APS Update

Brian Stephenson

Partner User Council Executive Committee meeting

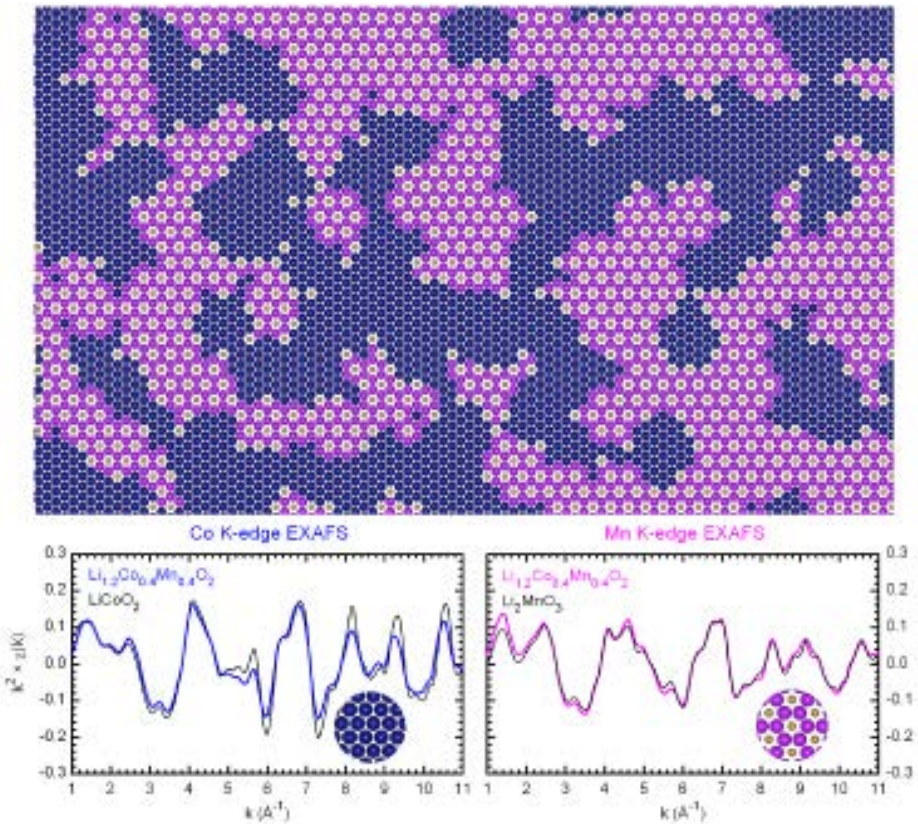
August 17, 2011

APS Update

- Science Highlights
- Safety and Cybersecurity
- News
  - NX School
  - User Awards
  - Personnel Changes
  - FY11 and FY12 Budget
  - Reviews of APS by DOE and UofC
- APS Upgrade Status and Plans
  - Interaction with operations
  - Strategic plan surrounding and beyond the Upgrade

Building a Better Battery

- Long-range & local structure of lithium-rich compound $Li_{1.2}Co_{0.4}Mn_{0.4}O_2$ produced model that could explain how such materials operate on electrochemical level, how to use them to build a better battery
- Experimenters studied samples of the compound using XRD and XAS at 20-BM as well as electron microscopy
- XAS studies were uniquely successful in distinguishing the local atomic environments around cobalt & manganese
- Crystalline structure compound is largely homogeneous over long range, local structure contains nanoclusters that might present connectivity over long distances as dendritic network
- Next step: Observe structural changes occuring in compounds as they cycle thru various voltage windows, critical for determining battery life and durability

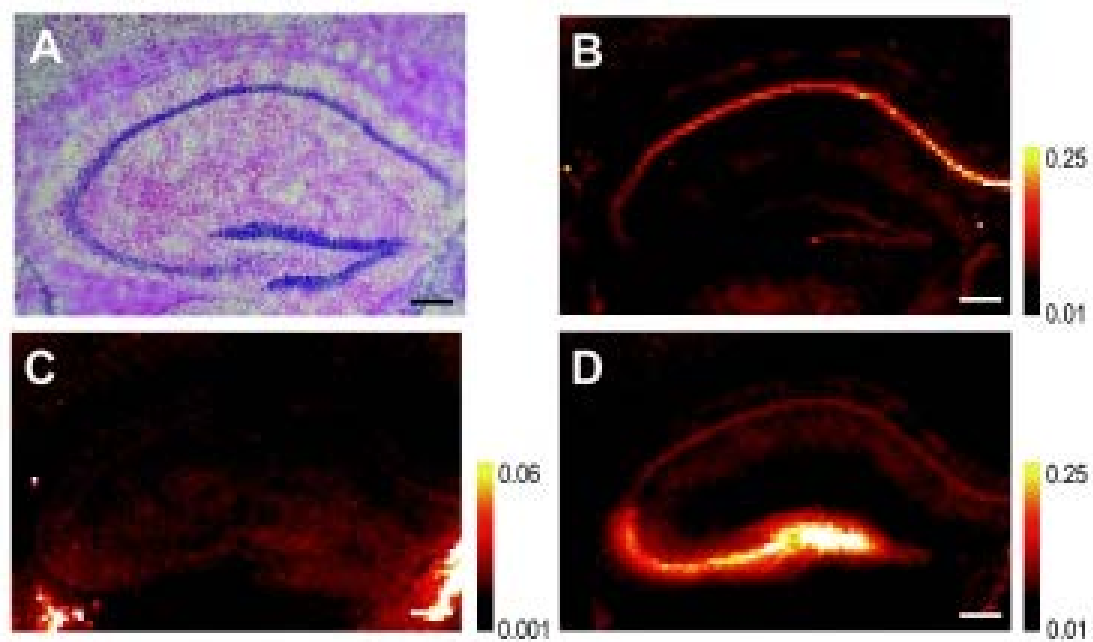


(Top panel) Schematic arrangement of lithium (yellow), cobalt (blue), and manganese (magenta) atoms in the transition metal plane of the layered $Li_{1.2}Co_{0.4}Mn_{0.4}O_2$ structure. Well connected areas with $LiCoO_2$, where only cobalt is present, and Li_2MnO_3, where manganese atoms surround lithium atoms in a hexagonal pattern, are observed. Each of these areas gives rise to a distinctly different EXAFS spectrum (bottom panel) that is characteristic of the local chemical environment.

J. Bareño et al., Chem. Mater. **23**(8), 2039 (2011).

Brain Iron as an Early Predictor of Alzheimer's Disease

- Use of elevated brain iron content (observed in late-stage Alzheimer's disease) identified as potential tool for early diagnosis
- XFM study at Bio-CAT 18-ID-D beamline (APS) and at NSLS beamline (BNL) used model system of amyloid plaque formation in mice to investigate how iron distributes in brain cortex and hippocampus over time
- Results show that iron content is significantly higher in cortex early in disease and corresponds to onset of plaque formation

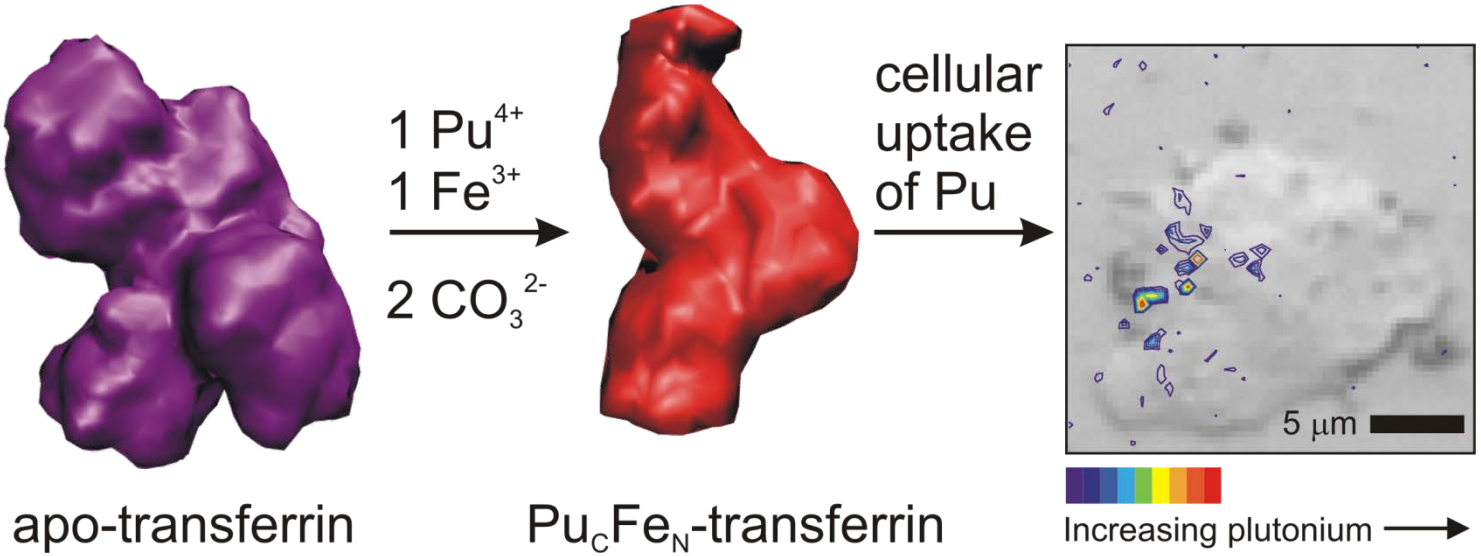


(A) Light micrograph of a stained hippocampal brain section from a mouse. XFM images: iron (B), copper (C), and zinc (D) in the same tissue section. Units are mM. Scale bar = 300 µm.

Andreana C. Leskovjan et al., NeuroImage **55**(1), 32 (1 March 2011).

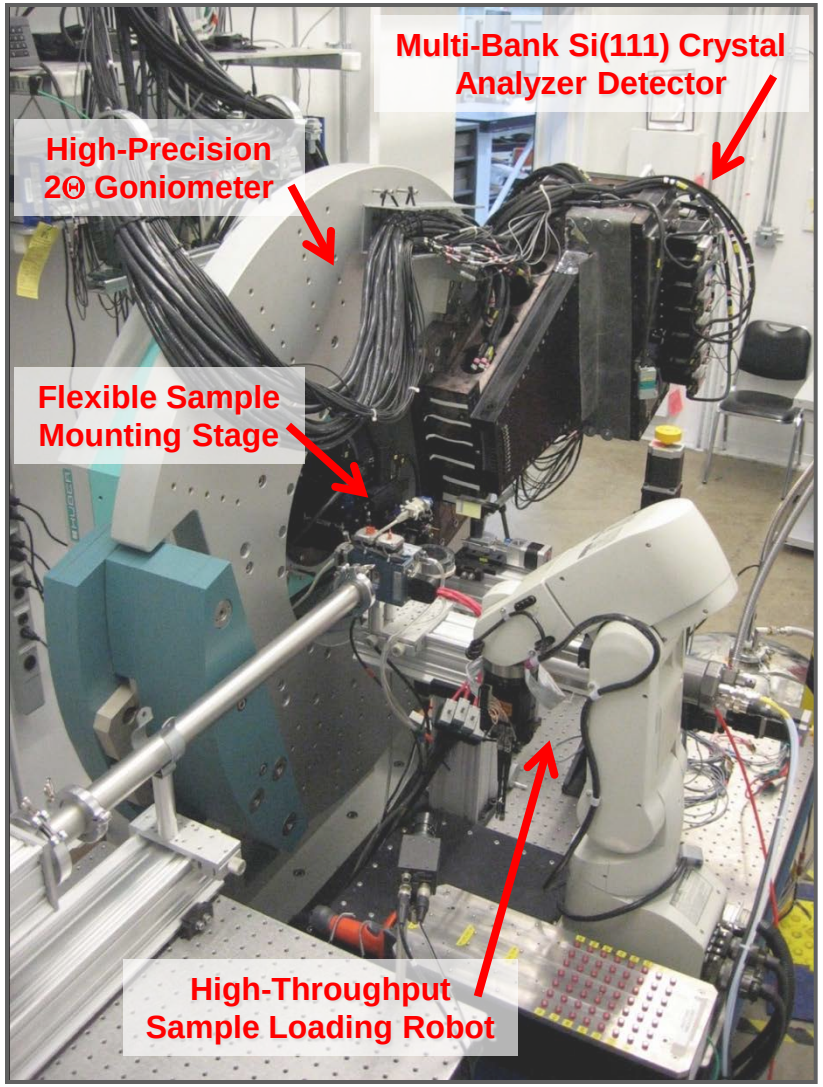
Hijacking Proteins with Plutonium: A Pathway for Uptake by Mammalian Cells

- Protein transferrin delivers needed iron to cells throughout the body, known to strongly bind plutonium but thought to not carry radioactive element into cells
- Structural studies of plutonium-containing transferrins combined with XM at beamine 12-ID-B (APS) revealed for first time that one specific conformation of metal-containing protein is mistaken for naturally occurring iron-transferrin and is taken in by cells
- Knowing a definite pathway that plutonium uses to enter cells presents target to specifically block cellular uptake of highly toxic element

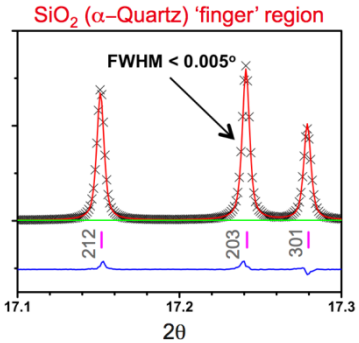


M. P. Jensen et al., Nat. Chem. Biol., advanced online publication (June 2011)

High-Resolution Powder XRD at 11-BM



World Class Synchrotron Powder Diffraction at the Advanced Photon Source



Exceptional Resolution & Count Sensitivity

$\Delta d/d$, $\Delta Q/Q \approx 2\times10^{-4}$

count statistics $\approx 10^5$

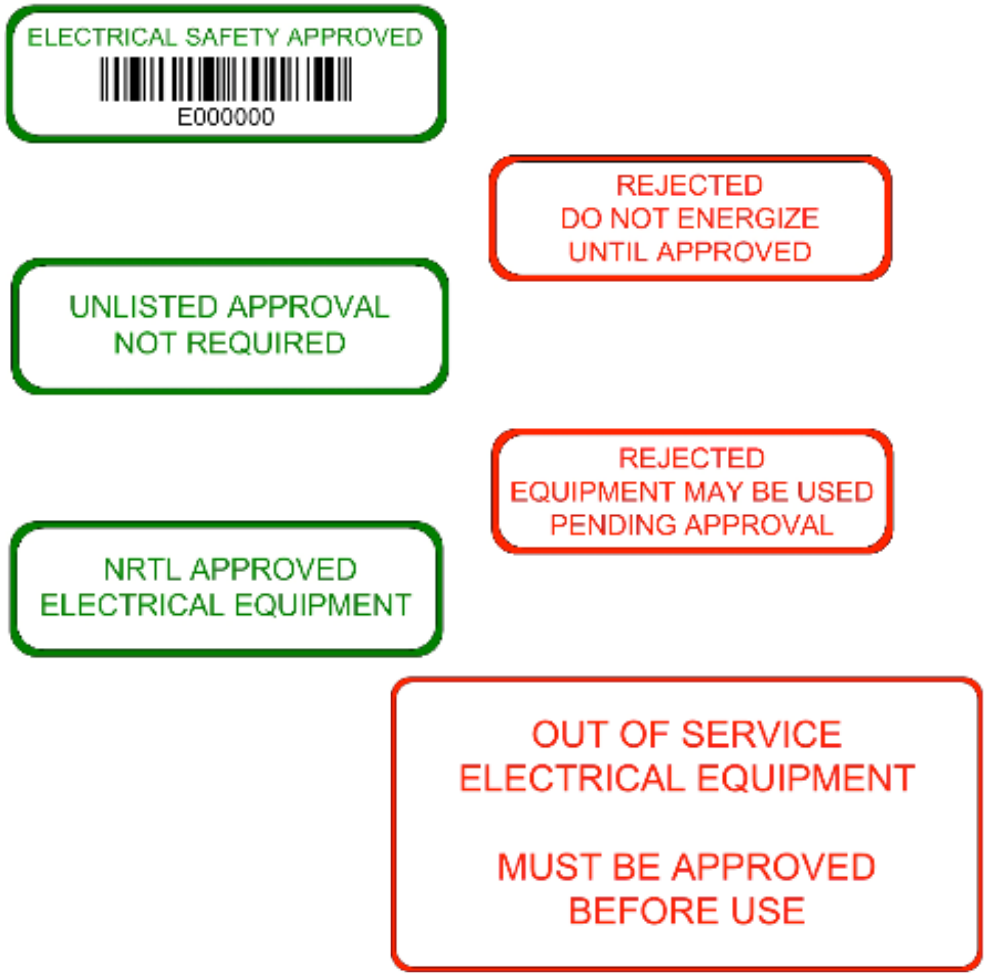
- Highest Resolution pXRD in Americas
- Variable Energy, 10 - 35 keV (1.0 - 0.35 Å)
- Suite of Sample Environments
  - Temperature, Pressure, In-Situ Cells
- Rapid Access Mail-In Program
  - Robotic Sample Loading
  - On-Site User Experiments also Supported

contact: Matthew Suchomel, Brian Toby

webpage: http://11bm.xor.aps.anl.gov

Electrical Equipment Inspections

- Five-year program to inspect all existing non-NRTL electrical equipment completing in September
- Thanks for making it a success; >98% so far from non-APS beamlines
- Please let us know about any problems for completion by end of FY, and continue to inspect newly-arrived equipment



Increased Focus on Safety

Subject: Labcast: Message from Bill Brinkman, Director, DOE-SC / Argonne's safety record

To: Argonne Lab Employees
Subject: SC-1 Safety Message

Argonne National Laboratory has a rich history of delivering transformational research across the globe. But the lab's ability to sustain its scientific contributions is directly linked to its ability to conduct its research and supporting operations safely. Accordingly, I am quite disappointed with the number of recent injuries at the laboratory. I spoke this week with your Director and the Argonne Site Office about the lab's current safety record and the necessity to identify causes, show improvement, and thereby demonstrate accountability.

Safety is everyone's responsibility, and one that must be felt personally. Industry's safety leaders commit to the belief that all accidents are preventable and that a realistic goal is one of zero injuries. I strongly encourage each of you to plan your work carefully, consider and mitigate hazards thoughtfully, and strictly conduct your work in accordance with documented laboratory practices.

"Safety is our full-time job, don't make it a part-time practice."

