National Synchrotron Light Source II

Project Progress Report

April 2011

Early on the last workday in April, materials are being staged for the last section (pentant 5) of the standing seam metal roof.

report due date:
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BROOKHAVEN
NATIONAL LABORATORY

OVERALL ASSESSMENT

The National Synchrotron Light Source II project continues to maintain satisfactory cost and schedule performance with a reasonable level of cost and schedule contingencies. At the end of April, the project is 53% complete, with over 31% of contingency and management reserve for the remaining cost to go. The cumulative cost and schedule indices are 1.02 and 0.96 respectively, both well within the acceptable range.

Construction of conventional facilities continues to be on track to deliver the remaining sections of the ring building. The beneficial occupancies of the RF building, pentant 2, and injection building will occur over next 3 months and the construction of the ring building is anticipated to be mostly completed by end of the calendar year 2011. The Lab–Office Building (LOB) work is also progressing as scheduled. Foundations for LOBs 1, 2, and 3 are now completed, and the erection of steel for LOB 1 is nearly complete.

In pentant 1 of the ring building, the installation of the Accelerator Systems components is quickly ramping up. Set up of the staging areas and storage cages was completed and cable trays, equipment racks, UPS, and girder floor plates are being installed. Progress continued with successful delivery of most production components, including girders and vacuum chambers. Production activities at the vendors for the linac, booster, RF transmitter, and damping wigglers are also progressing on schedule. About 80% of procurements for the Accelerator Systems have been awarded and the procurements for the remaining components are on track to be awarded. Magnet production continues to improve but remains significantly behind schedule. To date, 85 magnets (about 10% of the entire production) have been delivered. The project is formulating firmer schedule mitigation plans based on better estimates of the delivery rates. The current-month negative schedule variance of $1.4M for the overall project is mainly due to delayed delivery of production magnets, and to lagging status reports on some accelerator components from production vendors.

Excellent progress continues on preparation of the major procurement packages for six beamlines. The solicitations for lead and steel hutches have been released and the preparation of optics procurement packages is progressing as scheduled. The projected early project completion date of March 2014 and the critical path remain the same. Activities funded by the American Recovery and Reinvestment Act (ARRA) continue to be on schedule and on budget.

UPCOMING EVENTS 2011

High-energy X-ray Micro-mapping/Structural Engineering BL workshop	May 6
Medical Imaging and Radiation Therapy Beamline (BL) workshop	May 9
Accelerator Systems Advisory Committee meeting	May 10–11
Soft X-ray Spectroscopy BL Workshop	May 20
HXN Beamline Advisory Team (BAT) meeting	June 1
DOE Review of NSLS-II Project	June 21–23
Conceptual Design Review of NEXT project	June 28–29
DOE NEXT Project CD-1 Review	Aug 30–Sep1

ACCELERATOR SYSTEMS

Accelerator physics. The Accelerator Physics group remains strongly involved in the magnet acceptance procedure. Accelerator physicists participated in a one-by-one review of exceptions to field quality specifications of the magnets and a corresponding beam dynamics analysis. Good progress was made on top-off safety, and a comprehensive report from the study will be completed in late May for a final external safety review in September 2011. A new working group was formed to develop high-level applications in collaboration with the controls group.

Injector. The linac continues to make good progress. Manufacturing of key components—accelerating structures, solid state modulators, front end, and klystrons—is far advanced (Fig. 1). Delivery of the front end is expected in July, and delivery of the entire linac will begin in mid August.

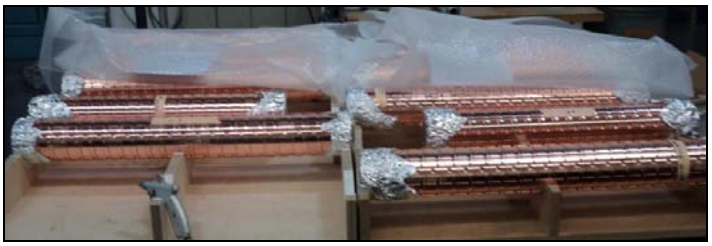


Figure 1. Accelerating structures of the NSLS-II linac. To complete the sections, cooling pipes will be brazed to the surface before final frequency tuning.

The NSLS-II booster has made excellent progress as well. Yokes of the first article BF-type combined function magnet have been manufactured. Most quadrupole and sextupole yokes have been completed (Fig. 2). Vacuum-, pulsed power-components, and BINP-built power supplies have been prototyped and production is underway. The booster production is on track for delivery in spring 2012.

Figure 2. Completed yoke for a booster quadrupole magnet.

