Zephyr Technology

OmniSense Analysis Help

OmniSense Help

This is the printed version of the OmniSense Help file.

Content has been optimised for screen display.

In the printed version, page breaks may interrupt continuity.

Printed: April 2016

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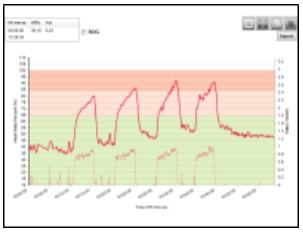
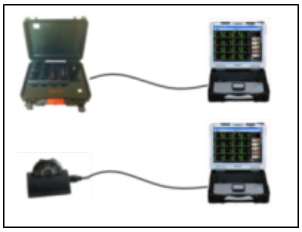
Part 1

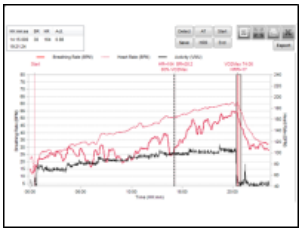
1 Getting Started

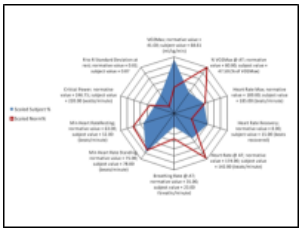
OmniSense Analysis User Guide

Click on the image to jump to the relevant introduction


Graph Display


Importing Logs


Fitness Testing


Reports

New Features

How to use this Guide

You are not connected to the internet - this is a local offline html document

1.1 Contact Zephyr

Contacts

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Zephyr Technology is a Division of Medtronic.

1.2 New Features

OmniSense 4.1 NovemberApril 2016

Logging	Improvements to the BioModule firmware have greatly reduced log

	download times
OmniSense Live	• Miscellaneous minor bug fixes and improvements • An Android/iPhone Readiness application which will receive data from an at-home orthostatic test and email the results to a recipient
BioHarness Module Firmware Version	BioModule 3.0 9800.0153 (BT only) BioHarness3_v1.5.0.0_1G BioModule 3.0 9800.0189v6-v9g (BT + ECHO) BioHarness3_v1.5.0.0_2G BioModule 3.0 9800.0189v9k (BT + ECHO + BLE) BioHarness3_v1.5.0.0_3G

OmniSense 4.0 November 2015

Google Maps	Maps will display if GPS devices are used. An internet connection is required for initial map download. Each subject displayed will be indicated by position and a colored snail trail with location heat map & distance markers
Altitude Zones	For GPS visualization
Parameter List	The expanded parameter list is now reorganized and divided into section which can be expanded or contracted
Accelerometery Variables	A variety of new data variables are available from accelerometry data, updated once per 1 / 2.5 / 5 second epoch. These have been incoporated into the Summary Data Packet, and an Enhanced Summary Log Format
Readiness Test Analysis	Automated Analysis of orthostatic test data, coupled with a user survey to give a 1 - 10 Readiness indication
Markers	Markers can now be added and managed in sessions
Data Filter Wizard	Time data can now be filtered according to its value, or conditional on other parameter values. Filtered data can be saved as a separate session.
Merge Sessions	Sessions can now be merged
Session Timestamps	Can now be edited
Bar graph vertical scales	Configurable
Variables	Categorized for easier management
Filter Session	Default Start and End Date and Time now configurable
OmniSense Live	• Two new ECHO modes to support up to 20 subject at 1 second data rate, or up to 100 subjects at 5 second data rate. Default remains at up to 50 subjects at 2.5 second data rate. • Google Map display • Altitude Zone display • Accelerometry Variables • Audio Workout Support • QStarz BT1300ST compact GPS now supported
BioHarness Module Firmware Version	BioModule 3.0 9800.0153 (BT only) BioHarness3_v1.4.12.0_1G BioModule 3.0 9800.0189v6-v9g (BT + ECHO) BioHarness3_v1.4.12.0_2G BioModule 3.0 9800.0189v9k (BT + ECHO + BLE) BioHarness3_v1.4.12.0_3G
BioHarness Module Log Format	New logging formats incorporating additional accelerometer data • Enhanced Summary

	• Enhanced Summary + Waveform • Enhanced Summary + Development

OmniSense 3.9.6 January 2015

Log Download by Bluetooth	Logs will be downloaded over Bluetooth by the Zephyr Downloader, from devices which are in the OmniSense database, and are powered on. Thus all 50 BioModules in the PSM Training system case may have logs downloaded automatically with no user input after starting.
Impact Angle	Now measured in degrees instead of radians in the Pro Impact Report
Delete Team/Subject	A right click in the Select Session panel will allow you to delete a team or subject and all associated data
Move subject	A right click in the Select Session panel will allow you to move a subject and all associated data to another team
Move session	A right click in the Select Session panel will allow you to move a session to another subject
OmniSense Live	• Rapid allocation to team, and assignment to BioModule and GPS can now be performed automatically using a supported barcode scanner • Add GPS modules to the system by connecting over Bluetooth • Pebble Watch support for latest version BioModule
BioHarness Module Firmware Version	BioModule 3.0 9800.0153 (BT only) BioHarness3_v1.4.5.0_1G BioModule 3.0 9800.0189v6-v9g (BT + ECHO) BioHarness3_v1.4.5.0_2G BioModule 3.0 9800.0189v9k (BT + ECHO + BLE) BioHarness3_v1.4.5.0_3G

OmniSense 3.8.0 September 2014

Clock Bug	In ECHO systems, device clocks are synchronized over-the-air before recording of data starts. This eliminates a bug which showed multiple subjects staring sessions at different times because their BioModule internal clocks were not synchronized
Marker Bug	The solution for the above bug also solves a problem where Markers set in OmniSense Live did not show up in OmniSense Analysis
Subsessions	Batch Subsessions are now supported. Time-based subsessions are also supported
Session Archive	Multiple sessions may now be removed from the OmniSense database, and archived as a single ZSF file, to de-clutter old sessions
OmniSense Live	See OmniSense Live Help for details: • Physiological & Mechanical Intensity 0 - 10 ranges are now configurable • Motorola APX radios are now supported • Session creation using Markers • Training Zones are now configurable using either %HR@AT or % HR_{max} as zone limits. • Training Thresholds can now be set - preset lower limits for Physiological, Mechanical & Training Loads, with an indication they have been achieved
BioHarness Module	BioModule 3.0 9800.0153 (BT only) BioHarness3_v1.3.27.0_1G

Firmware Version	BioModule 3.0 9800.0189 (BT + ECHO) BioHarness3_v1.3.27.0_2G

OmniSense 3.7.15 October 2013

Bug fixes	Various minor bug fixes as reported
Analysis Reports	Support for Chinese language
Impact Processor Tool	Now included in installer. Instructions added to Analysis Help file
Zephyr Config Tool	A new multi-device version of the tool now supplied. Users are required to enter their name to start, and a log file of any reconfigurations is created. Details in OmniSense Live Help.
Zephyr Firmware Updater	A new multi-device version of the tool now supplied. Users are required to enter their name to start, and a log file of any firmware updates is created. Details in OmniSense Live Help.
Time in Training Zone	A new summary graph has been added

OmniSense 3.7.8 April 2013

Minor Bug Fixes	Fix to minor bugs as reported
Zephyr Downloader	Now Supports Summary + GPS mode

OmniSense 3.7.0 January 2013

Windows 8 Support	Database management and charting updates to fix Windows 8 support issue
Minor Bug Fixes	Fix to minor bugs as reported

OmniSense 3.6.1 November 2012

Log Download Support for more than 50 devices	For large ECHO systems, more than 50 devices can be added to the OmniSense database so that logs can be downloaded automatically. Only the first 50 devices will be assigned ECHO Short addresses for radio communication. Any further devices will have a null value for the short address. They cannot be used for streaming data communication by ECHO when thus configured, but can be used in logging mode.

OmniSense 3.6.0 October 2012

Bug Fixes	Various minor bug fixes
Help File	(This file) Update of screen captures, index & omissions.
Default Filter Session Calender Setting	This has been changed to start from 6 months prior to the current date. It was previously 1 year prior.

OmniSense 3.5.1 October 2012

Graph Data Export	Previously only to .csv file; .JPG, .PNG,.GIF, .TIF, .SVG, .PDF now added
Reports	The number of reports has been expanded - subsets of periodization workout, training and GPS data are now available: • Group Consolidated Summary • Periodization • Summary GPS

	• Summary Physiological • Workout Compliance
Autopopulation of reports	Context menu autopopulation of the legend and reports helps streamline creating reports

OmniSense 3.4.18 September 2012

GPS Support	New variables added: Time Variables: Speed over Time, Distance Over Time Summary Variables:Speed Summary, Time in Speed Zone, Distance in Speed Zone, Total Distance Traveled
GPS Support	External kml files can now be generated from sessions in the *Select Session* tree which contain gps data. Right-click and use the context menu.

OmniSense 3.4.5 July 2012

GPS Support	The Zephyr Downloader can now download GPS data from a BioHarness configured to work with a supported GPS device and deposit data into the OmniSense database, as well as generate external kml files

Known Issues

ISM Limitations	OmniSense 3.x continues to support ISM devices, but users should be aware that some data is generated in the device itself, or relayed from an external Bluetooth sensor and if the ISM device does not provide or support it, then the parameter will not be available in OmniSense. In Analysis, *unavailable* parameters include: Heart Rate Recovery (except from a fitness test analysis), Skin Conductivity, Heart Rate Variation, Estimated Core Temperature, Device Temperature, Breathing Rate amplitude/noise/confidence, Jump and Dash Test parameters, SpO2, Blood Pressure , Heart Rate Confidence, System Confidence, Galvanic Skin Response, Bluetooth Link Quality, RSSI & Tx Power.

OmniSense 3.4.3 July 2012

Internal database development	The OmniSense database can now store GPS data imported from a BioHarness 3 log when the device has been used in conjunction with a compatible Bluetooth GPS unit. Displaying the data in the Analysis or live modules is still under development.

