NSLS-II Experimental Tools (NEXT)

December 2012 Project Activity

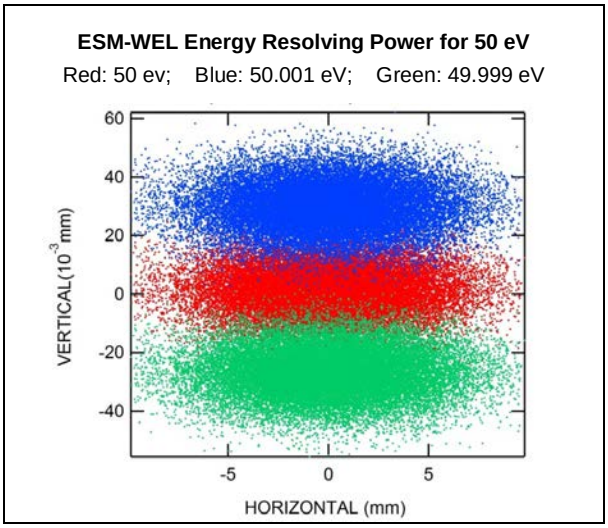

Figure 1. Shadow ray-tracing simulations for the Wide Energy Range Line (WEL) branch of the ESM beamline. Ray trace images at the exit slit plane for three photon energies separated by 1 meV at 50eV central energy (50,000 resolving power).

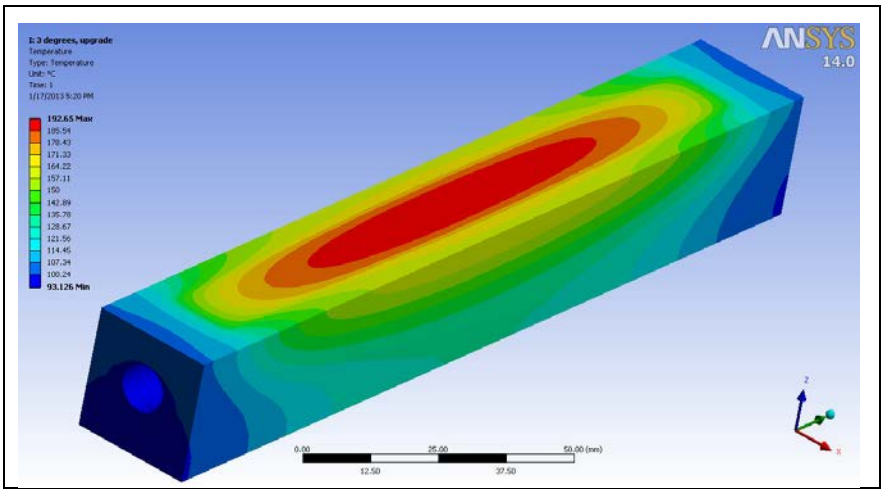

Figure 2. FEA simulation results showing the temperature distribution in a copper white-beam stop in the FXI FOE with a 3 degree incidence angle. Total input power is about twice that for FXI, to simulate the worst case scenario that includes illumination of a future side-branch upgrade to the beamline.

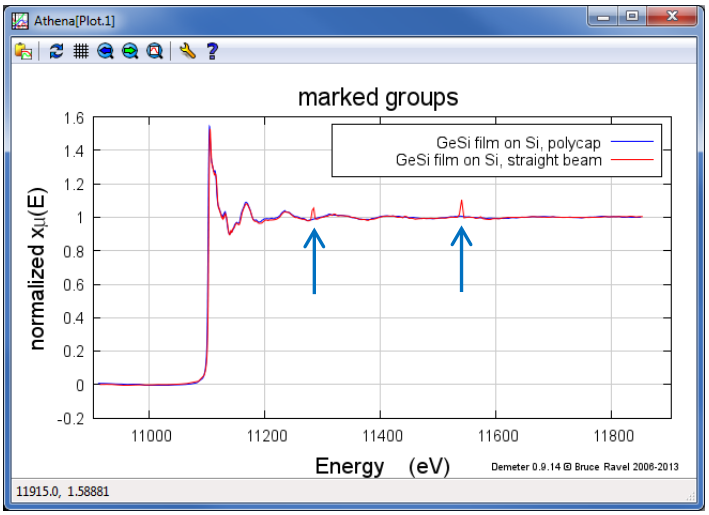

Figure 3. Ge-EXAFS spectrum of a GeSi film on a Si (100) wafer. Conventional optics results in an EXAFS spectrum (red line) containing two glitches (blue arrows) which impact seriously the achievable data quality. Data using angle-integrating polycapillary optics as focusing elements (blue line) show no indications of glitches and are otherwise fully consistent with the conventionally-acquired EXAFS spectrum.

