



**WORKSHOP ON TIME DOMAIN SCIENCE
USING X-RAY TECHNIQUES**

Introduction to Workshop

Lin Chen (Argonne National Laboratory)

Steve Milton (Argonne National Laboratory)

David Reis (University of Michigan)

Linda Young (Argonne National Laboratory)

Workshop Chairs

August 29 – September 1, 2004, The Abbey, Fontana, Lake Geneva Area, WI



Is a part of a study to explore future scientific directions for the Advanced Photon Source (APS)

Chair: Gopal Shenoy (APS/ANL)

Co-Chair: Sunil Sinha (UCSB/LANL)



Workshops held at the APS

1 Future Directions in Synchrotron Environmental Science

(**APS Users' Meeting**, May 4, 2004, APS)

Chairs: Steve Sutton, Ken Kemner, Shelly Kelly

2 Emerging Areas in Biological Crystallography

(Dates July 26-28, 2004, APS)

Chairs: Wayne Hendrickson, John Helliwell

3 Frontier Science Using Soft X-rays

(August 5-6, 2004, APS)

Organizers: Richard Rosenberg, Juan Carlos Campuzano

4 Science with High-Energy X-rays

(August 9-10, 2004, APS)

Chair: Dean Haeffner

5 Membrane Science

(August 17-18, 2004, APS)

Chairs: Millicent Firestone, Tom Irving, Jin Wang, Randall Winans

Workshops at the Abbey in Lake Geneva, WI



6 Emerging Scientific Opportunities Using X-ray Imaging

(August 29 to September 1, 2004, Lake Geneva)

Chairs: Francesco De Carlo, Wah Keat Lee, Gabrielle Long, Stuart Stock

**7 Time Domain Science Using X-ray Techniques
(August 29 to September 1, 2004, Lake Geneva)
Chairs: Lin Chen, David Reis, Steve Milton, Linda Youn**

8 Mesoscopic and Nanoscopic Science

(August 29 to September 1, 2004, Lake Geneva)

Chairs: Sunil Sinha, Eric Isaacs

9 Nanomagnetism Using X-ray Techniques

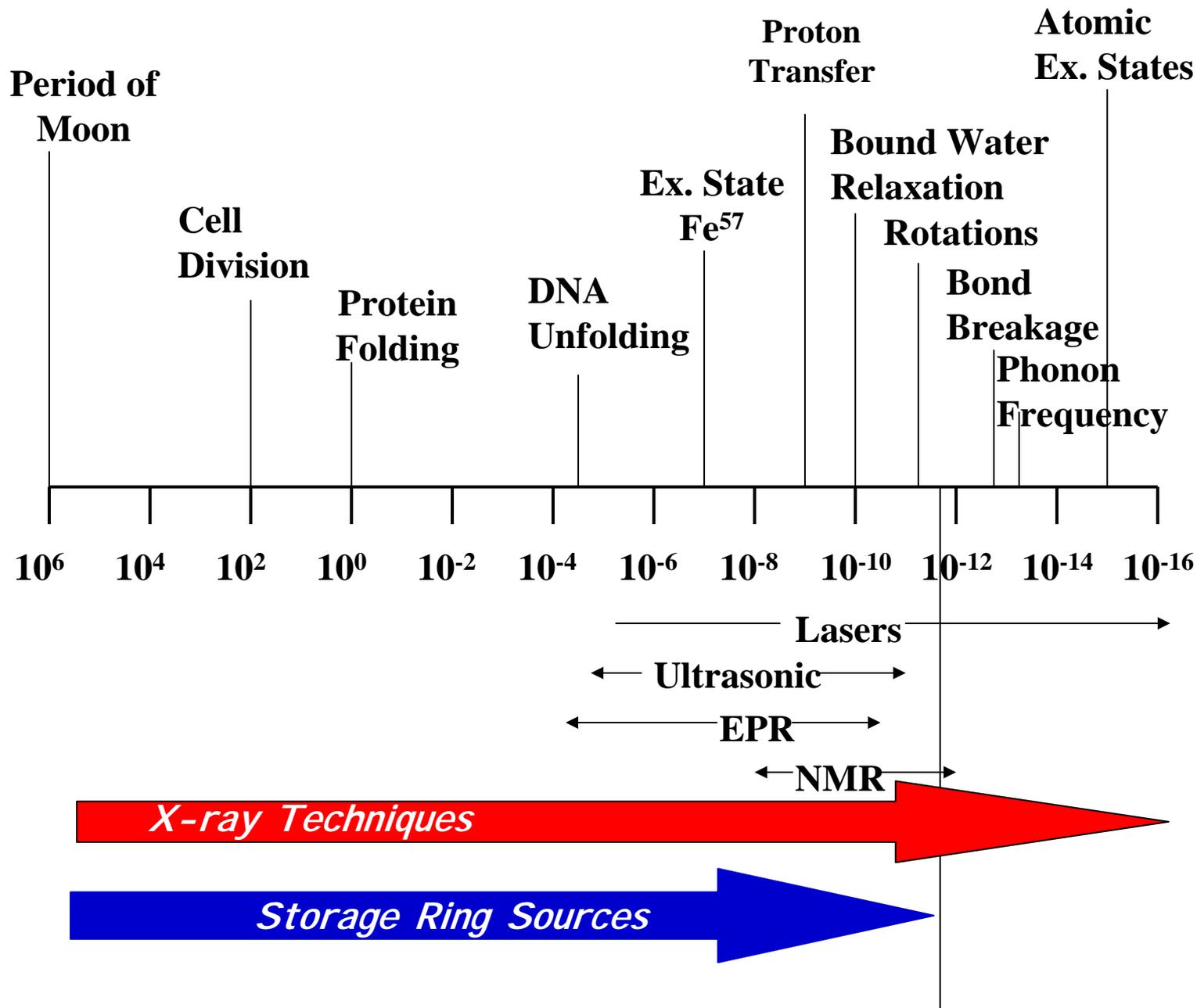
(August 29 to September 1, 2004, Lake Geneva)

