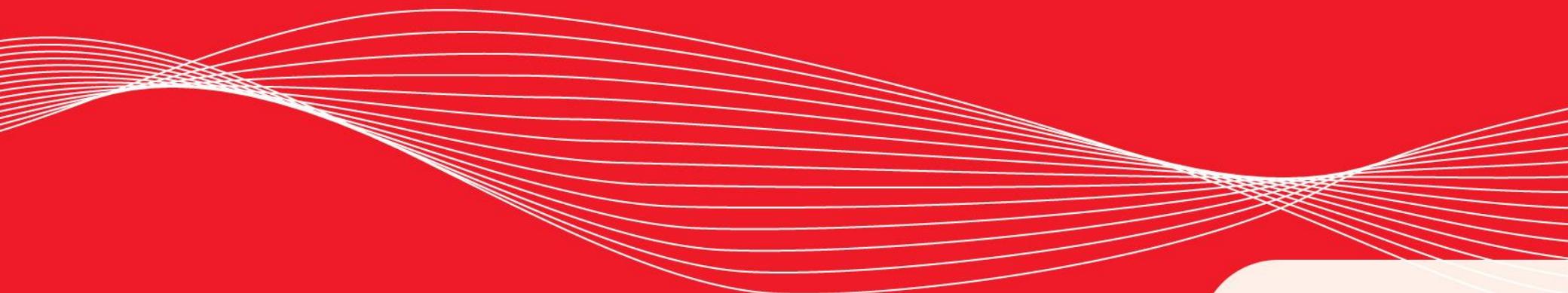


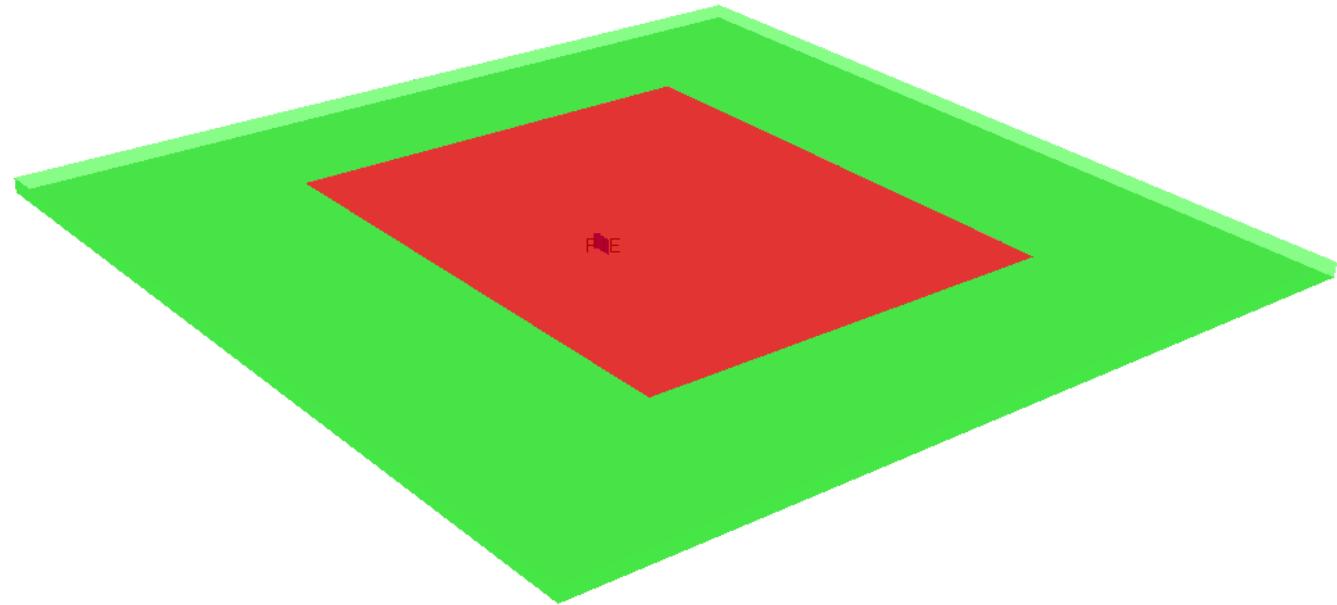
EMPIRE XPU Tutorial

Patch Antenna design



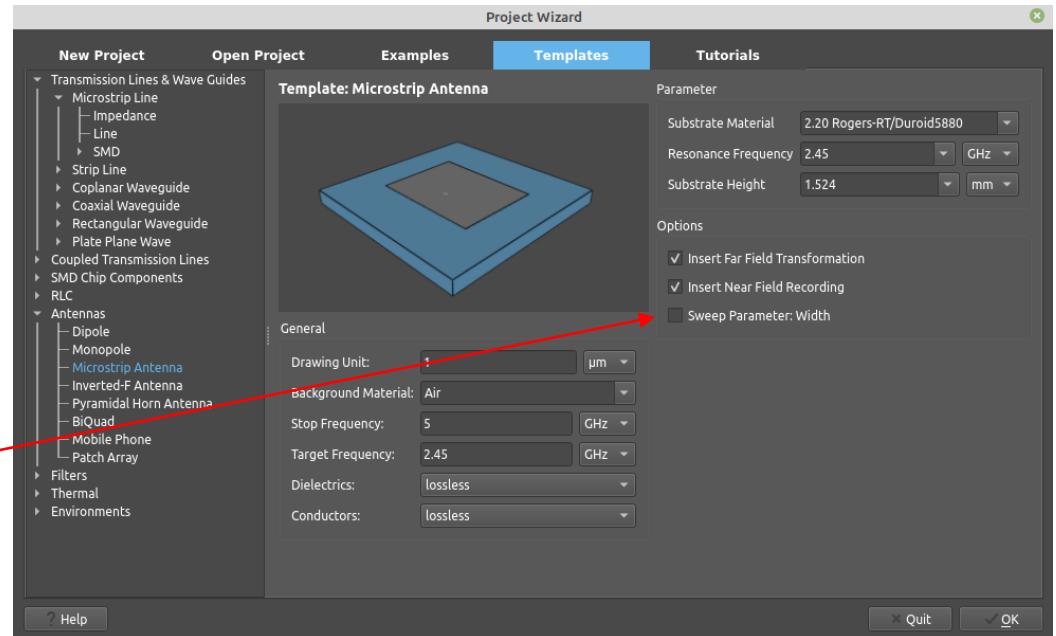
Overview: Topics

- Template wizard
- Basic features
- Simulation
- Postprocessing
- Nearfield
- Farfield
- Tuning



Step 1: Template Wizard

