EED4106 ANTENNAS AND PROPAGATION LABORATORY REPORT

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1 Dipole Antenna Simulation

Equations which characterize dipole antenna were previously observed in MATLAB. In this laboratory, dipole antenna is designed at an operating frequency of 2.5GHz in ANSYS HFSS.

1.1 Dimensions of Antenna

Dimensions of an antenna is calculated simply by using $c = \lambda * f$ equation. Since speed of light is $3 * 10^8$ and operating frequency of antenna is 2.5GHz wavelength is 12cm. One arm of dipole antenna is 6cm. Dimensions of the design can be seen in Table(1).

Table 1: Dimensions of the dipole antenna

Parameter	Parameter Name	Dimension
Radius	dR	1mm
Gap between arms of dipole	gL	1mm
Length of one arm	dL	60mm

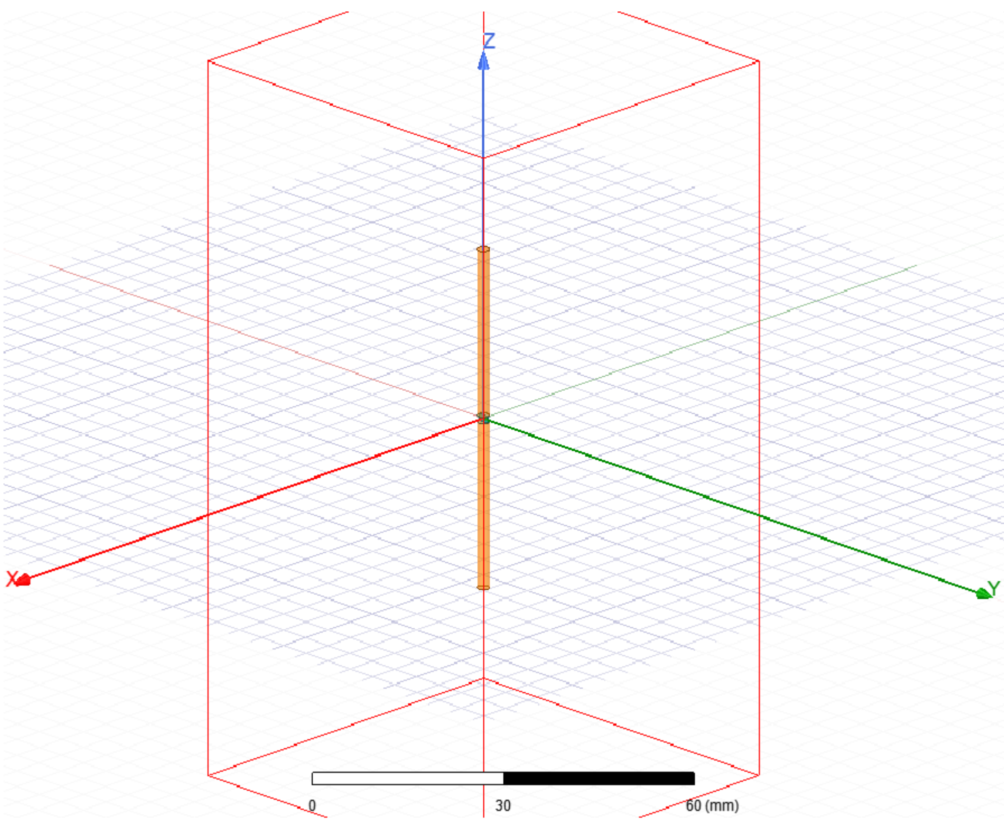

Figure 1: Simulated half wave dipole antenna

1.2 Simulation Parameters

Mechanical dimensions of antenna will not be enough for simulation. Operating frequency must also be set by Driven Solution Setup window. Simulation parameters can be seen in Figure(2).

