FIDELITY Non-Uniform & Conformal FDTD EM Simulator

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History of Zeland Software, Inc.

- Founded in 1992 for high frequency EM simulation and optimization.
- The 1st product IE3D EM Simulation and Optimization Package introduced in 1993.
- The 2nd product FIDELITY Full-3D FDTD EM Simulator introduced in 1997.
- Both packages, especially the IE3D, are widely used in industrial organizations, government labs and universities for R&D.

Electromagnetic Simulators

- IE3D EM Simulation and Optimization Package:
  - Moment method (F-domain) solving current distribution.
  - True 3D simulator focused on planar and 3D circuits and antennas (MMIC, RFIC, LTCC, PCB, packaging, wire antenna, patch antennas) .
- FIDELITY Time Domain Full 3D EM Simulator
  - Non-uniform and conformal FDTD (T-domain) for 3D field distribution.
  - For 3D dielectric and waveguide problems (microwave components, horn antennas, antennas next to lossy dielectrics, microwave heating).

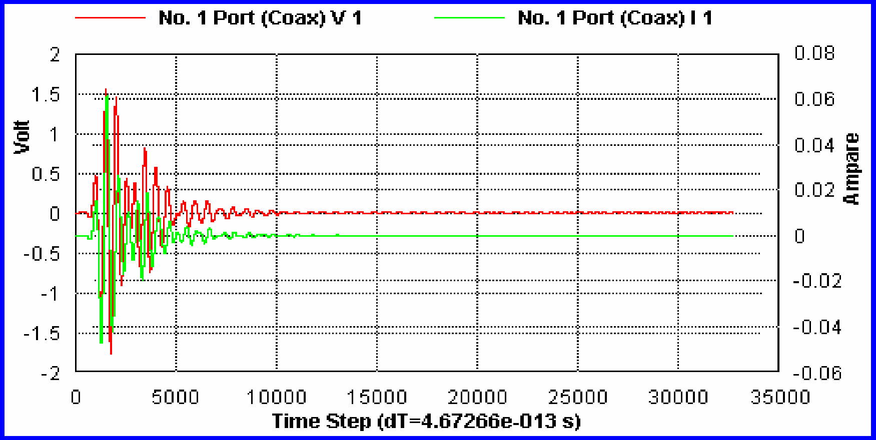
*more information on www.zeland.com

FIDELITY EM Simulator

- Non-uniform & conformal FDTD engine.
- Modeling dielectric discontinuities problems.
- Modeling waveguide structures
- Modeling 3D & planar antenna structures.
- Modeling connectors
- EMC & EMI
- Bio-medical applications or EM effects on human body
- Microwave food processing

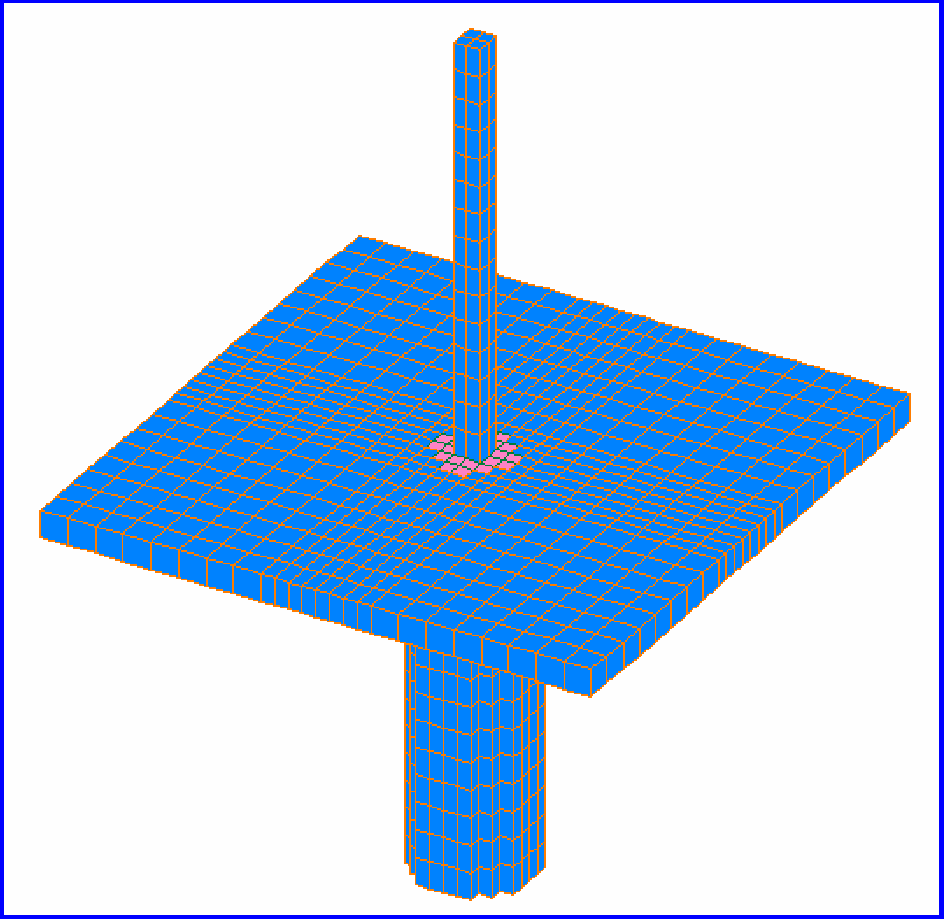
FDTD Easy for Large Structures

- No matrix inversion.
- Solution process is a time-marching process.
- Meaningful time signals.
- Fourier-Transform for wide range frequency response.
- More on special features for FIDELITY.



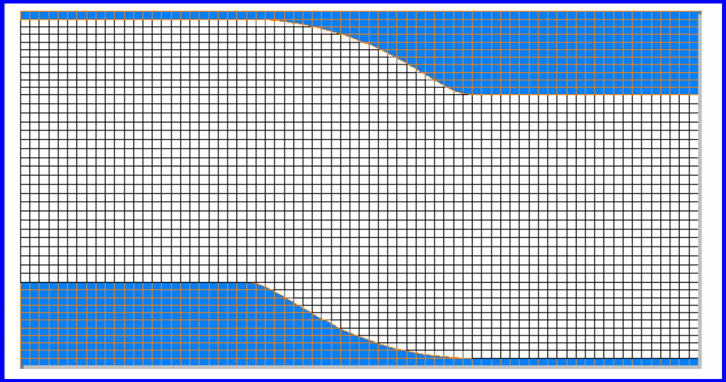
Automatic Non-Uniform Meshing

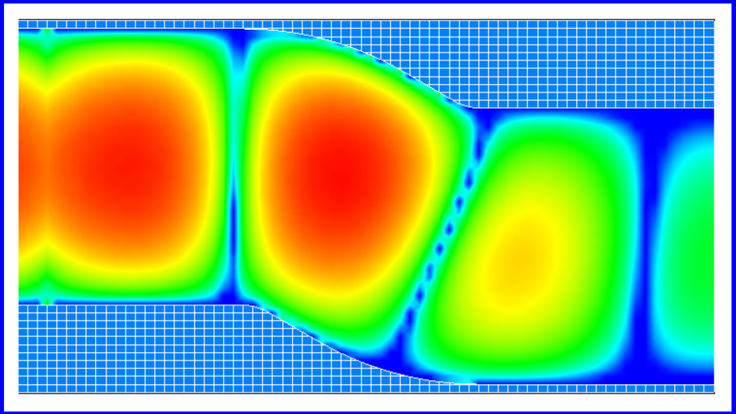
- Non-uniform meshing makes it much more flexible on modeling small features of a structure.



Optional Conformal Meshing

- Conformal FDTD allows users to model curved structures more precisely.

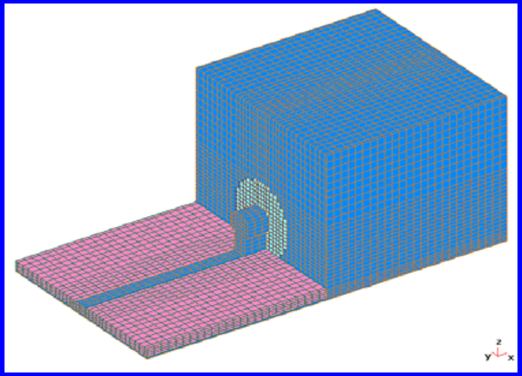




Object Oriented Geometry Modeling

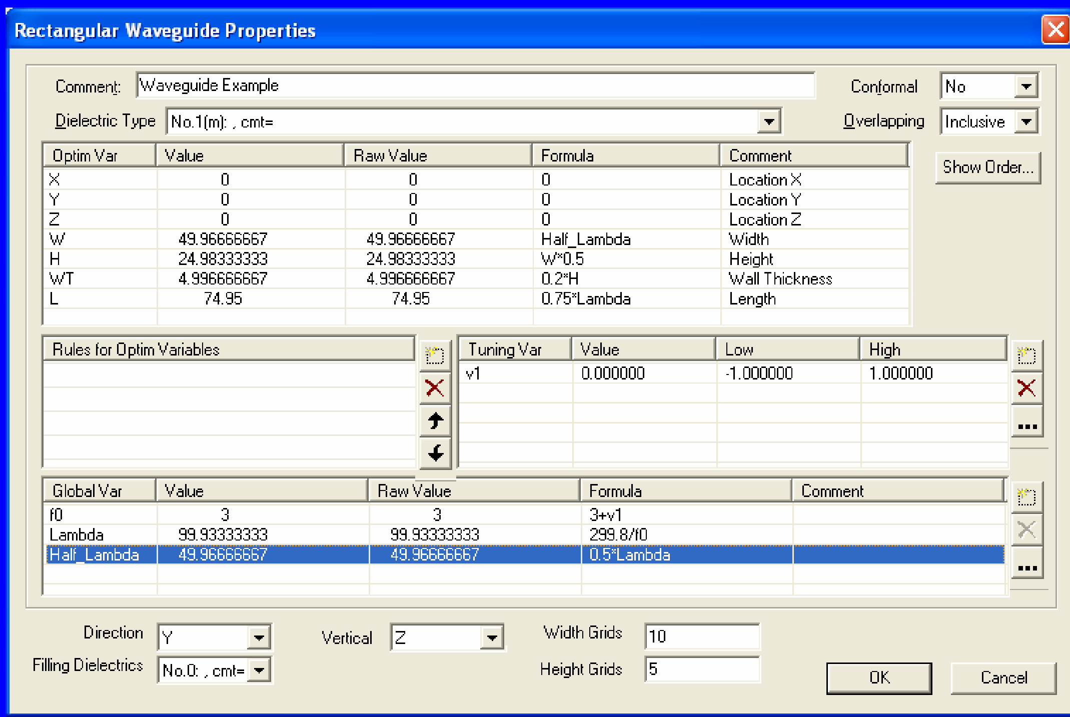
- A structure is described as a set of objects.
- Each object is described by actual geometry parameters independent of grids. Geometry dimensions can be edited anytime later.
- Automatic Boolean operations.
- Importing objects from ACIS.

Objects	Description	Comment
☑ Rectangular Cylinder	C=(5000, 0, 175), S=(10000, 10000, ...	Substrate
☑ TwoD Line	&Z: at 300, S=(0.,0.), E=(5000.,0.), W...	Printed Strip
☑ Rectangular Cylinder	C=(0, 0, 25), S=(50000, 10000, 50), (-...	Ground Plane
☑ Rectangular Cylinder	C=(7500, 0, 1050), S=(5000, 10000, ...	Outer Conductor
☑ Wire	R=1000, 2 Vertcies, D=3, O=Inc	Tube
☑ Wire	R=307, 2 Vertcies, D=1, O=Inc	Inner Conductor
☑ Rectangular Cylinder	C=(4750, 0, 750), S=(500, 400, 900), ...	Interconnect
☑ Microstrip Port	P(1), &X:, V&Z:, C=(2000,0,300), W=...	MS Port
☑ Coaxial Port	P(2), -&X:, C=(7000,0,1050), R1=307,...	Coax Port
☐ Blank		



Formula Based Geometry Modeling

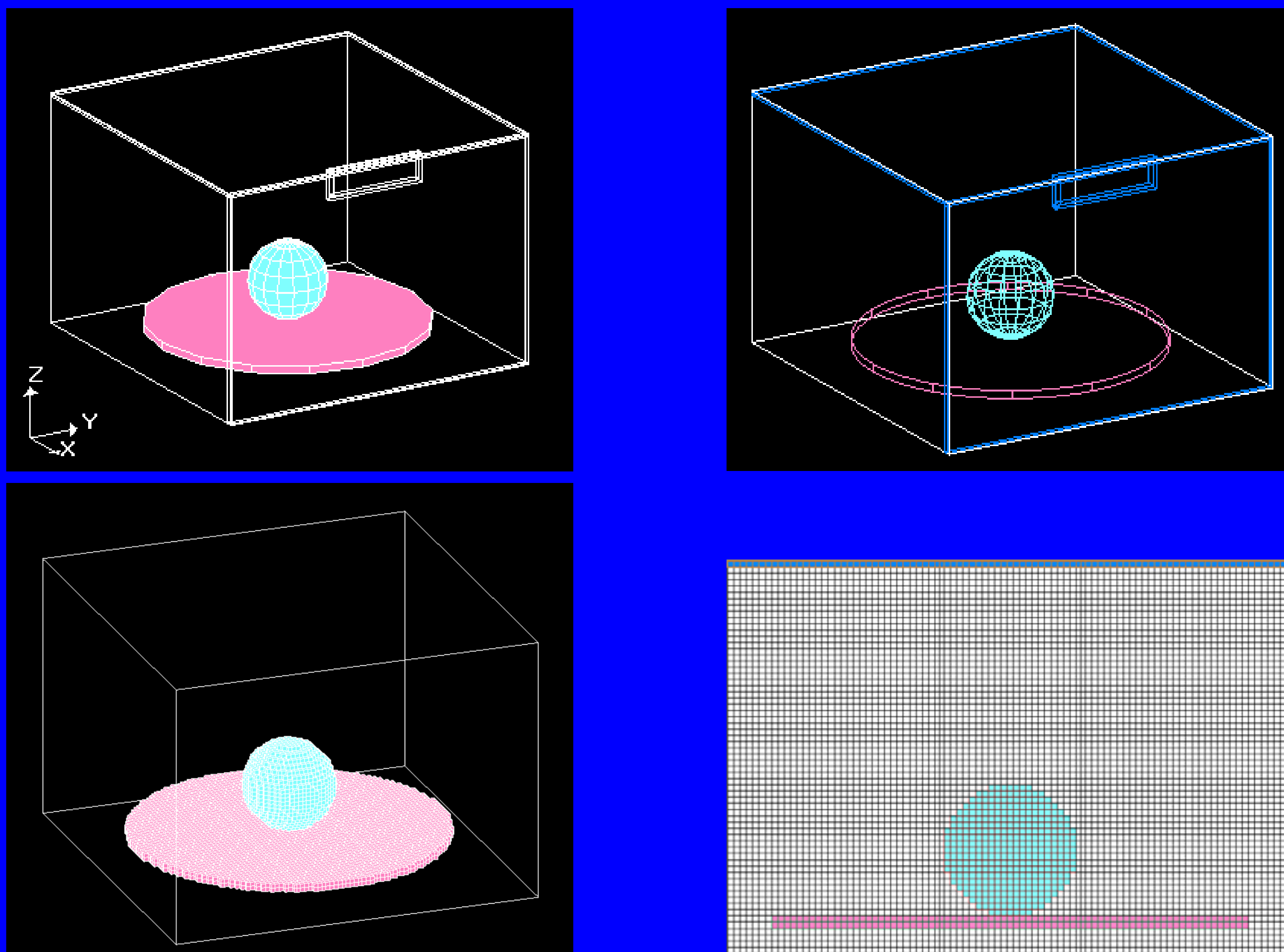
- Tuning of geometry made simple.



Each dimension of an object is a local variable. It can be a function of tuning variables, global variables shared by different objects, and local variables of the same object. You can apply rules to limit the range of a local variable and its relationship with other variables.

