

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY
WESTFORD, MASSACHUSETTS 01886**

July 20th, 2021

Telephone: 617-715-3495

To: EDGES Group

From: Parker Steen

Subject: Thermal test results of antenna insulation

The EDGES antenna is set to be covered with 1.7-pound density, closed cell, 1", polyethylene foam to provide insulation for essential electronics during cold night time temperatures. However, because the antenna will be deployed in western Australia where extreme temperature cycles occur, a concern emerged as to whether this foam would cause the electronics to become too hot during the day. Heat transfer calculations were not able to be performed due to no known emissivity and absorptivity properties of the foam. Three small test units resembling the basic configuration of the EDGES antenna were built and tested to investigate this issue. This included an uninsulated, insulated, and painted insulated unit. All test units had the same aluminum box dimensions.

1. 6061 aluminum box (3.5" x 3.5" x 1")
2. 6061 aluminum box covered with 1" closed cell polyethylene foam
3. 6061 aluminum box covered with 1" closed cell polyethylene foam, coated with Goldstone #7.

The objective of the test was to monitor the free air temperature inside each box to determine if the experimental temperature would exceed that of electronics operational limits. Temperature was measured using a Raspberry Pi outfitted with temperature probes (Adafruit DS18B20) at a sampling frequency of 0.2 Hz. Four temperature probes were used, one for each test unit box and one to serve as a control which would remain in free air. To measure the free air temperature, the temperature probes were taped to a stand to ensure they were not in contact with the ground, as shown in Figure 1.



Figure 1: Test probe set up used to measure free air temperature.

Testing was completed on July 15th, 2021. Shown below in Table 1 were the weather conditions at start of testing which roughly remained constant for the duration of testing. Cloud coverage was partial.

Parameter	Value	Unit
Temperature	27	°C
Humidity	84	%
Wind speed	0.44	m/s
Visibility	10	mi

Table 1: Environmental conditions at time of testing.

Shown in Figure 2 below is the test set up (from left to right) taking measurements in the insulated/painted test unit, insulated test unit, uninsulated test unit, and in ambient conditions.

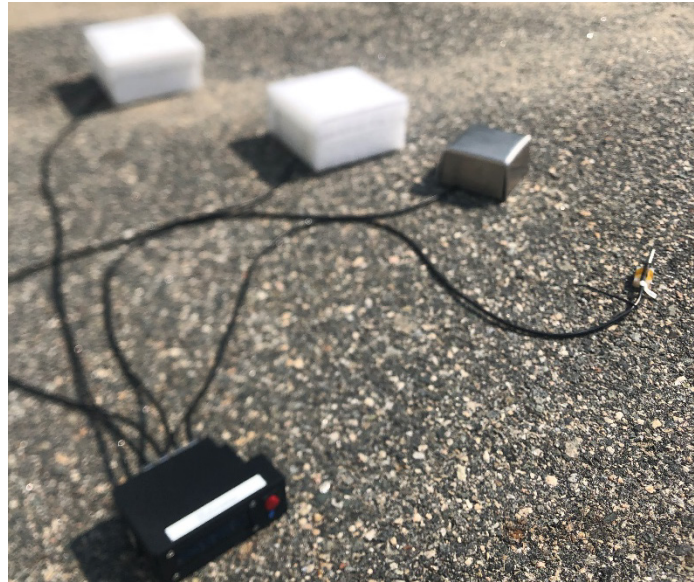


Figure 2: Experimental test set up.

Figure 3 below shows the raw data outputs from the testing. Figure 4 below shows polynomial line of best fit outputs of the raw data. The test began at 10:00AM and concluded at 4:00PM.

