High Resolution Propagation Measurements For the HamSCI Personal Space Weather system Using a Wsprdaemon RX888 16 bit 0-30 MHz SDR and a WsprSonde-8 160-6M WSPR/FST4W beacon

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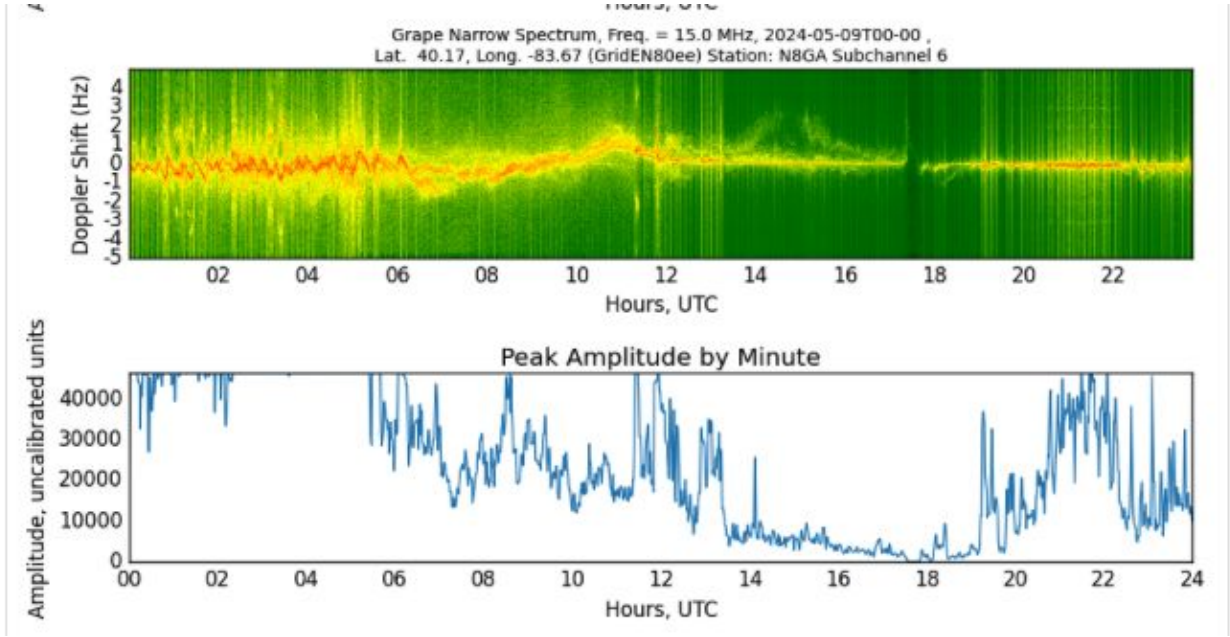
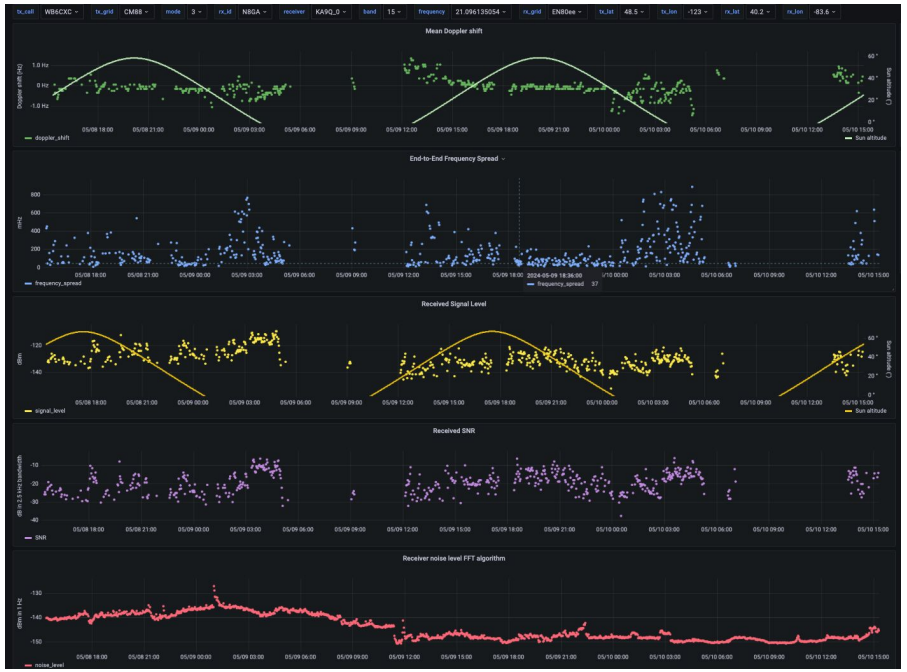
System Goals