OmniSense 3.3.11 June 2012

Summary Variables	Addition of a number of variables associated with the Summary data packet

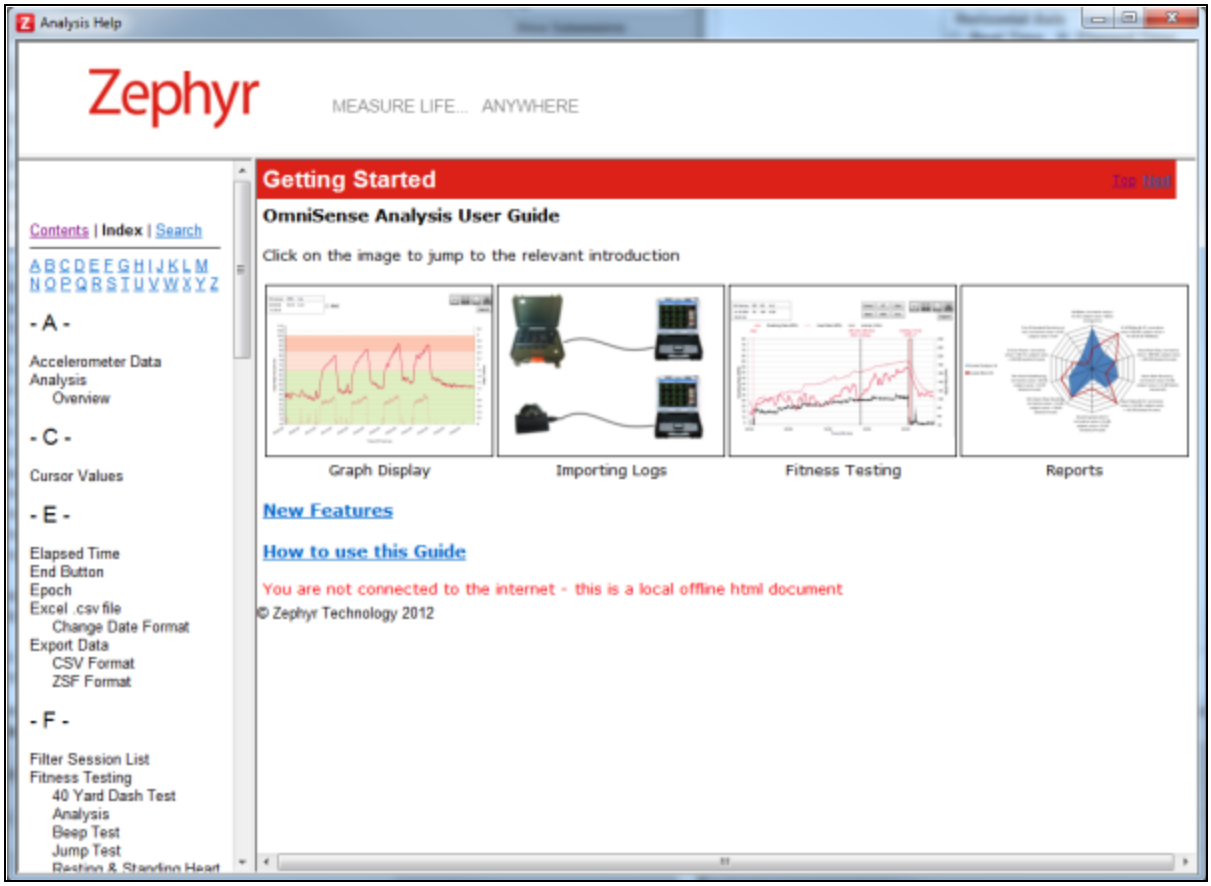
OmniSense 3.3.5 May 2012

Filter Session List	The logic of the filter session pull downs has been improved
Intensity and Load	New parameters for Physiological & Mechanical Load & Intensity

	replace the previous Effort & Exertion Score values. Training Load & Intensity provide an average load & intensity for each session.
Real & Elapsed Time	Sessions can now be displayed against each other in real time. Previously only elapsed time was available, starting all sessions at 00:00:00
DownLoader Tool	This utility can now be used to import data from multiple BioHarness modules simultaneously into the OmniSense database. It is accessed from the Analysis toolbar.

1.3 Using This Guide

If using the Quick Links on the Getting Started page doesn't help, then the quickest way to find information is to use the Index:



- Select the ***Index*** tab on the left-hand navigation panel. Use the Alphabet links to jump to a letter heading - it's quicker than scrolling through the list.
- Use the ***Search*** tab for a specific word search if the Index doesn't provide an appropriate reference
- Use the browser *Back*  button to retrace your path (Keyboard shortcut:  +

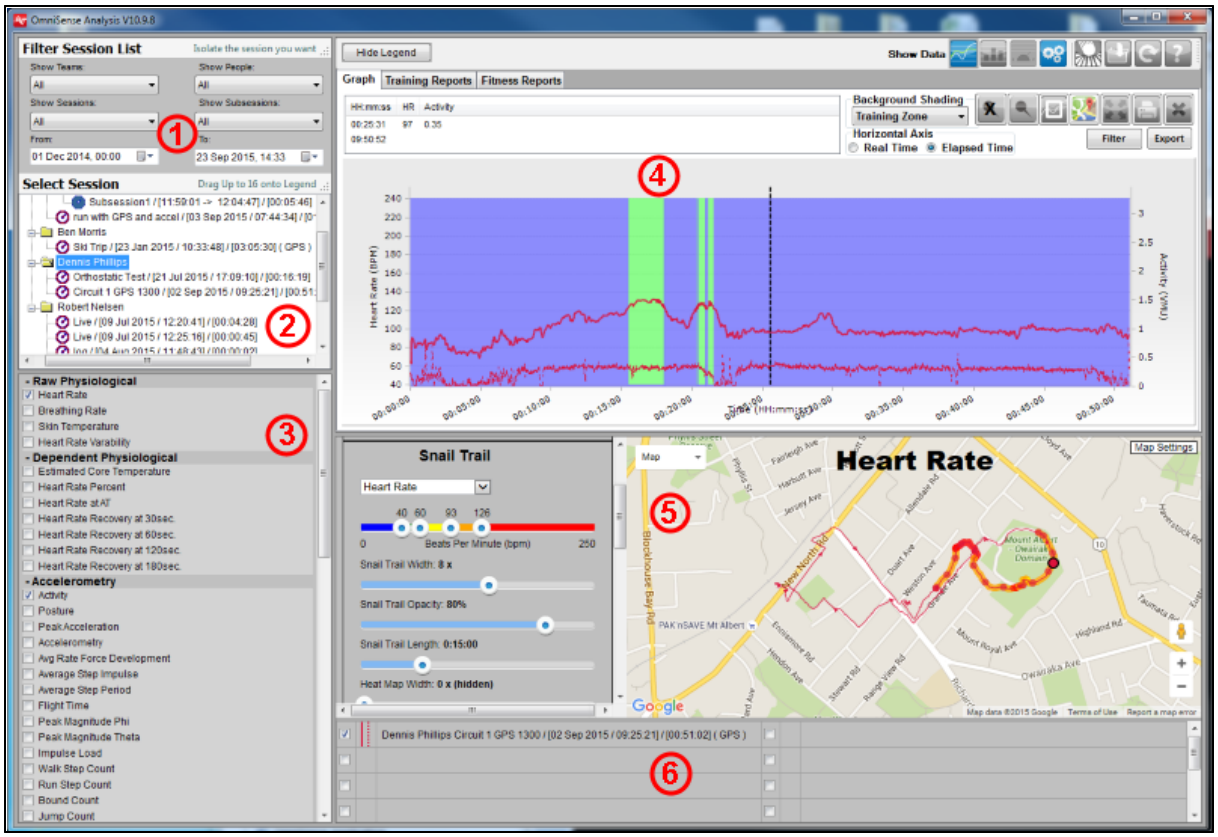

)

- If you have a suggestion to add to the index, email support@zephyrtech.zendesk.com

Note that a HM2GO web server application will run while you are viewing this file, to enable its viewing in Google Chrome browsers.
You are not connected to the internet.

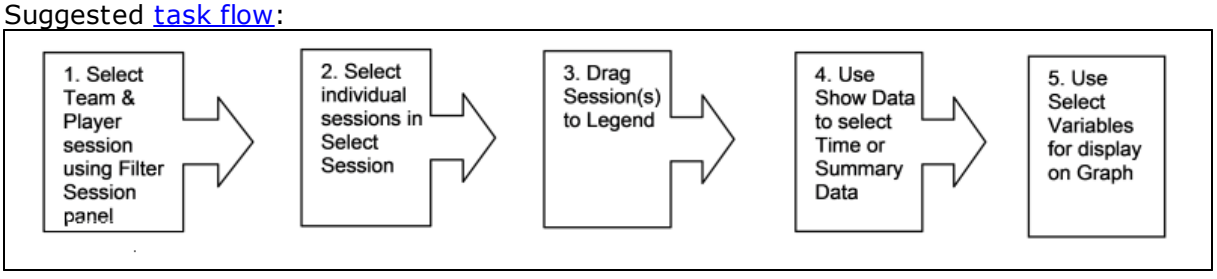
Part 2

2 Overview



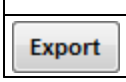
1	**Filter Session List** Use pulldowns to populate the Select Session tree.	**4**	**Graph / Report Panel** The graph - Time, Summary or Readiness data, or display Reports
2	**Select Session** Select Session by double clicking to send to legend. Right-click any session for multiple options	**5**	**Map Display** Use map button to hide or move to a separate Window, as map or satellite view
3	**Parameter List** Select any two parameters to display on graph	**6**	**Legend** List all sessions displayed on graph, by color

Suggested task flow:



2.1 Toolbar Buttons

Buttons are Blue when activated, grey when inactive (not disabled)

	Display Time data – line graphs
	Display Summary data – bar graphs
	Populate the graph panel with the readiness display and associated buttons for the selected session
	Display the Preferences dialogue
	Open the Impact Processor Tool
	Import log data from a device(s), or a .zsf file exported from another instance of Analysis
	Refresh database – used when Live is running simultaneously with Analysis module
	Help – display this guide
	Delete all vertical markers from the selected data session
	Add a vertical marker to the selected data session
	Set subsession – using cursor drag
	Toggle between Map/Satellite view display as a panel in Analysis, as an external window, or hidden. The session should contain GPS data.
	Expand graph panel to full screen
	Print
	Clear all graph and legend entries
	Display a dialogue to filter graphed data. Use any one parameter to exclude others by adding zero values, or interpolating. If the Filter text is red, then filters have been applied to the graphed data.
	Export the graph data as a csv file, or a variety of image files.

2.2 Preferences

The  toolbar button will display a dialogue giving access to a number of settings:

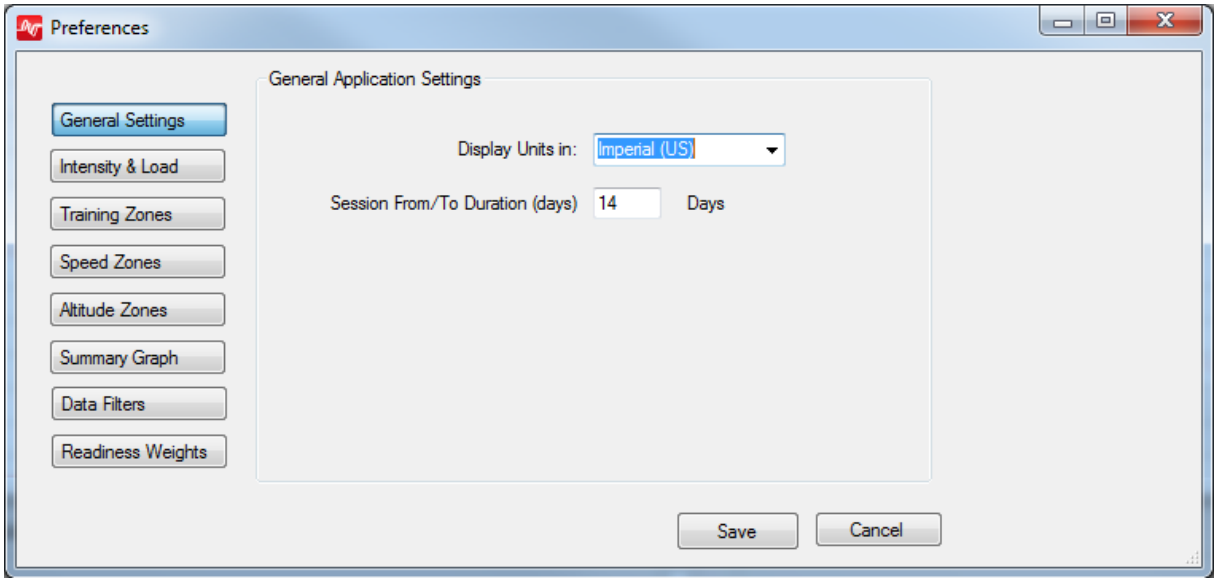
- General
- Intensity & Load
- Training Zones
- Speed Zones
- Altitude Zones
- Summary Graph
- Data Filters
- Readiness Weights

Note: changing any of the following preferences will change the corresponding settings in OmniSense Live:

- Units (Imperial/Metric)
- Intensity & Load
- Training Zones
- Speed Zones

You may need to use the refresh data button  to implement saved changes.

