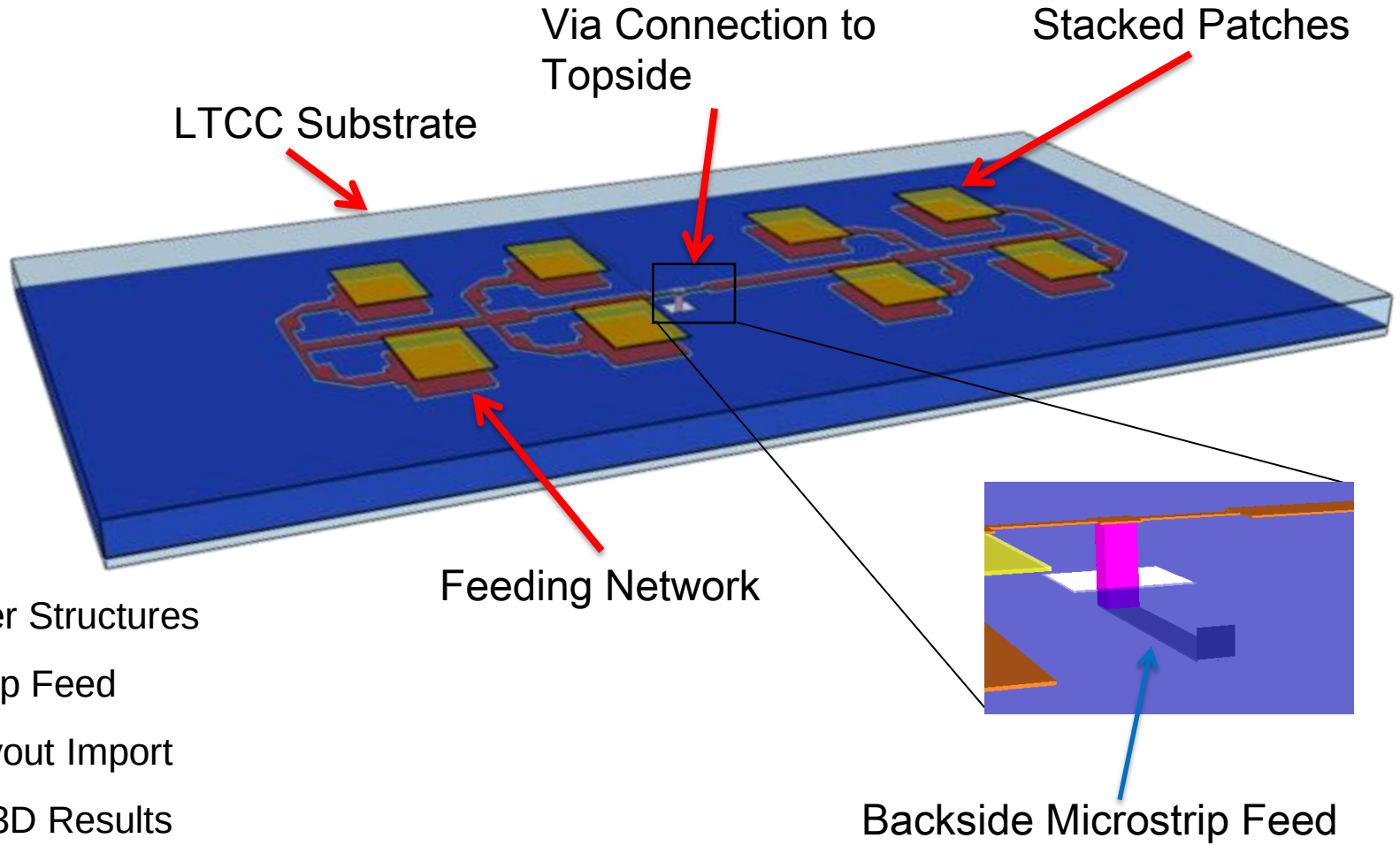
EMPIRE XPU Tutorial

Array Antenna with Feeding Network

Overview: Topics



- Multilayer Structures
- Microstrip Feed
- DXF Layout Import
- 2D and 3D Results

Step 1: Start

- Start Empire XPU
- Select „**New Project**“ Tab, OK
- File – Save As (create new folder)
- Enter file name, e.g. **array**

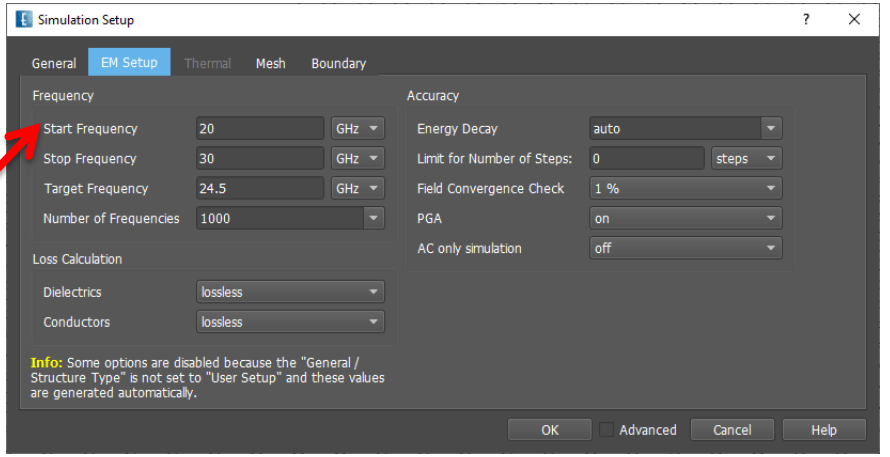
- Click “Simulation Setup“ 
- Select “**EM Setup**” Tab

