

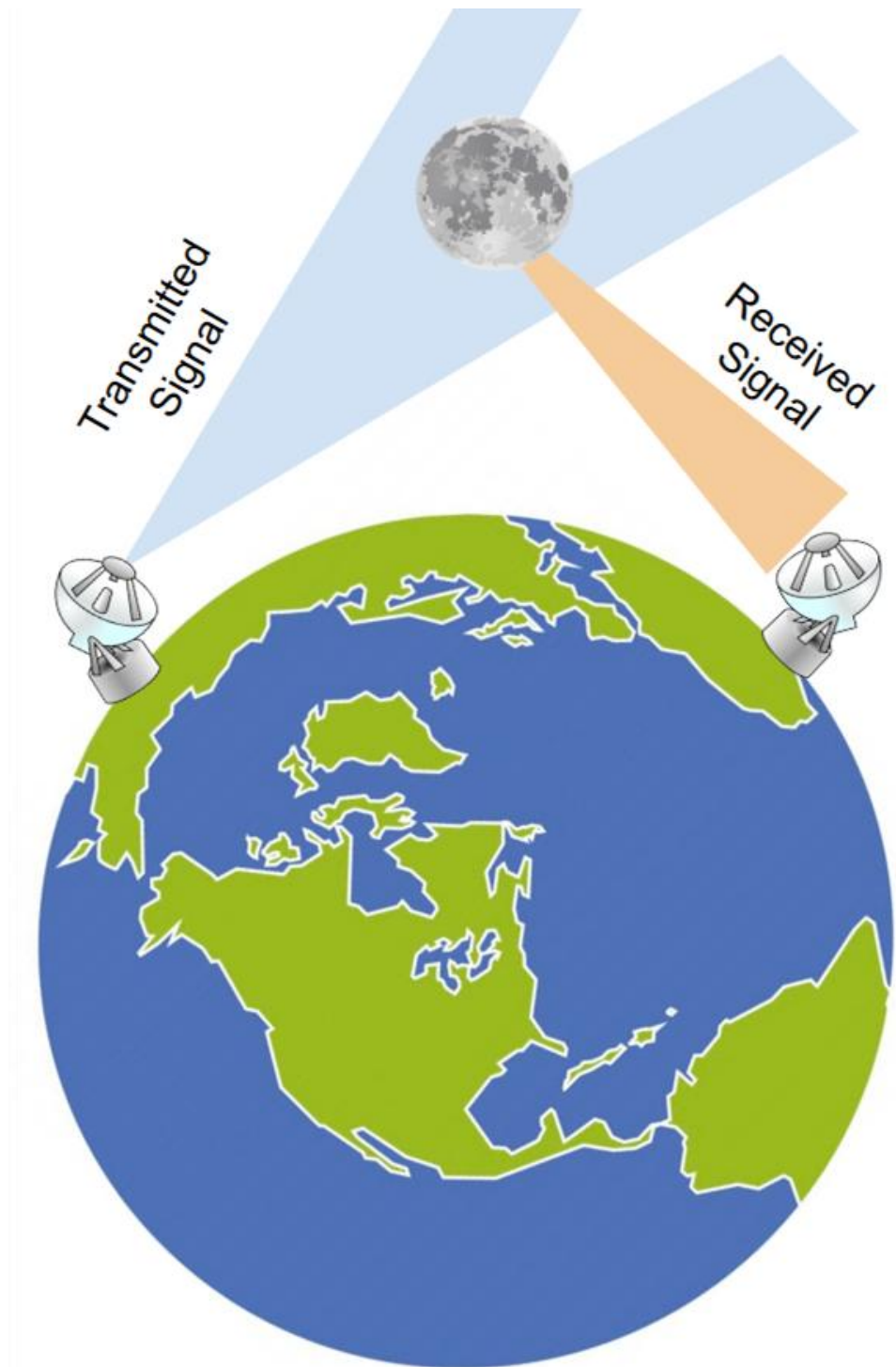
NC STATE **W4ATC**



**Earth-Moon-Earth
Communication
NC State University
Student Amateur Society
W4ATC**

Overview

- Earth-moon-earth (EME) communication is a challenging form of two-way communication which uses the moon to propagate signals
- EME is popular on the VHF and higher bands
- Traditionally, EME required large expensive stations; the advent of weak signal digital modes have made EME more accessible



History

- **1940:** First proposed by W.J. Bray
- **1943:** German Radar found to have echos
- **1946:** Project Diana successfully bounces a signal off the moon
- **1950s:** Moon relay project attempts to establish military communications
- **1953:** First amateur radio EME contact

QSL Card.

en.wikipedia.org/wiki/Project_Diana#/media/File:Diana_QSL.jpg

Project Diana Antenna.

https://en.wikipedia.org/wiki/Project_Diana#/media/File:Project_Diana_antenna.jpg



Necessary Equipment

- Directional Antenna and Rotator
 - Yagi-Uda or Dish
- Preamplifier and Sequencer
- RF Amplifier
- Radio capable of USB and CW
- Personal Computer
 - Multiple software applications



Directional Antenna

- Yagi common for lower bands (6 meter - 70 cm)
 - Large arrays often used to boost gain
- Dish used more often for higher bands (1296 MHz and above)
- Also need a rotator
 - Azimuth / Elevation options available commercially
 - Polar rotators can be homebrewed

