P3 Occupied Spectrum Measurements

Test Setup

- Two K3s with P3/SVGAs in SO2R setup
- #1 K3 transmits to 500W dummy load
- High isolation tapoff in line fed K3 #2
  - 20 dB attenuator added at tapoff for power amps
- LP100A wattmeter in line, set for peak reading
  - Listed power is from LP100A
- Power for K3s provided by 2-6V 220Ah golfcart batteries with solar and line powered charging
  - DC voltage under load 12.6 – 13 VDC

Test Setup

- Pink noise from 11 kHz .wav file drives K3 Line Input via Tascam US100 USB interface
- Value of compression noted is that indicated by peak value of K3 LED bar graph for Compression
- K3 TXEQ set for full cut (-16dB) of 50 Hz, 100 Hz, 200 Hz octave bands, 3dB cut of 400 Hz band, 3dB boost of 3.2 kHz 2/3 octave band
- CW test signal a string of dits from internal keyer
- Keying speed in the range of 30 wpm

P3 Setup

- Two different SVGA monitors were used, screen captures are different for the two
  - Started with 1024x768 normally used in SO2R setup
  - Switched to higher res monitor for later measurements
- On SSB, receiving K3 tuned to same frequency as TX K3, so that cursor indicates carrier frequency
- On CW, receiving K3 purposely tuned a bit off frequency so that RX frequency cursor does not obscure peak of wavefrom
- Blue traces are accumulated peaks

Post Measurement Analysis

- **Using the cursor to read frequency, recorded bandwidth at selected values of dBC for CW and dB re: peak for SSB, RTTY, and PSK31**

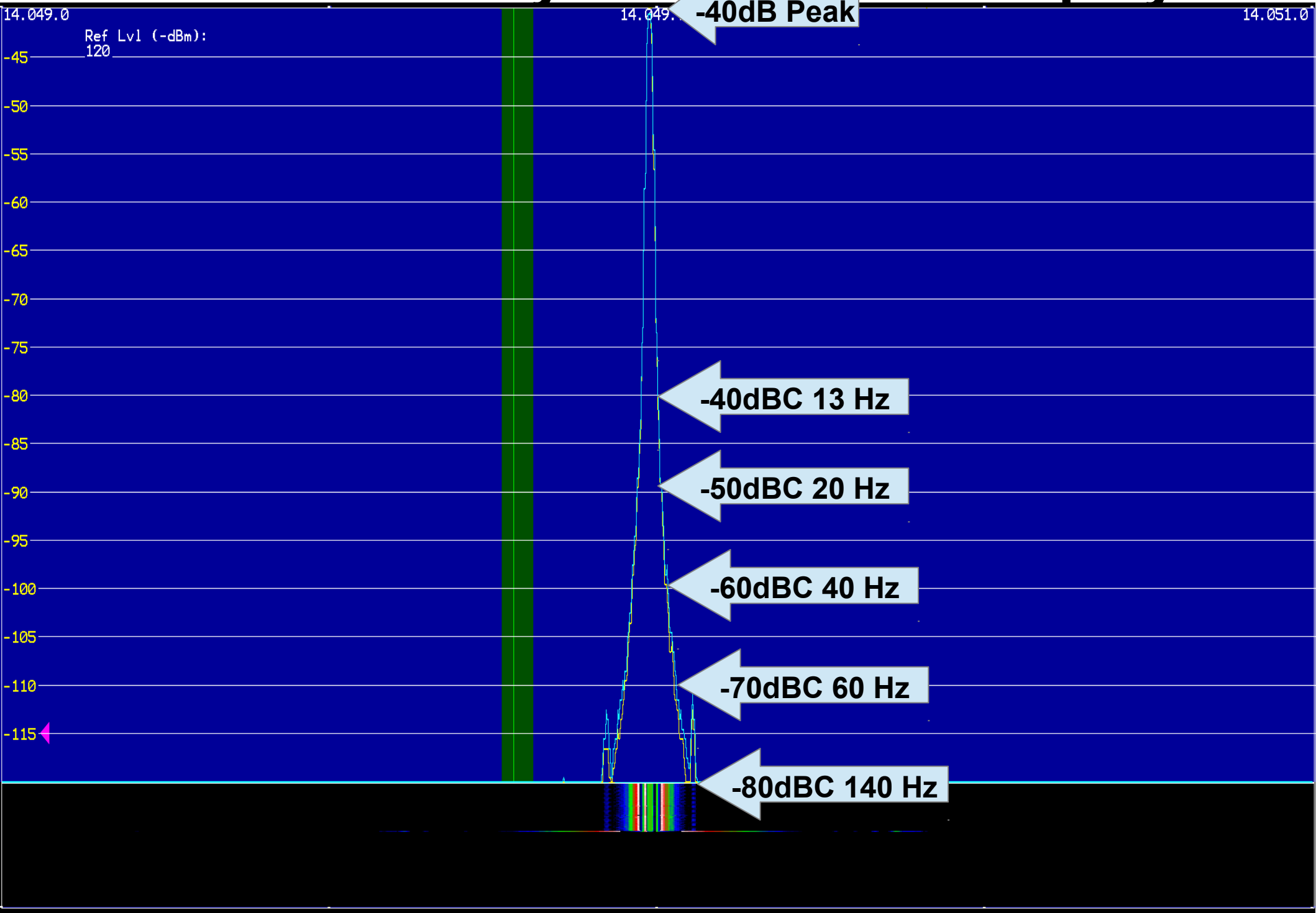
How Good Is The Measurement System?

- The next two slides show a steady carrier
- Both K3s now have the K3SYNA board installed
- The -70dBC spikes 30 Hz either side of the carrier may be in the measurement system or in the transmitted signal
- The arrows show the total width of the signal, measured by using the cursor on the higher resolution 2 kHz wide data

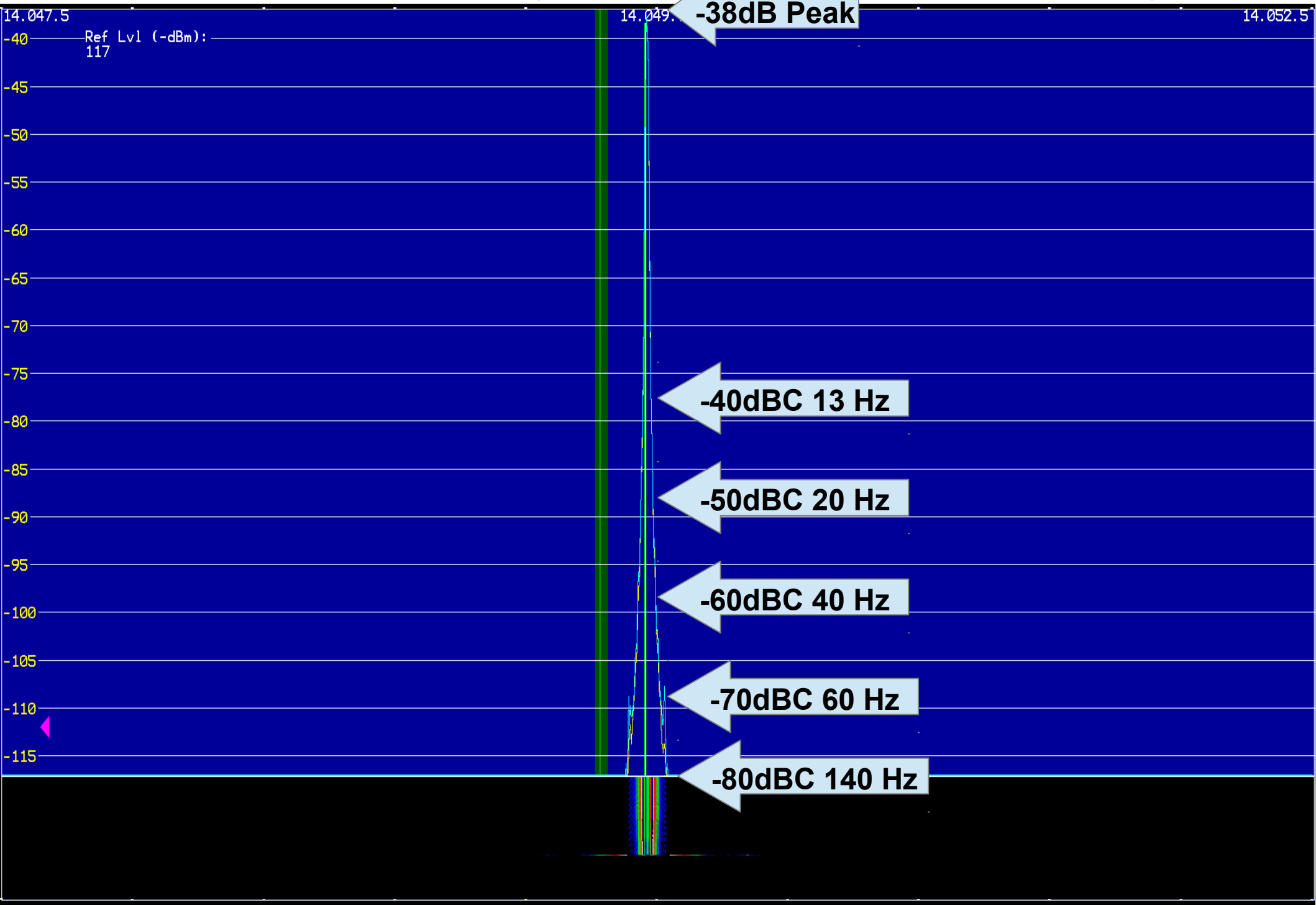
How Good Is The Measurement System?

- For an ideal transmitter and ideal measuremnt system, we should see a vertical line with zero bandwidth. We don't know whether the spreading of the carrier is due to phase noise in TX, RX, or both, the limitations of the FFT, or some combination of all three.
- What we do know is that the measurement system is at least 2 orders of magnitude better than transmitters we are measuring, and that the combined bandwidth of the analyzer and the carrier is only 13 Hz 40 dB down

K3 25W Steady Carrier 2 kHz Display



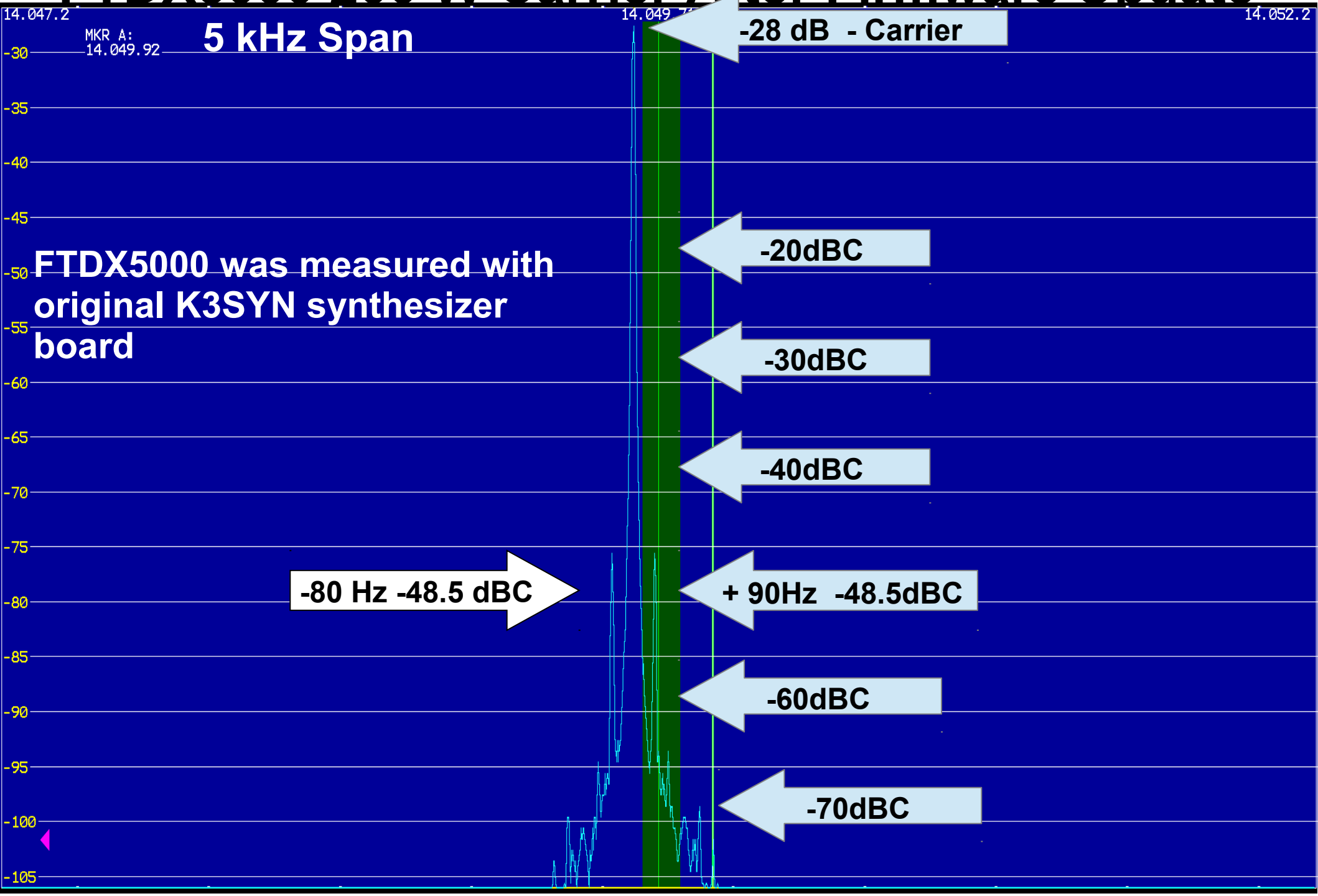
K3 25W Steady Carrier 5 kHz Display



Original K3 Used For FTDX5000 Data

- See the following data for the FTDX5000 with continuous carrier at 200W
  - Strongest responses are -48.5 dBC at -80 Hz, +90 Hz
  - Next strongest are -64dBC at -130 Hz, +140 Hz
  - Next strongest are -70dBC at -295 Hz, + 310 Hz
- These responses may be in the DUT or the measurement system
- It is clear that the measurement system was good enough – even if all of the spurious responses are in the measurement system (i.e., the transmitter is a pure sine wave with no noise), the strongest are at least 20 dB below the signals being measured

FTDX5000 200 W Carrier After Firmware Update



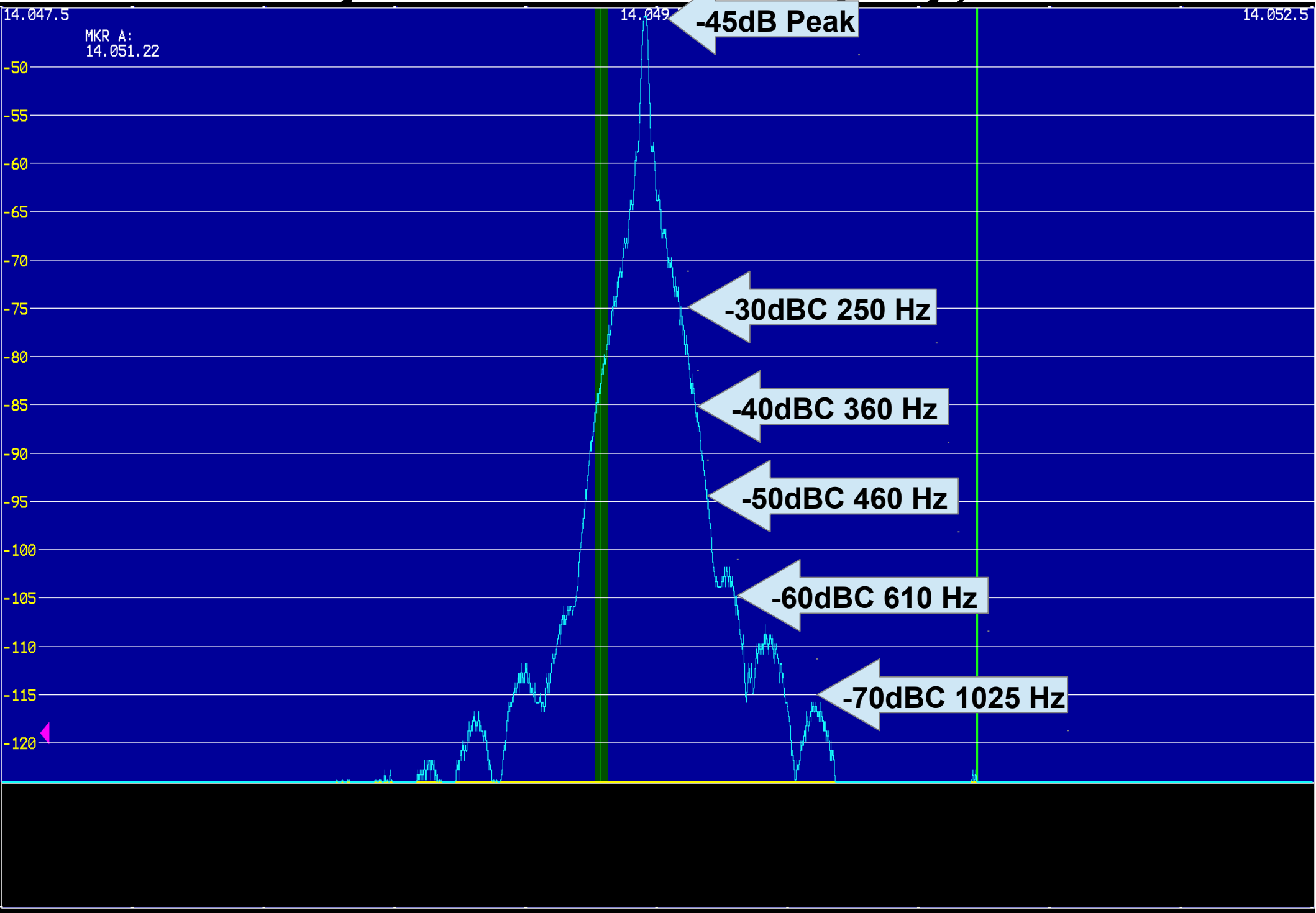
How Does K3SYNA Affect My P3 Data?

- Compare the next three slides, both with the K3 running 25W
- For the first slide, the new K3SYNA is in both the transmitting radio and the measurement radio
- For the second and third slides, both radios have the original K3SYN board

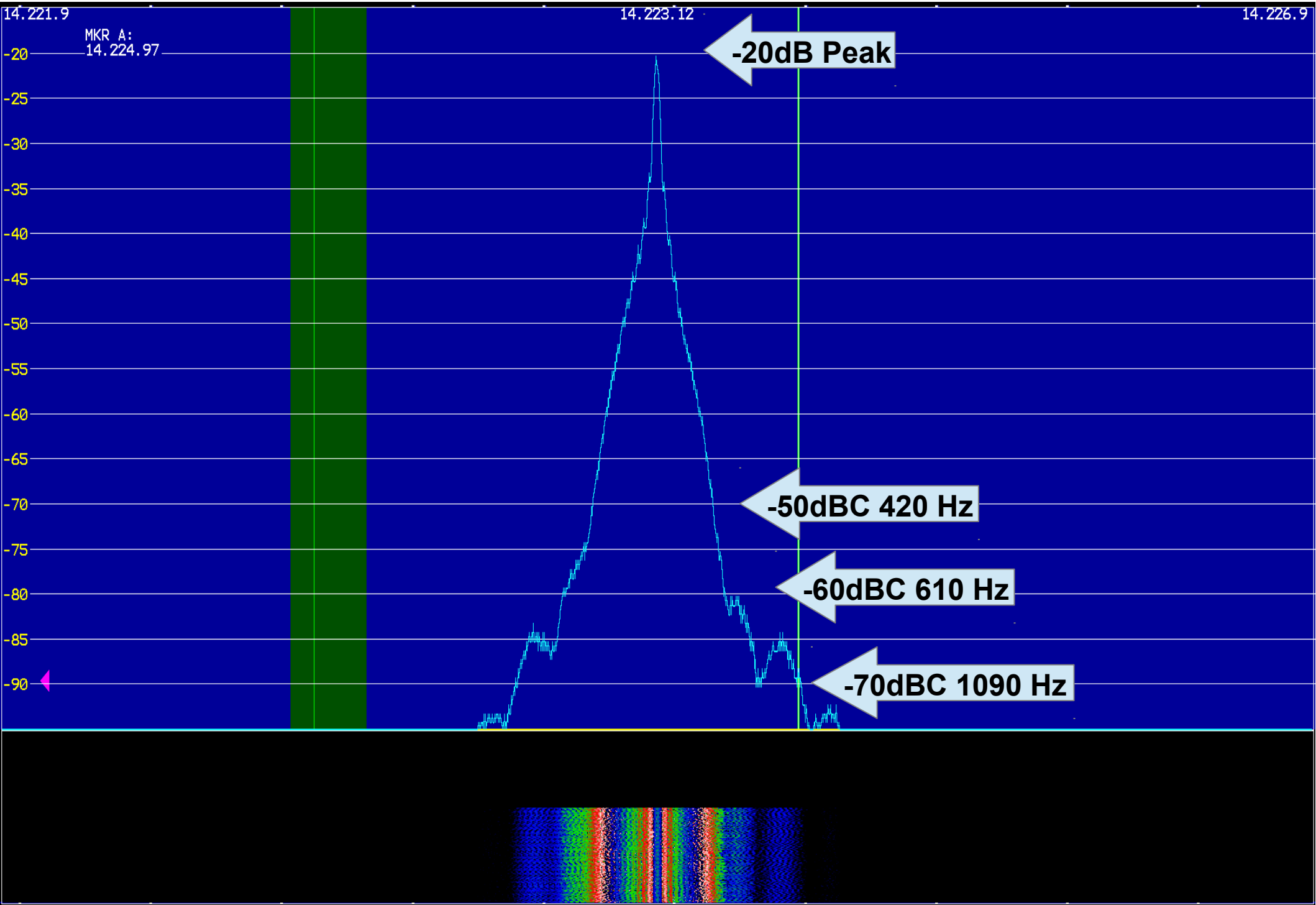
Conclusion

- **There's no measurable difference between K3SYN and K3SYNA within the 80 dB dynamic range of the P3**
- **The maximum dynamic range of the P3 display is 80dB, and for a K3, bandwidth is entirely determined by keying transients or modulation**
- **The K3SYNA (and the new K3S) improves phase noise, but that's well below the 80 dB dynamic range of the P3**
- **I could look closer to the noise floor by lowering the P3 reference level by 20 dB. I've done that with K3s using the new K3SYNA boards, but have no data for the old K3SYN boards to compare to**

