

Advanced Photon Source: Informational Update

Stephen Streiffer

Interim Director, Advanced Photon Source

Interim Associate Laboratory Director, Photon Sciences

All-Hands Meeting

July 1, 2014

Key Messages

- Myriad of reviews and events completed!
- APS is central to the DOE mission
- APS is central to the ANL mission
- The APS is successful
- APS path forward: strategic plan
- Budget



It's Been a Busy Two Months!

- The University of Chicago Argonne, LLC **Board of Governors Annual Review** of the Photon Sciences Directorate and Advanced Photon Source was held May 28-30.
 - “This review will focus on the facility’s accelerator/user operations and scientific productivity in preparation for the DOE Triennial Review to be held in June 2014.”
- Argonne annual **Lab Plan Presentation** to the Department of Energy on June 11.
- **Quarterly Board of Governors Meeting** held on June 18 – 19 focused on APS-U.
- Argonne’s strategy presented to Secretary of Energy Ernie Moniz and the **Secretary of Energy Advisory Board** on June 19.
 - “The Board will provide advice and recommendations to the Secretary of Energy on the Department’s basic and applied research and development activities, economic and national security policy, educational issues, operational issues, and on any other activities and operations of the Department of Energy as the Secretary may direct.”
- The **DOE Triennial Review of the APS** was held June 24-27.



Board of Governors Annual Review of the Photon Sciences Directorate and Advanced Photon Source



UChicago Argonne, LLC Board of Governors Review Committee Meeting for the
Photon Sciences Directorate and the Advanced Photon Source
at Argonne National Laboratory
May 28-30, 2014

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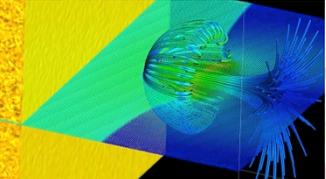
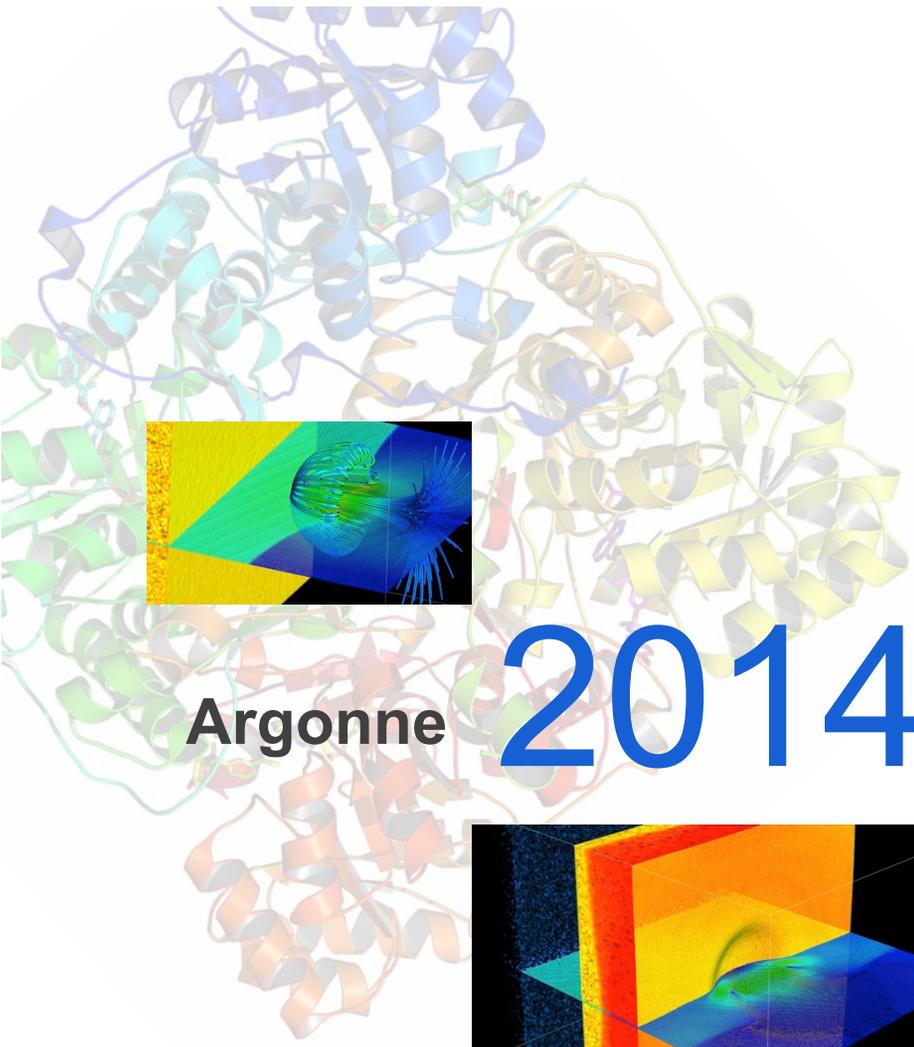
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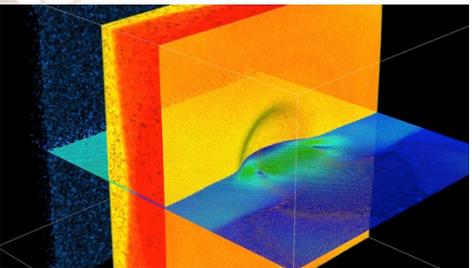
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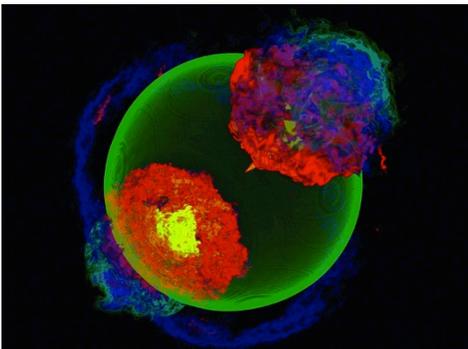




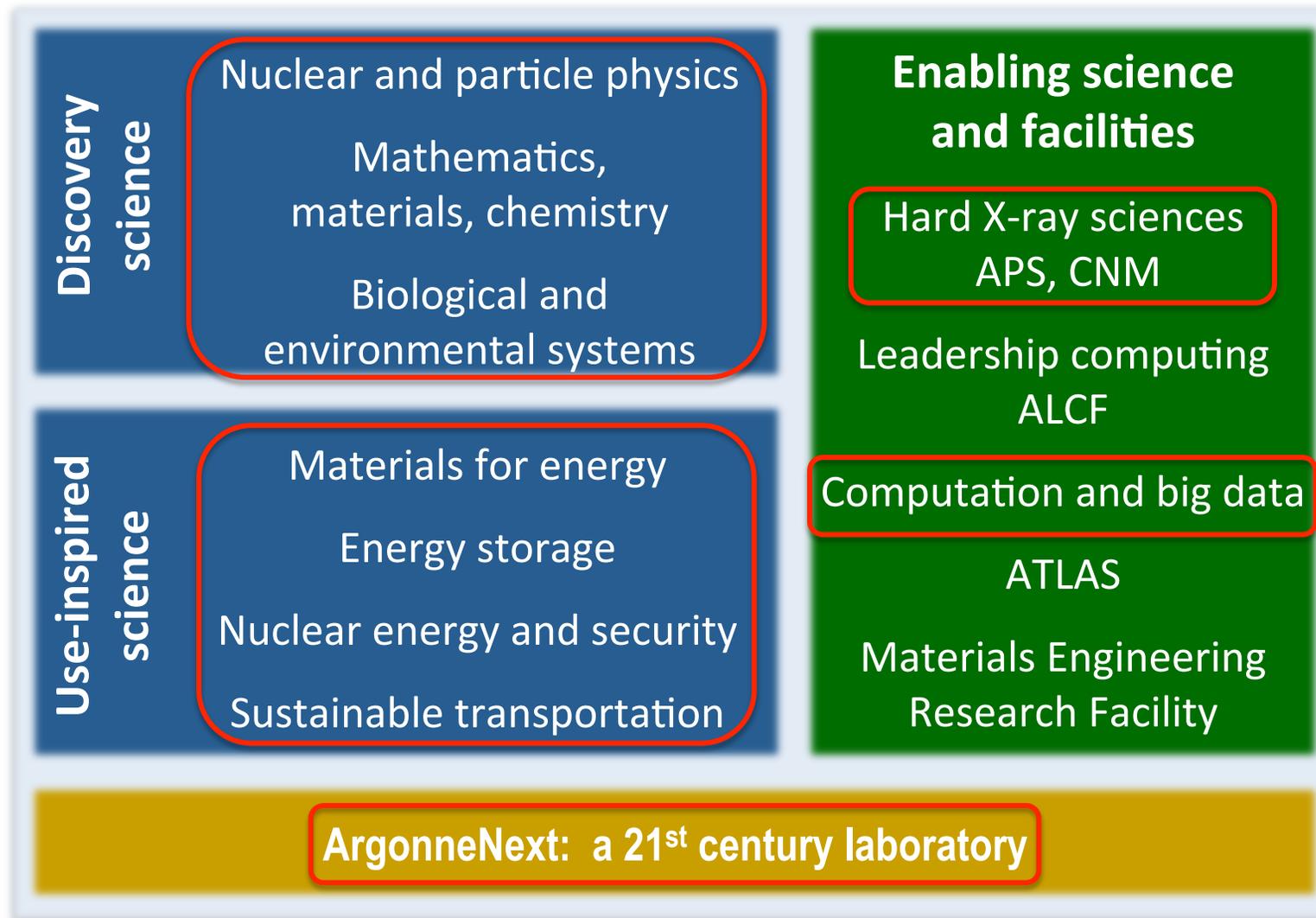
Argonne 2014 Laboratory Plan



Peter Littlewood, Director
Argonne National Laboratory
11 June 2014



Argonne's Initiatives





MAJOR INITIATIVE:

