QW-MODELLER 2020

FOR QUICKWAVE
SOFTWARE FOR ELECTROMAGNETIC DESIGN AND SIMULATIONS

QWED has continued efforts on extending availability and functionality of the *QW-Modeller* for *QuickWave* software for electromagnetic design as well as the scope of its applications.

New *QW-Modeller* for *QuickWave* allows preparing a complete V2D (BOR) axisymmetrical projects for electromagnetic simulation with *QuickWave* software.

Patch Antenna Array Module has been introduced as a response to increasing popularity of 5G communication systems, to provide the user with convenient tool for designing patch antenna arrays.

The *Basic Heating Module* is now enhanced with excitation ports configuration allowing setting port parameters for the consecutive BHM steps.

The effective and practically useful solution for simulation convergence monitoring has been introduced in QuickWave 2017. It utilises monitoring of the electromagnetic (EM) energy in the calculation model and automatically stops the simulation when it decays to a certain level. Such approach to running the simulation allows for reducing the number of performed FDTD iterations and as a result the computing time, without reducing a computational accuracy. This solution is now also available for complete S-matrix postprocessing (Smn).

The *QW-Modeller 2020* is based on the 0.18.4 version of FreeCAD migrated from Python 2 and Qt4 to Python 3 and Qt5, which introduces a lot of improvements in user interface and in geometry workbenches (Part, PartDesign and Sketcher).

NEW QW-MODELLER

QW-Modeller for QuickWave is a plug-in (workbench) for the open source *FreeCAD* (http://www.freecadweb.org), general purpose feature-based parametric 3D CAD modeller with a modular software architecture, which makes it easy to provide additional functionalities without modifying the core system. The CAD capabilities of *FreeCAD* are based on the OpenCasCade® kernel, a professional-level CAD kernel, featuring advanced 3D geometry manipulation and objects.

QW-Modeller for QuickWave is free and can be used without time limitations or any restrictions for creating geometry, assigning the materials, adding ports, boundary conditions, setting mesh, excitation parameters, postprocessings, etc.

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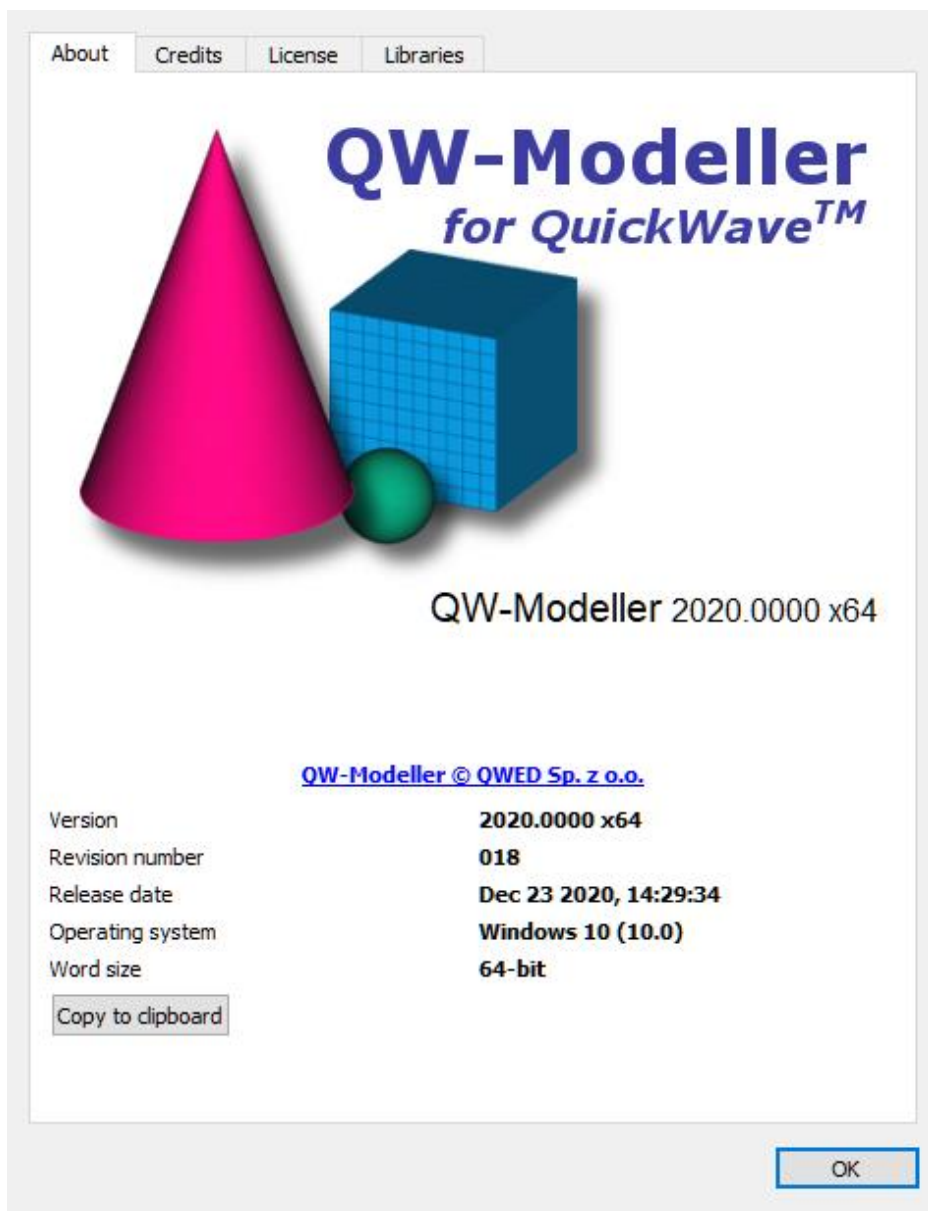
V2D BOR STRUCTURES

In the newest 2020 version, *QW-Modeller* allows for preparation and configuration of simulation scenarios considering *V2D (BOR)* structures.

