Numerical analysis of wakefield generated by a Gaussian microwave pulse in a plasma waveguide

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Abstract

In this paper, the propagation of microwave pulse with Gaussian profile is investigated in the rectangular waveguide filled with plasma in the presence of constant external magnetic field. For this purpose, by using the Maxwell's equations and the hydrodynamic fluid equations, the differential equation is calculated for the wake potential in the plasma waveguide. In the following, the differential equation is solved by the fourth order Runge-Kutta method, the distribution of the wakefield in the plasma waveguide is simulated by assuming that the pulse duration is equal to the plasma wave duration and the effect of pulse intensity and frequency, waveguide width, plasma density and the magnitude of the external magnetic field are investigated on the pulse propagation in the plasma waveguide and on the wakefield generation. The numerical results show that the microwave wakefield is amplified by increasing the pulse intensity, pulse width and external magnetic field, and decreasing by increasing the plasma density, the pulse frequency and the wavelength. Therefore, by optimizing parameters related to Gaussian pulse and plasma waveguide, creating a strong wakefield can possibly accelerate the charged particles.

Keywords: Microwave-plasma interaction, Wakefield, Plasma filled rectangular waveguide, Gaussian microwave pulse, External magnetic field

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