

Polystyrene Box Impact on Losses and S11

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The EDGES II antenna with the Roberts balun surrounded by a polystyrene box ($\epsilon_r = 2.5$, loss tangent $\delta = 1.0 \times 10^{-4}$) was simulated in CST to determine the effects of the box upon the S11 response and upon power loss in the box walls. The box was nominally 4' x 4' x 2' and the walls were 1" thick.

In order to obtain power losses, the simulation mode had to be changed. There are two ways to do this in CST. The first way is the Frequency Domain simulation mode which uses surface tetrahedrons as the modeling mesh (F-Tet). The second way is to remain in the Time Domain simulation mode, but choose the gridding to be Hexahedral as before but choose the TLM (tangent loss model) option when selecting a gridding style (T-Hex-TLM).

This study is a work in progress as I have been exploring these alternate simulation modes beginning with the Frequency mode and recently testing the Time Domain mode with Hex-TLM enabled, and finding great promise in the Hex-TLM mode.

The results depend strongly upon the number of grid points used. The Frequency Domain simulation used an adaptive mesh mode which means that if we did not saturate the model with tetrahedrons, the results may vary from run to run. The Frequency mode ran faster than the standard Time Domain –Hex mode because it required fewer surface tetrahedrons, but may be less accurate. The Time Domain –Hex TLM mode requires 20x more hexagons and initially reported that it would take 13 hrs to finish, but only took ~1.5 hrs to finish. The results of this last run are very promising as can be seen in Figures 1 and 2.

For now, we will focus on the Frequency mode simulations for which runs have been made. Figure 3 shows that the distance of the box to the antenna has a great effect upon the loss in power. The top panel is closest to the antenna while the box sides are further away. As the box top is moved away from the antenna, its losses approach those of the sides.

It appears that the box does have an obvious effect upon S11 (see Fig 4.), but this will have to be reconfirmed with the hopefully more robust Time Domain Hex-TLM simulations with the large number of mesh cells. The losses obtained in the F-Tet simulations do agree with the losses obtained in the T-Hex-TLM mode (see Fig 5.), lending more credibility to the F-Tet loss results. As a note, the F-Tet simulations use the shield while the T-Hex-TLM simulations do not.

I will repeat these loss calculations with the T-Hex-TLM mode for the cases of shield vs no shield and 3 box heights.