For the structures of axial symmetry (also called Bodies of Revolution or BOR), the 3D electromagnetic problem reduces to two dimensions in cylindrical coordinates $x\rho$ and the FDTD method reduces to a 2-dimensional (2D) one. In general, we can distinguish scalar 2D problems with only three non-zero field components, or more complicated vector 2D problems (*V2D* problems) in which we must consider all six field components. As suggested by its name, *QW-V2D* can deal with vector 2D problems, but the analysis of simpler scalar 2D problems is also possible.
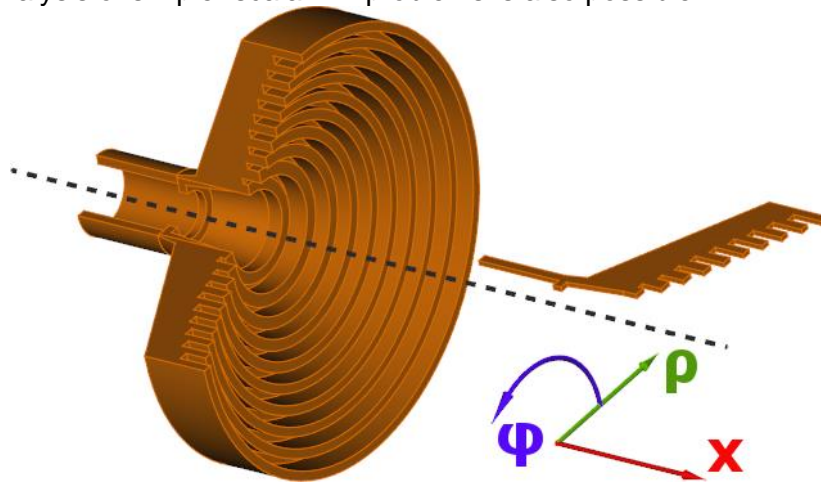
The *QW-Modeller* allows for definition of *V2D (BOR)* structures, mesh generation, and specification of simulation parameters.

The *V2D (BOR)* projects, axisymmetrical two dimensional in cylindrical coordinates, are considered in cylindrical coordinates x,ρ,φ with the assumption that the dependence of fields on the coordinate φ is analytically known. Therefore in fact we consider the structure in two dimensions x and ρ. In terms of FDTD meshing we have just one layer of FDTD cells reproducing the shape of the structure in the plane x, ρ. The third dimension (with respect to φ) is always equal to 2π.

