Short Course
in Electromagnetic Modeling for Microwave Processing

Grub AR, Switzerland

December 8–9, 2003

Instructor: Vadim Yakovlev*)

Profile – The course will cover fundamental and practical issues in computer modeling of systems and processes in microwave (MW) power engineering and will show what modern advanced simulation can bring to engineers and designers of the microwave heating applications. The emphasis will be made on the advantages of the Finite Difference Time Domain method and its implementation in *QuickWave-3D*, the 3D conformal FDTD EM simulator. Examples of modeling of practical applicators and their elements will be presented. The participants are encouraged to bring their laptops (on which *QuickWave-3D* would be installed for the duration of the course) and thus to get hands-on experience and deeper impression on the process of modeling of applied MW systems.

Course Syllabus

Day One: Monday, December 8

8:30 – 9:00 am: **Installation of *QuickWave-3D* on the participants' laptops**

9:00 – 10:00 am: **1. Computational Electromagnetics: Basics of Numerical Analysis**
Introduction to the course. Related theoretical points in electromagnetics: conceptual aspects of EM modeling: *why*'s, *what*'s and *how*'s. Maxwell's equations. Major numerical techniques. FDTD and FEM.

10:10 – 11:10 am: **2. Electromagnetic Simulators & Concepts of Modeling of Microwave Heating**
Database of EM software applicable to modeling of microwave heating scenarios. Test problem solved by different simulators; recommended solvers. Strategic objectives of modeling.

11:10 – 12:00 am: **3. Modeling with *QuickWave-3D* : Computational Strategy & Modal Excitation**
Computational strategy of FDTD modeling of microwave heating. Implementation of the strategy with *QuickWave-3D*. More issues in electromagnetic: waveguide modes and their characteristics. The concept of a modal template.

12:00 – 12:30 pm: **Tour over the Gigatherm facilities**

12:30 – 1:30 pm: **Lunch**

1:30 – 2:20 pm: **4. Building *QuickWave-3D* Scenarios. Practicum in Handling of Waveguide Modes**
Characterization and comparison of element and object approaches in making projects. Building pro-files: mesh control, modal templates. Excitation of TE- and TM-modes in a circular waveguide.

2:30 – 4:00 pm: **5. Making *QuickWave-3D* Models: *Element* Approach**
Practical work with the software: creation of element models from scratch (including discretization and excitation): MW domestic oven with a food load.

4:10 – 5:30 pm: **6. Simulation of Projects & Post-Processing of the Results**
Computation of the built models with a pulse and sinusoidal excitation. Detailed analysis of the software output, presentation of the results, export options (MS Excel, ACIS, etc.). Modeling options and sensitivity analysis.

Day Two: Tuesday, December 9

8:30 – 9:50 am: **7. Making *QuickWave-3D* Models: *Object* Approach**
Practical work with the software: creation of object models from scratch: MW domestic oven and industrial batch system. Basics of the UDO language. Illustrative examples from the software library.

10:00 – 10:50 am: **8. More Examples of Practical Modeling and Post-Processing**
Simulation of components and applicators: high power water loads, slotted waveguide as a radiating element. Industrial modeling at FCI.

11:00 – 12:00 am: **9. Aspects of Advanced Modeling: Coupling with Other Solvers; Optimization; Change of Geometry**
Temperature computation: *Basic Heating Module* (*QW-BHM*) – concepts and operations. Tools for optimization: *QW-Optimizer* and alternative approaches. Models for changing geometry. *QuickWave-3D* and MATLAB and FEMLAB.

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