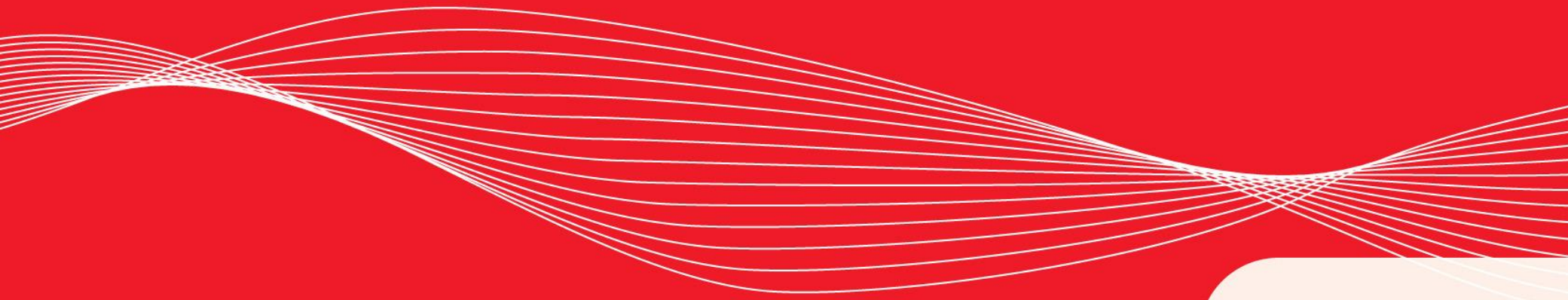
EMPIRE XPU Tutorial

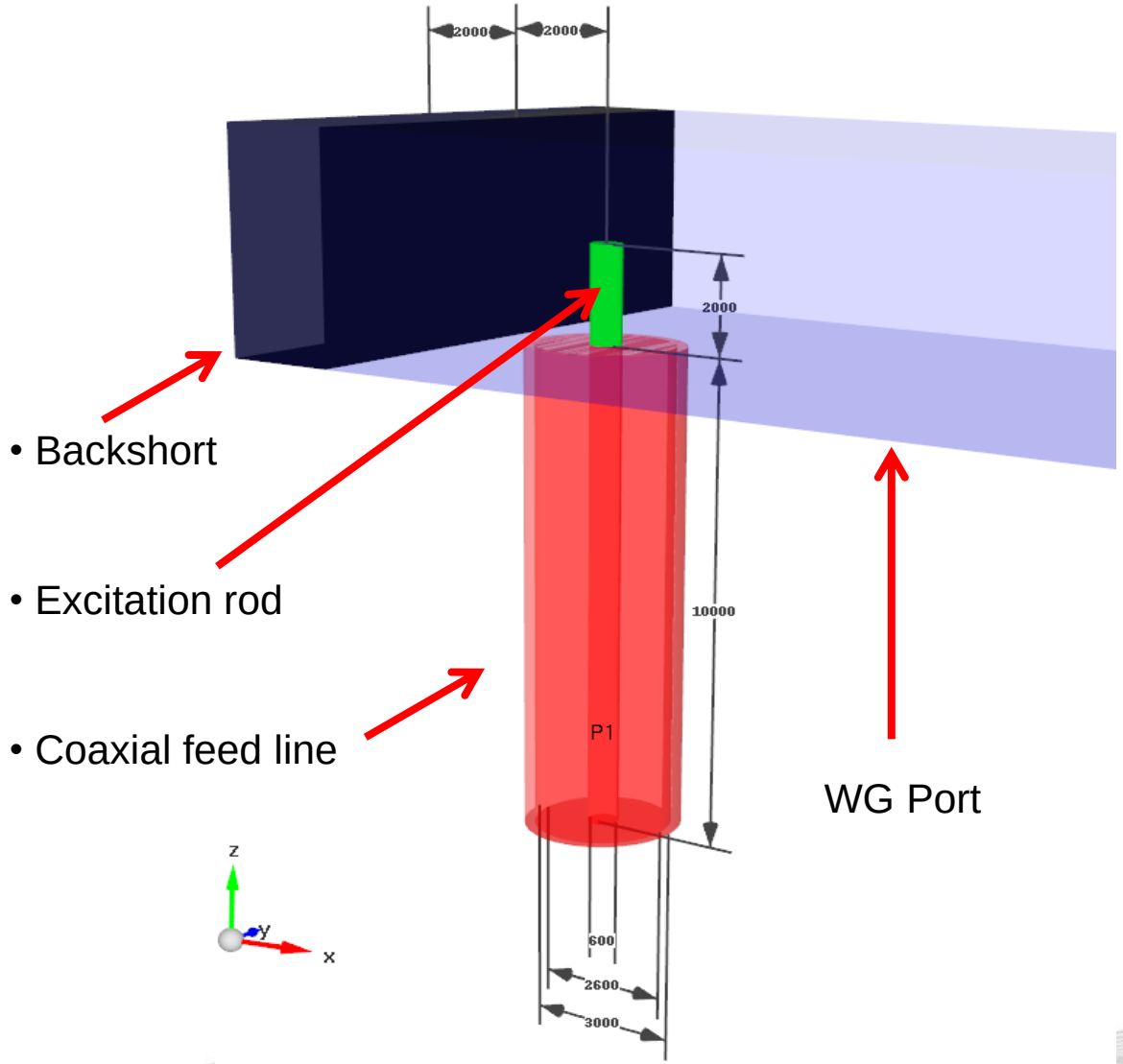
Waveguide Exciter



Topics and outline

Drawing Interface:
- Basic Features
- Waveguide Ports
- Coaxial Ports
- Priority Concept
- Parametric Objects

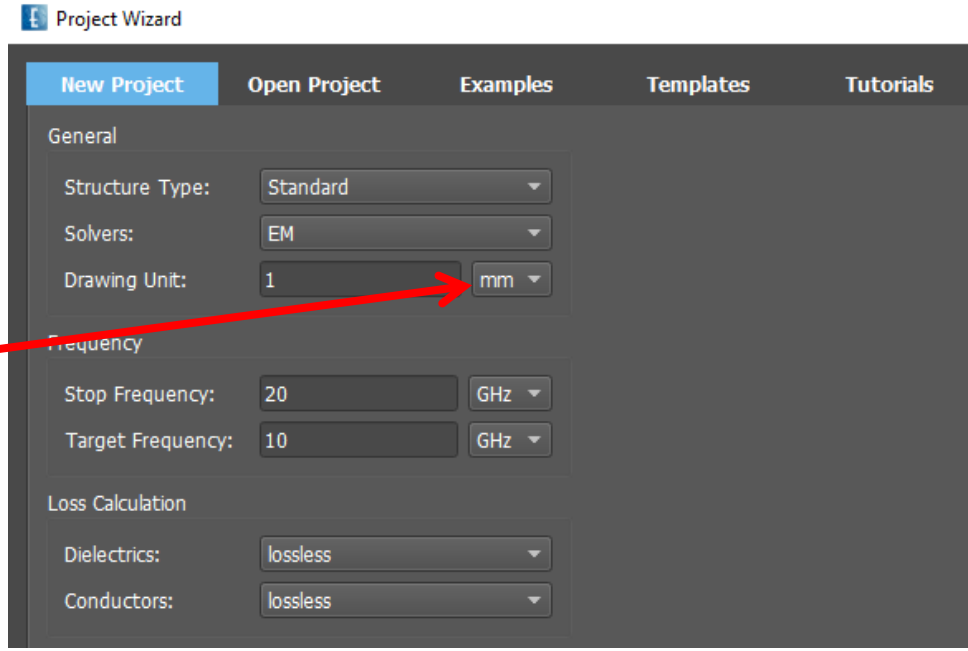
Processing Interface:
- Preprocessing
- Simulation Control
- Postprocessing
- Optimization



