Décomposition de domaine et équations de Maxwell

- **Scientific context :** The numerical simulation of large scale time harmonic wave propagation problems is a challenge in computational science with many applications in engineering sciences (in aeronautics, antenna design, geophysics, medical imaging, non destructive testing, ...). The development of domain decomposition methods (`DDM`) together with the exploitation of parallel computers led to tremendous improvements in the numerical solution of elliptic partial differential equations, a class of problems to which wave propagation models do not belong. The internship will concern iterative non overlaping domain decomposition methods for solving 3D Helmholtz and time harmonic Maxwell's equations.

  The pioneering work of Després, then Collino, Ghanemi and Joly, and Gander, Magoules and Nataf, have shown that it is mandatory, in the context of wave equations, to use impedance type transmission conditions in the coupling of subdomains in order to obtain convergence of the `DDM`. In the approaches considered so far in the literature, the impedance operator involved in the transmission conditions was always local . However, these methods lead to algebraic convergence of the `DDM` in the best cases.

  In a recent work on the scalar Helmholtz equation, Collino, Joly and Lecouvez have observed that using non-local impedance operators such as integral operators with suitable singular kernels (that can be partially localized by an appropriate truncation process) could lead to an exponential convergence of the `DDM`. One of the strengths of this approach is to rely on a solid theoretical basis that systematically guarantees geometrical convergence.

- **Subject of the internship :** Work on the extension of the above methods to 3D Maxwell's equations. The difficulty is to propose new non local impedance operators adapted to the functional analysis framework for Maxwell's equations (trace spaces of vector fields). In particular, one shall address the convergence of the method in the case of particular geometries adapted to separation of variables (propagation in waveguides, scattering by a sphere). One will study the influence of both the truncation process and of the frequency on this convergence rate and address the optimization of the parameters involved in the transmission conditions.

- **Required knowledge :** Solid background in the theory of partial differential equations and their numerical analysis.

- **Perspectives :** Thesis in Mathematics funded by the ANR Project NonLocalDD

Responsable: Patrick Joly (Patrick.Joly@inria.fr, 01 81 87 20 80)

Lieu : Le stage se tiendra au sein de l'équipe POems de l'unité de mathématiques appliquées de l'ENSTA (Palaiseau).