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Trans Atlantic Infrasound Payload (TAIP) Operation Plan

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2 Scientific Motivation

The Carolina Infrasound package, added as a piggyback to the 2016 ULDB flight, recorded unique acoustic signals such as the ocean microbarom and a large meteor. These data both yielded unique insights into the acoustic energy transfer from the lower to the upper atmosphere as well as highlighted the vast array of signals whose origins remain unknown.

Now, the opportunity to fly a payload across the north Atlantic offers an opportunity to sample one of the most active ocean microbarom sources on Earth. Improvements in payload capabilities should result in characterization of the higher frequency range of the stratospheric infrasound spectrum as well. Finally, numerous large mining and munitions disposal explosions in the region may provide "ground truth" events for assessing the detection capability of infrasound microphones in the stratosphere.

The flight will include three different types of infrasound sensors. One type is a pair of polarity reversed InfraBSU microphones (standard for high altitude flights since 2016), another is a highly sensitive Chaparral 60 modified for a very low corner period, and the final sensor is a lightweight, low power Gem infrasound package. By evaluating these configurations against each other on the same flight, we will be able to optimize future campaigns with different sensitivity and mass constraints.

3 Payload Description

The TAIP consists of one package that is 15 inches long, 13 inches wide, and 10 inches high (see Figure 1 and drawings in Section 14). It weighs 5.6 lbs. A bundle of tubes, two GPS antennae, two Ethernet cords, and one dual-channel speaker wire protrude from the package. Tubing that exits the package conveys pressure fluctuations to the microphones, so they must be open to the atmosphere during flight (see Figure 2 and Drawing B in Section 14). The Ethernet cords must be connected to each other prior to launch; by making this connection the microphones and an additional data logger receive power from internal battery packs. See Figure 3 for a view of the Ethernet cords on the side of the payload box, Drawing C in Section 14 for where these cords are located, and Figure 4 for an image of the connector. The two approximately 5 m long GPS antennae must have a view of the sky. The dual-channel speaker wire will be connected to CSBF power during integration. See Figure 5 for an image of a GPS antenna and the speaker wire for delivering power from CSBF to the Datacube. The package itself may be located anywhere on the gondola, though we prefer that it reside in a protected area such as behind the solar shields. This will keep it safe during impact as well as minimize temperature fluctuations.

The package consists of a Polar Tech medical grade shipping carton of the same variety used on the 2016 ULDB mission (see `http://a.co/2mrHBuM`). The package contains one Omnirecs Datacube digitizer `http://omnirecs.de/dc3.html`. This a lightweight, low power, three channel data logger originally developed for seismic applications, but it has flown on six high altitude balloon missions thus far. Two InfraBSU infrasound microphones (Marcillo et al., 2012) and one modified Chaparral 60 infrasound microphone (`http://chaparralphysics.com/model60.html`) comprise the acoustic sensing system logged by the Datacube. An additional Arduino-based infrasound sensor-logger system called the Gem (Anderson et al., 2017) is present inside the package. See Figure 6 for an image of the equipment inside the payload box.

4 Power Supply

CSBF has agreed to provide an approximately 30 volt power supply for the Datacube. The Datacube draws 0.3 Watts and accepts power at 4.5 - 24 volts. We have put a DC DC stepdown inside our payload box that will convert the CSBF input voltage to 20 volts internally. Integration with the CSBF power supply will occur when we arrive in Palestine.

Due to noise sensitivity, the microphones cannot be on the same power source as the digitizer. We have provided three Ultimate Lithium AA battery packs: one 8 battery pack for the Chaparral 60, one 8 battery pack for the InfraBSUs, and one 6 battery pack for the Gem. All batteries we provide will be inside our payload box. The microphones and the Gem are powered up when the Ethernet cord is connected prior to launch.

5 Telemetry

We have no telemetry requirements. We understand that the payload may be lost, in which case we will not be able to retrieve any data.

