LWA for radio Astronomy Blair Lade, Peter Gray, John Duffield, David Bennet

The Callisto solar radio spectrometer (receiver) lacks tunability below about 50MHz.

The Earth's atmosphere window for extra-terrestrial radio signals is from about 10MHz up, so there is a portion of the solar HF band that isn't able to be monitored by the Callisto receiver as it stands.

Two things are required to allow the monitoring below 50MHz, one is a suitable antenna and the other is some mechanism to lower the Callisto receiver's frequency range or raise the 'apparent' frequency of the signals in the HF band by using some sort of mixer and move the 10 to 100MHz band to somewhere about the 200 to 300 MHz band.

Peter started on this project once we had the standard Callisto system up and running at Sunnydale with data being sent to ETH in Zurich on a regular basis. See http://www.e-callisto.org/

There are several designs for broad band 'low' frequency HF antennas (1 to 100MHz) and these are discussed in the attached papers.

The choice seems to be the 'bow tie' Long Wave Antenna (LWA) for its ease of manufacture and relatively low cost while not affecting performance and the purpose designed matching Front End Electronics (FEE).

We're not going to detail the design, only the manufacture of the LWA and the FEE as we did it.

The design is covered in other documents. We'll tackle the antenna first as that is just hardware.

Picture of the antenna mounting pole and bow tie 'blades'.

The bow tie antenna is fairly straight forward as can be seen in the pictures. Manufacture just required the purchase of some aluminium ‘U’ section. Cut and file some relief pockets and get it welded up.

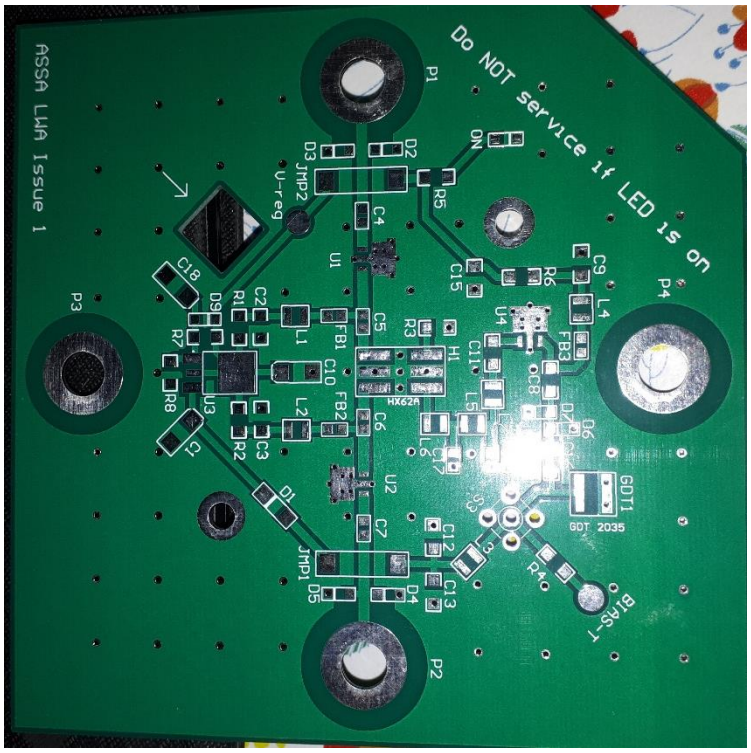
Welding was done for the grand sum of a carton of beer by the staff at Austek Engineering Pty Ltd, 39 Barfield Cresent, Edinburgh North SA 5113 phone 08 82871655. A superb job for which we are extremely grateful.

The pictures show the almost completed LWA at Peter’s place (first trial fit).

I used some Delrin to make a top end adapter up for the pipe which the bow tie blades and the FFE attaches to.

The Front End Electronic (FEE)

The design of the FFE is pretty straight forward and is copied from the original work with some minor changes in the power supply area and to suit locally accessible parts.



The bare FFE Pcb.

