

The Effect of LNA Metal Boxes upon S11 and Angle (Theta) of Peak Gain Along Excitation Axis

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Three cases of LNA box placement were simulated to observe the effect of the shift of the angle of peak gain from the exact zenith to a small angle in theta along the axis of excitation ($\phi = 0$). The balun shield is present in all simulations. Figures 1 and 2 show the simulated antenna with two of the box placement variations. Each box has dimensions of 5"x10"x17". The simulation was run in the Time Domain mode with the Hex gridding method. The number of grid points increased from 8.4 M mesh cells with no LNA boxes, to 9.4 M cells with one box, and 9.7 M cells with two boxes. Figure 3 shows the gridding specifications given to CST.

Figure 4. shows the S11 response of the three cases. It appears that S11 gets better as the boxes are added, but I can not rule out the possibility that S11 improved because there were more mesh cells. I will have to run one or two more simulations to rule out grid effects.

Figure 5 shows a typical 3D beam pattern and the location of the $\phi = 0$ axis. Figures 6 and 7 show typical 2D plots of the Gain vs Theta for Theta = 0.

Table 1 shows the values for the angle of peak gain vs. frequency and Figure 8 graphs this table. There is no appreciable difference in the peak angle below 180 MHz, but at 180 MHz and above, adding more material does increase the magnitude of the peak gain angle with frequency.

Summary/Conclusion. Below 180 MHz, adding a dummy box does not improve the angle of peak gain and that the S11 pattern is not degraded by the addition of one or two boxes. My recommendation would be not to use a dummy box if the peak angle drift above 180 MHz can be tolerated.

