FEKO Tutorial 0

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This tutorial will get you started with FEKO. FEKO is a full-wave electromagnetic field simulator that is based on the Method of Moments (MoM). It is a commercial software tool that can be used for antenna design, antenna placement analysis, RF structure performance prediction, EMC, as well as scattering problems and Bio-electromagnetics. A student version of FEKO can be obtained from www.feko.info, as well as the accompanying manuals. This is a quick step-by-step tutorial that is aimed to make learning and using the tool easier for new users.

1. We will design a Monopole antenna with a wire feed excitation (as opposed to Microstrip feed that is accomplished using a microstrip line with an Edge feed). Figure 1 shows the geometry of the antenna.

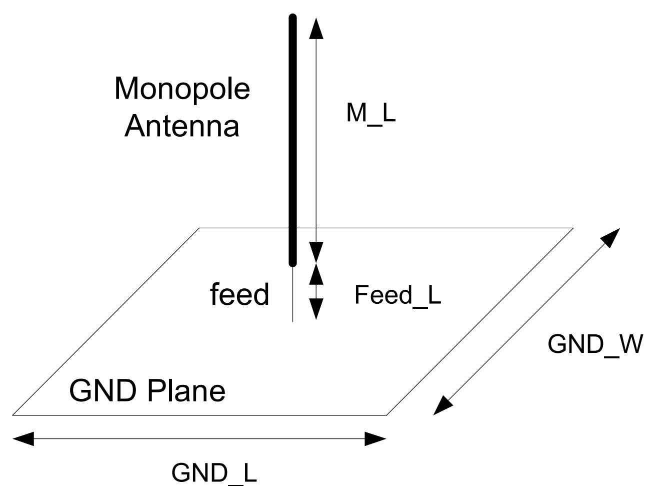

Figure 1.

2. Open your "CAD FEKO" program. You will have a widow as in Figure 2.
3. From the "Model" pull down menu, choose "Model Unit" and select "(mm)". Click "OK".
4. If you will be performing some changes on the model geometry (usually the case), it is recommended to define variables and then use them as the dimensions in your design. For this exercise, you will define several variables.

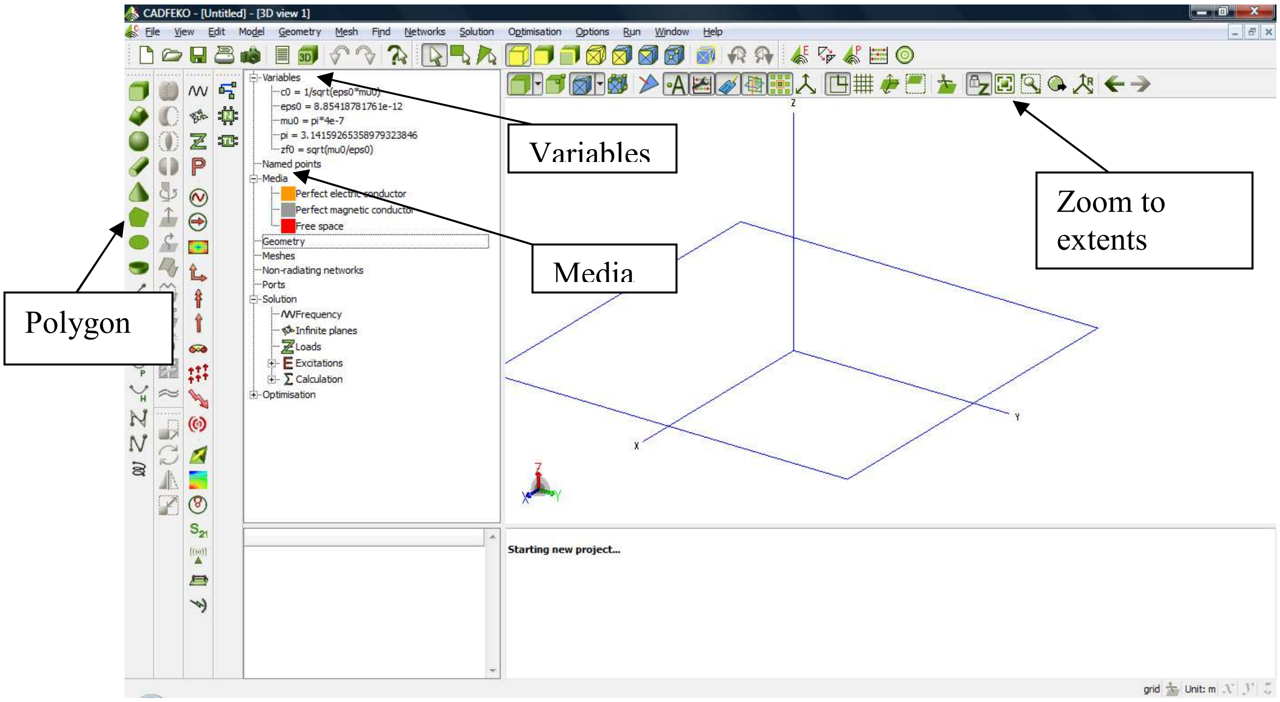

Figure 2.

5. Right click the “Variables” tree on the left side of the screen, and click on “Add Variable” to be prompted with a window like Figure 3. Fill the variables one after the other for the geometry of interest.
   The variables of interest as shown on Figure 1 are[*]:

GND_L	=	90 mm
GND_W	=	90 mm
M_L	=	25 mm
Feed_L	=	0.5 mm

[*] In case Lite FEKO complains about the size of the problem, shrink the antenna size by 0.25 and the GND plane dimension as well. Then increase the frequency range as well. Since smaller antennas resonate as higher frequencies. This will cut the size of the problem and you can simulate hopefully!