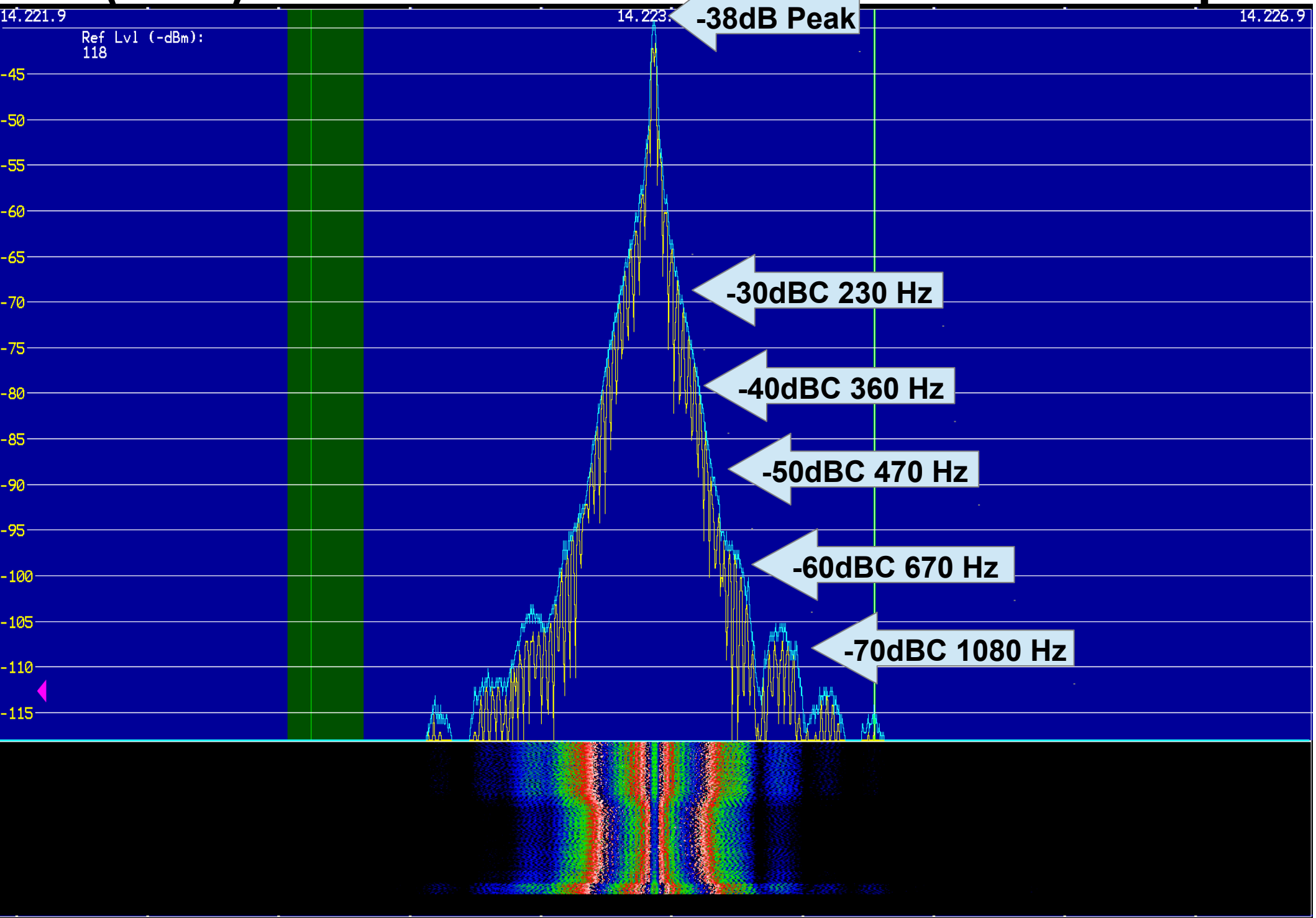
K3 25W Keyed CW 5 kHz Display, w/K3SYNA



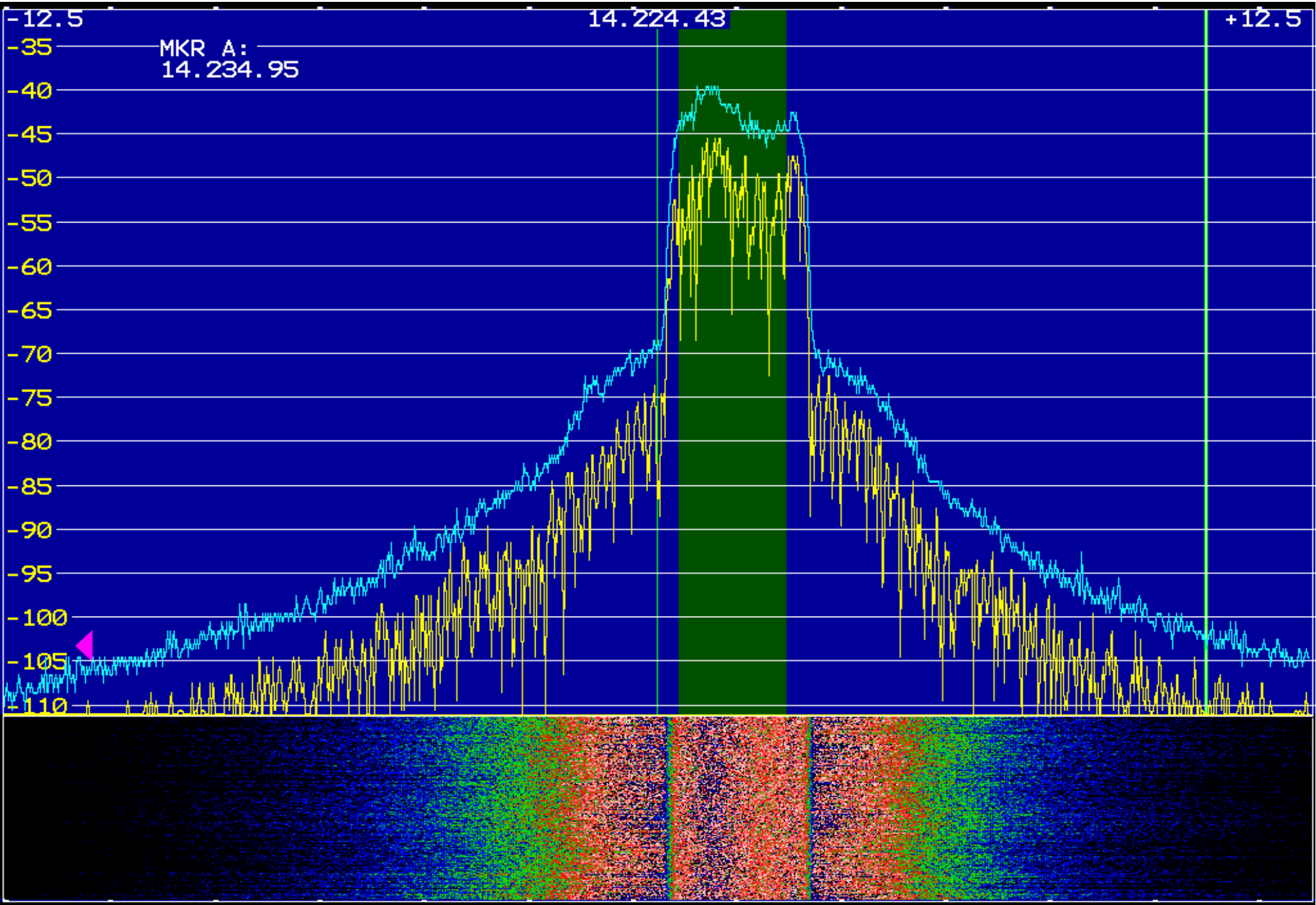
K3-KPA500 550W CW 5kHz Span



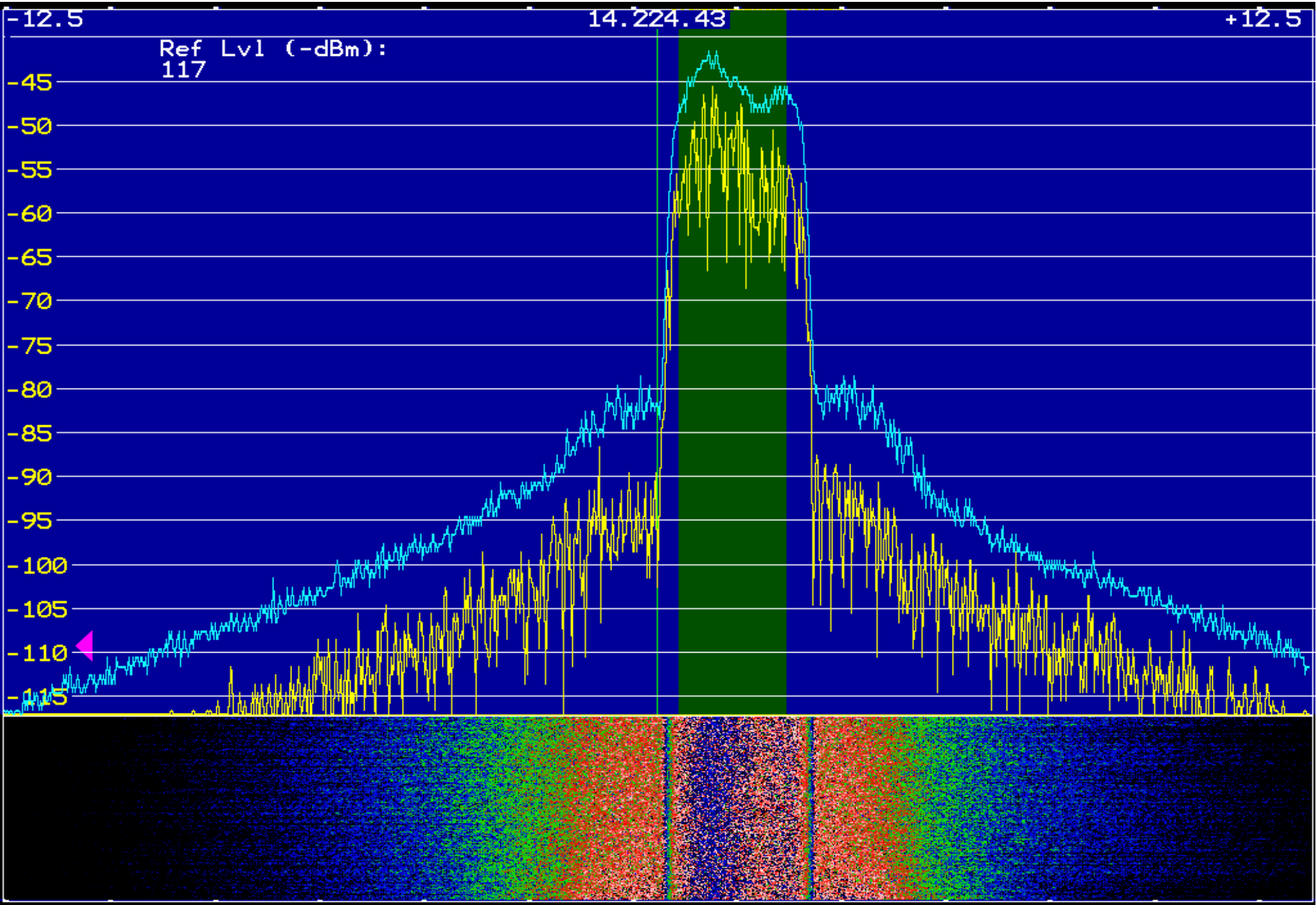
K3 (40W)-Ten Tec Titan 425 1500W CW 5 kHz Span



