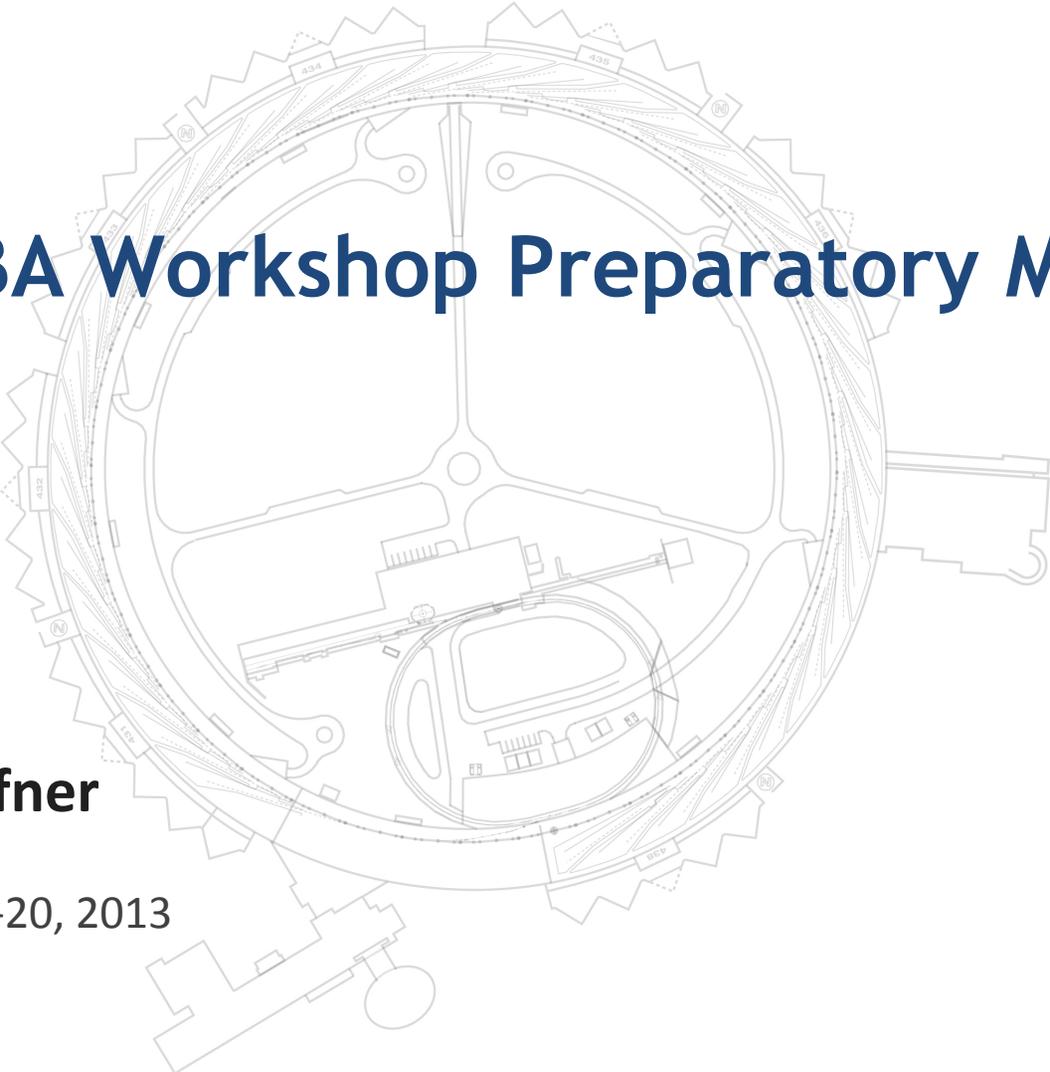


APS/MBA Workshop Preparatory Meeting I



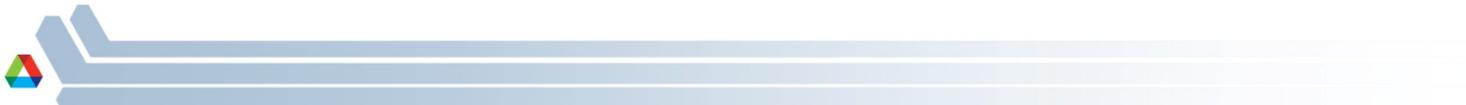
Dean Haeffner

September 12-20, 2013



Agenda

- Workshop, pre-workshop activities Dean Haeffner
- MBA accelerator parameters Louis Emery
- General Discussion



