

Beamline & Experimental Operations

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Triennial Operations Peer Review

Breakout sessions June 20th 2017



Outline

- Overview
- Photon Science Division Organization
- Costs, budget and planning for FY2015-FY2017
- Budget Scenarios for FY2018-2020
 - Plan for Flat Budget at FY2017 Level
 - Plan for the President's Request Budget for FY2018
- Summary

OVERVIEW

“Beamline Operations” Accomplishments

- FY2015
 - 7 BES-funded beamlines accepted ‘first light’
 - 110 Unique Users
 - 90 publications* (7 using NSLS-II photons)

- FY2016
 - 5 BES-funded beamlines accepted ‘first light’
 - 4 beamlines with primarily other funding (NIH, BER, NSF) accepted first light
 - 6 BES-funded beamlines initiated a General User Program
 - 477 Unique Users
 - 116 publications* (38 using NSLS-II photons)

- FY2017 (YTD)
 - 2 BES-funded beamlines, and 1 other funded beamline have accepted first light so far in FY2017
 - 586 Unique Users (through 9 June 2017)
 - 27 publications* (14 using NSLS-II photons)

- Presently have 12 beamlines in the general user program, 3 in the science commissioning phase, and 4 in technical commissioning.

*publications during calendar year



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- Presently have **13** beamlines in the general user program, 3 in the science commissioning phase, and **3** in technical commissioning. **UPDATE**



*publications during calendar year

“Beamline Operations” Budget and Spending

	FY2015		FY2016		FY2017	
	FTEs	Burdened Costs	FTEs	Burdened Costs	FTEs	Burdened Costs
BES-funded Operations	101.06	30.31M	145.49	46.30M	182.21	60.81M
Experimental Program	89.01	25.94M	91.27	28.43M	113.40	38.61M
Beamline Development	12.05	4.37M	54.22	17.86M	68.80	22.20M
Other Funded Operations	24.65	8.56M	37.18	12.60M	46.12	14.52M
Experimental Program	20.28	5.96M	22.91	6.52M	27.34	9.62M
Beamline Development	4.37	2.61M	14.27	6.08M	18.78	4.90M

- BES-Funded Experimental Program M&S was 19.1% of total budget for FY2015
- BES-Funded Experimental Program M&S was 18.3% of total budget for FY2016

Projected FTEs for operating beamlines (FY2017)

- FTEs on operating beamlines dropped from 5.54 in FY2016 to 4.83

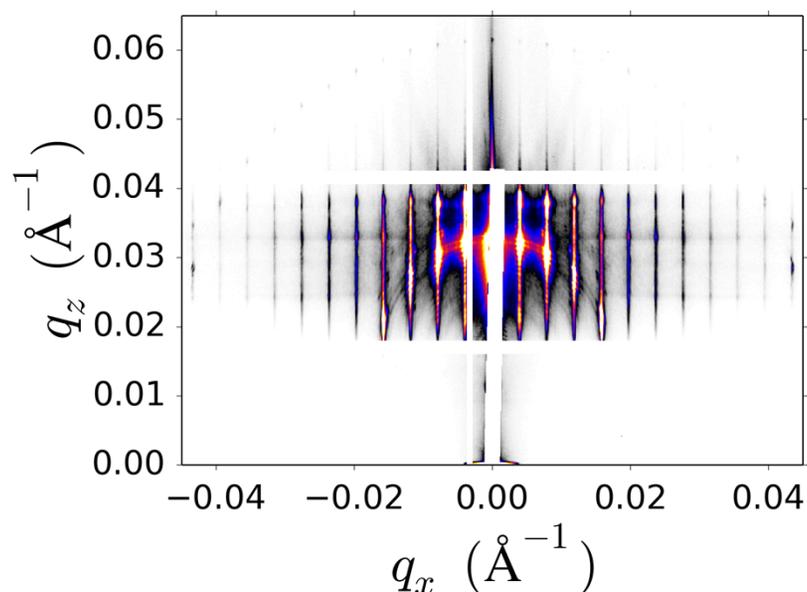


Image from 160 nm pitch grating taken at SMI. Early data demonstrate flux, resolution and q -range of SMI are impressive, and measurements of 1.5 μm pitch structures should be possible

Beamline		FTEs
3-ID	HXN	6.195
4-ID	ISR	4.63
5-ID	SRX	4.79
8-ID	ISS	4.2
10-ID	IXS	5.34
11-ID	CHX	4.93
12-ID	SMI	4.14
21-ID	ESM	4.87
23-ID-1	CSX-1	5.39
23-ID-2	CSX-2	4.36
28-ID-2	XPD	4.27

Total FTE count 53.12 in FY2017

Average FTE count 4.83 in FY2017

Beamline Complexity

- Beamlines are not turnkey instruments. Providing world leading capabilities requires considerable optimization and development to achieve the design objectives
- Beamline complexity results in considerably more time and effort to ‘train’ users to independently and productively exploit the beamline capabilities. This places additional stress on beamline staff.

