DL0SHF 24GHz Tests 4 and 7 Oct 2020

G3WDG

Equipment

- DL0SHF: 108W at feed, 3.7m dish
- RX: 1.2m dish with ~2dB NF RX (sun noise ~9.5dB, moon noise ~0.5dB)
- WSJT-X 2.3 rc1

The antennas

DL0SHF 3.7m

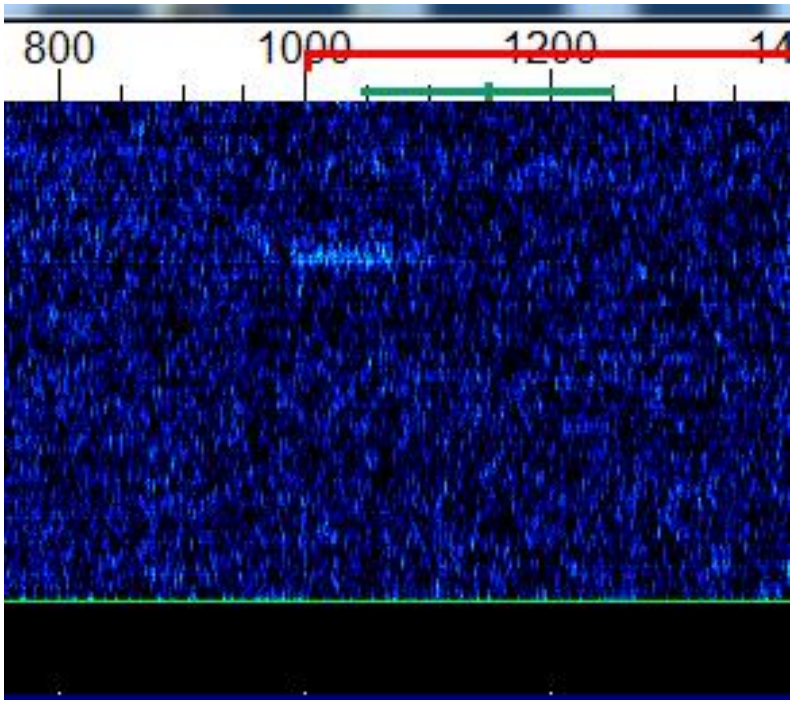
G3WDG 1.2m

2020-10-04 Ephemeris

me			Per		Limb to limb spreading
19:00	081°	+9°	080°	+8°	227 Hz
19:10	083°	+10°	082°	+9°	240 Hz
19:20	085°	+12°	084°	+11°	253 Hz
19:30	086°	+13°	086°	+12°	266 Hz
19:40	088°	+15°	088°	+14°	279 Hz
19:50	090°	+17°	090°	+15°	293 Hz
20:00	092°	+18°	092°	+16°	307 Hz
20:10	094°	+20°	093°	+18°	320 Hz
20:20	095°	+22°	095°	+19°	334 Hz
20:30	097°	+23°	097°	+21°	348 Hz
20:40	099°	+25°	100°	+22°	362 Hz

DGR 2.3dB

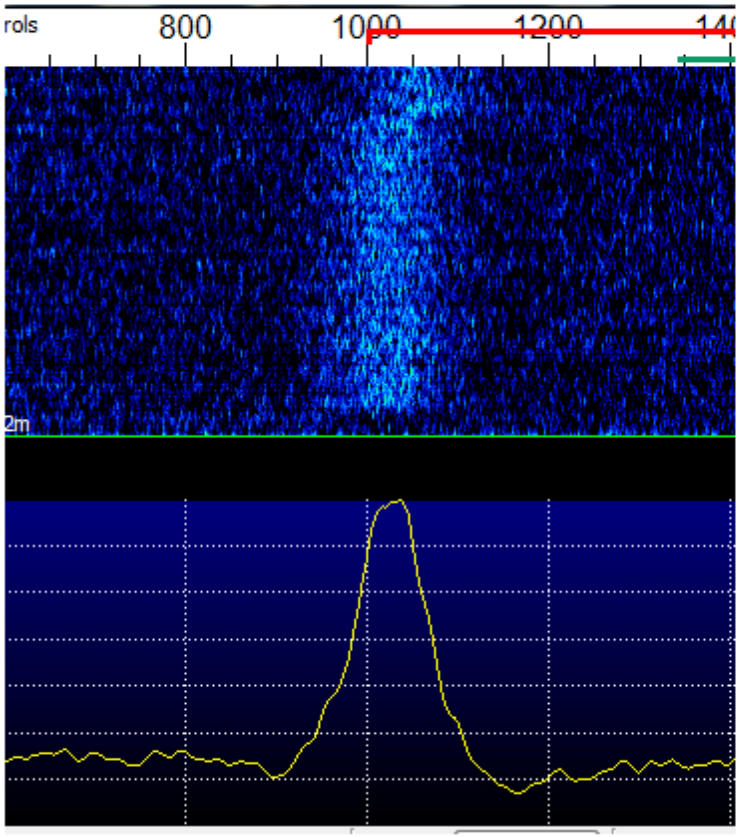
First signal seen at 1925, single 2.5s echo



