To: EDGES Group  
From: Alan E.E. Rogers  
Subject: Tests of EDGES spectrometer using a noise source based antenna simulator.

Tests of the absolute calibration of the EDGES spectrometer made with a hot filament source were described in memo 82. with this source the measured simulator output was 1660±1 K in good agreement with an estimated temperature of 1670±30 K estimated from the change in tungsten resistance. In order to perform a test at higher levels with a spectrum closer to the sky foreground in the 50 – 100 MHz range a simulator was made using a noise and filter as described in memo 199. While the noise source does not produce a known output level it does produce a smooth repeatable spectrum so that calibrated measurements made with the noise source plus filter plus attenuator provide an output level of about 10,000 k at 75 MHz with spectrum shown in Figure 1. The spectrum which is fit with parameters whose values are

\[
\begin{align*}
T & \text{ at } 75 \text{ MHz} & 10,440.5 \text{ K} \\
\text{Spectral index} & & -1.951 \\
\text{Spectral curvature} & & 0.086
\end{align*}
\]

when an additional 3 dB attenuator of known s-parameters is added between the simulator and the EDGES receiver the calibrated result with attenuator loss correction is shown in Figure 2. In this case the best fit values are

\[
\begin{align*}
T & \text{ at } 75 \text{ MHz} & 10445.9 \text{ K} \\
\text{Spectral index} & & -1.951 \\
\text{Spectral curvature} & & 0.087
\end{align*}
\]

The results with an additional 6 dB attenuator are

\[
\begin{align*}
T & \text{ at } 75 \text{ MHz} & 10429.8 \text{ K} \\
\text{Spectral index} & & -1.950 \\
\text{Spectral curvature} & & 0.087
\end{align*}
\]

these are in agreement with the result without attenuator to within about 1 in 1000.

Figure 3 shows the residual spectra with 4 polynomial terms removed for noise source direct, with an additional 3 dB and an additional 6 dB attenuators.
At a minimum this provides a good test of the linearity which is critical in the use of the Galaxy calibration method described in memos 48, 55, 145, 171, 172, 202, 215 and 222.

Figure 3 shows the individual 0 and 6 dB and difference spectra with 4-term polynomial removed.

Figure 1. Noise source antenna simulator spectrum.
Figure 2. Spectrum with added 3 dB attenuator and loss correction applied use attenuators s-parameters.
Figure 3. Spectral residuals with 4 polynomial terms removed for simulator alone, with 3 dB and 6 dB attenuators added.
Figure 4. Spectral residuals for 4-term polynomial with 0 and 6 dB additional attenuation.