Hard X-ray Sciences

VISION Develop and use forefront hard x-ray techniques to discover new materials and chemical processes that solve energy, environmental and biological challenges



STRATEGY

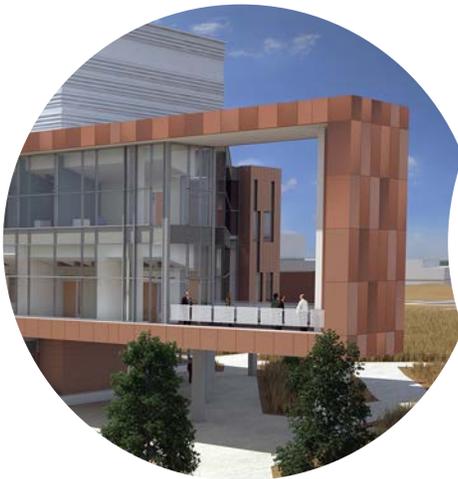
- Provide world-leading high-brightness hard X-ray user facility for mesoscale science
- Upgrade the APS with the best feasible technology to maintain world leadership
- Advance hard x-ray S&T to leverage APS-U high energy and brightness
- Develop integrated detector data-analysis-modeling capability

RECENT ACCOMPLISHMENTS

- *In situ* mesoscale imaging with CDI
- MBA design incorporated into expanded APS-U scope
- Three new undulator subprojects for LCLS-II
- Continued progress on SCU R&D for MBA
- MBA science workshop and report
- ASCR/BES pilot on data
- Dynamic compression sector beam line front end and undulator

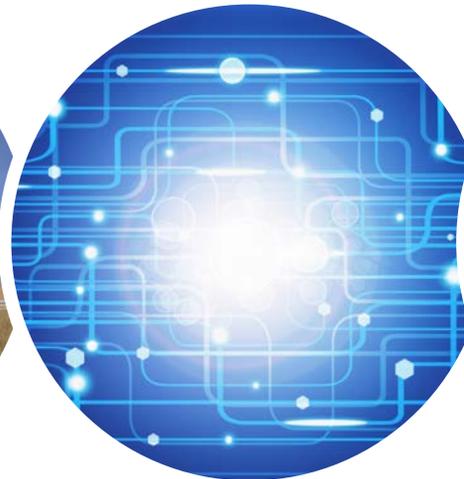
ArgonneNext

Four foundations for superior science and technology



Facilities

Modern
Flexible
Safe
Sustainable



Information systems

People-centric
Easy
Decision support
Access everywhere



Community

Talented & proud
Diverse
Collaborative
Widely recognized



Competitive advantage

Strategic
Funding capture
Innovative
High impact

↳ 2nd Site HV Power Source, Fiber Cabling, Rad Cleanup, Prep for EM Demolition



ARGONNE NEXT INITIATIVE:

Diversity and Inclusion

VISION Drive scientific excellence with a commitment to an inclusive and diverse workforce by maximizing individual potential and empowering all contributors



STRATEGY

Advance D&I across the lab:

- *Workforce Pipeline* - develop staff and establish Argonne as a destination of choice
- *Mentoring* – cultivate climate and relationships that help staff achieve their highest potential
- *Leadership Development* - improve readiness of current and future leaders
- *Policies and Practices* - promote work-life balance, diversity and accountability

RECENT ACCOMPLISHMENTS

- Search committee modules being adopted across DOE complex
- Mentoring Exchange program & leadership development courses
- Awarded \$20K in UChicago scholarship funds to minority students
- Hosted enrichment programs for over 500+ minority students
- New award programs to recognize outstanding mentors and promote best practices

Annual Argonne Laboratory Plan: Campus Strategy

Gail Stine
Director, Facilities Management
& Services Division
June 11, 2014

Argonne Campus Strategy Prioritized Objectives

- **Objective 1 - Support Mission Critical Programs**
 - Argonne Leadership Computing Facility Upgrade 3 (ALCF-3)
 - Advanced Photon Source Upgrade (APS-U)
- **Objective 2 - Construction of Replacement Facilities & Reutilization/Renovations of Existing**
 - Replace/update aging labs and offices to meet current scientific needs
- **Objective 3 - Address Support Infrastructure**
 - Replace aging equipment, reduce potential risks to impacting scientific operations, increase reliability and redundancy
- **Objective 4 - Address Legacy Waste and D&D**
 - Characterize and remove legacy waste, prepare facilities for Environmental Management funded demolition, D&D facilities (FY22+) that no longer support the mission



Argonne Multi-program Flex Facility

Multi-program building providing maximum flexibility and immediate support to programmatic needs

- Approximately 90,000sf of general office, high bay and industrial space modules
- Alternatively financed (\$25-35M)
- Completed FY17-FY18
- Support of APS upgrade MRAS (assembly and staging)

Future mission needs:

- Homeland defense and national security program
- Applied material programs
- Atmospheric Radiation Measurement Climate Research
- Carbon fiber recycling research
- Engine dynamometer testing
- Radiological Assistance Program



Enables flexible space to meet future program needs





Quarterly Board of Governor's Meeting: Focus on the APS-U



APS Upgrade Strategy

Stephen Streiffer

Interim Director, Advanced Photon Source

Interim Associate Laboratory Director, Photon Sciences

UChicago Argonne, LLC Board of Governors Meeting

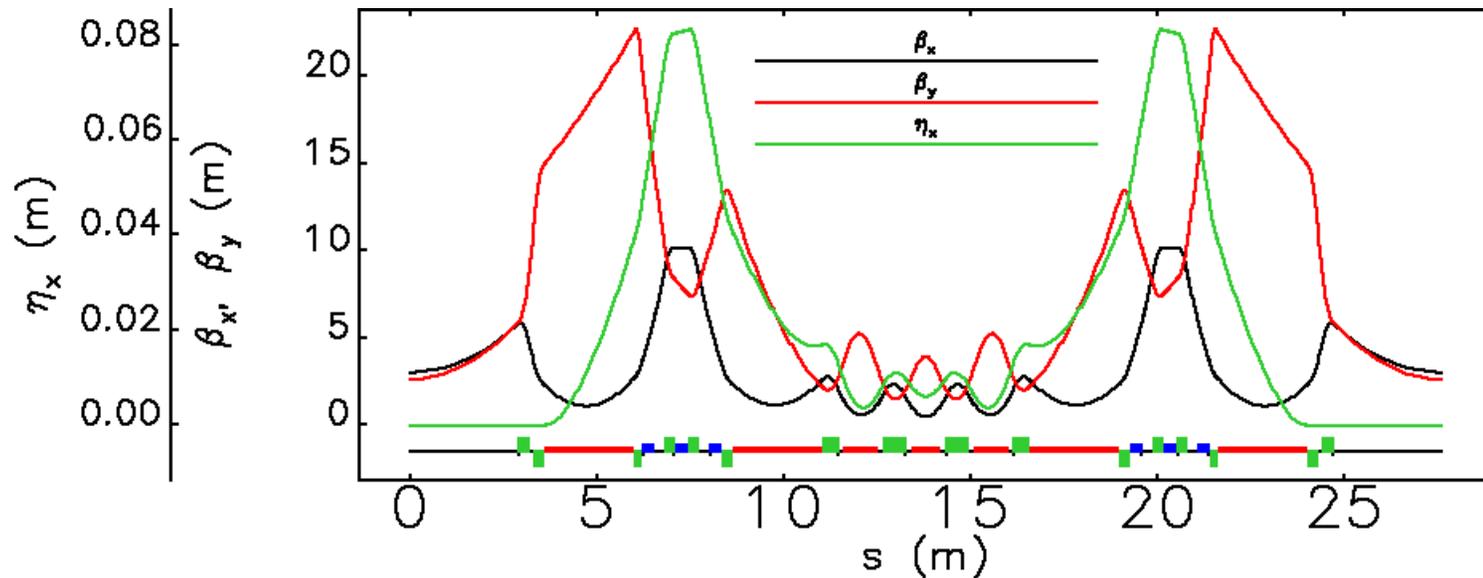
June 18, 2014

July 2013: BESAC Recommendations for Light Source Plans

Project	Prior to BESAC report	After BESAC report
Linac Coherent Light Source II (LCLS-II) SLAC	<ul style="list-style-type: none"> • Additional 1 km of linac • New electron injector and 2 new undulators • Major facility construction Status: Completed CD-0 and CD-1 TPC = approx. \$400M + instruments	SC directed SLAC to enhance scope based on BESAC recommendations Cost = approximately \$900M
Advanced Photon Source Upgrade (APS-U) ANL	<ul style="list-style-type: none"> • Upgrade of >20 beamlines • Addition of new insertion devices • Generation of 2 picosecond x-ray pulses; 50% increase in ring current Status: Completed CD-0 and CD-1 TPC = approx. \$400M	SC directed ANL to consider incorporating diffraction-limited storage ring technology into APS-U. Cost = approximately \$550M
Next Generation Light Source (NGLS) LBNL	High rep rate soft x-ray free electron laser facility based on a super-conducting linac and 3 undulators. Status: Completed CD-0 TPC range = \$0.9-1.5B	SC directed LBNL to consider whether NGLS could be modified at reasonable cost to cover broader wavelength range. After consideration, LBNL terminated the NGLS project.



