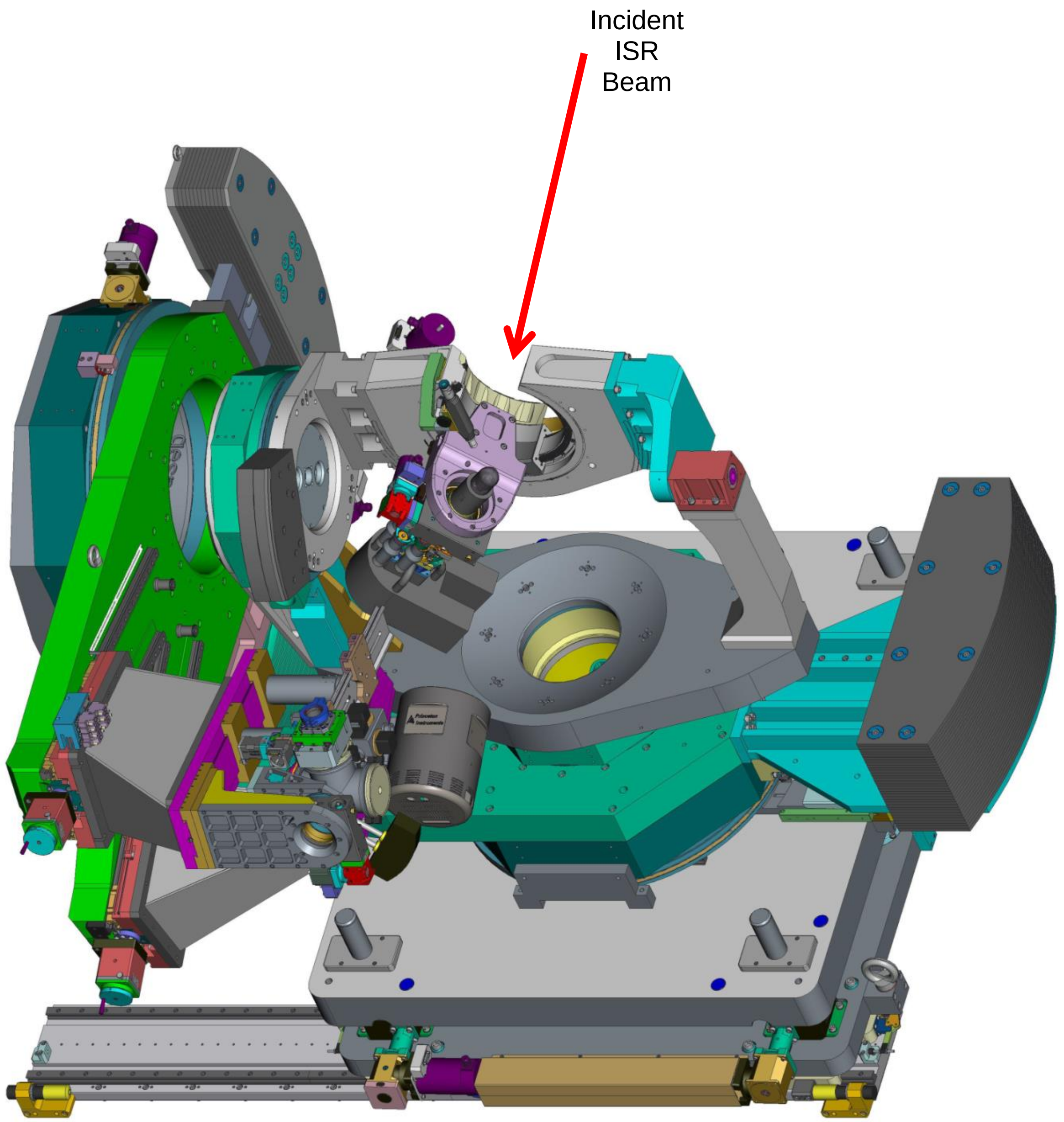
NSLS-II Experimental Tools (NEXT)

April 2015 Project Activity

Report due date: May 20, 2015



Preliminary model of the ISR Instrumented 6-Circle Endstation at 4-ID, provided by Huber Diffraction USA.

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OVERALL ASSESSMENT

During April 2015, progress continued to be made on all phases of the project, including awarding major procurements, finalizing endstation designs, and installing utilities.

A DOE/SC Mini-Review of NEXT was held on April 17. The principal recommendation provided at closeout is to implement systems and analysis needed to provide a clear view of the NEXT Project “end game” by the time of the full DOE/SC review tentatively planned for fall 2015.

Two major procurements were awarded during April: a contract for diamond phase plates for the ISR Dual Phase Plate Assembly on the 14th and a contract for the ISS High Harmonic Rejection Mirror tank and mechanics on the 29th. Upcoming major procurements include the vacuum sample stages for SMI, the sample handling system for ISS, and x-ray emission spectrometers for ISS. As of the end of April, all major photon delivery system procurements and 86% (54 of 63) of all major procurements have been awarded.

Two PCRs were approved in April, both related to contract awards or amendments, with a net cost reduction to baseline of $40K: PCR NEXT_15_084 (WBS 2.07.02, ISR Beamline Systems, -$57K change to baseline) implemented a correction to earlier PCR_15_075. PCR NEXT_15_070 (WBS 2.03.04, Control Station, +$17K change to baseline) implemented changes to cost, schedule, and WBS dictionary related to control stations.

BAC fell $0.04M in April, to $81.10M. EAC rose $0.6M, to $82.5M. The largest contributors to the -$1.4M VAC at this point are expected overages in project support ($0.4M), common systems ($0.5M), ISR beamline systems ($0.1M), and ISS beamline systems ($0.5M).

As of April 30, 2015, the project is 45.4% complete. Cost contingency is reported at $8.89M, which represents 20.1% of $44.3M BAC work remaining or 19.5% of $45.7M EAC work remaining. If all of estimated VAC were to materialize, contingency would be reduced to $7.46M, which represents 16.3% of $45.7M EAC work remaining. Since outstanding commitments total $22.9M, the $7.46M contingency on EAC represents 32.4% of the $23.0M unobligated EAC work to go.

The cumulative EVMS schedule index increased 0.01 in April, to 0.97, resulting from the net effect of schedule variances in four level 2 WBS elements. The cumulative EVMS cost index remained steady at 1.01.

Acceptance testing of NEXT shielded enclosures (hutches) made further progress in April, with 91% of the tests completed by the end of the month.

COMMON SYSTEMS

Progress on design and installation of NEXT mechanical and electrical utility systems continued at an accelerated pace in April, now that utilities work on the ABBIX project is complete, thereby freeing up additional resources to assign to NEXT installation. The accelerated pace is expected to continue until mechanical and electrical utilities installation for NEXT is complete.

