A Construction Manual for the Magnetometer Unit and the Ground Tube.

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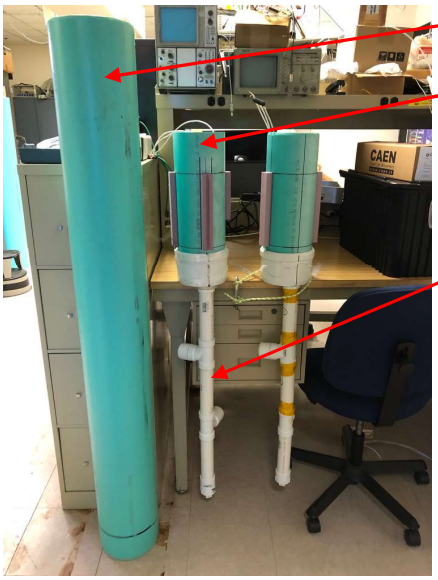
The purpose of this document is to provide instruction and guidance to build the basic deployment structures of the magnetometer unit. It is very important to follow these instructions because otherwise the magnetometer will not fit inside the deployment tube.

There is the outer shell (8” PVC tube) and the magnetometer unit consisting of the so-called “tree” (the coil structure) and the electronic compartment (see figure 1)



Outer 8“ PVC ground tube

Magnetometer, Data logger compartment
The violet bars are foam bars keeping the magnetometer unit centered in the outer tube.

Three axis coil structure (the tree). The coils form a right-handed cartesian co-ordinate system.

Figure 1: Outer tube and magnetometer unit.

The outer 8” tube should be about 66 inches tall. It this also recommended to make the top and the bottom rim round (see figure 2) by using a rasper. This will be very helpful to mount the bottom and the top tube cap.

The next step is to cut the 6” tube to a length of 18” (as shown in figure 3). It is also recommended to make the top and the bottom rim round (not done figure 3 yet).

Figure 3: Electronics compartment (6” tube)

Before you close the bottom of the outer (8” tube) add a foam board (green disk) as shown in figure 4. These foam boards are available in most craft store in 6” and 8” size. These foam boards will absorb rest moister inside the tube. Note: these foam boards fit tightly – one needs some efforts to push them inside the tube.

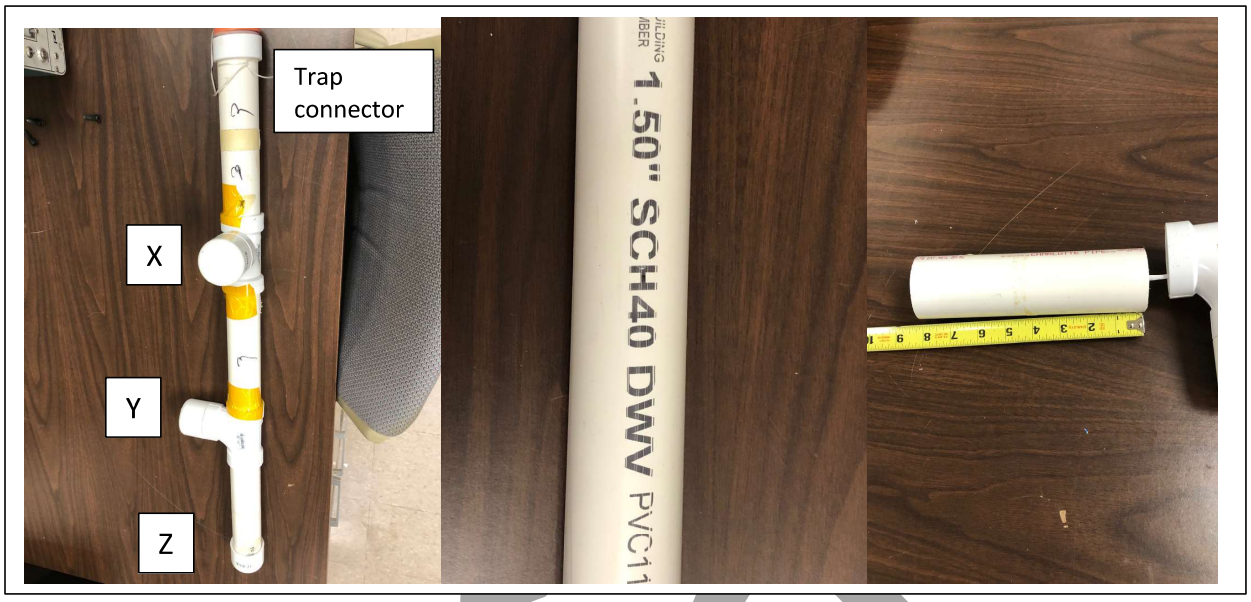
The bottom side of the magnetometer and data logger compartment we need to attach the so-called coil tree. This is done by a 1 ½ inch female “Trap” adapter (see figure 5 left). The next step is to drill a hole into the 6 inches PVC cap. The center of that hole needs to be 1.75 inches away from the center of that cap (see middle figure). The screw part should be inside the cap (right figure).

