

Ansys High Frequency Structure Simulator (HFSS) Tutorial

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Instructor: Dr. Jung-Chih Chiao

EE 3407

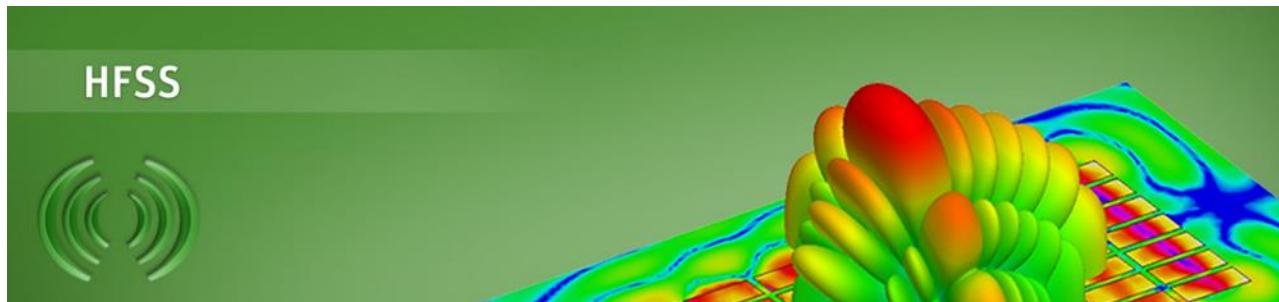
Department of Electrical Engineering

University of Texas at Arlington

October 11th 2017

How to solve this ?

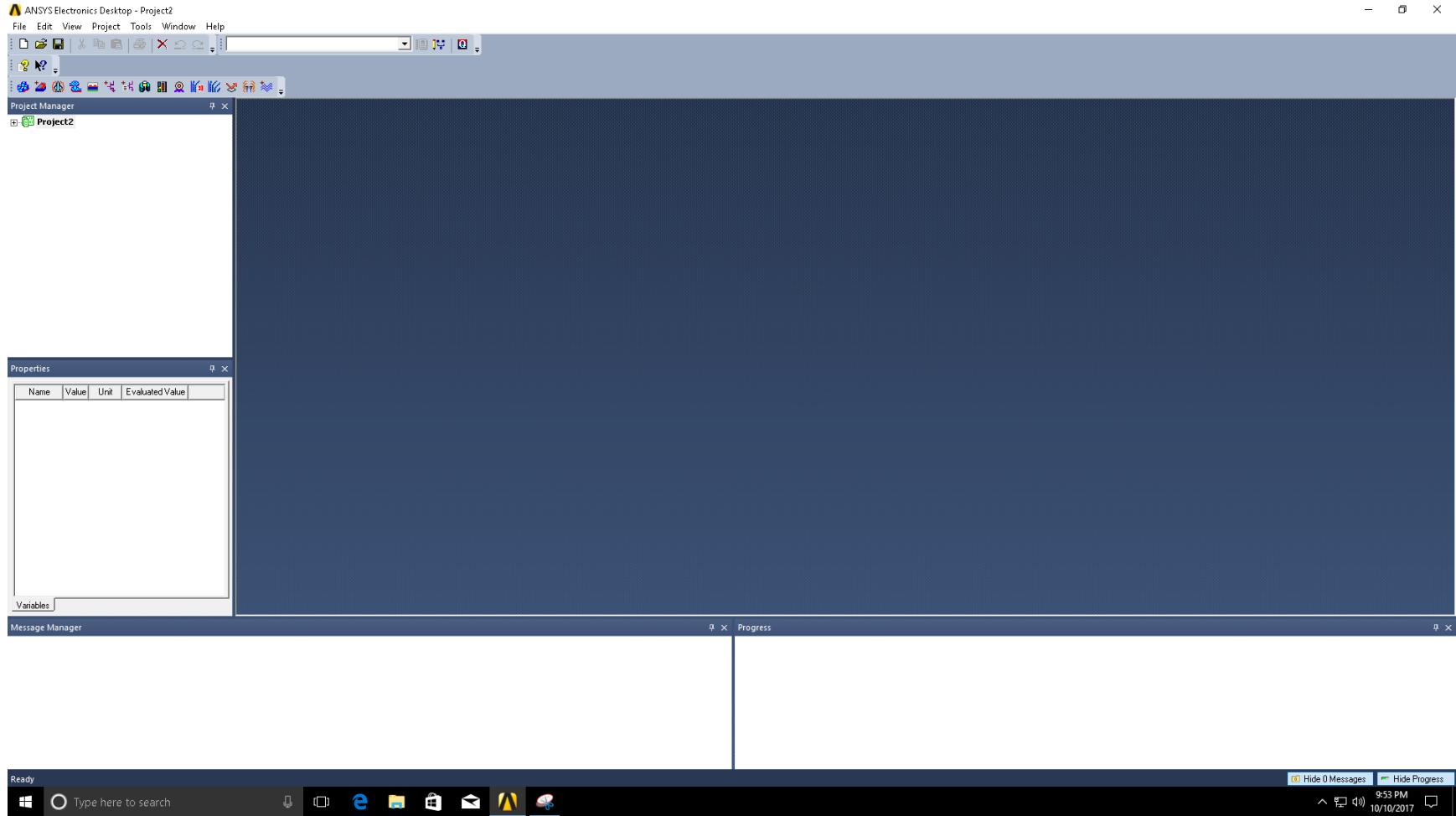
$$\begin{aligned} I &\equiv \frac{1}{c^2} \frac{\partial^2}{\partial t^2} \int_{-\infty}^{\infty} \mathbf{e}_\mu \varepsilon_{\mu\alpha}(\omega) E_\alpha(\mathbf{r}, \omega) \exp(-i\omega t) d\omega \\ &= - \int_{-\infty}^{\infty} \frac{\omega^2 n^2(\omega)}{c^2} \underbrace{\frac{1}{2} \sum_{\omega_\sigma \geq 0} [\mathbf{E}_{\omega_\sigma}(\mathbf{r}, \omega - \omega_\sigma) + \mathbf{E}_{\omega_\sigma}^*(\mathbf{r}, -\omega - \omega_\sigma)] \exp(-i\omega t) d\omega}_{\text{quasimonochromatic form of } \mathbf{E}(\mathbf{r}, \omega)} \\ &= \{\text{denote } \omega^2 \varepsilon(\omega)/c^2 \equiv \omega^2 n_0^2(\omega)/c^2 \equiv k^2(\omega)\} \\ &= -\frac{1}{2} \sum_{\omega_\sigma \geq 0} \int_{-\infty}^{\infty} k^2(\omega) [\mathbf{E}_{\omega_\sigma}(\mathbf{r}, \omega - \omega_\sigma) + \mathbf{E}_{\omega_\sigma}^*(\mathbf{r}, -\omega - \omega_\sigma)] \exp(-i\omega t) d\omega. \\ &= -\frac{1}{2} \sum_{\omega_\sigma \geq 0} \int_{-\infty}^{\infty} k^2(\omega) \mathbf{E}_{\omega_\sigma}(\mathbf{r}, \omega - \omega_\sigma) \exp(-i\omega t) d\omega + \text{c. c.} \end{aligned}$$



