National Synchrotron Light Source II

NSLS-II update

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NSLS-II Director

SAC Meeting March 28th 2019

U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

Outline

- Safety update
- Accelerator operations update
- Beamline construction program update
- User program update
- Science highlights
- Budget outlook
- Summary

NSLS-II Safety Statistics (FY19)

- FY19 Hours Worked: 246,294 hours (2/28/19)
- FY19 Recordable Cases: 0 Rate: 0 (12-month rolling rate = 0.31)
- FY19 DART Cases: 0 Rate: 0 (12-month rolling rate = 0.31)
- FY19 First Aid Cases: 7
- Last Recordable/DART Injury: 8.09.2018/8.09.2018

NSLS-II Events for FY19: 10 (7 injury and 3 non-injury events)

The frequency of events are significantly higher than last year. The injuries have thankfully remained minor (sprains, strains and bumps are typical), but the rate is concerning and this, and the other events, suggest that we need to renew our commitment to a culture of Operational Discipline: "Doing the right thing, first time, every time." We are looking into ways to reinvigorate that commitment now.

Accelerator update

- Overall reliability continues to be good: 97.4% for FY19 YTD.
- Cryoplant biggest single issue to date (20 hrs lost beamtime). Continues to have issues (contamination?). Warm ups still required.
- Operations at 400 mA. High current studies at 475 mA
- HXN IVU back in operations
- 3rd RF system procurement underway. On schedule for FY20 operations. Decision made to go with solid state amplifiers
- No longer targeting 500 mA operations in FY20

See Timur's talk

Beamlines Status

General User Operations (23)
CSX, IOS, XPD, HXN, SRX, IXS, CHX, LIX, AMX, FMX, ISS, XFP, CMS, ISR, TES, SMI, ESM, BMM, QAS, FXI, XFM, SIX, PDF