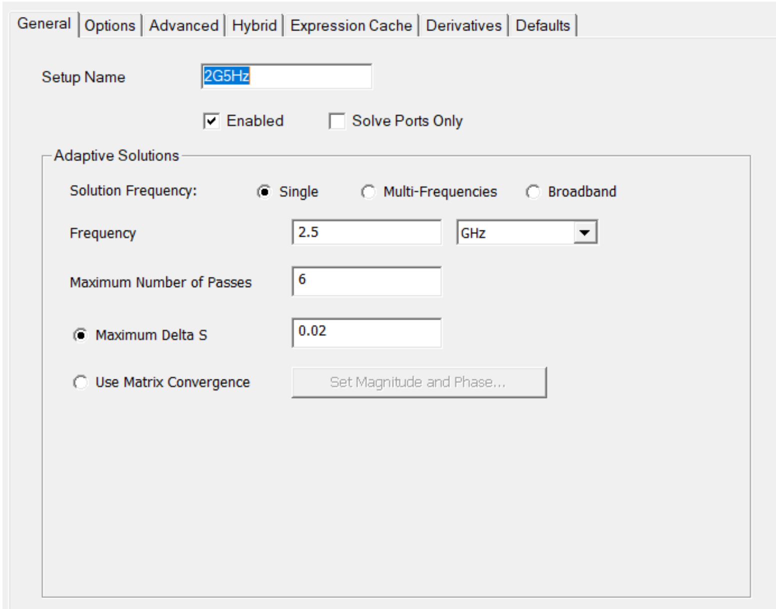

Figure 2: Simulation parameters

However, configurations are not sufficient to initialize simulation. One more step is needed to define frequency range and precision of simulation.

Frequency sweep parameter ranges were configured such that it contains operating frequency. The configurations can be seen in Figure(3).

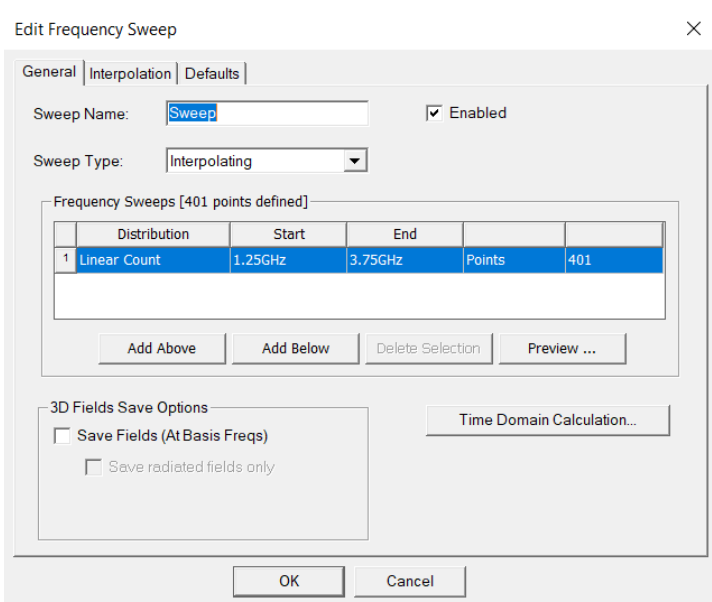

Figure 3: Frequency sweep parameters

1.3 Simulation Results

S_{11}-Frequency plot provides information about antenna radiation characteristics. The sharp decrease on the graph indicates the operation frequency of the antenna. In Figure(4), operation frequency of antenna 60mm length wire antenna is approximately 2GHz according to the simulation results.

