Responses to Request for Information for DOE-BES Triennial Review of NSLS-II

June 2017

Volume 3: Additional Information

Support Facilities, the User Program, and Future Plans

Volume 3

June 20-21, 2017

Our responses to the questions for the 2017 review are presented in five volumes.

Volume 1 contains general responses to the questions about the facility including budget information, response to recommendations, the organizational structure, development milestones, R&D, and facility input.

Volume 2a contains detailed lists of beamline information (including specifications, funding, publications, and invited talks) as well as the BES surveys for FY15-16, and other supplementary material.

Volume 2b contains the NSLS-II Operations funded Beamline Capability Build-up: Plan and Execution Status.

Volume 3 contains all other requested information and documentation pertinent to this review including support facilities, the user program, and future plans.

Volume 4 is the NSLS-II 2017 5-year Strategic Plan.

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Acronyms

ACS – American Chemical Society
ADD – Accelerator Division Director
AIP – American Institute of Physics
ALARA – As Low As Reasonably Achievable
ALS – Advanced Light Source
AMX – Highly Automated Macromolecular Crystallography Beamline
ANL – Argonne National Laboratory
APS – Advanced Photon Source
ARI - ARPES and RIX Nano-Imaging
ARM – Atmospheric Radiation Measurement
ARPA-E – Advanced Research Projects Agency-Energy
ASCR – Advanced Scientific Computing Research
BAG – Block Allocation Groups
BDT – Beamline Discretionary Time
BER – Basic Energy Research
BES – Basic Energy Science
BES-SUF – Basic Energy Science, Scientific User Facilities
BHSO – Brookhaven Site Office
BDP – Beamline Development Proposals
BM – Bending Magnet
BMM – Beamline Materials Measurement
BPM – Beam Position Monitor
BTR – Beam Time Request
CAS – Cost Accounting Standards
CD – Conceptual Design
CDI – Coherent Diffractive Imaging
CFM – Cubic Feet per Minute
CFN – Center for Functional Nanomaterials
CHX – Coherent Hard X-ray Scattering
CIW – Carnegie Institution of Washington
CMS – Complex Materials Scattering
CNR – Consiglio Nazionale delle Ricerche
CRADA – Cooperative Research and Development Agreement
CRYO EM – Cryo Electron Microscopes
CSI – Computational Science Initiative
CSIRO – Center for Functional Nanomaterials Chemistry Condensed Matter Physics and Materials Science and Industrial Research Organization
CSX – Coherent Soft X-ray
DI - Deionized
DOC – Department of Commerce
DOE – Department of Energy
EIC – Electron-Ion Collider
EMG – Executive Management Group
EPICS – Experimental Physics and Industrial Control
EPS – Equipment Protection System
eRHIC – Electron Relativistic Heavy Ion Collider
ERL – Energy Recovery Linac
ESH – Environment, Safety and Health
ESHI – Environment Safety and Health Improvement
ESM – Electron Spectro-Microscopy
FEL – Free Electron Laser
FFAG – Fixed Field Alternating Gradient
FIS – Frontier Synchrotron Infrared Spectroscopy
FMX – Frontier Microfocusing Macromolecular Crystallography
FNAL – Fermi National Accelerator Laboratory
FPGA – Field Programmable Gate Array
FXI – Full Field X-ray Imaging
GPU – Graphical Processing Unit
GU – General User
GUO – General User Operations
HFBR – High Flux Beam Reactor
HVAC – Heating, Ventilating, and Air Conditioning
HXN – Hard X-ray Nano-Probe
IC – Istituto di Cristallografia
ID – Insertion Device
IEEE – Institute of Electronic and Electrical Engineers
IESL – Institute of Electronic Structure and Laser
IGPP – Institutional General Physical Plant
INF – Infinite
IOC – Input/Output Controller
IPCC – International Pachyonychia Congenita Consortium
ISR – Integrated In-Situ and Resonant Hard X-Ray Studies
ISS – Inner-Shell Spectroscopy
IXS – Inelastic X-ray Scattering
LHC – Large Hadron Collider
LINAC – Linear Accelerator
LIX – Life Science X-ray Scattering
LLRF – Low-Level Radio Frequency
LN2 – Liquid Nitrogen
LOB 1 – Lab Office Building 1
LOB 3 – Lab Office Building 3

LSSOC – Light Source Safety and Operations
MET – Magnetospectroscopy, Ellipsometry and Time-Resolved Optical Spectroscopies
MPO – Modernization Project Office
NASA – National Aeronautics & Space Administration
NE – Nuclear Energy
NFS – Network File System
NIH – National Institutes of Health
NP – nanoparticles
NPP – Nuclear and Particle Physics
NPJ – New Physics Journal
NSLS-II – National Synchrotron Light Source II
OH – Overhead
OPS – Operations
PASS – Proposal Allocation, Safety, and Scheduling
PDF – Pair Distribution Function
PLC – Programmable Logic Controller
PLS – Polymer Liquid Studies/Scattering
PMOG – Project Management Oversight Group
PPS – Personal Protection System
PRP – Proposal Review Panel
PSBOC – Photon Sciences Business Operation Council
PU – Partner User
QAS – Quick X-ray Absorption and Scattering
QCD – Quantum Chromodynamics
QIX – Quick Inelastic X-ray
R&D – Research & Development
RA – Rapid Access
RAM – Random Access Memory
RHIC – Relativistic Heavy Iron Collider
SAC – Science Advisory Committee
SC – Science Commissioning
SDCC – Scientific Data and Computing Center
SIX – Soft Inelastic X-ray Scattering
SLI – Science Laboratories Infrastructure
SMF – Spectro Microscopy Facility
SMI – Soft Matter Interfaces
SNS – Spallation Neutron Source
SPMC – Scientific Program Management Committee
SPS – Special Process Spares
SRX – Submicron Resolution X-ray Spectroscopy
SSD – Solid State Detector
SSD – Solid State Drive
SSRL – Stanford Synchrotron Radiation Laboratory
SST - Spectroscopy and Tender
SSWP – Safety System Work Permit
SUSC – Science and User Support Center
TC – Technical Commissioning
TEC – Total Estimated Cost
TES – Tender Energy X-ray Absorption Spectroscopy
TMC – Total Modified Cost
TSA – Technical Service Agreement
UA – User-Available Time
VAB – Value Added Base
VIPIC – Vertical Integrated Pixel Imaging Chip
WBS – Work Breakdown Structure
XFM – X-ray Fluorescence Microprobe
XFP – X-ray Footprinting
XPD – X-ray Powder Diffractions

3. Support Facilities

This section will discuss the Support Facilities including sample preparation, sample environments, computing capabilities, what is available, and what is planned.

3.i Introduction

As a DOE Office of Science User Facility, and an operating Department within BNL, NSLS-II has a number of conventional and specialized buildings and facilities that are used to support accelerator and beamline operations, and the continued development of the facility. These include office, laboratories, machine shops, assembly and test areas and other special purpose spaces in a total of 21 buildings on the BNL site.

The information provided below will focus on those "support facilities" that provide direct programmatic support to operating beamlines and to the users conducting experiments on them at NSLS-II.

3.ii Sample Preparation

3.ii.1 Laboratories

i. Available:

NSLS-II operates a total of 42 laboratories in 7 buildings on the BNL site. Those that provide primary support to users are the 16 laboratories in Lab Office Building 1 (LOB1) and LOB3. Out of the 16 labs 6 of these labs are wet labs and 10 of them are dry labs. These labs are used to support sample preparation for the beamlines in General User Operations (GUO) and for setup, assembly, and testing of equipment. Many of the labs are fitted with specific equipment to support the type of sample preparation or testing needs for associated beamlines. Users request lab capability for a defined period, typically aligned with beam time, and function through the Proposal Allocation, Safety, and Scheduling (PASS) system and are matched to one or more labs best equipped to support their needs. The Research Operations Support Group within the Photon Science Division coordinates these allocations. All 16 laboratories are fully utilized. Depending on the type of work needing to be performed, the lab requested is reviewed to assure that the necessary equipment (Programmatic and Safety) is available in that lab. This review looks at compatibility elements such as the use of chemicals, presses, glovebox, exhaust needs, incubators, etc. If the review reveals an incompatibility, such as the selection of a dry lab with the use of chemicals, the lab requested is changed to a one that is compatible for the work that is being performed.

Table 1 below provides a list of the labs currently available in LOB1 and LOB3 along with the type of lab/function.

Location	Lab/Function		Location	Lab/Function
741 lab 4	Dry Lab for XPD, ESM & CSX		743 lab 1	Dry Lab for HXN, SRX, XFM, FXI
741 lab 5	Dry Lab for FMX, AMX, LIX		743 lab 2	Dry Lab for ISS, TES, QAS, BMM
741 lab 6	Dry Lab for Beamline Assembly		743 lab 3	ROS group/ Detectors
741 lab 7	Soft & Bio Materials Wet Lab		743 lab 4	Dry Lab for IXS, SIX, ISR, SST
741 lab 8	Structural Biology Wet Lab		743 lab 5	Dry Lab for SMI, CMS, CHX
741 lab 9	Condensed Matter Wet Lab		743 lab 6	Beamline Assembly Lab
741 lab 10	Infrared Lab		743 lab 7	Environmental Sciences Wet Lab
			743 lab 8	Mesoscale Imaging Wet Lab
			743 lab 9	Chemistry Wet Lab

Table 3.ii.1: Lab listing

ii. Planned:

A construction project (IGPP) to complete an additional ten laboratories is reaching completion of design, with construction start anticipated in the late summer of 2017. The labs are expected to be completed and transitioned to operations in late 2018. Based on input from the user community, the project will deliver 5 labs in LOB 4 and 5 labs in LOB5. Users and staff were actively engaged in the planning and design of the laboratories. These new laboratories will provide new capabilities such as combining labs together to make one larger wet lab, a satellite metrology/instrumentation lab that will provide the vibration and temperature stability needed for measuring optics here next to the beamlines instead of going across the campus to another lab, a newly designed electro-chemistry lab that will primarily be used for battery research, and dry labs that provide mobile benches to allow the ability to bring larger equipment into the lab.

Two additional IGPP projects are planned to complete the buildout of labs in LOBs 2, 4, and 5. The next project ($5.0M TEC) is anticipated for an FY18 start with delivery of 10 labs in LOB2 expected in FY20. An FY20 start is expected for the remaining LOB Build-Out project that will complete the remaining labs in LOBs 4 and 5, at a TEC of $5.7M. These 10 labs are expected to be on line in late FY22.

3.ii.2 Sample Preparation on the Experimental Floor

i. Available:
Sample preparation activities are also performed at individual beamlines. At present, no major, dedicated special facilities exist for this purpose. Most sample preparation done outside of the laboratories occurs within the control station areas and/or end station environments of the beamlines.

ii. Planned:
There are plans for dedicated facilities for sample preparation at ISS (8-ID), XFP (17-BM) and FIS-MET (22-BM 1&2). These would be enclosures with specialized features (e.g. controlled environments, gas handling systems, airlocks) constructed within the beamline's allocated footprint. This capability is currently under construction at FIS-MET as part of the cabins construction project. The sample preparation area in the cabin will include a work station for basic sample preparation and cryostat sample mounting. Other functions will be supported in a tech area outside the cabin. Dedicated sample preparation rooms for ISS and XFP have been conceptually designed and approved, but are not funded at this time.

3.iii Liquid Nitrogen and Experimental Gases

i. Available:
Liquid nitrogen for experimental use is provided. There are two LN_2 open dewar fill stations (1 in LOB1 and 1 in LOB3) and two closed dewar fill stations (1 in LOB1 and 1 in LOB3). A localized LN_2 open dewar fill station is also in service at 17-ID. Numerous beamlines have LN_2 distribution service for a cryo-cooler and/or for use in many of the hutches.

The NSLS-II experimental floor (B740) is served by a gas extraction system that extends around the experimental floor. This system is being used to exhaust non-hazardous and hazardous gases such as helium, argon, oxygen, carbon monoxide, and hydrogen. Each gas extraction drop nominally provides 400 cfm and can be increased based on the gas extraction needs for a particular beamline.

ii. Planned:
Several beamlines are planning for the use of hazardous gases in the course of their experiments. At present, plans do not anticipate use of toxic gases. Currently there are two Gas Handling Systems installed where one is located at 8-ID (ISS) and the other at 4-ID (ISR) beamlines. In addition, there is a Gas Handling System for 28-ID (XPD/PDF) that is going through the procurement process and has reached the preliminary design review stage. All such systems will discharge their exhaust gases to the building 740 Gas Extraction System.

3.iv Computing Capability

i. Available:
The NSLS-II IT Group maintains a large and robust private infrastructure comprising approximately 450 computer systems (including 66 virtual machines), 250 network switches and about 2.5 PB storage. These figures represent current totals across the facility and include

infrastructure used for both beamlines and accelerator operations, but exclude the "campus" desktop office computing.

Computer Systems

Computer systems are provisioned and maintained using an automated configuration management system. Standards are applied to hardware, operating systems, and installed software to ensure ease of maintenance, homogeneity, and interchangeability. These are:

Server hardware:

- (Pre-2015) IBM x3550/3650 M3/4 and (2015-present) HP DL360/380p
- (GPU-based) Supermicro SYS-1028GR and Tesla K80

Workstation hardware:

- HP z6xx/8xx
- Operating system: (Servers) Debian Stable and (Workstations) Debian Stable and Ubuntu LTS

Systems are grouped together based on function, namely:

1. Infrastructure and security
2. Web applications
3. Virtual Machine hosting
4. EPICS softIOCs
5. Storage frontend (GPFS and NFS)
6. Beamline detector capture and package
7. Computation and analysis

Central Computation and Storage

NSLS-II centralized computing and storage resources are provided for real-time data storage and analysis. Data is both backed-up on-site and packaged for use at external facilities.

The central compute and storage environment has a modular architecture so that it will scale linearly in cost and performance as the needs of the facility to perform high speed calculations in applications such as beamlines image processing, accelerator modeling and simulations, radiation and ray tracing calculations and the like grow.

Compute resources currently include:

- 17x compute nodes with
- 2x 18 and 22-core Intel v4 processors
- 512GB 2.4GHz RAM
- 10GbE and Infiniband
- Local SSD cache
- Access to distributed GPFS filesystem
- 1x GPU-based system with 2x Tesla K80s
- Job scheduling via Slurm and Univa

Storage resources include approximately:

- 200 TB GPFS storage nodes (network storage device)
- 800 TB NetApp storage arrays (1x controller + 2x expansion chassis)
- 100 TB Centralized of NFS servers
- 20 TB NetApp flash storage array
- 1200 TB Varied other storage solutions at local Beamlines (lots of IBM DCS3700)
- (In-process) An NSLS-II multi-PB tape (LTO-7) library

In all a total of approx. 2.5 PB total storage online (excluding tape and flash)

Network Resources

The NSLS-II has deployed a high-performance network that is capable of providing 10/40/100G resources for beamline data transfer into the foreseeable future.

Beamlines have 2x direct uplinks to each core

- 2x 10G (majority of beamlines)
- 2x 40G (recently upgraded for those with high-bandwidth detectors - FMX/AMX)
- 2x 1G (beamlines with minimal needs)

Fibre is installed to allow any beamlines to upgrade from 1G→ 10G → 40G at any time.
These systems are split among beamlines and the Accelerator Physics group.

ii. Planned:

Short Term

With continued funding, we will install a tiered central storage solution (fast - mid - slow):
Beamline → Flash (SSD/RAM) → Disk → Tape -> External

Beamlines will provide flash and significant disk storage, with data being consolidated to central NSLS-II storage. We are in the process of the Configuration for a multi-PB tape (LTO-7) library for immediate backup purposes until longer term options are available. We expect to transfer data directly to an institutional tape library from the central storage in the longer term.

Medium & Longer Term

The NSLS-II Network core is being upgraded in the medium term and will improve reliability and performance of all systems.

We are providing more centralized computing infrastructure. Firstly centralized to the facility (NSLS-II server room), where we consolidate both Disk storage and CPU/GPU power and then to the Computer Science Initiative facilities at BNL which will provide major (extremely big) computing and storage resources. Finally, we are looking at how we might best use cloud based services – given the bandwidth limitations off the BNL site and studying & understanding how to transmit reliably across third part networks.

4. Users

This section will discuss the User Program, in particular addressing how beam time is allocated to outside users. The reviewing process will also be shown using a plot of beam time allocations per year vs. the number of groups receiving this time allotment (broken out by field, i.e., Materials Science, Biology, etc.). Also provided are the user experiments per year and proposals per year. The percentage of beam time per year allocated to facility scientists (as principal investigator or co-principal investigator) is also shown in this section.

4.i How is beam time allocated to outside users?

All beam time at NSLS-II is allocated to outside users based on:

(1) a peer-reviewed proposal process that is fair, clear, and expedient, sensitive to the needs of users, and recognizes contributions that improve the overall scientific program, and
(2) the principle that all beam time proposals receive a finite amount of beam time for a limited duration that is justified by the need for beam time of the proposed work.

Details on the process for allocating beam time are described below and can be found in the NSLS-II Users' Guide at: https://www.bnl.gov/ps/access/proposals.php

Access Modes and Proposal Lifecycle

NSLS-II operates in three 4-month cycles and all beam time is requested each cycle through the web-based Proposal Allocation, Safety, and Scheduling System (PASS) system. In this system, a beam time proposal describes the scientific experiments to be performed and identifies the experimental team. Proposals have different durations depending upon the type of proposal submitted. For any proposal that has a duration of more than one cycle, a beam time request (BTR) must be submitted for every cycle that a user requests beam time. Every beam time request also requires a Safety Approval Form, which is also submitted through the PASS system once beam time is allocated.

There are a number of modes of access for beam time at NSLS-II, which are described in detail below. However, they all follow a common life cycle that involves the following steps: proposal submission, feasibility evaluation, peer review, allocation of beam time, scheduling, carrying out the work, and reporting the results.

General User (GU) Proposals

Most proposals requesting beam time at NSLS-II are GU proposals. General User (GU) proposals are for scientists that require beam time on beamlines that routinely support the technique needed for their experiment. For GU experiments, users often bring only samples, but can also provide custom instrumentation for the duration of their experiments. General User proposals are valid for one year (3 beam time cycles). Each proposal requests a total number of 8-hour shifts to complete the work. For each cycle that a user requests beam time, he/she must submit a beam time request (BTR) against their GU proposal. These proposals are peer-reviewed and allocated by the NSLS-II Proposal Review Panel. All GU proposals are considered active until either: (a) all beam time

allocated to the proposal for use during its lifetime has been used, (b) the proposal is withdrawn, or (c) one year has elapsed.

Rapid Access (RA) Proposals

Rapid Access (RA) proposals are for rapid access to beam time for "hot topics" or for scientists that require beam time for straightforward experiments using routine techniques with a fast turnaround time. Rapid Access proposals are valid for one beam time cycle and typically request a very small amount of beam time. These proposals are peer-reviewed and allocated by the NSLS-II Proposal Review Panel with a 2-3 day turnaround time prior to running the experiments. (Proposals are not reviewed retroactively.) Any user submitting a RA proposal must contact the beamline staff prior to submission. At this point, RA proposals are only accepted on the following beamlines at NSLS-II: 8-ID (ISS), 16-ID (LiX), 17-ID-1 (AMX), and 17-ID-2 (FMX).

Block Allocation Groups (BAGs)

Block Allocation Groups (BAGs) are a mode of beam time access at NSLS-II intended for groups of researchers that want to combine their beam time requests into a single proposal in order to permit greater flexibility in beam time allocation and scheduling. BAG proposals may be motivated by shared scientific interest, geographical location, affiliation, or other synergistic reasons. The term of a BAG proposal is 2 years (6 beam time cycles). New BAG proposals are rigorously reviewed by the NSLS-II Proposal Review Panel (PRP). If a BAG proposal scores well, this results in an initial beam time allocation. For beam time requests (BTR) in future cycles, BAGs will be required to submit a report reviewing their past work and a shift estimate for the next cycle. The reports are reviewed at the PRP meeting and an allocation for the next cycle will be considered. All users submitting a BAG proposal are required to contact the beamline staff prior to submission. At this point, BAG proposals are only accepted on the Structural Biology beamlines at NSLS-II, which include 16-ID (LiX), 17-ID-1 (AMX), and 17-ID-2 (FMX).

Partner User (PU) Proposals

Partner Users (PU) proposals are for individuals or groups who need regular access to beam time on NSLS-II beamlines to carry out their work and who also wish to partner with the facility in making contributions that benefit other facility users by enhancing the utilization or capabilities of the facility or contributing to its operation. Possible examples include, but are not limited to, creating or expanding a user community, contributing a sophisticated endstation, contributing staff and/or equipment to provide user support for a given program, or the design, construction, or operation of endstation equipment, or even a whole beamline. NSLS-II staff may be PU members with the approval of the NSLS-II Director.

PU proposals describe the proposed partnership and request beam time on one or more beamlines that support the techniques needed. Each PU proposal can request up to 40% of the available beam time per run cycle (per beamline in case more than one beamline is required) throughout the life of the proposal. For each cycle that a PU needs beam time, he/she must submit a beam time request (BTR) against their PU proposal. The lifetime of a Partner User proposal will typically be up to three years, although it may be up to five years in special circumstances.

Partner User proposals may be renewed following submission and review of a renewal proposal. PU proposals are peer-reviewed by the NSLS-II Proposal Review Panel, evaluated by the NSLS-II Science Advisory Committee, and allocated by NSLS-II management. PU group members may also submit GU proposals for beam time on any beamline. However, if a GU proposal is submitted for the beamline(s) on which they are a PU, the scientific scope may not overlap with the PU proposal. Any user submitting a PU proposal must contact the beamline staff prior to submission.

Proprietary Proposals

Proprietary research is work conducted under a Class Waiver for Proprietary Users of Energy Research Designated User Facilities. Private individuals, representatives from educational institutions, nonprofit organizations, or industry, may conduct such research. As of April 2017, two proprietary proposals have been run at NSLS-II for a total of four shifts of beam time. Under the terms of the DOE Class Waiver, the user is obligated to pay the full-cost recovery rate for use of NSLS-II. In return, the user has the option to take title to any inventions made during the proprietary research program and to treat as proprietary all technical data generated during the proprietary research program. The terms and conditions under which proprietary research may be conducted at the NSLS are set forth in the Proprietary User's Agreement, which must be in place before any experiment can commence. Proprietary work requires the submission of a Proprietary Proposal, which must contain a functional non-proprietary description of the work. Proprietary proposals are rapid-access proposals that are reviewed by NSLS-II management.

Beamline Discretionary Time (BDT) Proposals

Beamline management may allocate up to 10% of the available beam time for purposes that contribute to the utilization or enhancement of the beamline. Typical uses may include instrumentation development that is carried out by beamline staff and/or users, feasibility studies by beamline staff and/or users, or other purposes at the discretion of beamline management. All BDT usage is subject to retrospective review by NSLS-II management and will also be reviewed periodically by the Science Advisory Committee to ensure that it is appropriate and justified.

User Research Lab

In collaboration with the Carnegie Institution of Washington, proposals are currently being accepted for instrument time in the High Pressure Infrared Research Lab (741-LL10). Proposals are valid for one year (3 cycles). Each proposal requests a total number of 8-hour shifts to complete the work. For each cycle that a user requests beam time, he/she must submit a beam time request (BTR) against their proposal. These proposals are peer-reviewed by the NSLS-II Proposal Review Panel and allocated by CIW and NSLS-II.

Proposal Review and Beam Time Allocation

The total amount of beam time available on a beamline each cycle is a combination of the time required for commissioning, maintaining, and upgrading the beamlines (called "technical commissioning" time) and the time available for user experiments (called the "user-available" time). As beamlines come online, they transition from a majority of technical commissioning (TC) time to a majority of user-available (UA) time.

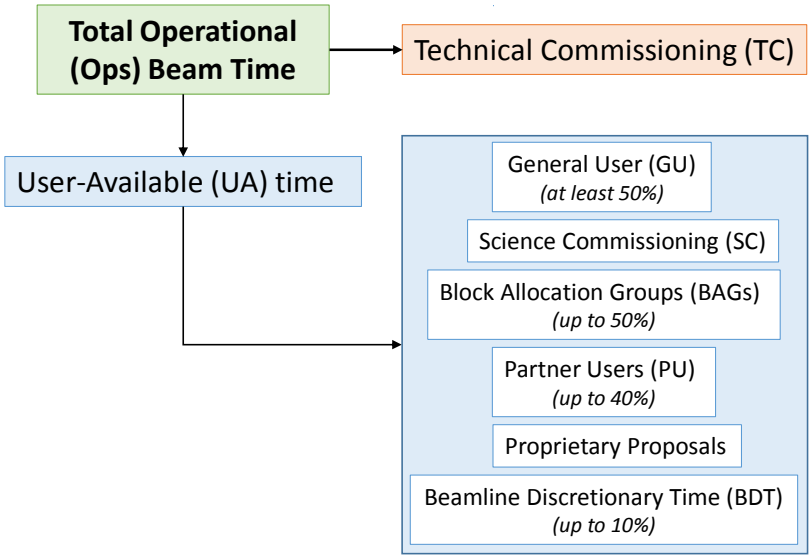


Figure 4.i.1: Schematic of the Categories of Total Operational Beamtime

Each cycle, beamlines may designate a fraction of their UA time for "science commissioning (SC)" experiments and allocate appropriate GU proposals for this purpose. Science commissioning is aimed at engaging the scientific community in user-assisted commissioning of new beamlines and/or newly implemented endstation capabilities.

The TC and UA fractions are determined by management in consultation with beamline staff prior to each run cycle. The use of TC and SC time by each beamline is reviewed each cycle by NSLS-II management to ensure that it is appropriate and justified.

Once a beamline reaches mature operations, which is typically ~1 year after "first light", a minimum of 50% of the UA time is allocated to a combination of GU, BAG, and RA proposals every run cycle. Up to 40% of the UA time may be allocated to PU proposals and up to 10% of the UA time may be allocated for beamline discretionary time.

Technical Feasibility

All GU, BAG, RA, proprietary, and PU proposals are first evaluated by beamline staff for technical feasibility on the requested beamline(s).

Proposal Review Panels (PRPs) and Review Criteria

All GU, BAG, RA, and PU proposals that are judged technically feasible are then reviewed and rated by one of several Proposal Review Panels (PRPs). PRPs are peer-review groups composed of scientific peers, external to NSLS-II, and organized by technique or scientific discipline, that cover a broad range of basic and applied science including instrumentation and method development. Proposals are assigned to an appropriate PRP, which evaluates and rates them.

For all proposals, the PRPs evaluate according to the following criteria:

- Scientific and/or technological merit of the proposal
- Is the proposed work a good use of the NSLS-II facilities and expertise?
- Capability of proposers and quality of past performance based on track record and/or expertise in the field
- Research plan and technical feasibility

These categories are designed to recognize and evaluate the feasibility, the value of basic, applied, and industrial research, the value of education and outreach activities, and the societal impact of the proposed work. The PRPs are expected to take into consideration supporting evidence provided in the proposal (e.g., publications, patents, or corporate impact statements as evidence of past performance), to impartially evaluate the likely success of the beam time, and to evaluate these categories in a balanced way (e.g., recognizing the merit of adventurous, exploratory experiments as well as those with a clear expected result, or recognizing the value of encouraging the development and contribution of new users as well as supporting proven performers from existing communities).

The PRPs make recommendations for (1) the maximum number of beam time shifts to be allocated over the lifetime of the proposal, and (2) the number of beam time shifts to be allocated during the upcoming cycle. GU proposals selected for science commissioning time may be allocated time out of rank-order in the proposal scoring.

Proposal Scoring

All NSLS-II proposals are scored on a scale of 1 to 5, with 1 being the best. Beam time is allocated based on a proposal's score compared to all other proposals for a given beamline in a given cycle. Proposals receiving a rating of 5 are automatically expired and no beam time request may be submitted for that proposal in a future cycle.

If a proposal did not receive beam time in the prior cycle, the score of the proposal is improved, or "aged," by 0.2 points. The proposal will retain this aged score until it either (1) receives beam time, or (2) expires. Once an aged proposal is allocated beam time, the score reverts to its original value. A proposal cannot be aged more than once.

Beam time allocation and scheduling

Each cycle, the PRPs review and score new proposals and they also recommend beam time allocations for all beam time requests (BTRs) against existing proposals. For the BTRs, if a proposal has already received beam time in one or more prior run cycles, the beam time request must also include a brief statement of progress resulting from those previous beam time awards. This progress report is reviewed by the PRP, and if it is not satisfactory, the PRP may reduce future beam time allocations.

Once allocation recommendations are made by the PRPs, they are approved and finalized by beamline staff and management. Users are notified of the results of the review process via the PASS system and the Lead Beamline Scientist at each beamline is responsible for the scheduling.

PRP Panel Membership

NSLS-II currently has 7 PRPs that meet in-person at NSLS-II three times per year (February, June, and October). Each PRP has a Chair that coordinates the meeting, compiles the reviews, and manages the review submission in the PASS system. PRP membership terms are 3 years, with the possibility of renewal. The current PRP membership can be found below and on the web at: https://www.bnl.gov/ps/access/evaluation.php

NSLS-II Proposal Review Panels

Soft X-ray & Photoelectrons	
Riccardo Comin	University of Toronto
Ian McNulty, Chair	Argonne National Laboratory
Eli Rotenberg	Lawrence Berkeley National Laboratory
Andreas Scholl	Lawrence Berkeley National Laboratory
X-ray Spectroscopy	
Simon Bare	SLAC National Accelerator Laboratory
Shelly Kelly	UOP LLC
John Newberg	University of Delaware
Hiro Ogasawara	SLAC National Accelerator Laboratory
Bruce Ravel, Chair	National Institute of Standards and Technology
Ashaki Rouff	Rutgers University
Trevor Tyson	New Jersey Institute of Technology
X-ray Scattering	
Brian Landes	Dow Chemical
Aymeric Robert	SLAC National Accelerator Laboratory
Jon Tischler	Argonne National Laboratory
Michael Toney	SLAC National Accelerator Laboratory
Jin Wang, Chair	Argonne National Laboratory
Inelastic Excitations	
Steve Durbin, Chair	Purdue University
Ken Finkelstein	Cornell University
High Energy Diffraction	
John Budai	Oak Ridge National Laboratory
Peter Chupas, Chair	Argonne National Laboratory
Stefan Kycia	University of Guelph
Pamela Whitfield	Oak Ridge National Laboratory
Angus Wilkinson	Georgia Institute of Technology
Microscopy and Imaging	
Paul Dumas	SOLEIL Synchrotron
Steve Heald, Chair	Argonne National Laboratory
Martin Holt	Argonne National Laboratory
Barry Lai	Argonne National Laboratory
Tony Lanzirotti	University of Chicago
Michael Martin	Lawrence Berkeley National Laboratory
Martina Ralle	Oregon Health & Science University
Structural Biology	
John Flanagan	Pennsylvania State University
Robert Fischetti	Argonne National Laboratory
Sandra Gabelli	John Hopkins University
Rebecca Page	Brown University
Eddie Snell	Hauptman-Woodward Medical Research Institute
Steve Wasserman, Chair	Eli Lilly and Company
Michael Wiener	University of Virginia
Methods and Instrumentation	
Paul Dumas	SOLEIL Synchrotron
Ken Finkelstein	Cornell University
Robert Fischetti	Argonne National Laboratory
Stefan Kycia	University of Guelph
Eli Rotenberg	Lawrence Berkeley National Laboratory
Jon Tischler	Argonne National Laboratory
Trevor Tyson	New Jersey Institute of Technology

4.ii Reviewing process

Reviewing process: A plot of the beam time allocations per year vs. the number of groups receiving this time allotment (i.e., Materials Science, Biology, etc.). Also, provide user experiments per year and proposals per year. Provide percentage of beam time per year allocated to facility scientists (as principle investigator or co-principal investigator).

Allocated Shifts by Field of Research						
	FY15		**FY16**		**FY17**	
	shifts used	*fraction*	*shifts used*	*fraction*	*shifts used*	*fraction*
Materials Science & Condensed Matter Physics	109	61%	1005.3	62%	1742.5	51%
Physics (not Condensed Matter)	0	0%	18	1%	35.5	1%
Chemistry (not Materials Chemistry)	5	3%	158	10%	310.1	9%
Polymers (including soft matter)	12	7%	75	5%	129	4%
Environmental Sciences	9	5%	106.75	7%	81.5	2%
Earth Sciences	15	8%	54	3%	176.5	5%
Biological & Life Sciences (not Medical Appl.'s)	18	10%	143.5	9%	736.5	22%
Medical Applications	0	0%	15	1%	12.5	0%
Engineering	9.5	5%	15.5	1%	39	1%
Optics	0	0%	18.5	1%	12	0%
User Facility Instrumentation (incl. detectors)	0	0%	0	0%	123	4%
Other	0	0%	21	1%	5.5	0%
TOTAL	177.5	100%	1630.55	100%	3403.6	100%
*all numbers are 8-hour shifts *used* except 2017-2 is shifts *allocated*						
**all numbers represent GU, SC, and PU proposals						

Table 4.ii.1: Allocated Shifts by Fields of Research and Fiscal Year

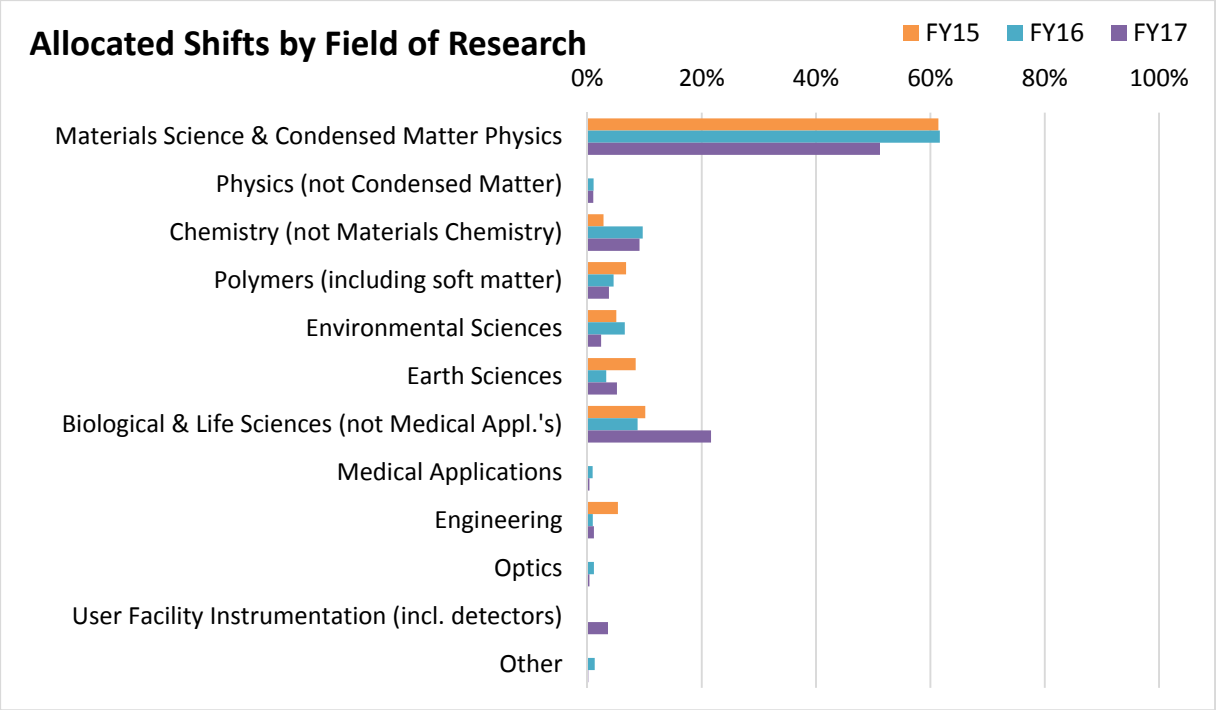


Figure 4.ii.1: Allocated Shifts by Field of Research as a Percentage of Total Allocated Shifts for FY15, and FY16. FY17 is year to date (up to and including cycle 2017-2).

