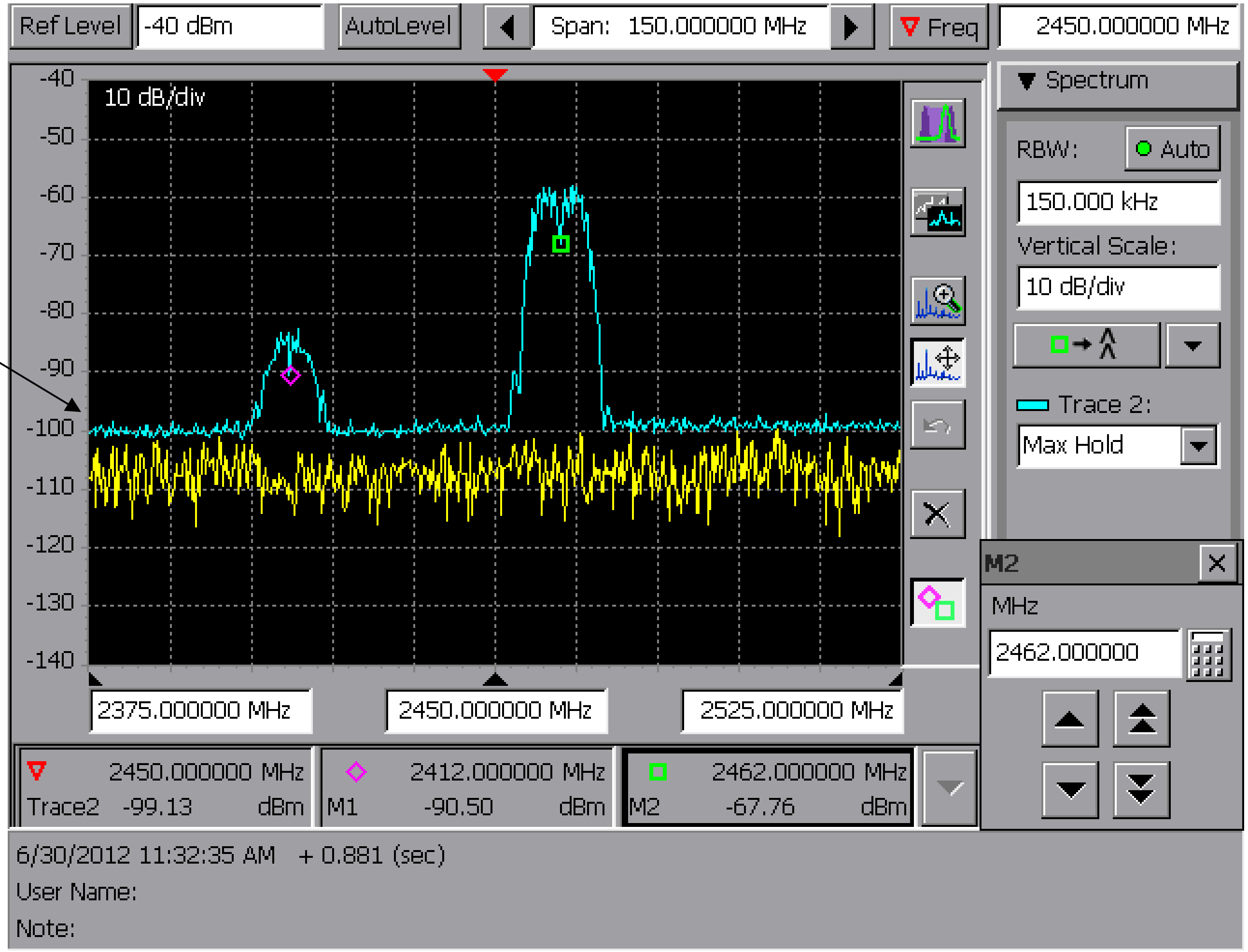
The Advantages of a "Real Time Analyzer" in Spectrum Analysis

Welcome to the 2nd Quarter 2012 CSEI Technical Report. The 1st Qtr report dealt with basic spectrum analysis, and then moved on to the advantages of a spectrogram display in locating and analyzing intermittent signals. This report now re-examines many of the same measurements (taken at the same physical location) performed during the 1st Qtr report, however, a real time spectrum analyzer (RTA) will be used to demonstrate why these instruments have become so important for analysis in the modern very crowded electromagnetic spectrum. Since considerable time was spent in the last report explaining spectrum analysis basics, you may wish to refer back to that report before reading on. This report keeps dialog and theory to a minimum; primarily making comparisons between screen shots (1st Qtr and 2nd Qtr reports) using a RTA, noting the {many} differences between a 'front-end sweep-tuned' analog versus a 'real-time FFT based' digital spectrum analyzer.

