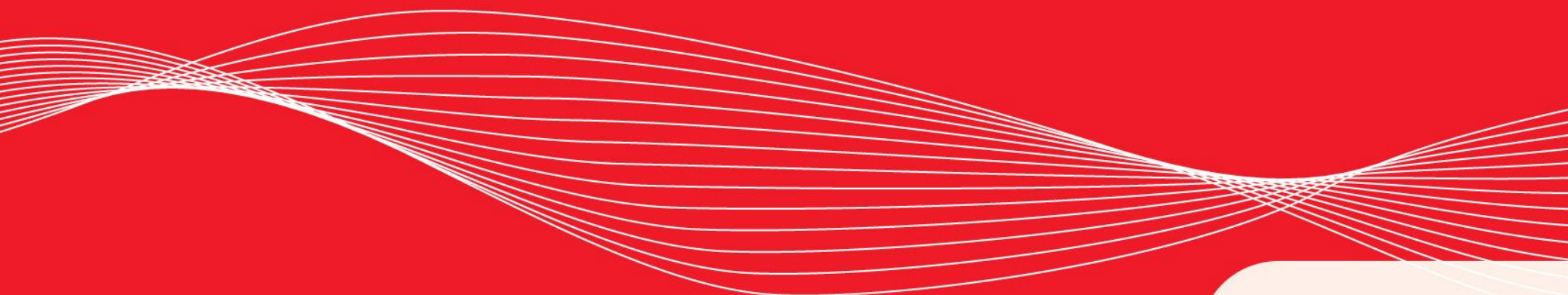


EMPIRE XPU Tutorial

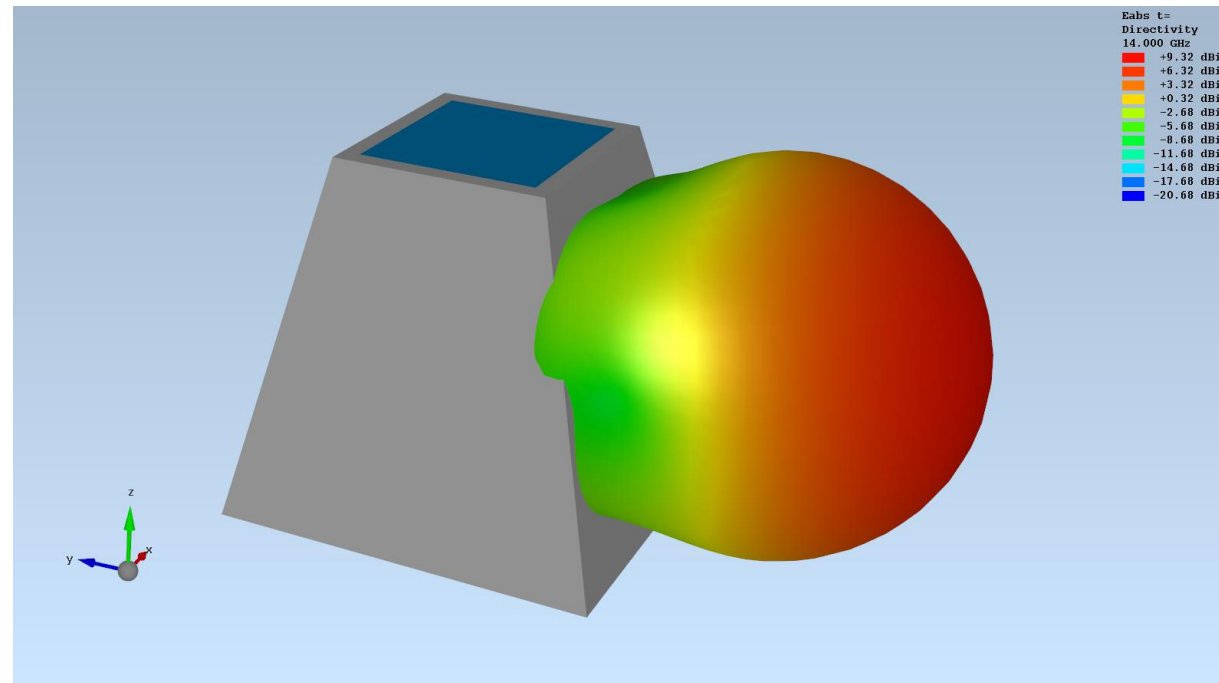
3D Design – Conformal Antenna



Overview: Topics

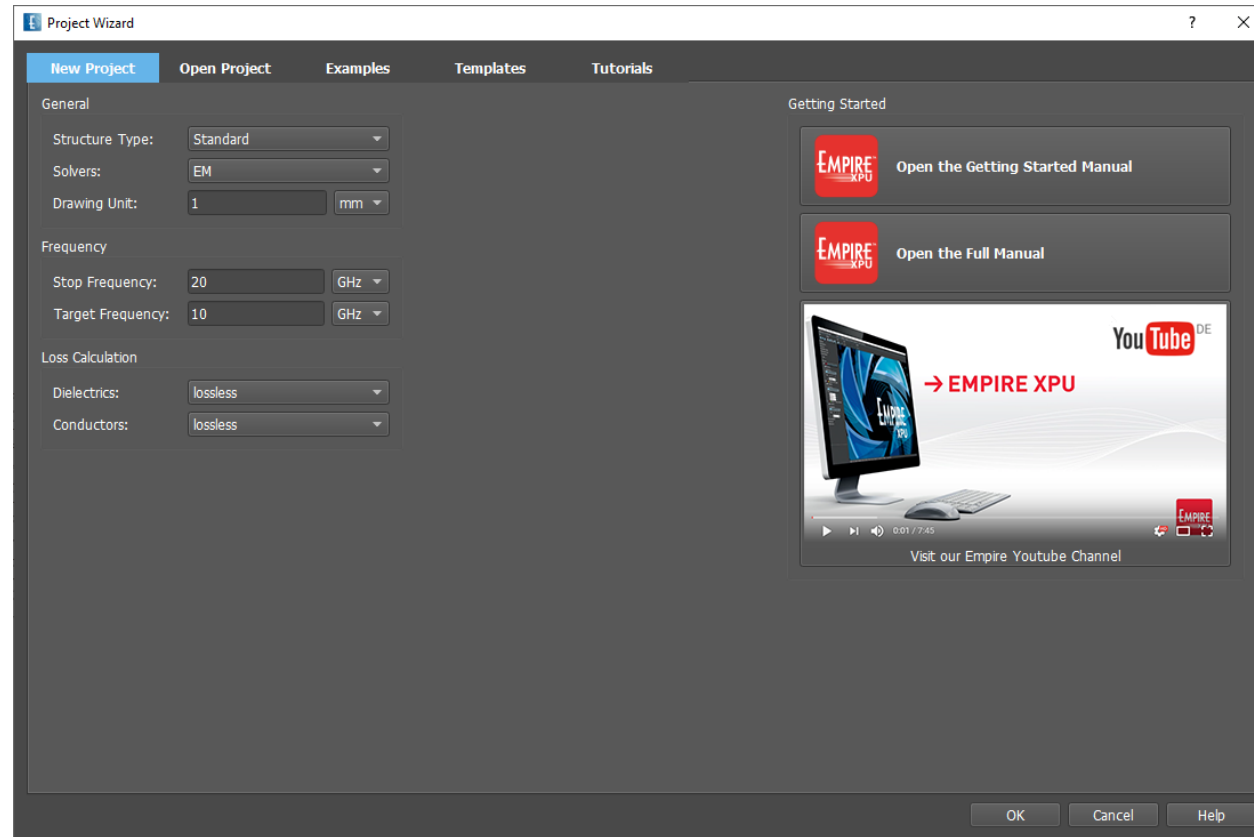
- Start from scratch
- 3D structure definition
- Local Coordinate System
- Polygon in LCS
- Wire Ports in LCS
- Mesh hints

- S-Parameters, impedances
- Far field



Step 1: Start

- Start Empire XPU 8.00 from Desktop
- Click „New Project“
- Set „Drawing Unit“: 1 mm
- OK
- Choose File → Save as
