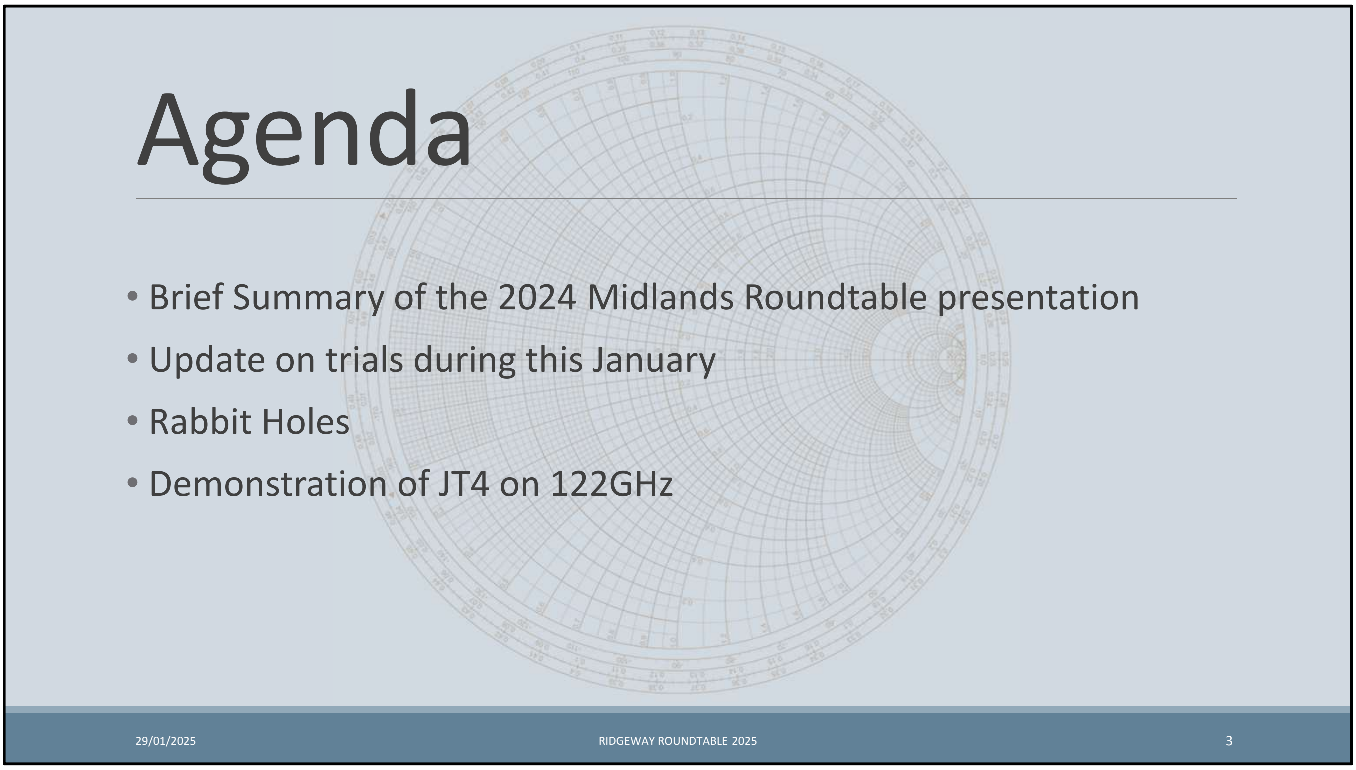
Ridgeway Roundtable

1 February 2025

This presentation follows on from the one we gave at the Midlands Roundtable in November 2024.

For those who couldn’t make it there due to the appalling weather there’s a write up in Scatterpoint, parts 1 and 2 in the last two issues with part 3 to come

The aim of this new roundtable is “show and tell” so as part of this presentation we’re aiming to show a few of the many rabbit holes we went down en-route to the system we’re demonstrating here. These are completely specific to 122 GHz so we hope that these will be of interest to those operating on all microwave bands



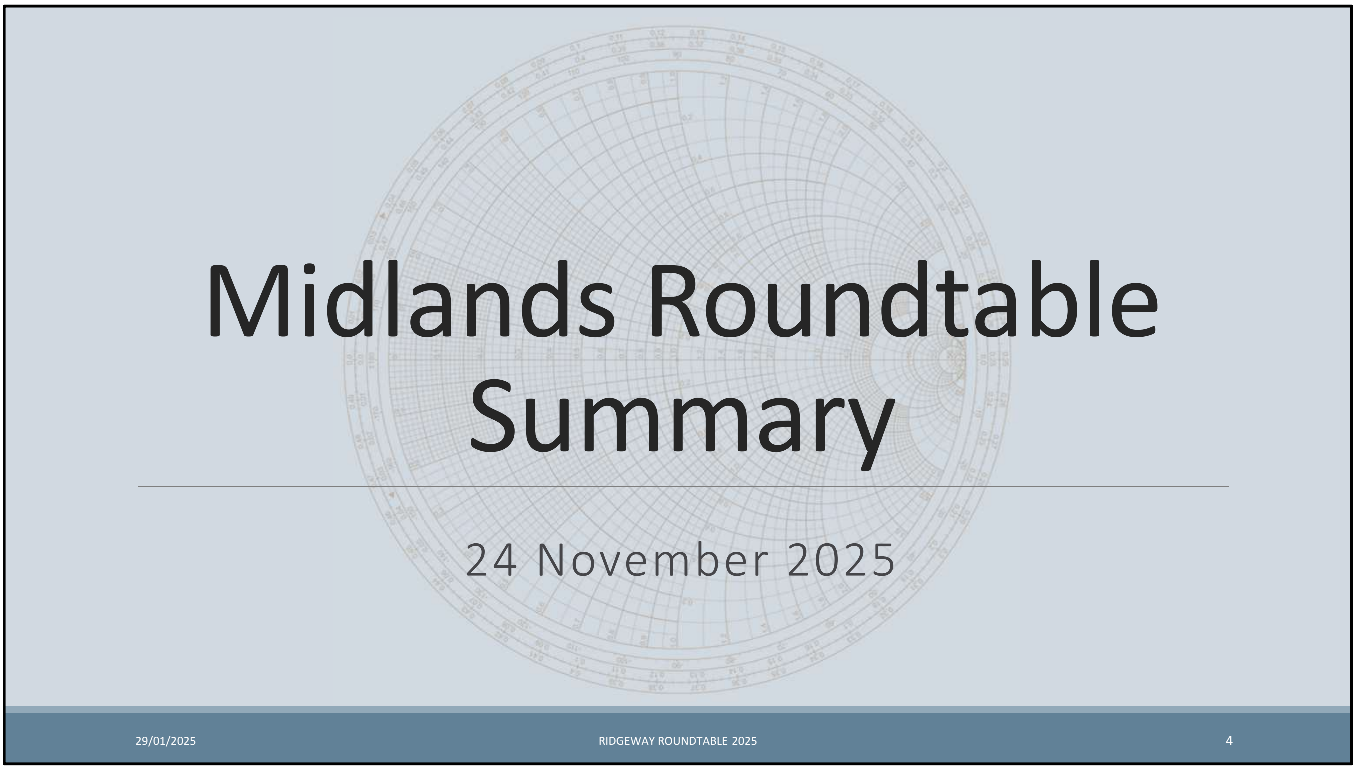
The topics we'd like to cover today are:

A quick summary of the Midlands presentation given in November last year

Update on our trials this month

On to a select few of the many Rabbit Holes we went down during the project so far

And then finally a Demonstration of JT4 on 122GHz



This is going to be a quick summary of the Midlands Roundtable presentation last year and the current Scatterpoint articles as a background to what we've been doing and where we are

Friis Equation

HORN ANTENNA TO HORN ANTENNA

The first part of our presentation covered the Friis transmission equation and the sources of data we used in the equation to generate a plot of predicted maximum ranges for different atmospheric absorption values.

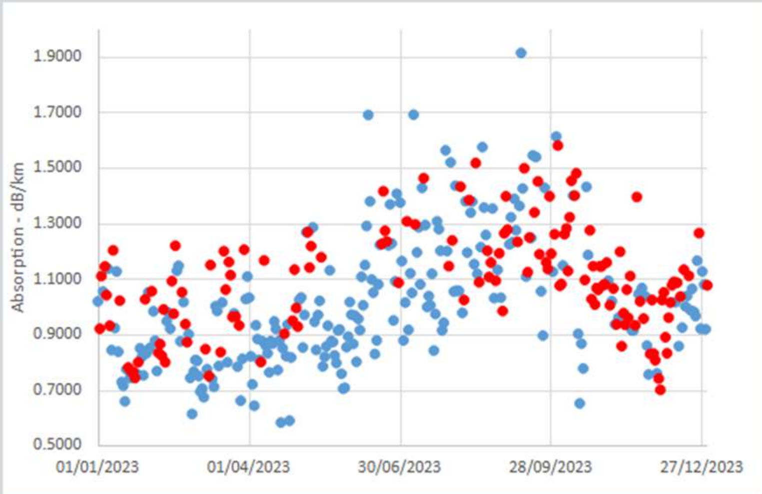
AAC Middle Wallop

Absorption @ 122 GHz (dB/km)

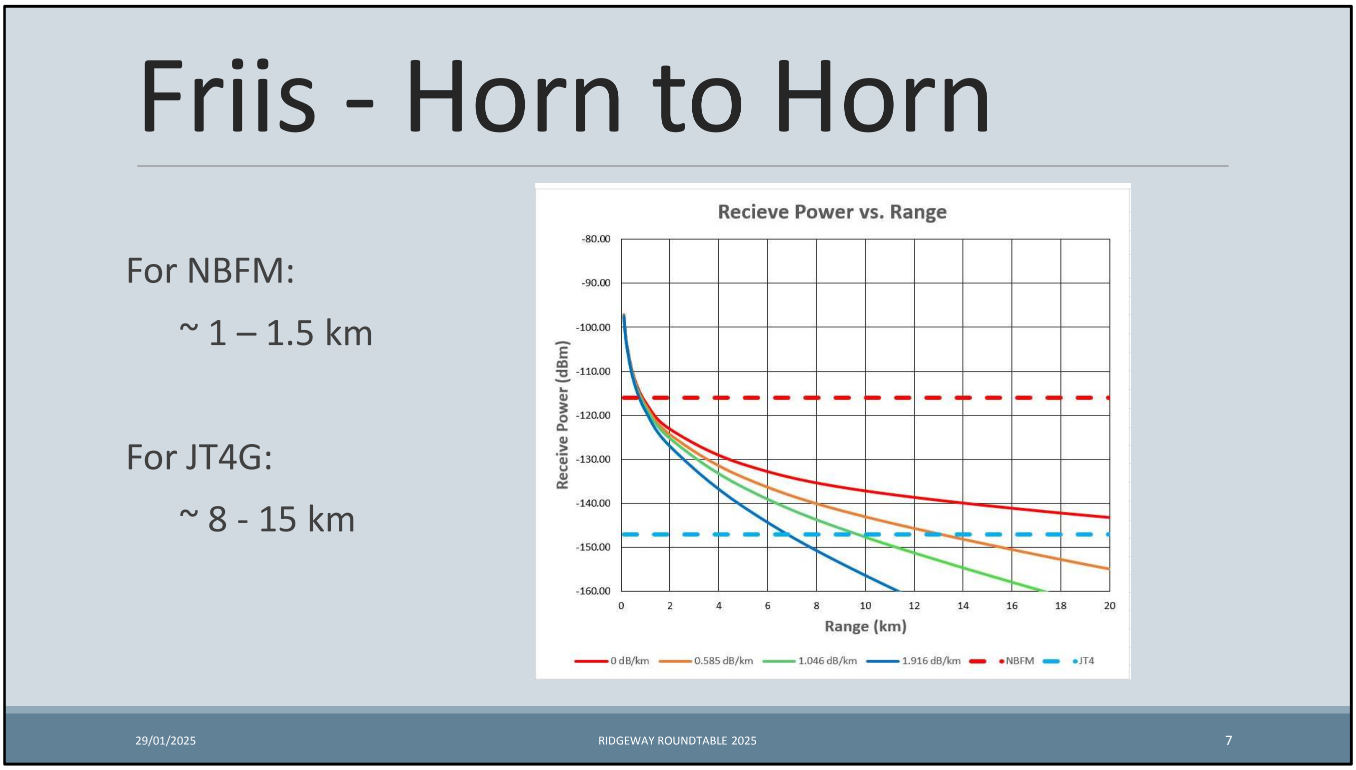
Min	0.585 dB/km
Mean	1.046 dB/km
Median	1.027 dB/km
Max	1.916 dB/km

RED – “Dry” days

BLUE – “Wet” Days



Here are the noon values for atmospheric absorption determined by analysing the daily weather reports from Middle Wallop airfield for the full year 2023



So here's the final plot we derived, now with corrected plot labels – which were wrong in the presentation and in the first part of the Scatterpoint series. The corrected plots were published in the last Scatterpoint – my apologies if they caused any confusion.

The plot shows the expected receive power for a VK3CV link using the reference horns as antennas. It shows receive power in dBm vs range; the red trace is the straightforward Friis prediction, the orange, green and blue traces show the effects of atmospheric absorption, 1.916 dB/km, 1.056 dB/m and 0.585 dB/km respectively. These are the maximum, median and minimum values determined from the daily Middle Wallop met data for 2023.

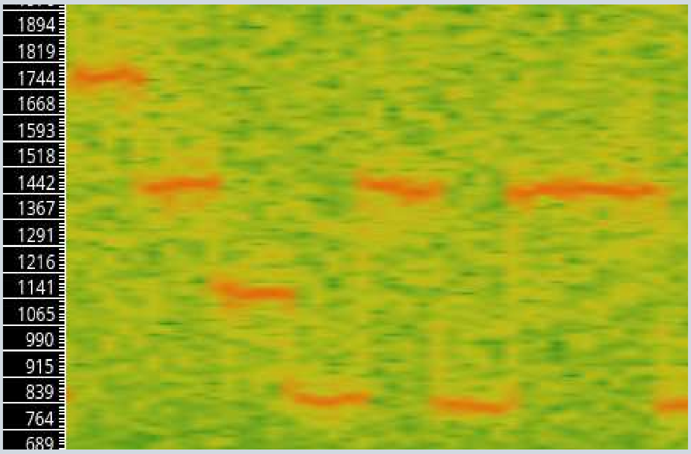
The horizontal limit lines show the predicted minimum detection limits for NBFM in red and JT4G in blue.

We'll come back to this plot later in our trials update.

The next part of the presentation covered how we generate and decode JT4

And also how we generated but then failed to decode JT9

Stepping the Reference



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So we generate JT by using the “JT4Code” console utility, to generate a string of tone numbers, which we convert into DAC values and use the DAC to micro-step our 10 MHz system reference OCXO so generating FSK. The PLL on the VK3CV board tracks the changes in reference and produces FSK with the required tone spacing. For JT4 the OCXO steps between tones by ~ 26 mHz this is multiplied by 12,240 from 10 MHz to 122.4 GHz so giving a tone step of 315 Hz at the output frequency.