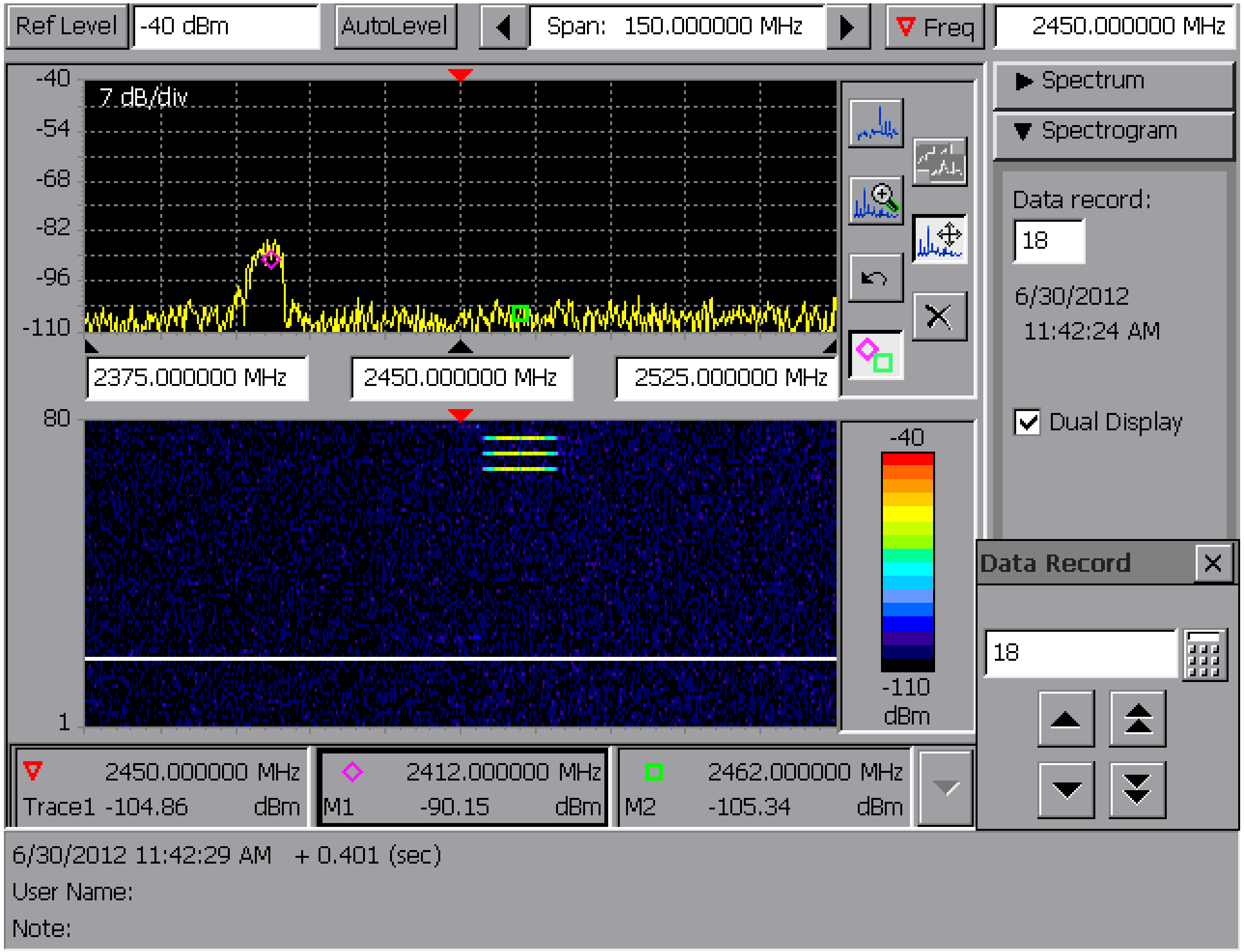
Sample Waveforms

The following waveforms are intended to provide illustration of how a real time spectrum analyzer locates and allows for the analysis of very intermittent waveforms, including those masked by other spectral sources that may be much higher in amplitude. Spectrogram displays will be employed, along with the use of DPX views (digital phosphorescence), that allow for a 3 dimensional representation of data – frequency vs amplitude vs rate of occurrence of each spectral source. As suggested above, you may wish to review our 1st Qtr report before proceeding, as this report is comprised primarily of screen shots along with an explanation of the information shown.

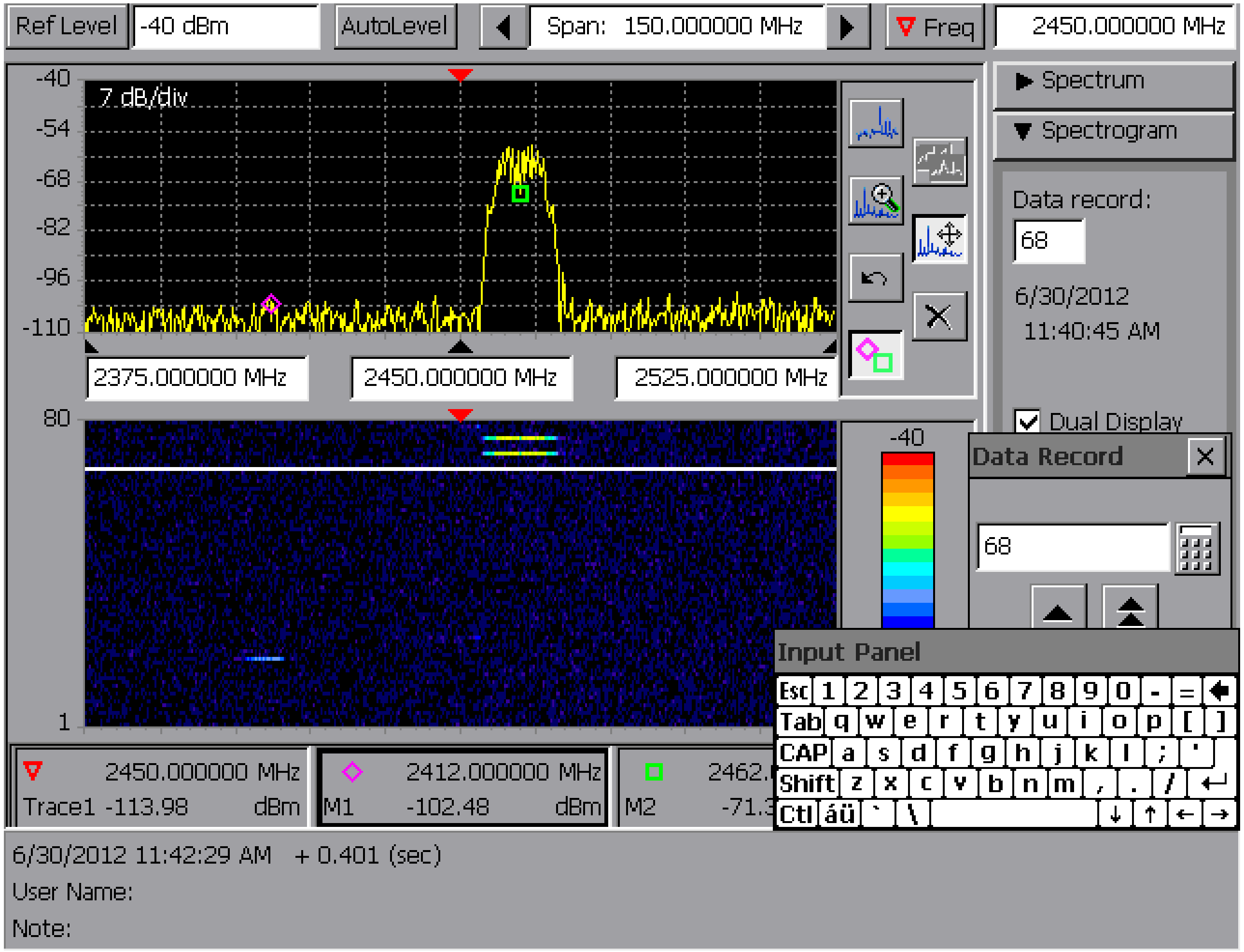
Note very low noise figure of FFT analyzer; basically just above the thermal noise floor limit.



