National Synchrotron Light Source II

Project Progress Report

October 2010

At the end of October, the ring building circle has been completed with the final structural steel in place. Roofing follows close behind.

report due date:
November 20, 2010

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BROOKHAVEN
NATIONAL LABORATORY

OVERALL ASSESSMENT

The National Synchrotron Light Source II project maintained excellent progress with overall satisfactory cost and schedule performance. The project is 41% complete with 28% of contingency and management reserve remaining. The cumulative cost and schedule performance indices are 1.02 and 0.99, respectively.

In late October, a steamfitter strained his back while aligning a 40-ft length of stainless steel pipe for welding, resulted in a lost-time injury. He was immediately attended and treated. After a thorough review, it was concluded that the steamfitter was wearing the appropriate PPE but his body position likely contributed to the muscle strain. All workers performing similar tasks were retrained for proper body positioning when performing this work.

Advisory committees met in October for Accelerator Systems and Conventional Facilities, and a review of the Preliminary Design Report for the six project beamlines also was held. Reports from all of these meetings noted that the project is making excellent progress and is on track for successful completion. They also provided a number of helpful recommendations.

Construction of the ring building and central chilled water plant expansion continues to make excellent progress; they are on track for beneficial occupancy in early 2011. With mobilization for construction of the Lab–Office Building (LOB), the workforce at the ring building construction site is increasing. The project continued to proactively manage the contracts for both the ring building and the LOB to ensure that sitewide safety goals are met.

Deliveries of production components for Accelerator Systems, including girders and vacuum chambers, continued at a steady pace. The contract for the damping wiggler is ready to be awarded, and the substantial progress made in controls systems over the past few months is summarized in this report. Magnet production continues to pick up the pace, and potential mitigation plans for the schedule delays occurred to date are being formulated for implementation. Although some built-in schedule float has been eroded, the overall project schedule has not been impacted by the challenges encountered in magnet production.

February 2014 remains the projected early completion date, and the critical path for the project has not changed. Activities funded by the American Recovery and Reinvestment Act (ARRA) continue to be on schedule and on budget.

UPCOMING EVENTS	2010– 2011
DOE Review of NSLS-II Project	Nov 15–17
Storage Ring Transmitter Final Design Review	Nov 30 – Dec 2
BSA Annual EVMS Self-Assessment Review	Dec 7–9
DOE Review of NSLS Operations	Dec 15–17
Coherent Soft X-ray (CSX) Beamline Design Review	Dec TBA
Project Advisory Committee (PAC) meeting	Feb 9–11

ACCELERATOR SYSTEMS

Excellent technical progress continued with steady deliveries of production components and good progress was made on key procurements.

Vacuum systems components are now in full production phase, with over 12% of the storage ring vacuum chambers already produced. Thirteen Al vacuum chambers were fully assembled and are ready for girder integration. Steps finished to date include inserting NEG pumps, mounting BPM buttons, inserting RF screens, installing feedthroughs, closing the vacuum, heat conditioning to achieve good vacuum, and performing fine leak checking. More than 20% of carbon fiber stands were delivered, and 22 dipole and 11 multipole extrusions were also received. Over 25% of the ion pumps and 30% of the ion pump controllers were delivered and tested. First-article titanium sublimation pump cartridges were delivered and tested successfully after integrating with a prototype power supply.

The design and procurement of a few remaining components are moving closer to the final phase. To improve dimensional tolerances during machining and welding, the S4A stainless chambers have been redesigned to use aluminum extrusions. Design of the RF-shielded bellows was completed, and final models of photon absorbers have been generated for vendor quotes. The procurement package for RF-shielded gate valves is nearly ready for its release. The detailed layout of the linac-to-booster transport line vacuum system was completed and component counts have been generated.

Fig. 1: About 12% of the storage ring vacuum chambers have been completed and a much larger fraction is in various stages of production.

Components for **power supply systems** are also moving into full production phase. Production contracts for electronic PC boards for switched-mode power supplies have been awarded for both the quadrupole and sextupole magnets, and the power supply chassis are also ready to be ordered. The specification for the power supply interface modules has been completed and the request for proposal for power converters has been released. Orders for AC power modules and mounting hardware are ready to be placed. From the full order of DDCT units already delivered, more than 950 units (>50%) have been tested. A one-wire temperature sensor system with an improved design is also ready for production after a successful test in the radiation environment at NSLS.

Production of **electrical utilities** equipment enclosures is well underway, with the first article delivery expected in November. Cable seals for the equipment enclosures were delivered. The order for the uninterruptible power supplies has been placed.

The **girder** assembly process has been finalized, the system of travelers and inspection documents has been completed, and girder production is well underway. The high-precision girder floor plates have been ordered. The setup for magnet jaw control during assembly was manufactured and successfully tested. Pre-alignment equipment and procedures were tested and are ready for the magnet–girder assembly work.

The final design review of beamline **front ends** was conducted. Invar stands for photon-collimating slits and photon-beam position monitors have been manufactured.

Contractors for production **magnets** picked up their paces, while the project continued to formulate mitigation plans for schedule delays occurred in three of the seven production contracts. Technical and management oversight by the project has been enhanced with more frequent visits and teleconference meetings than originally planned. For all magnets received, more thorough field measurements were performed, and the complete set of engineering drawings was updated to be compatible with the exact production designs by vendors. These additional field measurements and engineering drawings are key inputs to the magnet models and will enable us to quickly evaluate any quality issues with new magnets, as well as the potential for minor relaxation of some specs.

After delivery of acceptable first articles and a successful Production Readiness Review (PRR), the production of sextupole magnets by Danfysik and corrector magnets by Everson Tesla has started. Danfysik is scheduled to ship the production magnets to BNL starting in November.

First-article quadrupole magnets have been completed at Tesla and at Budker Institute. Tesla (UK) will ship one first-article quadrupole magnet to BNL by mid November; the PRR for Tesla then could take place in early December. Budker Institute has a goal of completing all first articles by the end of November and also holding their PRR in early December.

