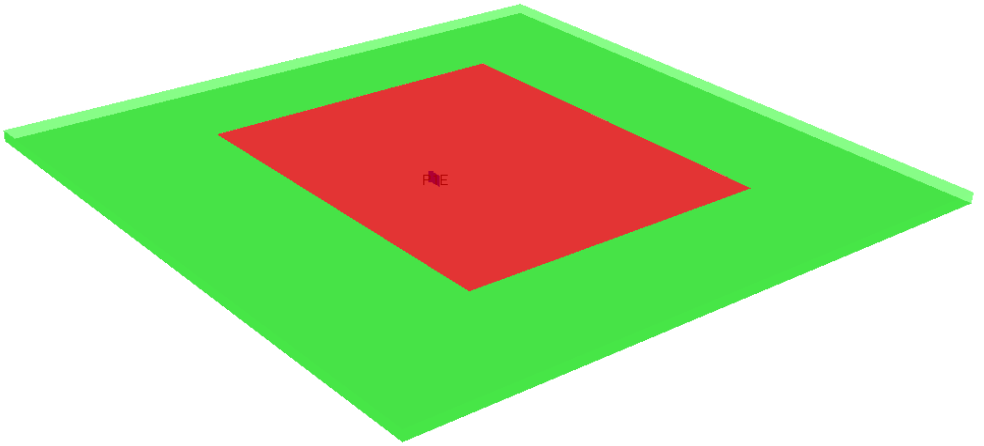
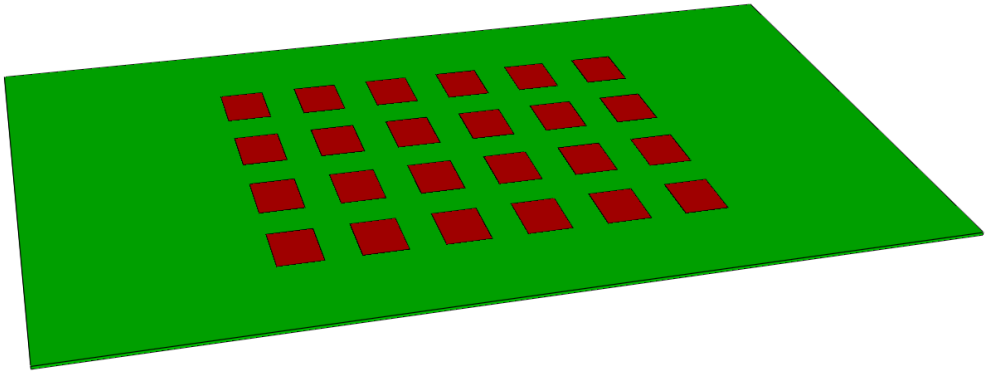
EMPIRE XPU Tutorial

Patch Antenna design

Overview: Topics

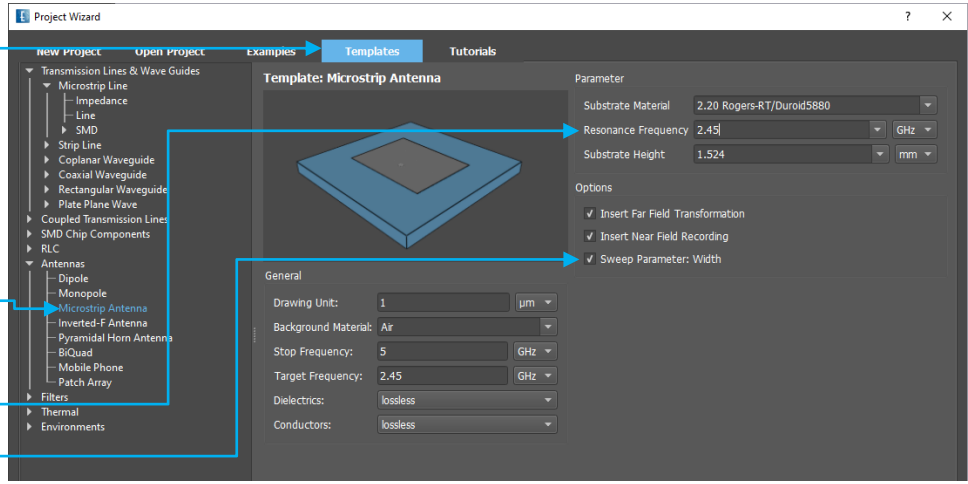
- Template wizard
- Simulation
- Nearfield
- Farfield
- Array Creation with Template
- Simulation
- Phased array investigations
  - Scan angle
  - Coupling
  - Active impedance





Step 1: Template Wizard

- Start Empire XPU
- Select Templates
- Open Antennas → Microstrip antenna
- Set the “Resonance Frequency” to 2.45 GHz
- Keep „Sweep Parameter: Width“
- Click “OK”
- Select File → Save As, optionally create new folder and name



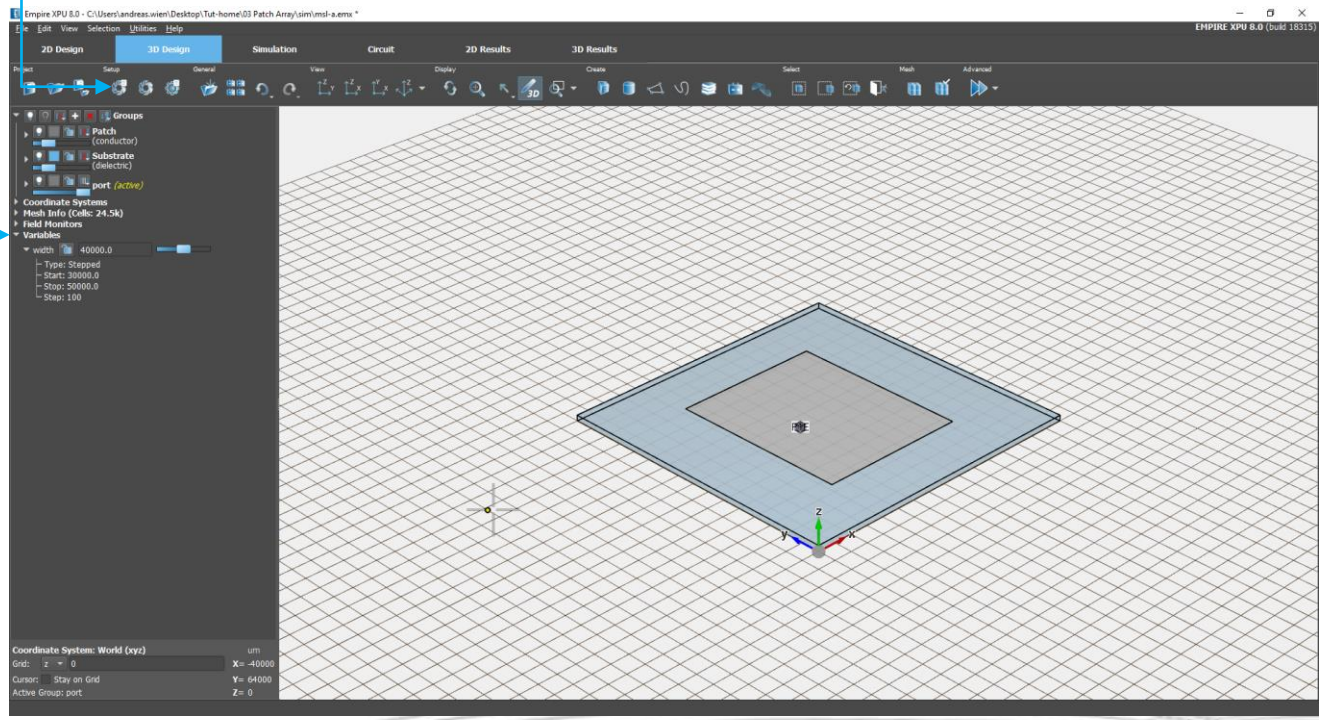
Comments:
Using the template “Microstrip antenna…”
• Automatic generation of patch dimensions, substrate, lumped port, near and far field definitions
• Automatic generation of mesh

