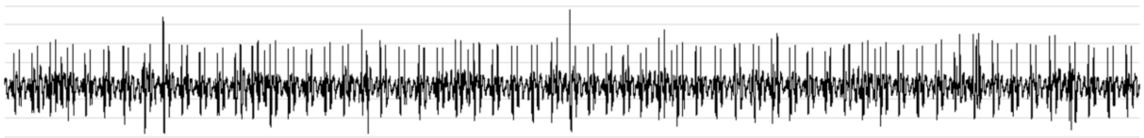
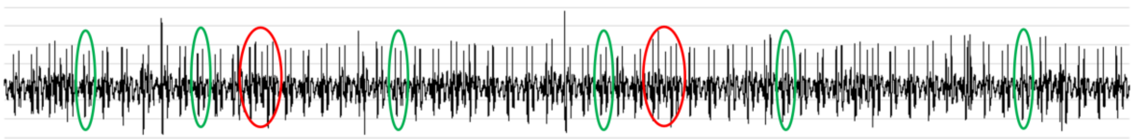
Heart Force Science Group
Presents
Heart Force Interval Identification

The Heart Force Science Group has created a new non-invasive system and method for extracting valuable heart-cycle operational characteristics, where that system can provide a plethora of information with one minute of data collection. The paper will describe the algorithmic process of data reduction that provides the valuable information of characteristics such as Dystolic Disfunction, Ejection Fraction and others. Many different physiological assessments require no human intervention beyond the actual measurement that can be performed by entry level technicians with as little as a half day of training. The simplistic system can be utilized in the doctor's office at the very first step of the yearly physical initial visit, providing report ready results in seconds. It is important to understand that this paper describes in visual terms what the system performs automatically at the end of the measurement session.

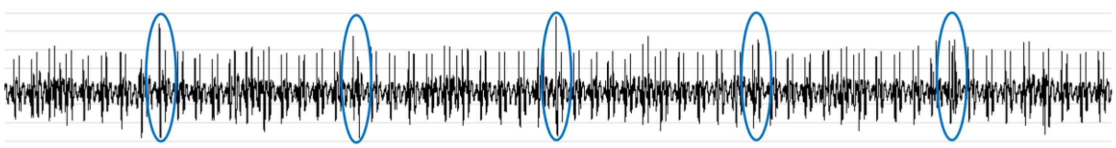
Shown here is a graph (Graph1) of the collected data in its raw form. Other than measuring the sensor's input to the system and presenting it for display to the operator no other operations have taken place. This data trace manifests itself on the system screen as the data occurs (left to right) spanning the one-minute data collection phase.


Graph 1

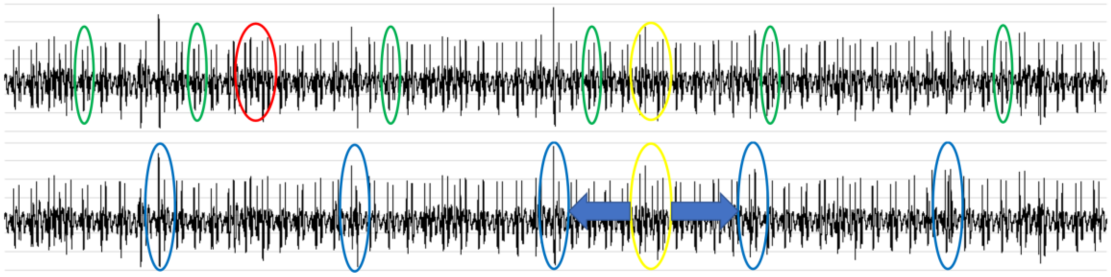
It is not difficult to see in Graph 2 very normal heart-beat intervals (some encircled in green) are in the majority. Also, more atypical heart-beat force intervals (circled in red) illustrate potential individual events of note. But these intervals are not to be confused with other normal repetitions.


Graph 2

Such a "normal" repetition would be that of the additional acceleration force created by peak respiration that took place five times within the one-minute measurement and whose peaks are shown in Graph 3 encircled in blue.

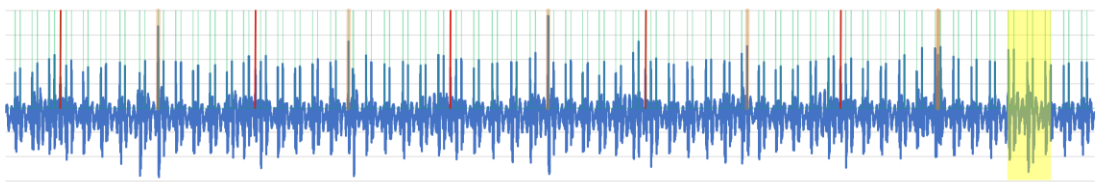

Graph 3

Note that it is NOT the technician's nor any medical staff's responsibility to identify any aspect of the data, although they are not prevented from doing so. This identification takes place automatically with the algorithmic and statistical analysis of the system. Which will automatically move what was the second encircled possible atypical interval in Graph3 to that of the respiration lull and downgraded to yellow in Graph 4.