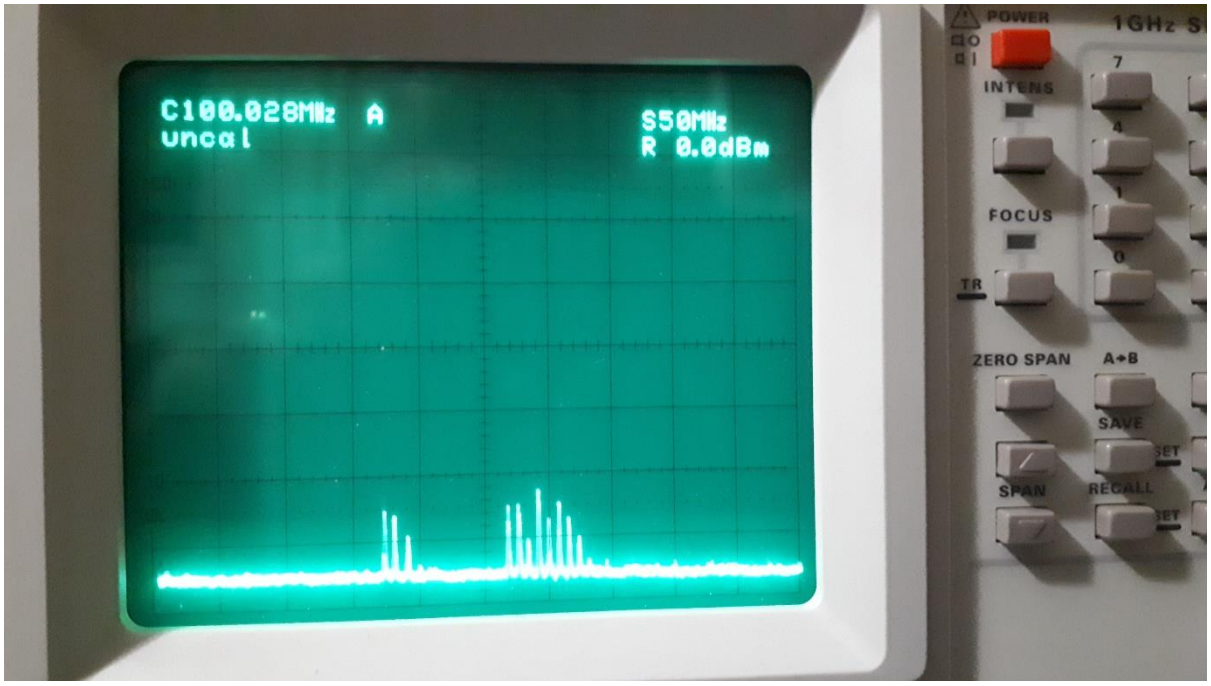
The PCB took a couple of days to draw up in Altium and the boards were made by Entech in South Australia.

Loading the bits on the boards took less than an hour by hand. A little tweaking of the values of the series resistors verse voltage in a spread sheet suggested that I could use the same value for both the GALI 74 and GALI 6 Rf devices (available from MiniKits) if I dropped the on-board regulated supply rail down, which was easy to do.

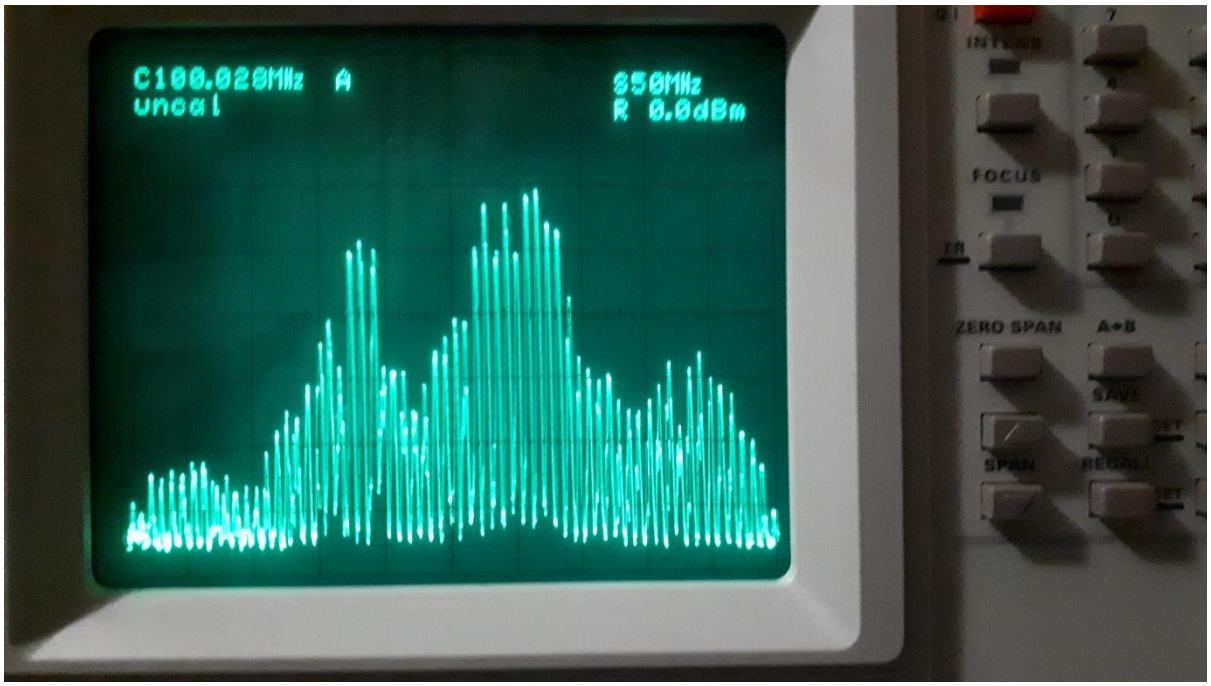
I've used a Mini-Circuits TC1-1TG2 RF Transformer, 50R, 0.4 to 500MHz @ 2dB 2:1 coupling transformer from local supplier MiniKits in Enfield South Australia instead of the hybrid coupler. A quick power up confirmed the correct bias points for the 2 GALI devices.

