

THE ADVANCED PHOTON SOURCE NUCLEAR MATERIALS AT EXTREME CONDITIONS ON APS BEAMLINE 6-ID-D

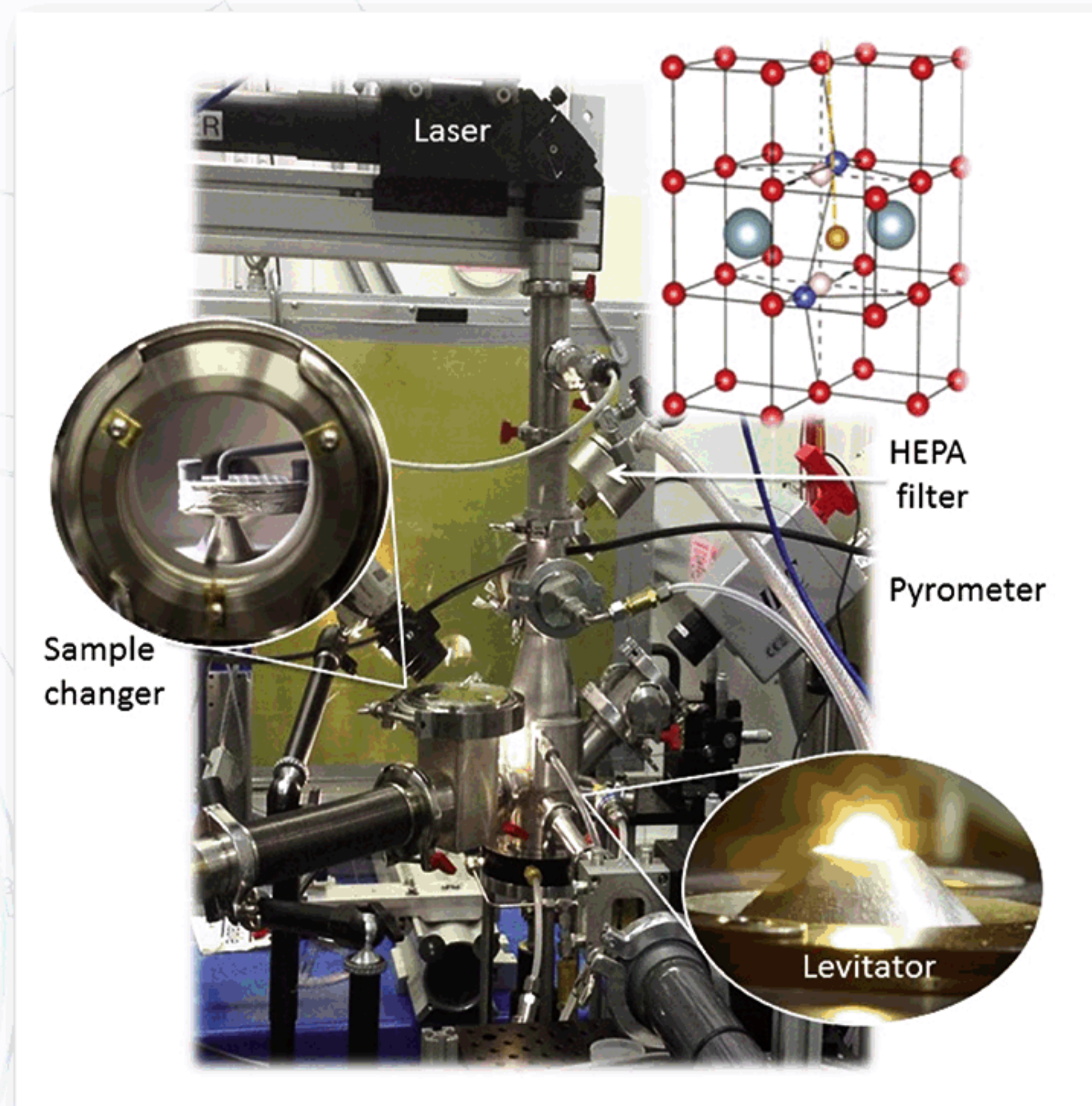
An aerodynamic levitator with laser beam heating has been integrated with a hermetically sealed chamber, suitable for containing radioactive samples on the high-energy X-ray Science Division beamline 6-ID-D at the U.S. Department of Energy Office of Science's Advanced Photon Source. Laser heating from above enables access to temperatures up to 3500° C. Integral safety features include a pressure-monitored double-laser window and a gas cross purge to a HEPA filter. Levitation eliminates chemical reactions with containers at high temperatures and gas mixing provides control of the process atmosphere chemistry. A built-in remote sample handling mechanism enables up to 25 samples to be interchanged during a single installation.

High-energy x-rays (typically 100 keV) can penetrate the bulky chamber enabling the study of radioactive samples (including nuclear fuel materials) using pair-distribution function. Powder diffraction experiments are also possible using a rotating levitation nozzle that spins the sample. The laser power, levitation gas flow, and pressure are remotely controlled using a LabVIEW GUI, which also logs the pyrometer temperature data. Diffraction patterns are typically measured from the top few hundred microns of the levitated sample, co-incident with the laser spot and focal point of the pyrometer to minimize temperature gradient effects.

See: J.K.R. Weber, A. Tamalonis, C. Benmore, O. Alderman, S. Sendelbach, A. Hebden and M. Williamson, "Aerodynamic levitator for in-situ x-ray structure measurements on high temperature and molten nuclear fuel materials," *Rev. Sci. Instr.* **87** (2016) 073902.

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The nuclear material is levitated from below on a gas jet and heated from above by a 400 W CO₂ laser. The scattered x-ray beam is measured with a large, wide-angle, flat-plate area detector. The sample manipulator is operated outside the chamber using a bellows system.

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The Advanced Photon Source is open to experimenters who can benefit from the facility's high-brightness hard x-ray beams.

General-user proposals for beam time during Run 2017-2 are due by Friday, March 3, 2017.

Information on access to beam time at the APS is at http://www.aps.anl.gov/Users/apply_for_beamtime.html or contact Dr. Dennis Mills, DMM@aps.anl.gov, 630/252-5680.

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