NSLS-II Accelerator Systems

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Triennial Operations Peer Review

Breakout sessions June 20th 2017

Outline

- Overview of charge questions
- Details on cost in FY15-17
- FY18 Budget scenario
- Benchmarking budgets
- Operations: status, improvements, developments
- Organization of accelerator operations
- Questions

Charge questions

1. Have NSLS-II management properly addressed the recommendations of the 2015 facility operations budget review?
2. Evaluate the appropriateness of the organization structure. Is the staffing level and skill distribution appropriate and consistent with the operational needs? Is the organization adaptable to reflect the ramp up of a new facility over the coming years?
3. Assess the appropriateness of the facility operating budget and staffing level, and subsequent operations cost for fiscal year (FY) 2015 to FY2017. Are they appropriately reflecting the required resources to achieve the overall strategic goal(s) of the facility?
4. Evaluate the effectiveness of budget execution for FY 2015 and FY2016?
5. Evaluate the performance and cost effectiveness of accelerator and beamline operation.

Charge questions

6. Evaluate the beamline build out plan and execution including the transition to operations. Is the cost and schedule consistent and appropriate to maximize the utilization of the new facility with the budget and resources provided?
7. Evaluate the Environment, Safety and Health (ES&H) and Quality Assurance (QA) at the NSLS-II facility. Is the organization and resource allocation appropriate?
8. What is the morale level of NSLS-II scientific and technical staff and their opportunities for career development?
9. Assess the appropriateness of the Facility Strategic Plan: scientific goals, facility improvement plans, Research and Development (R&D) program, etc.
10. Evaluate appropriateness, quality and selection process of the facility staff R&D programs (including research on synchrotron radiation science and accelerator science, beamline instrumentation and optic development, detector R&D, data management, and data acquisition and data analysis software development).
11. Evaluate if there is an appropriate level of funding for efforts related to improving operations, instrumentation, sample preparation, spares, upkeep, etc.

Introduction

- NSLS-II accelerator systems are ramping up
- Two major increments in operations requirements from FY16 to FY17
  - Reliability 90% → 95%
  - Total operations hours increased by 20% (3718 hrs → 4500 hrs)
- Good reliability record in FY17

- From FY15 we reduced the AD operations budget
- In the current year we see signs of increased faults and downtime
- Analyzed trends in faults, requirements for staffing for coverage of operations and materials, revisited improvement / development program
- Self-assessment and external reviews

- Show you details on our budget, operations and our organization

Details on cost in FY15-17

Details on cost for FY15-17

	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		

- 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

Accelerator Operations Cost in FY15-17

k$	FY15	FY16	FY17
Total	**37,136[A]**	**31,343[A]**	**37,821[P]***
Labor	29,975	25,875	25,769
Materials	6,952	5,254	11,886
Travel	209	214	166

[A,P] FY15 and FY16 data are **A**ctual cost, FY17 data are **P**rojected cost

* FY17 funds include commitments of 3.828M$ from FY16 for 3rd RF cavity work, development materials and one-time RF system spares

- Costs + commitments: FY15 - 37.136M$, FY16 - 35.171M$, FY17 - 33.993M$

- Details (Labor and Material breakdown) are presented in a separate Excel document (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

Accelerator Ops Labor

- 18% reduction in Accelerator operations labor (23.9 FTEs) from FY15 to FY16
- FY17 projected to be similar to FY16
- All groups have seen decreases since FY15 except survey and vacuum
  - More IDs & FEs to maintain
  - Supporting increased current
  - Developing Ti coating system
- Ops labor focus has shifted to preventative maintenance
- Almost all of AD staff (164 heads) are used in accelerator operations at some level
- Advantage of having large pool of experts with mixed skillset
- Survey and management requirements expected to decrease in FY18

Group	FY15 FTEs	FY16 FTEs	FY17 FTEs
Elec Engineering	19.3	15.4	17.0
Safety Systems	4.4	3.1	3.3
Mech Engineering	10.0	4.9	6.9
ID	4.7	5.5	3.4
Survey	2.1	1.7	3.3
Vacuum	8.2	6.9	10.2
RF	12.4	11.4	10.9
D&I	10.5	10.1	10.2
Accel Controls	13.0	7.0	6.0
Physics	10.8	6.8	6.7
Mech Utilities	7.2	8.3	6.8
Management	5.4	5.4	5.3
Beam Operations	17.5	16.2	14.5
Coordination	6.0	4.8	4.4
Total	**131.4**	**107.5**	**108.9**

Staffing of Accelerator Division

- Skill matrix per group compiled
- Areas of concern identified when:
  - Single expert covering critical subsystem
  - Inadequate back-up

Name	Responsible for NSLS-II subsystem / equipment	Skills critical for NSLS-II operations
Jane Doe	PLC logic for SR, FE and straight sections, integration of vacuum controls into global system, link between vacuum and EPS and controls group, oversees commissioning and testing of newly installed vacuum hardware.	Allen-Bradly PLC programming, logic diagrams, PLC hardware, chassis design, HMI programing, PLC tag database, knowledge of existing vacuum control system, vacuum interlock logic, integration of vacuum hardware into the control system, integration between vacuum and EPS, EPICS OPI programing, EPICS PV database

Main systems of concern:

- Pulsed Power systems (booster kickers, septa, bumps, SR septum, kickers)
- Controls (BPMs, PS, RF, IDs, timing, FOFB, control room tools, computing)
- Interlocks (Vacuum, temperature, orbit, subsystem, fault analysis tools)
- Vacuum (storage ring and injector systems)
- Utilities (DI water, cryo)

Internal Assessment of staffing

- In Nov. 2016, ADD appointed AD Reliability Panel to assess measures needed to increase reliability and sustain 95% uptime
  - Several seasoned engineers and Group Leaders from AD
  - Combined experience from CAD, NSLS, NSLS-II
- Some conclusions from the Report:
  - *"…Need to identify and train a backup person (engineer) for the dipole power supply."*
  - *"…Need to identify and train a backup person (technician) for the cryo system."*
  - *"…The Accelerator Controls group appears to be understaffed and does not have adequate back-up for several subsystems."*
  - *"…The interlock group would need to be expanded and further development to achieve this."*
  - *"…There is a shortage of RF staff to support the machine startup following maintenance periods, especially the long shutdowns."*
  - *"…Development funds need to be made available for small upgrades that could increase reliability."*

- Details are presented in a separate document (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

External Assessment of staffing

- Requested help from outside experts (seasoned engineers with management experience from DOE facilities) to independently assess NSLS-II staffing requirements
- Presentations compiled by each group including scope of work and FTE data

Lab	Reviewer	Group	Position
APS ANL	Glagola, Bruce G.	BO group	FloCo GL
APS ANL	Randy Flood	BO group	Ops GL
BNL CAD	Jon Sandberg	EE group	GL
BNL CAD	D. Gassner	D&I group	GL
FNAL	S. Belomestnykh	RF group	CTO
ANL	Joe Gagliano	V group	GL
ANL	M. Kirshenbaum	U group	GL
APS ANL	Yu. Ivanyushenkov	ID group	GL
APS ANL	L. Morrison	ME group	GL

AD Director charge questions:

- *Review the present and future scope of work assigned to the group. Is the staffing level and labor type composition adequate with respect to this scope of work?*
- *What are the challenges you see in operating a new synchrotron light source at the presented staffing level to achieve and sustain the reliability level of more than 98%?*

~98% presents a common level of operations for mature 3rd generation facilities

- Details are presented in a separate document (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

