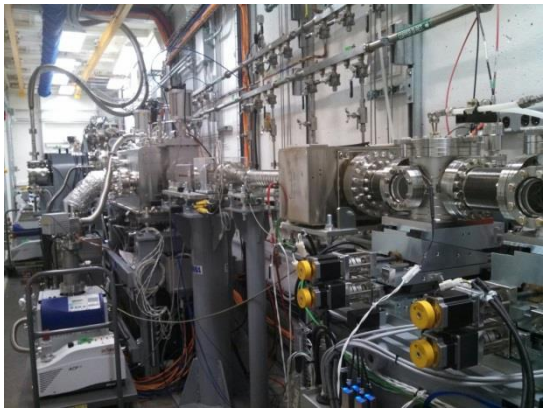
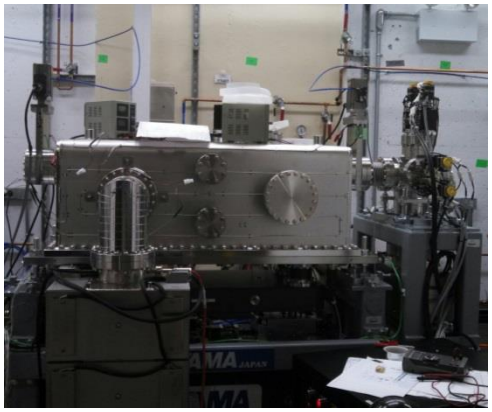
NSLS-II Experimental Tools (NEXT)

April 2016 Project Activity

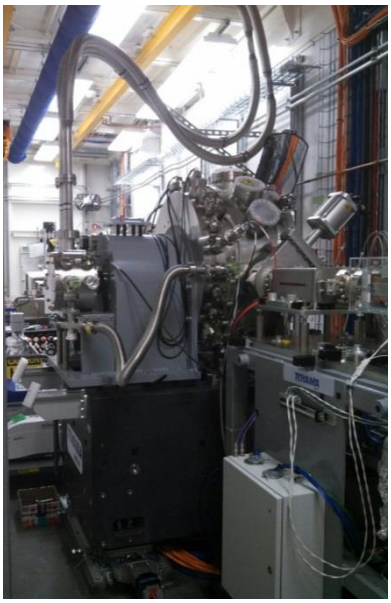
Report due date: May 20, 2016



White beam components in FOE

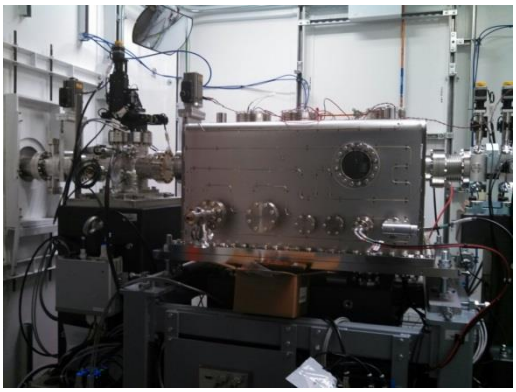


Beam position monitor and VFM in FOE



DCM in FOE (looking downstream)

VFM, visual beam diagnostic, bremsstrahlung stop, and photon shutter in FOE



Diamond beam position monitor, DHRM, and secondary source aperture in SOE

Cryocooler and phase separator on mezzanine

Gas handling system in Hutch D (looking outboard)

Gas handling system in Hutch D (looking inboard)

ISR: Photon delivery system and endstation installations (Toyama, Suzuki-Shokan, Huber, Applied Energy Systems)

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NEXT Project Manager

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OVERALL ASSESSMENT

The ISS beamline took first light on April 5 and propagated it to the endstation hutch on April 13. ISS is now approved for operation at typical NSLS-II beam current (250mA). Installation progress continued during April at all of the other NEXT beamlines. Particular attention was paid to completion of installations at the two beamlines scheduled for IRR at the end of June, ISR and ESM, along with completion of radiation shielding analyses, travelers, and all other documentation required for IRR. All five NEXT beamline PDSs will be substantially installed by June.

Three more major procurements were completed in April: ESM PGM, ISS GHS, and SMI H/V mirrors. Monitoring and management of contractor progress on the 25 remaining major procurement contracts are important ongoing activities that are crucial to maintaining project schedule. Nine of these contracts are for SIX, 6 are for ISR, 5 are for ISS, 3 for SMI, and 1 each for ESM and Insertion Devices (ESM EPU105).

As of April 31, 2016, the project is 83.5% complete based on base scope performance earned to date. The cumulative EVMS schedule and cost indices are both 0.94.

Two PCRs were approved and implemented during April, one for ESM and SIX contract amendment updates (+$99k) and one for Common Systems Adjustments (+$54k). These PCRs increased BAC by $0.15M, to $82.5M. Cost contingency is $7.5M, which is 55.4% of $13.6M BAC work remaining. The EAC, reported as the sum of actual cost to date (ACWP) plus the estimated cost to complete (ETC), is $86.66M, $0.65M greater than the March value. The increase is broken down as: $0.15M increase in BAC from PCRs, $0.15M contingency utilization to mitigate schedule risk for state-of-the-art soft x-ray grating rulings, and $0.35M cost overage on work performed ($0.13M M&S overage, $0.22M labor overage). As of the end of April, contingency on EAC is $3.34M, which represents 24.6% of $13.6M EAC work remaining, or 56% of $5.9M unobligated work to go ($7.7M of the remaining work is obligated to fixed-price equipment contracts). ETC will continue to be assessed monthly through project completion to contain costs while maintaining the good schedule performance that the project has demonstrated to date.

An EVMS “desktop” Review of Corrective Actions was held on April 1, to review documentation demonstrating progress of the NEXT project in addressing and closing out Corrective Action Requests (CARs) and Continuous Improvement Opportunities (CIOs) identified by the June-July 2015 EVMS Self-Assessment Review of the BSA EVMS, as captured in the Corrective Actions Plan developed in response to the report from that review. All NEXT corrective actions have been addressed and closed.

Looking ahead, a bottom-up EAC assessment will be conducted at the end of May, in conjunction with taking May EVMS status. With remaining activity strings extending for only a few months, this exercise will serve to inform the contingency planning process to be conducted in June.

COMMON SYSTEMS

Mechanical and electrical utilities finishing work continued in April, primarily in the SIX satellite building. Cable trays are now installed in that building, ready for cable installation scheduled to start by the end of May. LED lights are scheduled to be installed in the satellite building by early May. Installation of fire suppression plumbing for the gas handling systems in the ISR 4-ID-D and ISS 8-ID-B endstation hutches was also completed this month.

During April, significant progress continued to be made in PPS design, installation, and testing. PPS installation was completed at ESM and ISR, and PPS software and integrated testing at these two beamlines was substantially completed. The ISR and ESM beamline PPSs are scheduled to be certified during the May 2016 maintenance period.

The EPS team is continuing to receive EPS requirements for each beamline, and their efforts are being directed to where major beamline component installations are underway or soon will be taking place. EPS installation activities at ESM were completed earlier this month and integration into the control system will continue into early May. EPS installation in the ISR hutches resumed in April, with a focus on wiring the DI water valves and temperature sensors into the system. EPS work at ISR will finish in May, once Toyama completes the remainder of the PDS installation. At SMI, the EPS installation is pending the receipt of requirements in order to finish FOE work. Terminations of cables inside SMI FOE are expected to resume in mid-May, as resources become available following completion of ongoing work at ISR and ESM.

The remaining control station furniture at ISR and ESM was ordered this month and is expected to be delivered in May and June. Integration of AC power and network cables for all NEXT control stations is planned to occur over the next few months, once the control station partitions are received and installed. Depending on the timing of the furniture delivery, careful coordination with the ESM and ISR IRRs in late June will be required.