Step 1: Start

- Start Empire XPU 

- Select „New Project“ Tab
- Change „Drawing Unit“ to mm
- Click OK



- Select File → “Save As”
- Create new folder (e.g. on Desktop), save file

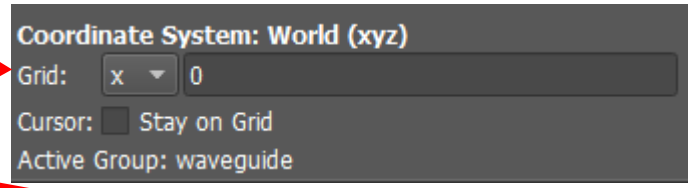
Step 2: Create Waveguide

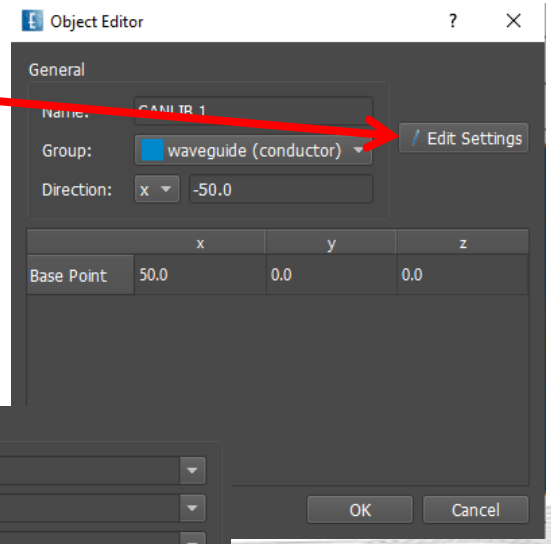
- Right click on #001, „Edit Name“ to „waveguide“

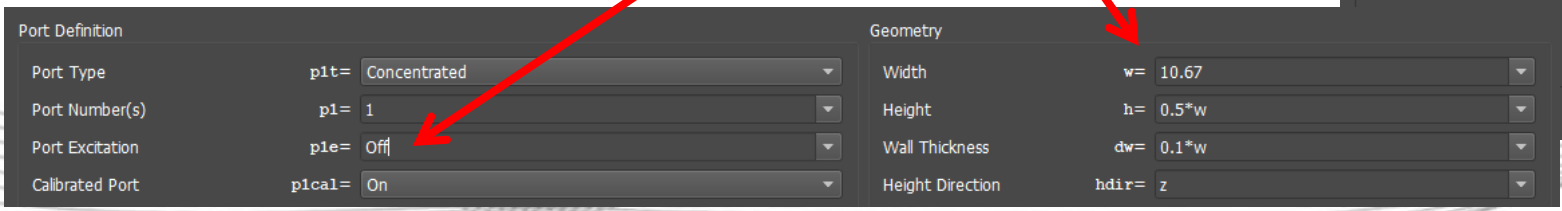
- Change grid from z=0 to x=0 (yz plane)

- Click Icon ‘Create Source‘
- Select ‘Waveguide‘ -> ‘Rectangular waveguide‘
- Left click at x=0, y=-5, z=-2.5
- Left click at dv=10, dw=5
- Zoom out* & left click to confirm du=50

- Click „Edit Settings“ in the editor
- In „Geometry“ adjust „Width“ to 10.67 (mm)
- Set „Height“ to ‘0.5*w‘
- In „Port Definition“ set „Port Excitation“ to Off
- Close Windows (OK)
- Zoom Extends (shortcut z)

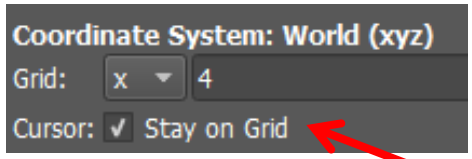






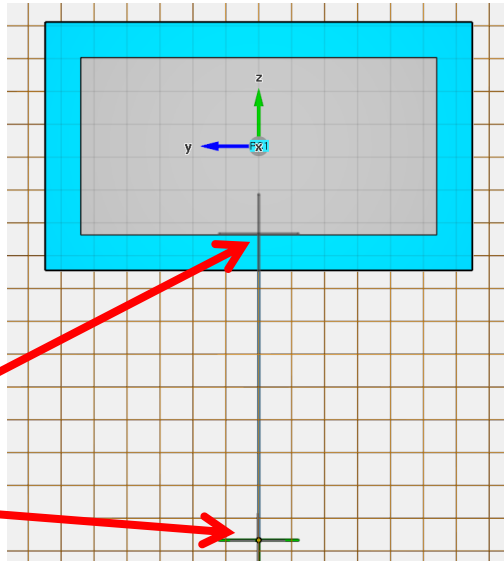
*Wheel backward

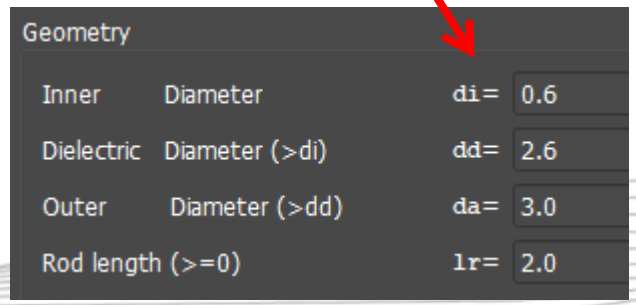
Step 3: Coaxial Port



- Set grid to x=4 and checkmark „Stay on Grid“
- Press „Add Group”
- Change group name to “Coax”

- Click Icon ‘Create Source‘
- Select ‘Coax‘ → ‘Coax‘
- Switch to „Side view“ & Opposite view, zoom out
- Left click at x=4, y=0, z=-2.6675* (feed position,edge center snap)
- Left click at x=4, y=0, z=-12 (load position)
- 2x left click at any position (to define further parameter as text input)
- Click „Edit Settings“ and set: di: 0.6 , dd: 2.6 , da: 3 , lr: 2
- Close windows (OK)
- Switch to Iso z view





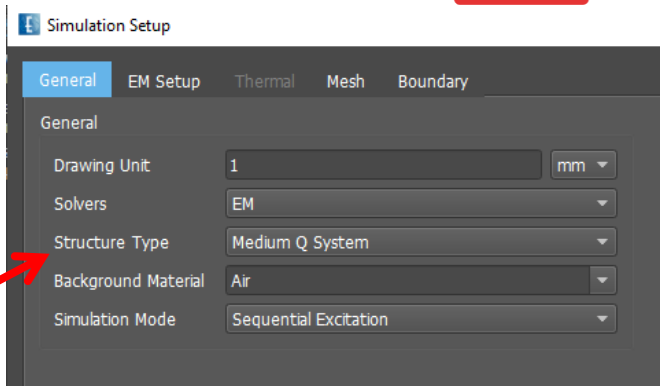
Comment:

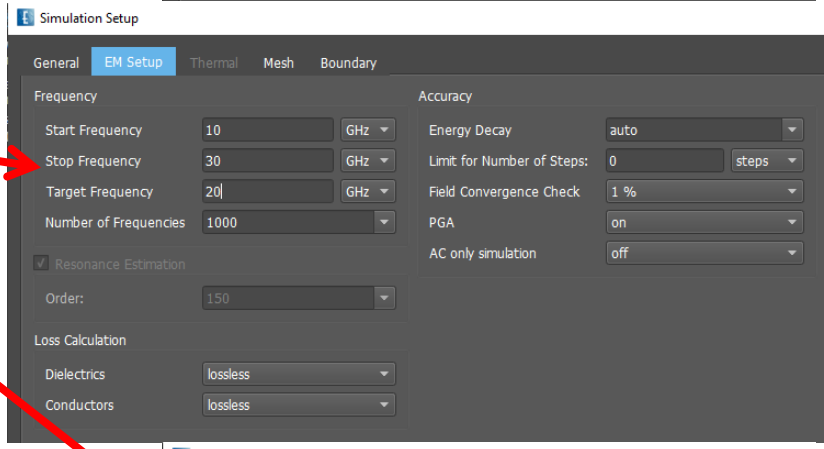
- ** Snap on inner edge of waveguide*

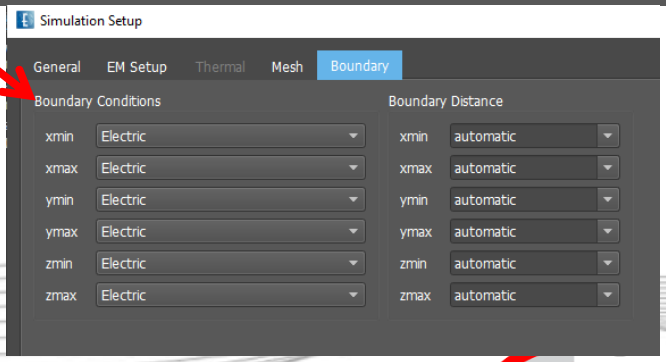
Step 4: Simulation setup

- Select Icon Simulation Setup

- Set “Structure Type” to Medium Q System’
- „EM Setup“: Start: 10 GHz
- Stop: 30 GHz, Target: 20 GHz
- „Boundary“: Conditions: Set all to Electric
- Close window with OK