The *V2D (BOR)* project geometries (i.e. cylinder) can be introduced as:
- full 3D structure with X-axis as an axial symmetry
- part of 3D structure with X-axis as an axial symmetry
- part of 3D structure with X-axis as an axial symmetry defined as a 2D long-section of the structure placed at Z=0 coordinate
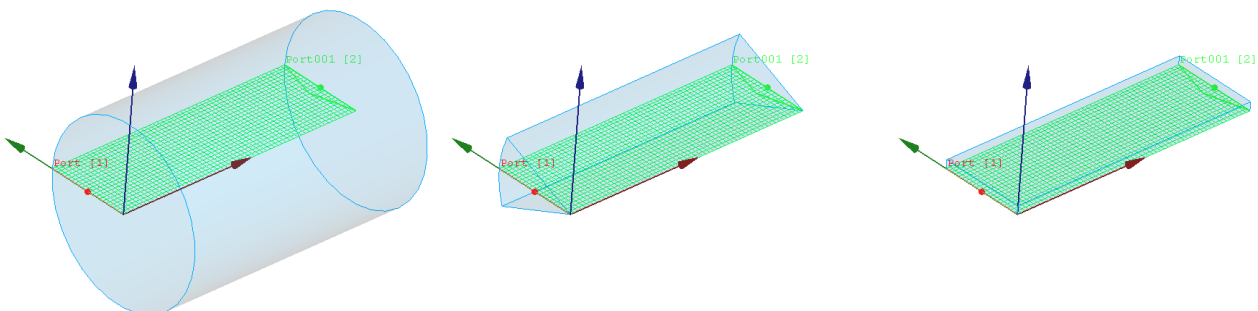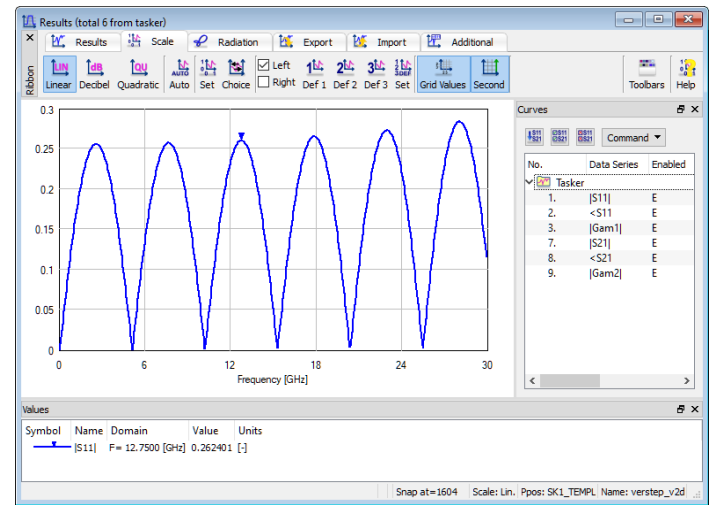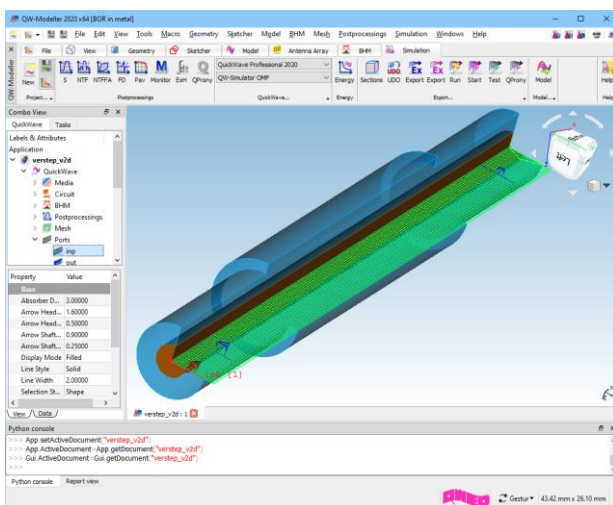
New set of V2D (BOR) axisymmetrical structures examples are included in the *QW-Modeller 2020* installation.
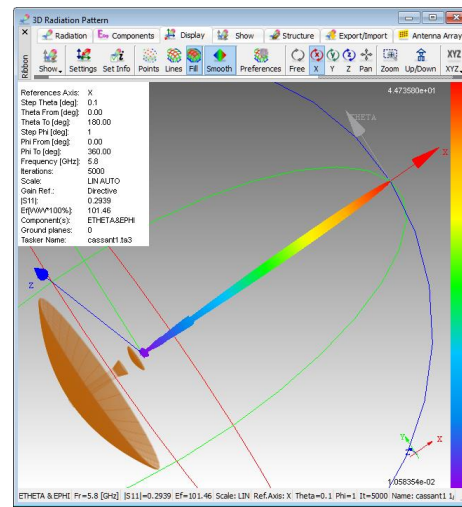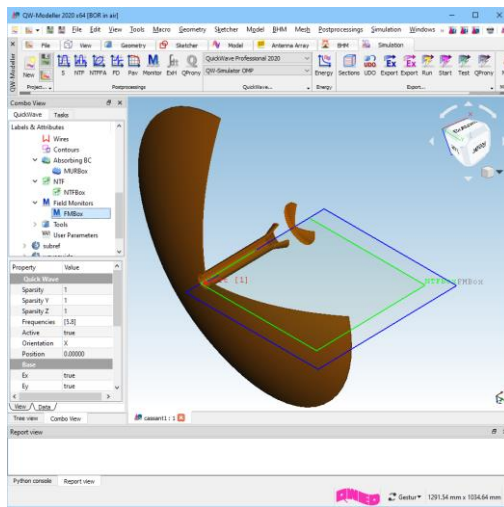

Two-reflector Cassegrain antenna
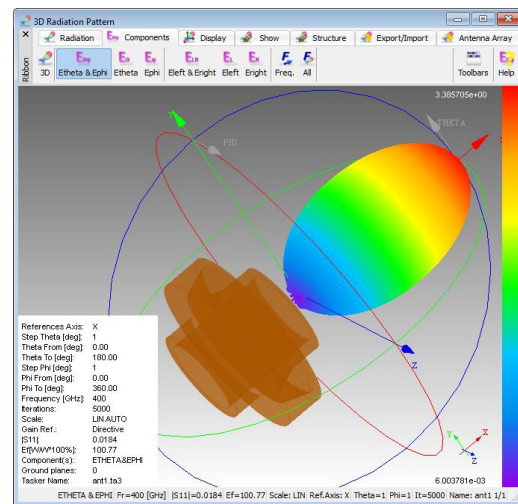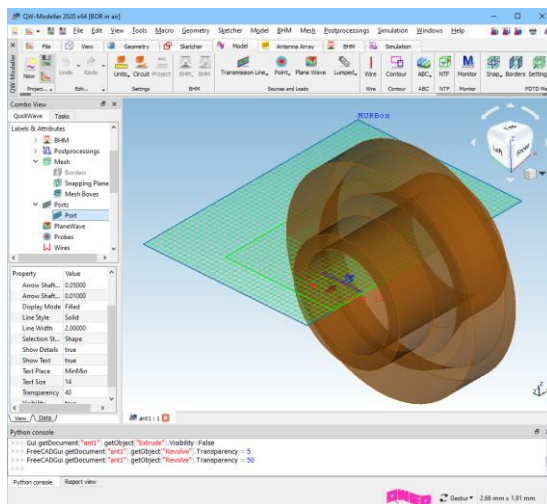
Axisymmetrical horn antenna with one corrugation

