EDGES MEMO #061

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To: EDGES Group
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Subject: Simulations of EoR with different fitting parameters

While EDGES is able to set interesting limits for a rapid EoR the ability to detect or set interesting limits for EoR which occurs over a significant bandwidth (or equivalently a significant range of redshift z) is severely limited unless the number of terms in the fitting function can be reduced.

If we use a fitting function that is a polynomial plus the following EoR model

$$(27/2)(1+z/10)^{1/2}\tanh(zz) \quad mK$$

Where $z(f)=(1420.4-f)/f$

$$zz = z(f)-z(fc)/\left(z(f+w)-z(f-w)\right)$$

Where w = width of EoR signature in MHz, f is frequency in MHz and fc is the center frequency of the EoR step in MHz.

Further if we assume a spectrum with 500 K system temperature obtained by 3 position switching the DP310 spectrometer which has about 5% efficiency the rms noise in the EoR in units of the assumed model is approximately given by

$$rms \simeq 0.03\left(20p/(tb)\right)^{1/2} 10^{2w(p-2)/b}$$

Where p = number of terms in the fit ≥ 2

w = width of EoR step MHz

b = bandwidth over which fit is made in MHz

t = time in years

Sample results for an integration of 1 year

b (MHz)	w (MHz)	p	rms	rms (from approx)
40	5	2	0.03	0.03
40	5	4	0.2	0.2
40	5	6	0.5	0.5
40	5	8	2	2
80	10	4	0.1	0.1
80	10	6	0.4	0.4
80	20	4	0.5	0.3
80	20	6	4	4
80	20	8	50	40

It is noted that when

$$p \gtrsim 2 + b/2w$$

The detect ability of the EoR step declines exponentially. For this reason it may be better to use the spectrum which has been "calibrated" by the Galactic noise since fewer parameters are needed to fit the systematic which remain after calibration. For example I find the Galaxy calibrated spectrum can be fit with a few as 4 terms compared with 6 or more using the uncalibrated spectrum. In this case using fewer terms more than makes up for the added noise when the EoR step a width of more than about 2 MHz