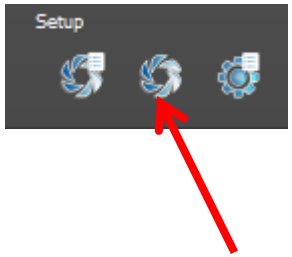




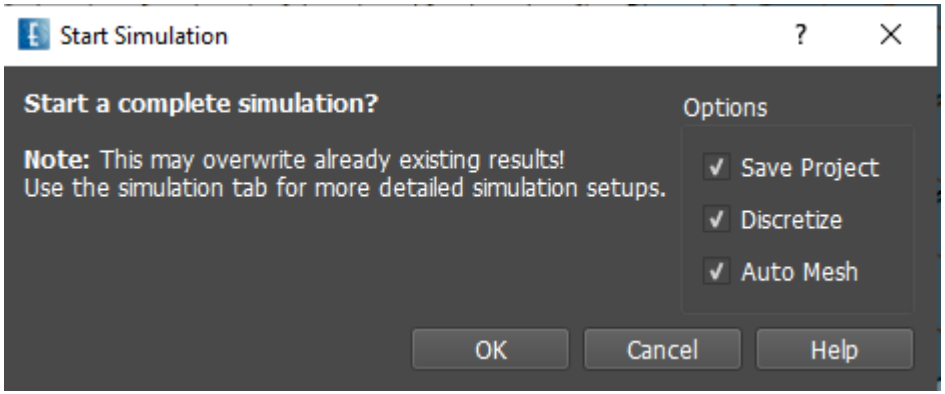
Simulation setup:

- *Geometry: 1 unit in the drawing equals 1 mm, here*
- *Structure Type: Information about the structure for automatic meshing and end criteria*
- *Frequency: Determines the range of the DFT, the pulse width used is derived by maximum cell size*
- *Accuracy – Resolution Medium (15/4): Maximum cell size determined by 15 cells per wavelength at Stop Frequency, using at least 4 cells per object or gap*
- *Boundary conditions:*
  - *electric defines infinite ground plane, Et=0, (magnetic Ht=0)*
  - *Absorbing N emulates open space (N should be larger in the main radiation direction)*

Step 5: Simulation

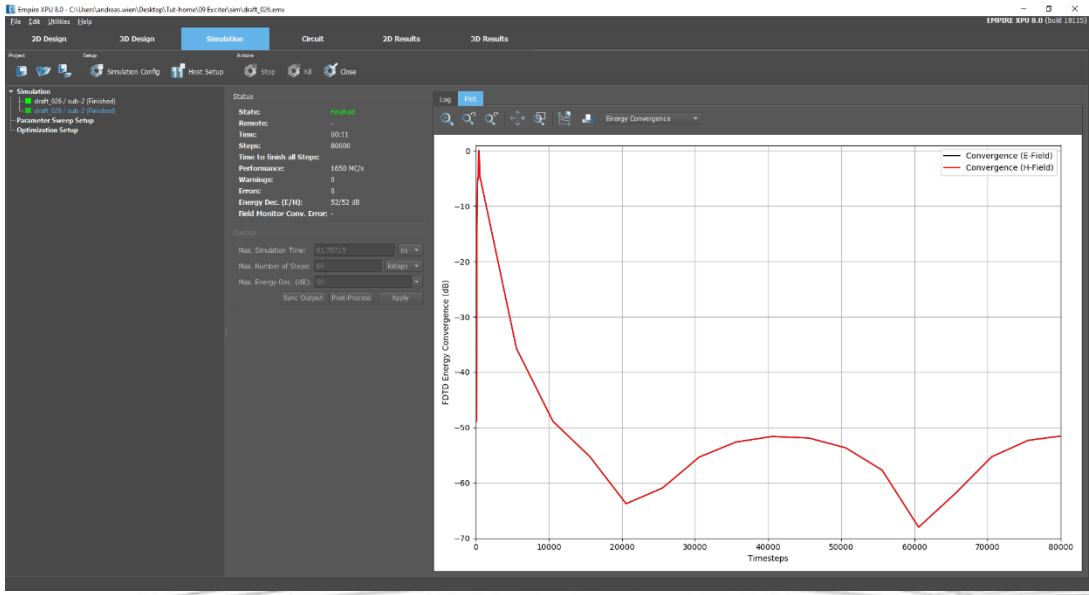


- Click “Start Simulation”
  → ‘OK’



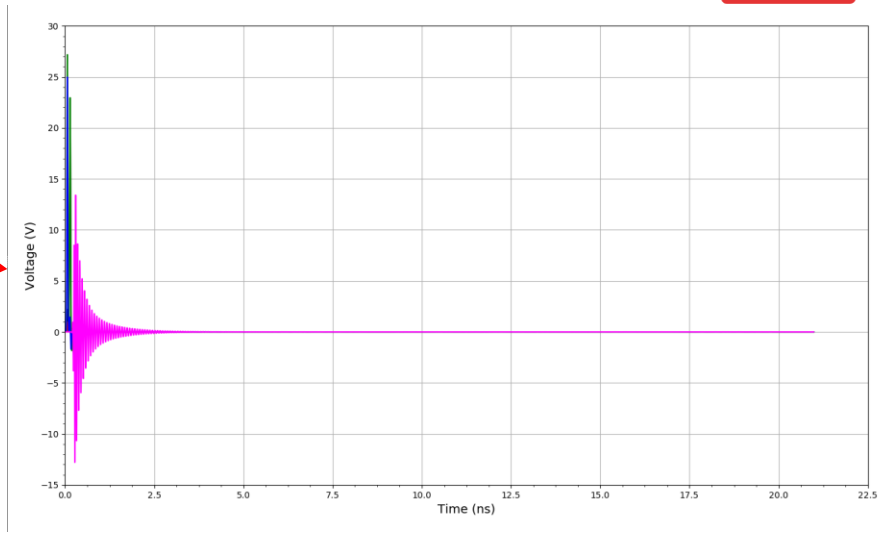
Meshing and simulation:

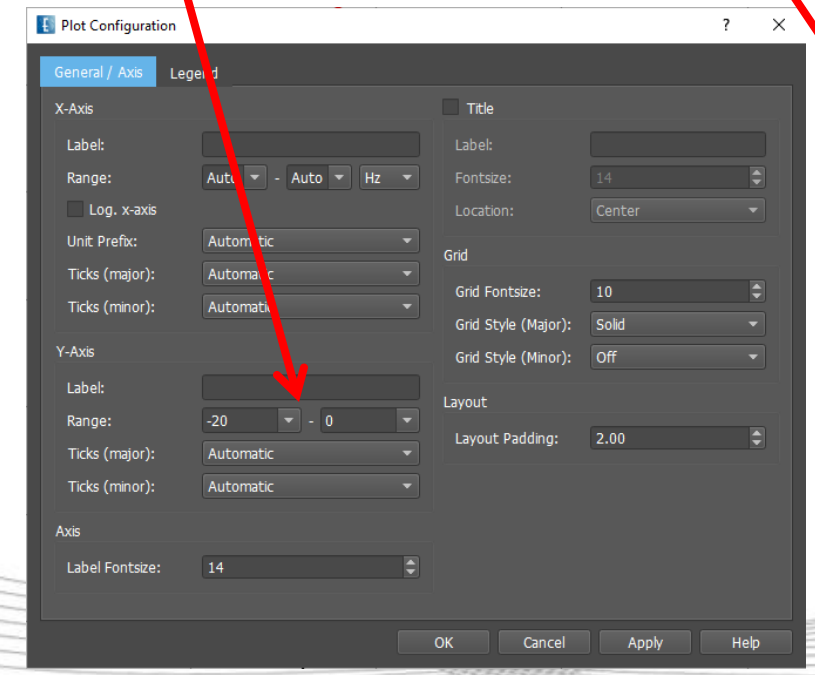
- *The created mesh lines are displayed on the bars at the right and at the bottom in 2D Design*
- *The simulation domain is marked by the red lines which indicate electric condition in 2D Design*
- *With “Start Simulation” the structure is checked, meshed and prepared for simulation*
- *As soon as the “Energy Convergence” plot comes up the simulation starts, the evolution of the time signal is shown*
- *When the end criteria has been reached, the “State” is marked as “Finished”*
- *In the Simulation Tab, the log window reports on the cut-off frequency and mode used for the simulation of the waveguide port*

