NSLS-II Experimental Tools (NEXT)

November 2012 Project Activity

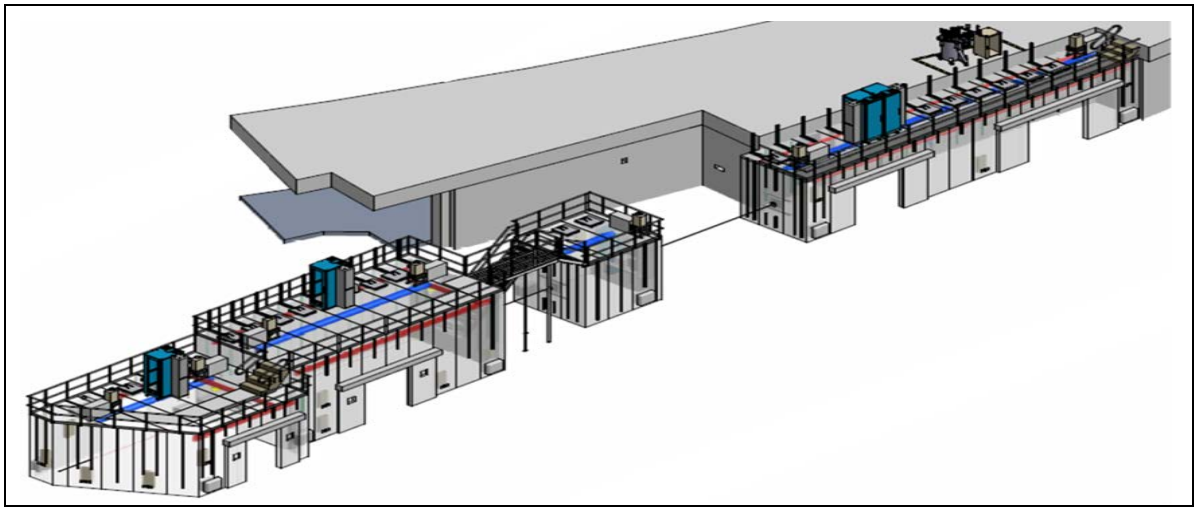

Figure 1. Lead first optics enclosure (FOE), steel secondary optics enclosure (SOE), and experimental end station enclosures (EESEs) for the ISR beamline.

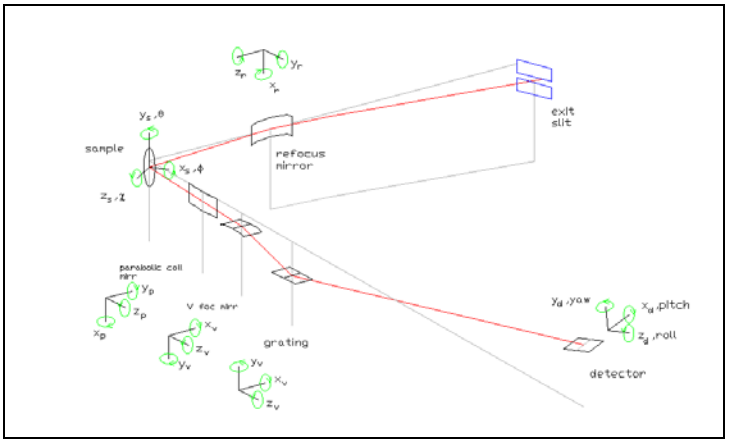

Figure 2. Diagram showing geometry and coordinate system for all optical elements downstream of the exit slit on SIX, used for analysis of their mechanical stability requirements. The coordinate system for each optic is taken to conform to the NSLS-II standard (LT-C-XFD-STD-BL-COORD-001), with the z axis in the plane of the optic along the light propagation direction, the y axis along the normal at the pole, and the x axis in the plane of the optic given by the right hand rule.

