NSLS-II Overview

J.P. Hill, Director, NSLS-II

Triennial Operations Peer Review

June 20th 2017

Outline

- Mission statement
- Current Status
  - ESH&QA
  - Accelerator operations
  - Beamline construction
  - Beamline operations,
  - User program
- High level budget summary FY15-17
- Response to 2015 Recommendations
- Future plans
- Summary

NSLS-II Mission and Strategy

Mission

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

Strategy

To integrate DOE mission objectives, community interests, BNL research initiatives and NSLS-II strengths to conduct a suite of advanced scientific programs to address grand challenges facing society as identified by the scientific communities

CURRENT STATUS

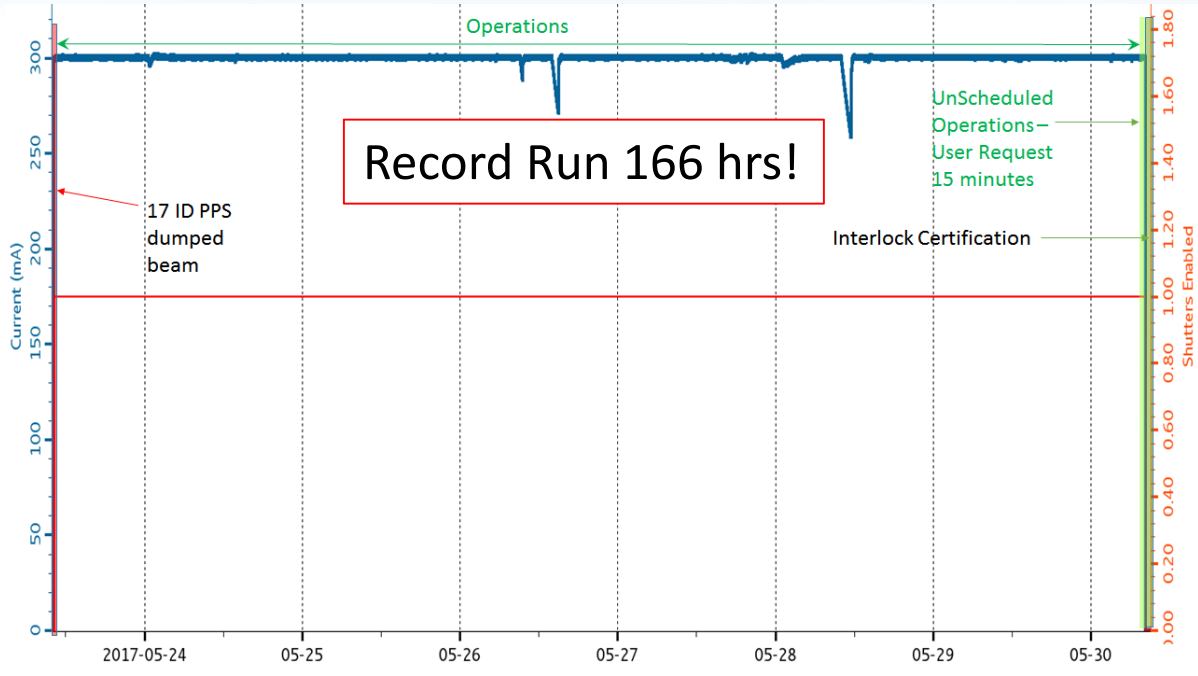
Safety Performance

	Hours Worked	First Aid Cases	Recordable Cases	TRC Rate	DART Cases	DART Rate
FY15	783,888	5	0	0	0	0
FY16	761,128	3	0	0	0	0
FY17 (YTD)	452,357	3	4	1.77	2	0.88
DOE Goals				0.65		0.25

- Outstanding Safety Statistics through FY16. (> 2.0 M hours worked without a lost time incident)
- FY17 uptick in Recordable/DART cases
  - FY17 Recordable cases include wind-blown debris an eye, a shoulder strain and two back injuries
  - Both back injuries were DART cases, one person is still out
  - All injuries are investigated and communicated with staff
  - ESH engaging with groups to discuss injuries to identify possible causes
  - Staff distractions due to work load and budget uncertainties are likely contributing causes
- Actions taken: increased messaging to put safety first, to report all events and that it is OK to stop work and evaluate: All-hands, newsletters, group meetings

Accelerator Update

- Accelerator is performing well, delivering 300 mA top-off in routine operations
- FY17-to-date reliability performance has been excellent (96.8 %)
- Will increase current to 350mA by end of cycle
- Goal is > 95% reliability