BEAMLINE CONTROLS

Beamline Controls efforts in April continued in support of supplier optics installations and testing of components for all five NEXT beamlines. Particular attention is being paid to controls progress at ESM and ISR in order to remain on track for the late-June IRRs scheduled for these beamlines.

For the SMI beamline, progress was made in the integration of vacuum gauge and pump controls, development of CSS operator screens, and tuning and testing of a large number of motion axes for JJ-Xray and Cinel optics installations. For the ESM and SIX beamlines, motion tuning and EPICS integration of optics installations continue to make progress. For the ISR beamline, progress was made in network installation and cable termination, to prepare motion controllers for the Toyama installation effort in May.

Following the departure of the controls engineer assigned to the ISS beamline after its IRR in late March, a newly hired controls engineer has been assigned to complete ISS beamline and endstation controls.

ESM – ELECTRON SPECTRO-MICROSCOPY

ESM installation activities continued at 21-ID during April. For the photon delivery system, the main accomplishment this month was completion of installation of the M3 mirror system. Considerable progress was also made on installation of the ARPES endstation.

The two M3 mirrors (M3A and M3B) were the last optics to be installed along the optical path of the ARPES branch of ESM. This branch is now optically complete. The M3 mechanical system consists of a single hexapod mechanism supporting a base plate upon which the two M3 mirrors are mounted in a vertical stack. Following alignment of this system, a simple vertical motion of the hexapod selects which mirror intercepts the light, sending the beam either to the ARPES or to the XPEEM branch. The two mirrors are identical elliptical cylinders manufactured by JTEC. Upon receiving them at BNL, their surface quality was verified in our optical metrology laboratory before mounting them in the hexapod chamber and surveying them into position. At the end of April, the M3 mirror system was being baked to achieve ultra-high vacuum.

The major components of the ARPES endstation were installed this month. As shown in Figure 1, these include: the Scienta DA30 electron energy analyzer, the liquid helium (LHe) cryostat for macro-ARPES, and the load-lock system. The Scienta DA30 analyzer is capable of recording angular information from a sample over a range of emission angles without rotating the sample. This capability is obtained using a clever design of the entrance electron optics based on deflection plates placed at strategic positions along the beam trajectories inside the analyzer. The LHe cryostat shown in Figure 1 is the first of three sample holders planned at ESM to bring the sample into the measurement position in front of the Scienta analyzer. The long horizontal linear motion for the LHe cryostat transports the sample from the preparation chamber to the main chamber. It also allows for exchange of samples with the load-lock system located above the preparation chamber. Note also that the entire endstation is tilted 5 degrees with respect to the horizontal plane in order to illuminate the sample at normal incidence.

Looking forward, the ESM white and pink beam masks are planned to be installed in the FOE in June. This will complete installation of the full vacuum path of the ARPES branch. At that point, the entire beamline will be under vacuum and ready for the final instrumentation needed for the IRR. A major task for ESM in May and June will be preparation of documentation needed for the IRR.

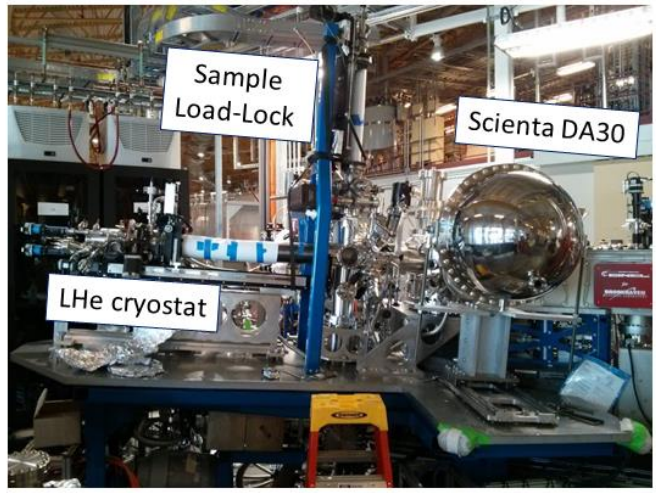


Figure 1: ESM: View of the ARPES endstation. The main components of the system are the electron energy analyzer (Scienta DA30), the LHe cryostat, and the sample load-lock system.

ISR – IN-SITU AND RESONANT HARD X-RAY

Survey data drawings for the masks, beam stops, bremsstrahlung collimators and stop, HFM, VFM, and DCM; photon shutters; and the KB Mirrors were released this month. Individual vendor item control drawings of the masks, beam stops, HFM, VFM, and DCM were also released.

FLUKA analysis of the secondary bremsstrahlung radiation was completed by NSLS-II health physicist Mo Benmerrouche for primary bremsstrahlung incident on the masks, mis-steer protection flange, HFM, and the white beam stop. The total dose on contact at the outboard and downstream walls of the FOE is <0.5 mrem/hr for all primary bremsstrahlung targets, except for the HFM. However, as shown in Figure 2, the addition of a single, secondary bremsstrahlung shield is sufficient to satisfy this shielding requirement for all identified scatterers.

A report of the KB Mirrors bender tests was received from Toyama on April 27. Using a large aperture, phase-shift Fizeau interferometer, both the HFM and VFM mirrors were mounted in their benders and tested. A significant twist was observed (see Figure 3), which would be detrimental to focusing performance. Toyama is therefore modifying the benders by adding clamping plates for the mirrors and support plates on either end of each bender. Additional tests will be carried out in mid-May.

The ISR PPS device was received on April 28 and handed to the NSLS-II Vacuum Group for leak testing prior to installation.

Installation of the orthogonal rotational stages on the five degree-of-freedom table, which together comprise the base diffractometer for *in-situ* studies, was completed, as shown in Figure 4. Installation of the laser curtain in the outboard doorway of Hutch 4-ID-D was also completed.

The Dual Phase Plate Assembly's vacuum chamber, stand, and granite support with out-of-vacuum stages arrived on April 25. Huber personnel also arrived on April 25, and completed installation of the components in Hutch 4-ID-A on April 28, as shown in Figure 5. The vacuum chamber will be baked by ISR technicians in late May, prior to receipt of the two phase plate stacks in early June. Installation of the stacks inside the vacuum chamber is anticipated to be completed by the middle of June.

Installation of the exhaust system in Hutch 4-ID-D by Blake Sheet Metal, the subcontractor for the Gas Handling System, was completed on April 22. Applied Energy Systems personnel returned in late April to continue installation of the Gas Handling System, with anticipated completion in mid-May.

Prior to the return of Toyama personnel on April 26, ISR technicians completed gentle (80˚ C) bakes of the HFM, VFM, and DHRM vacuum chambers. Two vacuum sections were also baked during April: the first section, which includes two masks, a beam position monitor, and the first bremsstrahlung collimator; and the third section, which is the beam stop unit between the HFM and DCM. During the last week of April, the HFM, VFM, and DHRM vacuum chambers were vented in preparation for the installation of the mirrors. Figure 6 shows the HFM being staged for installation on April 30.

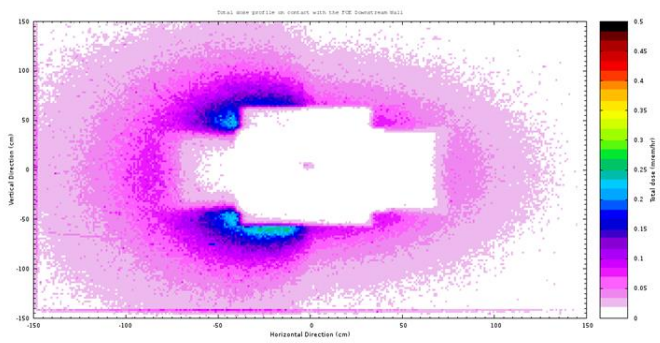


Figure 2: ISR: Calculated total dose on contact with the downstream wall of the FOE, with primary bremsstrahlung incident on the HFM and with a 0.6 m wide by 1 m tall secondary bremsstrahlung shield located just downstream of the primary bremsstrahlung stop.

