EDGES MEMO #059

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To: EDGES Group
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Subject: Tests of long integration using AC240

The Acqiris AC240 has the advantage of having an onboard FFT so that integration time is almost equal to real time. While it has limited dynamic range and a high level of spurious signals it performs well with added out of band noise to condition the 8-bit ADC. The optimum inband signal level was determined in memo #51 to be about 5 to 10 percent of the total power. In order to keep the ratio of the inband signal power to total power at this level a very quiet location is required and in addition all times when the Orbcomm satellites or other strong signals are present have to be excised from the integration. In practice about 30% of the data taken at Boolardy have an increase in the inband (80-210 MHz) signal strength of 3 dB due to RFI. About the same fraction of time with strong signals was found for most of the test sites in Oregon so that about 30% of the data would have to be excised at any site with Orbcomm coverage.

It is highly desirable to be able to use "Galactic Calibration" (see memos 55 and 57) in order to remove the effect of antenna mismatch and obtain a very smooth spectrum which requires only the removal of a low order polynomial to reach the millikelvin level.

Long integrations were tested with a signal from a noise source which was filtered to approximate the spectrum from the EDGES antenna in the frequency range 120 to 210 MHz and the results are shown in the table below..

Day	npoly	Resol (MHz)	Int. (hr)	Theoretical rms	Observed rms (mK)
10_55	7	6	4	5.2	5.2
	7	6	24	2.1	5.4
	9	6	24	2.1	3.6
	11	6	24	2.1	3.1
	11	1.5	4	10.4	11.7
55/56	11	1.5	48	2.9	8.4

Table 1. Residuals after removing polynomial with npoly terms

At integration times longer than about 24 hours the AC240 is limited to between about 3 to 8 mK rms. The residuals tend to show various artifacts and some of the ripple in the bandpass. Some improvement is expected when the 200 MHz low pass filter is replaced with one which has a smoother response.

Figure 1 shows the SNR contours for the detection of an EoR step added to the spectrum of the background obtained from software simulations. The SNR declines quite rapidly and the step increases in width and also declines with the number of terms in the polynomial. The simulation was done for a step amplitude of 25 mK and for a noise 30 mK in a 3kHz resolution. An 80 MHz band from 130 to 210 MHz was used. The 30 mK in 3 kHz is the theoretical noise for the EDGES spectrometer in 24 house using the AC240. In addition to a software simulation using a Gaussian noise function and EoR step was added to the data from days 55 and 56 shown in table 1. In this case the 25 mK step was detected for step widths of 10 and 20 MHz with SNRs of 17 and 11 respectively. When using the real data from the spectrometer looking at a filtered noise source a minimum of 11 terms were required to reach a level of residuals which are not dominated by systematics.

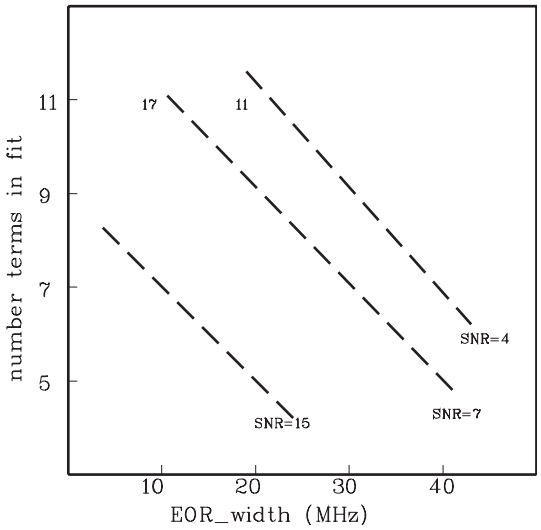

Figure 1.

After replacing the 200 MHz low pass with a filter with a smoother response and raising the signal levels so that the signal on the load is increased from 8 to 14 percent of the total the following results were obtained.

Day	Npoly	resol (MHz)	Int. (hr)	Theoretical rms	Observed rms (mK)
66/67	7	6	48	1.5	5.6
66/67	9	6	48	1.5	2.7
66/67	11	6	48	1.5	2.1
66/67	11	1.5	48	2.9	5.3

Table 2. Residuals with 200 MHz low pass with smoother response.