ZEPHIR Help

Content

Introduction

Presentation

ZEPHIR is a software based on the physical optics theory. It allows calculating the radar cross section of electrically large structures.

Methods

A triangle meshed structured is used to apply the PO technique . The PO can be optionally completed with the PTD. The geometrical optic magnetic field is obtained with up to 5 reflections.

The geometrical optics part is powered by RayBooster software developed by HPC-SA. This library provides a very fast ray/triangle intersection computation.

ZEPHIR can be optionally hybridised with ICARE MoM software.

Interface

ZEPHIR is integrated onto the CAD software GID. The result is a user-friendly interface. The geometry can be directly designed with GID. GID's import features allow using most of the common CAD formats (IGES, DXF,VDA,…). A triangle mesh is generated by GID. It is directly used by ZEPHIR.

The calculated RCS is available in a text file. To make its interpretation easier, it can also be directly visualized in the geometry.

Installation

System requirements :

ZEPHIR runs only under Windows. It was tested with windows XP.

ZEPHIR needs GID7.5.3b or later. It was tested with GID7.5.3b and GID8.0.7. ZEPHIR may be launch with a unlicensed GID version. However, ZEPHIR uses GID mesh capabilities which are limited in the unlicensed version.

GID is available from this internet link : http://www.gidhome.com

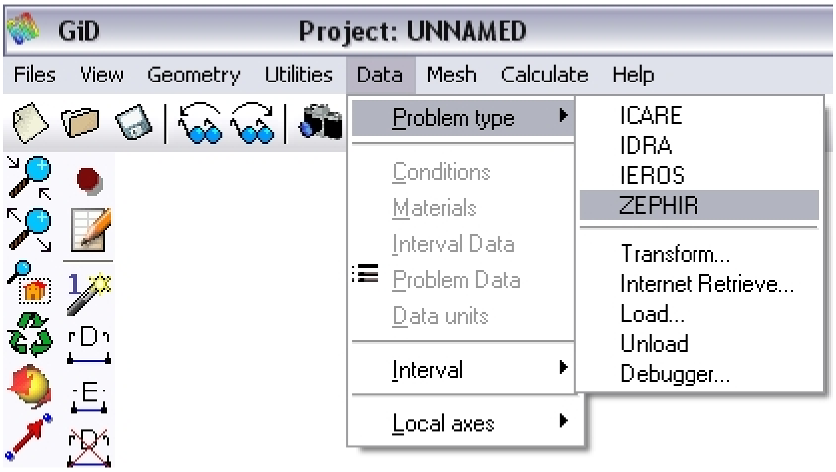
Installation :

The ZEPHIR.gid directory must be placed under the GID problemtypes directory, usually located at : C:\Program Files\GiD\GID8.0.7\problemtypes. This may be done manually or with the provided setup.

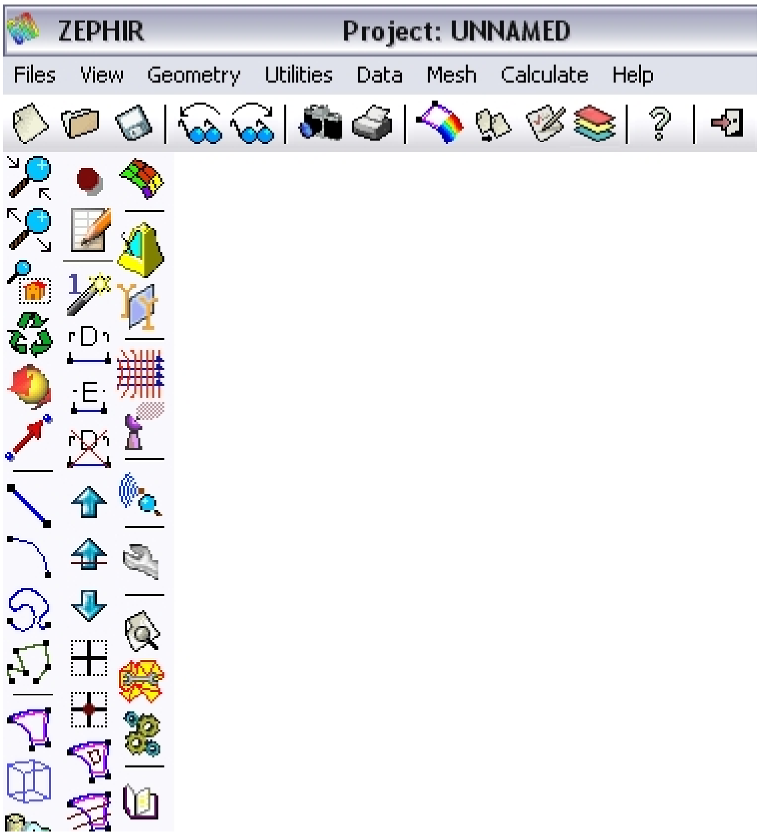
Getting start

GID must be launched

Select the ZEPHIR problem type as described below :



The ZEPHIR tool bar appears :



Each icon in the tool bar will start a ZEPHIR tool or definition window.

ZEPHIR's graphic user interface

Geometry

Electromagnetic data

- Interfaces
- Frequency
- Perfect Ground Plane
- Plane Wave
- Radar Cross Section
- Visualisations
- Options
- Mesh generation
- Check generation
- Execute ZEPHIR

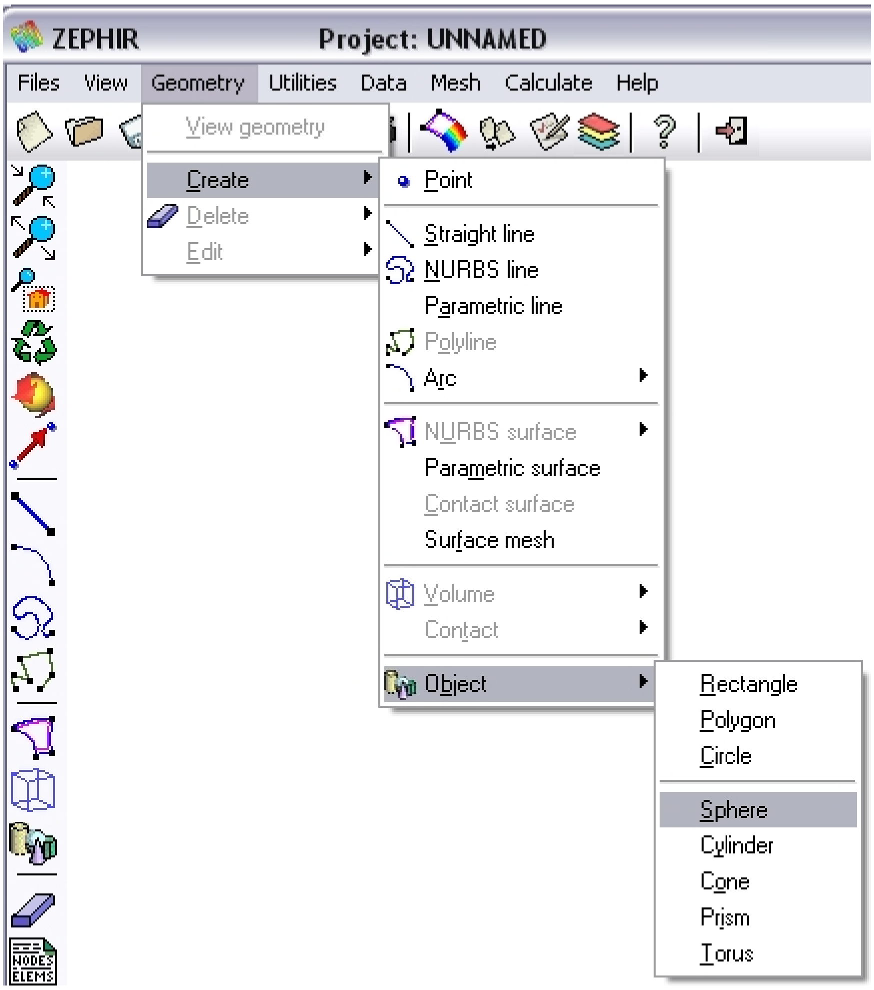
Post processing

- Graphics visualisation
- Rays visualisation

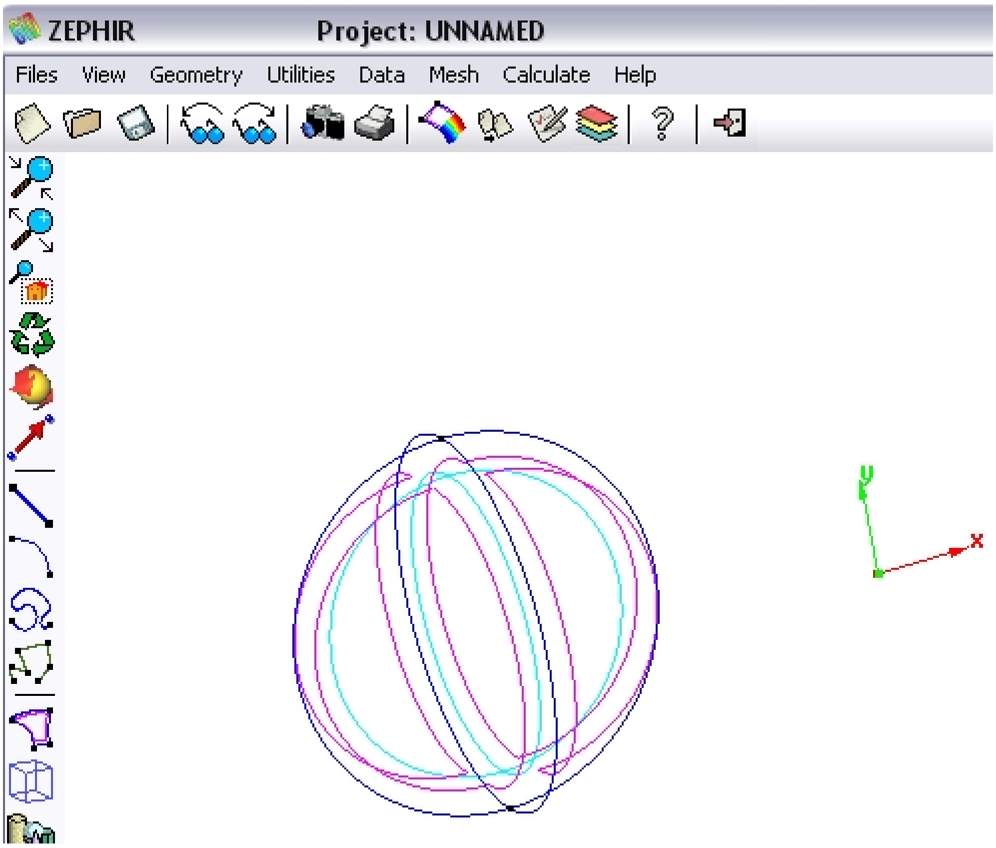
Using the Graphic Interface to build a mesh

GID is a CAD software. It enables the user to create the whole geometry and to generate the surface mesh treated by ZEPHIR. GID can also import most of common CAD and mesh formats. Please use the GID help and examples.

Please consider this simple example : draw a sphere by selecting the Geometry => Create => Object => Sphere menu.

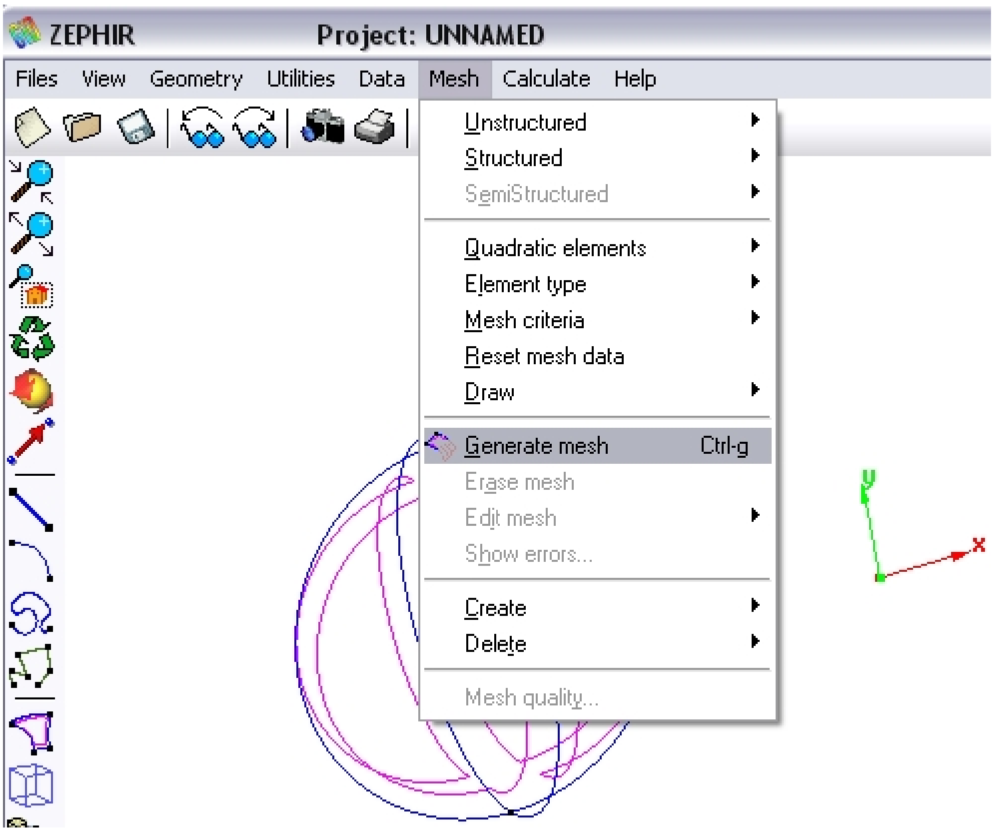


A NURBS volumic geometry is created in that case.

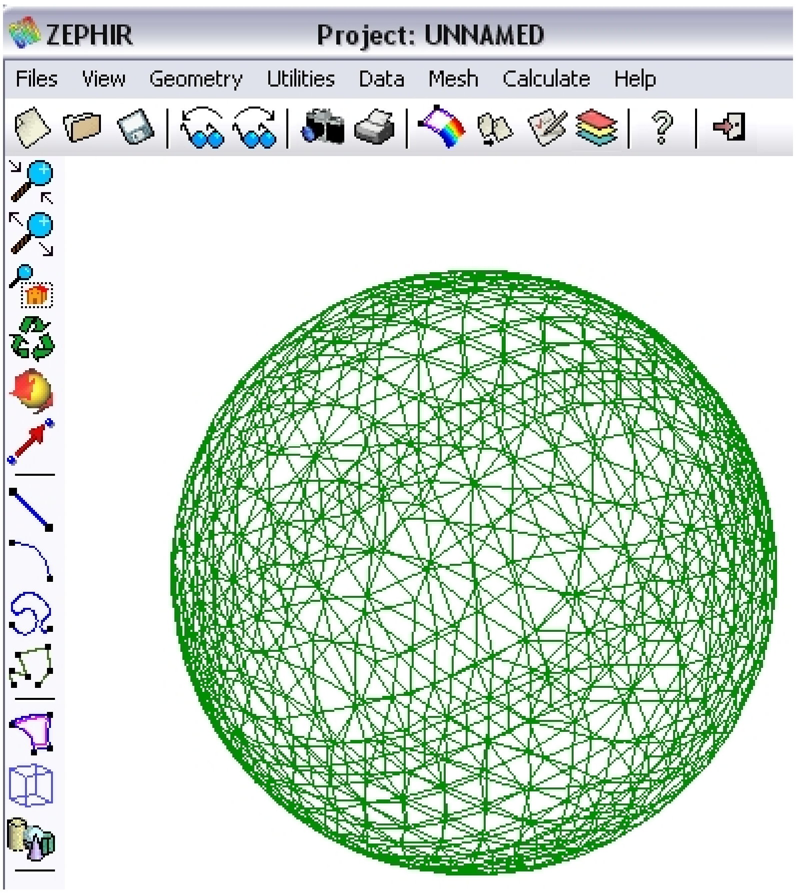


The PO code only needs surfaces. The volumes shall be deleted. Select Geometry => Delete => Volume and select the entire geometry.

Generate a mesh by selecting the Mesh =>Generate mesh menu.



The following mesh is obtained with the default mesh size :



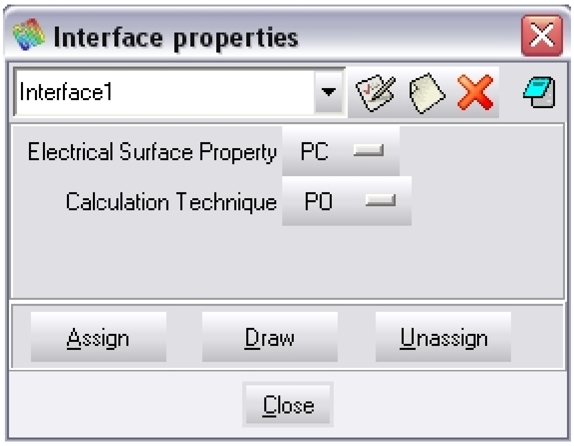
Using the Graphic Interface to fill the electromagnetic data file

- Interfaces
- Frequency
- Ground Plane
- Plane Wave
- Radar Cross Section
- Visualisations
- Options
- Mesh generation
- Check generation
- Execute ZEPHIR

Interfaces

Assign interface to the NURBS geometry (or directly to the mesh surface).

To set the calculation technique and the electrical characteristics of a surface element.



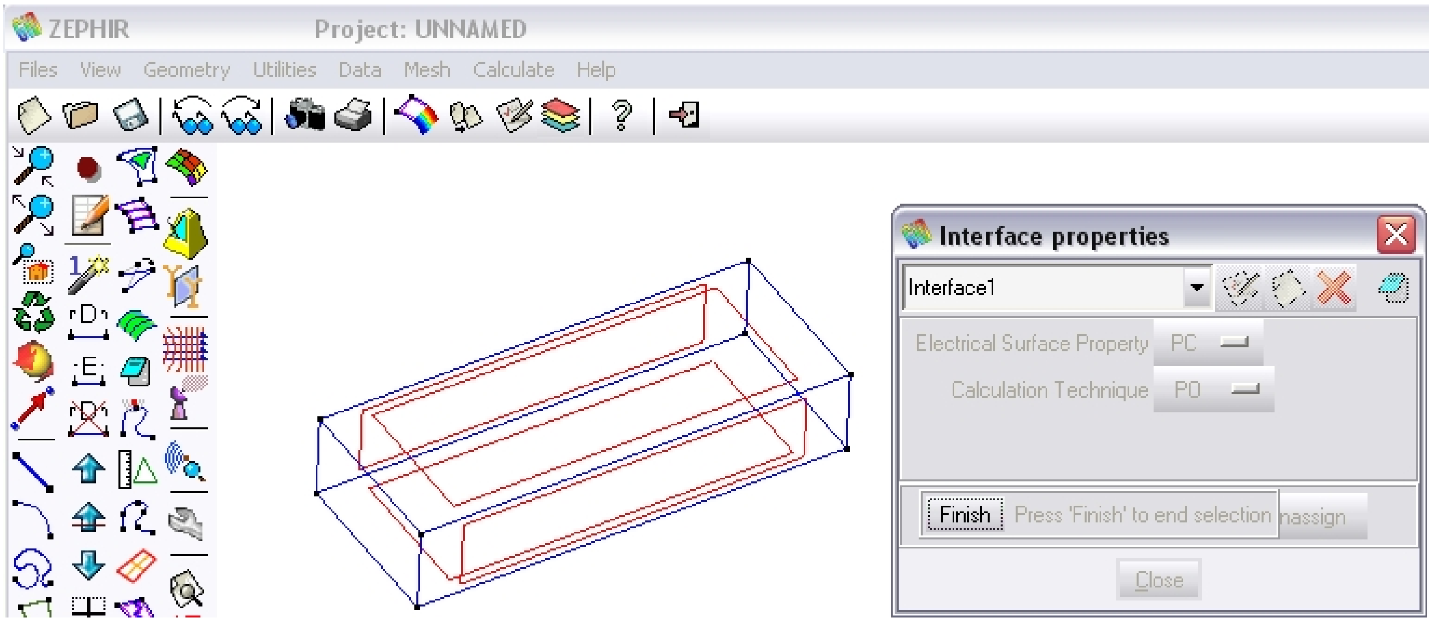
Electrical Surface Property : there are two different properties : perfectly conducting (PC) and surface impedance (Zs)

Calculation technique can be : Physical optics (PO) or Method of Moments (MoM). The MoM is available but it will be ignored in this version.

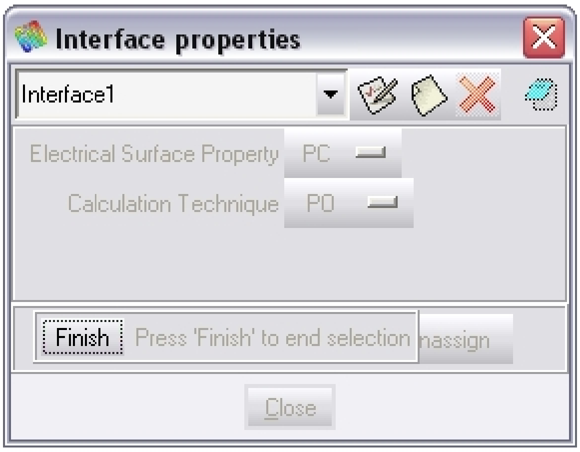
Each interface has a specific name and properties. Create a new interface by clicking on the « New » icon :  .

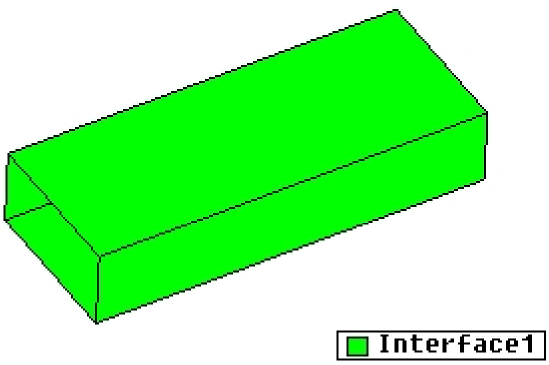
Define the properties of each interface, then store the information by clicking on the « update » icon :  .

Assign the properties to the NURBS geometry (or the mesh if no NURBS exist).



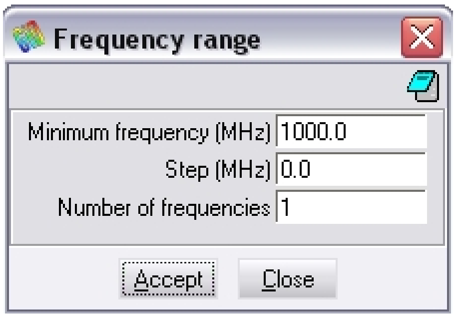
To check if the interface properties are properly assigned, select the « Draw » function, then the interface name.





