Geratherm®
Respiratory

CPET

User Manual

Version 1.2.2

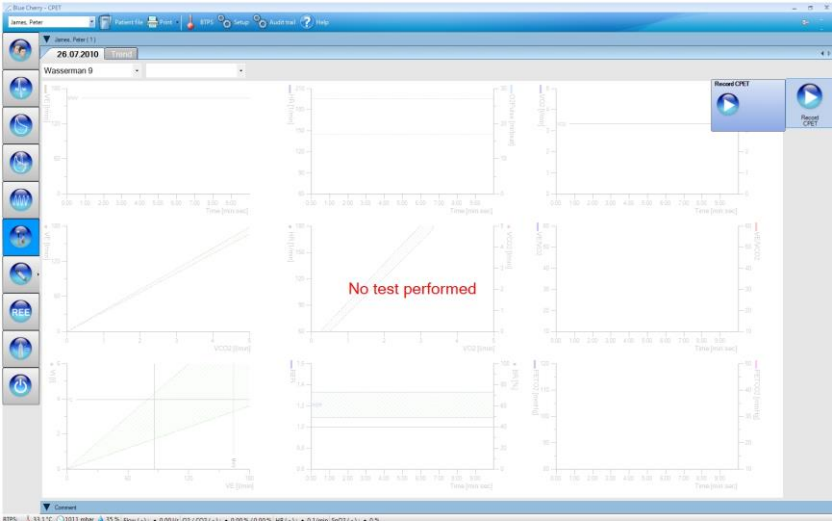
Date: 15th October 2014

1. CPET testing

The Cardiopulmonary Exercise Testing (CPET) refers to the determination of physical performance by measuring the gas metabolism. The interaction of heart, circulation, respiration and metabolism is analyzed during a defined physical exercise. The patient is thereby subjected to a load on an ergometer. Here continuous heart rate, respiratory rate, minute ventilation, oxygen uptake and carbon dioxide output are recorded.

1.1 CPET screen

Selecting the **“CPET”** button from the left selection bar will open the Ergospirometry screen.

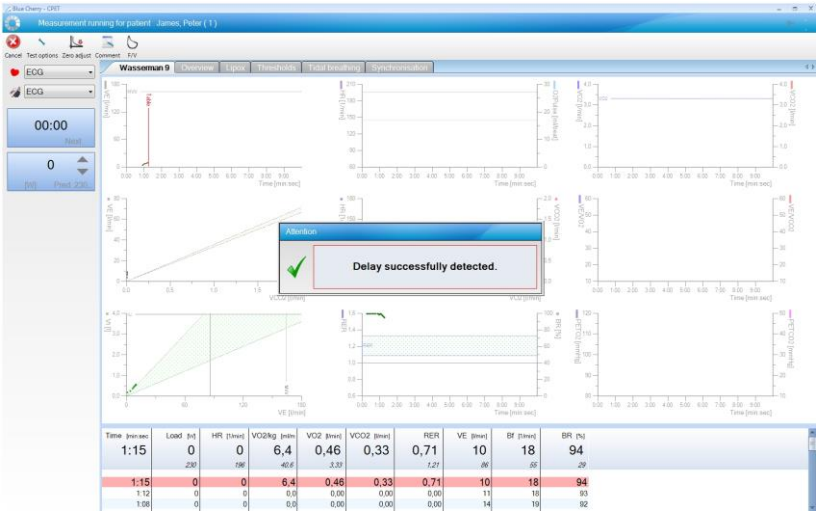


1.2 Prepare for testing

After clicking the **“Record CPET”** button the test will start. Now the Ergoflow sensor can be connected to the mouthpiece or the Mask adapter.

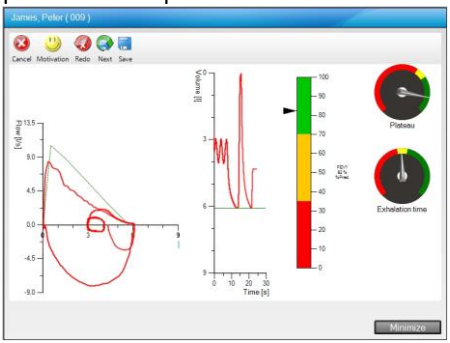
During the Cardiopulmonary Exercise test it is important to ensure a noseclip is used to occlude the subject’s nose and the subject’s mouth should be closed firmly around the mouthpiece to prevent leaks. The patient should be instructed to breathe as evenly as possible during the test and should not speak.

After determination of the zero line the gas signals will be synchronized automatically. A successful synchronization will be notified as shown in the picture below.



1.3 FVC test

Subsequent to the synchronization patient can perform FVC test. After selecting the **"F/V"** button the test will be started. The Patient should then perform a complete FVC manoeuvre.



During the investigation the following buttons are available:

Button	Function
	Cancel – Exit the FV measurement without saving any data
	show incentive graph
	Re-start – Start the measurement again recording no data from this attempt
	Save actual test and start a new measurement
	Save the current effort to the existing investigation file

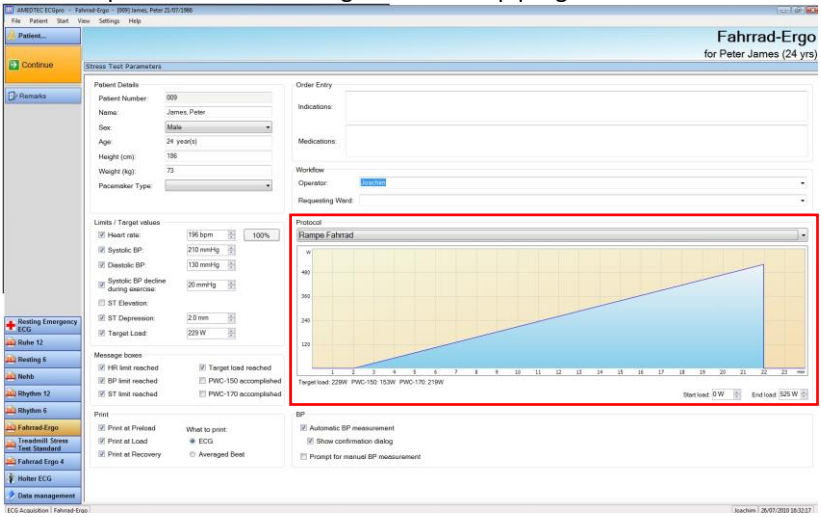
After the FV test has been finished the CPET test screen will be shown again.