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OVERALL ASSESSMENT

During December, NEXT Project staff finalized cost and schedule data following recommendations from the September DOE Review while continuing advanced preliminary design work. A large fraction of NEXT project staff chose to take well-deserved vacation during the last two weeks of December.

An internal review of NEXT cost and schedule was held on Dec. 17, 2012, chaired by Erik Johnson. In addition to Erik, the committee members were Diane Hatton (PS COO), Pete Selgrad (PS Project Controls), and Tom Fornek (APS/ANL). The review focused on the readiness of the cost and schedule for the NEXT Project to be baselined late in the second quarter of FY2013. The committee validated the completeness and consistency of the cost and schedule data, including basis of estimate documentation and reasonableness of the resource loaded schedule relative to the planned funding profile. The committee concluded that the NEXT Project will be ready to achieve CD-2 approval after addressing a few findings which were relatively minor in nature.

Preparation of specifications and SOWs for the steel- and lead-shielded enclosures continued, to be handed off to procurement in Feb. 2013. Drawings to accompany these specifications were finalized. NEXT beamline CAMs and staff have begun to draft specifications and SOWs for photon delivery systems procurements, to be ready for proposed long lead procurements in calendar year 2013.

ESM – ELECTRON SPECTRO-MICROSCOPY

One performance goal of the ESM beamline is high resolving power. Less than one milli-eV is to be achieved in the low-energy region from 15 eV up to 60 eV. The feasibility of this extreme resolving power is demonstrated in the Shadow ray-tracing simulation displayed in Figure 1 (cover). At 50 eV, a 10 micron exit slit is clearly adequate to provide the required resolving power. During December, the effect on resolving power of small misalignments of the optical elements was studied, thereby determining the level of accuracy and stability required for the mechanical systems. The most critical optics are the monochromator pre-mirror (M2-W) and the grating: the pitch angles of both optics must be controlled at the level of 0.1 micro-radian.

FXI – FULL-FIELD X-RAY IMAGING

Cost and schedule was checked again. Resources were leveled and checked. Drawings for the shielded enclosures were completed. Handoff of mechanical engineering of FXI to the newly hired engineer, William Loo, is underway.

The first thermal simulations for the white and pink beam stops in the FOE were completed, using a simple single-cooling-channel geometry in a copper block (Fig. 2, cover). The important aspect of this study is to know the maximum allowable inclination angle so that the length of the stops can be well estimated, enabling us to optimize their location in the FOE. Once the beam stop dimensions are determined, the detailed positions of all FOE components will be updated, together with the ray traces. Drafting of the technical specifications for the double crystal monochromator began.

ISS – INNER SHELL SPECTROSCOPY

To overcome the exceptional heat load condition of a damping wiggler source, ISS is using a novel focusing concept employing a polycapillary half-lens system. The focus spot of this lens is largely independent of source position, making this optical design very forgiving of thermal instabilities. However, so far these lenses have not been tested in spectroscopy applications where the photon energy is varied over a wide range and minimal variations of the transmission efficiency vs. energy can result in major systematic errors.

In December, we were able to perform spectroscopy tests with a commercial half-lens system, which showed that high-quality EXAFS scans are easily achievable. Additionally, we were able to demonstrate that the polycapillary lens system can also be used in combination with single-crystal samples or window materials. Diffraction effects in crystalline materials typically result in major intensity "glitches." Use of the polycapillary optics introduced a strong divergence in the probe beam, which reduces the contribution of diffraction glitches so greatly as to make them not observable, as shown in Figure 3 (cover).

ISR – IN-SITU AND RESONANT HARD X-RAY

An ISR BAT meeting was held on December 13 (Fig. 4), and included presentations about the IVU status, beamline controls, and hutches. The BAT suggested adding hutch labyrinths and laser protective windows in the doors of Hutch D, which will house a laser for pulsed laser deposition growth. These changes, as well as a shift in the location of a hutch door to facilitate access to equipment inside the hutch, were implemented, and the hutch drawings are 95% complete.

Figure 4. ISR BAT meeting, December 13, 2012

Members (l to r): Jean Jordan-Sweet (IBM), Valery Kiryukhin (Rutgers U.), Karl Ludwig (Boston U., Chair), Randy Headrick (U. Vermont), Christie Nelson (ISR)

SIX – SOFT INELASTIC X-RAY

Technical specifications and SOW for the first mirror (horizontal planar deflection) and tank package are in preparation. The first step in this effort is to finalize the tolerances for the mechanical stability of the various required mechanical motions of this mirror. The key stability tolerance is the one for the pitch motion, determined to be 100 nrad, which we know some suppliers can achieve. Discussions between SIX and ESM beamline staff have begun, to assess the benefits and impact of potential joint procurements for similar components in both beamlines. So far it appears that this strategy could be applied to one procurement package.

