

Photon Sciences Update



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User Executive Committee Town Meeting

August 15, 2012

Topics for Discussion

- Operations Safety
- NSLS Operations Highlights
- NSLS-II Project Status
- Transition Planning

NSLS Safety – Obey Evacuation Orders!

Rain, rain, go away but safety's here every day ...

- 100 year storms seem to be coming more often than that these days
- Storm on Saturday July 28th resulted in flooding on the x-ray floor
- Multiple announcements from the control room and assistance from operations coordinators to clear the area, but some users reluctant to leave or returned around the barriers
- *Operators on duty have the authority to evacuate an area if they believe it presents a hazard. All users and staff are REQUIRED to obey such orders.*
- Should a similar situation occur in future please obey the instructions of the staff to evacuate – fire, flood, whatever the hazard, they are working with your best interests and safety in mind. **It's really important . . .**
- Reinforce this message with your users when they visit –
it could save their life!

What We Do in Photon Sciences

- Overall Objective is to enable and conduct broad range of high-impact science programs at NSLS/NSLS-II:
 - Developing and operating world-class photon sciences facilities & beamlines
 - Interacting, collaborating, and partnering with scientific and industrial user communities
 - Developing and advancing support technology in optics, detectors, instrumentation, engineering, methodologies, and analyses
- High impact:
 - Enable revolutionary discoveries in science and technology
 - Support research pipeline from discovery to development to deployment



Discovery Research

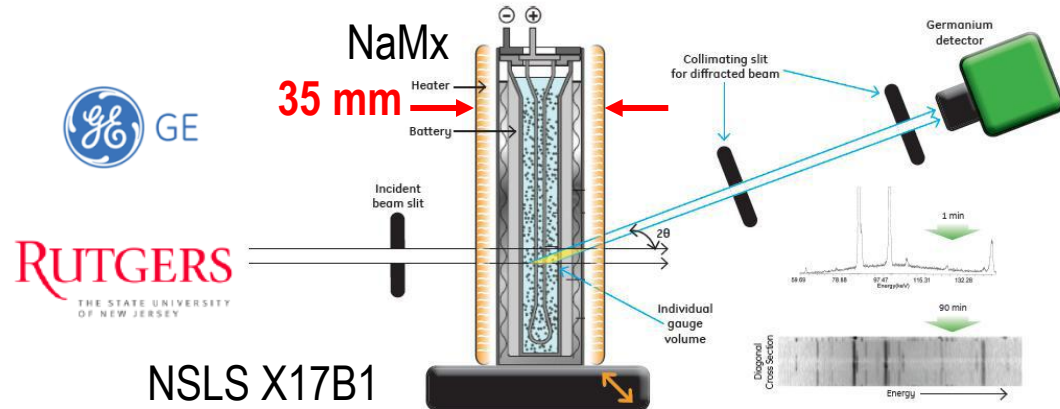
Use-inspired Basic Research

Applied Research

Technology Maturation
& Deployment

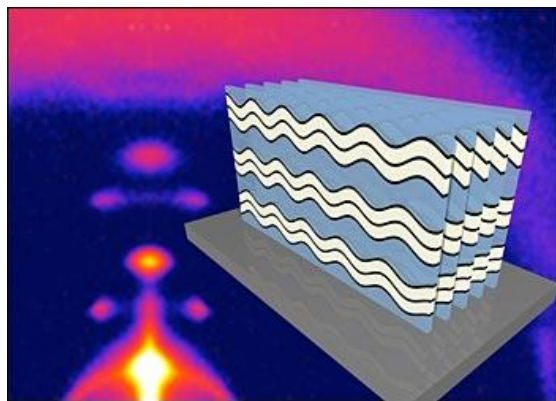
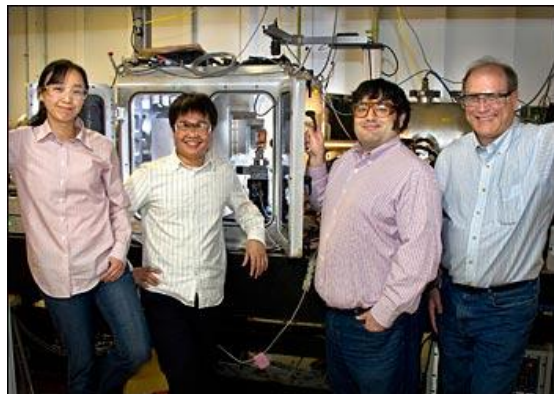
DOE User Facilities Noted for Scientific Breakthroughs

- that drive innovation and promote economic growth

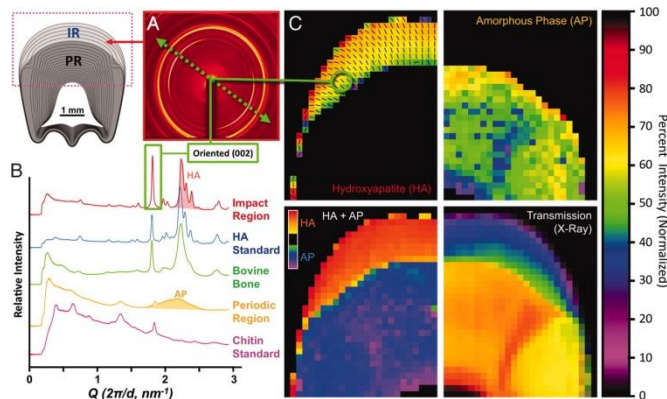


- At June 21 hearing of the House Science, Space, & Technology Subcommittee on Energy and Environment, politicians, scientists, and industry leaders expressed strong support for the past triumphs and great potential of the cutting-edge scientific user facilities
 - Ernie Hall, a chief scientist at General Electric Global Research, spoke highly at the hearing of his experience partnering with DOE facilities. He specifically noted the commercial impact and economic boost created by GE's collaboration with NSLS. GE now plans to open a new battery manufacturing plant in Schenectady, NY, that owes basic breakthroughs in underlying technology to research at NSLS

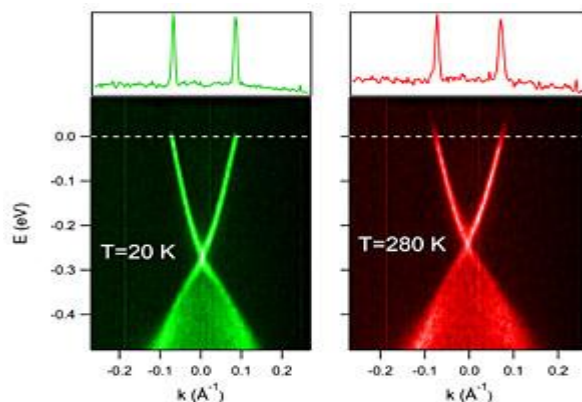
Science and R&D Highlights



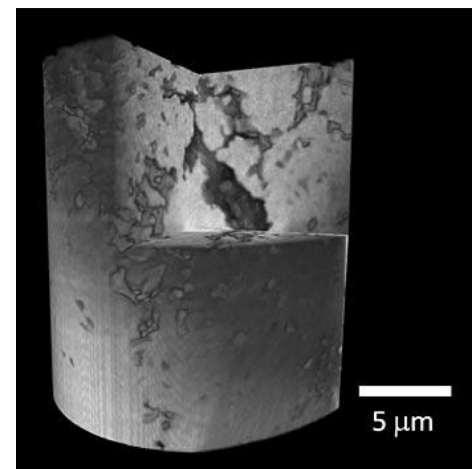
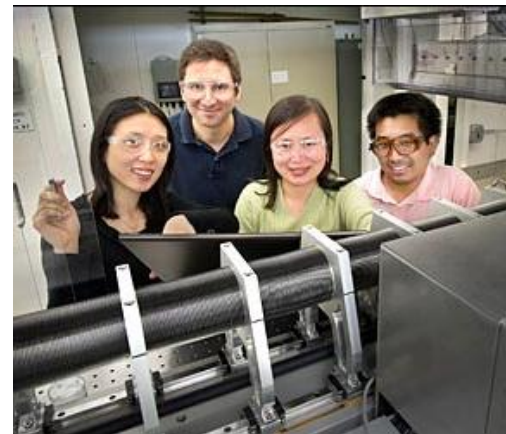
- Bilayer structures in efficient organic solar cell materials. Nature Comm. (2012)



