Ground Plane Test in the Softball Field

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Description

At the end of the antenna measurement performed in a softball field between August 13 and 14, we tested the sensitivity of S_{11} to changes in the ground plane. The shield was being used to cover the balun.

The ground plane consisted on three pieces of wire grid, 4 feet $\times$ 8 feet, for a total area of 12 feet $\times$ 8 feet. The active panels of the antenna were orientated parallel to the dimension that is 12-feet long.

Perturbations were applied to the 8-feet long edges of the ground plane (perpendicular to the axis of the active panels). They consisted on lifting each edge by 4 cm using a square, 70-cm long PVC pipe. When inserting this pipe underneath the edge of the wire grid, the height of the grid from the ground increases gradually from 0 to 4 cm within 1 feet from the edge. In other words, no changes occur at 5 feet or less from the antenna. The 70-cm pipe was inserted at the center of the 8-feet long edge, and therefore the height of the wire grid decreases to zero gradually along this axis, beyond the location of the pipe. At 1 feet from the ends of the pipe the wire grid is touching the ground.

Therefore, the perturbations increased to their maximum 6 feet away from the center of the antenna, along the axis of the active panels.

The perturbations were applied on one edge of the ground plane at a time. Before each perturbation, a reference trace was obtained without the PVC pipe and the full ground plane as flat as possible. The steps in the test are:

1. Measure reference trace without perturbation.
2. Apply perturbation at edge closest to antenna panel with brass pipe without the SMA connector. Measure 2 traces to check consistency.
3. Remove perturbation, and measure new reference trace.
4. Apply perturbation at edge closest to antenna panel whose brass pipe has the SMA connector. Measure 2 traces to check consistency.

The results are presented in the following figures.