Step in coaxial line

PATH ANTENNA ARRAY MODULE

Patch antenna arrays can be prepared in *QW-Modeller* as a finite sized $N_x \times N_y$ element matrices, arranged on a substrate of user-defined size. Each separate patch antenna is excited by a point port, placed in the middle of substrate height, joint with the wire connecting the patch and ground beneath the substrate. The direction of main radiation beam can be automatically steered by defining θ and φ angles, for which *QW-Modeller* calculates two-dimensional progression of the excitation signal delay (corresponding to phase shift) within all patch antennas.
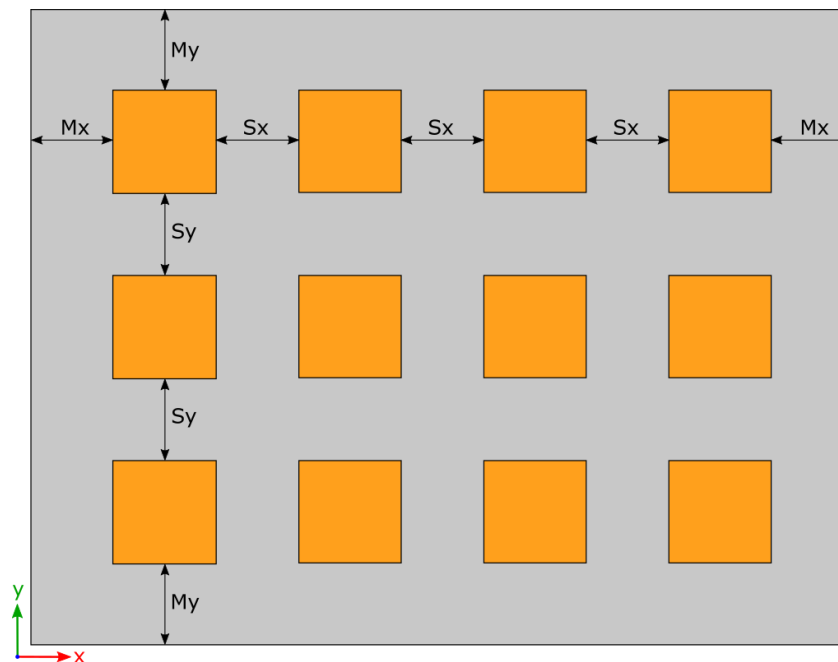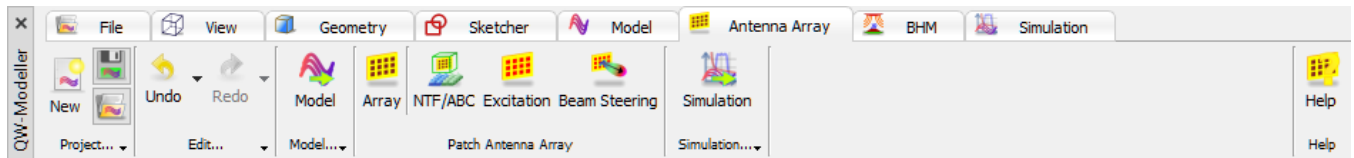
Patch antenna array with N_x=4 and N_y=3.

There are three types of individual patch shape available:
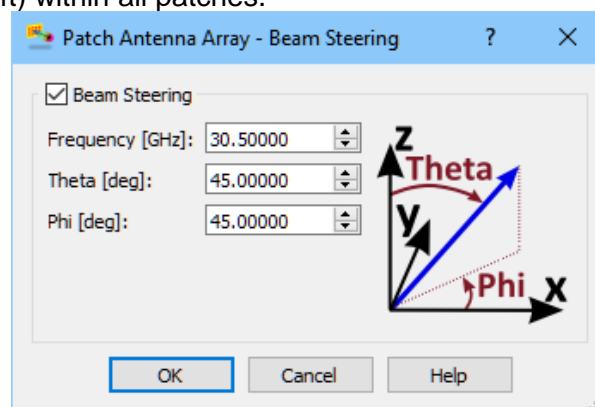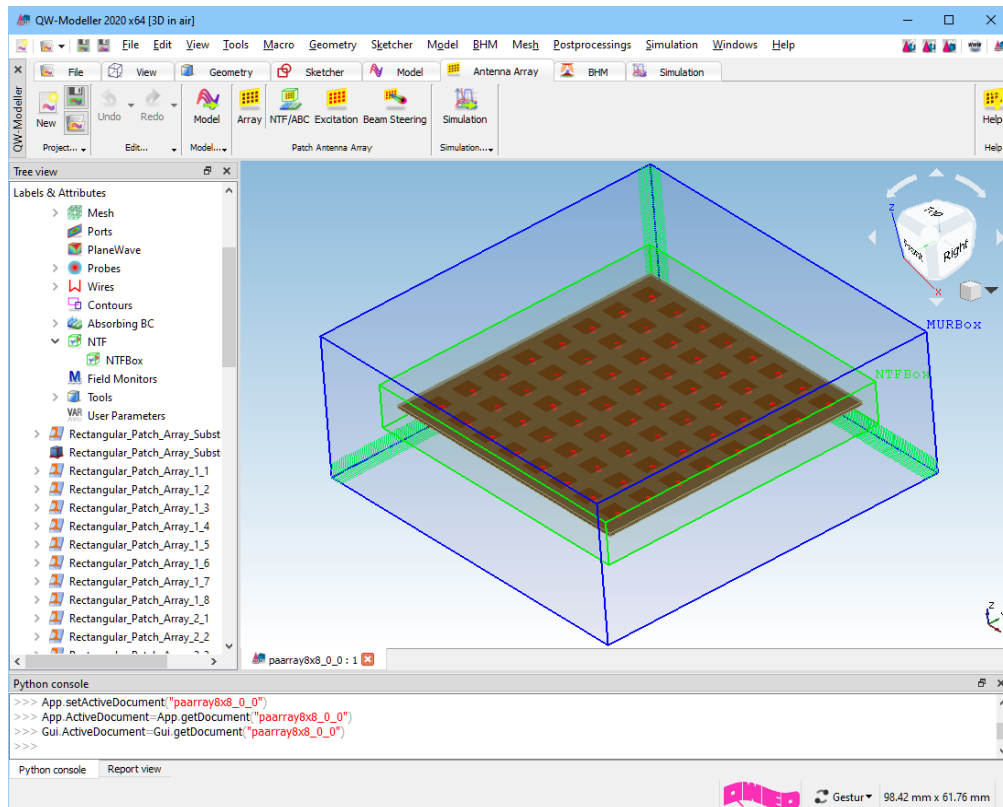
- *Rectangular*
- *Circular*
- *Geometry*
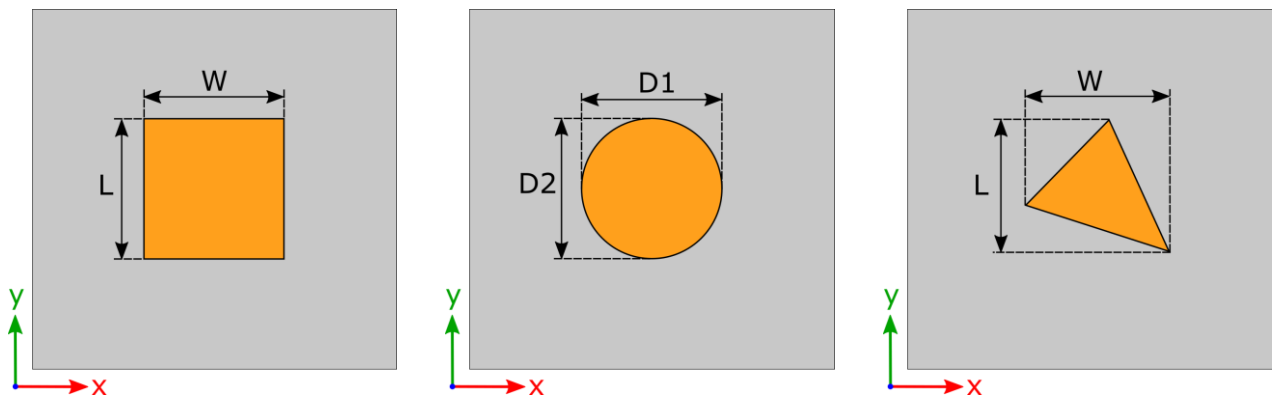
Definition of individual patch dimensions indicated for: rectangular patch, circular patch, and user-defined patch geometry.