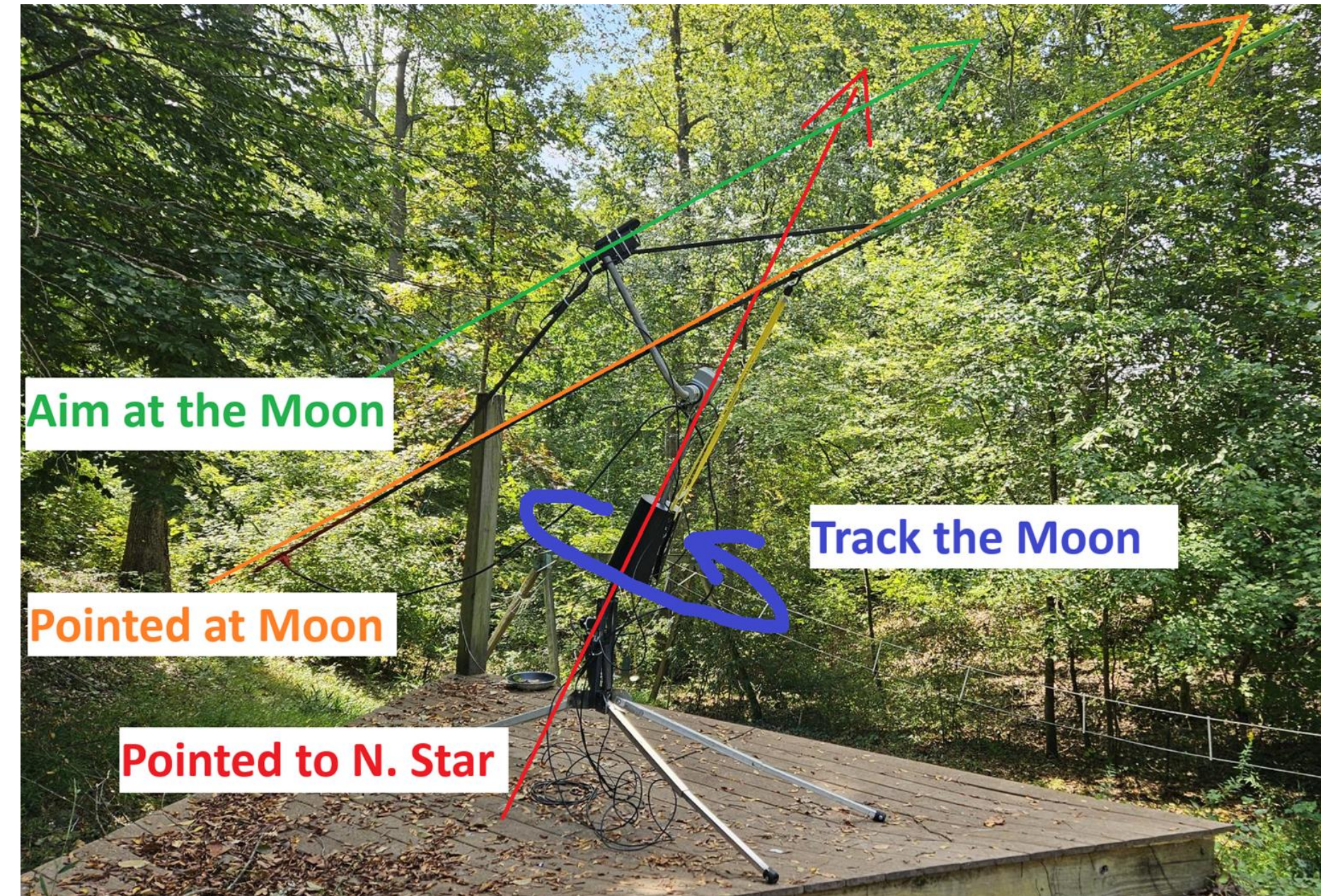
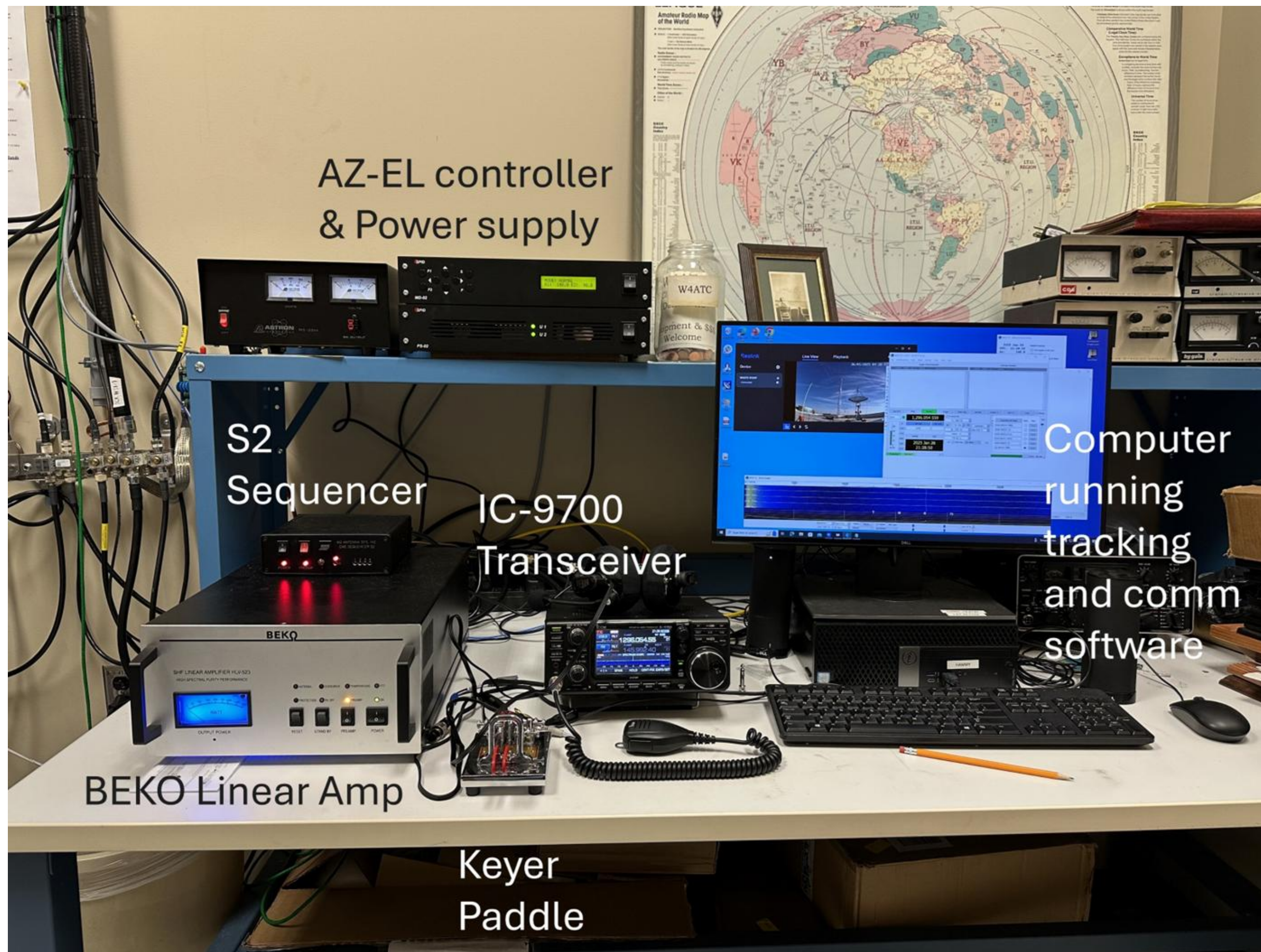