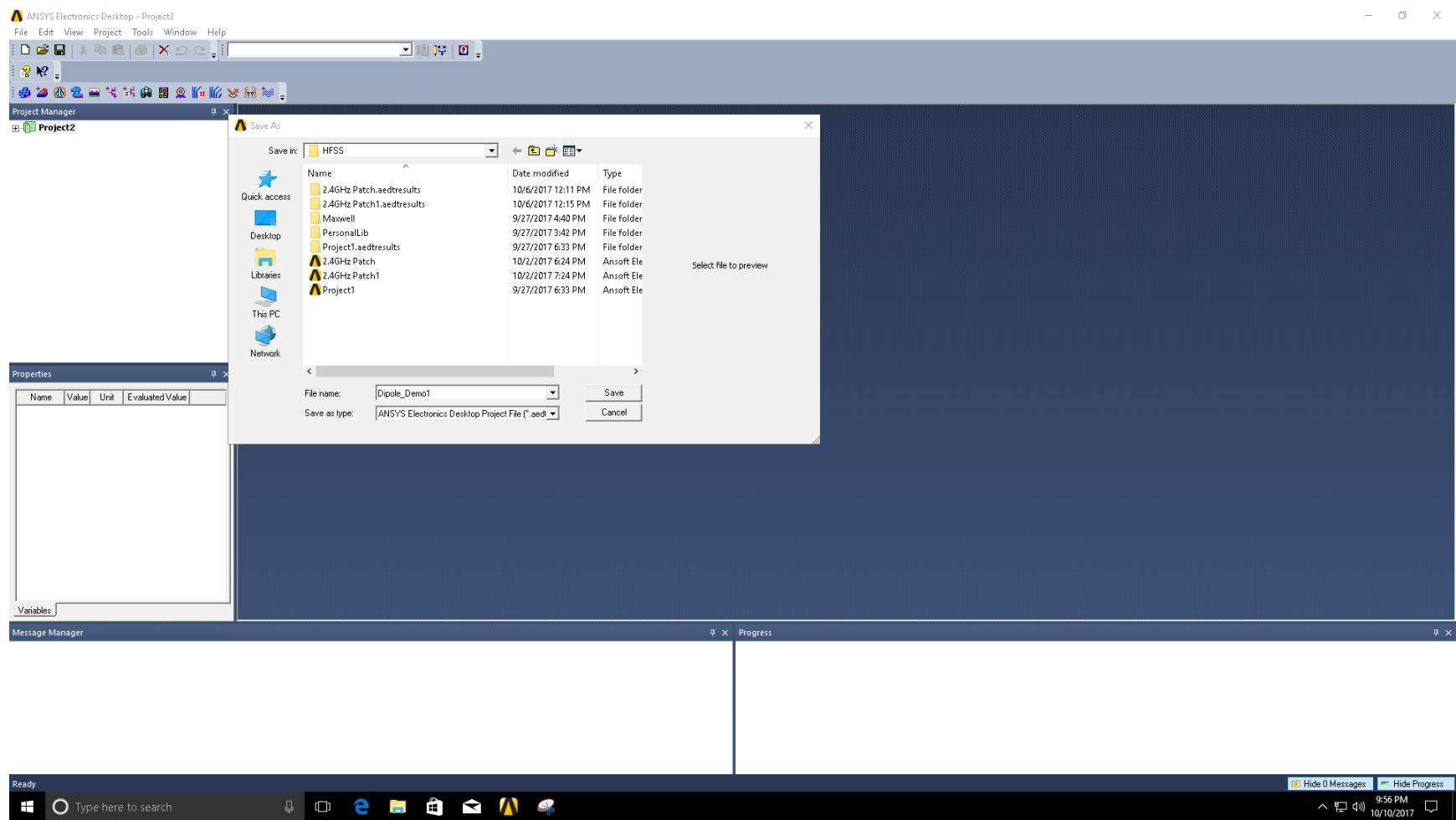
ANSYS Electronics Desktop



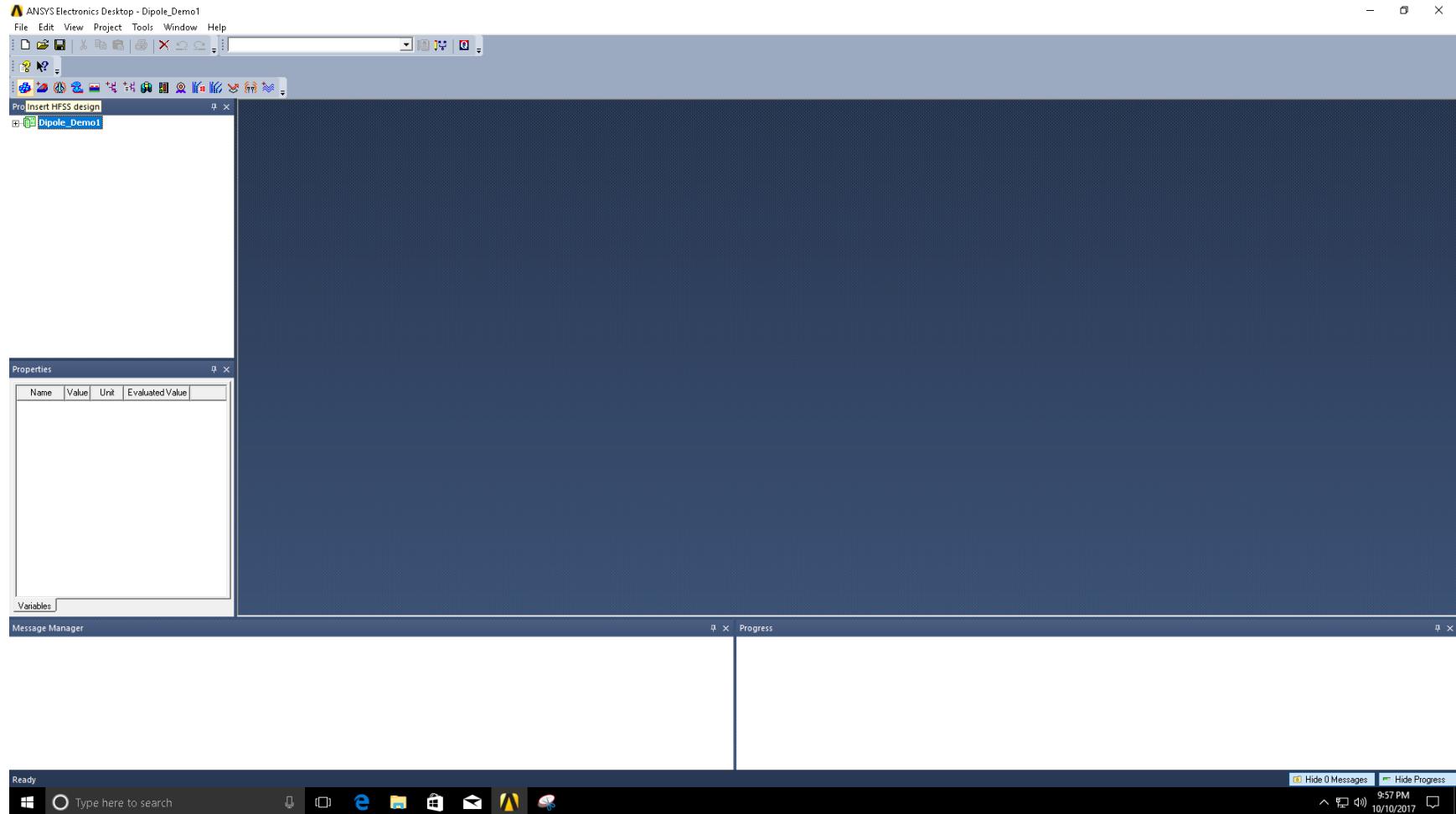
ANSYS Electronics User Interface



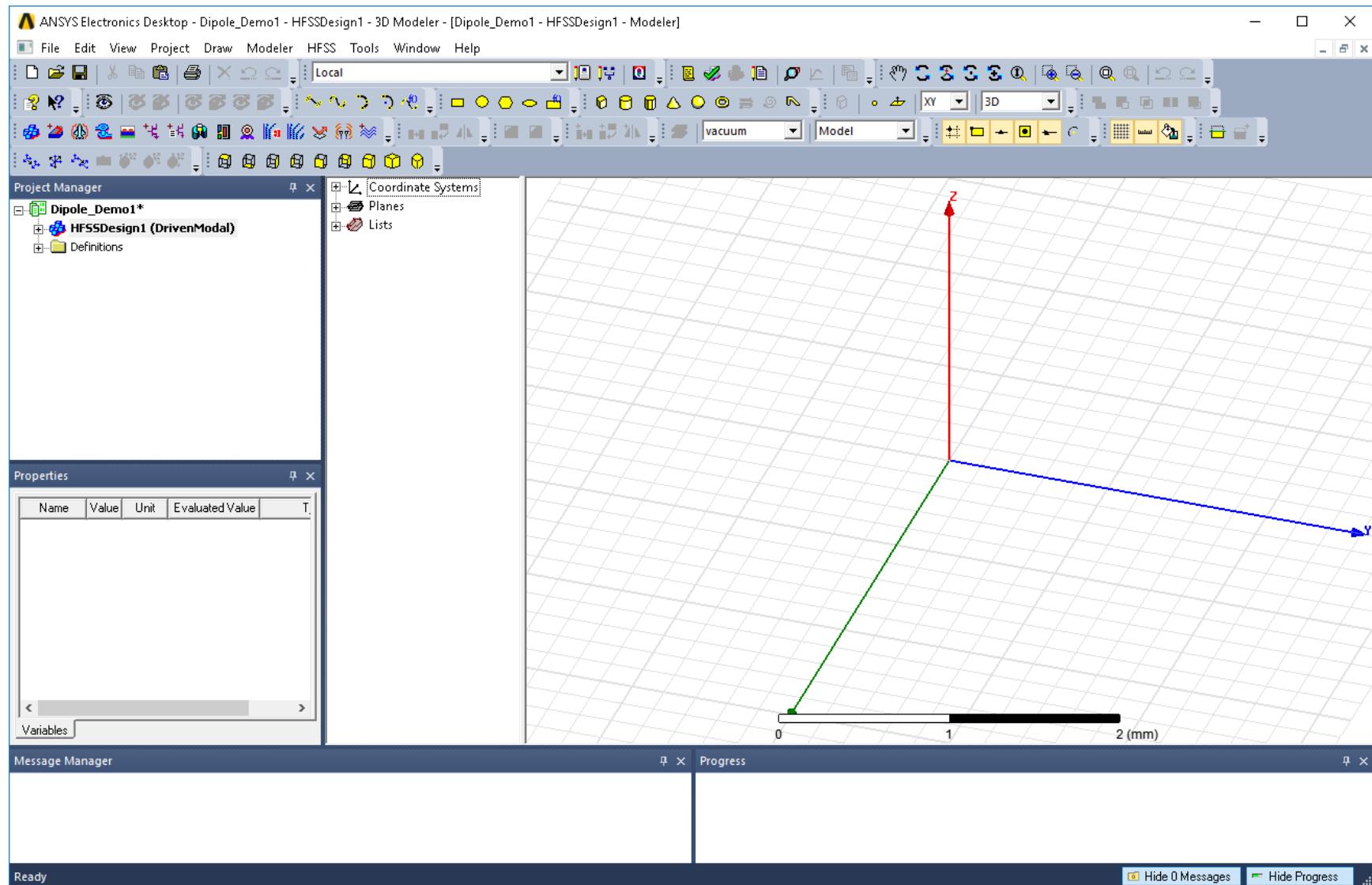
Save As Dipole_Demo1



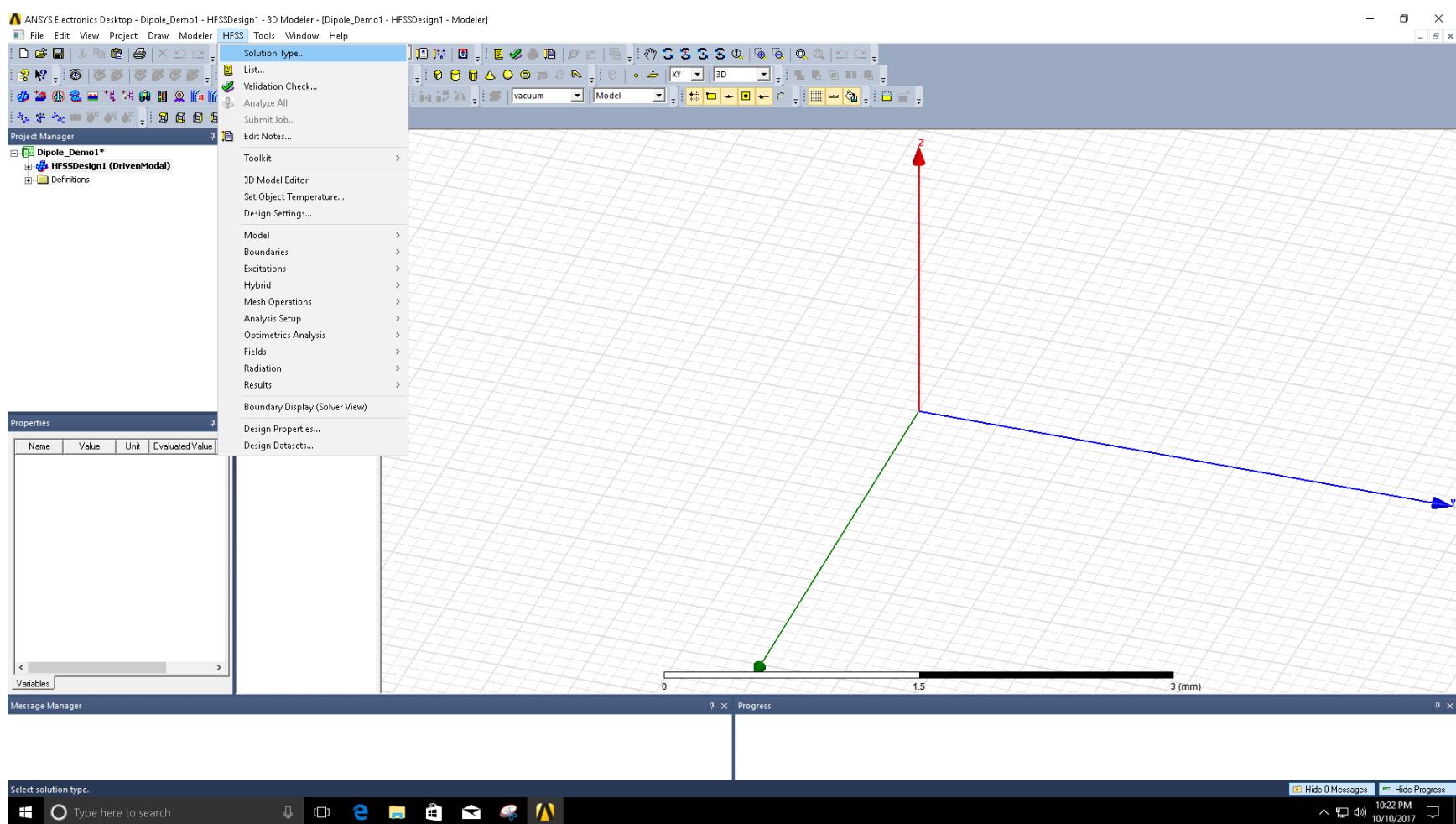
Insert HFSS Design



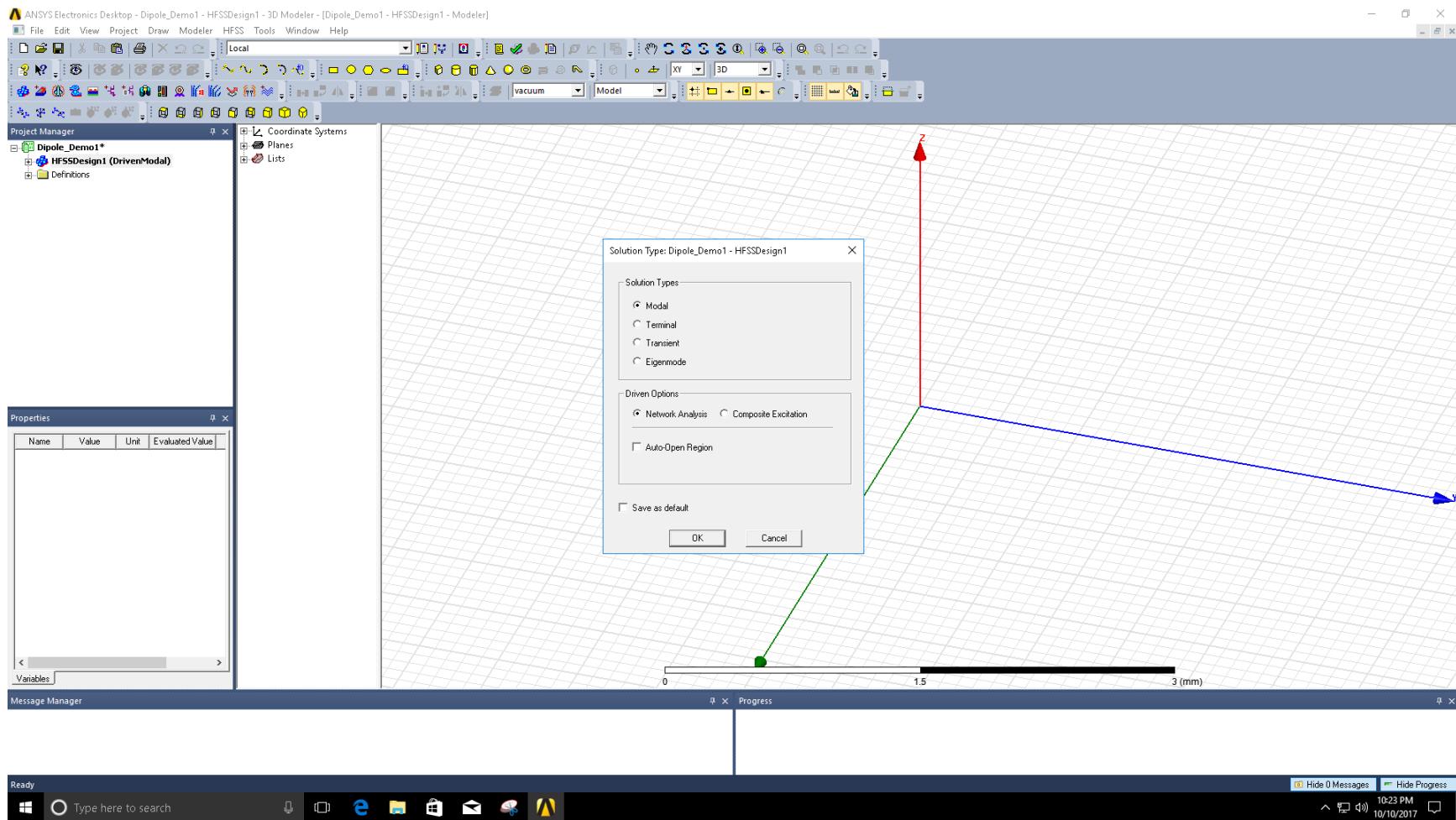
HFSS Modeler



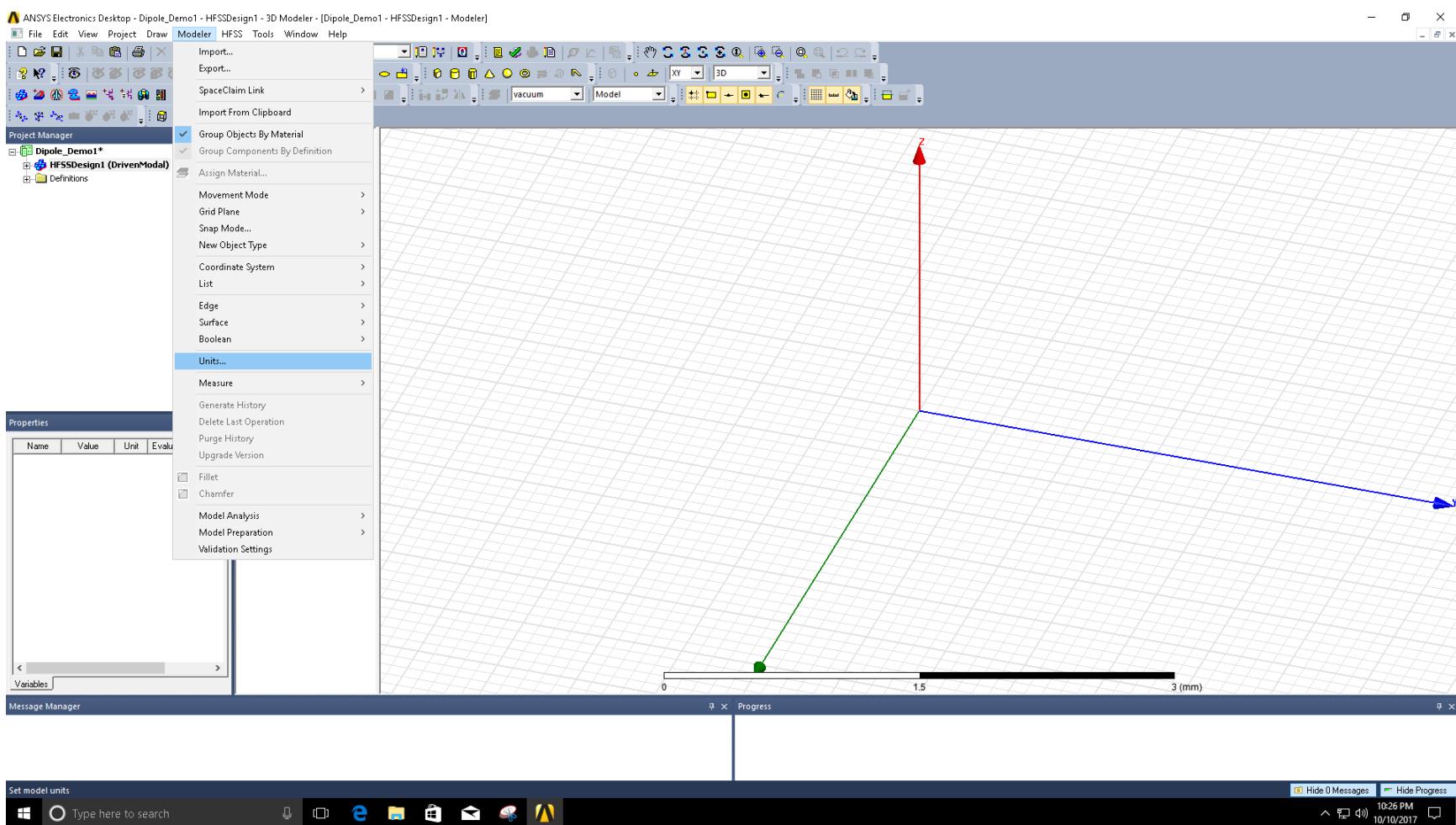
Solution Type Selection : HFSS > Solution Type



