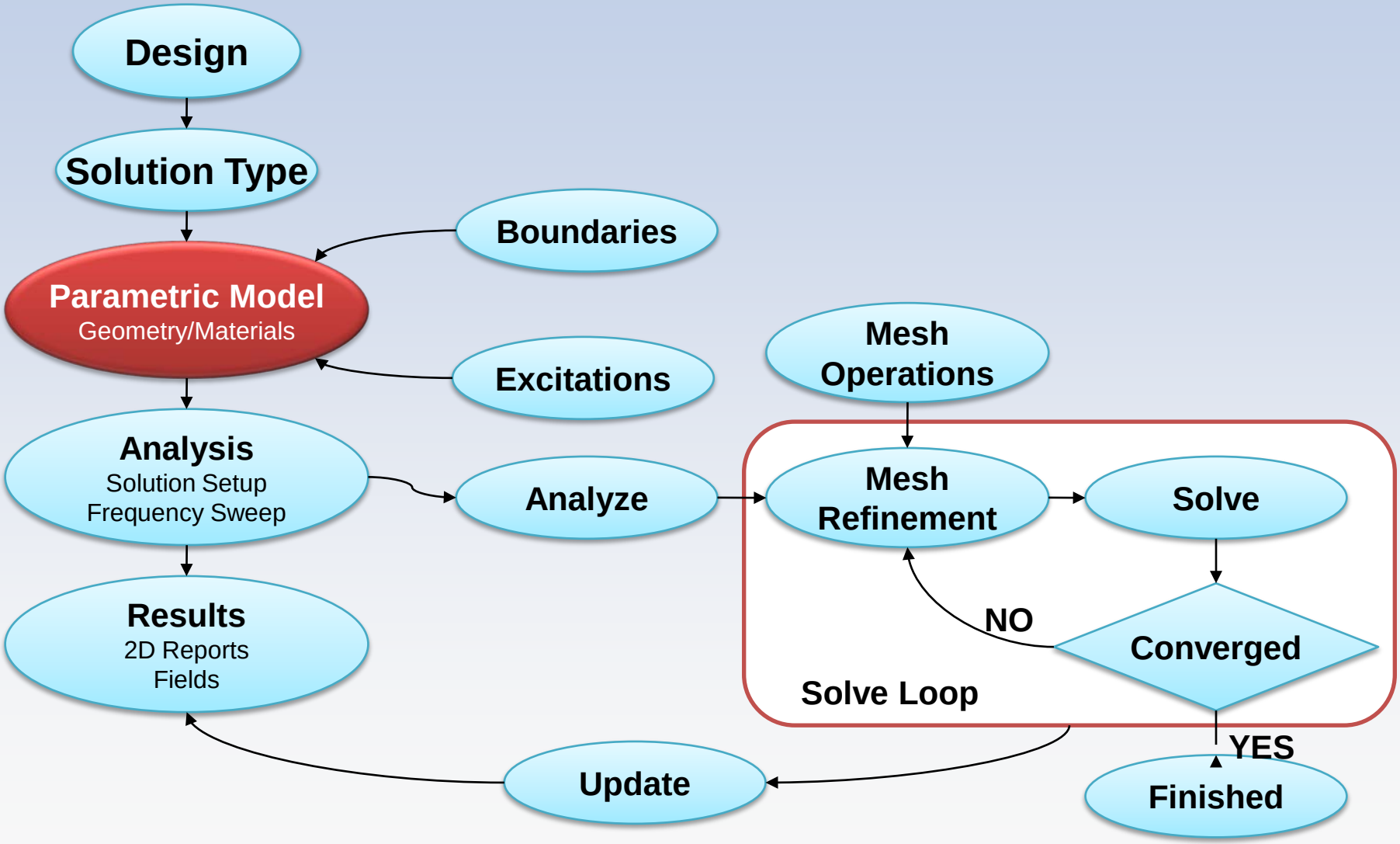
ANSYS®

HFSS 基础培训教程

建模、预处理

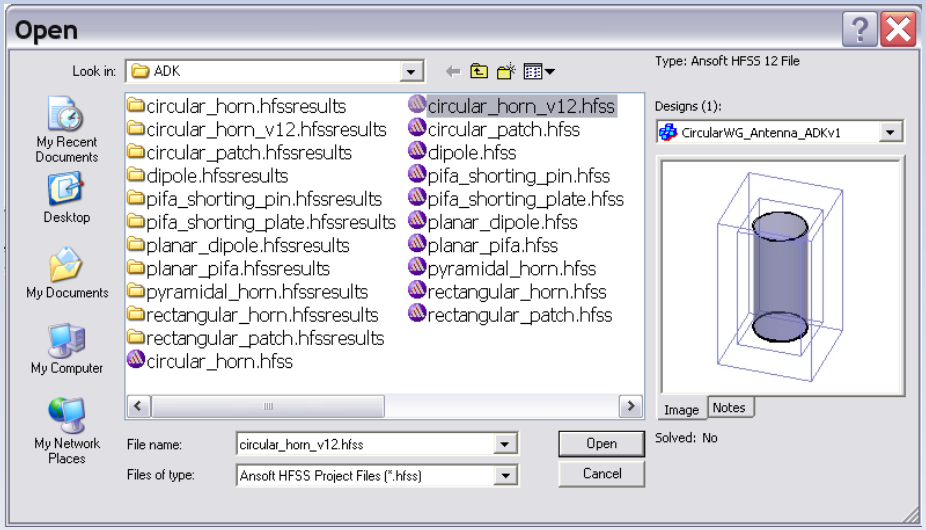
ANSYS 中国

HFSS设计流程

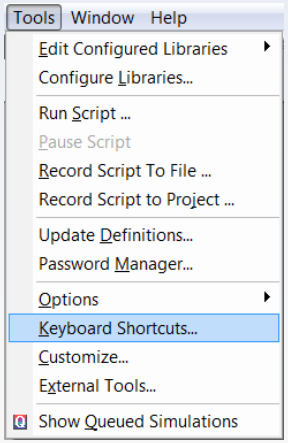


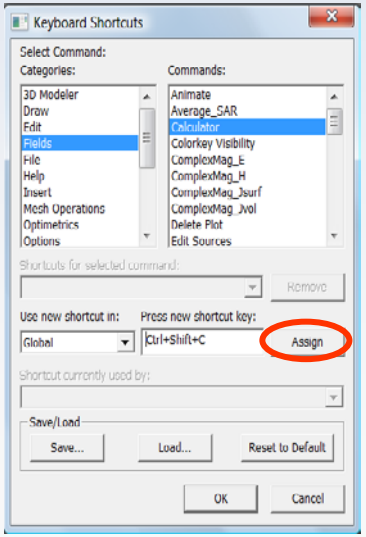
桌面增强功能

- 模型预览 New



- 用户自定义键盘快捷键 New

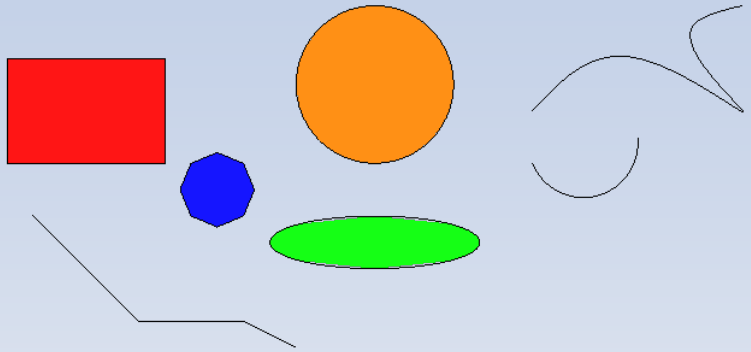




基本建模

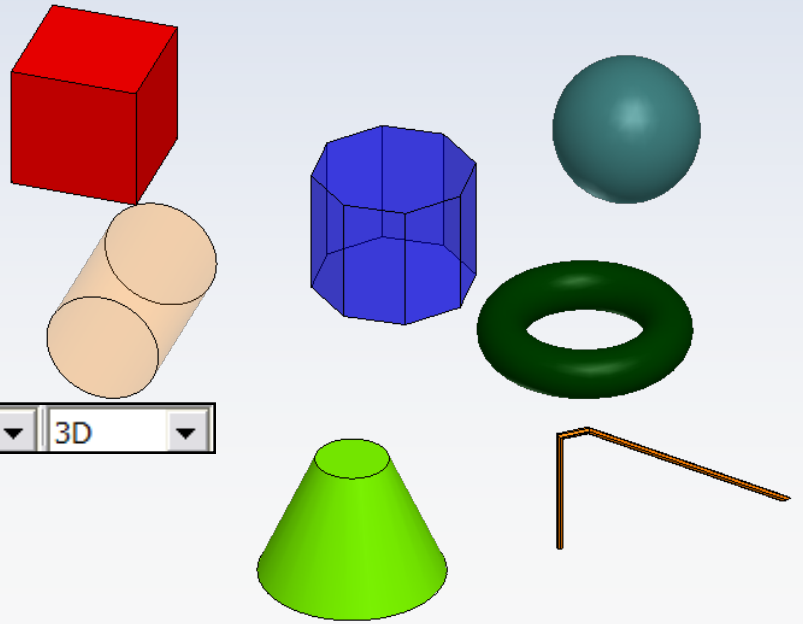
2D物体绘制

Line, Spline, Arc, Equation Based Curve,
Rectangle, Ellipse, Circle, Regular Polygon,
Equation Based Surface



3D 物体绘制

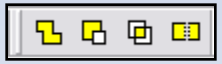
Box, Cylinder, Regular Polyhedron, Cone,
Sphere, Torus, Helix, Spiral, Bond Wire



工具栏：2D 物体　　工具栏：3D 物体

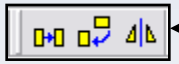
建模——布尔操作、模型变换

- ***Modeler > Boolean >***
  - **Unite** – combine multiple primitives
    - Unite disjoint objects (Separate Bodies to separate)
  - **Subtract** – remove part of a primitive from another
  - **Intersect**– keep only the parts of primitives that overlap
  - **Split** – break primitives into multiple parts along a plane (XY, YZ, XZ)
  - **Split Crossing Objects** – splits objects along a plane (XY, YZ, XZ) only where they intersect
  - **Separate Bodies** – separates objects which are united but not physically connected into individual objects


Toolbar: Boolean

- ***Modeler > Surfaces > Move Faces* – Resize or Reposition an objects face along a normal or vector.**

- ***Edit > Arrange >***
  - **Move** – Translates the structure along a vector
  - **Rotate** – Rotates the shape around a coordinate axis by an angle
  - **Mirror** – Mirrors the shape around a specified plane
  - **Offset** – Performs a uniform scale in x, y, and z.

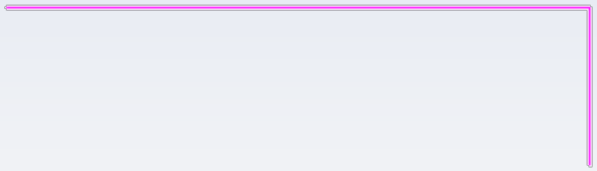

Toolbar: Arrange

- ***Edit > Duplicate >***
  - **Along Line** – Create multiple copies of an object along a vector
  - **Around Axis** – Create multiple copies of an object rotated by a fixed angle around the x, y, or z axis
  - **Mirror** - Mirrors the shape around a specified plane and creates a duplicate

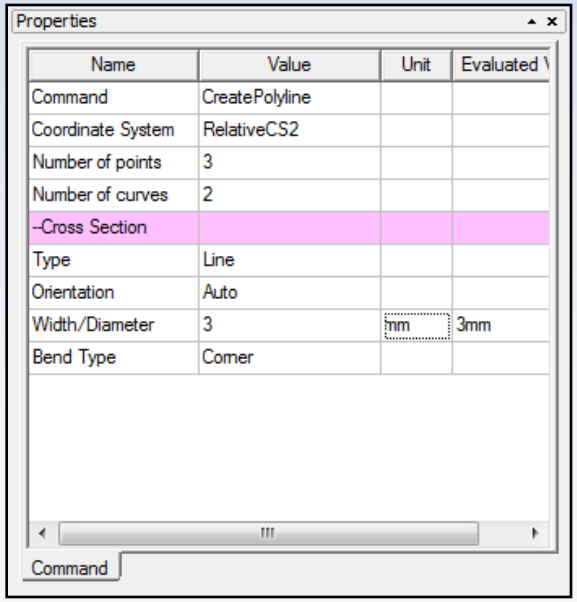
- ***Edit > Scale* – Allows non-uniform scaling in the x, y, or z direction**