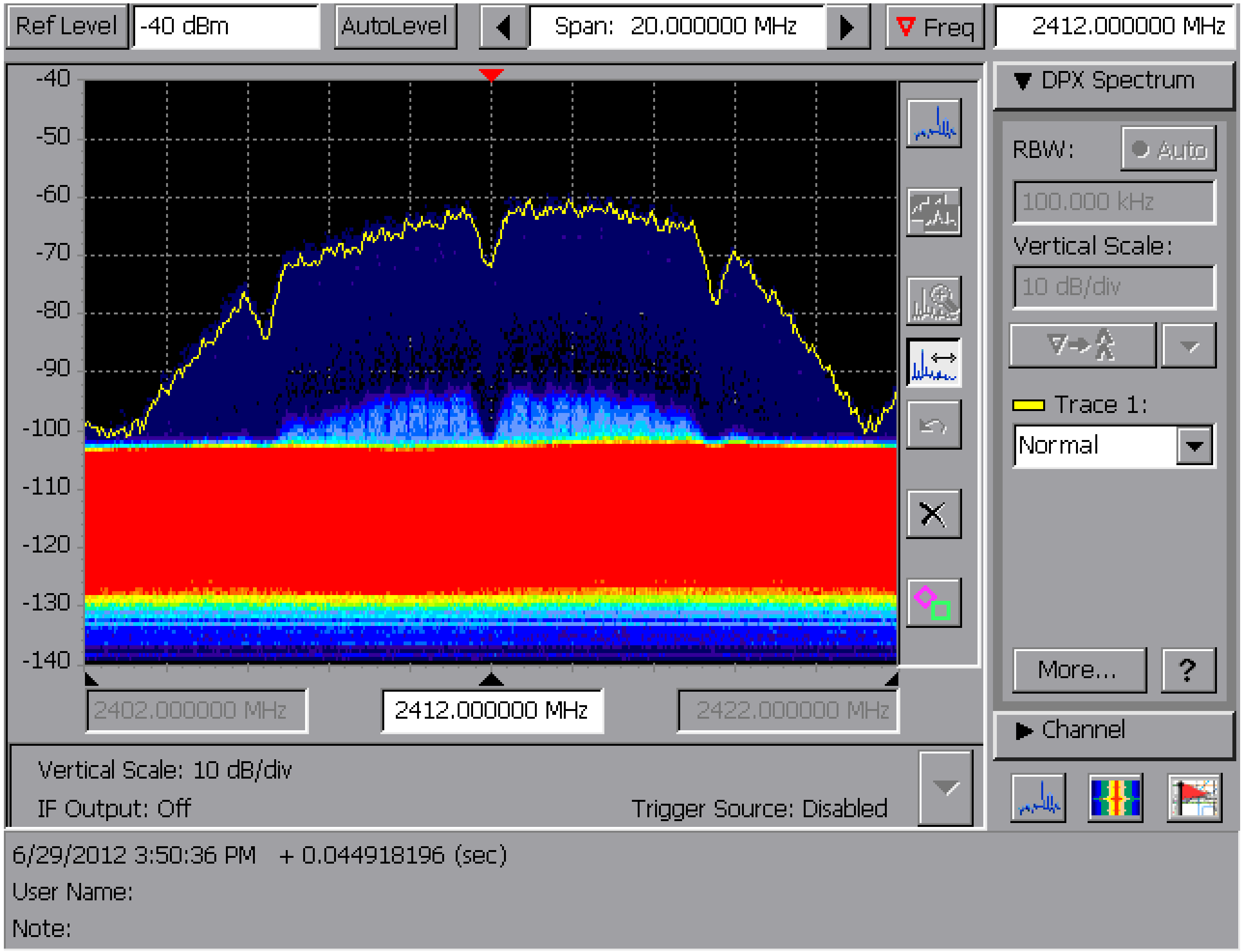
This is an exact repeat of a measurement taken during the 1st Qtr Report. An ‘omni-directional’ test antenna is positioned within the transmit area of two WIFI routers, with the closest router using WIFI Channel 11 and the more distant router using CH1. The blue trace captures the two very intermittent WIFI signals in peak-hold; however it provides no indication of how often transmissions occur or the presence of other interferring signals. WIFI CH1 is centered at 2.412 GHz, and WIFI CH11 is centered at 2.462 GHz. Levels are in dBm, & total frequency span is 150 MHz.



