Draft Project Closeout Report
for the
NSLS-II Experimental Tools (NEXT) Project

Project # MIE-SC-12-NEXT

at

Brookhaven National Laboratory
Upton, New York

Office of Basic Energy Sciences
Office of Science
U.S. Department of Energy

Date: May 2017

Project Closeout Report for the
NSLS-II Experimental Tools (NEXT) Project at the
Brookhaven National Laboratory

Submitted by:

_____ Date: _____

Steven Hulbert
NEXT Project Manager
Brookhaven National Laboratory

Approved by:

_____ Date: _____

Robert Caradonna
NEXT Federal Project Director
Brookhaven Site Office

Project Closeout Report for the
NSLS-II Experimental Tools (NEXT) Project at the
Brookhaven National Laboratory

Table of Contents

1. EXECUTIVE SUMMARY 4
2. INTRODUCTION 5
3. ACQUISITION APPROACH 5
4. PROJECT ORGANIZATION 6
5. PROJECT BASELINE 9
   - 5.1 Scope Baseline 9
   - 5.2 Cost Baseline 11
   - 5.3 Schedule Baseline 15
   - 5.4 Work Breakdown Structure 17
   - 5.5 Funding Profile 18
   - 5.6 Staffing Profile 19
   - 5.7 Environmental Requirements/Permits 19
   - 5.8 Safety Record 20
6. CLOSEOUT STATUS 20
7. LESSONS LEARNED 21
8. PHOTOS 24
9. PROJECT DOCUMENT ARCHIVES AND LOCATIONS 27

APPENDICES
- A. Complete WBS Dictionary 28
- B. Major External Reviews 42
- C. Baseline Change Log 43

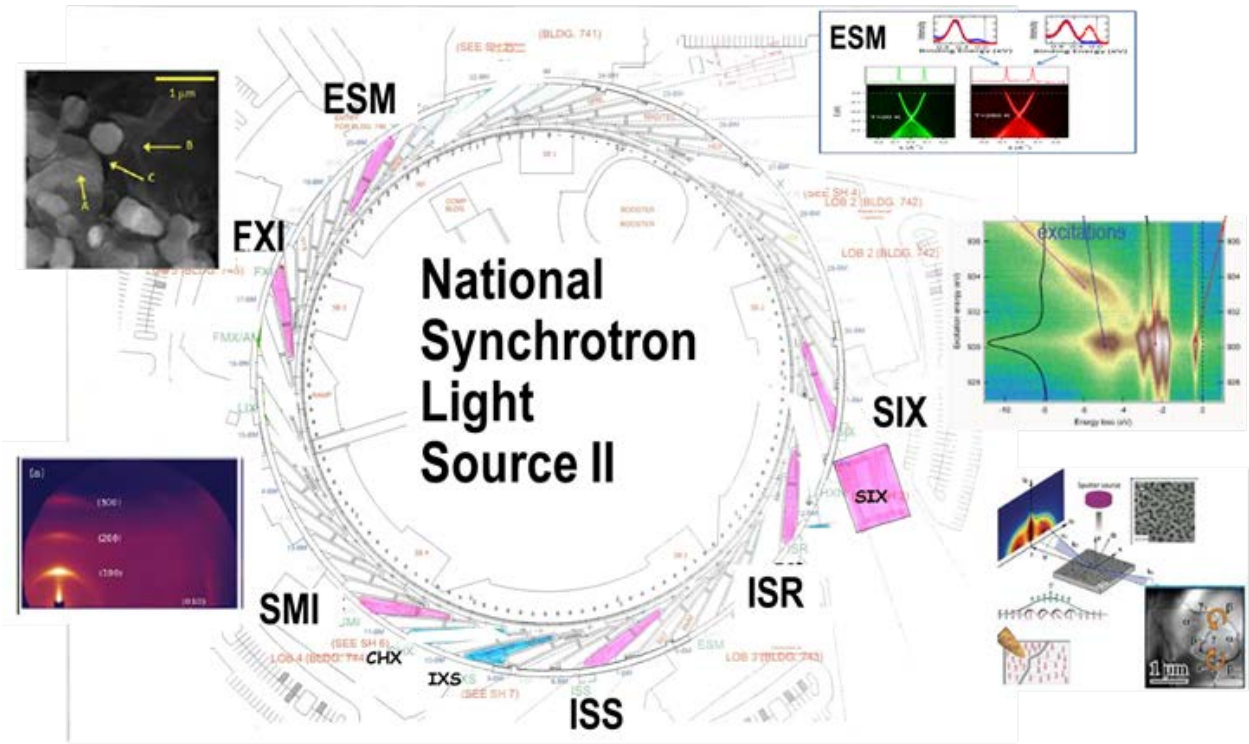
1. EXECUTIVE SUMMARY

The goal of the NSLS-II Experimental Tools (NEXT) project was to provide NSLS-II with "best-in-class" beamlines in order to explore unique advanced scientific capabilities offered by the NSLS-II facility beyond those provided by the initial set of NSLS-II beamlines. The NEXT beamline scientific programs will support the urgent needs identified by the U.S. research community for responding to the DOE mission of achieving transformational energy solutions in the near-term while simultaneously expanding our knowledge of fundamental energy science. The NEXT beamlines will also provide significant user capacity to NSLS-II facility operations, supporting a wide range of research programs.

The NEXT project provided five insertion device beamlines and the design of a sixth. It also provided insertion devices for two of the beamlines. The five beamlines cover a wide range of photon energies, from the VUV (20 eV) to the hard X-ray (36 keV), and a set of techniques ranging from spectroscopy and scattering to microprobes and imaging. When fully commissioned, the source-plus-beamline performance of the NEXT beamlines will be a world-class combination of flux, resolution, and spot size.

The NEXT project attained CD-2 and baselined in October 2013 with a Total Project Cost of $90M which included contingency of $21.8M. CD-3 was attained in July 2014. As of March 2017 the project was 99.6% complete with an EAC of $89.3M and a cumulative CPI of 0.93. Cumulative cost performance of the project has been within acceptable ranges (7% cumulative cost overage), and allowed the addition of $7.7M of scope to enhance the capabilities of the NEXT beamlines (between Aug. 2014 and Nov. 2015). The project has met or exceeded all of its KPPs on 16-May-2017 and expects to achieve early project completion on 31-Jul-2017 with the receipt and acceptance of the triple rotation flange for the SIX beamline, with CD-4 to follow shortly thereafter (will say date of ESAAB in final).

Readiness for operation with beam (technical commissioning phase) in the already-operating NSLS-II facility was reviewed and approved for each NEXT beamline as soon as beamline construction was complete. First-light dates for the five NEXT beamlines ranged from April 2016 to February 2017.



Beamlines of the NEXT Project

2. INTRODUCTION

This is the Draft Project Closeout Report for the NEXT project. This document was completed in May 2017 in preparation for the CD-4 OPA review on 31-May-2017 and 1-Jun-2017. The project is located at NSLS-II, Brookhaven National Laboratory, Upton, Long Island, New York.

3. ACQUISITION APPROACH

The acquisition strategy selected relied on the BNL management and operating (M&O) contractor (BSA) to manage the NEXT acquisition. BSA had direct responsibility for oversight of all NEXT contracts.

The design, some of the fabrication and assembly, installation, testing, and commissioning for the NEXT Project was performed by BNL NSLS-II scientific and technical staff assigned to NEXT.

Integrated engineering design for the NEXT beamlines was carried out primarily by BNL NSLS-II scientific and technical staff. However, where particular expertise resided in an entity outside of NSLS-II, memoranda of understanding or contracts with that external entity were generated for the particular scope of work best done externally.

Much of the NEXT M&S was procured via subcontracts, including the beamline optical components and their mechanical systems, endstation components including detectors, and

insertion devices. The major contractors for NEXT photon delivery system components were Toyama, IDT, and Bestec, while the major contractors for optical components were InSync, SESO, Winlight, and JTEC. All systems and components were procured using firm fixed price contracts. Best-value competitive procurements were employed to the maximum extent possible. Test and acceptance procedures for equipment were defined in the individual procurement specifications for each item based on the needs of the specific beamline.

A number of procurements were "build-to-print" following NEXT drawings and specifications. In addition, many ancillary components were readily available off-the-shelf. Source selection was carried out in accordance with DOE-approved policies and procedures. Acquisition strategies were chosen to obtain the best value based on the assessment of technical and costs risks on a case-by-case basis. For standard, build-to-print fabrications and the purchase of off-the-shelf equipment for routine applications, available purchasing techniques included price competition among technically qualified suppliers and use of competitively awarded blanket purchase agreements.

NEXT project management identified major procurements that represented significant complexity or cost and schedule risk. Advanced Procurement Plans (APPs) were prepared for each major procurement. The APPs included information such as: contract type, expected dollar amount, special contracting methods, and special clauses or deviations required. The use of APPs identified critical procurement activities for the NEXT Project and helped to mitigate or avoid schedule conflicts within NSLS-II and BNL and other procurement-related problems.

Installation and integration of each beamline was managed and, for scope outside executed procurement contracts, performed by BNL NSLS-II staff. Because the NSLS-II facility was operational when fabrication of NEXT components was completed, installation was carefully coordinated with the NSLS-II operating schedule. The NEXT Project and NSLS-II Operations ensured that the beamlines were appropriately integrated into the NSLS-II facility and met BNL ES&H and maintenance standards.

4. PROJECT ORGANIZATION

Authority for the oversight of the NEXT project resides with the Associate Director of Science for Basic Energy Sciences. The NEXT project was organized as shown in Figure 4.1. Members of the NEXT Integrated Project Team (IPT) established to accomplish this project, comprised of DOE and BNL personnel, are indicated.

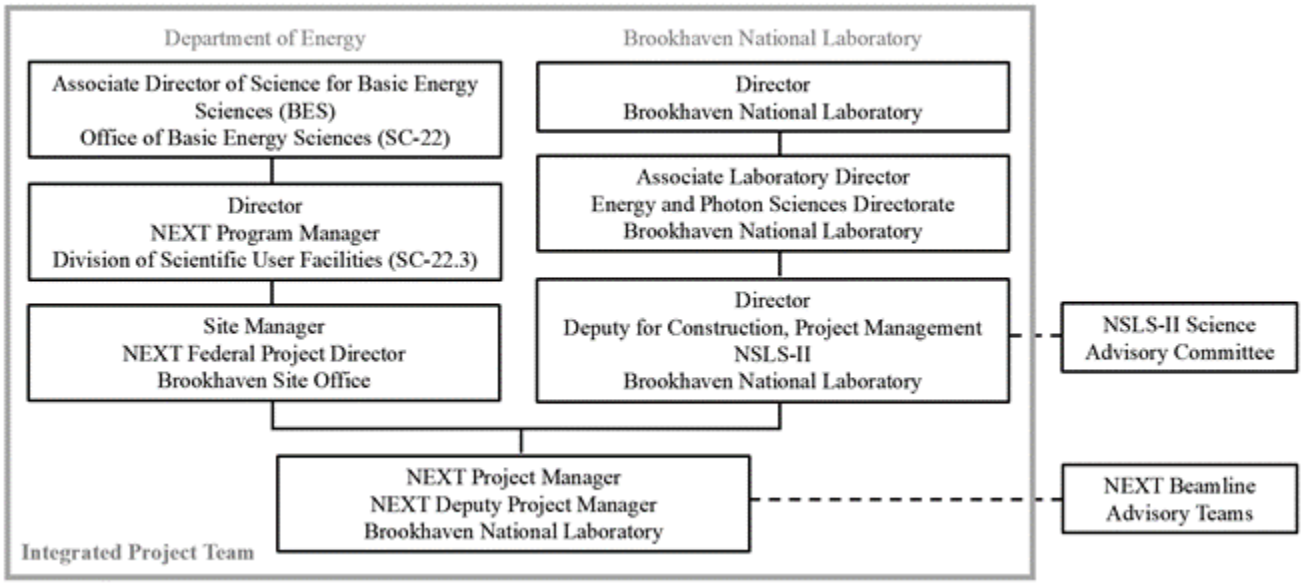


Figure 4.1 NEXT Project management relationships

The organization of the NEXT project itself is shown in Figure 4.2. The NEXT Project Management Team consists of the Project Manager, Deputy Project Manager, ES&H Manager, QA Manager, Project Controls Manager, and CAMs assigned to each WBS level 2 element.

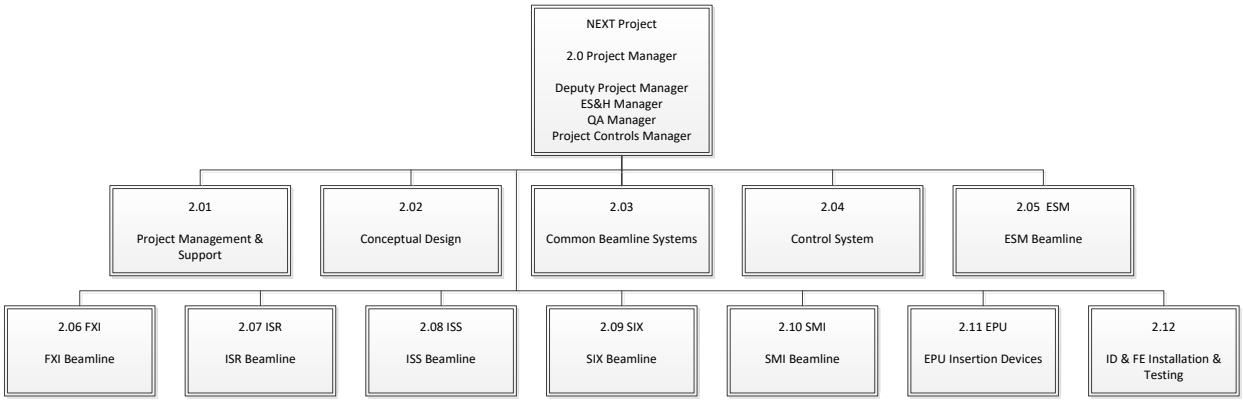


Figure 4.2 NEXT Project Work Breakdown Structure

WBS elements WBS 2.02 (Conceptual Design) and a portion of WBS 2.01 (Project Management and Support) represent the Other Project Cost (OPC) portion of the project. The remainder of WBS 2.01 and all of WBS 2.03 (Common Beamline Systems), WBS 2.04 (Control System), WBS 2.05 (ESM Beamline), WBS 2.06 (FXI Beamline), WBS 2.07 (ISR Beamline), WBS 2.08 (ISS Beamline), WBS 2.09 (SIX Beamline), WBS 2.10 (SMI Beamline), WBS 2.11 (EPU Insertion Devices), and WBS 2.12 (ID & FE Installation & Testing) formed the Total Estimated Cost (TEC) portion of the project.