- Measure WWV/H and CHU propagation with same sensitivity and accuracy as the HamSCI GRAPE 1/2 receivers
- 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





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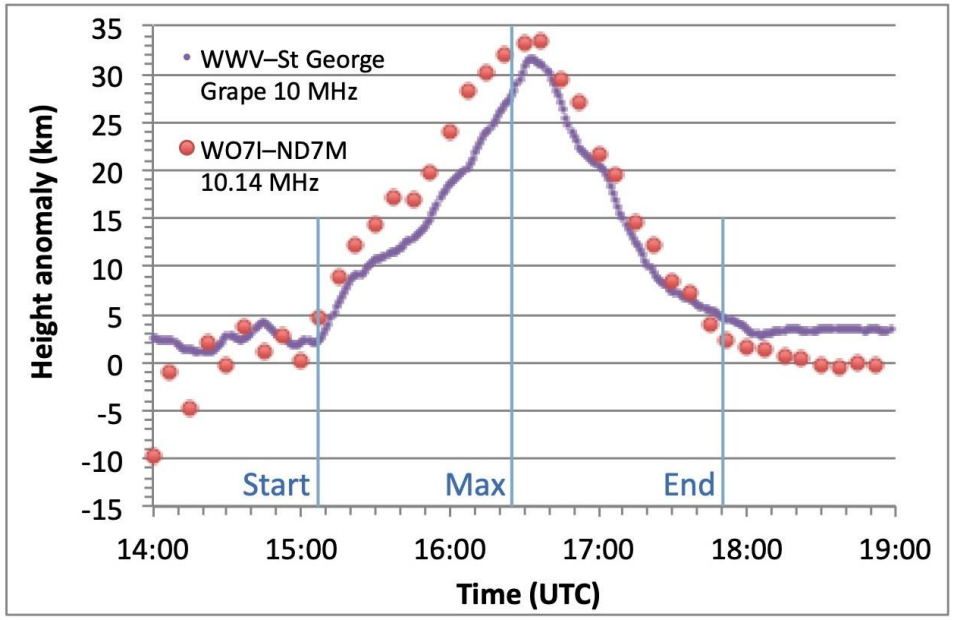
GRAPE and WSPRSONDE: Measuring ionospheric refraction height change, October '23 eclipse

Excellent agreement GRAPE and WSPRSONDE in height of refraction measurement, requiring high stability, low phase noise, and absolute frequency accuracy.

HamSci **GRAPE** receiver at St. George, Utah receives **WWV** 10 MHz.



KiwiSDR at ND7M, Nevada receives **WSPRSONDE** on 80, 40 and 30 m from WO7I

Analysis by Gwyn Griffiths G3ZIL from a presentation at 2024 HamSci.

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The WD-GRAPE 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, no-soldering or drilling modifications to improve thermals and to accept 27.0 MHz from an external GPSDO. Kit is available from Turn Island Systems
  - Needs 30 MHz Low Pass filter
- GPSDO
  - $175 Leo Bodnar mini-GPSDO
  - TAPR GERT GPSDO
- 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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A complete WSPR+GRAPE Receive Station

- GPSDO
  - Leo Bodnar mini GPSDO $175
    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!