- Start Empire XPU
- Open Templates, Antennas, Microstrip Antenna
- Set the “Resonance Frequency” to 2.45 GHz
- Uncheck “Sweep Parameter: Width”
- Press “Open Selection”
- Select File, Save As, optionally create new folder



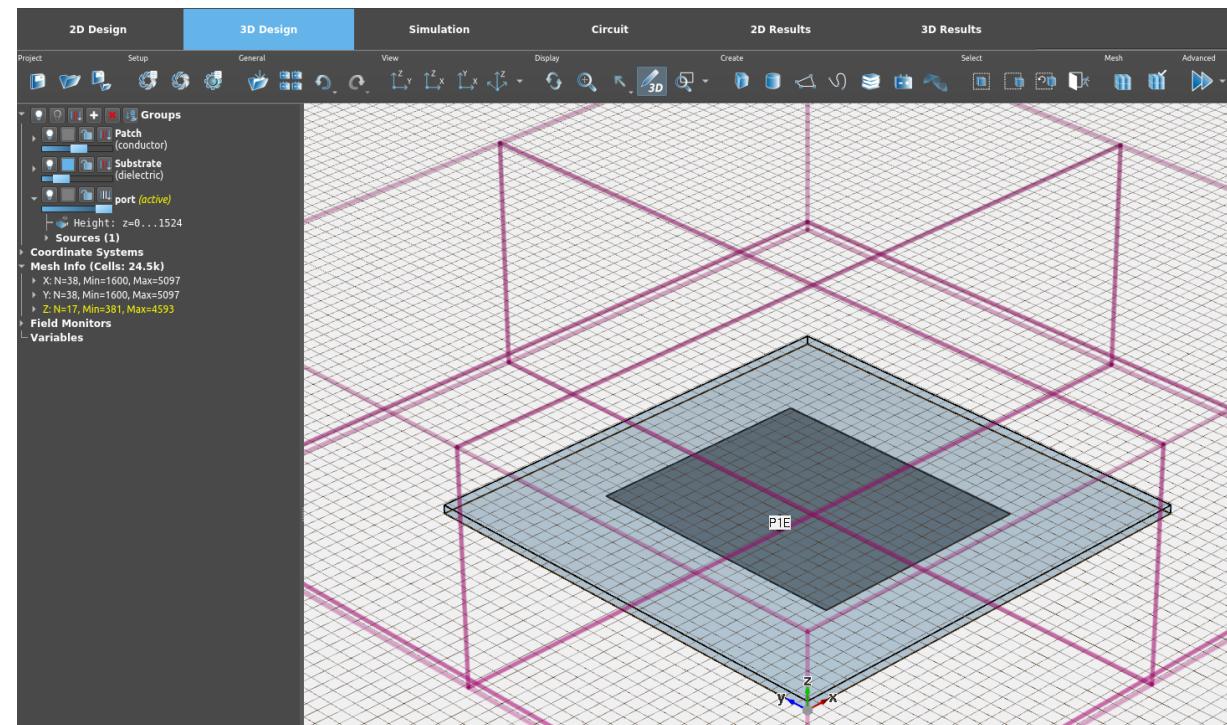
Comments:

Using the template “Microstrip antenna...”