A patch antenna array consists of $N_x \times N_y$ individual patch antennas, arranged in a rectangular grid, separated by spacing of S_x and S_y, in X and Y direction respectively, and located at a margin of M_x and M_y from substrate edges. The patch antenna array parameters can be defined in the *Patch Antenna Array* dialogue.
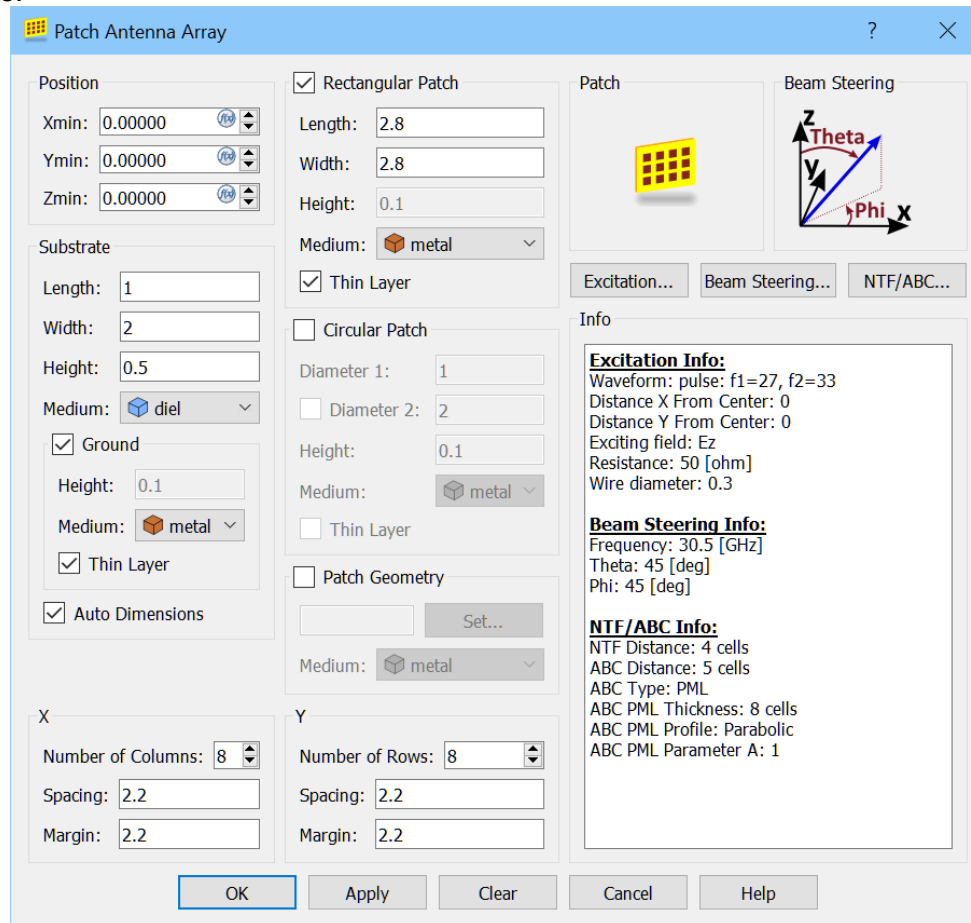

The direction of main radiation beam can be steered by defining φ and θ angles, for which *QW-Modeller* automatically calculates two-dimensional progression of the excitation signal delay (corresponding to phase shift) within all patches.