Feedback from External Assessment

- EEG: “The total level of technicians support seems appropriate in general for the work proposed with the exception of the number of technicians assigned to safety systems…”
- Utilities: “Operation, maintenance, and design activities related to all HVAC systems including the APS storage ring resides directly with Argonne’s facilities group supplementing and in addition to the MOM staff…”
- “Their biggest source of downtime is recovering from power transients and when they had 3 people on shift it was quicker to recover…”
- “There is a risk with relying on continued support an employee (in this case, 0.6FTE EE) who is shared with the Instrumentation Division.”
- RF group:”…the staffing level is barely adequate to keep the machine running and needs additional staff for mitigation of the issues and upgrades.“
- D&I Group: “…it appears that the existing staff (1AP, 1ME, 2.6EE, 6 technicians) in the Instrumentation Group is the bare minimum needed to support all of the diagnostics systems, sustain the goal of very high reliability operations and make steady progress on the development projects“
- Beam Ops. group: “…APS group consists of 10 operators, 2 chief of operations and himself.” and includes 8 FloCos = total of 21 as compared with NSLS-II Beam Ops group of 14”
- Utilities group: ”…The current staffing level of 10 full time employees (FTEs) does not appear to be adequate based on my 27 years in operations at the Advanced Photon Source (APS).“

Benchmarking: Comparison with APS

- Compared with sister facility of similar scale

- Received FTE data by WBS from APS
- APS Total FTE count 124
  - Added 8 FTEs from APS exp. facilities group to compare to NSLS-II FLOCOs
  - Excludes electrical utilities
- APS is mature synchrotron facility
  - Steady-state operations at 100 mA
  - Routinely delivering >98% reliability
  - Redundancy of critical subsystems
  - Complete spare inventory

- NSLS-II is in 3rd year of operations
  - Still improving and developing
  - Yearly increasing current
  - Constantly commissioning new IDs, FEs, BLs
  - Set of spares not yet complete

WBS Description	NSLS-II FY17 FTEs	APS FY16 FTEs
Acc Management	5.5	2.3
Operations Safety	1.1	0.3
Coordination Effort	3.8	-
Acc Physics Ops Support	6.7	4.8
Beam Operations	12.1	22.3
Mechanical Utilities	6.7	7.7
Electrical Utilities	3.5	-
RF	11.3	22.7
Pulsed Magnet Systems	2.4	-
Vacuum	10.2	8.9
Power Supplies	10.2	9.7
Safety Systems	3.6	2.7
Diagnostic Systems	10.3	8.4
Insertion Devices	3.4	15
Controls	8.4	15.5
Mechanical Systems	9.7	3.6
Total	**108.9**	**123.9**

Logic of comparing staff with partner facilities

- Assume two light source facilities: NLS (N cells) and MLS (M cells)
- One of the ways to compare the operations staff is as follows:

$$\frac{totalFTE_{NLS}}{totalFTE_{MLS}} = \frac{N}{M}$$

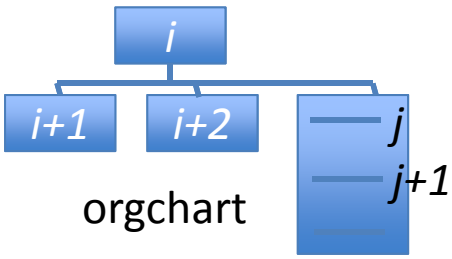
- This comparison employs linear scaling
- Modern economical and sociological sciences know accurate ways to describe staffing in time-dependent, semi-efficient, lab-specific environment
- Ex.: A Variable Nurse Staffing Model, https://www.gsb.stanford.edu/gsb-cmis/gsb-cmis-download-auth/311671, Stanford Business, 1971.

The All-Inclusive Model (AIM)

- The All-Inclusive Model (AIM):

$$totalFTE = \sum_{i}^{Groups} \sum_{j}^{Members} \varepsilon_{ij}(t) \cdot FTE_{ij}(C(t), P(t), S)$$

- *Groups* = number of Groups in Organization
- *Members* = number of Members per Group
- $\varepsilon=\varepsilon(t)$ = individual efficiency, 0…1
- $C=C(t)$=complexity, ex.: NSLS-II vs NSLS-I
- $P=P(t)$ = Level of Performance, ex.: 500 mA vs 100 mA
- S=size, ex: 1,104 m vs 792 m, or 40 cells vs 30 cells
- t=time is defined as time passed after commissioning, 2 years vs 20 years



- Steady-state ($t \rightarrow \infty$): the goal of staff optimization is:
  - to reduce *Groups & Members*
  - while increasing $\varepsilon \rightarrow 1$

- Applying the simple **linear** scaling to **NSLS-II** → making too many assumptions:

Still learning — Evolving performance

$t \rightarrow \infty$, $\varepsilon \rightarrow 1$, $C_{NSLSII} = C_{MLS}$, $P_{NSLSII} \neq P(t) = P_{MLS}$

Still ramping up — More complex

Linear scaling gives oversimplified result

Materials

Group	FY15	FY16	FY17	Notes
Electrical	1,137,029	1,032,622	1,077,622	Majority is for power supply spares
Safety Systems	332,586	269,394	542,156	
Mechanical	603,293	762,708	384,217	
ID	230,840	189,817	232,703	
Survey	-	-	-	Survey included with Mechanical
Vacuum	459,900	597,022	334,348	
RF	675,107	741,291	4,615,598	FY17 includes $3.2M of 3rd RF Cavity components; balance RF spare parts
D&I	523,393	445,339	553,834	
Accel Controls	828,516	57,690	129,975	
Physics	55,422	36,324	6,301	
Mech Utilities	1,049,196	1,059,869	1,531,214	Includes LN2, pumps seals, filter replacements, maintenance contracts
Management	111,471	114,945	117,362	
Beam Operations	38,288	65,653	13,522	
Coordination	46,444	3,708	2,297	
Development	1,346,315	91,118	2,510,751	FY17 includes FY16 carryover, RF spare parts, linac klystron & modulator
Total	**7,437,800**	**5,467,500**	**12,051,900**	

**FY15 and FY16 actuals and FY17 plan (as of 3/31/17)

Spare Parts

- Each AD Group has developed a list of spare parts and consumables
  - Associated with each item is the cost, impact on performance if missing, lead time and quantity in use.
  - A total of 1,717 items have been identified
- Replacement Spares (Replaced due to component failure)
  - ~100 per year (Power supplies, valve actuators, Flow meters, Pump seals, Klystrons and modulators)
- Required Spares not on hand (Not available in BNL inventory)
  - 726 items
- Special Process Spares (Unique to the program and vital)
  - 82 items, $7.9M direct, Secured in storage area in LOB 2. Examples: magnets and magnet coils, vacuum chambers, kicker magnets, septum's, linac klystron, BPM/electronics

Klystron Tube

SR Circulator

- 3 categories of spares,
  1. Halt ops immediately: 78% on hand the rest to be procured in the next few years
  2. Impede operations: almost all procured
  3. Can wait until shutdown: 50% available

Consumables

- Consumables are items with a finite and definable life.
- 235 discrete items on the NSLS-II AD list,
- 2.3M$ burdened, fixed cost to operate every year
- Typical replacement: 1-5 years.
- These are items that must be available for the continued operation of the accelerator.