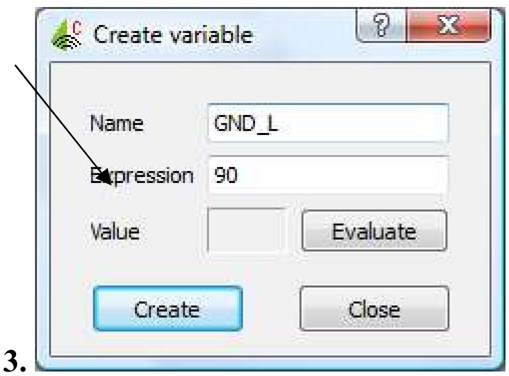

Figure 3.

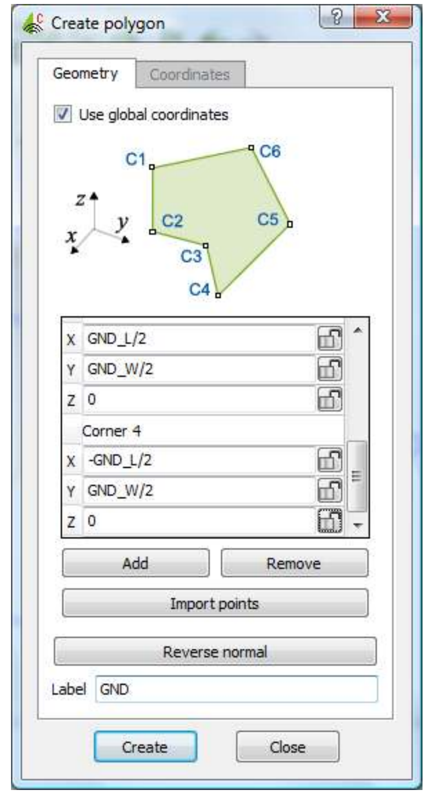

Figure 4.

6. Start from bottom to top. Thus, we will create the GND plane at the bottom. The dimensions of the GND plane are 90x90 mm^2. The length is over the y-axis, while the width is over the x-axis. The thickness is zero along the z-axis to reflect a metal sheet. Click on the “Polygon” icon located at the far left of the program window. And fill in the co-ordinates of the 4-points (corners) as follows (you need to add an extra point, as the default for the number of points is 3 not 4):
   (-GND_L/2, -GND_W/2, 0) , (GND_L/2, -GND_W/2,0) , (GND_L/2, GND_W/2, 0) ,
   (-GND/2, GND_W/2, 0)
   Name this polygon “GND”. This is illustrated in Figure 4.
7. After clicking “Create” in Figure 4 you will see the GND plane placed on the co-ordinate system as shown in Figure 5. (click on “zoom to extents” to view it all)
8. By default, all the created geometries are assigned a “PEC” perfect element conductor material. If you want to use a dielectric material for example, you need to defined one, assign its properties and then use it for the geometry of interest. (We will use this is Tutorial I)

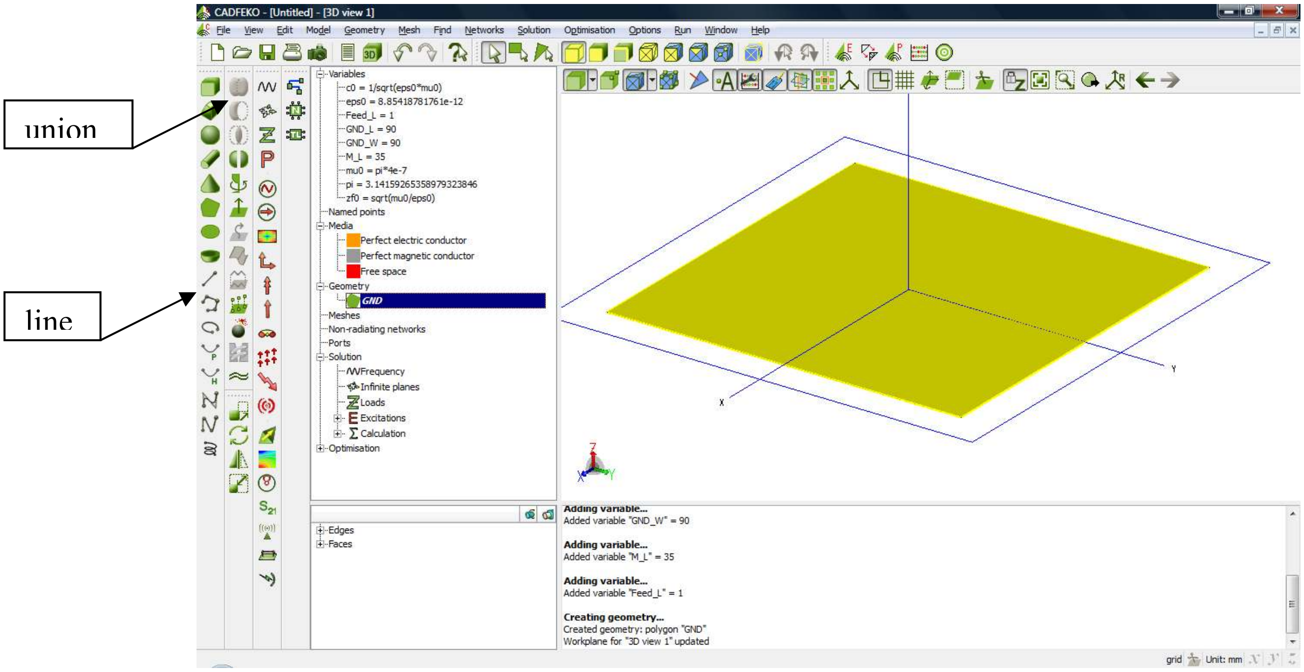

Figure 5.

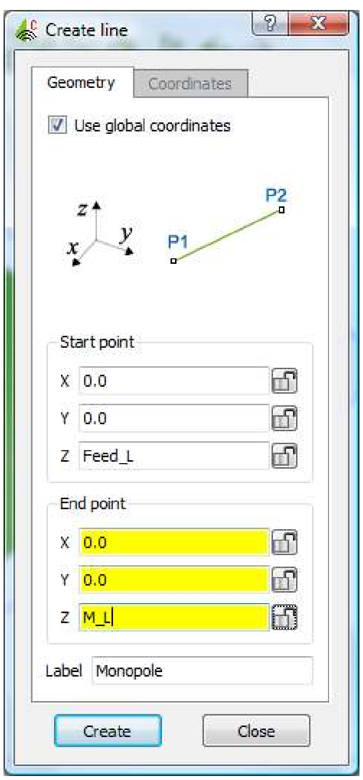

Figure 6.

