

# WSPR

Silvercreek Amateur Radio Association

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**DON'T SHOUT**

WHISPER



**Weak**

**Signal**

**Propagation**

**Reporter**



# What is WSPR?

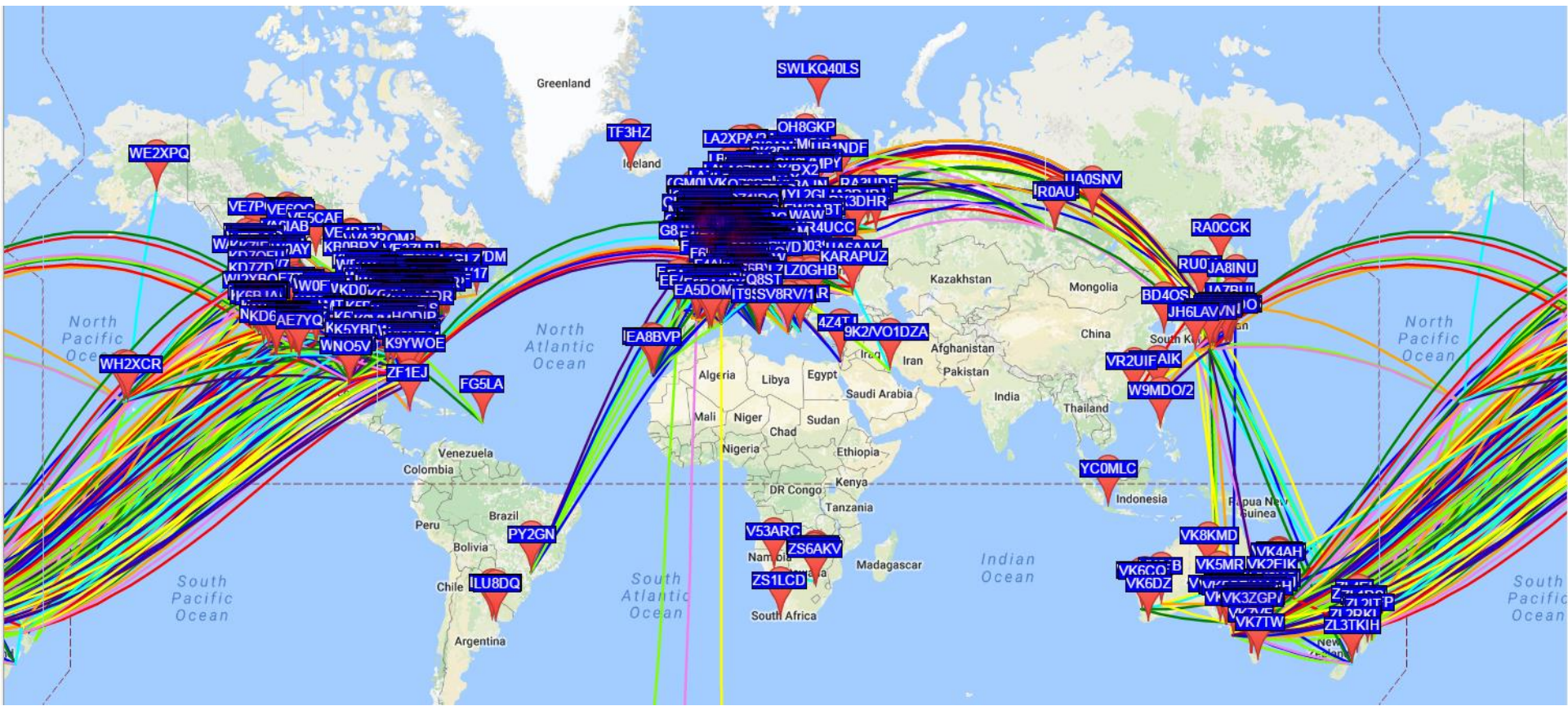
- **Wweak Signal Propagation Reporter “WSPR”** is a digital mode used for beacon transmissions
- It was invented by Professor Joe Taylor, K1JT a Nobel prize winning physicist (photo)
- It's not a communications mode
- It excels at being receivable below the noise
- Transmission and reception is largely automatic
- Results appear in real-time on the internet

# WSPR Family Tree

- WSPR
- MSK144
- ISCAT
- QRA64
- JT65
- JT9
- JT4
- FT8
- Echo

# Finding out about WSPR

- A good place to start is [WSPRnet.org](https://www.wsprnet.org)



WSPR is hugely popular – this is the activity in a single 10 minute period!

# How Do You WSPR?

- Just look at the reports on the web
- Run WSPR on your shack computer & rig
- Program a Raspberry PI to run WSPR
- Use a WSPRlite transmitter

Because it's largely automatic you can run WSPR while you are not in the shack...

**...basically it's a lot of fun!**



# Setting up a beacon



Lots of wire, lots of settings, lots to go wrong.

