NSLS-II

J.P. Hill, Director, NSLS-II

UEC Town Hall February 27th 2018

NSLS-II Safety Statistics (FY18)

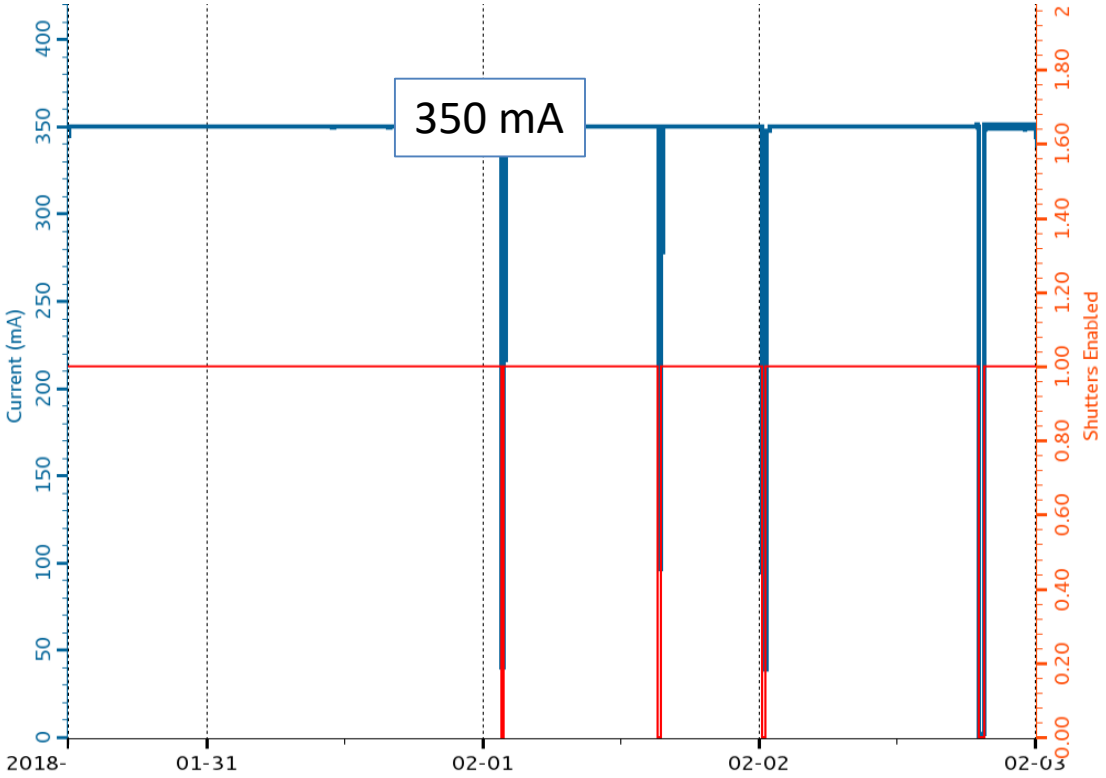
- FY18 Hours Worked: 190,365 hours (YTD as of 1/31/18)
- FY18 Recordable Cases: 1 Rate: 1.05 (12-month rolling rate = 1.17)
- FY18 DART Cases: 1 Rate: 1.05 (12-month rolling rate = 0.87)
- FY18 First Aid Cases: 0
- Last Recordable/Last DART Injury: 10.24.2017/10.24.2017

NSLS-II Events

- FY18 Events: 3 (1 Reportable Injury, 1 non-reportable injury; 1 reportable event (SCBNL), 1 non-reportable event)
- New Event: Scarifying storage ring tunnel roof 2/16/18

NSLS-II Accelerator Update

- Storage ring current is 350 mA
- FY18 reliability 97.8 % (2/2/18)
- Will raise the current to 375 mA March 13th
- Contamination of cryogenics in RF cryoplant remains a concern.



NSLS-II Beamlines Update

General User Operations (16)
CSX-1, CSX-2, XPD, HXN, SRX, IXS, CHX, LIX, AMX, FMX, ISS, XFP, CMS, ISR, TES, SMI

