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To: EDGES group
From: Rigel C. Cappallo, John P. Barrett
Subject: EDGES-3 deployment in Adak, AK, December 2024

1 Background

The EDGES program was awarded an NSF RAPID grant (PI: Colin Lonsdale) to deploy an autonomous EDGES-3 system to Adak Island in Alaska for the 2024-25 winter observing season. Due to the nature of the grant, the timeline for creating and deploying a functional, autonomous system was extremely accelerated, with only a couple of months to complete the task. The entire system consists of a 50 × 25 meter meandering wire ground plane (identical to the one created for the 2022 Devon Island deployment - Memo 396), the EDGES antenna, a remote-start gasoline generator with external fuel tank, a Starlink antenna, three Lithium Iron Phosophate batteries, and an electronics control box, along with ∼ 200 meters of optical fiber and copper power wire to run between the antenna and the electronics hut.

John Glover, a Haystack technician, traveled to Adak in the first week of November to install the ground plane, ground anchors, and frame. A month later, John Barrett and Rigel Cappallo went to Adak for a week to deploy the antenna, install the Starlink, generator, electronics box, and start the system taking data autonomously. The following is a report on that deployment trip.

2 Deployment

2.1 December 4th

The team arrived on Adak at ∼ 15:00 local time, upon which we secured our baggage and were shown our accommodations. After this we were able to briefly visit the site to determine the placement of the equipment prior to sunset (Fig. 1). The antenna is located at 51.9433 N, 176.5988 W.

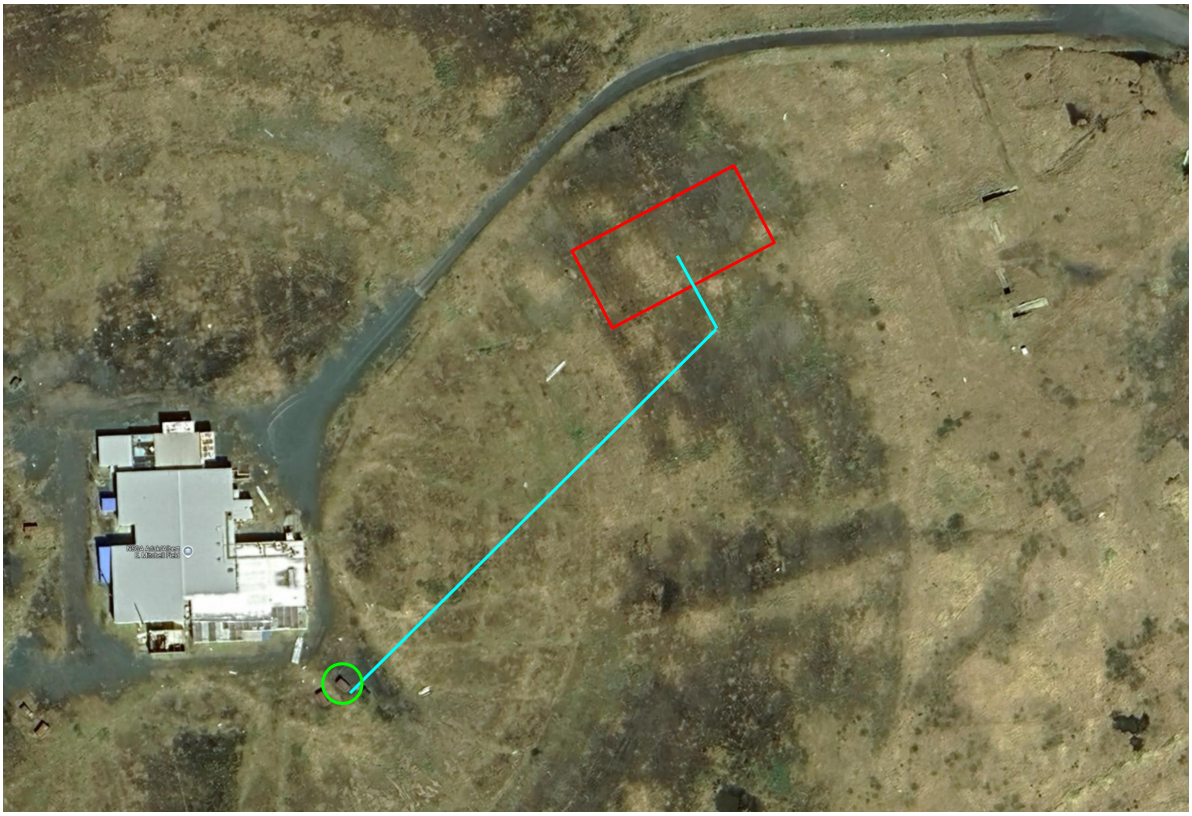

Figure 1: A satellite view of the EDGES-3 deployment site on Adak Island, AK. The red rectangle denotes the outline of the ground plane, the green circle is centered on the power/communications hut, and the cyan line represents the path of the power cable and fiber from the hut to the antenna. Vertical corresponds to north.