Reference Traces

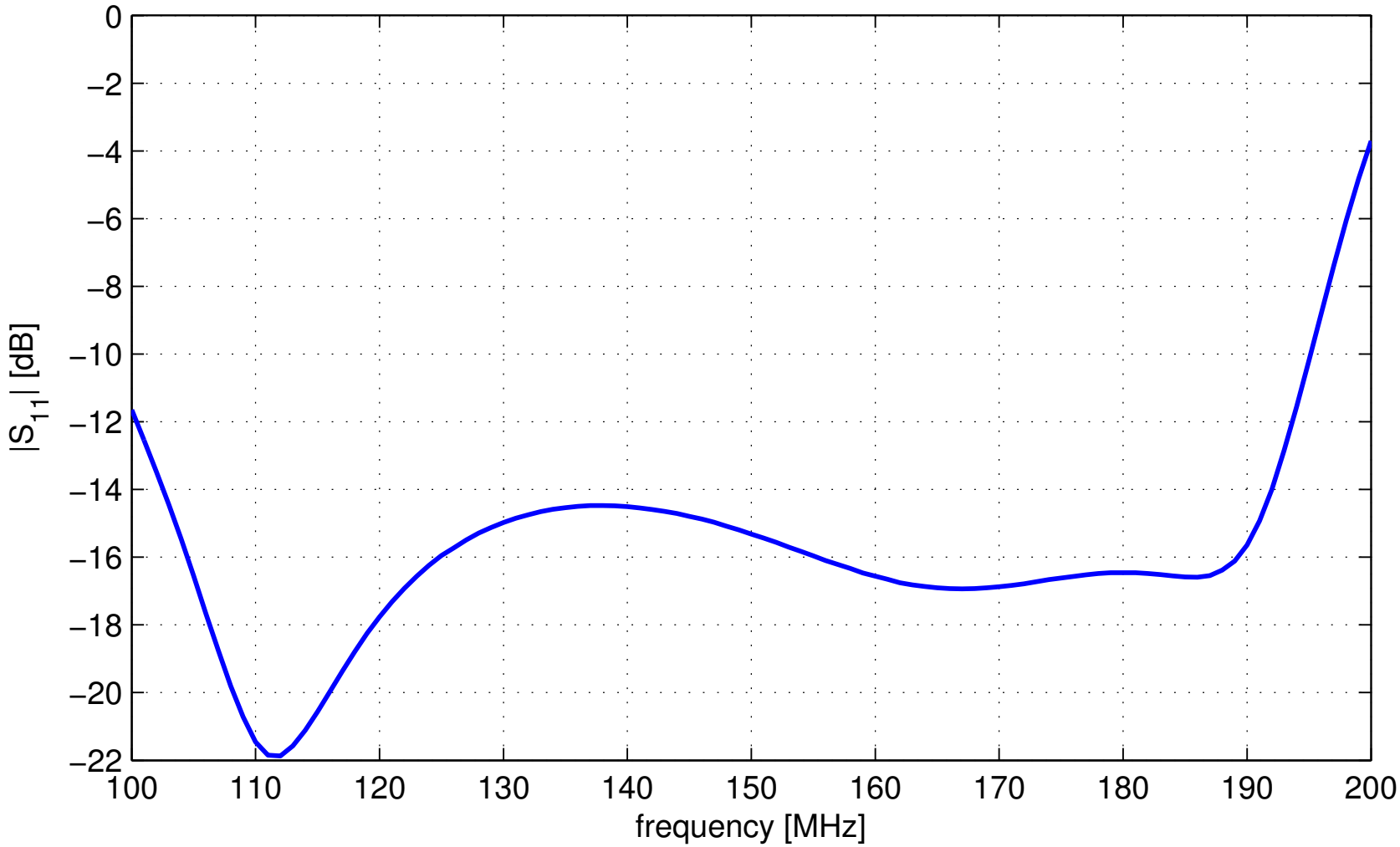

Figure: 1. Antenna response (using shield) with no perturbation applied. In this scale, the two reference traces before applying the perturbations cannot be distinguished.

First Perturbation (Magnitude)

