

EVALUATING WAVE FILES TO DETERMINE THE SEVERITY OF THE ULTRASONIC EMISSIONS

We are often asked at which voltages and on what type of equipment is ultrasound most effective. The answer is not simple since it often depends on the individual asking the question. First of all, determining the definition of low, mid and high voltages is relative. Those in the power distribution arena will look at 12 kV as low voltage, those who work in a typical manufacturing plant will look on 440 Volts as high voltage. The main electric problems detected ultrasonically are partial discharge, arcing, tracking and corona. Ultrasound detects the ionization of air, as it produces turbulence. This can be from Corona, Tracking or Arcing. Heat is produced when there is either Resistance due to corrosion or from Tracking and Arcing. Since Heat is produced by the flow of current through corrosion or resistance, you can have a “hot spot” detectable with IR, and have no Ultrasound because there would be no ionization.

Low voltages

The main concern in low voltage equipment is arcing. Typically 110, 220 and 440-volt systems are inspected with infrared imaging and/or spot radiometers for temperature changes. Hot spots, usually an indication of resistance, can be indicative of a potential for equipment failure or it could indicate a possible fire hazard. When arcing occurs, it is often accompanied by heat. However, it is not always possible to detect a hot spot if the equipment is covered. Ultrasound will hear arcing in circuit breakers, switches, contacts and relays. In most instances, a quick scan of a door seal or vent will detect the ultrasound emission. Listening for internal arcing in circuit breakers and switches can be accomplished with the contact probe. For example, touch a circuit breaker switch with the contact probe to listen for internally generated arcing. Remember to use caution whenever using the contact probe. Be sure you do not touch any surface that can conduct electricity. The most effective method of low

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voltage inspection will be to combine infrared imaging with an ultrasonic probe. Please keep in mind that since air cannot be a conductor of electricity below 1000 volts, corona cannot exist. Any "buzzing" sounds are either loose components vibrating at 60 (or 50) Hz or tracking.

Mid and High Voltage inspection

Higher voltages often produce more potential for equipment outage. Problems such as arcing, destructive corona or tracking (sometimes referred to as "baby arcing") as well as partial discharges and mechanical looseness all produce detectable ultrasound that warn of impending failure. Detecting these emissions is relatively easy with ultrasound. The acoustic difference among these potentially destructive events is the sound pattern. Arcing produces erratic bursts, with sudden starts and stops of energy, while corona is a steady "buzzing" sound. Destructive corona has a build up and drop-off of energy resulting in a buzzing sound accompanied by subtle popping noises.

If the subject equipment is at a distance while scanning for these emissions, use a parabolic reflector such as the UE UWC (Ultrasonic Wave Form concentrator) or the UE LRM (Long Range Module). These accessories more than double the detection distance of the standard scanning modules.

Partial discharge (PD) which occurs inside electrical components such as in transformers and insulated buss bars, is another problem that can be detected with ultrasound. Partial discharge can be quite destructive. It is effected by and causes deterioration of insulation. This is heard as a combination of buzzing and popping noises. The contact probe is employed for PD detection. Again, when using this probe exercise caution. If your Ultraprobe has frequency tuning, try 20 kHz. To learn more about our Ultrasonic Wave Form Concentrator and our Long Range Module, visit our web site: <http://www.uesystems.com>

ANALYSIS OF RECORDED SIGNALS

While it is relatively easy to determine arcing, tracking or corona by the sound pattern, there can be occasions where it may prove confusing. It may be possible that a strong buzzing sound related to corona might in fact be nothing more than mechanical looseness. Both Spectral analysis and Time Domain can be a useful tools in analyzing electric emissions.

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Since all Ultraprobe instruments heterodyne ultrasound down into the audible range, either the headphone jack or the Instrument itself (the Ultraprobe 10000) may be used to record sounds. You must use a suitable recording device that has a suitable bandwidth in the lower frequencies.

DIGITAL VOICE RECORDERS ARE NOT ACCEPTABLE as they only can record signals above 300 Hz, which is not low enough to be useful for the 50 or 60 Hz peaks. Laptop Computers, MP3 Recorders or a Quality Cassette Recorders work well for recording the signals in the field.

When recording the sound emissions, you need to make certain that the signal is not distorted. On the Analogue instruments, you should not let the signal go over 50% of full scale on the signal strength indicator. On the Digital Instruments, you should try to maintain the signal strength to between 4 to 6 segments.

These recorded sounds can then be downloaded to a PC with a sound card and viewed as a spectrum or time series for analysis. It is necessary to examine both the Spectrum and the Time Domain images to make a final decision on the severity.

The main harmonic of an electrical emission (60 Hz in the USA and 50 Hz elsewhere) will be most prevalent in corona. As the condition becomes more severe, there will be fewer and fewer 60 Hz harmonics observed. As an example, arcing has very few 60-cycle components. Mechanical looseness will be "rich" in 60 Hz Harmonics and will have little frequency content between the 60 Hz peaks and will also demonstrate harmonics other than 60 Hz.

Examining the Time Domain image can also be of help. In the case of Corona, you will have a uniform band of signal with very few peaks that extend above the average "band". With Tracking, you will begin to see the peaks created by the discharges extend above the average "band". With Arcing, you will see several "bursts" of energy, which correspond with the discharges. In all cases, both the Spectrum and the Time Domain should be examined before the final determination is made.

