newFASANT

Array Dipoles

Benchmark: Array Dipoles
Software Version: 6.2.7
Date: 29 Nov 20:32

Index

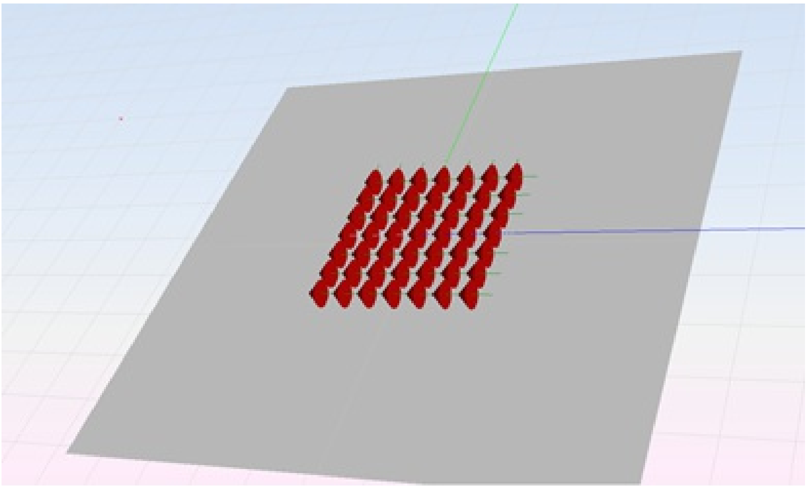
1. Benchmark description and objectives

This benchmark is divided into two steps:

- an example to show how to define an array of dipoles set the direction of the main beam and analyze it obtaining the 3D radiation pattern.
- after that, how the antenna feeding can be modified easily, in order to modify the direction of the main beam.

Explaining the recommended parameters for analyzing an array of dipoles and how to set the direction of the main beam are the main aims of this tutorial, but most of them are also general for similar problems, such an array of antennas defined by radiation pattern.

An array of 7 x 7 dipoles located on the plane XY has been chosen.The test case is shown in the below figure:



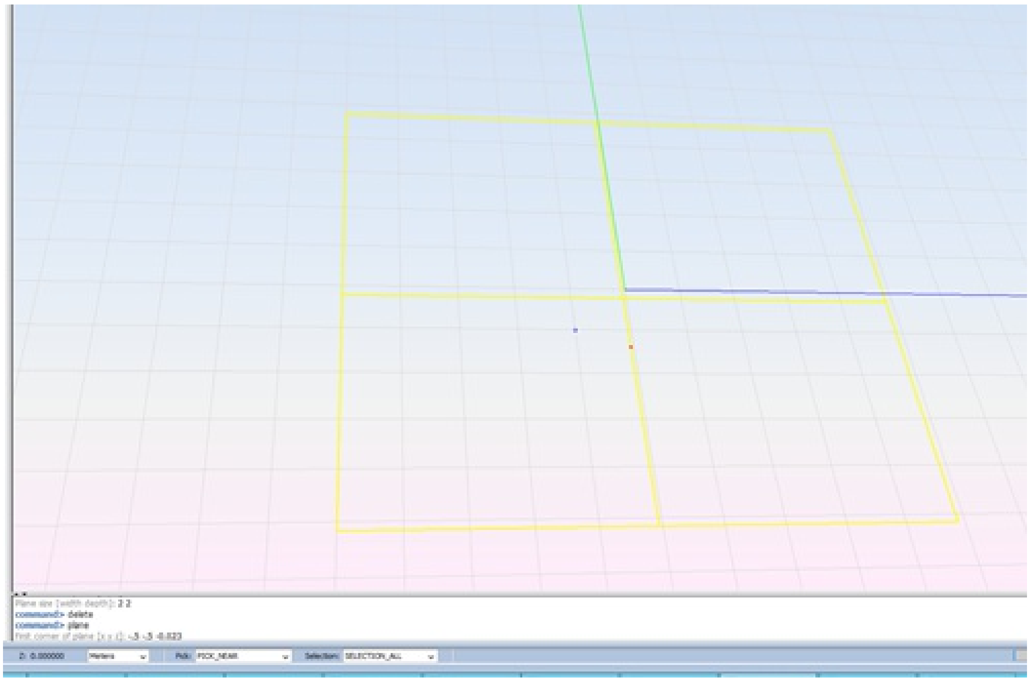
Test case

Default parameters are kept unless otherwise is stated. Anyway, effects of changing most of the parameters are briefly stated.

This example is generated using ***MoM*** module, so create a ***new MoM project*** by clicking on ***New Project*** button and selecting the ***MoM*** option.

1.1. Geometry creation

Only a ground plane is built using the ***plane*** *command* or ***Geometry - Surface - Plane*** menu. The first corner of the plane is (-0.5, -0.5, -0.023) and the dimensions of the plane are 1 x 1 m.

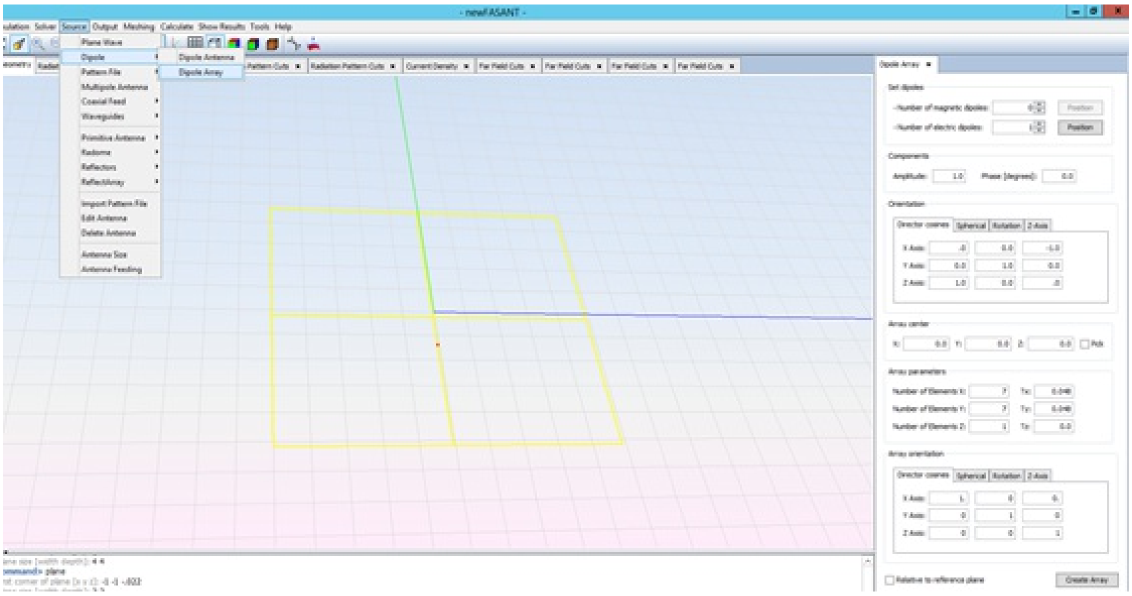


Plane definition

1.2. Source

1.2.1. Dipole Array

The Dipole Array operation is a fast way for generating a higher number of dipole antennas when they are placed in array structures, where a set of closely located dipoles should be simulated. To create a Dipole Array, select a ***Source - Dipole - Dipole Array*** *menu* to display the *Dipole Array panel*, as shown in the figure:



