# National Synchrotron Light Source II

# Project Progress Report

## July 2010

July 30: Roof surfacing continues, and insulated panels (minus their outer sheathing) begin to appear on the walls of pentant 1.

report due date:
August 20, 2010

**Steve Dierker**
NSLS-II Project Director

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

## OVERALL ASSESSMENT

The National Synchrotron Light Source II project continues on schedule and on budget with excellent technical progress and satisfactory cost and schedule performances. The cumulative schedule performance has improved from 0.96 in June, to 0.98 in July.

In late July, an iron worker injured his hands on sharp sheet metal at the ring building site and received stitches at a local hospital. As the worker refused a mandatory post-incident drug test, he was discharged from the project for cause. A thorough safety analysis of this incident was performed and corrective actions for similar work have been instituted.

Construction of the ring building and central chilled water plant expansion continues to make excellent progress. Interior mechanical work in pentant 1 has begun, in preparation for beneficial occupancy of the first section of the building in February 2011. Recommendation for the selection of the Lab–Office Building (LOB) contactor was approved by DOE. With award of the contract being placed in August, LOB construction is anticipated to begin in September.

Accelerator Systems progress continued with successful procurement and delivery of major production components. A number of production and final design reviews were successfully held in July, including reviews for the magnets, linac, diagnostics beamline, and power supplies. Schedule delay in the delivery of production magnets, however, remains a concern, and all five contractors are being actively managed.

Preliminary designs of the six project beamlines progressed steadily, and excellent progress was made in the engineering designs for major long-lead procurement items, high spatial resolution optics R&D, and optics metrology.

Since September 2009, the projected early completion date of February 2014 has been maintained; the critical path now tracks through fabrication, installation, and commissioning of the accelerator systems. Schedule floats for key elements in the accelerator systems are being closely monitored.

Activities funded by the American Recovery and Reinvestment Act (ARRA) continue to be on schedule and on budget.

| UPCOMING EVENTS | 2010 – 2011 |
|---|---|
| Magnet Production Readiness Reviews (7) | July–Aug. |
| Coherent Soft X-Ray Beamline Advisory Team (BAT) meeting | Aug. 11 |
| RF Beamline Position Monitor Electronics Design Review | Aug. 11–12 |
| Light Sources Directorate Scientific Advisory Cttee meeting | Aug. 12–13 |
| DOE Mini-review of NSLS-II | Aug. 25 |
| ASD Secondary Cooling System Design Review | Sept. 1–2 |
| RF Bellows and Absorbers Review | Sept. 8–9 |
| Earned Value Management System (EVMS) Training | Sept. 9–10 |
| Coherent Hard X-Ray( CHX) BAT meeting | Sept. 14 |
| Insertion Devices Review | Sept. 14–15 |
| Inelastic X-ray Spectroscopy (IXS) BAT meeting | Sept. 16 |
| Injection Straight Review | Sept. 16–17 |
| NSLS-II Conventional Facilities Advisory Cttee (CFAC) meeting | Oct. 5–6 |
| EPICS Collaboration Meeting | Oct. 11–14 |
| NSLS-II Accelerator Systems Advisory Cttee (ASAC) meeting | Oct. 14–15 |
| NSLS-II Prelim. Design Rev. (PDR) of Experimental Facilities | Oct. 19–20 |
| DOE Review of NSLS-II Project | Nov. 15–18 |
| Project Advisory Committee (PAC) | Feb. 9–11, 2011 |

## ACCELERATOR SYSTEMS DIVISION (ASD)

Activities continue to shift from design work to the construction and integration of first article systems. This has been particularly true of the systems which come together to form the storage ring girders. A number of significant design reviews were held in July, including the linac preliminary design review (PDR), diagnostics beamline review, and the final design review for the storage ring power supplies, including the dipole, multipole, and corrector supplies.

