Joint DESY and University of Hamburg Accelerator Physics Seminar

Tuesday, 19.10.2010

(14:00 in Room 459/30b)

Time Domain Numerical Calculations of the Short Electron Bunch Wakefields in Resistive Structures

(PhD defense))

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Abstract

The acceleration of electron bunches with very small longitudinal and transverse phase space volume is one of the most actual challenges for the future International Linear Collider and high brightness X-Ray Free Electron Lasers. The exact knowledge on the wake fields generated by the ultra-short electron bunches during its interaction with surrounding structures is a very important issue to prevent the beam quality degradation and to optimize the facility performance. The high accuracy time domain numerical calculations play the decisive role in correct evaluation of the wake fields in advanced accelerators. The thesis is devoted to the development of a new longitudinally dispersion-free 3D hybrid numerical scheme in time domain for wake field calculation of ultra short bunches in structures with walls of finite conductivity. The basic approaches used in the thesis to solve the problem are the following. For materials with high but finite conductivity the model of the plane wave reflection from a conducting half-space is used. It is shown that in the conductive half-space the field components perpendicular to the interface can be neglected. The electric tangential component on the surface contributes to the tangential magnetic field in the lossless area just before the boundary layer. For high conducting media, the task is reduced to 1D electromagnetic problem in metal and the so-called 1D conducting line model can be applied instead of a full 3D space description. Further, a TE/TM ("transverse electric - transverse magnetic") splitting implicit numerical scheme along with 1D conducting line model is applied to develop a new longitudinally dispersion-free hybrid numerical scheme in the time domain. The stability of the new hybrid numerical scheme in vacuum, conductor and bound cell is studied. The convergence of the new scheme is analyzed by comparison with the well-known analytical solutions. The wakefield calculations for a number of structures are performed and a good agreement with known analytical and numerical results is obtained. The new hybrid scheme was applied to calculate the wake potentials for the various components of FLASH linear accelerator at DESY and the European XFEL project.

NOTE THE UNUSUAL TIME

J.Roßbach (Univ. HH) and M.Vogt (MPY).