- Automatic generation of patch dimensions, substrate, lumped port, near and far field definitions
- Automatic generation of mesh

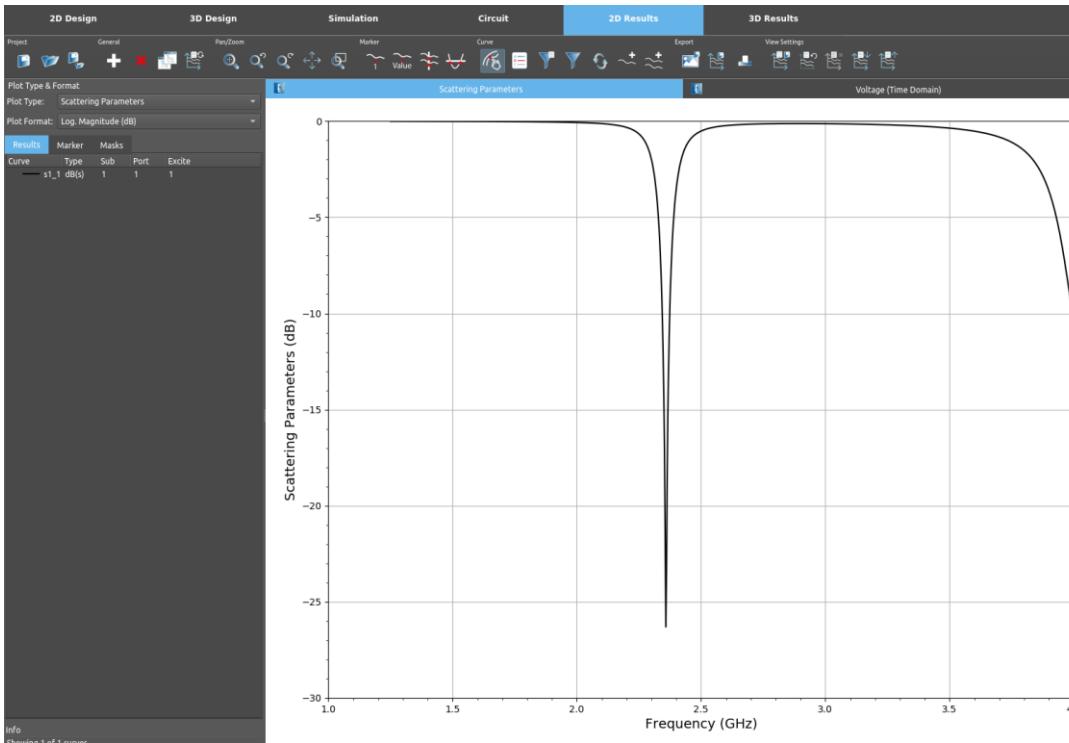
Step 2: Structure Check

- Switch to the 3D Design tab, verify that the design has the following features:
- Groups: Objects and properties
- Sources: Port parameters
- Simulation Setup:
 - Drawing unit
 - Frequency range
 - Accuracy
 - Loss calculation
 - Boundary Conditions
- Mesh Setup:
 - Automatic Meshing
 - Mesh Info: number of cells



Step 3: Simulation

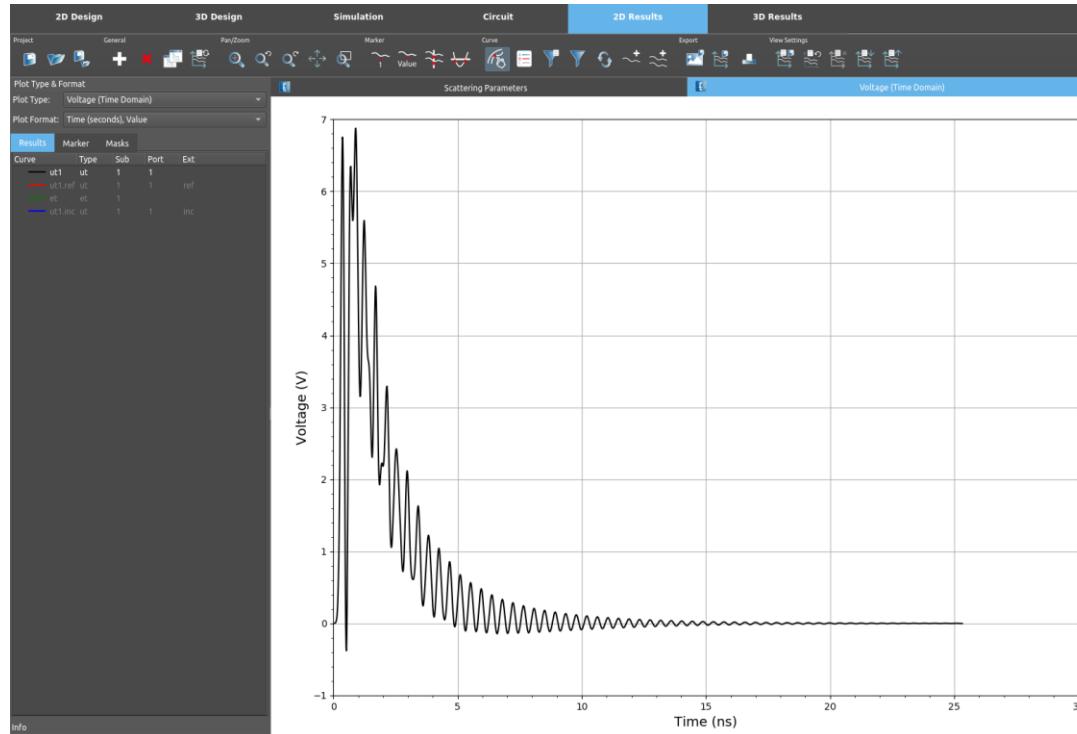
- Switch to the “Simulation” tab. Click on Start Complete Simulation and switch to the 2D Results tab, the result plots should appear shortly
- Select Scattering Parameters as the Plot Type