Frequency

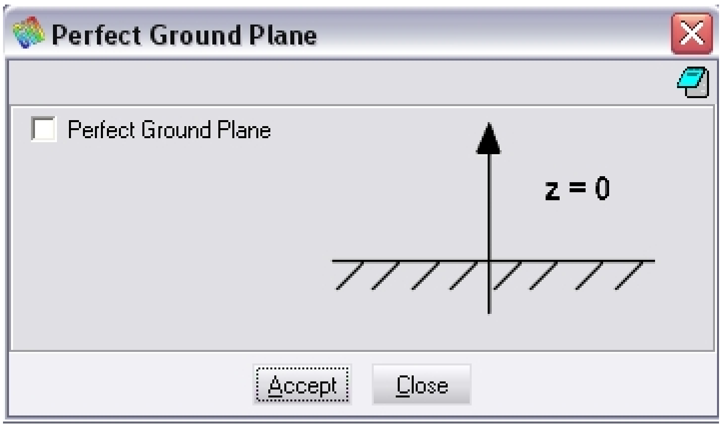
Define the operating frequency range.



Ground Plane

Define the ground plane

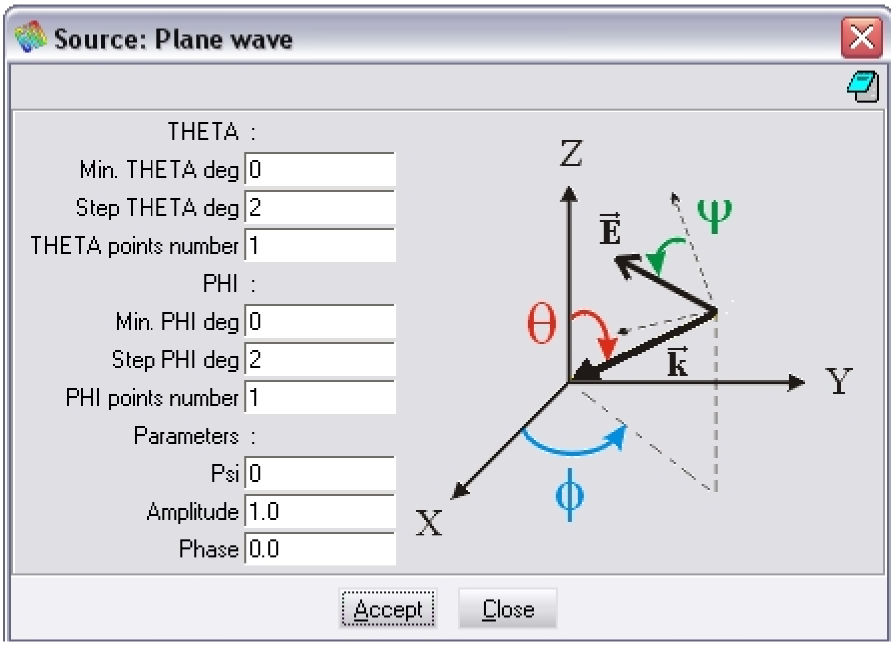
Check "Perfect Ground Plane". Then click on Accept.



This plane represents the sea's surface

Plane wave

Define the directions of arrival of the plane wave



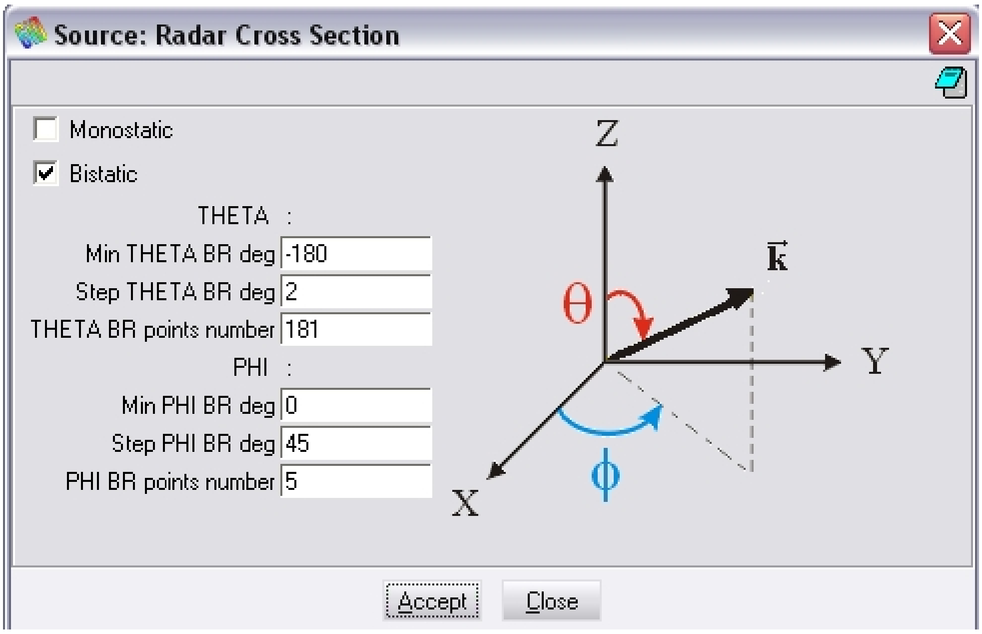
Theta is the angle between the wave vector and the z axis. Phi is the angle between the projection of the wave vector onto the xOy plane and the x axis. Psi is the polarisation angle.

NB : if you've chosen a Bistatic RCS you can only define one direction of arrival for the plane wave.

Radar Cross Section

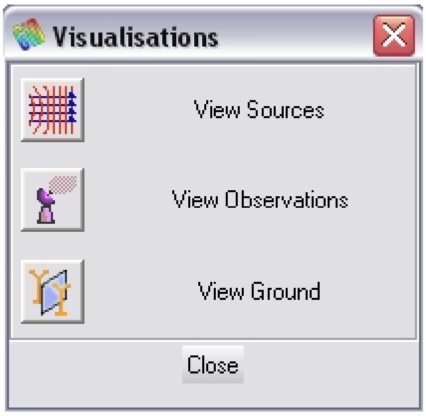
Define the kind of RCS to compute

Choose between Bistatic or Monostatic. For the Bistatic RCS, the directions of observation must be defined. For Monostatic RCS, the directions of observation are the same as set in the Plane wave window.

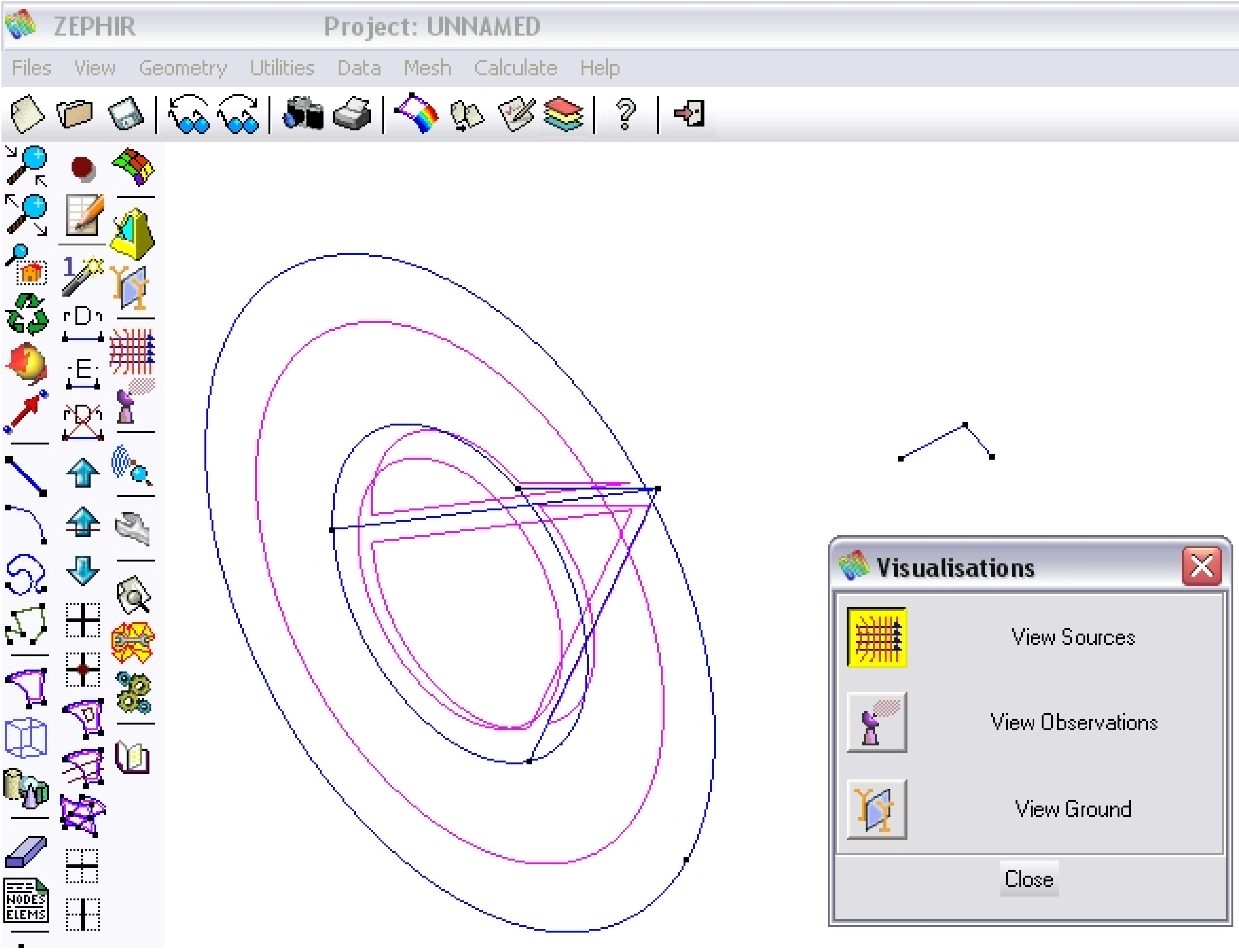


Visualisations

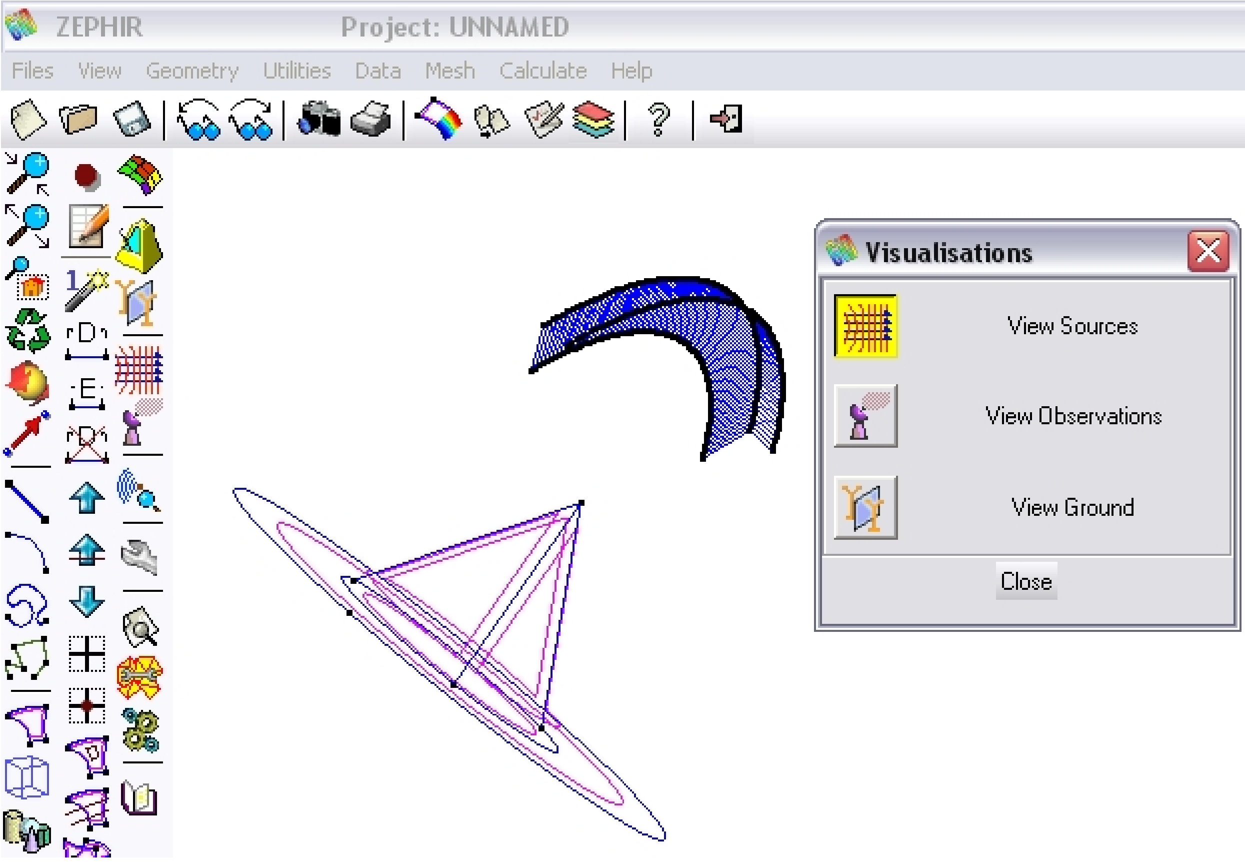
Open a window to check the source, the observations and the perfect ground plane



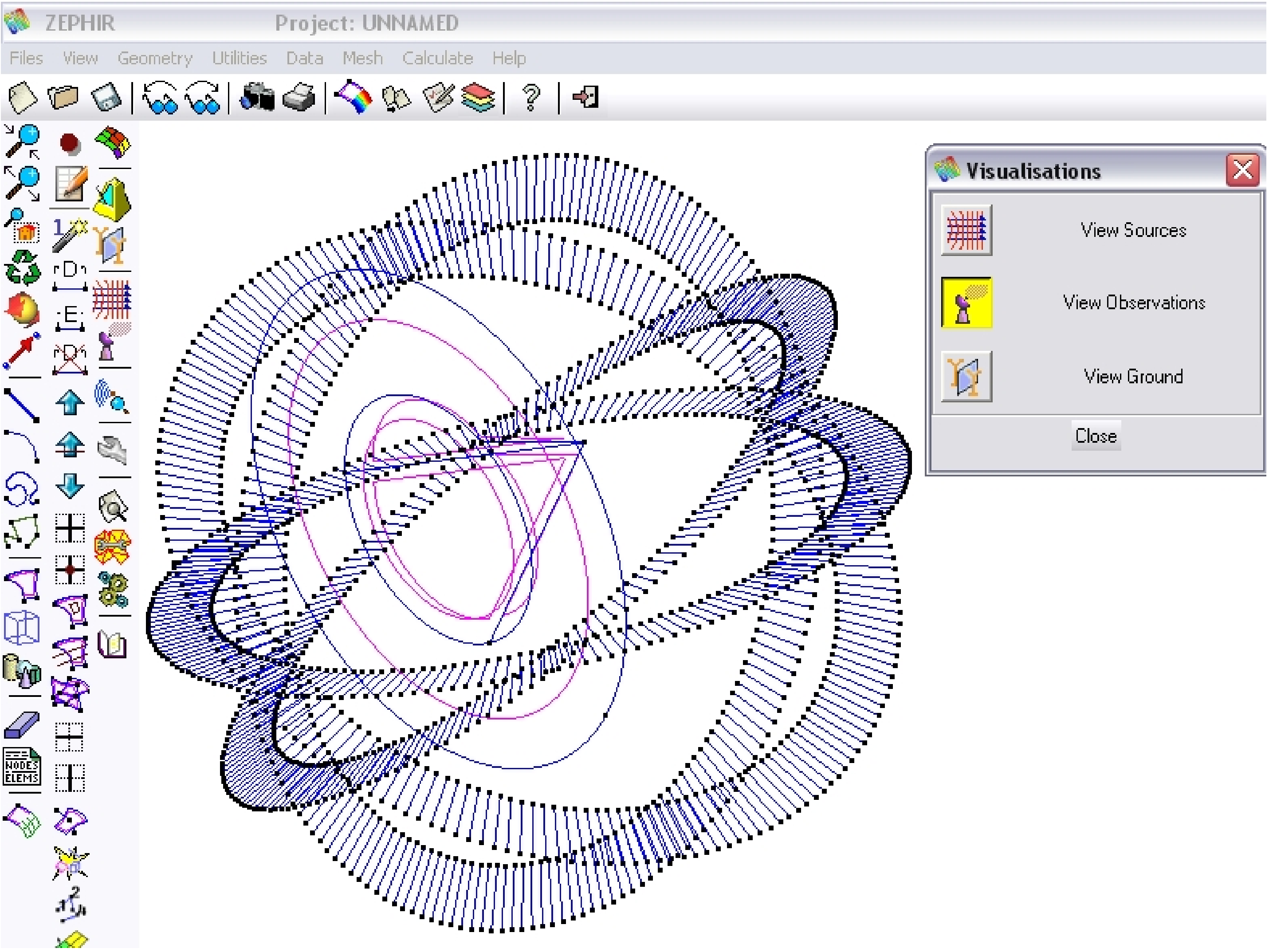
an incident wave :



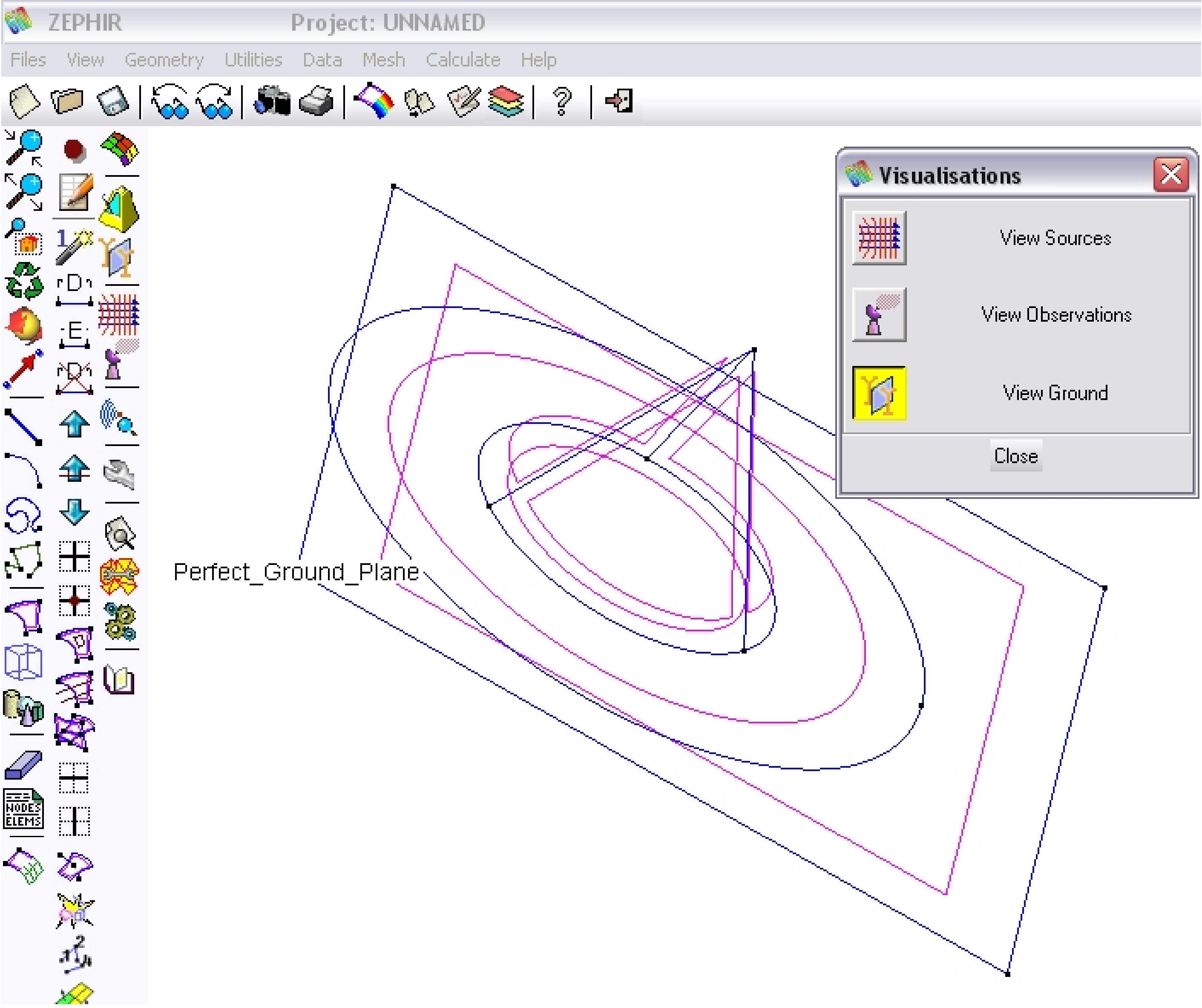
Several incident plane waves :



The directions of observation :

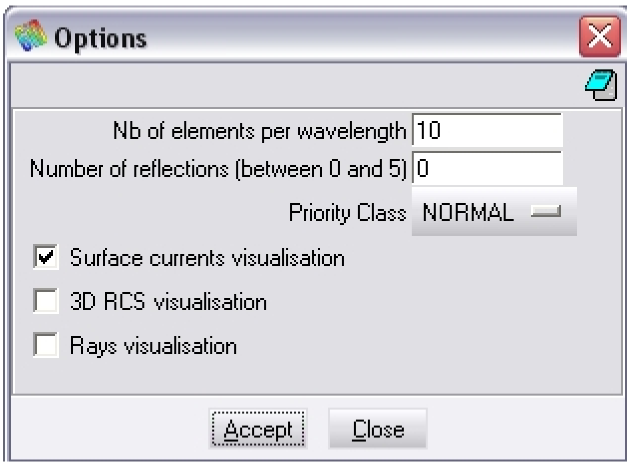


Perfect Ground Plane :



Options

Select special ZEPHIR's options



Nb of Elements per wavelength : define the size of the mesh elements.

Number of reflections : define the number of geometrical optic reflections.

Priority Class : define the priority of the process (Normal, Low or Idle).

Surface currents visualisation : check the button to produce a 3D visualisation of the PO surface currents. Uncheck the button to avoid large result files in the case of numerous plane waves and operating frequencies.

3D RCS visualisation : check the button to produce a 3D visualisation of the RCS. If more than one frequency step is present, then only the first will be shown.

