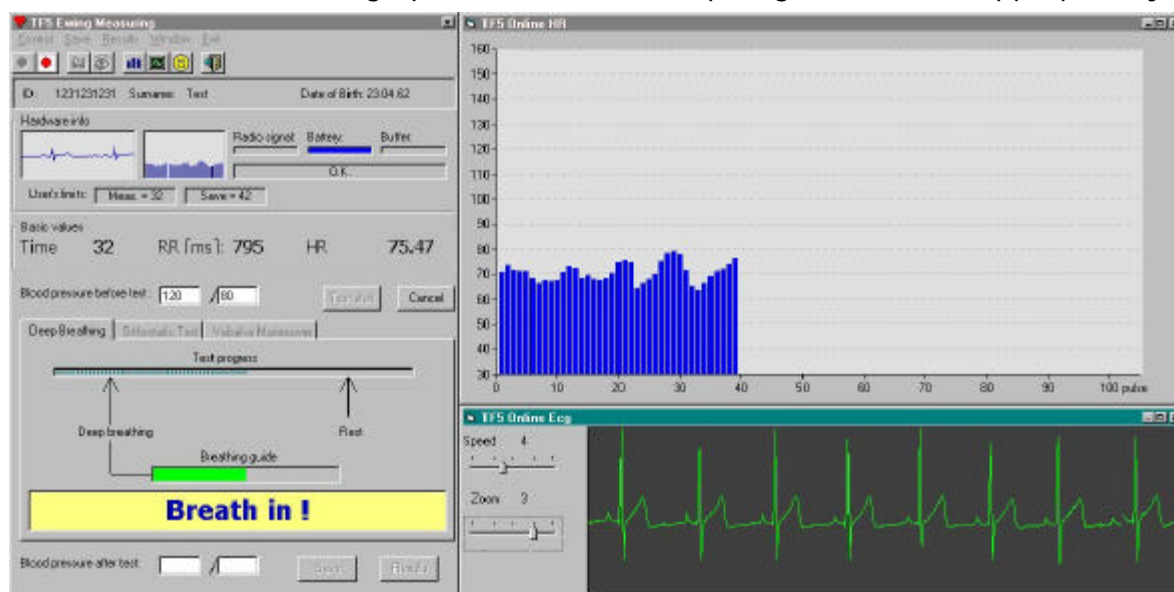## 8.2.1. Ewing Battery: How to Perform the Deep Breathing Test
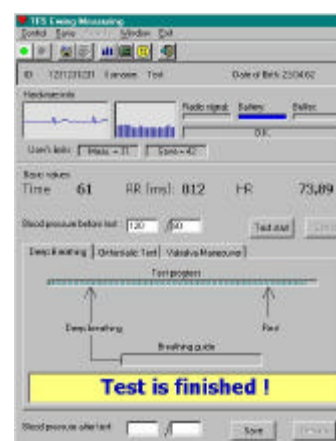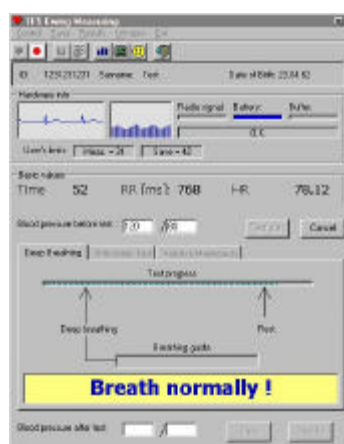
The subject sits quietly on the examination bed, the thorax belt with integral electrodes is correctly positioned on the chest and the transmitter switched on (regular signals as indicated by the LED-diode are detected).

