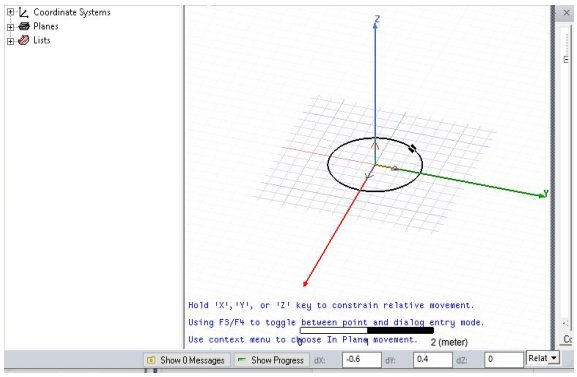
ANSYS HFSS RCS Simulation Instructions

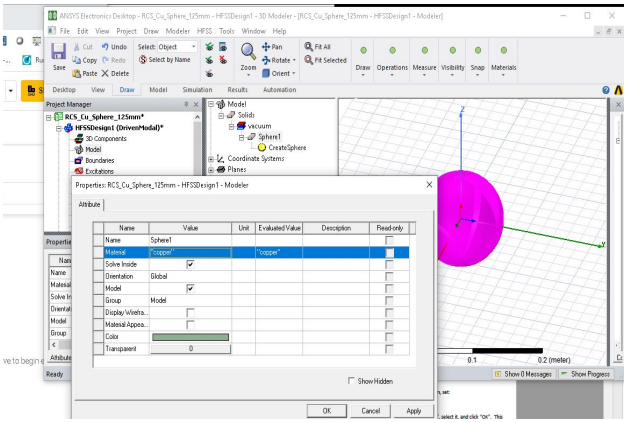
- Launch ANSYS HFSS from Start Menu or Icon
- Set Tool Options
  - On top menu bar, select Tools > Options > General Options
    - HFSS > Boundary Assignment
      - Check boxes that say “Use Wizards for data input when creating new boundaries” and “Duplicate Boundaries/mesh operations with geometry”
    - 3D Modeler > Drawing
      - Chex boxes that say “Edit properties of new primitives”

- Create and Save HFSS Design
  - On top menu bar, select **Project > Insert HFSS Design**
  - Select **File > Save As** and choose filename RCS_Cu_Sphere_125mm.aedt
- Set Solution Type and 3D Model
  - Select **HFSS > Solution Type**
    - Check Solution Type: Modal
    - Check Driven Options: Network Analysis
  - Select **Modeler > Units**
    - Select Meters
  - In the Modeler Toolbar, select **Materials**
    - Set default to Vacuum

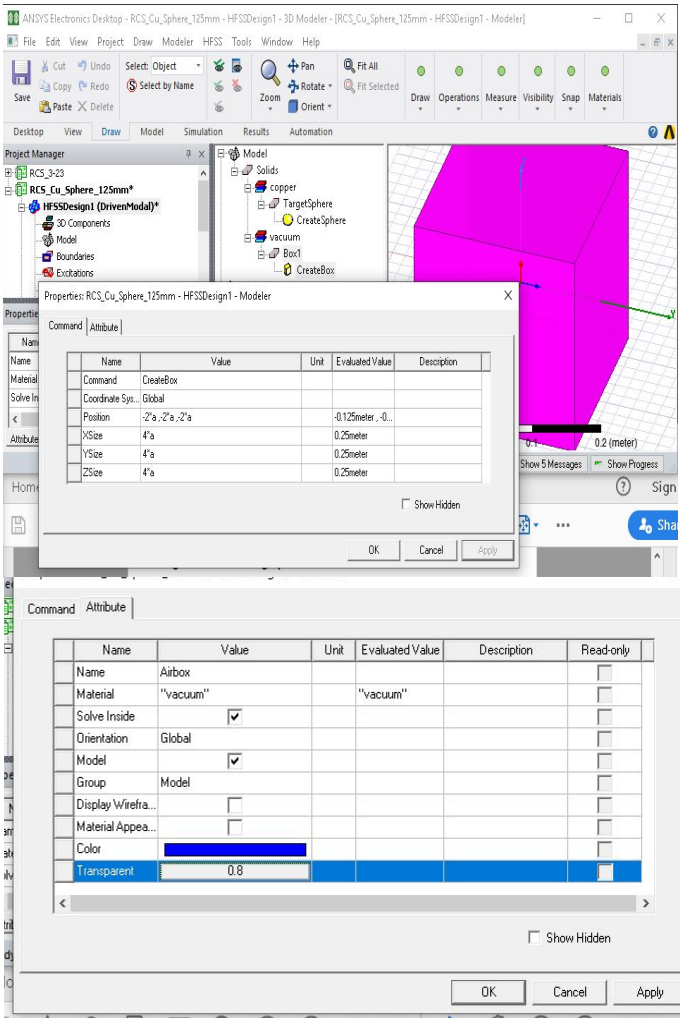
- Draw the Conducting Sphere
  - Select **Draw > Sphere**
    - Click on Origin of XYZ coordinates, then move mouse away from origin and click again to draw sphere
    - A **Properties** window should appear
      - Center Position: (0,0,0)
      - Radius: type ‘a’ as thevariable for radius
      - Unit Type: Length
      - Unit: meter
      - Value: 0.0625