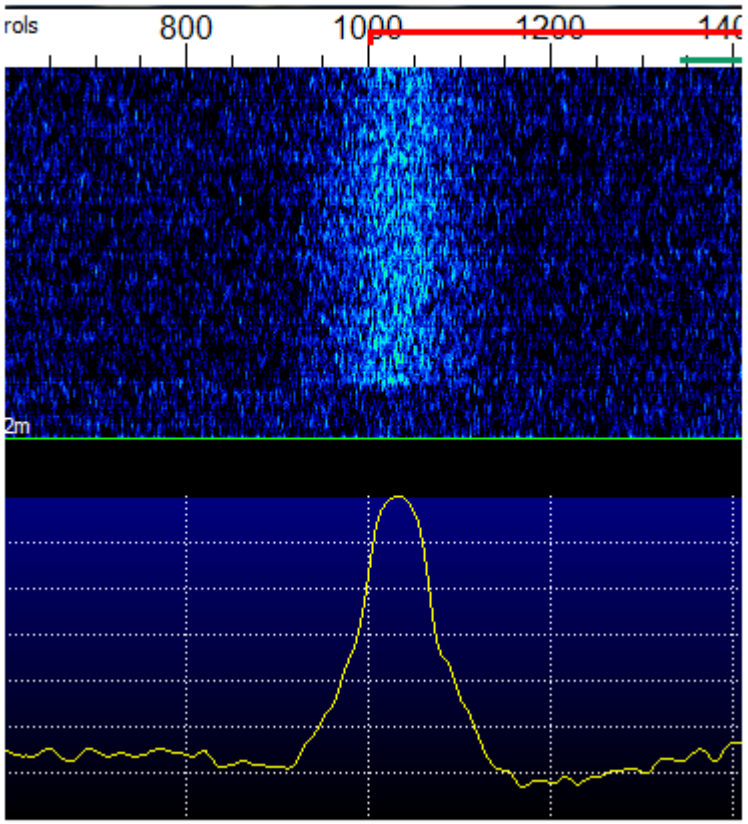
Before 1925 moon was in trees at DL0SHF

Single tones

This is a single tone transmitted at the start (1927 UTC):



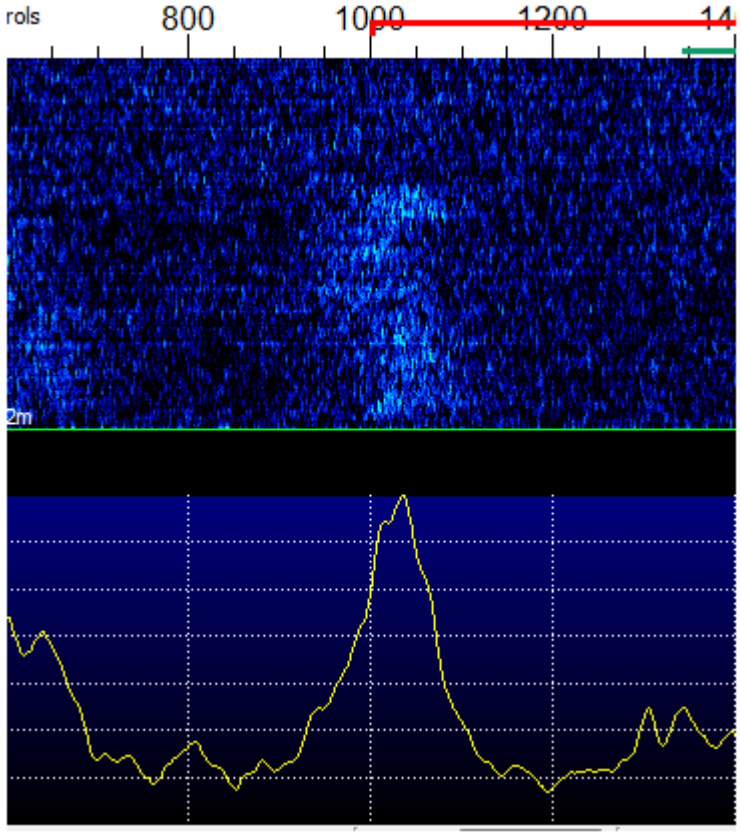
And this is another single tone at 2014 UTC.