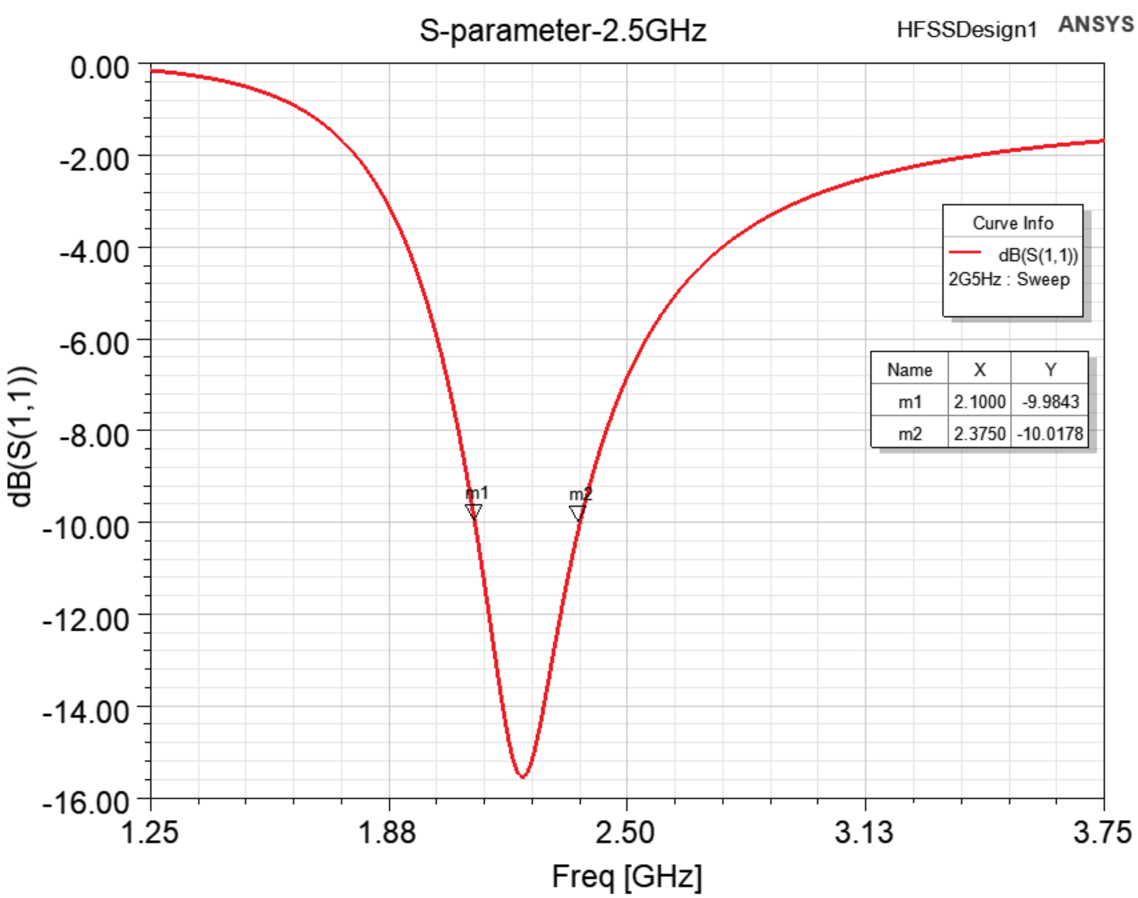

Figure 4: S_{11} of the finite length dipole antenna

There is a shift from the 2.5GHz to the lower frequency this is due to the parasitic capacitance caused by the finite length of the dipole antenna. That is why, antenna can not resonate at the designed frequency.

Antenna impedance for 60mm length wire antenna is in Figure(5).