Step 2: Structure Check

- 3D Results Tab: Geometry verification
- Groups: Objects and properties
- Simulation Setup: Settings

- Open Variables
- Open „width“
- Move slider
- Set Step to „100“

(Stop-Start)/Step= 200 possibilities

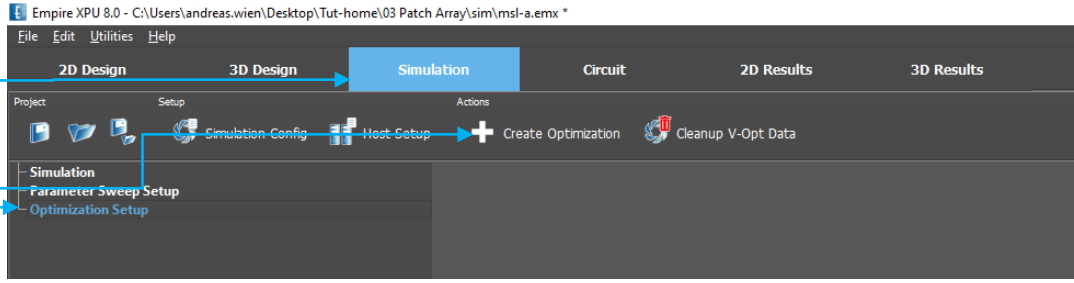


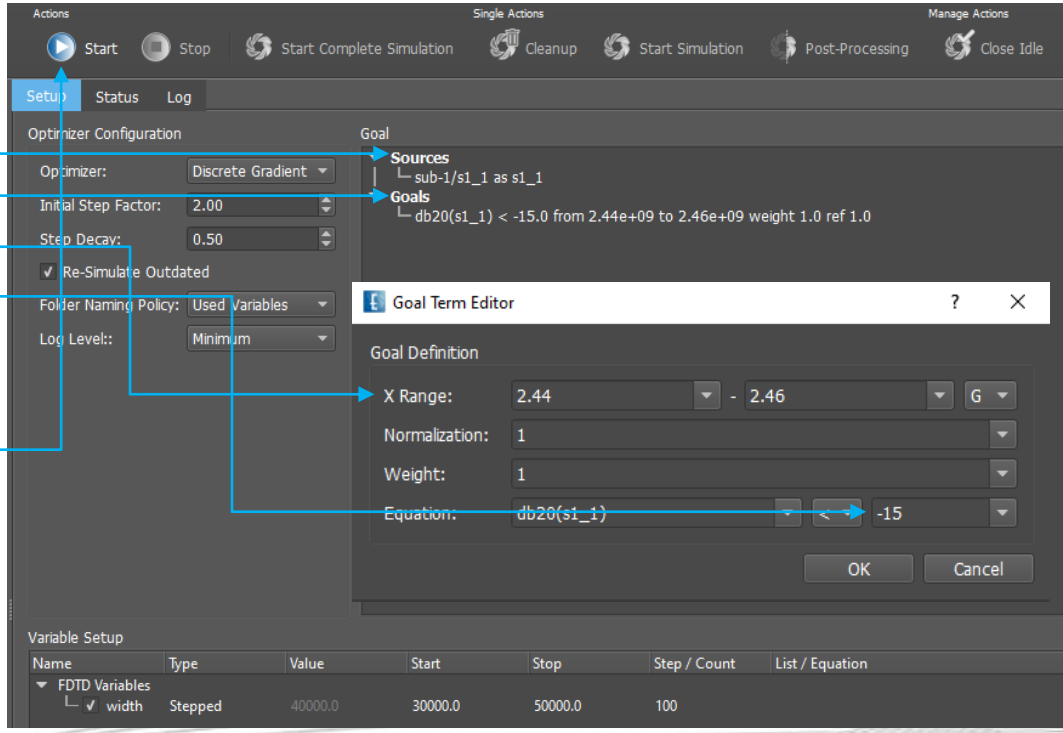
Step 3: Optimization

- Select “Simulation” Tab
- Click “Optimization Setup”
- Click “Create Optimization”

- Right click on “Sources”
- Select “Add Source”
- OK

- Right click on “Goals”
- Select “Add Goal”
- Set X Range “2.44” – “2.46” G
- Adjust Equation: db20(s1_1) < -15
- OK
- Click “Start”, Confirm

