FEKO and CST Simulations of the EDGES Panels without Inter-panel Capacitors

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Summary

A study was carried out to compare FEKO and CST simulation results using a simplified model of the EDGES antenna. The model used only the flat panels and the side lips of the four-point design. There were no inter-panel capacitors and the structure was placed above a ground plane. The reflection coefficient, S11, was measured between the frequencies of 80 MHz and 210 MHz.

Two factors were found to affect the simulation results. One factor is how excitation ports are formed. In FEKO, a physical metallic cylinder is required to be placed across the excited panels to which a port and an excitation voltage is applied. A wire radius is required. In CST, a physical wire is not required, just a port connected to two locations on the excited panels. CST says it treats the port as an electrical connection by filling in just enough grid cubes with PEC along the path of the port.

The second factor is meshing. FEKO uses the Method of Moments type solver in the frequency domain and uses surface triangles for meshing. Tetrahedrons are used if the panels are modeled as 3D solids instead of 2D surfaces. CST's best simulator engine uses a time domain solver and uses a cubic grid mesh.

It was found that both of the above factors significantly affect the S11 results. If a physical cylinder is used as a port in CST it was found that the FEKO and CST simulations produce similar results. The CST simulations without a physical cylinder as a port are similar to those of a simulation with a very small diameter physical port.

The meshing results are not completely understood at this time. It appears that the coarser mesh using FEKO (~300 triangles) produces results which can be brought closer to the real antenna after the balun corrections are made via transmission line equations. The finer mesh results cannot be brought into line with post processing.

A suggested follow-up would be to use CST to obtain a result that can be corrected by the balun equations. If this cannot be done, then the best choices would be to use CST on a full model or use FEKO on the panels only with a coarse gridding.

Simulation Setup

Figures 1 and 2 show the CST setup with a physical pin used as a physical port. The pin is cut in half so that CST can accept a port on the two wires. A 48" x48" thin (0.050") ground plane was inserted in CST to guarantee a minimum sized simulation box. Figure 3 shows an example of meshing in CST. Figures 4-6 show the FEKO views of the antenna, port, and meshing. Table 1 lists the physical parameters of the antenna.

Parameter	Value (meters)
Diagonal	0.685
Gap	0.0089
Lip	0.017 + (1/16")
Metal thickness	0.0015875 (1/16")
Side Length	0.375
Height above ground plane	0.525

Table 1. Physical Antenna Parameters

Simulation Results

Figure 7 shows the CST results when a physical port is inserted. The normal CST port method uses no wire. As the port wire radius becomes smaller and smaller, the simulation results approach that of the "no wire - port only" case.

Figure 8 shows the FEKO results comparing the use of various pin radii and meshing styles. The graphs labeled "Tom" used volumetric panels while the graphs labeled "Alan" used 2D surface elements. The simulations agree better at the lower frequencies than at the higher frequencies. 2D vs 3D simulations were compared and didn't make a significant difference. The coarse mesh generally ranged from 300-400 triangles while the fine mesh was in the 4000-5000 range.

Figure 9 shows a comparison between FEKO and CST using fine gridding in CST and a 0.3" diameter port wires in both CST and FEKO. In general, these simulation show general agreement with each other. The gridding seems to shift the second S11 dip about 5 MHz and the depth of the valleys differ.

Conclusions

The gridding and the port wires have a significant effect upon the S11 simulation results. A follow up study to post process the finely meshed simulations with the transmission line equations is recommended. It is not completely clear which method should be used to simulate future antenna designs. It appears that small structures which are fractions of a wavelength, such as pins and gaps, may not do well with fine meshes. However, the full model of the antenna + balun must use a fine mesh. The full model does better under CST than FEKO and this will be the topic of a future report.

