National Synchrotron Light Source II

Project Progress Report

August 2009

report due date:
September 20, 2009

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OVERALL ASSESSMENT

The National Synchrotron Light Source II project continued to make excellent progress. The project was on schedule and on budget, with satisfactory cost and schedule performances during the month of August. Since July, cost/schedule performance for the Accelerator Systems Division continues to be satisfactory and on track.

At the ring building construction site, earthwork associated with preparation of the building footprint for foundations was completed and extensive progress has been made in pouring concrete for building foundations and utility and vehicle tunnels. Work on the installation of underground utilities has continued, and steady progress on review of submittals was made to ensure all site activities continue on schedule. Design of the Lab-Office Buildings (LOBs) continued to make good progress and is on track for release of bid package in early November. The contractor for the Chilled Water Plant Expansion completed mobilization and started construction.

Accelerator Systems continued to make excellent progress in testing prototypes, refining final designs, and gearing up for production. Evaluations of the proposals for the quadrupole and sextupole magnet production were completed. Progress on procurement of the linac, booster, and damping wigglers (DW) continued.

The Experimental Facilities Division (XFD) continued to make progress on Conceptual Design Reports to be submitted and reviewed in October. A series of internal safety reviews of the conceptual designs for the six project beamlines were conducted. Collaborative R&D effort with the NSLS, the BNL Center for Functional Nanomaterials, and the Advanced Photon Source (APS) at Argonne National Laboratory (ANL) continued for both the 1nm and 0.1meV optics areas.

Overall project performance remains satisfactory and the activities funded by the American Recovery and Reinvestment Act (ARRA) continue to be on schedule and on budget.

SCHEDULED EVENTS 2009

LOB Contractor Outreach meeting	Sept. 24
XFD Conceptual Design Review meeting	Oct. 13-14
Conventional Facilities Advisory Committee (CFAC) meeting	Oct. 20-21
Accelerator Systems Advisory Committee (ASAC) meeting	Oct. 22-23
Project Advisory Committee (PAC) meeting	Fall 2009
DOE Review of the NSLS-II Project	Nov. 17

ACCELERATOR SYSTEMS DIVISION (ASD)

Significant progress has been made in all areas of Accelerator Systems.

The accelerator physics group evaluated the design for the transverse damper system in order to optimize the damping wiggler field specifications. Preparations for the procurements of the booster and linac continued, with vendor visits and production of specifications, statements of work, and drawing packages. Refinement of the injection systems design included booster beam stacking studies and the use of a realistic booster magnet model for particle tracking. Much progress has been made at the Pulsed Magnet Laboratory. The pulsed magnet design has progressed well, and pulsed power components to be tested at the lab have been procured. The High-Voltage Safety Interlock system was reviewed by the lab safety committee. Good progress has been made on components of the beam transfer line including diagnostics, magnet design, and pulsed magnet interface components.

The controls group has completed and successfully tested prototype NSLS-II controls using the NSLS beamlines X1A and X16A. Their integration of LIBERA-type beam positioning monitor (BPM) receivers into the EPICS controls system also was successfully completed. This includes both slow, asynchronous access from high-level applications as well as fast, synchronous access for fast-orbit feedback. A cyber security plan has been started with the BNL Information Technology Division that makes the control system independent of the facility network but provides secure portals to the outside. It also includes network access in the tunnel. Various hardware interfaces have been developed, such as the Power Supply Interface first article board, now on hand and being tested. The development of IRMIS database tools continued. Access to lattice data for online modeling via the control system is now available.

The electrical engineering group continued tests on the main dipole power supply filter circuit to suppress noise from the switched mode power converters. Efforts resulted in the final design of the switched mode power converter. The power supplies for quadrupoles, sextupoles, and correctors have been successfully prototyped. Five fully equipped units are under test in their nominal electronics rack environment. A calibration system for the DCCTs used in the regulator circuits has been developed. Tests on high-temperature stability equipment enclosures have been performed.

The mechanical engineering group performed tests of girder profiling with laser trackers and confirmed that the profiling error could be limited to ~5μm. A second round of girder positioning tests was also completed and confirmed the ability to quickly position girders to within 100 microns. The X-Y stages for supporting slits of the beamline front ends are now being fabricated. A second long-term testing cycle for the safety shutters has begun. In utilities work, engineering and the modeling of water and compressed gas systems are now complete. The secondary network monuments for survey and alignment of the storage ring were optimized and network error analysis was performed.

For insertion devices, the damping wiggler procurement documents have been modified and updated to support procurement of these devices via collaboration with the APS at ANL. Equipping the permanent magnet measurement laboratory continues to progress. Major procurements are underway and smaller components are being ordered.

In safety systems work, assembly of the tabletop SPPS mock-up of the personal protection system has progressed so

that the A-chain will be available in September for simulation and testing. The engineering design plan for the SPPS was prepared and authorized, and the initial design review took place on August 18. No significant issues were raised during the review. Work to integrate the ME-designed safety shutters into the safety systems is underway.