Toolbar: Duplicate

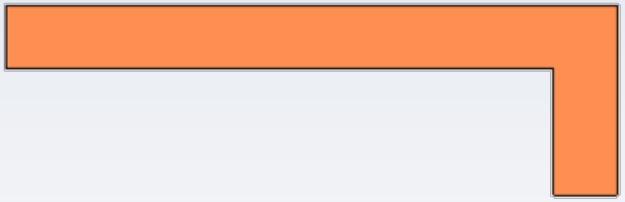
- **Polyline Cross Section** New
  - Choose Cross Section Type and Size
    - **Type**: Line, Rectangle, Circle
    - Size can be a variable
  - Section is automatically swept along the polyline



1. Create a Polyline



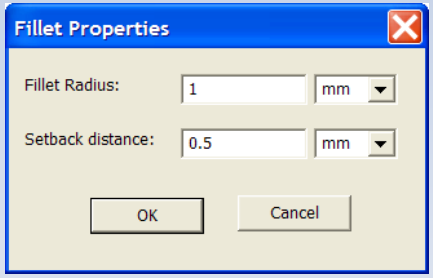
2. Set Cross Section Property



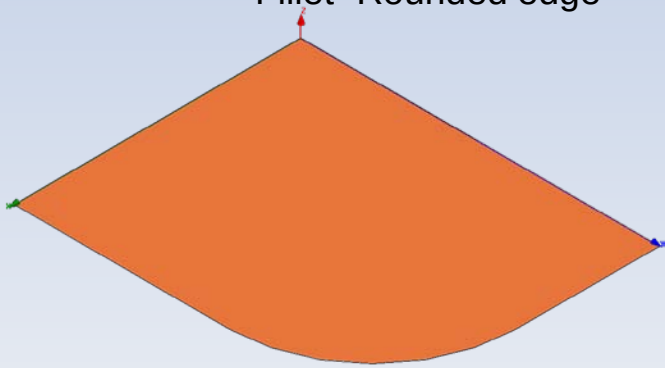
3. Polyline with Cross Section Property

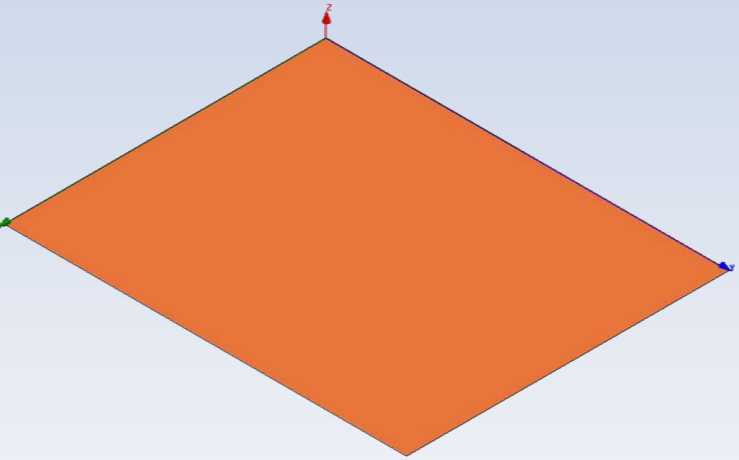
倒角和圆角

- **Create Chamfers and Fillets on 3D or 2D Objects**
  - Select a vertex graphically and choose the menu item:
    - Fillet or Chamfer

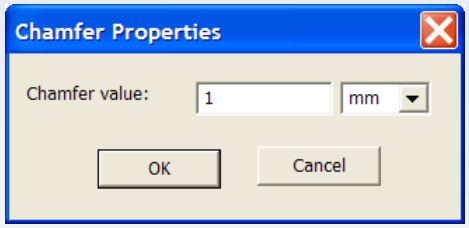


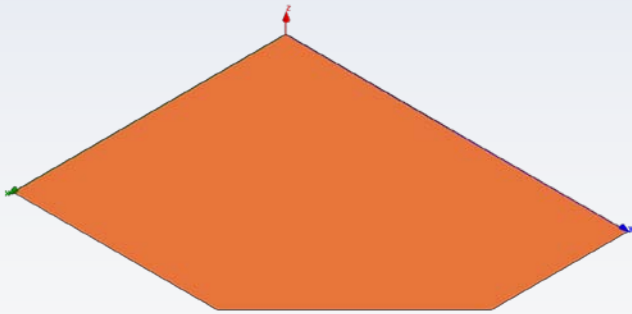
Fillet- Rounded edge





Original

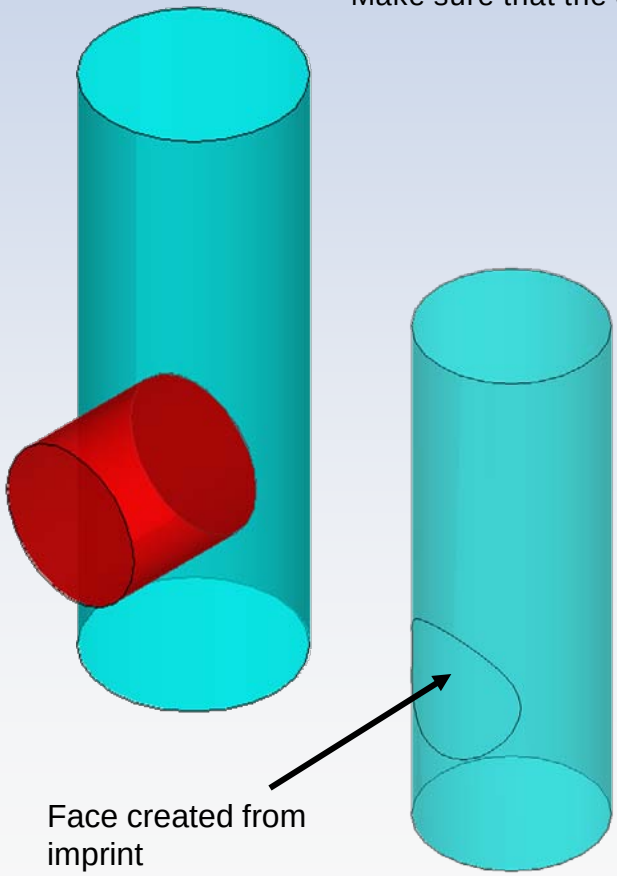




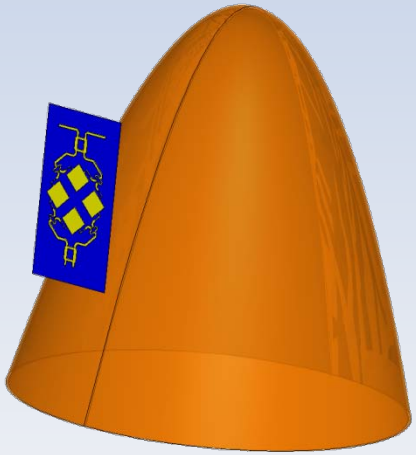
Chamfer - 45 degree cut

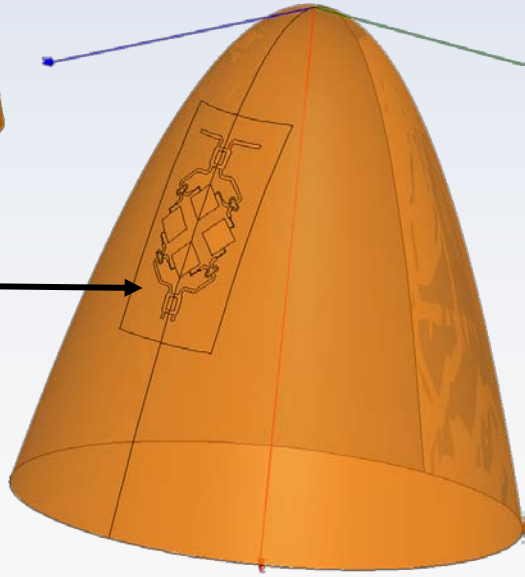
Imprint/Imprint Projection

- **Imprint** New
  - **Projection**
    - Patch Antenna Array Imprinted on a Nosecone
      - Results in Faces of original object imprinted
      - Make sure that the distance selected is greater than the distance between the antenna and nosecone



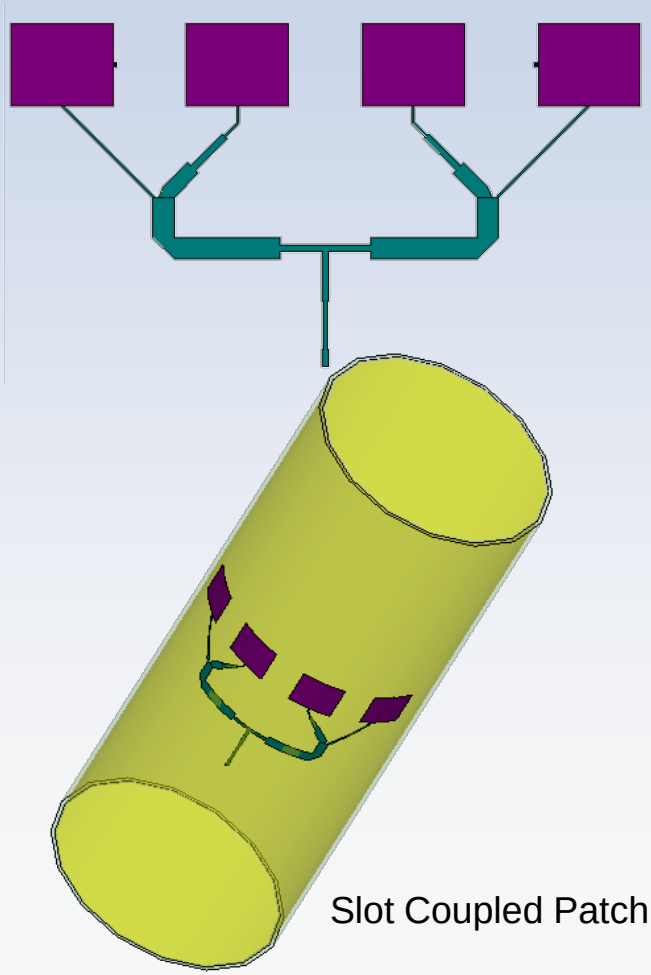
Face created from imprint

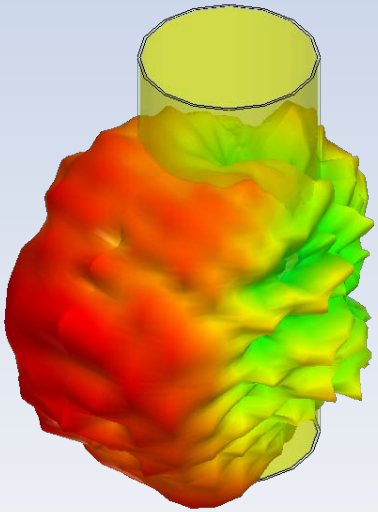


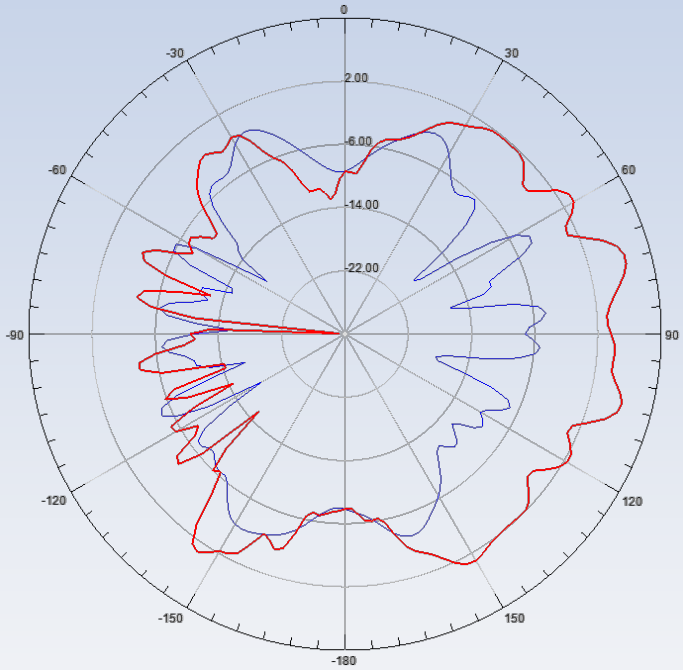


Face created from Imprint projection

- **Geometry Wrap** New
  - Wrap a 2D sheet on an arbitrary geometry

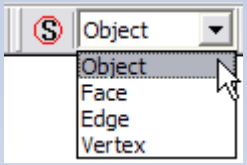


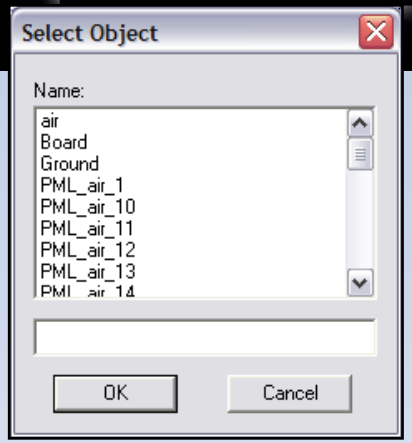




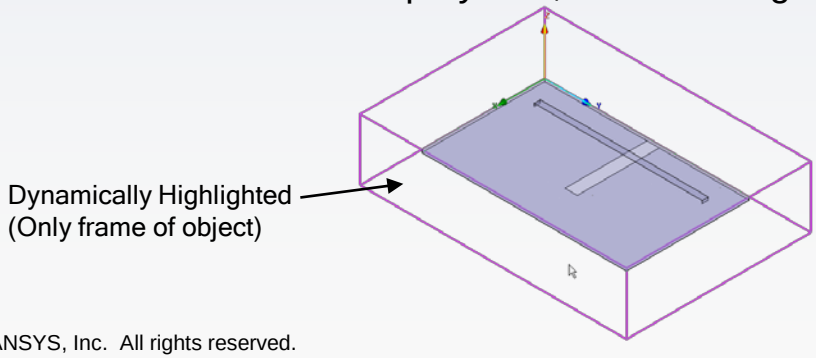
Slot Coupled Patch Array wrapped on a cylinder