1.4 Testing with external ECG

If the Ergostik is connected to an external ECG, Blue Cherry will carry over the patient information and the ECG software will automatically be started on the second monitor.

1.4.1 Selecting the load profile

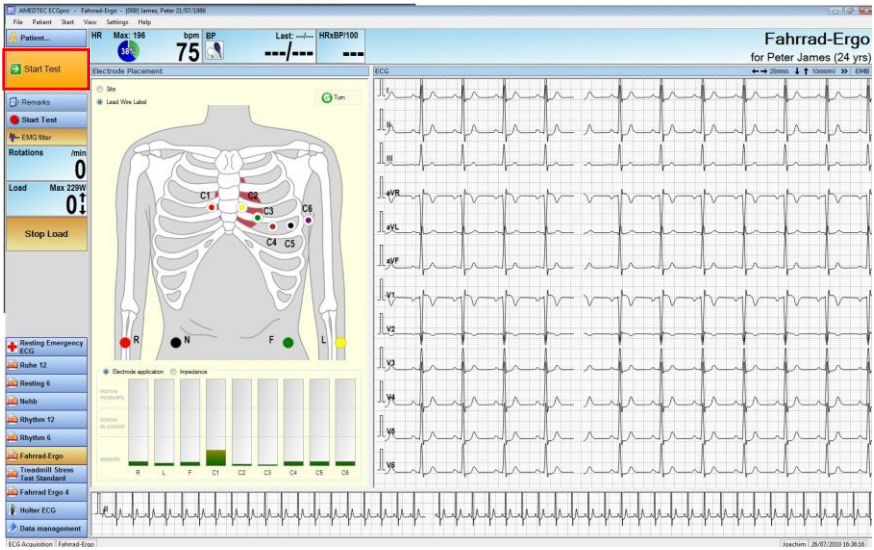
In the profile selection the load protocol for the investigation can be chosen. To control the profile will be shown below in a graphical way. New profiles can be implemented while using the ECG setup program.



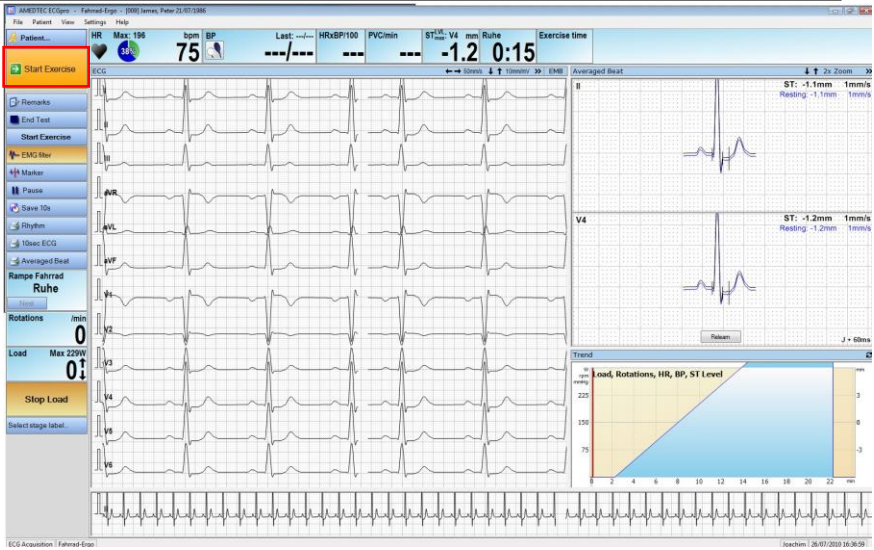
After selecting the **„Continue“** button opens the window to the equipment control.

1.4.2 Start the test

The ECG screen is now showing the hook up scheme. This graph indicates where to place the ECG electrodes. Incorrectly applied electrodes blink. Check the ECG traces. Please note, the graphs indicate the hook up quality. The bar diagram has 3 areas; lower part, indicating good ECG quality / middle part, indicating possibly need to be improved / upper part, indicating must be improved.
High bar signal is indicating that the skin contact needs to be improved. Please note, the acquisition quality mainly depend on the electrode application.



After selecting the **„Start Test“**-button the examination will start with the resting phase.



After determination of the averaged beat and the resting blood pressure user can continue the examination by selecting the „Start Exercise“-button. This will start the load phase.

1.4.3 Screen view during testing

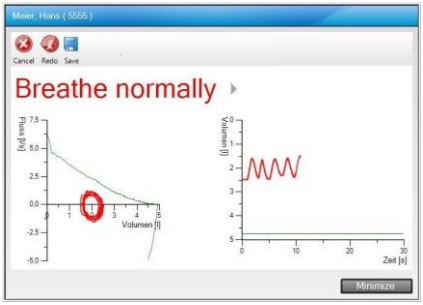
During examination the exercise screen will show the 9 Wasserman plot. Additional screen views are available while selecting the file cards besides „Wasserman 9“.

User can influence the examination while using the tool bar on the top of the screen. It is possible to enter comments, events, blood pressure and borg index. In addition Blue Cherry allows to set a marker for arterial blood gas event and to perform tidal breathing manoeuvre during exercise.

