EDGES MEMO #369

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To: EDGES Group

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Subject: Tests of EDGES-3 calibration and VNA measurement accuracy

The automated operation of EDGES-3 allows for a number of tests which can be conducted remotely without the need to connect an artificial antenna or calibration SOL to the receiver input. These tests would be especially useful in a remote deployment at an arctic site for which the sky noise is almost constant with Galactic Hour Angle (GHA). In this case variation of the observed spectrum with GHA cannot be used to distinguish between a global sky signal, a calibration or S11 measurement error, or frequency structure in the loss due to layers in the soil below a ground plane of limited size.

The following tests which can be made from an automated measurement of the s11 measurements of the ambient, hot, open, short, LNA and calibration SOL loads along with the spectra of the ambient, hot, open and shorted cables are:

1] A check of the calibrated s11 of the ambient load which should be within 1e-4 fractional units of the modeled s11 of the calibration load based on its resistance and delay. This is basically a check of the repeatability of the VNA since the ambient load and the calibration load are the same device measured at different times.

2] The calibrated spectra of the ambient, open and shorted cables should be constant within the noise and equal to temperature of the ambient load and the calibrated spectrum of the hot load should be equal to the measured temperature of the hot load.

3] A close examination of the calibrated spectrum of the open cable (and shorted cable) should be relatively free of ripples and for an integration of 400 3-position switched cycles has a rms of less than 270 mK. If a 100 ps or 1 dB offset the LNA s11 is introduced in the calibration and processing the rms should increase to about 370 mK for 1-term removed. A much larger increase to about 3000 mK in the rms occurs if the s11 change is only made for processing and not for the calibration.

Figure 1 shows the S11 of the load, the noise wave solutions, the fit to the open and shorted cables and the calibrated spectrum of the open cable and Figure 2 shows the results with a 100 ps offset applied to the S11 of the LNA. Figure 3 shows the results with 100 ps offset using the calibration without the offset. In all cases the average of calibrated spectra equals the measured temperatures which are used in the calibration as this is “forced” by the algorithms in the calibration analysis.