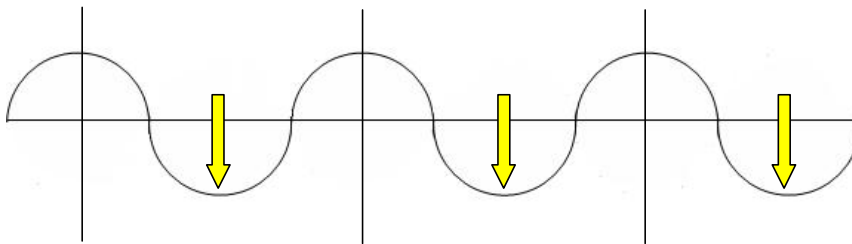
The following pages can be used as a guide to help determine how severe the discharge is when playing a suspect wave file in UE Spectralyzer:

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Electrical discharges take place in the Positive portion of the sine wave. Depending on the severity, the discharges take place in different points of the sine wave and have different durations in time. For example, for air to be a conductor of the discharge, you must have over a 1000 volt potential. This means that the actual discharge takes place only at the peak of the positive portion of the sine wave.

EXAMPLE OF DISCHARGE POINTS FOR CORONA



CORONA

Note that the discharge points only occur at the highest negative voltage point of the sine wave. This means that the amplitude peaks in the Time Domain are somewhat equally spaced as the discharges are only at the negative peak of the sine wave. This is best viewed in the Spectrum View.

The next stage of Severity is Tracking and then Arcing.

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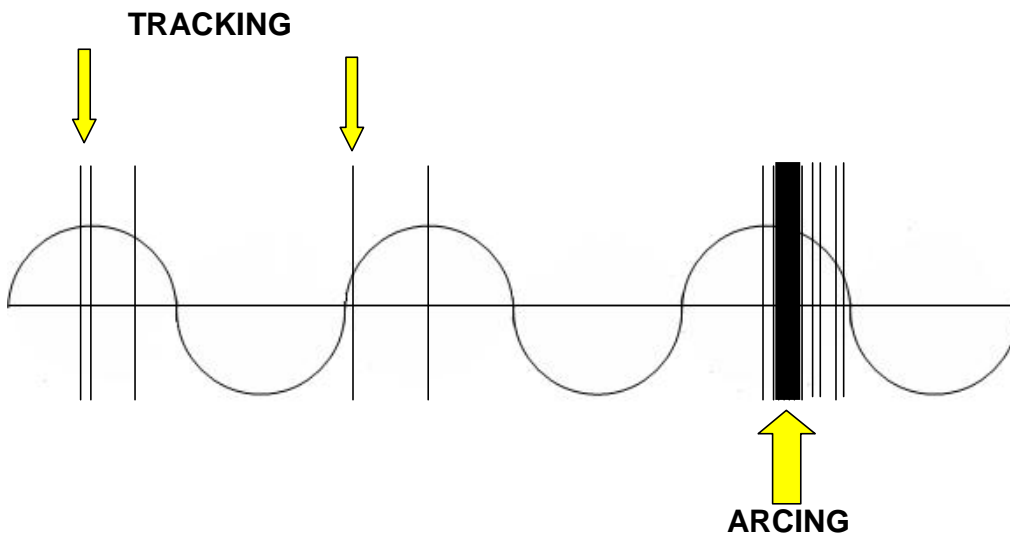
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TRACKING

When you have tracking, there is a low current pathway to ground across an insulator so the discharge does not have to take place at the peak of the waveform. It therefore can happen anywhere on the positive portion of the cycle. This can be seen by the location of the vertical lines indicated by the arrows on the left side of the diagram. The spacing for the peaks in the Time Series would be similar – non uniform spacing. They correspond to the “popping” sounds heard in the headphones (Heterodyned Ultrasonic signal) that are not uniformly spaced in time. As the Tracking becomes more severe, there are more discharge events and therefore more non uniform spaced narrow peaks.

ARCING

When you have Arcing, the discharge to ground across an insulator is a high current path over an insulator that does not require a high potential. This is a “burst of energy” that lasts for extended periods of time. It is indicated by the arrow on the right side of the diagram. The “buzzing” Sound that is heard with corona and the initial stages of tracking is not heard with arcing. Only the “bursts” of discharge can be heard. These will be seen as wide peaks in the time series.



