MIT, HAYSTACK OBSERVATORY
January 10, 2023

Telephone: 617-715-5517
Fax: 617-715-0590

To: EDGES Group
From: J. Barrett, R. Cappallo, K. Wilson
Subject: MRO EDGES-3 Installation, November 2022

1 Ground Plane Construction

Construction of the ground plane for the permanent installation of the EDGES-3 system at the Murchison Radio Observatory in Western Australia began on November 1^{st}, 2022, and was completed on November 11^{th}, 2022. The ground plane consists of 96 rectangular (5 m x 2.4 m), 4 mm-thick wire mesh pieces in addition to 48 triangular wire mesh pieces welded together at intervals of $\sim$ 20 cm (Fig. 1). To connect the ground plane to the base plate, four corners were removed from four wire mesh rectangles, which were then welded to the bottom part of the side frame of the base plate (Fig. 2a), thus the top of the base plate sits $\sim$ 30 mm above the surface of the ground plane (Fig. 2b).

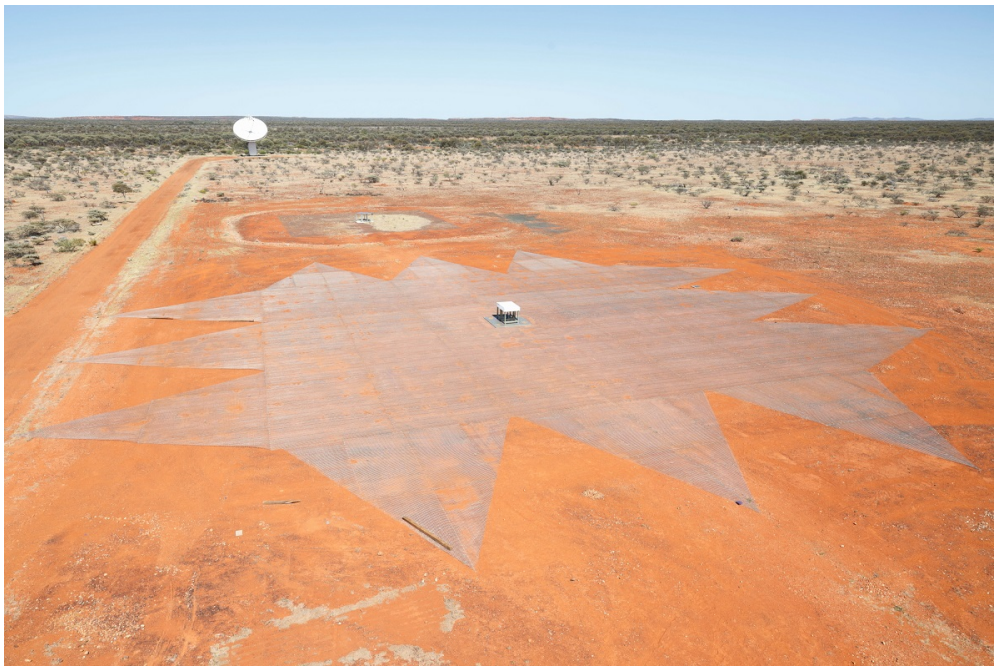


Figure 1: The completed ground plane.

The changes in elevation for various parts of the ground plane were measured using the same Bosche laser level used for the Devon Island deployment (Fig. 3).

2 Antenna installation

The EDGES-3 antenna was installed on the base-plate of the new ground plane with an approximately East-West orientation of the dipole axis (249°), which is roughly in-line with the direction placing the beam null towards the hut. The coordinates of the antenna are (26.714860° South, 116.604000° East). The top of the antenna was measured to be 1.034m above the base-plate, and the separation of between the two dipole halves was measured to be 35mm, as shown in figure 4a and 4b below. Below the antenna in the pit box are the two junction boxes for the DC power and the fiber connection, as well as the the pipes through which the cooling air is blown. Figure 5 shows the configuration of the pit, (A) is the DC power junction box, (B) is the fiber junction box (containing 4-spare ST-connector break-outs), while (C) and (D) are the in-flow (towards the antenna) and out-flow air conduits

(a) The base plate at the center of the ground plane. (b) Close-up of welds to base plate.