The instrumentation group has completed acceptance tests of the first article storage ring BPM buttons. Results of the tests were quite satisfactory and mass production can start. To perform the acceptance tests for large-scale production, several test set-up jigs were made and the instrumentation group is ready for production. Preparatory studies for BPM electronics are underway for in-house development as an alternative to purchasing expensive commercial hardware, which suffers from obsolete electric components. Intense investigation continues regarding the effectiveness of proposed shielding against a higher order (rogue) mode in the vacuum chamber, which would upset BPM measurements The tests, which have been performed with increasing sophistication for quite a while, so far confirm the effectiveness of the proposed mitigation method.

The RF group made further good progress on pressure vessel safety analysis of the superconducting cavities. The numerical stress analysis has been benchmarked by finding agreement between the calculations and a destructive test performed elsewhere. This validates the analysis for additional planned measures to increase mechanical stability of the Nb-cavity at room temperature. The analysis is complete and is scheduled for review by the laboratory cryogenic safety committee. This is a necessary step to obtain permission to operate the cavity on the BNL site.

EXPERIMENTAL FACILITIES DIVISION (XFD)

XFD efforts in August focused on completing and reviewing the conceptual designs of the six project beamlines. The beamline advisory teams (BATs) for the X-ray Powder Diffraction (XPD), the Coherent Soft X-ray (CSX), and the Coherent Hard X-ray (CHX) beamlines met to review the respective beamline conceptual designs.

For the XPD beamline, considerable discussion focused on high heat-load issues for the heat-load prefilters and endstation instruments, including feedback on one of the DOE June review recommendations to pursue smaller x-ray beam focus for certain experiments.

The main CSX beamline discussions were on fine-tuning the optical layouts and scattering geometry for the polarization branch. The CSX BAT also officially elected Stephen Kevan from the University of Oregon as the new BAT spokesperson to succeed Cecilia Sanchez-Hanke, who took the role of CSX Group Leader in June 2009.

The CHX BAT discussions focused on endstation instrumentation for CHX experiments, including a consensus to pursue R&D of coherent diffraction imaging at the beamline.

In addition to the BAT reviews and discussions, the XFD has initiated a series of internal beamline safety reviews of the conceptual designs for the six project beamlines. These safety reviews are assisted by the NSLS Beamline Safety Review Committee, chaired by Zhong Zhong of NSLS. The main purpose of these safety reviews is to integrate safety design considerations early in the beamline design phase, to minimize any potential risks due to design changes that might arise from safety requirements. In August, three such safety meetings took place to review the general beamline components, the beamline front ends, and the CHX, XPD, and submicron resolution x-ray spectroscopy (SRX) beamlines. Safety reviews of the remaining beamlines are scheduled to be completed by the middle of September 2009.

In the area of 1nm optics R&D, fabrication of the new deposition chamber for developing a wedged multilayer Laue lens (MLL) has progressed significantly. All five segments (Fig. 1) of the chamber have been manufactured and the internal parts are being received, including the critical linear motor system. The assembly and systems testing are underway, and delivery of the complete deposition system is expected in October 2009.

Figure 1: The new NSLS-II wedged-MLL deposition chamber being assembled at the manufacturer's facility in Ronkonkoma, NY.

The 1nm optics R&D group also made significant progress on developing a reactive ion etching procedure as an effective and efficient step to section MLLs into useable x-ray focusing lenses. The group deposited many multilayer samples using a small deposition chamber on loan from the Condensed Matter Physics and Materials Science Department at BNL. Working at BNL's Center for Functional Nanomaterials, they used these samples to develop and test reactive ion etching gap composition and the effects of environmental conditions such as temperature.

After many trials, the group achieved encouraging results of anisotropic etching and equal etch rate for the Si and WSi_2 layers that made up the multilayer structures (Fig. 2). This initial significant result paved the way to proceed with additional large-depth tests, with the ultimate goal to etch trenches >20–40 μm deep.

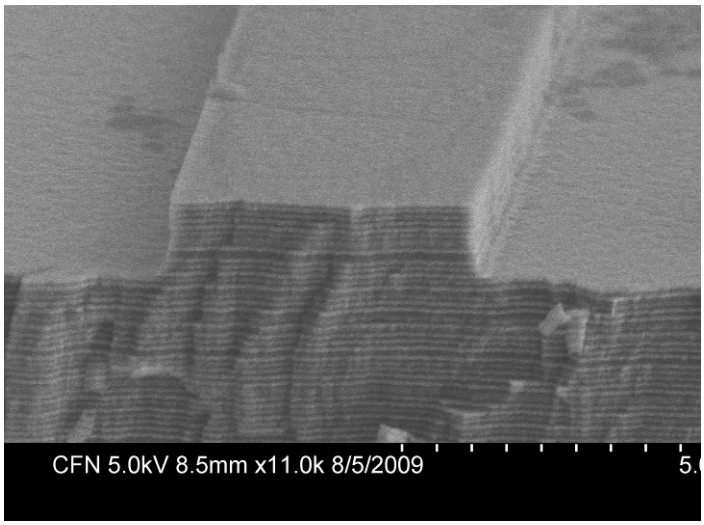


Figure 2: First test on reactive ion etching of multilayer structures for multilayer Laue lens fabrication yields very encouraging results, as shown in this SEM picture. The etched step height is about 1 μm, and the result was obtained after more than 40 trials of etching recipes and environmental conditions.