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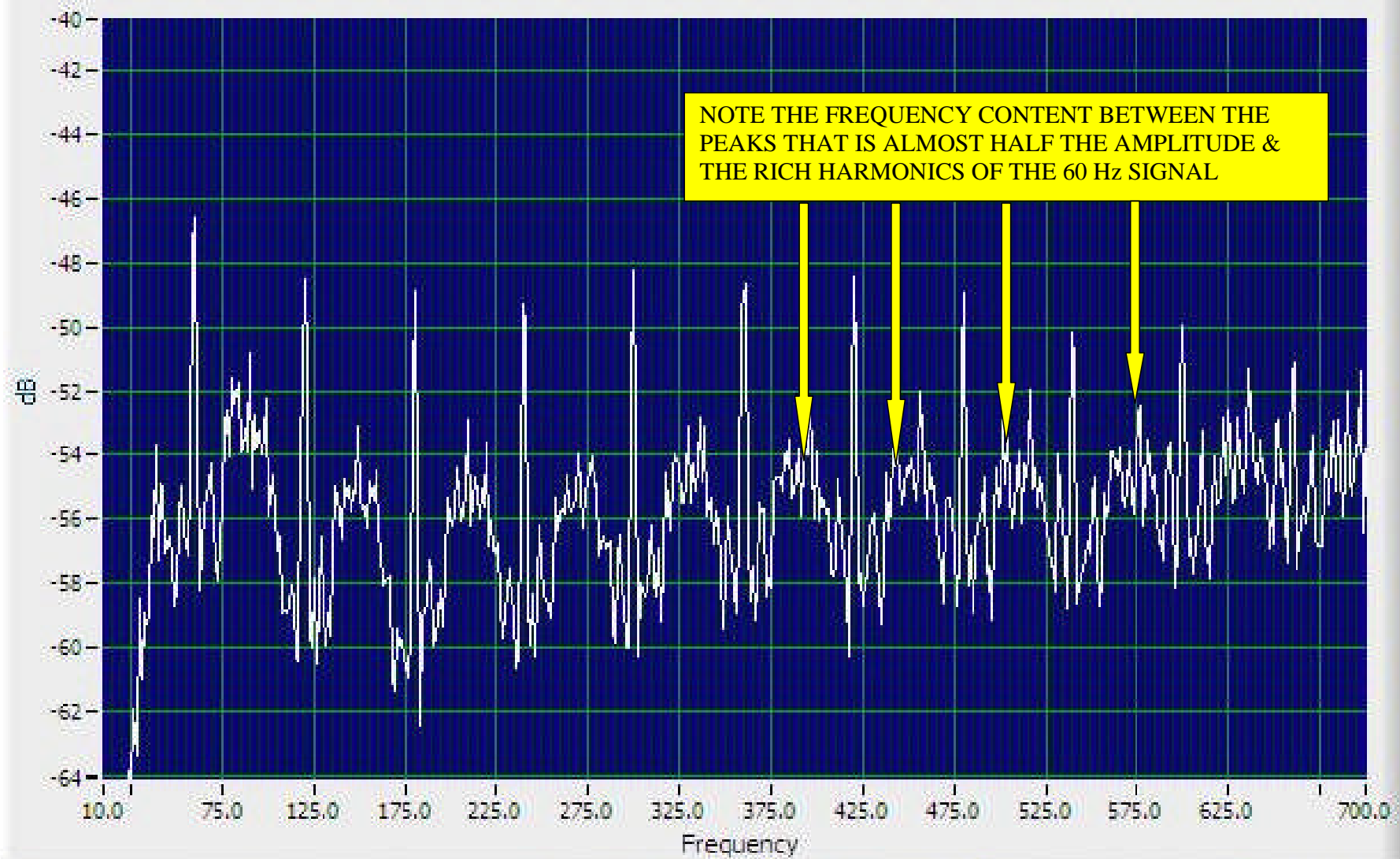
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