ISR utilities are now completely installed, while SMI and ESM utilities installation are both approximately 95% complete. Utilities installation on the SIX and ISS beamlines also made good progress, with both beamlines approximately 90% installed.

The installation of the NEXT liquid nitrogen distribution piping was successfully completed in April by Acme Cryogenics. Final testing reports and closure of this contract is expected in May. The scope of the installation included piping from the experimental floor mezzanine level to beamline cryo-coolers and to experimental hutches that require liquid nitrogen supply.

PPS design and development is well underway, with a focus on the interlock conduit installation at ESM and SMI. PPS interlock conduit installation of the A and B chains at ESM was completed in March, and started at SMI in April. In addition, the PPS team has been developing plans for rework of hutch interface points for compatibility with PPS hardware. The hutch suppliers have been engaged regarding remediation of mechanical interfaces. The majority (90%) of Personnel Protection System (PPS) components have been received through April. PPS installation work, while being part of one month behind schedule, is expected to accelerate in June as resources currently allocated to ABBIX become available.

The EPS team is continuing to receive EPS requirements for each beamline, and participates actively in design reviews with vendors so that interface points between EPS and photon delivery components can be understood early. The procurement of Equipment Protection System (EPS) components is approximately 70% complete through April, with components continuing to be received as system definition matures. Installation of EPS components expected to start in late FY2015.

Control station furniture for SIX was installed in the SEB-2 building in April. Furniture for ESM and ISS has been received and the supplier is expected to return to NSLS-II in June to install the furniture at each beamline. SMI furniture has been finalized and the contract awarded.

BEAMLINE CONTROLS

Controls engineers continue to participate in beamline optics and endstation PDRs and FDRs. During April, these include the FDR for the SMI Horizontal/Vertical Mirrors and SSA contract with Cinel, the PDR for the SMI CRL Transfocator contract with JJ-Xray, and the PDR for the ISR Dual Phase Plate contract with Huber. With updated design information from the suppliers, the controls designs can be fine-tuned and the master controls spreadsheet populated with detailed information.

EPS I/O requirements continue to be collected for beamline and endstation components, enabling EPS group staff to assemble EPS remote I/O units for shipment to suppliers prior to factory acceptance tests. A remote I/O PLC unit for the ISS optics package was specified, assembled, and sent to Toyama during April.

Controls engineers also participated in the NEXT endstation reviews that were held for ISS and SMI in April. The information provided and discussed during these reviews gives controls engineers a better understanding of the work needed for each endstation. Following these reviews, controls engineers have begun to work with each beamline on their requirements for user data storage.

Other controls activities during April include the purchase of 8 enhanced motion controllers providing support for absolute encoders and/or macro interfaces to support coordinated motions on two different controllers. Diagnostic cameras and lenses were purchased for ESM for offline testing activities. Finally, cable installation began at ESM during April. Additional effort for cable pulling and termination is being sought from other departments or divisions at BNL.

ESM – ELECTRON SPECTRO-MICROSCOPY

With ESM mechanical and electrical utility installation complete, the ongoing installation work at 21-ID consists of pulling and terminating cables to be used for controlling motors and vacuum components. This detailed work will occupy a team of technicians for several weeks. Over 500 cables need to be laid, including motor cables (~150 motion axes) and vacuum cables (~20 vacuum sections, each equipped with ion pumps, valves, and UHV gauges). At the end of April, approximately one third of the cables have been positioned. The goal is to complete cable installation from the FOE through the location of the monochromator before the end of May, so as to be ready for installation of the VLS plane grating monochromator (PGM) in June.

The experimental floor at 21-ID is being prepared for the installation of ESM optics, the first of which, the VLS PGM, is expected to be delivered in May and installed in June. When an optics chamber is received at NSLS-II, it must be positioned with high accuracy on the experimental floor. In modern optical instruments, the ranges of motion of the optics are limited to the bare minimum to assure the highest possible stability of the optics. This in turn relies on excellent pre-alignment and survey of the optics, prior to use with X-rays. To this end, the first step is to set up a local survey network of reference points consisting of monument sockets installed at numerous points around the 21-ID floor space. Precision laser tracker survey balls are then mounted on these monuments and the positions of these points are measured and precisely referenced to the electron beam orbit. Once this network is established, it allows:

(1) high resolution mapping of the height of the floor, such as shown for the 21-ID floor in Figure 1. Deviations from the nominal 1400 mm value are within ~10mm along the entire 44 meter length of the beamline outside the shield wall (26 – 70 m from the source point), and even smaller than this in the region downstream the FOE (> 35 m),

(2) definition of fiducial marks on the 21-ID floor, used for the rough alignment of the mechanical systems of all beamline components. More than 50 such alignment marks have been set for the ESM mirror system alone. More will be needed for the other beamline components (masks, diagnostic units, safety components, etc.), and, most importantly,

(3) positioning of optics surfaces within ~50 micron positional accuracy and ~0.2 micro-radian angular accuracy of the nominal values.

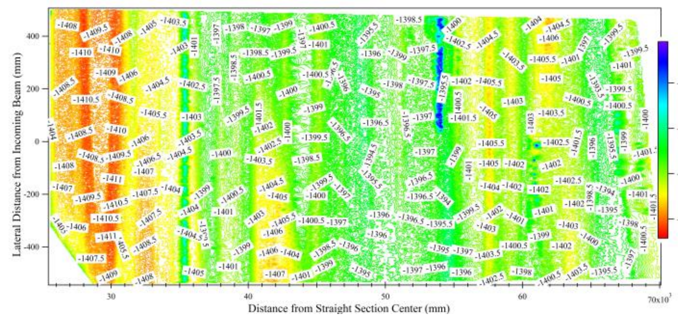


Figure 1: Survey map of 21-ID floor height along the ESM beamline. The reference is the nominal beam height (1.4 m).

FXI – FULL-FIELD X-RAY IMAGING

The FXI photon delivery system procurement contract was ready to award off project in April.

The FXI radiation enclosure (hutch) contract is proceeding on schedule, with final designs complete and fabrication continuing at Caratelli's site. Delivery and on-site construction is expected in September.

ISR – IN-SITU AND RESONANT HARD X-RAY

A purchase order for High-Pressure, High-Temperature-grown, type IIa, single-crystal diamonds, which will be used as phase plates for polarization control in the 3.5-14 keV energy range, was placed with the Technological Institute for Superhard & Novel Materials on April 14. All eight diamonds are due to arrive in November 2015.