FY13 LDRD Investment - Next-Generation Storage Ring Light Sources



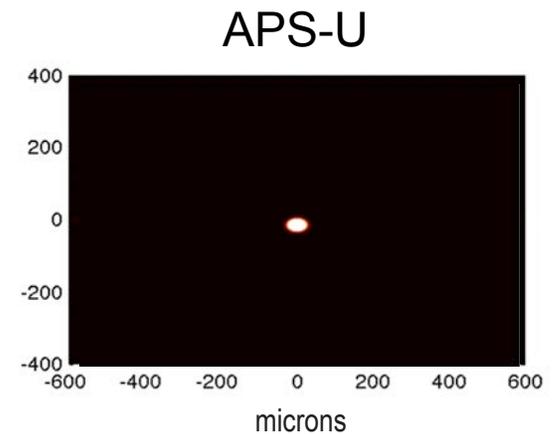
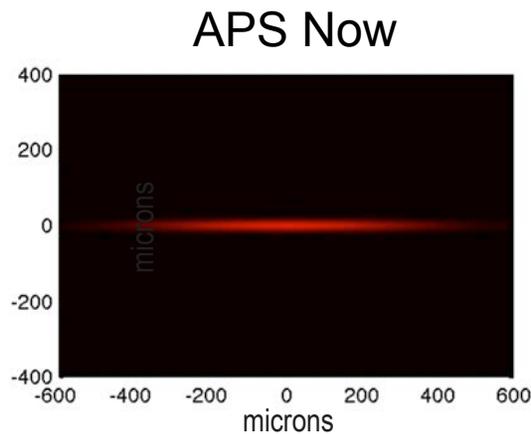
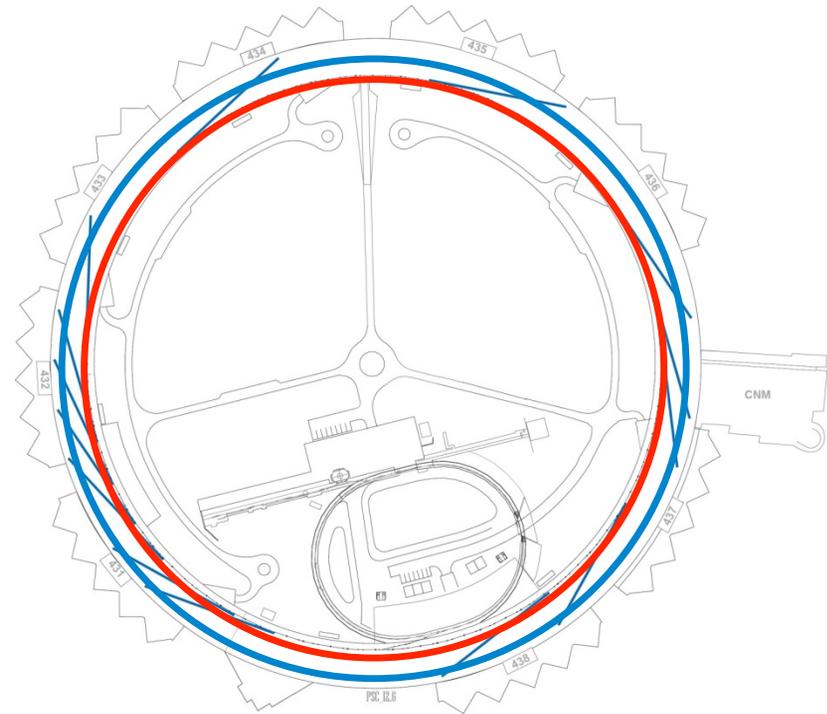
Hybrid 7-bend achromat lattice providing 80 pm emittance at 6 GeV in APS tunnel and >100-fold increases in brightness

- Multi-bend achromat (MBA) concept promises 40-fold decrease in APS emittance
- 100-fold or greater brightness increases within reach
- Project involves linear and nonlinear optics design, conceptual design of magnets and vacuum system, analysis of collective effects, and injection system design



APS Upgrade Features

- New accelerator: brightness and coherent flux increased by 2 to 3 orders of magnitude
- World class beam stability and control
- Higher operating current
- New beamlines and beamline upgrades with advanced optics
- Innovative undulators optimized for the MBA
- Advanced detectors



The electron beam inside the storage ring



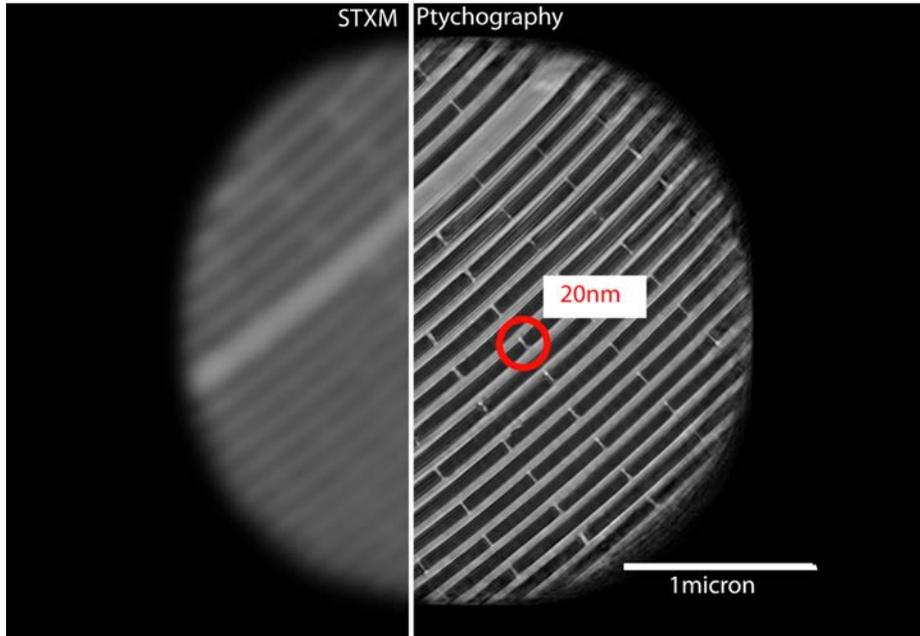
Emerging Science Drivers at the Advanced Photon Source



Dean Haeffner
APS-U Associate Project Manager

Board of Governors Meeting
June 19, 2014

Conclusions



- Coherent spectroscopies
Before Coherent imaging
(from D. Vine)

- Higher flux of the APS-U helps nearly every experimental technique currently used

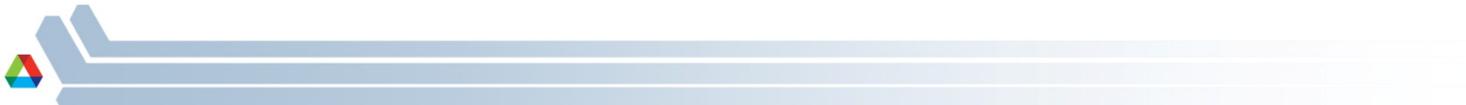
Last example:

- Current ptychography experiment
 - (ptychography is a form of coherent diffractive imaging)
 - Data Acquisition -> 21 hours
 - Data Analysis -> 52 days
- With APS-U and expected computer improvements:
 - Data Acquisition -> 13 minutes
 - Data Analysis -> 75 minutes