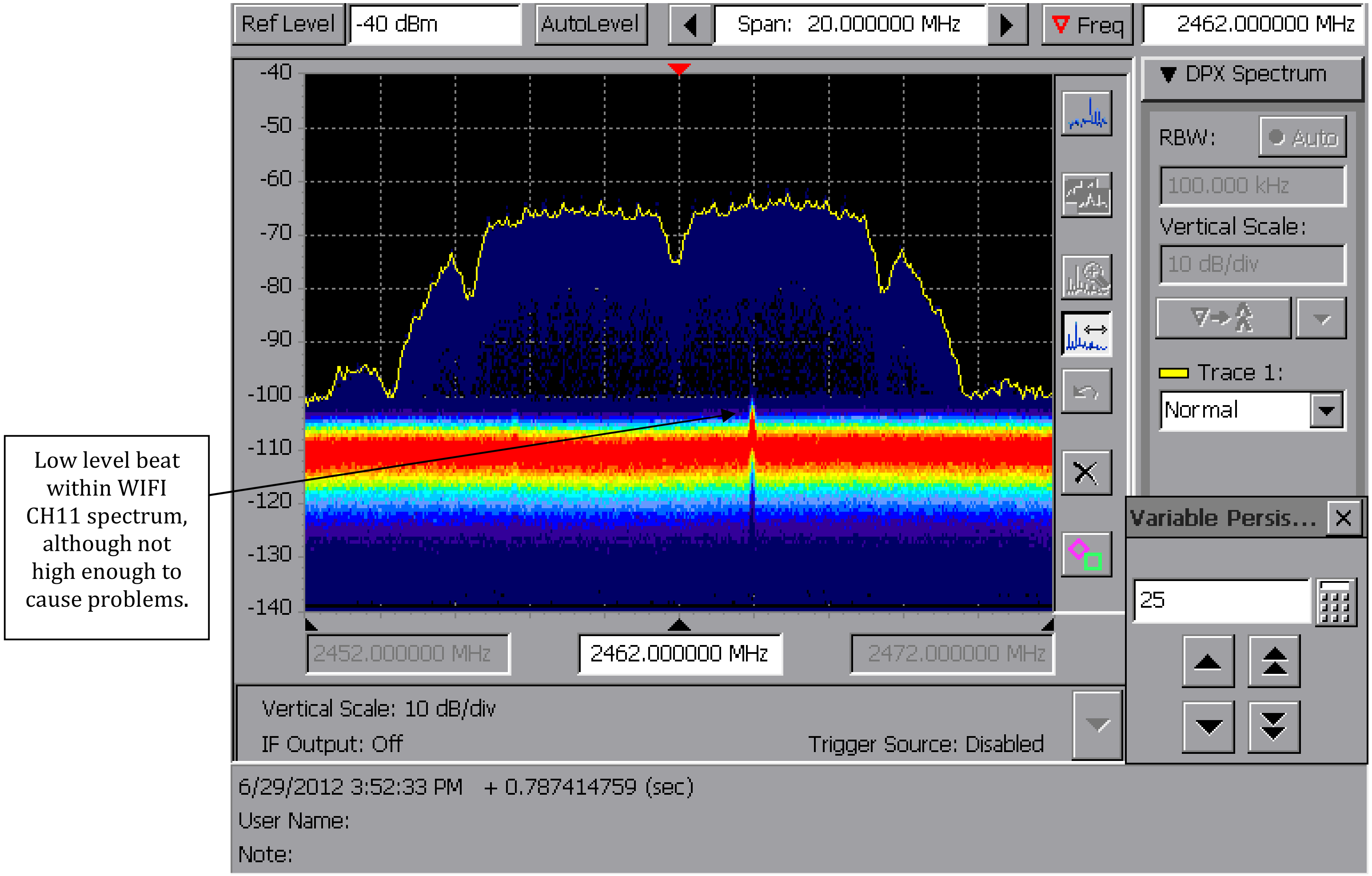
A split view is now employed, with the standard frequency vs amplitude display in the upper screen portion, and the spectrogram view enabled in the bottom portion. As explained in the 1st Qtr Technical Report, the spectrogram displays frequency (horizontal axis), vs time (vertical axis, with the most recent data record at the bottom), vs RF amplitude as displayed by a color range as defined by the operator. Note the lower right area showing RF levels ranging from -40 dBm (red) through -110 dBm (black). Markers are set at WIFI CH1 (2.412 GHz) and CH11 (2.462 GHz). Data record 18 is selected in the spectrogram, with the spectrum from that record shown in the top standard spectrum analyzer display. Each data record can be selected line by line for review of intermittent signals.



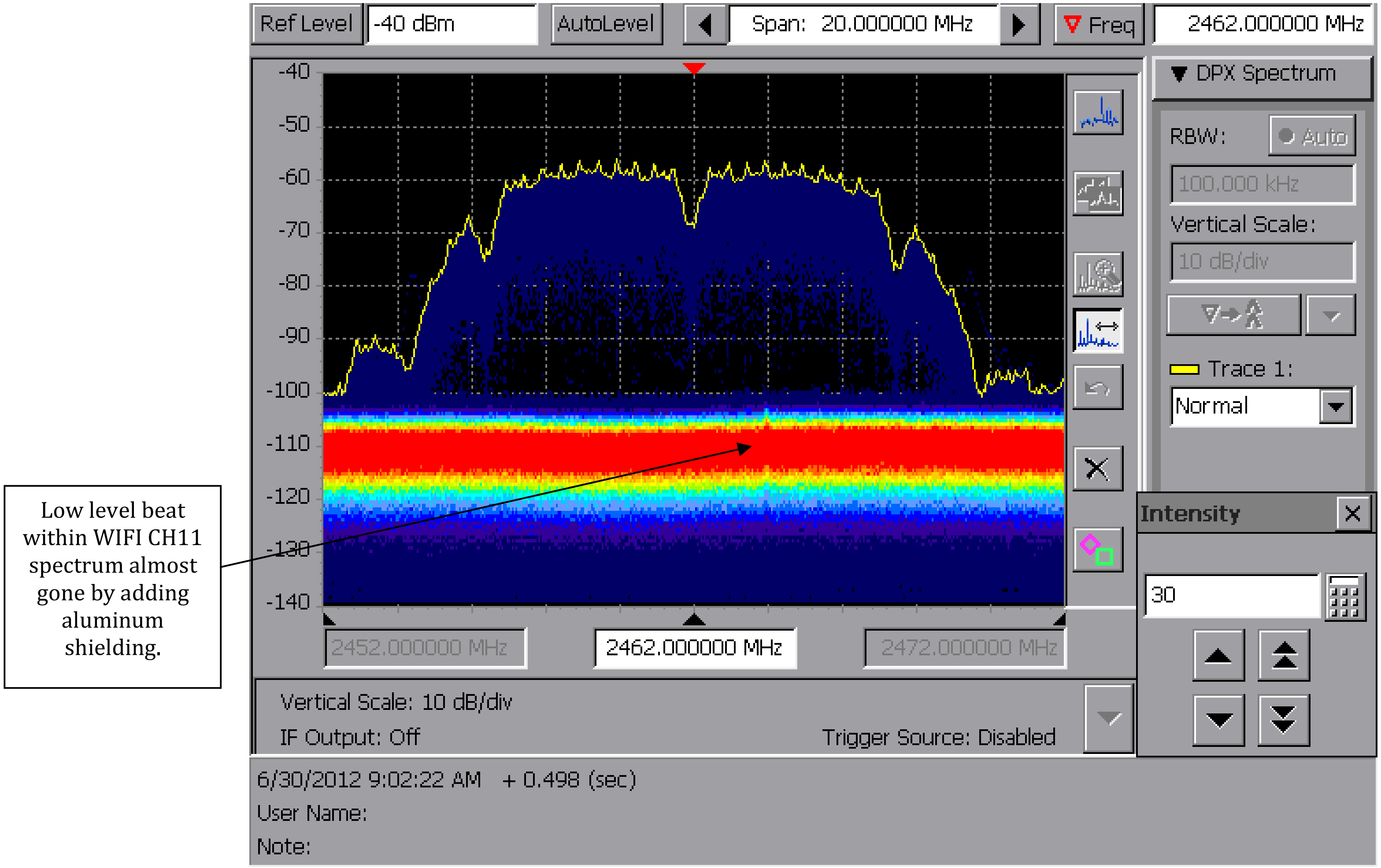
Advancing the spectrogram to data record 68 shows a transmission from the nearby router on WIFI Ch11. The point of these past two screenshots is to demonstrate how the spectrogram enables capturing and later analysis of intermittent signals. Spectrograms can be recorded to disk (hard or thumb drive) to monitor spectrum, if necessary, for long periods of time. Recordings can be continuous; or be set to trigger and record by time interval or when a ‘limit line’ is exceeded.



