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Optical pump generation for long-wave infrared drivers for wakefield accelerators

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Long-wave infrared (LWIR) lasers are well-suited for applications such as laser wakefield acceleration and high harmonic generation due to the favorable wavelength scaling of the ponderomotive force. Using CO2 amplifiers, multi-terawatt peak powers with sub-picosecond pulse durations have been demonstrated. However, a limiting factor for these amplifiers is the current necessity of using electrical discharges to pump the gain medium, reducing the maximum repetition rate and energy stability. Scaling a terawatt CO2 laser to repetition rates of 100-1000 Hz will likely necessitate switching from electrical discharge pumping to optical pumping. The optimal excitation for pumping is centered at 4.3 μm; however, slight detuning is necessary to manage absorption in the gain medium. We demonstrate a proof of principle of the generation of a 4.5 μm pump, by utilizing stimulated Raman scattering, a process where photons inelastically scatter from a material. Since typical Raman materials do not have the correct vibrational spectrum to generate 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.

Working group

WG1 : Laser-driven plasma wakefield acceleration

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