# National Synchrotron Light Source II

# Project Progress Report

## June 2010

June 30: The ring building structural steel is nearly complete, with a temporary opening maintained for construction access to the ring's interior.

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report due date:
July 20, 2010

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BROOKHAVEN
NATIONAL LABORATORY

## OVERALL ASSESSMENT

The National Synchrotron Light Source II project continues to make excellent progress with satisfactory cost and schedule performances. Overall, the project is on schedule and on budget with no major technical issues and no reportable safety incident in June.

Construction of the ring building and central chilled water plant expansion continues to be ahead of schedule. Installation of roofing, siding, masonry, and various utilities for the ring building are progressing and beneficial occupancy of the first section of the building in February 2011 is on track.

Accelerator Systems continued with successful procurement and delivery of major production components such as vacuum chambers, girders, BPM and power supply parts, injector transfer lines, and mechanical utility systems. Schedule delay in the delivery of production magnets, however, remains a concern and all five contractors are being actively managed. Design and production schedules submitted by the linac and booster vendors were successfully reviewed.

Preliminary designs of the six project beamlines are on track to complete the design reports and the engineering designs for major long-lead procurement items by this fall. Excellent progress continued in optics R&D.

The projected early completion date remains February 2014, with the critical path going through the 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.

## SCHEDULED EVENTS 2010 – 2011

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| Beamline Development Workshops (13) | April–June |
| Final Design Review of NSLS-II PPE | June 9 |
| Utility System Design Reviews (2) | June |
| Radiation Safety Workshop | June 22–23 |
| Final Design Reviews: Electrical System & Power Supplies (3) | May–July |
| Magnet Production Readiness Reviews (7) | July–Aug. |
| Beamline Access Team (BAT) meetings (6) | July |
| Scientific Advisory Cttee (SAC) Proposal Review meetings (7) | July |
| Timing and Fast Orbit Feedback Workshop | July |
| Synch. Light Diagnostics & Multi-Bunch Fdbk System Review | July 15-16 |
| Final Design Review for NSLS-II Power Supplies | July 26 |
| Light Sources Directorate SAC meeting | Aug. 12–13 |
| DOE Mini-review of NSLS-II | Aug. 25 |
| Insertion Devices Review | Sept. 14-15 |
| NSLS-II Conventional Facilities Advisory Cttee (CFAC) meeting | Oct. 5–6 |
| 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)

Three symmetric first-article sextupole magnets have been produced by Danfysik and are being measured and tested. TESLA has produced a high-precision quadrupole half-yoke (Fig. 1) but needs to increase its production pace in order to meet the schedule requirements. Buckley Industries is now on track with their reviewed first-article magnet production, having completed three quadrupole yokes with tolerances of about 10 microns or better, using the electrical wire erosion (EDM) technique. The first 90mm-aperture quadrupole magnet is being prepared for testing and field measurements; results are expected by the end of July. Quadrupole production at Budker Institute of Nuclear Physics (BINP) remains slow, due to an unsolved problem with the production of high-quality yokes. IHEP has produced three additional sextupole magnets with their improved EDM machine. Test results for these magnets will be available by mid July. The yokes for the five initial first-article corrector magnets have been completed and the first corrector is being assembled for testing.

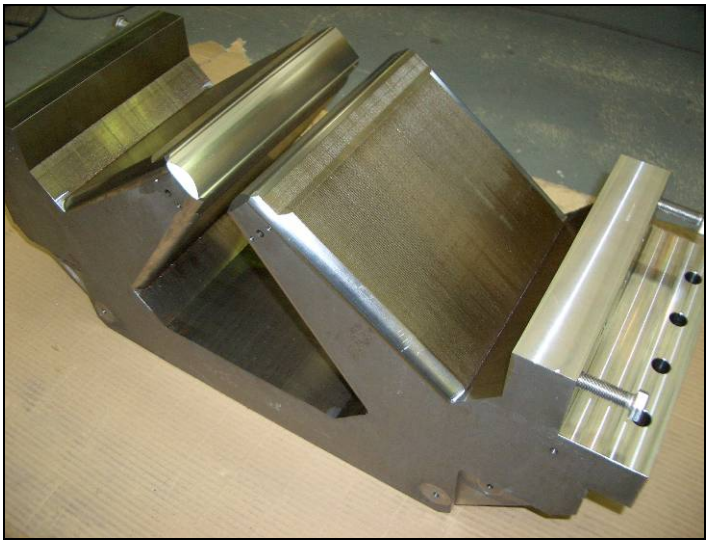


Figure 1: High-precision quadrupole half-yoke produced at TESLA.