- Bio-minerals with exceptional damage tolerance. Science (2012)

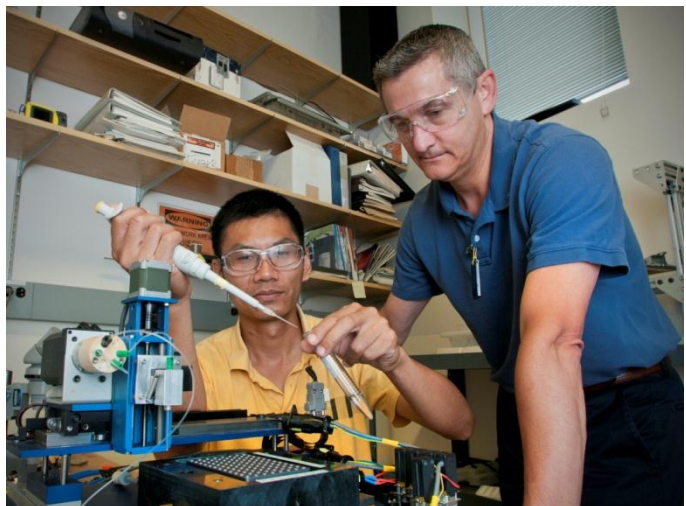
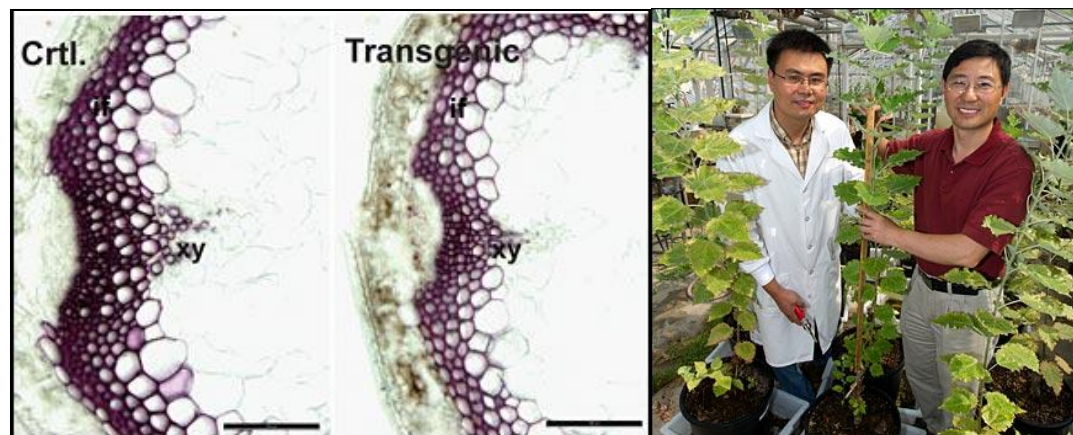


- ARPES study of topological insulator surface. PRL (2012)



- TXM 3D imaging of lithium-ion battery electrode. APL (2012)

Structural Biology at NSLS



- Top left: Protein crystallographers learn about remote data collection at NSLS
- Top right: Engineered enzyme alters cell wall composition in ways that could make it easier to convert plant biomass into biofuels. *Plant Cell* (2012)
- Left: NIH awards \$1M grant to NSLS for advanced photon-counting x-ray area detector for the solution scattering program



NSLS-II Project Status

- Excellent progress
- Project is 80% complete as of end of July 2012
- On schedule and on budget
 - Excellent technical, cost & schedule performance to date
 - Mitigation and contingency plans identified for major risks
 - Sound cost baseline with healthy remaining contingency
 - 12 month schedule float for CD-4
- Expect to complete ~90% of current baseline by January 2013
- 2011-2012 have been exciting with rapid change
- 2012-2013 conventional construction will draw to a close
- 2013-2014 are critical times to deliver on the promise of the NSLS-II project



NSLS-II Key Project Milestones

Aug 2005	CD-0 , Approve Mission Need_____	(Complete)
Jul 2007	CD-1 , Approve Alternative Selection and Cost Range_____	(Complete)
Jan 2008	CD-2 , Approve Performance Baseline_____	(Complete)
Jan 2009	CD-3 , Approve Start of Construction_____	(Complete)
Feb 2009	Contract Award for Ring Building_____	(Complete)
Aug 2009	Contract Award for Storage Ring Magnets_____	(Complete)
May 2010	Contract Award for Booster System_____	(Complete)
Feb 2011	1 st Pentant Ring Building Beneficial Occupancy_____	(Complete)
Feb 2011	Start Accelerator Installation_____	(Complete)
Feb 2012	Beneficial Occupancy of Entire Experimental Floor_____	(Complete)
Mar 2012	Start LINAC Commissioning_____	(Complete)
Jan 2013	Start Booster Commissioning	
Jul 2013	Start Storage Ring Commissioning	
Jun 2014	Projected Early Project Completion	
Jun 2015	CD-4 , Approve Start of Operations	

NSLS-II Construction Progress

5-7-12



23-ID first optics enclosure
under construction

Magnet girders & comps
staging area for Integration



Ring Building and LOBs

**View of LOB 2 Exterior
Siding Complete and tied
in to Ring Bldg**



**LOB 1 - clerestory area
framed dry-wall complete**

**Panoramic View of LOB 3 & HXN
on left & LOB 2 Center Right**



Accelerator Systems Status

- All large contracts placed and production progressing well
- In-house integration of components is in full force
- Accelerator installation is well planned and progressing well
 - Detail installation schedule continuously optimized based on production/installation progress
 - Additional labor resources being provided to reduce the schedule variance in some areas
- Preparations for commissioning are progressing well
 - LINAC commissioning nearly complete
 - Good progress made on commissioning software and database
 - Preparations for Booster and Storage Ring commissioning on going



