A Dedicated Synchrotron Radiation Source for Ultra-fast X-ray Science

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For several years LBNL has been assessing potential means of developing a multi-user radiation source suitable for the study of ultra-fast dynamical processes. After a brief look at the conceptual feasibility of several possible approaches, we have focused on two diverse techniques: 1) a femtosecond synchrotron radiation x-ray source based on a flat-beam, rf-gun and a recirculating superconducting linac that provides beam to an array of undulators and bend magnets. Optical pulses of <100 fs are obtained by a combination of electron pulse compression, transverse temporal correlation of the electrons, and x-ray pulse compression. In addition to incoherent hard x-ray beamlines, the facility would have several fully coherent soft X-ray FEL lines at wavelengths down to 1 nm. The FELs are based on a master oscillator-power amplifier configuration in which the oscillator is is temporally locked to the electron bunches. A study during the eighteen months has covered the following aspects of the design: layout and lattice, ultra-fast x-ray pulse production, flat electron-beam production, FEL design, the rf gun, rf systems, cryogenic systems, collective effects, photon production, and synchronization of x-ray and laser pulses. 2) The second approach would utilize TW lasers to produce an all optical Thompson scattering source. The present status of this experimental work is summarized. The presentation concludes with a summary of issues and areas of development that remain to be addressed.