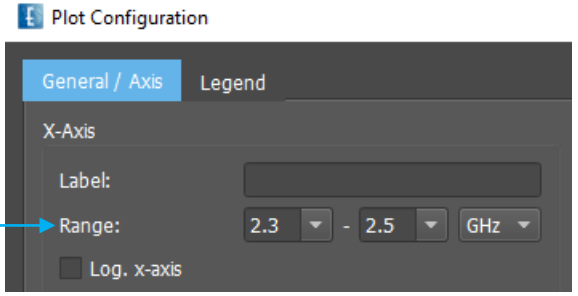


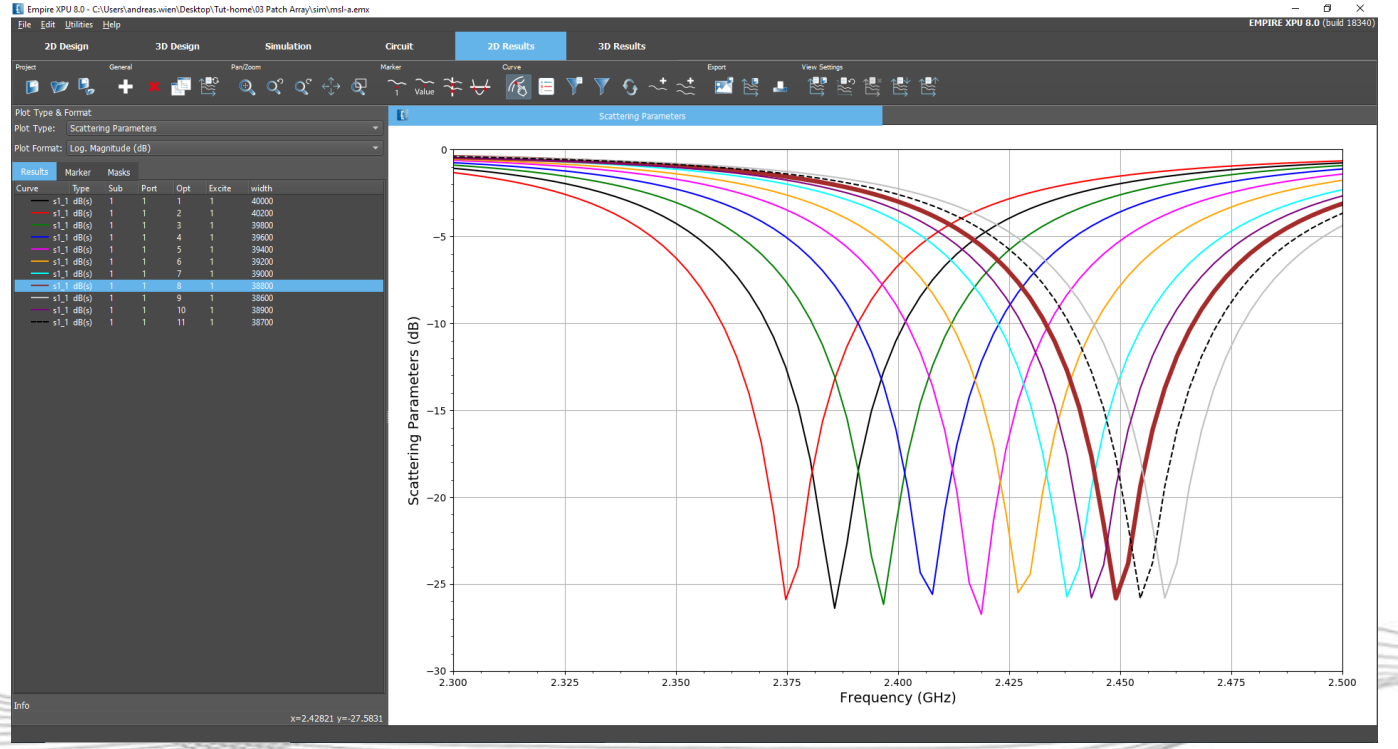


The goal is reached within 8 steps
The optimized width is 38.8 mm.

Step 4: Results

- Switch to 2D Results tab → right click in List, click “Show all”
- Right click on Plot, select “Configure Plot”
- Set Range “2.3” – “2.5” GHz, OK
- Select curve with peak nearest to 2.45 GHz and note Opt Number (here 0008)

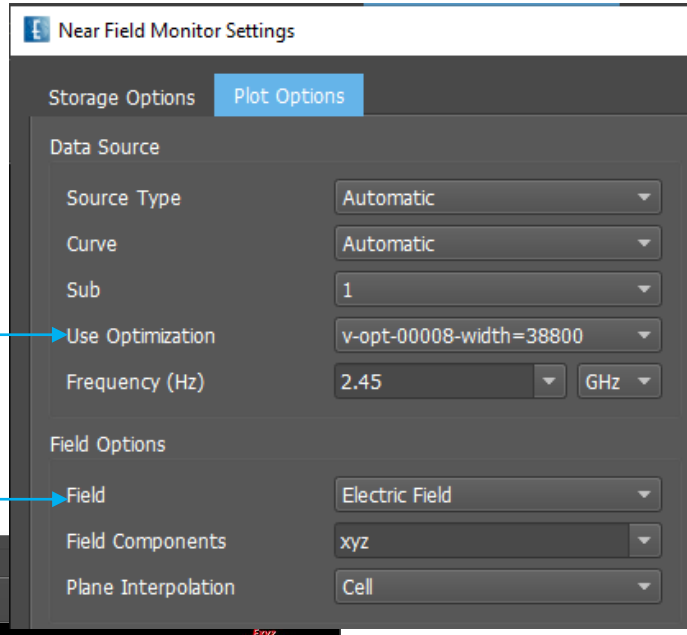


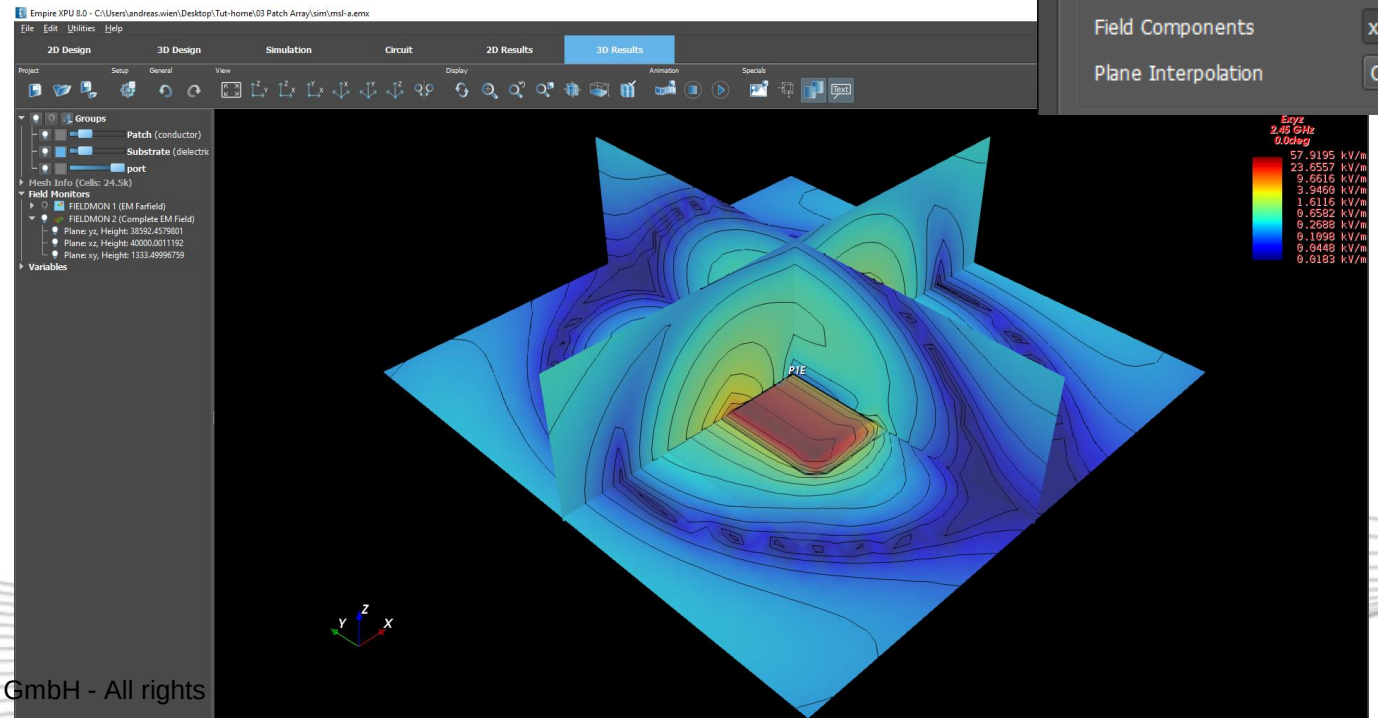


Step 5: Near Field Display

- Switch to 3D Results tab, Iso z view 
- Open Field Monitors
- Right click on FIELDMON2 - Edit