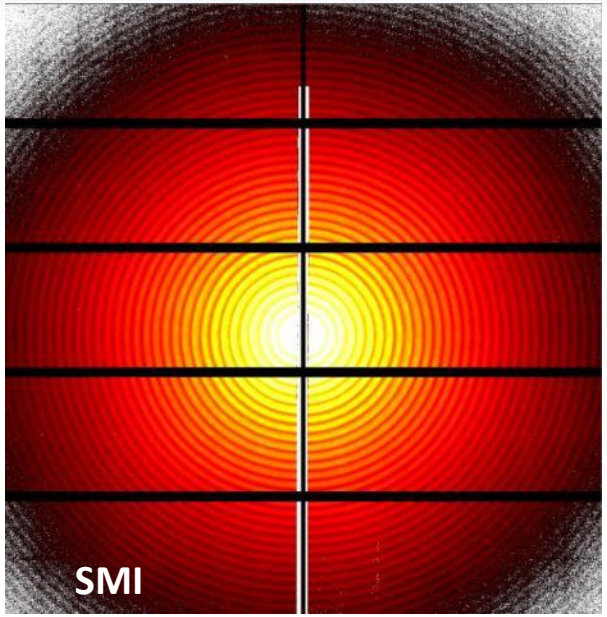
Science Commissioning (5)
ESM, BMM, SIX, QAS, XFM

Technical Commissioning (4)
NYX, FXI, SST-1, SST-2

Completion* in FY18 (3)
PDF, FIS, MET

- Defined as having completed IRR

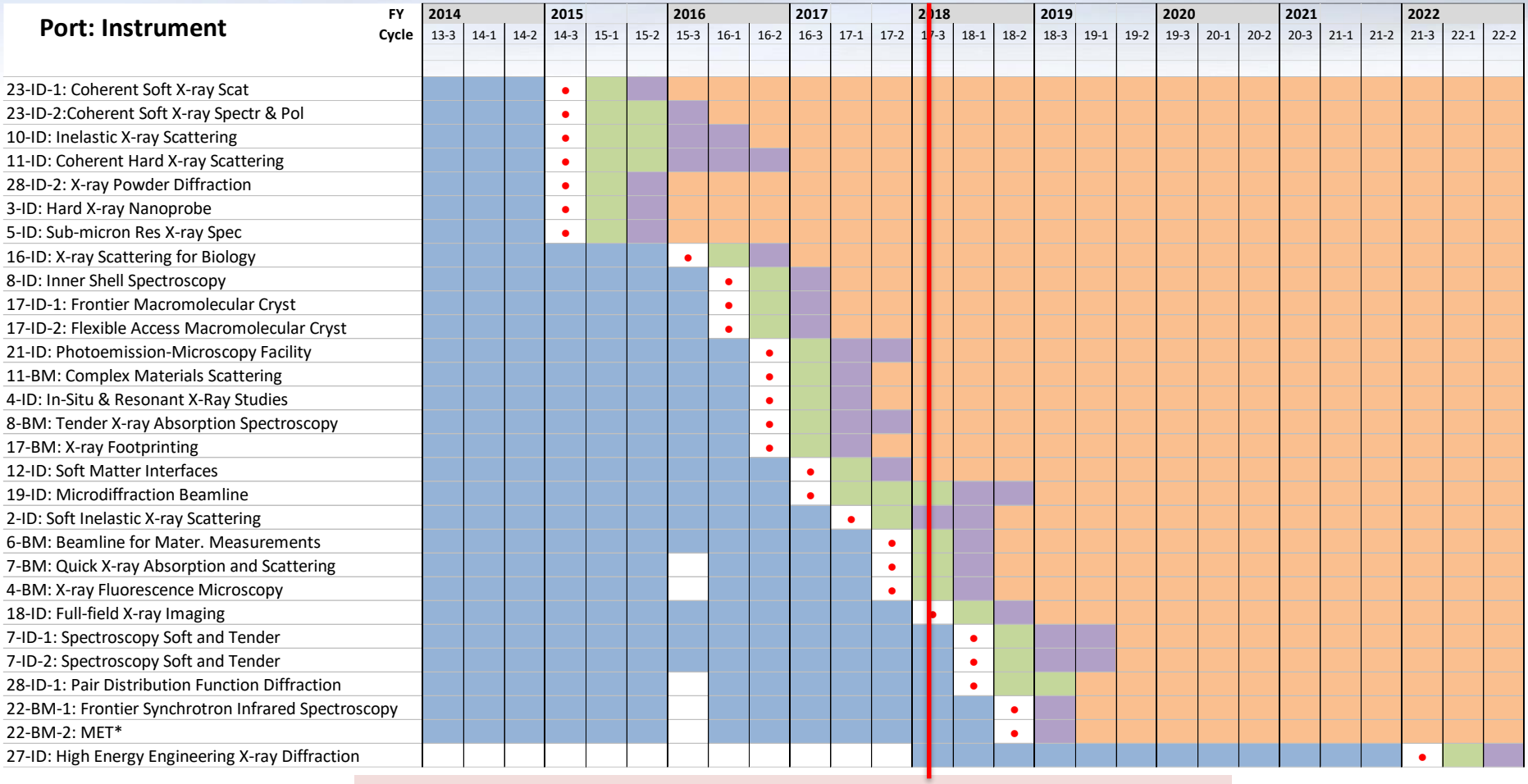
25 beamlines operating/commissioning
– 16 beamlines in GU ops, 5 in SC
28 beamlines operating by end FY18



First test data from Pilatus 1M (E. Gann, NIST):

Polystyrene beads with a diameter of 600 nm measured with 2470eV demonstrates resolution capabilities of SMI: about 40 diffraction orders can be clearly distinguished with the detector at 1.6 m away from the sample. Data suggests that objects as large as 2-3 μm can be resolved in SAXS with the detector placed 8 m away from a sample.