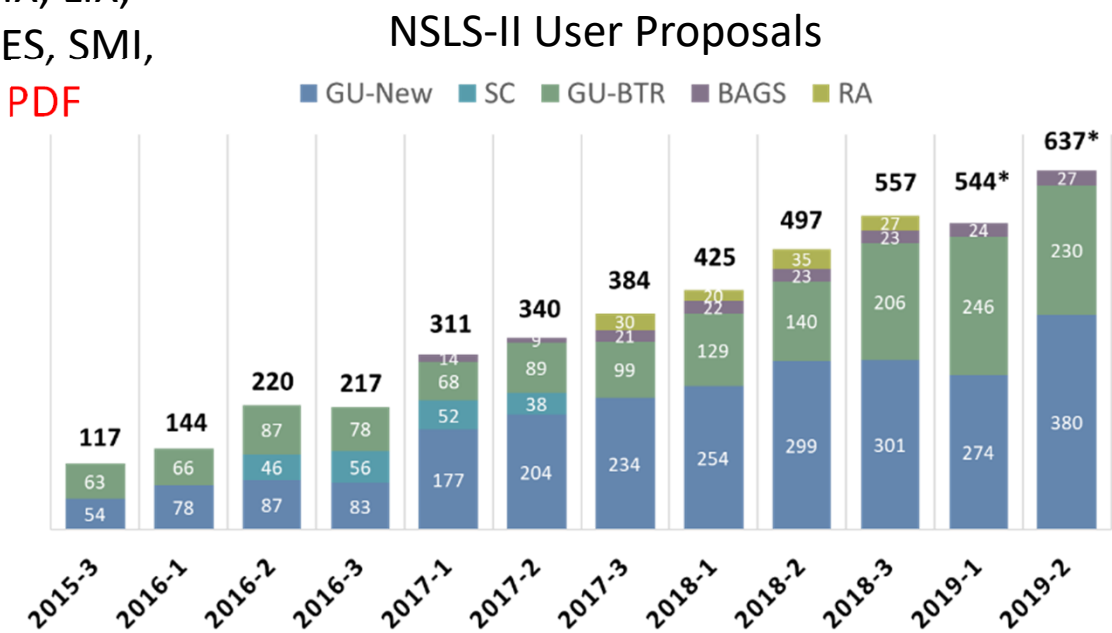
Science Commissioning (1)
NYX

Technical Commissioning (4)
SST-1, SST-2, FIS, MET

Completion* in FY21-22 (1)
HEX

* Defined as having completed IRR

Red denotes change since last SAC



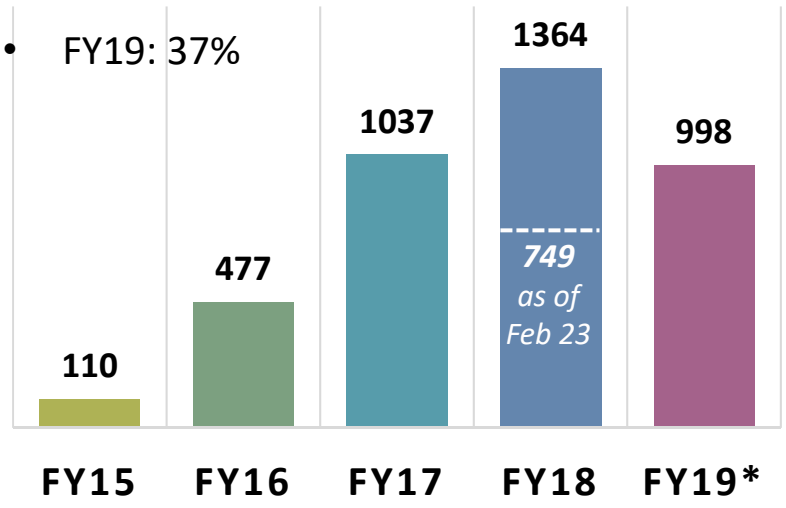
** does not include rapid access until cycle is complete*

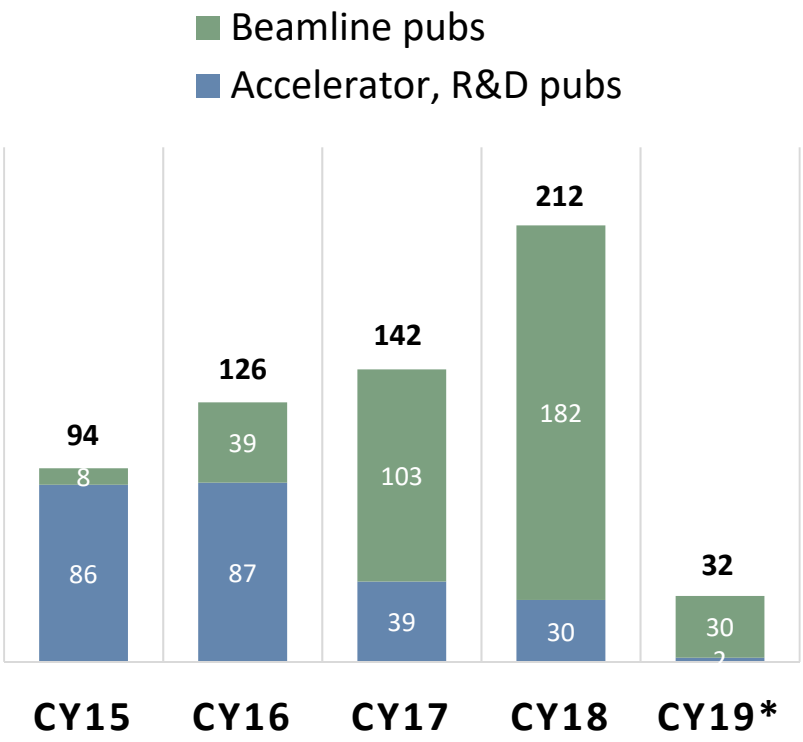
28 beamlines operating/commissioning
1 beamline under development

Users and Publications

Fraction New Users:

