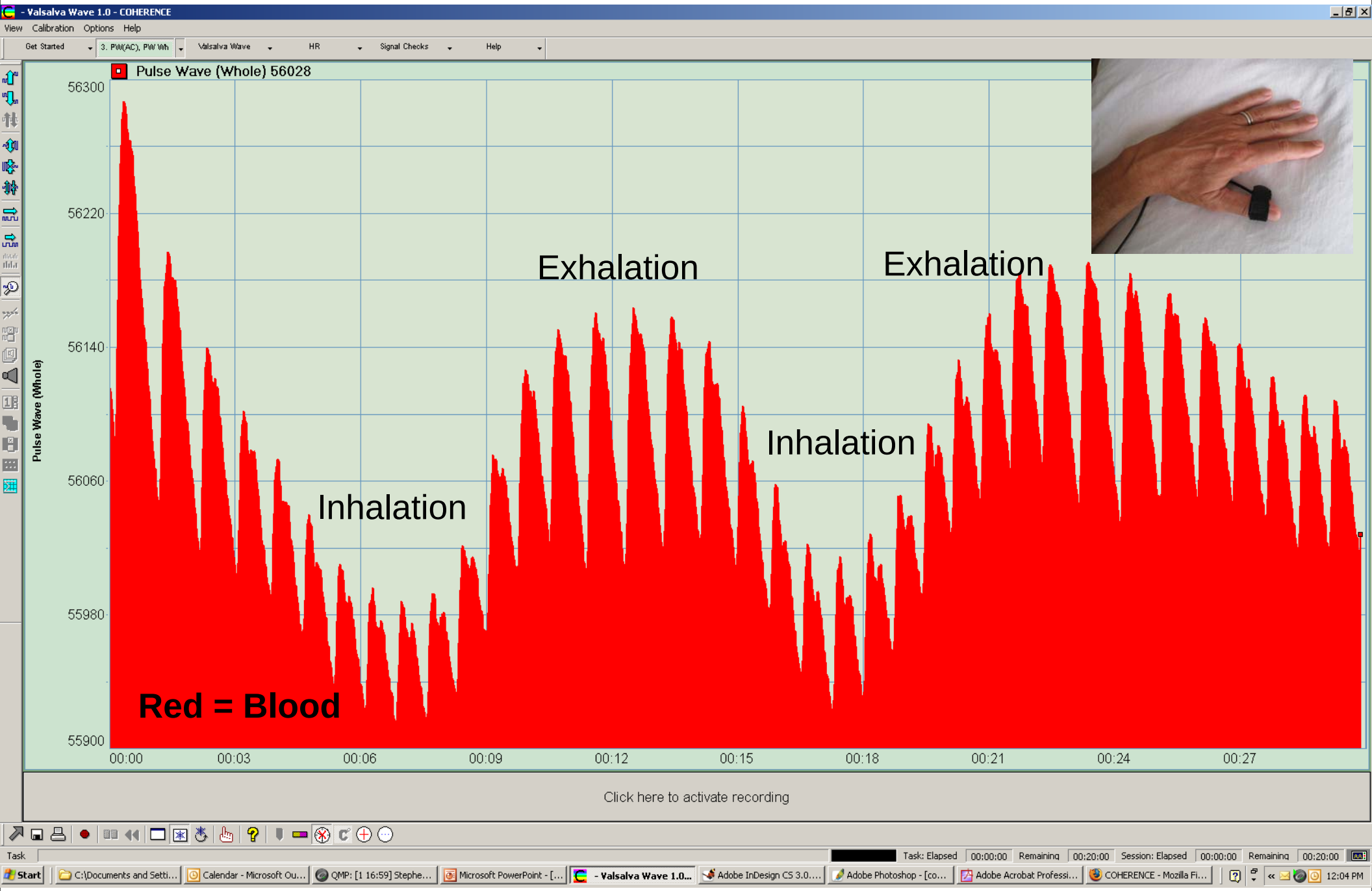
~Valsalva Wave~

The Biometric

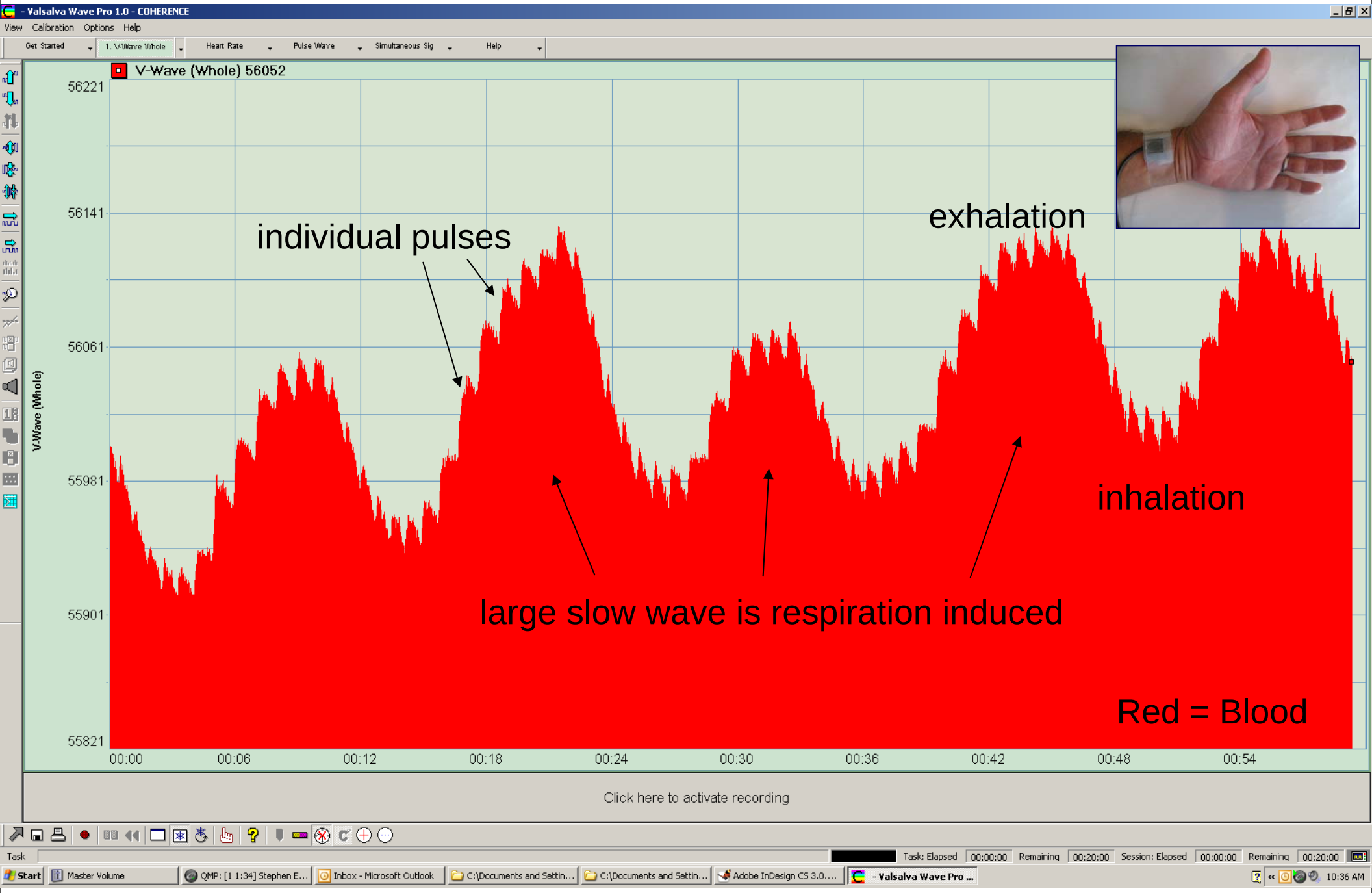
Characteristics

- We can see the Valsalva Wave at 3 principle types of locations:
  1. Termini: ear lobe, finger tips, toe tips, etc. (To date, clinical application has been limited to ear lobe, thumb, and finger.)
  2. Arteries that we can access: radial artery, temporal artery, etc.
  3. Veins that we can access: medial cubital vein, radial vein, jugular vein, etc.
- Magnitude is variable depending on where measured and the pressure being applied.
- Timing depends on where measured.
- The Valsalva Wave is “180 degrees” out of phase with the heart rate at resonance. (Actually slightly less.)