Figure 2

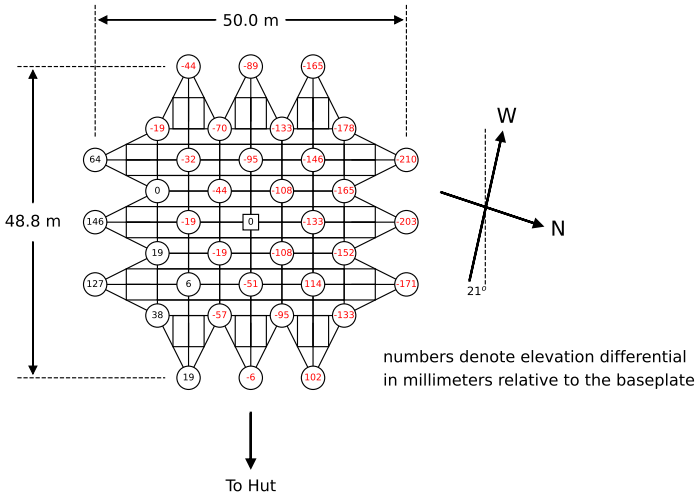
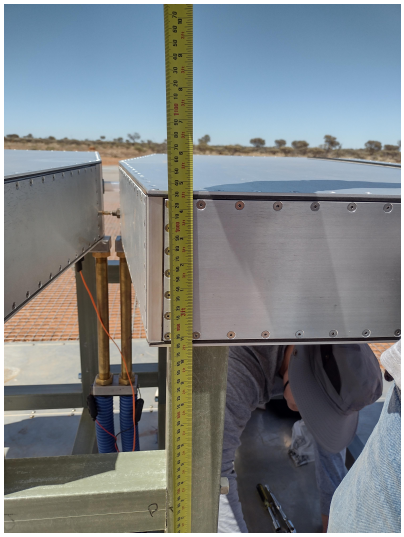


Figure 3: The difference in elevation between the top of the base plate and various points on the ground plane. All elevations are given in millimeters and have an uncertainty of ±10 mm.

respectively. Ferrites were attached to the DC power lines in the pit as shown in figure 5, as well as at the base of the brass pipes where the power enters the antenna as shown in figures 6a and 6b. The ground-wire is attached to the base-plate.

The pit cover was bolted down and the seams were covered with copper tape (ELK copper foil tape with conductive adhesive). In addition, all the seams of the antenna (which contain a flexible conductive gasket) were also covered with copper tape after the screws were tightened as shown in figure 7. The antenna top was then covered with a foam cover affixed with hook-and-loop strips, which was then painted with Goldstone #7 white reflective paint, as shown in figure 8. After several days, two additional covers were added to the underside of the antenna panels in order to help aid in insulating the antenna. These are not painted, and are labeled A on the side containing the antenna electronics side and B on the empty side as shown in figure 9.

(a) The antenna panel separation.



(b) The antenna height above the base-plate.