The first transport line support elements were received from a vendor. The remaining supports will be delivered in mid June 2011, in time for installation in the linac tunnel, well before the linac installation starts.

Magnet production. Full NSLS-II magnet production is in progress at several vendors. Budker Institute of Nuclear Physics (BINP) is producing 30 each of four different magnet types (120 total), Danfysik is producing 169 normal sextupole magnets, and Everson-Tesla is producing 192 correctors. By the end of April, two additional first-article quadrupoles had been received from BINP, who also have completed most yokes for the quadrupoles of types A and B. The production of 75 wide sextupole magnets at IHEP is still limited to yoke and coil production, as QA issues remain.

The production of yokes and coils has been released at Tesla Engineering, where 120 quadrupole magnets of types D and E are being built. Tesla is working to improve machining, with the goal of holding the Production Readiness Review on May 18. Danfysik production was halted to investigate why the integrated field of production magnets kept changing. The issue was resolved and production has resumed.

First-article large aperture magnets received from Buckley Industries are of good quality and meet NSLS-II specifications. IHEP production of first-article large aperture magnets, which was initiated to mitigate schedule delays, is in progress. The first-article 90 mm dipole magnet from Buckley was received at BNL in April.

A finite element analysis (FEA) was performed to qualitatively evaluate the effect of different bolt tightening sequences on the magnet pole profile reproducibility. The results showed that side bolts must be tightened only after vertical bolts. The torque applied to the side bolts must be a small percentage of the tightening torque used for the top (vertical) bolts. Also through FEA, the effect of the copper chromium bar (currently used for the BINP quad) was shown to have a significant minimizing effect on pole movement as a result of the forces applied during the tightening sequence. In the case of the quad, the reduction in pole movement is a factor of 50; for the sextupole, the movement is reduced by a factor of 4 to 10. This analysis confirms some of the vendors' successful procedures and provides suggestions for improving the results of other vendors—an important advance. Initial vibration tests performed on the 156 mm corrector magnet showed a natural frequency of 30 Hz in the horizontal direction (transverse to the beam). A wedge was inserted at the unsupported end of the corrector magnet, raising this natural frequency to ~48 Hz. All received quadrupole and sextupole magnets have been tested and measured magnetically in the NSLS-II magnet facility. To date, 85 NSLS-II magnets have been received at BNL; this is about 10% of the entire production.

SR girders and floor plates. Thirteen production girders have been received so far. Girder floor plate drill fixtures and floor plate positioning fixtures have been manufactured and tested, and mechanical inspection with the laser tracker has been completed. Fifty-two girder water manifolds have been manufactured to date. The production rate from BNL Central Shops is 24 per month.

Front ends. The design drawing for the radiation mask system is now ready for the HXN front end. Ray-tracing is in progress, to finalize the drawings for the other beamlines.

DI water systems. The contracts to produce the 13 pump and control stations for the accelerator de-ionized water systems were awarded to FW Sims. The first two pump skid systems were requested to be installed by the end of August.

Vacuum systems. Aluminum vacuum chamber production continues to progress well. About 36% of the chambers are ready for installation. Production of the designed short S4A and S5A chambers has begun. The design of the NSLS-II shielded bellows was completed, and production of first units started at BNL Central Shops.

Diagnostics and instrumentation. Design of a Faraday Cup/beam dump was completed. The dump is needed in the low-energy beam transfer line. A design has been released for the small aperture BPM, which will be installed around insertion devices. All design documents are ready for procurement. The design of the synchrotron radiation monitor for optical beam monitoring has been completed. The procurement process for the hutch for the optical monitoring systems (Fig. 3) has begun.

Figure 3. Optical diagnostic beamline and measurement hutch.

RF systems. The contract for the two superconducting 500 MHz cavities and their cryostates was awarded to AES, a local high-tech company.

The production of the NSLS-II RF transmitter is progressing well. Figure 4 shows the 500 MHz 310 kW klystron in the process of being completed.

Figure 4. 500 MHz 310 kW klystron.

Finite Element Analysis (FEA) has been carried out on the Landau RF cavity to certify compliance equivalence to the ASME Boiler and Pressure Vessel Code. The analysis was presented to the Laboratory ESH Committee and approved.

Insertion devices. The contract for building the 3-pole wiggler wave length shifter was awarded to ADC, an upstate New York company. The contract for the elliptically polarized undulator (EPU) was awarded to KYMA, a company based in northern Italy. The design documents for the SRX undulator have been completed and the procurement process was begun.

Installation. The first Super Period of multipole girders C23 and C24 have had their plate mounting holes drilled into the tunnel floor. The first girder floor plates for C24G6 have been positioned and bolted to the floor (Fig. 5).