Two first-article sextupole magnets from IHEP arrived at BNL and the PRR was held on Oct. 25 and 26. An approval to proceed with production will be granted after resolution of action items from the PRR.

The Buckley Systems first-article large aperture quadrupole and sextupole magnets are expected to be completed in November. The 35mm dipole and 90mm dipole magnet first articles also are expected to be completed by then. The PRRs for all of these magnets could take place in December.

Evaluation of the proposals for the movable gap **damping wiggler** was completed and the contract is on schedule to be awarded in early November. The long-awaited Hall probe bench for the magnet measurement lab is expected to arrive at BNL in early November.

The **Controls** group has been working very closely with the linac and booster vendors to assure that the controls of these accelerator subsystems can be integrated seamlessly into the NSLS-II control system. The preliminary design for the vacuum controls is complete, and all drivers for the mobile bake-out system also have been completed and integrated into EPICS. Substantial progress made in many areas over the past few months is summarized below.

The IOC has been changed from a Moxa Intel processor to a server-class LINUX machine from IBM, which provides better off-the-shelf management and maintainability of the server machines, and better technical support, than the original vendor.

The preliminary design document for diagnostics controls is complete and the synchrotron light imaging test stand is operational. 15Hz displays from the high-resolution camera are provided via the control system. All corresponding drivers are completed and integrated into EPICS for all selected hardware. Each cell will have a dedicated multi-core processor to read and analyze turn-by-turn or raw data, as needed. All configuration parameters will also use this path. The orbit and feedback data will be managed from a dedicated LINUX server-class machine in each cell.

The preliminary design document for the power supply controls (PSC) is complete. All drivers for the PSC, one-wire temperature sensor read-outs, and related external instrumentation are complete and operating on the test stands. The drivers for the Allen-Bradley programmable logic controller (PLC) and the Siemens S7 PLC for the equipment protection system (EPS) are operational and integrated into EPICS. The purchase request for motor controllers, based on an evaluation of many vendors, has been completed and three qualified vendors were identified.

Core switches for the controls network have been purchased and delivered. The Controls group supported the development of the BPM digital front end, which now can pass raw data over Ethernet at 16 Mbytes/sec in support of the acquisition of turn-by-turn and raw data analysis. This server was used for the Matlab interface and is faster than the competing device by a factor of two.

A prototype I/O board that provides the interface from the power supply controller to the cell controller has been fully tested. This I/O board provides copper Ethernet connection

for both the slow power supply loop and the fast corrector loop. In addition, it is designed to provide digital I/O for any fast machine mitigation that is required. The I/O allows the power supplies to be set within 5 microseconds.

The timing system drivers are complete for the event generator and event receiver. This new interface to the timing hardware was tested for time stamp distribution, master timing pattern configuration, and timing trigger production at the event receivers. The device support and integration into EPICS also were demonstrated.

Considerable progress was made on high-level applications. The Item Finder application is complete, enabling the application engineer to request an array of process variables from a directory based on properties or user-set tags.

EXPERIMENTAL FACILITIES

Following the completion of the Preliminary Design Report (PDR) for the six project beamlines, the project conducted an external review of the preliminary designs on October 19–20. The objective of the review was to assess the status and adequacy of the preliminary design effort. The review committee found that the general design progress is consistent with the requirement as specified in the Experimental Facilities Final Design Plan. It was also concluded that the PDR for the Experimental Facilities provided the detailed information needed to start procurement of long-lead-time components for the six project beamlines.

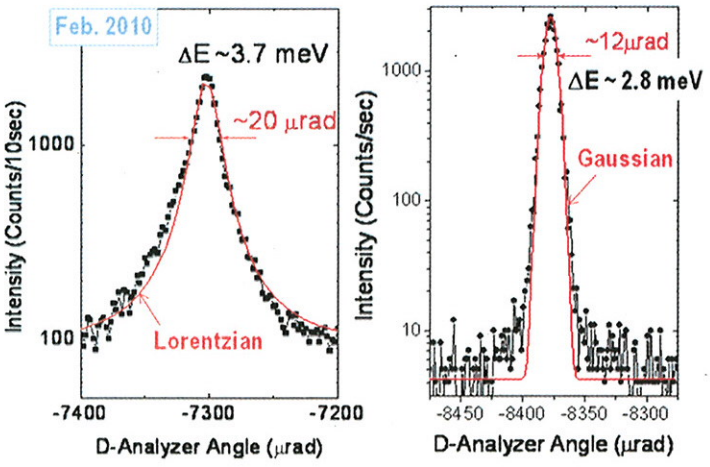


Fig. 2: (left) Previously measured resolution function of the CDW-CDW optical scheme. (right) New measurement of the resolution function indicates very sharp tails—the first observation of this key feature of the optical approach.

In experimental R&D, significant progress was made in the area of high-energy-resolution optics. Using a new set of high-quality dispersive crystal (D-crystal) optics, a much sharper D-crystal rocking curve was observed, indicating about 2.8 meV energy resolution. The measured resolution function exhibits very sharp tails (Fig. 2), compared with measurements made back in February. This new result is very encouraging, as the sharp resolution function is a key feature of the new optical scheme NSLS-II has been pursuing.

CONVENTIONAL FACILITIES

Construction continued to make excellent progress in October as the project celebrated the completion of structural steel and closing of the ring (Fig. 3). The onsite work force will soon be expanding, as the LOB contractor completes mobilization and begins construction concurrent with the ring building. Ring building activities are focused on achieving beneficial occupancy of the first building section in early 2011.

Fig. 3: DOE officials, politicians, and BSA and BNL leaders first sign the final structural steel beam, soon followed by several hundred construction workers and project staff members present at this historic moment on Oct. 13.