Figure 4

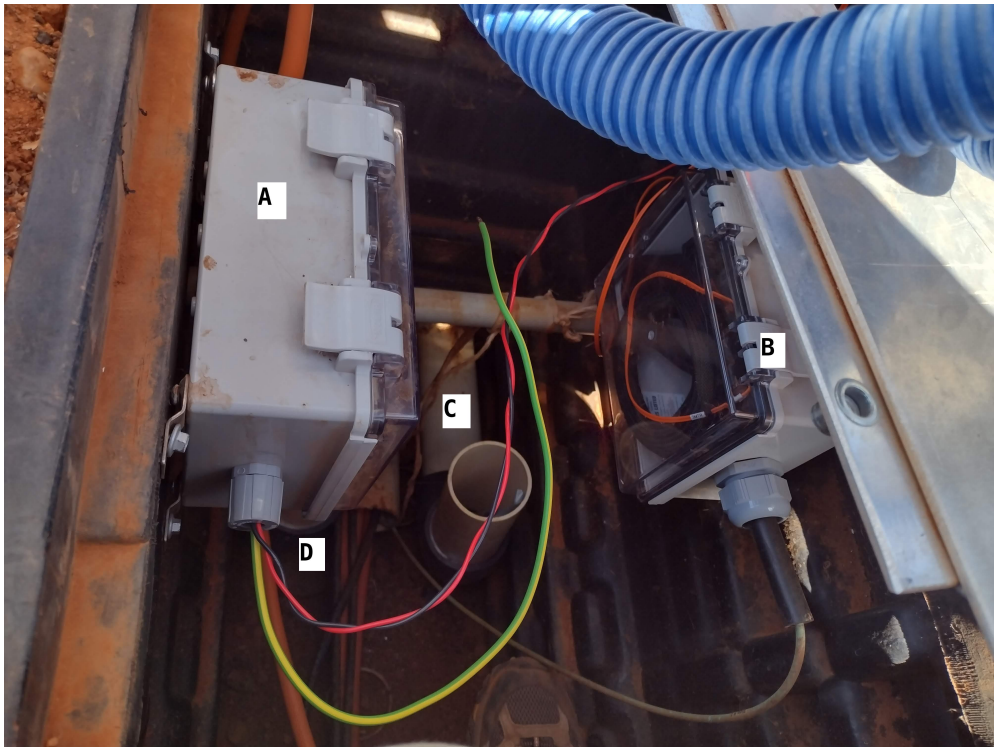


Figure 5: The DC power and fiber junction boxes in the pit.

3 Rack equipment installation

The power and network support equipment for the EDGES-3 system is installed on the underside of the shelf holding the VNA in the RF shielded cabinet. It consists primarily of a single DC power supply along with two fiber-to-copper ethernet media converters. These components are labeled in figure 10 according to:

A - The media converter for the data connection to the EDGES-3 system (blue fiber labels 1 & 2).

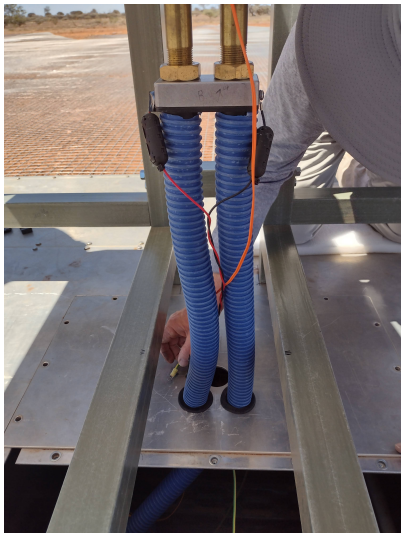
B - The media converter for the connection to the ADH Netcom air dehydrator.

C - The DC power supply for the EDGES-3 system.

D - Spare fiber connections on the same cable as the EDGES-3 system (labeled 3,4,5,6).

E - The fiber coupling for the dehydrator system on the orange patch fiber (note the fiber coupling for the EDGES-3 data line is fastened to the shelf above).

(a) The ferrites on the DC power lines in the pit.



(b) The ferrites at the DC input to the antenna.

Figure 6

Figure 7: Copper tape applied to seams of antenna and base-plate.

F - The positive terminal of the EDGES-3 power supply.

G - The negative terminal of the EDGES-3 power supply.

The power supply is currently set to 15V, but can be adjusted using the potentiometer on the front (small blue box, above the label 'C'). There is roughly a 1-2 volt drop over the supply line between the hut and the antenna depending on the current draw.

