

## EFFICIENT HIGH ORDER TIME SCHEMES FOR MAXWELL'S EQUATIONS

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The solution of time domain Maxwell's equations with locally time-stepping is of particular interest in case of realistic applications for which local high-order space approximations or locally refined mesh are relevant. The general form of the corresponding ODE (Ordinary Differential Equations) reads:

$$M_h \frac{dU}{dt} + K_h U = F(t),$$

where  $M_h$  is the mass matrix and  $K_h$  the stiffness matrix. This is a stiff problem because the eigenvalues of  $M_h^{-1}K_h$  may be large. As a consequence, the stability condition of explicit time schemes becomes so restrictive that it turns out interesting to use locally implicit time discretization to release the stability constraint in given regions. As a preliminary work for the design of high order locally implicit discretizations of wave problems, we provide a performance assessment of different implicit schemes. We focus on one-step methods mainly the classical implicit Runge-Kutta (SDIRK, DIRK, e.g. see [1]) schemes and Padé schemes (see [2]). The comparison criteria are based on the amplitude and phase errors which are reliable gauges of accuracy when approximating waves problems. Regarding Padé schemes, handling the source term  $F$  deserves a particular attention to keep the level of accuracy of high order discretizations. Numerical experiments are conducted in 1-D and 2-D for Maxwell's equations. The numerical results are performed with high order finite elements by using the code Montjoie (see [3]).

## REFERENCES

- [1] Ernst Hairer and Gerhard Wanner, "Solving ordinary differential equations II Stiff and differential-algebraic problem", *Springer*, 2010
- [2] Owe Axelsson and Andrey B. Kuchеров, "Real valued iterative methods for solving complex linear systems", *Department of Mathematics, University of Nijmegen*, 1999
- [3] Marc Duruflé, "Intégration numérique et éléments finis d'ordre élevé appliqués aux équations de Maxwell en regime harmonique", PhD Thesis of University Paris Dauphine, 2006