

## J.P. Hill, Director, NSLS-II UEC Town Hall February 27<sup>th</sup> 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**

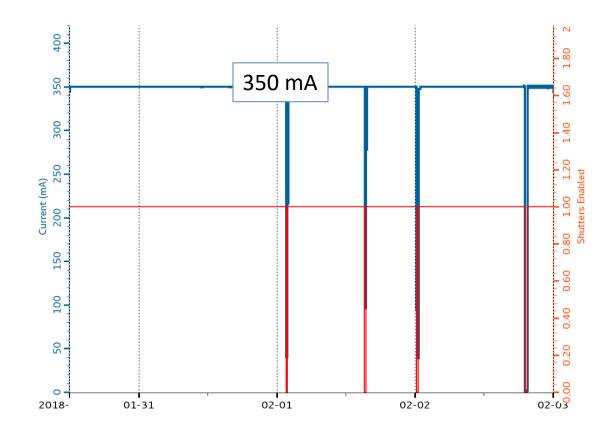
- FY18 Events: 3 (1 Reportable Injury, 1 non-reportable injury; 1 reportable event (SCBNL), 1 non-reportable event)
- New Event: Scarifying storage ring tunnel roof 2/16/18





# **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 13<sup>th</sup>
- 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)

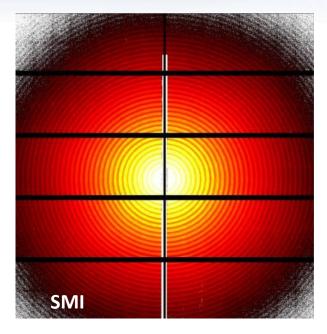
NYX, FXI, SST-1, SST-2

#### 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  $\mu$ m can be resolved in SAXS with the detector placed 8 m away from a sample.

National Synchrotron Light Source II

# **NSLS-II Beamline Buildout Update**

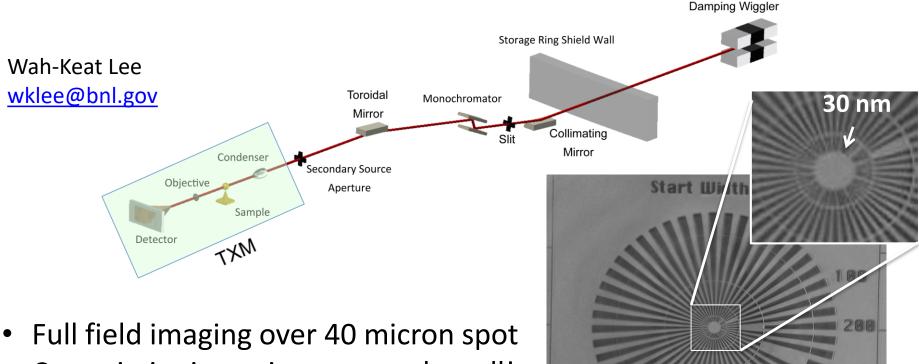
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In FY18 to date:

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



## FXI – now in commissioning!



- Commissioning going extremely well!
- 30 nm resolution demonstrated
- First science commissioning experiments in 2018-2

Office of

Science

First TXM Image from FXI (18-ID)



800

# **CDI** update

### Science Case:

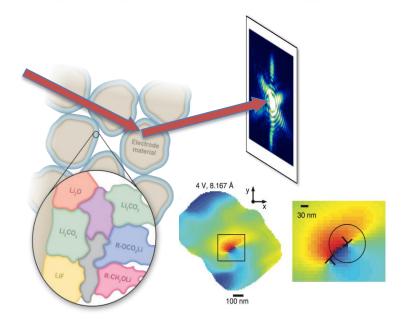
- Imaging defects, dislocations, and strain in single grains of heterogeneous materials
- Capable of imaging in-situ/operando under realistic conditions (e.g. charge & discharge)

### Technical Scope:

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

### Immediate scope of work

- 1<sup>st</sup> 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

National Synchrotron

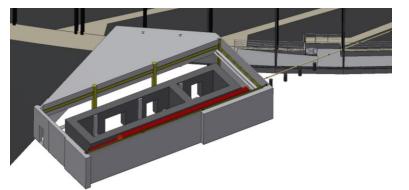
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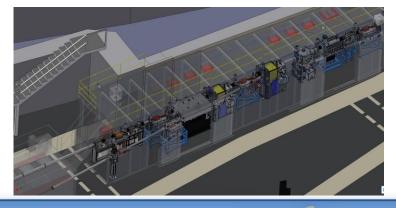


The High-energy Engineering X-ray (HEX) beamline is a partnership with NYS (NYSERDA) to enable the study and development of clean energy technologies

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

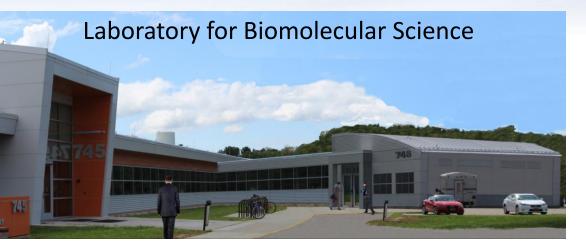
- CDR and BAT meeting held (Oct 2017).
- Preliminary design progressing well (April 2018)
  - Layout revisions incorporated from BAT and CDR
  - Front end design iterations in progress
  - Superconducting wiggler detailed specifications being completed.
- Design of satellite building in progressing well,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