Water filters

Heating jackets

Pump seals

Air filters

Typical Consumables
Certification and calibration of measuring equipment (gauges, instruments, electronics etc.)
pump seals
filters
lubricants
fans
bearings
tooling (belts, blades, grinding, training)
contracts
Software licenses
computers
liquid Nitrogen

FY18 BUDGET SCENARIO

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

President's budget

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

	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

President's Budget Details

Year	Labor	Materials	Development	Travel	Total
FY18 budget, M$	28.63	4.70	1.05	0.30	**34.7**

Impact:

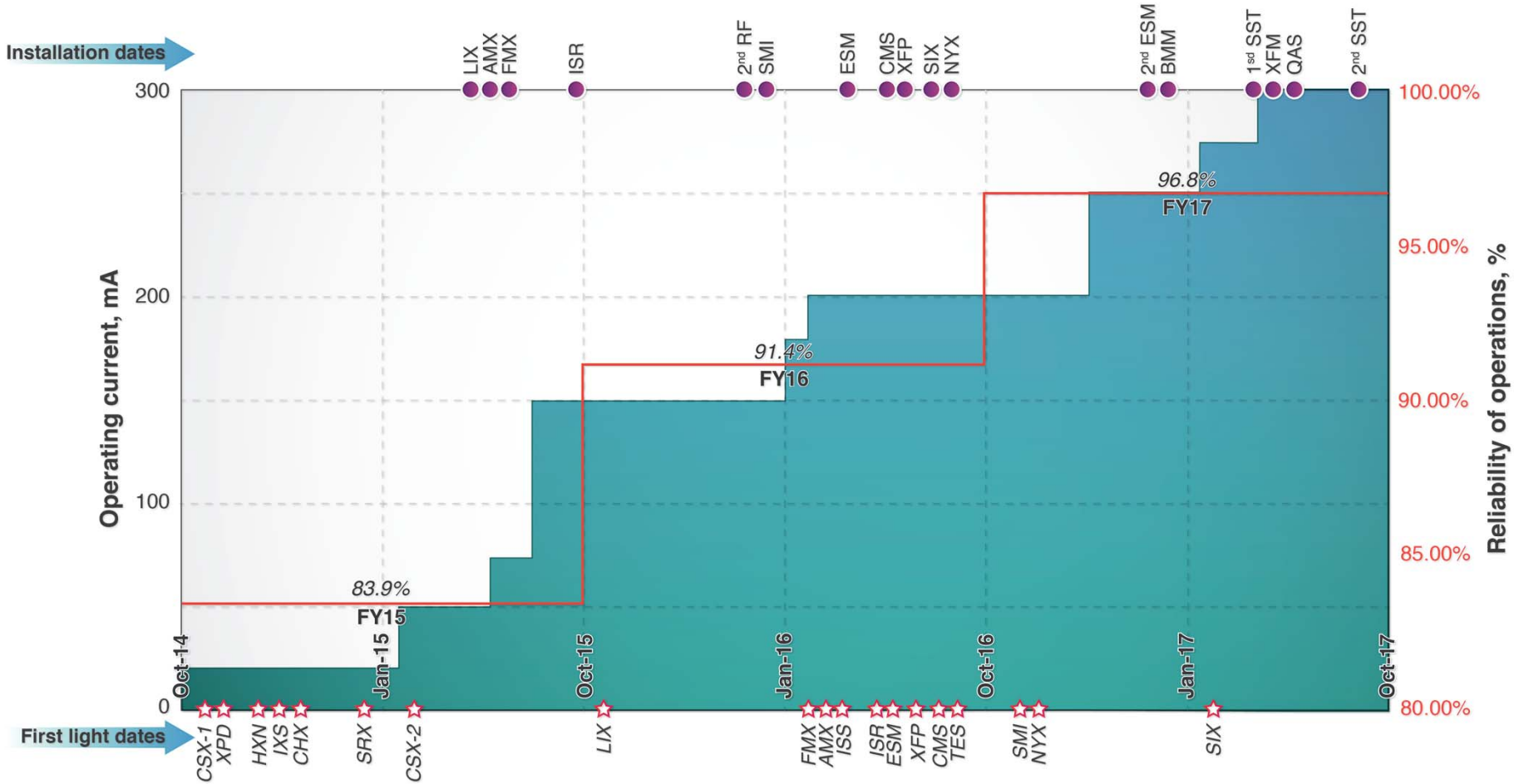
- Reduce accelerator user operation hours to 4300 hrs
- Delay purchase of spare parts not in-hand
- Reduce development projects
- Mothball ID magnetic measurement lab
- Delay the 3rd cavity transmitter and cryo-plant
  - Cavity will still be procured
- Delay harmonic cavity
- Reduce travel
- Reduce staff in out years FY19-20

Operations: status, improvements, developments

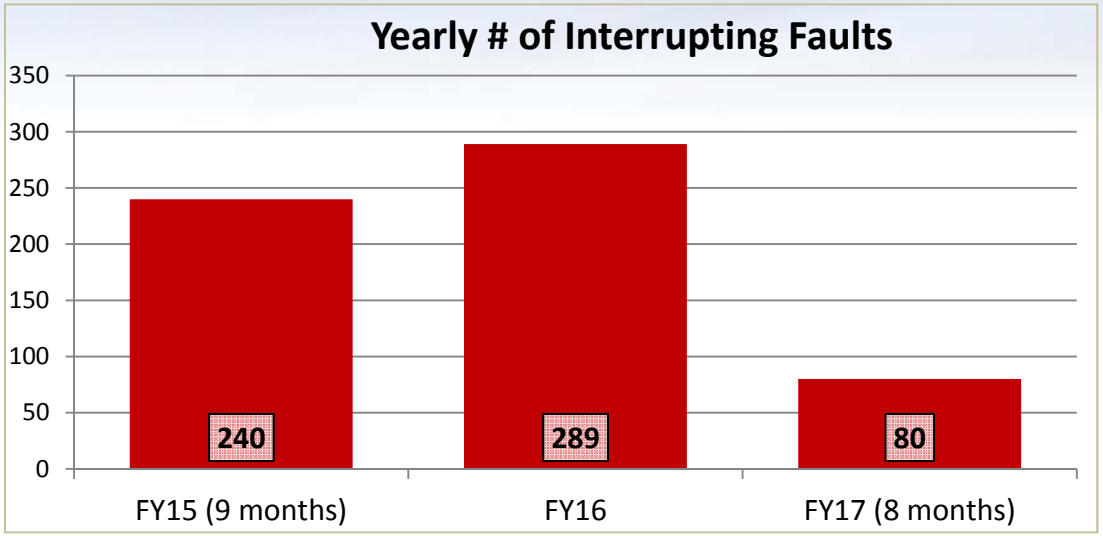
Performance Metrics: Reliability and Current

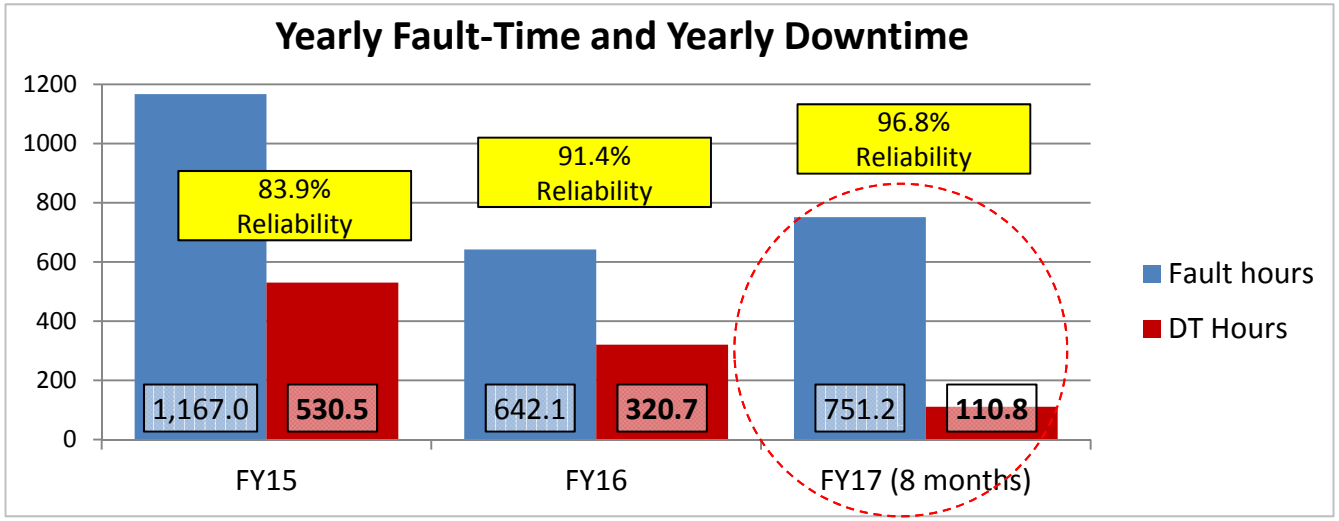
Two major increments in ops requirements from FY16 to FY17

