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October 12, 2022

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To: EDGES Group
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Subject: Simulations of the effects of DC power lines on EDGES-3 beam and S11

The deployment of the EDGES-3 prototype in Oregon used internal batteries and power wires were only attached to the antenna to charge the batteries. Wires were attached for running EDGES-3 on Devon Island and some FEKO simulations were made which show that the DC wires should come down vertically from the metal box that connects the pipes as discussed in memo 392. The design of the EDGES-3 air circulation pipes is shown in Figure 12 of memo 300 but lacks the details of how the DC power wire and fiber for communication enter the pipe and get to the electronics.

Figure 1 shows a diagram of the path of the air flow, DC power and communication fiber from the hut to the antenna. The desired features are:

- 1] Only the positive DC wire and the fiber are in the pipe to the electronics to minimize the air flow friction for maximum air flow.
- 2] The negative DC wire connects to the box at the bottom end of the pipes to minimize resistance and avoid additional air flow friction in the pipe.
- 3] Both the DC positive and negative wires have ferrite filters close to the box to help isolate the wires from the antenna and filter noise from the hut.
- 4] The positive DC wire enters the box via a feed-through capacitor to further filter out noise and isolate the EDGES-3 electronics from getting into the antenna.

The effects on the beam and S11 are simulated using a FEKO model. The antenna beam on a PEC ground plane in is then convolved with the Haslam sky map scaled from 408 MHz to 50 to 120 MHz using a spectral index of -2.5. The 0.5 K Nature feature at 78 MHz with width 19 MHz and $\tau = 7$ is added. The results with 5 physical terms from 52 – 110 MHz removed are shown in Table 1.

| case | center MHz | amp K | width MHz | resid mK |
|--|------------|-------|-----------|----------|
| no ferrites wire 30 deg tilt | 77.7 | 0.64 | 19.5 | 12 |
| no ferrites wire vertical | 77.7 | 0.59 | 19.2 | 7 |
| ferrite at box | 77.7 | 0.56 | 19.2 | 4 |
| ferrite at box and plate | 78.1 | 0.51 | 18.9 | 1 |
| No ferrites wire 30 deg tilt beam only | 78.1 | 0.53 | 19.1 | 3 |

Table 1. Effects of change in S11 and beam from the wires

The rms residual in the last column after fitting the absorption provides along with the deviation of the amplitude from 0.5K provides a measure magnitude of the effects. The last entry in Table 1 gives the effect of the change in beam only for the case of the first entry. The results in Table 1 are for GHA = 12 hours at the MRO on a infinite PEC ground plane. With a ferrite at the box and the plate over the pit box under the antenna the effect at GHA = 0 hours is under 3 mK.

In addition to reducing the effect the DC cable on the beam and S11 the ferrites are needed to ensure sufficient attenuation of RFI on the cable from the hut and are needed to avoid the potential coupling of the internally generated RFI by the EDGES electronics into the antenna. The coupling of RFI from the EDGES electronics is difficult to estimate and would require a screen room within a screen room to obtain sufficient isolation from digital TV, FM radio and other sources of RFI to get a good measurement.

While none of the sources of RFI observed in Oregon or Devon Island are known to be internally generated by the EDGES-3 electronics an additional filter is being added to positive DC wire a few inches after it enters the antenna box with the electronics to provide additional isolation. Also a protective thermostat (Sensata Tech INT01L-8418) will be added close to the inner box to disconnect the DC power if the temperature exceeds 70C to prevent permanent damage to the electronics in the event overheating due to a loss of air flow or other failure.

Some RFI isolation tests of the antenna box were made by placing antenna in the antenna box as described in memo 376. A test made by placing the small battery operated Explorer signal generator inside the antenna box to increase the level of internal RFI at a specific frequency might make it possible to get an isolation measurement at the 80 dB level in the Haystack screen room at a few specific frequencies.

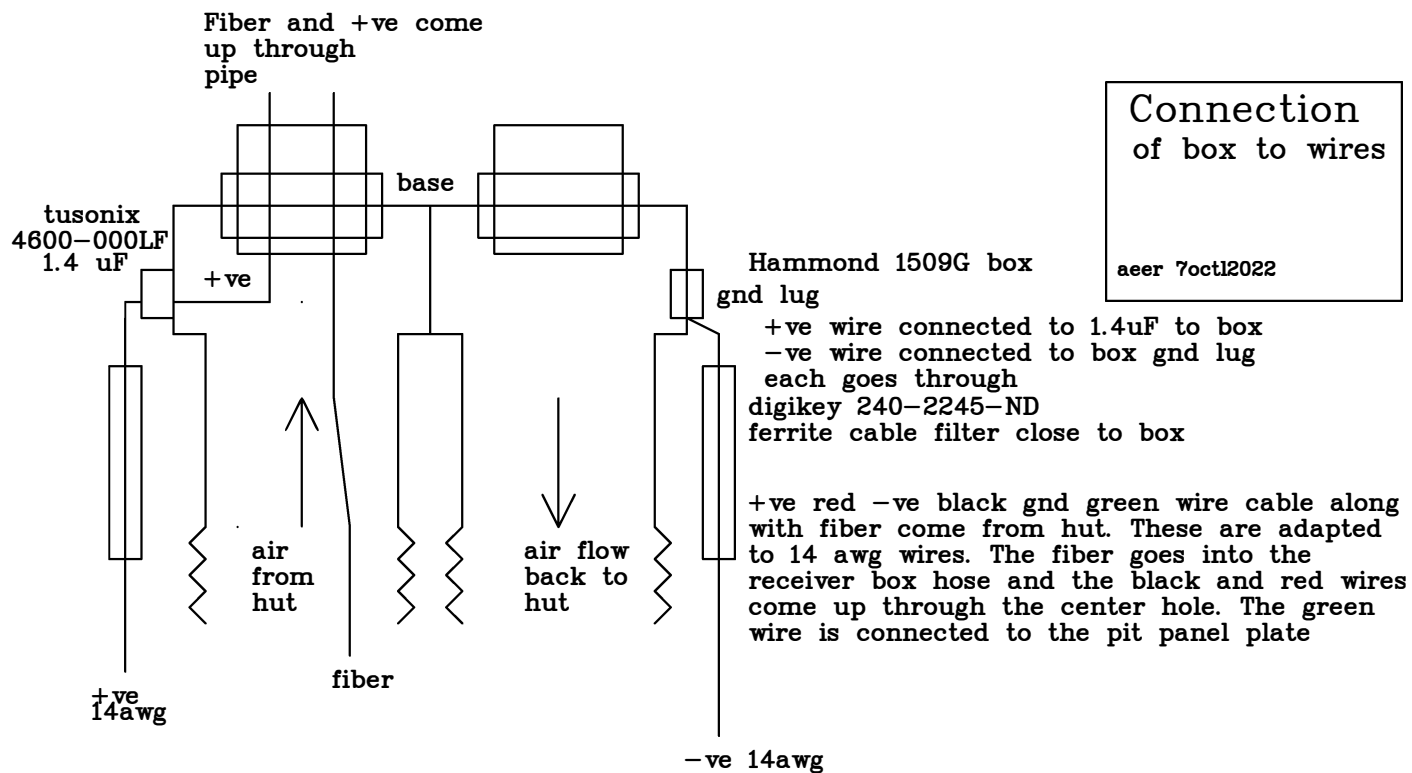


Figure 1. Diagram of the air flow and cable connections for the installation of EDGES-3 at the MRO.