NSLS-II Beamline Buildout Update

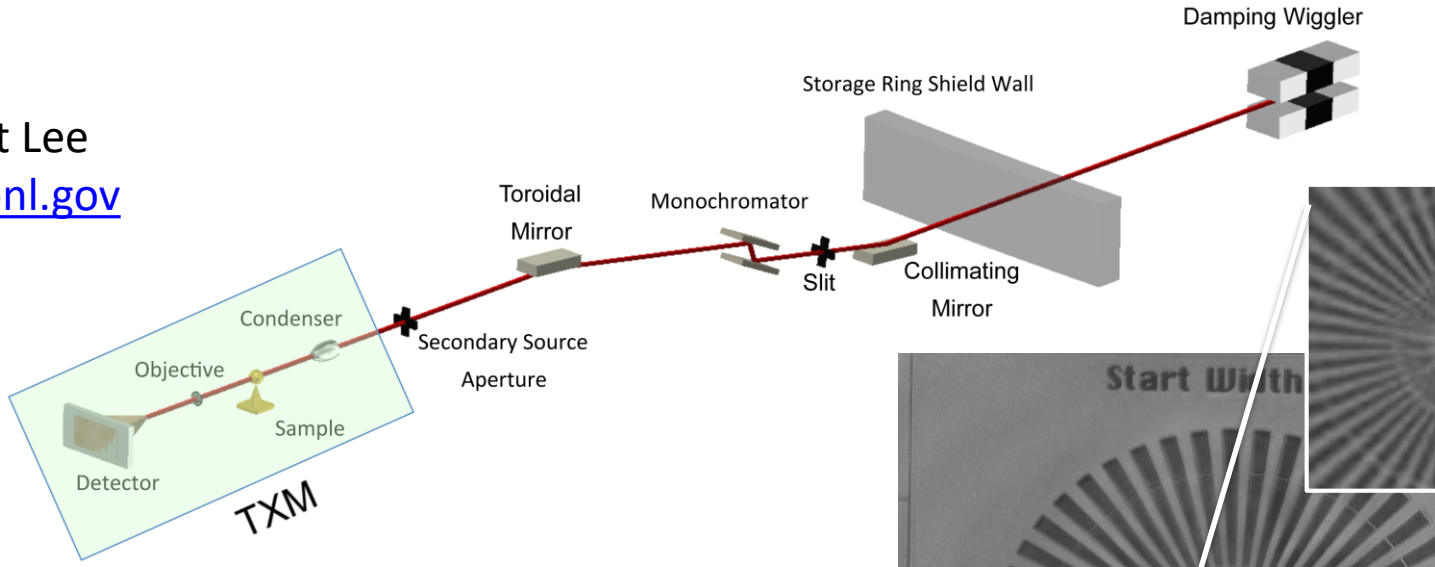


In FY18 to date:

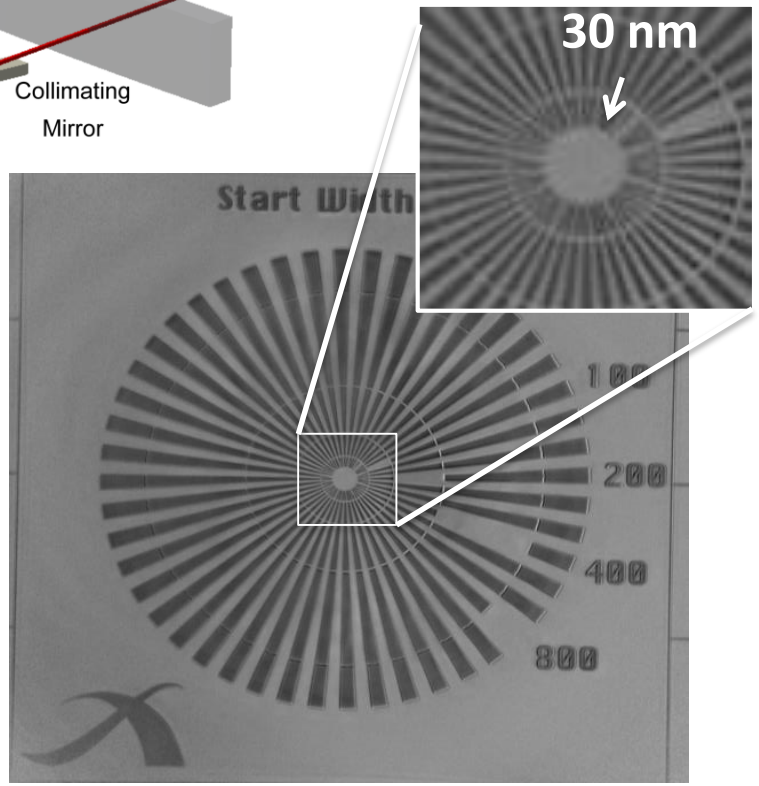
- QAS and XFM in Service (can take full beam)
- FXI in commissioning
- SST in commissioning