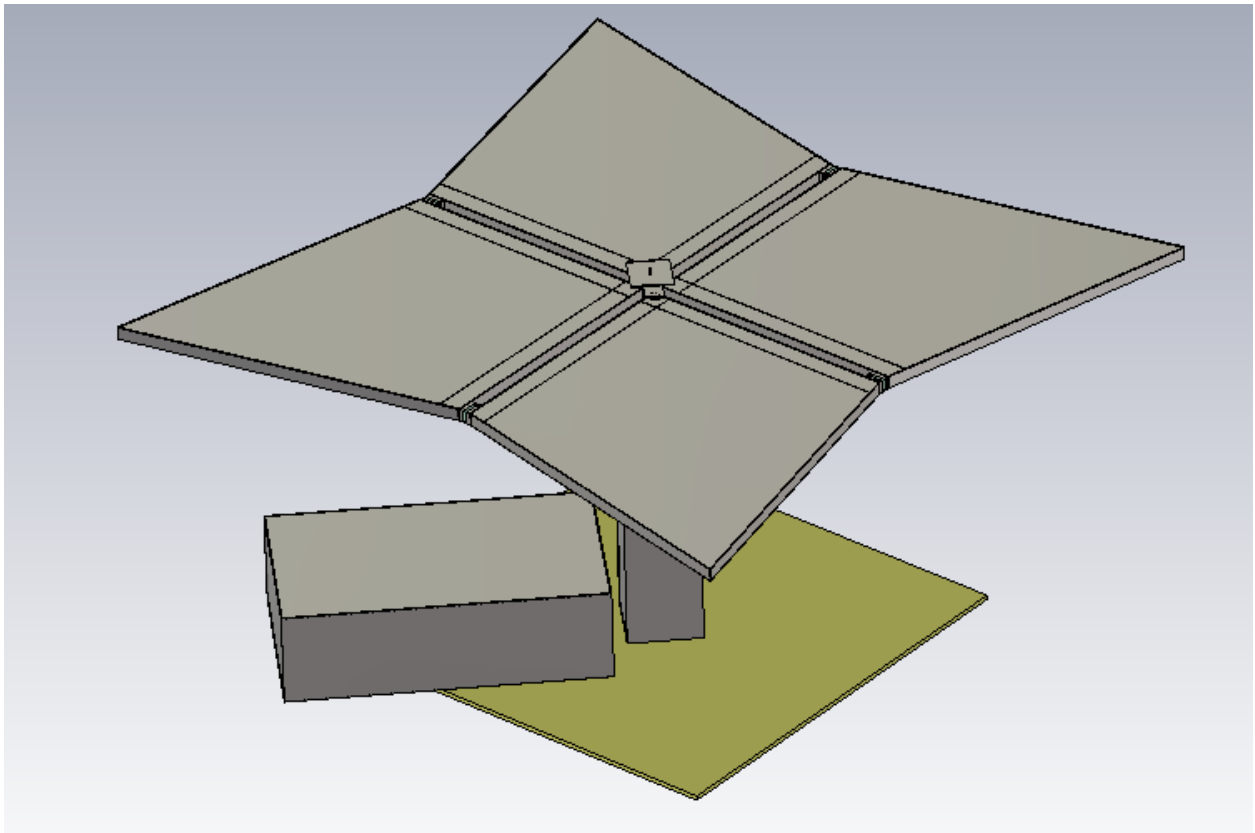


Figure 1. Antenna with one LNA box. The excitation axis runs from front to back.

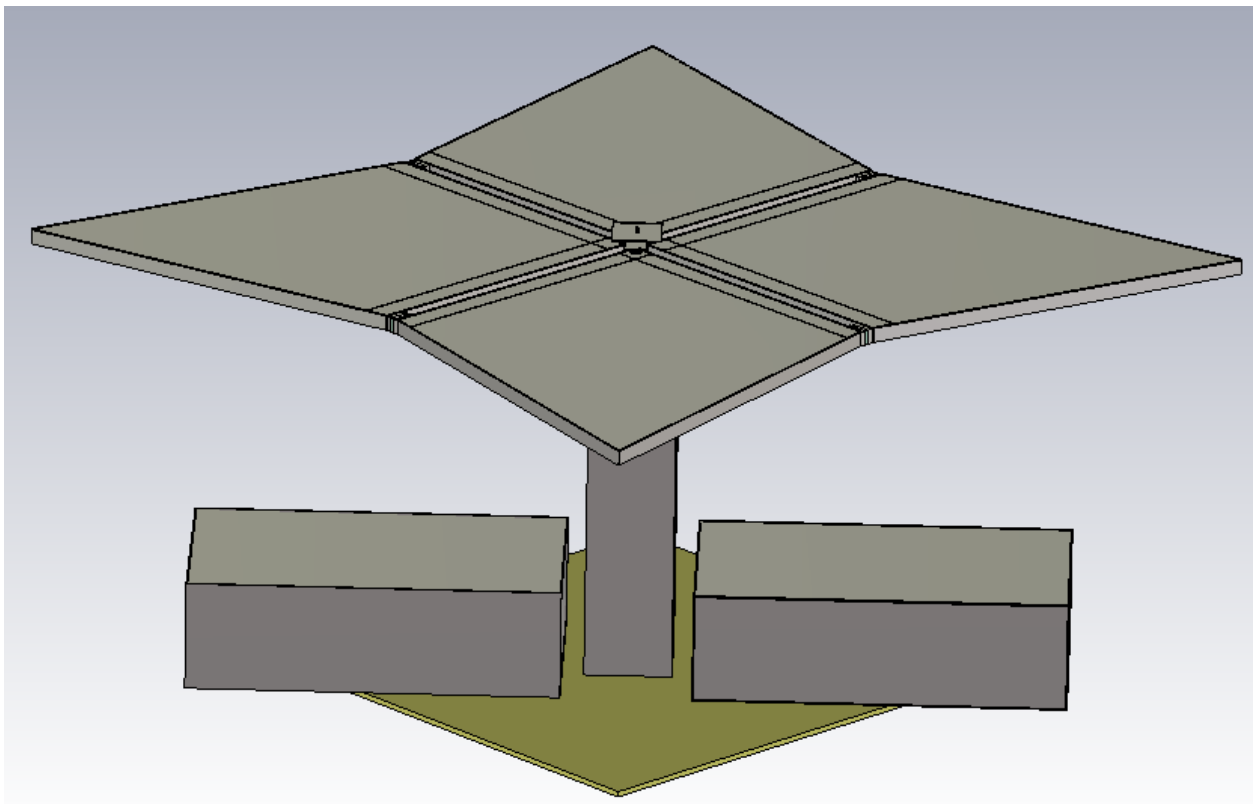


Figure 2. Antenna with two LNA boxes. The excitation axis runs from front to back.