	The **"Cancel"** button will end the current test without saving any of the recorded data. If the cancel button is clicked a security message will be displayed to ensure it is the intention of the user to cancel the investigation.
	Clicking the **"Zero adjustment"** button prevents both Flow and Gas signals being measured and the sensors are set to Zero. The patient can remain connected to the flow sensor.
	Clicking the **"Comments"** button opens a window where comments can be added. It is possible to type in new comments or to add pre-defined comments by clicking the **"Pre-defined"** button
	Clicking the **"Borg"** button opens a simple selection field for the input of the subject's current Borg score. It is possible to configure the Borg scale in the Blue Cherry Setup.
	Clicking the **"Blood pressure"** button will open a short input field, allowing the enty of the current systolic and diastolic Blood pressure values.
	Clicking on the **"Blood gas"** button will depending on the configuration set a marker or open a short input window allowing the entry of the current Blood gas values. The displayed blood gas parameters can be changed in the Blue Cherry Setup
	Clicking the **"Event"** button opens an input window. The event types of blood pressure, blood gas and Borg are available.
	Clicking the **"Tidal Volume"** button opens the TV measurement screen allowing the user to record tidal breathing values during exercise.

This investigation allows the determination of a dynamic hyperinflation under load. For this flow/volume measurement must be recorded before the load investigation. Under conditions of increasing load the Tidal volume is recorded several times and directly afterwards the IC (Inspiratory capacity) is measured. With flow-limited subjects an increase of the EELV (end expiratory lung volume) is demonstrated with regard to the IC.

Tidal volume | IC manoeuvre

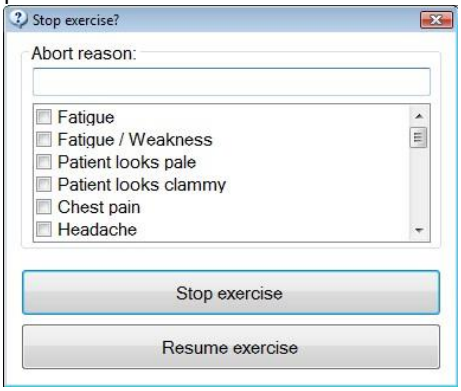


Initially 3 tidal volume curves should be measured followed by a maximum inspiratory measurement. Once this manoeuvre is completed the patient is breathing normally and the measurement can be recorded to the investigation using the **“Save”** button.

1.4.4 Start recovery

Clicking the **“Start Recovery”**-button will stop the load phase and start the recovery phase.

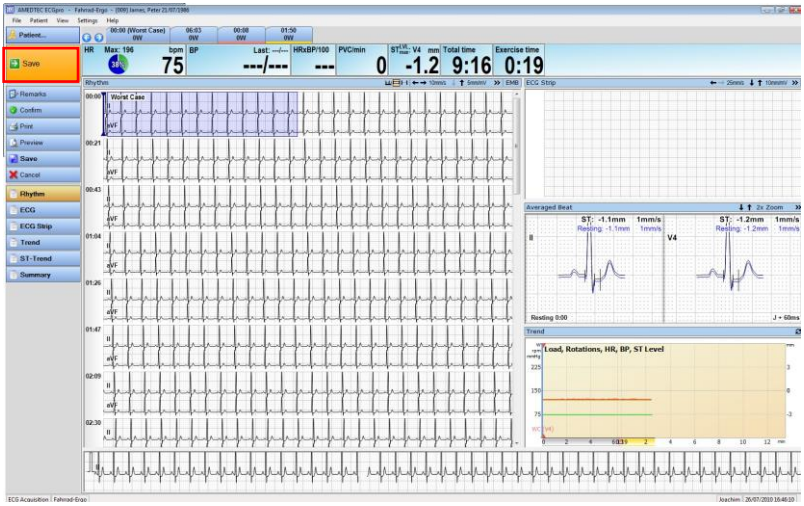
Subsequently the software will ask for the reason to terminate the exercise phase. The most commonly used termination reasons are already predefined and can be selected from a list.



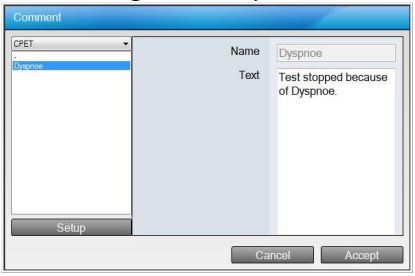
1.4.5 Terminate and save exercise test

After starting the recovery phase the mask and the sensor can be removed. During recovery phase the system will continue to monitor ECG and blood pressure. Clicking the **"End Test"** button will terminate the exercise test.

Selecting the **„Save"**-button will close the exercise text and store all test data into the database. This will allow reviewing the stress ECG data at any time.



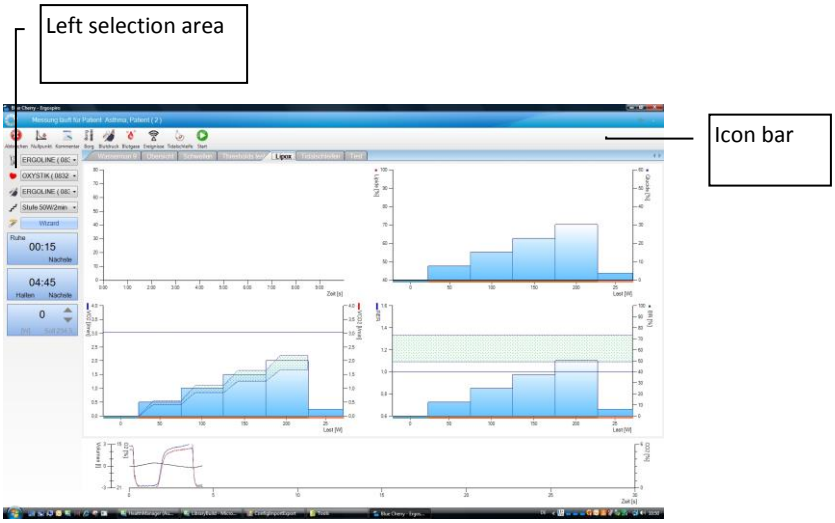
With the exit from the ECG program the spirometry measurement is closed automatically and the exercise screen will ask for the reason of termination. After clicking the "Accept" button the saved investigation will be displayed.



