3D MODEL FOR GREEN'S FUNCTION CHARGED-PARTICLE BEAM SIMULATIONS IN CYLINDRICAL GEOMETRY

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Over the recent years usefulness of Green's function approach in charged-particle beam simulations has been repeatedly demonstrated for modeling klystrons, gyrotrons, vircators, etc. [1,2]. Besides of more accuracy and/or simulation time reduction in calculations of space-charge field (cf., e.g., [1]) than with particle-in-cell methods, this approach allows one first principle checks of results obtained by other techniques.

In many modern applications the charged-particle beam propagating in cylindrical perfectly conducting grounded drift tubes is modeled by a collection of uniform density rings. Such a representation is most suitable for situations, which naturally possess cylindrical symmetry. In other cases, either absence of cylindrical symmetry of the beam [3], asymmetry of applied external fields (see, e.g., [4]) or even possible chaotization of charged-particle motion [2] may call for essentially 3-dimensional (3D) analysis.

Here we present such a scheme of modeling the transport of non-relativistic charged-particle beams propagating in cylindrical drift tubes based on our earlier work [5]. We show that, among other physical consequences of account for charge density induced on the drift tube wall by moving point-like non-relativistic charged macroparticles, a tangible difference is observed in projections on the drift tube cross-section of these trajectories if one accounts only for Coulomb's law “particle to particle” interaction, or there is inclusion into simulations of complete “particle to particle” interaction calculated using Green's functions of grounded ideally conducting cylindrical drift tube (“modified” Coulomb's law interaction), or one takes into account complete “particle to particle” and “particle to induced-by-itself surface-charge density” interactions (all non-relativistic contributions to the force of interaction between the charged-macroparticles). We also discuss situations the most suitable for utilization of the developed approach and formulate requirements necessary for its extension on weakly-relativistic charged-particle beams.

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