The level 2 WBS elements in place at CD-1 (2011) were: Project Management and Support, Conceptual Design, Common Beamline Systems, and the ESM, FXI, ISR, ISS, SIX, and SMI beamlines. The WBS 2.04 (Control System) and WBS 2.11 (EPU Insertion Devices) elements were added at CD-2 (2013). Insertion Device & Front End Installation & Testing (WBS 2.12) was added in 2015.

Staff dedicated to the NEXT Project were assigned from the NSLS-II facility organization. A high level NSLS-II organization chart is shown in Figure 4.3.

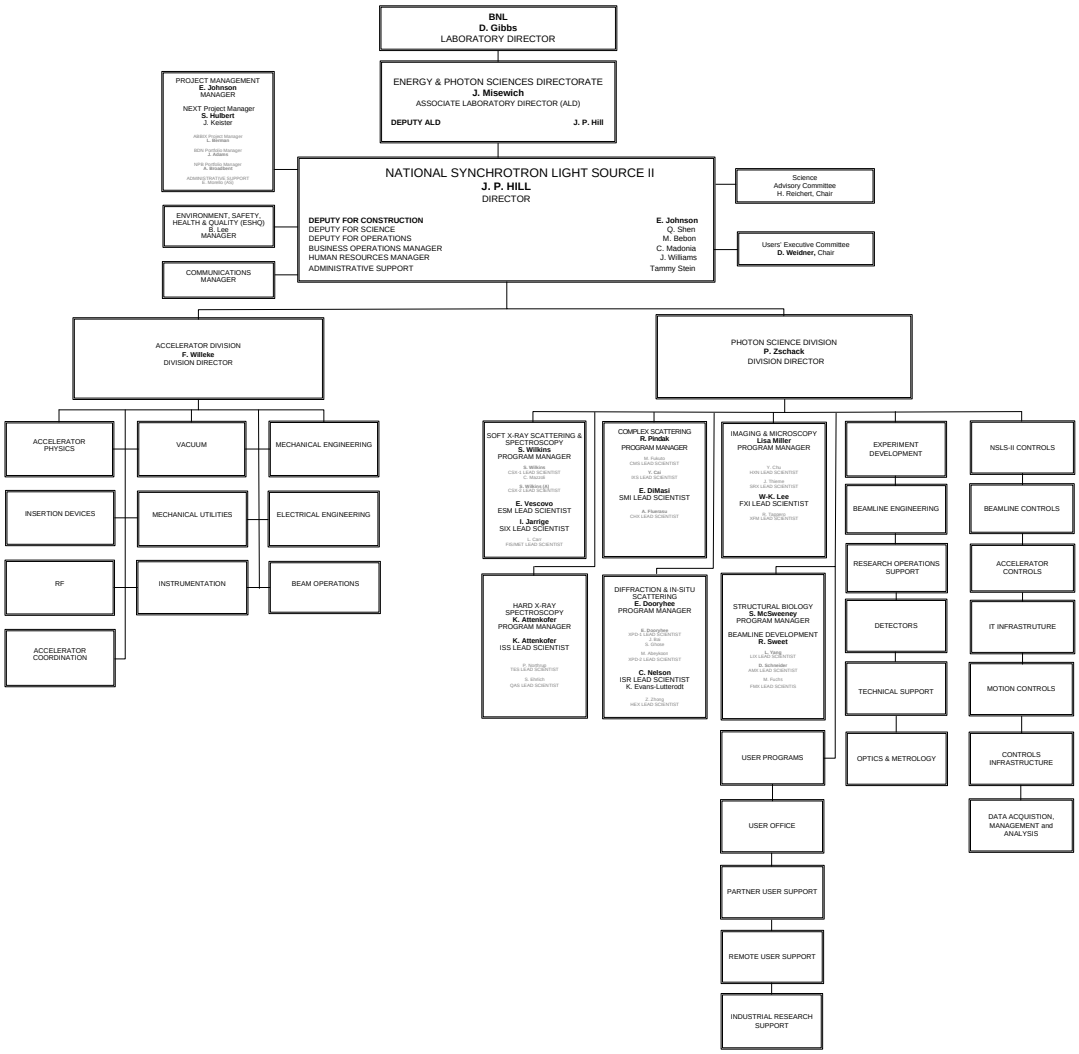


Figure 4.3 NSLS-II high level organization chart

The majority of the remainder of project labor was provided matrixed effort, at the task level, from the NSLS-II organization. In addition, effort was provided by other BNL organizations, some arranged by MOUs, and some effort was provided by job-shop contracts. The NSLS-II organization structure allows for the construction and operation of beamlines, providing an

effective and efficient means of staffing the NEXT Project without having to manage the ramp up/down phases of a standalone project.

The NEXT Project Manager, Steven Hulbert, and 5 Level 2 WBS Managers [Control System (Yin), ESM Beamline (Vescovo), FXI Beamline (Lee), ISR Beamline (Nelson), and Insertion Device & Front End Installation & Testing (Fries)] served throughout the life of the project. The Deputy Project Manager role, served by Jeffrey Keister, was added in October 2013. Other management positions experienced succession, including: E&H Manager (Hoey, Stiegler), QA Manager (Porretto, Zipper), Project Controls Manager (O'Connor, Hollabaugh), Common Beamline Systems CAM (Broadbent, Stebbins), ISS Beamline (Berman, Attenkofer), SIX Beamline (Dvorak, Jarrige), SMI Beamline (Wiegart, DiMasi), and EPU Insertion Devices (Tanabe, Kitegi). The succession transitions were accomplished with minimal disruption because they did not occur and the same time and an overlap period was provided in all cases to assure continuity.

5. PROJECT BASELINE

This section documents the project Performance Baseline (PB) that consists of the scope, cost, schedule, and funding profile, as well as outlining the achievements of the project at its completion.

5.1 Scope Baseline

At CD-2, the project was baselined with the Key Performance Parameters (KPPs) listed in table 5.1.1.

The NEXT beamlines were added to the NSLS-II operating portfolio following successful completion of Instrument Readiness Reviews and receipt of authorization from the NSLS-II Director to begin commissioning with beam. The milestones achieved by each beamline in the steps leading up to commissioning with beam are provided in Table 5.1.2.

Table 5.1.1 NEXT Project KPPs

Description of Scope	***CD-2 Threshold KPP***	***KPP Achieved at CD-4***	***CD-2 Threshold KPP Met or Exceeded?***
Beamlines designed	*6*	*6*	*Met*
Beamlines installed and ready for commissioning with x-ray beam	*5*	*5*	*Met*
Photon Delivery System branches installed and accepted by NSLS-II facility operations	*5*	*5*	*Met*
Endstations installed and accepted by NSLS-II facility operations	*5*	*7*	*Exceeded*
*Synchrotron flux value measured at an endstation position of ESM**	10^{10} *photons/s*	2×10^{11} *photons/s*	*Exceeded*
*Synchrotron flux value measured at an endstation position of ISR**	2×10^{11} *photons/s*	2.4×10^{12} *photons/s*	*Exceeded*
*Synchrotron flux value measured at an endstation position of ISS**	2×10^{12} *photons/s*	2.5×10^{13} *photons/s*	*Exceeded*
*Synchrotron flux value measured at an endstation position of SIX**	1.5×10^{10} *photons/s*	1×10^{12} *photons/s*	*Exceeded*
*Synchrotron flux value measured at an endstation position of SMI**	10^{12} *photons/s*	1.06×10^{13} *photons/s*	*Exceeded*
*On-axis spectral angular intensity capability at 1 keV for a delivered EPU insertion device**	2×10^{17} *photons/s/0.1%bw/mrad*^{2}	9.2×10^{17} *photons/s/0.1%bw/mrad*^{2}	*Exceeded*

**scaled to 500 mA ring current*

Table 5.1.2 NEXT Beamline Milestones leading up to Commissioning with Beam

Beamline	***PDS Construction and IRR complete***	***Authorization to Start Commissioning***	***Shutters Enabled and First Light Taken***	***Flux KPP verified***	***Endstation Construction Complete***
ISS	*24-Mar-2016*	*3-Apr-2016*	*5-Apr-2016*	*23-Jun-2016*	*28-Oct-2016*
ISR	*29-Jun-2016*	*7-Jul-2016*	*11-Jul-2016*	*8-Aug-2016*	*24-Mar-2017*
ESM	*29-Jun-2016*	*22-Jul-2016*	*25-Jul-2016*	*15-Aug-2016*	*26-Apr-2017*
SMI	*3-Nov-2016*	*7-Nov-2016*	*7-Nov-2016*	*3-Dec-2016*	*21-Apr-2017*
SIX	*15-Feb-2017*	*17-Feb-2017*	*21-Feb-2017*	*26-Feb-2017*	*4-May-2017*

Acknowledgment that all NEXT beamlines had been accepted by NSLS-II Operations was received from the NSLS-II Photon Science Director on 16-May-2017.

In addition, the project was able to add significant scope ($7.7M value) in order increase the scientific capabilities of the beamlines. This added scope includes endstation enhancements for SMI, ESM, and ISR beamlines, shielded enclosures (hutches) for FXI beamline, power supplies for EPU current strips, sprinklers and smoke detectors for gas handling systems, and installation of front ends and insertion devices.

5.2 Cost Baseline

Table 5.2.1 shows the project cost baseline approved at CD-2, scope additions, and the final cost achieved at project completion and a brief description of differences in contingency usage from planned versus actual. Table 5.2.2 shows the CD-2 baseline and final cost for TEC and OPC to level 3 of the dictionary. "Final" costs are taken from latest (March 2017) reporting.

Table 5.2.1—Project Cost and Contingency Utilization [$k]

WBS	WBS Name	At CD-2	Added Scope	Final	Contingency Utilization
2.01	PROJECT MANAGEMENT & SUPPORT	$8,025	$591	$9,828	Contingency was used primarily for project support which was underestimated. IRR and closeout effort was added (many areas).
2.03	COMMON BEAMLINE SYSTEMS	$4,315	$246	$8,520	Contingency was used to address underestimates in utilities and PPS costs, and to add sprinklers and smoke detectors.
2.04	CONTROL SYSTEM	$4,450	$10	4,968	Contingency was used to address labor cost underestimates.
2.05	ESM BEAMLINE	$7,656	$746	$10,184	Contingency was used to address materials and labor cost underestimates, and to provide endstation enhancement (electron analyzer).
2.06	FXI BEAMLINE	$938	$830	$1,793	Contingency was used to add lead hutches.
2.07	ISR BEAMLINE	$7,362	$2,126	$10,528	Contingency was used to provide endstation enhancement (instrumented six-circle diffractometer), and to address material and labor cost underestimates.
2.08	ISS BEAMLINE	$8,789	$136	$11,236	Contingency was used to address material and labor cost underestimates.
2.09	SIX BEAMLINE	$11,090	$136	$13,711	Contingency was used to address cost underestimates, mainly for labor.
2.10	SMI BEAMLINE	$7,349	$746	$9,546	Contingency was used to provide endstation enhancement (detectors), and to address materials and labor cost underestimates.
2.11	EPU INSERTION DEVICES	$5,117	$668	$4,566	Added current strip power supplies for EPU insertion device vacuum chambers.
2.12	FRONT END AND INSERTION DEVICE INSTALLATION	$0	$1,450	$1,453	Contingency was utilized to extend scope to include installation of front ends and insertion devices for the project beamlines.
	TEC Direct	$65,092	$7,684	$86,333	
	TEC Contingency (37% of ETC at CD-2)	$21,908		$667	
	TOTAL ESTIMATED COST	**$87,000**		**$87,000**	
2.01	PROJECT MANAGEMENT & SUPPORT	$1,177	$0	$1,177	No contingency utilization as Conceptual Design was managed to cost, prior to CD-2.
2.02	CONCEPTUAL DESIGN	1,807	$0	$1,807	No contingency utilization as Conceptual Design was managed to cost, prior to CD-2.
2.04	CONTROL SYSTEM	$16	$0	$16	No contingency utilization as Conceptual Design was managed to cost, prior to CD-2.
	OPC Direct	$3,000	$0	$3,000	
	OPC Contingency (No ETC at CD-2)	$0		$0	
	OTHER PROJECT COST	**$3,000**		**$3,000**	
	Total Project Cost (TPC)	**$90,000**		**$90,000**	

- *Other Project Costs (OPC) include Conceptual Design.*
- *Total Estimated Cost (TEC) Construction includes Preliminary and Final Designs, construction, project management, and other costs not captured in OPC.*
- *Total Project Cost (TPC) includes TEC and OPC.*

Table 5.2.2— TEC and OPC Project cost at CD-2 and Completion [$k]

