# newFASANT

## *PO Cavity analysis*

*Benchmark: PO Cavity analysis*
*Software Version: 6.2.7*
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# 1. Benchmark description and objectives

The benchmark presented in this paper is described in this section. The main goals of this example are also resumed. Images and figures of the geometry shall be given.

This benchmark shows the creation of a circular cavity. The monostatic RCS at 10.0GHz taking into account until 10 bounces.

Explaining the recommended parameters for analyzing this kind of structures is the main aim of this tutorial, but most of them are also general for similar problems. These cases have been chosen in order to show the capabilities of the PO module in the analysis of multiple bounces.

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

This example is generated on PO module, so create three new PO projects, one per each case, by clicking on New Project button and selecting the PO option.

## 1.1. Geometry creation

Before starting with the geometrical models, it is recommended to work with the Units that fit the most to the dimensions of the geometry, as some parameters are automatically set-up. The following functions are especially sensitive to the working Units:

- ***Mouse functions***: such as zoom and selection functions. If any difficulty is found for these purposes, select the approximated elements on the desired area or from the Tree, click on Reset View button and the click on Zoom Selected button. Then, the camera functions are centered on the selection to improve the mouse functions near this region.
- ***Boolean operations***: such as split or projection commands. It is recommended that the Units are similar to the smaller elements involved on boolean operations, as the accuracy may be improved.
- ***Meshing process***: advanced meshing parameters such as the topology detection factors are predefined to the working Units.

In this example, the *default* ***Units*** (Meters )is valid.

The circular cavity considered in this example is composed of a cylinder and a circle. First, the cylinder of radius = 0.35m is built. It is available within the ***Geometry – Solid – Cylinder*** menu, Figure 1, or by using the ***cylinder -c*** command. As shown in Figure 3, the center of the cylinder is **(0.0, 0.0, 0.0)** and its radius is **0.35m**. The cylinder has been rotated **90º** and the surfaces at **x = 1.9** have been deleted. Then a ring of radius **0.35m** and **1.0m**, minor and major respectively, has been created. It is available within the ***Geometry – Surface – Rings - Ring*** menu, Figure 2, or by using the ring command. The ring has also been rotated 90º and move to **x = 1.9**.

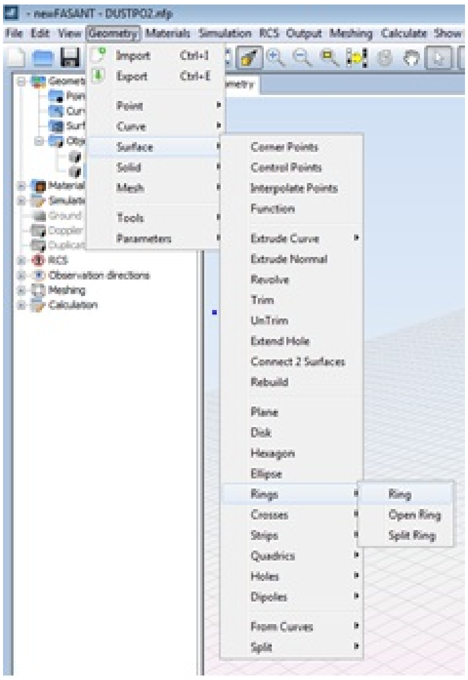



Figure 1: Solid menu.

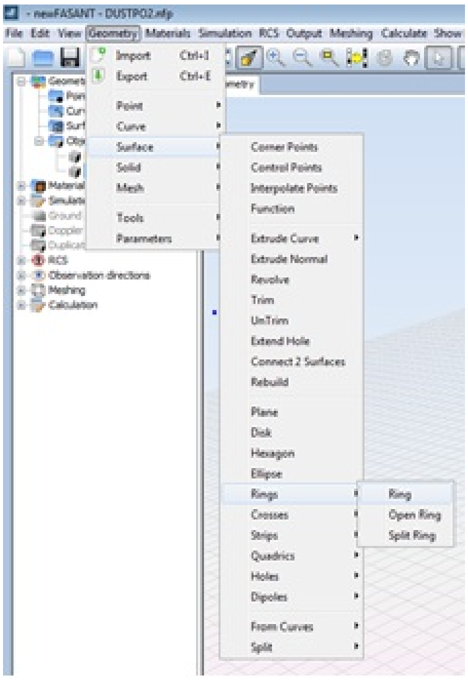



Figure 2: Surface menu.