HXN Satellite Building Near Completion



**LOB 3- HXN Endstation Hutch –
Nearing completion and
readiness for component
installation**

View from HXN endstation hutch



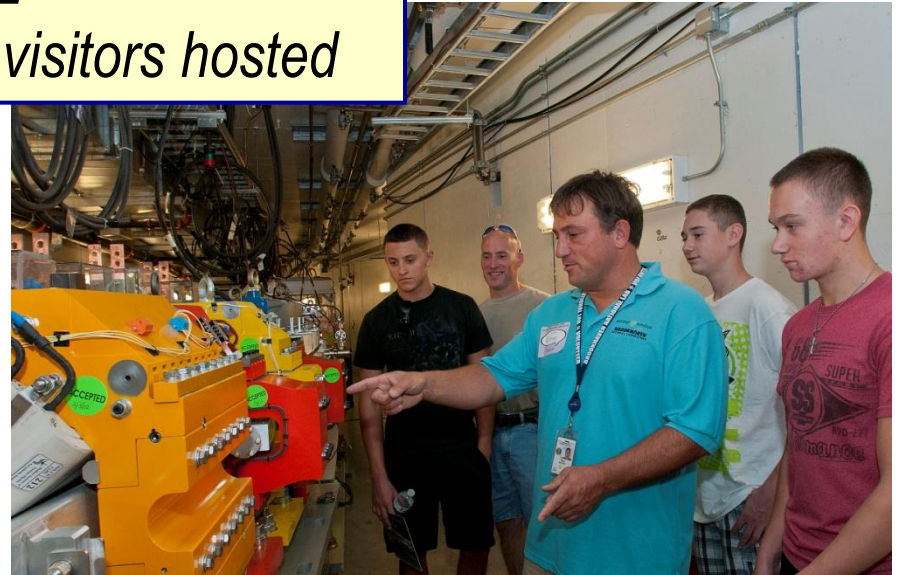
Exterior View of HXN Satellite Bldg next to LOB 3



Summer Sunday July 22, 2012

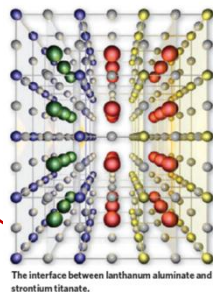
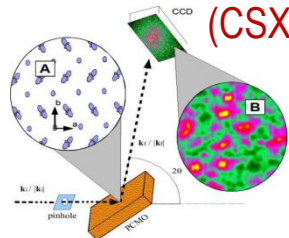


- Photon Sciences Summer Sunday July 22
- Close to 1300 visitors hosted



NSLS-II Project Beamlines

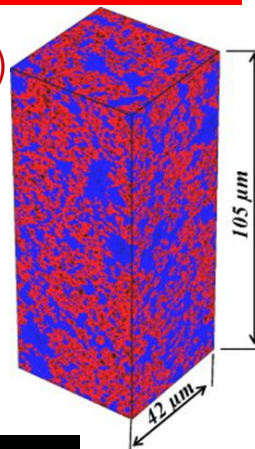
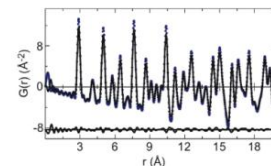
Coherent Soft X-ray Scattering (CSX-1)



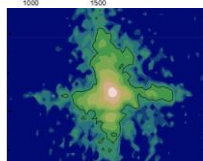
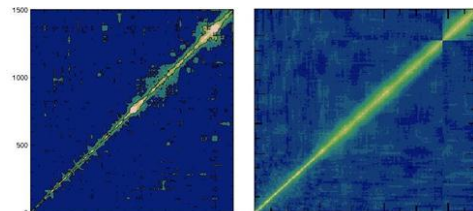
Fast switching polarization (CSX-2)

X-ray Powder Diffraction (XPD-1)

PDF studies (XPD-2)

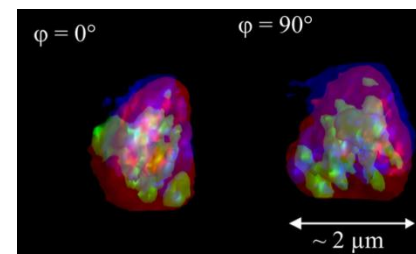
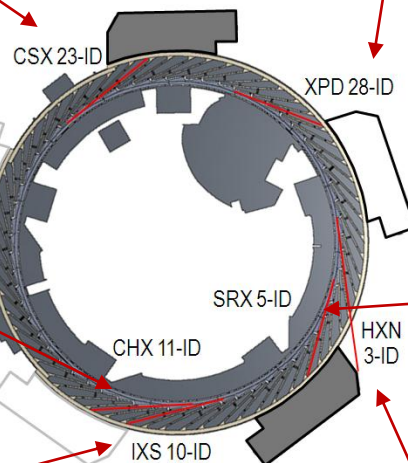
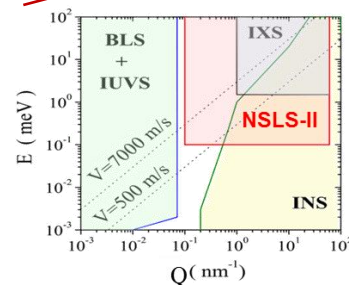
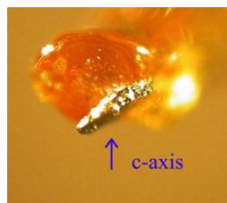
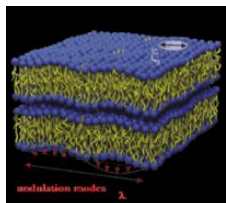


Coherent Hard X-ray Scattering (CHX)



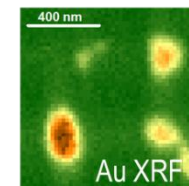
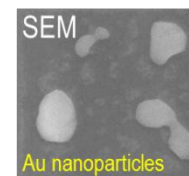
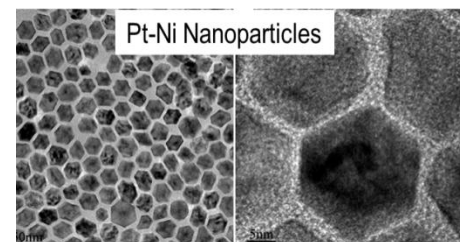
L. Li, LW, AF

Inelastic X-ray Scattering



Sub-um Resolution X-ray Spectroscopy (SRX)

Hard X-ray Nanoprobe (HXN)



U.S. DEPARTMENT OF
ENERGY

Construction Progress

- Experimental hutch construction making excellent progress
- Beamline optics and components in fabrication by vendors
- Utilities, PPS, EPS, shutters designs being finalized



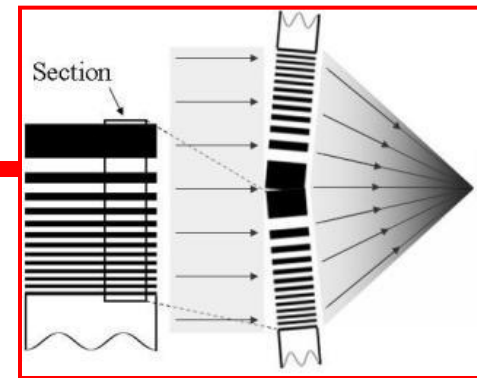
View of the 28ID-A and 28ID-B lead hutches