- Download WSJT-X software
- Configure the software
- Dig out (or buy) a radio/computer interface
- Try to get your interface to work properly with the software and the radio
- Adjust audio and RF levels
- Leave your computer and radio on running WSPR

**This process can be tricky to do. It's not very portable. It also ties up your shack computer and main radio.**

# The easy way...

- Get a WSPRlite
- Configure it using the easy configuration app
- Connect it to your antenna
- Relax and wait for results



WSPRlite settings - v1.0.8

Select serial port to use:  
COM47 (SOTABeams WSPRlite) Connect

Firmware version: v1.0.5-20170119  
Status: WSPR mode, waiting to start

Update firmware Save WSPR settings

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**WSPR settings**

WSPR ident: G3CWI

CW callsign: ☐ unsupported - firmware update needed

Locator: IO83  
Note: the WSPR protocol limits the locator to 4 characters (e.g. JN29)  
[Find my locator](#)

Band: 20m / 14 MHz

Transmit frequency: 14097133Hz (picked randomly within band)

WSPRlite output power: 200 mW

Reported transmit power: WSPRlite output power (no external amplifier)

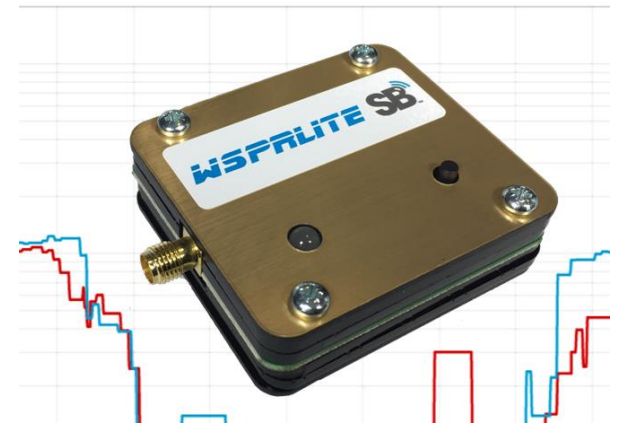
Repeat rate (%): 20

Max run time (days): 3

Statistics: <http://dxplorer.net/wspr/tx/?> Open in browser

# WSPRlite

from [www.SOTABEAMS.co.uk](http://www.SOTABEAMS.co.uk)



- USB powered (does not need a computer to run)
- 200 mW output
- Super portable – can even be run from a USB power pack
- Built in accurate power levels for antenna comparisons
- Runs on 20m or 30m out of the box
- 160m-80m-40m easily added with external filters
- Gives Premium Access to DXplorer.net analysis tools

# Watts a dBm?

$$\text{dB} = 10 \text{ LOG}(P1/P2)$$

Watts	milliwatts	dBm	dBm
0.001	1	0.00	0
0.010	10	10.00	10
0.050	50	16.99	17
0.100	100	20.00	20
0.150	150	21.76	22
0.200	200	23.01	23
0.250	250	23.98	24
0.500	500	26.99	27
1	1000	30.00	30
5	5000	36.99	37
10	10000	40.00	40
50	50000	46.99	47
100	100000	50.00	50
200	200000	53.01	53
400	400000	56.02	56
500	500000	56.99	57
1000	1000000	60.00	60
1500	1500000	61.76	62

# Relative Sensitivity of Communication Modes

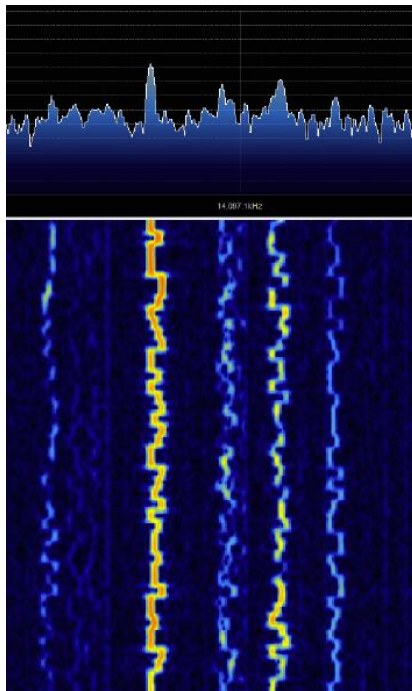
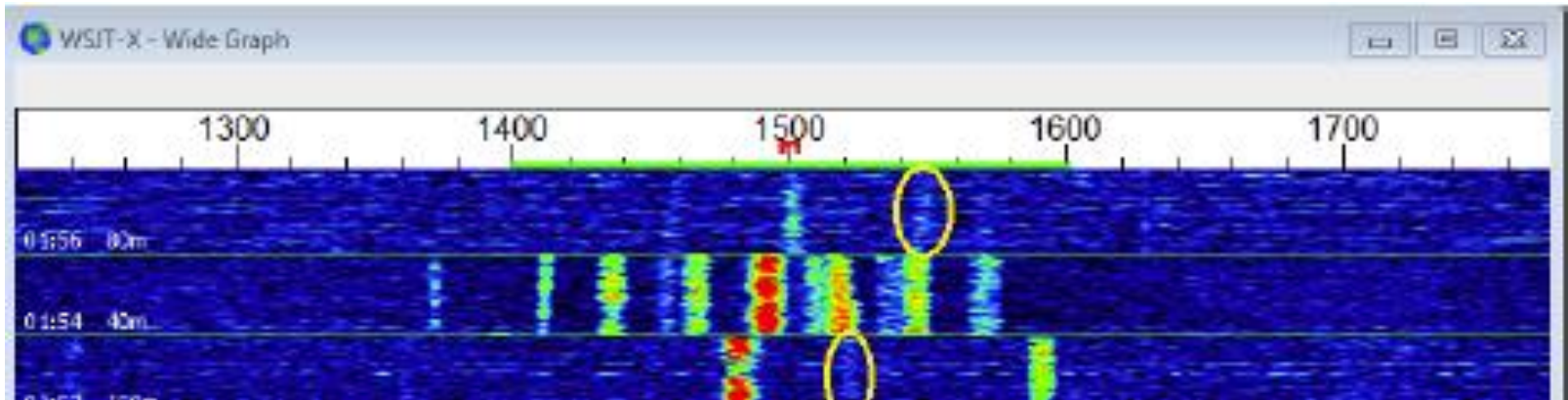
Mode	Signal to Noise Ratio Threshold	Power Equivalence
WSPR	-27 dB	200 mW
JT65	-24 dB	400 mW
FT8	-20 dB	1 W
Olivia	-17 dB	2 W
PSK31	-7 dB	20 W
CW	-1 dB	80 W
RTTY	+5 dB	320 W
SSB	+10 dB	1000 W

