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Generation of Pulse Trains Suitable for Multi-Pulse Laser Wakefield Acceleration

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In multi-pulse laser wakefield acceleration a plasma wave is driven by a train of laser pulses separated by the plasma period. This allows laser-driven plasma accelerators to be driven by emerging technologies, such as fibre and thin-disk lasers, which can generate low-energy pulses at kilohertz repetition rates with high efficiency.

As a first test of this concept we plan to convert single pulses from a Ti:sapphire laser into a train of ultrafast laser pulses, and use these to drive a plasma wakefield. This can be achieved by chirping the laser pulse and passing it through a multi-order waveplate (MWP) and a linear polarizer. This combination acts as a spectral filter for wavelengths for which the retardance of the MWP is an odd integer times pi. Varying the thickness of the MWP and the magnitude of chirp allows control over the number and spacing of the pulses.

We present simulations for parameters corresponding to the Astra laser system at Rutherford Laboratory. These show generation of trains of up to 47 pulses with pulse separation of 100-150fs. 2D EPOCH simulations of the wakefield driven by these trains predict accelerating gradients in excess of 11GV/m.

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