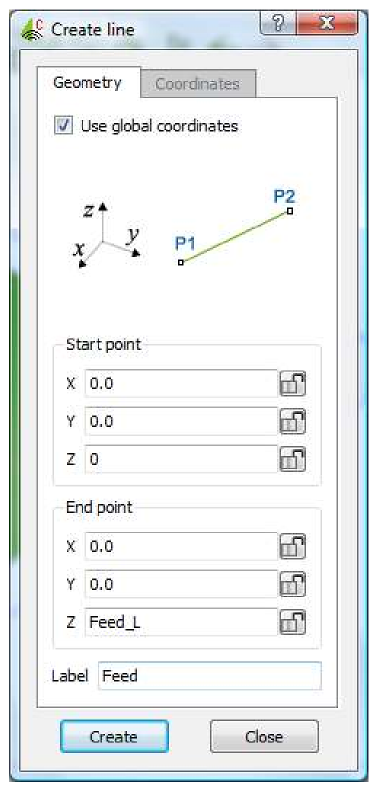

Figure 7.

9. To add the Monopole antenna, click on the "line" function. The line will be centered at (0,0,Feed_L) and extends M_L mm in z-axis. This is shown in Figure 6.
10. To add the feeding pin, choose the "line" function. Choose the points as shown in Figure 7.

11. The geometry creation of the antenna is complete. Select all the geometry components and "Union" them using the union function in the side menu. After the "Union" function, the properties of the metals might get changed if there is a dielectric volume. In this example we do not have to worry about this issue.
12. We have defined f1=2.0e9 (2.0 GHz) and f2=3.5e9 (3.5 GHz) as the start and stop frequency variables.
13. From the "Mesh" pull down menu, choose "Create Mesh". Fill in the fields as shown in Figure 8. This usually depends on the size of the problem.

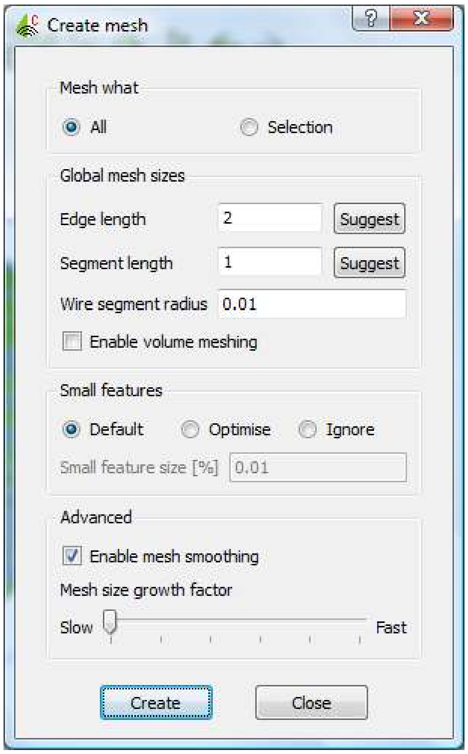

Figure 8.

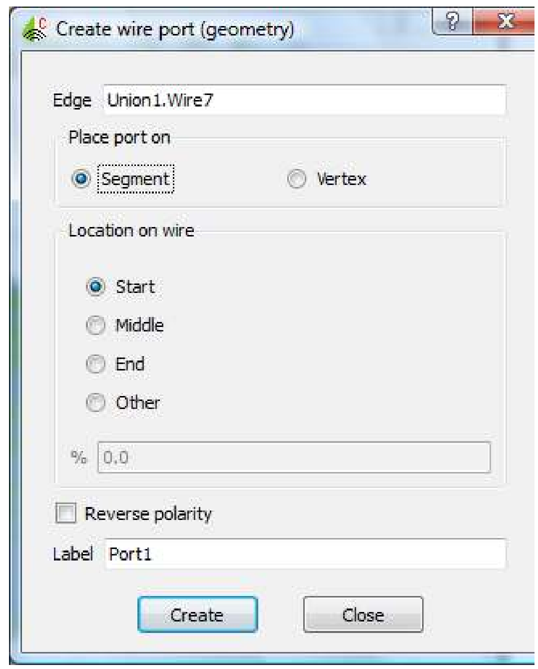

Figure 9.

14. After meshing is complete, you need to assign a port to feed the antenna with the excitation needed. From the side menu, right click "Ports" → "Create Port" → "Wire Port". A window like Figure 9 pops up. From the geometry tree on the left side menu, click on the "Union1" geometry, expand the "Edges" tree in the bottom side menu, and choose the "Wire xx" which corresponds to the feed section. Automatically, the name of the wire is substituted in the port window as shown in Figure 9. Keep the label as "Port 1", hit "Create", then "close".
15. Observe the created port in the geometry. After port creation, we need to specify the frequency of simulation. We will first examine the resonance of the antenna, and thus we are interested in the $|S_{11}|$ measurement. We need to sweep the frequency between f1 and f2 as shown in Figure 10.
16. Adding the excitation source is the step that follows. We will use a voltage source of amplitude 1 and phase 0. Figure 11 shows this window after right clicking the "Excitations" → "Voltage source". Since we have only one port, then the excitation source will be automatically assigned to the single port. Hit "Create". If you have multiple ports, then choose the port label from the "Port" menu in Figure 11.