Chairs: Sam Bader, Laura Lewis, George Srajer

Workshop Scope

- Time domain science is truly multi-disciplinary.
- Advances in time domain science are scientifically and technologically exciting and significant.
- Areas of time domain science where X-ray characterization techniques are potentially useful:
 - Atomic and Molecular Science
 - Biological Science
 - Chemical Science
 - Condensed Matter and Materials Science
- Work at the Third Generation Facilities is an excellent learning pad for launching future experimental programs at the Fourth Generation Facilities

Scope of Time Domain Considered in this Workshop



Challenges

**Grand Challenges
In
Time Domain Science and
Opportunities for X-ray
Techniques to Address them**

Scientific Challenges

Gas Phase Dynamics:

strong-field control of inner-shell processes
coherent control of molecular processes
geometry-dependent photoionization dynamics

Chemical and Biological Dynamics:

structural dynamics in photochemical reactions of molecules,
self-assembled supermolecules, and nanoparticles;
protein/DNA folding, structural relaxation and enzymatic intermediates;
structural dynamics of single protein/DNA/nanoparticles;
coherent structural dynamics in chemical reactions

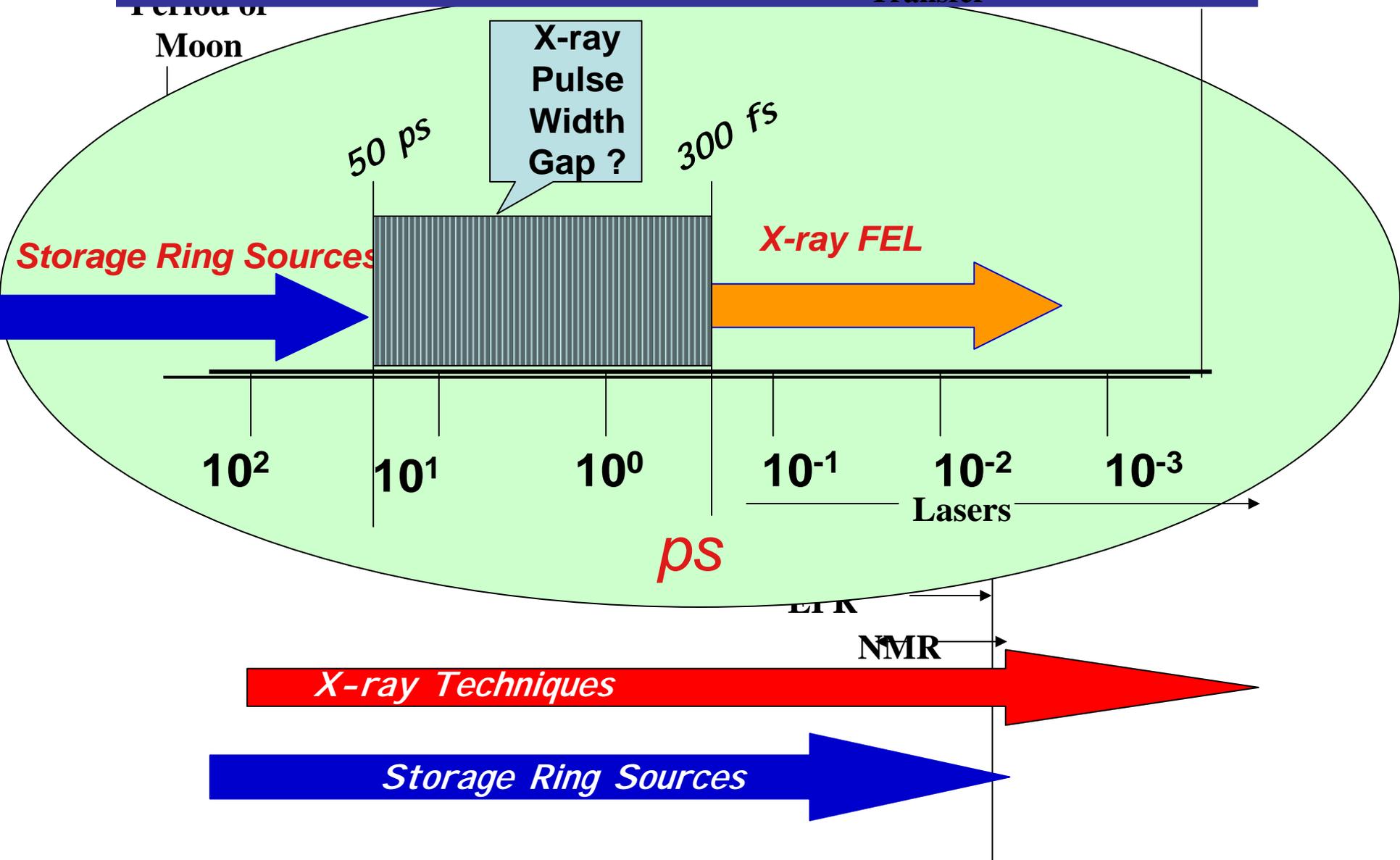
Dynamics in Condensed Matter:

nonequilibrium electron and phonon dynamics
phase transitions and domain reversals
nucleation, growth and phase separation