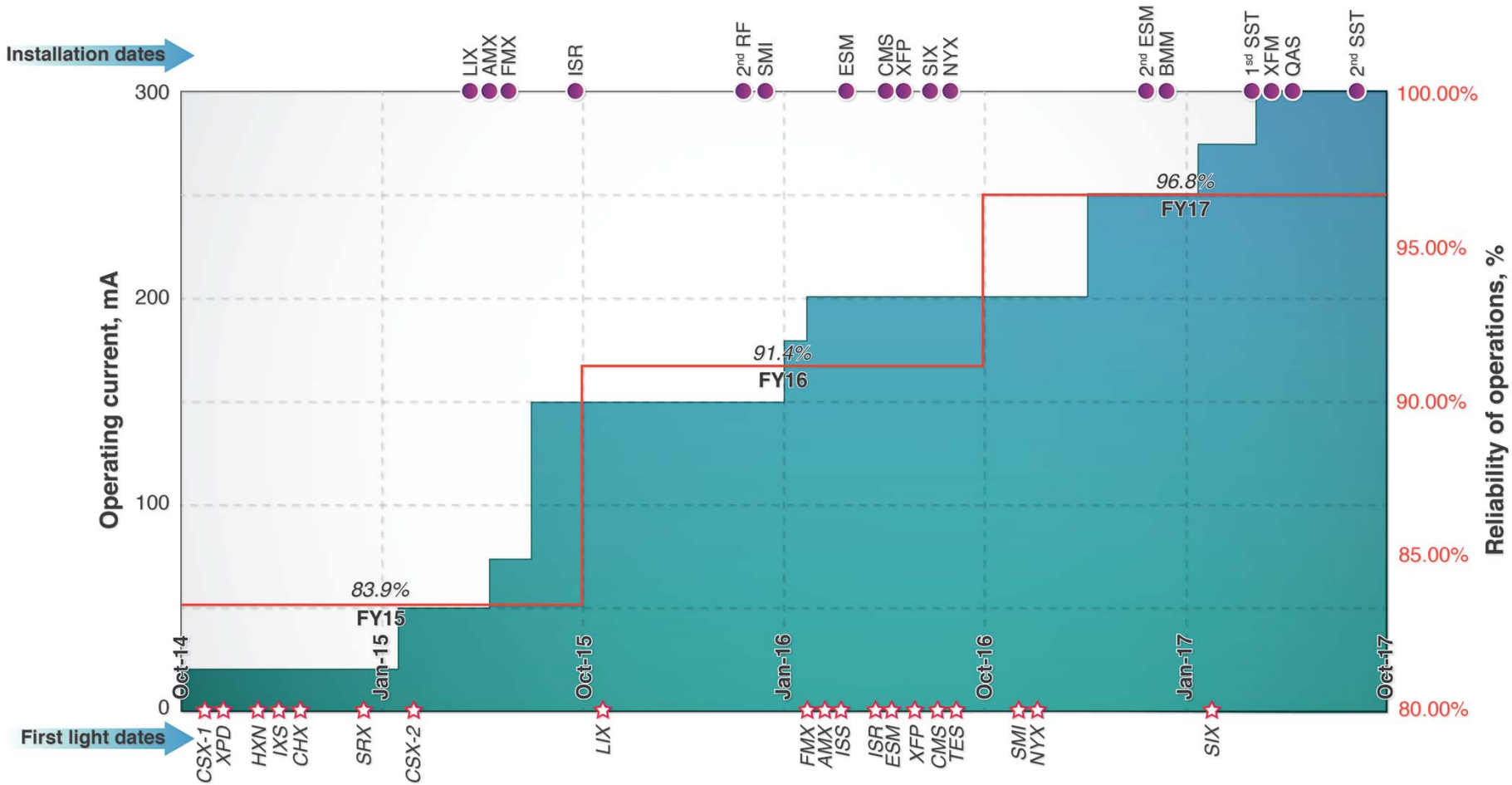


5/23/17 – 5/30/17

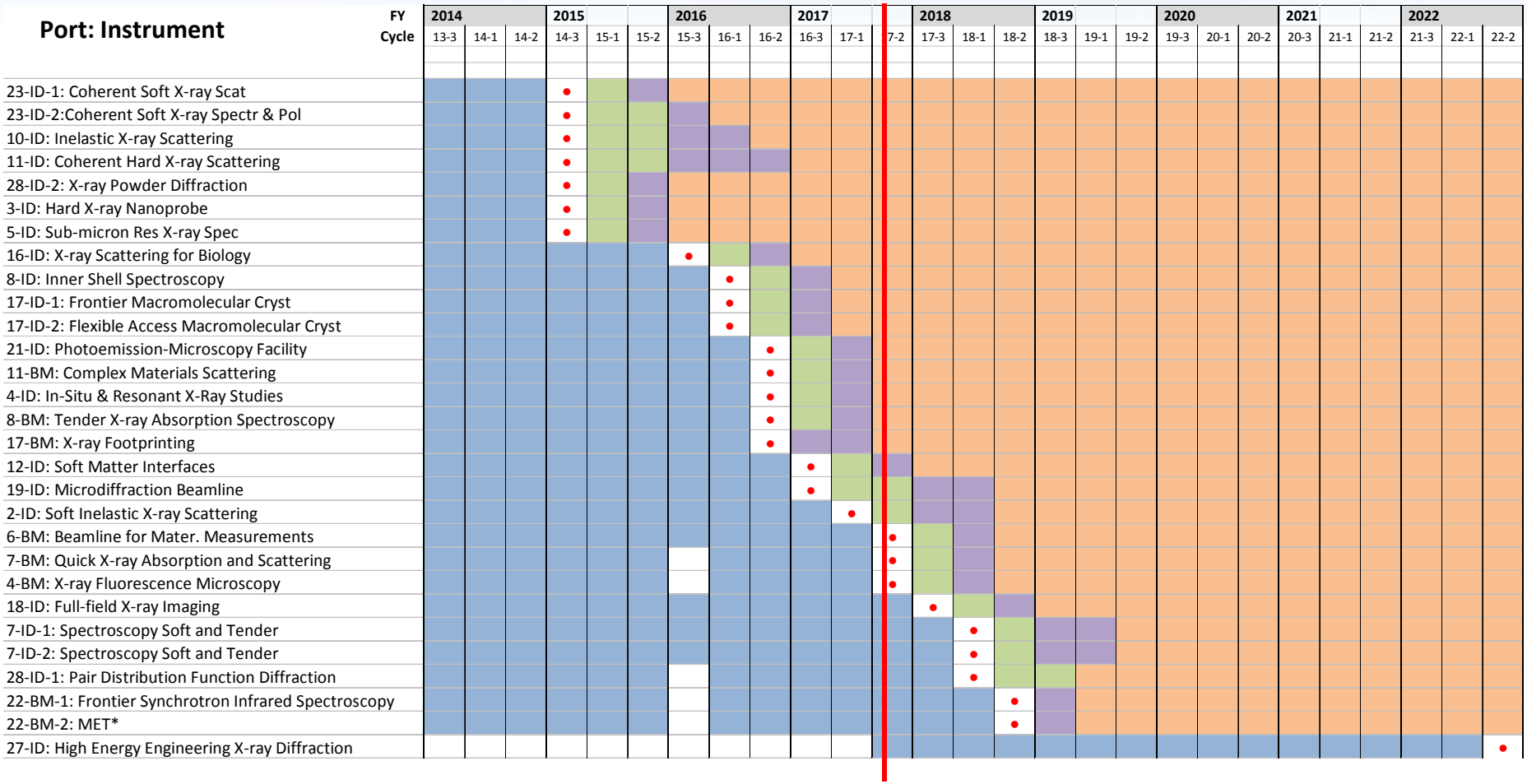
A 7 day operations period with no beam dumps!

Focus is on what users care about: reliability (long scans) and stability (data quality) then current (statistics)

Accelerator Division delivering reliability and current



Aggressive beamline buildout being successfully executed



Beamlines Developed by NSLS-II (BDN) and NSLS-II Partner Beamlines (NPB) are portfolios of **13** total beamlines. HEX will be added to NPB.

Beamline construction is being effectively managed

- Strong project management culture at NSLS-II.
- EVMS and associated tools embedded in the organization
- BDN (8 beamlines) being managed effectively and efficiently. All beamlines coming in under or at budget and on time.
- NPB (5 beamlines) being managed effectively. Partnerships mean projects are not entirely under our control.