Putting the new FEE on the signal generator and looking at the output we see that the response is flat from about 3MHz to 110MHz with the gain about 36db.

I installed ½ of the FEE (there are 2 boards required, one for each pair of bow ties), on ½ of the antenna and plugged it into (via the T-bias power adapter) into the spectrum analyser and had a look at what was coming out.



Above, Analyser with 1m vertical whip antenna on it showing the south Australian FM radio stations.

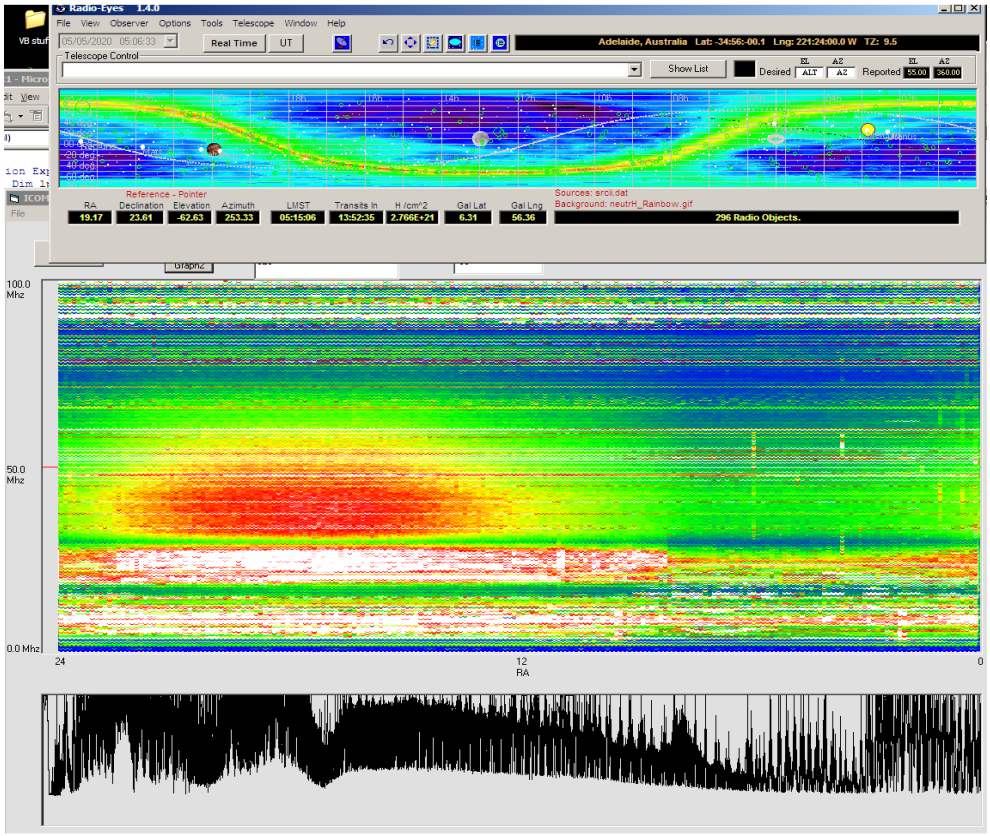


Above, Analyser connected to the FEE and the LWA, same settings. Looks like we have almost 40db gain over the vertical whip. So many FM stations! So much pollution!