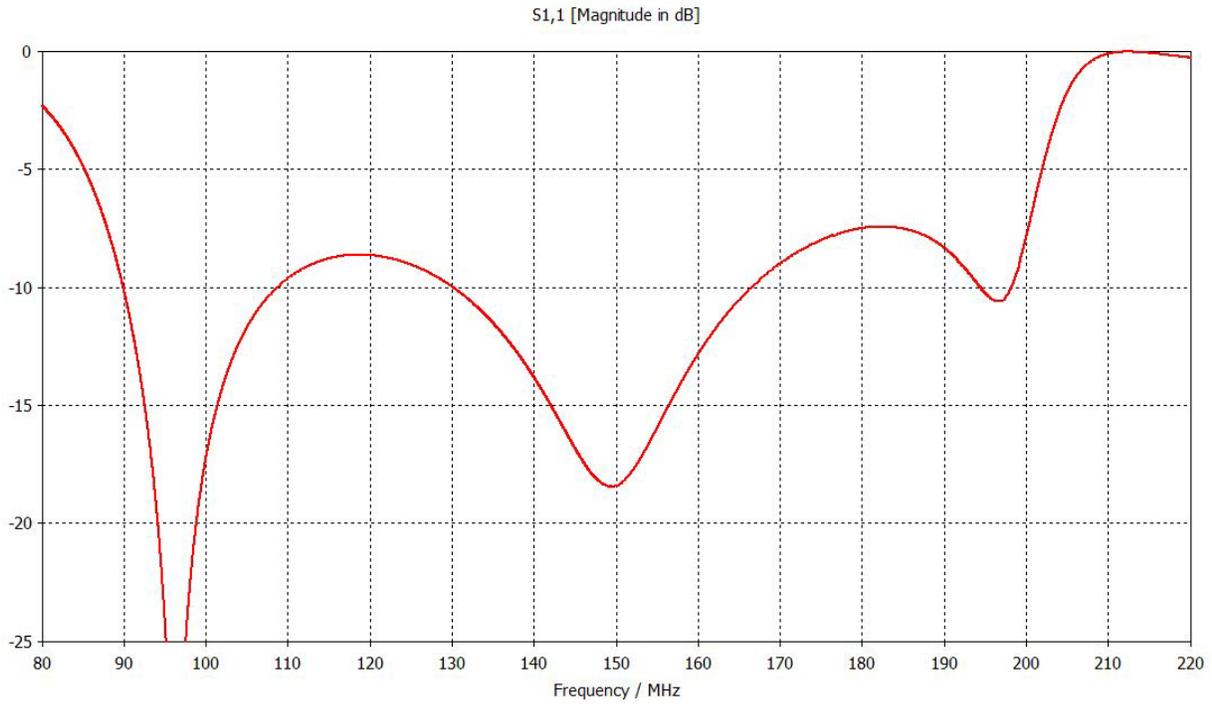


Figure 1. Time Domain Simulation with Hex-TLM mode and 57 M mesh cells – 6x more than was used in the plain Hex mode. A 4'x4'x2' polystyrene box with 1" walls is used along with no shield.

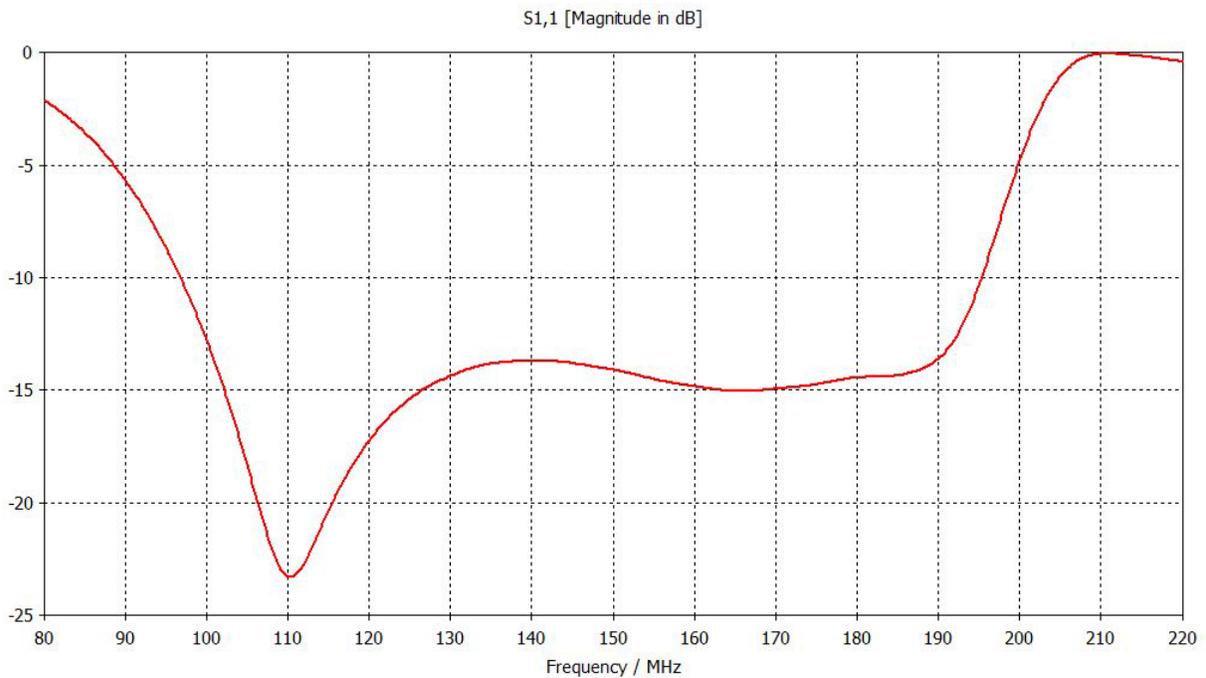


Figure 2. Time Domain Simulation with Hex-TLM mode and 169 M mesh cells – 20x more than was used in the plain Hex mode. A 4'x4'x2' polystyrene box with 1" walls is used along with no shield.