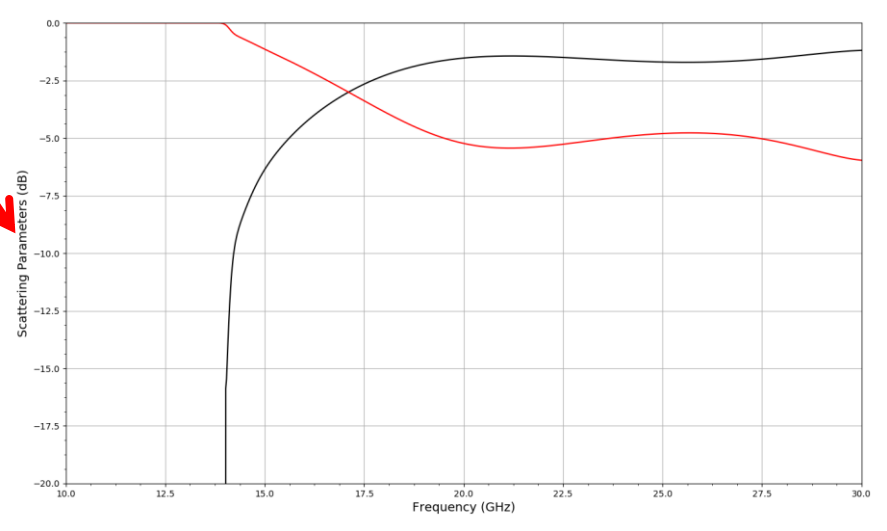


Step 6: Results

- Switch to “2D Results tab”
- Plot Type “Voltage (Time Domain)”
- Plot Type “Scattering Parameters”
- Right click in plot area, “Configure Plot”, and set Y-Axis range to -20 to 0, OK







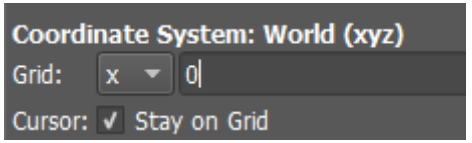
Step 7: Backshort

Create new group

- Return to 3D Design tab
- Create new group “Backshort”
- Adjust transparency sliders

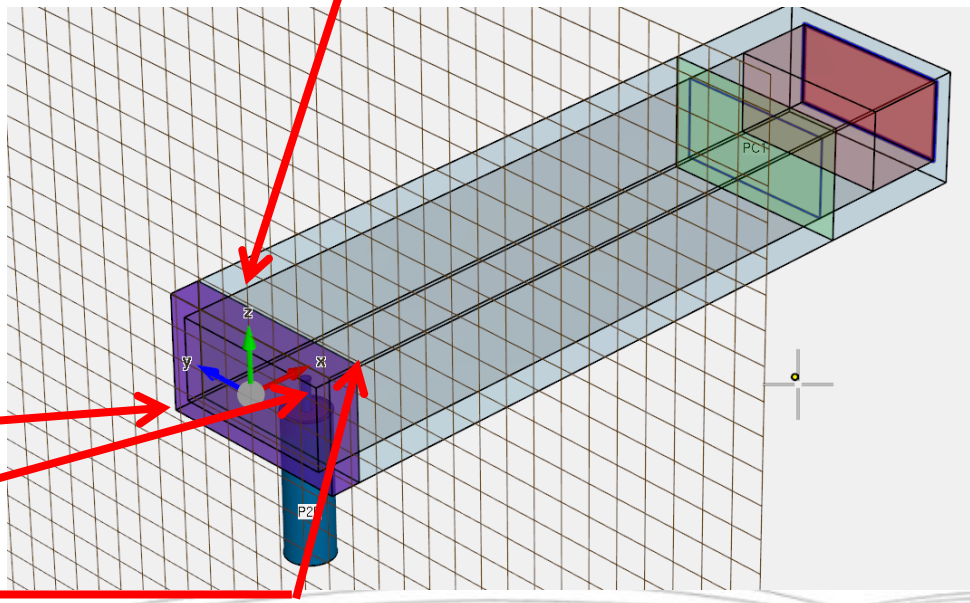
Backshort

Waveguide



Draw backshort box

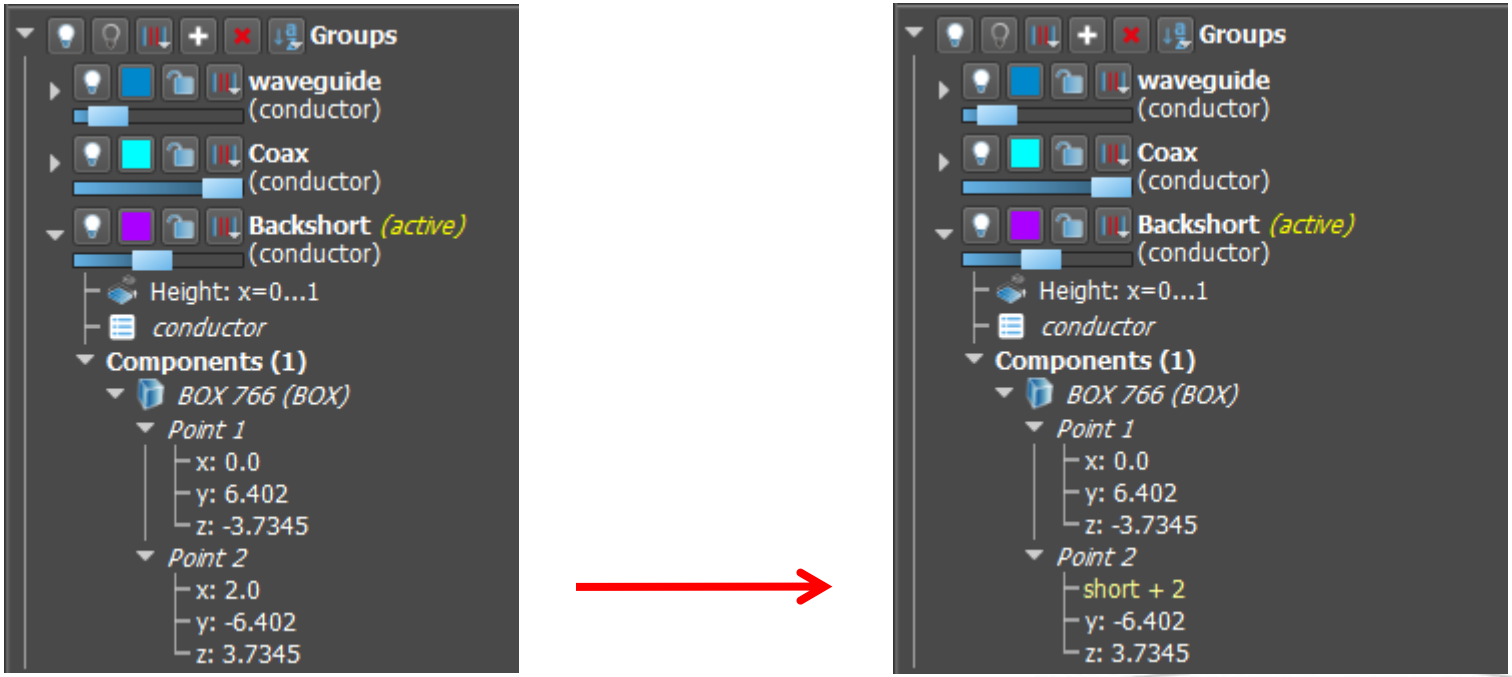
- Set grid x=0, keep checkmark for stay on grid snap
- Select Icon ’Create box’
- Left click at waveguide corner
- Left click at opposite waveguide corner
- Left click at du=2 position
- OK