Vacuum chamber production has picked up speed. Sixty multipole extrusions arrived from Tai Lain, Ltd. and are being measured. Many of these have been qualified as usable for the NSLS-II chamber production. Three additional S4 aluminum vacuum chambers were received from APS, bringing the total completed S4 chambers to six. Ten S5 dipole chambers have been welded at APS and are being vacuum tested. A wider channel for the damping wiggler radiation fan is required in the keyhole part of the downstream dipole vacuum chamber. A method for drilling a larger channel through the dipole chamber extraction gap was developed for S3 chambers. The design of dipole chambers for the 90mm magnet is complete. The design of scraper mounting ports has begun. Work on the conceptual layout and specification of the damping wiggler vacuum chamber has intensified. The design of transfer line bending chambers continues.

The first-article BPM buttons were modified to reduce impedance and were tested for installation and sealing. Several multipole chambers were assembled with RF screen, NEG strips, and BPM buttons for vacuum evaluation.

The design of RF fingers for gate valves is finalized. The order for 300 titanium sublimation pump cartridges was placed with the qualified bidder. The order for 200 dual ion pump PS was also placed.

The design of NSLS-II power supplies (PS) is coming to an end and the final design review will be held ahead of schedule. The most recent progress includes finalization of the printed circuit board for the two-channel regulator board, which has been sent to an outside vendor for prototype production. The design for the two-channel power supply interface has been completed, and testing on the existing prototypes and measurement of thermal performance for the 18-bit DACs is in progress. A second prototype alignment corrector power amplifier has been built with components that will be used in the final production version. Major procurements for components of the PS system are in preparation. Full production testing of DCCTs (200/month) is in progress. Results look good and there is confidence that all DCCTs will be available ahead of schedule by mid 2011. The final design review was held for the electrical utilities design tasks. This included the cable trays, AC power connection, and special AC power or uninterruptible power supplies. The production contract for the equipment enclosures has been awarded to a U.S. company.

All 12 first-article girders have been received and the first four have been inspected, with no adverse findings. The girder inspection traveler has been released. Meanwhile, preparation for the magnet-vacuum-girder integration is nearing completion: Models are 95 percent complete for section 2 yaw fixtures; precision spirit levels have been received for magnet roll measurement; the girder strong back for transport has been ordered; all shelving for magnet and hardware storage is installed; and the hydro test facility is functional and some magnet splice joints have been tested.

Procurements for the production of beamline front ends were put on hold while the final analysis and configuration adjustments were being made. The adjustments include addition of a fixed mask downstream of XBPMs and a pre-mask for the front ends. Preliminary ray tracing drawings for the IXS, XPD, CSX, HXN, and CHX front ends have been generated based on the reconfigured geometry.

For mechanical utilities, piping plan drawings have been completed and checked. This package is ready for procurement. The design of the cooling water units ("squids") has been fine-tuned and completed. The procurement documents have been written, and potential vendors have been visited.

The injector complex and linac procurement progressed well. The decision for the solid state modulator option has been made and the contract has been updated accordingly. An accelerator physics model of the linac has been created. The vendor's draft of the preliminary design report has been thoroughly reviewed and there are no major issues. Regular meetings with BINP on the design of the booster have taken place and any design issues have been resolved. A booster production schedule has been submitted by the vendor; this will be integrated into the project schedule. Components of the transfer lines are being procured. Transfer line magnet production will be open for tender by the end of July. The driver for the pulse-forming network for the booster extraction kicker has been designed. The vacuum chamber is being coated at NSLS. Collaboration with the Shanghai Synchrotron Research Facility is underway to explore the possibility of using technology from that light source.

The controls group has continued work on beamline test set-ups, which included various hardware and software tests on monochromators and other beamline devices. A prototype of the NSLS-II controls network was installed in the NSLS Network; it includes five switches in four locations and supports a virtual LAN-segmented controls network, virtual switching, plus features for rapid rerouting of data packages in case of a component failure. The installation also included a network boot server with image backups and a monitoring framework with email alerts and other network features of the NSLS-II design.