- 2016 Secretary's Award

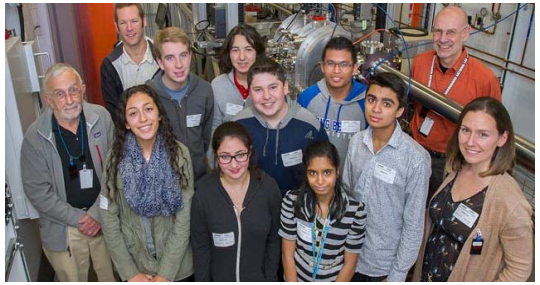
User Program is ramping up quickly

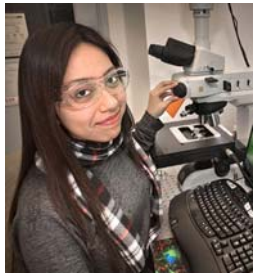
- Unique users in FY15: **110**
- Unique users in FY16: **477**
  - First-time users FY16 = 394 (83%)
- Unique users in FY17: **586** (as of 6/9/17)
  - First-time users FY17 = 355 (60%)

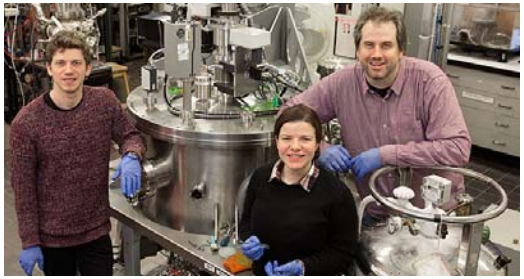
Productivity:

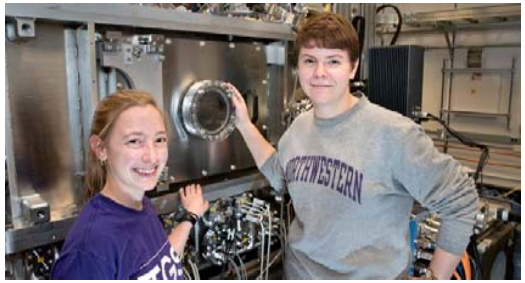
- 59 papers from NSLS-II beamlines
- 10 DOE "High impact"

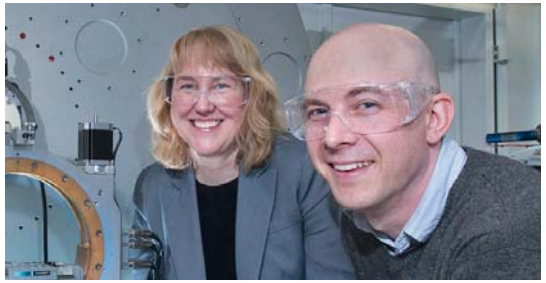
- Unique users for the facility over its lifetime (FY15-17)= **859**







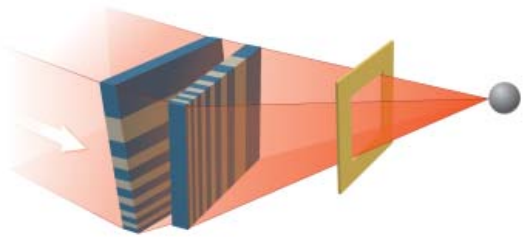




Hard X-ray Nanoprobe

Award Winning MLL design

Smallest spot in working x-ray microscope in the world (13 nm x 13 nm)!



E. Nazaretski, Y. S. Chu, *et al.*

2016 R&D 100 Awards

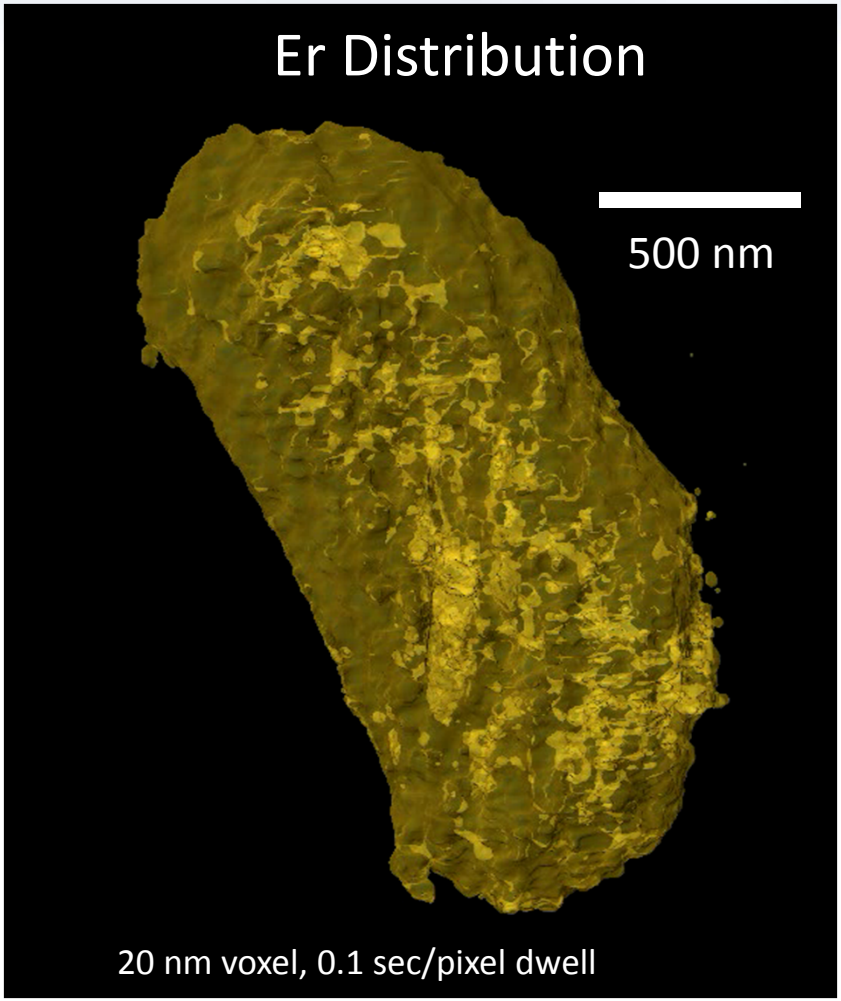
Microscopy TODAY 2016 Innovation Award

INNOVATELI INSIDE THE NEW ECONOMY 2017

Highest resolution 3D XRF image ever taken. Showing Er tag on surface of E-coli

Results prove:

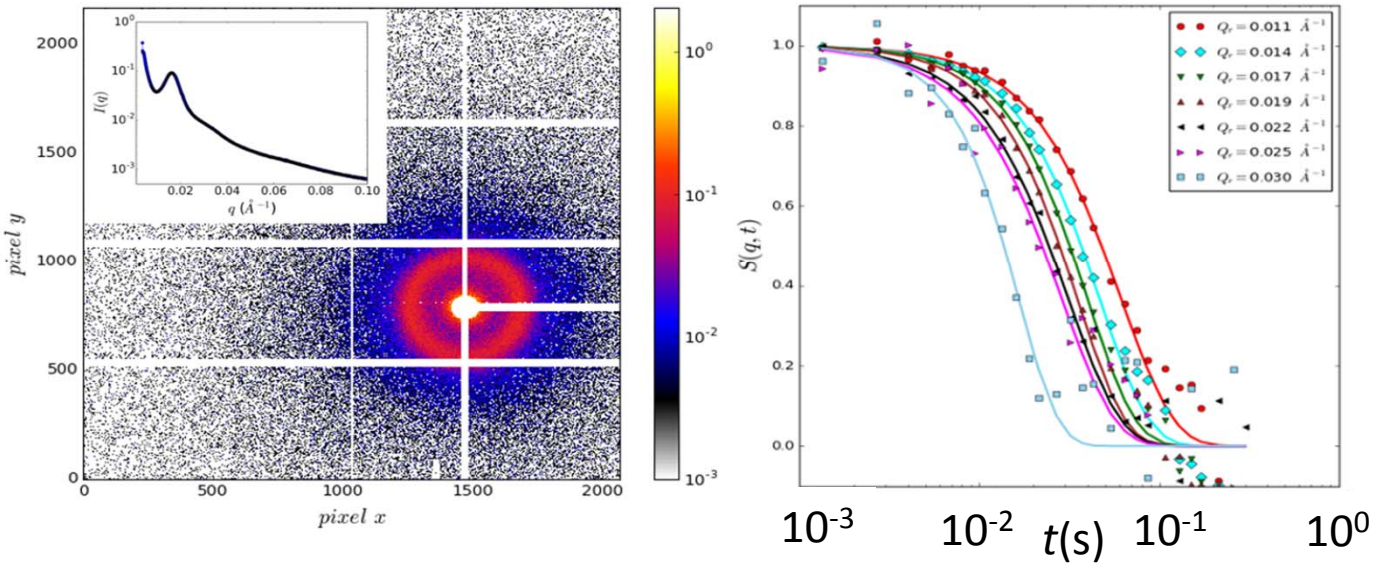
- New method of tagging works
- Presence of Er inside cell shows tagged proteins still functional



K. Allen (Boston Univ), B. Imperiali (MIT), L. Miller (BNL), whole HXN Team

Revealing dynamics of polymer gels

Coherent x-ray scattering studies of dynamics in transient networks of associative polymers which are used in applications such as artificial skin and self-healing gels

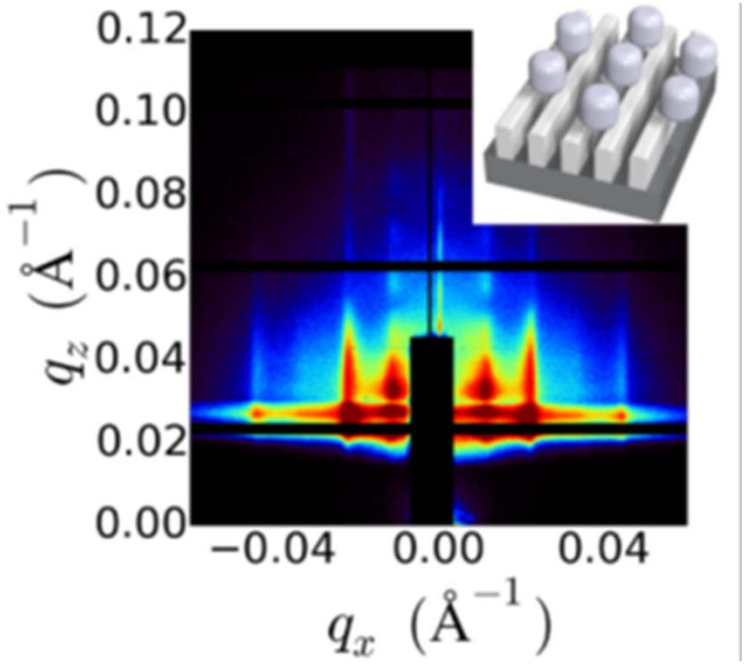


Olsen and Dursch (MIT) with CHX group, unpublished

- Challenging expt: low signal as samples are *real* and not *dressed* w/ nanoparticles
- Unprecedented coherent flux at CHX produced high quality dynamical information on smaller length scales (q~0.03 $Å^{-1}$) and shorter time scales (~10 ms) than ever possible before with similar polymer samples
- Suggestive of new regime of dynamics at length scales less than radius of gyration and time scales shorter than the "Rouse" time of the polymer strands.

Self-assembly of 3D nanostructures

- CFN developed a novel method for creating complex multilayered structures via block copolymer self-assembly
- The structures were characterized at NSLS-II where the high brightness enabled fast, high resolution understanding of the structure
- The revolutionary technique opens the door to a wide variety of nanomaterial structures which are difficult or impossible to achieve via conventional methods
- Potentially advancing nanotechnology used for medicine, energy generation, and other applications



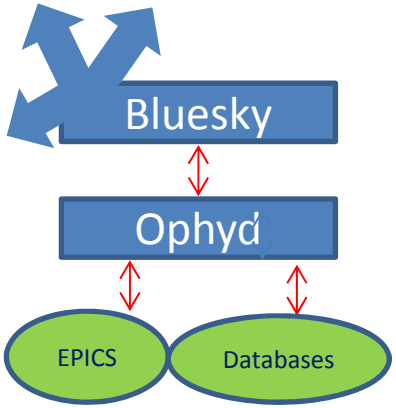
A. Rahman *et al*. Nature Comm. (2016)

Work in collaboration with CFN and CHX

Data Acquisition, Management and Analysis

Of central importance to success of the facility

- Developed next-generation software meeting the requirements of state-of-the-art beamlines
- BlueSky is installed on all operating beamlines. Initial user reviews are very positive
- Supports tiered computing and data storage resources: 1) local to the beamline, 2) central to the facility and 3) to BNL data center
- LCLS will be adopting BlueSky as their standard. Test implementations also installed at APS
- Workflows utilize code from CAMERA and APS where possible
- Hack-a-thons with BES user facilities very successful



NSLS-II is driving collaboration across BES Light Sources to create impactful synergies

- Initiated monthly phone calls and bi-annual “5-Way” meetings of senior management from the 5 facilities. Topics addressed to date include future beamline planning, coordinated R&D programs, data activities and beamline value engineering.
- Led the data “hack-a-thons” in coordination with other facilities
- Initiated working groups with APS on data and optics R&D with an explicit charge to rationalize efforts across the two facilities
- Exploring working with the APS-U on new beamline design
- Exploring superconducting IDs with APS
- Active pairwise R&D collaborations include
  - SLAC – at wavelength metrology, data acquisition software
  - ALS – soft RIXS spectrometer
  - APS - VIPIC, multi-layer optics, high-E nanofocusing