- FY15: 100%
- FY16: 83%
- FY17: 66%
- FY18: 57%
- FY19: 37%





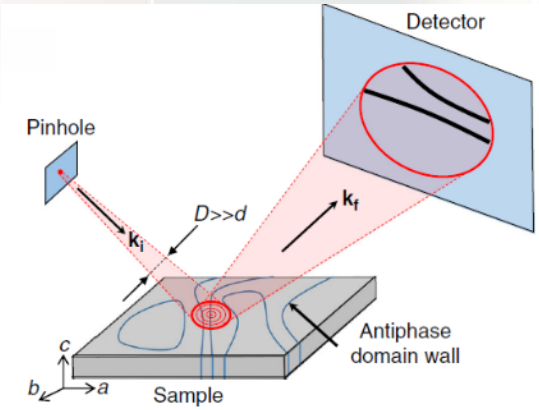
**as of Feb 28, 2019*

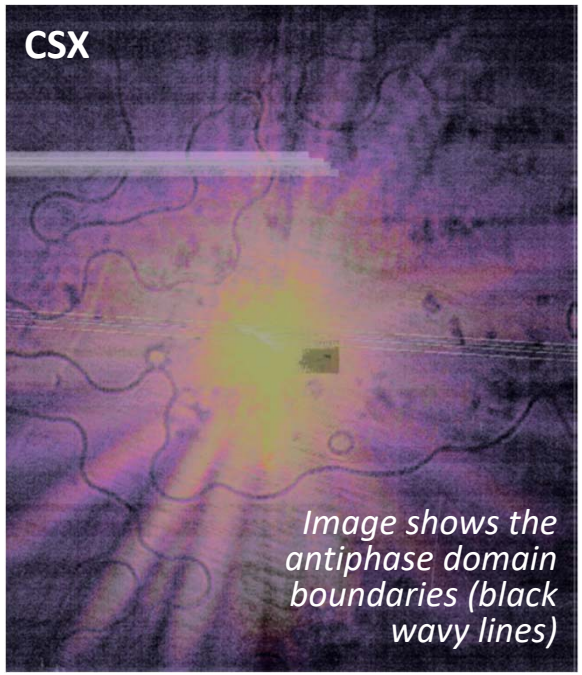
Proposal management software

- Explored (along with LCLS and CFN) three off-the-shelf commercial options. While all featured slick user interfaces, none were found to be viable
- Commissioned a thorough review of the BNL-developed PASS system. PASS was found to be functional, but criticized for its user interface, for not being a “complete tool” and there were concerns about scalability of performance. Data base appears solid. Presently awaiting final report.
- Multi-lab group investigating the ServiceNow platform as a place to develop custom system.
- Need to make a BNL decision on path forward for PASS

See Lisa’s talk

Direct Imaging of Antiphase Domain Boundaries in Antiferromagnetic $Fe_2Mo_3O_8$





Scientific Achievement

Scientists imaged antiferromagnetic (AFM) domains using a new coherent x-ray diffraction technique and observed evidence of the interaction between domain walls and structural defects in the material.

Significance and Impact

The capability to see and manipulate magnetic domains plays an essential role in the development of novel spintronic devices; this technique opens a new way to see and explore magnetic domains of AFMs.

Research Details

- Scientists demonstrated the capability to image antiphase AFM domain boundaries with 5 µm spatial resolution and images of 0.3 × 0.3 mm area.
- The new technique, resonant magnetic X-ray Bragg diffraction, probed the AFM structure directly.
- They discovered that some of the domains were free to move with each thermal cycle.

Kim, et al., ***Nat. Comm.*** **9**, 5013 (2018)