Click on the Deep breathing test button (section 9 in the measuring screen). Enter the blood pressure value, if needed (optional). Then click on the '**Test start**' button - - see below, the screen shows effect of a cyclical breathing on the heart rate course while voice and written / graphical commands help to guide the test appropriately:

After an initial phase (10 seconds) that is necessary for obtaining basic data for statistics, a voice and written command "**Breath in**" appears, followed after 5 seconds by "**Breath out**" command. Paralelly, a breathing guide bar slowly increases and decreases in green so that the subject's cyclical breathing excursions are maximally standardised, each of them 5 seconds (four inspirations and four exspirations). When finished (after 40 seconds), a message appears on the screen:

"**Breath normally**". Another 10 seconds of data are then recorded for computational purposes, a final longer beep and messages "**Test is finished**" indicate that the test is finished automatically.
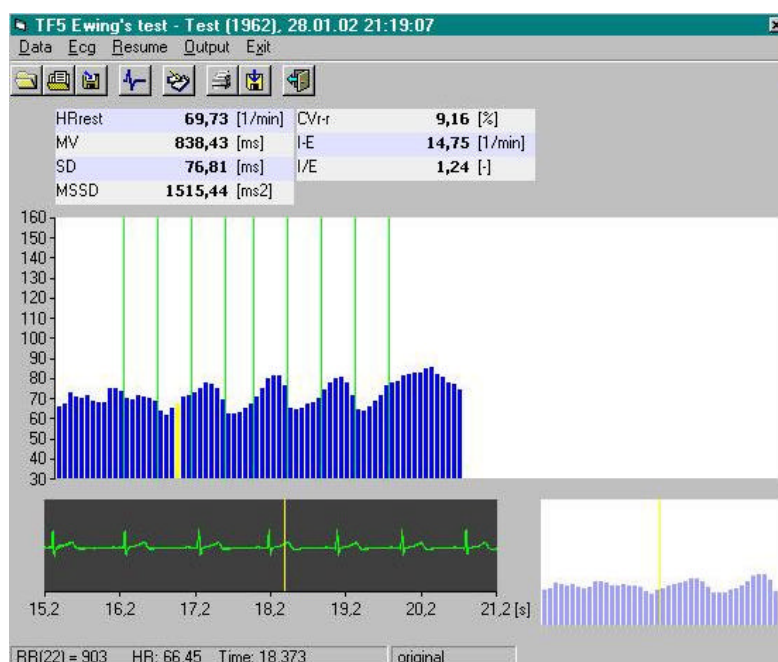

Important notice: the record must be absolutely artefact-free in order to ensure reliable test results. (See "Filtration" procedure)

After the measurement is *finished*, the following procedures/keys can be used:

After any of the Ewing's tests is finished, **save**, please, (by clicking on the '**Save**' button below) the recorded data immediately. Afterwards, the patient's record and identification information is displayed, as well as graphics displaying the heart rate course during the whole test and all relevant statistical results – click on the '**Results**' button below.
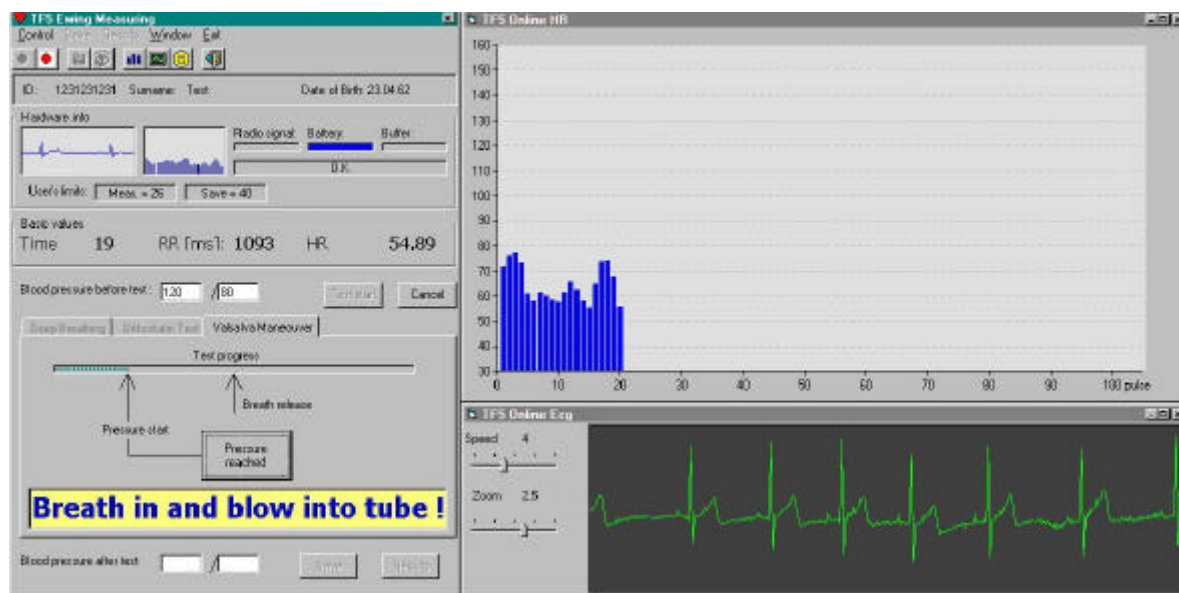
Relevant parameters: Deep breathing test