Dipole Array panel

In this example, an array of 7x7 electrically short dipoles is created, and the dipoles are oriented the following *x-axis* and located in the *z=0 plane*.

So, the following settings are available for defining the appearance of the overall dipole structure.

- **Set dipoles:** this setting specifies how many magnetic and electric dipoles have to be generated. This feature is covered later in this section.
  - **Number of magnetic dipoles:** set the number of magnetic dipoles that each one of the generated dipoles will have.
  - **Number of electric dipoles:** set the number of electric dipoles that each one of the generated dipoles will have. In this example, one electric dipole is selected.
- **Components:** the amplitude and phase for the dipole moment for each generated antenna.
- **Orientation:** dipole antenna rotation. There are multiple ways for setting the orientation.
  - **Director Cosines:** manually set the director cosines for the dipole.
  - **Spherical:** set the orientation using spherical system (theta, phi, alpha).
  - **Rotation**: specify X, Y, and Z angles as degrees.
  - **Z-Axis:** this option can be used for manually defining the local Z-axis of the dipole.
- **Array center:** the cartesian center for the generated dipole array structure. For a more precise mode, the pick-point mode can be enabled. Select Pick then clicks anywhere in the 3D Panel. The position where the mouse clicked will be set as coordinates.
- **Array parameters:** this setting lets the user specify the number of dipoles to be generated and the separation between each dipole. In this example, 7 dipoles in the *x-axis* and *y-axis* are setting.
- **Array orientation:** similar to the dipole orientation, this control lets the user specify the array rotation.

When the number of magnetic dipoles is greater than 0, the position and orientation of magnetic dipoles can be selected by pressing the Position button.

When the number of magnetic dipoles is greater than 0, the position and orientation of magnetic dipoles can be selected by pressing the Position button.

When all the parameters have been set, press *Create Array* to create the dipoles. *Note that generating the dipole generation will create separate dipoles. So, after generating the dipole array, you will be able to modify the values for each dipole separately.*

1.2.2. Antenna feeding

Once the dipole array has been built, the antenna feeding can be modified in the ***Source - Antenna Feeding** menu*. In this panel: the user has to set the degrees (theta and phi) and click on calculate phases in order to compute the amplitude and phase of each array element (the algorithm selected in the right windows considers a uniform amplitude of the array element weighs and a linear phase distribution) or the user can modify each amplitude and phase of each array individually.

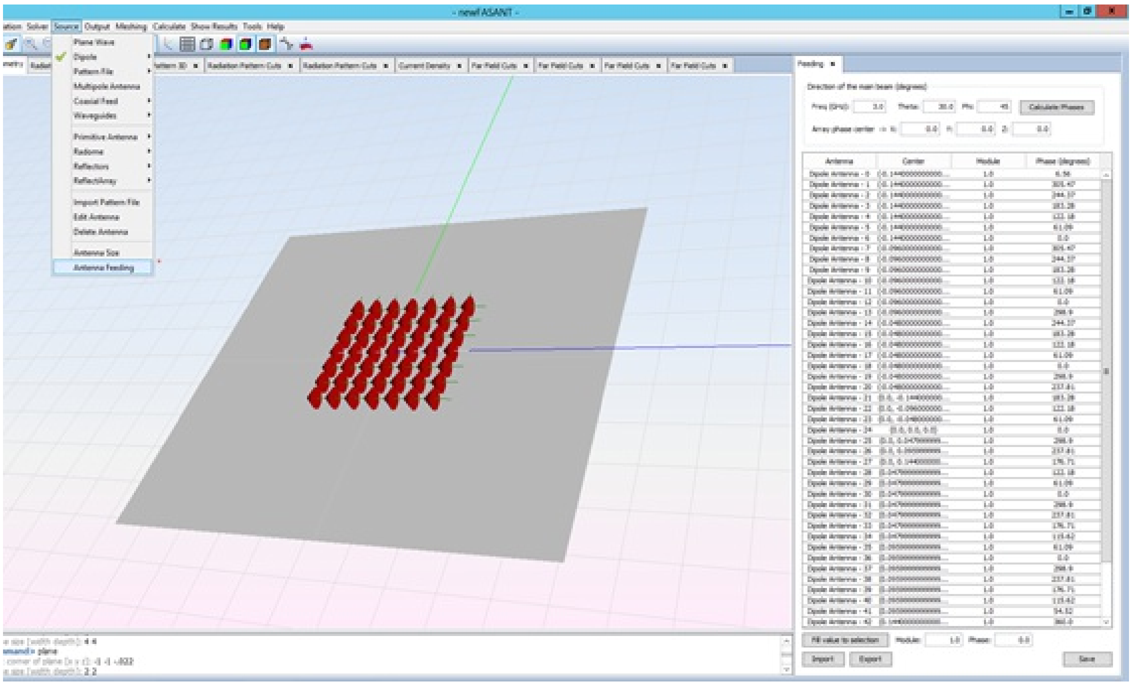
The amplitude and phase feeding each element have been saved clicking on ***Save** button*.

In order to use this antenna feeding in other projects, the user can export the array weights by clicking on the ***Export** button* and the weights are exported as a .txt file. The values of this file can be edit and modify and later import in the feeding menu. Also, the user can generate these files using other software, e.g. the toolbox for arrays of MATLAB.

- ***First step***

In this step, the user set theta = 30º and phi=45º and click on calculate phases, then click on Save button to save the amplitude and phase feeding each element.

The user has to save this project as array_dip0.nfs.