At the linac PDR in July, modifications were proposed to accommodate future upgrades, including drifts for the addition of components such as a chopper right after the gun. For the booster, staff from BINP have visited BNL as well as holding weekly conference calls to develop more detail for the utilities and installation procedures. BNL staff will visit BINP to discuss the injector in August, with a design review planned for September. Design of the transport line magnets is complete and procurement is expected to begin in August.

Production of magnets for the storage ring made good progress, although the delivery of first articles is slower than scheduled. Additional vendor visits are planned for August to address management concerns over schedule and technical performance in production first articles.

Figure 1. High-precision quadrupole first article at Buckley Systems.

The first article high-precision quad (Fig. 1) was completed by Buckley Systems, and the first 35mm dipole yoke is nearing completion. A Production Readiness Review (PRR) was conducted for the Danfysik sextupole magnet. Production has begun, with the first production units expected in October. The first article Danfysik sextupole arrived at BNL and is under test, with two additional first articles awaiting final testing in Denmark. First article correctors are nearing completion at Everson Tesla in Pennsylvania, with their PRR scheduled for August 27. The first high-precision yoke has been completed at Everson Tesla in the UK and is under test,

while the remaining first article yokes near completion. At IHEP the first article sextupole was completed and is being held while a second magnet is completed and tested. BINP has produced a Type A quadrupole yoke assembly; a field visit by BNL verified that their magnetic measurement system should be capable of the required measurements.

Preparation of other storage ring girder components made excellent progress, with all twelve first article girders received and inspected. Nine S5 dipole chambers were received from APS and are being measured. Six S2E chambers have been welded at APS and are being vacuum tested. The design of scraper mounting ports is complete and ready for prototyping. Two prototype S4A inconel chambers are being fabricated at vendors, with one almost completed. Vacuum pumps continue to arrive; 70 of the ion pumps and all 1,800 meters of NEG are in-house.

RF shields for rogue mode suppression (Fig. 2) have been successfully installed in both S2 and S4 production chambers. An installation tool was created; based on these initial installations, smooth production installation is expected.

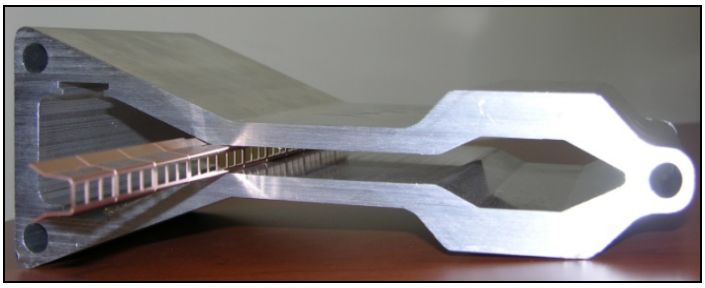


Figure 2. Rogue mode suppression shield in multipole chamber extrusion.

Testing of invar chamber supports was completed and showed that coupling of ground motion to the sensitive locations near the beamline position monitors (BPMs) is well within specification. Concerns over the possibility of these plates interfering with the lattice magnet fields have led to a testing program for low-expansion carbon fiber support plates as a nonmagnetic alternative. Thermal stability appears to be excellent in prototype testing, and material is being procured that would be sufficient to make and test one superperiod of vacuum chamber supports.

Changes were made to the body of the RF BPM button assembly to improve their performance and reliability in operations (Fig. 3). A modest relief was added to the helico flex seal surface on the flange to ensure proper seating of the assembly on the vacuum chamber. A groove for an RF seal on the assembly body was also added to provide suppression of a mode that could be excited in the gap between the chamber and BPM body.

Development of the BPM receiver electronics has been progressing, with several prototypes under test both in-house and at ALS, which has the same RF frequency as NSLS-II. Unanticipated noise issues in the turn-by-turn mode are being actively investigated. A review of the system is planned for August.

Figure 3. Production RF BPM button assembly with groove for RF spring ring to suppress longitudinal impedance mode.