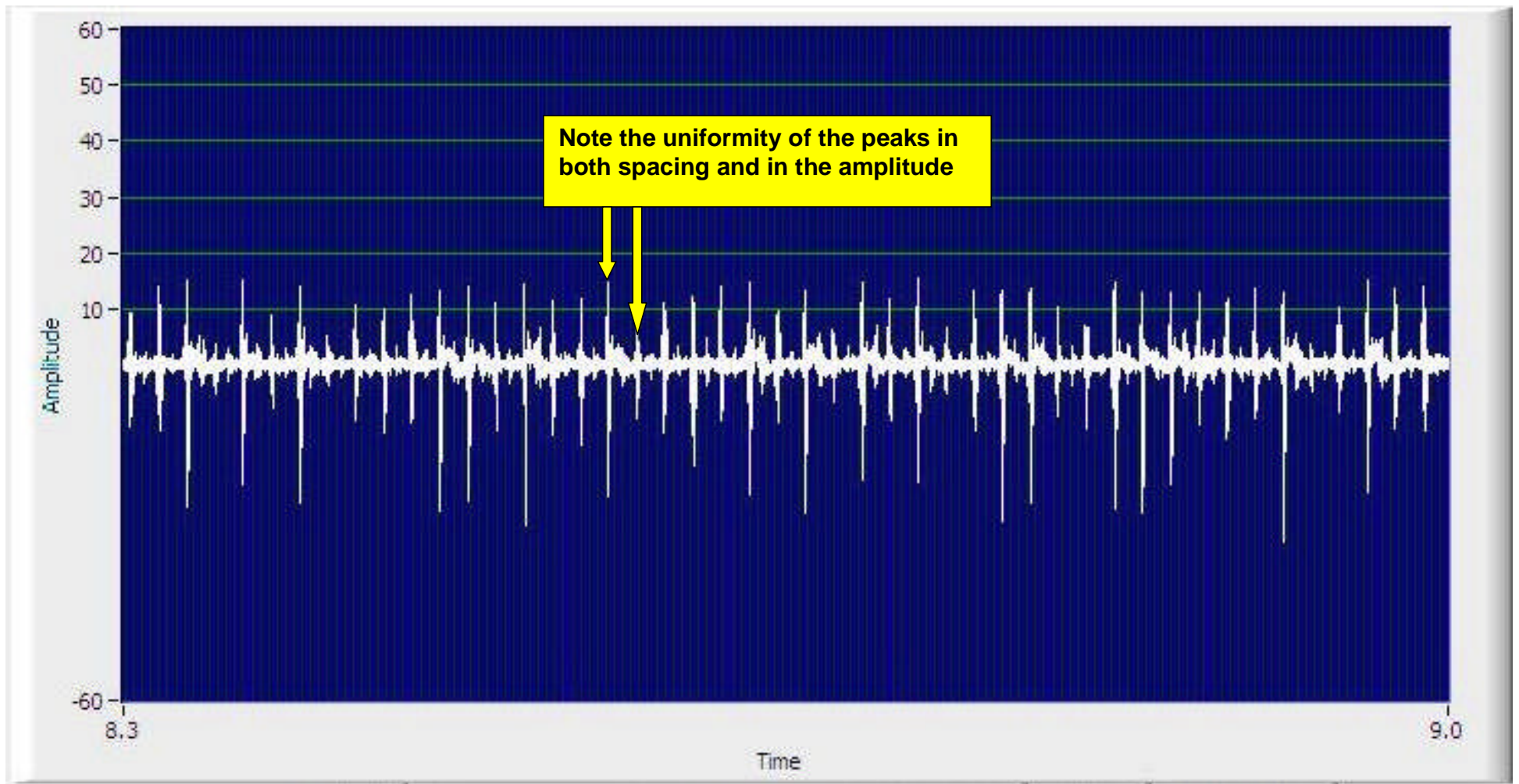
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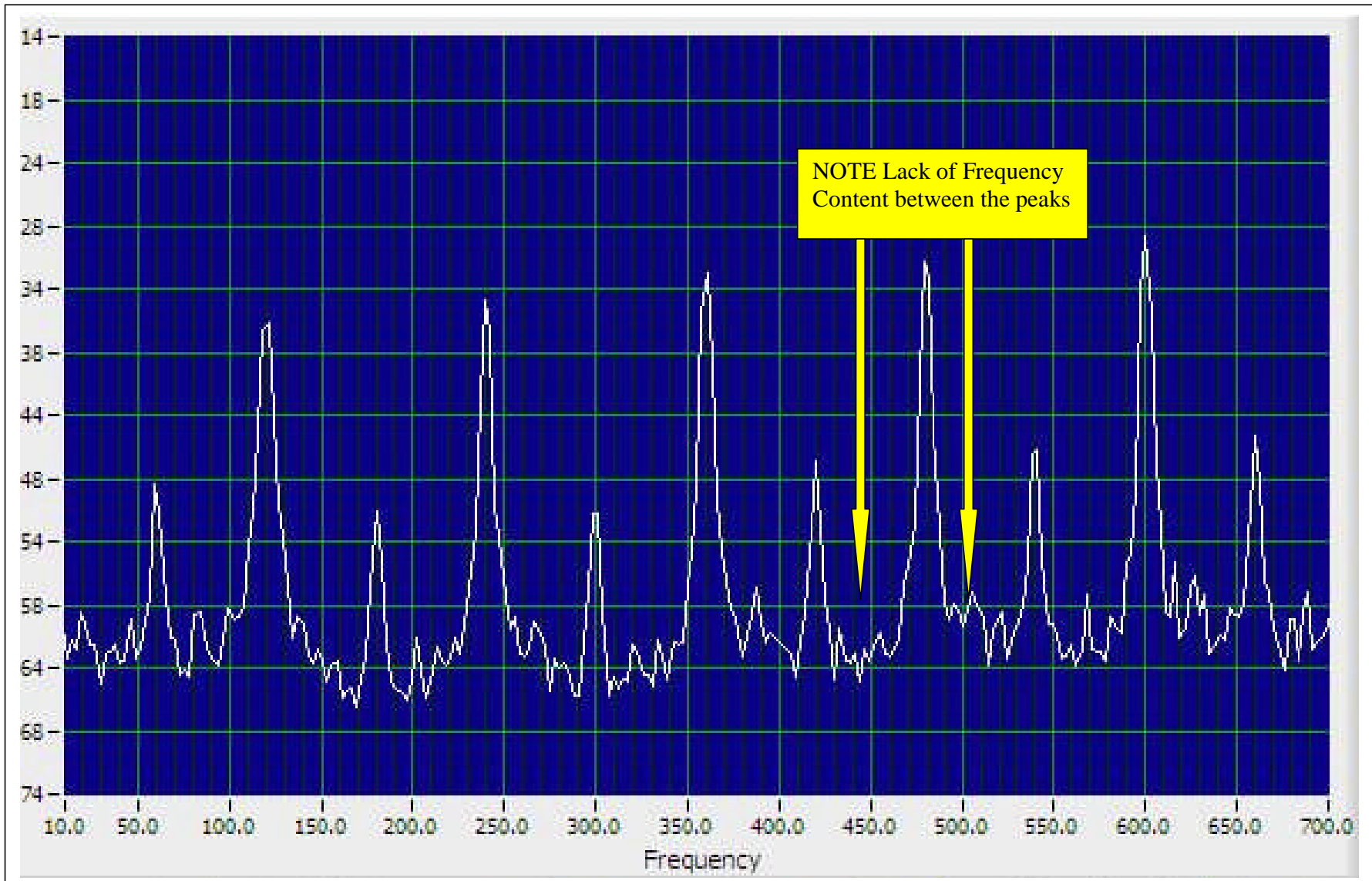
