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High-energy two-color terahertz generation

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A laser pulse composed of a fundamental and properly phased second harmonic exhibits an asymmetric electric field that can drive a time-dependent current of photoionized electrons. The current produces a near-single-cycle burst of terahertz (THz) radiation. Experiments using ~1-TW ultrashort laser pulses observe optimal THz energies (~10-uJ) when the "two-color" pulse undergoes filamentary propagation in low pressure gas. Here we use simulations to investigate the optimal conditions for two-color THz generation driven by >100-TW ultrashort laser pulses. Simple scalings indicate that the number of photoionized electrons is independent of gas pressure. As a result, use of a low-pressure, small nonlinear refractive index, high-ionization potential gas such as helium can mitigate multiple filamentation of the high-power pulse, while strengthening the field experienced by electrons at the instant of ionization, thereby increasing the current and THz energy. A high-energy (~1-mJ), THz source would enable access to a novel physics regime in which bound electron nonlinear optics and relativistic plasma physics coexist.

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Primary authors: SIMPSON, Tanner (Laboratory for Laser Energetics, University of Rochester); PIGEON, Jeremy (University of Rochester, Laboratory for Laser Energetics); LIM PAC CHONG, Mervin (University of Rochester, Laboratory for Laser Energetics); BONI, Robert (University of Rochester, Laboratory for Laser Energetics); Mr RAMSEY, Dillon (University of Rochester / Laboratory for Laser Energetics); WEICHMAN, Kathleen (University of Rochester Laboratory for Laser Energetics); Dr FROULA, Dustin (University of Rochester, Laboratory of Laser Energetics); Dr PALASTRO, John (University of Rochester, Laboratory of Laser Energetics)

Presenter: SIMPSON, Tanner (Laboratory for Laser Energetics, University of Rochester)

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