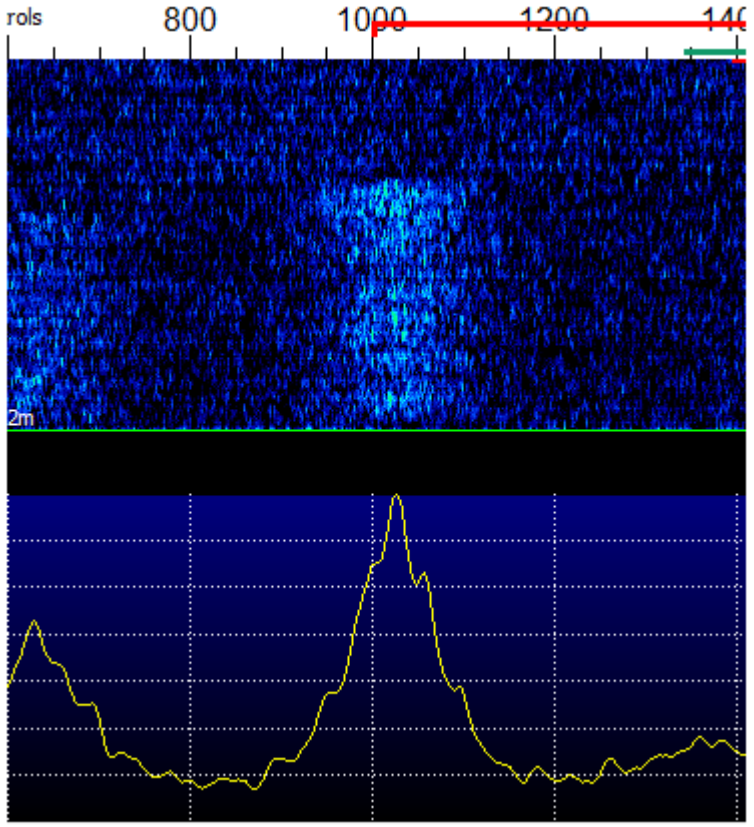
Signal width ~200Hz, Moonsked 327Hz

Some frequency drift/wobble seen early in the tests, which disappeared later.

CW sequences



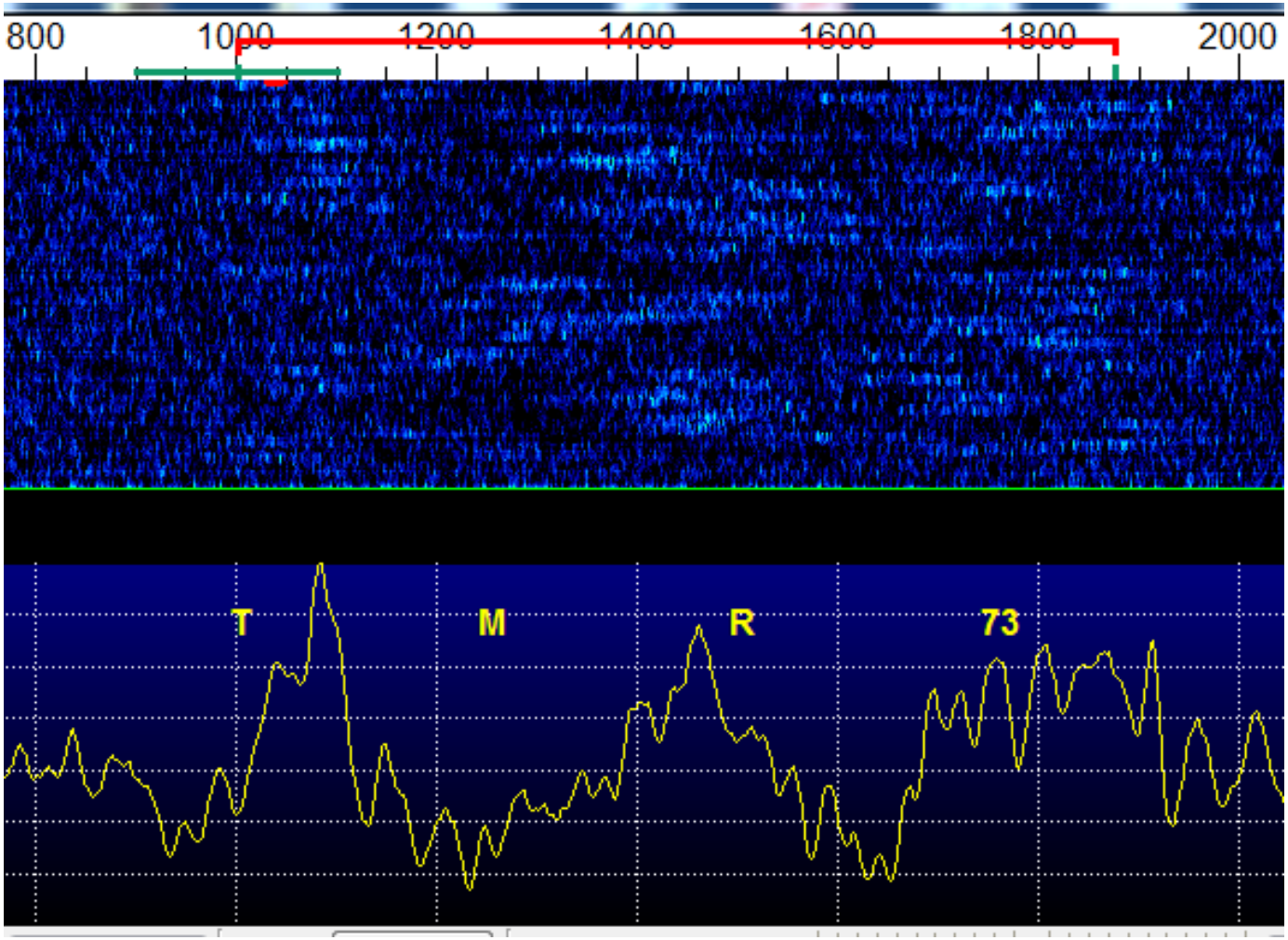
1931



2021

Some frequency drift/wobble seen early in the tests, which disappeared later.