In the area of 0.1 meV optics R&D, the IXS group made further improvements on the optics control system at the R&D beamline X16A. The precision alignments of the 1 meV optics continued, and x-ray Bragg reflections through the collimating and dispersing crystals have been observed and their optimization is underway. The new temperature oven has been fabricated, assembled, and tested. Initial temperature tests indicated that <4mK stability and uniformity have been achieved.

During August, the IXS group hosted Tom Toellner from the APS at ANL and discussed the high-energy-resolution monochromator optics that have been designed and tested at the 3-ID and the 30-ID beamlines for both nuclear Bragg scattering and inelastic scattering experiments. Further discussions are underway to evaluate whether these existing designs can be modified to achieve higher angular acceptance and thus be an acceptable alternative optical approach to achieving ultrahigh energy resolution.

CONVENTIONAL FACILITIES DIVISION (CFD)

Conventional facilities activities continued on schedule and on budget through August. Construction of the ring building continued to make excellent progress, as dry weather throughout the month aided the contractor's field productivity. Design of the LOBs on an accelerated schedule continued to make good progress and is on track for release of bid issue drawings and specifications the first week of November. The contract for Chilled Water Piping was awarded in August. The contractor for the recently awarded Chilled Water Plant Expansion completed mobilization and started construction.

A significant milestone for the ring building was achieved when earthwork associated with preparation of the ring building footprint for foundations was completed in August.

This milestone is significant in that it confirmed that the construction site has yielded sufficient select fill for all construction activities. Extensive progress has been made in pouring concrete for the building foundations. Column footings are in place for the RF Building, Pentant 1, part of Pentant 5, and most of Pentant 2, with grade beam installation following close behind. Substantial concrete work was also completed on the utility tunnel and vehicle tunnel (Figs. 3 and 4), which will be ready to receive steel columns in September. Preparation of the first section of the storage ring tunnel floor is underway and will enable pouring the first tunnel sections in early September. Overall, concrete activities are proceeding ahead of schedule.

Figure 3: Forms and reinforcing for the 27-inch-thick tunnel floor slab.

Figure 4: Utilities tunnel, looking west.

Installation of underground utilities for the ring building also made good progress, with continued installation of water mains, electrical ductbank, sanitary, and storm water systems.

Steady progress on review of submittals continues as nearly all structural steel piece drawings have been reviewed, enabling full release of all structural steel shapes for fabrication. Submittals for joists and decking are anticipated in early September. Review of rebar drawings has been coordinated with Torcon to keep pace with fast-moving concrete operations. Coordinating the balance of underground utilities submittals will be the focus in September, to assure

that underground utility fabrication and installation are on schedule.

Substantial progress was also made on the remaining conventional facilities construction packages. The Chilled Water Plant Expansion contractor received notice to proceed in late July and mobilized rapidly to begin site clearing and excavation on August 25. The Electrical Substation contract was awarded in late July and the contractor has submitted bonds, insurance, and a Health and Safety Plan (HASP), with issuance of Notice to Proceed likely in early September. The Chilled Water Piping Contract was awarded August 27 and preparation of submittals is just beginning.

Major material procurements have all been awarded and are proceeding on or ahead of schedule. Drawings for the eight Unit Substations have been received and approved, and the manufacturer anticipates delivery of the equipment 2 months earlier than contracted. Similarly, drawings for the 15kV switchgear have been approved and delivery of equipment is expected 3 months early. The main substation transformer drawings are in preparation and are expected in September.

Design of the LOBs continues to progress toward completion in time for release of the RFP the first week of November. The draft 100% design is anticipated to be delivered September 25 for final review, and bid issue drawings and specifications will be submitted in late October.

PROCUREMENT ACTIVITIES

Magnet proposals continue to be evaluated by the Proposal Evaluation Panel. The quadrupole and sextupole evaluations are complete, with award expected in September. Proposals for the correctors, dipole, and large-aperture magnets are in evaluation and awards are planned for early October. The statement of work and specification for the linac are complete, and release of the RFP to industry is anticipated by the end of September. The Chilled Water Piping Contract was issued on August 27.

RECENT HIRES

Henry Diaz – Electrical Technician – Electrical Engineering, ASD
Kelly Roy – Mechanical Designer – Mechanical Engineering, ASD
Jean Smiles – Administrative Services Assistant – PSD

ENVIRONMENT, SAFETY, AND HEALTH (ESH)

NSLS-II staff continues to work closely with Torcon and the subcontractors to develop Phase Hazards Analyses (PHAs), recording work steps, hazards, and controls to reduce the risk of incident. PHAs also provide a mechanism for feedback from the workers to improve future work. PHAs for concrete waterproofing and steel erection were completed in August.