Structural steel for the ring building is now complete, as all steel has been erected in the service area of the injection building and the last open section of the ring in pentant 5. Vehicle access to the interior courtyard of the facility is now only available through the vehicle tunnel.

Concrete work for the ring building is now more than 90% complete. Several retaining walls, equipment slabs, bypass corridor floors, and the open booster tunnel section were completed (Fig. 4). The only major remaining items are the open SR tunnel section in pentant 5 and floor slabs in the booster building.

Fig. 4: Concrete work is winding down, well in advance of the coldest days.

Excellent progress was made in the installation of utility systems. The inner courtyard mechanical utility installation is being readied for acceptance testing, and the last electrical ductbank sections near service building 1 and the RF area have been installed. Cable installation is now progressing rapidly in the ductbank sections in preparation for startup of permanent power in December.

Installation of the building envelope (cover photo and Fig. 5) is gaining momentum and importance as colder weather approaches and interior building systems need to be installed. Installation teams are fully mobilized. The pentant 1 envelope is nearly complete and work in other pentants is progressing rapidly. The roof for pentant 1 is complete except for interface work in the lobby area. The roof decking work is advancing to the final sections of exposed roof rafters, recently installed in pentant 5, and all decking will be in place by December. Waterproofing of the booster tunnel is now complete.

Fig. 5: Compressor building framing, staging for building wall panels, and RF building exterior skin (green) in the background.

The wall siding interior liner system is now extended through pentant 4, and finished exterior siding is progressing rapidly on pentant 2 and the RF building. Temporary closure panels have been installed on pentant 1 and 2 to temporarily seal the building openings where the LOBs will be connected, to seal out the weather so interior finish work can commence. Interior mechanical, electrical, and plumbing (MEP) work continues to make rapid progress. Major HVAC equipment items, including air handlers for the experimental floor and storage ring, have been installed in pentant 2. Fire protection headers and return air ductwork are now installed from pentant 1 into pentant 4. Supply and exhaust air ductwork has advanced to pentant 4. Electrical conduit and lighting in the storage ring tunnel are now complete from pentant 1 through pentant 3. Work continues on all piping, HVAC, and electrical systems throughout the ring building complex (Fig. 6).

Progress continues on various architectural finishes, including masonry block and the installation of shield doors in pentant 3. Painting of the storage ring tunnel is now complete up to pentant 4, and painting of the ring building exposed steel and decking is underway (Fig. 7). The RF area and RF compressor buildings and cooling tower buildings have also seen significant progress in the installation of MEP systems.

Fig. 6: HVAC equipment in the service building.

Fig. 7: Exposed steel and decking being painted in pentant 3.

The Chilled Water Plant Expansion is entering system test and start-up ahead of schedule, and will likely be ready to deliver chilled water several months earlier than required. The chilled water piping is installed and tested and ready to bring chilled water to the NSLS-II site when needed. Site restoration in the areas affected by the pipe installation is underway. The electrical substation will enable permanent power to be available to the site in late November.

The LOB contractor was issued Notice to Proceed in October after approval of their health and safety plan (HASP), bonds, and insurance certificates. A number of meetings have been held with the LOB and ring building contractors to work out access and site management details. The logistics plan for the LOB contractor has been approved and they are now mobilizing to begin construction in November, more than a year earlier than the original baseline plan.

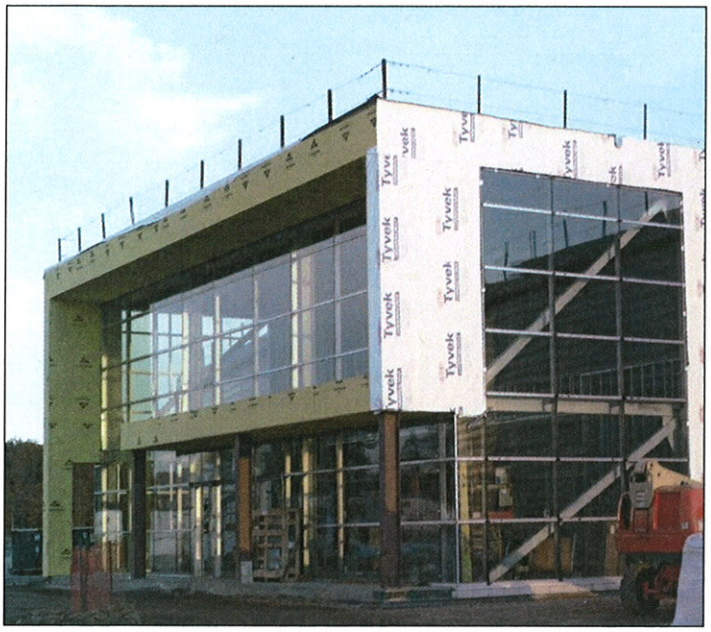


Fig. 8: The lobby becomes recognizable as the curtainwall glass is installed.

COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) is 1.02 and the cumulative Schedule Performance Index (SPI) remains the same at 0.99, both well within the acceptable range. The project is 41% complete with 28% of contingency and management reserve remaining on the project. The conventional construction schedule progress continues to be very positive, with approximately $8.7 million worth of work performed in October. The cumulative accelerator schedule performance was positive in October, due primarily to positive schedule performance in the linac, storage ring magnets, controls, and insertion devices.

Progress during October in most areas of the project was on schedule and on budget. The current-month CPI is 1.17, yellow status, and the current-month SPI is 1.03, green status. This current-month schedule variance is positive due to continued positive schedule performance in the ring building construction and in Accelerator Systems for October.

The critical path for the project remains the same in October, passing through accelerator magnet first article production; girder assembly, installation, survey, and alignment; then accelerator installation, testing, and commissioning. Ring building construction, magnet production, and vacuum chambers/components are within two to three months of the critical path, and the projected early completion date continues to be February 2014.

Fig. 9: Nitrogen Tank 1 rises beside the ring building.

