# Betatron x-ray radiation in the self-modulated laser wakefield acceleration regime: prospects for a novel probe at large scale laser facilities

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High Energy Density science laser facilities such as LMJ-PETAL, LFEX, 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 present recent experiments performed at the Jupiter Laser Facility (JLF) at LLNL [1]. 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 (SMLWFA). This experiment constitutes the first observation of betatron radiation in the SMLWFA regime, for laser intensities around $10^{18}$ W/cm$^2$ [1]. This was made possible by the addition of a long focal length optics (F/10), favorable for guiding laser pulses in gas targets. We will show a detailed experimental Betatron x-ray source characterization, as well as electron spectra above 200 MeV and forward laser spectra indicating a strongly self-modulated laser wakefield acceleration regime. OSIRIS 2D PIC simulations also show that the electrons gain energy both from the plasma wave and from their interaction with the laser field [2]. Finally, we will discuss the prospects of developing a Betatron x-ray source for probing high energy density science experiments at large-scale laser facilities, such as LMJ-PETAL, LFEX, OMEGA, or the National Ignition Facility.

Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344, supported by the LLNL LDRD program under tracking code 16-ERD-041, and supported by the DOE Office Science Early Career Research Program under SCW 1575-1.

## References

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[2] N. Lemos, et al, *Plasma Phys. Controlled Fusion* 58, 034018 (2016)