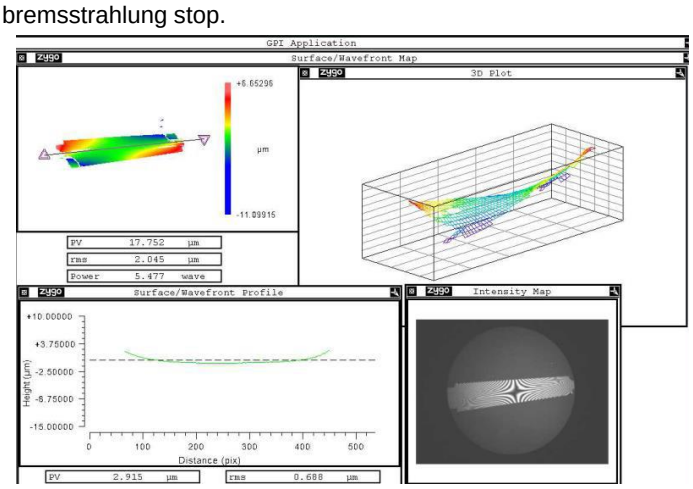


Figure 3: ISR: Fizeau interferometry measurements of the KB Mirrors' VFM.

Figure 4: ISR: Technician Dennis Carlson standing next to the base diffractometer for *in-situ* studies and the control rack for the five degree-of-freedom table inside Hutch 4-ID-D.

Figure 5: ISR: Dual Phase Plate Assembly vacuum chamber mounted on its stand, which straddles the granite and out-of-vacuum stages, installed in Hutch 4-ID-A.

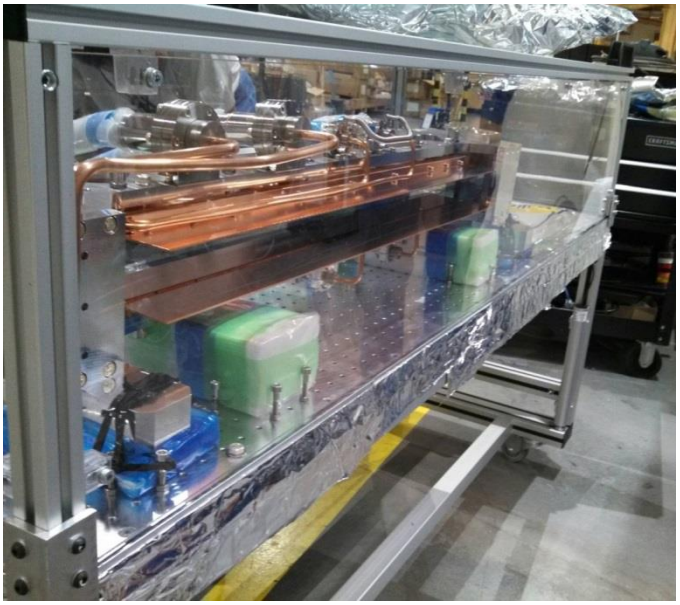


Figure 6: ISR: HFM in bender, with cooling lines attached, staged in a clean box prior to installation in the HFM vacuum chamber inside Hutch 4-ID-A.

ISS – INNER SHELL SPECTROSCOPY

After successful completion of the ISS PDS IRR on March 24, the ISS beamline was approved to take first light. In April, the ISS team focused on activities necessary to provide X-ray beam in the B1/B2 enclosure and to supply all necessary documentation and approvals including the radiation survey reports to operate the beamline under regular accelerator operation conditions. In parallel, final preparations were made for ISS endstation installation, including EPS and controls hardware and software installation, planning for the three endstation component FATs (sample chamber, spectrometer, and sample transfer system), and in-house design and fabrication activities of smaller components such as the ionization chamber, the connection between the sample chamber and the higher harmonic rejection mirror system, and the sample cryostat system.

The ISS front end shutter was opened for the first time during a dedicated studies period on April 5, at a ring current of 5mA (a factor of 100 below the NSLS-II design current). Using temperature readings from sensors installed on various masks, in the collimation mirror system, and in the pink beam screen system installed downstream of the collimation mirror system, rough alignment of the high heat load mirror and the collimation mirror was completed, sending pink beam into the monochromator system. In a second attempt on April 13, this time as 85mA beam current, the high heat load monochromator was aligned, sending beam downstream to the B1/B2 enclosure. A comprehensive radiation survey (CRS) of the complete beamline was performed, detecting no radiation above background. Operation was then approved for beam currents of up to 3 x 85mA = 255mA, permitting operation of ISS up to the current standard operating current value (240mA). Another CRS will be performed when beam returns in June following completion of the May maintenance period. Successfully passing this CRS is necessary to permit operations of ISS at the full NSLS-II design current (500mA).

The transition of ISS from the NEXT project umbrella to NSLS-II operations has begun. All commissioning activities utilizing beam, including planning for these activities, are covered by NSLS-II operations.

The ISS team held teleconferences and visited suppliers during April to help ensure that the three remaining procurement packages are completed and delivered per the contract schedules. These contracts are: the sample handling system, the sample chamber (Figure 7), and the spectrometer package. Installation of EPS and controls interfaces for these three remaining endstation components was completed this month, in support of smooth and efficient installations in June and July.

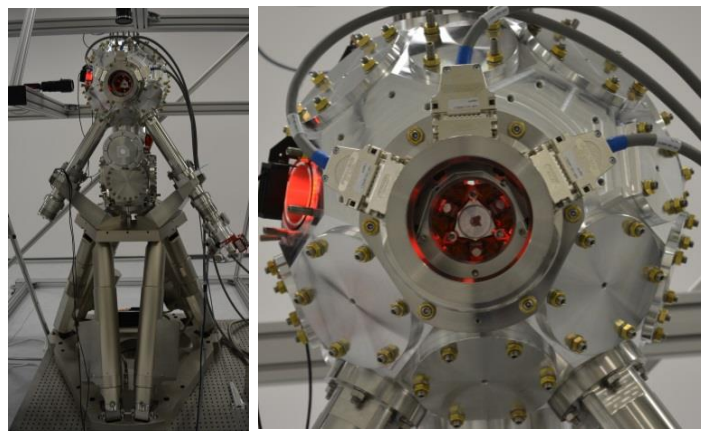


Figure 7: ISS: The ISS sample chamber system ready for FAT in April. Left: full system with base-hexapod (2T load capacity), sample chamber, sample transfer chamber, and sample chamber mount. Two cameras shown at left and above will be used to characterize the sphere of confusion of the full system. Right: Close up of the sample chamber, with the focusing lens alignment hexapod mounted inside the chamber viewable through the flange shown at center.

SIX – SOFT INELASTIC X-RAY

In April, final design of the SIX sample chamber and spectrometer arm (Bestec) was completed. Drawings of the sample chamber vessel were approved for production, and the design of the massive cable management system of the spectrometer arm was finalized. The design of this system, illustrated in Figure 8, was challenging for a number of reasons. First, the list of cables and hoses running along the arm (signal, cable, water, compressed air) is extensive. Second, because the cable chains are located on top of the spectrometer optics tank and sample chamber, the design of their bend geometry needs to accommodate ~120° rotation of the arm while leaving vertical clearance above the sample chamber cryostats for access to adapt their configuration to specific experimental requirements during operations, and also above the optics tank so that the lid can be opened for maintenance. Finally, the supporting structure of the cable

chains has to remain decoupled from the optics tank to avoid propagation of vibrations to the mechanical systems of the gratings, M6, and M7 mirrors. To this end, the structure has been designed to move on two dedicated rail tracks laid on top of granite shelf, while the optics tank rests on the granite shelf through air pads. A retractable tiller is used to either connect the optics tank to the cable supporting structure during motion of the arm, or to disconnect them when the arm is not moving.