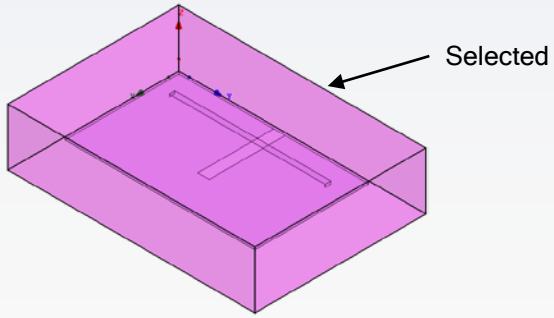
Modeler - Selection





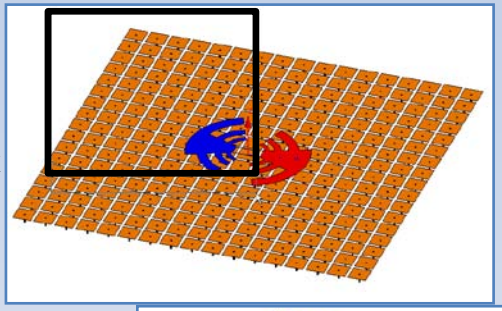
- **Selection Type**
  - Object (Default)、Face、Edge、Vertex
- **Selection Modes**
  - All Objects、All Visible Object、**By Name**
- **Highlight Selection Dynamically**
  - – By default, moving the mouse pointer over an object will dynamically highlight the object for selection. To select the object simply click the left mouse button.
  - **Multiple Object Selection** – Hold the CTRL key down to graphically select multiple objects
  - **Next Behind** – To select an object located behind another object, select the front object, press the b key to get the next behind. Note: The mouse pointer must be located such that the next behind object is under the mouse pointer.
  - To Disable: Select the menu item ***Tools > Options > 3D Modeler Options***
    - From the Display Tab, uncheck Highlight selection dynamically

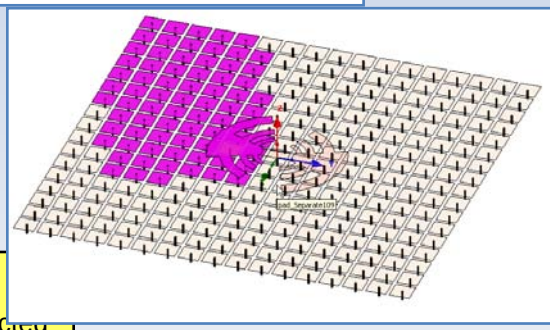


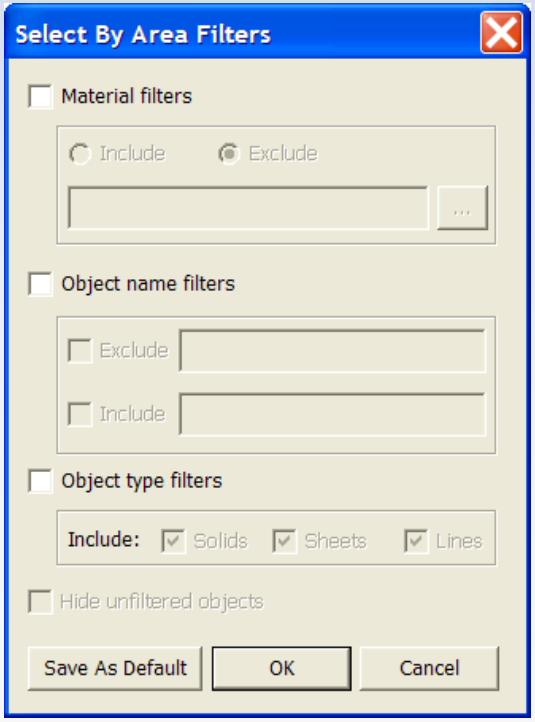


Enhanced Selection Options

- **Enhanced Selection Options** New
  - **Select By Area**
    - Click and drag to rubber-band select
      - Right-to-left selects all objects in passing through bounding box
      - Left-to-right select all objects enclosed by bounding box
  - **Select By Variable**
    - Helps find objects tied to variables
      - Select Variable and Click OK to highlight geometry

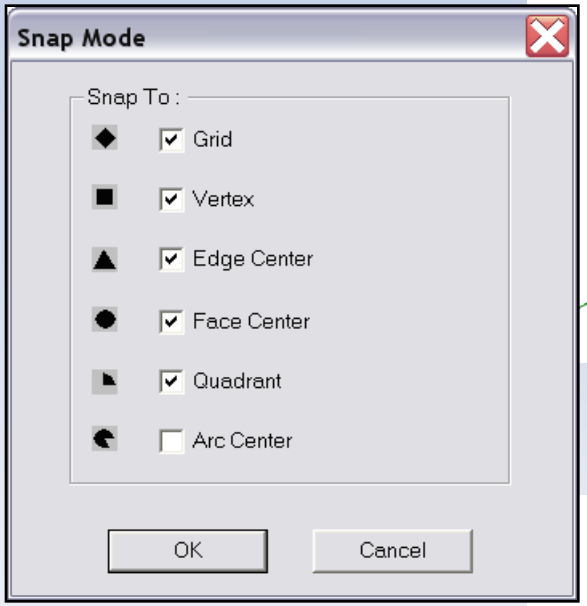


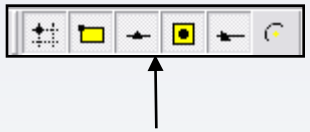




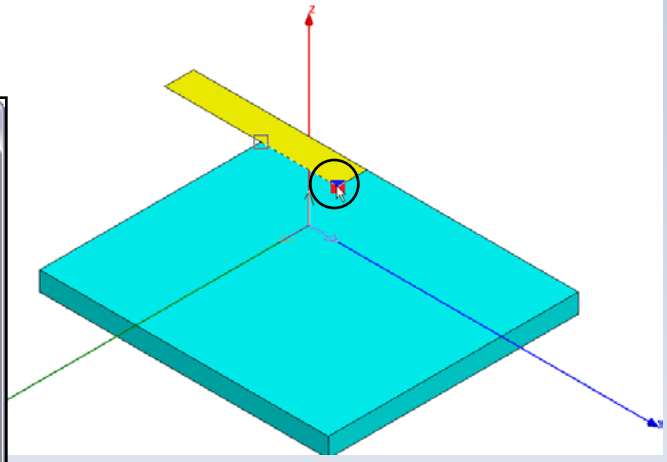
- Select By Area
  - By default, only items with external surfaces are selected
- Material filters
  - Enable the Include and Exclude radio buttons
- Object name filters
  - Enable the Exclude and Include check boxes
- Object type filters
  - Enable the check boxes for including Solids, Sheets, and/or Lines
- Hide unfiltered objects
  - Makes unfiltered objects transparent after selection

Modeler – Moving Around

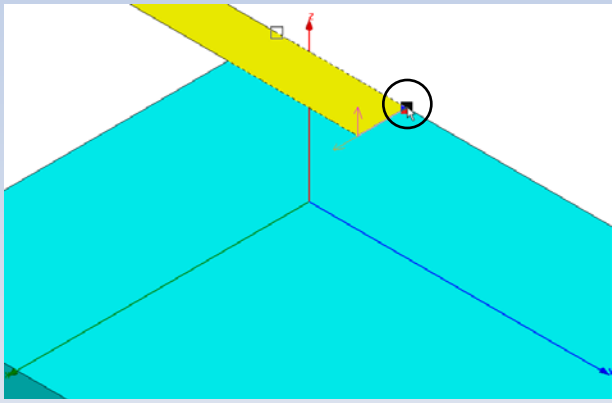




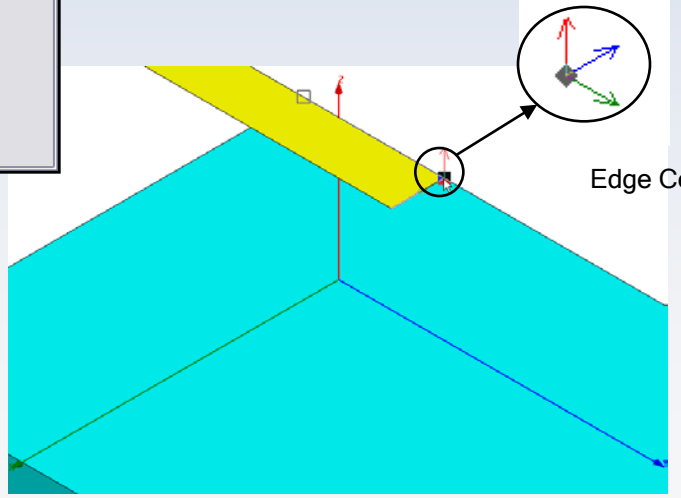
Toolbar: Snap Mode



Step 1: Start Point

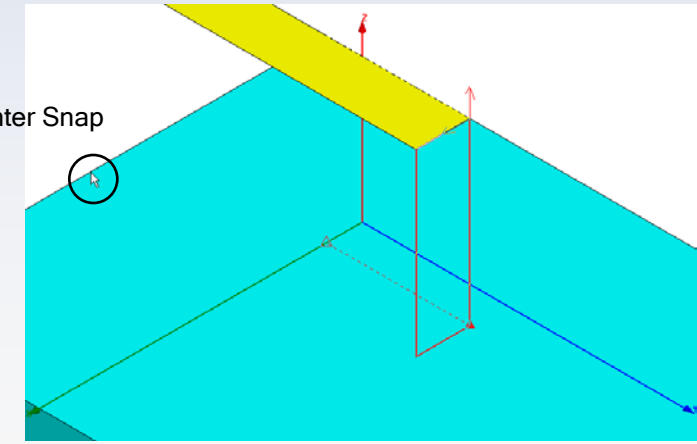


Step 2: Hold X key and select vertex point



Edge Center Snap

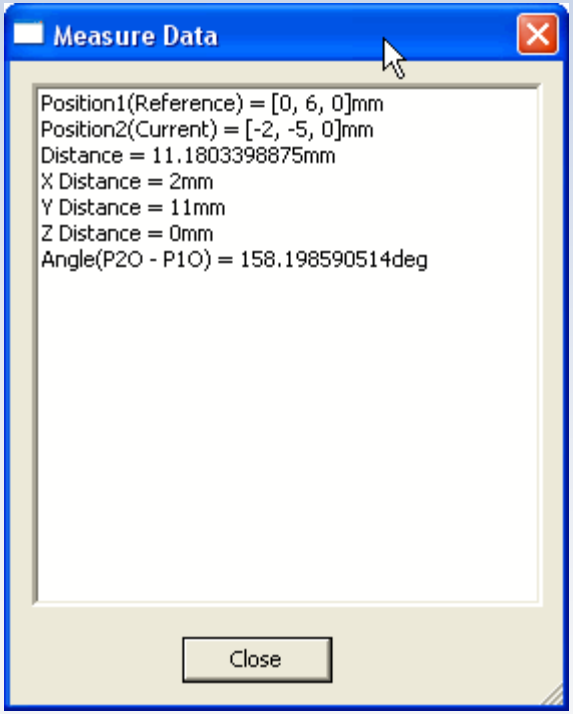
Step 3: CTRL+Enter Keys set a local reference