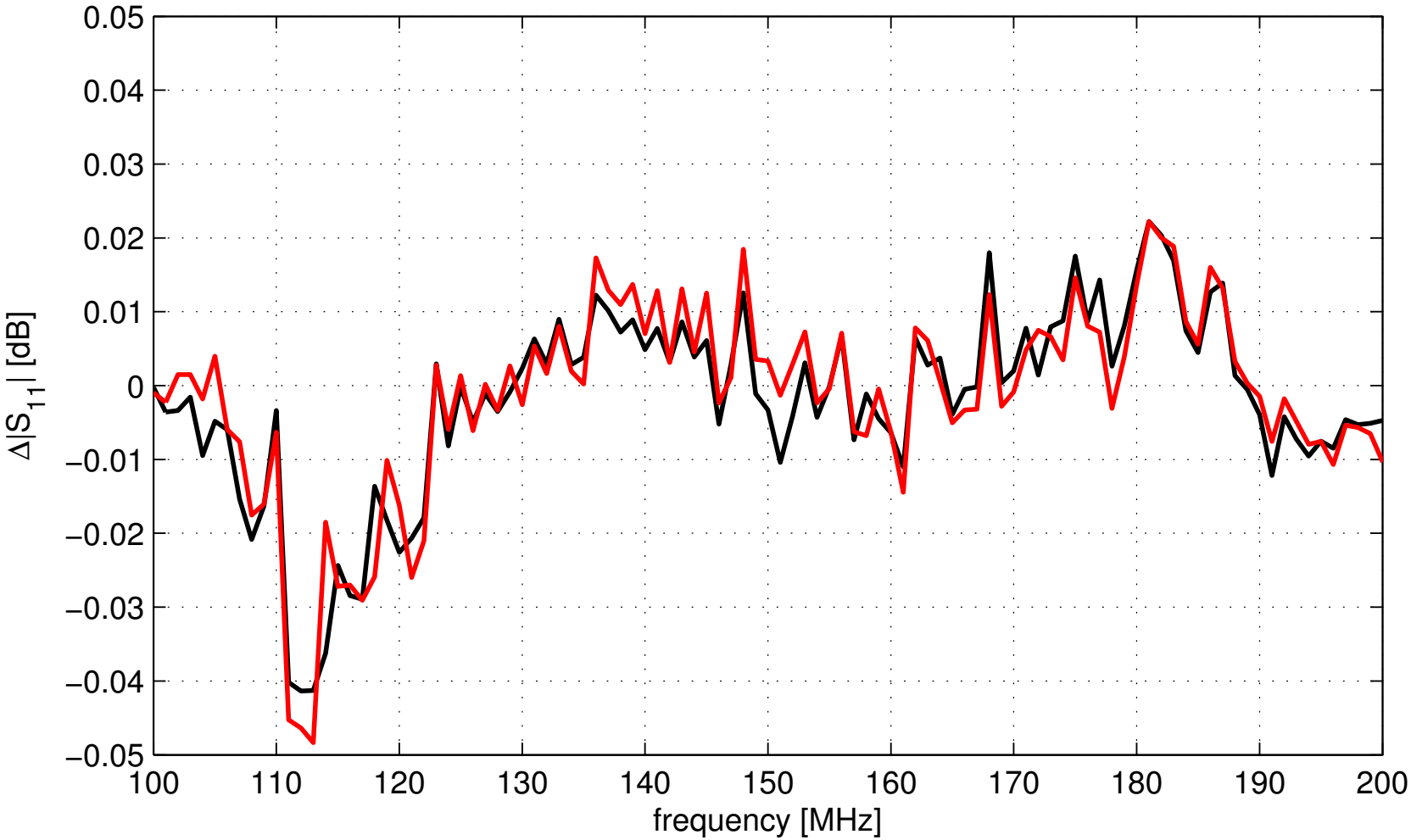

Figure: 2. Difference *After perturbation - Before Perturbation*, in MAGNITUDE. This perturbation was applied at edge closest to panel with brass pipe without the SMA connector. Two traces were measure for consistency check.

First Perturbation (Phase)