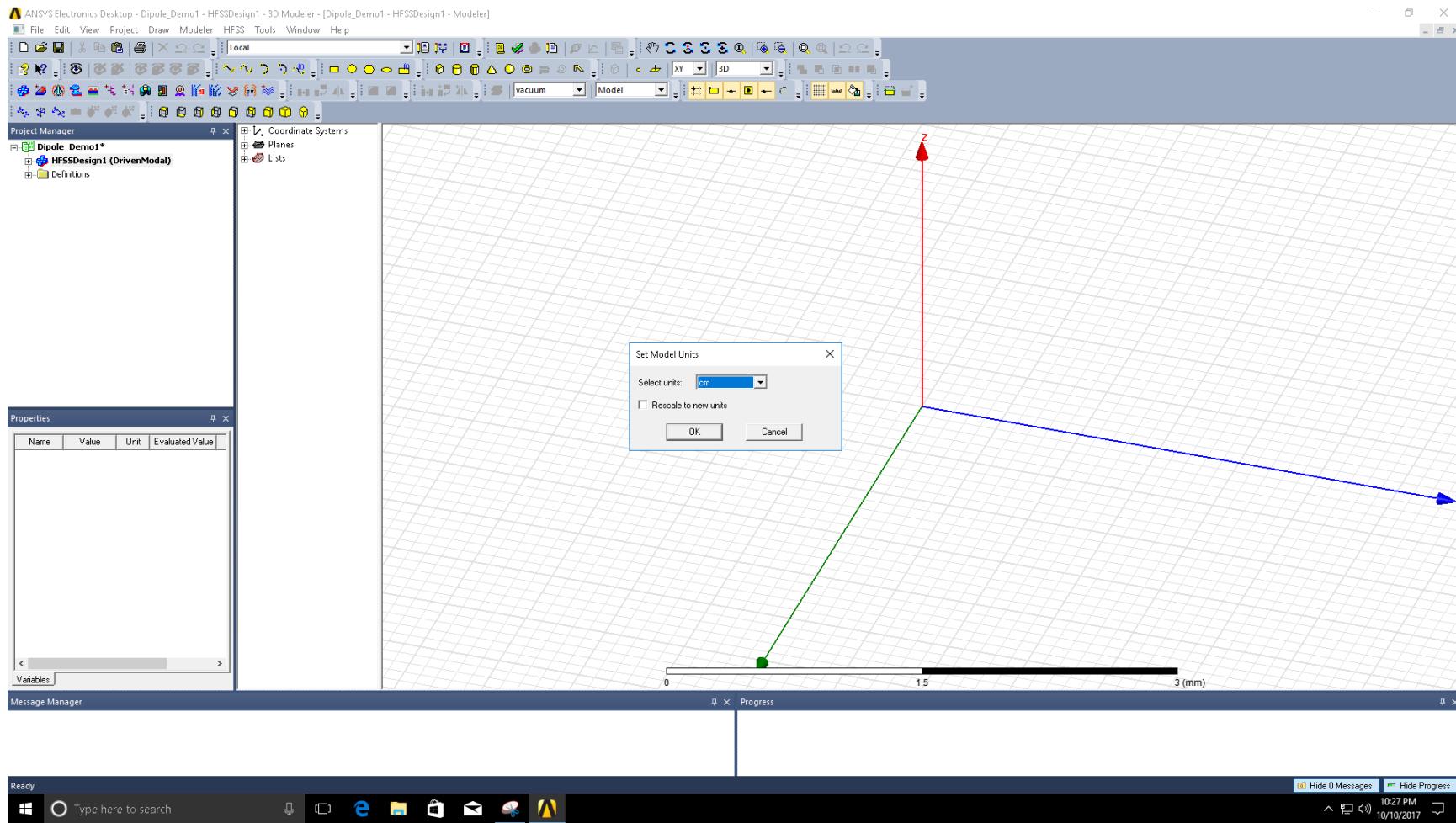
Select Modal > Press OK



Select Model Unit: Modeler>Units

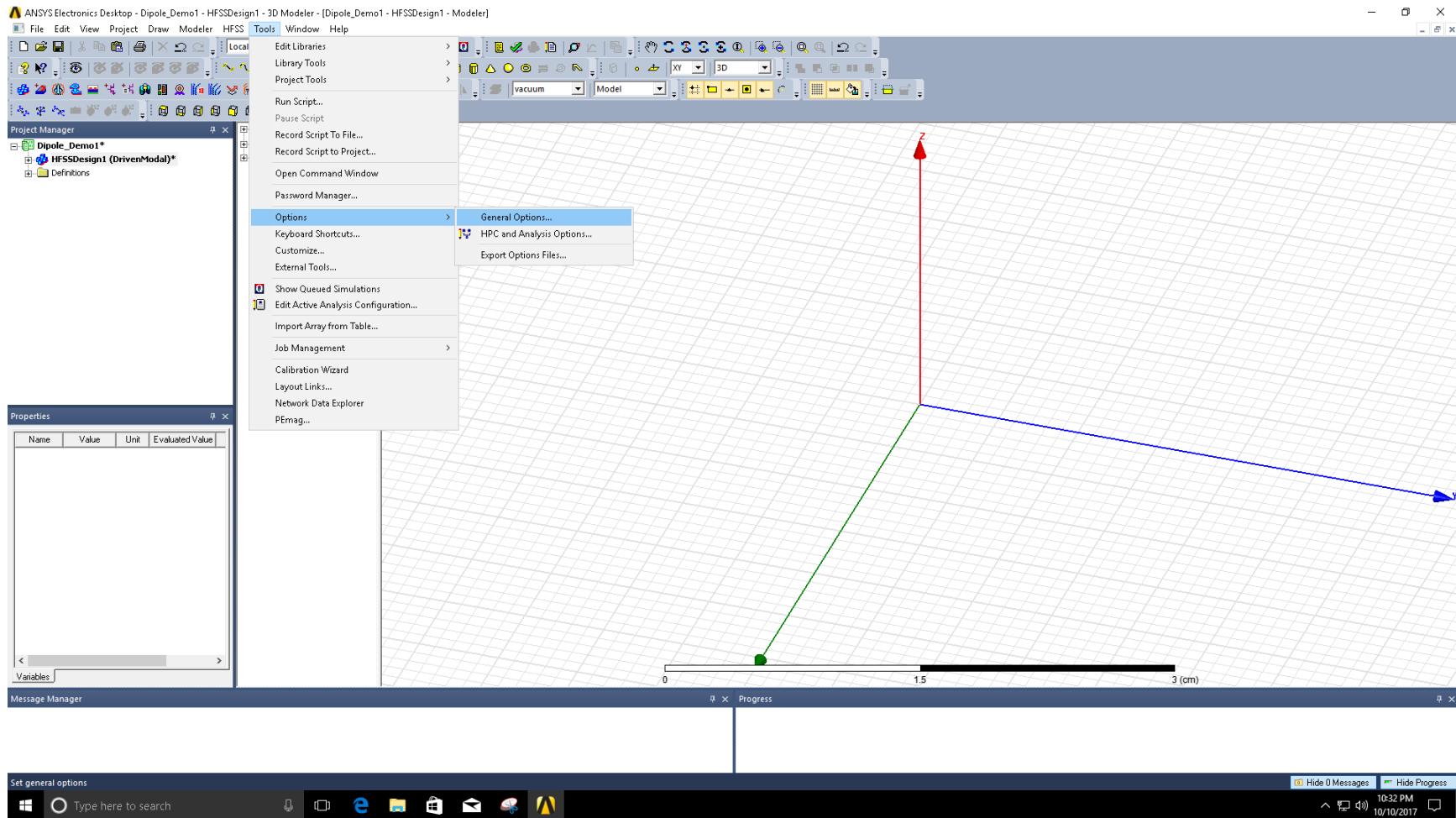


Select Model Unit: Modeler>Units>cm>ok



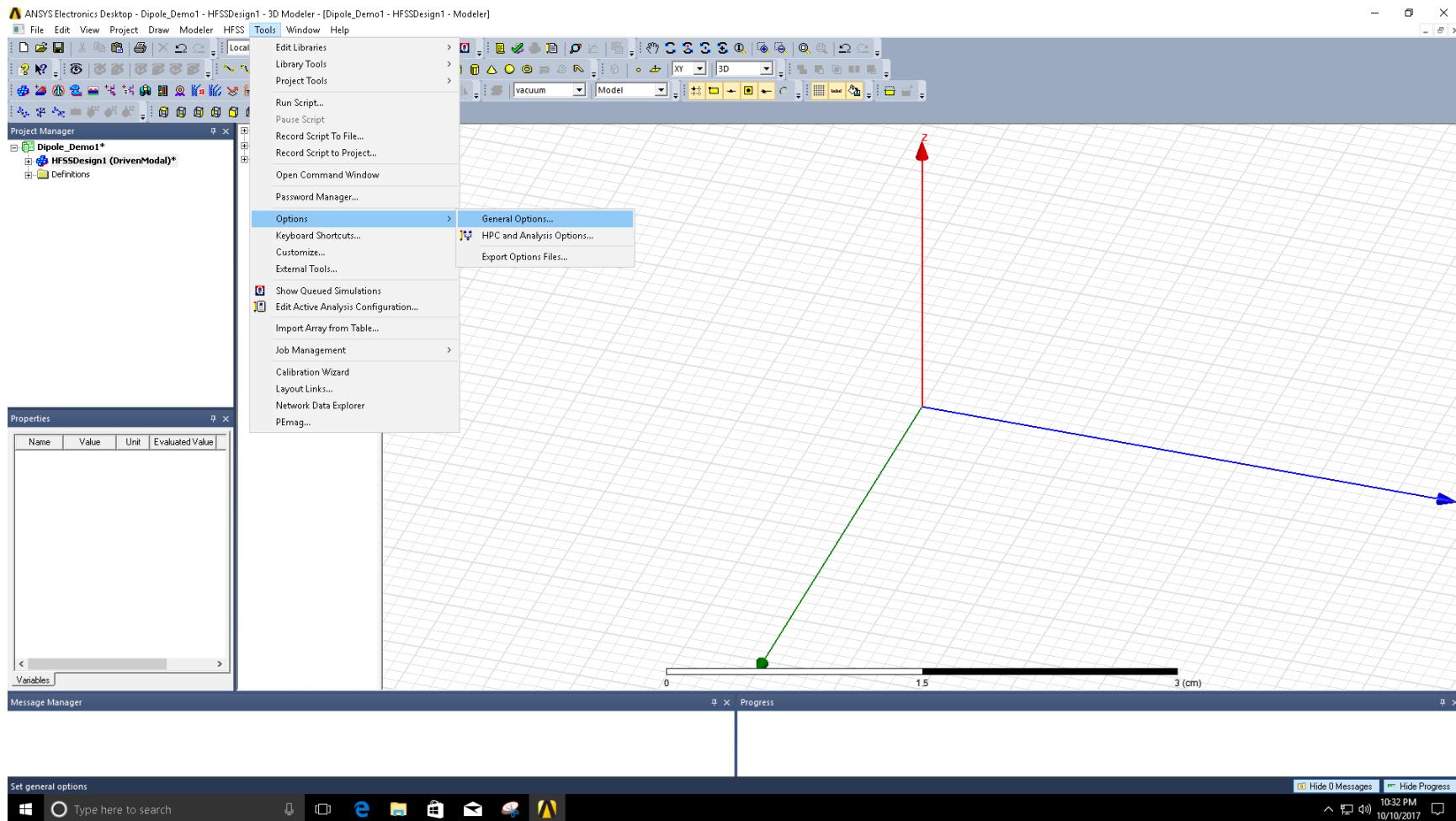
Set Dialog Data Entry Mode

Tools > Options > General Options



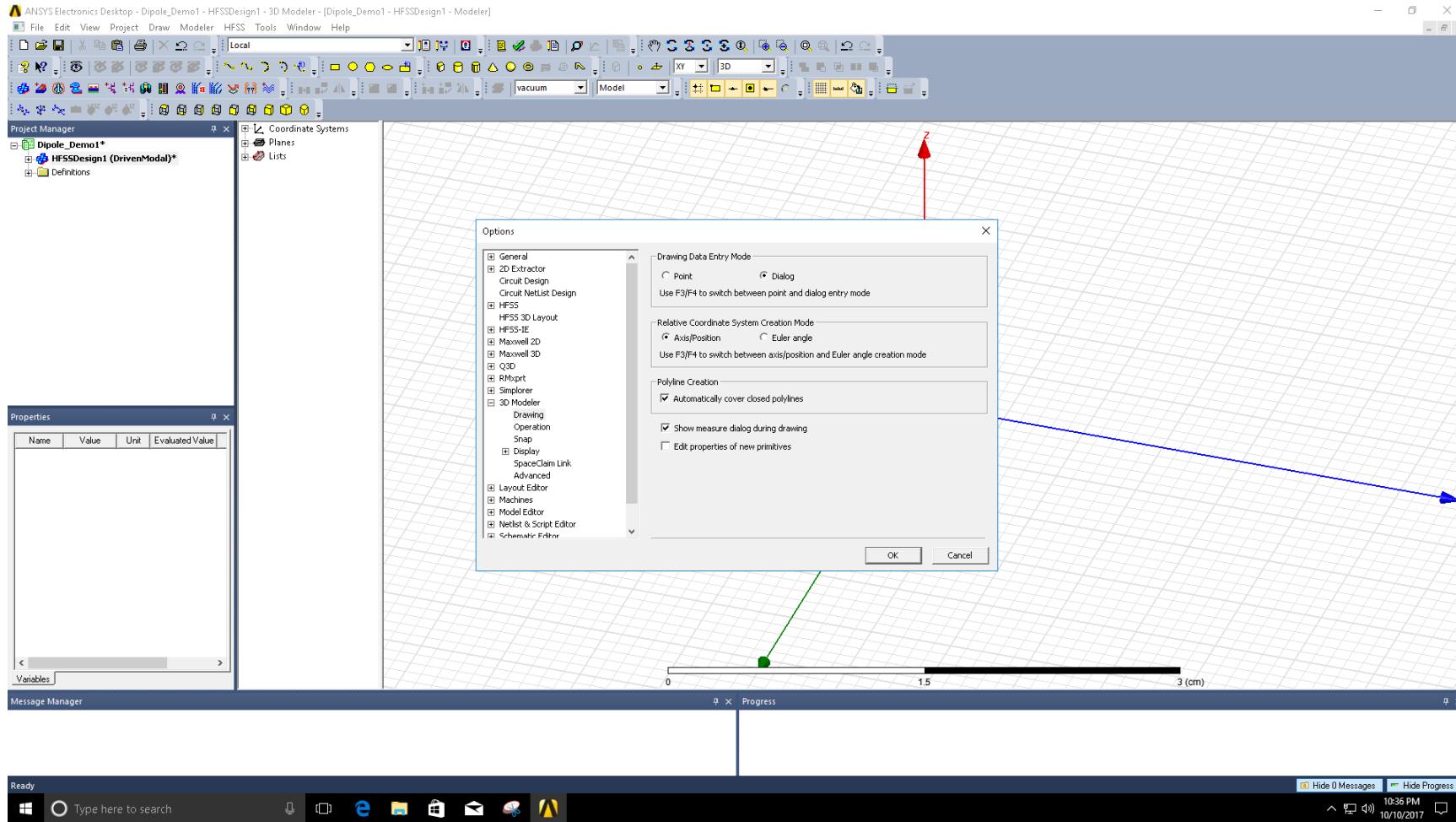
Set Dialog Data Entry Mode

Tools > Options > General Options



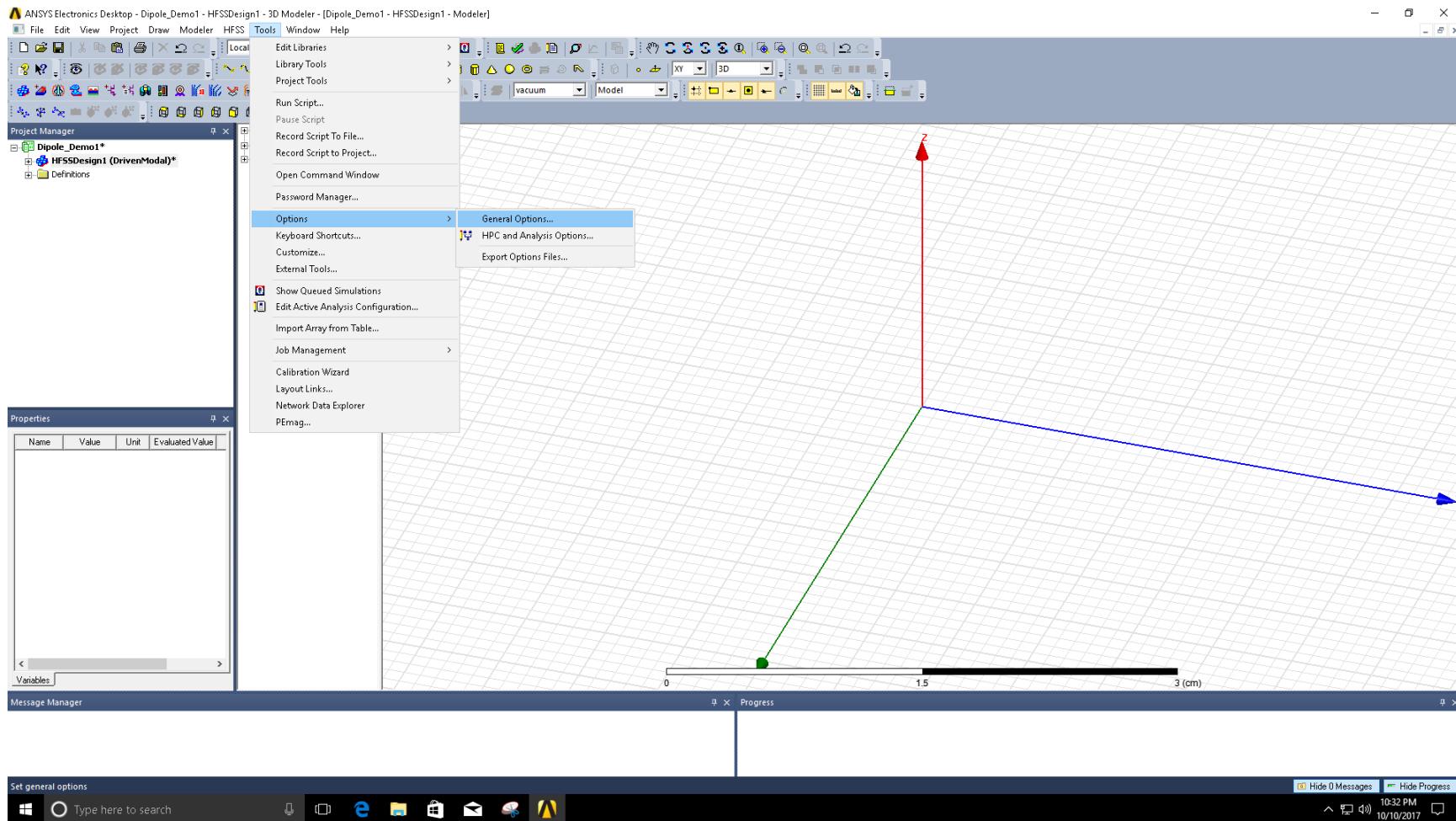
Set Dialog Data Entry Mode

3D Modeler > Drawing > Dialog



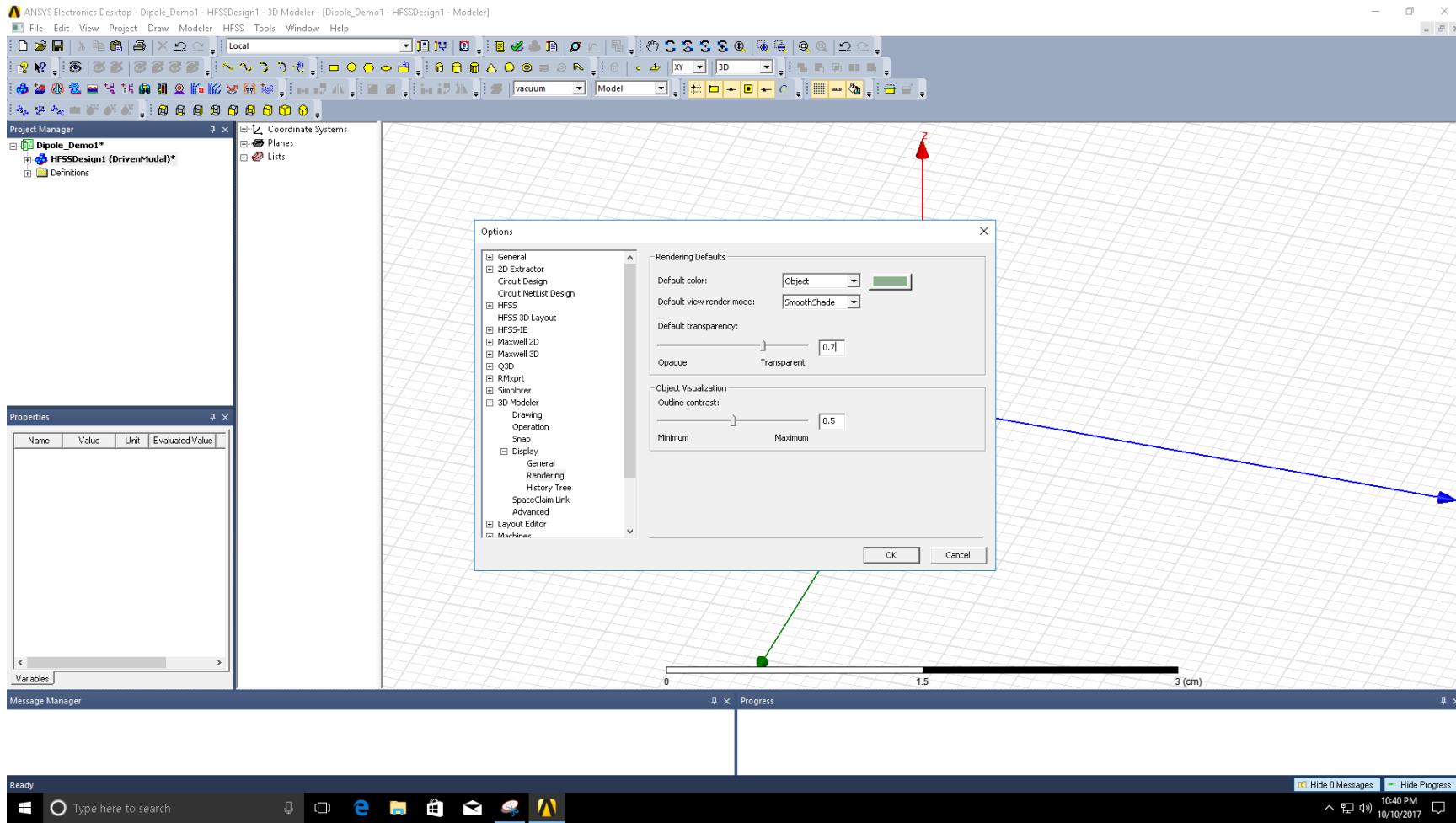
Set Default Transparency to 0.7

Tools > Options > General Options



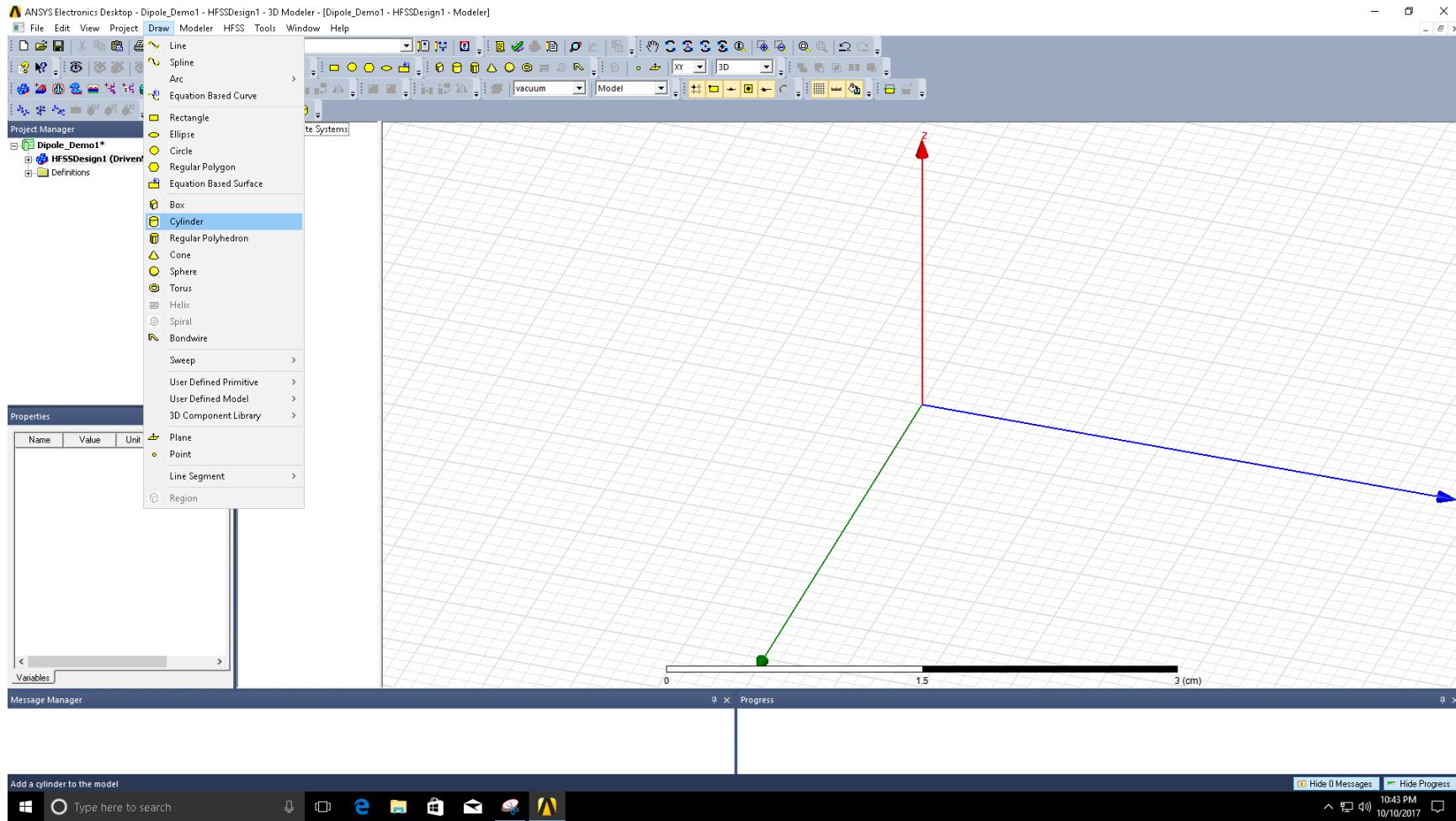
Set Default Transparency to 0.7

3D Modeler > Display > Rendering



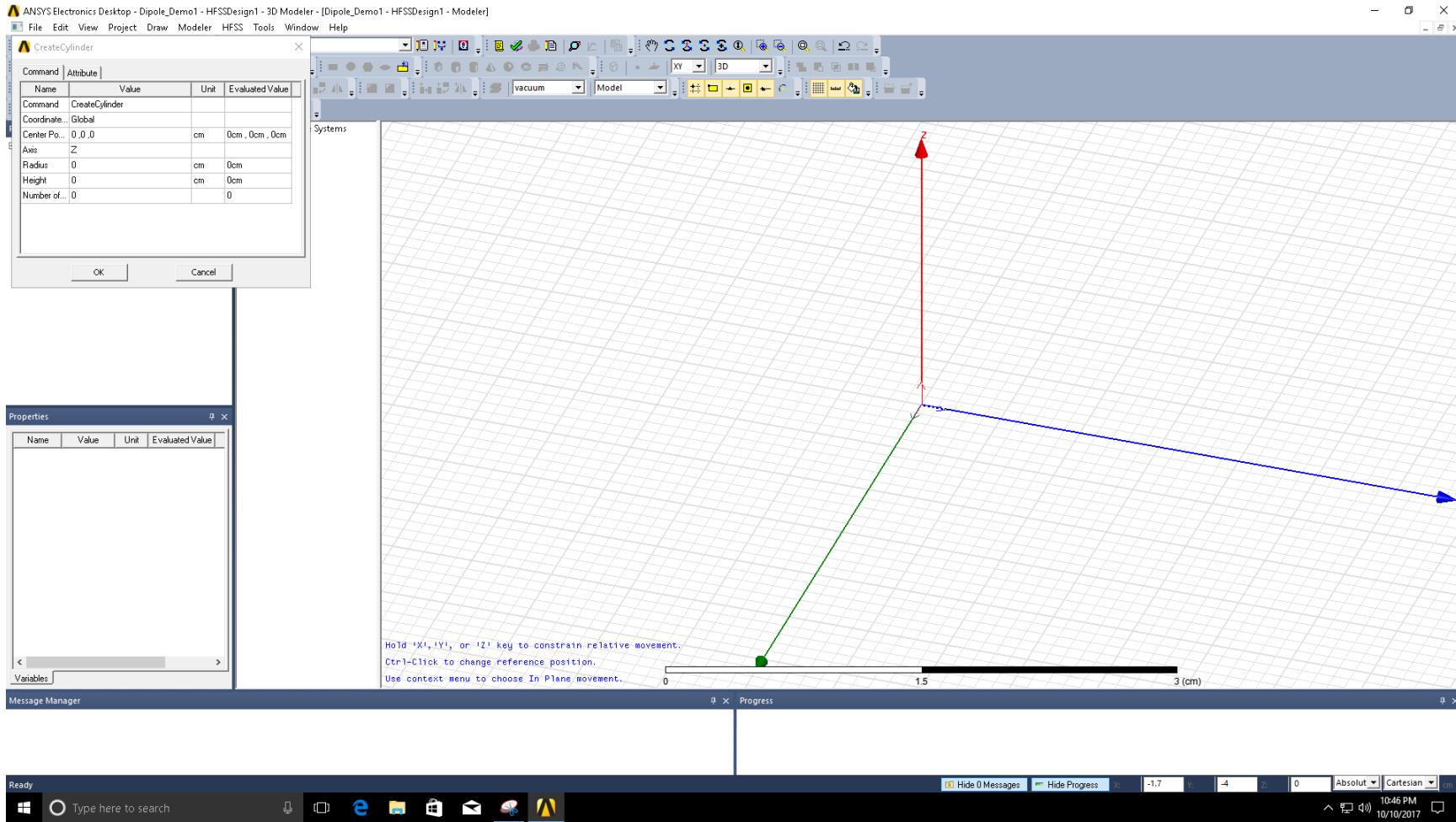
Drawing 3D Model

Draw > Cylinder



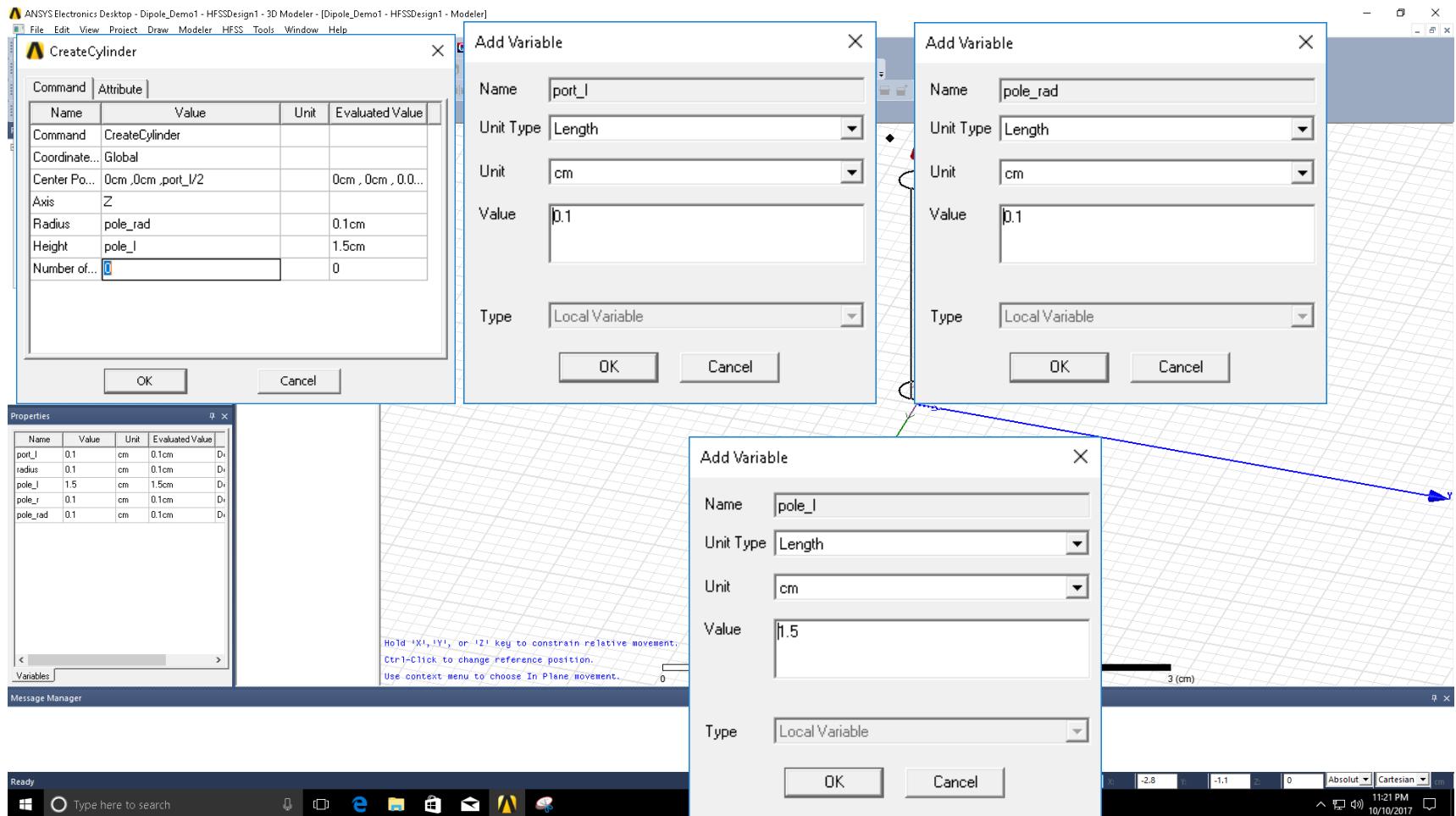
Drawing 3D Model

Create Cylinder Dialog Box Opens



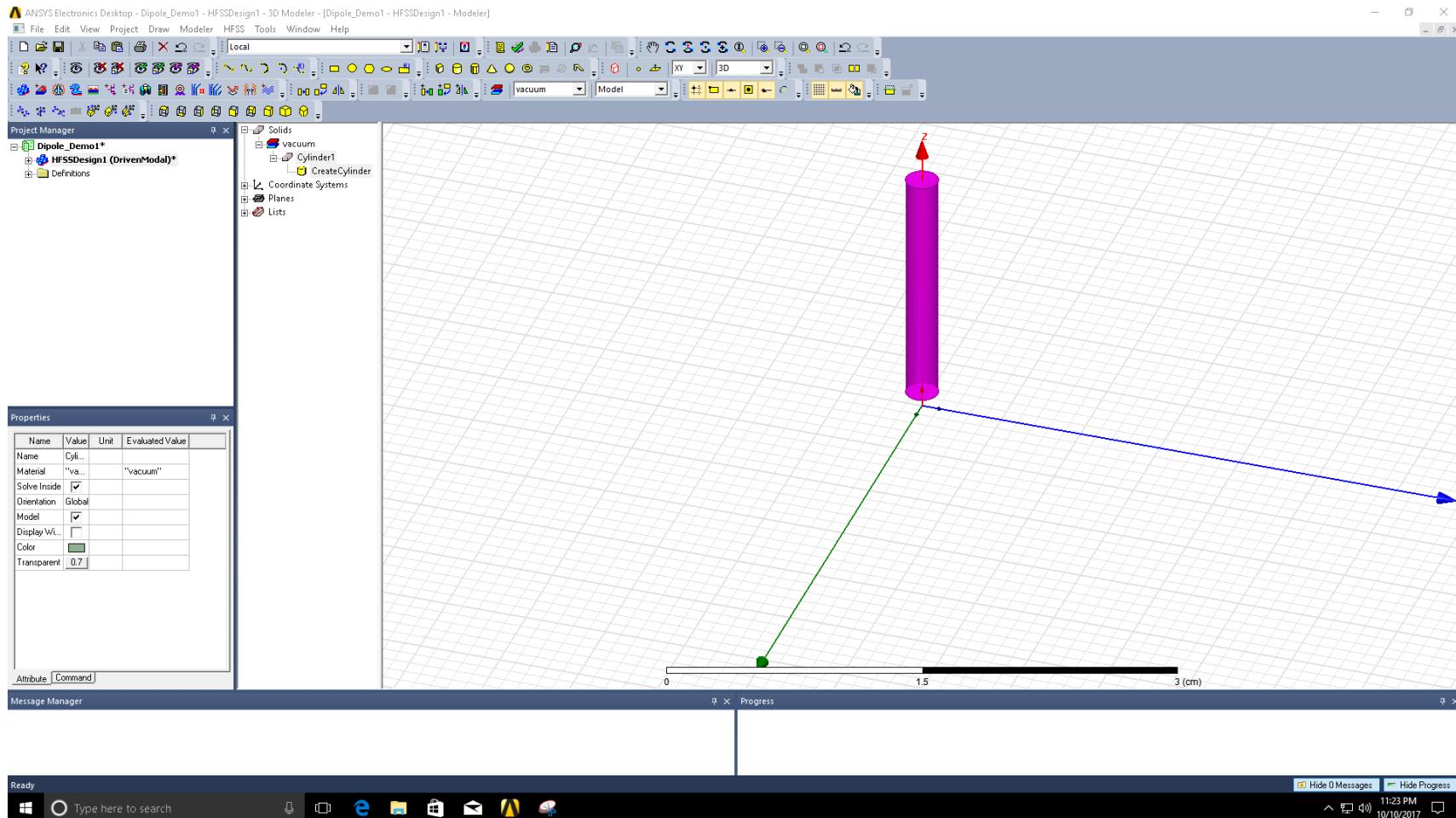
Drawing 3D Model

Create Variables



Drawing 3D Model

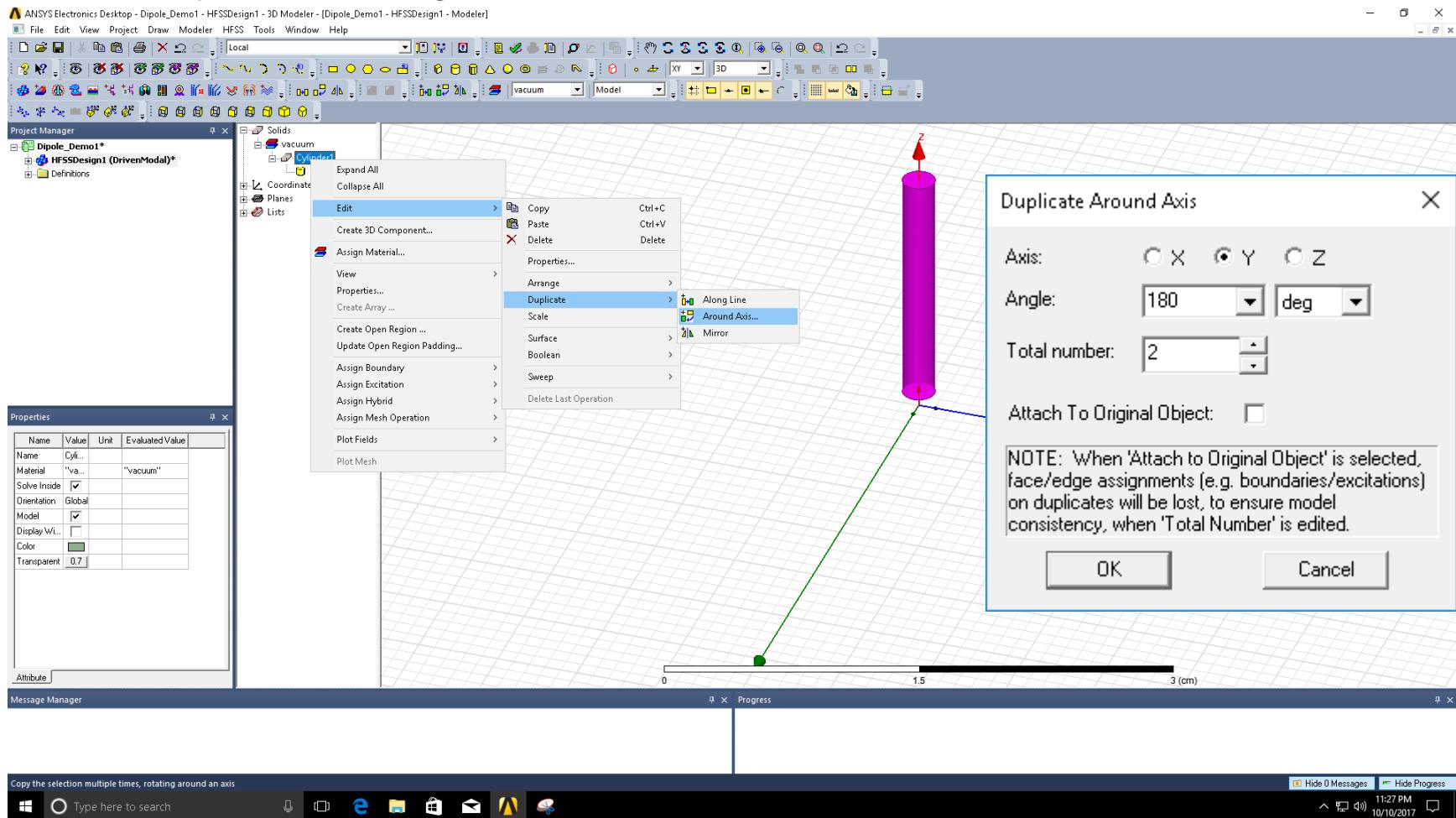
Cylinder1 Created



Drawing 3D Model

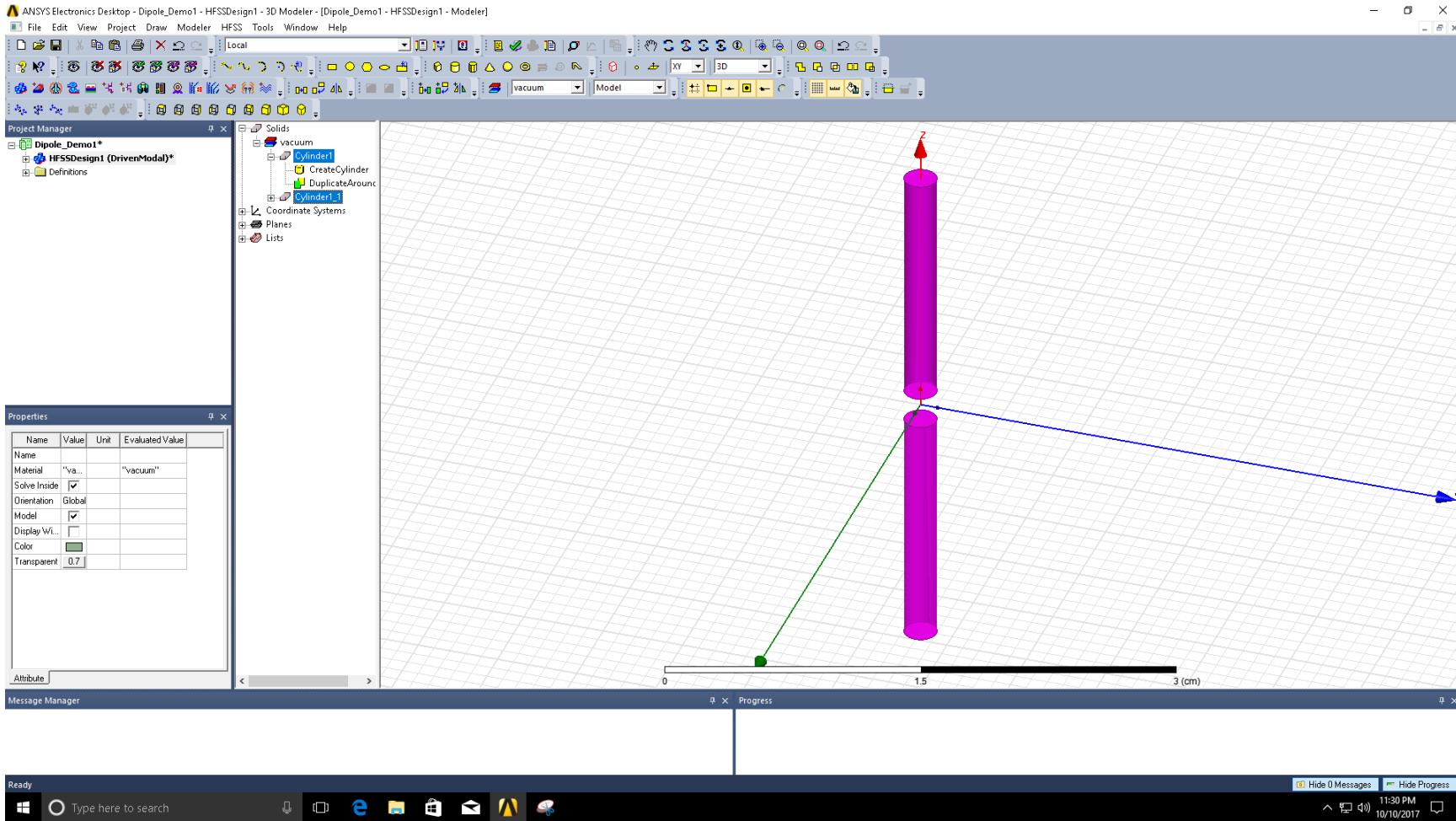
Duplicate Cylinder 1 to create second pole

Cylinder1 >(right click) Edit > Duplicate > Around Axis