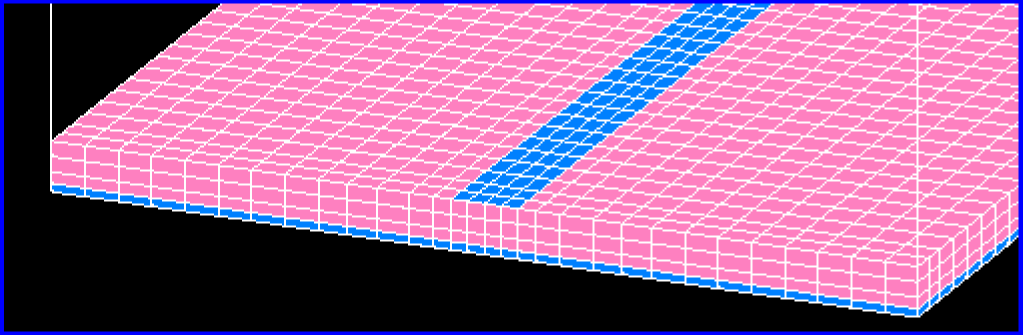
*Feature to be available in next version.

Multiple Visualization Views



Meshing Optimization

- No need to worry about the meshing at the time of geometry entry.
- The Meshing Optimizer automatically creates a gradually changing non-uniform grids to best fit the boundaries of objects.
- Critical grids can be controlled manually.

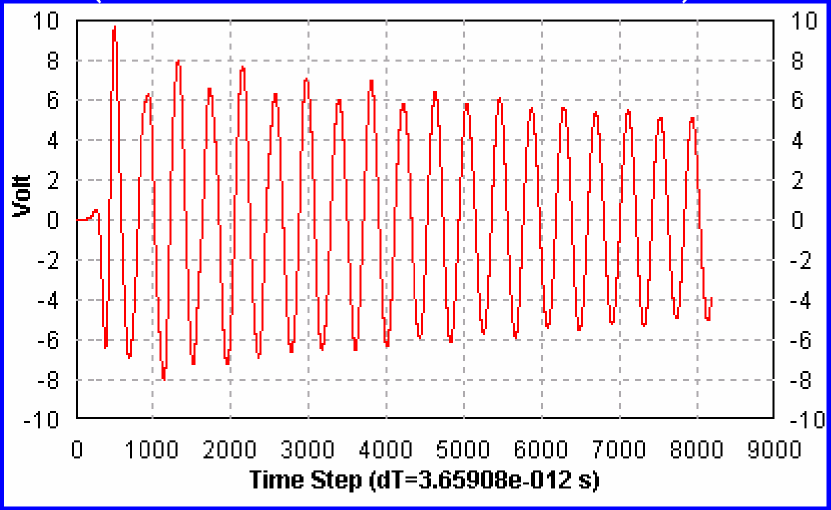


*Semi-automatic meshing optimization is available in current version and full optimization will be available in next version.

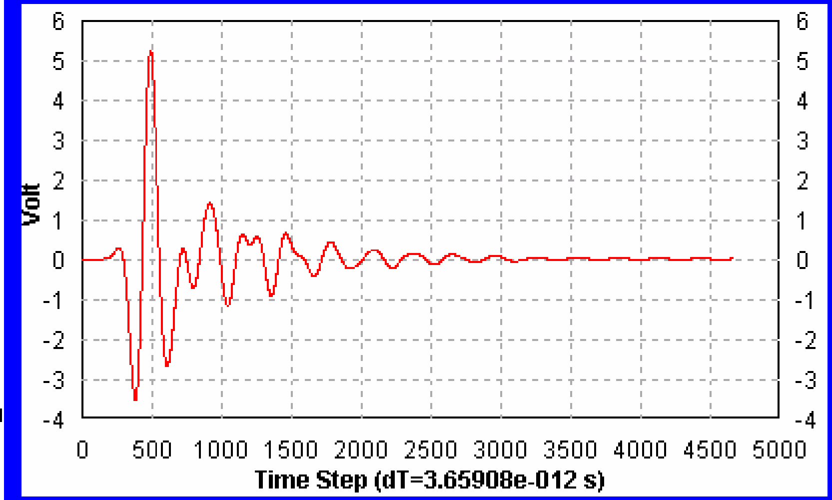
Time Signal Convergence Acceleration

- Localized ports are used to accelerate the time signal settling down. It yields results of same accuracy in much less time.

(without acceleration)

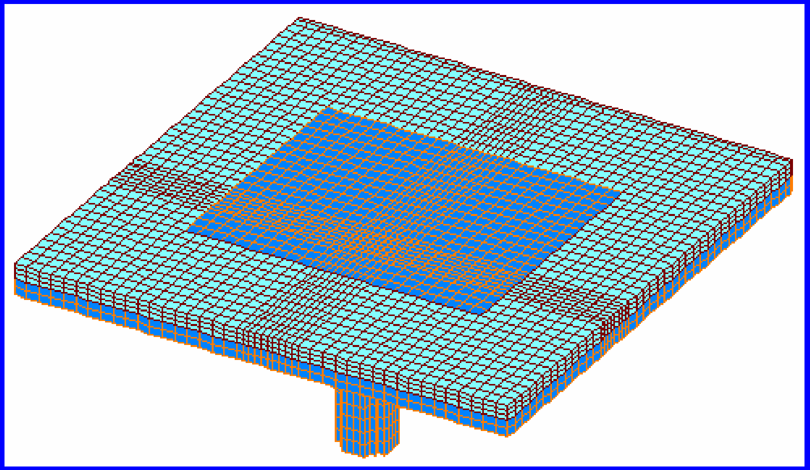


(with acceleration)



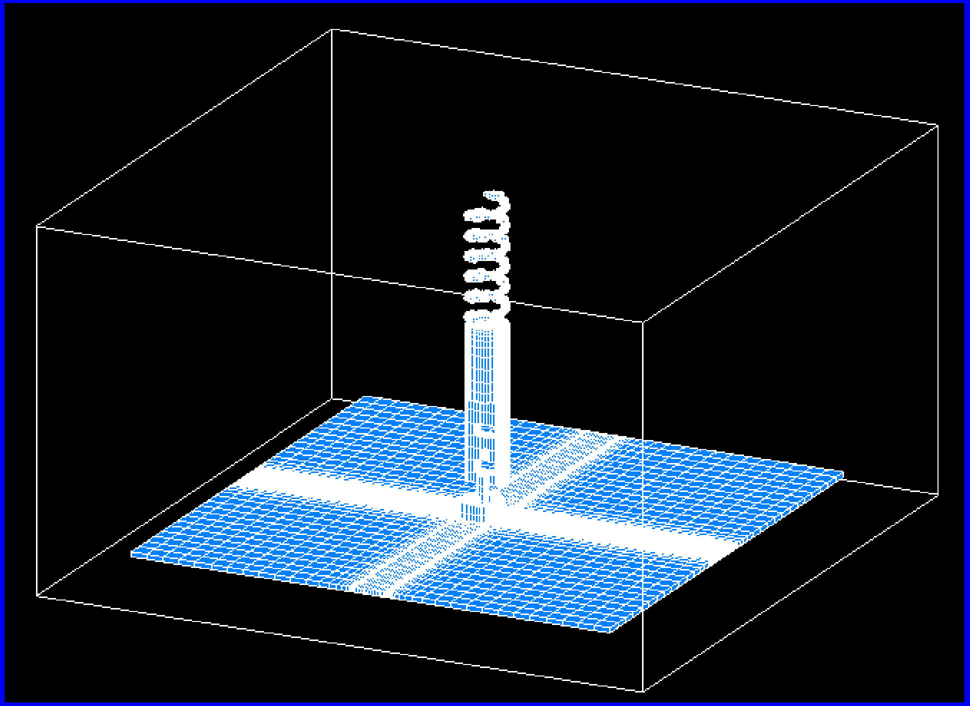
Absorbing Boundary Conditions & PML

- PML opens the door for FDTD to accurately simulate radiation problems (antennas and scattering)



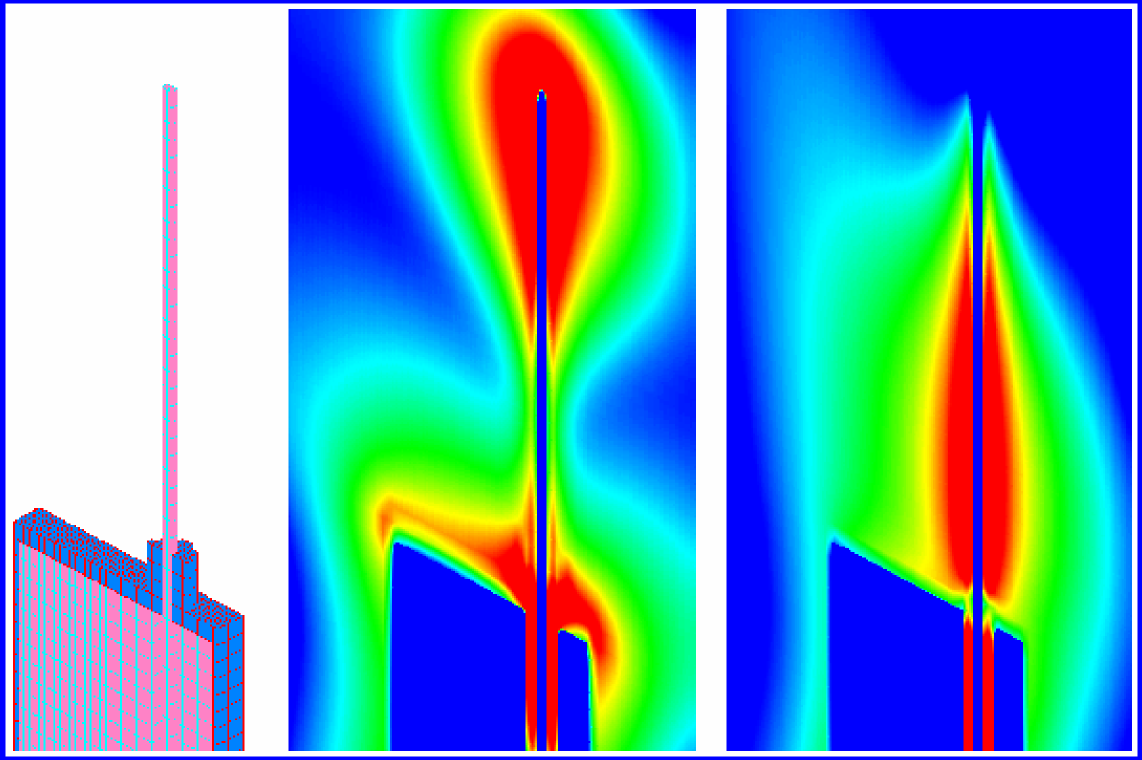
Multiple-Domain FDTD Engine

- Make it easy for efficient multiple CPU simulation.



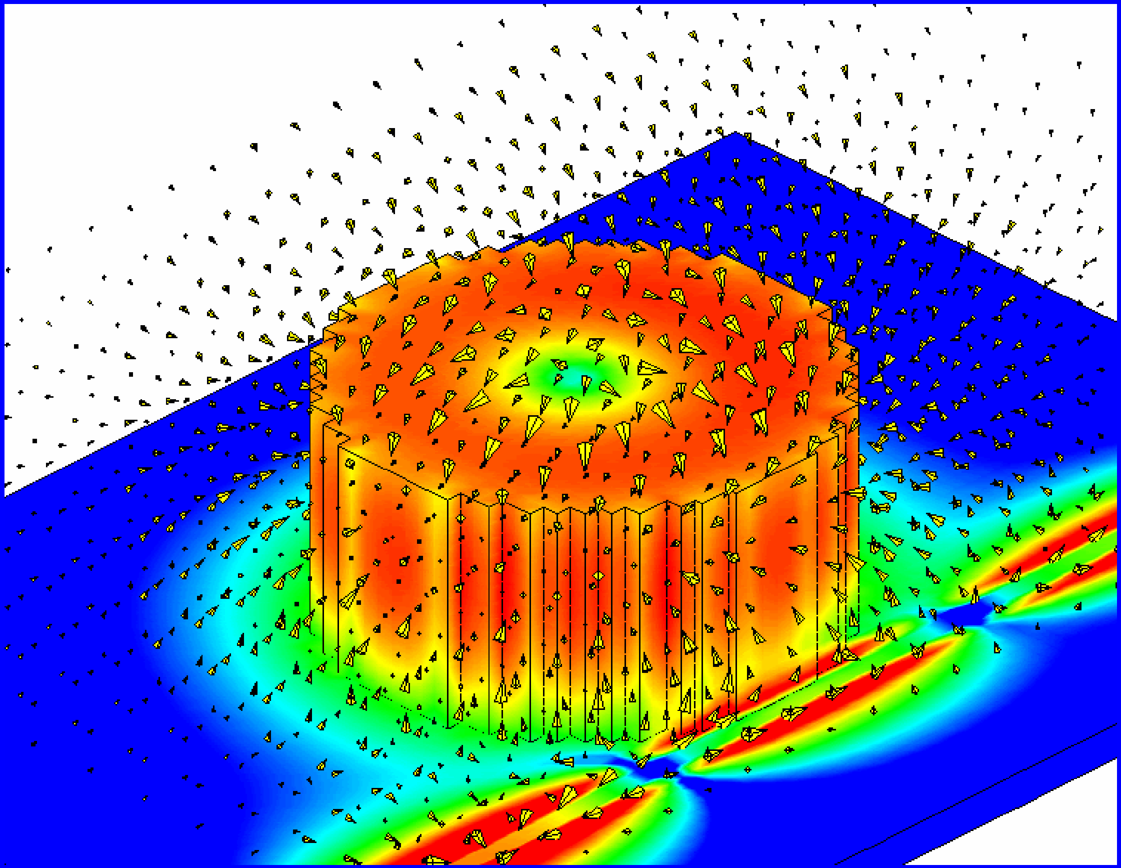
Near Field Visualization

- Near field distribution carries much information.
- FIDELITY allows near field display on each slice.