Testing of the transverse feedback system has also been undertaken at SPEAR-3 with a feedback bandwidth of ~20 MHz, limited by the stripline that was used. Overall the tests were quite successful, showing fast-ion trapping instabilities and horizontal resistive wall instabilities.

A very successful review of the three proposed diagnostic beamlines was also held in July. The review committee strongly endorsed the construction of all three beamlines as part of the suite of Day 1 diagnostics for commissioning and operation of the accelerator.

Another significant review was held for the final design of the power supplies for the storage ring. Its scope included the dipole supplies and the multipole and corrector supplies. Minor issues that were raised for the main power supply are being factored into the procurement specification. Multipole and corrector supplies had an error in their voltage ripple specification at low frequency; this has been corrected. The committee recommended that procurements proceed when the supporting documentation is available.

Testing of 1-wire temperature sensors in the NSLS x-ray ring has revealed they are more prone to radiation damage than their use and history at RHIC would have suggested. Different sensors and shielding configurations are being tested, to explore the solution. The equipment enclosure procurement is proceeding, although the contractor will be using a different subcontractor to fabricate the racks. The new manufacturer providing the racks was rated superior during the evaluation, so this change actually improves the quality of the system as a whole.

The Specification and Statement of Work (SOW) for the RF cryogenic system have been prepared and will be sent out for procurement. Finite Element Analysis of the Landau Cavity structure has shown an area of high stress at a weld joint between the fill tube and helium vessel, but including a bellows in the design appears to reduce the stress by a factor of 10. The results of this analysis have been shared with Niowave, who will factor them into their final design.

The controls group continued work on the various test stands (beamlines, PPS, RF, and vacuum) as well as hardware evaluations. Significant work was invested in supporting hardware development, particularly the BPM receiver, and including improvements in the development environment to

reduce turnaround times for FPGA compilations. First-revision boards for the power supply controller have been tested. Three second-revision boards have been under test for about a week. After more exhaustive testing, the production boards (900, total) will be ordered in September.

The Damping Wiggler RFP is in process, with vendor proposals anticipated by September 2. The RFP for the In-Vacuum Magnet Measuring System has been released to vendors, and it appears that at least two vendors are likely to present proposals. The SOW and Specification for testing the 4m-long vacuum seal have been circulated to staff for any final changes before being sent to the Procurement group. The Three-Pole Wiggler SOW and Specification have been approved for release to Procurement.

## EXPERIMENTAL FACILITIES DIVISION (XFD)

The Experimental Facilities Division continued to progress in design work for the six project beamlines. Preliminary designs of the experimental hutches (radiation enclosures) advanced significantly in July; the draft SOW was reviewed by the NSLS-II ESH group and the Laboratory-wide ESH staff on July 1 and is on track to go to Procurement in the fall of 2010. Baseline insertion device requirements and specifications were completed in the Requirements-Specifications-Interface (RSI) documents. Upgrade paths for advanced insertion device implementation were identified, and a preliminary plan was formed to provide enhanced spectral flux for the Inelastic X-ray Scattering (IXS) beamline. After discussions with ASD, the front-end design requirements were finalized for all six project beamlines with respect to fixed mask and x-ray BPM locations. Fixed mask angular apertures remained unchanged.

The preliminary designs of long-lead-time optics such as monochromators, mirrors, and gratings are well advanced. Groupings of x-ray optics across the six project beamlines were identified and preliminary procurement strategies have been established. Designs for specific optics and endstation components that require significant engineering physics input are progressing well, including the double Laue monochromator for focusing and good energy-resolution for the X-ray Powder Diffraction beamline, the Submicron Resolution X-ray Spectroscopy beamline endstation design compatible with a built-in cryogenic specimen environment, the consolidated SAXS/WAXS endstation for the Coherence Hard X-ray scattering beamline, the Hard X-ray Nanoprobe endstation design (Fig. 4) compatible with multilayer Laue lens (MLL) optics, and the collimating compound refractive lens in the white-beam for Inelastic X-ray Scattering (IXS).