Unique Users by Field of Research						
	FY15		FY16		FY17*	
	users	*fraction*	*users*	*fraction*	*users*	*fraction*
Materials Science & Condensed Matter Physics	66	60%	251	53%	242	42%
Physics (not Condensed Matter)	0	0%	3	1%	3	0%
Chemistry (not Materials Chemistry)	0	0%	60	13%	71	12%
Polymers (including soft matter)	0	0%	0	0%	15	3%
Environmental Sciences	0	0%	19	4%	10	2%
Earth Sciences	0	0%	19	4%	36	6%
Biological & Life Sciences (not Medical Appl.'s)	0	0%	57	12%	148	26%
Medical Applications	0	0%	6	1%	5	1%
Engineering	0	0%	3	1%	5	1%
Optics	0	0%	13	3%	5	1%
User Facility Instrumentation (incl. detectors)	29	27%	28	6%	28	5%
Other	15	13%	19	4%	10	2%
TOTAL	**110**		**477**		**579**	
**as of May 12, 2017*						

Table 4.ii.2: The Distribution of the Unique Users by Field of Research for FY15 and FY16. For FY17 the numbers are as of May 12, 2017.

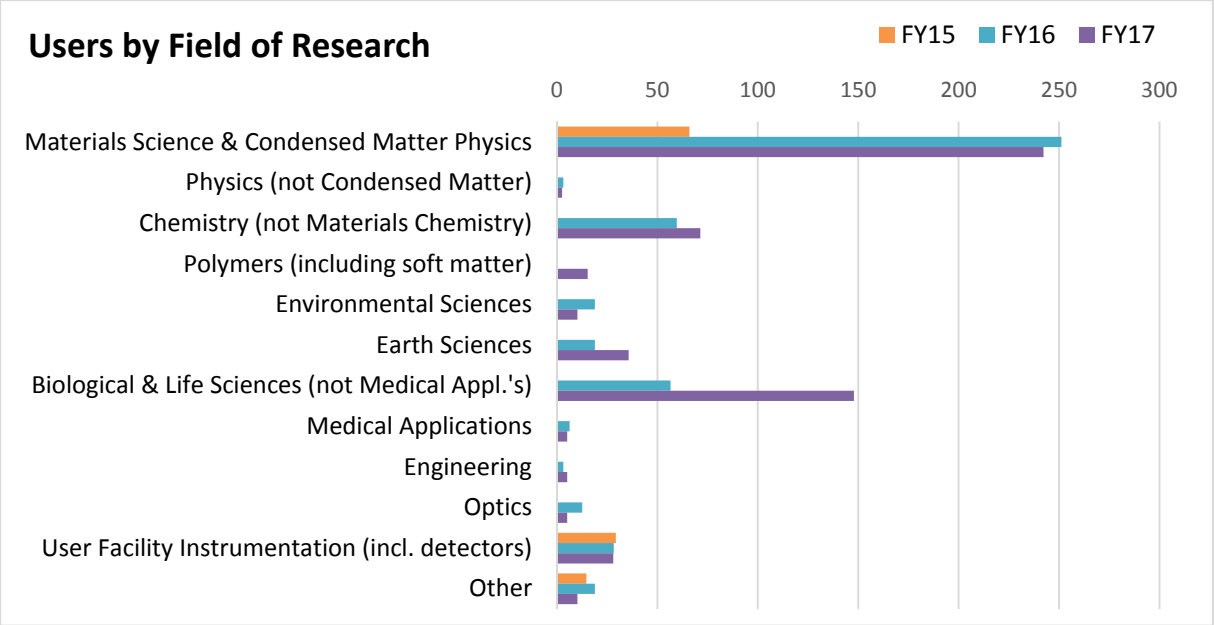
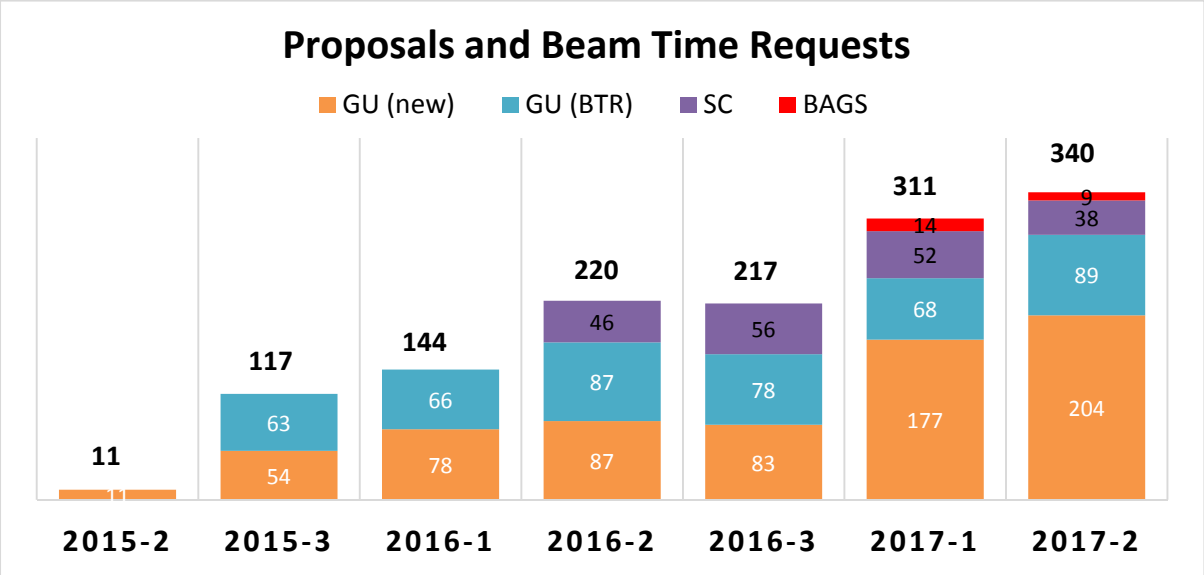


Figure 4.ii.2: Unique Users by Discipline for FY15-17

Proposals and Beam Time Requests							
	2015-2	*2015-3*	*2016-1*	*2016-2*	*2016-3*	*2017-1*	*2017-2*
General User (new)	11	54	78	87	83	177	204
General User (BTR)		63	66	87	78	68	89
Science Commissioning				46	56	52	38
Block Allocation Groups						14	9
Total	**11**	**117**	**144**	**220**	**217**	**311**	**340**

Table 4.ii.3: Proposals and Beam Time Requests by Proposed Type and Run Cycle



GU: General User; BTR: beam time request; SC: science commissioning; BAG: Block Allocation Group

Figure 4.ii.3: Data of Table 4.ii.3 Shown as a Bar Chart

Proposals Submitted & Experiments Allocated							
	2015-2	*2015-3*	*2016-1*	*2016-2*	*2016-3*	*2017-1*	*2017-2*
proposals submitted	11	117	144	220	217	311	340
experiments allocated	3	23	65	90	101	168	171
subscription rate*	3.7	5.1	2.2	2.4	2.1	1.9	2.0
*proposals submitted / experiments allocated							

Table 4.ii.4: Proposals Submitted and Experiments Allocated in a Given Cycle. The Subscription Rate is the Ratio of Proposals Submitted and Experiments Allocated.

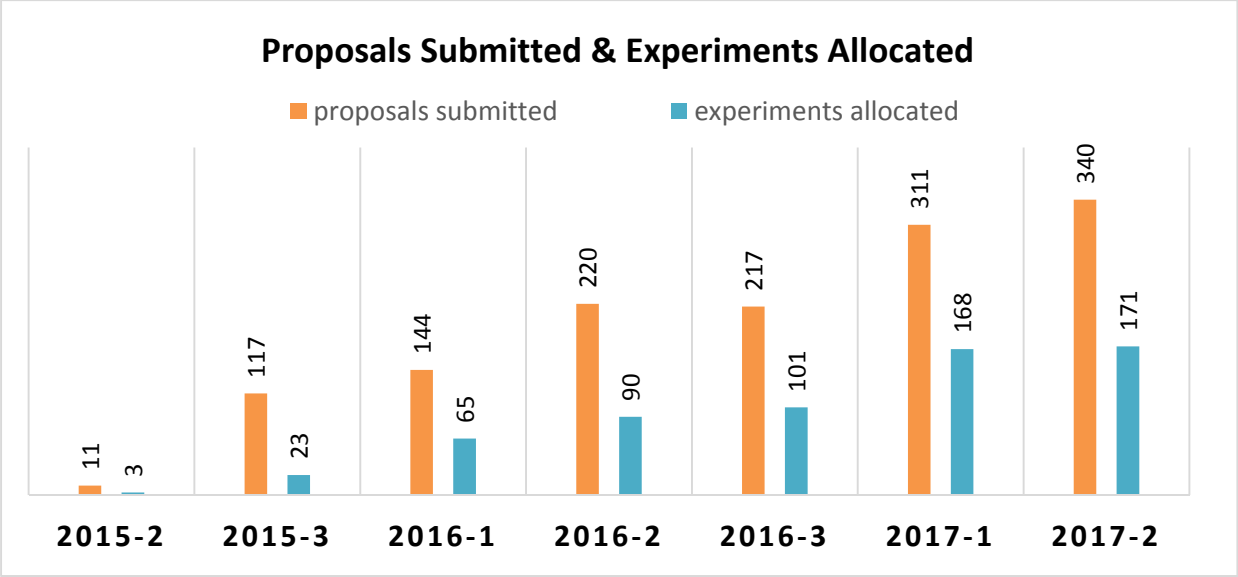


Figure 4.ii.4: Proposals Submitted and Experiment Allocated by Run Cycle

Percentage of Beam Time per Year Allocated to Facility Scientists

Up to 10% of the user-available (non-commissioning) beam time may be used by NSLS-II facility scientists for purposes such as instrument/technique development, feasibility studies, and/or research. Facility staff submit Beamline Discretionary Time (BDT) proposals each cycle, which are subject to review by NSLS-II management and are also retrospectively reviewed periodically by the Science Advisory Committee to ensure that the usage is appropriate and justified. Facility scientists may also submit General User (GU) proposals to any NSLS-II beamline and are provided a limited amount of funding to maintain individual research programs. The table below indicates the actual percentage of beam time that was used by the facility staff in CY15 – 17 broken into three categories (1) BDT time, (2) resident beamline staff that submitted GU proposals on that beamline, and (3) other NSLS-II staff (not resident at the respective beamline) that submitted GU proposals on that beamline.

Facility Staff Beam Time (%)

		CY 2015				CY 2016				CY 2017*			
Port	**Beamline**	BDT	beamline staff (GU)	other staff (GU)	**TOTAL**	BDT	beamline staff (GU)	other staff (GU)	**TOTAL**	BDT	beamline staff (GU)	other staff (GU)	**TOTAL**
3-ID	**HXN**	0	0	0	**0**	4.6	1.9	3.2	**9.7**	5.2	8	13.1	**26.3**
5-ID	**SRX**	0	6.6	0	**6.6**	2.7	8	2.3	**13**	4.9	4.1	3.5	**12.5**
8-ID	**ISS**	-	-	-	**-**	0	0	0	**0**	0	5.9	1.8	**7.7**
8-BM	**TES**	-	-	-	**-**	-	-	-	**-**	2	2.4	2	**6.4**
10-ID	**IXS**	0	0	0	**0**	3.4	13	0	**16.4**	6.6	21.3	4.8	**32.7**
11-ID	**CHX**	0	4.6	0	**4.6**	4.1	3.8	1.9	**9.8**	4.1	3.3	0	**7.4**
11-BM	**CMS**	-	-	-	**-**	-	-	-	**-**	2	3.5	3.6	**9.1**
16-ID	**LIX**	-	-	-	**-**	0.8	0	0	**0.8**	1.4	0	0	**1.4**
17-ID-1	**AMX**	-	-	-	**-**	0	0	0	**0**	1.6	0	0	**1.6**
17-ID-2	**FMX**	-	-	-	**-**	0	0	0	**0**	1.6	0	0	**1.6**
17-BM	**XFP**	-	-	-	**-**	-	-	-	**-**	3.2	0	0	**3.2**
23-ID-1	**CSX-1**	0	0	0	**0**	4.5	0	0	**4.5**	4.5	15.7	0	**20.2**
23-ID-2	**CSX-2**	0	0	0	**0**	4.1	0.9	0	**5**	7.1	7.6	0	**14.7**
28-ID-2	**XPD**	0	0	0	**0**	2.2	1.3	0.6	**4.1**	4.3	0	4.1	**8.4**

*as of May 1, 2017

Table 4.ii.5: Beam Time Used by Facility Staff as a Percentage of the Beam Time for a Given Beamline. Staff time is classified here as three categories. BDT time which is up to 10% of the available user time for staff to develop capabilities and programs. The beamline staff (GU) time is the time staff are able to compete for their own beamline in the general user program. The other staff GU time is time facility staff were able to get on a beamline other than their own, again competing in the general user program.

5. Impact

This section provides tables and lists with the publications, conference proceedings, books or book chapters, dissertations and patents over the last three years, as well as, invited lectures and major awards for facility staff and external users. Also listed are the twenty most important publications of work performed at the facility over the past three years, including the number of citations for these publications.

5.i

Provide a table that lists the number of publications for each individual refereed journal (excluding conference proceedings), and total number of high profile publications and high impact publications for the past 2 years and a figure that shows the number of publications of each journal vs. the 5-year impact factor of the journal.

In section 5.i we list NSLS-II publications by calendar year. Throughout this section we have used a strict definition for an NSLS-II publication. All papers have to have utilized NSLS-II photons for at least a portion of the work.

NSLS-II Refereed Journal Publications* by Journal - CY 2015				
Journal Name	**Impact Factor**	**Category**	**Publications**	**Publication with NSLS-II Facility Staff as Co-Author**
ACS Nano	14.5		1	1
APL Materials	4.3		1	1
IUCrJ	5.3		1	1
TOTAL			**3**	**3**
*all publications listed used NSLS-II photons				

Table 5.i.1: NSLS-II Peer Reviewed Publications by Journal with a publication date in CY 2015

NSLS-II Refereed Journal Publications* by Journal - CY 2016				
Journal Name	**Impact Factor**	**Category**	**Publications**	**Publication with NSLS-II Facility Staff as Co-Author**
Applied Physics Letters	3.3	*high impact*	2	2
Journal of the American Chemical Society	12.4	*high impact*	1	0
Nano Letters	14.9	*high impact*	1	1
Physical Review Letters	7.3	*high impact, high profile*	1	1
Nature Communications	12.0		2	0
ACS Applied Materials and Interfaces	7.3		1	0
ACS Energy Letters	New		1	0
Advanced Energy Materials	16.8		3	2
Catalysis Today	4.1		1	1
Chemical Communications	6.6		1	1
Chemistry - A European Journal	5.6		1	0
Chemistry of Materials	9.4		3	2
Inorganic Chemistry	4.6		1	1
The Journal of Physical Chemistry C	4.9		1	1
Nanoscale Horizon	New		1	0
Physical Chemistry Chemical Physics	4.3		1	0
Physical Review B: Condensed Matter and Materials Physics	3.5		2	0
Review of Scientific Instruments	1.4		1	0
Synchrotron Radiation News	n/a		1	1
TOTAL			**26**	**13**
*all publications listed used NSLS-II photons				

Table 5.i.2: NSLS-II Peer Reviewed Publications by Journal with a publication date in CY 2016

NSLS-II Refereed Journal Publications* by Journal - CY 2017				
Journal Name	**Impact Factor**	**Category**	**Publications**	**Publication with NSLS-II Facility Staff as Co-Author**
Journal of the American Chemical Society	12.4	*high impact*	2	0
Physical Review Letters	7.3	*high impact*	1	0
Nature Communications	12.0		1	0
Advanced Functional Materials	11.8		1	0
Journal of Nuclear Materials	2.2		1	1
NPJ Quantum Materials	New		1	1
Scientific Reports	5.5		1	0
TOTAL			**8**	**2**
*all publications listed used NSLS-II photons				

Table 5.i.3: NSLS-II Peer Reviewed Publications by Journal with a publication date in CY 2017

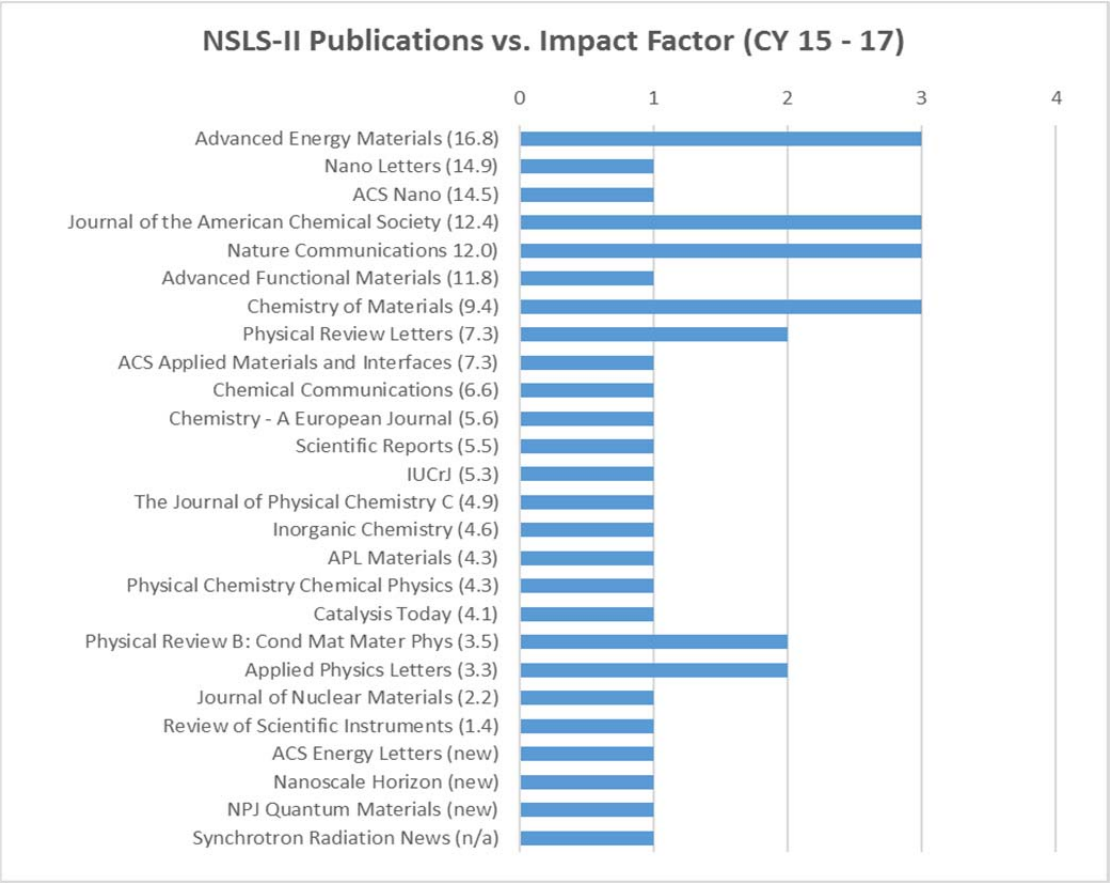


Figure 5.i.1: NSLS II Refereed Publications by Journal, ranked by impact factor for CY15, 16 & CY17 year to date.

5.ii

List the total number of other publications, conference proceedings, books, or book chapters, dissertations, and patents since the start of operations.

NSLS-II Total Publication Breakdown				
		CY2015	**CY2016**	**CY2017** (as of May 1, 2017)
1	User pubs using NSLS-II photons (no staff)	0	17	8
2	Staff pubs using NSLS-II photons	7	21	2
TOTAL pubs using NSLS-II photons (sum #1 - #2)		**7**	**38**	**10**
3	Staff pubs doing R&D related to NSLS-II beamlines	10	7	2
4	Staff pubs performing accelerator research (no beamline)	50	48	5
5	Staff research pubs as PI or co-PI (not on NSLS-II beamlines)	23	23	3
NSLS-II pubs TOTAL (sum #1 - #5)		**90**	**116**	**20**
Additional staff publications				
6	Other staff research pubs (at other facilities)	36	27	5
7	Staff pubs on NSLS beamlines	102	72	8
GRAND TOTAL (NSLS-II pubs + additional staff pubs) (sum #1 - #7)		**228**	**215**	**33**

Table 5.ii.1: Here we list all publications (i.e. refereed and non-refereed) by category, distinguishing those that utilized NSLS-II photons and those that did not, breaking the latter out into staff research related to NSLS-II beamlines, to the NSLS-II accelerator, those unrelated to a beamline, those that utilized other facilities or those that used the now-closed NSLS. In the following table we break down the publications that utilized NSLS-II photons further, listing them by type.

NSLS-II Beamline Total Publications* by Type			
Publication Type	**CY 2015**	**CY 2016**	**CY 2017** (as of May 1, 2017)
Chapter In Book	0 (0)	0 (0)	0 (0)
Conference Proceedings	1 (1)	0 (0)	0 (0)
Dissertation	0 (0)	7 (5)	1 (0)
Formal Report	1 (1)	0 (0)	0 (0)
Journal Article - High Profile	0 (0)	1 (1)	1 (0)
Journal Article - High Impact	0 (0)	6 (4)	3 (0)
Journal Article - Peer Reviewed, Not High Impact	3 (3)	19 (8)	5 (2)
Journal Article - Not Peer Reviewed	0 (0)	1 (1)	0 (0)
Patent	0 (0)	0 (0)	0 (0)
Technical Report	2 (2)	3 (3)	1 (0)
Thesis	0 (0)	2 (2)	0 (0)
TOTAL	**7 (7)**	**38 (21)**	**10 (2)**
* all publications used NSLS-II photons; numbers in parentheses indicates beamline publications with NSLS-II staff as co-authors			

Table 5.ii.2: NSLS-II Total Publications by Type. Here we list papers that utilized NSLS-II photons for some portion of the work. High profile journals and high impact journals follow the standard DOE definitions, specifically; high profile journals are Science, Nature, Physical Review Letters and Cell. High impact journals are Science, Nature, Physical Review Letters, Cell, Journal of the American Chemical Society, Proceedings of the National Academy of Sciences USA, Nano Letters, Nature Chemical Biology, Nature Chemistry, Nature Geosciences, Nature Materials, Nature Nanotechnology, Nature Photonics, Nature Physics, Nature Structural and Molecular Biology Angewandte Chemie International Edition, Advanced Materials, Environmental Science and Technology, Applied Physics Letters and EMBO Journal.

NSLS / NSLS-II Transition Beamline Program (2015 – 2017)

		Unique Users	*Proposals*	*Publications*
ALS-Infrared	Beamlines 1.4, 5.4	20	14	3
APS-TXM	Beamline 8-BM	29	44	7
APS-diffraction	Beamline 6-BM-A	53	29	2
SSRL-Spectroscopy	Beamline 2-2	60	33	20
SSRL-MX	Beamline 14-1	191	53	22
TOTAL		**353**	**173**	**54**

Table 5.ii.3: The NSLS-II supports a transition program for former NSLS Users to work at Other Facilities including ALS, APS and SSRL. Here we report the unique user supported on each of the beamlines (2015-2017), the number of proposals that were accepted, and the publications to date.

ALS-Infrared

1. Miller, L.M., M. Gragg, T.G. Kim, and P.S.H. Park, *Misfolded opsin mutants display elevated beta-sheet structure.* Febs Letters, 2015. **589**(20): p. 3119-3125.
2. Ross, R.D., M. Mashiatulla, A.G. Robling, L.M. Miller, and D.R. Sumner, *Bone Matrix Composition Following PTH Treatment is Not Dependent on Sclerostin Status.* Calcified Tissue International, 2016. **98**(2): p. 149-157.
3. Ross, R.D. and D.R. Sumner, *Bone Matrix Maturation in a Rat Model of Intra-Cortical Bone Remodeling.* Calcified Tissue International, 2017.

APS-Transmission X-Ray Microscopy

1. Bock, D.C., C.J. Pelliccione, W. Zhang, J. Wang, K.W. Knehr, J. Wang, F. Wang, A.C. West, A.C. Marschilok, K.J. Takeuchi, and E.S. Takeuchi, *Dispersion of Nanocrystalline Fe3O4within Composite Electrodes: Insights on Battery-Related Electrochemistry.* ACS Applied Materials & Interfaces, 2016. **8**(18): p. 11418-11430.
2. Cama, C.A., C.J. Pelliccione, A.B. Brady, J. Li, E.A. Stach, J. Wang, J. Wang, E.S. Takeuchi, K.J. Takeuchi, and A.C. Marschilok, *Redox chemistry of a binary transition metal oxide (AB2O4): a study of the Cu2+/Cu0and Fe3+/Fe0interconversions observed upon lithiation in a CuFe2O4battery using X-ray absorption spectroscopy.* Phys. Chem. Chem. Phys., 2016. **18**(25): p. 16930-16940.
3. Feng, H., W. Zhang, Y. Qian, W. Liu, L. Yu, S. Yoo, J. Wang, J.-J. Wang, C. Eng, C.-J. Liu, and R. Tappero, *Synchrotron X-ray microfluorescence measurement of metal distributions in Phragmites australis root system in the Yangtze River intertidal zone.* Journal of Synchrotron Radiation, 2016. **23**(4): p. 937-946.
4. Wang, H., B.P. Weiss, X.-N. Bai, B.G. Downey, J. Wang, J. Wang, C. Suavet, R.R. Fu, and M.E. Zucolotto, *Lifetime of the solar nebula constrained by meteorite paleomagnetism.* Science, 2017. **355**(6325): p. 623-627.
5. Wang, J., L. Wang, C. Eng, and J. Wang, *Elucidating the Irreversible Mechanism and Voltage Hysteresis in Conversion Reaction for High-Energy Sodium-Metal Sulfide Batteries.* Advanced Energy Materials, 2017: p. 1602706.

6. Wang, L., J. Wang, X. Zhang, Y. Ren, P. Zuo, G. Yin, and J. Wang, *Unravelling the origin of irreversible capacity loss in NaNiO 2 for high voltage sodium ion batteries.* Nano Energy, 2017. **34**: p. 215-223.
7. Xie, Y., H. Wang, G. Xu, J. Wang, H. Sheng, Z. Chen, Y. Ren, C.-J. Sun, J. Wen, J. Wang, D.J. Miller, J. Lu, K. Amine, and Z.-F. Ma, *In Operando XRD and TXM Study on the Metastable Structure Change of NaNi1/3 Fe1/3 Mn1/3 O2 under Electrochemical Sodium-Ion Intercalation.* Advanced Energy Materials, 2016. **6**(24): p. 1601306.

APS-Diffraction

1. Bock, D.C., A.M. Bruck, C.J. Pelliccione, Y. Zhang, K.J. Takeuchi, A.C. Marschilok, and E.S. Takeuchi, *Li/Ag2VO2PO4 batteries: the roles of composite electrode constituents on electrochemistry.* RSC Adv., 2016. **6**(108): p. 106887-106898.
2. Huie, M.M., D.C. Bock, Z. Zhong, A.M. Bruck, J. Yin, E.S. Takeuchi, K.J. Takeuchi, and A.C. Marschilok, *Rate Dependent Multi-Mechanism Discharge of Ag0.50VOPO4·1.8H2O: Insights from In Situ Energy Dispersive X-ray Diffraction.* Journal of The Electrochemical Society, 2016. **164**(1): p. A6007-A6016.

SSRL-Spectroscopy

1. Choi, Y., I. Sinev, H. Mistry, I. Zegkinoglou, and B.R. Cuenya, *Probing the Dynamic Structure and Chemical State of Au Nanocatalysts during the Electrochemical Oxidation of 2-Propanol.* Acs Catalysis, 2016. **6**(5): p. 3396-3403.
2. Colmer, H.E., A.W. Howcroft, and T.A. Jackson, *Formation, Characterization, and O-O Bond Activation of a Peroxomanganese(III) Complex Supported by a Cross-Clamped Cyclam Ligand.* Inorganic Chemistry, 2016. **55**(5): p. 2055-2069.
3. Corona, T., L. Ribas, M. Rovira, E.R. Farquhar, X. Ribas, K. Ray, and A. Company, *Characterization and Reactivity Studies of a Terminal Copper-Nitrene Species.* Angewandte Chemie International Edition, 2016. **55**(45): p. 14005-14008.
4. Engelmann, X., S. Yao, E.R. Farquhar, T. Szilvási, U. Kuhlmann, P. Hildebrandt, M. Driess, and K. Ray, *A New Domain of Reactivity for High-Valent Dinuclear [M(μ-O)2M'] Complexes in Oxidation Reactions.* Angewandte Chemie International Edition, 2017. **56**(1): p. 297-301.
5. Hughes, N.A., V. Gloriot, D.D. Smiley, G. Jacobs, V.R.R. Pendyala, U.M. Graham, W. Ma, M.K. Gnanamani, W.D. Shafer, A. Maclennan, Y. Hu, S. Khalid, and B.H. Davis, *Fischer-Tropsch synthesis: comparisons of Al2O3 and TiO2 supported Co catalysts prepared by aqueous impregnation and CVD methods* in *Fischer-Tropsch Synthesis, Catalysts and Catalysis: Advances and Applications*, B.H. Davis and M.L. Occelli, Editors. 2016, CRC Press, Taylor & Francis Group: Boca Raton, FL, USA. p. 85-106.
6. Kucheryavy, P., N. Lahanas, E. Velasco, C.J. Sun, and J.V. Lockard, *Probing Framework-Restricted Metal Axial Ligation and Spin State Patterns in a Post-Synthetically Reduced Iron-Porphyrin-Based Metal-Organic Framework.* Journal of Physical Chemistry Letters, 2016. **7**(7): p. 1109-1115.
7. Liu, J., Y. Amit, Y.Y. Li, A.M. Plonka, S. Ghose, L.H. Zhang, E.A. Stach, U. Banin, and A.I. Frenkel, *Reversed Nanoscale Kirkendall Effect in Au-InAs Hybrid Nanoparticles.* Chemistry of Materials, 2016. **28**(21): p. 8032-8043.
8. Matsubu, J.C., S. Zhang, L. DeRita, N.S. Marinkovic, J.G. Chen, G.W. Graham, X. Pan, and P. Christopher, *Adsorbate-mediated strong metal–support interactions in oxide-supported Rh catalysts.* Nature Chemistry, 2016. **9**(2): p. 120-127.

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In the following tables we list the publications for the former NSLS which remains productive.

NSLS Publications - CY 2015

	NSLS beamline publications	NSLS publications with staff as co-author
Chapter In Book	3	1
Conference Proceedings	10	5
Dissertation	10	0
Formal Report	0	0
Journal Article - High Profile	13	5
Journal Article - High Impact	82	10
Journal Article - Not Peer Reviewed	5	2
Journal Article - Peer Reviewed, Not High Impact	425	84
Patent	3	0
Technical Report	1	0
Thesis	13	0
CY 2015 Total	**552**	**102**

Table 5.ii.4: Publications resulting from work performed at NSLS in CY2015

NSLS Publications - CY 2016

	NSLS beamline publications	NSLS publications with staff as co-author
Chapter In Book	1	0
Conference Proceedings	12	10
Dissertation	8	2
Formal Report	8	1
Journal Article - High Profile	6	1
Journal Article - High Impact	35	6
Journal Article - Not Peer Reviewed	6	1
Journal Article - Peer Reviewed, Not High Impact	262	52
Patent	3	0
Technical Report	0	0
Thesis	3	0
CY 2016 Total	**338**	**72**

Table 5.ii.5: Publications resulting from work performed at NSLS in CY2016

NSLS Publications - CY 2017 (as of May 1, 2017)

	NSLS beamline publications	NSLS publications with staff as co-author
Conference Proceedings	2	0
Dissertation	1	0
Journal Article - High Profile	3	1
Journal Article - High Impact	10	1
Journal Article - Not Peer Reviewed	1	0
Journal Article - Peer Reviewed, Not High Impact	48	7
Patent	0	0
Technical Report	0	0
CY 2017 Total	**62**	**8**

Table 5.ii.6: Publications resulting from work performed at NSLS in CY2017

5.iii Invited Lectures and Major Awards for Facility Staff and External Users

Shown below are detailed lists of invited lectures for NSLS-II staff and users. Please note that NSLS-II does not regularly track information on lectures given by users. For the purpose of compiling this report, the NSLS-II made a special request to its users, and this list represents the responses received to date. Thus, it is not a complete list. Following the invited lectures listing, awards are detailed.

5.iii.a Invited Lectures: Users

Christopher Bunick, Yale University

"Defining the Chemical and Structural Properties of Human Keratins Using X-ray Crystallography," International Pachyonychia Congenita Consortium (IPCC) Symposium, Scottsdale, Arizona (May 10-11, 2016)

Rocco Caliandro, Istituto di Cristallografia (IC), Consiglio Nazionale delle Ricerche (CNR)

"Structural Mass Spectrometry of Protein Complexes and Membrane Proteins," Department of Chemistry, Tohoku University, Sendai Japan (Feb. 2015).

"Structural Dynamics by Modulated Enhanced Diffraction," Probing Dynamic Processes in Soft Materials Using Advanced Light Sources", tenutosi a Santa Fe, New Mexico (July 25-27, 2016).

Mark Chance, Case Western Reserve University

"*Structural Mass Spectrometry of Protein Complexes and Membrane Proteins,"* American Society for Mass Spectrometry, St Louis MO (June 2015).

"*New Opportunities in X-ray Footprinting"* ALS, Lawrence Berkeley Laboratories, Berkeley CA (October 2015).

"Systems Biology of Complex Disease," School of Informatics and Tohoku Megabank, *Organization* Tohoku University, Sendai Japan (November 2015).

"Mass Spectrometry for Structural Biology Research," Waters Corp, Milford MA (January 2016).

"Structural Mass Spectrometry of Protein Complexes and Membrane Proteins," Arizona State University (February 2017)

Richard Comin, Massachusetts Institute of Technology

"*Opportunities for Soft X-ray Scattering at the Nanoscale,"* ALS-U: Solving Scientific Challenges with Coherent Soft X-rays, Berkeley, CA (January 18-19, 2016).

Moeshe Deutsch, Bar-Ilan University

"The Nanoscale Structure of Liquid Interfaces: Where Order Emerges From Disorder," Israel-China Inter-Academy Symposium in Nanotechnology, Israel Academy of Sciences, Jerusalem, (July 2015)

"Using X-ray Crystallography to Correlate Protein Structure with Function in Human Skin Diseases," International Pachyonychia Congenita Consortium (IPCC) Symposium, Atlanta, Georgia (May 5-6, 2015).