Rays visualisation : check the button to store and visualise the geometrical optic ray paths. Uncheck it to avoid large result files.

Mesh generation

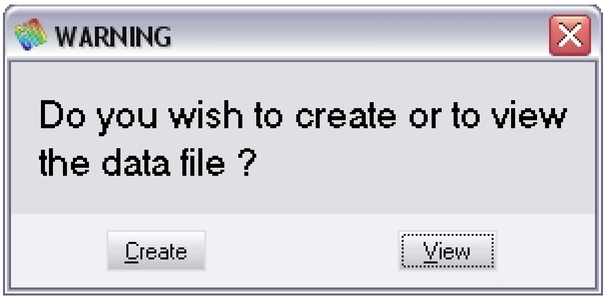
 Generate the mesh.

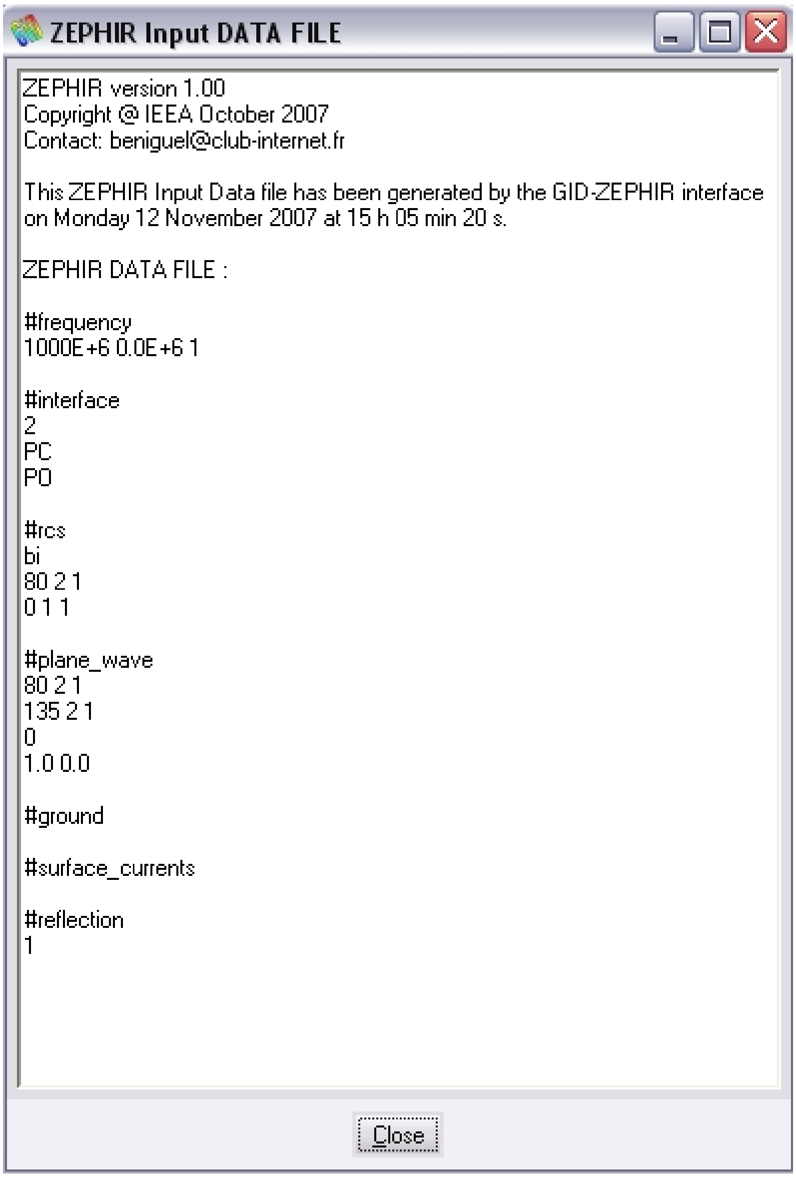
Generate the mesh and assign all the ZEPHIR conditions to it.

The default element size is defined in the options.

Check generation

 Check the ZEPHIR input data file.

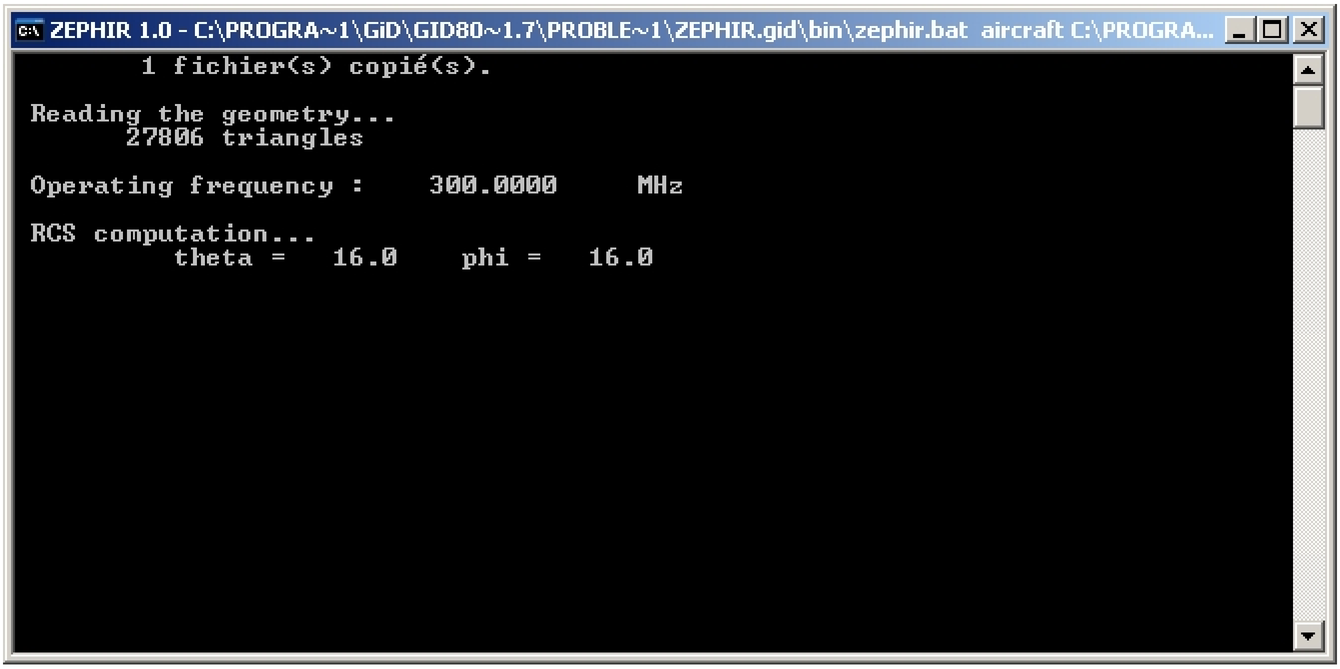




Execute ZEPHIR

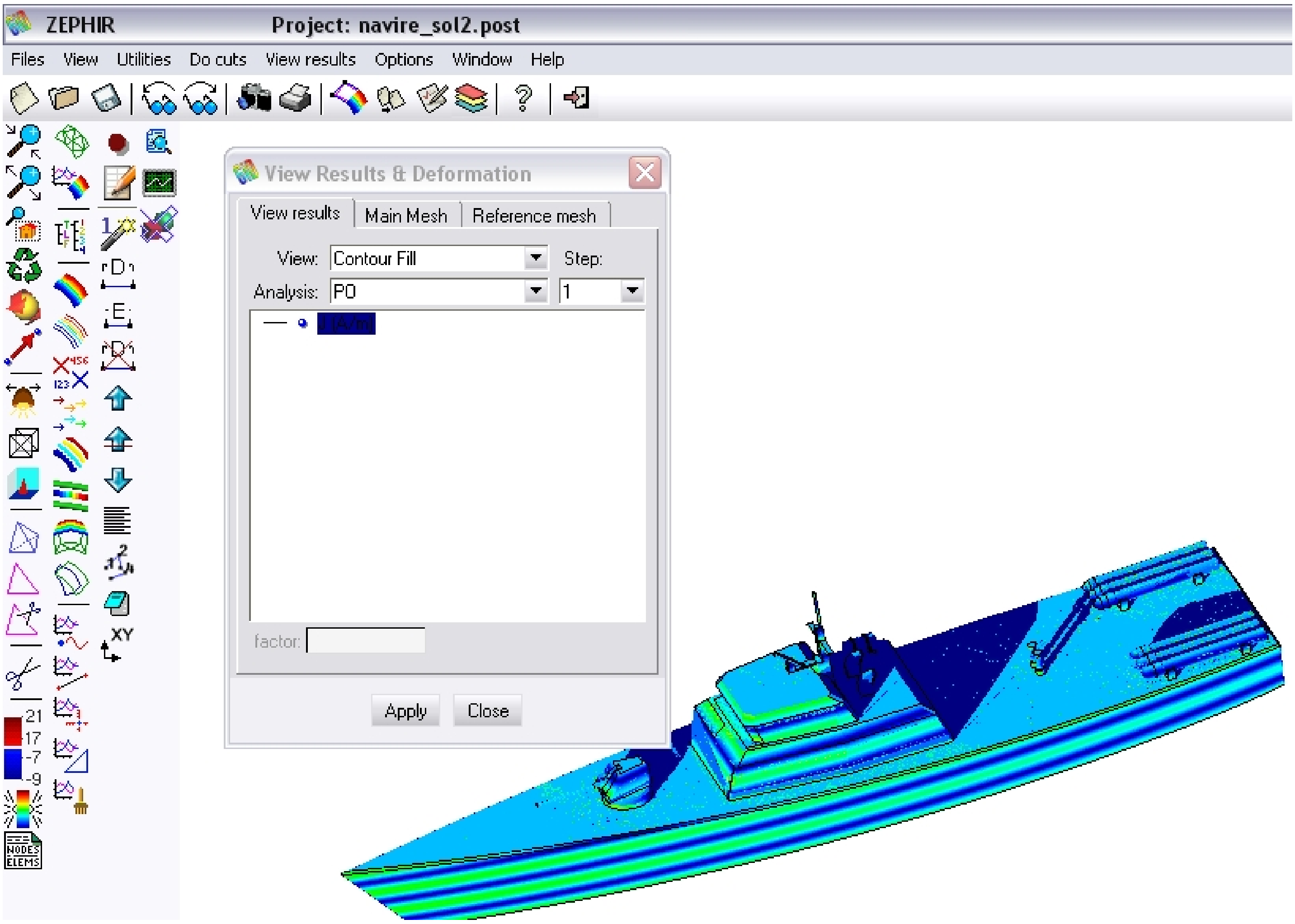
 Run ZEPHIR

This button launches the ZEPHIR computation. A command line window shows the progression :



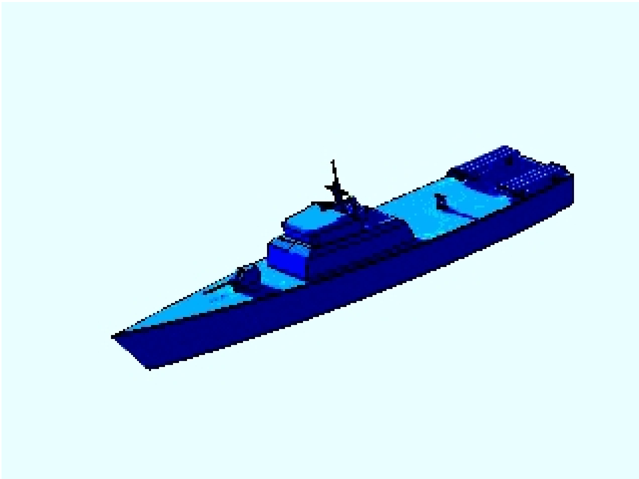
Post processing and visualization of results

The computed results can be viewed with the GID post-process : Files => Post-process or  .



The view results window is automatically opened.

If you have more than one frequency step or direction of incidence, then you can animate the results like this :



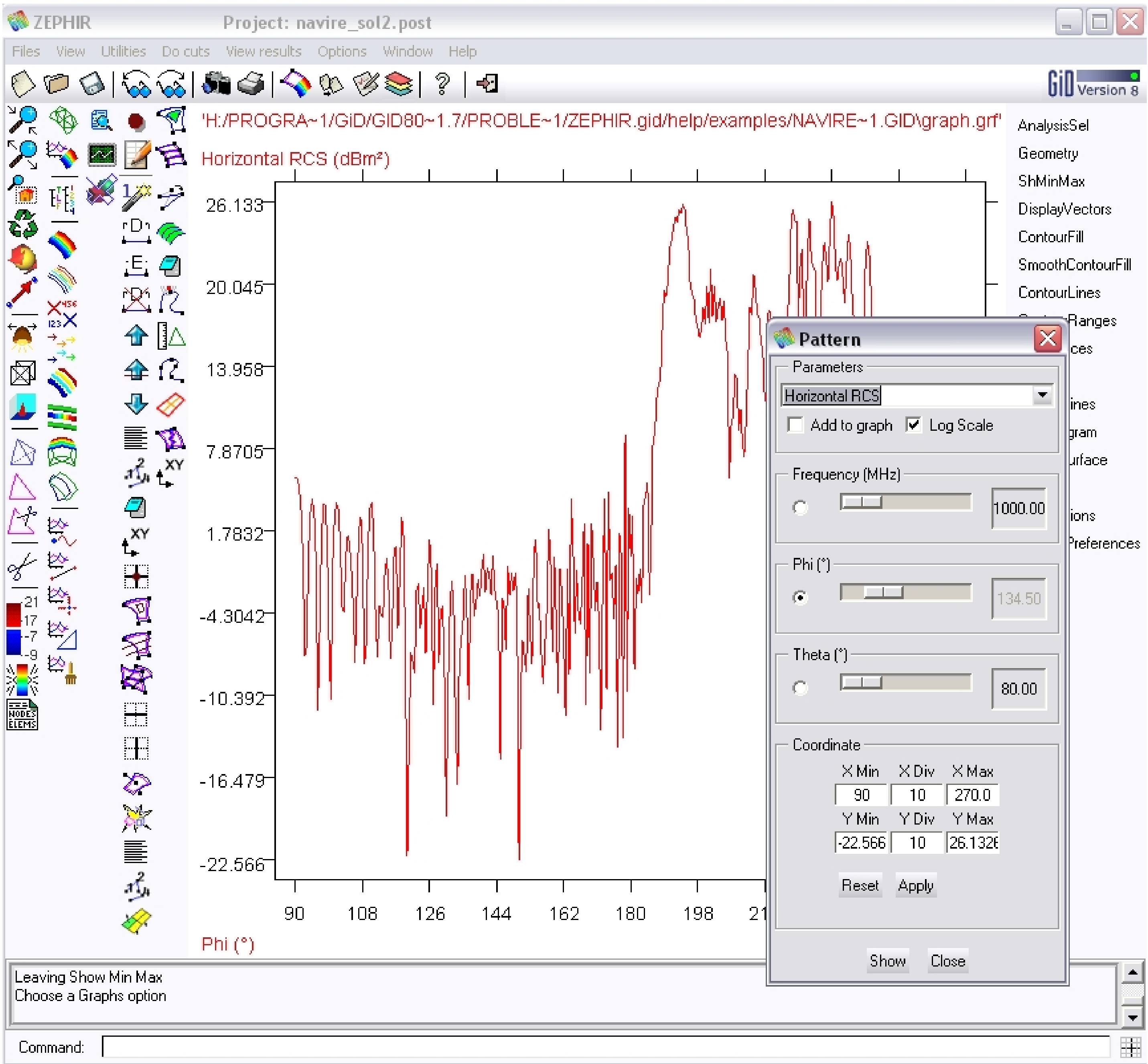
With you can open the result file and search through it. Several keyword are predefined.

With you can visualise the graphs

With you can visualise the rays

Graphics visualisation

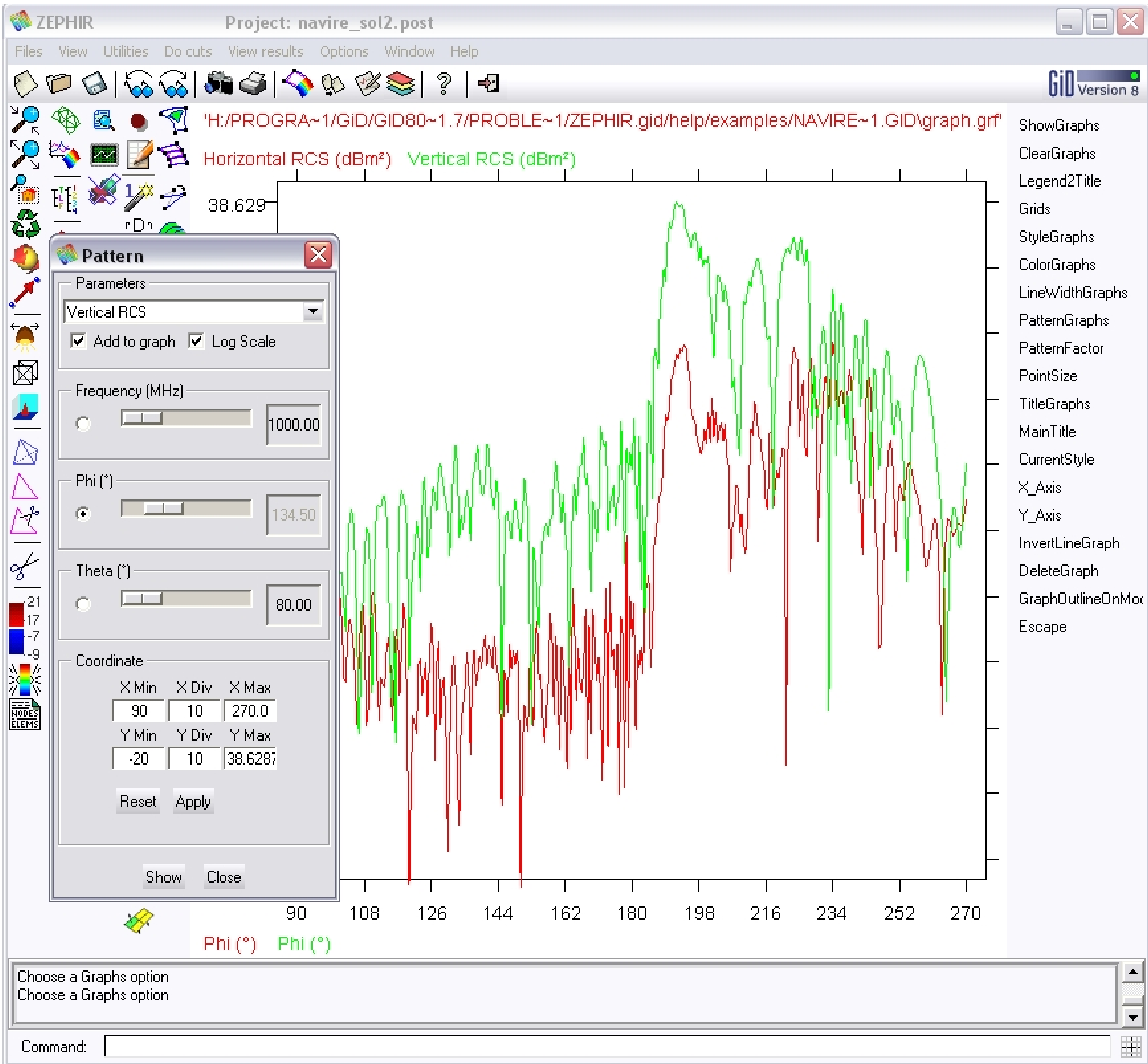
Open the Pattern window



Parameters:

Choose between Horizontal and Vertical RCS

Add to graph : to view different results on the same graph. The color will be different.



Log Scale : for see values in dBm² (or in m² if unchecked)

Frequency:
If you have several value you can choose a particular step with the scale.
If you check it, the frequency values will be on abscissa

Phi:
If you have several value you can choose a particular step with the scale.
If you check it, the φ values will be on abscissa

Theta:
If you have several value you can choose a particular step with the scale.
If you check it, the θ values will be on abscissa

Coordinates:
You can change the range of the graph's axis and the number of division for each axis.

Rays visualisation

 view the computed ray paths

This command inserts the computed ray paths into the geometry. This action isn't recommended if the geometry contains too much triangles. Once the rays are inserted, they can be removed with the same button.

Examples

In this section several geometries are created and solved with ZEPHIR. These examples are ready to run. To run GID with an example, please just click on the example title and accept to run the program.