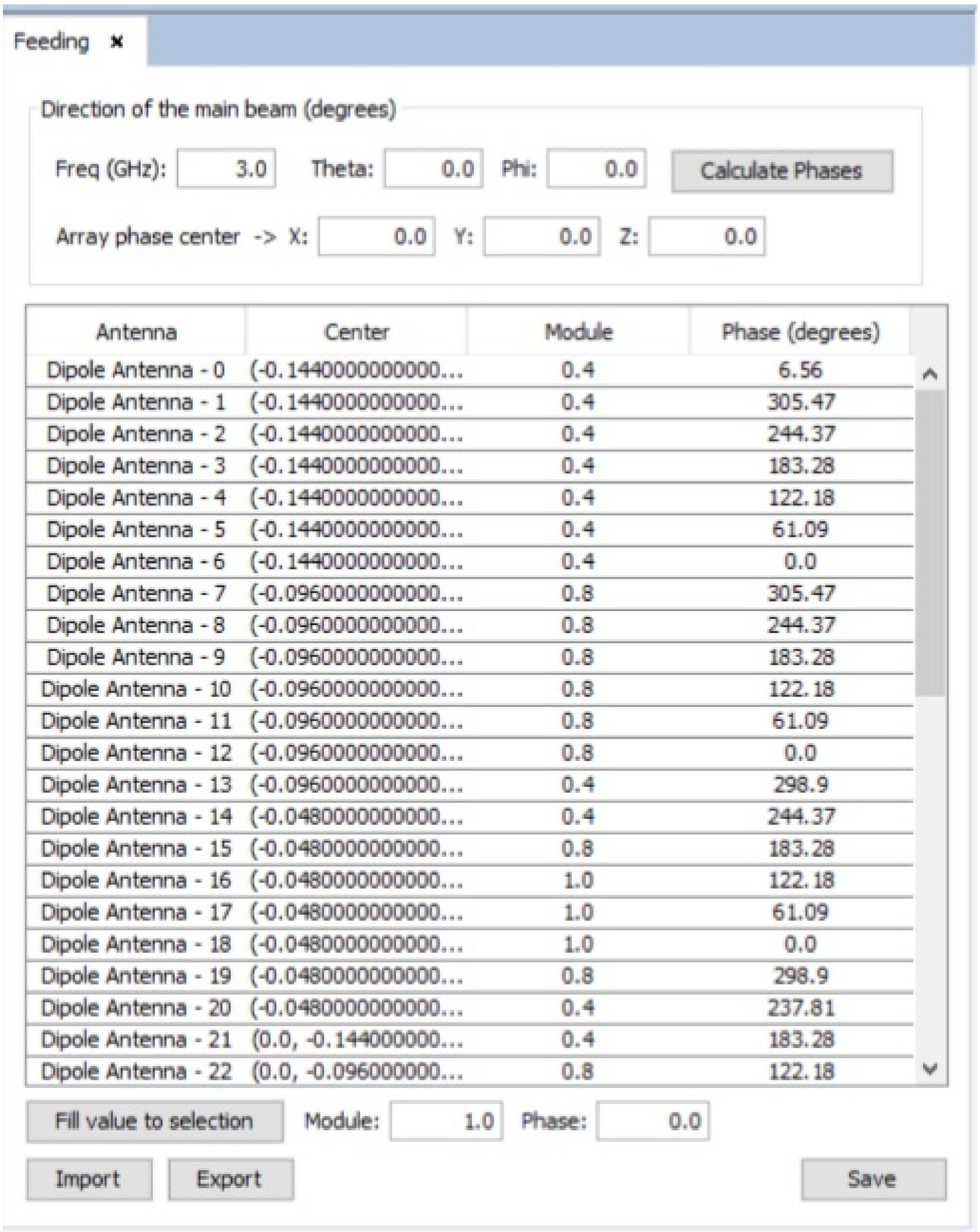
Antenna Feeding Panel

- ***Second step***

Once the previous project has been simulated and its results have been shown, the user has to save it with a new name: array_dip0_weighed.nfs, in order to modify it.

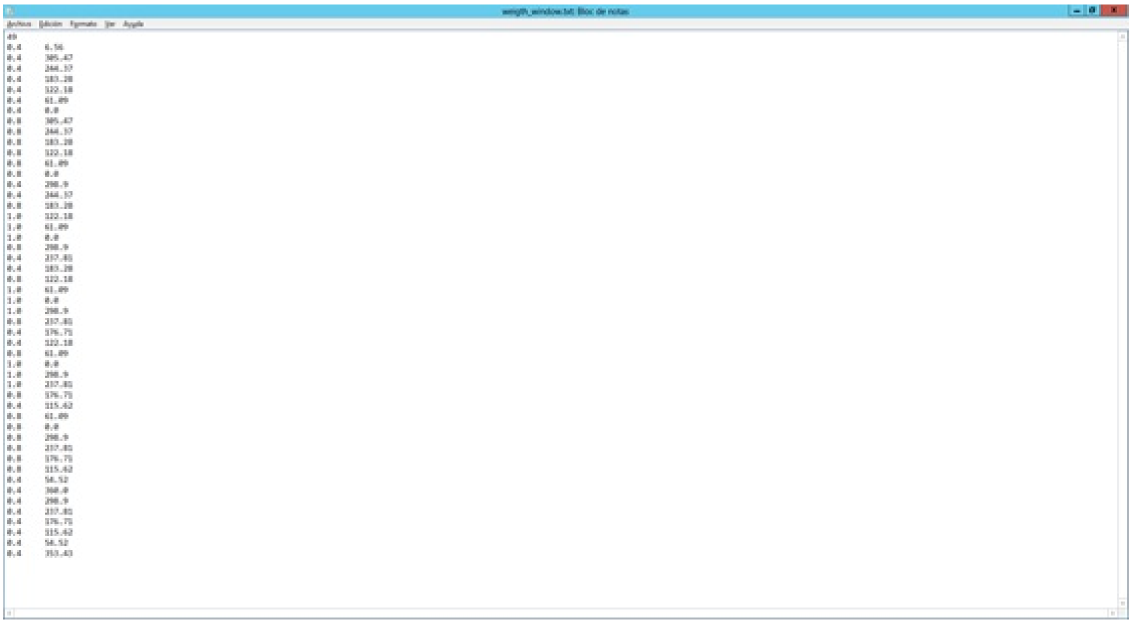
The antenna feeding can be modified in the ***Source - Antenna Feeding*** *menu*. The first seven rows of feeding weights have been selected, *note: the user has to maintain press the Ctrl key and select all the rows when a row is selected, it is highlighted in yellow, the corresponding array element.* Then, in the module column, we write 0.4 and click on fill value to selection. We can notice that the amplitude of the weights of the seven first elements of the array change from 1 to 0.4.