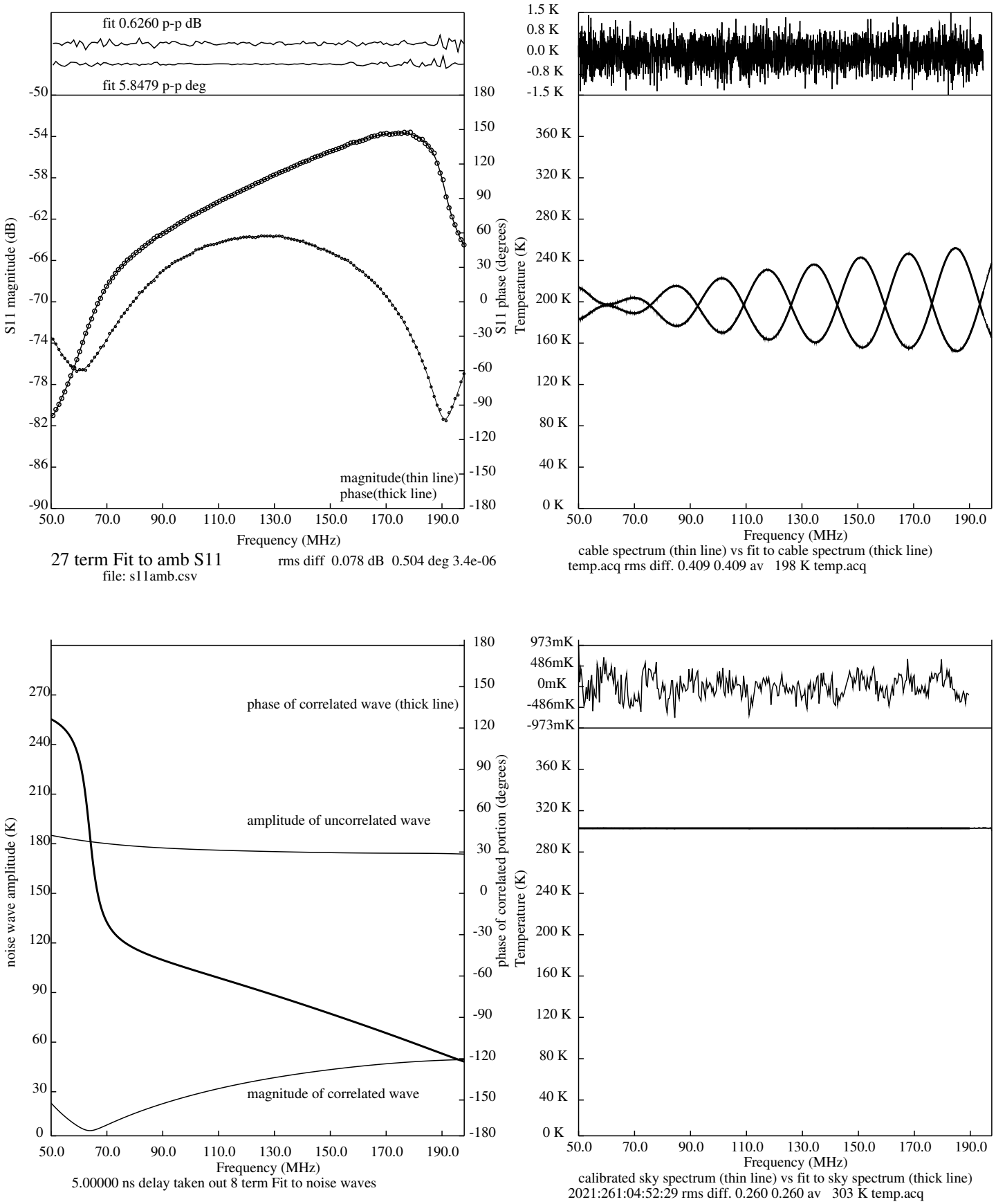

Figure 1. S11 of the load (top left), the noise wave solutions (bottom left), the fit to the open and shorted cables (top right) and calibrated spectrum of open cable (bottom right).