2.2 December 5th

The antenna frame was assembled, and the 6 awg copper power line was run from the center of the ground plane to the electronics hut. Before shipment from Haystack, the power line was split into four lengths $\sim$ 50 m each. Two-pole Anderson power connectors were placed at the breaks. However, some of the connectors failed in the field (the clips fell off of the wire), and so we had to fabricate connections by wrapping smaller gauge wire between the pieces and sealing it with shrinkwrap. For the electronics hut itself we chose a metal container roughly 2 $\times$ 2 $\times$ 3 meters with a semi-functional door on the front (Fig. 2). It stands roughly 170 meters due south west of the antenna.

Figure 2: The electronics hut, with the generator, electronics box, batteries, and red fuel tank installed.

We found that the 14-inch earth anchors had not been installed in the correct place. Although the ground was prepared by the military decades ago via grading and topping with a few-inch layer of fine gravel, large rocks still remain under the ground, making it difficult to get the eight anchors in the proper place, given the half-inch placement tolerance. This was dealt with by digging six deep holes to hold the anchors, attaching the anchors to the frame, and then placing the anchors plus frame in the holes and back-filling them with dirt (Fig. 3). Despite this technique, some of the anchors had to be shortened a bit to accommodate immovable underground rocks.

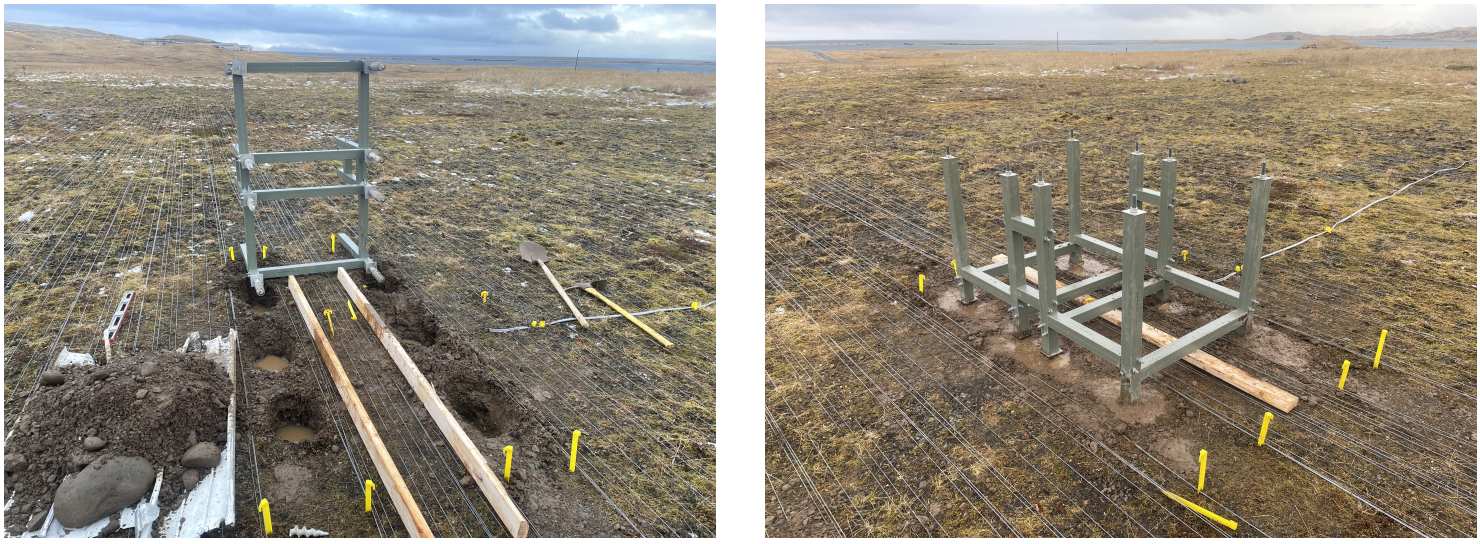

Figure 3: *left:* The six holes dug for the eight ground anchors. The ground anchors were affixed to the frame before putting the frame in the ground. *right:* The frame after installation, with the six holes back-filled with dirt. The yellow tent pegs were used to keep the ground plane wire diverted away from the construction area.

