National Synchrotron Light Source II

NSLS-II update

J.P. Hill

NSLS-II Director

SAC Meeting September 20th 2018

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 (FY18)

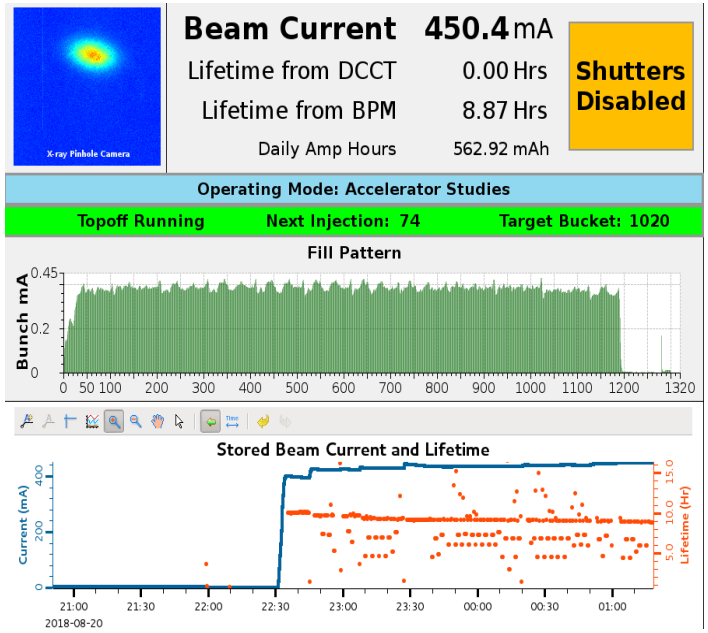
- FY18 Hours Worked: 574,718 hours (YTD as of 8/31/18)
- FY18 Recordable Cases: 2 Rate: 0.70 (12-month rolling rate = 0.61)
- FY18 DART Cases: 2 Rate: 0.70 (12-month rolling rate = 0.61)
- FY18 First Aid Cases: 3
- Last Recordable/Last DART Injury: 8.09.2018/8.09.2018

NSLS-II Events: 25 (5 injury and 20 non-injury events)

- Most are low level. Most frequent injuries are over-exertion. Investigating underlying causes – work planning control is a common theme. Initiated a review of WPC at NSLS-II. Improvement plan being implemented.
- Recent events:
  - August 8: a visitor wearing shorts was found on the experimental floor working side-by-side with a lead beamline scientist.
  - August 9: a vacuum technician experienced a shoulder strain when trying to slide a heavy crate across the floor. worker on restricted duty til 8/21.

Accelerator update

- RF cavities: Full warm up in April resulted in much improved performance
- Operations at 400 mA. High current studies at 450 mA
- 3rd RF system procurement underway. On schedule for FY20 operations. Decision made to go with solid state amplifiers
- 500 mA operations in FY20



- Reliability 96.5% for FY18. Would have been >97% if not for two singular events: 3ID IVU (30 hours) and Booster Dipole Power Supply (30 hours)

See Timur's talk

Beamline construction update

General User Operations (19)
CSX, IOS, XPD, HXN, SRX, IXS, CHX, LIX, AMX, FMX, ISS, XFP, CMS, ISR, TES, SMI, ESM, BMM, QAS