In 0.1meV optics R&D, progress was made in improving the crystal alignments in the CDW-CDW optics system. The measured resolution for the ~1meV optics improved slightly, to ~2.9 meV measured at the NSLS R&D beamline, X16A. The measurements of optics efficiency are ongoing.

Commissioning of the new MLL deposition system was completed at NSLS-II. The system was successfully used to

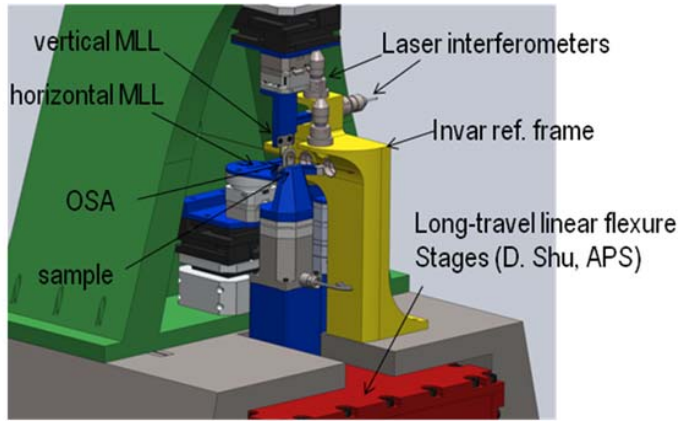



Figure 4. Conceptual design of the Hard X-ray Nanoprobe endstation that is designed to accommodate MLL optics along with a compact laser interferometry monitoring and feedback system. The design was a collaborative effort between NSLS-II and APS.

produce a test multilayer system that is 46 microns thick and took 128 hours to complete using more than 46,000 transport cycles. The deposited sample is being characterized by scanning electron microscope and x-ray reflectivity to verify its high quality.

## CONVENTIONAL FACILITIES DIVISION (CFD)

Construction of conventional facilities continued to make excellent progress in July, as nearly all trades are fully mobilized. Work now underway includes sitework, concrete, structural steel, all underground utilities, roofing and exterior siding, masonry, and interior mechanical and electrical trades. Overall progress is ahead of schedule and on track for completion of the first beneficial occupancy milestone early in 2011.

Figure 5. SR tunnel in pentant 1 painted, with conduit and lighting installed.

Concrete work during July included continued progress on the booster and linac tunnel, where the floors, walls, and roof are now complete; the only remaining issues are connections to the ring building and closure of the section left open for construction access. Backfilling of the inner area of the booster is now underway. The Experimental Floor slab and

access corridor sections are rapidly progressing around the ring and are completed through pentant 3.

The building envelope continues to make excellent progress; the roof membrane and insulation are now completed into pentant 4. Siding is completed on the cooling tower building and has begun on pentant 1. Masonry wall sections on the ring building are also underway.

Interior mechanical work began in pentant 1 with the installation of fire protection piping and HVAC ductwork (Fig. 6). The utility carrier system above the tunnel mezzanine, is now in place and is being loaded with electrical conduit and piping services. Conduit, lighting, and HVAC ductwork are being installed in the storage ring tunnel in pentant 1, as shown above in Figure 5.

Figure 6. Mechanical-electrical-plumbing (MEP) work underway in pentant 1.

The chilled water plant expansion made excellent progress during July, with installation of the chillers and major electrical equipment. All building construction, cooling towers, piping, and electrical cabling and conduit installation are ahead of schedule.

Figure 7. Cooling tower and process water building.

The chilled water piping package overcame some early delays and is now making excellent progress. Work under the intersection of Rowland Ave. and Rochester St. has been completed and the intersection has been reopened. Piping is progressing rapidly down Rowland Ave. and should be near the NSLS-II site by late August.