Measured At The Thumb

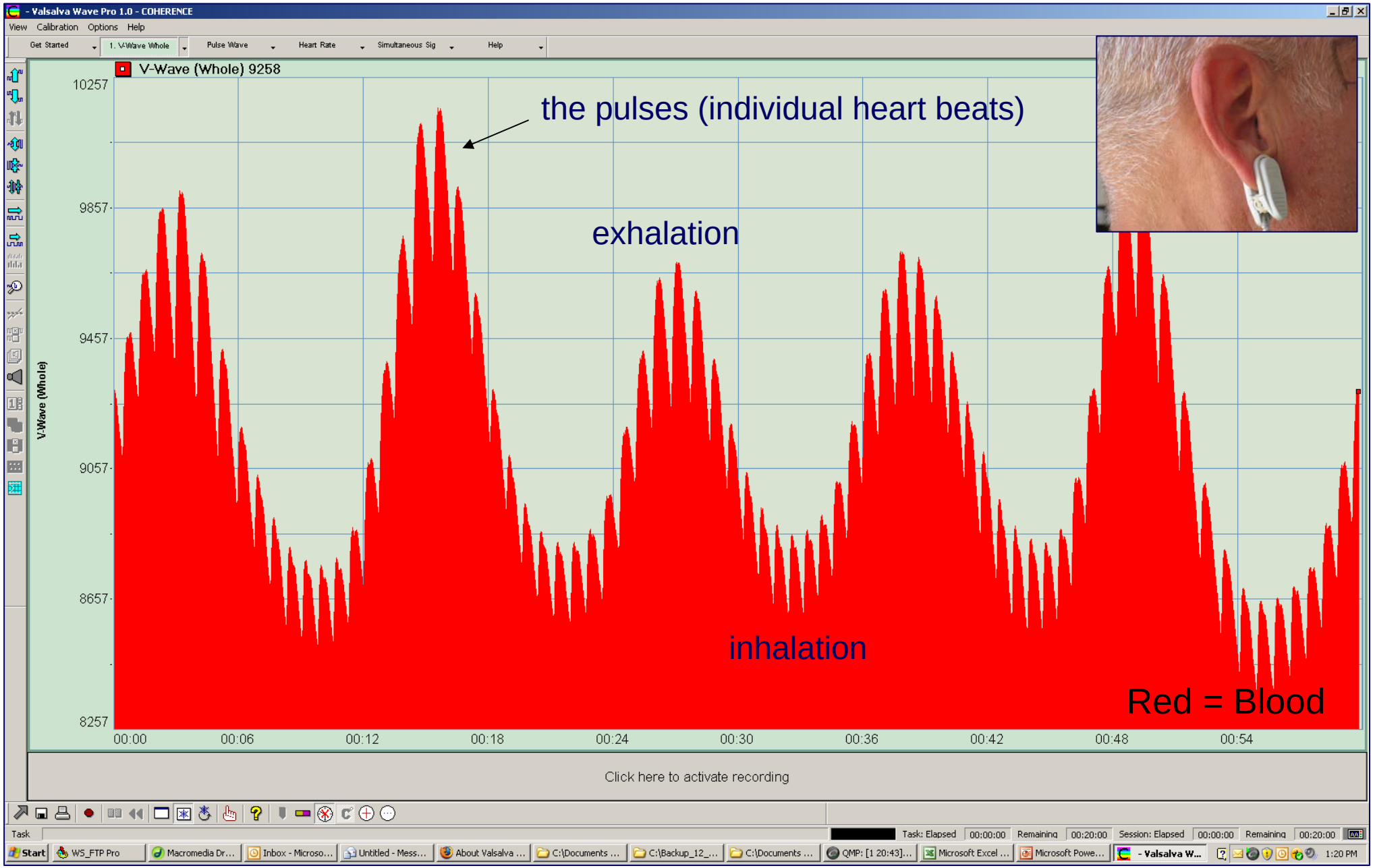


Measured At The Radial Artery



radial artery

Ear Lobe


- Valsalva Wave Pro 1.0 - COHERENCE
View Calibration Options Help
Get Started
1. V-Wave Whole
Pulse Wave
Heart Rate
Simultaneous Sig
Help
V-Wave (Whole) 9258
10257
9857
9457
9057
8657
8257
V-Wave (Whole)
00:00
00:06
00:12
00:18
00:24
00:30
00:36
00:42
00:48
00:54
the pulses (individual heart beats)
exhalation
inhalation
Red = Blood
Click here to activate recording
Task
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Start
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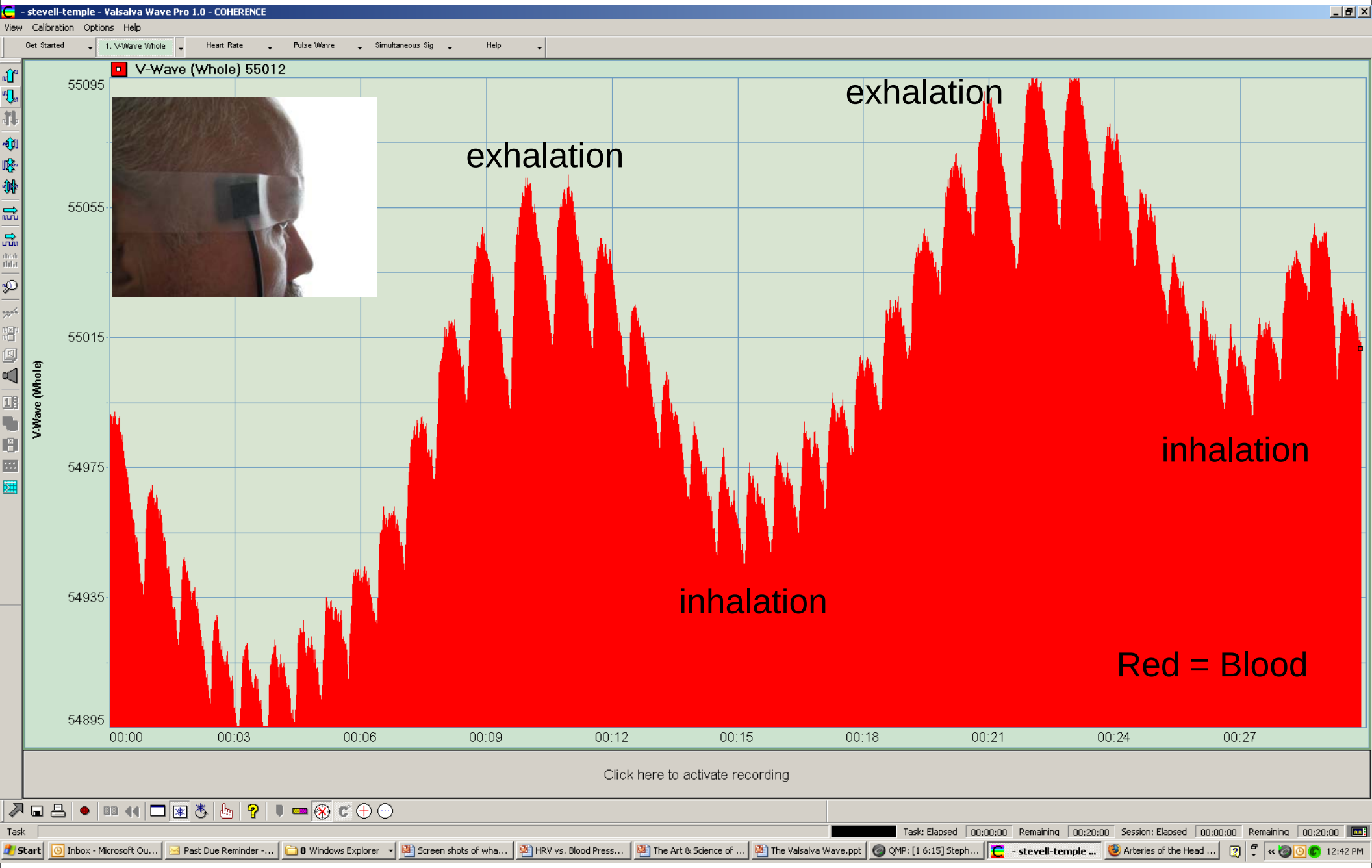
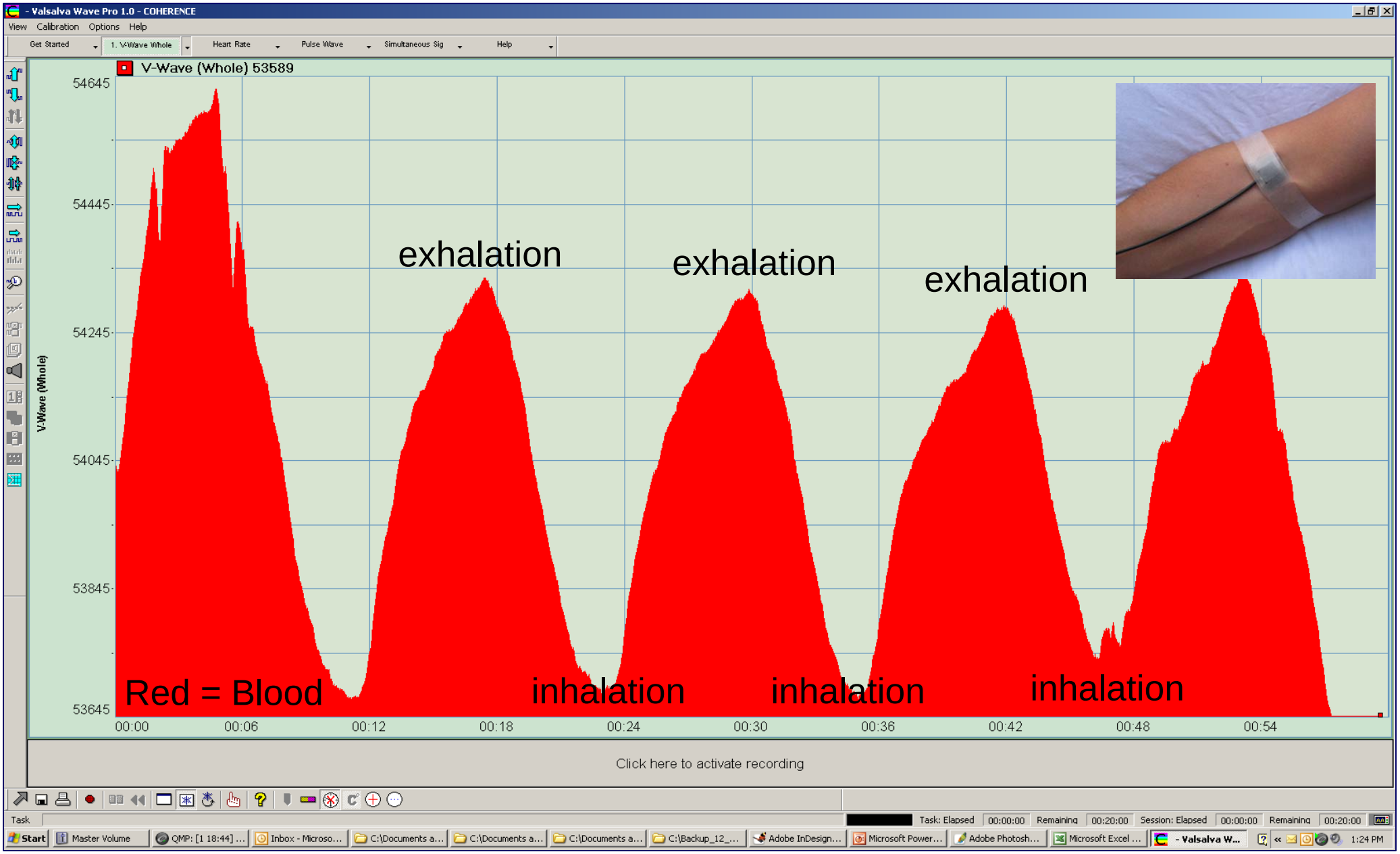
Temple

(Vicinity of Temporal Artery)