- In „Use Optimization“ select Data with Opt Number (00008)
- Change Field to „Electric Field“
- OK

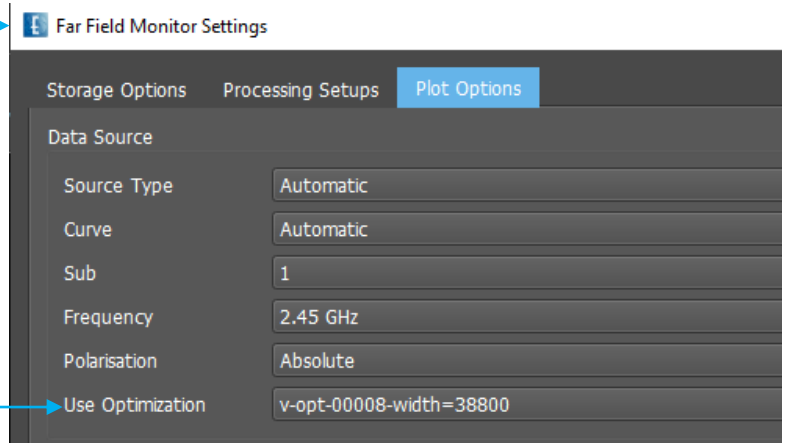


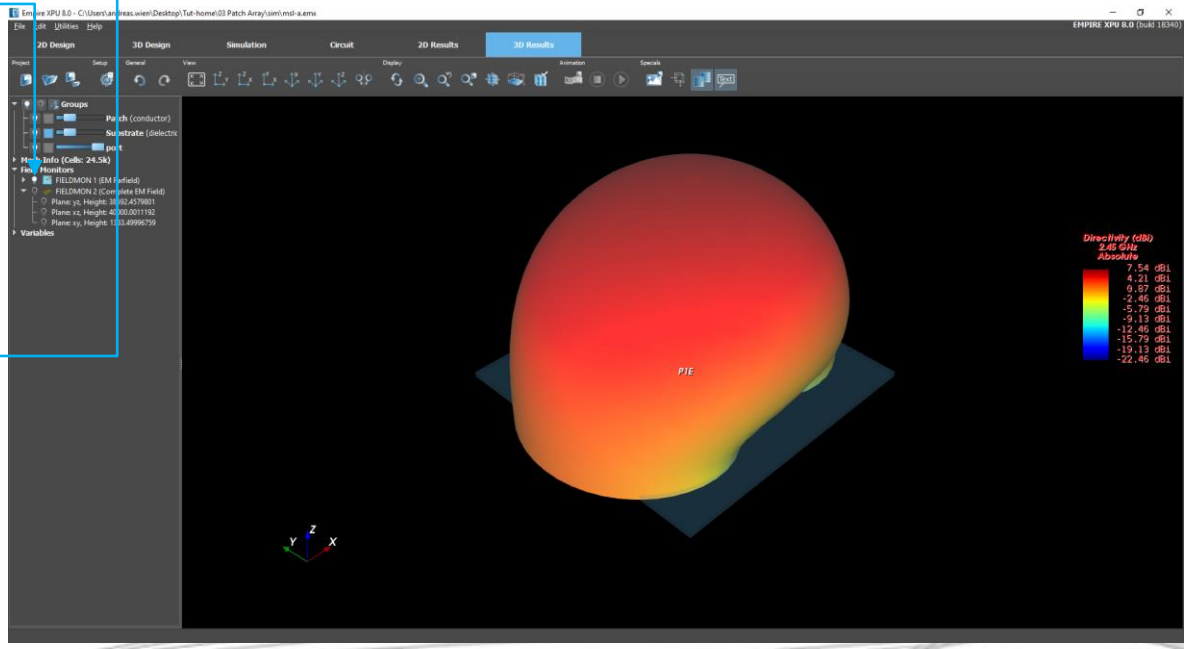


Step 6: Far field Display

- Turn off visibility of „FIELDMON 2“
- Turn On visibility of FIELDMON 1“
- Right click on FIELDMON 1
- Edit
- Select Optimization:

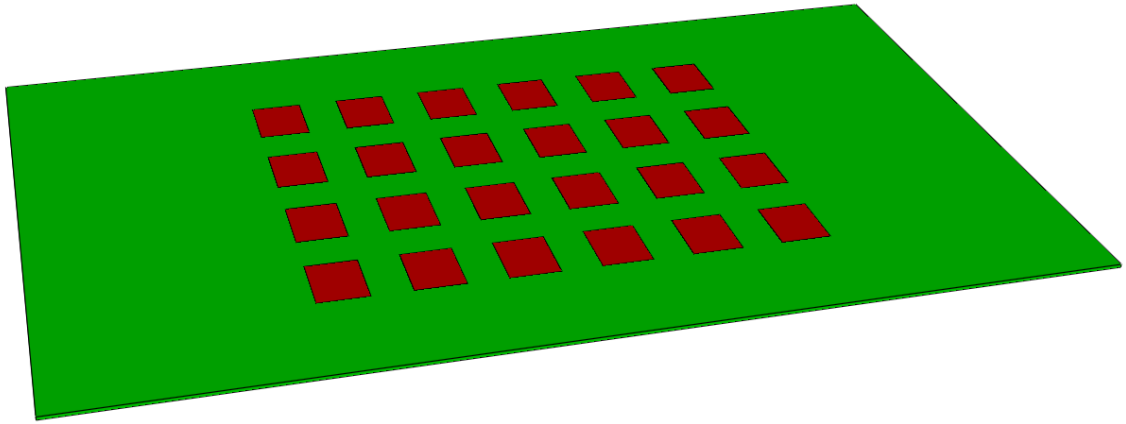
  v-opt-00008-width=38800
- OK
- Exit Empire





Part 2: Array Creation

- Template wizard
- Simulation
- Postprocessing
- Nearfield
- Farfield
- Phased array investigations
  - Scan angle
  - Coupling
  - Active impedance



