EDGES MEMO #154

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Subject: Measurements of blade antenna prototype

A wide planar dipole, or "blade" antenna for short, has been constructed from 2 rectangular panels supported by a fiberglass frame and driven by a Robert's balun

The key parameters are:

Panel size 0.626×0.482m

Height 0.52m

Panel separation: 0.022m

The prototype antenna is driven by a Roberts balun of the same design as used for the Fourpoint antenna. In addition balun is shielded with same 6.5" high shield as used by the Fourpoint. Modeling, using FEKO, was used to find the optimum values of panel size, panel separation, topcap capacitance and tip capacitance. These model simulations indicated that using a tuner capacitance was not needed and very low tip capacitance value of 0.5 pf was optimum. Once constructed it was found that tip capacitors were also unnecessary. Figure 1 shows the S11 of the best model and is not as good as the measured S11, shown in Figure 2, following adjustment of the panel separation from 0.018m to 0.022m. A photograph of the antenna on the radar splashplate is shown in Figure 3. The topcap was the same as for the latest version of the Fourpoint using an airgap of 0.42" without quartz.

The fiberglass support frame is designed using square 1.25"×1.25" tubing. In order to avoid magnification of the fiberglass expansion in the gap the panel separation is set by a short 1" long tube. FEKO S11 simulations show sensitivity to the gap of 0.01 dB for a 0.1% change in fiberglass dimensions and since the thermal expansion of aluminum (22×10^{-6}/K) and fiberglass (20×10^{-6}/K) are similar the main effect of a change in temperature is a change in scale of 10^{-3} for a 50K change. This change in scale is expected to result in a S11 change of about 0.01 dB.

A one percent asymmetry in the antenna was simulated with FEKO and found to be barely significant effect on the beam so that it is expected that asymmetries due to tolerances under 0.1 percent will have negligible effect. However at 0.1 percent tolerance on a gap of 0.22m is 20 microns 0.1 mil although 50 microns would be acceptable. A more complete study shows that the uniformity of the gap between panels is the most critical and needs to be held to about 1 mil.

Tests of the sensitivity of various dimensional errors were simulated using FEKO. Those errors which have the largest effect on the frequency dependence of the beam are those which introduce any asymmetry in a direction perpendicular to the line between panels. Of those asymmetries the one which produced the largest effect is a difference in the panel separation from side to side. In this case a 1.76 cm difference in the gap between the panels from one side to the other increased the rms fit with a 6 term polynomial by a factor of 61. Assuming a linear relationship a 0.1 mm difference would make a 35% increase in the rms.

Tests of Sensitivity to heat and moisture

The prototype was tested again in June 2015.

At this time the best panel separation was 0.022 m in agreement with the measurements in January. The topcap was modified by reducing it to a simple rectangular coupling of 3.1”×0.8”. With the portion used to add capacity used with the Fourpoint the best air gap was found to be 0.35”.

A test of the sensitivity to moisture was made by spacing water to the antenna. The largest change of up to 1 degree of phase at 180 MHz occurred when the fiber glass near the panel gap were covered with a layer of water and water droplets. Changes in S11 amplitude were under 0.05 dB. A photo plot of the S11 change in phase is shown in Figure 4. An attempt was made to see changes due to temperature by heating the balun tubes with a heat gun. In this case heating the tubes to 25˚ C from the ambient of 16˚ C made a change of 0.6˚ of phase as shown in Figure 5 and less than 0.05 dB change to the S11 magnitude. The S11 returned to the original values in a few minutes as the balun tubes returned in ambient. An attempt to heat only the topcap had a similar effect. The changes due to moisture also returned the S11 to its original value when the water was removed with a cloth. Figure 6 shows the water droplets.