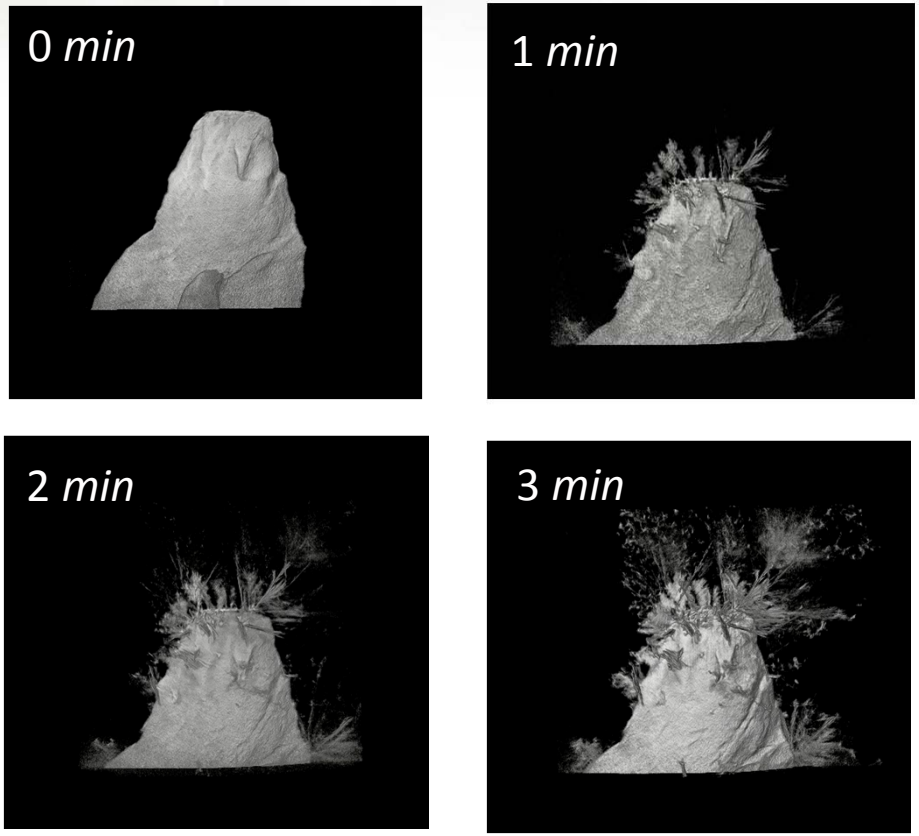
Science Commissioning (4)
XFM, FXI, PDF, SIX

Technical Commissioning (3)
NYX, SST-1, SST-2

Completion* in FY19 (2)
FIS, MET

* Defined as having completed IRR

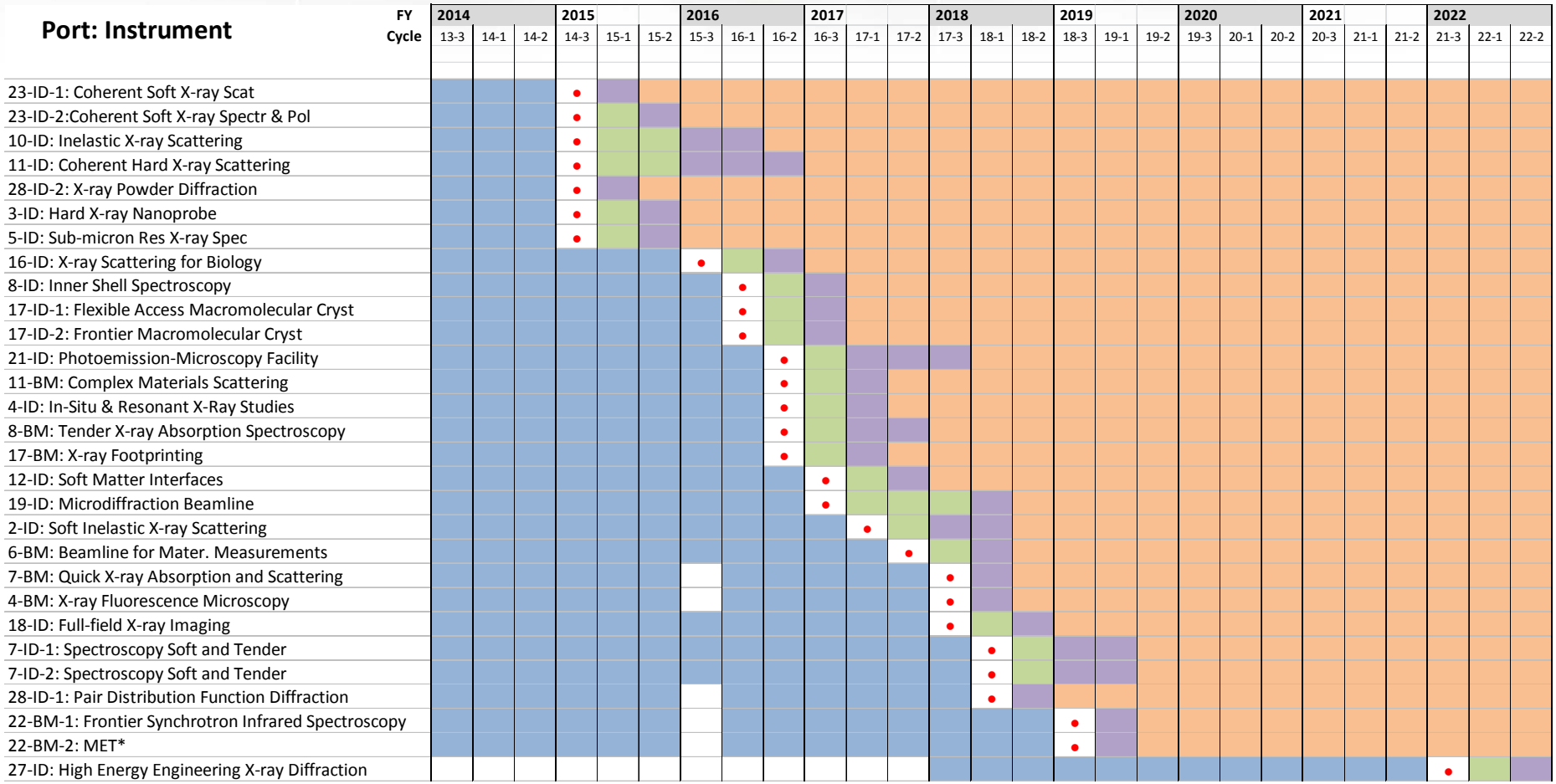
26 beamlines operating/commissioning
28 beamlines operating by end CY18