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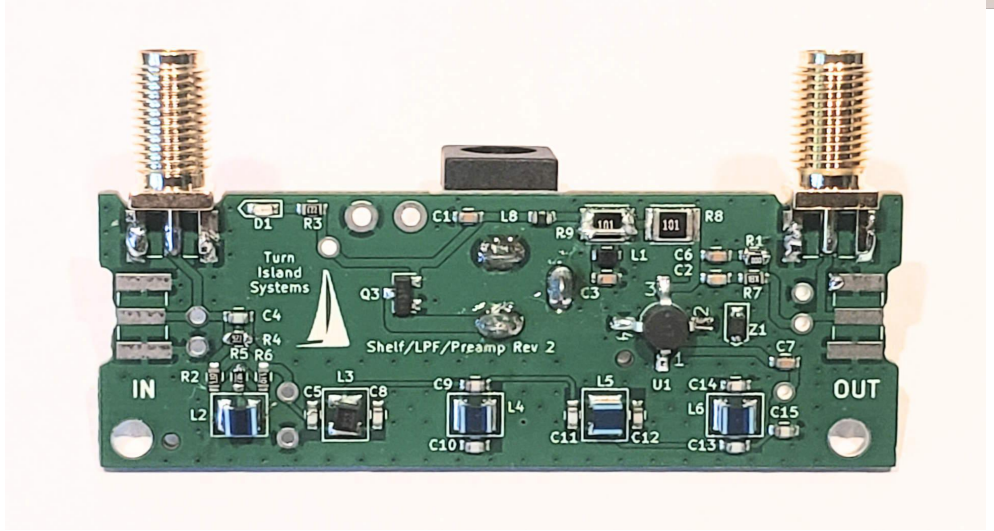
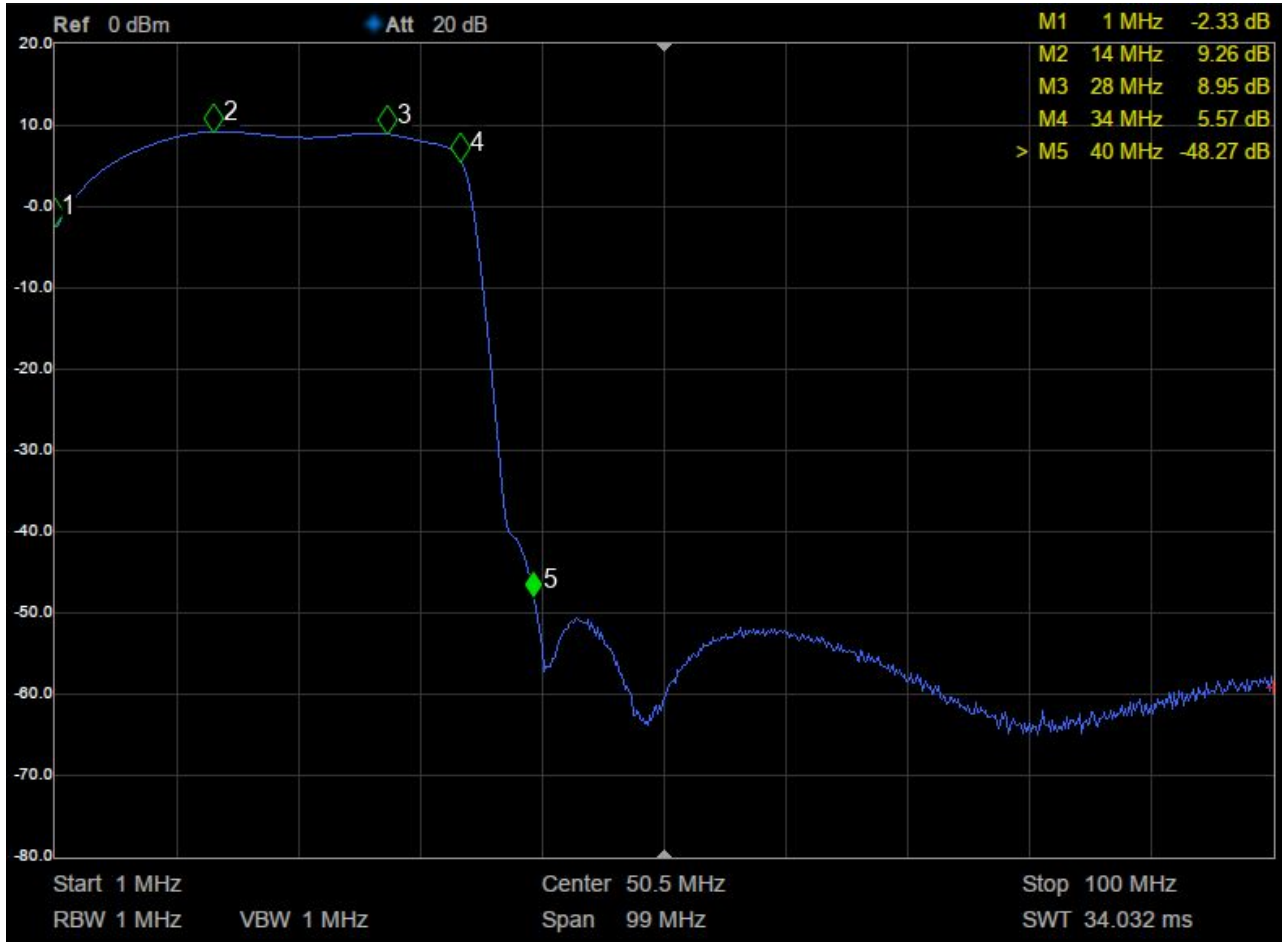
SDR RF Signal Conditioning Accessories