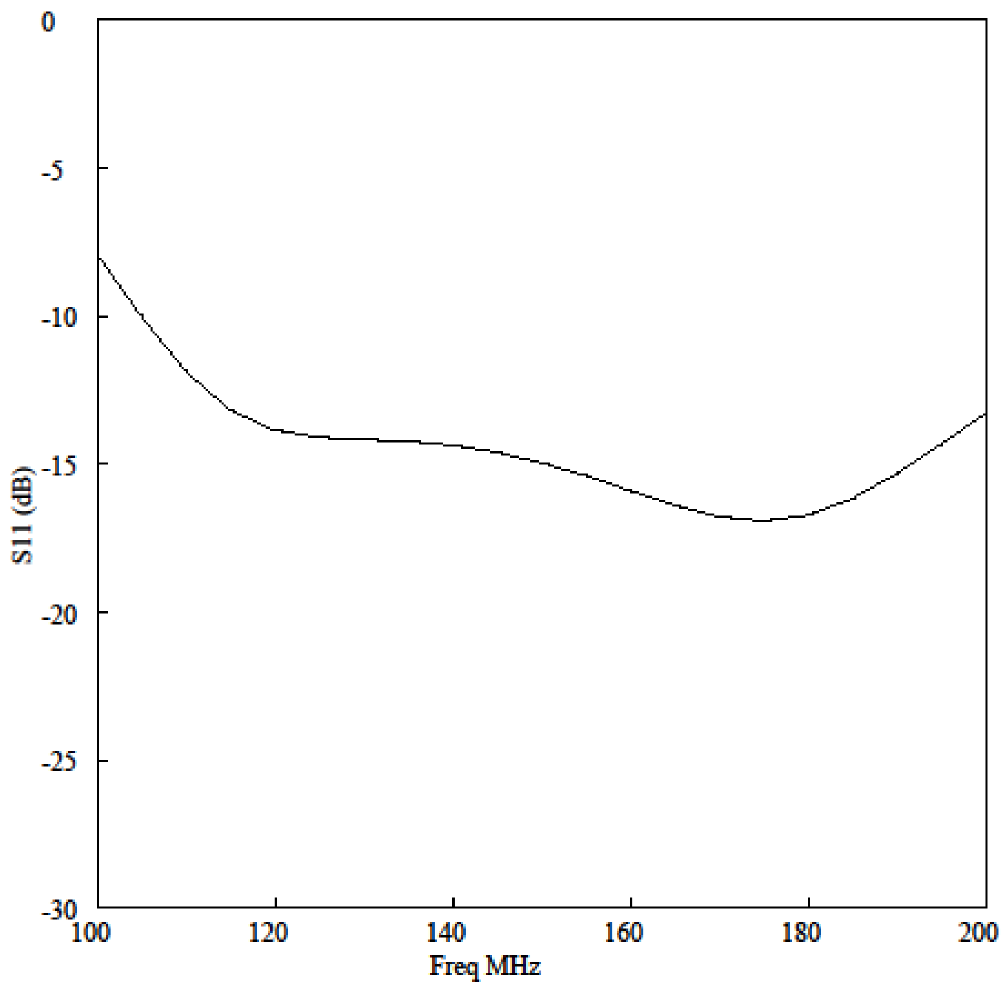

Figure 1. S11 from FEKO.