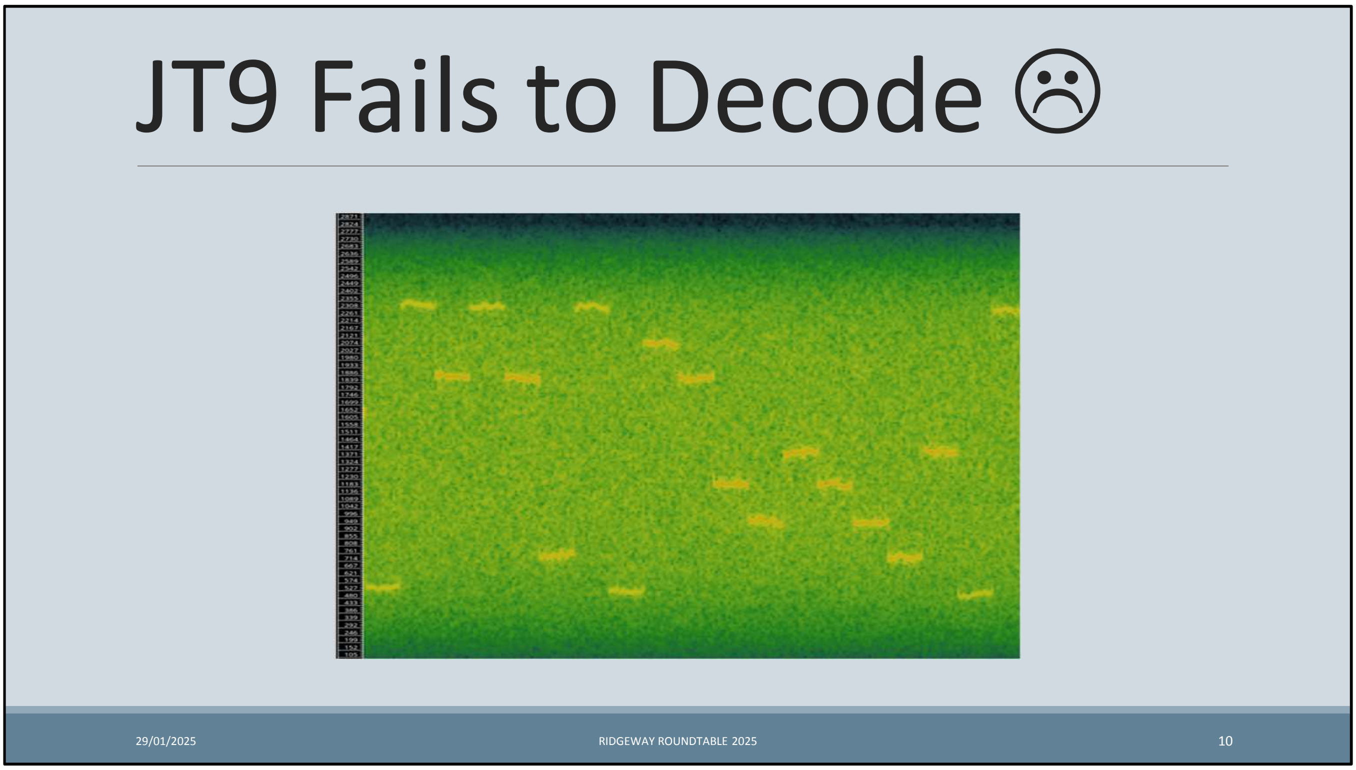
For JT9 the OCXO step between tones is 18 mHz giving a tone step of 222 Hz at the output frequency

We receive the JT using a FUNcube dongle – more on this later – which gives us digital data for a software defined radio utilising GNU radio. We demodulate the received signal with a USB detector to generate a stream of audio at 11025 Hz which we store as a .WAV file

The slides show the received audio transmitted across a short range. They plot frequency vs time with tone zero being about 800 Hz.

We continuously store these files which are 60 seconds long and time aligned to the top of the minute. We use GPS to achieve time synchronisation for the two ends of the link.

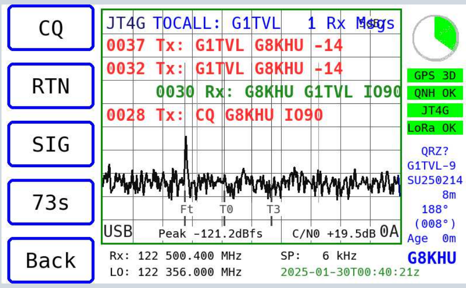
Immediately a .WAV file has been stored it is passed to the “JT9” console utility which decodes any message it finds. If it gets a successful decode it presents the result on the screen and adds it to the message log file.

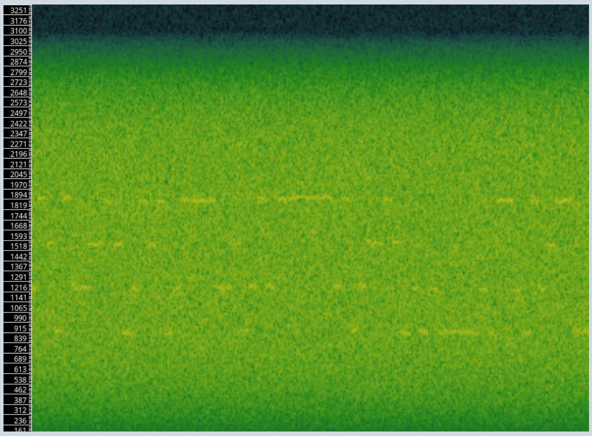


We have also tried using JT9 in mode JT9H with 222 Hz tone spacing. Again the tones are distinct
This encoded and received without issue but the received signal would not decode using the JT9 command line utility in our Raspberry Pi implementation.
Transferring the saved .WAV file to the same utility running on a PC resulted in a successful decode.

Searching the WSJT forums revealed this to be previously reported behaviour – both for the Pi and some other ARM based systems.
It appears the JT9 code has some issues when compiled for these ARM cores.
Due to this decoder behaviour we have, to date, not been able to fully trial JT9 in the field.

So does JT4 Sometimes





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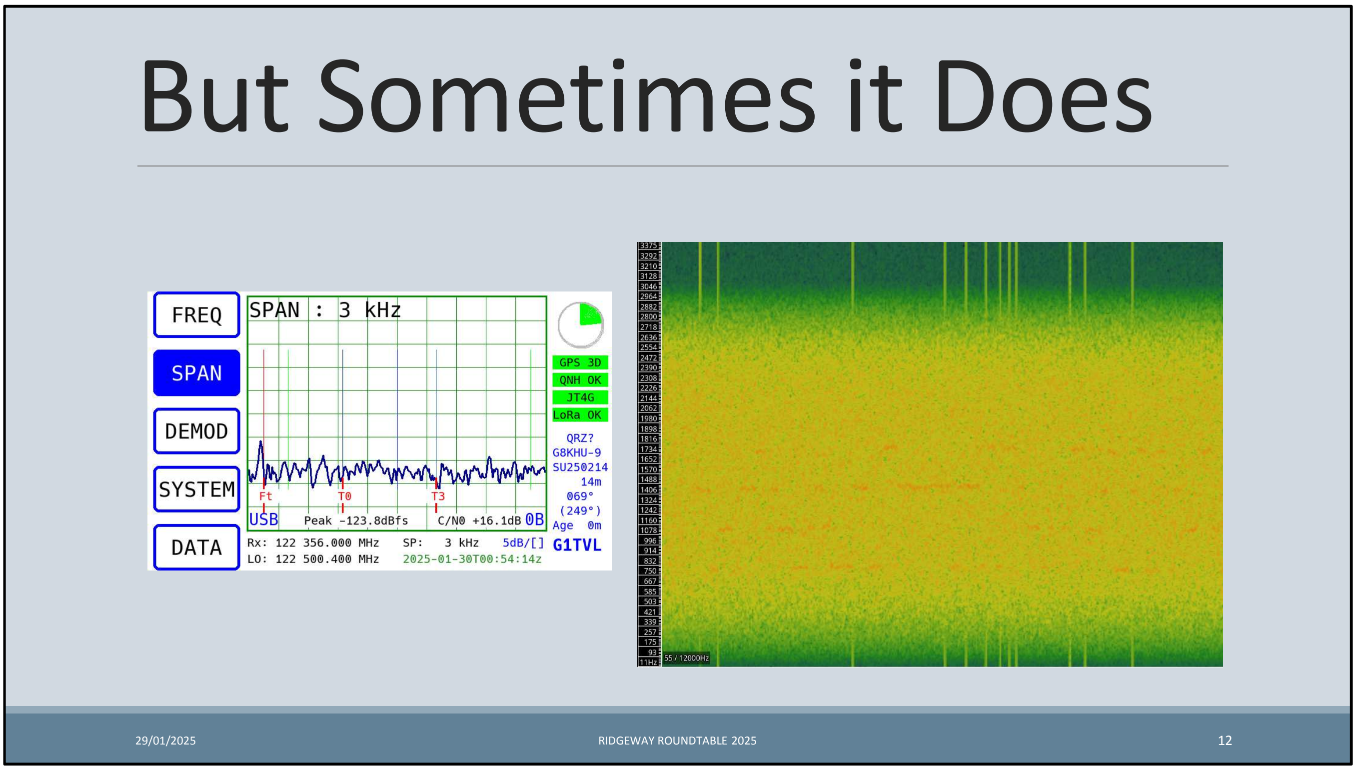
We know that the JT9 decoder can work well but sometimes we get signals that fail to decode – yet by eye they look reasonable

Here’s an example – it’s 5 to 6 dB above the detection threshold, looks clean, and fails to decode

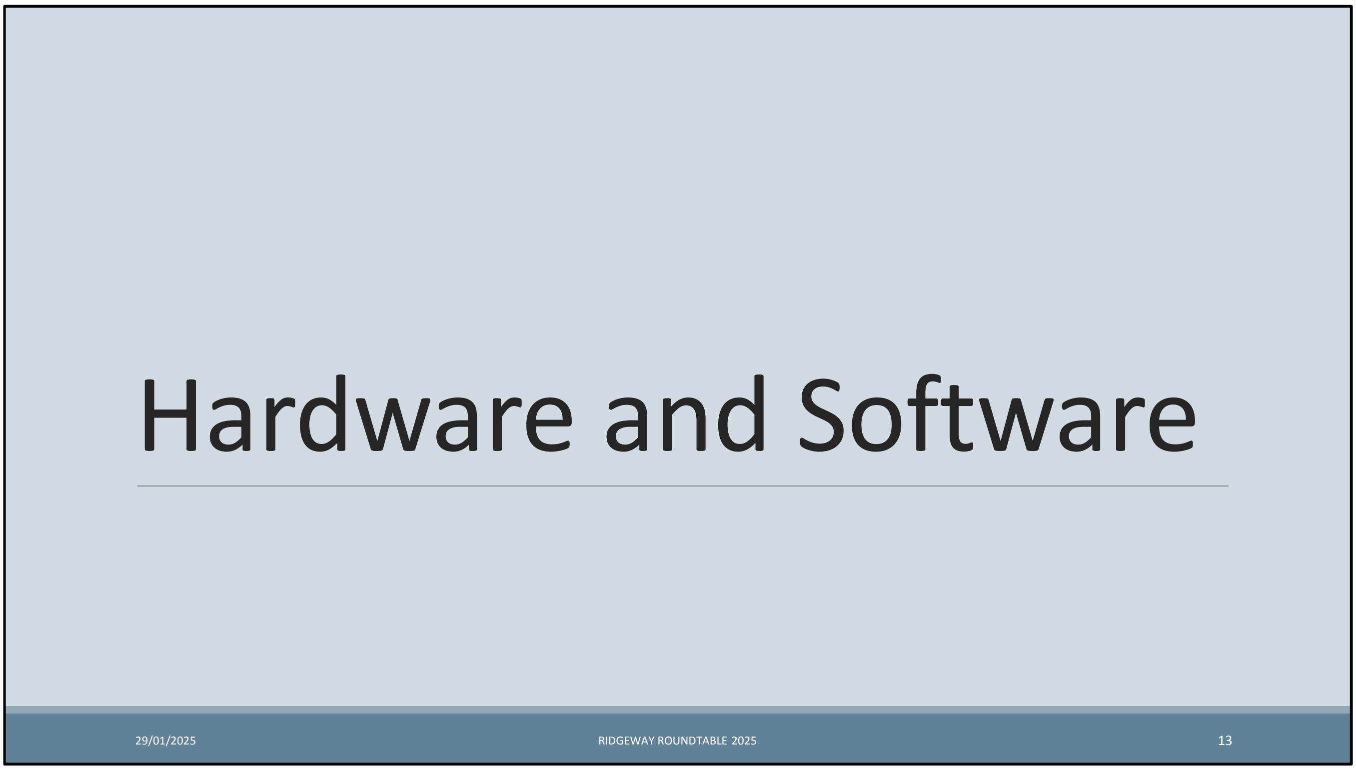


Compare the previous slide with this one

It looks revolting, its full of spikes (unknown) and its only a dB or so above the detection threshold

And yet it decodes ???

If anyone has any ideas or insight into this then we would love to talk with you in the wrap-up or afterwards, we’re here all day PLEASE DON’T BE SHY !



This will be a very superficial overview of the hardware and software as a more detailed description is currently being published in Scatterpoint. I aim to just give sufficient of an overview to be the foundation for the demonstration.

Hardware - RF Head

A VK3 board with Horn antenna mounted in a die-cast box

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The RF head is simply the VK3CV board and horn mounted in a diecast box

This connects to the main unit via an umbilical which carries the discrete power and data signals and also has 4 coax interconnects for Reference, IF, GPS and Tx Audio

Hardware – Main Unit

Joins to the RF Head via an umbilical

Mounted on a tripod leg for convenience

Sparse Controls

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The main unit is joined to the RF Head with an umbilical

It is mounted on one of the tripod legs for convenience

It has sparse controls, comprising:

a multipurpose tuning/selector encoder,

a fast/slow button for the encoder,

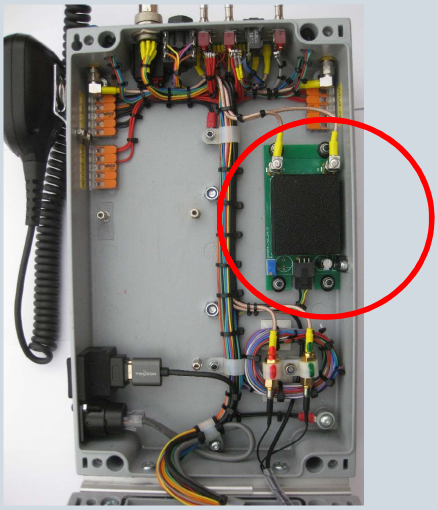
the volume control and

5 soft-keys with indicator LEDs to the left of the display

Main Unit - Base

This is the base section of the main unit

The Reference board is centre right



Looking inside the main unit base the main part of interest is the OCXO board, the OCXO is inside the 3D printed shield to prevent it being affected by air currents with the main unit – the OCXO only being a single ovened unit

The network and HDMI connections are top right and on each side at the bottom are 5 way Wago connectors for the Power Switched 12V supply (we can highly recommend these if you make a unit and are thinking ahead to future expansion)

The main switch powers the Reference board and RF head. It also routes to the Standby/On switch which powers the remainder of the system

The remainder is just wiring to the top panel umbilical and the panel switches and indicators

Main Unit - Lid

This is the lid section of the main unit

FUNcube SDR dongle

GPS Receiver

LoRa Transceiver

Raspberry Pi Compute 4 module

Environment Sensor

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This is the main PCB mounted on the underside of the lid

The FUNcube dongle is the SDR which receives the receive IF signal from the Head Unit

The GPS receiver gives us time and position information

LoRa is used to pass data between both ends of the link for path calculations

The Compute 4 module is the system processor

And the environment sensor gives us local weather data

Raspberry Pi Compute 4

Raspberry Pi Pi Pico CM4 CM4 Underside

For those not familiar with the Compute module it is a very compact version of the normal Raspberry Pi 4 board intended for embedded industrial use