The kick-off teleconference for the Instrumented Six-Circle Diffractometer contract was held with Huber on April 17. The overall project schedule was discussed, and May 18 was chosen as the date for the PDR. Huber will be at BNL for the ISR Dual Phase Plate Assembly FDR on May 15 and for the NSLS-II Users' Meeting on May 18-20, so the PDR for the diffractometer will be held at BNL.

The technical representative for the ISR Gas Handling System contract, ISR beamline scientist Kenneth Evans-Lutterodt, visited Applied Energy Systems on April 14 to address the layout of the vented enclosure, as part of the follow-up to the PDR. The FDR for this system is scheduled for May 13.

Regarding the Optical Components contract, updated models of the masks, beam stops, and collimators were provided by Toyama, and the third iteration on the raytracing was carried out by the ISR Team. Details of the required changes to the Second Mask, White Beam Stop, Pink Beam Stop, and collimators were conveyed to Toyama for what is expected to be a final iteration on the primary shielding design.

Ion pump controllers have been delivered and are undergoing acceptance testing. Gauge controllers, which arrived in February, were installed in the control racks. Installation of the liquid nitrogen distribution pipes occurred at ISR on April 16-17. In addition to the two drops on the mezzanine, one for the in-scope cryo-cooler and the second for the future canted build-out cryocooler, pipes were installed along the length of the beamline to provide liquid nitrogen inside Hutches C and D. Yellow lines defining the egress aisles on either side of the beamline were painted on the floor. The duck-under aisle downstream of the FOE was also painted. One of the stands to be used for endstation changeover in Hutch C arrived and was assembled. The stand for the laser in Hutch D, which will be used for *in-situ* studies during pulsed laser deposition growth, also arrived. Installation and testing of the magnet endstation in Hutch C, shown in Figure 2, began.

Figure 2: Base diffractometer that accommodates large magnets located in ISR Hutch C.

ISS – INNER SHELL SPECTROSCOPY

The production and delivery of all PDS contracts are on schedule, with Toyama as the supplier. Besides teleconferences, the ISS and Toyama teams are holding in-person meetings every ~6 weeks. These meetings have been proven to be an excellent platform to develop solutions to interface issues and to identify schedule threats and to fine-tune the program plan to avoid delays.

During the visit to Toyama by the ISS team in mid-April, discussion centered on the schedule and details of the test procedures of the monochromator FAT. Detailed analysis of the vibration and motion characterization for the high heat load monochromator and the high resolution monochromator were presented and discussed. Based on the first tests performed in February, it has been decided to use a modified optical interferometry system which can measure angular variations within 50 nrad at a minimum readout time of 10 msec, allowing characterization of the frequency response from the individual mechanical components up to 100 Hz. The system can be used under vacuum conditions, allowing realistic testing, for example the vibrations caused by the LN2 cooling system. In addition to vibrations associated with the liquid nitrogen pump system and phase separator, other technical aspects to be tested include vacuum capability of the two monochromator systems, including X-ray radiation masks, and controls performance of the four-crystal system.

During the same visit, metrology test results for the prototype bender for the collimating and focusing mirror systems were discussed. Within measurement precision, the latest test results show no twisting of the dummy mirror as a function of bend radius. Additional metrology improvements using Toyama's new coordinate measurement tool should lead to measurement accuracy better than 1 μrad, a subject of discussion at the next meeting with Toyama in May at BNL.

Other discussions with Toyama have focused on controls aspects of the monochromator system and options to slave motions of the endstation equipment, such as the analyzer energy of the spectrometers, to the monochromator motion. By using a look-up table with a time resolution of about 100 μsec containing the calculated motor motions over the full scan range, a smooth and coordinated motion between the two monochromators can be achieved. An upgrade to the standard motion controller should enable extension of the scan length from 3 s to 15 s. In addition, use of the EtherCat interface to the Delta Tau motion controllers will permit synchronization of multiple axes (up to 256 using controllers equipped with Power PMAC computers). The EtherCat interface will be also implemented in the controls systems of the sample chamber and the spectrometer, allowing fly scans of the sample chamber Hexapod and the spectrometer energy in concert with the monochromator energy, as is required for constant energy transfer scans.

Significant progress was also made during April in the endstation design. A BNL-internal endstation review was held focusing on the operations and safety aspects of the proposed endstation equipment. Aspects presented and discussed include: sample handling (including the proposed sample transfer system), the sample chamber with alignment mechanism and integrated focusing lens system, the spectrometer and detector systems, and the gas handling system. A written review report is expected in May 2015. One immediate suggestion from the review team is to increase the load capacity of the sample chamber Hexapod, allowing a load capacity of 2 metric tons and the design start of the sample cryo- and heating mechanism.

The PDR of the ISS sample chamber and its two integrated Hexapods was held in April. As a result of discussions at this review, the chamber design was modified to provide two ports with "90º geometry", the classical geometry used to minimize the background from elastically scattered photons. In addition, the chamber material will be changed from stainless steel to an aluminum alloy to reduce the fluorescence background from the chamber itself, caused by elastically scattered photons of the primary beam that are absorbed by the chamber wall, producing iron fluorescence. Finally, the potential advantages of replacing the stacked-Hexapod support design with a single, large, custom Hexapod capable of supporting the required 2 ton load were presented by the contractor, PI. The advantages of a single Hexapod include simplicity of design and operation, including simpler controls. The proposed Hexapod would provide sufficient travel range to lift the chamber from the operational height to a "parking" position allowing passage of the beam to a second endstation in hutch B2, avoiding a complex lifting mechanism. A decision on the Hexapod upgrade is expected in May.

In April also, the spectroscopy detector system (Ketek/SDD) as well as the detector system for the spectrometers (Dectris/Mythen) were received and accepted. Additionally, the three higher harmonic rejection mirrors (HHRM) fabricated by Crystal Scientific passed their metrology tests and will be shipped to BNL, with receipt expected in May 2015. The HHRM will be located upstream of the endstation chamber, as shown in Figure 3.

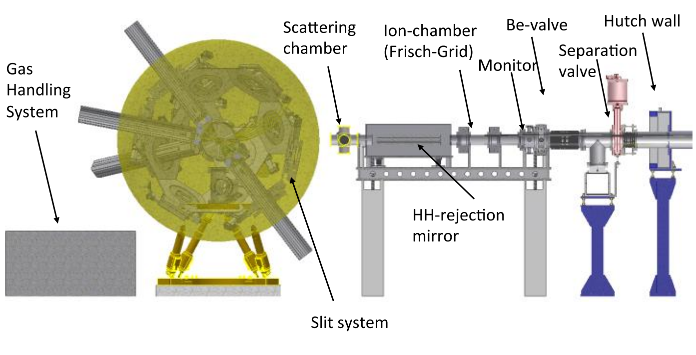


Figure 3: ISS endstation assembly (X-ray beam enters from right), showing beam characterization and manipulation modules upstream of the endstation itself: a double gate valve system for vacuum separation from beamline vacuum, a monitor and an ionization chamber with Frisch grid, the higher harmonics rejection mirror system, and the I0 scattering chamber which provides intensity measurement of the light reflected from the higher harmonic rejection mirror and a photon energy reference. This beam characterization system will be interfaced with the sample chamber, including the gas handling system.