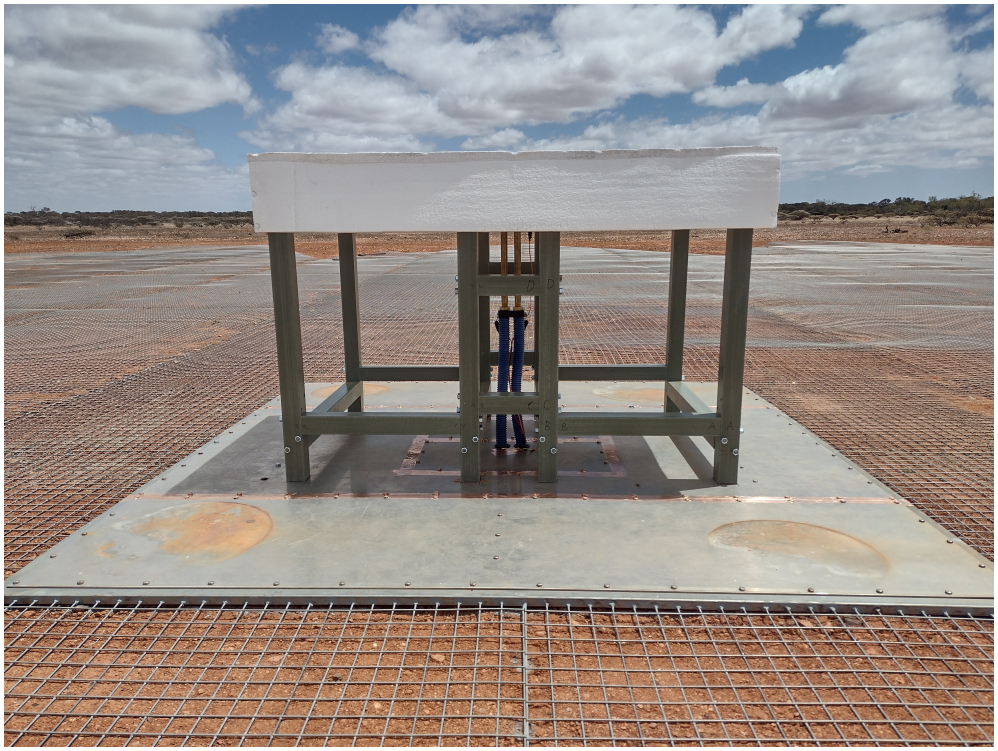


Figure 8: The painted foam cover on the antenna.

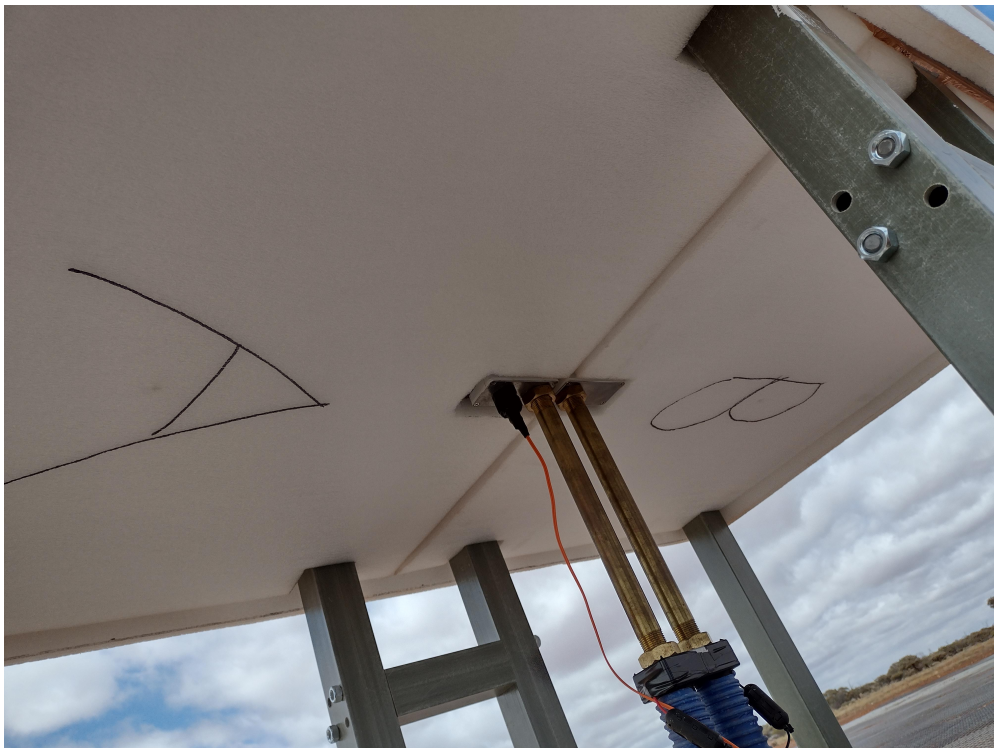


Figure 9: The foam covers on the underside of the antenna.