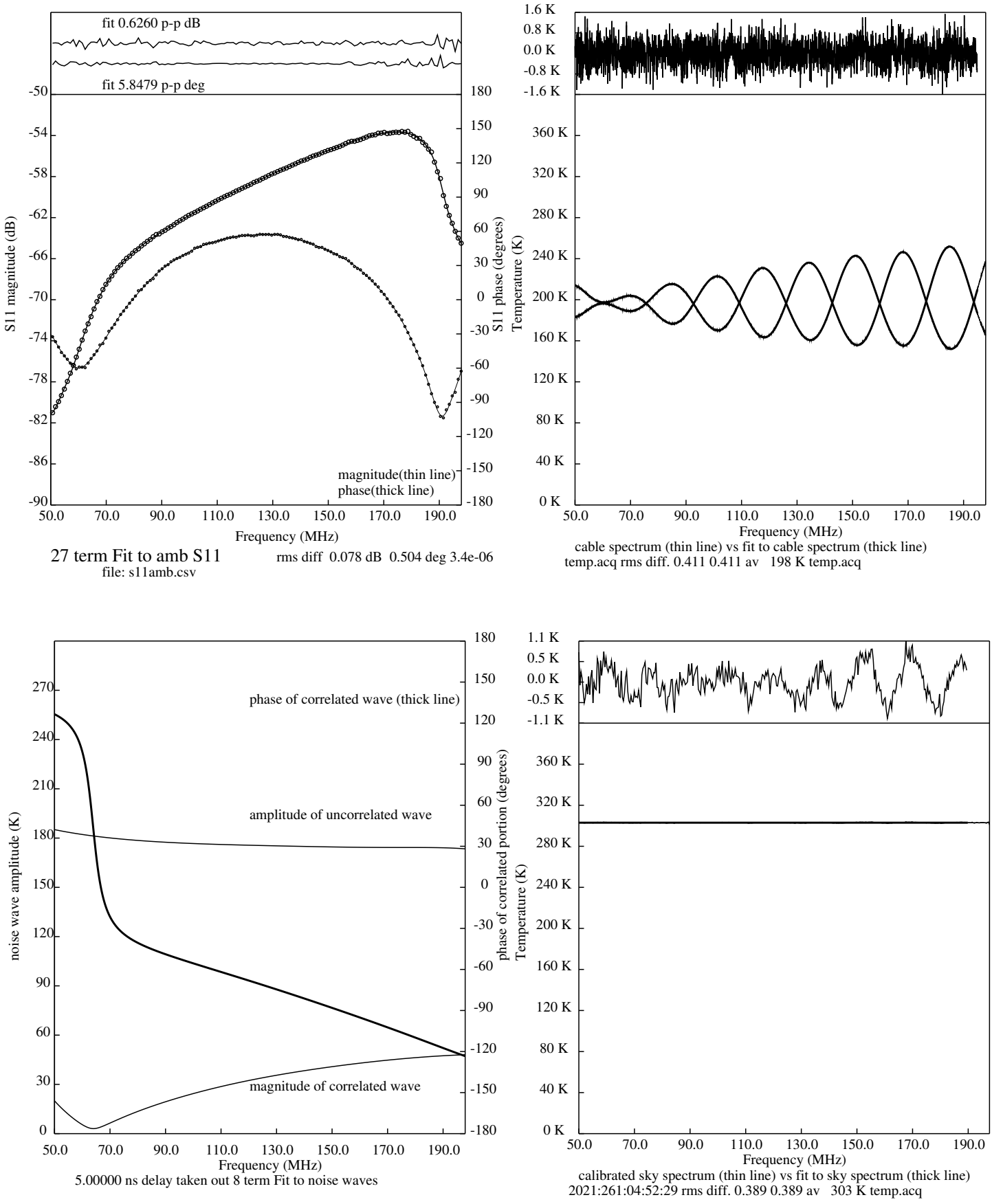

Figure 2. 100 ps offset applied to LNA S11 used for calibration.

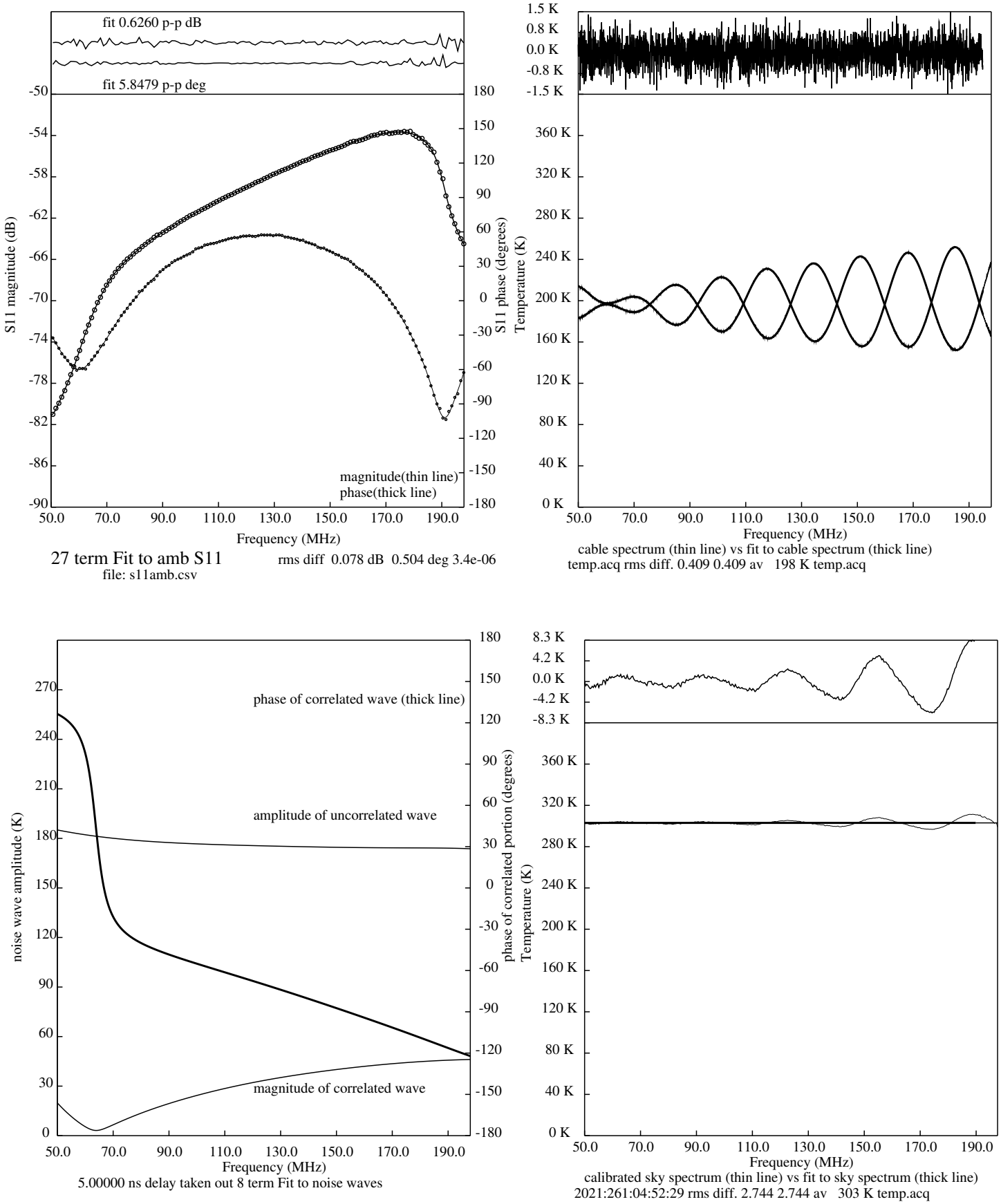

Figure 3. 100 ps offset applied to LNA S11 only for open cable and not for calibration.