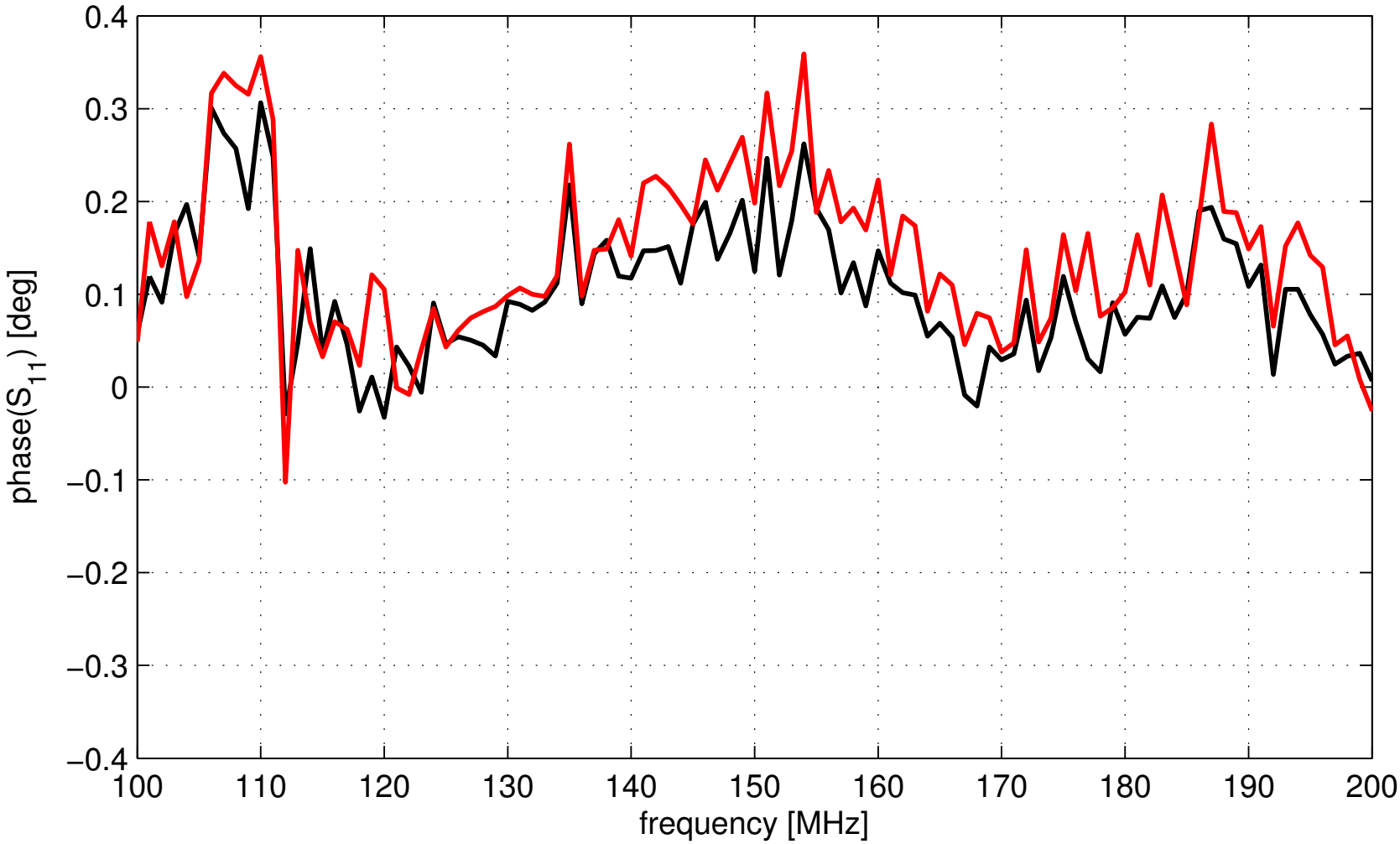

Figure: 3. Difference *After perturbation - Before Perturbation*, in PHASE. This perturbation was applied at edge closest to panel with brass pipe without the SMA connector. Two traces were measure for consistency check.

Second Perturbation (Magnitude)

