newFASANT

PO Multiple effects analysis

Benchmark: PO Multiple effects 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 three simple and interesting cases consist of the computation of the monostatic RCS at 9.0GHz of a dihedral, a trihedron and a cube open by one of its facets. The side of the edges in all the cases is 1 m and the polarization Vertical-Vertical (theta-theta) has been considered.

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.

First, to build a dihedral create two plane surfaces. It is available within the ***Geometry –Surface – Plane*** menu, Figure 1, or by using the plane command. As shown in Figure 2, the first corner of the first plane is **(-0.5, -0.5, -0.5)** and the first corner of the second plane is **(-0.5, -0.5, 0)**. The second plane will be rotated **90º** and move from **(0, 0, 0)** to **(-0.5, 0, 0)**.

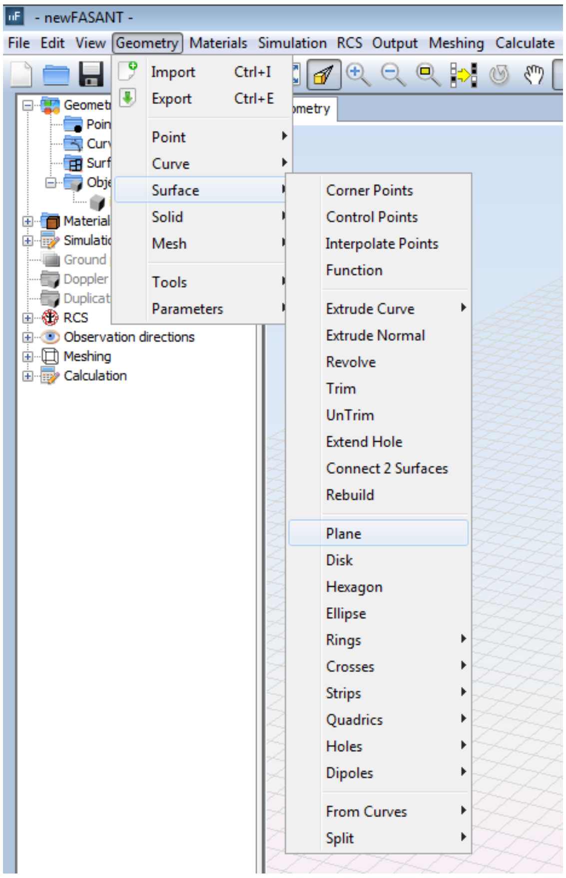


Figure 1: Surface menu.

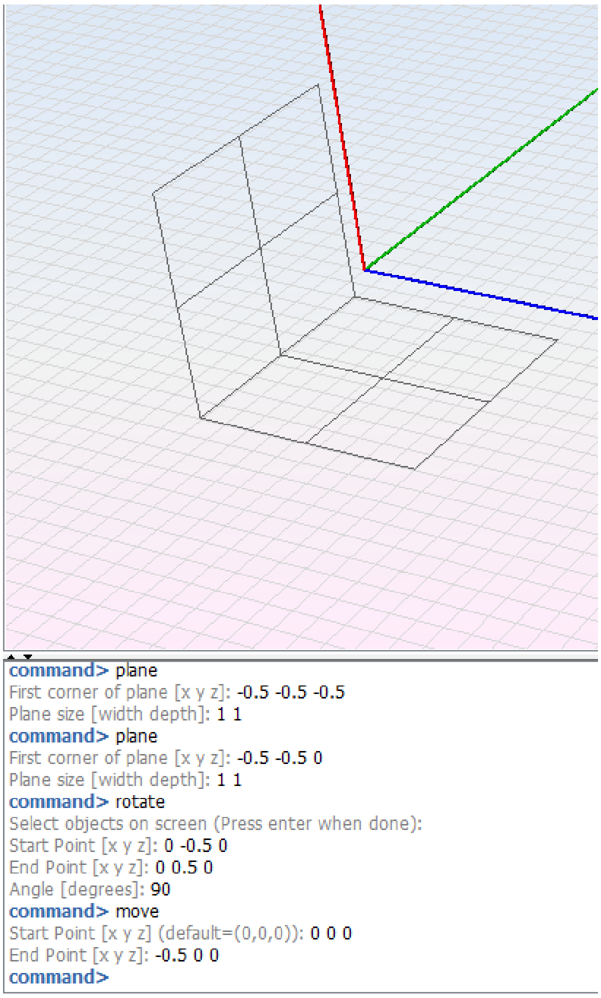
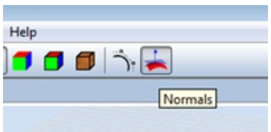
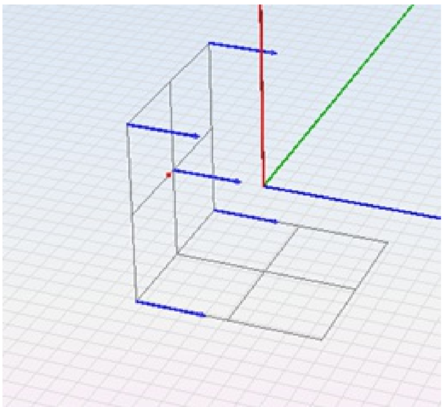