3.7 Billion Year Old Structures Formed By Tectonics, Not Life

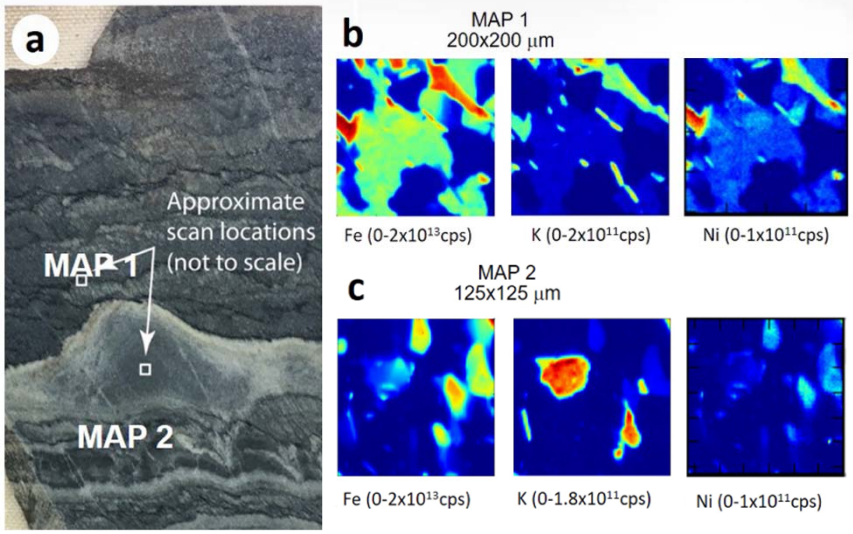


Image a) shows a photograph of the rock sample, while the collection of x-ray images b) and c), obtained at SRX beamline 5-ID, show the elemental distribution of the indicated regions in image a). These chemical maps reveal fine-scale chemical and mineralogical variations that were not captured in previously published analyses.

A.C. Allwood, M.T. Rosing, D.T. Flannery, J.A. Hurowitz, C.M. Heirwegh. *Nature* **563**, 241 (2018).

Scientific Achievement

Scientists re-examined early "fossils" and found the structures to be of geological, not biological, origin.

Significance and Impact

Dating the beginnings of life on Earth has important implications for understanding how life emerged and evolved. It also has implications for the search for life on Mars and other planets.

Research Details

- Previous conclusions about the origin of the "fossil" structures were based on millimeter scale information using laser ablation mass spectrometry analysis.
- The new study used x-ray fluorescence microscopy with a one micron beam at NSLS-II's SRX beamline and revealed new evidence about the elemental make-up of the rock, supporting the new conclusions.

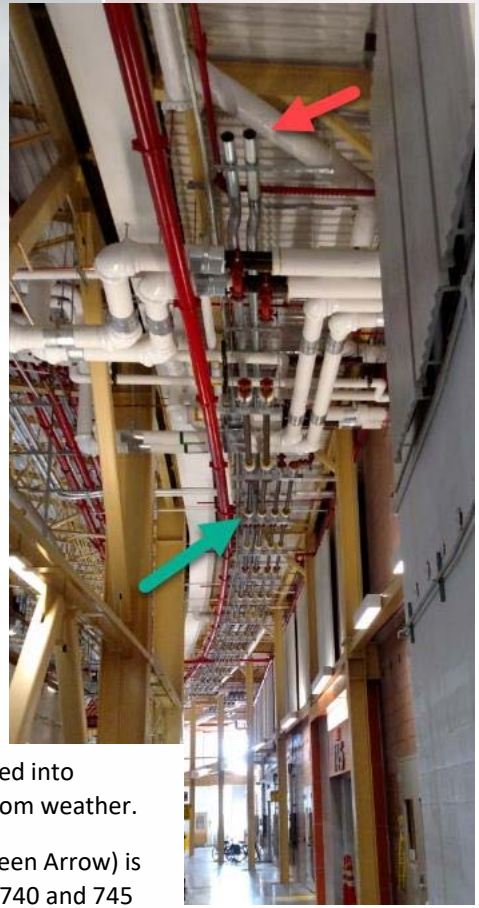
CryoEM

ESD funded Scope-

- Two CryoEMs and Laboratory building (748)

Status –

- $9.8M received from ESD in August 2018
- Microscopes ordered September ($8.3M)
  - Talos acceptance testing into March 2019
  - Krios at BNL ~December 2019
  - $3.7M received from ESD in January 2019



Piping work scheduled for August was pulled into February to counter construction delays from weather.

