Dynamics of relativistic electron beam propagation

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In this study, analytically and using numerical modeling using the PIC method, we examine the propagation in a vacuum chamber and the change in the characteristics of a beam of relativistic electrons on the way from the plasma target in which it is generated to the equipment that records the electron beam or to a sample that is irradiated by electrons. In high-current beams, characteristic of the conditions of the analyzed experiments, the transverse motion of electrons can only be described in a relativistic approach. The solution of the corresponding equations shows that the trajectories of beam electrons reach an asymptotic dependence, in which the angle of inclination of the electron trajectory to the beam axis is determined only by the initial energy of the electrons, whereas when low-current beams are described using non-relativistic equations, the beam dynamics are determined by both its energy and charge [1]. For the parameters discussed, the analysis indicates a small role of electrostatic repulsion of relativistic beam electrons accelerated in the DLA mode during their transportation in a vacuum chamber. However, with an increase in the energy of the laser pulse and a proportional increase in the current carried by electrons, the influence of the electrostatic and magnetic self-action of the beam on its propagation in the vacuum chamber increases. In addition, as the beam charge increases, relativistic effects can affect the change in the electron concentration in the radial direction.

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