EM.Illumina

Tutorial Lessons

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EM.Illumina Tutorial Lesson 4

Simulating Radiation in the Presence of Large Metallic Shipboard Platforms

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4.1 What You Will Learn

In this tutorial you will learn how to import an external CAD model and set up a large-scale physical optics simulation in EM.Illumina.

EM.Illumina Manual:

http://www.emagtech.com/wiki/index.php/EM.Illumina

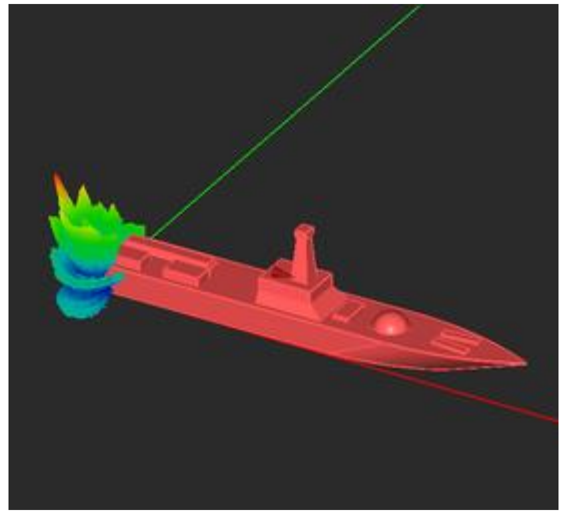
EM.Illumina Tutorial Gateway:

http://www.emagtech.com/wiki/index.php/EM.Cube#EM.Illumina_Documentation

Download projects related to this tutorial lesson:

http://www.emagtech.com/downloads/ProjectRepo/EMIllumina_Lesson4.zip

Tutorial Project: Simulating Radiation in the Presence of Large Metallic Shipboard Platforms



Objective: In this project, you will compute the radiation pattern of a short dipole radiator in the presence of a large metallic ship model imported from a CAD file.

Concepts/Features:

- CubeCAD
- CAD Import
- STEP Model
- PEC Surface
- Mesh Density
- Current Distribution
- Radiation Pattern

Minimum Version Required: All versions

4.2 Getting Started

Start a new project with the following parameters:

Starting Parameters	
Name	EMIllumina_Lesson4
Length Units	Meters
Frequency Units	MHz
Center Frequency	200MHz
Bandwidth	100MHz

For this tutorial lesson, you need to import a STEP CAD model file called "Ship.stp" from our from:

http://www.emagtech.com/downloads/ProjectRepo/Ship.zip

Make sure to set the project unit to meters.

4.3 Importing the Ship Model

EM.Cube allows you to import CAD models to a number of popular CAD file formats such as STEP, IGES, STL, etc. The STEP and IGES options import all the solid, surface, curve and point objects. The STL format imports only solid and surface objects as sets of interconnected triangles and ignores all the curve or point objects. Make sure your project **Units** is compatible with the length units of the model to be imported. CubeCAD is the module where import operations will take place (Figure 1).

> You can import external CAD models to CubeCAD only. From CubeCAD you can move objects to other modules like EM.Illumina.

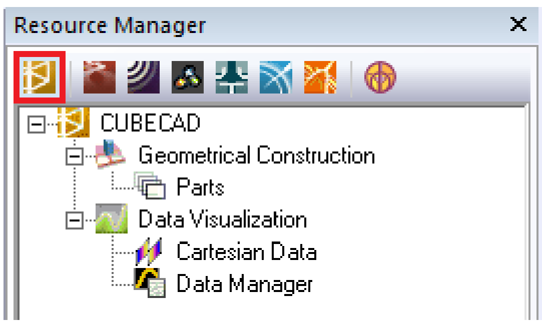


***Figure 1**. CubeCAD module in EM.Cube.*

In EM.Cube, external objects are always imported to CubeCAD first. From CubeCAD you can transfer an imported object to any of the other computational modules.

While in CubeCAD, select the menu item **File → Import...** or use the keyboard shortcut **Ctrl+Shift+O** (Figure 2). The Windows Open dialog opens up. From the **File Type** drop-down list, select STEP/STP. Use the Windows Explorer to go to the folder where your STP file was saved. Select "Ship.stp" and click the **Open** button of the dialog (Figure 3).

A total 12 solid CAD objects appear in the project workspace of the CubeCAD Module as shown in Figure 4