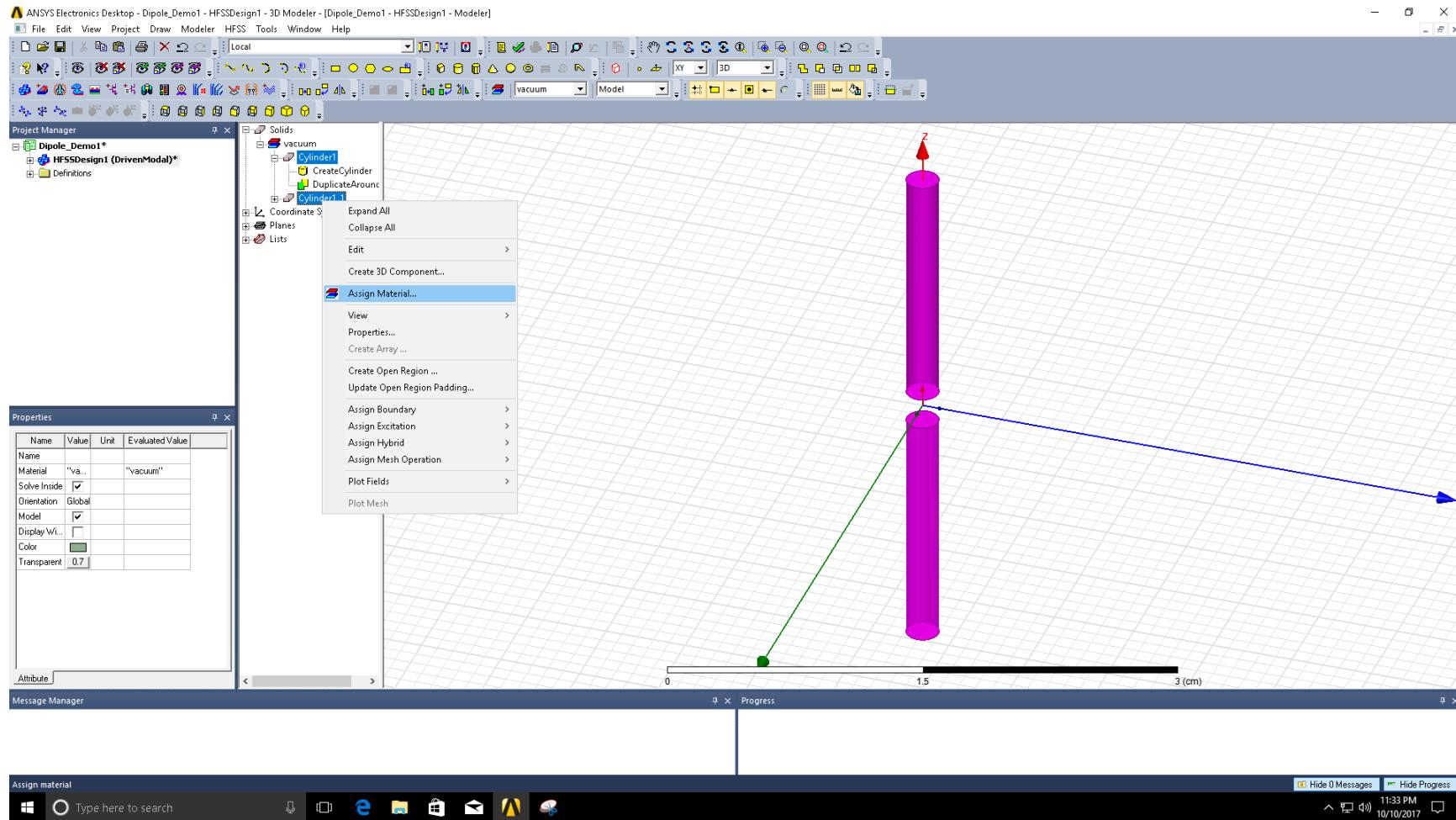
Drawing 3D Model

Cylinder1_1 created



Assigning Materials

Select Cylinder1 and Cylinder1_1 > (Right Click) > Assign Materials



Assigning Materials

Search Copper > Select > OK

Select Definition

Materials | Material Filters |

Search Parameters

Search by Name: Copper (Search button circled in red)

Search Criteria: by Name by Property

Relative Permittivity

Libraries: Show Project definitions Show all libraries

[sys] Materials
[sys] RMxprt

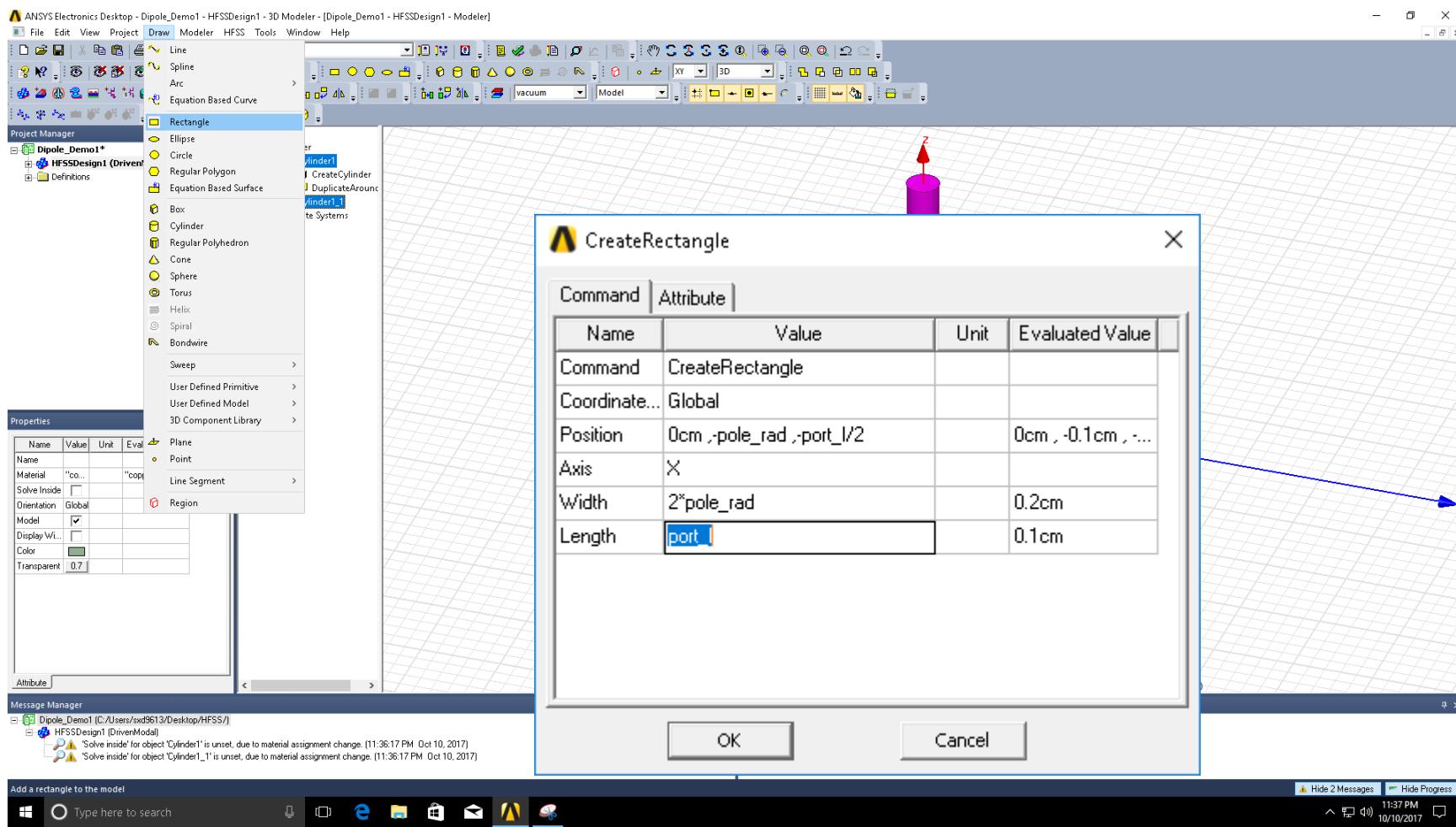
	Name	Location	Origin	Relative Permittivity	Relative Permeability	B Conc
cast_iron	SysLibrary	Materials	1	60	1500000sien	
chromium	SysLibrary	Materials	1	1	7600000sien	
cobalt	SysLibrary	Materials	1	250	10000000sie	
copper	SysLibrary	Materials	1	0.999991	58000000sie	
corning_glass	SysLibrary	Materials	5.75	1	0	
cyanate_ester	SysLibrary	Materials	3.8	1	0	
diamond	SysLibrary	Materials	16.5	1	0	
diamond_hi_pres	SysLibrary	Materials	5.7	1	0	
diamond_pl_cvd	SysLibrary	Materials	3.5	1	0	
Dupont Type 100 HN Film (tm)	SysLibrary	Materials	3.5	1	0	
Duroid (tm)	SysLibrary	Materials	2.2	1	0	

View/Edit Materials... | Add Material... | Clone Material(s) | Remove Material(s) | Export to Library...