## **CryoEM Initiative – Current Status**

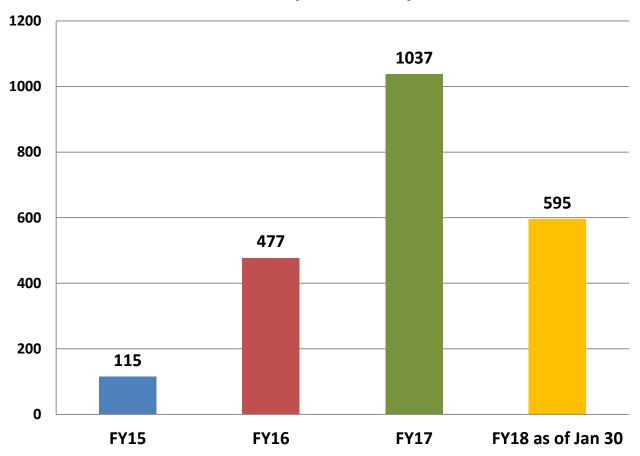




- NIH funding proposal in review
- Board approved NY state advanced funding of \$15M
- Official project at BNL:
  - Sean McSweeney as Project Director
  - Erik Johnson as Project Manager
- Screening microscope Aug 2018
- Building complete Aug 2019
- Hi-res microscope Nov 2019



## NSLS-II Facility Users by Fiscal Year (as of January 30<sup>th</sup> )



**Total Unique Users by FY** 

#### <u>FY15:</u>

- 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

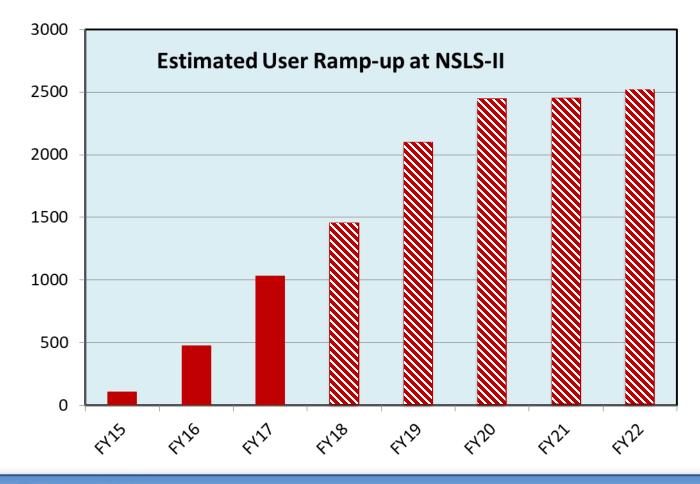
#### <u>FY18</u>

- Unique Users =595
- 50% are 1<sup>st</sup> 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

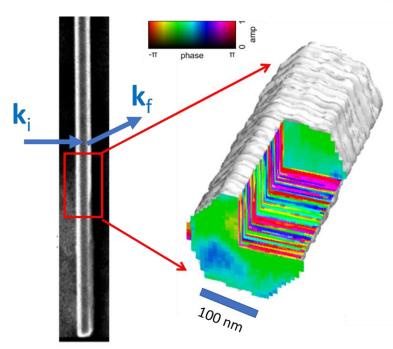


Start of remote users on AMX/FMX will slow user number growth slightly





## 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**

Northwestern

University

INSTITUT

FRESNE

 Beamline 3-ID at NSLS-II was used to measure nanodiffraction at two different Bragg peaks

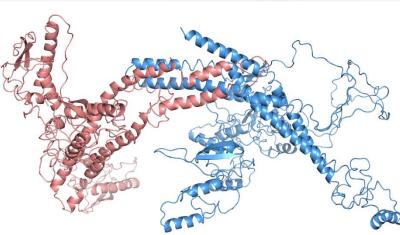
Argonn

 A new multi-angle Bragg projection ptychography method was used to make 3D images of structure down to a scale of 3 nm





## 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

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

#### **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**

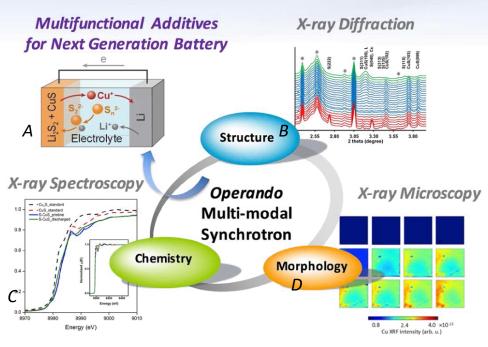
- Showed that the Snx4-Atg20 complex has a hybrid structure of ordered and disordered domains.
- Disordered domains bind to other proteins that are required for autophagy initiation.
- Used small angle x-ray scattering (SAXS) at beamline 16-ID to study the size and shape of the dynamic Snx4-Atg20 complex.







### 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 23<sup>rd</sup>
- Fiscal year began Oct 1<sup>st</sup>
- 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

- 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 3<sup>rd</sup> 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