Beamline	# motors	# iocs/servers	PVs	Estimate dData rate (TB/day)	# diagnostic modules, bpps	# feedback systems	# BL vacuum sections	# major optical components	# Endstations
CHX	173	60	49131	1.5	17	1	9	6	1
CSX-1,2	210	93	111592	6	8	3	33	7	1,2
HXN	~300	107	116838	11.8	7	2+4+18	14	5	2
IXS	175	42	40134	<0.1	2	2	14	5	1
SRX	85	65	40587	0.5	7	2	10	6	2
XPD	99	63	37813	5.4	3		8	3	2

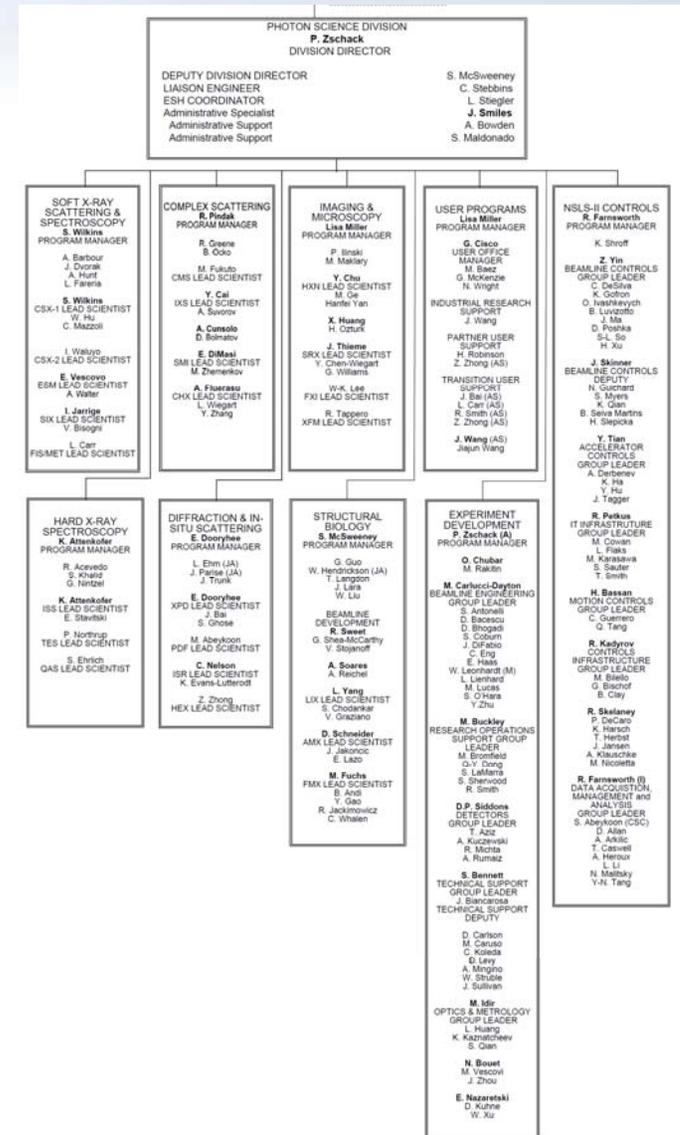
These represent significant challenges for high performance beamlines, and are typical for new, third generation facilities worldwide.