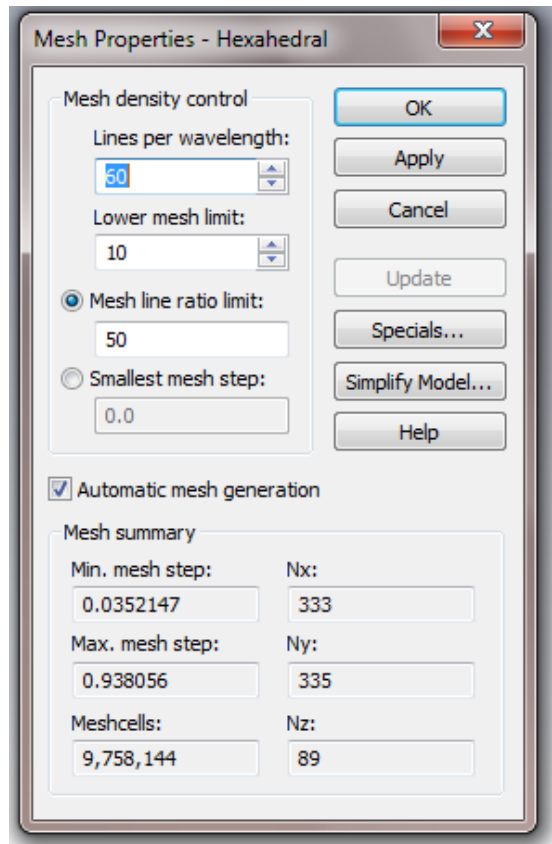


Figure 3. The grid generation specification was the same for all three cases but more mesh cells are generated when there are more geometrical items in the simulation.