OK | Cancel | Help

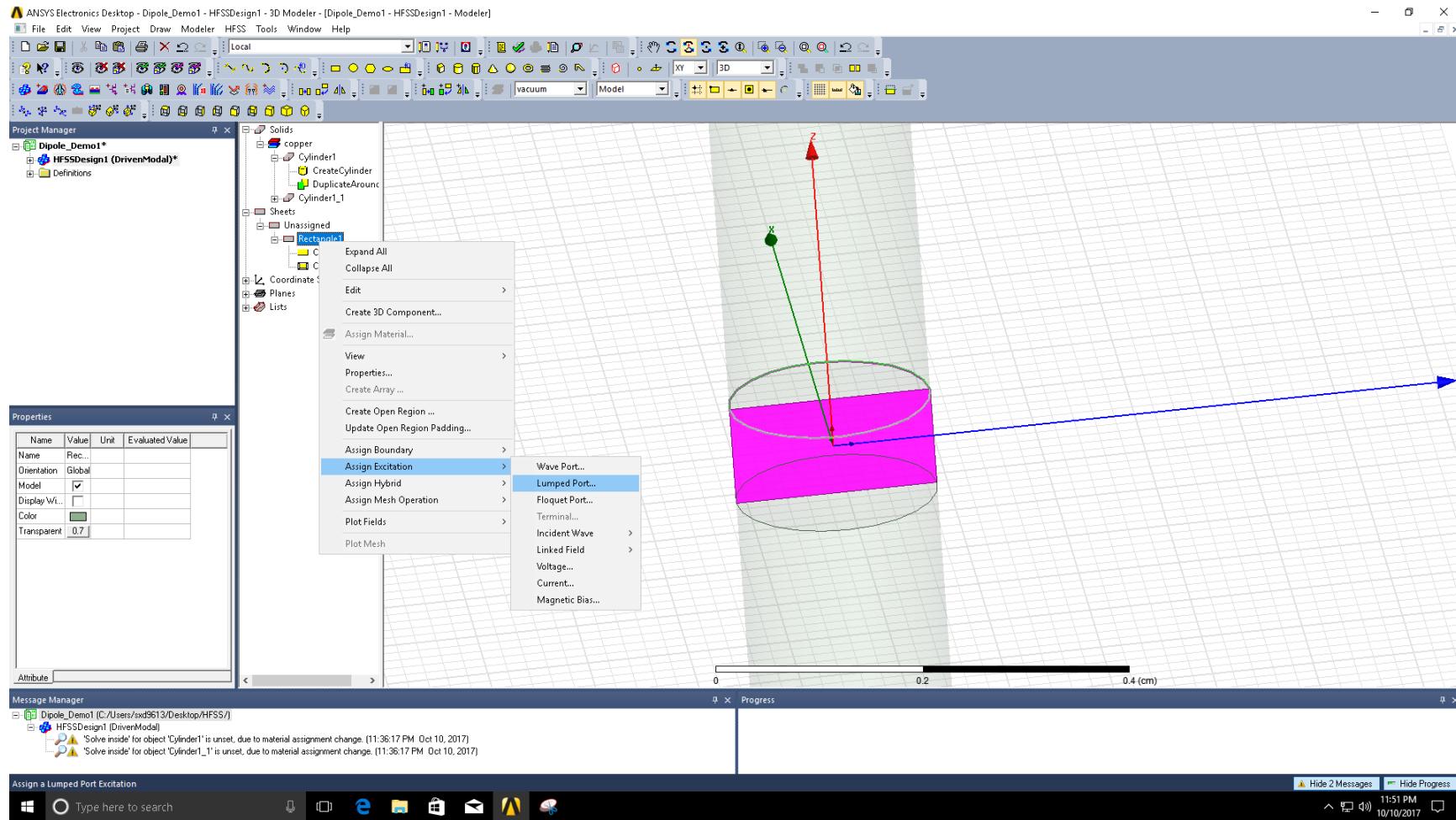
Create Port

Draw > Rectangle > OK



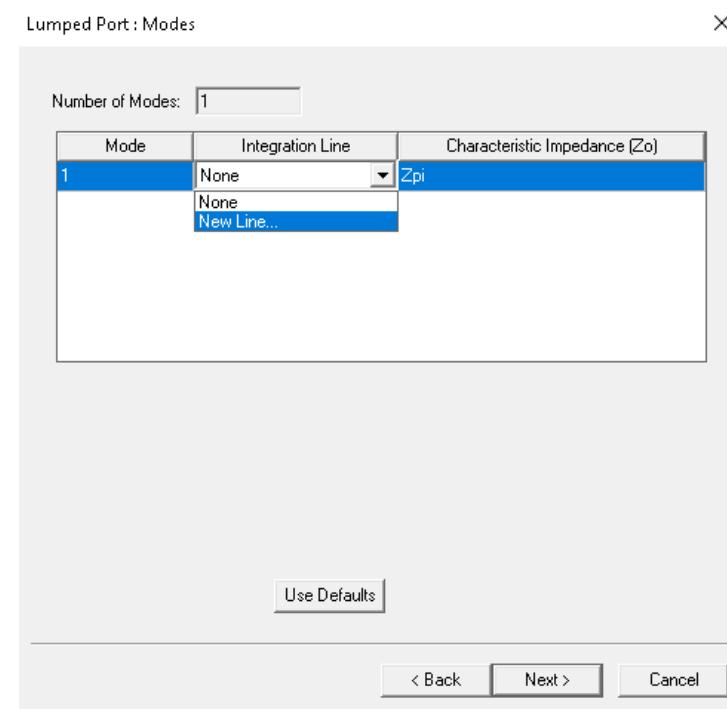
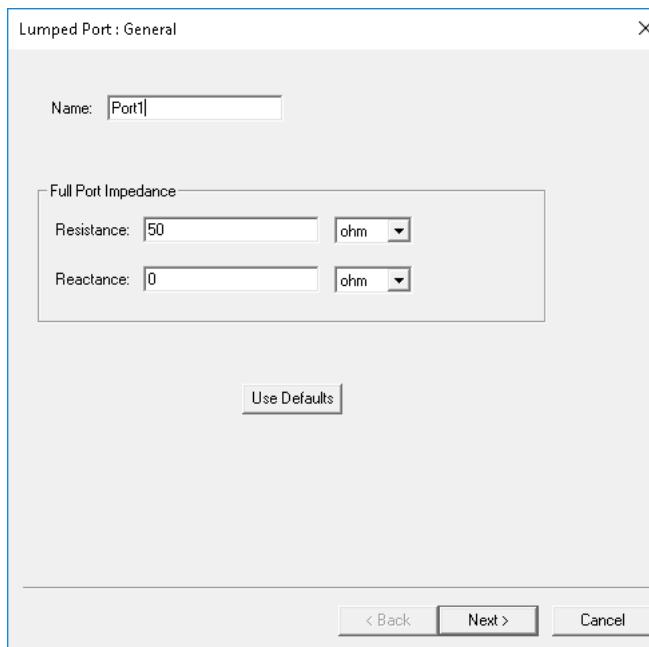
Create Port

Select Rectangle1 > (right click) > Assign Excitation > Lumped Port



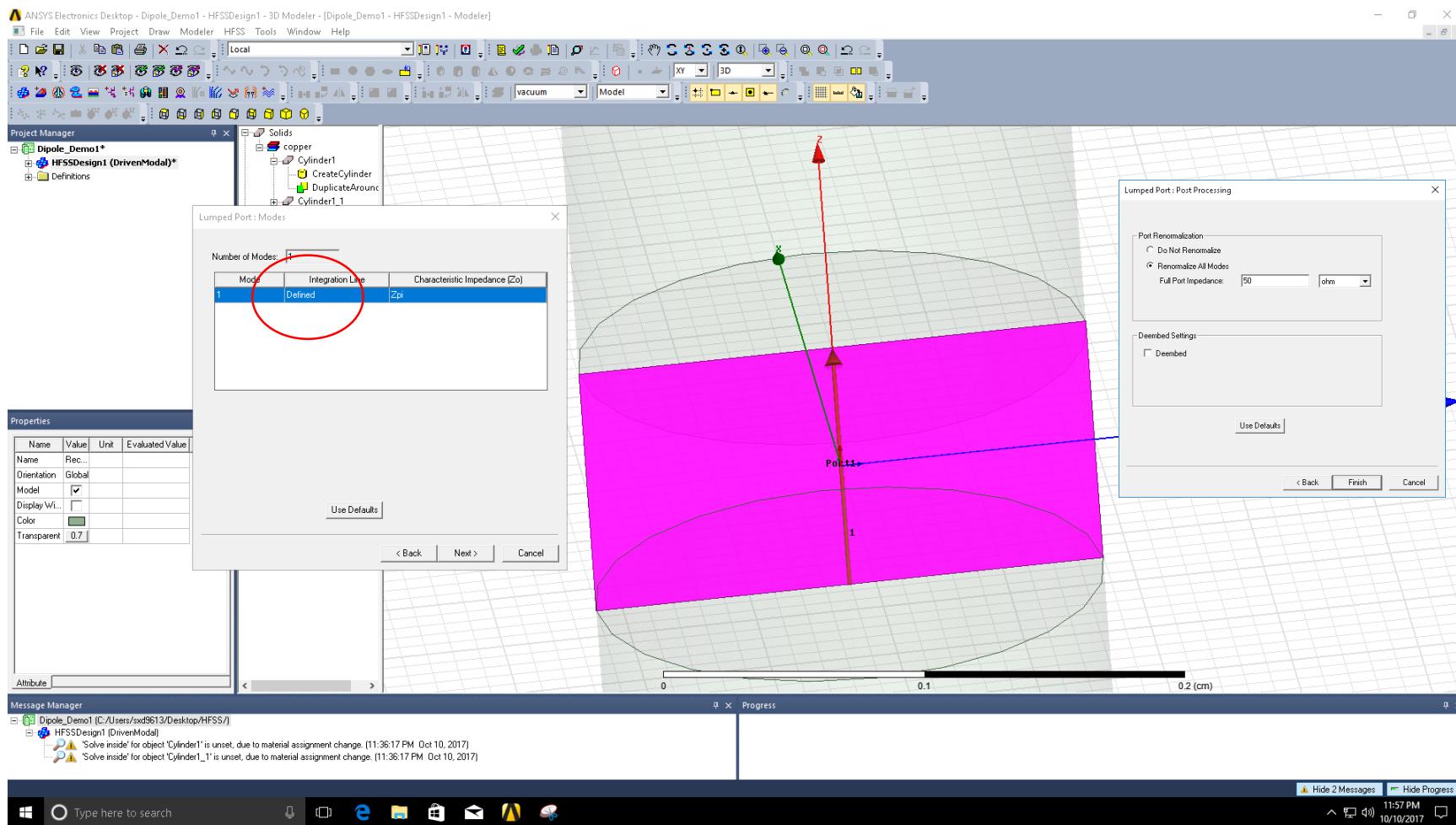
Create Port

Give Name Port1 > Next > Integration Line > New Line



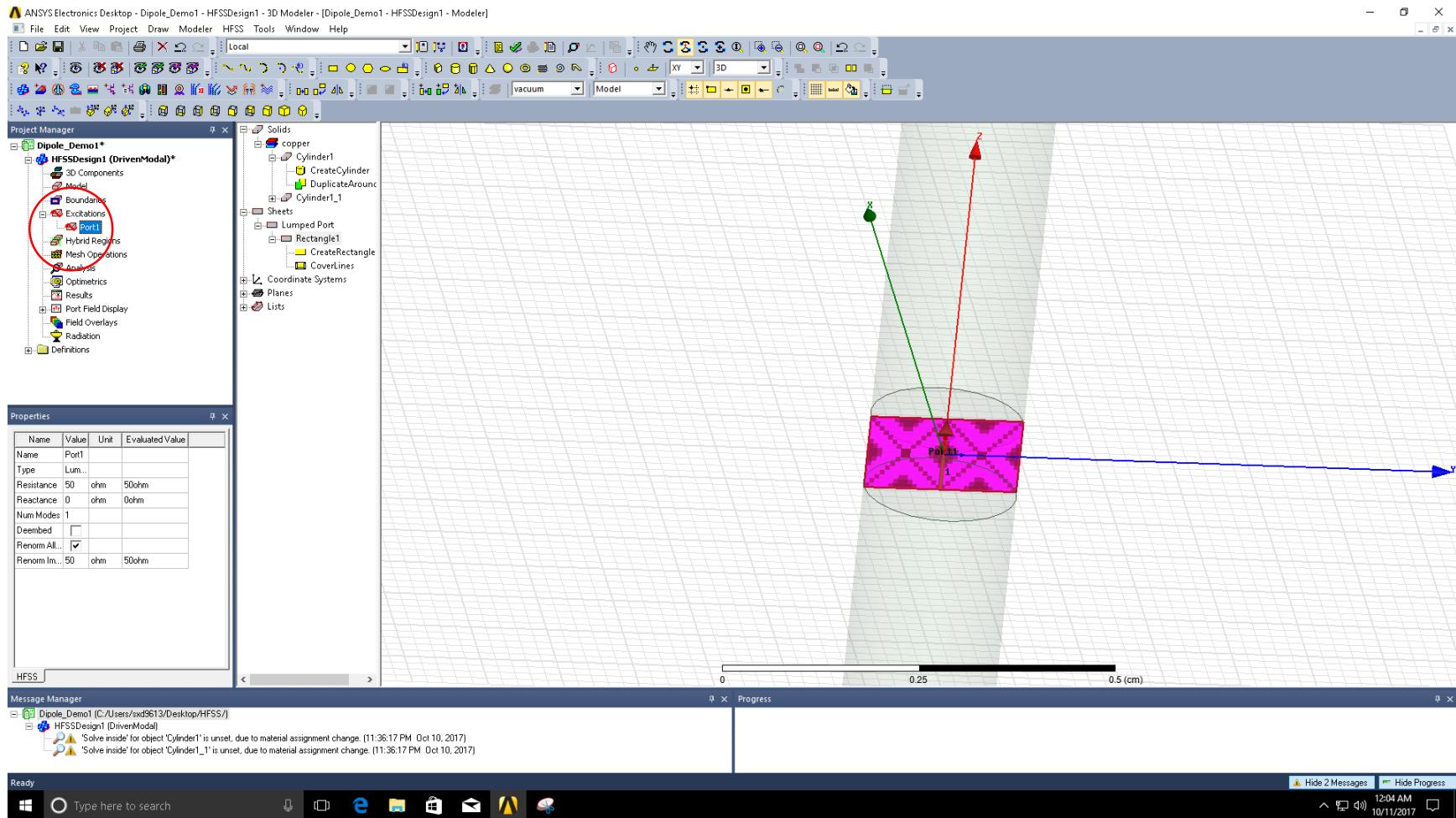
Create Port

Draw New Integration line along the center of the port between antenna arms >
Next > Renormalize all modes to 50 Ohm > Finish