QRA64 signal



QRA64D Decodes

```
1928 -14  0.4 1030 :* CQ DL0SHF JO54                    0
1930 -13  0.6 1028 :* CQ DL0SHF JO54                    0
1932 -12  2.7 1025 :* CQ DL0SHF JO54                    0
1934 -14  2.2 1020 :* CQ DL0SHF JO54                    0
1936 -12  2.7 1052 :* CQ DL0SHF JO54                    0
1938 -14  2.4 1041 :* CQ DL0SHF JO54                    0
1942 -11  2.8 1023 :* CQ DL0SHF JO54                    0
1944 -14  2.3 1015 :* CQ DL0SHF JO54                    0
2016 -11  0.5 1033 :* CQ DL0SHF JO54                    0
2018 -11  0.4 1027 :* CQ DL0SHF JO54                    0
2022 -13  2.6 1037 :* CQ DL0SHF JO54                    0
2024 -11  2.8 1022 :* CQ DL0SHF JO54                    0
```

Note: ‘wrong’ DT for periods 1928, 1930 and 2016, 2018 was due to GPS receiver used for timing not having received updated ephemeris, as it had only been switched on for a short time(2 sec error).

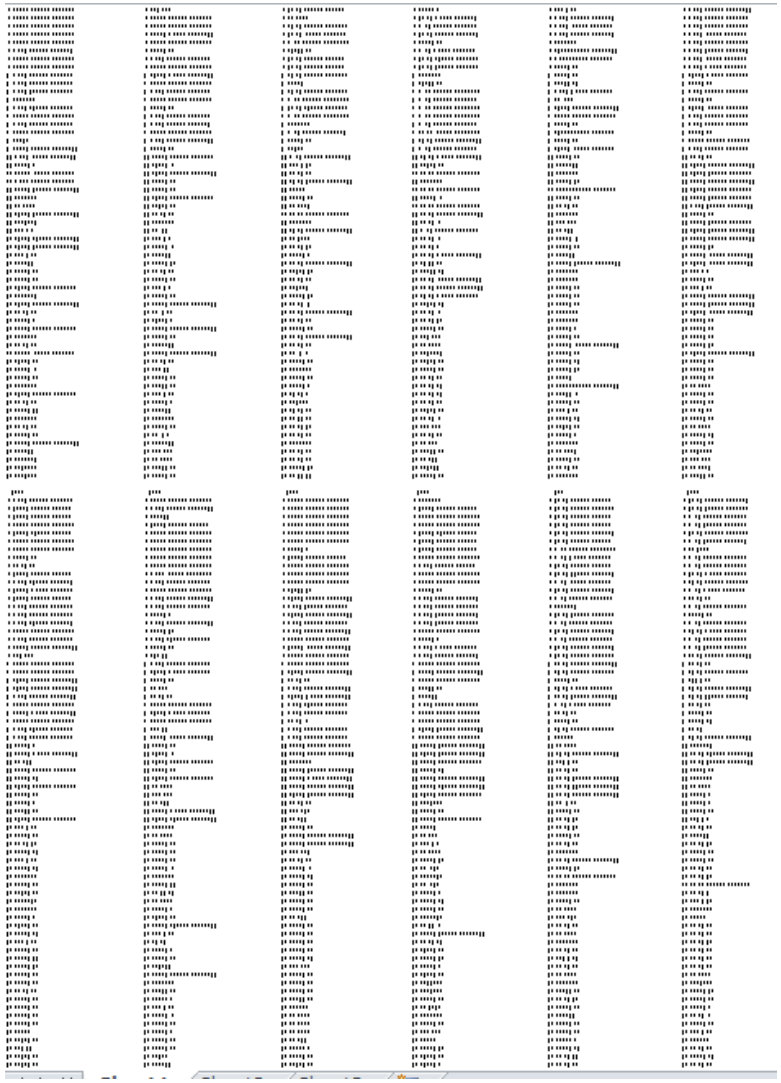
Tests were split into two sessions, 1920 – 1945 and 2014-2030. Beacon was switched off between the two sessions.

Degradation testing

- All periods were degraded from 8-14dB in 1 dB steps, using KA1GT's software.
- 10 files with different random number seeds were generated at each degradation step, to reduce statistical uncertainty. Files were then played back into WSJT-X to check decoding.
- From this, it is possible to see how much margin was available on the signals for them to still be able to be decoded.

Degradation summary

2024



1928

8dB X 10
9dB x 10
10dB x 10
11dB x 10
12dB x 10
13dB x 10
14dB x 10

2024	2022	2018	2016	1944	1942
-11	-13	-11	-11	-14	-11

Map of periods
and reported S/N

1938	1936	1934	1932	1930	1928
-14	-12	-14	-12	-13	-14

Estimated atmospheric loss (total for both stations)

1930z	4.1dB
1945z	3.3dB
2015z	2.6dB
2030z	2.3dB

Clear visible moon at my end, cloud at Per's QTH

Observations

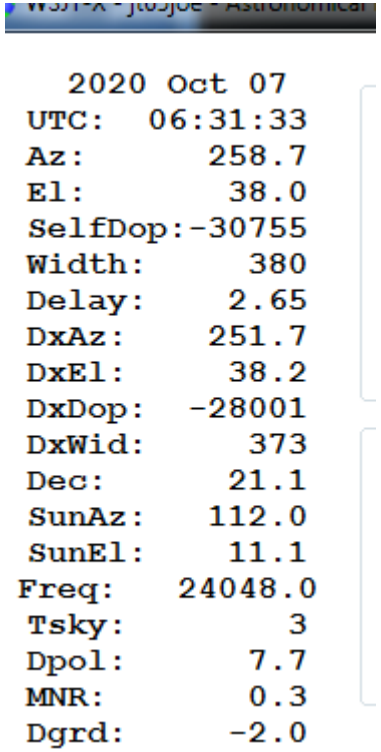
- Signal width significantly less than moonsked figure, as expected with DL0SHF dish putting a spot on the moon. Good news for QRA64D decoding!
- Margin for 50% decoding under test conditions was about 10dB. A few decodes were seen as high as 14dB, but these are few and far between.
- Propagation conditions were not ideal. With moon elevation of 45 deg at both ends, the signals would have improved by about 1dB. Water vapour content was not too high. Moon was near apogee. Spreading was not as bad as it can be. Overall, probably it was not a bad day for a first test. Tests by more stations under a wide variety of conditions will be very useful.