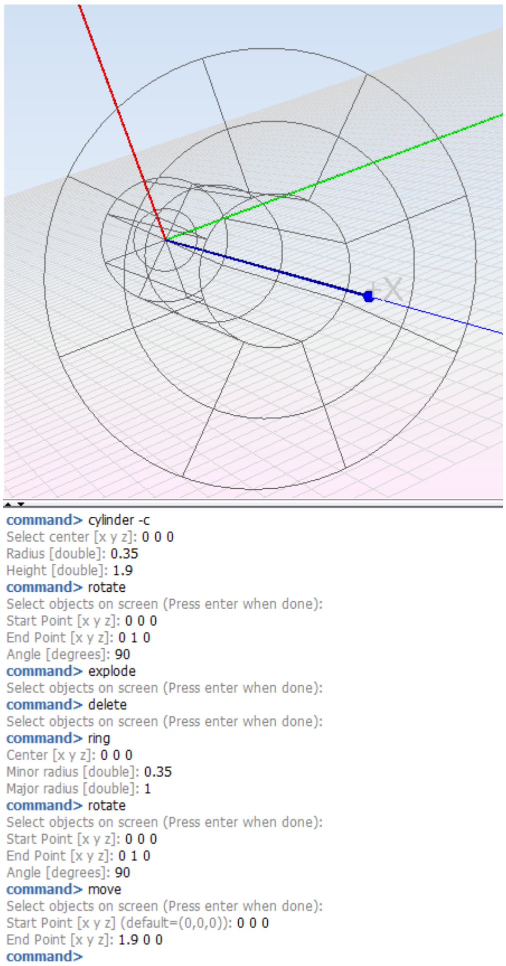
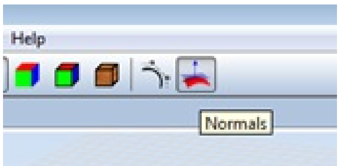



Figure 3: Circular cavity.

Revise the normal vectors of the geometry by clicking on the ***Normals icon***. The normal vectors must be as shown in Figure 4.



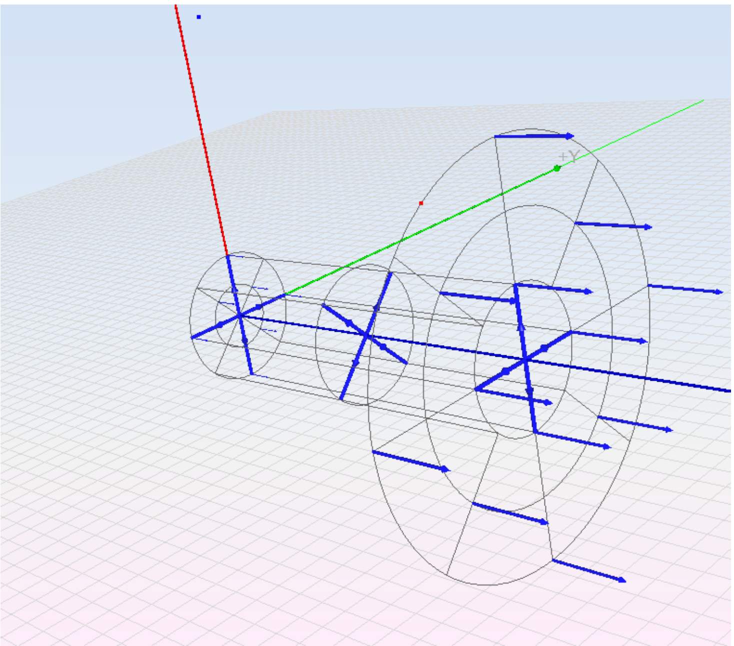



Figure 4: Normal vectors verification.

# 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 Parameters

The main simulation parameters are resumed in this section, such as the information about the units, materials and observation directions.

Click on ***Simulation – Parameters*** to open the Simulation panel. The only parameters which have been modified for this example are the Initial frequency that is set to **10 GHz**, which is the frequency of the simulation, and the Number of Bounces that is 10 bounces. As we are analyzing a cavity, it is recommended to consider multiple bounces.

