# High Resolution Propagation Measurements Using a
# *WSPRSONDE-8* beacon and a RX888 Receiver

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# *System Goals*

- Measure WWV/H propagation with same accuracy as the WWV GRAPE 1/2 systems
  - End-to-end frequency accuracy and stability must be much better than the doppler shift introduced by ionospheric motion
  - Simultaneously measure WSPR-2 frequency and doppler shift on all 15 WSPR bands, and upload to wsprnet.org and wsprdaemon.org
  - Simultaneously record all 10 WWV/CHU carrier frequencies and upload to the HamSCI GRAPE servers
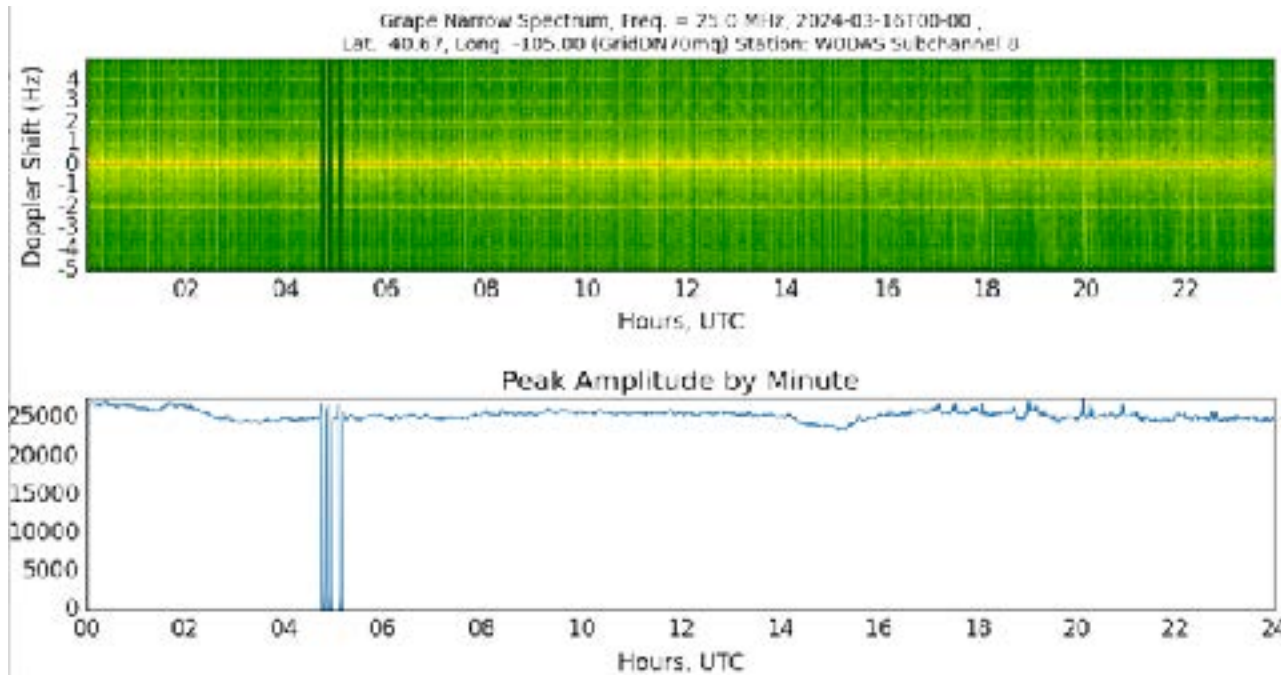


LOS (4 Km path) WWV 25 MHz at W0DAS

LOS (20 Km path) from WB6CXC to KPH

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# The transmit system: *WSPRSONDE-8*

- Goal: A better way to transmit stable and accurate multi-band FST4W and WSPR
  - Multiple one-Watt outputs can be combined for single-antenna operation
  - Frequency and scheduling flexibility
  - Quick and easy deployment
    - One multiband tx antenna
    - One GPSDO and GPS antenna
    - One 12 VDC / 1.5 A power supply
    - *** No Internet connection required ***