NASA Almond

Placyl

Aircraft

Battleship

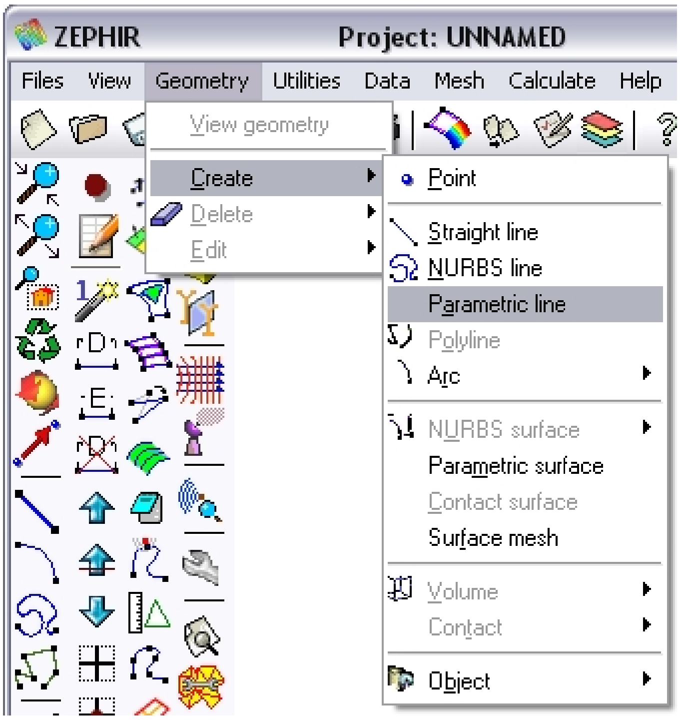
NASA Almond

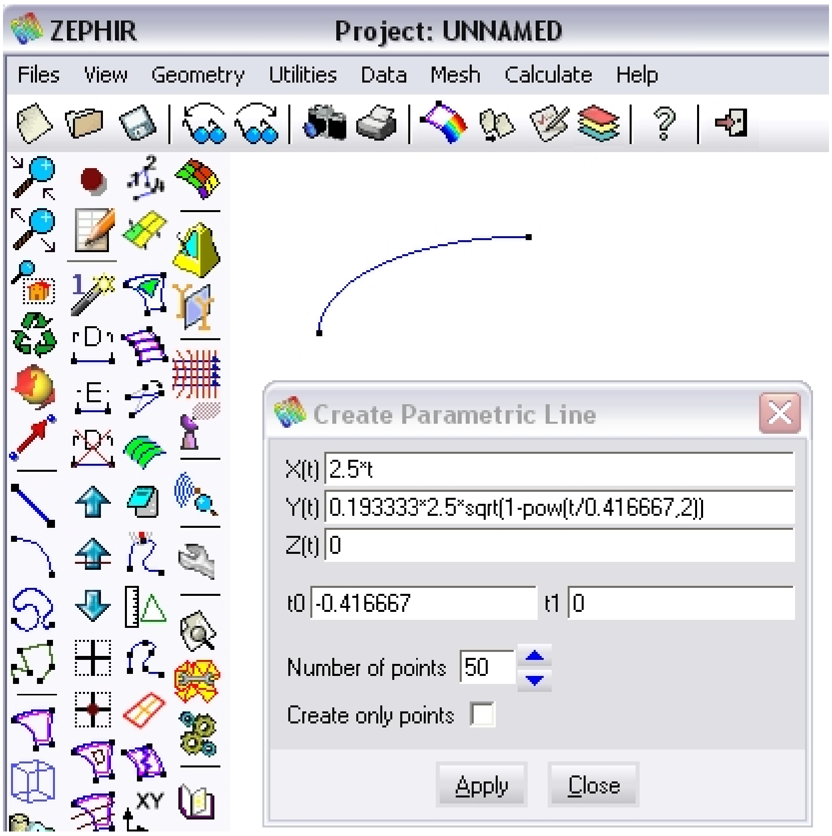
NASA Almond

NASA Almond 8 GHz bistatic RCS, from the JINA06 workshop. In that example a very low RCS is computed

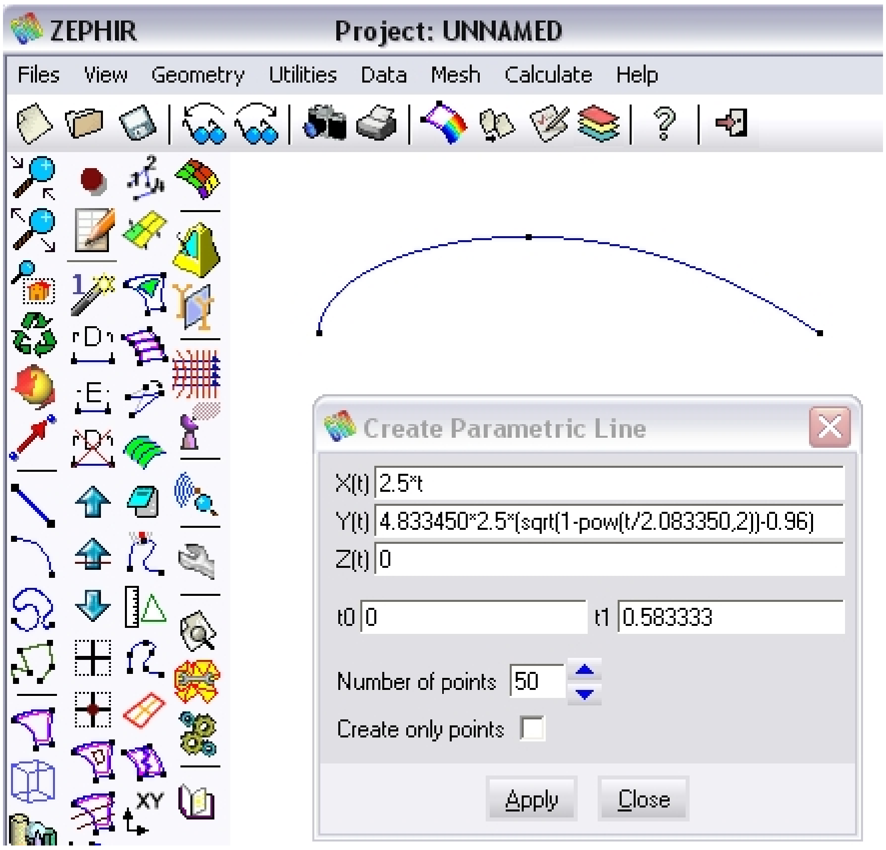
First we create the geometry defined with parametric equations :

Create a parametric line :Geometry => Create => parametric line

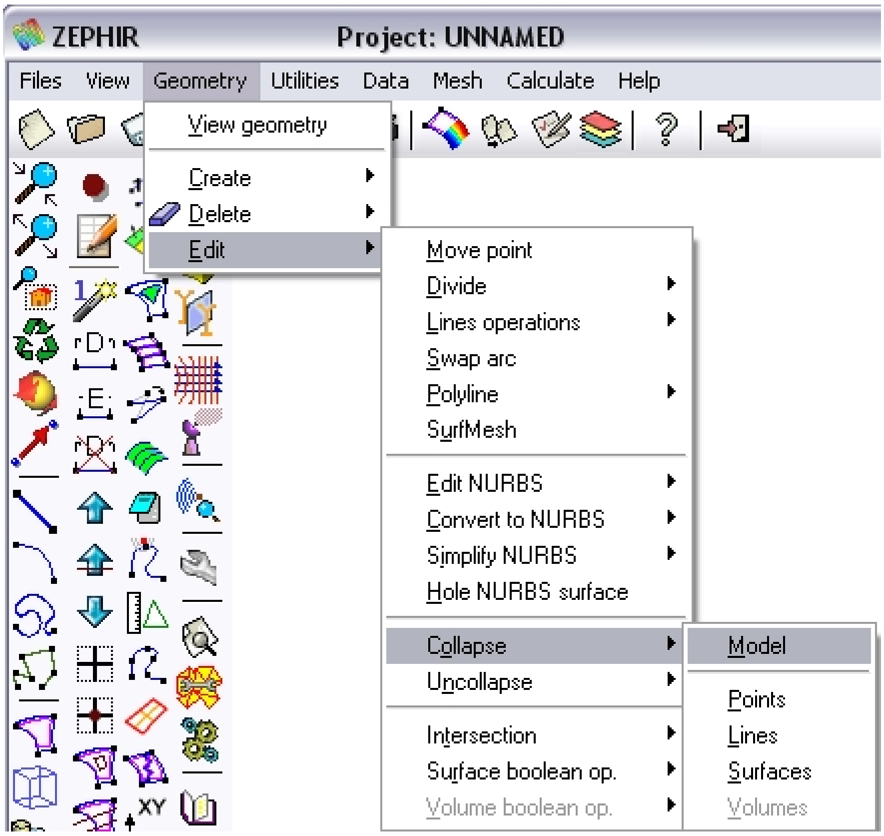


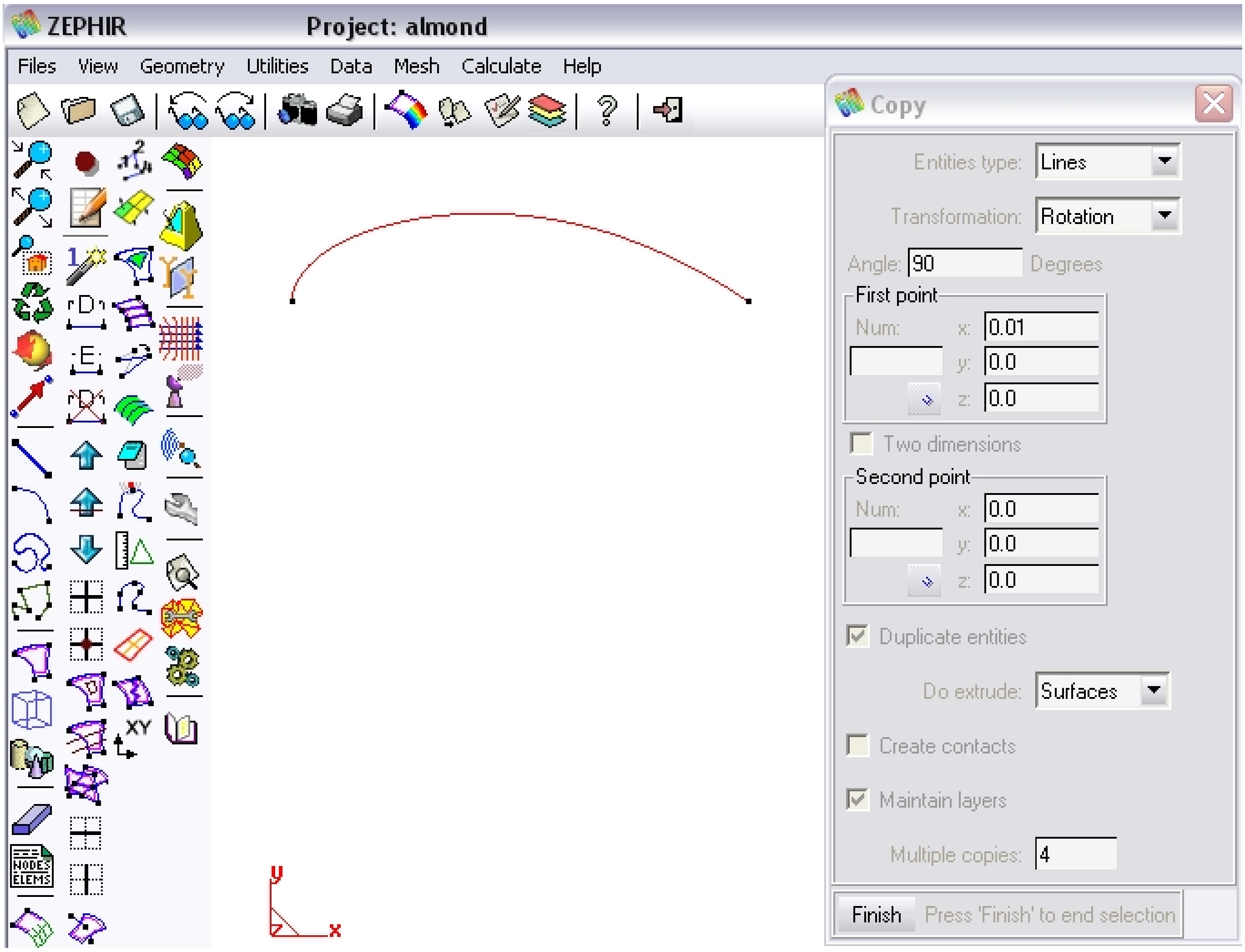


and another :

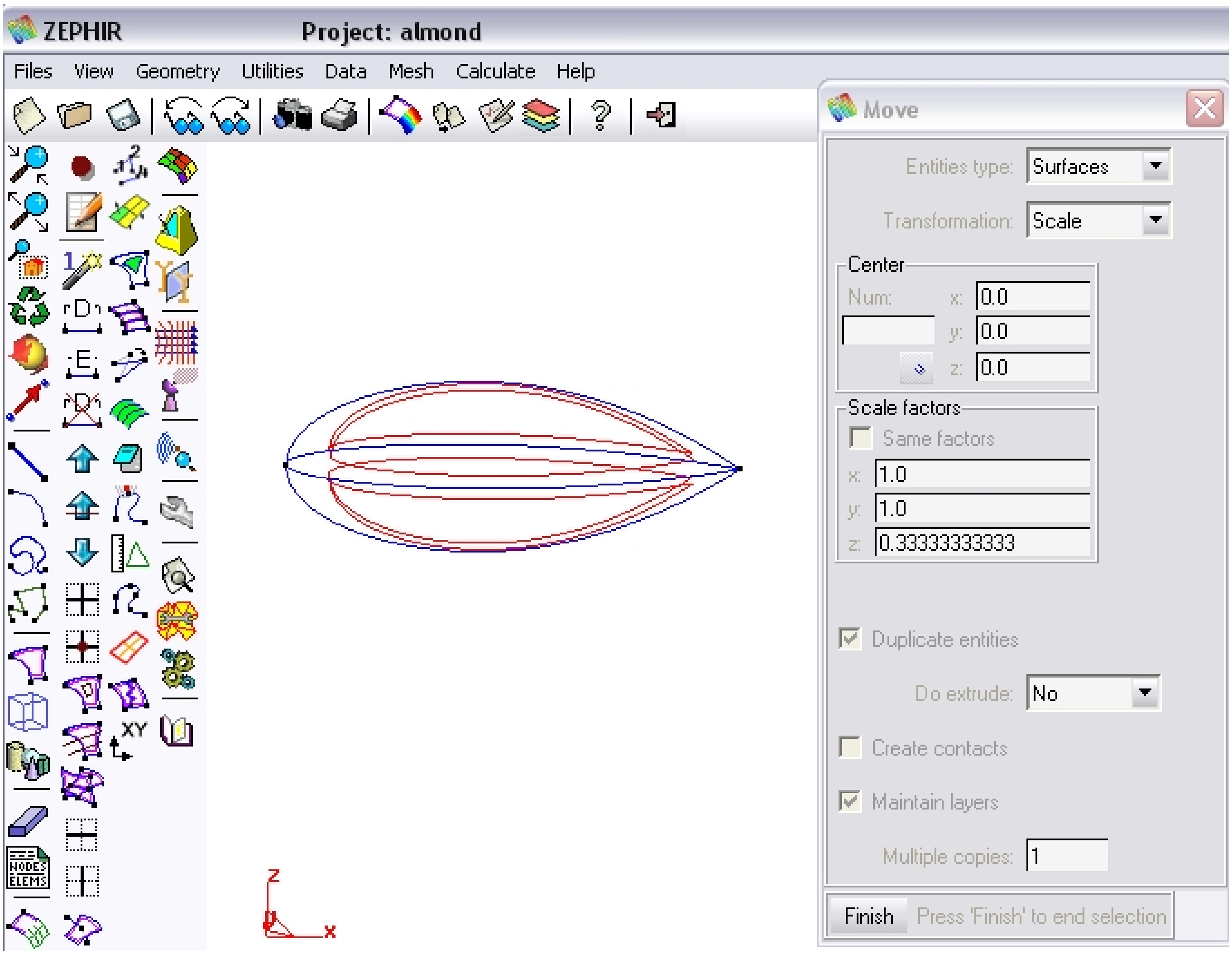


Collapse the model and make a revolution to create the surface with Ox axis:

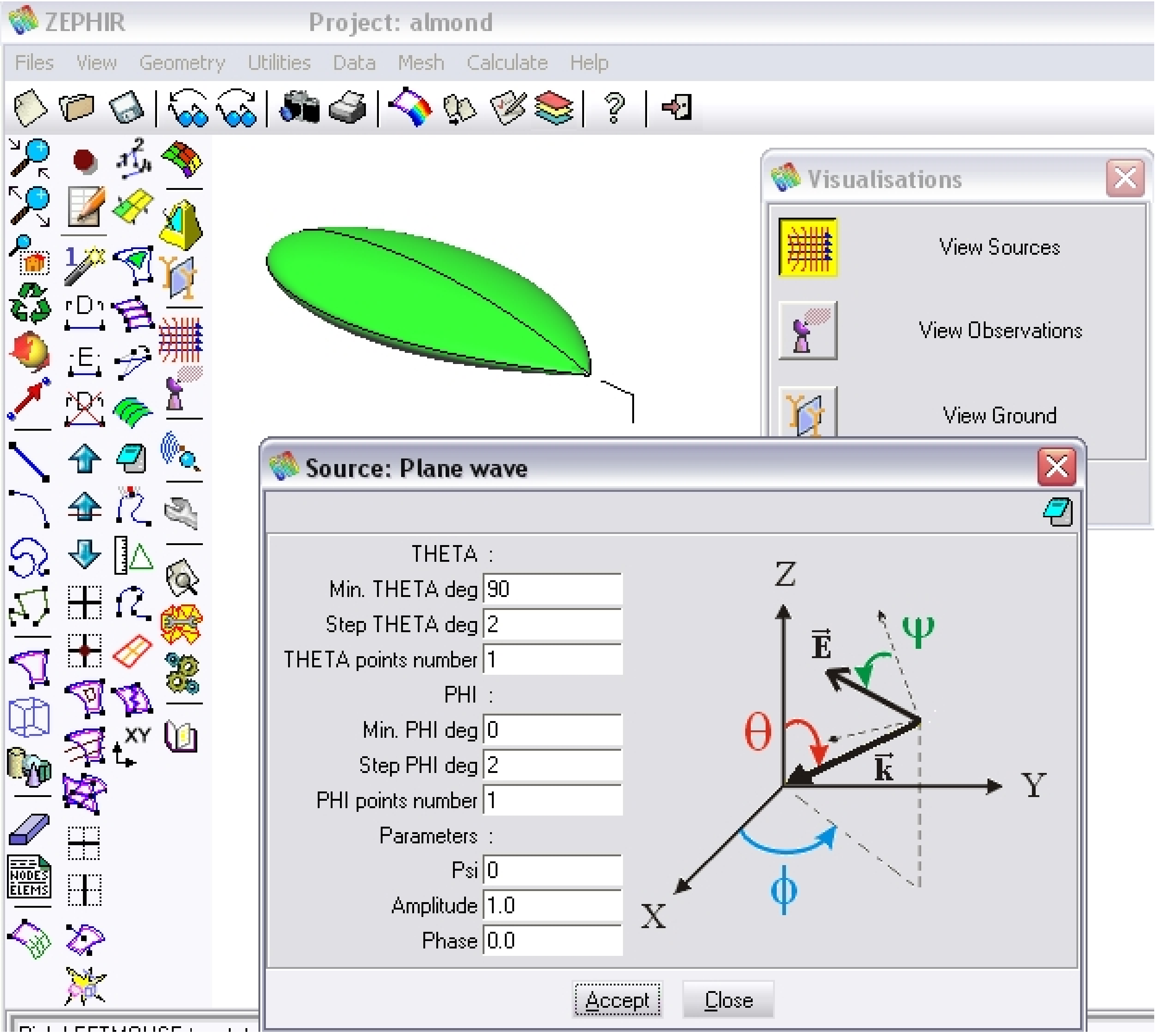

ZEPHIR
Project: UNNAMED
Files
View
Geometry
Utilities
Data
Mesh
Calculate
Help
View geometry
Create
Delete
Edit
Move point
Divide
Lines operations
Swap arc
Polyline
SurfMesh
Edit NURBS
Convert to NURBS
Simplify NURBS
Hole NURBS surface
Collapse
Uncollapse
Intersection
Surface boolean op.
Volume boolean op.
Model
Points
Lines
Surfaces
Volumes


ZEPHIR
Project: almond
Files
View
Geometry
Utilities
Data
Mesh
Calculate
Help
Copy
Entities type:
Lines
Transformation:
Rotation
Angle:
90
Degrees
First point
Num:
x:
0.01
y:
0.0
z:
0.0
Two dimensions
Second point
Num:
x:
0.0
y:
0.0
z:
0.0
Duplicate entities
Do extrude:
Surfaces
Create contacts
Maintain layers
Multiple copies:
4
Finish
Press 'Finish' to end selection

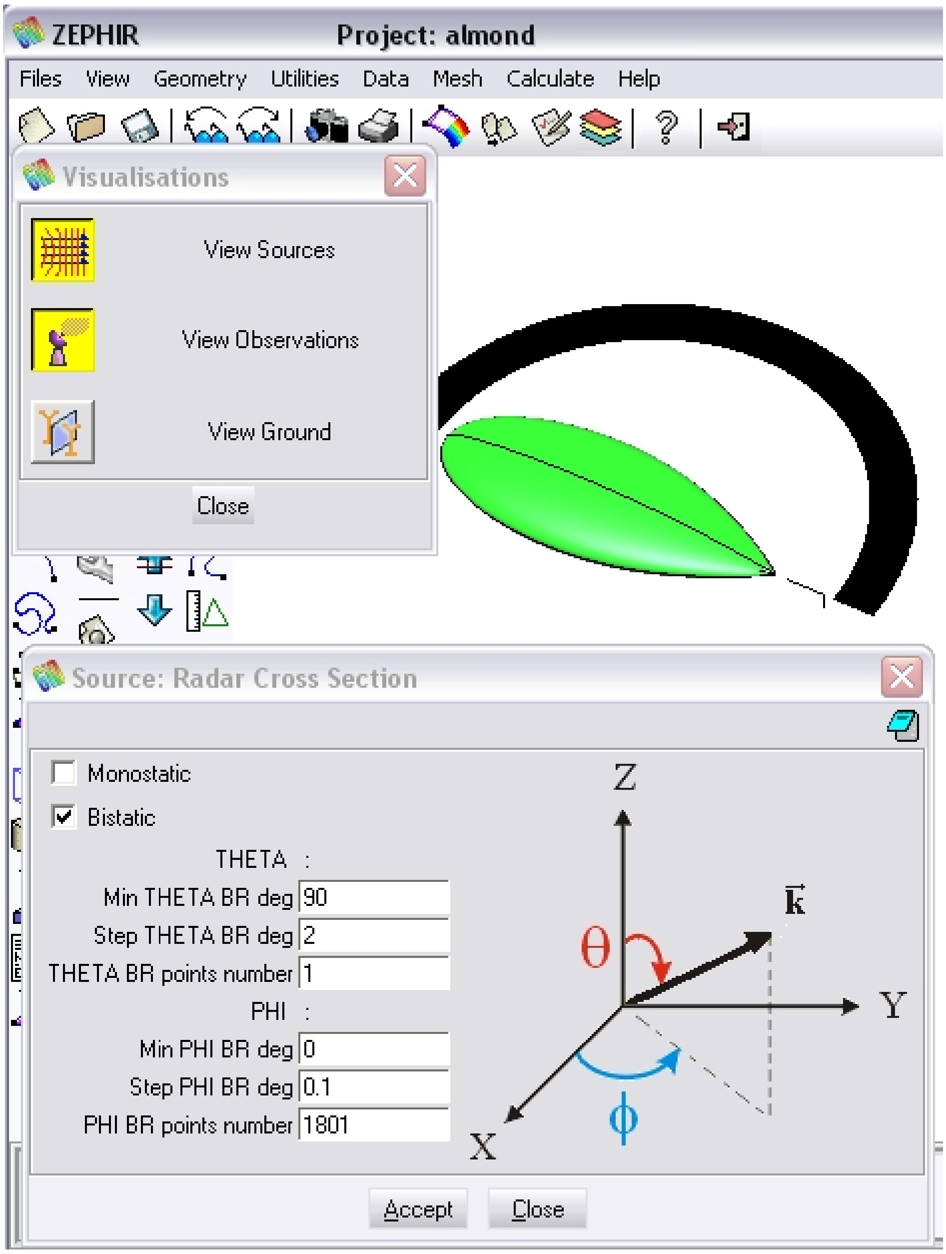
Flat the surface according to Oz axis with a scale factor 1/3 to obtain an almond.