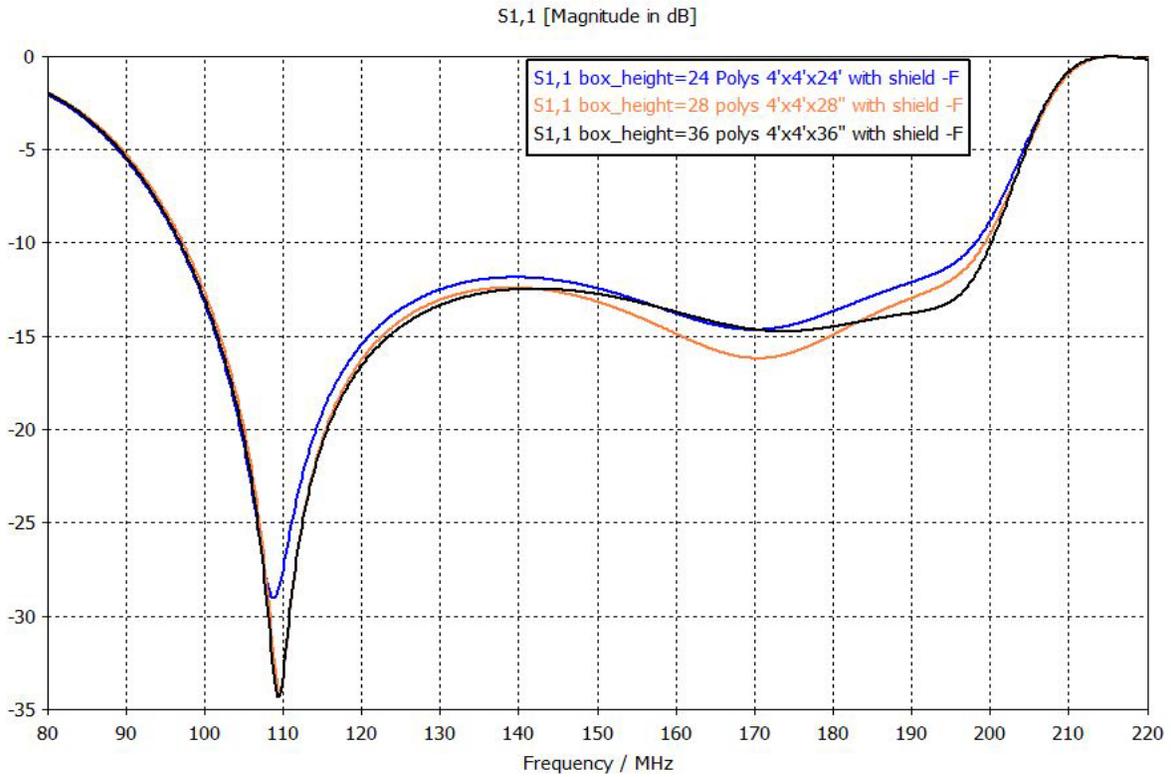


Figure 3. S11 response acquired in Frequency Domain simulations with a shield with varying box height dimensions. This effect needs to be verified in the Time Domain mode with 169 M or more mesh cells.