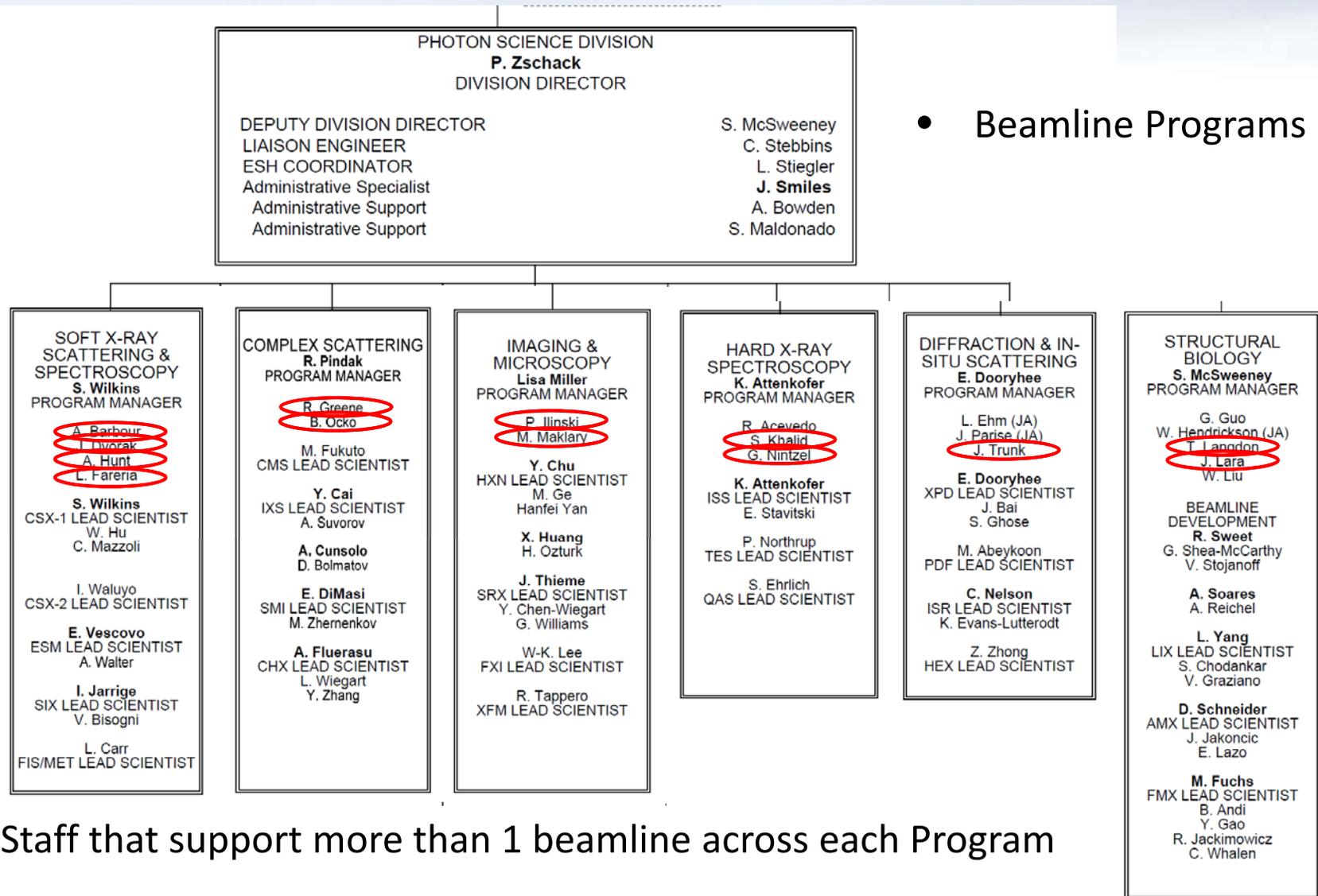
ORGANIZATION

Photon Science Division Organization Chart

- Photon Science Division organized into 9 Program areas
- 6 Beamline Programs
- User Program
- Experiment Development Program
- NSLS-II Controls Program
- All Programs report to PSD Director



Photon Science Division Organization Chart

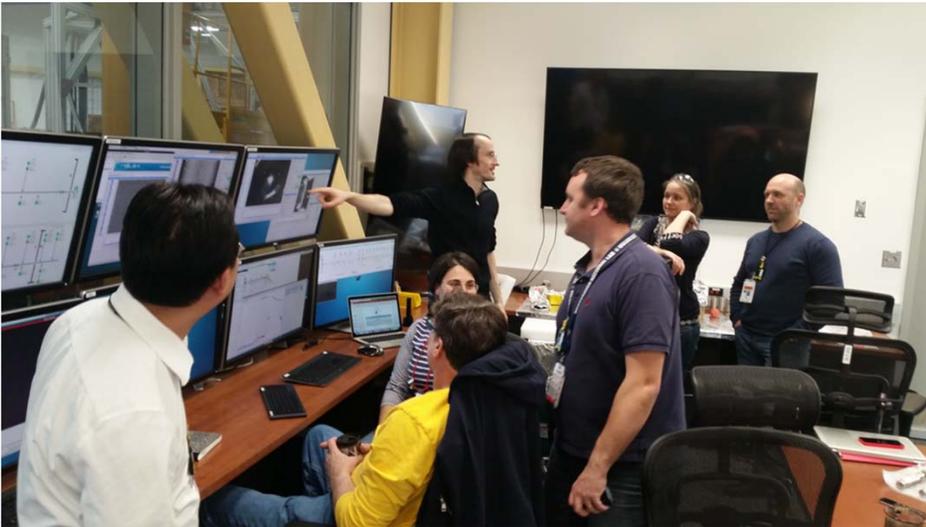


- Beamline Programs

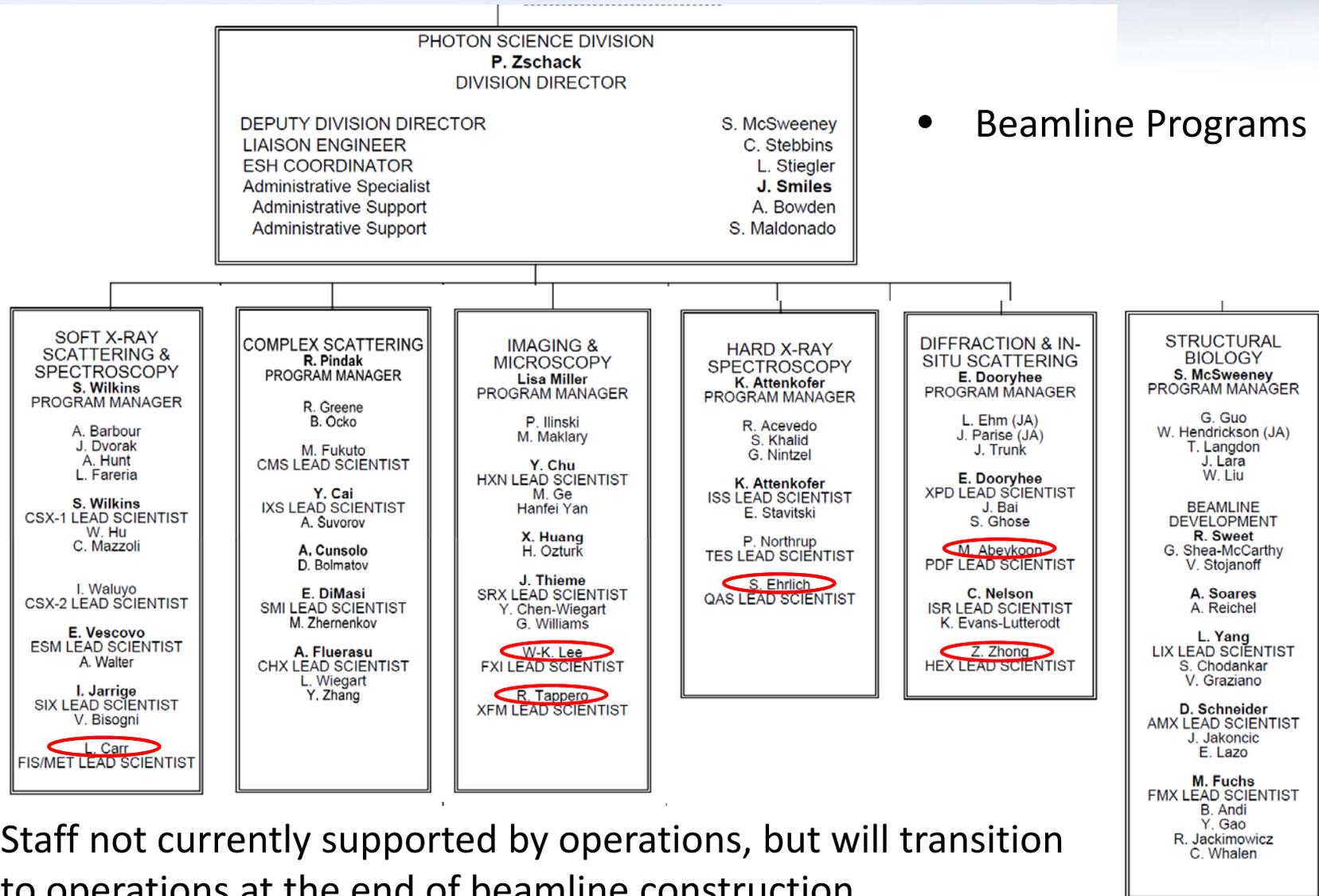
- Staff that support more than 1 beamline across each Program