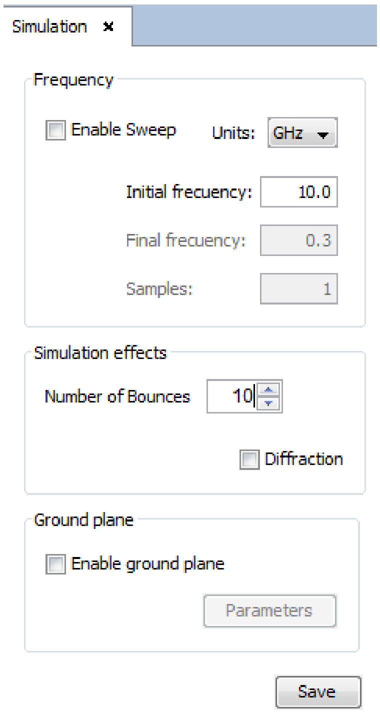



Figure 5: Simulation parameters.

The cylinder is a metallic structure. However, the ring is dielectric. Defining the new material named RAM60 as shown in Figures 6 and 7, it is added to the ring, Figure 8.

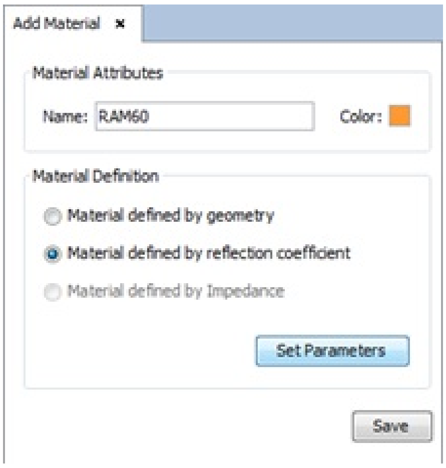



Figure 6: Add Material panel.

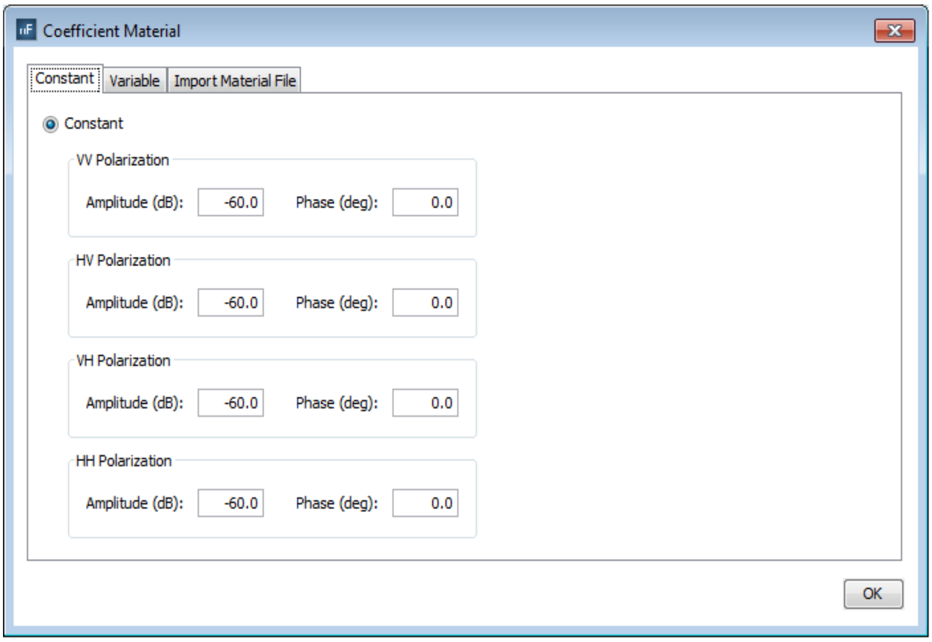



Figure 7: Coefficient Material panel.