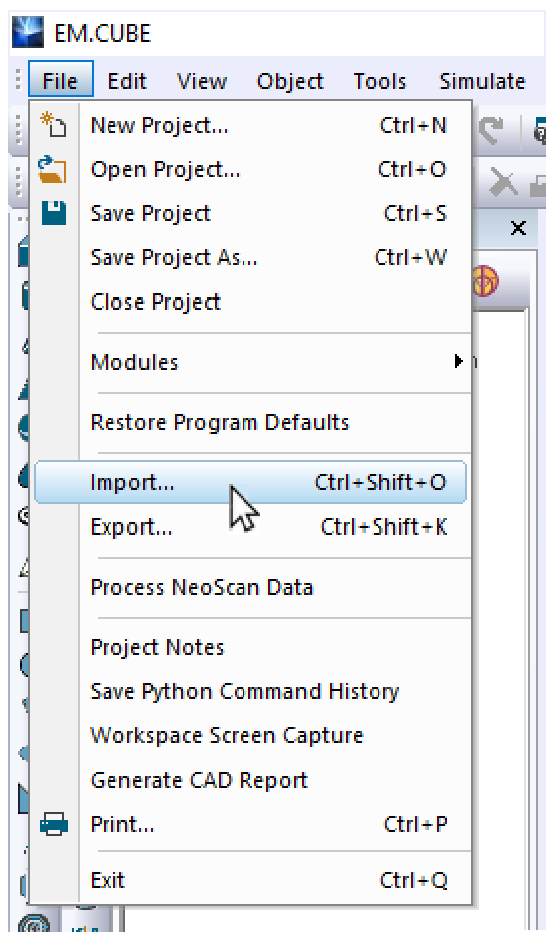


***Figure 2**. Selecting the import item from the menu.*

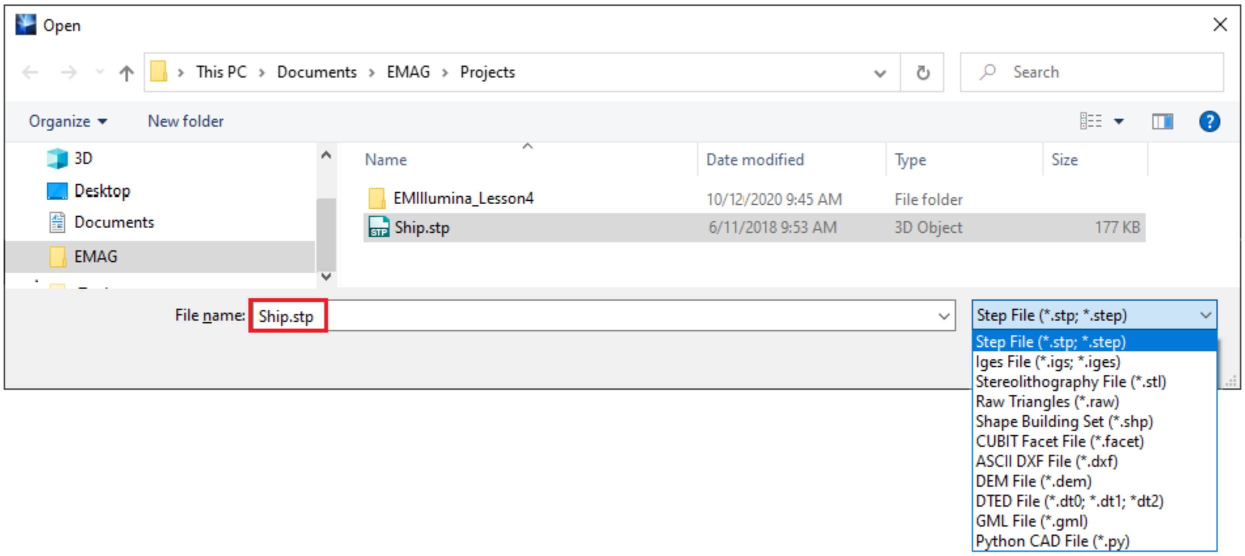


Figure 3. *The Windows Open dialog with the file type set to ".STP".*

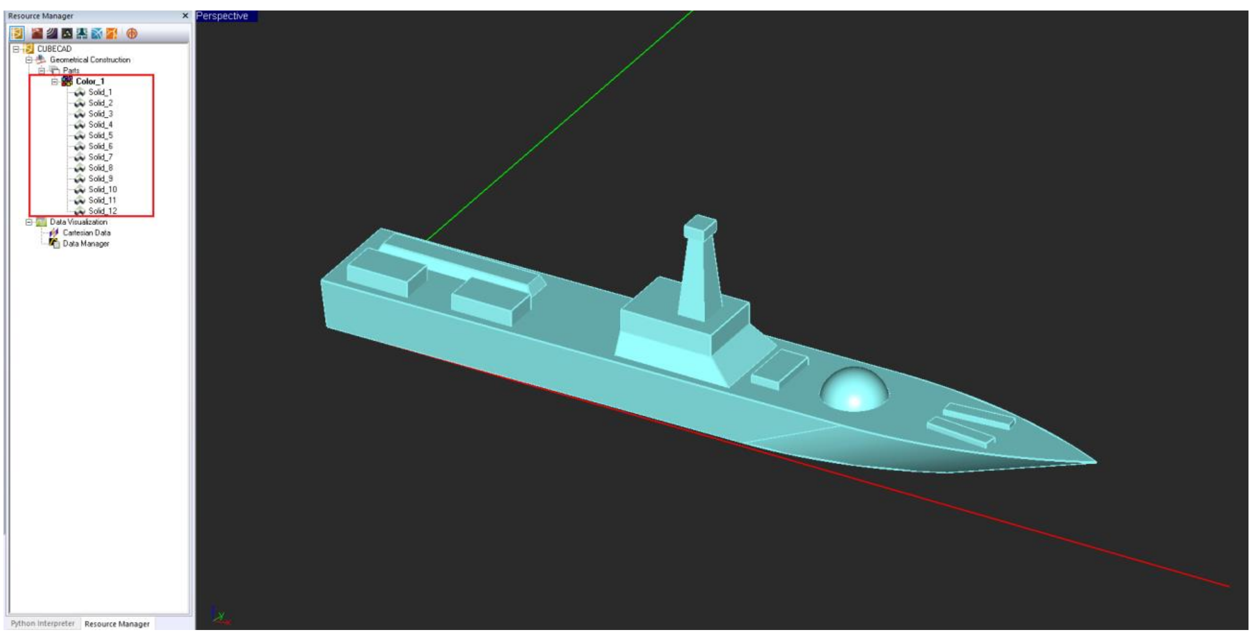


Figure 4. *The imported ship model in CubeCAD.*

Now go to the EM.Illumina tab and create a PEC group called “PEC_1” in EM.Illumina's navigation tree.

Group Name	Material Type	Color	Material Name	Material Properties
PEC_1	PEC Surfaces	Red	N/A	N/A

To do so, right-click on the **PEC Surfaces** item under **Physical Structure** and select **Insert New PEC...** from the contextual menu. The property of the newly created PEC group opens up (Figure 5). The default name of the group is "PEC_1" and its default color is rosy red. Accept the default settings and close the dialog.

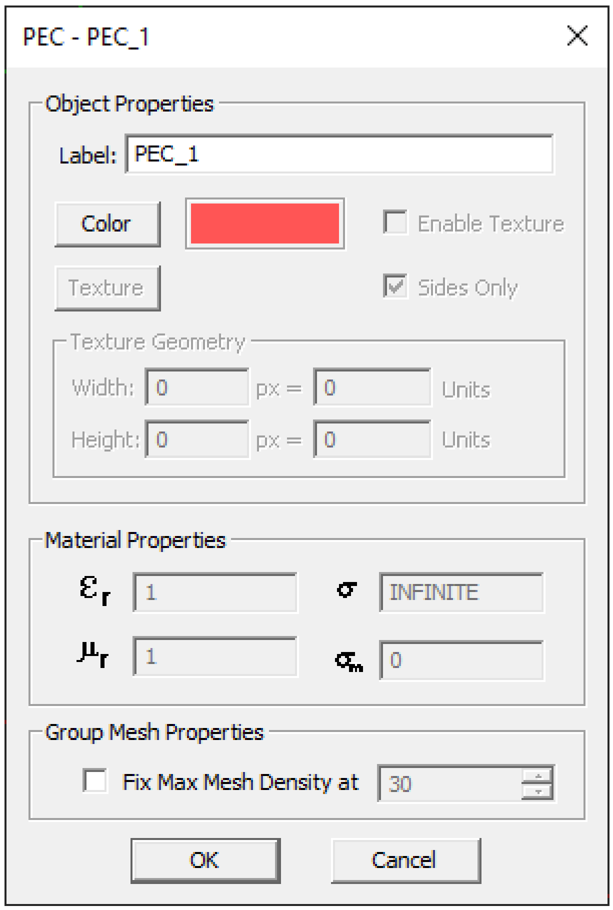


Figure 5. *The property dialog of the PEC group in EM.Illumina.*

Next, you have to move all the imported solids to the “PEC_1” group of EM.Illumina. You can select any object from the navigation tree of the CubeCAD module. To make a multiple selection, hold down your keyboard's **Ctrl** key while clicking on the objects' names in the navigation tree.