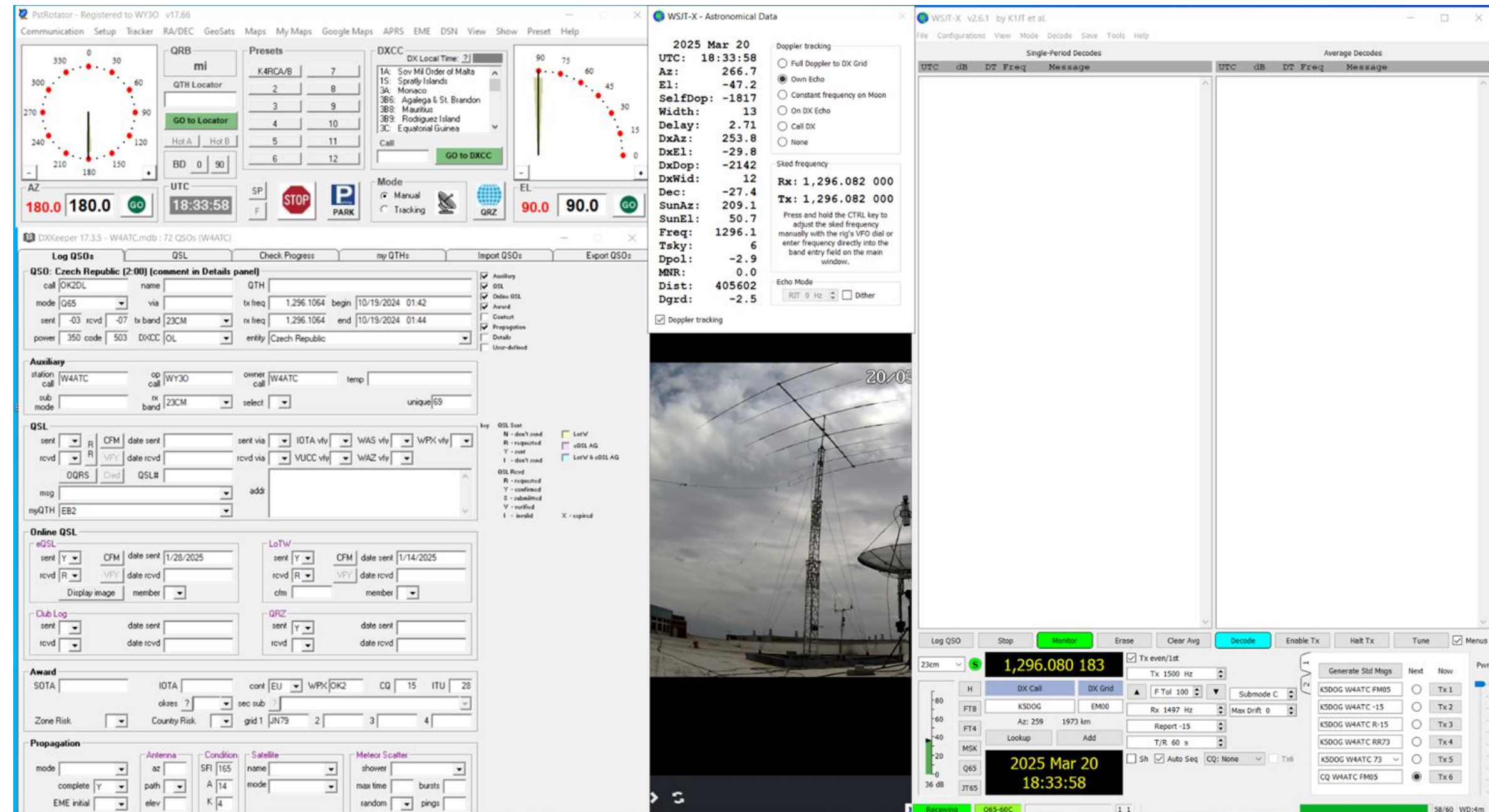


