LA-UR- 11-03110

Approved for public release; distribution is unlimited.

Title: Dynamic Experiments at the Advanced Photon Source (Argonne National Laboratory)

Author(s): Brian Jensen, Sheng Luo, Dan Hooks, John Yeager, Kyle Ramos
Los Alamos National Laboratory
Kamel Fezzaa
Argonne National Laboratory

Intended for: Project update

Los Alamos
NATIONAL LABORATORY
EST. 1943

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Form 836 (7/06)

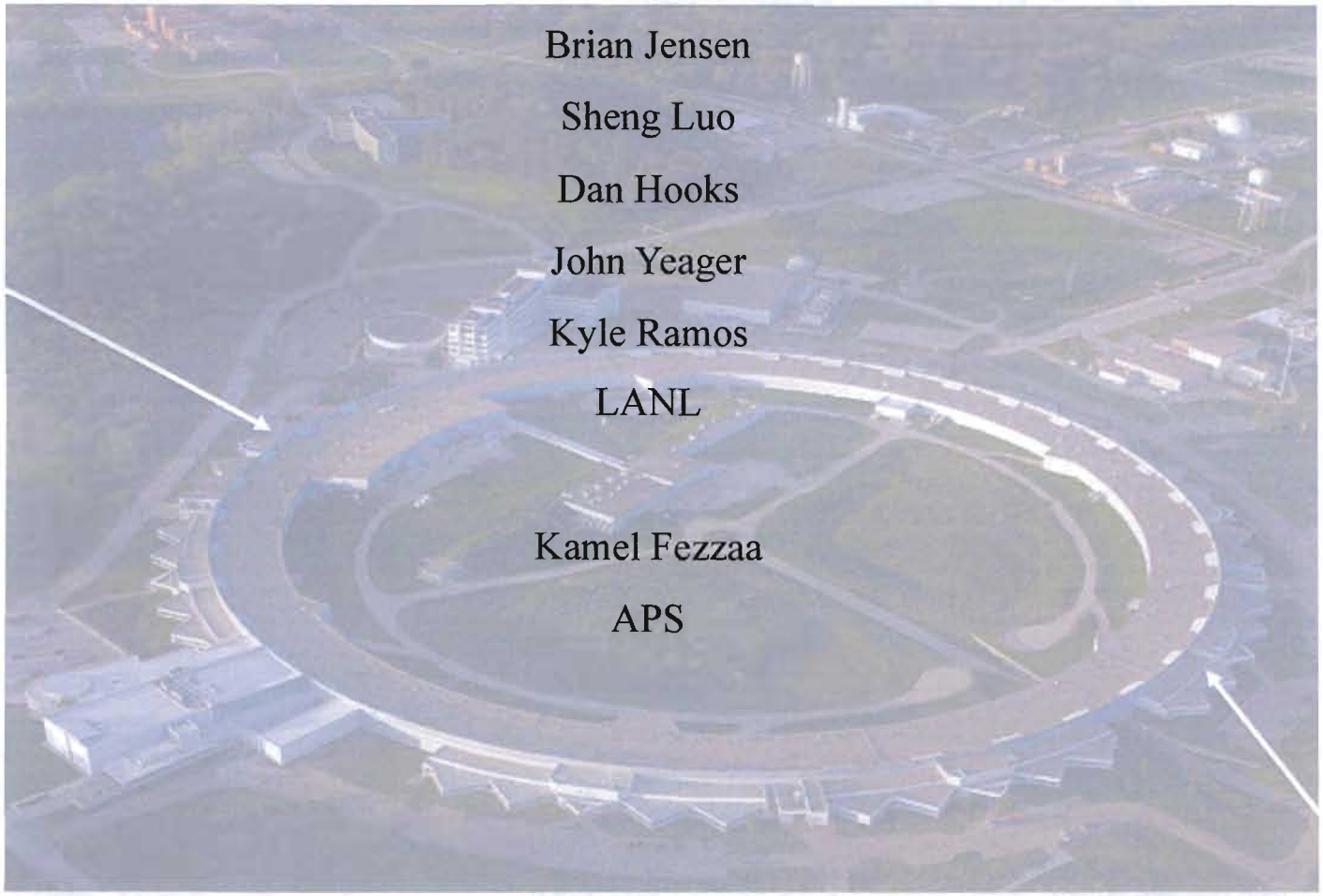
Dynamic Experiments at the Advanced Photon Source (Argonne National Laboratory)