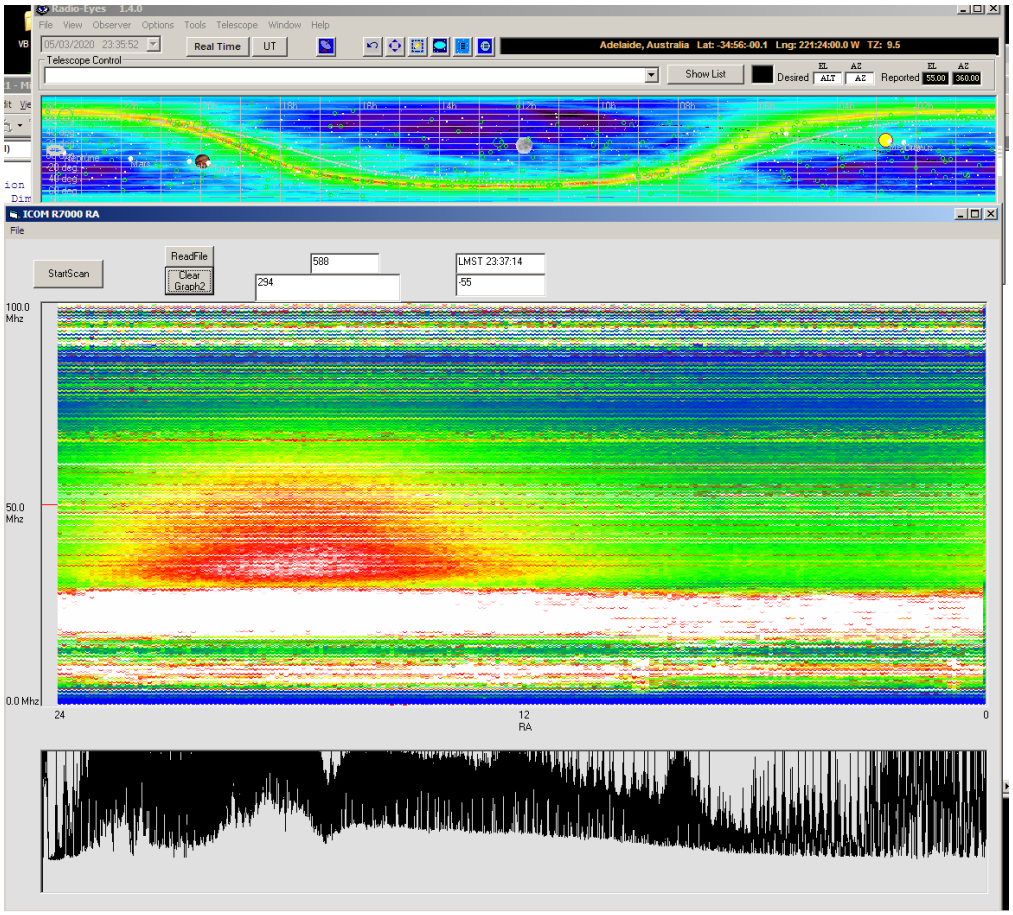
The FEE passed the smoke test (no smoke) and the whole shebang (LWA and FEE) looks like it is performing as expected. The frequency conversion is next, and a bit more complex than building the LWA and the FEE.

With the current LWA antenna, we should be able to see some galactic and Jove activity.

I set up ‘everything’ at work and let it all run for 2 days to test what the new system could ‘see’.



Above, Antenna bow ties facing N-S, Below, Antenna bow ties facing E-W



The Galactic noise really shows up (the big red blobs) in the two 24 hour scans above using the radio astronomy scanning software I wrote and my WinRadio 1550 receiver.

Details about the 2 scans, Frequency range is 0 (at the bottom) to 100Mhz (at the top). 1000 scan steps at 100kHz each, receiver bandwidth is 15kHz and the integration time at each frequency step is 100mS.

The horizontal lines at the top are the Adelaide FM stations (so much RF pollution!). The white mass in the middle is all the HF noise and transmitting stations in the sub 25MHz region. (it's very noisy where this was tested, but much quieter than Adelaide suburbia).

The receiver (a Win Radio 1550e), the attenuator, detector / integrator, bias T and network equipment.