Power conduit (Red Arrow) and Water (Green Arrow) is in place in the corridor between Buildings 740 and 745

February 27, 2019 – Winter weather continues to impede outside construction as snow falls on the construction site

- Building 748 ($4.6M)
  - Excavation complete in January
  - Weather has delayed outdoor construction work
  - Mechanical and electrical work inside of 745 undertaken to minimize schedule impact
  - Substantial completion planned January 2020

Controls Program

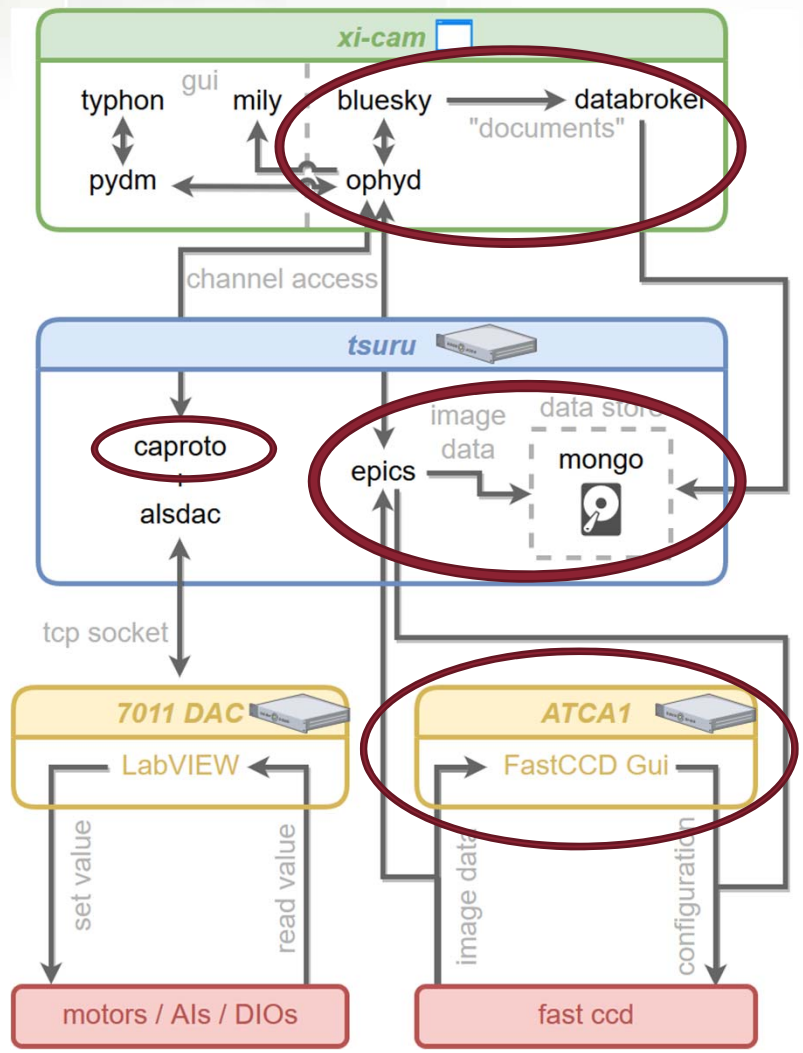
Controls remains a work in progress and a subject of concern. Recent actions taken since last SAC include:

- Reorganized Controls Program to strengthen POC system and group common functions together
- Handed over responsibility for our network to ITD, freeing up internal resources
- GPFS issues continue to be a problem. External contractor did not resolve the problem. Currently working with CSI
- Continuing to follow the action plan written based on reviews and associated recommendations. Implemented and being tracked to completion

See Richard's talk

BLUESKY / OPHYD at COSMIC (ALS)

- The COSMIC beamline at the ALS for Soft X-ray XPCS has adopted the NSLS-II DAMA software for next generation experimental control and data management.
- Close collaboration between COSMIC team, DAMA group at NSLS-II, computing group at ALS, Mark Rivers at APS, and Soft X-ray program at NSLS-II lead to a very quick deployment of the DAQ at the COSMIC Beamline
- NSLS-II developed and contributed the following components (circled):
  - *areaDetector* driver for the LBNL FastCCD
  - *ophyd* drivers for the control and *bluesky* DAQ
  - *databroker* Data Management Database
  - *caproto* which enabled an EPICS interface to the LBNL legacy LabVIEW controls
- This collaboration was also possible because of a long standing collaboration with the LBNL detector group