FXI – now in commissioning!

Wah-Keat Lee
wklee@bnl.gov



- Full field imaging over 40 micron spot
- Commissioning going extremely well!
- 30 nm resolution demonstrated
- First science commissioning experiments in 2018-2



First TXM Image from FXI (18-ID)

CDI update

Science Case:

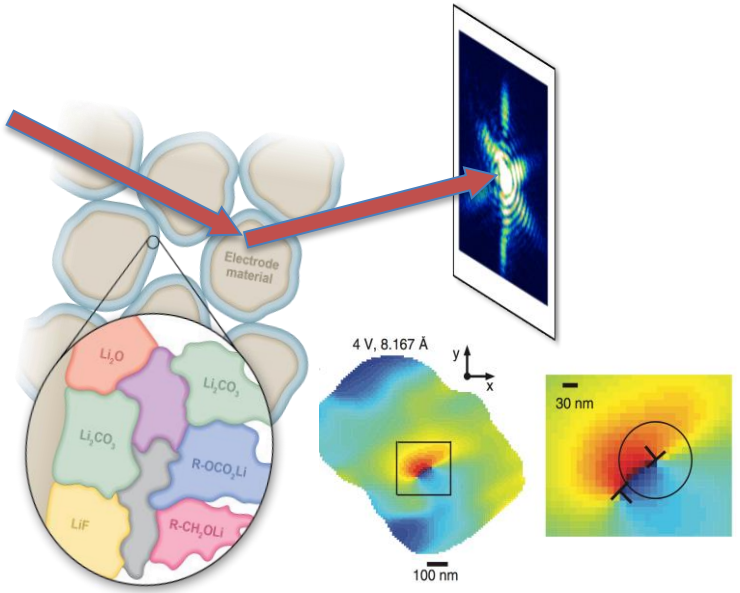
- Imaging defects, dislocations, and strain in single grains of heterogeneous materials
- Capable of imaging in-situ/operando under realistic conditions (e.g. charge & discharge)

Technical Scope:

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

Immediate scope of work

- 1st BAT meeting 2/27/18
- Develop cost, scope and schedule to "CD-2" level by FY19



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

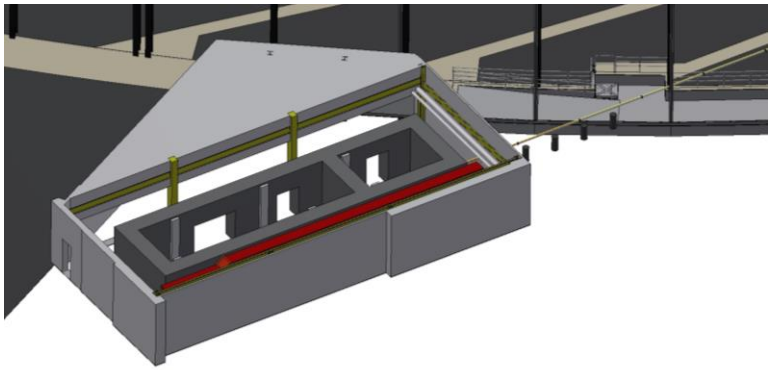
Lead Beamline scientist: Garth Williams

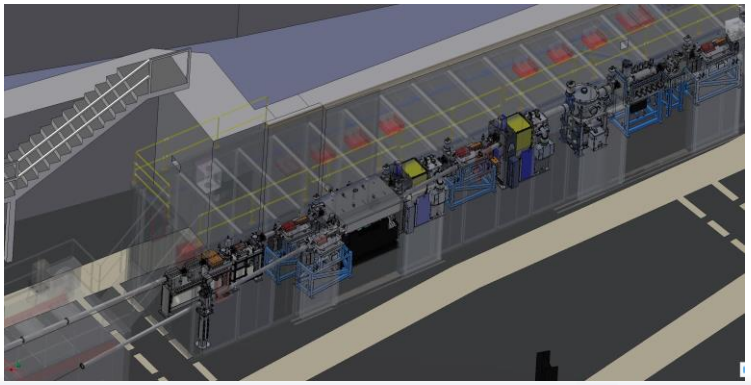
HEX Update

The High-energy Engineering X-ray (HEX) beamline is a partnership with NYS (NYSERDA) to enable the study and development of clean energy technologies

The project officially started Execution in September 2017. Completion end of 2021

- CDR and BAT meeting held (Oct 2017).
- Preliminary design progressing well (April 2018)
  - Layout revisions incorporated from BAT and CDR
  - Front end design iterations in progress
  - Superconducting wiggler detailed specifications being completed.
- Design of satellite building in progressing well,
  - independent cost estimate expected end Feb 2018.



