A DISPERSION FREE METHOD FOR MODELING SPACE-CHARGE PHYSICS IN A CIRCULAR PIPE*

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When modeling the physics of space-charge in high-power microwave sources, such as klystrons, it is necessary to have an accurate description of the space-charge fields which are generated by the time-dependent beam charge and current densities. In general, the method for computing these fields is nontrivial since the motion of charged particles in the beam can be in all three directions and includes the effects of image charges and currents on the surrounding conductor wall. We present a novel theoretical approach and corresponding numerical results for a dispersion free time-dependent Green's function method which can be utilized for calculating electromagnetic space-charge fields due to arbitrary circularly symmetric beam currents in a circular conducting pipe. Since the Green's function can be expanded in terms of solutions to the wave equation, the numerical solutions to the space-charge fields also satisfy the wave equation yielding a completely dispersion free numerical method. This technique is adequately suited for modeling bunched space-charge dominated beams, such as those found in high-power microwave sources, for which the effects of numerical grid dispersion and numerical Cherenkov radiation are typically found when using FDTD type methods. In addition, we also demonstrate how this new method can be used in a parallel computing framework.

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