ENVIRONMENT, SAFETY, AND HEALTH (ESH)

Significant progress has been made on development of the NSLS-II Authorization Basis documents. The Linac Safety Assessment Document and Accelerator Safety Envelope have been drafted with the assistance of NSLS-II technical staff and input from BHSO. Internal review of the documents will begin after the first of the year. The Fire Hazards Analysis (FHA) has been drafted and will begin internal review in December. The FHA is an important supporting document for the Authorization Basis Documentation package.

A steamfitter on the construction site was injured on Oct. 21 while attempting to align a 40-ft length of stainless steel pipe prior to welding. The pipe needed to be moved approximately 3/8 inch and he was using an 8-ft length of 2x4 as a lever. As he pushed on the wooden lever he felt a sudden pain in his lower back. He immediately reported this to his supervisor and then reported to the onsite EMT. He was referred to his personal physician, who diagnosed the injury as a strained back muscle. This incident resulted in a lost-time injury.

The steamfitter was wearing the appropriate PPE for the task and his footing was adequate; however, his body position likely contributed to the injury. All workers performing similar tasks were retrained for awareness of proper body positioning when performing this work.

RECENT HIRES

Suchit Bhattarai– Controls Engineer, Controls, ASD

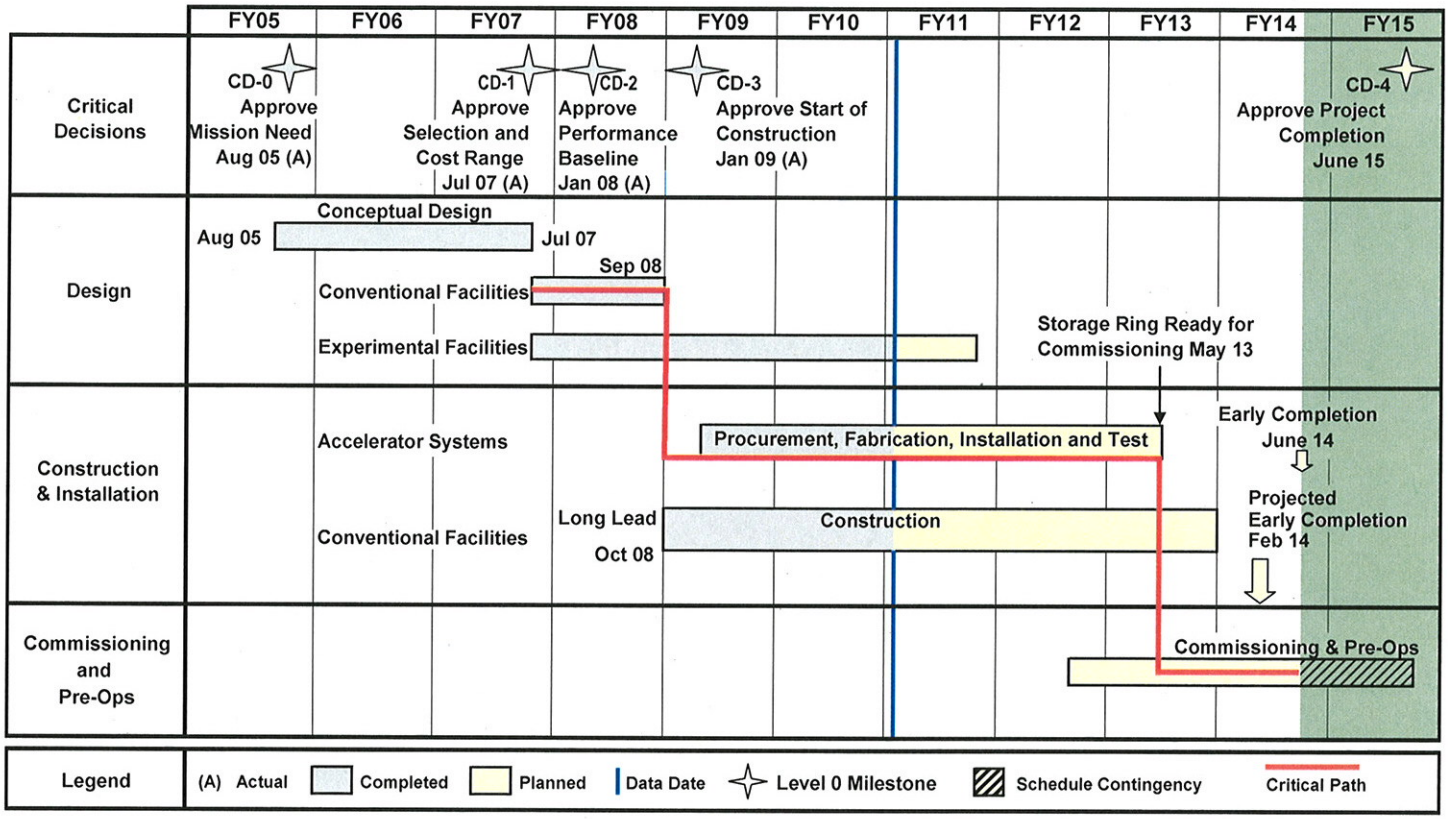
Timothy Campbell – Applications Analyst, Business Systems, PSD

Peter Cappadoro – Mechanical Engineer, Insertion Devices, ASD

Alexey Suvorov – Physicist, Inelastic X-ray Scattering Beamline, 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