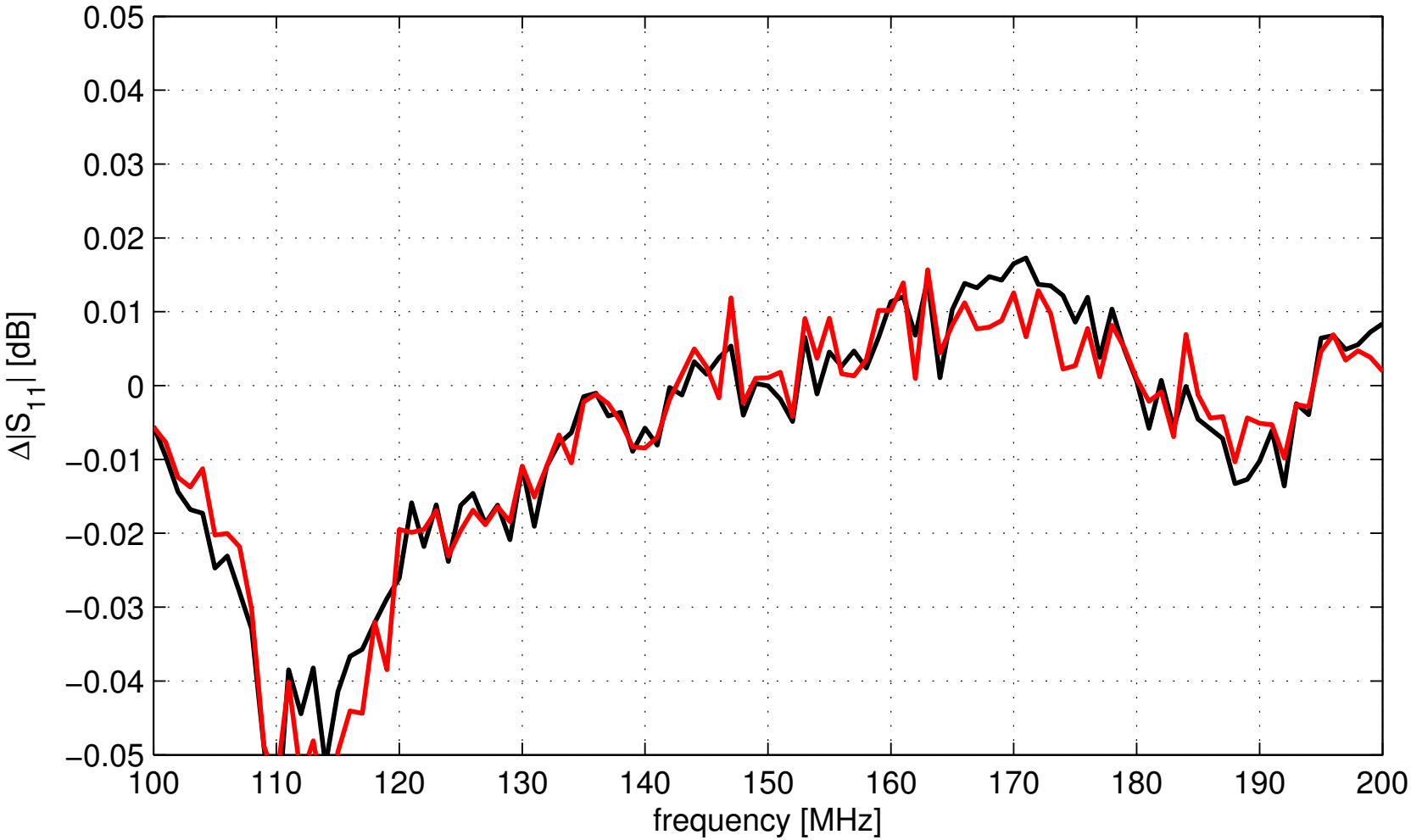

Figure: 4. Difference *After perturbation - Before Perturbation*, in MAGNITUDE. This perturbation was applied at edge closest to panel whose brass pipe has the SMA connector. Two traces were measure for consistency check.

Second Perturbation (Phase)