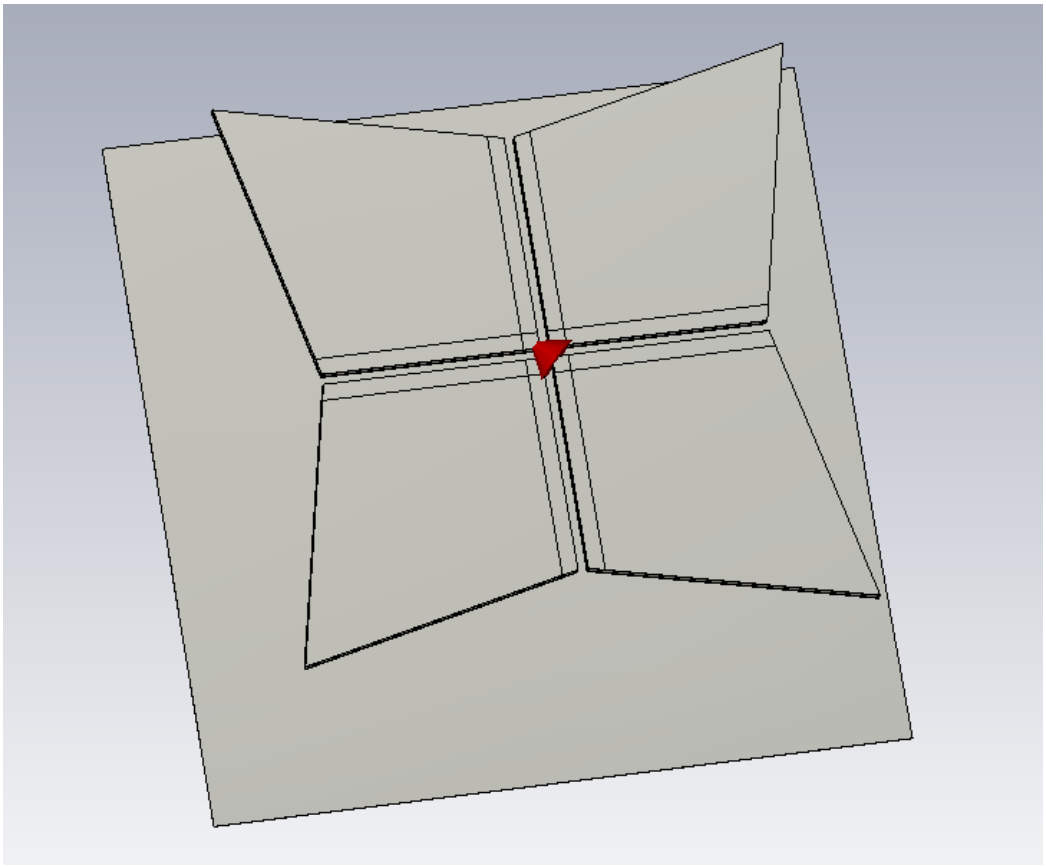

Figure 1. CST View of the Antenna

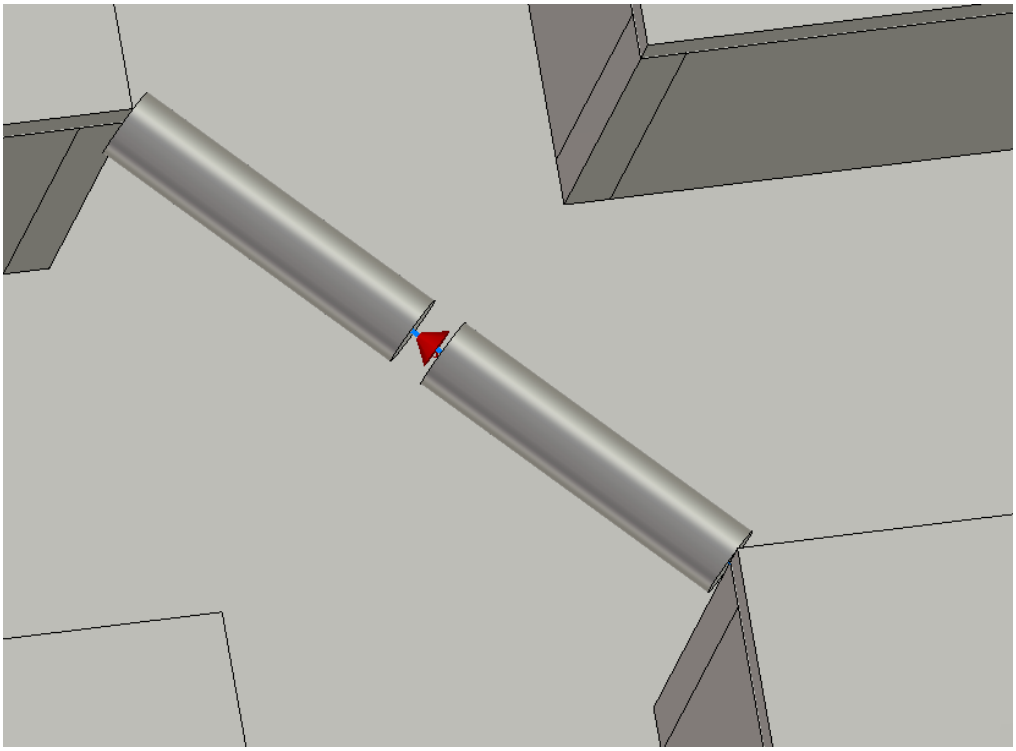

Figure 2. CST close up view of the physical port.