Figure 5. Multipole girder plates mounted on the floor.

All parts for girder moving dollies have been purchased. The installation of DI-water piping in pentant 1 has been completed. Figure 6 shows water piping in the tunnel.

Figure 6. Water piping in the tunnel.

The installation of AC cable connections between wall panels and racks has begun. Half the machine fiducials are installed and have been measured, including all those for the linac and booster. The installation of equipment enclosures on the mezzanine has started. All racks are in place.

Figure 7. Equipment racks installed on the mezzanine.

The cable tray is complete except for some grounding in the tunnel that BNL electricians will install. The human interlock interfaces are installed in the tunnel and the PPS cabinets are installed on the mezzanine. The uninterruptible power sources are in place on the mezzanine. An eyewash station near the forklift charging station was installed. Noise and silica sampling has been done throughout the drilling and scarifying process.

EXPERIMENTAL FACILITIES

XFD activities in April continued to focus on technical specifications and statements of work (SOWs) for long-lead-time procurement beamline components, including the larger beamline optics packages. Suppliers are working on proposals for both the lead and steel hutches. The evaluation of lead hutch proposals will commence in late May. The best-value evaluation process for motion controllers has been completed and the award of this contract is proceeding.

The **IXS** team has completed a draft of the SOW for the first optics enclosure (FOE) and is working on the technical specifications. Detailed shadow ray tracing study of the KB mirror system based on mirror metrology data obtained from potential vendors has been carried out; this is providing the basis for the optical specifications of the KB mirrors. In high-resolution crystal optics R&D, the mechanical stability of the high-precision mobile test system is being characterized, using a high- precision autocollimator and laser interferometer. In addition, mono beam topography at a PRT beamline (NSLS X19C) has been implemented to enhance crystal characterization capabilities. Mono beam topography images of several D crystals are being analyzed.

The **HXN** team completed writing the SOW for the HXN beamline optics package and expects to finish the technical specs in late May. For nanopositioning R&D, the long-travel flexure stages, with a maximum travel range of 3 mm, have been fabricated. Commercial nanopositioning stages are being evaluated for their feasibility as components of the HXN microscope. The feasibility of using the coarse piezo scanner in place of ball bearing stages is being explored. Tests revealed that coarse piezo stages from Attocube generated about 30 mW of power and reached an equilibrium temperature in about 20 minutes. These stages can hold their position after the power is turned off, making it possible to reduce the temperature gradient in the HXN microscope. The coarse stages demonstrated repeatability of about 50 nm (2 sigmas), which is excellent for coarse positioning.

The **CHX** team advanced with the first major procurement, the optics package. The SOW and specifications were handed over to Procurement, and the remaining work is progressing well toward a target date for the solicitation release of May 27. Work has also started on procurement of the diffractometer; first drafts of the SOW and specs are available.

The **CSX** team is evaluating proposals for fabricating the grating substrates and continues to work on technical specs for the remaining beamline optical components. The layout of the straight section and the specification of vacuum conditions at the front end are being detailed jointly with Accelerator groups. Exploratory measurements for mirror coatings were done, as well as studies to improve the pin-holes to be used.

The second procurement package for **XPD** is being prepared. It covers all white beam and monochromatic beam components (safety, beam transport and conditioning, diagnostics, high heat load) located in the FOE and in the endstation enclosure (hutch C), except for the optical components (mirror and monochromator). The specifications, experimental characteristics, and science capabilities of the XPD project beamline, both in initial scope and in mature status, are being examined. Discussion also includes a comparative analysis with the current state-of-the-art worldwide and a list of potential first experiments to be performed at XPD during the first few years of operation that may have high-impact in the relevant scientific disciplines.

The **SRX** team has finished writing the SOW for the SRX optics, and tje technical specs document and evaluation criteria are expected to be completed in late May. The RSI document has been modified to reflect positional changes for the IVU21 and the undulator for the zone plate branch. Documentation for purchasing KB mirrors will be prepared next. Discussions with potential vendors have continued, to survey their capabilities. In parallel, ray tracing calculations as well as wavefront propagation calculations have continued, to finalize the needed specifications.

The **optics fabrication** group completed rate testing for the 20:1 ratio wet etch mixture for silicon. A set of crystals for the **IXS** group is being prepared. A meeting with the HXN group was held to make a clear pathway for new MLL plans. The decisions was to grow new MLLs at 43 microns and 53 microns thick, using nitride reactive sputtering (for stress reduction) to try to have optics ready for the August and October beam times. If these optics are successful efforts will switch to fabrication of wedged MLL structures, with lower-z metal silicide materials.

