Generation of short electron bunches by a laser pulse crossing a sharp boundary of plasma

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The process of the generation of a short electron bunches by a laser pulse of relativistic intensity that passes through a sharp boundary of plasma and their subsequent acceleration in the wake wave of a laser pulse has been analytically studied [1, 2]. It is shown in one-dimensional geometry that a physical mechanism that is responsible for the generation of electron bunches is self-injection of electrons into the wake field of a laser pulse, which occurs due to the mixing of electrons during the action of the laser pulse on plasma. The length of the trapped electron bunch is determined by the effect of kinematic grouping, which consists in the fact that electron self-injection into the wake wave occurs at the point of space and the moment of time when the previously trapped electrons are close to this point. Subsequently, during acceleration of trapped electrons in the wake wave, the length of the bunch increases as a result of the initial spread in the conditions of electron injection and their mutual repulsion in the bunch. Simple analytic relationships were obtained that can be used for estimating the length, charge of an electron bunch and the spread of electron energies.

This work was supported in part by the Russian Science Foundation, project No. 14-50-00124.