6 Payload Operation

Once power is applied to the Datacube, it starts searching for a GPS signal. Once a GPS lock is acquired, it begins logging data. This means that two actions must be performed prior to launch: the Datacube must be powered, and the microphones must be powered. During the 2016 ULDB mission, CSBF installed a relay that switched the Datacube power on just prior to launch. This worked well and we see no reason to change it.

The microphones must also be turned on. This will be accomplished by connecting two blue Ethernet cables together. These cables are located on the outside of the box for easy access. Since the microphones draw so little power, they can be switched on and off for multiple scrubs without threatening the mission. For example, the ULDB 2016 was scrubbed 5 times, but the microphones had sufficient power left for the flight even so.

The payload box will be taped shut after integration and access to the interior will not be required.

7 Integration

Placement of the package must be such that:

1. Tubing protruding from the package are open to the atmosphere
2. The two GPS antennae on the package are placed such that they can receive a fix
3. The microphone power Ethernet cable on the outside of the box can be connected prior to launch attempt

Please note that the Ethernet cords **must not be attached to each other** until show. We prefer that the packages remain as far as practical from any transmitters (e. g. Iridium) as we have had issues with electronic noise on the HASP. The tubing on the package can be extended to provide some flexibility in package placement. If need be, additional tubing can be added on the ends to extend their reach. Tape, fasteners, etc, can be placed on the packages so long as the tube openings are not blocked.

I will be at CSBF all day on January 23rd to integrate the payload.

8 Launch Day Procedures

The connectors on the cabling protruding from the package must be connected prior to launch. This should take place less than 24 hours prior to show. Since I am not sure of the launch procedures in Sweden, I cannot offer specific guidance, except to point out that once the connection is made the payload begins drawing power from its internal batteries. Thus, we request the connection be made as close to the anticipated launch time as feasible. If there is a scrub, the connectors must be disconnected again.

9 Recovery

Please notify us when the packages have been returned to a CSBF facility, and we will provide a prepaid shipping label to have it returned to us. If necessary, the package can be opened and the batteries removed prior to shipment.

10 Safety

Recovery personnel should be made aware of the presence of lithium batteries in the payload box. If objects in the box are broken during impact, sharp fragments may be present. No other safety issues are anticipated.

11 Export Control

The payload components are classified as EAR99.

12 Checklists

12.1 Integration

- ☐ **Package is securely mounted to gondola**
- ☐ **Package tubing is open to the atmosphere**
- ☐ **GPS antennae are placed such that they can receive a fix**
- ☐ **The microphone power Ethernet cords are accessible**
- ☐ **Cabling, tubing, and GPS antenna are secured so they cannot move during flight**
- ☐ **Connectors are not connected**

12.2 Show

- ☐ **Attach Ethernet cables to each other**
- ☐ **Wrap cable connection in white tape**
- ☐ **Switch on CSBF provided power**

12.3 Scrub

- ☐ **Unwrap cable connection**
- ☐ **Disconnect connectors**

13 Photos

Figure 1: Top view of payload box.