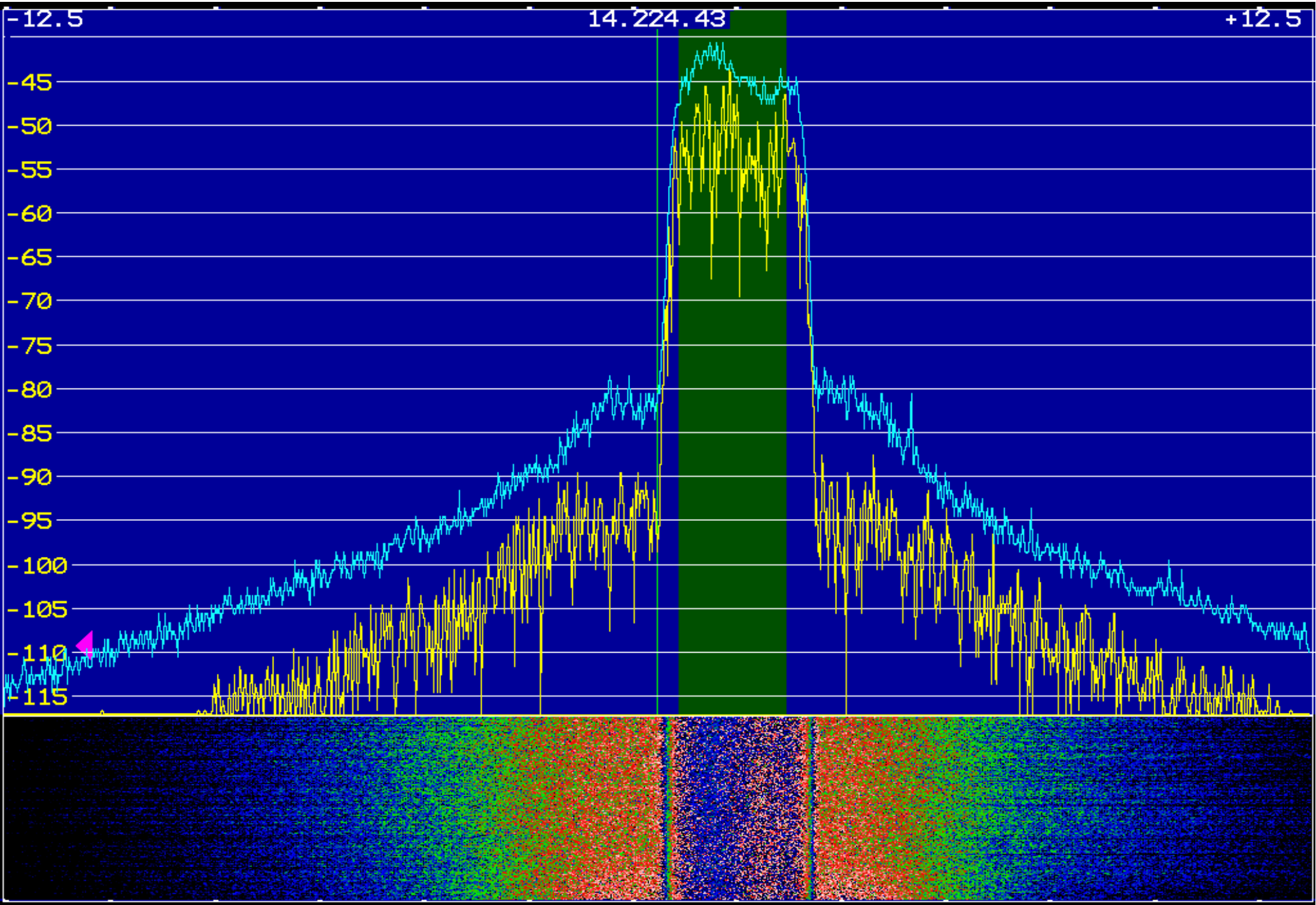
K3 100W Pink Noise No Compression



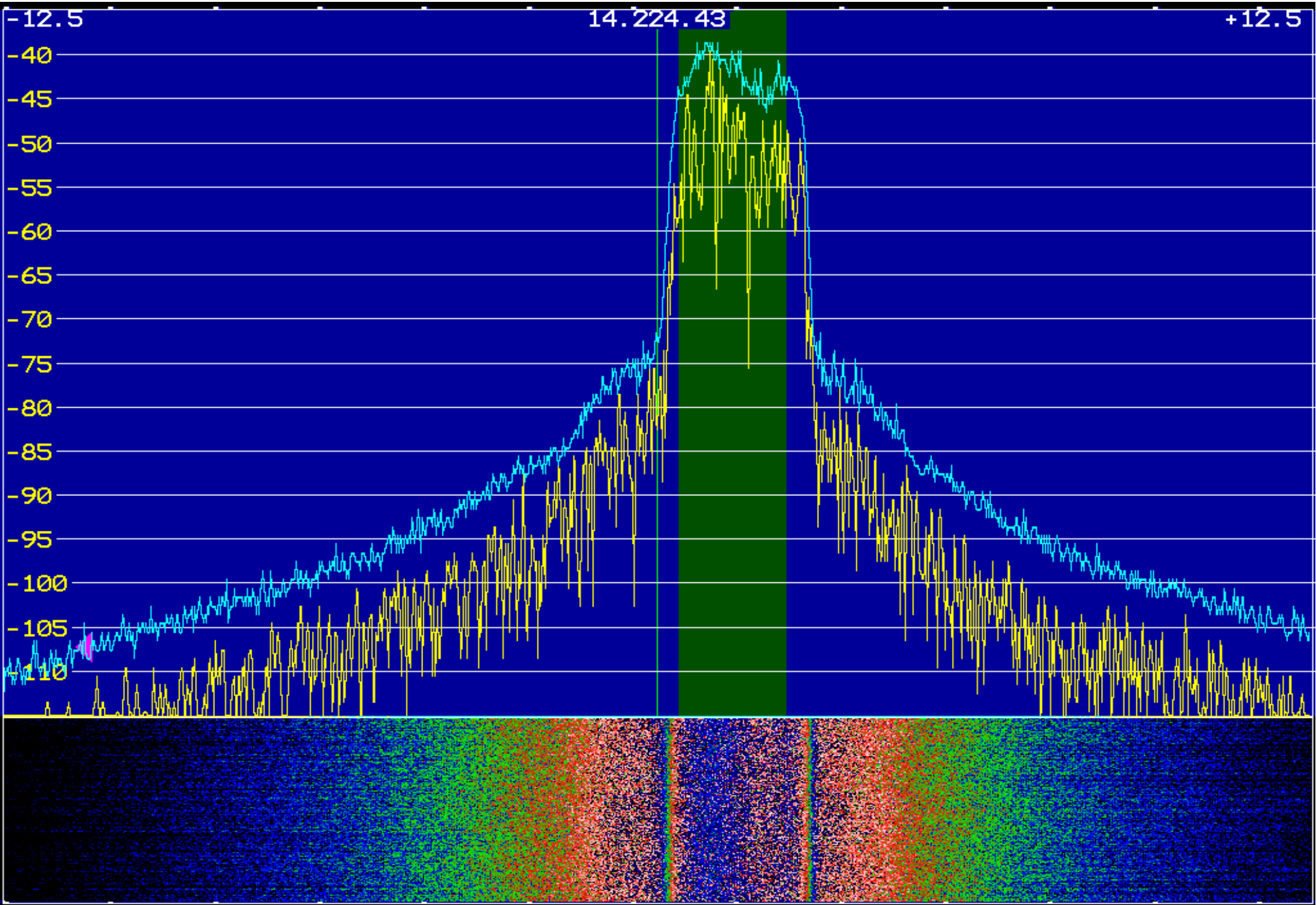
K3 30W Pink Noise 10dB Compression



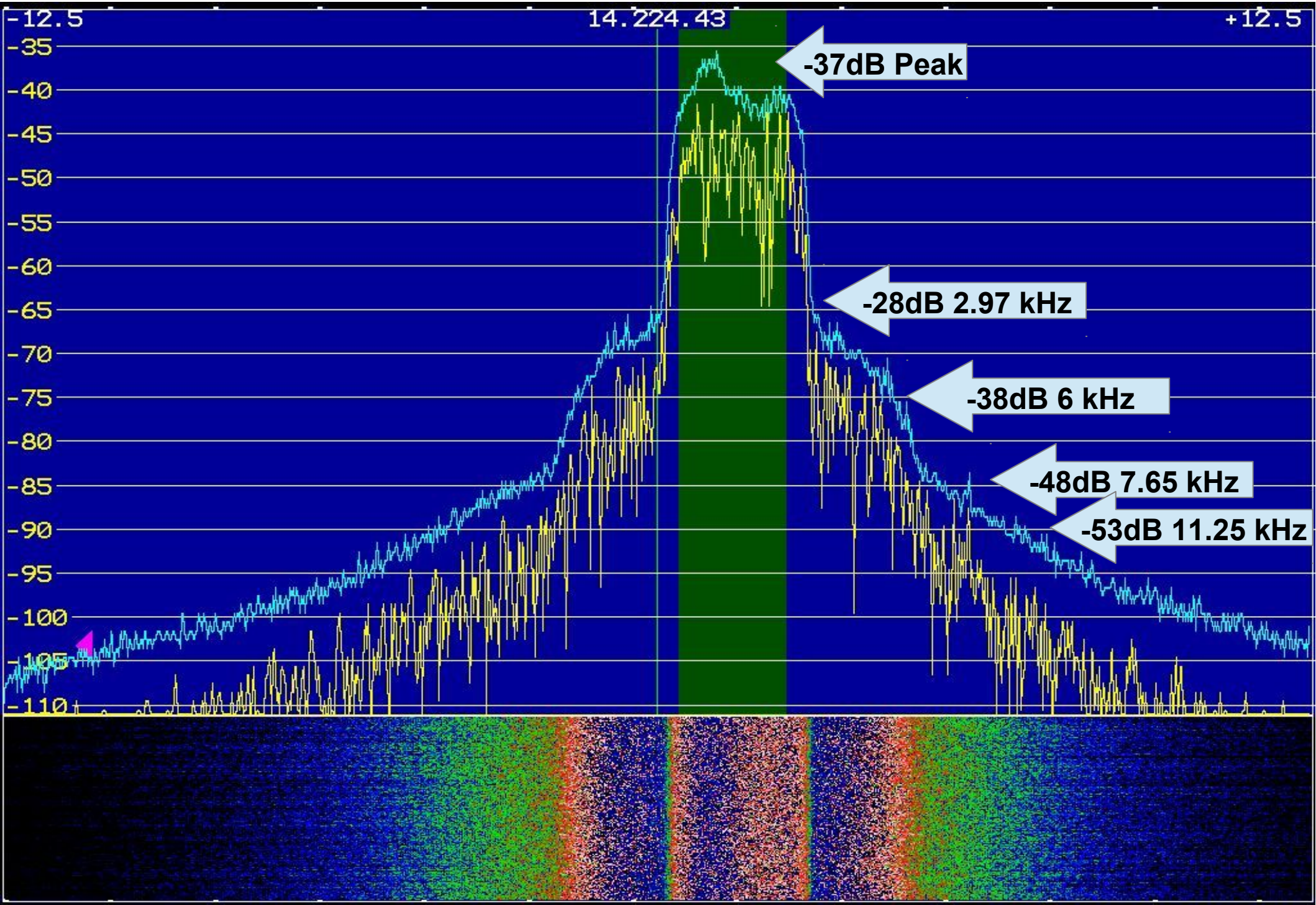
K3 50W Pink Noise 10dB Compression



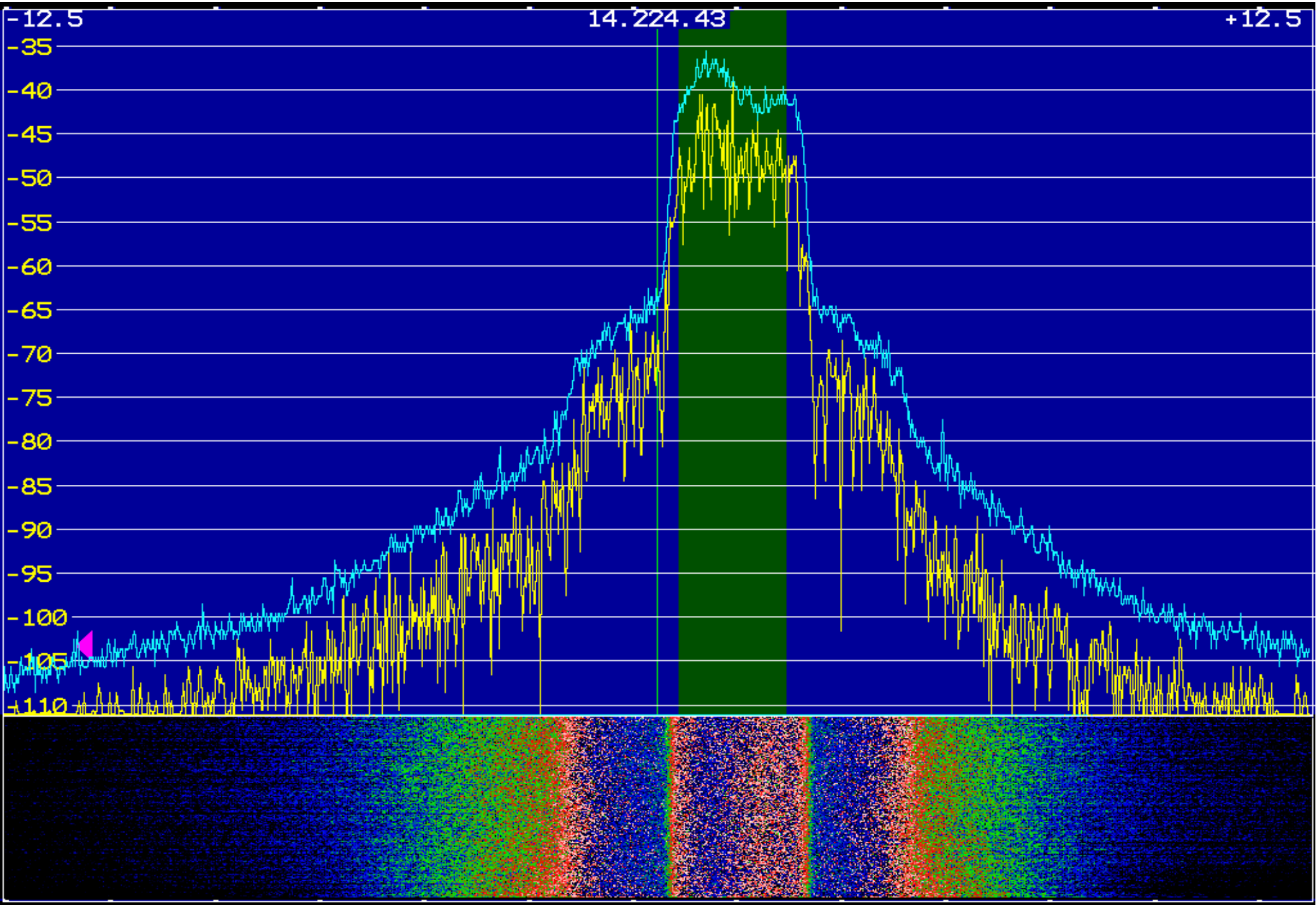
K3 66W Pink Noise 10dB Compression



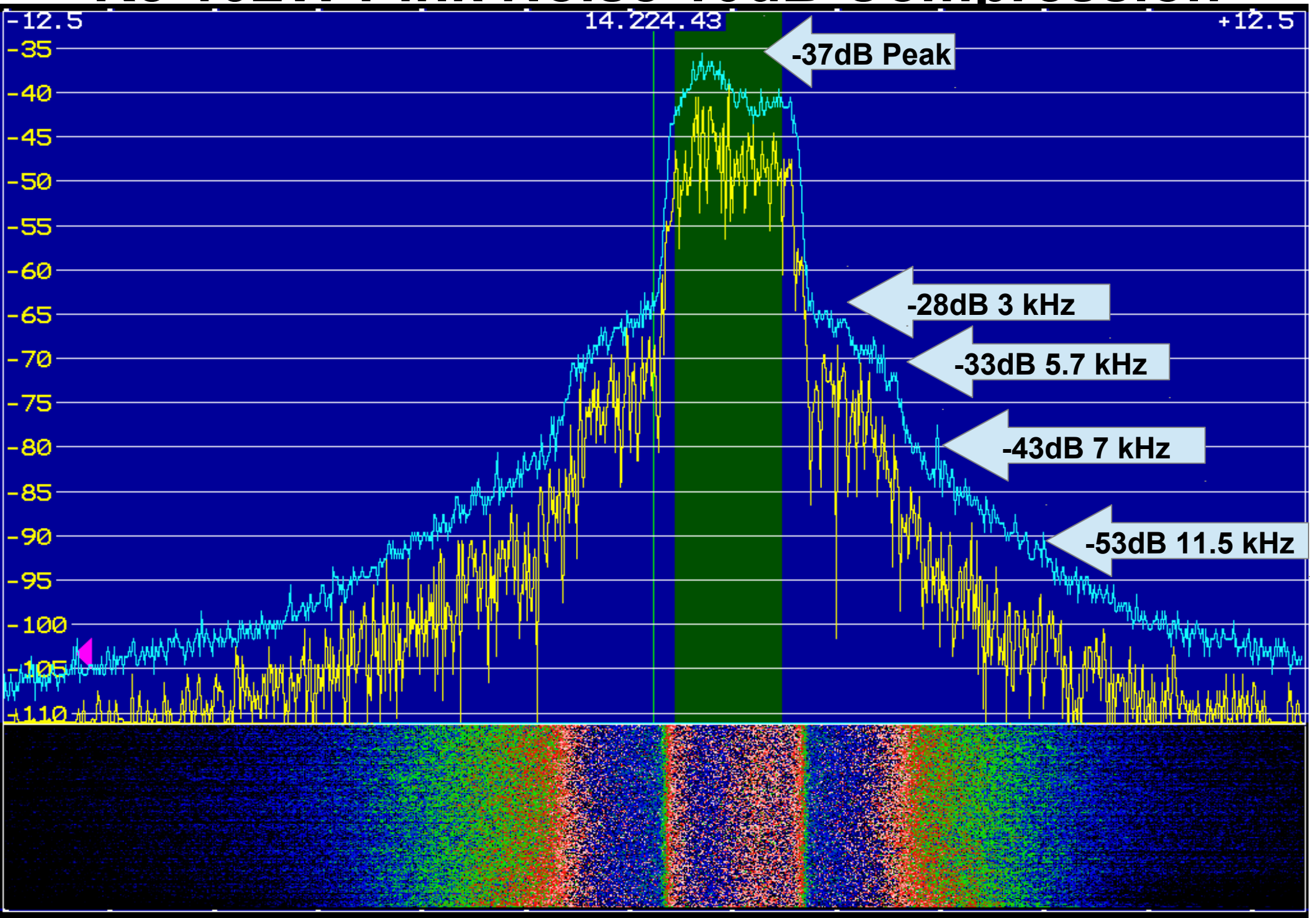
K3 92W Pink Noise 10dB Compression



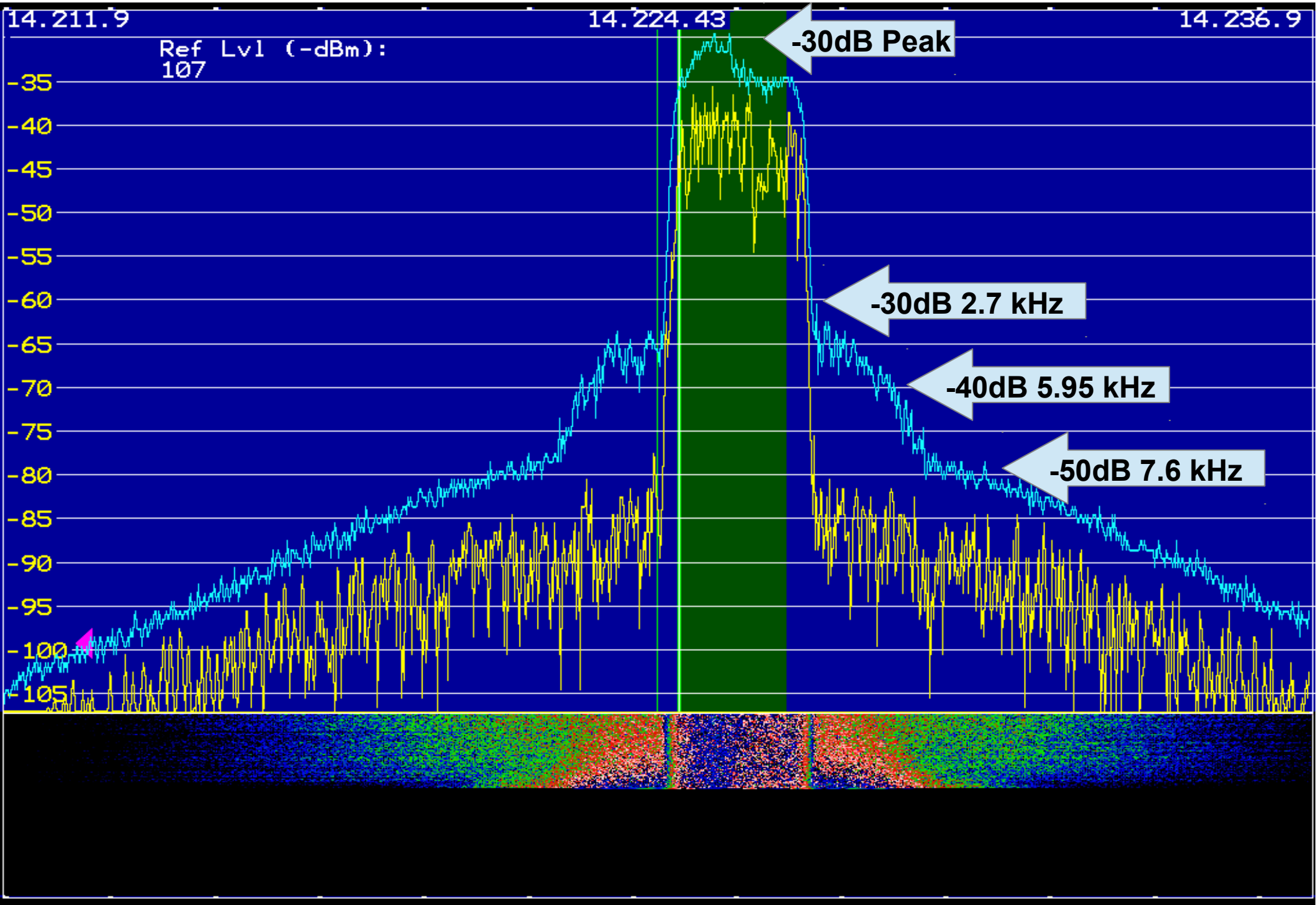
K3 100W Pink Noise 10dB Compression



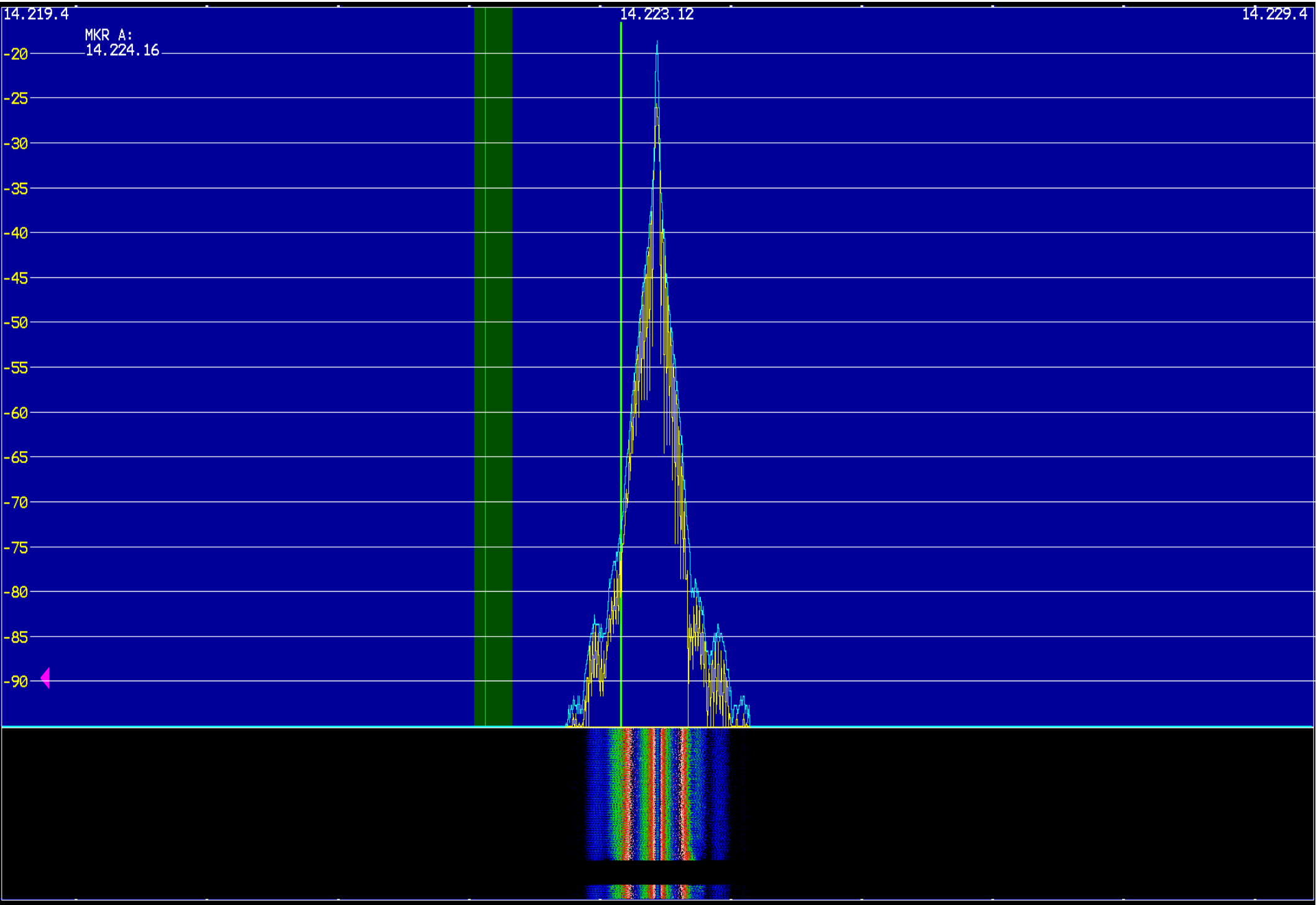
K3 102W Pink Noise 10dB Compression



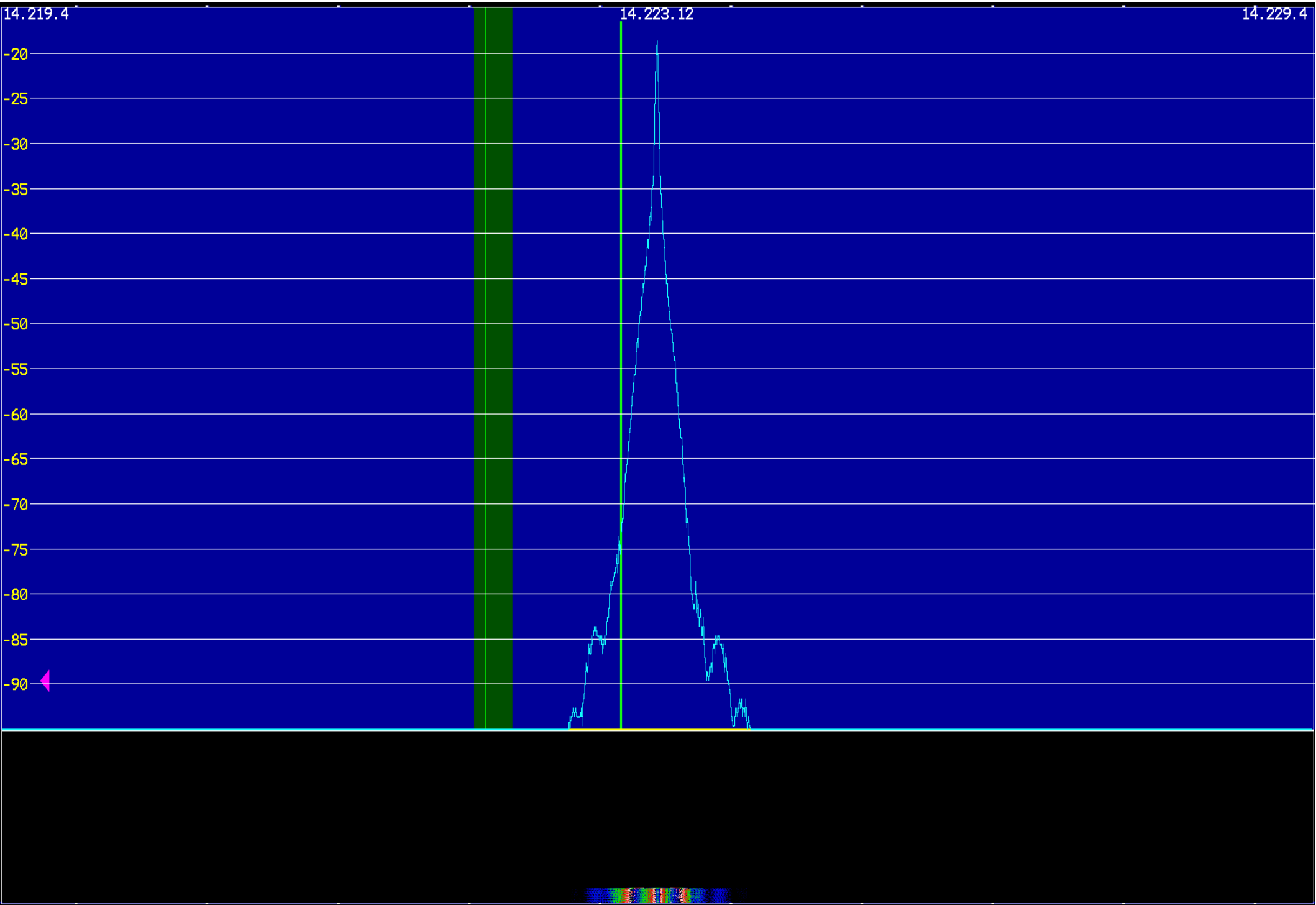
K3-KPA500 550W Pink Noise 10dB Compression



