

ICECAPS snow radar
HP Marshall
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Figure 1: Impulse radar system based around NOVELDA X2 chip, BeagleBone Black, and QPAR ultrabroadband antennas.

The ICECAPS snow radar is an impulse radar built around the NOVELDA X2 chip, using a custom cape designed for a BeagleBone embedded linux system. It has been configured to run with a 1.5 GHz bandwidth, and a center frequency of both 5.4 GHz (same as Sentinel), and 7.5 GHz. The two frequencies will enable sensitive detection of the onset of snowmelt. The broad bandwidth will enable measurement of snow accumulation during storms and tracking of stratigraphy. While this radar will be able to detect snow melt, penetration is likely to be limited in very wet snow conditions. An additional radar at a much lower frequency (500MHz-1 GHz) is under development for monitoring stratigraphy during wet snow conditions.

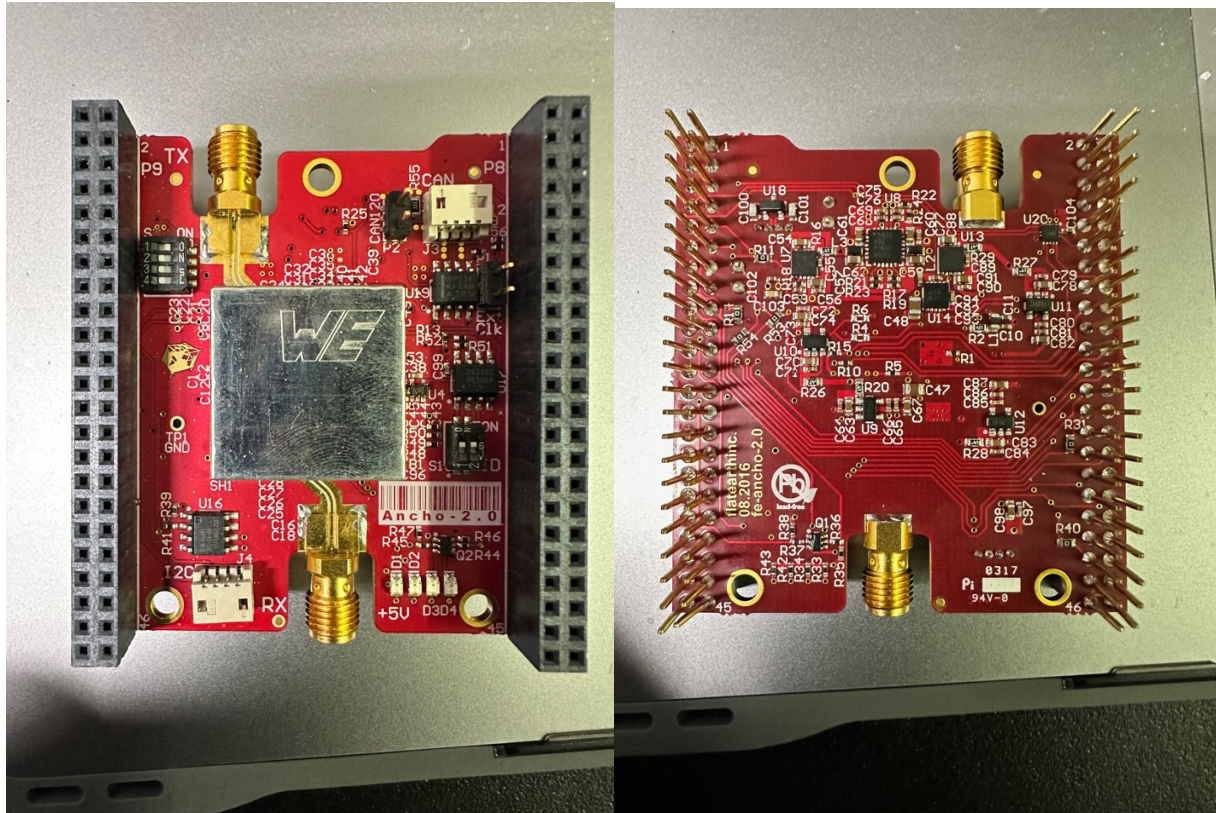


Figure 2: Custom radar Cape for BeagleBone Black. Transmit and Receive ports are shown with SMA connectors. Radar chip is under metal case in center, and cape includes signal conditioning, amplifiers, and a high speed ADC.

Specifications:

Weight: 10.3 lbs

Size: 12" x 8" x 10"

Power: 5V, 300-400 mA

The radar can be powered with 5V from the gray power cord (white=ground, red=+5V), or powered with 12V via the included DC-DC converter (green=ground, red=+12V).

The antennas are oriented out of the lid of the box, so the radar should be mounted with the lid facing the snow surface. A 1.9" OD coupling has been included for mounting and is attached to the side of the box.