Community Engagement Plan towards the MBA Lattice

- August:
 - Initial evaluation of impact on the Upgrade and draft White Paper on incorporating MBA lattice into APS Upgrade
<http://www.aps.anl.gov/Upgrade/Documents>
- September:
 - Engage user community, APS staff and other Labs in evaluating opportunities and organizing October workshop
- October 21-22:
 - Workshop to optimize incorporation of MBA into APS-U, including science opportunities for all communities
- November 6-7:
 - APS Scientific Advisory Committee review of Workshop report



Preliminary Meetings Schedule

<u>Preliminary Meeting</u>	<u>Location</u>	<u>Breakout Title</u>	<u>Internal Lead</u>
Thurs (9/12) 2:30 pm	438/C010	Coherent Diffraction and Phase Contrast Imaging, XPC	Jin Wang
Fri (9/13) 11:00 am	A1100	Timing and Dynamics	David Keavney
Mon (9/16) 11:00 am	E1100	Macromolecular Crystallography	Robert Fischetti
Mon (9/16) 1:30 pm	E1100	Interface and Single Crystal Diffraction	Jon Tischler
Tues (9/17) 11:00 am	A1100	Scanning Probe Imaging	Stefan Vogt
Wed. (9/18) 1:30 pm	A1100	Spectroscopy & Inelastic Scattering	Steve Heald
Fri (9/20) 11:00 am	E1100	Powder/Pair Distribution Functions/Small Angle X-ray Scattering/High Energy/Nano Diffraction/High Pressure	Jan Ilavsky

Note—Several of these rooms have changed.



Workshop on Science Opportunities with MBA Lattice

Monday, October 21

9:00-11:30 Plenary Session

MBA sources overview: scientific opportunities and global perspective

Source properties of a potential MBA lattice at the APS

Optics, detector, and instrumentation developments for high brightness x-ray sources

1:00-5:00 Breakout Sessions

Scanning Probe Imaging

Coherent Diffraction and Phase Contrast Imaging, XPCS

Timing and Dynamics

Interface and Single Crystal Diffraction

Structural and High Energy Scattering, SAXS

Spectroscopy and Inelastic Scattering

Macromolecular Crystallography

Tuesday, October 22

9:00-11:00 Breakout Discussion and Report Preparation

11:00-12:00 Workshop Reports and Plenary Discussion

1:30-4:30 Workshop Reports and Plenary Discussion continued



Goals for the Workshop

- *Inform the APS community* concerning the properties of an MBA low-emittance lattice being considered in the APS Upgrade.
- *Gather input on the new science opportunities* offered by such a source.
- Address how our current suite of beamlines map onto these envisioned science opportunities, and *what new capabilities are needed*.
- *Explore the technical advances in optics, detectors, and undulators* that are required to realize these science opportunities.
- *Identify areas that require R&D efforts* to achieve the ultimate performance from an MBA x-ray source.