Step 4: Hold Z key and set height

Modeler – Measure

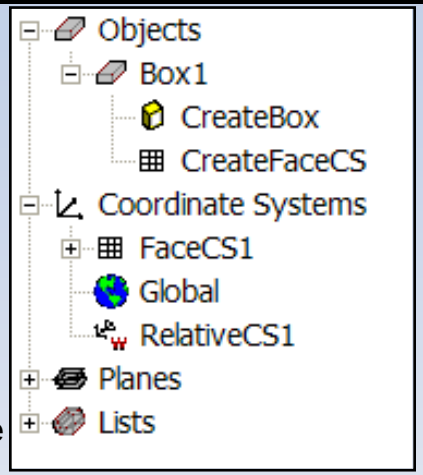
- ***Modeler > Measure >***
  - Position – Points and Distance
  - Length – Edge Length
  - Area – Surface Area
  - Volume – Object Volume

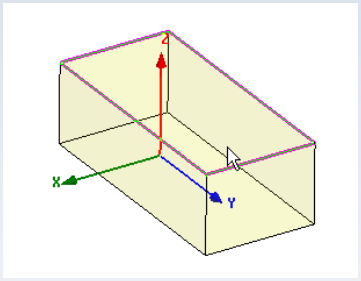


Modeler – Coordinate System

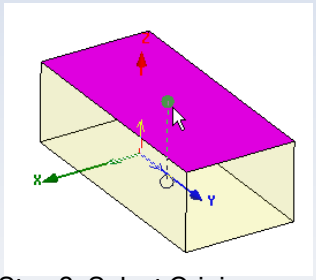
- **Can be Parameterized**
- **Working Coordinate System**
  - Currently selected CS. This can be a local or global CS
- **Global CS**
  - The default fixed coordinate system
- **Relative CS**
  - User defined local coordinate system.
    - Offset
    - Rotated
    - Both
- **Face CS (setting available to automatically switch to face coordinate system in the**

Toolbar: Coordinate System

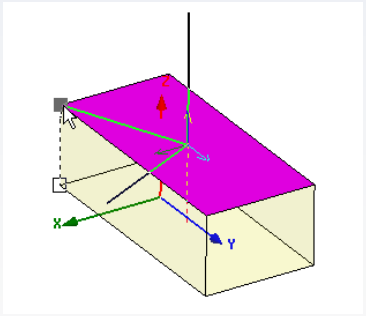




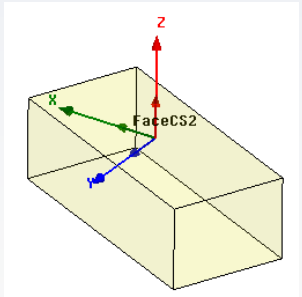
Step 1: Select Face



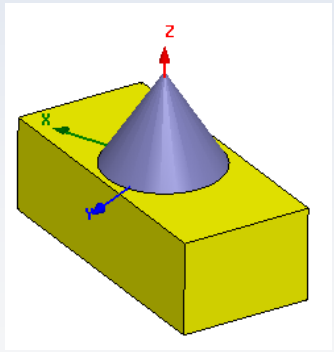
Step 2: Select Origin



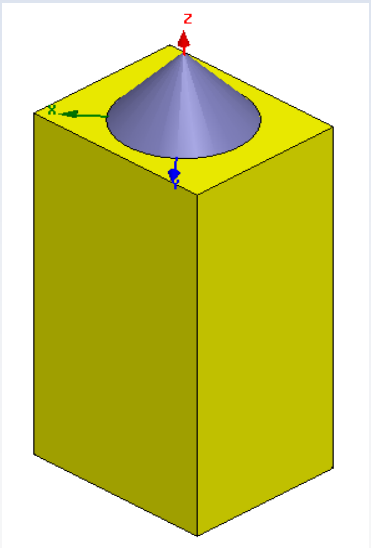
Step 3: Set X-Axis



New Working CS



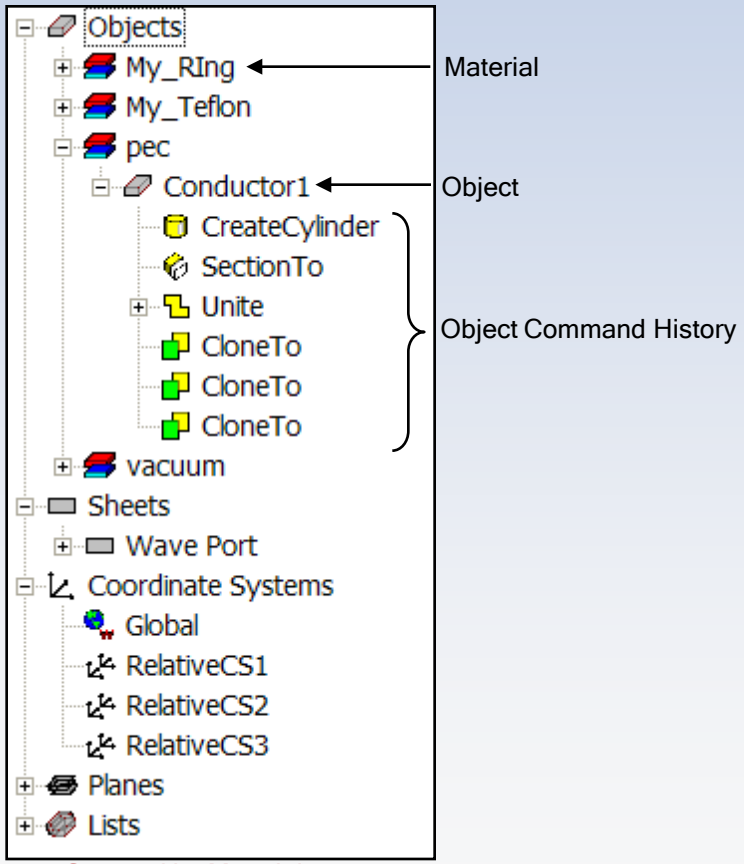
Cone created with Face CS



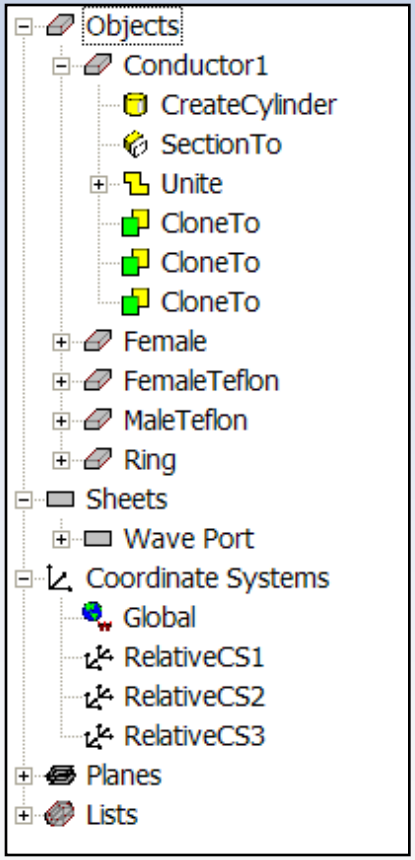
Change Box Size and Cone is automatically positioned with the top face of the box

Modeler – Model Tree

- **Select menu item *Modeler > Group by Material***



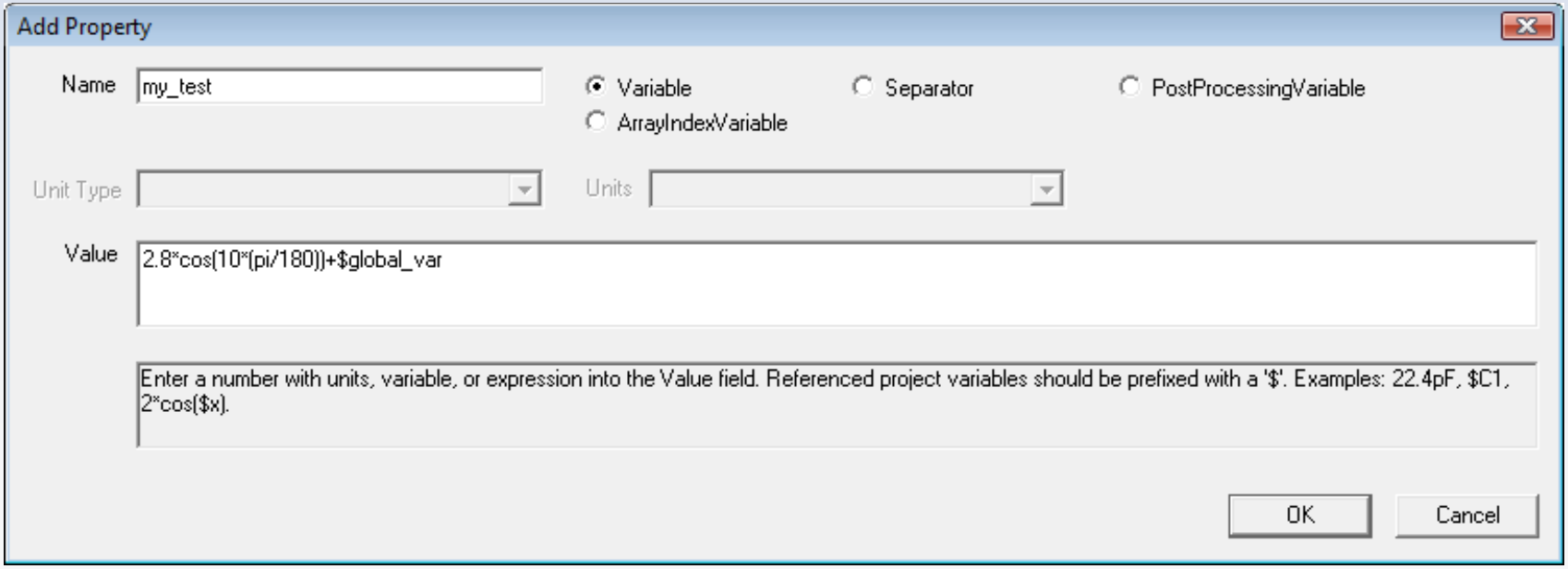
Grouped by Material



Object View

参数化建模

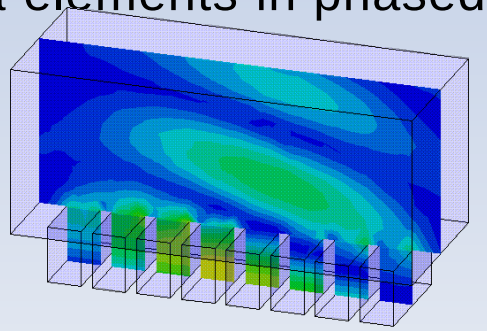
- **Parametric Technology**
  - Dynamic Edits - Change Dimensions
  - Add Variables
    - Project Variables (**Global**), Design Variables (**Local**), or Post Processing Variables
    - Animate Geometry
    - Include Units – Default Unit is meters
  - Supports mixed Units



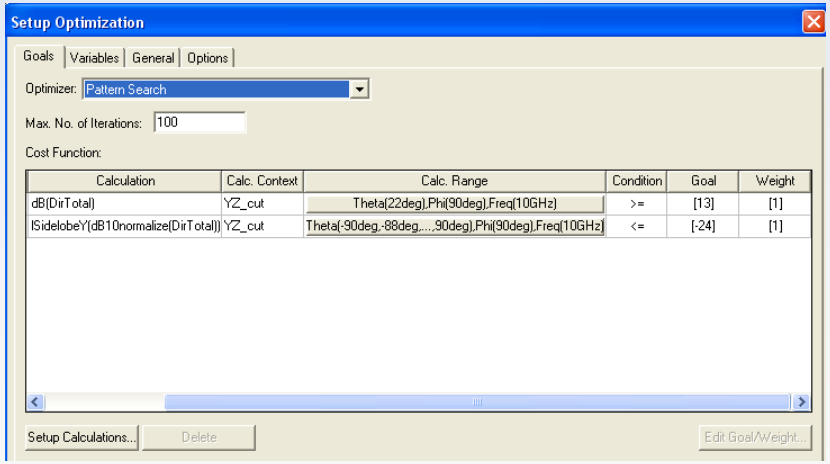
Post-Processing Variables

- **Post Processing Variables** New
  - Can be modified without re-simulating the model
  - Can optimize complex weights of antenna elements in phased array