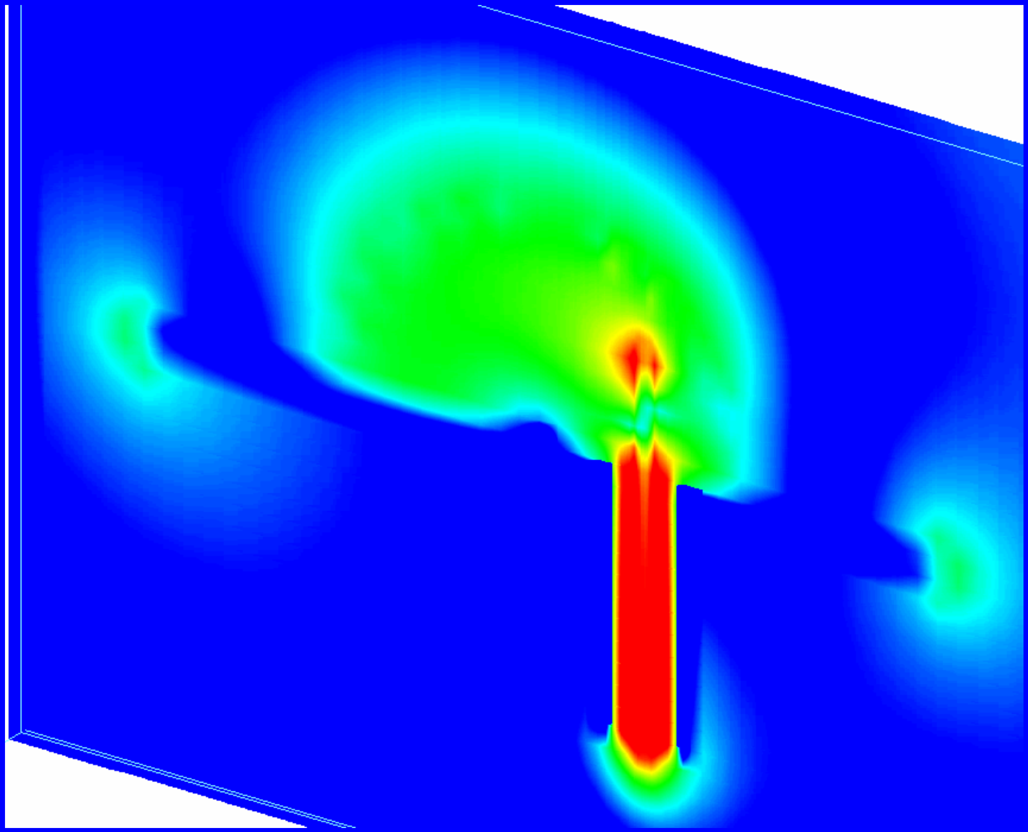
Poynting Vector Visualization

- E, H and Poynting vector display



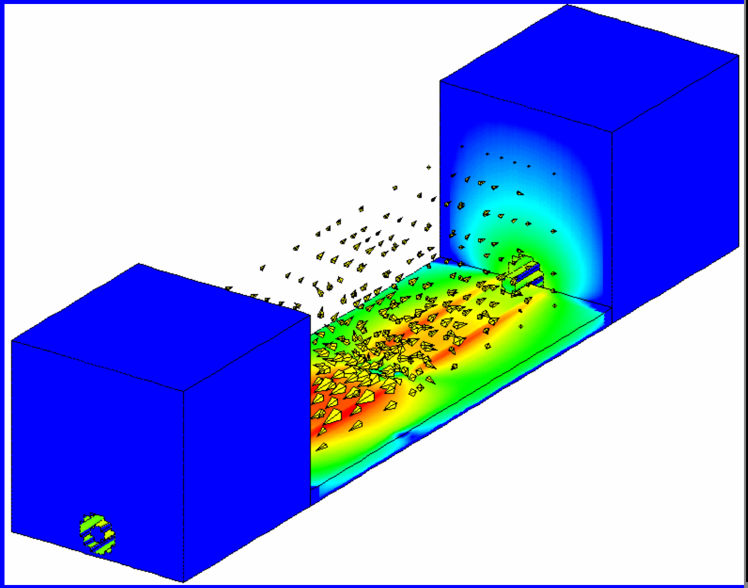
Field Animation

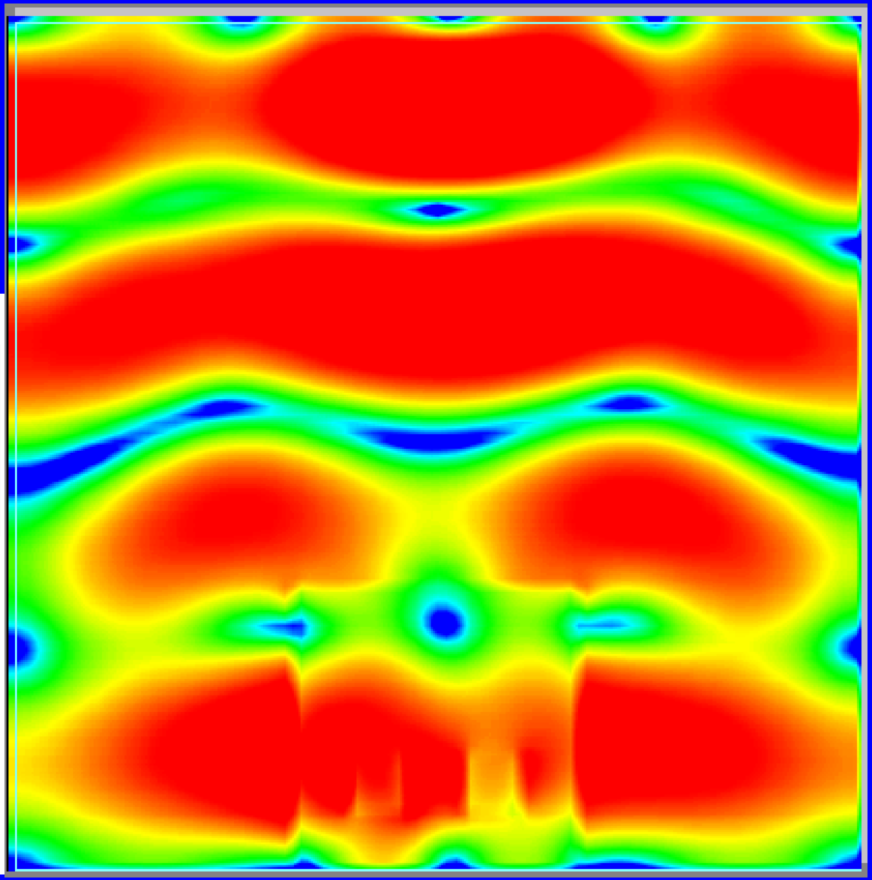
- Animation shows you how the power is distributing into your system. It will let you understand more what is going on inside your structure.



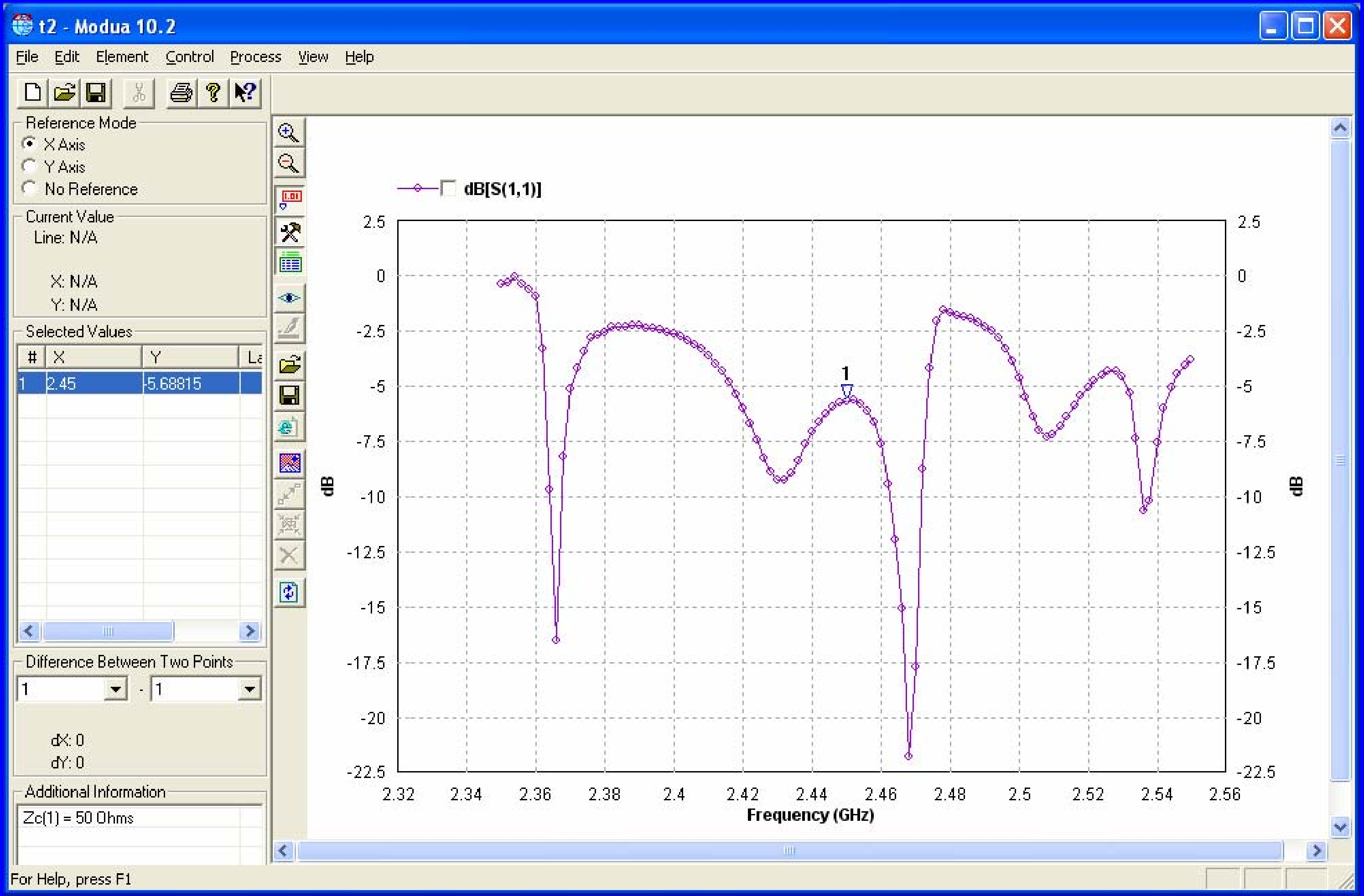
EMC & EMI

- Near field and far field evaluation and visualization



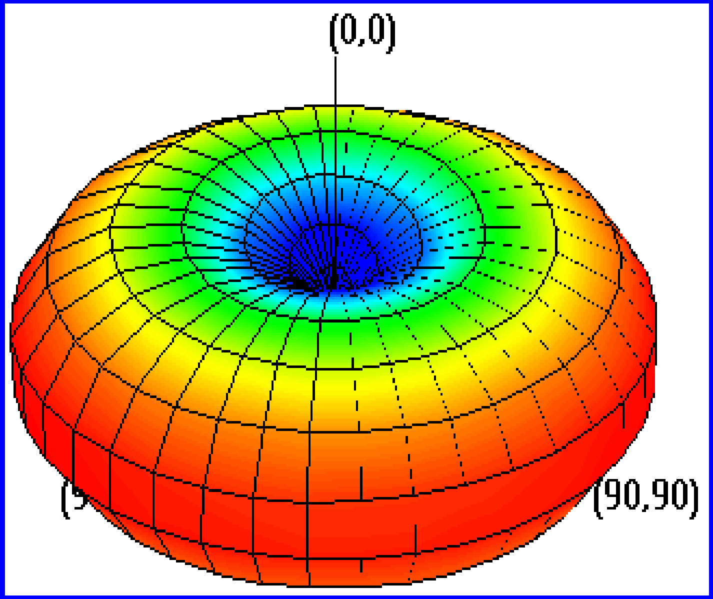


S-Parameter Display and Simulation



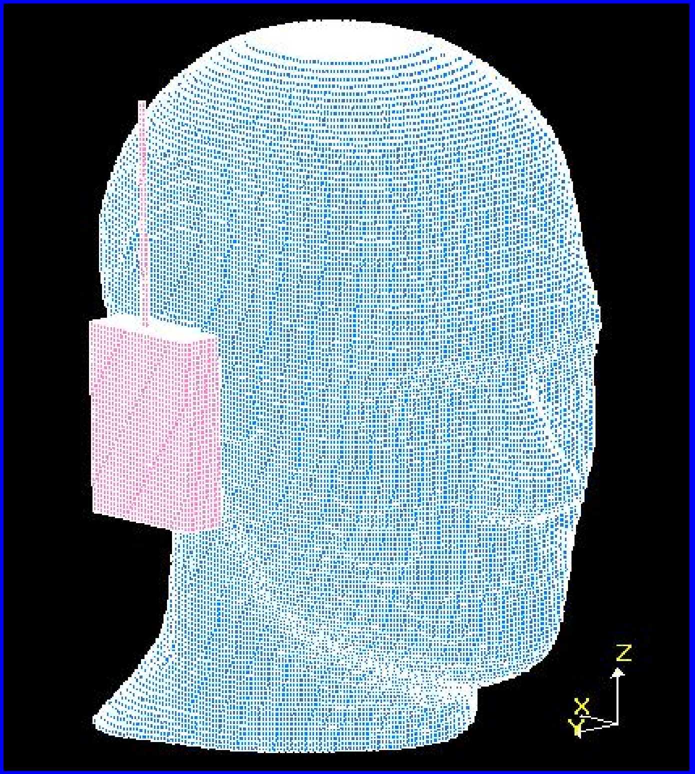
Radiation Patterns and RCS

- Radiation and RCS are very important for antenna designers.
- The bundled PATTERNVIEW allows users to display and process calculated radiation patterns.

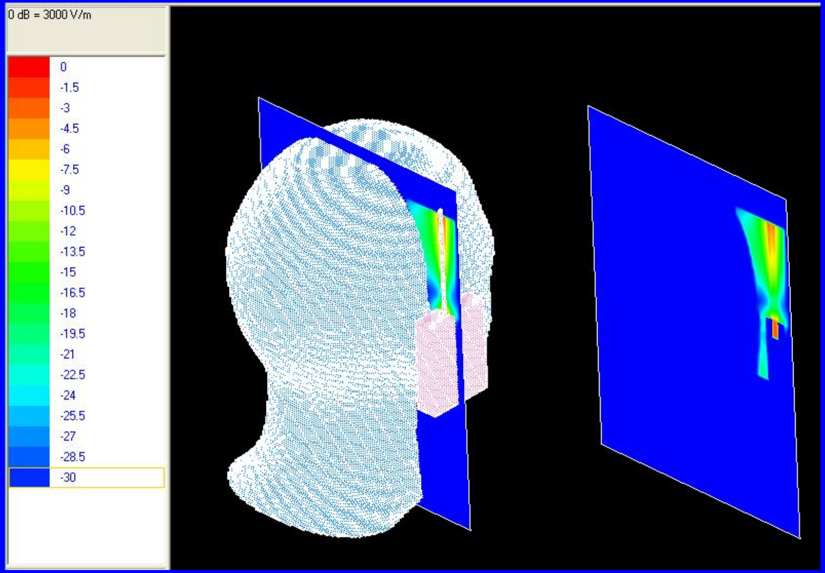


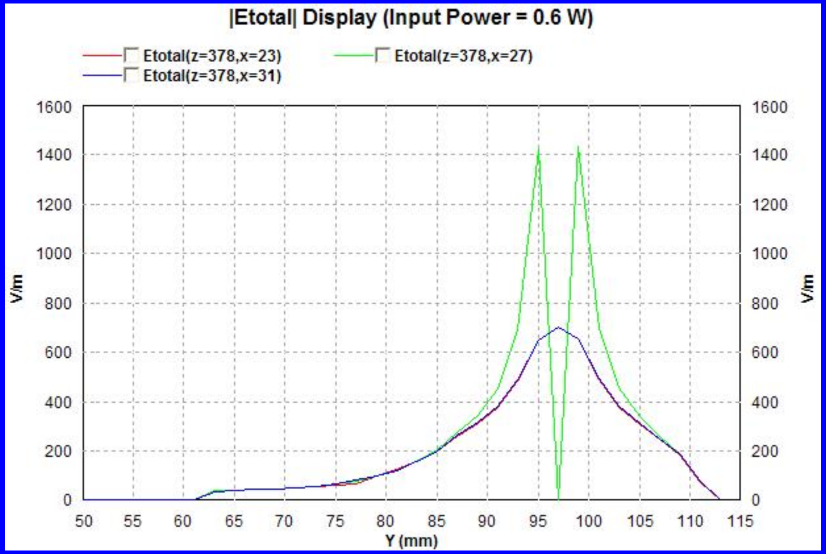
SAR Calculation and Display

- SAR (Specific Absorbing Rate) is the measure of EM effects to human body. It is very important for wireless applications and microwave power industry.
- FIDELITY offers 3D and Cartesian display of SAR, power and frequency domain near field visualization.