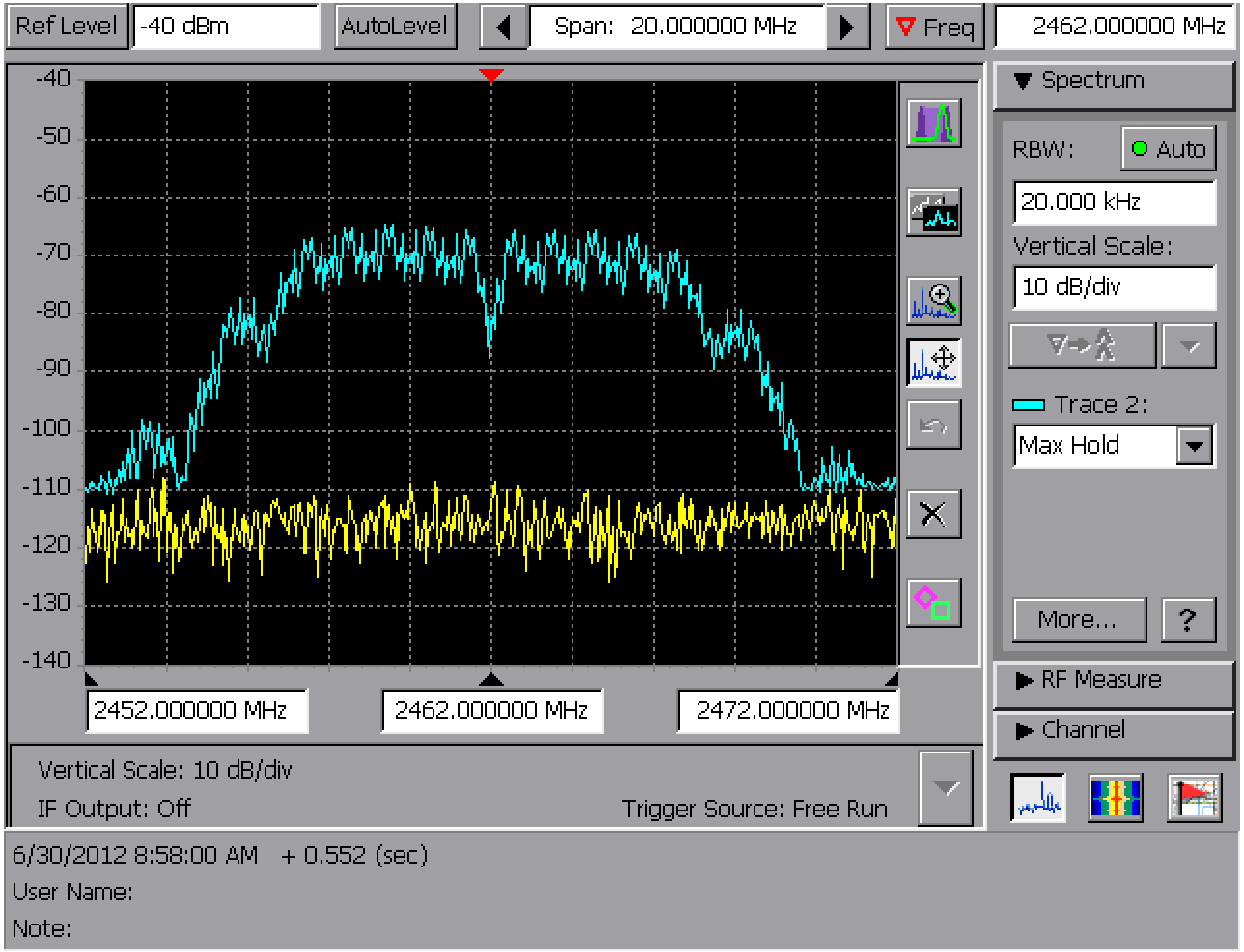
Now let's examine WIFI CH1 in DPX mode. Here, the horizontal axis is frequency and the vertical axis is again RF amplitude, however the range of colors indicate the 'rate of occurrence' of the signal at a particular frequency and amplitude (pixel location). Black indicates no spectral activity, through red which indicates a {near} continuous signal (example: thermal noise or a CW carrier). The color range (intensity) is set by the operator, and 'persistence' is also set – how long an intermittent signal stays visible on screen. The persistence can be low (disappears very quickly) or set to infinite (once captured, it remains until the screen is reset). Although not captured in this waveform, activity from the router vs various laptops vs other wireless equipment can be easily be differentiated. Even Bluetooth traffic, at much lower power levels, can be easily observed and measured.