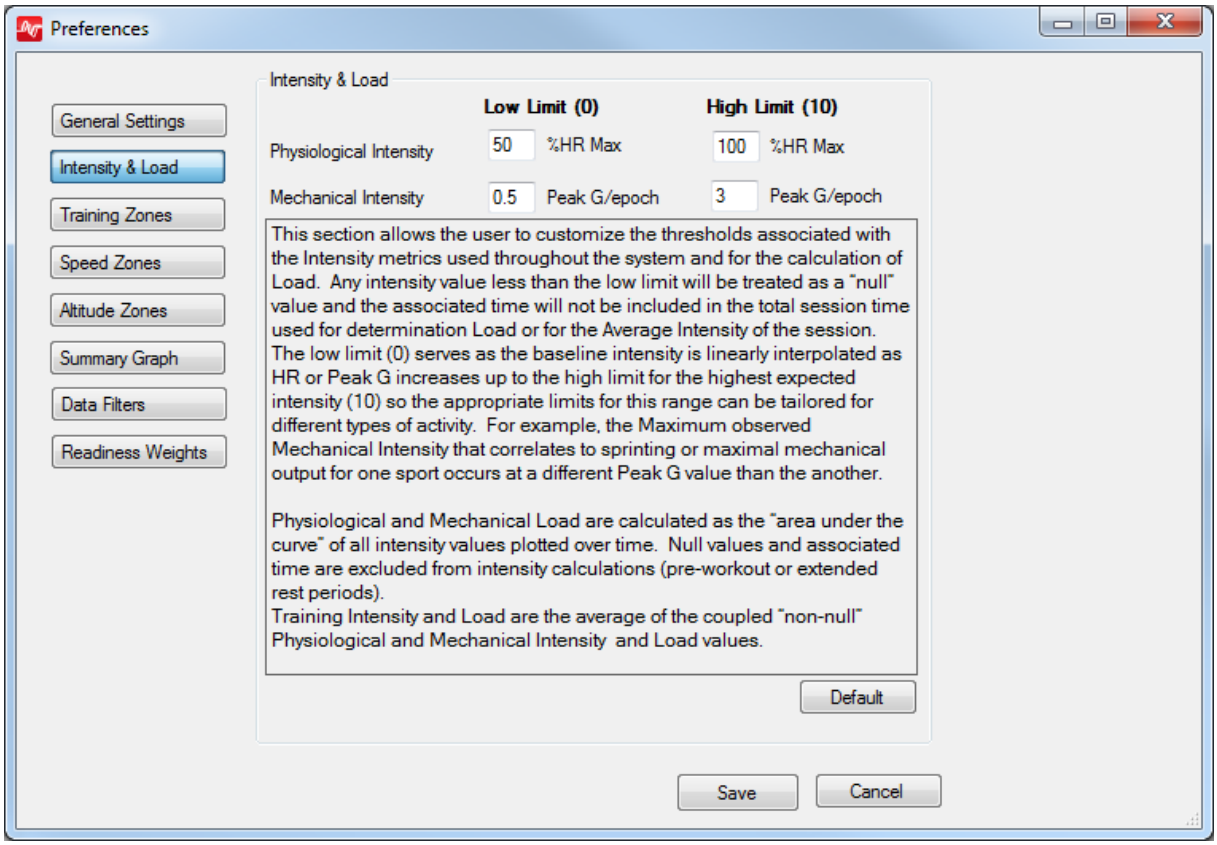
2.2.1 General



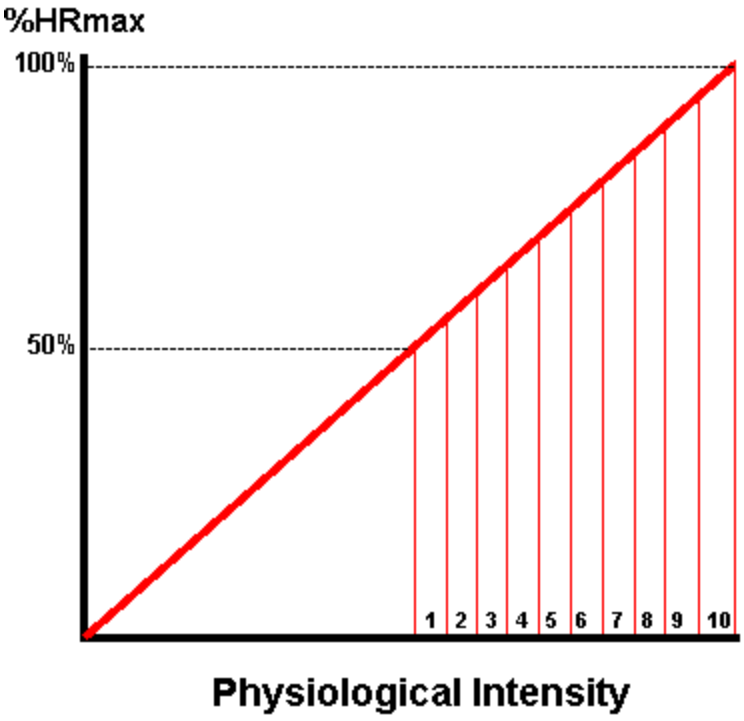
Display Units	Switch between Imperial & Metric units. Will change the corresponding preference in OmniSense Live
Session From / To	Set the default period for session data to display in the Filter Session List. Defaults to 14 days prior to today.

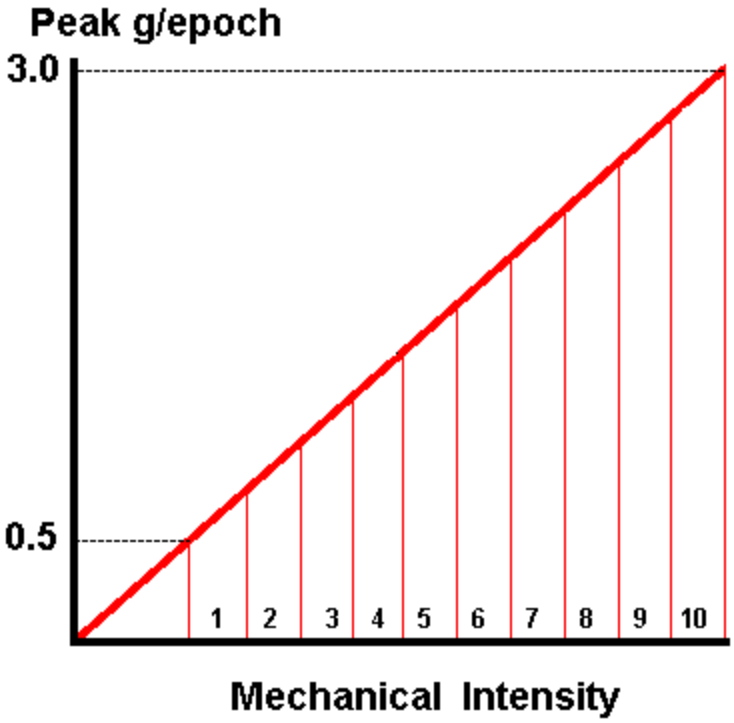
2.2.2 Intensity & Load

- Physiological Intensity is a measure of the effort made by the cardiovascular system, reflected in Heart Rate
- Mechanical Intensity is a measure of the effort made by the musculoskeletal system, reflected in accelerometer data



- Changing thresholds in Analysis will also change the same thresholds in OmniSense Live



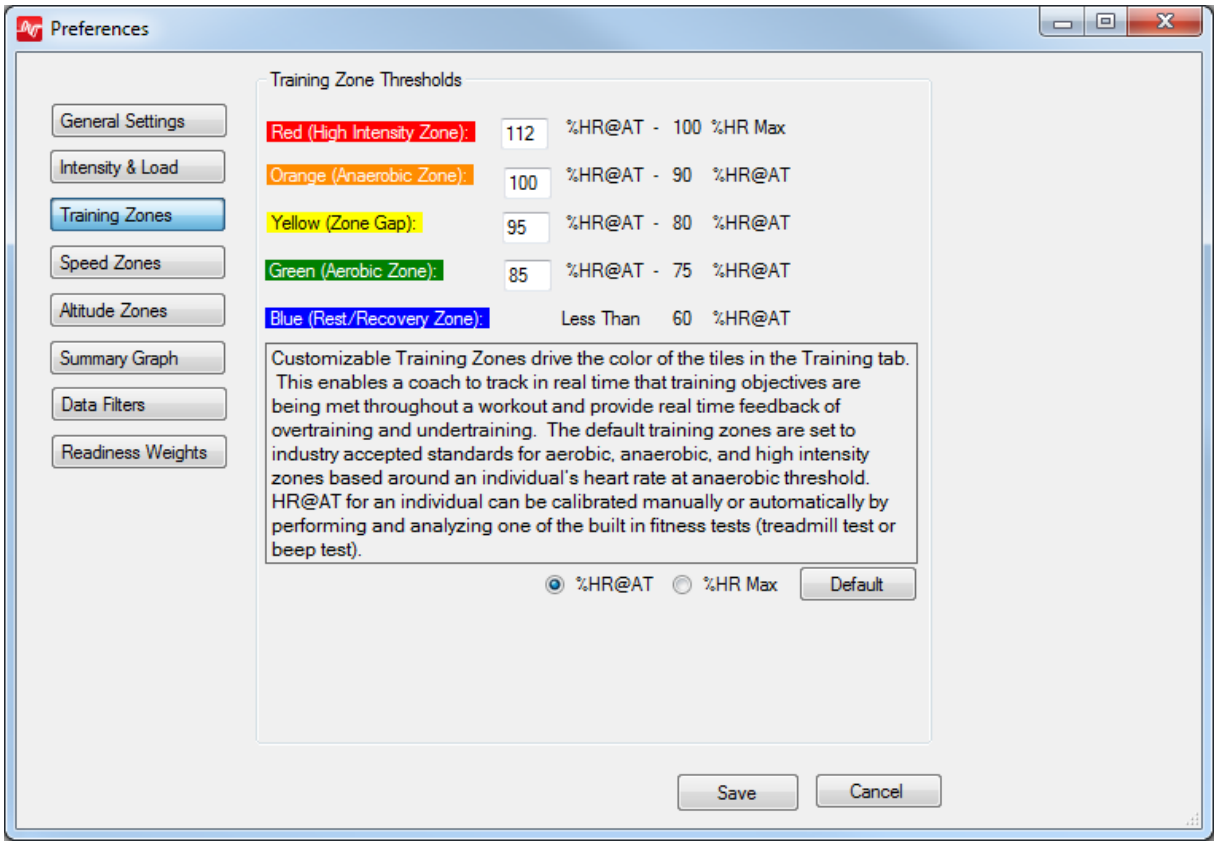


Physiological Intensity	

Low Limit	Below 50% of HR max the physiological intensity has a null (zero) value
High Limit	Between the lower and upper limit, physiological intensity is divided into a 1 - 10 scale of even steps. For default values, each step is 5%, so HR of 50 - 54.9% scores 1, 55 - 59.9% scores 2 etc
Mechanical Intensity	
Low Limit	Below 0.5 Peak G/epoch, mechanical intensity has a null (zero) value. Motion somewhere between a walk and a run will generate this value.
High Limit	Between the lower and upper limit, mechanical intensity is divided into a 1 - 10 scale of even steps. For default values, each step is 0.25g, so Peak G/epoch = 0.5 - 0.47 scores 1, 0.75 - 1.00 scores 2 etc