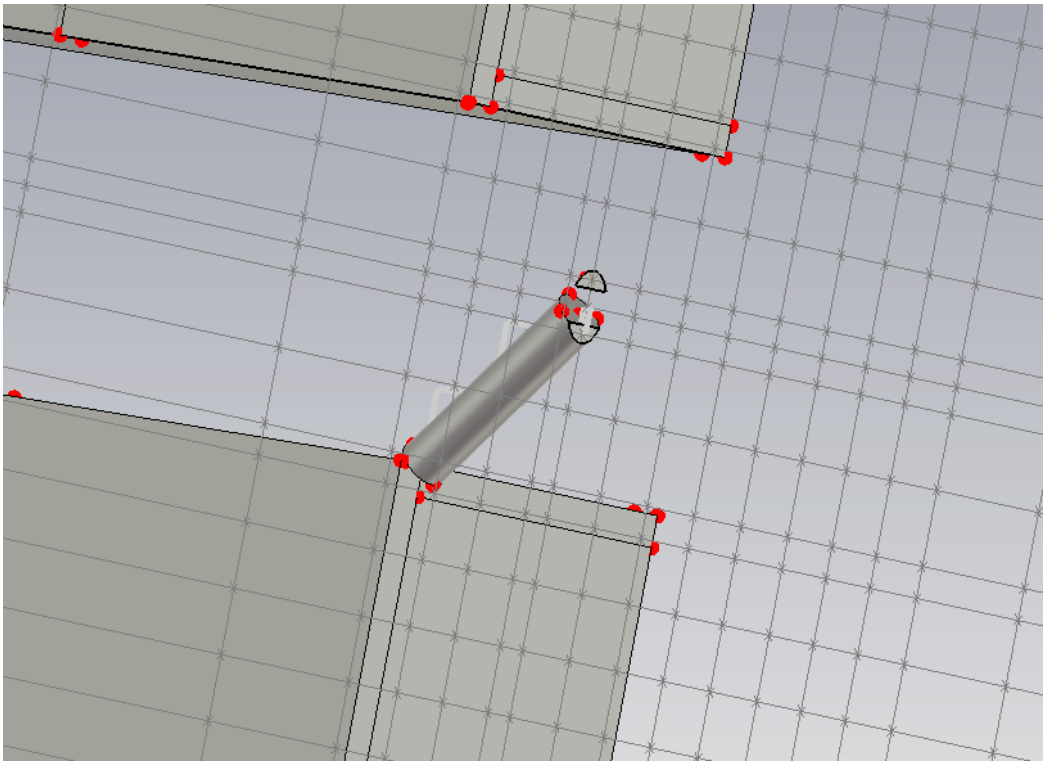

Figure 3. Gridding in CST

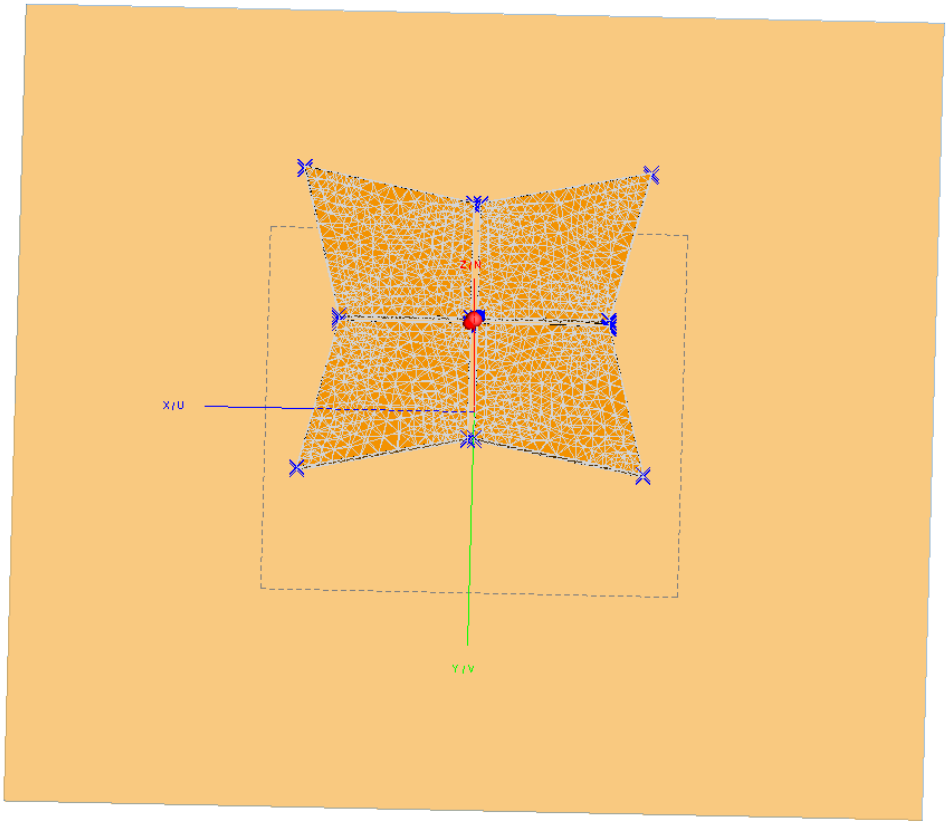