- First version developed for the October 2023 eclipse – the "Beacon Blaster 6"
  - A modular approach, allowing for rapid design evolution
  - Units successfully deployed on multiple continents, continuing operation

- *WSPRSONDE-8* is refined, simplified, and enhanced
  - Single-board design, no module interconnects
  - Eight frequency-flexible channels
  - Improved spurious output levels
  - Enhanced self-monitoring capabilities

# *WSPRSONDE-8*

- The WS-8, with the Six-Band Filter / Combiner (80 / 40 / 30 / 20 / 15 / 10 meter bands)
- A Bodnar GPSDO provides the 10 MHz reference clock
- GPS input via common puck antenna (or other type)
- The WS-8 includes a passive antenna splitter, which lets the GPSDO share the antenna
- USB connection for configuration, monitoring, and program updates, not required for operation
- +12VDC (2A) power input

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# WSPRSONDE-8
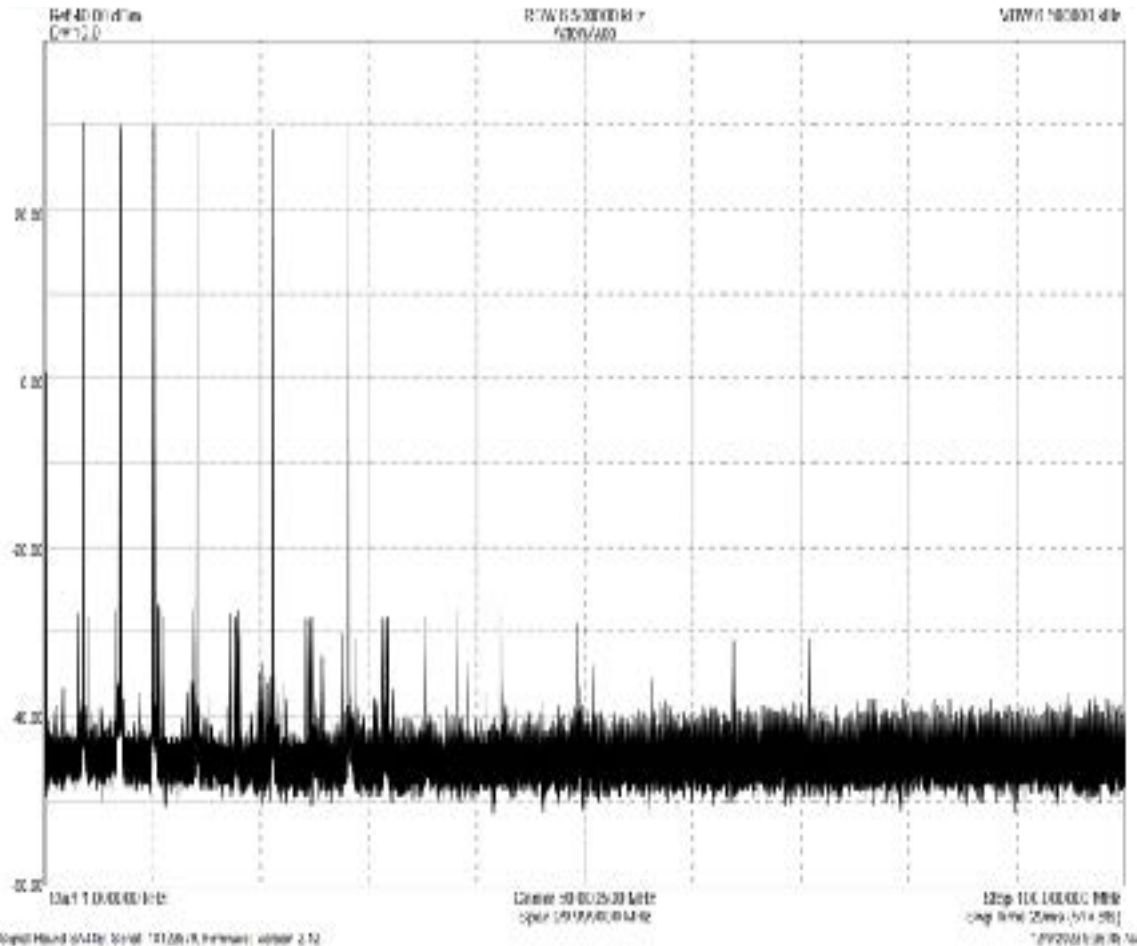
Six-channels through the Filter/Combiner
(some amplifier intermod, less than -57 dBc)
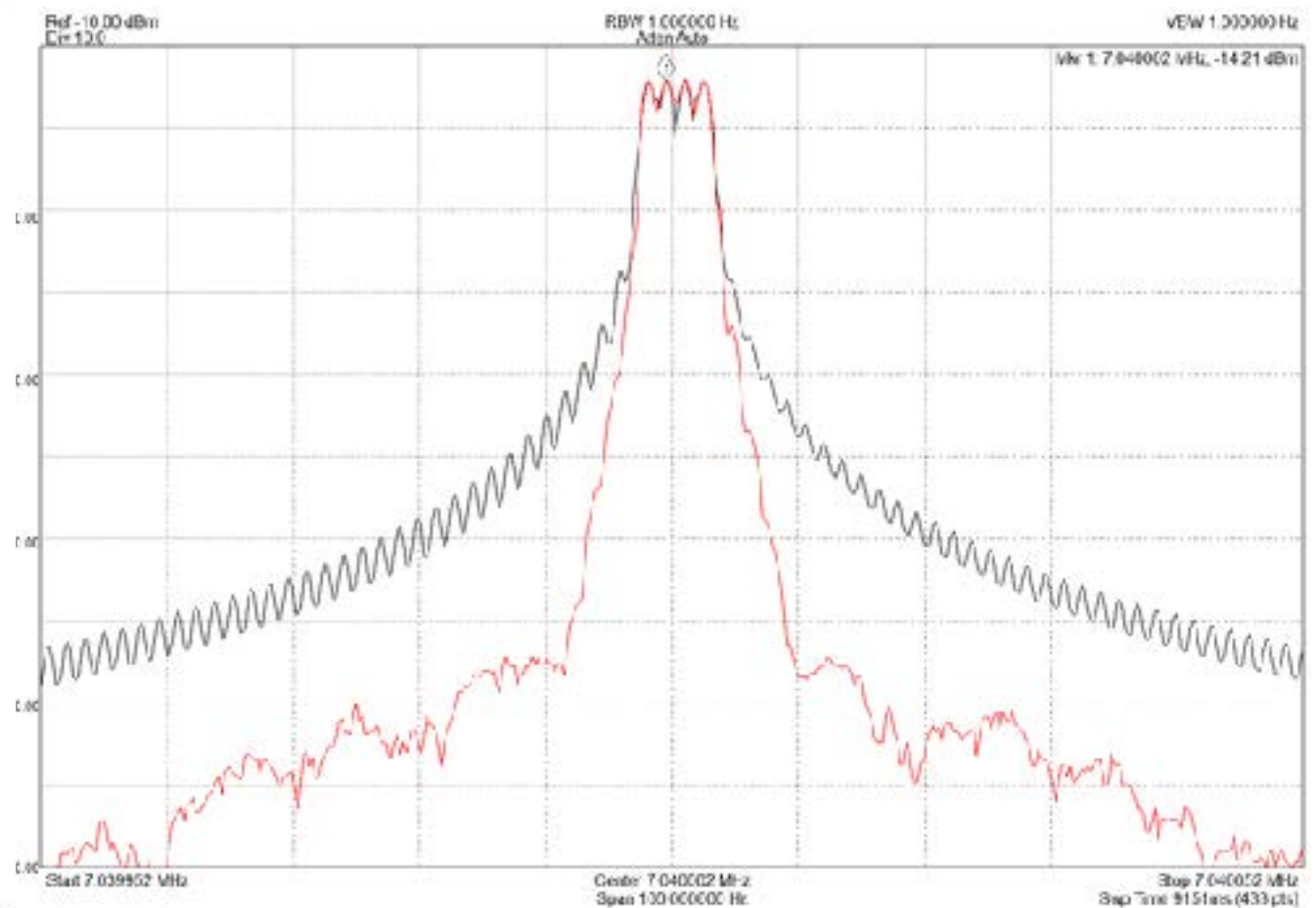
WSPR FSK and FST4W-120 GFSK spectra
(40 meter band)