For size comparison purposes there is a standard Raspberry Pi (in this case a model B) on the left, with a Pi Pico to its right and then the CM4 to the right of the Pico

The downside of the CM4 is the two fiddly connectors – shown far right. These are both 100 Pin connectors with a 0.4 mm lead pitch

On to the second part of the presentation, our trials in January this year

The Forecast was Good …

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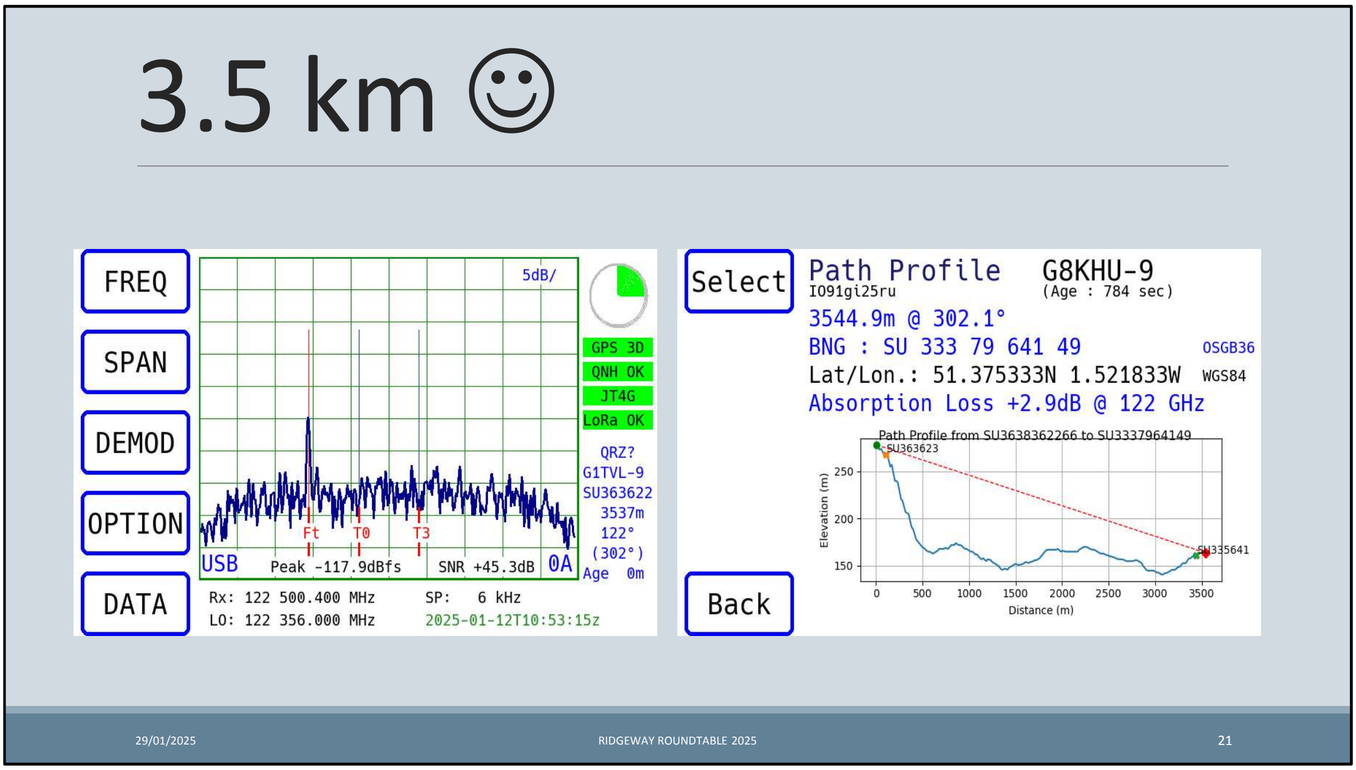
The Forecast was Good, so

On the 12th January we went out to do some trials on paths from Combe Gibbet north towards Hungerford

We repeated some of our previously accomplished paths and established that signals were well up on those previous contacts

En-route we managed a new path – within our previous dx but still new to us – as a farm gate was open

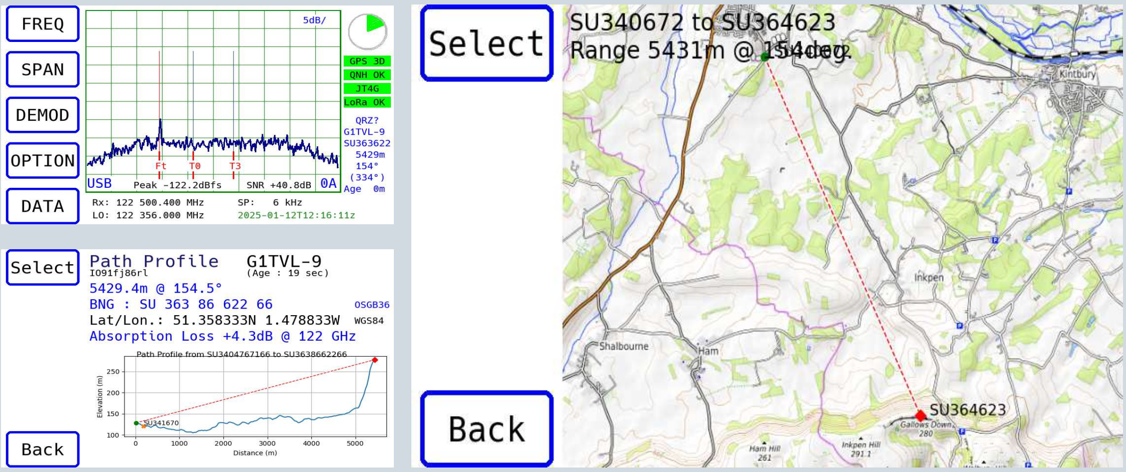
As the farmer was on site a quick chat gave us permission to go onto his land for another QSO



Our previous trials had halted at 3.5 km – we could just about make out signals but they were below the detection threshold

On this trial signals were well up and a successful QSO resulted with signal levels 6dB plus over the detection threshold

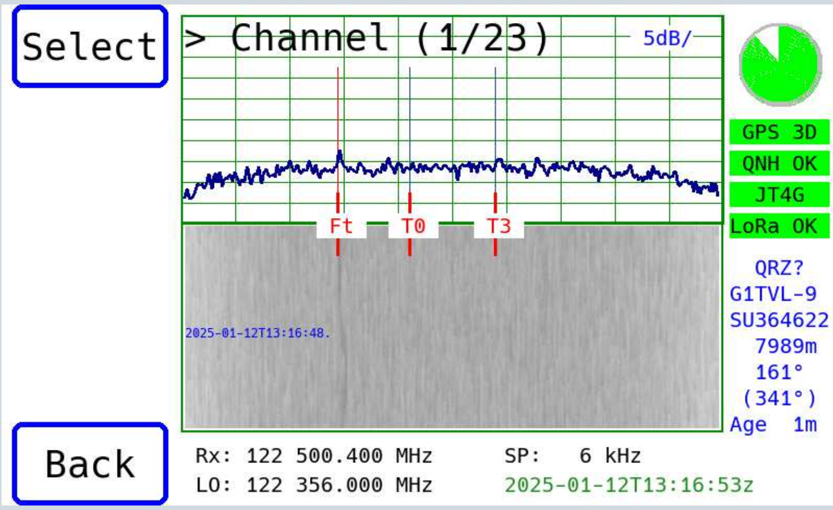
5.4 km ☺ ☺



We then moved on to the next path we had identified at 5.4 km

Good signals were seen at 2-3 dB above the detection threshold and a successful QSO resulted

7.9 km ☹



We then moved on to two longer paths

Due to roadworks and diversions I had to drive past the longer of these paths on my way to the shorter

After a quick call on the talkback channel we decided to see what would happen at this site

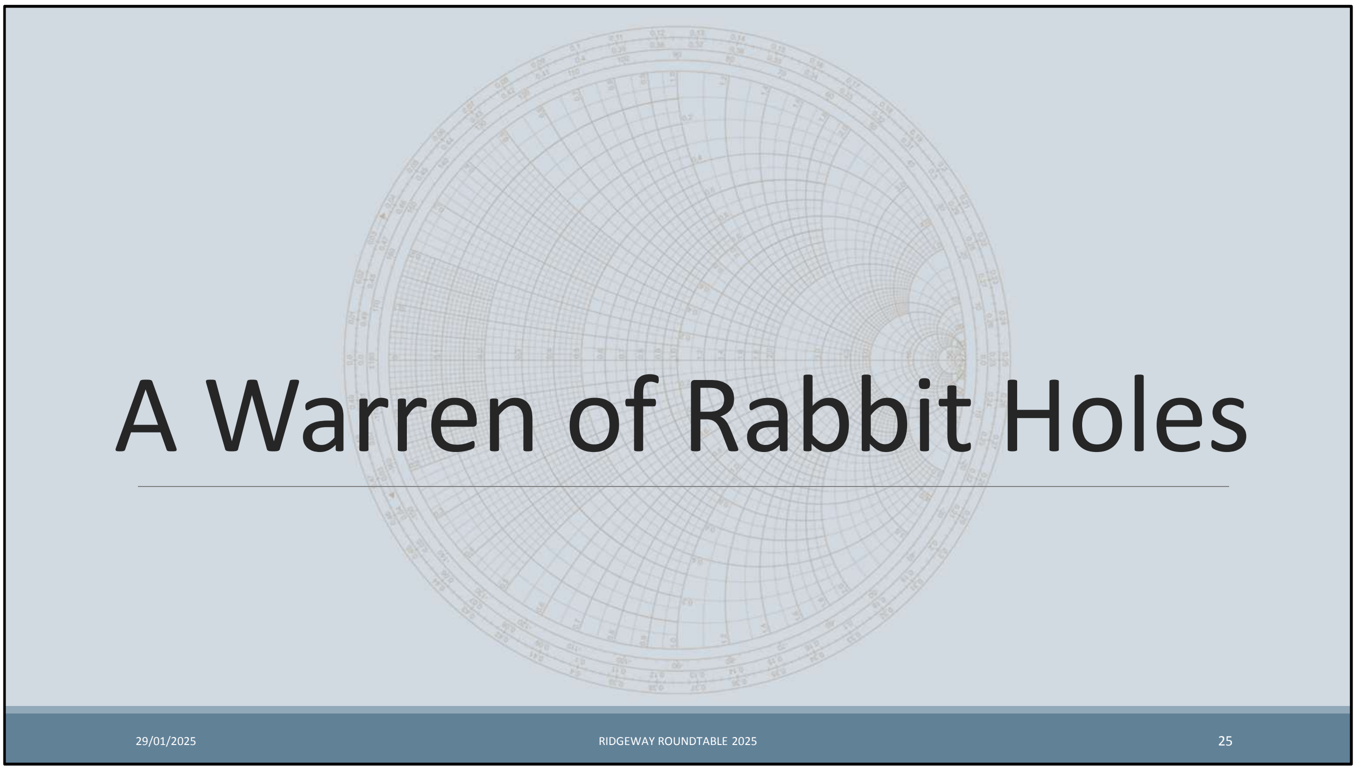
Signals were hovering right at the detection level, QSB wasn't so bad so we persisted but after awhile conclude the path wasn't going to go and relocacted to try the shorter path at 6.8 km

By this time it was late afternoon and as soon as we were aligned we could see that condition were deteriorating and the QSB was now very significant with 6 dB plus fades

In hindsight if we'd tried this path first it may have succeeded

20/20 hindsight is a wonderful thing

- FRIIS !!!



And now onto some of the rabbit holes we’ve been down in our journey so far

Towards Lighter Power

Replacing Lead Acid with Lithium Ion

It was obvious from initial FM trials with the basic VK3CV setup that we needed a set short range paths with reasonable range granularity.

It was equally obvious that we weren't going to find these paths if we constrained ourselves to simply driving to each end point and operating from beside the car.

We were going to have to carry the kit so one of the things to be addressed was weight.

Lead Acid

- Gel Alarm Battery
- Fairly Cheap
- 12 Volts Terminal Voltage
- 7 Amp Hour Rating
- 84 Watt Hours Capacity
- Weighs 2.2 kg
- Energy Density 38 WHrs / kg

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A car battery is an immediate solution to needing power – but it's far too heavy

Given the range we're operating over a simple handy will suffice for talkback so we only need power for the 122 GHz system.

As the current draw is only an Amp or so, the standard 7 Amp Hour alarm panel Gel Lead Acid battery was our first port of call.

It's smaller and much lighter than a car battery and gives 84 Watt hours capacity – more than enough for a days operation

Energy Density 38 Watt Hours / kilogram

Its not ruggedized though and has exposed spade terminals so ideally needs a housing that doesn't add to much weight or increase the bulk unduly

Lead Acid Packaged

- 12 Volt
- Typical 1.4 A
  (@ C/2)
- 84 Watt Hours
- 2.6 kg
- 32 WHrs / kg

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Plastic ammo boxes are readily available online in a variety of sizes

Very rugged and acid proof (at least short term),

Not too heavy

Convenient carrying handle

Scope for Power Pole connectors.

Best fit was good for length and width but a bit tall – getting bulky

Weight is now 2.6 kilograms

Decreased Energy Density – now 32 Watt Hours / Gram

Storage Space

We can use the extra height as storage so not all bad

We used this solution for quite some time – but it wasn't quite right

Lithium Ion

- Available as Power Tool Battery
- Medium Cost
- 18 Volts Terminal Voltage
- 5 Amp Hour Rating
- 90 Watt Hours Capacity
- Weighs 0.6 kilograms
- Energy Density 150 Watt Hours / kilogram

Lithium Ion is a more attractive solution compared with Lead Acid

Lighter and better energy density

Price is over double that of lead acid

More stringent charging requirements

BUT

Readily available as portable power tool batteries complete with dedicated chargers

Rugged packaging – intended for construction sites

SIGNIFICANTLY EASIER TO JUSTIFY TO SENIOR MANAGEMENT !!