Strong partnerships are a key component of our strategy

Center for Functional Nanomaterials (BNL)

Partnership on 4 beamlines:

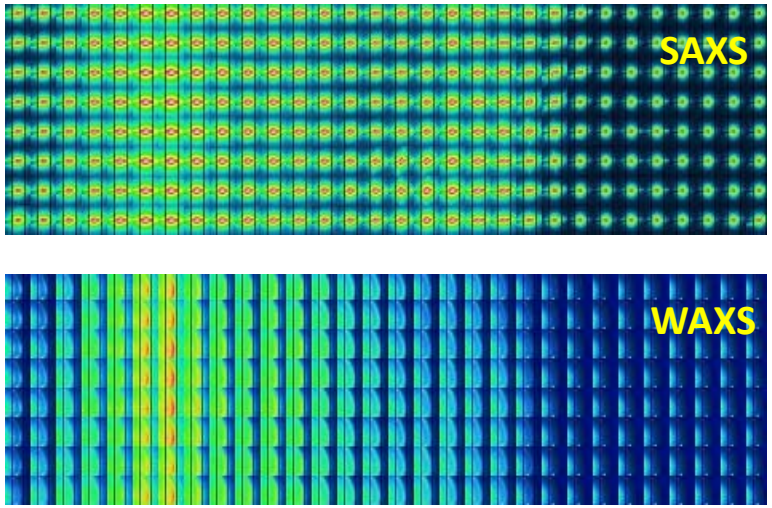
- CSX-2 – Ambient pressure PES
- ESM – LEEM/PEEM
- CMS – SAXS/WAXS
- SMI – GISAXS

Neutrons at ORNL (HFIR)

Combined SAXS and SANS program.

Users can write a **single** proposal for SAXS and SANS time at NSLS-II and ORNL

Microbeam SAXS/WAXS imaging at LiX



SAXS/WAXS imaging of plant tissues (Makowski, Northeastern U; Liu, BNL; Bomble, NREL)

NSLS-II is managing workforce development

As organization transitions from construction to operations, this is of increasing importance:

- Diversity and an inclusive environment central to our success. D&I initiatives underway
- Revision of Scientific Staff Policy to accurately reflect their roles in the facility
- Advancement opportunities for the staff including Supervisor Development Program (SDP), Laboratory Operations Supervisory Academy (LOSA), Scientist & Engineer Development Program as well as many others.
- Cross-training initiated to promote development of new skills, career development and increase the depth of organization
- Awards committee rewards high performance at all levels, internally to BNL and externally. Extensive use of BNL's "Rewards and Recognition" program
- Internships with Columbia and SBU to promote development of controls pipeline
- Graduate course exposes staff to local faculty and students and grows user program
- Research opportunities: LDRD program, EPSD collaborations,…

Work/life balance remains an issue. Staff are committed and pushing hard, but morale is a concern.

BUDGET OVERVIEW

Overview of BES Funding and Costs FY15-17

	Operations Funds and Costs ($M)			
		Actual	Actual	Expected
Funds		FY15	FY16	FY17
	new BA (Budget Authority)	90.1	109.6	111.8
	committed carryforward from previous FY	4.1	9	11.5
*	dedicated funds carried forward from previous FY	0	3.9	1.9
	Uncommitted carryforward from previous FY	16.7	8	19.1
	Total Funds	**110.9**	**130.5**	**144.3**
Costs	Operations Costs	85.6	80.1	98.1
	BL Build up costs	4.4	17.9	22.5
	commitments carried forward into next FY	9	11.5	4.2
*	dedicated funds carried forward into next FY	3.9	1.9	3.5
	uncommitted carryforward into next FY	8	19.1	16
	Total Cost, Commitments & Carryforward	**110.9**	**130.5**	**144.3**

$98 M

* Dedicated funds are funds for which there are definite plans in the following year, but not yet commitments. For example, BDN and NPB plans

Summary of FY16 operations costs

$98 M

	FY16 BES-SUF funds			FY16 Other funding source		
	FTEs	Direct ($k)	Burdened ($k)	FTEs	Direct ($k)	Burdened ($k)
Total	**289.5**	**69,858.2**	**98,011.3**	**42.6**	**10,951.0**	**13,805.7**
Facility Management and Business Operations	21.6	11,217.0	15,384.3	4.0	822.1	823.2
Facilties (management and biz services)	21.6	4,035.4	5,726.8	4.0	792.4	793.5
Space and power		7,181.6	9,657.5		29.6	29.6
Accelerator Operations	107.5	20,195.5	31,342.9	1.2	271.2	387.3
Accelerator ops	107.5	20,195.5	31,342.9		-	-
R&D	-	-	-	1.2	271.2	387.3
Beamline Operations	145.5	35,071.1	46,298.3	37.2	9,857.8	12,595.2
Experimental Program	91.3	18,626.9	28,434.7	22.9	4,346.5	6,517.8
Beamline Development	54.2	16,444.2	17,863.6	14.3	5,511.2	6,077.3
ESH&QA	14.9	3,374.6	4,985.8	0.2	-	-
ESH	13.1	3,374.6	4,985.8	-	-	-
QA	1.8			0.2		