The BNL Independent Assessment and Oversight Group, working with Liberty Mutual Insurance Co., began Phase Two of an independent Construction Safety Assessment for NSLS-II. Phase Two covers contractor training requirements. Phase Three will begin at the end of September and involves on-site work observations. The entire assessment is expected to be complete by the end of October.

An NSLS-II Authorization Basis Workshop was held on August 21 to gain consensus on the NSLS-II authorization basis strategy, by defining schedules and responsibilities, developing documentation, and studying lessons learned from other accelerator projects. The workshop was attended by NSLS-II staff, BNL support staff, DOE BHSO and CH representatives, and a representative from Oak Ridge National Lab's Spallation Neutron Source. Action items from the workshop included adding a new risk to the NSLS-II risk matrix to cover the possibility that DOE Order 420.2B, "Safety of Accelerator Facilities," could be significantly modified or eliminated, which would necessitate changes to the NSLS-II strategy. Other action items included developing more detail for the process and establishing a POC for coordination of startup. Future detailed Authorization Basis meetings will continue to expand on the process.

COST/SCHEDULE BASELINE STATUS

The cumulative Cost Performance Index (CPI) is 1.04 and the cumulative Schedule Performance Index (SPI) improved from 0.92 to .93. Both indices have green status and are well within the DOE acceptable range. The project's monthly CPI is 0.96 (green status) and the monthly SPI is 0.97 (green status).

The critical path for the current baseline runs through ring building construction, storage ring equipment and ID installation and integrated test, and commissioning of the storage ring. Schedule float is being carefully analyzed.

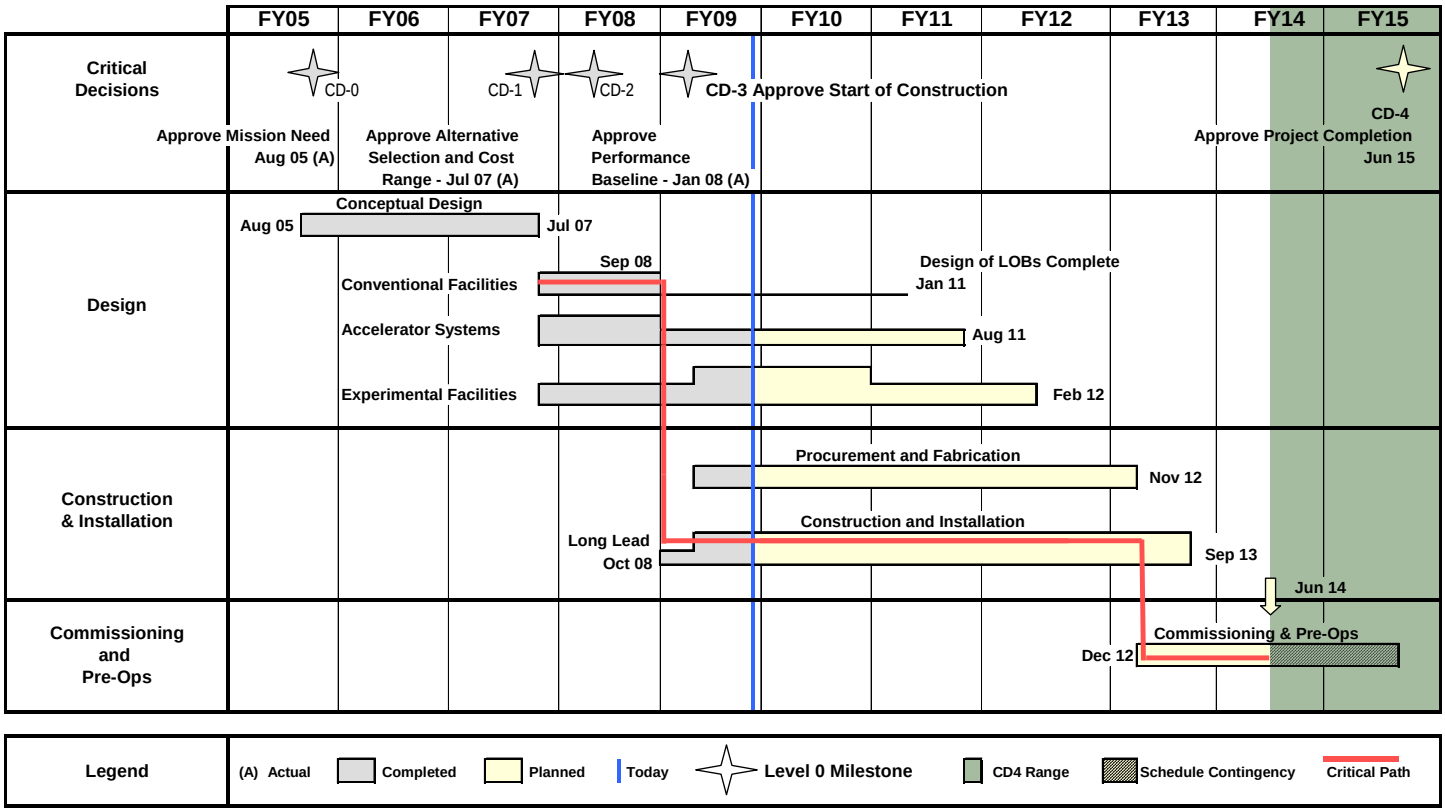
ARRA activities: During the month of August 2009, ARRA-funded work was on schedule and on budget. Activities included concrete work for Pentant 1 (Fig. 5), installation of underground sanitary piping, excavation of foundations and concrete work for a portion of Pentant 2, and completion of the slab and footings for the vehicle tunnel.