Frequency Domain Near Field Display

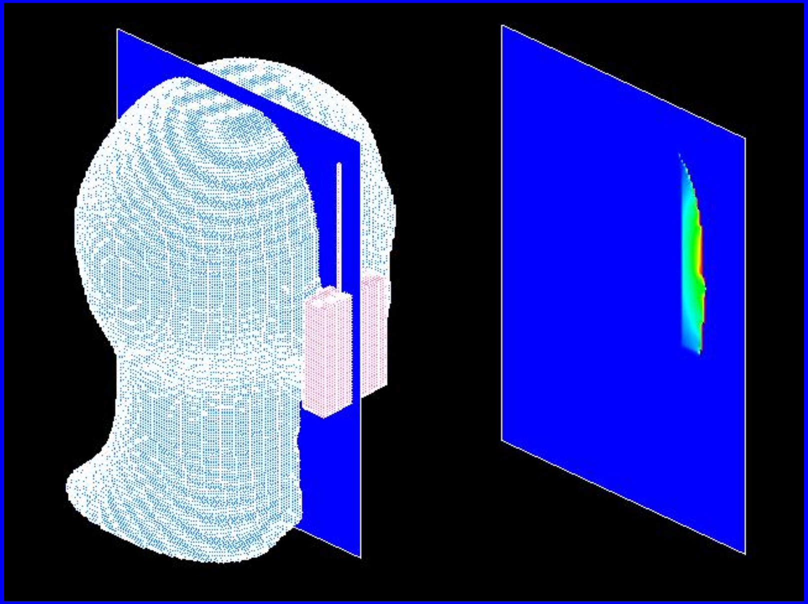




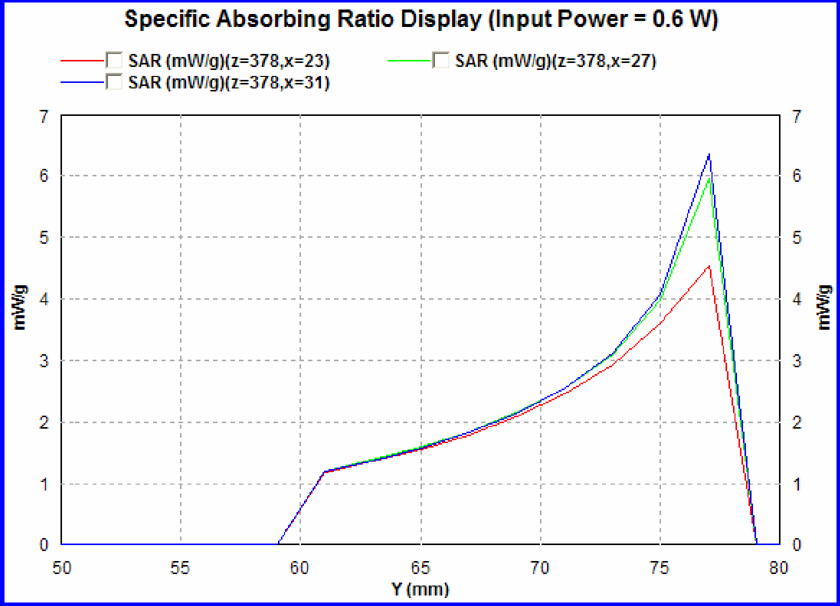
3D Near Field

2D Near Field

Display of SAR



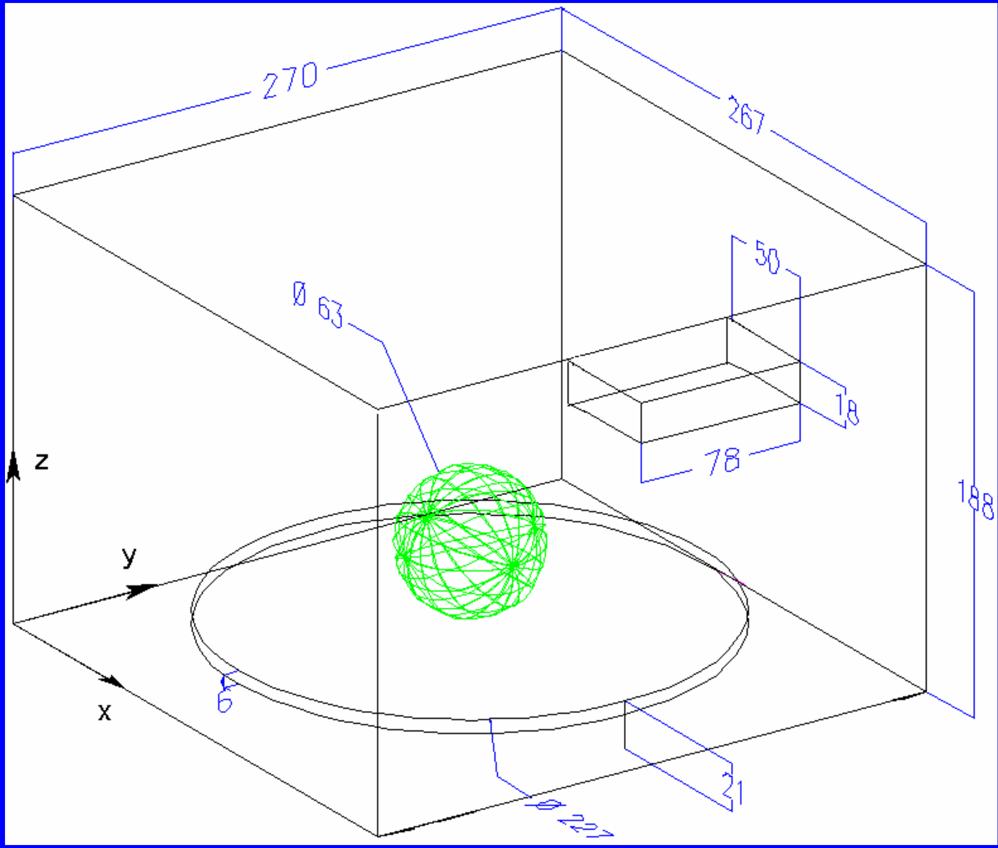
3D SAR Display



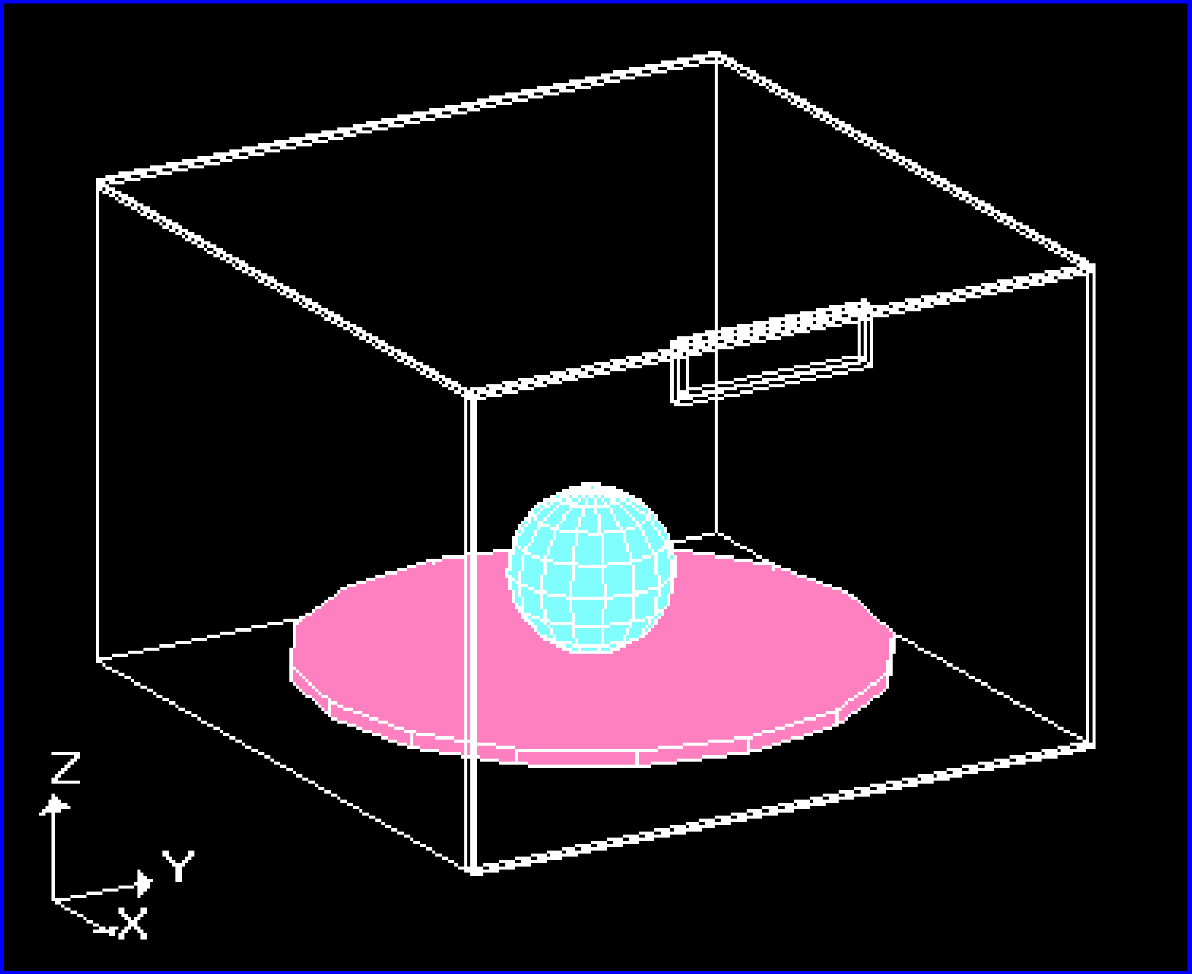
Cartesian Display

Simulation Example

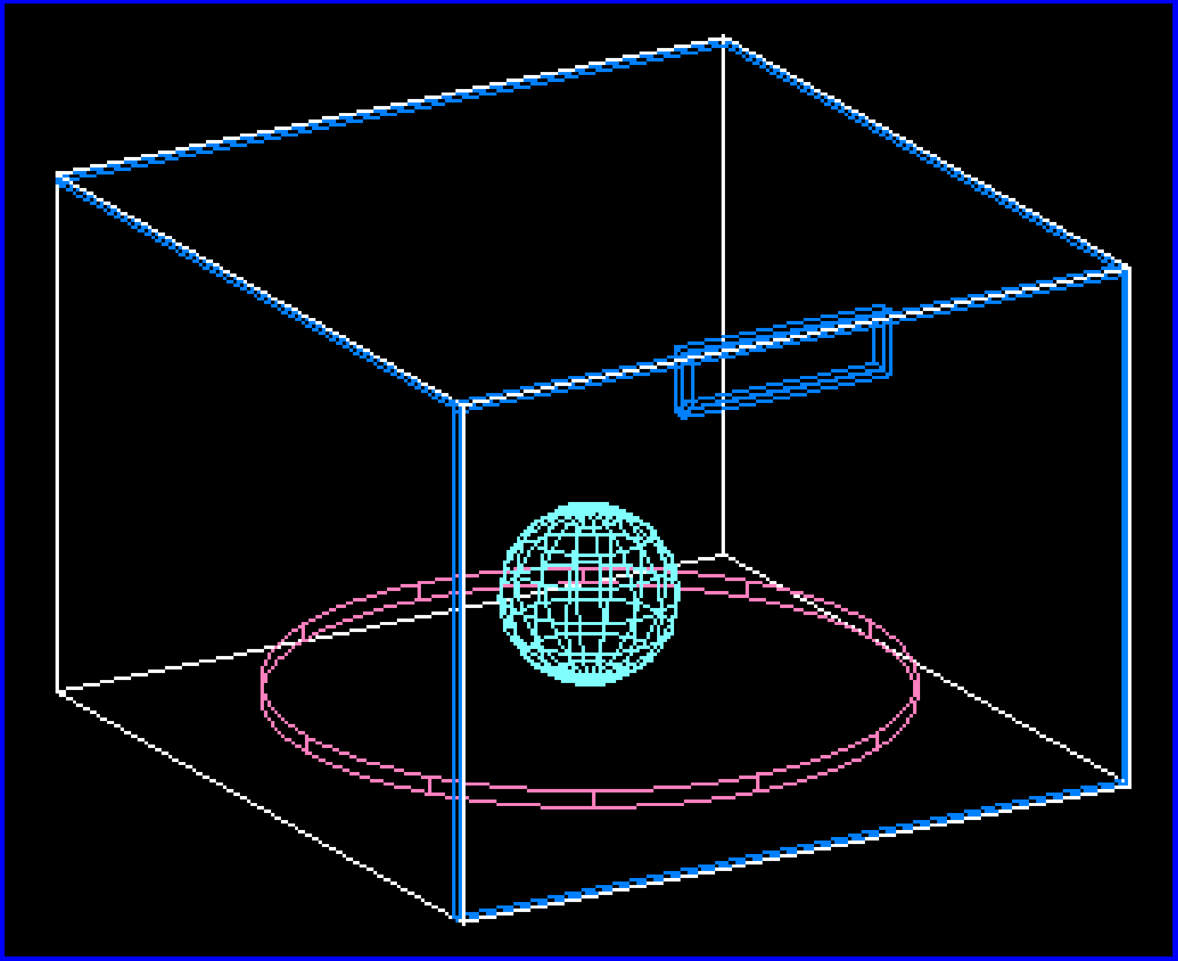
Electromagnetic processes in microwave oven: A potato modeled as a sphere of εr=65, σ=2.726 s/m. Cylindrical shelf with εr=2.55.