1.5 Testing without external ECG

Alternatively Blue Cherry allow also to run cardio pulmonary exercise tests on a single monitor screen while using an internal or external source for heart rate detection.

1.5.1 Equipment selection



In the left selection area the following buttons are available to select the equipment used during CPET testing. User can select the Ergometer, the heart rate and the blood pressure device.

	Clicking on the drop down menu for ergometer selection will reveal a list of the available ergometers for the investigation.
	Clicking the Heart rate source drop down menu will reveal a list of the available sources for recording Heart Rate during the investigation
	Clicking the Blood pressure source drop down menu will reveal a list of the available sources for recording Blood pressure during the investigation

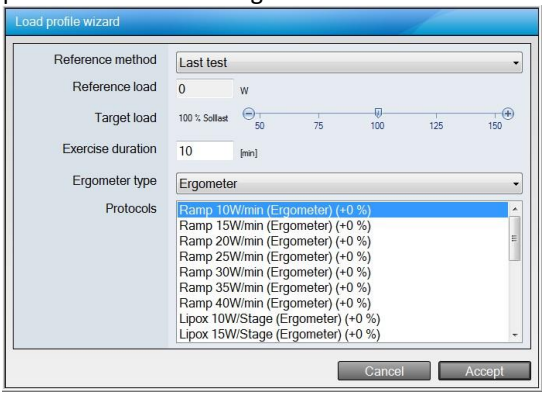
1.5.2 Selection of protocol

	Clicking the drop down menu for protocol selection reveals a list of the preconfigured protocols available for use during the investigation

A selection of commonly used protocols is available as default within the Blue Cherry software. Selecting New Protocol offers the opportunity to create a specific protocol, further details on this process can be found in the section setup.

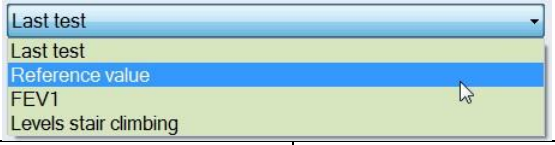
1.5.3 Protocol Wizard

The wizard facility is a useful tool to help the user determine a suitable protocol for the investigation.



Field	Description
Reference method	Selection of the method used for load calculation
Reference load	Input calculated reference load value
Target load	Default target load as percentage of reference load
Exercise duration	Required duration of exercise test
Ergometer type	Selection of ergometer type Ergometer(cycle) or Treadmill
Protocols	Protocols list for the selected Ergometer type. The number in brackets describes the proportional deviation of the achieved load after the given loading period, in the comparison to the target load.

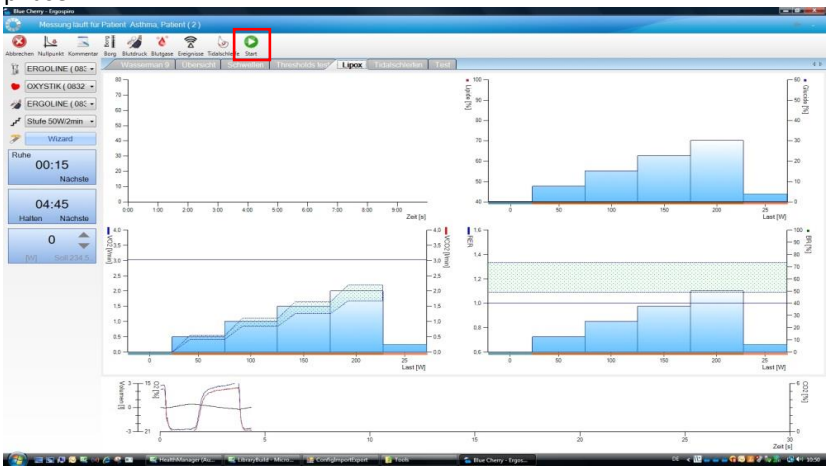
The following options are available for selection of Reference method:



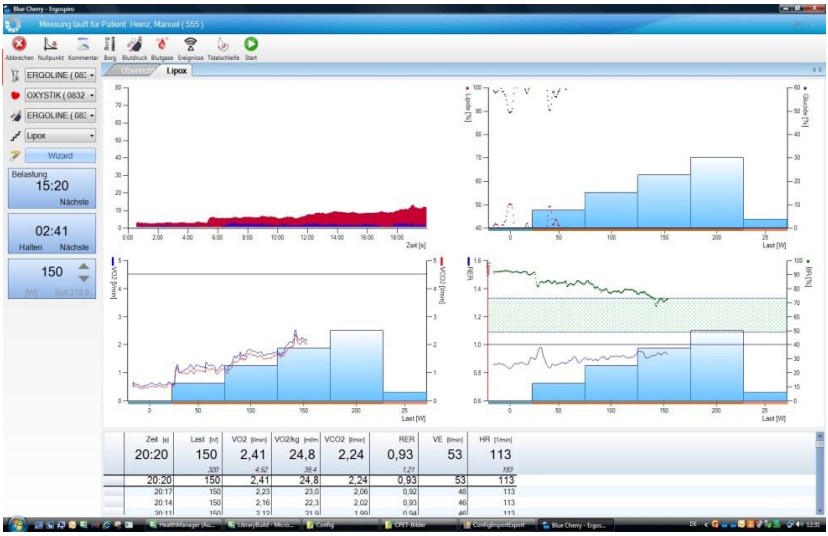
Option	Description
Last test	Reference load value taken from the last exercise test
Reference Value	Reference load value taken from formula used to calculate predicted load
FEV1	Reference load value calculated from best Pre FEV1 manoeuvre of the same day
Levels stair climbing	Reference load value calculated from anamnesis (How many stairs can you climb ?)