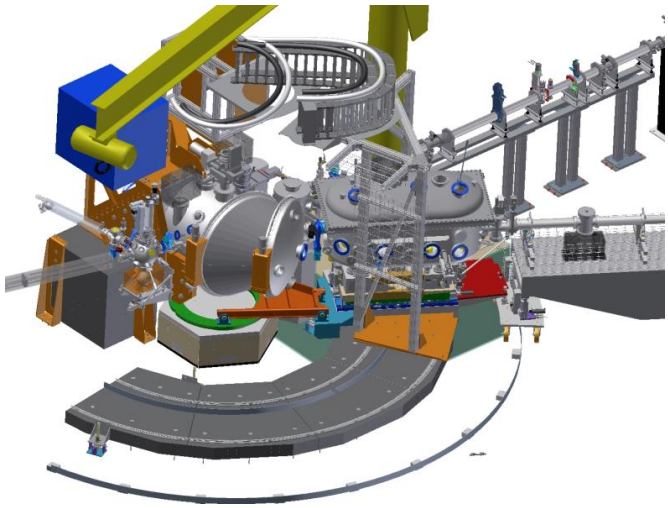


Figure 8: SIX: Rendering of SIX emission spectrometer showing the final design of its cable management system.

The Bestec installation crew visited NSLS-II for two weeks during April for installation of the M2 mirror and its cooling water bellows assembly in the mechanical system of the VLS PGM (see Figure 9). Metrology performed on the mirror installed in the holder with the bellows attached showed that the tight specification on the longitudinal slope error of 100 nrad has been met, which is a significant achievement. In addition, Bestec and SIX technicians started the bake out of the M3 mirror system.

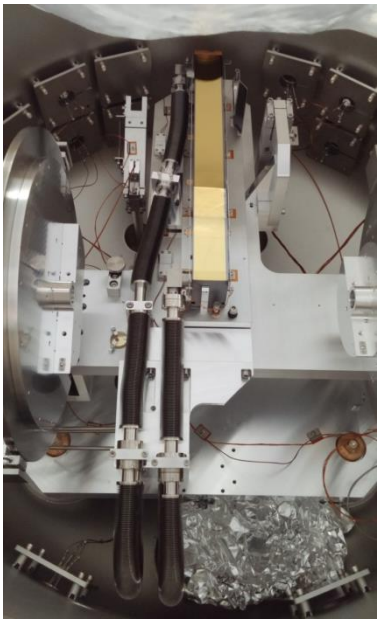


Figure 9: SIX: M2 mirror installed in the VLS PGM. The cooling water lines and their surrounding bellows are attached to the mirror while maintaining the tight figure error specifications for this mirror.

SMI – SOFT MATTER INTERFACES

Major contractor installations for SMI were completed during the first two weeks of April, with installation of the H-V Mirrors & SSA package (Cinel). This work included optical metrology measurement performed by the NSLS-II Optical Metrology Group in collaboration with Cinel and SMI staff. For each bimorph mirror, the first measurements were performed without applied voltage to characterize the native curvature and slope error. Then, each mirror was driven to the ends of its range of radius of curvature and slope error measurements were used to optimize the applied voltage matrices. Four separate active regions (stripes) on these mirrors, coated with B_4C, Si, Rh, and Pt, were characterized. The specified surface slope error values (0.3 and 0.5 µrad for the VFM and HFM, respectively) were satisfied in 18 out of 22 instances measured. Surface height peak-to-valley characteristics specified in the 10 to 15nm range were found to be out of spec, with values in the 20 to 50 nm range. However, earlier metrology performed by the contractor (Thales-SESO), which optimized the voltage matrices based on peak-to-valley height rather than slope error, yielded peak-to-valley values at or near specification, with correspondingly greater deviations of the slope errors. These complementary sets of metrology data, with their associated piezo voltage matrices, give us high confidence that well performing conditions can be established using the SMI photon beam during our commissioning phase. Each mirror is equipped with a slit of scan-gap design, which will be used to scan the mirror illumination from one end to the other to assess the focus. This final step is necessary for an additional reason, which is that the flat Vertical Deflecting Mirror (VDM) surface will be convolved with the others to create the working beam spot.

The H-V Mirrors systems were installed at SMI during April. All motors were bench tested during installation. With functioning motions, the survey group was able to measure the mirror pitch angles at their limit switches. These numbers are being incorporated into the SMI raytracing, which must include analysis of the consequences of unintended mirror excursions. Cable terminations and other interfacing were begun during the second half of April, work that is continuing into May.

Cinel also delivered and installed the removable shielded beam pipe and beam stop block during April, along with the mirror package. The removable shielded beam pipe requires rigging and hoisting during beamline operations. Hoisting and rigging procedures, developed and tested during installation, are being incorporated into the SMI Hoist & Rigging Plan. This plan captures masses and other information for moving the Sample Vacuum Chamber, the Pilatus 1M detector, and the removable transport items with the hutch hoist.

Progress was made on two SMI endstation components during April. Firstly, the FAT for the Vacuum Sample Stages package, consisting of two Hexapod systems, a rotation stage, and controllers programmed with a complex 13-degree-of-freedom coordinate system, was conducted at the PI-miCos site in Germany. All stage motions were demonstrated (Figure

10). Assembly techniques and the use of special tooling for the precision equipment were performed, and the EPICS functionality of the motion axes was shown, as well as the means of interacting with the controller commands. The stages will be delivered on schedule at the end of May. Secondly, at GNB Valves, the machinists and fabricators are hard at work to complete the SAXS Beam Chamber on time. Three of the five main chamber modules are shown in Figure 11. GNB has also sent photographs of the head and tail assemblies, the stands being fabricated, and a number of special brackets and plates. The FAT is scheduled for June and delivery in July.

With so many systems installed and others on their way, the SMI scientists and Controls Engineer have made significant progress in preparing the user interfaces. At present, the interface for beamline EPS (vacuum, temperature, and other utilities) is up-to-date and operating, while the interfaces for the CRL system, DCM system, and Cryo-Cooler system utilities have been mostly designed and partially populated with working process variables. In preparation for the SMI IRR, shielding analysis began at the beginning of May, using additional resources provided by NSLS-II for this effort. Preparation of shielding calculation inputs, raytracing, travelers, and configuration documents is all underway.

Figure 10: SMI: Putting the SMI Vacuum Sample Stages through their paces during the FAT at PI-miCos.

Figure 11: SMI: SAXS Beam Chamber modules in fabrication, with the first welding and machining operations mostly complete.

INSERTION DEVICES

A training session covering mechanical (magnetic) handling and controls for the ESM and SIX EPU57 IDs was conducted by the EPU contractor (Kyma s.r.l.) at BNL during the week of April 4. The ESM EPU57 ID was transferred to storage ring Service Building #5 the following week and subsequently installed in the cell 21 ID straight section during the first days of the NSLS-II spring maintenance period. Figure 12 shows the device in its final location in the upstream portion of the straight section. All installation steps for this device (migration of the IOC server and CSS client to the NSLS-II server, realignment and re-survey, setup of the EPS switches) are scheduled for completion during this maintenance period.

The SIX EPU57 ID will be installed in the magnetic measurement laboratory early in May.

Figure 12: Insertion Devices: ESM EPU57 insertion device installed in the upstream portion of the cell 21 ID straight section.