HRrest :	Resting heart rate
MV:	Average R-R interval
SD:	Standard deviation
MSSD:	Mean Square of Differences of Successive R-R Intervals
CVr-r :	Component Variance of R-R Intervals
I-E:	Difference Inspirium and Expirium heart rate
I/E:	Ratio maximum vers. minimum heart rate during Inspirium and Expirium

Practical example: Typical results screen with apparently normal heart rate variability during the deep breathing test. For parameters description, see above. The green lines in the main screen show time course of test commands (5-seconds cycles), ECG below, position of the browser of heart rate course and numbers shown at the bottom line are related to the marked HR value – in yellow, see the main screen. In order to remove artefacts, the marking can be changed by moving the mouse and clicking the left (mark) or right (unmark) buttons. This procedure is identical with that used in spectral analysis processing, as described earlier.
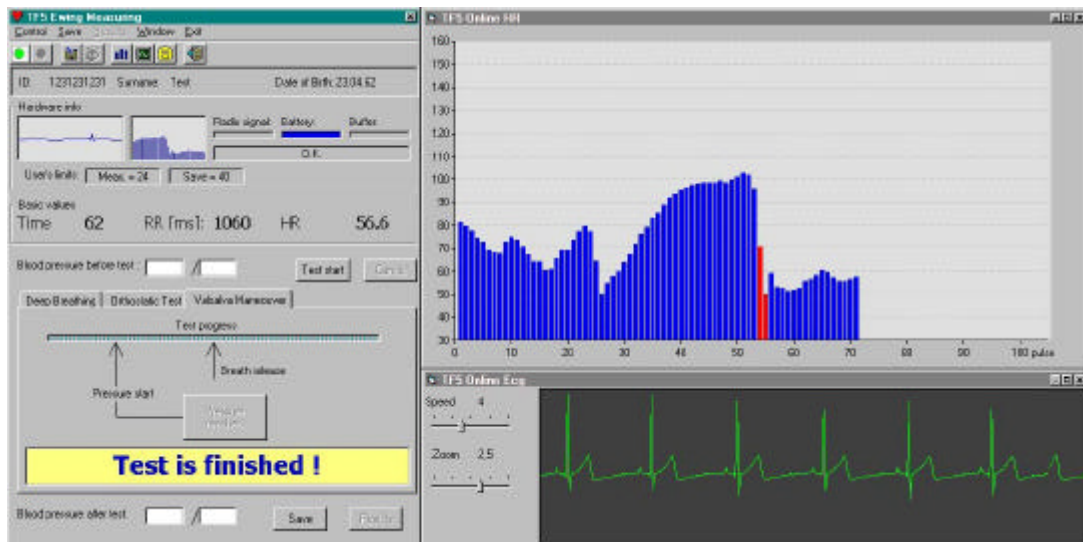
Choose the '**Valsalva maneuver**' option by clicking the button. Optionally, enter the blood pressure values and start the measurement by clicking the '**Test start**' button. After starting you have to wait for 10 seconds, after which a message '**Breath in and blow into tube**' appears. Identical voice command is heard, as well. The patient has to inhale deeply, and when starting the exhalation (while reaching 40 mmHg on the manometer), the examiner has to press the '**Pressure reached**' key. Under constant resistance of 40 mmHg during the expiration, the heart rate course is recorded for 15 seconds.