- The microstrip antenna from the template wizard will be automatically meshed and the simulation will be started
- During the simulation the time pulses are monitored
- After the simulation is finished the S-Parameter results are available

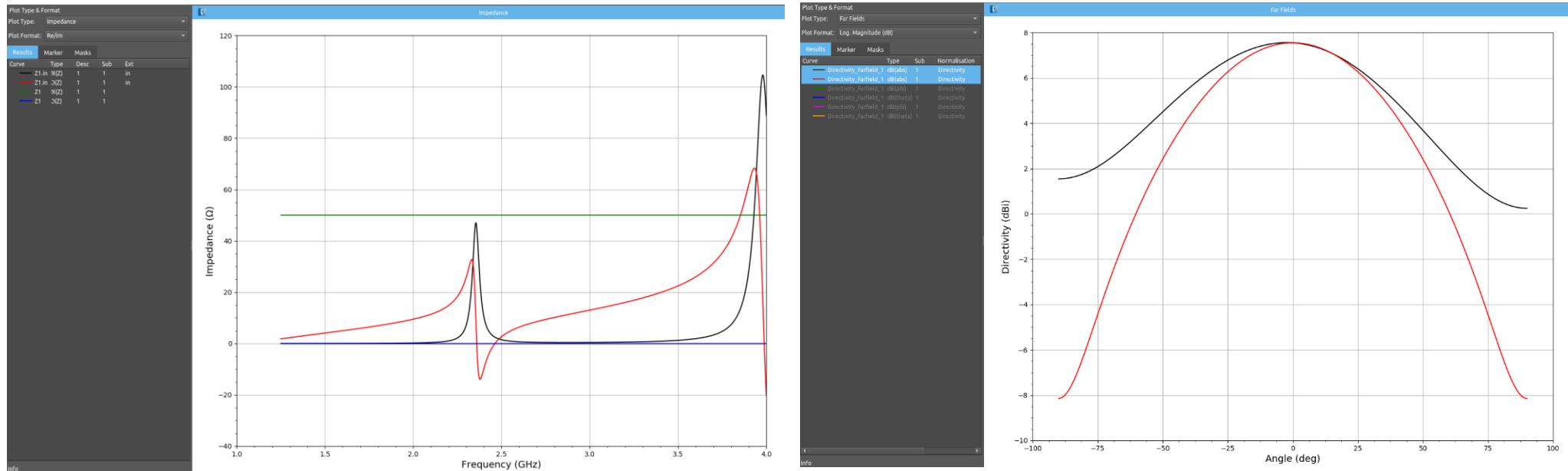
Step 3: Simulation

- Add a new result plot
- Select Voltage as the Plot Type



Step 4: Results

- Select Impedance as the Plot Type and check the input impedance
- Select Far Fields as the Plot Type and check the calculated far field