In the inside should be equipped with 6” crafted foam boards (see figure below). The purpose of these boards is to absorb moister, give stability to the electronic devised and thermal insulation. The bottom board (see left figure) has a cut-out for the coil cables and the magnetometer data unit. The center figure shows the middle foam board separating the magnetometer data unit from the data logger. The board cut-outs are for the connectors of the mag-unit, the power, the temperature sensor and for venting. The top foam has a cut-out for cables leaving to Electronics compartment (right-hand photo).

We are re-designing the top (6”) cap. There should be a compartment for two power connecters, and antenna cable, and “data” connection. A new final design is pending but will be done soon.

“The coil tree”

The coil tree is a PVC structure that contains the magnetometer coils. It is designed to fit into the outer tube and constitutes a 3D right-hand cartesian co-ordinate system.



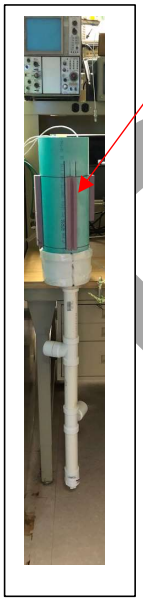
The “ tree” consists of 1.5” PVC tubing. Two “T” fittings, a female trap adapter, and three straight 8” equally long pipe pieces (as shown in the figure above). The minimum distance between the magnetometer coils need to be at least 6”. Therefore, we used 8 inch long PVC pieces between the “T”s. Every “T” (X, Y) and the bottom part (Z) of the tree contains a magnetometer oil. This is shown in figure xX.

As shown in figure YY, ever coil is closed with an end cap. This end cap is flush with the “T”. Inside every T, there is a piece of PVC 1.5” long. Inside this piece of PVC is a 3 inch long piece of 1 inch foam pipe insulation. This is the holder of the coil. It also reduces vibrations and large temperature changes. Slide the coil inside the foam insulation and rap a zip-tie around it. Secure the coil with the zip-tie by pulling at the lose end.

The Z-component does not need a 1.5” piece of PVC. It will just be places inside the tube before the end cap is attached.

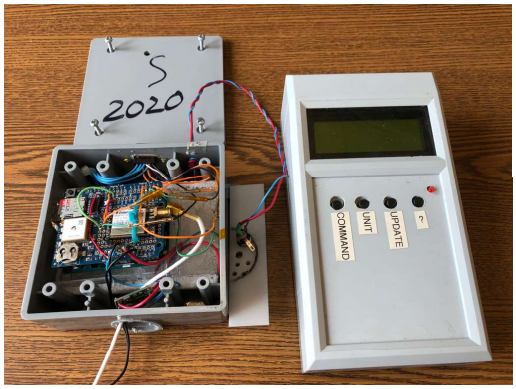
Note: After everything is assembled please secure all connections, but the coil end caps, with strong tape. Do not use glue – because we may want to disassemble parts later for repair, or system checks.