Figure 2: Dihedral.

Revise the normal vectors of the geometry by clicking on the ***Normals icon***. The normal vectors must be as shown in Figure 3.





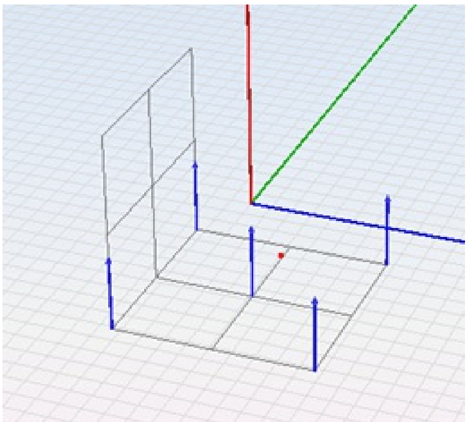


Figure 3: Normal vectors verification.

To build easily a trihedron creates a box of 1m x 1m with its first corner in **(0, 0, 0)**. It is available within the ***Geometry –Solid – Box*** menu, Figure 4, or by using the box command. Rotate the box **-45º** around the z axis. Finally, ***explode*** the geometry by using the explode command and ***delete*** three surfaces by using the delete command. The geometry is shown in Figure 5.

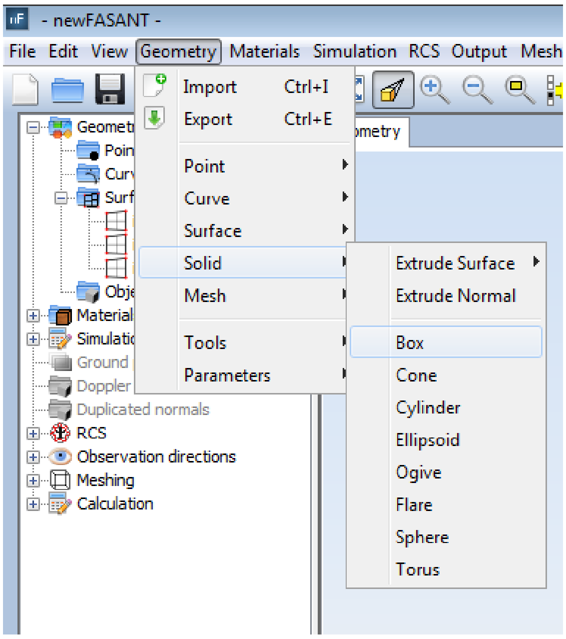


Figure 4: Box menu.