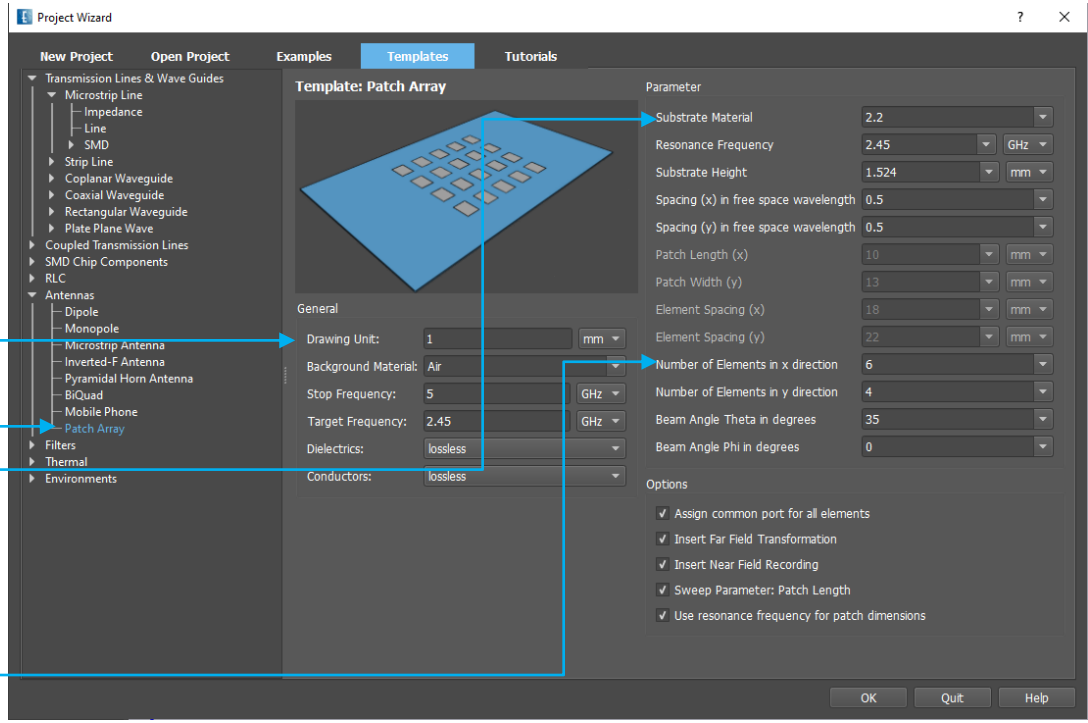
Step 7: Template Wizard

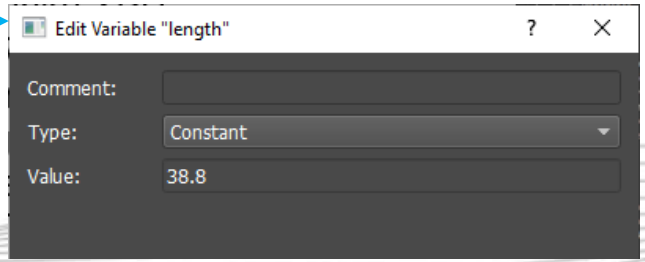
- Start Empire XPU
- Select Templates → Antennas → Patch Array
- Drawing unit: “mm”
- Stop Frequency: 5 GHz
- Target Frequency: 2.45 GHz

- Substrate Material: epsr=2.2
- Resonance Frequency: 2.45 GHz
- Substrate Height: 1.524 mm

- Number of elements in x: 6
- Beam Angle Theta: 35
- Click “OK”

