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To: EDGES Group

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Subject: Changes of the ranking of systematics with bandwidth

Since the ranking of systematics discussed in memo #249 a "mid" band (see memo 267) has been deployed which covers 60-180 MHz. With a wider bandwidth, which covers the 21-cm absorption signature as well as higher frequencies where the absorption is expected to change over to emission, tests of a signature search over a wider frequency ratio can be made using both simulations and real data. As the bandwidth expressed as a ratio is extended from 2:1 (as in lowband) to 3:1 more terms are needed to remove the systematics. However, over a wider band more terms can be used without the signature being soaked up in the polynomial terms. In addition, the relative importance or ranking of the systematics changes.

Simulations have been run in which a spectrum is generated using the midband antenna parameters and processed using the receiver 3 calibration parameters. In each case, listed in Table 1, an absorption signature has been added in addition a processing parameter has been changed from that used to simulate the data.

Test	
1	$\tau = 7$ signature of 0.5 K added at 78 MHz and 19 MHz wide
2	0.02 dB added to antenna S11
3	-0.02 dB added to antenna S11
4	20 ps delay added to antenna S11
5	20 ps delay added to LNA S11
6	No beam correction
7	No loss correction
8	0.2 dB added to LNA S11

Table 1. List of perturbations. In each case a signature has been added.

Figure 1 shows the residuals with 4 polynomial terms removed over the relatively narrow band of 60 to 100 MHz. In this case the highest ranked systematics as indicated by the departure of the extracted signature amplitude from 0.5 are tests 7 and 2. Figures 2 and 3 show the residuals with 6 and 9 poly terms removed and Table 2 lists the signature amplitude and rms residual when a signature is also extracted using fixed center, width and τ.

Test	4 poly terms		6 poly terms		9 poly terms	
	amp K	mK	amp K	mK	amp K	mK
2	0.2	52	0.05	39	0.53	3
3	1.0	52	0.9	39	0.46	3
4	0.3	28	0.6	160	0.42	20
5	0.4	19	0.5	40	0.45	8
6	0.5	2	0.53	8	0.50	1
7	1.8	122	1.8	190	0.48	2
8	0.1	35	0.03	48	0.37	28

Table 2. Signature amplitude and rms residual for each test. The frequency range for 4 terms was 60-100 MHz and 60-180 MHz for 6 and 9 terms.