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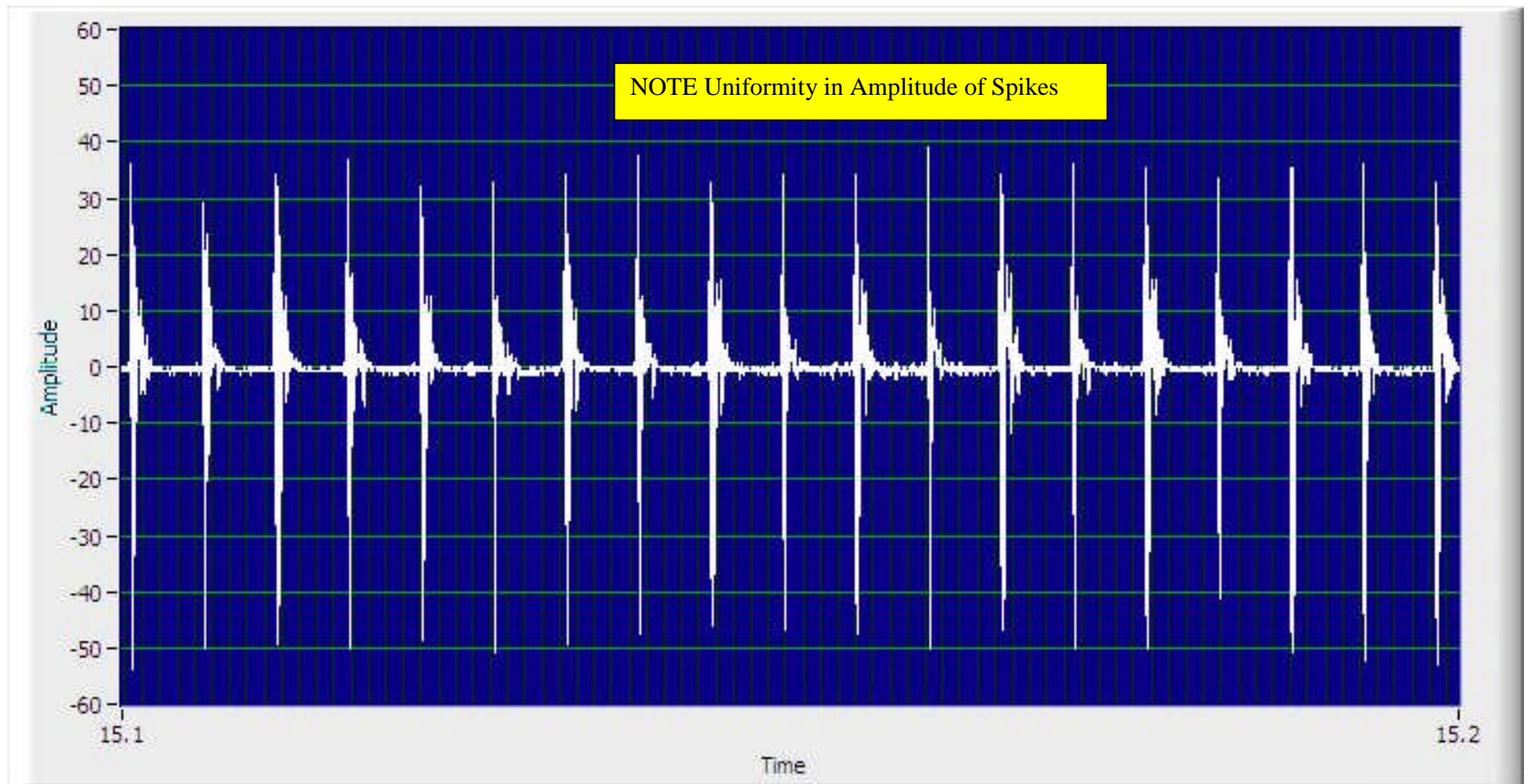
CORONA SPECTRUM