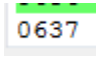
7 Oct test

- 96 11 per light drizzle PW = 21 0.9dB
- 82 10 me thin cloud PW = 17.5 0.7dB

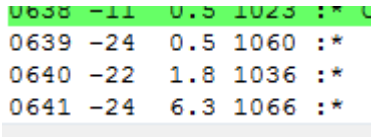
Total additional path loss = 1.6dB

06:00	**252°**	**+43°**	0 dB	+8°	244°	+42°	418 Hz
06:30	**258°**	**+38°**	0 dB	+8°	251°	+38°	377 Hz
07:00	**264°**	**+34°**	0 dB	+7°	258°	+34°	333 Hz
07:30	**270°**	**+29°**	0 dB	+7°	265°	+30°	287 Hz



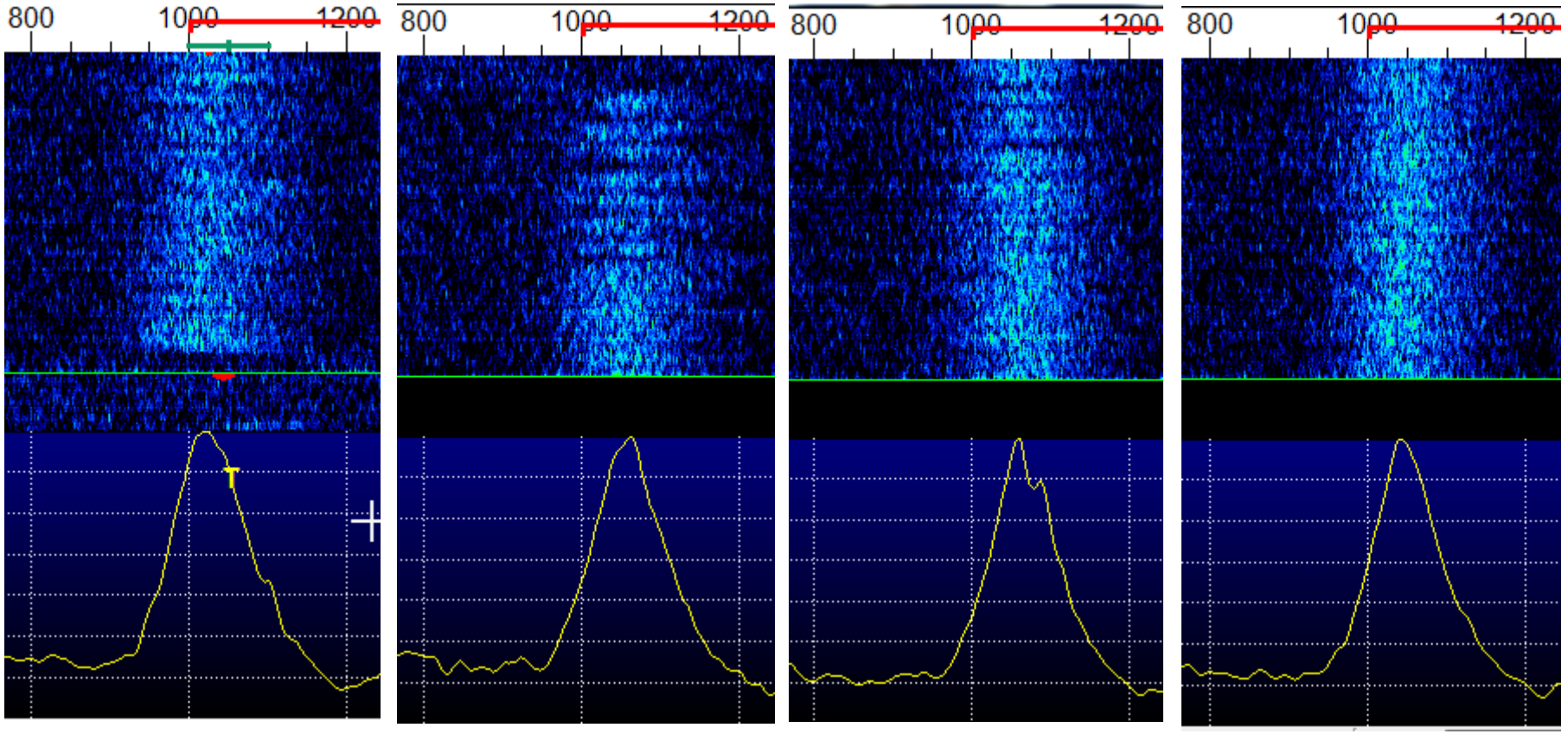


Moved az back and forth



Tracked first 2, rocked az third

Moving RX dish back and forth



0637, vary az

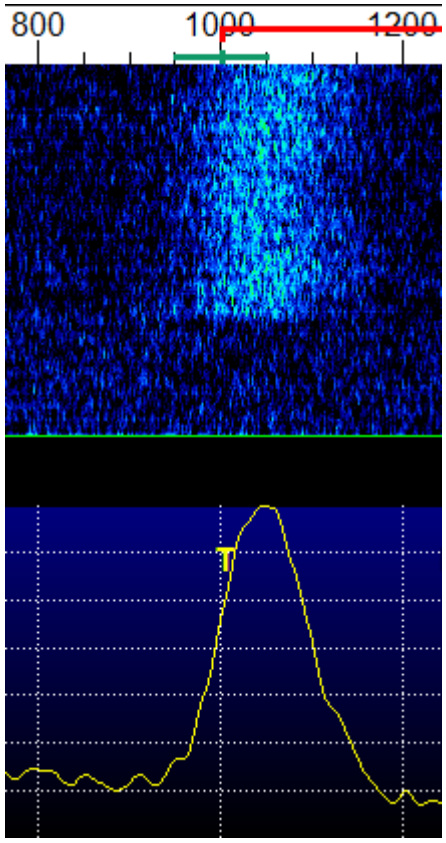
0641, vary az

0645, vary el

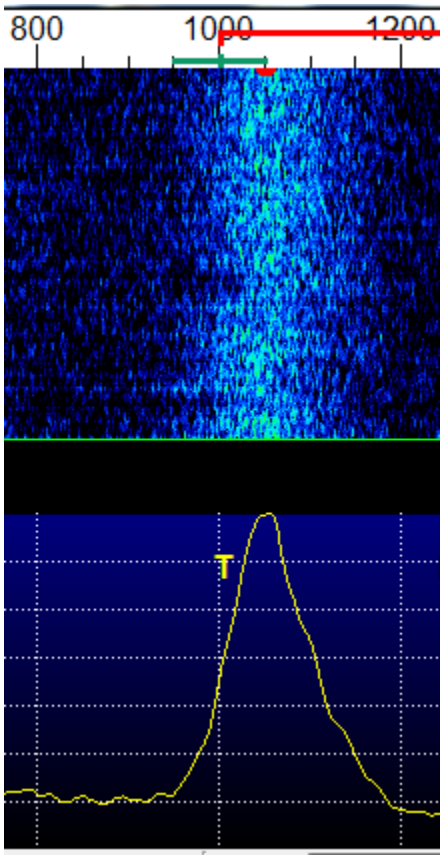
0640, perfect tracking

Moving dish off boresight does not seem to affect signal frequency as much as was seen in the early stages of the first test. G4JNT suggested that small variations are to be expected with GPS derived frequency standards, see later.