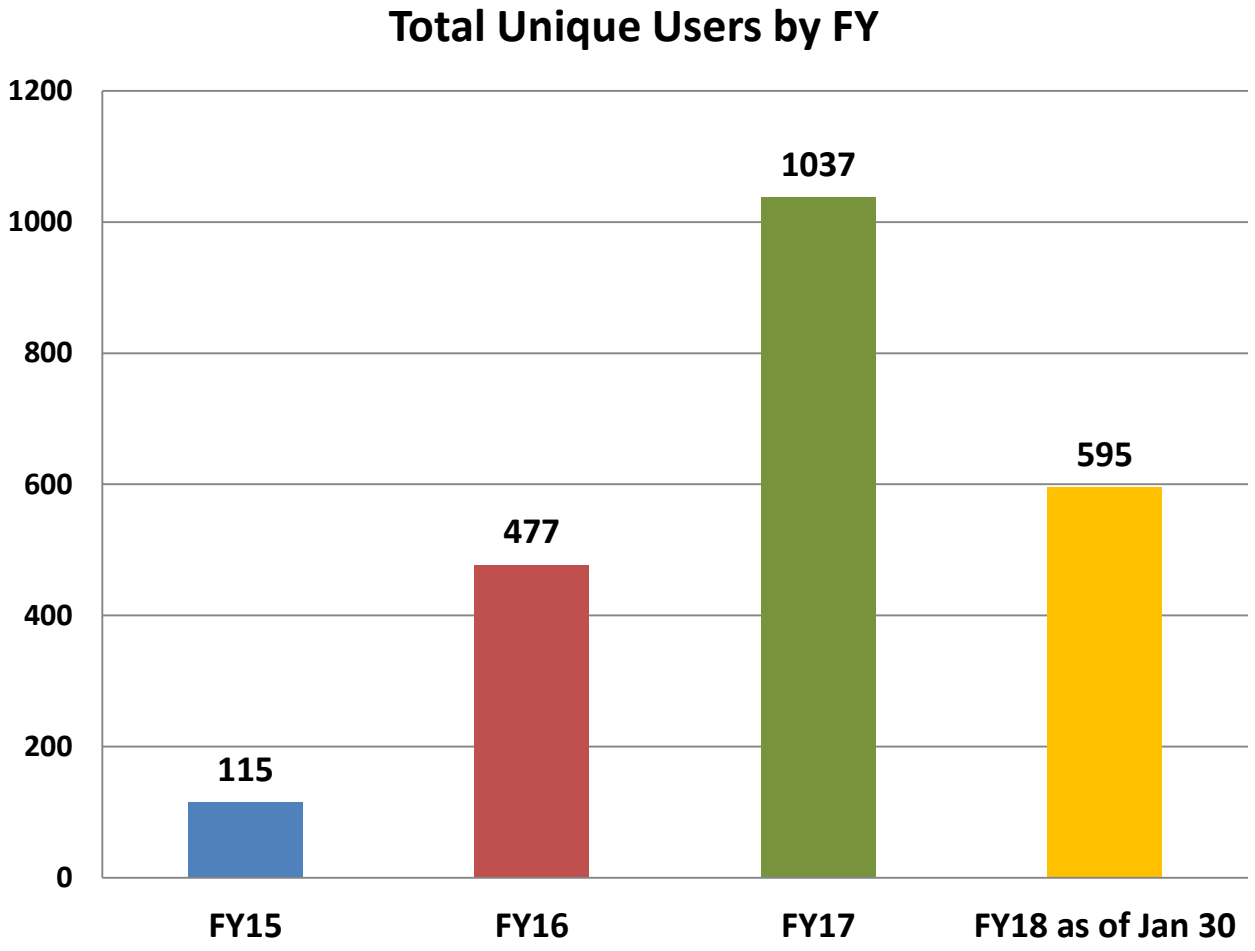


CryoEM Initiative – Current Status

- NIH funding proposal in review
- Board approved NY state advanced funding of $15M
- Official project at BNL:
  - Sean McSweeney as Project Director
  - Erik Johnson as Project Manager
- Screening microscope Aug 2018
- Building complete Aug 2019
- Hi-res microscope Nov 2019