Figure 4. The Antenna in FEKO

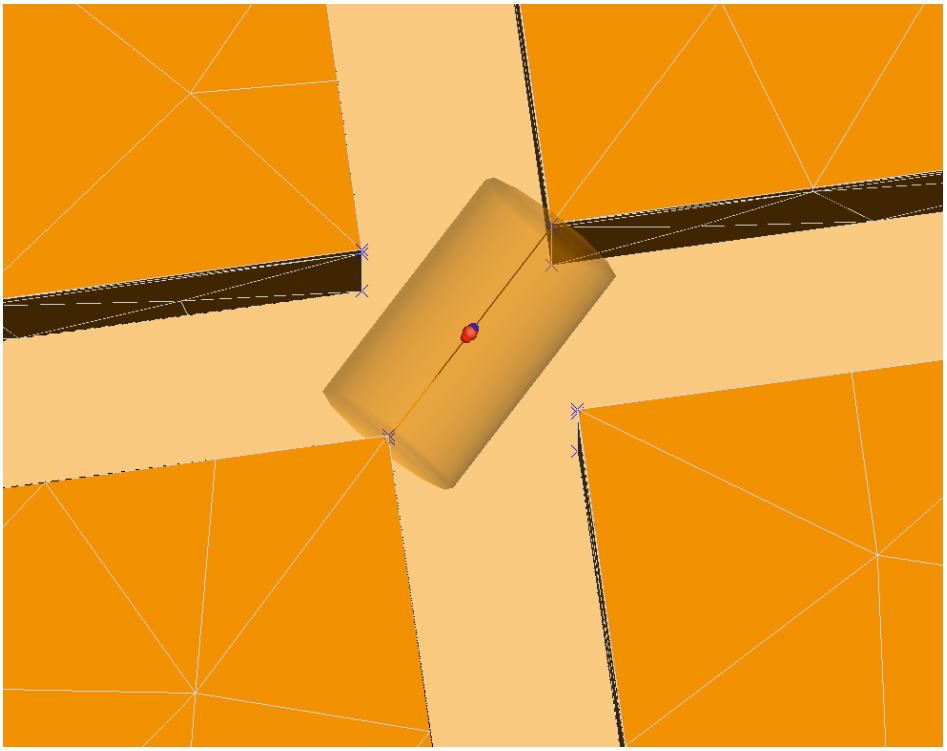

Figure 5. Close up of the FEKO port.