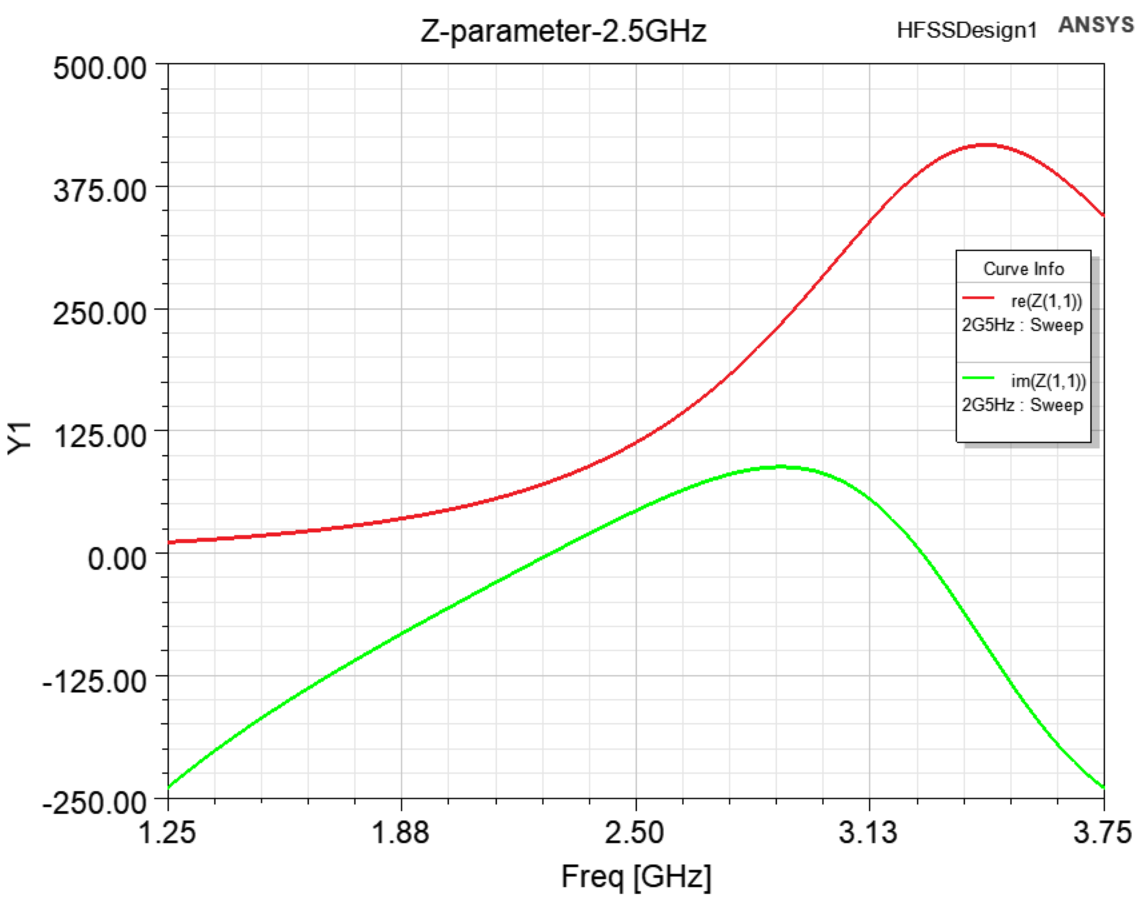

Figure 5: Impedance of the finite length dipole antenna

The resonance frequency is not 2.5GHz, this can be also observed in Figure(5). The point where imaginary part of the Z-parameter crosses zero indicates the frequency where the antenna resonates.

1.4 Parameter Dependence of Dipole Antenna

Under the *Optimetrics* title in HFSS, simulation can be carried out by the series of determined dimensions.

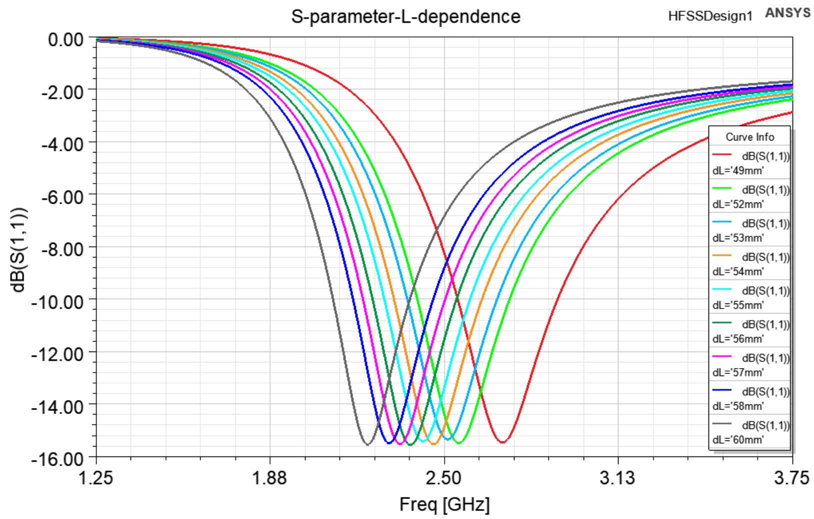

Figure 6: Parametric solver for "dL" parameter

It seen in Figure(6), antenna length directly affects the operation frequency of antenna. As the length of dipole increases, operation frequency of antenna decreases.

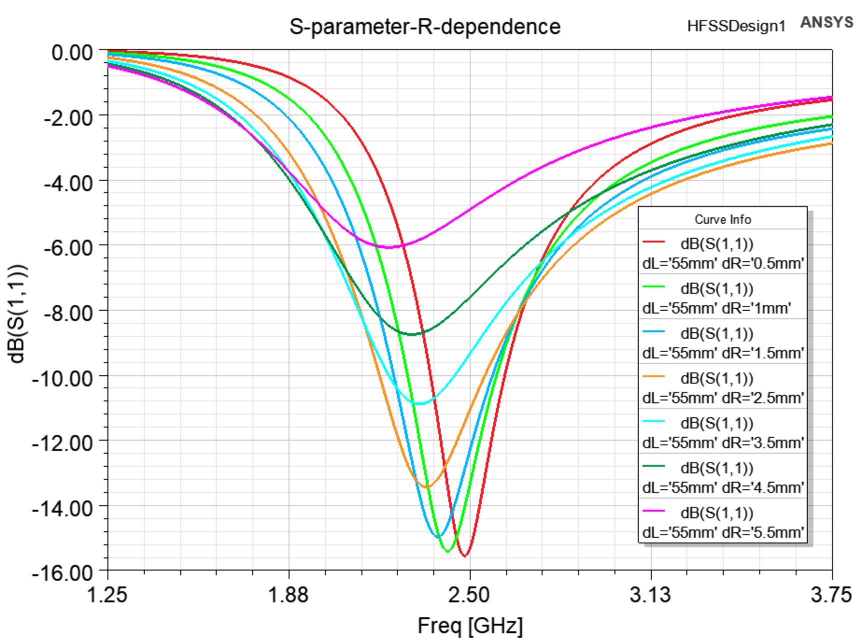

Figure 7: Parametric solver for "dR" parameter

In Figure(7), radius of the antenna wire have an impact on both performance and operating frequency of antenna. As the radius increases, operation frequency decreases and antenna performance becomes worse.