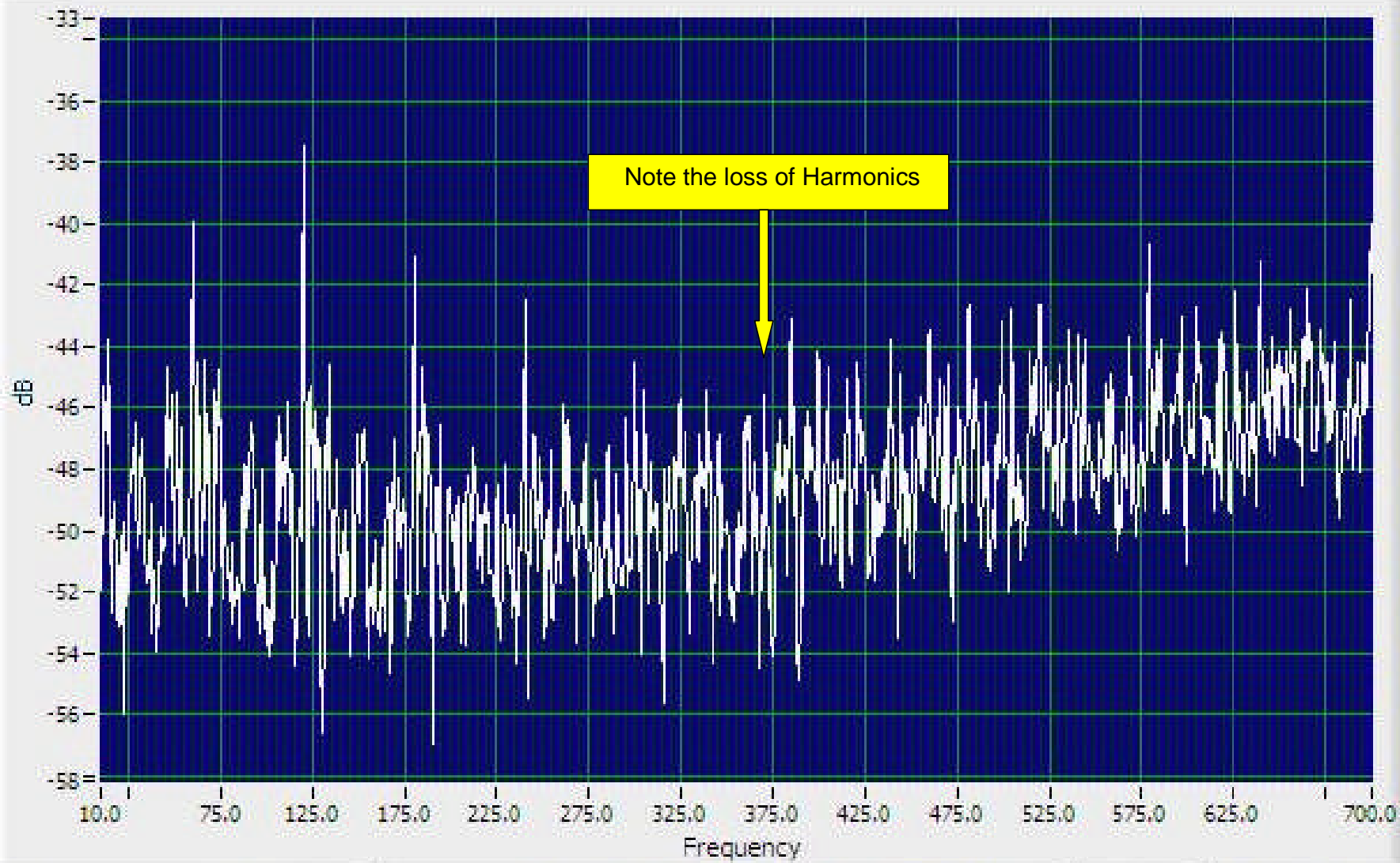
CORONA TIME SERIES



VIBRATING COMPONENT SPECTRUM

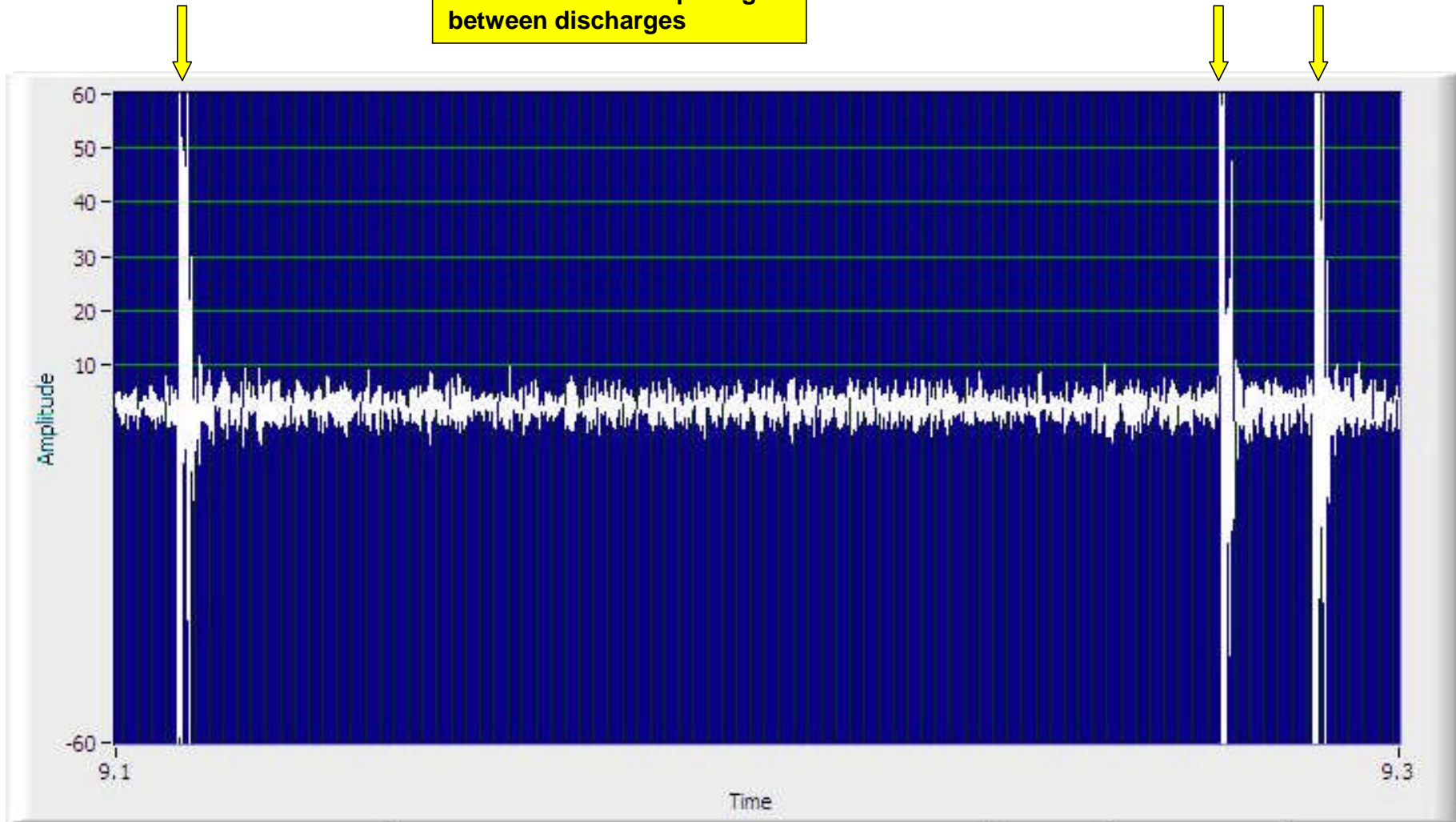


VIBRATING COMPONENT TIME SERIES



