Bow tie assembly guidelines

Requirement

The aim of the antenna is to be cheap, lightweight, and flat-packable. It must be able to withstand burial without changing its characteristics significantly. There are two aspects to the electrical characteristics that are key:

- the bandwidth must cover 200-400MHz to handle the bandwidth of the radar
- there must be enough forward gain to increase the lateral isolation to acceptable levels: the FMCW system means that the receiver and transmitter are operating at the same time, and so the level of direct coupling between the antennas will be one of the main determinants of the maximum gain we can have in the Rx chain (and equivalently the amount of power we can transmit).

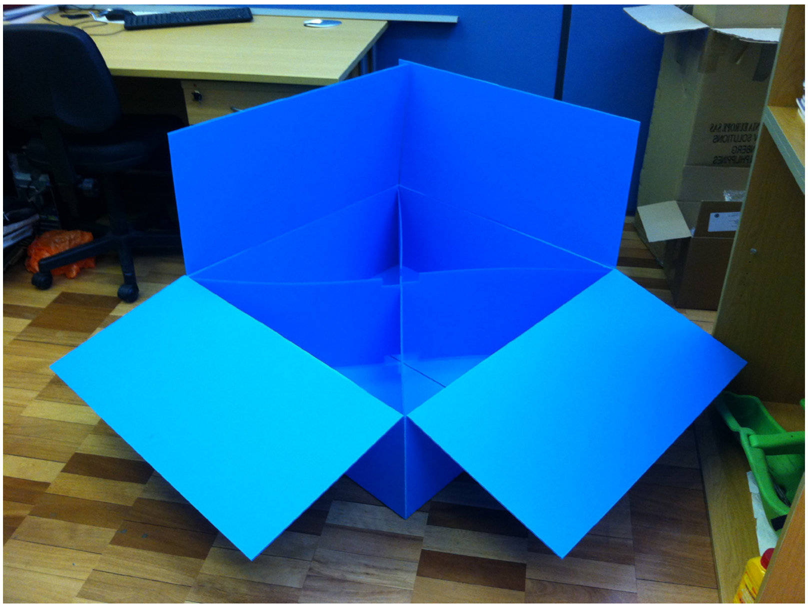
Solution

The solution we came up with was a bowtie antenna with a passive reflector. The essential components are a pair of triangular active elements, a balun (mounted on a small PCB) making the connection between the elements and the feeder cable, and a passive reflecting sheet around a quarter wavelength behind.

These elements are mounted in a correx (twin-walled, corrugated plastic) box, which is taped up with duct tape to keep snow out. The boxes are then shallowly buried. The idea is that if snow cannot enter the box during the period of deployment, then the characteristics of the antenna will not change too much. The measurements I give here are optimised for an antenna that is buried in snow of density typical of the upper metre or so,

The figure shows one of the prototypes built for testing in the lab. So this is the sort of thing we are

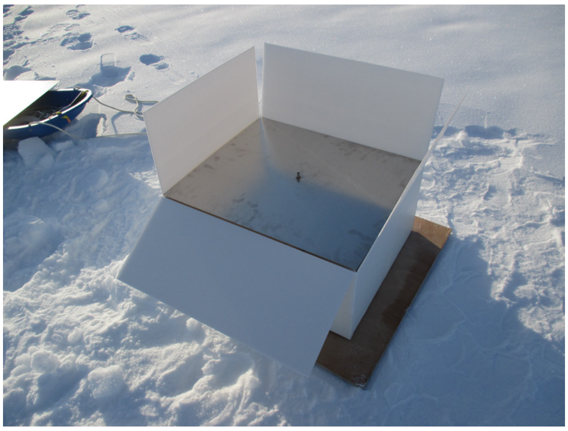
attempting to achieve, but in a seal correx box. The figure below shows one example of one of the antennas . This was a vivid blue-coloured correx (my preference is white) that was constructed by collaborators at SPRI for an experiment in Greenland. I've included it because it shows how, in