We repeat the procedure with other elements in the array edges in which we impose an amplitude of 0.4. In contiguous elements, we write an amplitude of 0.8, then we click on save button to keep the new values.



Antenna Feeding Panel

Then we export the array weights by clicking on the ***Export*** *button* and the weights are exported as a .txt file. The values of this file can be edit and modify and later import in the feeding menu. Also, the user can generate these files using other software, e.g. the toolbox for arrays of MATLAB.



```
49
0.4	6.56
0.4	305.47
0.4	244.37
0.4	183.28
0.4	122.18
0.4	61.09
0.4	0.0
0.8	305.47
0.8	244.37
0.8	183.28
0.8	122.18
0.8	61.09
0.8	0.0
0.4	298.9
0.4	244.37
0.8	183.28
1.0	122.18
1.0	61.09
1.0	0.0
0.8	298.9
0.4	237.85
0.4	183.28
0.8	122.18
1.0	61.09
1.0	0.0
1.0	298.9
0.8	237.85
0.4	176.75
0.4	122.18
0.8	61.09
1.0	0.0
1.0	298.9
1.0	237.85
0.8	176.75
0.4	115.62
0.8	61.09
0.8	0.0
0.8	298.9
0.8	237.85
0.8	176.75
0.8	115.62
0.4	54.52
0.4	360.0
0.4	298.9
0.4	237.85
0.4	176.75
0.4	115.62
0.4	54.52
0.4	353.43
```

.txt file

2. Set-up description

The main parameters recommended for solving this benchmark are presented in this section.

Every parameter value is justified and also a brief resume about the benefits and inconvenient of setting-up the recommended value or changing it are also included.

Critical parameters are highlighted and also justified.

2.1. Simulation parameteres

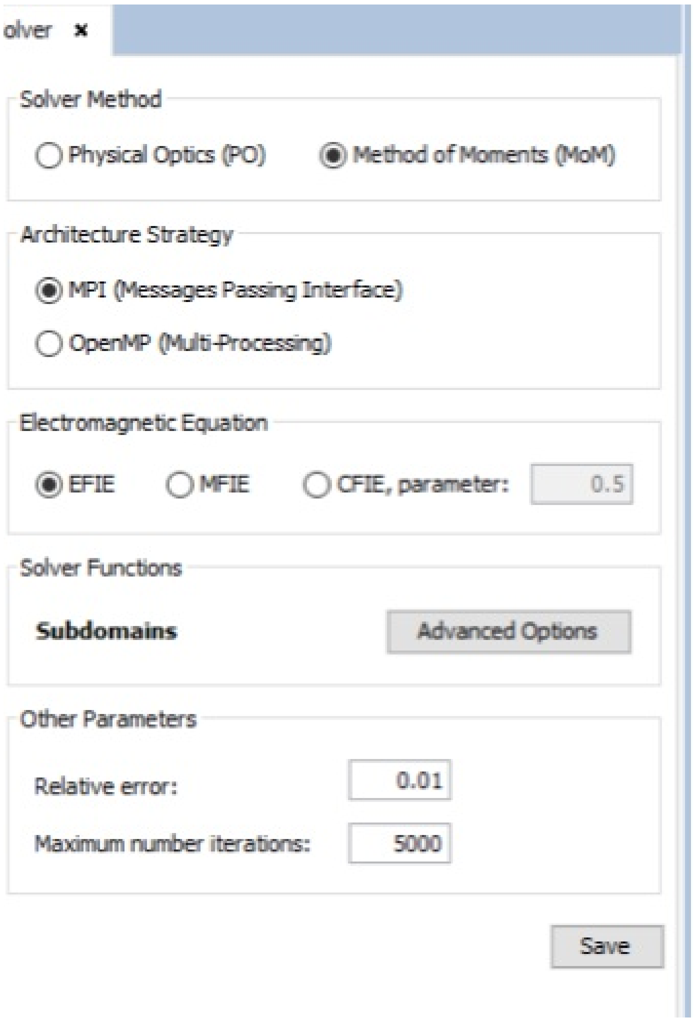
The main simulation parameters are resumed in this section.

Click on ***Simulate - Parameters*** *menu* to open the Simulation panel. A **simple frequency** will be considered, so set the **Initial Frequency** to **3 GHz**. due to the **None selection**, the most of the radiation pattern parameters, such as the 3-D pattern, or the currents density will be obtained.

No materials are required for this example, as the ground plane is metallic.

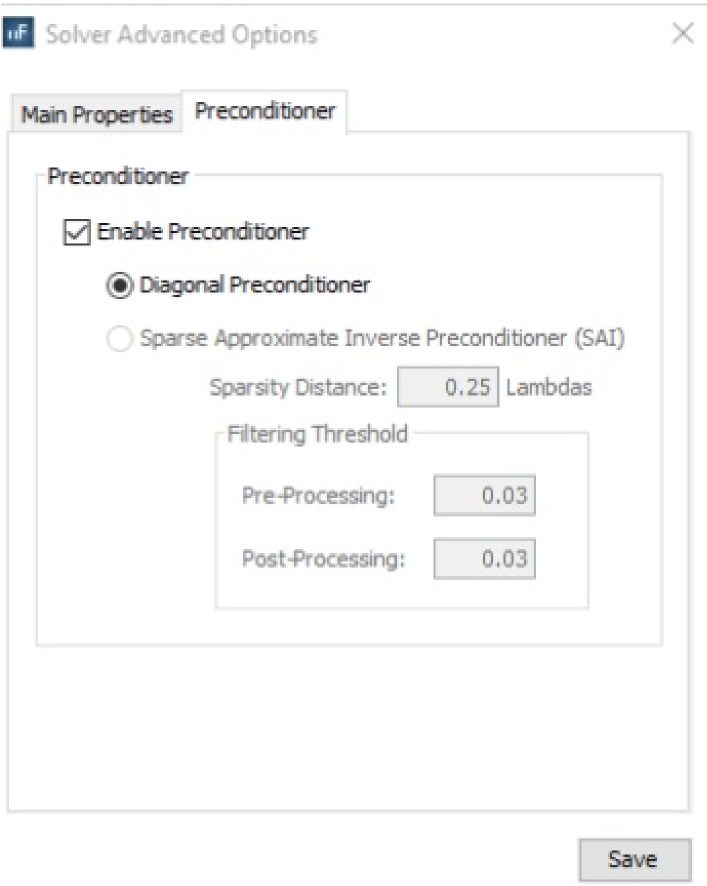
2.2. Solver parameters

In this example, all parameters are set-up by default within this section, as shown in the below figure.