Step 8: Variables 1

Define Variable *short* for the backshort distance

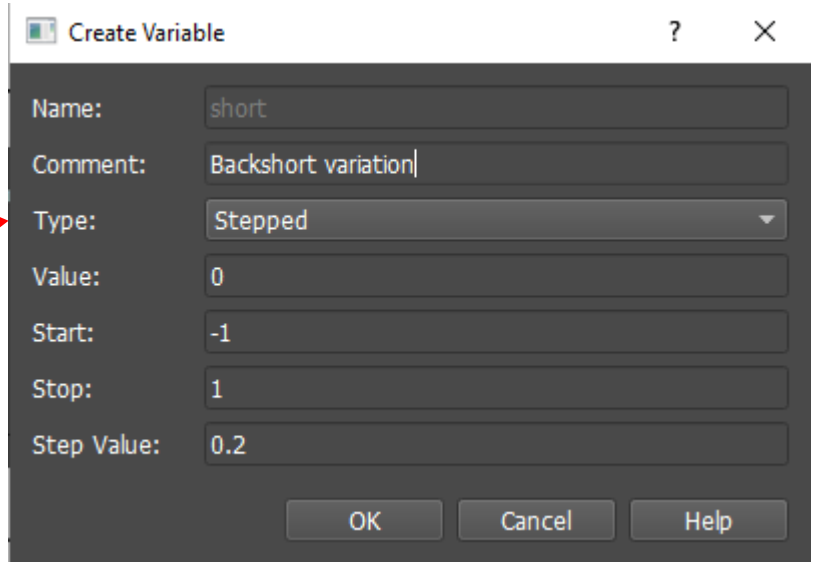
- Open Component in “Backshort” group
- Double click on x-value of Point 2: Enter string “short + 2”



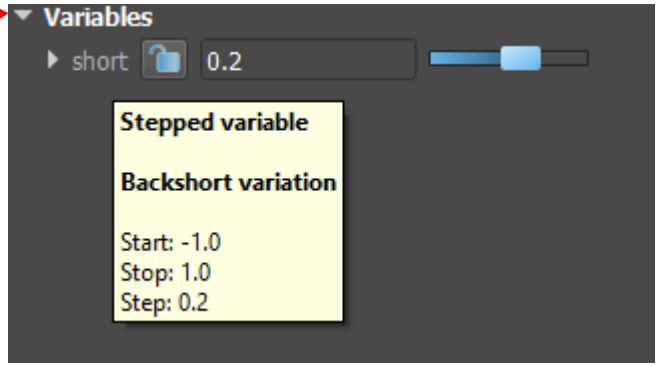
Step 9: Variables 2

Define parameter range for the backshort distance

- Set Type and Values
- Optionally enter a comment
- Close OK



- Open Variables on the left
- Move slider to verify range
- Reset short = 0



Step 10: Variables 3

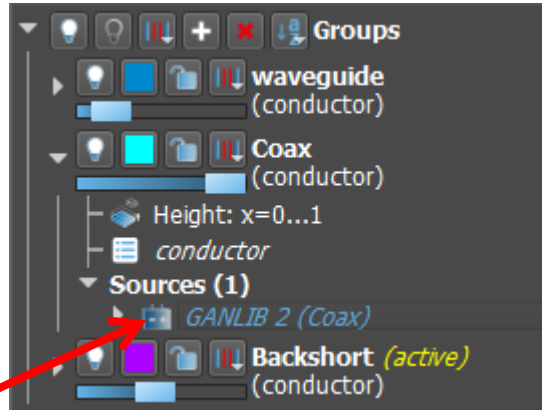
Define Parameter *rod* for the Coaxial inner conductor length

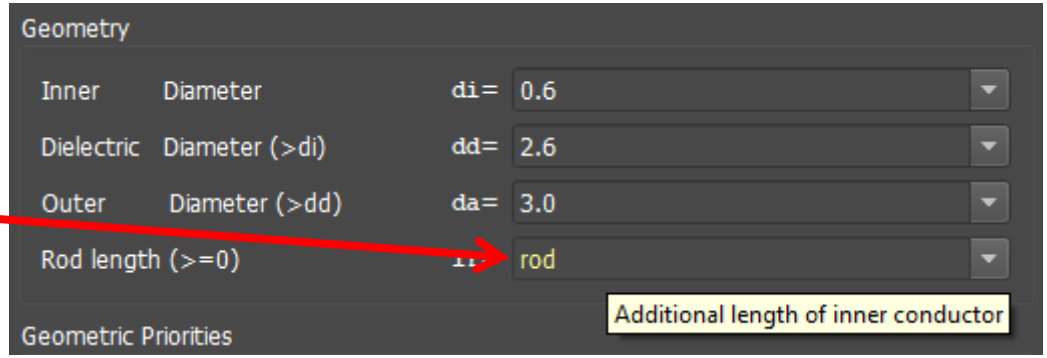
- Open Group Coax
- Open Sources(1), double click on icon
- Click “Edit Settings”

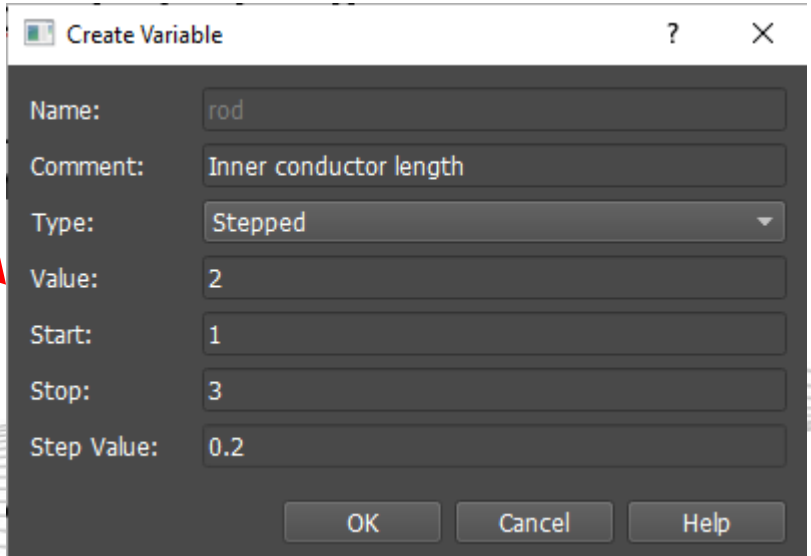
- Enter rod in ‘Rod length’
- Click OK

- Set New Parameter range
- Optionally enter a comment
- Close Windows (OK)