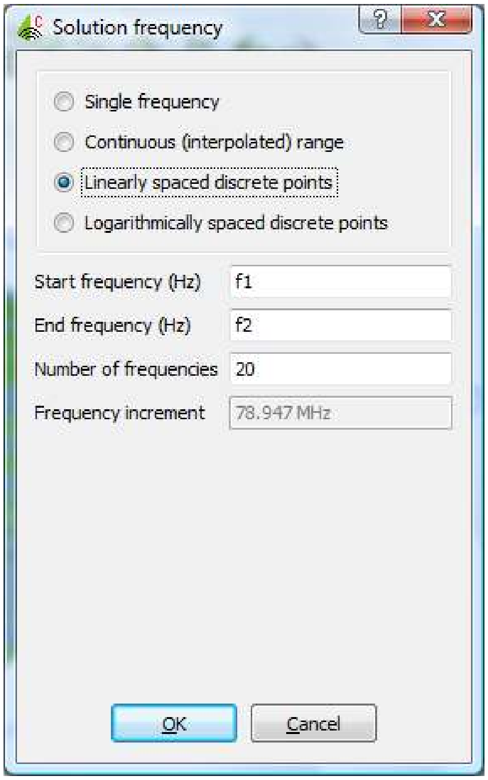

Figure 10.

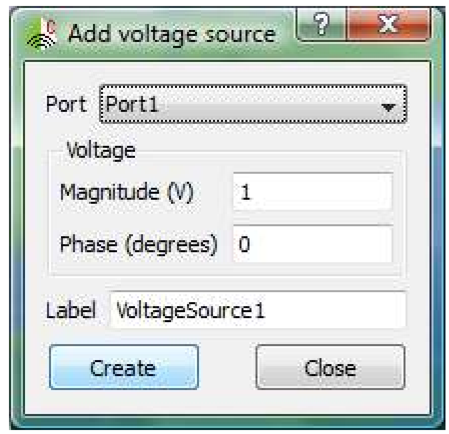

Figure 11.

17. Now, you can request the type of simulation/analysis you want to conduct. For this particular example, we are interested in the $|S_{11}|$ measurement. Thus right click "Calculation" → "Request S-parameters". You will get Figure 12. Click "Restore loads after calculation" then click "Create" and then "Close".

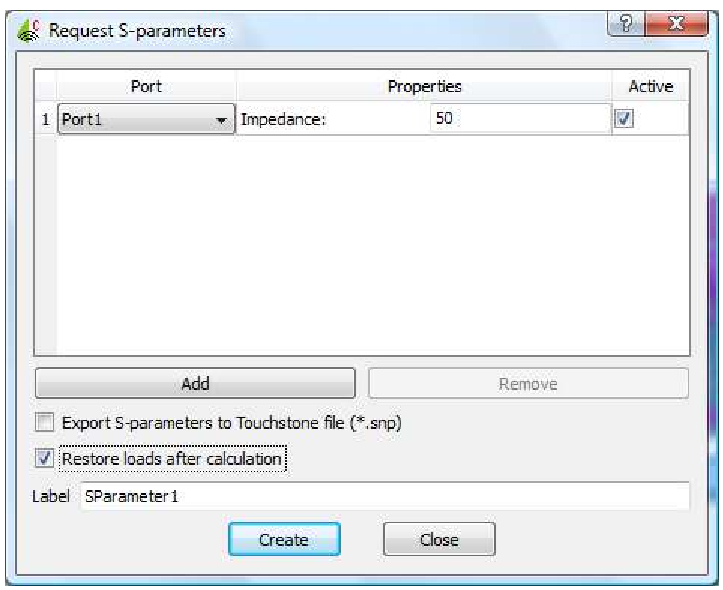

Figure 12.

18. You have to RE-MESH one more time before running the simulation to take into account the new port you created. Thus go to the "Mesh" pull down menu, and with the same values as before, just mesh again, and over-write the previous results.

Now you should have something that looks like Figure 13. Click on "Run FEKO" and wait for the simulation to finish.

If you get a MEMORY ERROR (NOT ENOUGH MEMORY) try to increase the mesh size from 2mm and 1mm to 2.5mm and 1.5mm instead and re-mesh, then re-simulate.

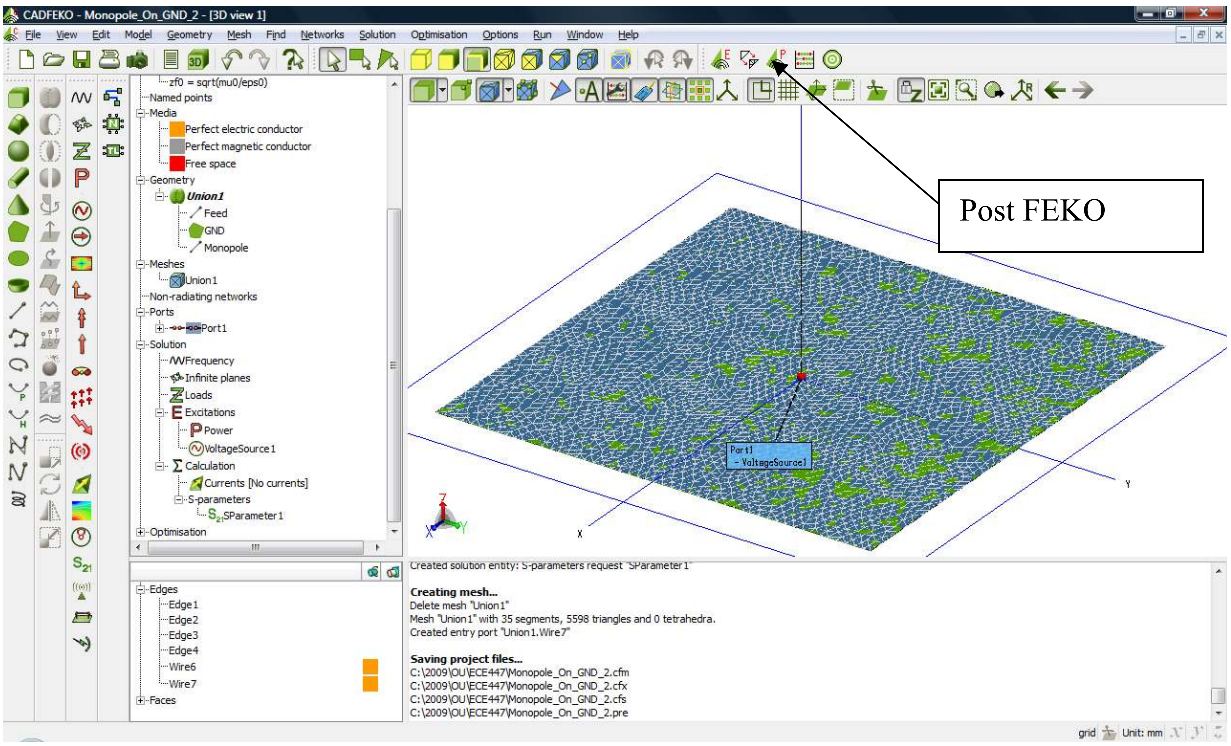

Figure 13.