Kyma, the NEXT EPUs contractor, completed most of the remaining fabrication and assembly activities for the ESM EPU105 ID (the final EPU for NEXT) during March and early April. The FAT for this device was held at the Kyma site from April 11-15. As for the other EPUs, the FAT was held in two phases: first, the Final Control Acceptance Test (FCAT) and, second, the Final Mechanical Acceptance Test (FMAT). During the FAT, the EPU105 was populated with magnets to demonstrate performance of the control and mechanical systems under the actual magnetic load. Photos of experimental setups used to characterize the mechanical deformation of mechanical sub-systems of this device are shown in Figure 13. Per the contract, Kyma performed magnetic measurements at minimum gap (16mm) to

demonstrate that the magnetic field amplitude is large enough to radiate photons from the NSLS-II storage ring at the specified minimum photon energy (15 eV in linear horizontal polarization, 30 eV in linear vertical polarization). The peak magnetic field strength for ESM EPU105 measured by Kyma, shown in Figure 14, significantly exceeds the minimum value required, which will provide useful physical margin for the shimming activities to be performed at BNL.

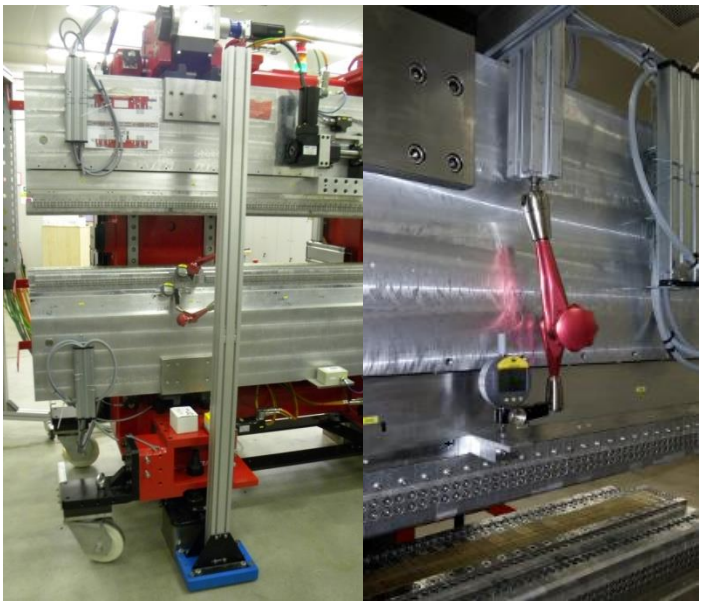


Figure 13: Insertion Devices: Experimental setups shown during the FAT of the ESM EPU105 ID, to measure the deformation of mechanical subassemblies (magnet holders on the left, moveable girders on the right) as a function of gap and phase.

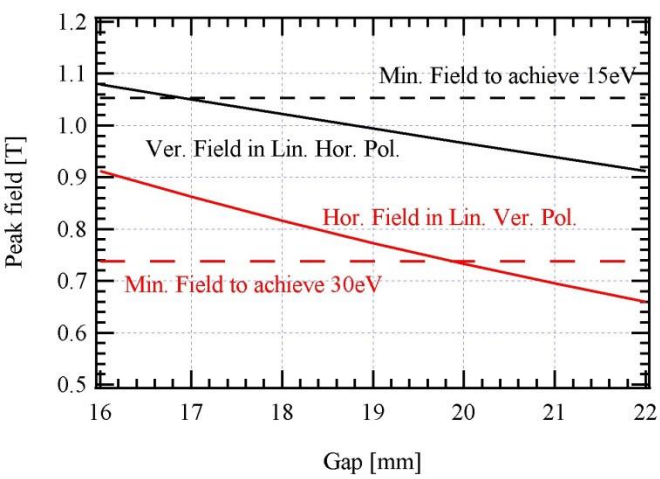


Figure 14: Insertion Devices: Horizontal and vertical peak field of the ESM EPU105 ID measured in linear horizontal and vertical polarization.

PROJECT MILESTONES

Milestone	Planned	Actual
CD-0 (Mission Need):	May 27, 2010	May 27, 2010
CD-1 (Alternative Selection):	Sept. 30, 2011	Dec. 19, 2011
CD-2 (Performance Baseline):	Dec. 31, 2013	Oct. 9, 2013
CD-3A (Long Lead Procurement):	Dec. 31, 2013	Oct. 9, 2013
CD-3 (Start Construction):	Mar. 31, 2014	Jul. 7, 2014
Internal Early Project Completion – Beamlines	Jan. 13, 2017	
Early Project Completion:	Jan. 31, 2017	
CD-4 (Project Completion):	Sept. 29, 2017	

RECENT AND UPCOMING EVENTS

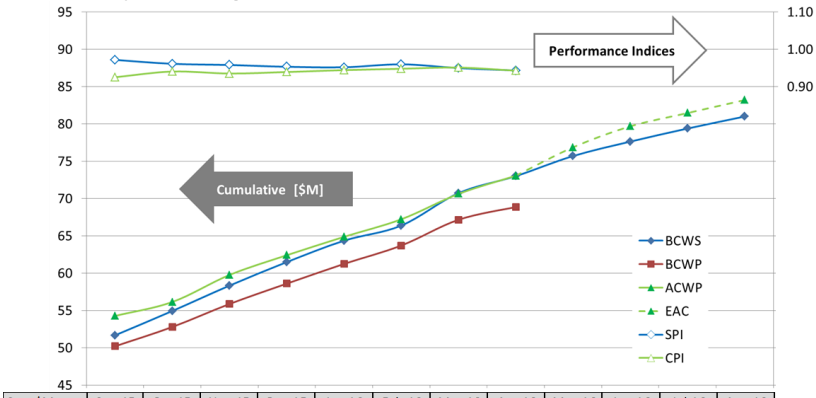
IRR for ESM and ISR	June 28-29, 2016
DOE OPA Status Review of NEXT	August 30-31, 2016
DOE OPA EVMS Review (BNL)	October 2016

Acronyms and Abbreviations

AC	Alternating Current
ACWP	Actual Cost of Work Performed
ARPES	Angle-Resolved PhotoElectron Spectroscopy
BAC	Budget at Completion
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
BDN	Beamlines Developed by NSLS-II
BNL	Brookhaven National Laboratory
BPM	Beam Position Monitor
BSA	Brookhaven Science Associates
CAM	Cost Account Manager
CAR	Corrective Action Request
CD	Critical Decision
CIO	Continuous Improvement Opportunity
CPI	Cost Performance Index
CRL	Compound Refractive Lens
CRS	Comprehensive Radiation Survey
CSS	Control System Studio
CV	Cost Variance
DCM	Double Crystal Monochromator
DI	De-Ionized
DOE	Department of Energy
DHRM	Double Harmonic Rejection Mirror
EAC	Estimate At Completion
EPICS	Experimental Physics and Industrial Control System
EPS	Equipment Protection System
EPU	Elliptically Polarizing Undulator
ES&H	Environment, Safety & Health
ESM	Electron Spectro-Microscopy beamline
ETC	Estimated Cost to Complete
EVMS	Earned Value Management System
FAT	Factory Acceptance Test
FCAT	Final Control Acceptance Test
FMAT	Final Mechanical Acceptance Test
FDR	Final Design Review
FE	Front End
FOE	First Optics Enclosure
FTE	Full Time Equivalent
FXI	Full-field X-ray Imaging beamline
FY	Fiscal Year
GHS	Gas Handling System
HFM	Horizontal Focusing Mirror
H/V	Horizontal/Vertical
ID	Insertion Device
IOC	Input / Output Controller
IRR	Instrument Readiness Review
ISR	Integrated In-Situ and Resonant X-ray Studies
ISS	Inner Shell Spectroscopy beamline
IVU	In-Vacuum Undulator
KB	Kirkpatrick Baez
LED	Light-Emitting Diode
LHe	Liquid Helium
M&S	Material & Supplies
NEXT	NSLS-II Experimental Tools project
NSLS	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source II
OPA	Office of Project Assessment
OPC	Other Project Costs
PCR	Project Change Request
PDS	Photon Delivery System
PGM	Plane Grating Monochromator
PMB	Performance Management Baseline
PPS	Personnel Protection System
SAXS	Small Angle X-ray Scattering
SC	Office of Science
SIX	Soft Inelastic X-ray Scattering beamline
SMI	Soft Matter Interfaces beamline
SPI	Schedule Performance Index
SSA	Secondary Source Aperture
SV	Schedule Variance
TEC	Total Estimated Cost
TPC	Total Project Cost
UB	Undistributed Budget
VAC	Variance At Completion
VDM	Vertical Deflecting Mirror
VFM	Vertical Focusing Mirror
VLS	Varied Line Spacing
WAXS	Wide Angle X-ray Scattering
WBS	Work Breakdown Structure
WS	Working Schedule
XBPM	X-ray Beam Position Monitor
XPEEM	X-ray PhotoEmission Electron Microscopy

