

Advanced Photon Source

An Office of Science National User Facility

Advanced Light Source  
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*National Synchrotron Light Source II*

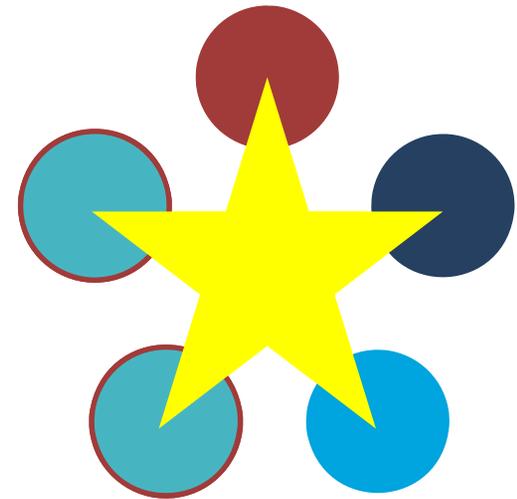
Stanford Synchrotron Radiation Lightsource

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Linac Coherent Light Source

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# Beamline Capabilities Roadmap



-Introduction-

October 5, 2016

SLAC-SSRL

# Agenda – Beamline Capabilities Roadmap

- *Survey of current capabilities and projection of capabilities in ca. 2021*
- *Identification of critical missing capabilities during APS-U*
- *Discussion of mitigation strategies*

# Background and objectives

- APS-U Dark period will have a significant impact on the Synchrotron User community
- More broadly we can aspire to match duplication of capabilities across facilities to user community needs and science drivers

## Objectives for this exercise

- Develop a survey of current capabilities
- Project to 2021 (anticipated APS-U down year)
- Identify critical missing capabilities for the users
- Develop Mitigation Strategies

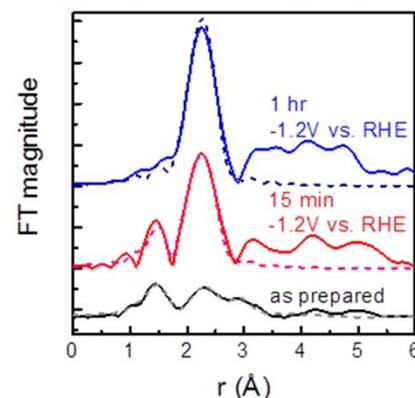
# ***We have seen this place before...***

- NSLS shut down in 2014 as NSLS-II was starting up
  - Overnight we went from ~50 beamlines to zero at BNL
- Anticipated issues and planning started in 2010
  - Worked with ALS, APS and SSRL to understand and mitigate impacts of NSLS ‘Dark’ period
  - Detailed plans discussed at the 2012 NSLS/CFN user meeting
    - Included participants from the other light sources
- Mitigation measures
  - Some additional capability at other light sources
    - A bit of ‘year end’ money from BES-SUF to help
  - Some ongoing support from BNL NSLS-II and partner staff to support former NSLS users at other facilities
  - Aggressive build-out of NSLS-II

# Transition User Support Programs at Other Facilities

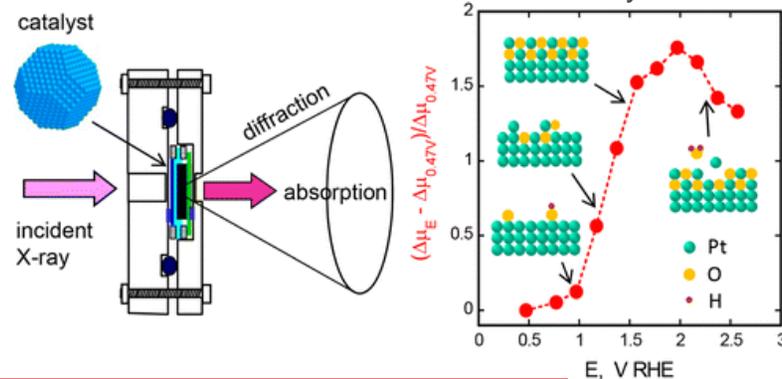
## - helping hundreds of former NSLS users

- X-ray Spectroscopy:
  - SSRL BL2-2 (~80% available beamtime)
- Protein Crystallography:
  - SSRL BL14-1 (50%)+ ID beamtimes
- Infrared Program:
  - ALS 1.4 & 5.4 (~15%)
- Energy Dispersive XRD:
  - APS 6-BM (~58%), as “mini-CAT”
- Transmission X-ray Microscopy:
  - TXM for FXI relocated to APS 8-BM (40%)