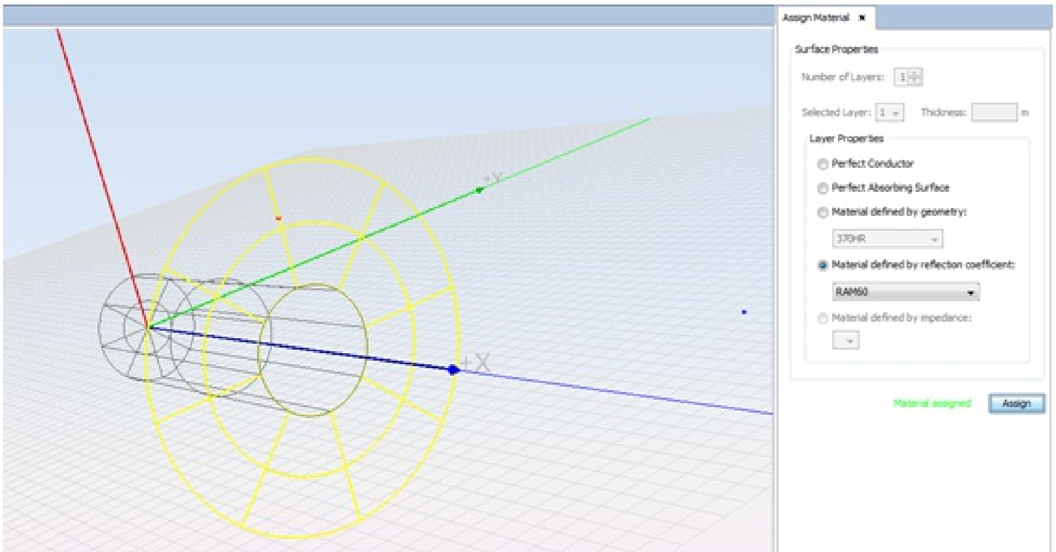



Figure 8: Material assignation.

The monostatic RCS will be computed as shown in Figure 9.

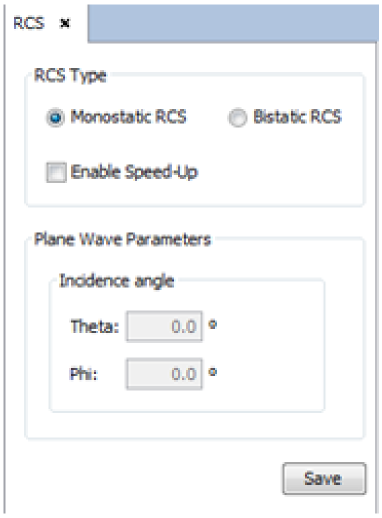



Figure 9: Monostatic RCS

The far field observation directions considered are: cut in theta=90º and a sweep form phi=0º to phi=80º with 81 directions. It may be modified within the ***Output – Observation Directions*** menu.

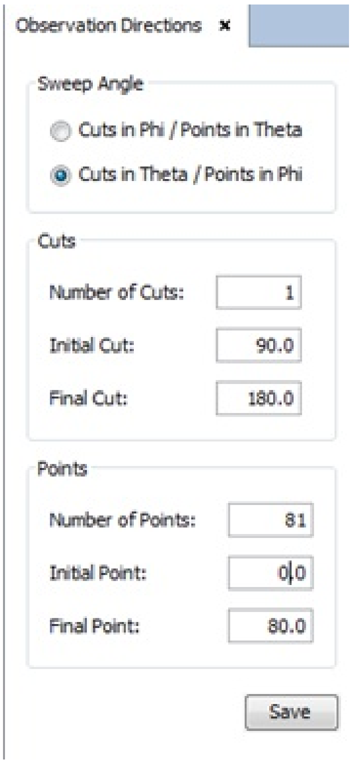



Figure 10: Observation Directions

# 2.2. Meshing Parameters

In the PO module, the mesh generation is a required step that is performed immediately before simulating. In the Meshing Parameters window, represented in Figure 11, the following options are available.

- ***Number of processors***: to set the number of processors for the meshing process
- ***Meshing strategy***:
  - ***Regular Meshing***: The size of the generated elements is selected by the user. Regular meshing is the common algorithm used in other modules such as MoM. It provides a mesh of triangles of similar sizes with a distribution as uniform as possible. It enables the user to set the exact size edge of the triangles to be generated, given in lambda units. However, a huge number of mesh elements may results when the geometry contains large surfaces.
    - **Multilevel**: Use Multilevel to generate the mesh automatically in several sequenced steps. This option is usually more efficient (in terms of runtime) than the common mesh generation option, so it is selected by default. However, there may be minor differences between the meshes obtained with and without the Multilevel mode.
    - **Edge size**: Desired size for the edge of the elements, in wavelengths.
  - ***Curvature Meshing***: The size of the generated elements is automatically computed in the meshing process. However, it depends on the global bounding box of the targets, their curvatures, and the Distance error and Surface error (lambda) parameters. This technique provides a non-regular mesh with patches generated to discretize the curvatures and edges of the geometry with a quasi-adaptative method. The generated meshes usually are less dense than the ones provided with the Regular Meshing strategy. The curvature meshing has been developed with the aim of solving the limitations that uniform meshes may cause in PO and GTD-PO modules. By using this technique, the planar surfaces are discretized with the minimum number of triangles that is possible; and the curved surfaces are discretized in a set of flat triangles. The criterion of curvature meshing converts the curved surfaces in planar triangles meshes where the maximum deviation between any planar triangle and the original surfaces is lower than the wavelength multiplied by the Surface Error factor.
    - **Distance error**: increasing this parameter creates a denser mesh in planar surfaces (smaller size of elements)
    - **Surface error (lambda)**: decreasing this parameter creates a denser mesh in curved surfaces (smaller size of elements)
  - ***Automatic Meshing***: The size of the generated elements is automatically computed by the meshing algorithm. Automatic Meshing method just simplifies the geometry with a low-density mesh of regular triangles with an automatically computed size. It is only recommended for simplest cases where the user does not know what can be the optimal setting up.