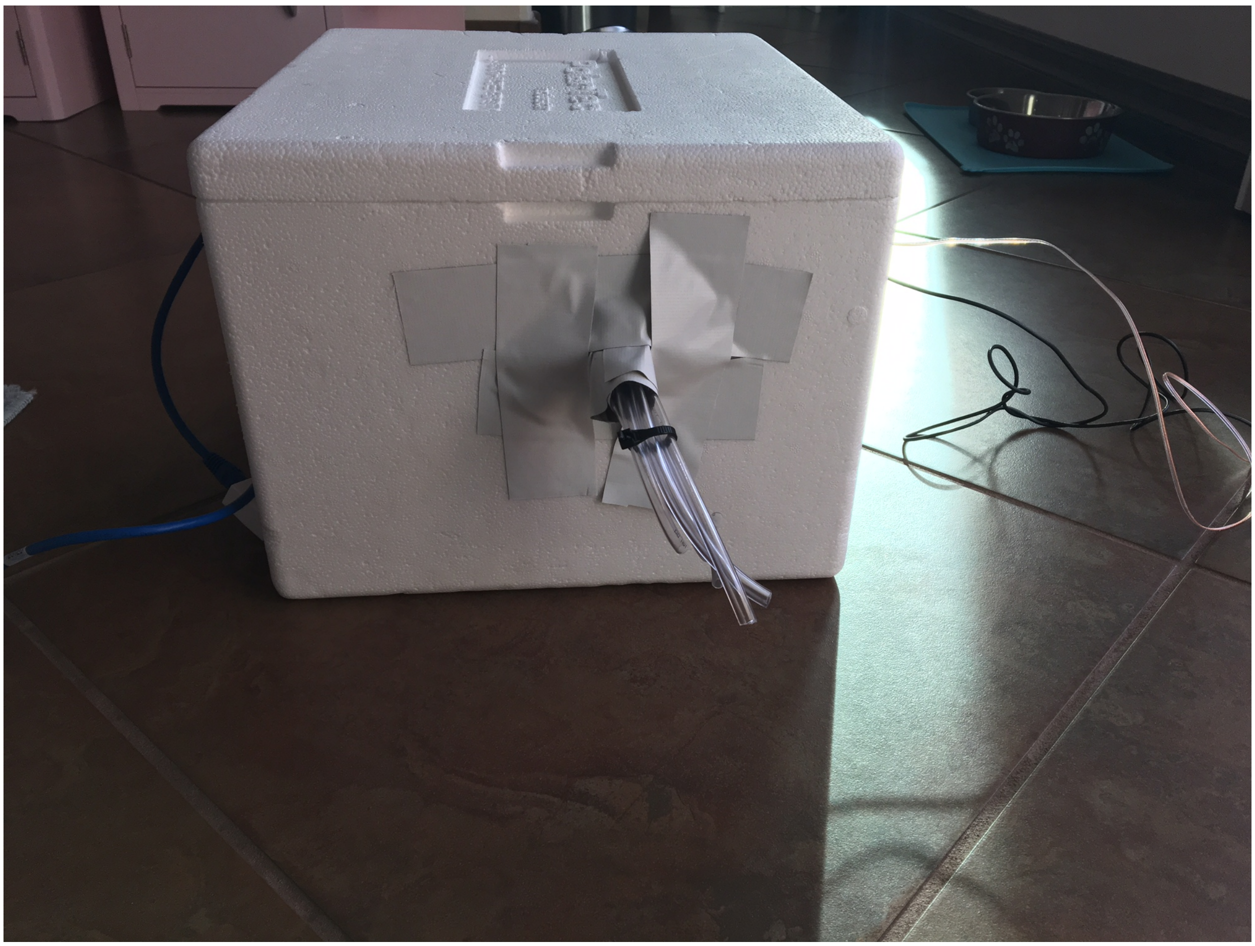


Figure 2: Side view, showing microphone tubing. These must have access to the atmosphere, but we can add longer conduits if necessary.