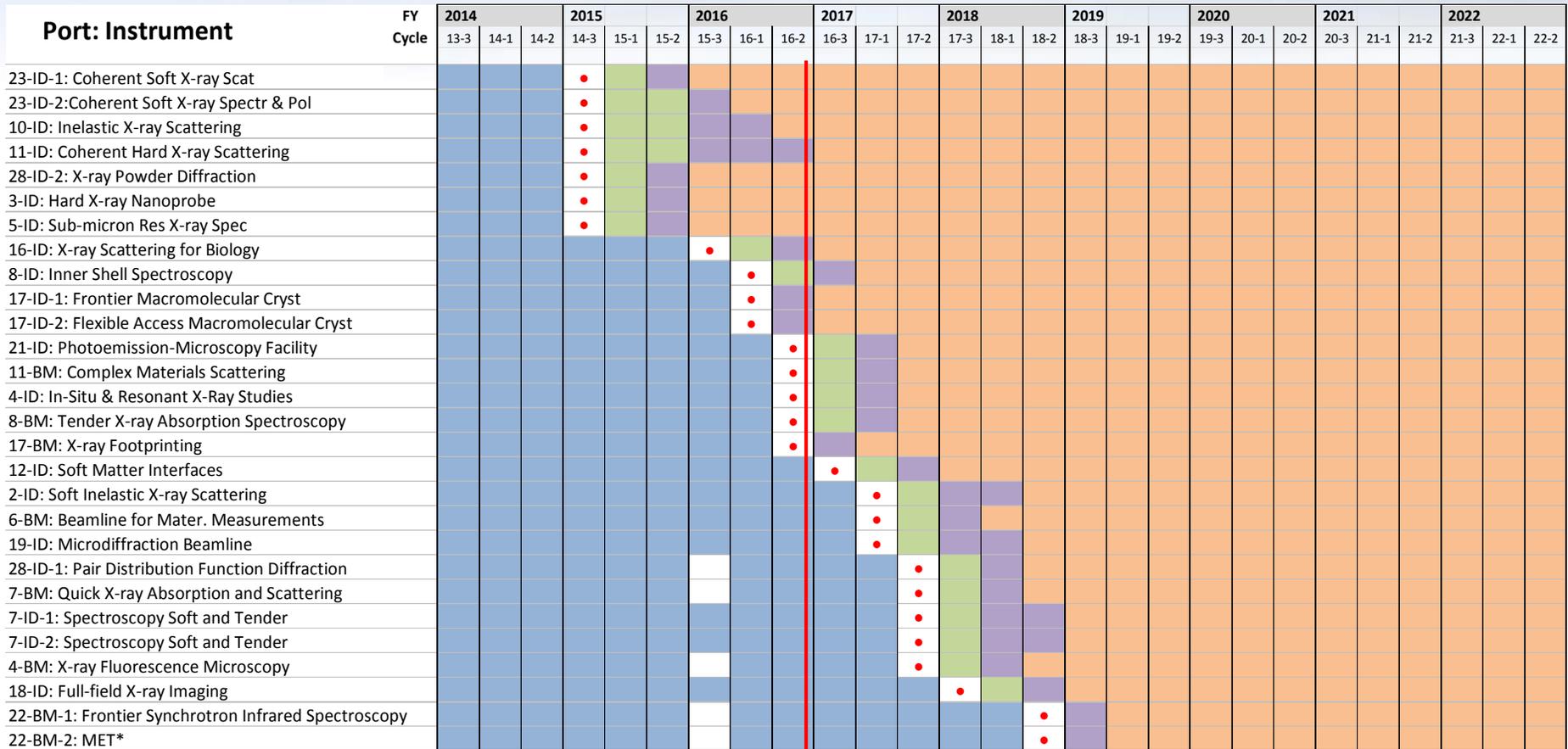
*Nat. Comm.* (2016):  
Operando EXAFS during  
CO<sub>2</sub> electro-reduction

*ACS Catalysis* (2016):  
In-situ Characterization  
of Carbon-Supported  
Platinum and Platinum  
Monolayer Electro-  
catalysts



- Excellent productivity so far: Over 120 user groups supported in FY16; 22 publications in refereed journals, with more manuscripts submitted

# NLS-II Beamline Buildout



Today - 13 September 2016



\*MET Magneto, Ellipsometry and Time Resolved Optical Spectroscopy

Includes only committed work as of 13-Sep-16  
 Several additional projects are in development