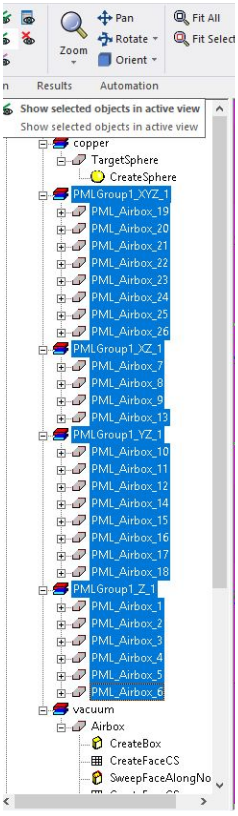
- Edit the Sphere Properties
  - In the modeler window, right-click **Sphere1 > Properties**
    - Name: TargetSphere
    - Material: “copper”
    - Color: Red



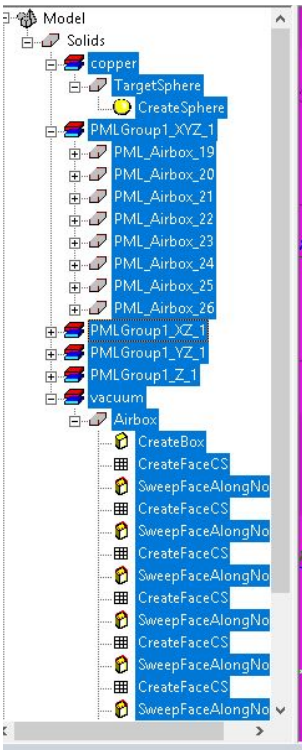
- Create the Airbox
  - Select **Draw > Box**
    - Draw 3D box anywhere in coordinate system
    - **Properties** window should come up again
      - Position: (-2*a, -2*a, -2*a)
      - XSize: 4*a
      - YSize: 4*a
      - ZSize: 4*a
  - In the Modeler Window, right click **Box1 > Properties > Attribute**
    - Name: Airbox
    - Material: Vacuum
    - Color: Blue
    - Transparent: 0.8

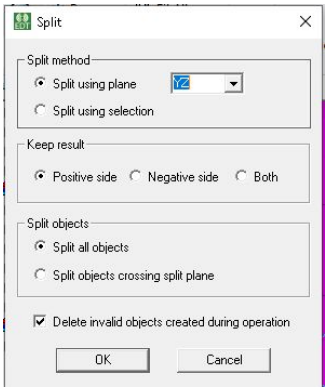


- Create PML (Perfectly Matched Layer)
  - A PML Box emulates an infinite vacuum or ideal anechoic chamber
  - In the Toolbar, select **Edit > Selection Mode > Faces**
  - **Edit > Select Objects > By Name**
    - Select **Airbox** then highlight all Faces and click OK
  - In the Toolbar, select **HFSS > Boundaries > PML Setup Wizard**
  - Check “Create PML Cover Objects On Selected Faces”
    - Uniform Layer Thickness : 0.250 meter (4*radius length)
  - Click **Next**
  - Check “PML Objects Accept Free Radiation”
    - Min Frequency: 0.04 GHz
    - Minimum Radiating Distance: 0.125 meter (2*radius length)
  - Click **Finish**
  - In Modeler Window, highlight all PMLGroup___ items
    - Click Green Eye up top to make visible