WBS#	***WBS NAME***	***Total $K at CD-2***	***Actual ($K)***
2	***NEXT Project [$k]***		
TOTAL ESTIMATED COST			
2.1	***Project Management & Support***	***$8,025***	***$9,829***
2.1.1	*Project Management*	*$3,431*	*$3,307*
2.1.2	*Project Support*	*$4,595*	*$6,522*
2.3	***Common Beamline Systems***	***$4,315***	***$8,520***
2.3.1	*Utilities*	*$2,551*	*$4,358*
2.3.2	*Personnel Protection System*	*$808*	*$2,363*
2.3.3	*Equipment Protection System*	*$301*	*$957*
2.3.4	*Control Station*	*$271*	*$221*
2.3.5	*Common Beamline Systems Management*	*$385*	*$620*
2.4	***Control System***	***$4,450***	***$4,968***
2.4.1	*Control System Management*	*$190*	*$242*
2.4.2	*Control System Design & Implementation*	*$2,729*	*$3,392*
2.4.3	*Control System Equipment*	*$1,531*	*$1,334*
2.5	***ESM Beamline***	***$7,656***	***$10,184***
2.5.1	*ESM Beamline Management*	*$556*	*$474*
2.5.2	*ESM Beamline Systems*	*$7,100*	*$9,710*
2.6	***FXI Beamline***	***$938***	***$1,793***
2.6.1	*FXI Beamline Management*	*$366*	*$471*
2.6.2	*FXI Beamline Systems*	*$571*	*$1,323*
2.7	***ISR Beamline***	***$7,362***	***$10,528***
2.7.1	*ISR Beamline Management*	*$915*	*$1,034*
2.7.2	*ISR Beamline Systems*	*$6,448*	*$9,493*
2.8	***ISS Beamline***	***$8,789***	***$11,236***
2.8.1	*ISS Beamline Management*	*$676*	*$681*
2.8.2	*ISS Beamline Systems*	*$8,114*	*$10,555*
2.9	***SIX Beamline***	***$11,090***	***$13,711***
2.9.1	*SIX Beamline Management*	*$710*	*$749*
2.9.2	*SIX Beamline Systems*	*$10,380*	*$12,962*
2.10	***SMI Beamline***	***$7,349***	***$9,546***
2.10.1	*SMI Beamline Management*	*$783*	*$707*
2.10.2	*SMI Beamline Systems*	*$6,567*	*$8,839*
2.11	***Insertion Devices***	***$5,117***	***$4,566***
2.11.1	*ESM EPU Insertion Device*	*$3,162*	*$4,401*
2.11.2	*SIX EPU Insertion Device*	*$1,864*	*$70*

WBS#	WBS NAME	Total $K at CD-2	Actual ($K)
2.11.3	Insertion Devices Management	$92	$94
2.12	**ID & FE Installation and Testing**	**$0**	**$1,453**
2.12.1	ID & FE Installation and Testing Management	$0	$21
2.12.2	ID Installation and Testing	$0	$585
2.12.3	FE Installation and Testing	$0	$848
	TEC Contingency (37 % of ETC at CD-2)	**$21,908**	**$667**
OTHER PROJECT COST			
2.1	**Project Management & Support**	**$1,177**	**$1,177**
2.1.1	Project Management	$938	$938
2.1.2	Project Support	$239	$239
2.2	**Conceptual Design**	**$1,807**	**$1,807**
2.2.2	Conceptual Design and Analysis of Photon Delivery Systems	$850	$850
2.2.4	ESM Advanced Conceptual Design	$101	$101
2.2.5	FXI Advanced Conceptual Design	$121	$121
2.2.6	ISR Advanced Conceptual Design	$211	$211
2.2.7	ISS Advanced Conceptual Design	$164	$164
2.2.8	SIX Advanced Conceptual Design	$180	$180
2.2.9	SMI Advanced Conceptual Design	$182	$182
2.4	**Control System**	**$16**	**$16**
2.4.1	Control System Management	$16	$16
	OPC Contingency (No ETC at CD-2)	**$0**	**$0**
	Total Project Cost	**$90,000**	**$90,000**

Table 5.2.3 summarizes the final Engineering Design Inspection and Administration (EDIA) versus construction cost breakdown. Table 5.2.4 summarizes the project contingency usage as a function of time while Figure 5.2.1 shows the remaining contingency as a function of project completion over the life of the project. Note that project completion, contingency, and ETC was calculated against the BAC and EV up to 90% project complete. Beyond that, these values were based on the EAC and AC.

Table 5.2.3—EDIA Cost Compared to Construction (March 2017 EAC)

EDIA as a % of Construction Cost*		***32.4% of construction overall***
Cost Categories	***Project $(K)***	***Comments***
Engineering	***$5,841***	*9% of construction cost*
Design (A/E, tech specs.; conceptual, preliminary, and final design; as-built drawings, etc.)	*Yes*	
Value Engineering	*Yes*	
Design Reviews	*Yes*	
Design Support (i.e., soil testing, vibration testing, seismic analysis, etc., needed for design)	*Yes*	
Other (specify)	*Yes*	*Accelerator Physics analysis and Requirements Development*
Management	***$15,620***	*23% of construction cost*
Design Management	*Yes*	
Construction Management	*Yes*	
Project Management (cost estimating, scheduling, project controls, risk assessment, etc.)	*Yes*	
QA/Inspection/testing/acceptance/etc.	*Yes*	
Procurement and Contracting	*Yes*	
Legal, Accounting, Real Estate	*Yes*	
Other (specify)	*No*	
ES&H	***$396***	*1% of construction cost*
Environmental Permitting	*Yes*	
Safety documentation	*Yes*	
Safety Inspection	*Yes*	
Security	*Yes*	*Charged via overhead on direct costs*
Other (specify)	*No*	
Construction/Fabrication	***$67,476***	
Building	*Yes*	*Land is DOE property and there is no cost to the project.*
Special Equipment (i.e., microscopes, probes, instruments, detectors, etc.)	*Yes*	*Accelerator and Experimental fabrication and installation; includes installation and labor costs of component fabrication and testing*
Standard Equipment (i.e., furniture, office equipment, benches, kitchen equipment, audio/visual, etc)	*Yes*	
Demolition/Disposal	*Yes*	
Research and Development	***$0***	
Commissioning/Testing or Start-up/Testing	***$0***	
Other (specify)	*Yes*	
Contingency	***$667***	
Total Project Cost	***$90,000***	

*EDIA as a % of Construction= (Engineering+Management+ES&H)/Construction/Fabrication

Table 5.2.4—Contingency Utilization [$K]

Date or End of Fiscal Year	% Project Complete	TPC	Actual Cost	Contingency remaining	ETC
FY13	13.8%	90,000	8,279	21,908	58,692
FY14	28.6%	90,000	21,027	17,779	51,549
FY15	60.8%	90,000	54,270	7,432	32,366
FY16	93.9%	90,000	82,546	2,072	5,382
31-Mar-17*	99.6%	90,000	88,993	667	340

*to be updated at completion

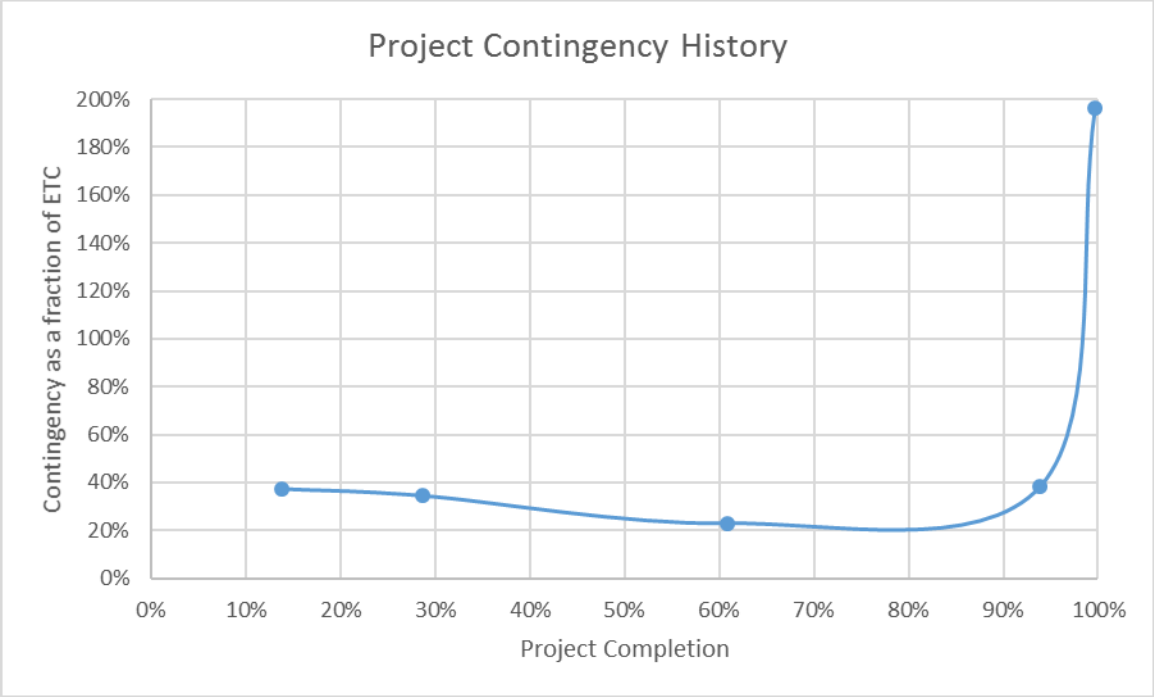


Figure 5.2.1 Contingency as a function of percent complete.

5.3 Schedule Baseline

The following Tables list the planned key schedule milestones and actual completion dates for Level 1 (DOE-SC) and Level 2 (DOE-BHSO) milestones.

Table 5.3.1 Level 1 Milestones (DOE-SC)

Level 1 Milestone	***Schedule at CD-2***	***Actual***
CD-0, Approve Mission Need	*5/27/2010*	*5/27/2010*
CD-1, Approve Alternative Selection and Cost Range	*12/19/2011*	*12/19/2011*
CD-2, Approve Performance Baseline	*1st Quarter FY2014*	*10/09/2013*
CD-3A, Approve Long Lead Procurement	*1st Quarter FY2014*	*10/09/2013*
CD-3, Approve Start of Construction	*2nd Quarter, FY2014*	*7/7/2014*
CD-4, Approve Start of Operations	*4th Quarter, FY2017*	

Table 5.3.2 Level 2 Milestones (DOE-BHSO)

Level 2 Milestone	***CD-2 Date***	***Actual***
Start Conceptual Design	*4/1/2011*	*4/1/2011*
Start Preliminary Design	*12/19/2011*	*12/19/2011*
Conceptual Design Complete	*9/28/2012*	*9/28/2012*
Hold 1st Photon Delivery System Design Review	*2nd Quarter, FY2014*	*10/21/2013*
Award 1st EPU Insertion Device Procurement Contract	*3rd Quarter, FY2014*	*6/9/2014*
Hold Final Design Review of SIX Beamline	*1st Quarter, FY2015*	*10/28/2014*
1st Shielded Enclosure Acceptance Test Completed	*1st Quarter, FY2015*	*10/30/2014*
Receive ISS Gas Handling System	*2nd Quarter, FY2015*	*7/22/2015*
Receive 1st Soft X-ray Grating	*4th Quarter, FY2015*	*9/16/2015*
Receive 1st Double Crystal X-ray Monochromator	*2nd Quarter, FY2016*	*9/30/2015*
Complete Installation of 1st Beamline Components	*3rd Quarter, FY2016*	*3/30/2016*
1st Beamline Available	*4th Quarter, FY2016*	*4/13/2016*
Receive EPUs for ESM and SIX	*4th Quarter, FY16*	*6/15/2016*
Common Beamline Systems: Mechanical Utilities Installed	*3rd Quarter, FY2016*	*8/29/2016*
Complete Installation of Common Beamline Systems PPS	*4th Quarter, FY2016*	*1/6/2017*
Early Project Completion – including IRR	*2nd Quarter, FY2017*	

Figure 5.3.1 is the summary schedule with major milestones and activities, durations, and the actual critical path.

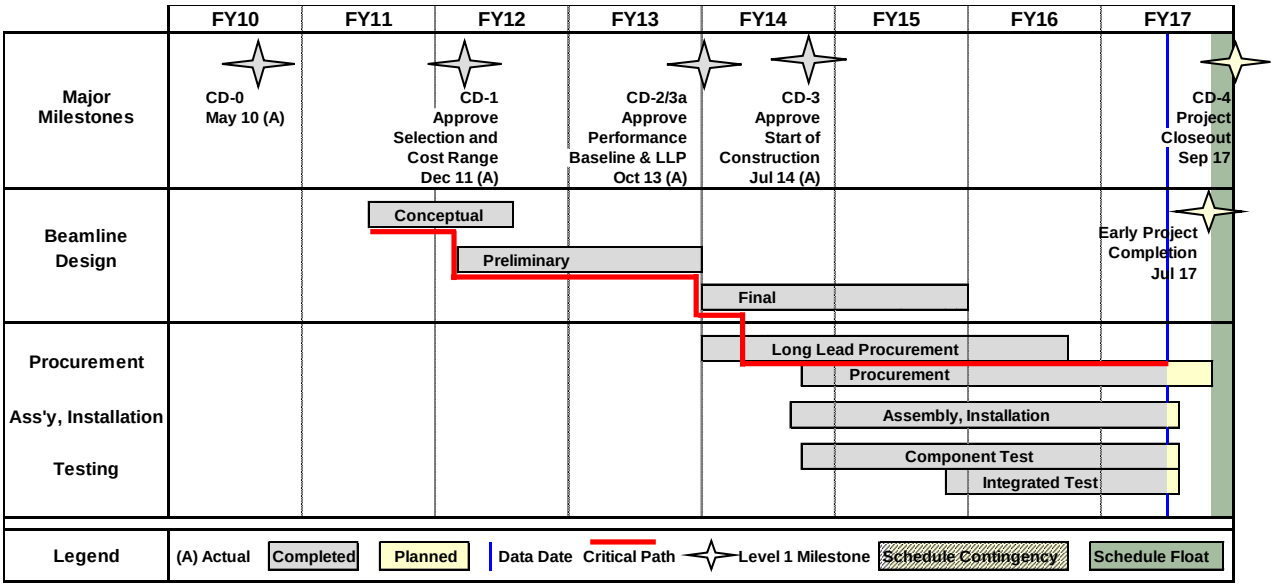


Figure 5.3.1 NEXT project summary schedule.

5.4 Work Breakdown Structure

The following table summarizes the Work Breakdown Structure for the NEXT project at level 2. The dictionary to the control account level (Level 3) is provided in appendix A for the final project scope.