2 Optimized Dipole Simulation

As it was mentioned before, due to parasitic capacitance of finite length dipole antenna, operation frequency shifts from the designed frequency. However, design can be optimized according to the parametric simulation results. Optimized design dimensions are in Table(2).

Table 2: Dimensions of the optimized dipole antenna

Parameter	Parameter Name	Dimension
Radius	dR	1mm
Gap between arms of dipole	gL	1mm
Length of one arm	dL	54mm

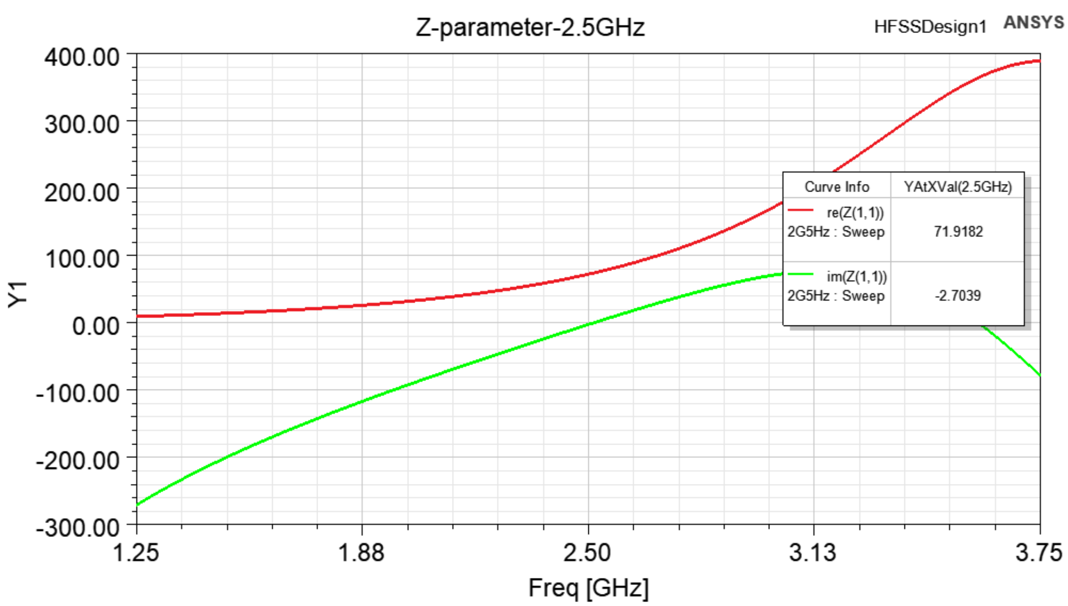

Figure 8: Optimized dipole antenna impedance

In Figure(8), optimized antenna impedance is seen. Since resonance frequency indicates operation point, the antenna in Figure(8) is improved with respect to the Figure(4). If imaginary part of the antenna impedance is zero, this shows the resonant frequency. Optimization can be improved by changing the post-processing parameters. Under the *Lumped Element* title,

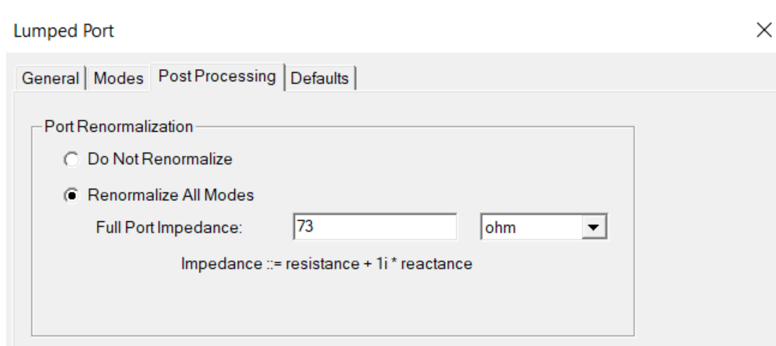

Figure 9: Post-processing parameters

Excitation port is renormalized with 73Ω. The purpose of choosing this value is to obtain the real part of the impedance which is in resonant frequency. In this way, antenna performance is improved one step further.