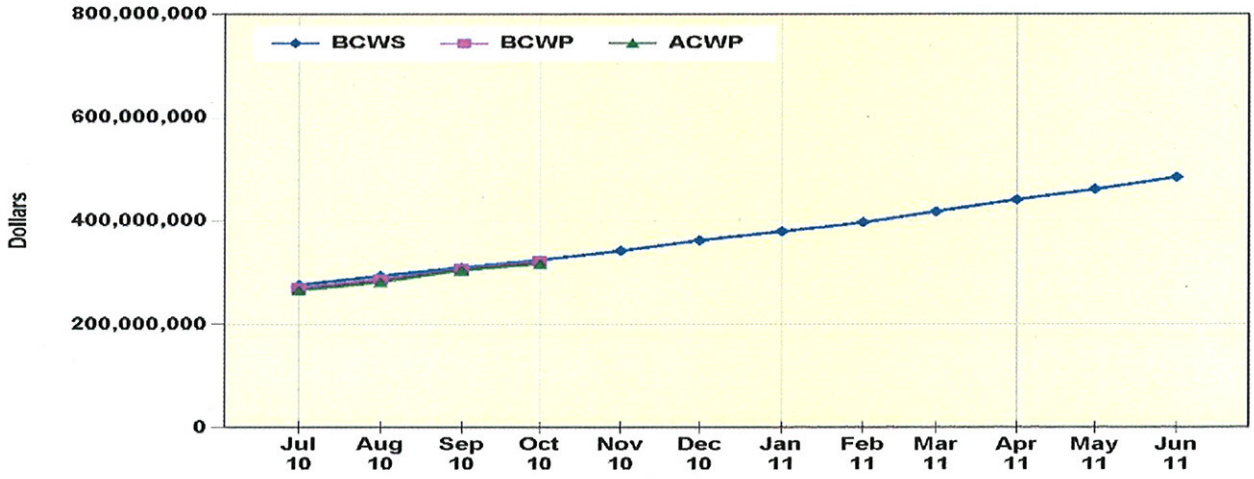
Funding Profile

	NSLS-II Funding Profile ($M)											
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

Key Personnel

Title	Name	Email	Phone
Federal Project Director	Frank Crescenzo	crescenzo@bnl.gov	631-344-3433
NSLS-II Project Director	Steve Dierker	dierker@bnl.gov	631-344-4966

EV for WBS 1 (NSLS-II Project) as of October 31, 2010



Cumulative to Date:	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11
BCWS	276,586	294,163	310,481	325,023	342,610	362,667	379,896	397,549	418,487	441,277	461,375	484,838
BCWP	270,668	287,518	307,447	322,376								
ACWP	266,302	282,695	304,688	317,488								

Project as of 10/31/10	Current Period	Cum-to-date
Plan (BCWS) $K	$14,542	$325,023
Earned (BCWP) $K	$14,929	$322,376
Actual (ACWP) $K	$12,800	$317,488
SV $K	$387	-$2,647
CV $K	$2,129	4,887
SPI	1.03	0.99
CPI	1.17	1.02
Budget at Completion $K (PMB (UB))		$780,679
Planned % Complete		41.6
Earned % Complete		41.3
Mgmt Reserve/Cont as % of BAC remaining		28.7
Mgmt Reserve/Cont as % of EAC remaining		27.9

The IPT can find further details on NSLS-II cost and schedule data at http://www.bnl.gov/nsls2/project/IPT/default.asp.

Milestones – Near Term	Baseline	Done
L3-Begin ring building steel erection	9/14/09	✓
L3-External tech. review of concept. design for project BLs done	11/16/09	✓
L3-Clean room contract awarded	12/30/09	✓
L3-Linac contract awarded	2/05/10	✓
L3-APS welding S2 ODD – first chamber ready for assembly	3/17/10	✓
L3-Pentant 1 structural steel erected	3/31/10	✓
L3-Initial test of new MLL deposition system completed	6/30/10	✓
L3-LOB construction contract awarded	7/01/10	✓
L3-LOB construction Notice to Proceed (NTP) issued	7/01/10	✓
L3-SR Magnet – Quads first article ready for integration	7/19/10	
L2-Pentant 2 structural steel erection completed	8/05/10	✓
L3-Safety review of preliminary designs for project BLs completed	8/30/10	✓
L2-BAT reviews of 100% prelim. designs for project BLs completed	9/15/10	✓
L2-Ring building pentant 1 BOD	1/01/11	
L3-Lobby BOD	2/01/11	

L3 = Level 3 milestone, L2 = Level 2 milestone

Schedule Performance Index, Project to Date:

SPI: 0.99

Cause & Impact: No reportable variance.
Corrective Action: None Required.

Cost Performance Index, Project to Date:

CPI: 1.02

Cause & Impact: No reportable variance.
Corrective Action: None Required.

Six PCRs were approved in October:

PCR #	Area	Δcost	Title or Description	PCR #	Area	Δcost	Title or Description
11_175	CF	-$173K	Return budget to MR from PCR 09_071 and 10_098	11_197	EF	0	WBS/Controls Account Change 1.2.2.2
11_183	ASD	0	ASD Detail Plan Instrumentation	11_198	EF	0	CAM Change
11_189	ASD	0	ASD Pre-Operations Timephasing	11_201	ASD	-$280K	Backbone Contract Award

ARRA DETAILS

The Recovery Act has provided advanced funding for NSLS-II construction, created jobs, and substantially reduced the cost and schedule risks for the project. The overall schedule for the ring building completion has not been accelerated; however, Recovery Act funds have allowed for re-ordering of the work sequence with a six-month acceleration of the injection building completion. Acceleration of the injection building allows for earlier installation and commissioning of the injector, which had been close to critical path. This addition of schedule float significantly reduces the schedule risk for the accelerator. In addition, Recovery Act funds have allowed for accelerated completion of the Laboratory–Office Buildings by approximately 15 months, which has enabled the project to maximize the cost advantage of the depressed construction market.