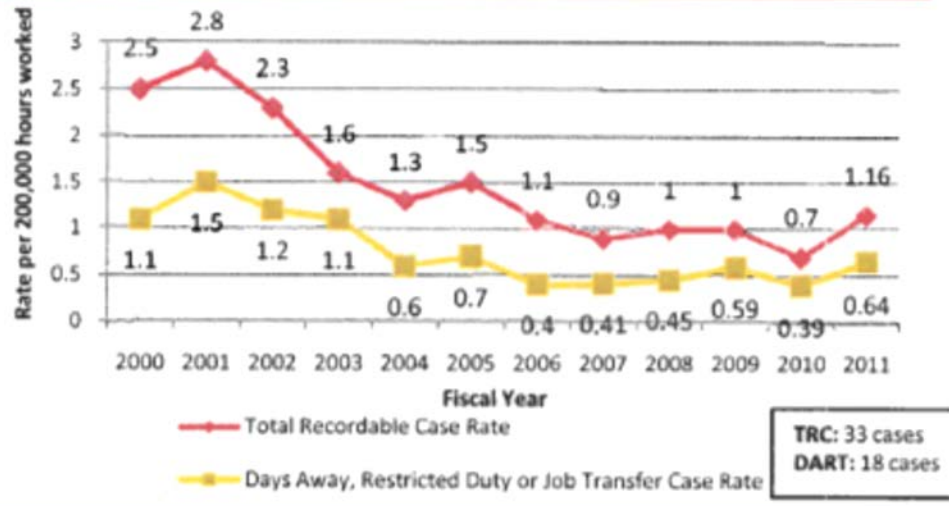
Bill Brinkman, Director
Office of Science

TRC and DART Performance Dashboard

	EESA	PSE	CELS	PSC	OPS/ OTD	Subs	Lab w/ Subs	Lab w/o Subs
TRC	0.45	0.78	0.68	1.24	1.91	1.33	1.16	1.16
DART	0.23	0.2	0.34	0.74	1.06	1.33	0.64	0.6
First Aid (#)	5	5	10	3	25	3	51	48

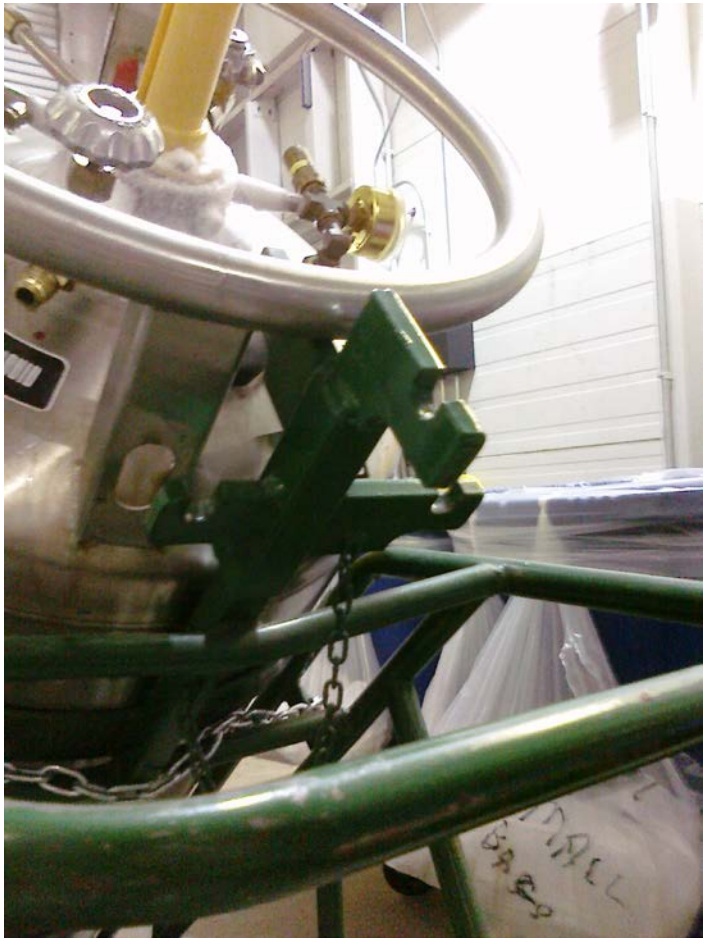
Green: ≤ DOE Goal (0.65 TRC; 0.25 DART); Red = ≥ 80% of FY09 Lab Performance (i.e., ≥ 0.8 TRC and ≥ 0.47 DART). Yellow: between DOE Goal and Lab goal.

Recordable Rates, FY2000 to FY2011



- APS and Argonne safety statistics not as good in FY11 as FY10
- We need to refocus our attention on safety

LN2 Hand Truck



Argonne NATIONAL LABORATORY

PHOTON SCIENCES SAFETY NOTICE

Liquid-Gas Cylinder Hand-Truck Awareness

Liquid-gas cylinder hand trucks similar to the Harper Model ULG65050-51 **(A)** use a spring-loaded hook assembly **(B)** to engage with the liquid nitrogen Dewar support ring.

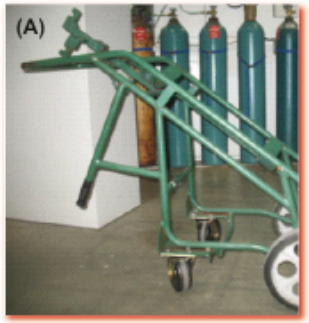
This provides a positive point of contact allowing the Dewar to be tilted onto the hand truck for transport.

Failure of this spring assembly can result in a loss of control, allowing the Dewar to become separated from the hand truck, leading to a very dangerous situation.

If the spring is weak such that it fails to fully engage the Dewar, replacement springs can be purchased through welding suppliers using part number HDW-SP-UL650-8

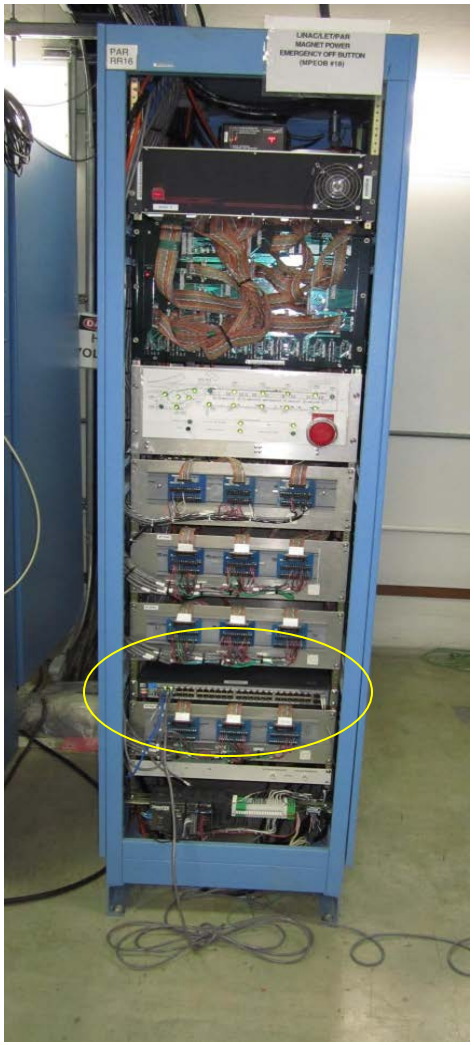
The entire cart assembly can be replaced with a newer model from Harper (model number 650-50-51).

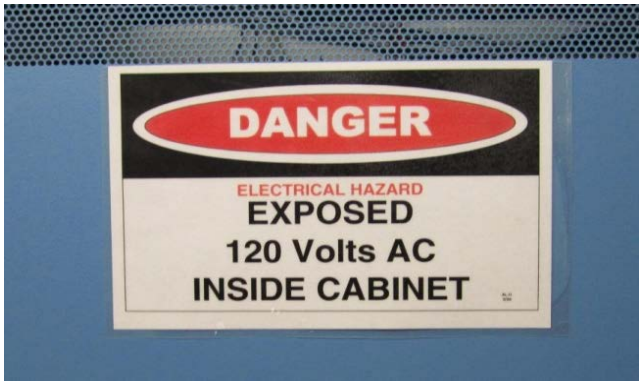
A potential replacement is an upright style cart such as the EZ Load 4L for SAFTCART **(C)**. This is a cart designed for any location where handling and maneuverability are paramount. Its phenolic wheels and swivel caster move easily and soundlessly over good terrain. Loading large liquid cylinders is simple due to the cart's low, front-loading platform. The cart can be used with platform scales to prevent the slamming of cylinders on scales. Grainger Item #5WXG3



PSC_11.05

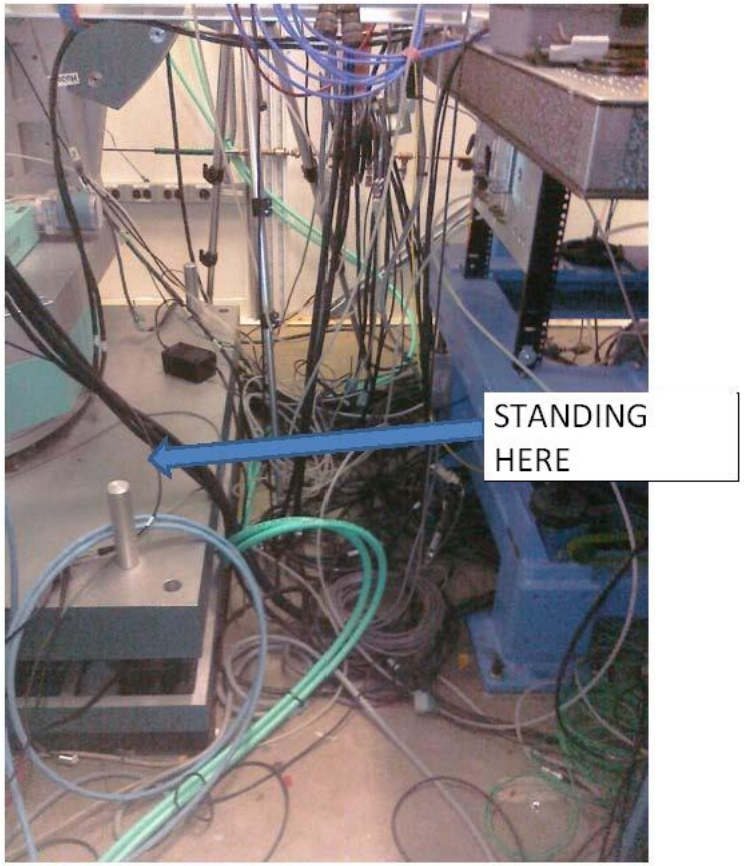
Shock Incident





- APS employee replacing network switches received a mild shock
- This cabinet had exposed 120VAC, but this hazard was not recognized during work planning
- **Lesson: Everyone should be aware of the "safety envelopes" for their activities, remain vigilant for unexpected conditions, and suspend and replan work if actual conditions don't correspond to safety planning**

Head Injury



- User was standing on platform to adjust equipment
- Lost balance and fell backwards
- Struck head – fortunately no serious injury
- Happened on third day of experiment and user was fatigued
- **Lessons learned: maintain good housekeeping even in areas not often accessed, fatigue reduces alertness and judgment**

APS Safety Action Plan

Engage all staff in group or one-on-one discussions with group leaders:

- Choose topics for the staff discussions based on types of work being performed
- Determine how the “safety envelope” has been defined for typical activities and how this has been documented
- Discuss how workers should be alert to whether or not they are staying within the safety envelope while performing the selected activities
- Emphasize that work is to be suspended if it appears to be going beyond the defined safety envelope
- Discuss the need to keep work areas clear through good housekeeping

- These actions should be documented with a copy to Tom Barkalow (APS ESH/QA Coordinator)

- The soon-to-be-implemented space & storage policy can be used to promote keeping areas clear of clutter

Cyber Security Update (1)

- In February 2008 the Argonne Physics division was compromised.
  - Computer user with administrative privileges clicked on the email link.
  - All the PCs on the PHY network had to be rebuilt and the division was unable to use the internet for almost one month.
  - The cost to the Laboratory to correct this problem has been estimated at $325,000 without accounting for the staff inconvenience.

- In April 2011 Oak Ridge National Laboratory Hacked.
  - Oak Ridge National Lab Finds Data Breach and shuts down Internet access.
  - An email targeting about 500 users was sent to ORNL. The email referenced HR benefits verification and included a link to an external malicious web server.
  - Computer user with administrative privileges clicked on the email link.
  - They were offline for a full 14 days, then partially online after that with increasing percentages every day.

Cyber Security Update (2)

- On July 1st, 2011 Pacific Northwest National Lab and Jefferson Lab were under attack from Internet hackers
  - Problem is identified as vulnerabilities in Adobe ColdFusion based web servers.
  - Once the hackers got a foothold on the web server, they worked their way out to other systems, elevate privileges and then infected more systems.
  - At both sites it appears the exploit was for a vulnerability that could have been patched on June 14.
  - Adobe warns customers on June 14 - vulnerabilities have been identified in ColdFusion 9.0.1 and earlier versions for Windows, Macintosh and UNIX. These vulnerabilities could lead to either a cross-site request forgery (CSRF) or a remote denial-of-service (DoS). Adobe has provided a solution to address the reported vulnerabilities. It is recommended that users update their product installation.
  - Argonne Cyber received information on the attacks from the other labs and added blocks to the lab border firewalls.

Cyber Security Update (3)

- From Eric Isaacs Focal Point on July 7, 2011 concerning emails
  - Remember, when in doubt:
    - Trust your intuition.
    - Mouse over a URL before clicking.
    - Check the sender's email address.
    - Watch for typos.
    - Be wary of urgent needs.
    - Never provide personal information.
    - Don't open an attachment.

National School on Neutron and X-ray Scattering

Jonathan Lang and Suzanne G.E. te Velthuis, Argonne

Bryan Chakoumakos and John Budai, Oak Ridge

Program Week 2
Advanced Photon Source (APS) Building 401 Auditorium

Time/Date	Monday June 20	Tuesday June 21	Wednesday June 22	Thursday June 23	Friday June 24	Saturday June 25
9:00 - 10:00 am	***Lecture 17*** X-ray Generation/ Instrumentation D. M. Mills Argonne National Laboratory	***Lecture 19*** X-ray Absorption Fine Structure (XAFS) B. Bunker Notre Dame University	***Lecture 22*** X-ray Imaging C. J. Jacobsen Northwestern University	***Lecture 25*** Surface Scattering P. Miceli Univ. of Missouri	***Lecture 28*** High-pressure Techniques Dr. M. Guthrie, Carnegie Institution of Washington	***9:30 am - 12:30 pm Student Presentations*** ***12:30 pm Student Closing Picnic***
10:00 - 10:15 am	Break	Break	Break	Break	Break	
10:15 - 11:15 am	***Lecture 17 (Continued)*** X-ray Generation/ Instrumentation	***Lecture 19 (Continued)*** X-ray Absorption Fine Structure (XAFS)	***Lecture 22 (Continued)*** X-ray Imaging	***Lecture 25 (Continued)*** Surface Scattering	***Lecture 29*** Real/Reciprocal Space Complimentarity Amanda Petford-Long Argonne National Laboratory	
11:15 - 11:30 am	Break	Break	Break	Break	Break	
11:30 - 12:30 pm	***Lecture 18*** X-ray Detection P. Denes Lawrence Berkley NL	***Lecture 20*** Magnetic Spectroscopy E. Arenholz Lawrence Berkley NL	***Lecture 23*** X-ray Photon Correlation Spectroscopy Larry Lurio University of Northern Illinois	***Lecture 26*** Nuclear Resonant Scattering E. Alp Argonne National Laboratory	***Lecture 30*** Proposal Writing J. Lang Argonne National Laboratory	
12:30 - 1:30 pm	Lunch	Lunch	Lunch	Lunch	Lunch	
1:30 - 2:30 pm	***Lecture 18 (Continued)*** X-ray Detection	***Lecture 21*** Time Resolved Scattering D. Tiede Argonne National Lab	***Lecture 24*** Pair Distribution Function Chris Benmore Argonne National Lab	***Lecture 27*** Inelastic X-ray Scattering P. Abbamonte University of Illinois - UC	***1:45 - 5:30 pm*** ***Experiment Time D*** ***See "Experiments Schedule"***	***1:30 pm School Participants Depart for Home***
2:30 - 2:45 pm	Break	Break	Break	Break		
2:45 - 6:45 pm	***Experiment Time A*** ***See "Experiments Schedule"***	***User Badging*** ***Optional Tour of APS or CNM*** ***Free Time***	***Experiment Time B*** ***See "Experiments Schedule"***	***Experiment Time C*** ***See "Experiments Schedule"***	***Reception/Banquet*** ***Argonne Guest House*** ***Building 460*** ***6:30 pm - Reception*** ***7:00 pm - Dinner***	
7:00 pm	**Dinner and Discussion**		**Dinner and Discussion**	**Dinner and Discussion**		

The Advanced Photon Source is an Office of Science User Facility operated for the U.S. Department of Energy Office of Science by Argonne National Laboratory

User Awards

- Paul Fenter (Argonne CSE): 2012 Warren Award of the American Crystallographic Association

- Keith Moffat (U Chicago): 2011 Patterson Award of the American Crystallographic Association

APS Personnel Changes

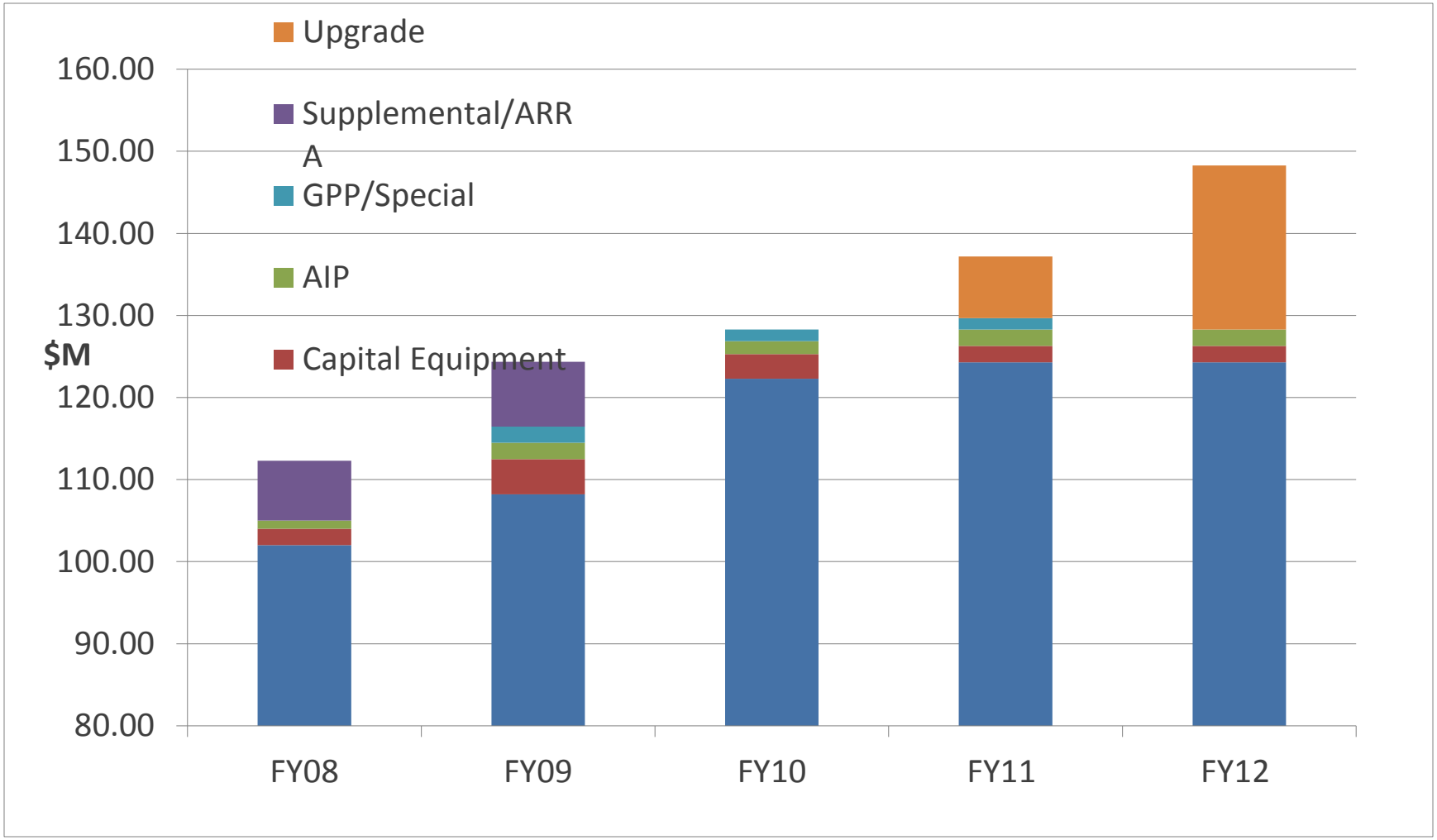
- Sue Marconi is moving from Assistant to ALD for Administration and Finance to a position in the Argonne CFO division
- Connie Markiewicz, formerly Argonne Assistant Chief Financial Officer for Budget Management, will be taking Sue's place as Assistant to ALD for Administration and Finance
- John Quintana is moving from Associate Division Director of the APS Engineering Support Division to the Deputy Chief Operating Officer for Argonne