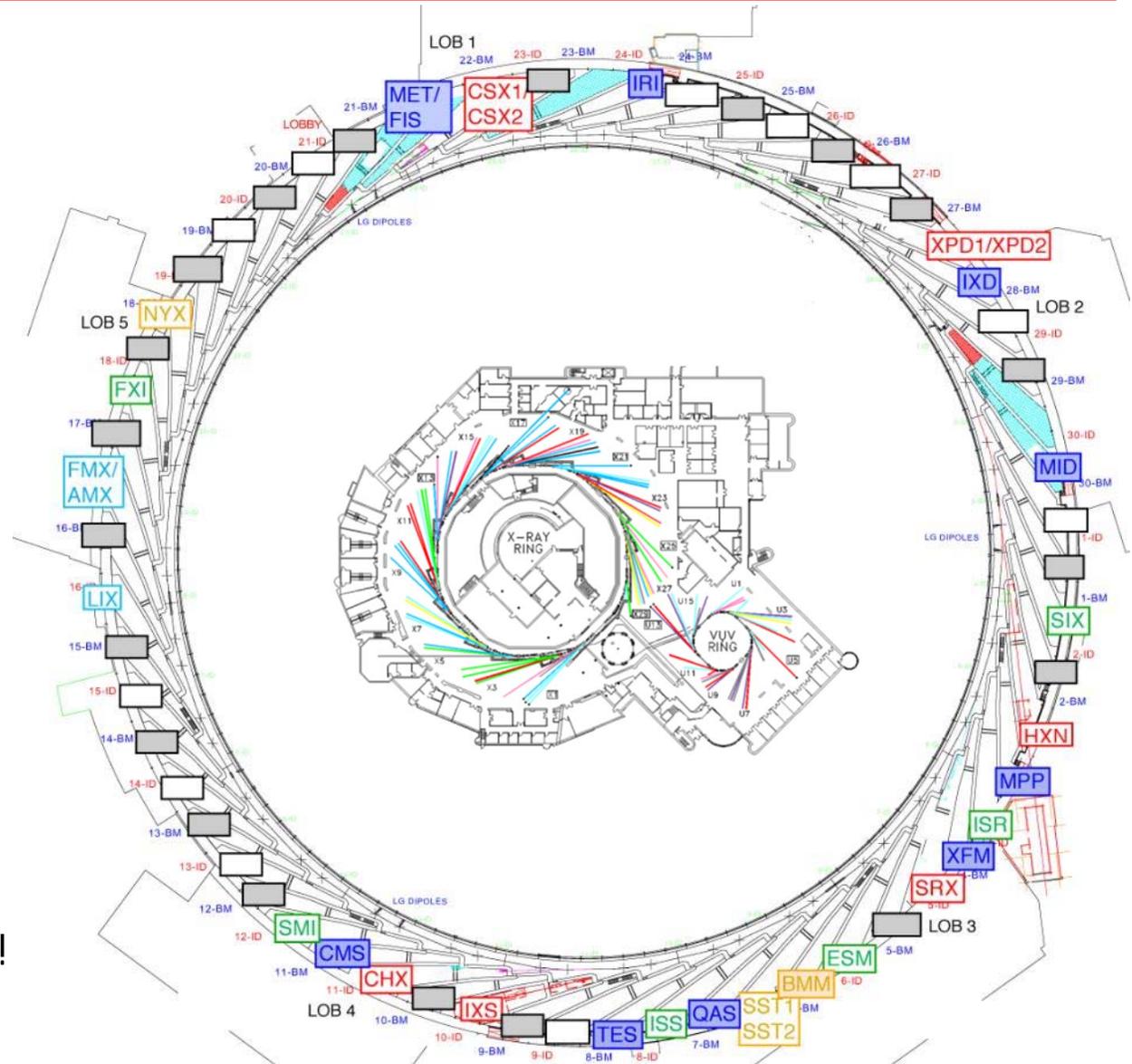
# NSLS User Transition Planning Forum

## 2012 NSLS/CFN Joint Users Meeting

May 21, 2012  
1:30 to 5:30 PM  
Hamilton Seminar Room  
Chemistry Building - 555

Committee:  
Jen Bohon  
Dan Fischer  
Annie Heroux  
Erik Johnson  
Tony Lanzirotti  
Ryan Tappero

Contributions from many others!



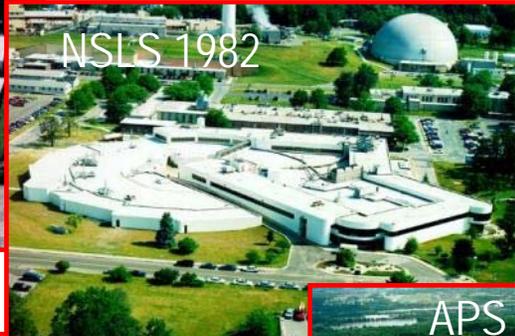
# .... on the way to the forum

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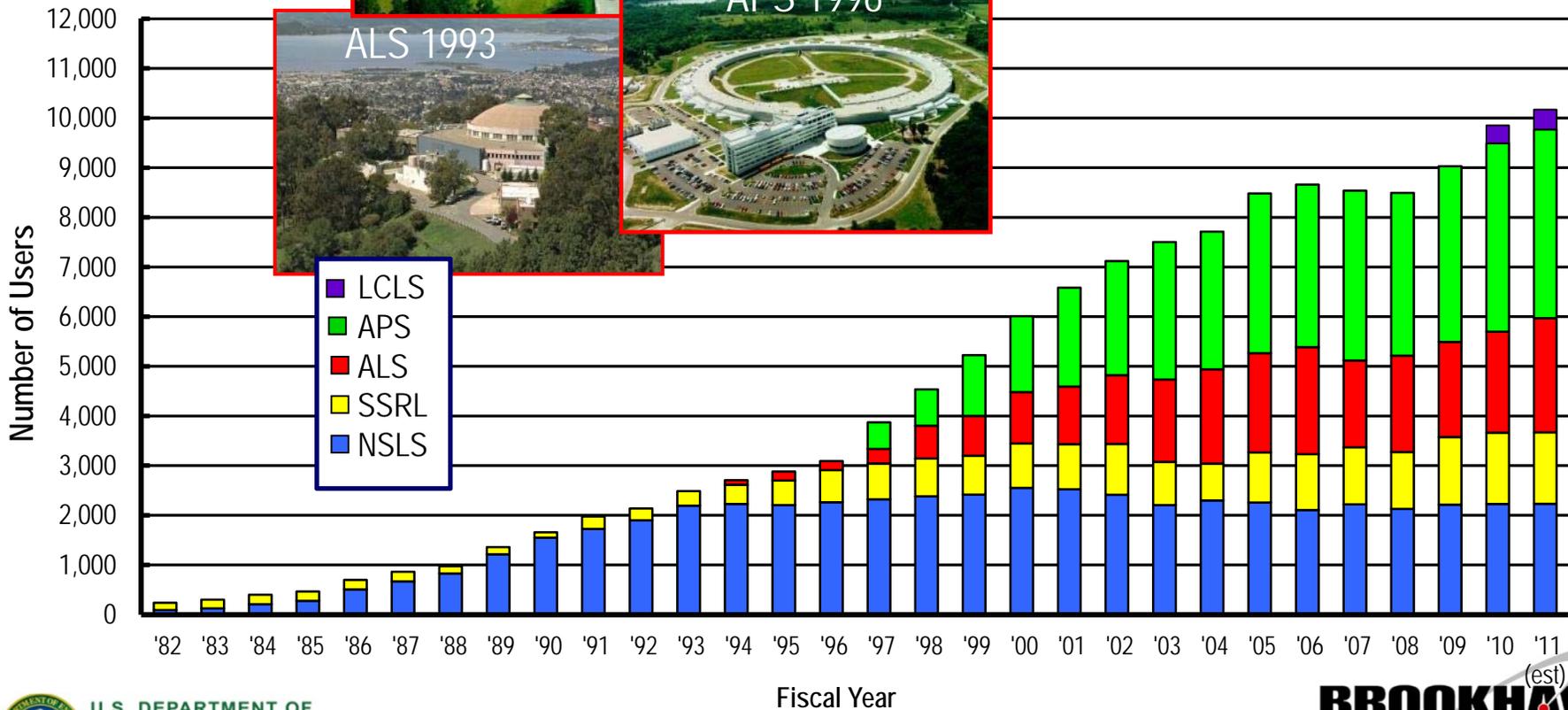
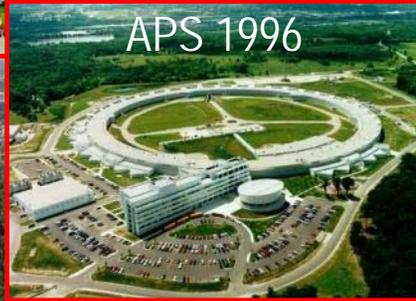
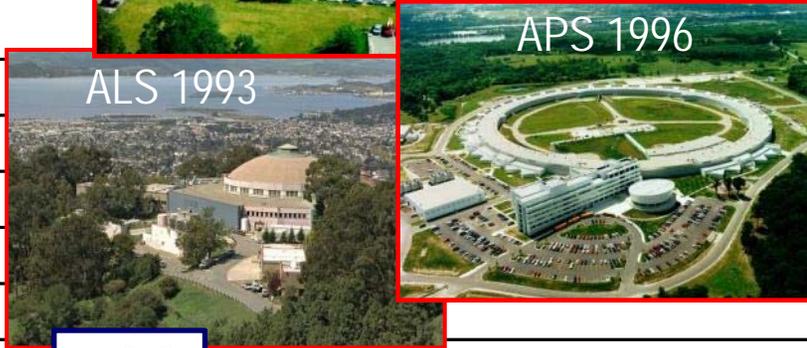
recollection of some events leading up to today ....