Solver Parameters

In the advanced options, the preconditioner has been set-up as shown in next figure:



Solver Advanced Options

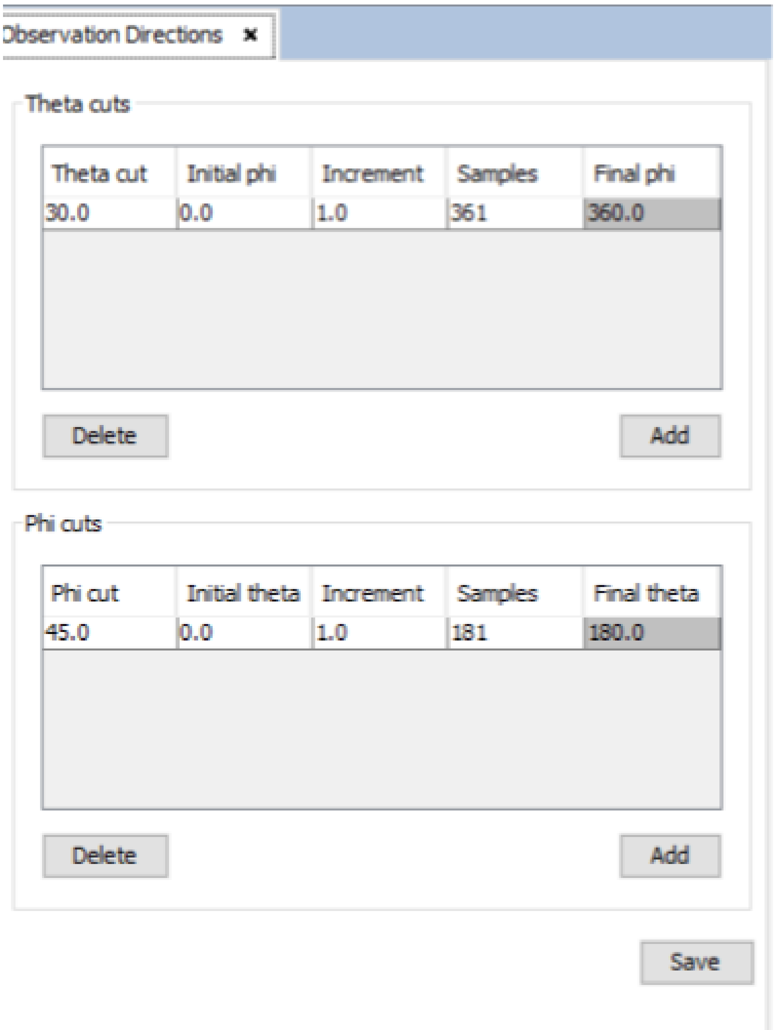
2.3. Output parameters

Far Field results are considered in this example.

The radiation of two cuts will be computed in this simulation:

- phi=45º, theta=0º to 180º (181 samples)
- theta=30º, phi=0º to 360º (361 samples)

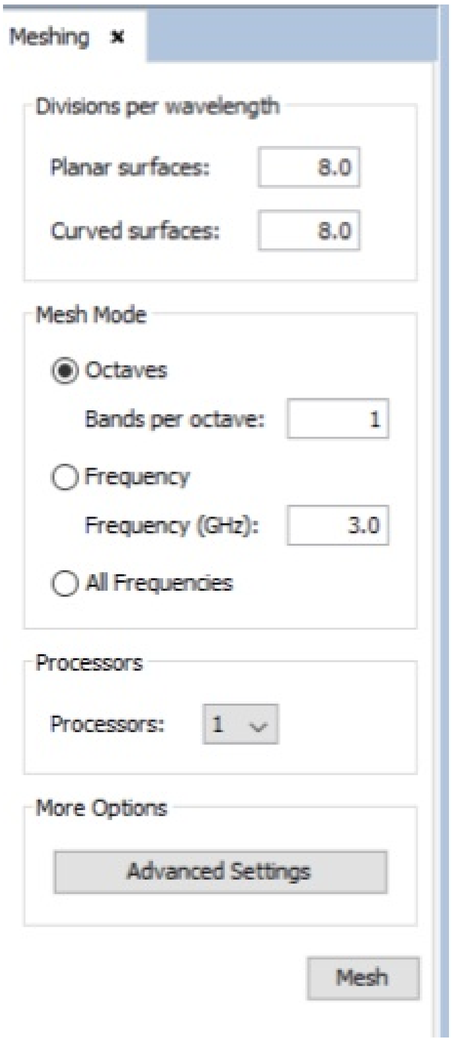
So, click on ***Output - Observation Direction*** *menu*, and set the required parameters in the *Observation Directions panel*, and click on **Save** button before closing.



Observation Direction panel

2.4. Meshing parameters

The most of the parameters are set-up by default within this section, as shown in the below figure. Two parameters have been modified for this example: the division per wavelength: planar and curved surfaces have been set to 8.



Meshing parameters

3. Results

Results obtained in this benchmark are included in this section.