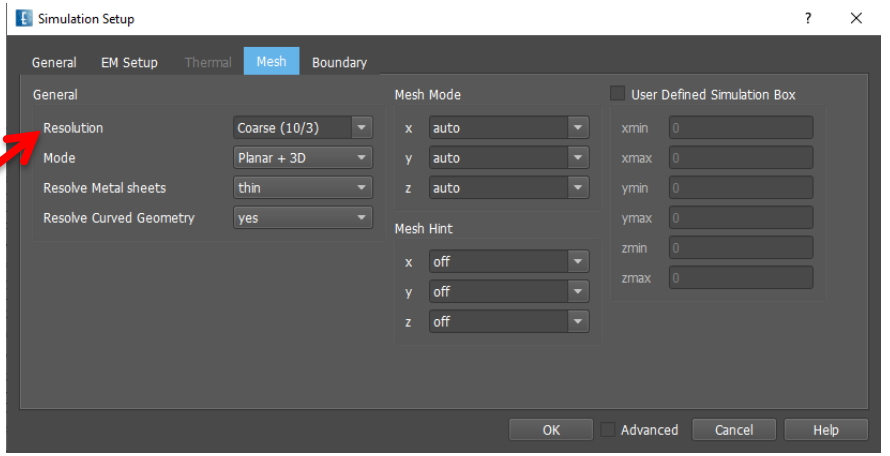
  Start Frequency: **20 GHz**

  Stop Frequency: **30** GHz

  Target Frequency: **24.5** GHz

- Select „**Mesh**“ Tab
- Set Resolution: **Coarse (10/3)**
- Confirm OK, Close OK



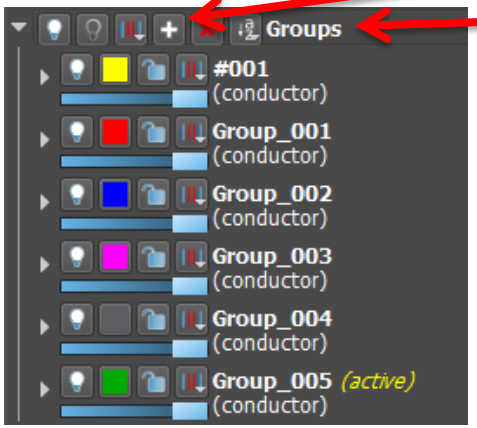


Comment: Coarse (10/3) means:
- *Minimum 10 cells per minimum wavelength*
- *Minimum 3 cells for each object‘s bounding box*

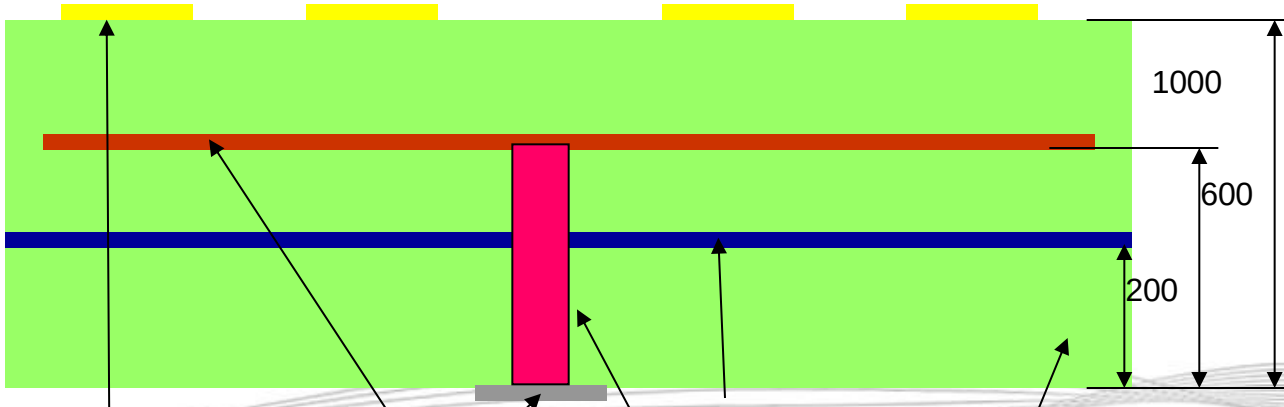
Step 2: Create Layer Stack

Group Tree Editor

Name	Status	Objects	Dir.	Start	Stop	Physical Property
Groups						
Top	Modified	0	z	1000	1015	conductor
04	Modified	0	z	600	615	conductor
Ground	Modified	0	z	200	215	conductor
Via	Modified	0	z	0	600	conductor
Microstrip	Modified	0	z	-15	0	conductor
Substrate	Modified	0	z	0	1000	dielectric name Dupont-951 prio 100 epsr 7.8 tand 0.005