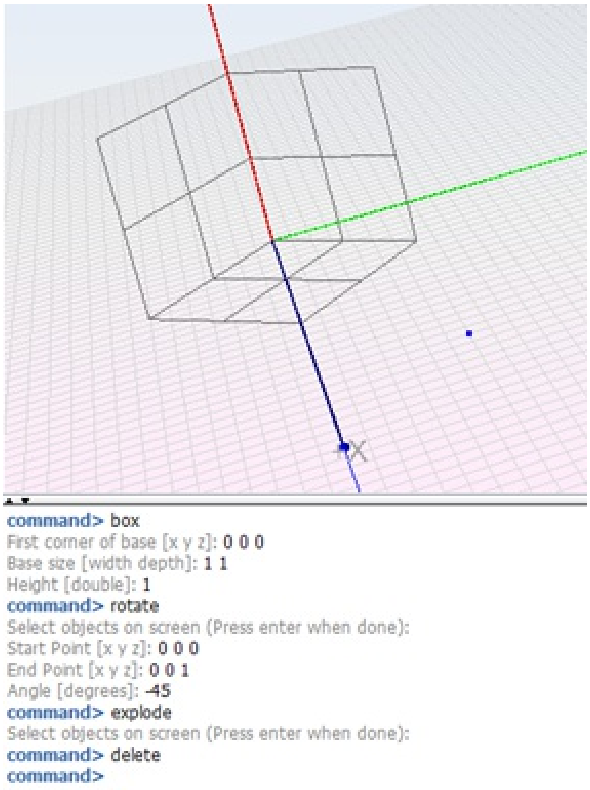


Figure 5. Trihedron.

It is necessary to correct the normal vectors by clicking on the ***Normals icon*** and then choose the direction clicking on the geometry. Also, ***invertNormals*** command can be used to perform this task. The final result per each surface will be as shown in Figure 6.

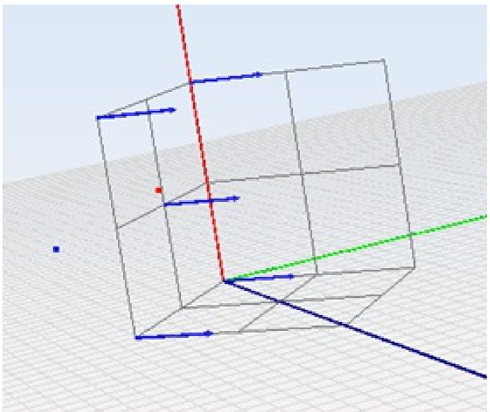


Figure 6: Normal vectors.

To build a cavity creates a box of 1m x 1m with its first corner in **(-0.5, -0.5, -0.5)**. Explode the geometry by using the **explode** command and **delete** one surface by using the delete command, as is shown in Figure 7.

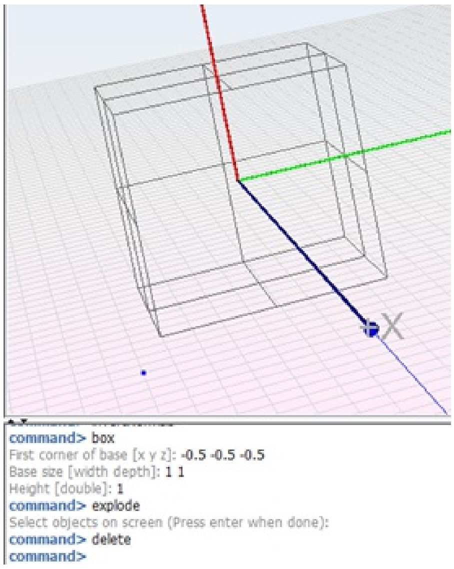


Figure 7: Cavity

Be sure that the normal vectors are as shown in Figure 8:

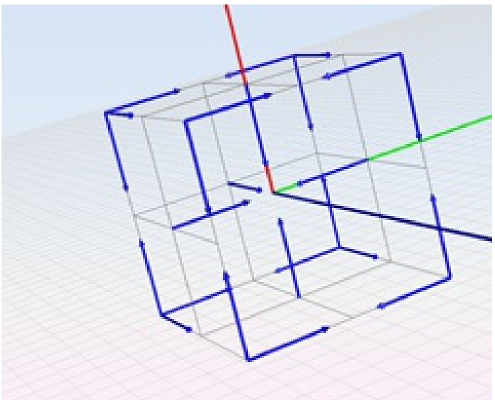
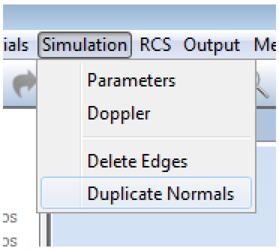


Figure 8: Normal vectors verification.

In order to consider the reflections within the cube, it is necessary to duplicate the normals of the geometry. It is available within the Simulation –Duplicate Normals menu, as shown in Figure 9.