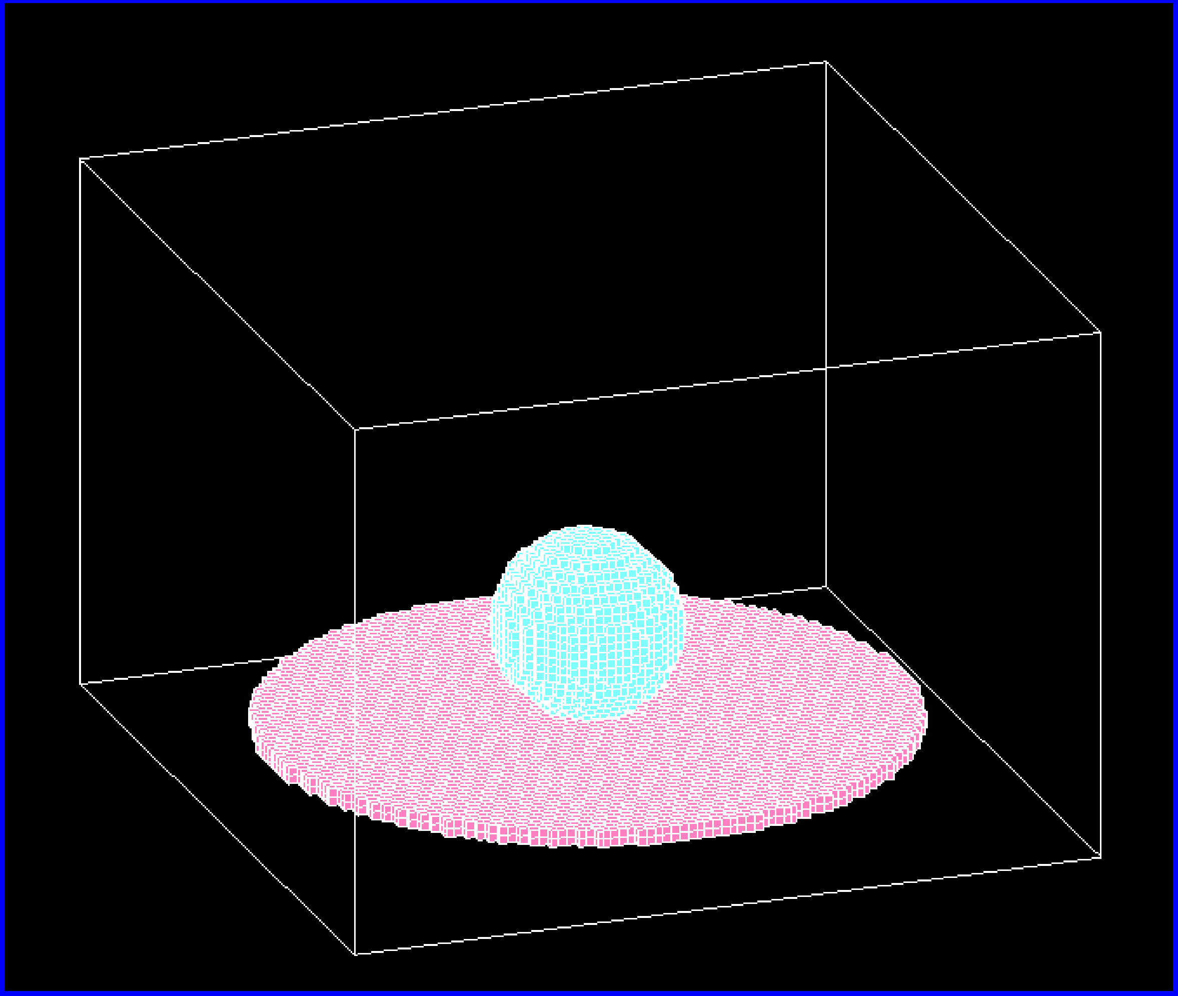
3D Detail View on FIDELITY



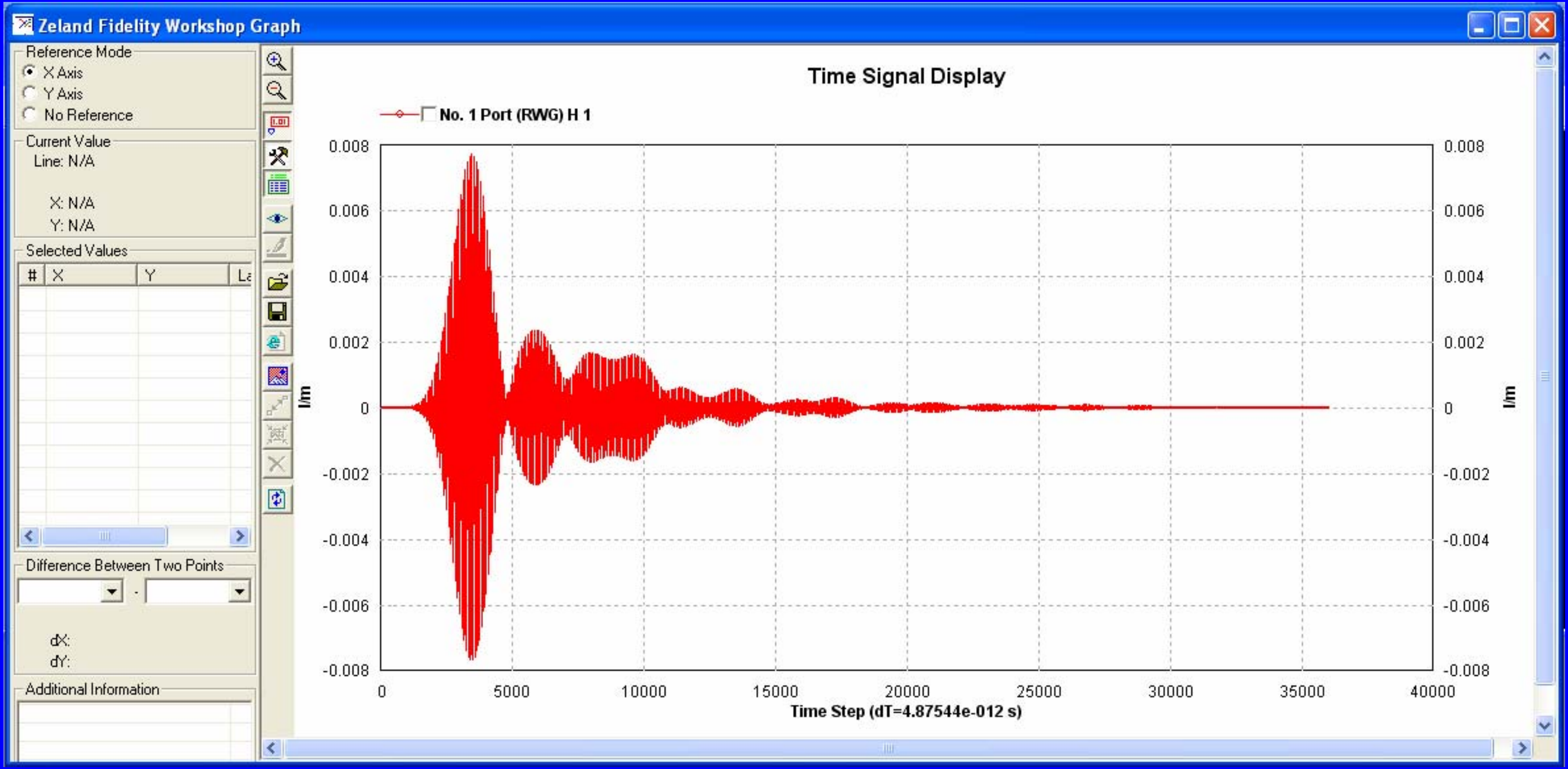
3D Wire Frame Display



3D Meshed View on FIDELITY

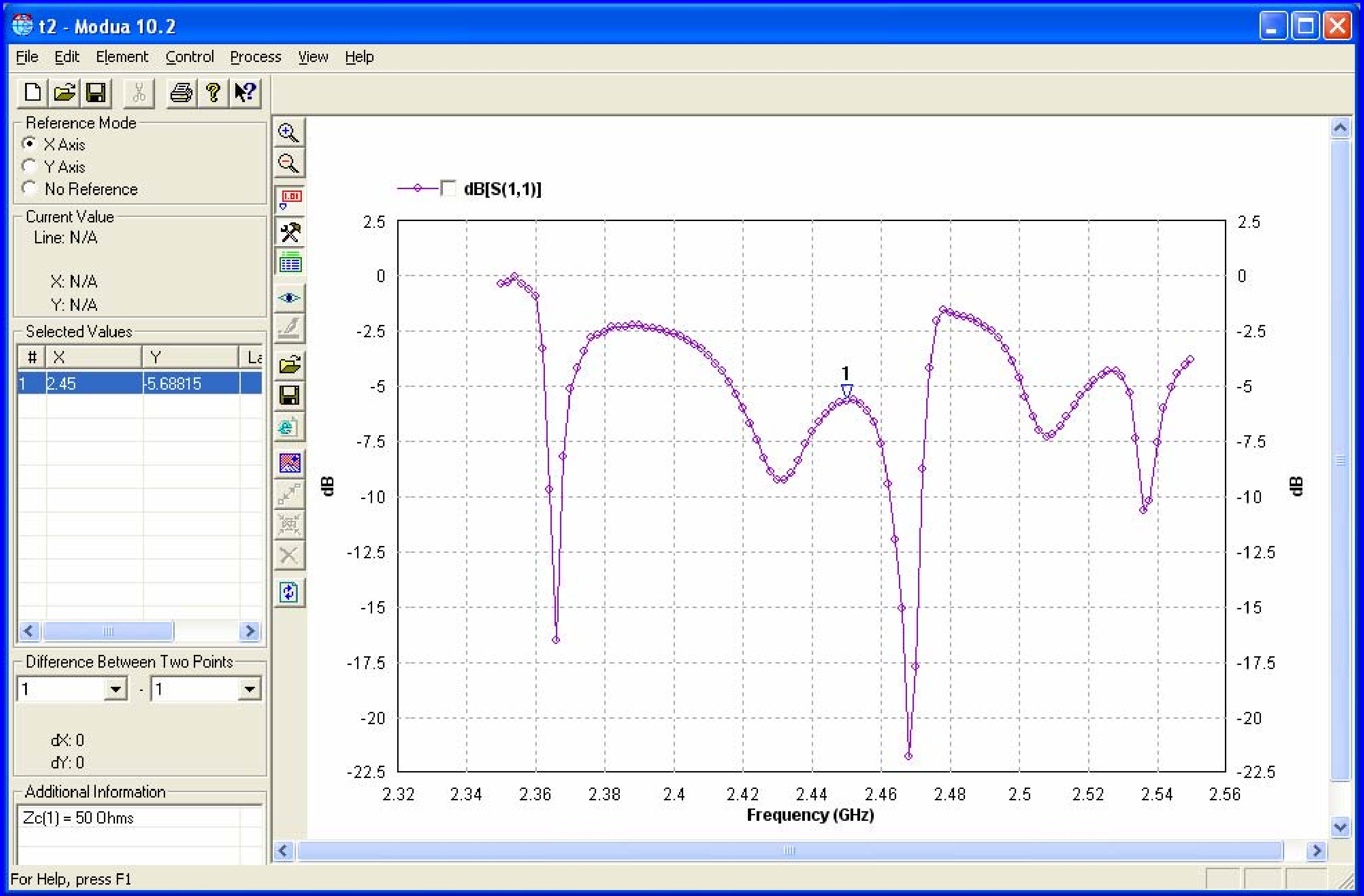


Time-Signal Display

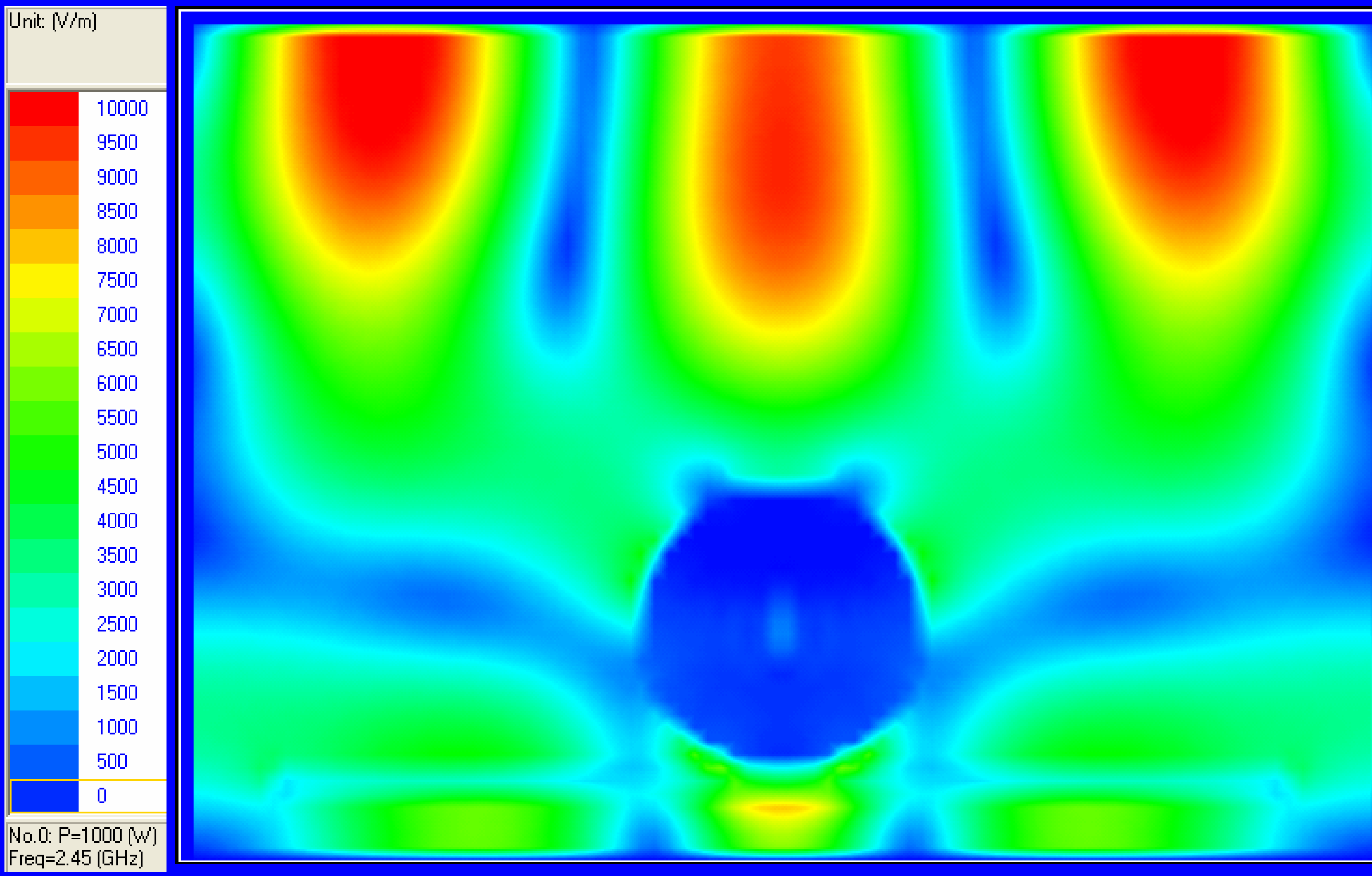


Input waveform: sine modulated with Gaussian

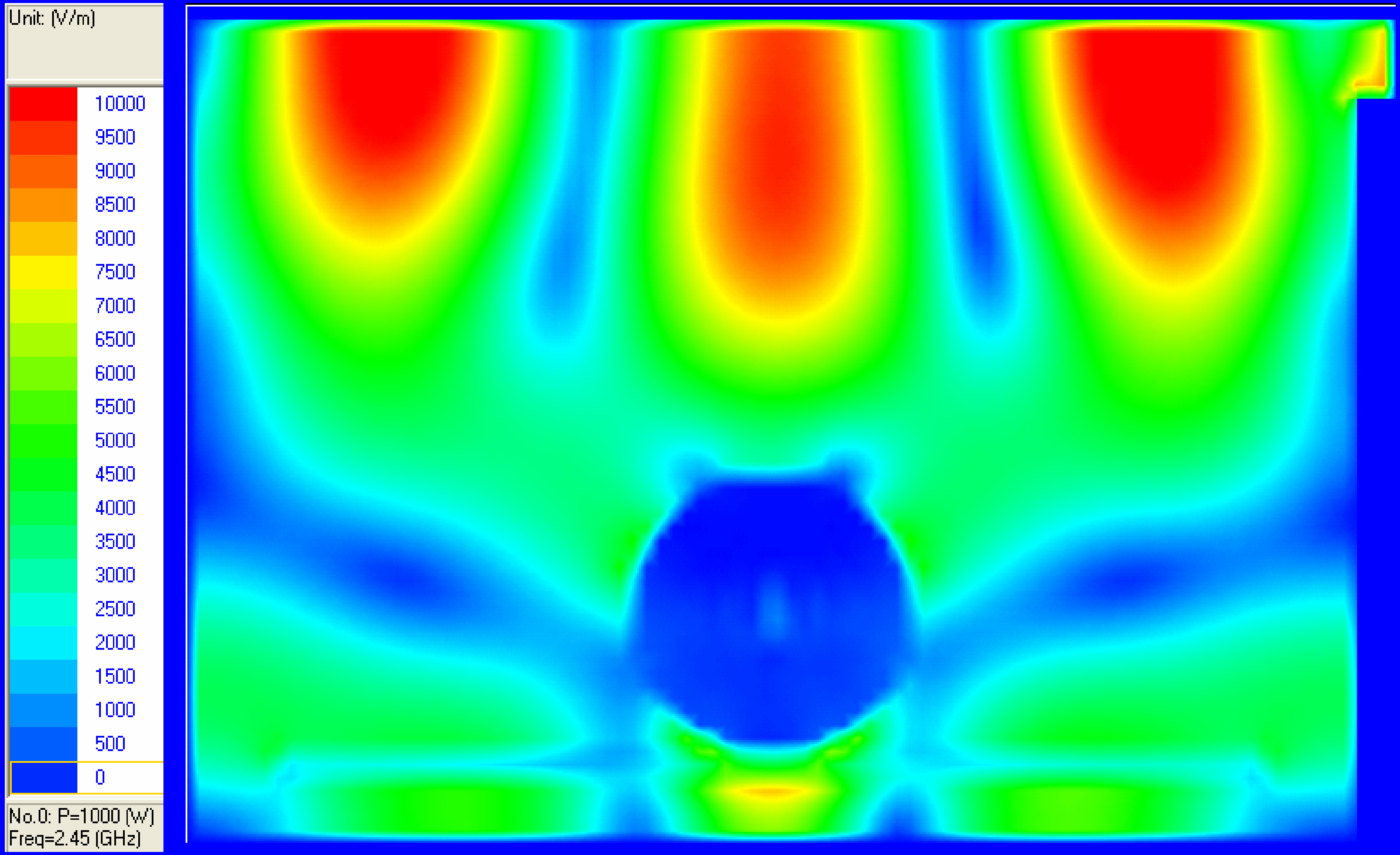
S-Parameters vs. Frequency



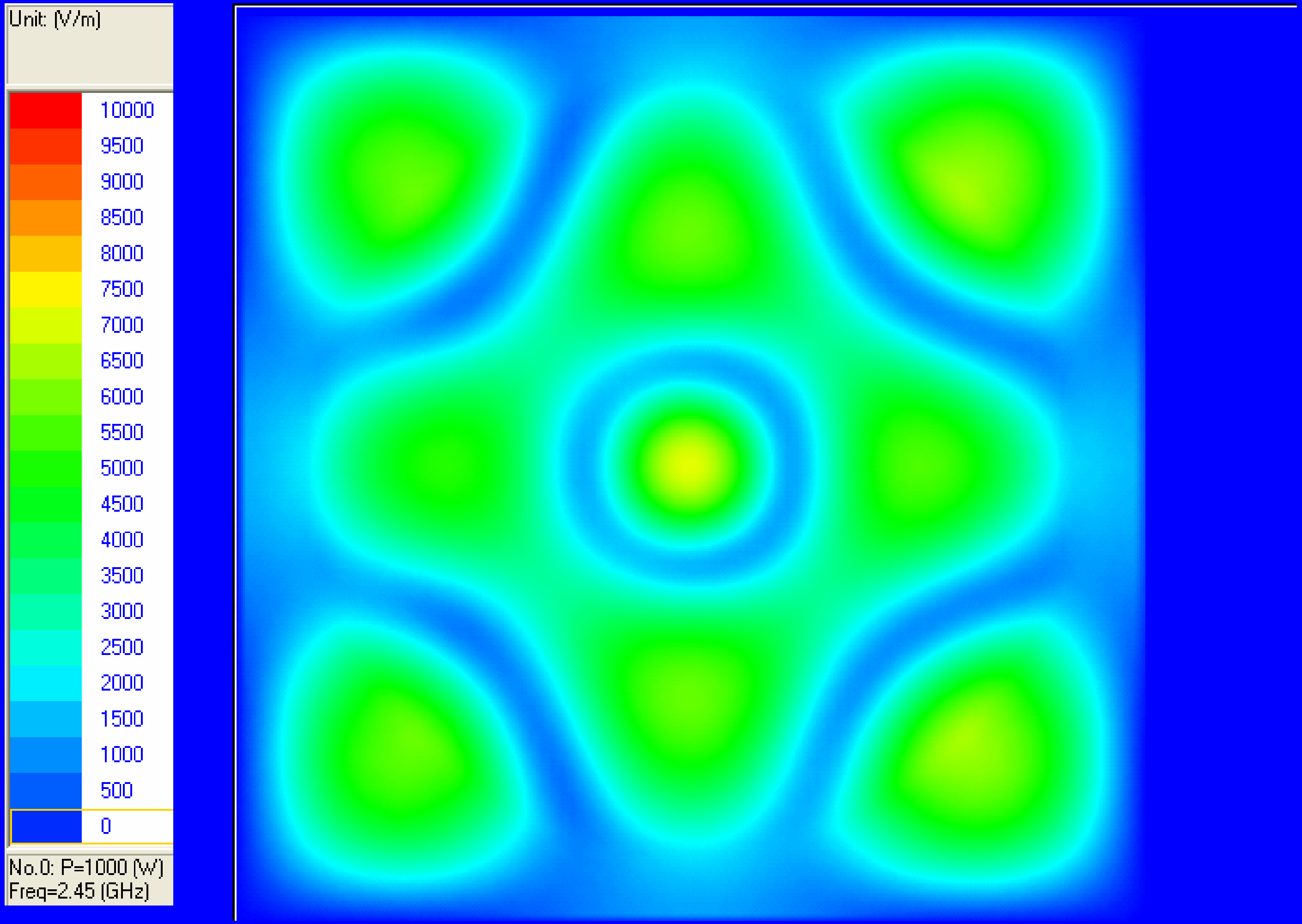
Total E-Field on X Center Cut



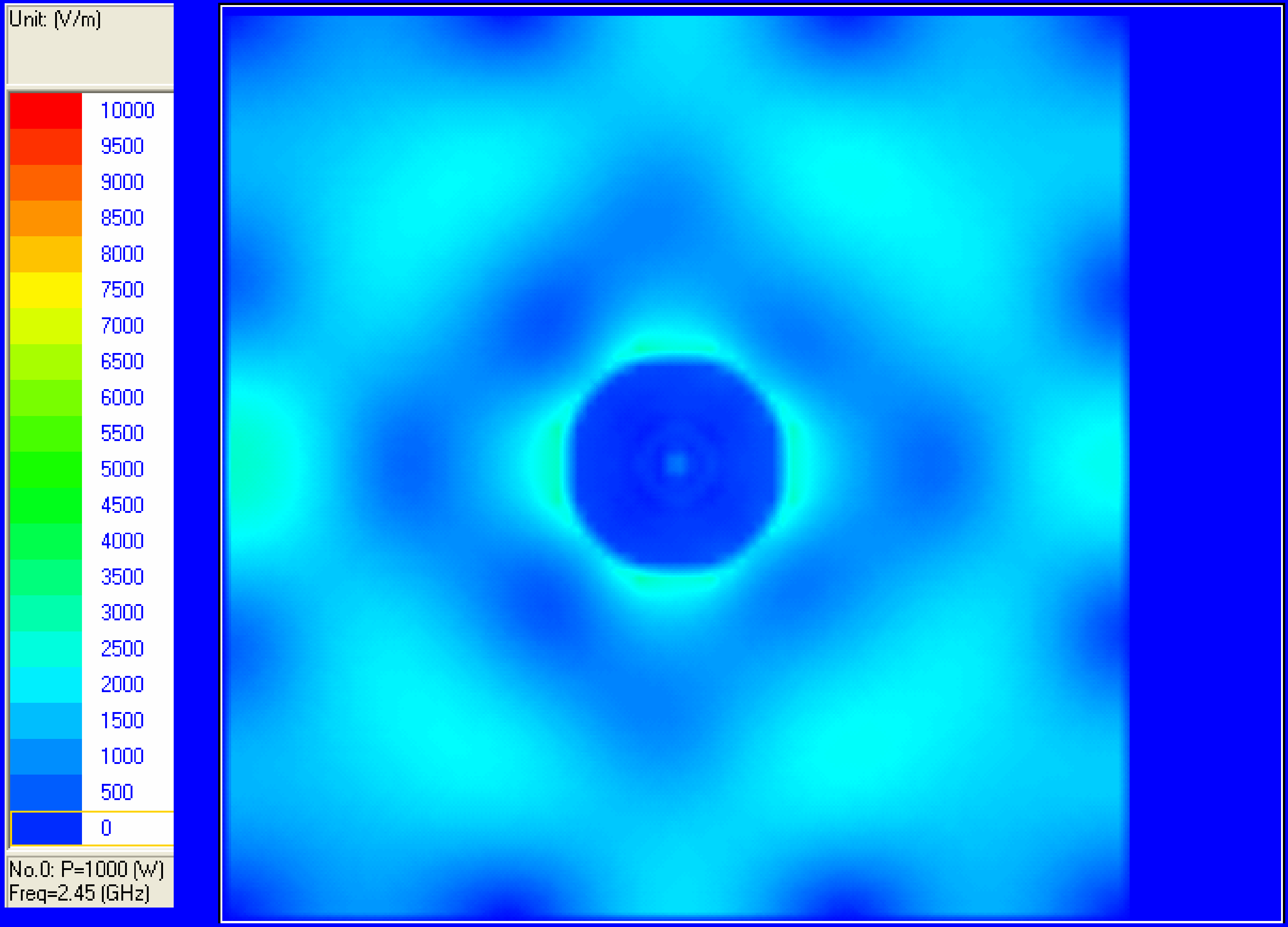
Total E-Field on Y Center Cut