Appl. Phys. Lett (2018) - 1st pub from FXI

Tracking 3D silver nano-dendritic growth in real time, under *in-situ* chemical reaction conditions: $Cu + AgNO_3 \rightarrow Ag + Cu(NO_3)_2$

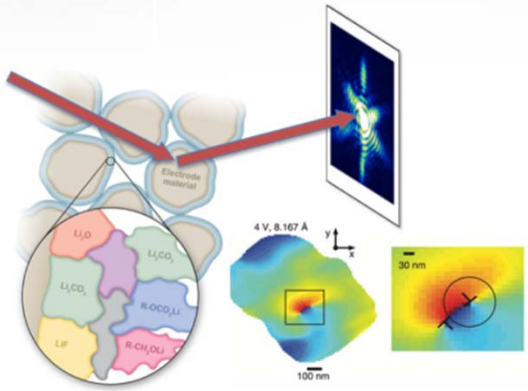
Beamline construction update



By the end of CY18, only HEX will be under construction

Next steps for beamline construction

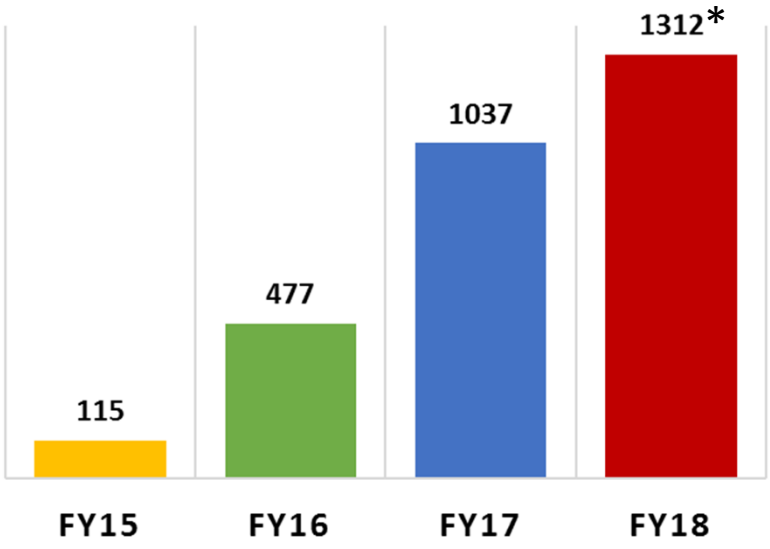
- New beamlines already identified (2016)
  - CDI: Bragg-CDI for world-class lensless imaging down to 5 nm
  - ARI: Scanning probe with simultaneous nano-APPES/nano-RIXS capabilities at ~100 nm resolution
  - SMF: Soft x-ray STXM with nm-scale resolution via ptychography
  - QIX: Quick RIXS for snapshots of chemical reactions in-operando
  - PLS: GISAXS/WAXS for liquid interfaces and polymer processing
  - INF: Nano-IR spectroscopy of heterogeneous solid state materials