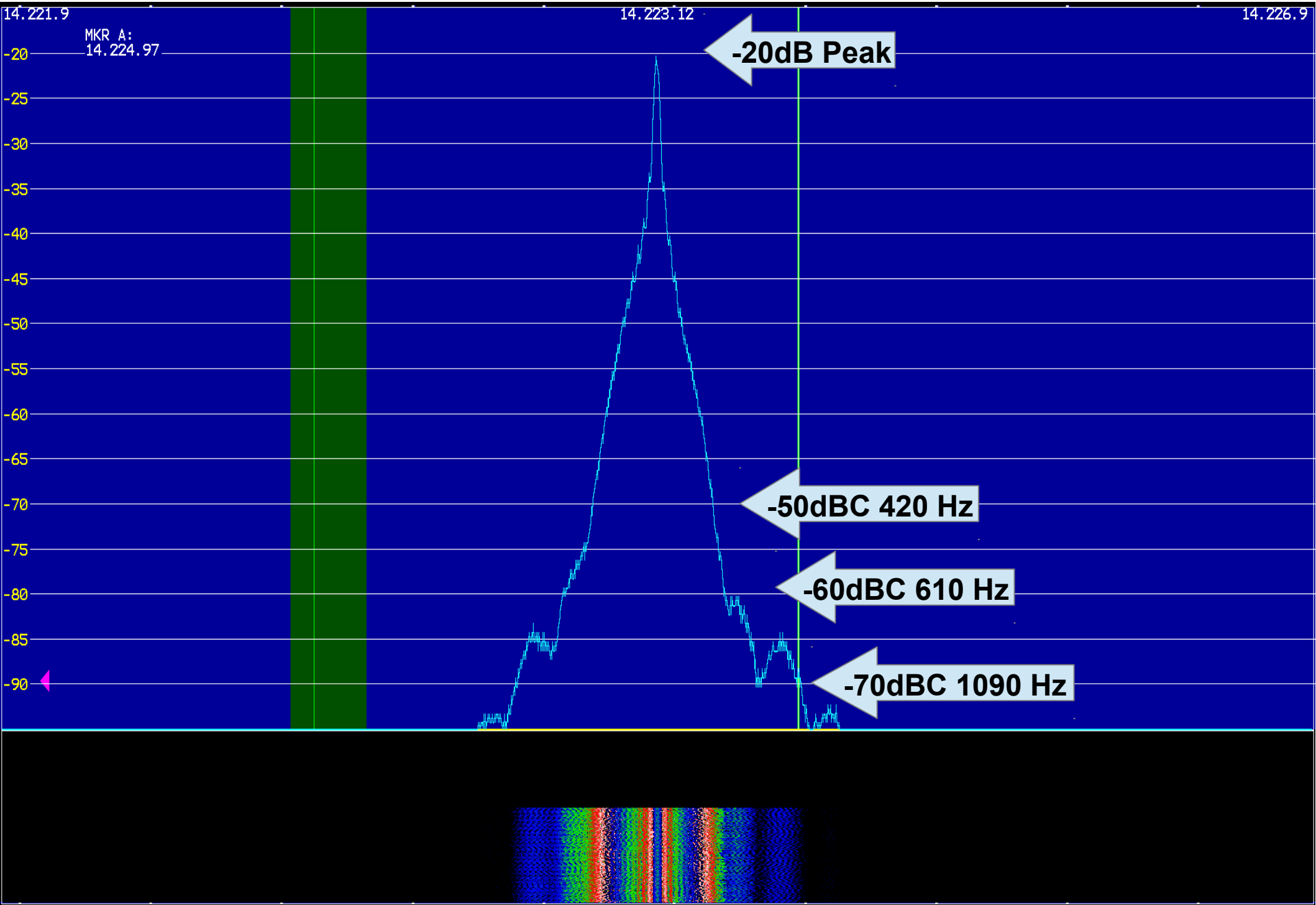
K3-KPA500 #1 CW 10 kHz Span



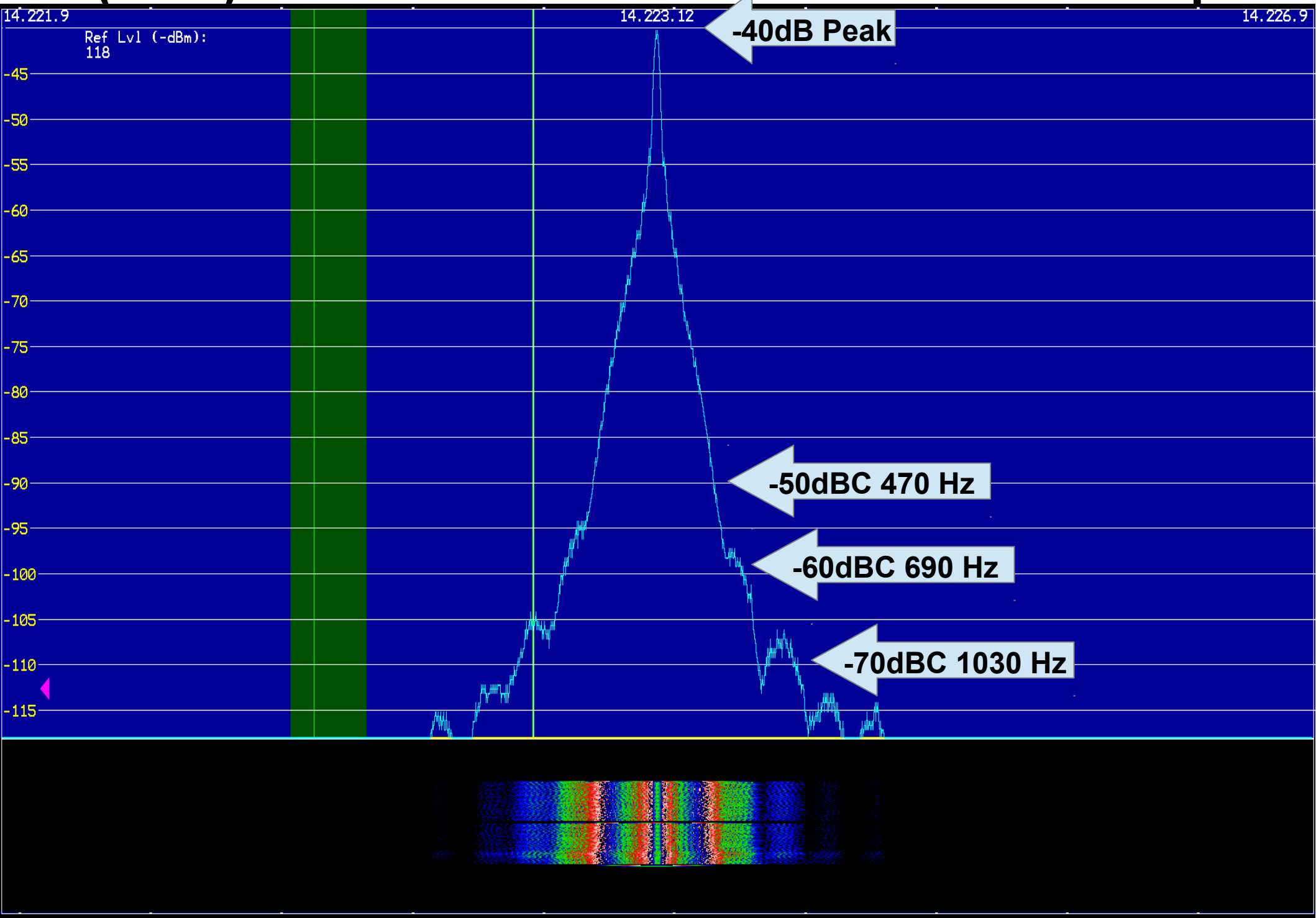
K3-KPA500 #2 CW 10 kHz Span



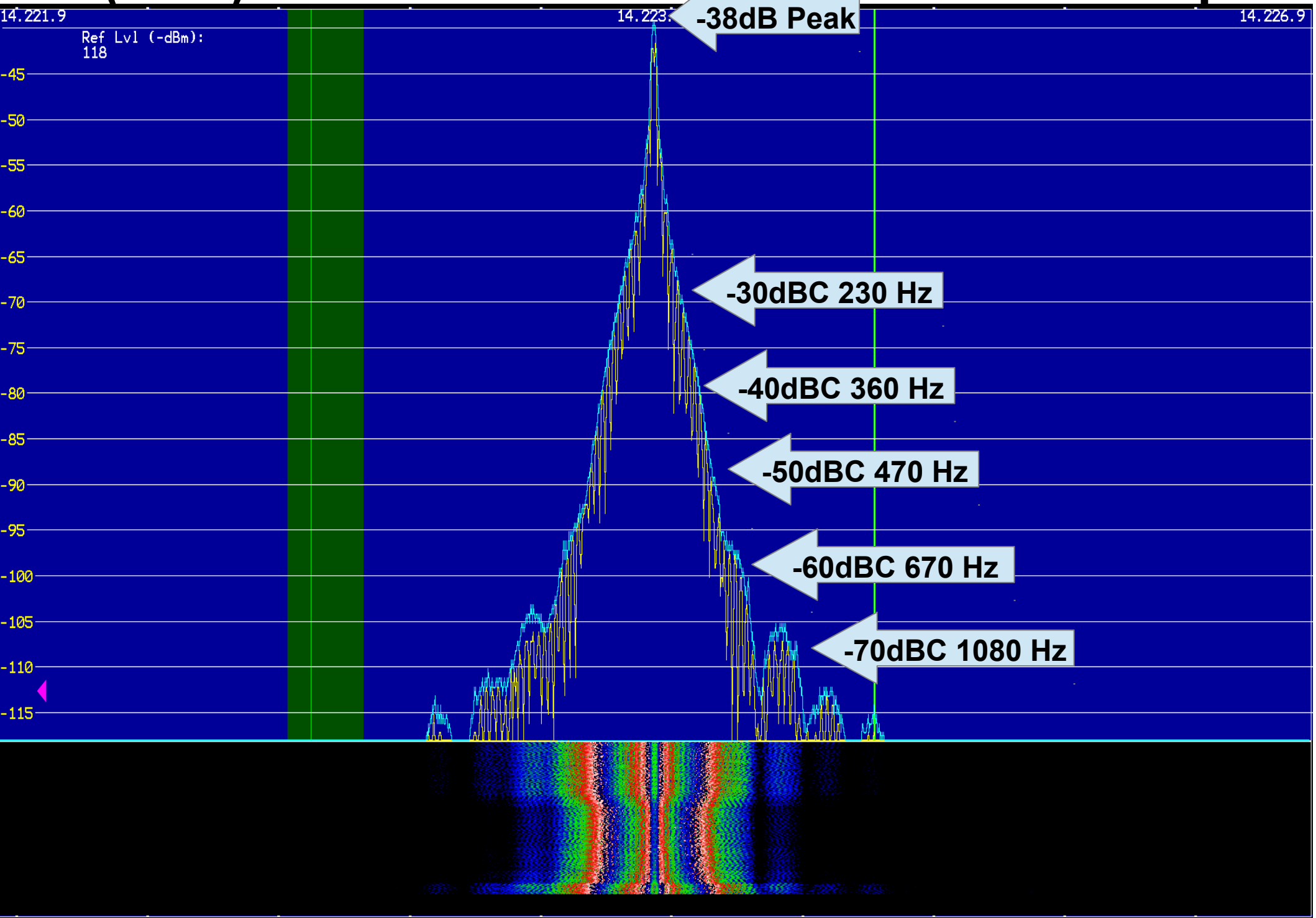
K3-KPA500 550W CW 5kHz Span



K3 (30W) -TenTec Titan 425 1100W CW 5 kHz Span



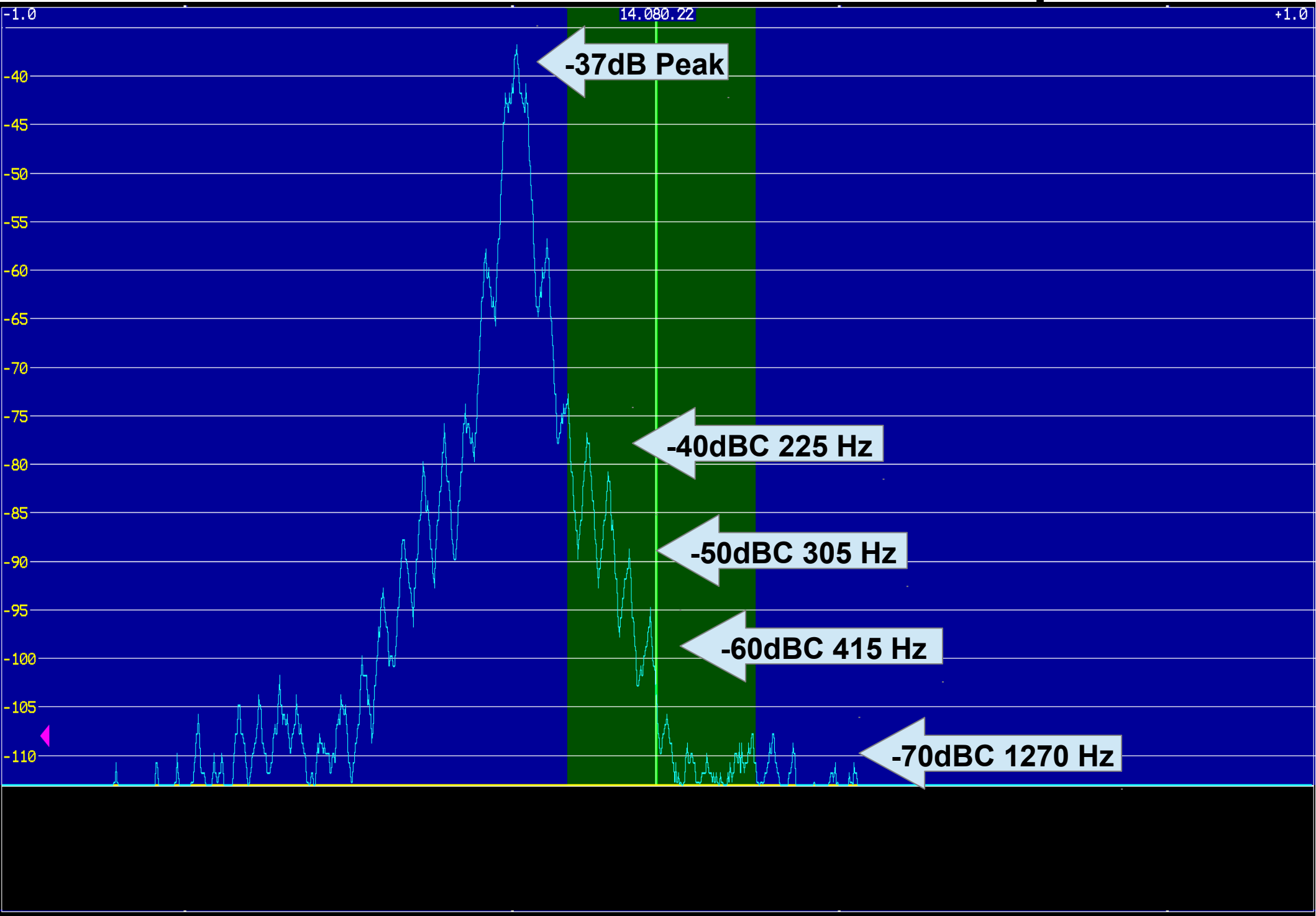
K3 (40W)-Ten Tec Titan 425 1500W CW 5 kHz Span



PSK31 Test Setup

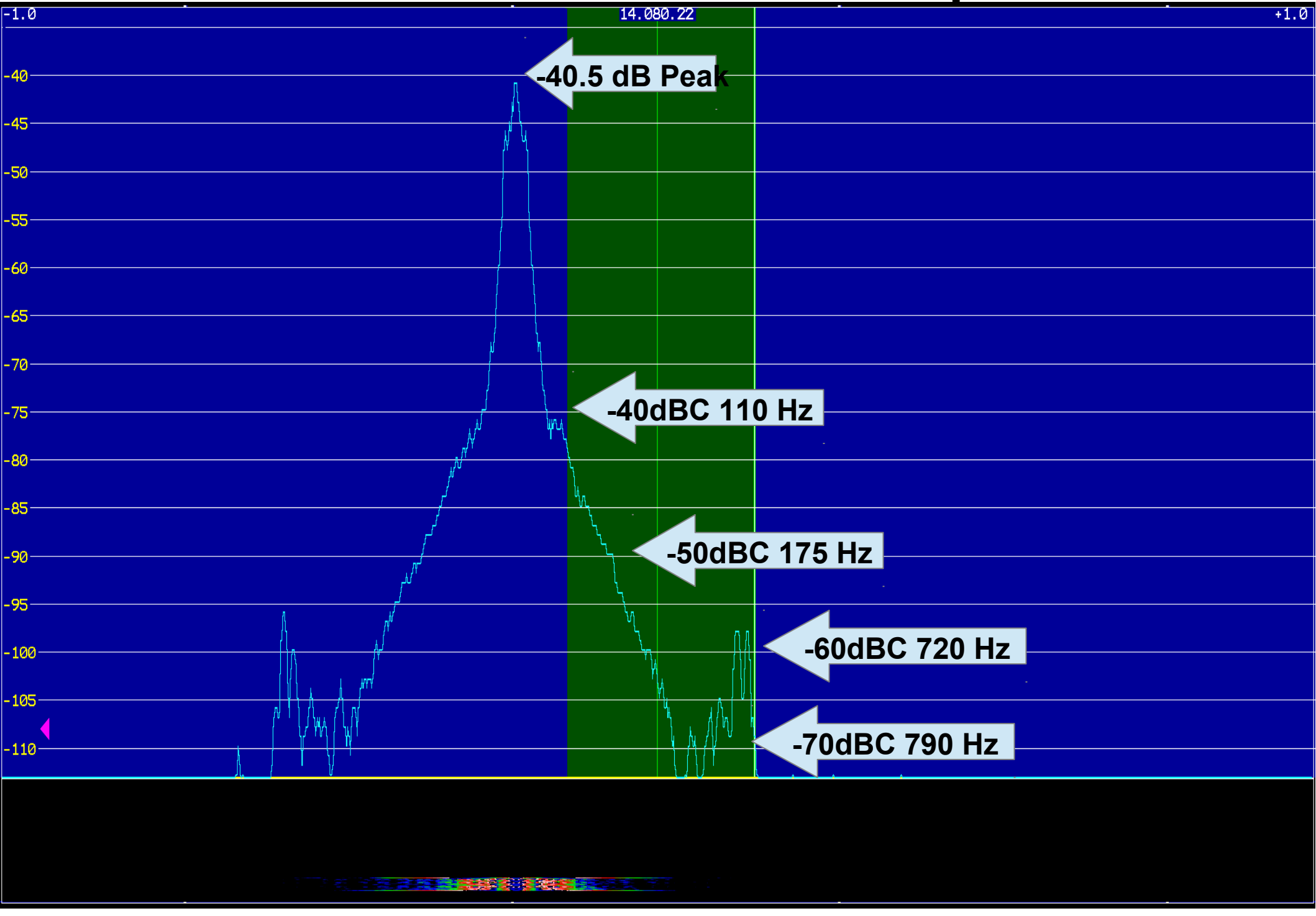
- PSK31 Signal Internally Generated by K3
- Transmitted several Long CQs
- Recorded Accumulated Peaks

K3 PSK31 Max Power 20M 2 kHz Span



K3 PSK31 93W 20M 2 kHz Span

K3 PSK31 50W 20M 2 kHz Span



K3 PSK31 28W 20M 2 kHz Span

K3 PSK31 28W to KPA500 500W 20M 2 kHz Span

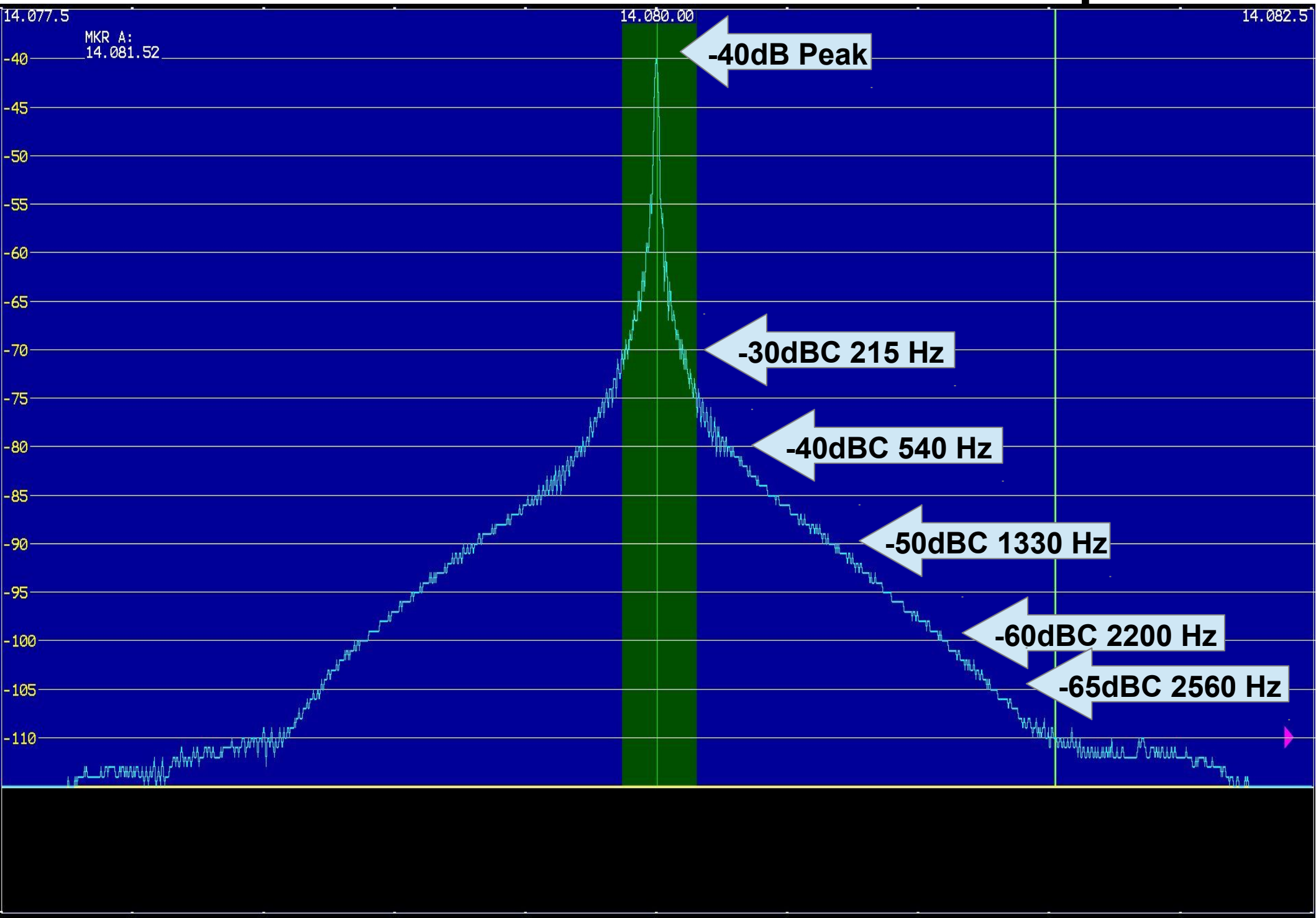
FT1000 Mark V Field Test Setup

- Pink Noise Fed to Patch Input Through 20 dB pad from Tascam US100 audio adapter
- Processing Turned Off
- Class A Mode Off
- CW sent as a string of dits using internal keyer
- No VOX or QSK, TX initiated by front panel
- This rig was loaned by K6XX, who bought it new, and advised that it was late production and needed no “key click fix”
- RTTY testing used “low” 915/1085 Hz tones
  - Audio distortion could be in sound card or Yaesu audio chain. -50dB is 0.32%

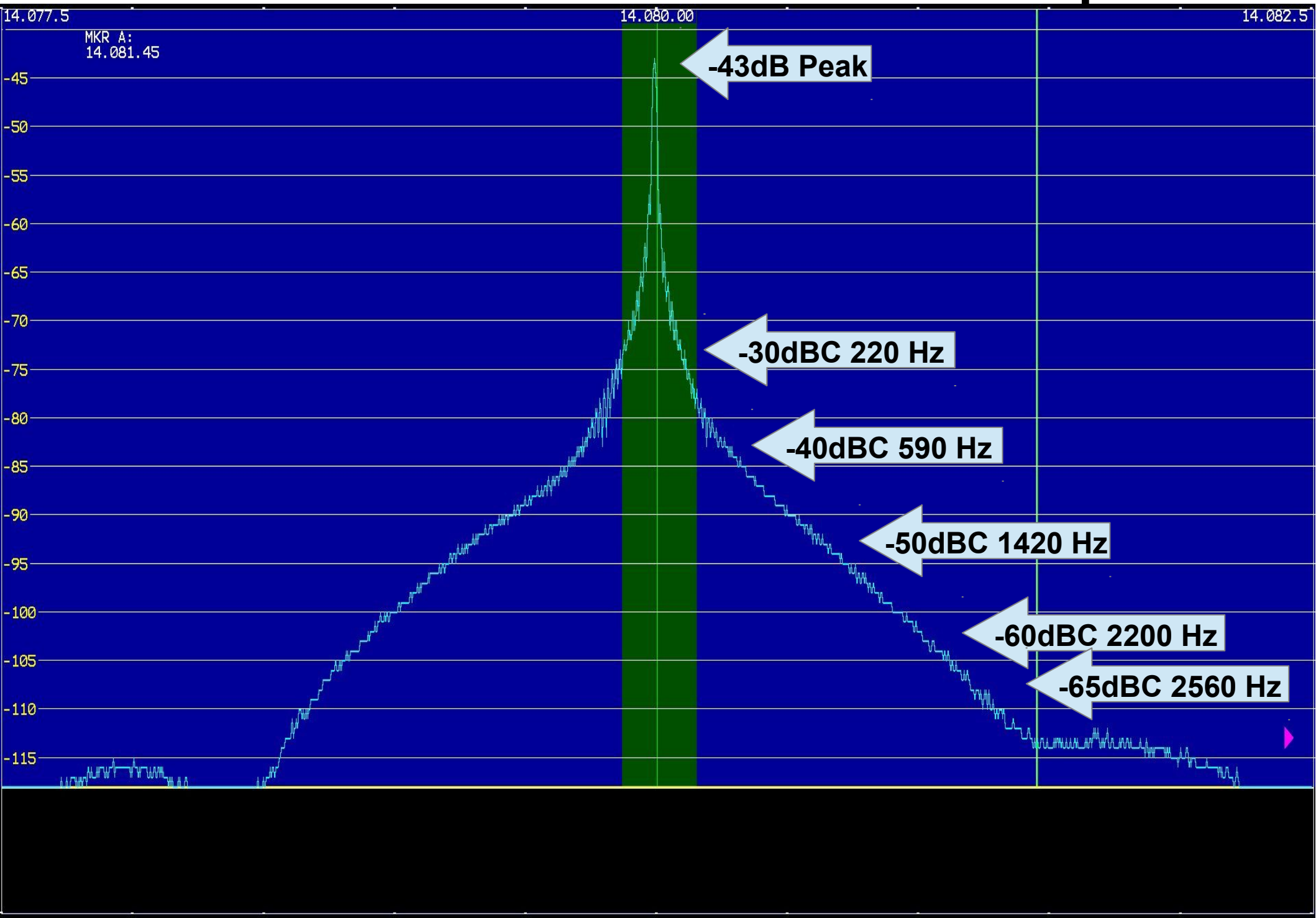
FT1000 Mark V Field Observations

- **Best performance is at full power**
  - **Suggests bandwidth is dominated by CW keying waveshape and phase noise**
- **On SSB, bandwidth is comparable to K3 down to -40 dB, phase noise makes it broader at -50 dB**
- **In all modes, K3 spectrum improves significantly at reduced output levels**