2.2.3 Training Zones

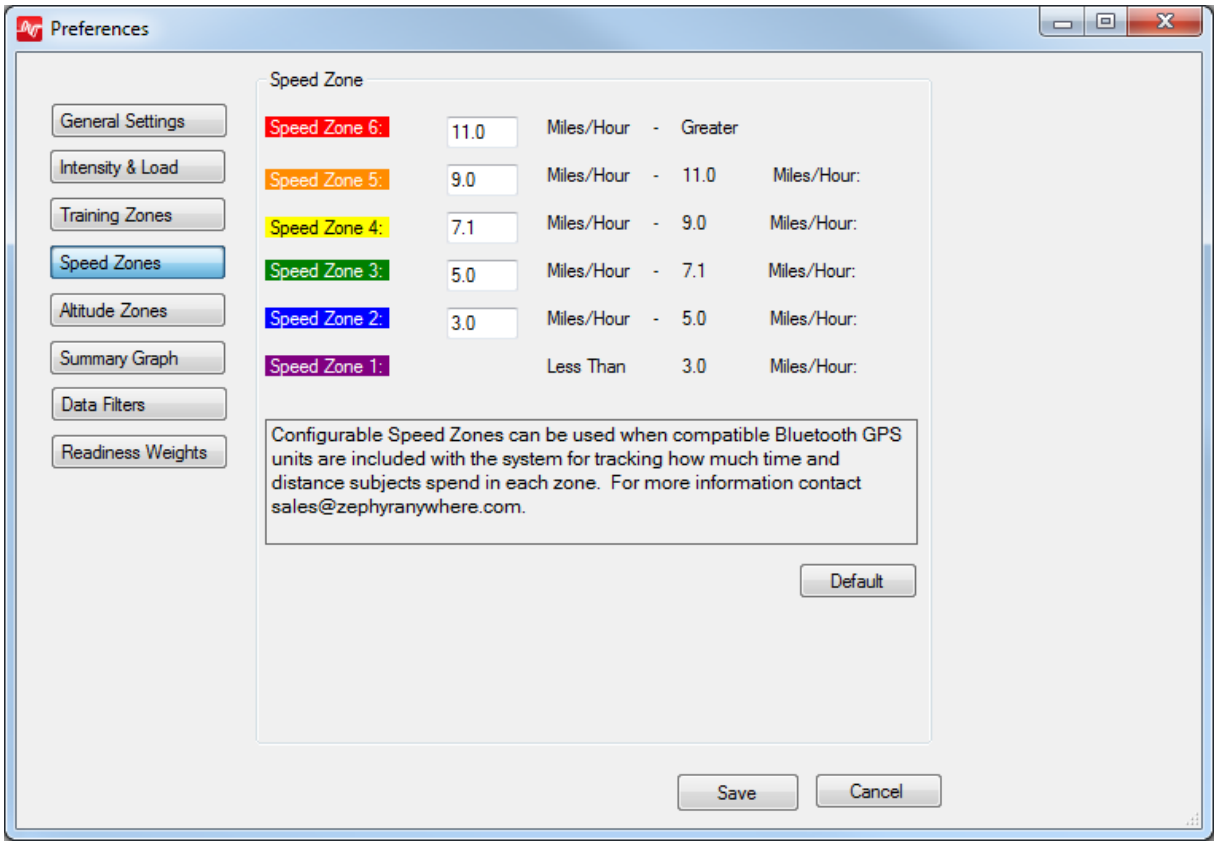
- Training Zones are heart rate zones and color the subject BioGauges in the Training tab in OmniSense Live
- The zone range and color can be referenced to each subject's HRmax, or their HR@AT as determined by a fitness Test



- Training Zones can be displayed as background shading in Time graphs, regardless of whether heart rate is displayed
- Changing zone thresholds in Analysis will also change the same thresholds in OmniSense Live

2.2.4 Speed Zones

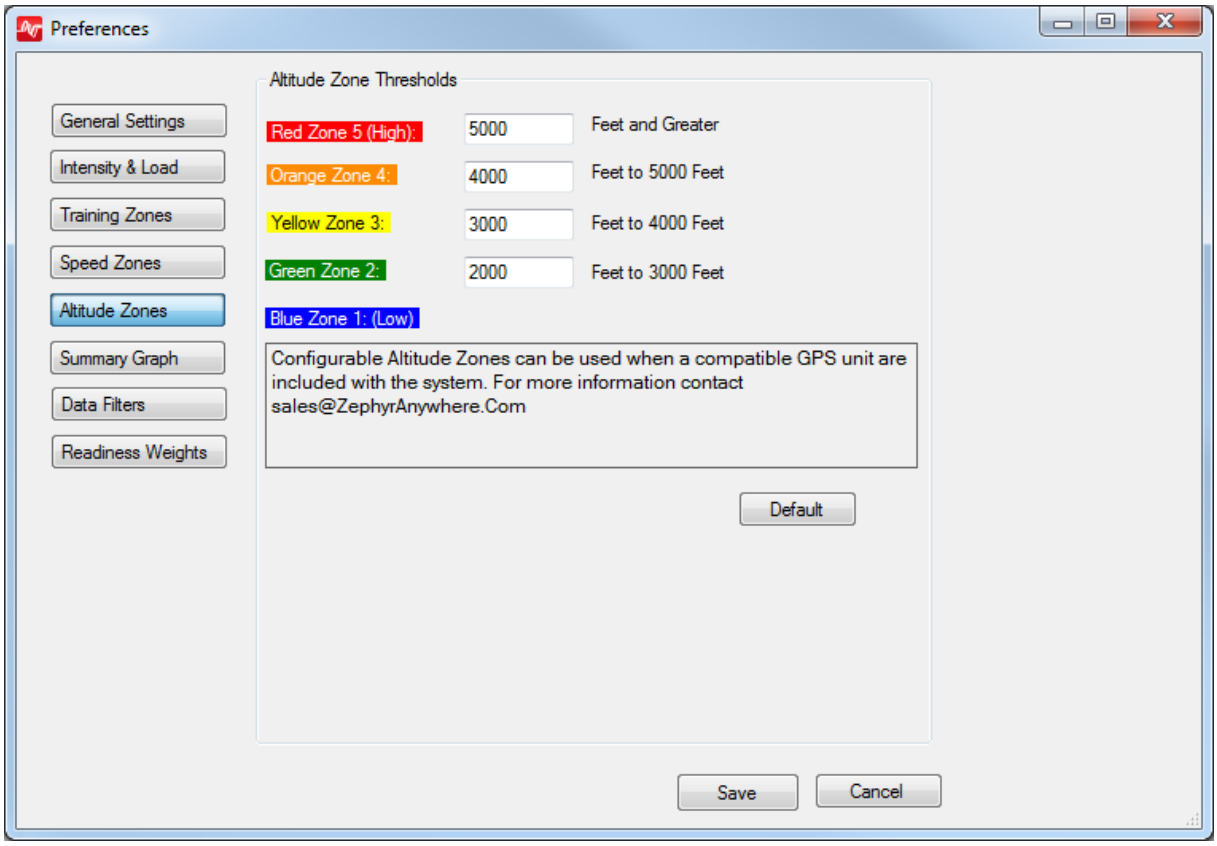
- Speed Zones can only be displayed for session gathered in OmniSense Live, or with BioModules in logging mode, when configured with supported GPS devices.



- Speed Zones can be displayed as background shading in Time graphs, regardless of whether speed is displayed
- Changing zone thresholds in Analysis will also change the same thresholds in OmniSense Live

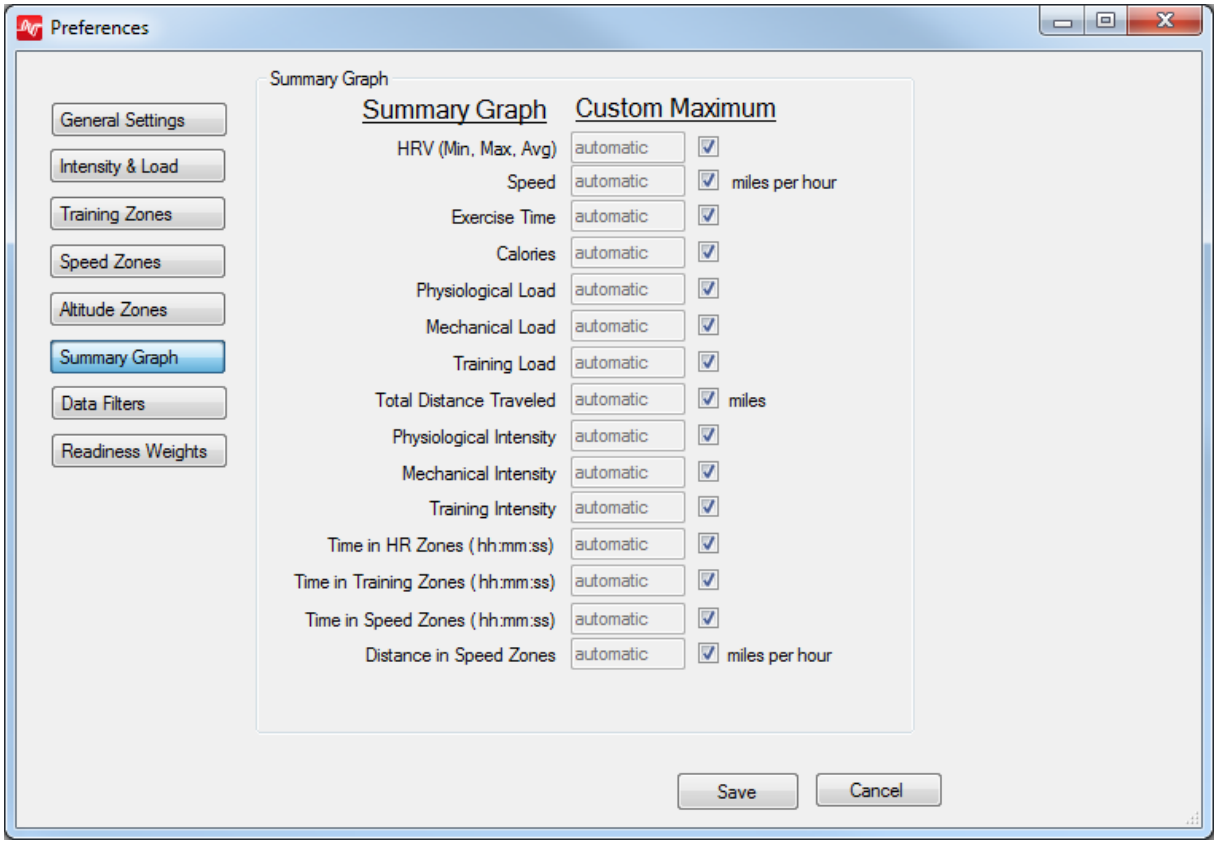
2.2.5 Altitude Zones

- Altitude Zones can only be displayed for session gathered in OmniSense Live, or with BioModules in logging mode, when configured with supported GPS devices.