Connie Markiewicz

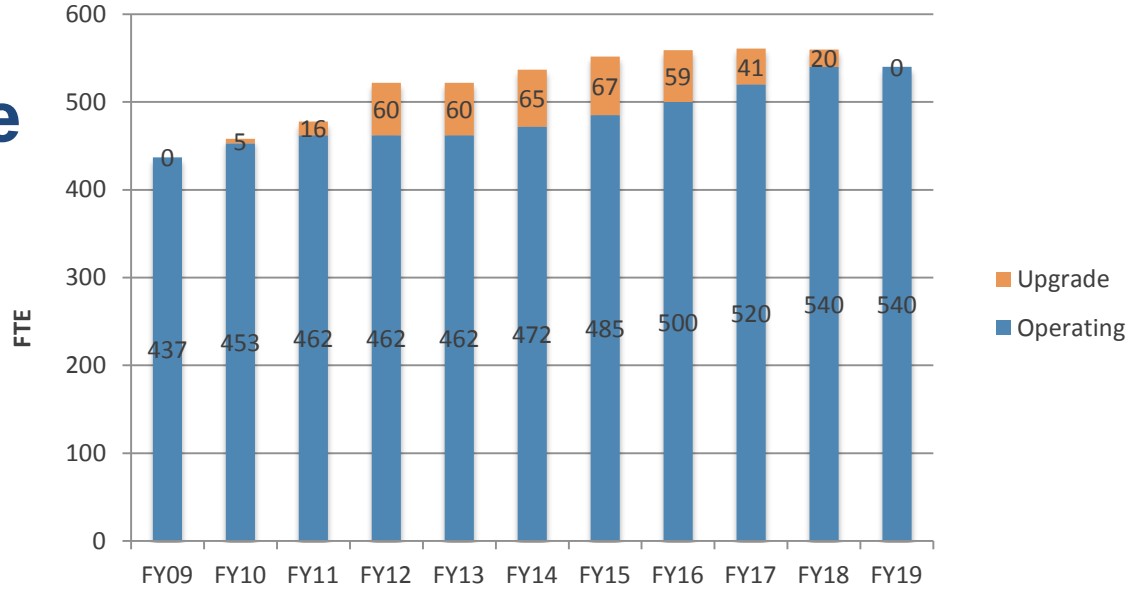
Budget Update

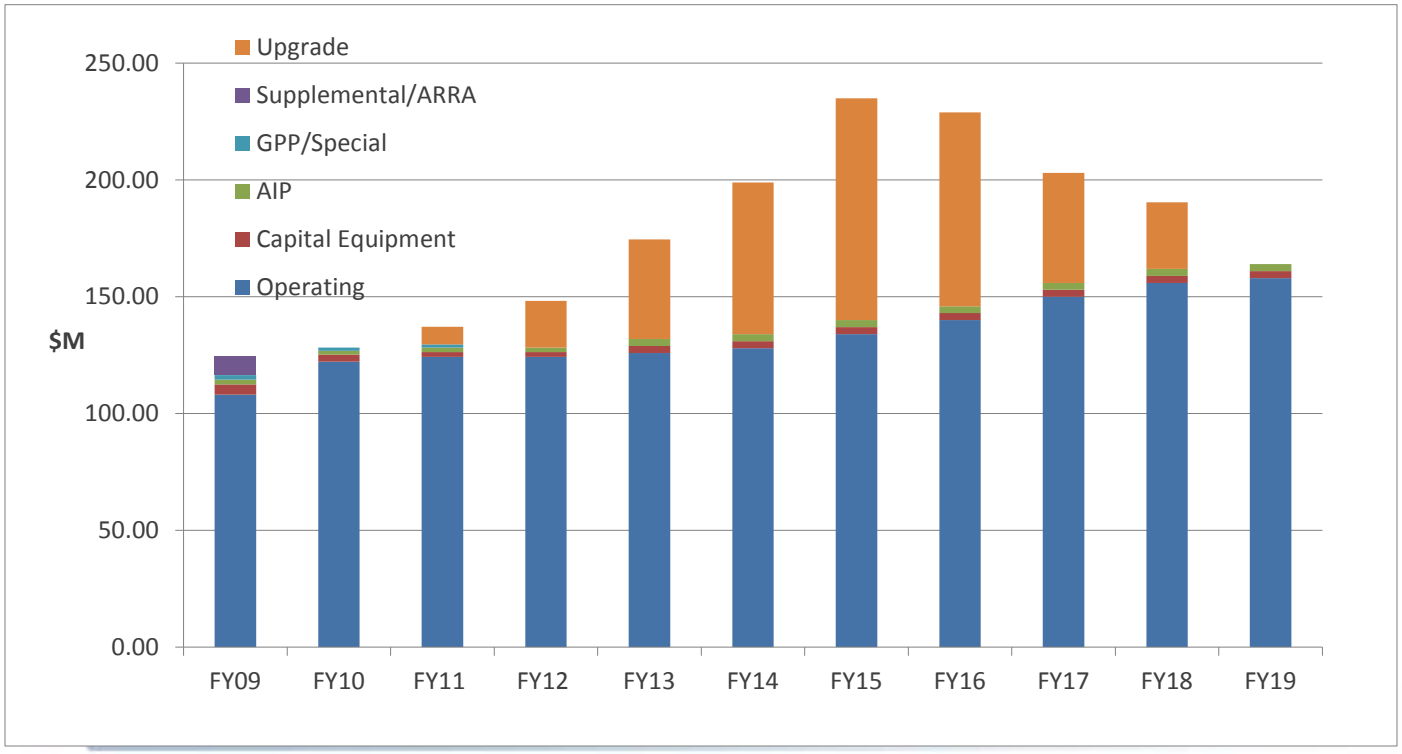
- In July we received an encouraging FY11 budget:
  - $9M above FY10 ($7.5M earmarked for Upgrade activities)
- House mark-up of FY12 budget:
  - Office of Science: -0.9% from FY11
  - BES: +0.6% from FY11
- APS Upgrade project budget on track for $20M funding in FY12
- A good starting point for FY12, given federal budget austerity
  - Advocacy: continue to support investment in Office of Science, User Facilities, APS

BES Budget for APS – Heading into the Upgrade

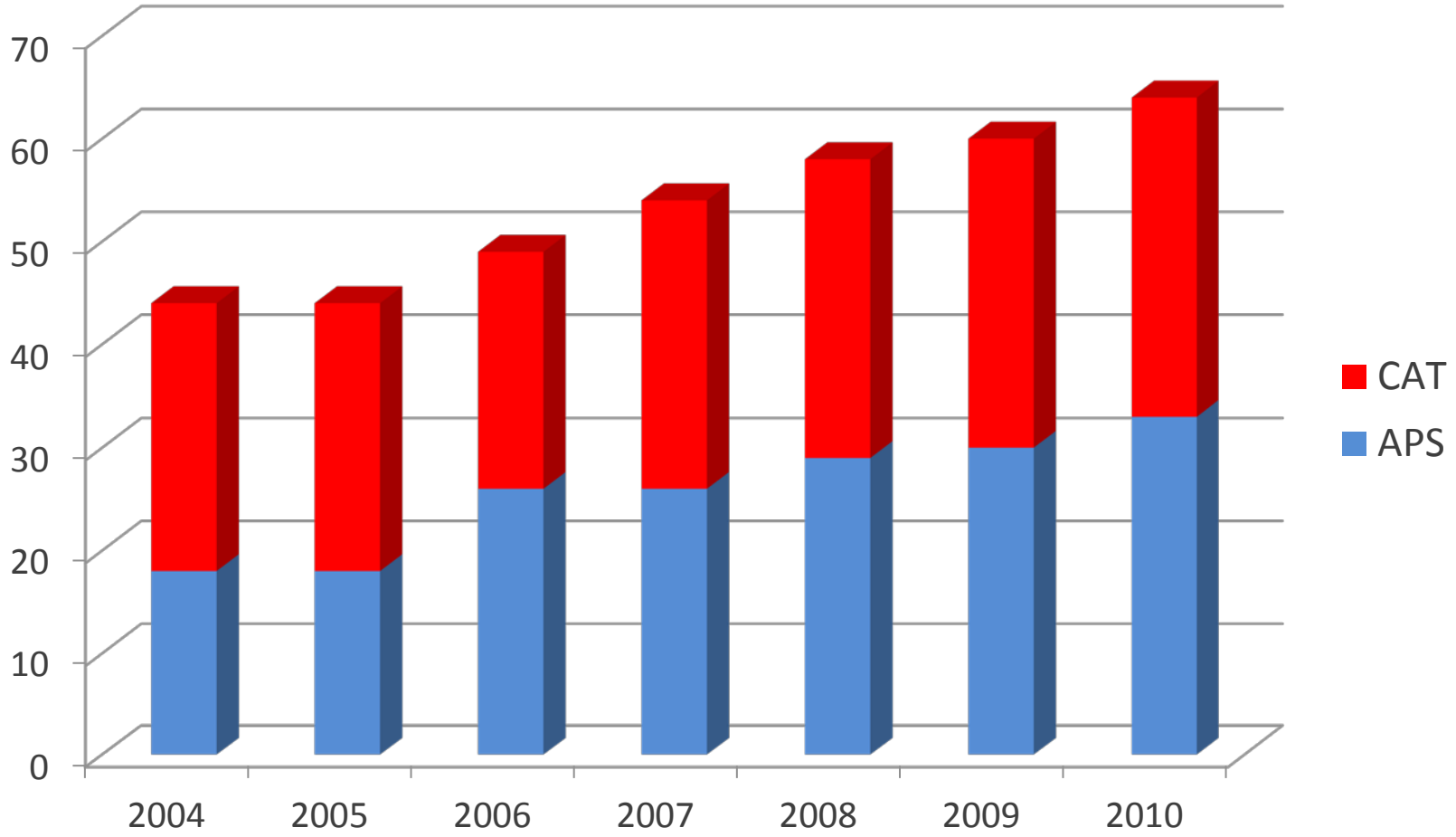


Staffing and Budget Planning through the Upgrade Underway



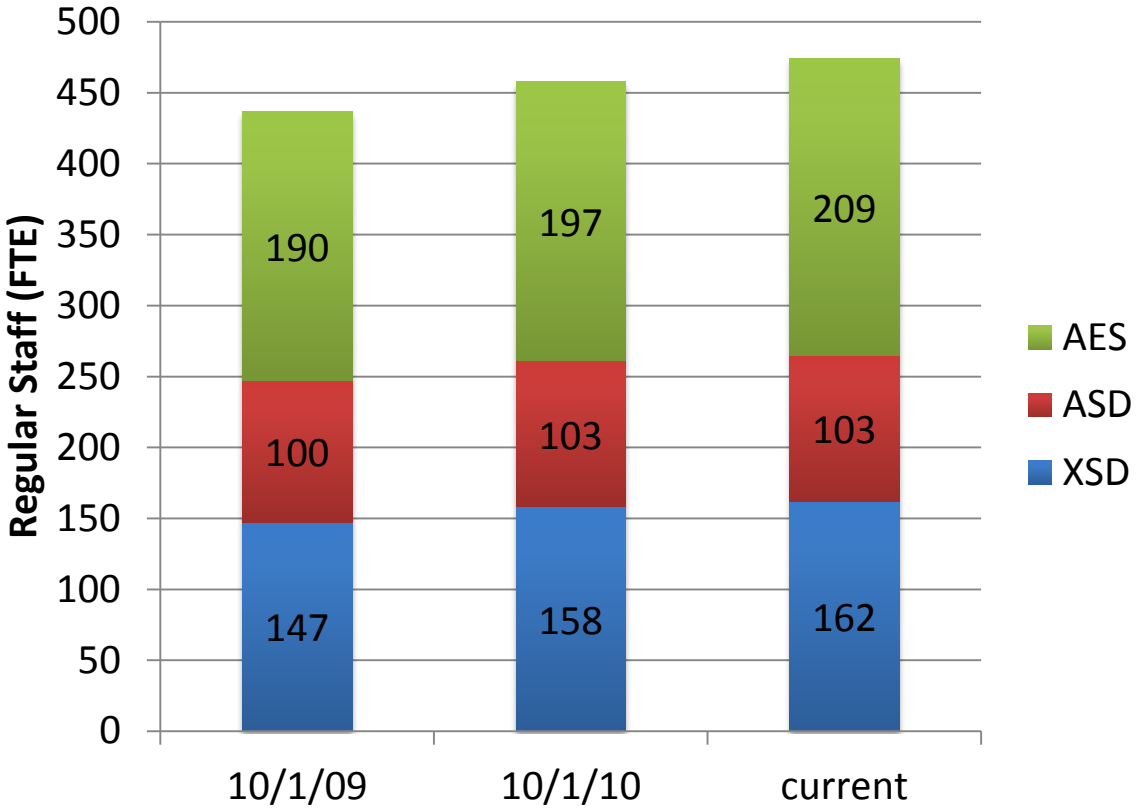


Number of Operating Beamlines



Program Balance

Have added 37 regular staff since 10/1/09, especially to XSD for beamline operations and to AES for Upgrade design support



University of Chicago and DOE Reviews of APS

- Just finished U of C Review of APS July 27-29
- DOE Review of APS scheduled for September 12-15
  - Combination of plenary talks, posters, and breakout session discussions with staff
  - We have invited users to give science highlight talks and posters and to meet with committee

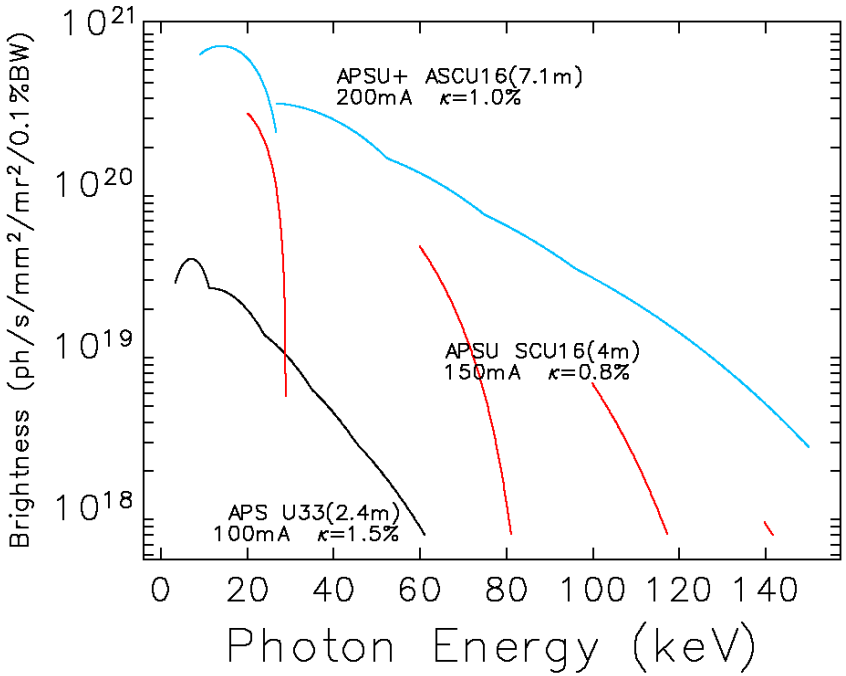
Advanced Photon Source Upgrade

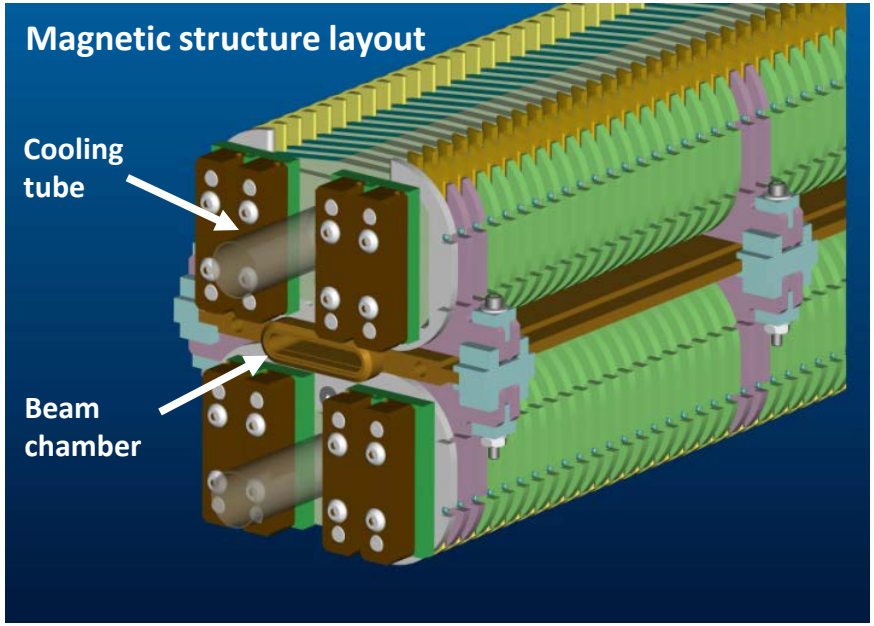
- Over-arching science themes: *real materials under real conditions in real time, imaging hierarchical structures*
- More than a dozen new or upgraded beamlines in areas such as high-energy diffraction, *in situ* studies of materials synthesis, wide-field imaging, ultrafast diffraction and spectroscopy
- Insertion devices optimized for brightness at high energies (e.g. superconducting or revolver), long straight sections, superconducting RF cavities to produce picosecond x-ray pulses, higher electron current and beam stability

- Plan to perform Upgrade without long periods of shutdown
- Funding started 2010; conceptual design completed and preparing for preliminary design; total cost est. $388M
- Google "APS Upgrade" for more information