Once everything is assembled the magnetometer unit should look like in figure ZZ
Note: This figure shows also the pink foam pieces that center the magnetometer unit in the outer tube. These foam stripes are 1bout 10inches long, 0.5 inches wide and 0.5 inches thick. Those pieces are glued to the tube with a hot glue gun.

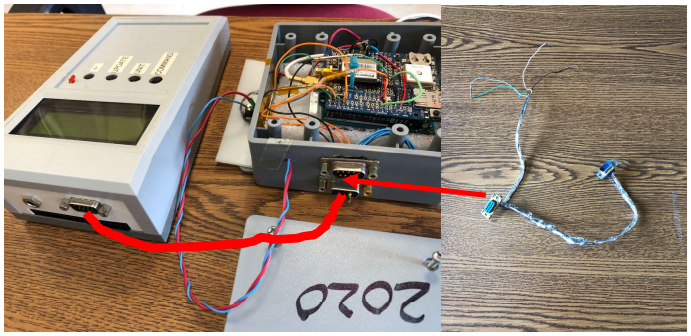


Inside the electronics compartment:

Inside the electronics compartment we have the magnetometer data unit (left) and the data logger (right). The magnetometer data unit is Reeves (SAM-III) simple aurora monitor (right). On the left side of this photo we show the so-called wireless data logger (left). The data logger is an Arduino UNO SMD R3 that is equipped with an ULTIMATE GPS logger shield. To measure the temperature inside the magnetometer unit we use a THERMISTOR NTC 10K ohm. The transmitter is a USGlobalSat LM-110H1 LoRa unit. More details are given in the document describing the build of the data logger.



For the data transmission between the magnetometer and the data logger we used male/female DB9 connectors. Part of the harness is shown in the right-hand photo. Per request we can provide these cables/connectors.



At this point in the build it is time to connect all cables and perform a test. Connect all power (power to the magnetometer data unit and the Arduino, connect the data cables). A more detailed description of that test will be given in another document.

If that test is successful, the electronics compartment should be populated. Figure XX (right) shows how the components should be stacked. Use the circular foam boards previously described. In the middle photo we show stack before we close the top part with another foam board as indicated by the left photo.

Do not forget to add cut-outs (left) for the cables that should leave the magnetometer unit (right). Holes for the cu-outs are indicated by the blue circles in this picture.
The cables leave the unit are the power for the magnetometer data unit, the power for the Arduino, the antenna cable, a DB-9 connector (for reprogramming the magnetometer, and two "sync" cables.

The final harness is currently under review to make it simpler and more robust.

Power to the MAG Station:

The magnetometer station is powered by solar power. Two solar panels deliver power to two batteries that are located in the “dog-house” compartment (see photo below).

The two solar panel (20W and 30W) power two batteries. The smaller battery (20Ah) is powering the data logger and the slightly more powerful battery (35Ah) powers the magnetometer data unit (Reeves SAM3). The batteries in this deployment are in a battery compartment (black box) that is located in the “dog-house”. While the 20W solar panel will power the 20Ah battery via a solar charge controller, the 30W panel uses a separate solar charge controller and to power the 35Ah battery. The system is designed to provide enough power to keeps the magnetometer station powered for at least two weeks without Sun light. All these parts are shown in the figure below.

The antenna shown in the lower right photo transmits the data to the Raspberry PI single board computer shown in the photo below. This computer receives the data and sends it via the internet to the UNH data center.

The distance between the antenna at the magnetometer station and the Raspberry Pi can be up to 4 miles (depending on the terrain).

This is the only devise that will be on your desk. One can connect a keyboard and a computer screen to watch, and/or plot the daily/hourly magnetometer data. Software is available. The yellow cable is the internet while and the black cable is the power connection.