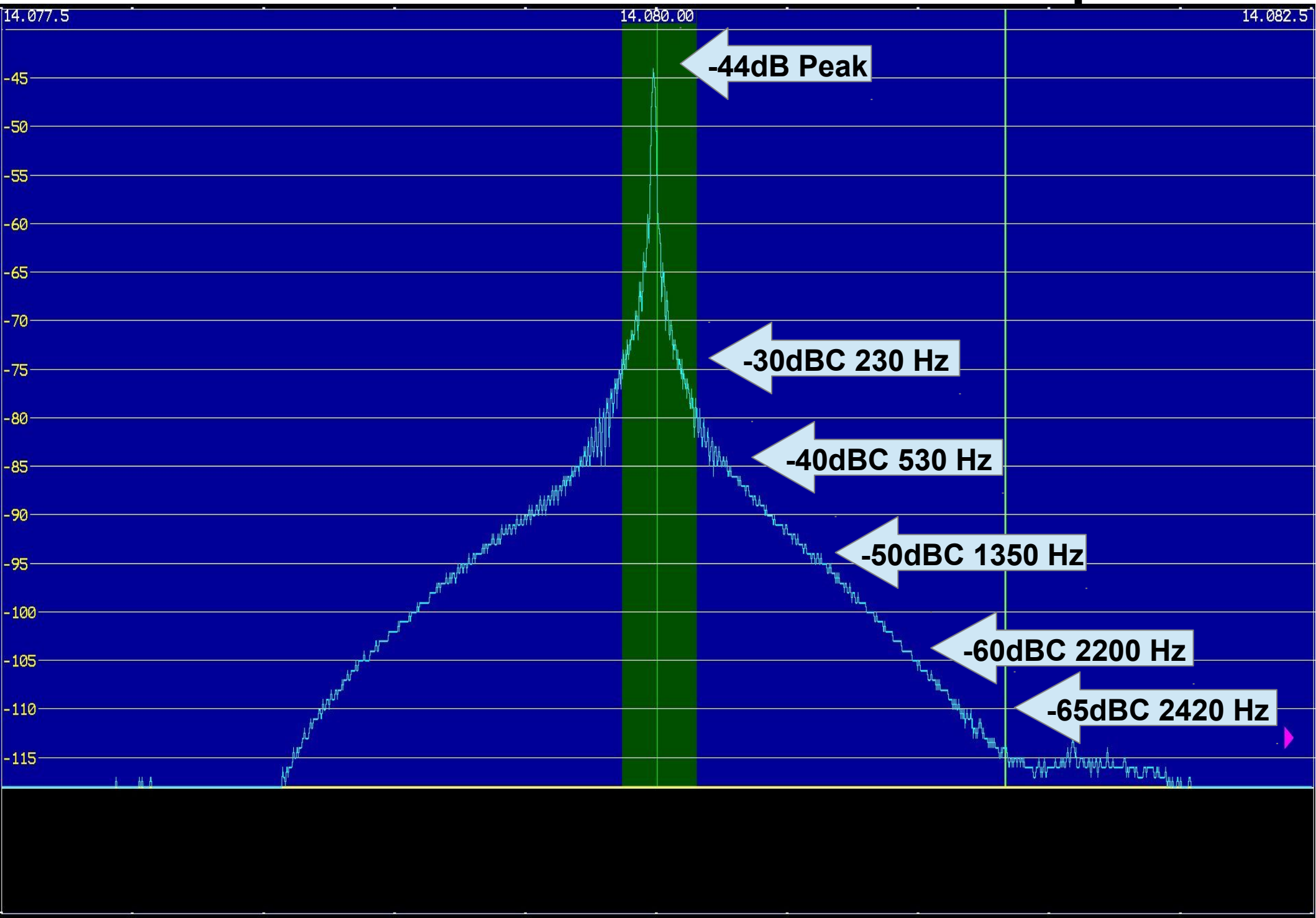
FT1000Mark V Field 95W CW 5 kHz Span



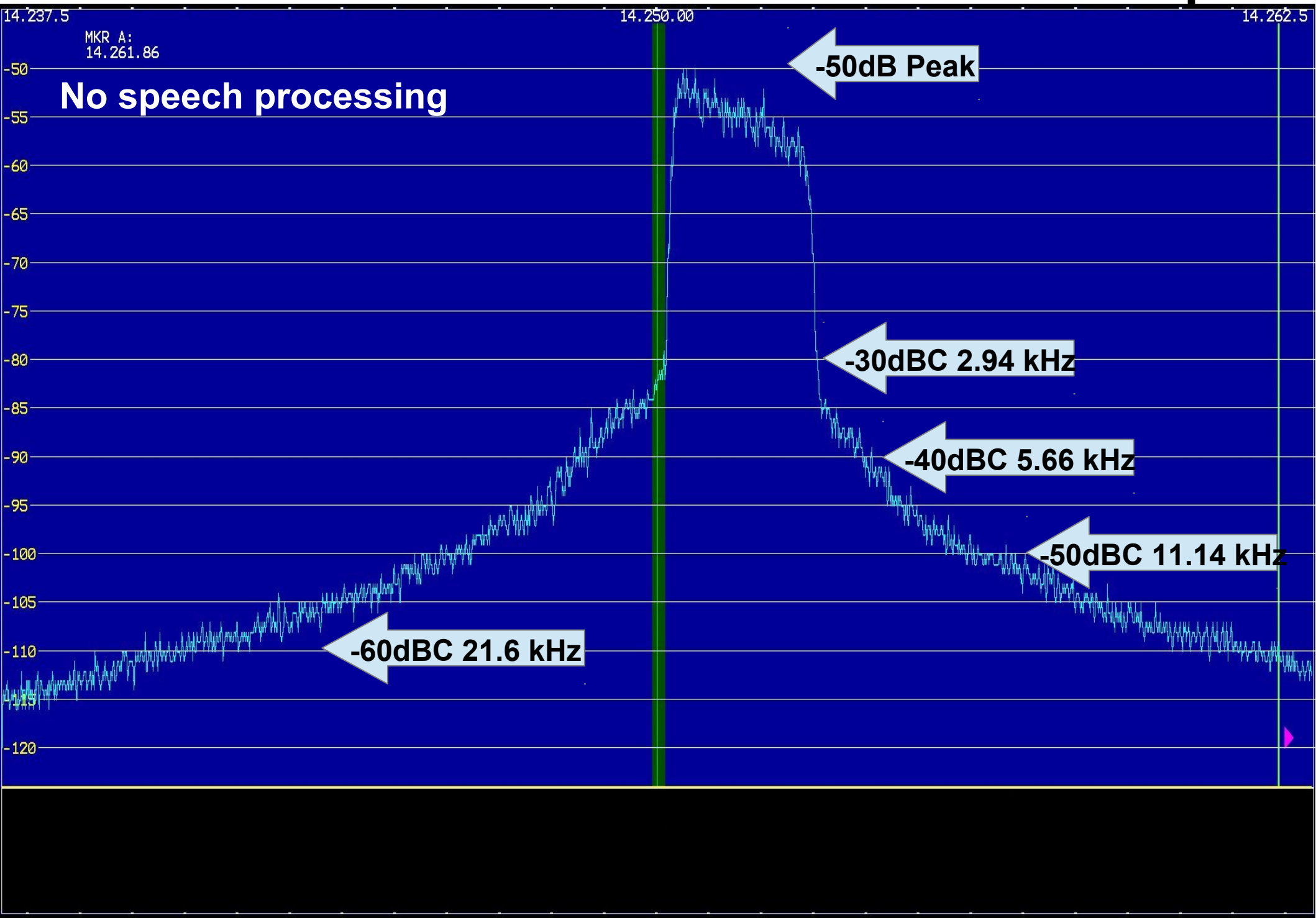
FT1000Mark V Field 50W CW 5 kHz Span



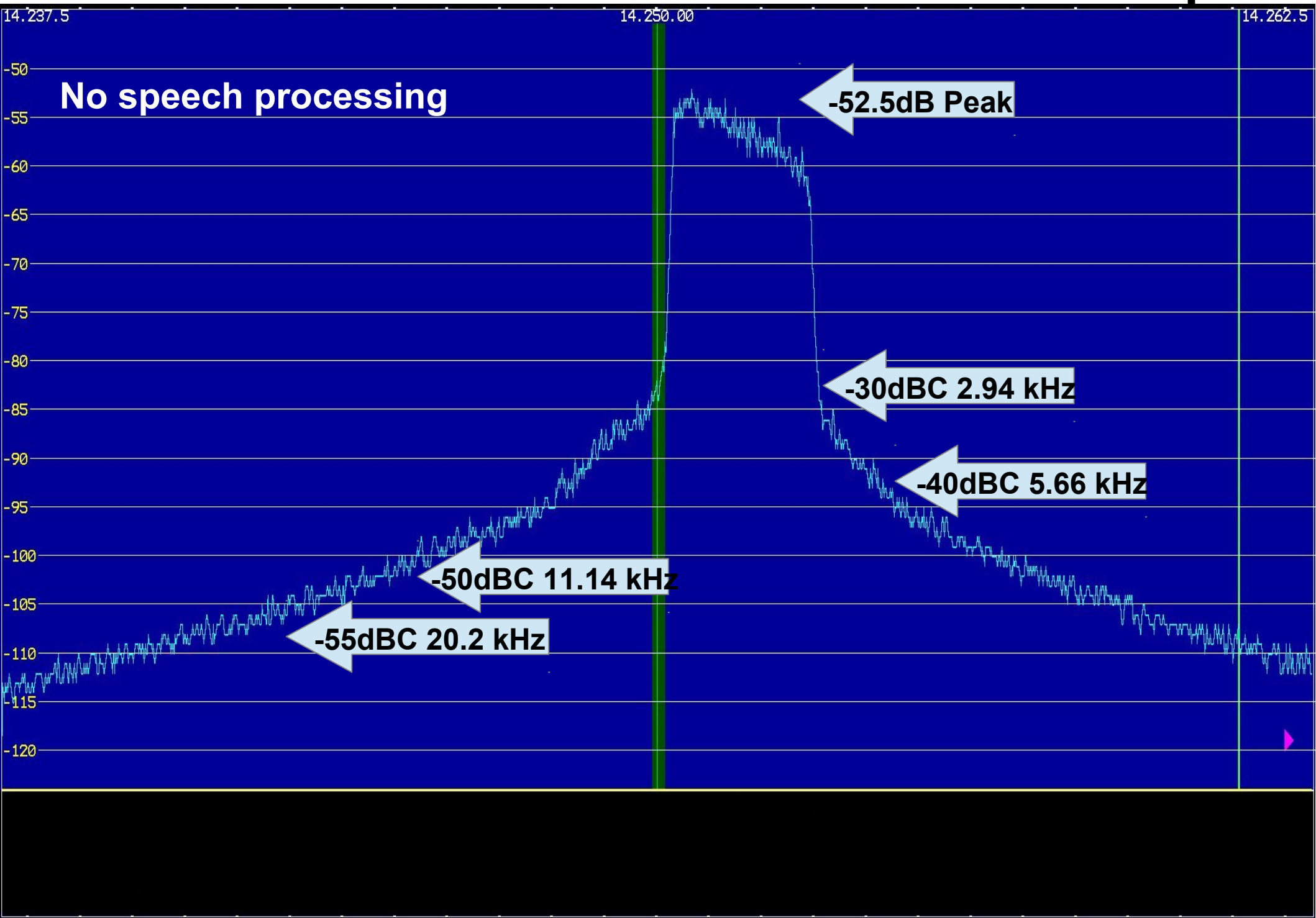
FT1000Mark V Field 37W CW 5 kHz Span



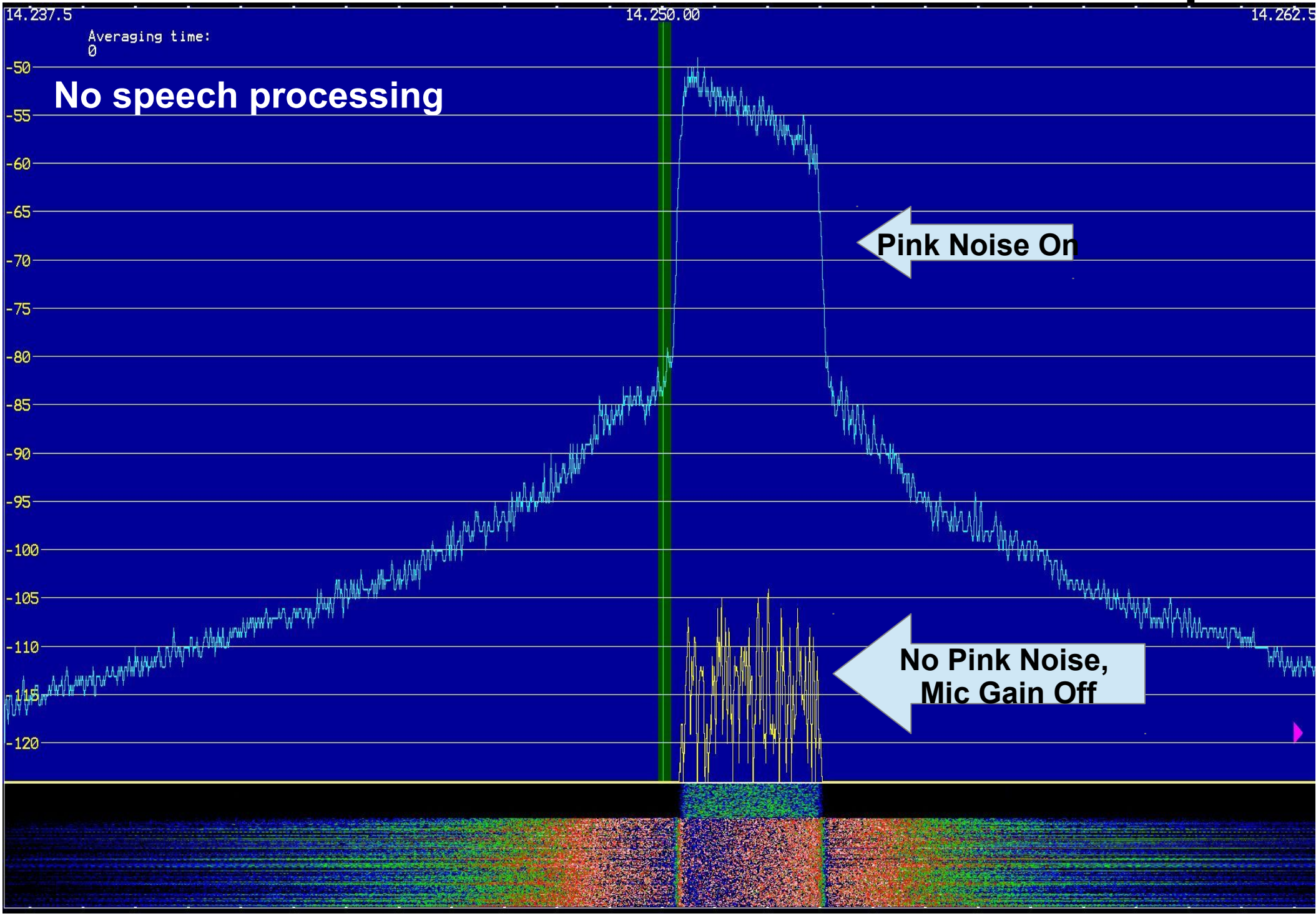
FT1000Mark V Field 95 W Pink Noise 25 kHz Span



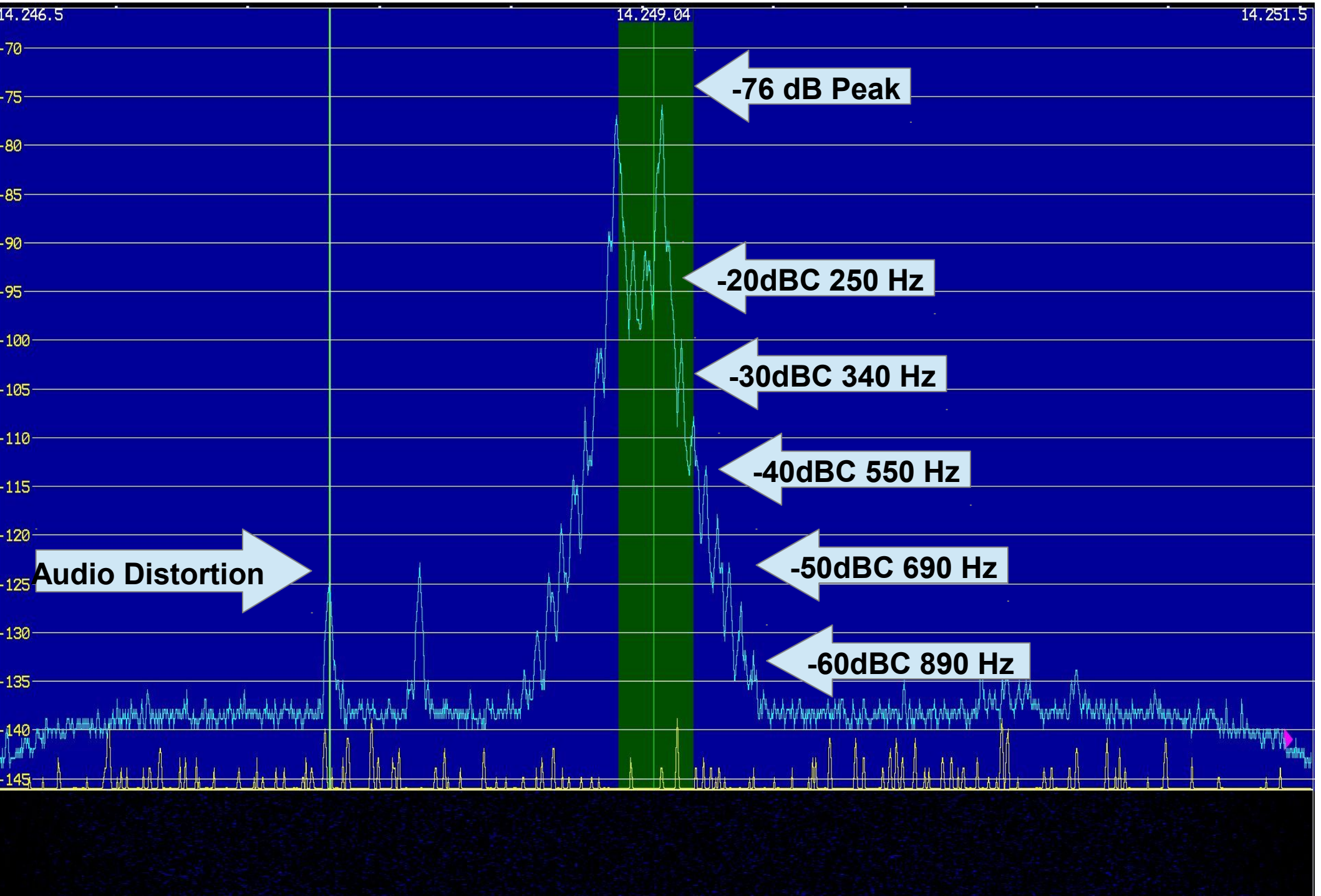
FT1000Mark V Field 50 W Pink Noise 25 kHz Span



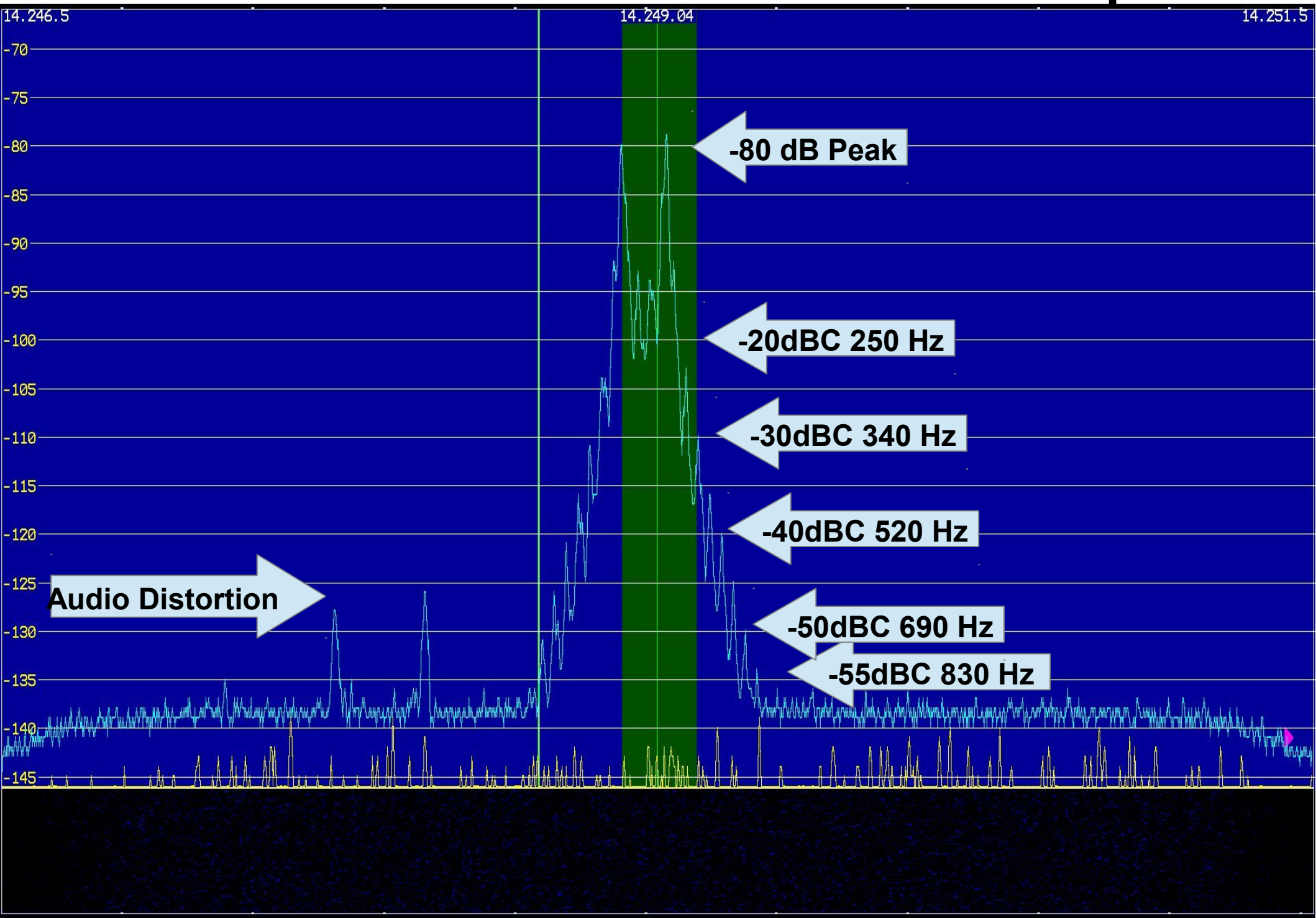
FT1000Mark V Field 95 W Pink Noise 25 kHz Span



FT1000Mark V Field 95W AFSK 5 kHz Span



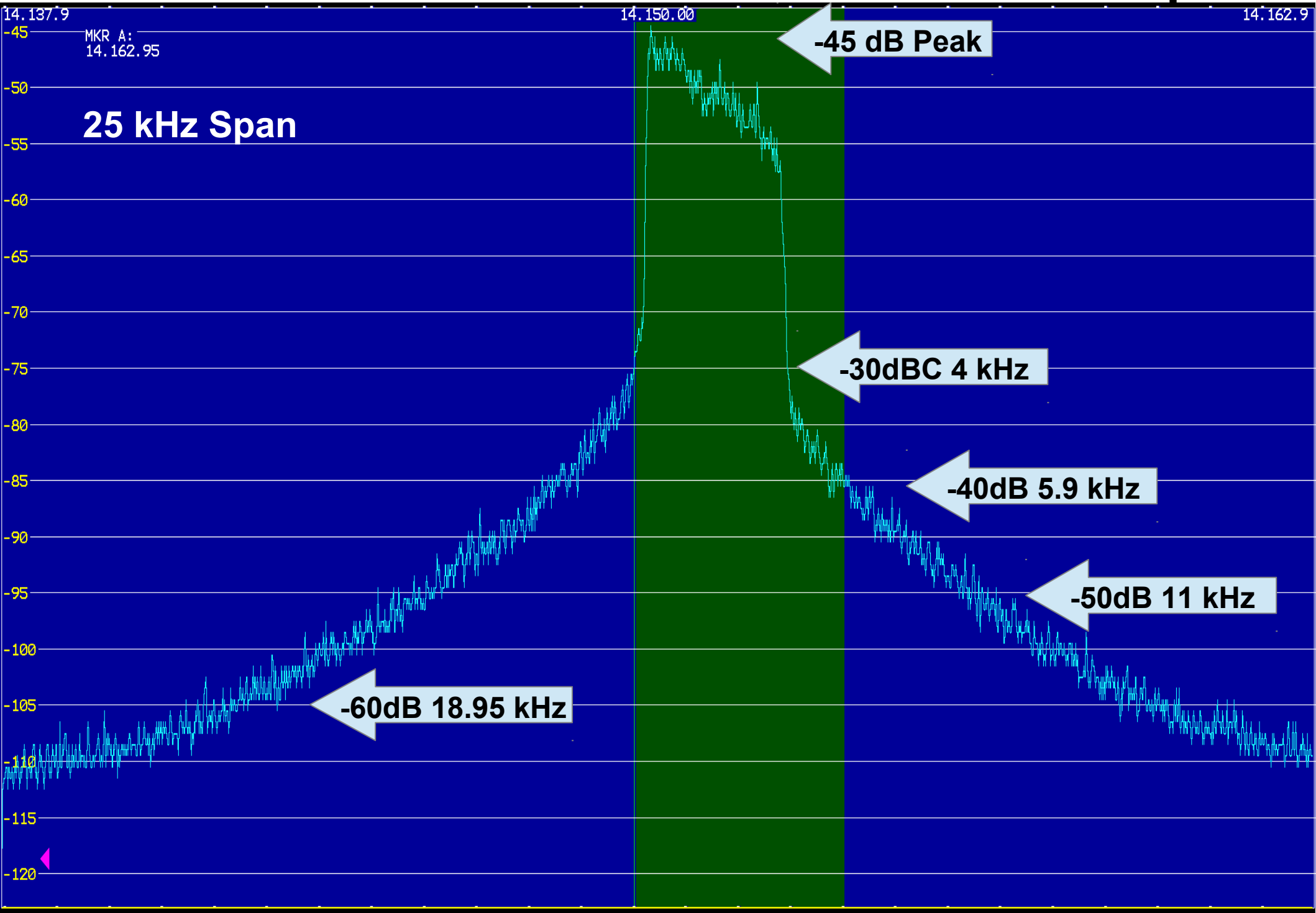
FT1000Mark V Field 50 W AFSK 5 kHz Span



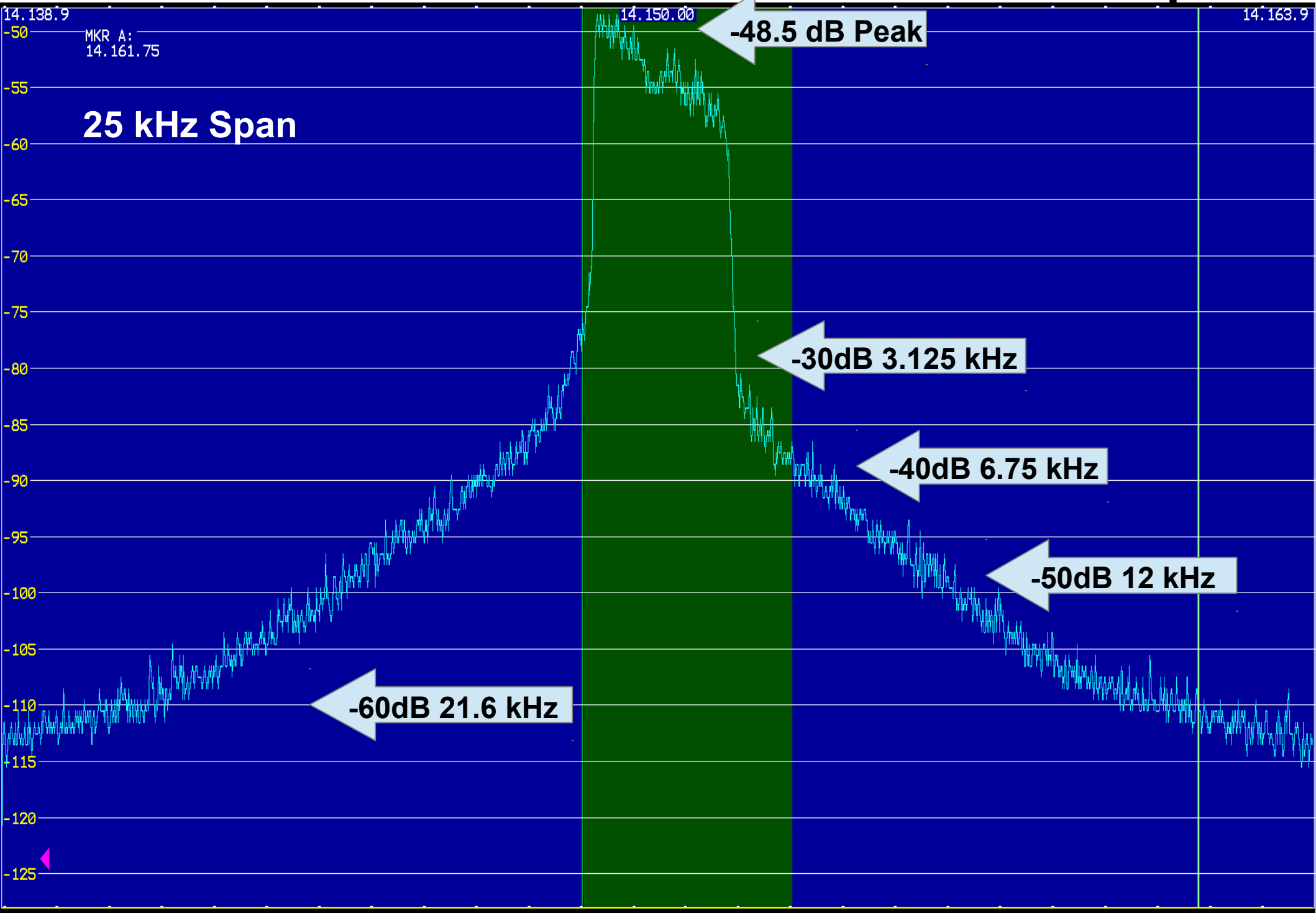
FTDX5000 Test Setup

- Pink Noise Fed to Mic Input from Numark USB audio adapter
- Processing Turned Off
- Class A Mode Off except as noted
- CW sent as a string of dits using internal keyer
- No VOX or QSK, TX initiated by front panel
- This rig was loaned by N6TA, who bought it new, and assisted with testing
- Unit was tested before and after installation of the Sept 2014 firmware update

