Computational electromagnetics for Power Engineering

In the field of electrical machine analysis, numerical simulation makes it possible to circumvent tests that can be costly, difficult to carry out, or even dangerous for the machine. The Finite Element Method has thus become a reference approach in the study of electromagnetic problems. It enables the numerical resolution of Maxwell's equations in space and time on systems with complex geometries by discretizing the equations in the form of a system of nonlinear algebraic differential equations, often of large size. In addition, it is naturally coupled with methods for taking into account the motion of a sub-domain, making it ideal for modeling electrical machines, particularly rotor motion. Moreover, the modeling error can be calculated, thus guaranteeing the accuracy of the model. These features make of it an essential technique for industrial applications.

EDF has developed computational electromagnetics softwares since 1980s. The objective is the verification and deep validation of the tools. Actually, EDF R&D co-developed a software with the Power Engineering and Power Electronics laboratory of Lille. This software code_Carmel can solve the Maxwell's equations in 3D when radiations are not accounted for. Electrical equipments like transformers, motors or wind generators are easily represented. However, EDF is interested in a state-of-the-art software. That's why specific issues like error estimation, adaptive meshing, reduced order modeling, or multiphysics modeling are investigated.

The situation for the non-destructive evaluation with eddy currents for tubes in steam generators is rather particular. Indeed, great attention is required to meshing. A specific methodology has been developed. In the case of complex flaws, the classical finite element method is very difficult to use. Other techniques must be investigated.