Relativistic laser beam propagation and critical density increase

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The propagation of relativistic laser beam in plasma has been studied by the Particle-in-Cell (PIC) code for a wide laser intensity range, where the fully time-dependent propagation characteristics are rather complicated owing to the highly nonlinear response of the plasma. Fortunately, however, the propagation features appear much more regular when averaged over a convenient number of cycles. Among other results, penetration in highly overdense plasma, temporary cavity formation and laser beam trapping are confirmed by our simulations. A more accurate analytical expression is suggested for estimating the relativistic critical density increase. Finally, particular attention is devoted to the generation of hot dense matter from macroscopic samples by taking advantage of overdense penetration.