1.5.4 Start the test

Clicking the button will start the measurement or move to the next test phase



1.5.5 Screenview during testing



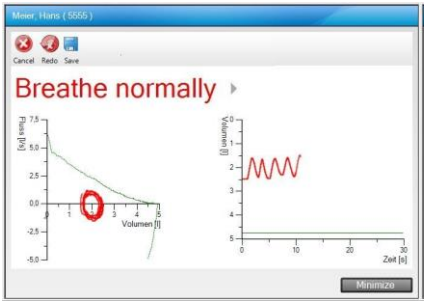
User can influence the examination while using the tool bar on the top of the screen. It is possible to enter comments, events, blood pressure and borg index. In addition Blue Cherry allows to set a marker for arterial blood gas event and to perform tidal breathing manoeuvre during exercise.

	The **"Cancel"** button will end the current test without saving any of the recorded data. If the cancel button is clicked a security message will be displayed to ensure it is the intention of the user to cancel the investigation.
	Clicking the **"Zero adjustment"** button prevents both Flow and Gas signals being measured and the sensors are set to Zero. The patient can remain connected to the flow sensor.
	Clicking the **"Comments"** button opens a window where comments can be added. It is possible to type in new comments or to add pre-defined comments by clicking the **"Pre-defined"** button
	Clicking the **"Borg"** button opens a simple selection field for the input of the subject's current Borg score. It is possible to configure the Borg scale in the Blue Cherry Setup.

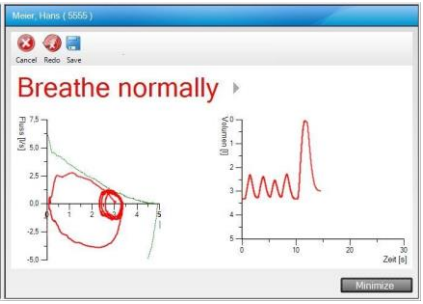
	Clicking the **"Blood pressure"** button will open a short input field, allowing the entry of the current systolic and diastolic Blood pressure values.
	Clicking the **"Blood gas"** button will depending on the configuration set a marker or open a short input window allowing the entry of the current Blood gas values. The displayed blood gas parameters can be changed in the Blue Cherry Setup
	Clicking the **"Event"** button opens an input window. The event types of blood pressure, blood gas and Borg are available.
	Clicking the **„Start"** button will start the measurement or switch to the next load phase.
	Clicking the **"Tidal Volume"** button opens the TV measurement screen allowing the user to record tidal breathing values during exercise.

This investigation allows the determination of a dynamic hyperinflation under load. For this flow/volume measurement must be recorded before the load investigation. Under conditions of increasing load the Tidal volume is recorded several times and directly afterwards the IC (Inspiratory capacity) is measured. With flow-limited subjects an increase of the EELV (end expiratory lung volume) is demonstrated with regard to the IC.

Tidal volume



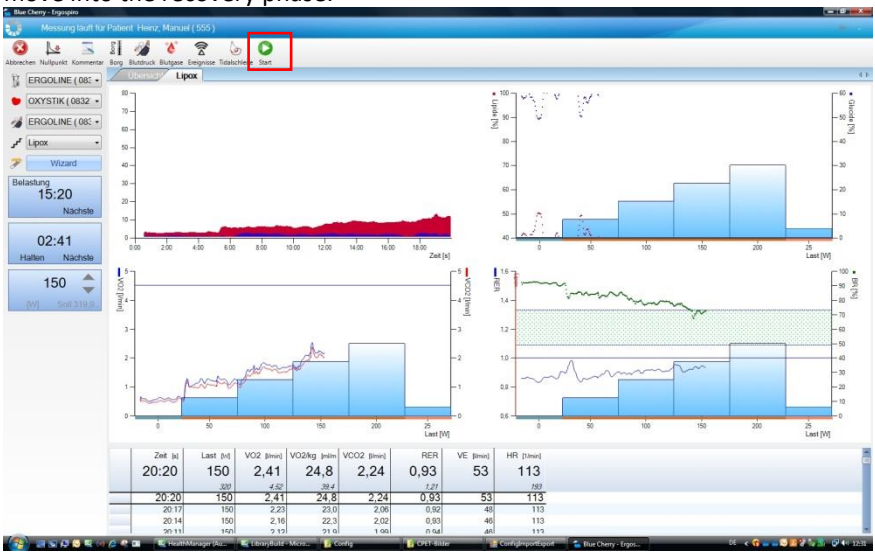
IC manoeuvre



Initially 3 tidal volume curves should be measured followed by a maximum inspiratory measurement. Once this manoeuvre is completed the measurement can be recorded to the investigation using the **"Save"** button.

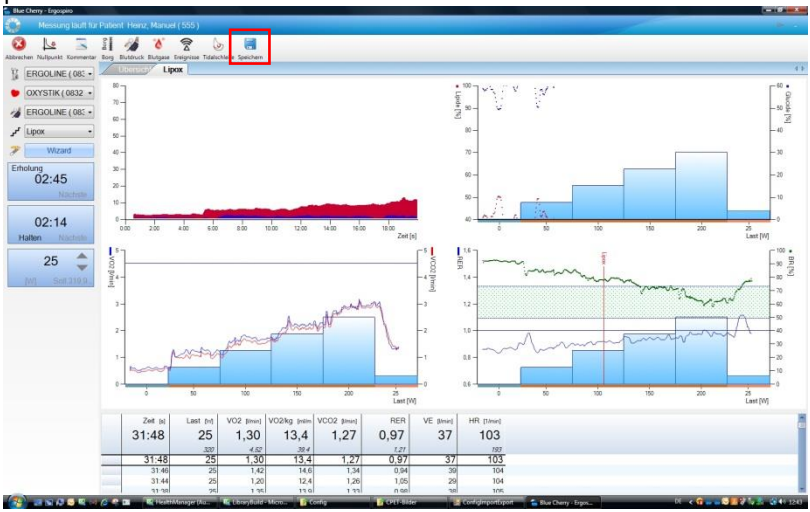
1.5.6 Start recovery

While using the “Recovery” button Blue cherry will stop the load phase and move into the recovery phase.