- Reliability 90% → 95%
- Total operations hours increased by 20% (3718 hrs → 4500 hrs)



Comparisons by Fiscal Year





Total hours lost in operations & studies= **Fault time**

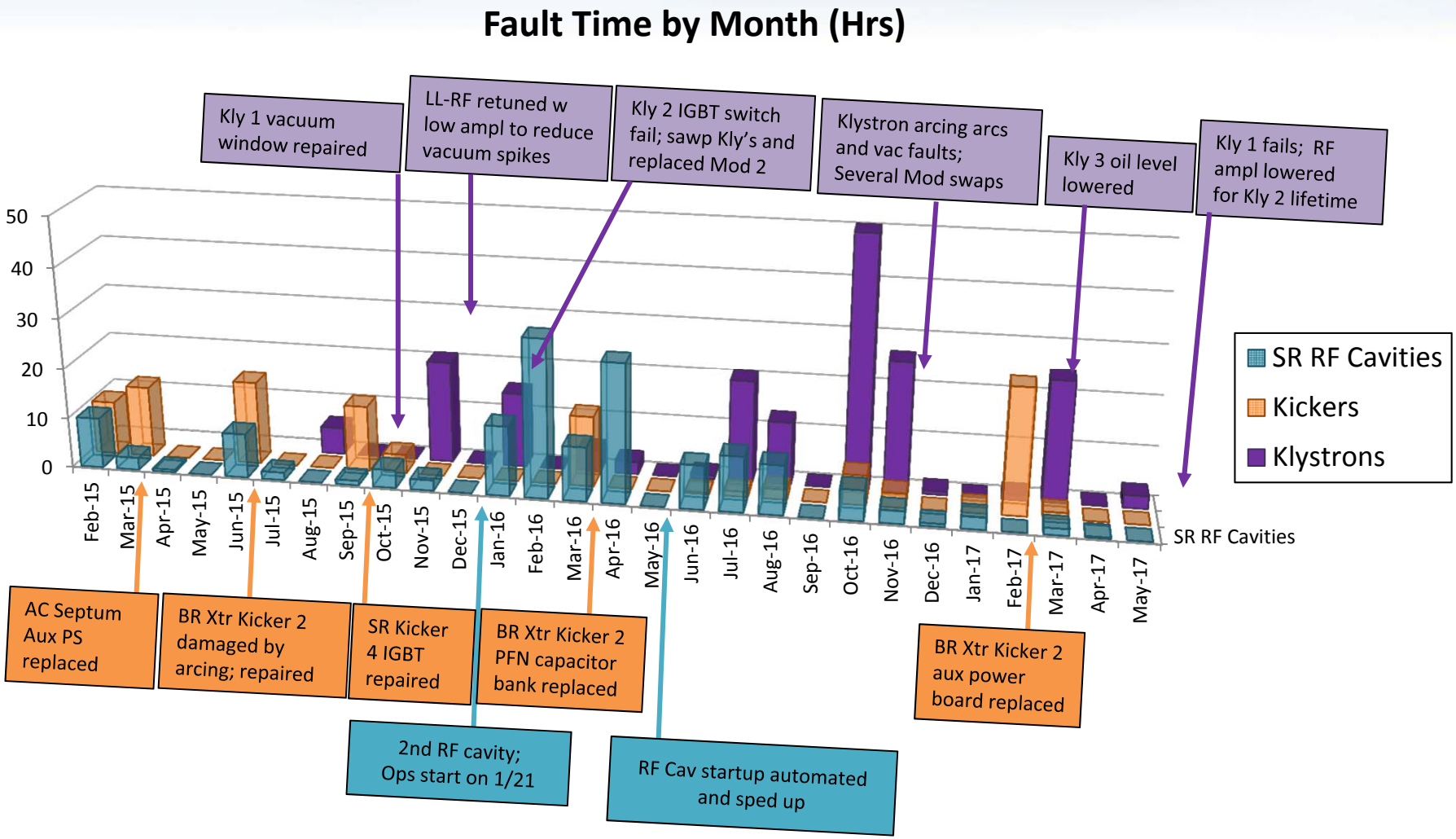
Total hours lost in operations <u>only</u> = **Downtime**

