review
ISR	In-Situ Resonant X-ray Studies beamline
IVMMS	In-Vacuum Magnetic Measurement System
IXS	Inelastic X-ray Scattering beamline
KB	Kirkpatrick-Baez
LOB	Lab–Office Building
LESHC	Laboratory ESH Committee
MR	Management Reserve
NEXT	NSLS-II Experimental Tools (beamlines)
ORE	Occupancy Readiness Evaluation
P1, P2…	Pentant 1, Pentant 2, etc.
PCHW	Process Chilled Water
PCR	Project Change Request
PPS	Personnel Protection System
PS	Power Supply
PSC	Power Supply Controller
RF	Radio Frequency
RFP	Request For Proposal
SAXS	Small-Angle X-ray Scattering
SB	Service Building
SPI	Schedule Performance Index
SR	Storage Ring
SRX	Submicron Resolution X-ray Spectroscopy
SV	Schedule Variance
WBS	Work Breakdown Structure
XPD	X-ray Powder Diffraction beamline

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	27.4		60.2
Total NSLS-II Project	1.0	4.8	25.0	49.7	253.3	141.0	152.8	159.1	71.6	53.7		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 Bldg 745, Brookhaven National Laboratory, Upton NY 119873.