Input from the user community and APS staff essential



Please Register



Advanced Photon Source
» an Office of Science User Facility



U.S. DEPARTMENT OF **ENERGY** | Office of Science

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- MBA Technology
- Pre-Workshop Activities
- Registration
- Resources
- Links
- Preliminary Program
- Travel Resources

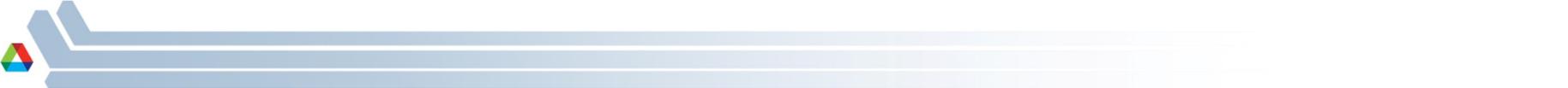
The Advanced Photon Source **Upgrade Project**

Workshop on new science opportunities provided by a multi-bend achromat lattice at the APS

October 21-22
Advanced Photon Source
Argonne National Lab

REGISTER NOW

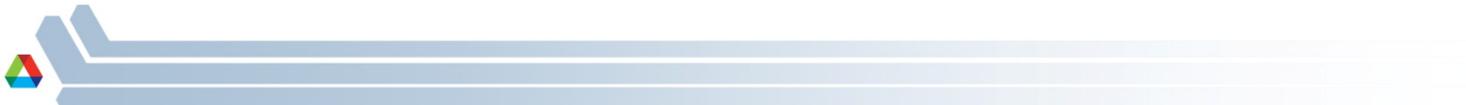
The Advanced Photon Source Upgrade is focused on delivering a powerful, versatile facility for science using high-brightness, high-energy X-rays. At APS, and around the light source community, scientists have been developing storage ring designs that push closer to the ultimate diffraction limit for X-ray sources. A recent report by the Basic Energy Sciences Advisory Committee, which advises the Director of the U.S. Department of Energy Office of Science, has recommended leveraging such "multi-bend achromat" (MBA) technology to advance the science performed by the U.S. synchrotron radiation user community. This emerging technology could provide orders-of-magnitude improvement in brightness and coherent flux, enabling transformational advances in imaging, in studies of dynamics, and in nanometer-resolution probes utilizing the full array of powerful X-ray contrast modes, from diffraction to spectroscopy to resonant inelastic X-ray scattering.





Workshop Organizing Committee

- *Dean Haeffner (chair)*
- *George Srajer*
- *Jonathan Lang*
- *Dennis Mills*
- *Mark Beno*
- *Connie Vanni*
- *Diane Wilkinson*
- *Denis Keane*



Workshop Breakout Areas

Breakout Session	Internal Chair	External Chair
Scanning Probe Imaging	Stefan Vogt	Tonio Buonassisi
Coherent Diffraction and Phase Contrast Imaging, XPCS	Jin Wang	Ian Robinson
Timing and Dynamics	David Keavney	Paul Evans
Interface and Single Crystal Diffraction	Jon Tischler	Paul Fuoss
Structural and High Energy Scattering, SAXS	Ian Ilavsky	Lyle Levine
Spectroscopy and Inelastic Scattering	Steve Heald	Clem Burns
Macromolecular Crystallography	Robert Fischetti	tbd



Pre-workshop Activities

- Two meetings with subject area local communities
 - Premeeting (this meeting)
 - Inform/kickoff thinking about beamlines, science with lower emittance
 - Followup (Early October)
 - Gather information, discussion on ideas
 - Begin putting together workshop report draft
- Optics tool tutorial session by Ruben Reininger
 - Schedule follows
 - First filled, second session to be scheduled
 - Contact Dean if interested
- Optics talk by Lahsen Assoufid & the Optics group