Rectangular patch antenna 8x8 array with beam steering

The Patch Antenna Array module allows for convenient analysis of planar antenna arrays with predefined direction of main beam direction. For patch antenna array scenarios prepared with dedicated functionalities of *QW-Modeller*, *QuickWave Simulator* provides visualisation of distribution of excitation parameters (amplitude and delay) across the matrix, together with 3D radiation pattern.
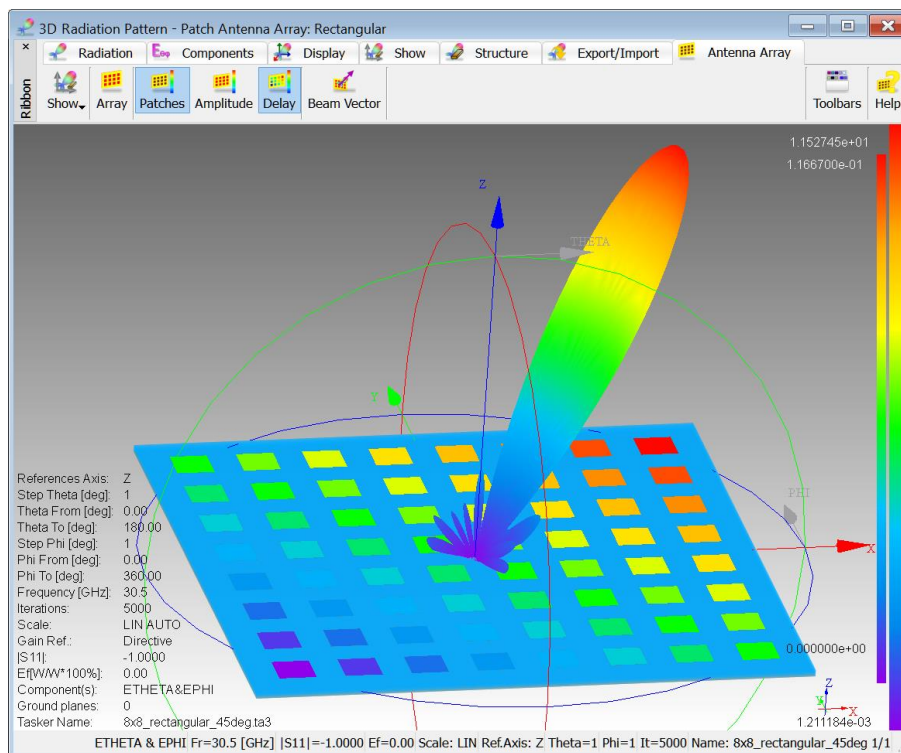
BASIC HEATING MODULE IMPROVEMENTS

The Basic Heating Module is now enhanced with excitation ports configuration allowing setting port parameters for the consecutive BHM steps.
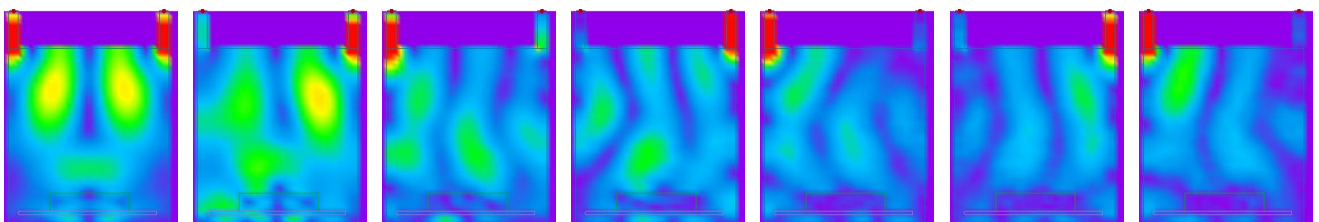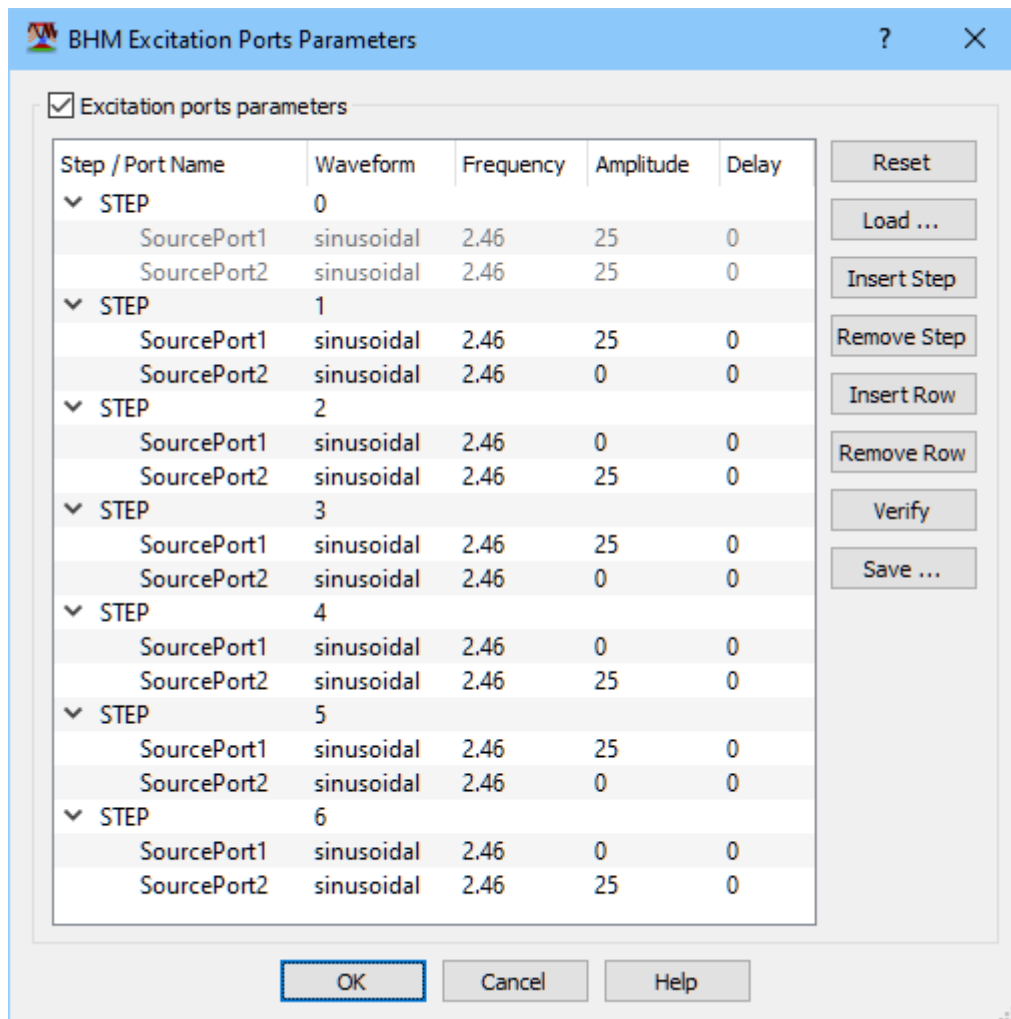

