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Simulations of laser-plasma interactions and electromagnetic pulse generation

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Numerical simulations of laser-plasma interactions demonstrate the generation of axially polarized electromagnetic pulses (EMPs) that radiate away energy in an initial transition state and a later steady state. This is confirmed by full 2D electromagnetic particle-in-cell simulations, as well as by a ponderomotively-driven reduced model that captures the EMP generation essentials and allows for simulations of the steady state. Investigations of uniformly or regionally pre-ionized plasma show radiation only in the transition state, while steady state radiation is still seen in the case of a laser-ionized plasma. When the laser's pulse length matches the plasma wavelength, that pulse's fractional energy losses to the wakefield are independent of the pulse width, while the losses to the EMP are inversely dependent on the pulse width.

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Primary authors: WOLFINGER, Kathryn; LEE, Valentina; WERNER, Gregory; LITOS, Michael; CARY, John

Presenter: WOLFINGER, Kathryn

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