- 2011 NSLS/CFN user meeting
  - Discuss coordination with other facilities w/Peter Lee
- 2011 August BESAC meeting
  - Met w/DOE and other facility leadership
  - Formed working group (Banda, Erik, Denny, Piero)
- UEC Town meetings Aug & Nov 2011, Feb 2012
  - Outlined anticipated changes in capacity and capability
  - UEC proposed NSLS User Transition Planning Forum
- DOE Review of NSLS-II Pre-Operations Budget

# DOE - BES Light Sources



Harriet Kung, BESAC March 17 2011



# NSLS to NSLS-II Transition

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- Closing NSLS will be a disruption to the NSLS user community and the beginning of a period of reduced capabilities and capacity nationally for synchrotron based experiments
- Competition for beam time will increase everywhere
- Solution is to develop experimental facilities at NSLS-II as rapidly as possible
  - The capabilities of the DOE-BES light source portfolio will be dramatically enhanced
  - The capacity will also be significantly enhanced, since NSLS-II is expected to host ~ 3500-4000 users/year when fully built out
- In addition to working to build out NSLS-II beamlines, we are also actively coordinating with the other light source facilities to develop measures to help minimize the disruption
  - Working group with members from each of the four DOE light sources has identified areas where similar capabilities exist among the light sources
  - Adjust capacities at ALS, APS, SSRL where possible, sensible, and little or no cost
  - Topic of the NSLS Users Transition Planning Forum ...

# Capability Assessment - August 2011

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- Met with DOE SUF and Synchrotron Facility leadership 1 August 2011
- Reviewed assessment of scientific capability changes anticipated with shutdown of NSLS and ramp up of NSLS-II
- Established working group with other facilities -
  - BNL- NSLS/NSLS-II Erik Johnson
  - LBNL- ALS Michael Banda
  - ANL- APS Denny Mills
  - SLAC - SSRL Piero Pianetta

# DOE Synchrotron Beamlines

Experimental techniques at Light-Source Beamlines

[http://science.energy.gov/~media/bes/pdf/Synchrotron\\_Techniques.pdf](http://science.energy.gov/~media/bes/pdf/Synchrotron_Techniques.pdf)

- Divides techniques into 3 broad categories
- 12 basic techniques

## SPECTROSCOPY

01 Low-Energy spectroscopy  
02 Soft X-ray spectroscopy  
03 Hard X-ray spectroscopy  
04 Optics/Calibration/Metrology

## SCATTERING

05 Hard X-ray diffraction  
06 Macromolecular X'tal  
07 Hard X-ray scattering  
08 Soft X-ray scattering

## IMAGING

09 Hard X-ray Imaging  
10 Soft X-ray Imaging  
11 Infrared Imaging  
12 Lithography

Worked with peers across the complex -

- Compiled list of DOE facility beamlines with techniques available at NSLS or NSLS-II
- Goal – see what is available where through the transition