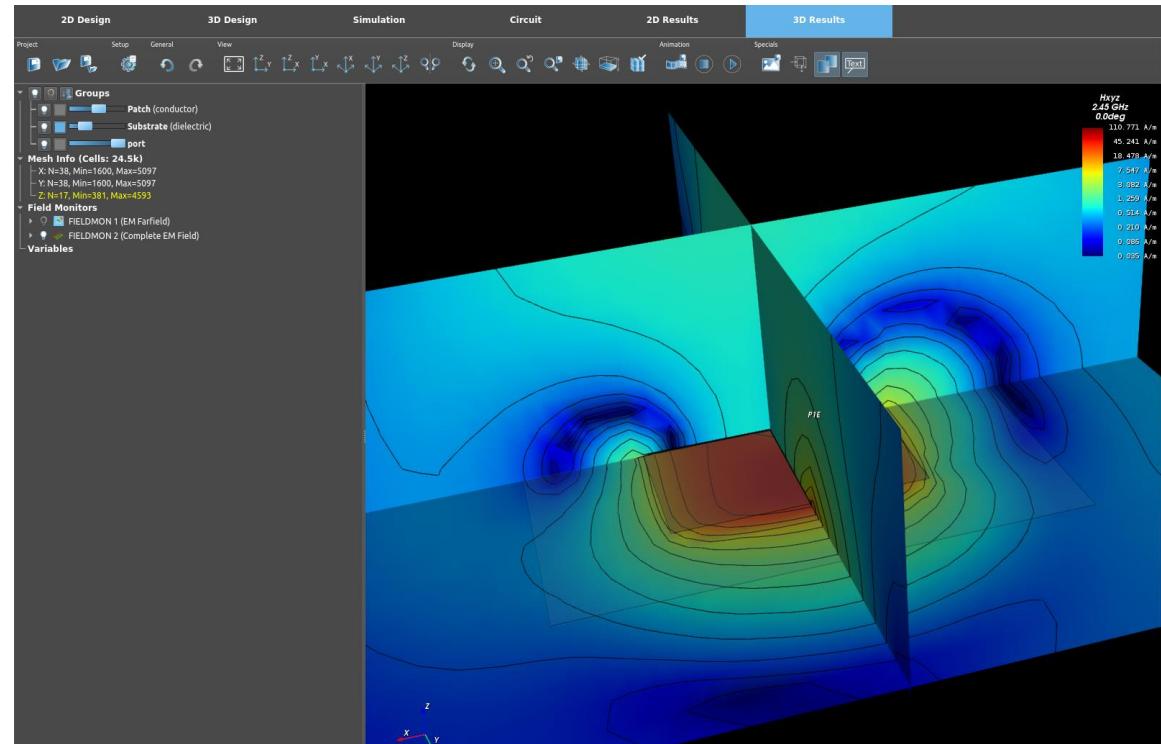


- By default, all the curves are displayed. Here, only $Z1.in$ is displayed, which is the impedance of the structure seen from Port 1
- The far field plot only shows patterns for cuts at angles $\phi=0^\circ$ (xz) and $\phi=90^\circ$ (yz)

* In Legend: Select curves “db(eabs)”, right click “Show only and autocolor”, Button “Autoscale”

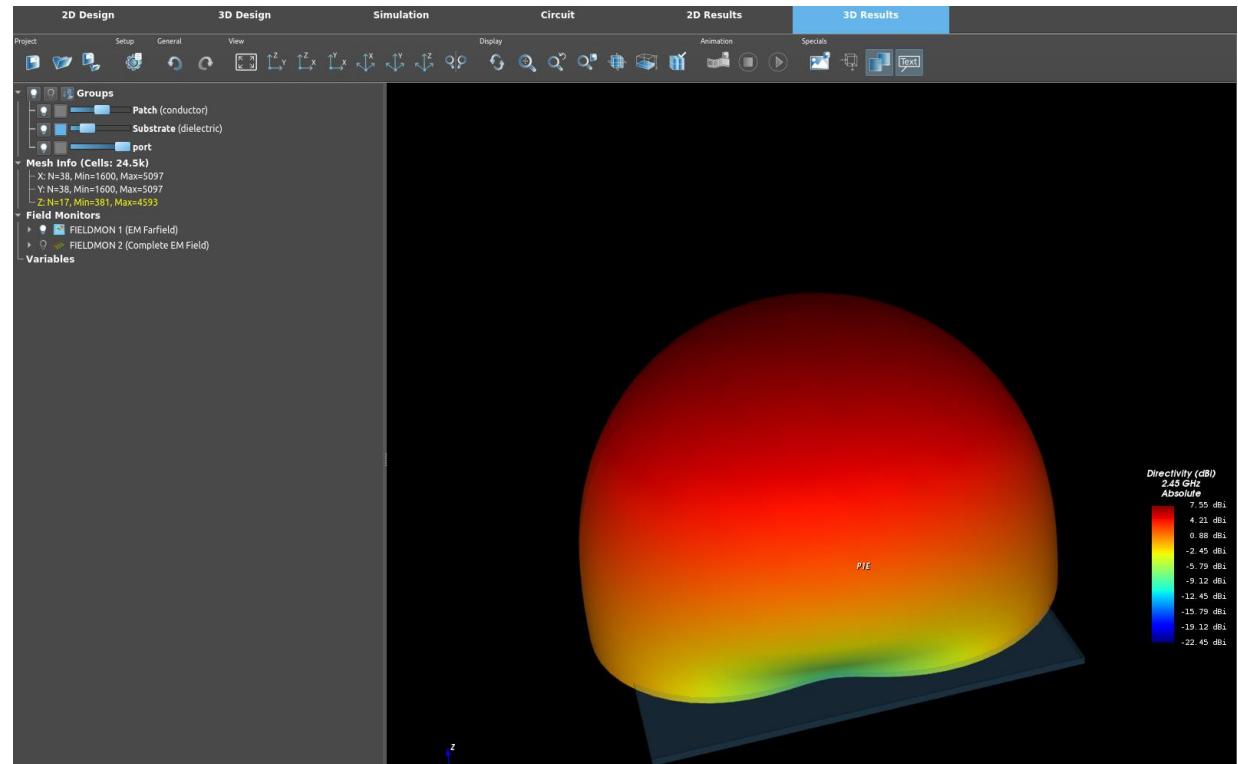
Step 5: Near Field

- Switch to the 3D Results tab
- Select Field Monitors to open Field Monitor overview
- Move sliders to control display planes
- Switch on/off planes