Image courtesy of Brad Odell, KK1LL
carc-nc.us/forums/threads/building-a-moon-bounce-station.345/



Computer and Software

- **WSJT-X** primary software for encoding/ decoding of Q65 signals
- **JT Alert for WSJT-X** sends contact data to logbook
- **DXKeeper** logbook
- **PSTRotator** for tracking the moon



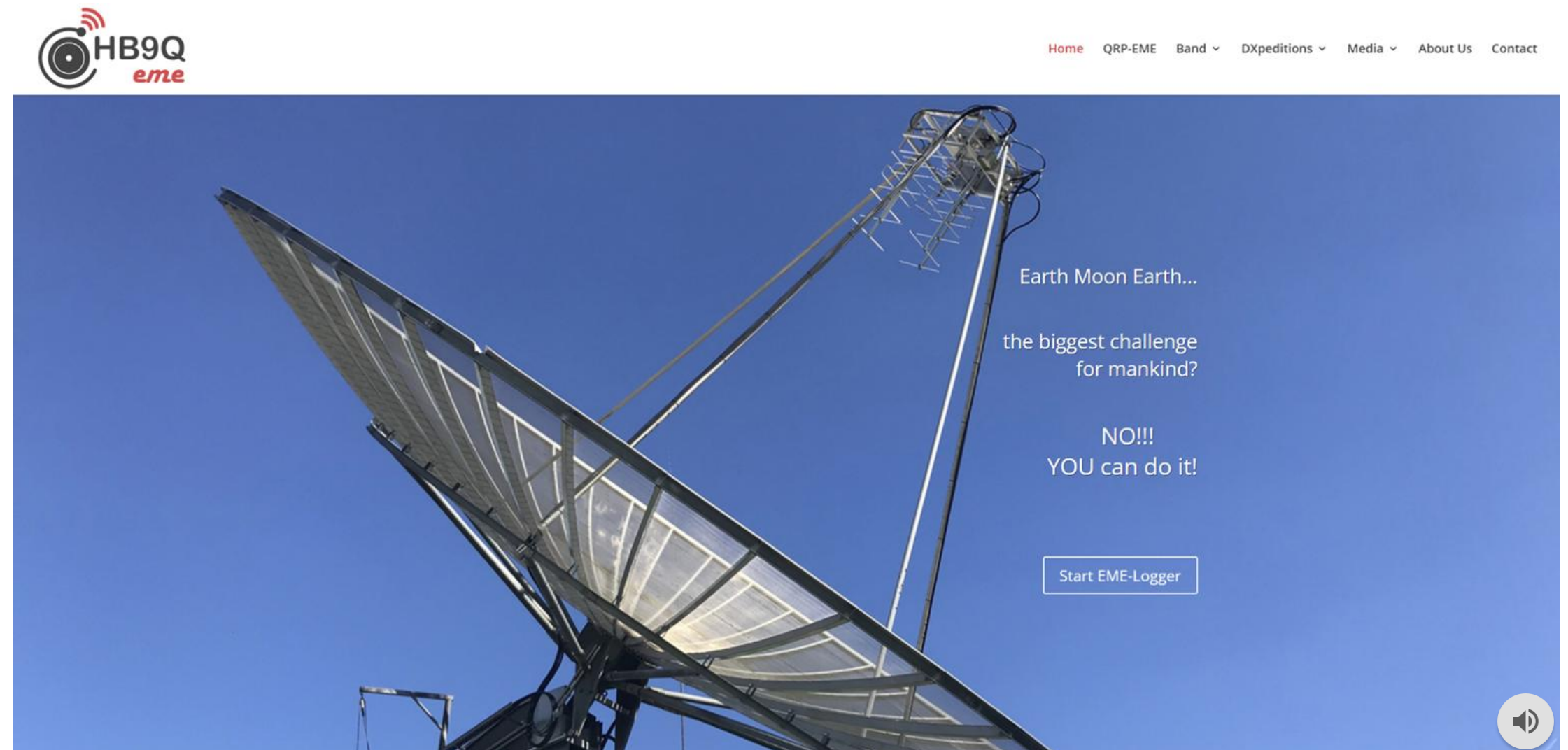
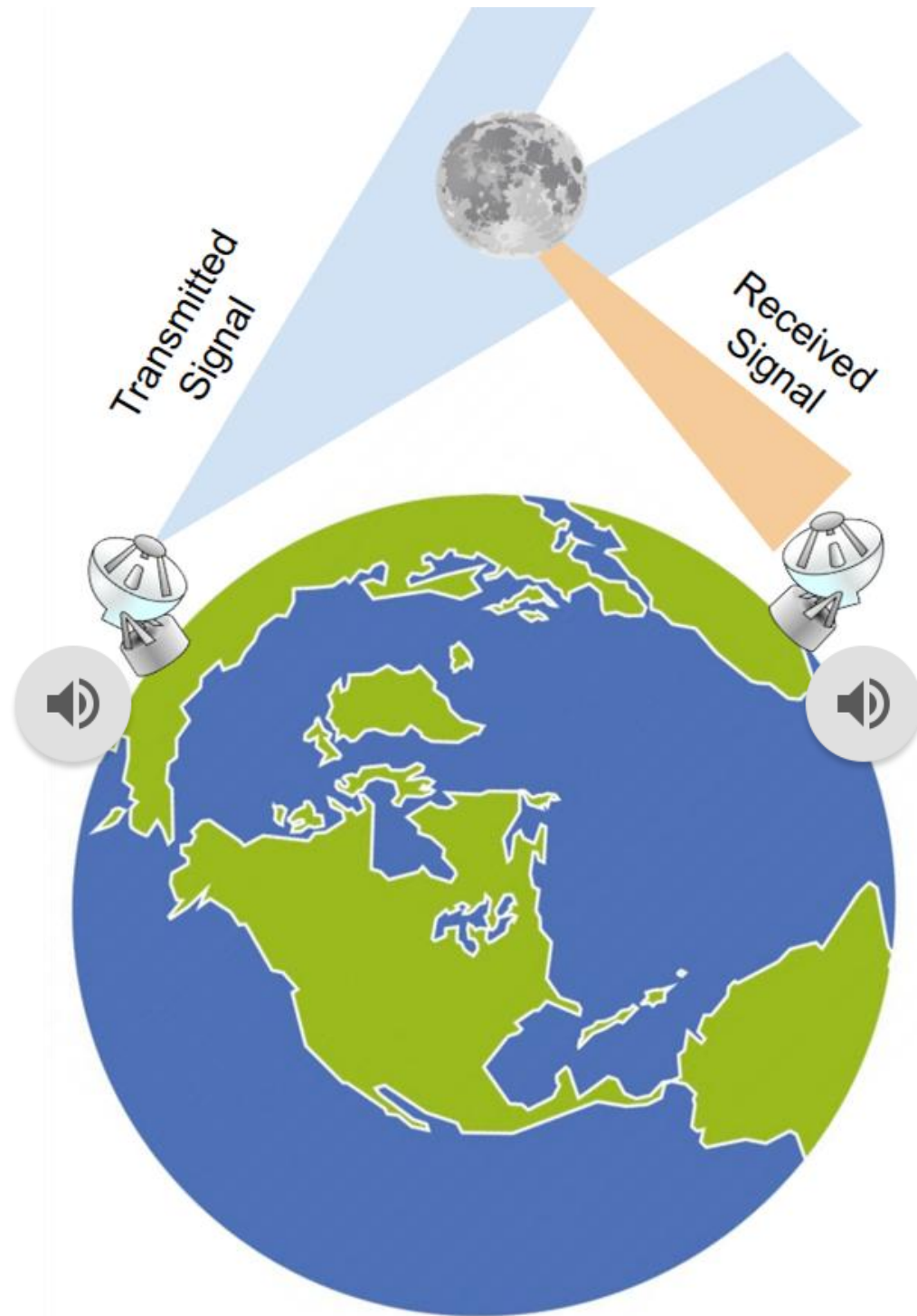
Weak Signal Detection: Q65

