

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
HAYSTACK OBSERVATORY  
WESTFORD, MASSACHUSETTS 01886**

February 22, 2016

*Telephone: 781-981-5400*

*Fax: 781-981-0590*

To: EDGES Group  
From: Alan E.E. Rogers  
Subject: Comparison of high and low band data with beam effects computed with infinite and finite ground planes

Figure 1 shows the high and low band residual spectra without beam correction vs the hour angle of the Galactic center (GHA) for 4 hours integration at each GHA with 5 physical terms removed. The data covers 2015-204 to 2015-015 for the high band and 2015-286 to 2016-015 for the low band. Also shown are the 5-term residuals to simulated data with beam obtained using FEKO with the blade antenna and an infinite ground plane. Notice that the simulated effects of the beam for the low band are much smaller than observed. For comparison Figure 2 shows the data compared with simulations that account for the finite size of the ground plane. The "GF" method was used with a soil dielectric of 3.5 and conductivity of  $10^{-3}$ . In order to preserve the fine frequency structure in the beam the beams from FEKO, which were obtained with frequency spacing of 5 MHz were interpolated using a polynomial with 9 terms.

Further tests of the fine structure in the frequency dependence show that FEKO needs to be run with 2 MHz frequency spacing. In addition a 50 term Fourier series is needed to fit the convolution with the sky to better than 5 mK. The result is shown in Figure 3. Note the added structure around 70 MHz which is also seen in the data. Figures 4 and 5 show the data and FEKO model for the frequency range extended from 51 to 97 MHz.

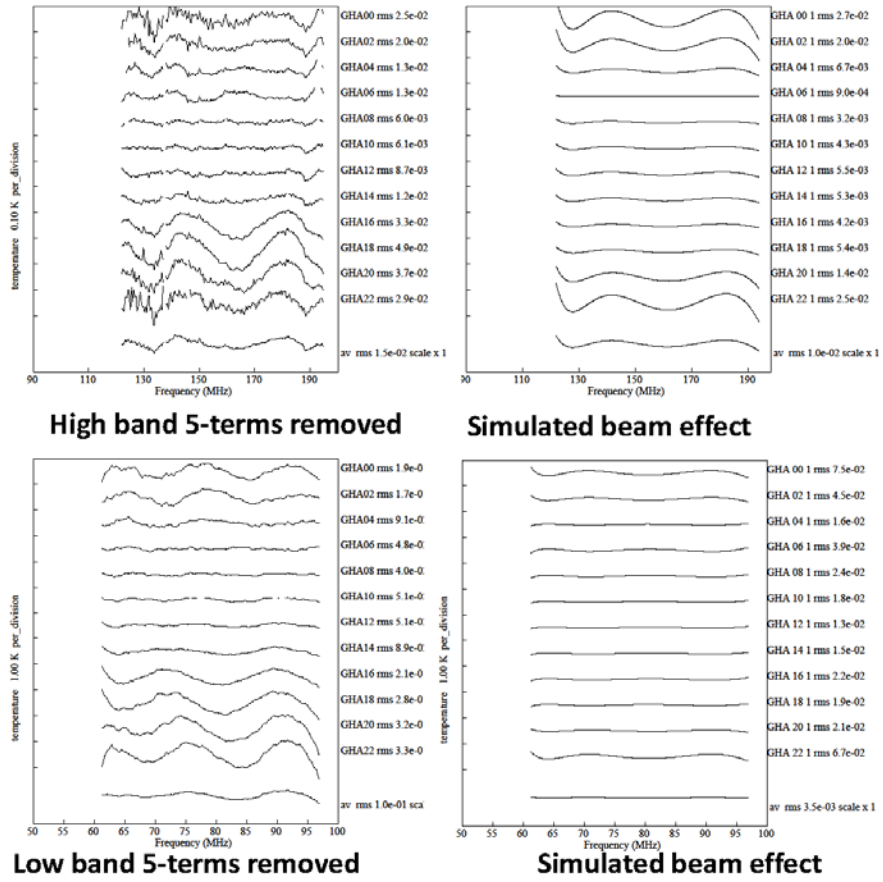


Figure 1. Residuals of high and low band data with 5-terms removed and without beam correction compared with simulated beam effects.