Create Port

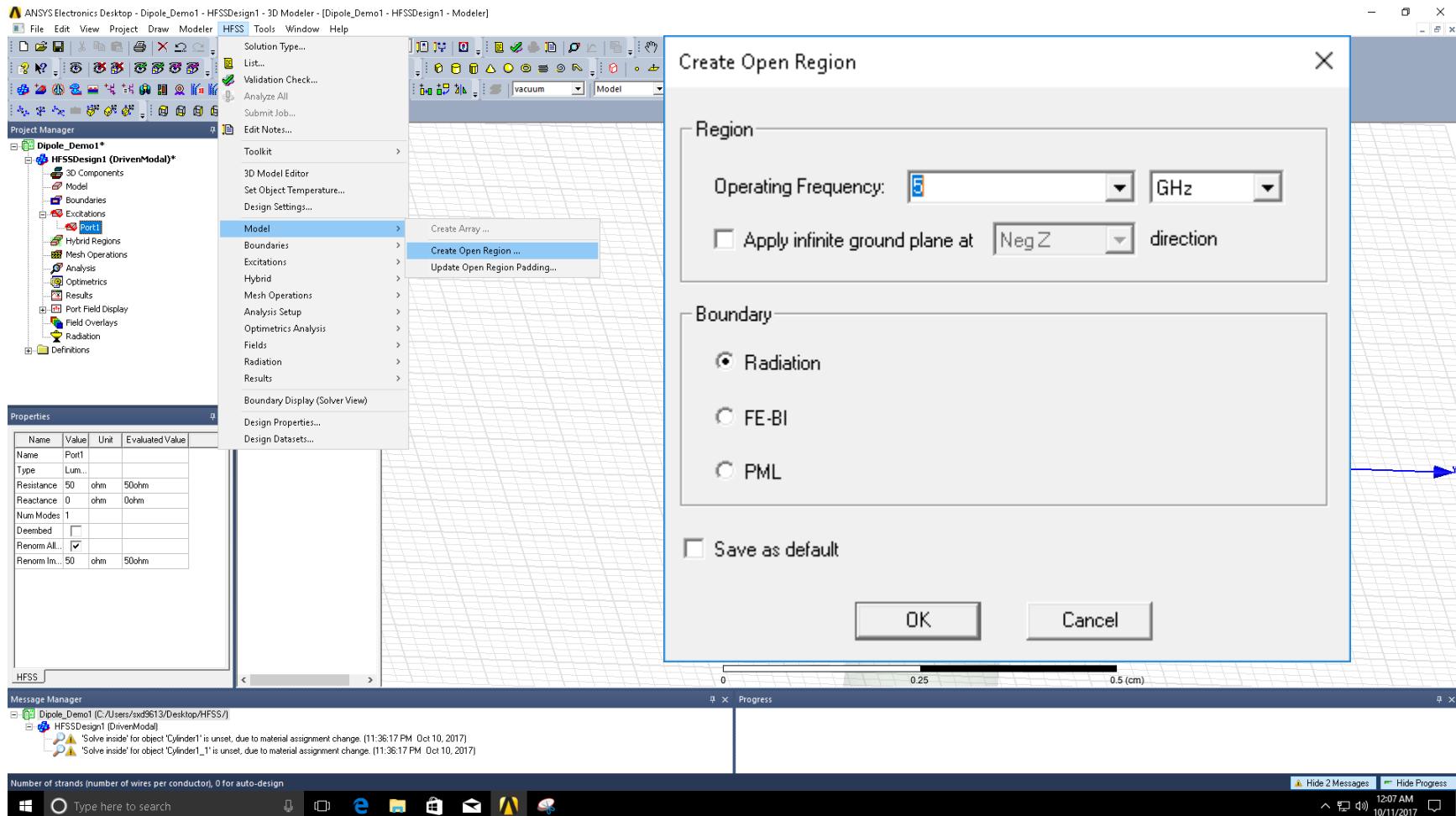
Port assignment should look like this



Create Radiation Boundary

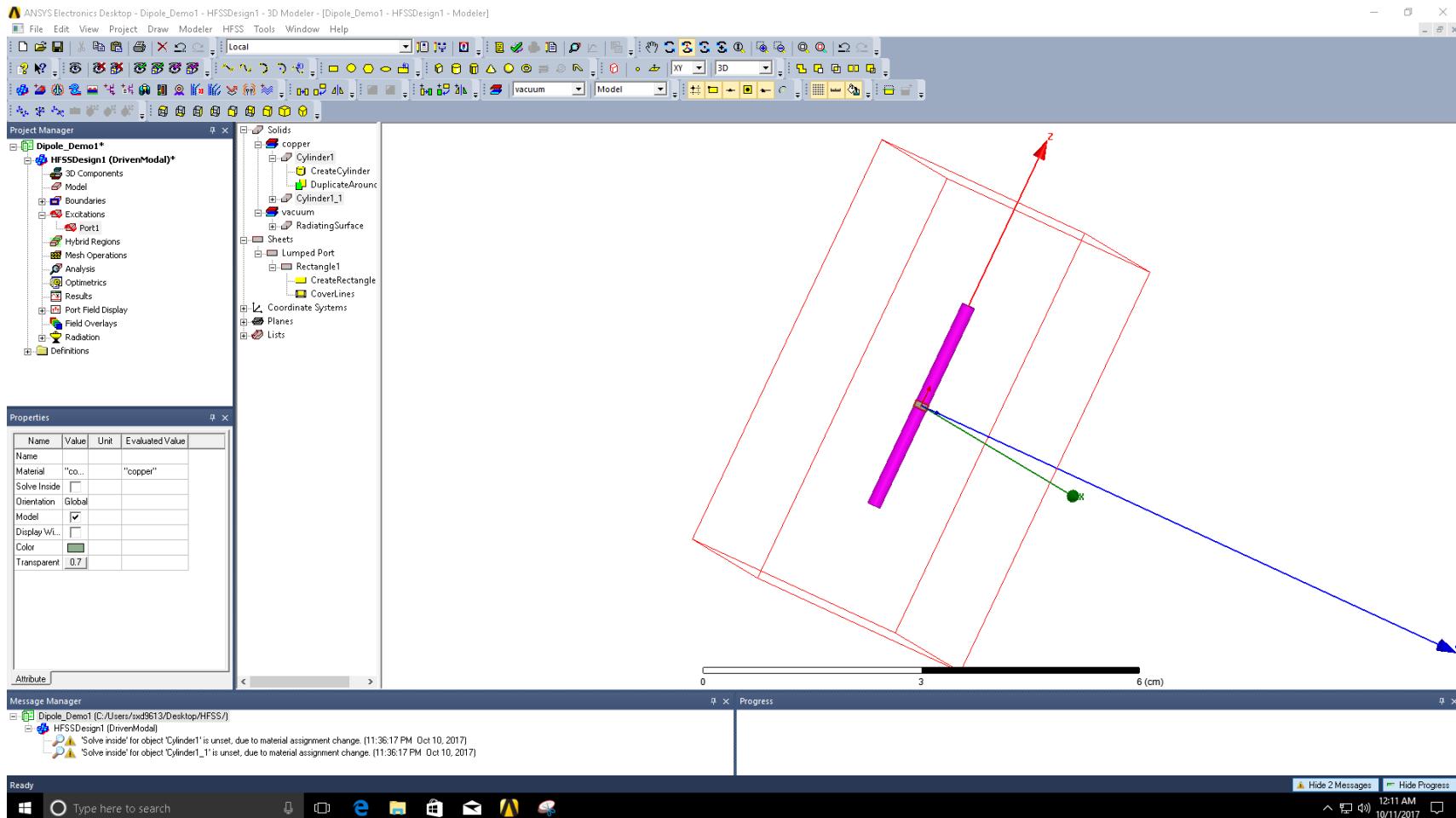
HFSS > Model > Create Open Region

Enter Operation Frequency and select radiation boundary



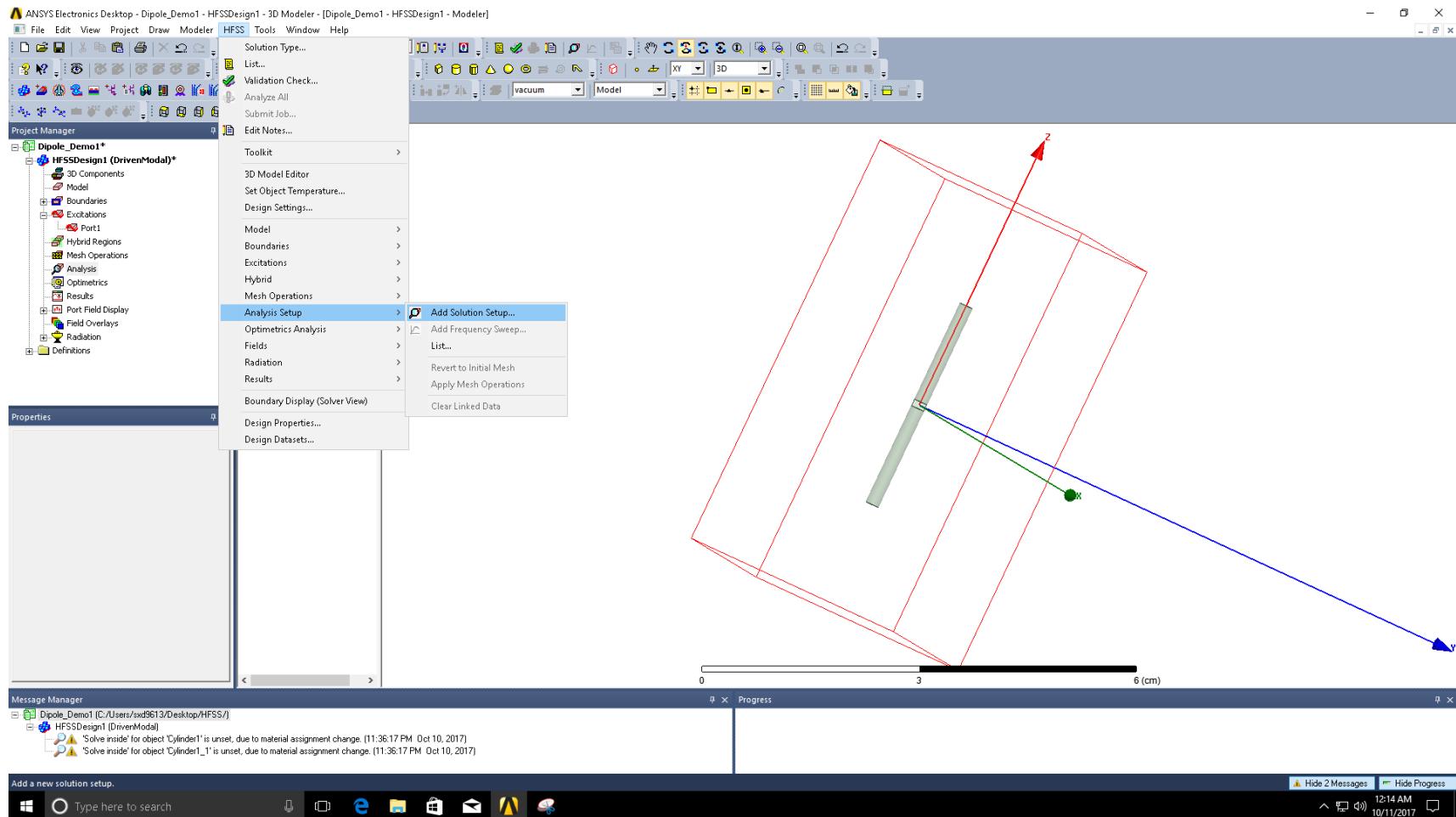
Create Radiation Boundary

Vacuum Radiating Surface Created



Solution Setup

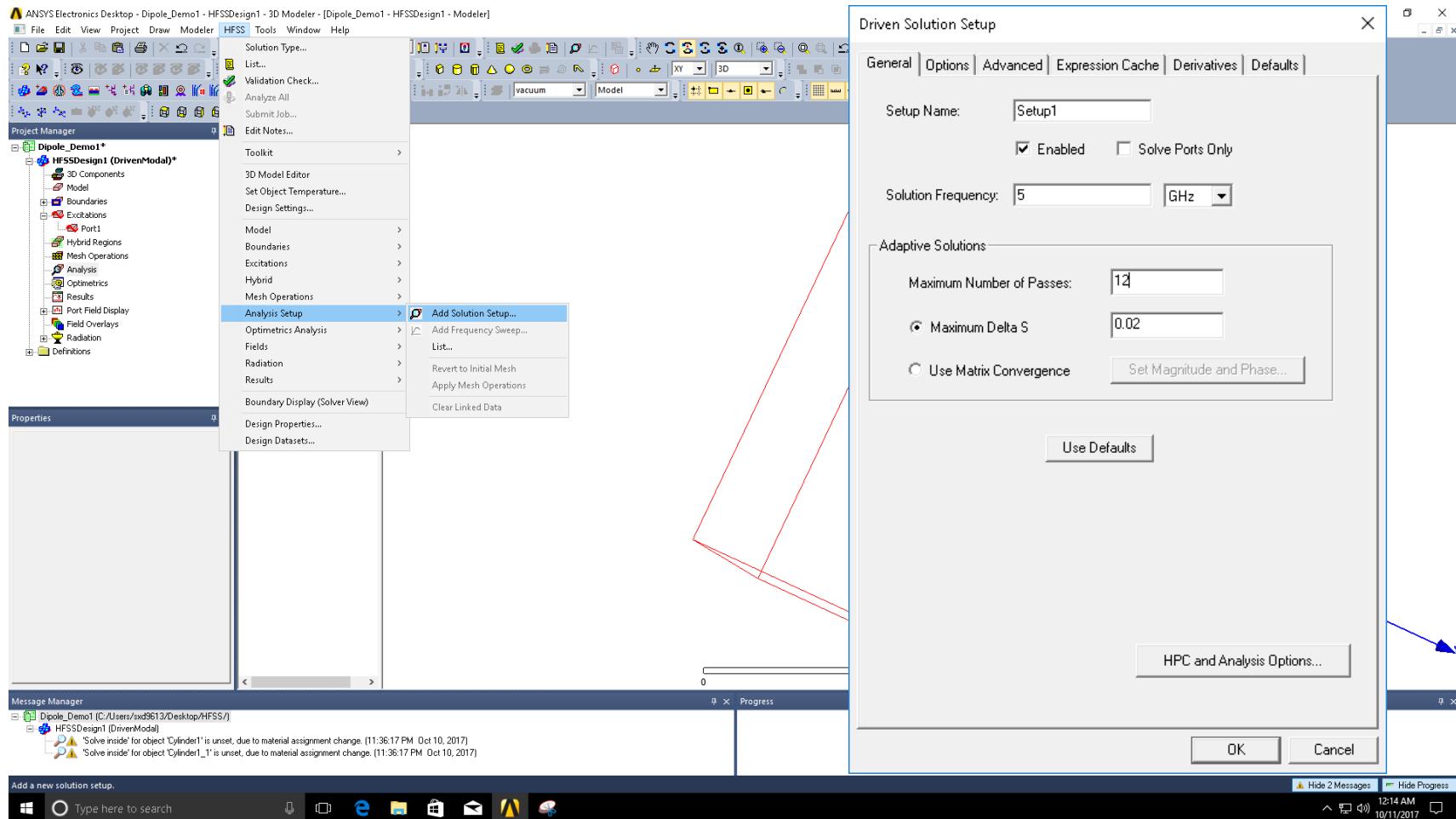
HFSS > Analysis Setup > Add Solution Setup



Solution Setup

HFSS > Analysis Setup > Add Solution Setup

Select solution frequency , Maximum Number of Passes 12



ANSYS Electronics Desktop - Dipole_Demo1 - HFSSDesign1 - 3D Modeler - [Dipole_Demo1 - HFSSDesign1 - Modeler]

File Edit View Project Draw Modeler HFSS Tools Window Help

Project Manager

Dipole_Demo1* HFSSDesign1 (DrivenModel)*

- 3D Components
- Model
- Boundaries
- Excitations
 - Port1
- Hybrid Regions
- Mesh Operations
- Optimetrics
- Results
- Port Field Display
- Field Overlays
- Radiation
- Definitions

Properties

Analysis Setup > Add Solution Setup...

Optimetrics Analysis > Add Frequency Sweep...

Fields > List...

Radiation > Revert to Initial Mesh

Results > Apply Mesh Operations

Boundary Display (Solver View)

Design Properties...

Design Datasets...

Message Manager

Dipole_Demo1 (C:/Users/xd8613/Desktop/HFSS/)

HFSSDesign1 (DrivenModel)

⚠ Solve inside for object 'Cylinder1' is unset, due to material assignment change. (11:36:17 PM 0ct 10, 2017)

⚠ Solve inside for object 'Cylinder_1' is unset, due to material assignment change. (11:36:17 PM 0ct 10, 2017)

Add a new solution setup.

Type here to search

12:14 AM 10/11/2017

Driven Solution Setup

General Options Advanced Expression Cache Derivatives Defaults

Setup Name: Setup1

Enabled Solve Ports Only

Solution Frequency: 5 GHz

Adaptive Solutions

Maximum Number of Passes: 12

Maximum Delta S 0.02

Use Matrix Convergence Set Magnitude and Phase...

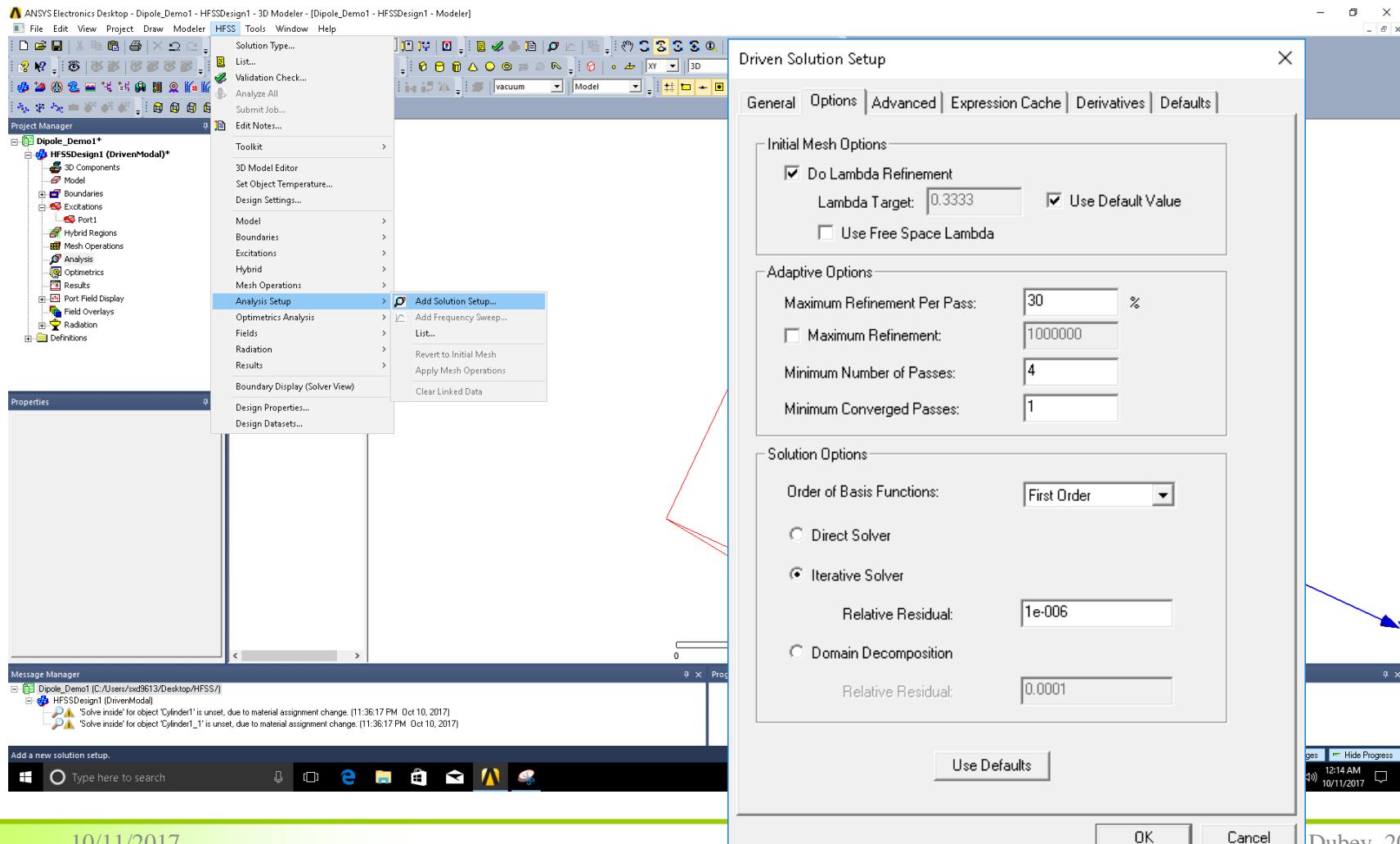
Use Defaults

OK Cancel

HPC and Analysis Options...

Solution Setup

In option tab enter Minimum Number of Passes 4, Solution option Iterative Solver



The image shows the ANSYS HFSS software interface. On the left, the 'Project Manager' pane displays the 'Dipole_Demo1' project with its various components and sub-components. The 'Properties' pane is visible below the project manager. A red line highlights the 'Analysis Setup' option in the 'HFSS' menu, which is expanded to show 'Add Solution Setup...'. The main workspace is occupied by the 'Driven Solution Setup' dialog box. This dialog box contains several tabs: General, Options (which is selected), Advanced, Expression Cache, Derivatives, and Defaults. The 'Options' tab is divided into sections: 'Initial Mesh Options', 'Adaptive Options', and 'Solution Options'. In the 'Adaptive Options' section, the 'Minimum Number of Passes' field is set to '4'. The 'Solution Options' section shows the 'Iterative Solver' option selected. The 'HFSSDesign1' project manager is also visible on the left, showing the status of various components like 3D Components, Model, Excitations, and Results. The 'Message Manager' at the bottom left shows some material assignment changes. The Windows taskbar at the bottom includes the Start button, a search bar, and icons for File Explorer, Edge, Mail, and File History.

Driven Solution Setup

General Options Advanced Expression Cache Derivatives Defaults

Initial Mesh Options

Do Lambda Refinement

Lambda Target: 0.3333 Use Default Value

Use Free Space Lambda

Adaptive Options

Maximum Refinement Per Pass: 30 %

Maximum Refinement: 1000000

Minimum Number of Passes: 4

Minimum Converged Passes: 1

Solution Options

Order of Basis Functions: First Order

Direct Solver

Iterative Solver

Relative Residual: 1e-006

Domain Decomposition

Relative Residual: 0.0001

Use Defaults

OK Cancel

ANSYS Electronics Desktop - Dipole_Demo1 - HFSSDesign1 - 3D Modeler - [Dipole_Demo1 - HFSSDesign1 - Modeler]

File Edit View Project Draw Modeler HFSS Tools Window Help

Project Manager

Dipole_Demo1* HFSSDesign1 (DrivenModel)*

- 3D Components
- Model
- Boundaries
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 - Port1
- Hybrid Regions
- Mesh Operations
- Analysis
- Optimetrics
- Results

Port Field Display

Field Overlays

Radiation

Definitions

Properties

Message Manager

Dipole_Demo1 (C:\Users\oxd8613\Desktop\HFSS\)

HFSSDesign1 (DrivenModel)

Solve inside for object 'Cylinder1' is unset, due to material assignment change. (11:36:17 PM 10/10/2017)

Solve inside for object 'Cylinder_1' is unset, due to material assignment change. (11:36:17 PM 10/10/2017)

Add a new solution setup.