- Click “Add Group” 5 times, recolor groups
- Right Click on “Groups”, select “Edit Group Tree”
- Double-click and edit Names, Start & Stop Values
- Change “Substrate” property to Dielectric → Database → Dupont-951
- OK

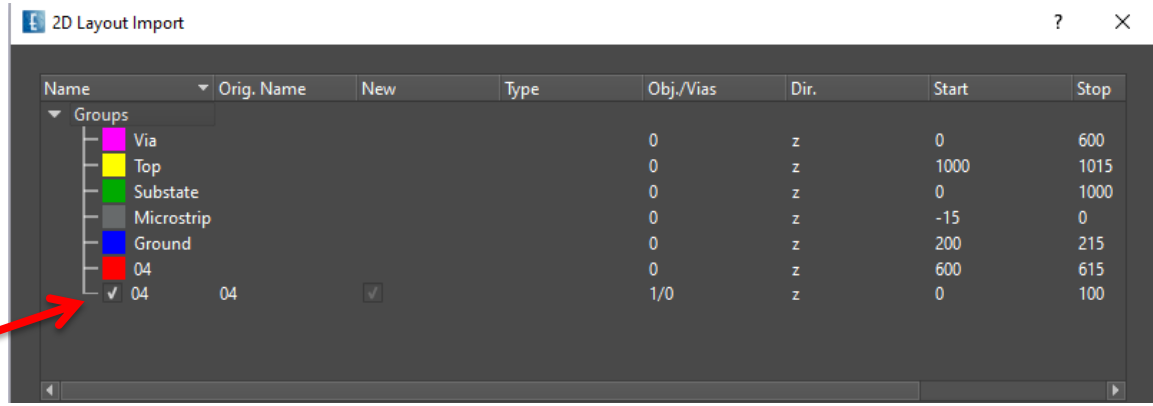


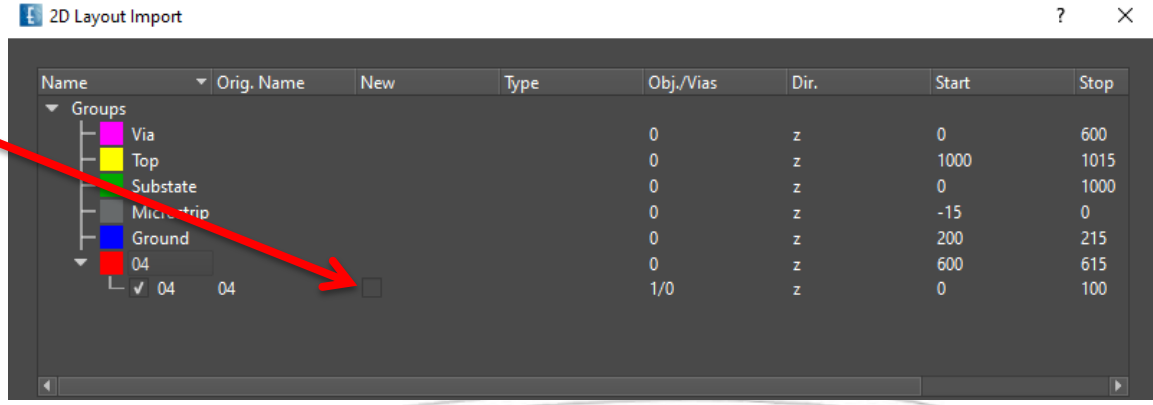
Metallization Thickness: 15 µm
Metallization conductivity: infinite
Substrate Material Dupont 951: ε_r =7.8
All dimensions in µm

Step 3: Feed Network

Comment: Top view display is always assumed as default during structure setup

- Select “2D Design” Tab
- Select File → Import → 2D Layout → Import DXF (2D)
- Locate and select network.dxf *
- Confirm File dialog
- Drag&Drop new group into group “04”
- Uncheck “New” checkmark
- Click OK