**200 mW => 100 W    +27 dB**

# WSPR Transmission Details

- **Worldwide - 800 Reporting, 1000 Transmitting Stations**
- **USB Operation on 0.136, 0.4742, 1.8355, 3.5926, 5.272, 7.0386, 10.1387, 14.0956, 18.1046, 21.0946, 24.9246, 28.1246, 50.293, 144.489, 432.300, 1296.500 MHz**
- **Standard Message (Type 1) – 2 Minute Window**
  - **Callsign , 4-Digit Grid Square, Power (in dBm) = 50 bits**
  - **Forward Error Correction = 162 bits**
  - **Synchronization Pattern = 162 bits**
- **Typical Transmitting Time 20% of 10 Minute Slots**
- **HF Xmit Power Typically 200 mW (23 dBm)**
  - **QRO 5 W (37 dBm)**
- **Transmissions start on even UTC minutes**

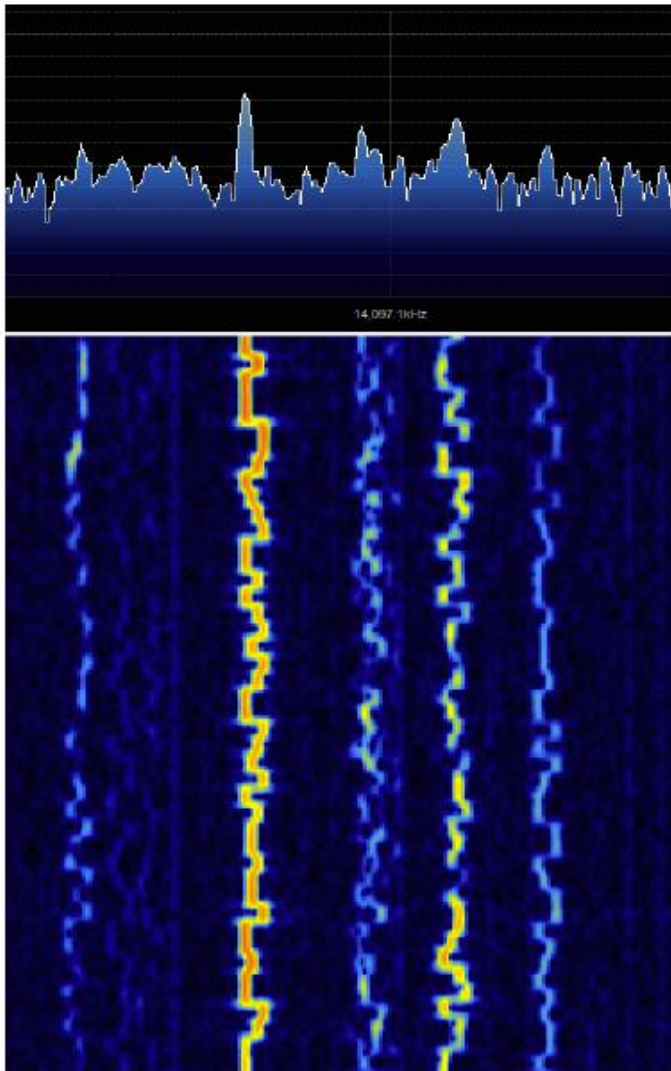
# WSPR Modulation Details



- Share Common 200 Hz Bandwidth
- Four Level FSK Modulation
  - 5.9 Hz Bandwidth
  - 1.4648 Hz Tone Separation
  - 1.4648 Hz Baud (2.9296 Bits/Second)
    - RTTY 45 Baud
- Random Selection of Frequency, Timeslots, Repetition Rates to Reduce Collisions
- Duration of Transmission – 110.6 Seconds
- -31 dB S/N Threshold