SIX – SOFT INELASTIC X-RAY

The alternative spectrometer optical scheme suggested last month by the SIX optics scientist was reviewed by the soft x-ray optics experts of the SIX BAT on April 9. The scheme relies on the addition of a plane pre-mirror before the grating and a Riemer-Torge mechanism for the motion of the pre-mirror/grating combination, in a similar fashion to that used in the PGMs that form the heart of soft x-ray PDSs. The significant simplification of the detector motions offered by the fixed outgoing beam height was viewed as major advantage, one that would reduce mechanical risk significantly. The recommendation of the April 9 informal review was to proceed with this new design. During the pre-PDR for the SIX spectrometer, held at Bestec's site on April 13-15, a mechanical conceptual design that accommodates this new optical scheme was proposed. As shown in the top panel of Figure 4, the detector and optics carriages are now fully decoupled during measurements, as the grippers connecting the pipe with both carriages retracts when not in motion. The conceptual bridge-like structure to hold the detectors from the top and decouple the cryocooler heads from the camera chambers is shown in the bottom panel of Figure 4.

PDS packages with Bestec are currently all in production. The delivery of the PGM is scheduled for May, in time for the installation in June. A delay by one month in the production and schedule delivery date of the M1M3 mirror systems has been introduced by the addition of white and pink beam components to the scope of this package. The delivery date of the larger package meets the need dates for SIX installation.

Production of JTEC Corp. optics (the elliptical mirror M3, the circular cylindrical mirror M6, and the ellipsoidal mirror M4), is on schedule. The internally cooled PGM pre-mirror M2 was shipped to JTEC on April 16 for polishing of the optical area to a 100 nrad tangential slope error.

The PDR of the CCD detector for the spectrometer was held at XCAM's site on April 17. The addition of a bellows to enhance the decoupling between the cryocooler head and the camera chamber, to minimize the propagation of vibrations to the camera sensors, was agreed upon. The FDR will be held on schedule, on May 11.

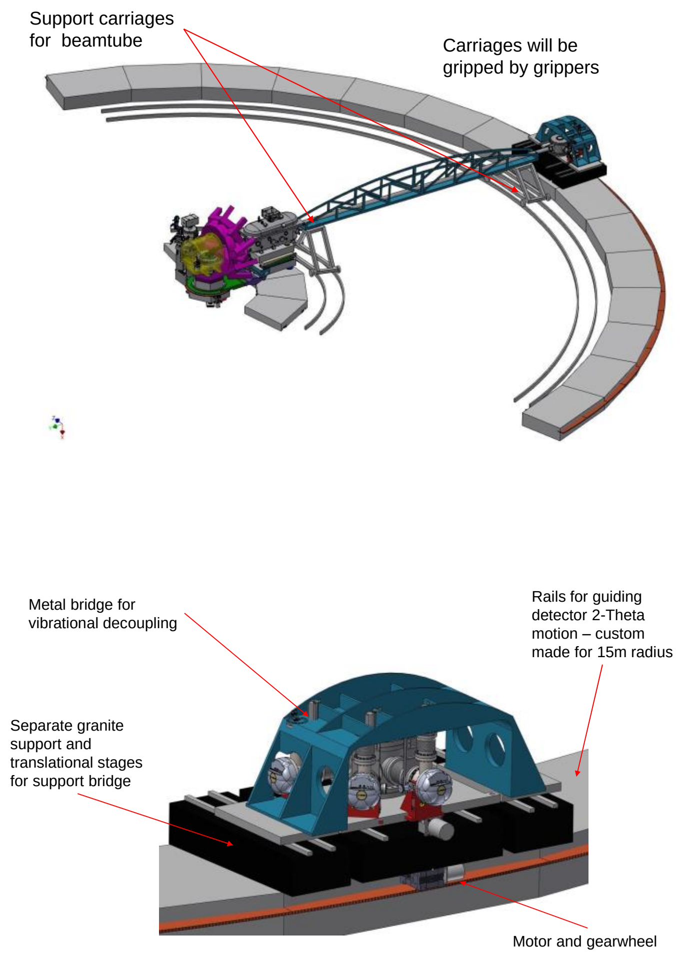


Figure 4: Conceptual design of the SIX spectrometer arm (top panel), and close-up view of the detector carriage (bottom panel), from Bestec.

SMI – SOFT MATTER INTERFACES

Progress was made on a number of SMI procurement contracts in April. The PDR for the Sample Vacuum Chamber was held at the very end of March at GNB (Elk Grove, CA). During April, the Preliminary Design was approved, a hoist safety review was organized and completed, the FDR teleconference was hosted, and approval of the FDR milestone was completed. Similarly, in March, SMI group members traveled to the JJ X-ray site in Denmark for the PDR of the CRL Transfocator contract. In April, the PDR was finalized and plans laid for the mid-May FDR at BNL, including receipt from JJ X-ray in April of a completed 50+ page FDR report. Even greater preparation was undertaken for the two-day FDR meeting with Cinel for the H-V Mirrors and SSA contract, a package supplying state-of-the-art optics as well as critical beamline shielding components. The Cinel FDR took place at the end of April and is on track for the approval of report, minutes, and payment milestone in May as scheduled. The vacuum interface drawings for the SMI pixel array detector contract with Dectris were approved in April, achieving the second milestone in the Detector Additions procurement. A specification for cryo-lines to cool the DCM crystals in the White Beam Components contract was approved, completing a prerequisite for Cryo-Cooler installation later this summer. Best value determination of proposals for the Vacuum Sample Stages was completed on the last day of April. Finally, the RFP for the Double Crystal Deflector was posted on FedBizOpps in April.

One common denominator that emerged among these procurements was the desire to avoid hoists of heavy, sensitive components wherever possible. To assist the suppliers, SMI has borrowed a pallet full of casters, shown in Figure 5, that were used to install large granite slabs for the IXS beamline. The spec sheets for these casters have been shared with Cinel and JJ X-ray, who have agreed to provide mounting provisions on their equipment, as well as spacer blocks on the pallets, so that components can be loaded with BNL forklifts and then, with casters attached, rolled into place, avoiding lifts. The granite base for the Sample Vacuum Chamber will be designed to utilize these casters, and it will be suggested to use them for the Double Crystal Deflector when that contract is awarded.