COST AND SCHEDULE STATUS

Cost and schedule progress is being tracked using an Earned Value Management System (EVMS) against the cost and schedule baseline established on October 1, 2013. All baseline changes are being controlled through the NEXT Change Control Board. Cost and schedule revisions are being managed using Project Change Control procedures. From June 2015 forward, EAC is reported as the sum of actual cost to date (ACWP) plus the estimated cost to complete (ETC), at the individual activity and resource level, with account-level cost corrections applied as needed to account for the difference between the Earned Value and accrual schedules. ETC values are shown in the final row of the EVMS table below, and all EAC changes are captured in the monthly EAC log.



Cum $M	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16
BCWS	51.7	54.9	58.3	61.5	64.3	66.4	70.7	73.0	75.7	77.6	79.4	81.0
BCWP	50.2	52.8	55.9	58.6	61.2	63.7	67.2	68.9				
ACWP	54.3	56.1	59.8	62.4	64.9	67.2	70.6	73.1				
SPI	0.97	0.96	0.96	0.95	0.95	0.96	0.95	0.94				
CPI	0.93	0.94	0.93	0.94	0.94	0.95	0.95	0.94				
ETC								13.6	9.8	7.0	5.2	3.5

The NEXT project Schedule Variance (SV) for April 2016 is -$579k, with an associated monthly Schedule Performance Index (SPI) of 0.75 (red status). The largest contributors to the current month schedule variance are provided in the table below. The cumulative SPI is 0.94 (green status), 0.01 lower than it was in March.

The NEXT project Cost Variance (CV) for April 2016 is -$740k, with an associated monthly Cost Performance Index (CPI) of 0.70 (red status). The primary contributors to the current month CV are provided in the table below. The cumulative CPI is 0.94 (green status), 0.01 lower than it was in March.

Leading Current Month Variances [$k], April 2016

WBS	Title	Schedule		Cost	
		SV	Issues	CV	Issues
2.01	Project Support	0	--	-43	Extra labor for radiation shielding calculations
2.03	Common Systems	-102	Delayed PPS installation effort resulting from prioritization of BDN and Partner beamline PPS; Delayed control station activities	-5	--
2.04	Controls	-26	SMI and SIX component testing behind schedule	-94	Combination of M&S overage (-$19k, mostly cameras), labor overage (-$44k, mostly for cable pulling & termination effort above estimates), and cost of EAC activities not in base scope (-$31k)
2.05	ESM Beamline	120	Positive EV for PDS and endstation activities scheduled in earlier months	-14	--
2.07	ISR Beamline	-358	Delayed commissioning of the FOE Optics Package (-$380k)	4	--
2.08	ISS Beamline	-101	Late activities, including: collimating mirror commissioning report (-$23k), focusing mirror installation & commissioning (-$43k), receive spectrometer mechanics (-$22k), and sample chamber commissioning (-$11k)	-154	Combination of -$40k material cost overage (APP cost for earlier performance), -$45k labor cost overage (3 mFTE technician, designer and engineer), and under-budgeted M&S items supporting beamline installation (-$68k, dominated by $40k FPGA parts and $14k beryllium window)
2.09	SIX Beamline	13	--	20	--
2.10	SMI Beamline	-172	CRL focusing optics installation and commissioning scheduled this month but performed in March (-$78k); Late SAXS/WAXS endstation activities (-$45k); Late DAQ testing activities (-$16k)	-498	Dominated by completion of the H-V Mirrors Receipt and Acceptance which was earned in March and accrued in April (-$553k)
2.11	Insertion Devices	46	EPU activities performed but not scheduled in April (+$212k); SIX EPU shimming activities scheduled but not performed (-$37k); Current strip power supply activities scheduled but not performed (-$123k)	44	Combination of +$94k uncosted material performance (accounted in accrual gap) and -$50k labor CV, representing technician, designer and engineer supporting EPU 105 FAT and design, fab and assembly of current strip power supplies
	Total	**-579**	**Total**	**-740**	

As of April 30, 2016, the project is 83.5% complete with 55.4% contingency ($7.5M) for $13.6M Budget At Completion (BAC) work remaining, based on PCRs processed and approved through April 2016. The project EAC for April is reported at $86,660k against a Performance Measurement Baseline (PMB)/Undistributed Budget (UB) of $82,458k. The Variance At Completion (VAC) is given by VAC = BAC – EAC, with EAC = ACWP + ETC. Through April 2016, the VAC (-$4,203k) is dominated by the cumulative cost variance (-$4,204k), which is in turn dominated by labor cost overage on work performed to date.

The April 2016 EAC ($86.66M) is $0.65M higher than the March value. The increase is broken down as: $0.15M increase in BAC from PCRs, $0.15M contingency utilization to mitigate schedule risk for state-of-the-art soft x-ray grating rulings, and $0.35M cost overage on work performed ($0.13M M&S overage, $0.22M labor overage). As of the end of April, contingency on EAC is $3.34M, which represents 24.6% of $13.6M EAC work remaining. Outstanding commitments on fixed-price equipment contracts total $7.7M, so the $3.34M contingency on EAC represents 56.7% of $5.9M unobligated EAC work to go. ETC will continue to be assessed monthly through project completion to contain costs while maintaining the good schedule performance that the project has demonstrated to date.

Two PCRs were approved and implemented in April.

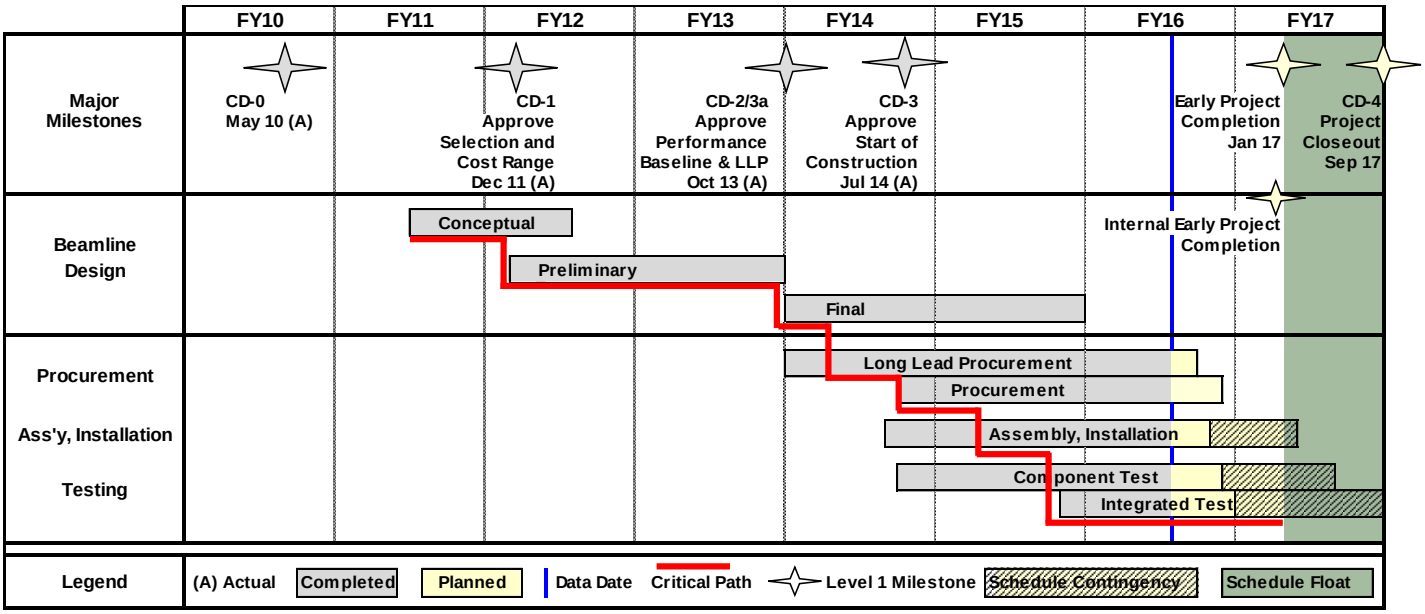
PCR	PCR Level	Baseline Change [$]	Description
16-114	L3	98,526	ESM & SIX Contract Amendment Updates
16-115	L3	54,270	Common Systems Adjustments