- Altitude Zones can be displayed as background shading in Time graphs, regardless of whether elevation is displayed

2.2.6 Summary Graph

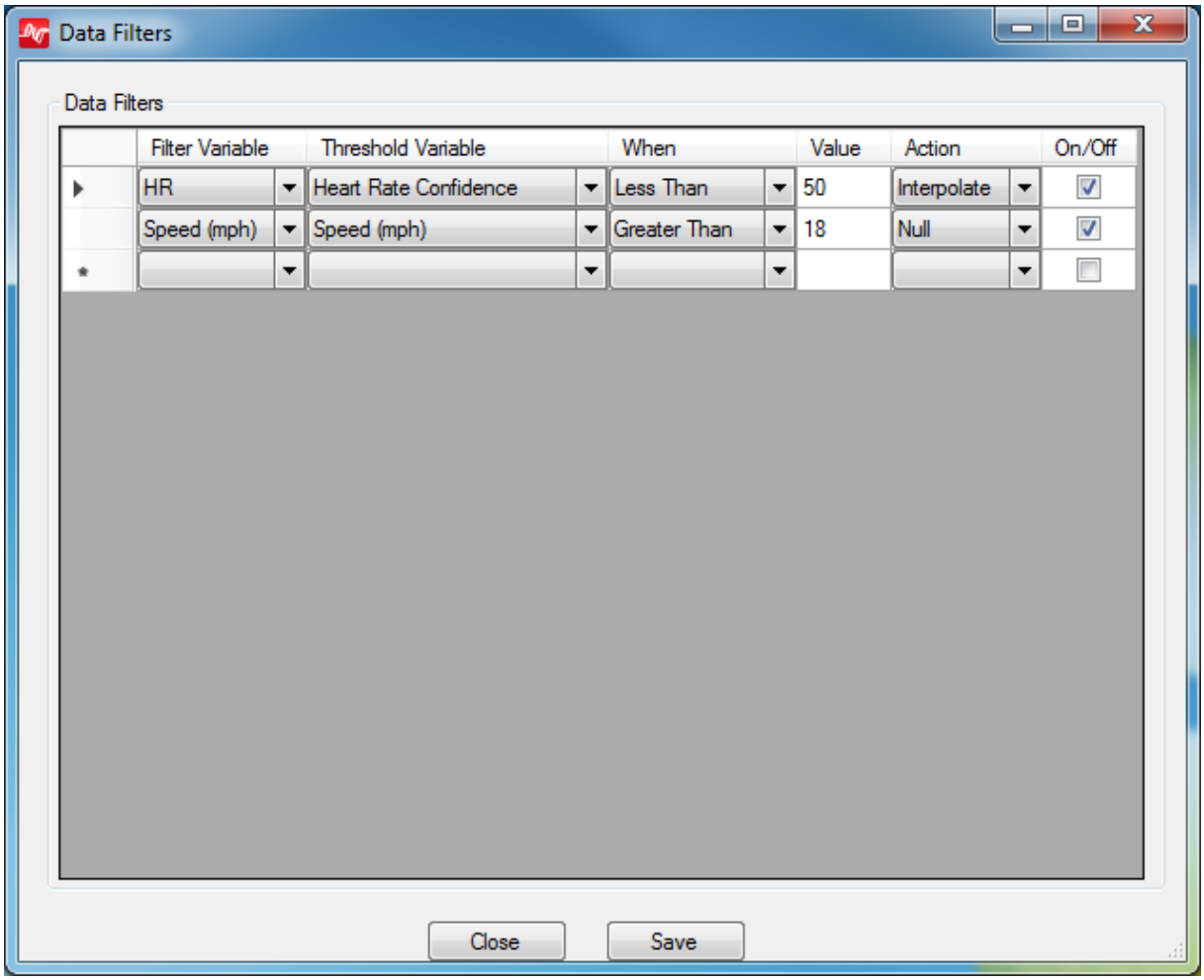


- Reset the vertical scale of the graphs as required.
- Default of *automatic* allows the vertical axis to auto-scale to the largest value
- Use the graph refresh button  to implement any saved changes

2.2.7 Data Filters

- Create filters and save in this dialogue - then turn on/off for a specific session using the 

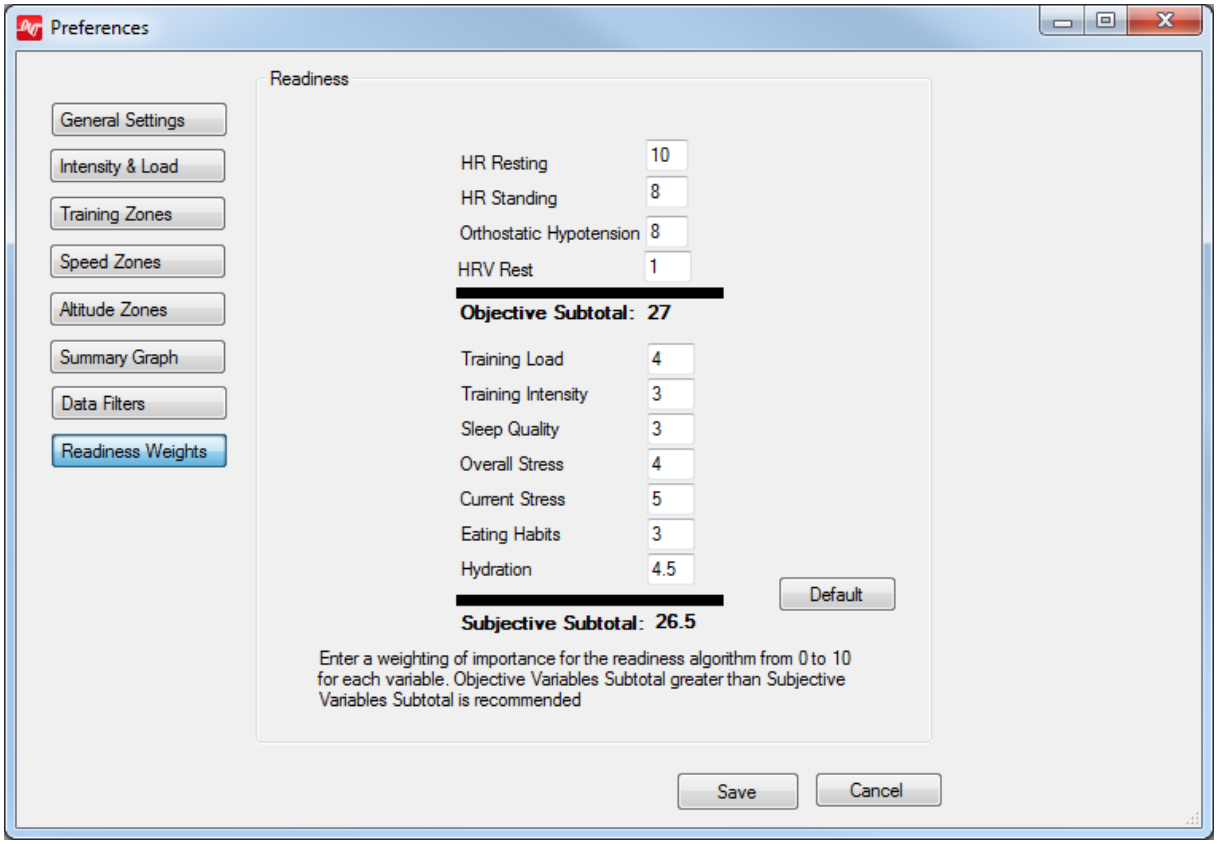
button in the time data graph panel.
- Parameters which can be filtered are: HR, BR, Posture, Activity, Peak Accel, HRV & Speed
- A new entry will be created automatically when the lowermost blank entry is edited



Examples (shown)

HR	Use Heart Rate confidence to interpolate HR, which will remove unrealistic spikes & troughs in HR caused by noise in the ECG circuit.
Speed	Set null values for speeds which are unrealistically high (or low) due to interruptions n satellite reception.