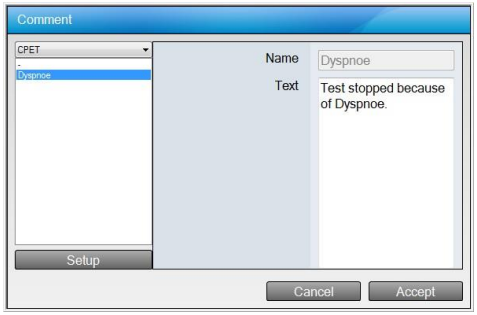


1.5.7 Terminate and save exercise test

After starting the recovery phase the mask and the sensor can be removed. During recovery phase the system will continue to monitor HR and blood pressure.

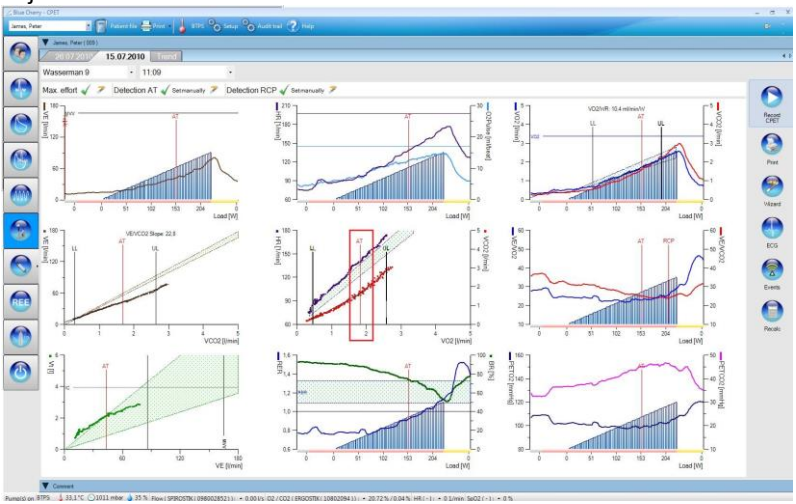


Selecting the „Save“-button will close the exercise text and store all test data into the database. This will allow reviewing test data at any time. Subsequently after terminating the program will ask for the reason of termination. Enter or select the reason of termination from the list and choose “Accept“ to close this window and the exercise screen will immediately show the test result.



1.6 After the measurement

Once the measurement is completed the following window appears to allow adjustments to be made

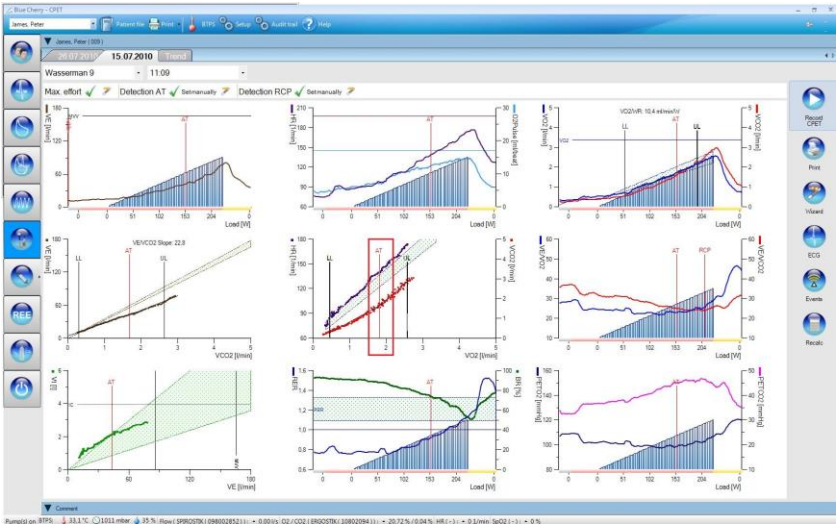


In the right hand selection range the following buttons will be available:

Button	Function
	Start new measurement
	Print results
	Open Wizard to evaluate test results
	Open related stress ECG investigation
	Open the recorded events table
	Perform new re calculation of test results
	Edit the recorded raw data of the test

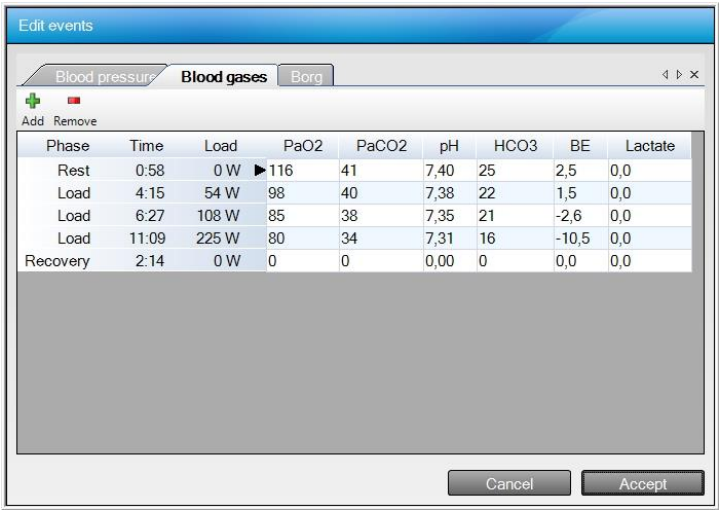
1.6.1 Adjust the test results

In addition to the previous described possibilities Blue Cherry allows to adjust the slope of regression lines and the position of different cursors. As an example in the following the adjustment of the AT (anaerobic threshold) cursor will be described. Even during testing Blue Cherry will automatically detect AT and store the cursor position when saving the test. In many cases it is necessary to adjust the cursor position manually.
As soon as the mouse will be moved close to the AT cursor the mouse pointer will change into a hand symbol. While pressing and holding the left mouse button the position of the cursor can be moved. Please note, this will move the cursor in all graphs and change the results of the threshold table as well.



1.6.2 Enter arterial blood gas values

After pressing the **„Event“**-button the following window will be shown.