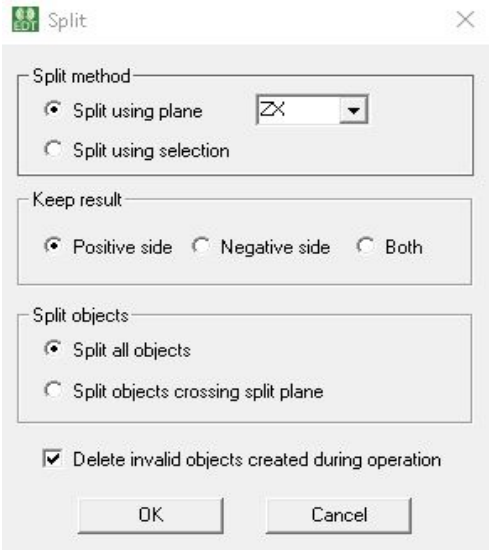


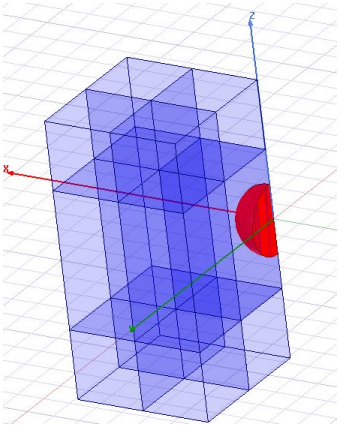
- Use symmetry to simplify solution
  - Because our target object is symmetrical, we can apply a symmetrical boundary condition on only a quarter of the sphere to reduce computation time
  - We will cut sphere, then set Perfect E and H boundaries on the appropriate sphere faces
  - In Modeler Window, highlight ALL Solids(include all items in drop-downs of PMLGroup_ objects)
    - In Toolbar, select **Modeler > Boolean > Split**
      - Split Plane: YZ
      - Keep Result: Positive Side
      - Splot Objects: Split all objects
      - Delete invalid objects



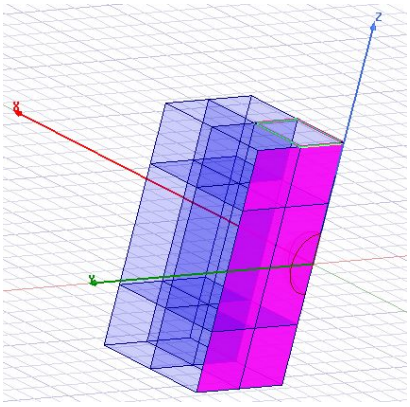


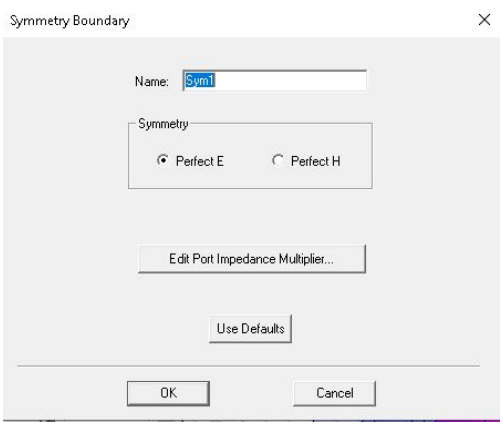
- Use Symmetry(continued)
  - In Modeler Window, highlight ALL Solids again (include all items in drop-downs of PMLGroup_ objects and new objects created from last split)
    - In Toolbar, select **Modeler > Boolean > Split**
      - Split Plane: ZX
      - Keep Result: Positive Side
      - Splot Objects: Split all objects
      - Delete invalid objects
  - You should now have a perfectly quartered sphere, Airbox, and PML Layer