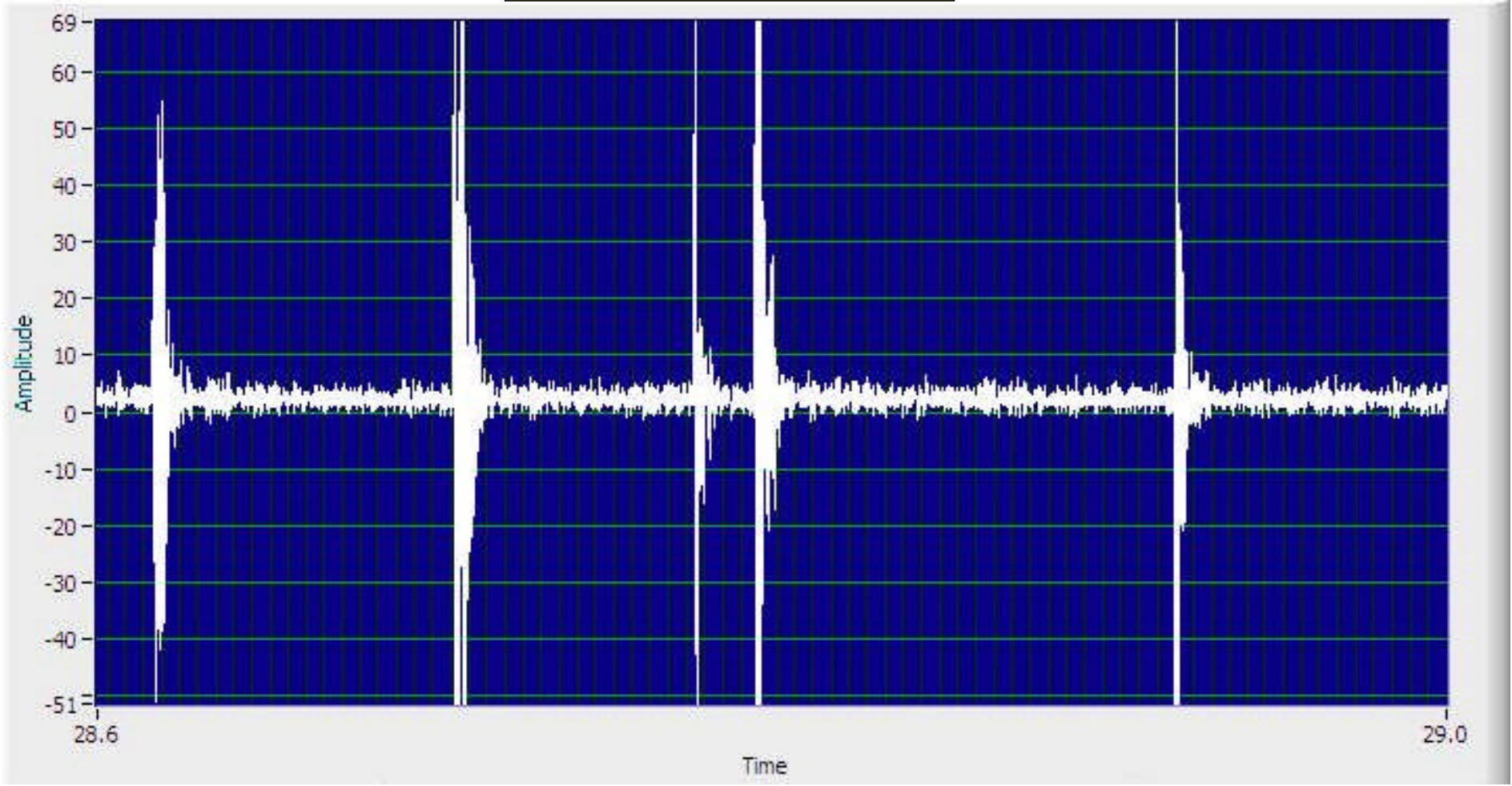
TRACKING SPECTRUM

Note non uniform spacing between discharges

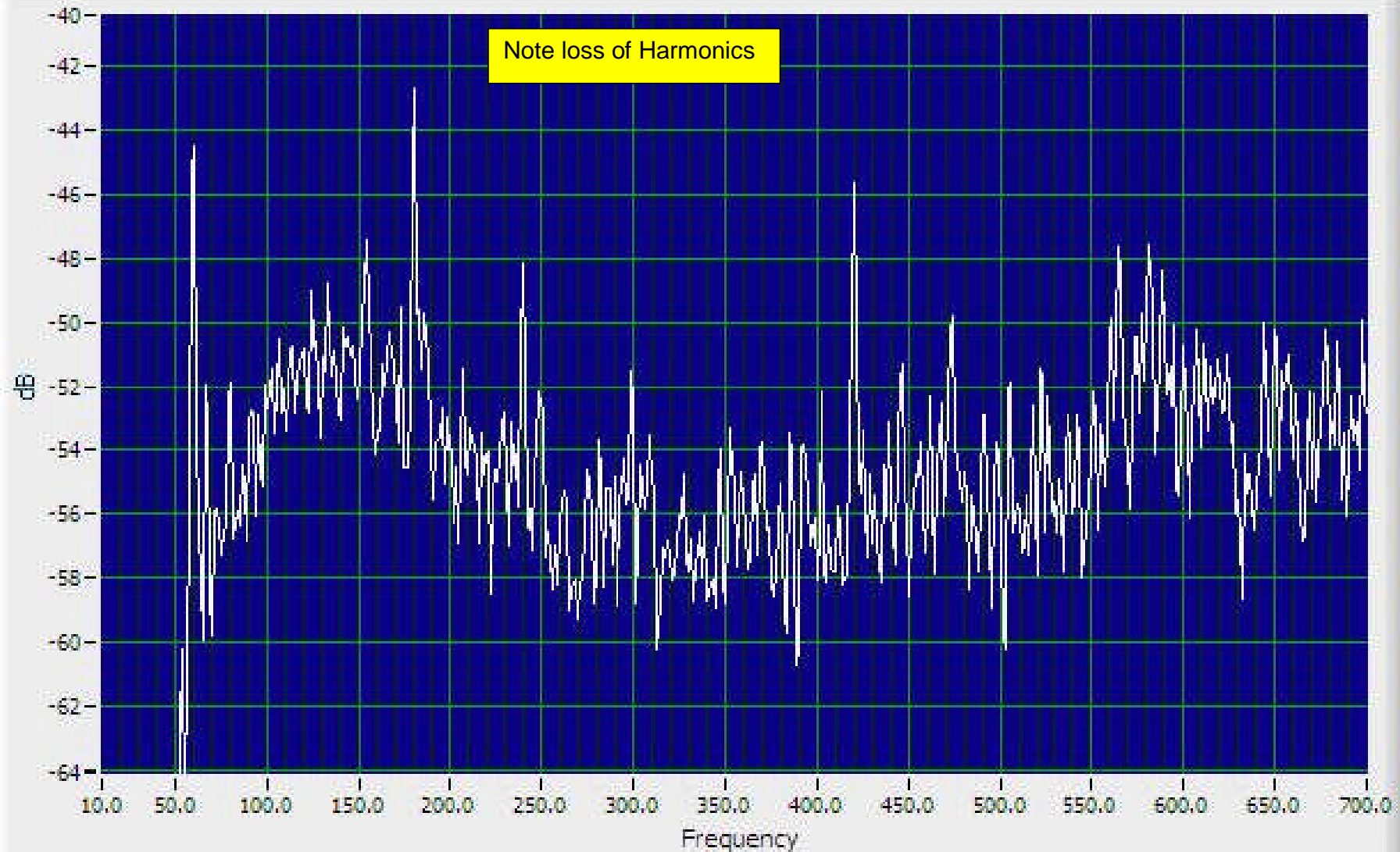