Afterwards a short signal beeps, and a message '**Release and breath normally**' appears, paralleled by a voice command. The subject returns to normal breathing and has to wait until the end of the test (some 20 seconds again). Finally, a message '**Test is finished**' closes the examination. Please save the recorded data immediately, again, by clicking the '**Save**' button below. Results of the test are available by clicking the '**Results**' button below on the screen.

Relevant parameters: Valsalva maneuver

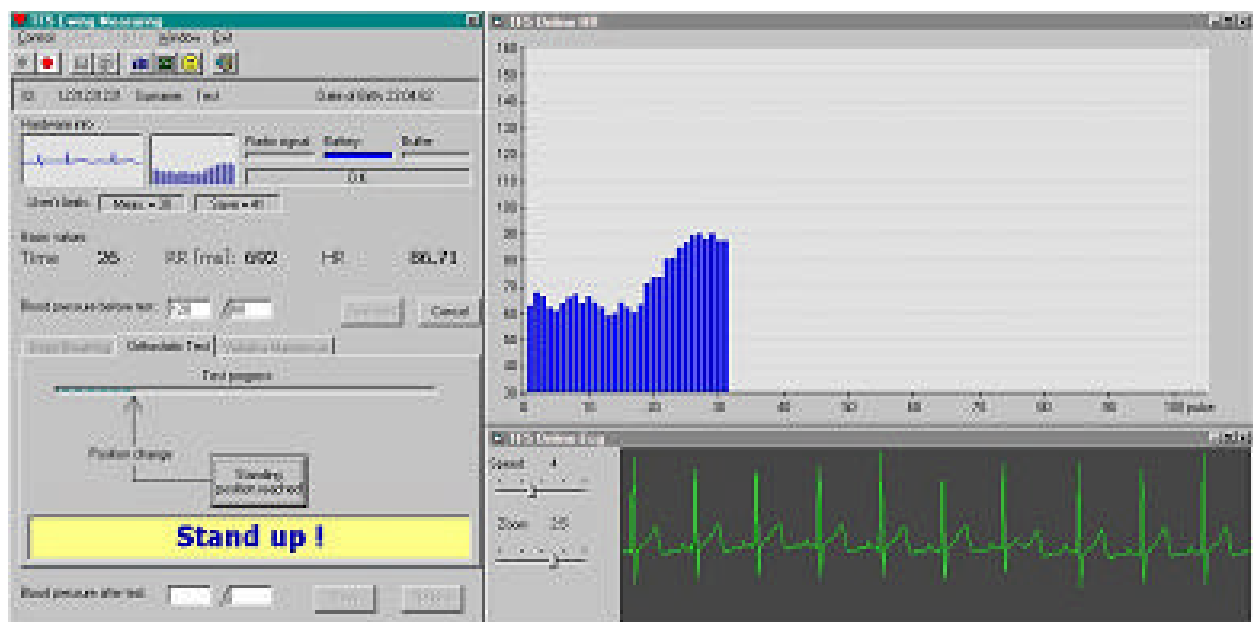|	
VR	Valsalva-Ratio
t max	Timepoint of maximal heart rate
t min	Timepoint of minimal heart rate
HRrest	Resting heart rate
HR max	Maximal heart rate
HR min	Minimal heart rate
HR max / HR rest	Ratio maximal heart rate vers. rest
HR max - HR rest	Difference maximal heart rate minus rest
HR min / HR rest	Ratio minimal heart rate vers. rest

Practical example: Above you can see a typical course of normal reaction of heart rate during the Valsalva maneuver (blue bars) as seen during the examination. Just a note, **save** always the obtained data as soon as possible to avoid unnecessary data loss etc.
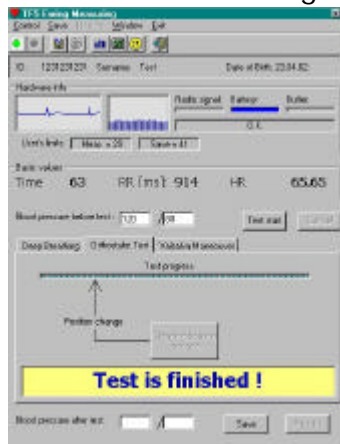
Notice: *From experience, it is recommended to make three Valsalva tests, and to express the result (the Valsalva ratio) as the mean ratio from the three successive tests (for more details see also Ewing DJ: The Value of Cardiovascular Autonomic Function Tests: 10 Years of Experience in Diabetes; Diabetes Care, 1985, 5: 491-498).*

