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Betatron radiation from a self-modulated laser-wakefield accelerator

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To diagnose transient and extreme states of matter, the development of fast (sub-ps) x-ray probes with energies larger than 50 keV is essential for high energy density science experiments.
We will present results from a recent experiment performed using the Titan laser (150 J, 1 ps) at LLNL, showing evidence of Betatron x-rays in the self-modulated regime of laser wakefield acceleration (SMLWF).
When a 0.5-1 ps laser pulse with an intensity approaching 1020 W/cm2 is focused on a gas target (density 1019 cm-3), electrons are accelerated via the SMLWF regime and the direct laser acceleration (DLA) regime. In SMLWF acceleration, electrons are accelerated by the plasma wave created in the wake of the light pulse, whereas in DLA, electrons are accelerated from the interaction of the laser field with the focusing force of the plasma channel. It is the first observation of Betatron radiation in the SMLWF regime, for a0 ~ 1-3. This was enabled by the addition of a long focal length optics, favorable for guiding laser pulses in gases. We will show a detailed Betatron source characterization, electron spectra above 200 MeV and forward laser spectra indicating self modulation.

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