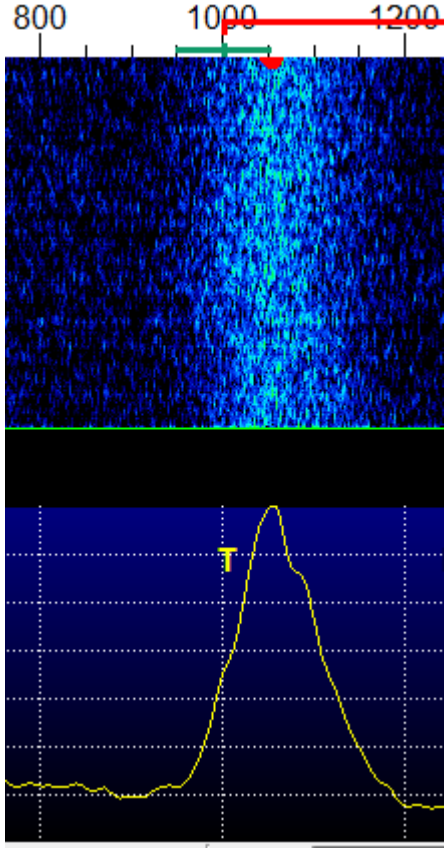
Perfect tracking single tones



0639



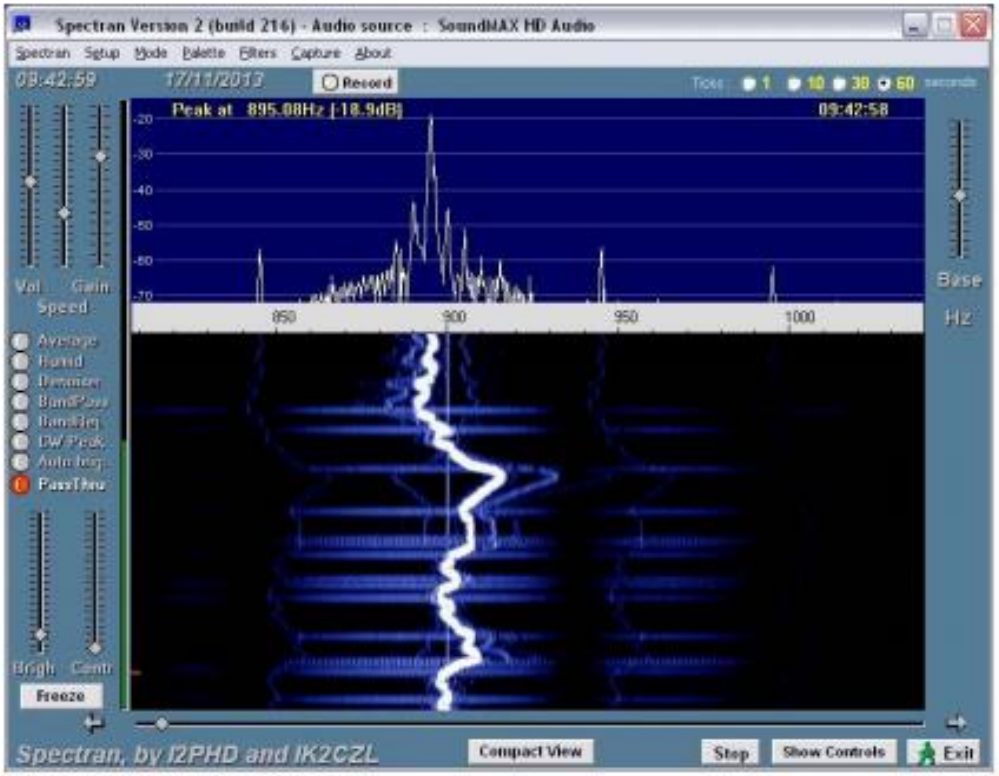
0643



0644

Difficult to be sure, but there does seem to be some small frequency