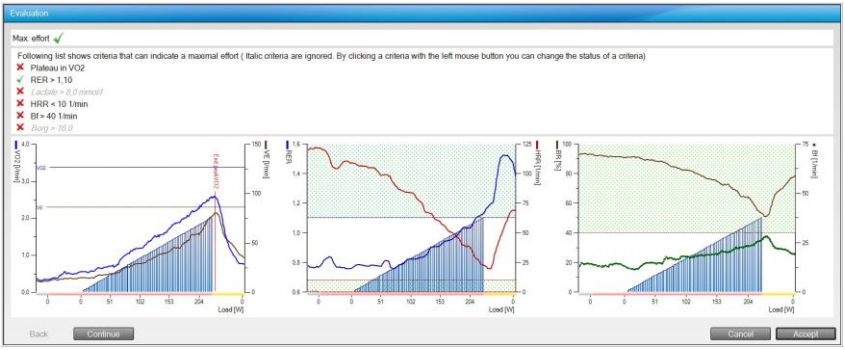


All events marked during testing will be shown on the screen. The user has the possibility to edit, add and delete events.

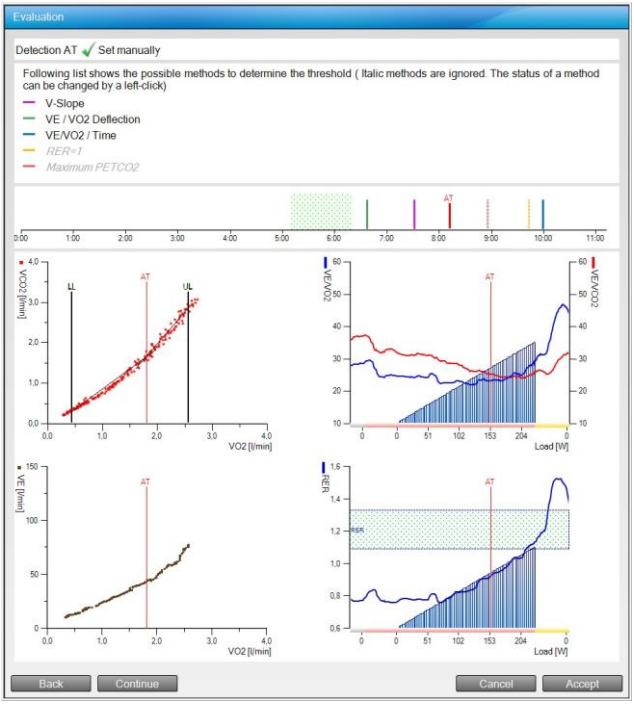
After selecting the file card **„Blood gases“** it is possible to enter the results of arterial blood gas analysis into the appropriate fields. The setup of Blue Cherry allows configuring the parameters. Press the „Accept“-button to close the event window and store the entered values.

1.6.3 CPET-Wizard

In order to simplify test evaluation Blue Cherry has an integrated CPET Wizard.
This software tool is allowing test analysis with regards to maximum effort, AT (anaerobic threshold) and RCP (respiratory compensation point).
After selecting the “Wizard”-button Blue Cherry will open the following screen to determine whether the patient reached maximum effort during CPET test.



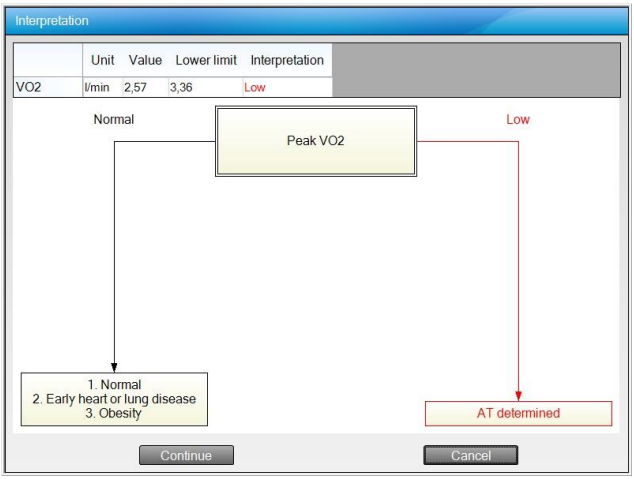
The top of the screen show some criteria indicating the patient reached maximum effort. The green check mark indicates that the criterion was met. However a red cross is showing that the criterion was not met. Clicking on the text can deactivate a criterion, which should not be used to identify maximum effort. This criterion will then be shown in grey and italic. For better evaluation the graph on the bottom side of the screen shows the most important parameters. Depending on setup configuration and test results Blue Cherry will automatically evaluate, if the patient reaches maximum effort during CPET test. The result of this evaluation will be shown in first line of the screen. User can overrule this evaluation by clicking the appropriate symbol in the same line. Selecting the „Accept“-button will close this window and go back to the previous shown screen. After selecting the “Continue”-button the wizard will open the next screen according to the setup configuration. In this example the evaluation for AT.



The AT (anaerobic threshold) wizard is showing 5 different methods and the appropriate cursor position to identify AT. It is possible to deactivate a method by selecting the text with mouse. This method will then be shown in grey and italic. For each method in the middle of the screen the appropriate cursor will be shown. Red cursor is indicating the AT cursor position. For better evaluation the graph on the bottom side of the screen shows the most important parameters. Selecting the „Accept“-button will close this window and go back to the viewing screen. Depending on the setup configuration the wizard will open the RCP or the Interpretation screen after selecting the “Continue”-button. The functionality of the RCP screen is equivalent to the AT determination screen.