Hardware control is maturing quickly, with firm plans for all hardware systems. Controls staff are closely involved in finalizing the interfaces between power supplies and BPMs. Good progress has been made in detailing the controls interface design for vacuum systems, instrumentation, and insertion devices.

A technical review of the controls systems is underway in the context of various accelerator subsystems. Design was completed for the cell controller, which coordinates deterministic and fast data transfer between different hardware systems via a timing bus and shared memory bus. Schematics were checked; the printed circuit board design was reviewed and released. The boards and parts have been ordered.

On the software front, extensions to EPICS have been implemented to support server-side filtering. With this feature, different applications can simultaneously monitor different events on the same channel. Electronic logs (elogs) from around the world were evaluated. Many of these rely on Oracle or a set of tables that are quite specific to the originating site. The most promising elog appears to be a version produced by the University of Michigan, based on the IRMIS database. A copy has been requested, for testing.

A document for high-level applications is being developed, with requirements and a manual that clarifies the Client Application Programming Interface and the data structure design. Preliminary performance benchmarks and improvements are complete for the Channel Finder service and the Gather service. Applications have been developed using this service to demonstrate "local orbit bump." The Control System Studio package that was started at DESY and taken up by ORNL is now our declared base. Engineers at BNL have modified the build and deployment system to allow parallel

development from all collaborators, along with unit testing, a modular build system, and simplified deployment. At the EPICS collaboration meeting in June, this new development environment was adopted as the standard.

## EXPERIMENTAL FACILITIES DIVISION (XFD)

Progress continued to be made in the preliminary design of the six project beamlines. Advanced procurement planning has started for major long-lead-time items, including radiation enclosures and optical systems for all six beamlines. Dimensions of the tungsten blocks are being finalized based on input from the NSLS-II Environmental Safety and Health group. To prepare for procurements in the coming months, a draft requirements and specifications document is in progress.

As part of the standard beamline components for the six beamlines, a preliminary design of a dual-shutter device was conceptualized (Fig. 2); it includes two independent shutters in a common enclosure with dual actuators, dual redundant/limit switches, and dual shutter blocks. A mechanical lock and an anti-tamper cover will be used with all wiring in protected conduits.

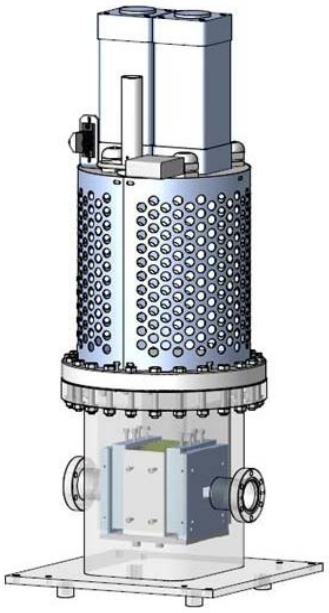


Figure 2. Preliminary design of a dual-shutter device for NSLS-II Experimental Facilities beamlines.

In the area of 1 nm optics R&D, the commissioning of the new Multilayer Laue Lens deposition system was completed at NSLS-II. The system was fully assembled in March and fully tested in April 2010. A first periodic multilayer sample was fabricated using the new system, and the ex-situ x-ray reflectivity measurement on the multilayer indicates excellent quality of the thin-film growth. The commissioning report for the new system was received at the end of June 2010.

The nanopositioning laboratory infrastructure was established in the clean laboratory space in Building 703 (Fig. 3). Nanopositioning environmental tests have demonstrated high background stability well below the VC-G criteria on top of the optical table, and a temperature stability of <0.1°C in an environment suitable for nanometrology. A prototype compact interferometer system was procured, and its delivery is expected by the end of July 2010.

In 0.1meV optics R&D, progress was made on replacing the old cracked beamline mirror at the R&D beamline at NSLS. A newly installed beamline mirror was commissioned, and the ~1meV optics test was resumed. The photon flux through the CDW-CDW optics system was found to be improved by a factor of ~30, and a more careful evaluation of the optics efficiency was undertaken. Preparations for procurement of a CDDW-CDDW prototype instrument were begun, with the goal of allowing complete experimental tests of the new optical scheme both at NSLS and at a third-generation synchrotron facility.