Lithium Ion + Converter

- 13.6 Volt
- 3.5 Amp
- 80 - 85 WHrs
  (inc DC/DC)
- Weighs 0.75 kilograms
- Energy Density 113 Whrs / kg

Add packaged DC/DC converter- 90% + efficiency

Add Power Poles

Two piece 3D printed case sandwiching PCB

De-Walt and Milwaukee batteries have same terminal pitch so only change one 3D printed part

Better size weight – far better for rucksack carriage

Factor of 3 improvement in energy density

Easily mounts to tripod

Comparison

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You pays your money, you takes your choice, … and you have to carry it

Note the cunning use of the "Estate Agents" camera here

Adding Antenna Gain

Some Experiments with Cassegrain Reflectors

Although we were primarily interested in short range systems we were intrigued with the possibilities of dish operation

We did however set ourselves two significant constraints

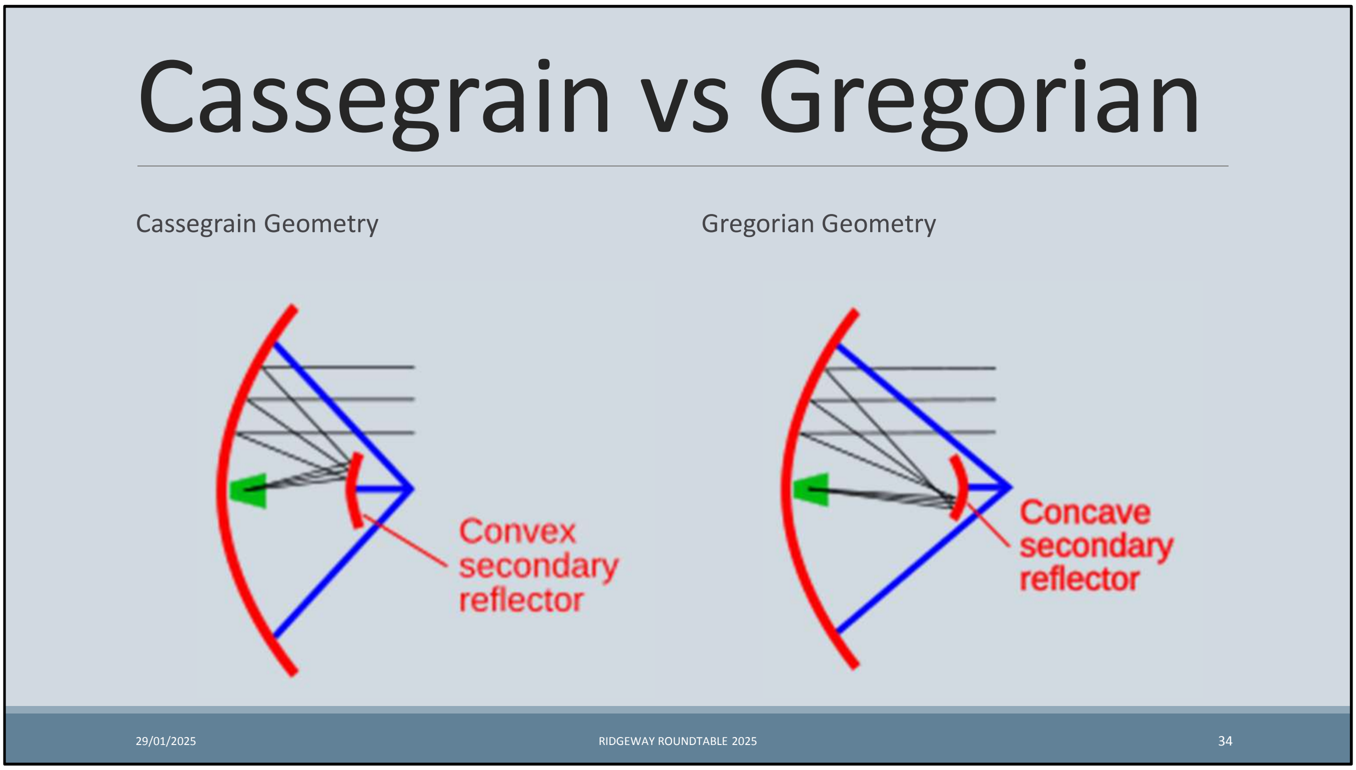
– any solution must be a simple add-on to the system and not required rework, this meant we were constrained using to the VK3CV horn as feed

- the dish should be easily transported on foot, this limits size - something of the order of 30 cm suited our purpose

We were also constrained by available dishes ie whatever popped up on eBay

Some new old stock dishes were advertised on eBay at a reasonable price and we purchased some – they turned out to be 25 cm diameter with an f/d ratio of 0.25

A Cassegrain or Gregorian configuration looked well worth pursuing



The Cassegrain and Gregorian antennas are closely related - both comprise a feed, a reflector and a dish.

In the Cassegrain case a convex reflector is placed between the feed and the focal point of the dish, conversely the Gregorian geometry has a concave reflector placed beyond the dish's focal point

One of the simplest geometries for a curved dish is parabolic and a quick set of measurements showed that the dishes we had acquired were indeed parabolic

We decided that we preferred the Cassegrain configuration, the Cassegrain is more compact than it's Gregorian counterpoint and a convex reflector would probably be easier to fabricate than a convex one

So how to calculate the geometry of the reflector ?

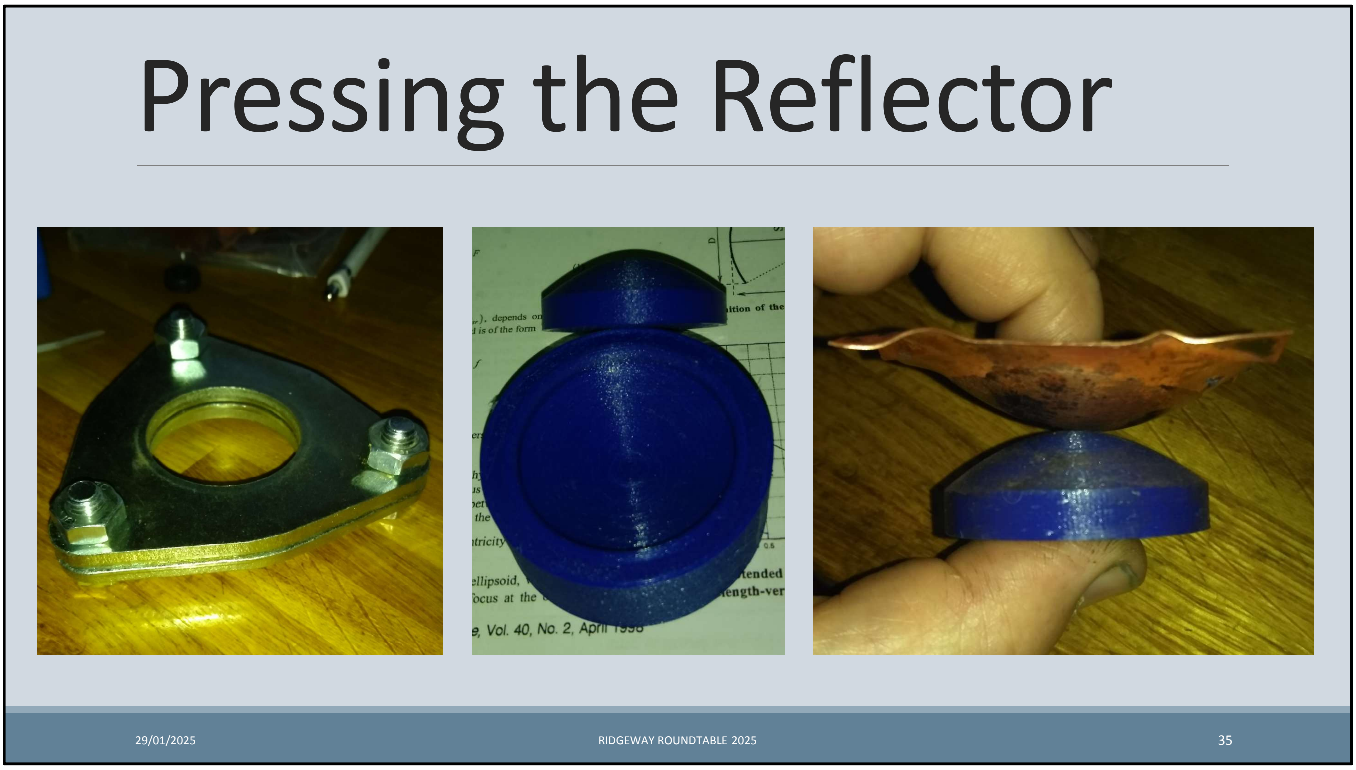
The only spreadsheet plus explanation we found on the internet that we truly trusted the provenance of was by Paul Wade W1GHZ

However using his spreadsheet would throw up errors without explanation.

We decided to see what was available in academia and found two papers by Christophe Granet in 1997 and 1998 and one by Hannan from 1961 which were very useful

Granet’s analysis was based on simple ray-tracing geometry and enabled the foci of the hyperbolic Cassegrain and elliptical Gregorian reflectors from the parameters of the parabolic dish and feed half-angle

We used his method to calculate the parameters of our reflectors



Having calculated the required reflector geometry how were we to manufacture it ?

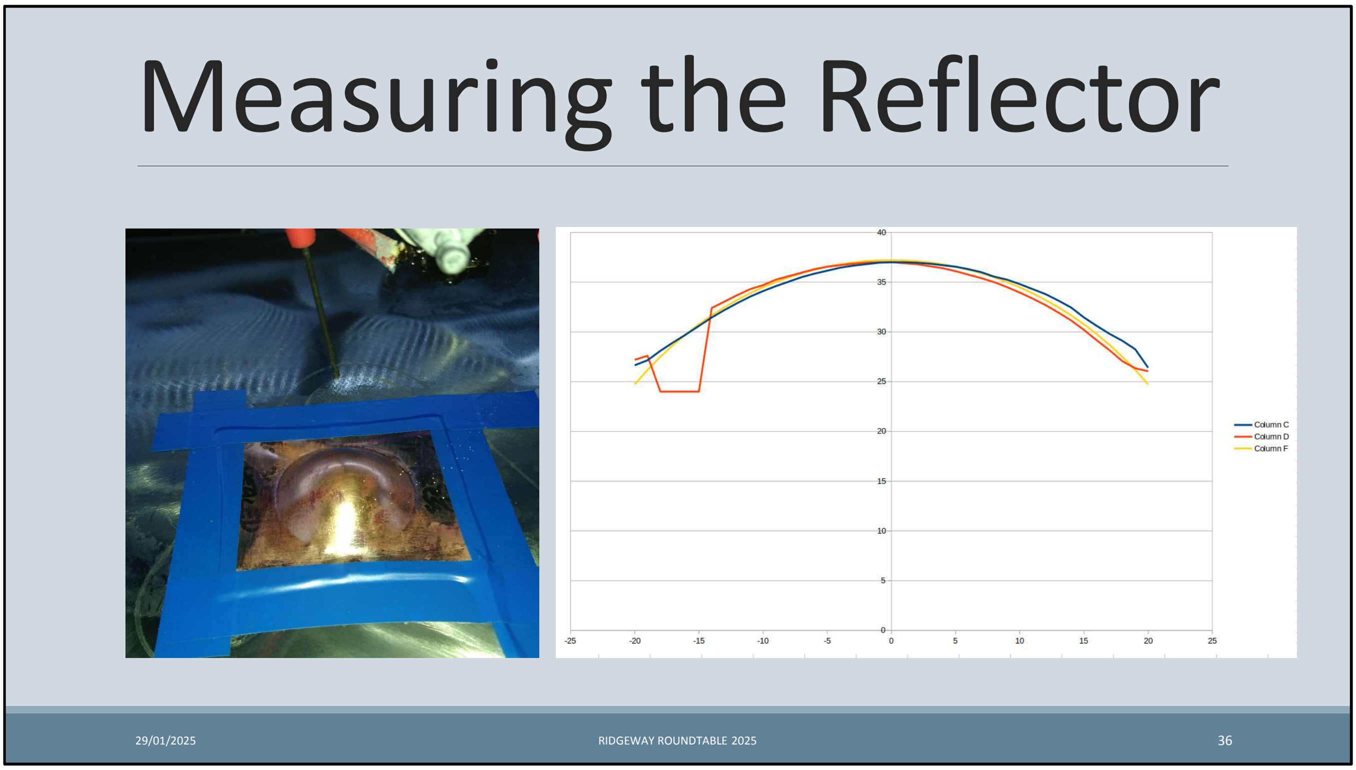
Some quick trials with kitchen foil on a bowl had very limited success, the foil was far, far better at tearing than stretching and deforming.

We then tried pressing the reflector out of annealed thin sheet copper using a 3D printed male and female dies in a workshop press. This was successful at producing shallow reflectors.

The 3D printed dies held up surprisingly well, without undue wear or deformation but the major problem was clamping the sheet so that the material was not pulled into the die as the process proceeded.

For deeper reflectors we didn’t manage to clamp successfully against the pressure of the press and this resulted in wrinkles on the periphery of the finished part.

On the left is the clamp, in the centre the male and female dies and on the right an early result



We measured the surface curvature using the 3D printer with a simple contact probe instead of the extruding head

This showed that in the main the forming had been quite accurate but there were some wrinkles – see the blue curve at the right

The step on the left is not real , possibly a patch of scale or heavy oxidation preventing prevented probe contact

Our next attempt was CNC milling out of aluminium. Ideally this would be done on a 5 or 6 axis mill, but we achieved quite reasonable surface results on a 3 axis mill using a ball cutter

This produced promising results across the garden with the dish at the receive end of the path with the received IF feeding a spectrum analyser, the source at the bottom of the garden being a microwave signal generator feeding a diode / WD40 can multiplier

Testing the Reflector

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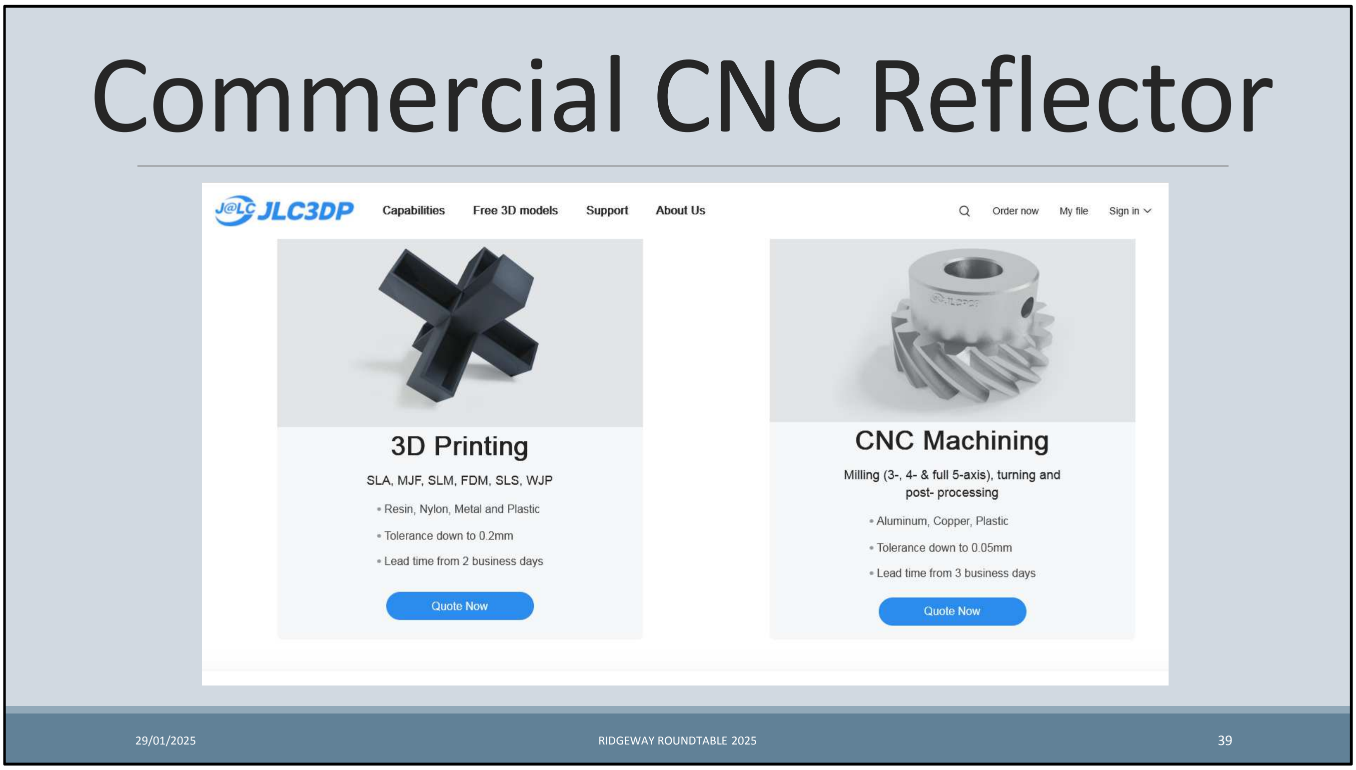
Focus was adjusted by simply mounting the reflector on a threaded mandrel running in a threaded mount fixed to the dish.