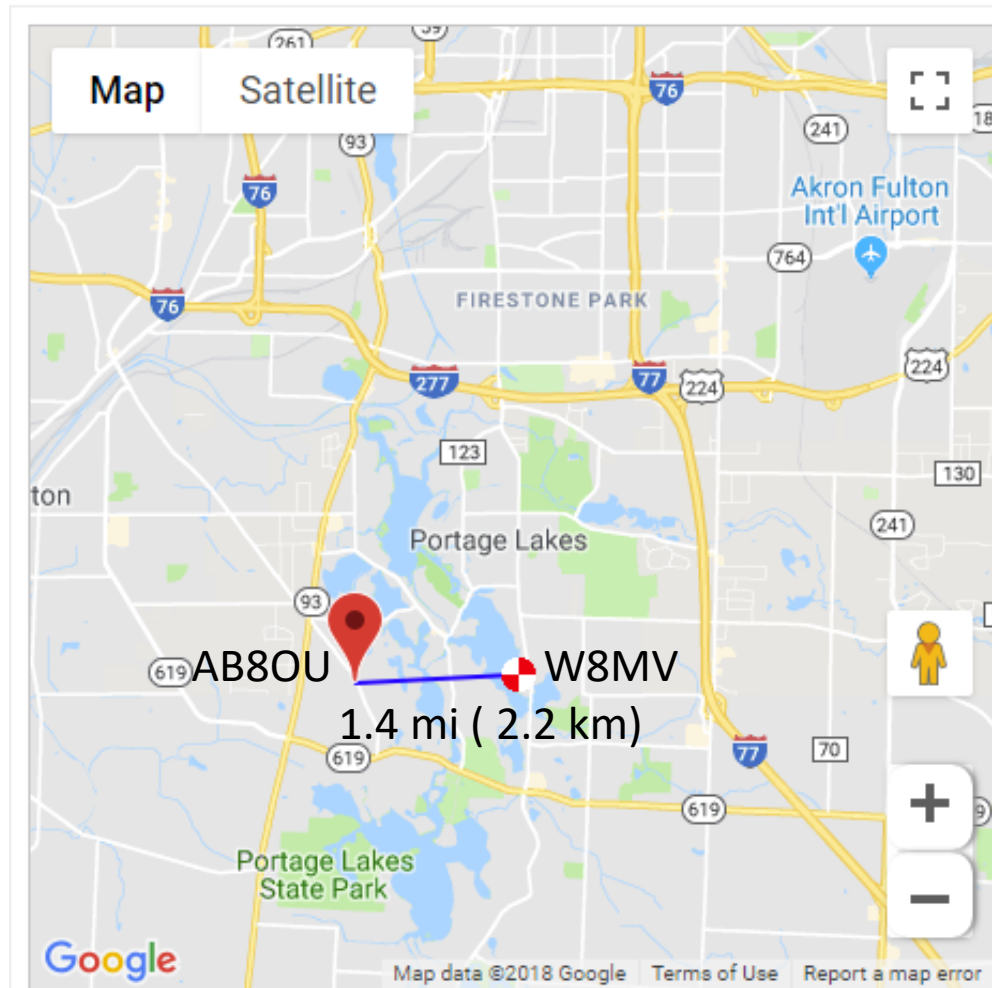
# Modulation Detail



- Multiple transmitters share a common 200 Hz-wide band
- There is no frequency assignment, so interference can occur
- People (or radios) randomize their frequency, pick timeslots, repetition rates to reduce collisions
- We can see the four-level FSK modulation
  - 1.4648 Hz tone separation
  - 1.4648 Hz Baud (2.9296 bits/second)