Alternatively, you can start with **Solid_1** and select it. Then, hold down the keyboard's **Shift** key and click the last object **Solid_12**. While still holding down the **Shift** key, right-click on the selection and select **Move To → EM.Illumina → PEC_1** from the contextual menu (see Figure 6). All the objects will disappear from CubeCAD and will reappear in EM.Illumina's workspace under the “PEC_1” group (Figure 7).

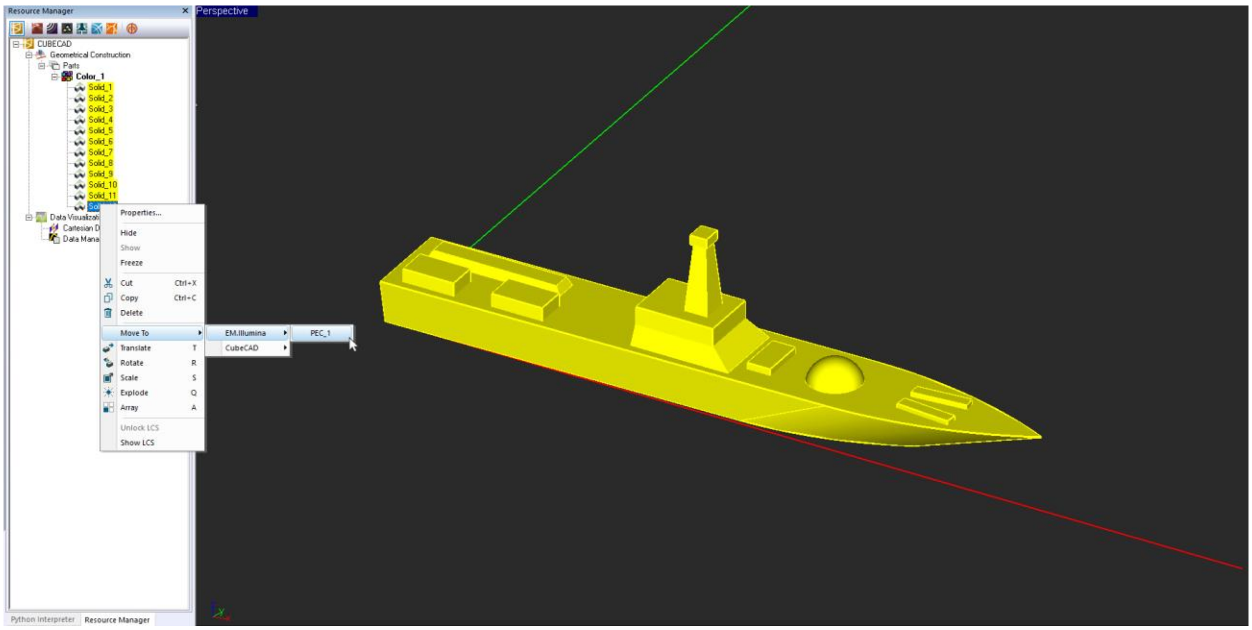


Figure 6. *Moving the imported objects from CubeCAD to EM.Illumina.*

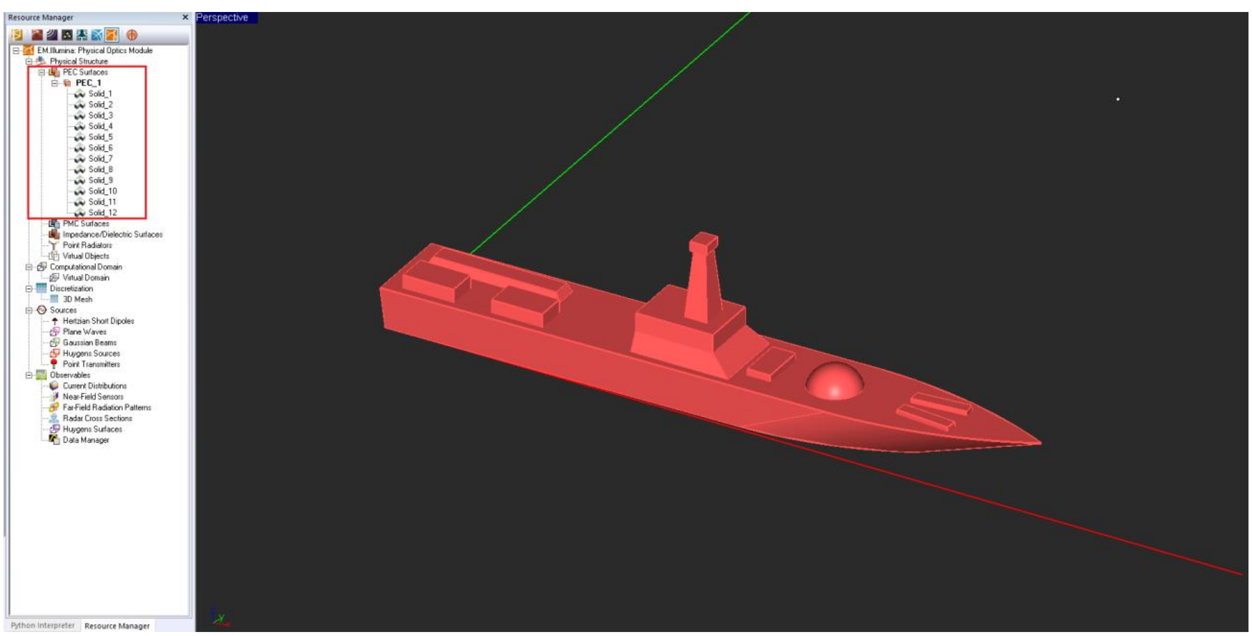


Figure 7. *The imported ship model in EM.Illumina's project workspace.*

4.4 Defining a Short Dipole Source & Simulation Observables

Next, define an X-directed short dipole source and place it at (59m, 5m, 20m). For this purpose, set the components of the unit vector to uX = 1, uY = uZ = 0 (Figure 8).