28ID-B hutch construction in progress

Contract managed by lead engineer Ed Haas

Nanofocusing Development

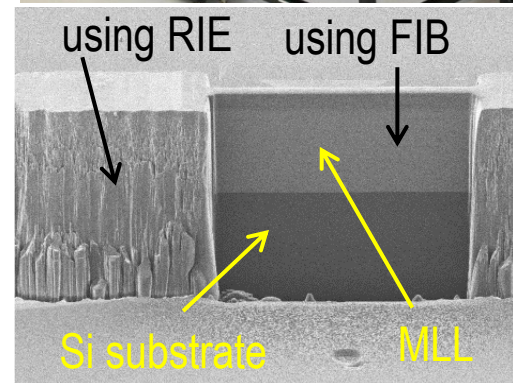
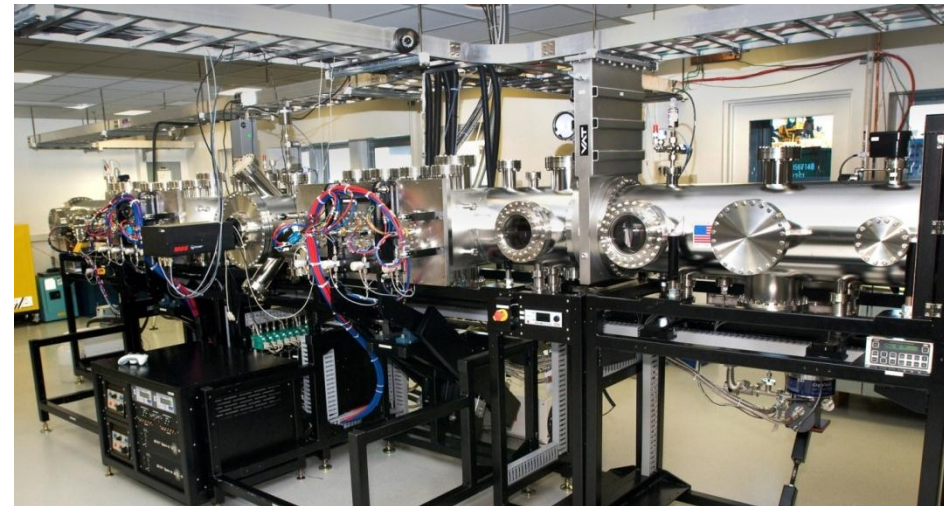
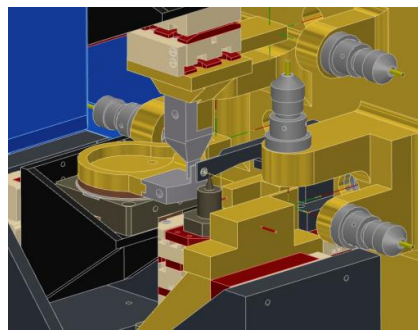
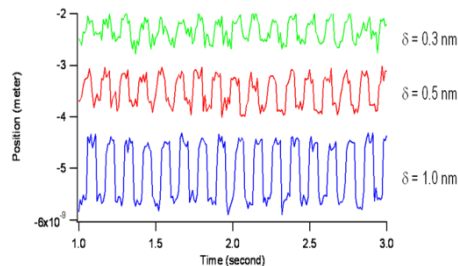


- MLL deposition laboratory established and in operations at BNL:
- Growth of MLLs: Mitigated interfacial stress build up using reactive gas mixture, and fabricated 68um-thick MLL thin-films ($d_r = 4$ nm).
- Used RIE/FIB to section MLL optics, introducing virtually no processing defects.
- 2D focusing using crossed MLL's achieved 25nm x 27nm (experiment conducted at APS 26-ID)

Opt. Express (2011)



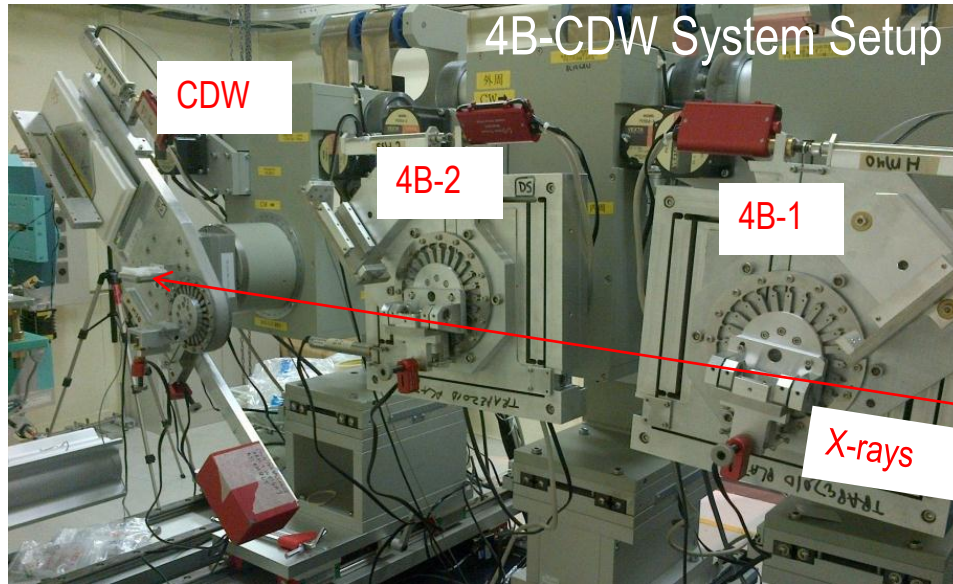
- HXN endstation: 10 nm microscope engineering design completed and being refined, with innovative design features