Figure 5. Installation casters from IXS beamline, to be used for SMI installations.

In mid-April, the SMI design status was reported at an Endstation Design Review attended by NSLS-II and BNL-CFN experts. Most of the discussion centered around the SMI components to be based on in-house designs. At this meeting, new design details were shown for the SAXS Beam Chamber, the SAXS Detector in-vacuum X/Y/Z mechanics, the B hutch removable shielded beam pipe (including details of physical support, hoisting, and PPS logic), and the Double Crystal Deflector. Despite recent advances in these designs, they remain ambitious, and equipment safety was a concern given significant attention in the meeting. It is very challenging to design a hard X-ray beamline for true windowless operation from SAXS tube to sample chamber to optics to front end, as is being done for SMI. A number of vacuum-related issues must be addressed, including: (i) the detectors are vulnerable because, for tender X-ray operation, their silicon chip sensors have to be exposed directly to the vacuum environment shared by the sample, and (ii) the sample chamber presents an obvious vulnerability because soft matter systems tend to outgas and because users need a fool-proof bleed-up procedure for regular access to their samples. The SMI beamline has been designed with several steps of safety implemented between these vacuum sections and the progressively more UHV compatible optics located upstream. Engineered controls include a differential pumping aperture and an additional fast valve, as well as air hoses to encapsulate detector cooling water lines to eliminate some water/vacuum interfaces. Nevertheless, considerable care must be taken, to design EPS logic that correctly responds to many possible failure modes. Fortunately, solutions to many of the challenges are being implemented for operating NSLS-II beamlines, and SMI will be able to draw upon this expertise.

INSERTION DEVICES

The FDR for the NEXT EPU vacuum chamber contract was held with FMB Berlin in April. This review focused on the design of the current strips.

Final design of the long EPUs (2.8m-long EPU105 for ESM and 3.5m-long EPU57 for SIX) continued by the contractor (Kyma) in April. The FDR for this contract, originally planned for May, will be held in June following the NSLS-II facility maintenance period ending May 29. During this shutdown, the ID group will be fully occupied with installation of three In-Vacuum Undulators for the ABBIX Project. The NEXT Insertion Devices CAM (Kitegi) is working with Kyma to minimize the impact of this few-week delay on the long EPUs contract schedule.

Requirements for the current strip power supplies were defined in April for procurement (RFQ) in May.

ID/FE INSTALLATION

During this month, NEXT front end installation started in earnest. At all five front end locations in the storage ring tunnel, the floor has been surveyed, drilled, and scarified to accept the upcoming installation of the stand assemblies. During April, vacuum and slit stage cables were pulled for ISR and SMI and the mask, slit, and photon shutter stand assemblies were installed at these beamlines. Wiring of the safety shutters, fitting the lead shielding and running the compressed air tubing among components is continuing on the ESM, ISS, & SIX front end assemblies. Installation work will continue during maintenance days and the extended shutdowns. Installation of the front ends is slightly behind the baseline schedule (0.91 SPI), but well within the timeframe that they are needed for the beamlines.

In previous months, cable trays were installed in the storage ring tunnel at the NEXT front end locations and the ratchet wall penetrations were surveyed. Surveying of these penetrations helps to prepare for the upcoming ratchet wall collimator installations, since the penetrations are only located and sized to construction tolerances.

The installation effort for the NEXT insertion devices hasn't yet begun, other than the completion of cable tray installation for NEXT insertion device straight sections in the storage ring tunnel.

PROJECT MILESTONES

Milestone	Planned	Actual
CD-0 (Mission Need):	May 27, 2010	May 27, 2010
CD-1 (Alternative Selection):	Dec. 19, 2011	Dec. 19, 2011
CD-2 (Performance Baseline):	Oct. 9, 2013	Oct. 9, 2013
CD-3A (Long Lead Procurement):	Oct. 9, 2013	Oct. 9, 2013
CD-3 (Start Construction):	Mar. 31, 2014	Jul. 7, 2014
Internal Early Project Completion – Beamlines	Sept. 30, 2016	
Early Project Completion:	Jan. 31, 2017	
CD-4 (Project Completion):	Sept. 29, 2017	

UPCOMING EVENTS

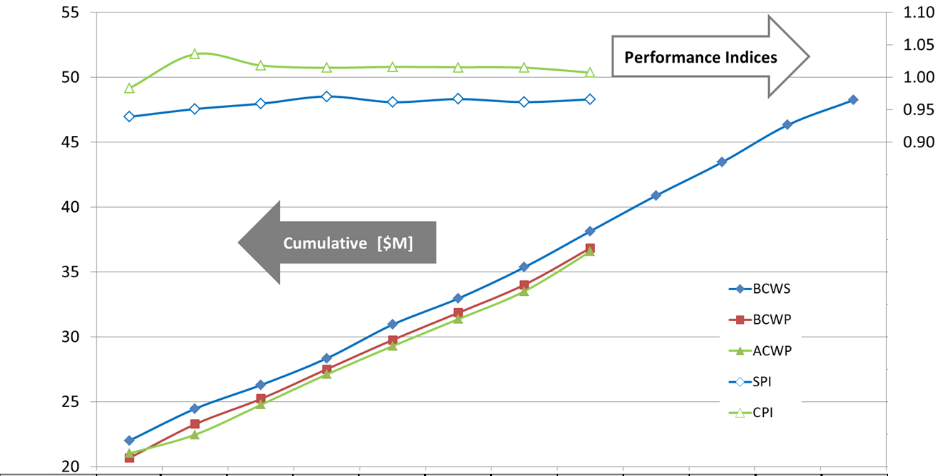
BNL EVMS Surveillance Review	June 29 – July 1, 2015