4 Thermal and air circulation system

The air circulation system for the EDGES-3 antenna is contained in the aluminum box immediately to the left of the RF shielded cabinet in the hut, as shown in figure 11 (the air output line to the antenna is labeled (A), while the return line is labeled (B)). The full system is described in Haystack EDGES memo #401, [1]. The system is powered directly from the hut's AC supply at an outlet next to the air conditioner.

[1] https://www.haystack.mit.edu/wp-content/uploads/2022/11/memo_EDGES_401.pdf

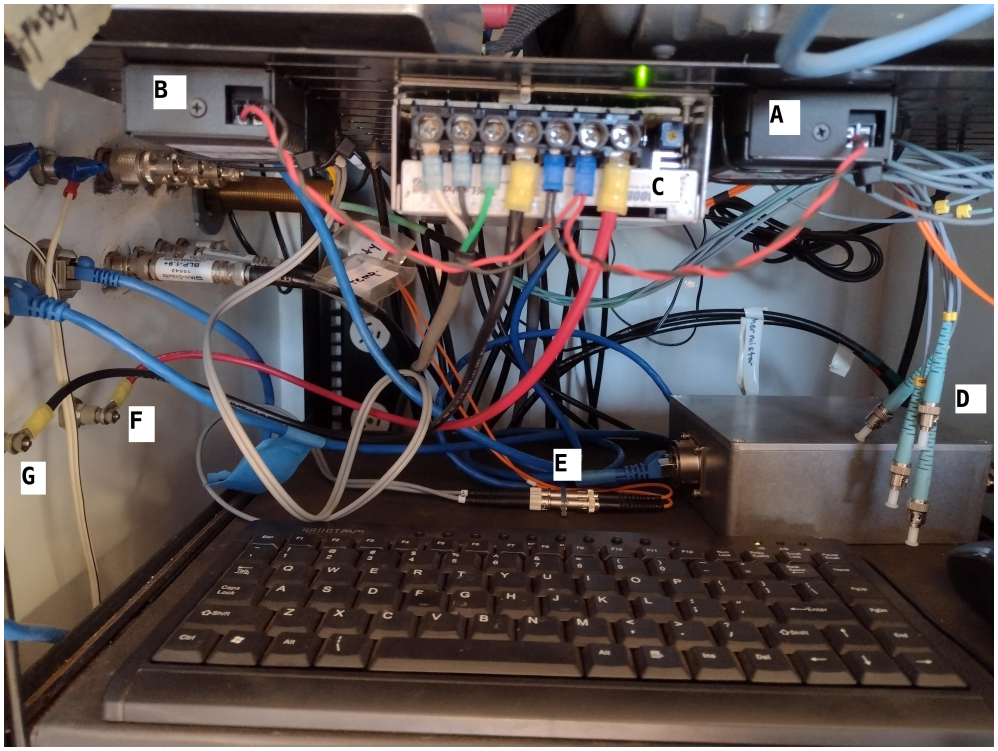


Figure 10: The EDGES-3 power and network equipment installed in the RF shielded cabinet.

The lid of this box has been modified with a conductive gasket that is compressed when the latches are engaged. The components of this box are labeled in figure 12 according to:

A - The micronel high speed blower fan.

B - The ADH NETCOM Dehydrator [2].

C - The fan intake port (return line from the EDGES-3 antenna).

D - The fan output port (output line sending air to the EDGES-3 antenna).

E - Analog pressure gauges (inches H_2O).

F - Analog temperature gauge (C).

G - The DC power supply for the blower fan, also used for the internal media converter.

H - The copper-to-fiber ethernet media converter.

