Science Opportunities with the Ångström Laser

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Developments of new research areas and breakthroughs in science are often linked to the development of new methodologies/instrumentation. In this talk I will summarize the scientific opportunities and the proposed layout of a novel type of compact X-ray source, which we call Ångström Laser, based on superconducting accelerator technology. In conventional X-ray facilities X-ray pulses are generated from electron pulses in magnetic undulators up to 100 m in length. We propose to replace magnetic undulators by the significantly more compact “optical undulator” of an intense optical laser field. In such a so-called inverse Compton source, laser pulses collide head on with electron bunches at relativistic speeds. The strong laser field acts very much like the magnetic field of a conventional undulator wiggling the electrons back and forth emitting X-rays in the process. The X-ray source is envisioned to provide scientists with high repetition rate femtosecond flashes of X-ray radiation for discovering novel materials systems, investigating biological molecules, and characterizing catalysts and nanostructures. By exploring materials on the ultimate quantum level of moving atoms and electrons, the Ångström Laser will be a discovery machine for new materials for new sustainable technologies.