S_{11} parameter of the optimized antenna is seen in Figure(10).

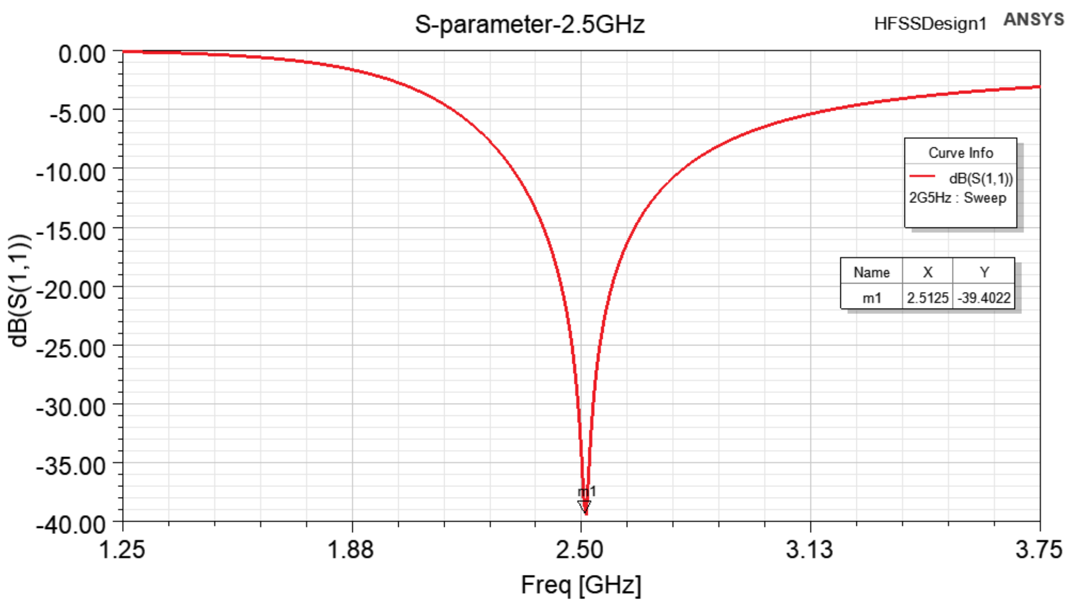

Figure 10: Perfect finite length dipole antenna reflection coefficient at its input

Parametric simulations are re-implemented with perfect finite length dipole parameters,