# AB80U vs W8MV



# AB8OU-W8MV at 14 MHz, 1 day

**DXPLOTTER SB**

1 hour 3 hours 6 hours **1 day** 1 week 30 days Menu Help

Spots: AB8OU - 14 MHz - 200mW

Compared to W8MV - 14 MHz - 200mW

Received by: ● AB8OU ● W8MV ● Both



# AB8OU-W8MV at 14 MHz, 1 day

**DXPLORE** SB

premium mode

1 hour 3 hours 6 hours **1 day** 1 week 30 days Menu Help

Spots: AB8OU - 14 MHz - 200mW

Compared to W8MV - 14 MHz - 200mW

Received by: ● AB8OU ● W8MV ● Both



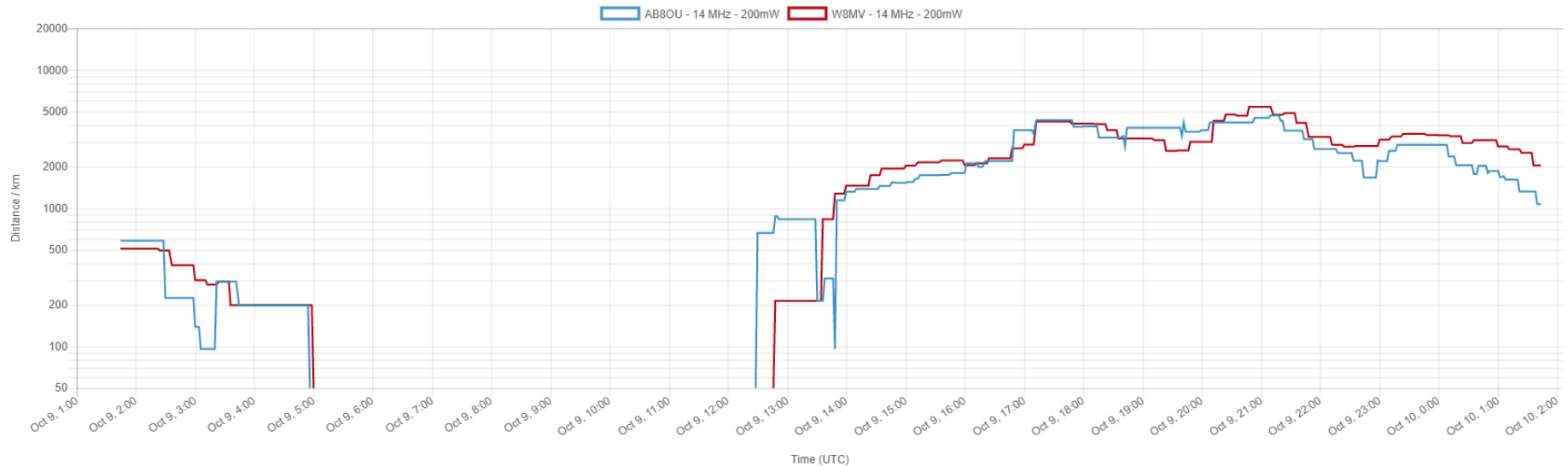
# AB8OU-W8MV at 14 MHz, 1 day

**DXPLORE** SB

1 hour 3 hours 6 hours **1 day** 1 week 30 days Menu Help

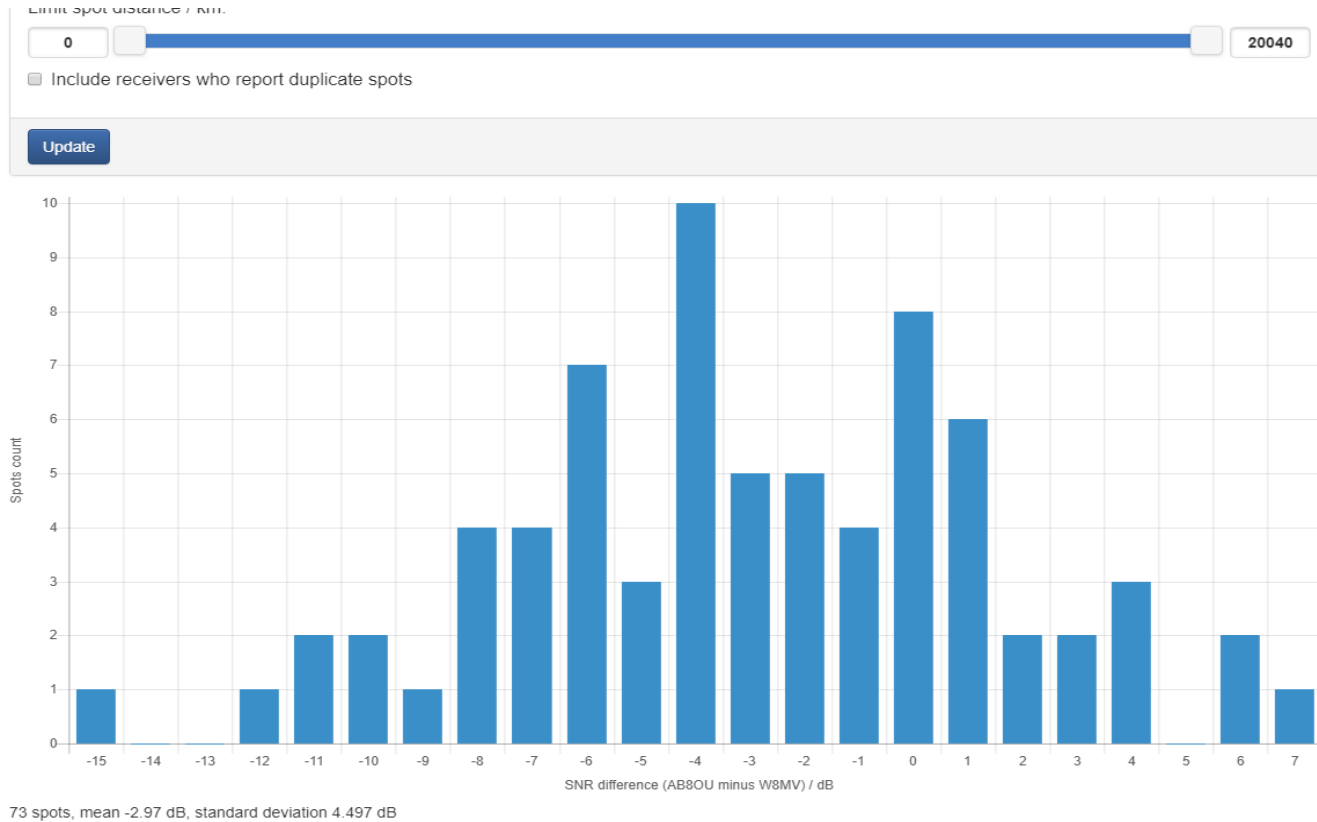
## DX10 graph

Range:  
AB8OU: mean 7.3%, max 23.5%  
W8MV: mean 8%, max 27.1%



Contact us: [richard@sotabeams.co.uk](mailto:richard@sotabeams.co.uk)

