Accuracy of ADI-FDTD for near-field calculations

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The unconditionally stable ADI-FDTD method is a novel alternative to the classical Yee FDTD method (T. Namiki, IEEE T. Microw. Theory, 47, 2003-2007, 1999). This is a computationally affordable approximation of the unconditionally stable Crank-Nicolson FDTD (CN-FDTD) (still unaffordable for real problems with today's computers). However, the method exhibits numerical artifacts often more severe than those of Yee-FDTD, raising concerns about its utility: dispersion, accuracy errors, instabilities in some applications, non-divergence free behavior, negative-group velocity modes, etc. (Salvador G. Garcia, *et al.*, Recent Res. Development in Electronics, 2, 55-96, Transworld Research Network, 2005).

In (Salvador G. Garcia, *et al.*, IEEE Antenn. Wireless Prop. Lett., 1, 31-34, 2002) the authors proved that the method showed for low-frequency problems, severe accuracy errors, even for moderate Courant numbers. Nevertheless, the method continues to be applied in literature for intermediate frequencies, mainly in problems involving fine details which are treated with non-uniform meshing techniques, which is a classical type of problem for which the method is computationally more efficient than the classical Yee-FDTD.

In this presentation, we show that even for the intermediate-frequency region, large errors may appear in the near-field zone for scattering problems involving objects with sharp edges, even for moderate Courant numbers. We show that these errors decrease with the distance to the object, actually achieving, for points far from the object, similar error levels to those of Yee-FDTD, but employing less CPU time. Simulations of a PEC NASA almond and a PEC sphere are employed to support these claims (Fig. 1 plots the behavior of the RMS error on the field calculated with ADI-FDTD with respect to benchmark results when the Courant number increases)