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Loss-free shaping of few-cycle terawatt pulses at 1 kHz for laser wakefield acceleration

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Precise control of the temporal shape of ultrashort pulses of terawatt scale peak power is often desirable in experiments. In previous work, we used single, few-cycle 5 fs pulses for 1 kHz rep. rate laser wakefield acceleration (LWFA) to 15 MeV in near-critical density hydrogen plasma [1]. Double pulses are also of interest for LWFA, as prior simulation studies suggest that resonant driving of wakes enhances injection and acceleration [2]. However, prior methods for generating double few-cycle pulses exhibit energy loss of up to 80% [3]. Our method [4] utilizes precise control of oscillator seed pulses before chirped pulse amplification. Pulse peak separations as short as 10 fs (~4 cycles) are generated [4]. We present the double pulse generation scheme, particle-in-cell simulations suggesting that the interaction of these pulses in plasma can tunably modify and enhance electron acceleration and injection, and preliminary experimental results.

- [1] F. Salehi et al., Phys. Rev. X 11, 021055 (2021).
- [2] C. Kim et al., Phys. Lett. A 370, 310 (2007)
- [3] A. Catanese et al., OSA Contin. 4, 3176 (2021).
- [4] L. M. Railing et al., Opt. Lett. 49, 1433-1436 (2024)

Working group

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Primary author: Mr LE, Manh (University of Maryland)

Co-authors: Mr LAZZARINI, Carlo (ELI Beamlines); Prof. MILCHBERG, Howard (University of Maryland); Mr RAILING, Lucas (University of Maryland)

Presenter: Mr LE, Manh (University of Maryland)

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