Type here to search

10/11/2017

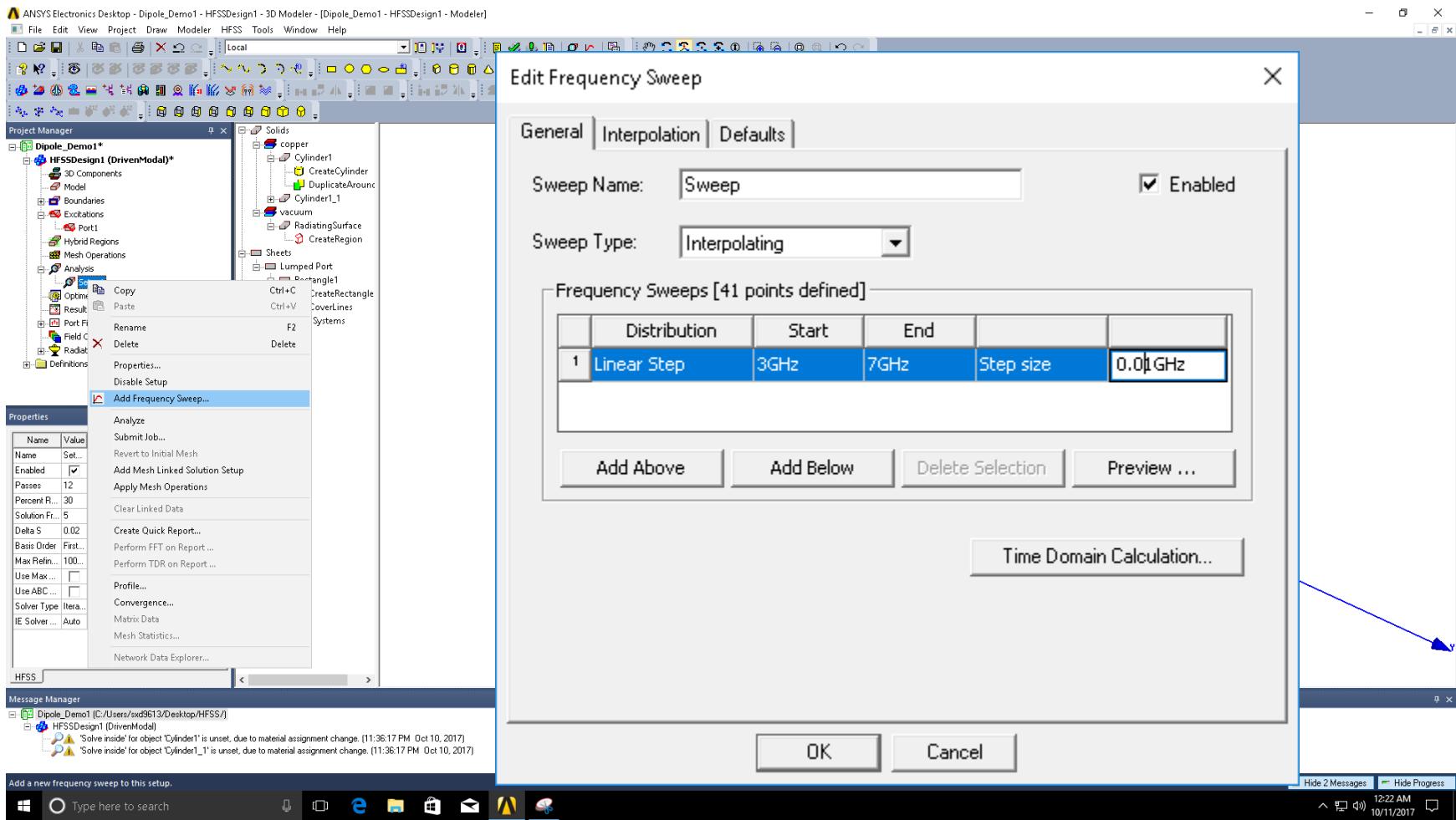
12:14 AM 10/11/2017

Dubey, 2017

34

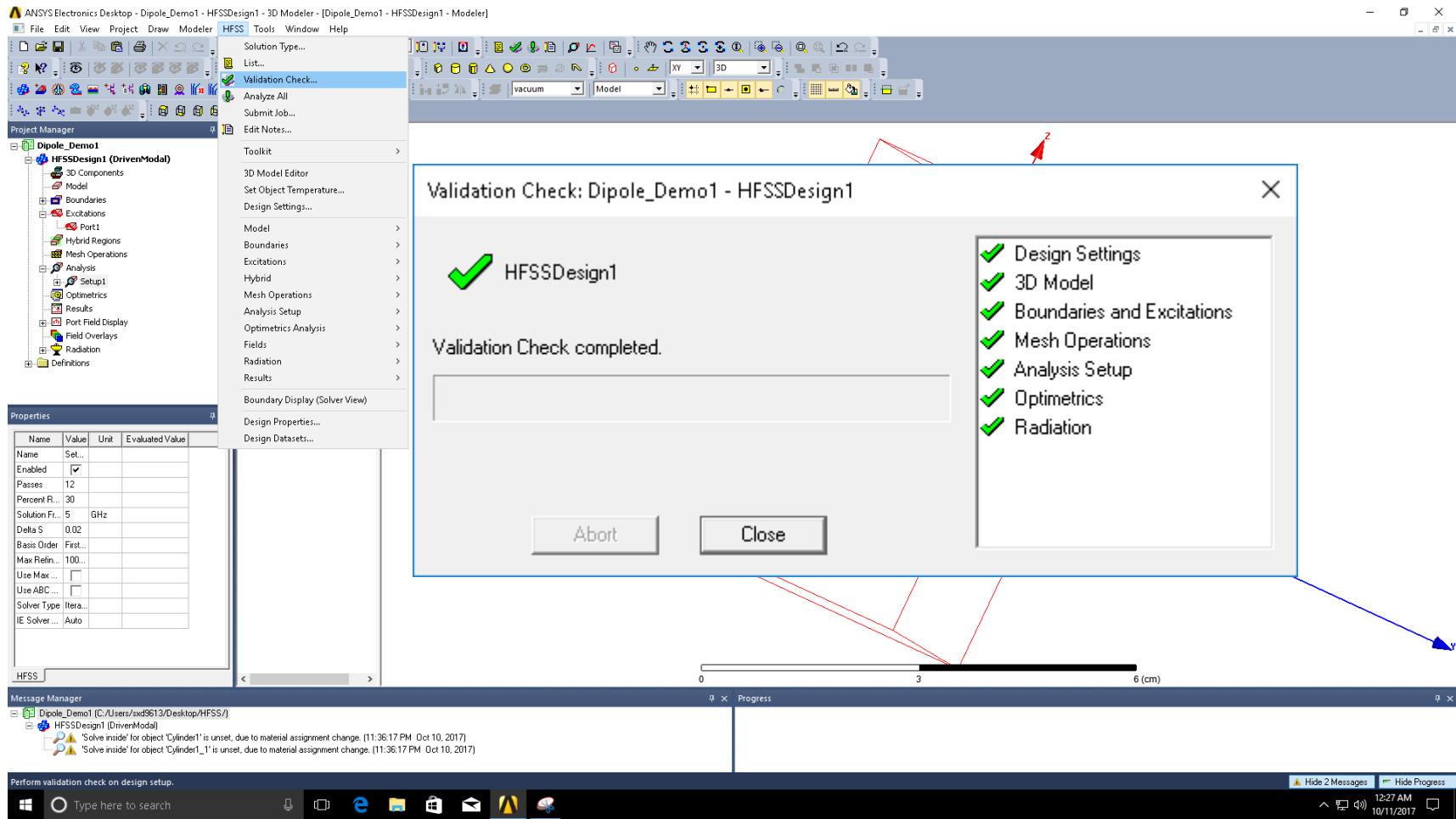
Add Frequency Sweep

Right click on newly created Setup1 from Analysis tab of project manger and add Frequency Sweep > Provide the start, end and step size as 3, 7 and 0.01 GHz



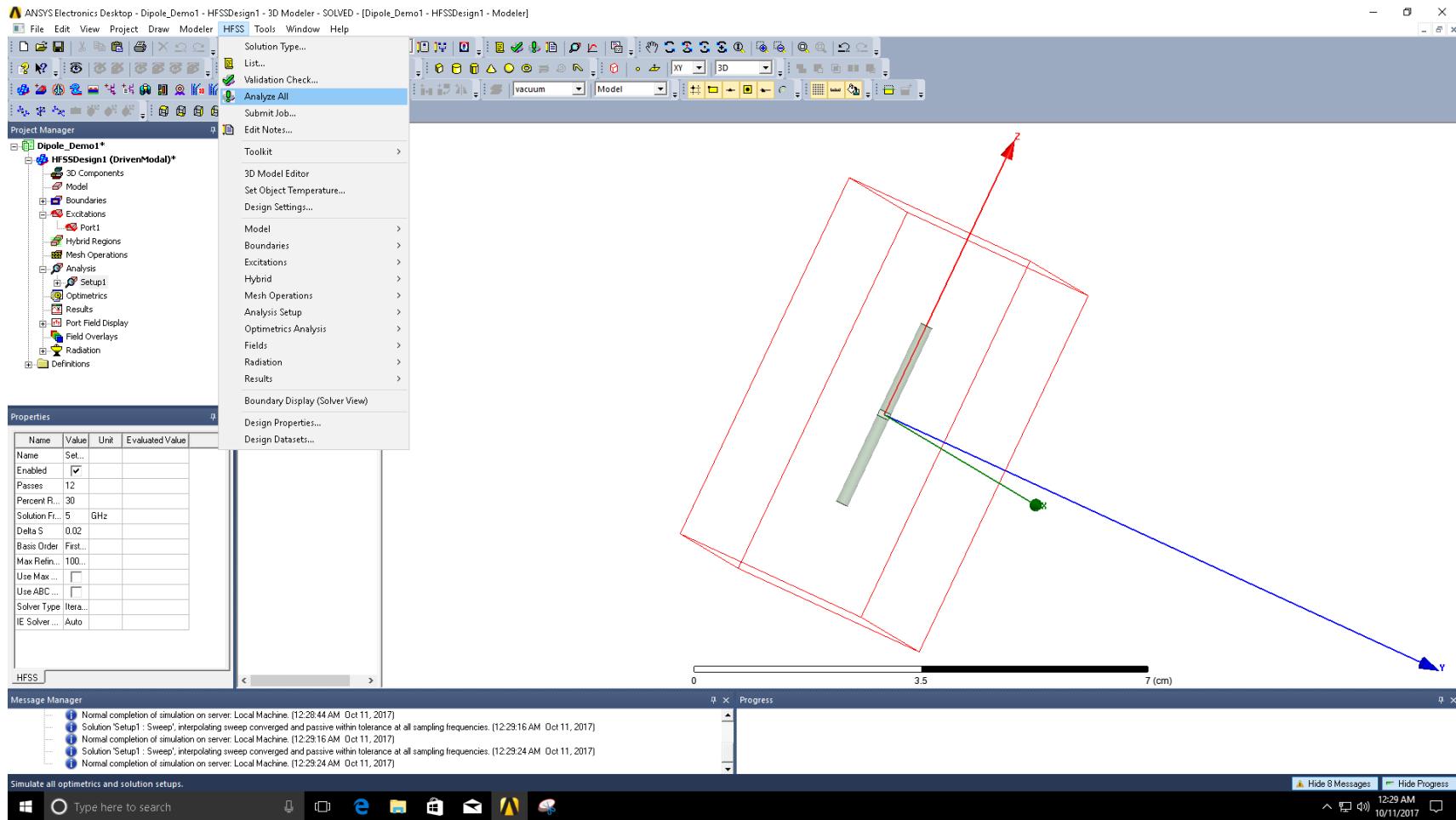
Save and Validation

Save the project > HFSS > Validation Check

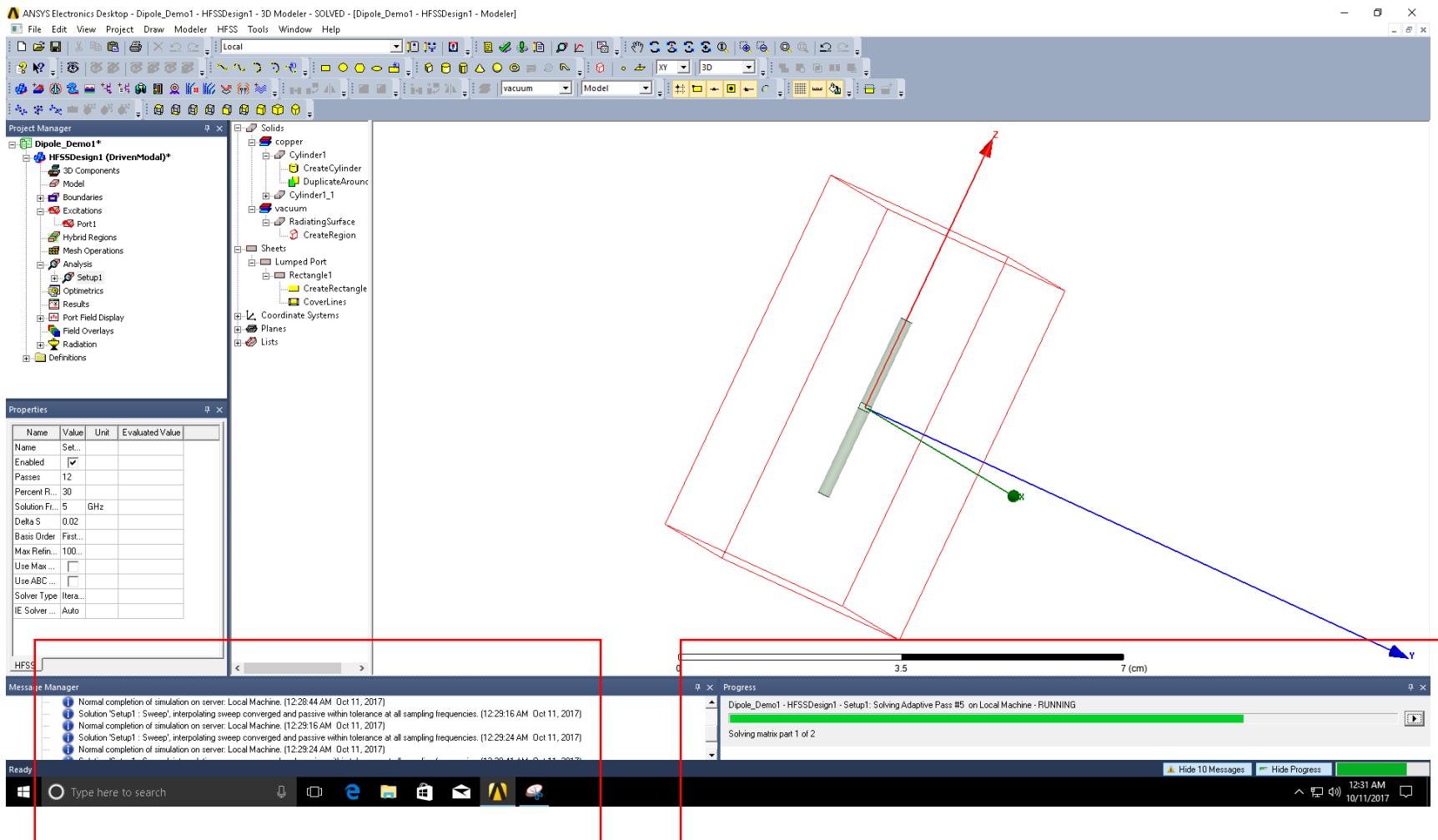


Run Simulation

HFSS > Analyze All



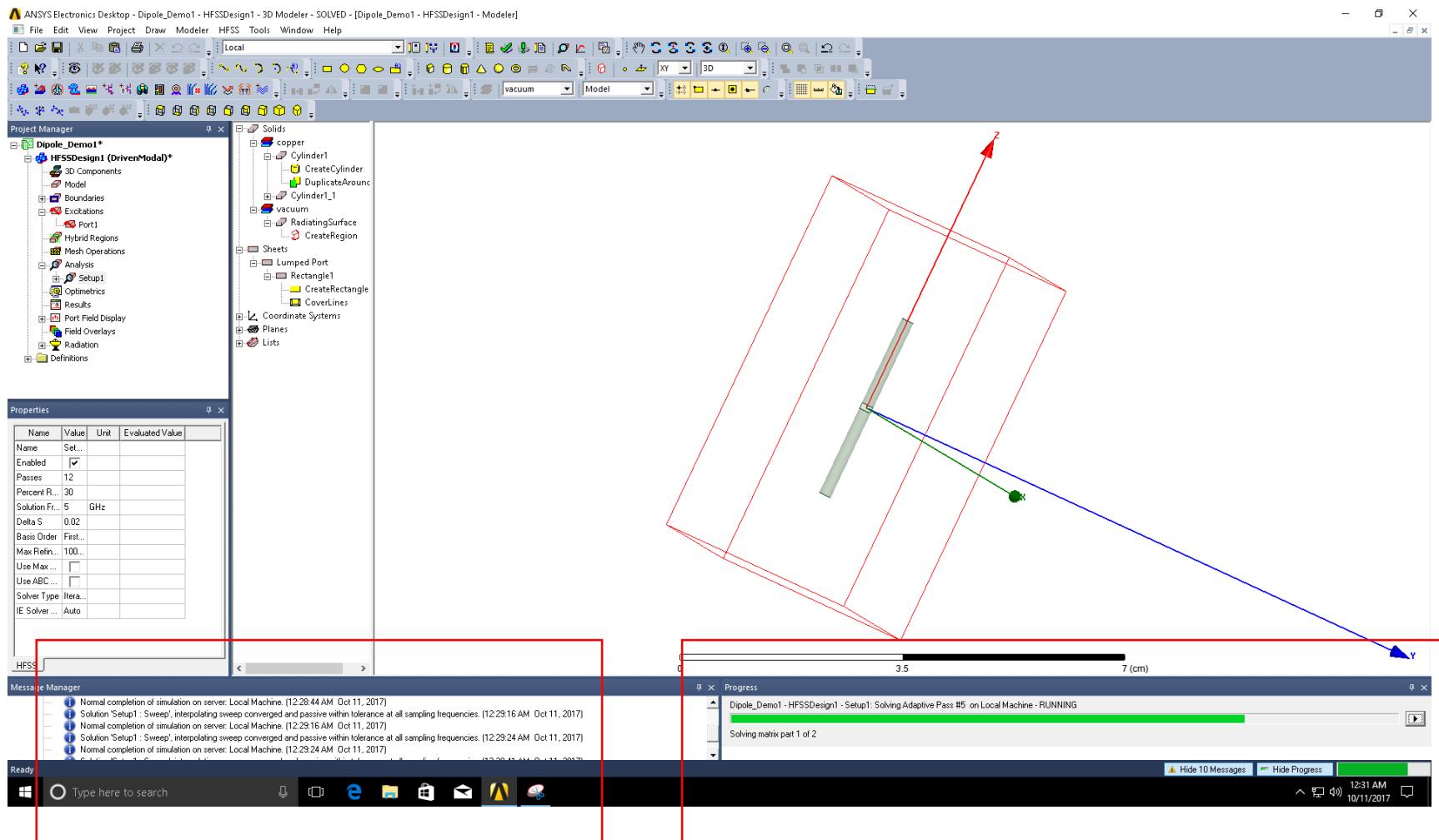
Simulation in Progress



Notifications

Progress Bar

Simulation in Progress

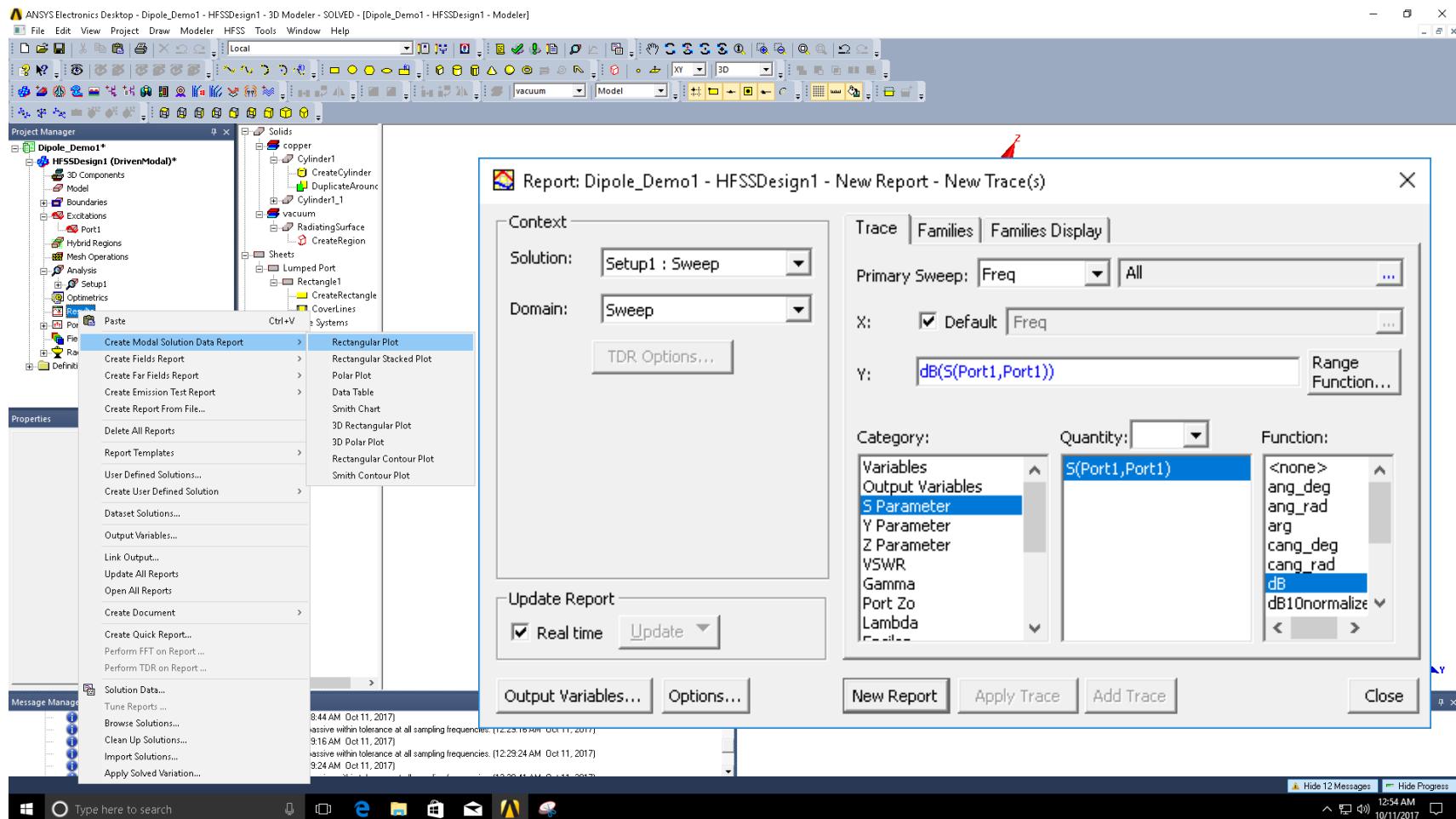


Notifications

Progress Bar

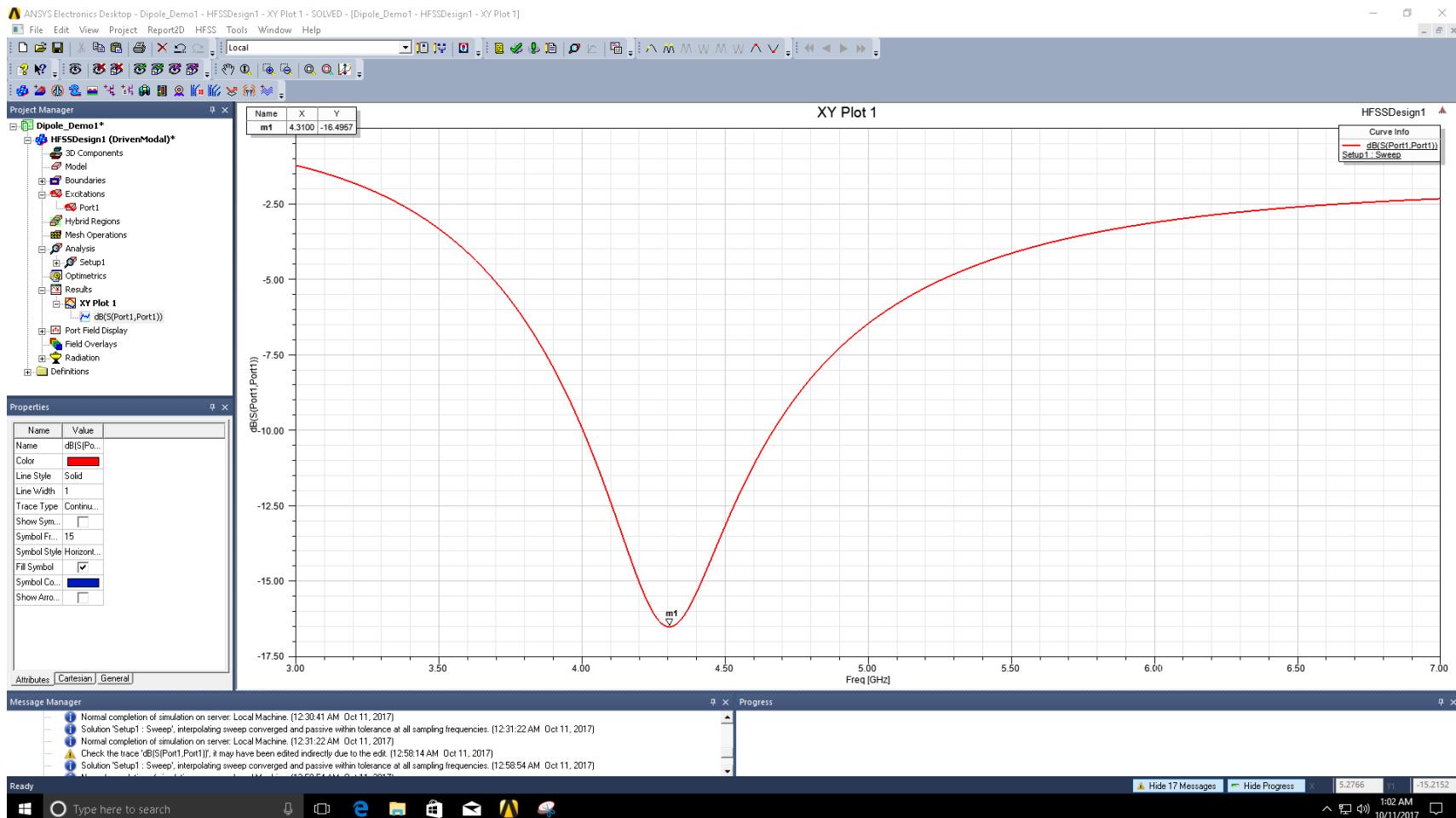
View Results (log magnitude)