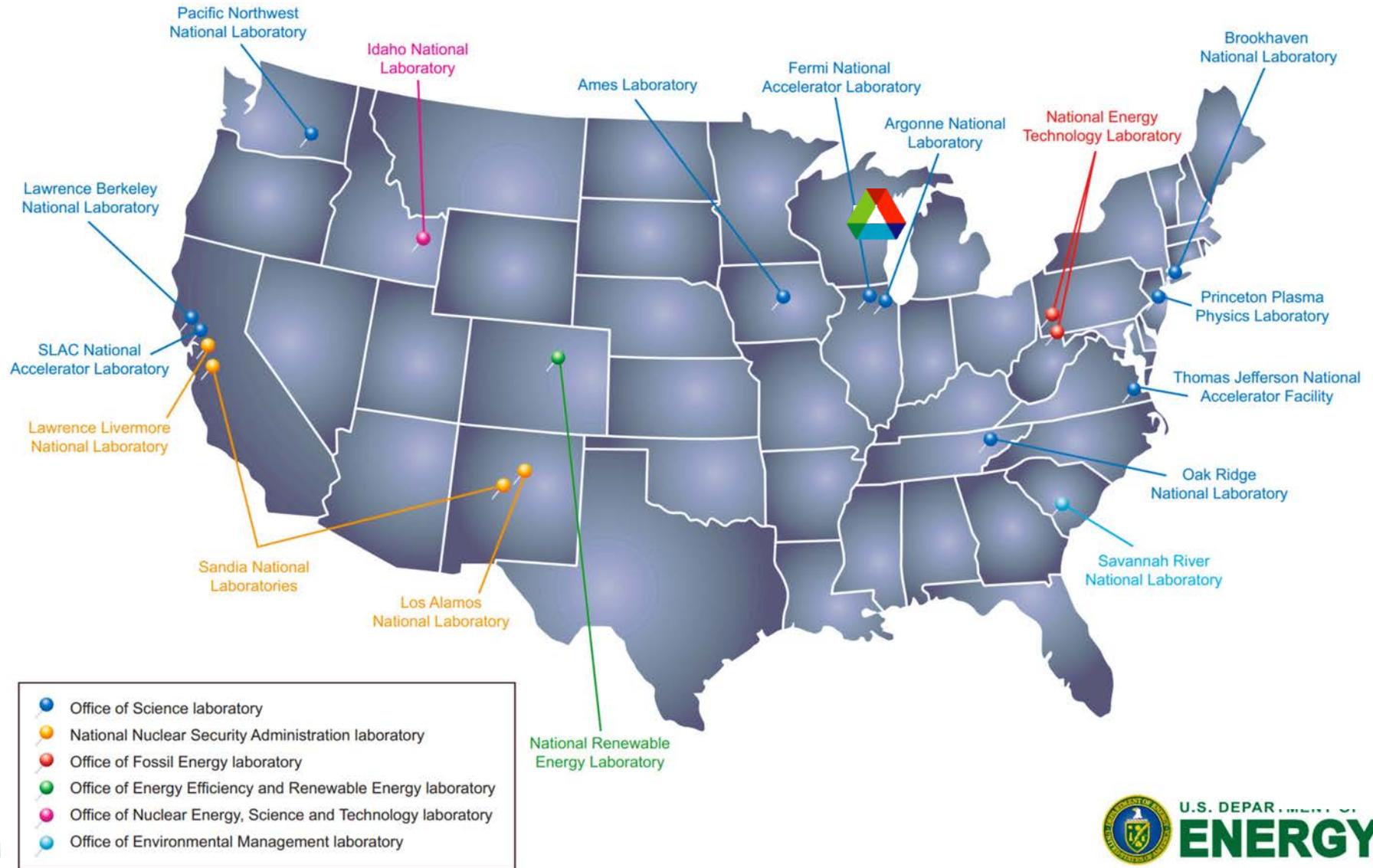
Secretary of Energy Advisory Board: Our Role in the National Science Ecosystem



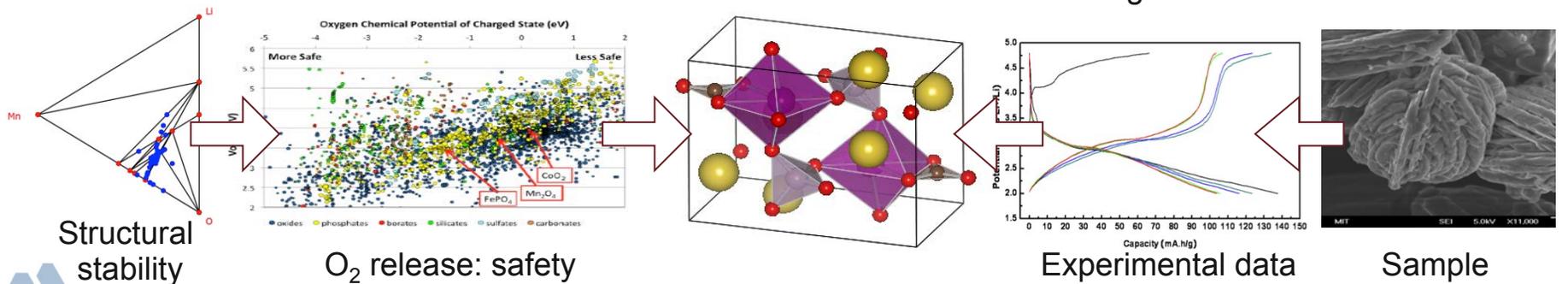
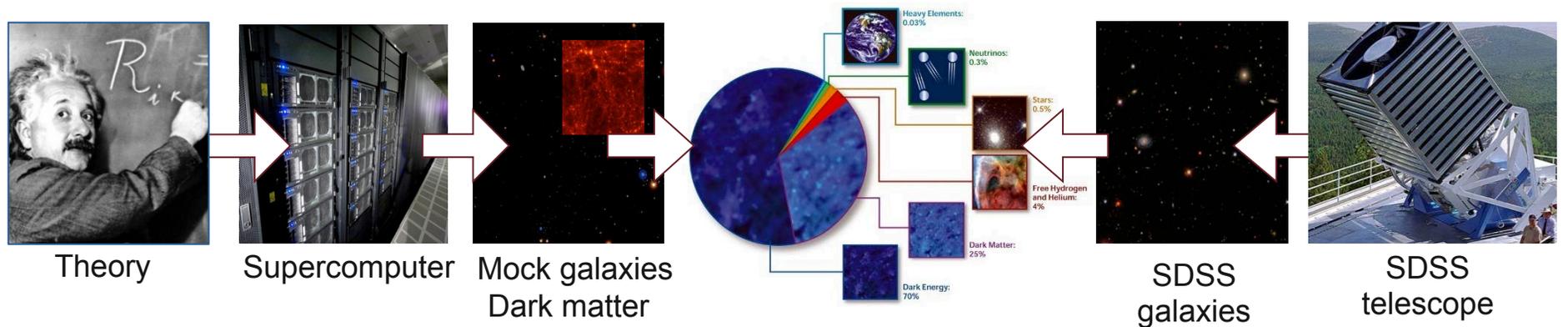
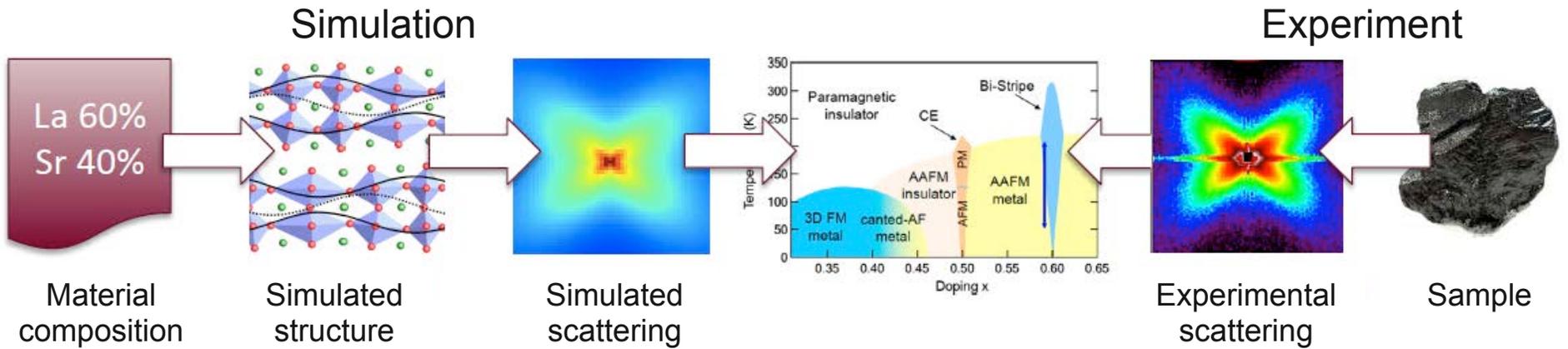
Meeting of the Secretary of Energy Advisory Board