NSLS-II Facility Users by Fiscal Year

(as of January 30th)



FY15:

- Unique users = 115
- 100% were first-time users

FY16:

- Unique users = 477
- 83% were first-time users

FY17

- Unique Users = 1037
- 69% were first-time users

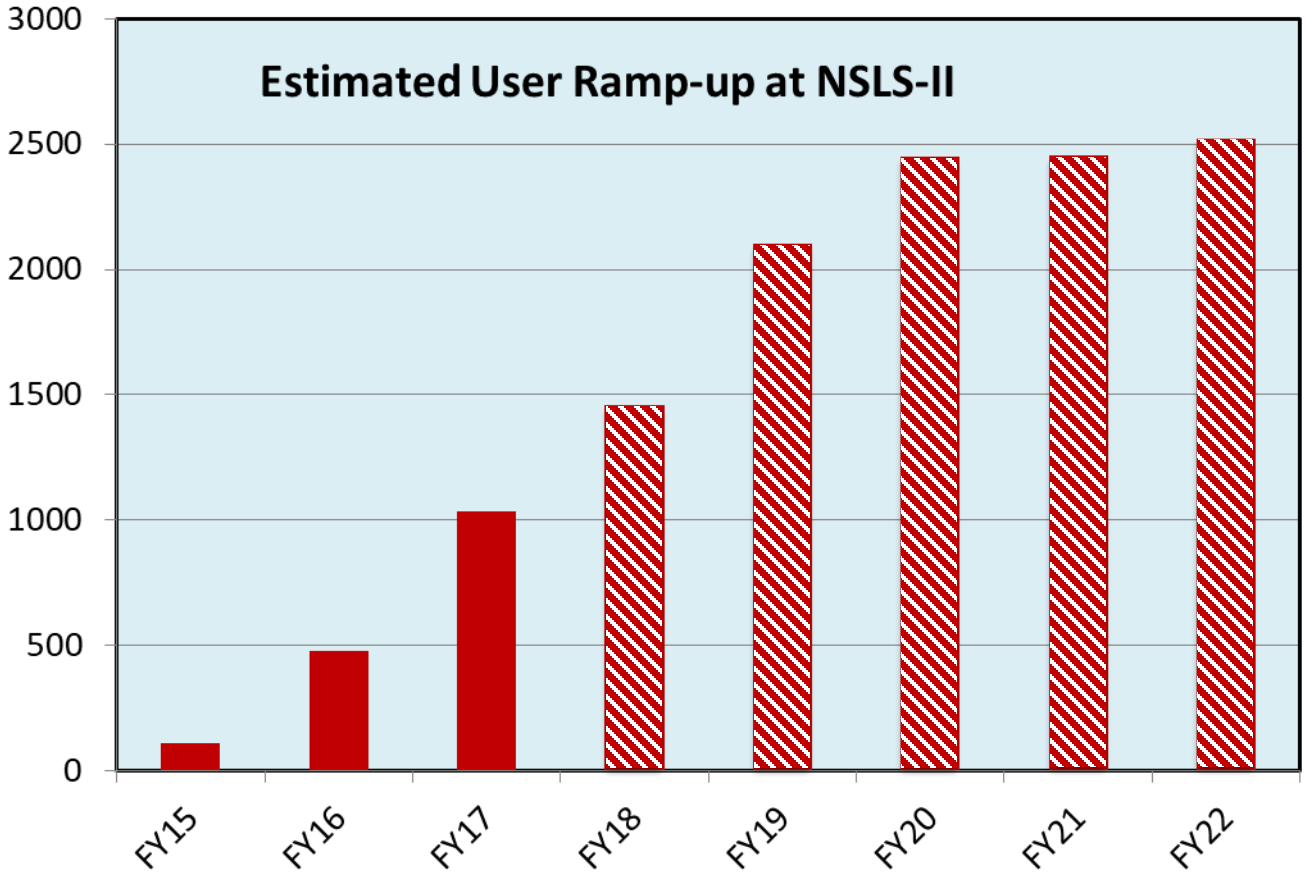
FY18

- Unique Users =595
- 50% are 1st time users

(433 users by same date in FY17)

