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Femtosecond X-ray Science at the ALS: Recent Results and Future Plans

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Abstract:

An important new area of research in chemistry, condensed matter physics, and biology is the application of x-ray techniques to investigate structural dynamics associated with ultrafast chemical reactions, phase transitions, vibrational energy transfer, and surface dynamics. The fundamental time scale for the atomic motion in such processes is a single vibrational period (~100 fs). While high-brightness synchrotrons are powerful tools for probing the "static" structure of materials, their time resolution is limited to >30 ps. We have recently demonstrated the generation of femtosecond synchrotron pulses from the Advanced Light Source. Femtosecond optical pulses are used to accelerate a femtosecond slice of a stored electron bunch via co-propagation through a resonantly tuned wiggler. The accelerated slice is then separated from the remainder of the bunch in a dispersive section of the storage ring, and used to generate femtosecond x-rays. We directly measure the femtosecond synchrotron pulses of ~300 fs duration by cross-correlating the visible radiation from a bend magnet with a femtosecond laser pulse. A new bend-magnet beamline is being developed at the ALS for generating 100 femtosecond x-rays to investigate structural dynamics in condensed matter using time-resolved optical pump and x-ray probe techniques. Future plans include the development of an in-vacuum insertion device beamline providing high-brightness femtosecond x-rays for time-resolved measurements of atomic motion.