NSLS-II Update

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UEC Town Hall, March 1st 2017
Outline

- **Accelerator Performance**
  - Outstanding reliability
  - Increasing current
- **User Program**
  - Growing rapidly, driven by beamline construction
  - Emphasis on new users.
  - Data and computing
- **Early Science**
  - High spatial resolution
  - High coherence
- **Next steps**
  - Developing designs for next 6 beamlines
- **Summary**
National context for NSLS-II

Brightness Envelope in ph/s/mrad²/mm²/0.1%BW

Brightness Envelope

0.1 1 10 100
6 8 10 8

Photon Energy (keV)

10^{18} \quad 10^{19} \quad 10^{20} \quad 10^{21} \quad 10^{22}

ALS-U

NSLS-II 500 mA

APS-U

ALS

NSLS-II

APS
NSLS-II Accelerator Update

- Accelerator is performing well, delivering 275 mA top-off in routine operations
- FY17-to-date reliability performance = 96.4%
- Operations plan in 2017 is to reach 300 mA top-off with > 95% reliability:
  - 2/16/17: 250 mA → 275 mA
  - 4/17: 275 mA → 300 mA
FY17 Goals: Reliability > 95%, Operating current 300 mA.
Beamlines Operations Update

General User Operations
CSX-1, CSX-2, XPD, HXN, SRX, IXS, CHX, LiX, AMX, FMX, ISS

Science Commissioning
XFP, TES, CMS

Technical Commissioning
ESM, ISR, SMI, NYX, SIX

Completion in FY17
BMM, SST-1, SST-2, QAS, XFM

Completion in FY18
PDF, FXI, FIS, MET

19 beamlines in operations or commissioning

GISAXS pattern from 2D ordered monolayer of nanoparticles self-assembled at a liquid-air interface [I. Herman group, Columbia U.]
SIX KPP achieved, February 25, 2017

M4  Exit Slit  M3  PGM  M1

Upstream of M4  Exit slit  Upstream of M3  EPU 57 light

10^{13}

10^{12}

10^{11}

10^{10}

400  600  800  1000  1200  1400

Energy (eV)

SIX Monochromatic Flux
(500 l/mm grating, normalized by ring current of 75 mA)

KPP objective flux
(1800 l/mm grating)

KPP threshold flux
(1800 l/mm grating)

Current on photodiode upstream of M4
NSLS-II IRR Schedule - 2017

- October 18: SMI (12-ID) Photon Delivery System (PDS) - Complete
- October 18: SIX (2-ID) Frontend and Insertion Device - Complete
- November 3: SMI PPS/EPS verification of completion - Complete
- November 8 - 9: NYX (19-ID) FE/ID and PDS - Complete
- November 8 – 9: SIX PDS (preliminary review) - Complete
- January 18, 2017: SIX PDS (Complete – Follow-up required)
- February 15, 2017: SIX PDS Follow-up Review Complete
- June 2017: BMM (6-BM) FE/ID and PDS
- August 2017: XFM (4-BM) FE/ID and PDS
- August 2017: QAS (7-BM) FE/ID and PDS
- September 2017: FXI (18-ID) FE/ID and PDS
- October 2017: SST 1 and 2 (7-ID-1, 7-ID-2) FE/ID and PDS
- May 2018: PDF (28-ID-1) FE/ID and PDS
Includes only committed work as of 6-Feb-17; Several additional projects are in development
USER PROGRAM
Beam Time Proposals

**BTR: Beam Time Request (against existing proposal)**

**GU = General User**

**SC = Science Commissioning**

**BAGs = Block Allocation Groups**

2016-1: Jan-Apr 2016

2016-2: May-Aug 2016

2016-3: Sept-Dec 2016

2017-1: Jan-Apr 2017

2017-2: May-Aug 2017
Subscription Rates

proposals submitted / proposals allocated

2016-2: May-Aug 2016
2016-3: Sept-Dec 2016
2017-1: Jan-Apr 2017
### NSLS-II Facility Users by FY