ARRA$ as of 10/31/10	Current Period	Cum-to-date
Plan (BCWS) $K	$6,767	$86,873
Earned (BCWP) $K	$4,800	$88,536
Actual (ACWP) $K	$4,820	$86,995
SV $K	-$1,968	$1,663
CV $K	-$20	$1,541

ARRA Milestones		
Description	**Baseline Date**	**Status**
Install sanitary UG piping SB3 footings.	12/08/09	Completed 12/10/09.
Pour tunnel slab CL 018-024.	12/14/09	Completed 11/02/09.
Excavate booster svc bldg. foundations.	12/24/09	Completed 10/7/09.
Pour tunnel slab CL 024-030.	12/30/09	Completed 11/25/09.
Begin concrete tunnel roof pentant 1.	12/10/09	Completed 11/12/09.
Complete tunnel slab pentant 2.	1/15/10	Completed 1/15/10.
Pentant 2 tunnel walls complete.	3/16/10	Completed 3/11/10.
Begin steel erection pentant 1.	4/14/10	Completed 3/16/10.
Start metal decking for pentant 1 Service Building.	5/12/10	Completed 4/14/10.
Pentant 5 tunnel slab complete.	5/25/10	In progress. Tunnel slab being formed; slated for completion 12/1/10. Intentionally deferred to enable access to inner courtyard.
Begin experimental floor concrete, pentant 1.	6/2010	Completed 6/7/10.
Begin experimental floor concrete, pentant 2.	7/2010	Completed 6/21/10.
Complete structural for steel pentant 3.	9/2010	Completed 8/13/10.
Complete chilled Water Plant enclosure.	9/2010	Completed 8/20/10.
Pentant 1 building enclosure complete.	10/20/10	Nearing completion. Will complete in December.
RF building enclosure complete.	11/20/10	Nearing completion. Will complete in December.

Blue text represents an addition.

CLASSIFICATION (When Filled In)

CONTRACT PERFORMANCE REPORT
FORMAT 1 - WORK BREAKDOWN STRUCTURE

FORM APPROVED
OMB No. 0704-0188

1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME Brookhaven Science Associates	a. NAME National Synchrotron Light Source II (NSLS-II)	a. NAME Oct 2010	a. FROM (YYYYMMDD) 2010 / 10 / 01
b. LOCATION (Address and ZIP Code) Brookhaven National Laboratory, Upton,NY	b. NUMBER	b. PHASE	b. TO (YYYYMMDD) 2010 / 10 / 31
	c. TYPE / d. SHARE RATIO	c. EVMS ACCEPTANCE NO YES X (YYYYMMDD)	

5. CONTRACT DATA

a. QUANTITY	b. NEGOTIATED COST	c. ESTIMATED COST OF AUTHORIZED UNPRICED WORK	d. TARGET PROFIT/ FEE	e. TARGET PRICE	f. ESTIMATED PRICE	g. CONTRACT CEILING	I. DATE OF OTB/OTS (YYYYMMDD)
1	912,000,000	0	0	912,000,000	0	0	