5 Installation Timeline

Note: CSIRO provided a trailer and generator for the welders to rest in (see background of Fig. 2a). The generator was run daily from 8:00 to 15:00 local time (0:00 to 7:00 UTC) each day, from day 308 to day 321. Additionally there was consistent activity at the site during these hours, so any data taken during this time should be interpreted with care.

Tuesday 11/1 (305) - Arrival on site, four inner rectangles welded to base plate.
Wednesday 11/2 (306) through Monday 11/7 (311) - Welding continues, center square finished, outer triangles started.
Tuesday 11/8 (312) - Antenna and equipment driven to site from Geraldton.
Wednesday 11/9 (313) - First day of assembling antenna, air circulation box is installed in the hut, fiber and power are tested.
Thursday 11/10 (314) - Frame is constructed and antenna is placed on frame.

[2] https://www.networketi.com/adh-netcom/

Figure 11: The EDGES-3 air circulation box.

Friday 11/11 (315) - Air flow system is connected to antenna and insulation cover is fabricated. Ground plane construction is completed, triangles are removed from the ground plane at Low-2.
Saturday 11/12 (316) - First data is taken, base plate is not bolted down.
Monday 11/14 (318) - Base plate is bolted down and taped - cover is put on antenna
Tuesday 11/15 (319) - Cover is removed, antenna boxes are taped, and cover is returned.
Wednesday 11/16 (320) - ADC board is removed from EDGES-2.
Thursday 11/17 (321) - Cover is painted. Tiling of the hut is completed.
Friday 11/18 (322) - Bottom insulation is installed.
Wednesday 11/23 (327) - Trailer and generator removed from site.

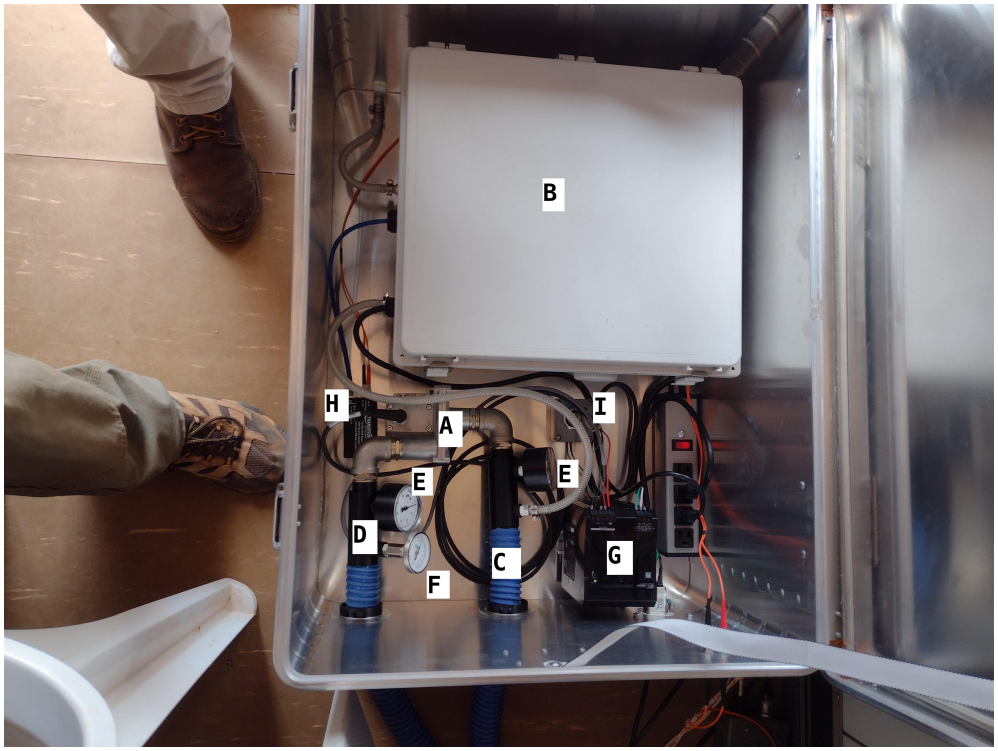


Figure 12: The EDGES-3 air circulation box contents.