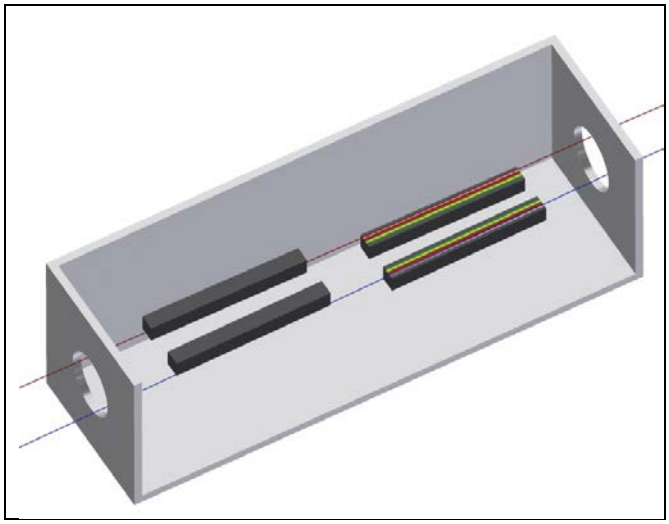

Figure 3. Conceptual sketch of additional mirror to be implemented for SMI. Vertical focusing is accomplished by a bendable bounce-up mirror with striped coatings to aid in harmonic rejection. A second flat mirror bounces the beam down for level beam transport into the EESEs.

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OVERALL ASSESSMENT

During November, NEXT Project staff continued to address recommendations from the September DOE Review while continuing advanced preliminary design work.

Schedule revision to pull forward procurement of lead- and steel-shielded enclosures and some major beamline optical components was completed. These revisions will provide more built-in schedule float for the overall project schedule. The cost and schedule refinement effort was completed, including revision of the obligation profile and provision of a complete basis of estimate and supporting documentation for all materials and supplies. An internal review of cost and schedule is scheduled for December 17, 2012.

Preparation of specifications and SOWs for planned FY13 procurements continued. The first of these, principal parameters and 3D layout renderings of lead- and steel-shielded enclosures for all NEXT beamlines, are nearing completion.

The ratio of actual to planned project spending was about 75% in November, due to later-than-expected arrival of a newly hired mechanical engineer, and expenditures for project and beamline management that were lower than planned. There was no significant impact on planned project activities.

ISR – IN-SITU AND RESONANT HARD X-RAY

Design refinement continued for the FOE, SOE, and two EESEs (Fig. 1, cover), scheduled to be the first major components procured for ISR. Major design issues for these enclosures, including the locations of doors, beam pipe penetrations, labyrinths, control racks, ventilation system components, and hoists, have been determined and will be presented to the BAT for comment on December 13.

ESM – ELECTRON SPECTRO-MICROSCOPY

A layout rendering of the ESM beamline (Fig. 4) shows the location of racks for beamline electronics and the routing of cable trays and other utilities. The ESM FOE is shown in marine green. In addition to the first mirror chamber, the FOE contains bremsstrahlung shields upstream and downstream of the mirror, a differential vacuum pump, and a small chamber housing the Diagon optics system. Space for additional elements is available inside the FOE.

Figure 4. ESM beamline 3D layout, showing planned locations of racks, utilities, and the First Optics Enclosure.

FXI – FULL-FIELD X-RAY IMAGING

Shielded enclosure drawings for the FXI beamline are 95% complete. Detailed design for the double crystal monochromator continued and a preliminary technical specification has been drafted. William Loo, newly hired mechanical engineer, will assume primary engineering responsibility for the FXI and ISS beamlines.

ISS – INNER SHELL SPECTROSCOPY

Detailed drawings and parameter listings for the ISS FOE and EESEs have been finalized. These and the counterparts for the other NEXT beamlines will form the basis for the planned procurements of these enclosures.

An important new toolset, a full 3D ray trace effort, was applied to a subsystem of the proposed x-ray emission spectrometer for the ISS endstation. Using only a precollimation lens, the simplified geometry resulted in a 1 mm x 1 mm array of 25 individual secondary sources; a single focusing lens was analyzed. The intensity distribution in the focal plane is shown in Figure 5. Three important results can be concluded: 1) Size of the secondary source is not important for the energy resolution of the spectrometer. 2) Even in this simplified geometry, the spectrometer will have a transmission bandwidth of about 4–5 eV at 10 keV, making this very interesting as a standard XAFS detector. 3) The spectrometer will image the sample in the "non-diffraction" plane. Magnification will be fully determined by the pre-collimation optics.

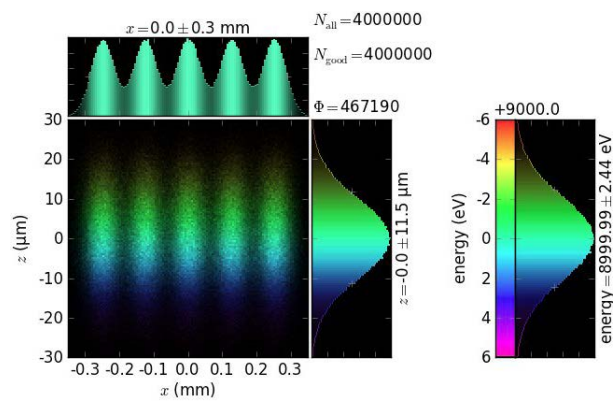


Figure 5. Intensity (left) and energy (right) distribution in the detector plane of a simplified spectrometer design using pre-collimation and focusing optics. The ray tracing is based on a pre-collimation lens producing 5x5 individual source points of 50 µm diameter in an area of 1x1 mm^2.