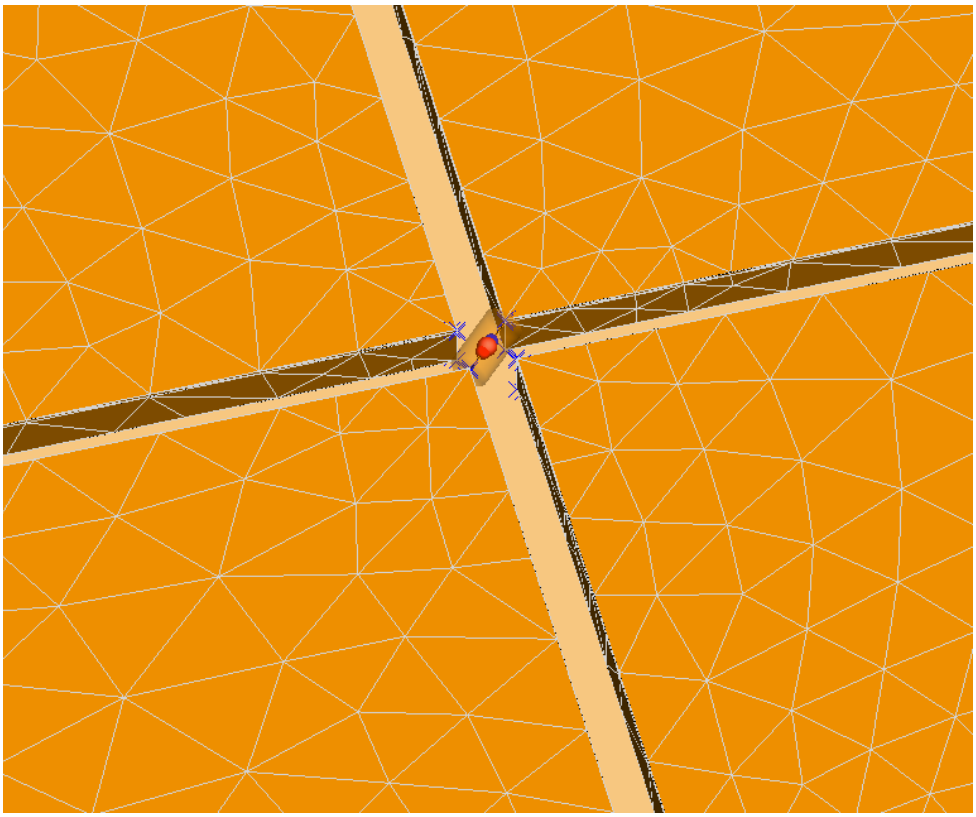

Figure 6. FEKO panels revealing the fine triangle meshing.