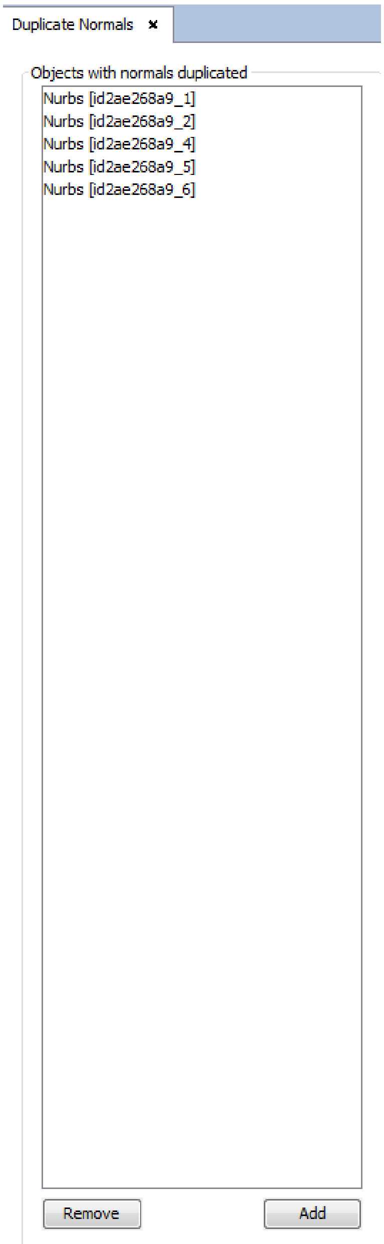


Figure 9: Duplicate normal vectors.

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 parameter which has been modified for this example is the Initial frequency that is set to ***3 GHz***, which is the frequency of the simulation for the dihedral and trihedron case and ***9GHz*** for the cavity cases. The number of bounces will be changed, double effects will be considered in the dihedral case, triple effects will be considered in the trihedron case and until 10 bounces will be considered in the cavity case.

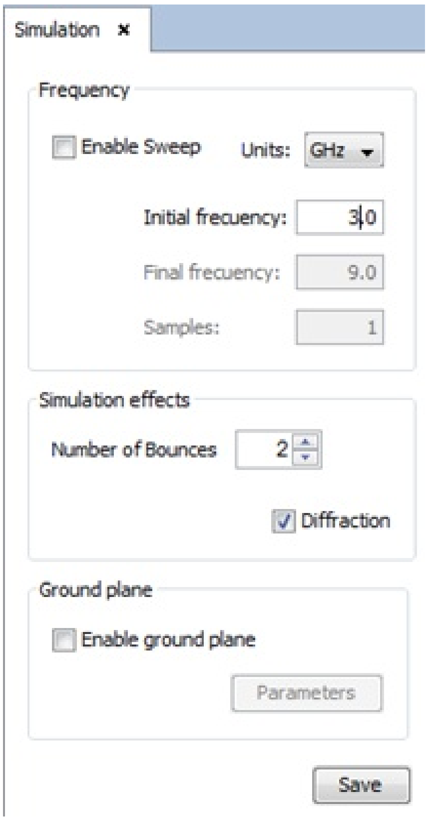


Figure 10: Simulation parameters for the dihedral case.

As the dihedral is a metallic structure, no materials are required for this example.

The monostatic RCS will be computed as shown in Figure 11.

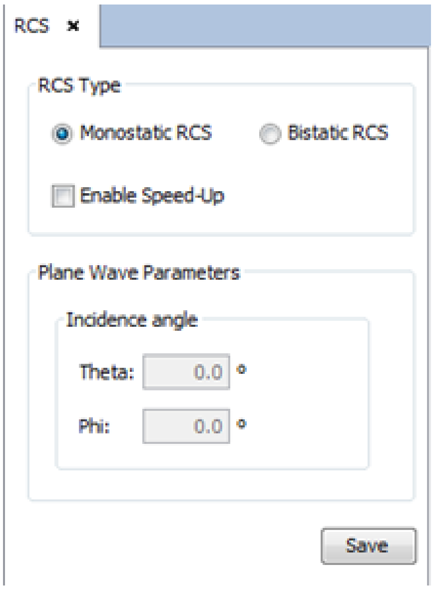


Figure 11: Monostatic RCS

The far field observation directions considered are: cut in phi=0º and a sweep from theta=0º to theta=90º with 91 directions for the dihedral and the trihedron case. For the cavity case, a sweep from theta=0º to theta=180º with 37 directions has been considered. It may be modified within the ***Output – Observation Directions*** menu.