Faults during FY15-17 operations

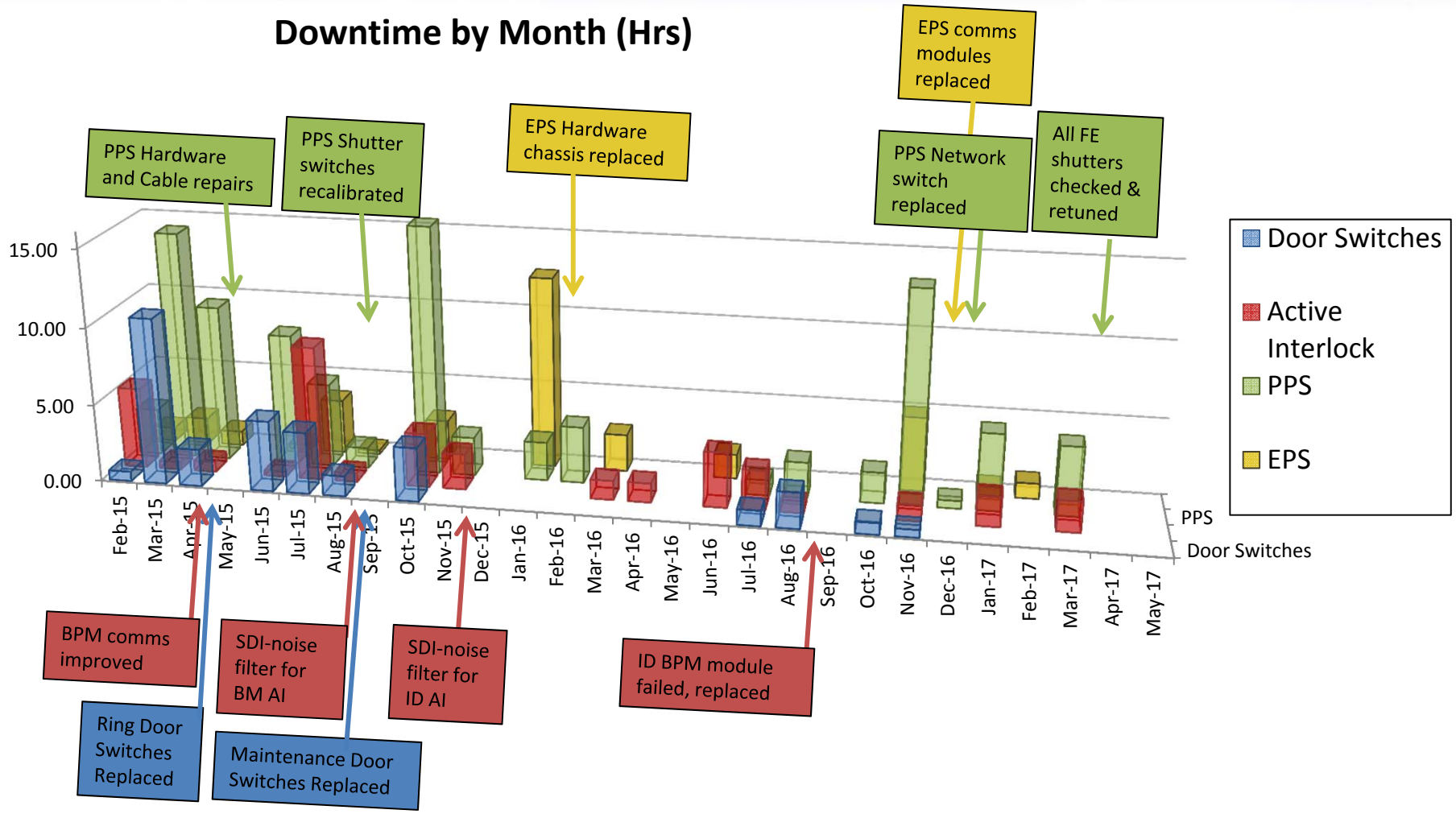
Controls	**52 faults** 109 hrs	**Jul 2015 -** Elevation motors on 10ID moved and stuck on Kill switch. **20 hrs** **Oct 2015 -** Failed ID BPM module showed large displacement of ID3 orbit**. 6.5 hrs** **Jan 2016 -** Overheated network switch in P4 caused PPS to trip**. 7.25 hrs** **Nov 2016 -** Connection from P4 FE to the CPU IO failed **11.25 hrs** **Mar 2017 -** Controls network timing failed due to corrupted NTP appliance GPS configuration**. 23 hrs**
Interlocks	**138 faults** 169.5 hrs	**Jan 2015 -** EPS klixon module failure **11 hrs** **Mar 2015 -** Cell 6 Network fault caused by cable failure between C06 and C07 PPS I/O panels**. 5.5 hrs** **Apr 2015 -** LLRF held off by a PPS hardware fault**. 5.25 hrs** **Oct 2016 -** Shutter indicated open on A-chain**. 5.3 hrs**
Power	**70 faults** 443.5 hrs	**Feb 2015 -** Auxiliary Power Supply to AC Septum (SR injection) failed. **10.5 hrs** **Mar 2015 -** BR XS-KIC2 failed; HV standoff-supports had significant evidence of damage from arcing**. 7 hrs** **Mar 2015 -** Lab-wide power dip. **31 hrs** **June 2015 -** Booster Dipole PS failed **292 hrs (12 days)** **Sept 2015 -** SR Kicker 4 tripped on cascade failure of several IGBT modules **13 hrs** **Oct 2015 -** Lab-wide power dip**. 23.5 hrs**
RF	**194 faults** 152.1 hrs	**Jul 2015 -** LINAC RF Mod#3 CT had repeated arc-faults **5.3 hrs** **Feb 2016 -** Cav D not stable enough to hold field without collapsing**. 13 hrs** **Jul 2016 –** Short in RF Rack Group M. **5.2 hrs**
Utilities	**51 faults** 55.4 hrs	**Mar 2015 -** Shutdown for leak in P5 Cu water skid**. 7 hrs**

We are trending hardware faults / fixing root causes

Fault Time Contributions - RF & POWER

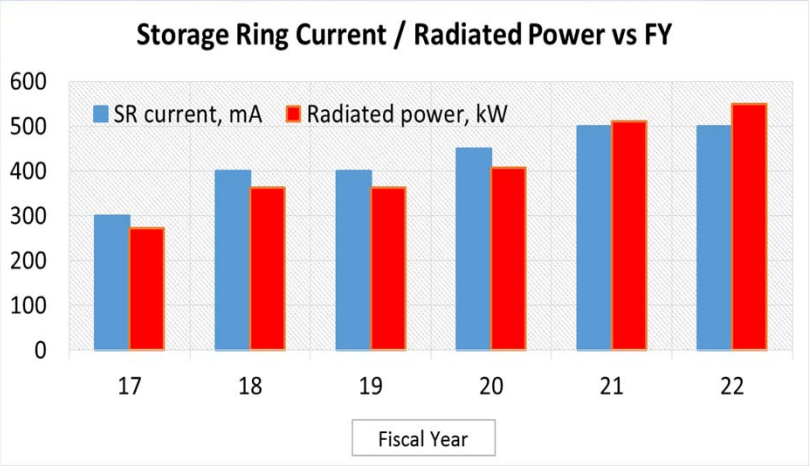


Downtime Contributions - INTERLOCKS



Increase in operating current

- Limit on RF power is near
  - NSLS-II design is based on 4 RF cavities + 4 transmitters
  - With present set of beam lines, we will approach the power limit at 400 mA
  - No redundancy: if one transmitter or cavity is down → current is 200 mA



- 3rd RF cavity is a funded project
  - Contract for reconditioning, testing and assembly of the existing cavity has been awarded

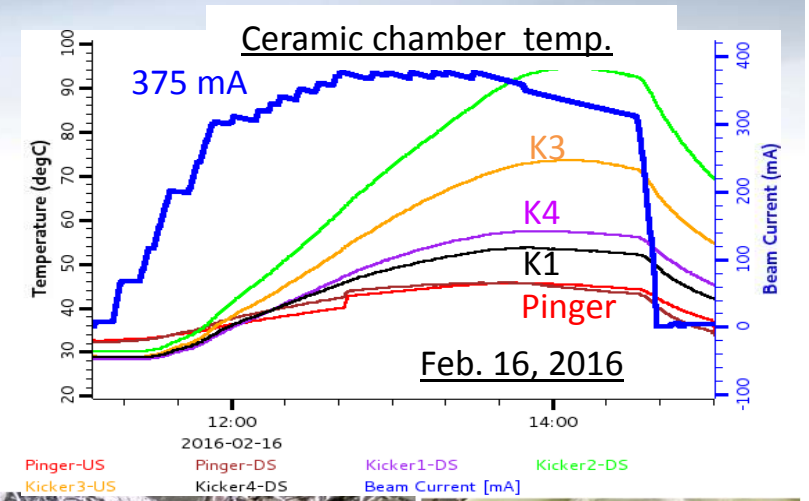
- Details are presented in a separate ppt (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

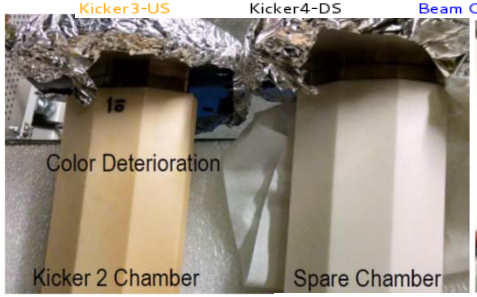
Increase in operating current

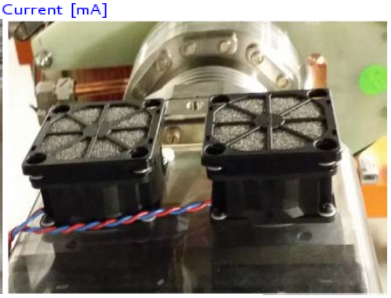
- Reached 400 mA in studies; planning on studying 450 mA

