MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886

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Telephone: 781-981-5407
Fax: 781-981-0590

To: MWA Group
From: Alan E.E. Rogers
Subject: MWA active antenna noise simulations

Using the measured impedance of the MWA antennas (old and new) I have simulated the performance. The noise theory is from EDGES memo #9 and the amplifier feedback theory is from EDGES memo #16. To simulate the MWA LNA I assumed a 270 nH lossless inductor in parallel with the input and a 10 k ohm feedback resistor. Further I modeled the performance as an “equivalent” single LNA connected to an antenna with half the impedance that was measured across the balanced terminals (see EDGES memo #31 For the impedance data.)

The plots assume a uniform sky noise temperature of

$$10^3 \left(f/100 \right)^{-2.6} K \tag{1}$$

where f = frequency in MHz.

Using the impedance referenced to the inputs of the transistor the results are plotted for several cases:

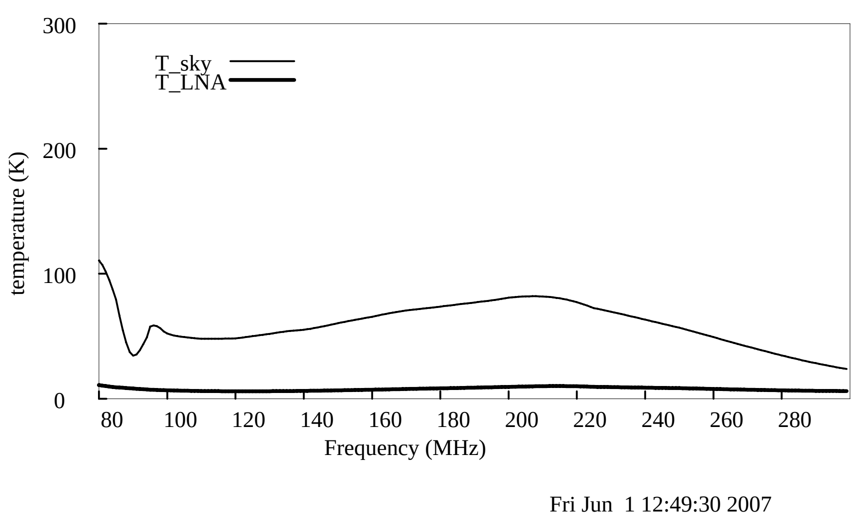

Figure 1. LNA output scaled to input in degrees Kelvin for the original antenna and LNA as used in the early deployment.

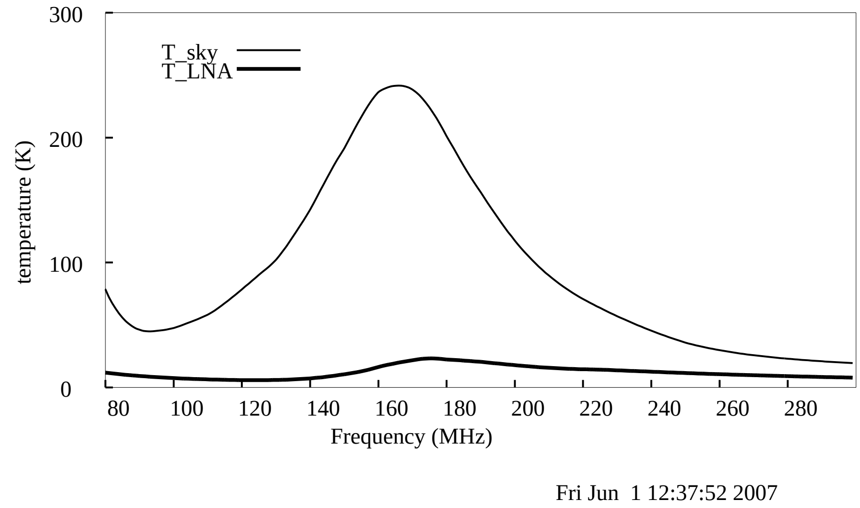

Figure 2. LNA output for new antenna with the new pc board.