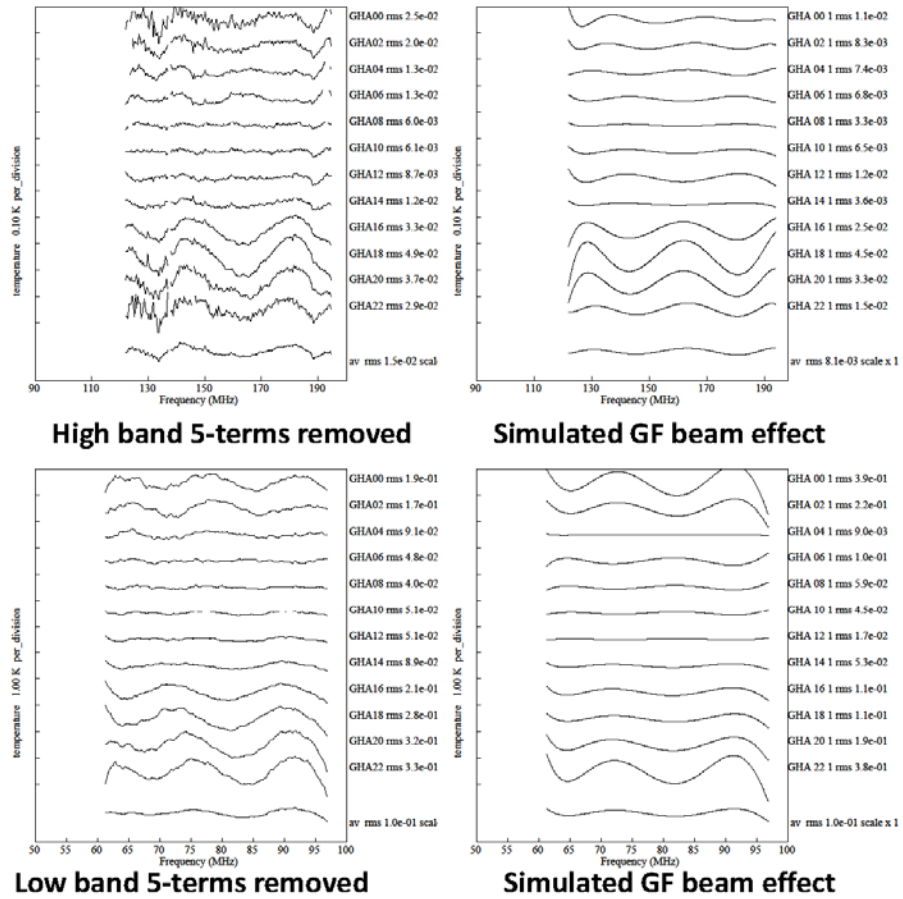


Figure 2. Comparison with beam effects which include the ground plane with soil of dielectric 3.5 below.