- Create new project folder “Conformal” and save file

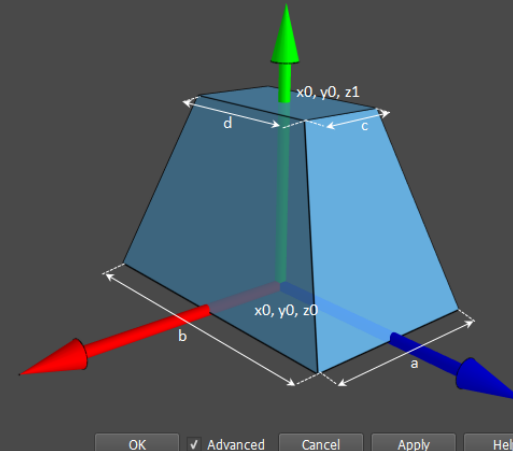
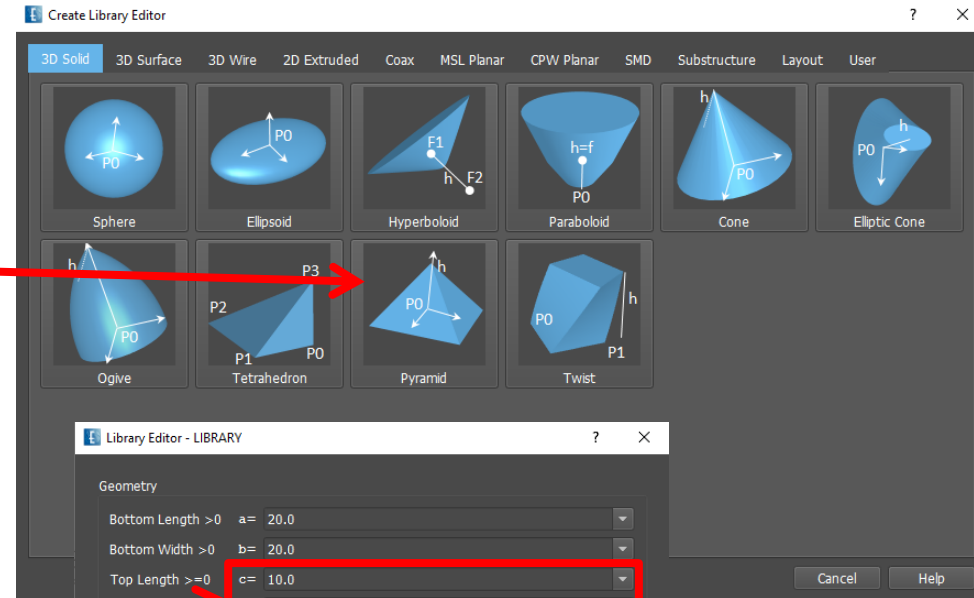
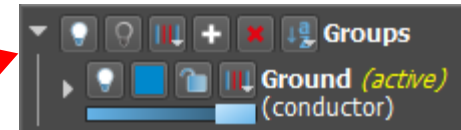


Step 2: Ground

- Open „Groups“ on left
- Right click on „#001“ select „Edit Name“
- Enter „Ground“ as name
- Click „Create Library Object“
- Select Pyramid
- Left click at $x=-10, y=-10$
- Left click at $x=10, y=10$
- Set height to $z=20^{**}$
- Click „Edit Settings“
- Adjust values:
Top Length: 10
- Top Width: 10
- Click OK

Comments:

