FOM: beam chromaticity and antenna S11

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The antenna chromaticity function is defined in the following and one first order correction as done by EDGES is to divide the "calibrated" antenna temperature by this factor:

$$C(\nu) = \frac{\int_\Omega B(\nu,\Omega)T(\nu_0,\Omega)d\Omega}{\int_\Omega B(\nu_0,\Omega)T(\nu_0,\Omega)d\Omega} \quad \text{and} \quad T_{sky}(\nu) = \frac{T_{ant}(\nu)}{C(\nu)}$$

Where the beam model is based on simulations and the sky model is based on the Haslam map using two spectral indices (one for the galactic plane and another for the cold sky) although in our analysis we are mainly doing this with one spectral index. It is important to note that this function is quite a good FOM for assessing the chromatic behaviour of different antennas. An example of this is shown in figure 1 for the EDGES dipole.

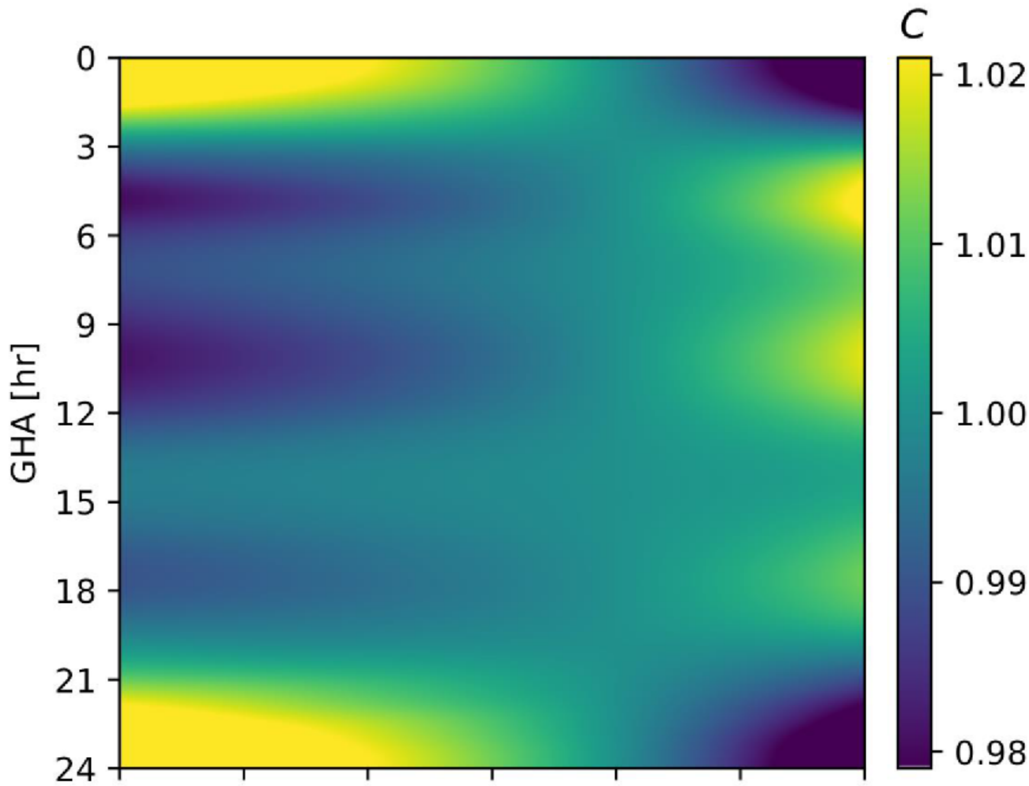

Figure 1: EDGES dipole chromaticity function Time v Frequency (credit Raul Monsalve).

A way of evaluating this is looking at GHA slices. The function should be close to 1 and have low order variation in frequency. This can be evaluated by differentiation to determine fluctuations. Each GHA slice gives a different scenario, i.e. a different sky coupling to the antenna beam sidelobes. It is therefore probably useful to differentiate over frequency for each GHA slice and take the worst case scenario as one FOM for that antenna.

With regard to S11, a similar approach could be taken where fluctuation and level are both weighted and used as a FOM. This should be determined by a number of tests on simulated results using the receiver calibraiton pipeline, e.g. is an antenna with great fluctuations in S11 at an average level of -25dB better or worst than a smoother S11 behaviour at a level of -10dB. In the first instance, any and all chromatic behaviour should be assumed to be detrimental to the calibration processing irrespective of the level (unless below a threshold of e.g. 30dB).