- Strategic planning and brainstorming sessions (2018):
  - Identified new capabilities and new beamlines that should be developed to meet science needs, taking into account the capability gaps in the current portfolio
- Current activities:
  - MIE CD-0 proposal to build three state-of-the-art imaging beamlines (see Erik's talk)
  - Working on concepts of add'l beamlines (see Qun's talk)
  - Will engage SAC and user community in coming months to further discuss these concepts

User program update

Unique users



Fraction New Users:

FY15: 100%

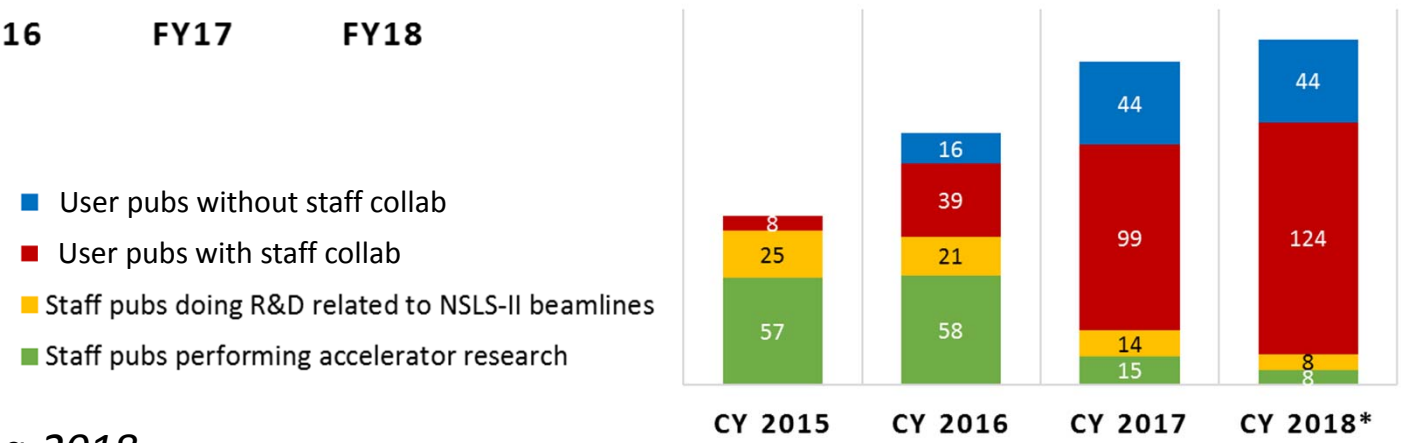
FY16: 83%

FY17: 66%

FY18: 55%

In FY18, > 30% of users used more than one beamline - one used five!