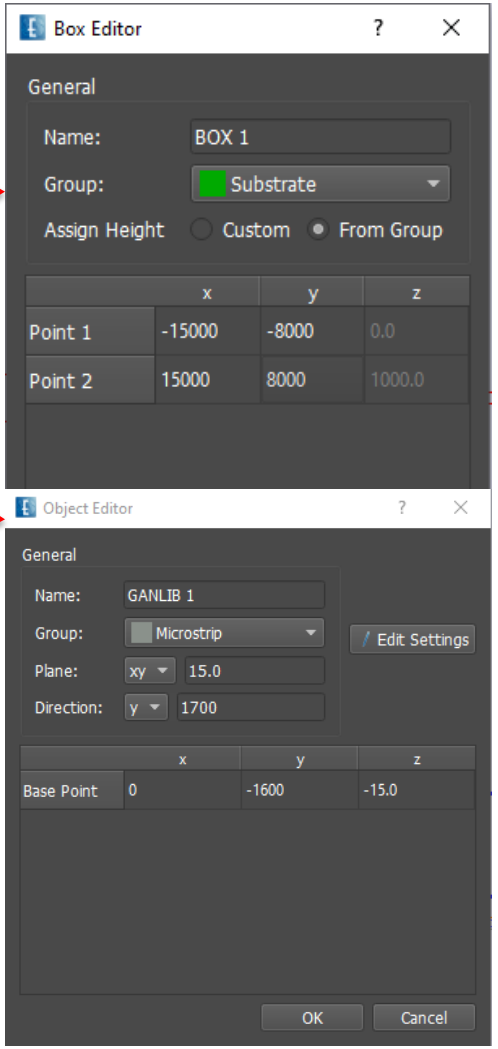


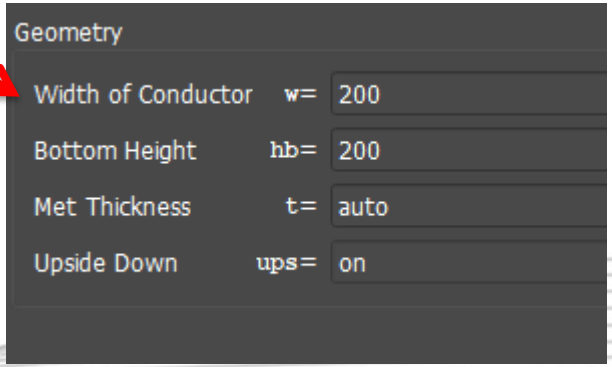
** e.g.*
C:\EMPIRE_XPU_8.01\Tutorials\2D Design\08 LTCC Array\data

Step 4: Substrate and Port

- Verify “active” group “Substrate”, (if not, set active with right click)
- Click Create Box 
- Set Point 1 x=-15000, y=-8000 Point 2: x=15000, y=8000
- OK, Zoom extents 

- Right click on “Microstrip”, Set Active
- Click ‘Create Source’  , Select ‘Planar’ – ‘MSL’
- Choose Direction y, 1700 (=port length)
- Base Point: x=0, y=-1600
- Click “Edit Settings”, checkmark “Advanced”
- Adjust values : w=200, hb=200, Upside down: on
- Click 2x OK

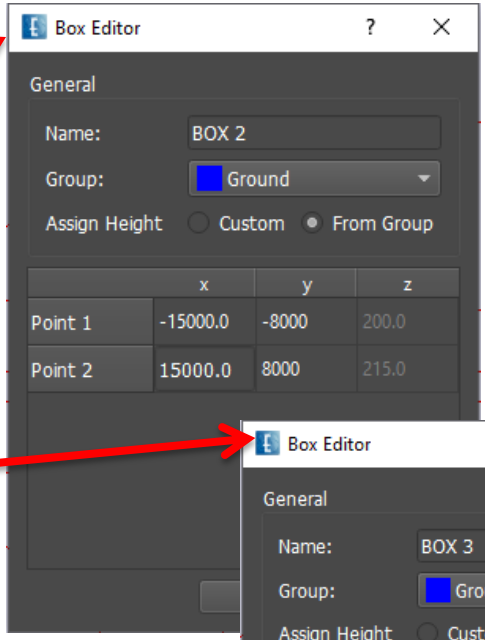


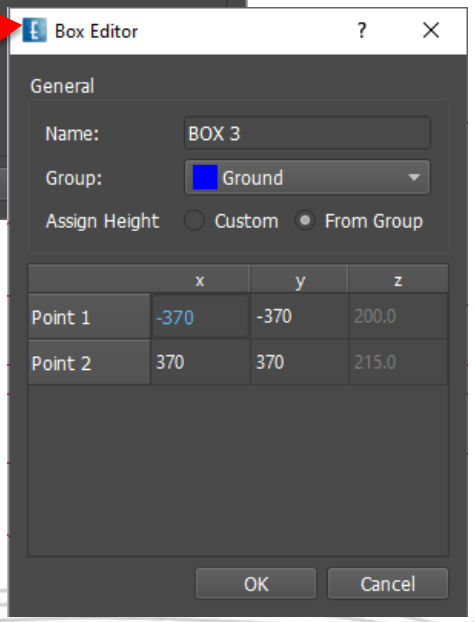


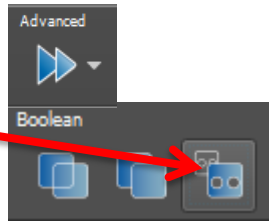
Comments:
• Z-values of the groups defined in Step 2 will be used.
• Upside down is chosen because ground plane of MSL above the strip
• Length of the MSL is chosen large enough to establish proper mode at port plane

Step 5: Ground Plane with hole

- Right click on “Ground”, Set active
- Click ‘Create Box’ 
- Point 1: x=-15000, y=-8000
- Point 2: x=15000, y=8000, OK
- Click ‘Create Box’ 
- Point 1: x=-370, y=-370
- Point 2: x=370, y=370, OK
- Right click on group “Ground”
- Choose “Select Group’s Objects”
- Click ‘Advanced – Boolean – Multiple Subtract’ to cutout a section for the via