APS Upgrade: Superconducting Undulators for High Energy X-rays

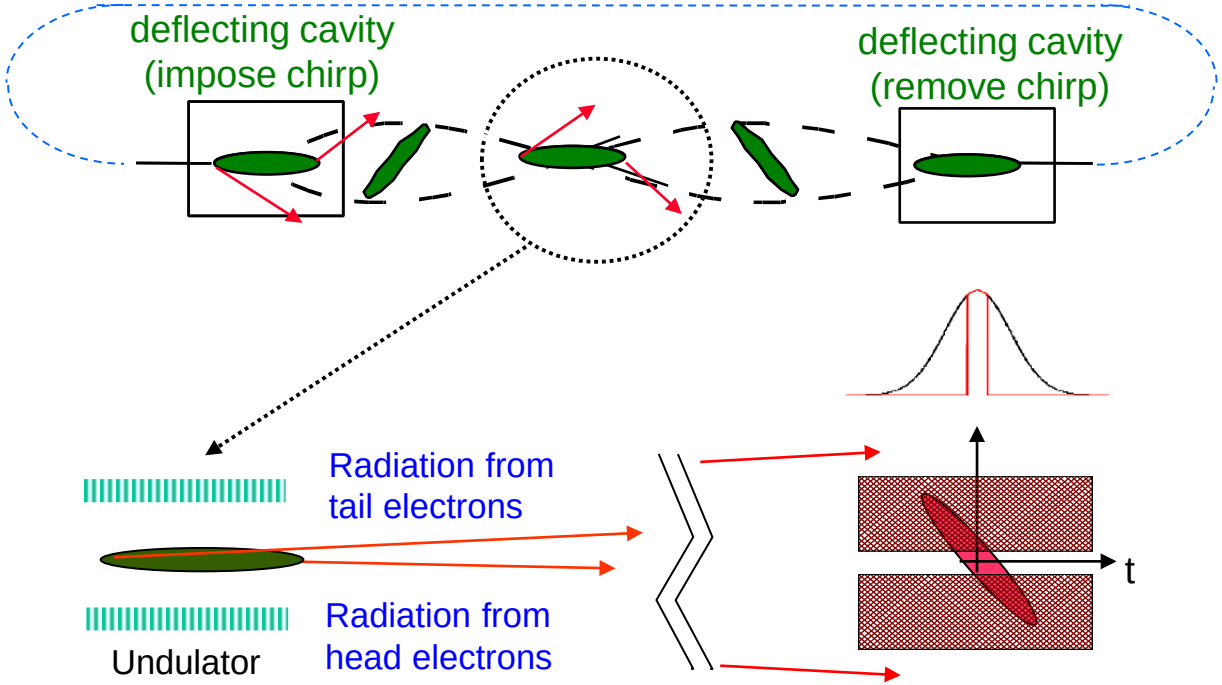
- Provide high brightness and flux at high energies (> 15 keV)
- The APS Upgrade will push the forefront of this new technology, which provides a long-term path forward to even higher flux and brightness (e.g. >100X improvement from standard U33 at 60 keV)

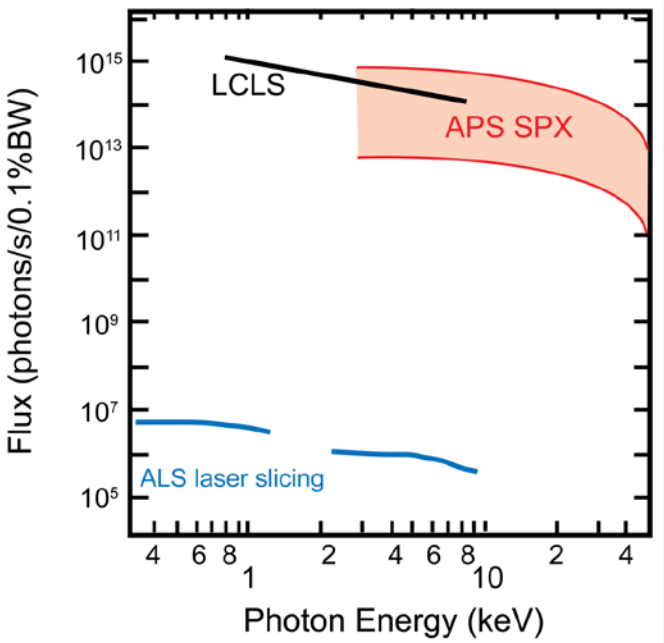




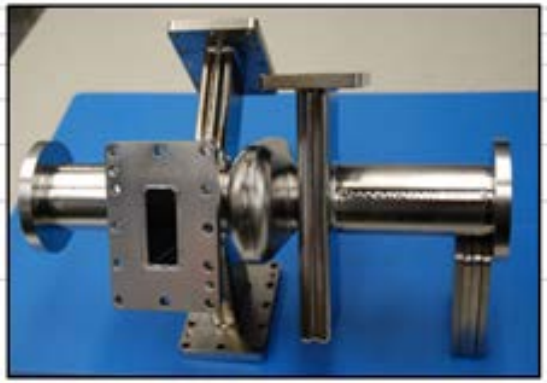
APS Upgrade: Superconducting RF for Picosecond Pulses

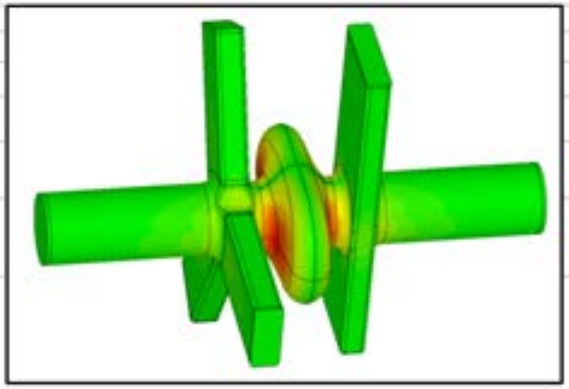
Provide ~2 ps FWHM X-ray pulses at 6.5 MHz rep. rate for time-resolved studies at several beamlines, with path forward to ~1 ps





Working prototype, as tested (at JLAB) and modeling:





User Involvement in APS Upgrade

- We have had very healthy user involvement in shaping the APS Upgrade
- Over last year, many users led and contributed to scientific cases for beamlines and facilities
- Written comments from SAC review in March were recently sent out
- We want to continue this strong engagement of users in driving the agenda for APS
- Interested to hear your ideas

Integration of the APS Upgrade with APS Operations

Brian Stephenson
Interim Associate Laboratory Director
Photon Sciences

UChicago Argonne LLC Board of Governors Review of Photon Sciences
July 28, 2011

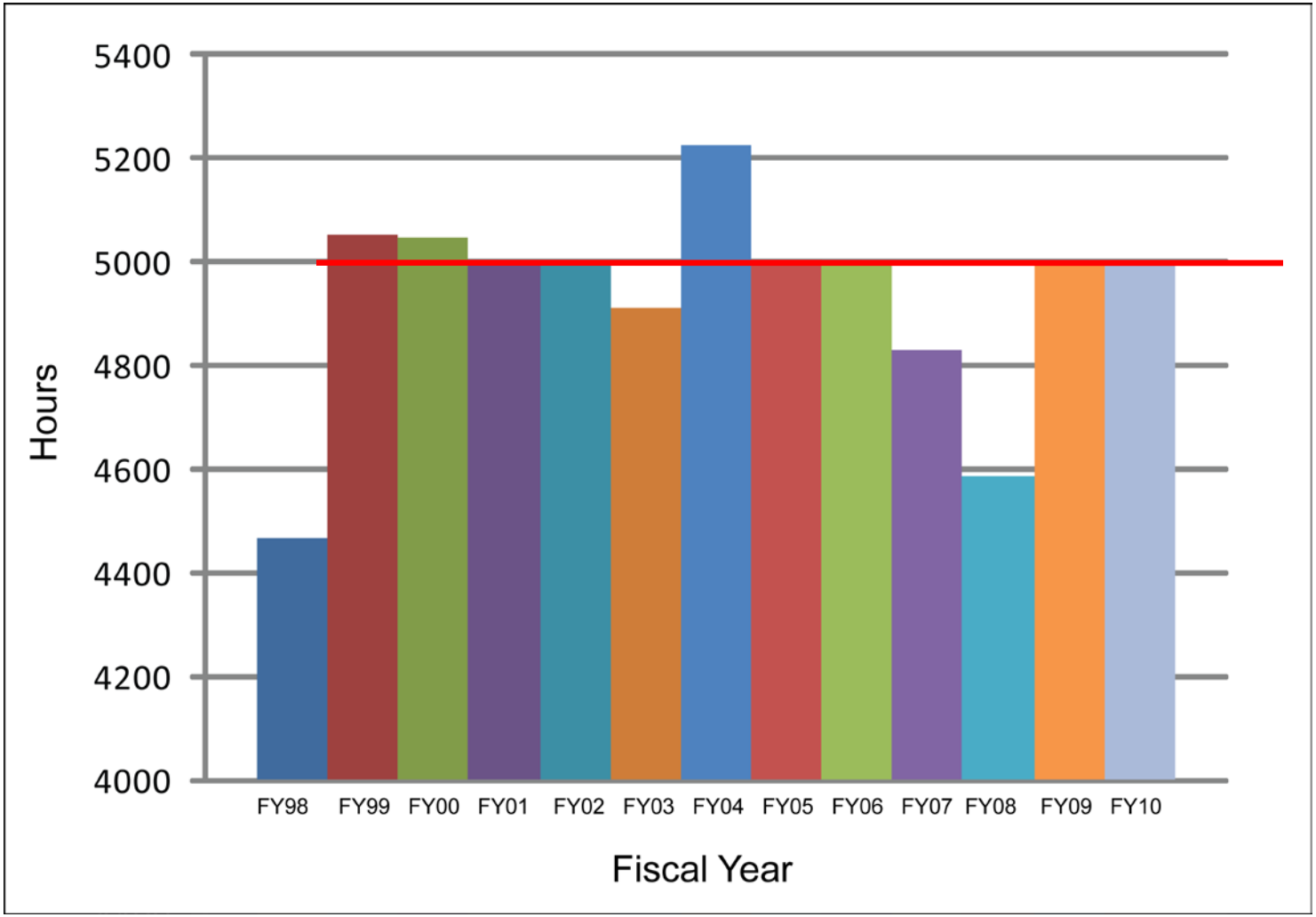
Talk Overview

Providing uninterrupted operation during the Upgrade has been stated, by our user community, to be a high priority

- The intent of Argonne, during the APS Upgrade, is to maintain operations at a level similar to what is presently experienced by the users. This includes annual hours of operation, beam availability, reliability, quality, and support for users.
  - This talk will discuss APS operation today, and how we intend to perform the upgrade project in the context of an operational APS.
  - Related to most issues in this talk is the possibility of reducing risk of the project on operations by redistributing resources. Cost-benefit studies are under consideration, and the outcome will be incorporated in the project baseline.