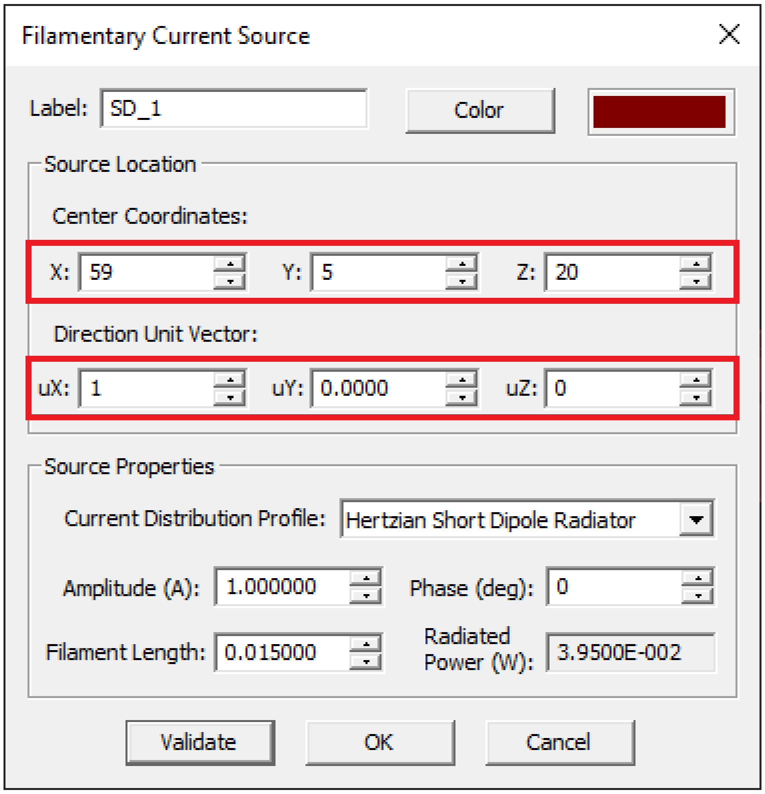


Figure 8. Setting the polarization of the short dipole source in its property dialog.

Also define a default current distribution observable.

Finally, define far-field radiation pattern observable. In the Radiation Pattern dialog, set the Angle Increments to 1° for both Theta and Phi angles.

4.5 Examining the Surface Mesh of the Ship Model

At the operational frequency of 200MHz, the free-space wavelength is $\lambda_0 = 1.5$m. Given that the ship hull has a length of 143.5m and a width of 21.5m, and the top of the tower has a height of 36m above the ground, the overall electrical dimensions of your physical structure are $95.67\,\lambda_0 \times 14.33\,\lambda_0 \times 24\,\lambda_0$. This leads to an enormous mesh size that might be too large for your computer memory to hold. Therefore, open the Physical Optics Mesh Settings dialog and change the value of Mesh **Density** to 3 cells per wavelength (Figure 9).

Also, uncheck the box labeled **Mesh all surface objects as double-sided cells** in the EM.Illumina's mesh settings dialog

Then, open the Tessellation Options dialog and change the value of **Curved Edge Angle Tolerance** parameter to 10°. Now generate and view the triangular surface mesh of your ship model. Figure 10 shows a magnified view of part of the mesh of your ship model.