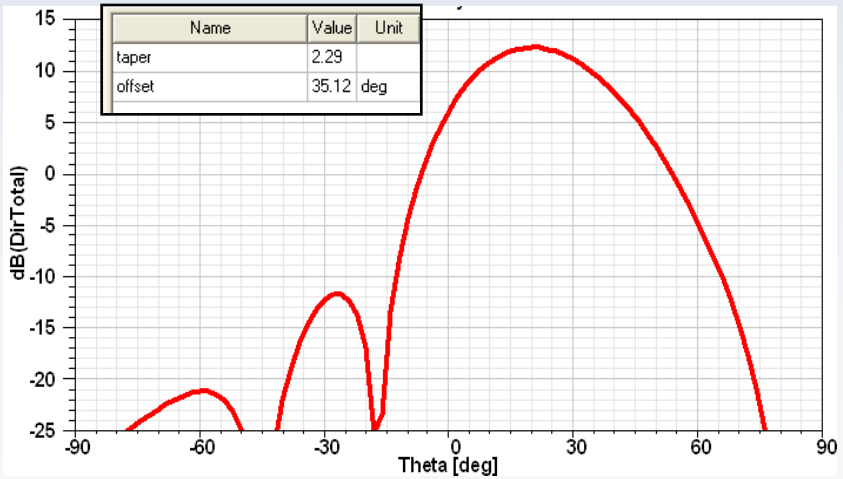
Scaling Factor	Offset Phase
(cos(70deg))^taper	3.5*offset
(cos(50deg))^taper	2.5*offset
(cos(30deg))^taper	1.5*offset
(cos(10deg))^taper	0.5*offset
(cos(10deg))^taper	-0.5*offset
(cos(30deg))^taper	-1.5*offset
(cos(50deg))^taper	-2.5*offset
(cos(70deg))^taper	-3.5*offset



Optimization of Phased Array Excitations

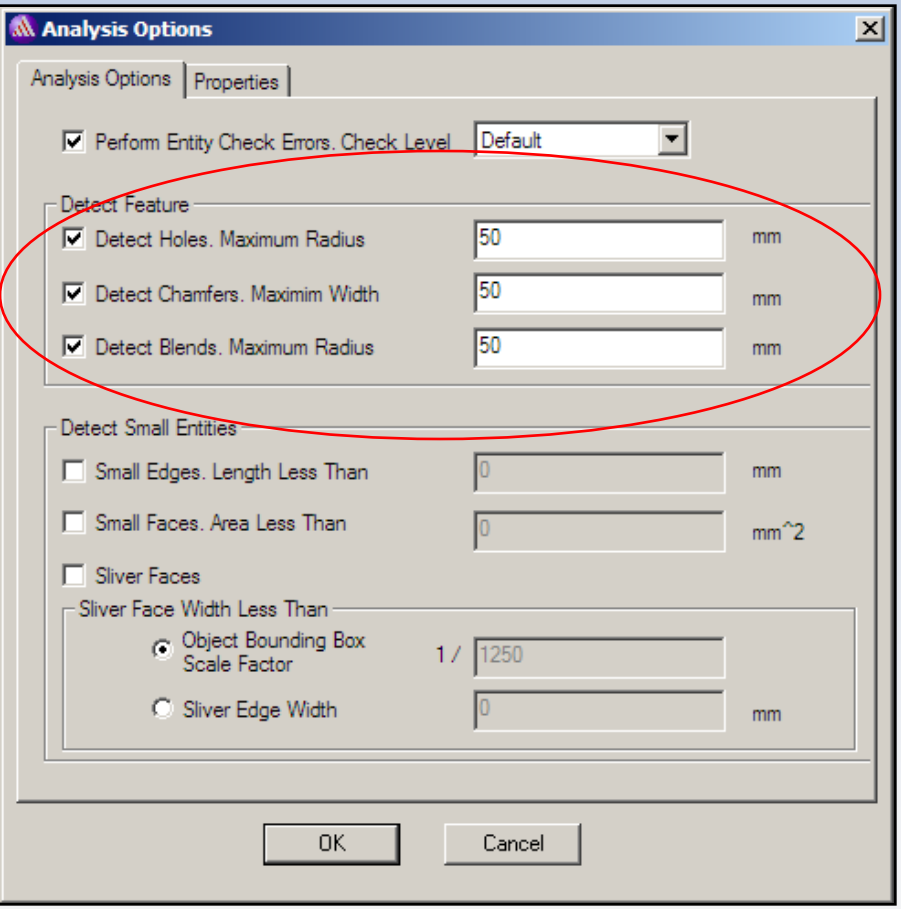


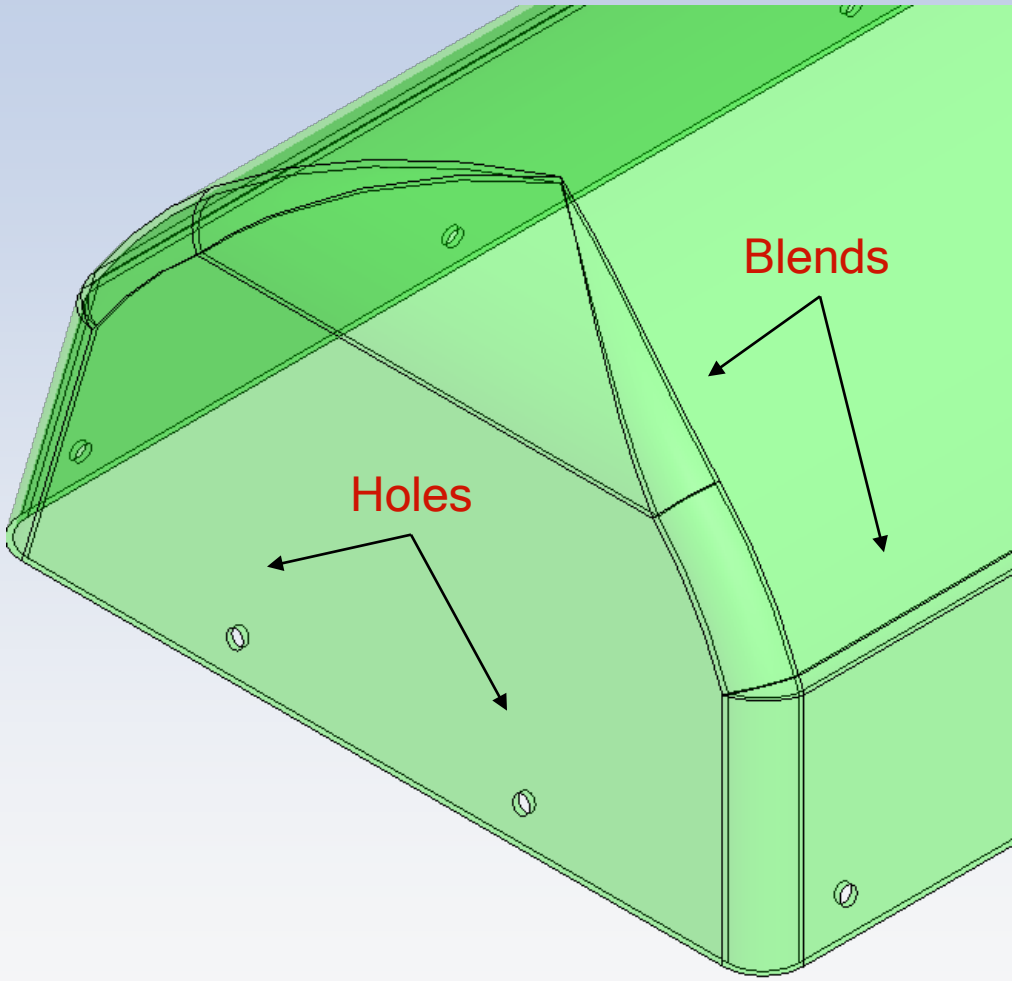
Specify Desired Scan Angle and Maximum Sidelobe Level



Synthesized Far-field Pattern

Automatic Feature Removal

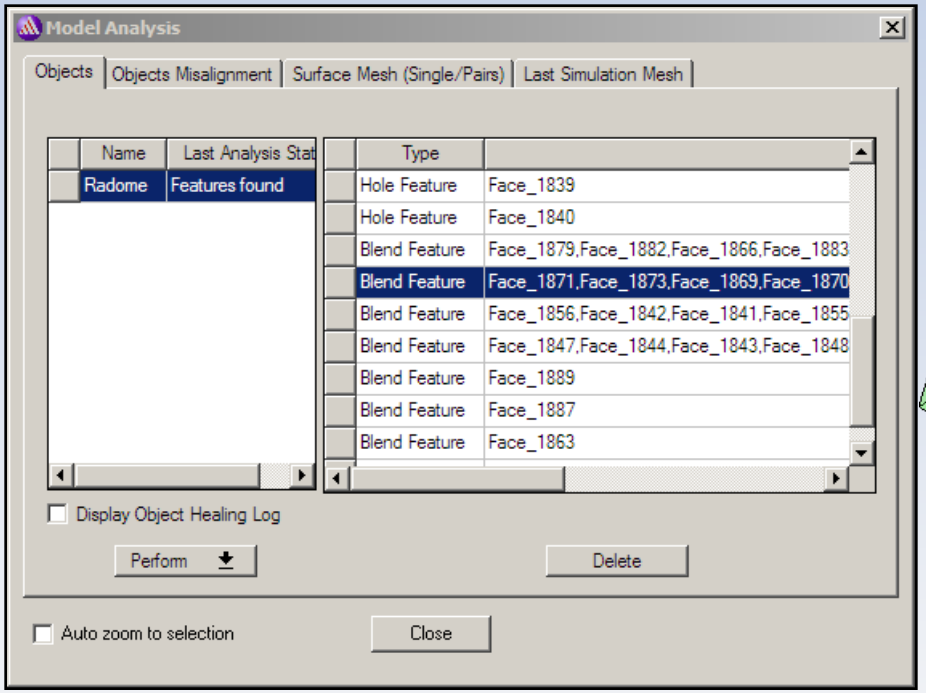


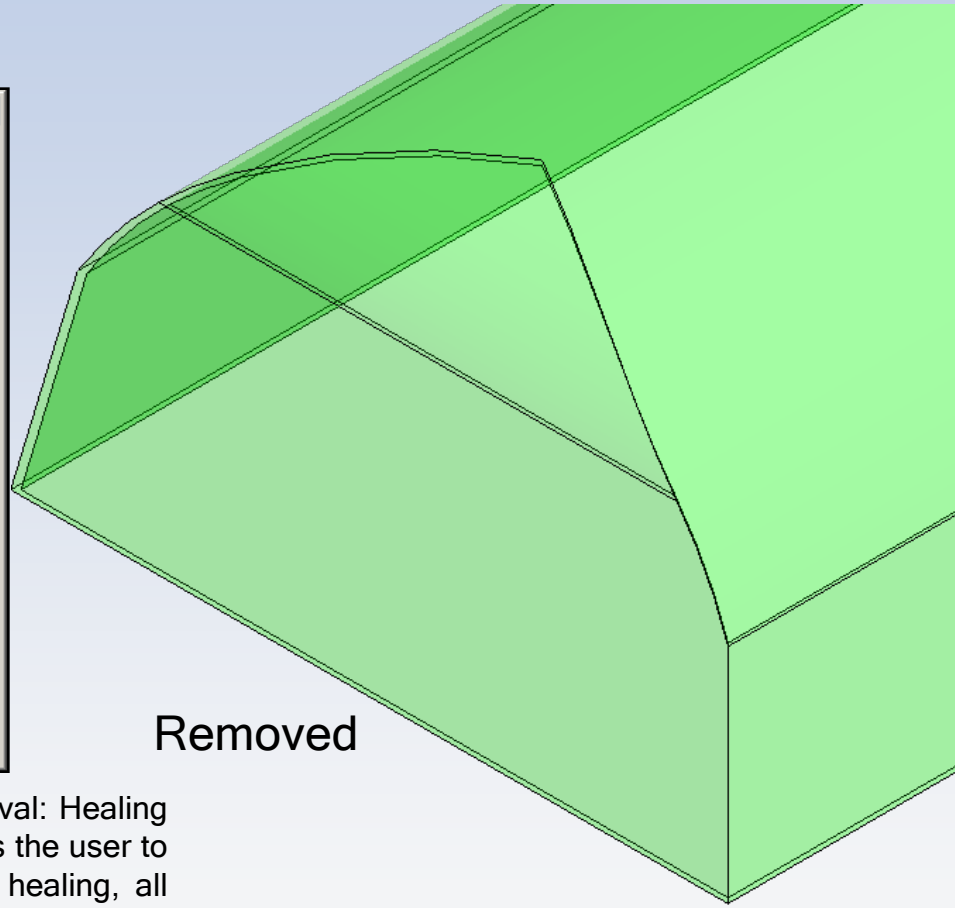


Step 1: Enter Feature Detection Options

Automatic Feature Removal

Step 2: Select Features to Remove

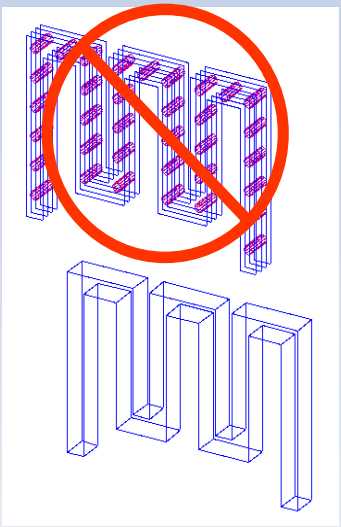


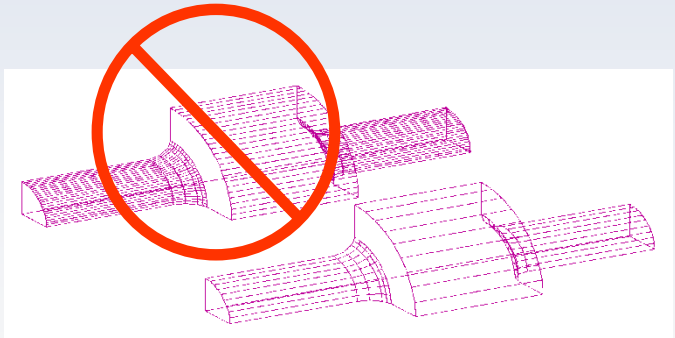


Note: There are two modes of operation for the feature removal: Healing and Model Analysis. Model Analysis was used here and allows the user to manually select which geometry features are removed. For healing, all features that meet the user defined criteria are automatically removed. Both options are found in the menu item *Modeler > Model Analysis*