SDR Shelf / Low-Pass Filter

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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 ***
- Single-board design, no module interconnects
- Eight frequency-flexible channels
- Low spurious output levels
- Self-monitoring capabilities

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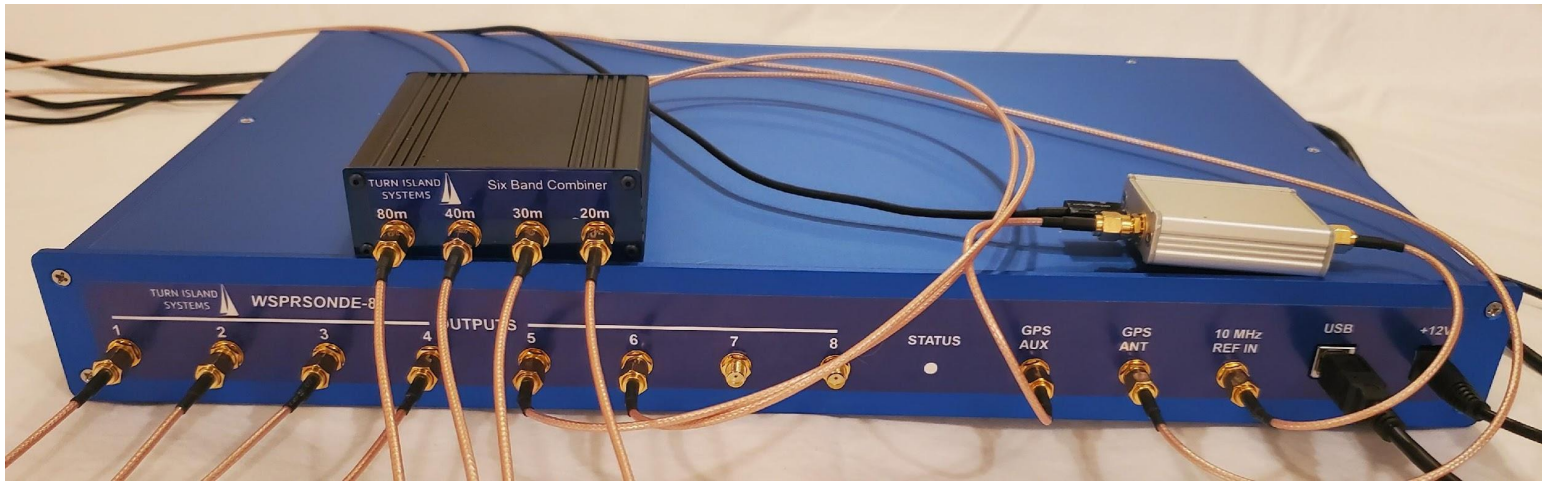
WSPRSONDE-8