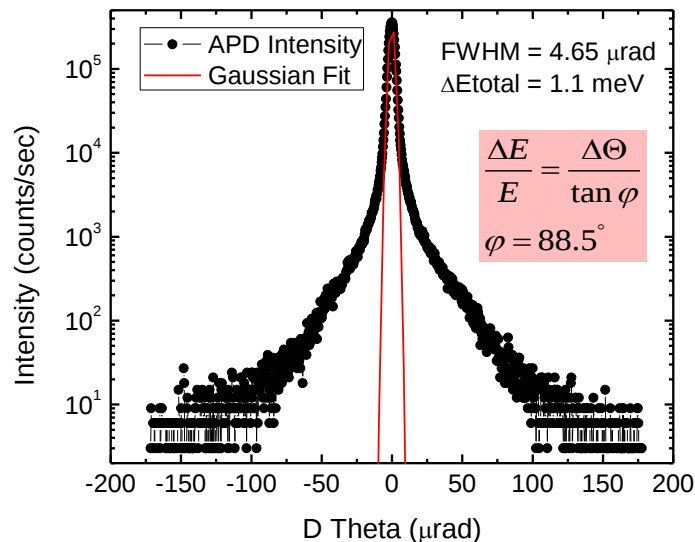
Work partly performed at CFN



High Energy-Resolution Sub-meV Optics Development



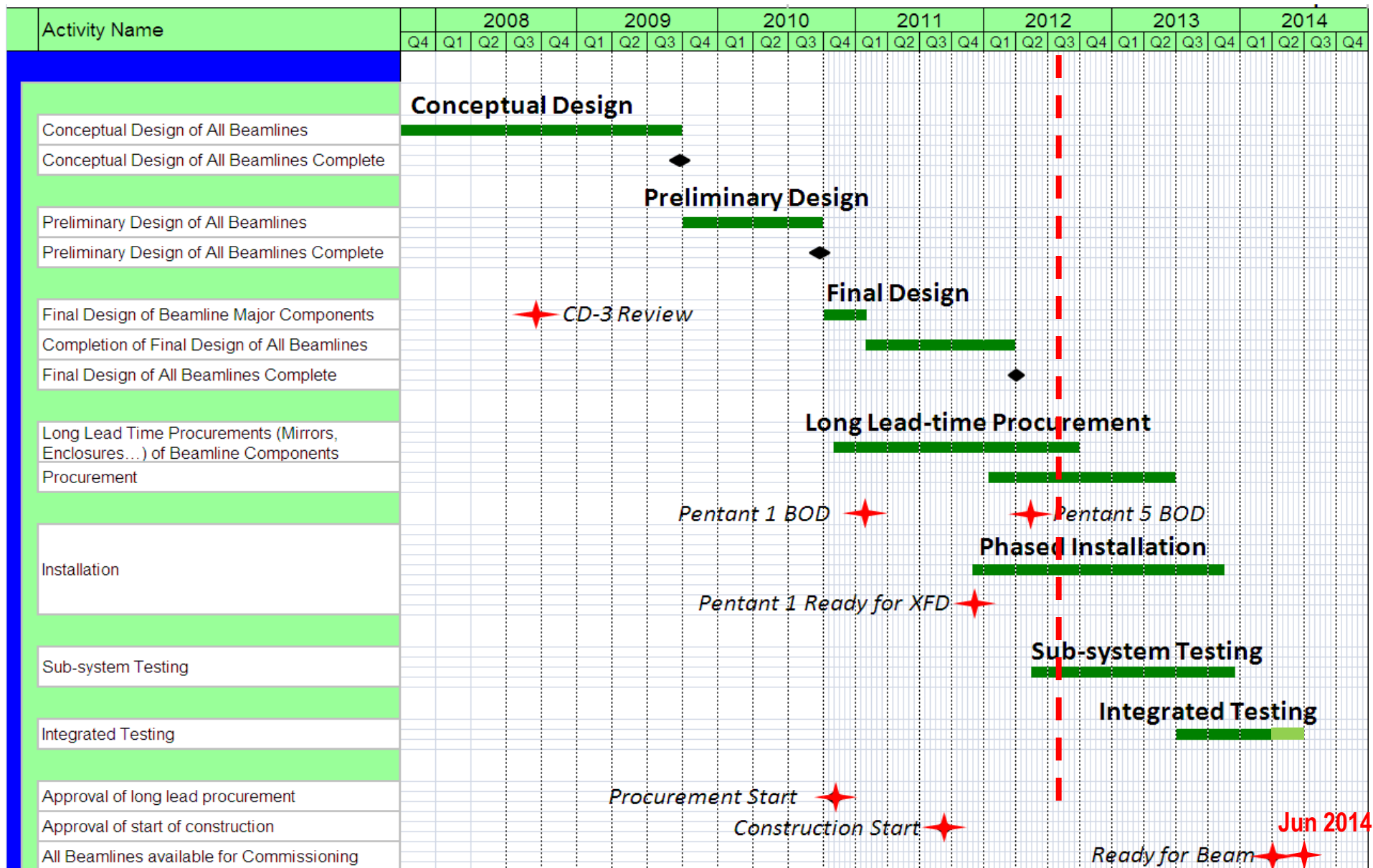
4B-CDW Total Resolution Scan



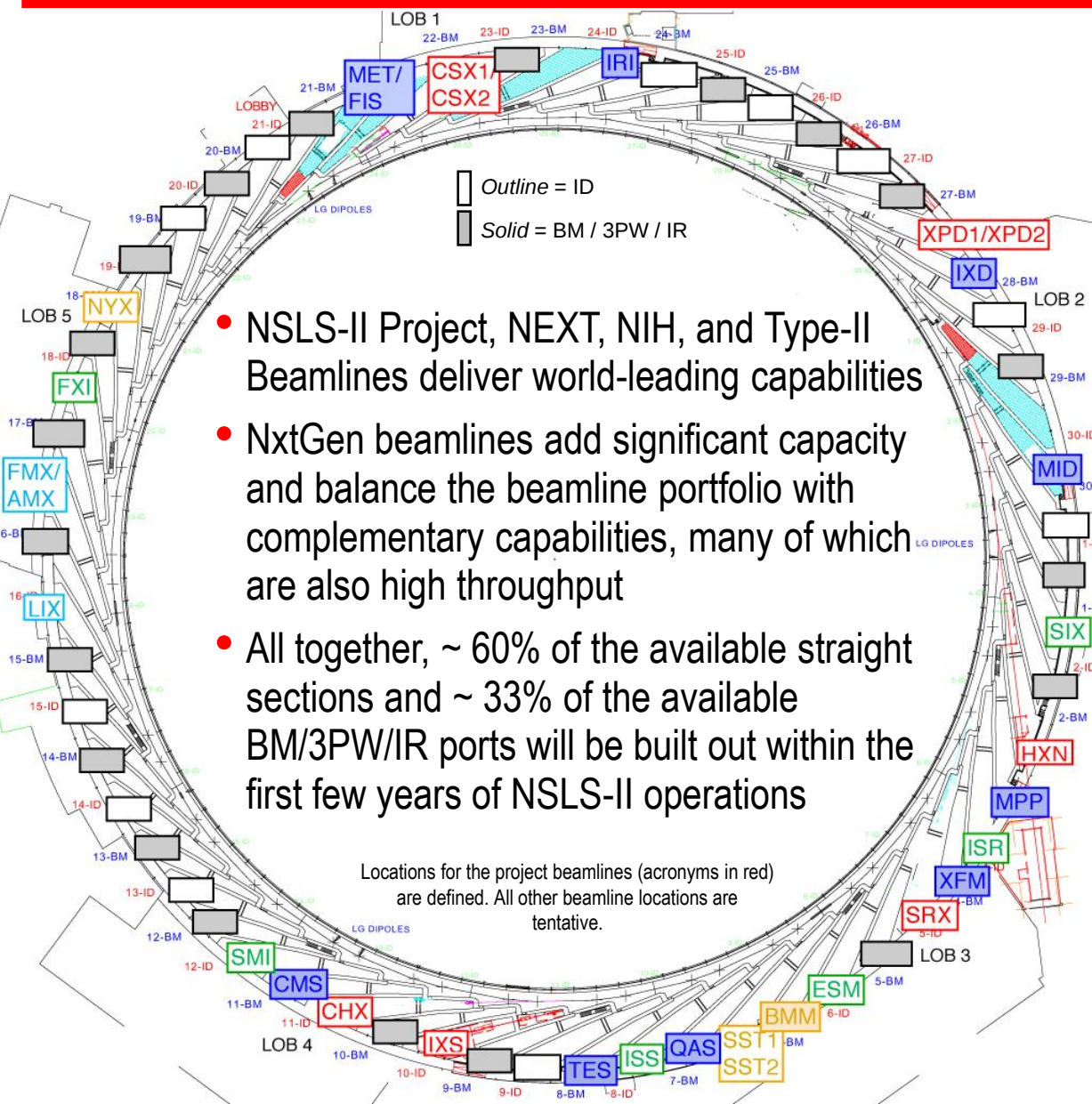
**~1 meV
@ 9.1 keV:
RP ~10⁷**

- Key test results achieved Jul 2011 using Spring-8 and Nov 2011 using PETRA-III
- 4B-CDW $\Delta E_{\text{total}} = 1.1$ meV, with 4B efficiency ~30%, CDW analyzer efficiency ~20%
- 4B energy scanning by synchronized two channel-cut angle scan tested with good results.
- Energy width estimates consistent between 4B-HRM angular scan and CDW-Ana D crystal angular scan
- CDW D-crystal temperature scan (by 2°C and 4B-HRM energy (theta angle for ~50 meV)) tested with excellent correspondence
- IXS optics performance tests indicate ~0.78 meV achieved