Measured At The Medial Cubital Vein



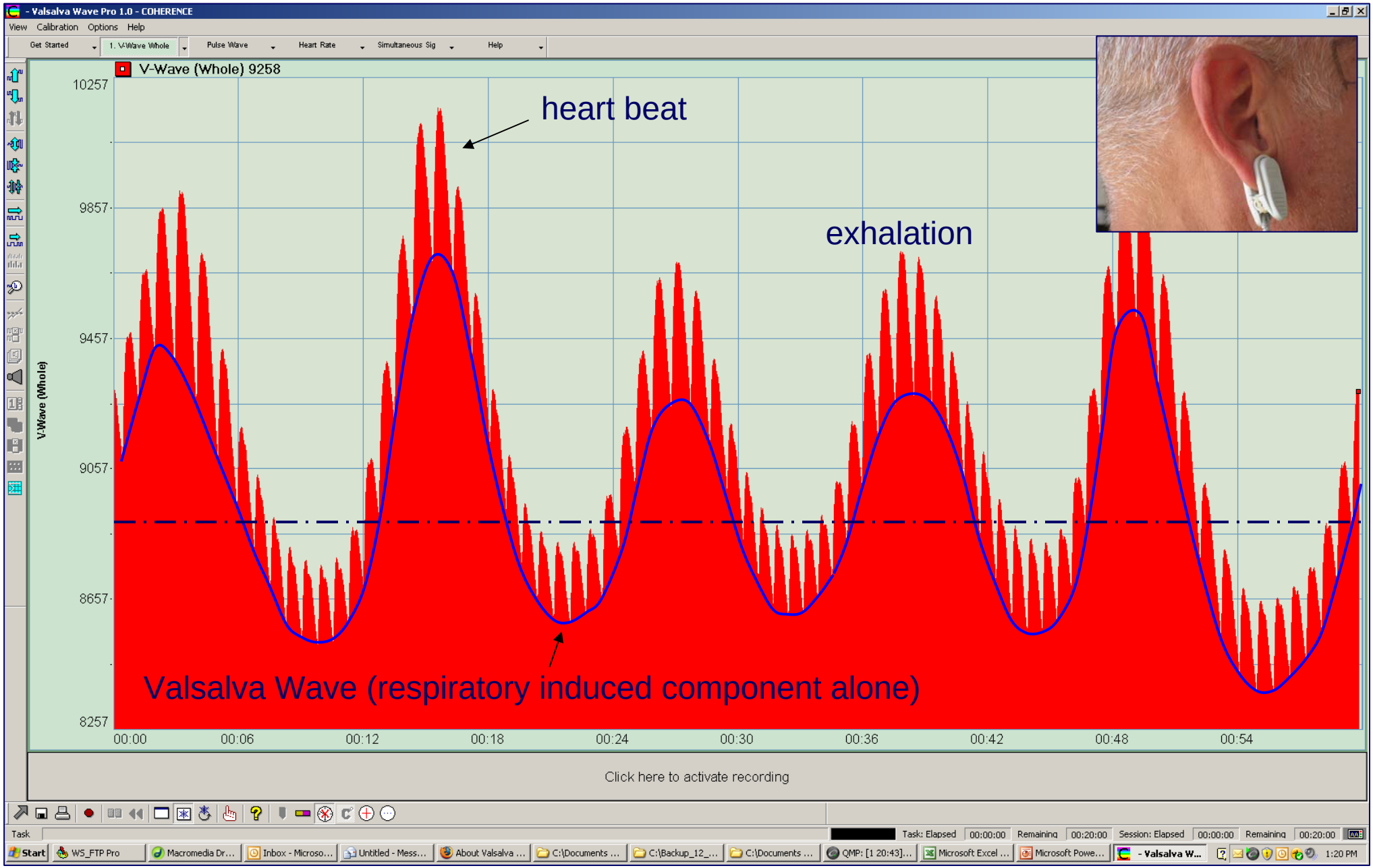
Characteristics (2)

- Effects other than respiration are observable:
  - Very responsive to thought and emotion
  - Mayer Wave (a longer term ANS regulatory function that modifies vascular capacity)

Some Key Questions

- What is correlation between HR and Valslava Wave:
  a. Cycle-to-cycle
  b. HR vs. Valsalva Wave variability
  c. Does one (HR or V-Wave) produce the other (the conventional understanding is that baroreceptor action elicits breathing induced HRV)
- Can we correlate Valsalva Wave magnitude with blood pressure?
- How does the Valsalva Wave relate to other biometrics, EEG, EDR, EMG?
-

If We Filter The Whole Wave...



Basic Signals & Relationships

- Valsalva Wave Pro 1.0 - COHERENCE

View Calibration Options Help

1. Basic Signals | Valsalva Wave | Heart Rate | Pulse Wave | Simultaneous Sig | Help

The Basic Signals

A. The Whole Valsalva Wave:

The *whole* Valsalva Wave is the complex output of the DC plethysmograph, demonstrating dynamic blood volume as a function of respiration, heart beat, and autonomic governance of vascular capacity. It is the basic signal from which we derive the Valsalva Wave, the AC Pulse Wave, and the Heart Rate. Generally, the *whole* Valsalva Wave rises with exhalation and falls with inhalation.

B. The Fast Valsalva Wave:

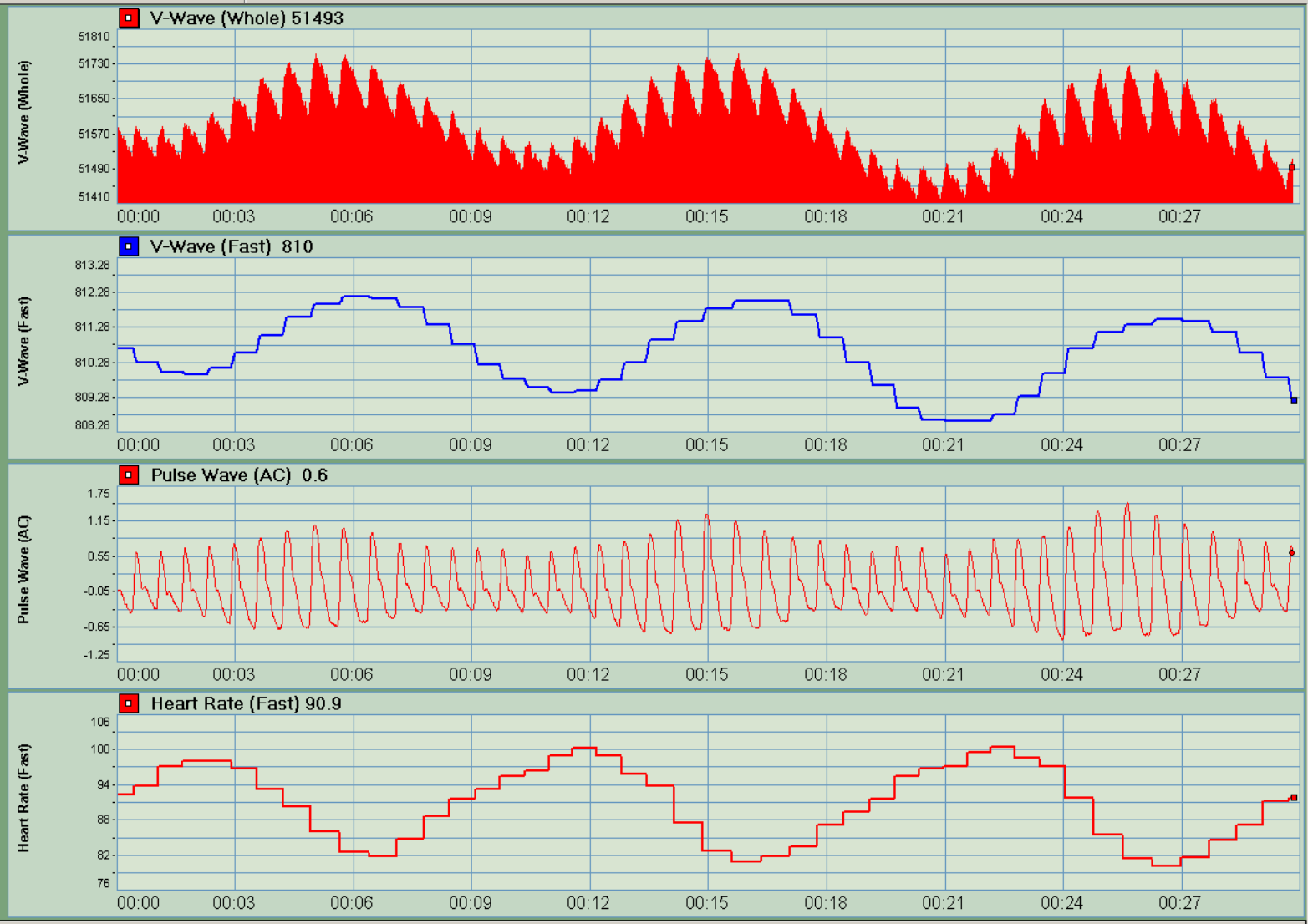
The *fast* Valsalva Wave is derived by measuring the whole Valsalva Wave during each inter-beat interval and averaging the output over 10 measurement samples. Generally, the Valsalva Wave rises with exhalation and falls with inhalation. Other V-Wave signals are derived from this signal. See the "Valsalva Wave" tab for more information.

C. The AC Pulse Wave:

The AC Pulse Wave is derived by applying a high pass filter to the *whole* Valsalva Wave, eliminating the low frequency components having to do with respiration. This leaves an "AC coupled" signal that varies equally around an X axis of zero. This signal is ideal for measuring the "inter-beat interval" from which instantaneous Heart Rate is determined. See the "Pulse Wave" tab for a more complete explanation.

D. The Fast Heart Rate:

When the inter-beat interval is divided into 60 seconds it yields instantaneous heart rate in "beats per minute". When heart rate is plotted it yields the signal we know