Publications

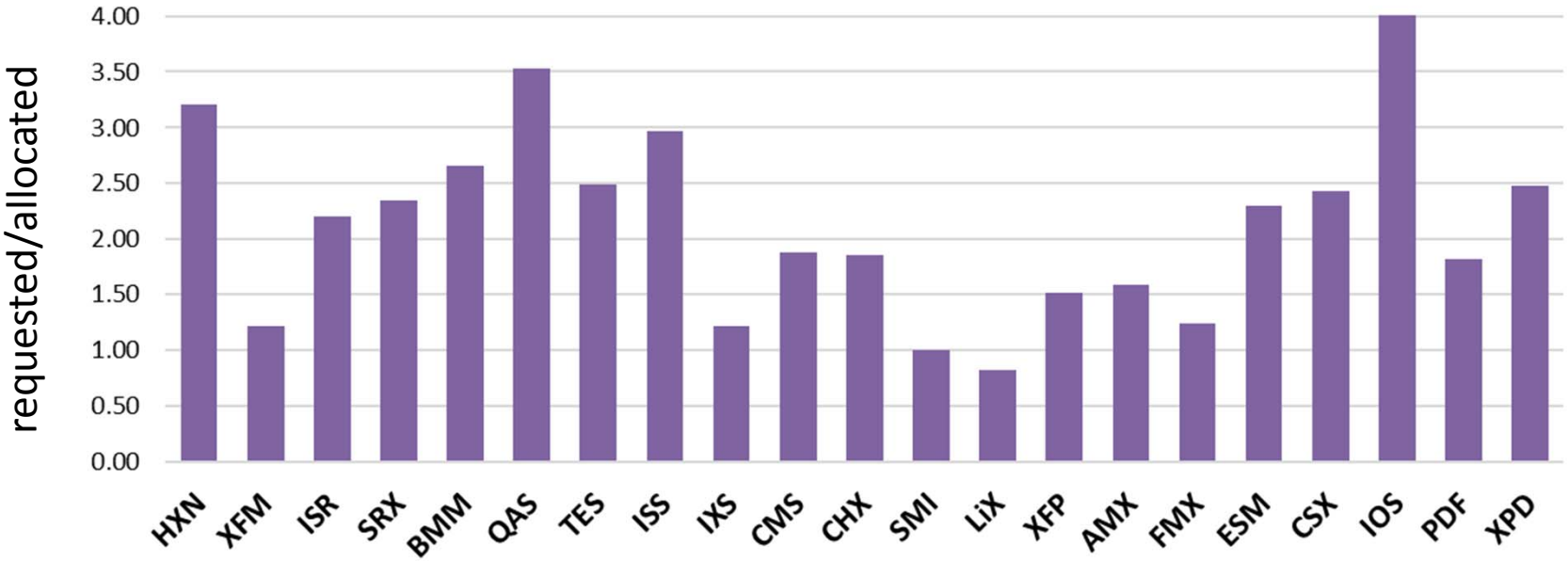


FY18: as of 30-Aug-2018

See Lisa's talk

User demand is high

Shift Subscription Rates (FY18)

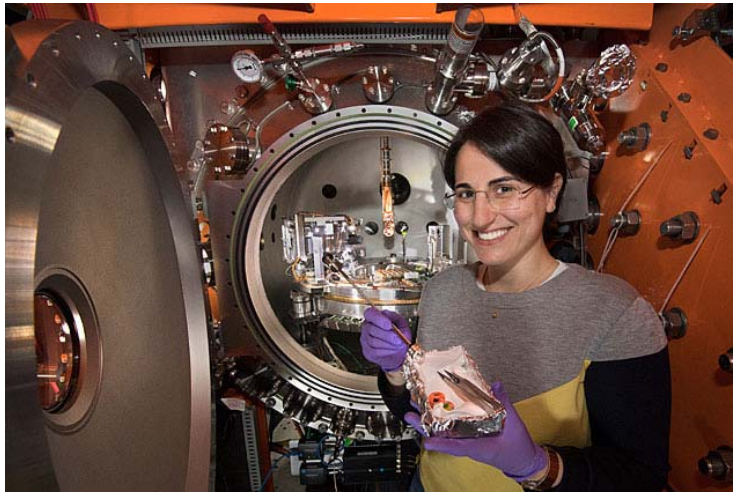


Most requested beamlines:

1. IOS (1277 shifts)
2. HXN (1202 shifts)
3. XPD (1187 shifts)

Awards and proposal success

Valentina Bisogni wins 2018 DOE Early Career Award



"Revealing collective spin dynamics under device operating conditions to enhance tomorrow's electronics"