8.2.2. Ewing Battery: How to Perform the Orthostatic Test

Whilst the subject is lying on the bed, measure his BP and – after choosing the '**Orthostatic test'** option -- enter the values into the fields '**Blood pressure before the test**'. Click the '**Start**' button and wait for 10 sec (see the description above).
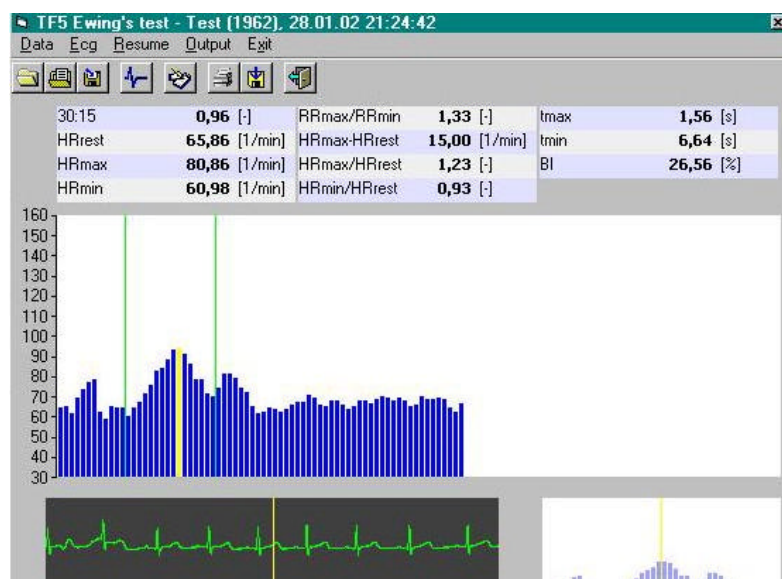
After this preparatory phase, a message '**Stand up**' appears, paralleled by a voice command. After the subject finished the change of his position and is quietly standing, click the button '**Standing position reached**'. The subject stands until the automatic ending of the test. The examiner (repeatedly) measures the blood

pressure throughout the test. It is highly recommended to enter the blood pressure values into the program at the beginning and end of the test, as indicated on the screen. Finally, a confirmation '**Test is finished**' appears/is heard, while you save the data immediately, by clicking the '**Save**' button to be found below on the screen left.

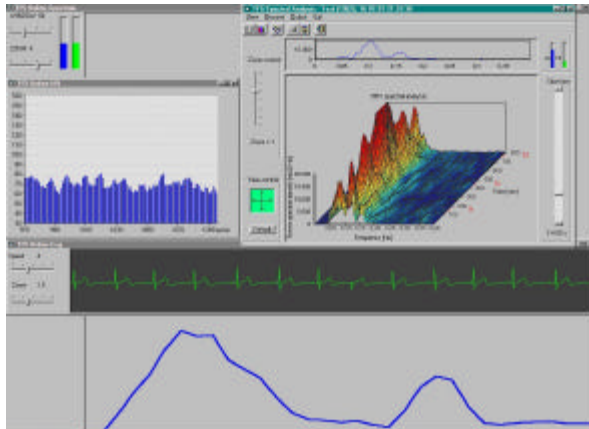### Relevant parameters: Orthostatic test

30:15 Ratio	Ratio of heart rates around the 30th & 15th beat
HR rest	Rest heart rate
HR max	Maximal heart rate
HR min	Minimal heart rate
HR max / HR min	Ratio maximal heart rate vers. minimal one
HR max - HR rest	Difference maximal heart rate minus rest
HR max / HR rest	Ratio maximal heart rate vers. rest
HR min / HR rest	Ratio minimal heart rate vers. rest
BP pre	Blood pressure value during lying down
t max	Timepoint of maximal heart rate
t min	Timepoint of minimal heart rate
BI	Brake Index
BP post:	Blood pressure value after standing up