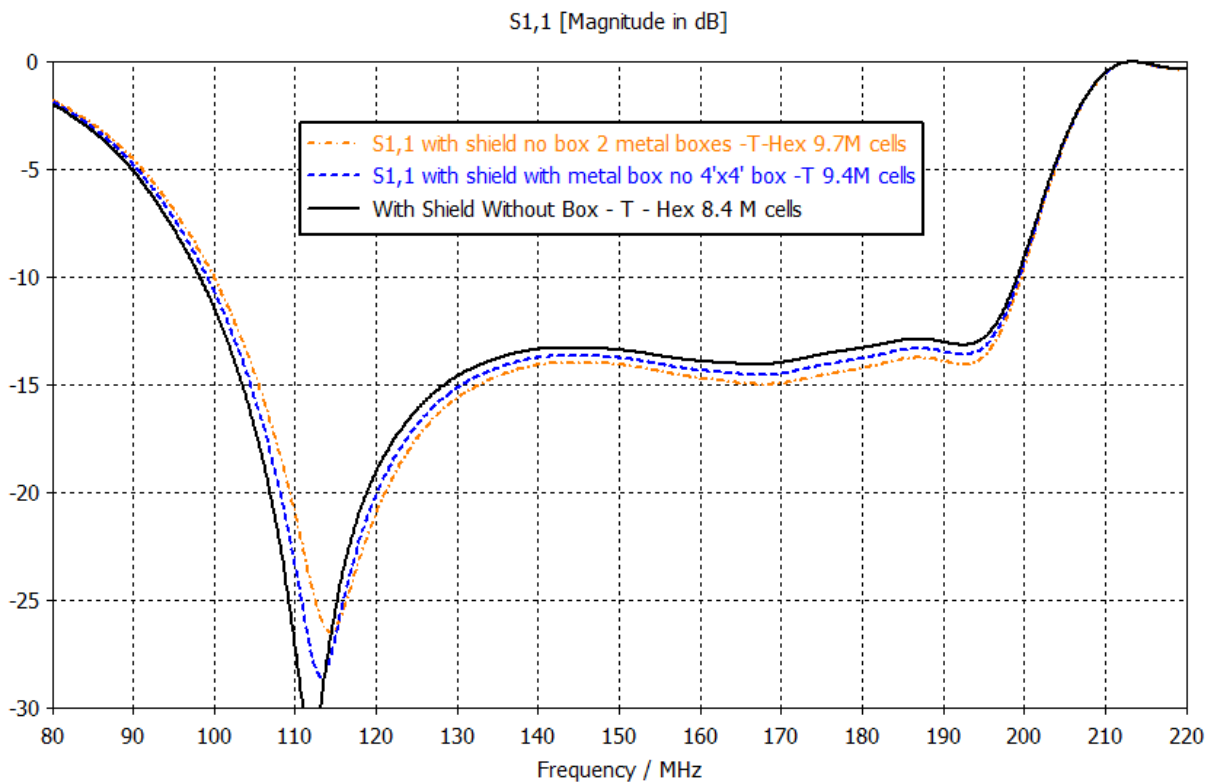


Figure 4. The S11 Response appears to have a better response as boxes are added. Grid issues must be investigated to determine if the effect is physical. The labels saying “no box or without box” refer to the protective polystyrene box, which was not used in any of the simulations.