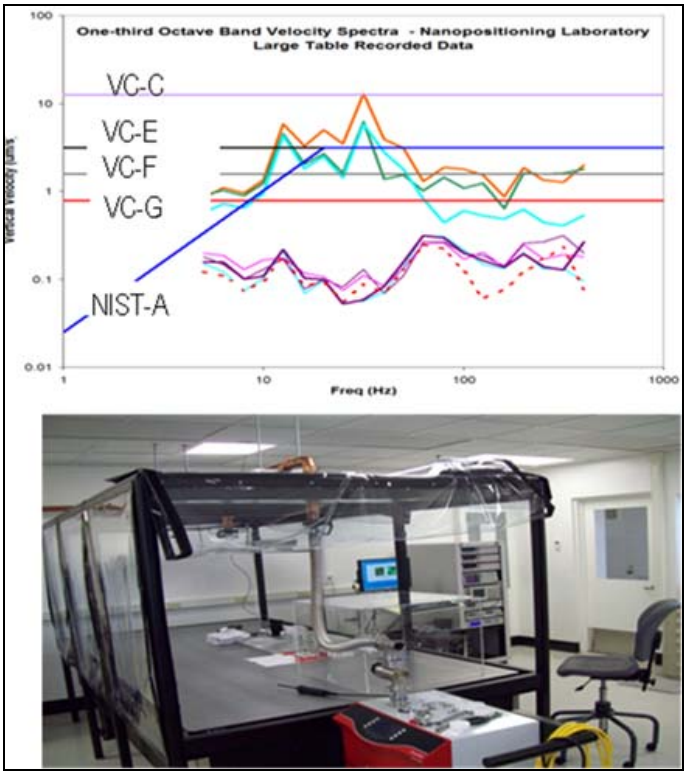



Figure 3. Measured background vibration spectra (top panel) indicate excellent vibration characteristics, well below the VC-G criterion, in the NSLS-II Nanopositioning R&D Laboratory (bottom panel) in Bldg. 703.

## CONVENTIONAL FACILITIES DIVISION (CFD)

Construction of conventional facilities continued to accelerate in June as additional subcontractors and trades were added to the workforce. Concrete and steel work for the ring building continue ahead of schedule, and work on the building envelope now includes installation of roofing, siding, and masonry. The installation of utilities in the center courtyard (Fig. 4) made excellent progress and includes chilled water, compressed air, deionized water, and electrical utilities. The contractor is maintaining the schedule established in their coordination plan for these utilities, prepared last month to ensure the utilities can be properly installed in time for commissioning and startup for the first beneficial occupancy date in February 2011.

The ring building structural steel and storage ring tunnel are now complete except for the section of pentant 5 that was left open to allow construction access until the vehicle tunnel is operational and the erection of steel for the injection building is complete.

Figure 4. Emergency generator and substation in the courtyard near pentant 4.

Concrete work during June included continued progress on the booster and linac tunnel (Fig. 5). Floor slabs are now complete and wall and roof sections are progressing rapidly.

Figure 5. Injection building booster ring floor slab and tunnel walls.

The first of many experimental floor slab and access corridor sections was poured, starting in pentant 1; workers have progressed through most of pentant 2 (Fig. 6).

Figure 6. Finishing the experimental floor in pentant 2.

The building envelope continues to make excellent progress as the roof membrane and insulation are now completed into pentant 3. Siding is nearing completion on the cooling tower building and will begin shortly on pentant 1. Masonry wall sections on the ring building are also underway in the bypass corridor areas.

Interior mechanical work has started in pentant 1 with the installation of fire protection piping and HVAC ductwork. The utility carrier system will begin installation shortly, above the tunnel mezzanine, and will be followed by the installation of electrical conduit and piping services.

The chilled water plant expansion is progressing well as all building construction, cooling towers, piping, and electrical cabling and conduit installation are ahead of schedule. This progress was offset by a contractor delay in rigging the chillers, substation, and switchgear into the building. These items are expected to be completed in July, bringing the chilled water plant expansion project back ahead of schedule.

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. is nearly completed and will enable reopening of the intersection in July. Piping will progress rapidly down Rowland Ave. and should be near the NSLS-II site by late August.

Final arrangements are being made for the delivery and installation of the 20MVA transformer in mid July as part of the electrical substation expansion. The substation yard has been prepped for delivery, and schedules for tie-in of the transformer are now complete.

