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Superluminal plasma wakefield acceleration BERNARDO MALACA, JORGE VIEIRA, RICARDO FONSECA, GoLP/Instituto de Plasmas e Fuso Nuclear, Instituto Superior Tcnico, Universidade de Lisboa, 1049-001 Lisbon, Portugal, DUSTIN FROULA, JOHN PALASTRO, University of Rochester, Laboratory for Laser Energetics, Rochester, New York 14623, USA — Laser wakefield acceleration (LWFA) experiments have demonstrated acceleration gradients of over 40 GV/m, almost three orders of magnitude above conventional radio-frequency accelerators. This tremendous acceleration cannot be maintained indefinitely, however, primarily due to dephasing and depletion. Recent advances in optics have shown that reflective elements such as axi-parabolas [Smartsev et al, Optics Letters, 2019] can produce a line-focus. When used in conjunction with an echelon, it becomes possible to tune the speed at which the laser peak intensity travels along this line-focus. As a result, this scheme can prevent dephasing by driving a wakefield at the vacuum speed of light [Palastro et al. PRL 2020]. Here, we perform particle-in-cell simulations with Osiris of superluminal plasma waves excited by superluminal perturbations. By comparing to equivalent subluminal cases, we found that at superluminal speeds, plasma waves can support arbitrarily high electric fields, free from the wave-breaking limits typical of subluminal plasma waves. We discuss the implications of these results in the development of more compact and efficient LWFAs.

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