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Physics of a 10 GeV laser-plasma accelerator[1] E. ESAREY, C.B. SCHROEDER, C.G.R. GEDDES, E. CORMIER-MICHEL, W.P. LEEMANS, Lawrence Berkeley National Laboratory, D. BRUHWILER, B. COWAN, Tech-X Corp., B.A. SHADWICK, U. Nebraska, Lincoln — The single-stage energy gain in a laser-plasma accelerator is limited by laser diffraction, electron dephasing, and laser depletion. Diffraction can be prevented by using a plasma channel and electron dephasing can be mitigated by increasing the on-axis density as a function of distance, which increases the wake phase velocity. Depletion (loss of laser energy to the wake) ultimately limits the single stage energy gain. Beam loading (modification of the wake by the accelerated electron bunch) limits the bunch charge and affects the energy spread and emittance. Advantages of various wake regimes,such as the quasi-linear or the blow-out regime, will be examined. Simulations of a 10 GeV stage driven by the 40 J BELLA laser will be presented. Also discussed are applications to future light sources and colliders.

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