2.2.8 Readiness Weights



- Assign weightings to each factor of the readiness calculation
- If each factor has a weighting of 10, they will all be equally weighted
- Objective factors are determined from analysis of orthostatic hypotension test data
- Subjective Factors are entered by submitting a survey in the Readiness panel
- The individual scores are used to calculate a final readiness score using

$$\text{Readiness Score} = \frac{\sum_{n=1}^{13} Input_n * Weight_n}{\sum_{n=1}^{13} 10 * Weight_n}$$

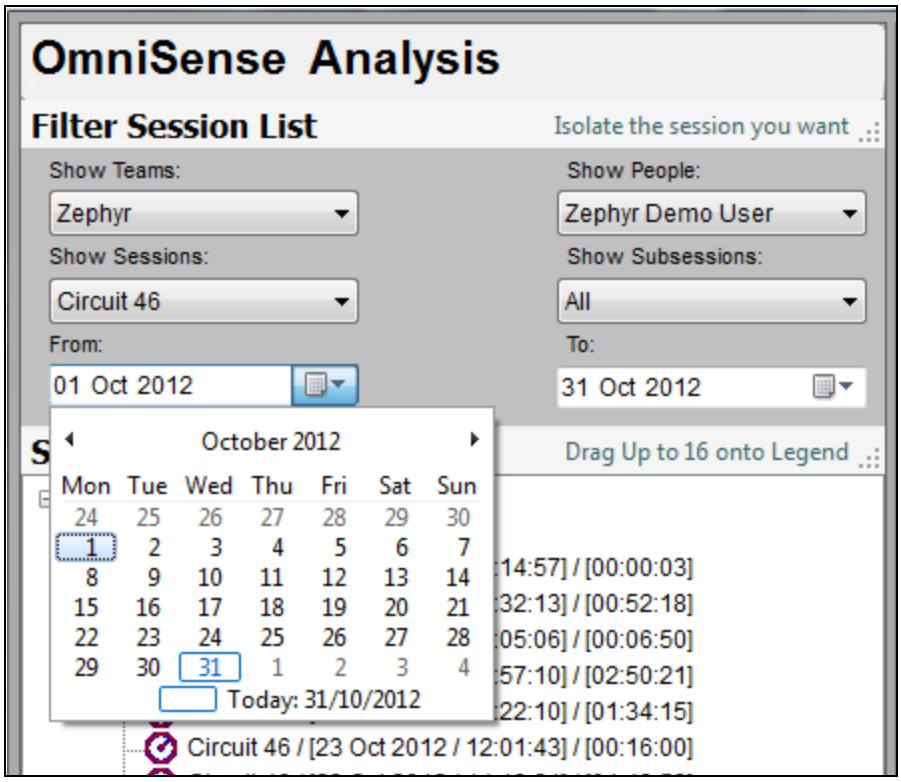
Part 3

3 Workflow

To use the module, use the panes in this order:
1. Filter Session List
2. Select Session to populate Legend
3. Choose Time or Summary Data
4. Select Parameters
5. Generate a Fitness Report

3.1 Filter Session List

- Use the filters to find particular sessions, select the sessions for display, and then change the filter settings if you need to find other data for display with the first.
- Plan ahead by naming specific sessions at the time of data collection (see OmniSense Live Help > User Preferences > Session Names)



Suggested filter order:
1. From: - (Defaults to the 6 months before current date). If the date of sessions is known, adjust *From* and *To* to that date for fastest filtering
2. To: - (Defaults to current date). As above
3. Show Sessions - plan session names in Live make for easier filtering in Analysis
4. Teams - this reduces the number of people available in the People pull down
5. People - this reduces the number of entries in the Sessions and Subsessions pull downs
6. Subsessions: - If you are systematically creating sub sessions to exclude irrelevant data at the beginning and end of each session, and naming them appropriately,

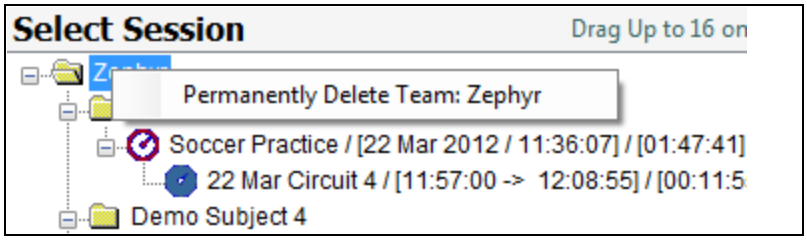
this will allow for fastest access to the most important data.

3.2 Select Session Options

Populate Legend or Training Reports
To move a session to the Legend for display:

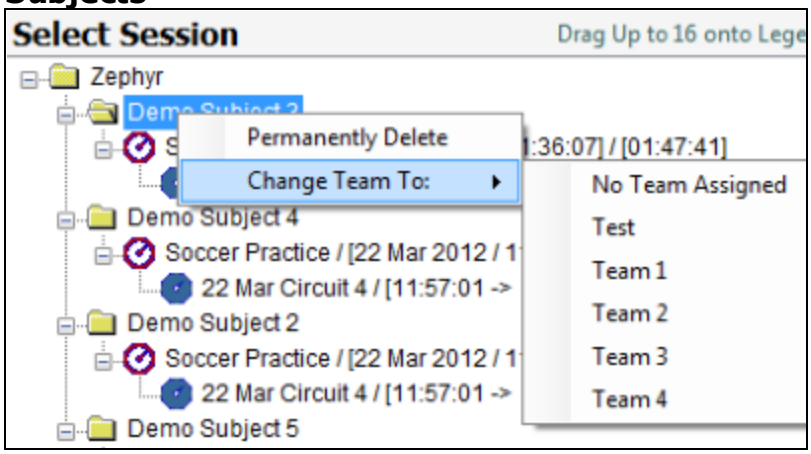
- Double click on a session or subsession to move it to the legend
- Left click and drag an individual session or subsession directly on to the legend
- Hold the Ctrl Key and left click multiple sessions, and then drag to legend (Shift + Select does not select a sequence of sessions)

Teams



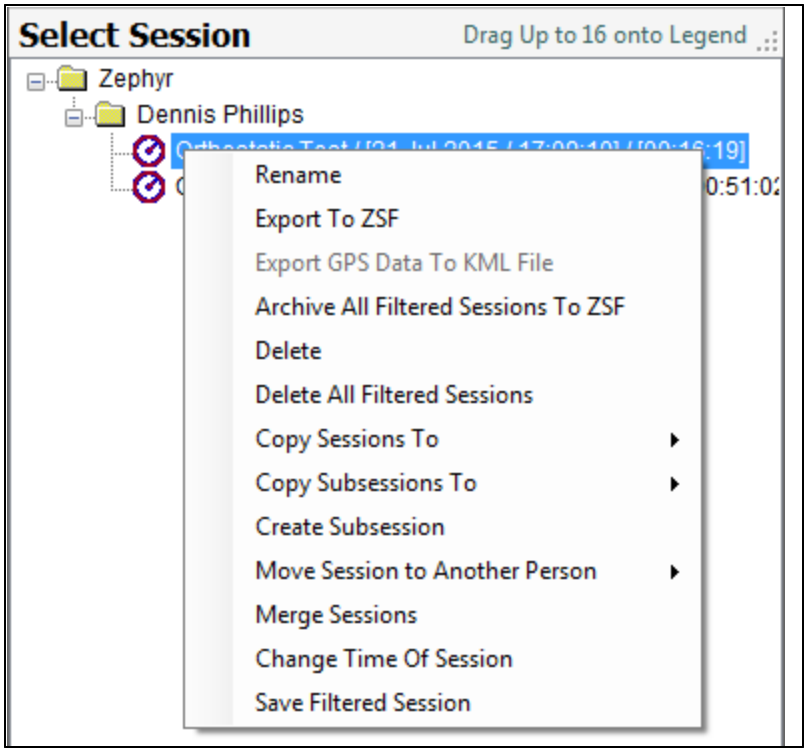
Permanently Delete Team	Permanently delete the team, all members, and all associated data

Subjects



Permanently Delete	Permanently delete the subject and all associated data
Change Team To	Move the subject and all associated data to another team. Use this before deleting a team, if you want to retain the subject and data. Create a 'holding' Team in Live if necessary.

Sessions



Rename	Rename Session
Export to ZSF	Create an external *Zephyr Serial Format file,* which can be re-imported later, or imported into a separate instance of OmniSense to transfer data between computers.
Export GPS data to a kml file	Generate an external file for import into Google Earth. The file will display location information, and also vital signs
Archive All Filtered Sessions to ZSF	Remove all the filtered sessions from the database and save them as a single archived file. A dialogue will display asking to confirm the action. Use the Filter Session List panel to display those you want to archive. Once removed, archived sessions can be re-imported into the database using the *Launch Log Downloader* button in the Analysis toolbar. Use the *From File* option
Delete	Permanently delete the session
Delete All Filtered Sessions	Permanently delete all sessions displayed in the Select Session tree. Use the Filter Session list panel to display only those you want to delete.
Copy Sessions To >	Import the session to Graph Legend or a Training Report (report tab must be pre-selected)
Copy Subsessions To >	As above
Create Subsession	Display a subsession dialogue
Move Session to Another Person	Transfer the session to another subject
Merge Sessions	Useful when data from a Live session is incomplete or fragmented e.g. BioModule turned off and on again. Combine two live sessions or a live and log data from the same session to create a continuous data session.

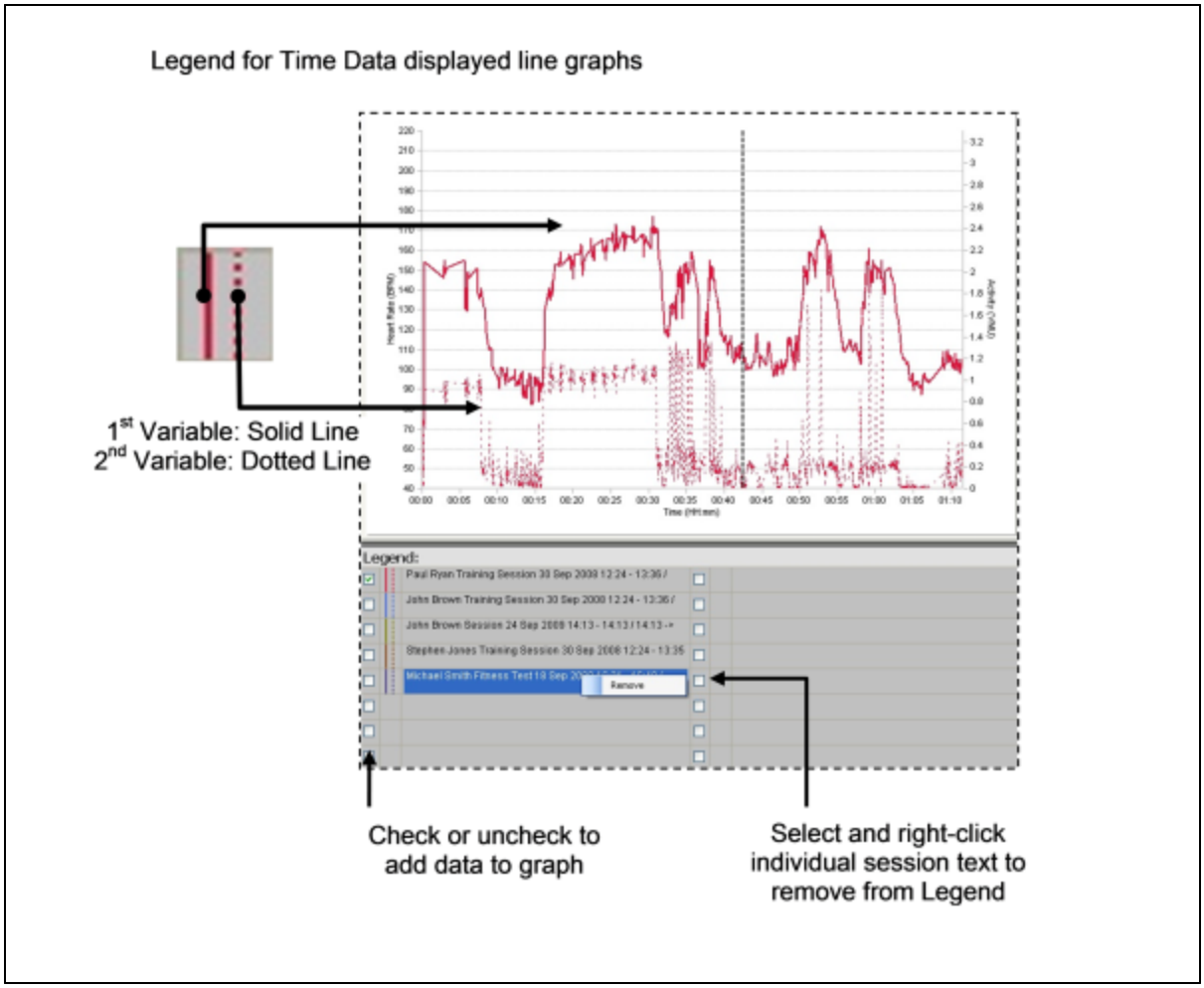
Change Time of Session	Display a dialogue to allow reassignment of time stamp (all components from year to seconds)
Save Filtered Session	Save a copy of the filtered session.