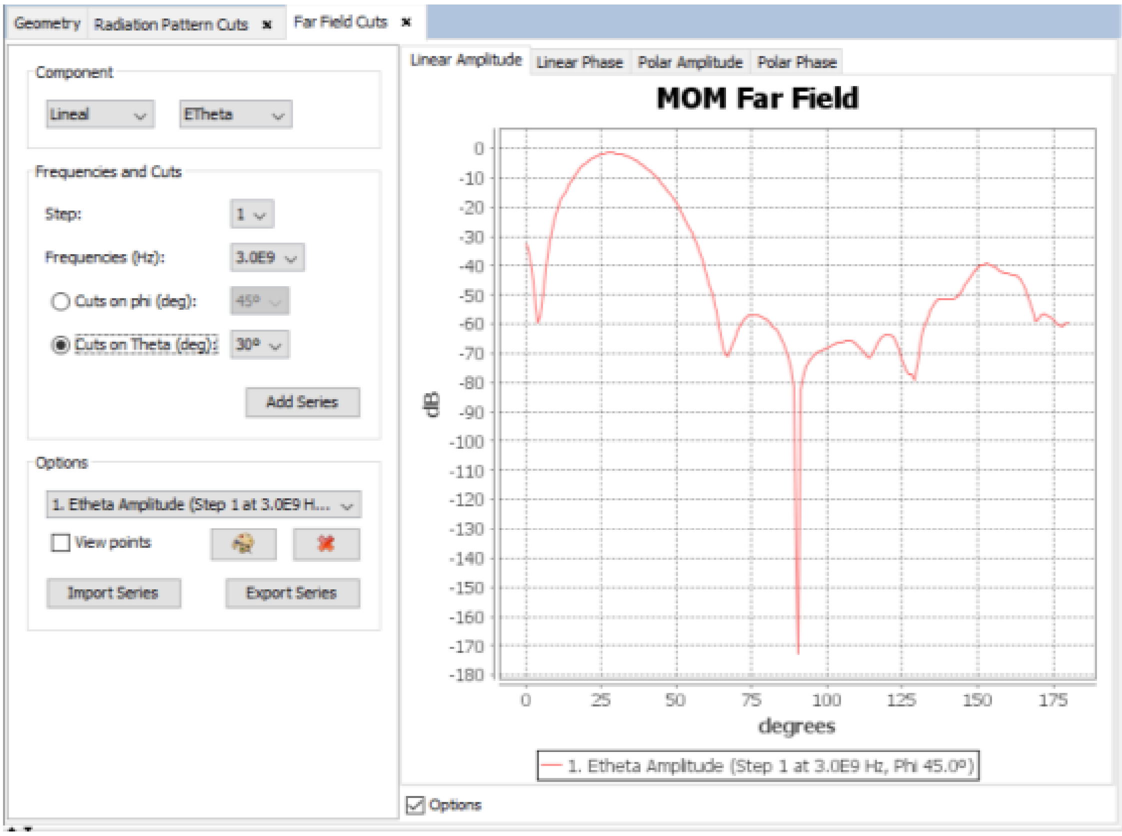
3.1. Radiation Pattern

- ***First case***

As the simulation Type has been set to None, multiple options are available within the Show Results menu: *Far Field, Radiation Pattern, View Currents and View Charges*.

Ther Radiation Pattern for the cut Phi=45º and Theta=30º can be shown by clicking on ***Show Results - Far Field - View Cuts***. In this panel, on *Options* box, the user can add or delete new curves, in order to compare them.

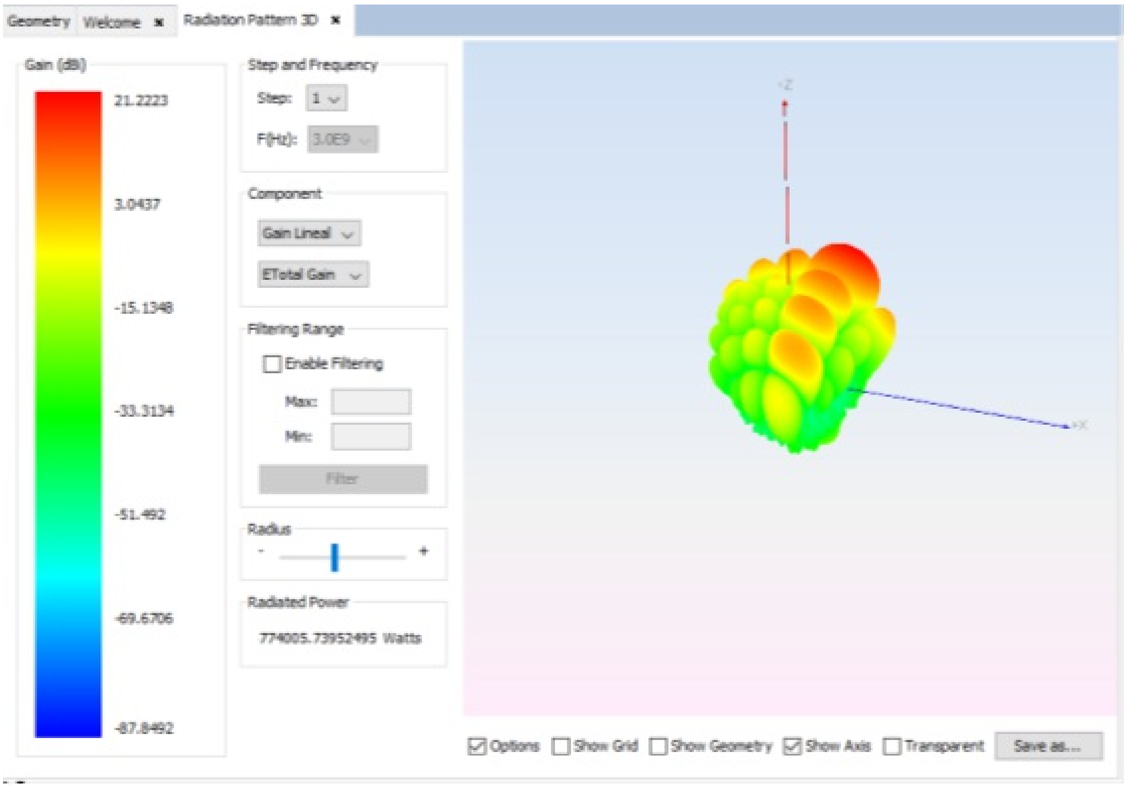
With the ***Export*** *button*, the values of this cut will be saved in a .txt file and with the ***Import*** *button*, new values can be imported in order to visualize them.



Radiation Pattern at Theta=30º

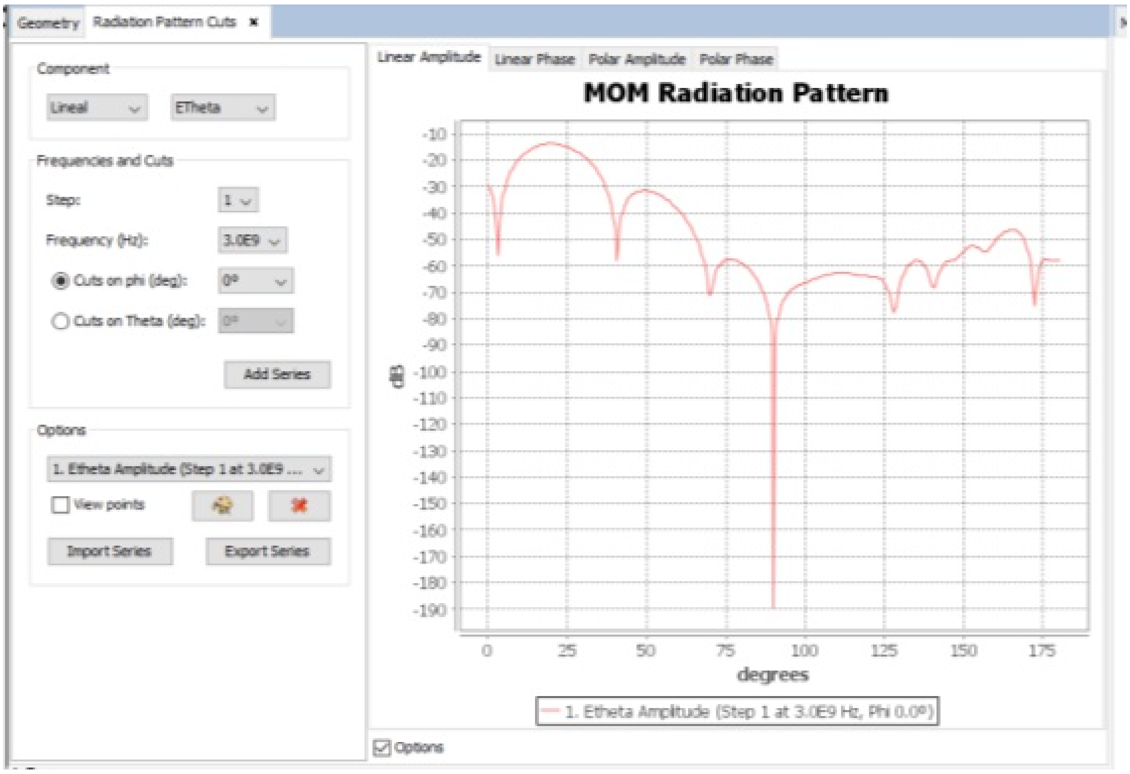
The 3-D pattern can be visualized by clicking on ***Show Results - Radiation Pattern - View 3D Pattern***.