CONVENTIONAL FACILITIES

Overall construction progress for the conventional facilities continues slightly ahead of schedule. Improving weather has enabled an increase in overall construction activity, particularly with additional progress in completing the ring building exterior enclosure and LOB foundations. A significant accomplishment is the start of structural steel erection of LOB 1 in late April, which has also created a significant visual change in the construction landscape (Fig. 8).

Figure 8. Structural steel provides the skeleton for LOB 1.

Beneficial occupancy was taken of pentant 1 in March, and Accelerator Division installation activities are now well underway. Remaining punchlist work required in this area by the general contractor is being controlled under a work permit system to prevent interference with accelerator installation activities. Punchlist work is mainly cosmetic. Some building systems in pentant 1 will require additional balancing and final adjustment later when the entire building is completed and full loads are available. Systems required to support experimental operations, such as liquid nitrogen and process cooling water, will be commissioned closer to the time they are needed, to reduce maintenance and operating costs and conserve system warranties.

The next areas slated for beneficial occupancy are the RF building and RF compressor building, which are now on track for availability in late May. Enclosure of those buildings is complete, interior finish work is being finalized, electrical service in the buildings is energized, and HVAC systems have been readied for commissioning. There were some delays due to a need to reconfigure the water service to the building, and contractor delays in assembling a prefabricated RF Cavity Test Room.

Work on the remaining sections of the ring building continues to progress well. The finished roof system and siding liner panel are now in place into pentant 4, and finished

exterior paneling is in place into pentant 3. The injection building enclosure is now moving forward rapidly, as the contractor has mobilized extra crews to make up time lost due to the weather.

Interior mechanical, electrical, and plumbing work is in progress in each of the remaining pentants and service buildings. The work includes HVAC ductwork, equipment placement and installation, fire protection, heating/cooling system piping, compressed air, nitrogen, and other utility services. This work is ahead of schedule in Pentants 3, 4, and 5. Although several early beneficial occupancy dates were impacted by the winter weather, we anticipate completing the later milestones several months early. To date, all structural steel, concrete, and major utility services for the ring building are complete.

LOB construction continues to make excellent progress. Foundations for LOBs 1 through 3 are now completed. Structural steel shop drawings have all been reviewed, and fabrication of steel is progressing on schedule. Delivery of steel for LOB 1 is completed and the erection is nearly done. Forms placement for the concrete HXN beamline endstation hutch at LOB 3 is in progress. The shop drawing submittal and review process for the LOBs is now well underway and proceeding on schedule. Work planning between contractors for the ring building and the LOBs continues cooperatively and without impact on the pace of either contractor's work.

ENVIRONMENT, SAFETY, AND HEALTH (ESH)

Planning is underway for the beneficial occupancy readiness evaluation (BORE) for phase 2, which includes the RF and compressor building. Pre-BORE walkthroughs are being conducted with subject matter experts to help expedite the process. The BORE is scheduled for the week of May 23.

The Linac Commissioning Safety Assessment Document and Accelerator Safety Envelope have been completed. They were reviewed by the BNL ESH Committee on April 12. All comments were adequately resolved and the documents are in the signature process, after which the documents will be submitted to DOE's Brookhaven Site Office for review and approval. Approval of these documents is a critical step in the process of commissioning the linac.

The erection of steel for LOB 1 began after a detailed steel erection plan was developed and approved by the project. The steel erection plan is a key document to assure that the work is performed safely and meets all OSHA standards.

COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) is 1.02 and the cumulative Schedule Performance Index (SPI) is 0.96, both well within the acceptable range. The project is 53% complete, with 30.6% of contingency and management reserve remaining, based on EAC work remaining. The project current-month CPI is 0.95, green status; the project current-month SPI is 0.92, also green status.

The project cumulative SPI remained constant from February at 0.96, due to a strong positive value for CF construction (cumulative SPI of 1.05, +$337K). This positive value was offset by the ASD current-month SPI of 0.79 (-$1.8M, for a cumulative AS schedule variance of negative $21.2M, SPI 0.83). The ASD current-month negative schedule variance was due to late deliveries of magnets, vacuum chambers, power supplies, and racks; and delays in completing the final design of the EVU Insertion Device. Experimental Facilities continues to perform close to plan for both cost and schedule.

The critical path for the project (see p. 7) remains the same as last month and includes RF cavity procurement lead-time to delivery, as well as delivery of the storage ring production magnets. The critical path runs through accelerator magnet deliveries; RF cavity contract award and fabrication; girder assembly, installation, survey, and alignment; then accelerator installation, integrated testing, and commissioning. The projected early completion date for the project is March 2014. There are 15 months of float between the project early completion milestone and CD-4, with approximately 30% schedule contingency.