3.3 Legend

Time Data

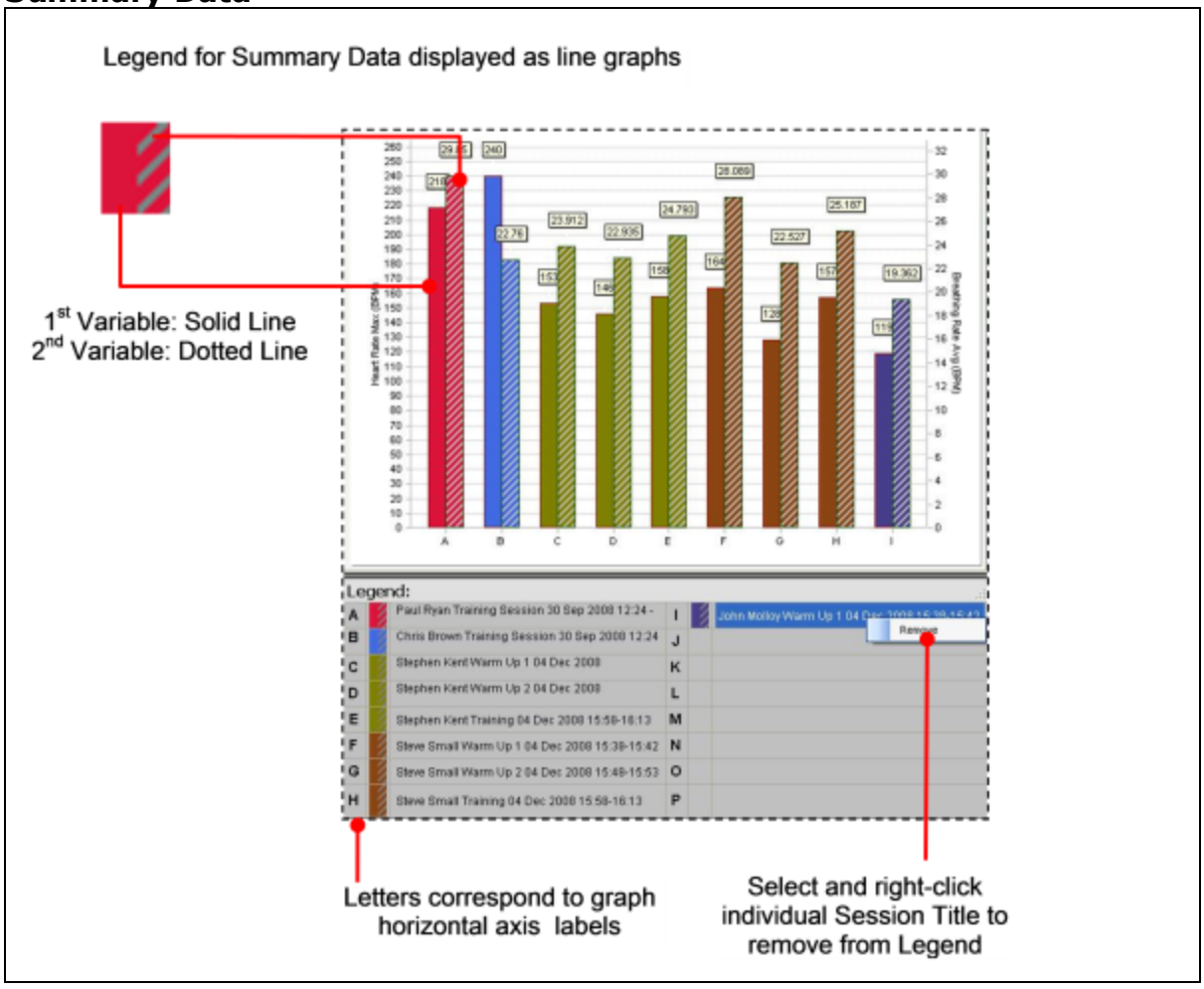
- Populate the legend by double-clicking on sessions in the Select Session tree
- Data sets on the graph are color-coded to match the legend

*The solid line indicates the first variable selected, chronologically. To reverse the solid/dotted line indication, deselect both parameters in the **Select Variables** pane, and reselect them in reverse order*



Use the Clear button  to remove <u>all</u> entries from the legend

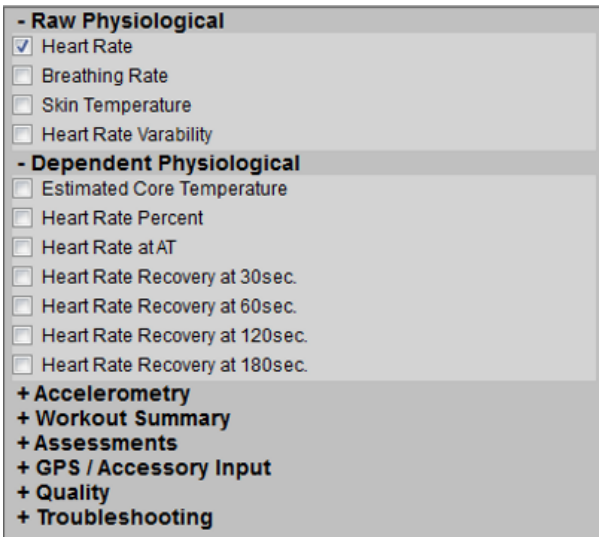
Summary Data

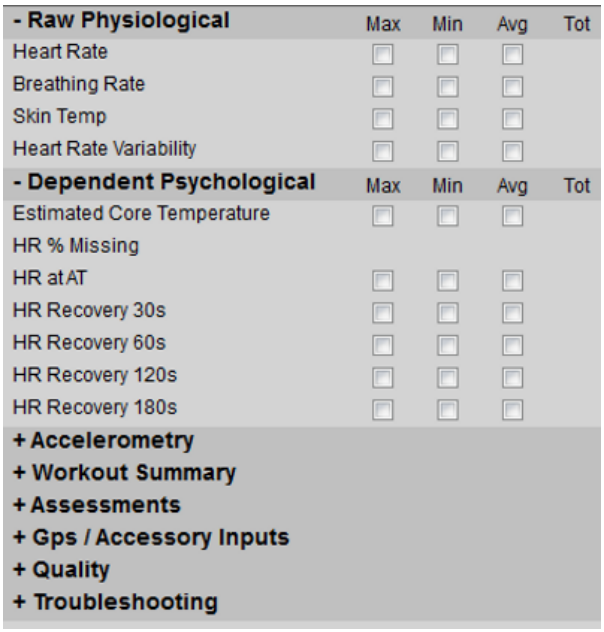


3.4 Select a Parameter

Select a *maximum* of two parameters from the check boxes in the Variables panel.

Time Parameters	Summary Parameters
+ Raw Physiological + Dependent Physiological + Accelerometry + Workout Summary + Assessments + GPS / Accessory Input + Quality + Troubleshooting	+ Raw Physiological + Dependent Physiological + Accelerometry + Workout Summary + Assessments + GPS / Accessory Input + Quality + Troubleshooting
Expand any node to see a full list	Expand any node to see a full list





If sessions exist in the Legend, then the graphs will populate automatically when the check box is selected.

The first checkbox selected will display on the graph as
- a *solid* line in a time variable graph
- the *leftmost* bar on a summary graph

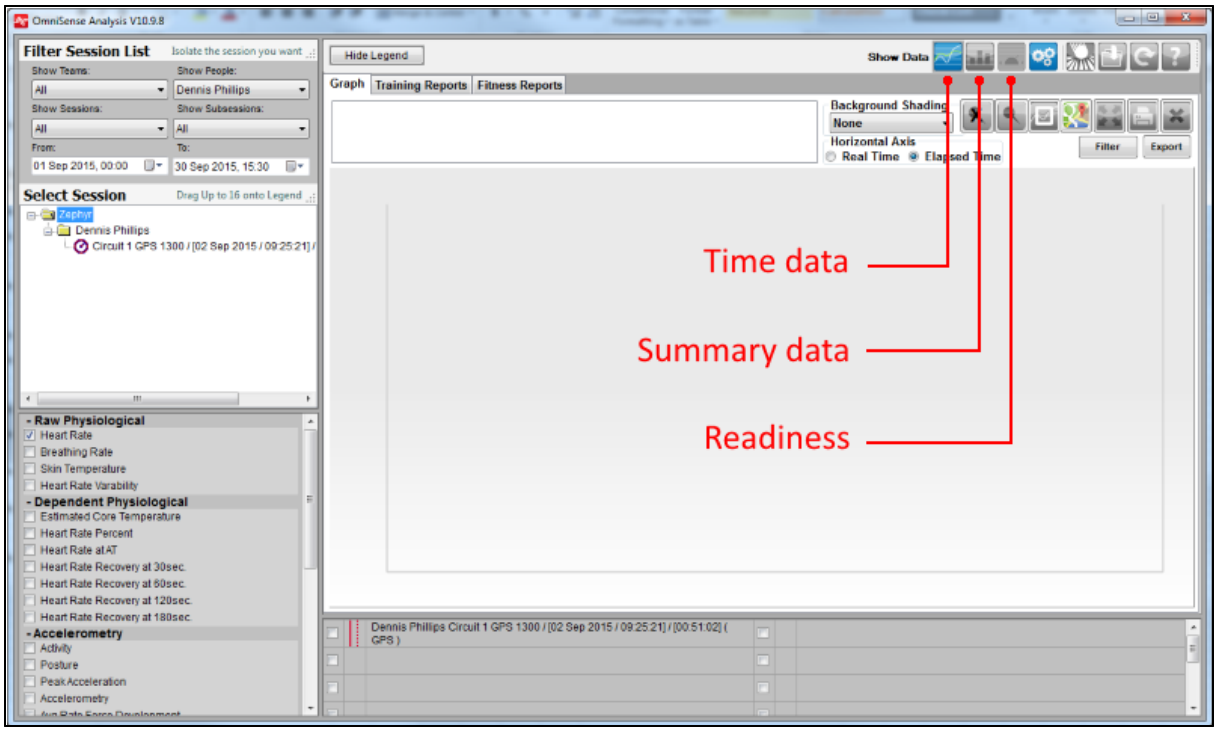
To remove a parameter from the graph
- Uncheck its check box to remove a single parameter
- Use the Clear button  to remove both parameters and remove all sessions from the legend