Benefits from programmatic emphasis

- Assistance from program staff and additional beamline scientists resulted in first light and successful completion of KPP in just under 3 days of beamtime
- Without program assistance, milestone achievement would have required considerably more time
- Forming a Commissioning “Team” – drawn from existing staff, who can be called upon to accelerate commissioning of particular capabilities.



Photon Science Division Organization Chart

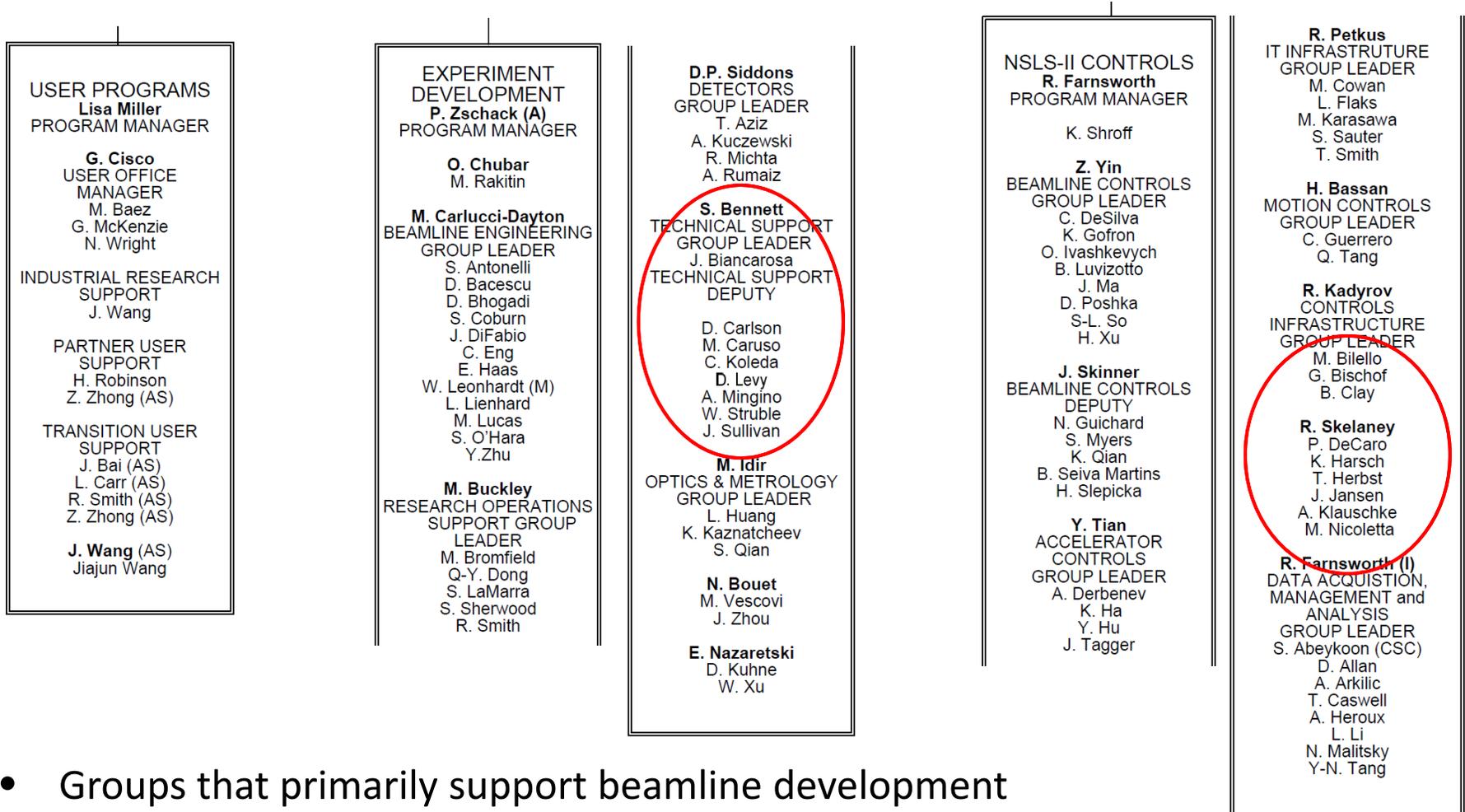


- Beamline Programs

- Staff not currently supported by operations, but will transition to operations at the end of beamline construction