SMI – SOFT MATTER INTERFACE

SMI performance will depend critically upon having a very stable beam and being able to optimize the footprint of the white beam on the monochromator. Following the practices of peer beamlines which succeed in this challenge, SMI will add a fixed mask and additional white beam slits in the FOE, which follow the fixed mask and white beam slits that are standard in the front end. Similar to the design of Project beamline IXS, the SMI FOE fixed mask will double as a differential pumping element, though it will need custom design for the canted beams.

As a starting point, the Front End design of canted Project beamline SRX is used as a model. With FEA calculations for the monochromator already in hand, it remains to work upstream from that point and investigate the heat load on desired apertures between the monochromator and the Front End mask, which is approximately ten times larger than our operating aperture. Failure modes, existing vendor designs, alignment procedures, and diagnostics must all be considered in order to prepare for the upcoming photon delivery system procurement. Figure 5 shows a preliminary ray tracing which was performed to define the locations of the tapered slit blades. Timely information and design work from the Front End Group will be needed to provide SMI-specific front end parameters.

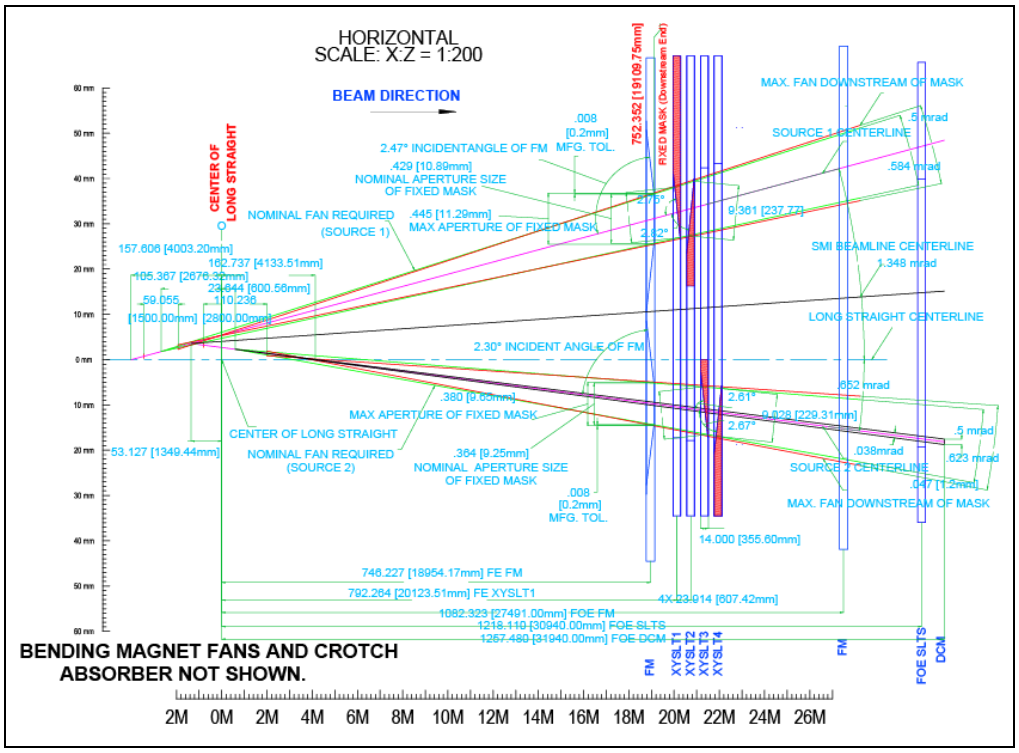
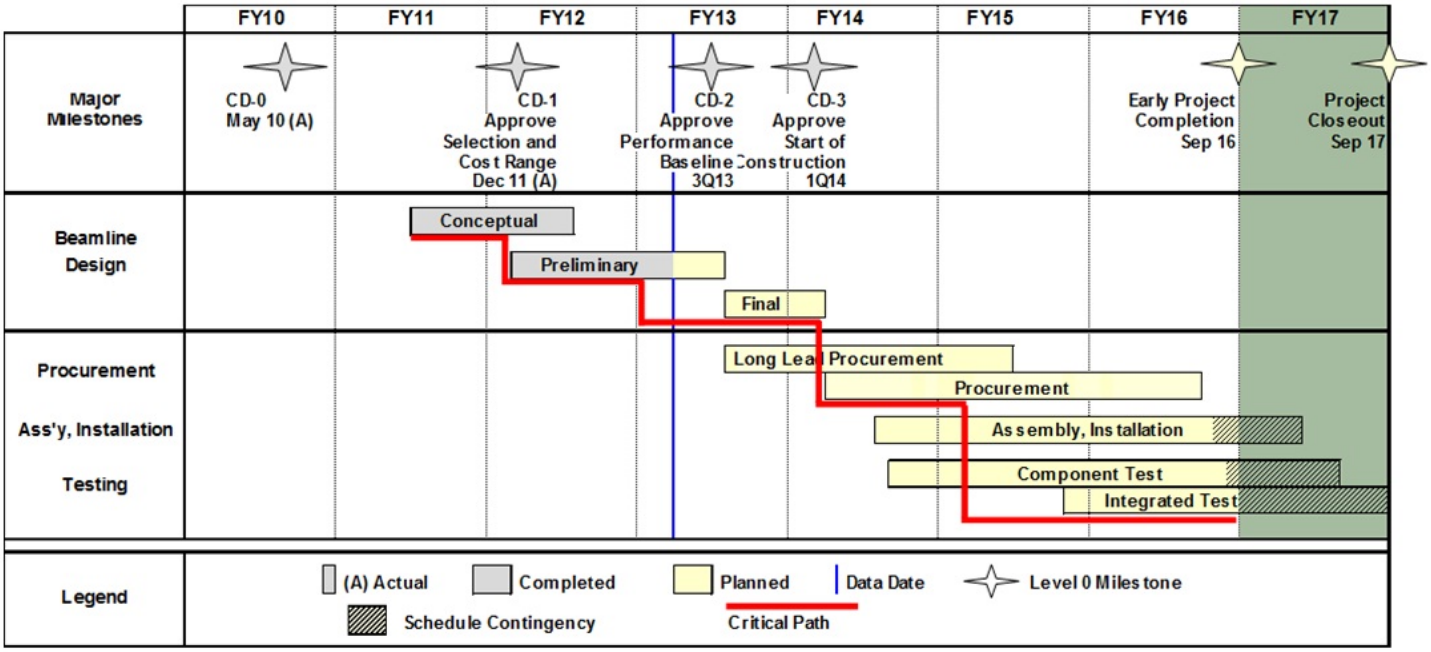