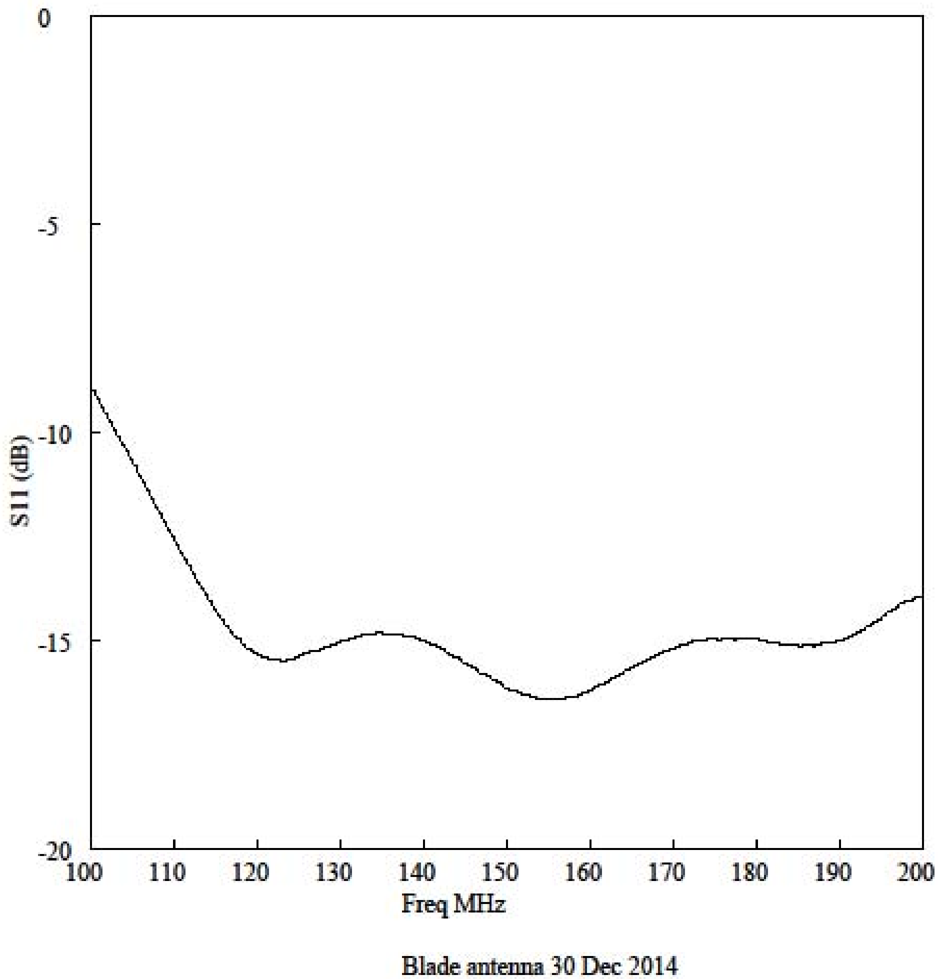

Figure 2. Measured S11.