Table 5.4.1 NEXT Project WBS dictionary at Level 2

WBS #	*WBS Title*	*WBS Description*
2.01	*Project Management*	*Performance of Project Management activities, including labor, materials, travel, and fixed costs associated with the operations of the Project Office, including the offices of the Project Manager; the project support functions; environment, safety, and health activities; quality assurance; configuration management; and document control.*
2.02	*Conceptual Design and Advanced Conceptual Design*	*Performance of conceptual design and advanced conceptual design activities to support the delivery of NEXT Project objectives, and management of these activities. The NEXT project will benefit from some of the designs already accomplished as part of the NSLS-II project and other modern SR facilities.*
2.03	*Common Beamline Systems*	*Performance of preliminary design, final design, specification, and procurement activities to support the delivery of common beamline components and systems for the NEXT Project beamlines, and management of these activities.*
2.04	*Control Systems*	*Engineering, design, procurement/fabrication, assembly, installation, and testing of beamline and endstation control systems for all NEXT project beamlines. These activities are separated into (i) beamline and*

WBS #	WBS Title	WBS Description
		endstation control system design and implementation and (ii) beamline and endstation control system equipment.
2.05	*ESM Beamline*	*Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the ESM beamline.*
2.06	*FXI Beamline*	*Preliminary and final design of the "Full Field X-ray Imaging with Transmission X-Ray Microscope" (FXI) beamline.*
2.07	*ISR Beamline*	*Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the ISR beamline.*
2.08	*ISS Beamline*	*Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the ISS beamline.*
2.09	*SIX Beamline*	*Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the SIX beamline.*
2.10	*SMI Beamline*	*Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (subsystem and integrated) of the SMI beamline.*
2.11	*EPU Insertion Devices*	*Fabrication of the EPU insertion devices and ID vacuum chambers for ESM and SIX. Includes effort for procurement oversight and contract management.*
2.12	*Front End & Insertion Device Installation & Commissioning*	*Begin the installation of the front ends & insertion devices for ESM, SIX, ISR, and SMI, and installation of the front end for ISS (the insertion devices for ISS were installed as part of NSLS-II). The completion of the installation after 1-Nov-15 is not be a part of the NEXT project.*

5.5 Funding Profile

The NEXT Project CD-2 baseline was formalized in October 2013. Table 5.5.1 shows the NEXT funding profile at CD-2 and Table 5.5.2 shows the actual NEXT funding profile received.

Table 5.5.1 NEXT Funding Profile Approved at CD-2

Fiscal Year	*FY11*	*FY12*	*FY13*	*FY14*	*FY15*	*FY16*	*Total ($M)*
OPC	***$3***						***$3***
TEC		***$12***	***$12***	***$25***	***$22.5***	***$15.5***	***$87***
Design		*$3*	*$2*				*$5*
Fabrication		*$9*	*$10*	*$25*	*$22.5*	*$15.5*	*$82*
Total Project Cost ($M)	***$3***	***$12***	***$12***	***$25***	***$22.5***	***$15.5***	***$90***

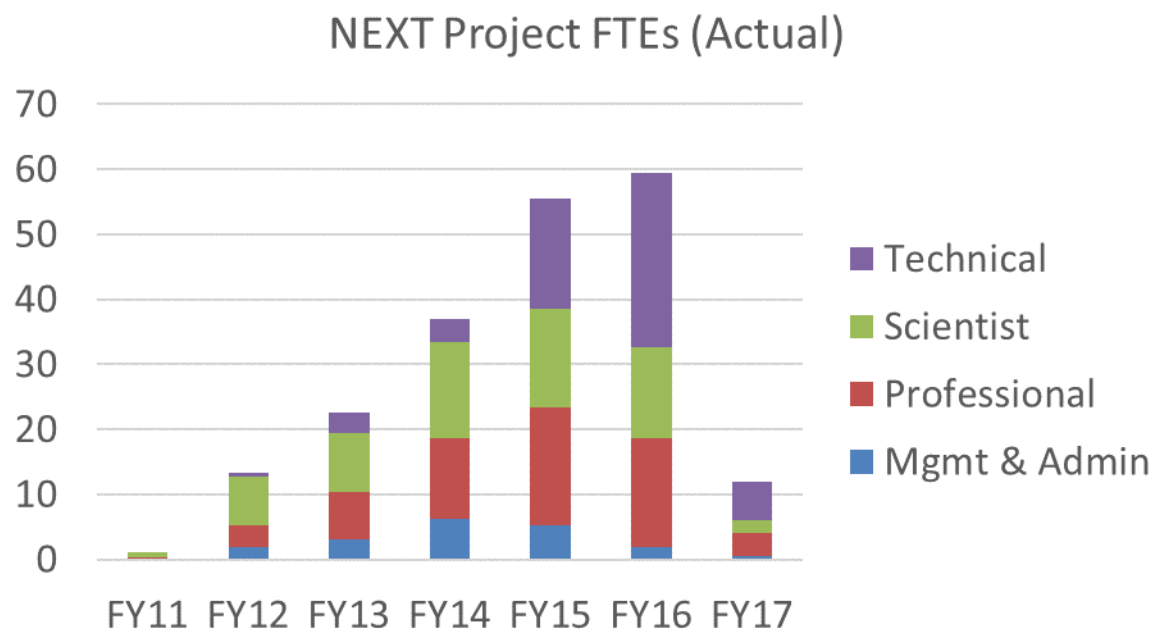
Table 5.5.2 NEXT Funding Profile Received

Fiscal Year	*FY11*	*FY12*	*FY13*	*FY14*	*FY15*	*FY16*	*Total ($M)*
OPC	***$3***						***$3***
TEC		***$12***	***$12***	***$25***	***$22.5***	***$15.5***	***$87***
Design		*$3*	*$2*				*$5*
Fabrication		*$9*	*$10*	*$25*	*$22.5*	*$15.5*	*$82*
Total Project Cost ($M)	***$3***	***$12***	***$12***	***$25***	***$22.5***	***$15.5***	***$90***

5.6 Staffing Profile

Staffing for the NEXT Project totaled approximately 200 FTE from CD-2 baseline to project complete. In addition, approximately 1/3 of the labor in WBS 2.03 (Common Beamline Systems) was obtained on project scope from job-shop contractors, who appear as M&S costs against the WBS areas where their work was completed. Figure 5.6.1 shows the staffing level by FY.

Figure 5.6.1 NEXT Staffing profile



5.7 Environmental Requirements/Permits

In April 2011, a review by the BNL Environmental Protection Division, in coordination with the DOE Brookhaven Site Office, concluded that development of the NEXT Project beamlines fell within the scope of the October 2006 Environmental Assessment for NSLS-II, DOE/EA-1558.

For reference, the October 2006 NSLS-II NEPA assessment is copied here:

> *NSLS-II In compliance with the National Environmental Protection Act (NEPA) and its implementing regulations (10 CFR 1021 and 40 CFR 1500-1508), an Environmental Assessment (EA) was prepared to evaluate the potential environmental consequences of constructing and operating NSLS-II. The EA analyzed the potential environmental consequences of the facility and compared them to the consequences of a No Action alternative. The assessment included detailed analysis of all potential environmental impacts anticipated as the design, construction, and operation of the facility progresses. The EA found that there would be no significant impact from the construction and operation of the proposed facility and determined that an Environmental Impact Statement was not required. A Finding of No Significant Impact (FONSI) was approved and made available to the general public and project stakeholders.*

5.8 Safety Record

The safety and security of all staff, guests, contractors, vendors, and the environment is a core value at Brookhaven National Laboratory, for the NSLS-II facility, and for NEXT project management. The expectation that all Project staff and contractors will plan, manage, and execute their respective duties consistent with the requirements of the BNL Integrated Safety Management Systems and ensure that the facility is designed, constructed, and operated in a safe and environmentally sound manner was made clear at every possible opportunity.

Expectations for Environment, Safety, and Health (ES&H) performance were established in the ES&H Plan for the NEXT. All work associated with this project was conducted in a manner that ensured protection of the workers, the public, and the environment. Policies and requirements to ensure implementation of these expectations was established and communicated to all project staff, contractors, and vendors.

After greater than 350,000 cumulative hours worked on the NEXT Project, no recordable or DART cases occurred.

6. CLOSEOUT STATUS

The NEXT project worked to close out activities as early as possible, with only a small portion of the commitments and contracts remaining to be formally closed after the CD-4 review. As of this report most have been closed. Over the course of the project a total of 35 charge accounts had been opened. As of this draft closeout report, 27 accounts have been closed, with 3 remaining in active use (project management, project support, and SIX systems) and 5 in the process of being closed out.

The NEXT project maintained regular EAC estimates and shifted to monthly bottoms up ETC estimates from June of 2015. This was beneficial in identifying pending work to be completed, to ensure a more accurate cost estimate and to assure that work was not improperly charged to the project which was actually related to operations. This helped in completing the administrative closeout of the project. Table 6.1 summarizes the closeout costs and likely completion dates of

major classes of activities that are remaining as of this Draft Project Closeout report. Several are now complete.

Table 6.1 Summary Closeout Costs anticipated as of March 2017*

Activity and Description	*Complete—Yes or No?*	*Planned Completion Date?*	*Planned Remaining Costs ($K)?*
Completion of SMI endstation assembly and installation	*No**	*04/28/17**	*$20*
Completion of SIX endstation assembly and installation	*No**	*05/04/17**	*$88*
Receipt and acceptance of TRF for SIX sample chamber	*No*	*07/31/17*	*$46*
Receipt and acceptance of M4 mirrors for ESM and SIX	*No**	*04/28/17**	*$98*
Management and reporting through project end	*No*	*08/01/17*	*$86*
TOTAL:			***$339***

*complete as of time of this draft (accomplished after March 2017 reporting), actual dates shown.

7. LESSONS LEARNED

The NEXT project was a substantial undertaking and provided many lessons learned. The project has developed its lessons learned throughout its execution and provides a draft document at CD-4 which includes relevant lessons from various aspects of the NEXT projects valuable to subsequent projects. The Lessons Learned are summarized in this document, capturing both Success Lessons (things that went well that should be captured for future projects), and Potential Improvements (things that could go better next time). It contains sections for lessons for the Overall Project, Project Management, Human Resources, ES&H, QA, Procurement, Conventional Facilities, Accelerator Systems, and Engineering and Design. Overall lessons learned are summarized below.

Overall NEXT Success Lessons

Lessons Learned	Description, Impacts, and Solutions
NSLS-II Project lessons learned adopted by NEXT	• A significant number of lessons learned by the NSLS-II Project were communicated to and adopted by NEXT, in all areas of this document.
Strong support from NSLS-II, Energy and Photon Sciences Directorate, and BNL	• NSLS-II, Energy and Photon Sciences Directorate, and the laboratory delivered strong support to NEXT in all areas, including Management, ESH, QA, Project Controls, Procurement, and Human Resources. • Organizational change of NSLS-II in summer 2014 to create the Project Management group provided management support and needed horizontal integration of WBS and resources common to all beamlines (utilities, safety systems, controls)
Successfully recruited and retained key staff	• NEXT was approved to use the HR Toolkit set up for the NSLS-II Project, including enhanced sign-on capabilities and

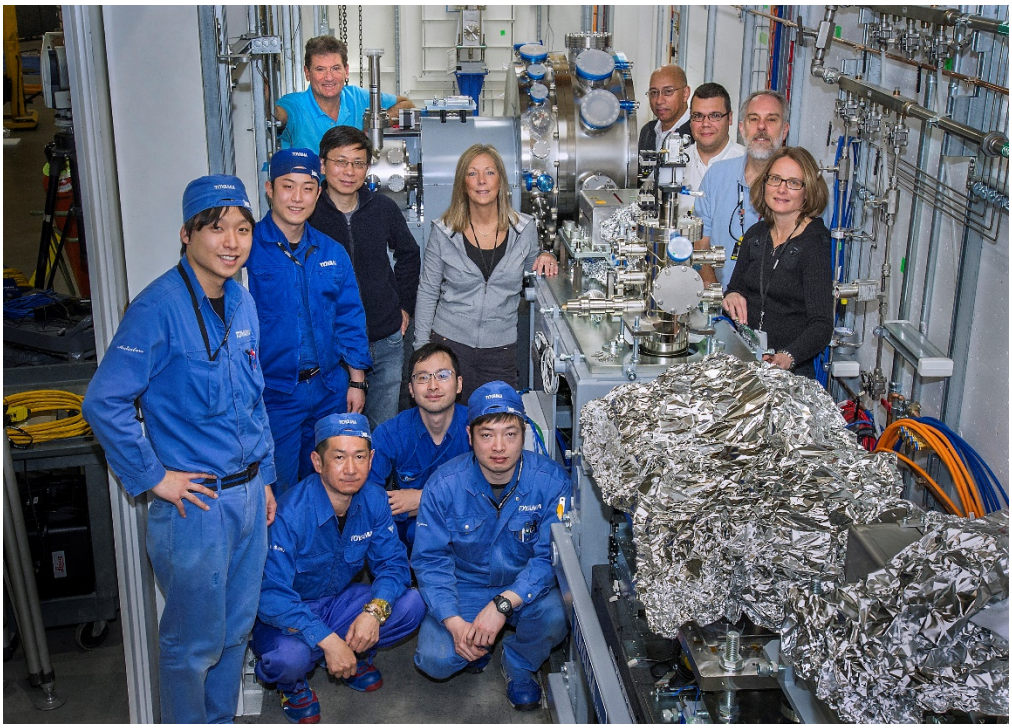
Lessons Learned	Description, Impacts, and Solutions
	performance-based incentive pay options for key project personnel. • The incentive program was an important tool for attracting and recruiting key project personnel.
Revision of schedule allocation for procurement process	• See "Insufficient schedule allocation for procurement process" in Lessons Learned – Potential Improvements" below; the resource loaded schedule initially formulated for NEXT did not include sufficient schedule durations for the procurement process. • As a result, procurement schedule duration, from pinning to award, was increased by approx. 20 working days in May 2014, affecting all future major procurements. • The revised procurement activity strings should be utilized for future major procurements.
Improvements in scheduling and tracking of major procurements	• Procurement process was re-evaluated, as described above. In addition, tools were developed to track procurements more closely. As a result, more realistic procurement schedules were attained, helping to maintain overall project schedule.
Significant post-CD-3 scope additions, directed by BHSO	• Scope additions were good for beamline performance but disruptive to project management. Robust real-time response, including diligent documentation of added scope and resultant cost/schedule changes, was successful.
Diligent monthly accounting of accruals is needed to understand cost performance	• EV and Accruals must either match each month or the discrepancy must be taken into account. Otherwise accrual gaps mask cost performance. • Analysis tools were developed to determine true cost performance each month
Continuous attention required to minimize cost growth	• EAC growth is typical, often driven by labor cost growth. • The project controlled cost growth by assessing EAC frequently, without padding. Total NEXT labor cost growth from CD-2 baseline to end of project was 13% of EAC.