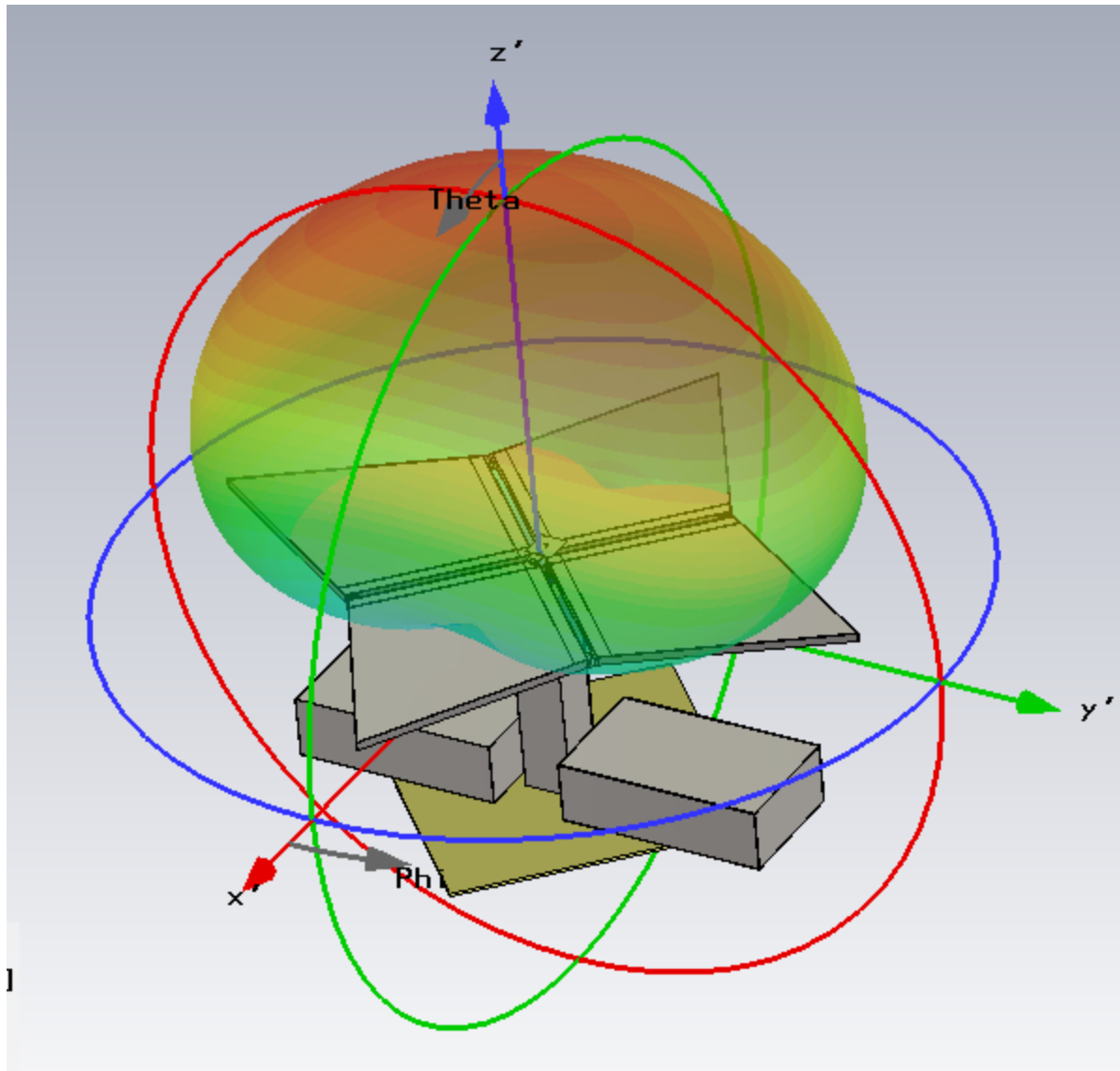


Figure 5. Typical 3D beam pattern and location of the Phi and Theta directions. Shown is the pattern at 160 MHz and the peak gain is 8.35 dB

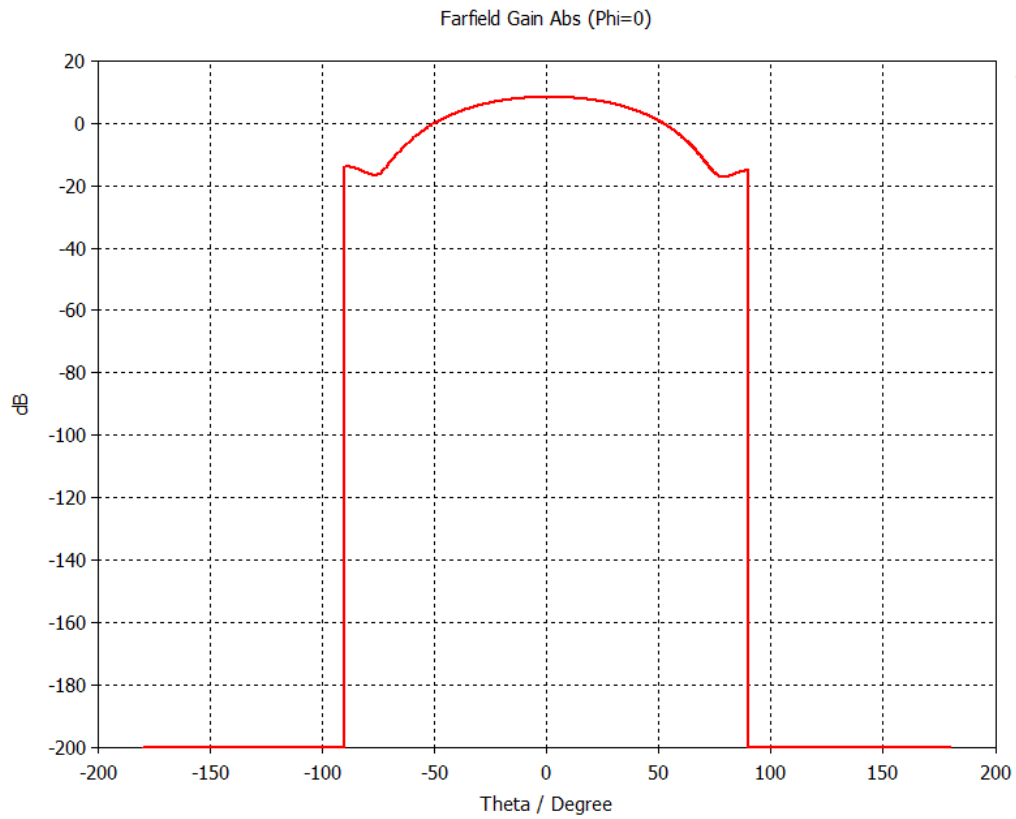


Figure 6. Typical 3D plot of Gain vs. Theta with phi = 0 at 160 MHz.