Figure 5: Foundation work at Pentant 1.

PROJECT DESCRIPTION

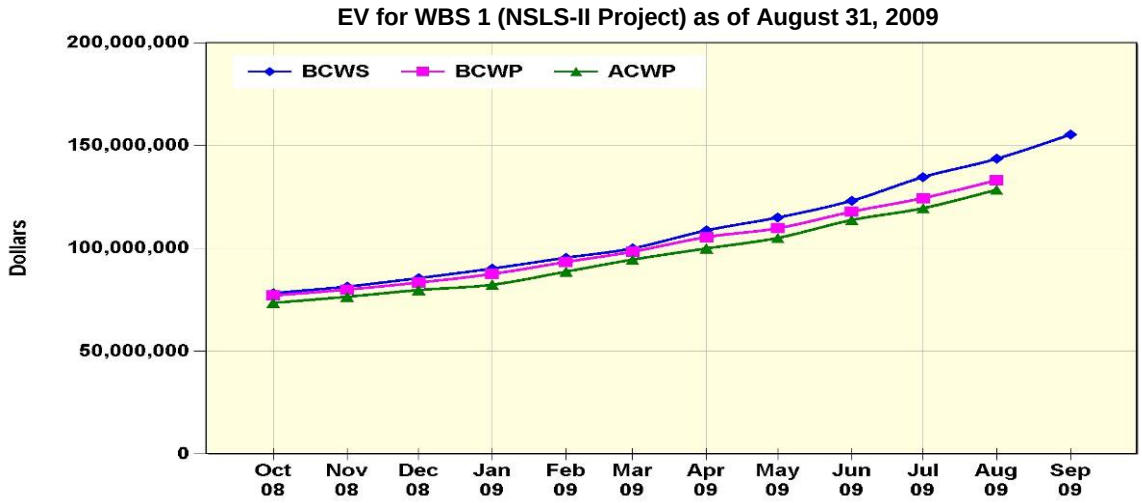
The NSLS-II project is being carried out to design and build a world-class user facility for scientific research using synchrotron radiation. The project scope includes the design, construction, and installation of the accelerator hardware, civil construction, and experimental facilities required to 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



RECENT PROJECT ACCOMPLISHMENTS

- The Accelerator Physics group evaluated the design for the transverse damper system to optimize DW field specifications.
- In preparation for booster and linac procurements, the ASD physics group visited vendors and produced specifications, statements of work, and drawing packages. They refined the injection systems design using booster beam stacking studies and a realistic booster magnet model for particle tracking.
- The Project has procured pulsed power components to be tested at the Pulsed Magnet Lab.
- The lab safety committee successfully reviewed the High Voltage Interlock system.
- The Controls group has integrated LIBERA-type BPM receivers into the EPICS control system.
- The Power Supply Interface first article board has been received and is being tested.
- Power supplies for quadrupoles, sextupoles, and corrector magnets have been successfully prototyped.
- The utilities design group successfully modeled the water and compressed gas systems.
- The DW procurement documents have been modified and updated to support procurement of these devices via APS/ANL.
- The instrumentation group completed acceptance tests of the first article storage ring BPM buttons.
- Three of the six project beamline advisory teams met to review conceptual designs for the beamlines (XPD, CHX, CSX). Three internal beamline safety reviews also were held, for the XPD, CHX, and SRX beamlines.
- The 1nm optics R&D group developed and tested reactive ion etching and the effects of environmental conditions.



Cumulative to Date (K$)	Oct 08	Nov 08	Dec 08	Jan 09	Feb 09	Mar 09	Apr 09	May 09	Jun 09	Jul 09	Aug 09	Sep 09
BCWS	78,248	81,437	85,551	90,181	95,480	100,025	108,753	115,036	123,163	134,682	147,567	163,305
BCWP	77,088	79,974	83,373	87,572	93,407	98,407	105,508	110,000	117,841	124,463	133,133	
ACWP	73,505	76,479	79,754	82,330	88,714	94,556	100,000	105,100	113,794	119,538	128,528	

Project as of 7/31/09	Current Period	Cum-to-date
Plan (BCWS) $K	8,923	143,604
Earned (BCWP) $K	8,670	133,133
Actual (ACWP) $K	8,990	128,528
SV $K	-253	-10,471
CV $K	-320	4,605
SPI	.97	0.93
CPI	.96	1.04
Budget at Completion $K (PMB)		741,983
Planned % Complete		19.4%
Earned % Complete		17.9%
Mgmt Rsrv/Cont. as % of BAC remaining		27.9%
Mgmt Rsrv/Cont. as % of EAC remaining		25.9%