Assign the interface properties over the surfaces, set a plane wave :



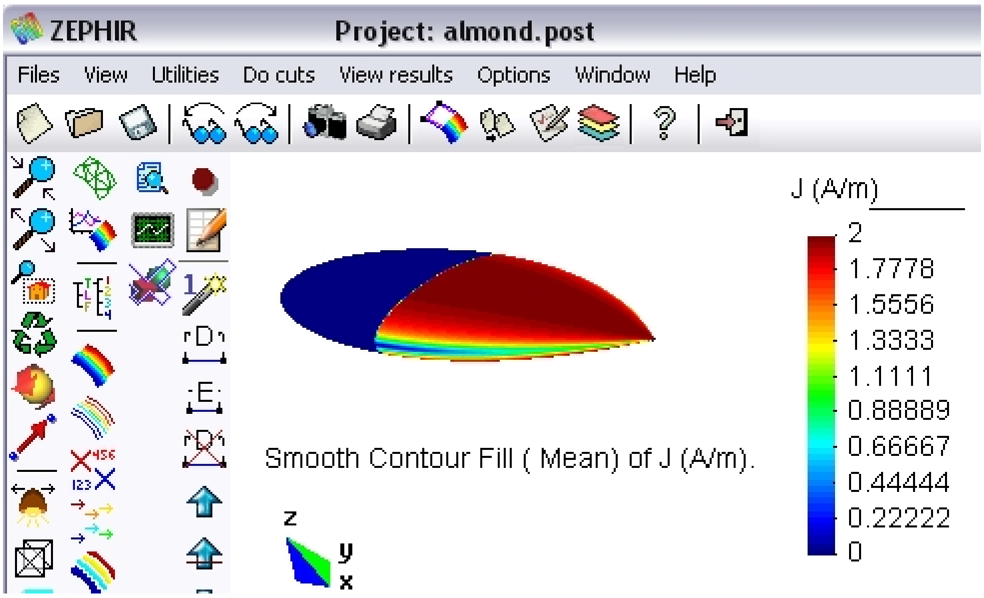
set the observation directions :



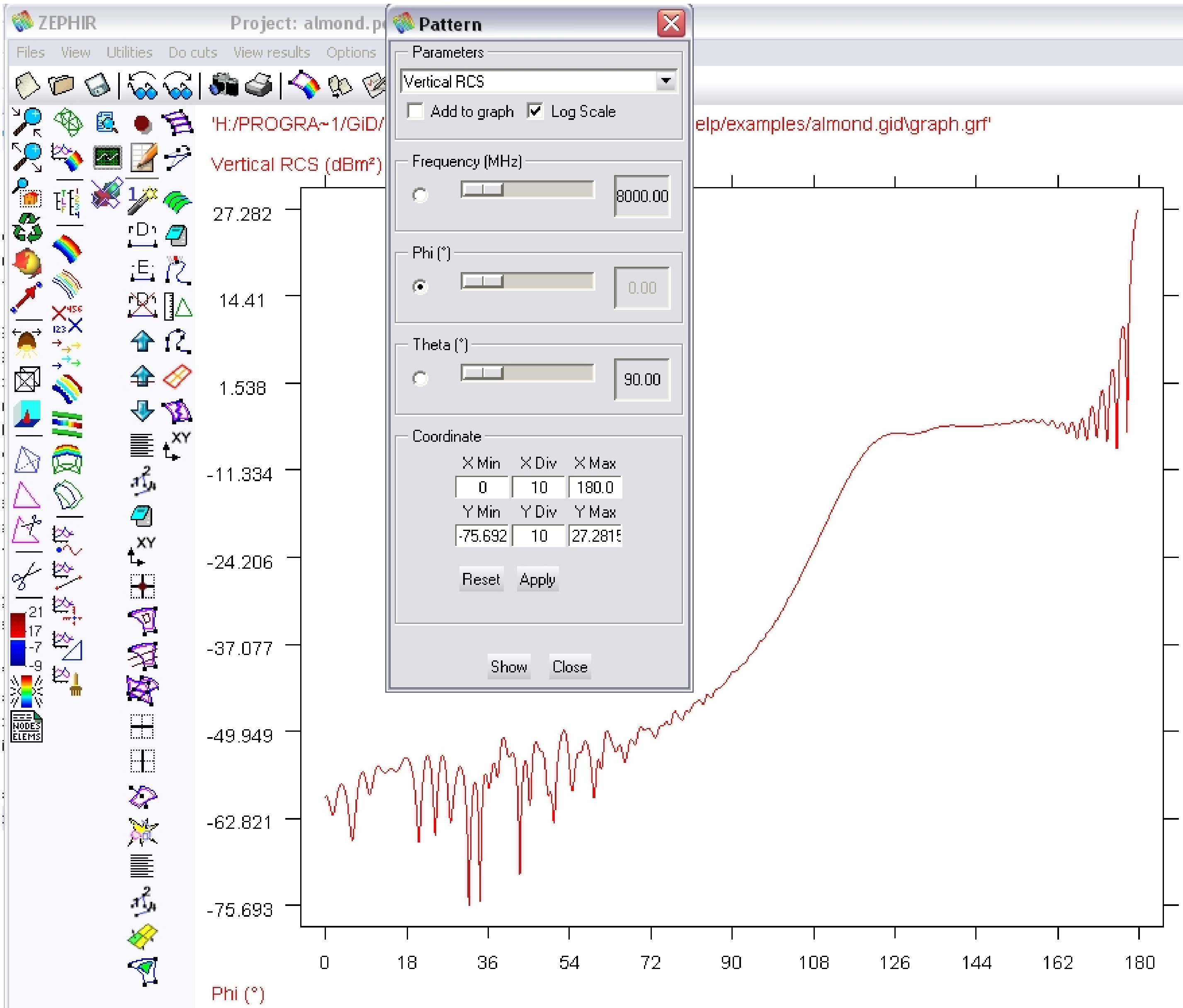
Set the frequency : 8 GHz

Save, generate the mesh and run.

The computed surface currents :



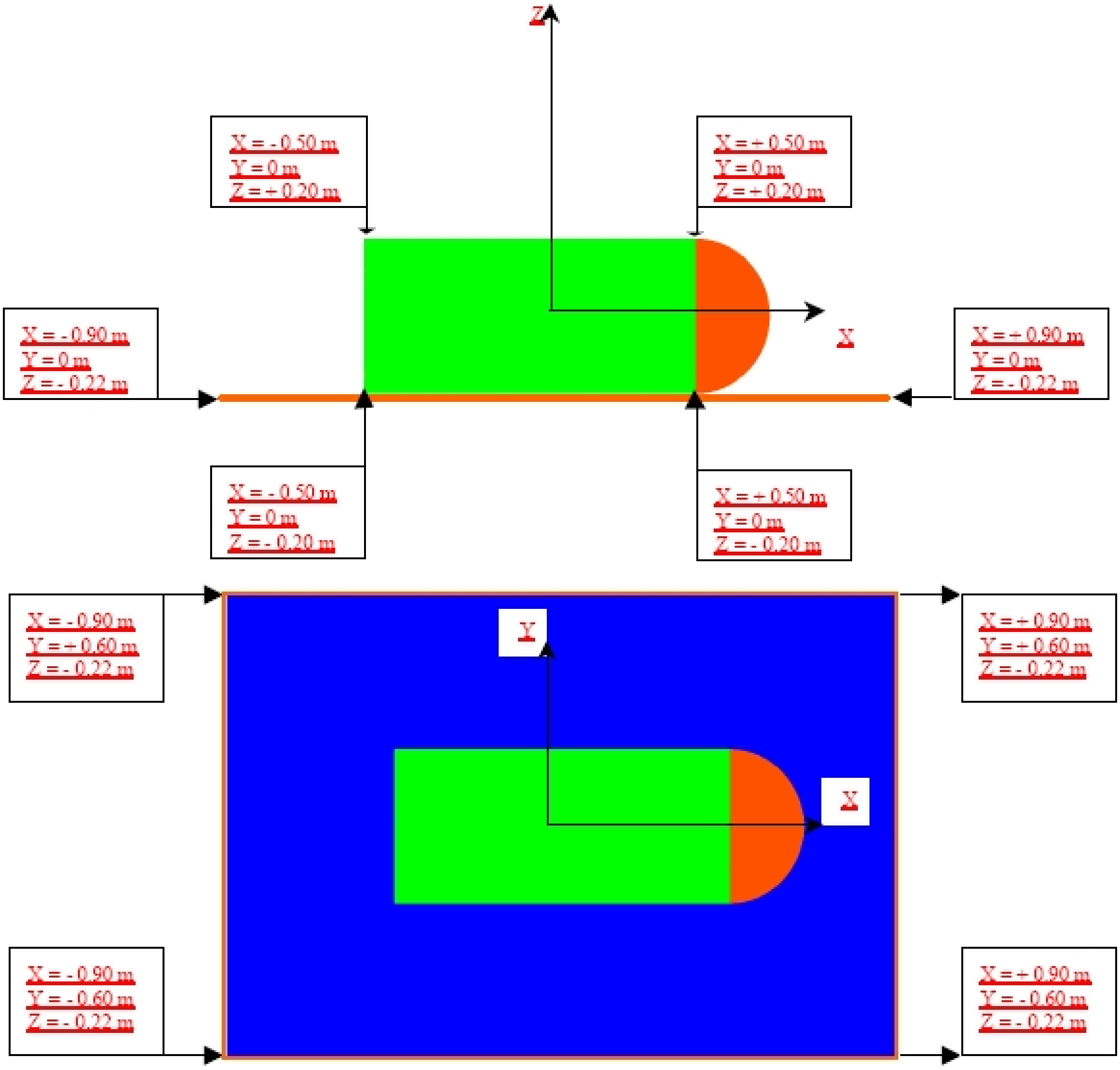
and the graph :



Placyl

[Placyl]

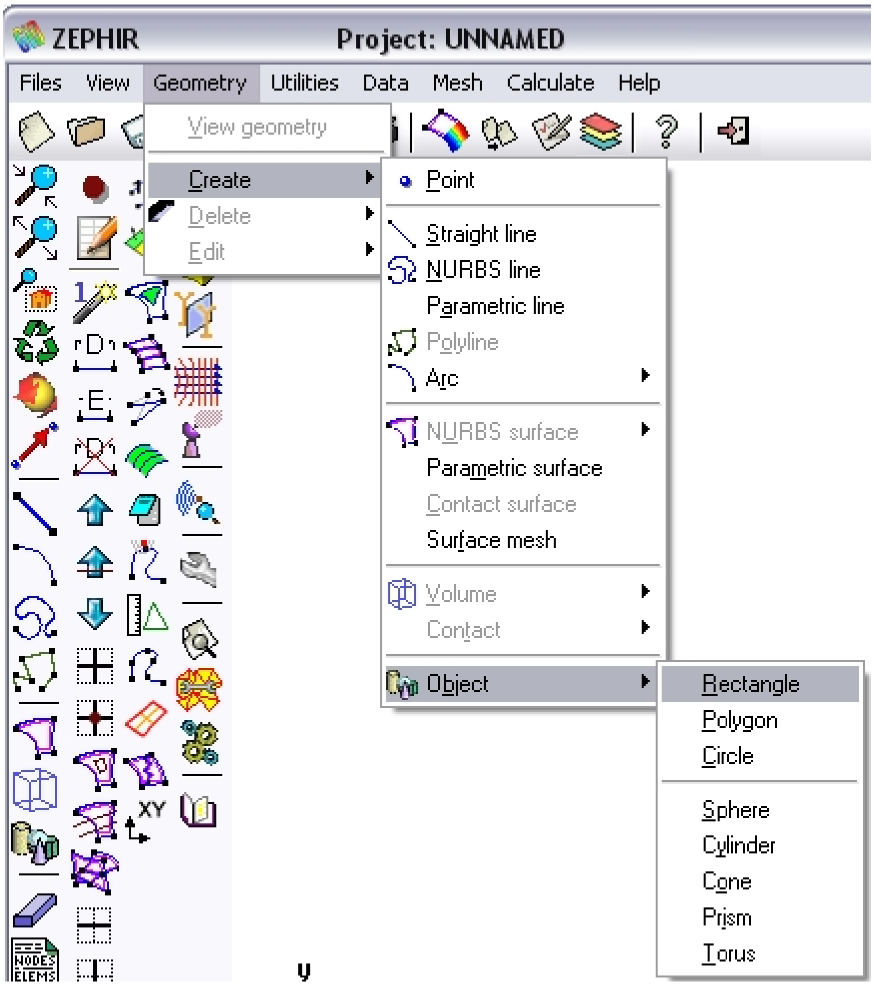
JINA04 workshop test case. The geometry is defined in the following figure :



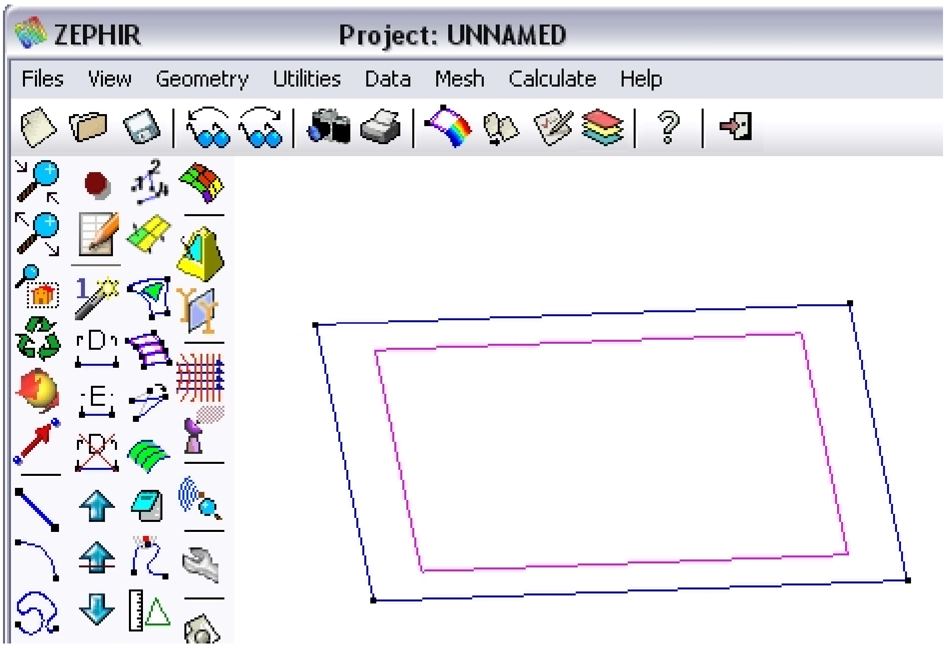
First create the plate :


ZEPHIR
Project: UNNAMED
Files View Geometry Utilities Data Mesh Calculate Help
y
z x
layer: 'Ground'. Using this
: Layer0

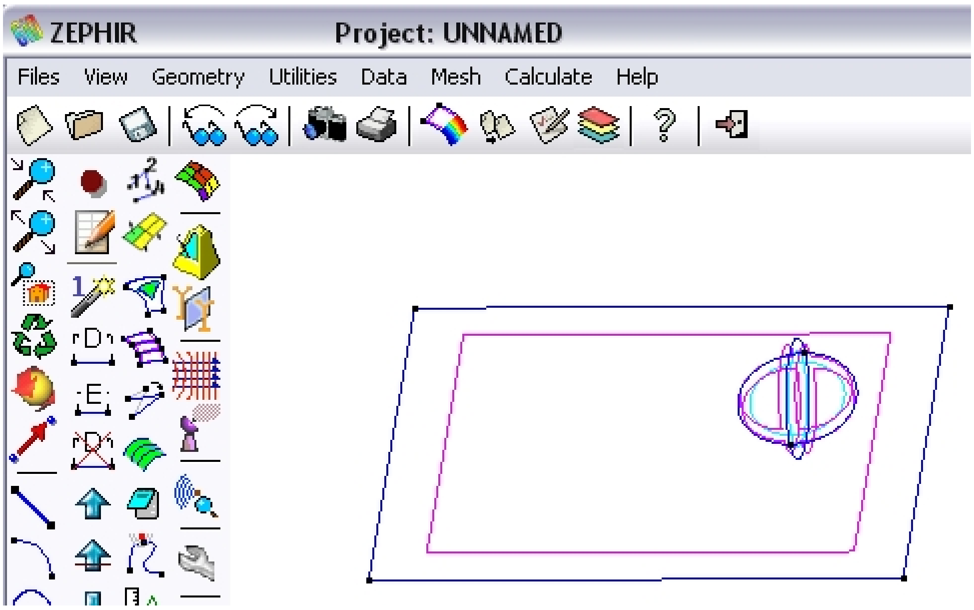
or



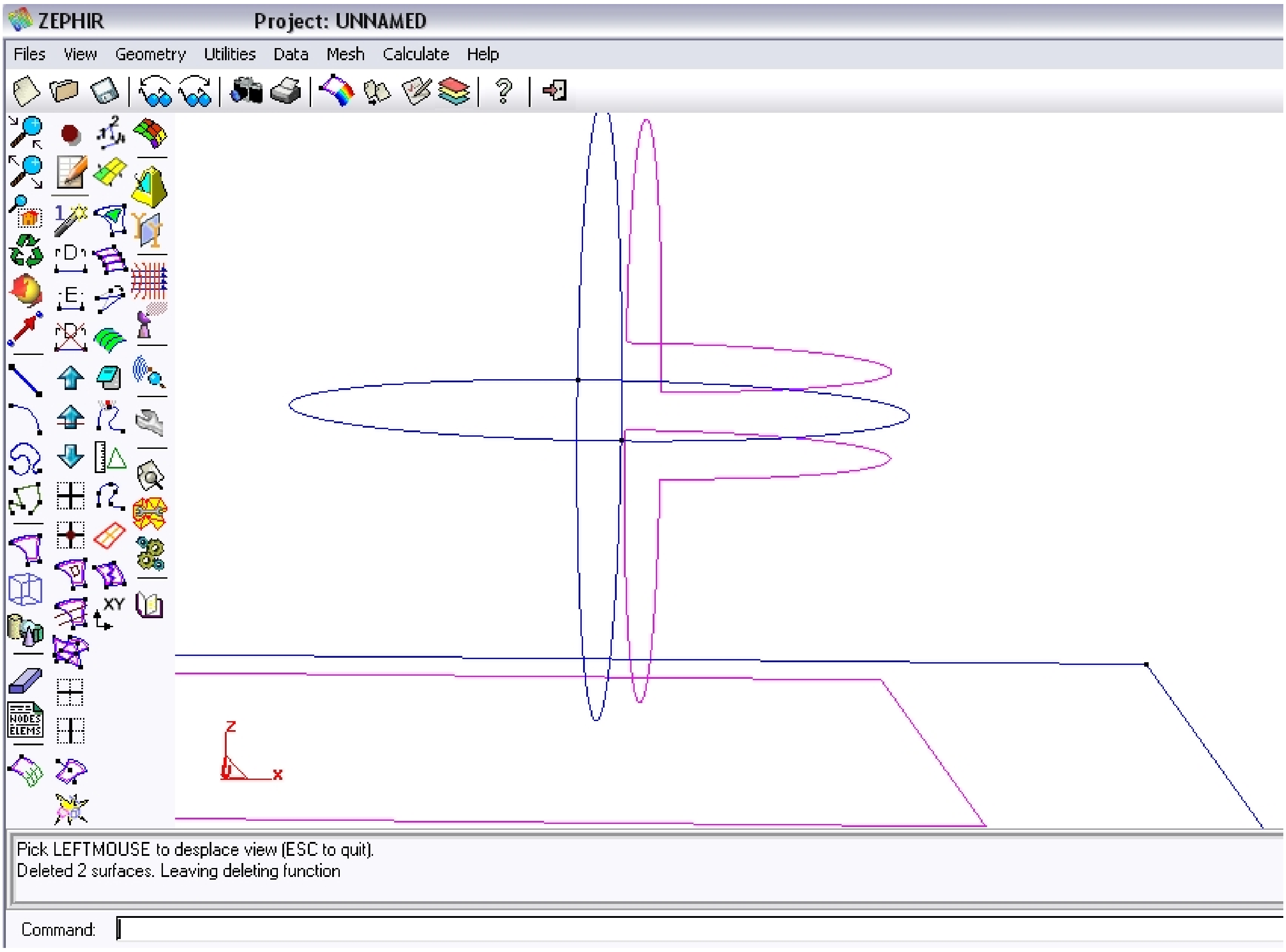
Enter the coordinates of the first corner : (-0.9 -0.6 -0.22)
Second Corner : (0.9 0.6 -0.22)