Bebon*

Shaftan

Zschack

Johnson*

Lee

* Breakout session

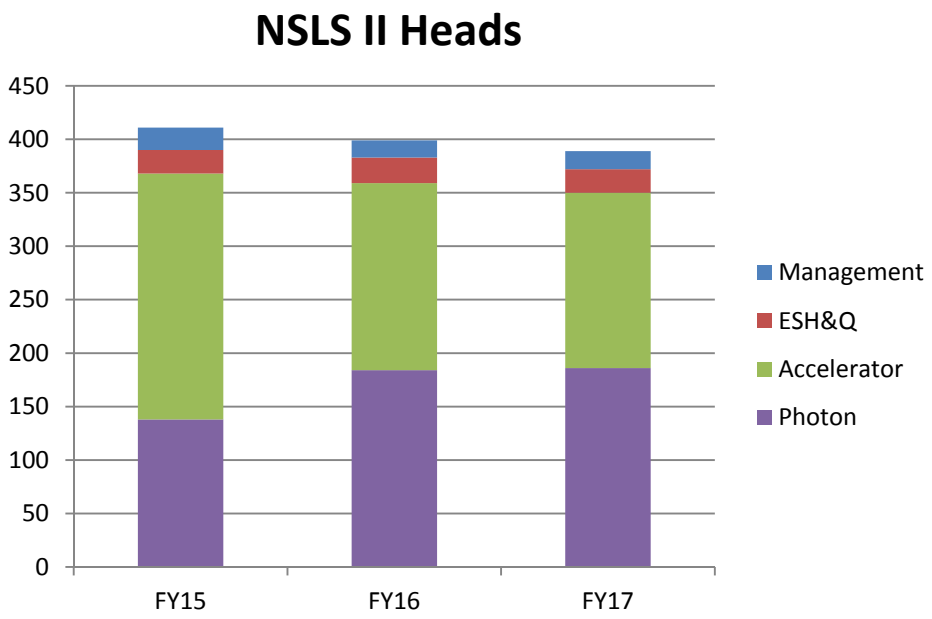
- Full data in **Facility FTE and Cost Summary** (table 1.iii.9) in volume 1
- BES SUF funds: Operations, BDN and NPB work
- Other funding: SPP, LDRD, Proprietary and NIH/BER
- Costs are recorded where they occur. FTEs are recorded where they work.
- We charge an org burden on all work. This shows up as a cost. The org burden pays for FTEs that support common activities. These show up where that activity occurs

RESPONSE TO RECOMMENDATIONS

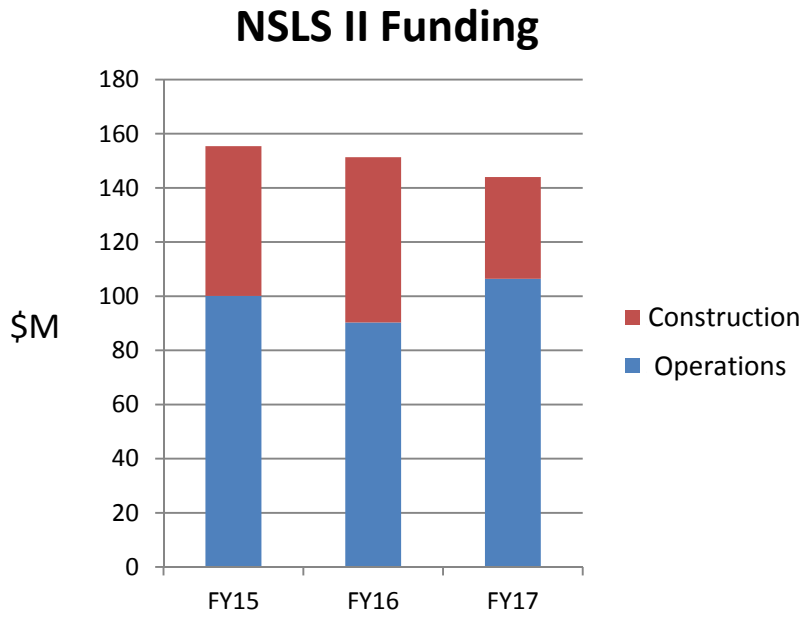
Recommendation 1

Fully transition the NSLS-II organization from a construction project to an efficient and effective facility operations organization.

The **total** organization is shrinking and evolving:



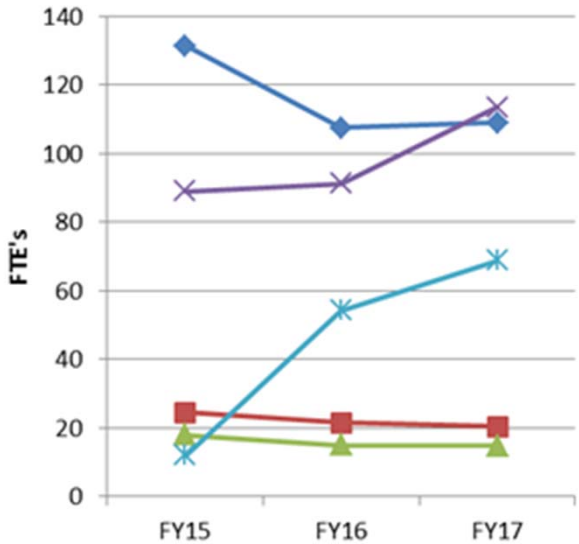
Number of people on the org chart, by Division



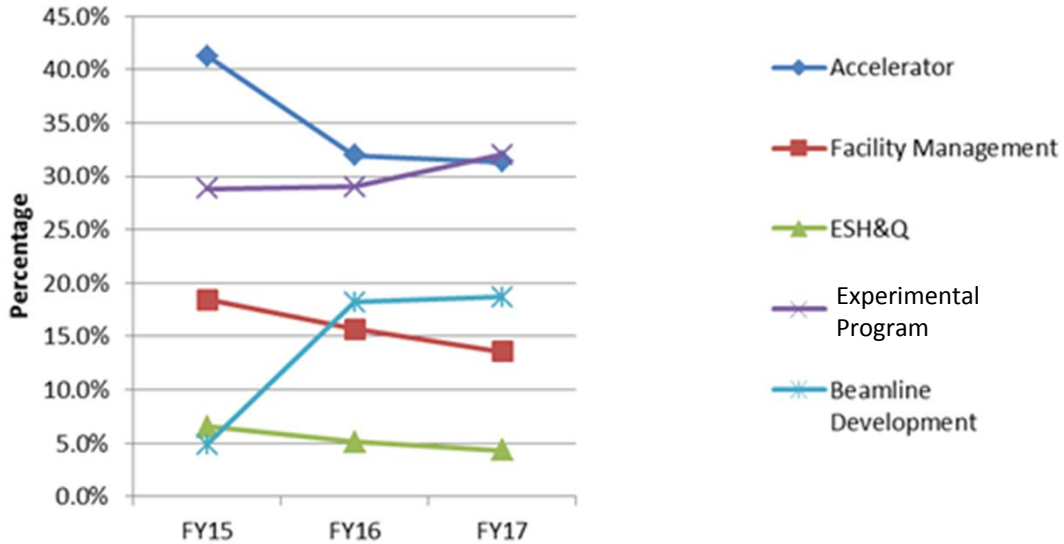
Total NSLS-II funding (all sources)

BES Operations funded work now dominated by beamlines piece

BES operations FTEs



Fractions of total BES operations



- Accelerator operations, management and ESH&QA all decreased in absolute numbers and as a fraction of total
- Experimental Program increased as more beamlines came online.