# The Receive System:
# RX-888 MkII SDR + KA9Q-radio + Wsprdaemon (WD)

- Goal is a high sensitivity and accuracy WSPR and GRAPE receive system at:
  - Low cost
  - From commercially available products
- RX-888 MkII
  - 16 bit ADC in stock from multiple Chinese vendors
  - Requires simple modifications to improve thermals and to accept 27.0 MHz from an external GPSDO
  - Needs 30 MHz Low Pass filter
- GPSDO
  - Leo Bodnar mini
  - TAPR GERT
- KA9Q-radio open source demodulation software
- Wsprdaemon open source WSPR decoding which now includes a GRAPE recording mode
- Linux mini PC host
  - Total system power consumption 25 watts

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- GPSDO
  - Leo Bodnar mini GPSDO $160 https://v3.airspy.us/product/lb-gpsdo-mini/
  - TAPR GERT (target) $100
- RX888 MkII
  - Amazon (next day) $250 https://www.amazon.com/dp/B09FB425CQ
  - AliExpress (China) $160 https://www.aliexpress.us/item/3256803776884712.html
- Linux x86 server
  Lenovo Thinkcentre Tiny i5-6500T for $120 https://www.amazon.com/dp/B07XFH6YXZ
  Beelink SER 5 with Ryzen 5 5560U for $240 https://www.amazon.com/dp/B0CRL3PL4X
- Turn Island System 30 MHz Low Pass Filter
- LNA
- Antenna!

# TURN ISLAND SYSTEMS

- Friday Harbor, WA
- Paul Elliott / WB6CXC
- Steve Roberts / N4RVE
- Other radio-related products:
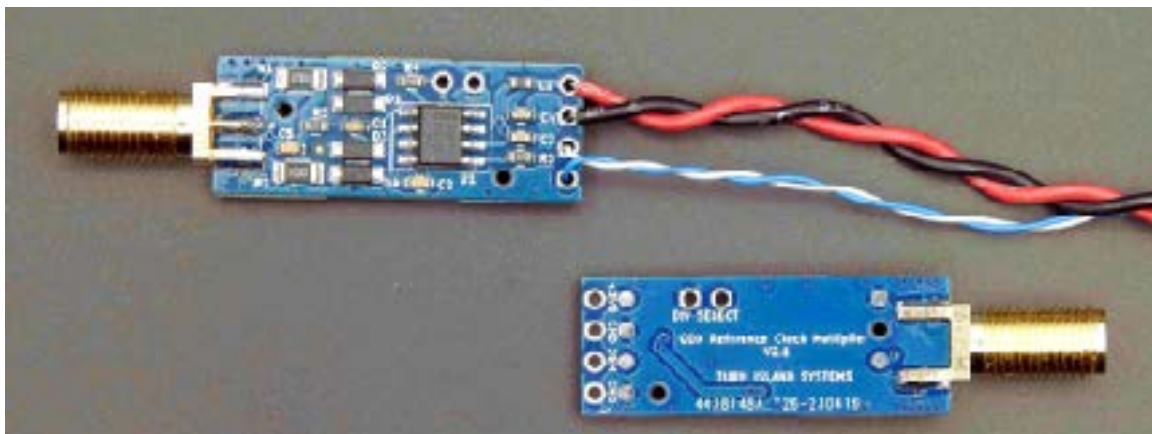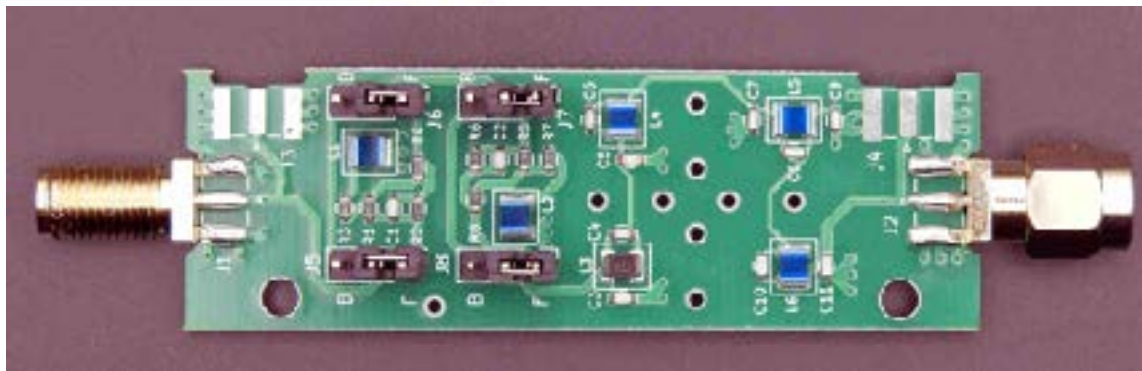