variations, visible in the waterfall traces

G4JNT plot of GPSDO variation



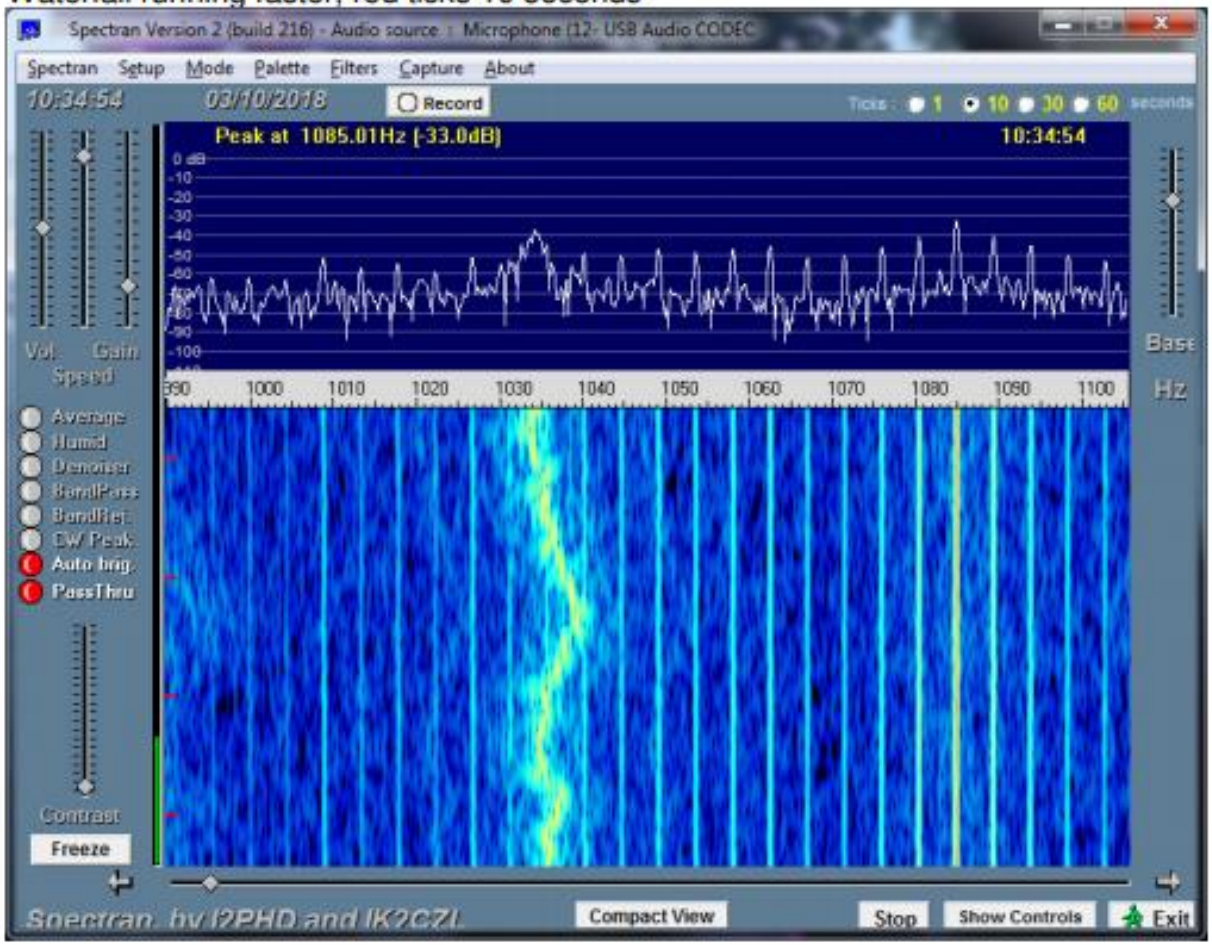
Timescale 60s top to bottom of trace, variation at 2.5GHz, so 24GHz would be x10 worse