TRACKING TIME SERIES

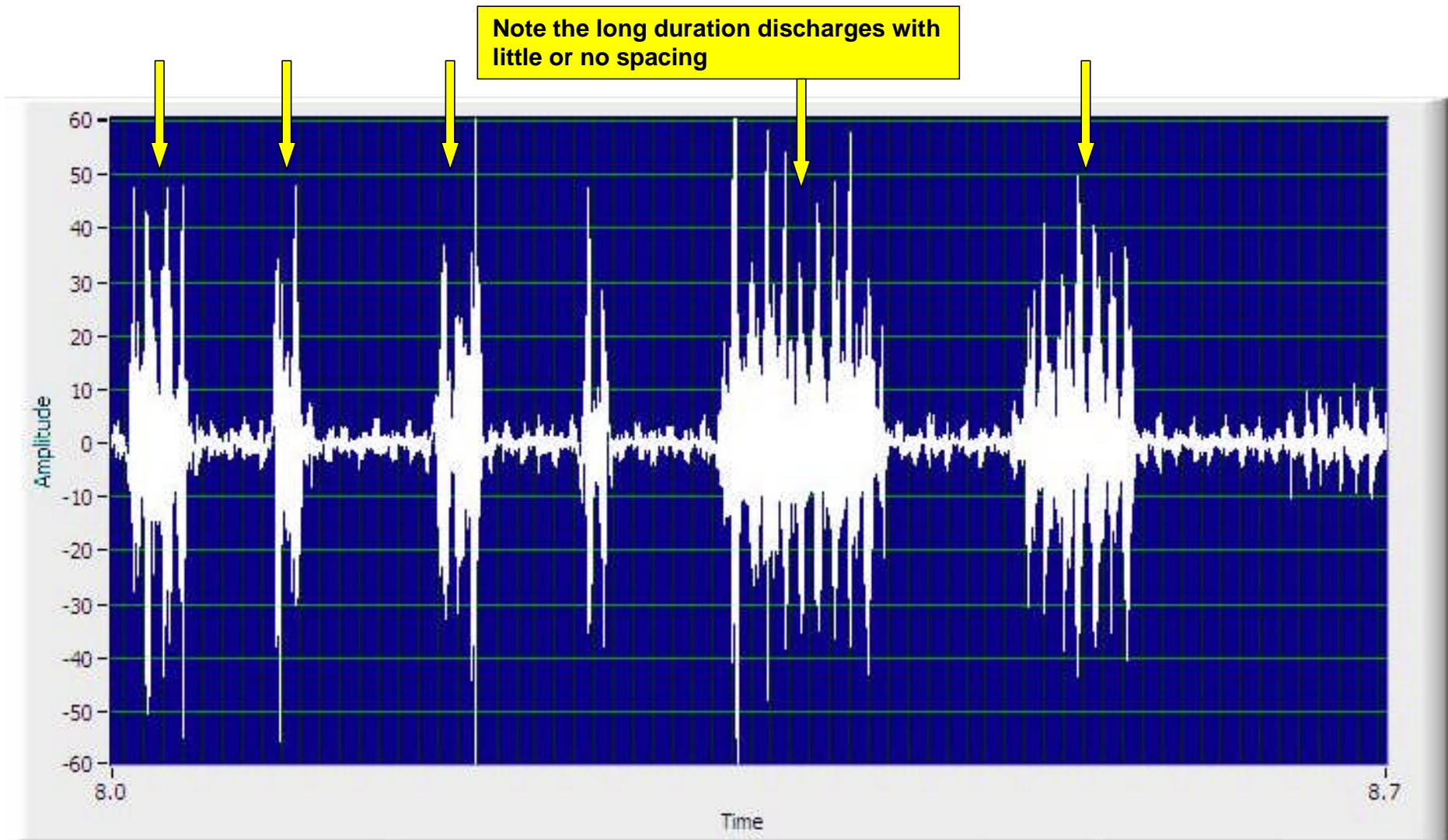
Note greater number of discharges



BAD TRACKING



ARC SPECTRUM



ARC TIME SERIES