Richard Ebright, Rutgers University

"Antibacterial Agents: Small-molecule Inhibitors of Bacterial RNA Polymerase," Revolution Medicines, Redwood City, California (2015).

"Antibacterial Agents: Small-molecule Inhibitors of Bacterial RNA Polymerase," Department of Antibacterial Discovery, Novartis, Emeryville, California (2015).

"Structural Studies of Transcription Initiation and Activation, and Anti-tuberculosis Drug Discovery Targeting Transcription," Department of Microbiology and Immunology, University of California, San Francisco, California (2015).

"Therapeutics for Drug-resistant Bacteria: Arylpropionyl Phloroglucinols," Centers of Excellence in Translational Research Review Meeting, National Institute of Allergy and Infectious Diseases, Rockville MD (2015).

"Structural Studies of Transcription Initiation and Activation, and Anti-tuberculosis Drug Discovery Targeting Transcription," National Institutes for Department of Microbiology and Immunology, Harvard Medical School, Boston, Massachusetts (2015).

"Mechanism of Nucleotide Addition by RNA Polymerase," Single-Molecule Biophysics (2015), Aspen, Colorado (2015).

"Structural Studies of Transcription Initiation and Transcription Activation," FASEB Meeting on Prokaryotic Transcription, Saxtons River, Vermont (2015).

"Structural Studies of Transcription Initiation and Activation, and Anti-tuberculosis Drug Discovery Targeting Transcription," Department of Microbiology and Immunology, Harvard Medical School, Boston, Massachusetts (2015).

"Antibacterial Agents: Small-molecule Inhibitors of Bacterial RNA Polymerase," Institute for Quantitative Biomedicine Symposium, Antimicrobial Resistance, Rutgers University, Piscataway, New Jersey (2015).

"Antibacterial Agents: Small-molecule Inhibitors of Bacterial RNA Polymerase," Department of Antibacterial Discovery, Novartis, Emeryville, California (2015).

"Structural Studies of Transcription Initiation and Activation, and Anti-tuberculosis Drug Discovery Targeting Transcription," Department of Microbiology and Immunology, University of California, San Francisco, California (2015).

"Therapeutics for Drug-resistant Bacteria: Arylpropionyl Phloroglucinols," Centers of Excellence in Translational Research Review Meeting, National Institute of Allergy and Infectious Diseases, Rockville MD (2015).

"Structural Studies of Transcription Initiation and Activation, and Anti-tuberculosis Drug Discovery Targeting Transcription," Department of Biochemistry, Duke University, Durham, North Carolina (2017).

"Structural Studies of Transcription Initiation and Activation, and Anti-tuberculosis Drug Discovery Targeting Transcription," National Institutes for Department of Microbiology and Immunology, Harvard Medical School, Boston, Massachusetts (2015).

"Mechanism of Nucleotide Addition by RNA Polymerase," Single-Molecule Biophysics (2015), Aspen, Colorado (2015).

"Therapeutics for Drug-resistant Bacteria: Arylpropionyl Phloroglucinols," Centers of Excellence in Translational Research Review Meeting, National Institute of Allergy and Infectious Diseases, Rockville MD (2016).

"Structural Studies of Transcription Initiation and Activation," Shanghai Institute of Plant Physiology and Ecology, Chinese Academy of Sciences, Shanghai, China (2016).

"Antibacterial Drug Discovery Targeting Bacterial RNA Polymerase: Myxopyronin (Myx)," Pharmaceutical Sciences Symposium, Rutgers University, Piscataway, New Jersey (2016).

Lynne Ecker, Brookhaven National Laboratory

"Advanced X-ray Characterization of Neutron Irradiated SiC," 40th International Conference and Expo on Advanced Ceramics and Composites, Daytona Beach, Florida, (January 2016).

"ATR Sample Characterization at the National Synchrotron Light Source – II," UCSB ATR-2 Second Annual Meeting, Presentation number: 8

"In Situ Synchrotron Characterization of the Field Assisted Sintering of UO2," 2017 TMS Annual Meeting & Exhibition, Symposium: Ceramic Materials for Nuclear Energy Research and Applications, San Diego, CA (February 26 – March 2, 2017).

Sandra Gabelli, Johns Hopkins University

"Regulation of Voltage-gated Na Channel: Dimerization and Calmodulation, University of Miami, FL (March 2015).

"PI3K: Mechanism & Drug Discovery," NSLSII, Upton, NY (March 2016).

"Girl POWER: STEP IT UP, On How Phosphate Shaped my Career," Stony Brook University. NY (March 2016).

"Nudix Superfamily," West Virginia University, Morgantown, WV (September 2016).

"Calmodulation of Sodium Voltage Gated Channels," University of Iowa-Carter School of Medicine, Iowa City, IO (December 2016).

Oleg Gang, Brookhaven National Laboratory

DNA Nanotechnology Meets Plasmonics Conference, Bad Honnef, Germany (December 2015).

"Keynote talk," 9th International Conference on Nano/Molecular Medicine and Engineering, Hawaii, November (2015)

"Keynote talk" Tailor-Made Multi-Scale Materials Systems Workshop, Hamburg, Germany (November 2015).

NYU Tandon School of Engineering, Colloquium at the Department of Chemical Engineering, New York, October (2015).

Advancing Nanoparticle Manufacturing Workshop, NIST, Washington, DC (October, 2015).

Plenary Lecture at Macromolecular Nano-objects and Polymer Nano-composites Conference, Moscow, Russia (October 2015).

Gordon Conference on Soft Matter, August, New London, NH (August 2015).

META'15, the 6th International Conference on Metamaterials, Photonic Crystals and Plasmonics, New York (August 2015).

"Enrico Fermi on Soft Matter Self-Assembly," Course of Lectures at the International School of Physics Varenna, Italy (July 2015).

Soft Nano Workshop at CUNY Advanced Science Research Center Nanoscience Initiative (June 2015).

"Design, Fabrication and Self-assembly of Anisotropic and Patchy Particles" European MRS, Symposium Lille, France (May 2015).

Workshop on Complex Liquids at Structured Substrates, Berlin (February, 2015).

Chemistry Colloquium, University of Georgia, Athens, GA (October 2015).

US Army Research Laboratory, Bio-Enable Materials, Planning and Strategy Meeting (December 2-3, 2016).

MRS Fall 2016, Symposium Functional Plasmonics, Boston, MA (November 2016)

"Opportunities for New X-Ray Sources to Shed Light on Mesoscale Functional Materials," Workshop, Santa Fe (July 21-22, 2016).

"Breakthrough Technologies for Energy: Atomic Precision for Energy Generation, Transmission, and Use Reduction", Workshop, Foresight Institute, Palo Alto, California (May 20-22, 2016).

Department of Energy, Basic Energy Sciences, Basic Energy Needs (BRN) workshop on *"Synthesis Science for Energy Relevant Technology"* (May 2-4, 2016).

14th International Conference on Magnetic Fluids, Ekaterinburg, Russia (July 2016).

Rutgers University, Seminar at the Institute for Advanced Materials, Devices and Nanotechnology and the Laboratory for Surface Modification (May, 2016).

Faraday Discussions Conference on Nanoparticle Assembly, Mumbai, India (January 2016).

Workshop on Synthesis, Characterization and Applications of Nanoparticle Assemblies, Pune, India (January 2016).

Dean Hesterberg, North Carolina State University

"Microscale Accumulation and Chemical Speciation of Arsenate on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 19-20, 2016).

"Microscale Accumulation and Speciation of Arsenic in a Soil Matrix in Relation to its Microsite Composition," Soil Science Society of America, Phoenix, AZ (Nov 6-9, 2016).

"Microscale Assessment of Arsenic Reactivity on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 17-18, 2017).

"Microscale Assessment of Arsenate Reactivity on a Sand Grain from Wagram Soil," Symposium of Center for Human Health and the Environment (CHHE), NC State University, Raleigh, NC (Feb 16, 2017).

Frederick Hughson, Princeton University

"A Direct Role for SM Proteins as Templates for SNARE Assembly," 40th FEBS Congress: The Biochemical Basis of Life, Berlin, Germany (July 2015).

"A Direct role for SM Proteins as Templates for SNARE Assembly," New York Structural Biology Discussion Group, New York, NY (August 2015).

"Know When to Hold 'em, Know When to Fold 'em: SM Proteins as Templates for SNARE Assembly," Biophysical Society 61st Annual Meeting, New Orleans, LA (February 2017).

"Know When to Hold 'em, Know When to Fold 'em: Chaperoning SNARE Assembly to Control Membrane Fusion," 38th Steenbock Symposium: Protein Trafficking in the Secretory Pathway, Madison, WI (June, 2017).

"*Know When to Hold 'em, Know When to Fold 'em*: Chaperoning SNARE Assembly to Control Membrane Fusion," Gordon Research Conference on Molecular Membrane Biology, Andover, NH (July, 2017).

Jean Jordan-Sweet, IBM

"Synchrotron X-ray Studies of Thin Films and Structures for IBM R&D," Semiconductor Technology Development through Characterization by Synchrotron and Electron Microscopy Techniques Workshop 5 in 2015 NSLS-II/CFN Users' Meeting, Brookhaven National Laboratory (May 20, 2015).

Roopali Kukreja, University of California at Davis

"Imaging Ultrafast Switching in Magnetite and Spin Currents in Copper," Lawrence Berkeley National Laboratory (October 2016)

"Imaging Ultrafast Switching in Magnetite and Spin Currents in Copper," University of California Davis, Laboratory (April 2016).

"Ultrafast X-ray Studies of Correlated Materials," University of Illinois at Urbana-Champaign (April 2017).

"Ultrafast X-ray Studies of Correlated Materials," THz UED Workshop at SLAC National Accelerator Laboratory (March 2017)

"Ultrafast X-ray Imaging of Magnetic and Correlated Materials," University of California Davis (January 2017).

Alexandros Lappas, Institute of Electronic Structure and Laser (IESL), Foundation for Research and Technology - Hellas (FORTH)

"Multicomponent Colloidal Nanocrystals: a Toolbox of Versatile Functionality," 15th European Powder Diffraction Conference (EPDIC15), Micro Symposium MS-09 "Nanomaterials, Surfaces and Interfaces Bari, Italy (June 12-15, 2016).

Robert C. Liebermann, Stony Brook University

"Indoor Seismology: Probing the Earth's Interior using Sound Velocity Measurements at High Pressures and Temperatures in Conjunction with Synchrotron X-Radiation," Hawaii Institute of Geophysics and Planetology, University of Hawaii (March 2015).

"Study of the Earth's Interior using Measurements of Sound Velocities in Minerals by Ultrasonic Interferometry," Joint Assembly of Canadian Geophysical Union and American Geophysical Union, Montreal, Canada **(**May 2015).

"Recent Advances in Measurements of Sound Velocities in Minerals by Ultrasonic Interferometry at High Pressures and Temperatures using Synchrotron X-radiation,", AIRAPT, Madrid, Spain (September 2015)

"Recent Advances in Measurements of Sound Velocities in Minerals by Ultrasonic Interferometry at High Pressures and Temperatures using Synchrotron X-radiation," European High Pressure Research Group, Bayreuth, Germany (September 2016).

"Recent Advances in Measurements of Sound Velocities in Minerals by Ultrasonic Interferometry at High Pressures and Temperatures using Synchrotron X-radiation," Study of Materials at Extreme Conditions Conference, Ft. Lauderdale, Florida (April 2017).

Dean Madden, Dartmouth College

"Trafficking in CF Therapies," Novartis Institute of Biomedical Research, Cambridge, MA (January 2015).

"Trafficking in CF Therapies," European Cystic Fibrosis Conference, Albufeira, Portugal. (March 2015).

"The Stereochemistry of Substrate Selectivity and Active-site Inhibition," Bioactive Lipids in Cancer Meeting, Budapest, Hungary (July 2015).

"Trafficking in CF Therapies: Selective Inhibitors of the CAL PDZ Domain," Dept. of Molecular Biology and Biotechnology, University of Sheffield, UK (July 2015).

"Trafficking in CF Therapies: Selective Inhibitors of the CAL PDZ Domain," SRI International, Harrisonburg, VA (September 2015).

"Trafficking in CF Therapies: Selective Inhibitors of the CAL PDZ Domain," Molecular and Cellular Biology Graduate Program, University of Massachusetts, Amherst, MA (April 2016).

Filippo Mangolini, Laboratoire de Tribologie et Dynamique des Systèmes, /Ecole Centrale de Lyon

"Unravelling the Physical Pathways and Energetics of the Thermally-Induced Structural Evolution of Advanced Amorphous Carbon-Based Surfaces," Laboratoire de Tribologie et Dynamique des Systèmes, Ecole Centrale de Lyon, Lyon, France (January 29, 2015)

Richard Osgood, Jr., Columbia University

"The Science of Energetic Beam Interactions with Solid-gas Interfaces," AVS-NW Section, Richland WA (September 25, 2016).

"Tuning the Electronic Structure in 2D Transition-Metal-Dichalcogenide Crystals", Seminar in Frontiers in Chemical Physics and Analysis Series, Richland, WA (September 24, 2016).

"Four Problems in Interfacial Chemistry and Physics of Weakly Bound Layers," Harvard University EFRC Seminar Series, Cambridge Mass (March 25, 2016).

"Tuning the Electronic Structure in 2D Transition-Metal-Dichalcogenide Crystals" Harvard University, Seminar Series, Cambridge Mass (March 1, 2016).

"NH Tuning the Electronic Structure of 2D Transition-Metal-Dichalcogenide Films," University of New Hampshire, Durham (2017).

Paul Park, Case Western Reserve University

"Nanodomains, Oligomers and Aggregates of Rhodopsin," 3rd Biennial Symposium: Optical Micro-Spectroscopy and Molecular Imaging, Milwaukee, WI (August 28-29, 2015).

"Nanodomains, Oligomers and Aggregates of Rhodopsin," 2nd European Meeting on Phototransduction, Monte Verita, Switzerland (September 4-7, 2016).

"Rhodopsin Structure and Activity in Health and Retinal Disease," Department of Pharmaceutical Sciences, Northeast Ohio Medical University, Rootstown, OH (February 12, 2016).

Chris Ryan, University of Melbourne

Australian X-ray Analytical Association Conference (AXAA), Melbourne (February 2017).

Brad Rothberg, Temple University School of Medicine

"Conformational Motions of K+ Channel RCK Domains," Southern Center for Research on Nervous System Diseases (CiSNe) Summer Symposium in Biophysics and Neurobiology, Valdivia, Chile (January 7, 2015).

"Conformational Motions of K+ Channel RCK Domains," Membrane Biophysics Subgroup Symposium, Biophysical Society 59th Annual Meeting, Baltimore, MD (February 7, 2015).

Nadrian C. Seeman

"*Keynote,"* NY Nanoscience, City University of New York, New York (2015).

Frontiers in Polymer and Biomolecular Chemistry, Tel Aviv, Israel (2015).

4th International Conference on Ontological Engineering, Leeds, UK (2015).

DNA-Based Materials and Nanosymposium, Leeds, UK (2015).

ARO MURI, Silver Spring, MD (2015).

Biologically Enabled Self-Assembly, Tallahassee, FL (2015).

Nineteenth Conversation in Biomolecular Stereodynamics, Albany, NY, 2015.

STAR Symposium, Shanghai, China (2015).

Fourth International Conference on DNA Nanotechnology, Xi'an, China (2015).

Crystal Engineering Symposium, ACA, Philadelphia, PA (2015).

DOE Biomolecular Materials Meeting, Gaithersburg, MD (2015).

DNA-21, Cambridge, MA (2015).

"*Keynote Speaker,"* Fifth International Seminar on Nanoscience & Nanotech, Havana (2015).

ONR Grant Review, Evanston, IL (2015).

Alexander Rich Memorial Gathering, Cambridge, MA (2015).

Materials Research Society, Boston, MA (2015).

DNA Nanotechnology Meets Plasmonics, Bad Honnef, Germany (2015).

ARO MURI Conference, Irvine, CA (2016).

Plenary Lecture, PACCON 2016, Bangkok, Thailand (2016).

Ten Years of DNA Origami, Pasadena, CA (2016).

Franklin Institute Prize Symposium, Philadelphia (2016).

NSF-AFOSR-ARO-DTRA-BU Symposium, Arlington, VA (2016).

Energy Landscapes: From Protein Folding to Molecular Assembly, Santa Fe, NM (2016).

Fifth International Conference on DNA Nanotechnology, Plenary Lecture, Nanjing, China (2016).

Society for Industrial and Applied Mathematics, Boston (2016).

"A Materials Genome Approach to Structure and Function," ACS, Philadelphia (2016).

Academy of Computational Life Sciences Summer School, New York (2016).

22nd Conference on DNA-Based Computers (tutorial), München (2016).

2016 Kavli Prize Laureate Lecture, Carnegie Institute for Science, Washington, DC (2016).

Chaikinfest, Aspen (2017).

Aakriti Sharma, North Carolina State University

"Microscale Accumulation and Chemical Speciation of Arsenate on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 19-20, 2016).

"Microscale Accumulation and Speciation of Arsenic in a Soil Matrix in Relation to its Microsite Composition," Soil Science Society of America, Phoenix, AZ (Nov 6-9, 2016).

"Microscale Assessment of Arsenic Reactivity on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 17-18, 2017).

"Microscale Assessment of Arsenate Reactivity on a Sand Grain from Wagram Soil," Symposium of Center for Human Health and the Environment (CHHE), NC State University, Raleigh, NC (Feb 16, 2017).

Matt Siebecker, University of Delaware

"Precipitation and Kinetics of Mixed-metal Solids in Soils, Sediments, and Mineral Systems: Implications for Equilibrium Speciation Calculations," 251st American Chemical Society National Meeting & Exposition, San Diego, CA (March 13-17, 2016).

Donald Sparks, University of Delaware

"Grand Challenges in Global Security: The Water, Climate, Soil and Food Nexus," The 12th Dahlia Greidinger Memorial Symposium 2016, Haifa, Israel (February 29-March 2, 2016).

"Main Targets and Challenges for Assuring Global Food and Water Security," The 12th Dahlia Greidinger Memorial Symposium 2016, Haifa, Israel (February 29-March 2, 2016).
Sparks, D.L. and H. Magen

"Precipitation and Kinetics of Mixed-metal Solids in Soils, Sediments, and Mineral Systems: Implications for Equilibrium Speciation Calculations," 250st American Chemical Society National Meeting and Exposition, San Diego, CA (March 13-17, 2016).
"Shining Light on Metal Speciation and Remediation of Contaminated Soils," Australian Land and Groundwater Association Meeting, Newcastle, Australia (April 5. 2016).

"Advances in the Use of Synchrotron Radiation to Study Biogeochemical Processes," The University of Newcastle (UON), Newcastle, Australia (April 6, 2016).

"The Water, Climate, Soil and Food Nexus: Grand Challenges and Opportunities," University of Wyoming, Laramie, WY (May 5, 2016).

"Advances In The Use Of Small Spatial And Temporal Scale Synchrotron-Based Techniques To Elucidate Biogeochemical Processes In Natural Systems," University of Wyoming, Laramie, WY (May 6, 2016).

"Drilling Into New Depths of Clay Science," Pioneer in Clay Science Lecture, Clay Minerals Society Meeting, Atlanta, GA (June 8, 2016)

"Hydrologically Controlled Arsenic Release in Deltaic Wetlands and Coastal Riparian Zones," AGU Fall Meeting, San Francisco, CA (December 12-16, 2016).

"Advances In The Use Of Small Spatial And Temporal Scale Synchrotron-Based Techniques To Elucidate Biogeochemical Processes In Natural Systems," Department of Environmental Sciences, UC-Riverside (May 9, 2017).

David Sprouster, Brookhaven National Laboratory

"Advanced X-ray Characterization of Neutron Irradiated SiC," 40th International Conference and Expo on Advanced Ceramics and Composites, Daytona Beach, Florida, (January 2016).

"In Situ Synchrotron Characterization of the Field Assisted Sintering of UO2," 2017 TMS Annual Meeting & Exhibition, Symposium: Ceramic Materials for Nuclear Energy Research and Applications, San Diego, CA (February 26 – March 2, 2017).

John Tranquada, Brookhaven National Laboratory

"Charge Pinning and Screening in Cuprate Superconductors," Spectroscopies in Novel Superconductors, Ludwigsburg, Germany (June 20--24, 2016).

"Intertwined Superconductivity and Antiferromagnetism in Cuprates," Superstripes Conference, Ischia, Italy (June 23--29, 2016).

Kurt Vetter, Oak Ridge National Laboratory

"The BNL EBPM Electronics -High Performance for Next Generation Light Sources," NAPAC2016, Chicago, IL (October 9-14, 2016).

M. Stanley Whittingham, Binghamton University

"The Ultimate Limits of Intercalation Cathodes: Two Li as an Alternative to Mg Intercalation," IBA Meeting, Waikoloa, Hawaii (January 2015).

"Two Electron Intercalation Cathodes: Two Li Ions as an Alternative to Mg," TMA Orlando, FL, (March 16, 2015).

"Cathode: Pushing the Limits of Intercalation Electrodes: What is Next?," 10th US-China Workshop, Beijing, China (March 29, 2015).

"Materials Limitations to Li Batteries – How far can we go?," Chemistry Department. Seminar, University of Albany (April 14, 2015).

"The Ultimate Limitations of Lithium Intercalation Batteries - A Reality Check on Beyond Li-Ion," 5th Next Generation Batteries Conference, San Diego, CA (April 21, 2015).

"What are the Ultimate Limits for Intercalation Reactions for Li-Batteries, and How Do We Attain Them?" Materials Institute Seminar, University of Texas at Austin (May 7, 2015).

"Intercalation Compounds: What are their Ultimate Limits in Lithium Batteries?" International Conference on Intercalation Compounds, Strasbourg, France (June 1, 2015).

"The Ultimate Limits of Li-ion Batteries, and What's Next - A Reality Check on Beyond Li-ion Reactions?" NERM, ACS, Ithaca, NY (June 11, 2015).

"The Ultimate Limits of Intercalation Reactions for Battery Electrodes," 20th International Conference on Solid State Ionics, Keystone, CO (June 18, 2015).

"What are the Limits of Intercalation Reactions for Lithium Batteries?," ICMAT, Singapore, (June 29, 2015).

5.iii.b Invited Lectures: NSLS-II Staff

Andi Barbour

"XPCS and the Soft X-ray Regime: Current Achievements and Future Opportunities at the Coherent Soft X-ray Scattering (CSX) Beamline," 2016 NSLS-II & CFN Joint Users' Meeting, Upton, NY (May 25, 2016).

Gabriele Bassi

"Impedance and Instabilities Studies at NSLS-II," Sirius Impedance and Collective Effects Meeting (November 2016).

"Analysis of Single- and Multi-bunch Collective Effects in NSLS-II," TWIICE 2, Second Topical Workshop on Instabilities, Impedances and Collective Effects (February 2016).

"Self-consistent Simulations of Coupled-bunch Instabilities for Arbitrary Multibunch Configurations," .NOCE'17, NOnlinear Dynamics and Collective Effects in Particle Beam Physics (September 19-22, 2017).

Lonny Berman

"Biological X-Ray Crystallography and Scattering Opportunities at the ABBIX Beamlines at the National Synchrotron Light Source –II (NSLS-II)," 66th Annual Meeting of the American Crystallographic Association, Denver, CO (July 2016).

Valentina Bisogni

"Probing Spin Interactions in Edge- and Corner-shared Cuprate Systems by Resonant Inelastic Soft X-ray Scattering," Workshop on Quantum Magnets, Crete, Greece (September 13-18 2015).

"Revealing the Electronic Ground State of ReNiO3 Combining High Resolution Ni-L3 X-ray Absorption and Resonant Inelastic X-ray Scattering," International Conference on Inelastic X-ray Scattering IXS 2015, Taiwan (November 22-26, 2015).

Alexei Blednykh

"Microwave Instability Studies in NSLS-II," 2016 North American Particle Accelerator conference (NAPAC16), Chicago, IL (October 9-14, 2016).

Yong Cai

"*Ultrahigh Resolution Crystal Optics Development at NSLS-II and Applications Towards 0.1 meV for Inelastic X-ray Scattering,*" BES-CAS Workshop on X-ray Optics and Detectors, SLAC National Accelerator Laboratory, Menlo Park, California (January 14-16, 2015).

"*Inelastic X-ray Scattering (10-ID IXS),*" 2015 NSLS-II & CFN Users' Meeting, Plenary Session, Brookhaven National Laboratory, Upton, New Year (May 19, 2015).

"*The Ultrahigh Resolution Inelastic X-ray Scattering (IXS) Beamline at NSLS-II and Opportunities for the Study of Fast Dynamics in Mesoscale*" (declined, travel was not approved),

International Workshop on The Structure and Dynamics of Supercooled Water and other Glassy Materials, Palermo, Italy (October 10-13, 2015).

"*The Ultrahigh Resolution Inelastic X-ray Scattering (IXS) Beamline at NSLS-II and Opportunities for the Study of Fast Dynamics in Mesoscale,*" IXS2015, 9th International Conference on Inelastic X-Ray Scattering, National Synchrotron Radiation Research Center, Hsinchu, Taiwan (November 22 – 26, 2015).

"*The IXS Beamlline: Capabilities and Opportunities,*" The Earth Laboratory – Workshop on Experimental and Computational Tools and Infrastructure for Cross-cutting Earth Sciences, NSLS-II & CFN Joint Users' Meeting, Brookhaven National Laboratory, New York (May 25, 2016).

"*The Ultrahigh Resolution IXS Beamline at NSLS-II: Current Status and Performance,*" Workshop on X-Ray Echo Spectroscopy, Advanced Photon Source (APS), Argonne National Laboratory, Illinois (September 9-10, 2016).

"*Ultrahigh-resolution Inelastic X-ray Scattering and Opportunities for High Pressure Research,*" European Materials Research Society 2016 Fall Meeting, Symposium on High Pressure Synthesis & Characterization of Functional Materials, Warsaw University of Technology, Warsaw, Poland (September 19-22, 2016).

G.L. Carr

"The Non-linear Response of a Superconductor to a Sub-Gap, Few-Cycle THz Pulse," Advanced Light Source Seminar, Berkeley, CA (Feb 2015).

"*The NSLS-II FIS | MET Beamline for Infrared and THz Spectroscopies,"* COMPRES site visit at NSLS-II, Upton, NY (August 2015).

"Dipole Bends and Other Source Opportunities for Optical, Infrared and THz Radiation on Future High-Brightness Storage Rings," Diamond Light Source, Harwell-Oxfordshire, UK (September 2015).

"A THz Time-Domain Model for Non-Equilibrium and Non-Linear Effects in Superconductors," Stony Brook University Physics Seminar, Stony Brook NY (December 2016).

"Why (and how to) Use Infrared from Synchrotron Storage Rings?," Chemical Imaging for the Future, Uppsala, Sweden (March 2017).

"Infrared Beamlines at NSLS-II", MAX-IV Lab Seminar, Lund, Sweden (March 2017).

Yu-chen Karen Chen-Wiegart

"Synchrotron Tomography and X-ray Fluorescence Imaging of Nanoporous Materials For Energy Applications," Materials Research Society Spring Meeting 2016, Phoenix, Arizona (Conference dates: March 28-April 1), (March 31, 2016).

"Microscale Accumulation and Chemical Speciation of Arsenate on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 19-20, 2016).

"Microscale Accumulation and Speciation of Arsenic in a Soil Matrix in Relation to its Microsite Composition," Soil Science Society of America, Phoenix, AZ (Nov 6-9, 2016).

"Microscale Assessment of Arsenic Reactivity on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 17-18, 2017).

"Microscale Assessment of Arsenate Reactivity on a Sand Grain from Wagram Soil," Symposium of Center for Human Health and the Environment (CHHE), NC State University, Raleigh, NC (Feb 16, 2017).

Eric Dooryhee

"X-ray Powder Diffraction," Columbia University Course, New York, NY (September 23, 2015).

"Advanced X-ray Characterization of Neutron Irradiated SiC," 40th International Conference and Expo on Advanced Ceramics and Composites, Daytona Beach, Florida, (January 2016).

"'X-ray Powder Diffraction," Yale University Course, CT (February 2, 2016).
Modern Methods in Rietveld Refinement for Structural Analysis school, Stony Brook University, NY (August 8-11, 2016).

"High-Energy X-rays for Characterizing Complex Materials," The Earth Laboratory Workshop, NSLS-ll and CFN Users' Meeting, Brookhaven National Laboratory, Upton, NY (May 23-25, 2016).

"First Steps into Powder Diffraction Science at Brookhaven's New Light Source," NYU X-Ray Diffraction Workshop, Department of Chemistry, New York University, NY (June 29-30, 2016).

"In Situ Synchrotron Characterization of the Field Assisted Sintering of UO2," 2017 TMS Annual Meeting & Exhibition, Symposium: Ceramic Materials for Nuclear Energy Research and Applications, San Diego, CA (February 26 – March 2, 2017).

Steven Ehrlich

"Quick and Conventional Scanning XAS and XRD – from NSLS to NSLS-II." Quick-scanning EXAFS Workshop, NRSSC 21st Users' Meeting & Workshops, Hsinchu, Taiwan (September 10, 2015)

John Peter Hill

"Inelastic X-ray Scattering Opportunities at LCLS-II," SLAC, February 2015

"NSLS-II Update," BESAC, February 2015

"News from Two Coasts: Time-resolved RIXS at the LCLS and an NSLS-II Update," ALS, Berkelely, CA April 1st 2015

"Electron Dynamics: From Electronvolts to Picoseconds," APS, ANL May 4, 2016

"Electron Dynamics from Electron Volts to Picoseconds," ASU Physics Colloquium, January 26, 2017

"Electron Dynamics from Electron Volts to Picoseconds," Columbia University Colloquium, February 27, 2017

Hsiao-chaun Hseuh

"National Synchrotron Light Source II Vacuum System: from Design to Operation," 20th International Vacuum Congress (IVC-20), Busan, Korea (August 21-26, 2016).

Yongjun Li

"Multi-objective Optimization of Dynamic Aperture in Storage Rings," IAS Program Conference on High Energy Physics, Hong Kong University of Science and Technology (Jan 18-21, 2016).

Nikolay Malitsky

"Bringing the HPC reconstruction algorithms to Big Data platforms," New York Scientific Data Summit (NYSDS) (August 14-17, 2016).

Evgeny Nazaretski

"Nm-scale Spatial Resolution X-ray Imaging with MLL Nanofocusing Optics: Instrumentational Challenges and Opportunities', 23rd International Congress on X-ray Optics and Microanalysis, Upton, NY (September 2015).

"Nm-scale Spatial Resolution X-ray Imaging with MLL Nanofocusing Optics: Instrumentational Challenges and Opportunities," 23rd International Congress on X-ray Optics and Microanalysis, Upton, NY (September 2015).

"Imaging with 10 nm Spatial Resolution: Instrumentational Challenges and Solutions," BES-CAS Workshop, Hangzhou, China (October 20, 2016).

Christie Nelson

"Magnetic and Structural Properties of Rare Earth Borates in Applied Magnetic Field," Energy Materials Nanotechnology Croatia Meeting (May 2016).

Ron Pindak

"Probing In-Situ Processing from Atoms to Polymers," CHESS-U Workshop: Materials Design and Processing from Nano to Mesoscale, Ithaca, NY (June 13-14, 2016).

Boris Podobedov

"Towards Sub-Micron Orbit Stability at NSLS-II," Low Emittance Rings Workshop 2015 (LER2015), Grenoble, France (September 2015).

Qun Shen

"NSLS-II Science and Development Programs", International Conference on X-ray Optics & Microanalysis, Stony Brook, NY, September 14-18, 2015.

"NSLS-II Science Programs", Molecular Science Research Seminar, Molecular Science Research Center, University of Puerto Rico, Puerto Rico, October 22, 2015.

"Puerto Rico Science, Technology and Research Trust (PRSTRT) – National Synchrotron Light Source II (NSLS-II) Alliance", Puerto Rico Science, Technology & Research Trust, Puerto Rico, October 23, 2015.

"Science and Technology Development at Light Source Facilities around the World", African Light Source Workshop at ESRF, Grenoble, France, November 16-20, 2015.

"NSLS-II Experimental Facilities & Opportunities in Advanced Manufacturing Sciences", Round Table on Advanced Manufacturing Sciences, Brookhaven National Laboratory, April 20-21, 2016.

"NSLS-II Science Programs and Capabilities for Earth Science Applications", Annual Meeting of COMPRES, Albuquerque, NM, June 20-23, 2016.

"Overview of Science Capabilities at NSLS-II", Workshop on Matter-Radiation Interactions at the Extremes (MaRIE)", Los Alamos National Laboratory, Santa Fe, NM, July 25-27, 2016.

"NSLS-II Capabilities & Opportunities in Advancing Materials Sciences of DTRA Interest", Keynote Presentation at the Defense Threat Reduction Agency (DTRA) Workshop on Surface Science & Multifunctional Materials, Raleigh, NC, September 27-29, 2016.

Ryan Tappero

"Microscale Accumulation and Chemical Speciation of Arsenate on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 19-20, 2016).

"Microscale Accumulation and Speciation of Arsenic in a Soil Matrix in Relation to its Microsite Composition," Soil Science Society of America, Phoenix, AZ (Nov 6-9, 2016).

"Microscale Assessment of Arsenic Reactivity on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 17-18, 2017).

"Microscale Assessment of Arsenate Reactivity on a Sand Grain from Wagram Soil," Symposium of Center for Human Health and the Environment (CHHE), NC State University, Raleigh, NC (Feb 16, 2017).

Guimei Wang

"Results of the NSLS-II Commissioning," American Physical Society April meeting, Baltimore, MD (April 11-14, 2015).

"Status of NSLS-II," Low Emittance Rings Workshop 2016, SOLEIL, France (Oct. 26-28, 2016).

Jun Wang

"Tracking Structural and Electrochemical Changes at the Nanoscale on Lithium Battery Material while Cycling," Next Generation Batteries Conference, San Diego, CA (April 21-22, 2015).

"In-situ Tracking Structural and Chemical Evolutions at Nanoscale," Colloquium at Shanghai Synchrotron Radiation Facility (May 2015).

"In-situ X-ray Nano-imaging Application in Energy Materials," SRI2015, New York (July 2015).

"Industrial Research Program," SRI2015, New York (July 2015).

"Industrial Research Discussion," NSLS-II Strategic Planning Workshop, Brookhaven National Laboratory (September 2015).

"TXM and its Applications," SINOPEC Beamline Review Meeting, Shanghai, China (October 2015).

"Synchrotron X-ray Microscopy and Microelectronics Application," HiREV Industry Day, The Aerospace Corporation, El Segundo CA (February 11, 2016).

"Synchrotrons and Batteries," BWIS Colloquia, Brookhaven National Laboratory, Upton, NY (March 31, 2016).

"Industrial Research Program," Round-Table on Synchrotron Techniques for Advanced Manufacturing, Brookhaven National Laboratory, Upton, NY (April 20-21, 2016)

"In situ characterization of battery materials by transmission x-ray microscopy," T*he Electronic Materials and Applications (EMA) 2017 Meeting*, Orlando, FL (January 18-20, 2017).