NSLS-II Project Beamline Schedule



NSLS-II Beamline Portfolio



- NSLS-II Project, NEXT, NIH, and Type-II Beamlines deliver world-leading capabilities
- NxtGen beamlines add significant capacity and balance the beamline portfolio with complementary capabilities, many of which are also high throughput
- All together, ~ 60% of the available straight sections and ~ 33% of the available BM/3PW/IR ports will be built out within the first few years of NSLS-II operations

8 NSLS-II Project Beamlines

Inelastic X-ray Scattering (IXS)
 Hard X-ray Nanoprobe (HXN)
 Coherent Hard X-ray Scattering (CHX)
 Coherent Soft X-ray Scat & Pol (CSX1, CSX2)
 Sub-micron Res X-ray Spec (SRX)
 X-ray Powder Diffraction (XPD1, XPD2)

6 NEXT MIE Beamlines

Photoemission-Microscopy Facility (ESM)
 Full-field X-ray Imaging (FXI)
 In-Situ & Resonant X-Ray Studies (ISR)
 Inner Shell Spectroscopy (ISS)
 Soft Inelastic X-ray Scattering (SIX)
 Soft Matter Interfaces (SMI)

3 ABBIX Beamlines

Frontier Macromolecular Cryst (FMX)
 Flexible Access Macromolecular Cryst (AMX)
 X-ray Scattering for Biology (LIX)

4 Type-II Beamlines

Spectroscopy Soft and Tender (SST1, SST2)
 Beamline for Mater. Measurements (BMM)
 Microdiffraction Beamline (NYX)

9 NxtGen Beamlines

Complex Materials Scattering (CMS)
 Magneto, Ellipso, High Pressure IR (MET/FIS)
 Metrology & Instrum Development (MID)
 Full-Field Infrared Spectroscopic Imaging (IRI)
 In-situ X-ray Diffraction Studies (IXD)
 Materials Physics & Processing (MPP)
 Quick X-ray Absorption Spectroscopy (QAS)
 Tender X-ray Absorption Spectroscopy (TES)
 X-ray Fluorescence Microscopy (XFM)

NSLS-II Experimental Tools (NEXT) Project

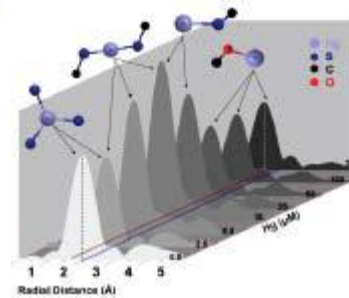
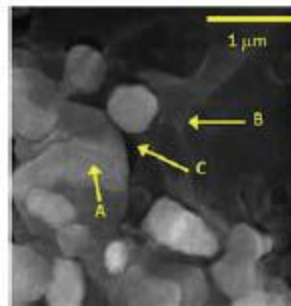
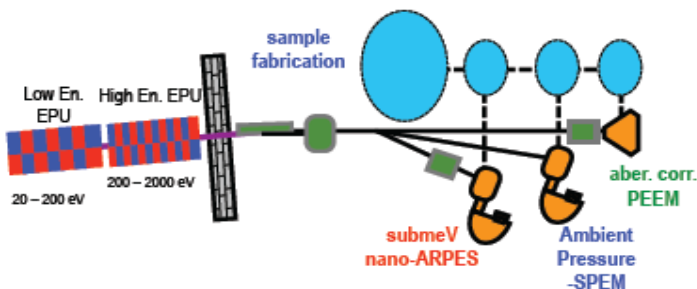
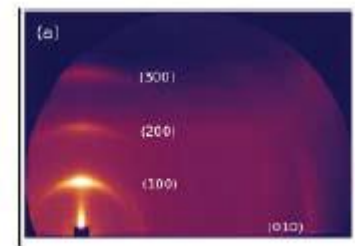
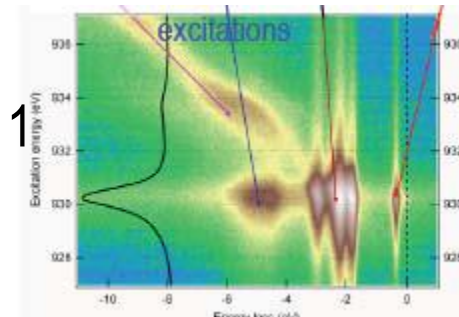
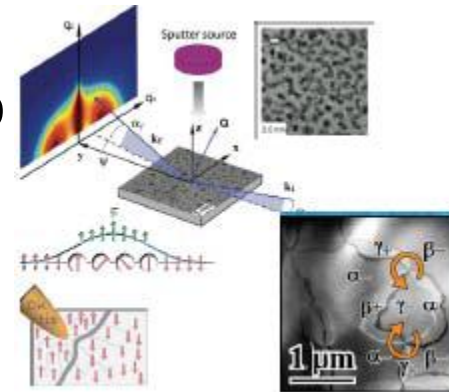
- DOE-BES funded \$90M MIE project 5-6 beamlines, ready for commissioning with x-ray beam, to expand BES beamline portfolio
- Scientific programs complementary to NSLS-II Project beamlines
- Leveraged by extensive auxiliary supporting infrastructure developed by NSLS-II Project

ESM -- Electron Spectro-Microscopy **FXI** -- Full-field X-ray Imaging

ISS -- Inner Shell Spectroscopy **ISR** -- Integrated In-Situ & Resonant X-Ray Studies

SIX -- Soft Inelastic X-ray Scattering **SMI** -- Soft Matter Interfaces

- Successful CD-1 review Sep, 2011 led to CD-1 approval Dec, 2011
- NEXT staff and Beamline Advisory Teams (BATs) in place
- Successful ALD review August 7-9 of preliminary design
- CD-2 review scheduled for Sep 11-13, 2012
- Operations to begin 1QFY17



ABBIX Project

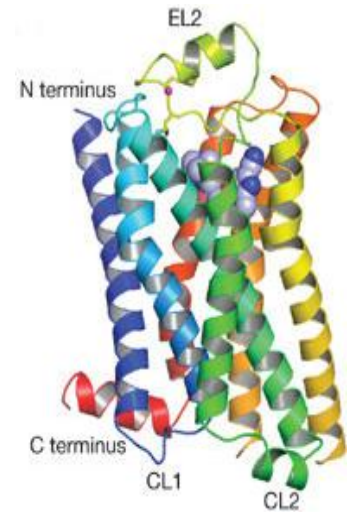
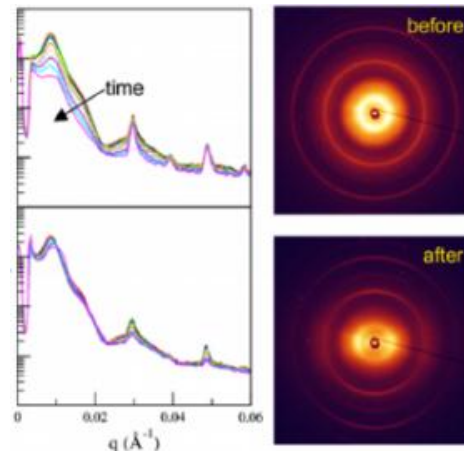
- Advanced Beamlines for Biological Investigations with X-rays (ABBIX)
- NIH funded \$45M project to build 3 beamlines to support the needs of the life sciences community at NSLS-II

AMX – Highly Automated Macromolecular Crystallography

FMX – Frontier Macromolecular Crystallography

LIX – High Brilliance X-ray Scattering for Life Sciences

- Successful “CD-1” Review held on Jan 17-18
- ABBIX staff and Beamline Advisory Teams (BATs) in place
- Successful Project Review June 26-27
- Final Design Review 2Q FY13
- Start Installation 1Q FY14
- Complete Integrated Testing 4Q FY15
- Operations to begin 1Q FY16