- Opened the door for smaller stations to participate in EME
- Designed by Joe Taylor, K1JT
- Time frames globally synchronized
 - 22 “tone 0” signals
- 77 bit message, with error correction
- 65 Tone FSK
- Multiple Submodes
 - Common: 60C



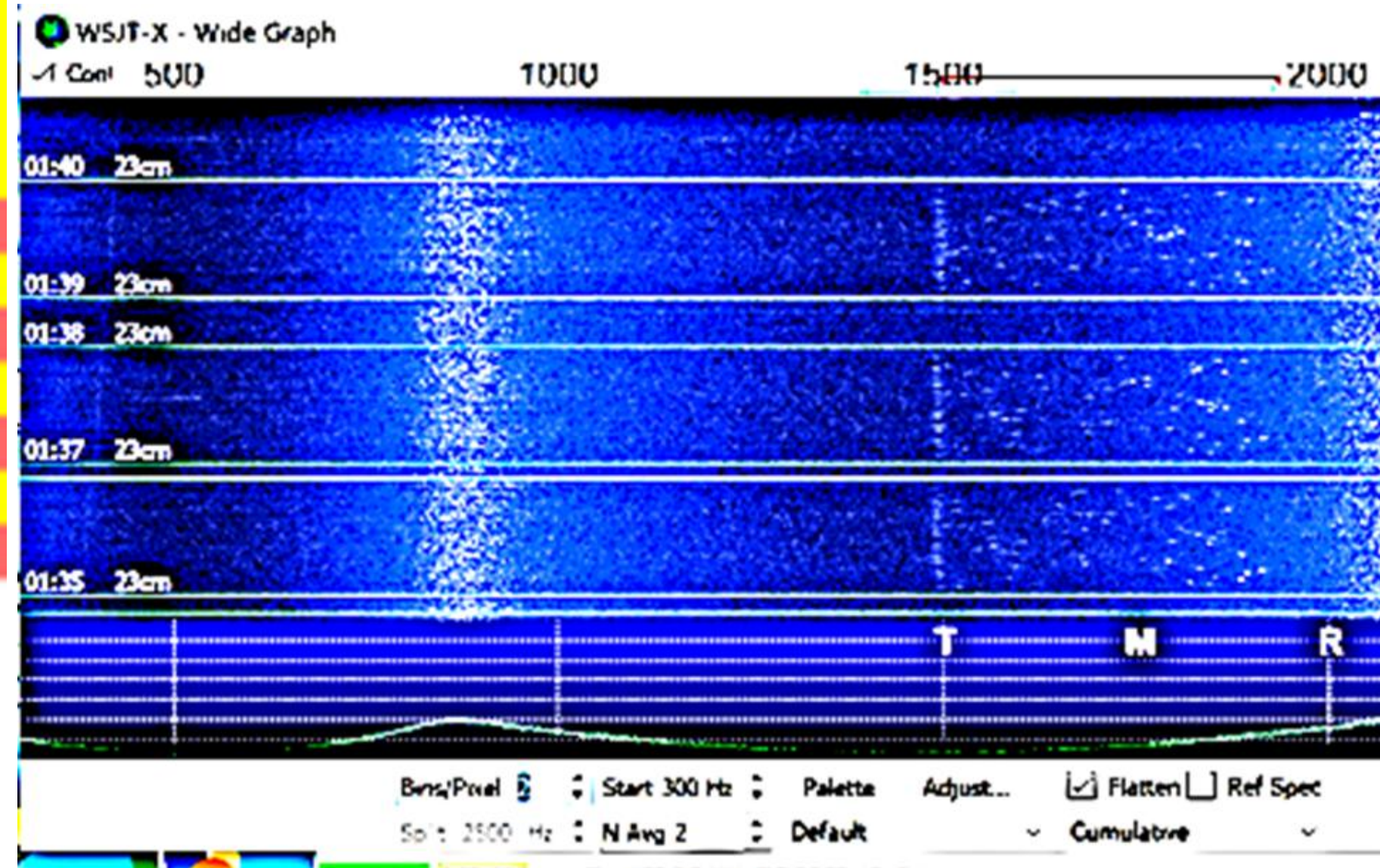
Joe Taylor, K1JT. ARRL.
<https://www.arrl.org/news/nobel-prize-winner-joe-taylor-k1jt-helps-reopen-dutch-radio-telescope>.

Q65 Transmit / Receive



Typical Contact

Average Decodes					
UTC	dB	DT	Freq	Message	
0116	Tx		1500	: NY1V W4ATC FM05	
0118	Tx		1500	: NY1V W4ATC FM05	
0124	Tx		1500	: CQ W4ATC FM05	
0126	Tx		1500	: CQ W4ATC FM05	
0128	Tx		1500	: CQ W4ATC FM05	
0130	Tx		1500	: CQ W4ATC FM05	
0132	Tx		1500	: CQ W4ATC FM05	
0133	-12	2.5	1492	: W4ATC K5DOG EM00	q0
0134	Tx		1500	: K5DOG W4ATC -12	
0135	-13	2.5	1492	: W4ATC K5DOG R-12	q3
0136	Tx		1500	: K5DOG W4ATC RR73	
0137	-13	2.6	1494	: W4ATC K5DOG R-12	q3
0138	Tx		1500	: K5DOG W4ATC RR73	
0139	-12	2.6	1495	: W4ATC K5DOG 73	q3