Ruben Reininger's X-ray Optics Tools Tutorials

September 19th, 9-11 AM, room E1100

Brief introduction to SHADOW

Sources

Mirror types and their aberrations

Meridional and sagittal focusing

Screens and slits

KB system

Double crystal monochromator

2nd set of sessions will be
scheduled

September 26th, 9-11 AM, room E1100

Complete beamline

Figure errors

Heat bump

Diffraction

Transfocator

Exercise for next meeting: Ray trace your own beamline

October 3rd, 9-11 AM B1209

Discussion of exercises



Homework

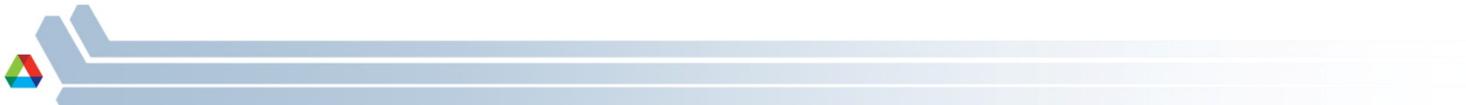
1. What scientific opportunities do you see in your area that may be enabled by an MBA lattice? Include new types of experiments and significant enhancements to current experiments.
2. What new beamline capabilities will be needed to utilize the lower emittance of the MBA lattice? Include upgrades to current beamlines and possible new facilities. If applicable, comment on:
 1. Optics
 2. Detectors
 3. Longer beamlines
 4. Facility infrastructure
 5. Data analysis/theory development
3. Is there any R&D on instrumentation needed to realize the scientific opportunities?
4. How are your experiments currently limited by storage-ring emittance? Describe how lower emittance will improve your capabilities.
5. As emittance is decreased, at what point (if any) will your current optics limit the gains from decreasing emittance?
6. As emittance is decreased, at what point (if any) would state-of-the-art optics limit the gains from decreasing emittance?
7. What are your needs for special operating modes?





Homework II

1. Develop one slide scientific opportunities slides.
 - A. Sooner the better (please send to Dean or your local area chair).
 - B. Should have several coming out of the workshop for every area.



Controlling Materials Exhibiting Nanoscale Order

Opportunity

- New electronic, mechanical, optical physics and devices require control of nanoscale order in electronic, magnetic, and orbital degrees of freedom.
- Non-equilibrium theory beginning to emerge via density functional theory but experiments have been challenging.