Acronyms and Abbreviations

ABBIX	Advanced Beamlines for Biological Investigations with X-rays
ACWP	Actual Cost of Work Performed
APP	Advanced Procurement Plan
BAC	Budget at Completion
BAT	Beamline Advisory Team
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
BNL	Brookhaven National Laboratory
CAM	Cost Account Manager
CCD	Charge-Coupled Device
CD	Critical Decision
CPI	Cost Performance Index
CRL	Compound Refractive Lens
CV	Cost Variance
DCM	Double Crystal Monochromator
DOE	Department of Energy
EAC	Estimate at Completion
EPS	Equipment Protection System
EPU	Elliptically Polarizing Undulator
ESM	Electron Spectro-Microscopy beamline
EVMS	Earned Value Management System
FAT	Factory Acceptance Test
FBO	Federal Business Opportunities
FDR	Final Design Review
FE	Front Ends
FOE	First Optics Enclosure
FTE	Full Time Equivalent
FXI	Full-field X-ray Imaging beamline
FY	Fiscal Year
HHRM	Higher Harmonic Rejection Mirrors
ID	Insertion Device
I/O	Input/Output
ISR	Integrated In-Situ and Resonant X-ray Studies
ISS	Inner Shell Spectroscopy beamline
M&S	Material & Supplies
NEXT	NSLS-II Experimental Tools project
NSLS-II	National Synchrotron Light Source II
OPC	Other Project Costs
PCR	Project Change Request
PDR	Preliminary Design Review
PDS	Photon Delivery System
PGM	Plane Grating Monochromator
PLCs	Programmable Logic Controllers
PMB	Performance Management Baseline
PPS	Personnel Protection System
RFP	Request for Proposal
RFQ	Request for Quote
SAXS	Small Angle X-ray Scattering
SC	Office of Science
SDD	Spectroscopy Detector System
SEB-2	Satellite Endstation Building 2
SIX	Soft Inelastic X-ray Scattering beamline
SMI	Soft Matter Interfaces beamline
SPI	Schedule Performance Index
SV	Schedule Variance
TEC	Total Estimated Cost
TPC	Total Project Cost
UB	Undistributed Budget
UHV	Ultra-high Vacuum
VAC	Variance At Completion
VLS	Vapor Liquid Solid
WBS	Work Breakdown Structure
XES	X-ray Emission Spectrometer

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.



Cum $M	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15
BCWS	22.0	24.5	26.3	28.4	31.0	33.0	35.4	38.1	40.9	43.5	46.3	48.3
BCWP	20.7	23.3	25.2	27.5	29.8	31.9	34.0	36.9				
ACWP	21.0	22.5	24.8	27.1	29.3	31.4	33.5	36.6				
SPI	0.94	0.95	0.96	0.97	0.96	0.97	0.96	0.97				
CPI	0.98	1.04	1.02	1.01	1.02	1.02	1.01	1.01				

The NEXT project Schedule Variance (SV) for April 2015 is -$62K, with an associated monthly Schedule Performance Index (SPI) of 0.98 (green status). The cumulative SPI is 0.97 (green status), 0.01 higher than in March 2015. The small negative current month schedule variance is the net result of a number of contributors, both positive and negative: +$118K in WBS 2.03 (Common Systems) resulting from greater-than-planned utilities installation progress in April, -$136K in WBS 2.04 (Control Systems) resulting from less-than-planned installation of cables in April, +$54K in WBS 2.09 (SIX beamline) resulting from early receipt of vacuum equipment in April, and -$81K in WBS 2.12 (ID/FE Installation) resulting from fewer-than-planned front end stands installed in April and delays in cable pulling and IVU measurement.

The NEXT project Cost Variance (CV) for April 2015 is -$352K, with an associated monthly Cost Performance Index (CPI) of 0.88 (yellow status). The primary contributor to the monthly CV is -$319K in WBS 2.05 (ESM Beamline) resulting from accruals or payments in April for contract activities earned in an earlier month. The cumulative CPI is 1.01 (green status).

As of April 30, 2015, the project is 45.4% complete with 20.1% contingency ($8.9M) for $44.3M Budget At Completion (BAC) work remaining, based on PCRs processed and approved through April 2015.

The project EAC for April is reported at $82,543K against a Performance Measurement Baseline (PMB)/Undistributed Budget (UB) of $81,110K. The Variance At Completion (VAC = BAC - EAC) of -$1433K represents the sum of contributors to EAC which have not been added to baseline via PCRs. The major contributors to VAC at the end of April include: -$0.4M in WBS 2.01.02 (Project Support) for estimated overruns in this account (primarily related to procurement effort), -$0.5M in common systems for estimated overruns in WBS 2.03.01 (Utilities) and additional required EPS hardware in WBS 2.03.03, -$0.1M in WBS 2.07 (ISR Beamline) for upcoming procurement awards, and -$0.5M in WBS 2.08 (ISS Beamline) for upcoming procurement awards. The expected overruns in Utilities include additional electronics racks for SIX and utilities systems required for the gas handling systems at ISS and ISR (emergency power, exhaust connections).

The contingency ($8.9M) is 19.5% of $45.7M EAC work remaining.

2 PCRs were approved and implemented in April.

PCR	PCR Level	Baseline Change [$]	Description
PCR-15-084	L3	(56,606)	Correction to PCR-15-075 (APP022 and APP096 Contract Awards)
PCR-15-070	L3	16,690	Control Station & Electronics Procurement Refinements

Forthcoming PCRs include (i) two Level 3 PCRs (NEXT_15_085, NEXT_15_082) to implement contract awards in WBS 2.08 (ISS High Harmonic Rejection Mirror) and WBS 2.07 (ISR Instrumented Six Circle Diffractometer), respectively, (ii) two Level 3 PCRs in WBS 2.03.01 (Common Systems Utilities), one for an amendment to the LN2 piping contract (NEXT_15_080) and the other for additional equipment racks for SIX (NEXT_15_083), and (iii) a Level 3 PCR (NEXT_15_086) in WBS 2.05.02 and 2.09.02 to implement contract awards and amendments for ESM and SIX.

NEXT as of 4/30/2015	Current Period	Cum-to-Date
Plan (BCWS) $K	2,773	38,142
Earned (BCWP) $K	2,711	36,852
Actual (ACWP) $K	3,063	36,584
SV $K	-62	-1,290
CV $K	-352	268
SPI	0.98	0.97
CPI	0.88	1.01
Budget at Completion $K (PMB [UB])		81,110
Planned % Complete (BCWS/BAC)		47.0%
Earned % Complete (BCWP/BAC)		45.4%
Contingency $K		8,890
Contingency / (BAC – BCWP)		20.1%
EAC $K		82,543
Contingency / (EAC – BCWP)		19.5%
(Contingency + VAC) / (EAC – BCWP)		16.3%
TPC = PMB + Contingency		90,000

SPI Project to Date*:

0.97

CPI Project to Date*:

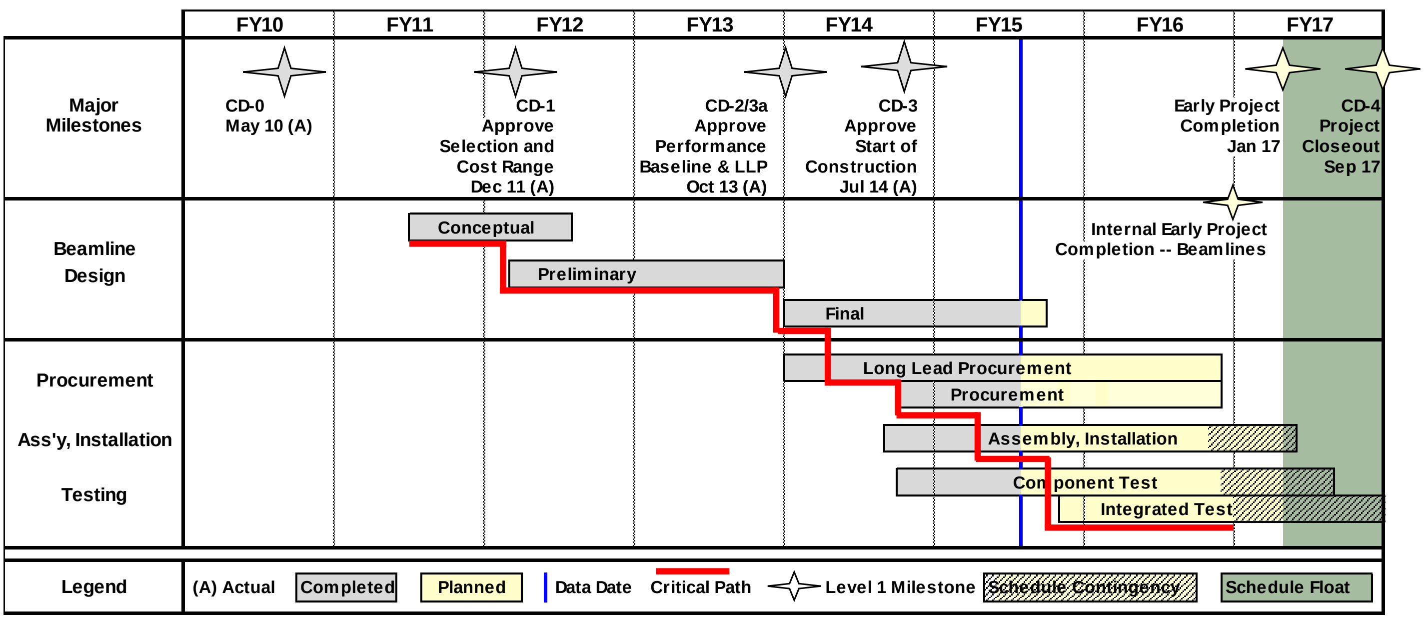
1.01

**Cause & Impact:* No reportable variance

Corrective Action: None required

Milestones – Near Term		Planned	Actual	Notes
L2,L3	Receive ISS Gas Handling System	17-Mar-15		Expect May
L3	SIX – Award Spectrometer Grating Chamber	17-Mar-15	4-Feb-15	
L3	ISS – Award XES Spectrometer	21-May-15		Expect June

PROJECT SCHEDULE



The project critical path runs through activities in WBS 2.10 (SMI beamline). As of March 2015, the active critical path activity is specification, procurement, design, fabrication, delivery, installation, and testing of the SMI Double Crystal Deflector MI, which delivers the SMI x-ray beam of varying energy to a fixed point on the surface of liquid samples in the liquids endstation (SMI ES1).

Staffing Report

Staffing as of 4/30/2015	Current Period		Cumulative-to-Date	
	Planned (FTE-yr)	Actual (FTE-yr)	Planned (FTE-yr)	Actual (FTE-yr)
WBS 2.01 Project Management and Support	0.84	0.99	24.42	25.30
WBS 2.02 Conceptual and Advanced Conceptual Design	0.00	0.00	8.74	8.74
WBS 2.03 Common Beamline Systems	0.64	0.55 *	12.52	4.03 *
WBS 2.04 Control System	1.25	0.46	11.21	8.34
WBS 2.05 ESM Beamline	0.49	0.60	8.40	8.79
WBS 2.06 FXI Beamline	0.00	0.06	4.61	4.33
WBS 2.07 ISR Beamline	0.52	0.40	8.41	8.40
WBS 2.08 ISS Beamline	0.23	0.40	7.90	8.57
WBS 2.09 SIX Beamline	0.23	0.46	12.20	12.60
WBS 2.10 SMI Beamline	0.44	0.41	8.21	8.33
WBS 2.11 Insertion Devices	0.39	0.36	2.56	1.85
WBS 2.12 ID & FE Installation	0.87	0.14	1.46	1.30
Total	**5.90**	**4.83**	**110.63**	**100.58**

* Utilities installation is being performed by contractors (mostly M&S) rather than staff as originally planned

Number of individuals who worked on NEXT during April 2015: 122

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

Thousands of $ | FORM APPROVED OMB No. 0704-0188

1. CONTRACTOR	2. CONTRACT	3. PROGRAM	4. REPORT PERIOD
a. NAME Brookhaven National Laboratory	a. NAME	a. NAME NSLS-II Experimental Tools (NEXT) Project	a. FROM *(YYYYMMDD)* 2015 / 04 / 01
b. LOCATION (Address and ZIP Code)	b. NUMBER	b. PHASE	b. TO *(YYYYMMDD)* 2015 / 04 / 30
	c. TYPE / d. SHARE RATIO	c. EVMS ACCEPTANCE X YES	