- Assign Boundary Conditions (YZ)
  - Select all the Faces in the YZ Plane:
    - On the Toolbar, select **Edit > Selection Mode > Faces**
    - In the 3D Model Window, hold CTRL and select all 6 faces on the YZ Plane
    - On the Toolbar, select **HFSS > Boundaries > Assign > Symmetry**
      - Select the “Perfect E” Button





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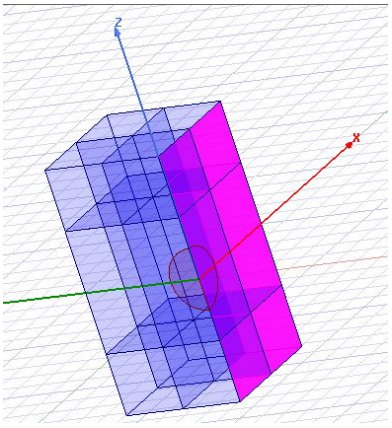
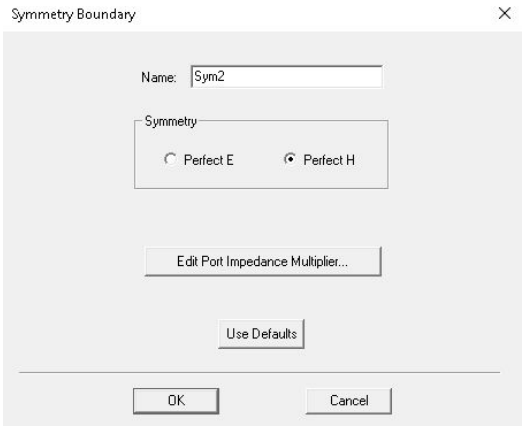
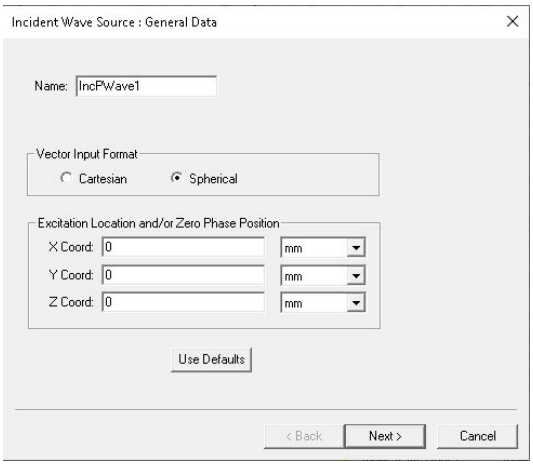
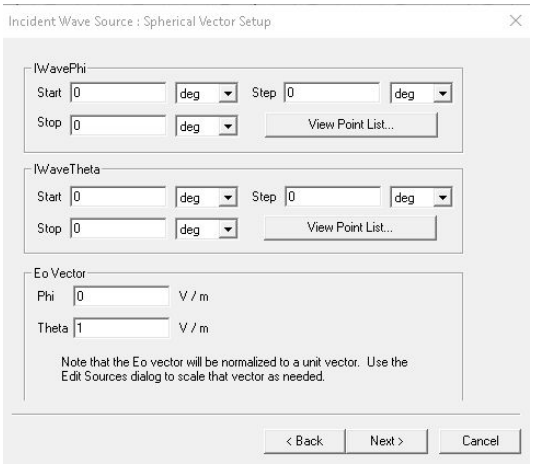
    - On the Toolbar, select **HFSS > Boundaries > Assign > Symmetry**
      - Select the “Perfect H” Button