Peter B. Littlewood, Director
Argonne National Laboratory
June 19, 2014

Argonne and the APS – are a vital part of DOE National Laboratory System



Bringing big data and simulation together





U.S. DEPARTMENT OF
ENERGY

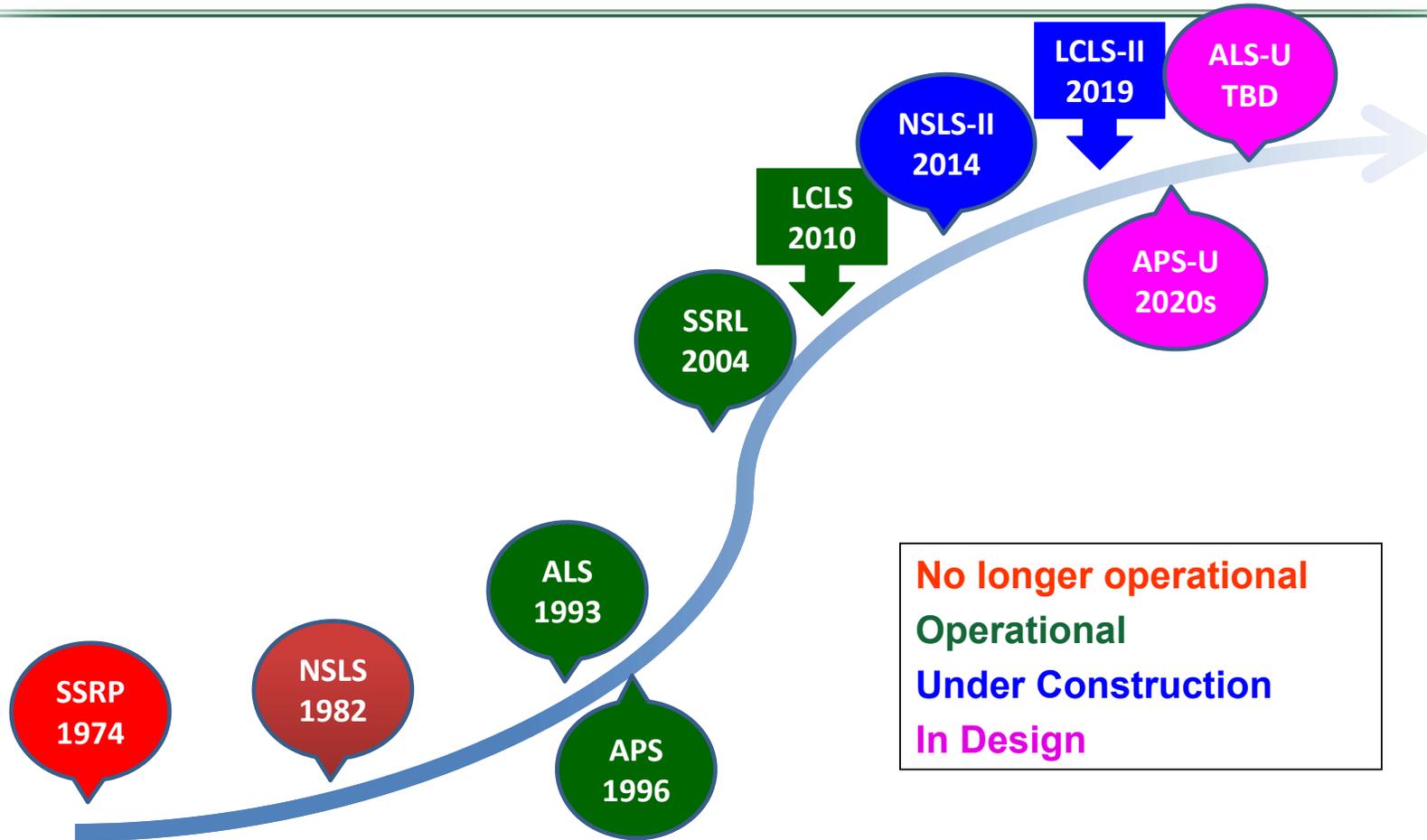
Office of
Science

Synchrotron Radiation Light Sources

Briefing for SEAB
20 June 2014

Patricia M. Dehmer
Acting Director, Office of Science
U.S. Department of Energy

The History of SC/BES Light Sources





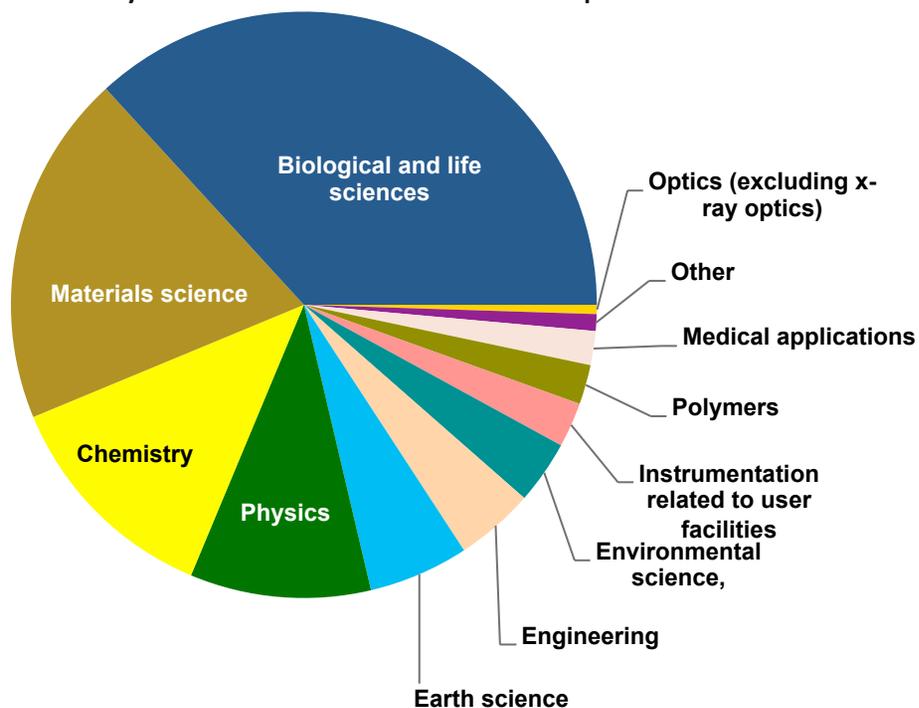
**The DOE Triennial Review:
Strategy, Strategy, and Strategy
And Budget**



The APS Has a Successful Record of Productivity and Growth

- High brightness and flux at high energies
- “Short” pulses, high rep rate, flexible bunch structure
- Wide array of beamlines, beam time available for complex experiments
- Large and diverse community
- Integrated with other Argonne strengths

- Life Sciences: ~40% of experiments
- Physical Sciences: ~60% of experiments



- >24,000 visits up from 22,500 by 5,728 users (+7%)
- 5,200 experiments in FY13, up from 4,900 (+6%)
- 1,771 total publications in CY13, up from 1,530 (+16%); 29% high impact
- >98% beam availability
- Over 1,500 protein structure deposits in CY13



Accelerator Performance Is Outstanding

FY11-13 Mean Time Between Faults (MTBF): 128.8 hours

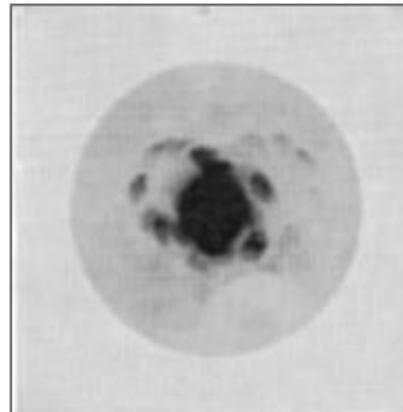
FY11-13 Availability: 98.5%

FY14 To Date: MTBF 121.9 hrs, Availability 98.3%

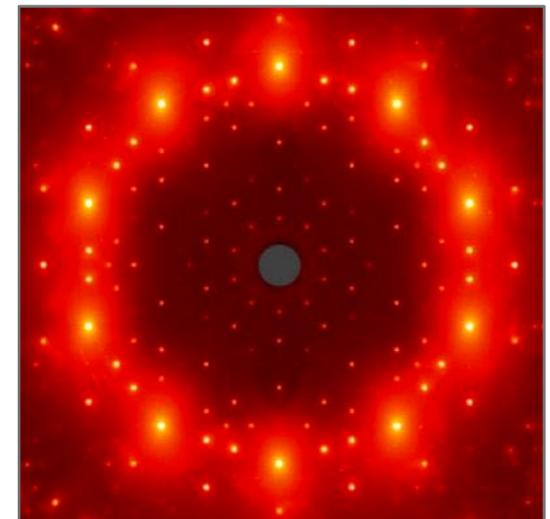
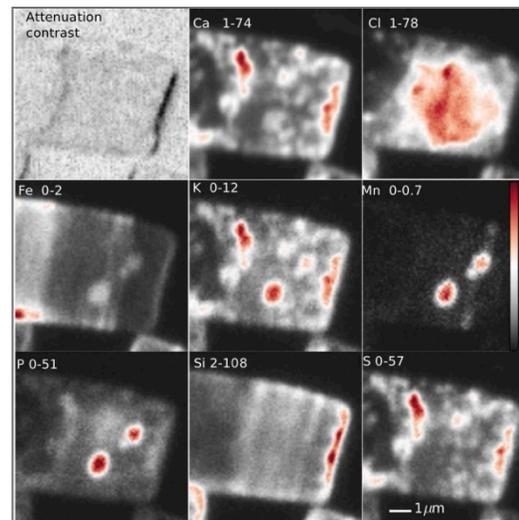
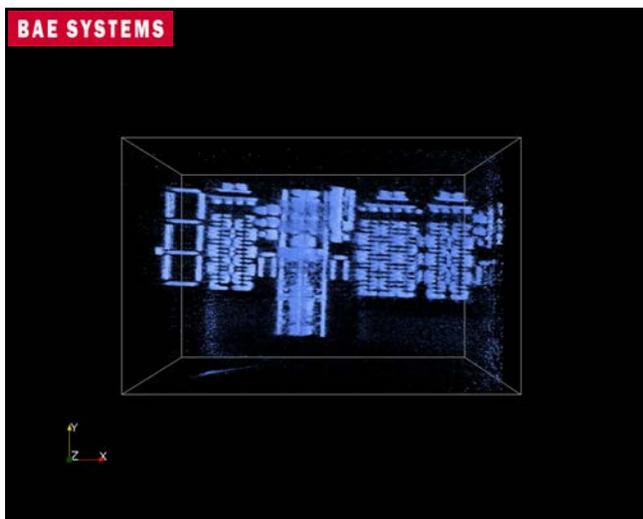
Made possible by proactive accelerator team and QA program



Vision: Uniting the Worlds of Roentgen and von Laue



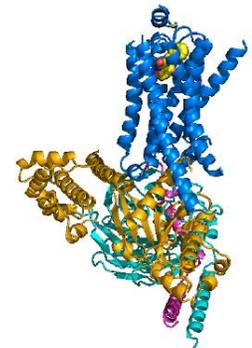
- Imaging yield submicron information
- Diffraction yields sub-nanometer information



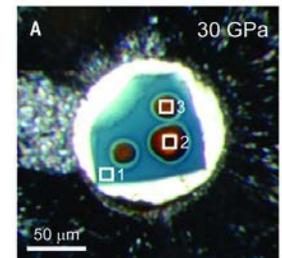
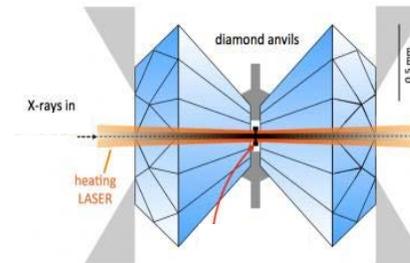
APS International Leadership in Science