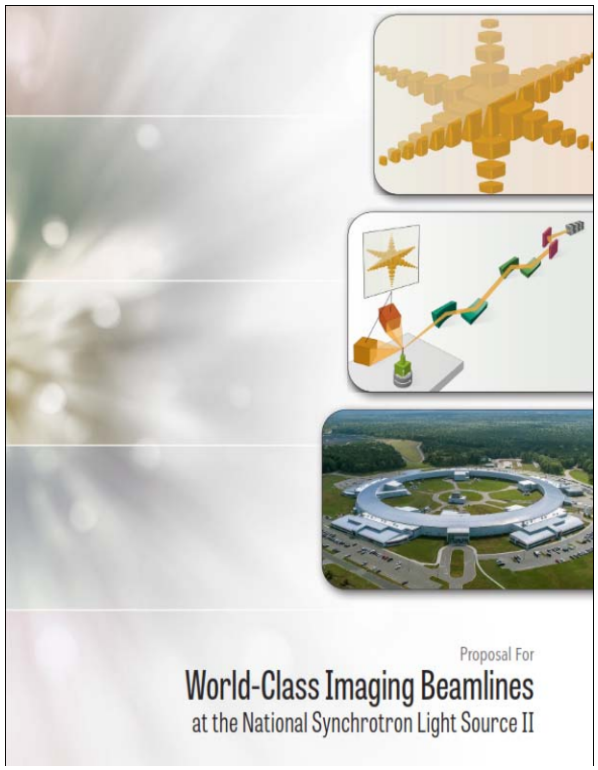


FY19 goals

- 5000 hrs operations, 400 mA, 97% reliability, >40hrs MTBF, < 1hr MTTR
- 1600 unique users, 28 beamlines taking light
- Complete FIS and MET. Complete PDR for HEX and CDI
- Obtain CD-0 for MIE for 3 new beamlines **ACHIEVED**
- Develop plans for additional beamlines **ACHIEVED**
- Prototype data storage facility at CSI established
- Robust network established
- User portal development begun. Decision on proposal management software. SSO implemented
- LOB 4/5 labs complete
- CryoEM building complete
- Remove TLD requirement for experimental floor **ACHIEVED**

NEXT-II

- CD-0 Mission Need granted Dec 19th
- Made the case for "Mission Need" for additional imaging beamlines to fill capability gaps in NSLS-II portfolio
- Science case based on quantum information science, energy storage and catalysis
- MIE for 3 beamlines, $60 M

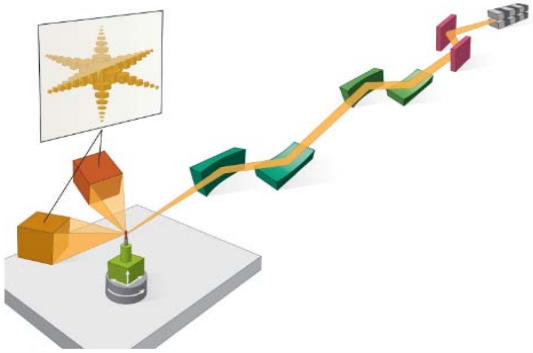


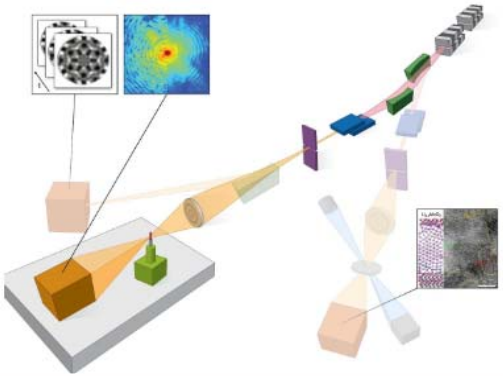
CD= "Critical Decision"

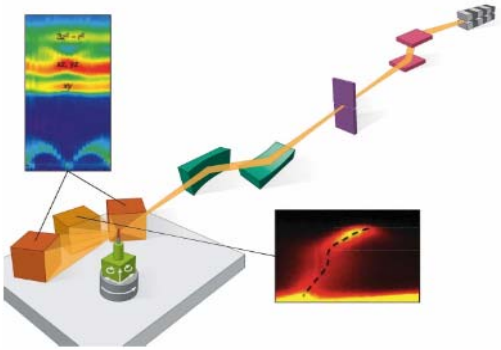
MIE= "Major Item of Equipment"