Actively driving the transition to an operations-oriented organization:

Examples of specific actions taken:

- Reduced Accelerator operations, Facility management and ESH&QA by a combined 13% relative to June 2015 review. Held these numbers through FY17
- Reduced beamline support by 0.8 FTE/ID line (=15 FTEs less over all BES beamlines when operational)
- Moved Controls Program to Photon Science Division to reflect it's more operations focused responsibilities
- Streamlined the IRR and Engineering processes. Launched an initiative to address overall proceduralization of our work (from 350 procedures down to 150)
- ESH&QA manager now reports directly to the Facility Director. Rest of the ESH&QA functions are provided by SLA from central organization.

Carried out careful benchmarking with other facilities

- As part of looking carefully at our operations budget following the 2015 review, we carried out a detailed benchmarking with our sister facilities. These comparisons informed the changes we drove in the organization.
- We benchmarked in the areas of:
  - Accelerator operations
  - Beamline operations
  - ESH&QA
- Utilized the WBS of the respective facilities where possible to ensure a detailed, apples-to-apples comparison of the FTEs that did the work, independent of how each facility was organized
- The benchmarking was a snapshot in time, but represents a best effort to get a detailed comparison with operating organizations.

Recommendation 2

Establish clear operational priorities across the NSLS-II organization to ensure excellent machine performance and scientific output… and delivering maximum operating hours, 5,000 hours or more per year, reliably to users by FY2018

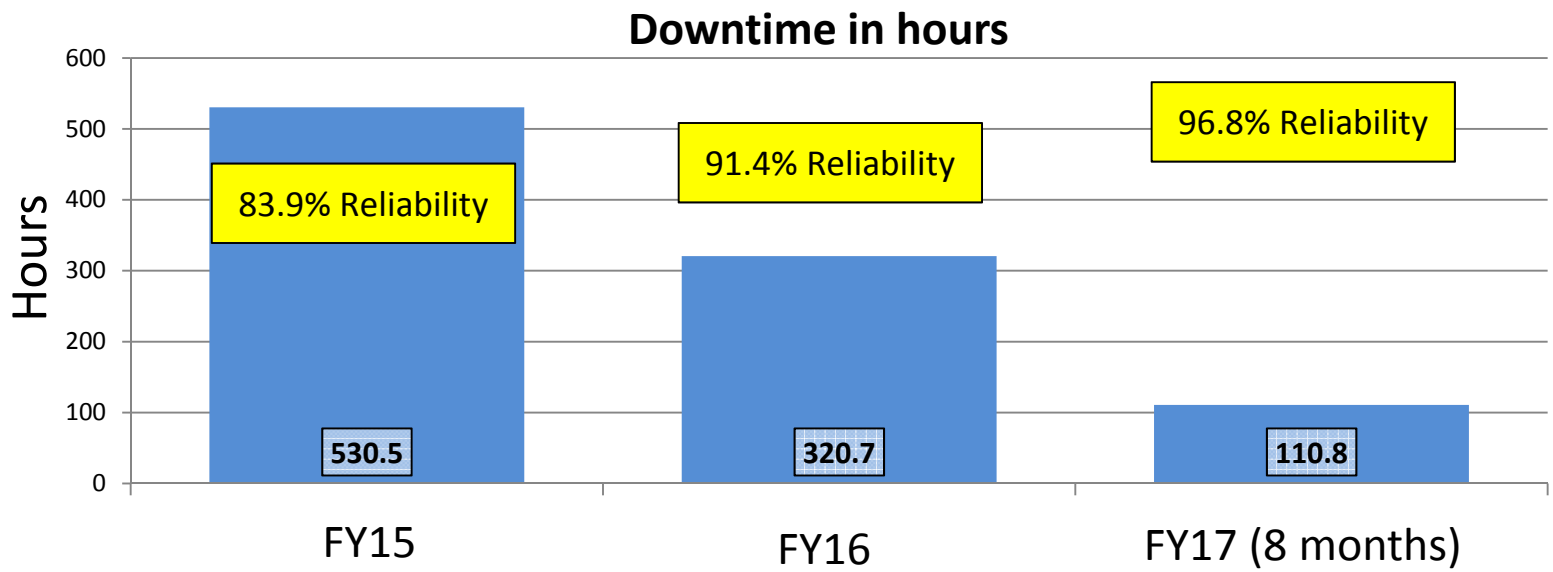
Clear operational priorities have been established:

1) Operate the accelerator at > 95% reliability
2) Operate the beamlines at a lean, efficient level
3) Develop new beamlines
4) Carry out development activities to improve performance

To support the first goal, we have

1) Held Reliability workshops (Feb 2016, April 2017)
2) Established a detailed, systematic tracking of causes of faults
3) Developed, and funded a detailed spares program, including initiating a 3rd RF cavity purchase in FY16

Reliability has improved significantly



- Reliable operation is the highest priority for the Accelerator Division.
- Systematic analysis of causes of downtime are carried out, and programs launched to mitigate these causes, including rigorous spares and preventative maintenance programs.

Increased number of user operations hours

	NSLS-II			
	FY16	FY17	FY18	FY19
Operations (hours)	3718	4500	4750	5000
Studies (hours)	1713	872	850	850
Maintenance and certification (hours)	594	440	440	440
Shutdown (hours)	2825	2224	2200	2200
ID, FE, BL Commissioning (hours)		724	520	270

In FY18, we will commission 3 BM and 3 ID beamlines. This commissioning, along with other activities, means there will be 4750 hrs of user operations.

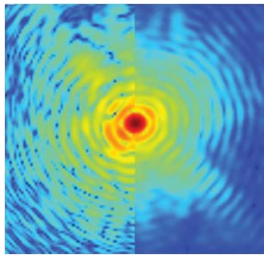
We believe that this is in the best interests of the user program. The 5% fewer ops hours will have little impact on user numbers in FY18 because the 6 new beamlines will add additional users. Further, in FY19, there will be a significant gain in user numbers from these additional beamlines over the course of a full year of operations

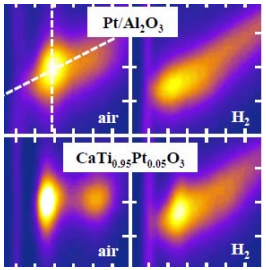
Recommendation 3

Use operating funds to accelerate beamline development.

- Operations supported beamline development through BDN (8 beamlines) and NPB (5 beamlines) portfolios is effective and efficient. Beamlines are on-time and under budget
- Through rigorous, peer-reviewed process identified 6 beamlines that would take advantage of the unique source, complement existing beamlines, deliver high-impact science and service large user communities:

1) Hard x-ray imaging (CDI): World-leading lensless imaging down to 5nm
2) Soft x-ray imaging-1 (ARI): Chemical and electronic structure down to 5 nm
3) Soft x-ray imaging-2 (SMF): State-of-the-art transmission x-ray microscope
4) Chemical reactions (QIX): Time-resolved chemical reactions in-operando
5) Polymer processing and liquids (PLS): Liquid interfaces and thin film processing studied in-situ
6) Infra-red spectroscopic imaging (INF): Nano-IR spectroscopy on heterogeneous solid state systems





Recommendation 3 (cont.)