# Techniques through the Transition

Number	Technique
<a href="#">01-01</a>	Infrared
<a href="#">01-02</a>	Photoemission
<a href="#">02-01</a>	Soft X-ray Spectroscopy
<a href="#">02-02</a>	Tender XAS
<a href="#">03-01</a>	EXAFS
<a href="#">04-01</a>	Metrology
<a href="#">05-01</a>	X-Ray Powder Diffraction
<a href="#">05-02</a>	Extreme Conditions
<a href="#">05-03</a>	Energy Dispersive
<a href="#">05-04</a>	Micro-Beam Diffraction
<a href="#">06-01</a>	Macromolecular Crystallography
<a href="#">06-02</a>	X-ray footprinting
<a href="#">07-01</a>	SAXS/WAXS/GISAXS/Liq Surface
<a href="#">07-02</a>	Resonant & High Magnetic-Field Scattering
<a href="#">07-03</a>	General Diffraction
<a href="#">07-04</a>	In-Situ Scattering
<a href="#">07-05</a>	XPCS
<a href="#">07-06</a>	Solution, BioSAXS
<a href="#">07-07</a>	Hard IXS
<a href="#">08-01</a>	Soft X-ray Scattering
<a href="#">08-02</a>	Pump/Probe
<a href="#">08-03</a>	Soft IXS
<a href="#">09-01</a>	HX Microprobe
<a href="#">09-02</a>	TXM
<a href="#">09-03</a>	Topography
<a href="#">09-04</a>	micro-CT
<a href="#">09-05</a>	Coherent Diffraction Imaging
<a href="#">10-01</a>	Soft X-ray Microprobe

- Collected a total of 28 subcategories
- Beamline Equivalents (BE) by facility

Technique	Photoemission	Resources Available - BE			
		Mid 2012	Mid 2014	Mid 2016	Mid 2017
Beamline	X-ray Source	Total	Total	Total	Total
<b>NSLS</b>		2.5	2.5	0	0
<b>USUA</b>	undulator	1	1	0	0
U13	undulator	1	1	0	0
X1A1*	undulator	0.5	0.5	0	0
<b>APS</b>		0.3	0.3	0.3	0.3
4 ID C	undulator	0.3	0.3	0.3	0.3
<b>ALS</b>		4	4	4	4
<b>7.0.1</b>	U5 - undulator	0	0	0	0
<b>10.0.1</b>	U10 - undulator	1	1	1	1
<b>12.0.1</b>	U8 - undulator	1	1	1	1
<b>11.0.1.1*</b>	EPU5 - undulator	1	1	1	1
<b>9.3.2**</b>	bend	1	1	1	1
<b>SSRL</b>		1	1	1	1
BL5-4	undulator	1	1	1	1
<b>NSLS-II</b>		0	0	0	1
ESM	EPU - undulator	0	0	0	1
<b>Totals</b>		<b>7.8</b>	<b>7.8</b>	<b>5.3</b>	<b>6.3</b>

# Techniques at DOE Synchrotrons

- Spectroscopy

- Scattering

- Imaging

Number	Technique	Contact	Coordinator	FY12	FY14	FY16
<a href="#">01-01</a>	Infrared	Carr	Lisa Miller	4.5	5	4
<a href="#">01-02</a>	Photoemission	Vescovo	Lisa Miller	7.8	7.8	5.3
<a href="#">02-01</a>	Soft X-ray Spectroscopy	Dvorak	Lisa Miller	8.85	8.85	7.6
<a href="#">02-02</a>	Tender XAS	Northrup	Lisa Miller	1.5	2.5	2
<a href="#">03-01</a>	EXAFS	Ravel	Lisa Miller	17.55	18.25	12.25
<a href="#">04-01</a>	Metrology	Kiester	Lisa Miller	9.65	9.95	4.7
<a href="#">05-01</a>	X-Ray Powder Diffraction	Dooryhee	Ron Pindak	14.2	14.2	10
<a href="#">05-02</a>	Extreme Conditions	Ehm	Ron Pindak	7	7.2	5.8
<a href="#">05-03</a>	Energy Dispersive	Zhong	Ron Pindak	0.4	0.4	0.1
<a href="#">05-04</a>	Micro-Beam Diffraction	Evans-Lutterodt	Ron Pindak	3.25	3.4	3.15
<a href="#">06-01</a>	Macromolecular Crystallography	Heroux	Lisa Miller	39	39	34
<a href="#">06-02</a>	X-ray footprinting	Bohon	Lisa Miller	1	1	0
<a href="#">07-01</a>	SAXS/WAXS/GISAXS/Liq Surface	DiMasi	Ron Pindak	14	14	10.5
<a href="#">07-02</a>	Resonant & High Magnetic-Field Scattering	Nelson	Ron Pindak	2.75	2.75	2.75
<a href="#">07-03</a>	General Diffraction	Ludwig	Ron Pindak	9.6	9.6	6.8
<a href="#">07-04</a>	In-Situ Scattering	Ludwig	Ron Pindak	5.7	5.7	4.65
<a href="#">07-05</a>	XPCS	Fluerasu	Ron Pindak	2	2	2.5
<a href="#">07-06</a>	Solution, BioSAXS	Yang	Ron Pindak	2.35	2.35	2.65
<a href="#">07-07</a>	Hard IXS	Cai	Ron Pindak	4.4	4.4	6.7
<a href="#">08-01</a>	Soft X-ray Scattering	Sanchez-Hanke	Ron Pindak	5.75	5.75	6.3
<a href="#">08-02</a>	Pump/Probe	Arena	Ron Pindak	5.65	5.85	5.7
<a href="#">08-03</a>	Soft IXS	Jarrige	Ron Pindak	1.2	1.2	0.7
<a href="#">09-01</a>	HX Microprobe	Lanzirrotti	Lisa Miller	7.6	7.8	9.8
<a href="#">09-02</a>	TXM	Lee	Lisa Miller	1.9	2.1	1.1
<a href="#">09-03</a>	Topography	Dudley	Lisa Miller	1	1.25	0.25
<a href="#">09-04</a>	micro-CT	Lee	Lisa Miller	2.75	1.85	1.85
<a href="#">09-05</a>	Coherent Diffraction Imaging	Lima	Lisa Miller	1.975	2.475	2.475
<a href="#">10-01</a>	Soft X-ray Microprobe	Thieme	Lisa Miller	4.5	4.6	4.6
				187.8	191.2	158.2