A few moments thought will reveal that this method is extraordinarily sensitive to the axis of symmetry of the reflector being perfectly aligned with the rotational axis of the mandrel

……. this thought only came to us after we discovered that we had re-invented mechanical conical-beam scanning …..

A few further attempts reduced the errors but not to completely acceptable levels

Testing was abruptly curtailed at this point as I put my back out carrying the heavy HP synthesiser down the garden



Prior to my back intervening though we had decided to get them milled professionally.

JLCPCB in China offer a CNC manufacturing service similar to their PCB offering. Their quote for 3 x 30mm reflectors was about £60 so we decided to try this

They offer a choice of surface finish, as machined, hand polished and bead blasted.

Hand polished sounded attractive - but expensive and as machined would involve sharp edges that would need hand finishing.

Bead blasting should remove sharp edges and burrs for minimal cost – we opted for this as finish.

Delivery happened in a couple of weeks as quoted and we eagerly opened the package ….

****

Consider this to be a dramatic pause while I remind you of the 60's / 70s when there was a fashion for beaten copper cooker hoods and chimney breasts, well …..

****

This what we found.

It may well be that this will polish out with some emery but this is afar as we got down this rabbit hole and we moved on to other things.

We do intend to pick it back up at some point in the future – preferably with a lighter signal source - but for the moment it remains a work in progress.

There have been quite a few reports and anecdote's of the RF Board PIC suddenly losing or corrupting the firmware

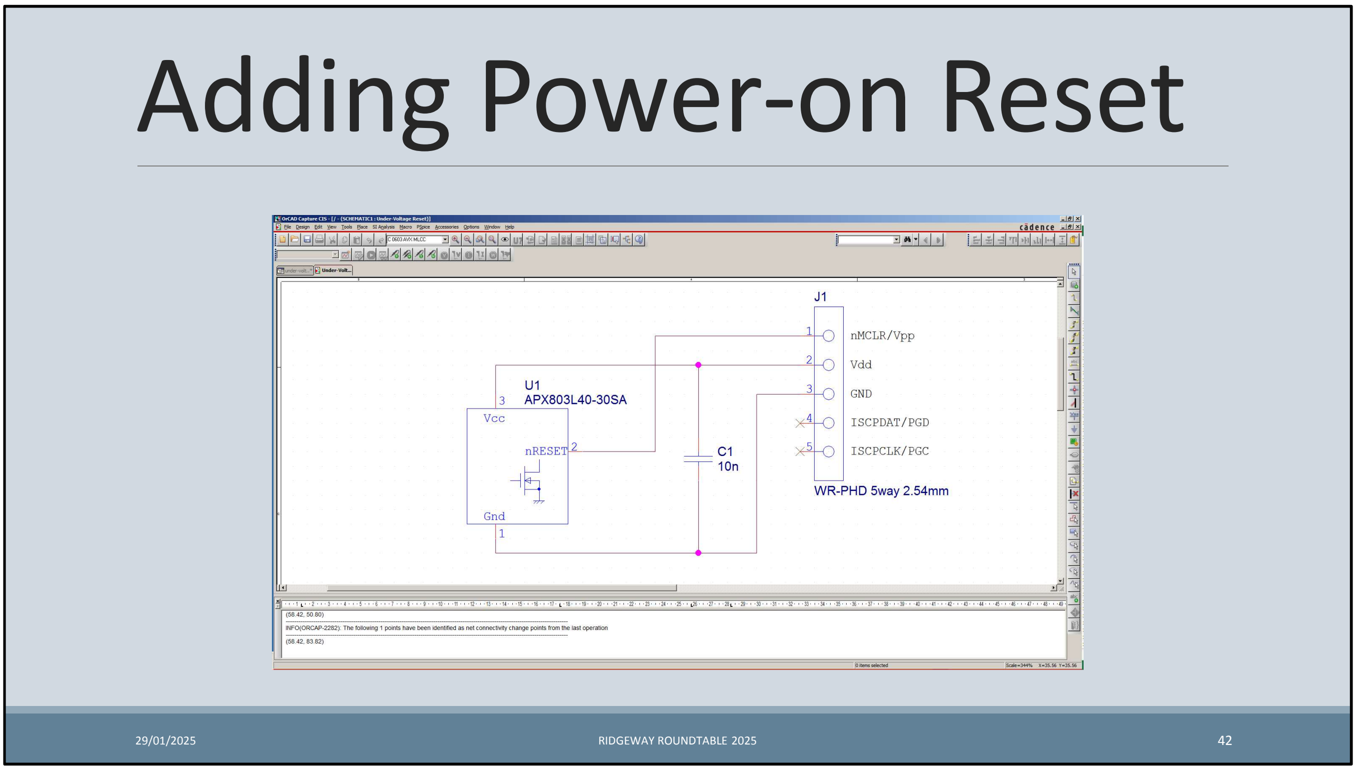
This is more prevalent after the board has been modified for an external reference

We had this problem once with the original board configuration with the TCXO, and then two or three times after modifying for use with an external reference

This self-destructive behaviour is not isolated to VK3 boards nor the PIC16LF 877 Andrew has used

We've experienced this behaviour with one of our commercial products that used PIC18F 87K22 This product shipped without problems for several years and then we suddenly experienced returns due to in service failure occurring within weeks of delivery. The cause of failure was corrupted firmware

One of my other hobbies is railway modelling. There is an active group applying electronics to layout control and automation – predominantly using a variety PIC16 series processors. Again a few years ago reports of PIC failures started to occur, and individual designers traced these failures to corrupt firmware



Our investigation showed that there were problems with fairly specific brownout behaviour – despite all brownout functions being enabled on the Silicon.

There were certain rates of supply decay and restoration that would reliably corrupt the firmware. We reported this to Microchip who were responsive but ultimately vague.

We found that adding a dedicated PoR device set 5% to 10% low in conjunction with gating the clock with the PoR was highly effective at preventing this behaviour – provided that the device also implemented a delay before releasing the Reset pin.

We hand fitted a suitable PoR device and gate to the returned boards to get them back in service ASAP while we re-span the PCB to incorporate the device.

Since replacing the failed units with this Issue of board we have had no reports of failure

The railway group independently came to the same conclusion about the problem and came with a rather good modification.

They found a PoR cured their problems, however all their designs use the PIC’s own oscillator so the Reset may also automatically stop the clock

As the ISP header has direct connections to the PIC supply, ground and Reset pins they made a simple PCB that had the PoR device plus a connector to plug directly on to the ISP header

Not only does this stop the firmware corruption but it means that the PoR device only experiences the normal operational voltage on the Reset O/P

As it is temporarily removed when attaching the programmer it never experiences the high voltages applied to the reset pin required by certain programming modes

Our version doesn't stop the clock so we'll see if just the PoR works

It's not exactly rocket science is it ?

The BoM cost is around £1 for the components and the PCB

We're currently waiting for the Chinese New Year holiday backlog at JLCPCB to clear before submitting our version for production - So this too is work in progress.

We'll also see if this cures the won't boot if the clock is applied prior to Vcc problem

We think it may well, the VK3CV pic is not rated for 10 MHz operation until it has in excess of 3V Vcc. If the reference is applied before power it rectifies in the PIC input ESD diodes and biases the chip to around 2V – your mileage will probably vary.

The PIC will be out of reset but with a suspect clock and probably does not execute the code from the start when the correct Vcc is applied

If it does work as we anticipate then we'll offer as a kit at cost if there is interest, and happily distribute documentation and gerbers

Spectral Purity

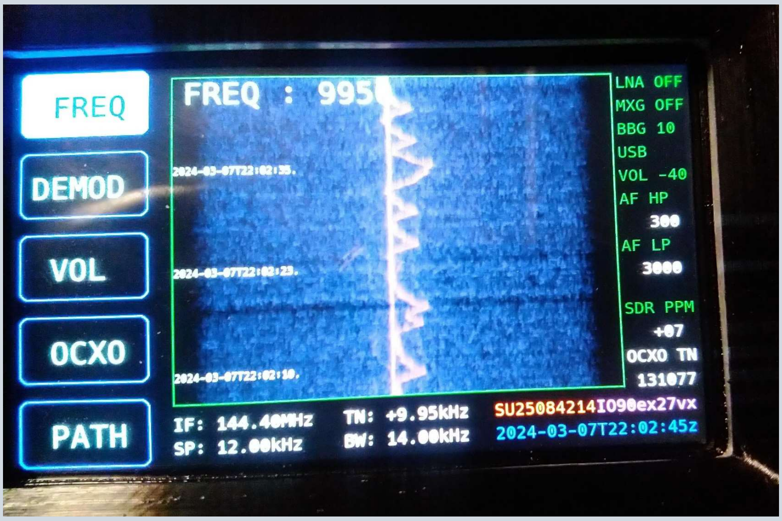
Phase Noise and Frequency Jitter

In our initial experiences with the VK3 board in FM mode and using the original GPS disciplined TCXO it was very apparent that we needed to pay attention to frequency stability

The original unit used GPS to correct the frequency of the TCXO on a regular basis, it did not provide a continuous lock

Many operators found that it was best to operate with the GPS disabled after initially allowing GPS to steer the TCXO to the nominal frequency

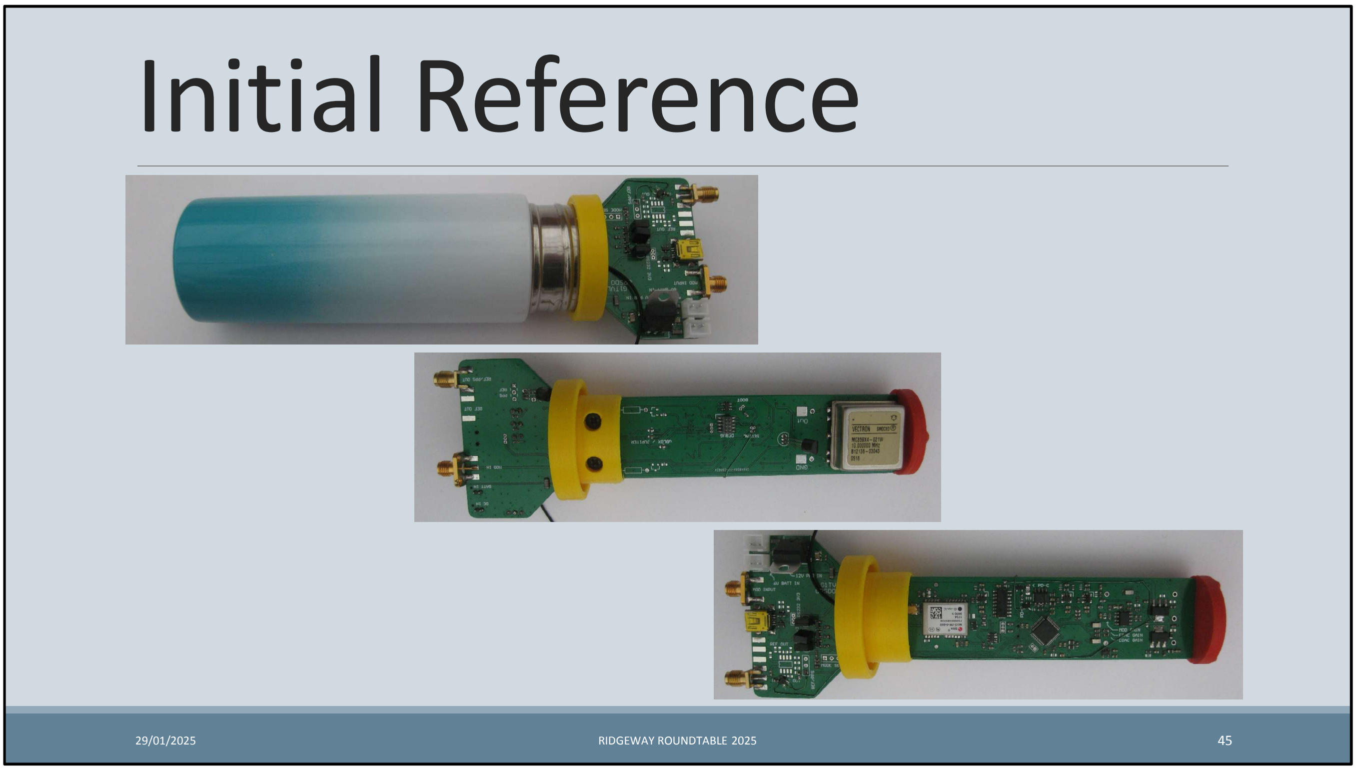
The Original TCXO



Even so the there was a large frequency wander as can be seen in this slide where one end of the link is locked to a high stability source with the other using the TCXO

The span is 12 kHz across the waterfall and the vertical time span is XXX seconds so the TCXO is wandering by up to a kHz short term

We resolved to use an external reference and looked to a GPS disciplined OCXO.



As we were already interested in JT4 we decided that our reference should be compatible with the WSJT-X software

Our initial external reference presented itself as a USB soundcard to the PC, The output of the soundcard was fed to what was effectively a tone decoder to produce tone numbers

These were converted to DAC codes.

The GPS disciplining loop provided its output in the form of a DAC code

The two DAC codes were summed and the DAC output applied to the Tune line of the OCXO

What it lacked in elegance it made up for in performance

The OCXO was chosen simply on the grounds we had a number salvaged from military radios

Early experience showed that their short term thermal stability performance wasn't the best – putting a finger on the can or wafting with a fan produced significant frequency variations

We decided that we'd approximate a double oven by using a closed thermal environment heated above ambient

A small metal vacuum flask fitted the bill for the environment and this is shown on the slide

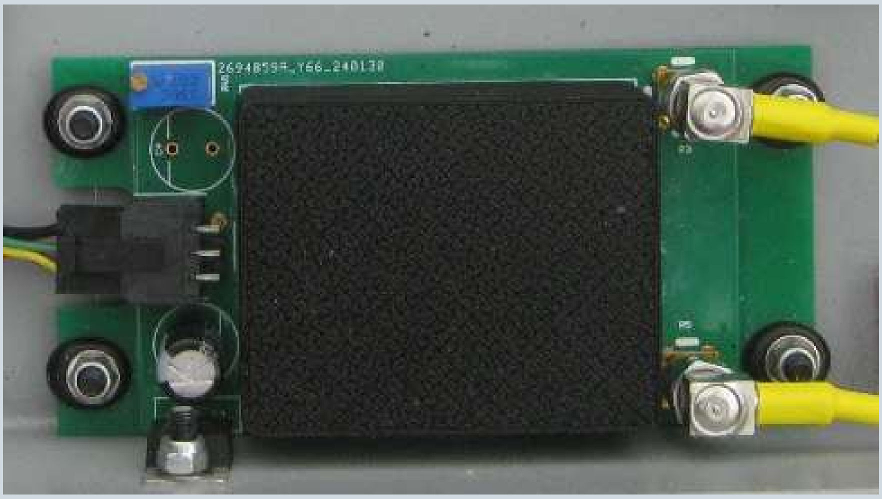
The board mounts in the vacuum flask and is loosely sealed by a 3D printed bung

A temperature sensor inside the flask controls a power transistor (used as a heating element) in a feedback loop to maintain a constant temperature

This is scaled so it supplements rather than fights the heating due to the OCXO

Altogether it worked rather well, but it was big

Moving On



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It was around this point that we came to the conclusion that our proposed system was getting unwieldy and we were failing to come up with suitable short range paths that could be worked vehicle to vehicle

This meant one or both of us would be walking to a site and we really needed to consolidate the desired functionality into a smaller system with less parts and cables

We decided to remove the 2 metre transceiver IF from the system by integrating that functionality into an SDR based on a FUNcube.