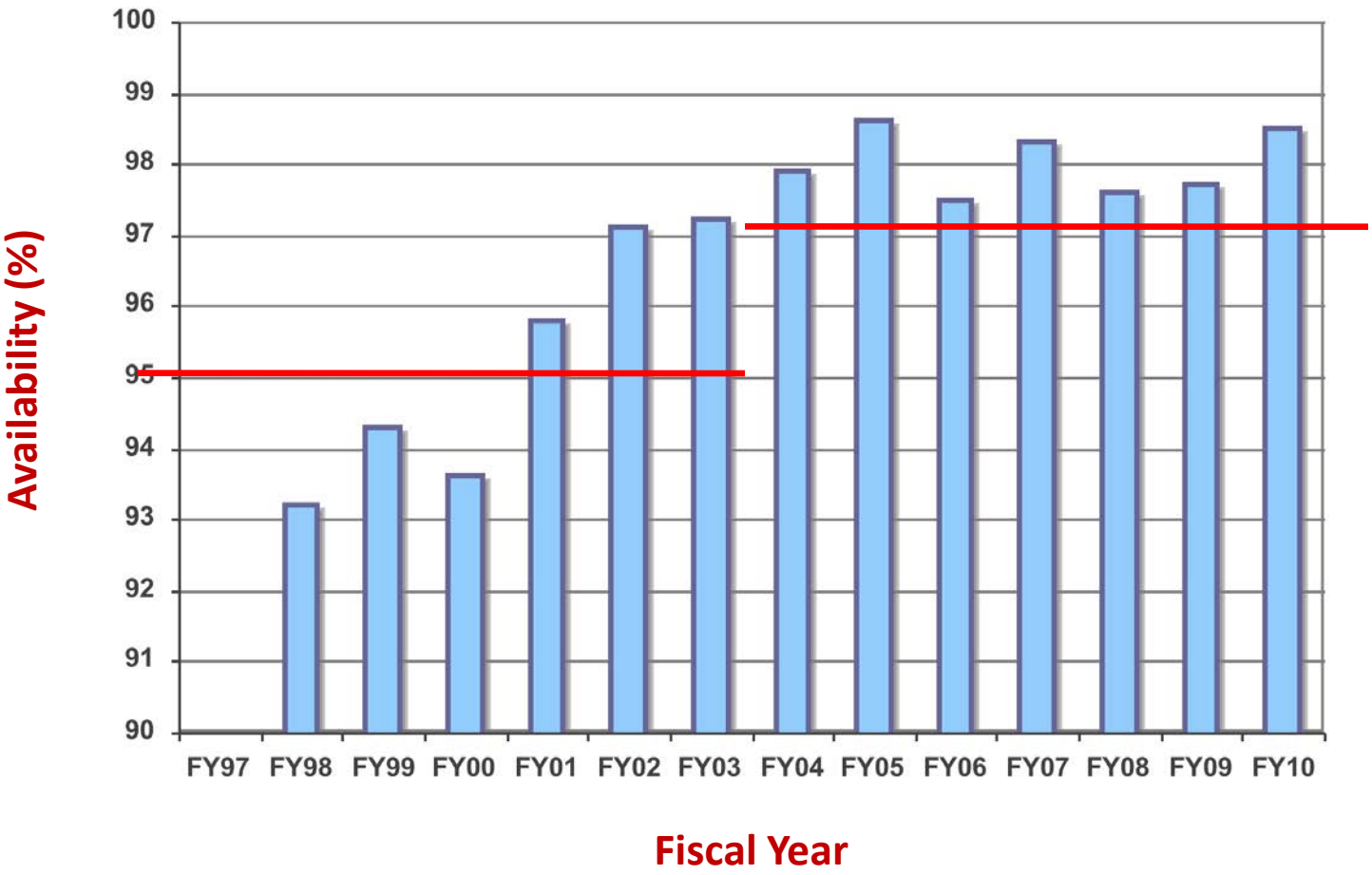
APS Accelerator Operations Statistics

- Hours of operation



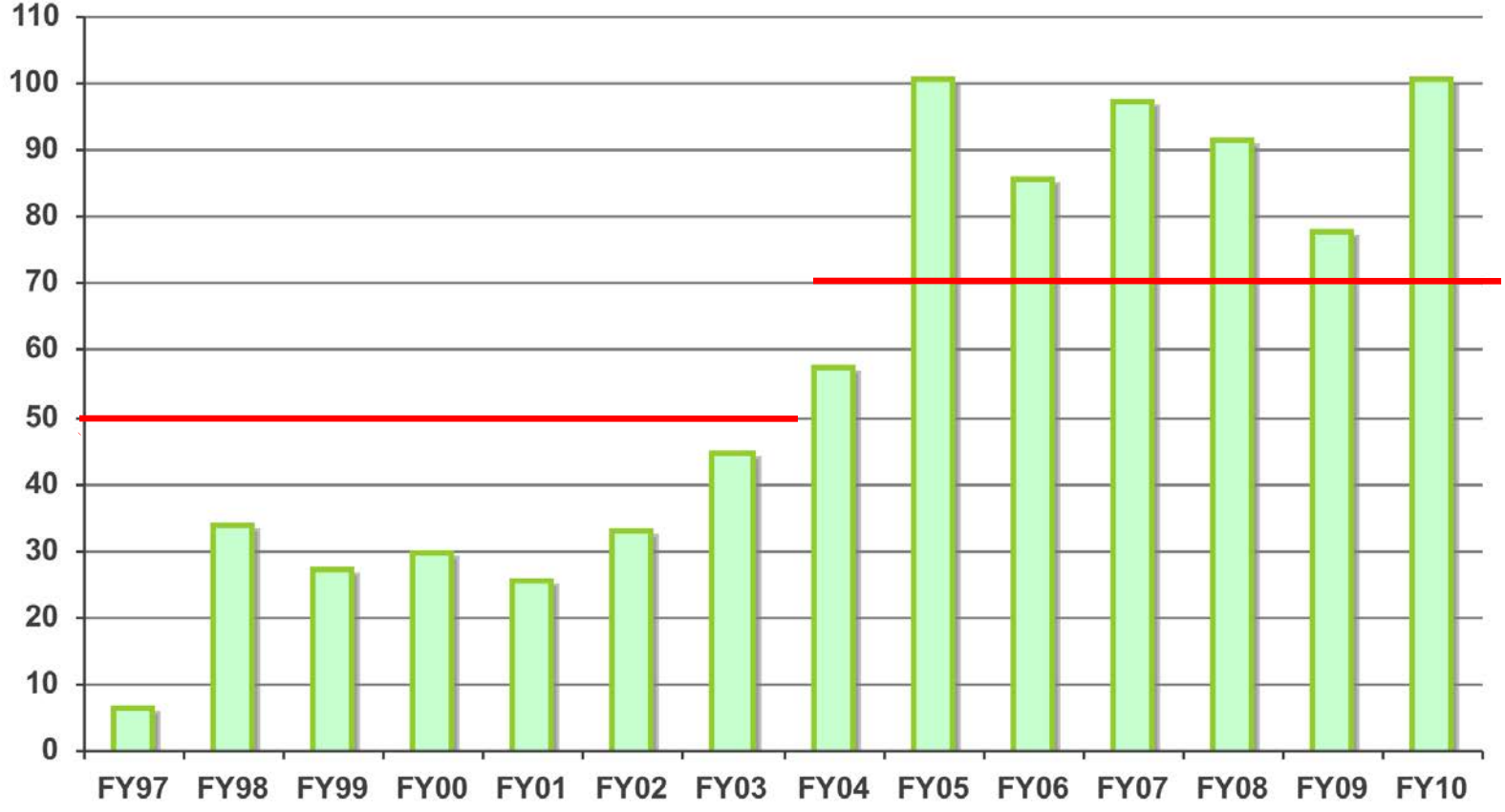
APS Accelerator Operations Statistics

- Availability

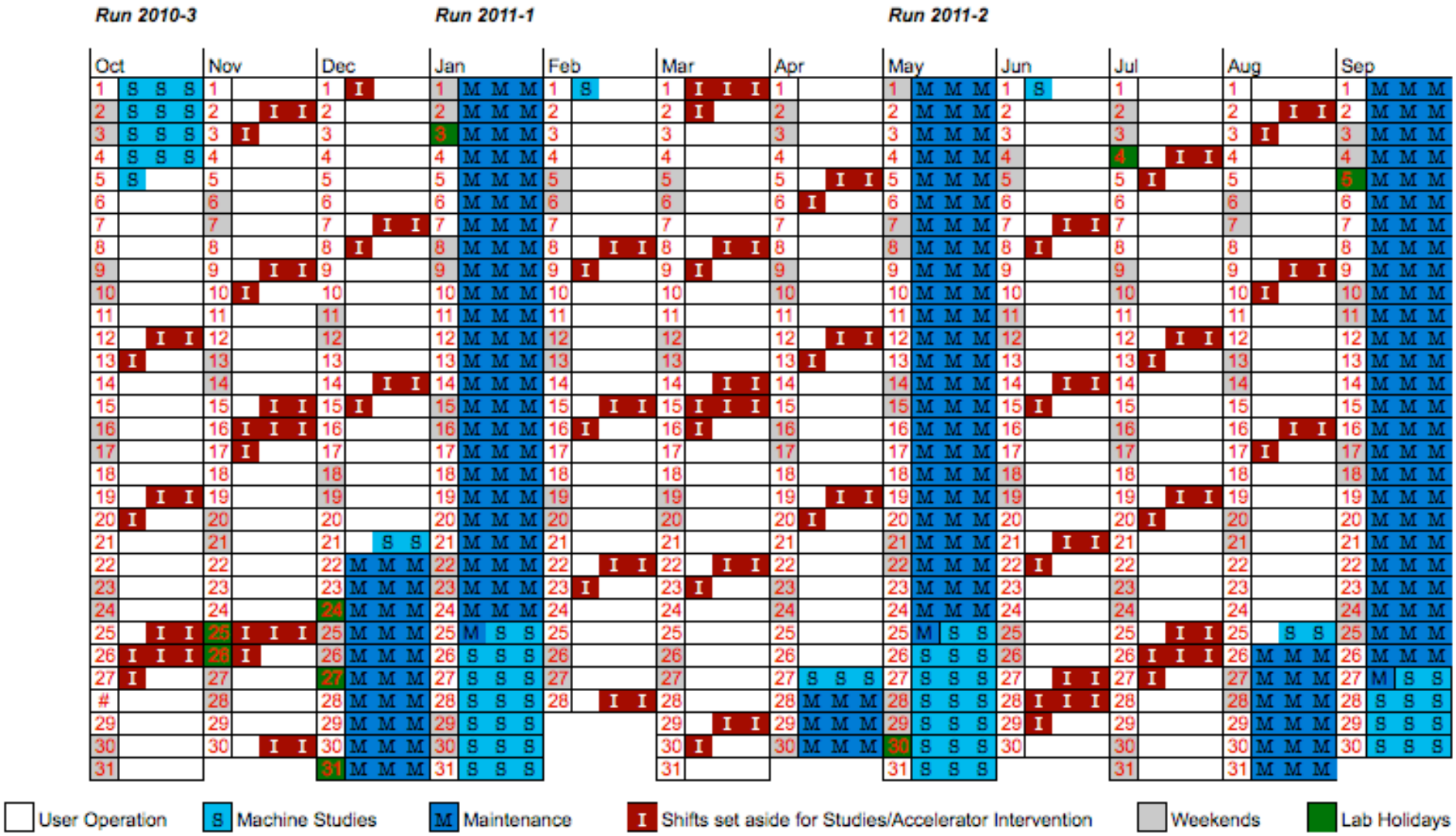


APS Accelerator Operations Statistics

- Reliability (MTBF)



Typical Operational Schedule
(FY11 schedule is shown, emphasizing Maintenance Periods)



Extent of Upgrade Work

- Inside Shield Wall
  - Work that impacts entire accelerator and must be completed before operations resumes
    - Long Straight Section Installation
    - SPX and SCU cryomodule installation
    - And in general any work that breaks vacuum
  - Work that can span shutdowns
    - Front End Upgrade (although supported beamline would be down for operational run), although we will attempt to perform some FE upgrades in one shutdown
    - SPX and SCU utility and infrastructure installation
- Outside Shield Wall
  - Beamline Upgrades - In general it is possible that a beamline upgrade could take a beamline off for one operational run
  - Realtime Feedback System upgrade
  - Preparation work for maintenance periods
- All work must be coordinated with facility maintenance and hardware upgrades
  - Manpower issues
  - Scheduling issues (i.e., orderly access to accelerator work areas)
- APS has a well-developed maintenance period scheduling process

Present Shutdown Planning Tool (example)

7/27 6:02 PM

Page 2
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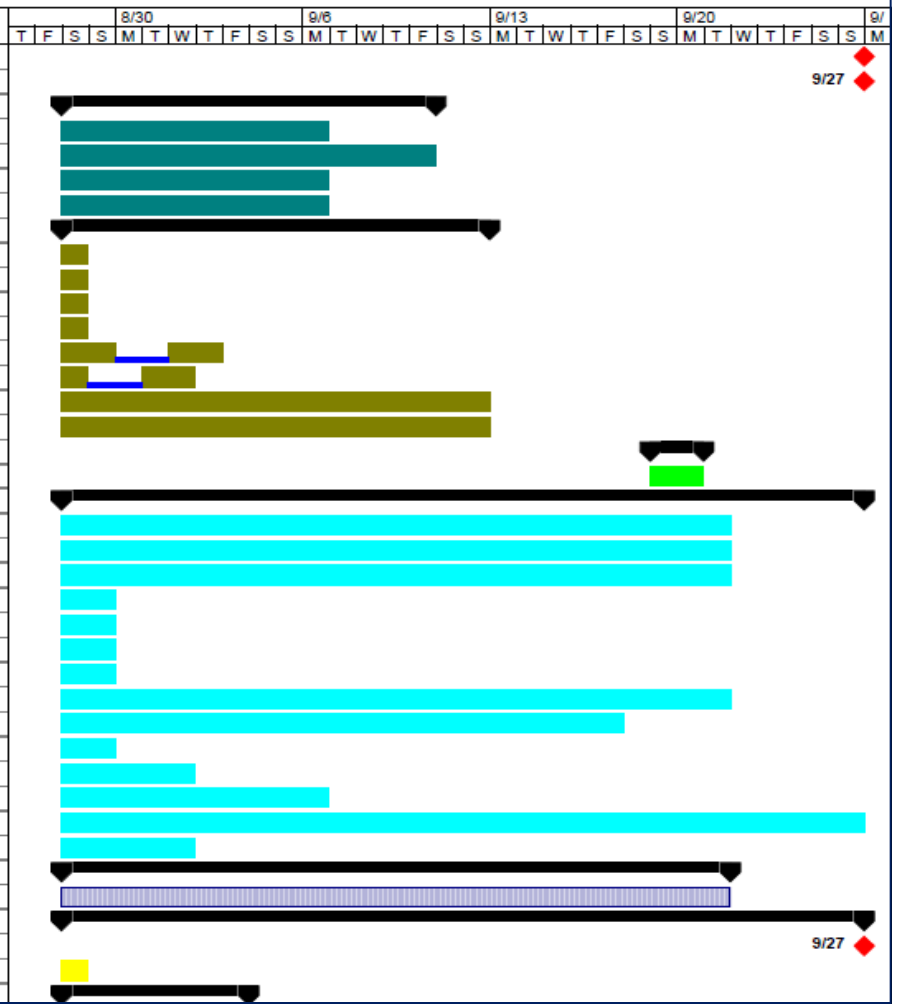
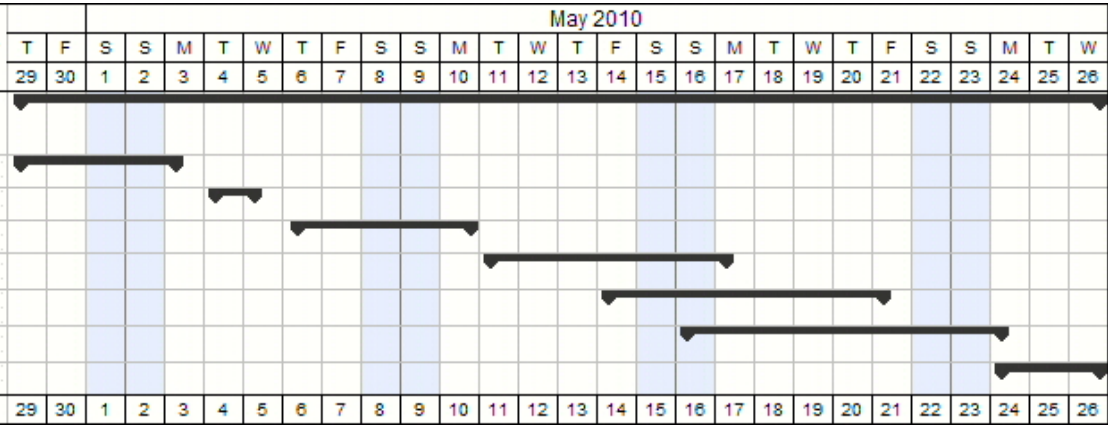
MAINTENANCE SCHEDULE for August-September 2010 Shutdown

ID	Rev	Task Name	Duration	Start	Finish	Rad Safety	WR #
103		**ZONE B SCHEDULE [August-September 2010]**	**0 days**	**9/27**	**9/27**		
104		Zone B (S10-17) Secure	0 days	9/27	9/27		
105		**Mechanical Ops- Maint [SR B August-September 2010]**	**14 days**	**8/28**	**9/10**		
106		Test and repair magnet switches (Klixons) at PS	10 days	8/28	9/6		
107		Citranox flush FE:ID's	14 days	8/28	9/10	Y	
108		Conversion of 15ID FE DIW to Yokogawa	10 days	8/28	9/6		
109		GO-NOGO gauge measure(check chamber-mag clear)	10 days	8/28	9/6		
110		**Mechanical Ops- Vacuum [SR B August-September 2010]**	**16 days**	**8/28**	**9/12**		
111		Close all SR exit valves & isolated valves	1 day	8/28	8/28		
112		Close all SR&FE valves & 1st photon shutters(PS1)	1 day	8/28	8/28		
113		Open all exit port and isolation valves	1 day	8/28	8/28		
114		Cycle all vacuum valves & shutters for proper operation	1 day	8/28	8/28		
115		Cycle all SR turbos in roughing system	4 days	8/28	9/2		
116		MPS SR validation (routine maintenance)	3 days	8/28	9/1		
117		17BM - Upgrade FE Shutter Interface	16 days	8/28	9/12	Y	
118		17ID - Upgrade FE Shutter Interface	16 days	8/28	9/12	Y	
119		**Power Supplies [SR B August-September 2010]**	**2 days**	**9/19**	**9/20**		
120		15ID: Support MOM: FE DIW conversion to Yokogawa	2 days	9/19	9/20		27531
121		**SI [SR B August-September 2010]**	**30 days**	**8/28**	**9/26**		
122		12ID PSS Gen I mini-upgrade & validation	25 days	8/28	9/21	Y	
123		17ID PSS Gen I mini-upgrade & validation	25 days	8/28	9/21	Y	
124		17BM PSS Gen I upgrade & install shutter switch interfac	25 days	8/28	9/21	Y	
125		14ID: PSS beamline validation	2 days	8/28	8/29	Y	
126		15ID: PSS beamline validation	2 days	8/28	8/29	Y	
127		16BM: PSS beamline validation	2 days	8/28	8/29	Y	
128		17BM: PSS beamline validation	2 days	8/28	8/29	Y	
129		10BM PSS upgrade:Relocate FE shutter E-stop panel	25 days	8/28	9/21	Y	
130		16BM PSS: Install emerg. shutter disable, upgrade & vali	21 days	8/28	9/17	Y	
131		14ID: Wire in the automatic door - Station B	2 days	8/28	8/29	Y	
132		17BM: Upgrade FE shutter interface	5 days	8/28	9/1	Y	
133		17ID: Upgrade FE shutter interface	10 days	8/28	9/6	Y	
134		16BM: Station B - Remove CB2	30 days	8/28	9/26	Y	
135		15ID: Support MOM: FE DIW conversion to Yokogawa	5 days	8/28	9/1		
136		**Engineering & Design [SR B August-September 2010]**	**25 days**	**8/28**	**9/21**		
137		Routine maintenance/calibration of ID's	25 days	8/28	9/21		
138		**ZONE C SCHEDULE [August-September 2010]**	**30 days**	**8/28**	**9/27**		
139		Zone C (S18-23) Secure	0 days	9/27	9/27		
140		Triennial maintenance of X-9 switchgear(S22-26	1 day	8/28	8/28	Y	
141		**Alignment [SR C August-September 2010]**	**7 days**	**8/28**	**9/3**		



Installation Schedule for a Front End

Activity Name	Start Date	Finish Date
Complete Removal and Replacement of One FE (utilizing two shifts)	4/29/10	5/26/10
Remove existing equipment...	4/29/10	5/3/10
Site preparation...	5/4/10	5/5/10
Install FE components...	5/6/10	5/10/10
Verify vacuum and bakeout...	5/11/10	5/17/10
Final connections and alignment...	5/14/10	5/21/10
FOE pumpout and bake...	5/16/10	5/24/10
Validation and completion...	5/24/10	5/26/10



← standard maintenance period →

The feasibility of removing and reinstalling a complete front end has been successfully demonstrated in a trial during the Spring 2011 shutdown

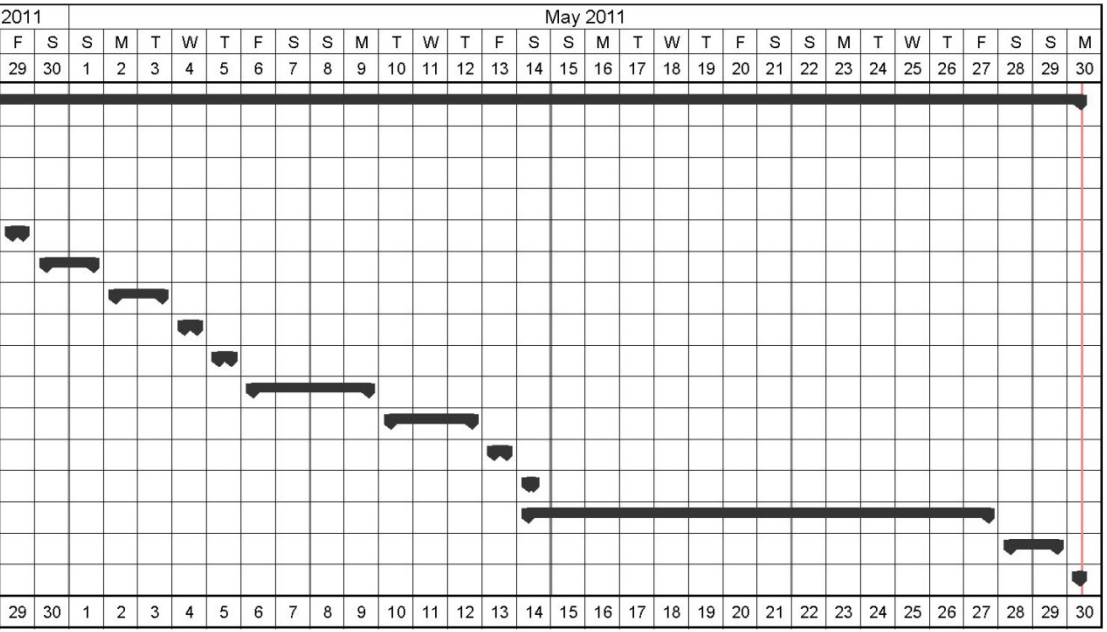
- Extended shifts utilized, two-shifts per day as needed

Example of Installation Planning, Long Straight Section

This activity will be done four times, in four different shutdowns, and will need to be completed for machine turn-on

Assumes eight hour shifts with weekends worked

	Activity Name	Duration (Hours)	Start Date	Finish Date
1	**Long Straight Section Installation**	258.00	4/28/11	5/30/11
2	Disconnect Power Systems	4.00	4/28/11	4/28/11
3	Disconnect Diagnostics	2.00	4/28/11	4/28/11
4	Disconnect Water	3.00	4/28/11	4/28/11
5	Disconnect Vacuum	7.00	4/29/11	4/29/11
6	Remove Girders	16.00	4/30/11	5/1/11
7	Survey & Alignment	16.00	5/2/11	5/3/11
8	Install Pedestals	8.00	5/4/11	5/4/11
9	Survey & Alignment	8.00	5/5/11	5/5/11
10	Install Girders	32.00	5/6/11	5/9/11
11	Survey & Alignment	24.00	5/10/11	5/12/11
12	Install Water	8.00	5/13/11	5/13/11
13	Connect Power Systems	4.00	5/14/11	5/14/11
14	Connect Vacuum & Bakeout	112.00	5/14/11	5/27/11
15	Survey & Alignment	16.00	5/28/11	5/29/11
16	Connect Diagnostics	2.00	5/30/11	5/30/11
		Tot: 262.00		



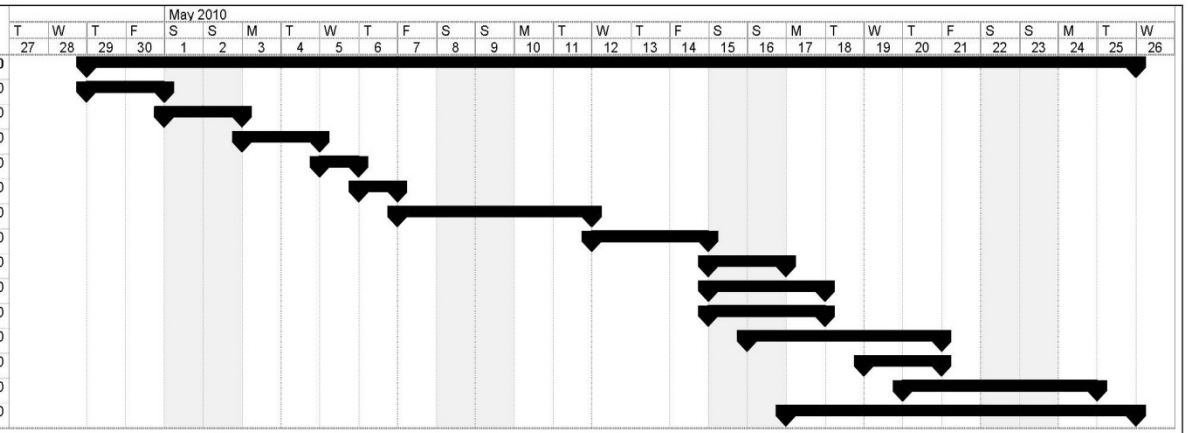
← standard maintenance period →

Challenging Maintenance Period Issue – Installation of SPX R&D Cavities

Installation of the SPX R&D cavities will be followed by a proof-of-principle demonstration that the storage ring can be operated with them installed. This is a leading example of a shutdown that may need to be extended, and, consequently, this activity is being planned and coordinated at this time in order to provide timely information to all stakeholders.

The following is a draft installation schedule for cavities, reflecting present thinking.