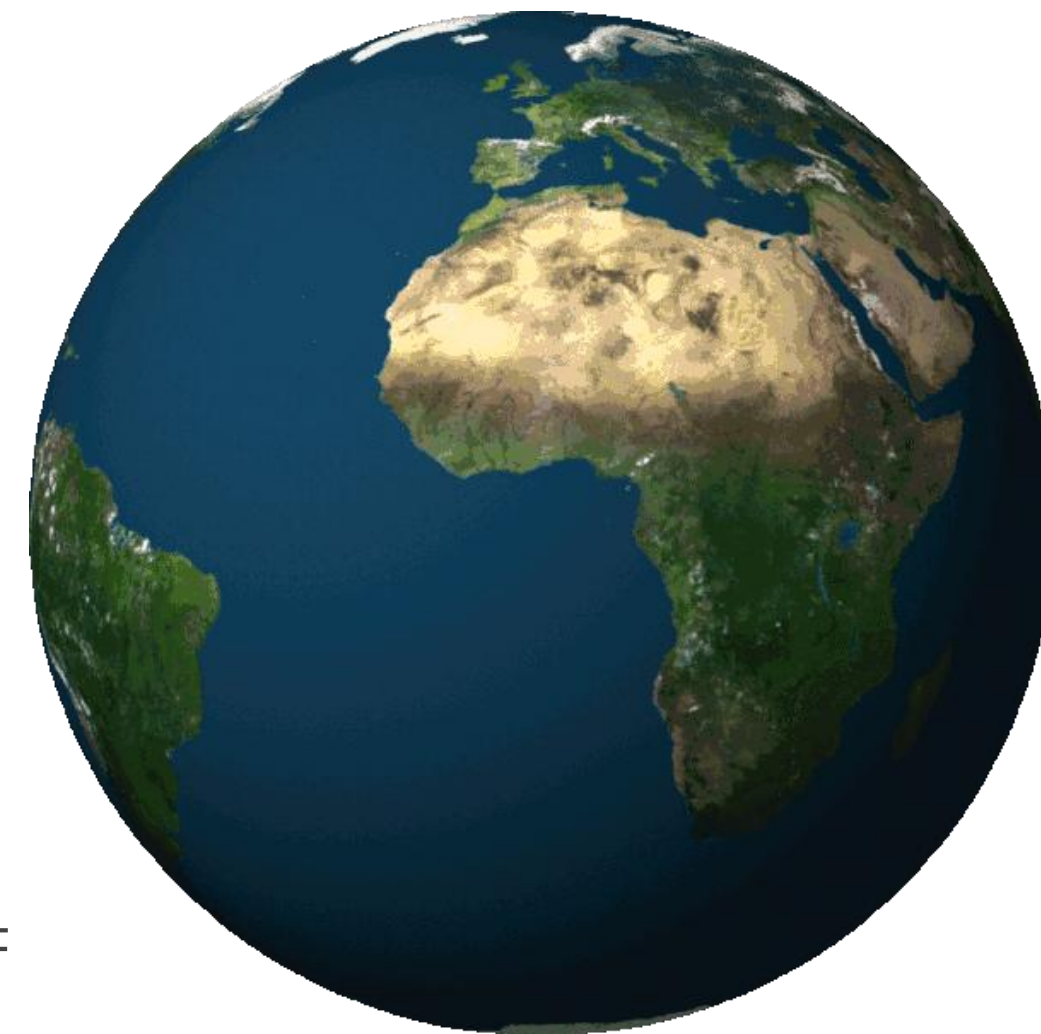
Doppler Shift

- Moving away from moon: apparent frequency decreases
- Moving towards the moon: apparent frequency increases
- Doppler shift at 1296 MHz can be up to ± 3 KHz
- Doppler affects transmit and receive
- Common practice: constant frequency on moon (CFOM)

