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Optimised density tailoring for dephasing mitigation in laser wakefield accelerators

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One of the key effects in laser wakefield acceleration is dephasing, whereby the electron beam outruns the accelerating structure created by the sub-luminal driving laser pulse. This process reduces the effectiveness of the accelerator and limits the maximum electron energy achievable with a given laser pulse. Therefore, mitigating dephasing is important in maximising the energy gain and efficiency of laser wakefield accelerators.

Several previous works have explored tailoring of the plasma density profile of a laser-wakefield accelerator such that the accelerating electron bunch remains in the ideal accelerating phase. In the non-linear regime, analytical calculation of optimal density profiles is complicated by the evolution of the laser pulse and the loss of validity of simplified models. Nevertheless, numerical, and experimental work have shown the promise of density tailoring if properly tuned.

In this work, I will present a methodology for optimising dephasing mitigation in quasi-3D simulations, and show results of applying this technique for different setups.

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