EDGES MEMO #110

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To: EDGES Group

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Subject: Effect of moving the reference point.

The proposed EDGES installation in Memo #108 requires moving the reference point away from the 3-position switch towards the antenna in order to make this point accessible to VNA measurements as well as the ambient and hot loads. The absolute calibration algorithms are not affected by this move as long as the added cable between the 3-position switch and the reference point remains unchanged. Since it would be difficult to control the temperature of this cable we need to rely on the constancy of its delay, impedance and loss or be able to correct for changes based on measurements of its temperature.

If we assume a 10' cable with 0.2 dB loss at 150 MHz with air or SiO2 dielectric a change of 10K is expected to increase its phase by degrees through the linear expansion of copper (16ppm/K) and its loss by dB owing to the increase resistivity of copper $\left(7\times10^{-3}/K\right)$.

Estimates of the effect of these changes are given in the table.

Cable change	rms ripple (mK)	Constant (mK)
Phase	23	0.002
Loss	13	460

Table 1. Estimated effect of 10K change in cable temperature

These variations are based on antenna S11 and LNA parameters typical of the current EDGES-2 system. The "ripple" has a period of the inverse cable 2-way delay or about 50 MHz. While a longer cable will result in greater loss and larger change of added thermal noise the shorter ripple period helps decorrelate the ripples with the EoR signature. The temperature variation can be limited by locating the cable as deep below ground as possible. While the thermal contribution with temperature change is large it is fairly smooth.

Figure 1 shows the estimate of the combined effects of the change in attenuation and electrical length for a 10' cable for a temperature increase of 10°C.

The plot assumes the following parameters:

One-way cable delay	10ns
Antenna S11	Prototype with Roberts balun
LNA S11	-20 dB
Cable temperature coefficient	8 ppm/°C
Cable loss	1.3 dB/100’ at 150 MHz
Increase of loss with frequency	$f^{1/2}$
Temperature coefficient of loss	3500 ppm/°C
Ambient temperature	300 K
Cable type 3/8” heliax	LDF2-50

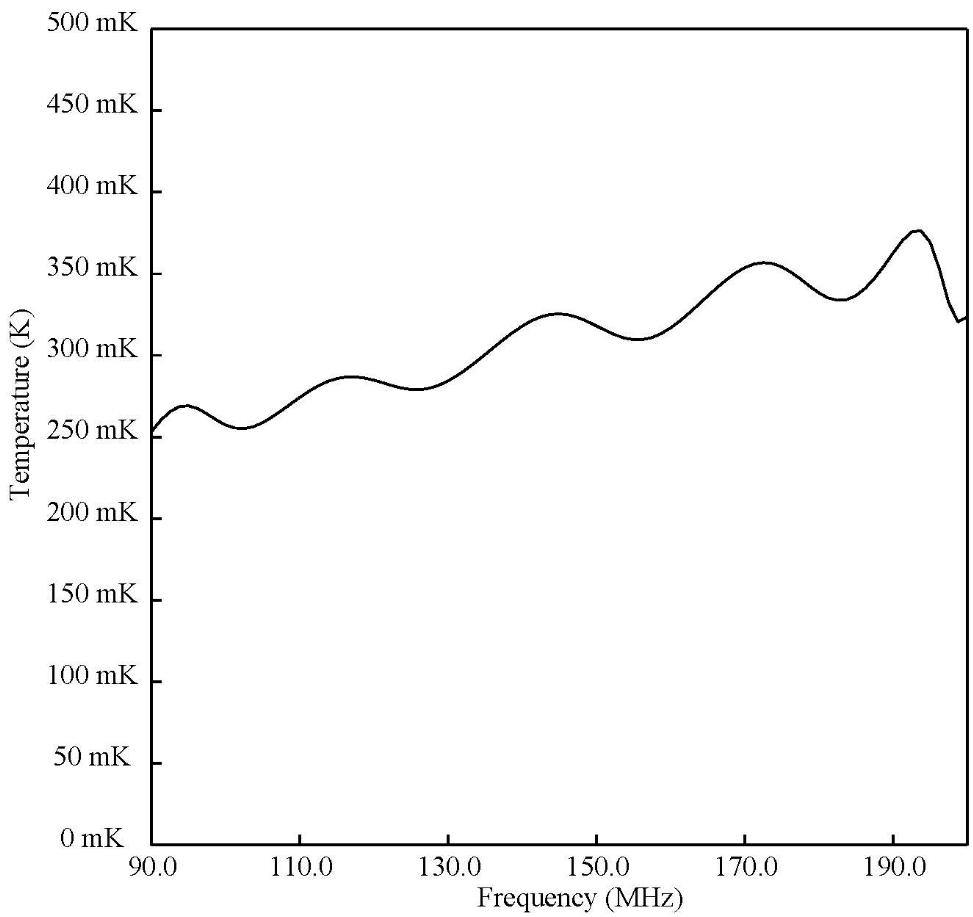

Figure 1. Expected change in spectrum for 10°C increase in temperature.