The APS differentiates itself from other global high-energy, high-brightness light sources by continually developing innovative beamlines and by establishing world leadership in select scientific fields

- Macromolecular crystallography
 - Newest area – microbeam, difficult-to-crystallize systems
- High-pressure science, dynamic compression
- Probing magnetism with hard x-rays
- X-rays in the 4th dimension: Stroboscopic and pump-probe-probe-probe.... x-ray movies of dynamics of complex systems
- 3-D microscopy with elemental & chemical specificity
- Analysis of complex materials structure from Ångstroms to microns
 - High-energy diffraction microscopy, tomography
 - Scattering (PDF, WAXS, SAXS, GISAXS, and USAXS) **and** spectroscopy



S.G.F. Rasmussen et al., *Nature* 477, 549 (2011)

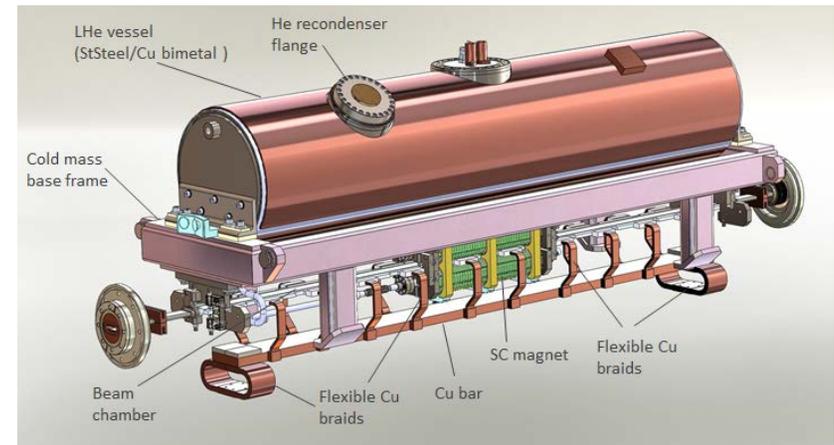


"Dehydration melting at the top of the lower mantle,"
B. Schmandt, S.D. Jacobsen, T.W. Becker, Z. Liu, and
K.G. Dueker, *Science* 344, 1265 (2014).



APS International Leadership in Light Source Science and Technology

- Novel undulators including permanent-magnet and superconducting undulators, and fast switching electromagnet undulators
- Advanced diagnostics, more specifically, development of the grazing incidence x-ray beam position monitor using fluorescence as a signal source, and development of the rf cavity-based high-precision beam position monitor for LCLS
- User friendly computer codes for simulation and modeling of accelerators
- Free-electron laser (FEL) theory, more specifically x-ray FEL oscillator



Cold mass inside SCU cryostat



High-Power
Hard x-ray BPM



Our Challenge: Develop a Strategic Plan that Achieves APS Goals and Allows Us to Prioritize Investments

- Provide the world-leading high-brightness hard x-ray user facility to enable outstanding science by users (including staff)
- Upgrade the APS with state-of-the-art technology to maintain world leadership
- Enable continued progress in light sources and their utilization
- Assure the safety of the facility users and staff and the environment
- Maintain a world-class organization that is diverse, inclusive, and focused on innovation. Provide a rewarding environment for staff and users that fosters professional growth.

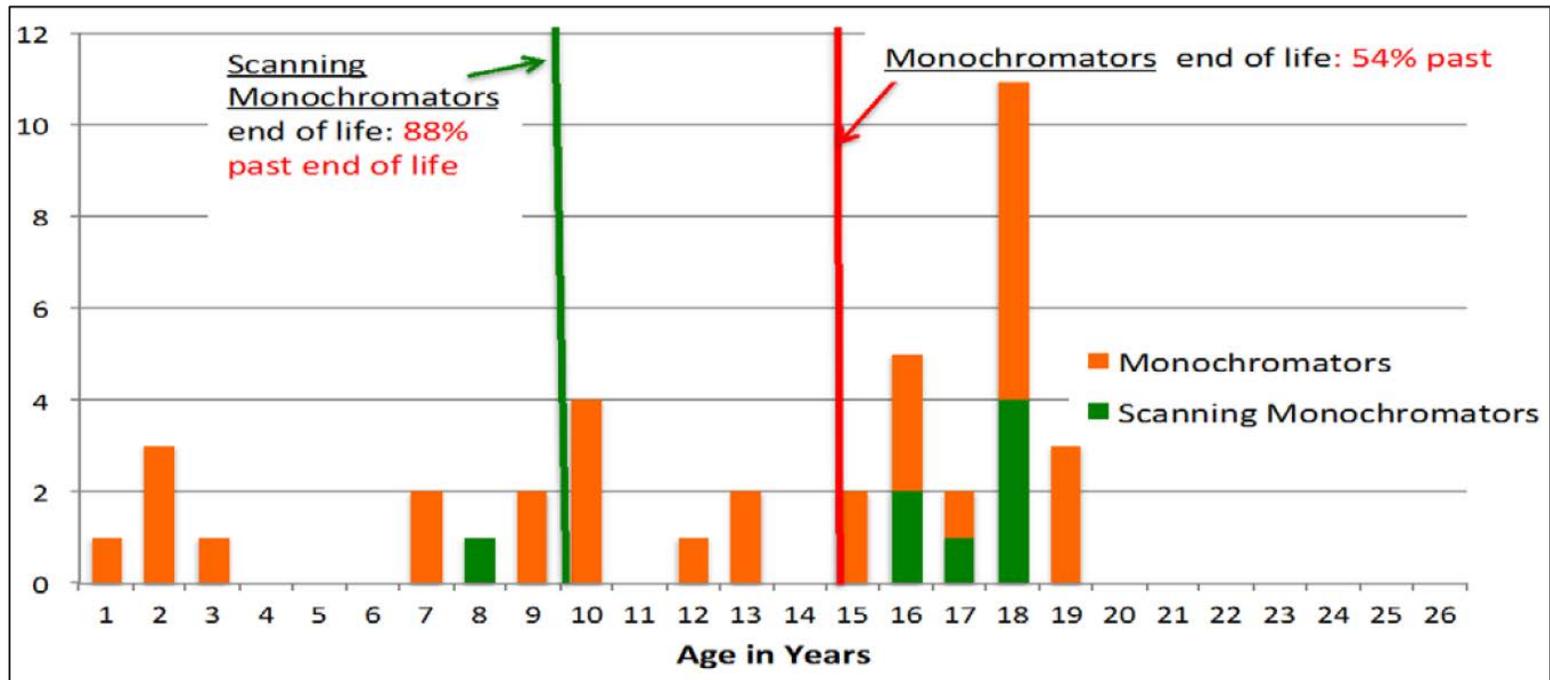
APS Will Achieve Its Goals By Investment in Well-Defined Areas

- X-ray operations
- Accelerator operations
- Improvements
- Staff science supporting the APS mission
- Mission readiness
- Strategic research and development
- Infrastructure, general operations, and administration
- Human capital and workforce development
- We will also engage in special projects and Work for Others that are consistent with our mission, strengths, and goals



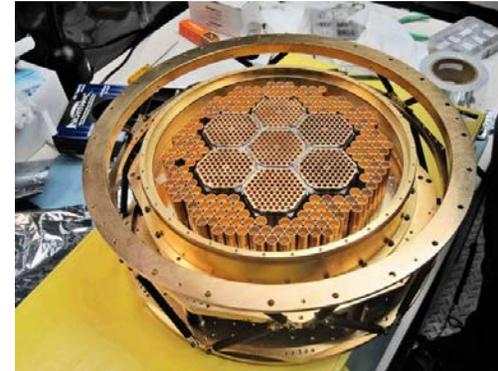
Invest in Mission Readiness Across the Facility

- Develop a comprehensive plan to anticipate and mitigate risks associated with beamline and accelerator equipment reliability, end-of-life failure, and obsolescence.
- Applied to all work that is not included in the scope of the APS Upgrade project but is required for the long-term reliable operation of APS.
- Includes beamline systems
- Began approx. 6 months ago



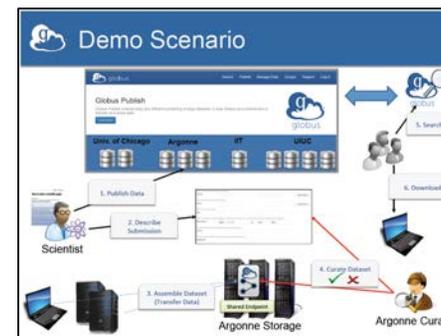
Strategic R&D Directions

- Optics
- Detectors
- Nanopositioning
- Sample Environments
- Data and Analysis
- Magnetic Devices
- Beam Stability
- Beamlines and Experimental Techniques that will Exploit APS-U
- Enabling Time-Resolved Research for the APS Upgrade
- Sources beyond APS-U



ANL will build all 15,200 sensors for SPT-3G

- Detectors: Leverage initiative between Argonne and University of Chicago
 - Large area photodetectors
 - Superconducting bolometric detectors for the South Pole Telescope (SPT)
 - Quantum engineering
 - **Future detector technologies for the APS**