# AB8OU vs W8MV at 14 MHz, 1 day - Simultaneous spots



# AB8OU vs W8MV at 14 MHz, 1 day - Simultaneous spots

73 spots

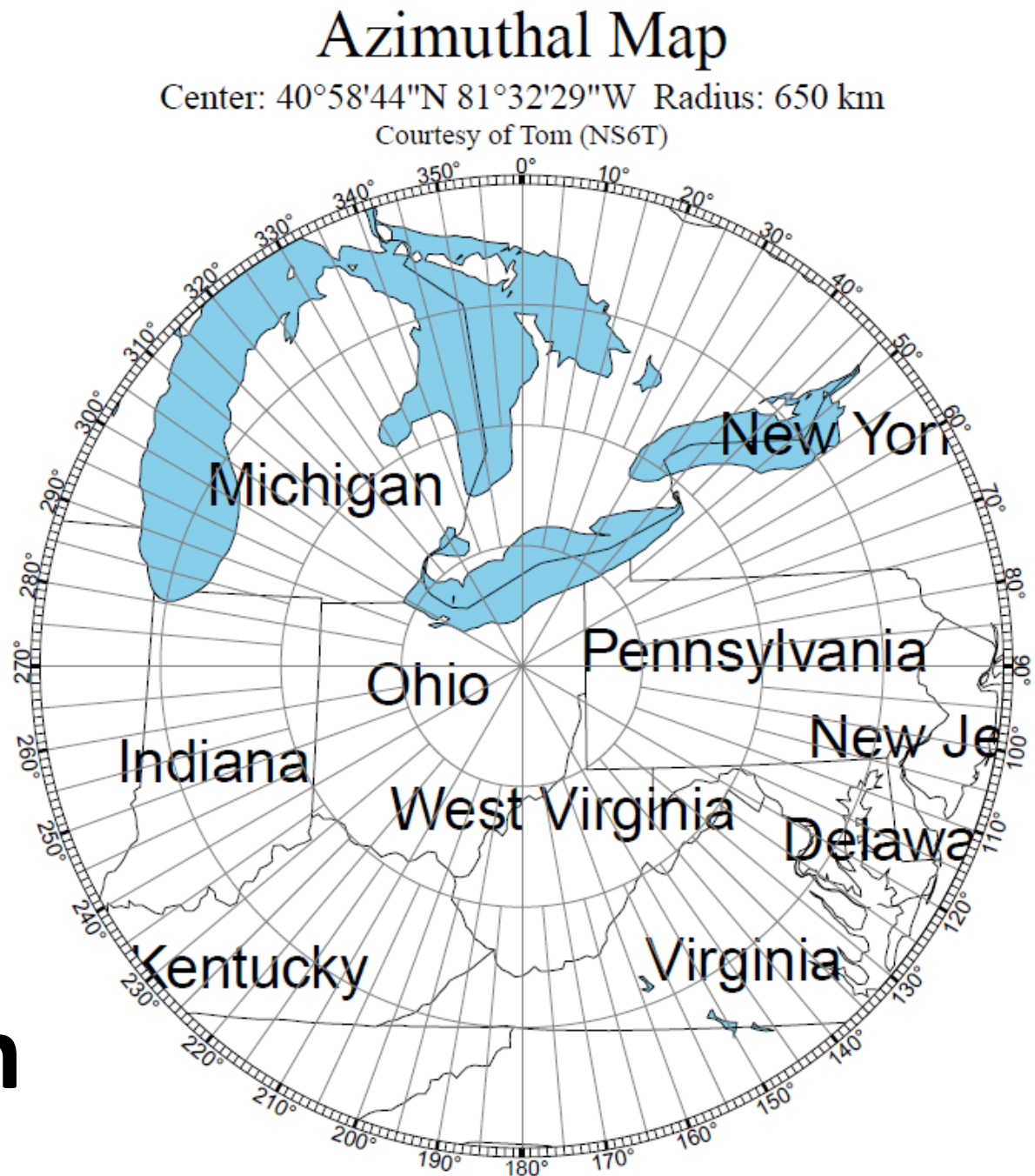
Export: [CSV](#)