A Challenge to Accelerator Physicists

Proton
Transfer

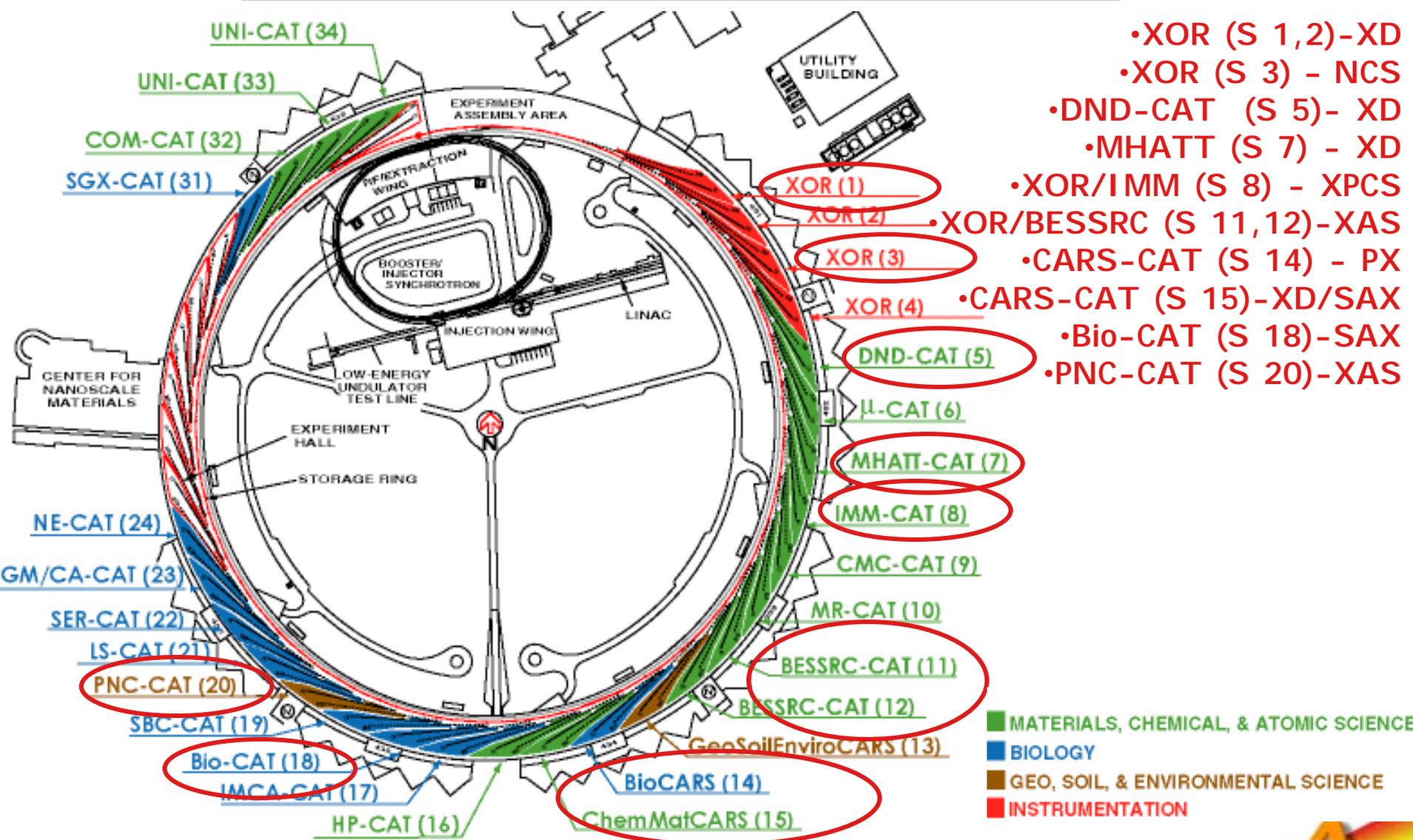
Atomic
Ex. States



Practical Challenges

- *Higher Beam Brilliance*
 - *Sub-Micro Second Small Angle Scattering (SAX)*
 - *Sub-Microsecond X-ray Photon Correlation Spectroscopy (XPCS)*
- *Higher Current per Single Bunch*
 - *Sub-nanosecond Diffraction*
 - *Sub-nanosecond X-ray Absorption (XAS) and related spectroscopies*
- *Sub-micro to Picosecond Pump-Probe Synchronization*
- *Sub-picosecond Detectors for XD*
- *2-D Low Noise PAD-type Detectors for XPCS and SAX*
- *R&D for Time Domain Technique Development*
- *Availability of **in situ** Optical Techniques*

APS Time Domain Science Capabilities



- XOR (S 1,2)-XD
- XOR (S 3) - NCS
- DND-CAT (S 5)- XD
- MHATT (S 7) - XD
- XOR/IMM (S 8) - XPCS
- XOR/BESSRC (S 11,12)-XAS
- CARS-CAT (S 14) - PX
- CARS-CAT (S 15)-XD/SAX
- Bio-CAT (S 18)-SAX
- PNC-CAT (S 20)-XAS

Draft Workshop Objectives

- 1. Explore the breadth of science covered by the workshop topics, *not* limiting to synchrotron techniques alone.**
- 2. Identify opportunities for continued scientific discovery and impact using the APS during the next 5-10 years in the multi-disciplinary areas of time domain science.**
- 3. Identify new scientific proposals/programs specific to the emerging areas of Time Domain Science that the participants will bring to the APS during next 5 to 10 years. Also evaluate the capital and operational requirements for these proposals/programs.**

Draft Workshop Objectives

- 4. In addition to available beamline capabilities at the APS, identify future needs to support research in this area of science and technology.**
- 5. Address accelerator and detector R&D that will enhance the capabilities of the APS time domain science.**
- 6. Address the need and support for theoretical work to strengthen the experimental research.**
- 6. Prepare a summary document for the archival literature to serve as a roadmap for the time domain research using x-rays at the APS Source and suggest the role of the Advanced Photon Source towards this objective.**