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Generation of Controllable Plasma Wakefield Noise in Particle-in-Cell Simulations

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Numerical simulations of beam-plasma instabilities may produce quantitatively incorrect results because of unrealistically high initial noise from which the instabilities develop. Of particular importance is the wakefield noise, the potential perturbations that have a phase velocity which is equal to the beam velocity. Controlling the noise level in simulations may offer the possibility of extrapolating simulation results to the more realistic low-noise case.
We propose a novel method for generating wakefield noise with a controllable amplitude by randomly located charged rods propagating ahead of the beam. The generation of this noise is not accompanied by parasitic Cherenkov radiation waves. We also illustrate the method with particle-in-cell simulations. The noise level and spectrum obtained in particle-in-cell simulations of randomly distributed thin rods with a smooth longitudinal charge distribution agrees with analytically calculated values. Consequently, the rod-based noise generator can be used in future numerical studies of beam-plasma instabilities.

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