Levels 1, 2, 3 Milestones – Near Term

Level	Description	Baseline Date
L1 00040	CD-3 Approve Start of Construction	Feb09 Actual=Jan09✓
L2 00100	100% Conventional Facility Title II Design Complete	Aug 2008✓
L2 00220	Begin Site Preparation	Nov 2008✓
L2 00240	Issue Ring Building NTP	Jun09 Actual=Mar09✓
L2 00260	Contract Award for Booster System	Mar 2010
L3 05732	40% Accelerator Design Complete	Feb 2008✓
L3 05735	60% Conventional Facility Title II Design Complete	May 08✓
L3 05765	Conventional Facility Site Prep Complete	Jan09 Actual=Feb09✓
L3 05770	Accelerator SR Magnet Design Complete	Feb 2009✓
L3 05780	Exp. Facilities – Prelim. Design End Stations 1 Complete	June 2010

✓ = Completed; on schedule, unless otherwise noted

Schedule Performance Index, Project to Date:

SPI **0.93**

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

Cost Performance Index, Project to Date:

CPI **1.04**

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

ACWP = Actual Cost of Work Performed
BAC = Budget at Completion
BCWP = Budgeted Cost of Work Performed
BCWS = Budgeted Cost of Work Scheduled
CPI = Cost Performance Index (BCWP/ACWP)
EV = Earned Value
IPT = Integrated Project Team
PMB = Performance Measurement Baseline
SPI = Schedule Performance Index
WBS = Work Breakdown Structure

SPI or CPI in the range of:	
	0.9 – 1.15 is green
	0.85 – 0.89 or 1.16 – 1.25 is yellow
	<0.85 or >1.25 is red

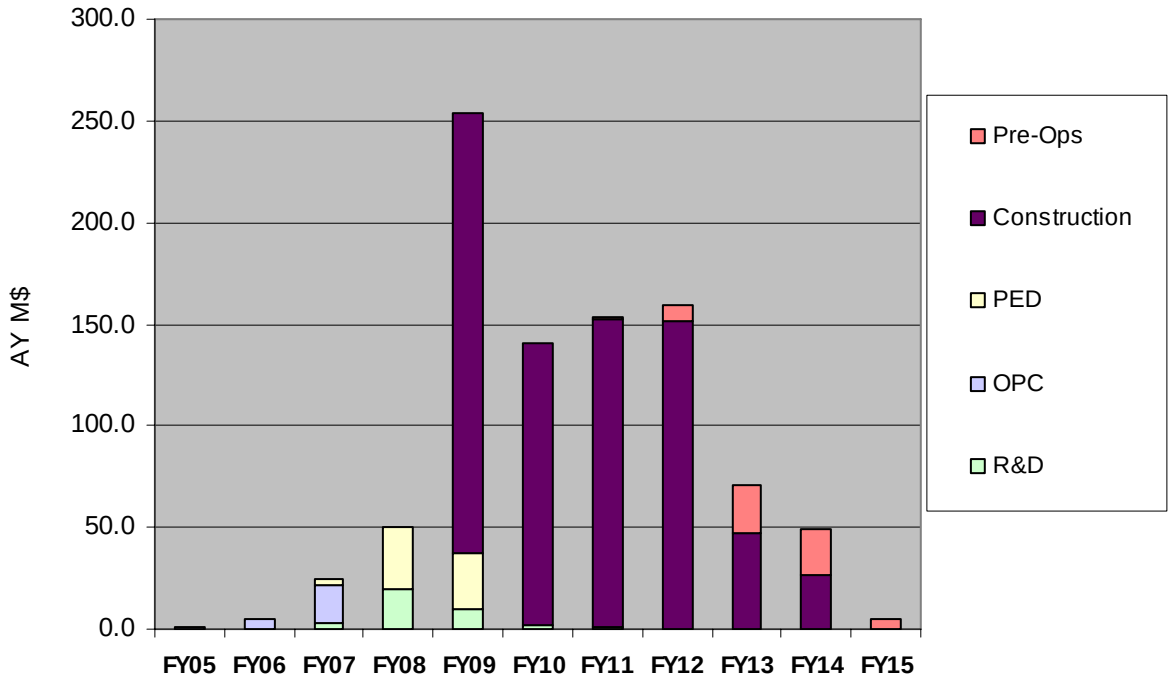
Four PCRs were approved in August:

PCR #	Area	Δ cost	Description
PCR_09_083	CFD	$0	Correct errors in the Torcon cost/schedule baseline.
PCR_09_084	CFD	$0	Update construction cost/schedule plan for CHW Plant, CHW Piping and Electrical Substation into the project baseline.
PCR_09_085	ASD	$12k	Update Storage Ring Magnet Delivery schedule to the project cost/schedule baseline.
PCR_09_086	ASD	$63k	Combine Linac Front End procurement with the linac procurement in the project cost/schedule baseline.

