Transition of Laser-Driven Wakefield Acceleration to Self-Injected Electron-Driven Wakefield Acceleration in Plasma of Metallic Density, Plateau Formation on Accelerating Wakefield and Zero Radial Wake Force by Laser Pulse, Shaped on Radius and Intensity

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The importance of laser plasma-based accelerators approved by a lot of number of experiments on wakefield acceleration [1-3]. For accelerators, where plasma is used, the accelerating gradient can be up to 100 GV/m [4, 5]. In this paper the wakefield excitation (several TV/m) in plasma of metallic density [6], self-injected electron bunch acceleration, the transition to combined laser and plasma wakefield acceleration are numerically simulated by 2.5D PIC code UMKA [7]. It was demonstrated that in blow-out regime the self-injected electron bunch at first is accelerated by laser wakefield, and then it is accelerated by wakefield, excited by both laser pulse and by previous self-injected electron bunch. It has been shown that laser-pulse shaping on radius (cone/bullet-shape) and intensity controls characteristics of the self-injected electron bunch and can provide at certain shaping small energy spread (self-formation of plateau on accelerating wakefield $E_x(x)$ and zero transverse wake force $F_y(y)=0$) and very small size (point) of self-injected and accelerated electron bunch. At wakefield excitation by a short train of laser pulses in plasma the effect of an increase in the amplitude of the accelerating wakefield has been observed in the region far after the last laser pulse up to the injection boundary due to a change in the geometry of the plasma electron oscillations.

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