Argonne NATIONAL LABORATORY

PROSPERITY AND THE ADVANCED PHOTON SOURCE

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Our U.S. Department of Energy (DOE) national laboratories are uniquely suited to meeting the challenges that spur economic prosperity and assure national security. DOE user facilities—such as the Argonne Advanced Photon Source (APS)—at the national labs bring valuable resources and talented people to bear on the DOE mission of advancing science and technology for the nation in a competitive technological and economic global arena.

The gross domestic product (GDP) is the primary engine for U.S. economic competitiveness. The (real) GDP, according to the U.S. Bureau of Economic Analysis (BEA), is "the output of goods and services produced by labor and property located in the United States." Much of the science carried out at the APS can be mapped onto the GDP, as shown by the examples below of GDP categories compiled by the BEA, and corresponding APS research.

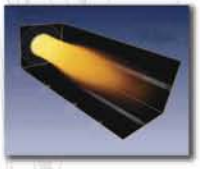
MEDICAL CARE: X-ray beams from the APS played an essential role in the development of Abbott Labs' Kaletra®—the most-prescribed pharmaceutical in its class for Acquired Immune Deficiency Syndrome therapy. ***See: www.anl.gov/Media_Center/News/2006/APS060901.html***

STRUCTURES: Studies at the APS are refining our understanding of how to make concrete and cement more durable. This may make possible improvements in the formulation and use of cement that could save hundreds of millions of dollars in annual maintenance and repair costs for the country's infrastructure.

GASOLINE, FUEL, OTHER ENERGY: The APS enabled a study of bacteria used to convert methane to methanol at room temperature, which may help improve methanol synthesis; and revealed new information on the structure of high-speed fuel injector sprays, which can help improve injector efficiency.

ELECTRICITY & GAS: APS x-rays gave researchers the first look at the composition of the plasma arcs that produce the glow in energy-efficient halide arc lamps, an important step in improving the lamps' efficiency even more.

INDUSTRIAL EQUIPMENT: The APS made possible the first x-ray images of the internal structure of the flow from a high-speed industrial paint sprayer, which could aid in improving sprayer efficiency.



The Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory provides this hemisphere's brightest x-ray beams for research. Scientists and engineers using the APS help assure a bright future for our nation by carrying out research that promises to have far-reaching impact on our technological and economic competitiveness, our health, and our fundamental knowledge of the materials that make up our world.

Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC

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Researchers using Industrial Macromolecular Crystallography Association beamline 17-ID at the Argonne Advanced Photon Source (APS) found the points of attack of the human immunodeficiency virus (HIV) protease inhibitors – agents that block the breakdown of proteins. Protease inhibitors stop HIV from making new copies of itself by blocking the last step in the process, when the virus attempts to replicate. Out of that discovery came the drug Kaletra®, now the most-prescribed drug in its class for AIDS therapy and a product of Abbott Laboratories.

See: www.anl.gov/Media_Center/News/2006/APS060901.html

Researchers from the National Institute of Standards and Technology (NIST) and from Northwestern University combined structural data from experiments at the NIST Center for Neutron Research and from an instrument built by NIST at X-ray Operations and Research (XOR)/UNI beamline 33-ID at the APS. Their experiments are the first to classify water by its location in cured cement.

See: Andrew J. Allen[1], Jeffrey J. Thomas[2], and Hamlin M. Jennings[2], "Composition and density of nanoscale calcium–silicate–hydrate in cement," Nat. Mater. **6**, 311 (01 Apr 2007). DOI: 10.1038/nmat1871
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Research at Northwestern University was supported by the National Science Foundation. Use of the Advanced Photon Source was supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences.

Researchers from Northwestern University used the Dow-Northwestern-DuPont Collaborative Access Team 5-ID beamline at the APS to characterize the first enzyme in the pathway that bacteria use to convert methane to methanol. Their work provides a clear picture of the enzyme's structure and is an important breakthrough in understanding how to improve the synthesis of methanol.

See: R.L. Lieberman and A.C. Rosenzweig, "Crystal Structure of a Membrane-bound Metalloenzyme that Catalyses the Biological Oxidation of Methane," Nature 434, 177 (10 March 2005).
Author affiliation: Northwestern University
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This work was supported by the American Chemical Society Petroleum Research Fund, the David and Lucile Packard Foundation, and the National Institutes of Health. Use of the Advanced Photon Source was supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences.
See also: *APS Science 2005, the annual report of the Advanced Photon Source*, "Making Methanol: How Bacteria Do It," ANL-05/29 P. 100, and on the Web at ANL-05/29; http://www.aps.anl. gov/News/Annual_Report/.

Researchers from Argonne, Cornell University, and Robert Bosch GmbHt used the X-ray Operations and Research beamline 1-BM at the APS and the D-1 beamline at the Cornell High Energy Synchrotron Source to record the time evolution of transient fuel sprays from a high-pressure injector, capturing the propagation of spray-induced shock waves in a gaseous medium, and revealing the complex nature of the spray hydrodynamics.

See: Andrew G. MacPhee[1], Mark W. Tate[2], Christopher F. Powell[1], Yong Yue[1], Matthew J. Renzi[2], Alper Ercan[2], Suresh Narayanan[1], Ernest Fontes[2], Jochen Walther[3], Johannes Schaller[3], Sol M. Gruner[2], and Jin Wang[1], Science **295**(5558), 1261 (2002) *and* Christopher F. Powell, Yong Yue[1], Ramesh Poola,[1] and Jin Wang[1], J. Synchrotron Rad. **7**, 356, (2000).
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This work was supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, and the Freedom CAR and Vehicle Technology Program.

Researchers from NIST, OSRAM SYLVANIA, and Argonne used the XOR 1-ID beamline at the APS to achieve the first successful application the x-ray-induced fluorescence technique to study the arc inside a metal-halide arc lamp.

See: J.J. Curry [1], H.G. Adler [2], S.D. Shastri [3], and W.-K. Lee [3], "X-ray induced fluorescence measurement of density distributions in a metal–halide lighting arc," J. Appl. Phys. **93**(5), 2359 (1 March 2003).
Author affiliations: [1]National Institute of Standards and Technology, [2]OSRAM SYLVANIA, [3]Argonne National Laboratory
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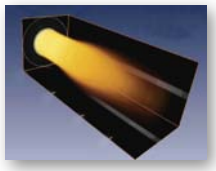
Work at the University of Wisconsin was supported by OSRAM SYLVANIA and by the NSF.. Use of the Advanced Photon Source was supported by the U. S. Department of Energy, Office of Science, Office of Basic Energy Sciences.



Researchers and engineers from Argonne and Illinois Tool Works, Inc., using extreme-brilliance x-ray beams from the XOR 7-ID beamline at the APS, captured the first images of the highly transient spray flow just millimeters from a high-speed industrial spray nozzle, taking us one step down the road toward improved high-speed industrial sprays.

See: Y.J. Wang[1], Kyoung-Su Im[1], K. Fezzaa[1], W.K. Lee[1], Jin Wang[1], P. Micheli[2], and C. Laub[2], "Quantitative x-ray phasecontrast imaging of air-assisted water sprays with high Weber numbers," Appl. Phys. Lett. **89**, 151913 (2006). DOI: 10.1063/1.2358322
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