Compact X-Ray Free Electron Laser Development and Applications

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This talk will highlight the development of a Compact X-ray Free Electron Laser (CXFEL) at Arizona State University's Biodesign Institute. CXFEL builds on the latest advances in laser technology and electron beam physics to produce a room-sized (roughly 10m long) X-ray laser with full coherence in time and space. The CXFEL will uniquely offer full control of the X-ray phase using electron-beam patterning that allows customized time-structure of the beam, *e.g.*, attosecond pulses, very narrow linewidths, and precise timing between multiple pulses with different colors. CXFEL facility consisting of hard and soft X-ray sources will support multiple end-stations to conduct femtosecond and attosecond X-ray spectroscopy, small- and wide-angle X-ray scattering, coincident attosecond momentum imaging, and time-resolved X-ray crystallography for studies in biology, quantum materials, atomic and molecular science, and optical sciences. In the Phase 1 of this project, we have successfully demonstrated the implementation of inverse Compton scattering to construct a compact hard-X-ray source. Results obtained from the commissioning of this 9 keV femtosecond X-ray source will be discussed, including preliminary experimentation to determinate protein structures and capture transient changes in materials.