Overall NEXT Areas of Potential Improvements

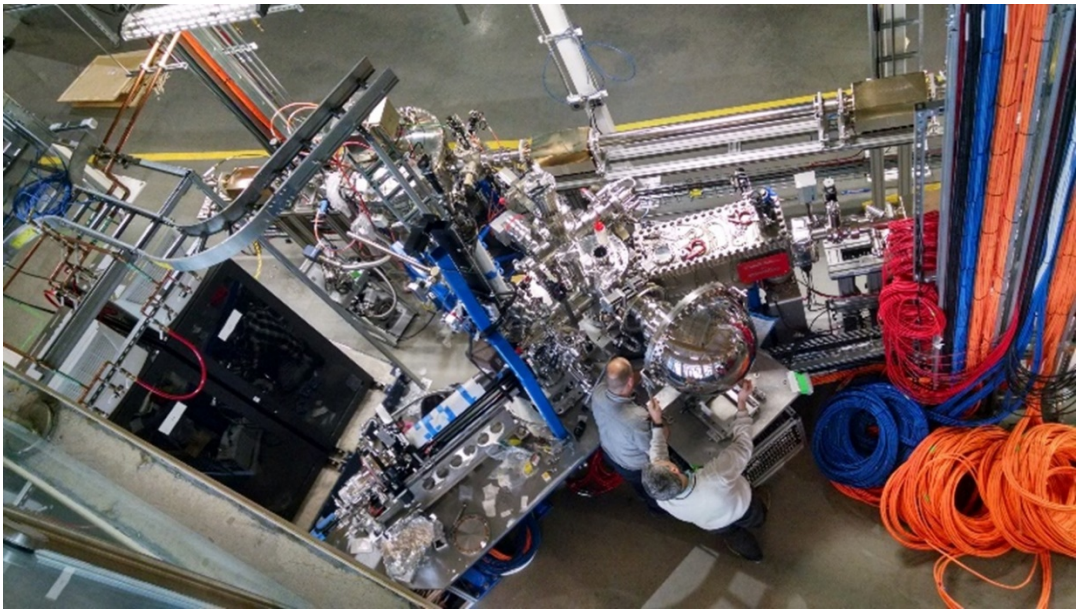
Lessons Learned	Description, Impacts, and Solutions
Overly aggressive resource-loaded schedule	• The NEXT resource-loaded schedule was revised in fall 2012 to pull forward many activities, some of which ended up being completed 1-2 months late, reducing the cumulative EVMS schedule index. • For future projects, the resource-loaded project schedule developed for baselining (CD-2) should be realistically achievable and not forced to be shorter in duration in order to conform to external constraints such as funding profiles or carryover predictions. Shifting schedule too early within a fixed overall project duration increases the likelihood of schedule slippage early in the project, when performance expectations are being monitored closely.
Insufficient schedule allocation for procurement process	• Resource loaded schedule initially formulated did not include sufficient schedule durations for the procurement process. • This shortfall consumed schedule contingency in some cases (others gained schedule float via shorter-than-estimated contracted delivery times). • See "Revision of schedule allocation for procurement process" in Lessons Learned – Successes above.
Complexity not fully captured in baseline cost.	• Complexity of SIX beamline (equivalent to two beamlines: photon delivery system + endstation) not fully captured in baseline schedule, cost, and risk. Added both schedule and cost. • This complexity was a major cause of the schedule delay experienced for the final M&S component of NEXT: the SIX endstation Triple Rotation Flange (TRF). Complexity of the SIX spectrometer, as well as that of the photon delivery systems for the soft x-ray beamline (ESM and SIX), led to major delays in engineering and design of the TRF. All of this scope for NEXT was provided by a single contractor. Concern regarding the magnitude of this combined scope was known and acted upon relatively early on, but lack of progress on one component (the TRF, a relatively small value fraction of the total) did not occur until relatively late, thereby delaying achievement of the NEXT Early Project Completion milestone.

8. PHOTOS

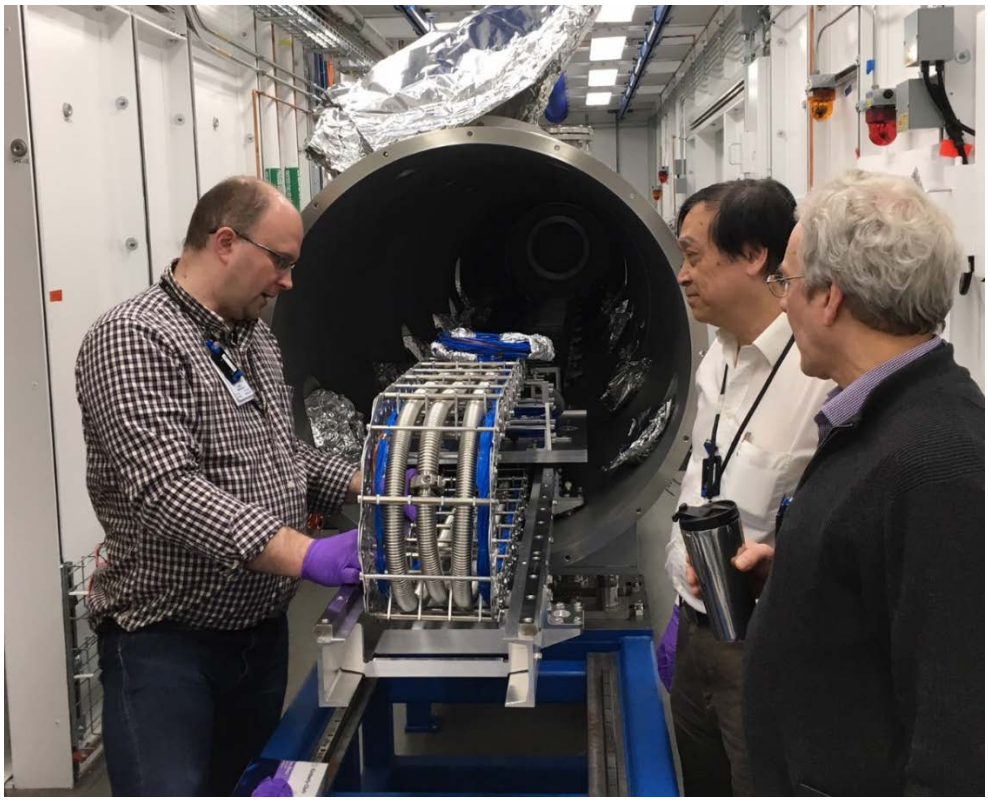
Photos have been collected throughout the execution of the NEXT project. Below is a sample; more will be included in the Final Closeout report.



Toyama and NSLS-II staff gathered in the ISR first optical enclosure during installation of the beamline optical components.



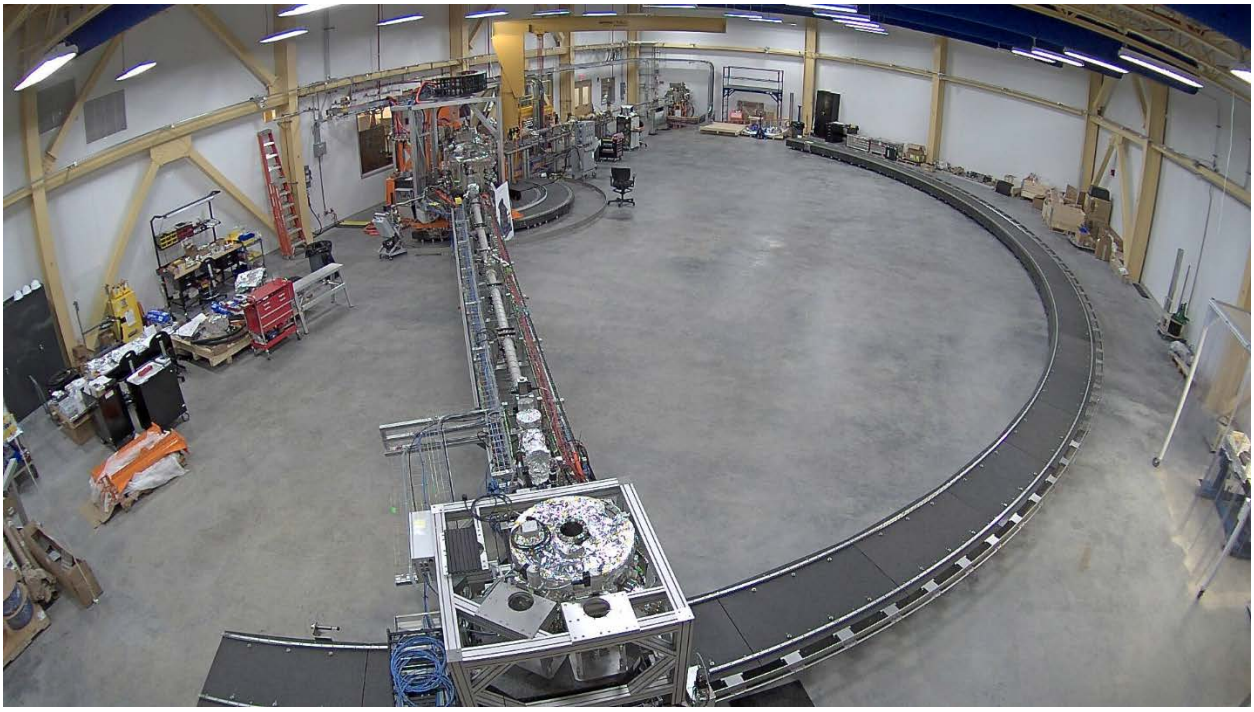
ESM scientists undertaking initial assembly and testing at the ARPES beamline endstation.

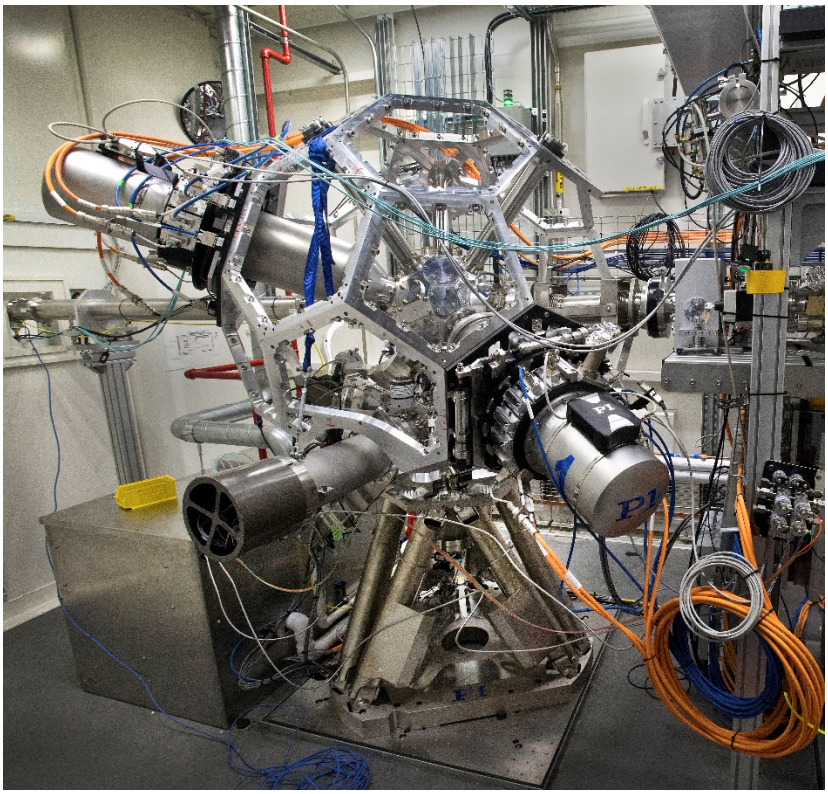


Assembly and installation of cable chain for the SMI beamline's small angle x-ray scattering (SAXS) endstation.

Installation of the SIX beamline endstation spectrometer optics tank, undertaken by BNL and Bestec staff.

Gas Handling System for the ISS beamline.


SIX spectrometer endstation, including sample chamber, optics chamber, beam transport arm, and detector chamber.


ISS endstation, including sample chamber, sample transfer system, and emission spectrometers.

9. PROJECT DOCUMENT ARCHIVES AND LOCATIONS

NEXT project documentation has been captured over several archived web servers. These include:

- NSLS-II Facility SharePoint – https://ps.bnl.gov/SitePages/Home.aspx (accessible from BNL campus network). Includes sites for Accelerator, Photon, Facilities, Business, Operations, ESH, the Document Center and other Team sites that support the NSLS-II project and operations. It also has links to some of the sites noted below-
- Integrated Project Data – http://ipdv2.ls.bnl.gov/ (accessible from BNL campus network), has all of the monthly project data from baseline to completion including Schedules, CPR and EVMS performance data and Configuration Management/Change Control data.
- Cost Estimate Data - CED – http://ced.nsls2.bnl.gov/default.aspx (accessible from BNL campus network)
- Drawings – Vault - \\ssp-adv2.bnl.gov (requires user account)
- Project review information is posted at https://www.bnl.gov/nsls2/project/reviews/ and includes agenda, review reports, back-up information and presentations. (accessible from www with shared user credentials) – this includes IRR reviews for individual NEXT beamlines.
- Reports of NEXT to the Integrated Project Team (IPT) are posted at https://www.bnl.gov/nsls2/project/NEXT/ipt.asp.

Appendix A – Complete WBS Dictionary

2: NSLS-II Experimental Tools (NEXT) Project
The goal of the NSLS-II Experimental Tools (NEXT) MIE Project is to design and build a suite of additional beamlines with new and advanced experimental techniques that will extend the insertion device based science programs beyond that provided by the six initial NSLS-II project beamlines, in a timely manner. The NEXT project will provide a significant capacity at the early years of NSLS-II operations to allow the exploration of the unique scientific opportunities offered by the new facility, as well as support the wide-ranging research programs of the existing NSLS user community.