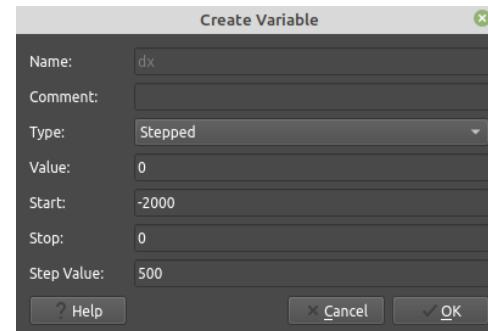
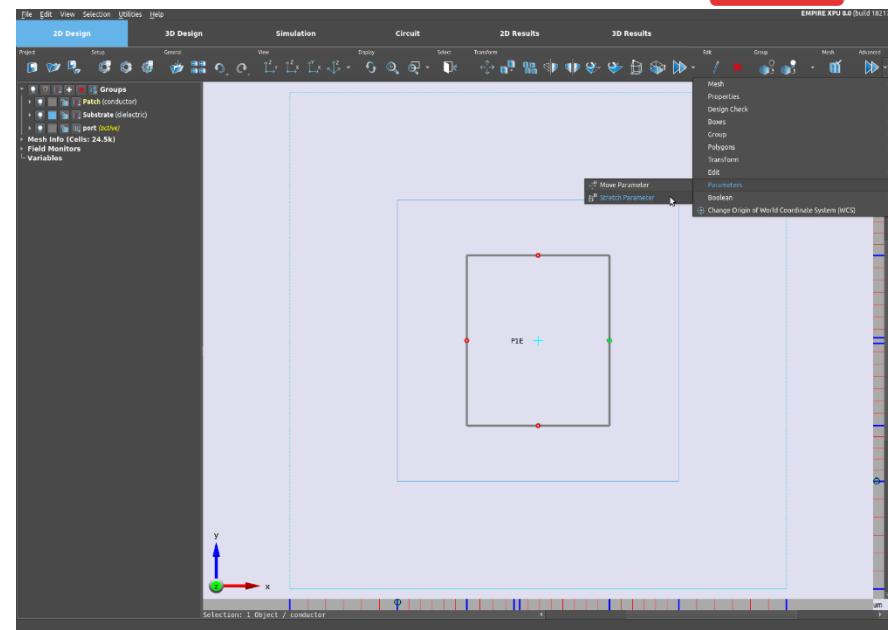
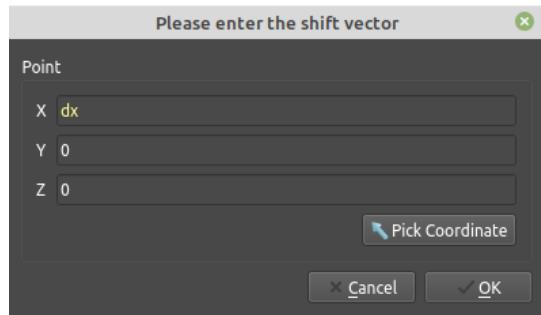
Step 6: Far field

- Turn off visibility of complete EM Field display 
- Turn On visibility of EM Farfield display 
- Press z-Key (Zoom Extents)



Step 7: Tuning 1

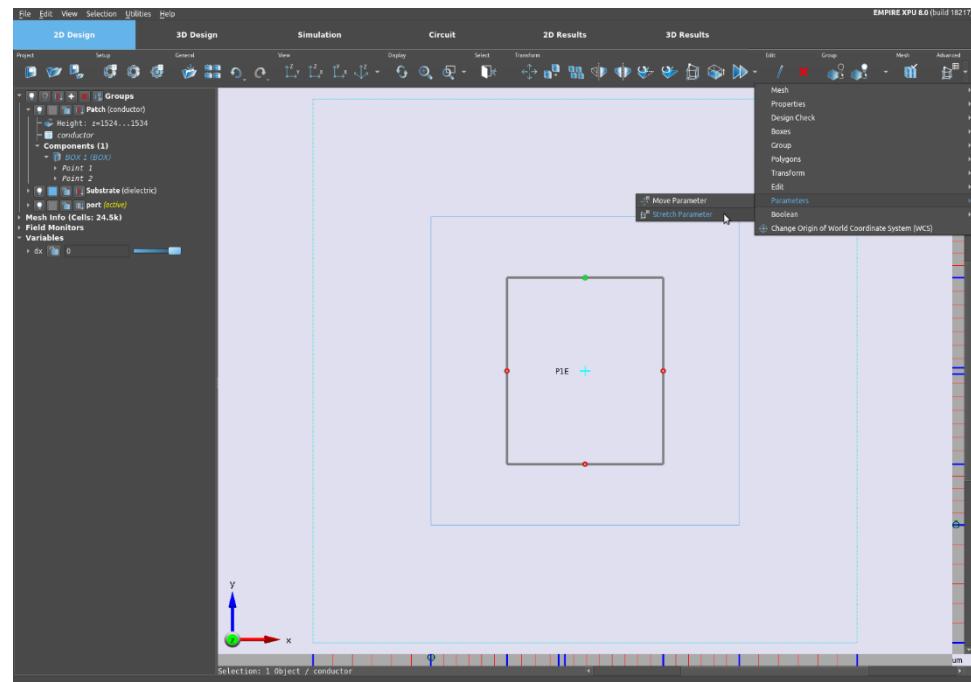
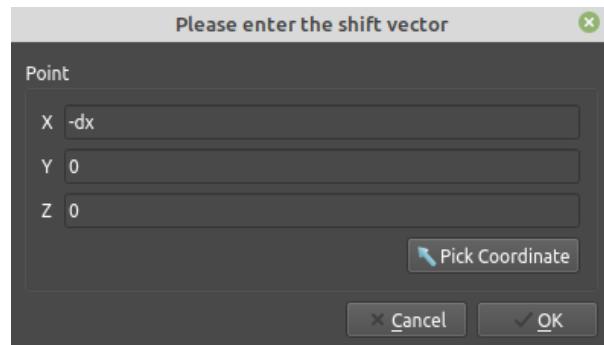
- Switch to 2D Design mode
- Select patch at right side (left click)
- Click on Advanced, Parameter, Stretch Parameter
- Enter X: dx as shift vector and confirm with OK
- Set Variable to:
- Type = Stepped
- Value:0, Min: -2000, Max: 0, Step: 500,
- OK