Delivery and installation of the 20MVA transformer (Fig. 8) was completed in July as part of the electrical substation expansion. Work is now underway to tie in the transformer and terminate all cabling.

Figure 8. Rigging the 20Mva transformer into the substation on July 30.

## ENVIRONMENT, SAFETY, AND HEALTH (ESH)

An iron worker was injured on July 26 at the ring building site while cleaning debris from the second floor of service building 4. As the worker pushed a scrap piece of corrugated sheet metal decking (approximately 3′ x 10′, weighing 20 to 30 lbs) across the floor, it caught on the edge of the deck, causing the sharp corners to cut into the palms of both of his hands. The worker was treated by the on-site EMT and transported to a local hospital. He received five stitches in the left hand and nine in the right hand. The worker refused a mandatory post-incident drug test and was discharged for cause. It was determined that the worker was wearing gloves, but the type could not be determined. A causal analysis was performed and corrective actions for similar work have been instituted, including the use of reinforced gloves and using a two-person lift to move pieces that are 6 feet or longer.

## PROCUREMENT ACTIVITIES

The Procurement package for recommendation of award of the Laboratory–Office Building contract has received DOE approval. Award of the LOB contract is anticipated during mid August, enabling the start of construction in September, approximately 14 months ahead of the original schedule.

## COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) is 1.02 and the cumulative Schedule Performance Index (SPI) is 0.98, both well within the acceptable range.

Progress during July in most areas of the project was on schedule and on budget. The current-month CPI is 1.09, green status. The current-month SPI of 1.19 (yellow status), which indicates a very positive schedule variance, is due to the continued strong schedule performance of the ring building construction. The accelerator schedule continues to run behind the baseline, due primarily to a delay in the delivery of storage ring first article magnets and late deliveries in vacuum chamber production.

The critical path for the project (see the milestone schedule on p. 7) passes through accelerator vacuum inconel chamber procurement and delivery; girder assembly and installation, survey and alignment; then through accelerator installation, testing, and commissioning. The ring building construction, magnet deliveries, booster, and vacuum chambers are within 3 months of the critical path. The projected early completion date remains at February 2014.

## RECENT HIRES

Daniel Bacescu – Mechanical Engineer, CSX Beamline, XFD

Susan Leng – Electrical Engineer, Vacuum, ASD

Ronald Loffredo – Mechanical Technician, Mechanical Eng., ASD

Craig Rhein – Mechanical Technician, Insertion Devices, ASD

## RECENT PROJECT ACCOMPLISHMENTS

- Recommended LOB contract award was approved by DOE.
- First article high-precision quad was completed by Buckley Systems.
- First article Danfysik sextupole is now at BNL, being tested.
- First high-precision yoke was completed at Everson Tesla, UK.
- IHEP first article sextupole was completed.
- All first article girders were received and inspected.
- Nine S5 dipole chambers received from APS are being measured.
- Six S2E chambers welded at APS are being vacuum tested.
- 70 ion pumps and all 1,800 meters of NEG are in-house.
- Transport line magnets design was completed.