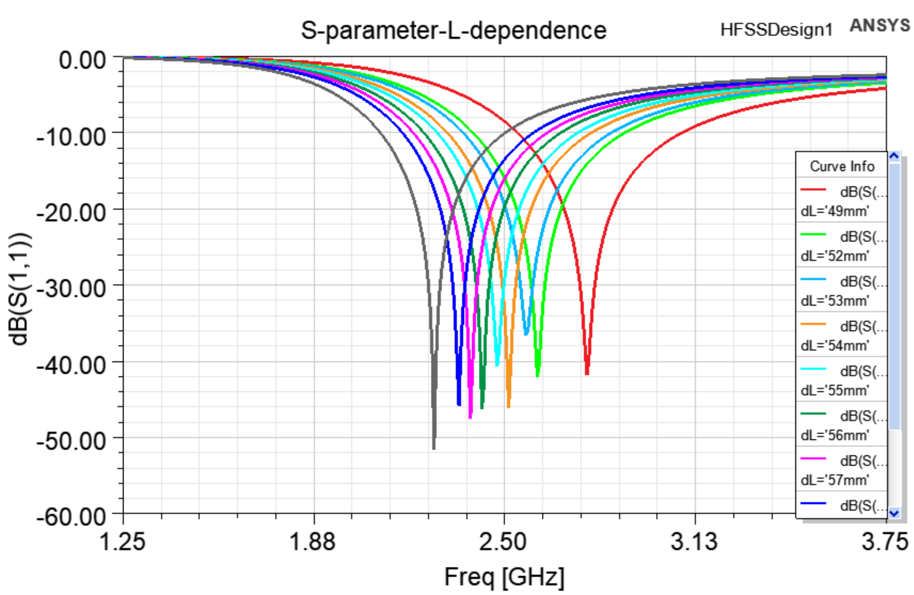

Figure 11: Perfect finite length dipole antenna parametric simulation

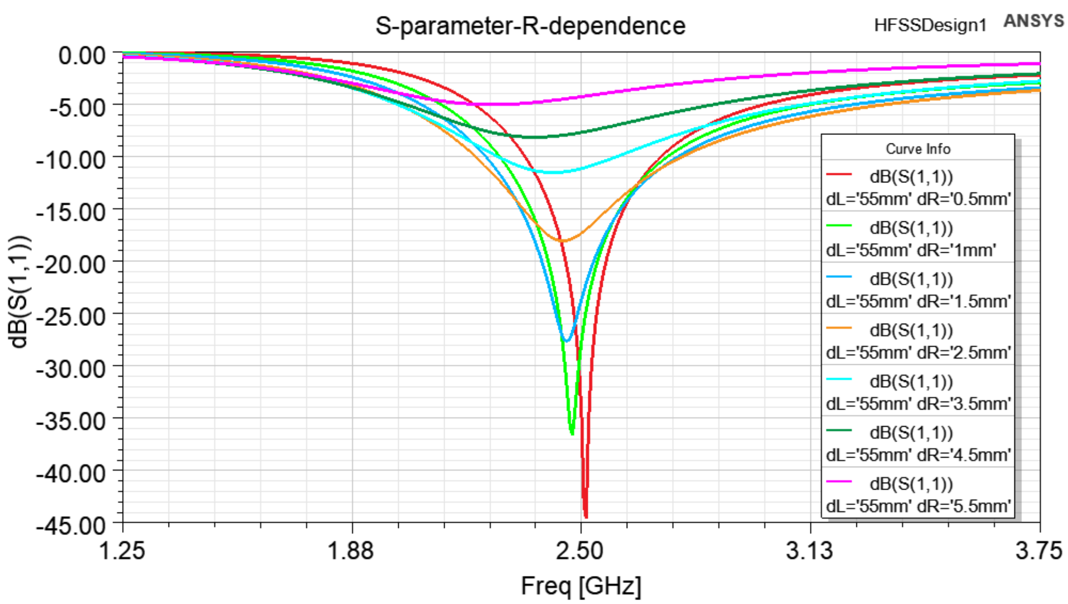

Figure 12: Perfect finite length dipole antenna parametric simulation

Cut plane gain of the perfect finite length dipole antenna is in Figure(13).

