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Force exerted on particle bunch propagating near plasma-vacuum boundary

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If a charged particle bunch propagates near a plasma-vacuum boundary, it experiences an additional force caused by the boundary. Taking account of this force may be important for witness injection into plasma wakefields or in case of beam and plasma misalignments. For the linearly responding plasma and short and narrow bunch, this force is calculated analytically and approximated by elementary functions. The force is attracting to the boundary, if the bunch is in vacuum, and repelling otherwise. There are also additional focusing and defocusing components of the force. Numerical simulations of electron beam crossing the boundary at a small angle agree with the theory, proving validity of the both.

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