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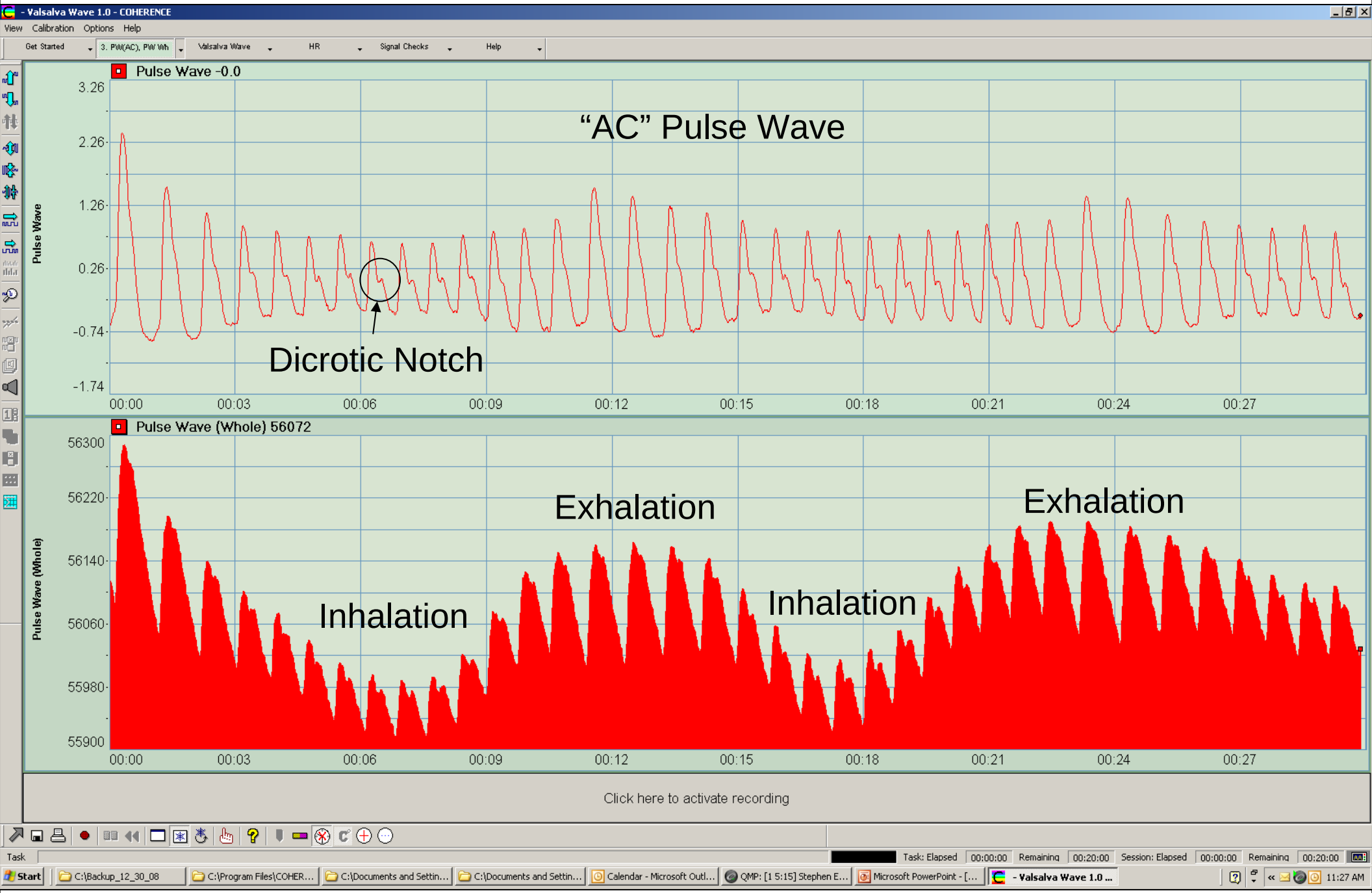
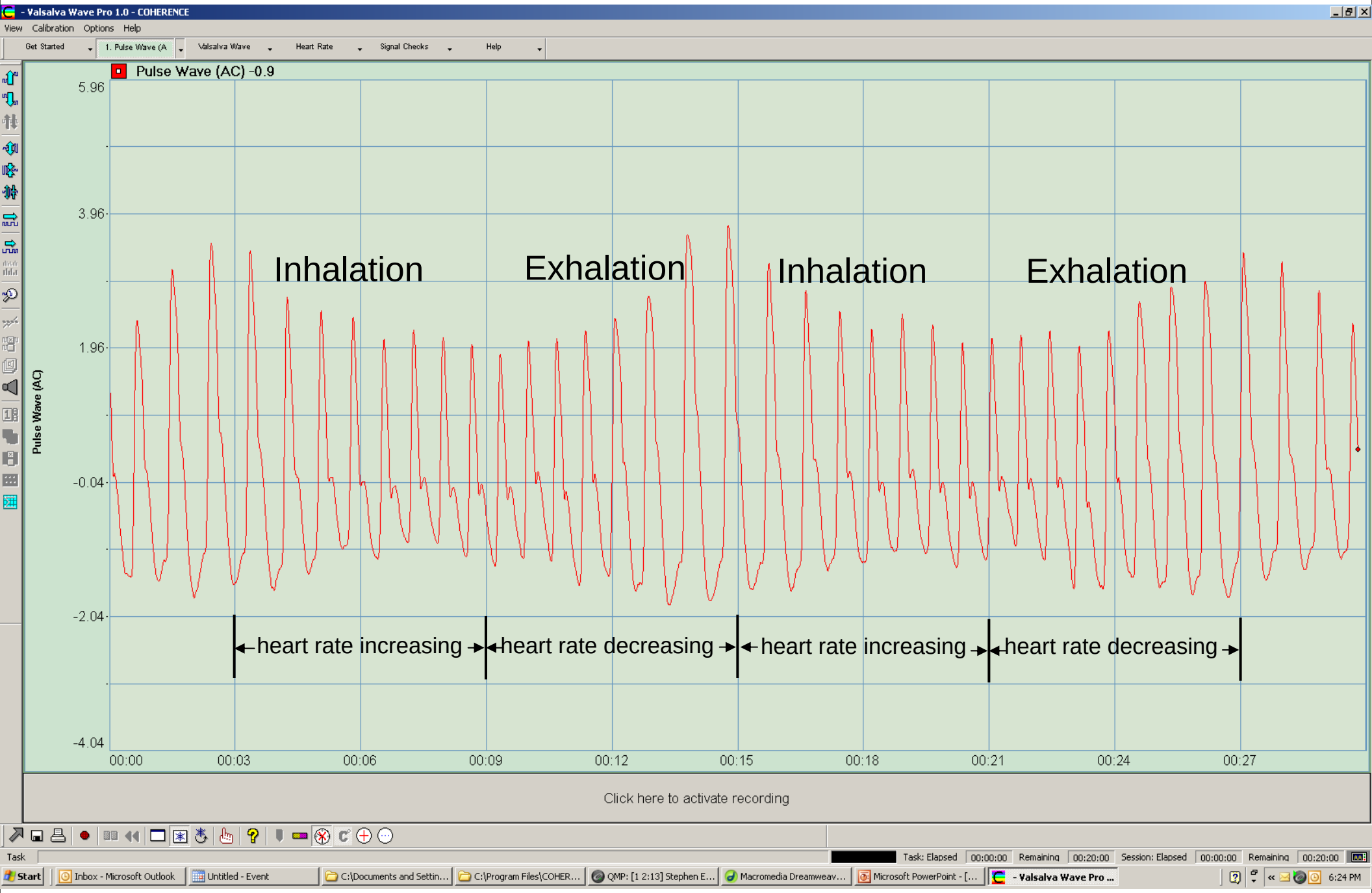
Relationship to the Pulse



The Pulse


- Valsalva Wave Pro 1.0 - COHERENCE
View Calibration Options Help
Get Started
1. Pulse Wave (A
Valsalva Wave
Heart Rate
Signal Checks
Help
Pulse Wave (AC) -0.9
Pulse Wave (AC)
5.96
3.96
1.96
-0.04
-2.04
-4.04
00:00
00:03
00:06
00:09
00:12
00:15
00:18
00:21
00:24
00:27
Inhalation
Exhalation
Inhalation
Exhalation
heart rate increasing
heart rate decreasing
heart rate increasing
heart rate decreasing
Click here to activate recording
Task
Task: Elapsed 00:00:00 Remaining 00:20:00 Session: Elapsed 00:00:00 Remaining 00:20:00
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- Valsalva Wave Pro ...
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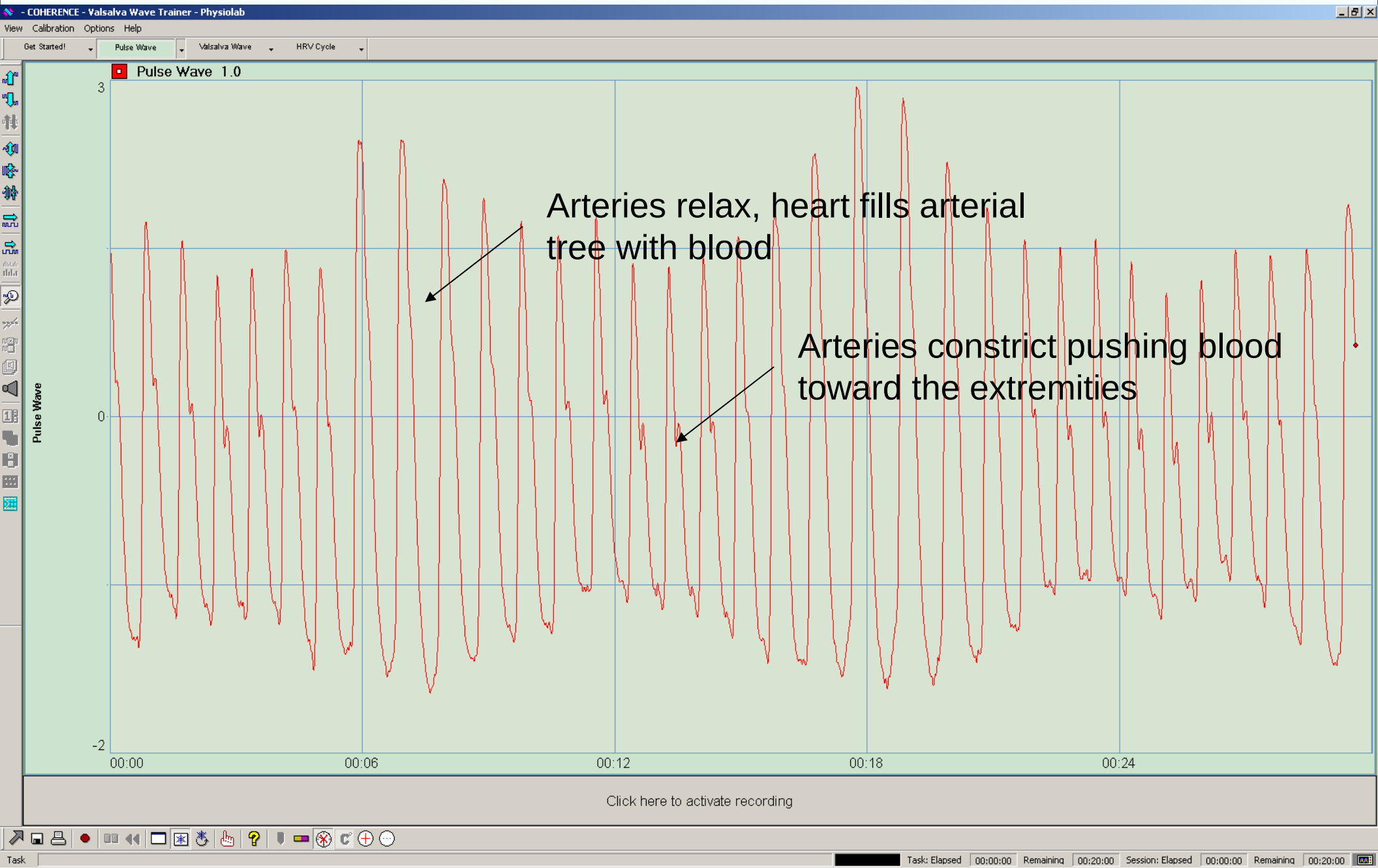
The Pulse