Figure 6 *Connor Winfield GPSDO, expanded trace showing a particulalrly bad GPS induced glitch*

http://g4jnt.com/10MHz_Reference_Source_Stability.pdf

G4JNT plot of GPSDO variation- 2

Waterfall running faster, red ticks 10 seconds



Timescale 30s top to bottom of trace, variation at 10GHz, so 24GHz would be x10 worse

http://g4jnt.com/ShortTermStabilityLeoBodnarGPSDO.pdf

Comment on freq stability

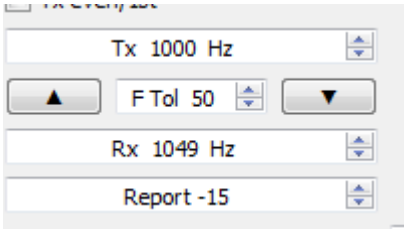
The observations of frequency wobble on the beacon appear to be in line with G4JNT's work. Thus it seems reasonable to assume that variations in the 10MHz GPS derived references are responsible for the small variations in frequency seen on 24GHz.

However, more tests are needed to verify this.

QRA64 decodes

```
0628 -12  0.5 1052 :* CQ DL0SHF JO54                    0
0630 -11  2.7 1048 :* CQ DL0SHF JO54                    0
0632 -11  2.6 1056 :* CQ DL0SHF JO54                    0
0634 -14  2.2 1053 :* CQ DL0SHF JO54                    0
0636 -13  2.7 1065 :* CQ DL0SHF JO54                    1
0638 -11  0.5 1023 :* CQ DL0SHF JO54                    0
0648 -12  0.5 1049 :* CQ DL0SHF JO54                    0
0650 -12  0.5 1076 :* CQ DL0SHF JO54                    0
0652 -11  0.5 1053 :* CQ DL0SHF JO54                    0
0654 -12  2.7 1021 :* CQ DL0SHF JO54                    0
0656 -13  2.3 1046 :* CQ DL0SHF JO54                    0
0658 -11  2.4 1039 :* CQ DL0SHF JO54                    0
0700 -10  2.7 1052 :* CQ DL0SHF JO54                    0
0702 -13  2.3 1039 :* CQ DL0SHF JO54                    0
0704 -12  2.3 1033 :* CQ DL0SHF JO54                    0
0706 -11  2.6 1042 :* CQ DL0SHF JO54                    0
```

0636 was a short transmission, about half a period



Note: with Ftol at 100, one or two periods did not decode, maybe lower Ftol is better for high spreading??

Degradation tests on 7 Oct signal, period 0700

Degradation x 10

0120 -20 2.7 1043 :* CQ DL0SHF JO54 9		
0120 -21 2.7 1052 :* CQ DL0SHF JO54 9		
0120 -21 2.7 1033 :* CQ DL0SHF JO54 9		
0120 -21 2.7 1060 :* CQ DL0SHF JO54 9		
0120 -20 2.7 1034 :* CQ DL0SHF JO54 9		
0120 -21 2.8 1040 :* CQ DL0SHF JO54 9		
0120 -19 2.8 1045 :* CQ DL0SHF JO54 9		
0120 -20 2.7 1047 :* CQ DL0SHF JO54 9		
0120 -20 2.7 1083 :* CQ DL0SHF JO54 11		
0120 -23 5.4 1057 :*		
0130 -23 2.9 1044 :*		
0130 -23 5.5 1077 :*		
0130 -24 -0.1 1044 :*		
0130 -21 2.8 1044 :* CQ DL0SHF JO54 9		
0130 -22 2.7 1055 :* CQ DL0SHF JO54 11		
0130 -21 2.7 1050 :* CQ DL0SHF JO54 9		
0130 -21 2.7 1053 :* CQ DL0SHF JO54 9		
0130 -21 2.7 1054 :* CQ DL0SHF JO54 9		
0130 -23 2.5 1089 :*		
0130 -20 2.7 1057 :* CQ DL0SHF JO54 11		
0140 -23 2.0 1065 :*		
0140 -22 2.8 1035 :* CQ DL0SHF JO54 11		
0140 -24 2.8 1061 :*		
0140 -22 2.5 1047 :*		
0140 -21 2.7 1056 :* CQ DL0SHF JO54 9		
0140 -23 2.3 1021 :*		
0140 -22 2.8 1054 :* CQ DL0SHF JO54 11		
0140 -22 3.1 1064 :*		
0140 -23 6.2 1065 :*		
0140 -23 6.4 1070 :*		

100% decoding with 8-11dB degradation

60% decoding at 13dB degradation

Comparing to 4 Oct, the best signal on 7 Oct was about 2-3dB stronger, based on these results. Atmospheric loss predicted is 1.6dB compared to about 3dB on 7 Oct, also EME path loss had reduced by 0.3dB. Overall predicted improvement in propagation was 1.9dB. Spreading was similar.

Beacon status

The beacon is currently available by arrangement with DK7LJ, at per@per-dudek.de

Note: The beacon frequency is 24048.025MHx. WSJT-X sked frequency therefore is 24048.024 for the beacon to appear at 1000Hz. Doppler shift can at times take the beacon below 24048MHz, which may be a problem with some radios that will not tune below the band edge.