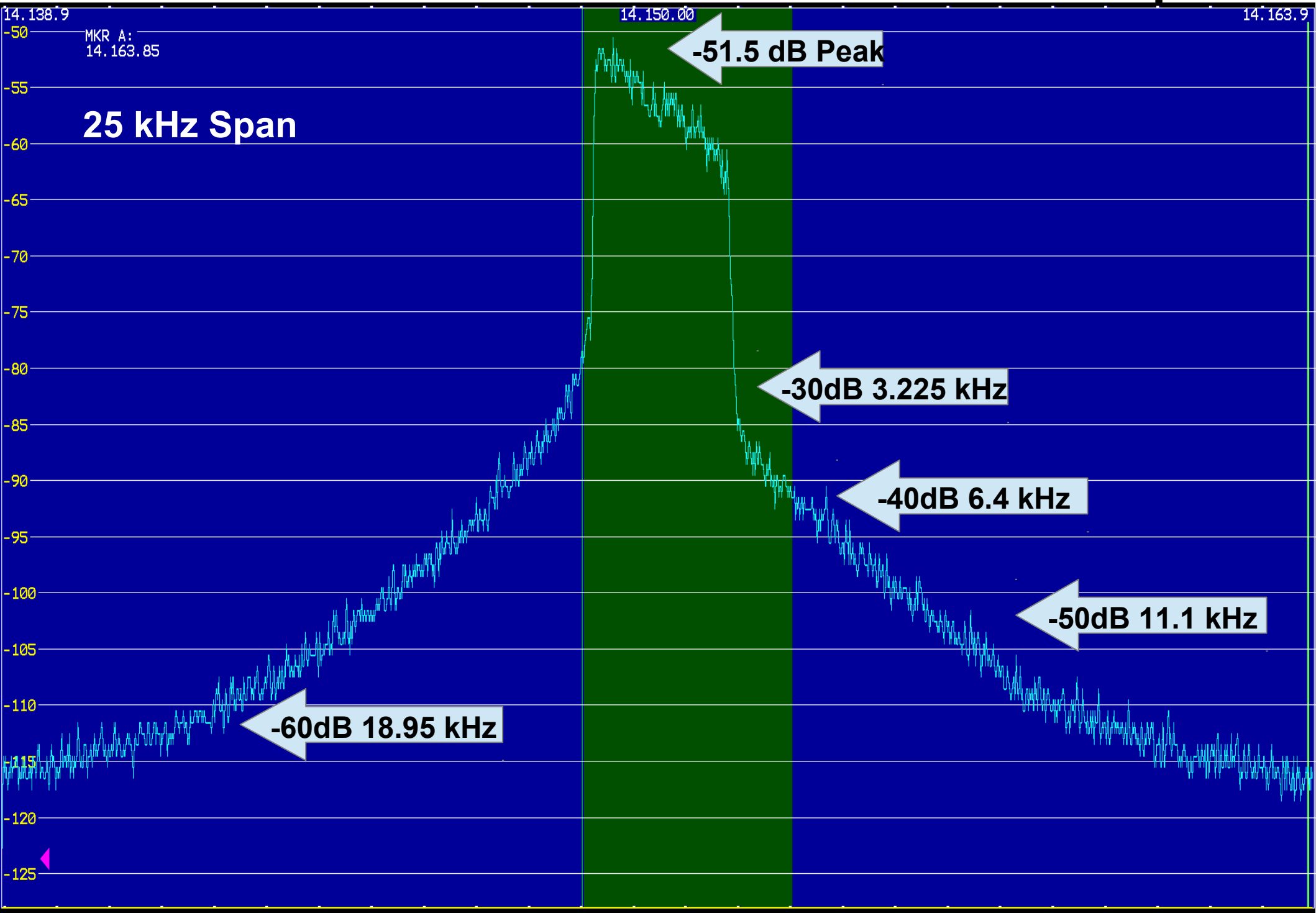
FTDX5000 194 W Pink Noise Before Firmware Update



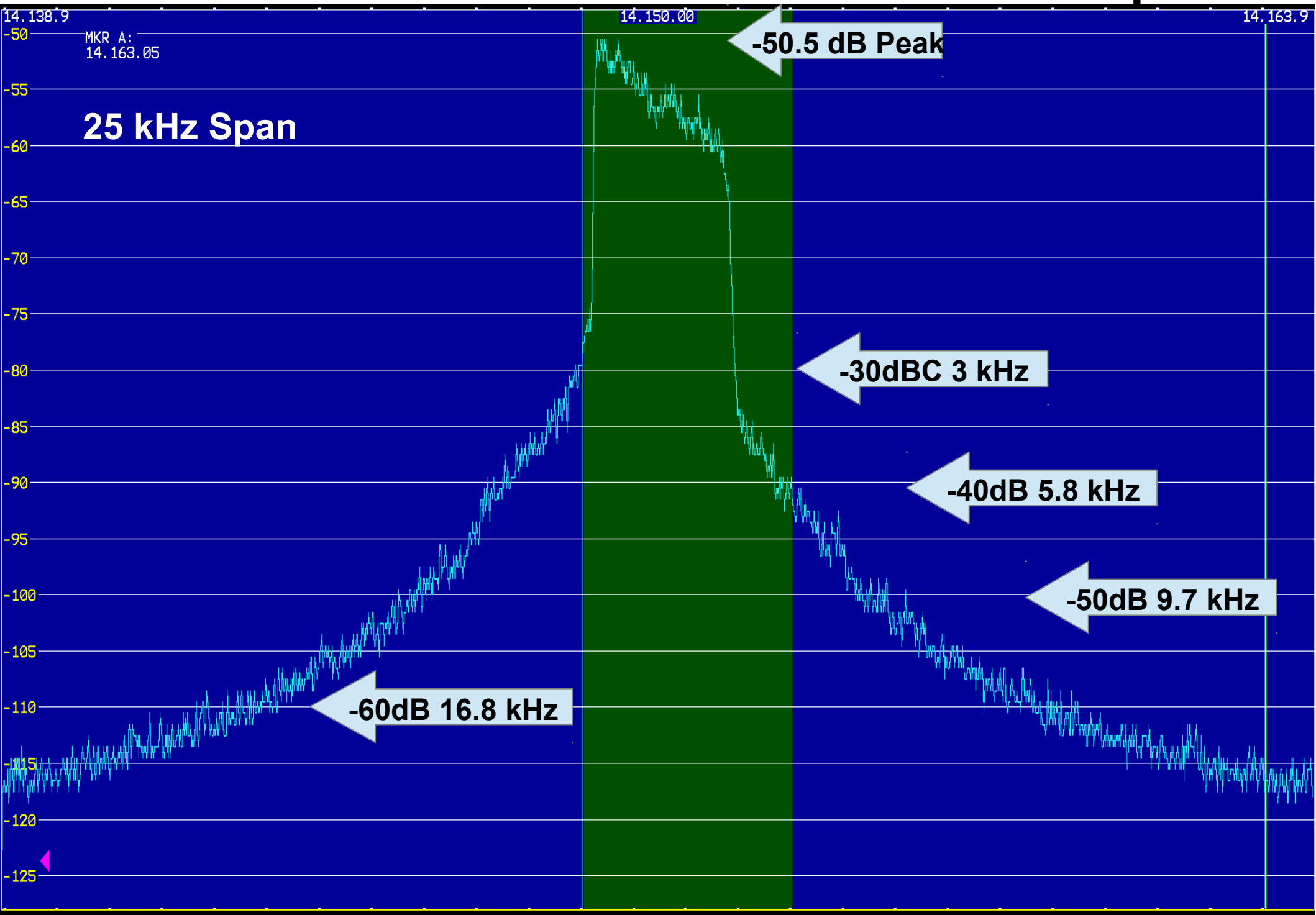
FTDX5000 100 W Pink Noise Before Firmware Update



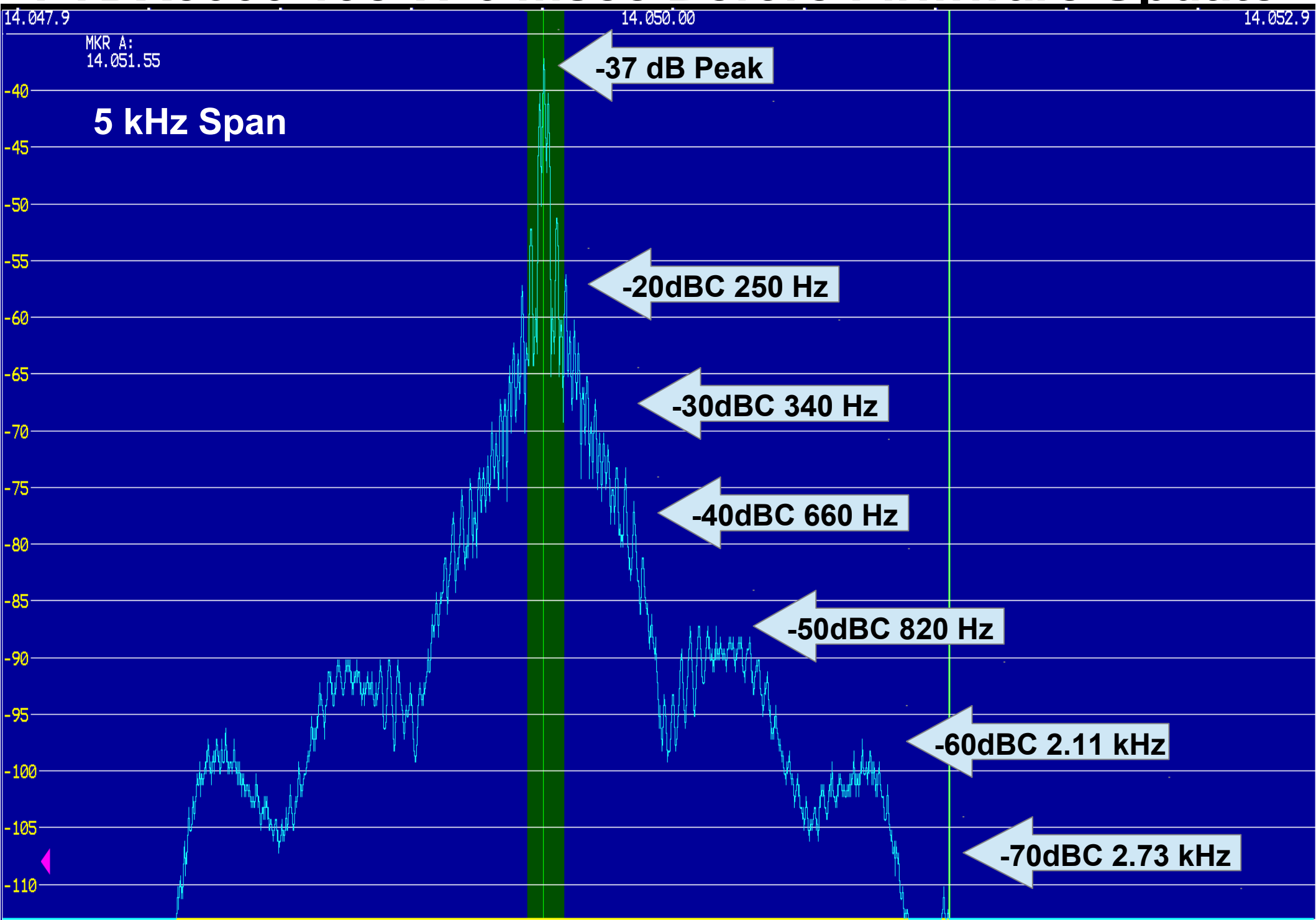
FTDX5000 50 W Pink Noise Before Firmware Update



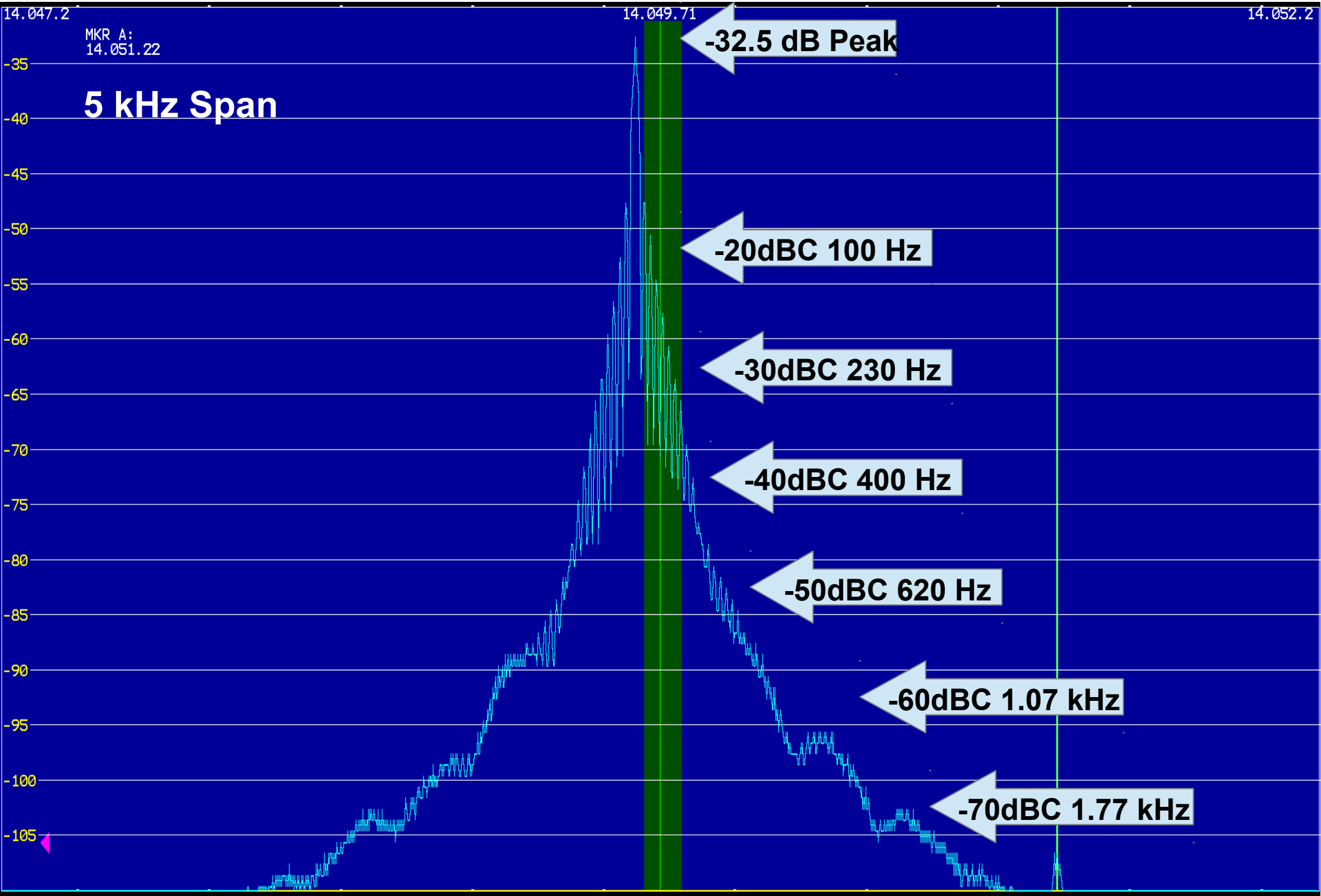
FTDX5000 50 W Class A Pink Noise Before Update



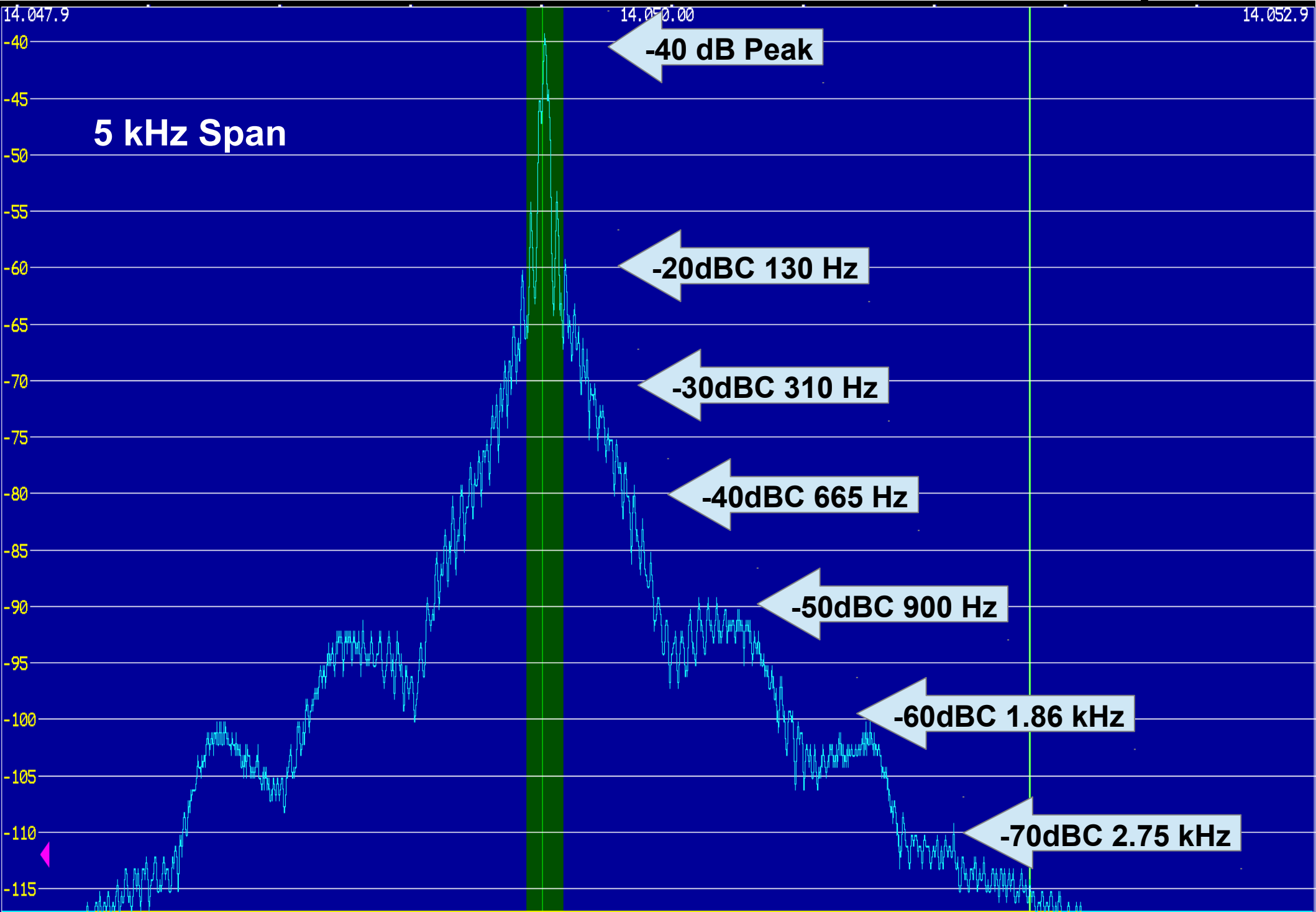
FTDX5000 198 W 6 msec Before Firmware Update



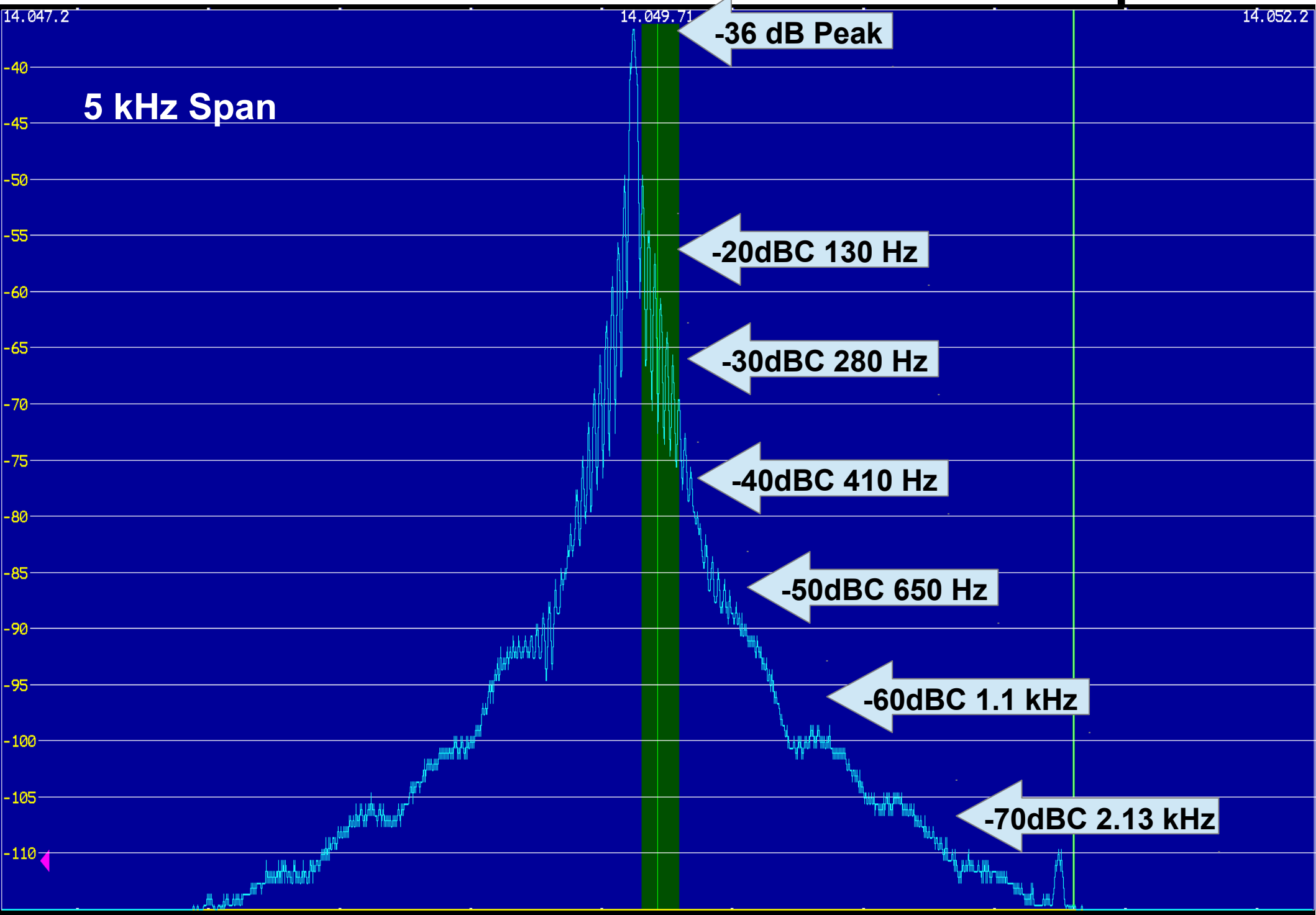
FTDX5000 198 W 6 msec After Firmware Update