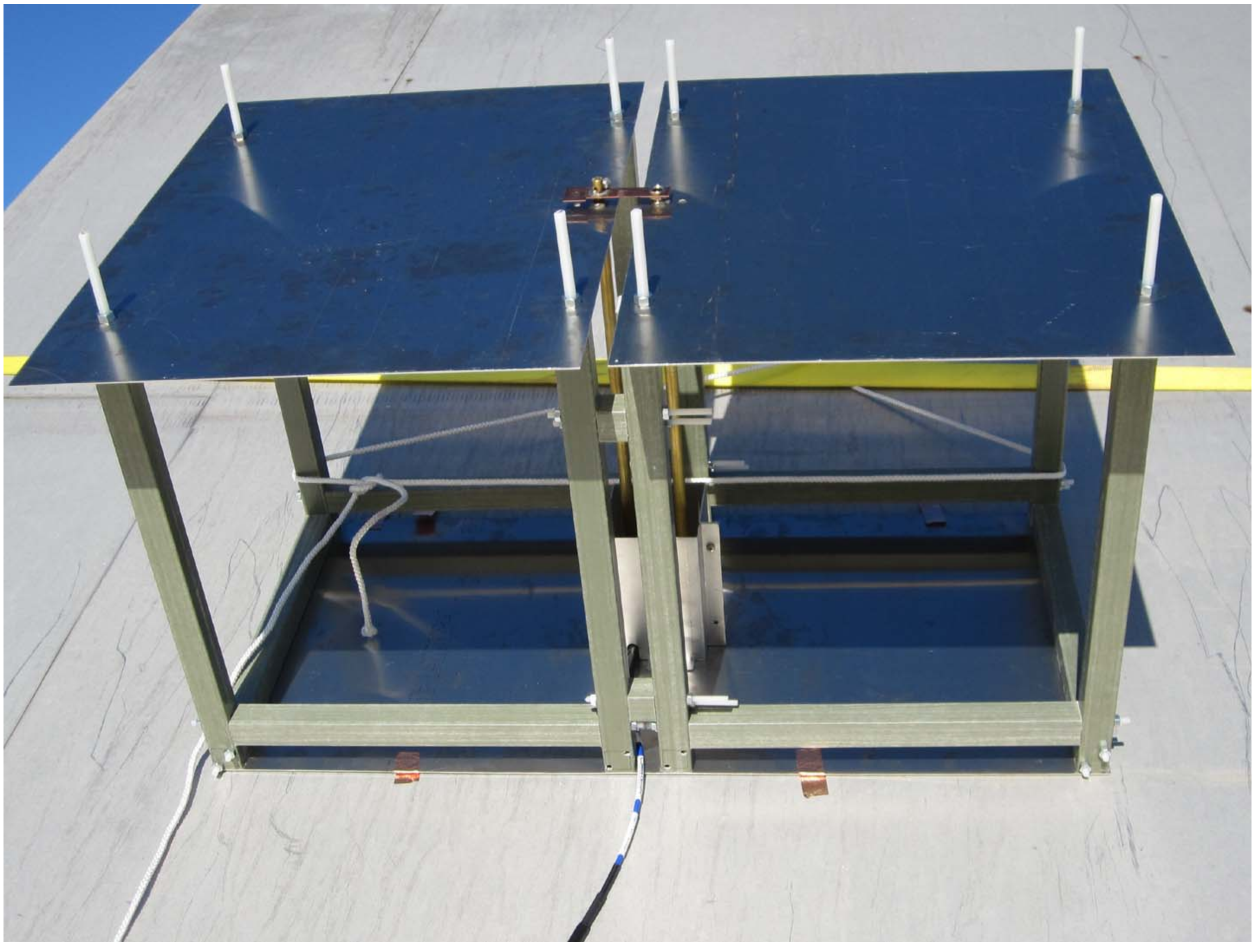

Figure 3. Blade antenna prototype on radar splashplate at Haystack.

Figure 4. Change in S11 phase with water deposit on fiber glass.

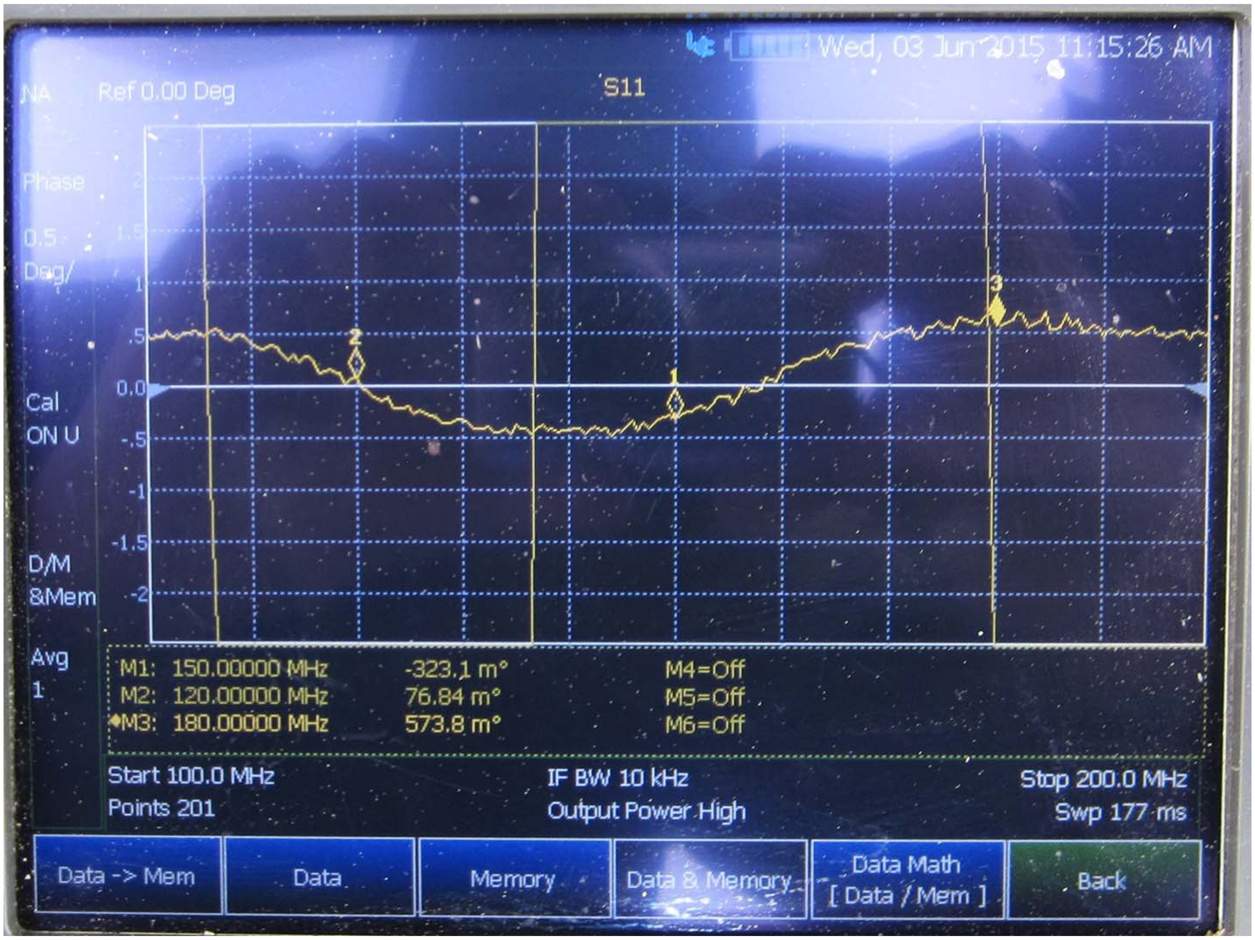

Figure 5. Change in S11 phase with heating of balun tubes.