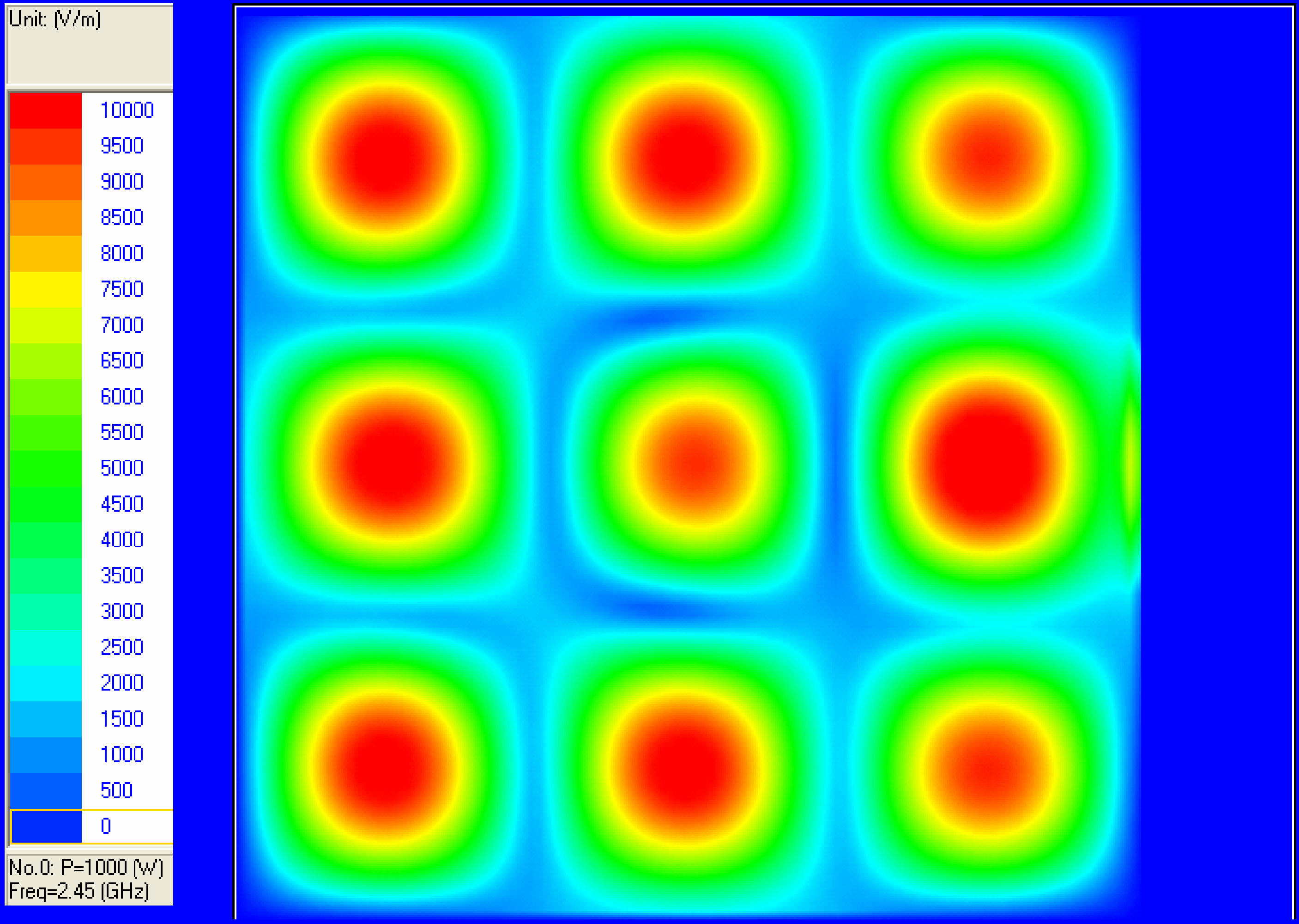
Total E-Field on Z = 9 mm Cut



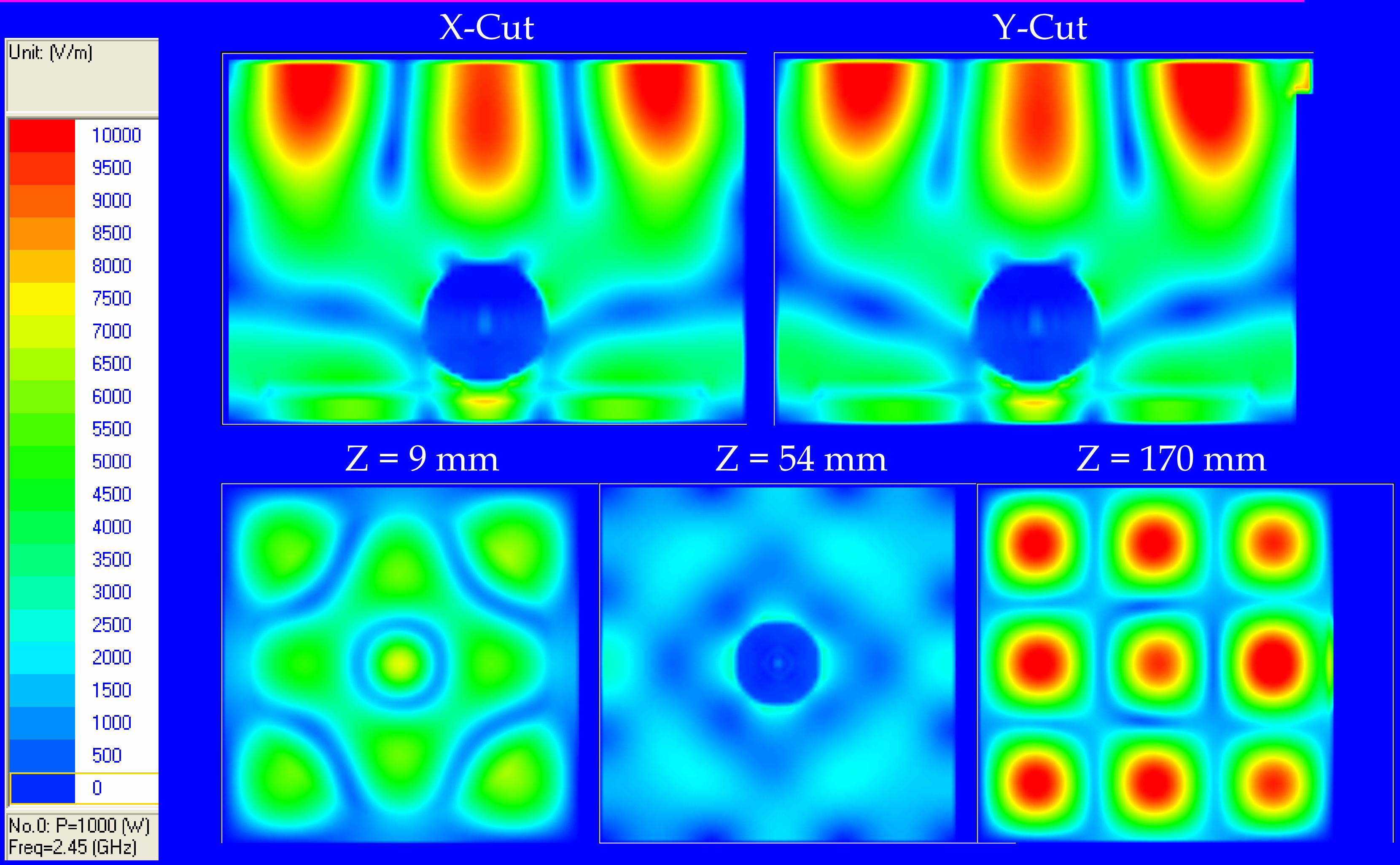
Total E-Field on Z = 54 mm Cut



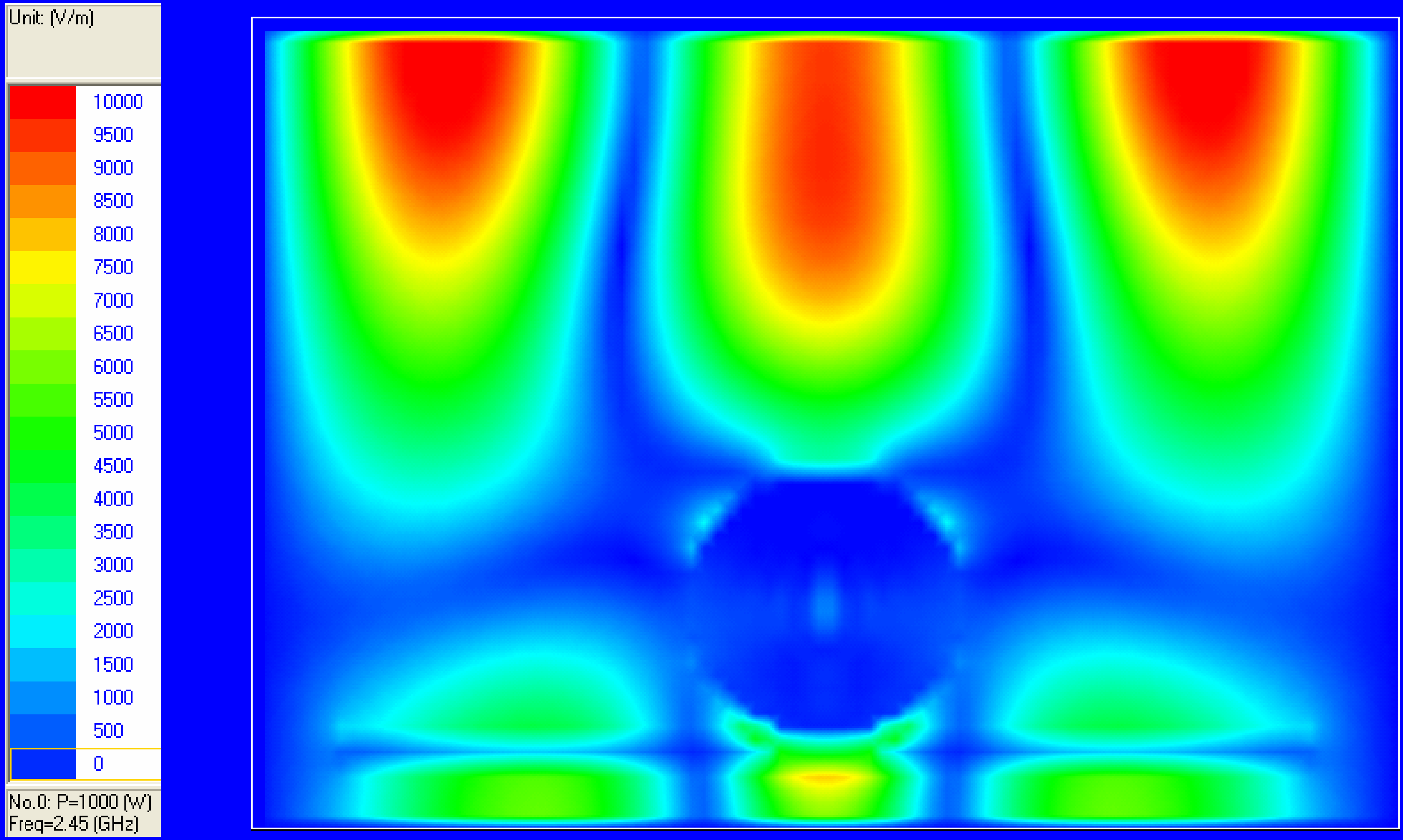
Total E-Field on Z = 170 mm Cut



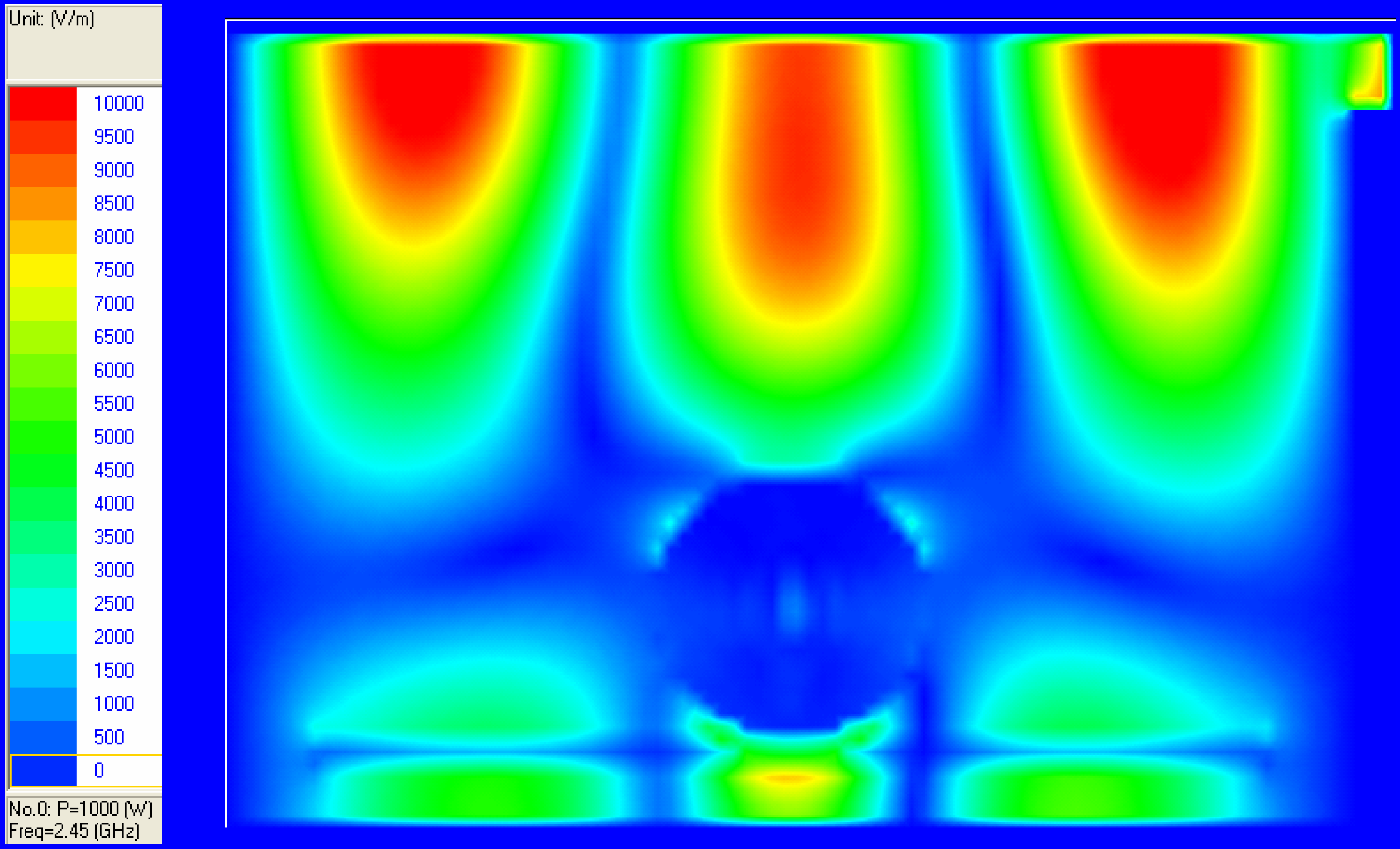
Total E-Field on Different Cuts



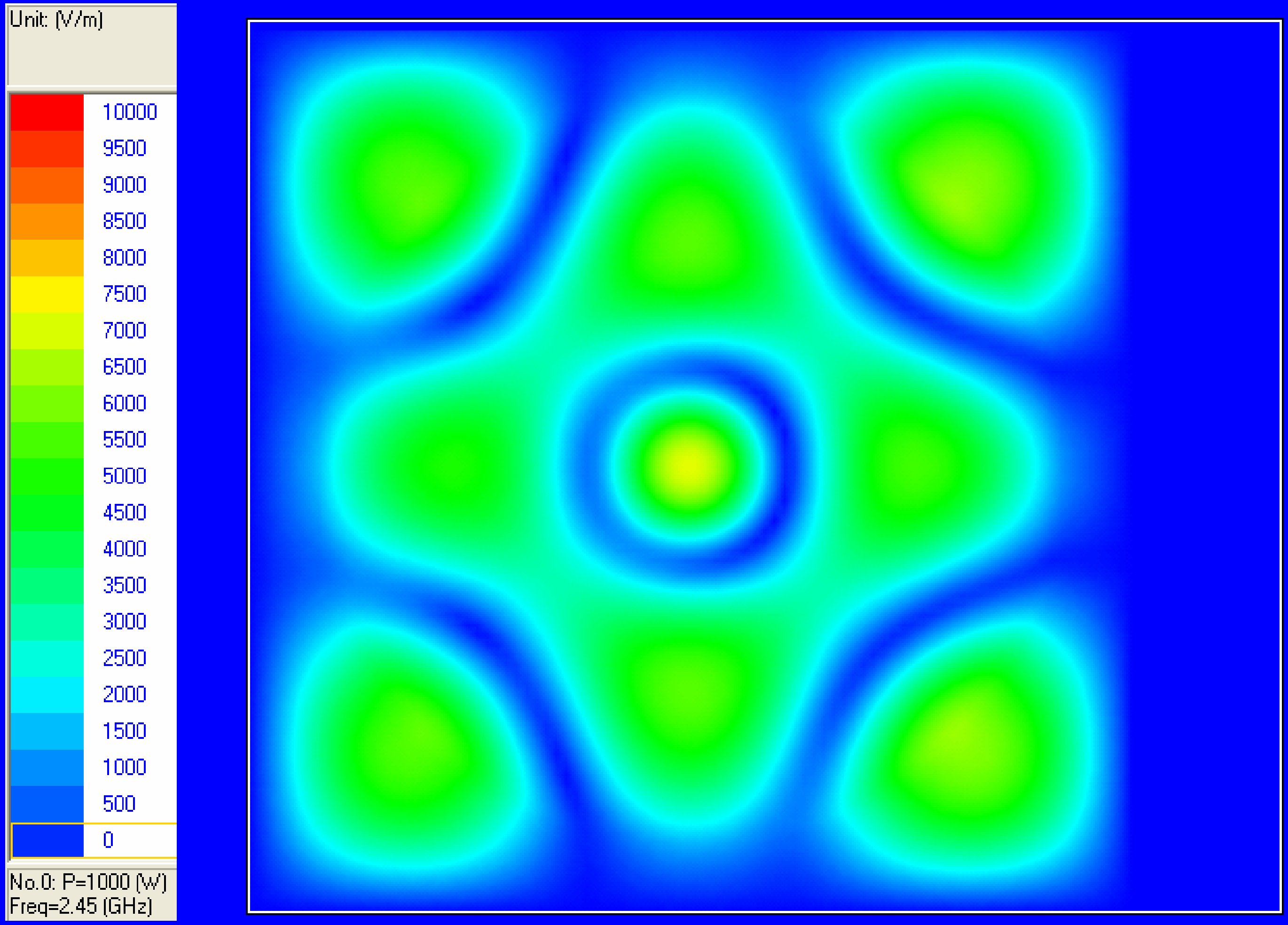
Ez-Field on X Center Cut



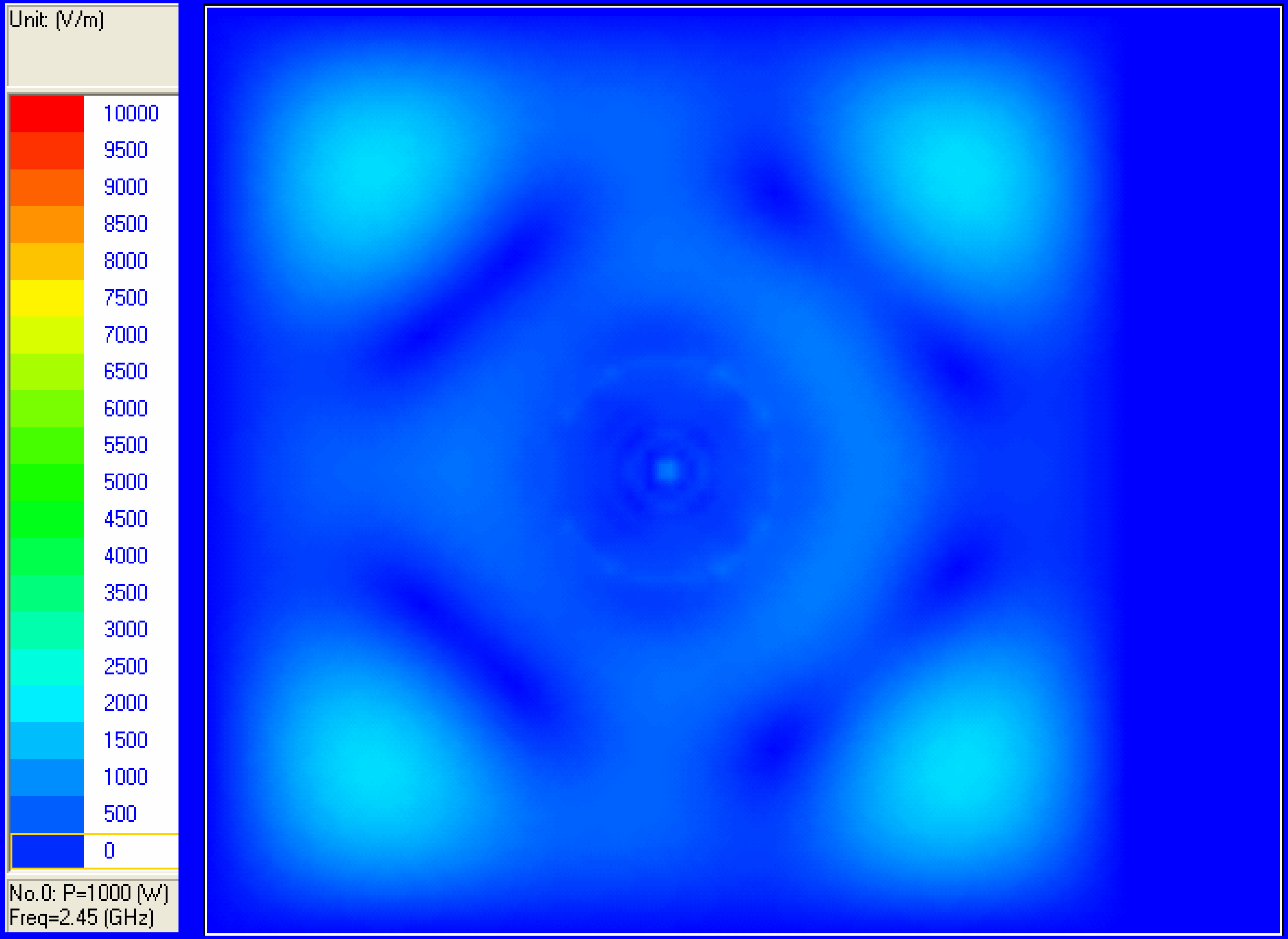
Ez-Field on Y Center Cut



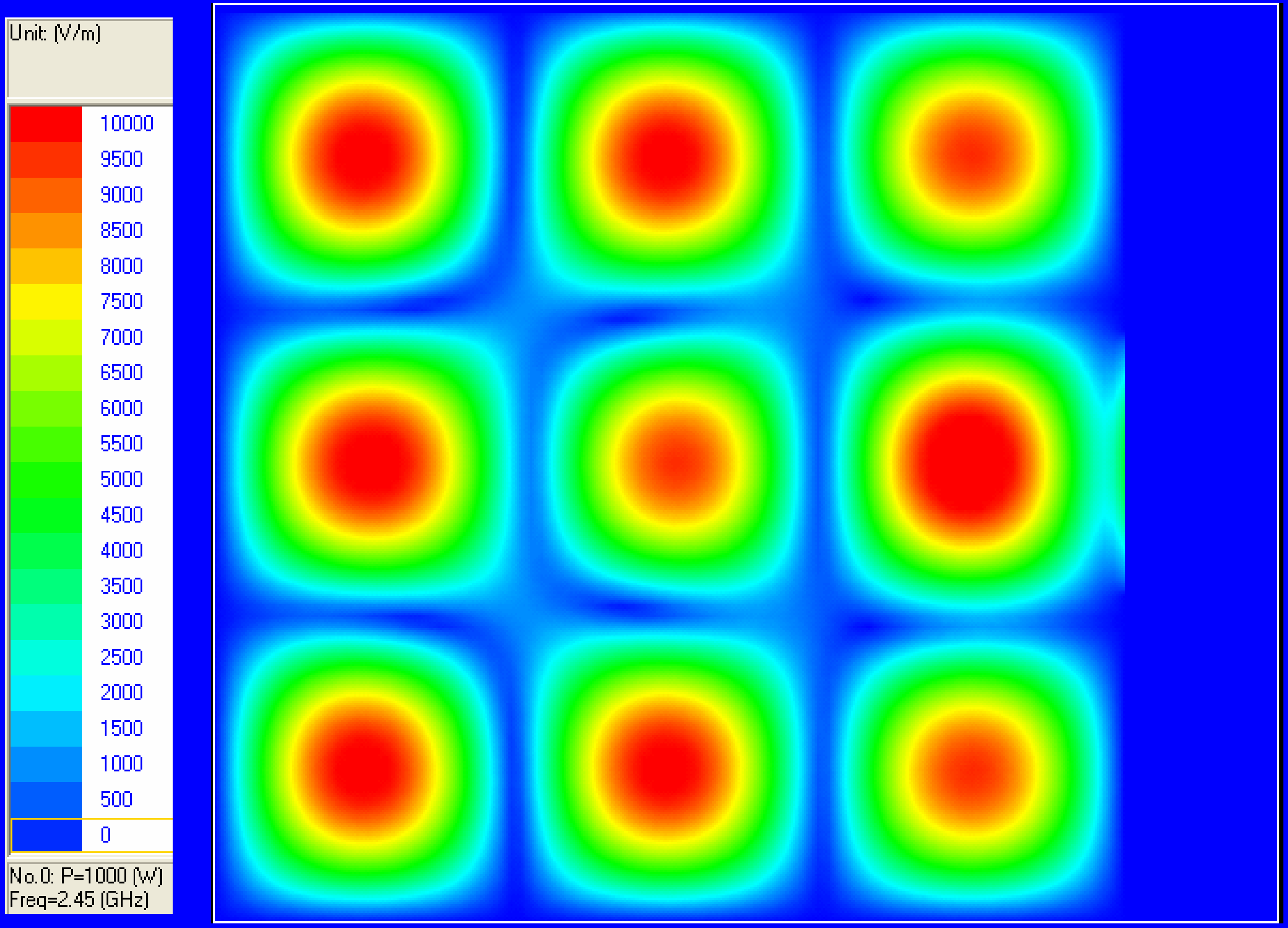
Ez-Field on Z = 9 mm Cut



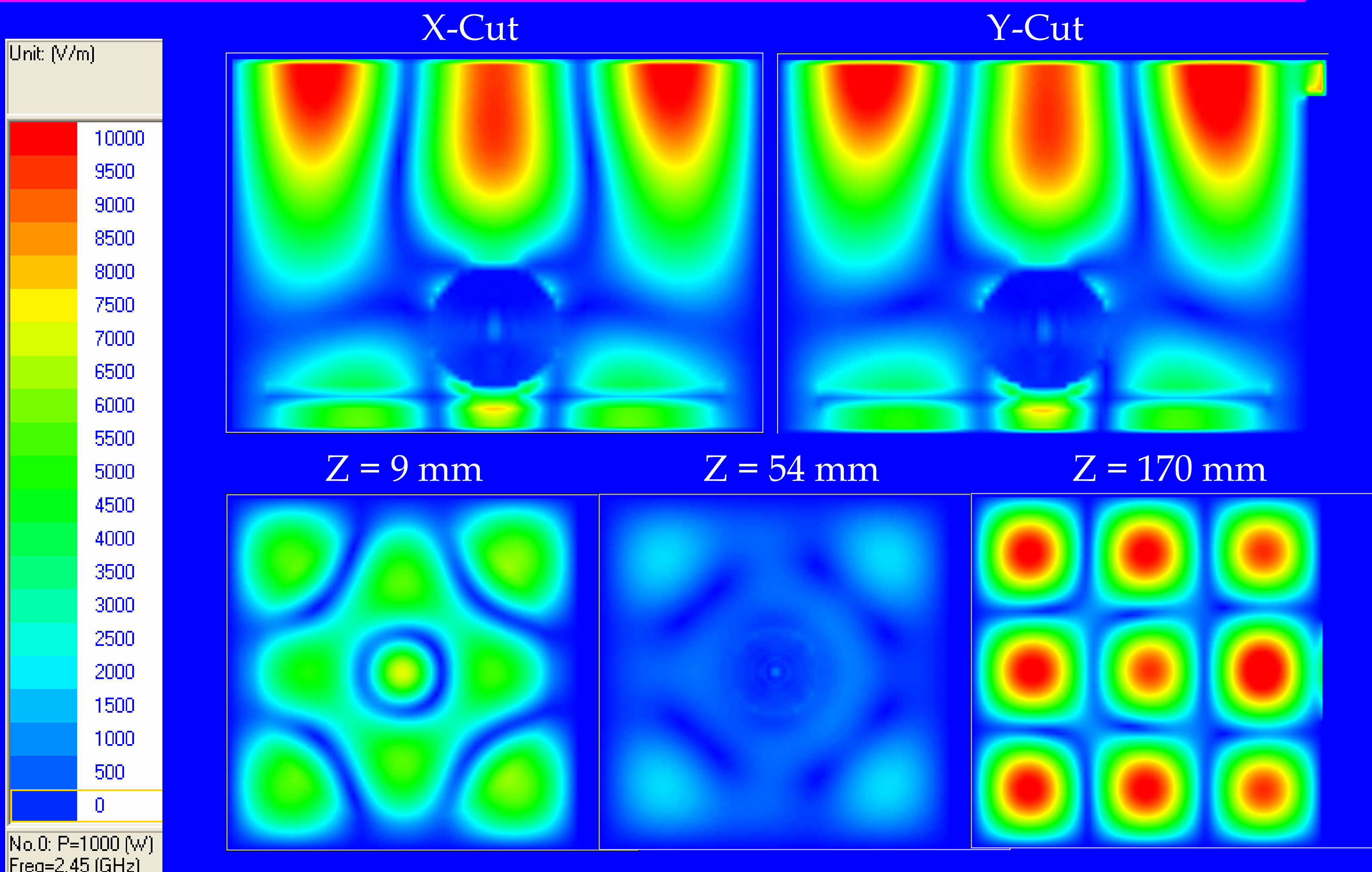
