EDGES MEMO #322

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Subject: Sensitivity simulations of EDGES-3 to VNA measurement errors.

Errors in VNA measurements are a significant source of systematics in EDGES. In EDGES-3 the same VNA is used for calibration and antenna S11 measurements.

Table 1 gives the sensitivity of EDGES-3 obtained from simulations using values of antenna, LNA S11 and noise waves close to the measured values. A frequency range of 60-120 MHz was used and the LinLog polynomial was employed for the rms measure of the sensitivity. The dependencies listed lower the rms by a factor of about 3 for a 10 dB reduction in the S11. In a separate test little dependency was found to the level of correlated noise waves up to 200 K and virtually no dependence on the uncorrelated noise. The "path" in the last 2 entries is the path difference, defined in memo 303 between the VNA paths for measurement of the LNA S11 and other S11 measurements.

Error source	Error magnitude	1-term rms mK	5-terms rms mK	dependencies
Cal load resistance	0.20 ohm	378	38	Antenna S11
Load offset	33 ps	95	14	Antenna S11
Open/short offset	33 ps	480	90	Antenna and LNA S11
VNA delay	33 ps	243	46	Antenna and LNA S11
VNA offset	Real 10^{-3}	166	11	Antenna S11
VNA offset	Imag 10^{-3}	692	77	Antenna S11
Path loss	50%	110	13	Antenna S11
Path delay	33 ps	268	48	Antenna and LNA S11

Table 1. Sensitivities of EDGES-3 to errors in VNA S11 measurements.

The path difference is measured in the lab and checked with a direct measurement of the LNA S11 from the antenna input corrected for path from the input to the internal reference plane whose s-parameters are obtained from the measurements of another SOL calibration placed on the antenna input.