- *Zoom in to access values with cursor*
- *** Zoom out to access value*

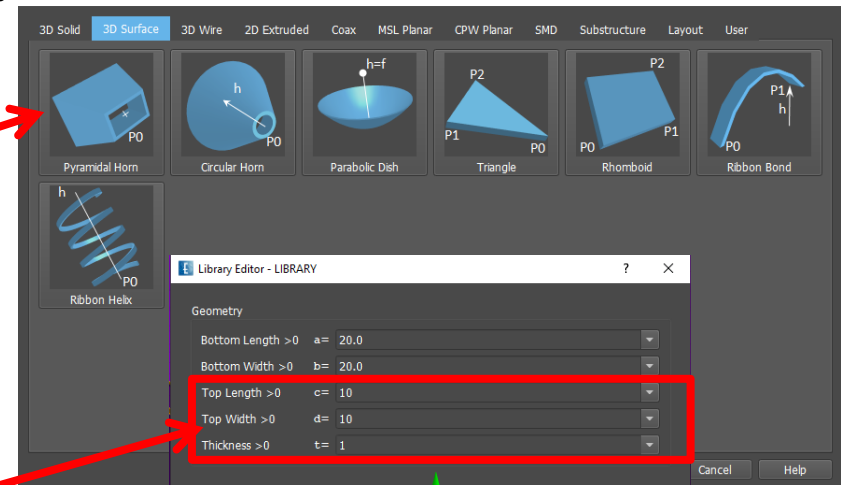


Step 3: Substrate

- Click „Create Group“
- Rename Group to Substrate
- Open group, double click „Property“
- Select „Dielectric“, Enter 2.2 as Rel. Permittivity, Click OK

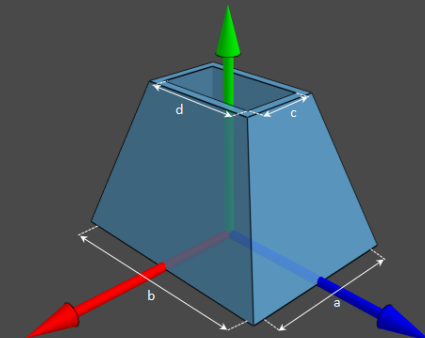


- Click „Create Library Object“
- Select 3D Surface – Pyramidal Horn

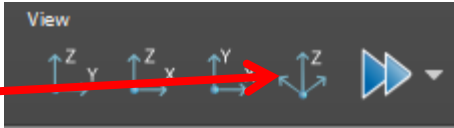


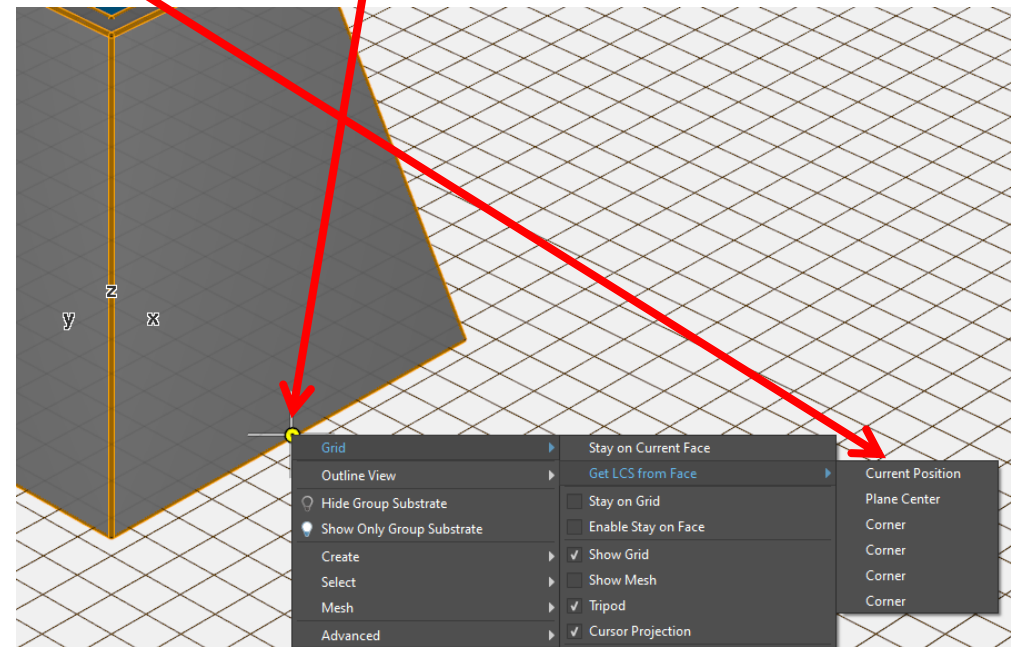
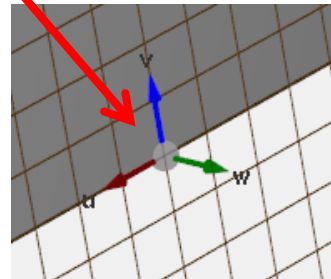
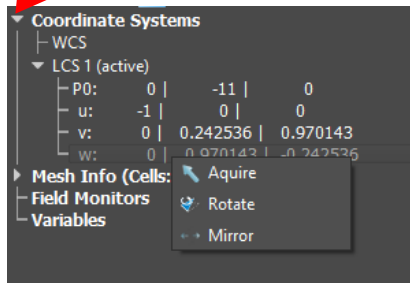
- Click at $x=-10, y=+10, z=0$
- Click at $x=+10, y=-10, z=0$
- Click at $z=20$

- Click „Parameters“ on the left
- Adjust values:
Top Length, Top Width=10,
Substrate thickness $t=1$
- Click OK



Step 4: Local Coordinate System



- Select Iso z View 
- Right click on center of edge (yellow snap point: center edge)
- Select „Grid“ – „Get LCS from Face“ – „Current Position“
- Open Coordinate System – LCS1
- Right click on „w“, apply „Mirror“ for the axes to obtain orientation:



Comments:

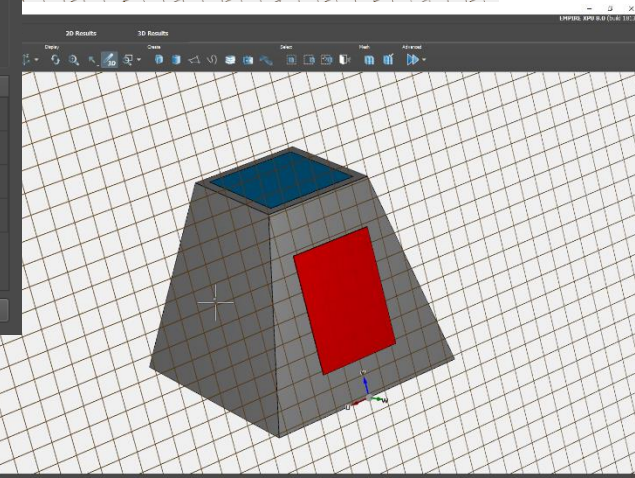
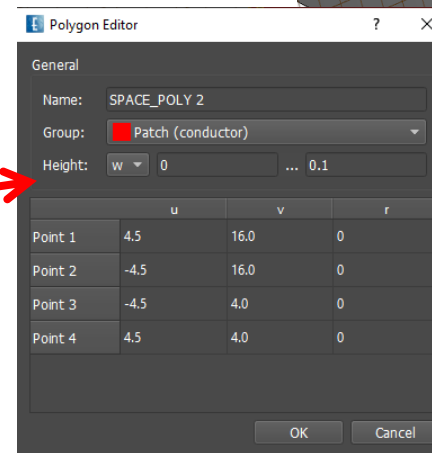
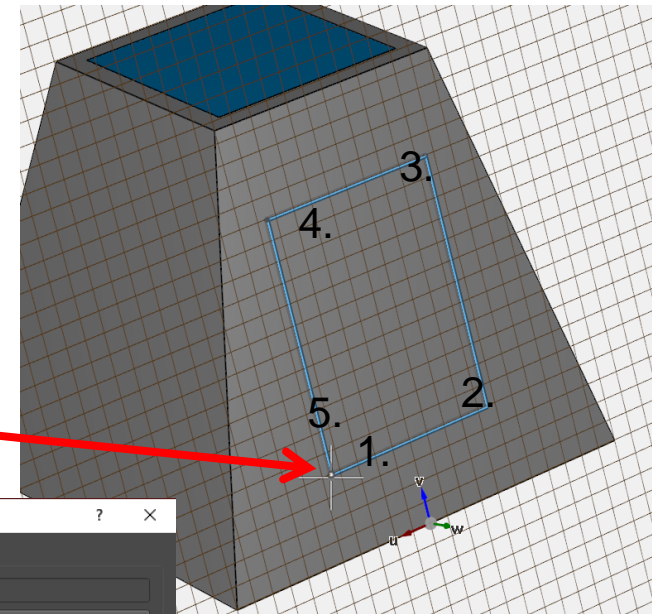
- An LCS can be defined on any surface
- w is always orthogonal, u is chosen to be parallel to one edge
- Here, it is advantageous that u is parallel to lower edge

Step 5: Patch

- Click „Create Group“
- Rename group to „Patch“ (red color)
- Zoom in (wheel forward)
- Click „Create Polygon“ 
- 1. Left click at $u=4.5$ $v=4$
- 2. Left click at $u=-4.5$ $v=4$
- 3. Left click at $u=-4.5$ $v=16$
- 4. Left click at $u=4.5$ $v=16$
- 5. Left click at $u=4.5$ $v=4$ to close
- Zoom in
- Left click at $w=0.1$
- Check Points 
- Zoom extents

Comments:

- After creation the point list is displayed. Coordinates and height can be adjusted if needed

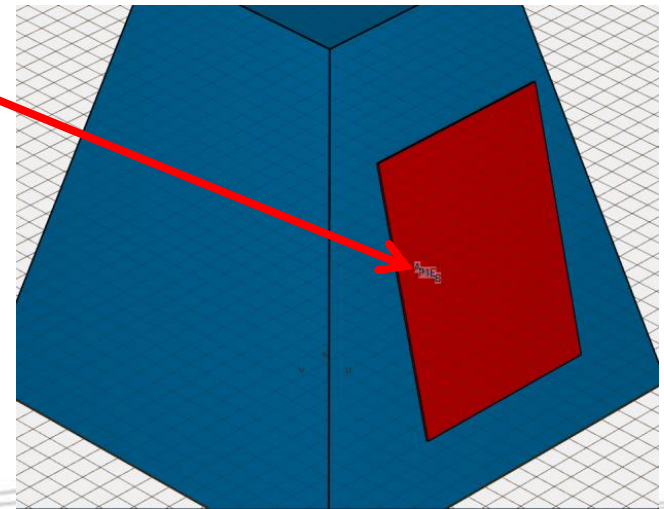
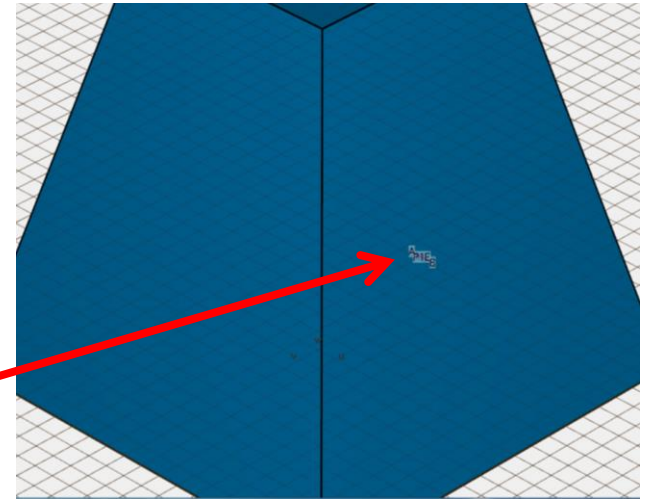