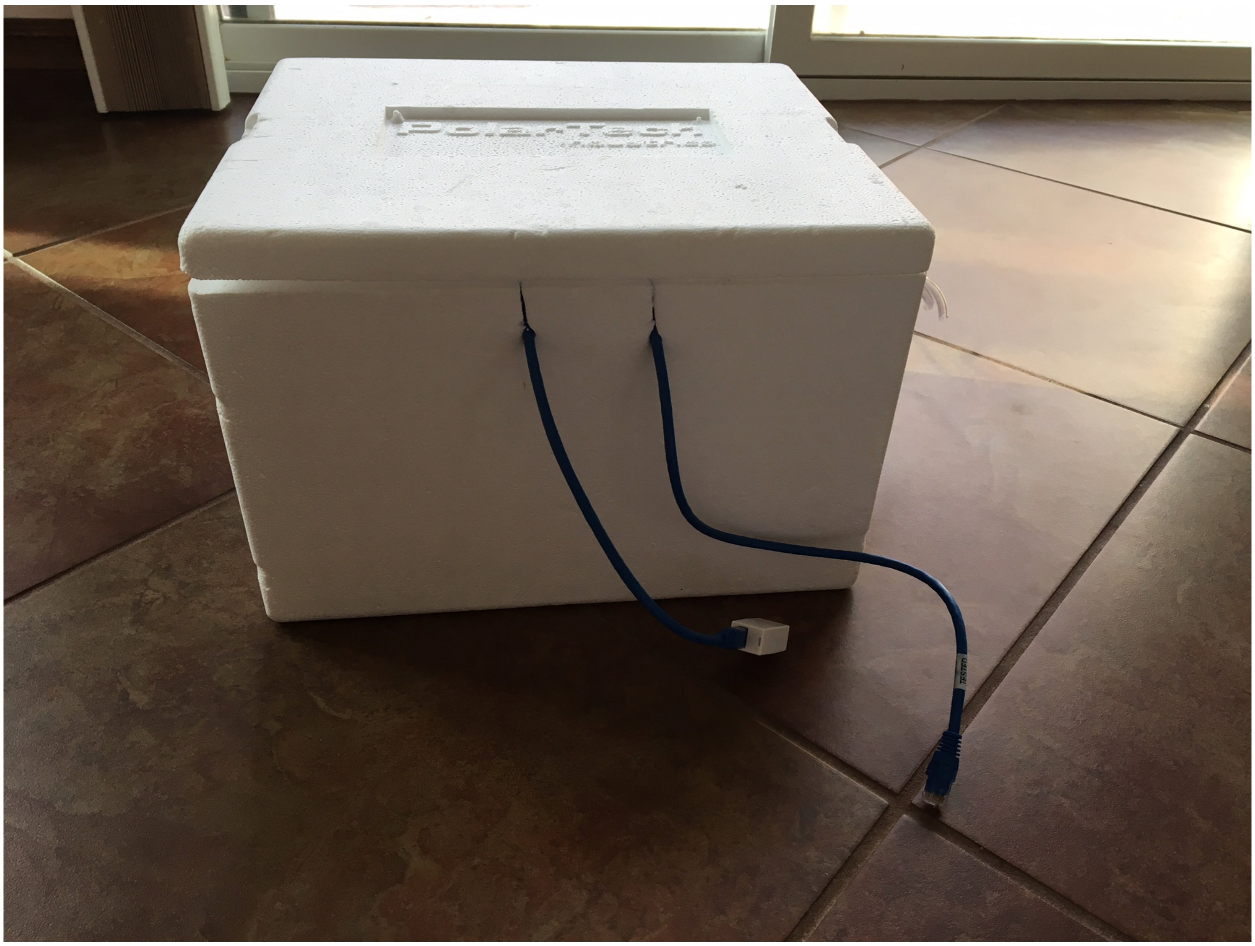


Figure 3: Side view showing the Ethernet cords that must be connected together prior to launch in order to power up the microphones. The Ethernet connector is already present (a small white box at the end of one of the cables).

Figure 4: Closeup of Ethernet connector and cables that must be attached prior to launch.

Figure 5: Side view showing GPS antennae and CSBF power connection.