2.3 December 6th

Installation of the frame into the ground was completed. The rest of the equipment was taken to the site (generator, electronics box, batteries, et al.). The empty antenna box was installed onto the frame (Fig. 4). The weather did not allow installation of the antenna box with the electronics - installation requires $\sim$ 1 hour of having the electronics exposed, and it was raining and windy enough to not attempt it.

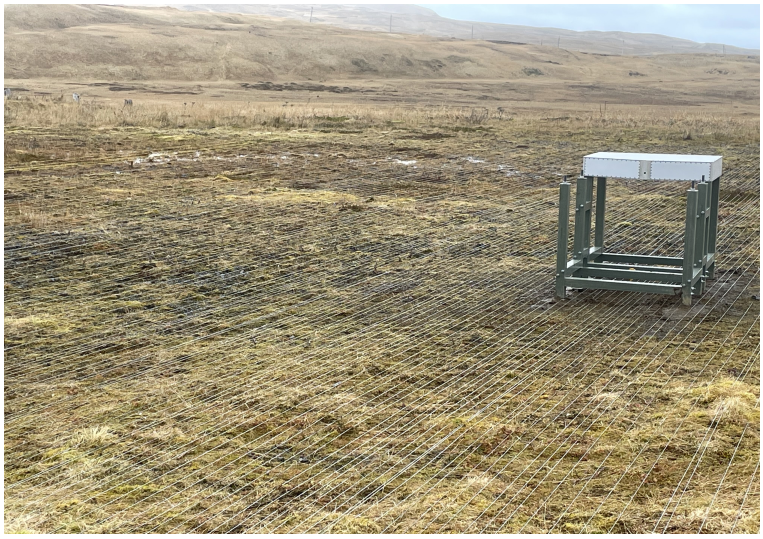

Figure 4: Antenna frame on the meandering-wire ground plane with the empty antenna box installed.

2.4 December 7th

The weather did not improve this day, and so the electronics half of the antenna was still not installed. In the morning the ground plane was completed (there was still $\sim$ 350 meters of wire to string between tent pegs) and all of the crossed wires were fixed. The Starlink antenna was successfully mounted on top of the electronics hut using self-tapping sheet metal screws (Fig. 5). The generator, fuel tank, and batteries were also set up in the hut.

Figure 5: The flat high-performance Starlink antenna after installation on the hut roof. The antenna is oriented to face south, as that is the direction of the highest satellite concentration.

The electronics box arrived on-island on the afternoon flight. After retrieving the box we put some fuel in the tank and hooked up everything in the hut. The Raspberry Pi in the electronics box booted up and functioned nominally, as did the generator and Starlink. We did notice a possible fuel-starvation issue with the generator, where it would start to sputter after a few minutes and required extra priming with the hand pump to keep it running.

2.5 December 8th

The weather was good enough to install the electronics half of the antenna, and the optical fiber was laid from the antenna to the hut, and connectivity was established. Additionally the central connection between the antennas was greased and covered (Fig. 6). Battery 3 was connected directly to the antenna to keep it powered up overnight and the Nuvo was configured to run a 'do spec all' script to take 12 hours of data on the calibration targets (ambient, hot, short, open).

Unfortunately, while shifting equipment in the hut, the electronics box came in contact with the positive terminal of battery 2 and there was a short. This resulted in the Arduino control system becoming inoperable. Without the Arduino working properly,