2.01: Project Management and Support
Performance of Project Management activities, including labor, materials, travel, and fixed costs associated with the operations of the Project Office, including the offices of the Project Manager; the project support functions; environment, safety, and health activities; quality assurance; configuration management; and document control.

2.01.01: Project Management
Perform project management activities and provide project support functions associated with the operations of the NEXT Project, including effort required to conduct project close-out activities. The Project Manager has line management responsibility and authority for carrying out the NEXT Project. Additionally, miscellaneous materials, appropriate conference expenses, and appropriate travel costs are included.

2.01.02: Project Support
Provide functions including project support, financial, administrative, procurement, human resources, and other support functions for all areas of the Project. Level of Effort labor, materials, travel, building maintenance, project close-out activities and utilities costs for the Project office and laboratory space are included in this area.

2.02: Conceptual Design and Advanced Conceptual Design
Performance of conceptual design and advanced conceptual design activities to support the delivery of NEXT Project objectives, and management of these activities. The NEXT project will benefit from some of the designs already accomplished as part of the NSLS-II project and other modern SR facilities.

2.02.02: Conceptual Design and Analysis of Photon Delivery Systems
Conceptual design and analysis of the optical systems delivering the required photon parameters to the experimental stations. These components include optical components such as mirrors, monochromators, and slits.

2.02.03: Conceptual Design of User Instruments
Conceptual design and analysis of the instruments required to carry out the user science experiments planned for the NEXT Project beamlines.

2.02.04: ESM Advanced Conceptual Design

Advanced conceptual design of the photon delivery system and user instruments for the ESM beamline. Performance of activities to support delivery of these objectives, including advanced optical design, advanced analysis, and advanced design of user instruments.

2.02.05: FXI Advanced Conceptual Design
Advanced conceptual design of the photon delivery system and user instruments for the FXI beamline. Performance of activities to support delivery of these objectives, including advanced optical design, advanced analysis, and advanced design of user instruments.

2.02.06: ISR Advanced Conceptual Design
Advanced conceptual design of the photon delivery system and user instruments for the ISR beamline. Performance of activities to support delivery of these objectives, including advanced optical design, advanced analysis, and advanced design of user instruments.

2.02.07: ISS Advanced Conceptual Design
Advanced conceptual design of the photon delivery system and user instruments for the ISS beamline. Performance of activities to support delivery of these objectives, including advanced optical design, advanced analysis, and advanced design of user instruments.

2.02.08: SIX Advanced Conceptual Design
Advanced conceptual design of the photon delivery system and user instruments for the SIX beamline. Performance of activities to support delivery of these objectives, including advanced optical design, advanced analysis, and advanced design of user instruments.

2.02.09: SMI Advanced Conceptual Design
Advanced conceptual design of the photon delivery system and user instruments for the SMI beamline. Performance of activities to support delivery of these objectives, including advanced optical design, advanced analysis, and advanced design of user instruments.

2.03: Common Beamline Systems
Performance of preliminary design, final design, specification, and procurement and installation activities to support the delivery of common beamline components and systems for the NEXT Project beamlines, and management of these activities.

2.03.01: Utilities
Preliminary design, final design, project management, and purchase contract for the beamline basic utilities pack to include chilled and process water, electricity, LN2, GN2, gas extraction system, and oxygen deficiency sensors, etc. In-house labor for utilities design and installation is included.

2.03.02: Personnel Protection System (PPS)
Preliminary design, final design, project management, and construction of the Personnel Protection System (PPS) for the NEXT Project beamlines. To include PLC, switches, locks, and Human Machine Interface (HMI) panel.

2.03.03: Equipment Protection System (EPS)

Preliminary design, final design, project management and construction of the Equipment Protection System (EPS) for the NEXT project beamlines. To include PLC, wiring, and custom sensors.

2.03.04: Control Station
Design and procurement of all beamline furniture including chairs, desks, conference tables, bookshelves, filing cabinets, partitions and mains wiring/ethernet connections mounted on this equipment, and procurement of standard computer workstations and associated computer hardware such as printers and displays.

2.03.05: Common Beamline Systems Management
The scope of Common Beamline Systems Management is to oversee the design, procurement, fabrication and installation of the Common Beamline Systems for ESM, ISR, ISS, SIX, and SMI and the design for the FXI Beamline. The Common Beamline systems include Electrical and Mechanical Utilities, the Personal Protection System and the Equipment Protection System for the NEXT Beamlines. The scope includes computers and software for the manager and support staff, as well as LOE effort for project close-out activities.

2.04: Control System
Engineering, design, procurement/fabrication, assembly, installation, and testing of beamline and endstation control systems for all NEXT project beamlines. These activities are separated into (i) beamline and endstation control system design and implementation and (ii) beamline and endstation control system equipment. The control system WBS includes labor to design and prototype (as needed) the control system for all beamline and endstation equipment. It also includes labor to implement, integrate, test, and commission this equipment through successful completion of each beamline's IRR and taking of first light. Funding for the development of tools to manage the data centrally, analyze the data, or visualize the data collected is not in this project, it is expected to be funded in operations. The material costs in this WBS include all of the instrumentation to control the beam line and the end station including operator consoles, network hardware, and disk storage for all of the instrumentation, serial to Ethernet connections, motor controllers, and camera controllers. It includes all of the motor cables, Ethernet cables, and serial cables. It includes a VME crate, controller, and timing to locally distribute the machine timing to the experiment. It includes all I/O controllers needed to integrate the instrumentation in the beam line and the end station. The funding for the computers and disks to store experimental data is in each of the experimental beam lines (WBS 2.[05-10].02.04). The PLCs for Personnel Protection and Equipment Protection are provided by the Common Systems WBS. In each beam line budget is the funding for all motors, detectors, instruments and any additional I/O modules such as PLCs or Multi-channel analyzers.

2.04.01: Control System Management
This WBS includes test equipment required to prototype beam line control components, control design and implementation travel, and the manager's effort, including efforts required for project close-out activities. It also includes equipment needed by the engineers to perform their job. It does not include time or travel needed by the employees for training.

2.04.02: Control System Design & Implementation

Effort required for preliminary design, final design, development of prototype systems, implementation, and commissioning of the controls, both hardware and software, for all NEXT project beamlines. These controls include motion control, vacuum control, and diagnostics. This WBS includes point to point tests required for installation and integration. It does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device. It does not include implementation labor for each beamline following successful completion of its IRR and taking of first light.

2.04.02.01: ESM Control System Design & Implementation
Effort required for preliminary design, final design, development of prototype systems, implementation, and commissioning of the controls, both hardware and software, for the ESM beamline. These controls include motion control, vacuum control, and diagnostics. This WBS includes point to point tests required for installation and integration. It does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device. It does not include implementation labor following successful completion of IRR and taking of first light.

2.04.02.02: FXI Control System Design
Effort required for preliminary and final design of the controls, both hardware and software, for the FXI beamline. These controls include motion control, vacuum control, beam control, and cooling, from the ratchet wall to the detector. This WBS does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device.

2.04.02.03: ISR Control System Design & Implementation
Effort required for preliminary design, final design, development of prototype systems, implementation, and commissioning of the controls, both hardware and software, for the ISR beamline. These controls include motion control, vacuum control, and diagnostics. This WBS includes point to point tests required for installation and integration. It does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device. It does not include implementation labor following successful completion of IRR and taking of first light.

2.04.02.04: ISS Control System Design & Implementation
Effort required for preliminary design, final design, development of prototype systems, implementation, and commissioning of the controls, both hardware and software, for the ISS beamline. These controls include motion control, vacuum control, and diagnostics. This WBS includes point to point tests required for installation and integration. It does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device. It does not include implementation labor following successful completion of IRR and taking of first light.

2.04.02.05: SIX Control System Design & Implementation
Effort required for preliminary design, final design, development of prototype systems, implementation, and commissioning of the controls, both hardware and software, for the SIX

beamline. These controls include motion control, vacuum control, and diagnostics. This WBS includes point to point tests required for installation and integration. It does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device. It does not include implementation labor following successful completion of IRR and taking of first light.

2.04.02.06: SMI Control System Design & Implementation
Effort required for preliminary design, final design, development of prototype systems, implementation, and commissioning of the controls, both hardware and software, for the SMI beamline. These controls include motion control, vacuum control, and diagnostics. This WBS includes point to point tests required for installation and integration. It does not include machine protection for the experimental beam line. It does not include data acquisition or data analysis. It does not include control of the front end or insertion device. It does not include implementation labor following successful completion of IRR and taking of first light.

2.04.03: Control System Equipment
Control Equipment needed for the NEXT Project beamlines including: two operator consoles for control and archive of control equipment, network routers, gateway to the machine control system, timing IOC to synchronize to the machine timing, motor controllers, serial to ethernet hubs, and a soft IOC for controlling all Ethernet based motors, serial devices, and PLCs. It also includes all Ethernet and timing cables. This does not include: cables from these controllers to the instruments, the required PLCs for machine protection and equipment control, the serial cables to the vacuum gauges nor the vacuum controllers, the detector control, the data acquisition computer, nor the data analysis equipment.

2.05: ESM Beamline
Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the ESM beamline.

2.05.01: ESM Management
Perform Project Management activities specific to the ESM beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.05.01.01: ESM Beamline Management
Perform Project Management activities specific to the ESM beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings,

perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.05.02: ESM Beamline Systems
Preliminary design, final design, specification, procurement, fabrication, assembly, installation, and testing of sub-system and integrated systems of all ESM beamline components from the shield wall to and including the endstation. These components include optical components such as mirrors, monochromators, beam diagnostic systems, shielded enclosures, endstation apparatus, sample changing equipment, detectors, and the hardware and software of data acquisition systems.

2.05.02.01: Photon Delivery System
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all beamline components from the shield wall to the endstation(s). These components include optical components such as mirrors, monochromators (containing crystals, gratings, lenses, and filters) and the systems that house, cool, and manipulate them; diagnostic systems that measure beam properties such as position, size, flux, and polarization; slits, shutters; collimators; masks; and beam stops.

2.05.02.02: Shielded Enclosures
Preliminary design, final design, specification, assembly and installation, and test of optic enclosures (first, second, third, ...) and experimental endstation enclosures (EESEs). Scope to include all labyrinths, doors, windows, fans, and lights, but not the wiring to these devices. Hutch fabrication and installation contract scope is excluded.

2.05.02.03: Endstation Equipment
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all experimental endstation equipment.

2.05.02.04: Data Acquisition
Hardware and software to acquire and store experimental data from the ESM beamline. This includes data produced by beamline and endstation diagnostic monitors and by experimental endstation detectors. Includes software to serve the user database and some aspects of data analysis.

2.06: FXI Beamline
Preliminary and final design of the "Full Field X-ray Imaging with Transmission X-Ray Microscope" (FXI) beamline. Construction of FXI shielded enclosures.

2.06.01: FXI Management
Perform Project Management activities specific to the FXI beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline

document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.06.01.01: FXI Beamline Management
Perform Project Management activities specific to the FXI beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.06.02: FXI Beamline Systems
Preliminary and final design of all FXI beamline components from the shield wall to and including the endstation. These components include optical components such as mirrors, monochromators, beam diagnostic systems, shielded enclosures, endstation apparatus, sample changing equipment, detectors, and the hardware and software of data acquisition systems.

2.06.02.01: Photon Delivery System
Preliminary and final design of all beamline components from the shield wall to the endstation(s). These components include optical components such as mirrors, monochromators (containing crystals, gratings, lenses, and filters) and the systems that house, cool, and manipulate them; diagnostic systems that measure beam properties such as position, size, flux, and polarization; shutters; masks; and slits.

2.06.02.02: Shielded Enclosures
Preliminary design, final design, specification, assembly and installation, and test of optics enclosure and experimental endstation enclosure. Scope to include design of all labyrinths, doors, windows, fans, and lights, but not the wiring to these devices. Hutch fabrication and installation contract scope is included.

2.06.02.03: Endstation Equipment
Preliminary and final design of all experimental endstation equipment.

2.06.02.04: Data Acquisition
Preliminary and final design of hardware and software to acquire and store experimental data from the FXI beamline. This includes data produced by beamline and endstation diagnostic monitors and by experimental endstation detectors. Includes software to serve the user database and some aspects of data analysis.

2.07: ISR Beamline
Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the ISR beamline.

2.07.01: ISR Management
Perform Project Management activities specific to the ISR beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group, including costs associated with ISR Beamline Advisory Team; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.07.01.01: ISR Beamline Management
Perform Project Management activities specific to the ISR beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group, including costs associated with ISR Beamline Advisory Team; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.07.02: ISR Beamline Systems
Preliminary design, final design, specification, procurement, fabrication, assembly, installation, and testing of sub-system and integrated systems of all ISR beamline components from the shield wall to and including the endstations. These components include optical components such as mirrors, a monochromator, phase plates, beam diagnostic systems, shielded enclosures, endstation apparatus, and the hardware and software of data acquisition systems.

2.07.02.01: Photon Delivery System
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all beamline components from the shield wall to the endstations. These components include optical components such as mirrors, a crystal monochromator, phase plates, and the systems that house, cool, manipulate, and pump them; diagnostic systems that measure beam properties such as position, size, flux, and polarization; slits, shutters; collimators; masks; and beam stops.

2.07.02.02: Shielded Enclosures
Preliminary design, final design, specification, assembly and installation, and test of optics enclosures (first and second) and experimental endstation enclosures (EESEs). Scope to include all labyrinths, doors, windows, fans, and lights, but not the wiring to these devices. Hutch fabrication and installation contract scope is excluded.

2.07.02.03: Endstation Equipment
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all experimental endstation equipment.

2.07.02.04: Data Acquisition
Hardware and software to acquire and store experimental data from the ISR beamline. This includes data produced by beamline and endstation diagnostic monitors and by experimental endstation detectors. Includes software to serve the user database and some aspects of data analysis.

2.08: ISS Beamline
Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the ISS beamline and the endstation.