Photon Science Division Organization Chart

- Programs that support x-ray operations



- Groups that primarily support beamline development

Staff morale and career development

Staff morale concerns

- Morale varies among the groups in the Photon Science Division
- Budget uncertainty creates anxiety in some groups
- Beamline groups are excited to commence science programs; some place additional pressure on themselves to quickly serve diverse user communities
- Groups that have largely worked on beamline development and construction are concerned by the decline in beamline construction

Response to concerns & staff development

- Scientific staff encouraged to develop individual research programs; considerable challenges due to time pressures on x-ray operations tempers this approach
- Staff have opportunities for growth by participating in Supervisor Development Programs, Lab Operations Supervisory Academy, Scientist & Engineer Development Program, and Lab Operations Leadership Academy
- Cross training technicians has been initiated to give staff the opportunity to develop new skills and make wider impact across the facility
- Scientific staff encouraged to participate at conferences for their own development and to advertise NSLS-II capabilities



COSTS, BUDGET AND PLANNING FOR FY2015-FY2017

“Beamline Operations” Budget and Spending

- “Beamline Operations” includes Experimental Program and Beamline Development

Resource	FY2015				FY2016				FY2017			
	BES-OPS		Other Funding		BES-OPS		Other Funding		BES-OPS		Other Funding	
	FTEs	Burdened (\$K)	FTEs	Burdened (\$K)	FTEs	Burdened (\$K)	FTEs	Burdened (\$K)	FTEs	Burdened (\$K)	FTEs	Burdened (\$K)
Total	101.1	30,310	24.6	8,563	145.5	46,298	37.2	12,595	182.2	61,167	46.1	14,521
Manager Effort	2.1	746	0.0	0	3.2	1,030	0.0	0	4.4	1,439	0.3	103
Scientist Effort	31.6	9,042	4.5	1,435	41.3	12,136	7.5	2,151	55.7	16,855	9.0	2,993
Engineer Effort	29.4	6,761	8.0	1,665	46.5	10,404	13.6	2,871	63.3	14,066	18.3	3,851
Technical Effort	27.1	4,967	3.7	559	42.2	6,423	11.0	1,586	46.0	7,807	13.9	2,225
Post Doc Effort	2.8	334	7.6	875	3.8	476	5.0	545	3.1	371	4.5	549
Student Effort	-	0	0.3	16	-	0	-	0	0.5	33	-	0
Admin Effort	8.1	1,128	0.5	56	8.6	1,266	0.1	17	9.3	1,439	0.1	17
M&S		6,869		3,799		14,005		5,296		18,218		4,701
Travel		464		158		559		128		940		83

- Designation of resource type directly from PeopleSoft management system
- Engineer effort includes beamline engineers, mechanical engineers, controls engineers and IT, science associates, and all other professional support
- Technical effort includes beamline technicians, electricians, plumbers, and all other technical support

Operating Costs FY2015-2017

- Experimental Program (does not include Beamline Development)

	FY2015		FY2016		FY2017 (projected)	
	FTEs	Burdened Costs (\$)	FTEs	Burdened Costs (\$)	FTEs	Burdened Costs (\$)
Manager Effort	0.75	351.8K	0.81	420.0K	0.76	398.3K
Scientist Effort	26.04	7.9M	31.75	10.1M	44.24	13.86M
Engineer Effort	26.41	6.2M	32.46	7.9M	36.68	8.7M
Technical Effort	23.98	4.5M	15.04	2.83M	20.82	4.2M
Post Doc Effort	2.76	333.6K	3.69	475.6K	3.06	371.2K
Student Effort					0.49	33.1K
Admin Effort	7.85	1.1M	6.36	948.7K	6.17	951.2K
Org Burden	1.21		1.09		1.18	
M&S		4.98M		5.26M		9.26M
Travel		442.9K		458.4K		848.2K
Total	89.01	25.94M	91.27	28.43M	113.4	38.61M

Actual costs incurred during FY15-16; FY17 estimated costs (w/o commitments).
 Note: Org Burden FTEs have no cost, so these are omitted from this table

Experimental Program for FY2016 (BES-Funded)

	FTEs
Experimental Program Totals	91.3
Experimental Management	2.29
Beamline & User Science Support	51.77
Engineering, Technical & User Operations Support	6.97
Beamline Engineering	0.32
Technical Support	1.34
Research Operations Support	2.54
LOB Lab Operations	2.19
Equipment Pool Support	0.54
General Experiment Activities	0.04
X-Ray Operations (scalable with # of beamlines)	44.80
Instrumentation Support and R&D	15.01
Optics Fabrication	2.98
Metrology	3.64
Detector Development	4.93
Nano-scale positioning	3.45
Facility Controls, Computing and Data	13.43
Control Program	1.12
IT & Computing Infrastructure	2.49
Beamline Controls	2.08
Controls Infrastructure	1.72
Data Acquisition, Visualization & Computing	6.00
User Programs	7.60
User Program	0.49
User Office	4.17
Industrial Research Support	0.99
Partner User Support	0.11
Support for Users @ Other Facilities	1.85
Org Burden	1.2