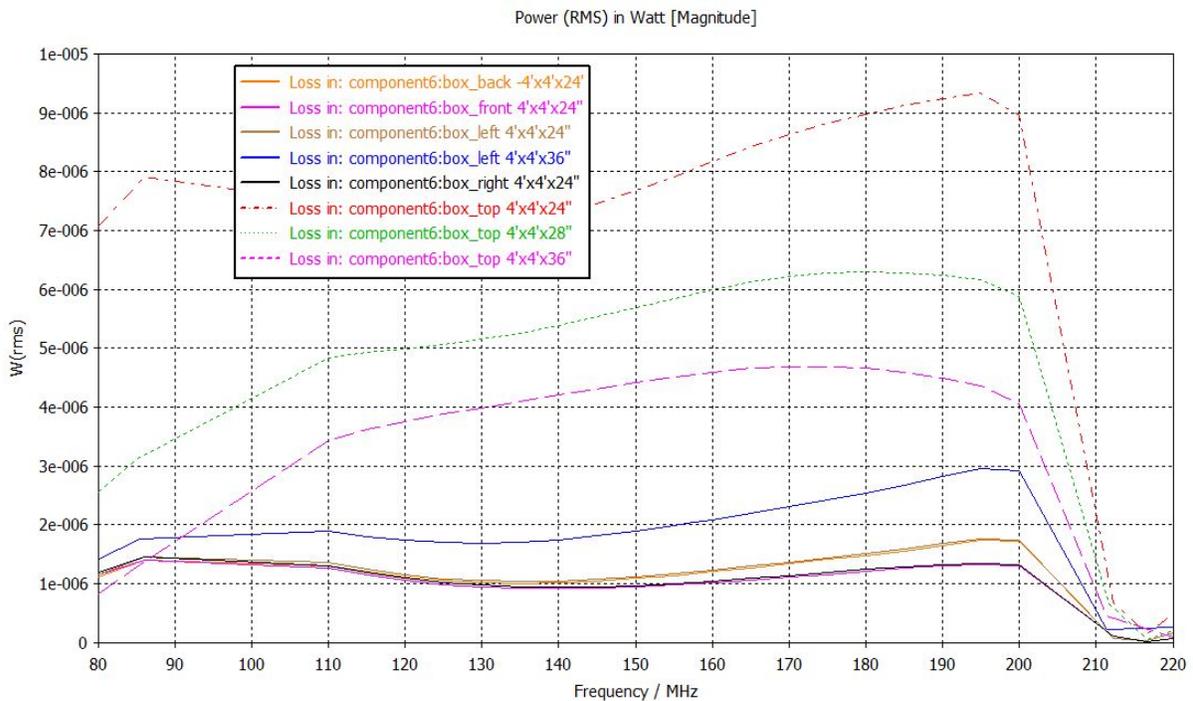


Figure 4. Power loss for the individual side panels and for the top panels of the polystyrene box with a shield. Note how the losses decrease as the top is moved away from the antenna. Note also how the loss increases as the area of the side panel increases in height to accommodate the higher top panel.

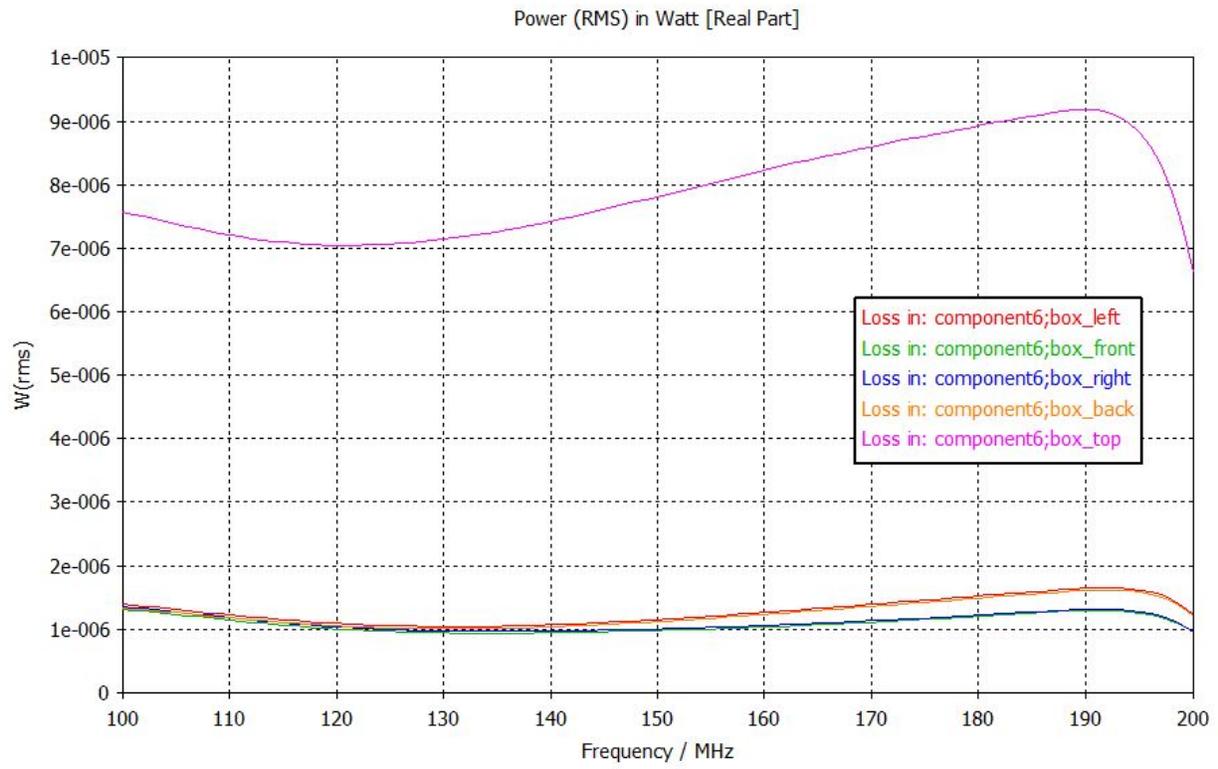


Figure 5. Time Domain Hex-TLM simulation mode 169 M mesh cells without a shield with a 4'x4'x2' polystyrene box. The values are similar to the Frequency Domain mode simulations.