2.08.01: ISS Management
Perform Project Management activities specific to the ISS beamline. Includes labor, materials, travel, and fixed costs associated with management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.08.01.01: ISS Beamline Management
Perform Project Management activities specific to the ISS beamline. Includes labor, materials, travel, and fixed costs associated with management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.08.02: ISS Beamline Systems
Preliminary design, final design, specification, procurement, fabrication, assembly, installation, and testing of sub-system and integrated systems of all ISS beamline components from the shield wall to and including the endstation. These components include optical components such as mirrors, monochromators, beam diagnostic systems, shielded enclosures, endstation apparatus, sample changing equipment, detectors, and the hardware and software of data acquisition systems.

2.08.02.01: Photon Delivery System
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all beamline components from the shield wall to the endstation(s). These components include optical components such as mirrors, monochromators (containing crystals, gratings, lenses, and filters) and the systems that house, cool, and manipulate them; diagnostic systems that measure beam properties such as position, size, flux, and polarization; slits, shutters; collimators; masks;

and beam stops.

2.08.02.02: Shielded Enclosures
Preliminary design, final design, specification, assembly and installation, and test of optics enclosures (first, second, third, …) and experimental endstation enclosures (EESEs). Scope to include all labyrinths, doors, windows, fans, and lights, but not the wiring to these devices. Hutch fabrication and installation contract scope is excluded.

2.08.02.03: Endstation Equipment
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all experimental endstation equipment. Prototyping activities are included as appropriate.

2.08.02.04: Data Acquisition
Hardware and software to acquire and store experimental data from the ISS beamline. This includes data produced by beamline and endstation diagnostic monitors and by experimental endstation detectors. Includes software to serve the user database and some aspects of data analysis.

2.09: SIX Beamline
Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the SIX beamline.

2.09.01: SIX Management
Perform Project Management activities specific to the SIX beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.09.01.01: SIX Beamline Management
Perform Project Management activities specific to the SIX beamline. Includes labor, materials, travel, and fixed costs associated with management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program

2.09.02: SIX Beamline Systems
Preliminary design, final design, specification, procurement, fabrication, assembly, installation, and testing of sub-system and integrated systems of all SIX beamline components from the

shield wall to and including the endstation. These components include optical components such as mirrors, monochromators, beam diagnostic systems, shielded enclosures, endstation apparatus, sample changing equipment, detectors, and the hardware and software of data acquisition systems.

2.09.02.01: Photon Delivery System
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all beamline components from the shield wall to the endstation(s). These components include optical components such as mirrors, monochromators (containing crystals, gratings, lenses, and filters) and the systems that house, cool, and manipulate them; diagnostic systems that measure beam properties such as position, size, flux, and polarization; slits, shutters; collimators; masks; and beam stops.

2.09.02.02: Shielded Enclosures
Preliminary design, final design, specification, assembly and installation, and test of optics enclosures (first, second, third, …) and experimental endstation enclosures (EESEs). Scope to include all labyrinths, doors, windows, fans, and lights, but not the wiring to these devices. This scope also includes the generation of the Requirements, Specifications and Interfaces (RSI) for the Satellite Building. Hutch fabrication and installation contract scope is excluded.

2.09.02.03: Endstation Equipment
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all experimental endstation equipment. Installation and commissioning activities associated with the Sample Chamber Triple Rotating Flange are excluded.

2.09.02.04: Data Acquisition
Hardware and software to acquire and store experimental data from the SIX beamline. This data includes that produced by beamline and endstation diagnostic monitors and by experimental endstation detectors. Includes software to serve the user database and some aspects of data analysis.

2.10: SMI Beamline
Preliminary design, final design, specification and procurement and/or fabrication, assembly and installation, and test (sub-system and integrated) of the SMI beamline.

2.10.01: SMI Management
Perform Project Management activities specific to the SMI beamline. Includes labor, materials, travel, and fixed costs associated with the management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.10.01.01: SMI Beamline Management
Perform Project Management activities specific to the SMI beamline. Includes labor, materials, travel, and fixed costs associated with management of the beamline group; project support functions specific to this beamline; beamline-specific environment, safety, and health activities; beamline-specific quality assurance; beamline configuration management; and beamline document control. Includes effort required to conduct project close-out activities. Scientific program development: Organize and participate in scientific and advisory team meetings, perform proof of principle experiments, and keep abreast of research fields related to beamline program.

2.10.02: SMI Beamline Systems
Preliminary design, final design, specification, procurement, fabrication, assembly, installation, and testing of sub-system and integrated systems of all SMI beamline components from the shield wall to and including the endstation. These components include optical components such as mirrors, monochromators, beam diagnostic systems, shielded enclosures, endstation apparatus, sample changing equipment, detectors, and the hardware and software of data acquisition systems.

2.10.02.01: Photon Delivery System
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all beamline components from the shield wall to the endstation(s). These components include optical components such as mirrors, monochromators (containing crystals, gratings, lenses, and filters) and the systems that house, cool, and manipulate them; diagnostic systems that measure beam properties such as position, size, flux, and polarization; slits, shutters; collimators; masks; and beam stops.

2.10.02.02: Shielded Enclosures
Preliminary design, final design, specification, assembly and installation, and test of optics enclosures (first, second, third, …) and experimental endstation enclosures (EESEs). Scope to include all labyrinths, doors, windows, fans, and lights, but not the wiring to these devices. Hutch fabrication and installation contract scope is excluded.

2.10.02.03: Endstation Equipment
Preliminary design, final design, specification and procurement and/or fabrication (including tooling if manufactured in house), assembly and installation, and test (sub-system and integrated) of all experimental endstation equipment.

2.10.02.04: Data Acquisition
Hardware and software to acquire and store experimental data from the SMI beamline. This includes data produced by beamline and endstation diagnostic monitors and by experimental endstation detectors. Includes software to serve the user database and some aspects of data analysis.

2.11: Insertion Devices

Fabrication of the EPU insertion devices and ID vacuum chambers for ESM and SIX. Includes effort for procurement oversight and contract management.

2.11.01: ESM EPU Insertion Device
Fabrication of the EPU insertion devices and ID vacuum chambers for ESM and SIX, including current strips & power supplies. Effort for procurement oversight and contract management is also included.

2.11.02: SIX EPU Insertion Device
Procurement Initiation for the EPU insertion device and ID vacuum chamber for SIX, including effort for procurement oversight and contract management.

2.11.03: Insertion Devices Management
Management of the EPU insertion devices and ID vacuum chambers for ESM and SIX. Includes effort for procurement oversight and contract management.

2.12: ID & FE Installation & Testing
Begin the installation of the front ends & insertion devices for ESM, SIX, ISR, and SMI, and installation of the front end for ISS (the insertion devices for ISS were installed as part of NSLS-II). The completion of the installation after 1-Nov-15 will not be a part of the NEXT project.

2.12.01: ID & FE Installation & Testing Management
Oversight of the initial installation of the front ends & insertion devices for the ESM, SIX, ISR, SMI & ISS Beamlines. Includes the scheduling activities and coordination with the groups performing the installation work and also with operations. Any oversight of the installation activities after 1-Nov-15 will not be a part of the NEXT project.

2.12.02: ID Installation & Testing
Begin magnetic measurement, installation, survey, bakeout and integrated testing of two EPUs for ESM beamline, one EPU for SIX beamline, one IVU for ISR beamline and one IVU for SMI beamline into the NSLS-II storage ring. Installation of the insertion devices includes preparation of the storage ring floor and positioning and grouting of all insertion device floor plates and required stands. Begin installation of canting magnets for ISR and SMI. Begin installation of vacuum chambers and transition pieces. Begin surveying all insertion devices and straight section components into position. Begin installation of insertion device power supplies, controls, vacuum equipment and associated electronics into racks on the storage ring mezzanine. Begin running all insertion device cabling and making connections. Begin installing water feed and return lines to each insertion device from the water headers. Begin pump down and bakeout of insertion device and straight section. Begin testing insertion devices controls and functionality. Completion of magnetic measurements and installation of ISR IVU and magnetic measurements for SMI IVU. The completion of the ID installation and testing after 1-Nov-15 will not be a part of the NEXT project.

2.12.03: FE Installation & Testing
Begin installation, survey, bakeout, and integrated testing of five front ends for the ESM, SIX, ISR, SMI and ISS beamlines in the NSLS-II storage ring tunnel. Installation of the front ends

includes preparation of the storage ring floor and positioning and grouting of all front end stands. Begin installation of the ratchet wall collimators and X-ray (beam alignment) flags. Begin surveying all front end components into position and securing hardware with safety wire. Begin installation of ion pump power supplies, TSP power supplies, gauge controllers and other miscellaneous electrical components in racks above the storage ring. Begin running all front end cabling to the individual components and making connections. Begin installing water feed and return lines to each front end components from the water headers. Begin installing pneumatic lines to each front end components from the pneumatic header. Begin pump down and bakeout of full front end assembly. Begin testing of all front end switches and actuators, and interfacing to EPS system. Completion of the installation of front ends for ISR and ISS. The completion of the FE installation and testing after 1-Nov-15 will not be a part of the NEXT project.

Appendix B – List of Major External Reviews

Review	**Date(s)**
ALD CDR	Jun. 28-29, 2011
CD-1 review	Aug. 31 - Sep. 1, 2011
ALD status review	Aug. 7-9, 2012
DOE status review	Sep. 11-13, 2012
ALD PDR	Mar. 6-7, 2013
DOE/SC review	Jul. 30 - Aug. 1, 2013
ALD FDR	Dec. 11-12, 2013
CD-3 review	Mar. 20-21, 2014
DOE/SC review	Aug. 12-13, 2014
DOE mini-review	Apr. 17, 2015
DOE/SC review	Nov. 3-4, 2015
DOE/SC review	Aug. 30-31, 2016
Scope Verification	Feb. 27-28, 2017
CD-4 review	May 31 - Jun. 1, 2017

PCR Number	PCR Level	WBS	CAM	Description	Status	Origination Date	Date Approved	CPR Implemented	Cost Impact	Baseline
PCR-14-022	L3	All	Hulbert	Establishing NEXT CD2 Baseline	Approved	11/12/2013	12/10/2013	Nov-13	(590,812)	68,092,431
PCR-14-023	L3	2.7.1; 2.7.2	Nelson	Increase in Mechanical Design Effort for ISR Beamline	Approved	12/19/2013	1/10/2014	Dec-13	87,923	68,180,353
PCR-14-025	L3	2.4.1	Yin	Controls Management Materials Addition	Approved	1/21/2014	1/31/2014	Jan-14	78,202	68,258,555
PCR-14-026	L2	2.5.2; 2.9.2	Jarrige	ESM/SIX M1 & M2 Mirror Package Award	Approved	1/24/2014	2/4/2014	Jan-14	(73,122)	68,185,433
PCR-14-024	L2	2.6.2.2	Lee	FXI Hutch Detailed Design	Approved	1/28/2014	2/6/2014	Jan-14	53,723	68,239,157
PCR-14-028	L4	2	Hulbert	NEXT Level 3 Milestone Title Revision	Approved	1/30/2014	1/31/2014	Jan-14	0	68,239,157
PCR-14-029	L3	2.5.2; 2.9.2	Jarrige	ESM/SIX Grating Substrates Award	Approved	1/31/2014	2/4/2014	Jan-14	11,088	68,250,245
PCR-14-027	L3	2.8.1; 2.8.2	Attenkofer	ISS Mechanical Design Effort Increase & Gas Handling Procurement	Approved	2/28/2014	3/6/2014	Feb-14	118,581	68,368,826
PCR-14-035	L3	2.10.02	DiMasi	SMI White Beam Package Contract Award	Approved	4/9/2014	4/15/2014	Mar-14	269,654	68,638,480
PCR-14-034	L3	2	Keister	NEXT Cost and Schedule Revisions	Approved	4/10/2014	4/20/2014	Mar-14	189,633	68,828,113
PCR-14-036	L2	2	Keister	NEXT Cost and Schedule Revisions	Approved	5/1/2014	5/9/2014	Apr-14	148,640	68,976,753
PCR-14-037	L3	2.09.02	Jarrige	SIX Monochromator Package Contract Award	Approved	5/8/2014	5/13/2014	Apr-14	(327,467)	68,649,286
PCR-14-041	L3	2.05.02; 2.08.02; 2.09.02	Keister	Contract Award Implementation of APPs 002NX, 027NX, 048NX	Approved	5/29/2014	6/12/2014	May-14	(112,143)	68,537,143
PCR-14-043	L4	2	Keister	Common Beamline Systems CAM Change	Approved	6/11/2014	6/12/2014	May-14	0	68,537,143
PCR-14-047	L3	2.05.02	Vescovo	Contract Award Implementation of APP 004NX ESM Gratings Rulings	Approved	6/30/2014	7/15/2014	Jun-14	(127,847)	68,409,296
PCR-14-046	L3	2.05.02; 2.09.02	Jarrige	ESM/SIX Gratings Substrates Contract Milestone Corrections	Approved	7/2/2014	7/11/2014	Jun-14	0	68,409,296
PCR-14-039	L3	2.10.02	DiMasi	SMI Endstation Design and Procurement Revisions	Approved	6/30/2014	7/15/2014	Jun-14	85,431	68,494,727
PCR-14-048	L3	2.05.02	Vescovo	APP090NX Wavefront Sensor Revisions	Approved	7/7/2014	7/15/2014	Jun-14	130,280	68,625,007
PCR-14-038	L3	2.09.02	Jarrige	Optical Metrology System	Approved	5/8/2014	7/7/2014	Jun-14	102,605	68,727,612
PCR-14-040	L3	2	Attenkofer	ISS Schedule Revisions	Approved	6/30/2014	7/17/2014	Jun-14	208,269	68,935,881
PCR-14-053	L3	2.04.03; 2.05.02; 2.09.02	Keister	Contract Award Implementation of APPs 006NX, 052NX, 073NX,087NX	Approved	7/29/2014	8/11/2014	Jul-14	(224,892)	68,710,989
PCR-14-054	L4	2.03.01	Bromfield	Update Plan for LN2 Piping System	Approved	7/29/2014	8/14/2014	Jul-14	0	68,710,989
PCR-14-031	L3	2.11.1; 2.11.2	Kitegi	APP082NX Contract Award & Labor Revisions	Approved	6/30/2014	8/25/2014	Jul-14	(416,290)	68,294,699
PCR-14-042	L3	2.07.02	Nelson	ISR Optical Package Contract Award - APP019NX	Approved	6/10/2014	8/18/2014	Jul-14	(184,643)	68,110,056
PCR-14-055	L3	2.05.02; 2.09.02; 2.08.02;2.10.02	Keister	Contract Award Implementation of APPs 026, 028, 029, 032, 089, 090	Approved	9/5/2014	9/11/2014	Aug-14	(302,026)	67,808,030
PCR-14-052	L2	2.05.02	Vescovo	ESM Endstation Scope Additions	Approved	8/28/2014	9/11/2014	Aug-14	614,369	68,422,399
PCR-14-051	L2	2.10.02	DiMasi	SMI Detector Scope Additions	Approved	8/27/2014	9/11/2014	Aug-14	1,130,007	69,552,407
PCR-14-056	L2	2.07.02	Nelson	ISR Endstation Scope Additions and Procurement Revisions	Approved	9/9/2014	9/12/2014	Aug-14	2,394,420	71,946,827
PCR-14-059	L4	2.01.02	Hulbert	Procurement Liaison Work Package Revision	Approved	9/10/2014	9/12/2014	Aug-14	0	71,946,827
PCR-14-058	L3	2.05.02; 2.09.02	Jarrige/ Vescovo	M1 Tanks & M3 Mirror Package Award (APP 001)	Approved	8/28/2014	9/16/2014	Aug-14	274,119	72,220,946
PCR-15-060	L4	2.3.1; 2.3.2; 2.4.3; 2.8.2; 2.10.2; 2.11.1	Keister	Correction of Performance Measurement Technique	Approved	10/2/2014	10/8/2014	Sep-14	0	72,220,946
PCR-15-062	L3	2.10.02	DiMasi	SMI H-V Mirror and SSA Contract Award APP060NX	Approved	10/10/2014	10/28/2014	Oct-14	559,004	72,779,950
PCR-15-064	L3	2.10.02	DiMasi	SMI Procurement Refinements	Approved	10/21/2014	11/17/2014	Oct-14	323,948	73,103,898
PCR-15-065	L3	2.05.02; 2.09.02	Vescovo/ Jarrige	ESM/SIX Contract Awards and Procurement Refinements	Approved	11/1/2014	11/17/2014	Oct-14	1,069,701	74,173,599
PCR-15-066	L3	2.08.02	Attenkofer	ISS Contract Awards and Procurement Refinements	Approved	11/7/2014	11/18/2014	Oct-14	439,541	74,613,140
PCR-15-063	L3	2.07.02	Nelson	ISR Procurement Refinements	Approved	12/5/2014	12/11/2014	Nov-14	310,513	74,923,653
PCR-15-071	L3	2.10.02	DiMasi	Contract Award Implementation APP093NX SMI SAXS/WAXS Detector	Approved	12/5/2014	12/16/2014	Nov-14	(179,039)	74,744,614
PCR-14-045	L3	2.04.03	Yin	Controls Equipment Procurement Revisions	Approved	12/1/2014	12/11/2014	Nov-14	451,245	75,195,859
PCR-15-072	L2	2.12.03	Fries	Insertion Devices and Front End Installation	Approved	12/17/2014	1/14/2015	Dec-15	1,007,524	76,203,383
PCR-14-032	L2	2	Lee	FXI Hutch Scope Additions	Approved	1/10/2015	2/9/2015	Jan-15	827,084	77,030,467
PCR-15-073	L3	2.08.02	Attenkofer	APP091NX ISS Beam Transport System Contract Award	Approved	1/30/2015	2/10/2015	Jan-15	138,476	77,168,943
PCR-15-061	L3	2	Stebbins	Common Beamline Systems Labor Additions	Approved	1/15/2015	2/13/2015	Jan-15	1,408,038	78,576,981
PCR-15-067	L3	2.11.01; 2.11.02	Kitegi	EPU Contract Award & Vacuum Chamber Power Supplies	Approved	1/25/2015	2/12/2015	Jan-15	(38,552)	78,538,429
PCR-15-076	L3	2.10.02	DiMasi	Correction to Approved PCR-15-064	Approved	2/9/2015	2/11/2015	Jan-15	1,435	78,539,864
PCR-15-075	L3	2.07.02	Nelson	APP022NX & APP096NX Contract Award	Approved	2/18/2015	3/10/2015	Feb-15	240,090	78,779,954