Garth Williams

"Microscale Accumulation and Chemical Speciation of Arsenate on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 19-20, 2016).

"Microscale Accumulation and Speciation of Arsenic in a Soil Matrix in Relation to its Microsite Composition," Soil Science Society of America, Phoenix, AZ (Nov 6-9, 2016).

"Microscale Assessment of Arsenic Reactivity on a Sand Grain from Wagram Soil," Soil Science Society of North Carolina Meeting, Raleigh, NC (Jan 17-18, 2017).
"Microscale Assessment of Arsenate Reactivity on a Sand Grain from Wagram Soil," Symposium of Center for Human Health and the Environment (CHHE), NC State University, Raleigh, NC (Feb 16, 2017).

Xi Yang

"Genesis Simulations with Forward Bragg Diffraction Seeding," Challenges of High Photon Energy, High-Repetition Rate XFELs, Buffalo Thunder Resort, Santa Fe, New Mexico (August 9-10, 2016).

5.iii.c Awards: Users

Christopher Bunick, Yale University

American Academy of Dermatology Young Investigator Award (March 2017).

Mark Chance, Case Western Reserve University

Elected Fellow of the American Association for the Advancement of Science- Chemistry (XFP) (2016).

Richard Ebright, Rutgers University

Elected Member, American Academy of Arts and Sciences (2016).

Oleg Gang, Center for Functional Nanomaterials, Brookhaven National Laboratory

Inventor of the Year, Battelle Award (2016).

Opening Plenary Lecture at Macromolecular Nano-objects and Polymer Nano-composites Conference, Moscow, Russia (2015).

Work included in the top 10 Scientific Advances of 2015 at Brookhaven National Laboratory (2015).

American Chemical Society, San Francisco, CA (April 3, 2017)

University California at Berkeley, Nanoscience Seminar (February 24, 2017-01-31)

Irving P. Herman, Columbia University

Edwin Howard Armstrong Professor of Applied Physics at Columbia University (2016).

Adrian Howansky, Stony Brook University

Robert F. Wagner Award (2017).

Best Student Paper in Medical Imaging (February 2017).

Jean Jordan-Sweet, IBM

"From Research to Production: Reliable High Performance NiPt Silicide Contacts from 65 to 22 nm Technologies," IBM Outstanding Technical Achievement Award," given to Jean Jordan-Sweet, Christian Lavoie, Cyril Cabral, Jr. (March 1, 2015).

Samson Lai, Georgia Tech

2nd Place Poster Award at the 3rd Annual MSE Poster Competition, Georgia Tech, Atlanta, GA (April 9, 2015).

1st Place Poster Award at Georgia Section and Atlanta Student Chapter Meeting of the Electrochemical Society (April 3, 2015).

Richard Osgood, Jr., Columbia University

Member National Academy of Inventors (2015).

EEE Photonics Society - Quantum Electronics Award (2015).

Donald Sparks, University of Delaware

Clay Minerals Society's Pioneer in Clay Science Award (2016).

5.iii.d Awards: NSLS-II Staff

Nathalie Bouet

R&D100 award (shared with scientists from APS, LBNL and ABeam, Inc.) (2015).

Microscopy Innovation award (shared with other NSLS-II scientists and 1 scientist from APS) (2016).

R&D100 award (shared with other NSLS-II scientists and 1 scientist from APS) (2016).

Evgeny Nazaretski

Engineering Award, Brookhaven National Laboratory (2015).

R&D100 Award (Principal Developer) (2016).

Microscopy Today Innovation Award (Principal Developer) (2016).

LI Innovator of the Year Award (2017).

6. Future

In this section, potential problems for facility operations will be identified. The expected trends in user demand: internal, external, mode of operation and scientific discipline, and facility's plans in respond to the trends will also be discussed.

6.i Identify potential problems for facility operations.

Introduction

In order to outline areas of concern and strategies for addressing the issues identified, NSLS-II senior management used the NSLS-II mission statement as a point of reference:

> *To develop and operate a premier user facility that embraces diversity to safely and efficiently deliver high-impact and cutting-edge science and technology for the benefit of society.*

The discussion here focuses on the *development* and *operation* of the facility as the two major topics, with specific potential challenges outlined for each topic. There is overlap across the topics, and major themes include management of budget realities, and the tension between development of the facility and ongoing user operations.

This treatment is at a high level and outlines potential problems as well as describing strategies for addressing the issues identified. Mitigation measures that are in place, or that could be developed if necessary to either avoid these problems, or minimize their impact on the mission capability are described in other sections of the 2017 triennial review supporting documentation.

Dealing with Potential Problems

Here we outline the general aspects of dealing with the potential problems which are then described in the next section of the document. It is important to have these strategies in mind when considering these issues to help frame the manner in which they can be addressed. While each specific area may differ in detail, three elements may be invoked in dealing with potential

problems. These include Situational Awareness, Contingency Planning, and where possible, Mitigation Measures.

Situational Awareness –

At the highest level, even the identification of potential problems represents an aspect of situational awareness. Once a potential problem is identified, the first indicators that it may be materializing are also identified. Where possible the consequences of the problem materializing are described and quantified, as well as the likelihood of their occurrence and the potential methods and costs for their acceptance, avoidance or mitigation. In this sense the elements are very similar to risk management in project execution. An important difference in operational analysis is the possibility that as an ongoing activity, operations may never retire the risk. Instead it must at a minimum continually invest in maintaining an adequate level of situational awareness.

For many of the problems identified in this document, there are obvious owners, while for others they represent institutional risk that is owned by the NSLS-II management, BNL management, or the DOE. Situational awareness may be developed from deep within the organization, say technicians or engineers for operational risks and vulnerabilities to spares (or lack thereof) for systems in which they are responsible.

Similarly awareness of competitive technologies or programs relies upon 'intelligence' provided by the engineers, scientists or program managers from their exposure to work around the laboratory, at other institutions, or by attention to the work of visitors to the laboratory. This is an important investment of effort across the department, as is the discussion and coordination of information arising from the issues that are identified. Conversely, for problems that may arise from outside of the direct sphere of activity of the NSLS-II department, laboratory management may identify and track issues that could have potential impact on NSLS-II and its operations.

The NSLS-II department runs a number of meetings throughout the organization that gather this information. These include division coordination meetings, planning meetings, staffing meetings, and the daily Plan of the Day meeting. Of particular note for gaining a department wide context and perspective are several meetings including the LSSOC (Light Source Safety and Operations Council), PSBOC (Photon Sciences Business Operation Council), PMOG (Project Management Oversight Group), SPMC (Scientific Program Management Committee), and the EMG (Executive Management Group). Issues identified in any of these meetings may be dispositioned for action by the participants, or where appropriate tasked for further investigation and recommendations for dealing with the issues that have been identified.

These meetings serve not only to track the evolution of potential problems that are already known, but also to identify ones that have not yet been considered. While these meetings can be a substantial investment of time and sometimes have significant overlap, they are vital in the management of the work of the department and the risks to which it is exposed.

Contingency Planning-

Evaluation of the problems that have been exposed often results in contingency planning to deal with the consequence of problems that do materialize, particularly for those that are beyond the

sphere of influence of the NSLS-II department directly. The most obvious example of such planning relates to the development of multiple budget scenarios that represent contingency plans for operations budgets which may be at, above, or below current levels.

A related planning exercise addresses the prioritization and execution of 'discretionary' work. This can materialize not only because of budget adjustments, but also due to the availability of key resources (generally staff, but also equipment or access to equipment). These problems occur within the normal course of operations and processes for identifying, discussing and resolving them have evolved over time. These processes and information pathways are an important 'template' for addressing problems that are of a larger scale and often set the pattern for how the facility grapples with newly identified problems. The processes and their participants may also serve as a reservoir of experience from which to draw when confronted with an issue that while not identical to one previously encountered may have enough similarity that its contingency strategies and plans can serve as the starting point for more rapidly addressing a new issue.

Contingency planning also reaches further down into the operating organization particularly as it relates to operational systems. For example if one component suddenly went off line are there ways to work without it in service (say disabling a feedback system)? Are there other systems that would be taken down to provide functionality for higher priority systems (say taking a detector from one beamline and putting it on another) to meet program objectives until a repair or replacement can be implemented?

To a large extent, contingency planning addresses issues that are either low probability (but potentially large impact), or problems for which effective mitigation measures are either not available, or are considered a poor investment on balance when evaluated for the potential benefit as compared to cost.

Mitigation Measures-

Related to contingency planning, mitigation measures may be put in place to reduce either the likelihood of a problem occurring, or the impact of it materializing. An example would be investment in preventive maintenance (reducing likelihood) or procurement of spares (reducing down-time or impact by virtue of having a replacement on hand). Generally these investments both in planning and in resources are more substantial than contingency planning because their likelihood or impact is considered greater than those issues for which contingency planning may be regarded as adequate or appropriate planning.

Less obvious investments in mitigation measures are also coupled to situational awareness. The likelihood of being 'surprised' by erosion of competitive position might well be mitigated by providing staff resources to participate in conferences, or inviting visitors to NSLS-II to discuss their work. One can also regard R&D investments as mitigation against loss of competitive position by being surpassed in technical capabilities at other facilities. These types of investments are often more difficult to characterize in this manner, but in fact may have much more leverage for the overall productivity of the facility than some of the more traditional technical risk mitigation measures. The benefit compared to cost of mitigation measures must be weighed against the requirements of achieving the core missions of the NSLS-II facility.

Potential Problems Facing Facility Development

Here we outline the topics that could impede development of the NSLS-II facility. In this context we regarded development as both technical improvement of the facility, and the extension of the user program. The 2017 NSLS-II strategic plan outlines growth areas for the science program which require both positioning of the staff to implement the plans, and creation or extension of infrastructure to support that development. Several interrelated challenges were considered.

User community development-

Generally this challenge relates to activities that need to be undertaken to develop the user community. Of particular importance are the 'soft processes' that need to be preserved or enhanced. Conversely one can consider events or actions that could undermine this development. For example a particular strategic direction might have been formulated based on an 'ecosystem' of institutional relationships that give rise to a particular program development plan. In some instances this could be undermined by the departure of key individuals at partner institutions (both inside and outside of the laboratory), or the failure to develop in a timely manner cutting edge capabilities at the facility that would support a new research program. This aspect of user community development is primarily handled through situational awareness.

Another aspect of the user community development relates to the utilization rates of the available instruments. Projections can be made regarding the total number of users anticipated as well as the expected rate of introduction of new users to the community at a given stage of development in the facility and its beamlines. For NSLS-II, a model based on several elements of instrument maturity was developed that also considered historic user numbers for comparable instruments at sister facilities. Presently the actual numbers fall short of projections and this is the subject of some concern. A number of factors enter into consideration of discrepancies between actual user numbers and the projections.

Foremost is an ongoing evaluation of the model and the parameters it includes, as well as consideration of other factors that may influence utilization patterns. For instance are the instruments actually sufficiently mature and adequately supported to align with the capabilities described by the model? That is, perhaps the current model over-rates the readiness of the beamlines to support general users. It may also be that the model, which is based on historical usage levels, has some incorrect assumptions.

We have for instance noticed a trend to send fewer users per visit than had traditionally been the case, which may be a reflection of their funding levels this will cause an over estimate of the user numbers in our model. It may also be that the NSLS-II instruments are sufficiently sophisticated that we are required to provide a relatively high level of user support, at least in the earliest stages of the beamline operation. This might appear to the user as more than adequate support and may also encourage user groups to send smaller teams, which also has the impact of overtaxing our staff to support them. The longer term metric for the beamlines will be their scientific productivity, and it is perhaps too soon in their development to gauge this. Never-the-less the user numbers are taken as a leading indicator of productivity and hence are watched very closely. We continue to monitor the situation as well as refining our user projection model to better align with actual experience. Knowledge gained as a consequence may assist the facility in guiding strategic investment in beamline capabilities.

Beamline Development-

A critical issue in developing the NSLS-II Facility is the full development of the beamline capabilities. Currently, there are a total of 29 beamlines, that are either in operations or development, including the newly funded HEX beamline from New York State. This leaves approximately 30 potential future beamlines that could be built to complement and extend the existing suite of capabilities. To not do so would threaten the ability of the facility to support the user community that might have been expected otherwise and to reduce the ability of the facility to have the scientific impact that would have otherwise have been enabled by the superlative characteristics of the source. It would also leave large portions of the user community's needs unmet and would directly impact the international competitiveness of the US synchrotron community.

However, the scale of the investment required to build a new beamline and the current budget climate makes the challenge of developing additional beamlines a large one. To address this challenge, NSLS-II has undertaken a series of measures. First, through a rigorous planning and proposal process, all beamlines chosen for development have the full support and engagement of the user community and have been rigorously peer-reviewed and endorsed by our SAC. Second NSLS-II is undergoing an extensive beamline value engineering process, seeking to understand and control construction and lifetime costs of state-of-the-art beamlines. It is using the knowledge it has built up during the course of the current waves of construction at NSLS-II and in addition is involving our sister facilities for their expertise. Third, we are actively seeking partners who may be able to bring resources to bear on new beamline construction, even if they cannot fund a full beamline development project. Fourth we are seeking a diversity of sponsors. In addition to DOE-BES, we are also talking to DOE-NE, DOE-BER, NIH, NSF, DOC, NASA, Pharmaceutical companies and the Moore Foundation. As discussed elsewhere, NSLS-II is also developing an additional beamline utilizing operations funds. The difficulty of such a range of sponsors of course is that each has its own requirements and constraints as well as its own needs and navigating these is itself a large challenge. Nevertheless, this is a challenge that must be overcome if NSLS-II is to reach its full potential in the coming decade.

Competitive Position-

Another aspect of developing new user science capabilities are those aspects of the plan that capitalize on some type of competitive advantage. An obvious one is the performance attributes of the NSLS-II accelerator or some of its beamline instrumentation, but perhaps more important are specific programs that leverage off of each other. The competitive position could therefore be undermined by arrested development of planned technical capabilities, competitive developments at other facilities, or the possible emergence of disruptive technologies that supplant the advantage at NSLS-II.

A concern here is the evolution of a 'tunnel vision' mindset that makes the facility vulnerable to failing to detect a potential competitor. In essence the facility must maintain adequate "peripheral vision" to be aware of potential threats that may come from unanticipated directions. Another type of failure can be the recognition of a development that is necessary to capture and develop a new capability, or the inability to marshal adequate resources (either staff or funds, or both) to be able to execute a development plan.

Barriers to timely development of Infrastructure-

Technical challenges (difficulty in design, requirement evolution), or coordination with research operations can impede the acquisition of infrastructure that is regarded as necessary to support strategic development of the facility. While these can and do occur, it is more likely that funding, or inability to access the proper type of funding (say IGPP for conventional facilities activities) can become a barrier to timely delivery of infrastructure.

A leading concern for NSLS-II is the development of the data infrastructure to support the facility. Generally this infrastructure is a rapidly evolving mix of hardware and software which must expand to meet the needs of the facility as its capabilities grow. In addition the hardware must be renewed at a rate roughly commensurate with a 5 year lifetime, and software constantly maintained to function optimally and securely. While the infrastructure scope is well understood, allocation of adequate resources in the face of other budget priorities has been challenging. In this case the situation must be monitored and resources adjusted to meet the overall objectives of the facility without incurring undue risk. It should be noted that this particular infrastructure has an enormous leverage on user satisfaction and productivity, and that it will not be appreciated (by the users) unless it is absent. The facility must therefore exercise caution in limiting the scope of investment in data infrastructure.

Another infrastructure investment which is more visible to the users relates to the fit out and operation of additional LOB spaces. Current projections indicate that the laboratory capacity is slightly behind the beamline build-out, and would fall far behind if additional laboratory space was not developed in a timely fashion in the FY19 to FY21 timeframe. Current plans have been developed for completing construction of 10 new laboratories in buildings 744 and 745 sponsored by IGPP funding, as the labs will be available throughout the BNL community. While this infrastructure is planned in the IGPP budget of the laboratory, changes in priority or in available funding could put these capabilities at risk. Completing this work as planned requires continued interaction with the laboratory management to advocate effectively for the allocation of the required IGPP funds. If the development proceeds more slowly than planned, contingency plans for sharing space, or prioritizing assignment of existing space will need to be developed.

Barriers to enhancements-

To support the program aspirations and growth, enhancements in the facility are required. For example increased beam current and reliability requires acquisition and installation of new accelerator hardware like RF systems. A program to develop a third RF cavity has been undertaken. This serves both to improve reliability by increasing the depth of spare RF cavities to support the current level of operations should one of the two in operation fail, and as a step on the path to implementation of a third powered RF system to increase the stored current capability of the facility.

This measure was deemed to be important enough to start the procurement with operations funds. Depending on future operating budgets and priorities it is possible that only the third cryomodule can be completed, ie. without the cryoplant and transmitter. This certainly reduces exposure to a technical vulnerability, but without further investment in cryogenic support equipment and a transmitter, does not allow for routine and reliable operation at high stored current.

Similarly experimental instrumentation may need expansion, upgrades or capability enhancements. As the facility is building out capabilities it has been difficult to maintain R&D

investment at a level sufficient to progress at the leading edge. For example, in an effort to maintain a critical mass within some areas, the difficult decision was made to halt the crystal optics program. What had been a strategic leadership position in optics metrology has likely been ceded to other facilities in the face of under-investment in the program. Apart from loss of a technical leadership position these decisions can have the effect of eroding morale within the broader organization.

NSLS-II has decided to maintain its investment in detector development, which has provided unique tools for use at the beamlines which would otherwise be unavailable. This includes the MAIA detector developed in collaboration with CSIRO, with one detector recently installed at SRX and another being constructed for XFM. Effort is also underway to develop and deliver new detectors optimized to the performance of NSLS-II, such as the Mega-Pixel array (VIPIC) detector for CHX. These developments are structured to leverage off of sources available at the laboratory, including the instrumentation division, and in collaboration with other laboratories (FNAL and ANL/APS for VIPIC).

The effort highlights several vulnerabilities; detector development is generally an expensive undertaking, often proceeding in trial and error steps over a long period of time. The cost is somewhat moderated by the sharing of effort and cost across multiple organizations. While this helps make the development possible, it also carries the risk that changes in funding or priorities in collaborating organizations could undermine progress in detector development. Dealing with these risks requires a high degree of situational awareness as well as communications between the stakeholders for the efforts to be successful.

Speaking generally, while in some instances technical or program coordination issues may delay enhancements, it is often more likely that funding for these capabilities is scarce in the face of competition for ongoing operations support.

Potential Problems Facing Facility Operations

Safety incident-

In any facility with the complexity and diversity of work and hazards encountered at NSLS-II very proactive attention to safety is warranted. As a user facility, with guests who may come for short duration visits, careful attention to conduct of operations, mitigation of potential hazards, and a continuously nurtured robust safety program are paramount to the overall success of the facility. The consequence of a serious injury or fatality for the facility would be devastating. While the equipment, safety management systems and training are carefully developed and reviewed, the potential for discovery of a latent or previously unrecognized problem is ever present. That, combined with the potential consequence of a serious lapse, makes assurance of the safety of the staff and users of the facility its foremost priority.

At the same time, the structure of the program, its requirements, and the difficulty of correctly implementing the safeguards and procedures must be thoughtfully implemented to minimize the likelihood that an individual would choose to work in a non-compliant fashion for their own convenience. Making sure the safety program is as effective as possible is a key objective of the facility and the laboratory.

Staff retention and recruiting-

The operation of the facility can be adversely impacted by the inability to have the people needed on board when they are needed. Many aspects of the operation of the facility require staff with unique and often highly technical skill sets. Not only can qualified individuals be difficult to find, they can be difficult to attract (cost of living and salary/benefit limitations) and retain (other institutions need them too and may offer work that they find more interesting).

Other factors can have an impact on our ability to recruit and retain staff. For individuals who have families the complications of relocation can be an impediment that the laboratory can work to mitigate. Part of the laboratory's competitive position in challenging recruitments can be the effectiveness at helping staff address these personal challenges. Another not infrequent dimension relates to the citizenship status and working permissions both for the employee and for their family members. In some instances a decision to leave the laboratory, or not come in the first place hinged on the willingness or capability of the laboratory to address issues such as green card applications.

The transition from a facility dominated by construction activities to routine operations has been difficult both technically and from the perspective of maintaining high staff morale. During the construction project the high demand on staff was to some degree mitigated by a shared sense of purpose in completing an exciting new facility. The enthusiasm and extended extra effort was in part motivated by the sense that the goal would be accomplished and then life would be different (and presumably not so demanding) when the project completed.

Instead the demands on staff have remained high as we work through transition, and undertake the development of operations. Unlike the construction project, a clear endpoint to this extra effort is not readily defined, nor is it likely that within the future foreseen by most of the staff that the situation will change. Resources are tight, and latitude for independent work is in many cases limited, which can erode morale. Also just as enthusiasm can be infectious, so can low morale.

Morale is often decomposed into three elements, Confidence, Enthusiasm and Discipline. Our staff in many respects has a high degree of each, but there are critical components to each that are challenging for the facility. Our staff is for instance confident in their capabilities and respected for their accomplishments, but the persistent concern regarding funding undermines their security in their work and hence their confidence and perhaps enthusiasm. We foster a very disciplined work environment and a culture of accountability which manifests itself in the pride of the workforce as well as the high quality and safety of the work we perform. At the same time, we can be highly regulated and require proscriptive work practices that can undermine the confidence of our work force and in extreme cases lead to a breakdown of discipline, which could result in unacceptable lapses in work practice.

The conditions and constraints under which NSLS-II operates bring the dual challenges of maintaining both high productivity and high efficiency. The staff is key in delivering both, and efforts to improve their morale are likely to promote both outcomes. The management is well aware of the challenges and benefits in promoting a high level of morale. We seek to provide information through many avenues to the staff to help them understand the plans of the department as well as its challenges it faces with the aim of creating a shared vision for the future.

This may help stabilize the confidence and enthusiasm of the staff during this period of dramatic change. In addition the management tries to remain attuned to the concerns of the staff and where possible address them, or at least explain why we cannot, or will not address them.

Component failures-

The NSLS-II has many components which in sum determine the operational performance of the facility. Some are quite sophisticated and all have an anticipated service life. Where the impact on operations would be significant, the design and specification of the components is aimed at providing robust operation and/or predictable or 'soft' failure. There will however be instances where required equipment may exhibit catastrophic failures making an abrupt transition from operational to non-functional. In these instances, where operations are significantly and adversely impacted, on-line equipment redundancy (where practical) and rapid repair or replacement are key considerations in the design and operation of the facility.

Several factors must be considered in implementation of these mitigation measures, including space (to install redundant systems), potential compromises (in complexity and system reliability) and benefits (how much down-time is likely to be saved) against cost. The depth of spares inventory where installed redundancy is not practical also has important trade-offs. In addition to the potential impact of a component failure and its impact on operations, there is the issue of equipment becoming obsolete with time. On one hand having spares for dated equipment which is still in service can be important for recovery from low incidence high impact failures, since replacements might not otherwise be available. Conversely, spares 'on the shelf' which are themselves no longer serviceable can be of limited value if the need for their use arises.

Obsolescence-

Equipment which has become obsolete can be a threat to smooth operations when such equipment fails, but even when it continues to be serviceable, it can be a drain on resources and performance. Where obsolete equipment is being replaced in an incremental fashion and the system itself is extensive (say a family of power supplies on the storage ring), then there will be a period of maintenance and operation of two types of equipment, as well as building an inventory of 'new' spares.

Over the lifetime of the facility it can readily be anticipated that some types of equipment will move through generations of design and technical performance improvements that should be implemented to keep overall reliability high, and the technical capability of the facility at the leading edge. This is particularly true of electronics and computing devices, but it is also true that optical components experience a similar, if generally slower evolution.

When planning for addressing obsolescence these total lifetime cost issues must be taken into consideration. For example from an operational perspective it might overall be advantageous to make a wholesale replacement of a family of power supplies all at once in total lifetime cost, but the required up front cost might be challenging for operations budgets.

Spares inventory-

Equipment will fail and its failure can lead to degradation or disruption of operations. While vigilant preventive maintenance can reduce or forestall such failures, strategies need to be in place to recover quickly when failures do occur. Where possible equipment may be designed with on line redundancy, so spare equipment can be brought on line quickly. More commonly spare assemblies or spare critical components are maintained in an inventory ready for use should the need arise to affect a repair or replacement.

It is generally impractical as well as prohibitively expensive to have spares for every component. Instead an evaluation is made of likelihood of failure and impact of failure are evaluated to determine which spare components would be desirable to keep in inventory, with the depth of the spares pool determined primarily by funding available to invest and the reliability required of the sub-system. The diversity of the supported systems can also be a factor in the makeup of the spares inventory. Several different vendors and designs for equipment that serves nominally the same function can needlessly drive up the cost of maintenance and the cost of the spares required.

Additional factors in planning the spares inventory include the replacement time from market (inventory in vendor stock and speed of delivery) and the potential of interim use of substitute equipment which is not identical to the failed component or system, but which can safely and capably carry out the function of the failed system. For instance a power supply rated for higher current than one which has failed might be used as a temporary substitute. Conversely, some equipment, though low value, may be fabricated by vendors on order and have long lead times, and functional substitution may not be possible. These factors must also be considered for making investment decisions for spares.

A thorough analysis has been undertaken for the accelerator systems spares inventory. The approach looked at systems from the bottom up and considered the impact on operations of missing spares. Spares were categorized into three categories: 1- spares for equipment that could halt operations immediately if it failed, 2- spares for equipment that would impede performance if it failed, and 3- spares for equipment that could await repair until the next service opportunity. The following table shows the estimated value of spares for accelerator operations in these categories as of May 2017.

Spares (all $ burdened)	1. Halt ops immediately	2. Impede performance	3. Can wait until break in ops	Total
In Stock	$ 11,657,751	$ 10,934,785	$ 4,048,417	$ 26,640,954
Spares not in hand	$ 2,651,196	$ 614,378	$ 3,982,337	$ 7,247,912
Total	$ 14,308,948	$ 11,549,164	$ 8,030,754	$ 33,888,866

Table 6.i.1: Values of Spares in Three Categories: Category 1 is for spares for components that would halt operations immediately if they failed. Category 2 is for spares that would impede performance if they failed. Category 3 components are those which can wait to be repaired or replaced until the next break in operations.

This illustrates the systematic approach that has been taken to the evaluation of the spares situation. This is a component of the planning that guides investment in spares for the accelerator. It may not be practical, nor even advisable to procure all possible spares, but for the

resources that are available, a clear rational approach, based on the required reliability that has been developed for their utilization.

Environmental factors-

There are a number of activities both on and off of the BNL site which could have impact on the operations of the NSLS-II facility. Key among them is environmental noise that can propagate to the NSLS-II site that can be detected by some of the most sensitive equipment. For example the condition of the Long Island Expressway (LIE) road surface is known to have an impact on vibrations that can make their way to the site and be detected. Some, if not all, of this impact can be addressed through feedback systems as the induced motion tends to be in an 'elastic' range. The possible introduction of a new train station south of the laboratory site may increase the frequency of noise from train traffic. At present the new station would be along an existing track that is currently in daily use, but it is possible that the frequency of the trains may increase. This situation will need to be monitored as plans progress for the development of the station.

It is also possible that on-site work could have an impact on the stability of the facility. Within the 'elastic' range we already observe noise from infrequent (but necessary) activities such as snow removal in the parking lots around NSLS-II. There is also the potential for demolition activities, such as the removal of the HFBR exhaust stack, which could have an impact on operations. Plans are not yet finalized for the method of removal, but this is an activity which must be monitored and the potential impact of the method selected on NSLS-II stability considered.

There are also natural phenomena which can impact on NSLS-II operations. Hurricanes and large snow events are not unknown in this region of the country. Generally impacts are of short term duration, but have the potential for significant disruption based on events off-site and beyond the control of the laboratory. For example significant damage to the power grid feeding the laboratory (say high tension power line icing and damage) could have longer lasting impact on operations. Preparation and contingency planning for protection of staff and users during events, and safe stand-by or stand-down facility planning for the possible aftermath of these events are prudent measures for securing long term operation of the facility.

Operating cost threats-

The operations cost for NSLS-II consists of a number of components where the consumption of resource is relatively fixed, including utilities and space. Labor is also a large portion of the operations cost. The ability to operate the facility can be significantly impacted by changes in the cost of these resources. Electric power rates are a particularly important consideration for NSLS-II, as the facility enjoys a remarkably favorable power rate as a consequence of long standing agreements between the laboratory, New York State, and the operators of the power generation and transportation infrastructure in New York.

For FY17 electric power is anticipated to cost about $3M, or roughly 3% of the NSLS-II operations budget. Roughly ¼ of the power is sourced by hydro-generation, leaving the balance provided by fossil fuel, and so that portion of the cost can be driven by market forces. Beyond the cost associated with the mix of energy generation is a larger component related to the complex arrangements whereby the effective BNL power rate is roughly 1/3 of the prevailing local market

rate in the region. Should the favorable power arrangement be dissolved, the electric power cost for the facility could become 10% or more of the operating budget, a very significant shift in the balance of resources.

Similarly the utilization of space, at least for experimental operations, is comparatively fixed. The annual cost is set by an agreement with the laboratory on how the space is assessed (type of space utilization), and the laboratory wide rates charged for space. A number of factors influence the space charge rate, including laboratory wide costs and space utilization that can change outside of the control of NSLS-II. Presently space charges for the facility constitute roughly 9% of the NSLS-II operations budget. Relatively modest changes in the space charge rates, materializing through any driver, would have a significant impact on the operations budget available for the other components of the NSLS-II activities.

The direct operations costs of the facility are assessed overhead charges, which are a component of the total budget for the facility. What overhead components are assessed, and how they are applied depends on the nature of the expenditure. Currently the laboratory utilizes a Total Modified Cost (TMC) overhead methodology that on average results in a material cost multiplier of roughly 1.55, a labor cost multiplier of 2.2, and a space cost multiplier of 1.44. These rates can vary depending on the details of the expenditure (for example large procurements are charged overhead only on the first $2M), and some construction activities can be charged at lower more favorable rates (Extraordinary Project Rates) through agreements with the laboratory and the DOE site office.

Changes in the rate structure, or the assessment methodology could have an impact on the direct funds available for operation of the facility. This is a particularly important consideration as the methodology will be changed for FY19 from the current TMC structure to a Value Added Base (VAB) assessment method (see Section 7.1). Current indications are that this change will not have a negative impact on NSLS-II operations, but this will be continually monitored. These rate considerations impact not only the DOE provided operations funds, and the net direct funding available for expenditures, but can also be a factor in attracting outside investment. External funding currently supports partner activities such as beamline construction and partner user operations, as well as research program investment. Rates that are unattractive, or simply beyond the guidelines of the potential sponsor could inhibit or preclude investments in work at NSLS-II.

<u>Budget pressure-</u>

Pressure on the operating budget could materialize from several directions. Apart from the potential for a directed change in NSLS-II operating funds due to congressional appropriations, there could be direction to adjust emphasis in the program which could be disruptive to the smooth operation of the facility. Changes that evolve over time are fairly typical and handled in the normal course of operations. Those which are large and materialize suddenly can be more problematic to address.

Reductions in funds are the usual consideration, and if great enough, can undermine specific areas of the operation, or the facility operation in its entirety.

Another potential important problem for NSLS-II operations could arise from budget pressure beyond BES-SUF and is related to the mix of activities at BNL. While the budget for NSLS-II is

a substantial portion of the laboratory business, it is small compared to the Nuclear and Particle Physics (NPP) budget and hence contribution to overhead functions of the laboratory. Should there be a major disruption in the NPP funding, it could ripple through to NSLS-II overhead costs as well as impacting on the services supported by the laboratory.

Similar problems, although perhaps at a somewhat smaller scale, could arise from disruptions in facilities and departments throughout the laboratory which provide significant scientific contributions to the work at NSLS-II. Examples include the Instrumentation Division, the Center for Functional Nanomaterials and other departments within the Energy and Photon Sciences Directorate, or the Environment, Biology, Nuclear Science & Nonproliferation Directorate. These departments are all part of the 'ecosystem' upon which NSLS-II relies for its scientific and technical success.

6.ii Expected Trends in User Program

What are the expected trends in user demand: internal, external, mode of operation and scientific discipline, and facility's plans in respond to the trends.

Research trends in science and user demand have been thoroughly discussed during the many years of planning for the NSLS-II involving the broad scientific community and key stakeholders. Examples of these activities include a large numbers of user community workshops, advisory committee meetings, beamline development workshops, beamline advisory teams, and expert panel reviews. Through this process, a number of areas of research where NSLS-II could or should play important roles and make critical contributions have been identified.

Materials Discovery: Discovery of new materials and mastering materials behavior is essential to designing future technologies. NSLS-II provides advanced materials characterization tools to enable rational materials synthesis, self-assembly, and processing to better understand materials and to answer important fundamental questions.

Emergent Material Properties: Global needs for renewable energy sources and effective ways to store and transmit energy or information motivate physical science researchers to explore increasingly more complex materials—or material architectures with enhanced or emergent properties—to drive transformative technologies. In-situ and operando tools at NSLS-II permit understanding and controlling materials synthesis and directed-assembly, materials behavior and degradation in real and extreme conditions.

Structures & Functions of Life: The study of biological systems is fundamental to our understanding of our place in the world, and our capacity to exploit this knowledge is fundamental to our health, our ability to produce food and fuel crops and our understanding of environmental change. Revealing atomic structures of biomolecules at NSLS-II allows researchers to study biological systems integrated from molecules to ecosystems.

Catalysis and Energy Systems: From lithium batteries in smart phones, to catalysts in cars, or even the availability of electrical power at home, devices for energy conversion and storage are an integral part of daily life. NSLS-II enables experiments to understand and ultimately control the chemistry of energy conversion and storage for clean energy.

Environmental Science: A wide range of characterization tools at NSLS-II helps scientists understand the complex geochemical, biogeochemical, and atmospheric processes in the Earth environment, and not only gives fundamental insight, but may identify essential environmental remediation strategies.

Although these have been identified as areas of opportunity for NSLS-II to have high-impact, the advanced x-ray tools developed at NSLS-II have wide application in very diverse scientific disciplines and will contribute to breakthroughs in many fields. Consideration of the many science disciplines discussed through the community engagement and strategic planning meetings leads to an identification of several common user themes or trends.

- Complexity and Dynamics: From simple material systems with self-organized interacting phases, to intrinsically heterogeneous functional systems, complexity and its dynamics is increasingly one of the key characteristics in scientific studies in the 21st century, and this is clearly reflected in synchrotron user trends.

- In-situ Functional Systems: There is a clear need and demand in the scientific user community for advanced characterization tools to allow in-situ and in-operando studies of real or realistic functional materials systems under working conditions that are relevant to natural or industrial processes.

- Mesoscale and Multiscale Science: Building upon the enormous atomic-scale scientific knowledge acquired in the past century, it has become clear that the structural and chemical information at the mesoscale – broadly defined as the length and time scales between the atomic and the macroscopic world, may hold the key to how to control the emergent macroscopic properties and processes of materials, environmental, and biological systems. This is also reflected in the synchrotron user community.