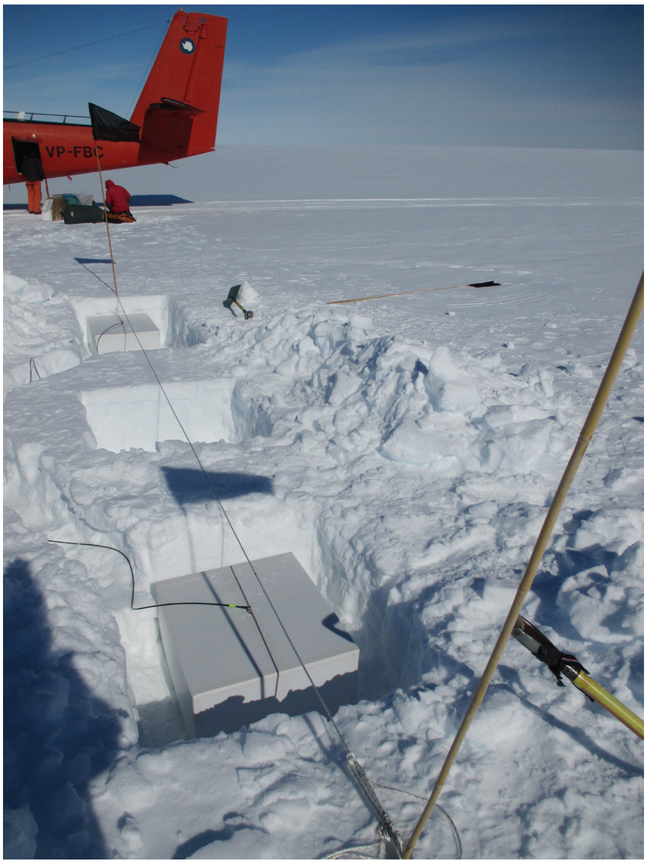


practice, we keep the reflector supported above the bow ties (we don't use the wooden posts shown in the prototype!).

A pair of dividers are built by the same company that makes the correx boxes. They have a slot so they slot-together and act both as a support for the reflector, and to give the box some strength against snow-loading. This particular design of antennas was used for an imaging system above the snow surface (it was in a Greenland glacier's ablation zone). Note the cutouts in the dividers – top and bottom. These give some space for the connector to the balun PCB at the bottom and TNC connector at the top.

Images below show what you will be making for Amery. These were constructed for systems

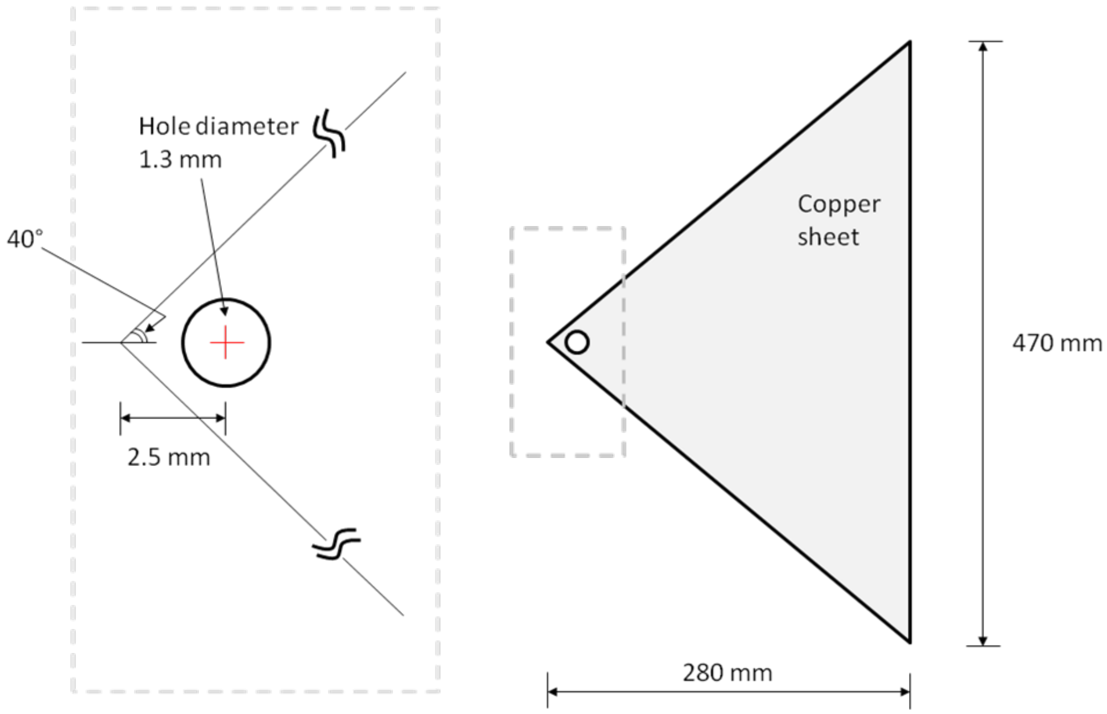




deployed on Pine Island Glacier (and are also the right colour...). The picture on the right shows them in their snow holes. The centre hole is for the radar and battery.

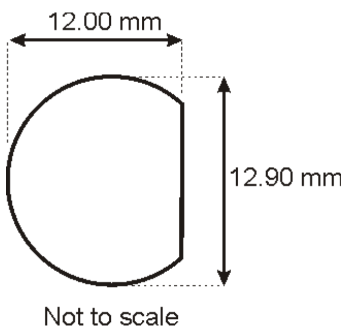
Construction details

The active elements of the bowtie were made from copper sheets, cut into triangles, with small holes in the corner that connects to the balun PCB. The sheets were stuck to polycarbonate roofing sheet using double-sided tape. The copper only has to be thick enough to allow the holes to be drilled. An alternative is sticky-backed copper foil, which can be bought as a 300-mm wide roll,



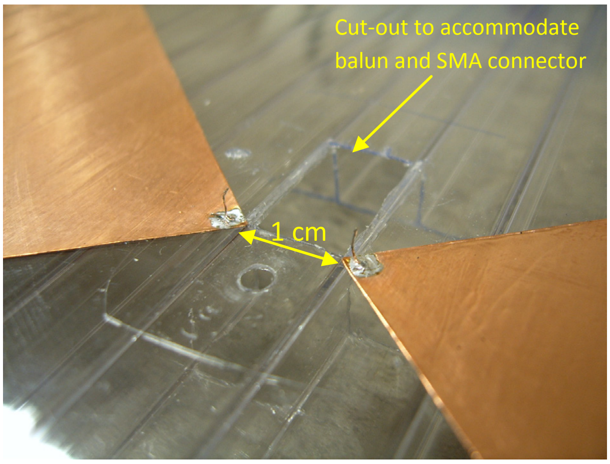
although soldering the connections will need to be done with care. The hole is to accept the solder pin that connects to the balun PCB.