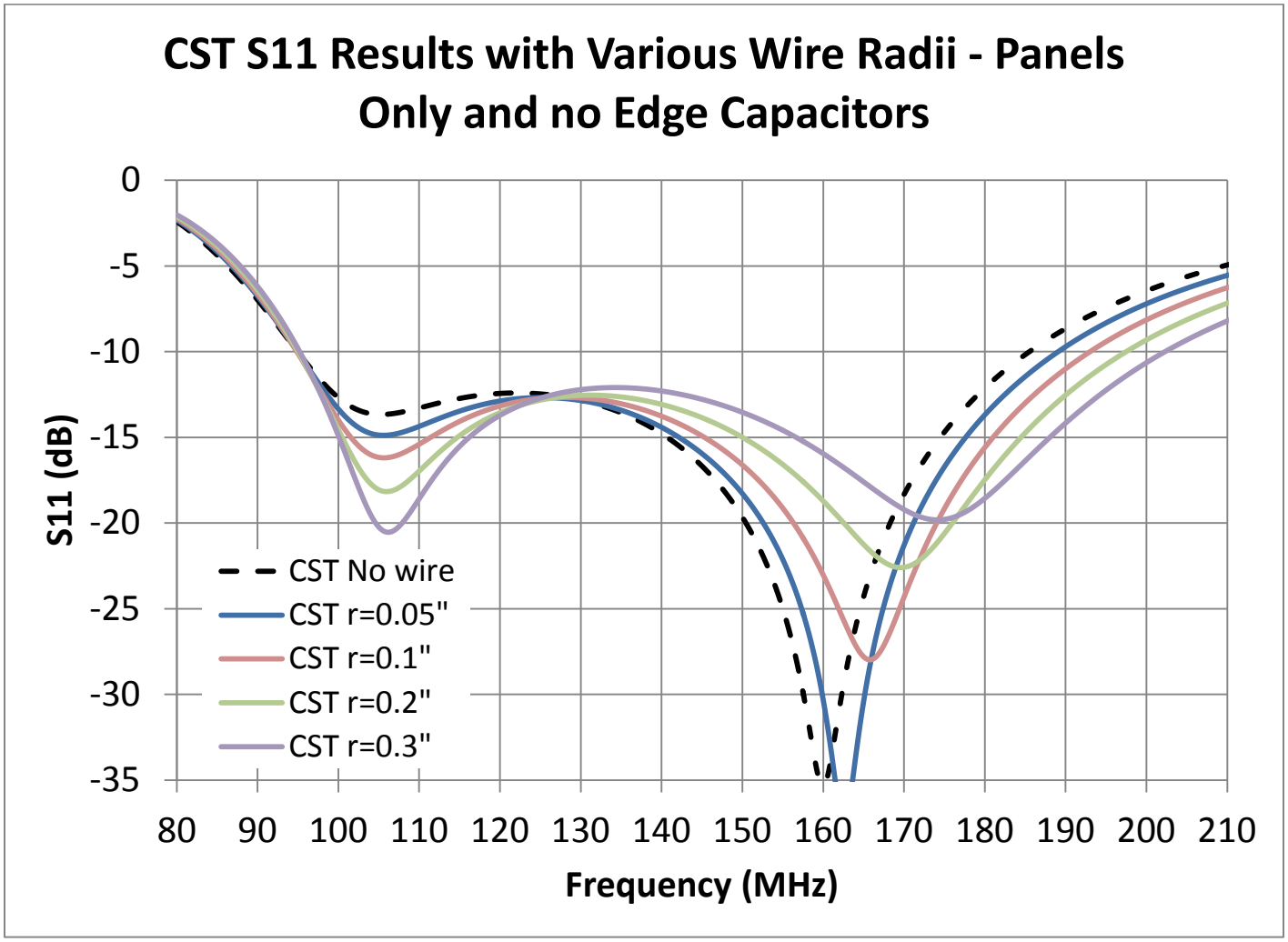

Figure 7. CST simulations using various sized port cylinders. Note how the “No wire” case is approached as the wire radius decreases.