Total E field instantaneous distribution - ports parameters switching in consecutive BHM steps.

ENERGY STOP CRITERION FOR SMN POSTPROCESSING

The effective and practically useful solution for simulation convergence monitoring has been introduced in version 2017 of *QuickWave*. It is enabled for pulse excitation with a finite duration time and utilises monitoring of the electromagnetic (EM) energy in the calculation model and automatically stops the simulation when it decays to a certain level. This allows reducing the number of performed FDTD iterations and as a result the computing time, without reducing computational accuracy.

The Energy Stop Criterion feature solution is now available in *QuickWave* for complete S-matrix postprocessing (Smn).
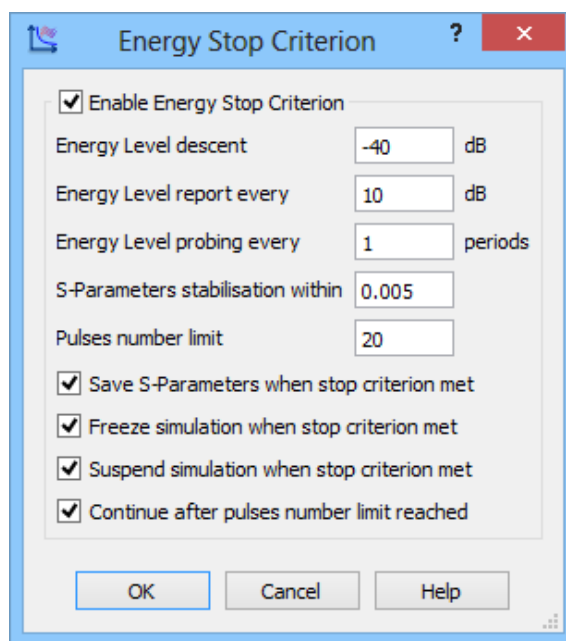
CONTOURS FOR CALCULATION OF INTEGRAL QUANTITIES

The definition of contours for calculation of integral quantities, such as a line integral of the electric field along a pre-defined integration path, is now available.
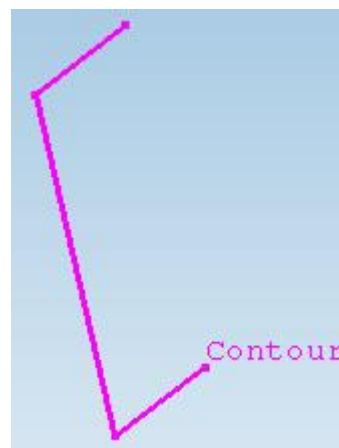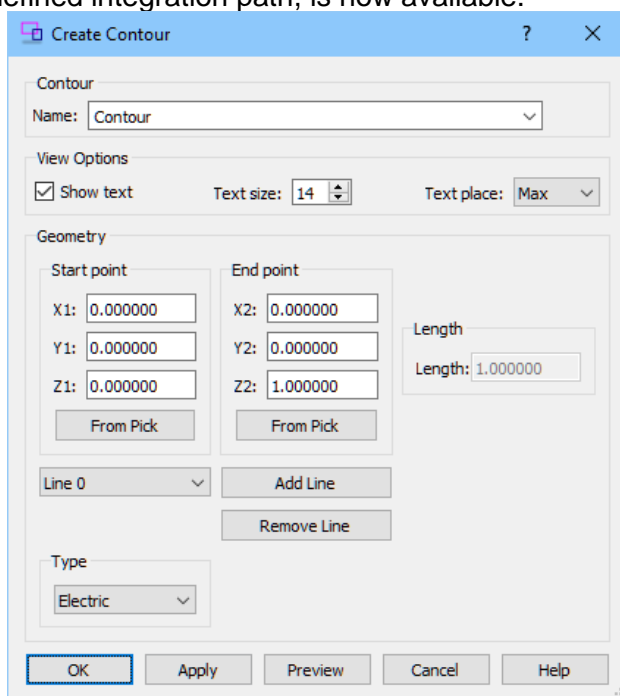
MICROWAVE COURSE

To facilitate using *QW-Modeller* and *QuickWave* in microwave courses, the examples investigating basic electromagnetic scenarios are included, as well as a short background description. These examples, together with microwave background description, become complementary introductory to fundamental microwave phenomena. All the interesting features and behaviours are visualised using electromagnetic simulation with *QuickWave* software.