*Note – Shown with NSLS running through FY14*

# Observations looking toward APS-U

- We are roughly the same time out from the APS-U dark as we were when we started planning for the NSLS to NSLS-II transition..
  - *(editorial opinions)*
    - *Should have started sooner for NSLS*
    - *Stakeholder outreach should get going for APS*
- NSLS represented  $\frac{1}{4}$  of the US user base; APS is about  $\frac{1}{2}$  !
- APS-U dark may be shorter (1-2 years from user perspective?); may open different mitigation strategies

# Starting Steps for a capability roadmap

- Points of Contact for the facilities –
  - ANL- APS Denny Mills
  - LBNL- ALS Steve Kevan
  - BNL- NSLS-II Erik Johnson
  - SLAC - SSRL Piero Pianetta
  - SLAC- LCLS David Fritz
- Revisit categories in classification scheme
  - Extensions/new sub-categories (common language...)
- Map current instruments onto scheme
  - Present set (2016)
  - Forward projection (2018,2020, 2022)
    - Understand anticipated situation straddling the APS-U shutdown

# Topics for Discussion

- Technique categories
- Survey of existing and anticipated instruments
- Strategic partnerships with APS community to bridge the APS to APS-U gap
- Longer view on strategic alignment and partnerships for beamline capabilities

## APS Critical Capabilities – Denny Mills

# IDENTIFYING MISSING CRITICAL CAPABILITIES



**DENNIS MILLS**  
**APS DEPUTY DIRECTOR**

5-Way Meeting October 5, 2016  
SLAC

# CRITICAL MISSING CAPABILITIES- HIGH ENERGY

- Although we have not completed the survey of capabilities, I can give you what I think what are the (current) unique capabilities that exist at APS.
- High Energy Diffraction Microscopy (HEDM @ 1-ID)
  - 60 to 100 keV x-rays from SCU
  - Very high demand
- Pair Distribution Function (PDF @ Sector 11)
  - 60 to 100 keV
  - High demand and very productive
- High Energy Scattering
  - 70 to 130 keV x-rays from SCU
  - Expect increased demand with installation of 1.1 m SCU
- High Energy Resolution Inelastic X-ray Scattering (HERIX @ 3-ID and 30-ID)
  - 30 keV with approximately 1 meV resolution
- High Speed Imaging and Diffraction (32-ID & DCS @ 35-ID)
  - Uses single pulse (need high flux per pulse, i.e. high current bunches)
  - Often done using hard x-ray pink beam
  - A lot of associated infrastructure (lasers, gas guns, etc.)

# CRITICAL MISSING CAPABILITIES - UNIQUE INSTRUMENTATION AND CAPACITY ISSUES.

- Time-resolved Diffraction/Spectroscopy (BioCARS, @ 14-ID, 7-ID, & 11-ID)
  - Sometimes use single pulse (need high flux per pulse, i.e. high current bunches)
  - A lot of associated infrastructure (lasers, etc.)
- Magnetic Scattering (6-ID-C)
  - pulsed field magnets (30T)
- Magnetic Circular Dichroism (4-ID-C and 4-ID-D)
  - crystal phase retarding optics for hard x-ray branch
  - 12.8 cm period circularly polarizing undulator (CPU) for soft x-ray branch
  - Various magnets for sample environments
- MX
  - Not unique but rather a capacity issue for both "regular" beams and "micro-beams"
  - Particularly troublesome for our industrial users

QUESTIONS????

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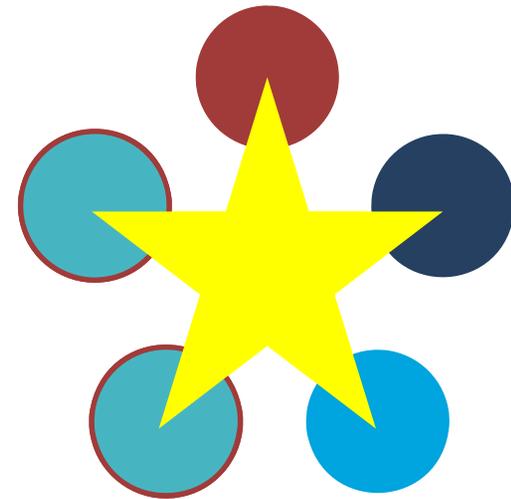
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# Beamline Capabilities Roadmap



-Discussion-

October 5, 2016

SLAC-SSRL

# Technique categories

- Some discussion around possible additions/changes
- Last go at this exercise didn't include LCLS
  - First pass from David with major categories

		LCLS Instrument						
		AMO	CXI	MEC	AFX	SXR	XCS	XPP
<b>Spectroscopy</b>								
01	Low Energy Spectroscopy	x						
02	Soft X-ray Spectroscopy	x				x		
03	Hard X-ray Spectroscopy		x	x	x		x	x
04	Optics/Calibration/Metrology							
<b>Scattering</b>								
05	Hard X-ray Diffraction			x			x	x
06	Macromolecular Crystallography		x		x			x
07	Hard X-ray Scattering		x	x	x		x	x
08	Soft X-ray Scattering	x				x		
<b>Imaging</b>								
09	Hard X-ray Imaging		x	x				x
10	Soft X-ray Imaging	x				x		
11	Infrared Imaging							
12	Lithography							

