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Effect of transverse non-uniformity of the plasma density on wakefield evolution

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Evolution of the plasma wakefield in transversely non-uniform plasmas is numerically studied in terms of energy fluxes in the co-moving frame. For stationary transverse inhomogeneities, two effects are observed. First, the wave energy is always pushed out of the vicinity of local density extrema. In both V-shaped density channels and Λ -shaped density crests the behavior of energy fluxes is similar to that in the case of a smooth Gaussian density distribution. Second, longitudinal plasma oscillations quickly transform to transverse ones, which fade away promptly. An oblique density crest co-propagating with the wave driver can sweep out the wave completely and clean the plasma for the next driver. There is also a configuration in which the longitudinal wakefield component increases due to the ion motion. This corresponds to self-modulating long beams like that of the AWAKE experiment at CERN.

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