- 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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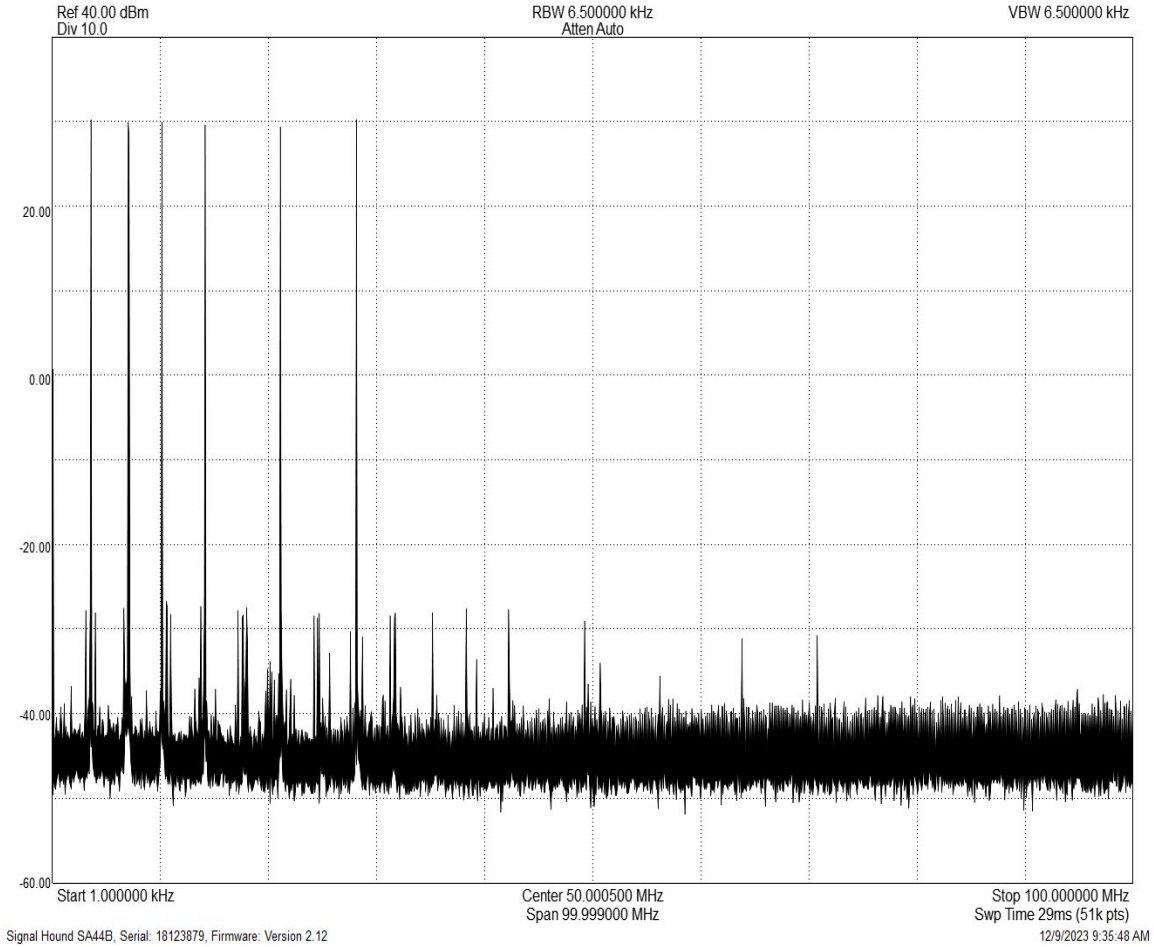
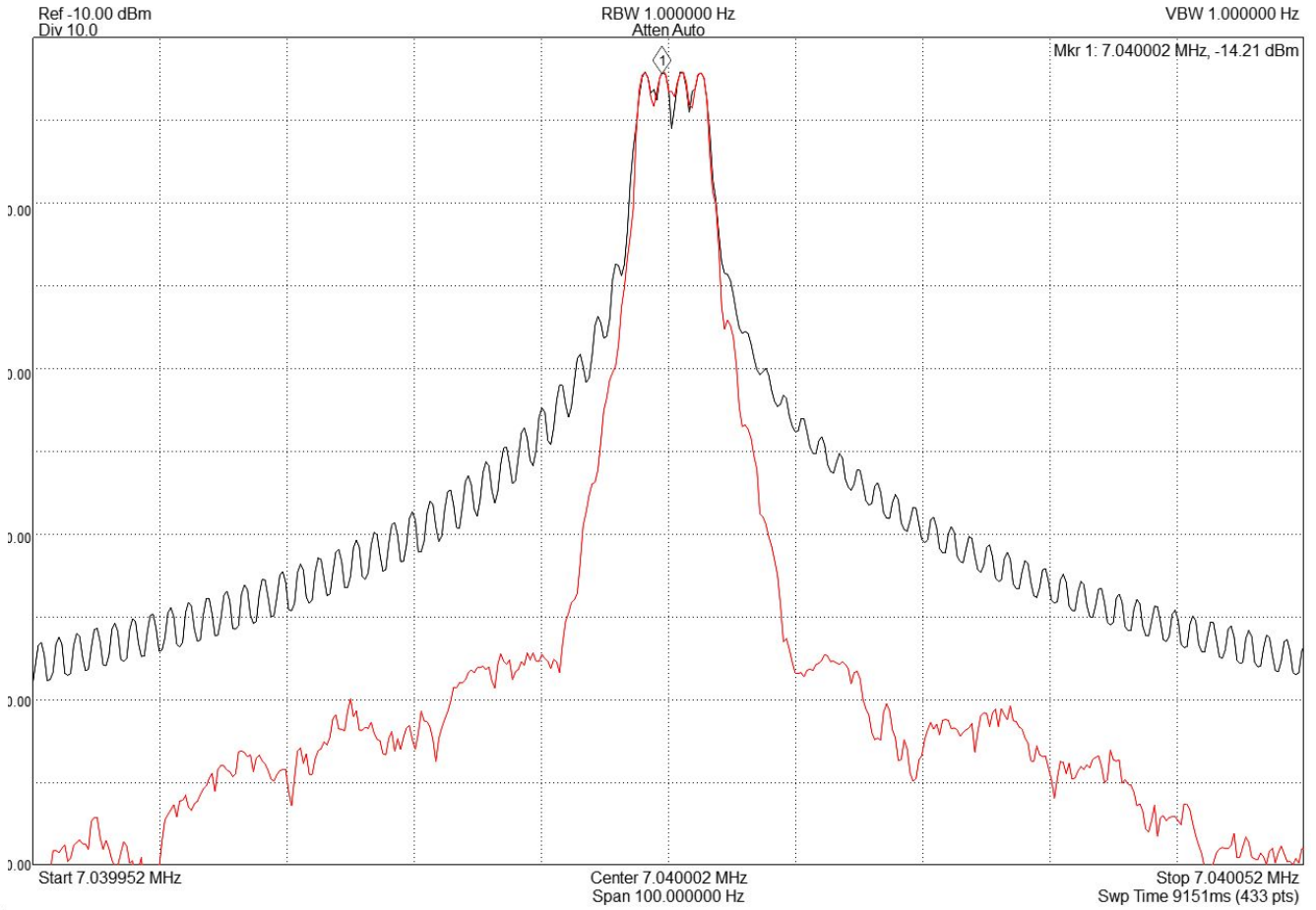
WSPRSONDE-8



Six-channels through the Filter/Combiner
(amplifier intermod is less than -57 dBc)



WSPR FSK and FST4W-120 GFSK spectra
(40 meter band)

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Acknowledgments

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HamSCI silhouette photo by Ann Marie Rogalcheck-Frissell KC2KRQ.