1.6.4 Interpretation

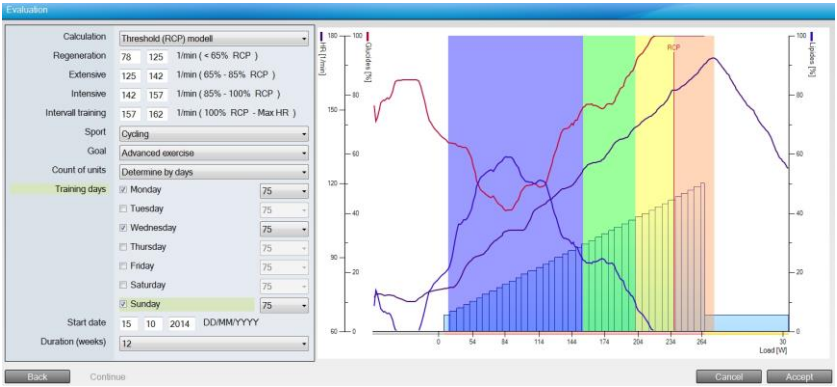
In order to assist CPET testing interpretation the interpretation algorithm according to Karlman Wasserman (Principle of exercise testing and interpretation 3rd edition) has been implemented into Blue Cherry.
Simply follow the decision tree until a suggestion for test interpretation has been found. It is then possible to store the interpretation text into the Blue Cherry comment field. In the tree diagram you need to decide for the left or the right path by selecting the appropriate arrow line. In order to help during interpretation user will always find the measured and the predicted values for important parameters on the top of the screen. The **„Continue“**-button will open the next interpretation step.



After the interpretation has been finished select the **„Continue“**-button. Depending on your setup configuration this will open the training planer or close the wizard.

1.6.5 Training planer

As an option Blue cherry can come with an integrated training planer. This software tool will allow creating an individual training plan.
Depending on CPET testing results Blue Cherry has already predefined the training areas. After selecting the sport, the training target, the number of training sessions per week respectively the training days, the start date and the training duration Blue Cherry will automatically create a complete training plan.



The following table will describe the configuration possibilities of the training planer.

Field	Description
Calculation	Selection of method whether the threshold model or the maximum heart rate model will be used to determine the training areas.
Regeneration	Heart rate area for the regeneration training phase (definition see below)
Extensive	Heart rate area for the extensive training phase (definition see below)
Intensive	Heart rate area for the intensive training phase (definition see below)
Interval training	Heart rate area for interval training (definition see below)
Sport	Selection between running and cycling
Goal	Selection of training target. The following is a choice: - Basic exercise - Advanced exercise - Basic amateur sports - Advanced amateur sports
Count of units	Training plan by days or training units per week
Training days	Selection of training days
Start date	Start date for the training plan
Duration (weeks)	Duration of the training plan in weeks

The following table describes the definition of the training areas.

1.6.6 Training areas for cycling

VAT threshold model:

Identifier	Intensity (in % of VAT)
Regeneration	Begin of Load - 100
Extensive	100 - 120
Intensive	120 – 140
Interval-Training	140 – Load at VO2peak

RCP threshold model:

Identifier	Intensity (in % of RCP)
Regeneration	Begin of Load - 65
Extensive	65 - 85
Intensive	85 – 100
Interval-Training	100 – Load at VO2peak

Max. HR model:

Identifier	Intensity (in % of max. HR)
Regeneration	Begin of Load – 62.5
Extensive	62.5 – 77.5
Intensive	77.5 – 90
Interval-Training	90 – 100

1.6.7 Training areas for running

RCP threshold model:

Identifier	Intensity (in % of RCP)
Regeneration	Begin of Load – 82.5
Extensive	82.5 – 92.5
Intensive	92.5 – 100
Interval-Training	100 – Load at VO2peak

Max HR Model:

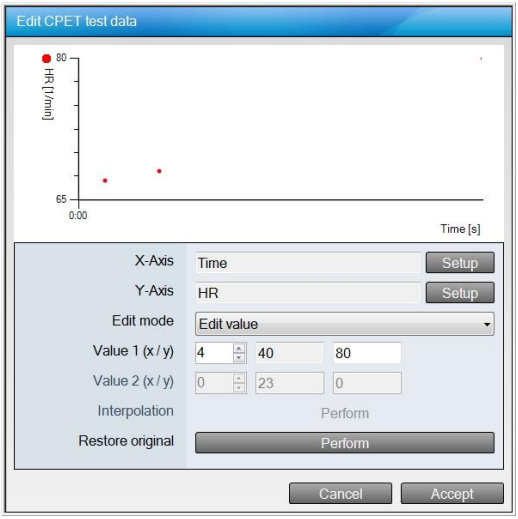
Identifier	Intensity (in % of max HR)
Regeneration	HR at begin of Load - 70
Extensive	70 – 82.5
Intensive	82.5 – 95
Interval-Training	95 - 100

1.6.8 Test recalculation

The button **„Recalculate“** allows discarding all done modifications and going back to the original findings of Blue Cherry.

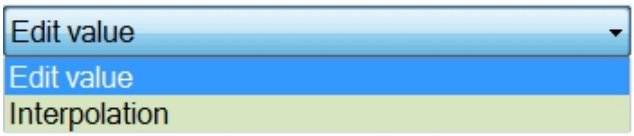
1.6.9 Data editing

The setup of Blue cherry allows activating the **„Data editing“**-button. Clicking the button allows the result values from the investigation to be reviewed and edited with the following possibilities.



Field	Description
X-Axis	Select the parameter for the X-axis
Y-Axis	Select the parameter for the Y-axis
Edit mode	Select handling method
Value 1 (x/y)	Parameter 1 (x and y value, in this example: Time 1:20min and HR 138)
Wert 2 (x/y)	Parameter 2 (x and y value)
Interpolation	Button to start interpolation if edit mode is „Interpolation“
Restore original	Button to discard all done modifications

The following configurations for „Edit mode“ are possible:



Field	Description
Edit value	Enter value manually
Interpolation	Linear interpolation between value1 and value2

1.7 Lipox Measurement

The Lipox measurement facility provides calorimetry measurement where the maximum ‘fat burn’ under rising physical load is determined. The so called LIPOXmax range describes an optimal training range for subjects, with predetermined metabolic disorders. This measurement is predominantly used for nutritional medicine and such specialist areas in practices and hospitals.

All relevant information for the execution of this investigation can be found in the preceding chapters.