9.1. Some Practical Examples

Below you can find some examples to show the versatility of applications and use of the TF5 program just to help you in finding appropriate use of the system:
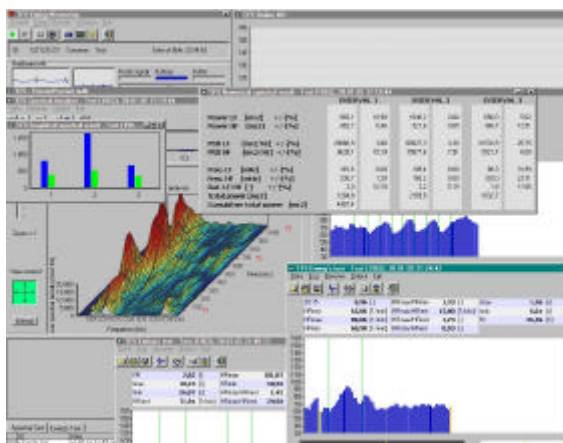
♦ E.g., it is possible to revise the previous results, while another examination is running, and to show both paralelly on the screen.
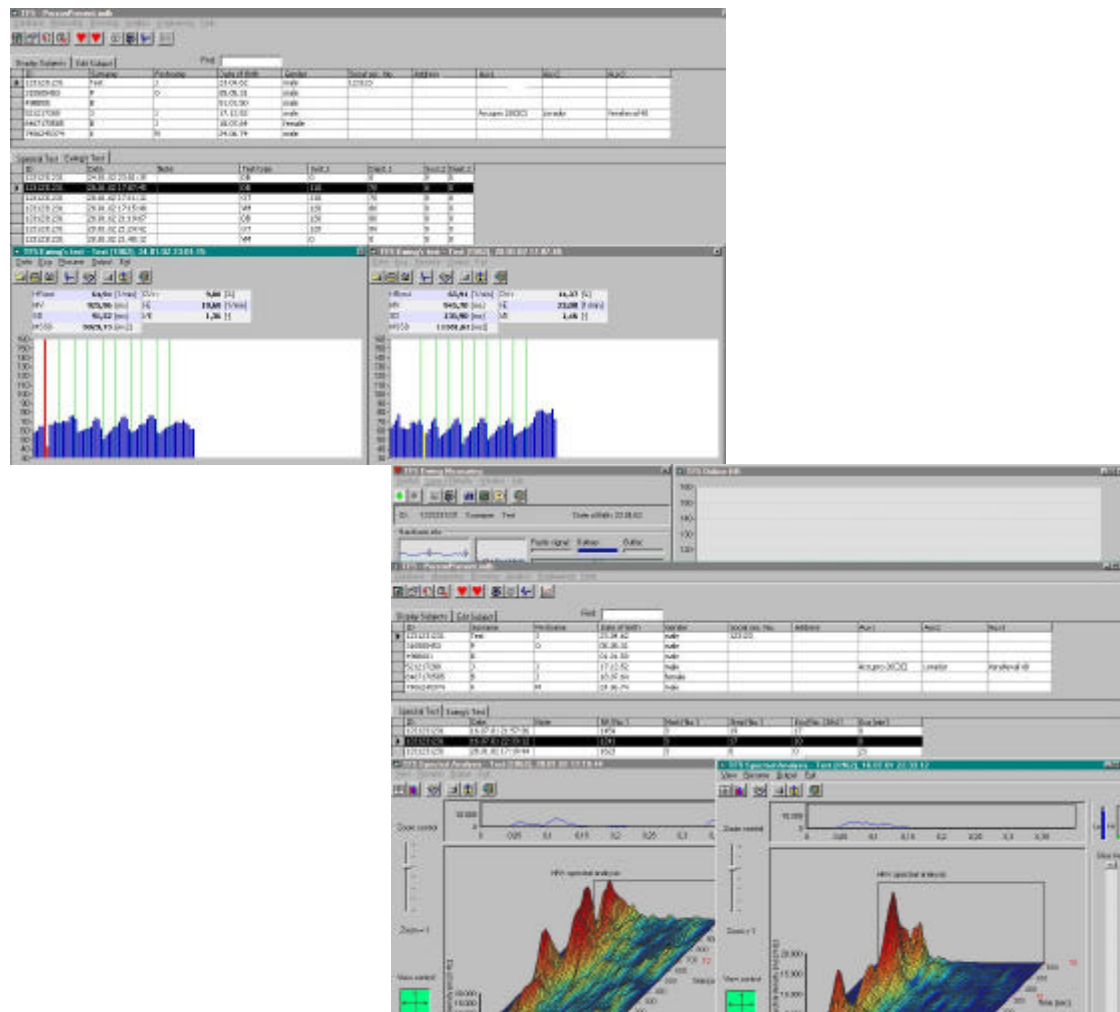