Ez-Field on Z = 54 mm Cut



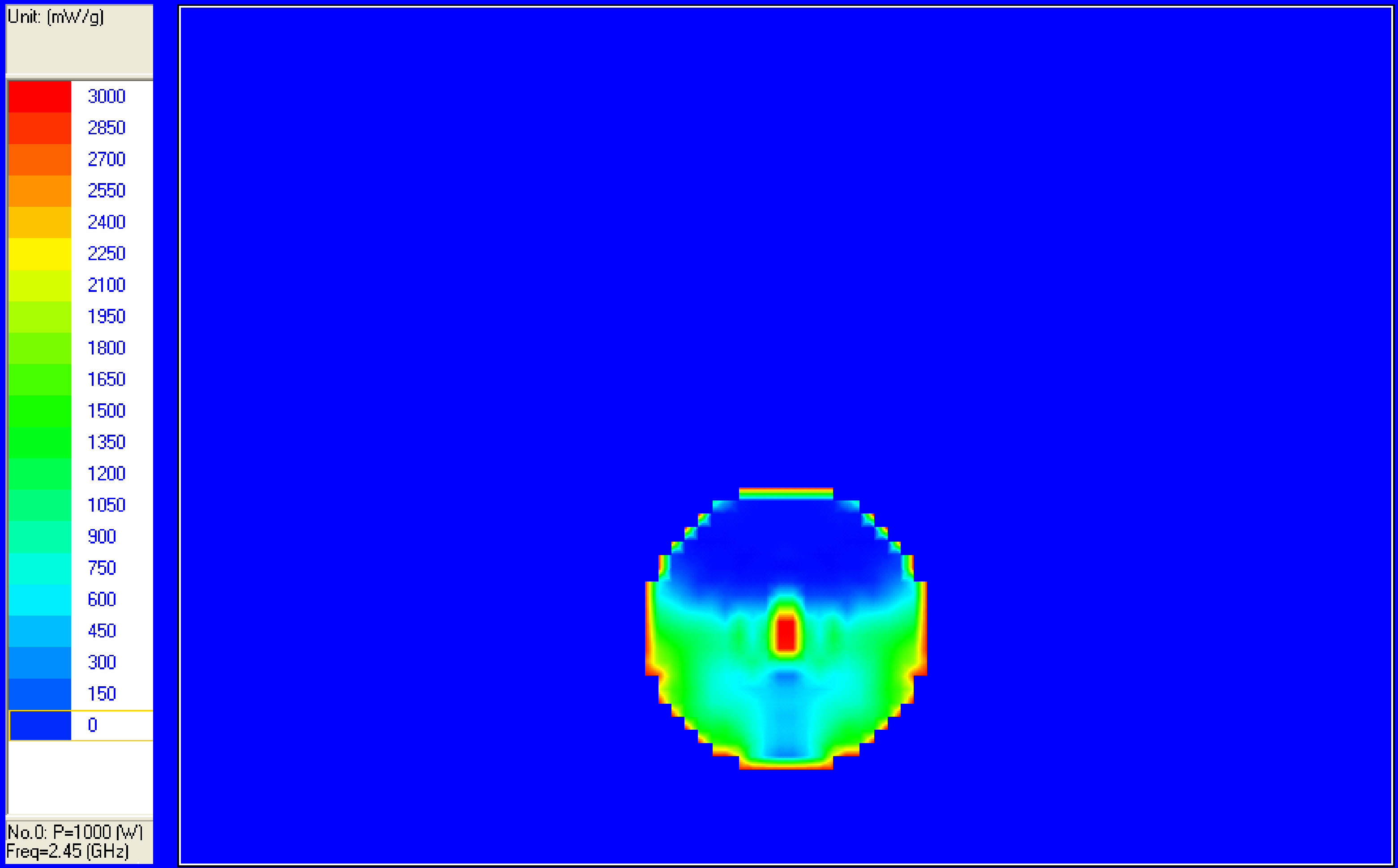
Ez-Field on Z = 170 mm Cut



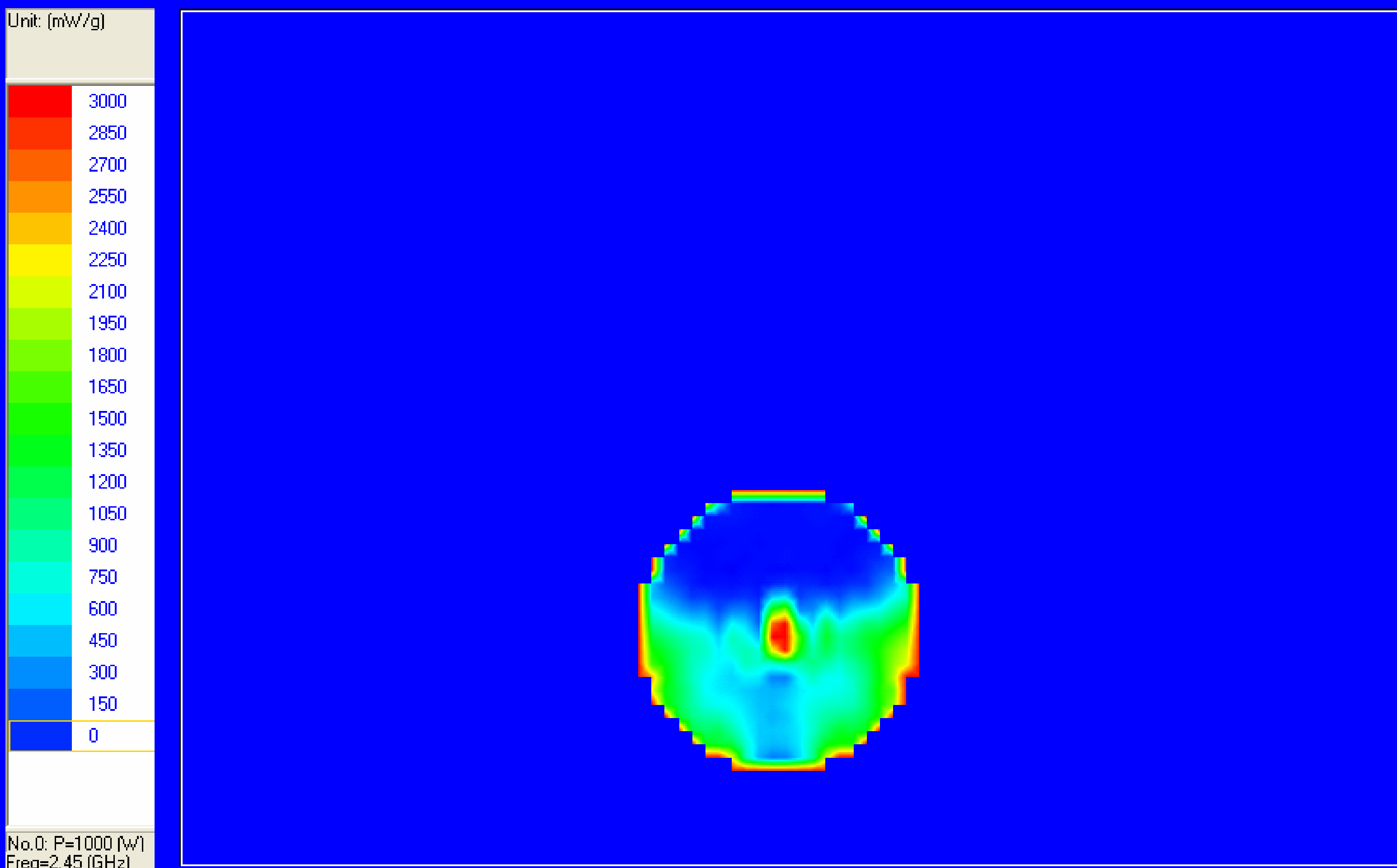
Ez-Field on Different Cuts



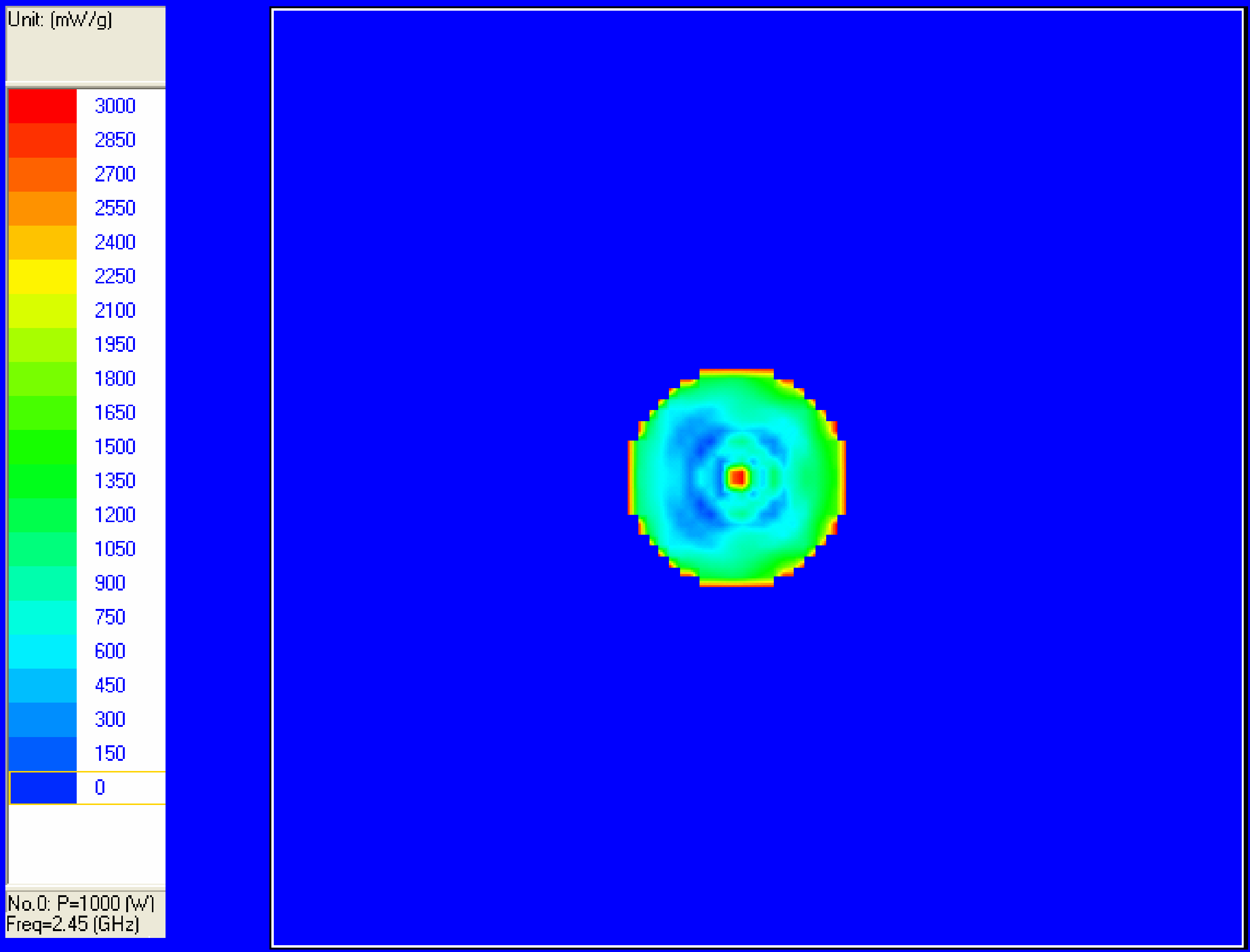
SAR on X Center Cut



SAR on Y Center Cut



SAR on Z = 54 mm Cut



Summary on the Example

- Ez field is the dominant field.
- The potato reduces the field in and around it and the field is disturbed greatly.
- The skin absorbs much energy.
- The center has some focus point and it also absorbs much energy.
- Simulation data: 40 MB RAM, 63 minutes on Pentium 4, 2.8 GHz for the s-parameter frequency response and the SAR calculation.

Summary on FIDELITY Simulator

- Non-uniform and conformal FDTD for precise and flexible modeling of complicated structures.
- Menu-driven GUI with powerful object oriented editing capability.
- Automatic meshing optimization.
- S-parameters, Time-domain near field, frequency domain near field and SAR visualization and processing.
- Suitable for general purpose applications including microwave power applications.

Discussion is welcomed (jian@zeland.com)