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Optical pump generation for long-wave infrared lasers for advanced acceleration

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The favorable wavelength scaling of ponderomotive interactions indicates that long-wave infrared (LWIR) lasers are well suited for applications such as laser wakefield acceleration and high harmonic generation. CO2 amplifiers are the primary source of such wavelengths, able to generate TW peak powers with sub-ps pulse lengths. However, a limiting factor for these amplifiers is the necessity of using electrical discharges to pump the gain medium, reducing the maximum repetition rate and energy stability. This can be mitigated by instead optically pumping the CO2 at 4.5 µm. We demonstrate a proof of principle of the generation of this wavelength by utilizing stimulated Raman scattering, a process where photons inelastically scatter from a material. For this wavelength, we employ a novel class of material known as ionic liquids as the Raman medium. We demonstrate efficient conversion from a 532 nm frequency doubled Nd:YAG laser to 603 nm in the ionic liquid EMIM DCA, followed by performing difference frequency generation to produce the 4.5 µm pump.

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