All examples were prepared in free CAD *QW-Modeller* for *QuickWave* and the models preparation procedures are described in separate documents. All examples considered herein are included in the *QW-Modeller* and *QuickWave STUDENT Release* installation as both, *QW-Modeller* and *QW-Editor* projects.

Plane Wave - normal incidence

The aim of this training is to point out main properties and behaviour of the plane wave propagating in an isotropic medium and incident normally at the media boundaries.
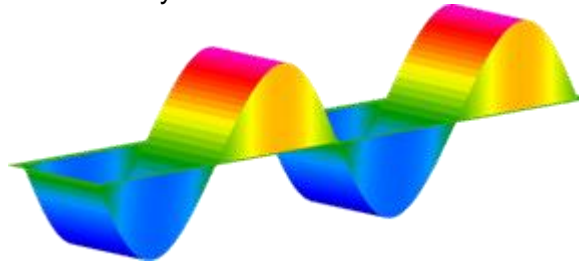
Rectangular Waveguides

Waveguides are transmission lines commonly used in electronics, especially in higher frequency ranges like microwaves. A waveguide can be simply described as a metal pipe usually filled with air. This tutorial is dedicated to rectangular waveguides and contains all basic information concerning their operation rules.
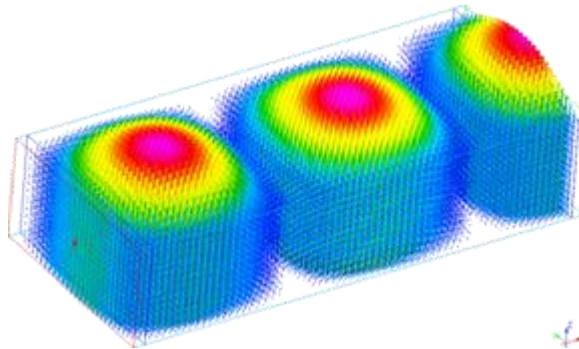
Circular Waveguides

This tutorial is dedicated to basic properties of circular waveguides.
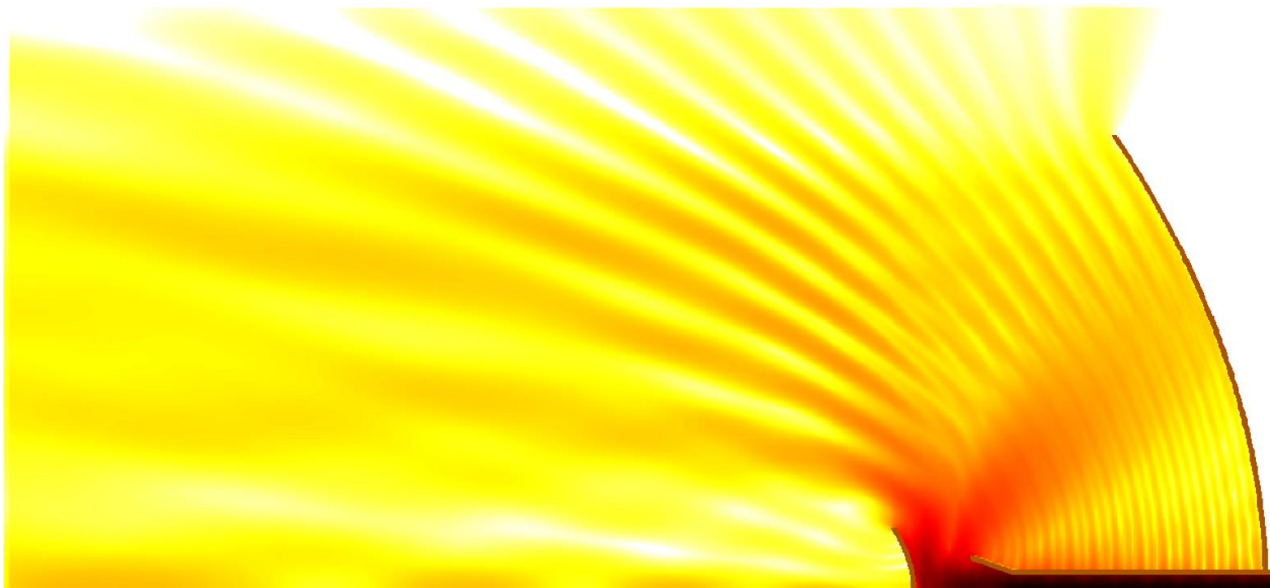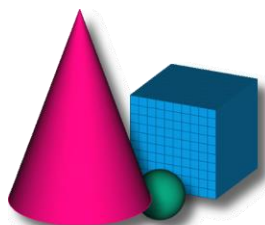
Design is as simple as it can be.

Simulation is as fast as you want it to be.

Results are as accurate as they should be.

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