By selecting ***Enable Filtering*** in ***Filtering Range***, the appropriated range for the color palette can be fixed.



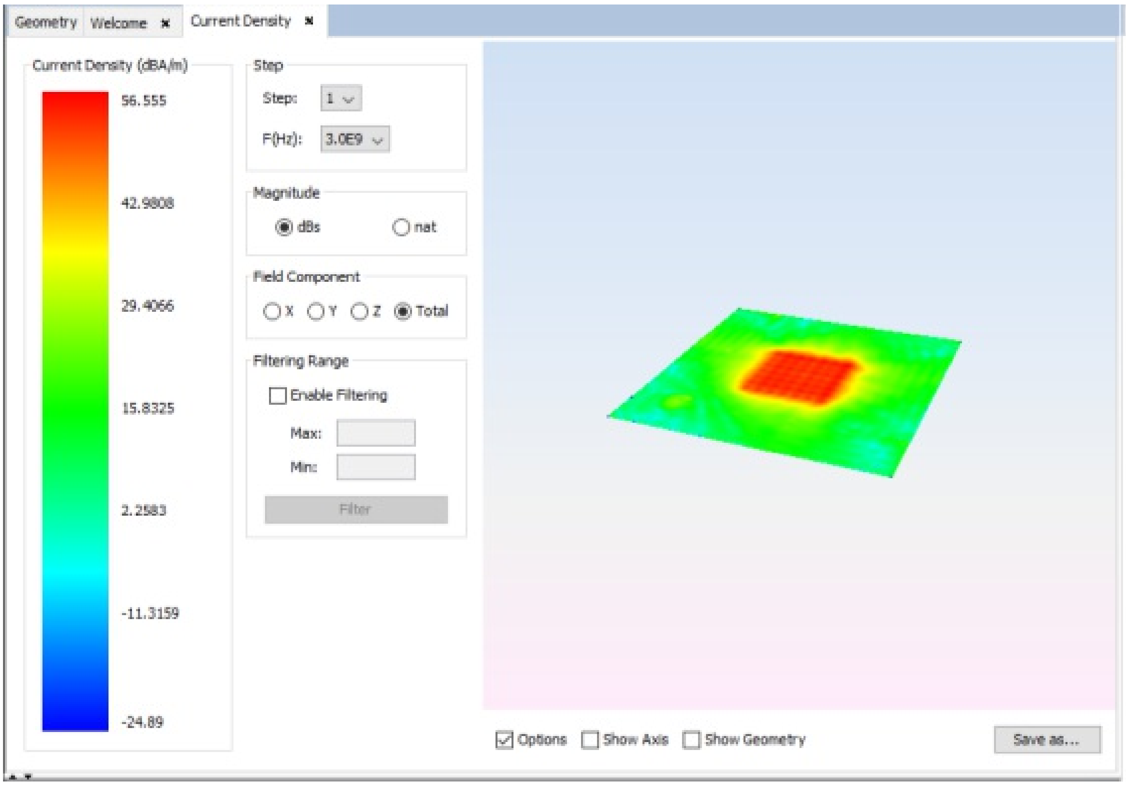
Radiation Pattern

Any cut within the 3-D pattern can be also visualized by clicking on ***Show Results - Radiation Pattern - View Cuts***. The figure below shows the Radiation Pattern for the direction *Phi=0º*.



Radiation Pattern at Phi=0º

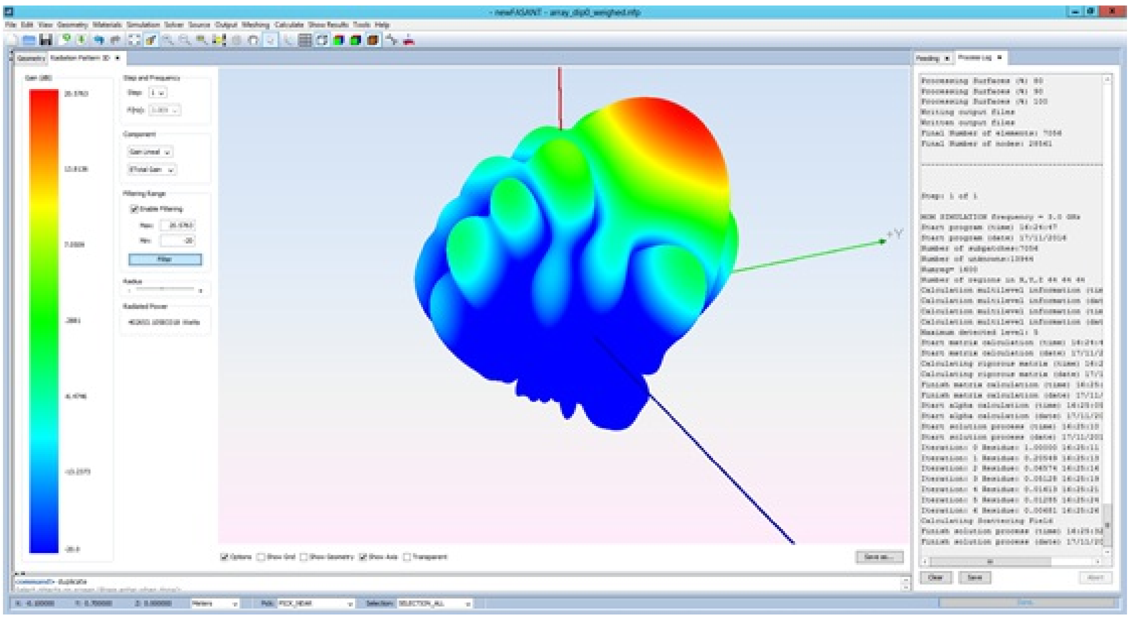
The *Current Density* can be visualized by clicking on ***Show Results - View Currents***. The next figures show three currents at different frequencies.