Partner User Beamline Support

- Support beamline operations on partner-operated beamlines to assure these remain in excellent working condition
- Provide controls effort to encourage standardization using NSLS-II approaches to controls and data handling

Budgeted effort per ID partner beamline	ID
	(FTE)
Experimental Motion Controls (1 FTE for 20 beamlines)	0.05
Experimental Controls EE/EPS (1 FTE for 20 beamlines)	0.05
Experimental Controls Engineer (1 FTE for 10 Beamlines)	0.1
IT prof for Network/Data Storage & Processing (1 FTE for 10 beamlines)	0.1
Mechanical Utilities Engineer (1 FTE for 40 beamlines)	0.025
Mechanical Utilities Tech (1 FTE for 20 beamlines)	0.05
Survey Support (1 FTE for 50 beamlines)	0.02
electrical designer (1 FTE for 25 beamlines)	0.04
electricians (1 FTE for 30 beamlines)	0.03
PPS maintenance Engineer (1 FTE for 40 beamlines)	0.026
PPS maintenance tech (1 FTE for 18 beamlines)	0.054
Vacuum Engineer (1 FTE for 22 beamlines)	0.046
Vacuum Tech (1 FTE for 30 beamlines)	0.034
Engineering & Tech support (1 FTE for 20 beamlines)	0.05
Total	0.675

Processes for resource distribution for Experimental Program

- In the Photon Science Division, the Lead Beamline Scientists and Group Leaders are charged with preparing an annual budget request for the beamlines, support groups, and R&D activities. This is done in consultation with the respective Program Manager.
- The request includes routine operational needs (such as consumables, new instrumentation, small improvements, routine maintenance, service contracts, etc...), and also includes major upgrades & projects.
- The request is divided into 3 priority levels. The highest priority routine items are generally allocated. Highest priority major upgrades or projects included as budget permits.
- Major upgrades & projects are also considered if resources become available during the fiscal year. The overall priorities for these are established through discussion with the Program Managers and NSLS-II Facility Director.
- Major items not funded in any given year are considered for inclusion in the subsequent year budget plan.
- Staffing requests are proposed from various levels and decided with approval of the Facility Director

MST Budget Preparation for FY2017

- FY2016 actual costs inform the estimates for the FY2017 budget plan
- In July-August, 2016, request was sent to each Lead Beamline Scientist and Group Leader for budget priorities which are determined with Program Manager
- When budget guideline established, M&S budgets released
- Mid-year evaluation performed across the NSLS-II facility and adjustments made as needed
- End-of-year procurements authorized if projections determine adequate budget

CSX-1 Operations M&S FY2017 request (direct budget)	K\$
Consumables	30
User experiment support	30
Repairs	10
Maintenance	5
Fabrications; new mounting hardware, sample stages, etc...	15
Service contracts	30
Samples, supplies, research equipment	35
Travel	15
Total	170

Operating Beamline M&S Costs FY2015-2017

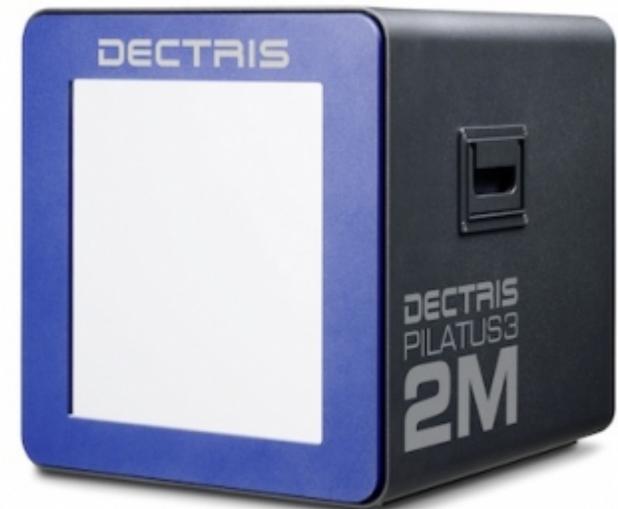
	<i>Contract Milestone Payments</i>	<i>Travel</i>	<i>Contract Labor, JT Appts & Shops</i>	<i>Maint/ Service Contracts</i>	<i>Materials & Purchasing</i>	<i>Total</i>
FY2015 - Burdened Actuals						
IXS	55K	23K	115K	72K	151K	416K
CHX	110K	16K	252K	69K	267K	714K
CSX	0	22K	36K	72K	282K	412K
CSX-2	0	0	72K	66K	202K	340K
XPD	42K	14K	174K	12K	140K	382K
HXN	0	17K	128K	12K	259K	416K
SRX	19K	39K	47K	10K	110K	225K
FY2016 - Burdened Actuals						
IXS	0	28K	18K	25K	127K	198K
CHX	0	2K	109K	46K	273K	431K
CSX	0	1K	40K	62K	261K	364K
CSX-2	0	4K	19K	15K	239K	277K
XPD	42K	33K	44K	22K	50K	190K
HXN	235K	50K	22K	46K	153K	507K
SRX	177K	35K	7K	12K	27K	258K
Projected Burdened FY2017						
IXS	0	23K	7K	0	176K	206K
CHX	0	28K	4K	0	280K	312K
CSX	0	23K	27K	46K	162K	259K
CSX-2	0	15K	1K	0	170K	187K
XPD	0	28K	16K	0	147K	191K
HXN	0	23K	0	0	241K	264K
SRX	0	23K	7K	8K	220K	257K