NEXT-II

- Three example beamlines were used to illustrate the case
  - Bragg CDI beamline (BCDI)
  - NanoRIXS and NanoARPES beamline (ARI)
  - Soft x-ray STXM beamline (SMF)







See Erik's talk

Future beamline development

- IR beamline proposal (INF) presently with NSF
- MRE beamline proposal presently with DOE-NE
- Other concepts developed internally at NSLS-II
- Next steps however are to determine where NSLS-II can have impact in areas aligned with its strategic plan
- Hold Strategic Planning Workshop in October with leaders in the fields and the user community coming together to understand the key questions in each area and how NSLS-II can have impact in those areas.

Budget outlook

- FY16 $110.0 M
- FY17 $111.8 M
- FY18 $110.8 M
- FY19 $113.5 M
- FY20 (PBR) $107.1 M (-5.6%) + $1M for NEXT-II

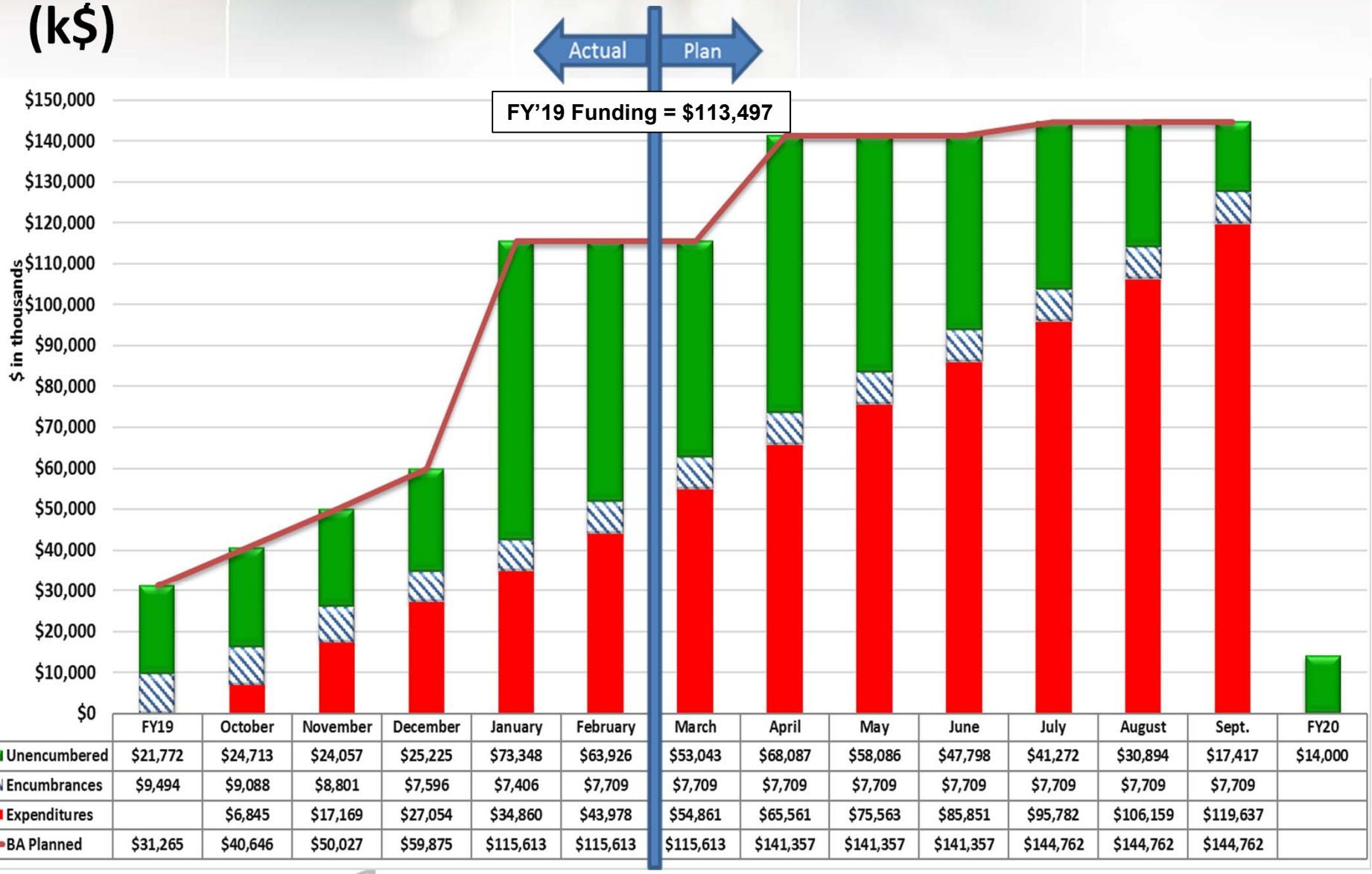
While good in the context of DOE (-16.5%), this budget would have severe consequences for NSLS-II operations:

- Closure of 3 beamline-equivalents (~200 users)
- Increased risk of accelerator reliability metric being threatened

Out year budgets

- Presently a lot of uncertainty. Likely to continue well into FY20
- For a given budget, our priorities are
  - Operate the accelerator reliably (internal goal > 97%)
  - Operate existing beamlines effectively
  - Develop new beamlines
- Given these priorities in tight budgets we will curtail beamline development, long-term R&D and close or partially close beamlines
- Some of these difficult choices will have to be made even in a flat budget scenario

NSLS II Operations FY2019 Budget Planning & Spending (k$)



	FY19	October	November	December	January	February	March	April	May	June	July	August	Sept.	FY20
Unencumbered	$21,772	$24,713	$24,057	$25,225	$73,348	$63,926	$53,043	$68,087	$58,086	$47,798	$41,272	$30,894	$17,417	$14,000
Encumbrances	$9,494	$9,088	$8,801	$7,596	$7,406	$7,709	$7,709	$7,709	$7,709	$7,709	$7,709	$7,709	$7,709	
Expenditures		$6,845	$17,169	$27,054	$34,860	$43,978	$54,861	$65,561	$75,563	$85,851	$95,782	$106,159	$119,637	
BA Planned	$31,265	$40,646	$50,027	$59,875	$115,613	$115,613	$115,613	$141,357	$141,357	$141,357	$144,762	$144,762	$144,762	

SAC March 2019 Charge

- Is the schedule for mitigating our vulnerabilities appropriate and achievable? (Timur's talk)
- Have we made the right choices in regard to the performance vs reliability trade-offs? (Timur's talk)
- Beamline controls: (Richard's talk)
  - Is the controls program on a path to success?
  - Has there been an improvement in the last six months?
  - Are the extant issues (technical and organizational) understood?
  - Is there a clear plan to address these issues going forward?
  - Is that plan executable on a reasonable timeframe with the current resources?
- Are the plans for storage and compute appropriate? (Stuart's talk)
- Does the "beamline user guide" layout a reasonable set of expectations for the staff? For the users? (Web site)
- Any comment on the decision to cant IOS and CSX? (Paul's talk)
- Is the biosciences strategic plan appropriate for enabling success (Sean's talk)
- Triennial reviews of CHX and SRX: Are these beamlines on track? (reviews)
- Is the approach on exploring new beamline concepts appropriate? (Erik's talk)
- Any feedback on the MIE beamline concepts? (Erik's talk)

SAC September 2018 recommendations

- Make a decision on 3rd HC and decide on 500 mA (Shaftan)
- Develop a prioritized resource-loaded schedule for the reliability program (Shaftan)
- Controls and networking. Staff retention and hiring. Clear prioritization paths. Communication. (Farnsworth)
- Communications channels with staff (Zschack)

Summary

- Accelerator continues to operate well (reliability, intensity, stability), though there are concerns about critical spares program
- 28 beamlines taking light. 1 under construction. MIE approved for 3 more. Limited funding likely in FY20. Other proposals active
- Science and user program continues to ramp up and is producing high impact science
- Overall the facility is performing extremely well. The organization is under stress however
- Budgetary uncertainty has returned. FY20 likely to be tricky to manage