Comment: Parameters may also be added to the coordinates of the elements in the structure list.

Step 7: Tuning 1

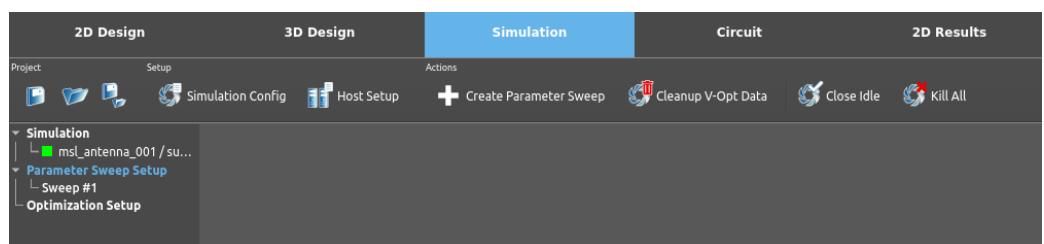
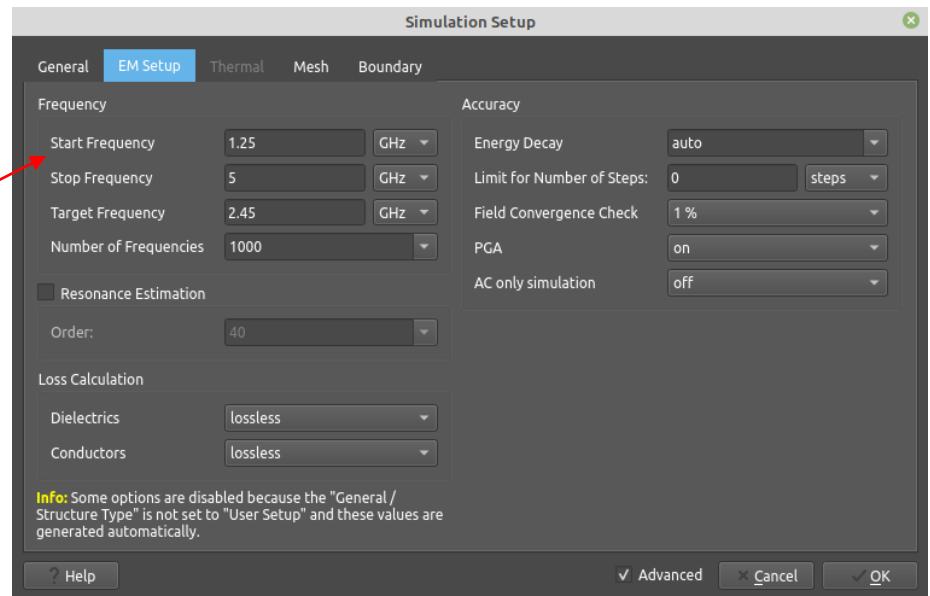
- Select patch at left side
- Click on Advanced, Parameters, Stretch Parameter
- Enter X: -dx as shift vector and confirm with OK
- Open Side menu: Variables and use the slider bar to check the range



Comment: Variables may also be added to the coordinates of the elements in the group list.

Step 8: Tuning 2

- Click “Simulation Setup”,  set „Start Frequency“ to 1.25 GHz, „Stop Frequency“ to 5 GHz and „Target Frequency“ to 2.45 GHz
- Click “Simulation” Tab
- Select “Parameter Sweep Setup”
- Click “Create Parameter Sweep”
- Click “Start” to start



2D Design 3D Design Simulation Circuit 2D Results 3D Results

Project **Setup** **Status**

Simulation ms1_antenna_001 / su...
+ Parameter Sweep Setup
 - Sweep #1
 - Sweep #2
- Optimization Setup

Variable Sweep Config

Sweep Mode: Sweep Independent
Sweep Count: 5
Creation Mode: Export and Run
Folder Naming Policy: Used Variables