- Save the project



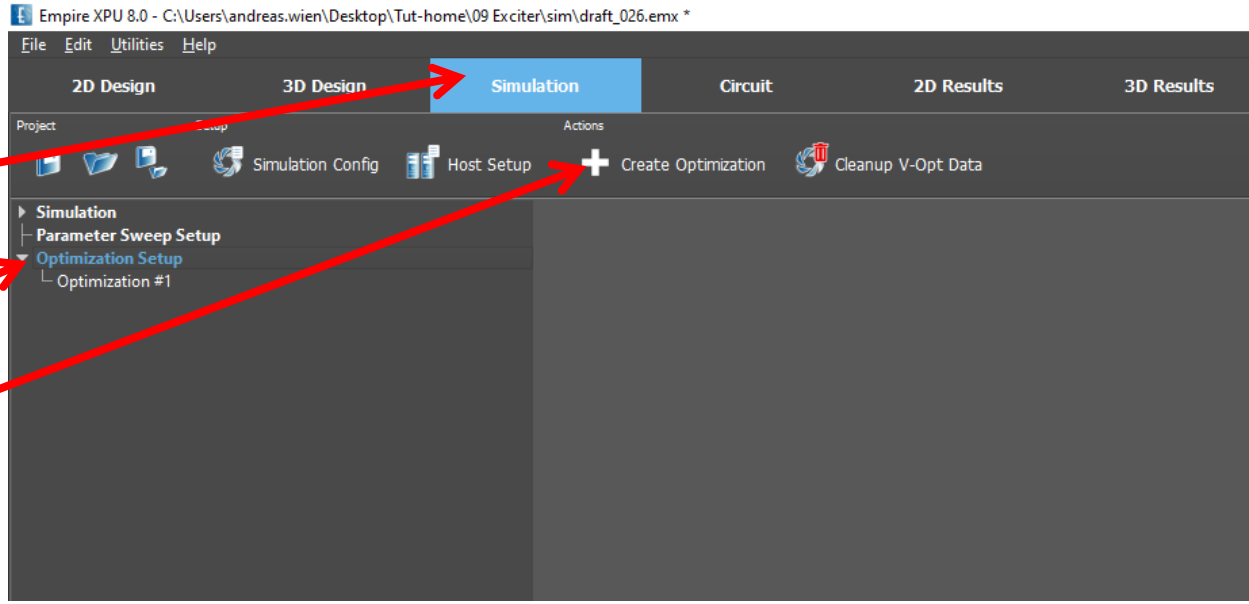




Step 11: Optimization 1

Setting up the optimization

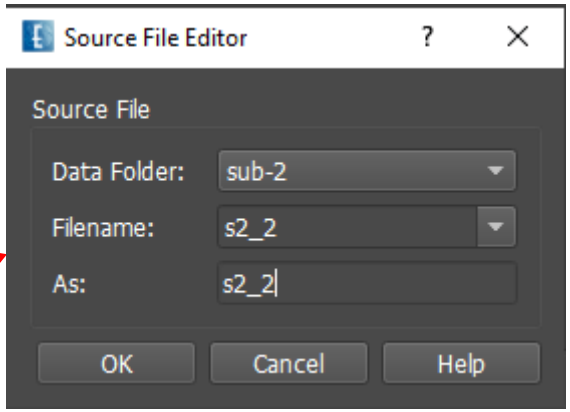
1. Click Simulation tab
2. Click Optimization Setup
3. Click Create Optimization

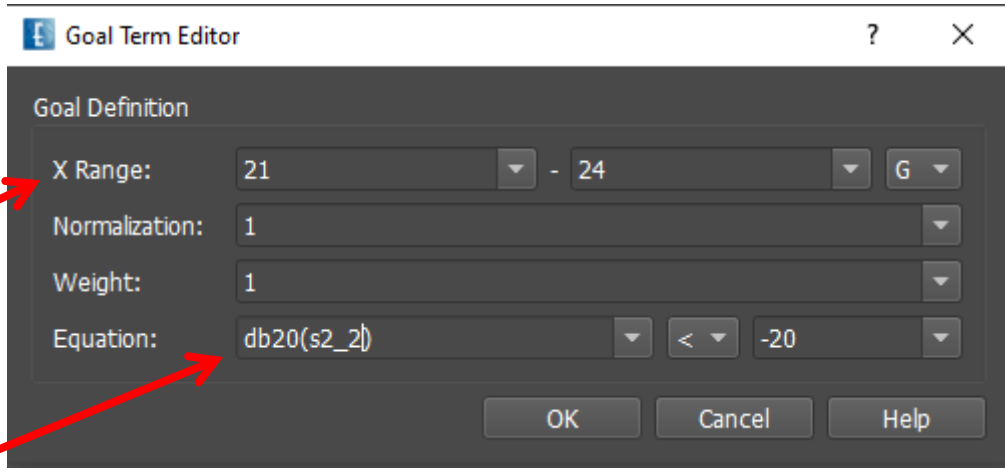


Step 12: Optimization 2

Defining the source file

- Right Click in “Goal” Window – Add Source
- Enter s2_2 in “Filename” and “As”, OK
- Right Click in “Goal” Window – Add Goal
- Define the frequency range: 21 – 24 in X Range using “G” as unit
- Set Equation db20(s2_2), OK





Goal: from 21GHz to 24GHz the matching should be less than -20dB

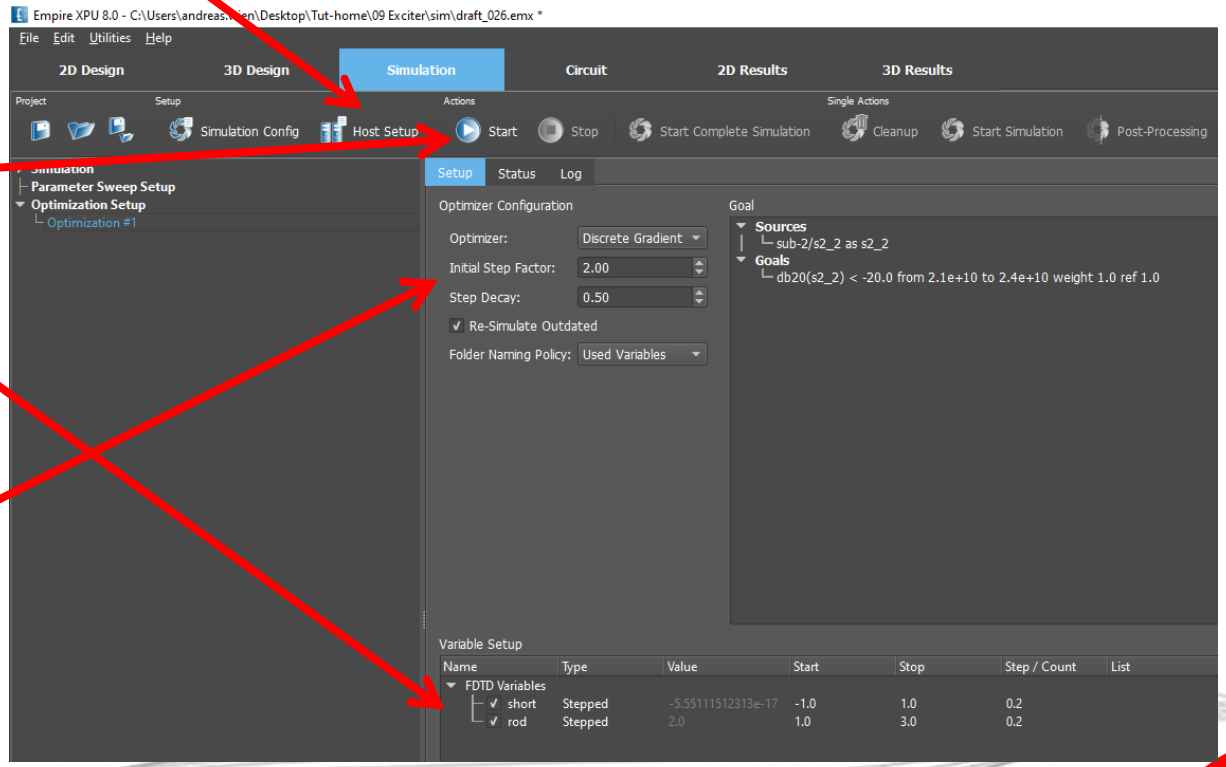
Step 13: Optimization 3

Starting the optimization

- Optionally click “Host Setup” to select remote computers for simulation (you can use multiple PC’s from your network in parallel if you have multiple licenses)
- Keep localhost, if there are no further Empire Servers available
- Check Sources and Goal
- Press Start optimization

Optimization Iteration (each opt. parameter is varied +/-) here two parameters (rod and short) with 200µm

Initial Step Factor set to 2; a 400µm stepping is performed in first iteration If there is no improvement with a 400µm step, a refinement with a Decay of ½ is performed => 200µm stepping in second iteration