ID	Task Name	Duration	Start	Finish
1	**RF Deflecting Cavities Cryomodule Installation**	**27 days**	**4/29/10**	**5/25/10**
2	Disconnect Existing Straight Section Peripherals	2 days	4/29/10	4/30/10
3	Remove Girders	2 days	5/1/10	5/2/10
4	Survey & Alignment	2 days	5/3/10	5/4/10
5	Install Pedestals	1 day	5/5/10	5/5/10
6	Survey & Alignment	1 day	5/6/10	5/6/10
7	Install Cryomodule	5 days	5/7/10	5/11/10
8	Survey & Alignment	3 days	5/12/10	5/14/10
9	Connect Diagnostics Cabling	2 days	5/15/10	5/16/10
10	Connect Water System	3 days	5/15/10	5/17/10
11	Connect Waveguide	3 days	5/15/10	5/17/10
12	Connect RF, Interlock & Control Cabling	5 days	5/16/10	5/20/10
13	Connect Cryo Distribution Lines	2 days	5/19/10	5/20/10
14	Perform ACIS Validation	5 days	5/20/10	5/24/10
15	Perform In-Tunnel System Checks	9 days	5/17/10	5/25/10



← standard maintenance period →

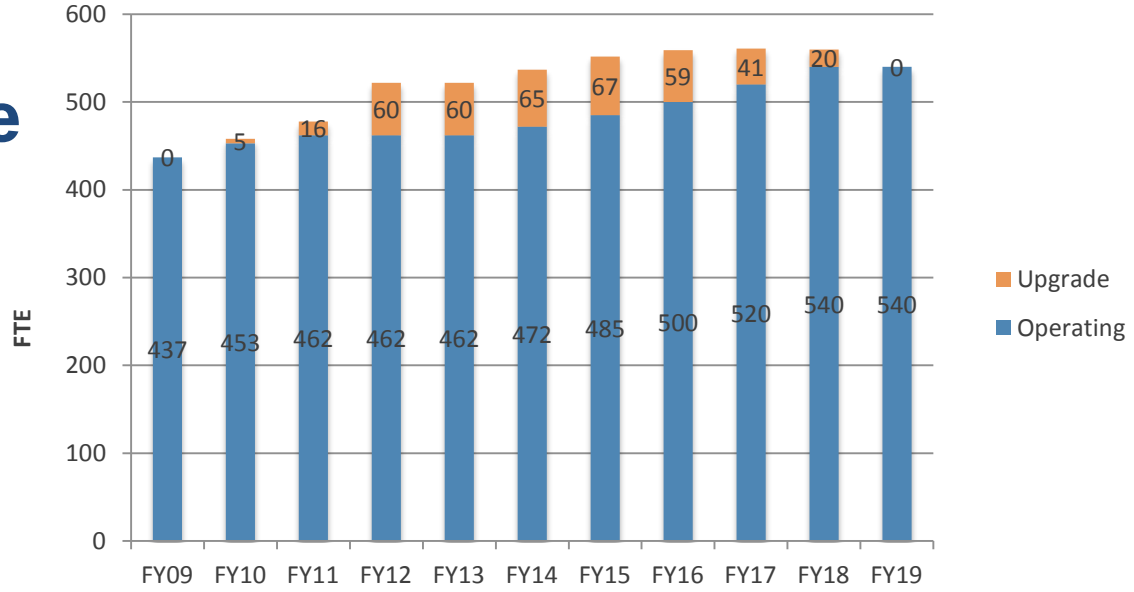
Things that can be done ahead of time

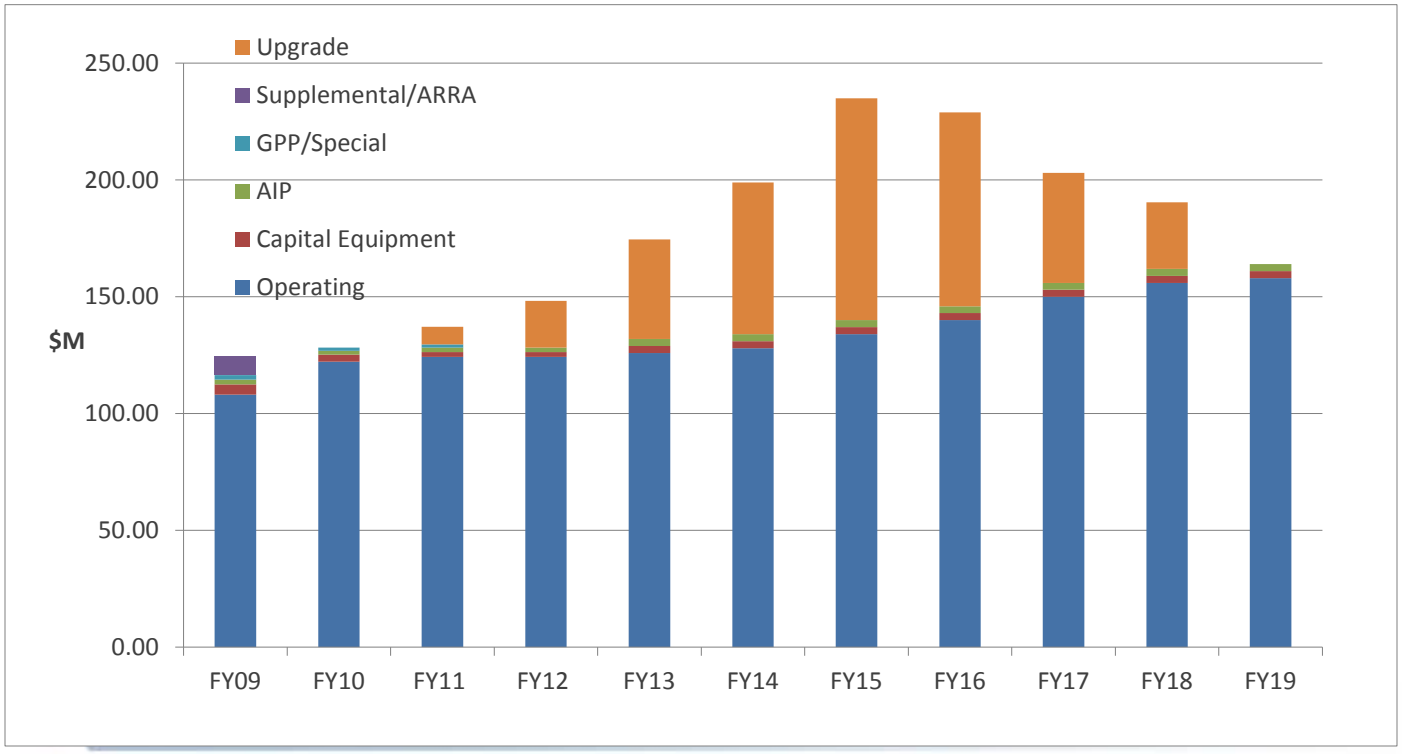
- Develop and implement procedures for intrusive work. For example, we have successfully demonstrated the ability to remove and reinstall a front end in a standard shutdown (Spring 2011 shutdown).
- Develop and exercise Storage Ring Recommissioning Plans: After each maintenance period the storage ring will need to be recommissioned; the repeated issue will be long straight section lattice commissioning. Other issues will be real time feedback implementation, SRF cavity commissioning.
- Early procurement of (for example) front end components to best utilize all maintenance periods within the project period.

Additional Issues

- Individual beamline upgrades are expected to require more than a single shutdown. The schedule for beamline upgrades will be developed to have the least impact on APS scientific capabilities.
- For beamlines being moved, where possible new beamlines will be built first before decommissioning old beamlines.
- User Support – APS support of beamline operation will be impacted, even early on in the project by the necessity to utilize present beamline resources on the project. We will need to increase the staffing levels of beamline support personnel and have already begun to do so.
- Coordination of programmatic and project activities … Ongoing operational tasks that are required by the project are presently being identified and will be managed by APS with schedule ties to the project schedule.
  - Ring and beamline realignment
  - Installation of microwave mode dampers

Staffing and Budget Planning through the Upgrade Underway





Safety

- Work Planning and Control (WP&C) is integral to our maintenance period planning activities. The work done during these periods incorporates Argonne's and the APS' WP&C implementation including analysis of hazards, work approval, work authorization, and lessons learned.

- We are careful not to schedule work in a way that pressures staff to place schedule completion over safe behavior. Pre-project trial activities and ongoing experience ensure this.

Communication and Decisions

Present APS Meetings that are/will be used to communicate between operational and Project Interests (other meetings will be added as needed)

- Daily Four O'clock Main Control Room Meeting
- Weekly Operations Directorate (Project Director and Manager attend now along with reps from APSUO, Partner User Council, and Life Sciences Council)
- Shutdown Maintenance Scheduling Meeting (weekly) originated during APS start-up
- Monthly Operations Meeting for User Community
- APS-U Monthly Meetings

Summary

- Providing “normal operation” during the upgrade has been stated, by our user community, to be a high priority
- Based on our experience and planning efforts we can safely deliver “normal operation”
- Facility management has the responsibility of setting and communicating expectations regarding the impact of the upgrade on operations
- We also must set and communicate expectations of the impact of operations on the project
- This presentation identifies the risks and the plans to address them

Strategic Plan for APS Beyond the APS Upgrade

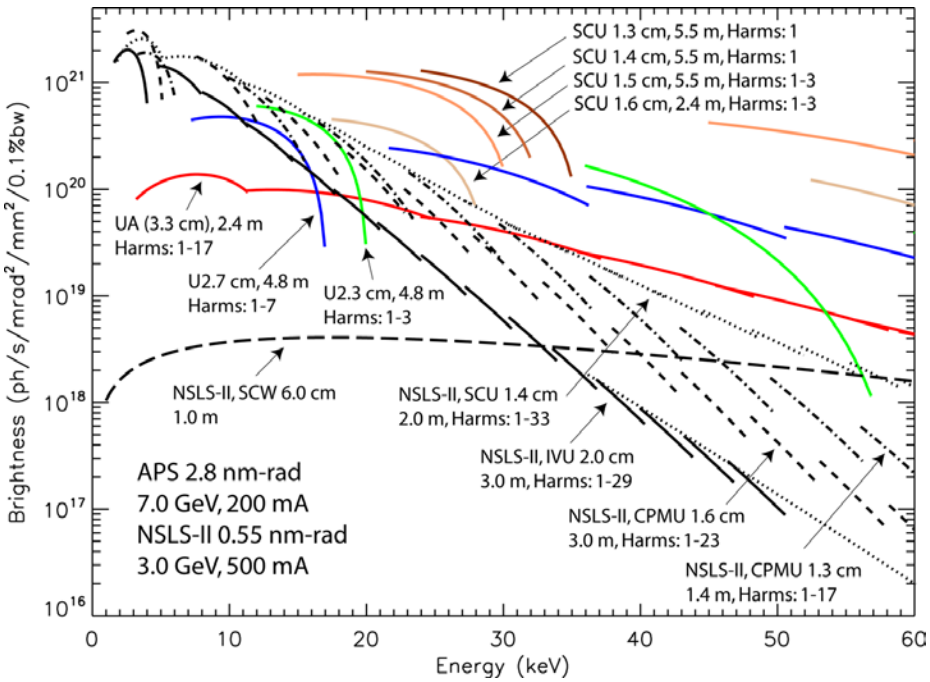
Brian Stephenson
Interim Associate Laboratory Director
Photon Sciences

UChicago Argonne LLC Board of Governors Review of Photon Sciences
July 28, 2011

APS Strengths

- High brightness and flux at high energies
- Fast pulses, high rep rate, flexible bunch structure
- Wide array of beamlines, beamtime available for complex experiments
- Large and diverse community

Future Brightness of APS (color) and NSLS-II (black) vs. Energy



APS Strategy

- Drive advances in accelerators, undulators, optics, and detectors that build upon these strengths
- Make them available to the broad user community through optimized beamlines and strong groups of staff
- Bring forefront synchrotron capabilities to priority DOE and Argonne programs

APS 2020 Strategy: Surrounding and Beyond the Upgrade

The APS Upgrade is the lead component in the overall APS 2020 strategy for improvements to APS, that also includes:

- Additional beamlines funded by BES, as well as NIH, BER, NSF, NNSA
- New, neighboring facilities, e.g. the Advanced Protein Crystallization Facility funded by the State of IL
- Accelerator improvements and retirement of obsolescence
- Expansion of lab and office space for users and user support
- Continued development of superconducting undulator and short-pulse technologies pioneered by the Upgrade

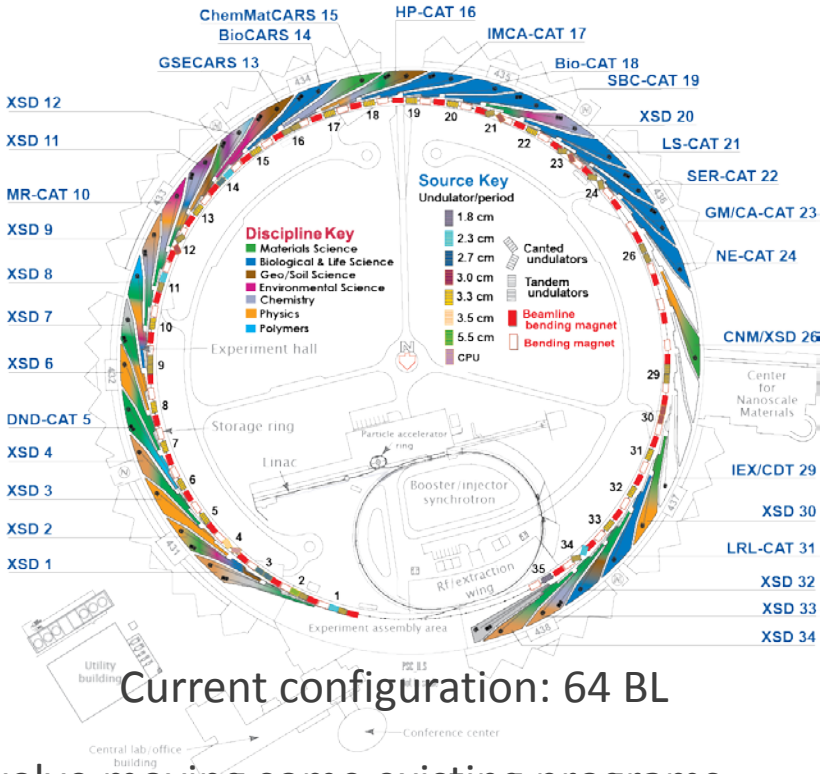
APS 2020 Strategy

APS Upgrade Project

Roadmap for APS Beamlines

- We are currently developing a "roadmap" for the future location of APS beamlines that includes anticipated beamlines:

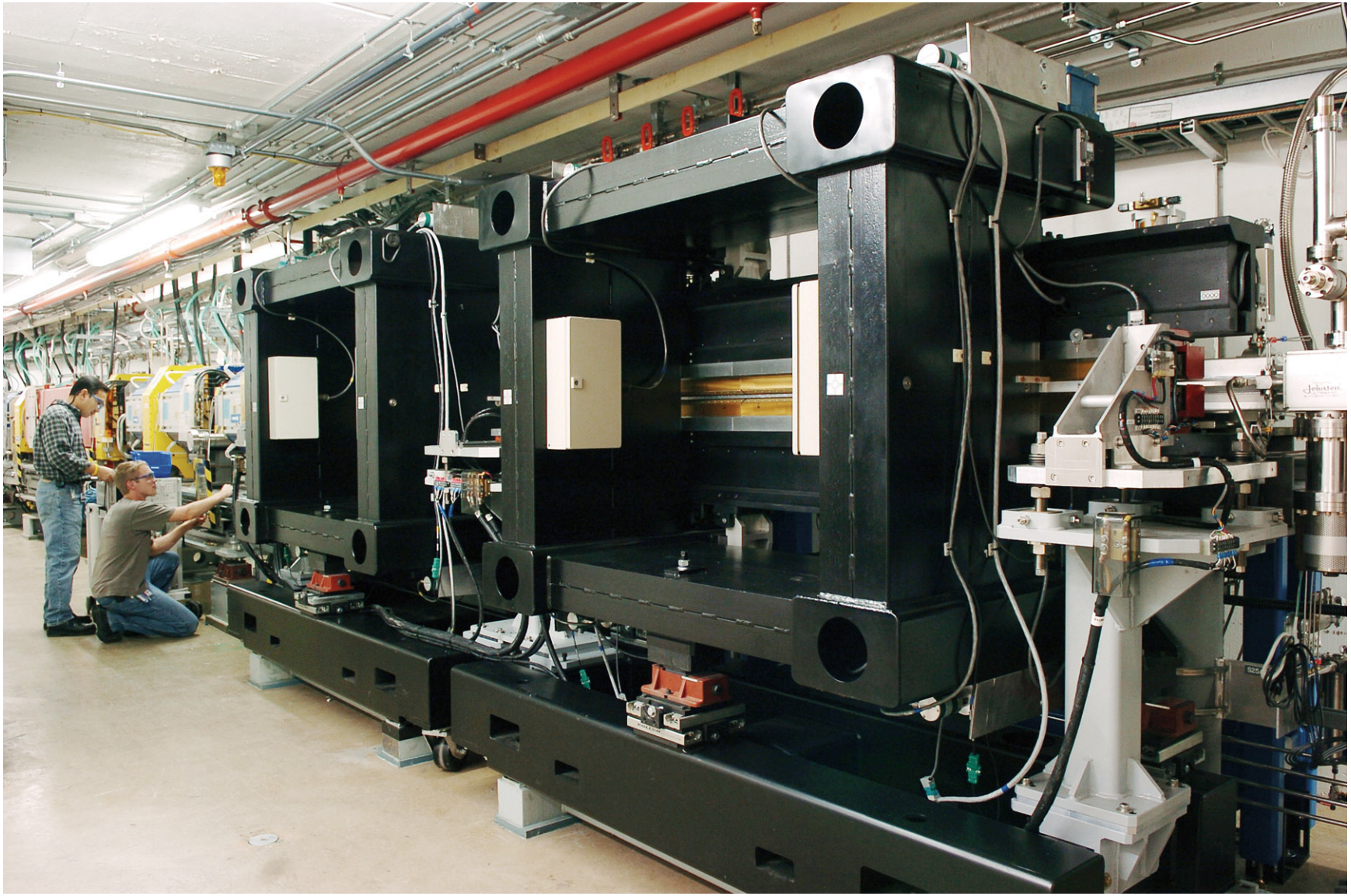
	New BL	Upgr. BL
Underway	2	1
APS-U baseline	6	8
APS-U contingent	8	7
Other SAC-approved Biological Science	3	1
Other SAC-approved Physical Science	2	6
Future	1	