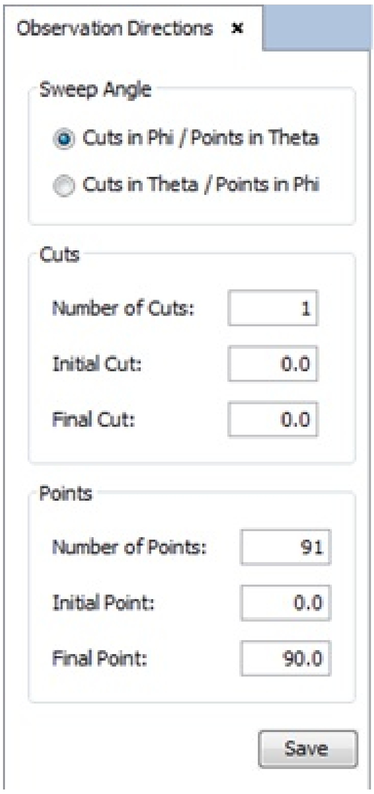


Figure 12: Observation Directions

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 15, 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, it 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,** as shown in Figure 13.

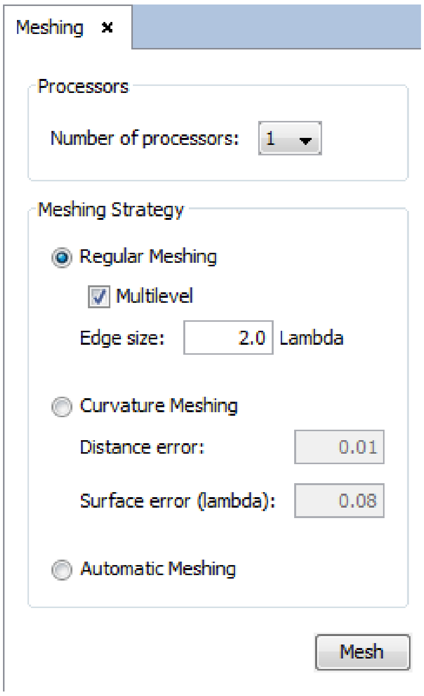
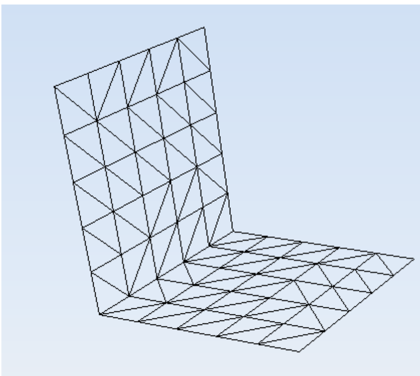


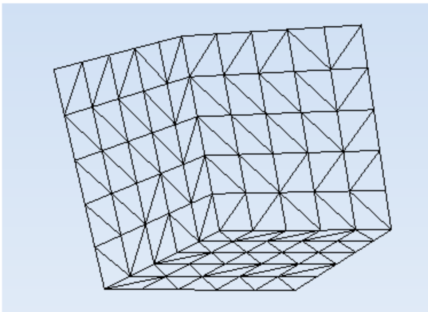
Figure 13: Meshing parameters.

Figure 14 shows the mesh obtained for each geometry, dihedral, trihedron and cavity, respectively.

Nodes: 331
Surfaces: 100



Nodes: 481
Surfaces: 150



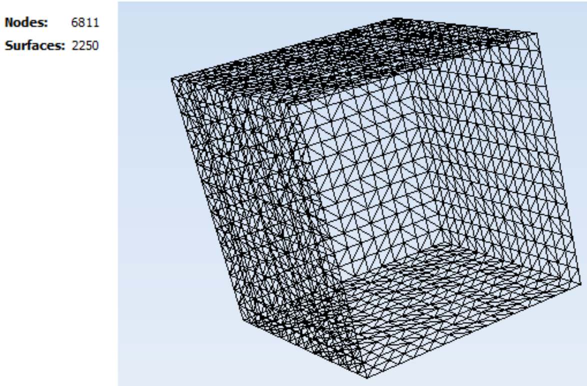


Figure 14: Mesh for the dihedral, trihedron and cavity.