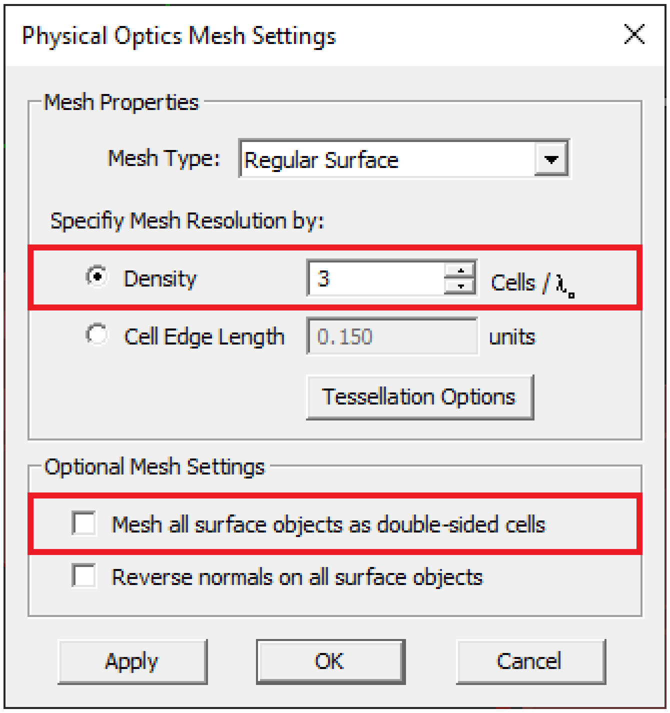


Figure 9. *Reducing the mesh density in EM.Illumina's mesh settings dialog.*

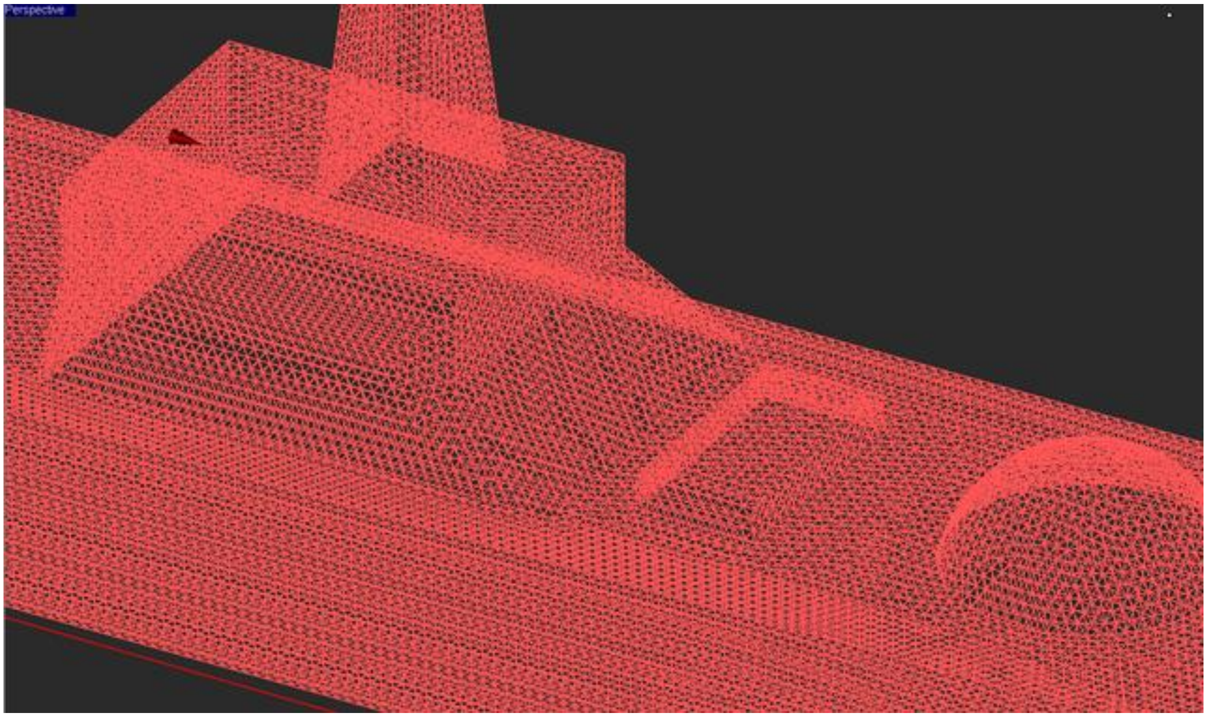


Figure 10. *A close-up of the mesh of the imported ship model.*

4.6 Running an IPO Analysis of the Ship Model

Run an IPO simulation of the short dipole radiator above your large-scale ship model. This simulation involves a total of 78,468 cells and converges after two IPO iterations.

Visualize the total current distribution on the surface of the ship ("JsMagTotal"). You will see that most of the ship is initially dark. A lot of times, it would be better to plot the 3D visualization of current or field distributions in dB scale. Double-click on the surface of the legend box to open the output plot settings dialog. Switch the **Scale** radio button from "Linear" to "dB". Also, in the **Limits** section at the top of the dialog, choose the **User Defined** option. Set the lower and upper limits of the plot to -120dB and -50dB, respectively (Figure 11).

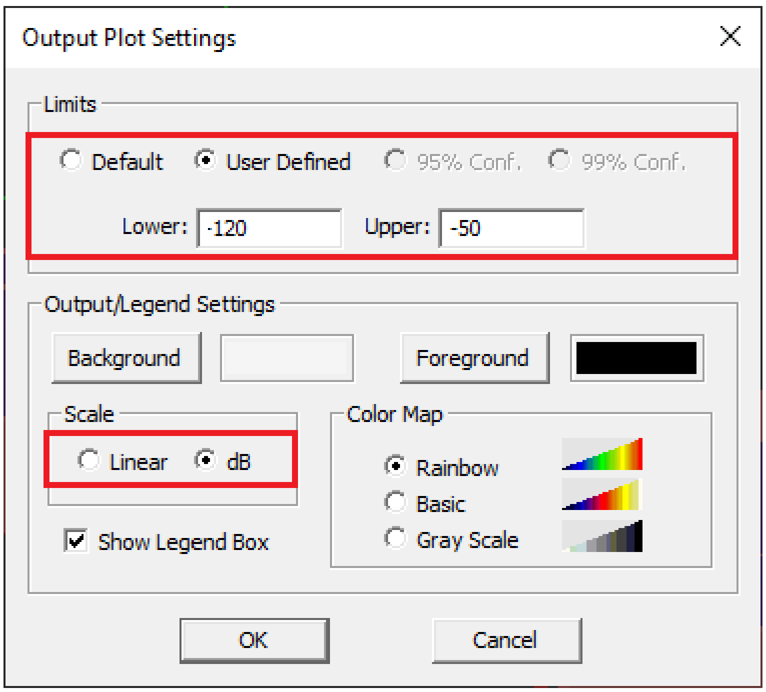


Figure 11. *Changing the dB-scale plot parameters in the output plot settings dialog.*

Now plot the dB-scale current distribution of your antenna-platform combo structure (Figure 12).

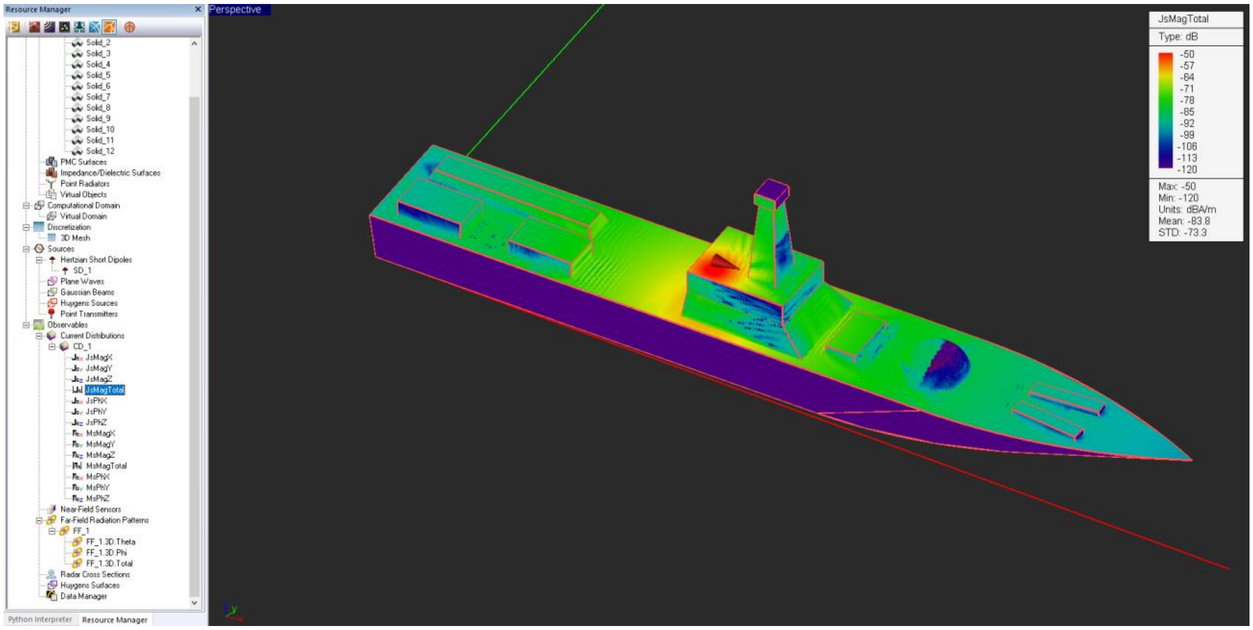


Figure 12. *The total current distribution on the ship model in dB scale with a horizontal short dipole radiator.*

Next, visualize the 3D radiation pattern of your antenna-platform combo structure. Explore the theta and phi components of the radiation pattern, too (see Figures 13-15).