19. After the simulation finishes, click on "Post FEKO" to plot/view the results.
20. After running "Post FEKO", you will obtain a window as shown in Figure 14.
21. Click on the "Cartesian" icon, and a graph with Cartesian coordinates appears. Select the "S-Matrix" icon as shown in Figure 15. You will get the $|S_{11}|$ measurement as a function of frequency. Choose the "dB" display.
22. Note that the Monopole resonance frequency (the frequency corresponding to the minimum value in the $|S_{11}|$ curve) is at about 2.889GHz with an $|S_{11}|$ value of -22.25dB. Also the Bandwidth is measured as the difference between the upper -10dB frequency and the lower -10dB frequency. You can use the "Cursers" from the "Display" Menu to add cursers and you can use the "Curser Table" to show the values of the two cursers and the difference between them. The -10 dB bandwidth for this antenna is shown in Figure 16 and equals to 281 MHz.
23. Other functionalities can be done from the menus provided.

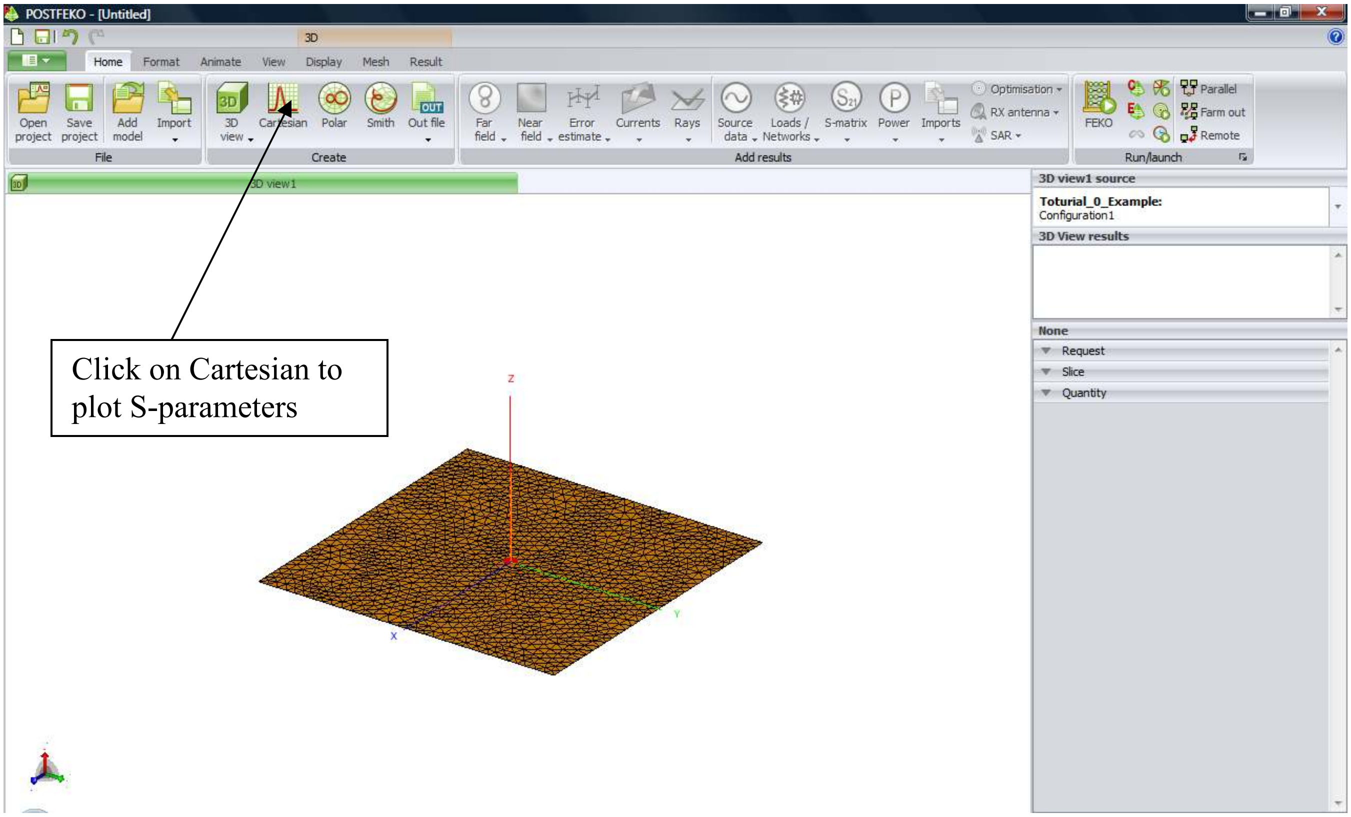

Figure 14.