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

Funding Profile (revised to reflect ARRA funding)

	NSLS-II Funding Profile ($M)												
Fiscal Year	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	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
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NSLS-II Project Support Division Director	Diane Hatton	dhatton@bnl.gov	631-344-5073

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 NSLS-II	a. NAME August 2009 EV8	a. FROM (YYYYMMDD) 2009 / 08 / 01
b. LOCATION (Address and ZIP Code) Brookhaven National Laboratory, Upton,NY	b. NUMBER	b. PHASE	b. TO (YYYYMMDD) 2009 / 08 / 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	

8. PERFORMANCE DATA

WBS[2] / WBS[3] / Control Acct / 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)
1.01 Project Management													
1.01.01 Project Management													
WBS[3]Totals:	97,883	97,883	59,518	0	38,365	2,092,949	2,092,949	2,341,257	0	-248,308	6,692,091	7,445,091	-753,000
1.01.02 Environmental, Safety & Health													
WBS[3]Totals:	77,867	77,867	89,518	0	-11,651	1,611,030	1,611,030	1,872,380	0	-261,350	6,154,591	6,154,591	-0
1.01.03 Project Support													
WBS[3]Totals:	803,085	803,085	847,079	0	-43,994	12,558,166	12,558,166	12,806,883	-0	-248,717	36,375,557	39,221,557	-2,846,000
1.01.04 Quality Assurance													
WBS[3]Totals:	49,875	49,875	60,939	0	-11,064	959,447	959,447	674,273	0	285,173	3,073,212	3,073,212	0
1.01.05 Configuration Management & Document Control													
WBS[3]Totals:	26,294	26,294	24,604	0	1,690	611,337	611,337	471,280	0	140,056	1,972,567	1,972,567	-0
WBS[2]Totals:	**1,055,004**	**1,055,004**	**1,081,658**	**0**	**-26,655**	**17,832,928**	**17,832,928**	**18,166,073**	**-0**	**-333,144**	**54,268,017**	**57,867,018**	**-3,599,000**
1.02 R&D and Conceptual Design													
1.02.01 Accelerator Systems R&D													
WBS[3]Totals:	110,342	124,272	149,246	13,930	-24,974	9,046,598	8,609,771	8,891,901	-436,828	-282,130	11,460,076	11,460,076	-0
1.02.02 Experimental Systems R&D													
WBS[3]Totals:	370,386	194,500	394,701	-175,886	-200,201	10,718,087	10,117,694	8,886,957	-600,393	1,230,737	19,166,553	19,163,549	3,004
1.02.03 Conceptual Design - Accelerator Systems													
WBS[3]Totals:	0	0	0	0	0	12,998,214	12,998,214	12,953,527	0	44,686	12,998,214	12,998,214	0
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	7,325,314	0	-239,126	7,086,188	7,325,314	-239,126
1.02.07 Project Management - R&D													
WBS[3]Totals:	49,434	49,434	31,698	0	17,737	4,619,297	4,619,297	4,708,537	0	-89,240	5,305,339	5,066,213	239,125
WBS[2]Totals:	**530,162**	**368,206**	**575,645**	**-161,956**	**-207,439**	**49,064,781**	**48,027,561**	**47,351,564**	**-1,037,221**	**675,997**	**60,612,767**	**60,612,767**	**-0**
1.03 Accelerator Systems													
1.03.01 Accelerator Systems Management													
WBS[3]Totals:	109,492	109,492	143,165	0	-33,673	2,068,476	2,068,476	1,815,416	0	253,059	6,019,099	11,081,099	-5,062,000
1.03.02 Accelerator Physics													
WBS[3]Totals:	213,942	213,942	182,578	0	31,364	2,543,840	2,543,840	2,140,797	0	403,043	10,071,767	12,071,767	-2,000,000
1.03.03 Injection System													
WBS[3]Totals:	-420,799	79,617	130,204	500,416	-50,587	1,679,004	1,425,252	1,005,886	-253,752	419,367	39,969,095	40,970,095	-1,001,000
1.03.04 Storage Ring													
WBS[3]Totals:	667,056	552,859	887,698	-114,197	-334,840	13,384,611	11,636,728	10,796,777	-1,747,884	839,951	140,738,451	147,408,452	-6,670,000
1.03.05 Controls Systems													
WBS[3]Totals:	221,989	116,491	246,342	-105,499	-129,851	3,408,427	2,400,937	2,631,376	-1,007,490	-230,439	20,121,954	20,121,953	0
1.03.06 Accelerator Safety Systems													
WBS[3]Totals:	36,268	13,156	40,977	-23,112	-27,821	612,631	550,131	446,809	-62,500	103,322	4,297,433	4,506,432	-209,000
1.03.07 Insertion Devices													