Connecting to the radar:

There are two options for communicating with the radar, for changing recording settings, dumping data and troubleshooting. This is done via ssh communication with the embedded linux system.

- 1) With a computer connected to the radar via the provided USB cable, the beaglebone will be recognized as a harddrive. Ignore this, and from the command line, connect via ssh, with different IP addresses depending on the OS:

WINDOZE: 192.168.7.2 (note that you may need to install a driver from www.beagleboard.org)

Mac/linux: 192.168.6.2 (with updated BB OS, you shouldn't need a driver)

- 2) With a router connected to the radar via the provided ethernet cable. IP address: 192.168.1.161 (note this might be a bit different depending on router. Suggest using USB to connect initially, and then "ifconfig" to see what address "eth0" is set to.)

The typical command would be:

```
>ssh root@192.168.6.2
```

If a password is requested, it is "root".

Once the radar is powered, regardless of whether it is connected to an external computer or not, it will record data @ 5GHz every 15min, and @7GHz once an hour. I've set this up so that it should be fine logging data internally for up to 4 months. This is done via a cronjob.

The data is stored at: `"/root/FlatEarth/cilantro_ancha_logger/LOG5"` (for the 5GHz data), and `"/root/FlatEarth/cilantro_ancha_logger/LOG7"` (for the 7 GHz data).

There are lots of ways this data could be moved to the server, either via sftp, scp, or rsync. I would probably rsync the directories above to the server once a day. Happy to help here if this doesn't make sense.

Ideally the radar would be installed with the lid pointed to the sky for maybe 24-72 hours to get a good sky calibration, and then rotated to point the lid at the snow surface. If its possible to keep the radar ~50cm above the snow surface, that will help with interpretation. It is currently set to record up to 5 meters within the snow, which is the approximate penetration depth, so it could be mounted up to 2.5m above the snow surface without issues. If it will be mounted higher, we should change some settings to allow a longer recording window.

Below is an example image during testing in my shop, where I moved a small metal object towards and away from the radar system over a distance of around 0.2-1.6meters.

Before powering the radar down, please ssh into the system, and run:

```
>shutdown -h now
```


If power is removed without doing this, it can lead, in rare cases, to the OS getting corrupted.

Please contact HP Marshall, hpmarshall@boisestate.edu, 303-859-3106, with any questions or issues.

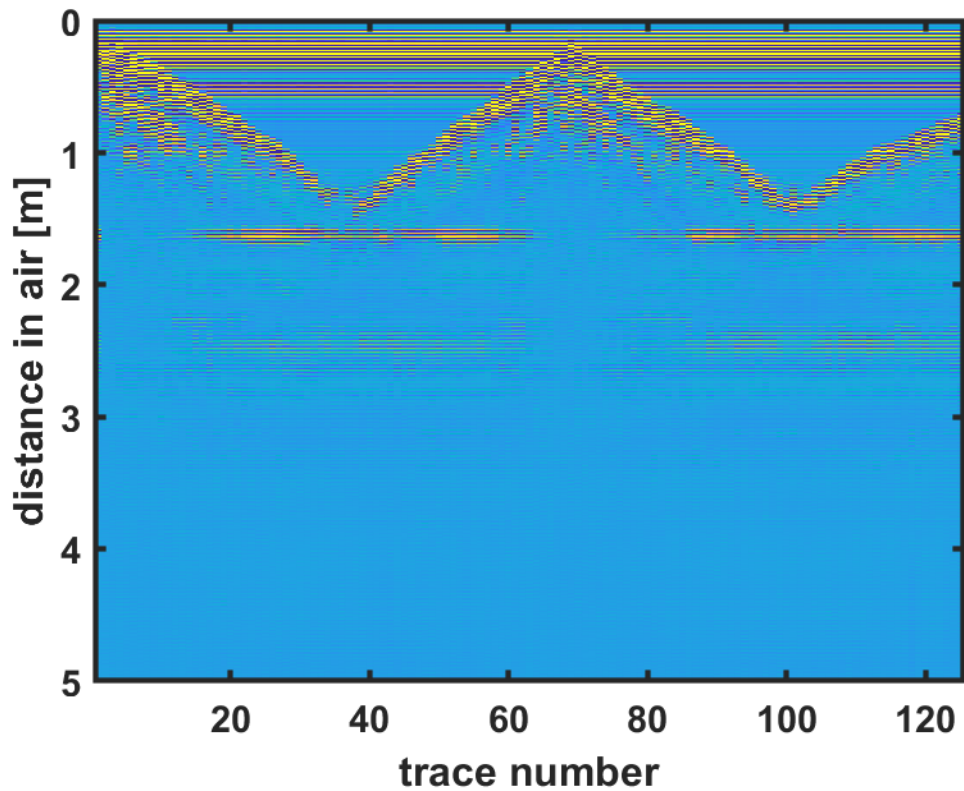


Figure 3: reflector test in lab, with small reflector moved between 0.2 and 1.6 meters from radar.