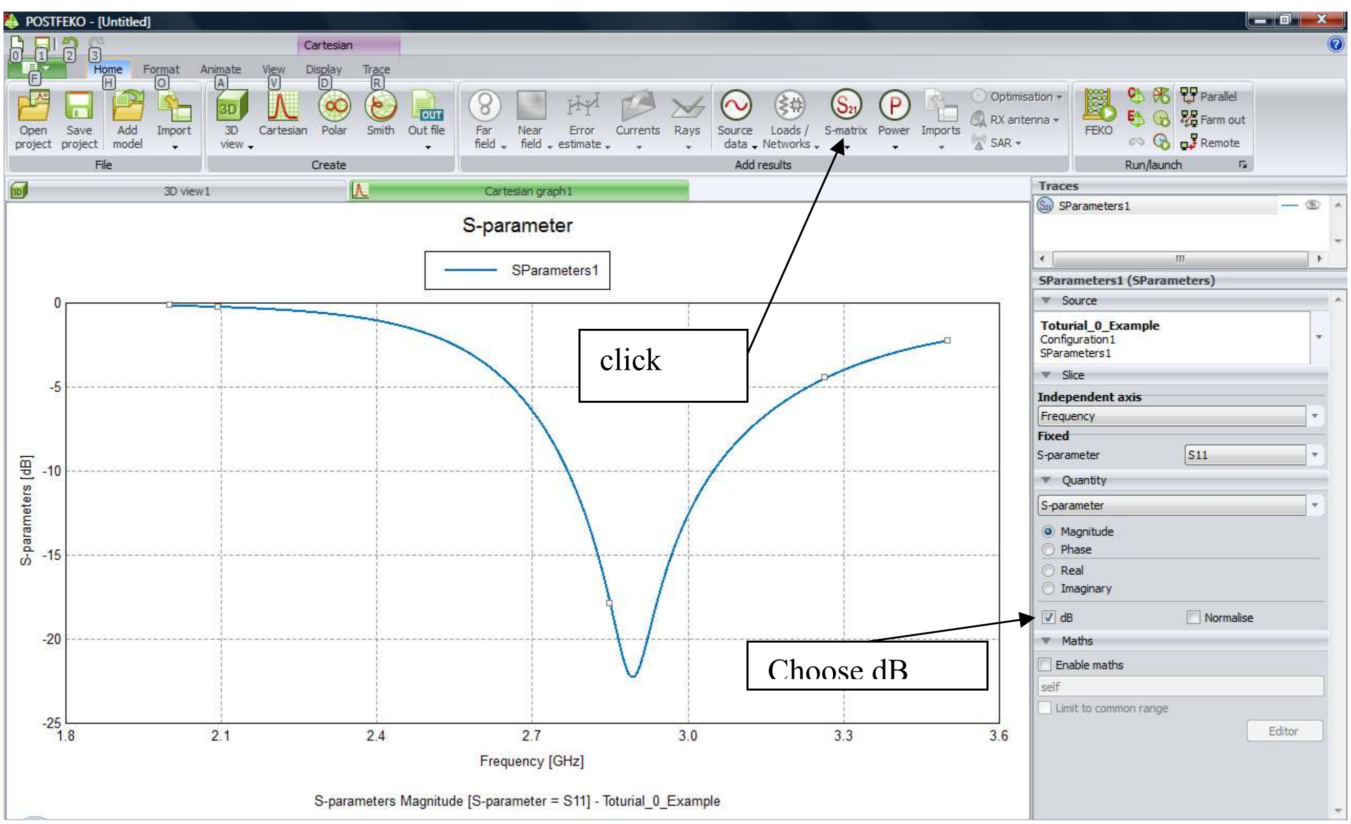

Figure 15.

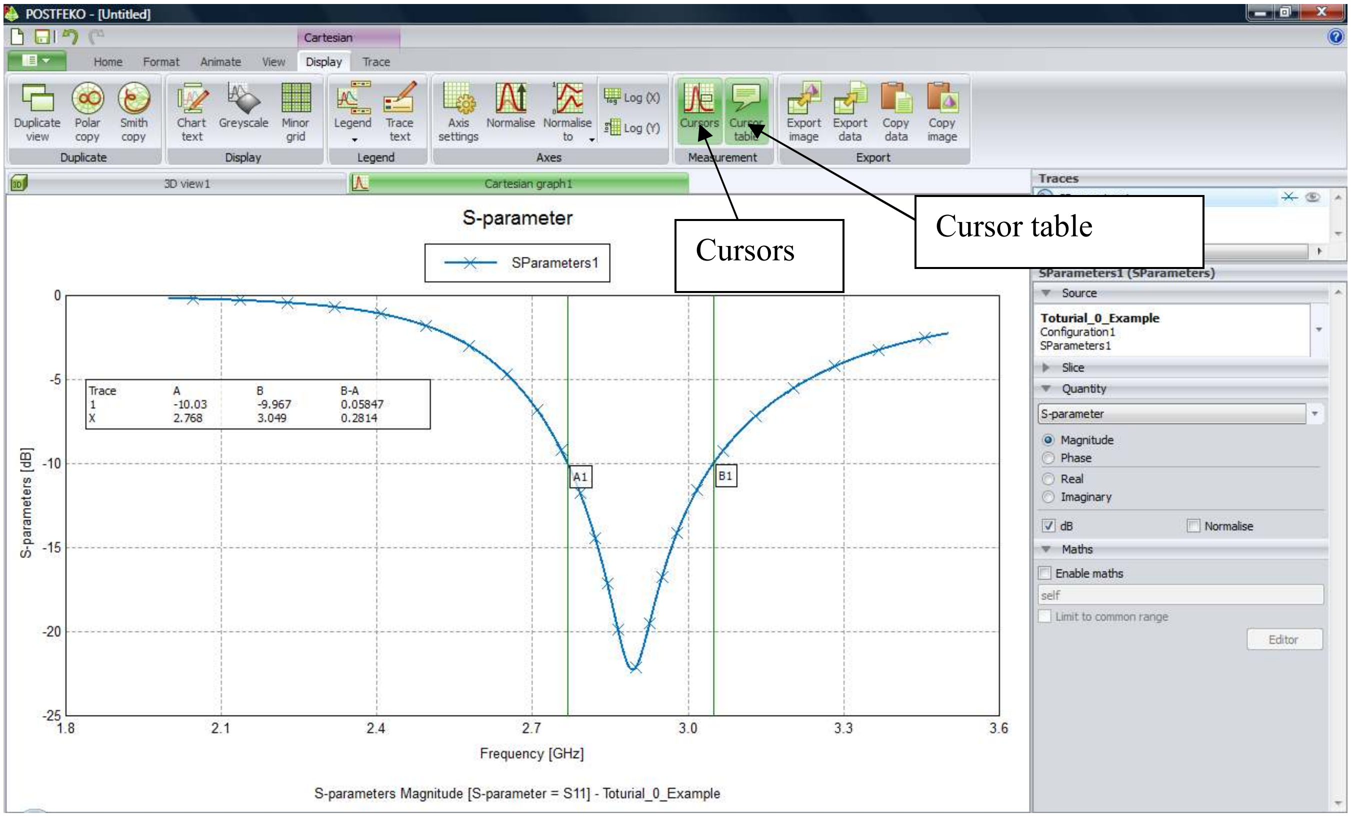

Figure 16.