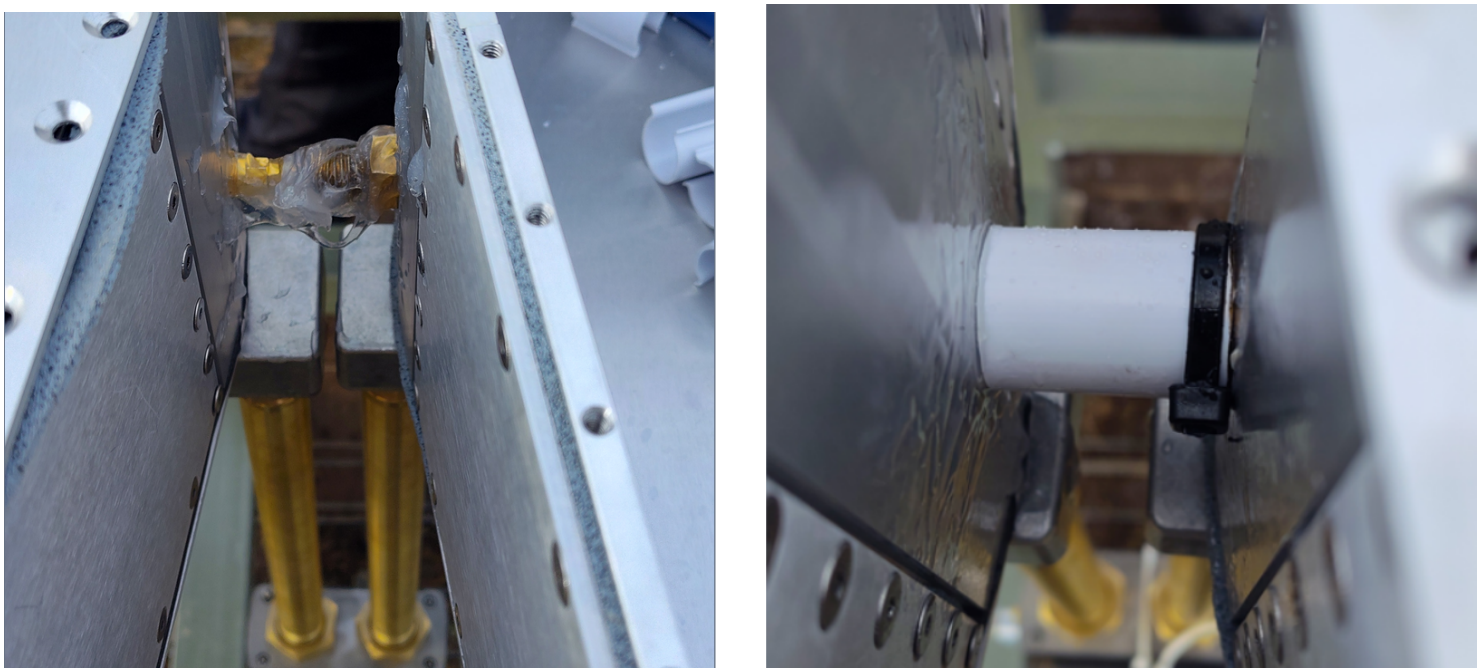

Figure 6: *left:* The SMA connection after the weatherproof grease was applied. *right:* The same connection after the tubing cover was installed.

all of the autonomous functionality of the system was lost. The Arduino was the mechanism for controlling the relays that divert power to the various instruments at the proper times.

2.6 December 9th

The morning was spent unsuccessfully troubleshooting the Arduino issue. In the afternoon the power line going out to the antenna was secured to the ground using tent pegs and zip ties. Additionally the top panel of the electronics half of the antenna was screwed down, which was quite time-consuming as the tolerances are extremely small. Before leaving for the evening the antenna was set to run overnight off of battery power, taking sky data.

2.7 December 10th

In the morning more time was spent troubleshooting the Arduino, to no avail. The sky data collected the previous night was successfully transferred to enterprise[1]. The orientation and dimensions of the antenna were measured, and the deviations from flatness in the ground plane were also measured using a laser level (Fig. 7).

We were unable to get most of the screws into the top panel of the empty antenna box. It was decided to insert what screws we could (roughly ten or so), and then complete the connection by lining the top panel seams with conductive copper tape. The electronics half of the antenna was weatherproofed by applying tape to the seams and the internal fuel pump was removed from the generator in hopes of correcting the gas starvation issue. Things were left in a state that allows the antenna to continue to take data without the Arduino and with minimal babysitting. As it currently stands, someone on-island will have to start the generator to charge the batteries every so often, along with keeping gas in the tank. An additional failure mode also arose, as the digitizer board started to behave as the previous one did, with an internal clock error. Currently the only solution to this error is a hard reset of the Nuvo, requiring someone to physically open the electronics box and flip the EDGES relay off and then on.