This gave us a view of 192 kHz and we reasoned that we didn't need the frequency accuracy afforded by GPS

Our experience showed that day to day stability of the non GPS locked OCXO was ample for our needs – we were never more than a couple of kHz off frequency

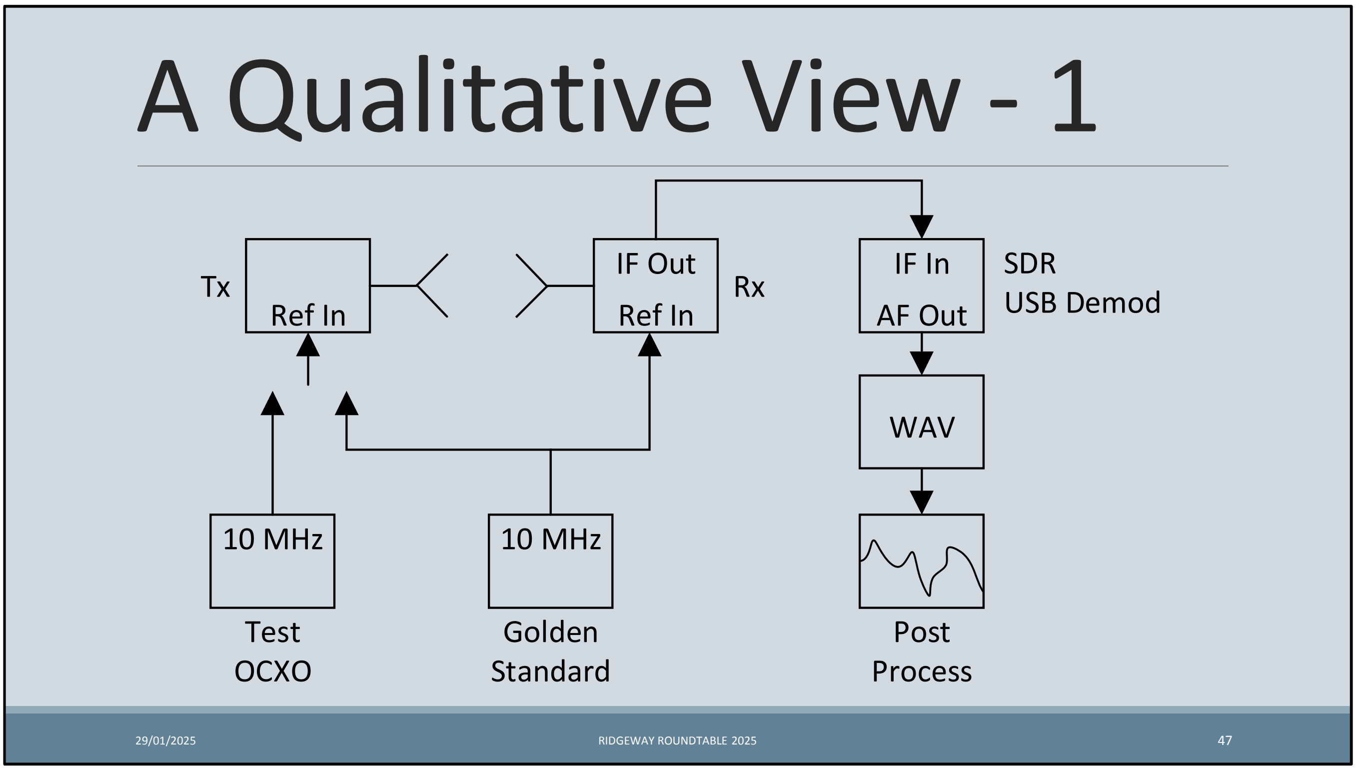
(Bear in mind though that this is short range so the ambient temperature and wind will be similar at each end of the path)

We therefore parked the initial OCXO and made a much simpler OCXO board with a 3D printed cover, no double oven heating. And no GPS locking

With this inside a nominally sealed die-cast box we reasoned that we would always be close enough to each other to be able to see each others carrier – and we have found this to be the case in practice

All was really promising in our trails in August but when we went out in December the performance dropped

As part of our investigation into this we looked at optimising the phase noise and frequency jitter of the OCXO so we purchased various types of ex equipment OCXOs from eBay



Obtaining the phase noise of a 122 GHz source directly was not an option,

But we could certainly get a qualitative comparison of the system in a link by evaluating the SSB demodulated frequency of a carrier by offset tuning

We had a known very high stability and low phase noise 10 MHz source manufactured by HP – what it came out of we don't know unfortunately

It's the size of a house brick and doe not have an electronic tuning input

However it looked to be significantly cleaner and more stable than any of the OCXOs we acquired so we used this as the golden standard

We test this across the room – so strong signals and a stable temperature for the tests

At the Tx end the reference is either the HP OCXO or the oscillator under test. At the Rx end the reference is the HP OCXO.

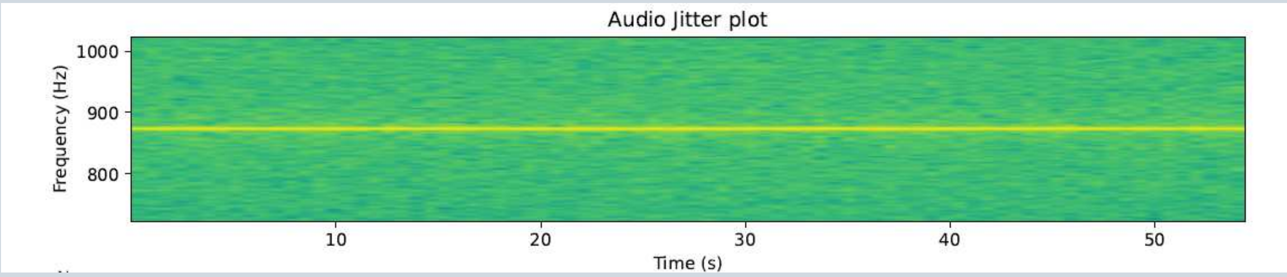
The IF from the Rx head goes to our main SDR box which saves demodulated audio in 60 second WAV files

The Rx SDR is tuned a little low such that the Tx carrier demodulates as a tone in the region of 800 – 1000 Hz

The WAV files are then post processed and the stability data is presented as a plot of audio frequency as a function of time

A Qualitative View - 2

Tx – HP OCXO   Rx – HP OCXO



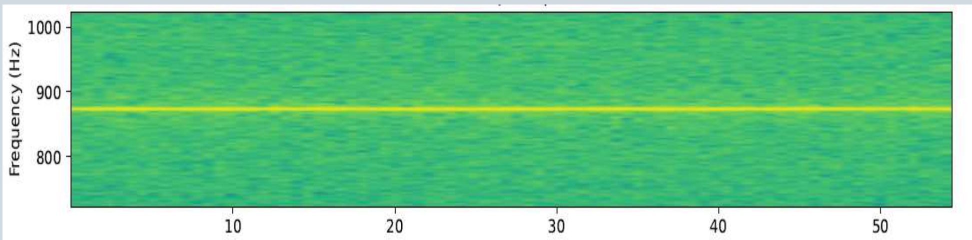
We provide both Tx and Rx a the same reference from the HP OCXO

The two references are correlated and noise an jitter from the Reference cancels

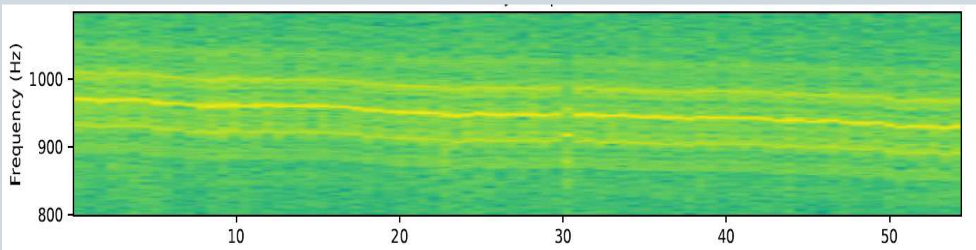
This is the residual noise of the measurement system

A Qualitative View - 3

HP Reference



Oscilloquartz

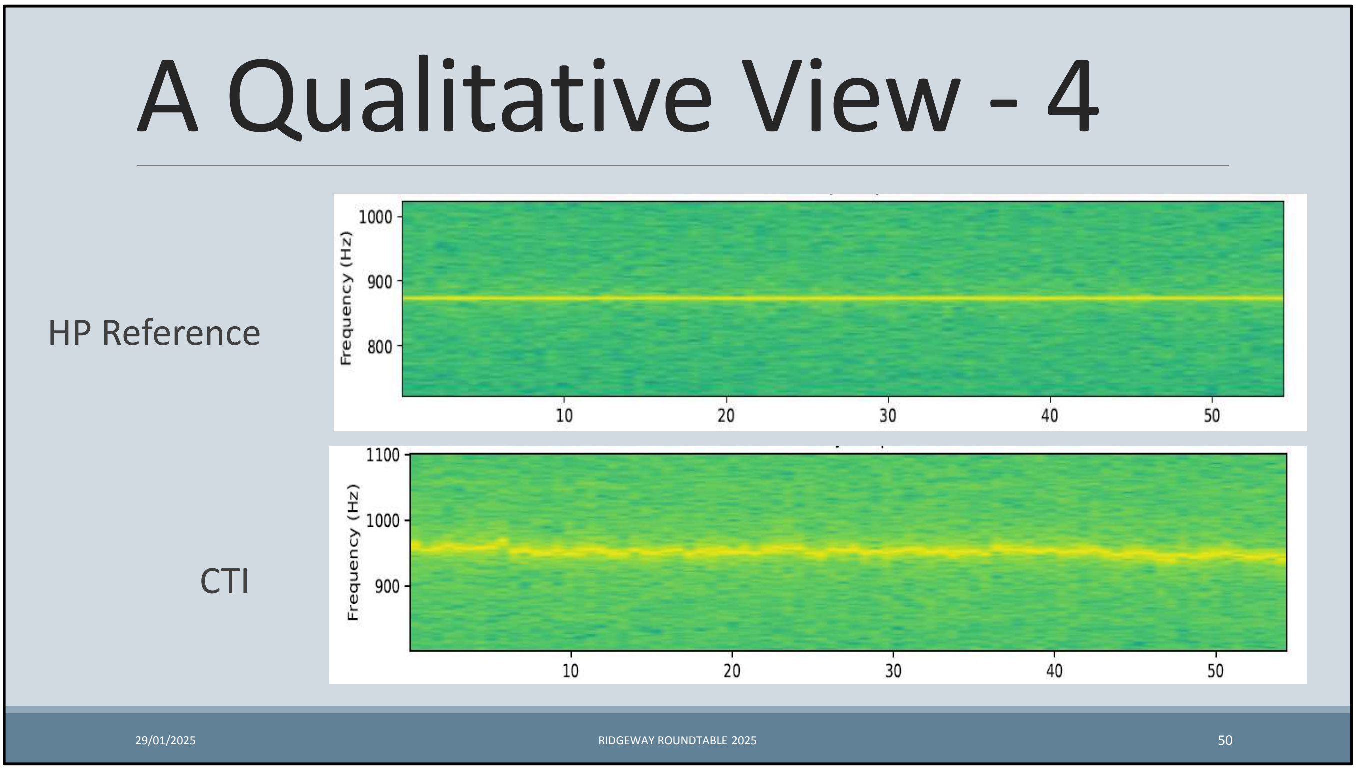


We compared 3 different VCOCXOs used as the Tx Reference

The Rx Reference remains the HP Golden Standard

The Oscilloquartz has a clean carrier stable carrier with minimal noise. It does however have range of close in sidebands

Slope can be ignored, it just means that the OCXO under test had not fully warmed up

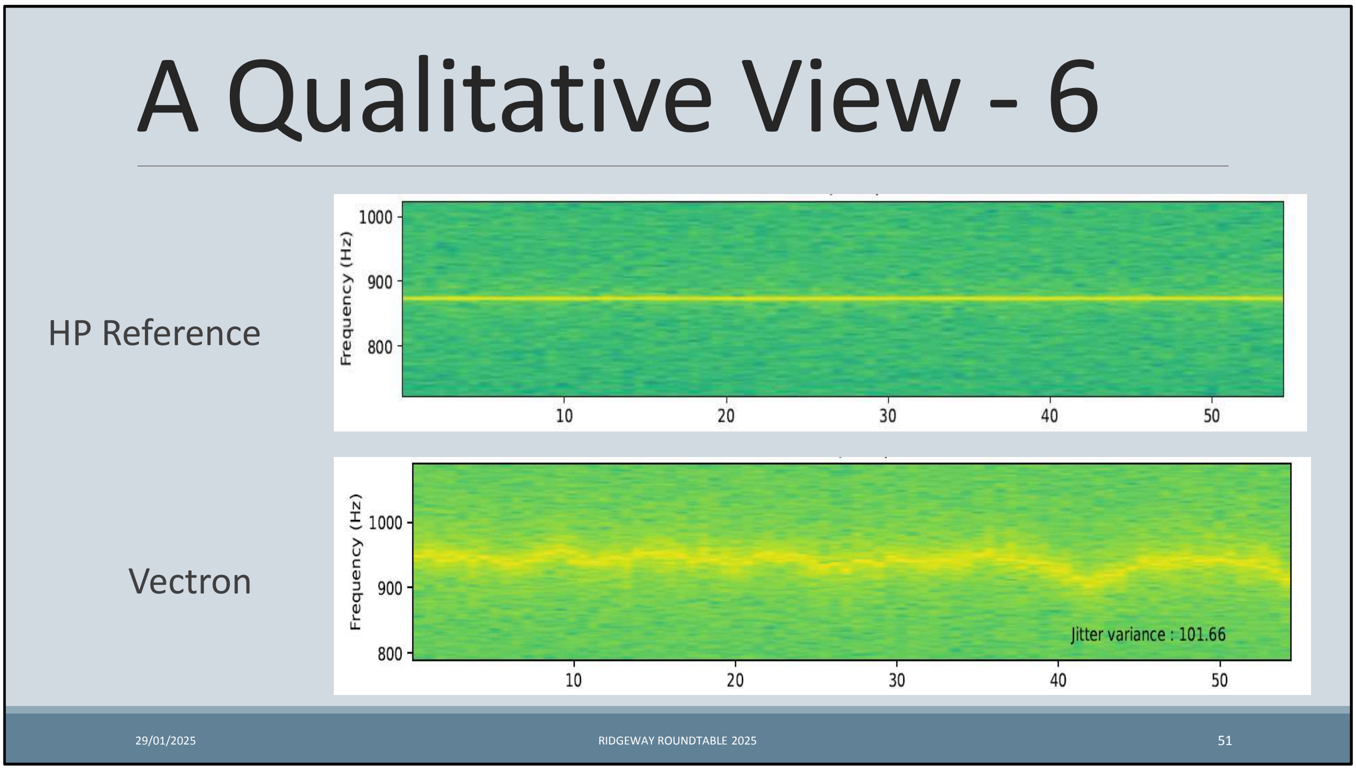


We compared 3 different VCOCXOs used as the Tx Reference

The Rx Reference remains the HP Golden Standard

The CTI is not as stable is not as stable as the Oscilloquatz - it jitters up and down a little – and its noisier note the thickened trace