This example has been meshed in a personal computer by using 4 processors and requiring approximately 1.2 GB of RAM and 1 second to obtain a mesh of about 100 elements for the dihedral, 150 elements for the trihedron and 2250 elements for the cavity.

3. Results

Results obtained in this benchmark are included within this section. The results have been obtained by using the configurations indicated in the next section.

Use the ***Show Results – Far Field – View Cuts*** menu to visualize the RCS. The monostatic RCS of the dihedral, trihedron and cavity are shown in Figures 15, 16 and 17, respectively.

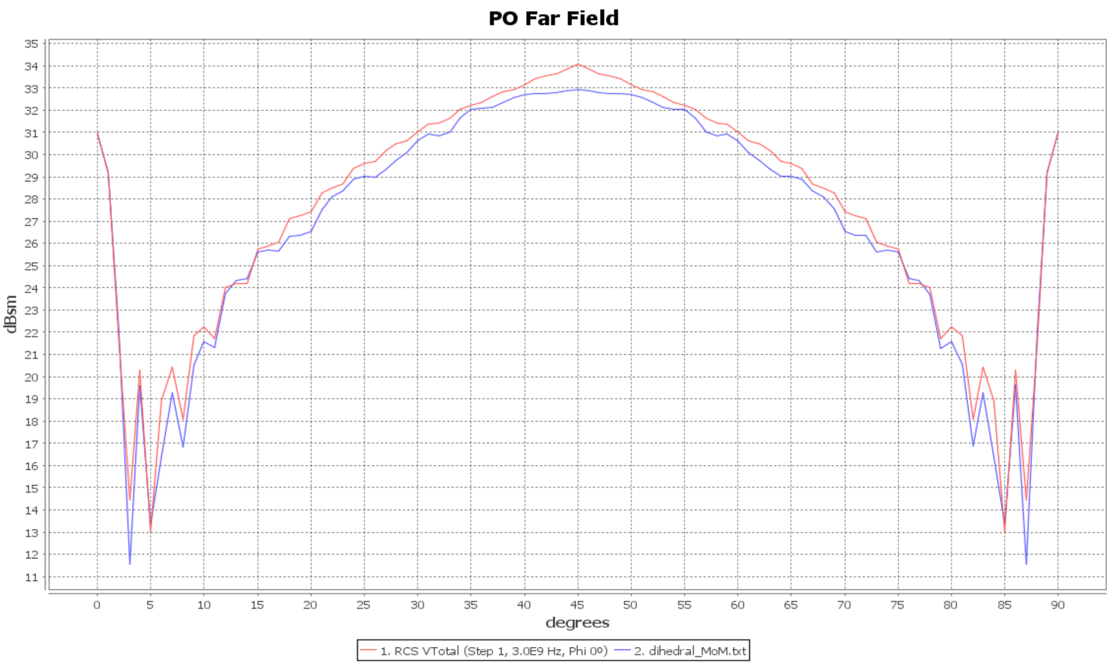


Figure 15: RCS of the dihedral.