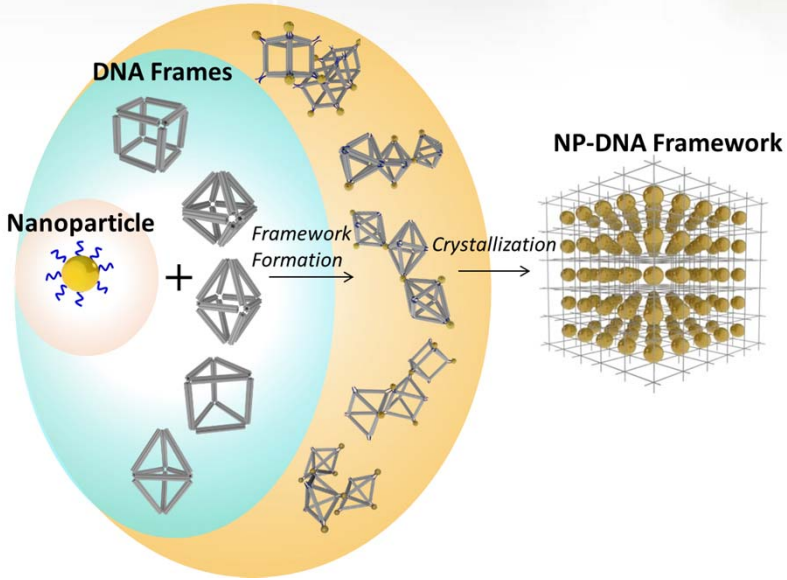
Awards

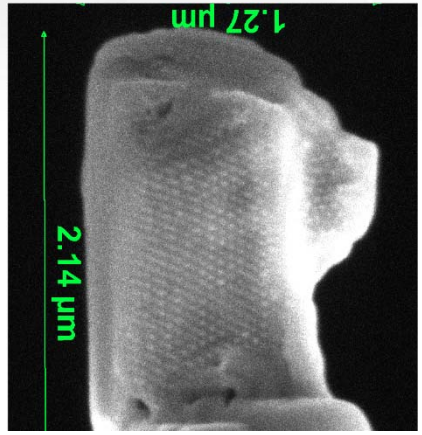
- R&D 100 Award Finalist; Nazeretski et al. fast scanning goniometer
- NSLS-II User, Esther Takeuchi won 2018 "European Inventor of the year award for non-EPO countries"
- NSLS-II JA, Karen Chen-Wiegert won 2018 NSF Early Career Award

Proposals

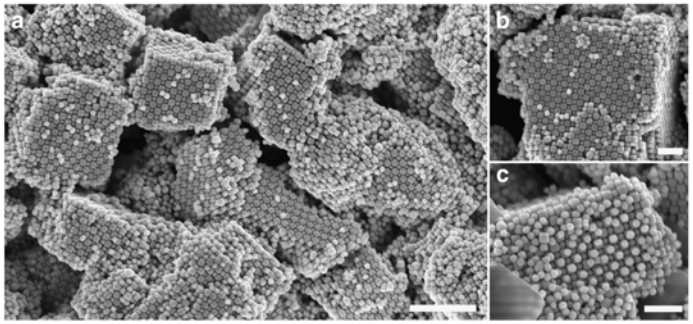
- McSweeney; BER operating grant for cryoEM $2.3 M
- Rumaiz: High E spectroscopic detector $400k/yr
- Chubar: Experiment simulation software $400k/yr
- 4 SBIR Awards for a total of $292k
- Chu/Lee/Wang IARPA $200k
- Ocko/Attenkofer/Dooryhee EFRC Molten salts, EFRC synthesis

3D tomography of DNA-guided superlattice

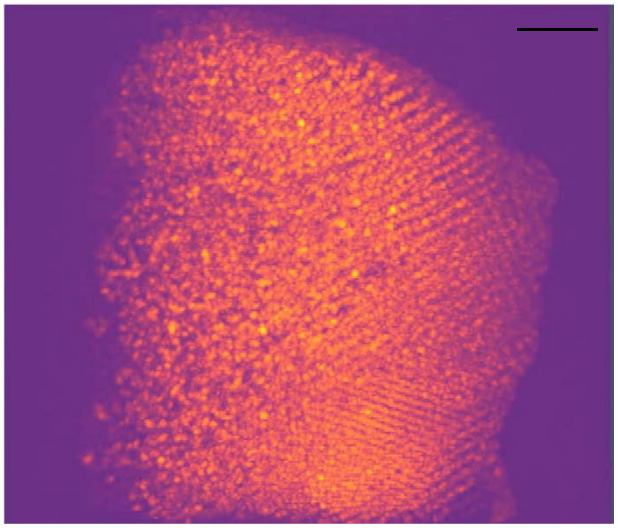




SEM



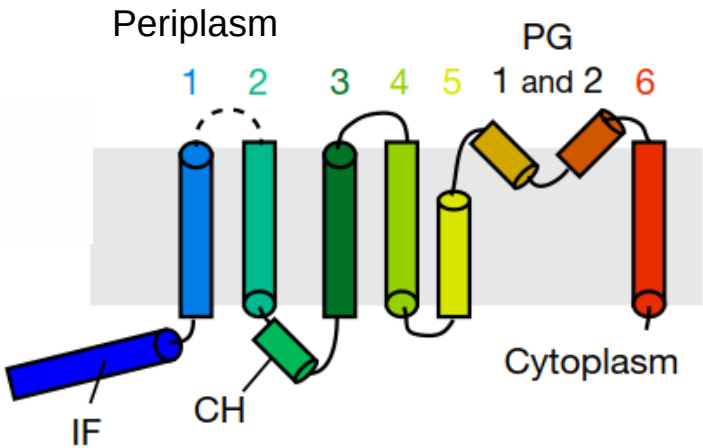
X-ray Tomography



HXN, NSLS-II (scale bar: 200 nm)