- In FY16, we launched a task force to conduct a preliminary analysis of cost, schedule and scope for these beamlines
- The task force reported in Feb 2017
- NSLS-II has chosen to develop the CDI beamline, based on strong science case, good synergy with existing beamlines (HXN, CHX), utilization of facility's strengths and strong user community
- In addition, we will carry out R&D for the ARI beamline spectrometer, in collaboration with the ALS
- We will also refurbish a liquid spectrometer to jump start the PLS community

NSLS-II is developing a world-leading Bragg CDI beamline from operations funds

Science Case:

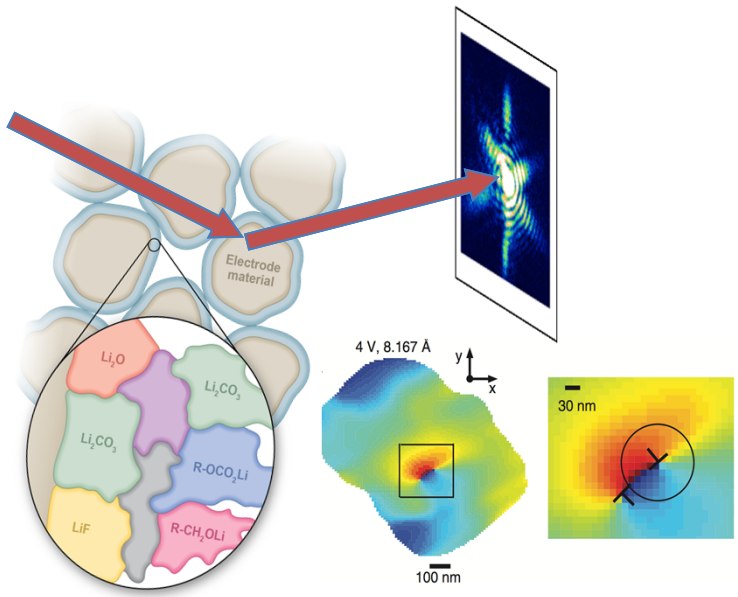
- Imaging defects, dislocations, and strain in single grains of heterogeneous materials
- Capable of imaging in-situ/operando under realistic conditions (e.g. charge & discharge)

Technical Scope:

- High coherent flux in 6 – 15 keV, with µm sized beam and ptychography capability

Immediate scope of work

- Given science case, determine the technical case for a remote endstation
- Develop cost, scope and schedule to "CD-2" level



Science Example: imaging Li battery electrode to see how it changes following Li insertion and de-insertion

Offer out to lead beamline scientist

Recommendation 4

Re-evaluate the overhead rates applied to the NSLS-II operations budget.

Total	FY15 ($k)	FY16 ($k)	FY17 ($k)	FY17 with no BL Dev ($k)
Direct costs (salary, M&S, power)	56,113	64,295	78,696	59,528
Space Direct	5,338	5,563	6,000	6,000
Indirects	28,485	28,153	35,885	32,500
Overhead (Indirects + Space)	33,823	33,716	41,885	38,500
(Indirects+Space)/Direct	60.3%	52.4%	53.2%	64.7%

- Effective OH rate on NSLS-II ops varies depending on the mix of operations and Extraordinary Construction Rated (ECR) work
- We have benefitted significantly from the ECR.

FUTURE PLANS

Strategic Plan

5 year strategic plan developed

- Includes strategic objectives, competitive analysis, prioritization and 5 year actionable plan.
- Provides guidance for tough budget decisions.
- Input from SAC, UEC
- Plan is on the web: https://www.bnl.gov/ps/docs/pdf/NSLS2-Strategic-Plan.pdf

FY18 Goals

1) Operate the accelerator and deliver 4750 hours for user operations at > 95% reliability. Achieve 400 mA by the end of FY18 and remain on track to achieve 500 mA operations in FY20 (3rd RF cavity and 3HC).
2) Operate the existing beamlines and commission and operate those finishing construction in FY18
3) Continue beamline development. Specifically
   a. Complete the FXI, PDF, FIS and MET beamlines
   b. Complete the SST-1 and SST-2 partner beamlines
   c. Continue the HEX beamline in partnership with NYS
   d. Continue development of the CDI beamline and ARI R&D
4) Maintain operational excellence

Minimal budget to achieve FY18 goals

In early May, we carried out an assessment of what it would take to achieve FY 18 goals:

	FY18	FY19	FY20
New Funds	118.2	123.1	127.9
Unobligated carryover from previous FY	16.0	14.8	15.0
Total	**134.2**	**137.9**	**142.9**
Accelerator Operations	36.1	37.0	39.0
Photon Science operations	46.5	50.5	52.3
BL Development	6.9	6.0	6.9
Facilities	18.7	19.0	20.5
ESH&QA	5.2	5.6	6.1
Unobligated carryforward into next FY (ops)	14.8	15.0	16.0
Line items	6.1	4.8	2.1
Total	**134.2**	**137.9**	**142.9**

Minimal budget reviewed Director's review, May 11th 12th 2017

Reviewers: Streiffer (APS), Kevan (ALS), Lang (APS), Schmerge (SSRL), P. Rossi (APS), S.Rossi (ALS)

President's budget would drive tough choices

- $102.9 M, -6.5% relative to FY16
- Reduce head count by ~ 55 FTEs relative to current staffing
  - Loss of expertise, long term damage. Years to recover. Impact to morale causes loss of good people who opt to leave beyond the RIF
- Slow construction of 3rd RF system, procure only the cavity. Delays 500 mA ops to beyond FY20.
- Users reduced by ~ 550 users/year (long term)
  - Cease beamline development on 4 beamlines, reducing future user community by ~350 researchers each year
  - Reduce operations on 3 existing beamlines (impact increased because of lack of CFN partnership), impacting 100 users/year now
  - Reduce user operations hours to 4300 hrs, impacting 100 users/yr now

SUMMARY

Summary

- NSLS-II has managed funds effectively to deliver a remarkable ramp up of the accelerator, an unprecedented beamline construction program and a growing user program
- Through prudent budget management, we have evolved from a construction-oriented organization into a lean, operations-oriented organization
- Science productivity is growing. We have a set of exceptional tools that are performing well
- We have a clear set of goals and associated priorities for developing the facility further. We will use these to make choices based on future funding realities
- NSLS-II is delivering on its promise to be a world-leading synchrotron light source!