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To: EDGES Group

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Subject: EDGES-3 at West Forks Maine and limits of internally generated RFI

EDGES-3 was deployed on the ground at the Ballpark at West Forks Maine during a one day trip on 2 November 2021. Figure 1 shows EDGES-3 being assembled. The electronics was powered by a battery inside the antenna box and data was first taken with the box cover removed and later with the box cover screwed on with conductive gasket. The Nuvo pc in the antenna was connected to the "EDGES" laptop via a 30 ft. fiber and to check for any RFI from the laptop the last set of data at 2021 306 18 55 UT was taken with the laptop shutdown.

Figure 2 shows the data on a very coarse log scale for comparison with data taken at West Forks in memo 26 in 2006, memo 44 in 2009, memo 75 in 2011 and memo 306 in 2019. The largest difference in the FM band between the years is a notable increase in the strongest FM station which is WTOS at 105.1 MHz in Skowhegan, there is a broadband signal from 55 to 65 MHz which appeared in 2019. Figure 3 shows the antenna S11 which was taken at West Forks for a quick check of the automated VNA measurement system but was not used for the plots which are only approximately calibrated by the 3-position switching. In EDGES-3 the VNA is only powered when needed to take s11 data so that it cannot contribute to any internally generated RFI.

Figures 4 shows spectra on 10 dB per division log scale for 17:11,17:57,18:08 and 18:45. 18:45 and 18:55 is with the cover on and the others are without a cover on the box with the electronics. Figure 5 shows the spectrum at 18:55 with the laptop turned off.

Based on the comparison of the spectra between those with cover on and cover off there is no source of RFI from the EDGES-3 system definitively determined so upon returning the EDGES-3 to the screen room a more sensitive test was made to check for RFI from EDGES-3. In this test an antenna is placed in the box and is connected to the EDGES-3 antenna input connector via a cable and a temporary SMA feed-through into the box using the hole which will provide the airflow path from the box to the empty box. The photo in Figure 6 shows this connection.

The following tests were run with cover on and off, an Explorer signal generator set at 0 dBm placed about 1 m from EDGES-3 antenna box turned on and off and screen room doors closed and open. The results of these tests are summarized in Table 1:

These results show that the box provides shielding of about 40 dB with only 10 screws used to fasten the cover to the box and increases to about 60 dB for 20 screws. With only 10 screws and the screen doors open exposing EDGES-3 to the local FM which is about 80 dB above the noise leaks into the antenna box. On the assumption of path loss reciprocity 60 dB is adequate to keep the any self RFI generated under 1 mK. When permanently deployed at the MRO or other sites for which the DC the power is supplied via a cable another test will be needed to be sure there is no RFI from the power which will be filtered at the hut and at the entry to the pipes under the antenna boxes.

UT hr_mn	cover	95 MHz	screen room doors	95 MHz	comments
15_40	off	on	closed	1.6e7 K	No FM or internal RFI
16_20	on	on	closed	2e3 K	No FM or internal RFI 10 cover screws
16_37	on	off	closed		No FM or internal RFI
16_55	on	off	open		Some FM 99.5 ~ 15 K
17_56	on	off	closed		Long integration spikes at 110 MHz
20_13	on	on	closed	12 K	From 10 to 20 screws

Table 1. EDGES-3 spectra connected to an antenna in the box with the electronics.



Figure 1. Setting up EDGES-3 at West Forks Maine on 2 November 2021.



Fri Nov 5 08:15:57 2021

Figure 2. Data taken at 18_55 UT plotted on a coarse log scale



Figure 3. S11 of antenna which was on the ground without a ground plane



Figure 4. Spectra from 17:11,17:57,18:08 and 18:45



Figure 5. Spectrum from 18:55 for which the laptop was turned off



Figure 6. Photo of the connection to a length of wire which acts as an antenna inside the outer box around the inner box which contains the digital and power supply switching electronics.



Figure 7. Plots of the spectra for the box isolation results listed in Table 1.