WBS[3]Totals:	55,491	334,898	35,930	279,407	298,968	1,093,732	832,741	413,955	-260,991	418,786	25,237,478	29,310,479	-4,073,000
1.03.08 Accelerator Fabrication Facilities													
WBS[3]Totals:	284,489	227,288	220,819	-57,201	6,468	4,621,102	3,365,579	3,310,550	-1,255,522	55,030	5,722,387	6,142,387	-420,000
WBS[2]Totals:	**1,167,928**	**1,647,743**	**1,887,715**	**479,814**	**-239,973**	**29,411,822**	**24,823,684**	**22,561,565**	**-4,588,138**	**2,262,119**	**252,177,664**	**271,612,663**	**-19,435,000**
1.04 Experimental Facilities													
1.04.01 Experimental Facilities Management													
1.04.01 Experimental Facilities Management	83,921	83,921	109,608	0	-25,687	1,415,131	1,415,131	1,749,876	0	-334,745	4,568,673	5,118,673	-550,000
WBS[3]Totals:	83,921	83,921	109,608	0	-25,687	1,415,131	1,415,131	1,749,876	0	-334,745	4,568,673	5,118,673	-550,000
1.04.02 Standard Local Controls & Data Acquisition Systems													
1.04.02 Standard Local Controls & Data Acquisition Systems	1,265	0	0	-1,265	0	20,562	11,656	0	-8,906	11,656	69,585	69,585	-0
WBS[3]Totals:	1,265	0	0	-1,265	0	20,562	11,656	0	-8,906	11,656	69,585	69,585	-0
1.04.05 User Instruments													
WBS[3]Totals:	184,773	259,195	233,934	74,422	25,261	2,833,083	2,641,455	1,667,902	-191,628	973,553	63,573,084	67,523,084	-3,950,000
1.04.06 Front End User Requirements Development													
1.04.06 Front End User Requirements Development	0	0	0	0	0	456	456	1,205	-0	-749	456	1,205	-749
WBS[3]Totals:	0	0	0	0	0	456	456	1,205	-0	-749	456	1,205	-749
1.04.07 Optics Labs													
WBS[3]Totals:	4,341	0	2,640	-4,341	-2,640	827,223	633,098	548,934	-194,126	84,163	2,072,162	2,072,162	0
WBS[2]Totals:	**274,300**	**343,116**	**346,182**	**68,815**	**-3,066**	**5,096,455**	**4,701,796**	**3,967,918**	**-394,659**	**733,878**	**70,283,960**	**74,784,709**	**-4,500,749**
1.05 Conventional Facilities													
1.05.01 Conventional Facilities Management													
WBS[3]Totals:	208,719	208,719	214,643	0	-5,924	3,829,656	3,829,656	3,680,747	0	148,909	14,187,003	14,223,590	-36,588
1.05.02 Conventional Facilities Engineering and Design													
WBS[3]Totals:	165,847	171,522	276,910	5,675	-105,388	14,443,869	14,432,753	14,294,420	-11,116	138,333	20,673,299	23,442,952	-2,769,652
1.05.03 Conventional Facilities Construction													
WBS[3]Totals:	5,508,426	4,875,764	4,607,583	-632,662	268,181	23,782,669	19,447,843	18,470,939	-4,334,826	976,903	217,414,846	235,354,281	-17,939,435
1.05.04 Integrated Controls & Communications													
1.05.04 Integrated Controls & Communications	10,000	0	0	-10,000	0	125,000	0	0	-125,000	0	561,273	961,273	-400,000
WBS[3]Totals:	10,000	0	0	-10,000	0	125,000	0	0	-125,000	0	561,273	961,273	-400,000
1.05.05 Standard Equipment													
1.05.05 Standard Equipment	0	0	0	0	0	0	0	0	0	0	1,025,586	1,025,586	0
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													
1.05.06 Commissioning	2,500	0	0	-2,500	0	17,500	37,233	34,825	19,733	2,407	578,000	578,000	0
WBS[3]Totals:	2,500	0	0	-2,500	0	17,500	37,233	34,825	19,733	2,407	578,000	578,000	0
WBS[2]Totals:	**5,895,492**	**5,256,005**	**5,099,136**	**-639,487**	**156,869**	**42,198,694**	**37,747,484**	**36,480,933**	**-4,451,209**	**1,266,552**	**254,440,008**	**275,585,683**	**-21,145,674**
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	3,823,660	0
1.06.04 Spares													
1.06.04 Spares	0	0	0	0	0	0	0	0	0	0	9,134,454	9,134,454	-0
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**	**50,200,405**	**0**
b. Cost of Money	0	0	0	0	0	0	0	0	0	0	0	0	0
c. Gen. and Admin.	0	0	0	0	0	0	0	0	0	0	0	0	0
d. Undist. Budget											0	0	0
e. Sub Total	8,922,886	8,670,072	8,990,336	-252,813	-320,264	143,604,680	133,133,453	128,528,052	-10,471,227	4,605,401	741,982,822	790,663,245	-48,680,423
f. Contingency/Management Reserve											170,017,178		
g. Total	8,922,886	8,670,072	8,990,336	-252,813	-320,264	143,604,680	133,133,453	128,528,052	-10,471,227	4,605,401	912,000,000		