HFSS Modeler: Pre-Process
3D modeler Solid-modeling considerations (1)

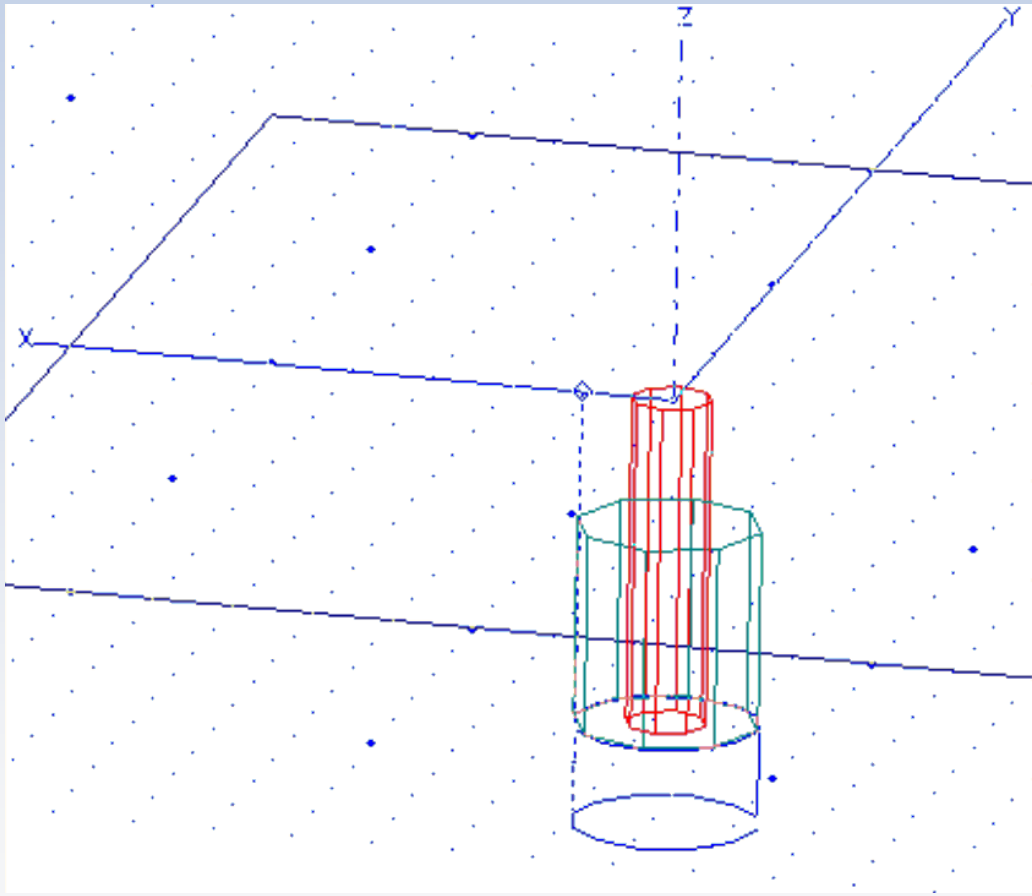
- 模型复杂度尽可能低
  - small number of segments in circles and cylinders
  - omit details if possible
- 避免大边宽比
  - maximum aspect ratio is 1:2500
  - use 2D objects instead of thin structures
- 使求解空间尽可能小
  - use symmetry whenever possible
  - don't include too much air or transmission line
- 避免 **Intersect** 物体





HFSS Modeler: Pre-Process
Solid-Modeling Considerations (2)

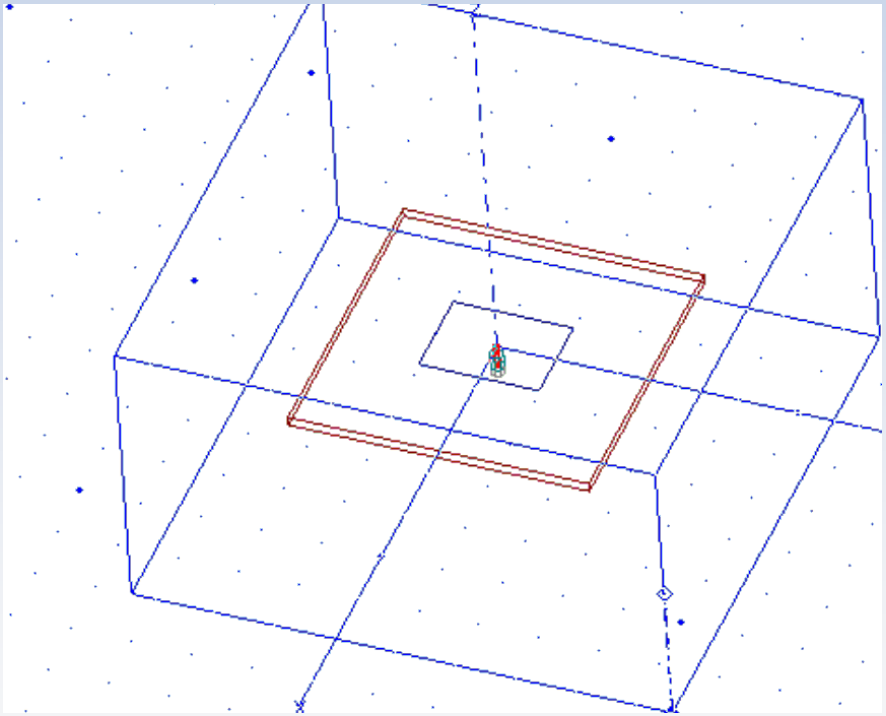
- **Few segments around circles and cylinders**
- **Thin metal patch is 2D object (aspect ratio!)**
- **No overlapping objects (inner conductor is two objects because it goes through two dielectrics)**



HFSS Modeler: Pre-Process
Solid-Modeling Considerations (3)

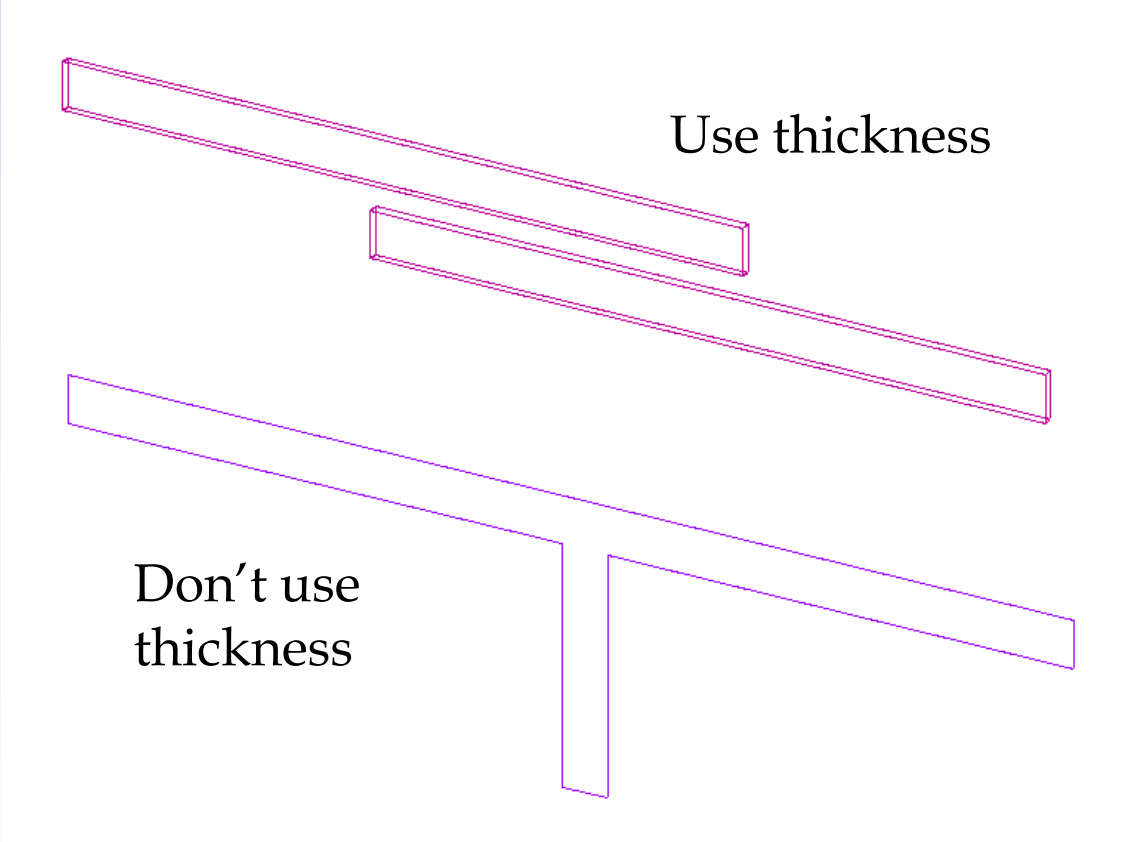
- **Some transmission line between port and antenna (length line not much smaller than cross section port)**

- **Some air between antenna and radiation boundary (λ/4)**



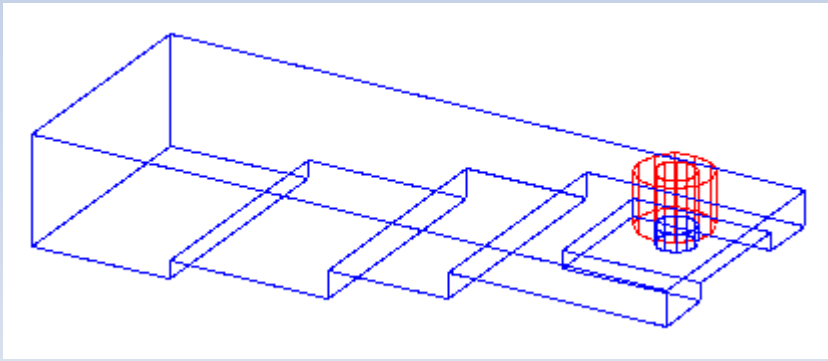
Preconditioning Geometry

- **Use trace thickness only when needed (when edge coupling is important or metal thickness < δ)**

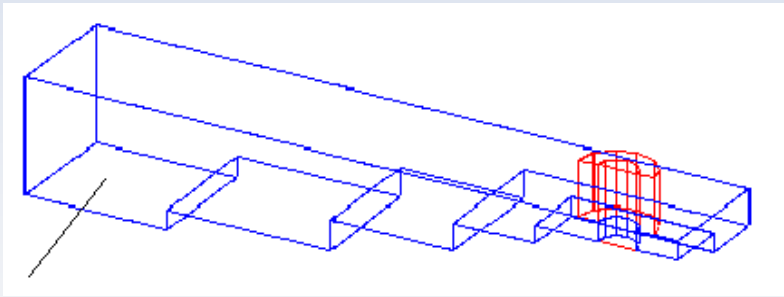


Preconditioning Geometry

Last, but not least:



Always use symmetry b.c. whenever possible to reduce problem size

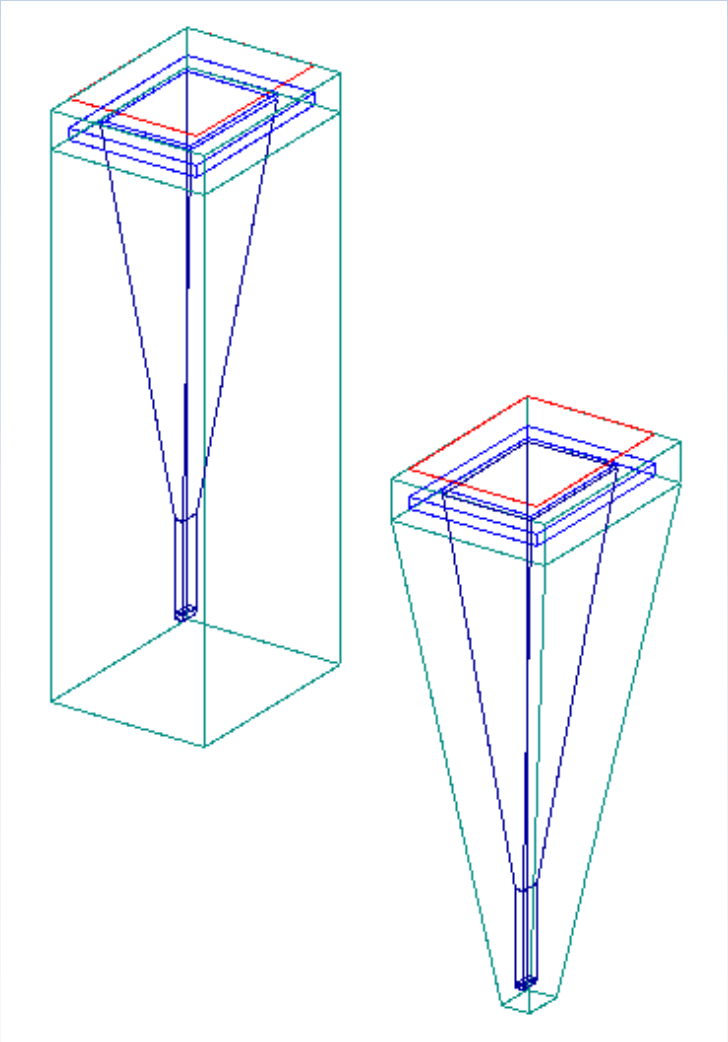


Perfect H

Use of **periodic boundaries** and/or **symmetry planes** whenever possible will reduce problem size AND create constraints that help meshing

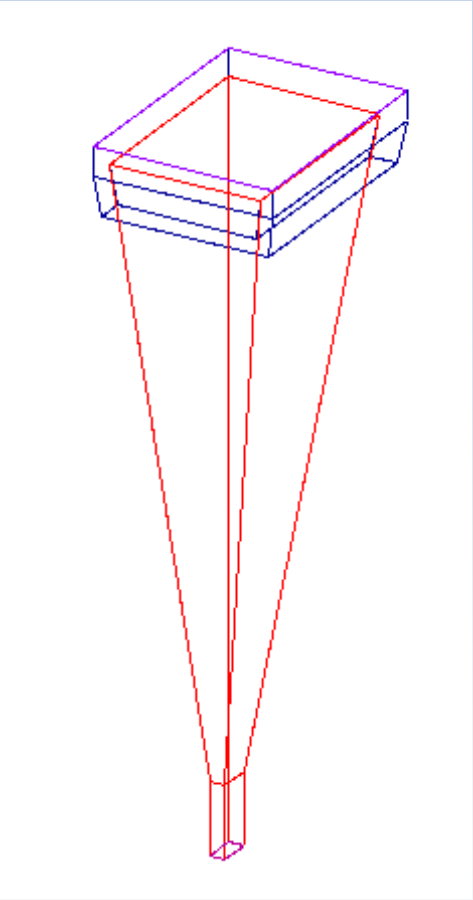
Sizing

- **Avoid making geometry larger than necessary**
- **Use symmetry planes when possible**



Sizing

Sometimes airbox can be made very small--in this case there is very little reason to wrap airbox around entire structure



Virtual Objects

- *Virtual* Objects **Are Dummy 2D or 3D Objects that do not change the physics of the model (e.g. an air object inside another air object).**

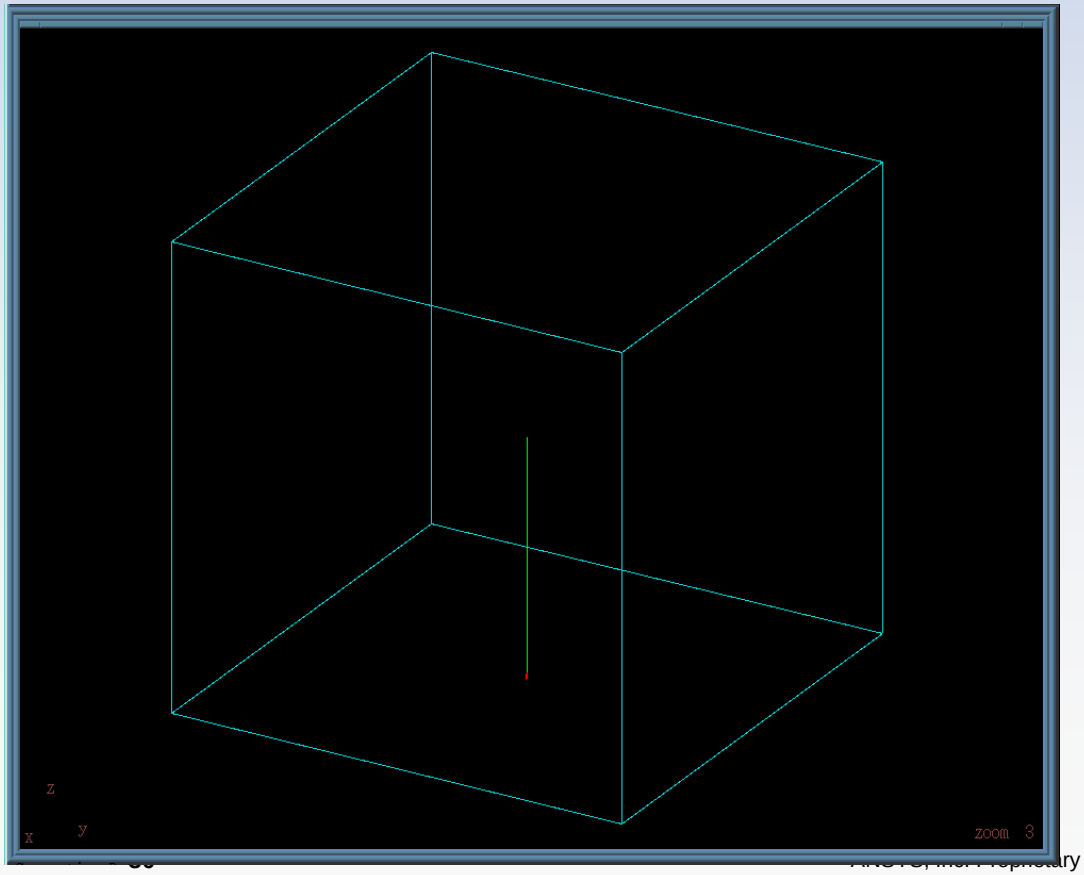
- **They Are Used to Assist in Getting a Higher-Quality Mesh**

Virtual Objects And Mesh Aspect Ratio

- **Field Simulator May Not be Able to Generate a Useful Finite Element Mesh For Projects Containing Geometric Objects Whose Dimensions Differ by More Than Three Orders of Magnitude**

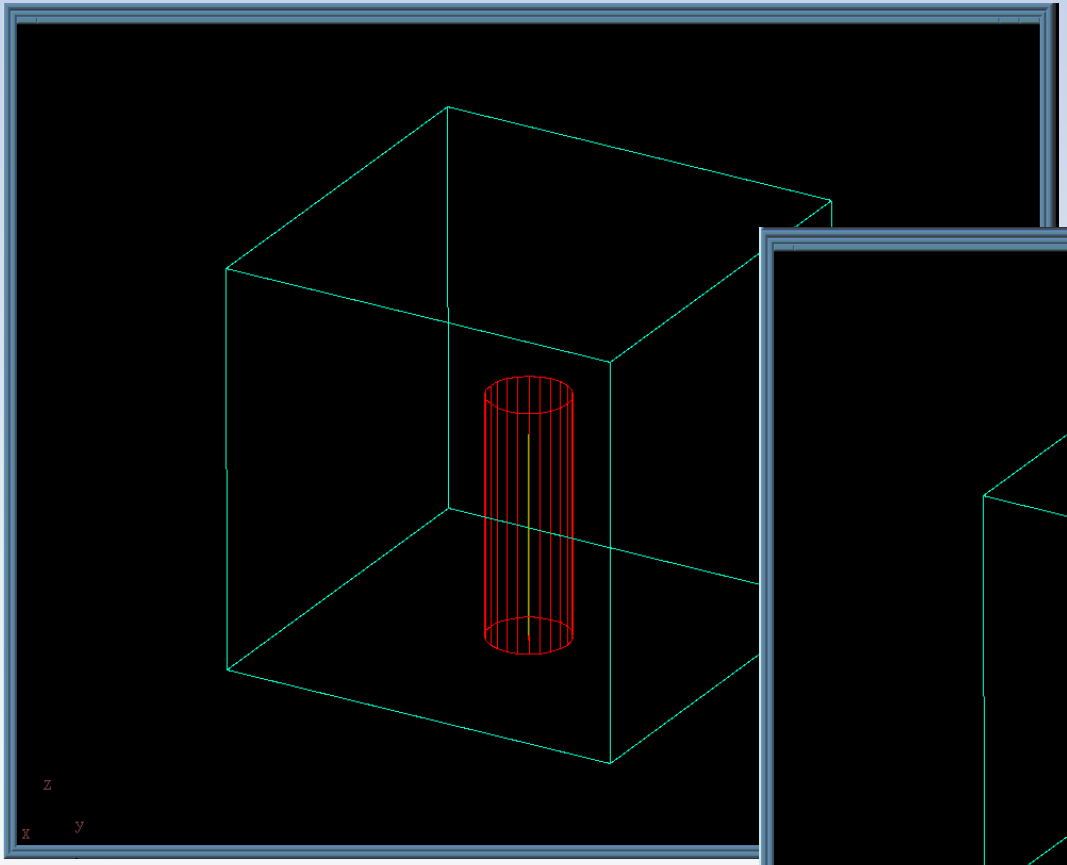
- **Monopole on a Groundplane:**
  - f = 5.9 GHz
  - $r_{monopole}$ = 1 mil
  - $l_{monopole}$ = 500 mil
  - l_{radbox} = 1000 mil