The results for a frequency range 60-180 MHz show that the sensitivity to an error in S11 delay become larger relative to the other systematics for signature search over a wider range of frequencies.
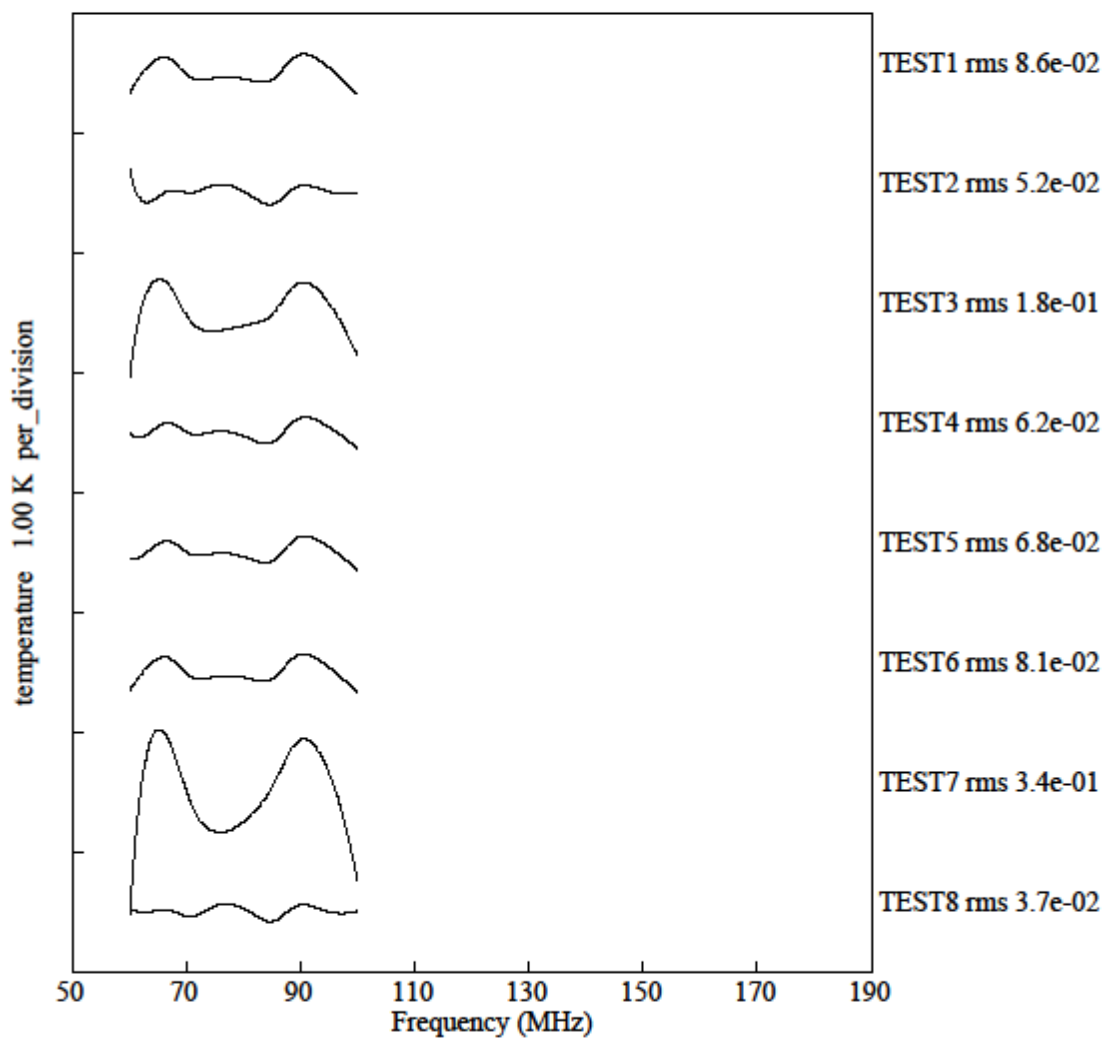