Over the past decade, NSLS-II has worked with the scientific community and strategically identified twenty-eight beamlines to develop as the initial suite of scientific facilities. Among these twenty-eight beamlines, as of April 2017, nineteen have completed construction and are either in user operations or under commissioning while the remaining nine beamlines continuing their construction activities. Based on their scientific capabilities, all beamlines are currently grouped into six program areas that exploit synergies among the beamlines and enhance efficiencies in operations. These six program areas are: Soft X-Ray Scattering and Spectroscopy, Hard X-ray Spectroscopy, Complex Scattering, In-Situ Scattering and Diffraction, Imaging & Microscopy, and Structural Biology.

So, important scientific opportunities have been identified and a suite of complimentary beamlines have been developed to address these opportunities and position NSLS-II to have significant impact in broad scientific disciplines. The beamlines largely exploit the source characteristics and competitive advantages of the NSLS-II to address these opportunities. The number of users is anticipated to grow dramatically in the next few years as the NSLS-II beamlines mature and become fully optimized for cutting edge scientific programs.

Data Science

Many high-impact opportunities for NSLS-II will take advantage of advanced techniques and detector technologies that exploit the brilliance of the NSLS-II source. These techniques sometimes depend on sophisticated algorithms for inverting and processing data and for interpreting raw data, and often utilize detectors that can produce multi-megapixel images with frame-rates in the kilohertz range. Increasingly, all scientific disciplines are using multi-element area detectors rather than point detectors to efficiently measure and record the results of the experiment. These new detectors and techniques drive the need for a new paradigm for data acquisition, management, and analysis at synchrotron sources worldwide.

Adding to the complexity of this issue is the fact that individual users often lack the expertize to write the sophisticated algorithms required to process, analyze, visualize or otherwise extract the important information from raw detector data and even if they did have the expertise, often lack the hardware resources required to handle the data. Further, the volume of data associated with an experiment may now exceed several tens of terabytes so even simply moving data from one location to another is prohibitive.

We anticipate that many users will therefore need to depend on analysis codes and hardware developed and maintained at the NSLS-II facility for nearly real-time analysis and visualization tools and workflows during their experiments. This will allow users to understand their measurements and will help inform the next steps in their experiments. In addition to user facility maintained workflows with provenance of data analysis algorithms, users will also want seamless access to all metadata, detector data, and intermediate processed results.

Further, we anticipate that users will also want to have easy access to their data and the analysis codes long after they've returned to their home institution and will want to continue detailed analysis of their data using NSLS-II and BNL resources. For this, users will want single authentication (login) to access all the data that they are entitled to use. That is, users will need access to all data collected as a result of any proposal that identifies them as a participant, on any beamline or other BNL facility. Anticipating this need for post-experiment data mining and processing, NSLS-II will work with other stakeholders on computing within BNL to develop and operate a central data processing computing facility as part of a multi-tier data management system. The main goal of this facility is to provide front-end computing and centralized data storage/archiving system for NSLS-II users. This will allow users to access their data on-site during the experiment and also later when they return to their home institutions. As required, resources in the central computing facility will be assigned as part of the beamtime. NSLS-II is also working with supercomputing facilities across the DOE complex and in particular with NERSC for which test case studies are underway.

Full utilization of the NSLS-II facility requires that users are able to analyze NSLS-II data to produce high impact scientific results. Given the complexity and volume of data produced this will be a particular issue for many advanced experimental protocols (CDI, XPCS, tomography, ptychography, etc.). To address these needs, we are utilizing operations resources and wherever possible leveraging the work of others. For example, the codes developed at NSLS-II are open source software that invites community involvement and further development. NSLS-II staff have been actively participating in a series of 'hack-a-thons" with other facilities to develop and

share needed software. And codes or workflows that have been developed elsewhere (for example ALS, APS, CAMERA) are implemented wherever possible. The goal of this effort is to produce a robust, user friendly software stack that is accessible to novice users and extendable by expert users, providing transparent access to their data and ultimately the ability to combine data sets across beamlines and eventually across facilities.

User Access

A critical element to the success of NSLS-II is a clear, flexible system for user access to the facility. As a new facility, NSLS-II has the opportunity to evaluate the success of more traditional access modes worldwide and to implement new modes of access that are amenable to what scientists need and expect from a synchrotron facility today.

At NSLS-II, two principles underlie all user access to beam time. The first is that it is based on proposals that are subjected to peer review that is fair, clear, and expedient, that is sensitive to the needs of users, and that recognizes contributions that improve the overall scientific program. The second is that all proposals receive a finite amount of beam time for a limited duration that is justified by the need for beam time of the proposed work.

Consistent with this policy, NSLS-II currently accepts traditional General User proposals with deadlines three times per year. These proposals are valid for one year. The facility also accepts Partner User proposals for researchers that will partner with the facility to develop a cutting-edge capability for the user community. Recently, new modes of access including Rapid Access, Proprietary, and Block Allocation Groups (BAGs) have been implemented. For users with a quick, routine experiment to perform, Rapid Access proposals provide a quick turnaround time (~1-2 weeks). For large groups of users that want to share a small block of beam time (typically >3 groups sharing a few days), BAG proposals provide a means for these groups to manage their time allocation. Proprietary proposals are used by researchers, typically companies, who want to retain the intellectual property (IP) rights to their data by paying a full-cost recovery fee for their beam time. We expect that each of these modes will grow significantly as a fraction of all beamtime awarded as the facility matures.

The nature of synchrotron radiation experiments and the character of the user community have evolved over the years. The pioneers of synchrotron radiation experimentation were expert users who were highly proficient in x-ray science methods and instrumentation and for whom, in many cases, synchrotron research represented their entire experimental program. Since the success of third generation light sources worldwide, the advanced capabilities and techniques have now also attracted large communities of scientists who are not experts in x-ray science, but represent many scientific disciplines that greatly benefit from the measurements and understanding provided through access to light sources such as NSLS-II, often as one component of their program addressing a particular problem. These users often have options to use other facilities worldwide, and different requirements on how they access the facility and new access modes might be needed to attract and to retain this vibrant user community.

For example, users might not need to travel to the NSLS-II to collect data, but may be interested in mailing samples and retrieving the resulting data. This would apply to routine samples and straightforward measurements where users can ship samples to the facility and have data collected by the beamline staff. This will likely require more staff resources and automation, but the

efficiency of data collection will clearly be improved. In cases where users require data processing or analysis as well as raw data collection, NSLS-II is exploring the use of BNL's new Technical Service Agreement (TSA) as a way to implement this fee-for-service to cover the incremental cost associated with such work.

Already implemented at other third generation facilities is remote access to light source beamlines. Here, with standard samples and sufficient automation at the beamline, users can control their experiments without traveling to the facility. This has become an expected mode of operation for structural biology at other facilities, and we will implement it here and extend it to other techniques (e.g. XAS, XRD).

In addition, other modes of user access are being discussed that would be unique to NSLS-II and provide alternative, flexible modes of access for users. Currently, users must write multiple proposals if they wish to access different beamlines (or other facilities such as CFN) for their single project. A new mode of access would allow users to submit one proposal that focuses on their scientific research problem and can propose the use of multiple beamlines/facilities to accomplish the stated goals. This multi-modal access mode would facilitate users' access to multiple resources such as beamlines, CFN instruments and labs, and to computational resources at the CSI. To address the requirements of this type of access, a Multi-Modal Issues Task Force (MMITF) has been established to identify the issues involved in utilizing techniques across multiple beamlines at NSLS-II, and in combining synchrotron techniques with other techniques, such as the electron-based imaging methods at CFN. The taskforce will identify scientific cases and communities in which techniques and beamlines may be usefully combined; identify sample mounting/geometry requirements, standard form factor sample cells, sample environment control, common equipment and stages that would be required to execute multi-modal work; identify the issues in data acquisition, registration, analysis, visualization, and access; and in modeling required for an effective multimodal program. Naturally, issues in proposal submission and review, as well as beamtime and cross-facility allocation must be addressed for an effective multimodal program.

A related activity concerns Joint Access with other Facilities. NSLS-II has recently initiated a joint proposal process with ORNL for combined SAXS/SANS experiments. Users can submit proposals to either facility requesting both techniques. They are reviewed jointly and allocated time at both facilities if deemed appropriate. Similar arrangements might also be made for combined X-ray PDF and neutron PDF studies. Other opportunities exist with EMSL at PNNL, cryoEM with BNL, CSHL, SBU, and/or NYSBC, and with the MagLab at Florida State University.

Beyond user access to the NSLS-II, the overall user experience is an essential issue for the success of the facility. Recognizing the importance of the comprehensive user experience, a User Issues Task Force has been formed to gather information and make recommendations concerning all aspects of user issues and outreach. In addition to access modes, the task force considers topics such as communications and outreach for both new and existing users. This includes educational outreach through hosting "schools" at BNL or elsewhere, providing online materials, organizing and coordinating courses taught at nearby institutions, and launching programs such as Introducing Synchrotrons into the Classroom (InSynC) for teacher training. Other key aspects of the user experience considered by the task force include GIS processing, badging, key card

access, issuing TLDs, user computer accounts and passwords, user data and data analysis, and general amenities important to users during their visits to NSLS-II. Generally, the task force seeks to identify actions to be taken that enable an effective and productive user experience at NSLS-II.

In-situ and Operando Measurements

In almost all scientific disciplines, a challenging research goal is to understand how things work in real, functional environments and under working conditions. NSLS-II high brightness and flux in a broad synchrotron spectrum enables correlated in-situ and operando capabilities in scattering and diffraction, spectroscopy, and imaging studies in a variety of functional systems critical to future energy needs, the environment, and human health. X-rays are an excellent probe of these complex environments and we anticipate many applications where users will be interested in such measurements.

For example, synchrotron x-ray methods have been used to characterize energy storage and energy conversion systems, where complex heterogeneous structures exhibit chemical and structural changes across multi-length scales during electrochemical operation. And, catalytic systems with multiple components in the catalyst in contact with reactants either in gaseous or liquid phase, where dynamic interactions result in structural, morphological, chemical, and electronic changes that may be characterized by methods available at NSLS-II. A trend in materials synthesis is moving away from traditional materials growth techniques towards more directed assembly. Nano-assembly methods developed at CFN (DNA origami and block co-polymer self-assembly) and 3D printing are areas that we expect to grow and in which NSLS-II can play a part in characterization and understanding underlying mechanisms.

Furthermore, many problems in catalysis, energy storage, or environmental science benefit from various probes available at NSLS-II. For example, users may have interest in applying diffraction and scattering, spectroscopy, and imaging tools to their samples. Operando or in-situ experiments require measuring samples that are evolving under various conditions, and in some systems, it may not be feasible to measure the same samples across different beamlines because the samples may have evolved after one measurement and cannot be reused. To address this challenge, we plan to develop in-situ sample cells that are compatible across different beamlines in order to create the same operando conditions for correlative measurements using multiple techniques, and to develop data handling software that provides the ability to align, analyze, correlate, and integrate the operando data measured from different beamlines and techniques. This dovetails with the multimodal access mentioned above.

Cryo-EM

Recent advances in medicine, drug development, and biotechnology have been made possible by our ability to study processes at the molecular level. In many cases it is the coordinated action of tens of thousands of atoms that form bio-molecular machines that provides the essential functionality. The significance of these processes is apparent in the awarding of Nobel prizes in the last decade for diverse and important biological systems. Also significant is that these have directly depended on national synchrotron x-ray facilities. Resolving the structure of these proteins enabled fundamental insights into the basic bio-molecular causes of a range of diseases.

For almost forty years, scientists have been using x-ray crystallography to determine the structure of crystalline proteins and elucidating their internal workings. Recent advances in cryo-electron microscopy (cryo-EM) have opened the possibility of resolving the structure of the large multi-protein complexes that perform vital functions within cells without having to grow crystals. This is a significant advance, since such complexes are difficult, if not impossible, to crystallize, and therefore are not accessible to x-ray crystallography.

We expect that in the future, scientists will combine information from both techniques to be able to obtain atomic resolution of the biological complex. A complete picture of these complexes is needed to fully understand the vital processes they perform, and this knowledge would form the basis for the development of novel drugs or biotechnology. The transformative opportunities offered by the cryo-EM revolution have been recognized by the U.S. National Institutes of Health (NIH) and the U.S. Department of Energy (DOE). Both of these agencies are working to establish funding opportunities for regional cryo-EM user facilities. To provide maximum impact, we plan to combine BNL's NSLS-II and its world-leading capabilities in protein structure analysis with a new cryo-EM facility. The initial steps towards this facility have been funded by New York State with a grant of $15 M. This will fund the first microscope and, together with investment from BNL, a building to house it in. This building will be attached to 745 to increase the interaction and synergy with the structural biology program within NSLS-II. BNL will also submit a proposal to NIH in the competition for a National user facility for cryoEM. If successful, this would fund another 3 microscopes and the operations costs of the facility.

Partnerships and cooperative research agreements

Other than the user program, there are a number of vehicles for the user community to engage the NSLS-II. Cooperative Research and Development Agreements (CRADA) provide a method for DOE laboratories to carry out collaborative research with public and private sponsors. Strategic Partnership Project (SPP) agreements, formerly referred to as Work for Others (WFO), provide an excellent way for companies, universities, and other institutions to access the unique facilities, technologies, and expertise available at BNL on a project-specific basis. Agreement for Commercializing Technology (ACT) was created to make negotiation between non-federal entities and the national laboratories more flexible and timely. The ACT provides more flexible terms that are geared towards private industry practice, such as IP rights, payment arrangements, indemnification and development of multi-party research and development partnerships. With the flexibility that ACT provides, more private companies that are unable to do work under a CRADA or SPP agreement have an option to do work with the national laboratories under an ACT agreement.

Finally, the industrial user community has demonstrated interest in various access modes at NSLS-II. These range from the CRADA and SPP vehicles mentioned above to proprietary access where intellectual property is protected in exchange for full cost recovery. Capabilities are now being developed at NSLS-II beamlines tailored to industrial applications, particularly in the areas of in-situ and operando research with automated specimen handling. Staff support is being enhanced to support industrial users, flexible and timely access modes are being created, and

industrial research partnerships are being formed that include external scientists in proposal review panels and other advisory committees.

Industrial research has been an integral part of the research portfolio at US light sources, and the NSLS-II will continue this tradition with potential corporate partnership in beamline programs in areas such as polymers, catalysis and petrochemicals, microelectronics, advanced materials, and pharmaceuticals.

7. Additional Information

This section discusses a number of BNL plans that may affect NSLS-II in the future.

7.i Change in Overhead Rate Structure at BNL

There will be a Cost Accounting Change at BNL starting in FY 2019. Below we discuss the basis for this action and the nature of the change.

In a letter to BNL's Chief Financial Officer in January 2016, DOE BHSO advised that BNL's use of a Modified Total Cost (TMC) Basis for the allocation of Traditional G&A and Common Support G&A was no longer in accordance with current interpretations of Cost Accounting Standards. DOE BHSO recommended, and BNL engaged, a Cost Accounting Standards (CAS) expert to aid in developing CAS compliant cost models for review. Following this review of CAS Standards, it was determined that the causal/beneficial relationship between overhead pools and the bases on which overhead would be allocated would be best reflected with implementation of a Value Added Base (VAB) methodology. Subsequent to this recommendation, BNL's proposal to implement a Value Added Base methodology in FY2019 was reviewed and approved by DOE BHSO and DOE Chicago Integrated Service Center.

In addition, in an effort to address Laboratory concerns regarding high space rates and appropriateness of cost components within our space pool, BNL's review of CAS methodologies included a review of space pool cost allocation options. It was determined that the operational cost of utility facilities including fuel cost should be reflected as an institutional overhead and removed from current rates that allocate the cost of space on a square footage basis. The addition of fuel and utilities to the common institutional pool added ~$13M in estimated cost to overhead pools and reduced space rates by approximately 36.5%. Maintenance cost for space continues to be assessed on a square footage basis while fuel and utility costs which have been moved into overhead will now be based on labor components of cost.

FY2017 Disclosure Statement Approval

In September 2016, DOE-BHSO approved the change in methodology to assessing General and Administrative (G&A) expense from a TMC Base to a Value Added Base (VAB). They also approved for pricing for implementation of VAB in FY 2019, the redefining the cost pools for Common Support to a Common Institutional Pool, the realignment of Space Pool Components to Common Institutional Pool, the retaining an Extraordinary Project Rate, and retaining the large

procurement policy for application of material burden. BNL is implementing the change in FY 2019 such that it will be cost neutral across the laboratory (i.e., same total overhead recovery).

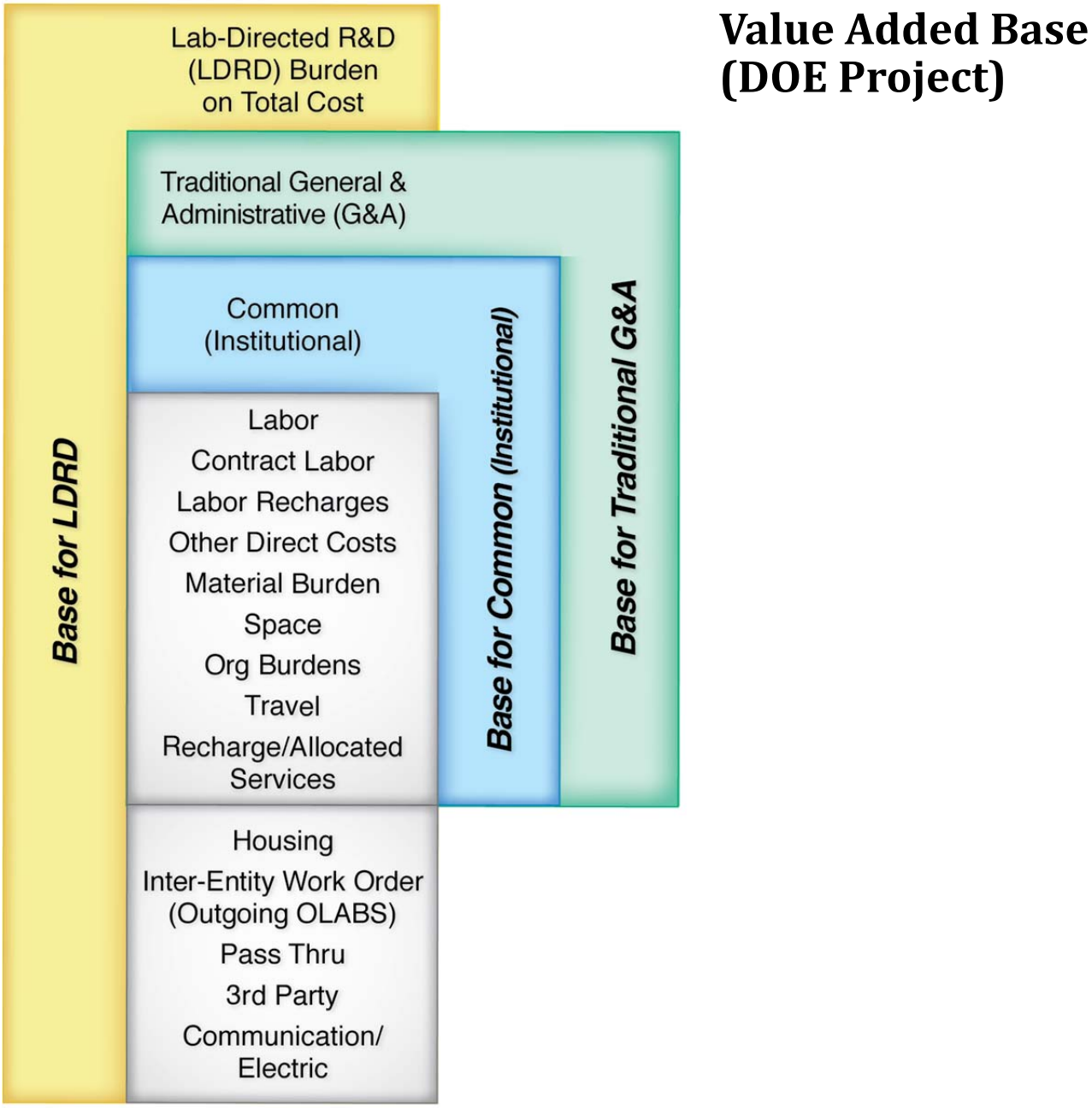

Figure 7.i.1: Understanding of how the burdens are applied in the new value added base (VAB) methodology that will begin in FY19.

Initial rates for forward pricing FY18 (TMC) and FY 2019 (VAB) are shown below:

Rates and Escalation Guidelines for the FY 2019 Budget Submission			
Type of Burden	FY17 Current Method	FY18 current Method	FY19 VAB Method
Standard Rated Projects			
Common Institutional	32.35%	32.35%	41.30%
G&A	8.25%	8.25%	6.90%
LDRD on Total Cost (TC)	2.30%	2.30%	2.30%
Offsite Rates			
Common Institutional	NA	NA	8.70%
G&A	8.25%	8.25%	6.90%
LDRD on Total Cost (TC)	2.30%	2.30%	2.30%
ACT Project Rates			
Common Institutional	32.35%	32.35%	41.30%
G&A	6.40%	6.40%	6.50%
LDRD on Total Cost (TC)	2.30%	2.30%	2.30%
Unique Government subcontract rate			
Unique Government subcontract rate	2.00%	2.00%	NA
Extraordinary Projects Rates (EPR) - FY16 and going forward			
Common Institutional	11.10%	11.10%	15.40%
G&A	5.30%	5.30%	4.60%
LDRD on Total Cost (TC)	2.30%	2.30%	2.30%
Extraordinary Projects Rates (EPR)-only projects approved thru FY15			
Common Institutional	9.60%	9.60%	15.40%
G&A	6.50%	6.50%	4.60%
LDRD on Total Cost (TC)	2.30%	2.30%	2.30%
LS II - (Grandfathered Projects only)			
Common Institutional	6.50%	6.50%	NA
G&A	4.00%	4.00%	NA
LDRD on Total Cost (TC) - LS II Project Exempt	NA	NA	NA
Material Burden Rate			
Material Burden Rate	7.50%	7.50%	7.50%
Infrastructure Rates			
Space/Fuel/DMR ($/sq. ft.)			
- Lab / Office space	$ 38.36	$ 38.36	$ 24.37
- Industrial space	$ 26.46	$ 26.46	$ 16.81
- Storage space	$ 10.19	$ 10.19	$ 6.48

Table 7.i.1: Comparison of FY17 rates and FY18 rates under the award methodology with an initial set of rates for FY19 under the value added base methodology. The FY19 rates are preliminary at this point and subject to change.

More details are available on request, but in summary, it is important to note that the total space/overhead cost at BNL will not change. The overall impact to given funded programs will depend on the cost mix between labor, materials, subcontracts, equipment, purchased services, power & space. Finally, it is emphasized that BNL's new rate structure is competitive as compared to other DOE laboratories.

7.ii Discovery Park

Brookhaven National Laboratory (BNL) is implementing a campus development strategy that is designed to renew the campus and position the Laboratory for maximum scientific productivity. This strategy, which has four elements, focuses not only on creating unique science facilities, but also on developing the support capability to ensure cost effectiveness, user facility reliability, and the environment that enhances collaboration with our national and international user community and industry partners. The strategies are implemented with a diverse funding portfolio that includes Federal Science Laboratories Infrastructure (SLI) funding as well as Laboratory-generated indirect funds, and access to private capital through Discovery Park.

Figure 7.ii.1: Discovery Park

BNL Campus Development Strategy
1. **Improve capability of critical core buildings to enable the scientific agenda** 2. **Enhance safety and cost effectiveness by optimizing the campus footprint and demolishing old buildings** 3. **Ensure scientific facility reliability through targeted utility and infrastructure investments** 4. **Renew infrastructure and support the growing population of scientific users through an innovative public-private concept of Discovery Park**

Figure 7.ii.2: BNL's Campus Development Strategy

Discovery Park Vision

BNL Discovery Park is a public-private partnership that redevelops the existing BNL apartment area, a previously utilized site of roughly 60 acres near the current entrance of the Laboratory. Discovery Park is a critical part of the Laboratory infrastructure renewal plan, provides needed user accommodation, and presents an opportunity to enhance technology transfer and regional economic development. The initial development will create a "User Village" called Upton Square, providing streamlined visitor access, conference space, modern office space and enhanced and renewed user housing in a dense and highly-interactive setting outside the secure area of BNL and therefore publicly accessible. The plan also accommodates the future opportunity for additional private partnership space expansion in a research park that provides the growing population of national and international users and collaborators the ability to co-locate adjacent to the Laboratory. A master plan concept for Discovery Park is shown in figure 4 below.

Figure 7.ii.3: Location of Discovery Park at the Front of BNL's Campus

Upton Square

In 2015-2016, BNL conducted a feasibility study to support the concept of Discovery Park. This study recommended a "split-site development" approach with a Federal building serving as an anchor tenant in Discovery Park and providing any needed space for BNL staff functions. This approach was the impetus for the creation of the Science and User Support Center (SUSC) which received CD-0 approval in December 2016 as an ~$80M DOE SLI Project. The SUSC has three components: office space for approximately 300 laboratory staff, a new, easily accessible one-stop visitor processing center, and a conference and collaboration center for 300-500 people.

The SUSC will be the signature entrance of BNL and will be accompanied in Upton Square by a privately owned and operated housing facility for BNL users and guests, as well as a planned educational outreach facility to expand BNL's highly successful STEM education program. Upton Square is envisioned as a small mixed-use development and will include the ability for private food service and needed amenities to create an attractive "sense of place" that is welcoming to our guest and user community and will help attract the next generation of scientists. The governance model for the private facilities, including model lease language, is currently being developed.

Research Park

In addition to Upton Square, the concept of Discovery Park includes roughly 40 acres (500-600K square feet capacity for facilities) for evolution of a research park that is complimentary to the mission of BNL. The governance model is designed to minimize carrying costs and allow facilities to develop as they mature in conjunction with Laboratory programs. It is anticipated that close proximity to facilities such as the NSLS-II, and the Center for Functional Nanomaterials will be a significant attractor to potential tenants in Discovery Park.

The Laboratory currently anticipates at least four functional areas where tenant relationships might develop:

1. Supply Chain Relationships with BNL, such as equipment suppliers or medical isotope production and distribution companies;
2. "Implant Laboratories" for proprietary development work around the user facilities and other unique BNL capabilities, accommodating office space, light laboratories and computational and technical support;
3. Joint Institutes: specific research platform collaborations that combine the scientific resources of BNL, core universities, and other academic and industrial partners to solve significant problems or leverage emerging opportunities, and;
4. Technology Incubation to create new companies or products.

Schedule

A BNL Institutional General Plant Project (IGPP) will provide the roundabout entrance into the Discovery Park area from the main entrance road and will also rebuild the main Guard Portal for improved efficiency and security. Construction is planned to begin in FY 2018.

For Upton Square, the SUSC is planned to achieve CD-1 later in 2017, and, as funding allows, occupancy in FY 2022. The housing facility is being pursued as the initial private building in Upton Square and could actually achieve occupancy in advance of the SUSC. The overall integrated schedule for Discovery Park is shown in figure 5 below.

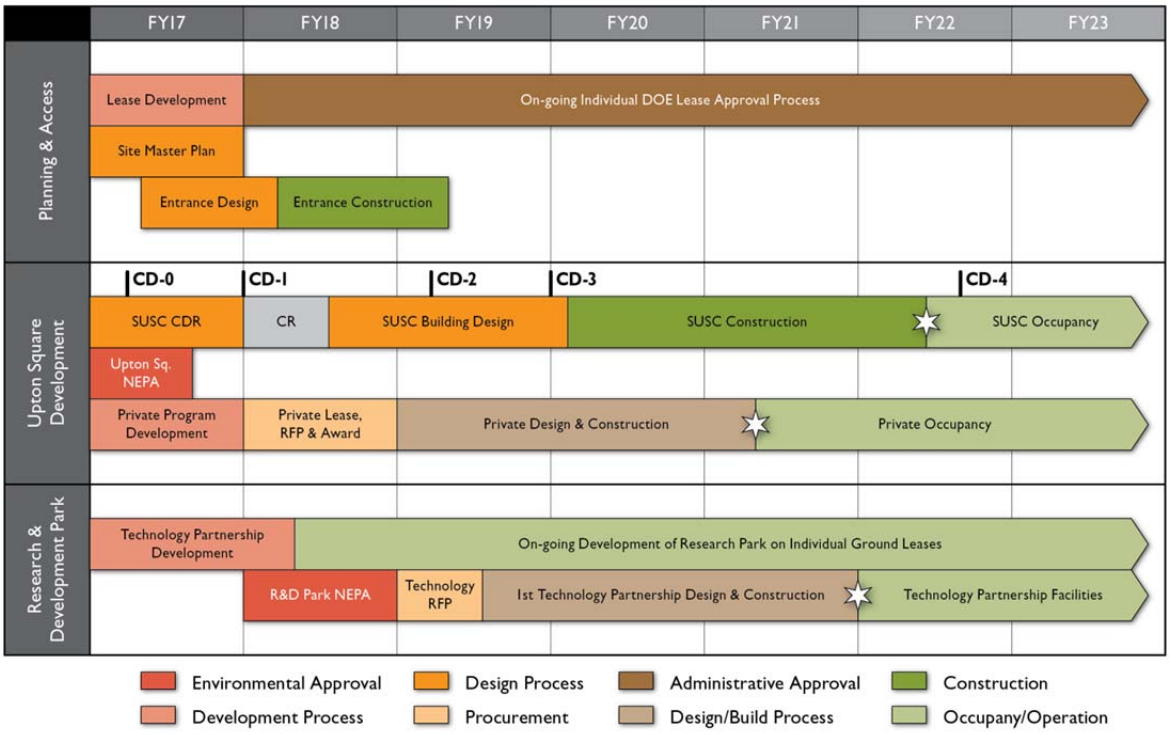

Figure 7.ii.4: Discovery Park Integrated Schedule

7.iii Computational Science Initiative (CSI)

BNL science is dominated by data rich experimental facilities, such as the Relativistic Heavy Iron Collider (RHIC), National Synchrotron Light Source-II (NSLS-II), and the Center for Functional Nanomaterials (CFN) as well as support of others, *e.g.*, LHC ATLAS and the BER Atmospheric Radiation Measurement (ARM) Facility. Driven by the requirements of these facilities BNL developed a long standing research, development and operational program in advanced data centric computer science and applied mathematics methods, algorithms, tools and infrastructures, making it today the largest data science lab in the DOE complex. In the past these efforts were distributed across its different science directorates, however in 2015, BNL established the

Computational Science Initiative (CSI), integrating its many outstanding capabilities under one umbrella.

A core focus of CSI is the continued development of novel data analysis and visualization paradigms in support of data-based discovery at large scale experimental, observational and computational facilities. CSI is driving a paradigm shift, by developing new methods, tools and infrastructures that enable scientists to analyze and interpret their scientific results as they are emerging during experiments, observations and/or computational modeling. This, in turn, will allow scientists to steer and optimize their research more effectively towards new discoveries. Examples of this approach can be found in projects such as:

- Machine Learning Assisted Material Discovery
- Deep Structured Analysis for Image Datasets from CFN and NSLS-II
- Dynamic Visualization and Visual Analytics for Scientific Data at NSLS-II
- High Performance X-ray Diffraction Simulation Toolkit Using GPU and CPU Clusters
- An In Situ, Streaming, Data- and Compute-Intensive Platform for Experimental Data
- Complex Modeling Infrastructure – Automated support for the analysis of multi-modal experimental results
- A Co-Design Center for Online Data Analysis and Reduction at the Exascale
- Analysis on the Wire – Real time analysis of experimental data while it is being transferred to a central computing facility

To create these transformational capabilities, BNL is following a co-design approach in its research, pursuing areas from novel hardware design to highly scalable data analytics methods, with an aim to create integrated end-to-end solutions with measurable impact on scientific discovery cycles. Key strengths are the development of fast and reliable I/O and data transfer mechanisms, new programming models for data intensive computing applications, data intensive workflow frameworks, scalable and incremental machine learning, visual analytics-supported decision making environments and provenance for reproducibility, and performance analysis. Two new research areas are: "Analysis on the Wire", where the network is used as a high throughput computer for high volume, high velocity, highly correlated data analytics, combining BNL's strength in network and machine learning; and "White Box Machine Learning", where visual analytics and machine learning are integrated to enable the training of the validation of machine learning algorithms. Going forward BNL will, in addition, focus on two additional areas:

1. Autonomous Optimal Experimental Design
   - BNL is building a goal-driven capability that optimally leverages theory, modeling/simulation and experiments for the autonomous design and execution of experiments, making the well targeted use of limited resources, such as computing and data to accelerate scientific discovery. The framework will involve developing optimal representations for domain knowledge that account for uncertainties in the state of nature in highly complex systems and leverage heterogeneous prior information available in different forms and scales.
   - The study of complex materials, biological or physical processes requires the usage of multiple, different experimental and observational techniques, as well as complex numerical simulations. BNL is continuing its leading research into its Complex

Modeling Infrastructure that will make the integration, analysis and interpretation of these heterogeneous results an easy, routine task.

2. Interactive exploration and analysis of multi-petabyte data sets
   - The new frontier of data science is the ability to support scientific discovery – interactive, collaborative – in data sets exceeding multiple PBs in size, such as are found, in particular, in nuclear physics, high energy physics, computational biology, materials science and climate science. BNL is executing a pioneering, tightly integrated research program into the required novel hardware, system software, programming models, analysis and visual analytics paradigms to provide such a capability.

In support of data intensive computing, BNL has built the third largest data centric computing laboratory worldwide with over 100 PB of archived data. BNL annually ingests ~35 PB, distributes 37 PB, and processes 400 PB of scientific data, delivering ~200 TB/Day to over 100 data centers across the world. All scientific computing facilities have been integrated in the BNL Scientific Data and Computing Center (SDCC), that provides provisional hosting, maintenance and support services to its clients. SDCC is currently offering two service models, operation of client specific hardware and service level defined buy in to multi-tenant storage and computing services.

As part of SDCC BNL also provides 45 PB of fast disk space. The available storage capacity is connected via a 3 Terabits/s network infrastructure to BNL's extensive data analytics and high performance computing infrastructure. In 2016, BNL hosted 250 racks with ~70,000 cores of high throughput data analysis resource. Next to operating its 3.5 rack Blue Gene Q High Performance Computing resource – 3584 nodes, 64,512 cores, BNL acquired a 108 node Institutional Cluster, each node with 36 Broadwell CPUs and 2 K80 GPUs, to support numerical modeling and novel data analysis development. BNL started its Novel Data-Intensive Architecture Testbed Facility with a 144 node Knights Landing-based system with Dual Rail Omni-Path, in support of research into co-designing new data intensive-computing solutions. In addition BNL operates an institutional cloud service, that provides elastic computing capabilities for smaller scale interactive analysis applications. A 200 GB/s network link connects BNL to ESnet, which is expected to be upgraded to 300 GB/s in the coming year. BNL's computing infrastructure is supporting ~1700 active users. New service developments in the past year included: the BNLBox, a tool to provide a universal data back-up, storage and sharing service accessible from any device on site and anywhere in the world; and Invenio/Zenodo-based service for the long term management and sharing of data, publications and software, which can host and be customized for a number of communities in parallel.

