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Hosing in Multi-Pulse Laser Wakefield Accelerators

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It has now been shown experimentally that electrons can be accelerated to 4-GeV energies in a plasma wakefield driven by a single high-intensity laser pulse. However, such laser systems have limited repetition rates and low wall-plug efficiency. An alternative method is to resonantly excite plasma oscillations using a train of laser pulses of lower intensity spaced by the plasma period to drive multi-pulse laser wakefield accelerators (MP-LWFAs). Fibre and thin-disc laser technologies offer the possibility to drive MP-LWFAs efficiently and at high repetition rate (tens of kHz), opening a new domain for applications including compact X-ray sources with high mean brightness.

We will describe our study of one potential issue for MP-LWFAs: laser pulse hosing. This can arise when the centroid of a laser pulse is displaced from the axis of the wake or pulse guiding structure, due to transverse refractive index gradients. We use three-dimensional (axial symmetry), weakly relativistic fluid simulations and particle-in-cell simulations to study the effect of random and systematic pulse misalignment. We show that hosing can be stabilized by adjusting the laser pulse separation and/or by channelling the laser pulses in a waveguide.

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