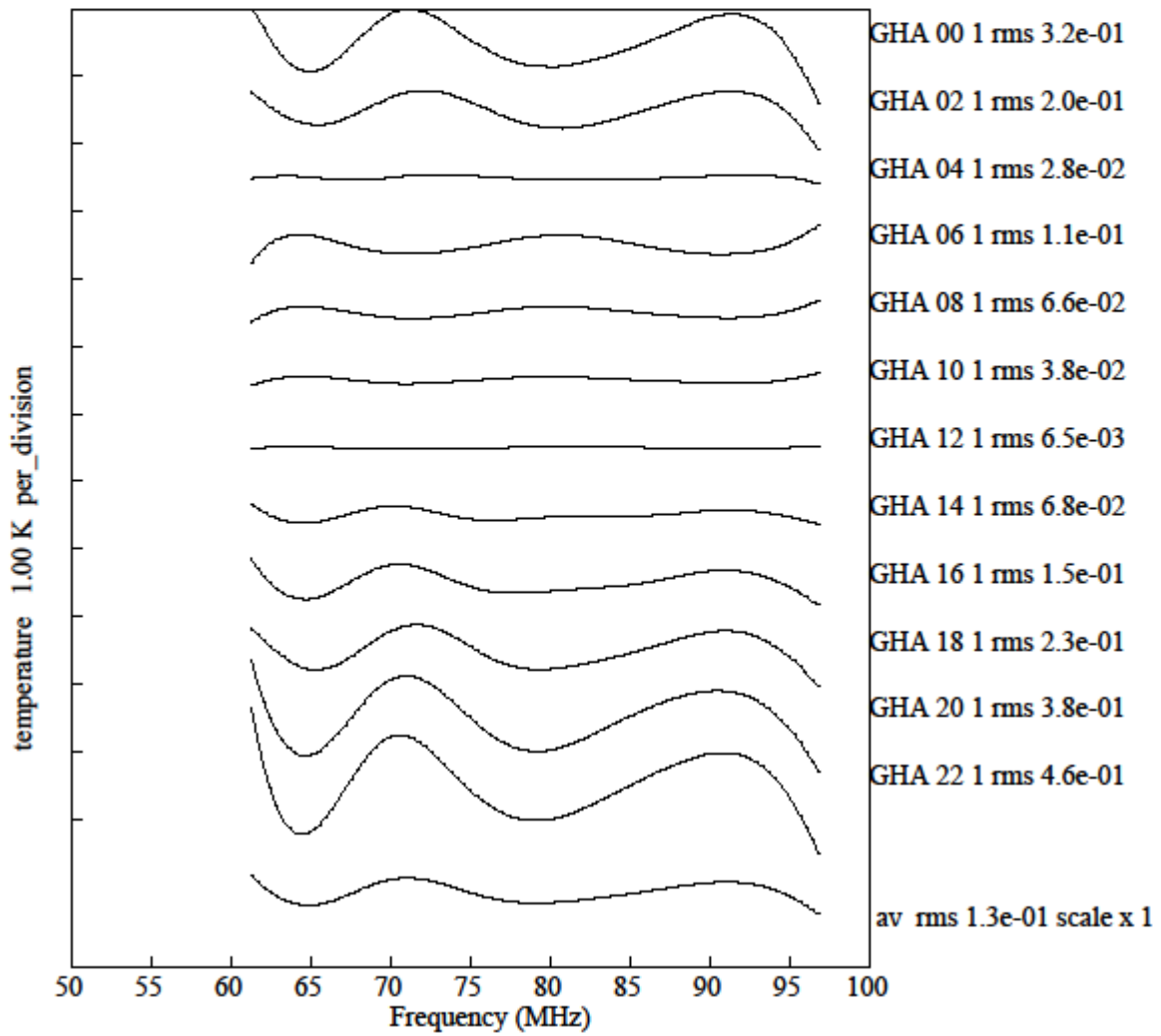


Figure 3. GF beam simulation using 2 MHz frequency spacing and 50 term Fourier series fit.