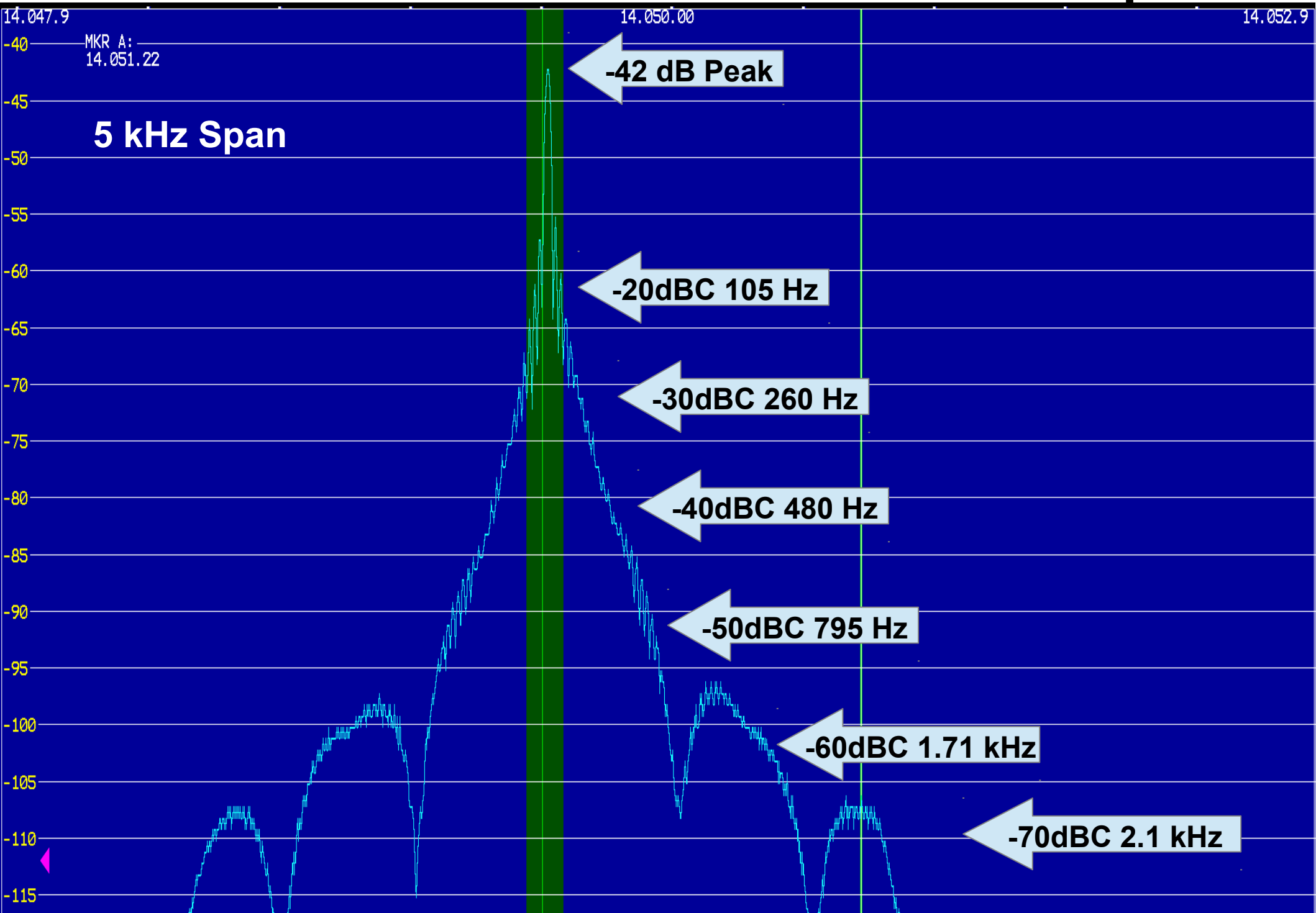
FTDX5000 100 W 6 msec Before Firmware Update



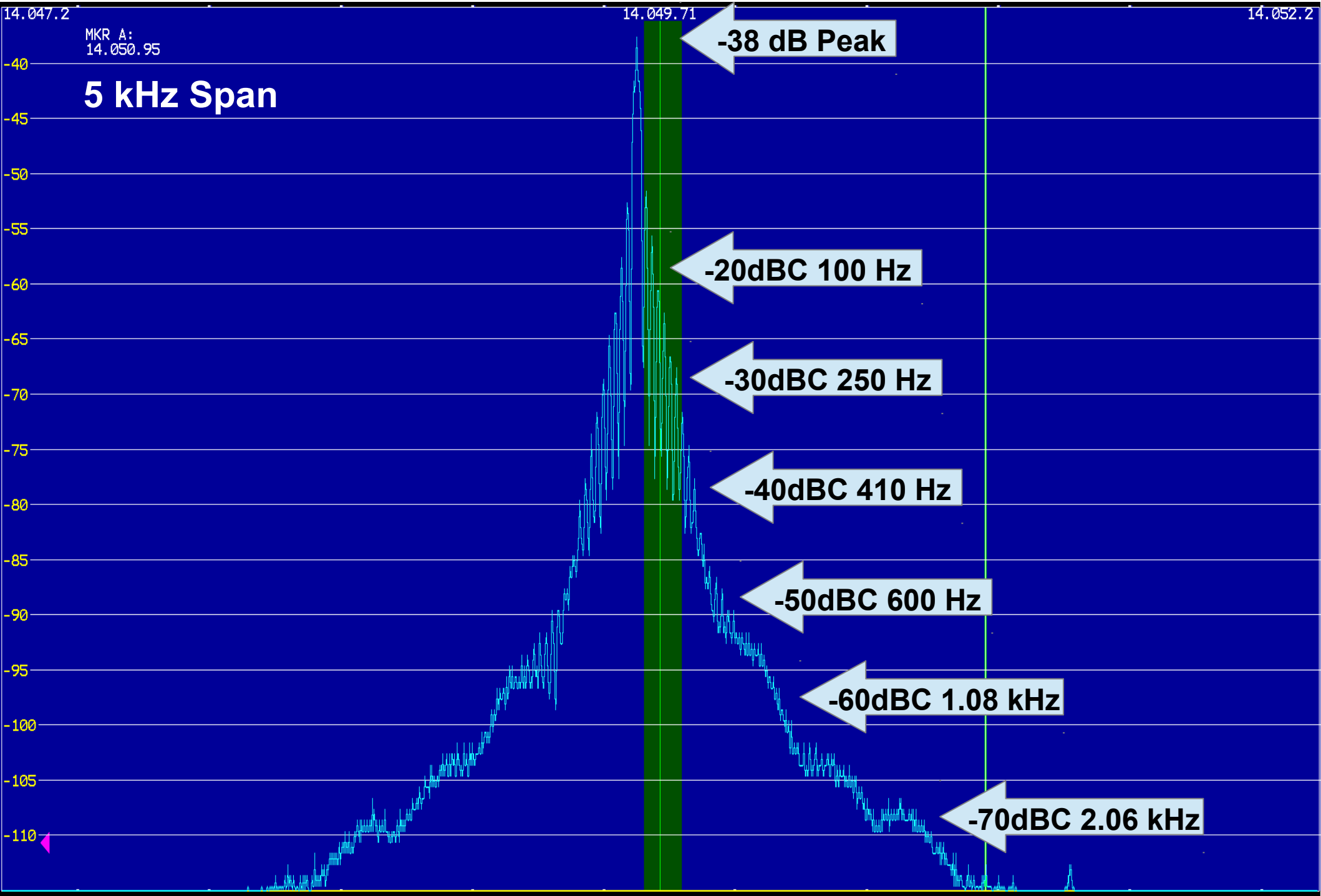
FTDX5000 100 W 6 msec After Firmware Update



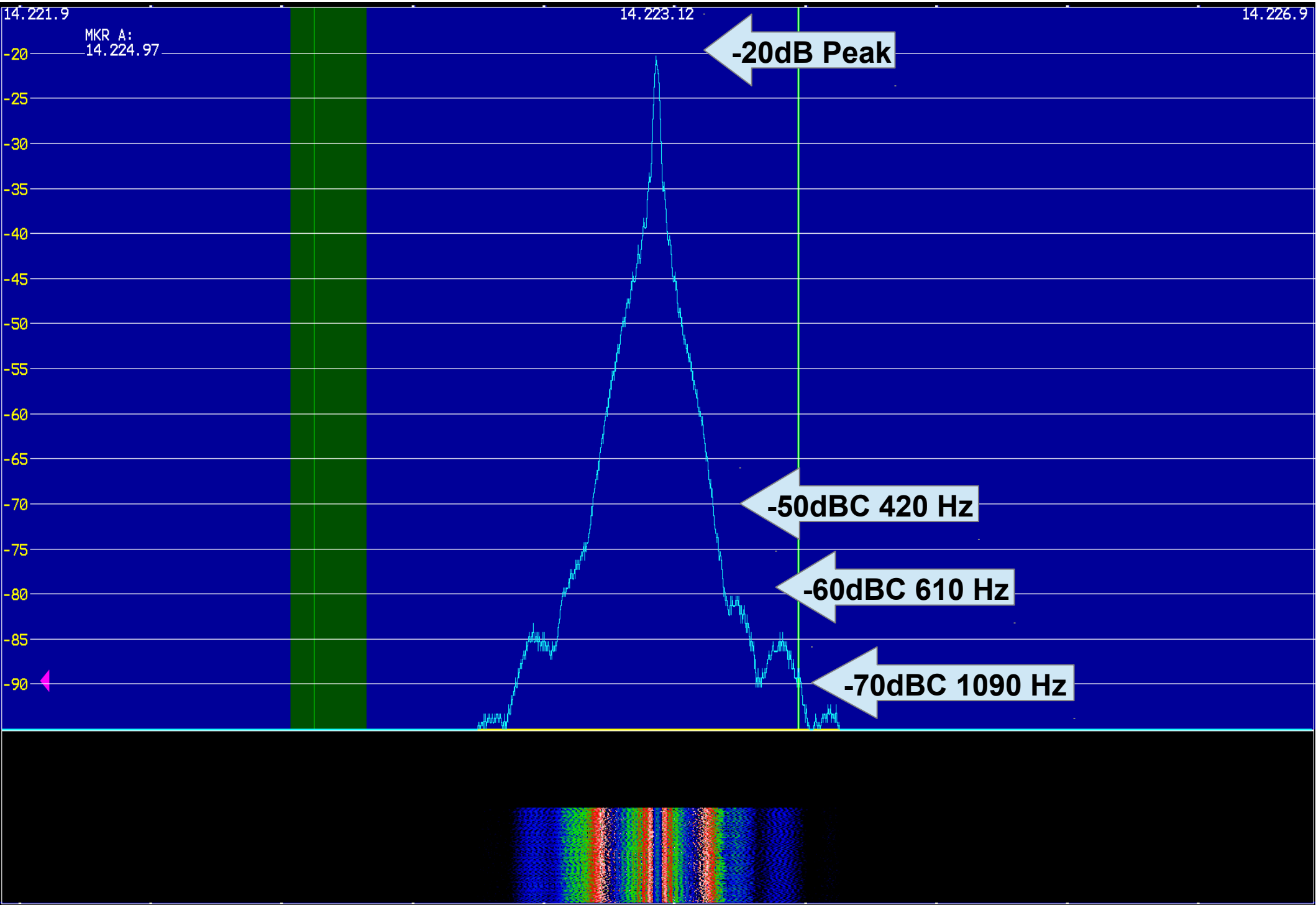
FTDX5000 50 W 6 msec Before Firmware Update



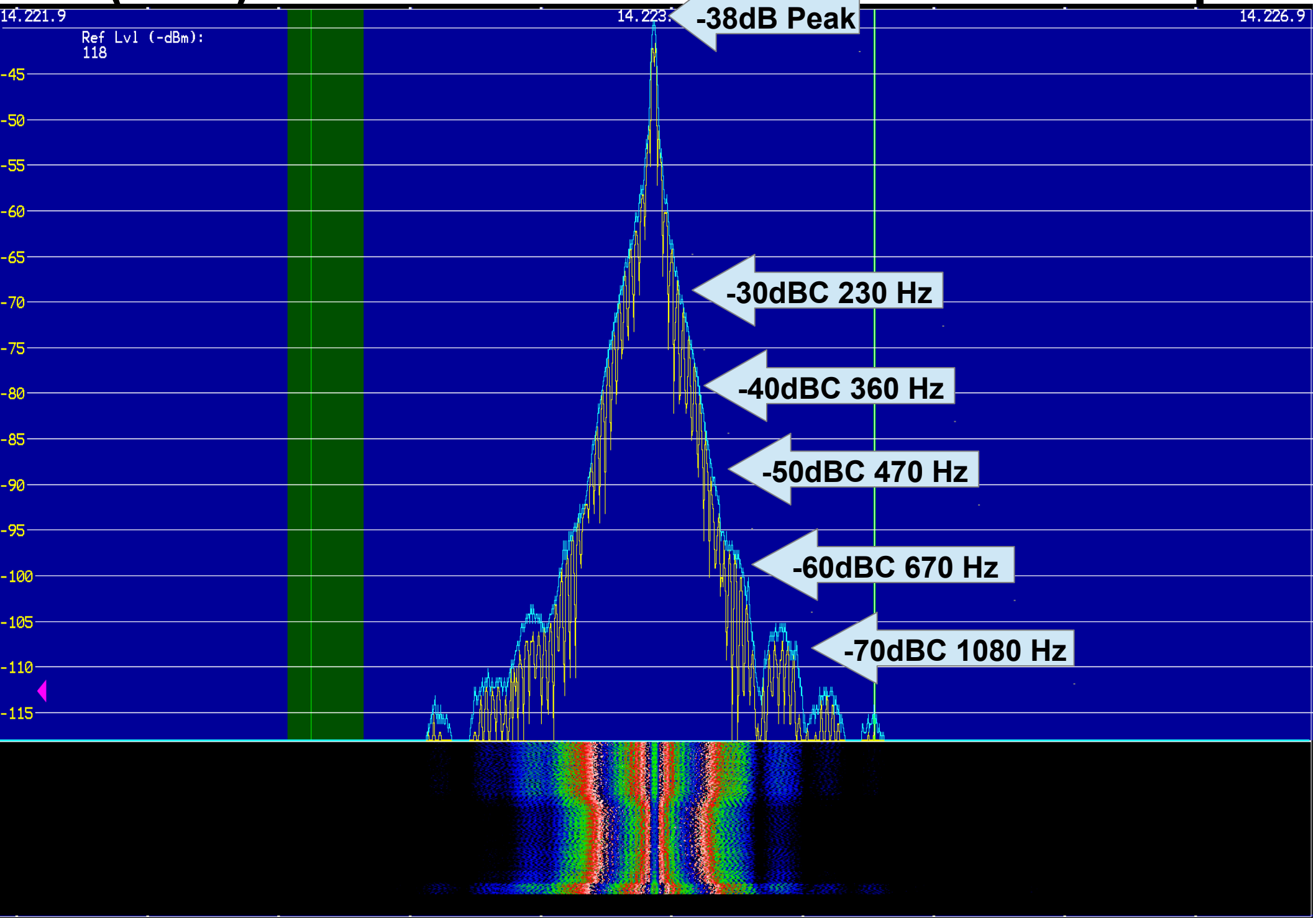
FTDX5000 50 W 6 msec After Firmware Update



K3-KPA500 550W CW 5kHz Span



K3 (40W)-Ten Tec Titan 425 1500W CW 5 kHz Span



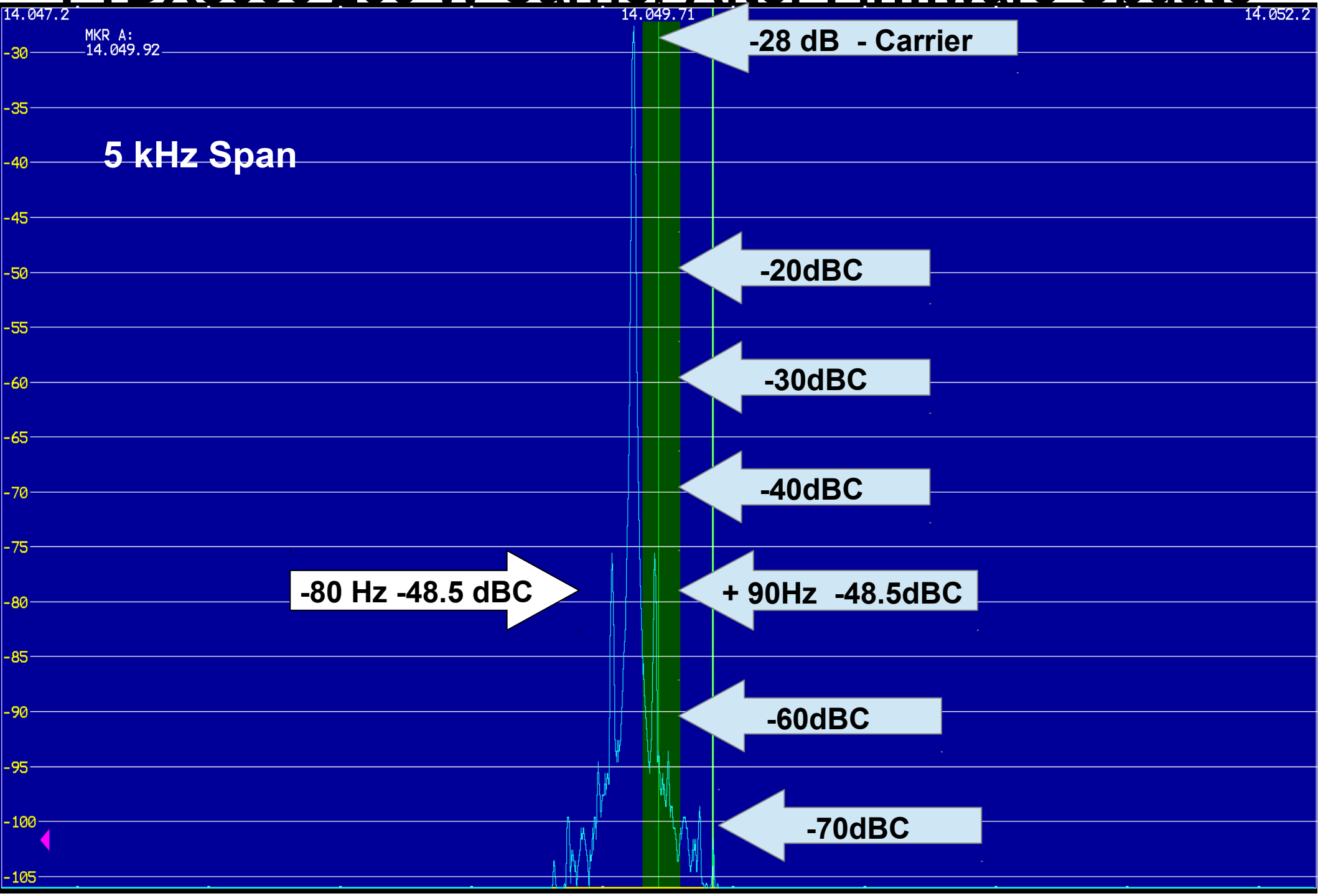
FTDX5000 Observations

- **CW Bandwidth is significantly reduced by the Sept 2014 update**
  - **The greatest improvement is at 200W, and for the lower amplitude sidebands**
  - **The update bring the FTDX5000 bandwidth closer to the the IC7800 and 7600**
  - **The improvement might best be described as a reduction in the higher order harmonics that excite IMD to produce the more widely spaced sidebands**
  - **CW bandwidth is now nearly the same at 50W, 100W, and 200W**
- **Thanks to N6TA for the loan of his FTDX5000, and for assisting with the measurements**

FTDX5000 Observations

- **The updated rig is not “nearly as good” as a K3 at the power levels needed to drive a power amp**
  - **See data for K3 driving KPA500 to rated power**
  - **See data for K3 driving Ten Tec Titan to rated power**

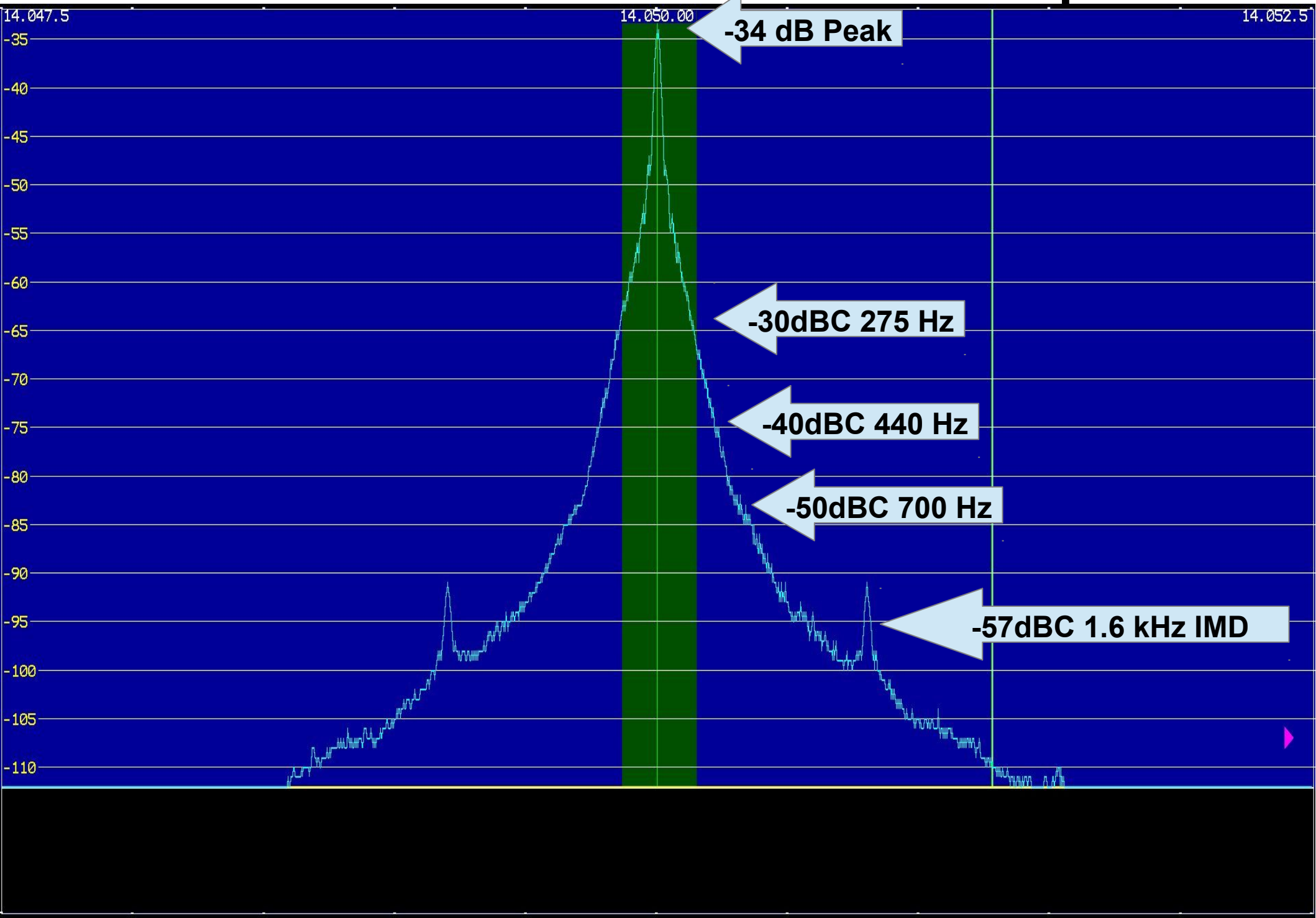
FTDX5000 200 W Carrier After Firmware Update



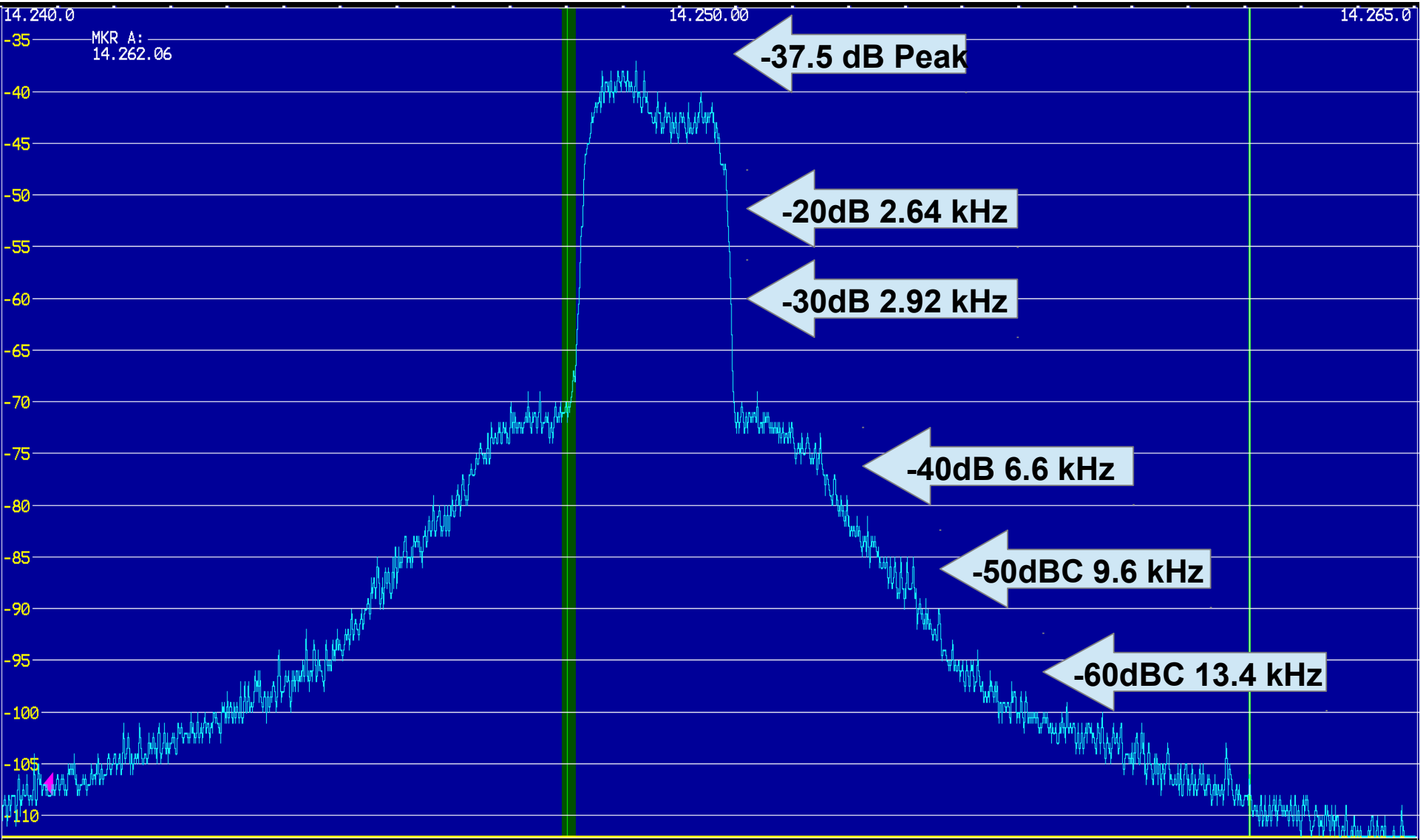
ACOM 1010 Test Setup

- Exciter was Elecraft K3, same unit tested for other data, set for indicated 10 dB compression on SSB
- N8LP LP100A used for power measurement into 500W 50 Ohm dummy load
- Amplifier was keyed from PTT output of K3
- Accumulation of peaks began after rig was transmitting, thus excluding turn-on transients
- Amplifier was tuned per instructions for a string of dits at 700W for both CW and SSB modes
- Amplifier is wired for 120VAC, and was fed from a 20A circuit with a #14 line cord