Radiation Surface/Monopole Facet Aspect Ratio is Greater Than 1000:1

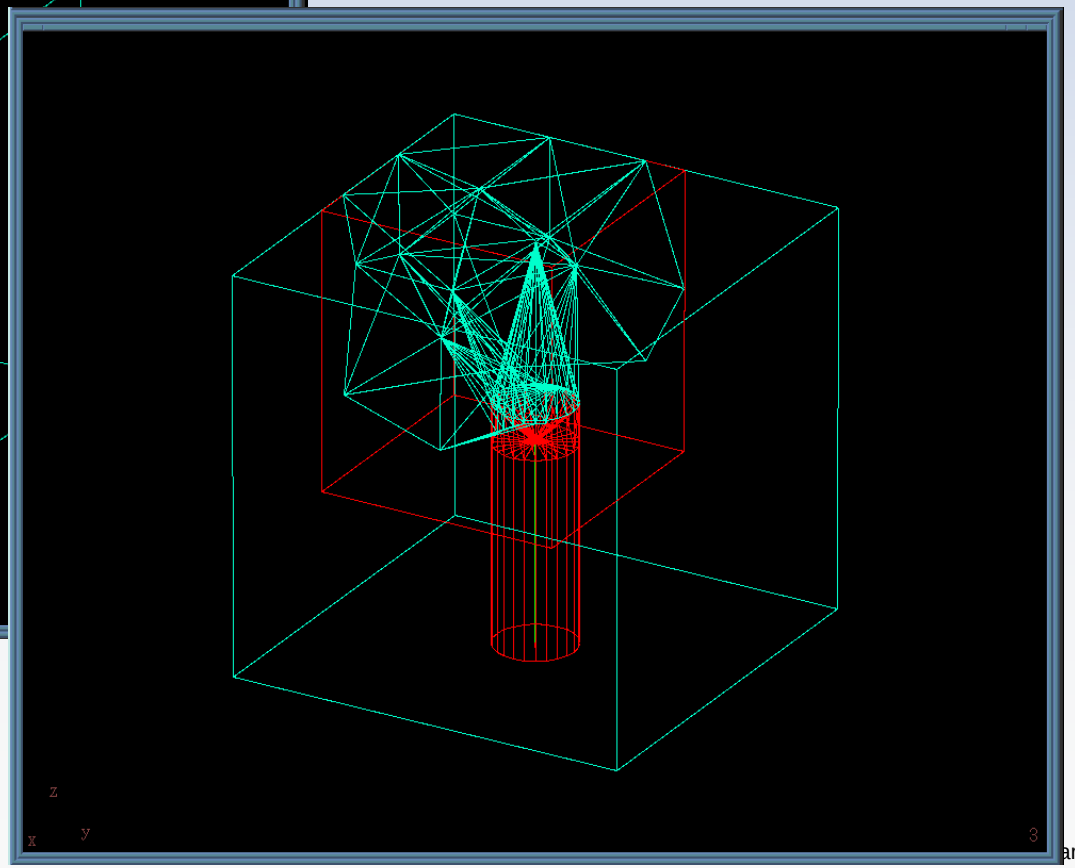


HFSS Modeler: Pre-Process

Inclusion of a Virtual Object Compensates For High Aspect Ratio

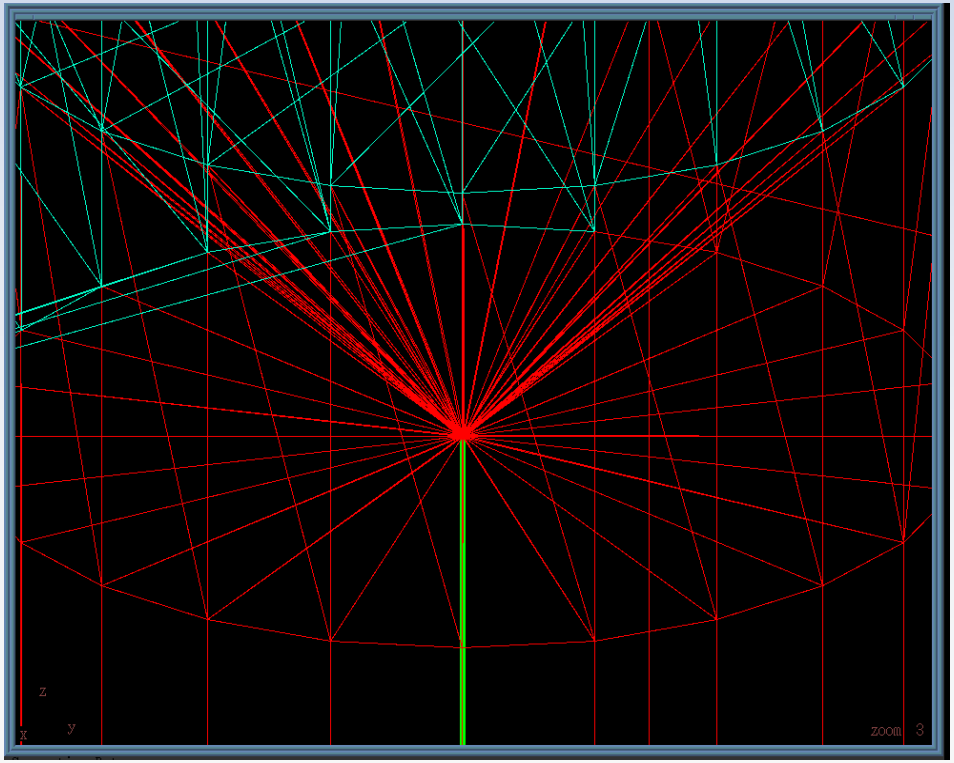


Use The *Plot/Mesh* Feature in the *Fields* Post Processor



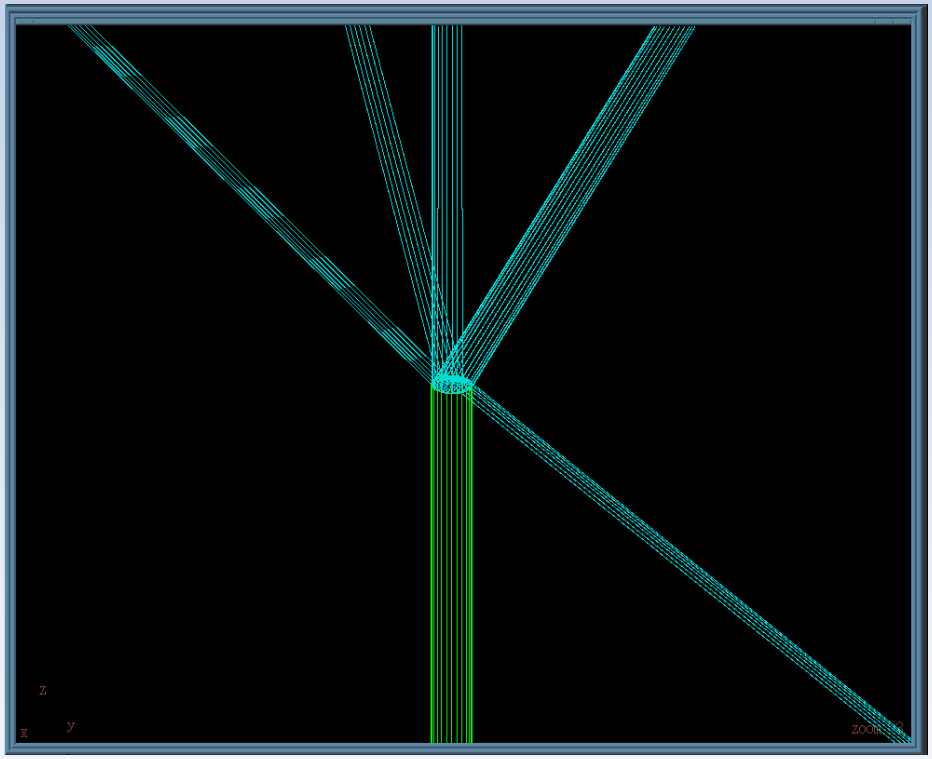
HFSS Modeler: Pre-Process

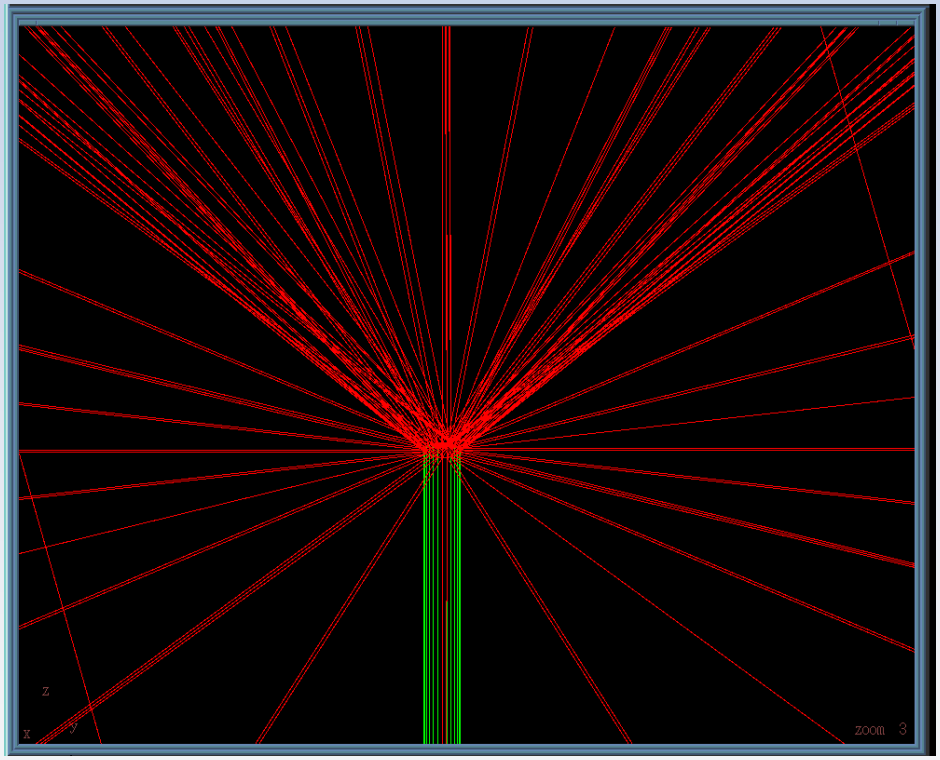
Inclusion of a Virtual Object Compensates For High Aspect Ratio



HFSS Modeler: Pre-Process

Volume Mesh Comparison With and Without Virtual Object





Without Virtual Object

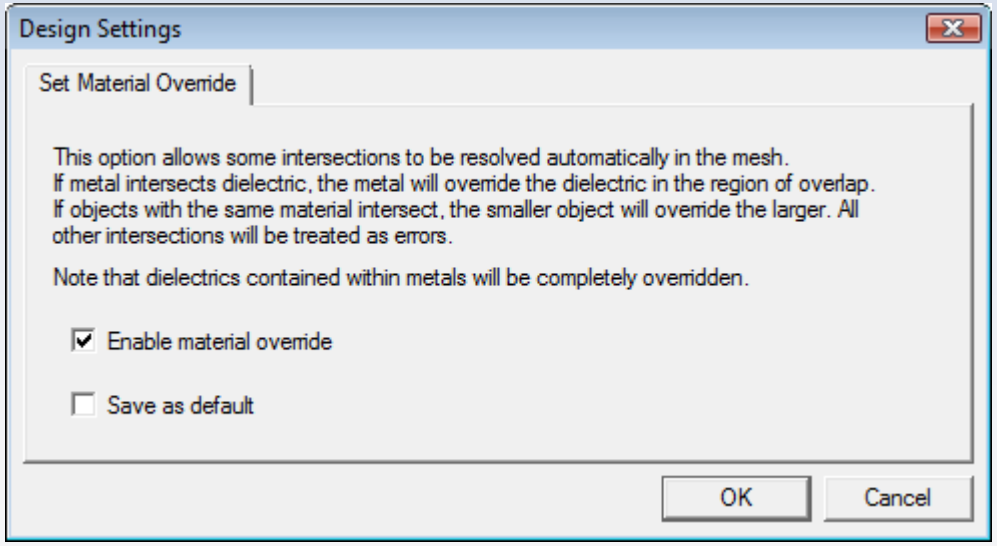
With Virtual Object

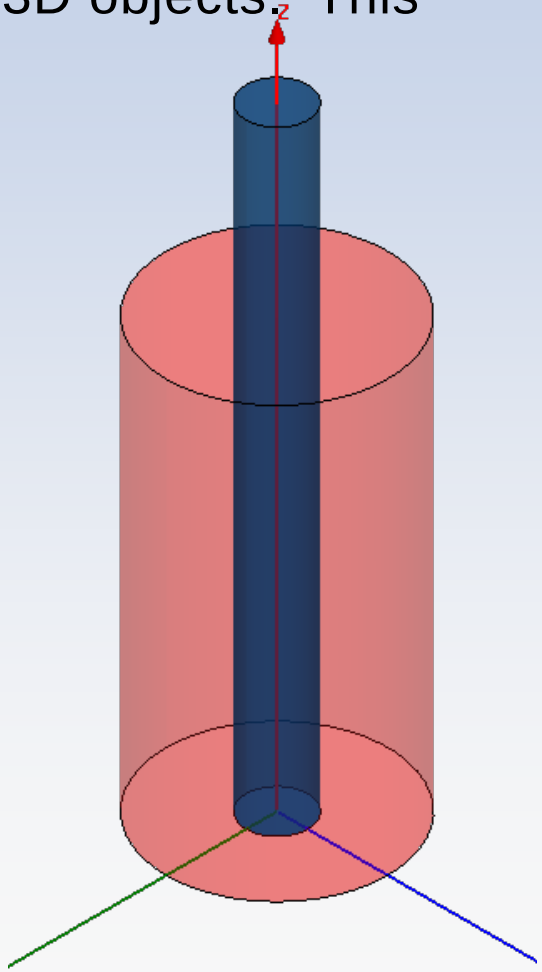
Tetrahedrons are like pins

Mesh is somewhat better

Overlapping Geometry

- **定义:**
  - When an object occupies volume in multiple 3D objects. This does not apply to sheet objects
- **解决方法:**
  - Set Material Override
    - Menu item: ***HFSS > Design Settings***





(Overlap between two cylinders)

Q&A Time

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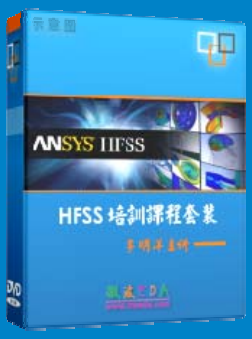

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