PCR Number	PCR Level	WBS	CAM	Description	Status	Origination Date	Date Approved	CPR Implemented	Cost Impact	Baseline
PCR-15-077	L3	2.10.02	DiMasi	APP063NX SMI CRL Focusing Optics Contract Award	Approved	3/4/2015	3/11/2015	Feb-15	57,084	78,837,038
PCR-15-079	L3	2.08.02	Attenkofer	APP039NX ISS DAQ Contract Award	Approved	3/4/2015	3/11/2015	Feb-15	15,463	78,852,501
PCR-15-074	L3	2.03.01	Bromfield	LN2 Piping Contract Award	Approved	3/2/2015	3/11/2015	Feb-15	(40,885)	78,811,616
PCR-14-049	L2	2.01.01, 2.01.02, 2.03.05, 2.04.01, 2.05.01, 2.07.01, 2.08.01, 2.09.01, 2.10.01, 2.11.03, 2.11.01, 2.12.01, 2.12.02, 2.12.03	Keister	IRR & Project Close-Out Activities	Approved	3/8/2015	3/16/2015	Feb-15	1,304,086	80,115,702
PCR-15-081	L3	2.08.02	Attenkofer	APP032 and APP 037 Contract Amendments, APP038 Award	Approved	4/3/2015	4/14/2015	Mar-15	82,501	80,198,203
PCR-15-078	L3	2.05.02; 2.09.02	Vescovo	ESM/SIX APP Contract Awards	Approved	4/8/2015	4/14/2015	Mar-15	951,779	81,149,983
PCR-15-084	L3	2.07.02	Nelson	Correction to PCR-15-075	Approved	4/29/2015	5/1/2015	Apr-15	(56,606)	81,093,377
PCR-15-070	L3	2.03.04	Bromfield	Control Station & Electronics Procurement Refinements	Approved	4/2/2015	4/29/2015	Apr-15	16,690	81,110,067
PCR-15-085	L3	2.08.02	Attenkofer	APP036 High Harmonic Rejection Mirror Contract Award	Approved	5/7/2015	5/18/2015	May-15	62,845	81,172,912
PCR-15-082	L3	2.07.02	Nelson	APP097 Instrumented Six Circle Contract Award	Approved	5/7/2015	5/14/2015	May-15	(94,120)	81,078,792
PCR-15-080	L3	2.03.01	Bromfield	LN2 Contract Amendment	Approved	5/13/2015	5/18/2015	May-15	8,235	81,087,027
PCR-15-086	L3	2.05.02	Vescovo	SIX & EXM Contract Awards and Mods	Approved	5/19/2015	5/27/2015	May-15	24,970	81,111,996
PCR-15-088	L3	2.10.02	DiMasi	APP094NX Contract Award & Contract Amendments	Approved	6/5/2015	6/19/2015	Jun-15	33,724	81,145,720
PCR-15-089	L3	2.04.02, 2.04.03	Yin	Linux Servers Award & Additional Cables	Approved	6/10/2015	6/19/2015	Jun-15	19,387	81,165,107
PCR-15-083	L3	2.03.01	Bromfield	Additional Equipment Racks for SIX	Approved	6/18/2015	7/1/2015	Jun-15	226,363	81,391,470
PCR-15-092	L3	2.08.02	Attenkofer	APP033NX ISS XES Spectrometer Contract Award	Approved	7/9/2015	7/24/2015	Jul-15	(144,890)	81,246,580
PCR-15-093	L3	2.07.02	Nelson	ISR Gas Handling System Contract Amendment	Approved	7/20/2015	7/24/2015	Jul-15	29,701	81,276,282
PCR-15-094	L3	2.12.1, 2.12.2, 2.12.3	Fries	Additional Labor and Material for ID and FE Installation & Testing	Approved	7/22/2015	7/24/2015	Jul-15	1,083,366	82,359,647
PCR-15-097	L3	2.07.02; 2.10.02	Nelson DiMasi	ISR 5 DOF Table Award, DAQ Procurement Refinements, SMI Milestone Rev	Approved	8/5/2015	8/20/2015	Aug-15	101,449	82,461,096
PCR-15-096	L3	2.08.02	Attenkofer	ISS Contract Awards and Contract Amendments	Approved	8/7/2015	8/20/2015	Aug-15	454,247	82,915,343
PCR-15-090	L3	2.03.01, 2.03.04	Bromfield	Additional Resources to complete Utilities, Fire Detection & Suppression, &	Approved	8/3/2015	8/20/2015	Aug-15	237,603	83,152,946
PCR-15-098	L3	2.09.02	Jarrige	Sample Chamber Award & Spectrometer Amendment	Approved	8/17/2015	8/25/2015	Aug-15	(209,811)	82,943,135
PCR-15-099	L3	2.10.02	DiMasi	SMI Endstation Scope Reductions	Approved	8/19/2015	8/24/2015	Aug-15	(518,906)	82,424,229
PCR-15-100	L3	2.08.02	Attenkofer	ISS High Heatload Mono and Shielded Beam Transport Contract	Approved	9/10/2015	9/29/2015	Sep-15	143,767	82,567,996
PCR-16-101	L3	2.07.02	Nelson	ISR Gas Handling System Contract Amendment and Labor Resource	Approved	10/8/2015	10/19/2015	Oct-15	(50,200)	82,517,796
PCR-16-102	L3	2.10.02	DiMasi	SMI APP060 Contract Amendment and Procurement Refinements	Approved	10/19/2015	10/26/2015	Oct-15	0	82,517,796
PCR-16-105	L2	2.12.01, 2.12.02, 2.12.03	Fries	Delete Remaining Scope for Installation of IDs and FEs for the NEXT	Approved	11/9/2015	11/16/2015	Nov-15	(648,331)	81,869,465
PCR-16-104	L3	2.07.02	Nelson	5 DOF and Mirror Package Contract Amendments	Approved	11/12/2015	11/19/2015	Nov-15	0	81,869,465
PCR-16-103	L3	2.10.02	DiMasi	APP065 SMI SAXS Beam Chamber Award	Approved	11/13/2015	11/19/2015	Nov-15	(72,034)	81,797,430
PCR-16-106	L3	2.08.02	Attenkofer	ISS Harmonic Rejection Mirror Tank & Mechanics Contract Amendment	Approved	12/16/2015	12/22/2015	Dec-15	12,064	81,809,494
PCR-16-108	L3	2.09.01, 2.09.02	Jarrige	SIX Sample Manipulator & Cryostat Award	Approved	12/15/2015	12/23/2015	Dec-15	(407,895)	81,401,599
PCR-16-109	L3	2.08.02	Attenkofer	ISS Lens Package Procurement Revisions	Approved	12/16/2015	12/23/2015	Dec-15	0	81,401,599
PCR-16-107	L2	2.01.01, 2.01.02, 2.03.01, 2.03.02, 2.03.03, 2.03.04, 2.03.05, 2.05.01, 2.05.02, 2.07.01, 2.07.02, 2.08.02, 2.10.01, 2.11.01	Keister	Add Future ETC Items into the NEXT Baseline	Approved	12/2/2015	1/4/2016	Dec-15	898,414	82,300,012
PCR-16-111	L3	2.08.02	Attenkofer	APP037 and APP038 Contract Amendments	Approved	1/26/2016	2/10/2016	Feb-16	57,248	82,357,260
PCR-16-112	L2	2	Keister	Revisions to Schedule Milestones	Approved	2/10/2016	2/19/2016	Feb-16	0	82,357,260
PCR-16-110	L3	2.11.01	Kitegi	Amendment of APP 77	Approved	2/11/2016	2/24/2016	Feb-16	(52,400)	82,304,860
PCR-16-113	L3	2.08.02	Attenkofer	ISS Spectrometer System Contract Amendment	Approved	3/18/2016	3/29/2016	Mar-16	0	82,304,860
PCR-16-115	L3	2.03.02, 2.03.05	Stebbins	Common Systems Adjustments	Approved	4/20/2016	4/25/2016	Apr-16	54,270	82,359,130
PCR-16-114	L3	2.05.02, 2.09.02	Jarrige/ Vescovo	ESM & SIX Contract Amendment Updates	Approved	4/13/2016	4/25/2016	Apr-16	98,526	82,457,656

PCR Number	PCR Level	WBS	CAM	Description	Status	Origination Date	Date Approved	CPR Implemented	Cost Impact	Baseline
PCR-16-116	L3	2.09.02	Jarrige	APP 111NX Contract Award	Approved	5/11/2016	5/24/2016	May-16	153,790	82,611,446
PCR-16-117	L3	2.07.02	Nelson	ISR 6 Circle Diffractometer Contract Amendment	Approved	5/17/2016	5/23/2016	May-16	0	82,611,446
PCR-16-118	L3	2.05.01,2.05.02, 2.09.02	Jarrige/ Vescovo	ESM & SIX Contract Amendment Updates	Approved	5/24/2016	6/22/2016	Jun-16	73,697	82,685,143
PCR-16-120	L3	2.04.02,2.04.03, 2.11.01	Kitegi, Yin	ESM & SIX Contract Amendment Updates	Approved	7/13/2016	7/29/2016	Jul-16	162,491	82,847,634
PCR-16-119	L3	2.03.01, 2.03.02	Bromfield, Fries	Update Common System Baseline with Additional Support Identified in ETC	Approved	7/13/2016	7/26/2016	Jul-16	73,540	82,921,174
PCR-16-121	L3	2.07.02. 2.10.01, 2.10.02	Keister	Incorporate EAC Changes in WBS 2.07 and 2.10 into Baseline	Approved	7/13/2016	7/26/2016	Jul-16	48,942	82,970,116
PCR-17-122	L2	2.01.01, 2.01.02, 2.03.01, 2.03.05, 2.05.02, 2.06.02, 2.07.02, 2.08.02, 2.09.02, 2.10.02	Keister	Extended Support for NEXT Project Closeout, Update of WBS Dictionary, and SIX Milestone Revision	Approved	2/17/2017	3/16/2017	Feb-17	123,297	83,093,413