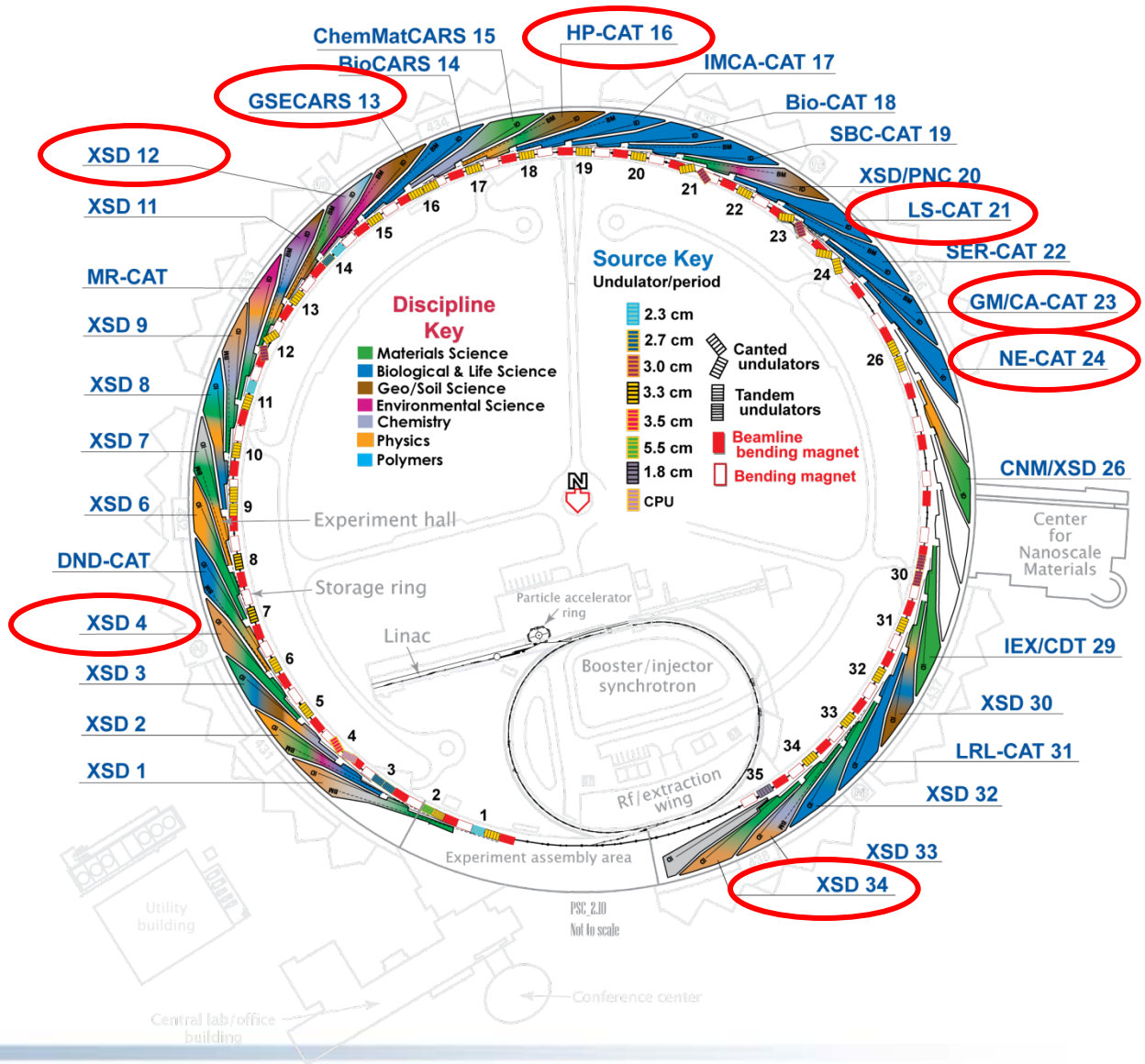
Current configuration: 64 BL

- Optimizing the location of all beamlines may involve moving some existing programs, and our decision process will include close consultation with all stakeholders
- We are working to help secure funding for new beamlines where needed

Canted Undulators – Potential to Double Beamtime



Canted Undulators at APS, in place and underway



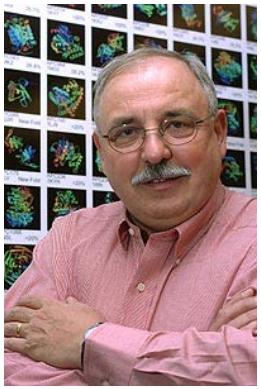
Office of Biological and Environmental Research (BER) Workshop "Applications of New DOE National User Facilities in Biology"

- May 9-11, Rockville, MD
- Purpose: To outline scientific needs of biology community and how they map onto new and upgraded facilities
- Written documents and presentation solicited from NSLS-II, APS-U, LCLS, NGLS, SNS
- Delegation writing and attending with me:

B. Kobilka
Stanford

T. Paunesku
Northwestern

C. Giometti
ANL/BIO



A. Joachimiak
ANL/BIO

K. Kemner
ANL/BIO

C. Jacobsen
ANL & NU

Biological and Environmental Science at the APS

About half of APS beamlines and users carry out research in biological and environmental science

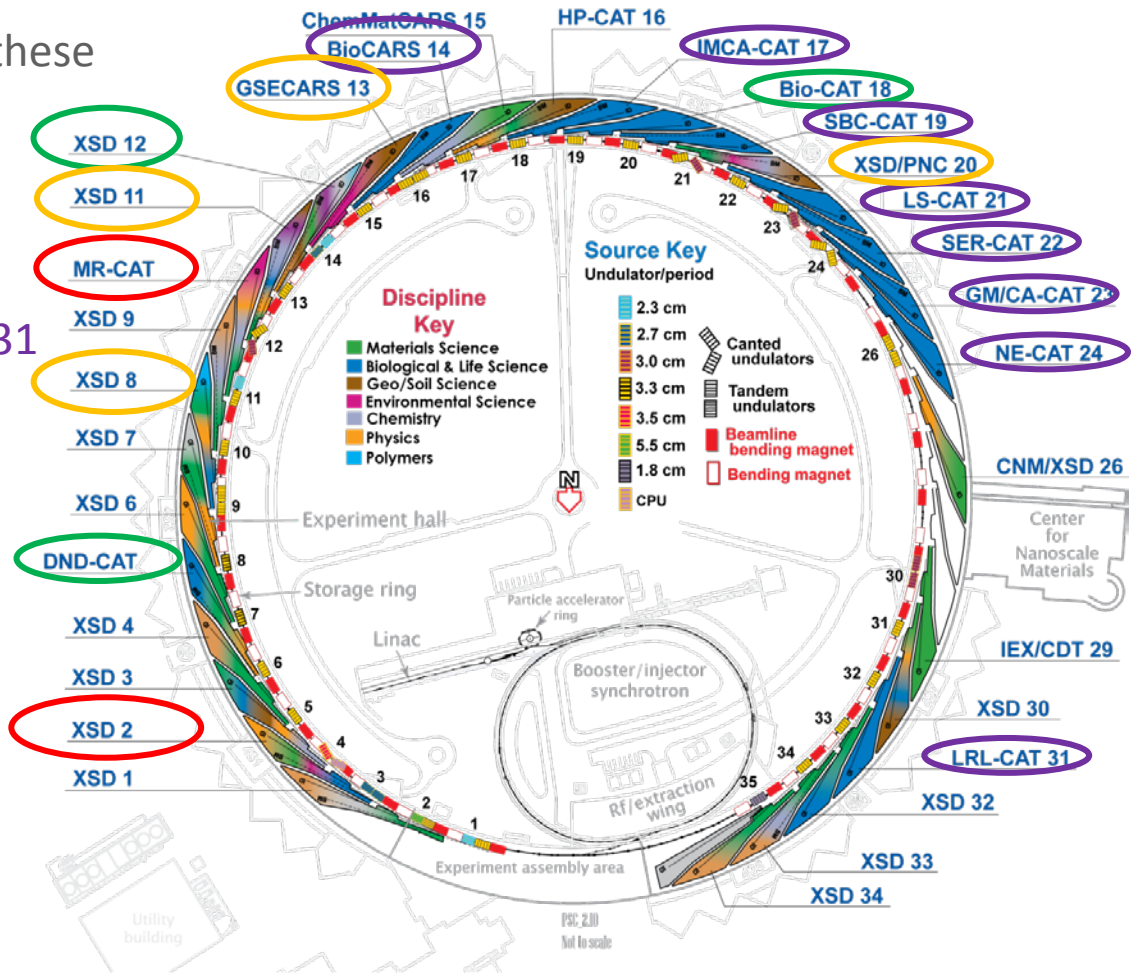
The APS Upgrade Project enhances these capabilities through higher current, stability, and/or improved sources

Macromolecular crystallography:
Sectors 14, 17, 19, 21-24, 31

SAXS/WAXS/Fiber diffraction:
Sectors 5, 12, 18

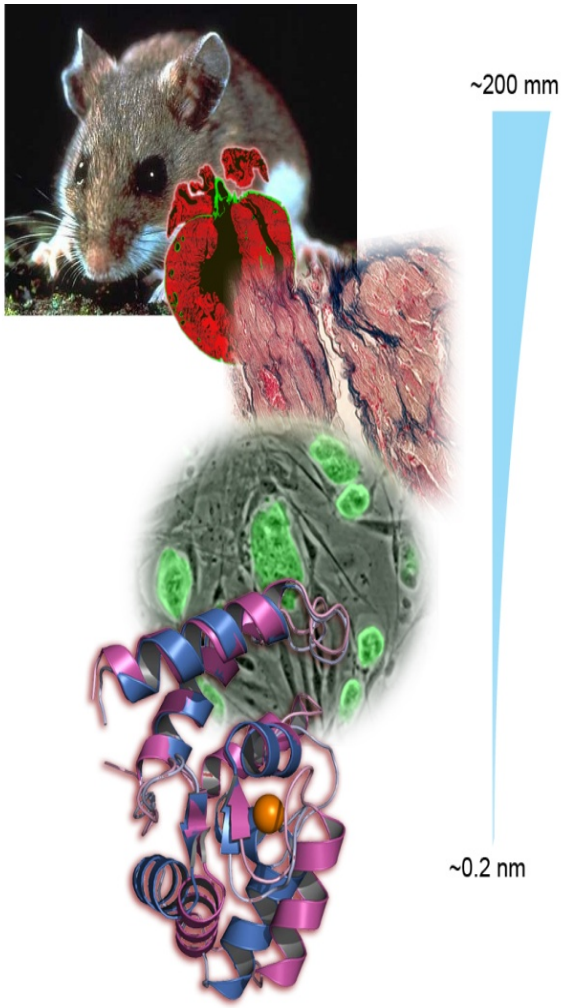
Microprobes:
Sectors 2, 10, 13, 18, 21

Environmental Science:
Sectors 2, 8, 10, 11, 13, 20



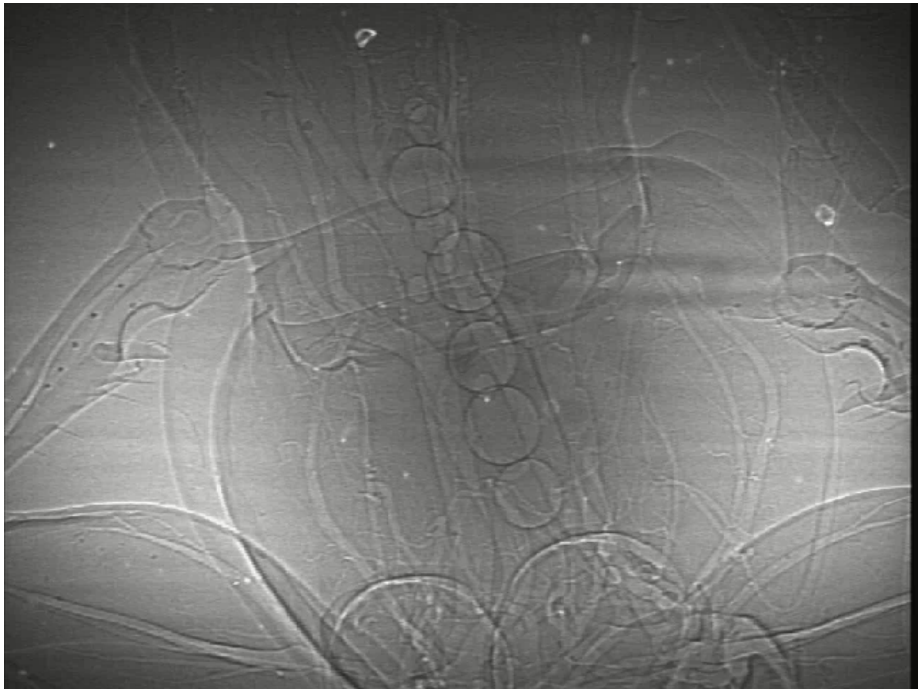
Future Biological Science Facilities at APS: Determining Structure and Dynamics from Proteins to Organisms

- Wide-Field Imaging
- BioNanoprobe II
- Cryo Sample Preparation Facility
- Enhanced SAXS/WAXS
- Enhanced 100-ps Pump-Probe
- Microfocus Macromolecular Crystallography



Wide-Field Imaging Beamline (APS Upgrade Project)

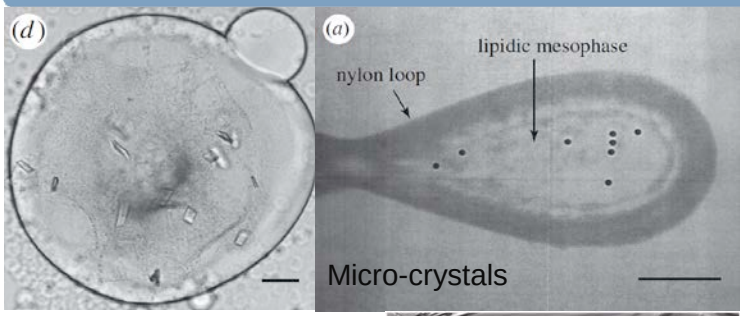
- 250-m-long beamline for hard x-ray phase contrast and tomographic imaging up to 6 x 2-cm field of view
- Will offer world-leading flux density in this large field of view
- Primary mission (DoE-BES support): fluid flow, crack propagation, and materials failure
- Additional support for animal handling will enable real-time imaging of small-animal physiology

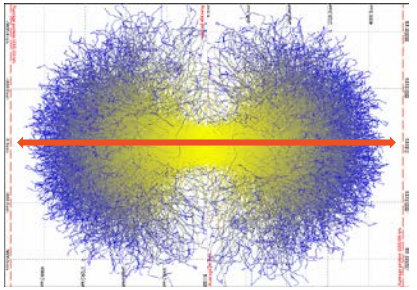


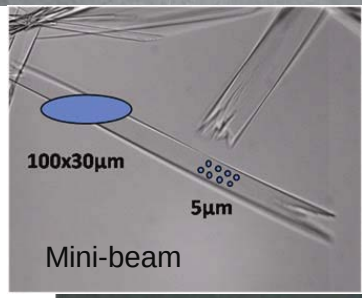
Tracheal pumping in a beetle (3 x 2-mm field). Socha *et al., J. Exp. Biol.* **211**, 3409 (2008).

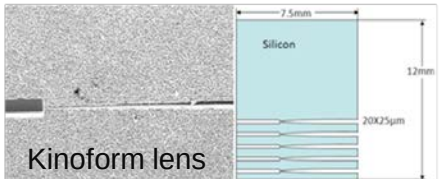
Microfocus Macromolecular Crystallography

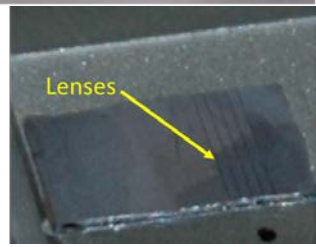
- Micron-size X-ray beams enable the study of very small crystals and can address the most challenging problems in macromolecular crystallography.
  - Microbeam improves data quality with very small samples and reduces the effect of radiation damage.
  - APS-U increase in X-ray beam stability and brightness is highly advantageous.
- Kinoform lens will allow use of a multiple line focus at the sample.
- Source: optimized canted undulator
  - Photon energy range 4-28 keV.
  - X-ray flux at 20 keV of 7.1 x 10^{13} photons/s into a microfocus 1 µm wide and 3 µm high.

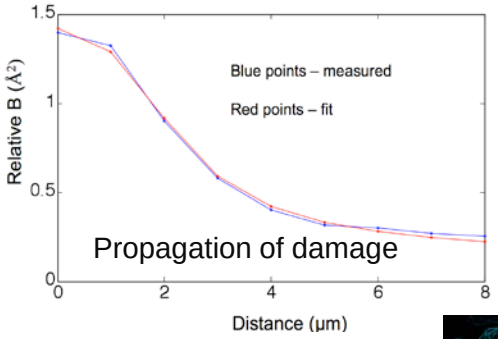


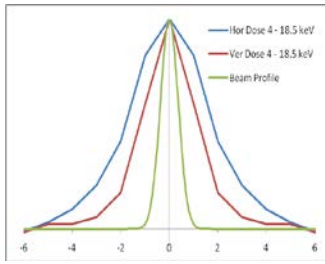


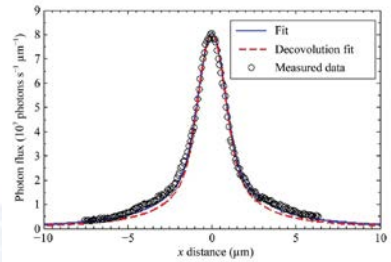


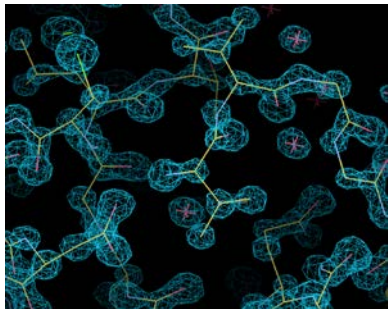








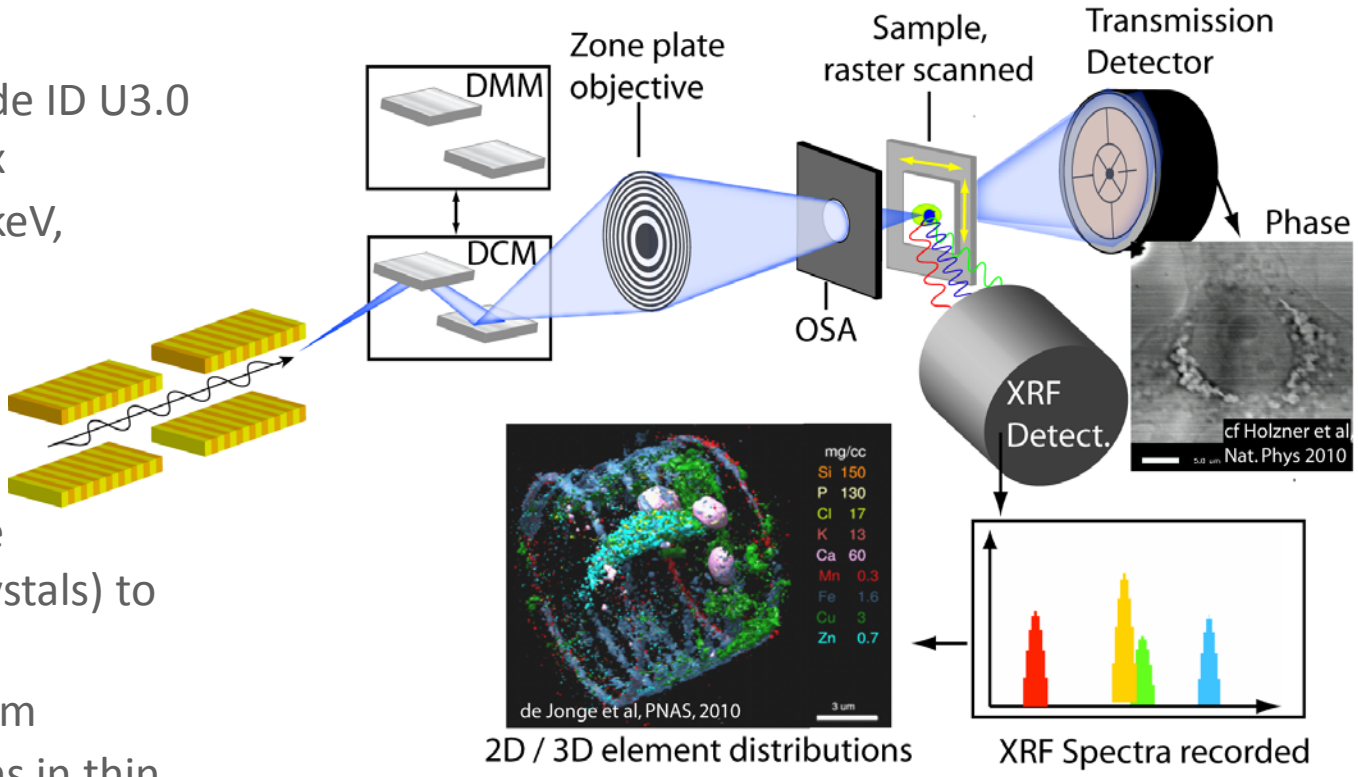




BioNanoprobe II

- Understand the fundamental, intrinsic role trace elements play in biological systems, specifically as integral components with regulatory or catalytic functions
- Understand and address the links between metals and disease
- Develop functional nanocomposites for medical targeting, diagnostics, therapy