Graph 4

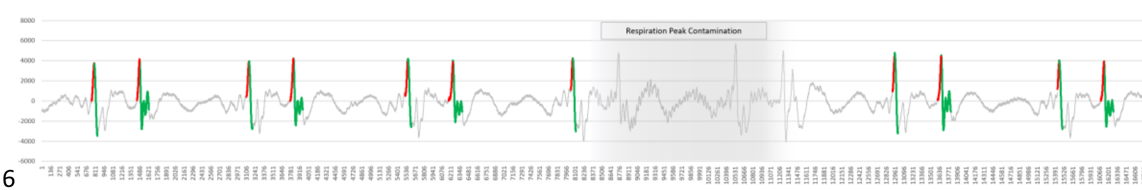
The first primary step of the algorithm process for determining the heart-beat cycles and subsequent intervals is to determine the statistically ideal cycles for that processing. It has readily been seen that the additive maximum and minimum acceleration force of respiration adversely impact the uniformity of the consistent heart-beat force cycle. The simplest step of the algorithm process is selecting the "good" cycles for examination. Shown in Graph 5 are the 60 heart-beat cycles with those individual cycles impacted by respiration highlighted. The respiration maximum additive acceleration rates are shown highlighted in orange and the minimums are shown in red.



Graph 5

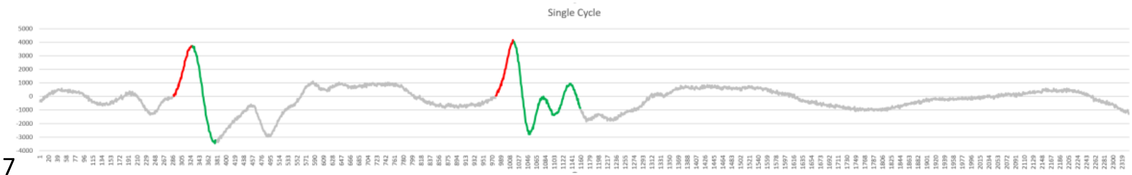
Patterns begin to emerge visually with these points highlighted. It becomes easy to see that the measurement session began between a respiration max and min where only three heart-beat cycles were recorded prior to the minimum of that particular respiration cycle. Whereas at the end, five respiration cycles and 60 heart-beat cycles later, there are eight apparent un-affected heart-beat cycles at the end of the measurement. It is most likely that respiration did indeed take place but the minimum did not fully manifest an adverse acceleration force impact on the data. This anticipated region is highlighted in yellow. As far as the algorithm statistical counts for marking ideal heart-cycles this yellow highlighted data may or may not be used. It appears statistically that out of the actual 61 heart-beat intervals that were recorded, just short of 50 cycles will most likely be utilized to determine the statistical normal cycle; where the determination of the internal intervals of the heart-beat cycle is the goal.

Closer observation shows the next pattern that emerges when viewed at this level of detail is that of the two high positive pulse pairs (shown in red), that repeat 61 times across Graph 5, and 6 times in Graph 6; discounting the section that is contaminated by the Respiration Peak Contamination.



Graph 6

Once the data is expanded to the view of Graph 6; more detail is revealed about the high positive peaks that come in pairs in the measurement session. Each of the two positive peaks (red) are followed by two negative going peaks, shown in green. But there a difference takes place. The left most positive peak is as stated followed by a reciprocal negative going peak, but then another trend takes place when compared to the second positive peak. The second positive peak is indeed followed by the reciprocal negative going peak, but that negative going peak is followed by an oscillation of a couple of cycles that curiously has similar characteristics to the shape of the negative going peak itself. Compare the two graphs above and below. It becomes possible to see that the oscillation that follows the second positive peak is very different from the non-consistent activity following the first positive peak. The second set of positive and negative excursions coupled with the associated oscillation are very similar throughout the measurement, where the first set of positive and negative are not so repeatable.



Graph 7

Just as observation can make note of the difference so can algorithms designed to determine differentiated intervals be created. Later the differences will separate the Systole Force (first peak) from the Diastole Force (second peak). More importantly it will also reveal heart characteristics, see the paper on Diastolic Dysfunction.