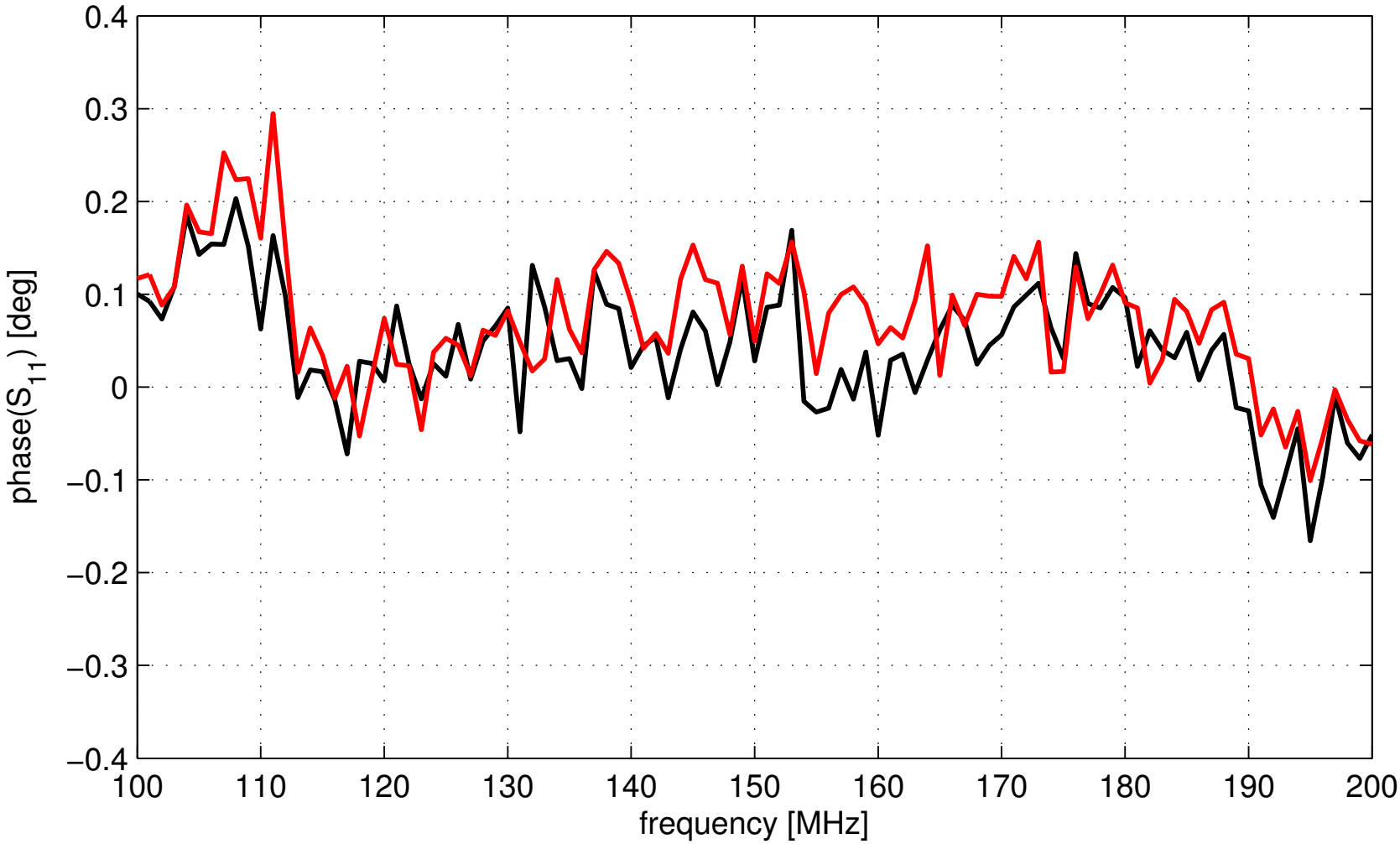

Figure: 5. Difference *After perturbation - Before Perturbation*, in PHASE. This perturbation was applied at edge closest to panel whose brass pipe has the SMA connector. Two traces were measure for consistency check.

Conclusion

The height of the wire grid from the ground, along the axis of the active antenna panels, is increased from 0 to 4 cm, between 5 and 6 feet from the center of the antenna. As described at the beginning, the perturbations are not constant along the perpendicular direction because the PVC pipe used to change the height was only 70-cm long.

The perturbations were applied at each edge of the wire grid, one at a time. As shown in Figures 2 and 4, the changes in $|S_{11}|$, due to each perturbation applied separately, are within ± 0.02 dB between 120 and 200 MHz.

Figures 3 and 5 show the changes in phase. They are $\sim 0.4^\circ$ in the first case (on the side without the SMA connector), and $\pm 0.15^\circ$ on the side with the connector.

The shape of the changes is different between the two sides of the antenna. The side without the connector shows two bumps in magnitude and phase, although not at the same frequencies. The side with the connector changes with a smoother response in frequency.

The shapes are significantly different from those reported in Memo 107, figures 9 and 10, when a perturbation is applied 2 m $\sim$ 6 feet away from the antenna center (blue lines in those figures). Since the new measurements in the softball field indicate changes much smaller and no sharp spikes, it is suggested that those large features (in memo 107) were due to walls.