Step 6: Port

- Create group Port
- Switch off groups „Substrate“ and „Patch“ (click light bulb)
- Click „Create Source“
- Select tab „Lumped“, choose „Wire Port“
- Left click at $u=2.5, v=10.5, w \sim -1$ (Face)*
- Switch on group „Patch“ (click light bulb)
- Left click at $u=2.5, v=10.5, w=0.1$ (Face)*
- Switch on group „Substrate“
- Click on „Simulation Setup“ - Tab „Mesh“
- Set „Mesh Hint“ $y = „\text{min } 0.1“$ **
- Set „Mesh Hint“ $z = „\text{min } 0.1“$ **
- Close OK

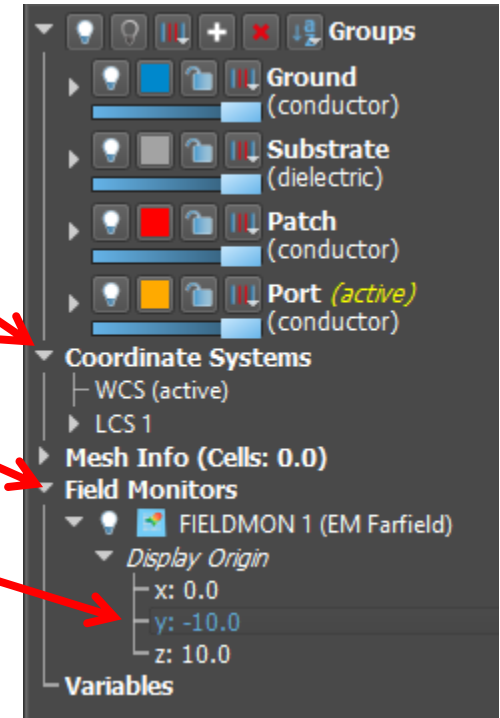
Comments:

- * Due to surface snap coordinates are dependent and w is determined automatically
- ** A minimum cell size is entered to avoid very dense meshing in the port area



Step 7: Monitor & Simulation

- „Coordinate Systems“ – Right Click on „WCS“
- Select „Set Active“
- Right Click on „Field Monitors“
- Select „EM Far field“ – „Boundary“
- Keep Settings, Click OK
- Open Field Monitors – FIELDMON 1 – Display Origin
- Double Click on y, enter „-10“*
- Click „Start Simulation“
- Confirm OK



Comments:

- *The Display Origin is used for position the 3D pattern relative to structure

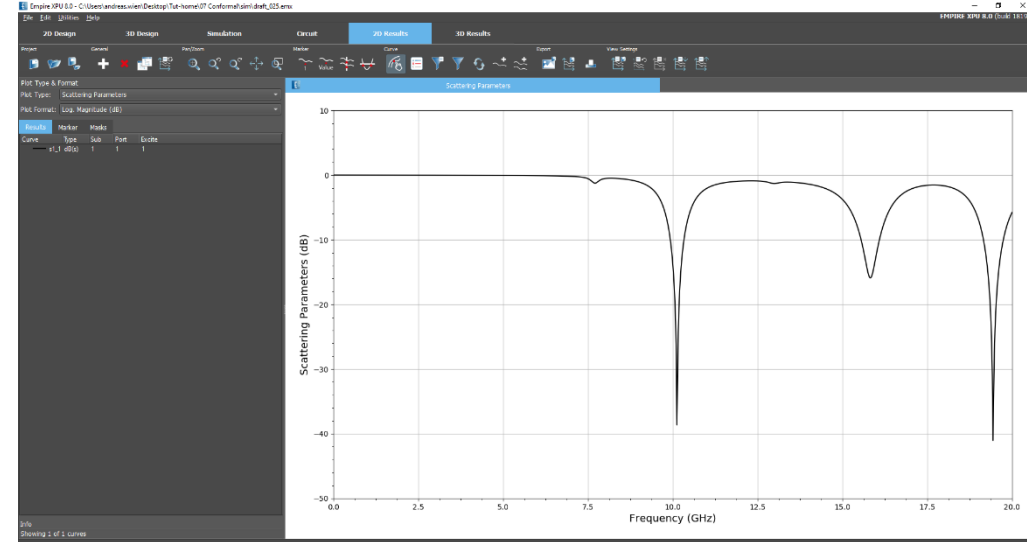
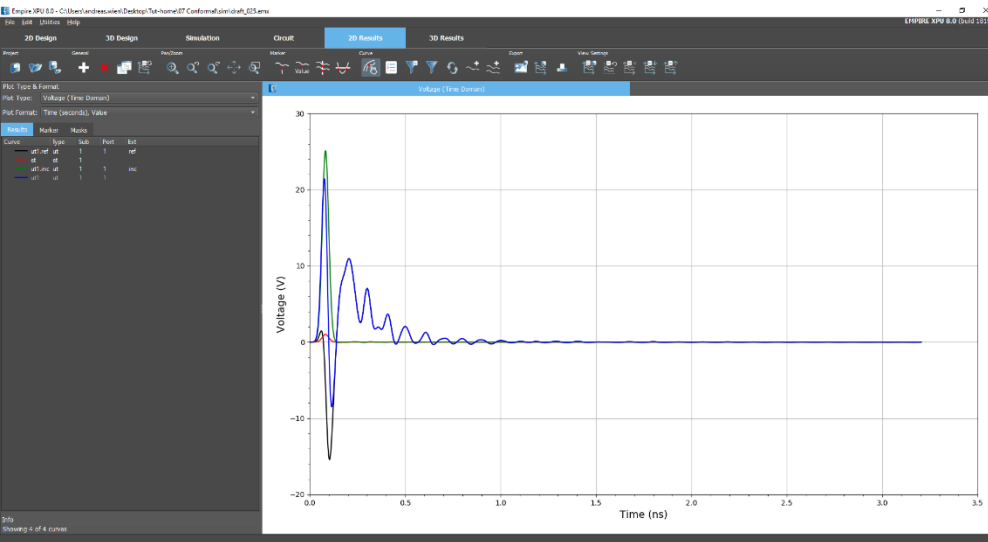
Step 8: Results