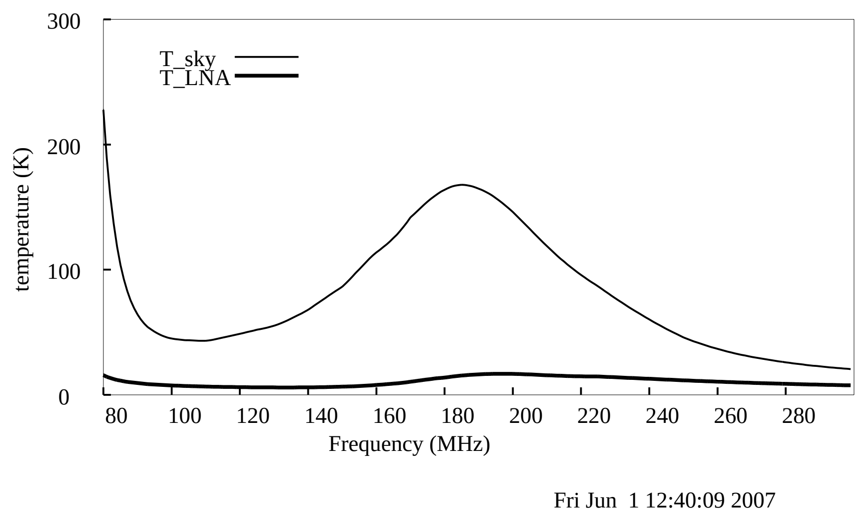

Figure 3. Same as figure 2 but with 270 nH inductor reduced to 100 nH.

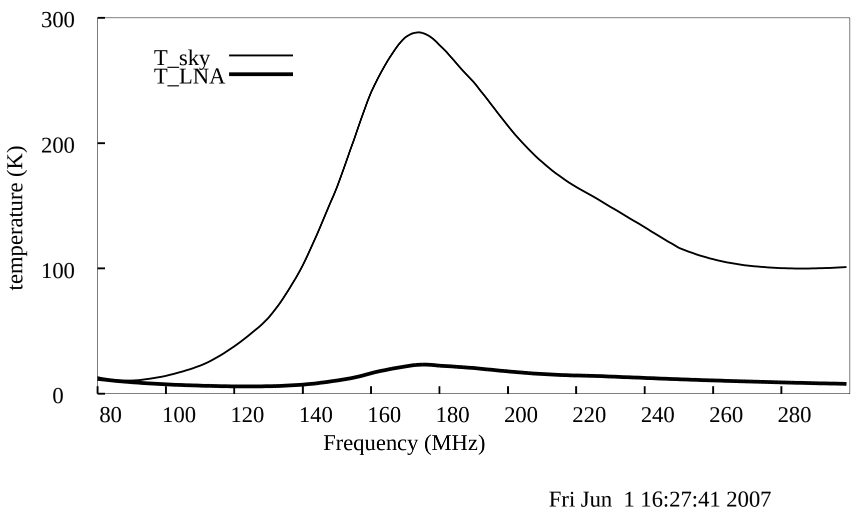

Figure 4. Simulated LNA output for new antenna with new pc board inside an ideal 300 K chamber.

The noise contribution from the stages following the LNA are ignored. This "second stage" noise is likely to be significant because Figure 4 shows the LNA noise to be about 7K referred to the LNA. This is only about 700 K at the LNA output as the LNA gain with cable loss is about 20 dB. A 3 dB second stage will add 300 K plus another 200 K or more from the cable loss. It also should be noted that the impedance measurements below 100 MHz, when the antenna VSWR is very high, may have been influenced by grounds losses due to the small ground plane. These impedance measurement errors are responsible for the increased sky noise below 100 MHz in the simulations shown in figures 1 through 3.