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A novel analytical model of space charge forces in RF-guns

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A novel model of space charge forces is proposed for a low-energy (γ~1) bunch with arbitrary charge distribution in RF-guns. By exploiting Green function method, it is possible to develop an analytical approach and derive expressions of self-induced forces for any transverse and longitudinal bunch distribution. The model is accurate also in the approximation of low energy beams, when the 3D distribution can be decoupled in the two longitudinal and transverse planes. After having reproduced the results known in literature for Gaussian and Uniform charge distribution, we derive space charge forces in parabolic charge distributions. The proposed model highlights the dependence of rms beam emittance on the non-linearities, observed in the transverse phase space due to the space charge forces. Moreover, the model shows that the strongest non-linearities of the transverse phase space are already generated at the cathode when the beam is emitted. Finally, the method allows to include a quadrupolar perturbations on the transverse charge density.

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