2.8 December 11th

This was the last day of the deployment. We visited the site a final time in the morning, to check on the system and perform a final clean-up and walk-through of the site, and to try a final fix to the Arduino, which was unsuccessful. We boarded our return flight in the early afternoon.

[1]The data currently sits in the following directory: /data5/edges/data/Adak/data-backup/antenna/edges3_adak/ADAK/adak

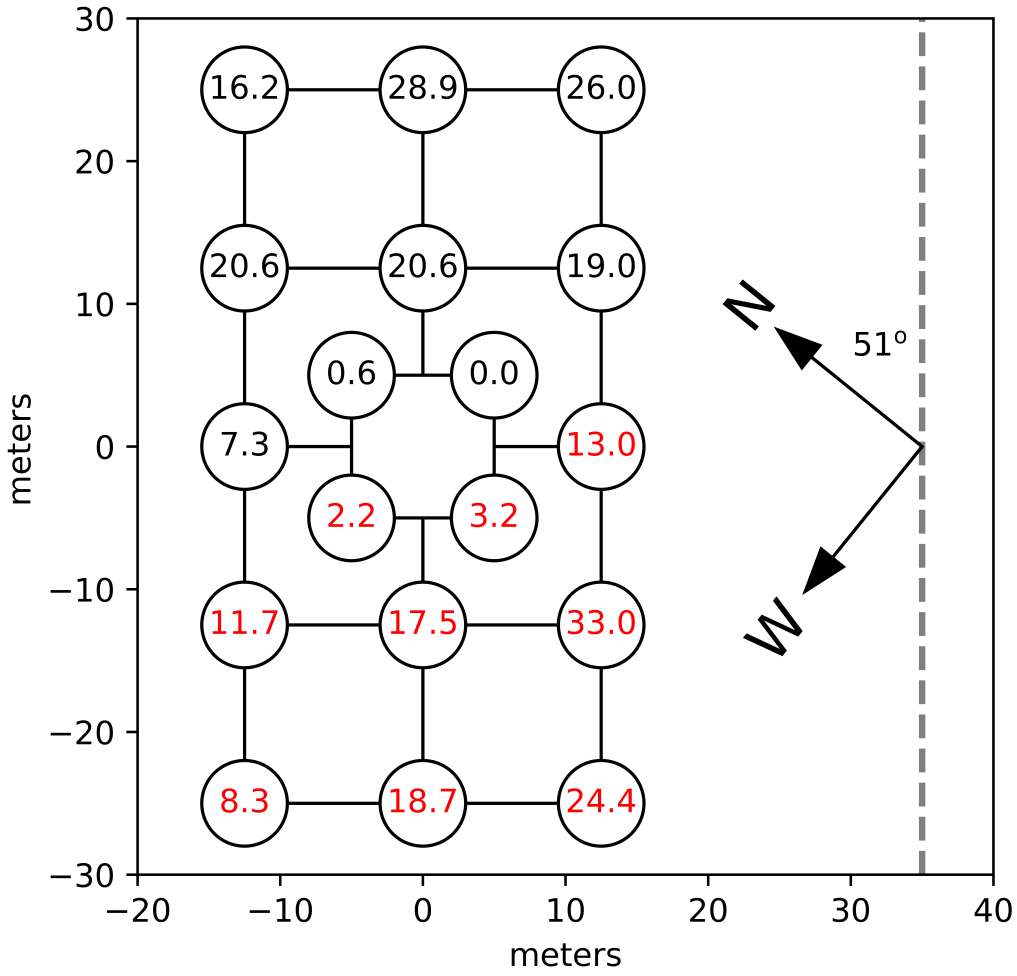

Figure 7: The differential elevations of various points on the ground plane, given in centimeters with an estimated uncertainty of ± 1.3 cm. The compass rose points to the magnetic north pole, and the dashed vertical line is parallel to the antenna and ground plane wires. The antenna is represented by the square in the center of the ground plane. All elevation measurements were made in reference to the eastern corner of the antenna; black numbers lie above this reference point, and red values lie below it. It should be noted that the placement of the antenna corner measurements is not to scale in this diagram, as the footprint of the antenna itself is only ∼ 1 x 2 meters.

3 Additional site photos

Figure 8: The surface of the antenna after the first night of observations. Ice had accumulated on the panels overnight, but melted away within a few hours of sunrise.

Figure 9: The spacing between the two antenna boxes.