In 2017, BNL is set to expand its computing capabilities through the purchase of a US Quantum Chromodynamics (QCD) system, a doubling of the institutional cluster, and a second data intensive novel architecture system likely to be CPU/FPGA based in support of ultra-fast machine learning applications. In addition CSI is establishing a visualization center in close proximity to BNL's experimental facilities that will be open to facilities users to visually explore their results with the support of CSI staff and leading edge visualization capabilities. As part of the New York State funded Center for Data Driven Discovery BNL plans to make further investments over the coming 5 years to expand and adapt its computing and storage capabilities to the needs of its user communities.

At present BNL's scientific computing infrastructure is housed in building 515, however the age and limited expansion potential make it desirable to develop the new data center. In support of this effort BNL has worked with the DOE SLI program to identify a suitable new location. With the recent award of CD-1 BNL is set to create a new ~60,000 sqf data center by 2020 in the former NSLS building, which since November 2015 also house most CSI staff. The data center will provide ample space to grow BNL's computing capabilities in support of DOE's core missions, as well as offering further growth potential for the future.

The primary sources of funding for this core capability come from OHEP, NP, the Office of Advanced Scientific Computing Research (ASCR), Office of Biological and Environmental Research (BER), and BES [mission areas SC 7-11], as well as Advanced Research Projects Agency-Energy (ARPA-E) and Laboratory Discretionary Research Funds. In addition, CSI received New York State funding in support of data-driven discovery research and underpinning hardware purchases.

7.iv CryoEM

BNL is seeking to establish a World Leading Facility for Multiscale Bio-imaging. In particular, it seeks to establish a National User Facility that will dramatically accelerate our understanding of the fundamental molecular structures and processes underlying disease, thereby leading to faster and more effective new treatments.

Accelerating how quickly researchers can determine biological structures would significantly impact life sciences, pharmaceutical, and medical research. BNL is proposing to establish a National User Facility that will provide state-of-the-art cryo-electron-microscopy (cryoEM) capabilities to an emerging user community through a National Institutes of Health (NIH) competition. Co-locating this center at National Synchrotron Light Source (NSLS-II) will enable BNL to leverage its existing expertise and capabilities to allow imaging of bio-molecules in entirely new ways, while integrating partners and the broad scientific community (as illustrated in the figure below). The BNL CryoEM center will attract scientists from across the nation and around the world, and provide a significant boost to the competitiveness of NY State's bioscience and biotechnology communities. The project has already secured $15M in funding from New York State that will fund the first microscope and partial funding of the building to house the center.

The new facility will be developed through both technical and scientific partnerships. NSLS-II's structural biology group has expertise in automation and high-throughput methods – its expertise will be used to increase the capacity and efficiency of the CryoEM facility. This team is already working on innovative techniques for sample preparation, data analysis, and workflows. We will collaborate with Prof. Leslie Greengard, Director of the Simons Center for Data Analysis, on single particle reconstruction algorithms. Additional technical and scientific partnerships have been established with BNL's Center for Functional Nanomaterials (CFN), Stony Brook University, Cold Spring Harbor Lab, Johns Hopkins University, and Yale University. Collaboration and support from BNL's Computational Science Initiative (CSI) and the RCSB Protein Data Bank (Rutgers University) are a critical component of the center. These organizations will underpin the management of the large volume of data generated by the

microscopes, develop new data analysis methods, and tackle the challenges of integrating large volumes of data with rigorous data validation protocols and standards.

BNL's distinguishing advantage in the NIH competition is that the Lab operates cutting-edge large-scale facilities for studies in physics, chemistry, biology, medicine, applied science, and a wide range of advanced technologies. The Laboratory's in-house scientists, engineers, and support staff annually accommodate more than 4,000 visiting researchers from around the world. This experience in running user facilities and providing scientific service and support is critical to the success of an open-access user facility. BNL has the support infrastructures in place for administrative assistance, including online application procedures and peer-review mechanisms, along with on-site accommodation and amenities.

BNL has decades of experience in developing training programs for scientists who want to access its capabilities. A wide range of training opportunities will be made available, from day-to-day coaching and help in sample preparation and data collection; to in-depth training enabling users to become autonomous expert users of the instruments; to advanced workshops with world-leading experts to discuss and teach the latest methods and software developments.

Experience in building and coordinating a multi-disciplinary and talented team is a key factor for success in fostering a vibrant scientific community at the new facility. By running each microscope for 5500 hours a year and developing high-throughput automated techniques, BNL aims to increase project throughput and maximize the number of important scientific projects that can be granted microscope time. Each visitor to the facility will be assigned a scientific contact to help them for all phases of data collection, as well as support for data processing, analysis, and more. We plan to support at least 250 projects per year.

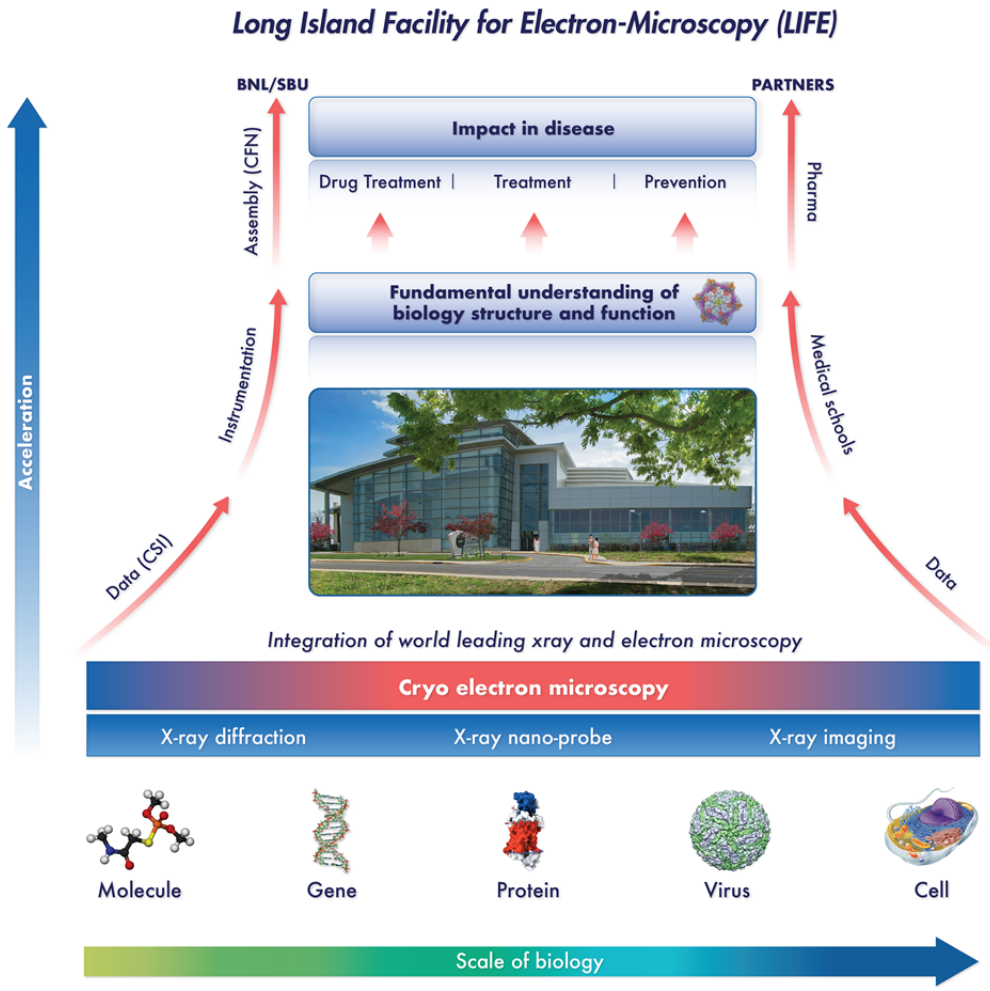

Figure 7.iv.1: Accelerating the Rate of Multiscale Structural Analysis

7.v Plans to propose an Electron Ion Collider to be constructed at BNL

BNL is working on a proposal to construct an Electron-Ion Collider (EIC) on the BNL site which is designed for an electron-ion luminosity of $10^{34}cm^{-2}s^{-1}$ and a center of mass energy range of (30-140) GeV.

The EIC is a prominent part of the NP Long Range Plan. It has been endorsed by NSAC as the highest priority next large accelerator project in Nuclear Physics. A white paper on the EIC has been worked out in a collaborative effort in recent years, which defines the physics program and specifies the requirements on an EIC in the US.

The EIC has an exciting physics program, which is not only supported by the worldwide Nuclear Physics community but has also been acknowledged by the wider physics community. The EIC will be a next generation tool to answer many remaining questions on the nature and properties of the strong nuclear force and will enable us to understand confinement of quarks inside nucleons and the mechanism of nuclear binding. A study of the National Academy of Sciences on the scientific case for a U.S.-based EIC is in progress.

The BNL version of the EIC is called eRHIC. An alternative proposal is being worked out by scientists at the Thomas Jefferson National Accelerator Facility.

The Relativistic Ion Collider (RHIC) and its injector complex would be an essential part of eRHIC. Our present eRHIC design requires only minor modifications to the present hadron accelerator complex. The RHIC Hadron beam would be operated at a slightly increased beam energy of 275 GeV (for protons). The plan includes adding an 18 GeV Electron Storage Ring with a recirculating LINAC as an injector. A high charge polarized electron source is required to provide polarized hadron and electron beams in collision.

Part of the effort is value engineering activities such as investigations of alternate designs using an Energy Recovery LINAC, FFAG type electron accelerators or a fast cycling synchrotron as electron accelerator.

A high luminosity EIC requires the development of novel accelerator technologies. A prominent part of the R&D program is to develop strong emittance cooling of the hadron beams using a technology which is a liaison of ERL, FEL, and advanced electron cooling technology.

According the present plans only minimal civil construction for new accelerator enclosures would be required. A modest amount of civil construction would be required for a new klystron gallery and new 2K cryogenic plant extension. The present design efforts are aimed at generating a comprehensive proposal in FY18 as a basis for the decision of DOE mission need (CD-0) for the Electron-Ion Collider following a positive report from the ongoing NAS study.

eRHIC is an essential part of the BNL vision for the next decade. If built, it will enhance and strengthen the laboratory's capacities, expertise, and skills in accelerator science and technology with synergistic benefit to all accelerator based facilities and research efforts at BNL.

8. WBS (Work Breakdown Structure)

All work at NSLS-II operations is planned and tracked via a detailed work breakdown structure. The tables below list the elements of that structure.

8.i Facilities & ESH WBS

Facilities & ESH			
4.01		Facilities Management Hill, John [20446]	
4.01.01		Management Hill, John [20446]	
4.01.01.01		Department Management Bebon, Michael [18403]	
4.01.01.01.01	20270/20270	Directorate Mgmt	Bebon
4.01.01.01.02	20270/21940	Sched/plannin/ctrl	
4.01.01.01.03	20270/21957	post doc program	
4.01.01.01.04	20270/22123	Diversity Program	
4.01.01.02	19943	Quality Assurance Porretto, Christopher [20561]	
4.01.01.03	20483	Communications Whyte, Chelsea [25125]	
4.01.01.04	19946	Human Resources Williams, Joann [24690]	Williams
4.01.01.05	19947	Business Systems Development Bindert, Brian [22924]	Bindert
4.01.01.06	20800	Enterprise computing, Levine,Gross	
4.01.02		ESH and training Lee, Robert [20222]	
4.01.02.01	19942/19942	ESH Services Lee, Robert [20222]	Lee
4.01.02.02	19942/20759	ESHI Committee Lee, Robert [20222]	Stuve
4.01.02.03	19942/21441	Smoke/Radiation Detector Installation Lee, Robert [20222]	Lee
4.01.02.04	19942/25593	SSWP E-system	Lee
4.01.03		Business Services Madonia, Christine [20562]	
4.01.03.01	19948	Business Operations Madonia, Christine [20562]	
4.01.03.01 .01	19948/20967	Freight charges	Madonia
4.01.03.02	20445	NSLS II Stockroom	Boomer
4.01.04		Building Operations Bebon, Michael [18403]	
4.01.04.01	19944	Facilities Mendez, Tony [15359]	Lee
4.01.04.01.01	19944/22599	Mods to LOB Rcevng Room ODH montrs	Lee
4.01.04.02	19945	Space, elec and utilities Madonia, Christine [20562] (includes phone)	
4.01.05	**Other**		
4.01.05.01	01670	Org Burden	
4.01.05.02	TBD	Special Process Spares	
4.01.05.02.01	91272	SPS-Magnet Systems	Boomer
4.01.05.02.02	91273	SPS-Vacuum Systems	Boomer
4.01.05.02.03	91274	SPS-RF Components	Boomer
4.01.05.02.04	91275	SPS-Power Supplies	Boomer
4.01.05.02.05	91276	SPS-Diagnostics & Controls	Boomer
4.01.06	**21376/21376**	**Beamline Development**	
4.01.06.01	21376/21740	BLD-BDP Development	
4.01.06.02	21376/21939	BL Dev Task Force	
4.01.06.03	21376/22105	Wiggler Dev (aka HEX)	
4.01.06.04	21376/22563	Optics Metrology Enhancement	Johnson
4.01.06.05	21376/22564	Front-End and ID Development	Johnson
4.01.06.06	21376/22565	HEX Advd Concptl Design	Johnson
4.01.06.07	21376/22566	Sample Environment Development	Johnson
4.01.06.08	21376/22204	Controls Surge	Johnson
4.01.06.09	21376/22205	CDI ACD	Johnson
4.01.06.10	21376/22206	QIX ACD	Johnson
4.01.06.11	21376/22207	PLS ACD	Johnson
4.01.06.12	21376/22208	INF ACD	Johnson
4.01.06.13	21376/22209	SMF ACD	Johnson
4.01.06.14	21376/22210	ARI ACD	Johnson

Facilities & ESH			
4.01.07	**LDRD & Prog. Dev**		
4.01.07.01	20662	LDRD14-021-In-Situ Investigation of the Strain Distribtuion in Next-Generation 3D Transistors Using X-Ray Nanodiffraction	Yan,Hanfei
4.01.07.02	21118	LDRD15-031-Inelastic X-Ray Scattering determination of the inter- and intra-particle dynamics of nanoparticle superlattices: key to the development of THz phononic crystals	Cunsolo,Alessandro
4.01.07.03	21121	LDRD15-034-Searching and sorting haystacks	McSweeney,Sean
4.01.07.04	21120	LDRD15-037-In-situ microscopy investigation of complex manganese oxides for energy storage	Chu,Yong
4.01.07.05	21114	LDRD15-038-Segmented Adaptive-Gap Undulator with Different Period Lengths in Segments for Production of High Flux and Brightness Hard X-rays at NSLS-II	Tchoubar,Oleg / Kitegi,Charles
4.01.07.06	21689	LDRD16-006-Serial Micro Crystallography at Full Flux	(blank)
4.01.07.07	21690	LDRD16-007-3D Ptychography imaging without rotation using highly convergent X-ray beam	Huang,Xiaojing
4.01.07.08	21691	LDRD16-010-100fs single-shot electron beam slicing technology towards ultra-fast imaging	Yu,Li Hua; Zhu,Yimei; Shatan,T.; Willeke,F.
4.01.07.09	21952	LDRD16-046-Strong-Strong Beam-Beam Interaction Studies for a Ring-Ring Based Electron Ion Collider	Willeke,Ferdinand
4.01.07.10	20322	PD13-015-Post Doc Interviews	Didie,Kathleen
4.01.07.11	21706	PD16-030-Ultrafast Electron Diffraction	Willeke,Ferdinand
4.01.07.12	22367	17-015-NSLS-II HIGH BRIGHTNESS UPGRADE DESIGN STUDIES	E BLUM
4.01.07.13	22368	17-016-DIFFRACTION LIMITED AND WAVEFRONT PRESERVING REFLECTIVE OPTICS DEVELOPMENT	M IDIR
4.01.07.14	22369	17-017-DEVELOPMENT OF COMPACT, HIGH EFFICIENCY NANOFOCUSING OPTICS FOR HARD X-RAY NANO-IMAGING	E NAZARETSKI
4.01.08		SPP	
4.01.08.01		SPP-traditional stand alone	
4.01.08.02		SPP-other	

Table 8.i.1: Facilities & ESH WBS

8.ii Accelerator Division WBS

WBS	Project/Activity	Description	PI
4.02		Accelerator Management	
4.02.01	**19949/19949**	**Accelerator Management**	Shaftan
4.02.02	**19996/19996**	**Operatons Safety**	Zitvogel
4.02.03	**19997/19997**	**Accelerator Development**	Shaftan
4.02.03.01	19997/21523	Physics Develop	Smalyuk
4.02.03.02	19997/21524	RF Develop	Rose
4.02.03.03	19997/21525	Diagnostics Devep	Padrazo
4.02.03.04	19997/21526	Pulsed Magnet Develop	Ganetis
4.02.03.05	19997/21527	Controls Develop	Tian
4.02.03.06	19997/21528	Power Systems Develop	Ganetis
4.02.03.07	19997/21529	Insertion Devices Develop	Tanabe
4.02.03.08	19997/21530	Infrastructure Develop	Ganetis/Gosman
4.02.03.09	19997/22373	Correction of residuals multi-poles generaed by ID's	Tanabe
4.02.03.10	19997/22374	Ceramic Chambers	Hetzel
4.02.03.11	19997/22544	Mechanical Engineering Development	Sharma
4.02.04		**Accelerator Coordination**	
4.02.04.01	19999/19999	Coordinate Effort	Wang
4.02.04.05	20002/20002	Acc Physics Ops Support	Smalyuk
4.02.04.06	20003/20003	Beam Oper of Acc Complex	Zitvogel
4.02.04.07	20004/20004	Mechanical Utilities	Gosman
4.02.04.07.01	20004/20004	Central DI Water Plant	Gosman
4.02.04.07.02	20004/20004	Sat CU DI Water Cool Plant	Gosman
4.02.04.07.03	20004/20004	Sat AL DI Water Cool Plant	Gosman
4.02.04.07.04	20004/20004	Cryo Cooling Plant	Gosman
4.02.04.07.05	20004/20004	Chilled Water Distribution	Gosman
4.02.04.07.06	20004/20004	Liq N2 Supply Distribution	Gosman
4.02.04.07.08	20004/20004	HVAC	Gosman
4.02.04.08	20005/20005	Electrical Utilities	Ganetis
4.02.04.08.01	20005/20005	AC distribution switches	Ganetis
4.02.04.08.02	20005/20005	Cabling & Cable Trays	Ganetis
4.02.04.08.03	20005/20005	Equipment Enclosures	Ganetis
4.02.04.08.04	20005/20005	UPS Systems	Ganetis
4.02.04.08.05	20005/20005	Electrical Design Support	Ganetis
4.02.04.09	20006/20006	RF	Rose
4.02.04.09.01	20006/20006	Superconducting Cavities	Rose
4.02.04.09.02	20006/20006	Storage Ring Transmitters	Rose
4.02.04.09.03	20006/20006	Booster Cavities	Rose
4.02.04.09.04	20006/20006	Booster Transmitter	Rose
4.02.04.09.05	20006/20006	LINAC Transmitter	Rose
4.02.04.09.06	20006/20006	LINAC Acc Structures & Gun	Rose
4.02.04.09.07	20006/20006	RF Sensors & LLRF	Rose
4.02.04.09.08	50421/50421	Third Superconducting RF Cavity	Rose

WBS	Project/Activity	Description	PI
4.02.04.10	20013/20013	Pulsed Magnet Systems	Ganetis
4.02.04.10.01	20013/20013	Booster Inj Kicker Systems	Ganetis
4.02.04.10.02	20013/20013	Booster Ext Kicker Systems	Ganetis
4.02.04.10.03	20013/20013	Storage Ring Inj Kicker Systems	Ganetis
4.02.04.10.04	20013/20013	Booster Inj Septum System	Ganetis
4.02.04.10.05	20013/20013	Booster Ext Septum System	Ganetis
4.02.04.10.06	20013/20013	Storage Ring Inj Septum System	Ganetis
4.02.04.11	20007/20007	Vacuum	Hetzel
4.02.04.11.01	20007/20007	Vacuum Mechanics	Hetzel
4.02.04.11.02	20007/20007	Vacuum Electronics	Hetzel
4.02.04.11.03	20007/20007	Front End Vacuum	Hetzel
4.02.04.11.04	20007/20007	Special Straight Vacuum	Hetzel
4.02.04.11.05	20007/20007	Vacuum Development	Hetzel
4.02.04.12	20008/20008	Power Supplies	Ganetis
4.02.04.12.01	20008/20008	Main Power Supplies	Ganetis
4.02.04.12.02	20008/20008	Switched Mode Power Systems	Ganetis
4.02.04.12.03	20008/20008	Ramped Power Electronics	Ganetis
4.02.04.12.04	20008/20008	Power Supply Electronics	Ganetis
4.02.04.12.05	20008/20008	Power Supply Interlock Systems	Ganetis
4.02.04.12.06	20008/20008	Power Supply Mon/Interlock	Ganetis
4.02.04.13	20014/20014	Safety Systems	Ganetis
4.02.04.13.01	20014/20014	PPS Electronics	Ganetis
4.02.04.13.02	20014/20014	EPS Electronics	Ganetis
4.02.04.13.03	20014/20014	PPS Hardware	Ganetis
4.02.04.13.04	20014/20014	ALARA system	Ganetis
4.02.04.14	20009/20009	Diagnostic Systems	Padrazo
4.02.04.14.01	20009/20009	BPM	Padrazo
4.02.04.14.02	20009/20009	Current & Loss Monitoring	Padrazo
4.02.04.14.03	20009/20009	Light & Xray Monitoring	Padrazo
4.02.04.14.04	20009/20009	Mechanical Monitors	Padrazo
4.02.04.14.05	20009/20009	Feedback Systems	Padrazo
4.02.04.14.06	20009/20009	PLC Support	Padrazo
4.02.04.15	20601/20601	Insertion Devices	Tanabe
4.02.04.15.01	20601/20601	Magnetic Structure	Tanabe
4.02.04.15.02	20601/20601	Vacuum Cryo Structures	Tanabe
4.02.04.15.03	20601/20601	Moving Parts	Tanabe
4.02.04.15.04	20601/20601	Corrections	Tanabe
4.02.04.15.05	20601/20601	Magnetic Measurements	Tanabe
4.02.04.16	20010/20010	Controls	Tian
4.02.04.16.01	20010/20010	Applications Software	Tian
4.02.04.16.02	20010/20010	Front End Hardware	Tian
4.02.04.16.03	20010/20010	Front End Software	Tian
4.02.04.16.04	20010/20010	Database	Tian
4.02.04.16.05	20010/20010	Controls Networking	Tian
4.02.04.16.06	20010/20010	Timing	Tian
4.02.04.17	20011/20011	Mechanical Systems	Sharma
4.02.04.17.01	20011/20011	Magnets & Supports	Sharma
4.02.04.17.02	20011/20011	Front Ends	Sharma
4.02.04.17.03	20011/20011	Design Support	Sharma
4.02.04.17.04	20011/20011	Survey	Sharma
4.02.04.17.05	20011/20011	Machine Shop	Sharma
4.02.05		**SPP**	
4.02.05.01	80950	ANL-DEPAOLA CORRECTOR MAGNET	Depaola
4.02.05.02	80969	MPO MAGNET CROSS TALK APS	Spataro
4.02.05.03	80900	ANL - Effect Analysis Support	Blednykh
4.02.05.04	87364	Taiwan Light Source	Rose

Table 8.ii.1: Accelerator Division WBS

8.iii Photon Science Division WBS

WBS #	Proj	Act	Activity
4.3			**Experimental Operations**
4.3.1			**Experimental Management**
4.3.1.1	20734	20734	Organizational Management
4.3.1.2	21026	21026	Structural Biology Program
4.3.1.3	21031	21031	Imaging and Microscopy Program
4.3.1.4	21030	21030	Complex Scattering Program
4.3.1.5	21025	21025	Soft X-Ray Scattering and Spectroscopy Program
4.3.1.6	21032	21032	Diffraction and In Situ Scattering Program
4.3.1.7	21027	21027	Hard X-Ray Spectroscopy Program
4.3.1.8	21705	21705	Experiment Development Program
4.3.1.9	21670	21670	Controls Program
4.3.1.10	21695	21695	User Program
4.3.2			**Beamline Operations**
4.3.2.1			Engineering, Technical & User Operations Support
4.3.2.1.1	20738	20738	Beamline Engineering
4.3.2.1.2	21033	21033	Technical Support
4.3.2.1.3	21153	21153	Beamline Upgrade Projects
4.3.2.1.4	21664	21664	General Experimental Activities
4.3.2.1.5	20737	20737	Research Operations Support
4.3.2.1.6	21688	21688	LOB Lab Operations
4.3.2.1.7	21693	21693	Equipment Pool Support

WBS #	Proj	Act	Activity
4.3.2.2			Direct Beamline Support
4.3.2.2.1			3-ID HXN Bml Operations
4.3.2.2.1.1	20361	20361	3-ID HXN Bml Management
4.3.2.2.1.2	20361	22375	3-ID HXN User Support
4.3.2.2.1.3	20361	22376	3-ID HXN Beamline Development & Research
4.3.2.2.1.4	20361	22377	3-ID HXN Maintenance & Improvements
4.3.2.2.2			5-ID-2 SRX Bml Operations
4.3.2.2.2.1	20362	20362	5-ID-2 SRX Bml Management
4.3.2.2.2.2	20362	22378	5-ID-2 SRX User Support
4.3.2.2.2.3	20362	22379	5-ID-2 SRX Beamline Development & Research
4.3.2.2.2.4	20362	22380	5-ID-2 SRX Maintenance & Improvements
4.3.2.2.3			18-ID FXI Bml Management
4.3.2.2.3.1	20745	20745	18-ID FXI Bml Operations
4.3.2.2.3.2	20745	22381	18-ID FXI User Support
4.3.2.2.3.3	20745	22382	18-ID FXI Beamline Development & Research
4.3.2.2.3.4	20745	22383	18-ID FXI Maintenance & Improvements
4.3.2.2.4.			4-BM XFM Bml Management
4.3.2.2.4.1	21415	21415	4-BM XFM Bml Operations
4.3.2.2.4.2	21415	22384	4-BM XFM User Support
4.3.2.2.4.3	21415	22385	4-BM XFM Beamline Development & Research
4.3.2.2.4.4	21415	22386	4-BM XFM Maintenance & Improvements
4.3.2.2.5			10-ID IXS Bml Management
4.3.2.2.5.1	20356	20356	10-ID IXS Bml Operations
4.3.2.2.5.2	20356	22387	10-ID IXS User Support
4.3.2.2.5.3	20356	22388	10-ID IXS Beamline Development & Research
4.3.2.2.5.4	20356	22389	10-ID IXS Maintenance & Improvements
4.3.2.2.6			11-ID CHX Bml Management
4.3.2.2.6.1	20357	20357	11-ID CHX Bml Operations
4.3.2.2.6.2	20357	22390	11-ID CHX User Support
4.3.2.2.6.3	20357	22391	11-ID CHX Beamline Development & Research
4.3.2.2.6.4	20357	22392	11-ID CHX Maintenance & Improvements
4.3.2.2.7			12-ID-2 SMI Bml Management
4.3.2.2.7.1	20740	20740	12-ID-2 SMI Bml Operations
4.3.2.2.7.2	20740	22393	12-ID-2 SMI User Support
4.3.2.2.7.3	20740	22394	12-ID-2 SMI Beamline Development & Research
4.3.2.2.7.4	20740	22395	12-ID-2 SMI Maintenance & Improvements
4.3.2.2.8			11-BM CMS Bml Management
4.3.2.2.8.1	21416	21416	11-BM CMS Bml Operations
4.3.2.2.8.2	21416	22396	11-BM CMS User Support
4.3.2.2.8.3	21416	22397	11-BM CMS Beamline Development & Research
4.3.2.2.8.4	21416	22398	11-BM CMS Maintenance & Improvements

WBS #	Proj	Act	Activity
4.3.2.2.9			23-ID-1 CSX-1 Bml Management
4.3.2.2.9.1	20358	20358	23-ID-1 CSX-1 Bml Operations
4.3.2.2.9.2	20358	22399	23-ID-1 CSX-1 User Support
4.3.2.2.9.3	20358	22400	23-ID-1 CSX-1 Beamline Development & Research
4.3.2.2.9.4	20358	22401	23-ID-1 CSX-1 Maintenance & Improvements
4.3.2.2.10			23-ID-2 CSX-2 Bml Management
4.3.2.2.10.	20359	20359	23-ID-2 CSX-2 Bml Operations
4.3.2.2.10.	20359	22402	23-ID-2 CSX-2 User Support
4.3.2.2.10.	20359	22403	23-ID-2 CSX-2 Beamline Development & Research
4.3.2.2.10.	20359	22404	23-ID-2 CSX-2 Maintenance & Improvements
4.3.2.2.11			21-ID ESM Bml Management
4.3.2.2.11.	20744	20744	21-ID ESM Bml Operations
4.3.2.2.11.	20744	22405	21-ID ESM User Support
4.3.2.2.11.	20744	22406	21-ID ESM Beamline Development & Research
4.3.2.2.11.	20744	22407	21-ID ESM Maintenance & Improvements
4.3.2.2.12			2-ID SIX Bml Management
4.3.2.2.12.	20741	20741	2-ID SIX Bml Operations
4.3.2.2.12.	20741	22408	2-ID SIX User Support
4.3.2.2.12.	20741	22409	2-ID SIX Beamline Development & Research
4.3.2.2.12.	20741	22410	2-ID SIX Maintenance & Improvements
4.3.2.2.13			22-BM-1 FIS/MET Bml Management
4.3.2.2.13.	21417	21417	22-BM-1 FIS/MET Bml Operations
4.3.2.2.13.	21417	22411	22-BM-1 FIS/MET User Support
4.3.2.2.13.	21417	22412	22-BM-1 FIS/MET Beamline Development & Research
4.3.2.2.13.	21417	22413	22-BM-1 FIS/MET Maintenance & Improvements
4.3.2.2.14			28-ID-2 XPD Bml Management
4.3.2.2.14.	20360	20360	28-ID-2 XPD Bml Operations
4.3.2.2.14.	20360	22414	28-ID-2 XPD User Support
4.3.2.2.14.	20360	22435	28-ID-2 XPD Beamline Development & Research
4.3.2.2.14.	20360	22416	28-ID-2 XPD Maintenance & Improvements
4.3.2.2.15			28-ID-1 PDF Bml Management
4.3.2.2.15.	21412	21412	28-ID-1 PDF Bml Operations
4.3.2.2.15.	21412	22417	28-ID-1 PDF User Support
4.3.2.2.15.	21412	22418	28-ID-1 PDF Beamline Development & Research
4.3.2.2.15.	21412	22419	28-ID-1 PDF Maintenance & Improvements
4.3.2.2.16			4-ID-2 ISR Bml Management
4.3.2.2.16.	20742	20742	4-ID-2 ISR Bml Operations
4.3.2.2.16.	20742	22420	4-ID-2 ISR User Support
4.3.2.2.16.	20742	22421	4-ID-2 ISR Beamline Development & Research
4.3.2.2.16.	20742	22422	4-ID-2 ISR Maintenance & Improvements
4.3.2.2.17			HEX Bml Management
4.3.2.2.17.	21418	21418	HEX Bml Operations
4.3.2.2.17.	21418	22423	HEX User Support
4.3.2.2.17.	21418	22424	HEX Beamline Development & Research
4.3.2.2.17.	21418	22425	HEX Maintenance & Improvements
4.3.2.2.18			8-ID ISS Bml Management
4.3.2.2.18.	20743	20743	8-ID ISS Bml Operations
4.3.2.2.18.	20743	22426	8-ID ISS User Support
4.3.2.2.18.	20743	22427	8-ID ISS Beamline Development & Research
4.3.2.2.18.	20743	22428	8-ID ISS Maintenance & Improvements
4.3.2.2.19			7-BM QAS Bml Management
4.3.2.2.19.	21413	21413	7-BM QAS Bml Operations
4.3.2.2.19.	21413	22429	7-BM QAS User Support
4.3.2.2.19.	21413	22430	7-BM QAS Beamline Development & Research
4.3.2.2.19.	21413	22431	7-BM QAS Maintenance & Improvements
4.3.2.2.20			8-BM TES Bml Management
4.3.2.2.20.	21414	21414	8-BM TES Bml Operations
4.3.2.2.20.	21414	22432	8-BM TES User Support
4.3.2.2.20.	21414	22433	8-BM TES Beamline Development & Research
4.3.2.2.20.	21414	22434	8-BM TES Maintenance & Improvements

WBS #	Proj	Act	Activity
4.3.3			**Instrumentation Support and R&D**
4.3.3.1.1	20012	20012	Thin Film (Dev of sub-5 nm MLL optics)
4.3.3.1.2	20012	22545	Dev of ML mirrors
4.3.3.1.2	20086	20086	Dev of ML mirrors
4.3.3.1.3	20012	22546	Dev of high E-res optics
4.3.3.1.4	20012	22547	Optics Fab - User Support for Operations
4.3.3.2			Metrology
4.3.3.2.1	20087	20087	Optical metrology characterization
4.3.3.2.2	20087	22548	At-wavelength metrology development & characterization
4.3.3.2.3	20087	22549	Simulations
4.3.3.3			Detector Development
4.3.3.3.1	20736	20736	Dev fast E-res pixel detector - HEXID
4.3.3.3.2	20736	22550	Detector Support
4.3.3.3.3	20736	22551	Dev MAIA-II detector
4.3.3.3.4	20736	22552	Dev GE strip-detector
4.3.3.3.5	20736	22553	Dev XPCS detector - VIPIC
4.3.3.3.6	20736	22554	Detector Projects Development
4.3.3.4			Nano-scale Positioning
4.3.3.4.1	20088	20088	Development of Nanopositioning Systems
4.3.3.4.2	20088	22555	System Integration & Control
4.3.3.4.3	20088	22556	Services & Characterization
4.3.4			**Facility Controls, Computing and Data**
4.3.4.1			IT and Computing Infrastructure
4.03.04.01	21675	21675	Development/ Maintenance of New Facility IT/ Network Infrastructure
4.03.04.01	21675	22557	Development/ Maintenance of Facility Computing & Data Storage Infrastructure
4.03.04.01	21675	22558	Sysadmin
4.03.04.02			Beamline Controls
4.03.04.02	21671	21671	Engineering Support
4.03.04.02	21674	21674	Motion Controls & Automation
4.03.04.03	21673	21673	Controls Infrastructure
4.03.04.04			Accelerator Controls
4.03.04.04	21672	21672	Accelerator Controls
4.03.04.04	21672	22559	ID Controls
4.03.04.05			Data Acquisition, Visualization & Computing
4.03.04.05	20735	20735	Data Acquisition
4.03.04.05	20735	22560	Software Development & Support

WBS #	Proj	Act	Activity
4.03.05			**User Programs**
4.03.05.01			User Office
4.03.05.01	20739	20739	User Proposal Administration
4.03.05.01	20739	22561	User Access Support
4.03.05.01	21029	21029	User Meetings & Workshops
4.03.05.01	20739	22562	Publications, Records & Reporting
4.03.05.02	21028	21028	Industrial Research Support
4.03.05.03			Partner User Support
4.03.05.03	20747	20747	17-ID-1 AMX Bml Operations
4.03.05.03	20746	20746	17-ID-2 FMX Bml Operations
4.03.05.03	20748	20748	16-ID LIX Bml Operations
4.03.05.03	21997	21997	17-BM XFP Bml - Case Western Operations
4.03.05.03	21732	21732	7-ID-1 SST-1 Bml - NIST Operations
4.03.05.03	21733	21733	7-ID-2 SST-2 Bml - NIST Operations
4.03.05.03	21231	21231	6-BM BMM Bml - NIST Operations
4.03.05.03	21998	21998	19-ID NYX Bml - NYSBC Operations
4.03.05.04			Support for Users @ Other Facilities
4.03.05.04	20929	20929	X-Ray Spectroscopy @ SSRL
4.03.05.04.02			Protein Crystallography at Westcoast
4.03.05.04	21154	21154	Energy Dispersive XRD
4.03.05.04	21155	21155	Infrared Program
4.03.05.04	21421	21421	Transmission X-ray Microscopy
4.03.06			**LSBR Experimental Operations**
4.03.06.01	20907	20907	LSBR Organizational Management
4.03.06.02	20907	20907	LSBR Beamline Operations
4.03.06.02	20907	20907	LIX Operations
4.03.06.02	20907	20907	FMX Operations
4.03.06.02	20907	20907	AMX Operations
4.03.06.03	20907	20907	Other LSBR Programs
4.03.06.03	20907	20907	SRX R&D Operations
4.03.06.03	20907	20907	Laboratories - Service & User Support (crystal & wet labs)
4.03.06.03	20907	20907	Training and Dissemination
4.03.07			**Other Funded Work**
4.03.07.01			DOE - BES Funded Work
4.03.07.01	22021	22021	Wavefront Preserving
4.03.07.01	22022	22022	Saw- Tooth and Kinoform Lenses
4.03.07.01	12627	12627	Advanced Photon Detector for Synchrotron Radaiation Applications
4.03.07.02			BER Funded Work
4.03.07.03			NIH Funded Work
4.03.07.03	12123	12123	Characterization of Sensor Proteins & Demands
4.03.07.03	12731	12731	Molecular Mechanisms Mediating Environment Sensing & Response
4.03.07.03	19144	19144	Molecular Mechanisms Mediating Environment Sensing & Response
4.03.07.03	20846	20846	Mesoscale - PS
4.03.07.03	21948	21948	HDRMX Meeting - LSBR
4.03.07.03	09761	09761	Flexplate Design Improvement
4.03.07.04			SBIR Funded Work
4.03.07.04	87357	87357	Radiasoft Phase II SBIR
4.03.07.04	87363	87363	Sydor Instruments Phase II
4.03.07.04	84112	84112	ACCUSTRATA - SBIR
4.03.07.04	87283	87283	INCOM Phase II
4.03.07.05			NSLS Funded Work
4.03.07.05	20592	20592	PS Support of NIST Beamlines
4.03.07.05	07578	07578	X6A Protein Crystallography Operations
4.03.07.06			CSIRO Funded Work
4.03.07.06	84164	84164	CSIRO MAIA DAM #4
4.03.07.07			NYS Funded Work
4.03.07.07	84065	84065	NYS CRYO-EM
4.03.07.08			Private Funded Work
4.03.07.08	89151	89151	PFIZER Inc

Table 8.iii.1: Photon Science Division WBS

8.iv NSLS-II Operations WBS Dictionary

WBS 4.1 **Facilities Management**

Facility Management functions including: labor, materials, travel, and fixed costs associated with operations of the NSLS-II Facility, including the office of the Director for NSLS-II; the ESH&Q activities and the Business support functions.