- COHERENCE - Valsalva Wave Trainer - Physiolab
View Calibration Options Help
Get Started!
Pulse Wave
Valsalva Wave
HRV Cycle
Pulse Wave 1.0
Pulse Wave
3
0
-2
00:00
00:06
00:12
00:18
00:24
Arteries relax, heart fills arterial tree with blood
Arteries constrict pushing blood toward the extremities
Click here to activate recording
Task
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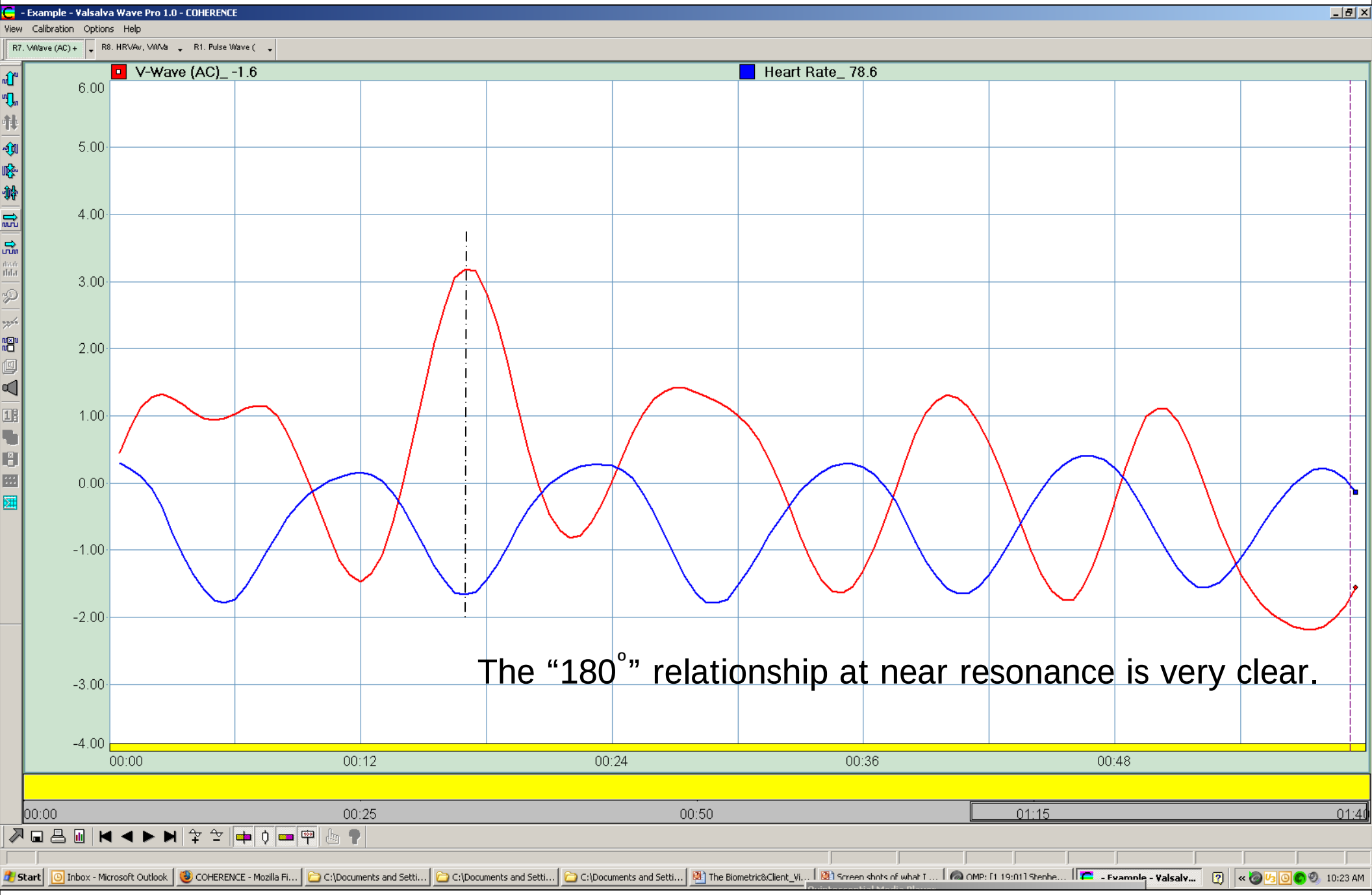
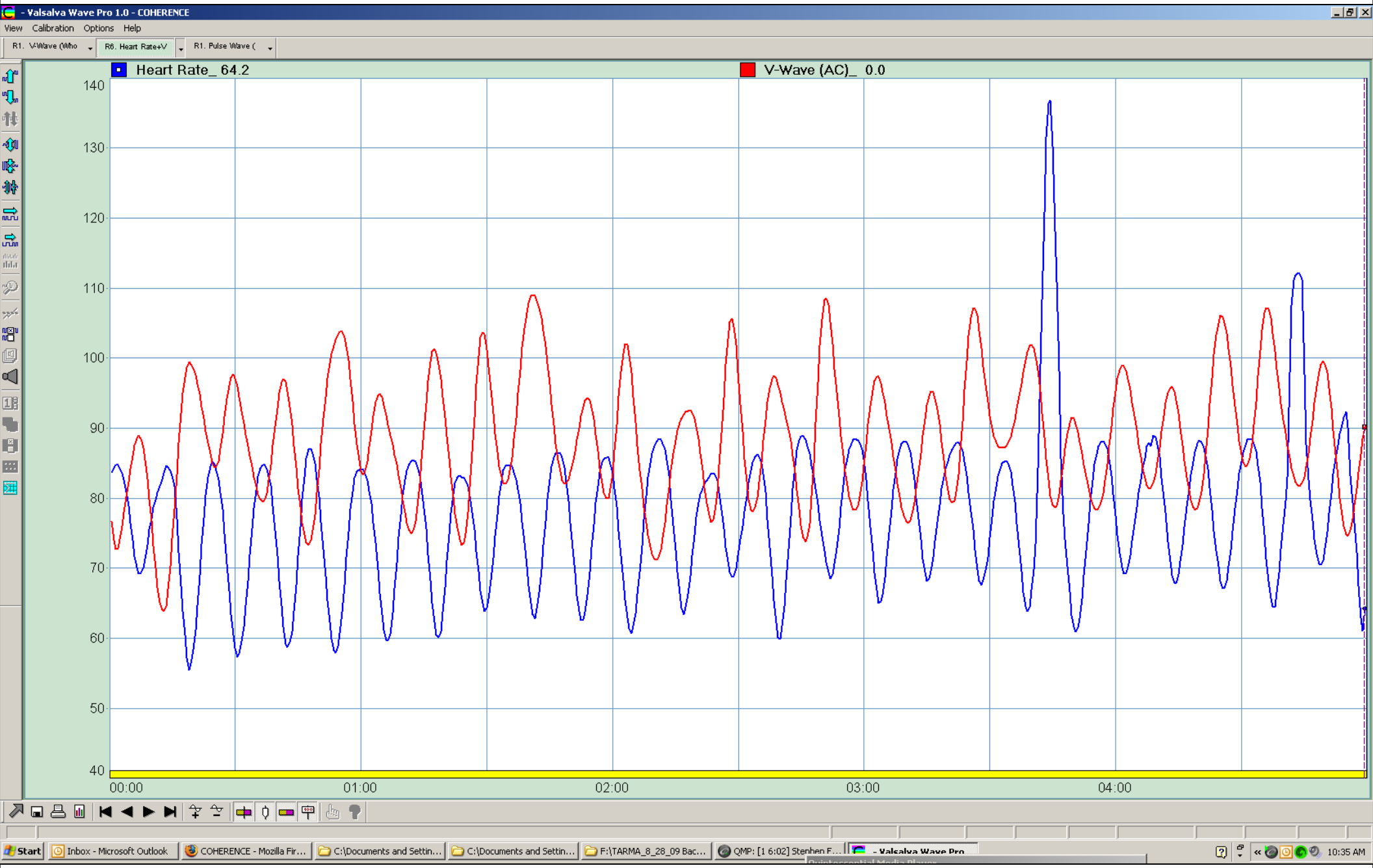
Valsalva Wave + Heart Rate



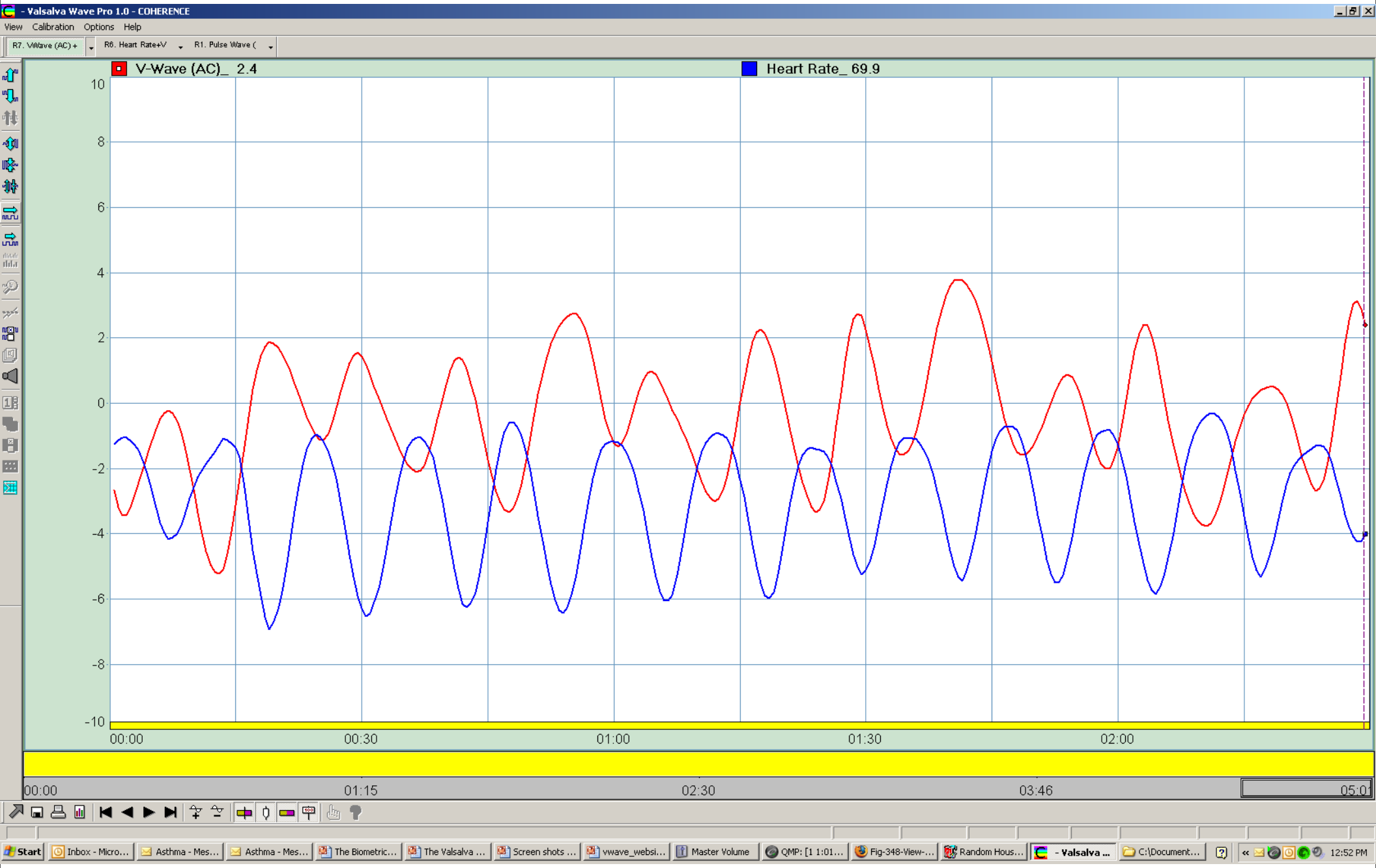
Valsalva Wave + Heart Rate



A longer term view.