Next, create a sphere :
Center : (0.5 0 0)
Radius : 0.2

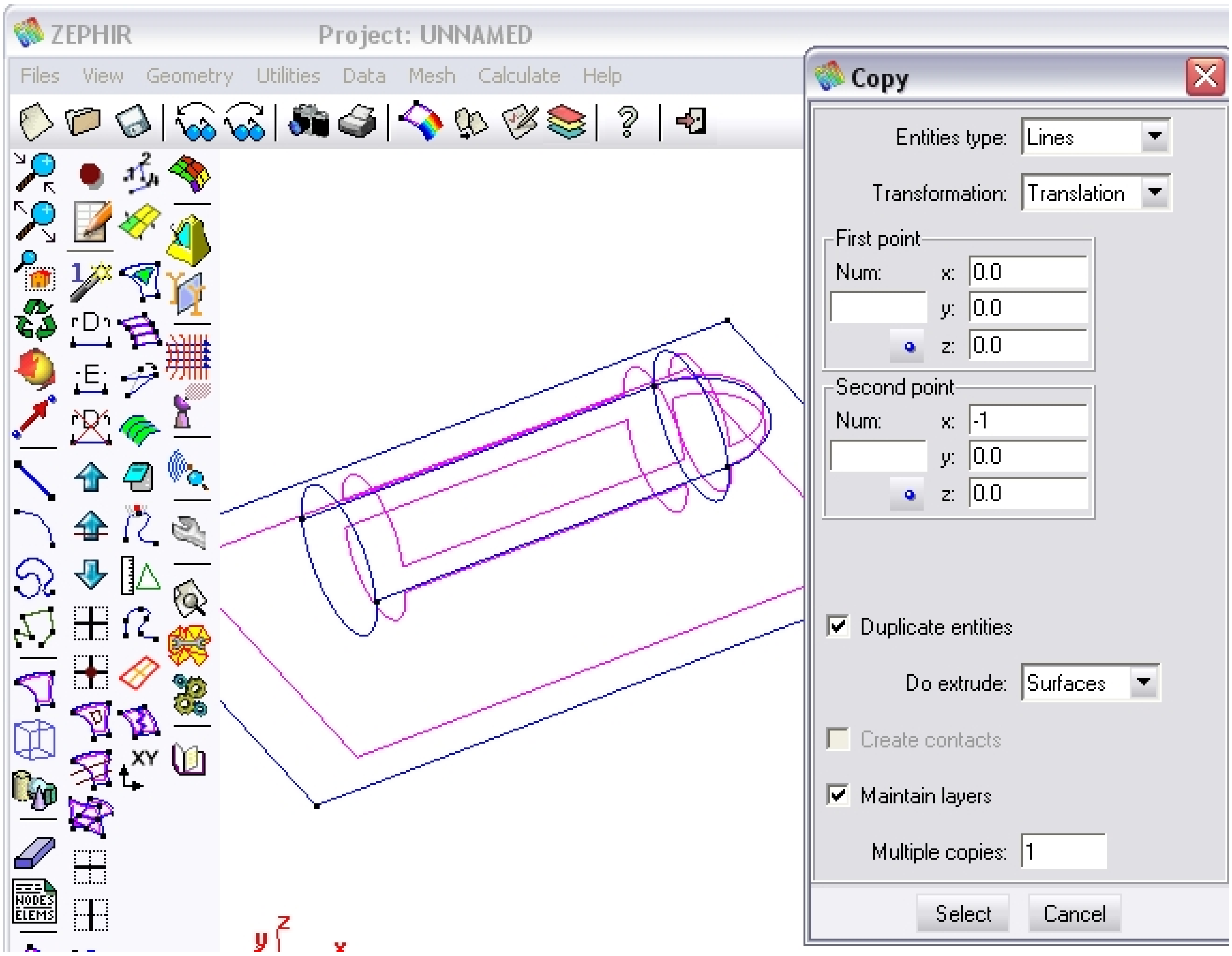


Remove the volume and the left part of the sphere with 



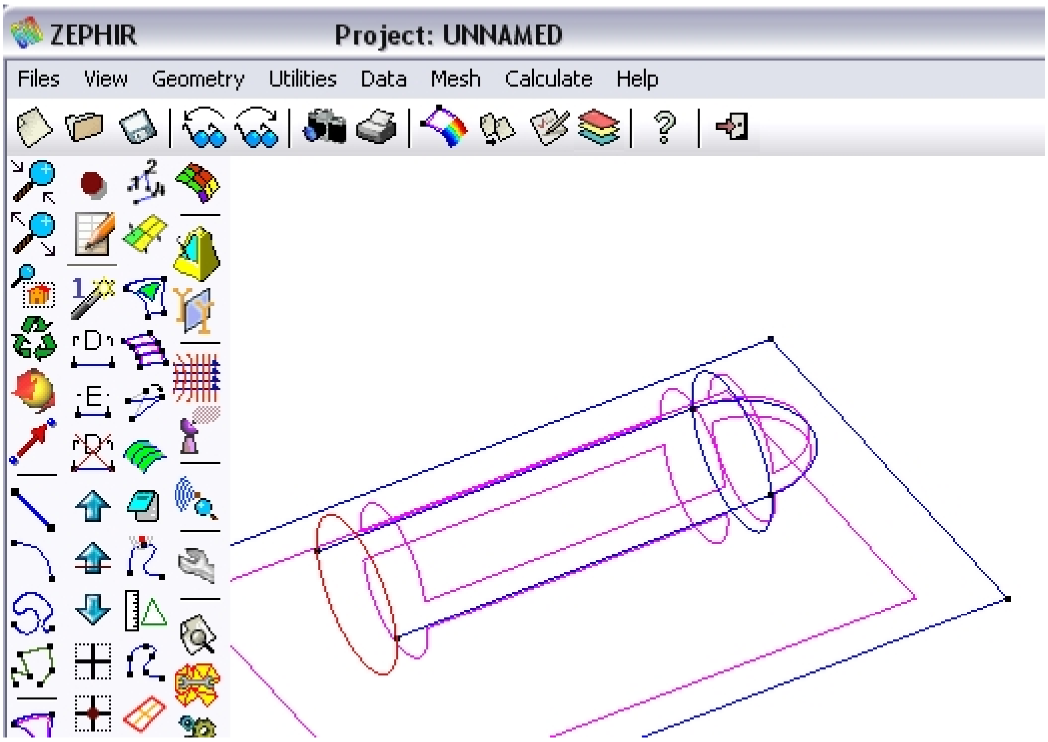
Please remove also the line.

Create the left circle by copying the half-sphere base :

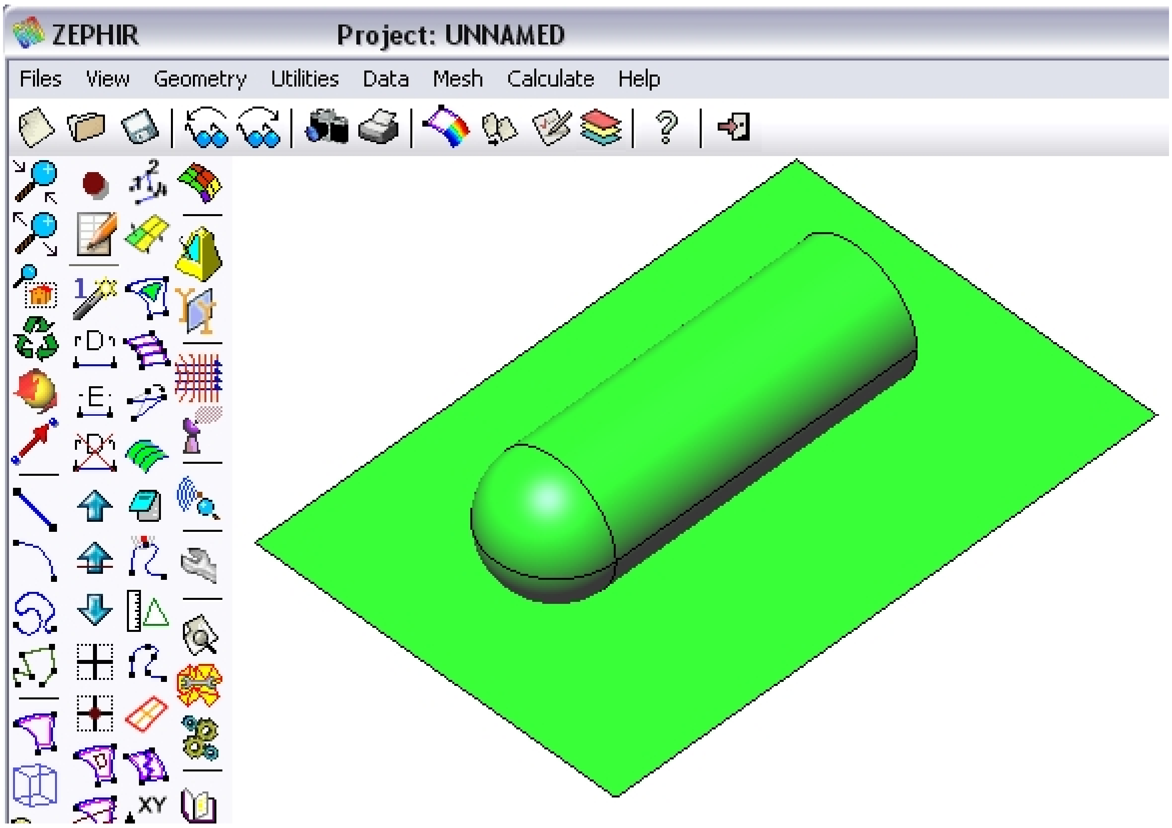


With the extrude option, the cylinder is created.

To finish, complete the cylinder base with a surface. Use  and select the two lines forming the circle :



Obtained geometry with flat render :

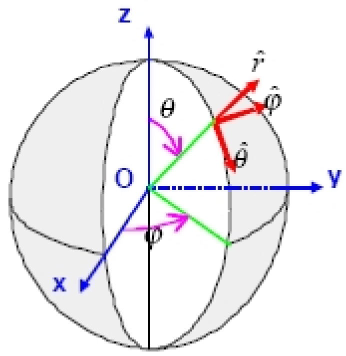


The RCS computation definition :

monostatic RCS:

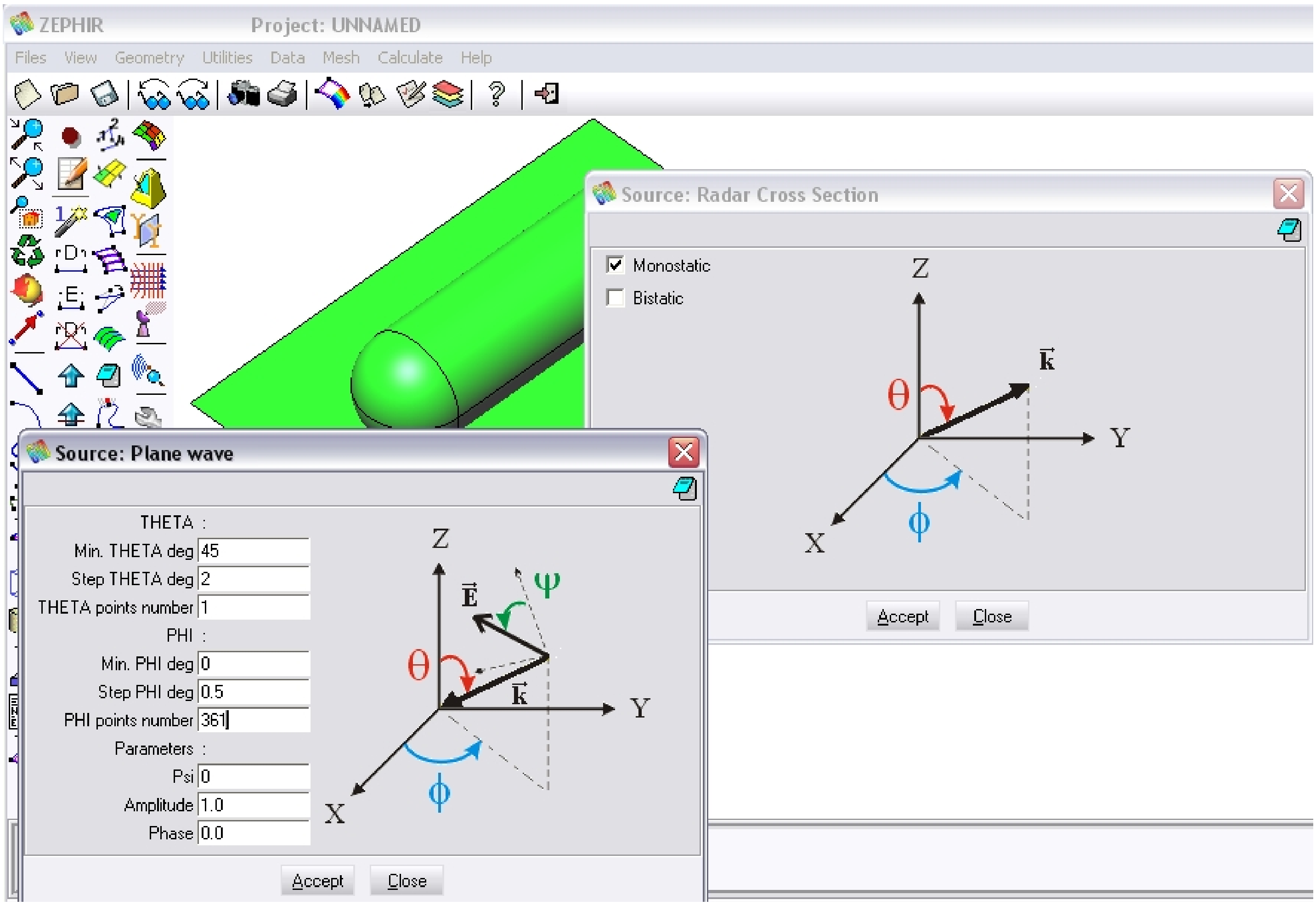
- **frequency** f_1**=1 Ghz,**
- **incidence angles :** $\theta = 45^\circ$, φ from 0° to 180°
- **polarisations** : $\theta\theta$ and $\varphi\varphi$

$\theta\theta$: co-polarisation with incident electric field parallel to $\hat{\theta}$
$\varphi\varphi$: co-polarisation with incident electric field parallel to $\hat{\varphi}$



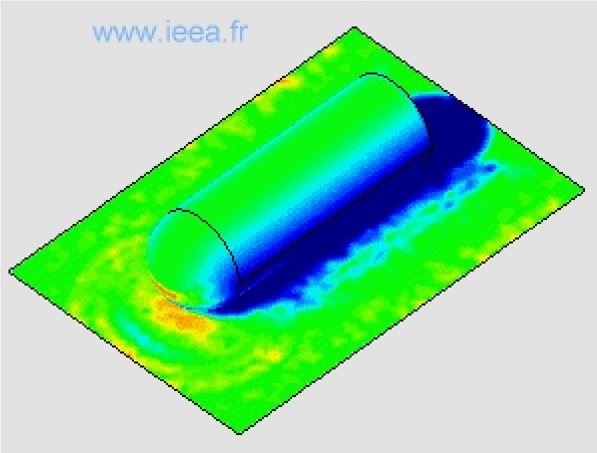
Set the frequency : 1 GHz

Enter the directions of incidence for the plane wave and choose a Monostatic RCS :

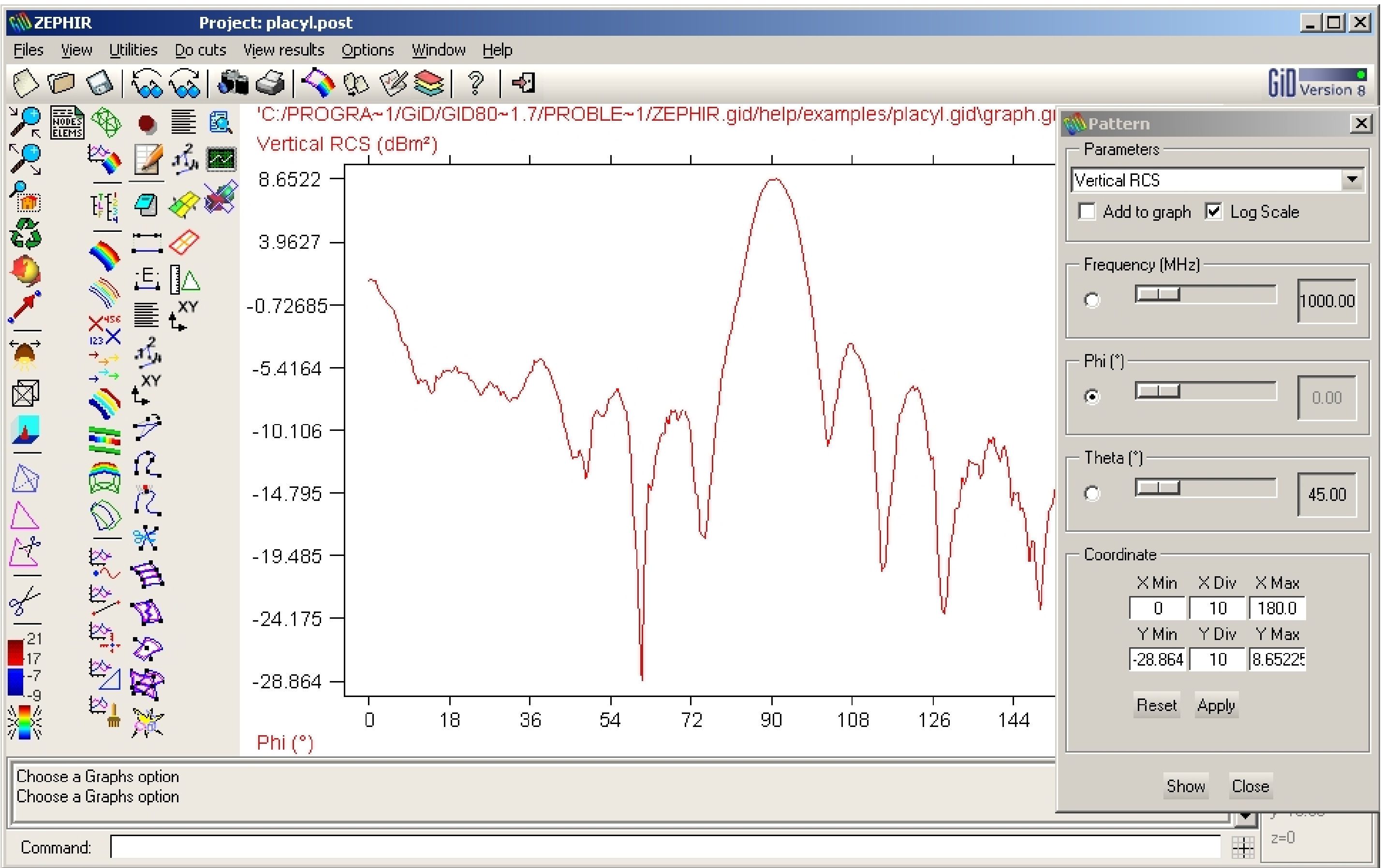


Assign the interface properties over the surfaces, generate the mesh, run.

This is the animation of the currents surface :



Visualisation of the computed monostatic RCS :

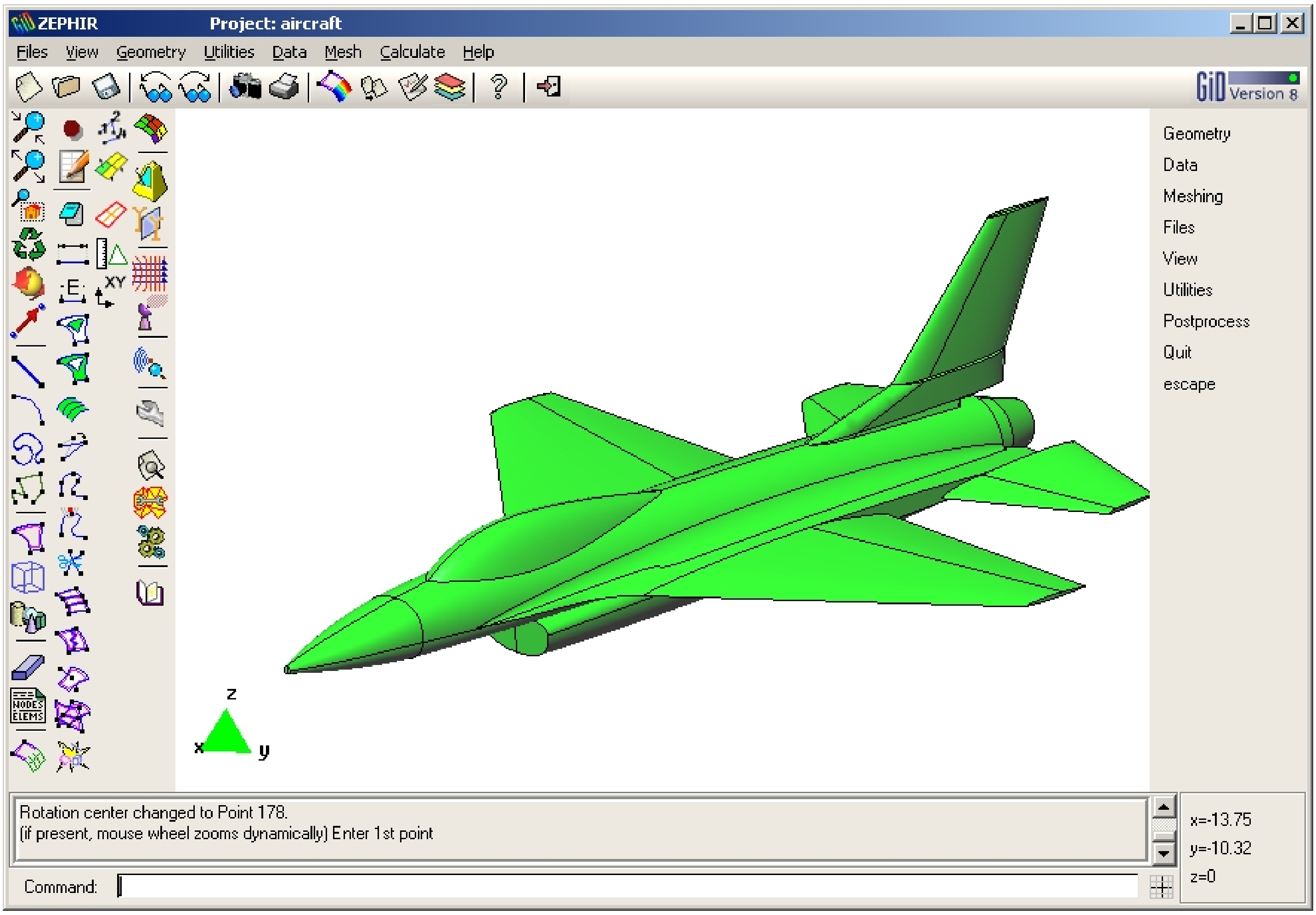


aircraft

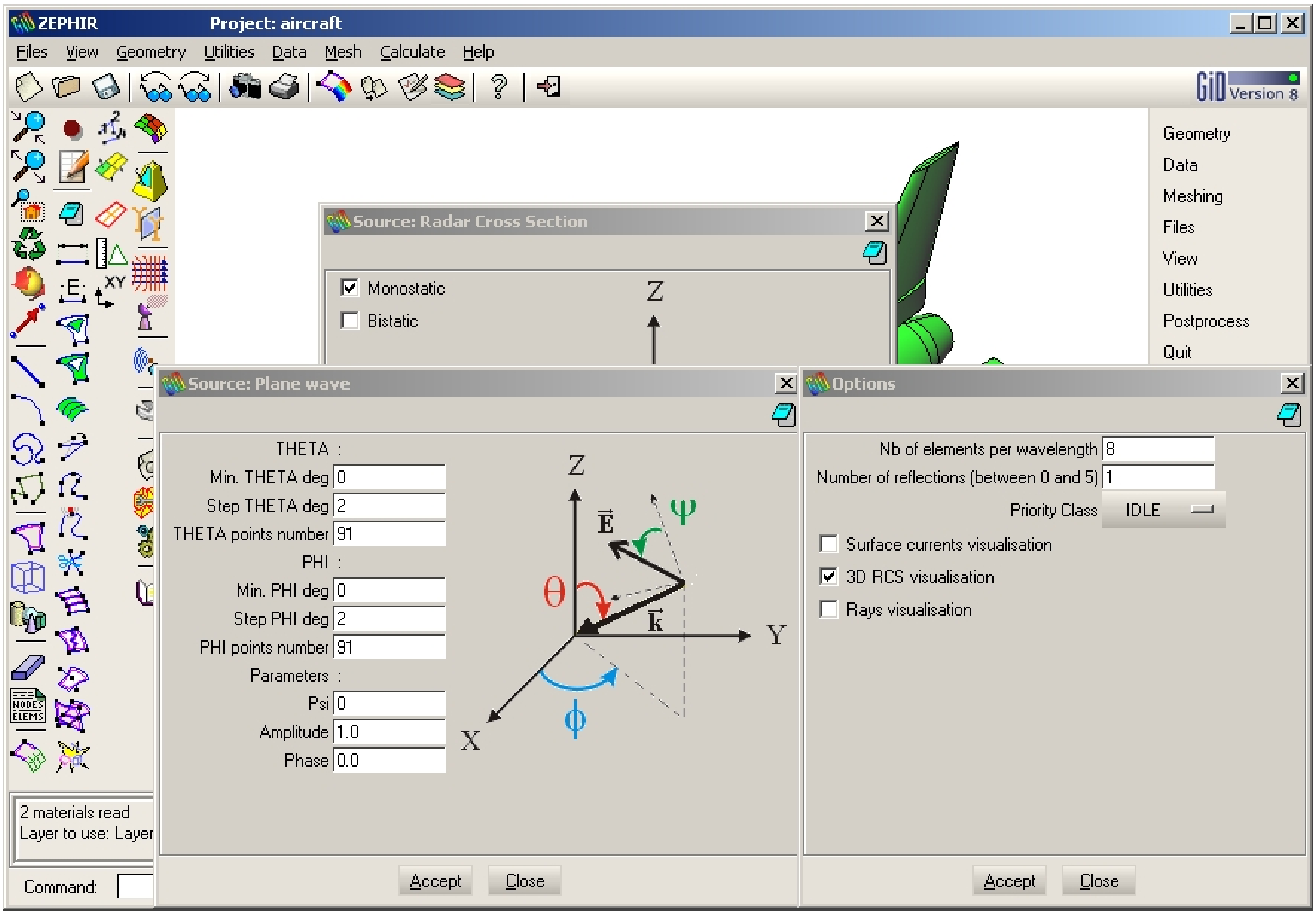
[Aircraft]