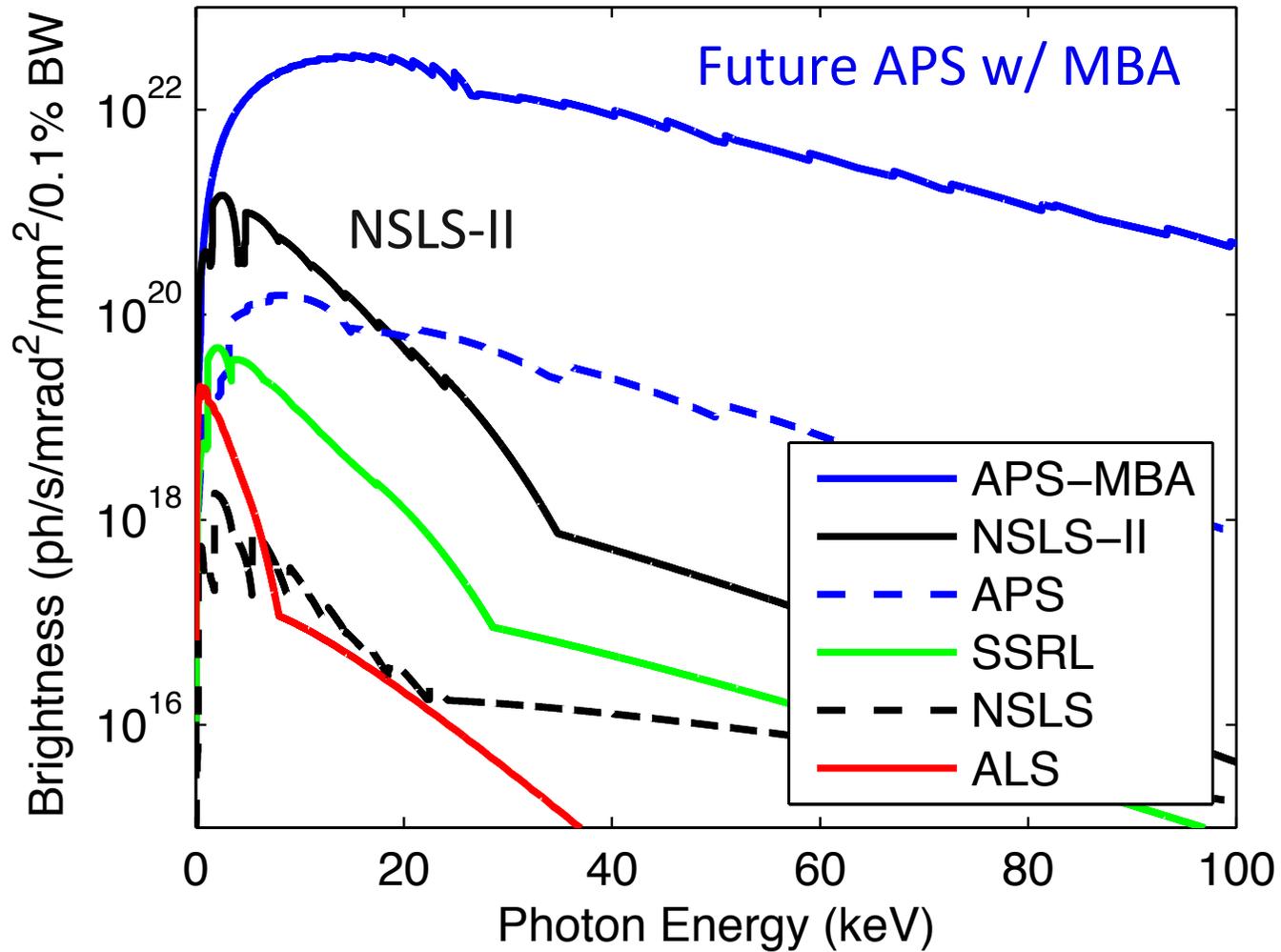


*Ian Foster, et al.,
(Argonne and U.
Chicago),
Globus – Publishing and
Discovery Demo, Globus
World 2014*

- Leverage Argonne expertise in exascale computing, data and computational science applications



APS-U: MBA lattice will yield unprecedented brightness and coherence up to high energies

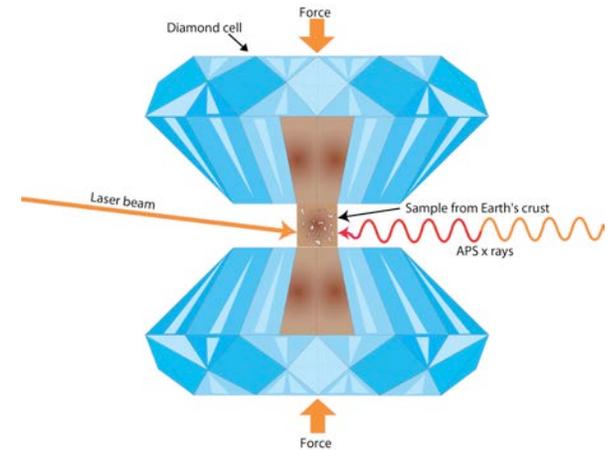


Brightness vs. x-ray energy at top beamlines among BES synchrotron facilities

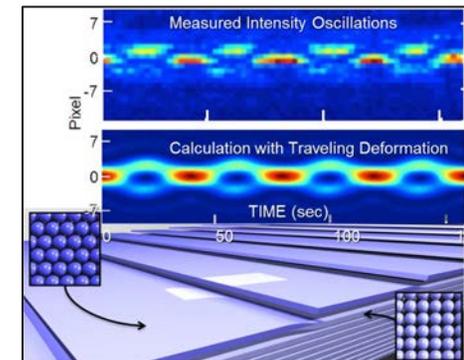


Exploits APS' Future Source Characteristics: High Energy Brightness, Coherence, and Nanobeams

- High resolution, real time exploration of *in operando* or *in situ* phenomena: exploring engineered systems and chemical processes
- Science at terascale pressures
- Structure and chemistry of individual nano-objects: beyond ensemble measurements
- Structure and dynamics in non-periodic systems
- Nanoscale imaging and spectroscopy of collective behavior in inhomogeneous systems
- Structure and dynamics of cellular machinery
- Trace element migration and evolution in environmental and biological systems



To exceed today's limit of 400 MPa,
need higher flux
to see signals from small samples



Increased coherence for better time and
spatial resolution





**APS-U Strategy:
Work with Stakeholders on Plans for the
APS-U Installation Period**



Developing the APS Strategic Plan

- Working draft of the Strategic Plan completed for Triennial Review
 - Created based on input provided to ALD office by Division management
 - Division management created their input from their own divisional planning processes
- Next step: Present to staff and stakeholders for feedback
 - Introduce at All-Hands meeting on July 1st
 - Division staff meetings will be held during July
 - SAC asked to provide initial feedback by July 14th
 - Plan will be introduced to Joint APSUO and PUC Meeting on July 9th, 2014
 - Revised Plan will be presented at next APS Users Monthly Operations Meeting on July 30th and through the User News newsletter and targeted communications to obtain community input, with feedback request by August 29th
- Will schedule discussions with partners / CATs missed by the July 9th meeting
- Will consult with BES on plan directions
- Feedback will be incorporated by APS management into a final draft by Sept. 30th
- Consult with Scientific Advisory Committee at November 2014 meeting
- Finalize Plan by end of the Calendar Year