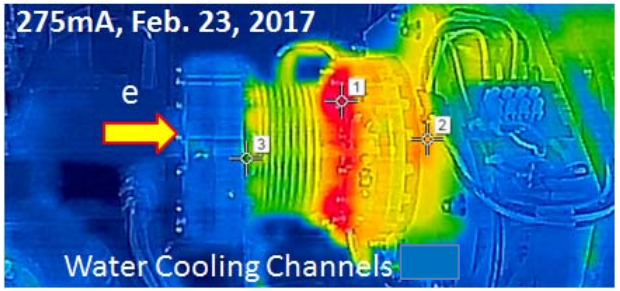
- Observed heating of chambers
  - Ceramic chambers and bellows
- Addressing heating issues
  - New Ti coating system at BNL is being tested
  - Bellows are being inspected and springs reinstalled

- 3rd Harmonic RF cavity is a proposed project for FY18-19

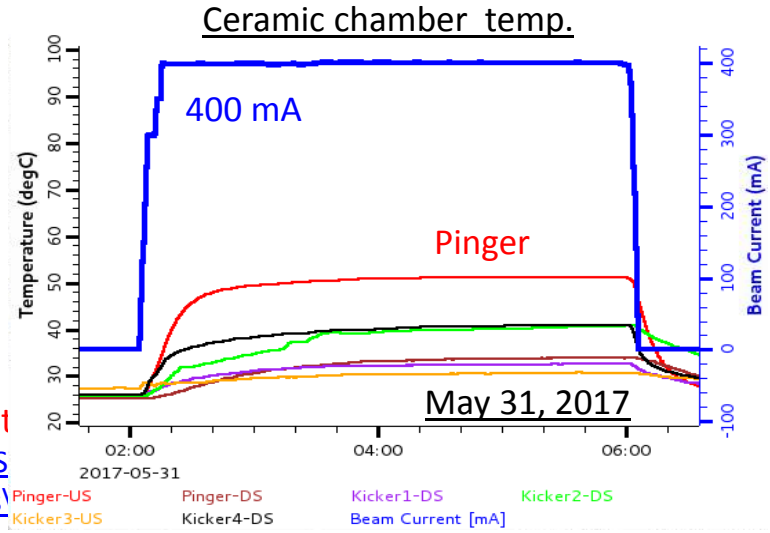








Hot spot on DS flange of bellows at DS end of straight sections



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Accelerator Improvements: Process

- List of accelerator improvements developed and costed in 2015
- Currently contains total of 80 proposals
- Proposals considered for FY17-20:
  - 4 facility upgrades, 1 funded (3rd RF cavity)
  - 29 improvements, 6 funded in FY17 (booster pulsers, linac klystrons / modulators, magnet temperature measurement system, DI water system improvements, ceramic chamber developments, booster QPS upgrade)
  - 2 R&D, 0 funded in FY17
- Periodic discussions on I&D list with AD Group Leaders
- Priorities are given to the subsystems of highest risk of reliability

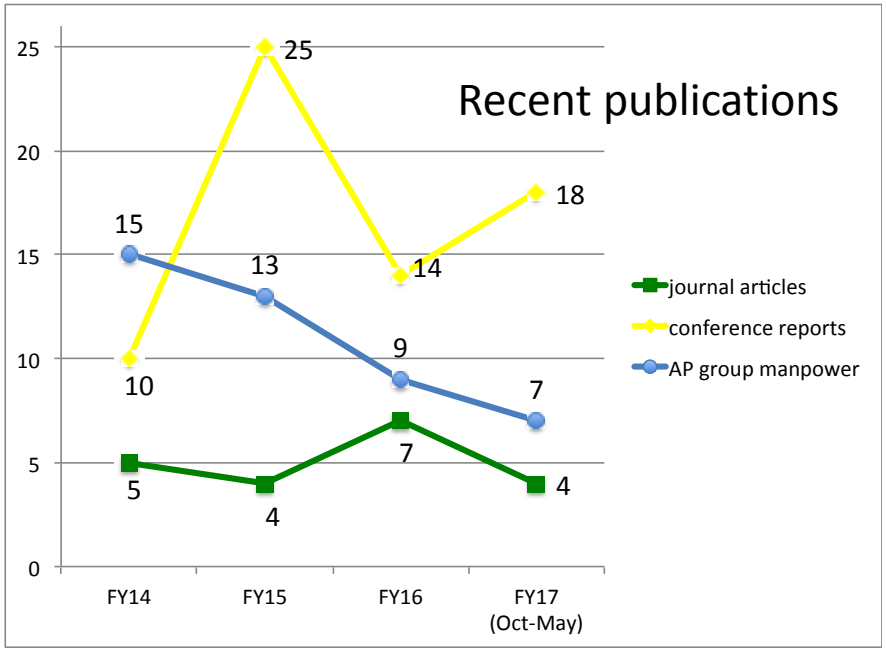
- Details (Lists of proposals) are presented in a separate Excel documents (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

Accelerator Improvements: constant evolution

- PPS door switch improvement
- Front End shutter EPS/PPS trips
- 170 MeV booster injection
  - Reduce klystron power to 25 MW
- Fast RF autostart and fast refills
  - Restarts shortened 45 mins → 20 mins
- Reproducibility program complete
  - Recovery of orbit / optics after beam dumps
- BM/3PW sources: RF frequency feedback
  - Reduced drift in dispersive source points
- FF tables for coupling correction
  - Minimized changes in σ_Y due to gap variations
- Realignment of IDs with beam
  - Increased intensity of harmonics by 30-70%
- Glitch filters in Active Interlock
  - Greatly reduced # of AI trips
- FOFB improvements
- Top-off mode of operations
- Minimization of injection transients
  - Reduced x by factor 3
- "Sleeping mode" of injection operations
  - Injector idling at 170 MeV
- Post-mortem functions
  - Effective investigation of faults
- 2nd RF cavity
  - Installed and commissioned
- Spurious gate valve closures
  - Fixed by optimizing PLC logic
- Ceramic chamber coating facility
  - First chambers tested with beam
- Local bump optimization for X-ray alignment
  - Matched bumps with low leakage

Accelerator R&D

- AD staff is busy with facility ramp-up and operations
  - No funded R&D projects in FY17
- We are awarded by LDRD on NSLS-II lattice upgrades
  - Find limited-scope solution for reducing horizontal emittance by a factor of 4
- We are new facility operating with high-brightness beam
- Beam shifts deliver new results and publications
  - Single-particle beam dynamics
  - Collective effects
  - Beam diagnostics



- Looking for collaboration with other DOE laboratories
  - APS, APS-U and ALS-U
    - Prepared collaboration proposals on machine developments and IDs
  - NSLS-II developments advance state-of-the art
    - BMP electronics, Front-end components, LLRF, PSI/PSC
    - Offering our know-how to other DOE partners

- Details are presented in a separate Excel document (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

