EDGES MEMO #057

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To: EDGES Group
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Subject: Simulations of EoR signature detection

The EoR signature, r,

$$r = -(a/2)\sin\left((f - f_0)\pi/w\right) \quad w/2 < f < w/2$$
$$= -a/2 \quad f > w/2$$
$$= +a/2 \quad f < w/2$$

is added to the sky spectrum plus noise

$$S = 500(f/150)^{-2.5} + r + n$$

where a is the amplitude of the EoR "step"

w is the width of the EoR "step" MHz

f_0 is the frequency of the EoR "step" MHz

n is Gaussian noise

The spectrum, S, is then fit with a polynomial plus the EoR signature using weighted least squares. Simulations done with a noise level of 100 mK rms per 6 kHz channel gave the results in the table.

The general trends are as follows:

1] The detection threshold increases in approximate proportion to the number of terms in the polynomial needed to remove the systematics.

2] The detection threshold is approximately constant for a range of EoR signal width less than the bandwidth (100 MHz in these simulations) over which the polynomial is fit divided by the number of terms in the polynomial.

3] For EoR signal widths greater than the bandwidth divided by the number of terms in the polynomial the detection threshold increases at a rate greater than proportional to the EoR width.

The detection of thresholds given in the table are for a 50% probability of detection. For a 99% probability of detection the number should be approximately doubled.

Npoly	Sig_width (MHz)	Sig_threshold (mK)
7	5 10 20 30 40	25 25 50 80 100
13	5 10 20 30 40	50 50 100 300 1000

Table – Simulation results