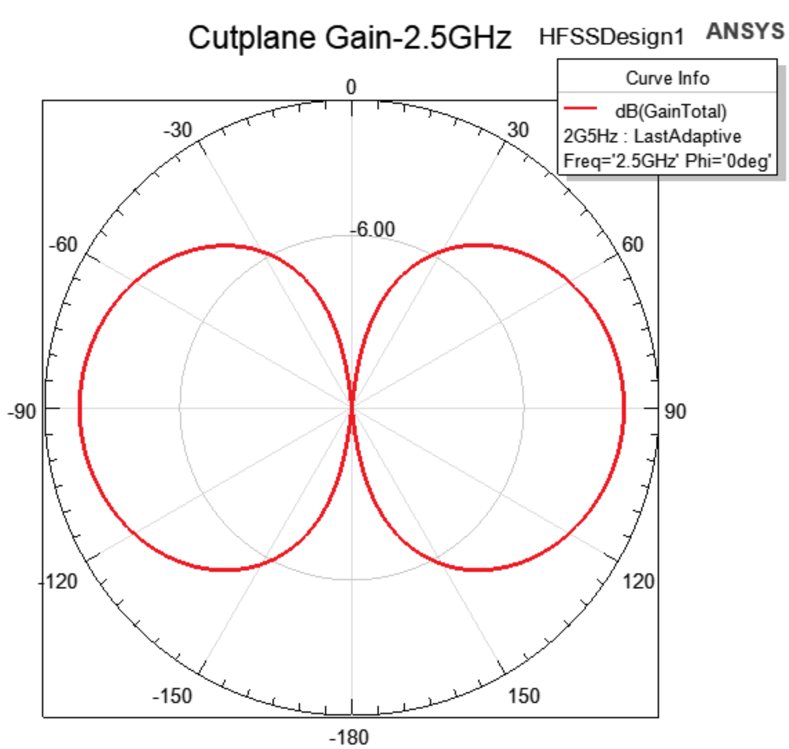

Figure 13: Cut-plane gain at 2.5GHz

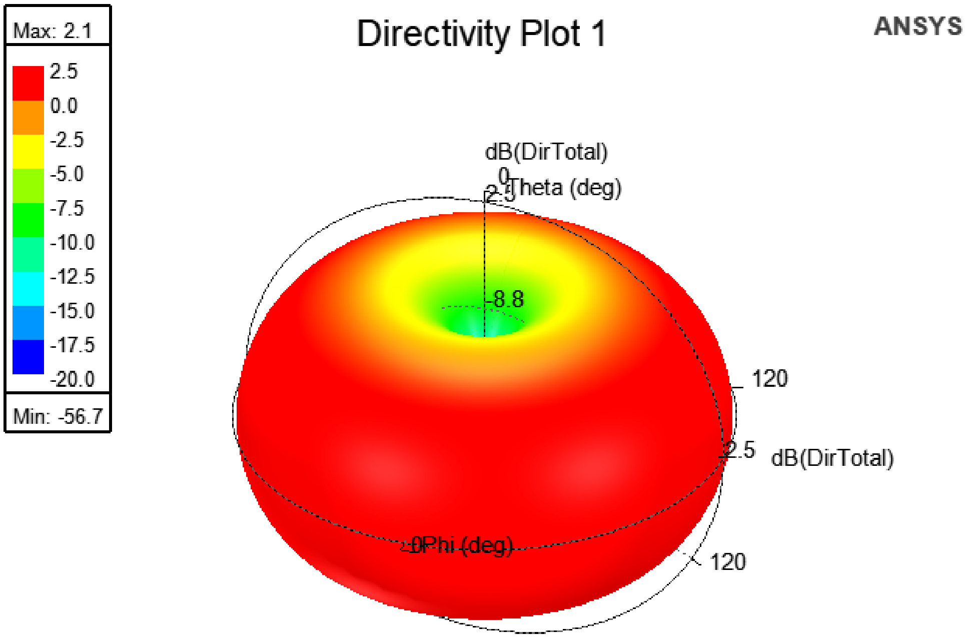

Figure 14: Directivity at 2.5GHz

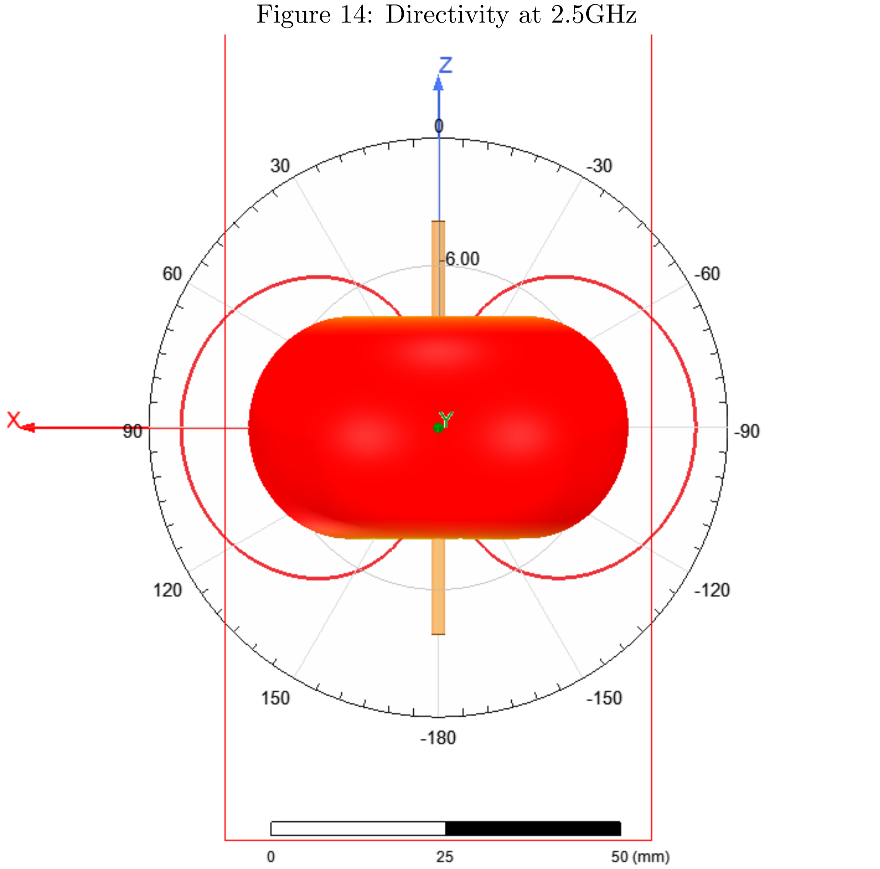

Figure 15: Antenna, its radiation pattern, cut plane gain and radiation box