Science and Technology of the Wisconsin Seeded XFEL Project

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When passing through an undulator magnet, the electron beam within a linear accelerator is an extraordinarily effective gain medium to amplify the modulation impressed on it by a co-propagating laser pulse. The resulting radiation has higher flux and much higher brilliance than conventional synchrotron radiation. The pulses can be fully coherent, of short temporal duration, and of high monochromaticity. In short these beams truly represent an ideal form of electromagnetic radiation, and the concept is known as a seeded x-ray free electron laser. In collaboration, the SRC and MIT have developed this advanced concept as a proposed new user facility offering remarkable new scientific opportunity. It is planned to span the energy range from 4.6 eV to 900 eV with continuous tunability of wavelength and polarization. Because the accelerator is a high repetition rate superconducting structure, the pulse stream can be subdivided into a large number of totally independent beamlines, each operating at rates from 1 Hz-1 MHz.
This talk will give an overview of the physics behind the concept, the basic attributes of the facility itself, and the beams it will produce. Most importantly we will review the current thinking about the science that it will enable—from femtochemistry and biology, to nanoscience and novel condensed matter and atomic physics.