Time	Freq/MHz		Rx callsign	Rx grid	SNR			Pwr/dBm		km	az
	AB8OU	W8MV			AB8OU	W8MV	diff	AB8OU	W8MV		
2018-10-09 23:36	14.097141	14.097107	KA7OEI-1	DN31uo	-13	-12	-1	23	23	2556	282
2018-10-09 23:36	14.097152	14.097118	KD6RF	EM22lr	2	2	0	23	23	1508	237
2018-10-09 23:36	14.097142	14.097108	KPH	CM88mc	-29	-18	-11	23	23	3533	279
2018-10-09 23:36	14.097153	14.097119	N0TOI	EM48dd	-26	-23	-3	23	23	926	253
2018-10-09 23:36	14.097142	14.097109	N6GN/K2	DN70jo	-24	-13	-11	23	23	1987	277
2018-10-09 23:36	14.097150	14.097116	W5TCX	EL29	-3	1	-4	23	23	1763	228
2018-10-09 22:48	14.097142	14.097109	K5XL	EM12kp	-8	-2	-6	23	23	1664	241
2018-10-09 22:48	14.097142	14.097109	KA7OEI-1	DN31uo	-24	-20	-4	23	23	2556	282
2018-10-09 22:48	14.097156	14.097123	KG5LBS	EM10bf	-17	-17	0	23	23	1894	236
2018-10-09 22:48	14.097142	14.097109	N6GN/K2	DN70jo	-20	-10	-10	23	23	1987	277
2018-10-09 22:48	14.097150	14.097116	W5TCX	EL29	-8	-2	-6	23	23	1763	228
2018-10-09 22:12	14.097142	14.097109	K5XL	EM12kp	-2	4	-6	23	23	1664	241
2018-10-09 22:12	14.097142	14.097109	KA7OEI-1	DN31uo	-19	-15	-4	23	23	2556	282
2018-10-09 22:12	14.097141	14.097107	KE7A	EM12kx	-4	-2	-2	23	23	1642	242
2018-10-09 22:12	14.097156	14.097123	KG5LBS	EM10bf	-13	-14	1	23	23	1894	236
2018-10-09 22:12	14.097149	14.097116	W5TCX	EL29	-6	-2	-4	23	23	1763	228
2018-10-09 22:00	14.097142	14.097108	K5XL	EM12kp	-6	0	-6	23	23	1664	241
2018-10-09 22:00	14.097142	14.097108	KA7OEI-1	DN31uo	-8	-9	1	23	23	2556	282
2018-10-09 22:00	14.097142	14.097108	N6GN/K2	DN70jo	-5	0	-5	23	23	1987	277
2018-10-09 22:00	14.097149	14.097116	W5TCX	EL29	-4	2	-6	23	23	1763	228
2018-10-09 21:24	14.097142	14.097109	K5XL	EM12kp	-3	5	-8	23	23	1664	241
2018-10-09 21:24	14.097147	14.097114	KA7OEI-1	DN31uo	-15	-11	-4	23	23	2556	282
2018-10-09 21:24	14.097156	14.097123	KG5LBS	EM10bf	-19	-19	0	23	23	1894	236
2018-10-09 21:24	14.097142	14.097109	KJ6MKI	CM88oi	-24	-21	-3	23	23	3510	279
2018-10-09 21:24	14.097142	14.097109	N6GN/K2	DN70jo	-18	-6	-12	23	23	1987	277
2018-10-09 21:24	14.097142	14.097109	N6KOG	CM97gs	-18	-12	-6	23	23	3420	277
2018-10-09 21:24	14.097150	14.097116	W5TCX	EL29	-4	3	-7	23	23	1763	228