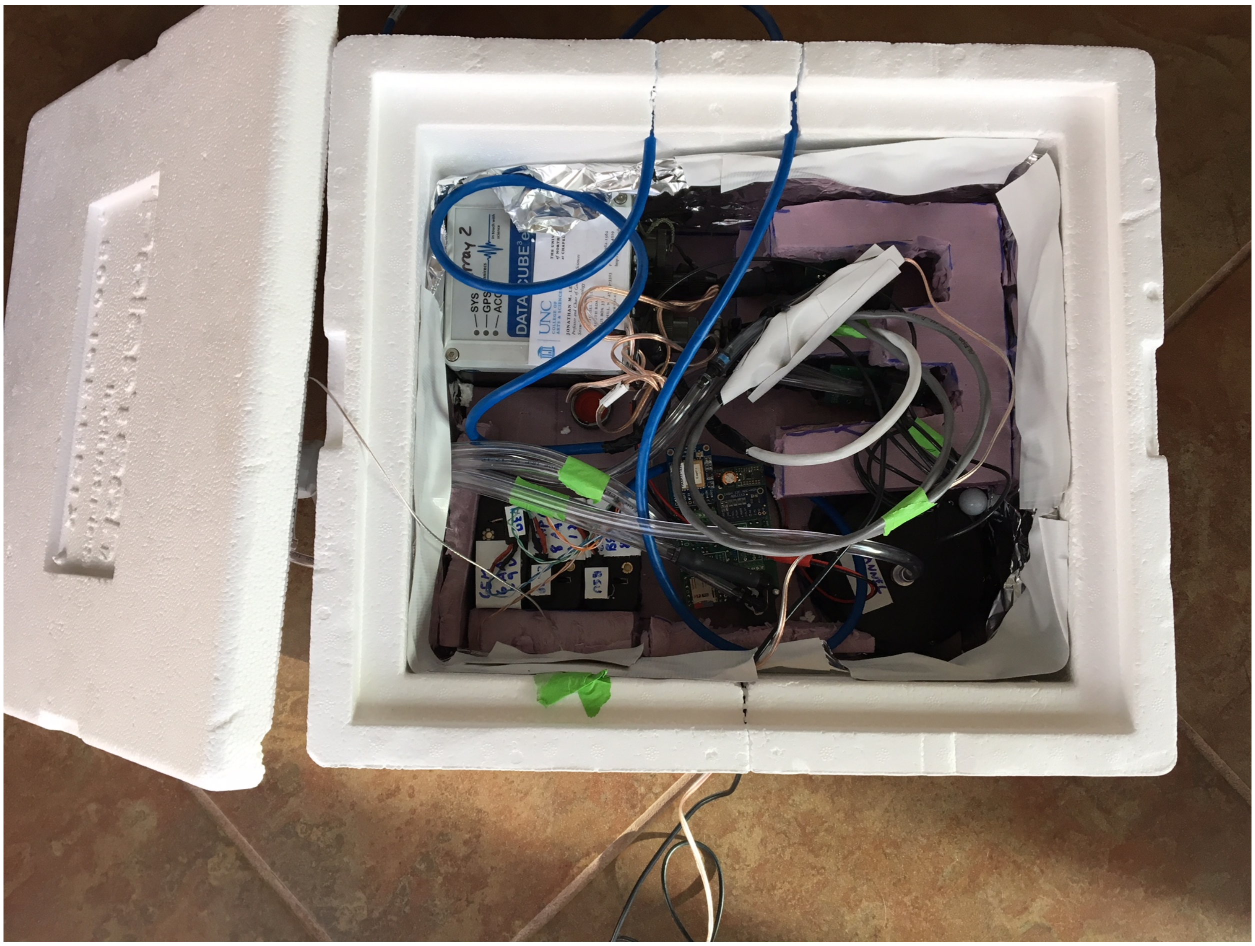