We have been busy: Installation / Commissioning

Cell Num	ID name	BL name	ID params	ID install date	BL 1st light date	project pkg
C23	EPU-2	CSX-1	2m-EPU49	Aug. 2014	Oct. 2014	PROJECT
C23	EPU-1	CSX-2	2m-EPU49	Aug. 2014	Mar. 2015	PROJECT
C3	IVU	HXN	3m-IVU20	June 2014	Nov. 2014	PROJECT
C5	IVU	SRX	1.5m-IVU21	June 2014	Dec. 2014	PROJECT
C10	IVU	IXS	3m-IVU22	Aug. 2014	Nov. 2014	PROJECT
C11	IVU	CHX	3m-IVU20	June 2014	Nov. 2014	PROJECT
C28	DW	XPD	6.8m-DW100	Oct. 2013	Nov. 2014	PROJECT
C16	IVU	LIX	2.8m-IVU23	May 2015	Nov. 2015	ABBIX
C17	IVU	AMX	1.5m-IVU21	May 2015	Mar. 2016	ABBIX
C17	IVU	FMX	1.5m-IVU21	May 2015	Mar. 2016	ABBIX
C4	IVU	ISR	2.8m-IVU23	Sept. 2015	July. 2016	NEXT
C8	DW	ISS	6.8m-DW100	Dec. 2013	Apr. 2016	NEXT
C12	IVU	SMI	2.8m-IVU23	Dec. 2015	Nov. 2016	NEXT
C21	EPU57	ESM	1.4m-EPU57	May 2016	July. 2016	NEXT
C21	EPU105	ESM	2.7m-EPU105	Dec. 2016	None	NEXT
C2	EPU	SIX	3.5m-EPU57	Sept. 2016	Feb. 2017	NEXT
C8	Dipole	TES			Aug. 2016	BDN
C11	3PW	CMS		May 2016	Aug. 2016	BDN
C4	3PW	XFM		Apr. 2017	Sep. 2017	BDN
C7	3PW	QAS		Apr. 2017	Sep. 2017	BDN
C18	DW	FXI	6.8m-DW100	Jan. 2014	Nov. 2017	BDN
C19	IVU	NYX	1m-IVU18	Sep. 2016	Nov. 2016	PARTNER
C17	3PW	XFP		May 2016	July. 2016	PARTNER
C6	3PW	BMM		Dec 2016	Aug. 2017	PARTNER
C7	U42	SST1	1.6m-U42	Apr. 2017	Feb. 2018	PARTNER
C7	EPU60	SST2	0.89m-EPU60	Aug. 2017	Feb. 2018	PARTNER

Plans for accelerator operations in FY17-19

- Increasing annual hours of operations towards 5,000 hours in FY19
- Shorter studies and shutdown periods while:
  - Increasing current
  - Commissioning new IDs, FEs and beamlines
- Increasing operating hours to 4,750 hours in FY18

	NSLS-II				NSLS X-Ray	APS
	FY16	FY17	**FY18**	FY19	FY12	FY16
Operations (hours)	3718	4500	**4750**	5000	5150	5000
Studies (hours)	1713	872	**850**	850	721	632
Maintenance and certification (hours)	594	440	**440**	440	376	872
Shutdown (hours)	2825	2224	**2200**	2200	2513	2256
ID, FE, BL Commissioning (hours)		724	**520**	270		
Reliability, %	90	95	**95**	95	95	
Operating Current: Start/End (mA)	200/250	250/300	**300/400**	400	300	100

Planning accelerator operations in FY18

4750 hours of user operations

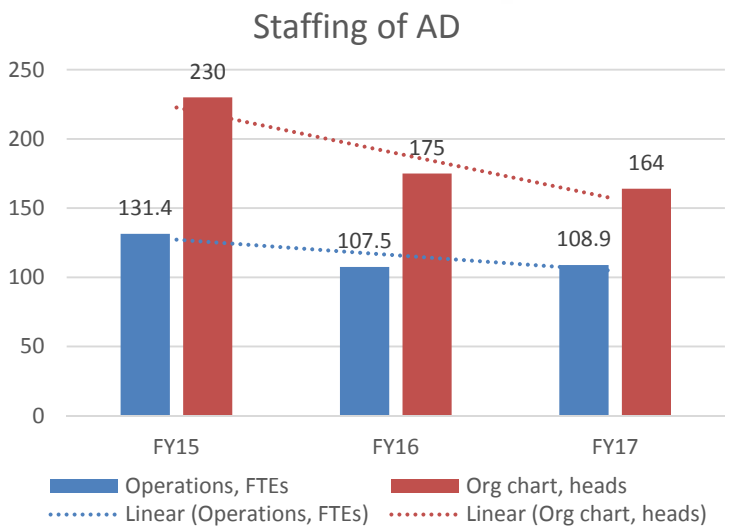
- Shutdown: 2200 hrs
  - Winter: 840 hrs (FIS-MET, 3rd RFC, repair and mainten., PPS cert. and SR RF conditioning)
  - Spring: 672 hrs (3rd RFC, repair and mainten., PPS cert. and SR RF conditioning)
  - Fall: 720 hrs (3rd RFC, repair and mainten., PPS cert. and SR RF conditioning)
- Studies: 850 hrs
  - Machine Start-up / Shutdown, Lattice Optimization, Injector, Beam Stability, Lifetime, High Beam Current, Instabilities & RF-Related Beam Dynamics, RF Optimization, Diagnostics, Slow and Fast Orbit Feedback
- Beamline Commissioning: 520 hrs
  - XFM (4-BM), QAS (7-BM) – 3PW, FE, BL
  - SST-1, SST-2 (7-ID), EPU60, U42, FE, BL
  - FXI (18-ID) – FE and BL, PDF (28-ID) new beamline to B-hutch,
  - FIS-MET (22-BMV), IR BL, new dipole chamber with mirror
  - beamline improvements and optimization with beam
- Maintenance: 360 hrs
  - Parallel Maintenance Activities, Injector Start-up, RF Conditioning, Injector Study Overnight
- Dedicated Interlock Recertification: 80 hrs
  - All operating beamlines

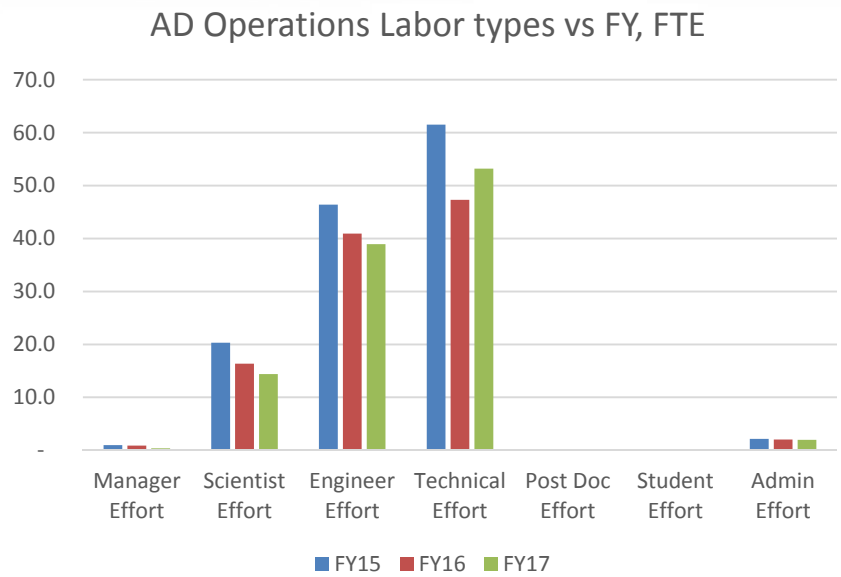
- Details are presented in a separate ppt (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

Total: 8760

Organization of accelerator operations

Evolution of Accelerator Division FY15-FY17





- Scientist, engineer, & tech effort have significantly reduced since FY15
- At the start of FY17 164 heads in support of both operations and construction
- FY17 Accelerator Operating budget supports 108.9 FTEs (rest of heads support beamline operations and construction)

Changes in Org Chart

- Injection and Storage Ring Coordination groups merged in early 2015
- Controls group moved to Photon Division
- In FY15, 230 heads in AD (including Controls group, 43 heads)
- In FY17, 164 heads in AD reflecting reduction in staffing requirements in operations and in beam line construction
- Ongoing changes to the AD org chart to increase efficiency further
- Transitioning organization from construction/commissioning to reliability, stability and intensity of operations

- Details are presented in separate documents (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)