The procurement package for recommendation of award of the Laboratory–Office Building (LOB) contract has been routed for DOE approval. Award of the LOB contract is anticipated during early August, enabling the start of construction in late August, approximately 14 months ahead of the original schedule.

## ENVIRONMENT, SAFETY, AND HEALTH (ESH)

The ring building contractor completed its first period under the newly modified safety incentive. For the period from April 1 through May 31, the incentive earned was $39,432. Per the terms of the incentive, 90% of this money must go directly to the workers. The contractor has the potential to earn nearly double this amount for the period ending July 31.

A Beneficial Occupancy Readiness Evaluation (BORE) plan has been developed, laying out the schedule, criteria, and responsibilities for turning over conventional facilities to the project so that equipment installations may begin. The BORE process for the NSLS-II conventional facilities will be divided into phases that coincide with the scheduled delivery of facilities from the contractor.

Work began on development of the Linac Safety Assessment Document (SAD) and the Accelerator Safety Envelope (ASE) to support commissioning of the linac. The SAD and ASE documents are required to be in place and approved prior

to the Accelerator Readiness Review that must be performed to obtain approval for commissioning. SADs and ASEs will also be developed for the booster, storage, and routine operations.

A radiation safety workshop was held June 22–23, with experts from APS, SSRL, ALS, and BNL participating in the discussions. The objective was to gain feedback and lessons learned from radiation safety experts in the DOE complex. Workshop topics included shielding, top-off, interlocks and interlocking strategies, beam loss control, and monitoring. The committee stated at the closeout that they were "highly impressed with the progress that has been made to date in working and resolving radiation safety issues for design and commissioning of the NSLS-II since the last radiation safety workshop in April 2008." The committee provided preliminary feedback and recommendations for shielding, top-off operation, beamline radiation safety, the personnel protection system, beam loss control and monitoring, commissioning, area monitoring, and the accelerator safety envelope. A final report is forthcoming, and all recommendations will be tracked to closure.

## PROCUREMENT ACTIVITIES

The LOB award and the Damping Wiggler Request for Proposal (RFP) were reviewed and approved by the BSA Contract Review Board. Both proposals will be forwarded to DOE for review in early July. All magnet contractors are proceeding with first article manufacture and delivery. Minor technical issues with each contractor are being addressed through weekly status meetings and site visits. The equipment racks procurement ($3M) was awarded in mid June.

## COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) is 1.01 and the cumulative Schedule Performance Index (SPI) is 0.96, both well within the acceptable range.

Progress during June in most areas of the project was on schedule and on budget. The current-month CPI (1.05) and SPI (0.85) (yellow status) are primarily due to a delay in the delivery of storage ring first article magnets, late completion of the preliminary linac design, a redesign of the beamline front ends, and catch-up in vacuum chamber production.

Ring building construction continues ahead of schedule. The current-month negative schedule variance was due to delays in the installation of electrical and mechanical underground utilities. The cumulative schedule variance for the ring building construction continues to be positive, with the critical path for the project (see the milestone schedule on p. 7) passing through accelerator vacuum Inconel chamber procurement and delivery; girder assembly/installation, survey and alignment; then through accelerator installation, testing, and commissioning. Ring building construction, magnet deliveries, and the booster and linac commissioning are within 3 months of the critical path. The projected early completion date remains at February 2014.

## RECENT HIRES

Edward Marczak – Electronic Technician, Vacuum, ASD

Arturo Munoz – Electronic Tech, Diagnostics & Instrumentation, ASD

Chenghao Yu – Survey & Alignment Engr, Mechanical Engring, ASD

## RECENT PROJECT ACCOMPLISHMENTS

- Three symmetric first-article sextupole magnets being measured and tested. High-precision quadrupole half-yoke produced. Three quadrupole yokes delivered. First 90mm-aperture quadrupole magnet being prepped for testing and field measurements. Sixty multipole extrusions arrived and being measured. All 12 first-article girders received. Three-hundred titanium sublimation pump cartridges and 200 dual ion pump PS ordered.

- New Multilayer Laue lens deposition system produced an excellent first periodic multilayer sample. Testing completed.

- Ring building structural steel and storage ring tunnel now complete except for a construction access gap. Roof membrane and insulation now completed into pentant 3. Siding nearing completion on cooling tower building and begins shortly on pentant 1. Masonry wall sections on ring building underway in bypass corridor areas. Interior mechanical work now started in pentant 1. First floor-slabs and access corridor sections poured.