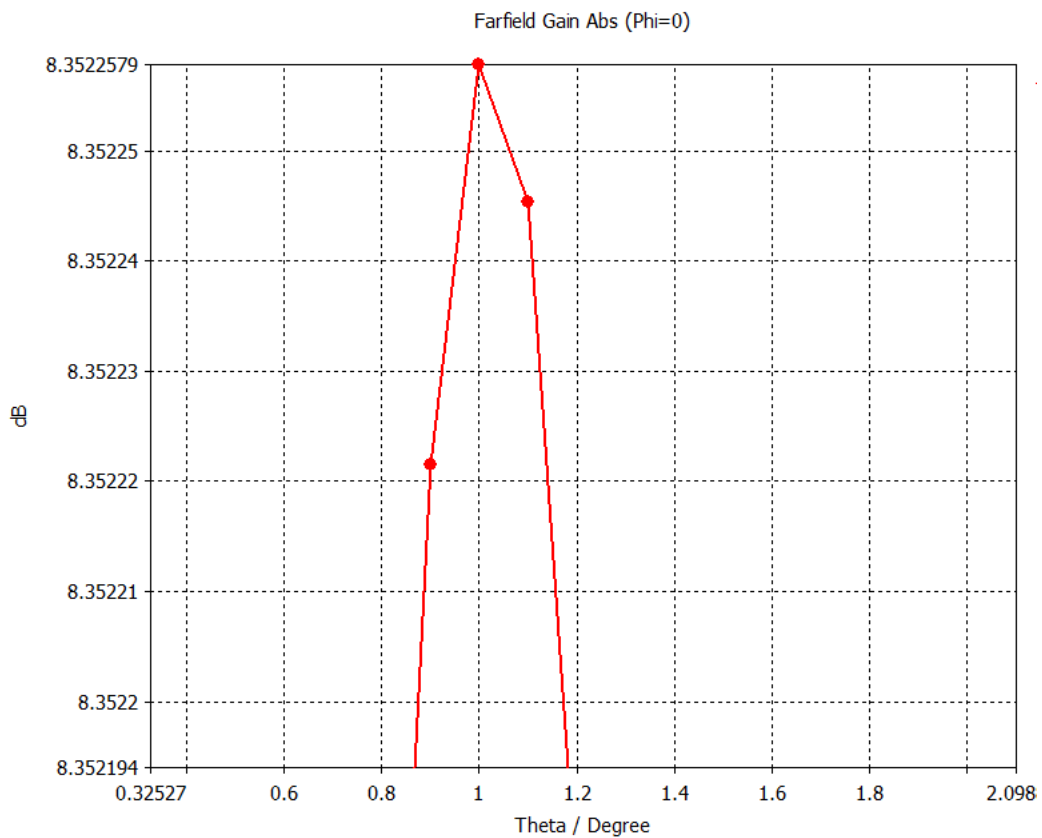


Figure 7. Zoomed in area of the Gain peak at 160 MHz (two metal box case).