WBS (2) Control Account Work Package ITEM (1)	CURRENT PERIOD BUDGETED COST WORK SCHEDULED (2)	 BUDGETED COST WORK PERFORMED (3)	 ACTUAL COST WORK PERFORMED (4)	 VARIANCE SCHEDULE (5)	 VARIANCE COST (6)	CUMULATIVE TO DATE BUDGETED COST WORK SCHEDULED (7)	 BUDGETED COST WORK PERFORMED (8)	 ACTUAL COST WORK PERFORMED (9)	 VARIANCE SCHEDULE (10)	 VARIANCE COST (11)	AT COMPLETION BUDGETED (14)	 ESTIMATED (15)	 VARIANCE (16)
2.01 Project Management and Support	207,744	207,744	238,573	0	-30,829	6,197,343	6,197,343	6,576,992	0	-379,649	9,792,909	10,181,909	-389,000
2.01.01 Project Management	85,619	85,619	68,008	0	17,610	3,019,056	3,019,056	2,915,778	0	103,278	4,657,379	4,657,379	0
2.01.02 Project Support	122,126	122,126	170,565	0	-48,440	3,178,287	3,178,287	3,661,214	0	-482,928	5,135,530	5,524,530	-389,000
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	302,412	420,306	498,049	117,894	-77,743	4,064,663	3,579,929	4,450,868	-484,734	-870,938	6,147,856	6,645,435	-497,579
2.03.01 Utilities	216,091	341,434	200,089	125,342	141,345	3,051,338	2,598,298	3,006,713	-453,040	-408,415	3,458,105	3,761,284	-303,179
2.03.02 Personnel Protection System (PPS)	40,387	50,343	60,367	9,957	-10,024	382,218	460,805	696,327	78,587	-235,522	1,323,218	1,364,818	-41,600
2.03.03 Equipment Protection System (EPS)	30,878	18,924	205,839	-11,954	-186,915	257,424	169,421	299,547	-88,003	-130,125	594,451	747,251	-152,800
2.03.04 Control Station	5,451	0	13,661	-5,451	-13,661	22,278	0	30,248	-22,278	-30,248	295,394	295,394	0
2.03.05 Common Beamline Systems Management	9,605	9,605	18,092	0	-8,487	351,405	351,405	418,034	0	-66,629	476,689	476,689	0
2.04 Control System	233,703	97,279	87,324	-136,425	9,955	2,818,615	2,386,922	2,415,383	-431,693	-28,461	4,538,849	4,538,849	0
2.04.01 Control System Management	7,113	7,113	6,541	0	571	190,405	190,405	137,945	0	52,460	294,427	294,427	0
2.04.02 Control System Design & Implementation	190,822	90,166	77,419	-100,656	12,747	1,659,993	1,306,856	1,445,712	-353,137	-138,856	2,912,234	2,912,234	0
2.04.03 Control System Equipment	35,769	0	3,364	-35,769	-3,364	968,217	889,661	831,726	-78,556	57,935	1,332,188	1,332,188	0
2.05 ESM Beamline	201,973	208,187	527,338	6,214	-319,150	4,793,269	4,818,653	4,537,046	25,383	281,607	9,130,823	9,130,822	0
2.05.01 ESM Management	12,032	12,032	5,218	0	6,813	378,498	378,498	370,186	0	8,311	692,100	692,100	0
2.05.02 ESM Beamline Systems	189,941	196,155	522,119	6,214	-325,964	4,414,772	4,440,155	4,166,860	25,383	273,295	8,438,722	8,438,722	0
2.06 FXI Beamline	37,250	7,318	15,865	-29,932	-8,547	1,360,382	1,497,479	989,794	137,097	507,685	1,818,324	1,818,324	0
2.06.01 FXI Management	0	0	12,313	0	-12,313	409,359	409,359	443,257	0	-33,898	409,359	409,359	0
2.06.02 FXI Beamline Systems	37,250	7,318	3,552	-29,932	3,767	951,023	1,088,120	546,537	137,097	541,583	1,408,965	1,408,965	0
2.07 ISR Beamline	243,643	271,408	204,290	27,765	67,118	2,628,858	2,514,434	2,584,779	-114,424	-70,344	10,290,579	10,361,931	-71,352
2.07.01 ISR Management	28,798	28,798	23,566	0	5,232	630,130	630,130	624,933	0	5,197	1,076,573	1,076,573	0
2.07.02 ISR Beamline Systems	214,846	242,611	180,724	27,765	61,887	1,998,728	1,884,304	1,959,845	-114,424	-75,541	9,214,006	9,285,358	-71,352
2.08 ISS Beamline	391,316	370,988	294,818	-20,327	76,170	4,977,271	4,771,017	4,447,976	-206,255	323,041	9,824,531	10,295,609	-471,078
2.08.01 ISS Management	20,818	20,818	18,169	0	2,649	447,641	447,641	444,017	0	3,624	838,199	838,199	0
2.08.02 ISS Beamline Systems	370,498	350,171	276,650	-20,327	73,521	4,529,630	4,323,376	4,003,959	-206,255	319,417	8,986,332	9,457,410	-471,078
2.09 SIX Beamline	531,532	585,185	557,140	53,653	28,045	4,669,646	4,573,454	4,432,752	-96,192	140,702	12,231,759	12,231,758	0
2.09.01 SIX Management	19,704	19,704	42,732	0	-23,027	395,065	395,065	397,538	0	-2,473	845,551	845,551	0
2.09.02 SIX Beamline Systems	511,828	565,481	514,408	53,653	51,073	4,274,581	4,178,389	4,035,214	-96,192	143,175	11,386,207	11,386,207	0
2.10 SMI Beamline	315,951	338,208	367,701	22,257	-29,493	3,345,766	3,419,509	3,450,726	73,742	-31,217	9,729,726	9,733,763	-4,038
2.10.01 SMI Management	25,756	25,756	12,171	0	13,585	473,029	473,029	420,868	0	52,161	918,583	918,583	0
2.10.02 SMI Beamline Systems	290,195	312,452	355,530	22,257	-43,078	2,872,737	2,946,480	3,029,858	73,742	-83,378	8,811,142	8,815,180	-4,038
2.11 Insertion Devices	175,361	153,085	174,020	-22,275	-20,935	1,248,898	1,119,239	540,702	-129,659	578,538	4,779,614	4,779,613	0
2.11.01 ESM EPU Insertion Device	172,538	150,263	172,921	-22,275	-22,658	1,084,357	954,698	445,033	-129,659	509,665	4,562,016	4,562,016	0
2.11.02 SIX EPU Insertion Device	0	0	0	0	0	117,137	117,137	70,375	0	46,762	117,137	117,137	0
2.11.03 Insertion Devices Management	2,823	2,823	1,099	0	1,724	47,404	47,404	25,294	0	22,110	100,460	100,460	0
2.12 ID & FE Installation & Testing	131,659	50,915	97,825	-80,745	-46,910	229,483	166,690	350,053	-62,793	-183,362	1,017,782	1,017,781	0
2.12.01 ID & FE Installation & Testing Management	2,704	2,704	883	0	1,821	7,866	7,866	3,495	0	4,371	31,153	31,153	0
2.12.02 ID Installation & Testing	29,694	4,083	21,323	-25,611	-17,240	86,383	35,700	123,333	-50,683	-87,633	423,921	423,921	0
2.12.03 FE Installation & Testing	99,261	44,127	75,618	-55,134	-31,491	135,234	123,124	223,224	-12,110	-100,101	562,708	562,708	0
Total Project Baseline	2,772,545	2,710,625	3,062,943	-61,921	-352,318	38,141,513	36,851,986	36,584,385	-1,289,527	267,601	81,110,067	82,543,112	-1,433,046
Undistributed Budget													
Management Reserve													
Performance Management Baseline - PMB	**2,772,545**	**2,710,625**	**3,062,943**	**-61,921**	**-352,318**	**38,141,513**	**36,851,986**	**36,584,385**	**-1,289,527**	**267,601**	**81,110,067**	**82,543,112**	**-1,433,046**