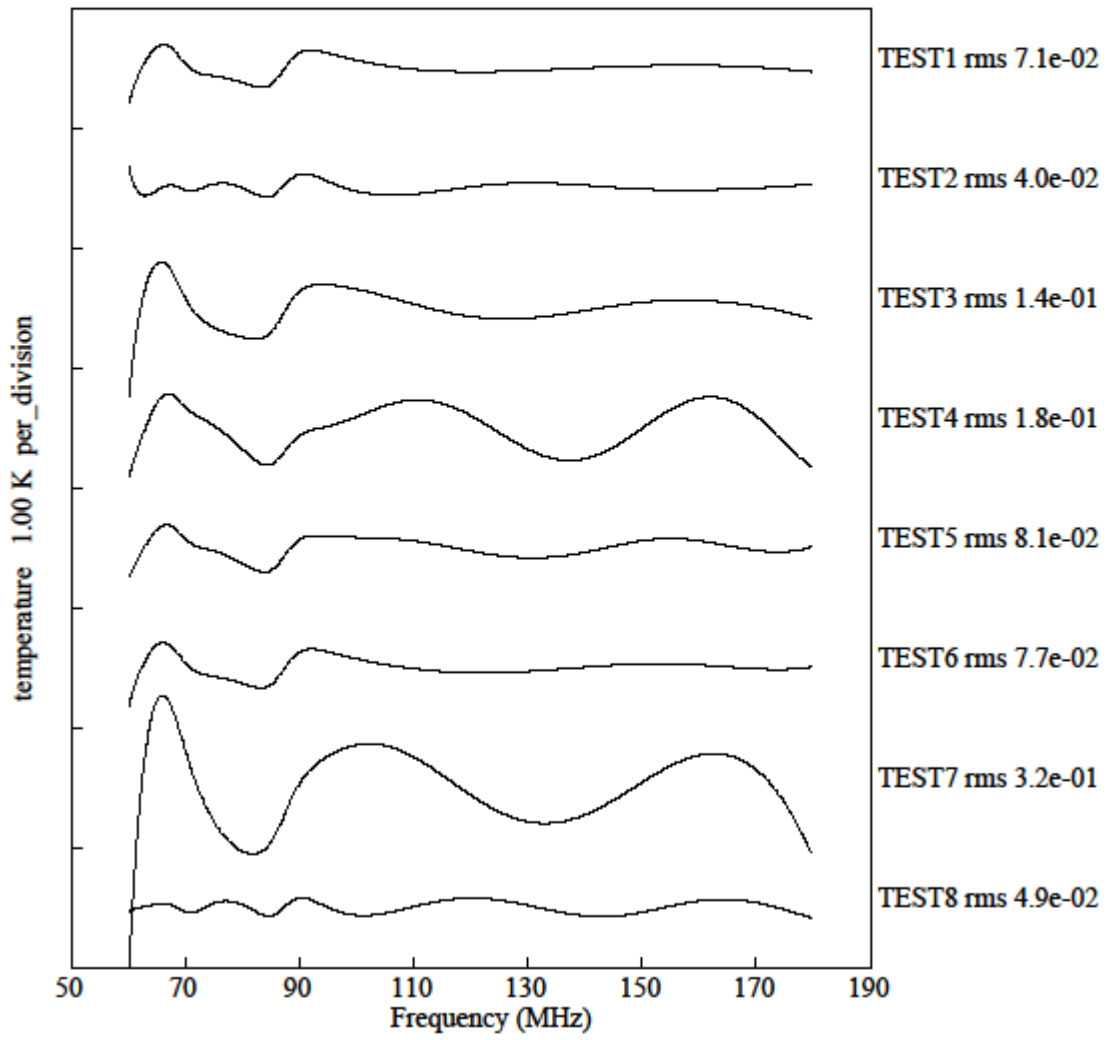Figure 1. Residuals to best fit using 4 polynomial terms.
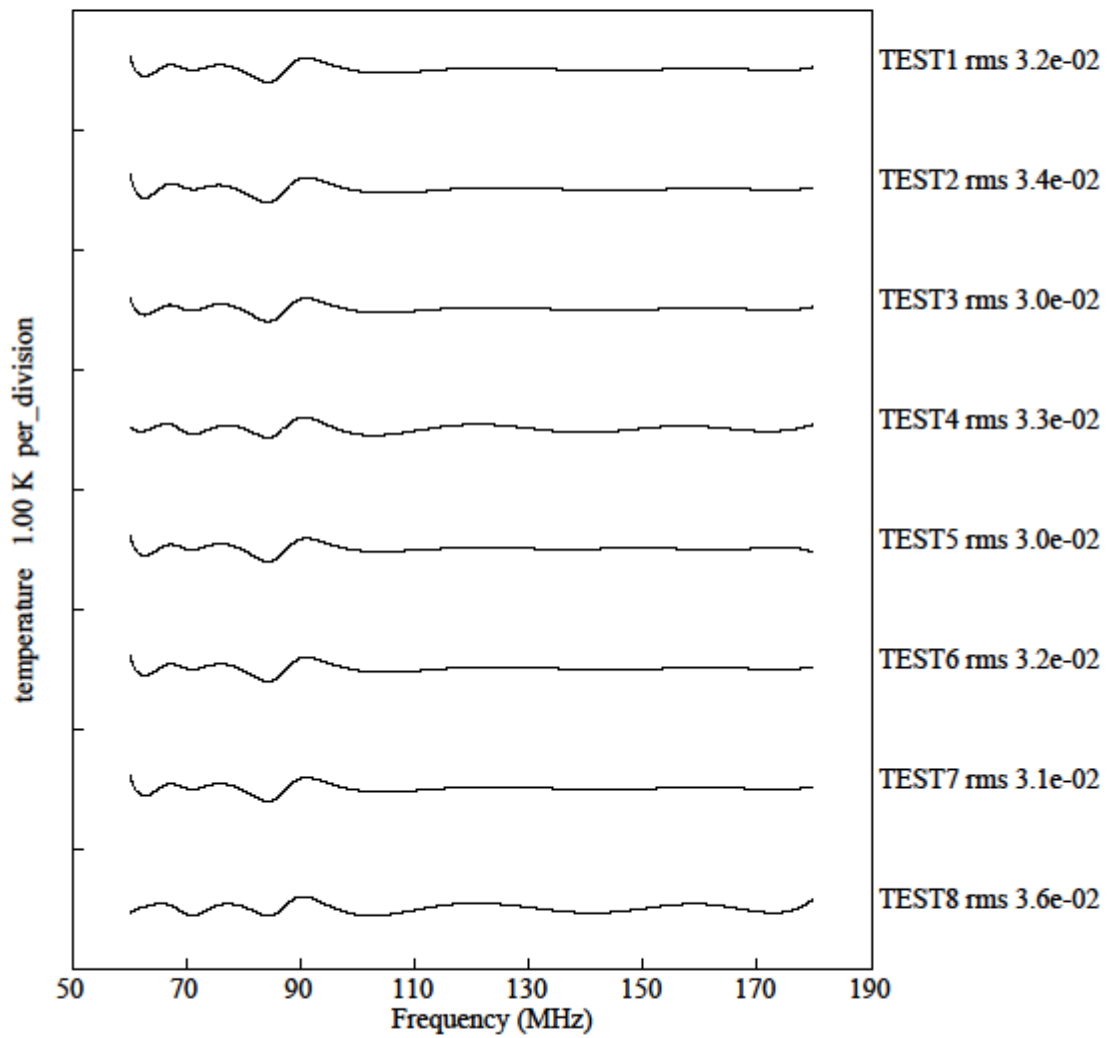
Figure 2. Residuals to be fit using 6 polynomial terms.

Figure 3. Residuals to be fit using 9 polynomial terms.