For this case is interesting to use the ***Regular Meshing*** option, in order to obtain a regular mesh of the geometry. As the simulation frequency is high, a good mesh will be obtained with **edge size = 2.0 lambda**. Figure 12 shows the mesh obtained.

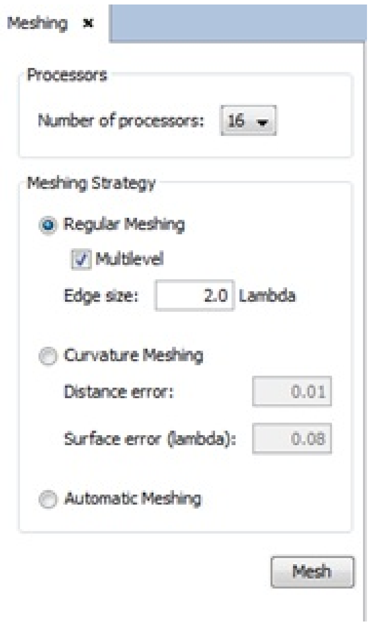



Figure 11: Meshing parameters.

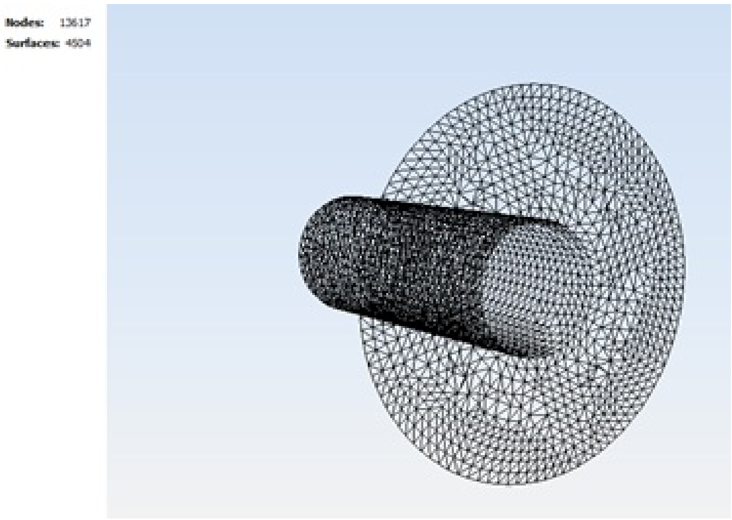



Figure 12: Mesh.

This example has been meshed in a personal computer by using 4 processors and requiring approximately 1.2 GB of RAM and 30 seconds to obtain a mesh of about 4.504 elements.

# 3. Results

Results obtained in this benchmark are included within this section. The results have been obtained by using the Configuration 3 unless otherwise is stated.

Use the ***Show Results – Far Field – View Cuts*** menu to visualize the RCS. The monostatic RCS is shown in Figure 13.