WBS 4.1.1 **Management**

Perform facility management activities and provide support functions associated with the operations of the offices of the management team and the support functions of the NSLS-II facility. It also includes a comprehensive communications program.

WBS 4.1.1.1 **Department Management**

Strategic level direction of the NSLS-II science program, and facility operations.

WBS 4.1.1.1.1 **Department Management**

Developing and directing the implementation of strategic plans for optimizing NSLS-II capabilities and applying them to grand challenge science; reviewing and approving user proposals and allocating beam time; user and scientific community liaison.

Direction and Oversight of Facility Operations - Assuring excellence in operations including compliance with the Accelerator Safety Envelope (ASE) and other BNL and NSLS-II requirements; implement and sustain conduct of operations, allocate resources and provide overall direction of activities under Facilities Management WBS 4.1; performance management, process optimization, and continuous improvement; ensure integration among Accelerator Division, Photon Science Division and support staff to optimize facility reliability and efficiency

WBS 4.1.1.1.2 **Schedule/Planning/Control**

This WBS captures the initiation and development of new tools or management procedures that are meant to help facilitate the coordination of work.

WBS 4.1.1.1.3 **Post Doc Program**

An NSLS II competitively awarded program used to provide partial support for a small number of post docs who work on NSLS II ongoing science programs.

WBS 4.1.1.1.4 **Diversity Program**

Stony Brook Diversity program providing support to diversity graduate students at Stony Brook University working at NSLS II.

WBS 4.1.1.2 **Quality Assurance**

Provide Quality Engineering expertise for the operations and maintenance of the NSLS-II facility. Functions include:

Routine Operations - Writing, revising and reviewing procedures; reviewing, approving and archiving ECNs and formal drawings; controlling documents and records; routing electronic documents for approval; acting as Records Rep. archiving all NSLS and NSLS-II records; maintaining ECN/EDP/Design Review and Calculation logs; process PCRs and maintain project configuration management plans; implement and administer Calibration Recall System; maintain QA SharePoint sites; attend weekly technical meetings and regularly scheduled meetings; Supervision/Oversight; providing and receiving training; Performance/Salary review.

Continuous Improvement - Leading and participating in self-assessments and external reviews; Developing and tracking annual organizational assessment plan execution; Developing and implementing improvement and corrective action plans; Dispersing DOE Lessons Learned (LL) and drafting NSLS-II LLs; Monitoring, trending, analyzing and reporting organizational performance; Participating in set-up and roll-out of IOPS and OPEXShare.

Safety System Compliance and Verification - Implementing and Administering Safety System Verification Recall System; maintaining Key Safety Records; conducting event investigations, causal analysis and tracking findings; providing software quality assurance oversight; attending Radiation Safety Committee meetings and tracking recommendations.

WBS 4.1.1.3 **Communications**

Message and information development and dissemination. Functions include:

Internal Communications - Message development and communications products to inform staff of organizational progress, accomplishments, issues; enewsletter, NSLS-II and ES homepage articles.

External Communications - Message development and communications products to inform other BNL employees, Users, DOE, and other stakeholders; tours, media interactions; ES homepage articles.

WBS 4.1.1.4 **Human Resources**

Provide Human Resources services to NSLS-II managers and staff [Service Level Agreement]. Functions include:

Strategic Human Resources Planning - Support NSLS-II management in the development and implementation of short- and long-range HR strategies, programs and policies for NSLS-II; advise and assist senior management in the preparation of effective human resource plans. Identify human resource trends that may impact the NSLS-II in the long term and helps ensure that management is prepared to proactively and strategically manage change.

Managing Human Resources Processes-Establish, manage, coordinate and oversee policies, procedures, programs and services pertaining to the human resources of the NSLS-II, including change management, organizational development, and talent management to include staff development, and succession planning, workforce planning.

Managing Employee Performance Management - Guide and counsel senior management in the effective utilization of human resources: staff assessment and development, performance management, human resource strategies for problem resolution, Manage highly complex and sensitive employment and employee relations issues.

Managing employee transitions - Recruiting and "on-boarding" staff to support NSLS-II mission and support needs; advising management and coordinating the transfer, termination, and reduction in force processes.

WBS 4.1.1.5 **Information Technology**

This is the provide Business Systems Development services to support the NSLS-II facility. These efforts cover the building and maintaining of the various systems that are used to effectively support the NSLS-II facility (PASS, SharePoint, Vault, etc.).

WBS 4.1.1.6 **Enterprise Computing**

This is the provide Enterprise Computing services to support the NSLS-II facility. These efforts cover additional desk side support to cover such things as reviews and committee meetings.

WBS 4.1.2 **Environment, Safety, and Health**

Provide Environmental, Safety, Health and QA activities associated with the NSLS-II operating facility. It includes ESH support and oversight for all ESH issues including radiation, industrial hygiene, training and general safety; It provides quality assurance activities to ensure that a quality program is established, implemented, and maintained in accordance with operations requirements; It provides facility-related support to the staff and researchers by interfacing with the Facilities and Operations Directorate, contractors, and vendors.

WBS 4.1.2.1 **ES&H Services**

Providing ES&H support to NSLS-II construction projects and operations through implementation of an approved Integrated Safety Management (ISM) program. Functions include:

ES&H Improvements - Provides funding to address issues and suggestions by NSLS-II staff to improve ES&H at the facility, allowing supervisors and managers to be responsive to worker feedback. No FTEs.

Field Support - Supporting work planning and control processes (analyzing hazards and specifying controls; judging circumstances for Human Performance Improvement (HPI) factors); reviewing experiments and experimental facilities to identify, analyze and control risks - Experimental Safety Review (ESR) process; inspecting equipment for operational readiness; conducting ESH inspections of work areas (Tier I's) to recognize, evaluate, and control risks to personnel; monitoring work in the field to assure performance within specified controls (NSLS-II staff, users, vendors, contractors); monitoring for industrial hygiene risks (air and surface chemical sampling); maintaining monitoring equipment (e.g. O2 sensors); managing the receipt, inventory, storage, use, and disposal of chemicals; consulting with staff and users upon request to analyze and control the risks presented by their work activities as changes occur; managing event investigations, causal analyses, development of findings; supporting the recycling program;. communicating and implementing policy decisions.

Authorization Basis Management - Monitoring Laboratory requirements related to authorization basis documentation; monitoring all operations for compliance with the ASE; reviewing designs, plans, procedures, proposed actions, events, to determine if USI screening is required; managing the USI program (conducting screenings and evaluations); updating the ASE and SAD and supporting the Laboratory and DOE review and approval processes; maintaining documentation related to the ASE and SAD; tracking recurring calibration and certification requirements for credited controls and notifying system owners and management.

Integrated Assessment - Organizational and external assessment activity support; tracking, trending, analyzing, and reporting on key ES&H performance measures; assessment planning, investigating, analyzing, and implementing regulatory compliance; managing event investigations, causal analyses, development of findings; leading and participating in self-assessments and external reviews; developing and implementing improvement and corrective action plans.

Configuration Management - Managing Commissioning Activity Approval Forms and Safety System Work Permits; judging and implementing configuration control system identification, checklist, and physical inspection requirements; independent certification of PPS interlock systems and Area Radiation Monitors; monitoring CM of supplemental shielding; interpreting system control requirements.

Emergency Planning and Response - Planning, developing, and implementing Local Emergency Plans (LEPs) for all NSLS II facilities; planning, conducting and reporting on annual emergency drills and executing follow-up actions; coordinating and managing the Local Emergency Coordinator (LEC) staff; communicating emergency plan requirements and lessons learned; coordinate special circumstances/conditions with Laboratory Protection Division (Security, Fire, Emergency Management).

Requirements Management and Communication - Monitoring emerging requirements and providing feedback to Laboratory and DOE on impacts and effectiveness; analyzing and interpreting the changing ESH and operational requirements and needs and developing implementation strategies; writing, reviewing, and implementing ES&H and operational procedures and policies; tracking procedures through the development process and for revision

control; reviewing and approving work plans; reviewing and approving engineering changes; conducting staff reviews, validations, and walk-downs of new or significantly revised procedures; managing procedure change and revision processes; managing procedure "work flow" process (reviews, signatures, approvals); directing electronic ESH support program development.

Health Physics and Radiation Science - Implementing the operational health physics (Personnel dosimetry, PARM, ARM, routine prompt and residual radiological surveys, fault studies and comprehensive radiation surveys); performing and documenting calculations using Monte Carlo and other applicable computer codes to determine shielding requirements and to estimate induced radioactivity and dose to personnel and environment; Managing the receipt, inventory, storage, use of radioactive material including monitoring, inspecting and disposal of radwaste; Maintaining instruments in good working order (inventory, calibration, source function testing), inventory, record-keeping, and leak testing of radioactive sources; participating in LESH, RSC, Interlock working group.

Training - Providing qualified staff to perform all work required to operate and continue to build-out NSLS-II by analyzing staff work assignment to determine training and qualification requirements; generating Job Training Assessments and prepare for BTMS submission. This includes the planning, developing and delivering of training by identifying target audience through coordination with staff and implementation of 'Training Development forms'; developing specialized training courses to support operations; providing training to staff or coordinating training delivery by others. This requires continuous monitoring of work activities for contractors to assure adequate training assignment; analyzing training data to generate required reports and status tracking.

WBS 4.1.2.2 **ES&HI Committee**

Provides essential ES&H support services to the overall NSLS-II organization including personnel dosimetry (monthly collection, processing, and reissuance of TLDs), instrument calibration services, and waste management (waste removal, packaging, shipping and disposal). Services of an operational safety consultant are also made available for Instrument Readiness Reviews (IRRs).

WBS 4.1.2.3 **Smoke/Radiation Detector Installation**

WBS 4.1.2.4 **SSWP E-system**

WBS 4.1.3 **Business Services**

Provide oversight and coordination to the delivery of business support services, including interfacing with the central support organizations.

WBS 4.1.3.1 **Business Operations**

Establish, coordinate, manage and oversee the business functions that support the operations of the NSLS-II facility. This includes personnel forecasting, cost plans, budget submission,

electronic time reporting, financial reporting, reviewing/approving travel, project and activity assignments, audits, property and special process spares. Functions include:

Strategic Business Planning - Support NSLS-II management in the development and implementation of short- and long-range Business plans, programs and policies for NSLS-II. Communicate trends and/or changes which could affect our ability to execute our Business plans.

Managing Procurements - Provide the support to coordinate, process, review and manage the procurement needs of the NSLS-II facility. This includes credit cards, purchase orders, contracts, invoice approvals, inspections, commitments, audits and the Stock room, including receiving

WBS 4.1.3.1.1 **Freight charges**

Captures the NSLS II Departments freight charges when the charge can't be allocated to a specific purchase.

WBS 4.1.3.2 **NSLS II Stockroom**

The NSLS II stockroom is established to have an inventory of goods available 24/7 based on the proposed needs of the facility.

WBS 4.1.4 **Building Operations**

Support the NSLS-II activities with space, building power, and communications costs for the offices and laboratories.

WBS 4.1.4.1 **Facilities**

Coordinating operations and maintenance of the NSLS-II conventional facilities and providing occupant support. Functions include:

Coordinating Facilities Work by Others-Planning, coordinating, and providing oversight of work by Facilities & Operations and vendors conducted in NSLS-II facilities; estimating small projects, work planning and control; grievances, other union issues; Davis Bacon Committee reviews; assigned labor tracking.

Arranging for Materials and Supplies - Providing for materials, supplies and services for small maintenance, repair and minor construction jobs including ordering, expediting, receiving, checking, staging in the field; ordering, inventorying, coordinating deliveries of industrial gases.

Logistical Support-Providing logistics support for staff, users, students, visitors including arranging and coordinating space assignments, staff moves, and setup of workstations– furniture, minor repairs, provide computer connections, phone and data services; temporary furniture and audio-visual setup for reviews; assigning, tracking tricycles, motor vehicles.

ES&H, Security, Emergency Management-Implementing facilities related ES&H, security, and emergency management programs including responding to facilities "events" – leaks, flooding, building system malfunctions; planning and preparations for severe weather; tracking prox cards,

key control, reporting and resolving security and fire alarm system malfunctions; safety training and orientation on NSLS-II facilities; managing the Research Space Manager and Cognizant Space Manager programs; administration, records management.

Facilities Operations, Maintenance and Improvements - Planning, coordinating, and providing oversight of maintenance and improvements for the NSLS-II facilities.

WBS 4.1.4.2 **Space, Electric and Utilities**

Buildings, offices and labs which are occupied by NSLS-II staff and users. The electric power associated with the space occupied by NSLS-II staff and users. Telephone's necessary for the safe operations of the NSLS-II facility.

WBS 4.1.5 **Other**

Organizational Burden and the management of Special Process Spares.

WBS 4.1.5.1 **Organizational Burden**

Support to cover goods and services which cannot be identified with any particular program that benefit the entire department or for which no cost benefit is derived by direct charging.

WBS 4.1.5.2 **Special Process Spares**

Those spare parts which were identified as unique to the NSLS II facility and being vital to the continuous operation of the facility. These include the following:

4.1.5.2.1 SPS-Magnet Systems
4.1.5.2.2 SPS-Vacuum Systems
4.1.5.2.3 SPS-RF Components
4.1.5.2.4 SPS-Power Supplies
4.1.5.2.5 SPS-Diagnostics & Controls

WBS 4.1.6 **Beamline Development**

The work in beamline development centers on the development and execution of project oriented activities for the NSLS-II Department. The aim of consolidation of this work into one Facility Management function as a 'construction practice' is to optimize the formulation and delivery of the project work of the department. Engagements are developed within the scope of this WBS element up to the point they are authorized for execution, when they will become elements of a suitable portfolio or project. Ongoing monitoring and oversight of those engagements is included in the work of the construction group.

4.1.6.1 BLD-BDP Development

4.1.6.2 BL Dev Task Force

Complete evaluation and disposition of IEPD-2016 beamlines – present forecast/plan for baseline.

4.1.6.3 **Superconducting Wiggler Development**

4.1.6.4 **Optics Metrology Enhancement**

4.1.6.5 **Front End and ID Development**

4.1.6.6 **HEX Advanced Conceptual Design**

HEX planning and transition to the NPB portfolio.

4.1.6.7 **Sample Environment Development**

Complete requirements assessment.

4.1.6.8 Beamline Controls Development

4.1.6.9 **CDI Advanced Conceptual Design (ACD)**

Planning and transition to the BDN portfolio for execution – plan to baseline F18Q1

4.1.6.10 **QIX Advanced Conceptual Design (ACD)**

Extended planning – Requirements and Alternatives analysis (plan to baseline in F19)

4.1.6.11 **PLS Advanced Conceptual Design (ACD)**

Extended planning – Requirements and Alternatives analysis (plan to baseline in F19)

4.1.6.12 **INF Advanced Conceptual Design (ACD)**

Extended planning – plan to baseline F18Q2

4.1.6.13 **SMF Advanced Conceptual Design (ACD)**

SMF Extended planning – Requirements and Alternatives analysis (plan to baseline in F19

4.1.6.14 **ARI Advanced Conceptual Design (ACD)**

Planning and R&D program (pre authorization – go forward gate point by F18Q2)

4.01.07 **LDRD & Prog. Dev**

LDRD provides investment funding for the development of core capabilities through innovative R&D efforts. NSLS II funded efforts include:

4.01.07.01 LDRD14-021-In-Situ Investigation of the Strain Distribution in Next-Generation 3D Transistors Using X-Ray Nanodiffraction

4.01.07.02 LDRD15-031-Inelastic X-Ray Scattering determination of the inter- and intra-particle dynamics of nanoparticle superlattices: key to the development of THz phononic crystals

4.01.07.03 LDRD15-034-Searching and sorting haystacks

4.01.07.04 LDRD15-037-In-situ microscopy investigation of complex manganese oxides for energy storage

4.01.07.05 LDRD15-038-Segmented Adaptive-Gap Undulator with Different Period Lengths in Segments for Production of High Flux and Brightness Hard X-rays at NSLS-II

4.01.07.06 LDRD16-006-Serial Micro Crystallography at Full Flux

4.01.07.07 LDRD16-007-3D Ptychography imaging without rotation using highly convergent X-ray beam

4.01.07.08 LDRD16-010-100fs single-shot electron beam slicing technology towards ultra-fast imaging

4.01.07.09 LDRD16-046-Strong-Strong Beam-Beam Interaction Studies for a Ring-Ring Based Electron Ion Collider

4.01.07.10 PD13-015-Post Doc Interviews

4.01.07.11 PD16-030-Ultrafast Electron Diffraction

4.01.07.12 17-015-NSLS-II High Brightness Upgrade Design Studies

4.01.07.13 17-016-Diffraction Limited And Wavefront Preserving Reflective Optics Development

4.01.07.14 17-017-Development Of Compact, High Efficiency Nanofocusing Optics For Hard X-Ray Nano-Imaging

4.01.08 SPP

4.01.08.01 SPP-Traditional Stand Alone

4.01.08.02 SPP-other

WBS 4.2 **Accelerator Operations**

Operate the NSLS-II Accelerator complex and the associated auxiliary support systems, train and educate staff, organize and perform maintenance at the subsystem level, trouble shoot and repair or organize repair of subsystems, develop technical subsystems, plan the allocation of resources for operations, develop and maintain plans to keep accelerator operations safe.

WBS 4.2.1 **Operations Management**

Plan staffing, allocation of funds for consumable materials like power costs, coolants, lubricants etc., resource planning of external services such as UPS maintenance, electrical switch gear maintenance, resource planning continuous investments such as klystrons, thyristors, thyratrons, fans, resource planning for accelerator development and improvement program, organize performance reviews, this also contains the effort of the management team in support of operations oversight of all operational activities, plan development and R&D.

WBS 4.2.2 **Operations Safety**

Ensure that accelerator operation is safe, provide safety relevant training to operators and technicians, review and support work planning, control proper functioning of safety systems in collaboration with department and laboratory ES&H organizations, organize radiation safety monitoring in conjunction of working in accelerator areas, work out hazard analysis associated with system changes and system developments.

WBS 4.2.3 **Accelerator Development**

Development and modernization of components of the existing accelerator subsystems.

WBS 4.2.3.1 **Accelerator Physics Development**

Accelerator Physics development: Accelerator theory improvements, codes, operational procedures, beam optics improvements, improved methods for beam optimization, new methods for improving beam parameters.

WBS 4.2.3.2 **RF Development**

Develop RF Systems: build up 3rd s.c. cavity, build out 3rd harmonic cavity, develop high power cavity input coupler, improve cavity HOM coupler, Transmitter development (Solid State), development and modernization of Cavity low level controls.

WBS 4.2.3.3 **Diagnostic Development**

Improvements of specific critical devices beam position monitor systems, emittance measurement, damper and feedback systems, system upgrades to keep up with electronics and software, 2nd X-ray emittance measurement system , longitudinal damper system.

WBS 4.2.3.4 **Pulsed Magnet Development**

Develop kicker pulser systems to maximize reliability; upgrade the systems to solid state technology. Develop new kicker pulser based on hot cathode thyratrons for the booster, development of high precision injection kickers for the storage ring, develop pulsed multipole injection.

WBS 4.2.3.5 **Controls Development**

Improve and develop high level controls software, develop and modernize controls hardware to stay in phase with global software and electronics development and availability of electronics components. In particular develop 2nd generation cell controller.

WBS 4.2.3.6 **Power Systems Development**

Develop and modernize hardware and software for power supplies to improve on reliability issues. Rebuild booster quadrupole magnet power supplies.

WBS 4.2.3.7 **Insertion Device Development**

Improve shimming techniques for insertion devices, extent measurement capabilities, pursue opportunities by new materials becoming available, perform R&D on novel insertion device techniques.

WBS 4.2.3.8 **Infra Structure Development**

Improve develop modernize and upgrade global infrastructure such as water cooling systems, emergency power, information and communication systems, develop vacuum systems, develop design rooms, develop and maintain central computer room, develop and modernize alignment and survey systems.

WBS 4.2.3.9 **Correction of residuals multi-poles generated by IDs**

NSLS-II ring is sensitive in the variation of skew quadrupole generated by IDs due to small fractional tune differences. To minimize this effect, the existing IDs will be re-measured and reduce the residual multipoles. For further reduction, introduce small SQ correctors which can be installed in the places of current ID dipole correctors.

WBS 4.2.3.10 **Ceramic Chambers**

Design, build and develop an in-house thin film deposition system capable of coating ceramic chambers to be used in the NSLS II storage ring. This development includes a measuring system capable of characterizing the thickness of uniformity of the film along the length of the chamber.

WBS 4.2.3.11 **Mechanical Engineering Development**

Improve, develop, modernize and upgrade mechanical systems related to monitoring performance, optimizing applications software, generating optimized settings, performing small scale system improvements

WBS 4.2.4 **Accelerator Coordination**

Coordinate the operation of the NSLS-II accelerator complex.

WBS 4.2.4.1 **Coordinate Effort**

Coordinate the operation of the NSLS-II accelerator operations between storage ring, booster and LINAC, between accelerator subsystem requirements and user needs, plan operational parameters, plan scheduled maintenance, coordinate and decide on accelerator study program, communicate technical issues with the corresponding subsystem experts, propose improvements to hardware and software systems, generate and develop operational procedures, document and report on accelerator operations, organize safety tests.

WBS 4.2.4.2 **Intentionally left blank**

WBS 4.2.4.3 **Intentionally left blank**

WBS 4.2.4.4 **Intentionally left blank**

WBS 4.2.4.5 **Accelerator Physics Ops Support**

Analyze data from operating the accelerator, develop plans for accelerator studies, analyze results of accelerator studies, propose optimized operational parameter settings of accelerator hardware and control, propose technical improvements to accelerator subsystems, propose improvement to operational procedures, generate, optimize, develop and maintain computer code to support accelerator study program.

WBS 4.2.4.6 **Beam Operation of the Accelerator Complex**

Perform and document 24/7 beam operation of the LINAC, Booster, Transfer lines, Storage Ring, train operators, develop operating procedures, communicate information on subsystem issues to subsystem owners, generate shift plans, define beam operator training program, develop beam operations procedures, secure accelerator tunnels, assume role of local emergency coordinators off-business hours.

WBS 4.2.4.7 **Operation of Mechanical Utilities**

The following systems belong to this group of hardware:
WBS 4.2.4.7.1 Central DI cooling water plant
WBS 4.2.4.7.2 Satellite Al

WBS 4.2.4.7.3 CU water systems
WBS 4.2.4.7.4 Chilled water distribution systems
WBS 4.2.4.7.5 Lq He cryogenic plant
WBS 4.2.4.7.6 Lq N2 supply system. The effort also includes survey and alignment activities.

The WBS captures the following work: optimize performance of mechanical utility systems, generated optimized settings to the operation of mechanical utility systems, monitor operations of mechanical utility systems, plan and execute maintenance on mechanical utility systems, perform trouble shooting, and perform or organize repair on these systems, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.8 **Operation of the Electrical Utilities**

The following systems belong to this group of hardware:
WBS 4.2.4.8.1 AC distribution switches
WBS 4.2.4.8.2 cabling and cable trays
WBS 4.2.4.8.3 Equipment enclosures
WBS 4.2.4.8.4 UPS systems

The WBS captures the following work: optimize performance of electrical utility systems, generated optimized settings to the operation of electrical utility systems, monitor operations of electrical utility systems, plan and execute maintenance on electrical utility systems, perform trouble shooting, and perform or organize repair on these systems, perform small scale system improvements, generate on-call plan.

WBS 4.2.4.8.5 **Electrical Design Support**

The design room needs to maintain and develop all electrical drawings. There are 10,000 electrical drawings in the system. Each drawing has to be revised, updated and ported to new systems, modifications have to be applied and documented, errors and mistakes in the drawing systems have to be corrected.

WBS 4.2.4.9 **Operation of RF Systems**

The following systems belong to this group of hardware:
WBS 4.2.4.9.1 Storage ring super conducting cavities
WBS 4.2.4.9.2 Storage Ring transmitters, WBS 4.WBS 4.2.4.9.3 Booster RF cavities
WBS 4.2.4.9.4 Booster Transmitter, WBS 4.WBS 4.2.4.9.5 Linac RF transmitters
WBS 4.2.4.9.6 LINAC accelerating structures
WBS 4.2.4.9.7 RF sensors and low level control and software
WBS 4.2.4.9.8 Third Superconducting RF Cavity

The WBS captures the following work: optimize performance of RF systems, generated optimized settings to the operation of RF systems, monitor operations of RF systems, plan and execute maintenance on RF systems, perform trouble shooting, and perform or organize repair on

these systems, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.10 **Operation of Pulsed Magnet systems**

The following systems belong to this group of hardware:
WBS 4.4.10.1 Booster Injection Kicker System
WBS 4.4.10.2 Booster extraction kicker system
WBS 4.4.10.3 Storage Ring injection kicker system, LINAC Chopper system, Pinger System
WBS 4.4.10.4 Booster Injection Septum System
WBS 4.2.10.5 Booster extraction septa system, Storage Ring injection Septa system
WBS 4.4.10.6 Storage Ring Injection Septum system

The WBS captures the following work: optimize performance of pulsed magnet systems, generated optimized settings to the operation of pulsed magnet systems, monitor operations of, plan and execute maintenance, perform trouble shooting, and perform or organize repair on these systems, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.11 **Operation of Vacuum Systems**

The following systems belong to this group of hardware:
WBS 4.2.4.10.1 Mechanical Vacuum system, chambers, valves, flanges, bellows
WBS 4.4.11.2 Vacuum pumps, monitoring, electronics and electrical systems, vacuum pump stands; Movable vacuum parts
WBS 4.4.11.3 Beam Line Font end Vacuum systems
The WBS captures the following work: monitor operations, analyze logged vacuum data, perform trouble shooting, perform leak checking, perform or organize repair, perform small scale system improvements, generate on-call plans.

WBS 4.4.11.4 **Vacuum Development**

This work package summarizes the maintenance and development work on specific vacuum systems such as bake out systems, brazing oven, cleaning facility.

WBS 4.2.4.12 **Operation of Power Supply Systems**

The following systems belong to this group of hardware:
WBS 4.2.4.12.1 Main Power supply
WBS 4.2.4.12.2 Switches mode power supplies for quadrupoles, sextupoles and correctors
WBS 4.2.4.12.3 Ramped magnet power supplies for the booster
WBS 4.2.4.12.4 Power Supply interfaces and Power supply controllers
WBS 4.2.04.12.05 Power supply hardware interlock systems
WBS 4.2.04.12.06 magnet temperature survey systems (klixons, temperature sensors)

The WBS captures the following work: optimize performance of power supply systems, generated optimized settings to the operation of ps systems, monitor operations of mechanical utility systems, plan and execute maintenance on ps systems, perform trouble shooting, and perform or

organize repair on these systems, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.13 **Operation of Safety Systems**

The following systems belong to this group of hardware:
WBS 4.2.4.13.1 PPS logic controller hard and software
WBS 4.2.4.13.2 EPS logic controller hard and software
WBS 4.2.4.13.3 PPS auxiliary hardware such door contacts, light dimmers, bling warning lights, lighted warning panels, emergency button system
WBS 4.2.4.13.4 ALARA systems
The WBS captures the following work: monitor performance of safety systems, generated optimized settings for the EPS and ALARA systems , plan and execute maintenance , perform regular safety tests (prior to independent safety checks of the system) perform trouble shooting, and perform or organize repair, perform small scale system improvements, generate on-call plans

WBS 4.2.4.14 **Operation of Diagnostic Systems**

The following systems belong to this group of hardware:
WBS 4.2.4.14.1 BPM System
WBS 4.2.4.14.3 Current Monitors
WBS 4.2.4.14.3 Optical and X-ray monitoring
WBS 4.2.4.14.4 Mechanical devices: scrapers, screens
WBS 4.WBS 4.4.13.5 Feedback and damper systems

The WBS captures the following work: monitor performance, generated optimized settings, plan and execute maintenance, perform trouble shooting, and perform or organize repair, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.15 **Operation of Insertion Devices**

The accelerator has slots for 27 insertion devices (some of them canted double devices) and 30 3PWs. The ID includes the magnetic structure, vacuum or cryogenic structure, mechanics, mover-motors, control electronics, correction magnets. The WBS captures the following work: monitor performance, generated optimized settings, plan and execute maintenance, perform trouble shooting, and perform or organize repair, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.16 **Operation of Controls**

The following systems belong to this system:
WBS 4.2.4.15.1 Application Software
WBS 4.2.4.16.2 Frontend Hardware Systems and shared memory system
WBS 4.2.4.16.3 Frontend Software systems
WBS 4.2.4.16.4 Controls Database
WBS 4.2.4.16.5 Controls Network Hardware and Administration

WBS 4.2.4.16.6 Timing system

The WBS captures the following work: monitor performance, keep the control system on the latest software standards, optimize applications software; generate optimized settings, plan and execute maintenance, and perform or organize repair, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.17 **Operation of Mechanical Systems**

Systems: 1200 magnets, 60 frontends, miscellaneous mechanical systems, The WBS captures the following work: monitor performance, keep the control system on the latest software standards, optimize applications software; generate optimized settings, plan and execute maintenance, and perform or organize repair, perform small scale system improvements, generate on-call plans.

WBS 4.2.4.17.1 will cover magnets and support

WBS 4.2.4.17.2 will cover beam line frontend and support for beam diagnostics

WBS 4.2.4.17.3 **Mechanical Design Room**

Design room needs to maintain and develop all mechanical drawings. There are 20,000 drawings in the system. Each drawing has to be revised, updated and ported to new systems, modifications have to be applied and documented, errors and mistakes in the drawing systems have to be corrected.

WBS 4.2.4.17.4 **Survey System**

1100 m of accelerator tunnel with ~1500 survey targets and survey monuments, to be surveyed, analyzed and realigned every 2 years as well as after each intervention which requires removal of a surveyed component from the machine (includes also temporary removals), this is expected.

WBS 4.2.4.17.5 **Mechanical Machine Shop**

This WBS captures activities to keep the machine shop compliant and operable and to maintain the training of the mechanical technicians.

WBS 4.2.5.1 **APS Corrector Magnet**

This WBS captures activities related to the design, construction and testing of a prototype fast corrector magnet for the APS Upgrade Project.

WBS 4.2.5.2 **APS Magnet Cross Talk**

This WBS captures activities related to the conduct of analyses to further understand and identify the technical risks involved with placing magnets near each other in the APSU storage ring.

WBS 4.2.5.3 **Collective Effects Analysis Support**

This WBS captures the activity of the Accelerator Physics group to provide collective effects analysis support to assist with understanding and design of beam physics and engineering issues related to collective effects in the multi-bend achromat lattice for the APS upgrade.

WBS 4.2.5.4 **Taiwan Light Source**

This WBS relates to the activity around producing 4 additional cavity controllers during the NSLS-II project production run to be used by National Synchrotron Radiation Research Center (NSRRC). And managing, local data storage and data processing computing facilities for FIS/MET, including providing technical support for access and usage by staff and users.

WBS 4.3 **Experimental Operations**

All activities associated with NSLS-II experimental operations.

WBS 4.3.1 **Experimental Management**

All activities associated with planning, directing, and managing resources needed for experimental operations.

WBS 4.3.1.1 **Organizational Management**

All activities associated with management of the organizational and administrative aspects of the experimental programs, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes organizational management and administrative support.

WBS 4.3.1.2 **Structural Biology Program**

All activities associated with management of the organizational aspects of the Structural Biology program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes oversight of beamlines in this program area.

WBS 4.3.1.3 **Imaging and Microscopy Program**

All activities associated with management of the organizational aspects of the Imaging and Microscopy program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes oversight of beamlines in this program area.