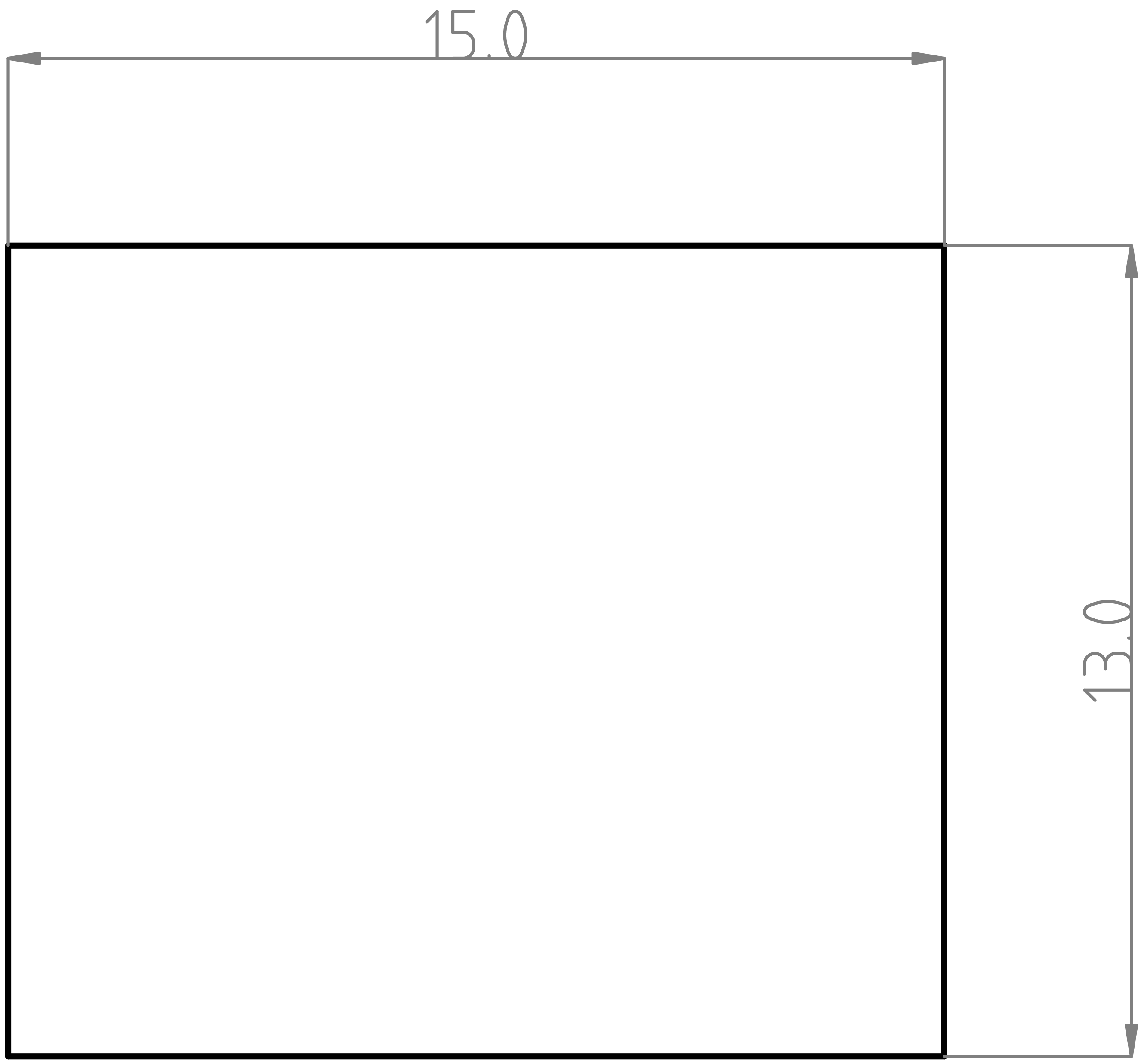