Roses are red

Roses are blue

Depending on their velocity,
Relative to you

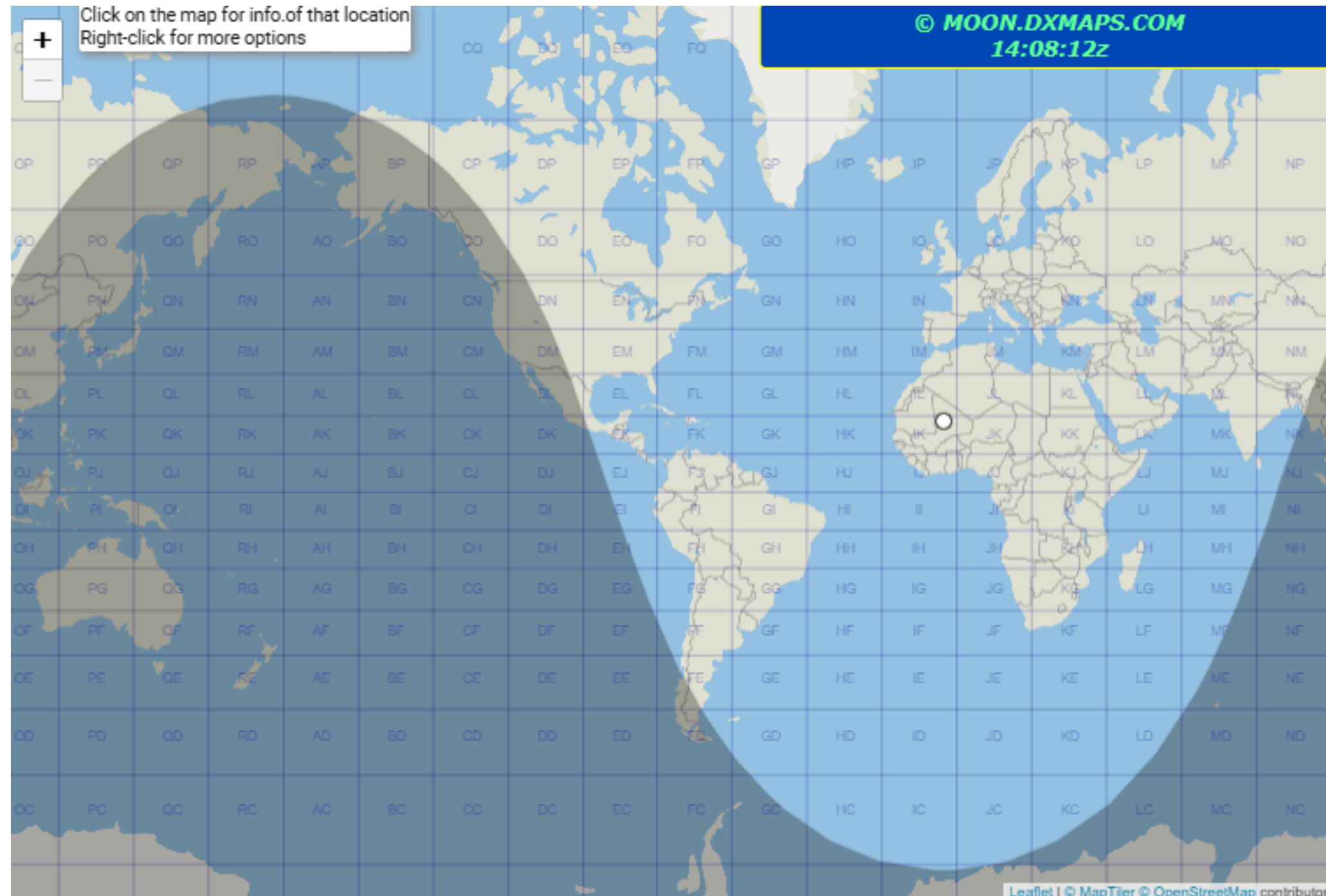


Doppler Effect GIF. Wikimedia.
https://upload.wikimedia.org/wikipedia/commons/e/e6/Doppler_Effect.gif

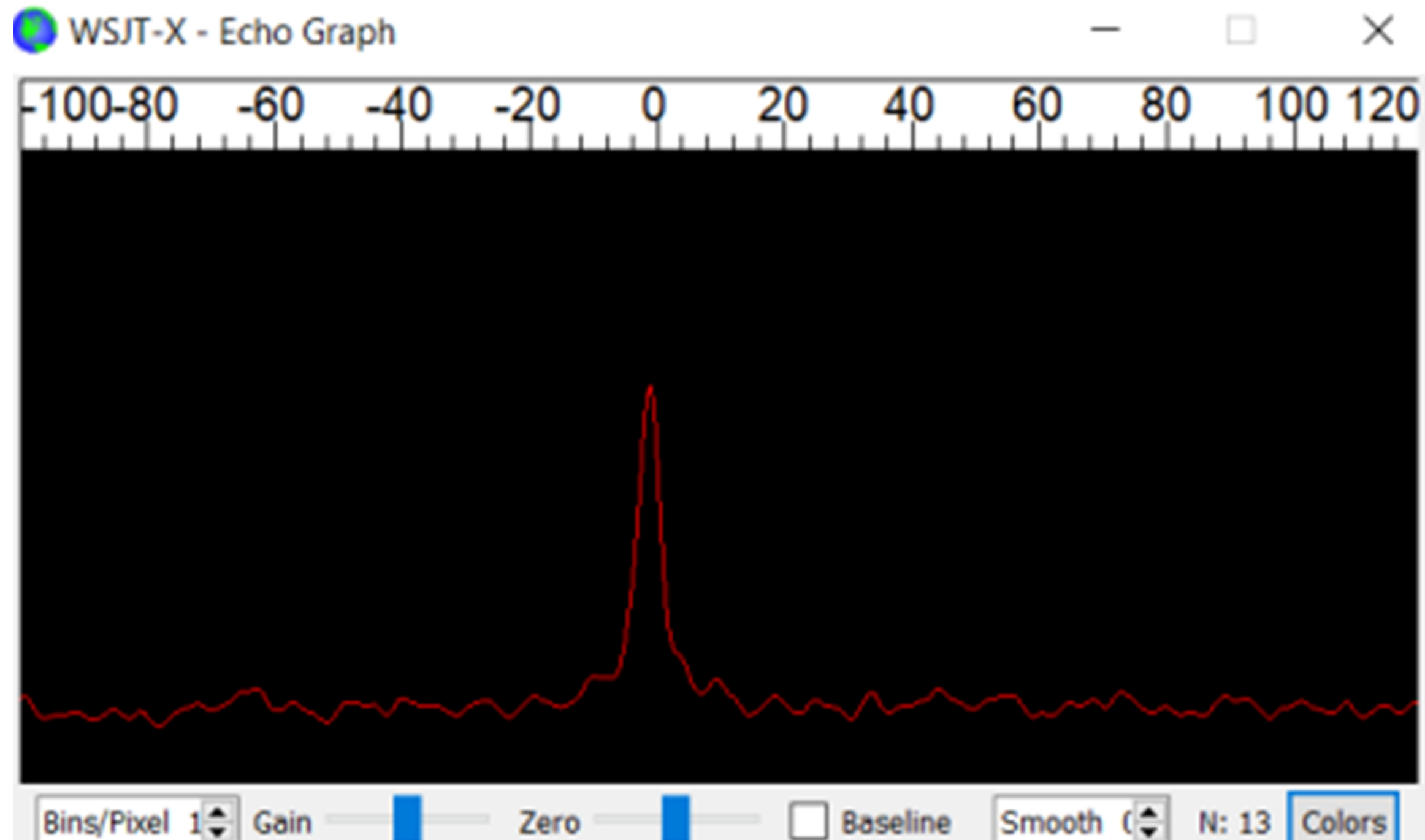
Rotating Earth. Wikimedia.
https://commons.wikimedia.org/wiki/File:Rotating_earth_%28huge%29.gif

Who can you contact?

Anyone else who can see the moon!



W4ATC Station Echos



Thank you from W4ATC!

W4ATC Repeater

442.675 MHz, 100 Hz, +5 MHz

Weekly Nets each Tuesday at 20:00
(8:00 PM) throughout the school year.