EDGES MEMO #085

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February 21, 2012

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To: EDGES Group

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Subject: Tests of EDGES calibration

1] Test loads
   a. 50 ohm at ambient and 400 K
   b. Mismatched tungsten filament at ambient and 1660 K
   c. Open CBL-10FT-SMSM cable
   d. Short cable terminated with 3 dB attenuator
2] EDGES Measurements of all test loads
3] Ancillary measurements of S11 of all test loads at ambient and hot in the case of the lamp and hot load.
4] Ancillary measurement of temperature internal load in EDGES.
5] Ancillary measurement of S11 of the LNA input using -30 dBm power from VNA.

For a given test the EDGES spectra were analyzed with software which accepted the following inputs.

   a. Test measurement spectrum from 3-position switch
   b. Open CBL cable spectrum
   c. S11 for test load, open cable and LNA

The software made polynomial fits to the S11 data for smoothing and interpolation. In the case of the open cable an analytic model fit was used in place of a polynomial. The software used the open cable spectrum to estimate polynomial fits to the LNA noise waves. The noise wave estimates are then subtracted from the test spectrum and the spectrum is then divided by the mismatch loss and in the case of hot loads corrections are made for the cable loss between the EDGES input and the hot filament or heated termination.

The 50 ohm ambient and 400 K load was used to correct the noise diode in the software that calculates the 3-position switched spectrum.

The following results were obtained over the frequency range 50 to 190 MHz.

Test load	Approx refl. coefl. dB	Average temp. K	rms K
Open cable	-0.5	300	1.5
Hot load	< - 50	488	0.2
Hot filament	-3.5	1777	1.2
Cable with 3 dB	-7	294	0.3
Cold filament	-3	280	1.3

The rms error is obtained from the deviations to the best fit constant. The errors are consistent with VNA accuracy of about 0.004 in amplitude and phase dominated by the error in measurement of the "test" loads. The 0.2 rms for the hot load was dominated by the noise in the short integration used. If an antenna reflection coefficient better than -20 dB could be achieved then the VNA accuracy of 0.001 (which may be possible with calibration corrections) should result in a fractional accuracy of about

$$2\times10^{-2}\times0.001\sim2\times10^{-5}$$

Or about 40 mK for 2000 K sky noise. The residuals to the fit for the hot filament test load are shown in Figure 1.

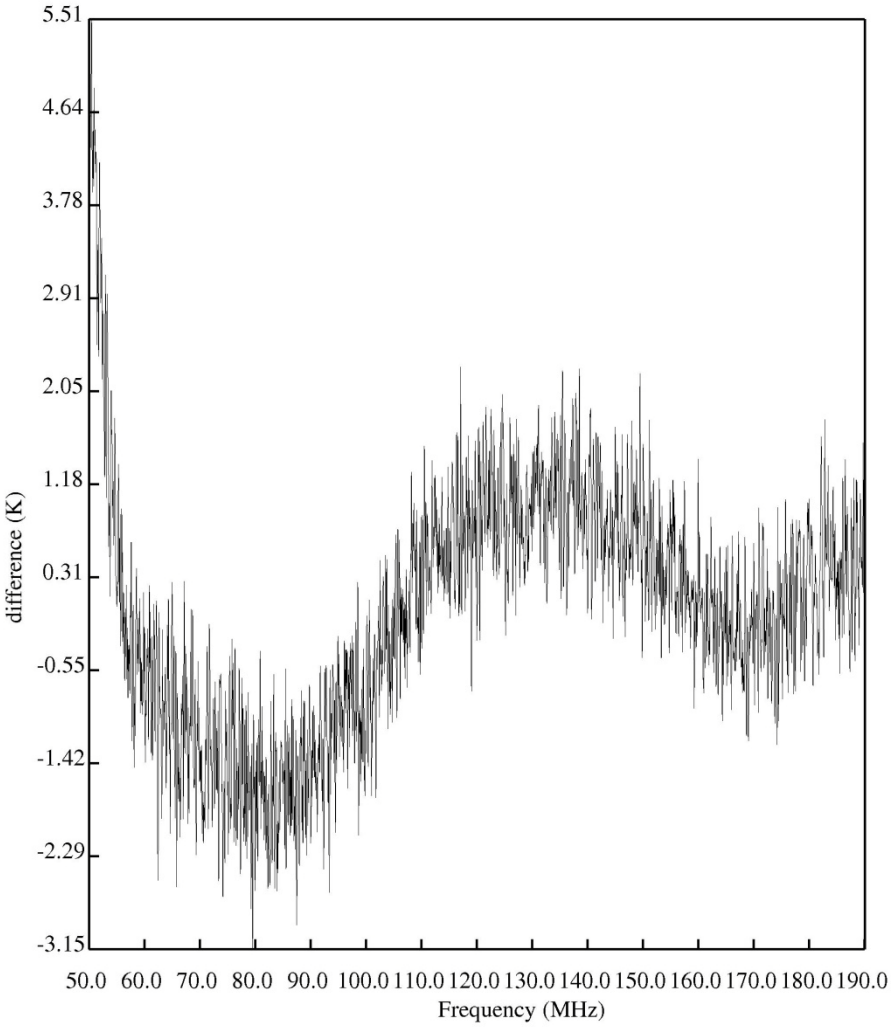

Figure 1. Residuals to best constant fit of 1777 K