Cold plasma based on mass lumped finite elements

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Recent advances in FDTD simulations of simple dielectrics have opened the possibility of various forms of local refinement [1], including spatial refinement (subgridding), polynomial refinement, and temporal refinement. These possibilities are based on writing FDTD as a special case of a finite element technique, whereby certain integrals are approximated using trapezoidal integration, which recovers the classical explicit FDTD scheme. We have recently shown [2] that these techniques can be extended to Body-Of-Revolution (BOR) FDTD which is well-suited for modeling toroidal cavities.
Further extending this technique to the time-domain modeling of plasmas does not turn out to be straightforward. The classical Whitney basis-functions and their analogues in toroidal geometries are insufficiently smooth to be used as testing functions for the time-domain constitutive equations of cold plasma [3].
In this contribution we present a new set of basis-functions that can be used to derive an FDTD modeling scheme for cold plasma based on a mass lumped finite element description.

[1] R. Chilton., Phd thesis, Ohio state university (2008).
[2] W. Tierens, D. De Zutter, J. of Comp. Phys. (2011)
[3] D. Smithe., Physics of plasmas (2007).