- Wait for State: Finished

Status	
State:	Finished
Remote:	-
Time:	01:21
Steps:	23508
Time to finish all Steps:	
Performance:	712 MC/s
Warnings:	0
Errors:	0
Energy Dec. (E/H):	49/49 dB
Field Monitor Conv. Error:	0.0%

Tab 2D Results – Plot Type: Voltage (Time Domain)

Plot Type: Scattering Parameters



Comments:

- Click Update button to refresh list



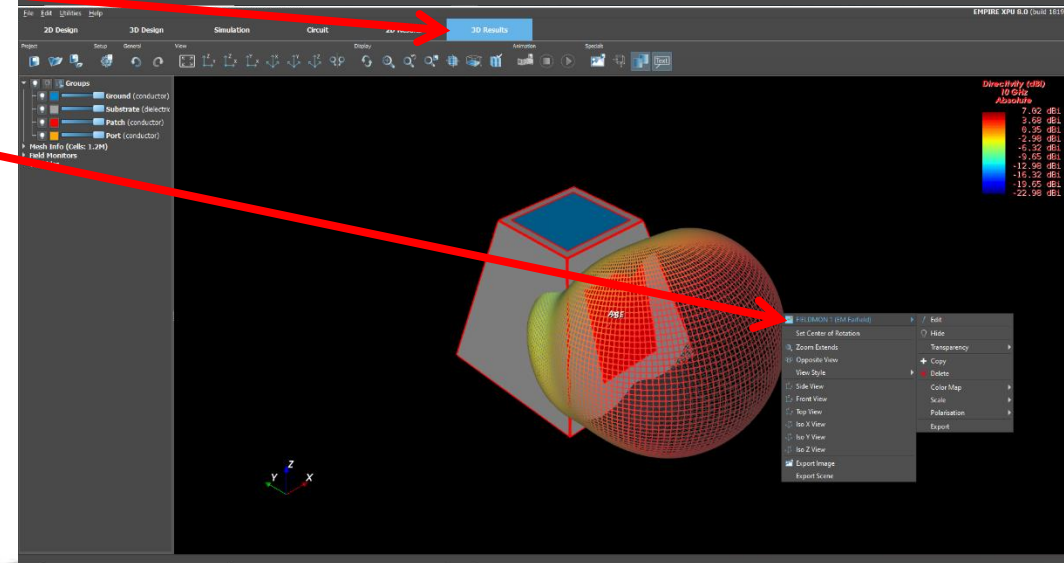
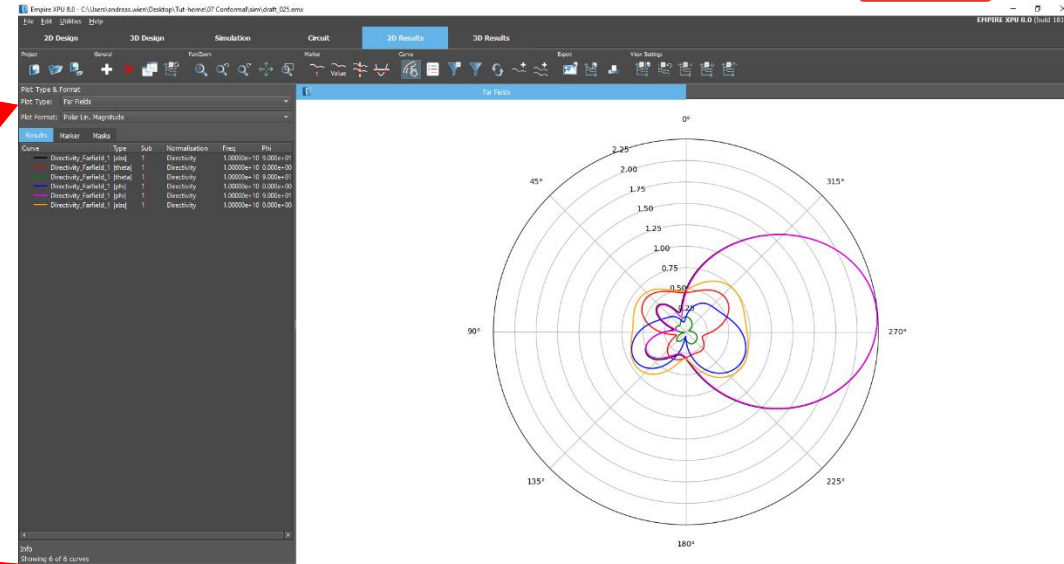
Step 9: Far field

- Plot Type: Farfield
- Plot Format: Polar Lin. Magnitude

- Select 3D Results Tab
- Choose Iso Z view
- Right click on pattern
- Select “Edit”
- In “Display” options set „Plot Style“ = Wireframe, OK