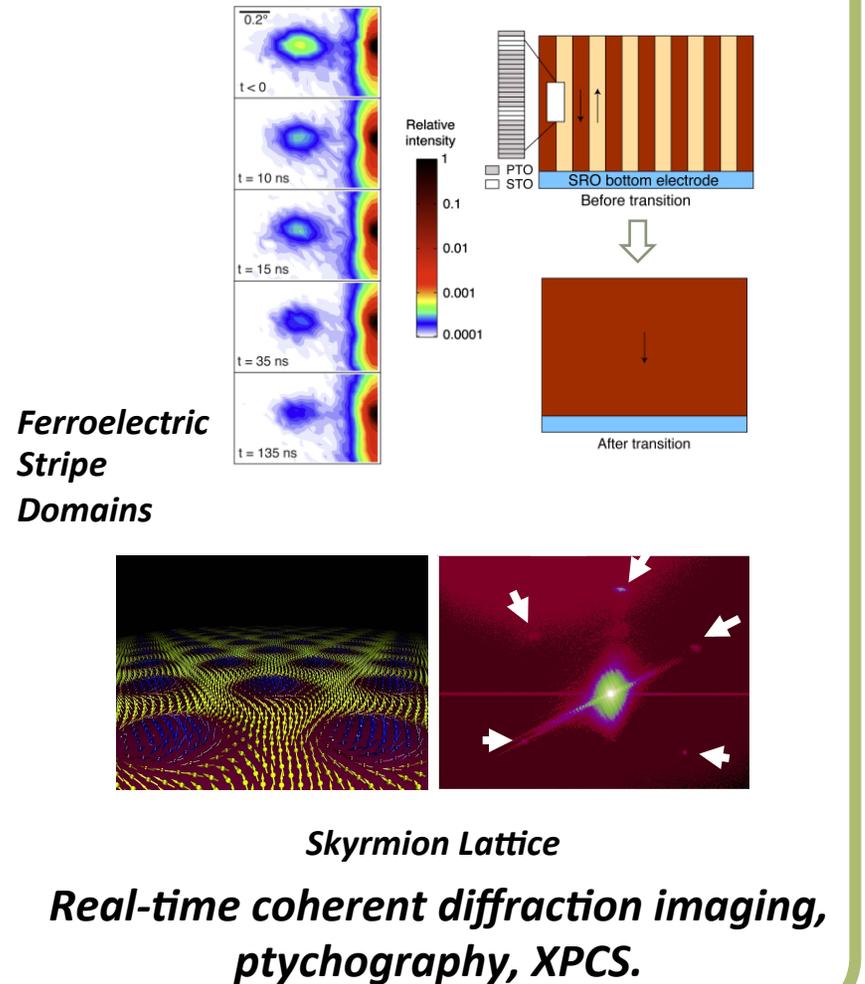
Challenge

Now use the macroscopic averages of nanoscale order parameters (e.g. ferroelectric or spin/orbital stripes). Local characterization and control not yet possible.

4GSR Strength

Higher coherent flux, allowing us to probe equilibrium dynamics and transitions driven by external fields.

“Soft” Hard Materials: Nanoscale Order



Nanoscale Collective Dynamics in Biomaterials

Opportunity

- *Biological function requires motion: ps-to-s scale non-thermal reorganization.*
- *Structure-dynamics-function relationships for model artificial and biomembranes.*

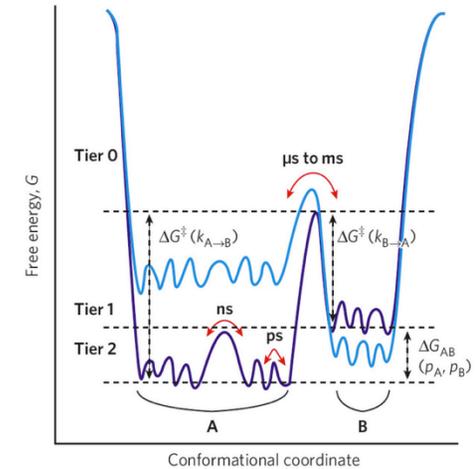
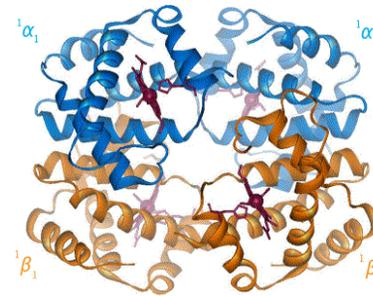
Challenge

- Many degrees of freedom in protein backbones and side chains.
- Collective fluctuations occur on a wide range of time scales from ps to s.
- Functional systems are not periodic.

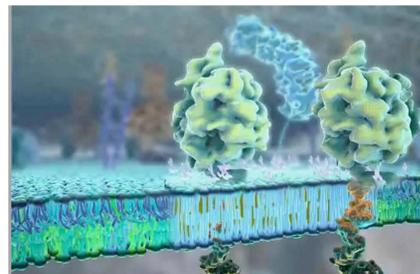
4GSR Strength

- Simultaneous probe of nanoscale order, assembly, and dynamics via microscopy and scattering.
- Multimodal approach (CDI, TXM, SAXS, XPCS, cryo-TEM) to enhance spatial & temporal resolution and chemical speciation

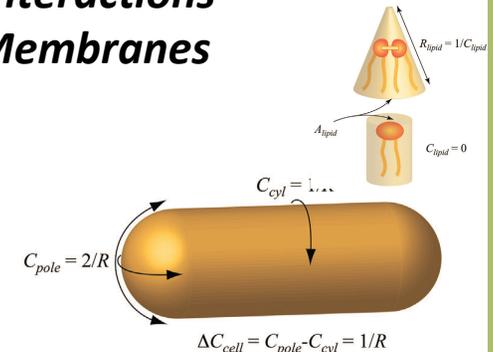
Collective Dynamics of Proteins



Elastically Mediated Interactions between Proteins in Membranes



Harvard MCB Inner Life of a Cell



$$\Delta E_{curv} \approx \kappa C_{lipid} \Delta C_{cell} A_{lipid}$$