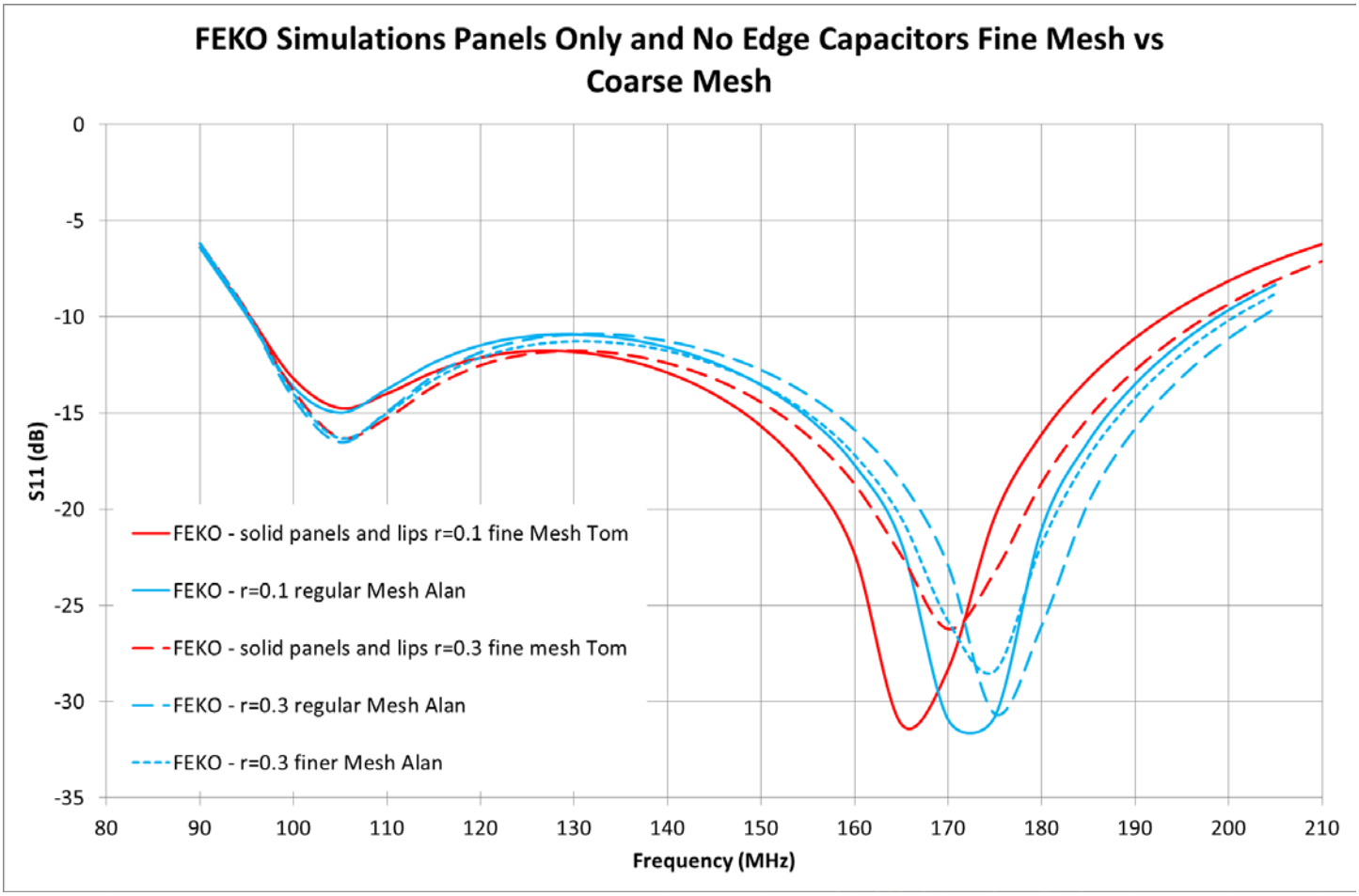

Figure 8. FEKO results comparing mesh granularity and port pin radius. A coarse mesh was typically 300-400 triangles while the fine mesh was in the 4000-5000 range.