- Long straight, upgrade ID U3.0 & 2.7 => 4-5 more flux
- Energy range: 5–30 keV, optimized for >10 keV



Schematic view of the Bionanoprobe II. Hard x-rays are focused onto a specimen, which is raster scanned through focus; ultrastructural information is acquired exploiting phase

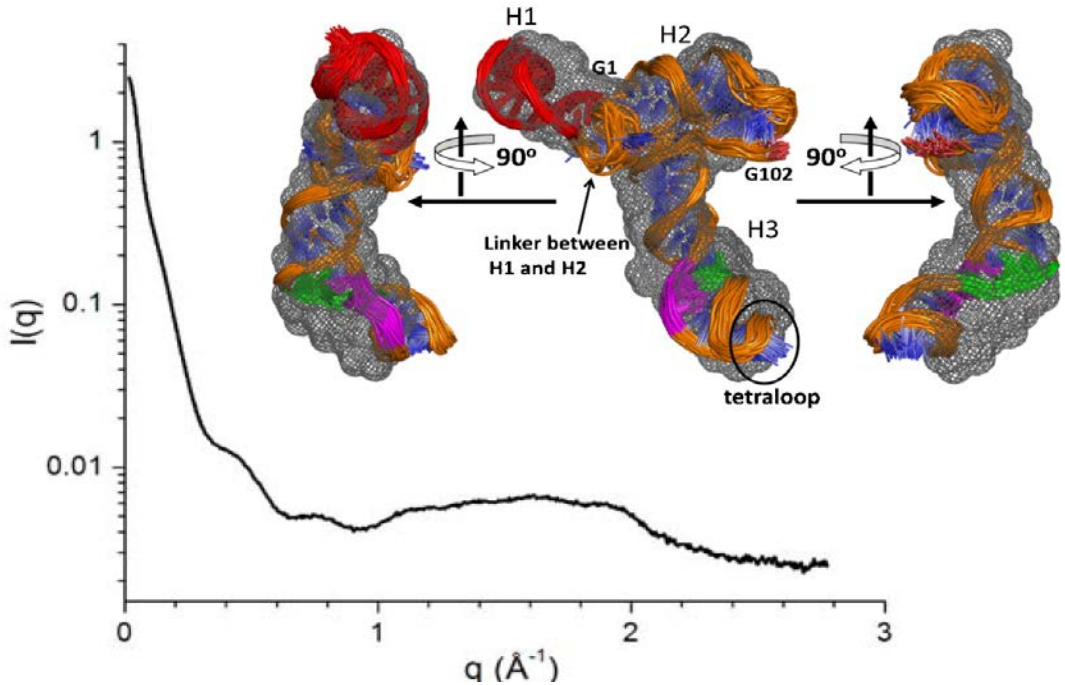
- Two interchangeable monochromators (crystals) to trade flux *vs* res
- Resolution: δ <=20 nm
- Sensitivity: <10 atoms in thin samples
- In vacuum, cryo-system

Enhanced SAXS/WAXS

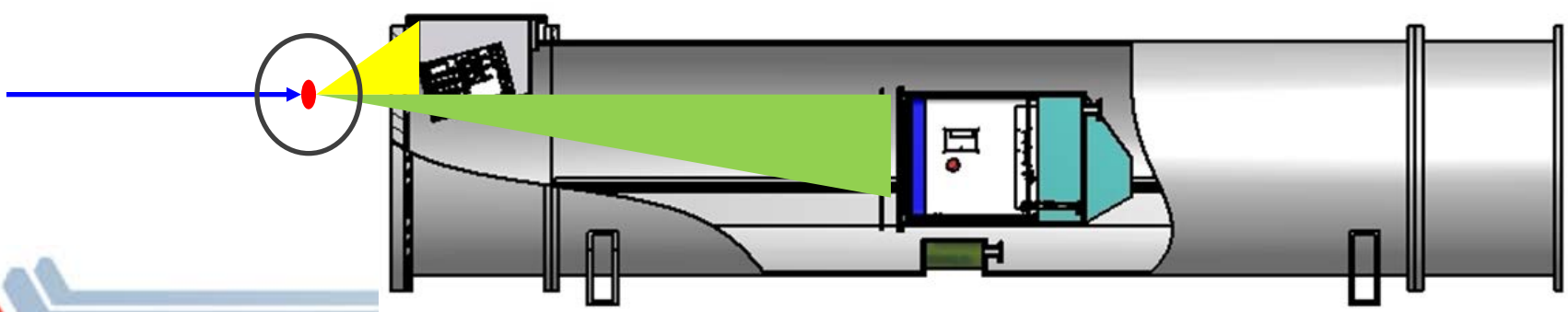
- SAXS provides a low-resolution electron density map, but requires precise background-scattering (from buffer) subtraction
- Water scattering measured by WAXS is an ideal reference to determine the background-scattering contribution to SAXS

The ensemble of global structures of the ribosome-binding structural element determined by SAXS

Zuo X et al., PNAS **107,** 1385-1390 (2010)



Dedicated beamline and sample environment

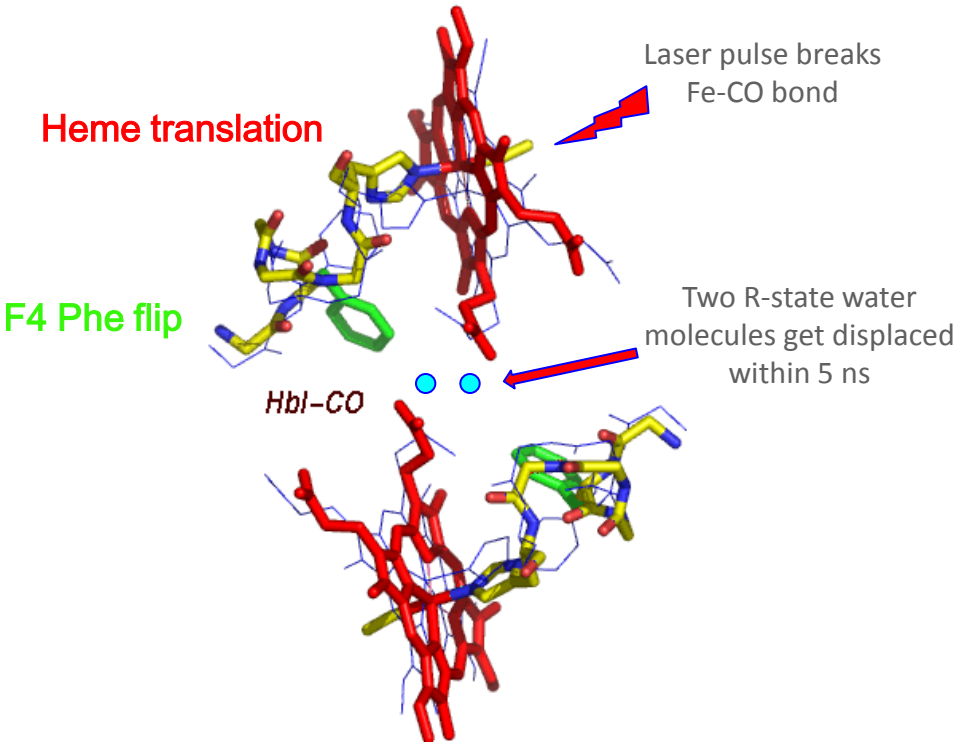


Enhanced 100-ps Pump-Probe: Macromolecules in Action

Allosteric action in real time:
Time-resolved crystallographic studies of a cooperative dimeric hemoglobin (HbI)

W.E. Royer, Univ. of Mass. Medical School, and V. Srajer, BioCARS

Knapp et al., Structure **17**, 1504 (2009)
Srajer and Royer, Methods Enzymol. **437**, 379 (2008)
Knapp et al., PNAS **103**, 7649 (2006)



Models derived from difference refinement for the following individual time points: dark, 5 ns, 200 ns, 700 ns, 2 µs, 9 µs, 80 µs

Key structural transitions in dimeric HbI

What is the cascade of structural events?
An intermediate is formed rapidly (100 ps) upon CO ligand release, relaxing to HbI T-like structure in the µs time domain

Are these transitions concerted or sequential?
Key allosteric changes appear to be tightly coupled

What is the triggering event?
Rapid disordering of two water molecules H-bonded to heme propionates

Do structural intermediates facilitate R to T transition?
Disordering of water molecules appears to lay the foundation for subsequent heme movement

Large-area pixel array detector, enhancements to hutch

Advanced Protein Crystallization Facility

- APS is the proposed site for the Advanced Protein Crystallization Facility
- State of Illinois-funded facility will establish highly automated laboratories and user facilities for the production of proteins and protein crystals from gene sequence data
- Unique state-of-the-art resource for academic and industrial biotechnology and biomedical researchers, serving as a focus for launching new opportunities made possible by large-scale molecular biology, biochemistry, and protein engineering

Our Summary at the BER Workshop

Through the Upgrade and these advanced facilities, APS will continue to provide forefront biological science capabilities for decades to come

- To better understand how proteins and macromolecules function and interact
  - Probe membrane proteins and other difficult to crystallize proteins
  - Explore opportunities for reduced radiation damage in MX
  - Solve protein structures for dynamic , irreversible processes
  - Determine larger ensembles and molecule interactions using enhanced SAXS/WAXS
  - determine interactions between proteins, protein assemblies and nanomaterials using imaging by XFM coupled with MX and SAX/WAXS
- To probe trace element content at the subcellular level, and investigate their role in cell biology, environmental stewardship, disease, and nanomedicine.

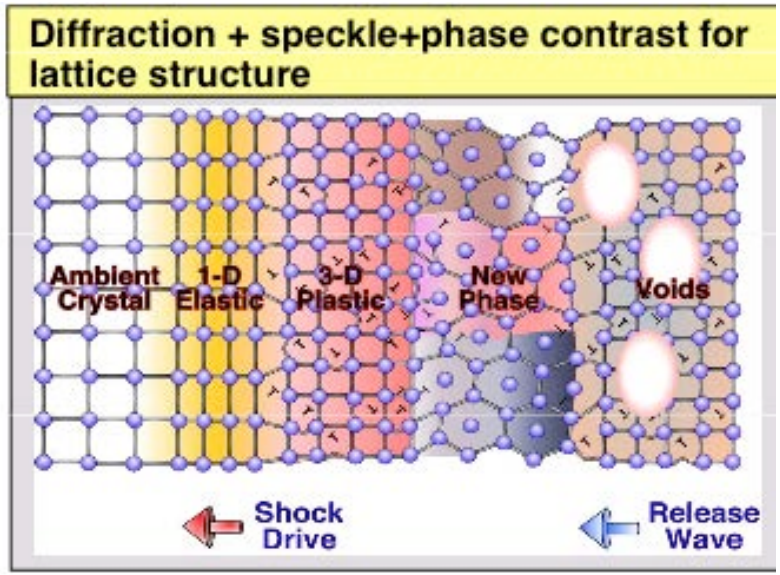
"Make a connection from proteins to organisms"

Dynamic Compression Sector

NNSA-supported beamline organized by Y. Gupta (WSU) to study materials in real time under extreme conditions of pressure (e.g. shock waves)

- Diffraction and imaging, 10 – 100 keV
- Time resolution down to 100 ps
- X-ray source, optics, hutches built by APS
- Drivers built and operated by WSU

Two stage gun (~7 km/s)



Laser Shock

Accelerator Improvements and Retirement of Obsolescence

- In parallel with the Upgrade, we will continue to make improvements to accelerator performance
  - e.g. beam stability: RF BPM electronics
- We also will invest in preventitive maintenance and upgrade of systems to retire accumulated obsolescence

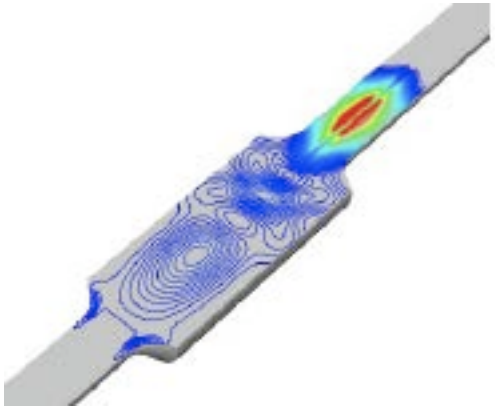
Expanding Office and Lab Space

- We are working with Argonne FMS Division to design expansion of Lab Office Modules to house users and staff for expanded operations
- Site planning for infrastructure such as parking and roadways is also underway
- Based on the "Workshop on the Role of Synchrotron Radiation in Solving Scientific Challenges in Advanced Nuclear Energy Systsems," held in January 2010, we are also planning a facility to enable handling and encapsulat
at APS

Continued Improvements to Performance Enabled by Pioneering Developments from the Upgrade

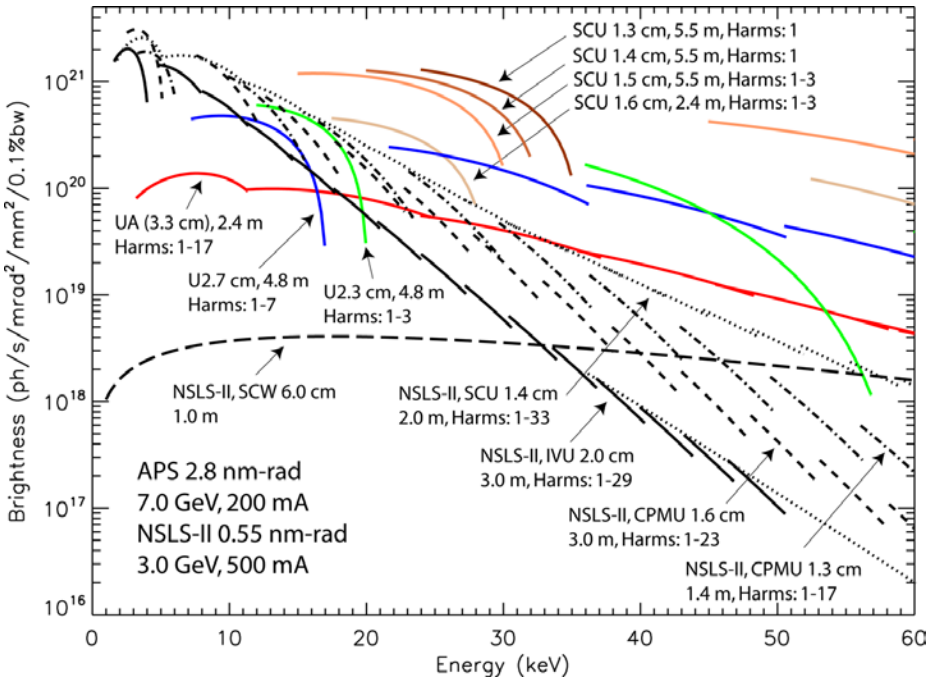
New technologies developed by APS Upgrade project provide a continuing path for improvement:

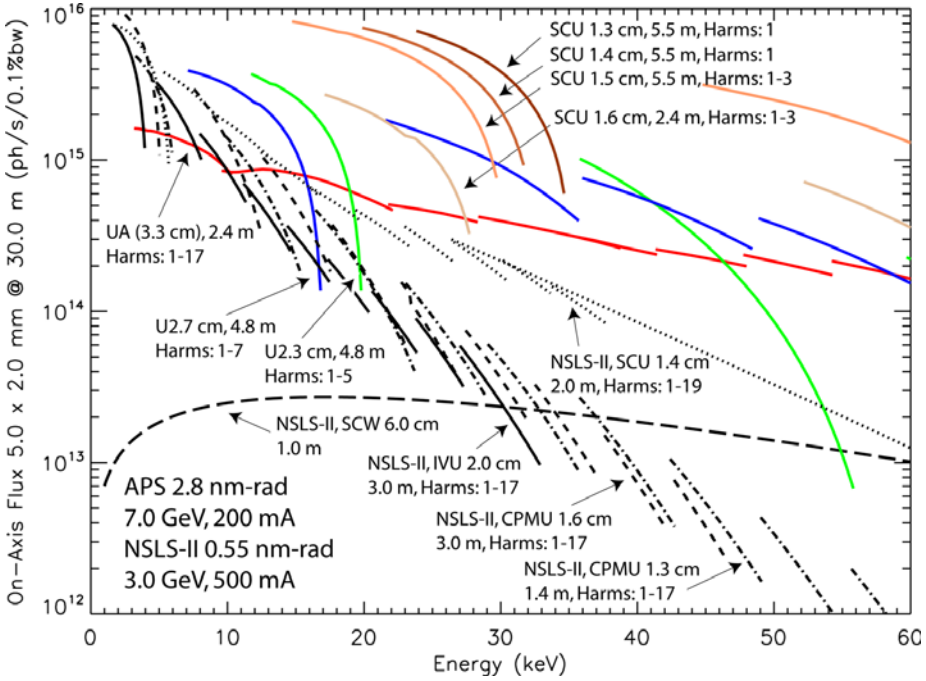
- Further development of superconducting undulators will allow continuing increases in flux and brillance at high energies
- Further development of superconducting RF chirping capability will allow additional improvement of short-pulse capability



Future Brightness and Flux of APS and NSLS

Brightness vs. E (APS curves in color) Flux vs. E





Future short-period superconducting undulators at APS could provide additional major improvement to source brightness and flux at high energies

Summary

- The APS Upgrade is part of a comprehensive strategy for the future of APS for the next decade and beyond
- The strategy includes new and upgraded beamlines in addition to those in the baseline and contingent scope of the Upgrade, as well as accelerator and infrastructure improvements in parallel with the Upgrade
- The new technologies developed by the Upgrade will provide a continued path forward to maintain APS leadership in high energy and ultrafast capabilities