NxtGen Beamlines

- Establish additional beamline capacity at NSLS-II by extensive re-use and recycling of existing NSLS Beamline equipment (whole beamlines or components along with new equipment where necessary), funded by ops \$\$

WBS	Beamline
6.02	Complex Materials Scattering (CMS)
6.03	Magneto, Ellipsometric and high-Pressure IR spectroscopy (MET/FIS)
6.04	Metrology and Instrumentation Development (MID)
6.05	Full-Field Infrared Spectroscopic Imaging (IRI)
6.06	In situ X-ray Diffraction studies of structural and chemical transformations (IXD)
6.07	Materials Physics and Processing Beamline (MPP)
6.08	Quick x-ray Absorption Spectroscopy (QAS)
6.09	Tender X-ray Absorption Spectroscopy (TES)
6.10	X-ray Fluorescence Microscopy (XFM)

NSLS to NSLS-II Beamline Transitions

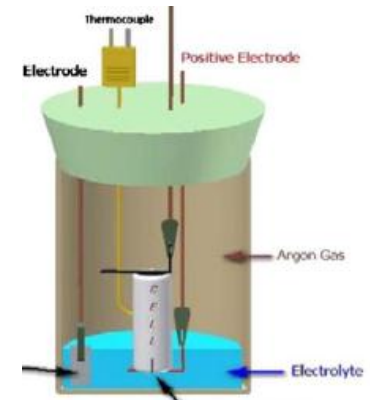
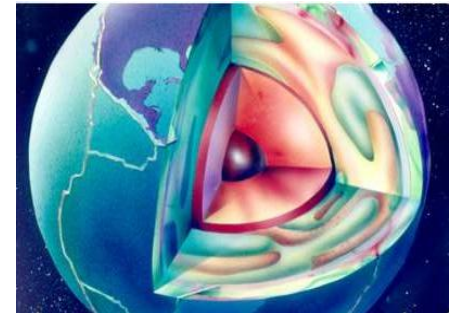
- Clear transition path to NSLS-II for almost every NSLS capability & program
- In some cases, there is continuous coverage but for a few there is a gap of one or two years
- Many new capabilities that don't exist at NSLS and will spawn new programs and user communities
- NxtGen beamlines are critical for providing continuity and capacity
- All beamlines at NSLS-II are expected to be in high demand
- Achieving this scenario is sensitive to available funding

		FY12	FY13	FY14	FY15	FY16	FY17
Hard X-ray Diffraction	Powder Diffraction	X7B, X10B, X14A, X16C			IXD		
					XPD-1		
	Diffraction - Extreme Cond.	X17B2 / B3 / C					
					XPD-1		
	Rapid Acquisition PDF	X17A					
					XPD-2		
	Microbeam Diffraction	X13B					
					CHX		
	Energy Dispersive	X17B1					
Hard X-ray Scattering	SAXS / WAXS / GISAXS / Liq	X6B, X9, X10A, X22B, X27C			CMS		
							SMI
	Resonant / In-Situ	X20A, X20C, X21, X22C			MPP		
							ISR
	Inelastic				IXS		
Soft X-ray Scattering	Scattering / XMCD	U4B, X1A2, X1B, X13A					
					CSX-2		
	Coherent Scattering				CSX-1		
							SIX
Spectroscopy	Hard X-ray	X3A, X3B, X10C, X11A, X11B, X18A, X18B, X23A2			QAS		
						BMM	
							ISS
	Tender X-ray	X15B, X19A			TES		
						SST-1	
	Soft / UV	U7A, U5UA, U12A, U13B, X1A1, X24A				SST-2	
							ESM
	IR	U2A, U4IR, U12IR			MET / FIS		
Imaging	Hard X-ray Nanoprobe				HXN, SRX		
	Hard X-ray Microprobe	X26A, X27A			XFM		
	Hard X-ray Nano CT	X8C					FXI
	Hard X-ray Micro CT, DEI	X2B, X15A					
	Instrum, Top, Det Char	X19C, X27B			MID		
	Tender X-ray				TES		
						SST-1	
	CDI				CHX		
	Soft / UV Full-field	U5UA				SST-2	
							ESM
	IR Microprobe, Full-field	U2B, U10B			IRI		
Structural Biology	Protein Crystallography	X3A, X4A, X4C, X6A, X12B, X12C, X25, X26C, X29			FMX, AMX		
					NYX		
	Solution Scattering				LIX		
	X-ray Footprinting	X28C					

Key
NSLS
NSLS-II Project
NxtGen
NEXT
TYPE II
ABBIX

Working with Scientific User Community

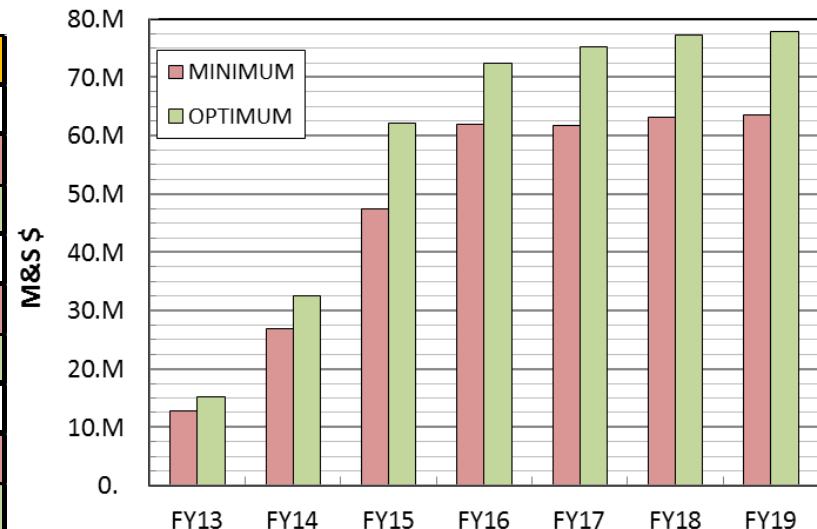
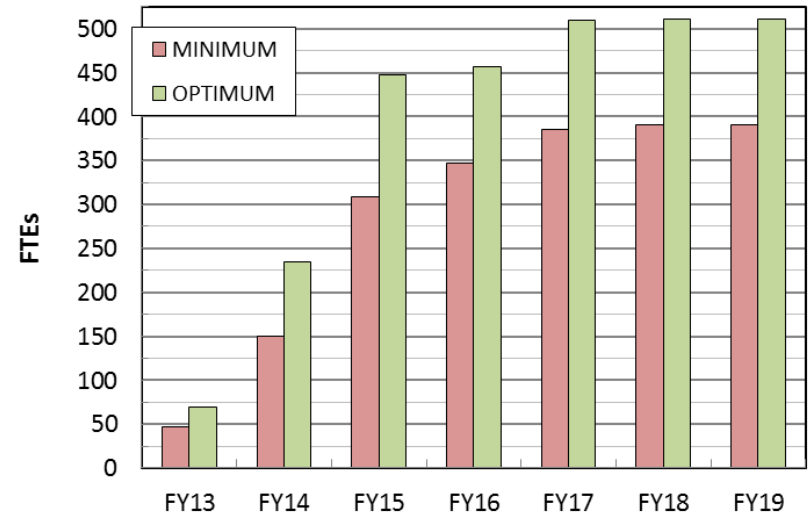
- Recognizing the exceptional contributions to the science portfolio at existing NSLS by several strong scientific consortia user groups, Photon Sciences has been working with the community to
 - Help secure grant renewals to continue operations at NSLS
 - Identify the paths to accommodate these consortia programs to transition to NSLS-II
- COMPRES (Consortium for Materials Properties Res in Earth Sciences):
 - Made connections to XPD beamline so that COMPRES science programs can be accommodated on Day-1 of NSLS-II ops;
 - Led to successful NSF grant renewal
- Synchrotron Catalysis Consortium (SCC):
 - Consortium grant successfully renewed
 - Identified possible partnership at SRX beamline for in-situ spatially resolved spectroscopy
- BNL/SBU Energy Storage Hub Proposal:
 - Energy Storage workshop held Mar 12-13, 2012, identified potential exciting science experiments at NSLS-II
- NSF funding for TES endstation and XFP beamline