Two PCRs are planned for May: PCR_16_116, a Level 3 PCR in WBS 2.09.02 (SIX Beamline Systems) for award of a contract for additional monochromator and spectrometer grating substrates, and PCR_16_117, a Level 3 PCR in WBS 2.07.02 (ISR Beamline Systems), to implement a zero-cost amendment to the 6-Circle Diffractometer contract.

NEXT as of 4/30/2016	Current Period	Cum-to-Date
Plan (BCWS) $k	2,279	73,003
Earned (BCWP) $k	1,700	68,854
Actual (ACWP) $k	2,440	73,058
SV $k	-579	-4,149
CV $k	-740	-4,204
SPI	0.75	0.94
CPI	0.70	0.94
Budget at Completion $k (PMB [UB])		82,458
Planned % Complete (BCWS/BAC)		88.5%
Earned % Complete (BCWP/BAC)		83.5%
Contingency $k		7,542
Contingency / (BAC – BCWP)		55.4%
EAC $k		86,660
Contingency / (EAC – BCWP)		42.4%
(Contingency + VAC) / (EAC – ACWP)		24.6%
TPC = PMB + Contingency		90,000

Milestones – Near Term		Planned	Actual
L3	SIX - Testing Monochromator and Slits complete	1-Mar-16	Expect May
L3	ESM - Photon Delivery System Ready for Integration	7-Mar-16	1-Mar-16
L3	ISR - Installation of DCM Monochromator complete	15-Mar-16	Expect June
L3	Common Beamline Systems: Electrical Utilities Installed	29-Apr-16	Expect May
L3	ESM - Testing Monochromator and Slits complete	12-May-16	Expect May
L2	Complete Installation of 1st Beamline Components	25-May-16	30-Mar-16
L2, L3	Common Beamline Systems: Mechanical Utilities Installed	31-May-16	Expect June
L3	Insertion Devices - SIX EPU57 Received	6-Jun-16	2-Mar-16
L3	SMI - Installation of CRL Focusing Optics Complete	17-Jun-16	24-Mar-16
L3	ISR – Installation of Beamline Components Complete	29-Jun-16	Expect June
L3	ISS - Testing Collimating Mirror complete	7-Jul-16	26-Feb-16
L2	Receive EPUs for ESM and SIX	12-Aug-16	
L3	Insertion Devices - ESM EPU105 Received	12-Aug-16	
L3	SIX - Testing of Spectrometer Detector Complete	23-Aug-16	
L3	WBS 2.04 – Beamline Control Systems Complete	14-Sep-16	
L3	ISS – Installation of Beamline Components Complete	14-Sep-16	30-Mar-16
L3	SMI – Installation of Beamline Components Complete	16-Sep-16	
L3	ESM – Installation of Beamline Components Complete	29-Sep-16	Expect June
L3	SIX – Installation of Beamline Components Complete	30-Sep-16	
L3	Common Beamline Systems: EPS Installed	30-Sep-16	
L2, L3	Complete Installation of Common Beamline Systems PPS	30-Sep-16	Expect December
L2	1st Beamline Available	30-Sep-16	13-Apr-16
L2	Early Project Completion – incl. IRR	31-Jan-17	

PROJECT SCHEDULE



As of April 2016, the critical path runs through PPS design, software development, testing, and integration for the SIX beamline (WBS 2.03.02, Common Systems PPS).

Staffing Report

Staffing as of 4/30/2016	Current Period		Cumulative-to-Date	
	Planned ** (FTE-yr)	Actual (FTE-yr)	Planned ** (FTE-yr)	Actual (FTE-yr)
WBS 2.01 Project Management and Support	0.69	0.66	35.78	32.87
WBS 2.02 Conceptual and Advanced Conceptual Design	0.00	0.00	8.74	8.74
WBS 2.03 Common Beamline Systems	0.97	0.99	25.83	13.61 *
WBS 2.04 Control System	0.96	1.01	18.08	17.21
WBS 2.05 ESM Beamline	0.42	0.83	14.45	15.89
WBS 2.06 FXI Beamline	0.00	0.01	4.77	4.60
WBS 2.07 ISR Beamline	0.45	0.54	14.22	13.11
WBS 2.08 ISS Beamline	0.40	0.58	13.67	13.58
WBS 2.09 SIX Beamline	0.48	0.59	16.52	19.42
WBS 2.10 SMI Beamline	0.46	0.56	13.76	13.05
WBS 2.11 Insertion Devices	0.37	0.42	4.76	4.57
WBS 2.12 ID & FE Installation	0.00	0.00	3.88	7.97
Total	**5.19**	**6.19**	**174.46**	**164.62**

** Based on the NEXT working schedule

* A large fraction of utilities installation has been performed by contractors (M&S) rather than staff as originally planned

Number of individuals who worked on NEXT during April 2016: 138

Funding Profile

Funding Type	NEXT Funding Profile ($M)						
	FY11	FY12	FY13	FY14	FY15	FY16	Total
OPC	3.0						3.0
TEC – Design		3.0	2.0				5.0
TEC – Fabrication		9.0	10.0	25.0	22.5	15.5	82.0
Total Project Cost	**3.0**	**12.0**	**12.0**	**25.0**	**22.5**	**15.5**	**90.0**

Key NEXT Personnel

Title	Name	Email	Phone
Federal Project Director	Robert Caradonna	rcaradonna@bnl.gov	631-344-2945
NEXT Project Manager	Steve Hulbert	hulbert@bnl.gov	631-344-7570

COST PERFORMANCE REPORT

CONTRACT PERFORMANCE REPORT
FORMAT 1 - WORK BREAKDOWN STRUCTURE

FORM APPROVED
$ OMB No. 0704-0188

1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME	a. NAME	a. NAME	a. FROM (YYYYMMDD)
Brookhaven National Laboratory	NEXT	NSLS-II Experimental Tools (NEXT) Project	2016 / 04 / 01
b. LOCATION (Address and ZIP Code)	b. NUMBER	b. PHASE	b. TO (YYYYMMDD)
	c. TYPE / d. SHARE RATIO	c. EVMS ACCEPTANCE: X YES	2016 / 04 / 30