- Nicely illustrates that some instruments straddle categories -

Spectroscopy	Comments/Action	
01 - Low Energy Spectroscopy ( E < a few 100 ev)		
Infrared	in BES techniques document	keep
Photoemission/ARPES	in BES techniques document	keep
IR Ellipsometry/spectroscopy	Suggested at SPMC Mtg	need to be separate from IR?
02 - Soft X-Ray Spectroscopy (a few 100 ev < E < a few keV)		
NEXAFS	in BES techniques document	keep
XAS	in BES techniques document	keep
dichroism	Suggested at SPMC Mtg	keep
RIXS	in BES techniques document	put under "scattering?"
XPS	in BES techniques document	keep
XX - Tender x-rays???		
XAS		
XPS		
03 - Hard X-ray Spectroscopy (a few keV < E < tens of keV)		
EXAFS	in BES techniques document	keep
X-ray Dichroism	Suggested at SPMC Mtg and in BES techniques document	keep
Raman	Suggested at SPMC Mtg	put under "scattering?"
XES	Suggested at SPMC Mtg	keep
RIXS	Suggested at SPMC Mtg	put under "scattering?"
04 - Optics/Calibration/Metrology		

on Eriks's original list	
not on Erik's list but suggested @ SPMC mtg	
not on Erik's list but mentioned in BES techniques document	
not on Erik's list but suggested by Mills to capture APS capabilities	
Kevan's additions	

# Scattering (I)

Scattering			Comments/Action
<b>05 X-ray Diffraction (ordered systems)</b>			
X-Ray Powder Diffraction	in BES techniques document		keep
Extreme Conditions	in BES techniques document		refine: HP, high magnetic fields, temp????
Energy Dispersive	previous list		keep
Micro-Beam Diffraction	previous list		keep
PDF	Suggested at SPMC Mtg		put under "scattering?"
General Diffraction	in BES techniques document		currently in "scattering" - move
Magnetic X-ray Scattering	Suggested at SPMC Mtg		keep
Surface Diffraction	in BES techniques document		keep/ combine with in-situ??
Standing waves	in BES techniques document		do we need this??
<b>05a High Energy X-ray Diffraction (E &gt; 50 keV)</b>			
Micro-Beam Diffraction	added by DMM		keep
General Diffraction	added by DMM		keep
<b>06 MX, footprinting</b>			
Protein Crystallography	in BES techniques document		keep
X-ray footprinting	previous list		keep
Serial Crystallography	Suggested at SPMC Mtg		keep

	on Eriks's original list
	not on Erik's list but suggested @ SPMC mtg
	not on Erik's list but mentioned in BES techniques document
	not on Erik's list but suggested by Mills to capture APS capabilities
	Kevan's additions

# Scattering (II)

Scattering		Comments/Action
<b>07 Hard X-ray Scattering (systems not perfectly ordered or static)</b>		
SAXS/WAXS/GISAXS/ <b>GIWAXS</b>	in BES techniques document	separate techniques out???
Resonant & High Magnetic-Field Scattering	previous list- not exactly sure what this is	rename/define/separate???
General Diffraction	in BES techniques document	put under "diffraction?"
In- Situ Scattering	previous list	put in "Diffraction"/ or both ???
XPCS	in BES techniques document	keep
Solution, BioSAXS	in BES techniques document	keep
IXS	in BES techniques document	keep
Truncation rod scattering	in BES techniques document	is this the same as "surface diffraction"??
NRS	in BES techniques document	keep
RIXS	in BES techniques document	keep
<b>Liquid Surface Scattering</b>	<b>added by DMM</b>	keep
<b>07a High Energy X-ray Scattering (E &gt; 50 keV)</b>		
<b>PDF/Diffuse</b>	<b>added by DMM</b>	keep
<b>XX Tender Scattering</b>		
<b>08 Soft X-Ray Scattering</b>		
SAXS/GISAXS/XMCD	in BES techniques document	keep
Pump/Probe	not so obvious this belongs here	does not belong here - remove
IXS	in BES techniques document	keep
<b>XPCS</b>	<b>Suggested at SPMC Mtg / in BES techniques document</b>	keep
RIXS	in BES techniques document	included in "spectroscopy" - delete one or other

on Eriks's original list
not on Erik's list but suggested @ SPMC mtg
not on Erik's list but mentioned in BES techniques document
not on Erik's list but suggested by Mills to capture APS capabilities
Kevan's additions

# Imaging (I)

Imaging		Comments/Action
<b>09- Hard X-ray Imaging</b>		
HX Microprobe	in BES techniques document	keep
TXM	in BES techniques document	keep
Topography	in BES techniques document	keep
micro-CT	in BES techniques document	keep
Coherent Diffraction Imaging	previous list	keep
Diffraction Microscopy	Suggested at SPMC Mtg	keep
Fluorescence Tomography	Suggested at SPMC Mtg	how about just "Tomography"?
Ptychography	Suggested at SPMC Mtg	is this a technique or way to analyze??
BCDI	Suggested at SPMC Mtg	diffraction???
Full Field Imaging	Suggested at SPMC Mtg / in BES techniques document	keep - can be with microscope or not
<b>09a High Energy X-ray Scattering (E &gt; 50 keV)</b>		
Diffraction Microscopy	added by DMM	keep
Full Field Imaging	added by DMM	keep

on Eriks's original list	
not on Erik's list but suggested @ SPMC mtg	
not on Erik's list but mentioned in BES techniques document	
not on Erik's list but suggested by Mills to capture APS capabilities	
Kevan's additions	