Frequency : 300 MHz

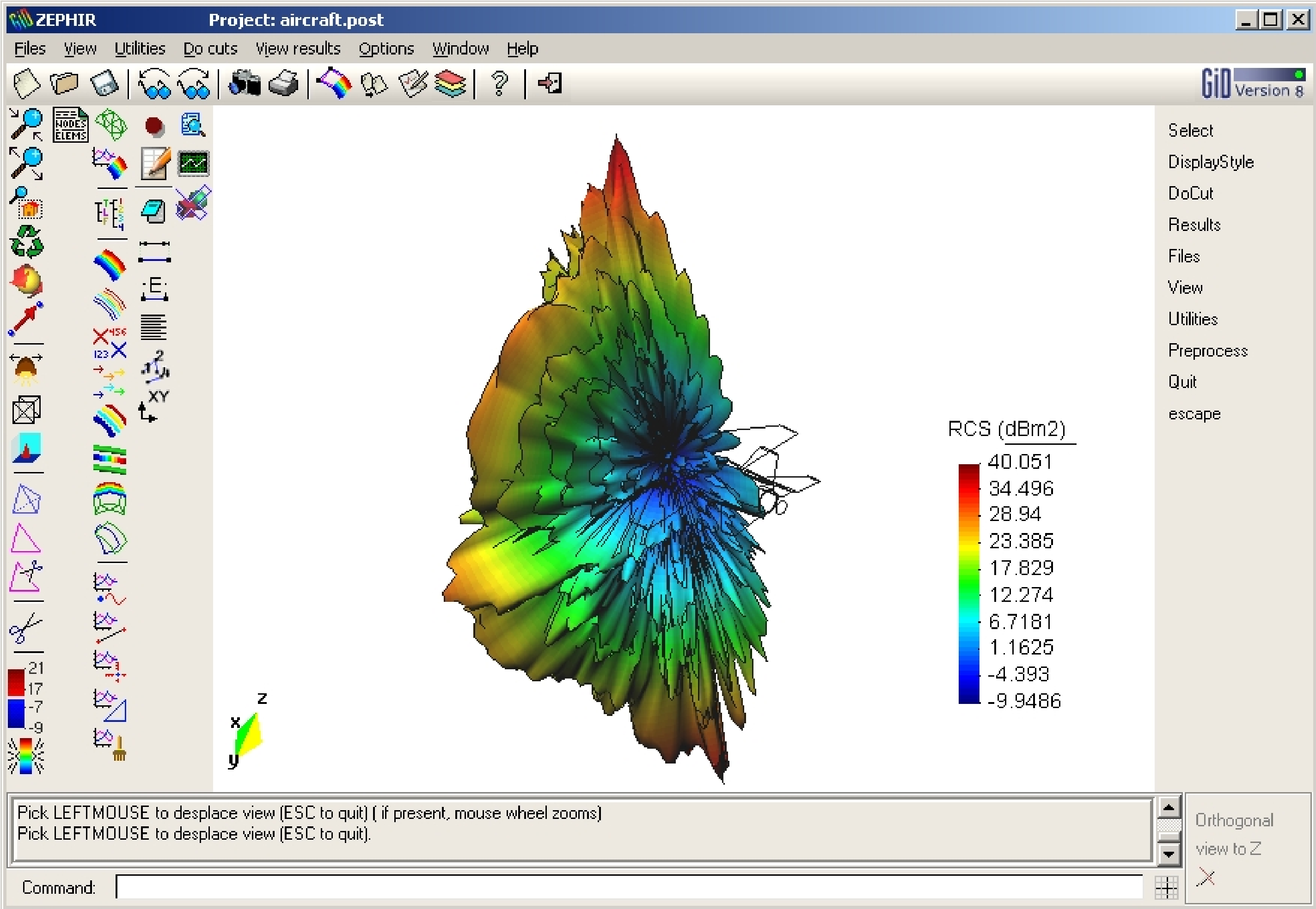
The geometry was imported from an IGES format file :



Set the directions of incidence for the plane wave. Note that only a half sphere is considered because of the symmetry of the structure. Select a monostatic computation. In addition, please select a 3D RCS visualisation and unselect the surface currents visualisation in the options window.



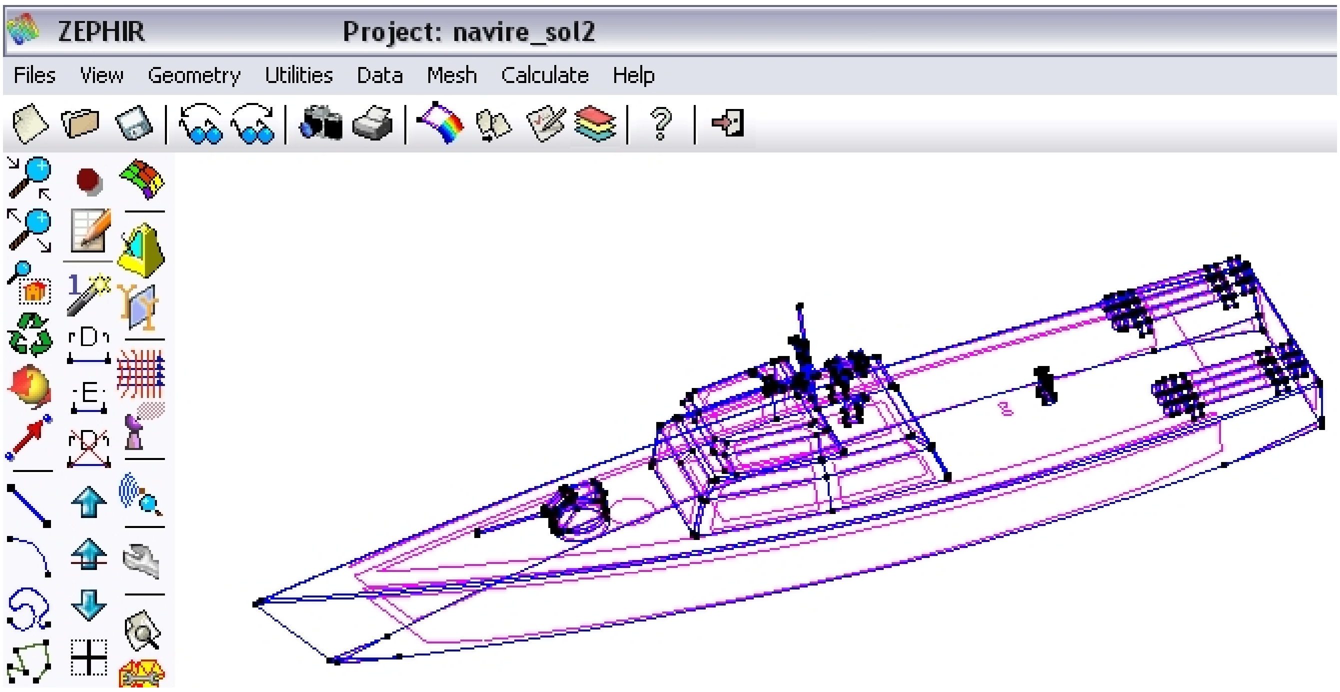
The computed 3D RCS visualisation :

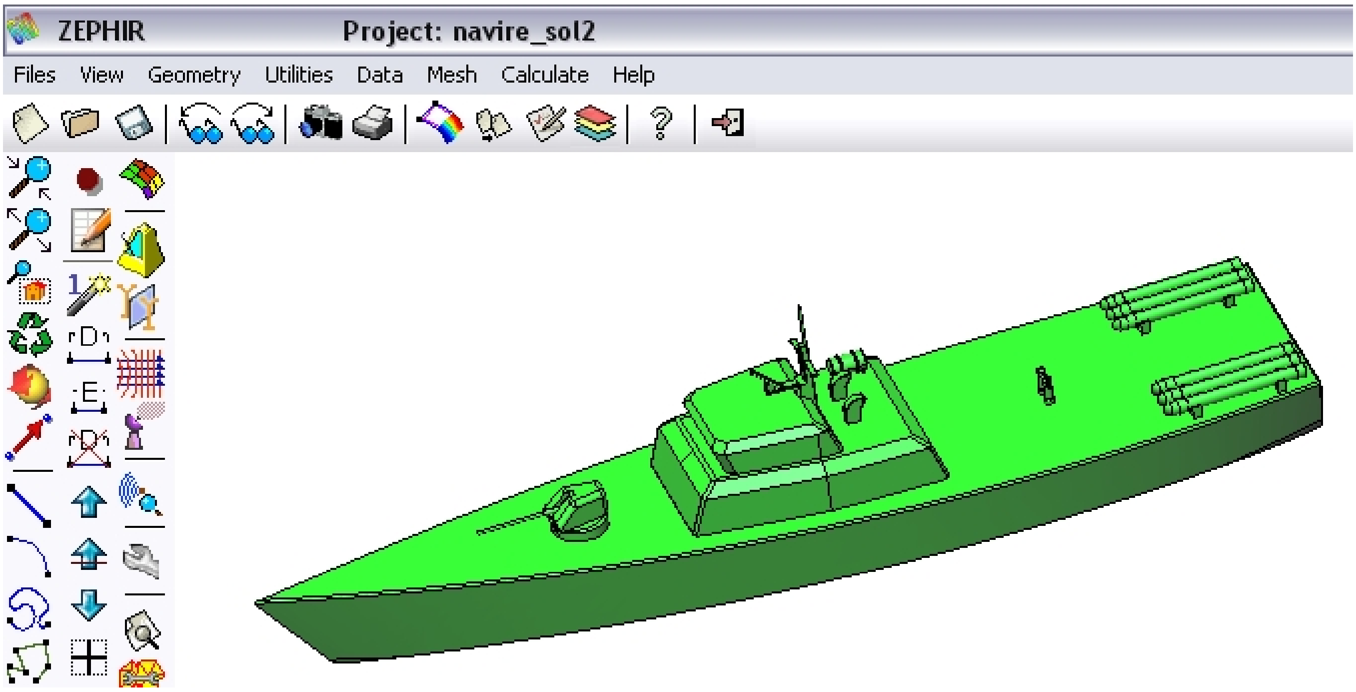


A battleship

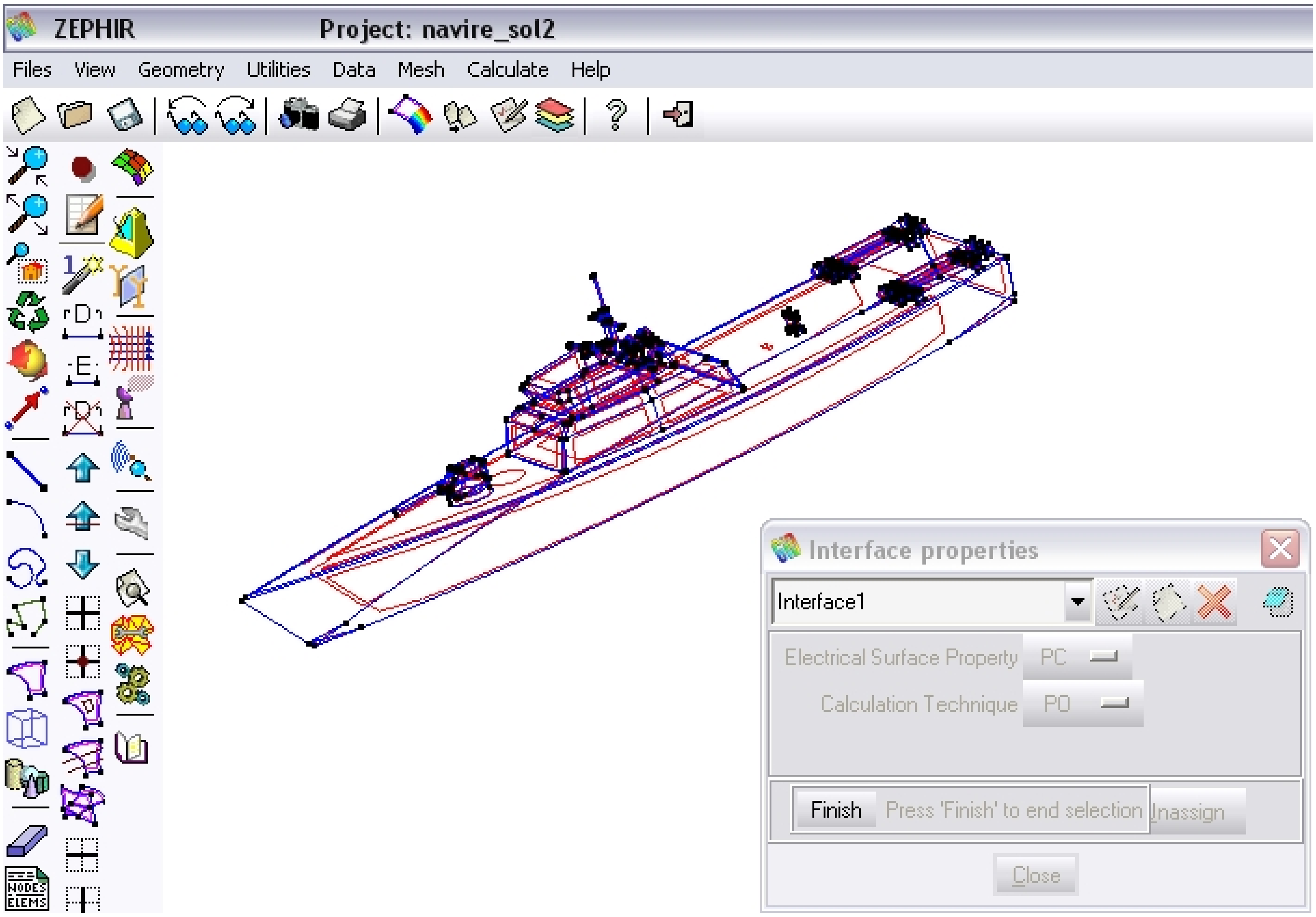
[Battleship]

In this example, the geometry of a boat was imported from an IGES file :

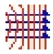


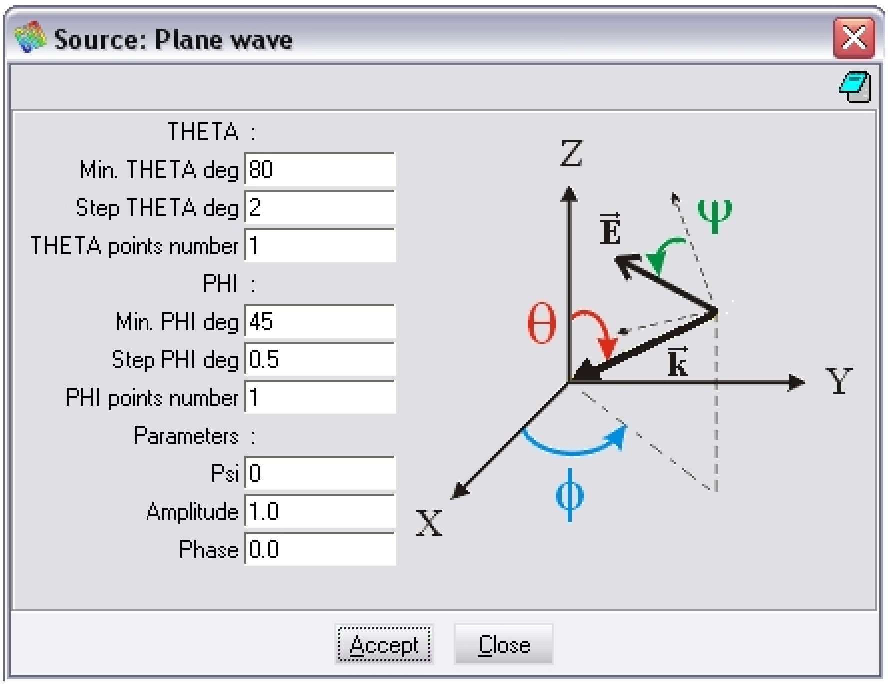


Please assign the properties over the surfaces with :

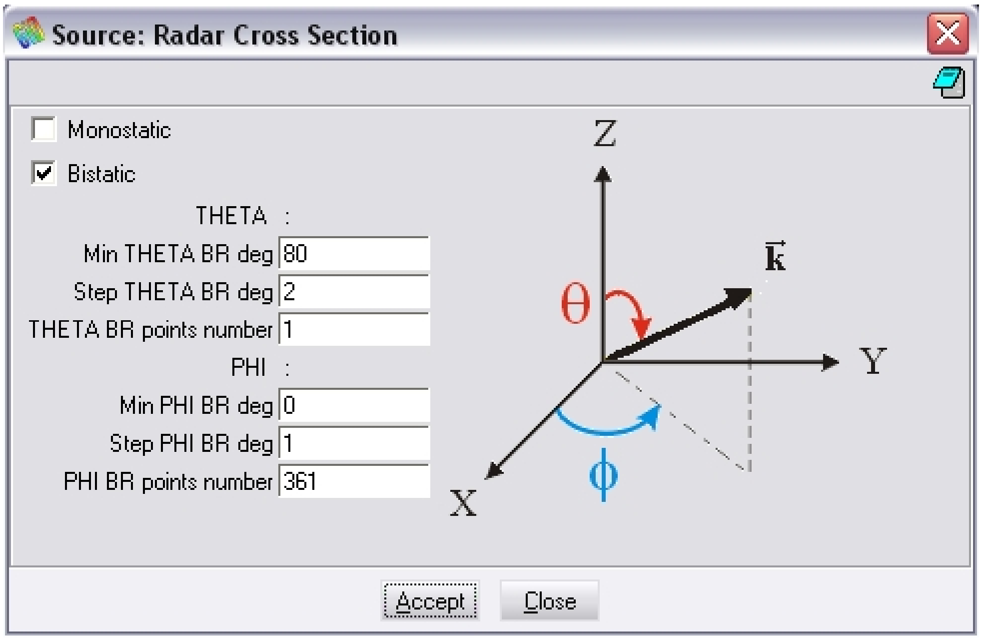


Define the frequency with . The operating frequency is 1 GHz.