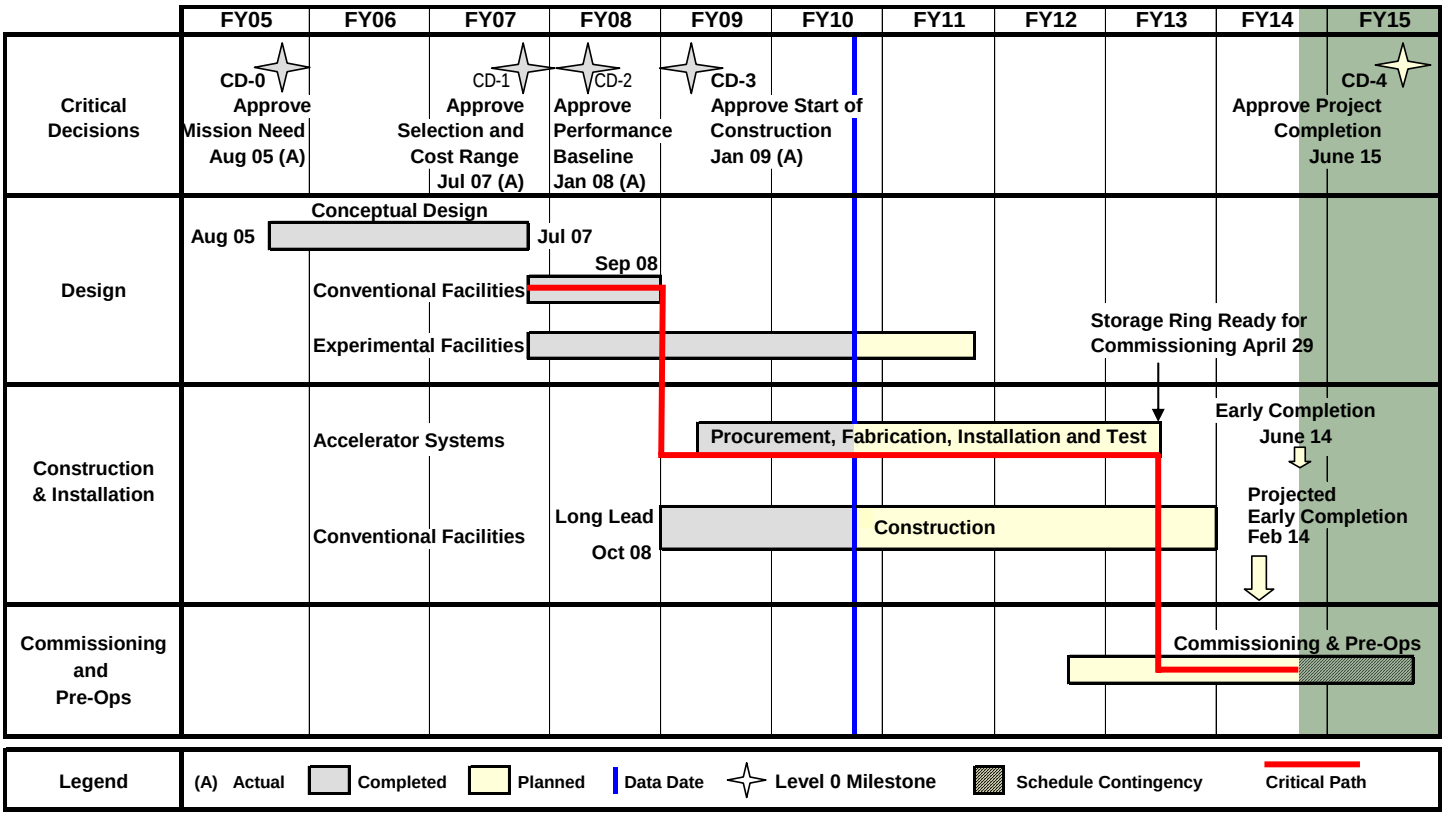
- Radiation safety workshop held with experts from APS, SSRL, ALS, and BNL participating.

- LOB award and Damping Wiggler RFP reviewed, approved by BSA Contract Review Board, circulating for approval at DOE.

## 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




### Key Personnel

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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
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