♦ You can display all results of short reflex test (Ewing) battery on one screen, and resize/manipulate the results windows to obtain the best overview.

♦ Also results of both analysis types – Ewing battery and spectral analysis – can be displayed in one screen for better and instant overview of the subject's results.

♦ Progress of the individual test results overt longer time period can be shown e.g., as follows.

9.2. Application Notes

Examination of heart rate variability has considerable potential to assess the role of autonomic nervous system fluctuations in normal healthy individuals and in those with various cardiovascular and non-cardiovascular disorders. Population based clinical trials show that the short-term examination of HRV, particularly in frequency domain, offers relevant prognostic information independent of and beyond that provided by traditional risk factors. Depressed HRV is a predictor of mortality and arrhythmic complications, however, like in any other method, to improve the predictive value HRV can be combined with other factors, e.g. LV ejection fraction in post-myocardial infarction risk stratification etc.
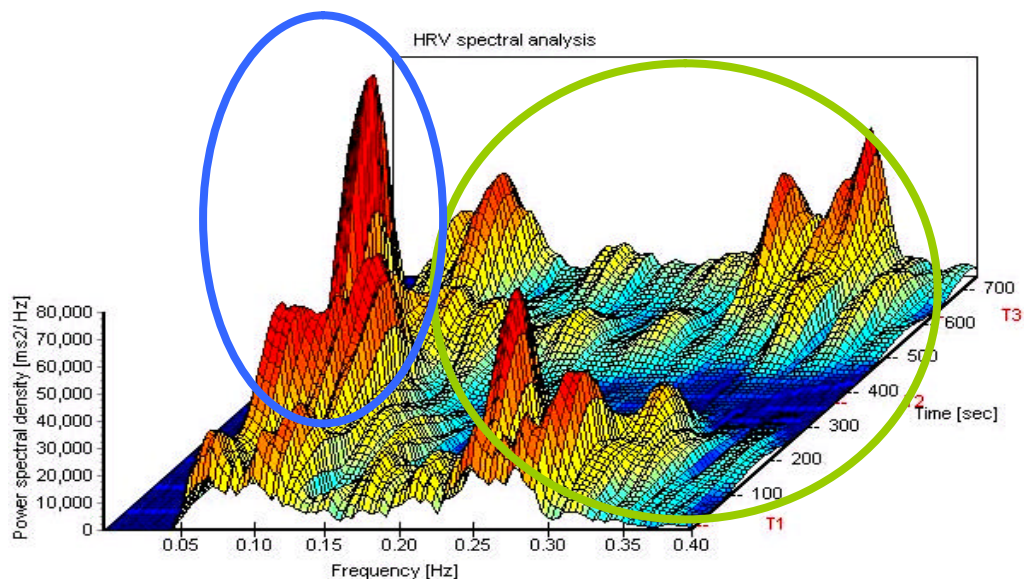
General Picture:

During the modified orthostatic load (provided it is performed as recommended in the user manual) the following characteristics are of particular interest:

(a) Three-dimensional graphics:
■ Total energy contents (fluctuations) of the low and high frequency bands
■ Physiological predominance of both control sub-systems during different positions
■ Reactivity/reflexivity of the system during the standing up and after lying down.
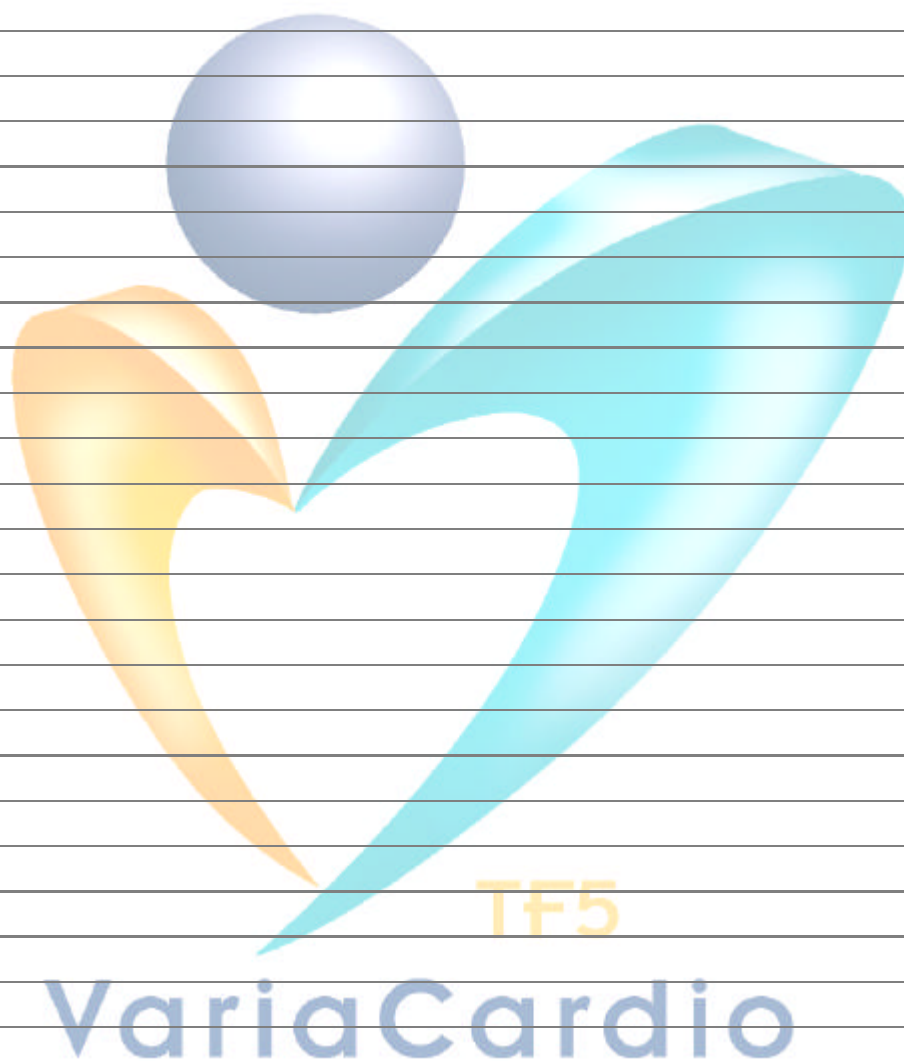
SY(+PASY)   **PASY**

Principally, the area under the fluctuations to the left from 0.15 Hz on the x-axis represents the *sympathetic* activity including probably a certain amount of parasympathetic influence. Fluctuations to the right from the arbitrary limit 0.15 Hz on the frequency axis reflect solely the *parasympathetic* cardiovascular control.

(b) Statistical table:
It is often helpful to compare the visual results with the numerical values as listed in the statistical table (see user manual). Please note that there is a strong relationship between age and normal reference range which considerable diminishes with severity of disturbance (described later in this chapter).

Normally, during supine positions (the first and third time intervals, labelled T1 and T3 on the z-axis) there is a predominance of a parasympathetic tone, as indicated in the above graph labelled "PASY". During standing (position T2), activation of the sympathetic tone can be detected (labelled "SY").

In case of any comments and/or questions, please feel free to contact your distributor, or the manufacturer directly:

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Thank you.