Figure 6: Interior of payload box.

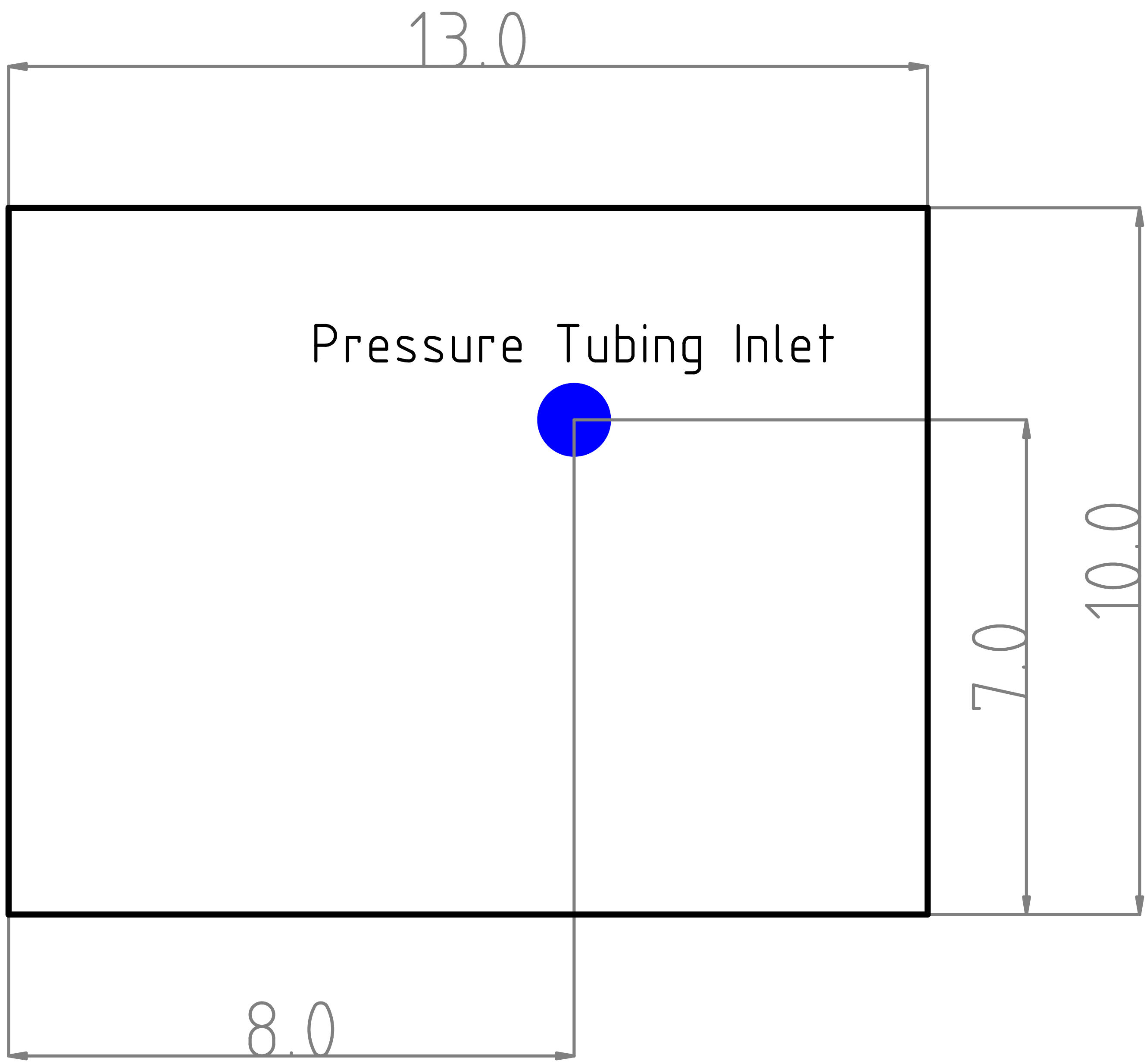
14 Dimensioned Drawings

All units in inches.