Sample of Improvements in FY2015 – FY2017

Activity/Item	(\$K)	Description
Metrology enhancements	107.3	Sources, stages, and optical standards
Nano-positioning instrumentation	112.5	Interferometers, cryostat, controllers and vacuum hardware
Humidity Controller	28.3	Enable experiments with humidity-sensitive samples
Diamond Windows	71.5	Spare and new windows to improve wavefront errors, and mitigate potential window failures
Thin-film standards for beamlines	30.2	Provides robust benchmarking & beamline performance characterization
Vacuum bakeout & pump hardware	59.7	Expand vacuum support for operating beamlines
Semiconductor analyzer upgrade	29.2	Significant improvement in characterizing detector component parameters
Beamline data storage	123.2	Increase local storage capacity for data at beamline
Cryo-cooler upgrade	56.5	Upgrade to Oxford cryo-cooler to minimize downtime risks
3D Microscope	82.9	Microscope needed for characterization of MLL optics / MEMS
Interferometry upgrades	134.9	Replacement of obsolete metrology hardware and software

Significant investments to support operations

- CSX-1 detector (\$261K)
- Pilatus 2M detector for CMS (\$550K)
- Core switch replacement – in progress (\$336.4K PSD portion; \$591.5K total)
- Central computing & storage – in progress (\$465K)



Research and Development (R&D) program

- R&D directions are largely informed by the NSLS-II Strategic Plan, BNL and Directorate priorities, LDRD opportunities, and BES strategic directions
- Photon Division R&D goals are almost exclusively driven by beamline needs and opportunities
- R&D in metrology, detectors, optics, and nano-positioning are very closely tied to specific beamline needs at NSLS-II. External reviews have helped establish priorities.
- To remain internationally competitive or world-leading requires growth in some R&D areas. Operating budget pressures have permitted stable, ongoing R&D without growth.
- Beamline staff R&D generally extends beamline capabilities, benefitting the general user community. Beamline scientific staff budgeted \$10K each for individual research.

BUDGET SCENARIOS

FY2018 Goals for Experimental Program

NSLS-II source currently holds competitive advantage and aggressive user program ramp-up is needed to fully exploit this advantage for high-impact science

- Maintain safe and productive operations on all beamlines and user support labs
- Grow Unique User participation and publication output at NSLS-II beamlines
- Continue efficient user operations and commissioning for additional capabilities on all 20 BES-operated beamlines
- Advance the open-source model for data handling/analysis environment to facilitate user access to data and analysis codes
- Maintain detector development program to support NSLS-II beamlines
- Continue development of Multilayer Laue Lens technology for nano-scale focusing applications; implement MLLs with improved spatial resolution
- Deploy nano-positioning advancements to NSLS-II beamlines for sample and optical component positioning requirements
- Extend wavefront simulation framework to include beamline commissioning and virtual beamline experiments.

Note: Not all these goals can be achieved within the constraints of the proposed President's request budget

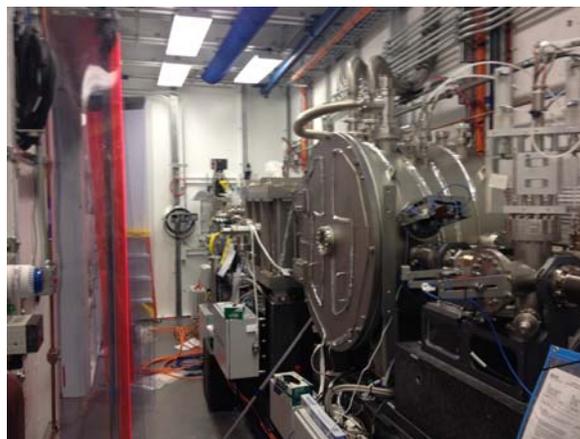
Prioritization of FY2018 activities close to cut-off

Activity	FY18 (\$)	Deliverable
Additional Program Manager	265,000	Lead and manage Experiment Development Program activities
Research Operations Support Staff	265,000	Add staff to support user access to LOB labs and support beamline operations; critical for safe gas-handling operations
New/replacement optics	225,000	Improve beamline performance; add new capability (IXS, CHX)
New/replacement detector	120,000	Mitigate risk of extended downtime; improve performance (XPD)
Cant angle correction at CSX	200,000*	Eliminate cross-talk between ID beamlines; improve beamline performance and utilization
Taskforce Support	65,000*	Support for User Issue, Beam Stability, & Multi-modal taskforces
New sample environments	100,000	Add new capabilities for multiple beamlines; equipment pool
Computing/IT infrastructure	150,000	Advance progress on central data storage & analysis architecture
Detector upgrades	210,000	Improved performance at ISS & CHX
Spare Cryo-cooler	250,000	Mitigate risk of extended downtime; improve standardization
Nano-positioning hardware	150,000	Microscopy & nano-positioning advancements; spares
Hutch Temperature Stability	100,000	Improve performance for inelastic scattering (IXS)
New Micro-diffraction Detector	150,000	New capability at SRX
Gas Handling Systems	750,000	New capability at QAS & TES
UHV Highway at ESM	350,000	Add capability to move samples between instruments in UHV
Operando Sample Prep. Area	350,000	Adds controlled space on experiment hall for dedicated operando
PILATUS3 X CdTe (2M) detector	1,000,000	Dramatically improves high energy diffraction and PDF exps.
Metrology Upgrades	300,000	Improve ability to characterize state of the art optics
PECVD film growth facility	400,000	Eliminate contamination from sensors