Frequency (MHz)	Theta Angle of Peak (no box)	Theta Angle of Peak (one box)	Theta Angle of Peak (two boxes)
100.0	0.2	0.2	0.2
105.0	0.2	0.2	0.2
110.0	0.2	0.2	0.2
115.0	0.3	0.3	0.3
120.0	0.3	0.3	0.3
125.0	0.4	0.4	0.4
130.0	0.4	0.4	0.4
135.0	0.5	0.5	0.5
140.0	0.6	0.5	0.5
145.0	0.6	0.6	0.6
150.0	0.7	0.7	0.7
155.0	0.9	0.8	0.8
160.0	1.1	1.0	1.0
165.0	1.3	1.2	1.3
170.0	1.5	1.5	1.5
175.0	1.6	1.7	1.7
180.0	1.7	1.8	1.9
185.0	1.6	1.8	2.0
190.0	1.4	1.8	2.0
195.0	1.4	1.9	2.1
200.0	2.1	2.2	2.3

Table 1. Angle of peak gain along $\phi = 0$ for the three cases of LNA box usage.

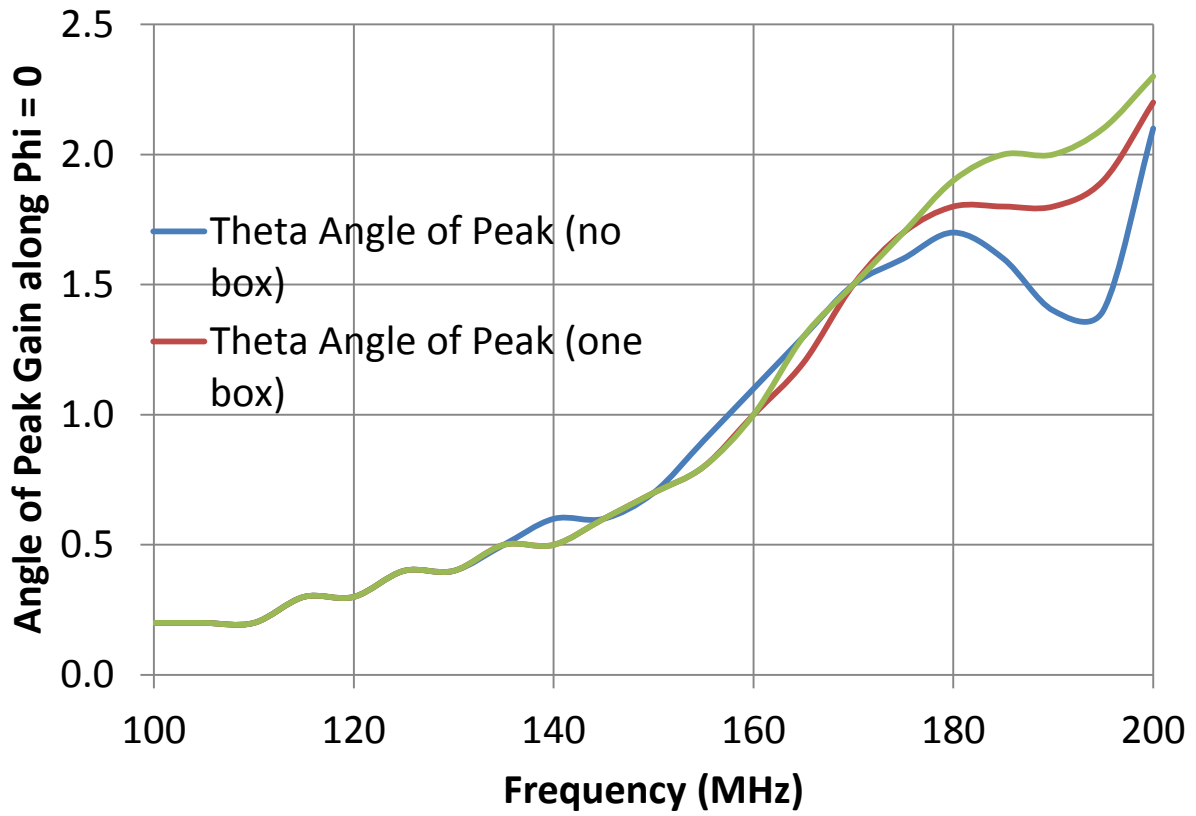


Figure 8. Graph of the peak gain angle vs Frequency.