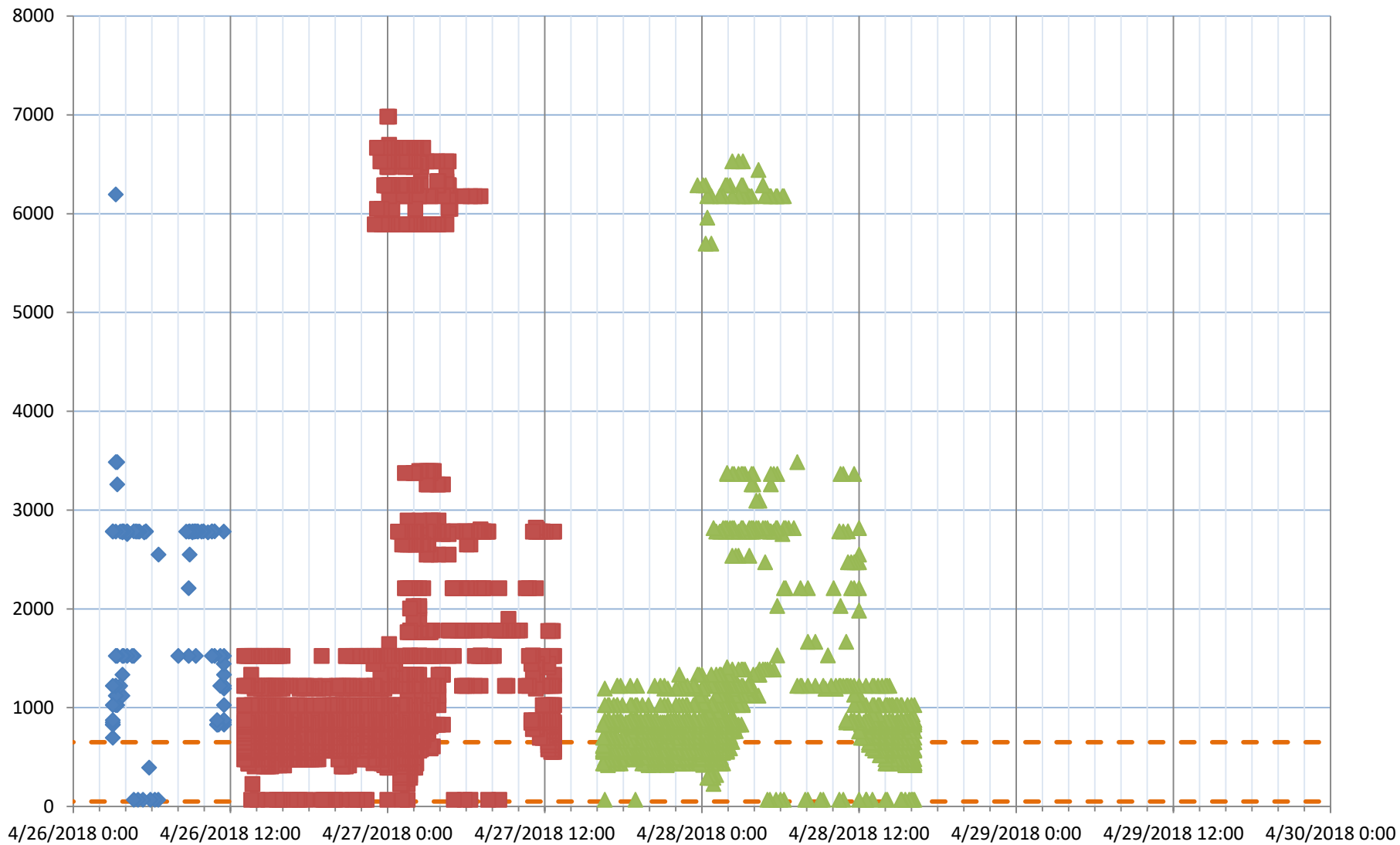
# NVIS

## Near Vertical Incidence Skywave

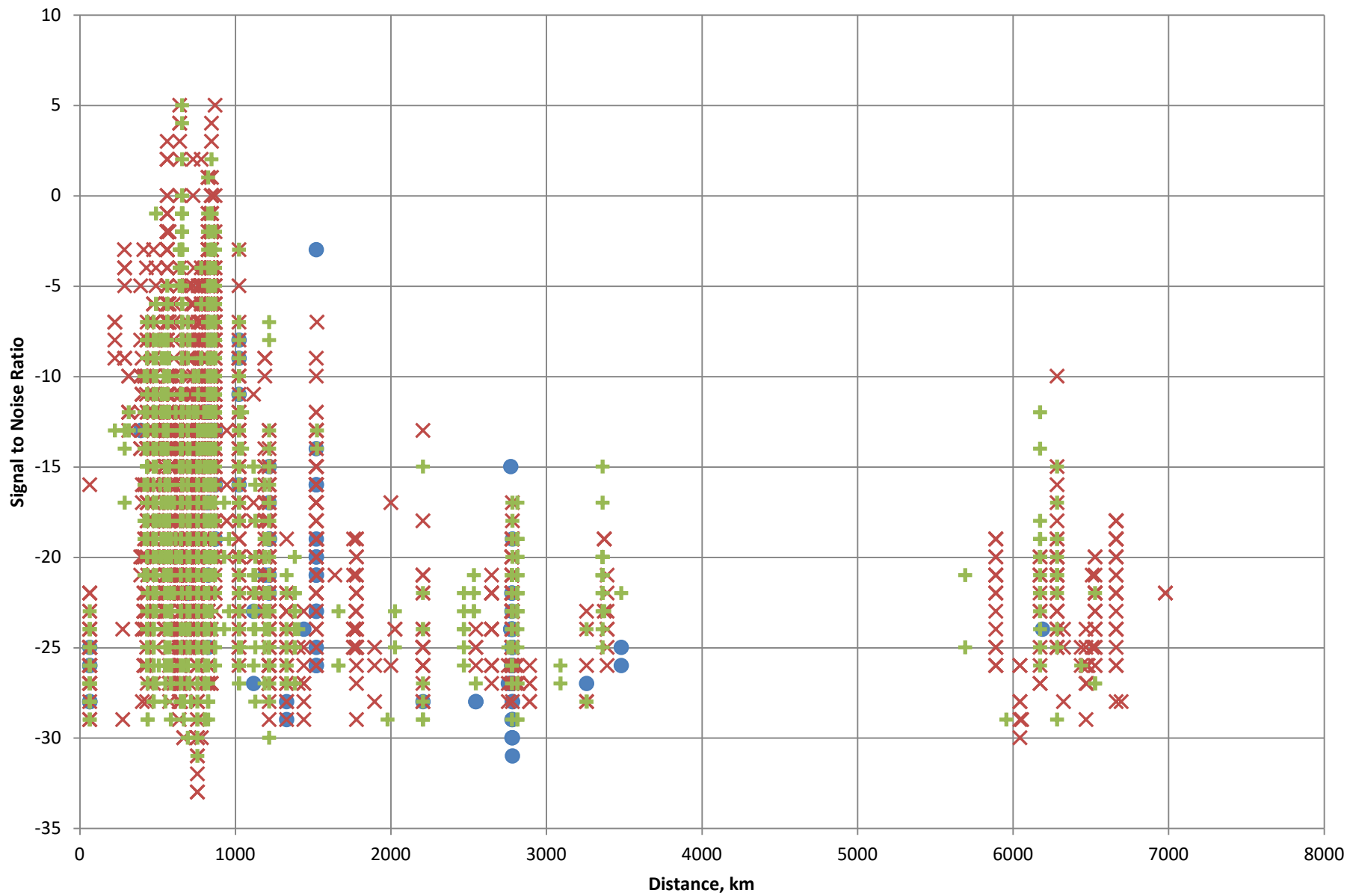
### 50 - 650 km



◆ 6BTV    ■ 40M DIPOLE    ▲ 6BTV    -x- NVIS 650 km    -x- NVIS 50 km







# For Further Information

- <http://wsprnet.org>
- <https://physics.princeton.edu/pulsar/k1jt/>
- <https://www.sotabeams.co.uk/wsprlite-antenna-tester/>
- <https://www.dxengineering.com>
- [wb6cxc.com/wp-content/uploads/2016/03/Ham-Presentation.pdf](http://wb6cxc.com/wp-content/uploads/2016/03/Ham-Presentation.pdf)