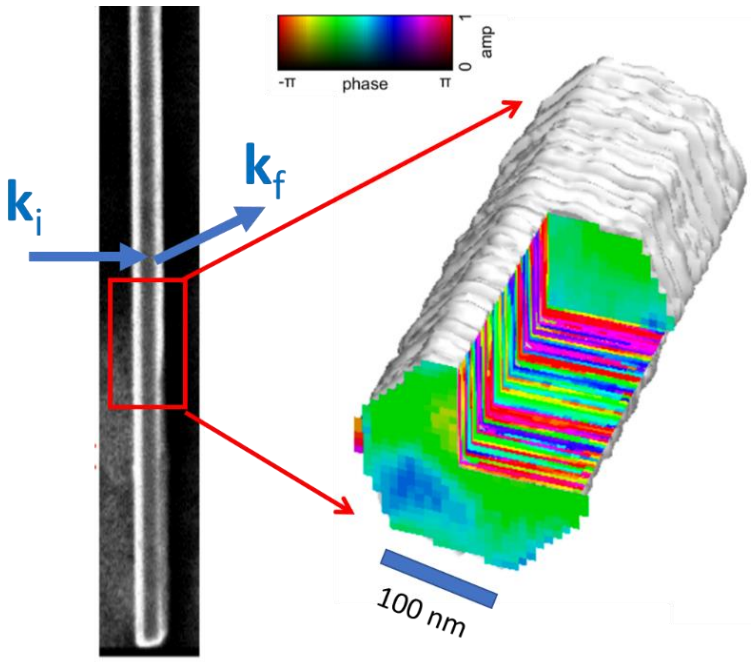
NSLS-II User Ramp-up Estimate

- FY17 actual: 1,037 users on 8.3 FTE-Beamlines
- FY18 estimate: 1,400 users on 11.6 FTE-Beamlines



Start of remote users on AMX/FMX will slow user number growth slightly

Imaging of strain and stacking defects in a III-V nanowire



SEM image of nanowire with diffraction geometry (left) and cutouts from 3D images sensitive to stacking defects (right).

Scientific Achievement

In a single III-V nanowire, the 3D distribution of both strain and stacking defects was measured using coherent x-rays, revealing structural heterogeneity from nano- to micro-meter scales.

Significance and Impact

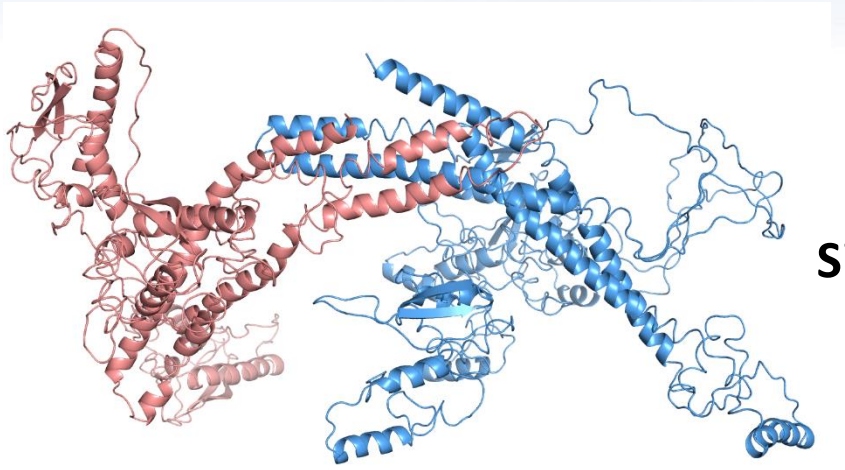
Structural features that determine the performance of advanced optoelectronic nanodevices can be imaged by a new coherent x-ray Bragg ptychography method suitable for studies in operando.

Research Details

- Beamline 3-ID at NSLS-II was used to measure nanodiffraction at two different Bragg peaks
- A new multi-angle Bragg projection ptychography method was used to make 3D images of structure down to a scale of 3 nm

M.O. Hill et al.. Nano Letters. XX, XXXX (2018)

Structure & Function of a Cellular Autophagy Complex



Structural model of the Snx4 (red) and Atg20 (blue) complex. This complex has been very challenging to investigate using other structural methods. SAXS at beamline 16-ID provided the first insight into the architecture of this important complex

Scientific Achievement

Small Angle X-ray Scattering with in-line size exclusion chromatography helped scientists develop a new structure-function model for the Snx4-Atg20 complex in cellular autophagy.

Significance and Impact

Autophagy is a cellular process that ensures damaged or long-lived cellular components are recycled to prevent damage to the cell. Defects in autophagy have been correlated with cancer and neurodegenerative diseases.