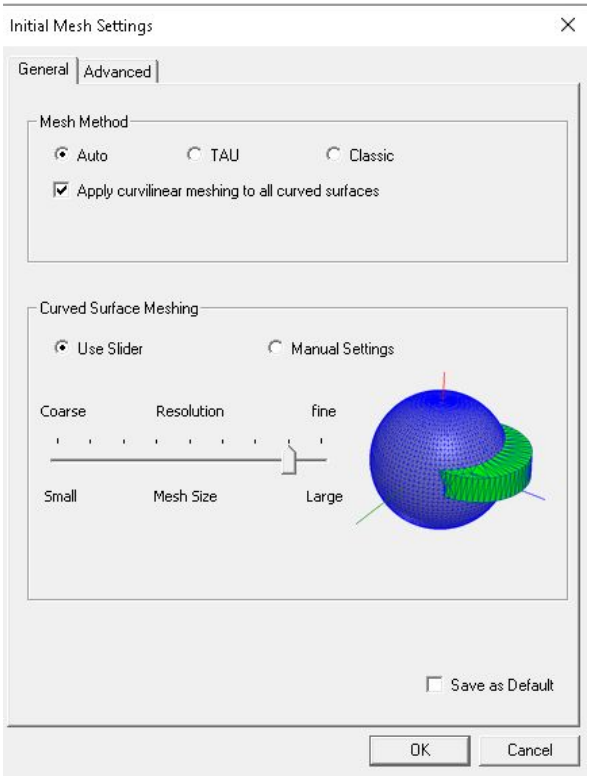


- Assign Plane Wave
  - On the Toolbar, select **HFSS > Excitations > Assign > Incident Wave > Plane Wave**
    - Vector Input Format: Spherical
  - Click Next
    - IWavePhi Start, Stop, Step: 0
    - IWaveTheta Start, Stop, Step: 0
    - Eo Vector
      - Phi: 0
      - Theta: 1
  - Click Next
    - Type of Plane Wave: Regular/Propagating
  - Click Finish

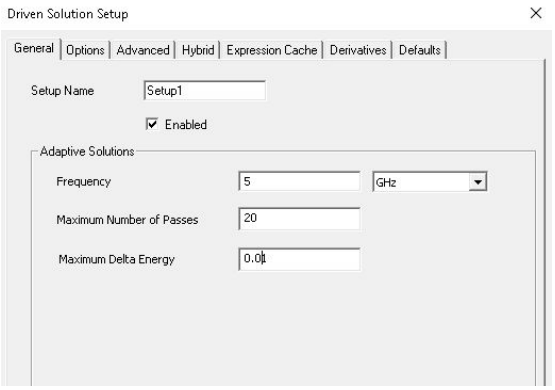


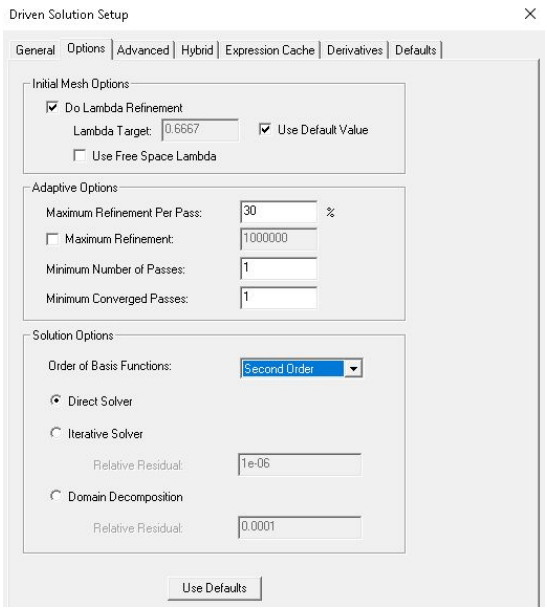


- Assign Meshing
  - On the Toolbar, select **HFSS > Mesh Operations > Initial Mesh Settings**
    - Check “Apply curvilinear meshing to all curved surfaces”
    - Set Mesh Size to Large/fine for greater accuracy at higher frequencies but longer computation time