A hole was made in the centre of the polycarbonate sheet to make space for the balun PCB, the small coaxial (SMA) connector on which points up through the sheet, and is connects to a coaxial cable, which runs up to a TNC coaxial connector mounted in the reflector.

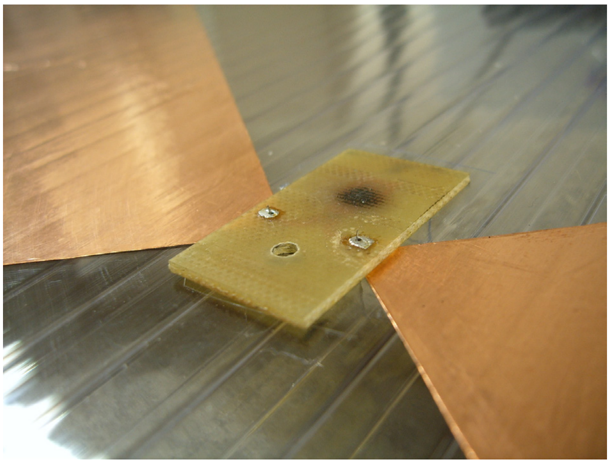


The internal dimensions of the correx box are 600 x 700 x 300 mm, so that the 10-mm thick roofing sheet needs to be 600 x 700 mm. The aluminium reflector is therefore 600 x 700 mm, with a TNC-type hole in the centre, as in the drawing below. We used 1-mm thick aluminium.

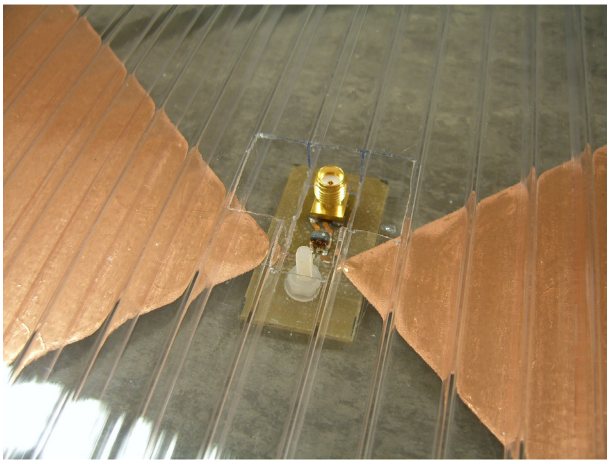
Some photographs below show some stages in mounting the PCB, but you'll find your own way of doing this. One thing to note, is that connecting the solder pins to the sheets of copper requires quite a powerful soldering iron, as the copper acts as a very effective heat sink.



These pictures were taken when using sticky-backed copper foil. This is a view from beneath.



This is with the balun PCB positioned over the pins, which then need to be soldered to the board



View from on top. This assembly PCB made use of the hole in the PCB to fit a nylon screw to secure to the roofing sheet. We found that this wasn't needed when using copper plates. The other difference is that the balun itself (seen here mounted on the PCB – the tiny transformer) is of a different design, and will look different on the boards I supply.

Things to do

The most urgent thing will be to get in touch with a local packaging company and get the correx boxes built. The boxes themselves will be easy enough, but there will be tooling charges to make the cutouts for the cross pieces. The alternative is for you to get the boxes built and make the cross pieces yourselves put of some purchased correx, or anything else (maybe some left-over polycarbonate roofing material). We had the cross pieces made because we had 76 antennas to build for some imaging systems, but you will only have 8 individual pieces to make.

The correx boxes will probably be stapled down two corners – the staples don't seem to cause any problems for the performance of the antennas. The other thing to note is that ours were made with the corrugations running horizontally. You'd get more strength against snow loading by having the corrugations running vertically. Having said that, as far as I can tell our antennas are doing ok on Pine Island Glacier. The size of the box means that they can get more out of one sheet by running the m horizontally, and it might require a discussion with the company to decide which way to go. Our correx was about 4 mm thick. You could go for the slightly thicker stuff, 5 mm perhaps, although, again, ours seems to be working ok.

You also need to contact a local metal-bashing/light engineering company (or your workshops) to get the reflectors and copper sheets made. You also need to find someone (workshops?) to cut the polycarbonate roofing sheet to size.

We will supply the baluns and the coaxial cable assemblies.

Keith Nicholls
4th September 2014