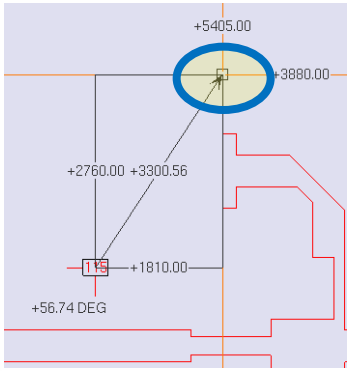






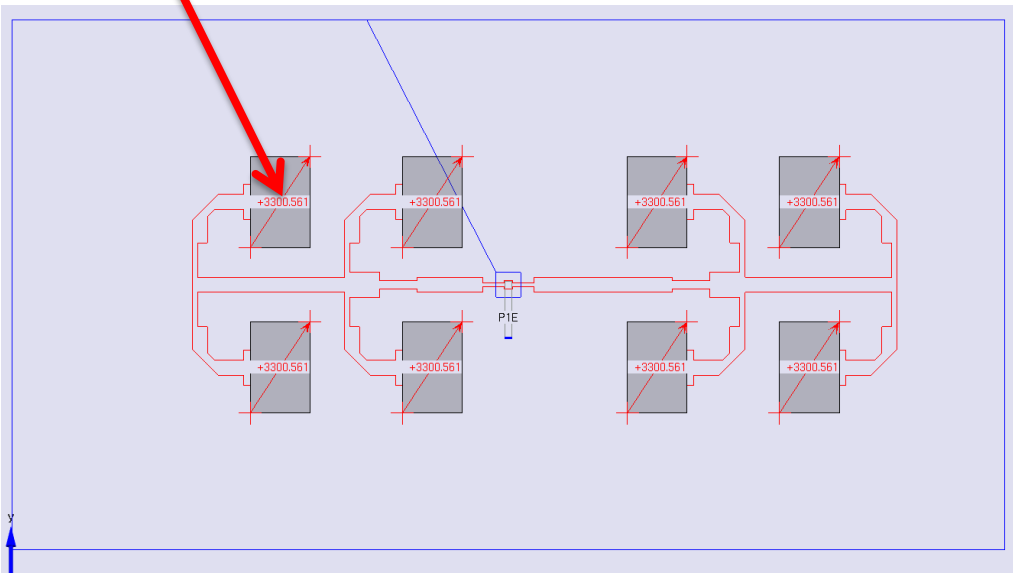
Comment: A cut-line is drawn to indicate that the result is a single object

Step 6: Stacked Patches and Via

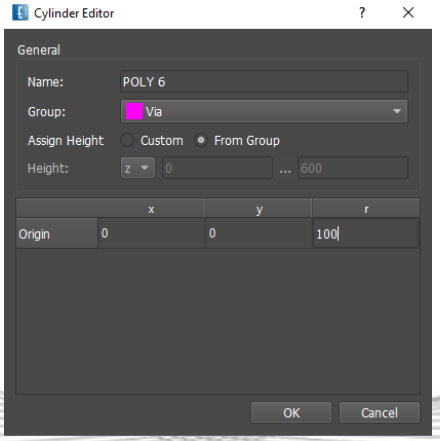


The square at the cursor indicates a snap to the corner of the object

- Activate group “Top” (set active)
- Draw arrows across all patches by dragging left mouse button (Hint: Use patch corners as reference)
- Click  to draw the Patches, OK



