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Controlled, High-repetition rate Plasma Accelerators

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We will describe work towards developing a new architecture for plasma accelerators able to generate GeV-scale electron beams at kilohertz repetition rates. Our approach is based on multi-pulse laser wakefield acceleration (MP-LWFA) in which a plasma wakefield is excited by a train of low-energy laser pulses; this approach opens wakefield acceleration to rapidly evolving laser technologies, such as fibre and thin-disk lasers, which are able to deliver ultrafast multi-mJ pulses at kHz repetition rates with high wall-plug efficiency.

Generating high-quality electron bunches with high reliability and low shot-to-shot jitter requires control over electron injection. For the case of MP-LWFAs this requires the development of new methods since the wakefield will be quasi-linear regime, and hence existing techniques developed for nonlinear wakes will not be directly applicable.

We will describe progress in understanding processes which might limit the operation of MP-LWFAs, such as non-uniformities in the plasma or pulse train and the effects of ion motion and laser hosing. Possible methods for controlling injection in MP-LWFAs will be discussed.

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