But no evident sidebands



This is the Vectron

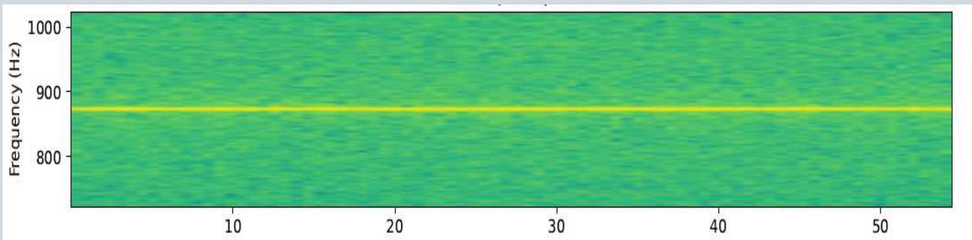
It has significantly more noise and jitter

– unfortunately this was our initial choice and is the one in the system …… Annoying

We have more VCOCXOs queued up to test in the future

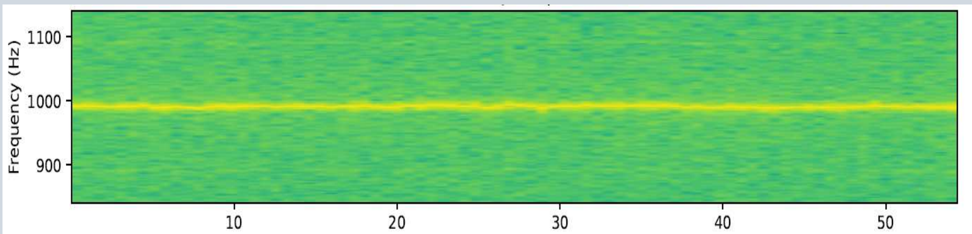
A Qualitative View - 7

HP Reference



C-Mac

Not Tuneable



This is the C-Mac which gets a very honourable mention indeed

It stable and clean

BUT the downside is that its not tuneable – either mechanically or electrically – which is a real shame

It would however make a decent and available golden standard for this sort of testing

New old stock - currently £20 on eBay and as of last night more than 10 available

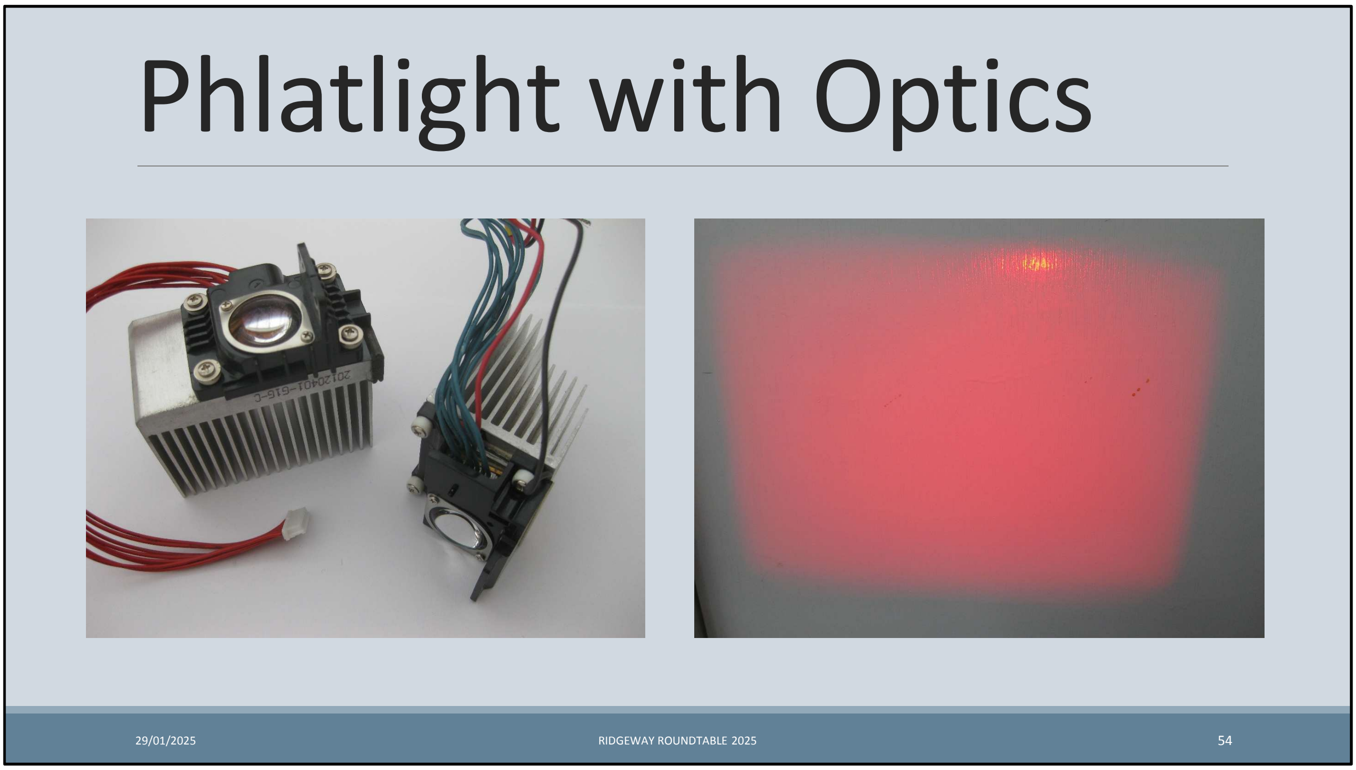
Optical Location

Reducing the Power Consumption of the Phatlight

Barry G8AGN did some really impressive red light communication using Phaltlights with a Fresnel lens to collimate the beam

Roger, Noel et al have used these to good effect to align 122GHz systems over very significant distances

The concept was attractive, the 16A current draw was not



I'd had the term Phlatlight as a saved search on eBay and one day a new hit came up

These were Phlatlight modules with the Phlatlight mounted on a heatsink with a bulbous lens in front. The vendor had more than 10 and they were sub a tenner so I bought one

When it arrived I took it apart (I'm an engineer, it's part of the job description)

The lens turned out to be a pair of lenses in what looked to be a very high grade moulding, obviously designed and not just thrown together

The Phatlight module was a PT-54 module – similar if not identical to Barry's

Testing at a few mA showed a moderately focused rectangular pattern – shown at 85cm range at 50mA

The horizontal beam angle is about +/- 11 degrees and the vertical angle of about +/- 8 degrees – so we might need a further lens to reduce these angles by perhaps half or three quarters

It's ever so nice BUT it still draws 16A at full output

It looked promisig so we bought a some more while they were available

Use a Flashing Source ?

We could use Flash Powder

As an alternative …….

Great fun –

just mind the eyebrows

Victor Flash Circa 1909

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Why should the Phlatlight be operated in CW?

Human eyesight is attracted by flashing lights so if we have a flashing source with - say - a 10:1 duty cycle we can save 90% of the power compared with the CW case

16A pulses don’t sound pleasant from a small battery perspective but at 16A the Phlatlight has a forward voltage between 3 and 4 Volts

So use a DC/DC converter to drive the Phatlight and those pulse now become 4A to 6A - still significant but more manageable

How about emulating an electronic ignition or capacitor discharge flashgun? Charge a capacitor with a constant current and use that to provide high current pulses

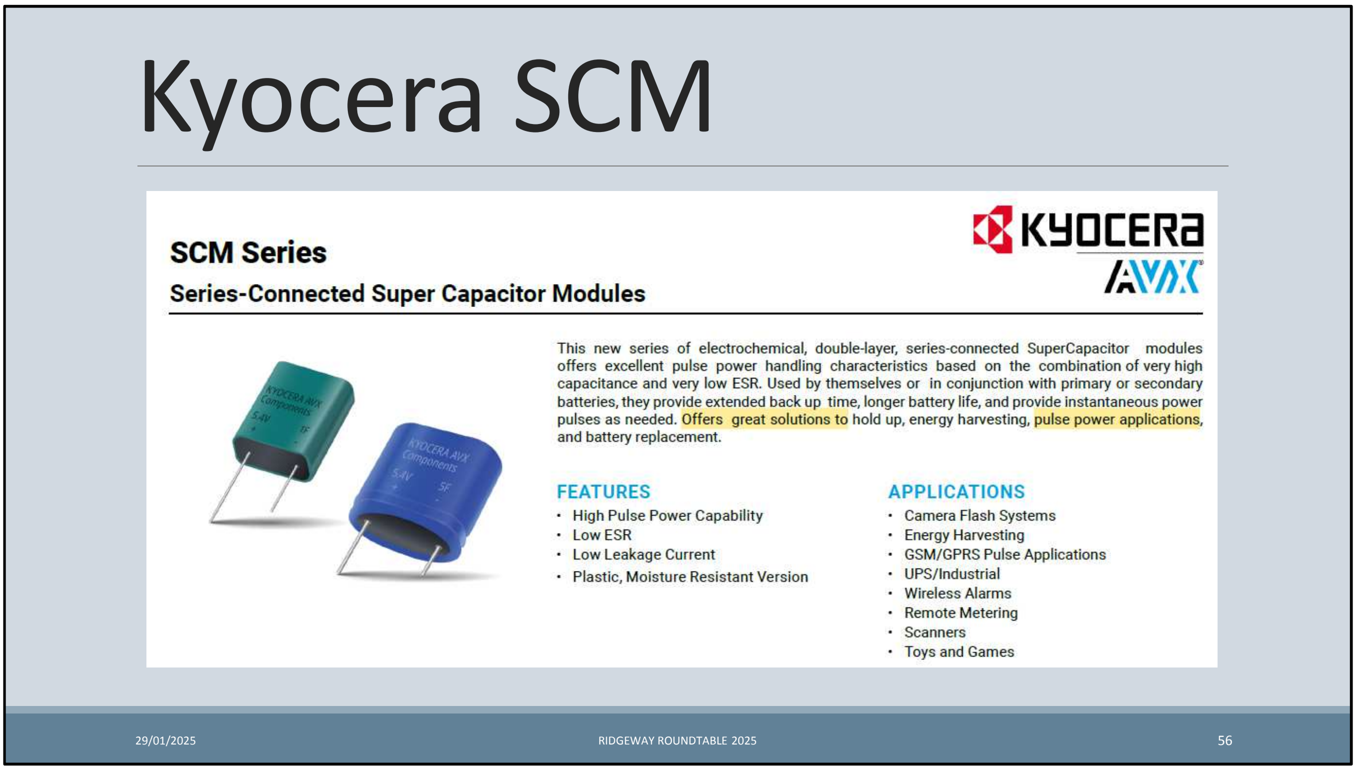
A 15 Farad capacitor charged at 1A continually would support 15 A pulses of around 50ms at 10:1 duty cycle

With a DC/DC in front of the charge circuit the current draw would be ~0.5 A – that looked very promising indeed

Is a Supercap capable of working in this manner ?

I remember supercaps in their infancy – 1 Farad was amazing and had an ESR of hundreds of Ohms. You could (and we did) put a LED directly across it with no current limit and it would run safely for ages

An internet search revealed that modern supercaps have low ESR's and are rated for 10's of Amps discharge current. We settled on a Kyocera part



The Datasheet for the Kyocera SCM capacitors says its designed for pulse power applications

Kyocera SCM

SCM Series

6.0V/5.5V Series-Connected SuperCapacitors Modules

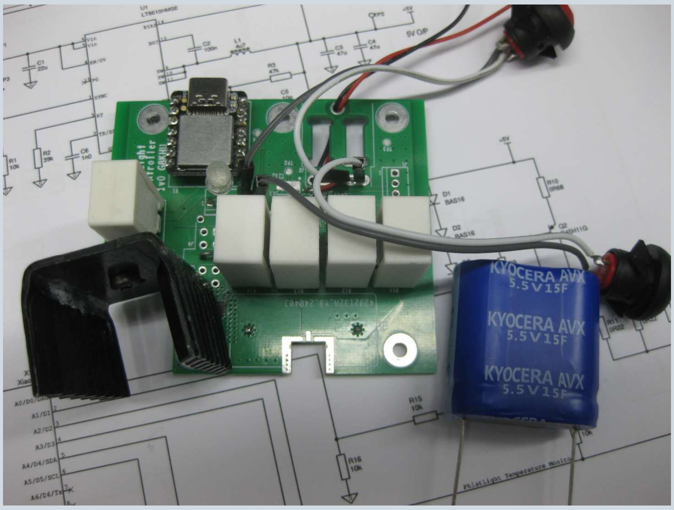
Part Number	Diameter (mm)	Length (mm)	Rated Capacitance (F)	Capacitance Tolerance	Rated Voltage (V)	Rated Temperature (°C)	DCL Max @ 72 Hrs (µA)	ESR Max @ 1000 Hz (mΩ)	ESR Max @ DC (mΩ)	Peak Current (A)	Power Density (W/kg)	Max Energy (Wh)	Energy Density (Wh/kg)
Shrink Wrap / Radial Lead													
SCMQ14F474MRBA0	6.3	14	0.47	±20%	5.5/4.6*	65/85*	6	500	3000	0.54	864	0.0020	1.41
SCMQ14H474MRBB0	6.3	14	0.47	±20%	6.0/5.0*	65/85*	7	500	3000	0.59	1029	0.0024	1.68
SCMR14F474SRBA0	8	14	0.47	+30%/-10%	5.5/4.6*	65/85*	6	380	1720	0.71	1005	0.0020	0.94
SCMR14H474SRBB0	8	14	0.47	+30%/-10%	6.0/5.0*	65/85*	7	380	1720	0.78	1196	0.0024	1.12
SCMR18F105SRBA0	8	18	1	+30%/-10%	5.5/4.6*	65/85*	9	250	730	1.60	2017	0.0042	1.68
SCMR18H105SRBB0	8	18	1	+30%/-10%	6.0/5.0*	65/85*	11	250	730	1.74	2400	0.0050	2.00
SCMR22F155SRBA0	8	22	1.5	+30%/-10%	5.5/4.6*	65/85*	12	200	590	2.24	2091	0.0063	2.03
SCMR22H155SRBB0	8	22	1.5	+30%/-10%	6.0/5.0*	65/85*	18	200	590	2.45	2488	0.0075	2.42
SCMS22F255SRBA0	10	22	2.5	+30%/-10%	5.5/4.6*	65/85*	24	180	370	3.72	2373	0.0105	2.33
SCMS22H255SRBB0	10	22	2.5	+30%/-10%	6.0/5.0*	65/85*	30	180	370	4.05	2762	0.0125	2.72
SCMS32F505SRBA0	10	32	5	+30%/-10%	5.5/4.6*	65/85*	30	120	160	7.86	3580	0.0210	3.11
SCMS32H505SRBB0	10	32	5	+30%/-10%	6.0/5.0*	65/85*	36	120	160	8.57	4235	0.0250	3.68
SCMT22F505SRBA0	12.5	22	5	+30%/-10%	5.5/4.6*	65/85*	30	120	160	7.86	3176	0.0210	2.76
SCMT32F755SRBA0	12.5	32	7.5	+30%/-10%	5.5/4.6*	65/85*	78	90	130	10.86	3151	0.0315	3.28
SCMT32H755SRBB0	12.5	32	7.5	+30%/-10%	6.0/5.0*	65/85*	84	90	130	11.84	3600	0.0375	3.75
SCMU33F156SRBA0	16	33	15	+30%/-10%	5.5/4.6*	65/85*	85	40	100	23.57	4033	0.0630	3.50
SCMU33F156SRBB0	16	33	15	+30%/-10%	5.5/4.6*	65/85*	90	40	100	23.57	3946	0.0630	3.43

Looking at the 15 Farad part data we see the peak current rating is 23.5 Amps with a DC ESR of 100 milli-Ohms max

This looks pretty ideal so currently we have breadboard assembled and a prototype is being tested

Watch this space !! … With appropriate eye protection naturally ;-)