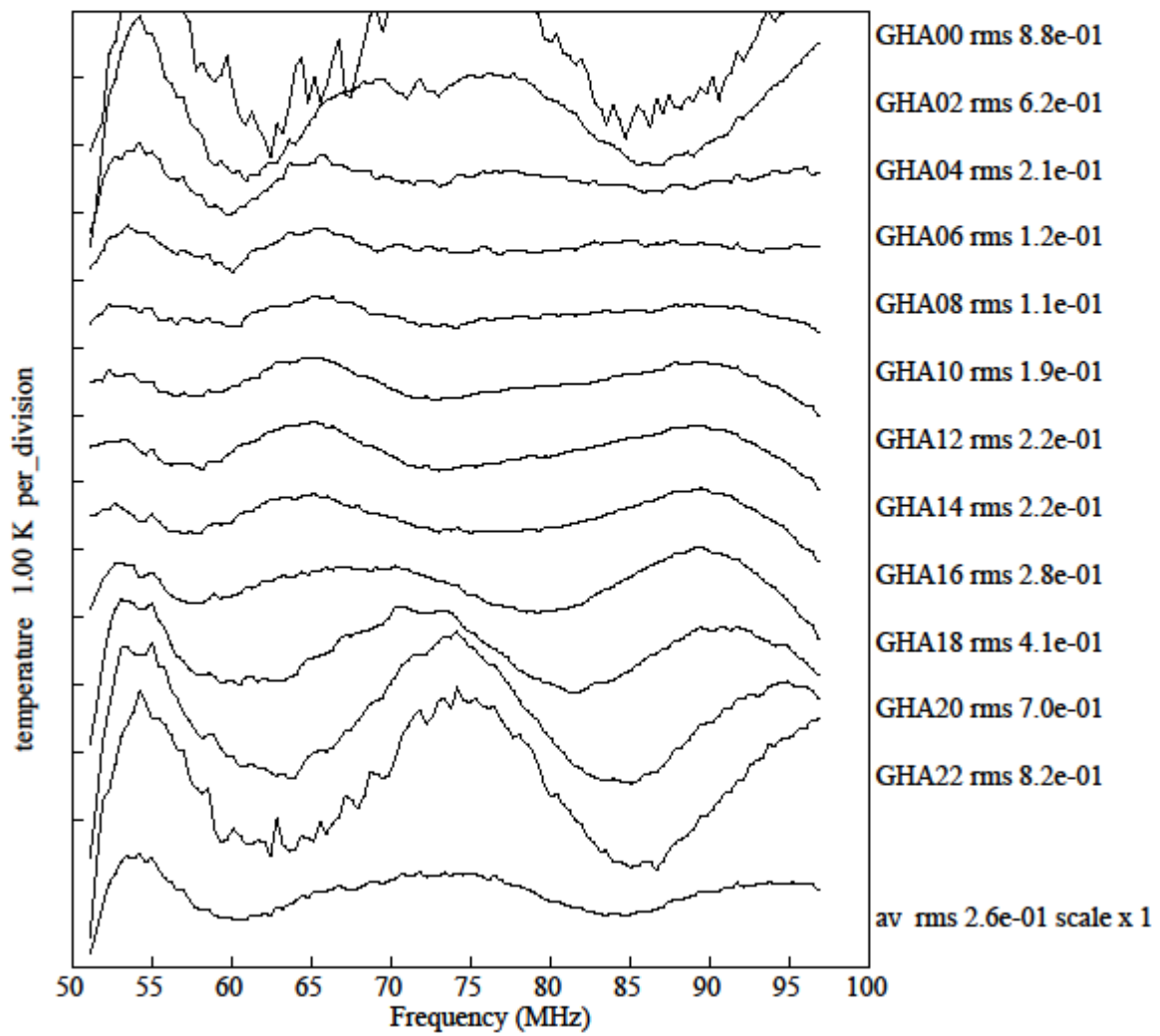


Figure 4. 5-term fit to low band data from 2015-286 to 2016-015.

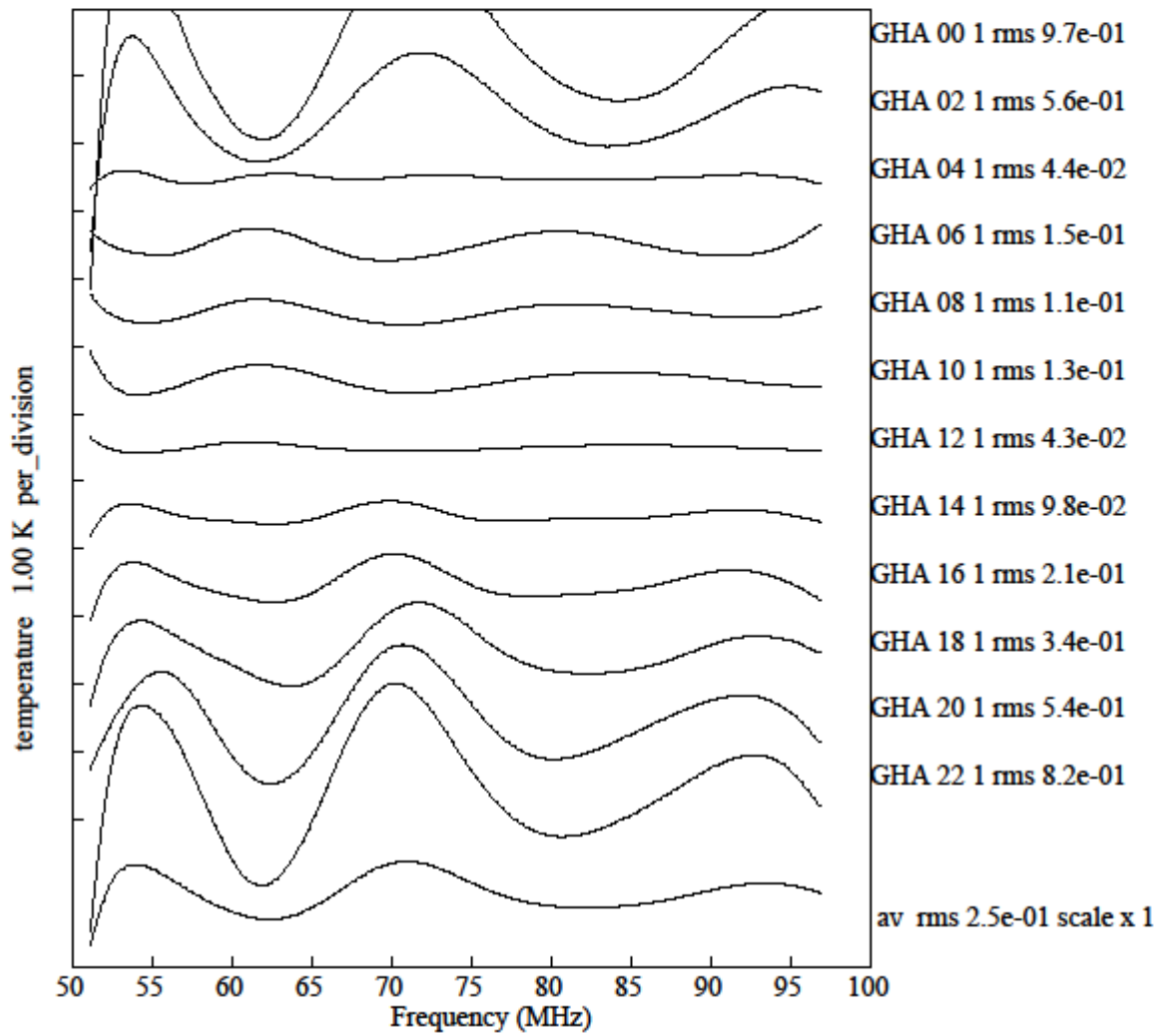


Figure 5. Same as Figure 3 extended down to 51 MHz.