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EM simulations II

Tuesday, 20 June 2023 12:00 (1 hour)

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In the presentation foundations of electromagnetic simulations are recapitulated. Initially, the need for numerical methods used in electromagnetic simulations is motivated. Then, spatial discretization is discussed in a general way. This will be followed by a detailed introduction to the finite-integration technique, which allows to transfer Maxwell’s equations into their discrete counterpart, namely Maxwell’s grid equations. Complementary to that, foundations on the spatial discretization using finite-element methods are provided, which are based on a weak formulation of the field problem. Based on these introductions, time domain computations are revisited in general and in particular for the finite-integration technique using the leap-frog approach. Complementary, frequency domain approaches are discussed in a very general fashion. In this context, the advantages of iterative methods over direct methods to solve large (sparse) linear systems of equations are highlighted. Special attention is devoted to the computation of network matrices (i.e. scattering matrices) of structures with large quality factors as this topic is highly relevant for RF for accelerators. This leads to a very short introduction of model order reduction methods and fast-frequency sweeps. The talk closes with some remarks on the finite-integration technique, the finite-element method and on challenges arising when setting up new simulation models. Finally, recommendations on how to carefully validate and assess the results delivered by simulations are given. “

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