The next ISS Beamline Advisory Team meeting is planned for the end of January 2013. The timing of this meeting will ensure that important BAT guidance can be taken into consideration during the final design of ISS. The preliminary agenda for this meeting, to be developed in concert with the BAT chair, will include a detailed overview of the photon delivery system, FOE and EESE layout, and various aspects of sample handling, and will provide time for personal discussions between BAT members and the ISS team. The hiring process for the ISS beamline scientist is underway. Initial telephone interviews with pre-selected candidates will begin in December.

SIX – SOFT INELASTIC X-RAY

Three main design tasks for the SIX beamline have been completed. First, a motion analysis based on ray-tracing has been performed for all optical elements of the beamline and spectrometer, to determine the required stability and position tolerances. Such an analysis will greatly help in writing the technical specifications for all mirror mechanics. The geometry and chosen coordinate system for the optical elements downstream of the exit slit are shown in Figure 2 (cover). Second, the design of the first optical enclosure has been refined and is now completed (Fig. 6, below).

Figure 6. Layout of the first optical enclosure of the SIX beamline.

Third, after extensive consultation with the BAT, experts in soft inelastic x-ray scattering on soft matter, and the NSLS-II Insertion Device group, we have decided to increase the required period length of the SIX EPU from 51 to 57 mm, so that linear horizontal, linear vertical, and helical polarization modes will be available down to the C-*K* edge at 280 eV. Opening up the possibility of RIXS at the C-*K* edge at SIX holds promises of innovative, high-impact research on numerous carbon-based materials such as gas and liquid phases, graphene, and organic semiconductors.

SMI – SOFT MATTER INTERFACES

Taking advice offered at the DOE September Review, it has been decided to follow the vertical bounce-up focusing mirror by an additional mirror, having a flat surface to bounce the outgoing beam down to level its travel parallel to the floor (Fig. 3, cover). This configuration brings several advantages.

First, the level beam impinging on the liquid diffractometer optics and GISAXS secondary optics makes these elements easier to align. Second, such a mirror can be removed from the beam path to allow the substitution of refractive optics, without greatly changing the beam transit point in EESEs far downstream—an option of great interest for microbeam applications. Third, the double mirror allows adjustment of the incidence angle to improve harmonic rejection—a crucial advantage at tender x-ray energies.

Development of this analysis was timely, as the SMI BAT's second meeting is scheduled for mid-December, making it possible to receive their input on this important optic. While the mechanics are straightforward, the impact of this additional optical element on beam quality will need scrutiny, as will the choice of coatings (Fig. 7).