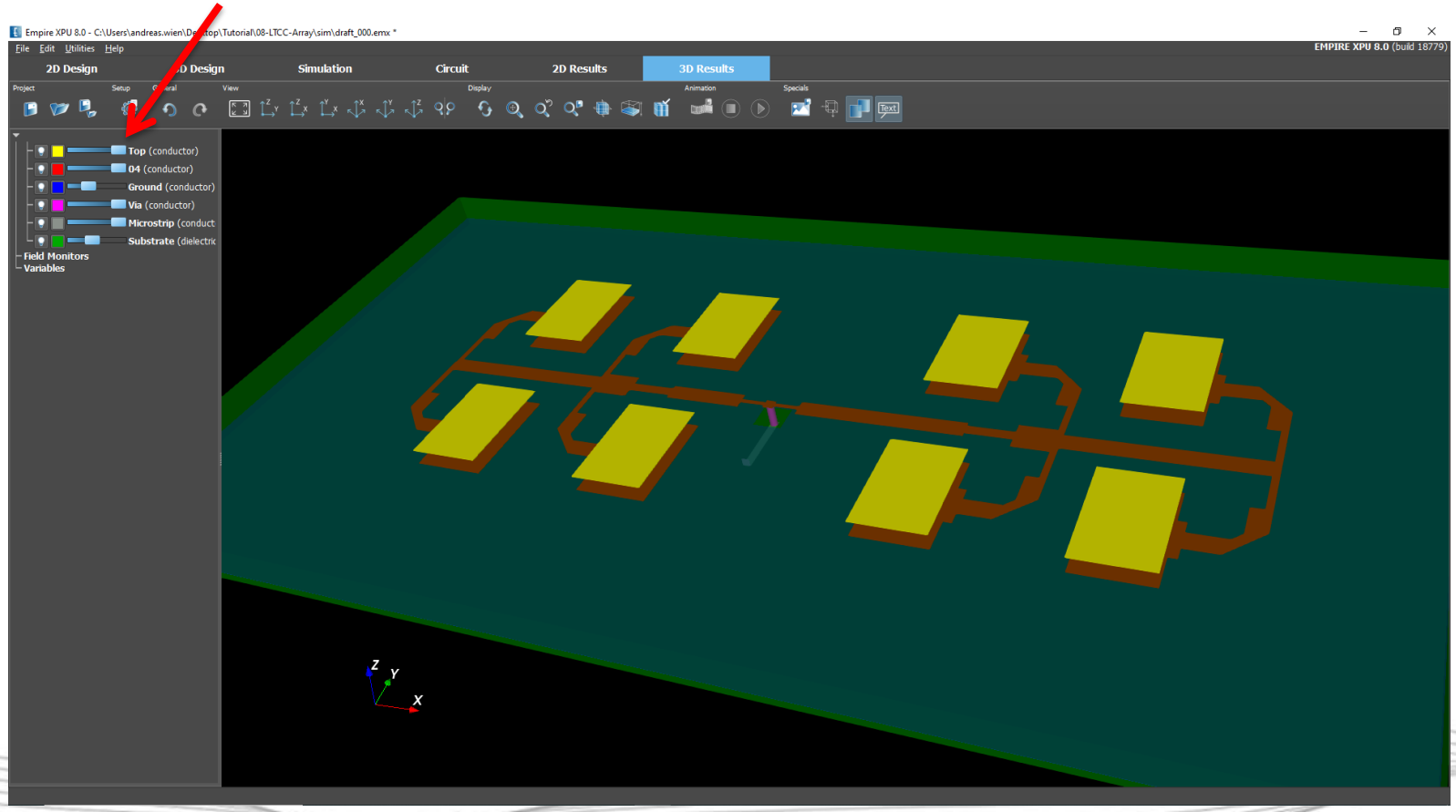
- Set group “Via” as active
- Click  ‘Create Cylinder’
- Set x=0, y=0, Radius r=100
- OK



Comment: Here, the object snap helps to draw the arrows to create boxes with the same cross section as the patches of the feeding network.

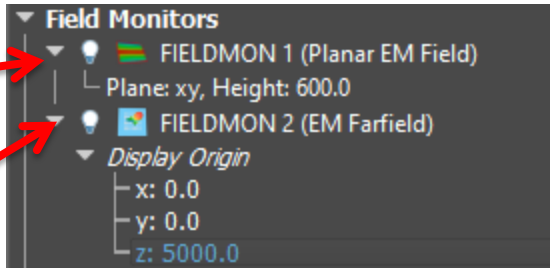
Step 7: Check Input

- Select “3D Results”
- Adjust groups transparency sliders as shown



Step 8: Field Recording

- Select “2D Design” Tab
- Click “Create Field Monitor” 
- Select - EM Field – ‘Plane’, OK
- Expand “Field Monitor” “FIELDMON 1
- Double click “Plane” - Enter xy=600



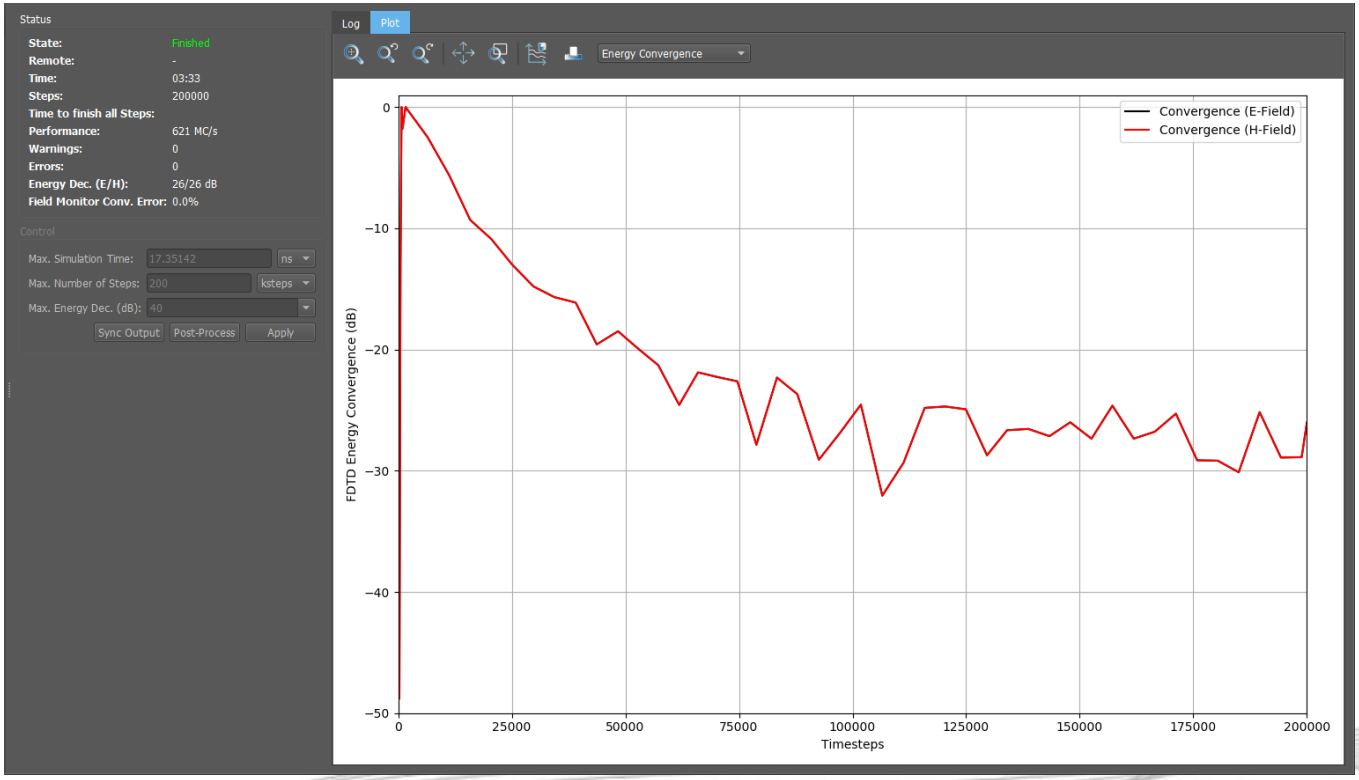
- Click “Create Field Monitor” 
- Select - EM Far Field monitor - Boundary, OK
- Expand “FIELDMON 2
- Set Display Origin x=0, y=0, z=5000*