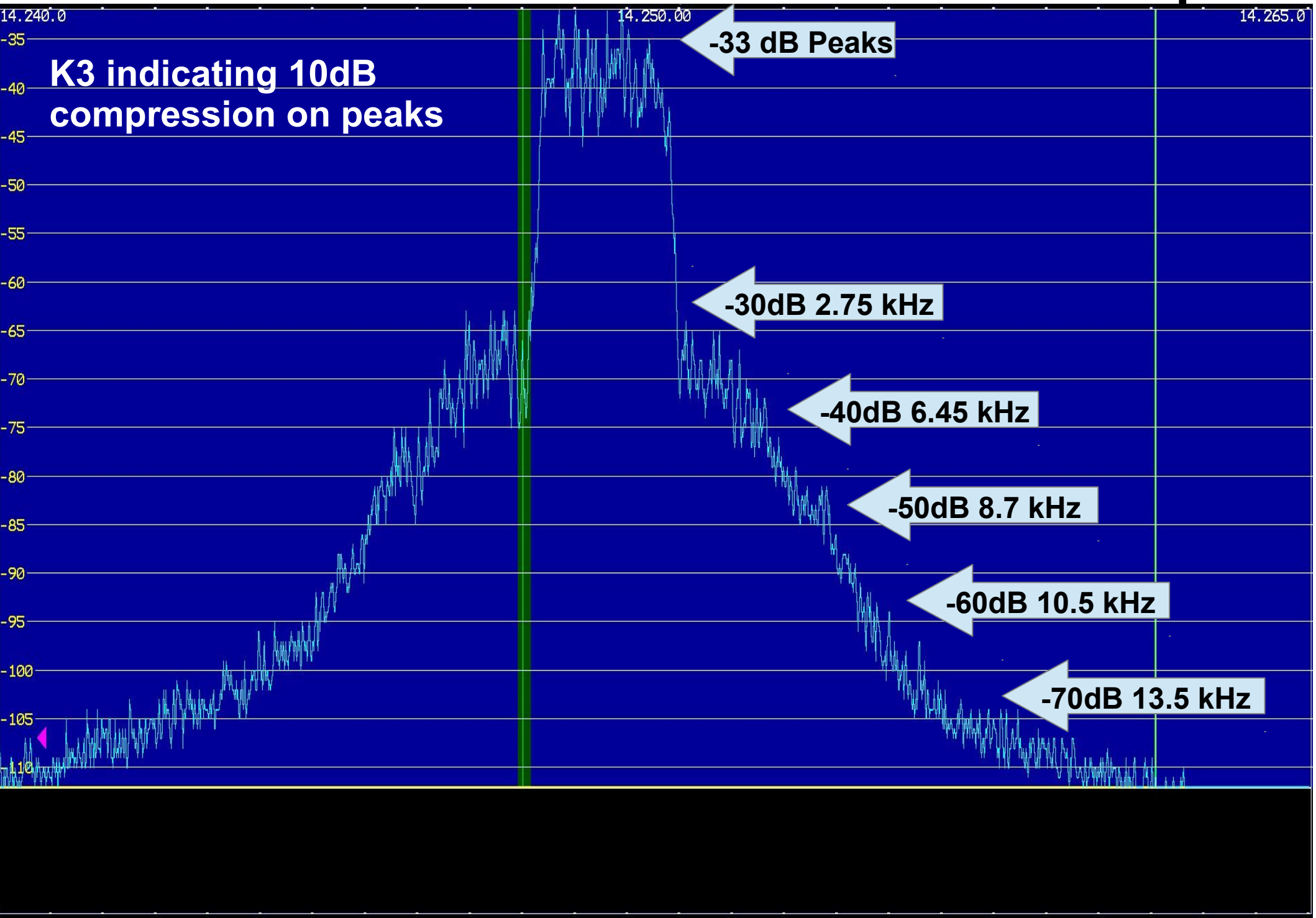
K3 to ACOM 1010 675W CW 5 kHz Span



K3 / ACOM 1010 675W PEP Pink Noise 25 kHz Span

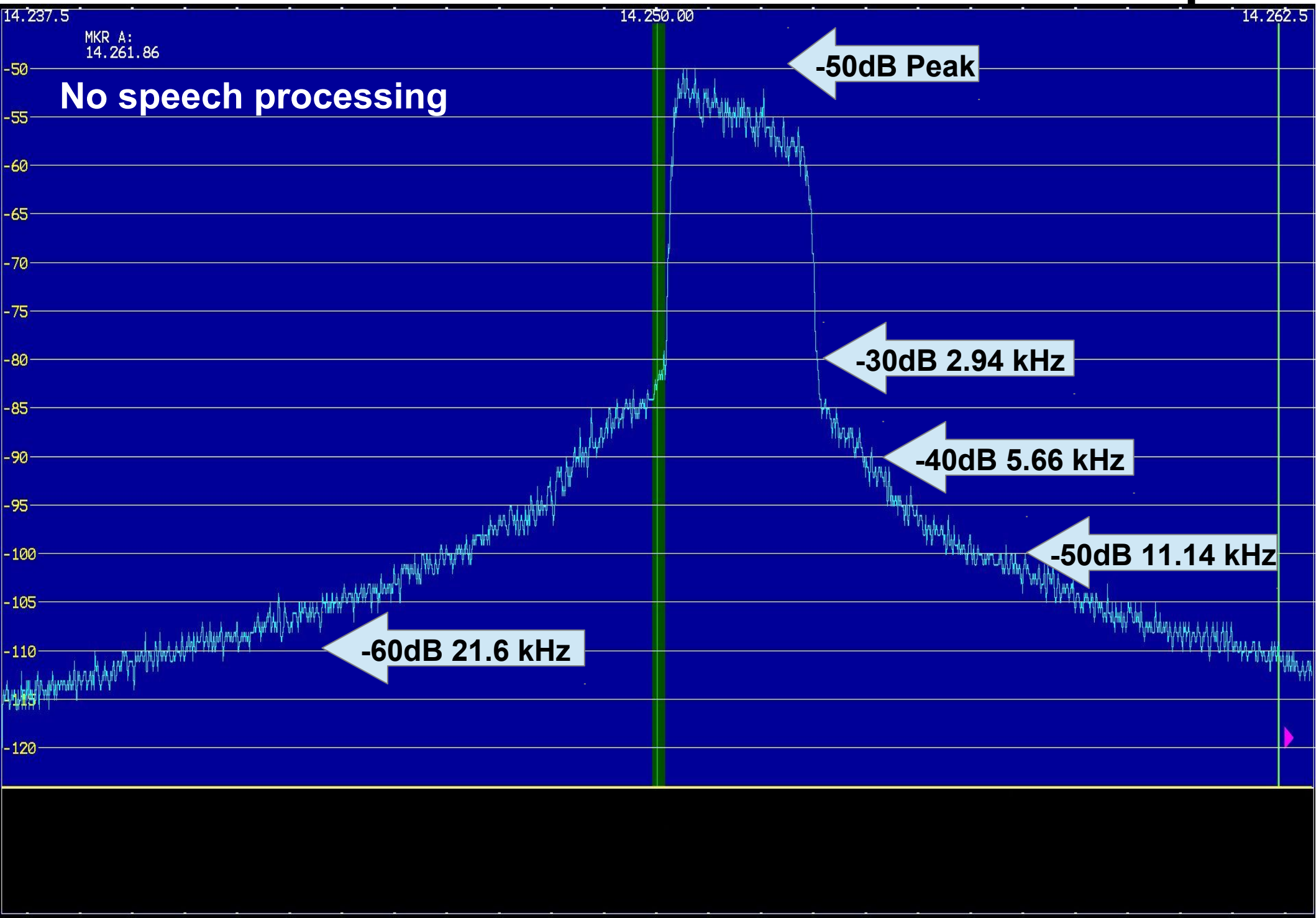


K3 / ACOM 1010 700W PEP Live Mic 25 kHz Span

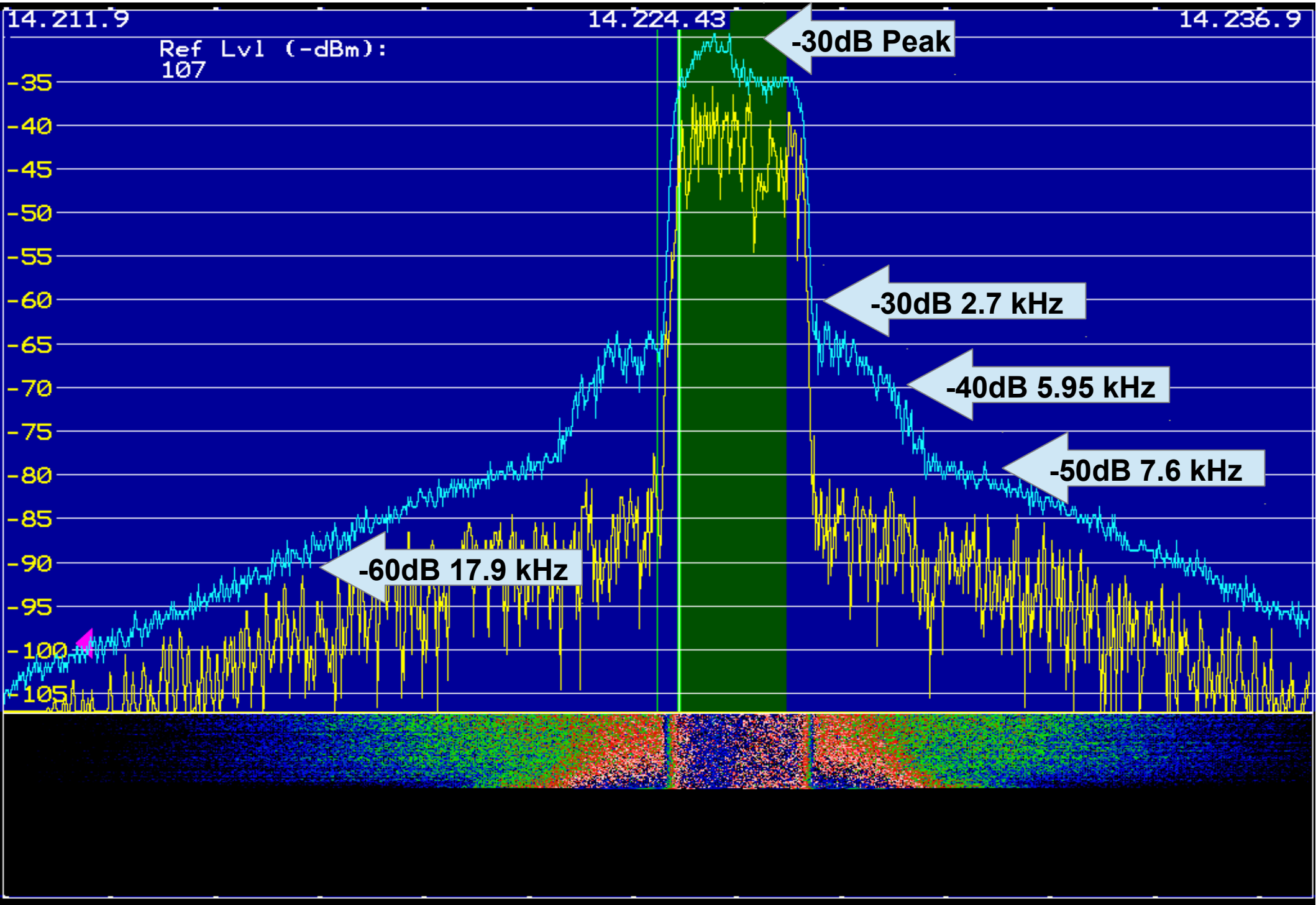


Comparing Rigs and Amplifiers

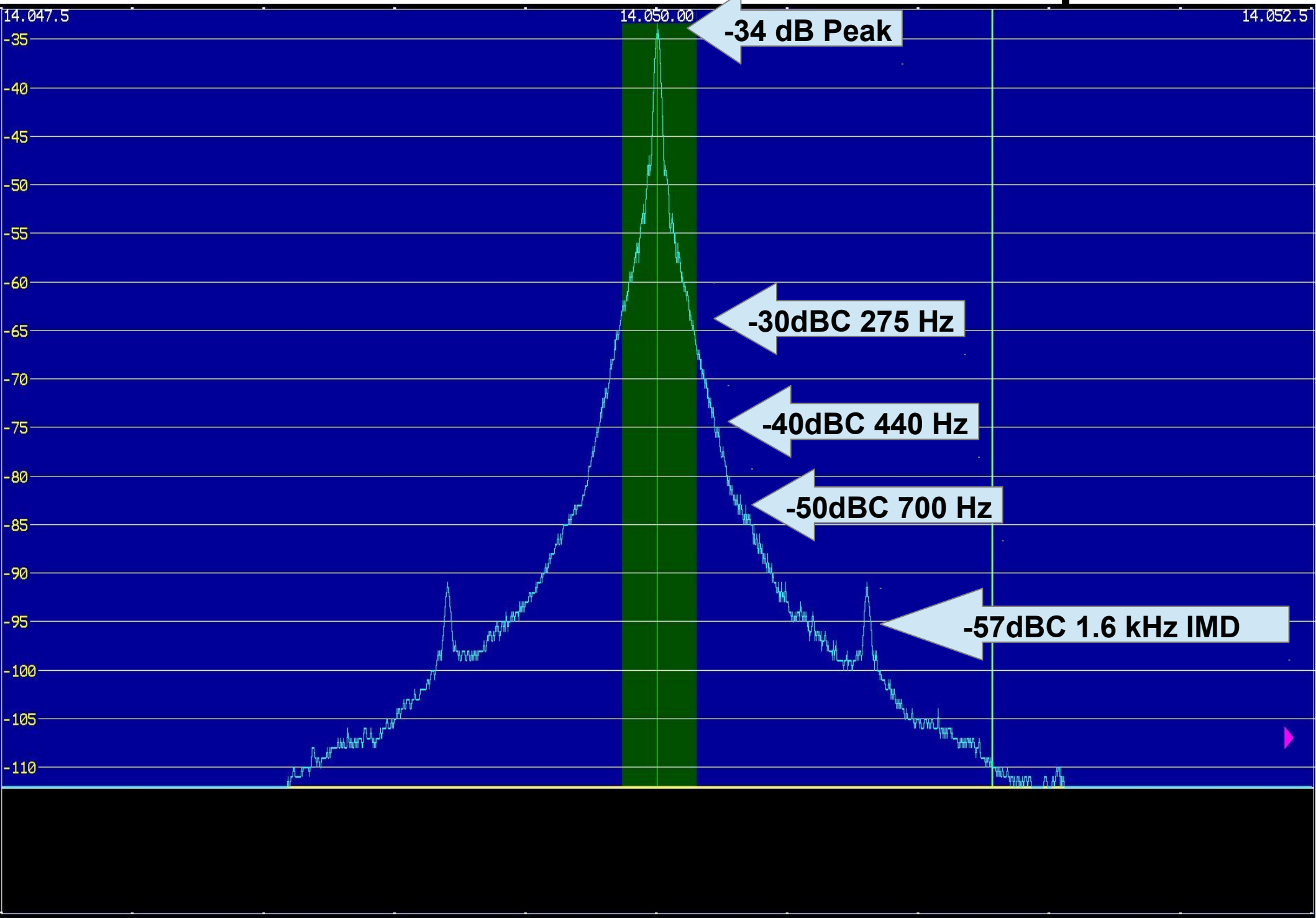
FT1000Mark V Field 95 W Pink Noise 25 kHz Span



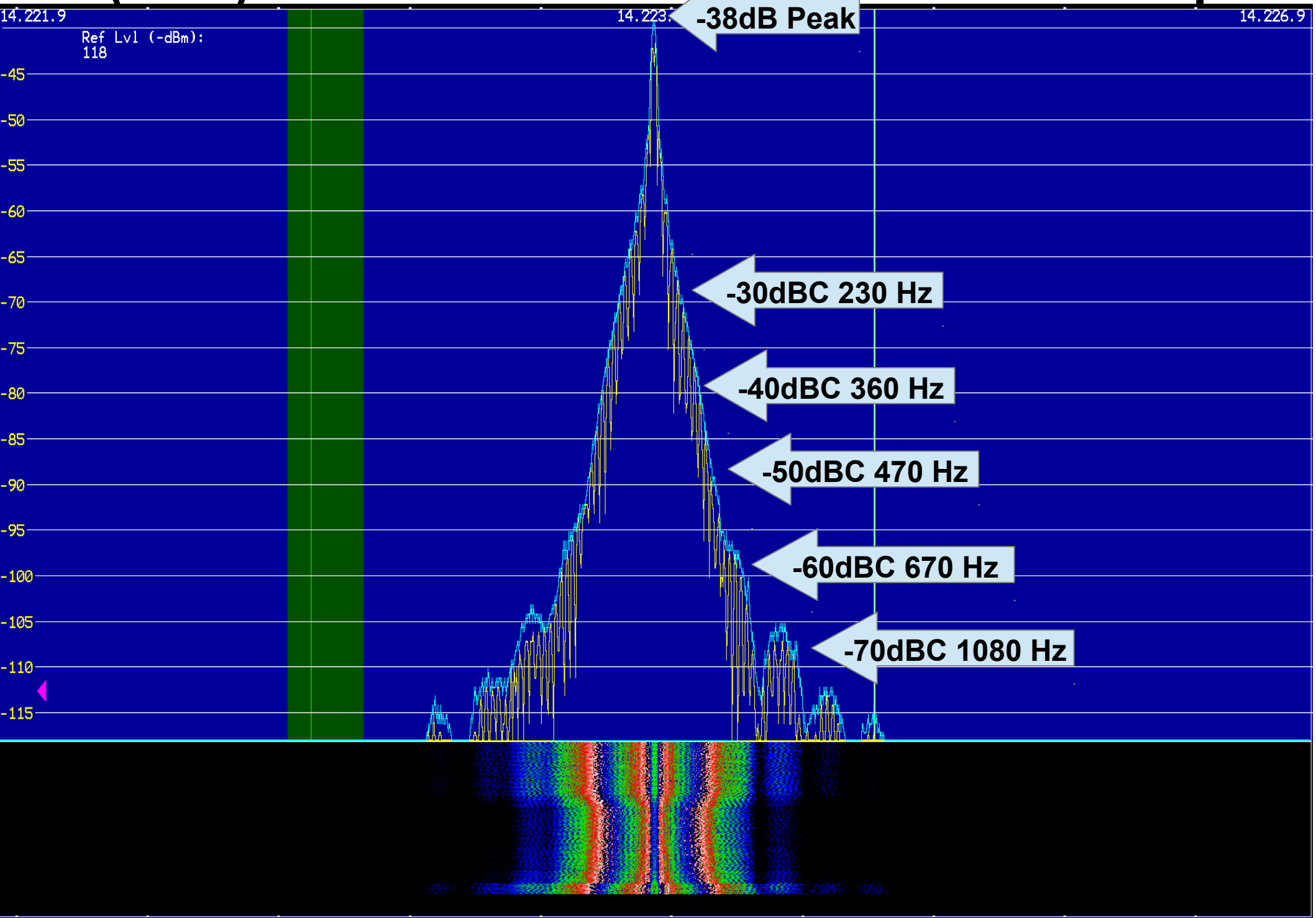
K3-KPA500 550W Pink Noise 10dB Compression



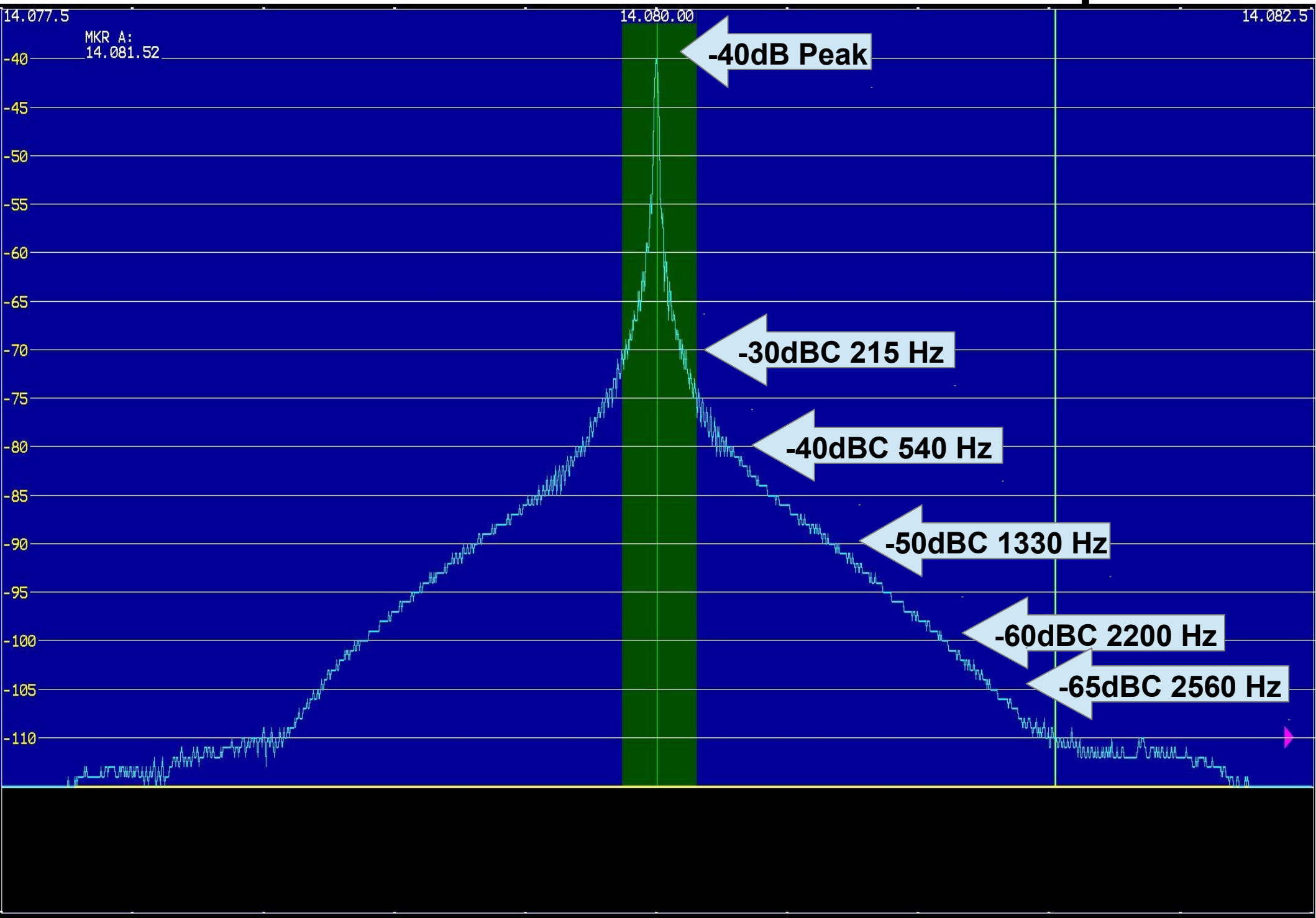
K3 to ACOM 1010 675W CW 5 kHz Span



K3 (40W)-Ten Tec Titan 425 1500W CW 5 kHz Span



FT1000Mark V Field 95W CW 5 kHz Span



K3-KPA500 550W CW 5kHz Span