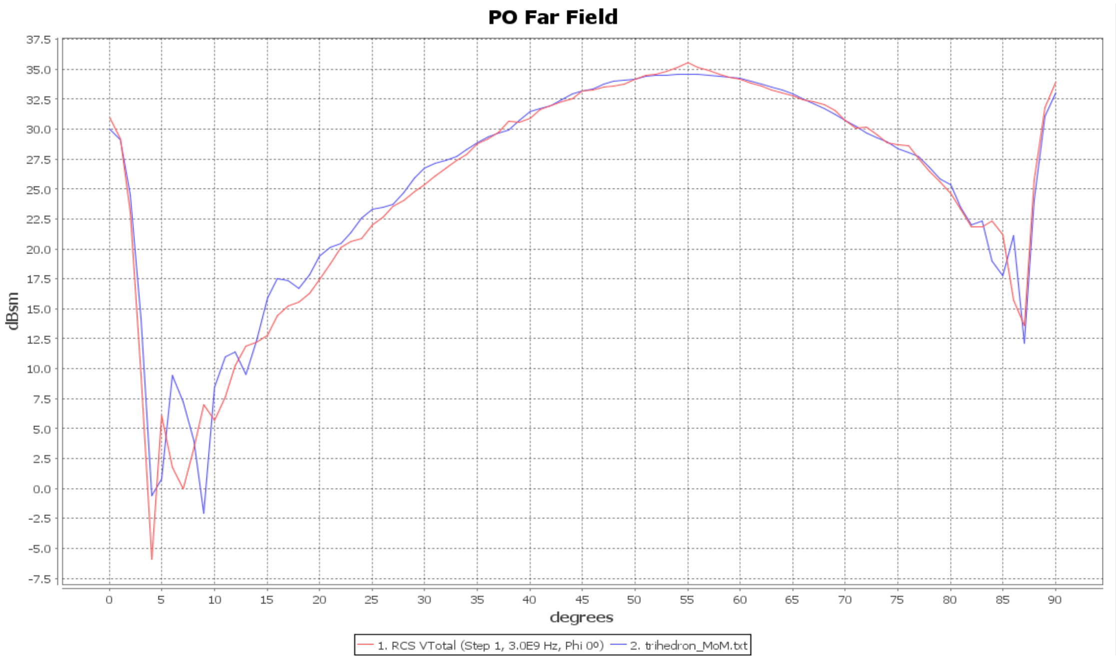


Figure 16: RCS of the trihedron.

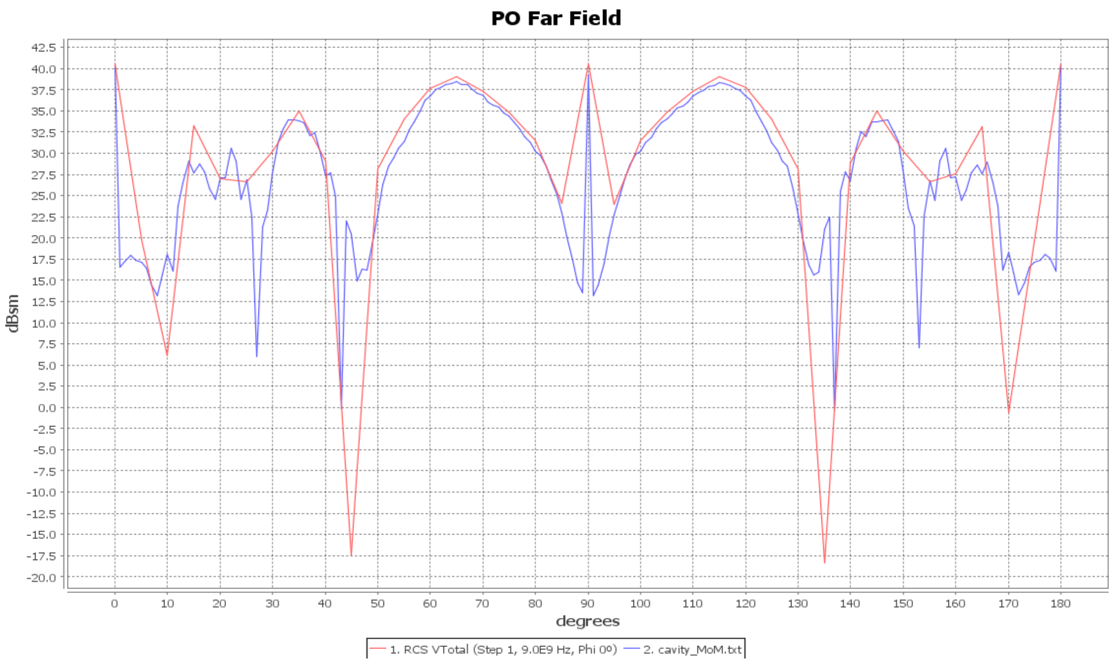


Figure 17: RCS of the cavity.

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 dihedral	2	0.4	0 : 18
Configuration trihedron	2	0.4	2 : 20
Configuration cavity	2	0.5	30 : 48