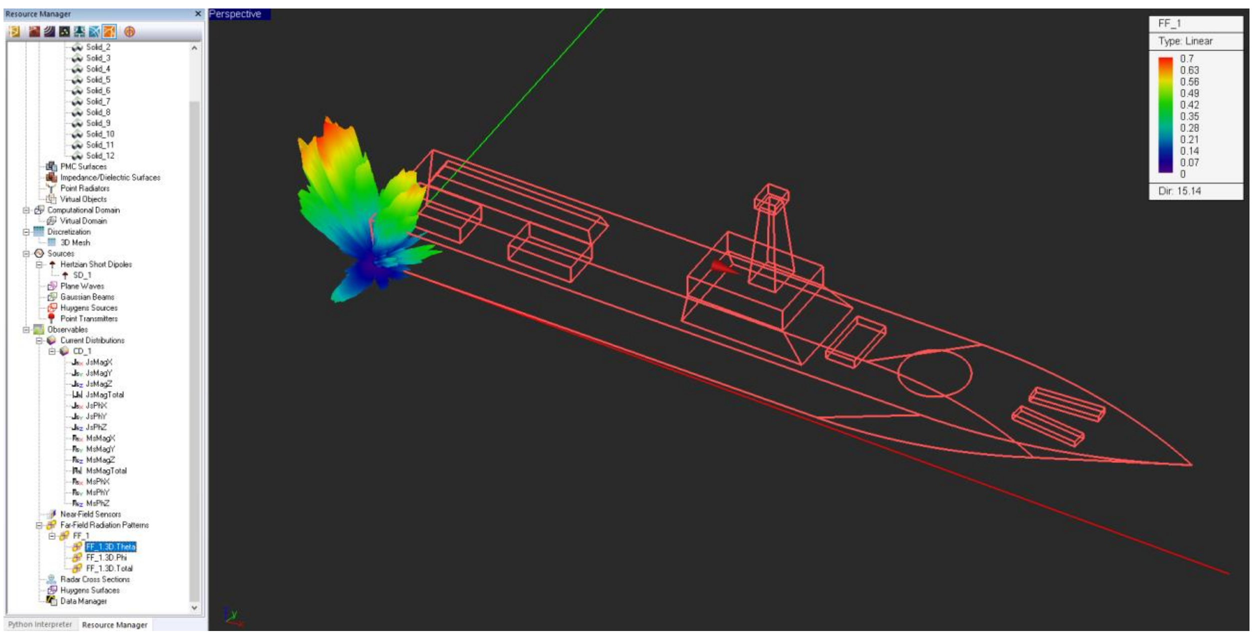


Figure 13. *The theta component of the 3D radiation pattern of the horizontal short dipole in the presence of the ship model.*

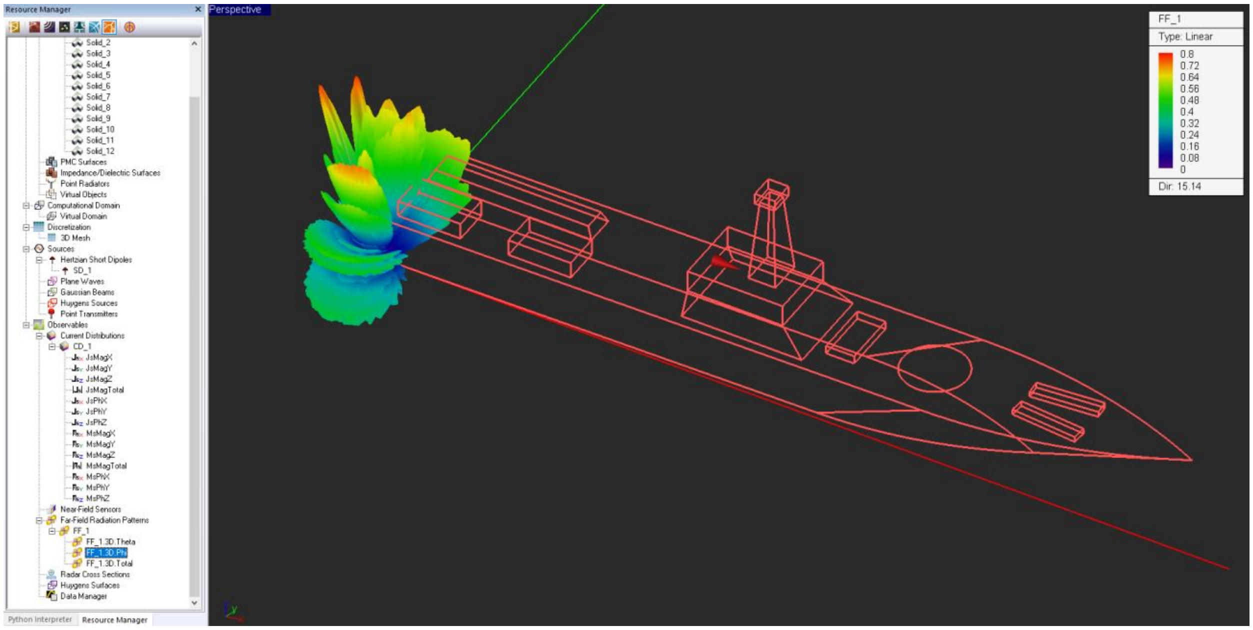


Figure 14. *The phi component of the 3D radiation pattern of the horizontal short dipole in the presence of the ship model.*