QDX External Reference Adaptor
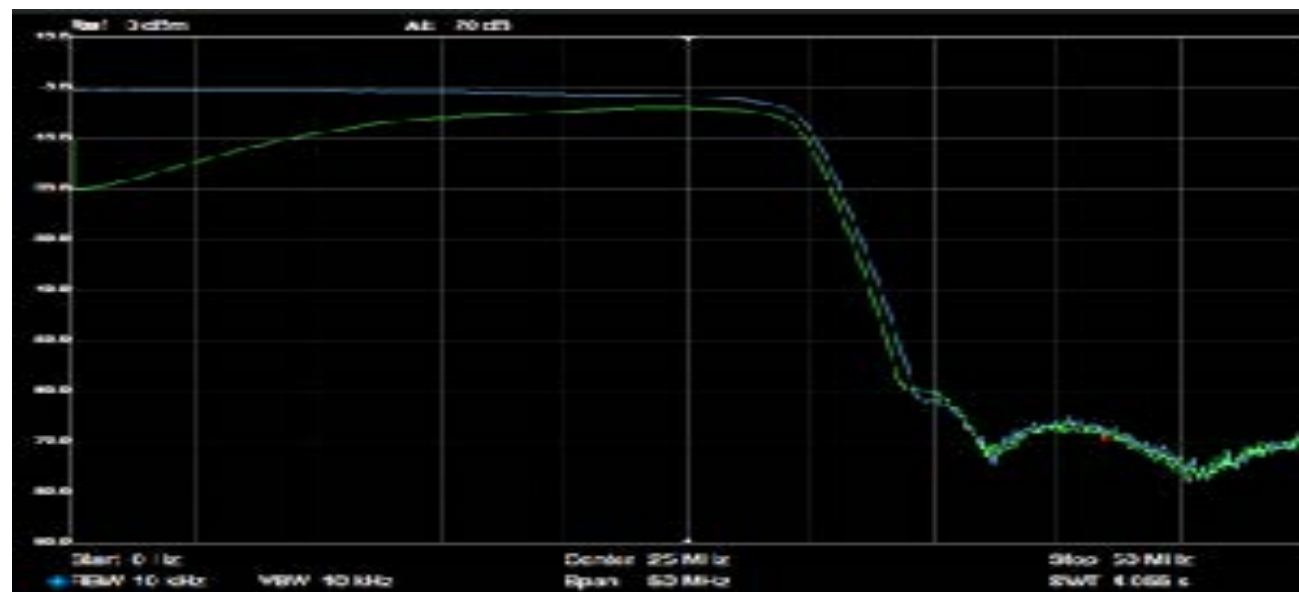
SDR Shelf / Low-Pass Filter

# Acknowledgments

Clint KA7OEI - For introducing me to the RX-888 and KA9Q-radio
Phil KA9Q - For creating KA9Q-radio and his support in integrating it with Wsprdaemon
Nathaniel W2NAF - Fo creating the GRAPE project
Gwyn G3ZIL - For his years of help creating Wsprdaemon and using its data for new propagation insights
Glenn N6GN - For insights into antennas, filters, and external clocking the RX-888
Michael AC0G - For his support in deploying and maintaining the Wsprdaemon sites