24. Now that we know the resonant frequency is about 2.889GHz. We want to simulate a single frequency (the one of resonance) or multiple frequencies, to plot the radiation pattern (gain pattern) of the antenna.
25. Close “Post FEKO”. Go back to “Cad FEKO”.
26. Right click the “Frequency” function under “Solution” tree in the left side menu. Choose “Set Frequency”, and then “Single Frequency”. Fill is the value as shown in Figure 17.

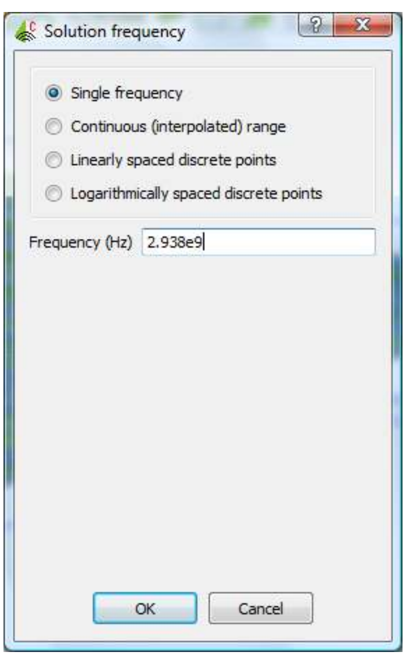

Figure 17.

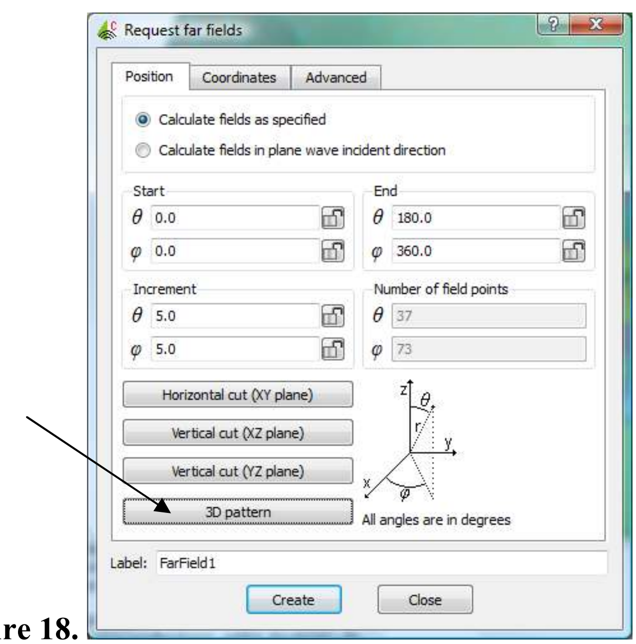

Figure 18.

27. Click “Ok”, and then save the project.
28. You need to add a “Far Field” calculation to the simulation. From the side menu, right click on “Calculation”→ ”Request Far Fields”. Click on “3D pattern” as shown in Figure 18. Hit “Create”.
29. Re-mesh the design, and then click “Run FEKO”. Choose “yes” to re-save the design and “yes” to over-write the results. Once the simulation is complete, open “Post FEKO”.
30. In “Post FEKO”, choose the second menu option on the right side of the screen, under the 3D view 1 source as shown in Figure 19 (First). Then, click on the “Far Field” icon. The 3D pattern is displayed with its center at the origin. This represents the center of the antenna structure as shown in Figure 20. Choose “Gain” and display in dB. You will get the omni-directional pattern of a standard monopole antenna.
31. Now you can plot Elevation (θ) or Azimuth (φ) cuts within the gain pattern to examine a specific behavior in 2D.
32. To add a 2D gain plot, click on “Polar” from the top icon menu, then click on “Far field” to add the pattern analyzed. Then from the right menu, choose the plane cuts and the angles of interest. Make sure to adjust the scales accordingly.
33. **This concludes this exercise**. If you need more information, you can read the accompanied manuals or just play around with the tool!