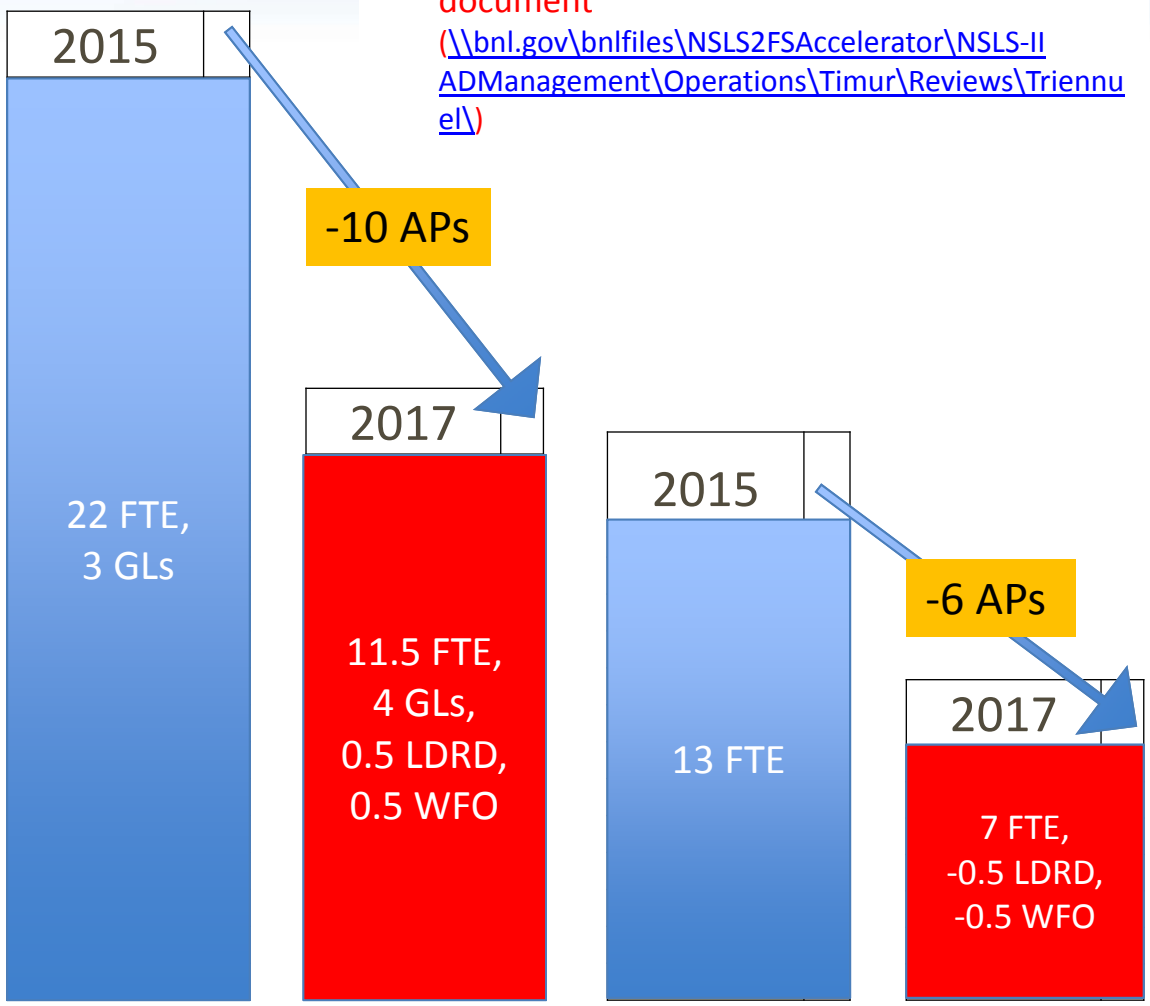
Additional Proposed Changes to Org Chart

- Flatter structure
- Lost several staff members to attrition since last posted org chart
- Remove MOUs that are no longer needed
- Reduced staff by letting term employees expire
- No longer employing job shoppers for temp. help
- Show matrixed ESH representative
- Identify those working on LDRDs & WFO
- Identify those working part-time
- Identify those who have been cross-trained to support other groups
- Assign each member of the Coord. Group a subsystem
  - Storage ring, injector, controls/interlocks, maintenance/spares
- Move a technician from the ID Group to the Vacuum Group
- Reduced ADD box by moving staff member to ½ on LDRD

Accelerator Physics FY15 to FY17

- Accelerator physicists are focused on support of user operations.
- Frequent beam shifts
  - Lattice
  - High current
  - Instabilities
  - FOFB
- Scientific R&D
  - Three LDRD projects are funded
  - WFO: APS-U

- Details are presented in a separate Excel document (\\bnl.gov\bnlfiles\NSLS2FSAccelerator\NSLS-II ADManagement\Operations\Timur\Reviews\Triennuel\)



All AD physicists **AP group**

Accelerator Controls and ID groups

- Accelerator Controls group (resides in Photon Division)
  - Responsible for:
    - PS controls, Timing, Diagnostics controls, FOFB, RF controls, CR tools
  - Staff of 4 and a group leader
  - Budgeted for operations 6 FTE in total
  - Occasional help from IT group in Photon Controls
  - Experts from other AD groups helping out

- Insertion Device group (resides in Accelerator Division)
  - Responsible for:
    - Maintaining 25 IDs, five 3PWs, Magnetic Measurement lab
  - Staff of 9 and a group leader
  - Budgeted for operations 3.3 FTE total
  - Currently understaffed as the number of IDs had grown and needs to be maintained. Specific expertize in building, measuring, maintaining IVUs.
  - Looking to collaborate with CAD

Workforce development

- Education
  - Supervisors Training Programs
  - Vibrant safety program
  - Line Audit Safety Operations (LOSA) training
  - Cross-training

- Collaboration with other light sources

- Publications and Meetings
  - Nuclear Instruments and Methods Special Issue on NSLS-II
  - Reliability Workshop (April 2016) and High-Brightness Synchrotron Light Source Workshop (April 2017)

- Taskforces

- Teaching
  - Lectures at Stony Brook, Yale, Columbia
  - USPAS
  - Summer students
  - Summer Sundays

Cross-training Details

- ID techs help Vacuum Group
  - Supporting cleaning facility and vacuum installation work during recent shutdown
- Electrical engineers support safety activities across NSLS-II and lab wide
  - Investigations, training, review committees
- RF group supports cryo operations
  - Provides programming support
- Coordination and ID groups support Controls group efforts in software development
  - Creating CSS screens, writing scrips, trending data, analyzing faults
  - Troubleshooting & reworking ID controls
- FLOCOs supporting PPS certification & repairs
  - Work with ESH during PPS certifications (actuate buttons, monitor signals, etc.)
  - Training to perform minor repairs & system resets
- Ops staff supports installation work during shutdowns
  - Beamline cable pulling & termination, EPS wiring
  - RF testing, Power supply rework
- Power supply group supporting front end, vacuum, PPS & ID groups
  - Tuning front end slit stage motors
  - Supporting ceramic coating facility
  - Wiring PPS control cabinets & devices
  - Designing & building ID controls
- Instrumentation Group supporting ID group
  - ID straight layouts and detailed design

Cross-training Challenges

- Requires time, effort and documentation
  - Specific procedures & work instructions
  - Often requires working in a pairs initially

- Specialized subsystems
  - Each group's equipment is unique
  - Often requires different skillset

- Additional safety responsibility
  - Different systems have different risks (ex. high voltage/high current)
  - Require additional training & experience

- Scheduling time across groups
- Shutdowns are peak labor need for all groups

- Volume of preventative maintenance
- Volume of beamline project work