PROCUREMENT ACTIVITIES

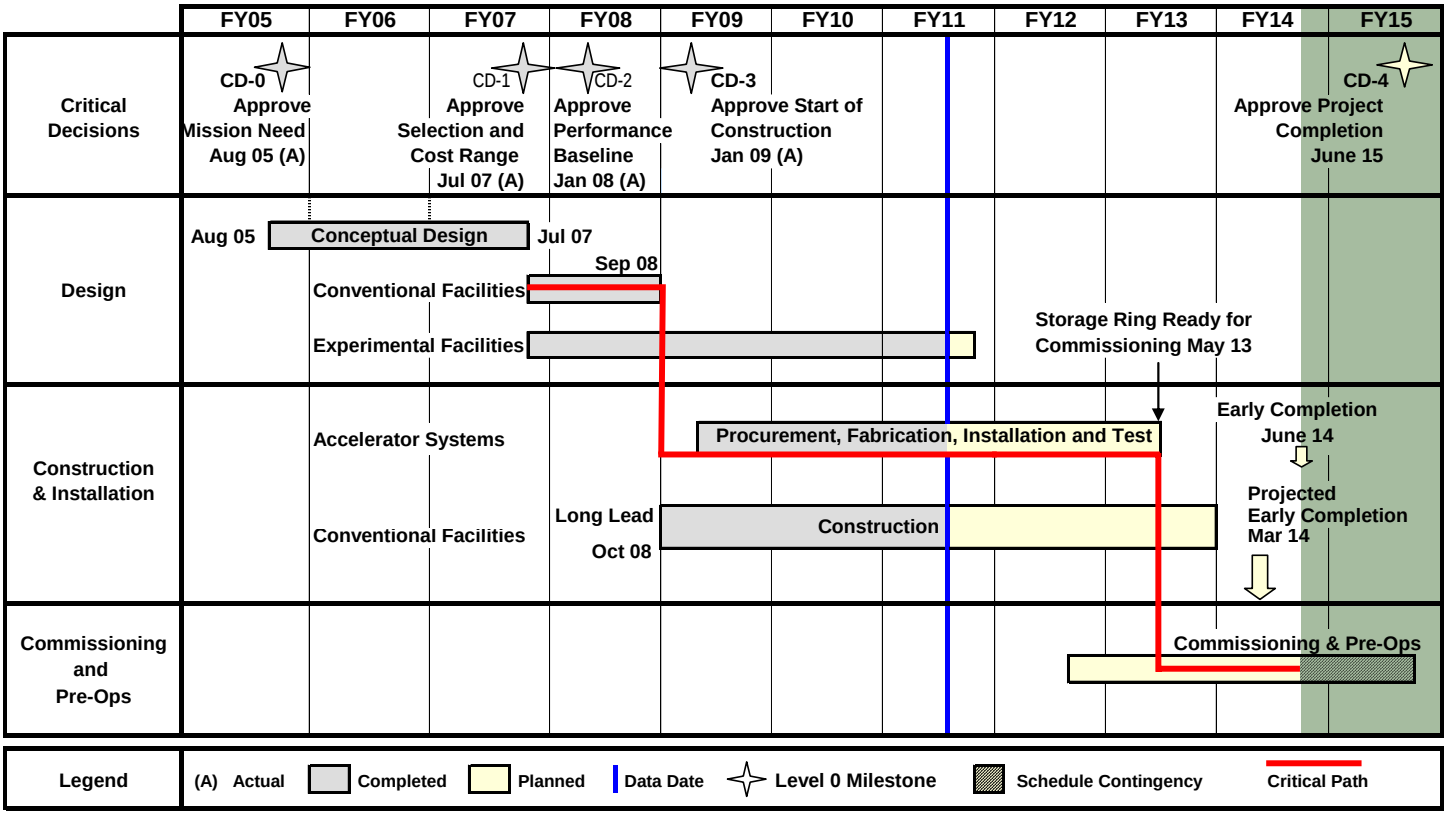
The proposals for the EPU are in the final evaluation process; a decision has been made and award is expected to be announced by late May. The solicitations for the hutches (both lead and steel) have been completed and successfully posted on FedBizOps. Proposal responses for the lead hutches are due the second week of May. The steel hutches responses are due the first week of June. Awards are expected in late June and July, respectively.

RECENTLY HIRED

Chelsie Cummings – Student Assistant, Training Group, PM
Jungdae Kim – Research Associate, Hard X-ray Nanoprobe, XFD

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)											
Topic	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	151.6	151.4	46.9	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	153.1	159.1	71.3	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 11973.