6. PERFORMANCE DATA

WBS[2] WBS[3] Control Acct ITEM (1)	CURRENT PERIOD BUDGETED COST WORK SCHEDULED (2)	 WORK PERFORMED (3)	 ACTUAL COST WORK PERFORMED (4)	VARIANCE SCHEDULE (5)	 COST (6)	CUMULATIVE TO DATE BUDGETED COST WORK SCHEDULED (7)	 WORK PERFORMED (8)	 ACTUAL COST WORK PERFORMED (9)	VARIANCE SCHEDULE (10)	 COST (11)	AT COMPLETION BUDGETED (14)	 ESTIMATED (15)	 VARIANCE (16)
1.01 Project Management													
1.01.01 Project Management													
WBS[3]Totals:	121,594	121,594	55,854	0	65,740	4,381,396	4,381,396	4,322,332	0	59,064	7,503,242	7,503,242	0
1.01.02 Environmental, Safety & Health													
WBS[3]Totals:	109,294	109,294	71,321	0	37,974	2,830,750	2,830,750	3,282,108	0	-451,358	6,478,032	6,478,032	0
1.01.03 Project Support													
WBS[3]Totals:	601,658	601,658	718,985	0	-117,327	25,380,735	25,380,735	25,169,439	-0	211,296	40,447,041	42,123,066	-1,676,025
1.01.04 Quality Assurance													
WBS[3]Totals:	61,584	61,584	3,876	0	57,707	1,754,819	1,754,819	1,370,506	0	384,313	3,397,133	3,397,133	0
1.01.05 Configuration Management & Document Control													
WBS[3]Totals:	27,803	27,803	19,378	0	8,425	1,001,523	1,001,523	806,989	0	194,534	1,972,567	1,972,567	0
WBS[2]Totals:	**921,933**	**921,933**	**869,414**	**0**	**52,519**	**35,349,223**	**35,349,223**	**34,951,374**	**-0**	**397,850**	**59,798,015**	**61,474,040**	**-1,676,025**
1.02 R&D and Conceptual Design													
1.02.01 Accelerator Systems R&D													
WBS[3]Totals:	14,583	123,257	246,587	108,675	-123,329	11,031,968	10,482,620	10,648,286	-549,348	-165,666	11,460,076	11,497,786	-37,710
1.02.02 Experimental Systems R&D													
WBS[3]Totals:	201,141	211,599	190,949	10,458	20,650	14,506,179	14,342,266	13,760,311	-163,913	581,955	19,166,550	19,163,545	3,005
1.02.03 Conceptual Design - Accelerator Systems													
WBS[3]Totals:	0	0	0	0	0	12,998,214	12,998,214	12,960,504	0	37,709	12,998,214	12,960,504	37,709
1.02.04 Conceptual Design - Experimental Facilities													
WBS[3]Totals:	0	0	0	0	0	709,445	709,445	712,450	0	-3,005	709,445	712,450	-3,005
1.02.05 Conceptual Design - Conventional Facilities													
WBS[3]Totals:	0	0	0	0	0	3,886,952	3,886,952	3,872,878	0	14,074	3,886,952	3,886,952	0
1.02.06 Conceptual Design - Project Management & Support													
WBS[3]Totals:	0	0	0	0	0	7,086,188	7,086,188	7,326,180	0	-239,992	7,086,188	7,325,314	-239,126
1.02.07 Project Management - R&D													
WBS[3]Totals:	17,286	17,286	-543	0	17,829	5,107,776	5,107,776	5,033,085	0	74,691	5,305,339	5,066,213	239,126
WBS[2]Totals:	**233,009**	**352,142**	**436,992**	**119,133**	**-84,850**	**55,326,722**	**54,613,461**	**54,313,694**	**-713,261**	**299,767**	**60,612,763**	**60,612,763**	**-0**
1.03 Accelerator Systems													
1.03.01 Accelerator Systems Management													
WBS[3]Totals:	82,170	82,170	75,398	0	6,772	3,346,454	3,346,454	3,641,726	0	-295,272	6,019,099	6,019,099	0
1.03.02 Accelerator Physics													
WBS[3]Totals:	190,728	190,728	196,341	0	-5,612	5,575,009	5,575,009	5,404,132	0	170,877	10,071,767	10,071,767	0
1.03.03 Injection System													
WBS[3]Totals:	1,737,208	1,629,166	160,259	-108,041	1,468,907	12,118,403	9,873,282	4,774,747	-2,245,121	5,098,535	41,185,604	41,185,604	0
1.03.04 Storage Ring													
WBS[3]Totals:	1,722,144	2,002,471	1,351,332	280,327	651,140	42,701,223	35,517,902	37,285,261	-7,183,321	-1,767,359	152,855,308	158,301,735	-5,446,427
1.03.05 Controls Systems													
WBS[3]Totals:	300,621	440,020	174,769	139,399	265,251	7,871,000	7,183,146	6,424,006	-687,854	759,140	20,084,946	20,084,946	0
1.03.06 Accelerator Safety Systems													
WBS[3]Totals:	10,581	56,323	77,650	45,742	-21,327	1,444,671	1,119,636	1,960,382	-325,036	-840,746	4,488,070	4,932,382	-444,312
1.03.07 Insertion Devices													
WBS[3]Totals:	70,133	193,884	49,969	123,750	143,915	2,037,897	1,608,928	1,343,711	-428,969	265,217	25,432,532	25,432,532	0
1.03.08 Accelerator Fabrication Facilities													
WBS[3]Totals:	65,005	144,316	189,454	79,311	-45,137	6,484,285	5,255,707	5,473,020	-1,228,578	-217,313	6,961,411	7,022,171	-60,760
WBS[2]Totals:	**4,178,591**	**4,739,079**	**2,275,171**	**560,488**	**2,463,908**	**81,578,941**	**69,480,063**	**66,306,985**	**-12,098,879**	**3,173,078**	**267,098,737**	**273,050,237**	**-5,951,499**
1.04 Experimental Facilities													
1.04.01 Experimental Facilities Management													
WBS[3]Totals:	88,421	88,421	81,625	0	6,796	2,913,125	2,913,125	3,470,026	0	-556,901	4,828,335	6,586,298	-1,757,962
1.04.02 Standard Local Controls & Data Acquisition Systems													
WBS[3]Totals:	0	0	0	0	0	37,454	44,941	3,457	7,487	41,485	69,585	69,585	0
1.04.05 User Instruments													
WBS[3]Totals:	334,838	158,809	229,325	-176,029	-70,516	6,523,577	6,091,120	5,858,035	-432,457	233,086	63,112,765	64,589,648	-1,476,882
1.04.06 Front End User Requirements Development													
WBS[3]Totals:	0	0	0	0	0	456	456	2,111	-0	-1,655	456	1,099	-643
1.04.07 Optics Labs													
WBS[3]Totals:	0	0	11,106	0	-11,106	880,354	681,681	635,844	-198,674	45,836	1,117,071	2,190,402	-1,073,331
WBS[2]Totals:	**423,259**	**247,230**	**322,056**	**-176,029**	**-74,826**	**10,354,967**	**9,731,323**	**9,969,473**	**-623,644**	**-238,150**	**69,128,213**	**73,437,031**	**-4,308,818**
1.05 Conventional Facilities													
1.05.01 Conventional Facilities Management													
WBS[3]Totals:	313,328	313,328	184,218	0	129,110	7,775,980	7,775,980	7,773,755	0	2,225	16,099,717	16,136,305	-36,588
1.05.02 Conventional Facilities Engineering and Design													
WBS[3]Totals:	111,813	114,194	315,391	2,381	-201,197	19,854,870	19,857,251	18,813,065	2,381	1,044,186	22,741,410	22,741,410	0
1.05.03 Conventional Facilities Construction													
WBS[3]Totals:	8,331,003	8,230,773	8,316,613	-100,230	-85,840	114,346,857	125,422,465	125,195,710	11,075,608	226,756	231,177,679	232,645,052	-1,467,373
1.05.04 Integrated Controls & Communications													
WBS[3]Totals:	13,300	0	80,346	-13,300	-80,346	278,265	6,289	93,940	-271,976	-87,650	1,256,000	1,256,000	0
1.05.05 Standard Equipment													
WBS[3]Totals:	0	0	0	0	0	0	0	0	0	0	1,025,586	1,025,586	0
1.05.06 Conventional Facilities Commissioning													
WBS[3]Totals:	15,488	10,183	0	-5,305	10,183	156,717	139,618	70,251	-17,099	69,368	578,000	578,000	-0
WBS[2]Totals:	**8,784,933**	**8,668,478**	**8,896,568**	**-116,455**	**-228,090**	**142,412,689**	**153,201,603**	**151,946,720**	**10,788,914**	**1,254,883**	**272,878,393**	**274,382,354**	**-1,503,961**
1.06 Pre-Operations													
1.06.01 Management - Pre Ops													
WBS[3]Totals:	0	0	0	0	0	0	0	0	0	0	20,170,700	20,170,700	0
1.06.02 Accelerator Systems - Pre Ops													
WBS[3]Totals:	0	0	0	0	0	0	0	0	0	0	17,071,591	17,071,591	0
1.06.03 Experimental Facilities - Pre Ops													
WBS[3]Totals:	0	0	0	0	0	0	0	0	0	0	3,823,660	4,310,217	-486,557
1.06.04 Spares													
WBS[3]Totals:	0	0	0	0	0	0	0	0	0	0	9,134,454	9,134,454	0
WBS[2]Totals:	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**50,200,405**	**50,686,962**	**-486,557**
Performance Measurement Baseline - PMB	14,541,725	14,928,862	12,800,201	387,138	2,128,661	325,022,543	322,375,674	317,488,245	-2,646,869	4,887,429	779,716,527	793,643,388	-13,926,860
Undistributed Budget											962,490	0	962,490
Sub Total	14,541,725	14,928,862	12,800,201	387,138	2,128,661	325,022,543	322,375,674	317,488,245	-2,646,869	4,887,429	780,679,017	793,643,388	-12,964,370
Contingency/Mangement Reserve											131,320,983		
Total Project Cost -TPC	14,541,725	14,928,862	12,800,201	387,138	2,128,661	325,022,543	322,375,674	317,488,245	-2,646,869	4,887,429	912,000,000		