NSLS-II Operation Budget Review

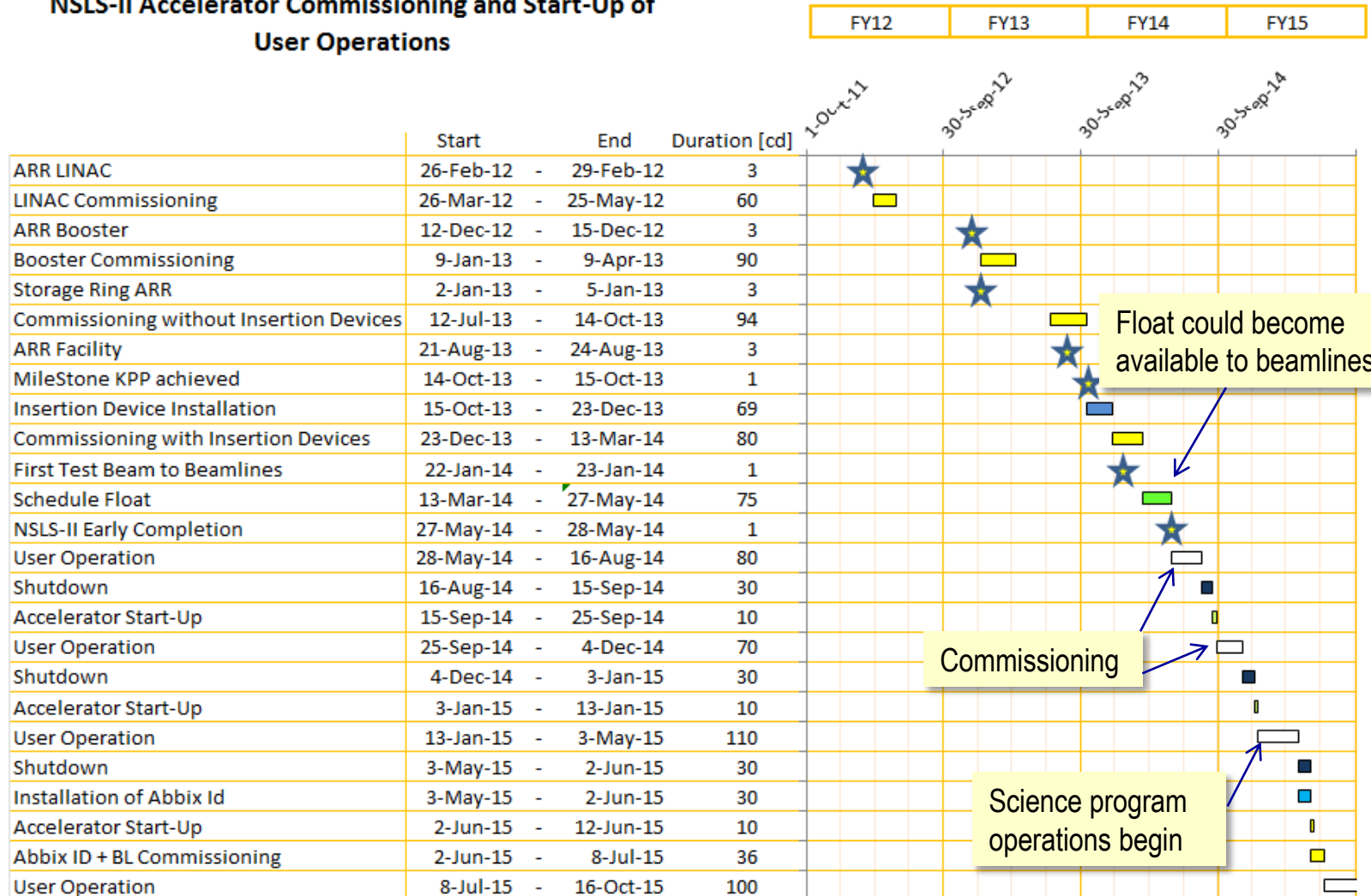
- DOE pre-ops review of NSLS-II operations budget held in May 2012
 - Essentially endorsed the bottoms-up estimates based on operating activities in the minimum scenario
- Expect \$22M NSLS-II operations funding in FY13

NSLS-II Ops 4.1+4.2+4.3							
FTEs	FY13	FY14	FY15	FY16	FY17	FY18	FY19
MINIMUM	47.2	150.3	308.2	347.1	385.3	390.1	390.1
OPTIMUM	68.9	234.3	448.	456.4	509.4	511.5	511.5
M&S \$	FY13	FY14	FY15	FY16	FY17	FY18	FY19
MINIMUM	12.7M	26.9M	47.5M	62.M	61.7M	63.1M	63.6M
OPTIMUM	15.2M	32.5M	62.1M	72.4M	75.2M	77.3M	77.8M
TOTAL \$	FY13	FY14	FY15	FY16	FY17	FY18	FY19
MINIMUM	22.2M	58.1M	115.2M	140.3M	152.1M	157.4M	161.M
OPTIMUM	29.1M	81.M	159.M	174.5M	193.6M	199.9M	204.4M



NSLS-II Start-Up of Operations Schedule

NSLS-II Accelerator Commissioning and Start-Up of User Operations



NSLS-II Project



Looking Ahead

- Upcoming reviews and meetings:
 - DOE Lehman CD-2 Review of the NEXT Project, Sep 11-13
 - SAC meeting originally scheduled for Aug 16-17 has been postponed
 - Project Beamlines Commissioning Review is being scheduled for October
 - NSLS-II early science workshops planning
- Filling in Transition Details:
 - NSLS ops planned to end of Sep 2014, with ~5000 hrs/yr operation likely
 - Aim for 'standard' schedule (minimal summer gap)
 - NxtGen may take some beamlines out of service, maybe as early as December 2013
 - Need to work with PRTs to establish their operating constraints
 - Develop model of available user hours going into NSLS-II Operations

Summary

- NSLS continues to be highly productive
- NSLS-II continues to make excellent progress, on schedule, on budget
- NEXT and ABBIX progressing well
- NxtGen will balance the beamline portfolio with complementary capabilities and add significant capacity → critical for continuity of user operations from NSLS to NSLS-II
- Altogether, 30 NSLS-II beamlines expected in operations by FY17
- Clear path for capabilities and programs to transition to NSLS-II, with community engagements and partnerships
- Looking forward to fast ramp up of operations and exciting science at NSLS-II