*materials cost only

Adding New Capabilities to Beamlines

- XPD high resolution operation mode
- XPD high pressure – large volume press
- SRX ultra-high spatial resolution operation mode
- CHX multilayer monochromator
- HXN sample temperature environment
- IXS improvements in energy resolution and throughput



Assumptions

The following assumptions were used in our budget planning:

- 1) That the BNL environment remains unchanged from current practice including
 - 1) Indirect rates unchanged
 - 2) Electric power costs as currently projected
 - 3) BNL rules on return of space unchanged
 - 4) IGPP projects remain as currently planned
 - 5) SLAs remain possible in their current form
 - 6) Escalation rates remain as projected on labor and materials
- 2) Estimates are made in terms of FTEs to carry out the work. In the cases where this will require a reduction in the number of heads in the organization, if this cannot be done starting October first, larger reductions will be required
- 3) Out years beyond FY18 will be flat relative to FY18

Flat budget at FY2017 level

- All goals for Experimental Program can be achieved for FY2018, but challenges remain in out-years.
- Beamline Development will experience significant negative impact

	FY18	FY19	FY20
New Funds	111.8	111.8	111.8
Unobligated carryover from previous FY	16.0	14.0	14.0
Obligated carryover from previous FY			
Total	127.8	125.8	125.8
Accelerator Operations	35.1	36.6	37.6
Experimental Operations	46.5	50.3	51.8
BL Development	4.5	1.0	0.0
Facilities	18.6	16.8	17.0
ESH	5.2	5.3	5.4
Unobligated carryforward into next FY (ops)	14.0	14.0	14.0
commitments from prior year			
Add-ins*	3.9	1.8	0.0
NLSL stabilization			
Total	127.8	125.8	125.8

* 3rd RF cavity and \$0.05 M for a diversity program

Note FY19 and FY20 are notional and reflect changes to VAB for OH rates

FY2018 FTE Plan for Flat Budget

	FY2018
Experimental Program total	139.84
X-Ray Operations (scalable)	86.57
Instrumentation Support and R&D	15.35
Facility Controls, Computing and Data	11.25
User Programs	11.40
Engineering, Technical & User Operations Support	11.57
Experimental Management	2.50
Org Burden	1.20

President's budget (NSLS-II down 6.5%)

In addition to the previous assumptions, the following decisions were made by senior management, reflecting the NSLS-II priorities for FY18 and beyond:

- 1) To curtail beamline development on 4 beamlines
- 2) To reduce accelerator user operation hours to 4300 hrs
- 3) To reduce operations on 3 beamlines
- 4) To procure the 3rd RF cavity, but to slow the schedule on the transmitter and cryo-plant
- 5) To return space to the Laboratory

President's budget

- Goals for Experimental Program cannot be achieved; revision needed

	FY18	FY19	FY20
New Funds	103.1	103.1	103.1
Unobligated carryover from previous FY	16.0	12.9	12.9
Obligated carryover from previous FY			
Total	119.1	116.0	116.0
Accelerator Operations	34.7	35.3	35.3
Experimental Operations	44.0	46.0	46.0
BL Development	1.5	0.0	0.0
Facilities	18.0	16.6	16.6
ESH	5.2	5.2	5.2
Unobligated carryforward into next FY (ops)	12.9	12.9	12.9
commitments from prior year			
3rd RF Cavity	2.8	0.0	0.0
NSLS stabilization			
Total	119.1	116.0	116.0

Note FY19 and FY20 are notional and reflect changes to VAB for OH rates

Actions to address President's request budget

- Would not be able to operate at least 1 beamline that was completed
- Would have reduced operations on 2-3 beamlines
- CFN closure would leave shortcoming at CSX-2, CMS, SMI, and ESM
 - Might be able to operate CMS and SMI
 - Might operate ESM without XPEEM branch beamline
 - Might reduce operations on CSX-2
- Would not plan to operate beamlines with incomplete construction
- Decisions concerning specific beamlines would consider number of users affected, opportunity for high-impact science, and unique capabilities provided by the NSLS-II source.
- Coordination with other facilities needed to minimize the impact on the user community to the greatest extent possible.

FY2018 FTE Plan for President's Budget

	FY2018
Experimental Program total	127.88
X-Ray Operations (scalable)	75.22
Instrumentation Support and R&D	15.35
Facility Controls, Computing and Data	11.25
User Programs	11.40
Engineering, Technical & User Operations Support	10.96
Experimental Management	2.50
Org Burden	1.20

SUMMARY

Summary

- Very successful initial ramp-up of beamlines into commissioning and general user operations
- Resources for operation of beamlines have been trimmed to minimum levels
- PSD Experimental Program can achieve stated goals for FY2018 with flat budget for NSLS-II at FY2017 levels
- The President's budget request requires adjustments to the achievable goals for the Experimental Program in FY2018