Figure 5. Preliminary depiction of the Front End and First Optics Enclosure mask and slit clearances for SMI. The initial mask opening and desired operating divergences are already known. Work is currently underway to establish the parameters for intervening masks and slits.

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 12/31/2012	Current Period		Cumulative-to-Date	
	Cost	Staffing (FTE-yr)	Cost	Staffing (FTE-yr)
WBS 2.01	$143,376	0.60	$1,525,263	5.66
WBS 2.02	$-25	0.00	$1,807,316	8.74
WBS 2.03	$4,399	0.00 *	$23,092	0.07 **
WBS 2.04	$19,013	0.10	$75,249	0.37
WBS 2.05	$32,528	0.16	$124,384	0.63
WBS 2.06	$48,173	0.20	$148,960	0.72
WBS 2.07	$32,478	0.16	$128,025	0.67
WBS 2.08	$45,779	0.18	$183,438	0.72
WBS 2.09	$60,811	0.36	$248,216	1.43
WBS 2.10	$34,830	0.20	$115,353	0.69
Total	$421,362	1.96	$4,379,296	19.70

* Due to reporting error, Nov. and Dec. 2012 effort will appear in the Jan. and Feb. 2013 data, respectively.

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

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

UPCOMING EVENTS

Project Controls EVMS Training	Jan 8-9
ISS BAT Meeting	Feb 11-12
ESM BAT Meeting	Feb 19-20
BNL Director's Review of NSLS-II Beamline Projects	Apr 4-5
DOE Review of NEXT Project	Apr 9-11

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: 3Q13	
CD-3 (Start Construction):	Planned: 1Q14	
Early Project Completion:	Planned: 4Q16	
CD-4 (Project Completion):	Planned: 4Q17	

Acronyms

BAT	Beamline Advisory Team
ESM	Electron Spectro-Microscopy beamline
FOE	First Optics Enclosure
FXI	Full-field X-ray Imaging beamline
ISR	Integrated In-Situ and Resonant X-ray Studies
ISS	Inner Shell Spectroscopy beamline
IVU	In-Vacuum Undulator
PS	Photon Sciences (Division)
SIX	Soft Inelastic X-ray Scattering
SMI	Soft Matter Interfaces beamline
SOW	Statement of Work