(As of February 13, 2017)

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<th>FY 15</th>
<th>FY 16</th>
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<td>Users</td>
<td>110</td>
<td>477</td>
<td>334</td>
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#### Productivity:
- 51 papers from NSLS-II beamlines
- 6 high-impact
NSLS-II: Brightest MX beamlines

![Graph showing the comparison of different light sources based on flux density and beam size. The graph is labeled "Lightsource" and includes markers for APS, ESRF, NSLS-II, SLS, Spring8, Diamond, MAX-IV, PETRAIII, and SSRL. The graph highlights NSLS-II with a larger circle, indicating it is the brightest MX beamlines.]
The old brightness problem
The new brightness problem
NSLS-II can change the way structural biology is done

~ 5ms before radiation damage destroys sample = 4 frames
• Developing raster data collection
• Serial microcrystallography of 1-5 µm size Thaumatin crystals
• “real samples” now being studied.

• Maben, Stern (U Massachusetts Medical School)
  – Endoplasmic-reticulum associated aminopeptidase 1
  – Very large unit cell $585 \times 545 \times 125 \text{ Å}^3$
  – Full separation of 2 large axes
Hard X-ray Nanoprobe

Award Winning MLL design

Smallest spot in working x-ray microscope in the world (13 nm x 13 nm)!

E. Nazaretski, Y. S. Chu, et al.

Highest resolution 3D XRF image ever taken. Showing Er tag on surface of E-coli

K. Allen (Boston Univ), B. Imperiali (MIT), L. Miller (BNL), whole HXN Team
Revealing Dynamics of Polymer Gels

Coherent x-ray scattering studies of dynamics in transient networks of associative polymers which are used in applications such as artificial skin and self-healing gels

• Challenging expt: low signal as samples are real and not dressed w/ nanoparticles
• Unprecedented coherent flux at CHX produced high quality dynamical information on smaller length scales (q~0.03 Å⁻¹) and shorter time scales (~10 ms) than ever possible before with similar polymer samples

Olsen and Dursch (MIT) with CHX group, unpublished
Budget

• FY17 remains uncertain. CR through April 28th.
• We are currently executing a plan that assumes a full year CR at FY16 levels ($110 M) and leaves $14 M carryforward in to FY18.
• No guidance for FY18 yet.
• Demands on DOE-BES budget are high
  – SUF operations
  – Construction: LCLS-II, APS-U, ALS-U, LCLS-II-HE, SNS STS, SNS PU....
  – Core programs research
• Triennial review of NSLS-II June 20-21st
Next steps

Priority is to

1) Operate existing beamlines. Grow user program
2) Maintain reliable accelerator operations. Reach design performance
3) Develop new beamlines:
   • FY15 – User community-driven proposal process
   • FY16 – Selection of 6 beamlines. Task force developed approximate cost and schedule
   • FY17 – Advance designs to appropriate level to seek additional funding. Push development of highest priority beamline, dependent on operating budgets
New Beamlines

1) Hard x-ray imaging
World-leading lensless imaging down to 5nm

2) Soft x-ray imaging-1
Chemical and electronic structure down to 5 nm resolution

3) Soft x-ray imaging-2
State-of-the-art transmission x-ray microscope

4) Chemical reactions
Time-resolved snapshots of chemical reactions in-operando

5) Polymer processing and liquids
Liquid interfaces and thin film processing studied in-situ

6) Infra-red spectroscopic imaging
Nano-IR spectroscopy on heterogeneous solid state systems

These beamlines will provide world-leading capabilities that will significantly enhance NSLS-II. We are working with BES and others to seek additional funds to develop and operate them.
Summary

- Accelerator is performing very well. We will continue to increase the current, consistent with maintaining reliability
- Beamline construction has been very rapid. 19 beamlines currently taking light. 9 more on the way
- 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