Valsalva Wave & Heart Rate

- The Valsalva Wave tends to lead HR at resonance.



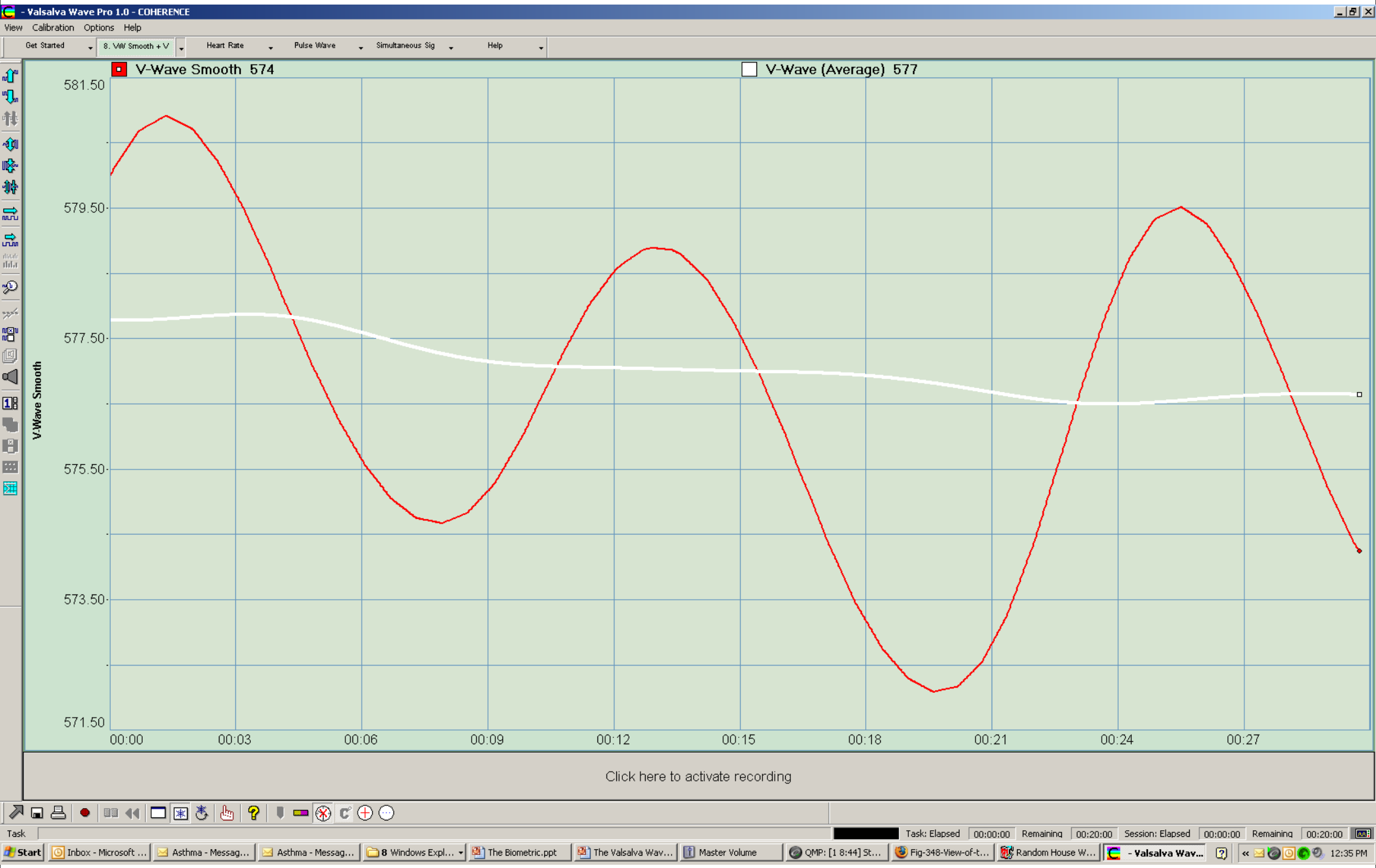
Valsalva Wave - Measures

1. Complete wave
2. The average or “DC” component
3. AC component (“Variability”)
4. Amplitude of the AC component
5. Spectral content of the AC component

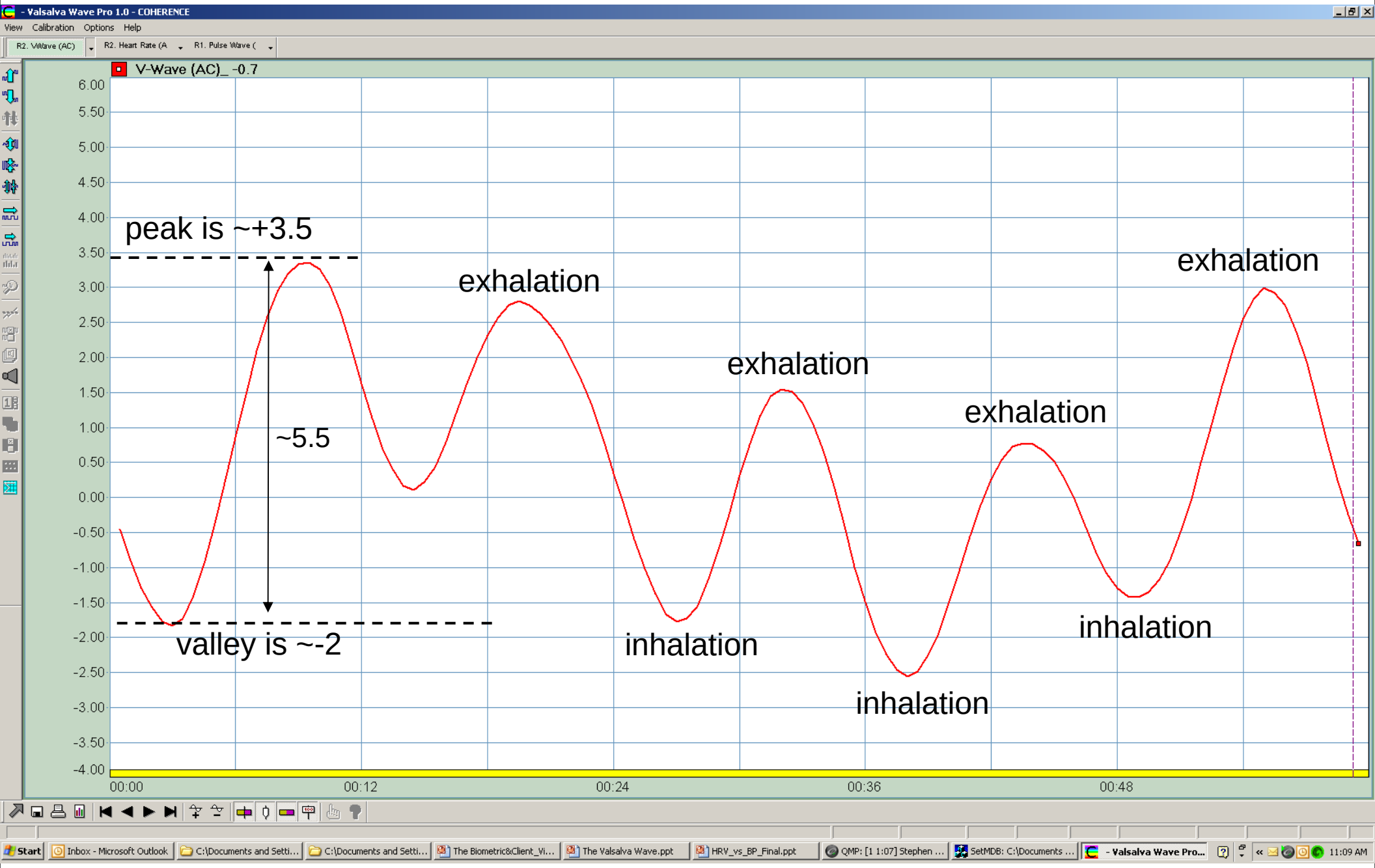
Simultaneous views with heart rate or pulse:

1. AC component
2. Spectral content of AC component

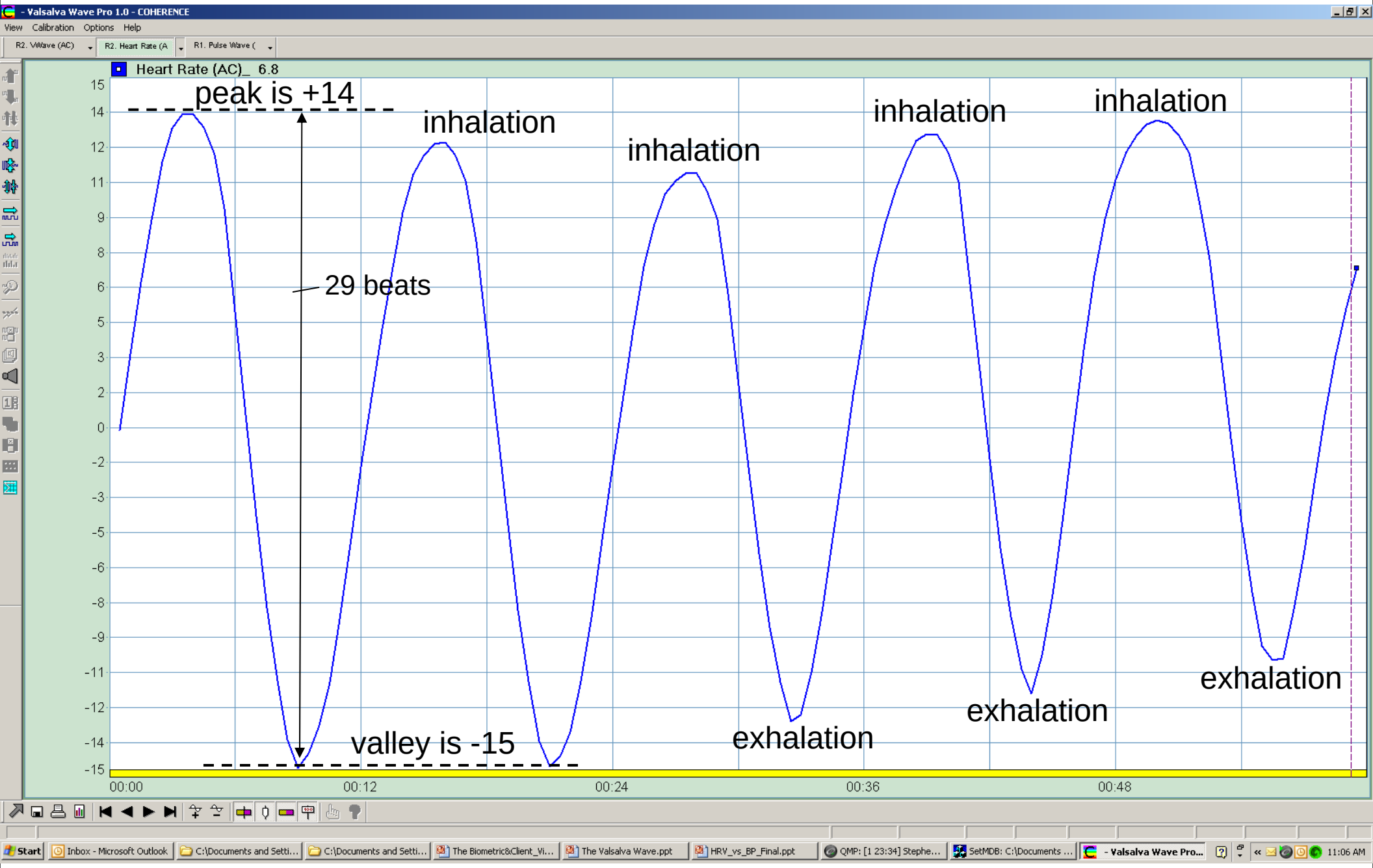
AC and DC Components



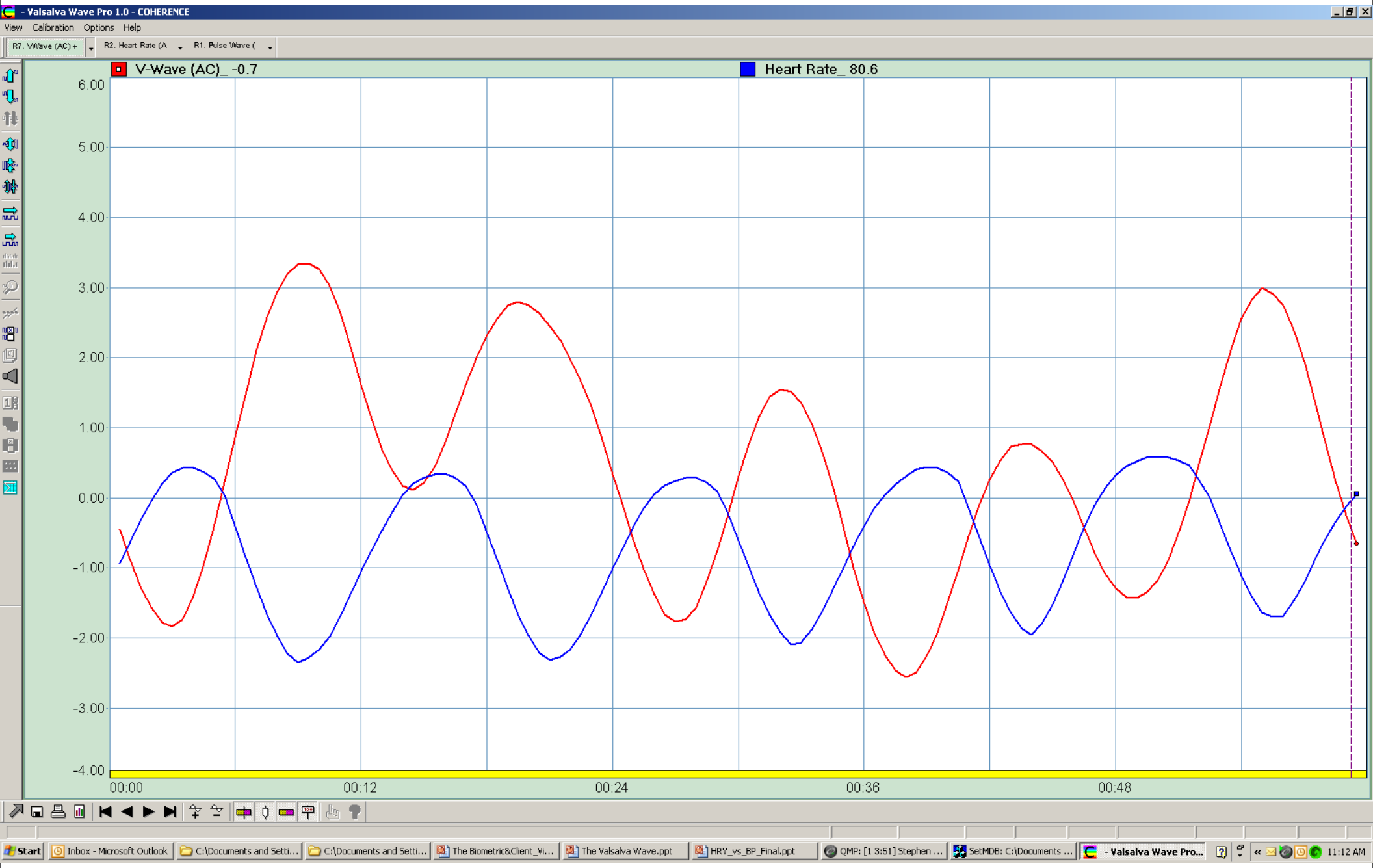
AC Component Demonstrating Variability



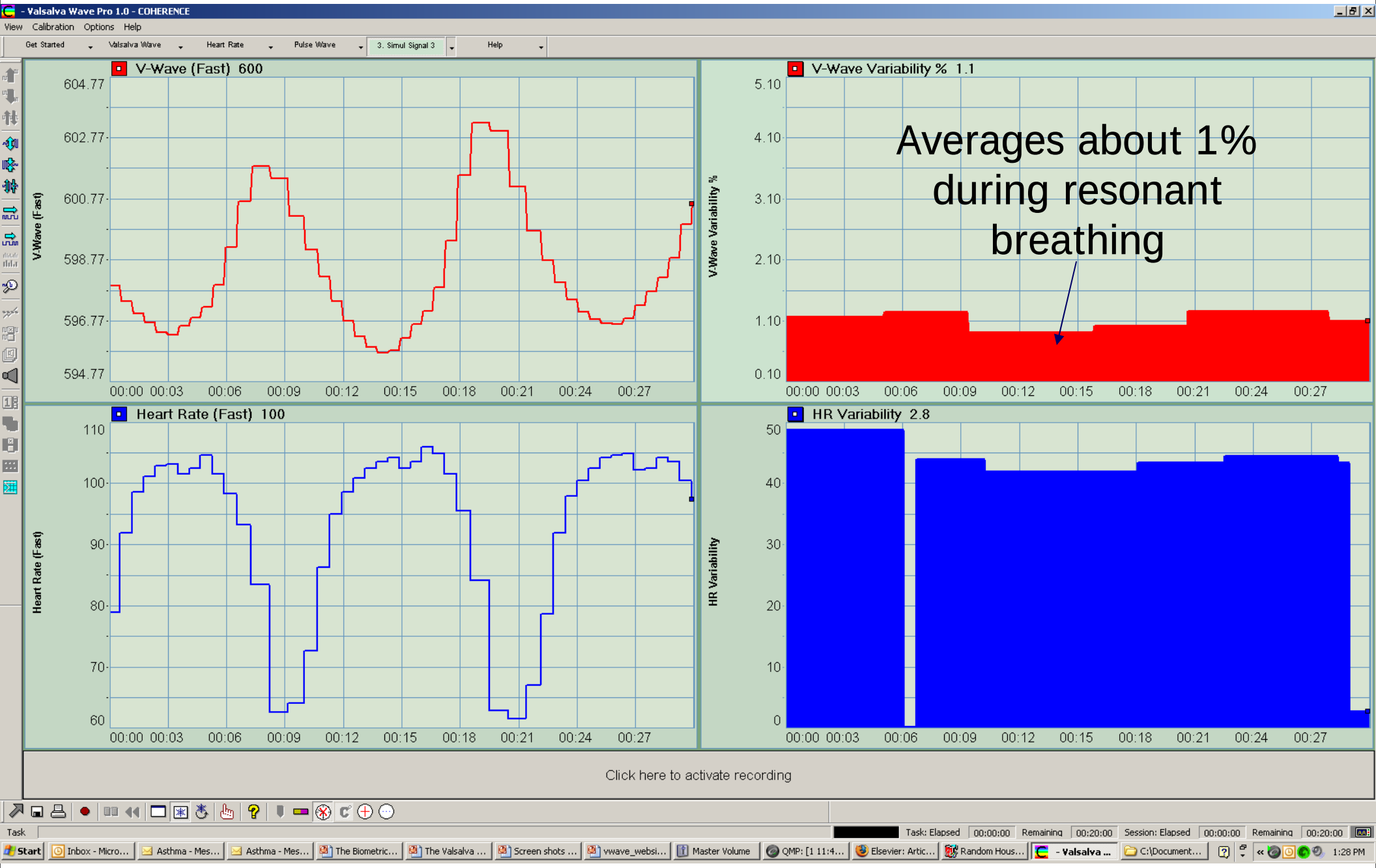
Heart Rate Variability



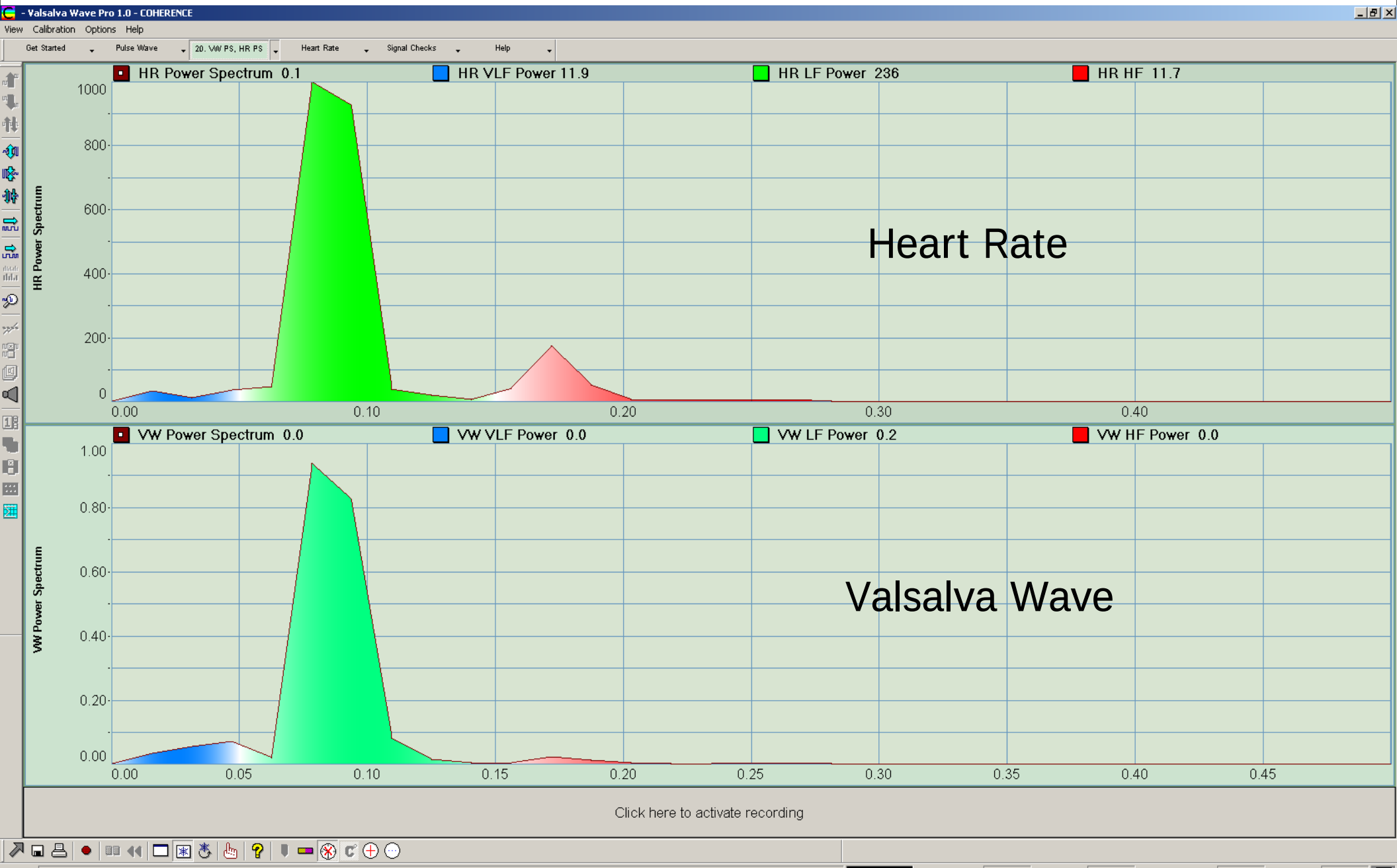
V-Wave + Heart Rate Variability



Variability



Power Spectrum At Resonance



Variability

- “Variability” is the training goal. *Why?*
- Because it is the measure of thoracic pump effectiveness.
- In theory, Valsalva Wave variability elicits heart rate variability.

The Goal Is A Standard Measure

- We're most interested in Valsalva Wave "variability".
- However, its difficult:

  1) Variation where measured, distance, gravity, etc.