- Open Variables
- Right click on length – Edit
- Set Type:Constant, Value:38.8

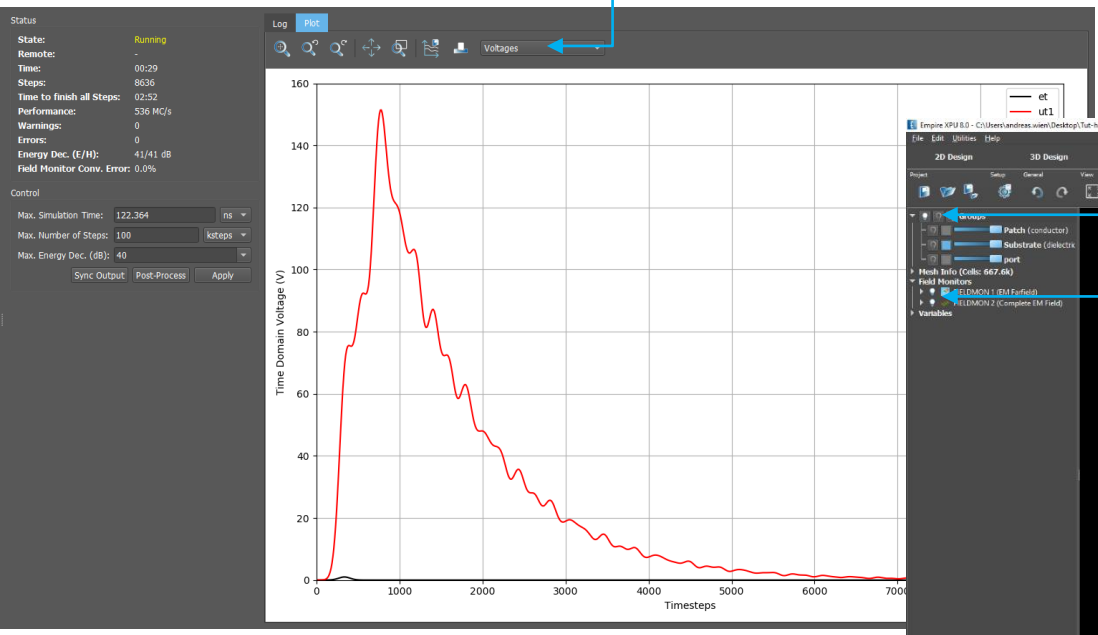


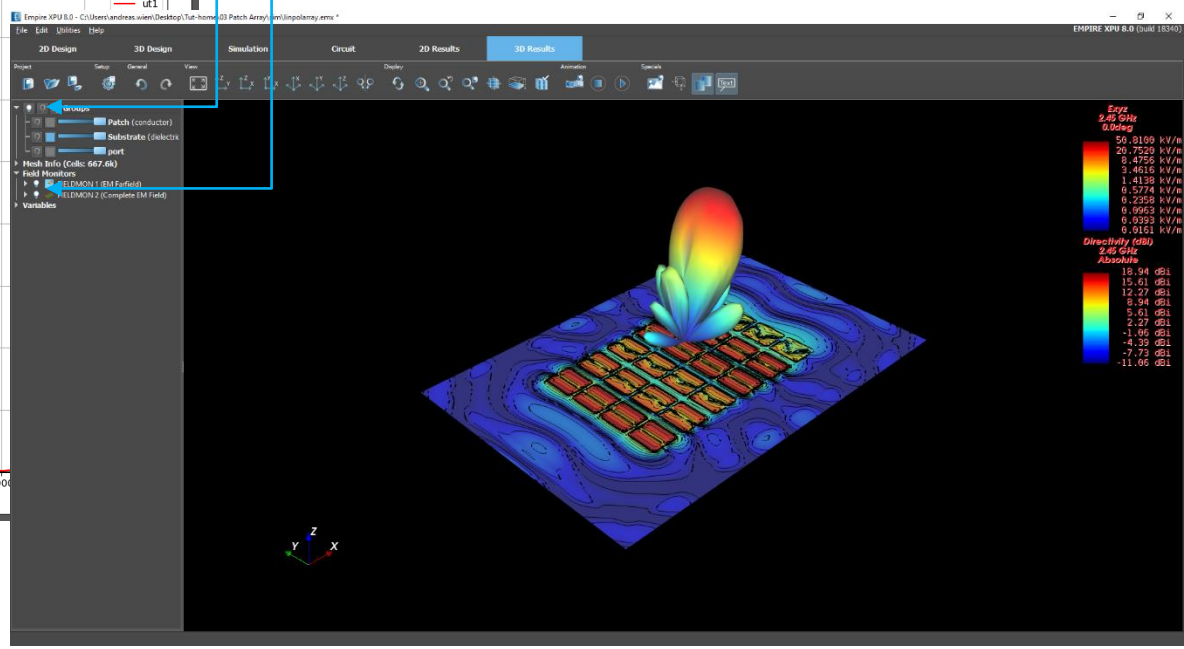


Step 8: Simulation Results

- Select File → Save As, create new folder
- Click „Start Simulation“, OK
- In Plot Tab switch to ‘Voltages’

- Switch to ‘3D Results’ tab
- Turn off all groups
- Turn on all Field Monitors



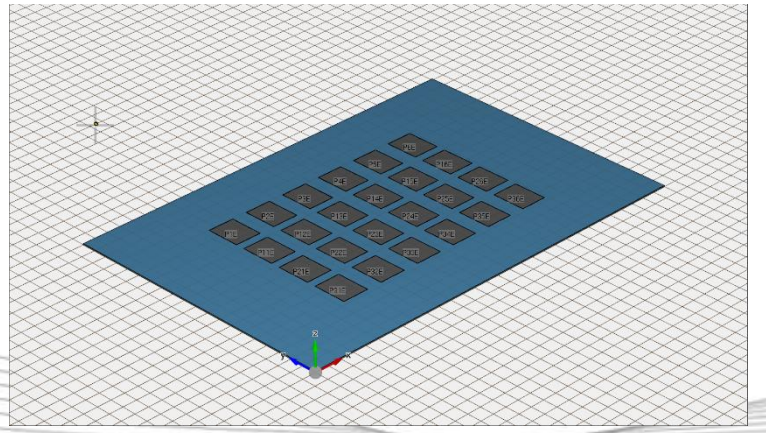


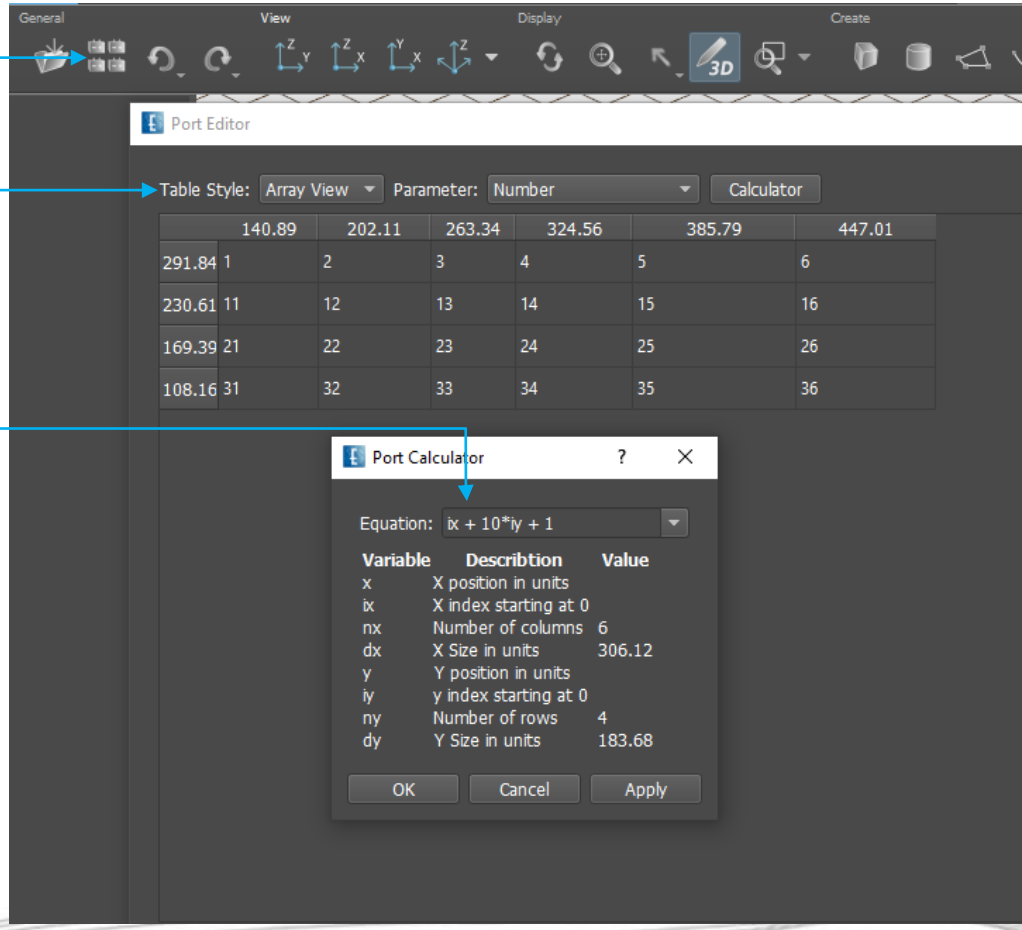
Comment:
- The S-parameter results are not valid if multiple ports with the same number are used

Step 9: Patch Array - Coupling

- Save EMPIRE project to a new file named ‘coupling‘
- Create individual port numbers for all patches like in the picture below