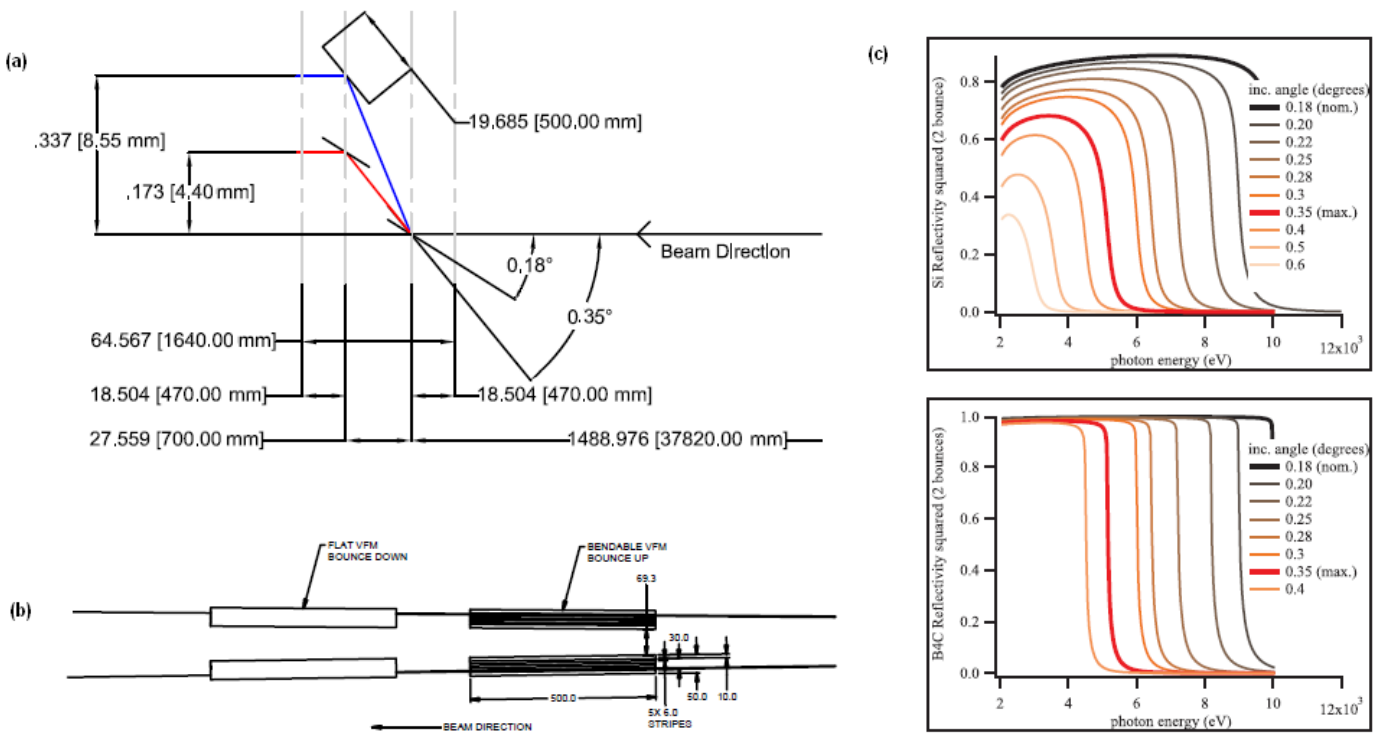
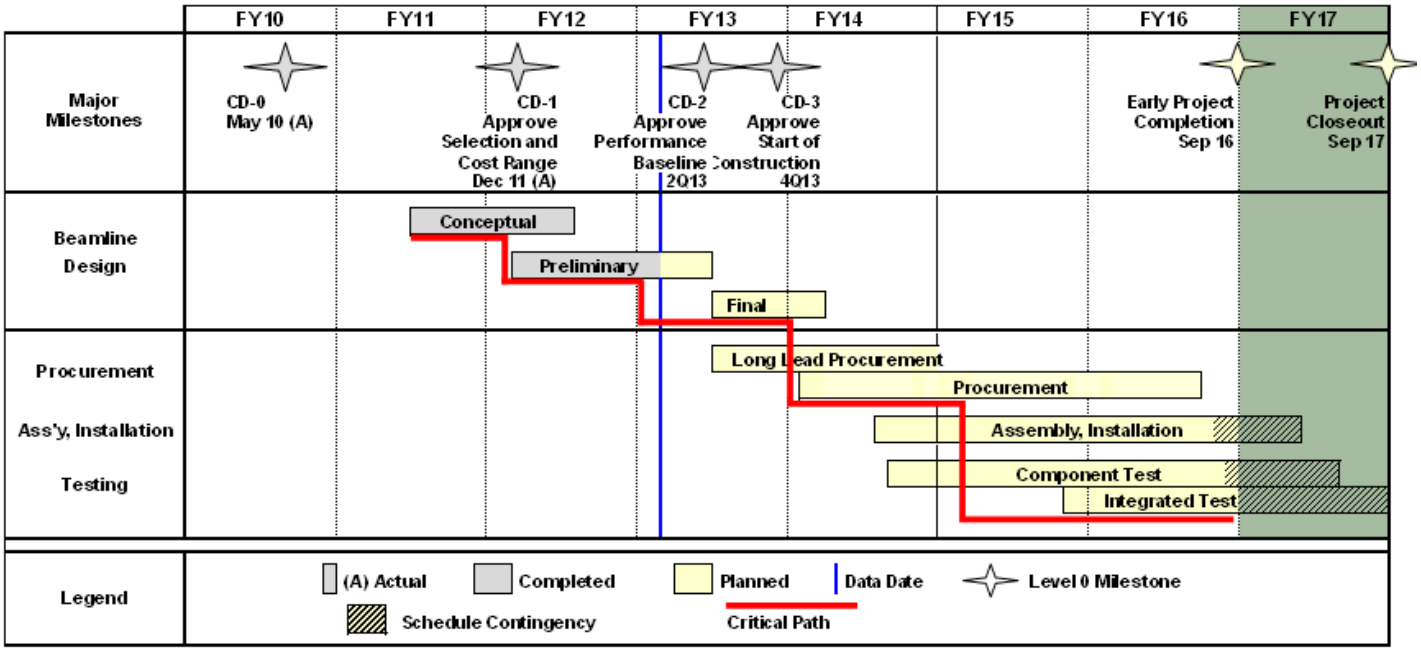