  2) Variation with applied pressure (velcro, spring clip, tape)

- The solution:

  [AC component/DC component] X 100 = % variability

  (No matter where measured or the pressure being applied, the relationship of AC and DC components should be constant – a theory.)

- With this, we can assess variability at any measurable location.

Variability At Different Parts Of The Body

	Seated Position		
	DC	AC	% Variability
Earlobe	607	3.6	0.6
Left Thumb	938	1.9	0.2
Left big toe	943	0.9	0.1

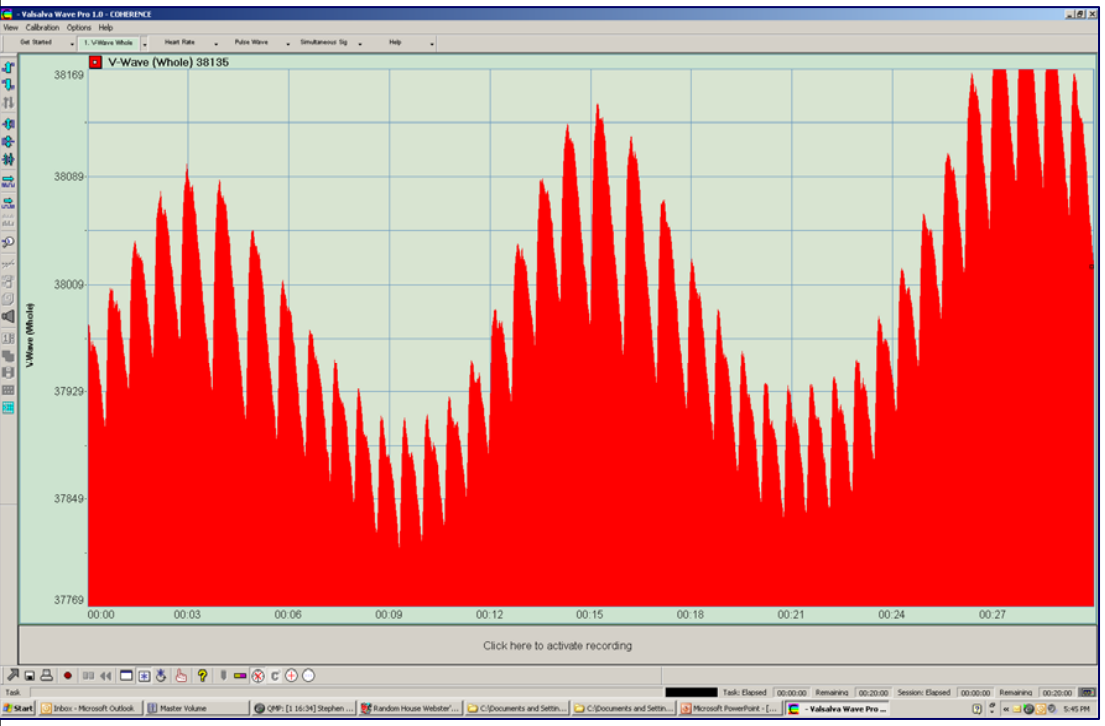
A work in progress....

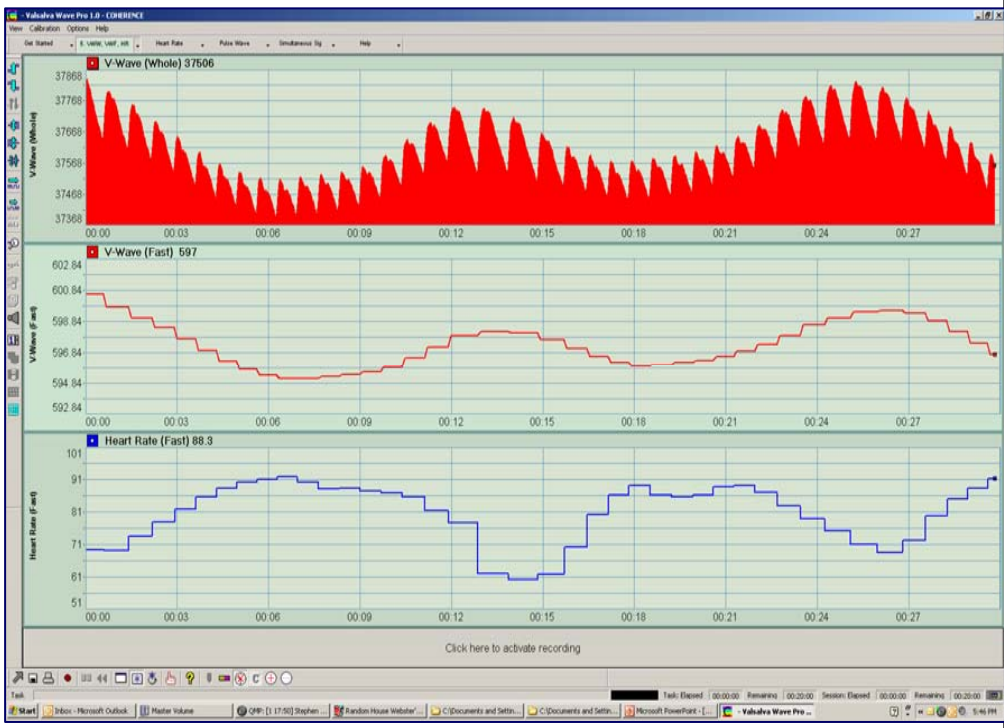
Variability At The Earlobe

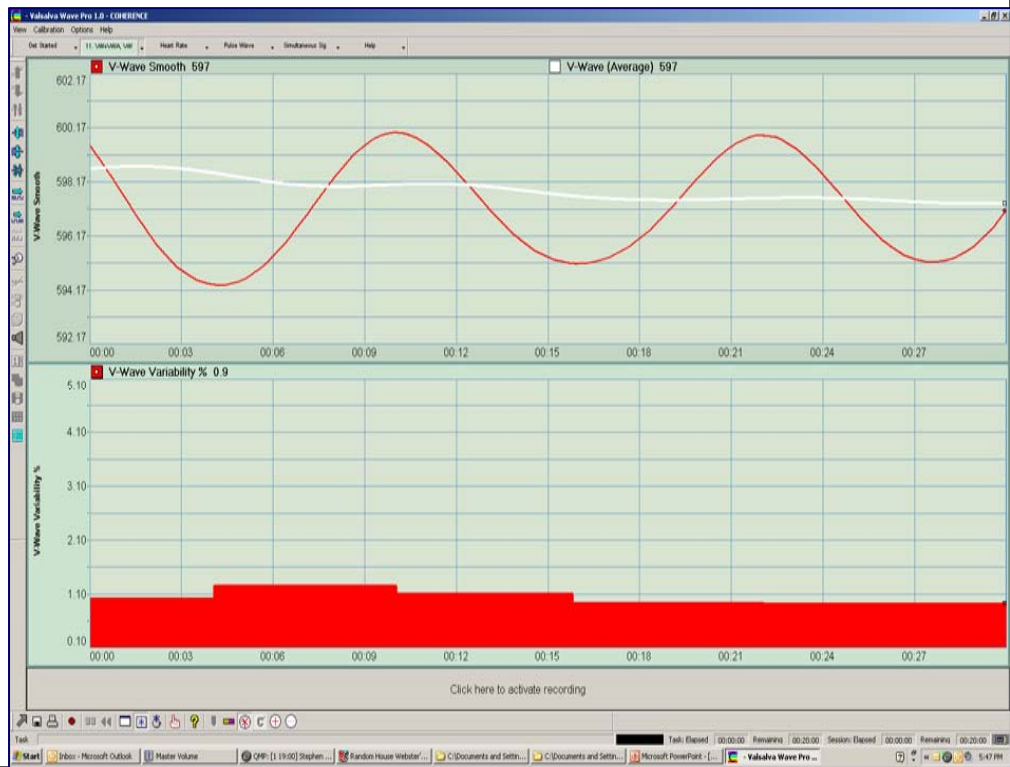
Variability At Big Toe

Variability At Thumb

Screens We've Used For Feedback







The End of Part 2