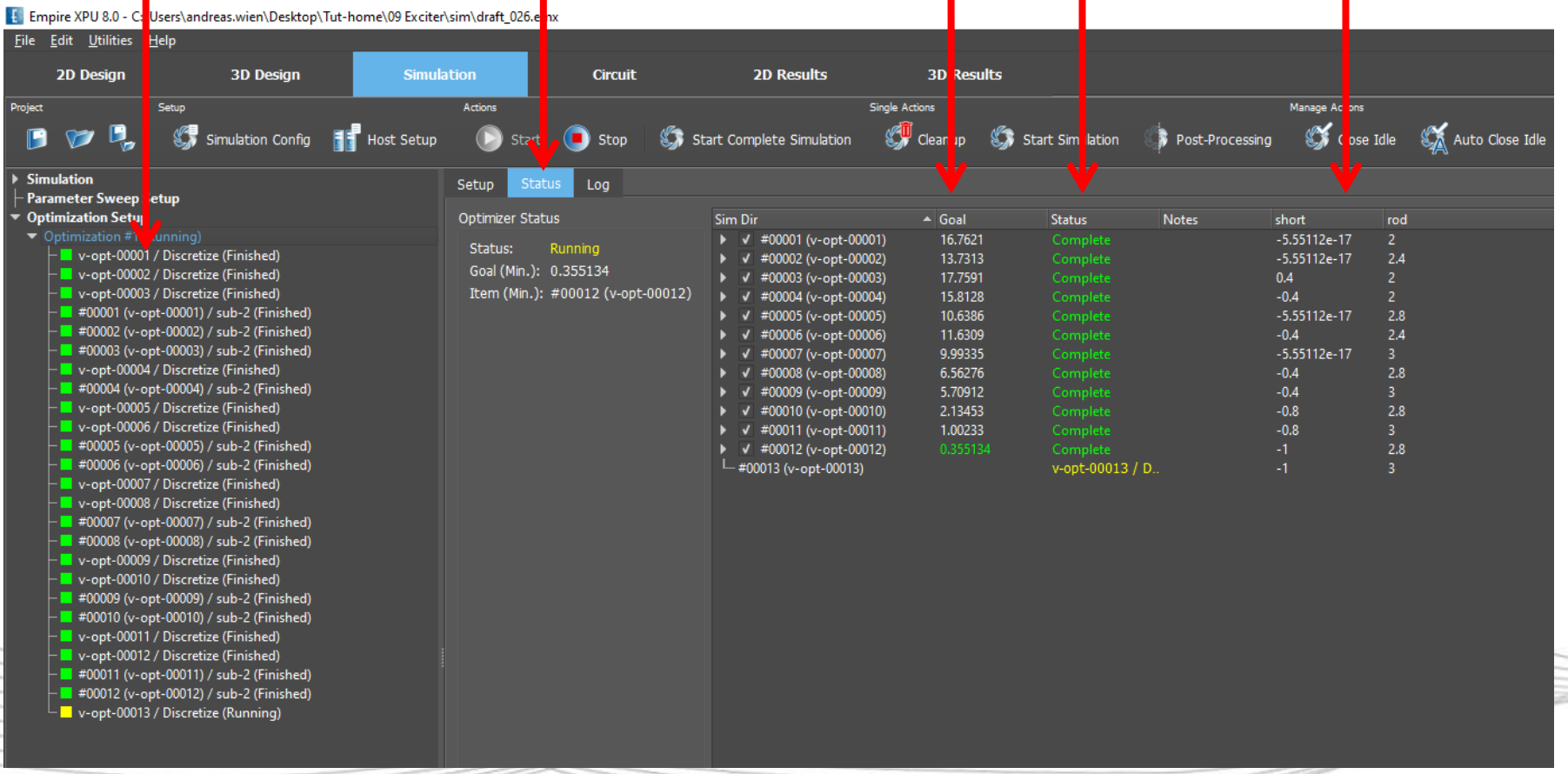


Step 14: Optimization Status

Status Tab

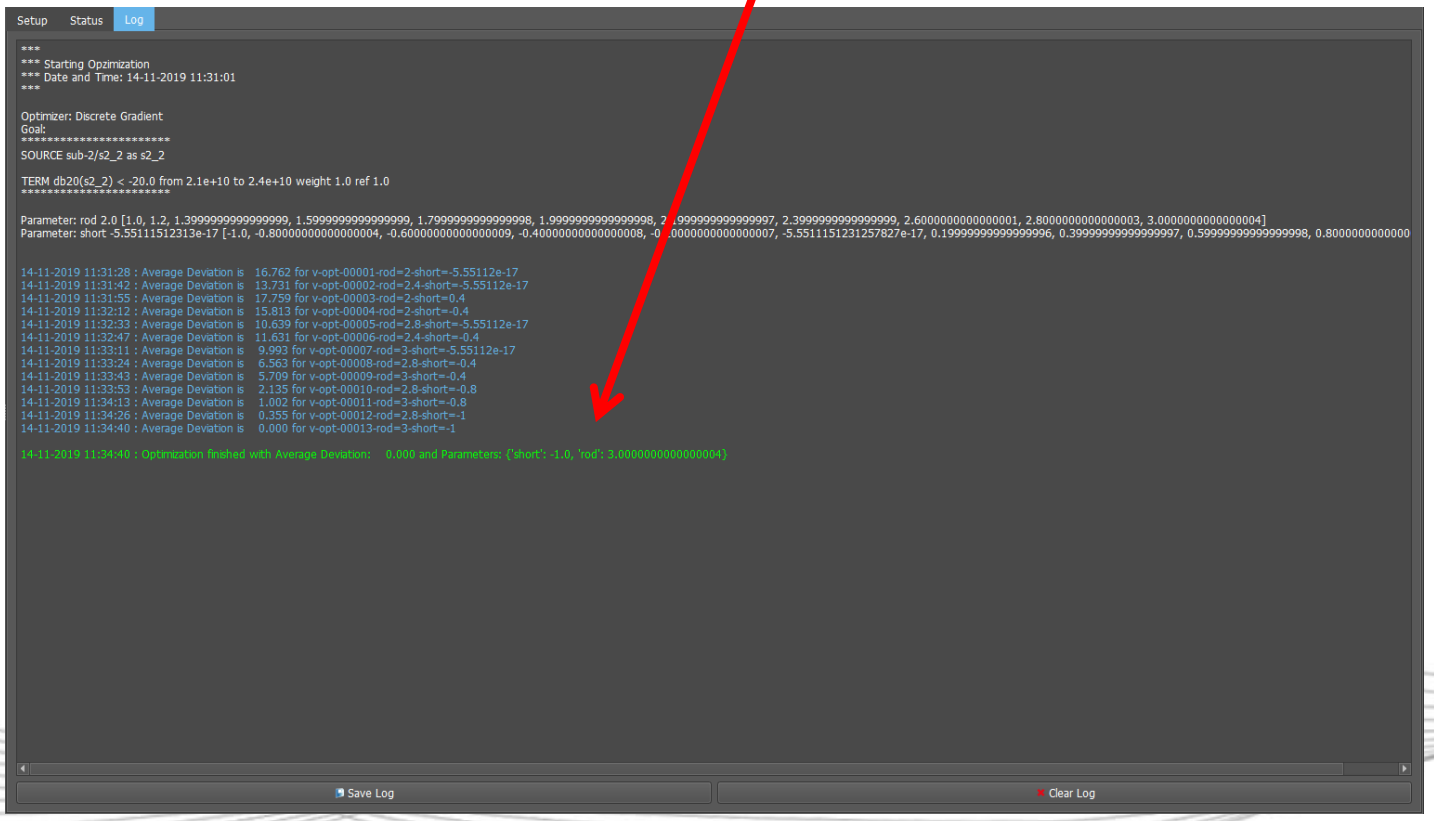
Access to individual simulation log window