Variable Setup

Name	Type	Value	Start	Stop	Step / Count	List / Equation
FDTD Variables	Stepped	0.0	-2000.0	0.0	500.0	

2D Design 3D Design Simulation Circuit 2D Results 3D Results

Project **Setup** **Status**

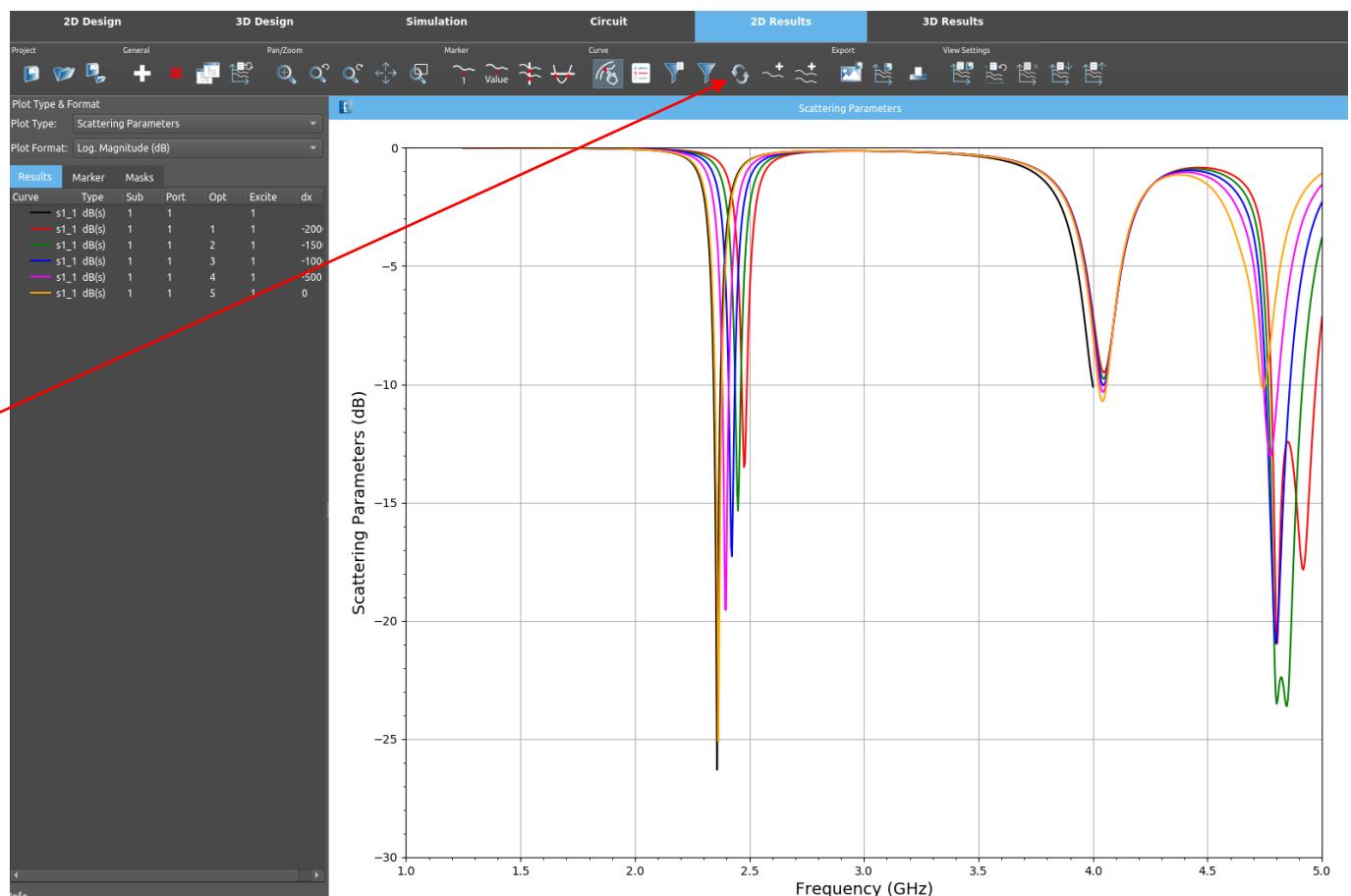
Simulation ms1_antenna_001 / su...
+ Parameter Sweep Setup
 - Sweep #1
 - Sweep #2
- Optimization Setup

Sim Dir **Status**

Notes	dx
-2000	v-opt... Complete
-1500	v-opt... Complete
-1000	v-opt... Complete
-500	v-opt... Complete
0	v-opt... Complete
	v-opt00001 / Disc...
	v-opt00002 / Disc...
	v-opt00003 / Disc...
	v-opt00004 / Disc...
	v-opt00005 / Disc...
	v-opt00001 / sub1...
	v-opt00002 / sub1...
	v-opt00003 / sub1...
	v-opt00004 / sub1...
	v-opt00005 / sub1...

Step 9: Tuning 3

- Switch from Simulation to Results - S-Parameters
- Press Update Data



Comment: All results of subsequent simulations can be automatically displayed in the window