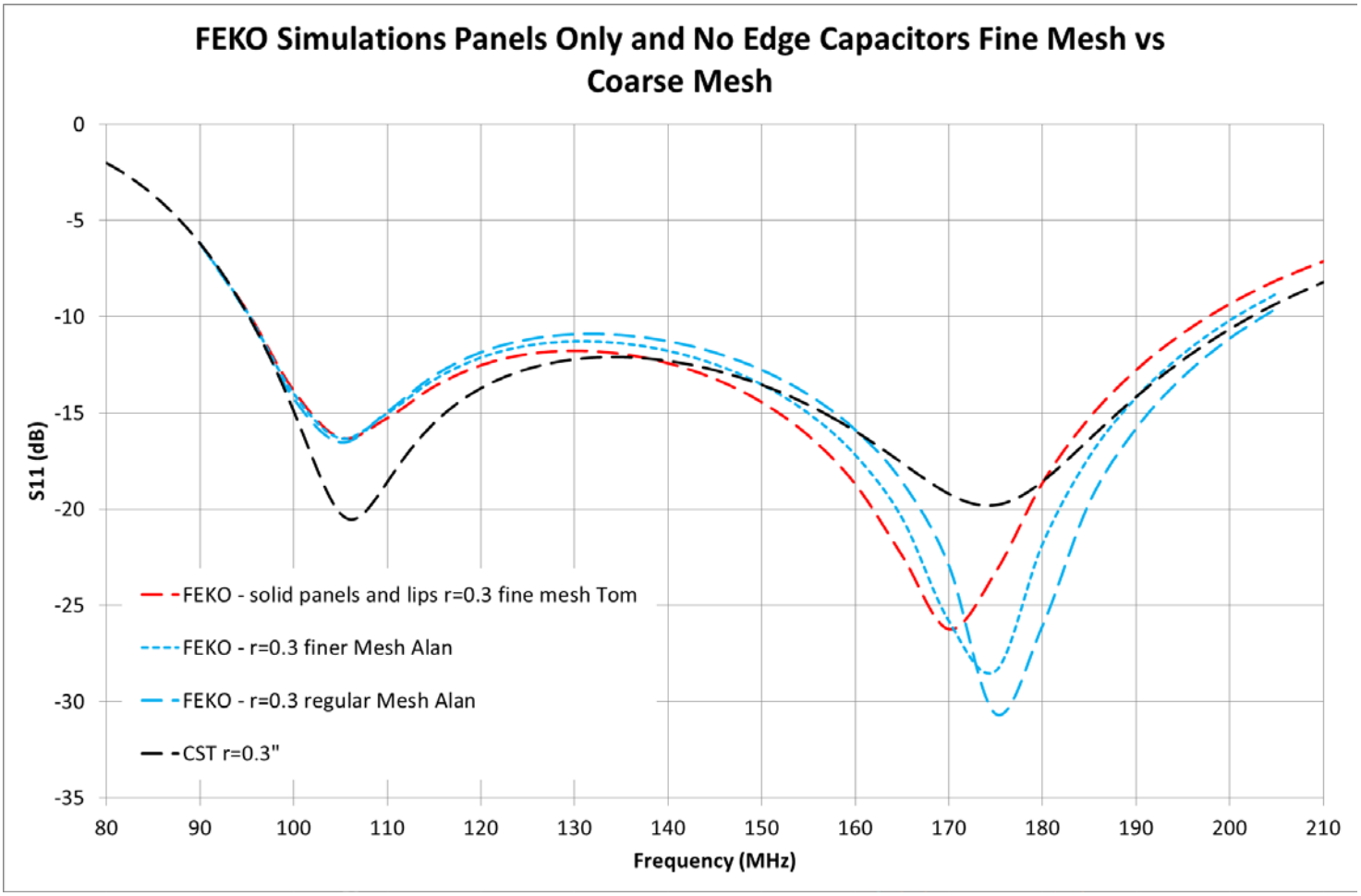

Figure 9. Comparison of CST and similar FEKO simulations