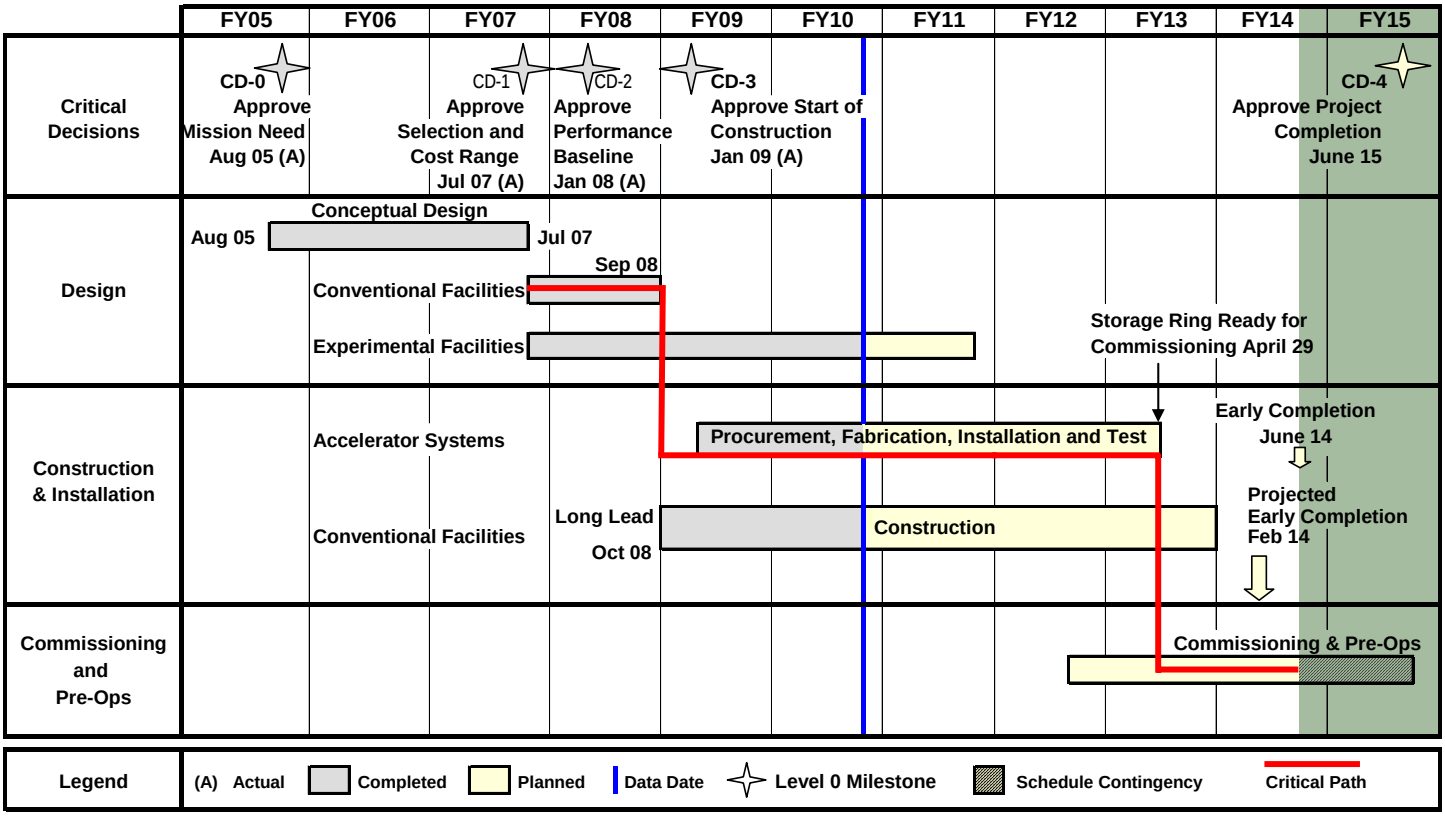
Shield door installation is a portal to the future.

- 70 ion pumps and all 1,800 meters of NEG are in-house.
- Transport line magnets design was completed.
- RF shields for rogue mode suppression were successfully installed in both S2 and S4 production chambers.
- Baseline insertion device requirements and specifications were completed and updated in RSI documents.
- Front-end design requirements for fixed mask and X-ray BPM locations were finalized for all project beamlines.
- Commissioning of new MLL deposition system completed at NSLS-II and used to produce a test multilayer system 46 microns thick.
- Conventional Facilities progress ahead of schedule, on track for first beneficial occupancy in February 2011.
- Roof membrane and insulation are now completed into pentant 4. Siding is completed on the cooling tower building and has begun on pentant 1.
- Delivery and installation of 20MVA transformer was completed in July as part of the electrical substation expansion.

## PROJECT DESCRIPTION

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) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fiscal Year | 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