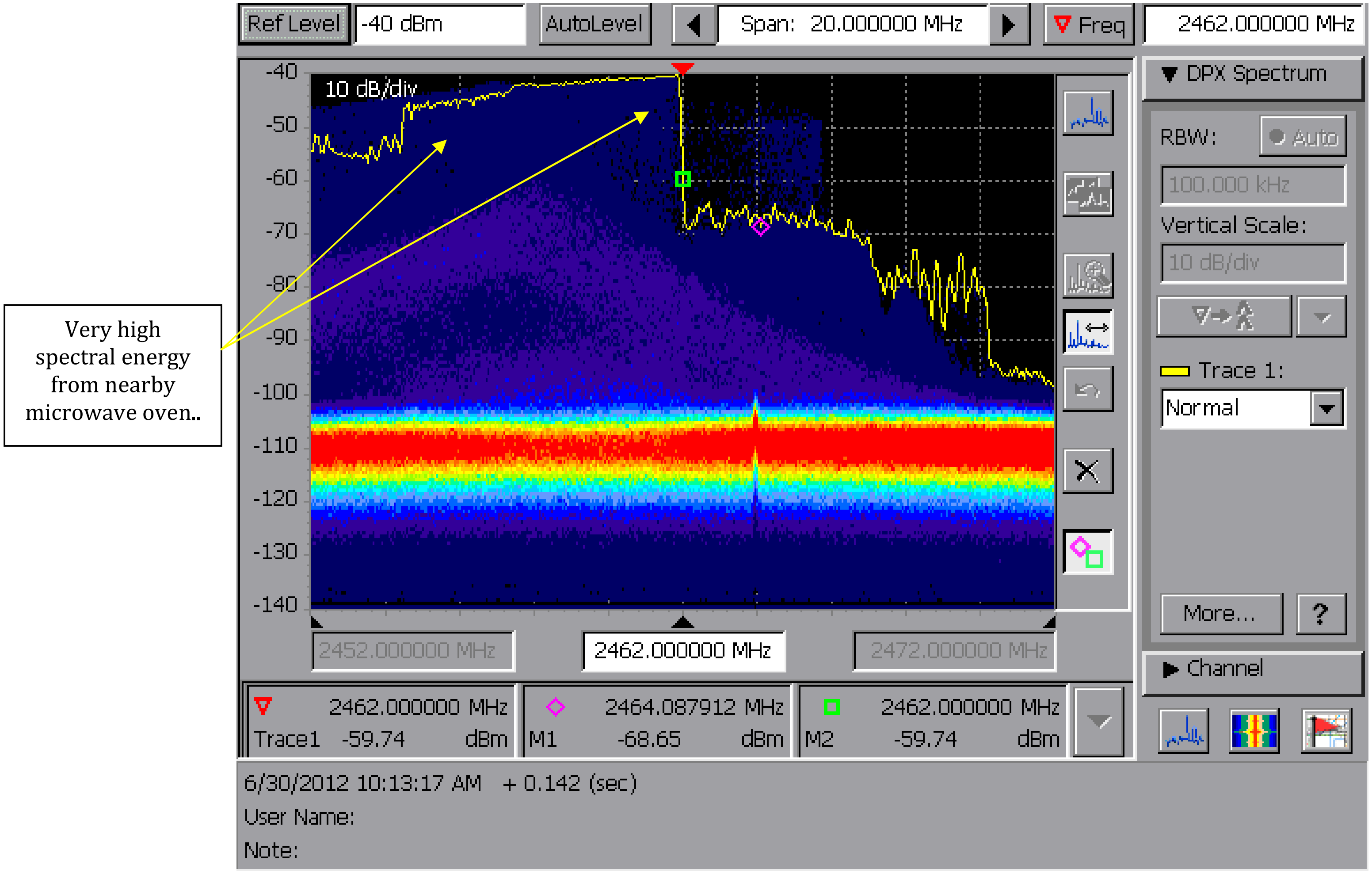
I've now switched to WIFI CH11, the router physically closer to the analyzer. Although router spectrum and activity generally looks OK, note the low-level 'beat' within the spectrum. This carrier is from a distant source as shown in the next slide, and is not high enough in amplitude to cause packet loss problems; however it's still interesting to note it's presence and that it can be measured. See the next several slides for further illustration.



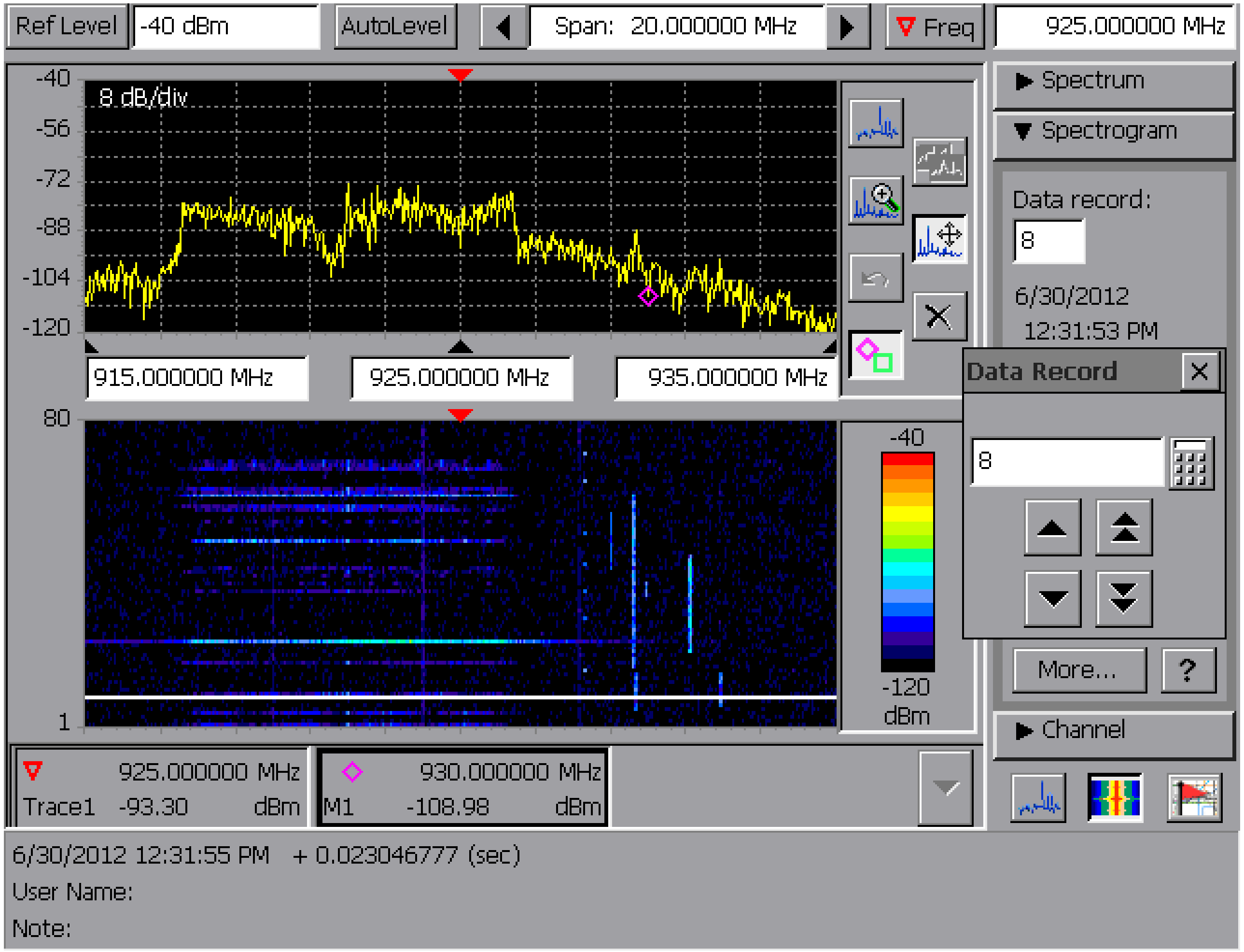
Note that the beat is now significantly reduced in amplitude through the addition of some aluminum shielding between the antenna and interferring source direction.