Brian Jensen, Sheng Luo, Dan Hooks, John Yeager, Kyle Ramos
Los Alamos National Laboratory
Kamel Fezzaa
Argonne National Laboratory

The development of time-resolved techniques for x-ray imaging and diffraction is crucial for understanding dynamic processes in materials. For high-rate loading events, scientific tools have advanced only to a limited extent over the past 60 years, and as a result mechanistic descriptions are typically derived from continuum observations and ex-situ post-experiment characterization. Photon intensities and detection technology development have reached a stage where the use of these techniques in real-time loading events will create a renaissance in our understanding of these materials. We propose to test the limits of real-time x-ray imaging and diffraction characterization in a variety of materials through a series of dynamic loading experiments at the APS. Experiments techniques include Laue diffraction and X-ray imaging in single crystal, polycrystal, and engineered microsctructures (both high- and low-Z) using model systems (e.g., Fe, Ce, LiF, paracetamol) that typically have a large body of existing continuum data available to guide the synchrotron work. The short timescales (ns to microseconds) and length scales (microns to mm) needed to examine shock-induced deformation will undoubtedly push the development of high-rate detection technologies by probing the state-of-the-art limitations, and forge a pathway for investigation of long-unresolved material processes undergoing high-rate deformation. This information will also be useful as roadmaps for future capabilities are developed (e.g. DC-CAT).

Dynamic Experiments at the Advanced Photon Source (Argonne National Laboratory)

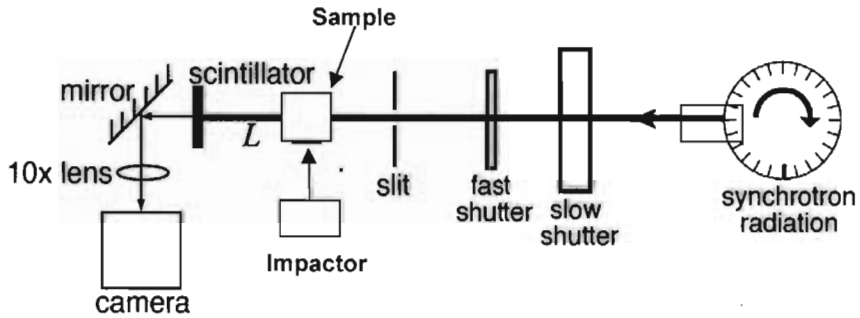
Sector 32



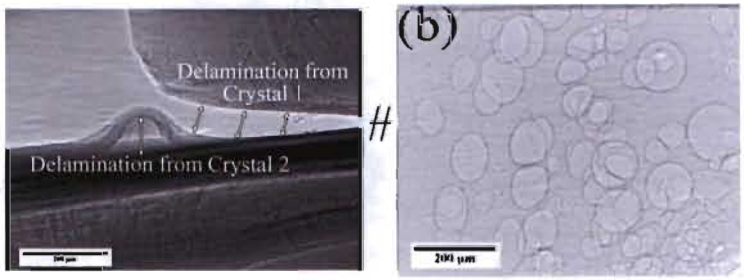
Sector 16
HPCAT

Dynamic experiments at APS are designed to probe the limits of time resolved detection for single crystals, polycrystals, and composites of varied materials (metals, organics)

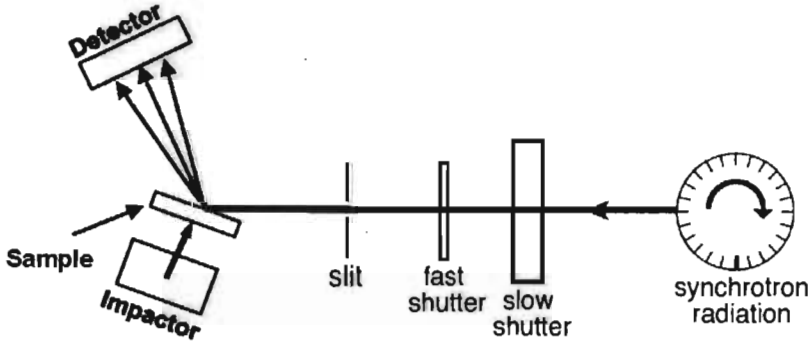
Phase Contrast Imaging (PCI)