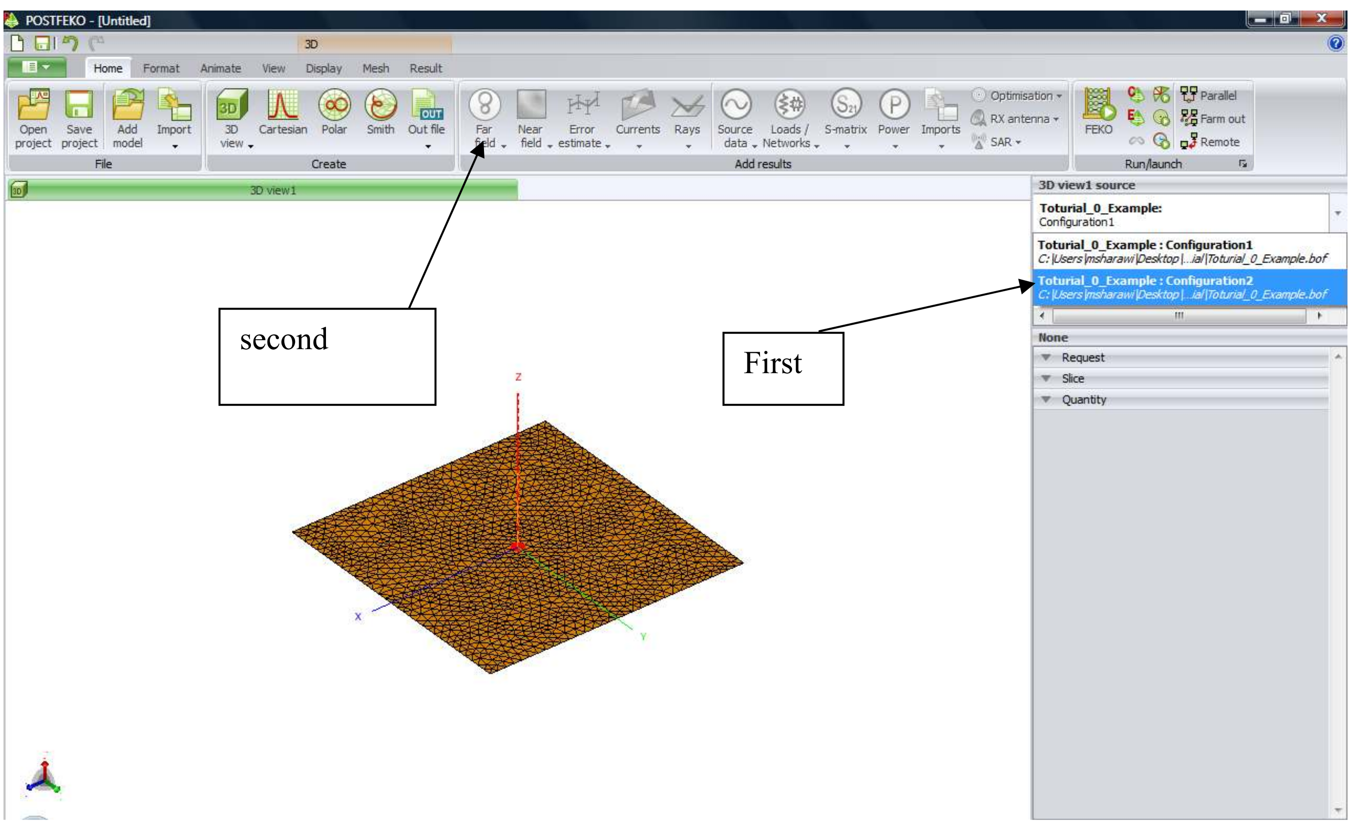

Figure 19.

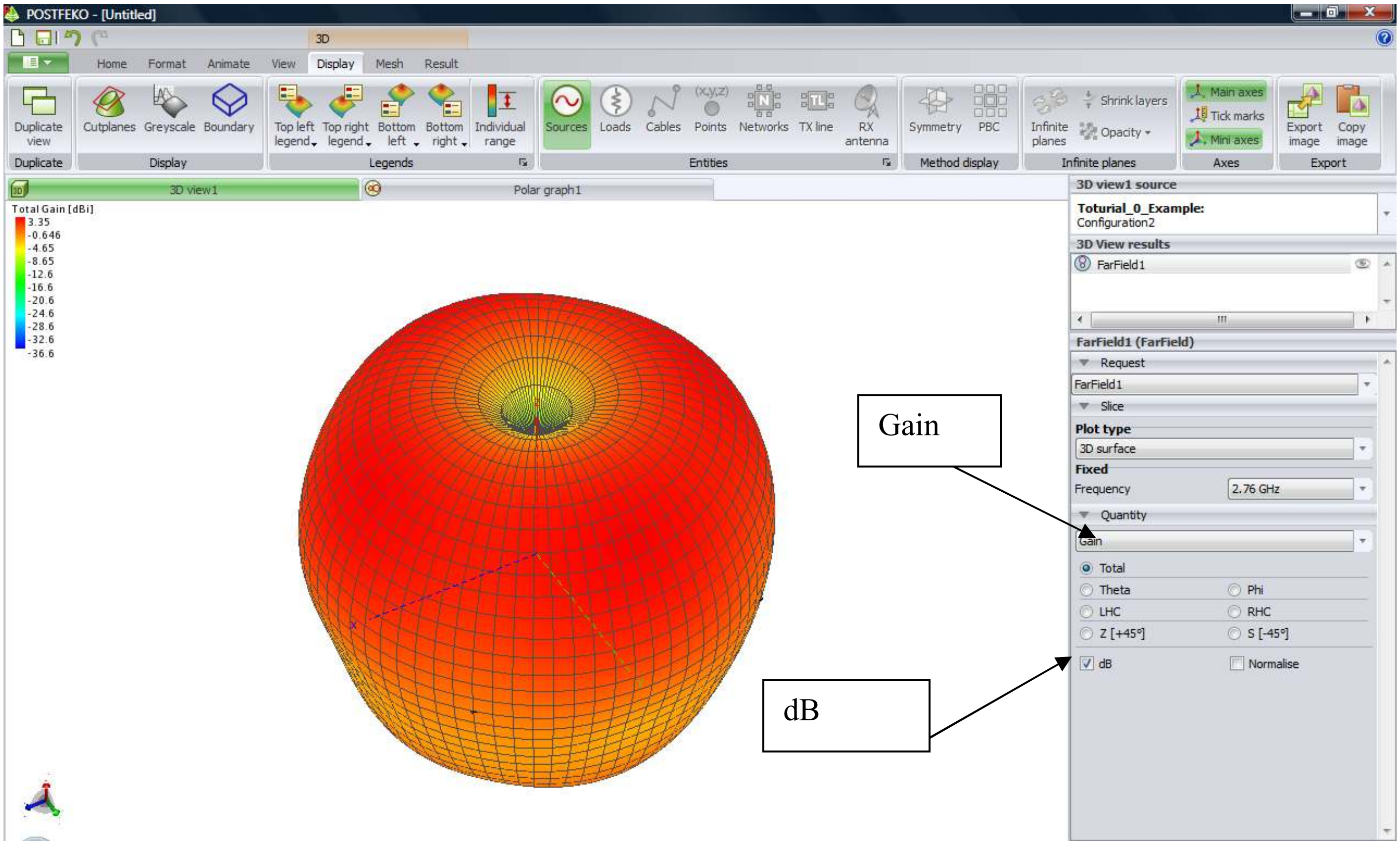

Figure 20.

THE END.