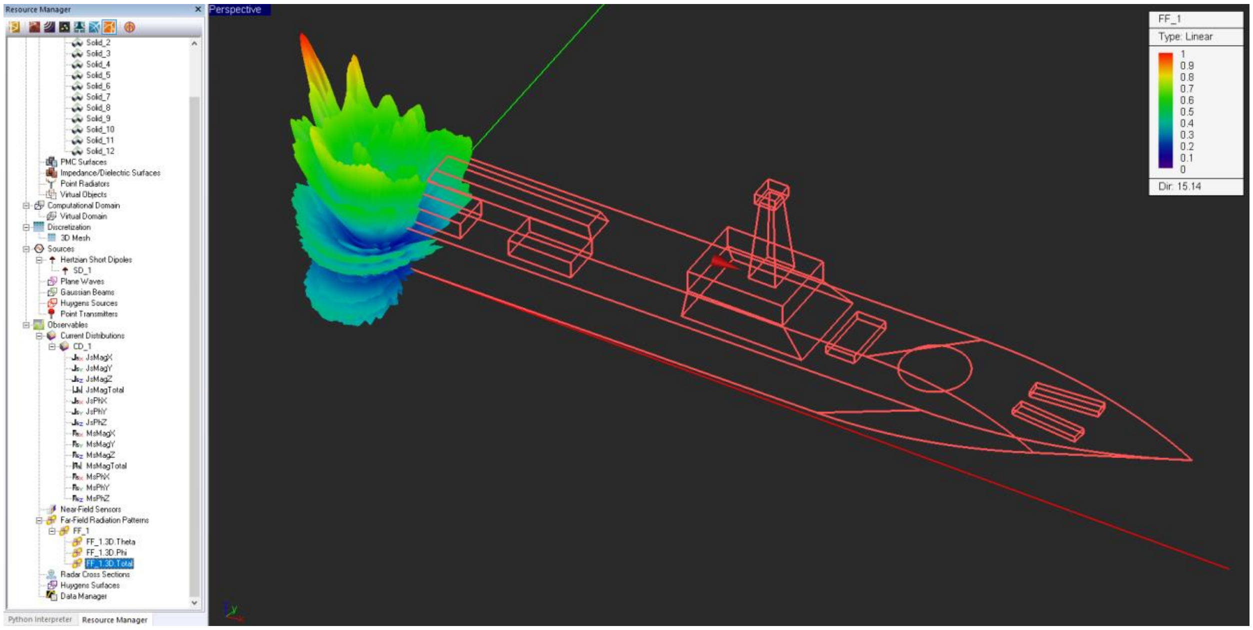


Figure 15. *The total 3D radiation pattern plot of the horizontal short dipole in the presence of the ship model.*

Figures 16-18 show the dB-scale 2D graphs of the radiation patterns in the XY, YZ and ZX planes plotted.

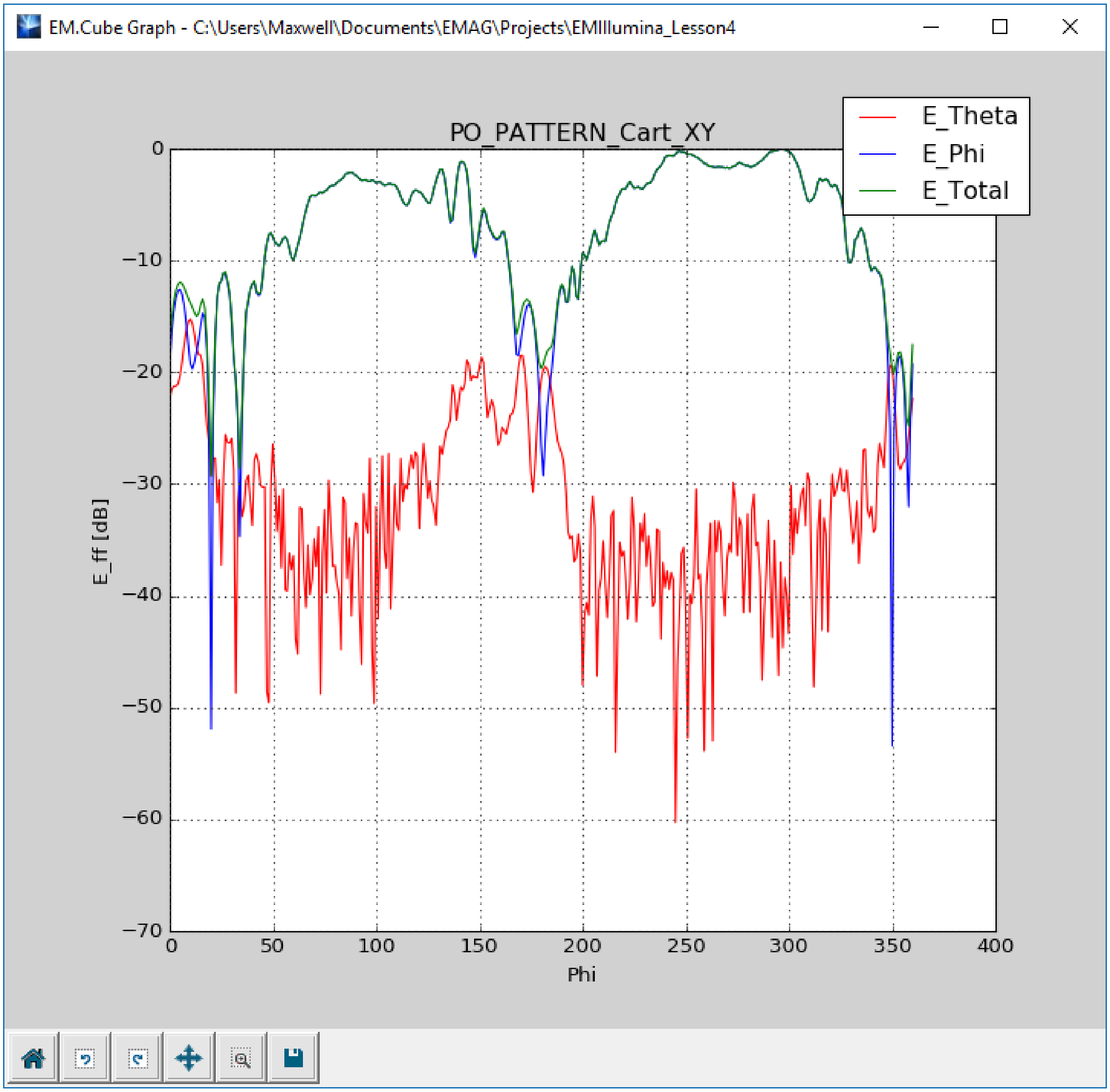


Figure 16. *2D dB-scale Cartesian graph of the XY-plane radiation pattern of the horizontal short dipole in the presence of the ship model.*