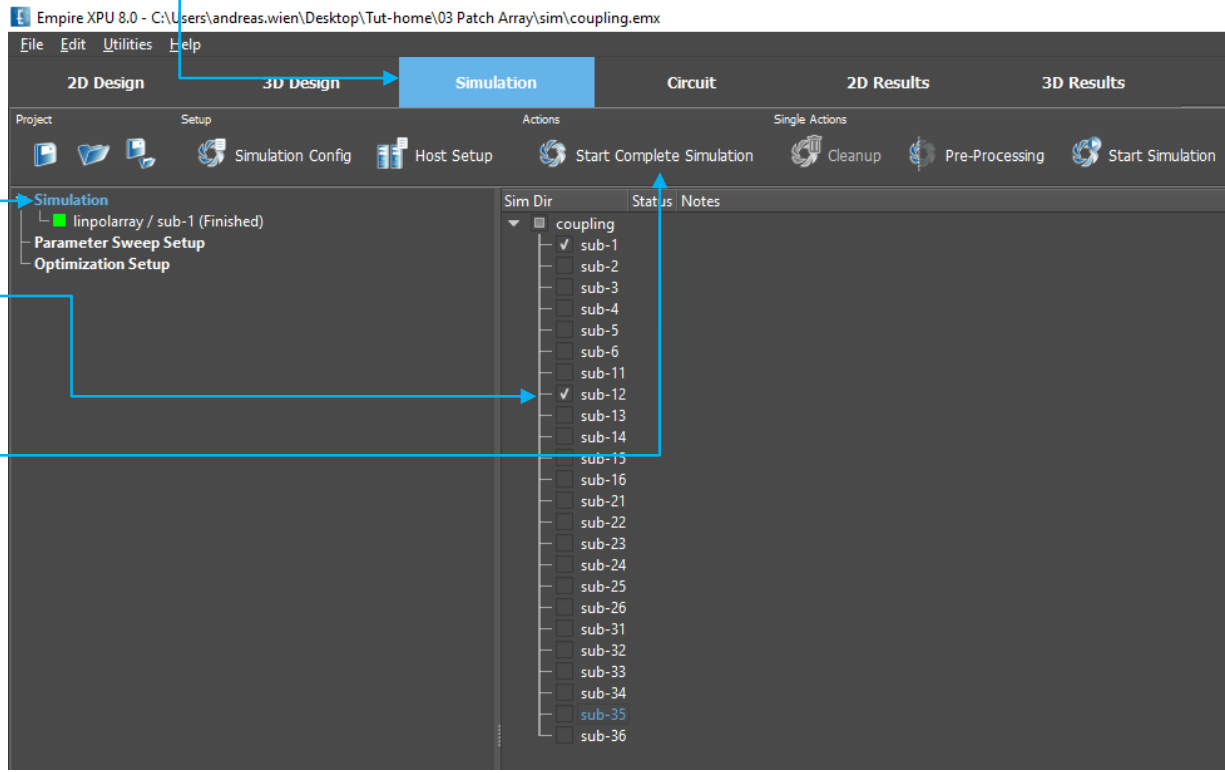
- Switch on group „port“
- Click Port Setup Wizard
- Table Style: Array View
- Click on Calculator and enter „ix+iy*10+1“
- Click OK





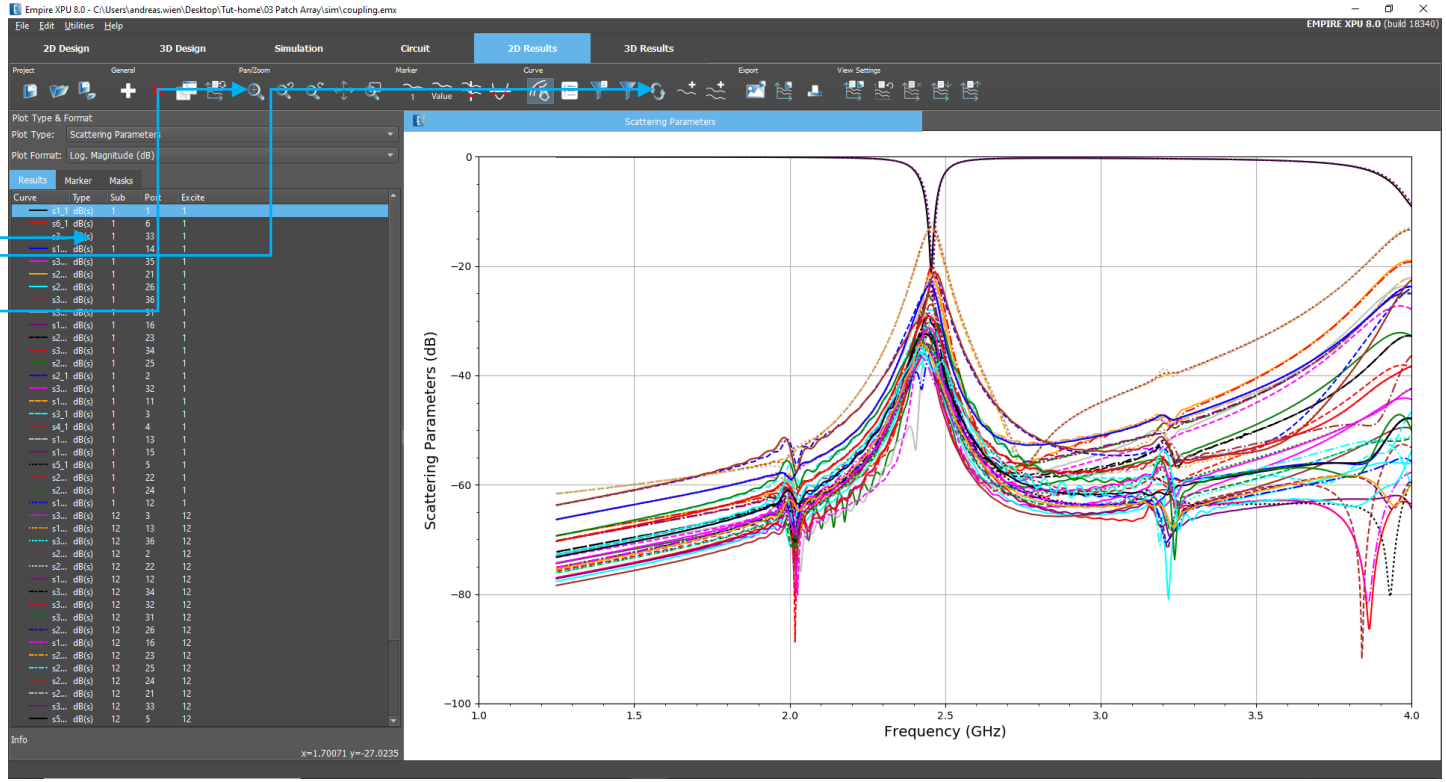
Step 10: Simulation

- Switch to ‘Simulation’ tab
- Select “Simulation” on the left
- Click “Preprocessing”
- Select only some folders for simulation (e.g. sub-1, sub-12)
- Click “Start Complete Simulation”
- After completion change to 2D Results Tab