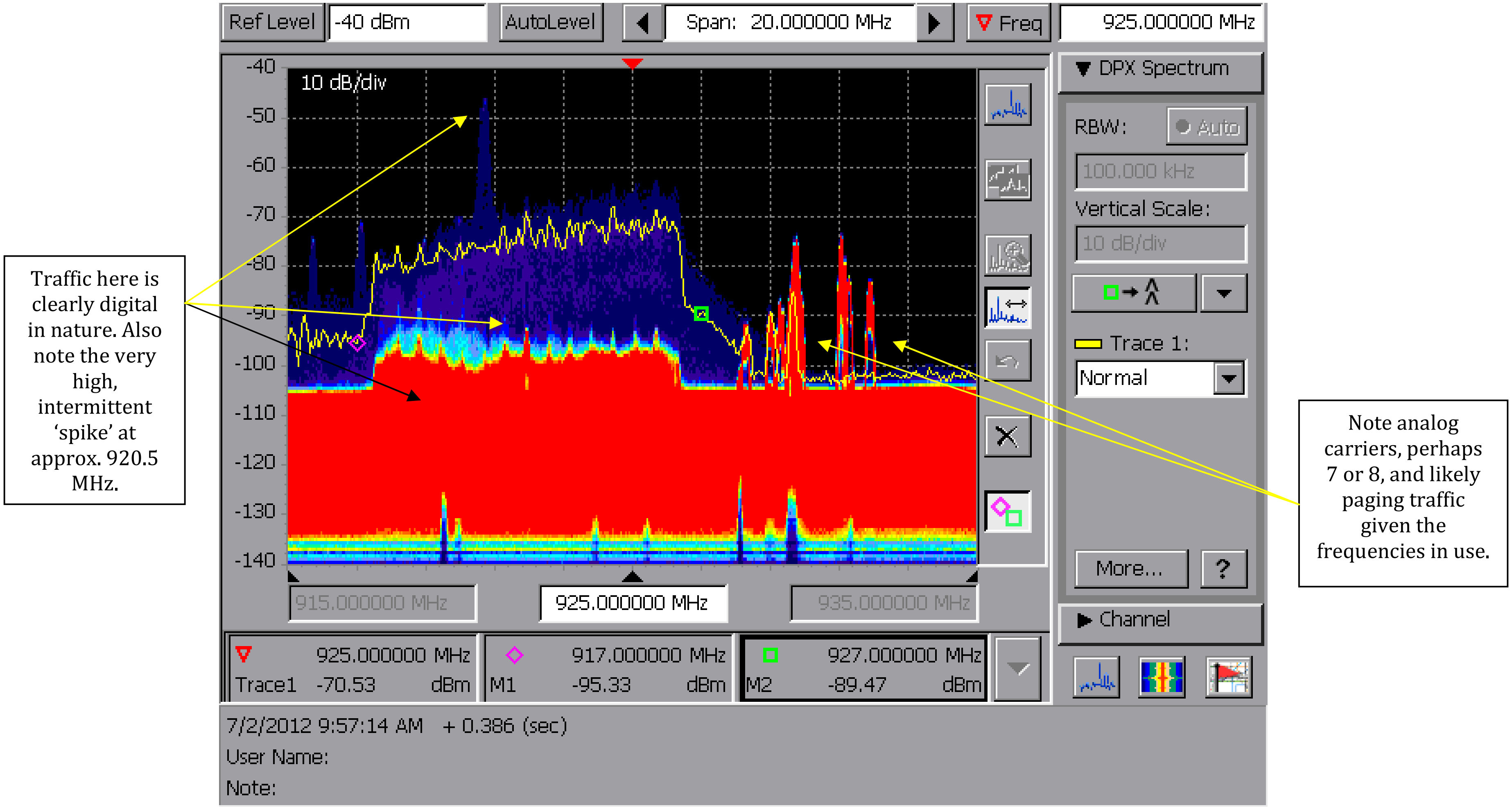
I've reverted back to standard frequency analysis mode, with a 'real time and peak hold trace', to demonstrate that without the spectrogram or DPX views, it's very difficult to determine any sort of problem within the WIFI spectrum. The beat is too low to see with the real time trace, and peak-hold obviously will not show a beat unless it's amplitude exceeds the amplitude of the desired signal. Basically, everything looks fine here.



