Betatron x-rays from laser-wakefield accelerators: a novel probe for time-resolved high energy density science experiments.

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High Energy Density science facilities such as LCLS, OMEGA, or the National Ignition Facility are now uniquely able to recreate in the laboratory conditions of temperature and pressure that were thought to be only attainable in the interiors of stars and planets. To diagnose such transient and extreme states of matter, the development of efficient, versatile and fast (sub-picosecond scale) x-ray probes with energies larger than 50 kilo-electronvolts has become essential for HED science experiments. Betatron x-ray radiation, a source driven by laser-wakefield accelerated electrons, holds great promise in this field of research.

We will present recent and upcoming experiments performed at the Linac Coherent Light Source Free Electron Laser (LCLS), as well as at the Jupiter Laser Facility (JLF), LLNL. At JLF, we used the Titan laser (150 J, 1 ps), showing evidence of betatron x-ray production in the self-modulated regime of laser wakefield acceleration. At LCLS, we have recently commissioned the betatron x-ray source driven by the MEC short pulse laser (1 J, 40 fs). The source is being used for pump-probe studies by investigating the X-ray absorption near edge structure (XANES) spectrum at the K- or L-edge of several materials driven to a warm dense matter state.

Within this context, we will also present a brief overview of betatron x-ray experiments with various laser systems and give an outlook on HED science experiments that could be executed at the BELLA-i facility.

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