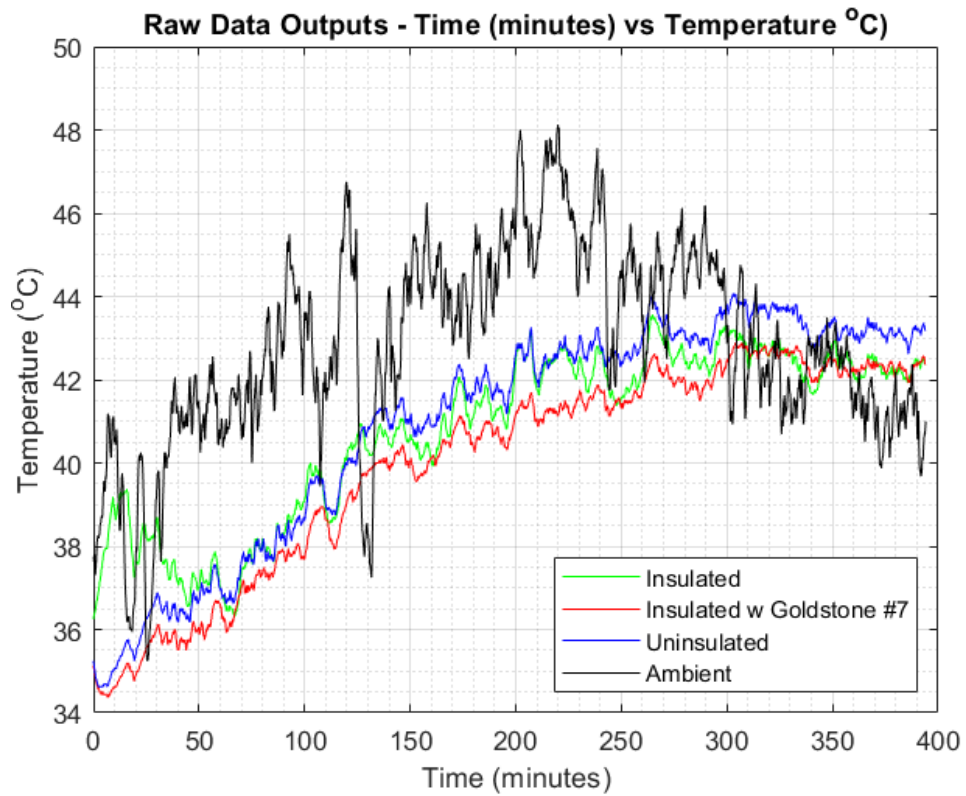


Figure 3: Raw data outputs.

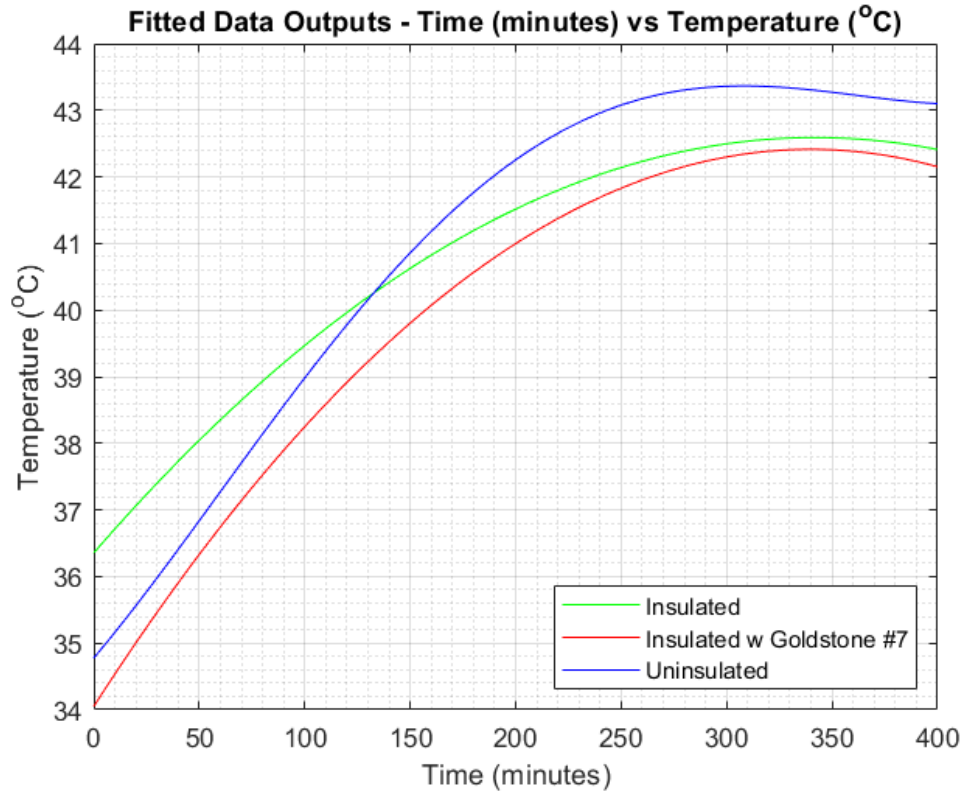


Figure 4: Data curves fitted to 3rd degree polynomial functions.

Given the slightly better thermal performance of the insulated test unit with Goldstone #7 and the ease of adding this coating to the insulation, it would therefore be valuable to coat the insulation on the EDGES antenna with Goldstone #7. While temperatures inside of the test units did reach ~42°C, the planned circulation system should be more than enough to maintain electronics within operational temperatures.