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2D Particle-in-cell simulations of laser pulse propagation in plasma channels RODOLFO GIACONE, DIMITRE DIMITROV, DAVID BRUHWILER, JOHN CARY, Tech-X Corporation, CAMERON GEDDES, ERIC ESAREY, WIM LEEMANS, Ernest Orlando Lawrence Berkeley National Laboratory — In the absence of optical guiding, diffractive spreading of a laser pulse imposes a severe limitation on the acceleration length and maximum electron energy in the laser wake field accelerator (LWFA). Optical guiding of a laser pulse via plasma channels can overcome these difficulties. Energy efficient coupling of laser pulses into and through plasma channels is very important for optimal LWFA performance. We have run parameter studies on channel guiding using the PIC code VORPAL. We considered the effects that density ramp length and the position of the laser pulse focus have on coupling into the channel. We also considered enhanced leakage of laser energy transversely through the channel walls and the effects of tunneling ionization of a neutral gas on the guided laser pulse. The results of our simulations show that density ramps longer that one Rayleigh length have a negative effect on pulse-channel coupling and produce higher energy loss. When the pulse is focused on the channel entrance, large spot size oscillations result in increased energy leakage. Refocusing the pulse can reduce spot oscillations resulting in a reduction of leakage by a factor of three. Using power spectral diagnostics, we are able to separate pump depletion from energy leakage in the channel. In all cases the observed pump depletion is roughly four times larger than expected from 1D theory.

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