WBS 4.3.1.4 **Complex Scattering Program**

All activities associated with management of the organizational aspects of the Complex Scattering program, including activities to interact with the scientific community and to organize staff and

management for programmatic alignments of resources with scientific initiatives and priorities. Includes oversight of beamlines in this program area.

WBS 4.3.1.5 **Soft X-Ray Scattering and Spectroscopy Program**

All activities associated with management of the organizational aspects of the Soft X-ray Scattering and Spectroscopy program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes oversight of beamlines in this program area.

WBS 4.3.1.6 **Diffraction and In Situ Scattering Program**

All activities associated with management of the organizational aspects of the Diffraction and In Situ Scattering program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes oversight of beamlines in this program area.

WBS 4.3.1.7 **Hard X-Ray Spectroscopy Program**

All activities associated with management of the organizational aspects of the Hard X-ray Spectroscopy program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes oversight of beamlines in this program area.

WBS 4.3.1.8 **Experiment Development Program**

All activities associated with management of the organizational aspects of the experimental programs, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities.

WBS 4.3.1.9 **Controls Program**

All activities associated with management of the organizational aspects of the Controls program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities.

WBS 4.3.1.10 **User Program**

All activities associated with management of the organizational and administrative aspects of user program, including activities to interact with the scientific community and to organize staff and management for programmatic alignments of resources with scientific initiatives and priorities. Includes organizational management and administrative support.

WBS 4.3.2 **Beamline Operations**

All activities associated with operation, maintenance, and improvements of all operating beamlines at NSLS-II including beamline operations, development and support of science programs at beamlines, and LOB operations support.

WBS 4.3.2.1 **Engineering, Technical & User Operations Support**

All activities to support experimental systems operations, maintenance, and major upgrades, including engineering support for mechanical and vacuum systems at beamlines, as well as ancillary equipment and operations in LOB laboratories.

WBS 4.3.2.1.1 **Beamline Engineering Support**

Beamline development and implementation planning for operating beamlines, including engineering support for beamline upgrades, engineering design reviews, and materials & services for implementation and commissioning.

WBS 4.3.2.1.2 **Technical Support**

All technical support for experimental systems operations, maintenance, and major upgrades, including technical support for mechanical and vacuum systems at beamlines, as well as ancillary equipment and operations in LOB laboratories.

WBS 4.3.2.1.3 **Beamline Upgrade Projects**

Procurement & specification of beamline component upgrades and improvements for operating beamlines, design reviews, and costs associated with beamline procurements such as new detectors, standard cryocooler spares/replacements, sample environments, cryostats, flow cells, endstations, and new optics (mirrors, CRLs, multilayers).

WBS 4.3.2.1.4 **Experimental Maintenance & Support Activities**

Coordination for common beamline equipment maintenance and records, including ODH systems, and cryo-system operations. Development and implementation of operations procedures, assistance with approvals, inspections, and shipping users' equipment/samples.

WBS 4.3.2.1.5 **Research Operations Support**

Activities and costs associated with support for operations and experiments at beamlines and LOB laboratories, including development and maintenance of sample environments, common systems trouble-shooting.

WBS 4.3.2.1.6 **LOB Lab Operations**

Procurement & maintenance of LOB laboratory ancillary equipment and instrumentation, lab supplies, and required PPE. Oversight and supervision for lab and machine shop operations.

WBS 4.3.2.1.7 **Equipment Pool Support**

Activities associated with operation and maintenance of an equipment pool for shared usage by beamline staff and users, including maintaining a user access schedule for all equipment in the pool before each run cycle, and providing assistance and training to staff and users.

WBS 4.3.2.2 **Direct Beamline Support**

All activities associated with beamlines for management, user support, beamline development and research, and maintenance and improvements in operations.

WBS 4.3.2.2.1 **3-ID HXN Operations**

All activities associated with HXN beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.1.1 **3-ID HXN Management and other Activities**

All activities associated with HXN beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.1.2 **3-ID HXN User Support**

Activities related to scientific and technical support for HXN user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.1.3 **3-ID HXN Beamline Development & Research**

Support for HXN beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.1.4 **3-ID HXN Maintenance & Improvements**

Activities associated with planning and coordination of HXN maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs,

endstation component repairs, and repair services from vendors or suppliers. Effort and resources for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.2 **5-ID SRX Operations**

All activities associated with SRX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.2.1 **5-ID SRX Management and other Activities**

All activities associated with SRX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.2.2 **5-ID SRX User Support**

Activities related to scientific and technical support for SRX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures , endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.2.3 **5-ID SRX Beamline Development & Research**

Support for SRX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.2.4 **5-ID SRX Maintenance & Improvements**

Activities associated with planning and coordination of SRX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.3 **18-ID FXI Operations**

All activities associated with FXI beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.3.1 **18-ID FXI Management and other Activities**

All activities associated with FXI beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.3.2 **18-ID FXI User Support**

Activities related to scientific and technical support for FXI user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.3.3 **18-ID FXI Beamline Development & Research**

Support for FXI beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.3.4 **18-ID FXI Maintenance & Improvements**

Activities associated with planning and coordination of FXI maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.4 **4-BM XFM Operations**

All activities associated with XFM beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.4.1 **4-BM XFM Management and other Activities**

All activities associated with XFM beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.4.2 **4-BM XFM User Support**

Activities related to scientific and technical support for XFM user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.4.3 **4-BM XFM Beamline Development & Research**

Support for XFM beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.4.4 **4-BM XFM Maintenance & Improvements**

Activities associated with planning and coordination of XFM maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.5 **10-ID IXS Operations**

All activities associated with IXS beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.5.1 **10-ID IXS Management and other Activities**

All activities associated with IXS beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.5.2 **10-ID IXS User Support**

Activities related to scientific and technical support for IXS user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.5.3 **10-ID IXS Beamline Development & Research**

Support for IXS beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.5.4 **10-ID IXS Maintenance & Improvements**

Activities associated with planning and coordination of IXS maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.6 **11-ID CHX Operations**

All activities associated with CHX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.6.1 **11-ID CHX Management and other Activities**

All activities associated with CHX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.6.2 **11-ID CHX User Support**

Activities related to scientific and technical support for CHX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.6.3 **11-ID CHX Beamline Development & Research**

Support for CHX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.6.4 **11-ID CHX Maintenance & Improvements**

Activities associated with planning and coordination of CHX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.7 **12-ID-2 SMI Operations**

All activities associated with SMI beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.7.1 **12-ID-2 SMI Management and other Activities**

All activities associated with SMI beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.7.2 **12-ID-2 SMI User Support**

Activities related to scientific and technical support for SMI user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.7.3 **12-ID-2 SMI Beamline Development & Research**

Support for SMI beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.7.4 **12-ID-2 SMI Maintenance & Improvements**

Activities associated with planning and coordination of SMI maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.8 **11-BM CMS Operations**

All activities associated with CMS beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.8.1 **11-BM CMS Management and other Activities**

All activities associated with CMS beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.8.2 **11-BM CMS User Support**

Activities related to scientific and technical support for CMS user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.8.3 **11-BM CMS Beamline Development & Research**

Support for CMS beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.8.4 **11-BM CMS Maintenance & Improvements**

Activities associated with planning and coordination of CMS maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.9 **23-ID-1 CSX-1 Operations**

All activities associated with CXS-1 beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.9.1 **23-ID-1 CSX-1 Management and other Activities**

All activities associated with CXS-1 beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.9.2 **23-ID-1 CSX-1 User Support**

Activities related to scientific and technical support for CXS-1 user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.9.3 **23-ID-1 CSX-1 Beamline Development & Research**

Support for CSX-1 beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.9.4 **23-ID-1 CSX-1 Maintenance & Improvements**

Activities associated with planning and coordination of CSX-1 maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.10 **23-ID-2 CSX-2 Operations**

All activities associated with CXS-2 beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.10.1 **23-ID-2 CSX-2 Management and other Activities**

All activities associated with CXS-2 beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.10.2 **23-ID-2 CSX-2 User Support**

Activities related to scientific and technical support for CXS-2 user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.10.3 **23-ID-2 CSX-2 Beamline Development & Research**

Support for CSX-2 beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.10.4 **23-ID-2 CSX-2 Maintenance & Improvements**

Activities associated with planning and coordination of CSX-2 maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.11 **21-ID ESM Operations**

All activities associated with ESM beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.11.1 **21-ID ESM Management and other Activities**

All activities associated with ESM beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.11.2 **21-ID ESM User Support**

Activities related to scientific and technical support for ESM user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.11.3 **21-ID ESM Beamline Development & Research**

Support for ESM beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.11.4 **21-ID ESM Maintenance & Improvements**

Activities associated with planning and coordination of ESM maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.12 **2-ID SIX Operations**

All activities associated with SIX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.12.1 **2-ID SIX Management and other Activities**

All activities associated with SIX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.12.2 **2-ID SIX User Support**

Activities related to scientific and technical support for SIX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.12.3 **2-ID SIX Beamline Development & Research**

Support for SIX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.12.4 **2-ID SIX Maintenance & Improvements**

Activities associated with planning and coordination of SIX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.13 **22-BM-1 FIS/MET Operations**

All activities associated with FIS/MET beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.13.1 **22-BM-1 FIS/MET Management and other Activities**

All activities associated with FIS/MET beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.13.2 **22-BM-1 FIS/MET User Support**

Activities related to scientific and technical support for FIS/MET user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.13.3 **22-BM-1 FIS/MET Beamline Development & Research**

Support for FIS/MET beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.13.4 **22-BM-1 FIS/MET Maintenance & Improvements**

Activities associated with planning and coordination of FIS/MET maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.14 **28-ID-2 XPD Operations**

All activities associated with XPD beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.14.1 **28-ID-2 XPD Management and other Activities**

All activities associated with XPD beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.14.2 **28-ID-2 XPD User Support**

Activities related to scientific and technical support for XPD user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.14.3 **28-ID-2 XPD Beamline Development & Research**

Support for XPD beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.14.4 **28-ID-2 XPD Maintenance & Improvements**

Activities associated with planning and coordination of XPD maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.15 **28-ID-1 PDF Operations**

All activities associated with PDF beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.15.1 **28-ID-1 PDF Management and other Activities**

All activities associated with PDF beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.15.2 **28-ID-1 PDF User Support**

Activities related to scientific and technical support for PDF user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.15.3 **28-ID-1 PDF Beamline Development & Research**

Support for PDF beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.15.4 **28-ID-1 PDF Maintenance & Improvements**

Activities associated with planning and coordination of PDF maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.16 **4-ID-2 ISR Operations**

All activities associated with ISR beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.16.1 **4-ID-2 ISR Management and other Activities**

All activities associated with ISR beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.16.2 **4-ID-2 ISR User Support**

Activities related to scientific and technical support for ISR user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.16.3 **4-ID-2 ISR Beamline Development & Research**

Support for ISR beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.16.4 **4-ID-2 ISR Maintenance & Improvements**

Activities associated with planning and coordination of ISR maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.17 **HEX Operations**

All activities associated with HEX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.17.1 **HEX Management and other Activities**

All activities associated with HEX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.17.2 **HEX User Support**

Activities related to scientific and technical support for HEX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.17.3 **HEX Beamline Development & Research**

Support for HEX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.17.4 **HEX Maintenance & Improvements**

Activities associated with planning and coordination of HEX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.18 **8-ID ISS Operations**

All activities associated with ISS beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.18.1 **8-ID ISS Management and other Activities**

All activities associated with ISS beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.18.2 **8-ID ISS User Support**

Activities related to scientific and technical support for ISS user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.18.3 **8-ID ISS Beamline Development & Research**

Support for ISS beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.18.4 **8-ID ISS Maintenance & Improvements**

Activities associated with planning and coordination of ISS maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.19 **7-BM QAS Operations**

All activities associated with QAS beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.19.1 **7-BM QAS Management and other Activities**

All activities associated with QAS beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.19.2 **7-BM QAS User Support**

Activities related to scientific and technical support for QAS user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.19.3 **7-BM QAS Beamline Development & Research**

Support for QAS beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.19.4 **7-BM QAS Maintenance & Improvements**

Activities associated with planning and coordination of QAS maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.2.2.20 **8-BM TES Operations**

All activities associated with TES beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.2.2.20.1 **8-BM TES Management and other Activities**

All activities associated with TES beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.2.2.20.2 **8-BM TES User Support**

Activities related to scientific and technical support for TES user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.2.2.20.3 **8-BM TES Beamline Development & Research**

Support for TES beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.2.2.20.4 **8-BM TES Maintenance & Improvements**

Activities associated with planning and coordination of TES maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources

for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.3 **Instrumentation Support and R&D**

Activities in support of beamline optics instrumentation as well as advanced optics R&D and associated enabling technologies. Includes development and implementation of nanofocusing optics, nanopositioning technology, high resolution crystal optics, detectors, and coherence preserving optics and associated metrology.

WBS 4.3.3.1 **Optics Fabrication**

All activities related to fabrication of optics for NSLS-II beamlines.

4.03.03.01.01 **Thin Film (Dev of sub-5 nm MLL optics)**

Activities related to the development of sub-5nm nanofocusing optics based on Multilayer Laue Lens approach, including operation of the clean rooms, MLL deposition, sectioning and polishing, nanofocusing theory support, and characterization and testing.

4.03.03.01.02 **Dev of ML mirrors**

Activities related to the development of sub-10nm nanofocusing reflective optics based on profile deposition of coatings of single and multi-layer thin-films, including operation of the clean rooms, ML deposition, nanofocusing simulations, and characterization and testing.

4.03.03.01.03 **Dev of high E-res optics**

Activities related to the development of high energy-resolution crystal optics, including operation of the x-ray orientation setup and crystal fabrication facility, crystal cutting and slicing, lapping, polishing, and etching, diffraction theory support, and characterization and testing.

4.03.03.01.04 **Optics Fab - User Support for Operations**

Service activities related to fabrication of optics previously developed for staff and users.

WBS 4.3.3.2 **Metrology**

All activities related to metrology development and characterization of NSLS-II optical components.

WBS 4.3.3.2.1 **Optical metrology characterization**

Activities related to the development and characterization of coherence-preserving optics and associated technologies, including operation of the optical metrology laboratory with long-trace profiler, stitching interferometer, large-aperture interferometry, and atomic force microscopy, characterization and testing of the optics, and assisting beamline staff in the development of coherence preserving optics.

WBS 4.3.3.2.2 **At-wavelength metrology development & characterization**

Development and implementation of at-wavelength metrology tools for aligning and characterizing NSLS-II beamline optics performance.

WBS 4.3.3.2.3 **Simulations**

Development and operation of codes to simulate beamline performance, including efforts for specifying beamline components and aiding in beamline optical design.

WBS 4.3.3.3 **Detector Development**

Activities associated with advanced detector development, including fast energy resolving pixel detectors, smart XPCS detectors, and fast strip detectors for high energy x-ray applications. Also includes efforts to coordinate WFO detector projects.

WBS 4.3.3.3.1 **Development of fast E-res pixel detector - HEXID**

Activities related to the development of fast energy-resolving pixel detectors, including efforts for conceptual development, sensor design and fabrication, custom ASIC development, conventional electronics and controls, and engineering and packing.

WBS 4.3.3.3.2 **Detector Support**

Activities related to support for all detector operations, including assistance with troubleshooting, calibration, testing and repair of custom and commercial detectors.

WBS 4.3.3.3.3 **Development of MAIA-II detector**

Activities related to the development of fast SDD-array (MAIA-II) detectors, including efforts for conceptual development, sensor design and fabrication, custom ASIC development, conventional electronics and controls, and engineering and packing.

WBS 4.3.3.3.4 **Development of Ge Strip Detectors**

Activities related to the development of gemanium strip detectors for high energy x-ray applications, including efforts for conceptual development, sensor design and fabrication, custom ASIC development, conventional electronics and controls, and engineering and packing.

WBS 4.3.3.3.5 **Development of Intelligent XPCS Area Detector - VIPIC**

Activities related to the development of an intelligent area detector for x-ray photon correlation spectroscopy applications, including efforts for conceptual development, sensor design and fabrication, custom ASIC development, conventional electronics and controls, and engineering and packing.

WBS 4.3.3.3.6 **Detector Projects Development**

Activities related to coordination of detector projects, and identification of new technologies for NSLS-II detector applications.

WBS 4.3.3.4 **Nano-scale positioning**

Activities related to the development and implementation of precision mechanics and associated technologies for nanopositioning of optics and samples, including operation of the nanopositioning laboratory, testing of prototype mechanical systems, and assisting beamline staff in the development of high-precision mechanical systems for beamline operations.

WBS 4.3.3.4.1 **Advanced position sensing technology**

Activities related to development and deployment of advanced position sensing technology for beamline components and sample manipulations.

WBS 4.3.3.4.2 **Nano-scale position feedback systems**

Activities related to development and deployment of nano-scale position feedback systems for beamline components and sample manipulations.

WBS 4.3.3.4.3 **Advanced systems integration**

Activities related to development and implementation of advanced controls systems for nano-scale positioning applications at NSLS-II.

WBS 4.3.4 **Facility Controls, Computing and Data**

All effort and materials to support the installation, operation, and management of all computer and motion controls, networking and information technology resources, and diagnostics and control systems for all NSLS-II operating beamline facilities.

WBS 4.3.4.1 **IT & Computing Infrastructure**

Effort and resources for all Facility Computing & Data Storage Infrastructure, development and maintenance of all Facility IT and Network Infrastructure, and sysadmin functions for the facility.

WBS 4.3.4.1.1 **Development/ Maintenance of New Facility IT/ Network Infrastructure**

Activities associated with network activities for developing and managing the controls network and centralized and/or distributed data storage facilities for beamlines, including providing support for staff and users to collect and access their data.

WBS 4.3.4.1.2 **Development/Maintenance of Facility Computing & Data Storage Infrastructure**

All activities associated with developing and maintaining the necessary computing infrastructure for the Data Facility, such as front-end computers, to allow both on-site and remote access by staff and users to collected data for analysis.

WBS 4.3.4.1.3 **Sysadmin**

System administration activates needed for managing staff and user access to computational and controls resources to enable data collection and analysis.

WBS 4.3.4.2 **Beamline Controls**

Effort for maintaining and developing controls for operating beamlines.

WBS 4.3.4.2.1 **Beamline Controls - Engineering Support**

Controls engineering support for maintenance and development of controls for beam line components (mirrors, monochromators, experimental end stations, material handling systems, equipment protection systems) and maintenance and development of data acquisition systems and sample control for all operating beam lines.

WBS 4.3.4.2.2 **Motion Controls & Automation**

Effort associated with control of beamline motor systems, beamline and endstation diagnostics and actuators, and integration of robotic and other automation advancements for operating beamlines.

WBS 4.3.4.3 **Controls Infrastructure**

All activities associated with developing and maintaining the necessary infrastructure for the Data Facility, such as networks and front-end computers, to allow both on-site and remote access by staff and users.

WBS 4.3.4.4 **Accelerator Controls**

Beamline resources needed to support accelerator controls.

WBS 4.3.4.4.1 **Accelerator Controls**

Materials needed for supporting beamline needs for front ends; M&S to support accelerator controls staff.

WBS 4.3.4.4.2 **ID Controls**

Effort and materials to support insertion device maintenance and improvements for operating beamlines.

WBS 4.3.4.5 **Data Acquisition, Visualization & Computing**

All activities associated with designing, implementing and maintaining the NSLS-II data collection architecture and data analysis workflows largely developed in collaboration with beamline scientists.

WBS 4.3.4.5.1 **Data Acquisition Management**

Effort and materials for designing, implementing and maintaining the NSLS-II data collection architecture extending from data collection & scanning through the storage of all experimental data both local at the beamline and at the central data center prototype. Scanning workflows are developed in collaboration with beamline scientists.

WBS 4.3.4.5.2 **Data Analysis & Visualization**

Effort and materials for designing, implementing and maintaining NSLS-II data analysis workflows largely developed in collaboration with beamline scientists. Includes efforts to adapt and implement codes developed at other facilities for NSLS-II beamline analysis and visualization needs.

WBS 4.3.5 **User Programs**

All activities supporting user programs.

WBS 4.3.5.1 **User Office**

All activities associated with NSLS-II user administration and support, including development and maintenance of the user beam time proposal system, supporting user site access and access to beamlines, supporting annual users meetings and associated workshops, and developing and making use of a record-keeping system to track user statistics, agreements, and publications.

WBS 4.3.5.1.1 **User Proposal Administration**

Activities associated with NSLS-II user proposal administration and support, including developing and maintaining a general user proposal system, coordinating user proposal reviews, assisting in beam time allocation and scheduling, and coordinating rapid access and proprietary access requests.

WBS 4.3.5.1.2 **User Access Support**

Activities to provide logistical support for user access to BNL site and NSLS-II beamlines, including processing user appointments in coordination with BNL GUV center, user training, user demographics and record retention, coordinating beamline safety form approvals, and supporting proprietary user visits.

WBS 4.3.5.1.3 **Users Meetings and Workshops**

Activities to support organization of annual users meeting and associated workshops, including planning activities in coordination with NSLS-II management and UEC, coordinating meeting/workshop logistics, and supporting vendors/posters/registration. Also includes coordinating UEC town meetings, and supporting hands-on schools and workbenches at NSLS-II beamlines.

WBS 4.3.5.1.4 **Publication and Record-Keeping**

Activities associated with tracking user statistics and publications, including developing and maintaining a tracking system for user and staff publications, keeping track of end-of-run reports and correspondences, maintaining beamline usage and user demographics statistics, and record keeping for user agreements and memoranda of understanding.

WBS 4.3.5.2 **Industrial Research Support**

Activities to provide coordination and scientific and technical support to industrial user programs. Effort and resources to provide coordination and scientific and technical support to industrial user programs, including staff effort to directly work with industry users during beam time. Effort and resources for experiment support services, for industrial user training, and for holding workshops to educate, train and expand the impact of industrial user research at NSLS-II.

WBS 4.3.5.3 **Partner User Support**

Effort and resources to support Partner User beamlines in operations.

WBS 4.3.5.3.1 **17-ID-1 AMX Operations**

Effort and resources to support Partner User beamlines in operations for AMX Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.2 **17-ID-2 FMX Operations**

Effort and resources to support Partner User beamlines in operations for FMX Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.3 **16-ID-2 LIX Operations**

Effort and resources to support Partner User beamlines in operations for LIX Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.4 **17-BM XFP Operations**

Effort and resources to support Partner User beamlines in operations for XFP Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.5 **7-ID-1 SST-1 Operations**

Effort and resources to support Partner User beamlines in operations for SST-1 Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.6 **7-ID-2 SST-2 Operations**

Effort and resources to support Partner User beamlines in operations for SST-2 Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.7 **6-BM BMM Operations**

Effort and resources to support Partner User beamlines in operations for BMM Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.3.8 **19-ID NYX Operations**

Effort and resources to support Partner User beamlines in operations for NYX Beamline to assure these are optimally standardized and maintained to maximize productive availability to the NSLS-II user community – includes utility maintenance, PPS, EPS, vacuum and controls support.

WBS 4.3.5.4 **Support for Users at Other Facilities**

Support for former NSLS users at other facilities.

WBS 4.3.5.4.1 **X-Ray Spectroscopy @ SSRL**

Effort and resources to support X-ray Spectroscopy users at SSRL, including travel and incidental M&S expenditures.

WBS 4.3.5.4.2 **Protein Crystallography at Westcoast**

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WBS 4.3.5.4.3 **Energy Dispersive XRD**

Effort and resources to set-up and support X-ray Energy Dispersive Diffraction users at APS, including travel and incidental M&S expenditures.

WBS 4.3.5.4.4 **Infrared Program**

Effort and resources to support Infrared program users at ALS, including travel and incidental M&S expenditures.

WBS 4.3.5.4.5 **Transmission X-ray Microscopy**

Effort and resources to support Transmission X-ray Microscopy users at SSRL and APS, including travel and incidental M&S expenditures.

WBS 4.3.5.6 **Experimental Facility Development**

All activities to facilitate preparation of NSLS-II experimental facility development.

WBS 4.3.6 **LSBR Experimental Operations**

All materials and activities to support the NIH & BER funded Life Science and Biomedical Technology Research (LSBR) resource at the National Synchrotron Light Source II.

WBS 4.3.6.1 **LSBR Organizational Management**

Activities associated with managing the LSBR organization.

WBS 4.3.6.2 **LSBR Beamline Operations**

Materials and activities associated with beamline operations.

WBS 4.3.6.2.1 **16-ID LIX Operations**

All activities associated with LIX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.6.2.1.1 **16-ID LIX Management & other Activities**

All activities associated with LIX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.6.2.1.2 **16-ID LIX User Support & Collaboration**

Activities related to scientific and technical support for LIX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.6.2.1.3 **16-ID LIX Beamline Development & Research**

Support for LIX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.6.2.1.4 **16-ID LIX Maintenance & Improvements**

Activities associated with planning and coordination of LIX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.6.2.1.5 **Facility Controls, Computing and Data**

All effort and materials to support the installation, operation, and management of all computer and motion controls, networking and information technology resources, and diagnostics and control systems for LIX beamline facilities.

WBS 4.3.6.2.1.6 **IT & Controls Infrastructure**

Effort and resources for all Facility Computing & Data Storage Infrastructure, development and maintenance of all Facility IT and Network Infrastructure, and sysadmin functions for the LIX facility.

WBS 4.3.6.2.1.7 **Beamline Controls**

Controls engineering support for maintenance and development of controls for LIX beam line components (mirrors, monochromators, experimental end stations, material handling systems, equipment protection systems) and maintenance and development of data acquisition systems and sample controls.

WBS 4.3.6.2.1.8 **Data Acquisition, Visualization & Computing**

Effort and materials for designing and implementing LIX data analysis workflows largely developed in collaboration with beamline scientists. Includes efforts to adapt and implement codes developed at other facilities for LIX beamline analysis and visualization needs

WBS 4.3.6.2.2 **17-ID-2 FMX Operations**

All activities associated with FMX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.6.2.2.1 **17-ID-2 FMX Management & other Activities**

All activities associated with FMX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.6.2.2.2 **17-ID-2 FMX User Support & Collaboration**

Activities related to scientific and technical support for FMX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.6.2.2.3 **17-ID-2 FMX Beamline Development & Research**

Support for FMX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as

data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.6.2.2.4 **17-ID-2 FMX Maintenance & Improvements**

Activities associated with planning and coordination of FMX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.6.2.2.5 **Facility Controls, Computing and Data**

All effort and materials to support the installation, operation, and management of all computer and motion controls, networking and information technology resources, and diagnostics and control systems for FMX beamline facilities.

WBS 4.3.6.2.2.6 **IT & Controls Infrastructure**

Effort and resources for all Facility Computing & Data Storage Infrastructure, development and maintenance of all Facility IT and Network Infrastructure, and sysadmin functions for the FMX facility.

WBS 4.3.6.2.2.7 **Beamline Controls**

Controls engineering support for maintenance and development of controls for FMX beam line components (mirrors, monochromators, experimental end stations, material handling systems, equipment protection systems) and maintenance and development of data acquisition systems and sample controls.

WBS 4.3.6.2.2.8 **Data Acquisition, Visualization & Computing**

Effort and materials for designing and implementing FMX data analysis workflows largely developed in collaboration with beamline scientists. Includes efforts to adapt and implement codes developed at other facilities for FMX beamline analysis and visualization needs

WBS 4.3.6.2.3 **17-ID-1 AMX Operations**

All activities associated with AMX beamline user operations. Activities include beamline operations management, beamline user support, technical support and controls.

WBS 4.3.6.2.3.1 **17-ID-1 AMX Management & other Activities**

All activities associated with AMX beamline management and other activities not otherwise specifically identified in the WBS. This includes but is not limited to supervision, budgeting, training, reviewing proposals and procedures, attendance at NSLS-II regular, periodic

group/division meetings, participation at DOE reviews and/or DOE workshops, participation at NSF or other agency meetings or reviews, BNL or NSLS-II committee participation, conference attendance, attendance at meetings at other facilities (PRP, SAC, UEC…), and tours and local outreach activities.

WBS 4.3.6.2.3.2 **17-ID-1 AMX User Support & Collaboration**

Activities related to scientific and technical support for AMX user operations. Activities include safety orientations, training users to use beamline instruments, assisting users on specimen setup and addressing any safety issues, assisting users on experiment procedures, endstation configuration, and alignment, discussing issues and solutions during experiments, remote monitoring and on-call troubleshooting, assisting users in data analysis, data transfer, and data backup, participating in research, post-experiment discussions, assisting users in preparations of publications and reports, planning for next experiments, and engaging in new user outreach and collaborations. Effort and resources for beamline configuration for user experiments, optics set-up and calibrations, diagnostic tuning, endstation configuration and set-up, and incidental materials and supplies for user experiments.

WBS 4.3.6.2.3.3 **17-ID-1 AMX Beamline Development & Research**

Support for AMX beamline development & research, including activities to attract new user communities, strategic planning and beamline program development, planning meetings, workshops and seminars as needed. Beamline development & research includes experiment proposal development, experiment planning & preparations, and experiment execution as well as data analysis, manuscript preparation & editing, development of new protocols, software (scanning) development, development & implementation of new experiment or analysis methods, and planning, development, implementation of new sample environments.

WBS 4.3.6.2.3.4 **17-ID-1 AMX Maintenance & Improvements**

Activities associated with planning and coordination of AMX maintenance, servicing, upgrades, troubleshooting, fabrication of beamline and endstation mounting adapters and sample holders, and related materials and supplies. Effort and resources for beamline component repairs, endstation component repairs, and repair services from vendors or suppliers. Effort and resources for safety walkthroughs, housekeeping, materials and supply inventory, and installation, testing and integration of new instruments.

WBS 4.3.6.2.3.5 **Facility Controls, Computing and Data**

All effort and materials to support the installation, operation, and management of all computer and motion controls, networking and information technology resources, and diagnostics and control systems for AMX beamline facilities.

WBS 4.3.6.2.3.6 **IT & Controls Infrastructure**

Effort and resources for all Facility Computing & Data Storage Infrastructure, development and maintenance of all Facility IT and Network Infrastructure, and sysadmin functions for the AMX facility.

WBS 4.3.6.2.3.7 **Beamline Controls**

Controls engineering support for maintenance and development of controls for AMX beam line components (mirrors, monochromators, experimental end stations, material handling systems, equipment protection systems) and maintenance and development of data acquisition systems and sample controls.

WBS 4.3.6.2.3.8 **Data Acquisition, Visualization & Computing**

Effort and materials for designing and implementing AMX data analysis workflows largely developed in collaboration with beamline scientists. Includes efforts to adapt and implement codes developed at other facilities for AMX beamline analysis and visualization needs

WBS 4.3.6.3 **Other LSBR Programs**

LSBR work and materials not related to LIX, AMX, or FMX beamline operations

WBS 4.3.6.3.1 **SRX R&D Operations**

Effort and materials associated with NSLS-II spectroscopy beamlines that primarily host materials science and environmental science programs but also have a fraction of the beam time allocated to the life sciences program.

WBS 4.3.6.3.2 **Laboratories – Service & User Support (crystal & wet labs)**

Effort and materials to support operations and research in NSLS-II biology & life science laboratories

WBS 4.3.6.3.3 **Training and Dissemination**

Effort and materials to support LSBR training and information dissemination

WBS 4.3.7 **Other Funded Work**

Work funded through sources not related to BES operations.

WBS 4.3.7.1 **DOE-BES Funded Work**

DOE-BES funded work not related to BES operations resources

WBS 4.3.7.1.1 **Wavefront Preserving**

Development of a novel room-temperature mirror cooling system coupled with in-situ, at-wavelength testing, and the study of non-invasive wavefront sensing to preserve the wavefront and the beam quality of Free Electron Lasers (FELs) and Diffraction Limited Storage Rings (DLSR).

WBS 4.3.7.1.2 **Saw-Tooth and Kinoform Lenses**

BNL component/effort of a joint ANL-BNL project aimed at developing improved saw-tooth and kinoform focusing refractive lenses for high-energy x-rays (50-100 keV). with a goal to provide prototypes to some high-energy x-ray beamlines at DOE-BES facilities, e.g., APS 1-ID, 6-ID-D, 11-ID-C, and/or NSLS-II XPD.

WBS 4.3.7.1.3 **Advanced Photon Detector for Synchrotron Radiation Applications**

Effort and materials for detector Advanced Photon Detector developments for Synchrotron Radiation Applications

WBS 4.3.7.2 **BES Funded Work**

WBS 4.3.7.3 **NIH Funded Work**

Work supported through National Instsitutes of Health (NIH) funding

WBS 4.3.7.3.1 **Characterization of Sensor Proteins & Demands**

WBS 4.3.7.3.2 **Molecular Mechanisms Mediating Environment Sensing & Response**

WBS 4.3.7.3.3 **Molecular Mechanisms Mediating Environment Sensing & Response**

WBS 4.3.7.3.4 **Mesoscale – PS**

Effort and materials to support a program in Mesoscale Imaging for Environmental and Biological Sciences

WBS 4.3.7.3.5 **HDRMX Meeting – LSBR**

Effort and materials to support discussions on changes needed to existing major software packages for support of very high data rate macromolecular crystallography due to brighter x-ray sources, faster detectors, and techniques for serial crystallography.

WBS 4.3.7.3.6 **Flexplate Design Improvement**

WBS 4.3.7.4 **SBIR Funded Work**

Work supported through US Small Business Innovation Research (SBIR) funding

WBS 4.3.7.4.1 **Radiasoft Phase II SBIR**

Effort and materials to develop a software framework for managing x-ray optics modeling codes and algorithms.

WBS 4.3.7.4.2 **Sydor Instruments Phase II**

Effort and materials to complete the commercialization of the HERMES-based x-ray strip detector and make it readily available to a broad community of researchers in order to support fundamental energy science.

WBS 4.3.7.4.3 **ACCUSTRATA – SBIR**

Effort and materials for X-ray optical components required to perform a new level of material characterization at the nanometer scale

WBS 4.3.7.4.4 **INCOM Phase II**

Effort and materials to support an Advanced Compact X-Ray Spectrometer with High Resolution and Efficiency

WBS 4.3.7.5 **NSLS Funded Work**

Effort and materials supporting work at NSLS

WBS 4.3.7.5.1 **PS Support of NIST Beamlines**

Work at NSLS supported by National Institute of Standards and Technology (NIST)

WBS 4.3.7.5.2 **X6A Protein Crystallography Operations**

WBS 4.3.7.6 **CSIRO Funded Work**

Work supported through Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO)

WBS 4.3.7.6.1 **CSIRO MAIA DAM #4**

Effort and materials for fabrication of Maia detector analog modules.

WBS 4.3.7.7 **NYS Funded Work**

Work funded through New York State resources

WBS 4.3.7.7.1 **NYS CRYO-EM**

Effort and materials for cryo-electron microscope at BNL. The state-of-the-art imaging technology is at the heart of a new center, the Long Island Facility for Electron Microscopy, which is to be established on the Brookhaven campus, and also involves scientists from Stony Brook University and Cold Spring Harbor Laboratory,

WBS 4.3.7.8 **Private Funded Work**

Work funded through private sources

WBS 4.3.7.8.1 **PFIZER Inc.**