SELF-GUIDING OF ULTRA-SHORT, RELATIVISTICALLY INTENSE LASER PULSES THROUGH UNDERDENSE PLASMAS IN THE BLOWOUT LASER WAKEFIELD ACCELERATOR REGIME

J.E. Ralph, F. Fang, C. Joshi, W. Lu, K.A. Marsh,
W.B. Mori, A.E. Pak, F.S. Tsung, UCLA, Los Angeles, California

Abstract

The self-guiding of relativistically intense but ultra-short laser pulses has been experimentally investigated as a function of laser power, plasma density and plasma length in the so-called "blowout" regime. Although etching of the short laser pulse due to diffraction and local pump depletion erodes the the head of the laser pulse, an intense portion of the pulse is guided over tens of Rayleigh lengths, as observed by imaging the exit of the plasma. Spectrally-resolved images of the laser pulse at the exit of the plasma show evidence for photon acceleration as well as deceleration (pump depletion)in a well defined narrow guided region. This is indicative of the self-guided pulse residing in the wake excited in the plasma. Energy outside the guided region was found to be minimized when the initial conditions at the plasma entrance were closest to the theoretical matching conditions for guiding in the blowout regime. The maximum extent of the guided length is shown to be consistent with the nonlinear pump depletion length predicted by theory.

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