Current density

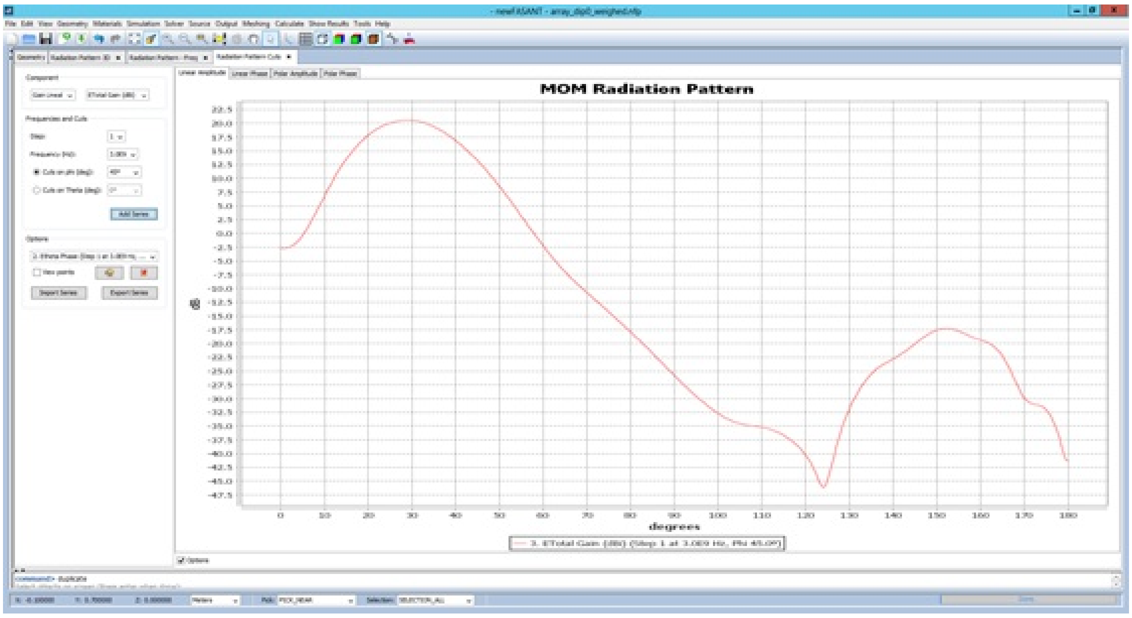
- ***Second Case:***

The 3-D Pattern can be visualized by clicking on ***Show Results - Radiation Pattern - View 3D Pattern.***



3D Radiation Pattern

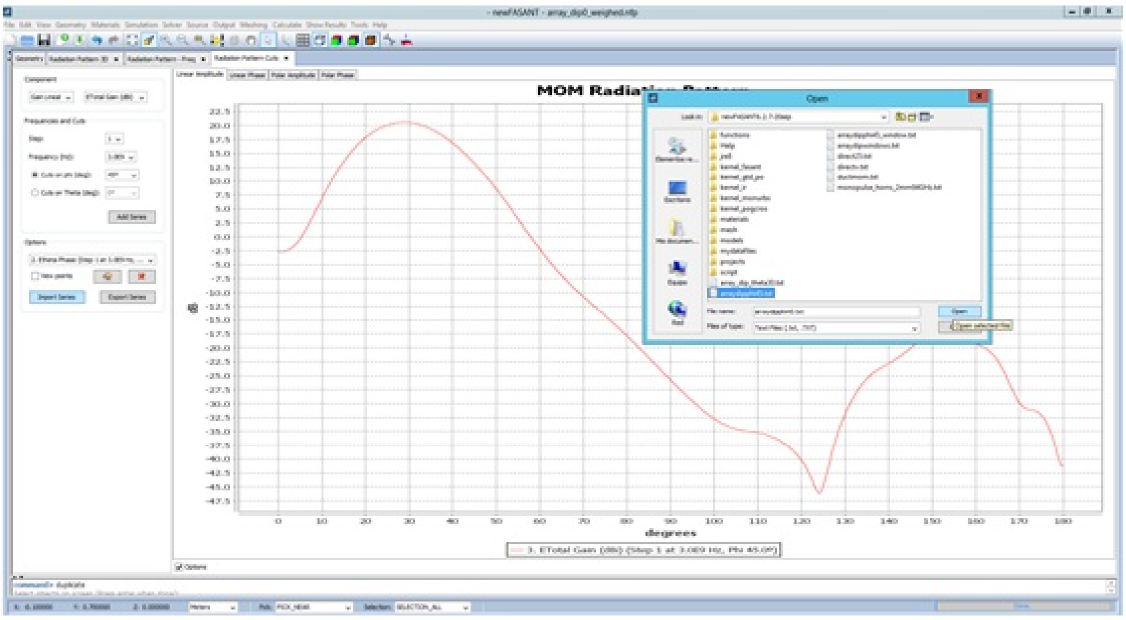
The Radiation Pattern for the cut Phi=45º has been shown by clicking on ***Show Results - Far Field - View Cuts.***



Radiation Pattern cut for Phi=45º

The radiation pattern of the previous project will be imported, in order to check the effect of modifying the weight of the array elements in the radiation.

Click on ***Import Series*** *button* and import the .txt files of the results of the previous project.



Import .txt file

Comparison of the results for a phi=45º cut. Array with windowed weights (red line) and array with original weights (blue line)

Comparison of the results for a phi=30º cut. Array with windowed weights (red line) and array with original weights (blue line)

In this case, we can appreciate that the array with windowed weights has its lobes at a lower level.

4. CPU Resources

The benchmark includes a resume of the average computational resources required for achieving the provided results according to the *Simulation Type*.

CPU type		Workstation / Personal Computer / Laptop	
Simulation Type	**Number of processors**	**RAM required (MB)**	**Time required (mm : ss)**
None	16	150	00 : 30

Resources resume