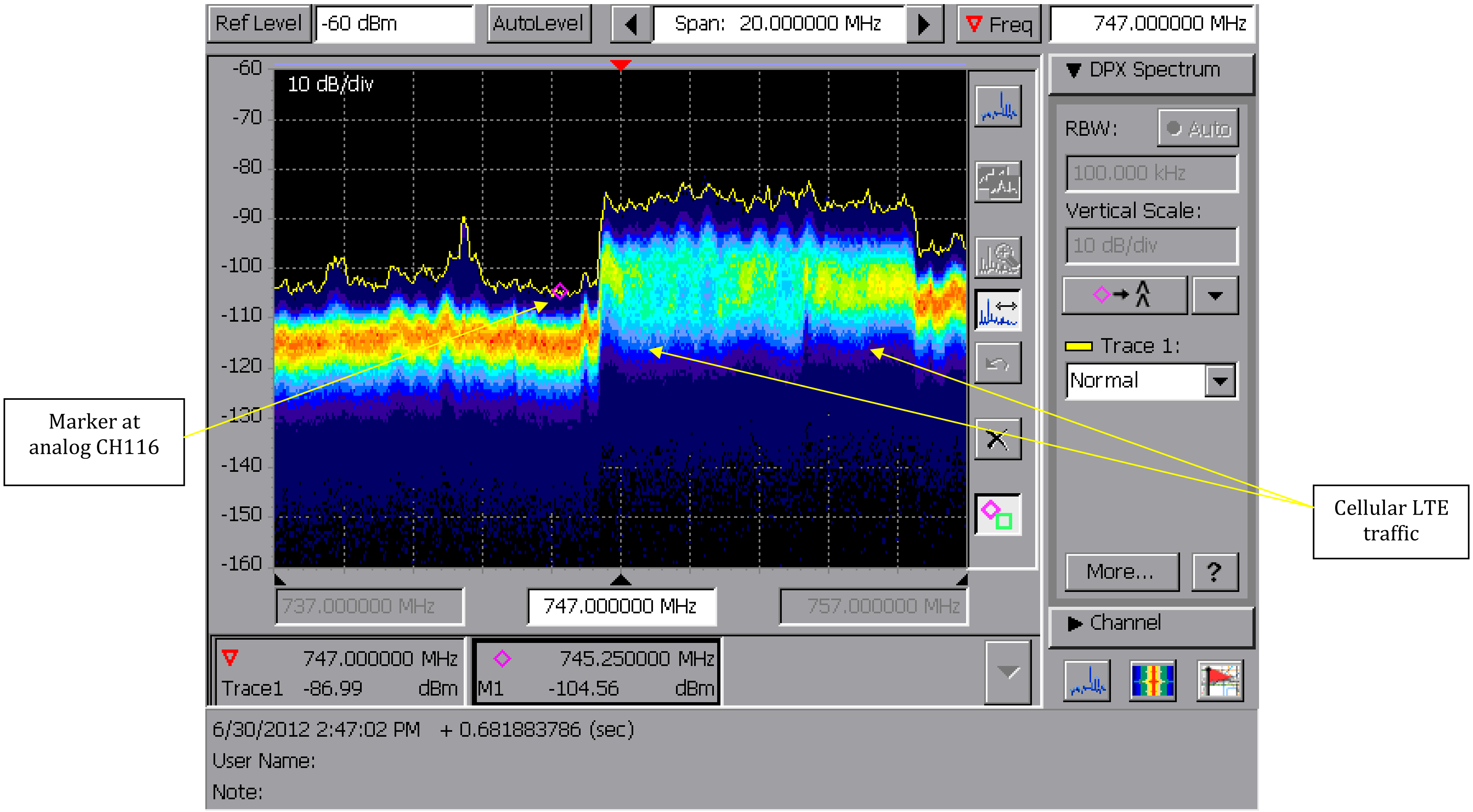
Finally, the above shows the spectrum around WIFI CH11 with a microwave oven running approximately 20 ft away. Note that the lower spectral portion of CH11 is completely overridden by energy from the nearby magnetron. Compare this with previous DPX waveforms for WIFI CH11.



In the 1st Quarter 2012 Technical Report we examined some very active spectrum from 915 to 935 MHz. Selecting data record 8 in the spectrogram above, we can see considerable spectral activity. The spectrum from approx. 917 to 927 MHz 'appears' to be digital in nature (QAM, VSB, PSK, etc.), along with what appears to be many low level analog carriers in the 929 to 934 MHz region.



This same spectrum (as in the previous screen shot) in DPX mode provides far more detail as to spectral activity. See my annotations above as well as the following. Starting at around 928 MHz and higher, at least 7 separate analog carriers are present, all fairly low in level. Using SA2600 features that assist in spectral identification, it appears this is likely pager traffic. And the spectrum with markers, from 917 to 927 MHz is now clearly digital in nature. Also note the strong but intermittent energy spike at approx. 920.5 MHz. Remember, in DPX view, the colors represent the 'rate of occurrence' of energy at a given frequency and amplitude. Persistence can be set such that an intermittent fades within several seconds, or stays visible until the screen is reset. Finally, note the very low level carriers present 'under' the digital traffic from 917 to 927 MHz.



This final DPX spectral capture shows spectrum from 737 to 757 MHz. A marker (purple diamond shape) is placed at 745.25 MHz to indicate where analog CH116 would appear if I were in a cable system with leakage at this frequency (I was not in a system during this testing). LTE traffic from a distant cell tower is clearly evident from approx. 746.5 MHz to 755.5 MHz. These cellular traffic levels are very low (on the order of -35 to -40 dBmV), and even a low level leak CATV leak could interfere with local cell traffic depending on the location and overall conditions.

Conclusions

In the 1st Qtr Technical Report for this year, spectrum analyzer basics were reviewed, and the use of the spectrogram view was shown to be of great assistance in the capturing, analyzing and storing (for later analysis) of intermittent signal changes in either amplitude and frequency. However, the spectrum analyzer used was of the swept front-end type. In this report, the use of a real time spectrum analyzer demonstrates a quantum leap in performance and analysis. The spectrum analyzer utilized for my analysis, a Tektronix SA2600/EP1 will capture any signal that lasts 125 µseconds or longer, with *10,000 FFT's captured and processed per second.* Again, see the 1st Qtr 2012 Technical Report to review the differences between swept heterodyne (analog) and FFT (digital) spectrum analysis.

Present plans for the 3rd Qtr 2012 Technical Report are to patrol a portion of a working cable system for leakage at 750 MHz, making use of GPS to link leakage field strength measurements to a system map, and to investigate whether leakage at higher frequencies is indeed of concern given the launch of LTE services by most cellular carriers. If leakage is found;

- Is it likely to interfere with local cellular traffic?
- Does it exceed FCC specifications of 15 µvolts/meter at 100 ft (150 µvolts/meter at 10 ft)?

These are important questions to be answered, and the Tektronix SA2600 allows for measurements that are 'geo-coded' to system maps, with calibrated field strength measurements stored in a database for later analysis. An analysis of the captured data will also be undertaken if significant leakage is found.

Be sure to contact me if you have questions regarding the RTA technology employed in this report, and how it can be applied to the challenges of maintaining and troubleshooting the modern cable network.

Take care and best regards.

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Cablesoft Engineering, Inc.