WBS (2) / WBS (3) / ITEM	CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
	BUDGETED COST		ACTUAL	VARIANCE		BUDGETED COST		ACTUAL	VARIANCE		BUDGETED	ESTIMATED	VARIANCE
	WORK SCHEDULED	WORK PERFORMED	COST WORK PERFORMED	SCHEDULE	COST	WORK SCHEDULED	WORK PERFORMED	COST WORK PERFORMED	SCHEDULE	COST			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)
2.01 Project Management and Support	168,704	168,704	211,578	0	(42,874)	8,378,564	8,378,564	9,162,574	0	(784,010)	9,918,232	10,579,636	(661,403)
2.01.01 Project Management	72,023	72,023	79,919	0	(7,896)	3,931,808	3,931,808	3,670,907	0	260,901	4,598,029	4,332,529	265,500
2.01.02 Project Support	96,680	96,680	131,659	0	(34,978)	4,446,756	4,446,756	5,491,667	0	(1,044,911)	5,320,204	6,247,107	(926,903)
2.02 Conceptual Design and Advanced Conceptual Design	0	0	0	0	0	1,807,316	1,807,316	1,807,316	0	0	1,807,316	1,807,316	0
2.03 Common Beamline Systems	296,612	194,841	200,253	(101,771)	(5,412)	6,283,481	5,992,898	7,372,477	(290,584)	(1,379,580)	7,266,877	8,668,884	(1,402,007)
2.03.01 Utilities	3,133	77,067	84,336	73,934	(7,269)	4,197,181	3,920,861	4,153,555	(276,320)	(232,694)	4,209,423	4,486,514	(277,091)
2.03.02 Personnel Protection System (PPS)	132,274	52,846	67,234	(79,428)	(14,388)	975,522	924,477	1,766,555	(51,045)	(842,078)	1,547,893	2,338,154	(790,262)
2.03.03 Equipment Protection System (EPS)	56,408	33,312	27,028	(23,096)	6,284	450,248	499,561	774,054	49,313	(274,492)	680,294	984,458	(304,164)
2.03.04 Control Station	96,794	20,054	7,417	(76,740)	12,637	212,076	199,545	134,803	(12,531)	64,742	306,744	241,690	65,054
2.03.05 Common Beamline Systems Management	8,002	11,562	14,238	3,560	(2,676)	448,454	448,454	543,512	(0)	(95,058)	522,524	618,068	(95,544)
2.04 Control System	104,330	78,257	171,911	(26,073)	(93,655)	4,114,074	4,121,695	4,292,010	7,621	(170,316)	4,558,236	4,730,213	(171,977)
2.04.01 Control System Management	4,964	4,964	2,293	0	2,671	258,168	258,168	234,245	0	23,924	294,427	270,128	24,299
2.04.02 Control System Design & Implementation	99,366	73,293	150,398	(26,073)	(77,105)	2,505,683	2,521,810	2,772,190	16,127	(250,380)	2,913,586	3,166,003	(252,417)
2.04.03 Control System Equipment	0	0	19,221	0	(19,221)	1,350,223	1,341,717	1,285,576	(8,507)	56,141	1,350,223	1,294,083	56,141
2.05 ESM Beamline	74,283	194,805	208,771	120,523	(13,966)	9,108,471	8,732,638	9,226,404	(375,834)	(493,766)	9,362,135	9,832,173	(470,038)
2.05.01 ESM Management	13,770	13,770	7,342	0	6,427	523,282	523,282	452,907	0	70,375	626,650	549,264	77,386
2.05.02 ESM Beamline Systems	60,513	181,036	201,428	120,523	(20,393)	8,585,189	8,209,356	8,773,497	(375,834)	(564,141)	8,735,485	9,282,909	(547,423)
2.06 FXI Beamline	0	0	789	0	(789)	1,818,324	1,818,324	1,793,425	0	24,899	1,818,324	1,793,322	25,002
2.06.01 FXI Management	0	0	0	0	0	409,359	409,359	470,908	0	(61,549)	409,359	470,908	(61,549)
2.06.02 FXI Beamline Systems	0	0	789	0	(789)	1,408,965	1,408,965	1,322,516	0	86,448	1,408,965	1,322,414	86,551
2.07 ISR Beamline	604,335	246,366	242,230	(357,969)	4,136	9,159,691	7,689,677	7,889,566	(1,470,014)	(199,889)	10,361,410	10,500,193	(138,783)
2.07.01 ISR Management	27,509	27,509	29,181	0	(1,671)	922,356	922,356	913,532	0	8,824	1,105,394	1,044,162	61,232
2.07.02 ISR Beamline Systems	576,826	218,857	213,050	(357,969)	5,807	8,237,335	6,767,321	6,976,034	(1,470,014)	(208,713)	9,256,015	9,456,031	(200,016)
2.08 ISS Beamline	190,846	90,067	243,603	(100,779)	(153,536)	9,641,214	9,428,704	10,043,590	(212,510)	(614,886)	10,472,212	11,057,350	(585,138)
2.08.01 ISS Management	12,928	12,928	13,315	0	(388)	634,692	762,101	613,837	127,408	148,264	838,199	688,360	149,838
2.08.02 ISS Beamline Systems	177,919	77,140	230,288	(100,779)	(153,148)	9,006,522	8,666,603	9,429,753	(339,919)	(763,150)	9,634,013	10,368,989	(734,976)
2.09 SIX Beamline	177,657	190,631	170,708	12,974	19,923	9,232,552	7,947,278	8,485,210	(1,285,273)	(537,931)	11,597,677	12,528,056	(930,379)
2.09.01 SIX Management	18,223	18,223	18,167	0	56	614,306	614,306	617,826	0	(3,520)	729,841	730,882	(1,041)
2.09.02 SIX Beamline Systems	159,434	172,408	152,541	12,974	19,867	8,618,246	7,332,973	7,867,384	(1,285,273)	(534,412)	10,867,836	11,797,174	(929,338)
2.10 SMI Beamline	409,698	237,541	735,201	(172,157)	(497,660)	8,231,080	7,692,691	7,944,466	(538,389)	(251,775)	9,108,910	9,220,017	(111,106)
2.10.01 SMI Management	11,253	11,253	19,242	0	(7,988)	671,041	671,041	599,589	0	71,452	802,179	727,394	74,785
2.10.02 SMI Beamline Systems	398,444	226,288	715,959	(172,157)	(489,672)	7,560,040	7,021,650	7,344,877	(538,389)	(323,227)	8,306,731	8,492,622	(185,891)
2.11 Insertion Devices	252,438	298,527	254,475	46,088	44,051	3,775,336	3,791,349	3,587,657	16,013	203,692	4,733,509	4,490,061	243,448
2.11.01 ESM EPU Insertion Device	249,861	295,949	252,234	46,088	43,715	3,579,622	3,595,635	3,442,165	16,013	153,470	4,515,912	4,323,033	192,878
2.11.02 SIX EPU Insertion Device	0	0	0	0	0	117,137	117,137	70,375	0	46,762	117,137	70,375	46,762
2.11.03 Insertion Devices Management	2,577	2,577	2,241	0	336	78,577	78,577	75,117	0	3,460	100,460	96,653	3,807
2.12 ID & FE Installation & Testing	0	0	0	0	0	1,452,816	1,452,816	1,452,960	0	(143)	1,452,816	1,452,960	(143)
2.12.01 ID & FE Installation & Testing Management	0	0	0	0	0	20,739	20,739	20,739	0	0	20,739	20,739	0
2.12.02 ID Installation & Testing	0	0	0	0	0	584,560	584,560	584,560	0	(0)	584,560	584,560	(0)
2.12.03 FE Installation & Testing	0	0	0	0	0	847,517	847,517	847,660	0	(143)	847,517	847,660	(143)
Total Project Baseline	**2,278,903**	**1,699,739**	**2,439,520**	**(579,163)**	**(739,781)**	**73,002,922**	**68,853,951**	**73,057,655**	**(4,148,971)**	**(4,203,704)**	**82,457,656**	**86,660,182**	**(4,202,526)**
Undistributed Budget													
Management Reserve													
Performance Management Baseline - PMB	**2,278,903**	**1,699,739**	**2,439,520**	**(579,163)**	**(739,781)**	**73,002,922**	**68,853,951**	**73,057,655**	**(4,148,971)**	**(4,203,704)**	**82,457,656**	**86,660,182**	**(4,202,526)**