*Point specifies far field center for display

Step 9: Simulation

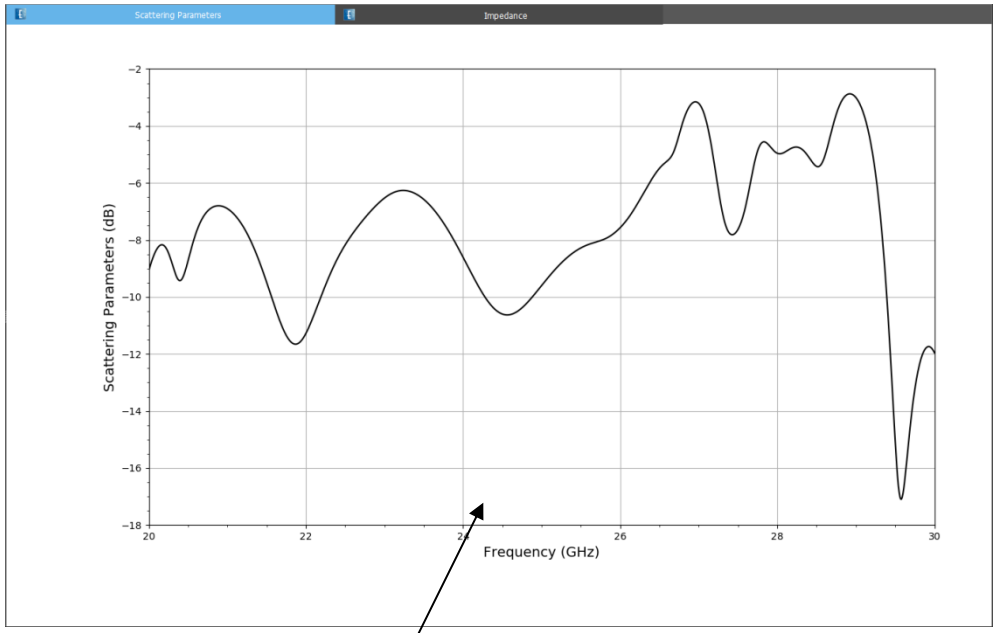
- Click “Start Simulation”, OK
- Wait to finish Simulation
- Check the results