F. Lu, et al, (2015), 6, 6912 Nature Communications
Y. Tian et al. Nature Materials 15, 654 (2016);
D. Nykypanchuk et al, Nature, 451, 549 (2008)

Unexpected architecture of a membrane protein revealed



Wzm forms six transmembrane helices and the cytoplasmic loop (CH) forms the coupling helix. The periplasmic loop, between helices 5 and 6, generates two periplasmic gate helices (PG1 and PG2). Gray box indicates likely membrane boundaries.

Y. Bi, E. Mann, C. Whitfield, J. Zimmer, *Nature 553*, 361–365 (2018).

Scientific Achievement

The crystal structure of a channel-forming O-antigen polysaccharide transporter called Wzm-Wzt was revealed and showed an unexpected, non-traditional architecture.

Significance and Impact

O-antigens are important cell wall components in Gram-negative bacteria; Understanding how O-antigens are synthesized and secreted can help treat many human infections.

Research Details

- X-ray crystallography, structure-derived models, and additional functional analyses showed a processive O-antigen translocation mechanism.
- This mechanism stands in contrast to the classical alternating access mechanism of ABC transporters.

CryoEM update

Sean McSweeney, Project Director
Erik Johnson, Project Manager

- $15M NYS funding in place
- Microscopes ordered
  - Screening: Nov 18
  - Krios: Summer 19

- Site Prep completed
- Building 50% design completed. Cost estimate in range
- Construction to start Dec 18
- Building complete Summer 19
- Operations funds in place

Controls Program

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

- Initiated monthly “Controls’ Town Hall” meetings
- External assessment of network by ITD. Decision to outsource responsibility for network to ITD, freeing up internal resources
- External contractor brought in to assess and improve GPFS disk sharing. Initial results promising
- Further definition of “POC” system and relaunch
- Investigating new motor control standards for simple motions
- Reorganizing controls program to align responsibilities with expertise
- Action plan written based on reviews and associated recommendations. Implemented and being tracked to completion

See Richard’s talk

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
- Develop plans for additional beamlines
- 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

Budget outlook

- FY16 $110 M
- FY17 $111.8 M
- FY18 $110.8 M
- FY19 (PBR) $111.8 M
- FY19 (bill) $118.2 M and plan for new BLs by FY20

With a flat budget, we believe we can accomplish our FY19 goals.

If additional funds are allocated, we will use them to purchase critical accelerator spares, start the 4th RF cavity and pursue beamline development

SAC September 2018 Charge

- Are we on track to be ready for 500 mA ops in FY20?
- Do we have a good handle on operations downtime?
- Beamline controls:
  - 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?
- Early mini-reviews of beamlines BMM, NYX, SIX
  - Are these beamlines on a path to success?
  - If not, are there things we can be doing to ensure successful programs?
- Triennial beamline reviews of CSX, IOS, HXN and XPD
  - Is the science program looking healthy for this stage of their development?
  - Are there outstanding issues that require attention?
  - Was the format for the reviews appropriate? Are there opportunities for improvement?
- Is the approach being taken to explore new beamline concepts appropriate?
- Any early feedback on the concepts identified?
- Any feedback on the prioritization of the next round of beamlines?

SAC March 2018 recommendations

- Develop plans if critical component fails (Shaftan)
- Continue to develop accelerator road map (Shaftan)
- Work on computing support for AD from CSI (Shaftan)
- Controls and networking. Numerous issues. (Farnsworth)
- Partner user program (GU/PU fraction) and delivering on expectations (PU program review delayed)
- Communications channels with staff (Zschack)
- Continue beamline value engineering process (ongoing)
- User proposal software and SSO (Miller)

Summary

- Accelerator continues to operate well (reliability, intensity, stability), though there are concerns about critical spares program.
- Science program continues to ramp up and is on track
- Three beamlines experienced extended downtime (HXN, FXI and ISS)
- Staff stress remains a concern
- Beamline construction program proceeding. By the end of CY18, only HEX will be under construction
- We are exploring new beamline concepts and opportunities for funding these concepts
- Overall the facility is performing extremely well. The organization is under stress however.