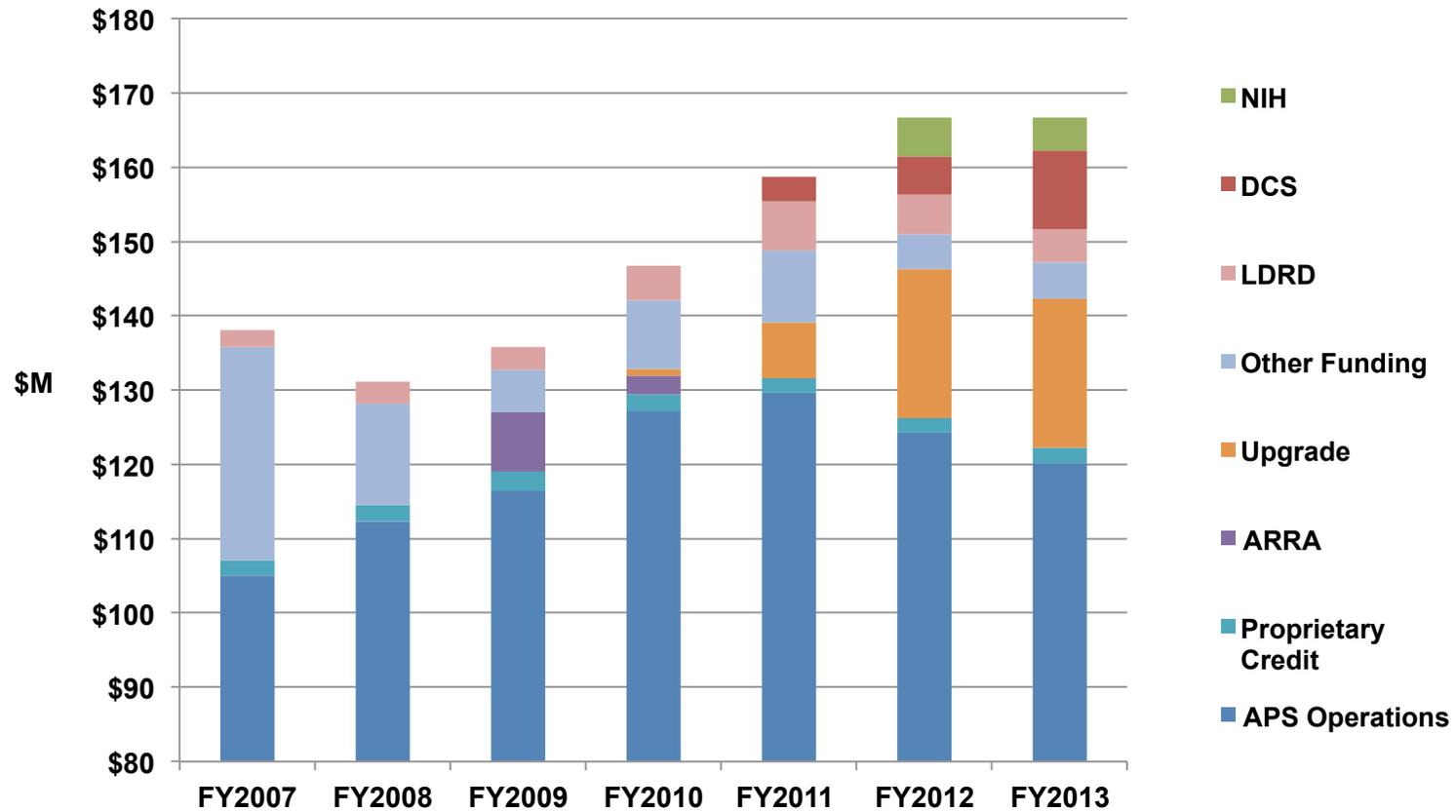




**Budget:
Efficiency, Investment for the Future
with Flat or Declining Budgets**



Photon Sciences Funding



FY15 Funding Outlook

Office of Science (SC)

ITEM	FY12 Conf.	FY13 Enacted	FY14 Omnibus	FY15 Request	FY15 House	FY15 Senate
SC						
ASCR:	442,000	440,825	478,593	541,000	541,000	
BES:						
Research	1,542,600	1,538,498	1,610,757	1,667,800	1,574,000	
<u>Construction</u>	<u>151,400</u>	<u>150,997</u>	<u>102,000</u>	<u>138,700</u>	<u>128,000</u>	
Total BES	1,694,000	1,689,495	1,712,757	1,806,500	1,702,000	
BER:	611,823	610,196	610,196	628,000	540,000	
FES:						
Research			305,677	266,000	315,000	
<u>Constr. ITER</u>			<u>200,000</u>	<u>150,000</u>	<u>225,000</u>	
Total FES	402,177	401,108	505,667	416,000	540,000	
HEP:						
Research	763,700	761,669	746,521	738,000	738,000	
<u>Construction</u>	<u>28,000</u>	<u>27,926</u>	<u>51,000</u>	<u>25,000</u>	<u>37,000</u>	
Total HEP	791,700	789,595	797,521	744,000	775,000	
NP:						
Research	---	498,670	489,438	487,073	493,500	
<u>Construction</u>	<u>---</u>	<u>49,867</u>	<u>80,500</u>	<u>106,500</u>	<u>106,500</u>	
Total NP	550,000	548,537	569,938	593,573	600,000	
SLI:	111,800	111,503	97,818	79,189	79,189	
S&S:	82,000	81,782	87,000	94,000	94,000	
Workforce:	18,500	18,451	26,500	19,500	19,500	
Prog. Dir.:	185,000	184,508	185,000	189,393	180,000	
<u>Resc. /Pr. Yr.</u>	<u>---</u>	<u>---</u>	<u>---</u>	<u>---</u>	<u>---</u>	
Total	4,889,000	4,876,000	5,071,000	5,111,155	5,071,000	5,086,000



We must deliver more scope for the dollar

- Senior management will conduct a top-down assessment of organization and efficiencies
- A working group will evaluate several aspects of APS operations, organization, and interactions with central Argonne support services. The task force includes both key APS and Argonne mission support leaders.
- We will gather input from experimental-floor-level staff on what they believe is working and what is not.



Intra-Laboratory Memo

May 22, 2014

TO: Mark Beno, XSD Deputy Division Director
John Carwardine, PSC Deputy Associate Project Manager
Mike Dunn, FMS Deputy Division Director
Stuart Hannay, CIS Division Director/Chief Information Officer
John MacLean, AES Associate Division Director
Geoff Pile, AES Associate Division Director
John Quintana, OPS Deputy Chief Operations Officer
Susan White De Pace, XSD Manager, APS User Programs

FROM: Paul Kearns *Paul K. Kearns* Deputy Laboratory Director for Operations/
Stephen Streiffer *SS* Chief Operations Officer
Interim PSC Associate Laboratory Director/APS Director

SUBJECT: Formation of a Task Force to Review APS Operations

You have been appointed to a task force to assist in ensuring APS operations, including Mission Support services, are appropriately structured to provide support services that are effectively and efficiently delivered to support APS programmatic and facility operations. The members of the task force reflect an initial focus on three areas: IT and computer support; delivery of engineering services; and user services/site access. Mark Beno and John Quintana, will serve as conveners/facilitators for this effort. The conveners are responsible for coordinating meetings and support from their respective organizations. The task force is to:

1. Review the services, across the spectrum, currently being provided by APS support groups. Identify services that could be more effectively and efficiently provided by Mission Support organizations. Where possible, work with the relevant Mission Support organization to identify a timeline for handoff. Conversely, identify which services are unique and/or critical to APS that are most efficiently performed by internal APS support groups.
2. Evaluate services and processes that are part of or impact APS operations and are candidates for process improvement efforts for increased effectiveness, cost savings, and efficiency. The evaluation should include internal APS processes, as well as Mission Support processes, and any interfaces between them.
3. Evaluate the effectiveness of APS mechanisms to coordinate operations and prioritize resource allocation, including Operations activities, shutdown planning, the Service Coordination Board and other engineering support allocation mechanisms (small projects, Tech Tuesdays), as it pertains to addressing the relevant recommendations from the 2011 and 2013 DOE/BES reviews of the APS.
4. Evaluate organizational alignment of groups and functions within APS and suggest opportunities for improvement.
5. Identify opportunities for receiving best value through outsourcing to outside vendors.

We recognize new areas of engagement beyond the initial focus areas may emerge as the task force undertakes its evaluations. Formal addition of focus areas and designation of any additional members required to address those areas should be provided in writing for our approval. Any proposed changes with potential Lab-wide implications will be referred to the Business and Operations Council for recommendation to Laboratory Management.

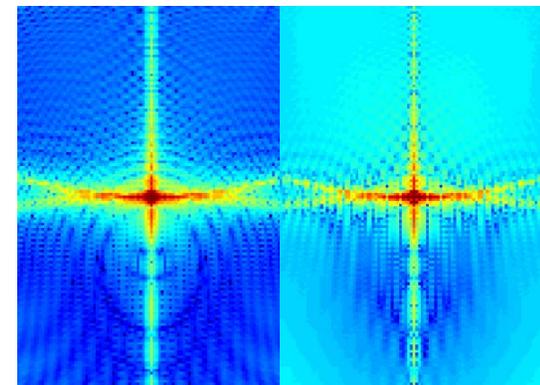
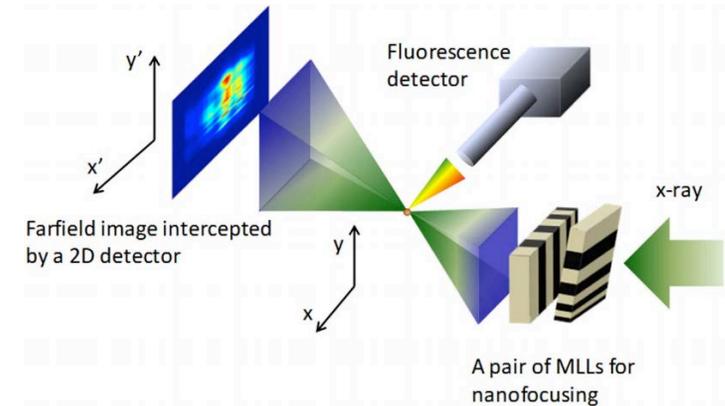
Deliverables: The facilitators will provide updates periodically. A written report of the task force status and initial recommendations is due by July 22, 2014. The task force will continue to engage after July 22, 2014, to more deeply develop recommendations and potential optimized procedures/processes based on the initial report. The facilitators will then provide quarterly updates until the completion of work is agreed.

cc: W. Ruzicka
G. Stine
L. Young



Where Do We Go From Here? The Future in a Nutshell

- Provide the world-leading high-brightness hard X-ray user facility to enable outstanding science
 - Accelerate discovery (*in situ* observation/control, computation)
 - Exploit high energy x-rays, time structure
 - Invest in data science
 - Invest in directions that will be the sweet spot for the future: high energy, nano-focusing, coherence
- Upgrade the APS with the best feasible technology to maintain science leadership
 - Rebuild the storage ring with a multi-bend achromat design and high stability to provide the U.S.'s first fourth-generation storage ring hard X-ray source
 - Develop next-generation undulators to produce the highest possible x-ray brightness
 - Develop advanced beamlines that fully exploit the high-brightness source
- Enable continued progress in light sources and their utilization



Simulated coherent scattering off (left) and on (right) a single vacancy in Si, using APS-U MBA beam parameters



Questions?