Figure 7. Analysis of a bounce-down mirror to be added to the SMI photon delivery system. (a) At grazing angle 0.18 degrees, the mirror performs well at high energies; increasing the angle to 0.35 degrees is optimal for tender x-ray energies. The most efficient design is one in which the mirror travels vertically. For a 500 mm-long optical length, and with the two mirrors spaced 700 mm apart, the resulting beam height change is less than 5 mm. (b) The in-plane dimensions show that in the SMI future canted build-out, two mirror systems side by side can operate independently, each with several coating stripes. (c) The square of the mirror reflectivity was examined over a range of incidence angles to determine the energy cutoff, for the bare silicon mirror (top) and for a boron carbide (B_4C) coating (bottom). The B_4C coating is more efficient in the ideal case, but the surface quality of this coating in comparison to polished silicon will have to be addressed.

PROJECT SCHEDULE



Funding Profile

Funding Type	NEXT Funding Profile ($M)						
	FY11	FY12	FY13	FY14	FY15	FY16	TOTAL
OPC	3.0						3.0
TEC		12.0	12.0	25.9	21.6	15.5	87.0
Total Project Cost	3.0	12.0	12.0	25.9	21.6	15.5	90.0

Cost and Staffing Report

As of 11/30/2012	Current Period		Cumulative-to-Date	
	Cost	Staffing (FTE-yr)	Cost	Staffing (FTE-yr)
WBS 2.01	$ 68,629	0.37	$ 1,381,887	5.06
WBS 2.02	$ 25	0	$ 1,807,341	8.74
WBS 2.03	$ 0	0 *	$ 18,693	0.07 **
WBS 2.04	$ 11,872	0.06	$ 56,236	0.27
WBS 2.05	$ 30,711	0.14	$ 91,856	0.47
WBS 2.06	$ 33,804	0.18	$ 100,787	0.52
WBS 2.07	$ 33,323	0.17	$ 95,547	0.51
WBS 2.08	$ 32,836	0.17	$ 137,659	0.54
WBS 2.09	$ 62,196	0.35	$ 187,405	1.07
WBS 2.10	$ 31,165	0.18	$ 80,523	0.49
Total	$ 304,561	1.62	$ 3,957,934	17.74

* Due to reporting error, November 2012 effort will appear in the January 2013 data.

** Common Beamline Systems management effort was charged to WBS 2.01 for all of FY11 and FY12.

Key NEXT Personnel

Title	Name	Email	Phone
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UPCOMING EVENTS

SMI BAT Meeting	Dec 10
ISR BAT Meeting	Dec 13
Internal Cost & Schedule review	Dec 17
ISS BAT Meeting	Feb 2013
BNL Director's Review of NSLS-II Beamline Projects	Mar 2013

PROJECT MILESTONES

CD-0 (Mission Need):	Planned: 3Q10	Actual: May 27, 2010
CD-1 (Alternative Selection):	Planned: 4Q11	Actual: Dec. 19, 2011
CD-2 (Performance Baseline):	Planned: 2Q13	
CD-3 (Start Construction):	Planned: 4Q13	
Early Project Completion:	Planned: 4Q16	
CD-4 (Project Completion):	Planned: 4Q17	

Acronyms

ALD	Associate Laboratory Director
BAT	Beamline Advisory Team
EESE	Experimental Endstation Enclosure
EPU	Elliptically Polarizing Undulator
ESM	Electron Spectro-Microscopy beamline
FOE	First Optics Enclosure
FXI	Full-field X-ray Imaging beamline
GISAXS	Grazing Incidence SAXS
ISR	Integrated In-Situ and Resonant X-ray Studies
ISS	Inner Shell Spectroscopy beamline
SAXS	Small-Angle X-ray Scattering
SIX	Soft Inelastic X-ray Scattering
SMI	Soft Matter Interfaces beamline
SOE	Second Optics Enclosure
SOW	Statement of Work