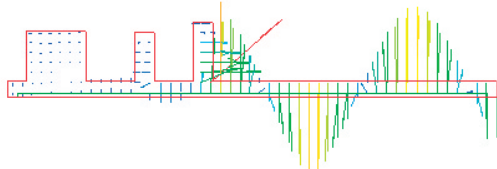
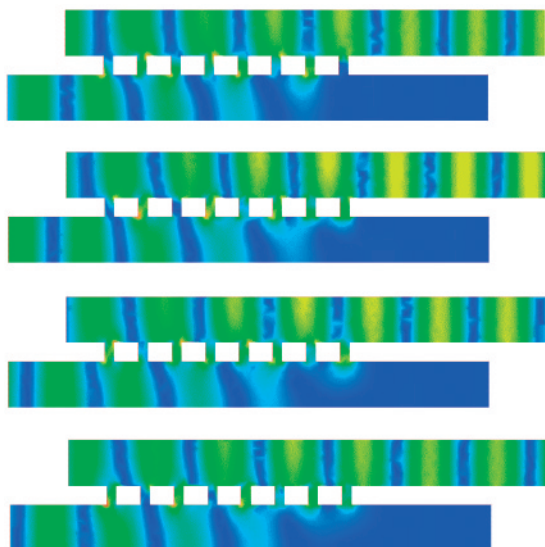


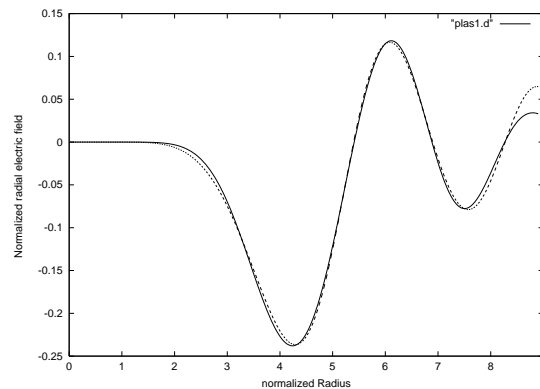
HF-Field-Simulation of a Monomode-System



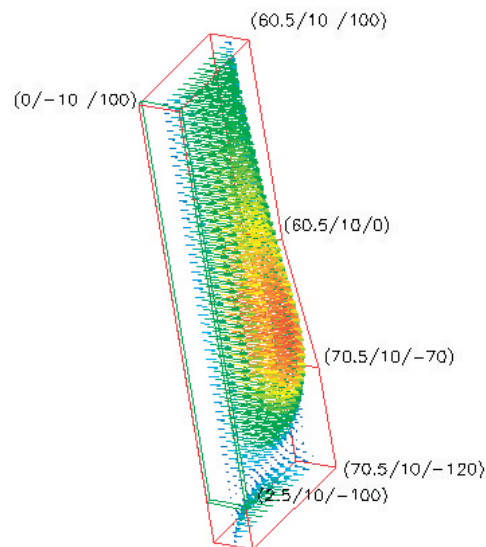
Simulation of Coupling and Leakage in a HF-System



A Directional Coupler HF-Field-Simulation



Radial electric field component of the TE 10-4 mode (dashed lines) and a decomposition into orthogonal modes (solid line)



HF - Field - Simulation of a tapered Cutoff Applicator

The first step in developing a product using microwaves or elaborating a solution to an electrodynamic problem is the numerical analysis of the situation. For that reason extensive computer codes have been either in-house developed, purchased or leased. They basically can be split into two categories.

The first relies on a purely numerical approach. The geometry of material boundaries and the material properties as well as excitations are the input values. The entire space to be investigated is divided by means of a grid into elements where in each individual element uniform conditions are assumed. This is the basis of finite element or finite difference programs. Only a little instruction is needed for use. Not much knowledge is required to handle these programmes.

RM has a commercial finite element code available to solve electrodynamic problems. Also we have an in-house-developed code (HEAT) to calculate the heat flux in objects of a given geometry and material parameters. Though these codes are very convenient in use they have severe drawbacks. These mainly are the high consumption of computation time and storage and/or low accuracy of the obtained results. In case of electrodynamic problems as soon as the geometry of the obstacles in three dimensions is larger than about ten times the wavelength in the material the required storage easily reaches the computer's limit. Also the computation time may exceed several hours.

As soon as the electrodynamic dimensions are large compared to the wavelength the fully numerical treatment has to be replaced by a "more" analytical treatment. In all these programs the operators need to have strong insight into the problem. These codes take advantage of either circular or coaxial symmetries or rectangular geometries, which allows the development of the present field into orthogonal

eigenmodes. The major advantage is a reduction in storage by an order of a magnitude and a reduction of computation time to less than one percent of the time consumed by purely numerical codes.

A powerful tool is to use these codes in hybrid form. This means that if large geometries have to be investigated the entire space is separated into a part where a development into eigenmodes is possible (in microwave processing systems these are the feed waveguides the launching system and parts of the applicator) and remaining relatively small areas (the space where the often a non symmetric sample is placed).

HEAT

Task: Heatflux
Calculates the temperature distribution in objects of a given geometry and material parameters.

Language: C++

Developer: In-house

Property: IMT GmbH

For the design of an applicator, the possible temperature rise and cooling time constants and the need of insulation and cooling installations the three dimensional heat transfer equation has to be solved. The code takes into account radiation and heat convection boundaries as well the change of material properties during temperature rise.

MODMAT

Task: Modematching
Calculates the change of mode content at distortions of waveguides of cylindrical, coaxial or rectangular shape.

Language: C++

Developer: In-house

Property: IMT GmbH

Electromagnetic energy propagates in waveguides in form of orthogonal eigenmodes which for waveguides of rectangular, circular and coaxial shape can be expressed analytically. Changes of size and shape of the guide lead to a change of the mode content. MODMAT is able to calculate the change of the mixture of eigenmodes for any size of change in waveguide transverse dimensions. Also the effect of dielectric components like microwave windows can be investigated and optimized. The programs are applied in particular for the design of feed waveguides and launching sections of microwave processing units.

MODCON

Task: Periodic Mode Converters
Calculation of modemixtures in periodically deformed irregular waveguides.

Language: C++

Developer: In-house

Property: IMT GmbH

Desired changes of mode content can be achieved by means of periodic waveguide deformations. For weak deformations no mode matching is necessary but the generalized telegraphist equations have to be solved. Non symmetric deformations and tapers are considered as well. These programs have been used for the design of mode converting antennas as they have been integrated into the ultra high vacuum of millimeter wave high power tubes, called gyrotrons. Both weak deformations as well as tapering can be calculated simultaneously.

G-BEAM

Task: Gaussian Beam Propagation
Calculation of Mixtures of Gaussian Beams in Free Space.

Language: C++

Developer: In-house

Property: IMT GmbH

Gaussian beams are the eigenmodes of free space. They can efficiently be carried over long distances via a reflector transmission line. These reflectors lead to a slight change in mode content. G-BEAM calculates the change of mode content as the Gaussian beams propagate along a mirror line.

OSSI

Task: Optical structure simulation interpreter
Calculation of reflectors of non quadratic surface.

Language: C++

Developer: Georg Michel

Property: Forschungszentrum Karlsruhe

As long as reflectors in a quasi-optical transmission line have the commonly used quadratic surface the transverse field distribution is only weakly changed. In case a significant change of this field (amplitude and phase) distribution is desired a pair of non quadratic phase correcting reflectors is needed. The surface is optimized by means of the program OSSI. This program is rented from FZK Karlsruhe and can not be sold.

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