A study of beam hosing in different regimes

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Beam hosing is a transverse beam-plasma instability that causes the centroid of a beam to oscillate with increasing amplitude and can therefore lead to the disruption of the beam as it propagates in plasma [1, 2, 3]. This instability can jeopardize those novel accelerator concepts which are based on plasma wakefields driven by long particle beams (where long is with respect to the plasma skin depth). The AWAKE experiment, for example, has recently demonstrated one such concept using a long proton beam as the driver [4]. Besides the successful acceleration of injected electrons, however, the experiment also enabled the observation of short-wavelength (at the plasma wavelength λ_{pe}) beam hosing under particular experimental conditions [5].

Simulation results indicate that the hosing instability can be suppressed by seeding the self-modulation instability [6] (a competing transverse instability) at a high enough level [6, 7] in the linear plasma wakefield excitation regime. It is not clear, however, whether some slower-growing, longer-wavelength modes of hosing (which find analogy in long-wavelength laser hosing [8]) are as effectively suppressed.

Using particle-in-cell simulations in conjunction with experimental data, this work will show how beam hosing can be observed in two different regimes: one where this instability develops on its own, and one where it develops while coupling to the self-modulation instability [9]. In addition, this work will investigate the long-wavelength regime of beam hosing through theory and simulations.

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