Results (right click) > Create Modal Solution Data Report > Rectangular Plot
S parameter > S(Port1, Port1) > dB > New Report



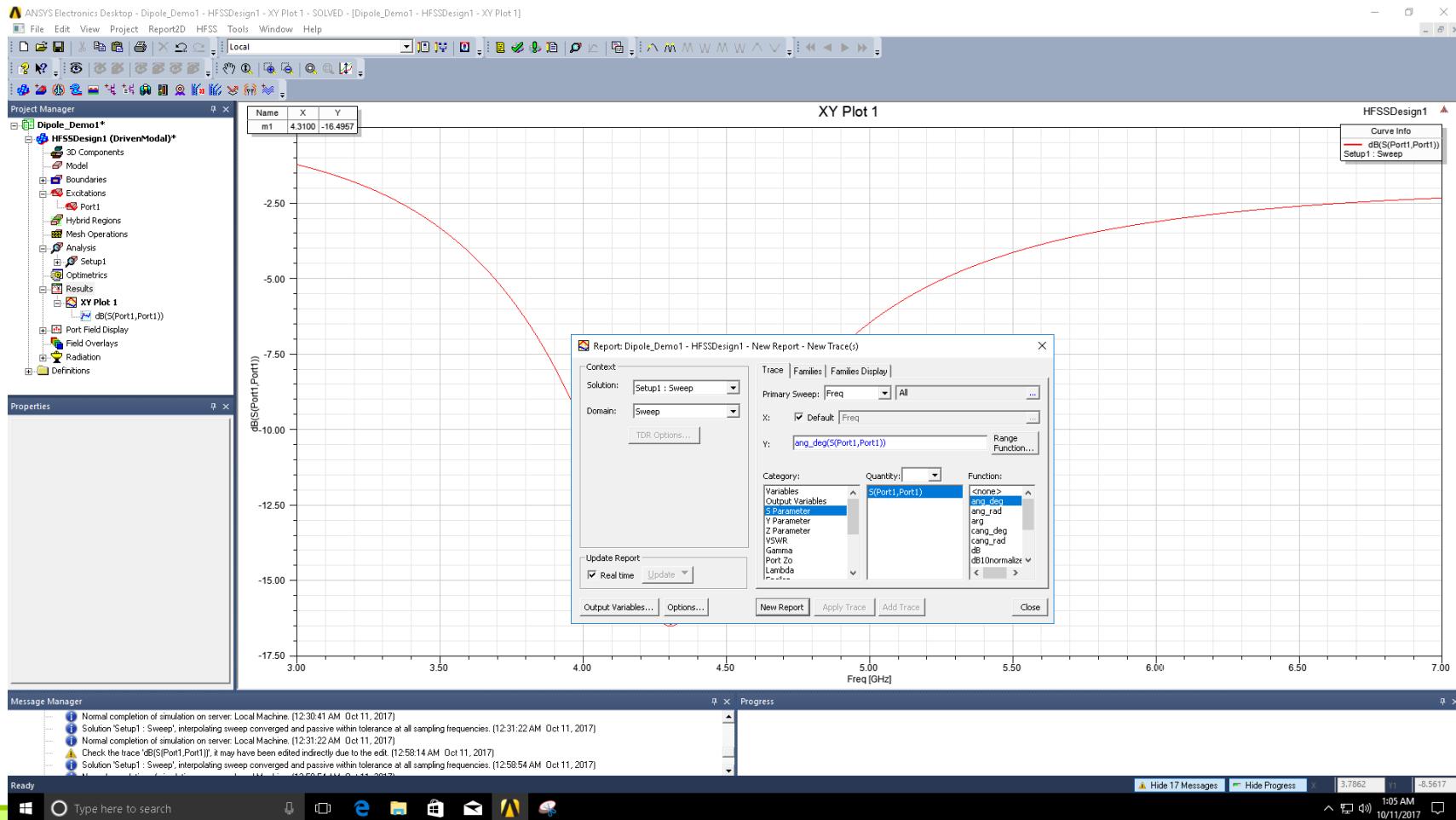
View Results (log magnitude)

Antenna Resonates at 4.31 GHz
 $|S_{11}| = -16.5 \text{ dB}$

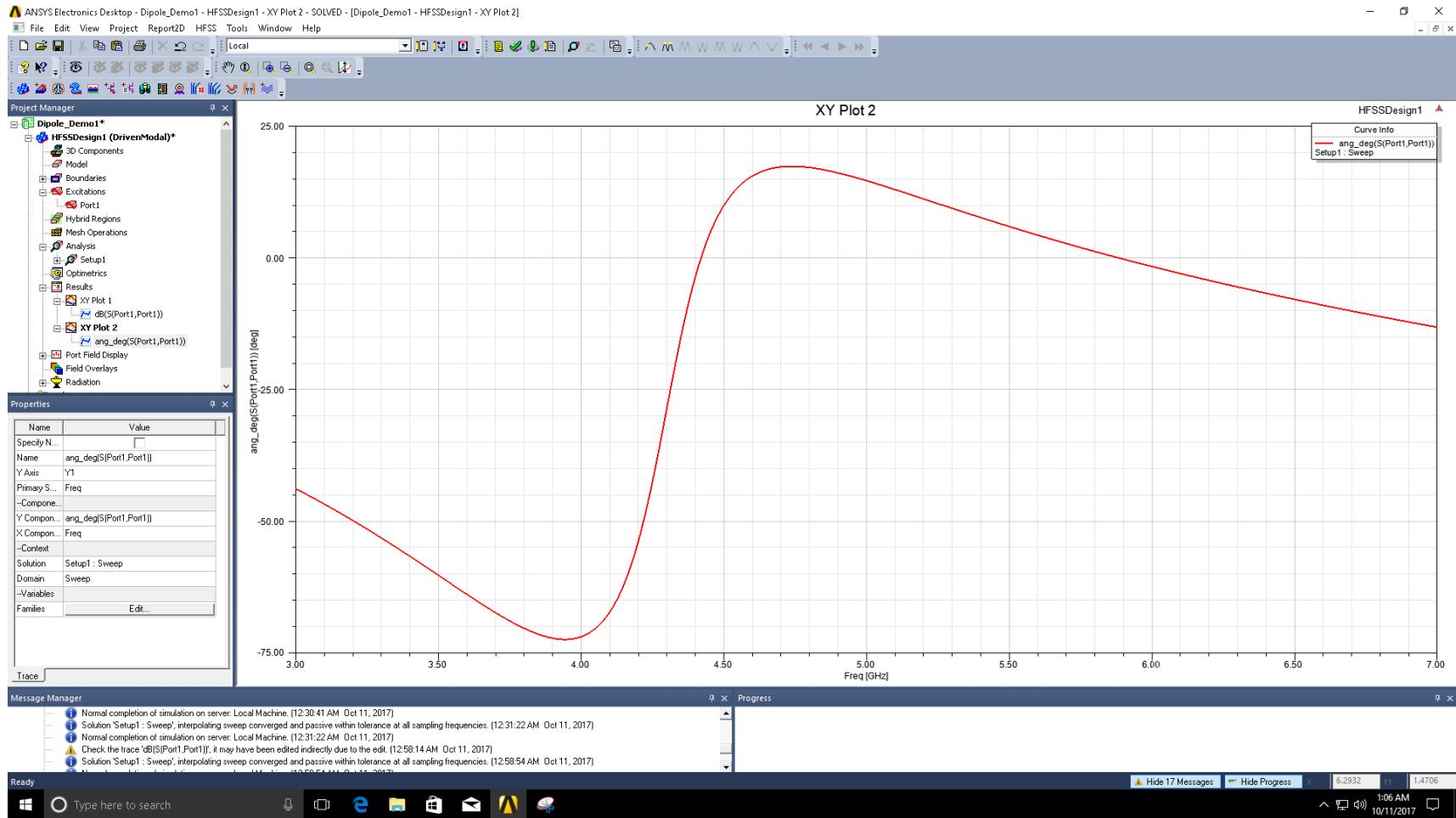


View Results (phase)

Results (right click) > Create Modal Solution Data Report > Rectangular Plot
 S parameter > S(Port1, Port1) > and_deg > New Report

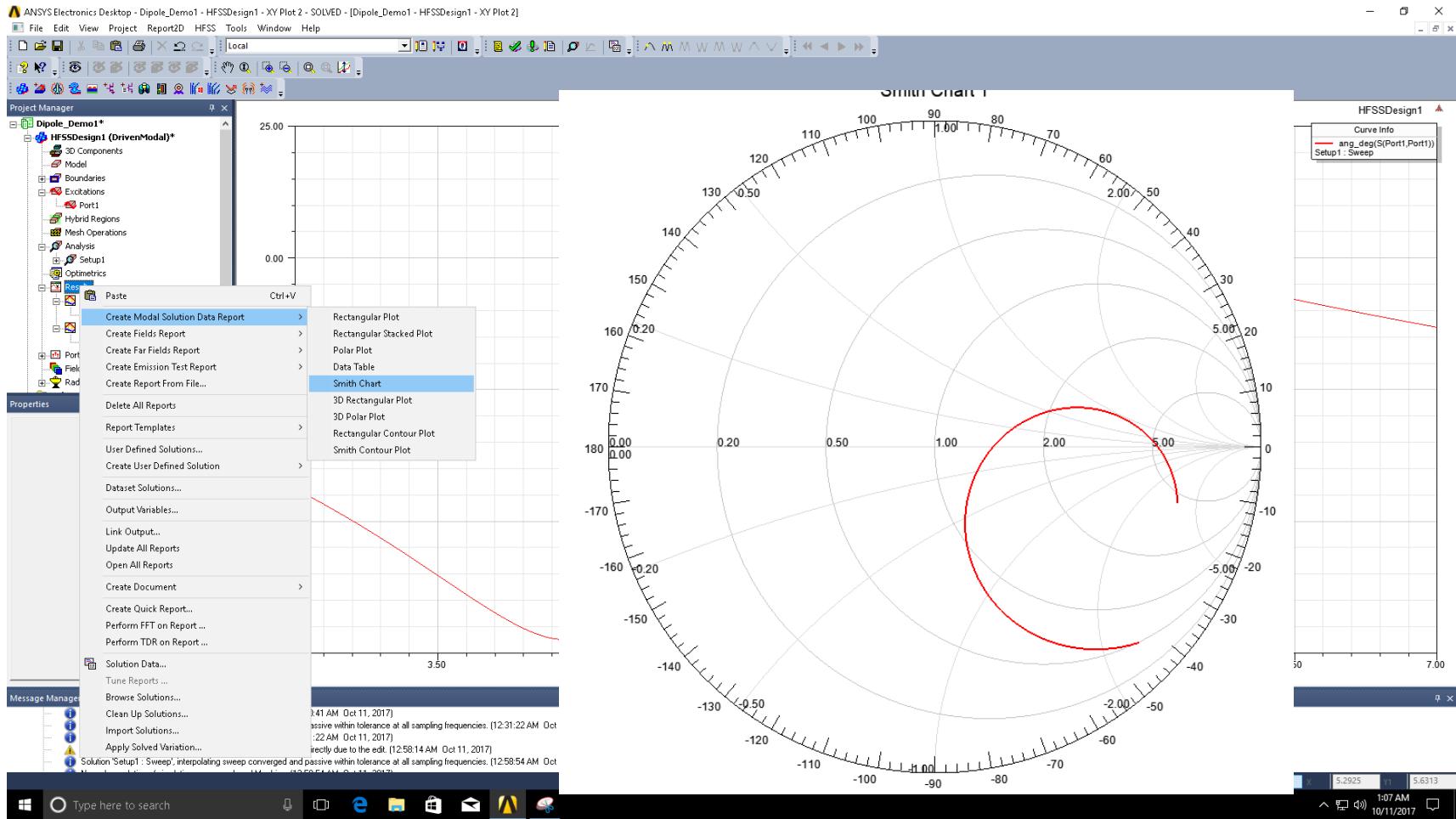


View Results (phase)



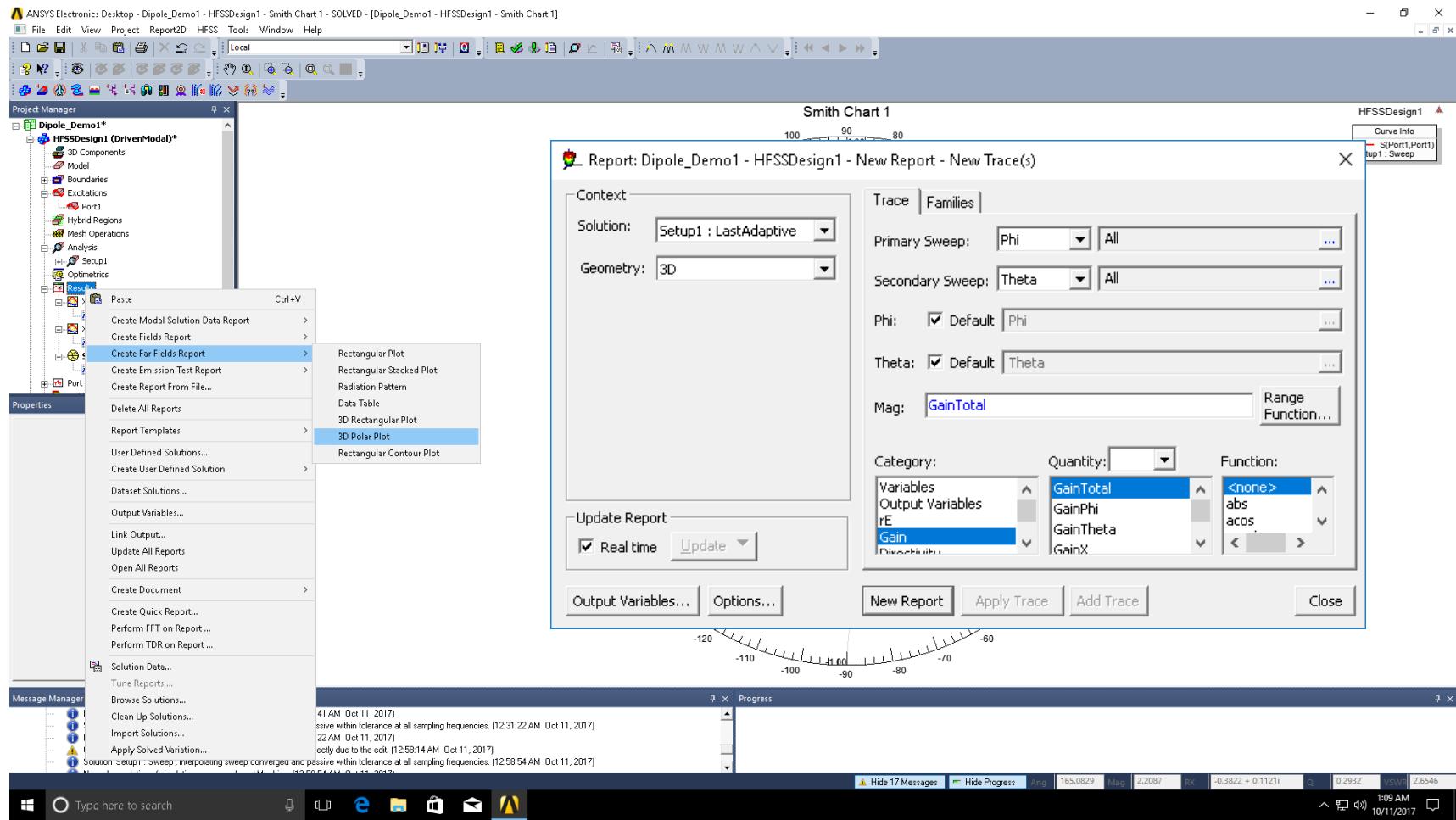
View Results (smith chart)

Results (right click) > Create Modal Solution Data Report > Smith Chart

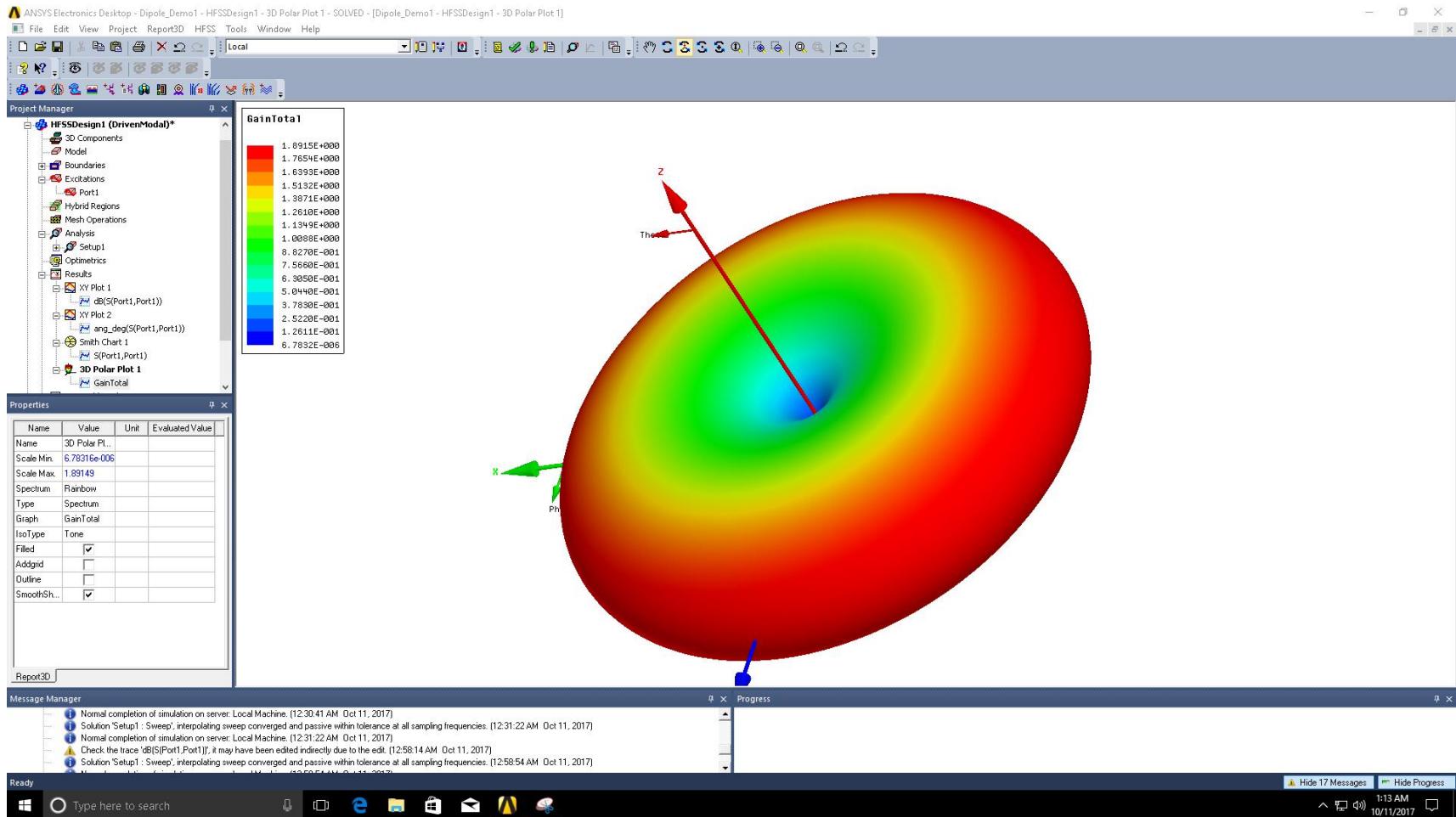


View Results (Far field report)

Results (right click) > Create Far field report > 3D polar plot
Select Gain > Gain Total > New Report



View Results (Far field report)



Thank You !

Further Queries

souvik.dubey@mavs.uta.edu

Download link:

<http://www.souvikdubey.com/hfsstutorial.html>