8. PERFORMANCE DATA

ARRA Cost Account ITEM (1)	CURRENT PERIOD BUDGETED COST WORK SCHEDULED (2)	BUDGETED COST WORK PERFORMED (3)	ACTUAL COST WORK PERFORMED (4)	VARIANCE SCHEDULE (5)	VARIANCE COST (6)	CUMULATIVE TO DATE BUDGETED COST WORK SCHEDULED (7)	BUDGETED COST WORK PERFORMED (8)	ACTUAL COST WORK PERFORMED (9)	VARIANCE SCHEDULE (10)	VARIANCE COST (11)	AT COMPLETION BUDGETED (14)	ESTIMATED (15)	VARIANCE (16)
A ARRA													
1.05.03.02.01 General Requirements	44,173	44,173	44,173	0	0	5,051,264	5,133,074	3,171,702	81,810	1,961,371	5,299,456		
1.05.03.02.02 Site Work	100,157	133,232	133,230	33,075	2	3,448,026	3,398,140	3,225,105	-49,886	173,035	3,611,419		
1.05.03.02.03 Pentant 1 and Service Building	1,892,957	647,489	648,990	-1,245,468	-1,501	15,256,993	15,811,932	15,915,083	554,939	-103,151	18,988,847		
1.05.03.02.04 Pentant 2 and Service Building	1,411,478	688,827	688,830	-722,651	-3	10,144,895	12,148,984	12,256,794	2,004,089	-107,810	15,448,371		
1.05.03.02.05 Pentant 3 and Service Building	428,180	149,684	149,684	-278,497	0	6,410,597	8,511,387	8,649,431	2,100,789	-138,044	10,298,355		
1.05.03.02.06 Pentant 4 and Service Building	272,280	6,413	6,413	-265,867	0	1,778,282	2,093,754	2,266,116	315,473	-172,362	2,594,850		
1.05.03.02.07 Pentant 5 and Service Building	33,666	35,750	38,350	2,084	-2,600	5,959,064	5,407,095	5,339,349	-551,969	67,747	7,246,240		
1.05.03.02.08 Injection Building	316,497	708,475	708,475	391,978	0	3,921,779	2,860,229	2,756,825	-1,061,550	103,404	5,918,100		
1.05.03.02.09 RF and Compressor Building	325,410	352,479	352,558	27,069	-79	2,848,088	3,037,515	3,114,273	189,428	-76,758	4,946,461		
1.05.03.02.10 Lobby	152,127	290,162	297,025	138,035	-6,863	1,432,466	1,428,518	1,433,001	-3,948	-4,483	3,005,358		
1.05.03.02.11 Cooling Tower and Process Water	386,193	325,900	325,900	-60,293	0	3,188,622	2,442,548	2,539,411	-746,075	-96,864	4,458,617		
1.05.03.02.12 Underground Mechanical Utilities	845,350	663,657	663,660	-181,693	-3	8,564,615	7,785,438	7,844,415	-779,177	-58,977	8,573,121		
1.05.03.02.13 Site Electrical Utilities	156,717	278,327	278,327	121,610	0	7,514,384	7,033,752	7,186,399	-480,632	-152,647	8,411,720		
1.05.03.02.14 LN2 and GN2 Systems	0	0	0	0	0	0	0	0	0	0	0		
1.05.03.03 Electrical Substation and Feeder (Contract)	99,728	61,767	52,140	-37,961	9,628	2,824,948	2,628,364	2,359,958	-196,583	268,406	2,943,143		
1.05.03.04 Chilled Water Plant (Contract)	203,036	159,124	309,064	-43,912	-149,940	8,129,295	8,261,149	8,368,399	131,854	-107,250	9,200,000		
1.05.03.06.01 LOB 1	99,453	85,078	0	-14,374	85,078	99,453	85,078	85,009	-14,374	69	13,293,500		
1.05.03.06.02 LOB 2	0	84,700	0	84,700	84,700	0	84,700	85,009	84,700	-309	7,700,000		
1.05.03.06.03 LOB 3	0	84,458	0	84,458	84,458	0	84,458	85,009	84,458	-552	12,993,500		
1.05.03.07.01 HXN Sattelite Building Design	0	0	122,879	0	-122,879	300,000	300,000	313,466	0	-13,466	300,000		
1.05.03.07.02 HXN Satellite Building Construction	0	0	0	0	0	0	0	0	0	0	1,264,573		
ARRA Sub Total	6,767,402	4,799,695	4,819,698	-1,967,707	-20,002	86,872,771	88,536,115	86,994,756	1,663,344	1,541,359	146,495,631		
d. Undist. Budget											962,490		
b. Total Contract Variance	6,767,402	4,799,695	4,819,698	-1,967,707	-20,002	86,872,771	88,536,115	86,994,756	1,663,344	1,541,359	147,458,121		