Step 11: Simulation Results

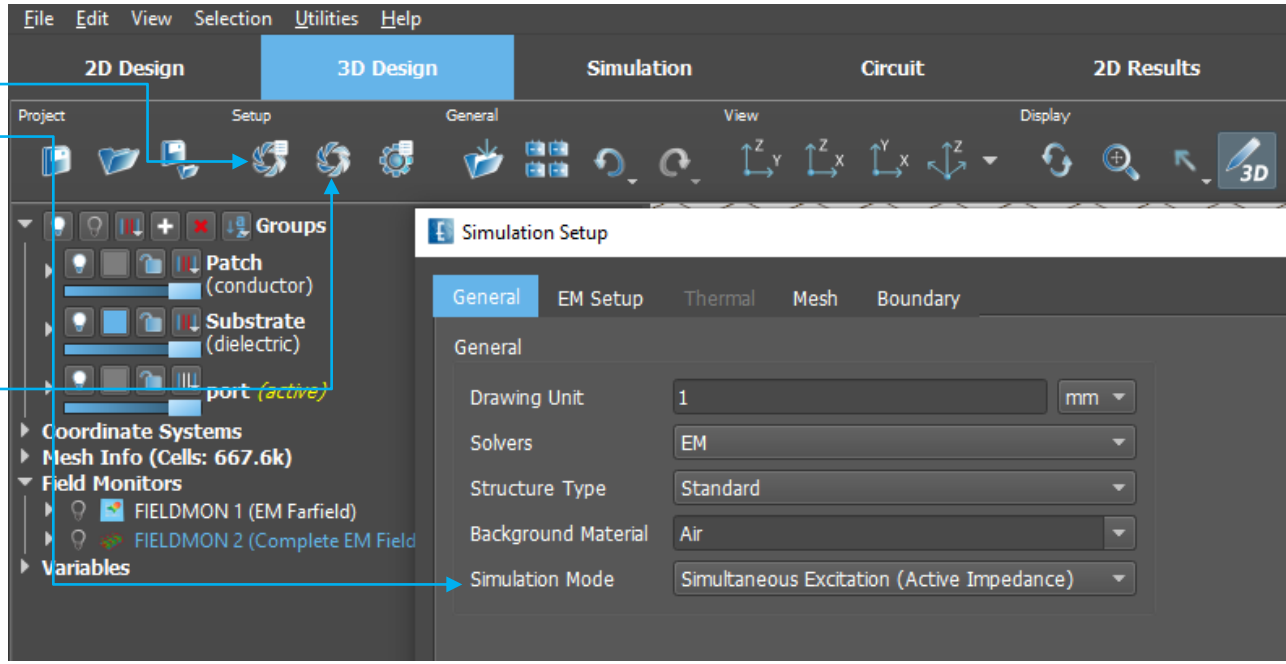
- Right click in list
- Select “Show all”
- Click “Update”
- Click “Autoscale”



Comment: The s-parameter results show the coupling between the different patches and the individual matching if only one port is excited at a time

Step 12: Active Impedance

- Save EMPIRE project to a new file named ‘active‘
- Click “Simulation Setup”
- Change “Simulation Mode” to “Simultaneous Excitation (Active Impedance)”
- Click “Start Simulation”
- OK



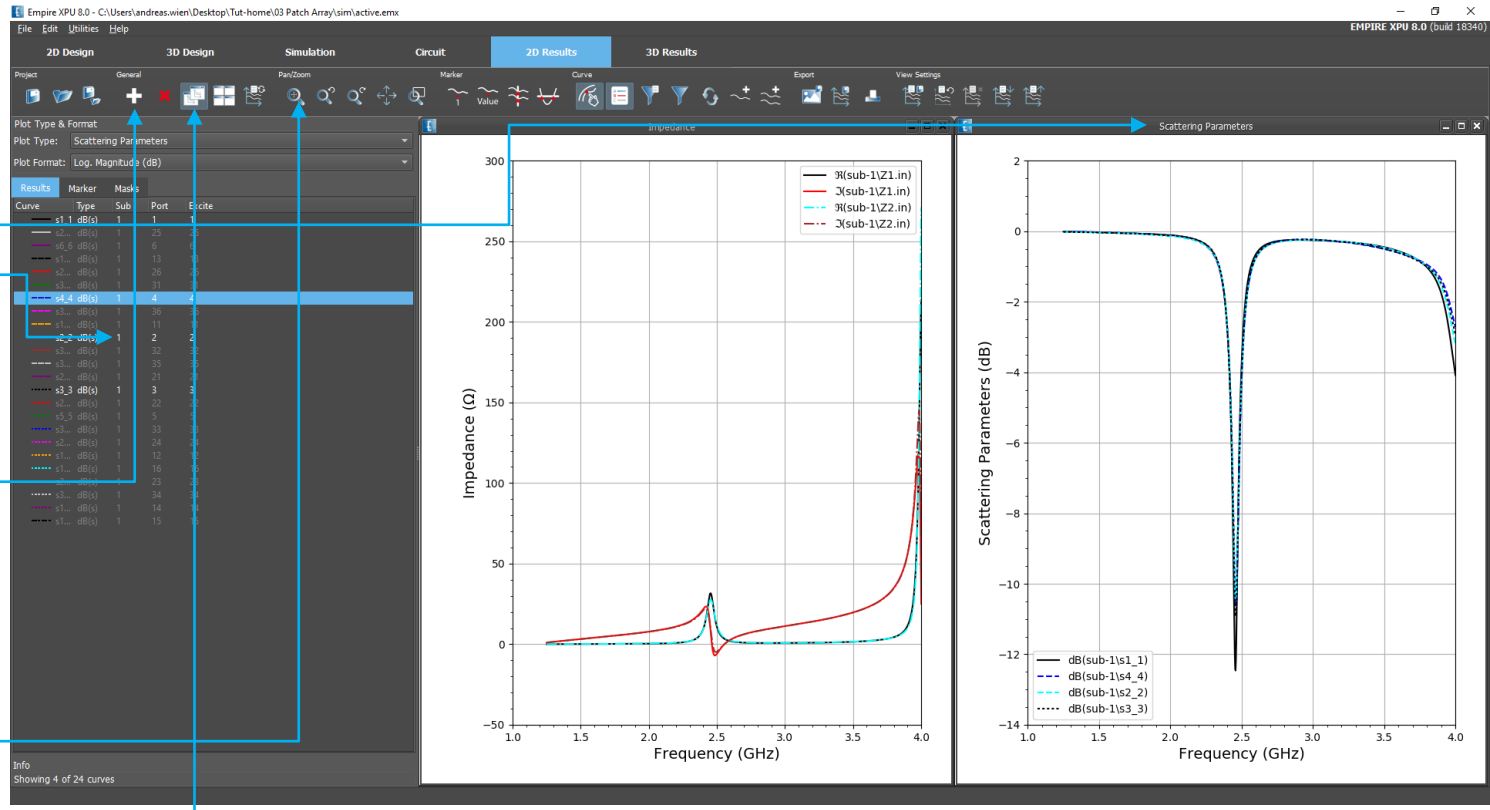
Step 13: Simulation Results

- 2D Results tab

- S-Parameters:
- Mark s11, s22, s33
- Right click “Show only”

- Click “Add Result”
- Impedance:
- Mark Z1.in, Z2.in
- Right click “Show only”
- Autoscale

- Optionally “Toggle View Mode”, Tile Sub Windows



Comment: The s-parameter results show the individual matching if all ports are excited at a time. The active input impedance at all ports can be investigated