Energy vs. timesteps



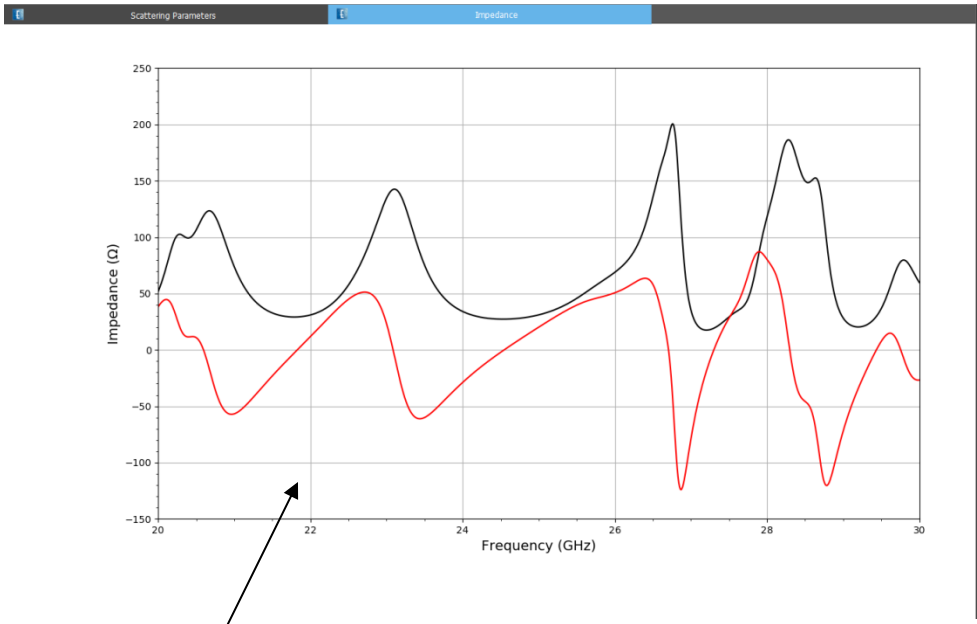
Step 10: Results

S-Parameter



S-Parameter plot is there per default

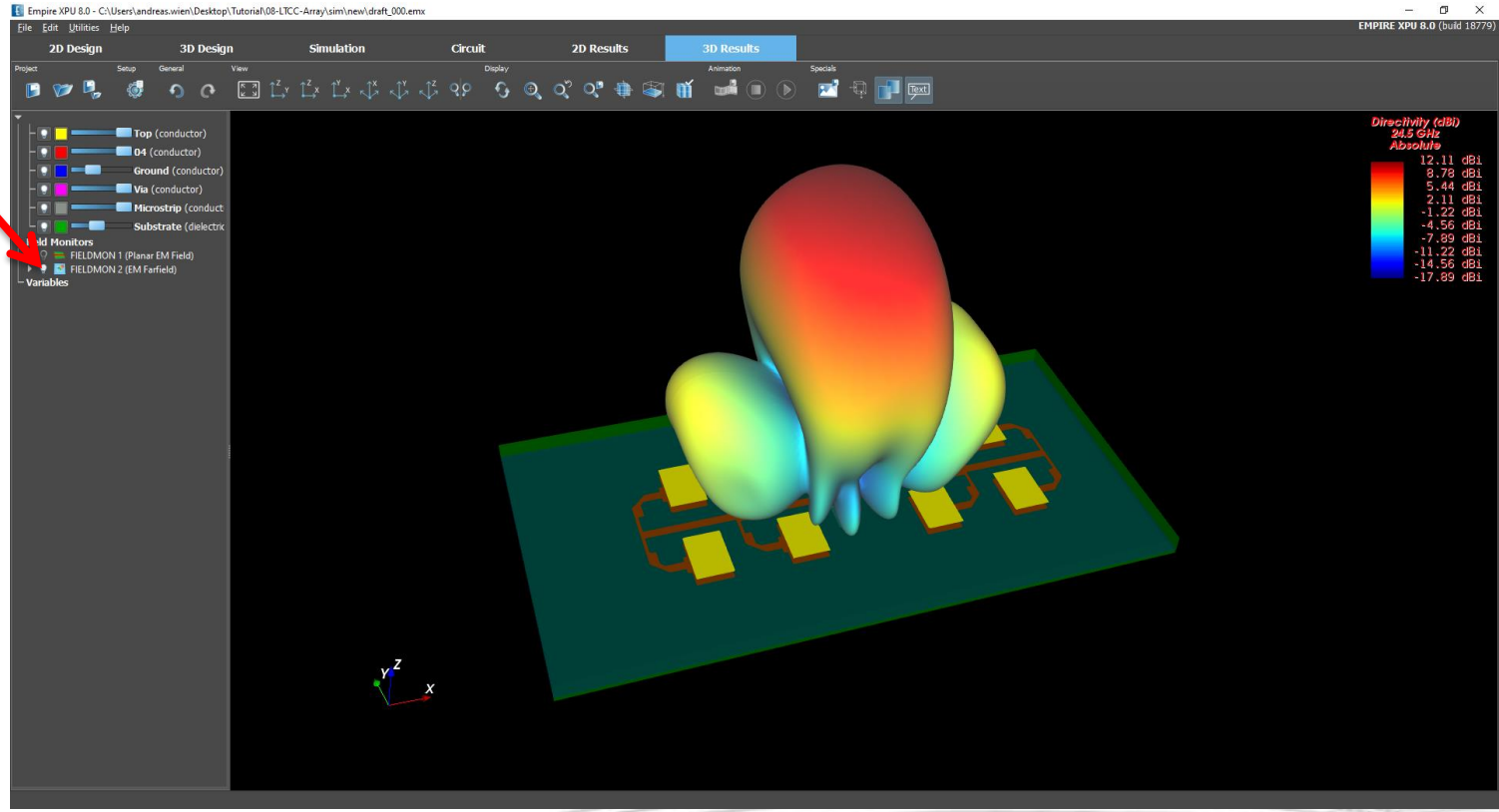
Impedance Z1.in



Click “Add Result” to add impedance plot

Step 11: Far Field Animation

- Return to 2D Design mode
- Switch On Monitor “EM Farfield”
- Switch to the 3D Results mode



Step 12: Near Field

→ Near Field Animation Definition

- Right Click on Planar EM Field – Edit
- Field Components: z
- Animation Loop Type : phase_loop_15_deg
- Field Plot Amplitude: 2500, OK

→ 3D Near Field Result

- Switch off visibility of “EM Farfield”, “Substrate” and “Top”
- Switch on visibility of “Planar EM Field”
- Start Animation in 3D Results tab