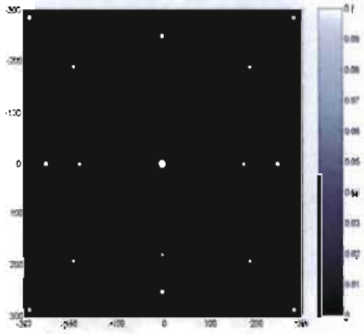
Static PCI Images



Laue X-ray Diffraction



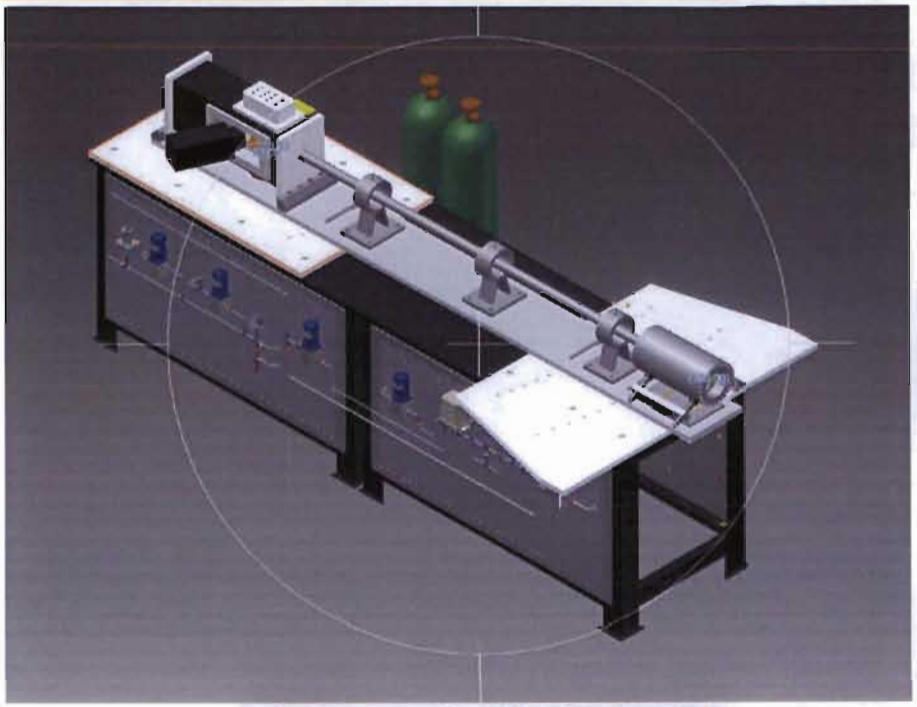
Calculated Laue Pattern



DAC Polycrystalline Data

A 12-mm Launcher System has been prepared for use at APS
IMPULSE = Impact system for MultiPhase ULtrafast Synchrotron Experiments

- Standard wrap-around breech design
- 12-mm diameter projectile
- Velocity up to 1 km/s
- Small footprint and portable
- Maximum pressure within breech 1800 psi
- Engineering calculations performed on breech/ barrel by SNL



We have completed static detector testing for time-resolved applications, prepared a compatible launcher system, and planned initial dynamic testing with some new ideas for detector gating

- Detector tests (3/16-3/19) for PCI and Laue diffraction (polycrystalline metal)
- Fabrication of system underway (table, goniometer, etc.)
- Engineering analysis of launcher system (breech, barrel, target chamber, etc.) to be completed by 6/1
- Detector Issues:
  - PI-MAX Cameras – Gate & Trigger, Image intensified, small format
  - Use Fiber optic taper 50mm or 40-mm diameter
  - Alternate methods rely on fast shutter (film, large area detectors, etc.)
- System Qualification – test shots at LANL in June
- Move System to APS – June 26-28
- Beam time for next series of tests (gun/detector) July 17-18
- GUP being developed for consideration at sectors 16 and 32 for more dynamic testing in the next run cycle