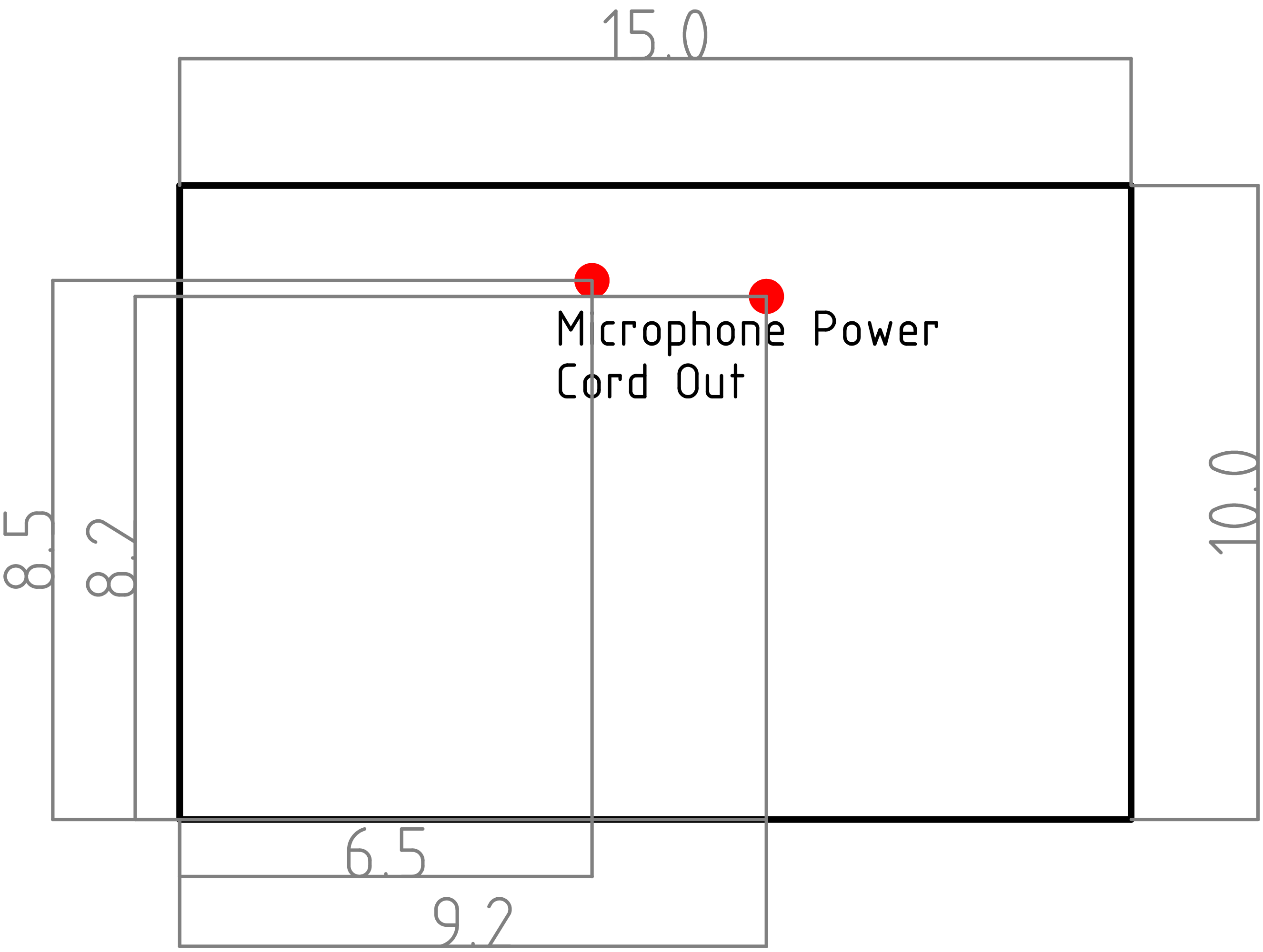
A: Top View



B: Side View with Pressure Tubing Inlet



C. Side View with Microphone Power



References

Anderson, J. F., Johnson, J. B., Bowman, D. C., and Ronan, T. J. (2017). The gem infrasound logger and custom-built instrumentation. *Seismological Research Letters*.

Marcillo, O., Johnson, J. B., and Hart, D. (2012). Implementation, characterization, and evaluation of an inexpensive low-power low-noise infrasound sensor based on a micromachined differential pressure transducer and a mechanical filter. *Journal of Atmospheric and Oceanic Technology*, 29:1275–1284.