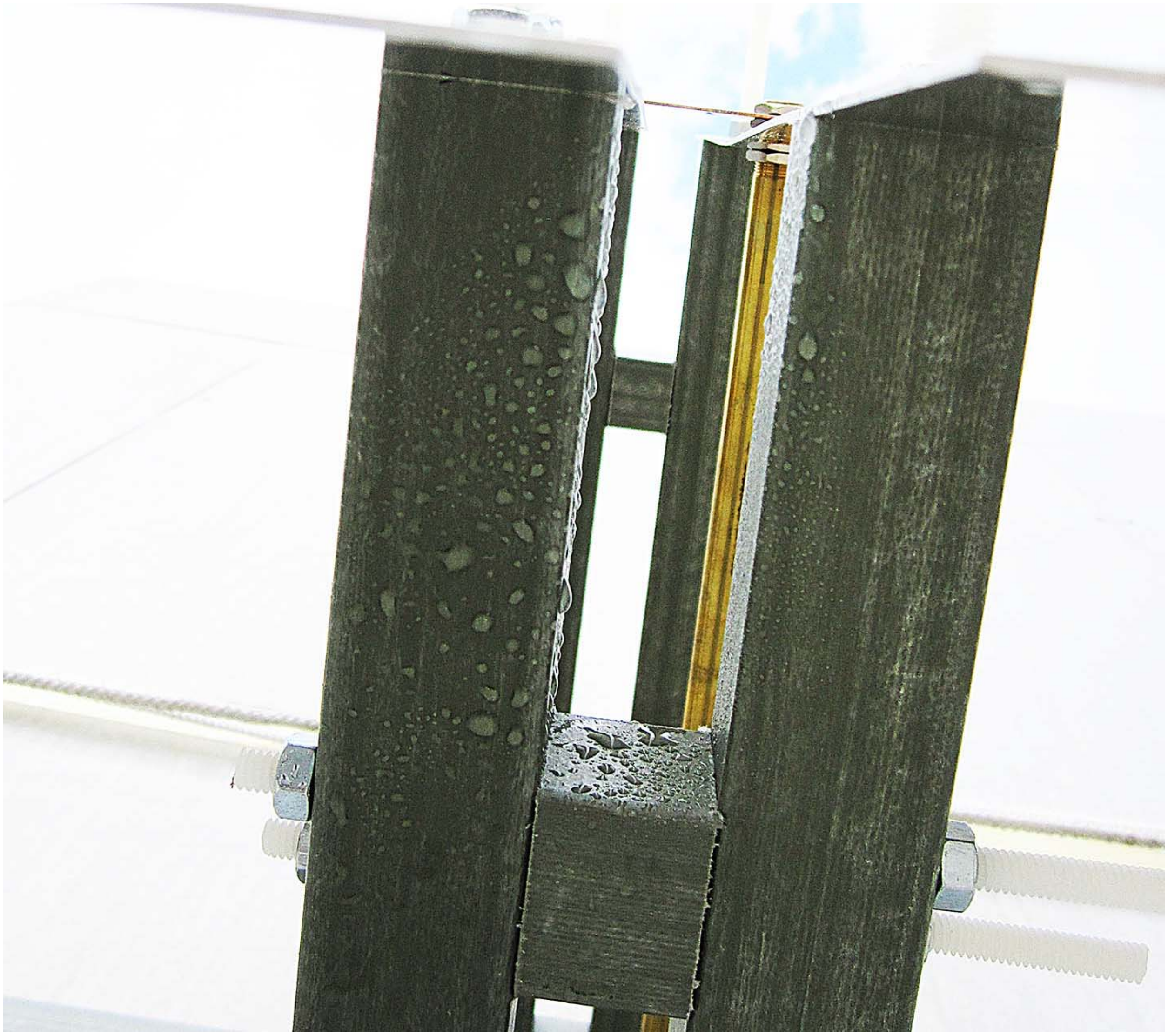

Figure 6. Water droplets