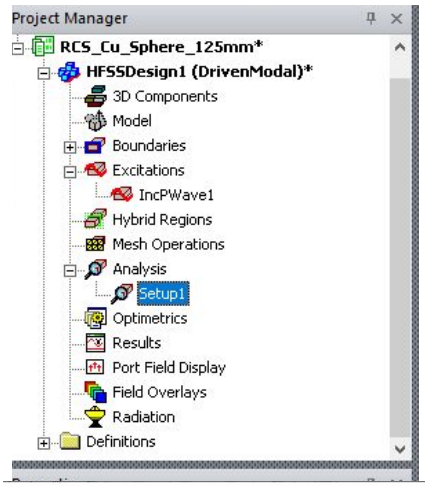


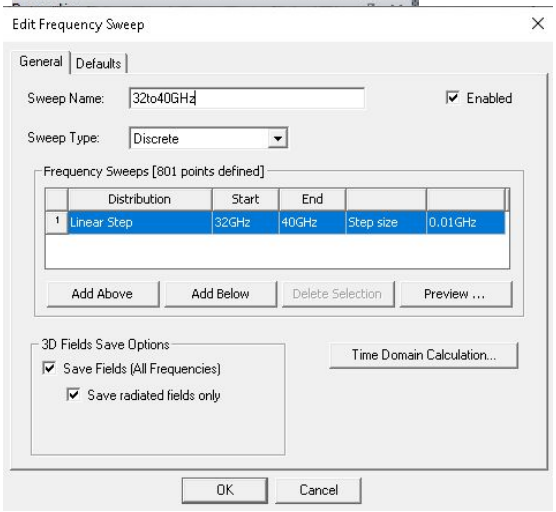
- Add Solution Setup
  - In the Toolbar, select **HFSS > Analysis Setup > Add Solution Setup**
    - Frequency: 5 GHz (This is not the excitation frequency)
    - Maximum Number of Passes: 20
    - Maximum Delta Energy: 0.01
  - Select Options tab
    - Order of Basis Functions: Second Order



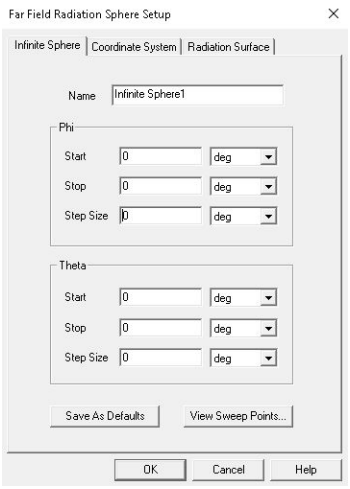


- Add Solution Setup
  - In the Project Manager window, expand the HFSSDesign1 dropdown menu
  - Expand “Analysis”
  - Highlight “Setup1”
    - In the Toolbar, select **HFSS > Analysis Setup > Add Frequency Sweep**
      - Sweep Name: 32to40GHz
      - Sweep Type: Discrete
      - Distribution: Linear Step
      - Start: 32 GHz
      - End: 40 GHz
      - Step Size: 0.01 GHz
      - Check “Save Radiated Field Only” box

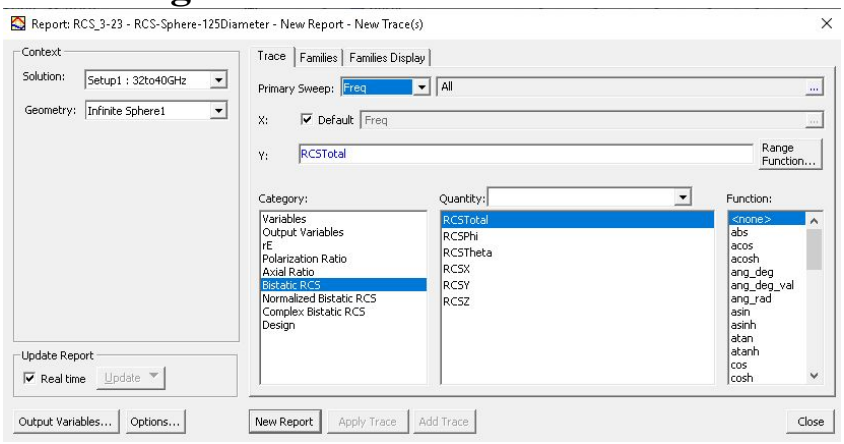




- Add Far-Field Setup
  - In the Toolbar, select **HFSS > Radiation > Insert Far Field Setup > Infinite Sphere**
    - Phi Start, Stop, Step Size: 0, 0, 0
    - Theta Start, Stop, Step Size: 0, 0, 0



- Add Plot
  - In the Toolbar, select **HFSS > Results > Create Far Fields Report > Rectangular Plot**
    - Primary Sweep: Freq
    - Category: Bistatic RCS
    - Quantity: RCSTotal
    - Click New Report



- Save RCS Data for Processing
  - Last step should have resulted in a Plot of RCS(in meters^2) as a function of Frequency
  - Right click plot to Export as image and/or .csv file in desired location