Current average deviation
Status of Current simulation
Current variable vlaues



Step 15: Optimization Log

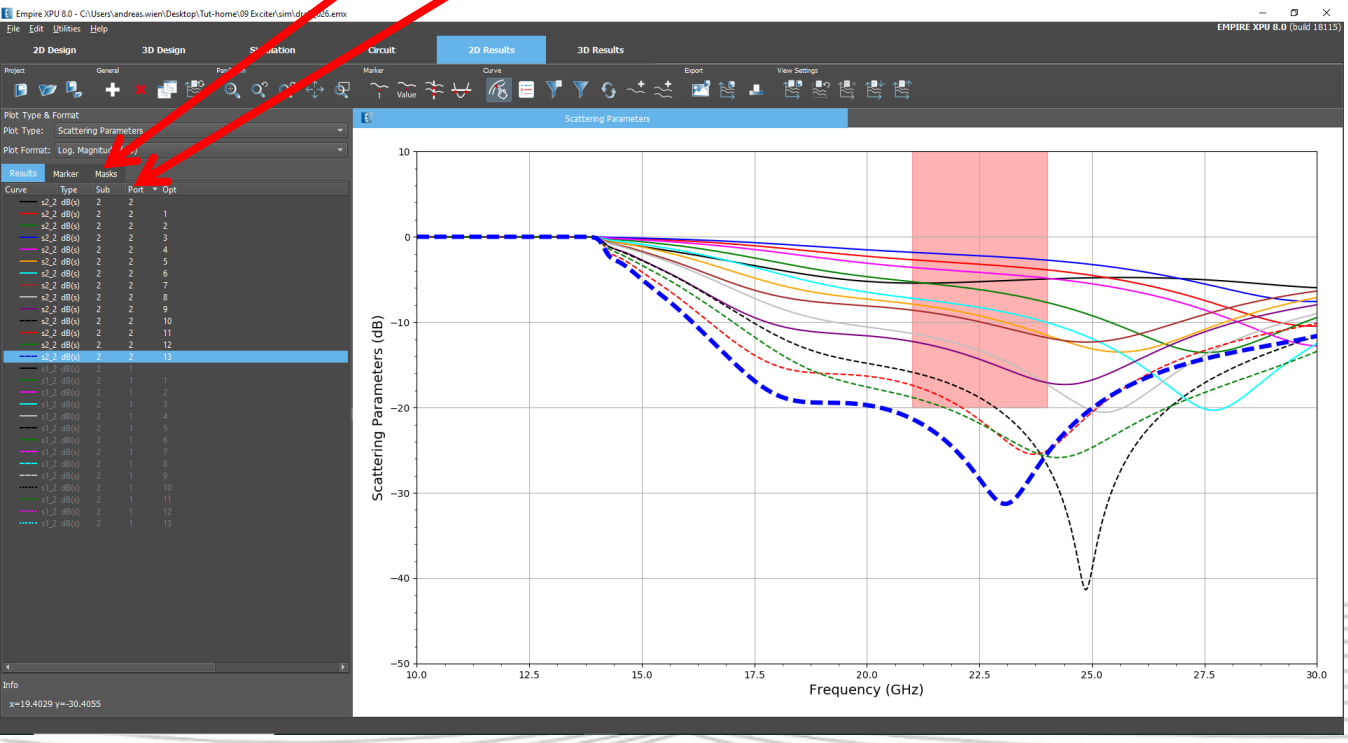
- Every parameter variation is computed in a new subdirectory v-opt-000xx-par-name …
- Optimized values rod = 3 mm short = -1 mm in subdirectory:v-opt-00013-rod=3-short=-1

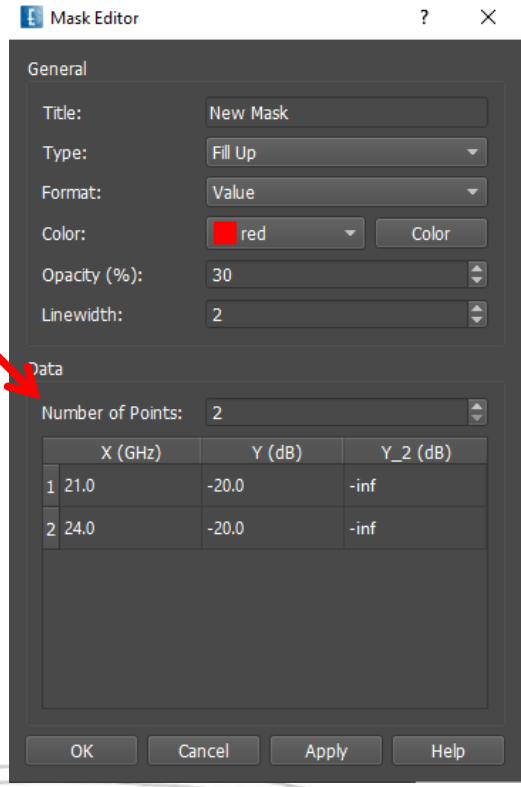


Step 16: Optimization Results

Optimized S-Parameters

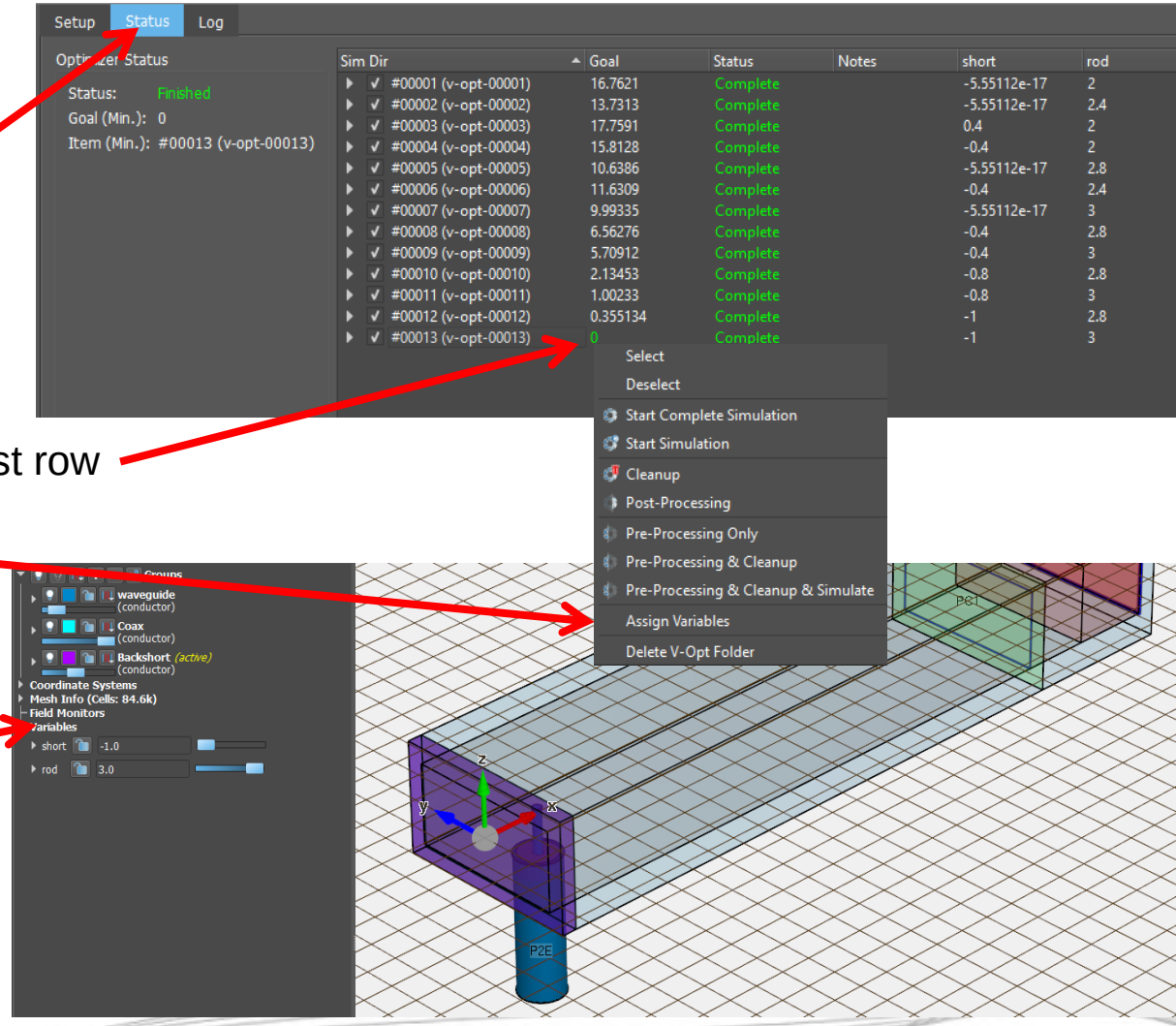
- Switch to “2D Results” tab. “Plot Type” Scattering Parameters
- Sort list: 2x Left Click on “Port”. Click & Drag all s2_2 curves to select
- Right click on List, “Show only & Autocolor”, Click Autoscale
- Switch to Mask Tab, right click – Add Mask, edit values





Step 17: Optimized Structure

- Switch to Simulation Tab
- Click on Optimization #1
- In Status Tab, right click on last row
- Select “Assign Variables”
- Switch to 3D Design Tab
- Open Variable List



Variables are now set to optimized values (-1, 3)