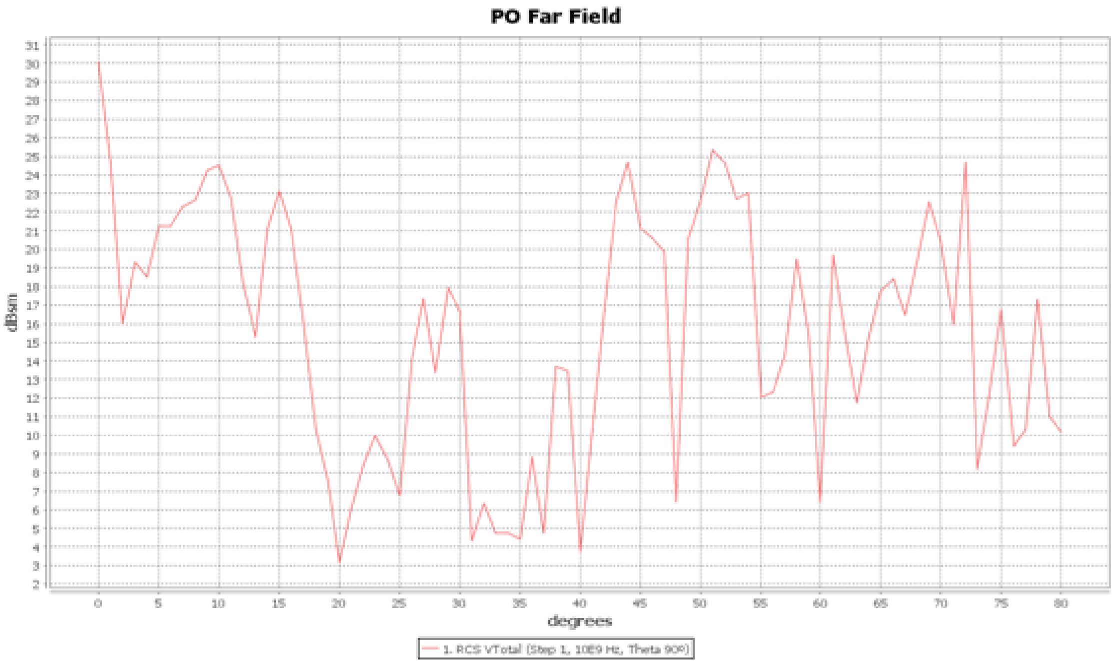



Figure 13: RCS results for the mesh obtained at 2.0 lambda.

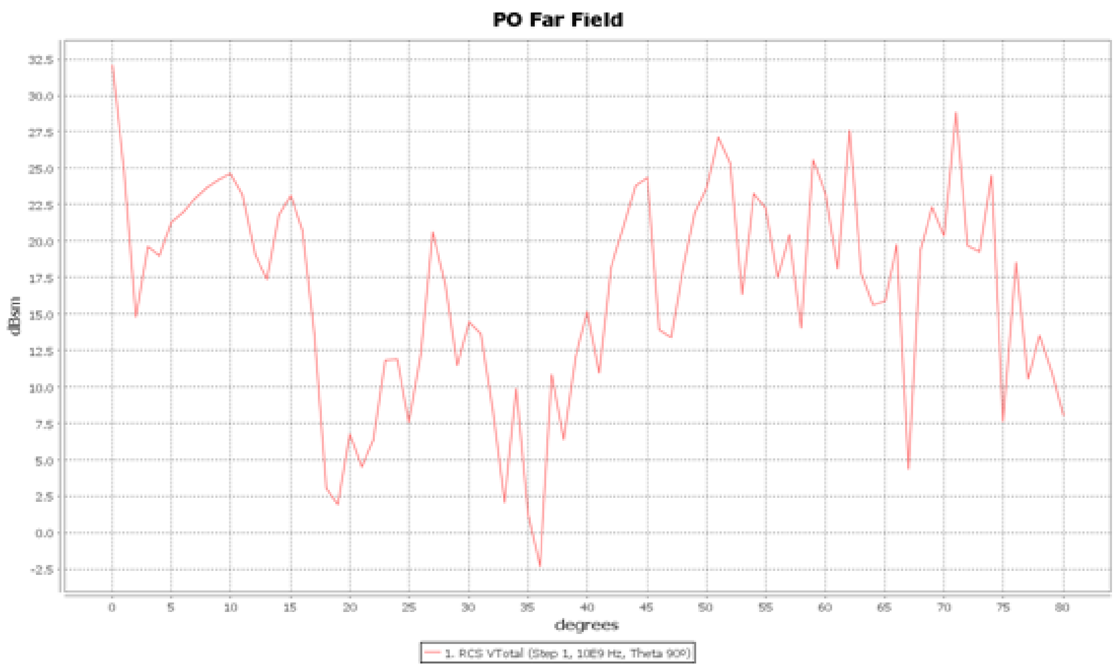



Figure 14: RCS results for the mesh obtained at 1.0 lambda.

# 4. CPU Resources

The benchmark includes a resume of the computational resources required for achieving the provided results.

| **CPU type** | | **Workstation** / Personal Computer / Laptop: Memory + Processors | |
|---|---|---|---|
| **Resources** | **Number of processors** | **RAM required (GB)** | **Time Required (mm : ss)** |
| **Configuration** | 16 | 0.4 | 106 : 35 |