Controller



This is our current breadboard controller

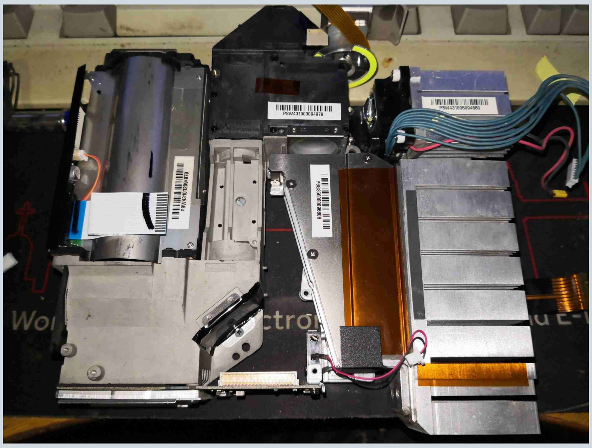
Top Left is Seeedstudio Xiau board with SAMD21 processor

This is running Python so programming is easy – it just needs a text editor and Thonny (or equivalent)

The white blocks are wire wound power resistors, required to handle the peak current

The supercap is to the right of the PCB

Phlatlight Modules



www. Experimental Engineering.co.uk

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Having suitably wetted your appetites - we hope – some of you may be wondering about availability of these modules

The eBay source of the bare modules has dried up but I've been searching the internet and found the original source they came from

It appears that they were used by Casio in various models of a hybrid LED / Laser digital projector

I found a tear down blog of the Casio XJ-A140 projector on Experimental Engineering.co.uk

https://www.experimental-engineering.co.uk/2020/01/18/casio-xj-a140-hybrid-projector-teardown/

You can see the Phlatlight module at the top right

The buzzword that seems to apply to the series is "Casio Laser & LED Hybrid light source" and the LEDs may be in many of these projectors in this series

A pixelated display fault indicates a failure of the TI DLP array and will scrap a projector but the LED module (and some interesting blue laser diodes) are probably OK

Obviously CHECK BEFORE YOU BUY and do your own research but recycled used projectors in various states are available on eBay from £20 - £50

A Measure of Absorption

Enhancing the Functionality of the Weather Box

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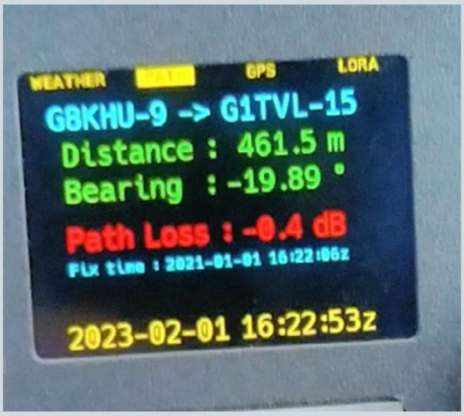
Barry G8AGN (once again) came up with the weather box – which triggered a flurry of thoughts

The first of which was, a GPS gives us our location – so if we have two boxes that can talk to each other we can get range and bearing information automatically

The Initial Prototype



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Using Barry’s Weatherbox for a guide to functionality we developed our own version in Python running on a Raspberry Pi Pico

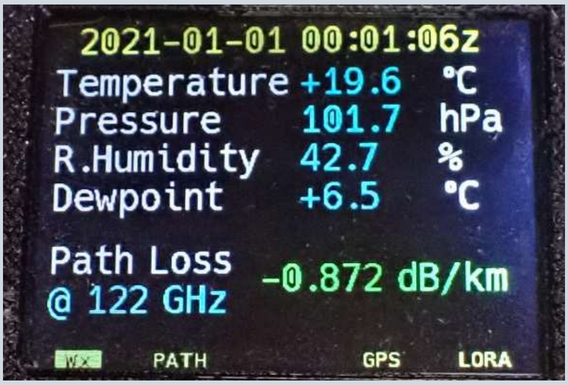
Our contribution the Barry's idea was the introduction of LoRa for communication

Here's our first attempt, 3D printed box, homebrew navigation keypad with a 3.2” 320x240 colour screen

In the left hand picture you can see the two coaxes connection to the box, on the left the GPS antenna and on the right is LoRa

What listed as Path Loss on the screen is the total; Atmospheric Absorption loss for the path, this is additional to the basic geometrical loss predicted by Friis

The Second Spin



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This is the second iteration, more compact with a 2.4" screen

Power in both cases is an external 5V USB battery pack

In our quest for accuracy we used survey receivers for GPS – capable of amazing precision but at the expense of time to a fix – 10 to 15 minutes in normal operation

At this point we stopped working on this as a standalone product and integrated it into our main SDR unit

Since then it has developed even further, as we hope to show you in the demonstration

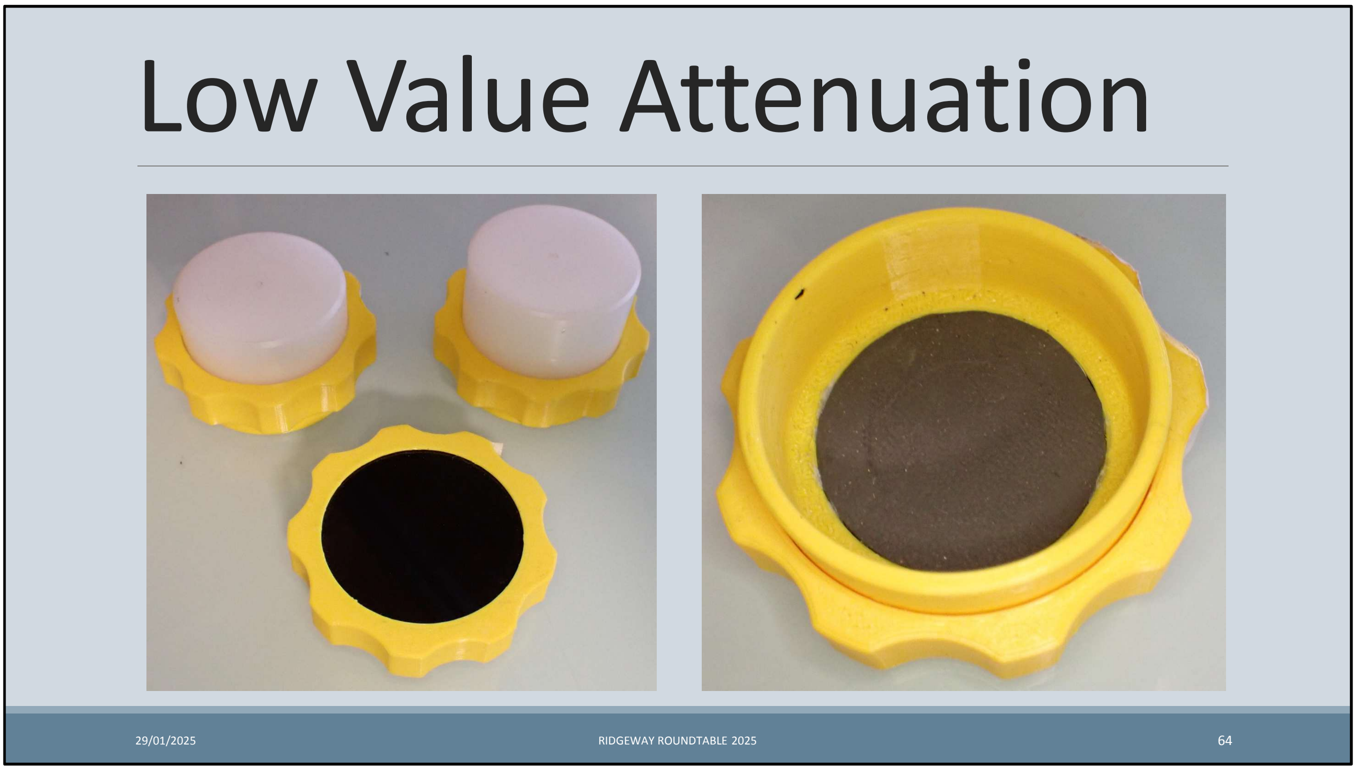
A Degree of Attenuation

Sometimes Less is Better

Sometimes it's nice to be able to reduce the signal, by a small or a large amount

For example if we complete a QSO successfully then if we could reduce the signal, by lets say 6 dB, and still be able to communicate then that gives confidence to relocate and try a longer path with 4-5 dB more loss

In the lab we'd often like a test signal at levels approaching the detection limit – getting on towards 100 dB would be nice



For low values of attenuation we placed various materials over the horn od one station in a link and simply noted the drop signal strength between the two stations

For repeatability we 3D printed a holder which is a simple push fit onto the boss protecting the horn on our RF heads

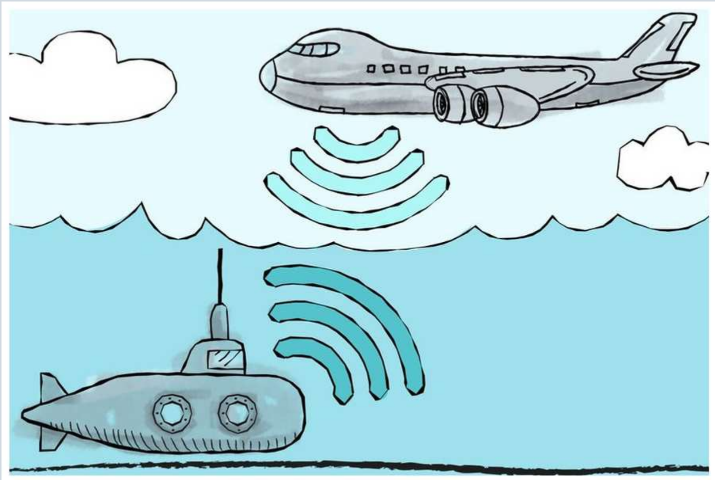
The three types we made are shown in the left picture, the upper two being different lengths of Delrin bar (Polyoxymethylene)

The lower one is a sheet of Perspex with RAM stuck to the inside face (right hand photograph)

We chose the RAM by trial and error from what we had in stock and a couple of sample kits

We're somewhat reluctant to call these attenuators as that implies to us that the signal loss is attributable to energy absorption in the bulk of the material. In this case there may well be some absorption but equally we suspect a significant proportion of the energy loss is by means of diffraction, reflection and scattering

Higher Value Attenuation



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We haven’t got a reliable solution to higher values of attenuation for transmission across a room as yet

Ideally we want absorption as scattering, reflection and diffusion way well result in multipaths which are unpredictable

Higher Value Attenuation

Water is looking our best way forward at the moment, a glass of water in front of the attenuator works well but there is some scattering and reflection from the curvature of the vessel

Note the calibration sticker – perhaps not UKAS traceable

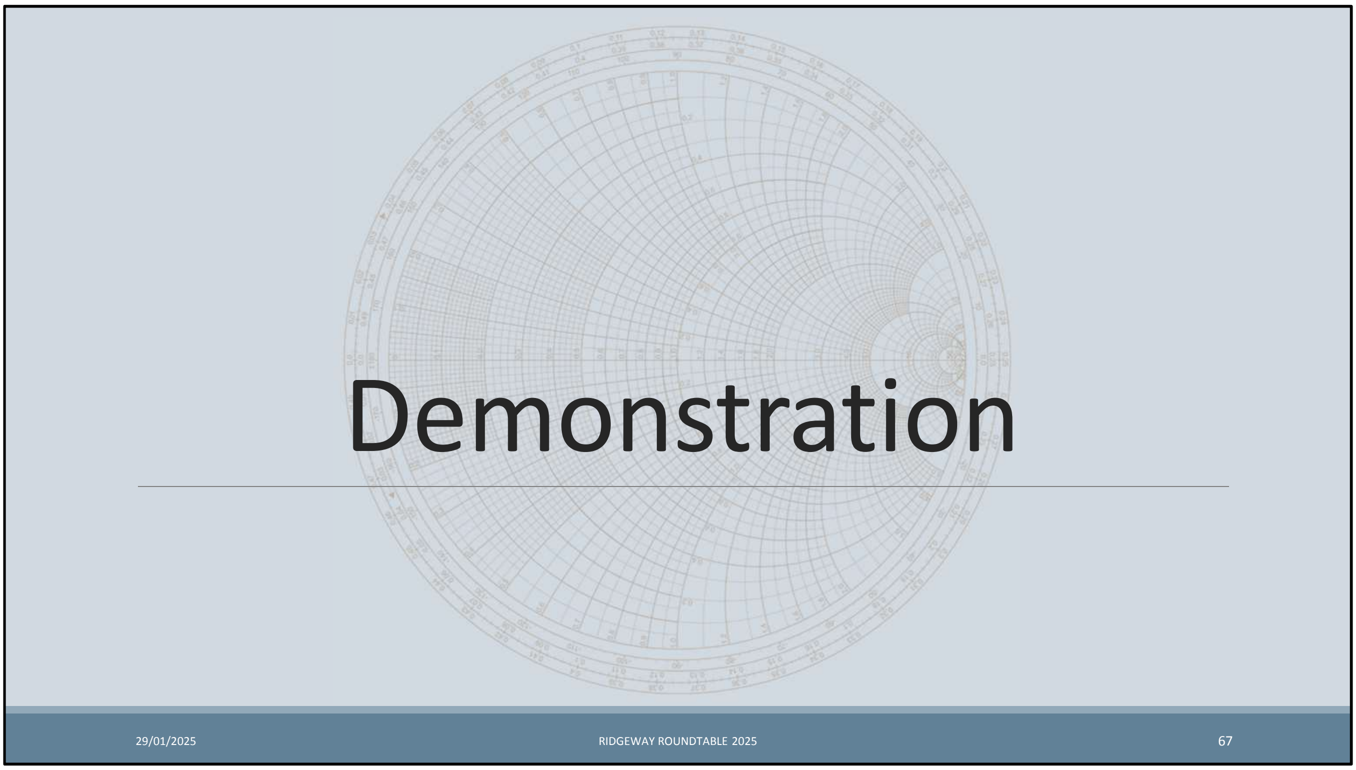
We think the best way forward is to seal the test source into a sealed plastic lunch box and then sink it in a large useful box filled with water.

The attenuation is then varied by moving the source box within the larger container

It should work but sounds rather messy

Replacing the Delrin rod in one of our low value attenuators with a water filled pipe may be another way forward

– this could be a bellows with water added and removed by syringe to make it variable – perhaps straying a little too close to the boundaries of Heath Robinson country



And finally we come to the demonstration

We only demonstrated a one way contact at the Midlands Roundtable due to problems getting a GPS signal in the conference hall

We needed to reboot one station but this would have resulted in the loss of GPS time alignment (needed for JT4 synchronisation). The conference room was well screened from GPS signals so if we had rebooted we would not have been able ro recover time synchronisation

A hardware modification to the system should overcome this issue if we need to reboot today -- it comprises a long length of coax so we can dangle the GPS antenna out of the window …

We'll talk about what the software is doing (and what it really ought to be doing instead) during the demonstration

JT4 QSO

•CQ de G1TVL	CQ G1TVL IO91
•RTN de G8KHU	G1TVL G8KHU IO91
•SIG de G1TVL	G8KHU G1TVL -17
•SIG de G8KHU	G1TVL G8KHU -16
•73 de G1TVL	G8KHU G1TVL 73
•73 de G8KHU	G1TVL G8KHU 73

G1TVL predefined	IO91 from G1TVL GPS
G1TLV from JT4	IO91 from G8KHU GPS
G8KHU from JT4	-17 signal report from JT4
G1TVL from JT4	-16 signal report from JT4
G8KHU from JT4	73 predefined
G8KHU from JT4	73 predefined
G1TVL from JT4	73 predefined