Projects C1,C2: Performance improvement of the Discontinuous Galerkin Time Domain method

DGTD is a modern numerical method that shows good efficiency in solving partial differential equations in time domain. It is based on the explicit numerical scheme and unstructured meshing. We use DGTD in the simulations of light interaction with various objects, from nano-structures to cosmic dust. As the formulation of the DGTD is very flexible it allows continuous work on its performance.

In this project we want to speed up time integration. Currently we use standard Runge-Kutta methods. The choice of the time-step is a critical point here. Small values lead to slow simulations and if too large one gets numerical instability. The time-step depends strongly on the quality of the unstructured mesh which is not trivial to achieve. Often, e. g., in multi-scale problems it appears to be very small due to complicated geometries of the objects of interest.

The tasks of the project will be to implement:

C1: The so-called local time-stepping technique. In this case one has two or more different timesteps adaptively chosen for different regions in the computational domain.

C2: The so-called super time stepping (STS) or Runge-Kutta-Chebyshev method. STS technique frees the explicit scheme from the stability restriction on the time-step, rendering it as usable as any implicit scheme, while retaining its simplicity and better accuracy.

The implementation will be tested in the simulations of light interaction with metallic nanostructures.