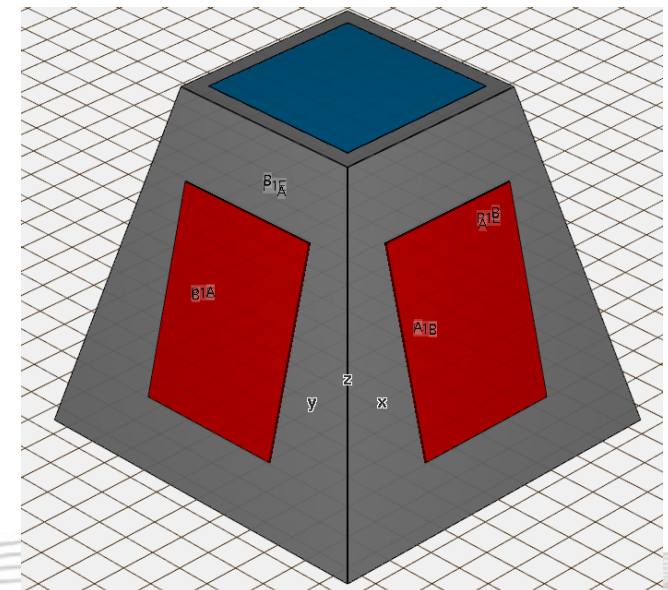
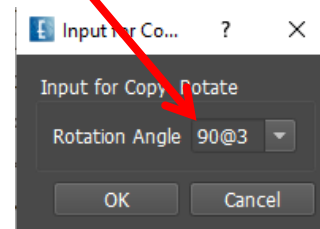
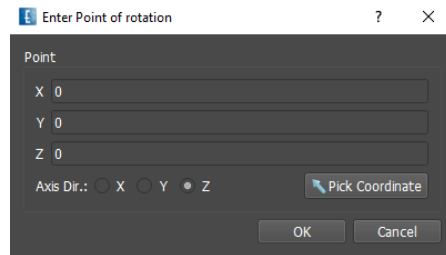
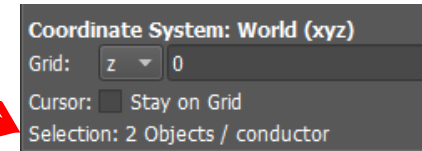
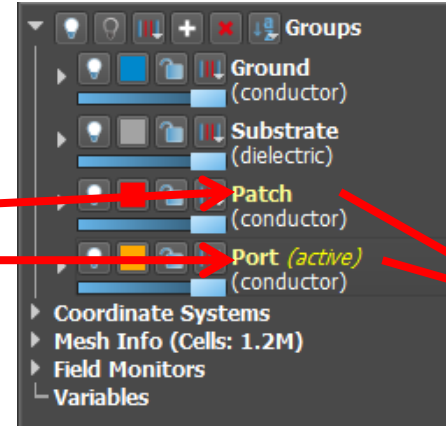
Comments:

- By default, the absolute component is selected in 3D display. Select other components by choosing “Polarization”



Step 10: Option: Array definition

- Save as “array”
- Switch to 3D Design tab
- Right click on Patch “Select Group’s Objects”
- Right click on Port “Select Group’s Objects”
- Click „Copy & Rotate“
- Keep Point and Axis x:0, y:0, z:0
- Click Ok
- Enter „90@3“ for 3 copies with 90 degree rotation

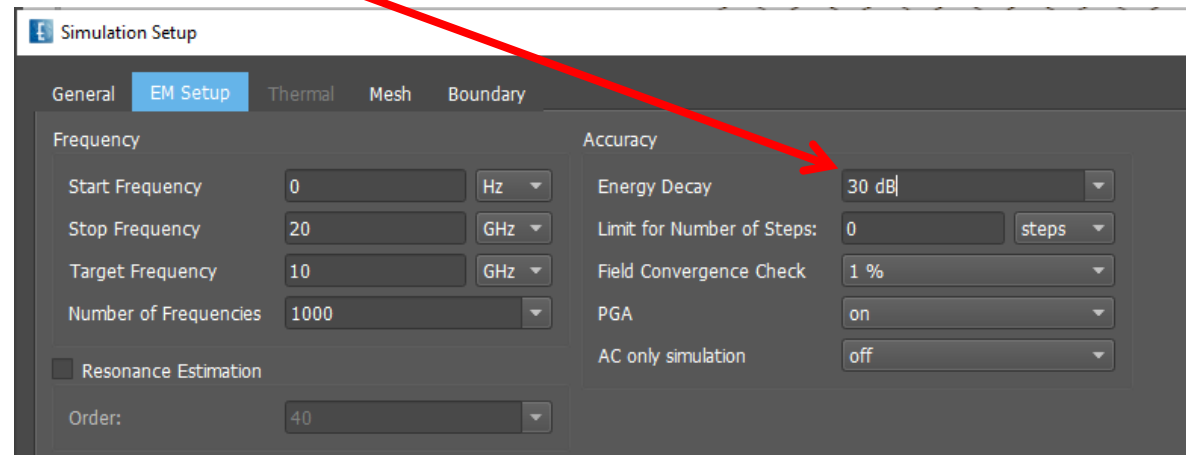
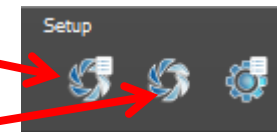
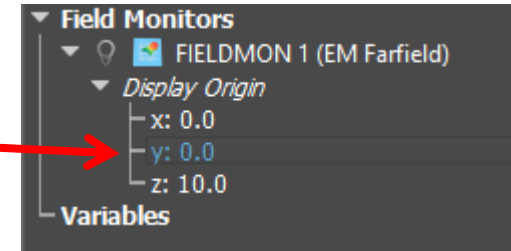


Comments:

- *Optionally “Load Project”: File/Single_Patch.emx to begin with Step 10*

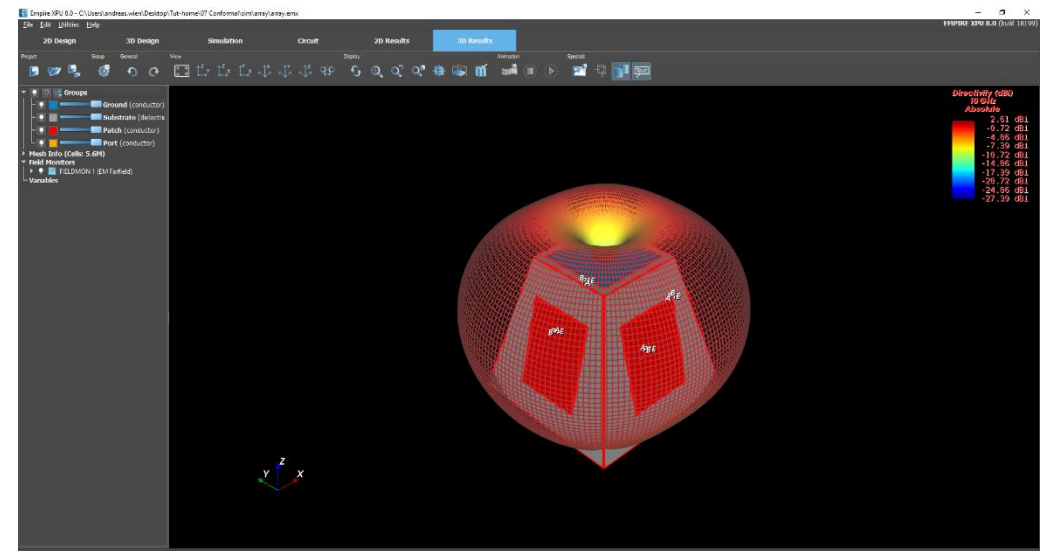
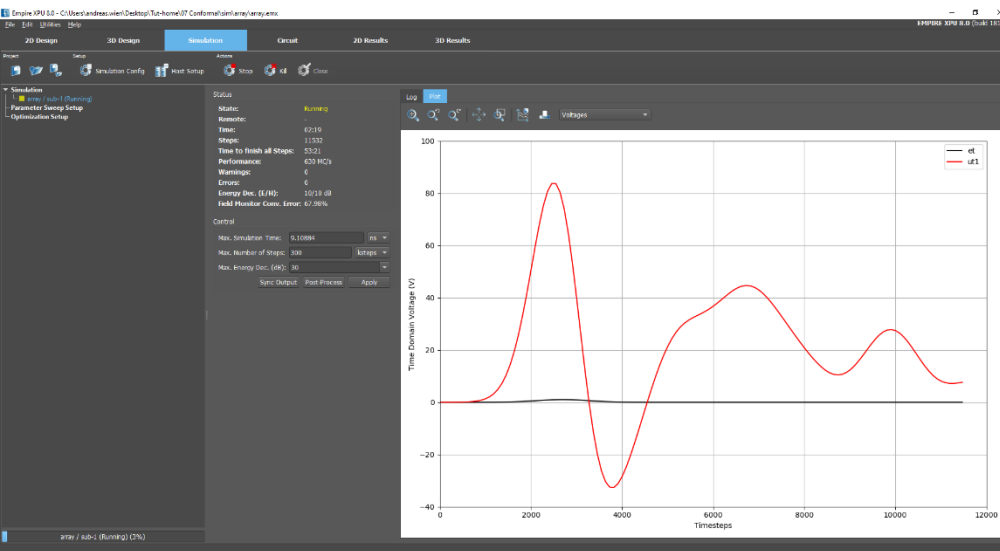
Step 11: Option: Array Setup

- Open Field Monitors, FIELDMON 1
- Set Display Origin to $y=0$
- Open Simulation Setup
- Switch to EM Options tab
- Set Energy Decay to '30 dB' to shorten simulation time
- Close Window
- Start Simulation
- Confirm OK



Step 12: Array Far field

- Simulation Tab - Voltages
- When finished select 3D Results Tab



Comments:

- Simulation progress: Energy, Field monitor convergence, Speed or Port Voltages over time steps
- Simulation is finished when either:
 - a. Energy & Field Monitor Convergence limits are reached
 - b. Maximum number of time steps is reached

Step 13: Option: Array Coupling

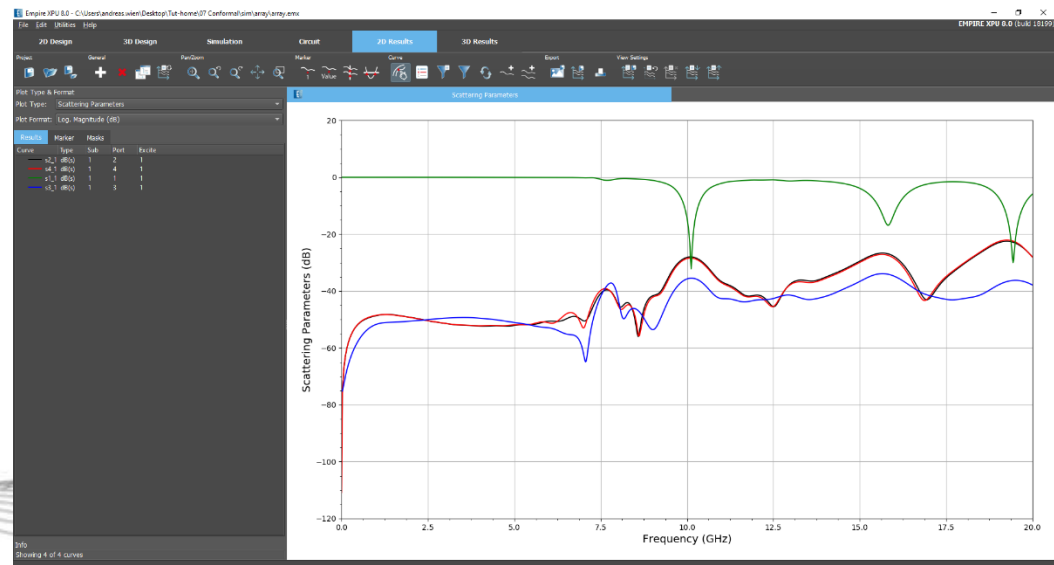
- Switch to 3D Design tab
- Click “Port Setup Wizard”
- Enter unique numbers for each port (double click on number)
- In Excitation column, deselect all but one port
- Click OK
- Run Simulation
- S-Parameters in 2D Results



Port Editor

Table Style: Detail View

Number	Excitation	Group	Amplitude	Load Impedance	Phase (Delta)
1	<input checked="" type="checkbox"/>	Port (conductor)	1	50	
2	<input type="checkbox"/>	Port (conductor)	1	50	
3	<input type="checkbox"/>	Port (conductor)	1	50	
4	<input type="checkbox"/>	Port (conductor)	1	50	



Comments:

- If Port 1 is excited the following S-parameters will be calculated in result folder sub-1:
- s_{11} , s_{21} , s_{31} , s_{42}