# Imaging (II)

Imaging		Comments/Action
<b>10- Soft X-ray Imaging</b>		
X-ray Microprobe	in BES techniques document	keep
CDI	Suggested at SPMC Mtg / in BES techniques document	keep
Ptychography	Suggested at SPMC Mtg	is this a technique or way to analyze??
PEEM		
micro-CT		
Full Field Imaging	Suggested at SPMC Mtg	keep - can be with microscope or not
<b>11- IR Imaging</b>		
Nano-spectroscopy	Suggested at SPMC Mtg	???

on Eriks's original list
not on Erik's list but suggested @ SPMC mtg
not on Erik's list but mentioned in BES techniques document
not on Erik's list but suggested by Mills to capture APS capabilities
Kevan's additions

Note for microprobe instruments discussion around spectroscopy on a small area, or imaging that has spectroscopic contrast  
 Answer depends on who you ask....

# Some example assignments

- Excel workbooks
  - APS [BES BL techniques list DMM 15 SEP 16](#)
  - ALS [2012 May 21 Technique Matrix + ALS SK 13 SEP 16](#)
- Illustration of how things get added when considering beamlines at a particular facility
- Original (2012) list wound up with 28 categories

# NLSL-II

	FY 2015			FY 2016			FY 2017			FY 2018			FY 2019			FY 2020			FY 2021			FY 2022				
	CY 2014	14-3	15-1	15-2	15-3	16-1	16-2	16-3	17-1	17-2	17-3	18-1	18-2	18-3	19-1	19-2	19-3	20-1	20-2	20-3	21-1	21-2	21-3	22-1	22-2	
<b>'Committed' Beamlines</b>																										
<b>Soft X-Ray Scattering &amp; Spectroscopy</b>																										
23-ID-1: Coherent Soft X-ray Scat (2015)	●																									
23-ID-2: Coherent Soft X-ray Spectr & Pol (2015/2016)	●																									
21-ID: Photoemission-Microscopy Facility (2017)						●																				
2-ID: Soft Inelastic X-ray Scattering (2017)								●																		
22-BM-1: Frontier Synchrotron Infrared Spectroscopy (2018)												●														
22-BM-2: Magneto, Ellipsometry and Time Resolved Optical Spectroscopy (2018)												●														
<b>Complex Scattering</b>																										
10-ID: Inelastic X-ray Scattering (2015)	●																									
11-ID: Coherent Hard X-ray Scattering (2015)	●																									
11-BM: Complex Materials Scattering (2017)						●																				
12-ID: Soft Matter Interfaces (2017)							●																			
<b>Diffraction &amp; In Situ Scattering</b>																										
28-ID-2: X-ray Powder Diffraction (2015)	●																									
28-ID-1: Pair Distribution Function Diffraction (2018)										●																
4-ID: In-Situ & Resonant X-Ray Studies (2017)						●																				
27-ID: High Energy X-ray Diffraction (2020)																				●						
25-ID: Materials in Radiation Environments (2020?)																										
<b>Hard X-Ray Spectroscopy</b>																										
8-ID: Inner Shell Spectroscopy (2016)					●																					
7-BM: Quick X-ray Absorption and Scattering (2018)										●																
8-BM: Tender X-ray Absorption Spectroscopy (2017)						●																				
7-ID-1: Spectroscopy Soft and Tender (2018)									●																	
7-ID-2: Spectroscopy Soft and Tender (2018)									●																	
6-BM: Beamline for Mater. Measurements (20178)								●																		
<b>Imaging &amp; Microscopy</b>																										
3-ID: Hard X-ray Nanoprobe (2015)	●																									
5-ID: Sub-micron Res X-ray Spec (2015)	●																									
4-BM: X-ray Fluorescence Microscopy (2018)										●																
18-ID: Full-field X-ray Imaging (2018)										●																
<b>Structural Biology</b>																										
17-ID-1: Frontier Macromolecular Cryst (2016)					●																					
17-ID-2: Flexible Access Macromolecular Cryst (2016)					●																					
16-ID: X-ray Scattering for Biology (2016)				●																						
17-BM: X-ray Footprinting (2017)						●																				
19-ID: Microdiffraction Beamline (2017)							●																			
Operations Support								9		6		6			0				0			1			0	
Fully NLSL-II budget																										
Common support (user operations supported by others)																										
								7		16		20			28				28			28			29	

At the end of FY16, 16 beamlines 'In-Service'

# Follow up on Survey of capabilities

- Agree on technique categories
- Facility POC to collect existing and projected beamline equivalents (BE)
  - BE – 5000 hour user capability
  - Baseline 2016, project for 2018, 2020 and 2022?
- Where mixed use across techniques assign fractional BE – each beamline can sum to no more than one BE

## APS-U Dark Period Mitigation Strategy Discussion

# Comments/Discussion

- Get the categories by end of CY16
- Taxonomy with multiple levels (not just two as in our modified list) e.g. 1.01.xx
- Make sure it rolls up to the BES 12
- Plug in the FY16
- In F17Q2 make projections for out years
  - FY18, FY20, FY22, FY24 - maybe FY26?
- For prospective beamlines (not yet committed) include but clearly designate them as not yet set
- Draft a notional schedule for the process up to APS-U shutdown