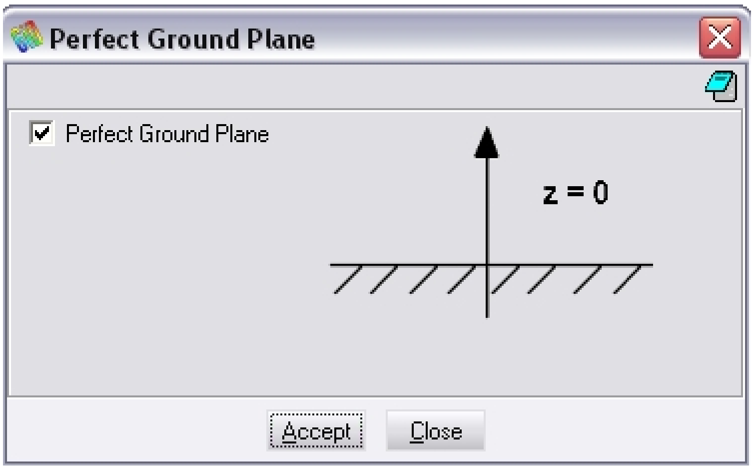
Define a Bistatic RCS problem with an incident plane wave  :



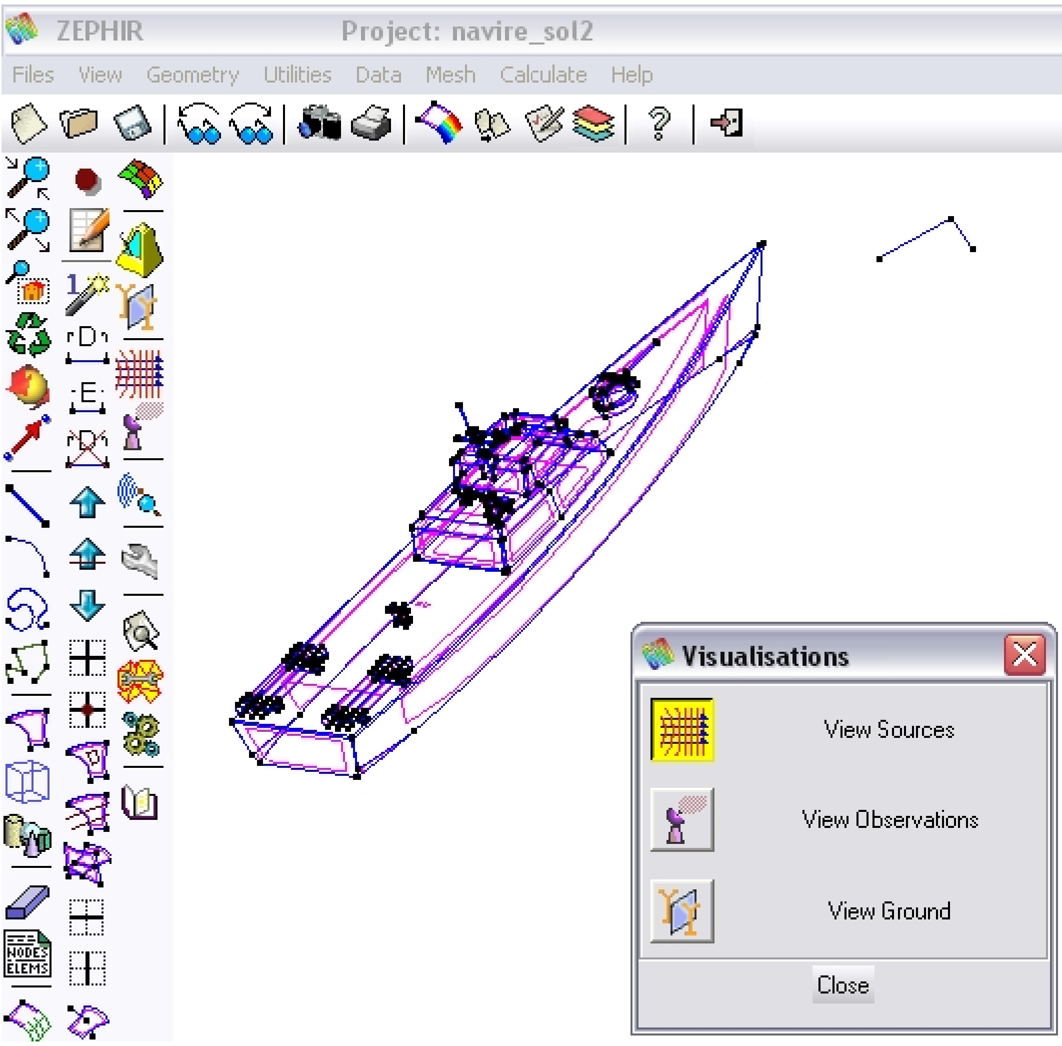
and the directions of observation with  :

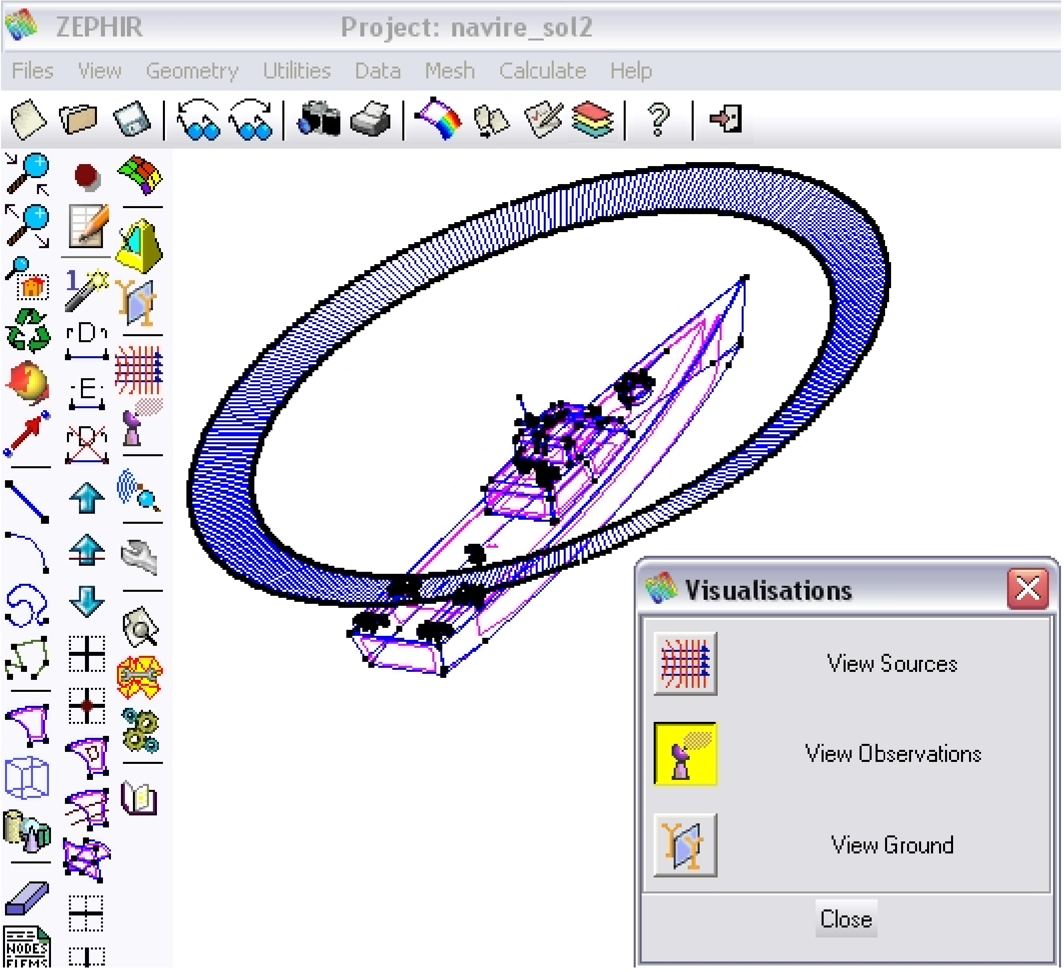


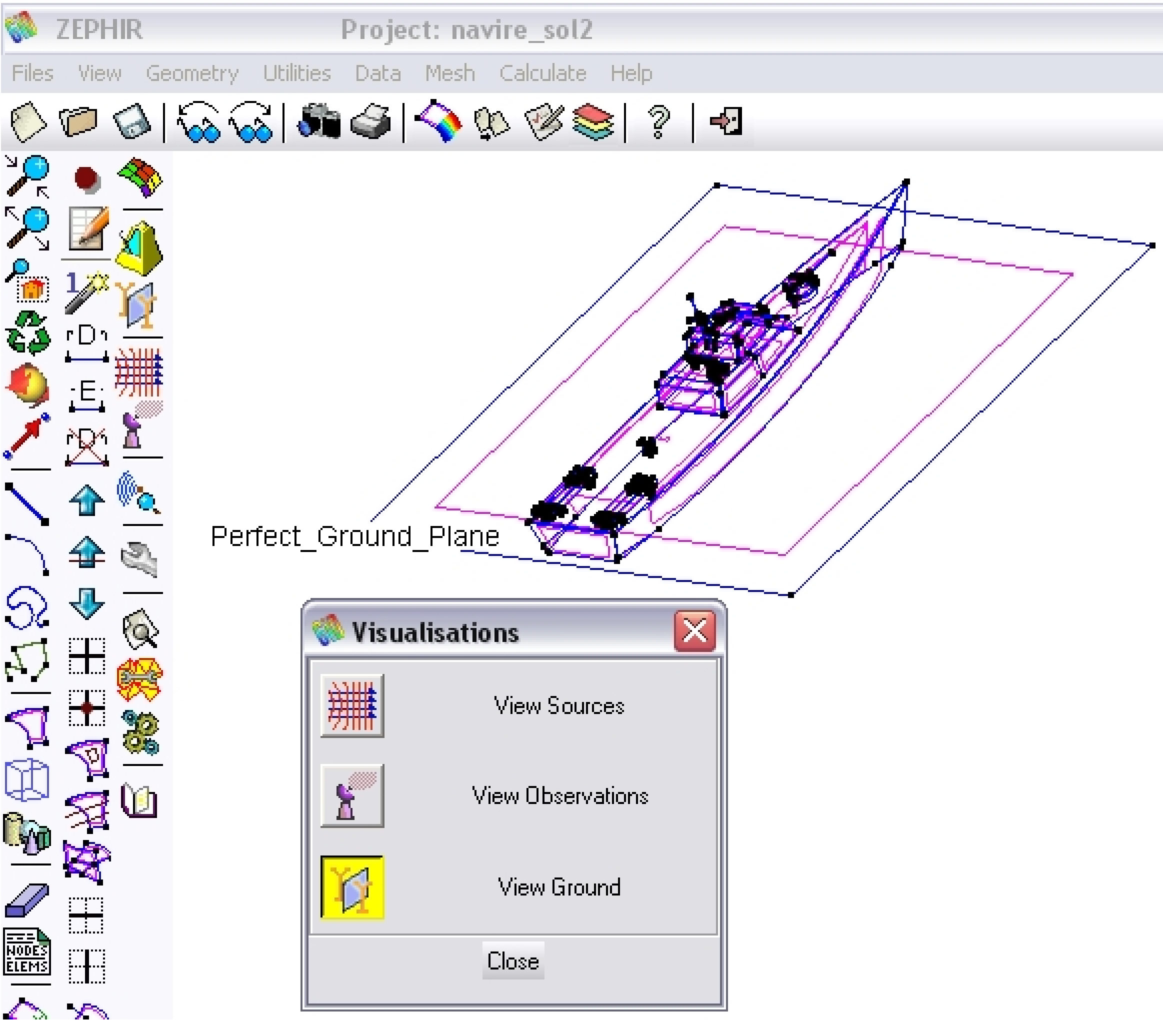
Set a perfect ground plane with  , in order to simulate the sea :



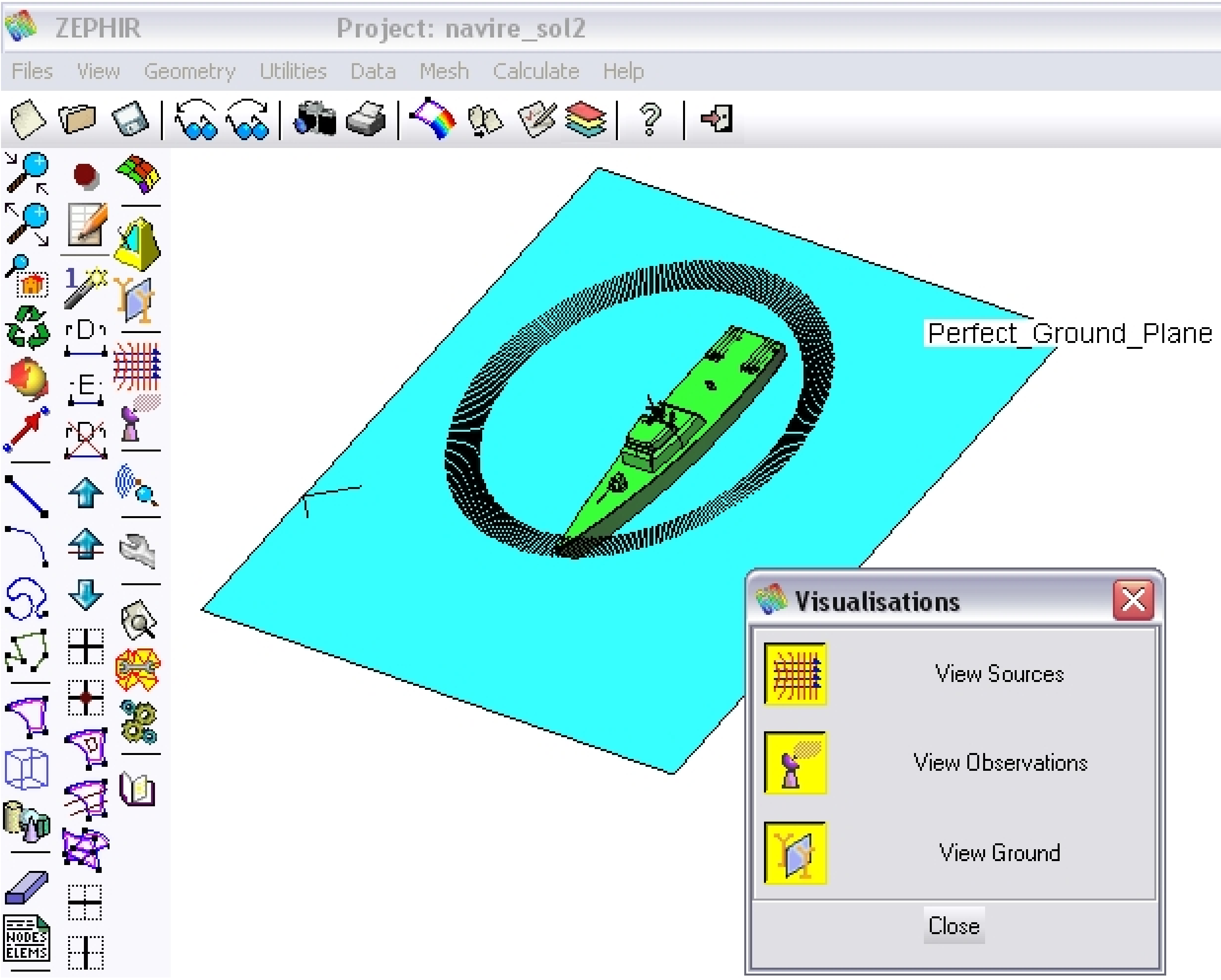
It is possible to check the incident plane wave, the directions of observation and the ground plane position with :



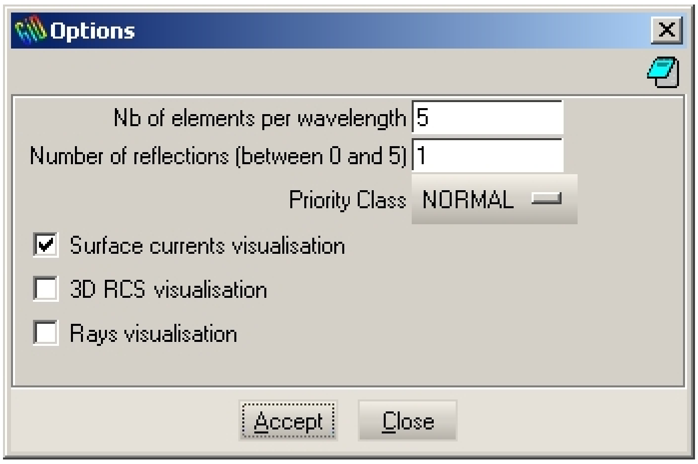

ZEPHIR
Project: navire_sol2
Files View Geometry Utilities Data Mesh Calculate Help
Visualisations
View Sources
View Observations
View Ground
Close


ZEPHIR
Project: navire_sol2
Files View Geometry Utilities Data Mesh Calculate Help
Perfect_Ground_Plane
Visualisations
View Sources
View Observations
View Ground
Close

And with the flat render of GID :

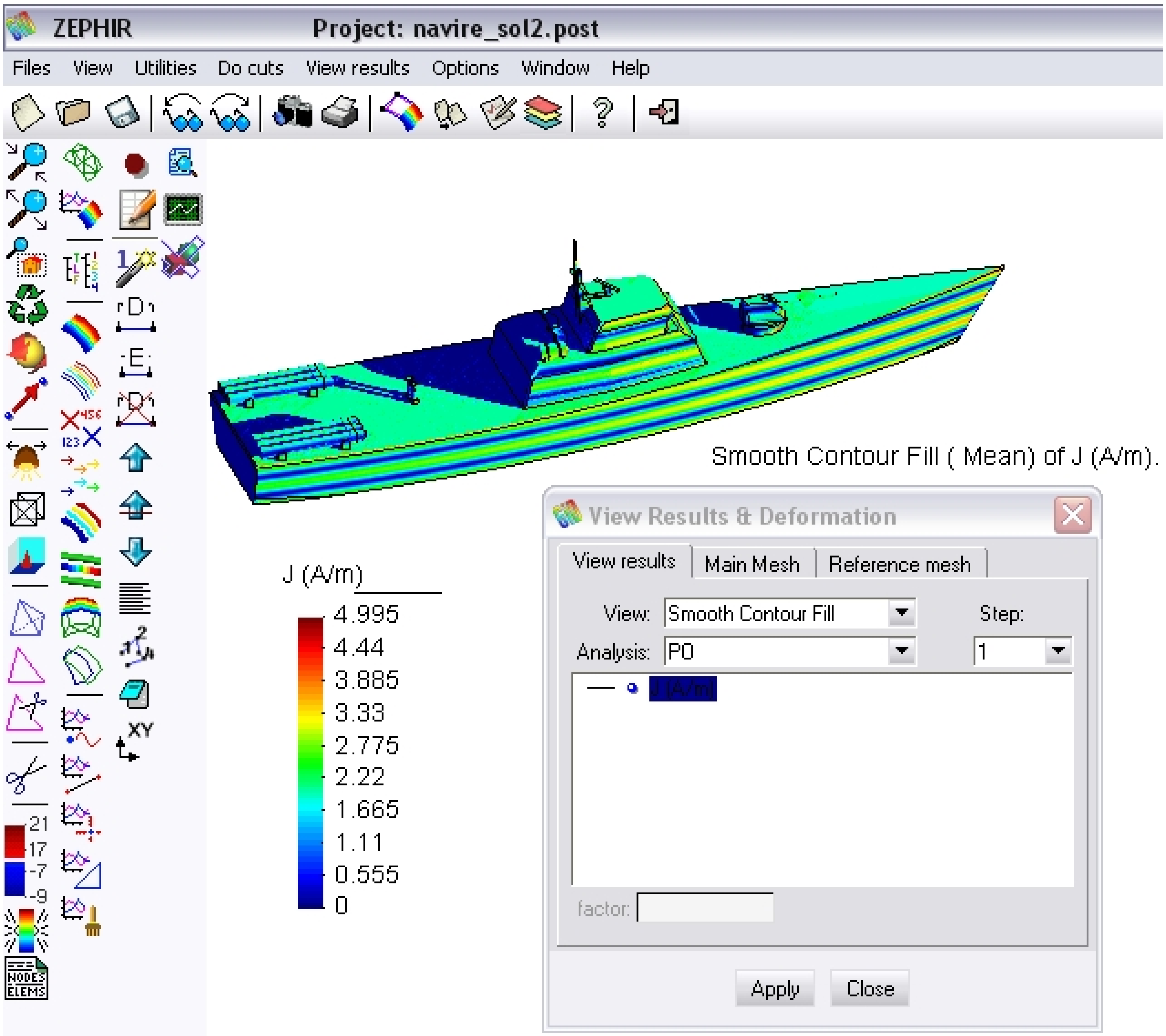


Suggested options  :

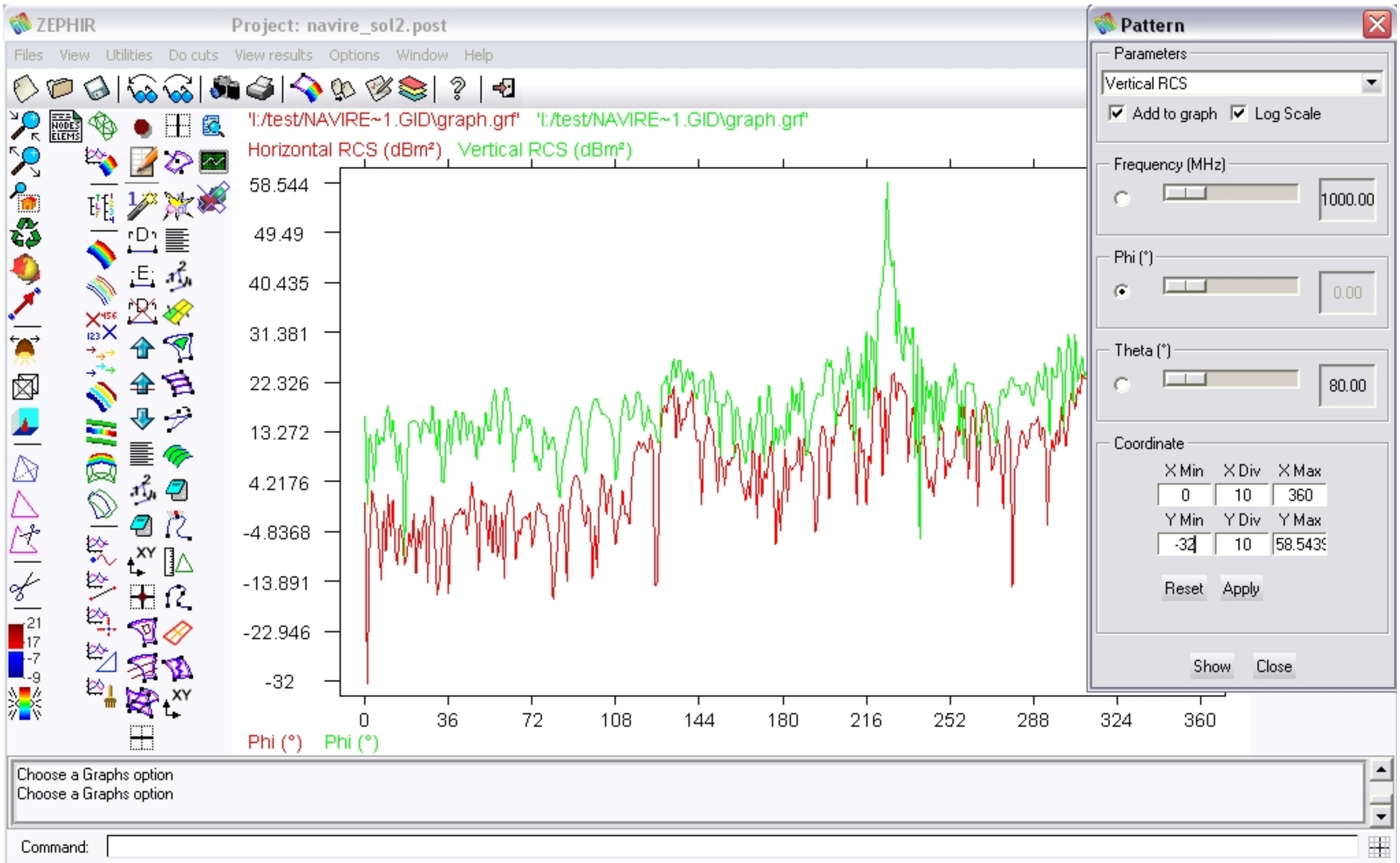


Generate the mesh with 
Save and run.

The surface currents visualisation :



The following graphs are obtained with  :


ZEPHIR
Project: navire_sol2.post
Files View Utilities Do cuts View results Options Window Help
'I:/test/NAVIRE~1.GID\graph.grf' 'I:/test/NAVIRE~1.GID\graph.grf'
Horizontal RCS (dBm²) Vertical RCS (dBm²)
58.544
49.49
40.435
31.381
22.326
13.272
4.2176
-4.8368
-13.891
-22.946
-32
0 36 72 108 144 180 216 252 288 324 360
Phi (°) Phi (°)
Pattern
Parameters
Vertical RCS
Add to graph
Log Scale
Frequency (MHz)
1000.00
Phi (°)
0.00
Theta (°)
80.00
Coordinate
X Min X Div X Max
0 10 360
Y Min Y Div Y Max
-32 10 58.5439
Reset Apply
Show Close
Choose a Graphs option
Choose a Graphs option
Command:

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