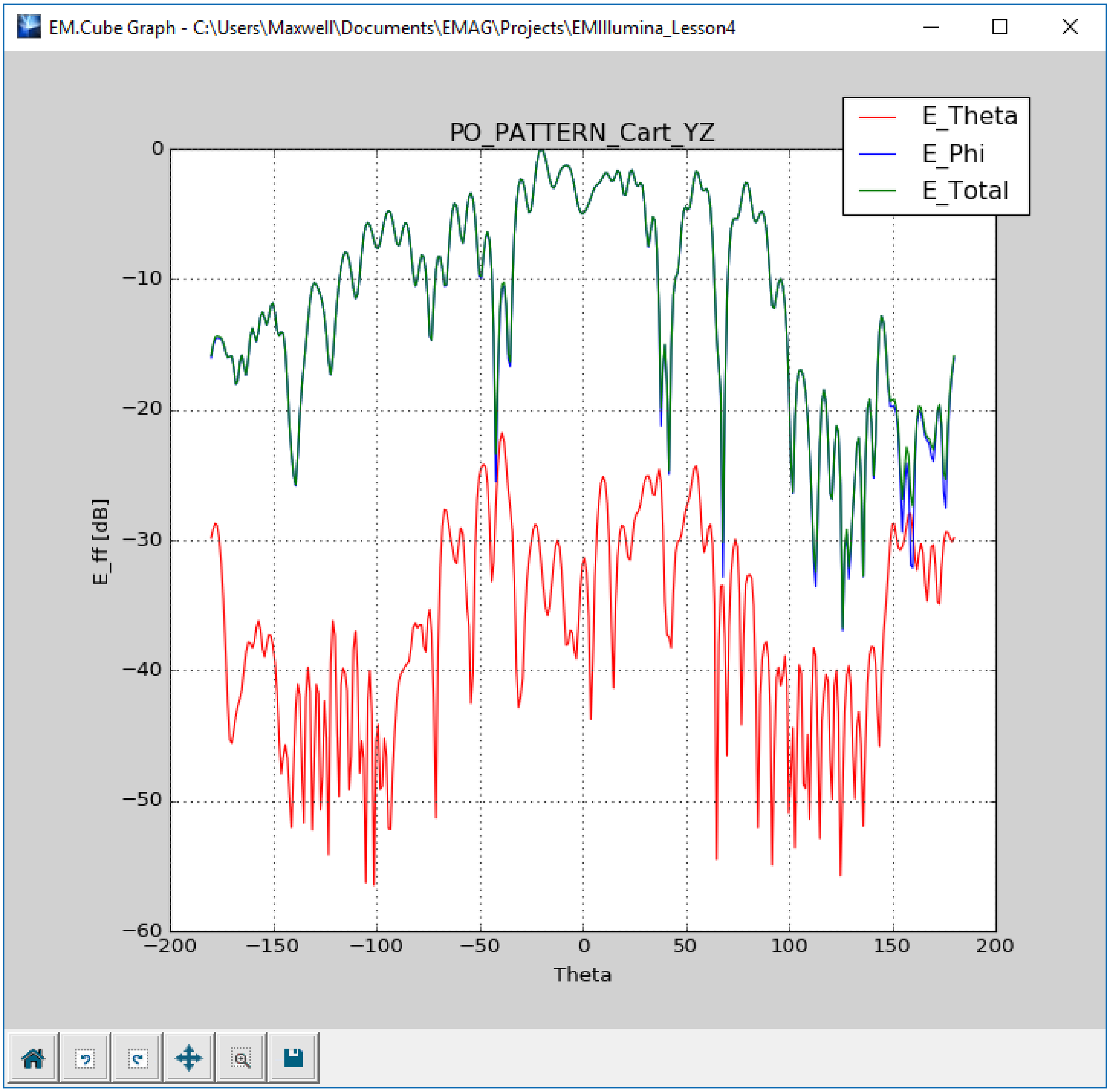


Figure 17. *2D dB-scale Cartesian graph of the YZ-plane radiation pattern of the horizontal short dipole in the presence of the ship model.*

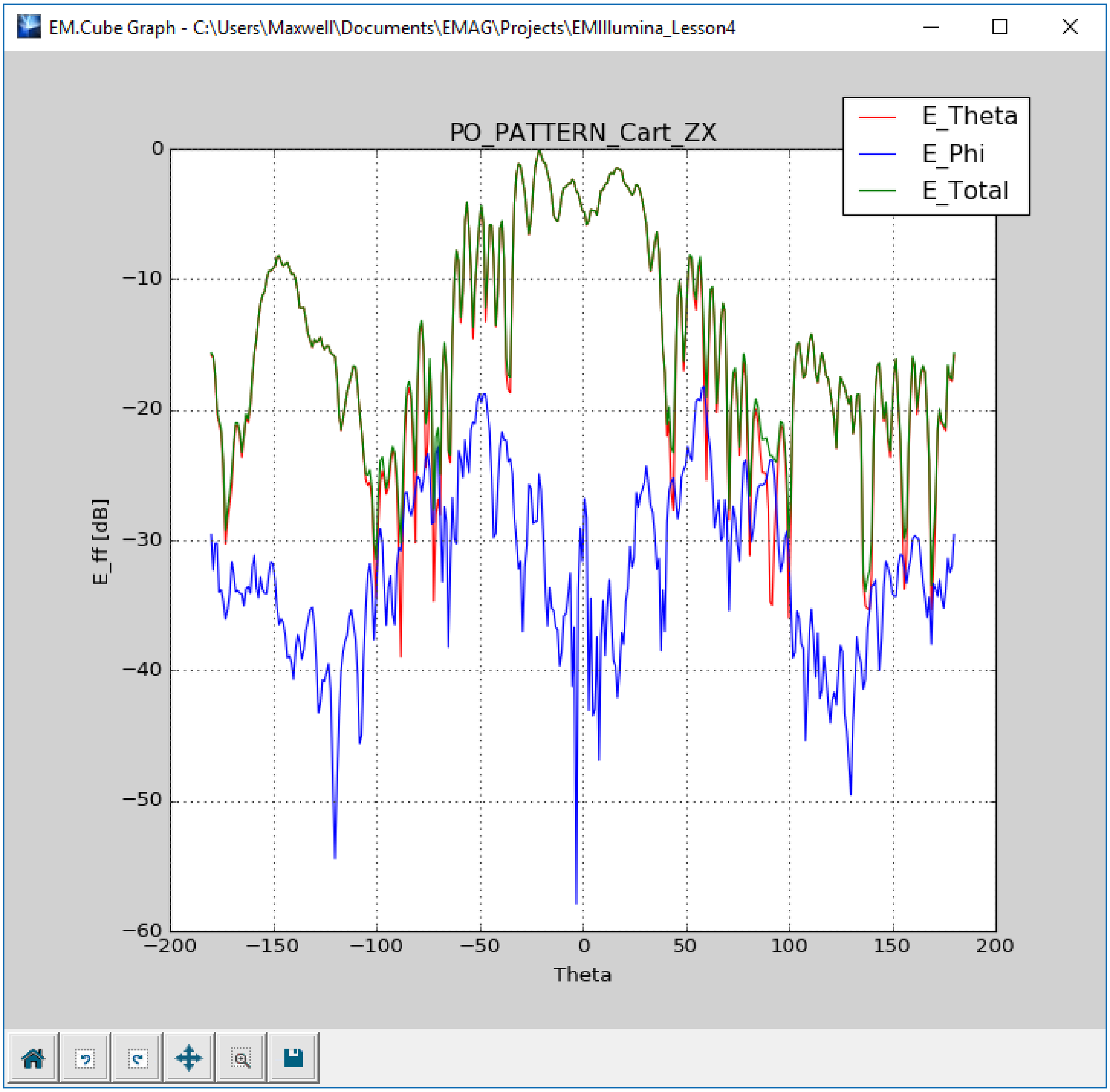


Figure 18. *2D dB-scale Cartesian graph of the ZX-plane radiation pattern of the horizontal short dipole in the presence of the ship model.*