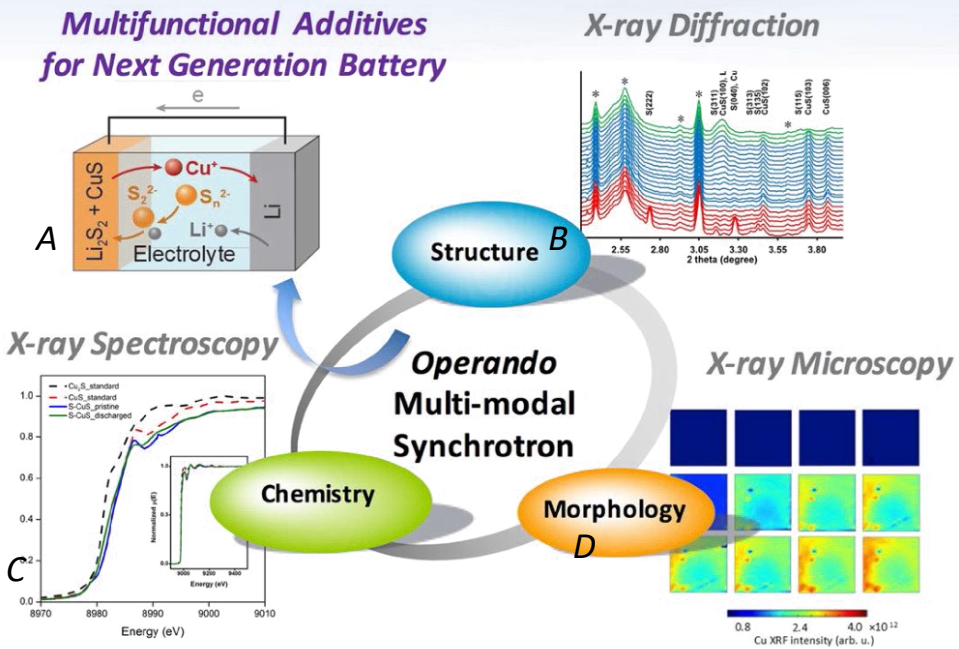
Research Details

- Showed that the Snx4-Atg20 complex has a hybrid structure of ordered and disordered domains.
- Disordered domains bind to other proteins that are required for autophagy initiation.
- Used small angle x-ray scattering (SAXS) at beamline 16-ID to study the size and shape of the dynamic Snx4-Atg20 complex.

H. Popelka, A. Damasio, J. E. Hinshaw, D. J. Klionsky, and M. J. Ragusa, PNAS, **2017,** E10112–E10121

Work was partly performed at Brookhaven National Laboratory

Multimodal Approach Provides Insight into Lithium-Sulfur Batteries



Scientists used three different synchrotron techniques to study the chemistry, structure and morphology of the battery.

K. Sun, C. Zhao, C. Lin, E. Stavitski, G. Williams, J. Bai, E. Dooryhee, K. Attenkofer, J. Thieme, Y. K. Chen-Wiegart & H. Gan; *Sci. Rep.* 7, 12976 (2017)

Work was performed at Brookhaven National Laboratory and Stony Brook University

Scientific Achievement

The detailed mechanism of CuS dissolution and its participation in electrochemical discharge of a Li-S battery were uncovered using an *in operando* multimodal approach

Significance and Impact

Lithium-sulfur (Li-S) batteries are promising new electrochemical energy storage devices but their fundamental chemistry needs to be understood

Research Details

- Mechanistic understanding is important to mitigate the possible & unwanted secondary reactions
- The battery was studied under working conditions at 3 beamlines at NSLS-II:
  - X-ray diffraction at 28-ID-2 resolved the cathode structural evolution during the battery cycling
  - X-ray microscopy at 5-ID monitored the Cu species migration from cathode to anode
  - X-ray spectroscopy at 8-ID determined the chemical evolution of cathode materials

FY18 ops budget planning

- Presently in CR until March 23rd
- Fiscal year began Oct 1st
- Executing a budget assuming flat at FY17 (= $111.8 M)
- Have assigned this budget to the different activities, “holding back” $4.5 M (=4%)
- Commitments released carefully depending on funding projections
- FY19 President’s budget released: NSLS-II is $111.8 M

FY18 Goals

1) Operate the accelerator and deliver ~~4750~~ 4850 hours for user operations at > 95% reliability. Achieve 400 mA by the end of FY18 and remain on track to deliver 3rd RF cavity by FY20
2) Operate the existing beamlines and commission and operate those finishing construction in FY18
3) Continue beamline development. Specifically
    a. Complete the PDF, FIS and MET beamlines
    b. Complete the SST-1 and SST-2 partner beamlines (Done)
    c. Continue the HEX beamline in partnership with NYS
    d. Continue development of the CDI beamline and ARI R&D
4) Maintain operational excellence

Summary

- Accelerator is performing very well. We will continue to increase the current, consistent with maintaining reliability
- Beamline construction has been very rapid. 25 beamlines currently taking light. 3 more this year. HEX now underway.
- User program is growing rapidly, strong demand for beamtime
- Early science is exciting! Publications following
- Next steps
  - Continue strong focus on user program growth
  - Continue to push accelerator performance
  - Work with BES and others to develop funding for additional beamlines