Part 4

4 Choose Time or Summary Data, or Readiness

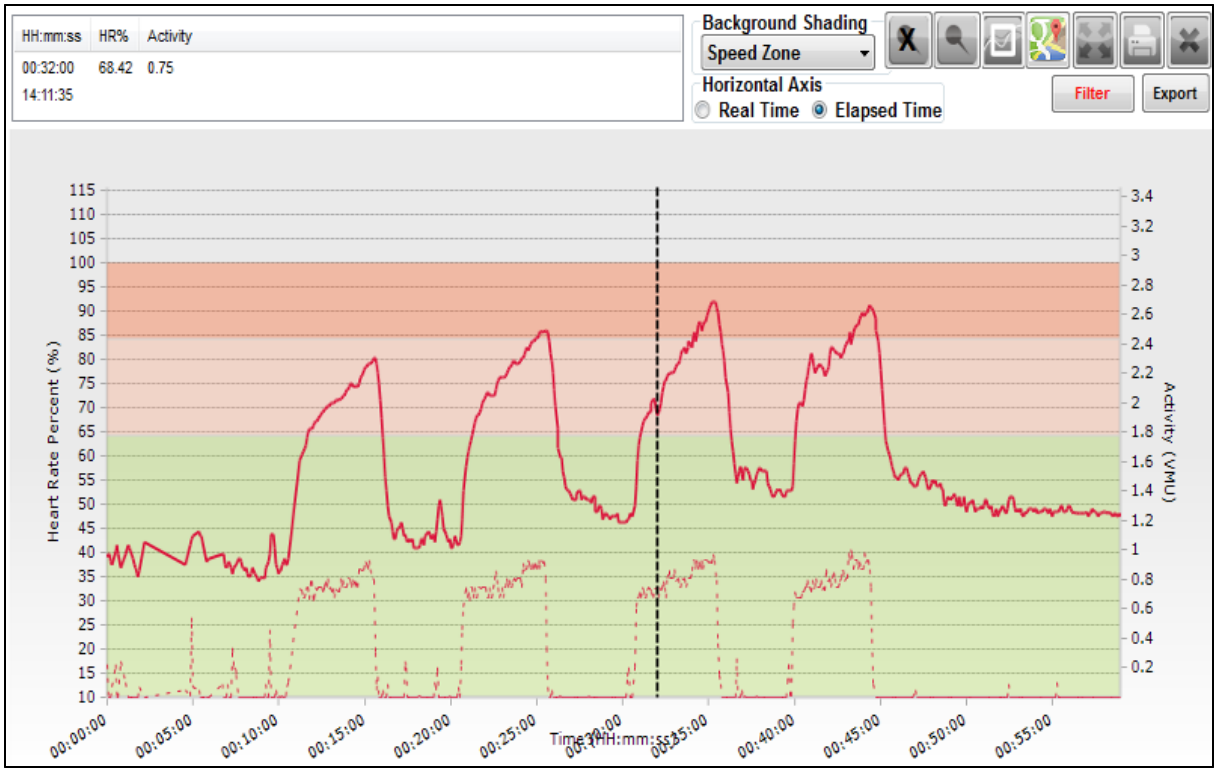
Select graph type using the buttons provided:

- Time data - line graph showing raw data at 1 sec intervals
- Summary data - bar graph showing min/max/avg
- Readiness - a line graph for analyzing orthostatic test data, and buttons to complete a readiness survey



4.1 Time Data Parameters

- Raw data is a line graph of the streaming data captured at 1/2.5/5 second intervals depending on Radio Network ECHO setting in OmniSense Live. It is always 1 second for log data.
- Two parameters may be displayed per subject.
- The *first parameter selected* displays as a solid line _____
- The *second parameter selected* displays as a dotted line - - - -



Raw Physiological	
Heart Rate	Beats per minute
Breathing Rate	Breaths per minute
Skin Temperature	Supported by BioHarness 2 only
Heart Rate Variability	No data for 1st 300 beats of session - updated per second
Dependent Physiological	
Estimated Core Temperature	Determined by HR data - independently researched algorithm. Not supported by BioHarness 2
Heart Rate Percent	HR displayed against background stratified at 65% and 85% of subject's HR max (illustrated)
Heart Rate at AT	Recorded when subject crosses their breathing rate anaerobic threshold
Heart Rate Recovery at 30sec	Recorded when HRR criteria are met
Heart Rate Recovery at 60sec	Recorded when HRR criteria are met
Heart Rate Recovery at 120sec	Recorded when HRR criteria are met
Heart Rate Recovery at 180sec	Recorded when HRR criteria are met
Accelerometry	
Activity	VMU = 0.2~walking 0.8~jogging. At each 100Hz sampling point, the three axial accelerometer values are combined to give a single acceleration magnitude in g. VMU is the average

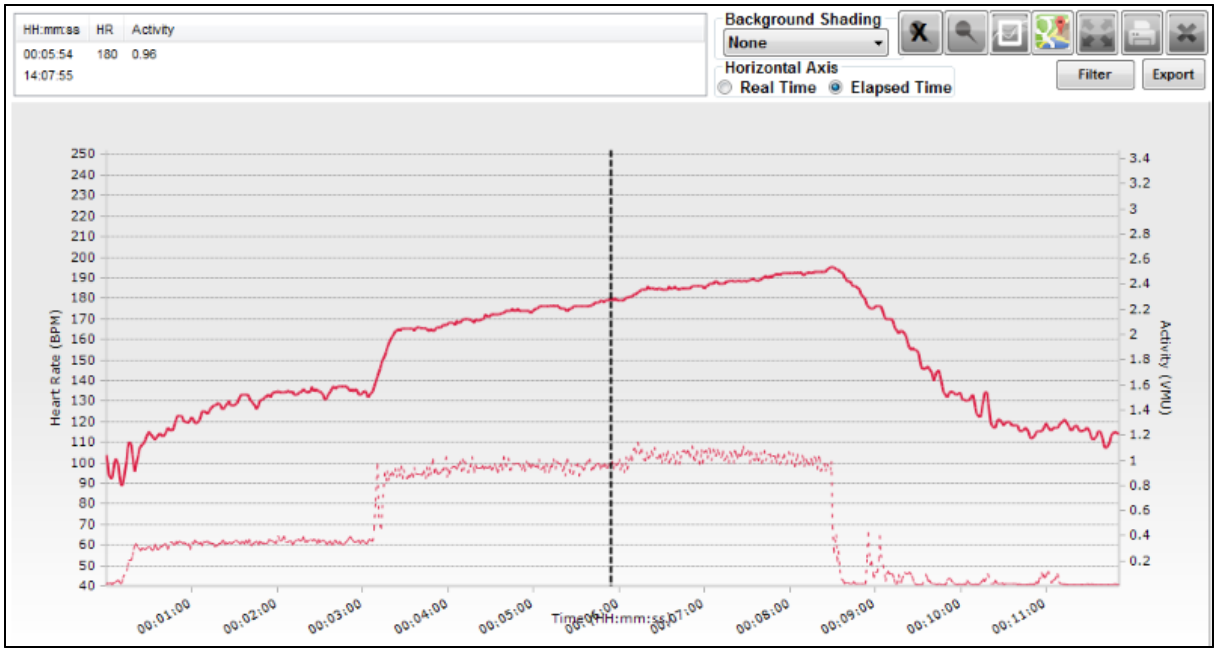
	value of this magnitude over a 1 second epoch
Posture	0°=vertical 90°=prone (lying face down) 180°=inverted -90°= supine (lying face up)
Peak Acceleration	The largest acceleration magnitude - 3 axes combined - in previous second, out of 100Hz samples. Max. dependent on hardware version. 3.3g on older hardware; currently 8g
Accelerometry	Supported by PSM Direct Connect & Training 3.0 (ECHO) systems only. 3-axis data displayed
Average Rate Force Development	A measurement of explosive power, averaged over the previous 10 steps, measured in Newton/s
Average Step Impulse	A measure of the efficiency of steps, i.e. how much energy is expended during a step. Shorter (in duration) steps expend less energy. Measured in Newtons.
Average Step Period	Seconds - time duration of step
Flight Time	Milliseconds - time in the air for a detected jump event (crouch/pause/jump)
Peak Magnitude Phi	Degrees from vertical of force or impact during an epoch*
Peak Magnitude Theta	Degress from horizontal of force or impact during an epoch*
Impulse Load	A cumulative measure of mechanical load - the sum of the areas under the accelerometer magnitude curve for all impulses, measured in Newtons
Walk Step Count	Cumulative count of walking steps. Steps, bounds and jumps are distinguished by analysis of the direction of impulse, magnitude of the impulse, and time interval from the previous impulse.
Run Step Count	Cumulative count of running steps
Bound Count	Cumulative count of bounding steps
Jump Count	Cumulative count of detected jumps
Minor Impact Count	Cumulative count of minor impacts (3 to 7g peak)
Major Impact Count	Cumulative count of major impacts (> 7g peak)
Workout Summary	
Physiological Load	Cumulative index of effort based on heart rate
Physiological Intensity	Instantaneous index of effort based on heart rate
Mechanical Load	Cumulative index of effort based on acceleration
Mechanical Intensity	Instantaneous index of effort based on acceleration
Training Load	Average of the above two
Training Intensity	Average of the above two
Assessments	
Treadmill Test	Displays heart rate, breathing rate & activity level
Beep Test	Displays heart rate, breathing rate & activity level
40 yard dash test	Maximum acceleration value attained if dash event detected
Jump Test	Maximum vertical acceleration attained if jump event detected
Jump Time in Air	Measured in milliseconds
Jump Height	Estimated maximum height attained if jump event detected, in

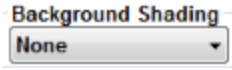
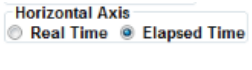
	meters
ROG Alert Status	Displayed as line in graph - additional checkbox above graph can display as vertical banding superimposed on other parameters
GPS/Accessory Input	
Speed Over Time	GPS data - speed vs time
Distance Over Time	GPS data - accumulated distance vs time
Elevation Over Time	GPS data - elevation vs time
Pulse Oximeter Oxygen Saturation (%)	Supported by PSM Direct Connect & PSM Responder only, when a supported external SPO2 sensor has been assigned to the subject
Blood Pressure	Supported by PSM Direct Connect & PSM Responder only, when a supported external Blood Pressure sensor has been assigned to the subject
Aux ADC 1	For Zephyr internal use (any data observed represents circuit noise)
Aux ADC 2	For Zephyr internal use
Aux ADC 3	For Zephyr internal use
Quality	
Heart Rate Confidence	Expressed as %. Dependent upon wear detection, ECG amplitude & ECG noise level
ECG Amplitude	Indicative only - represents an uncalibrated R-peak to S-peak. Measured in Volts
ECG Noise	Indicative only - represents an uncalibrated amplitude of noise between QRS complexes
Breathing Wave Amplitude	A metric extracted from the breathing detection algorithm - used for internal development only. A large initial value rapidly reduces. No inference on breathing depth can be made from this data
Breathing Wave Noise	N/a - 'Invalid' value always returned
Breathing Rate Confidence	N/a - 'Invalid' value always returned
Troubleshooting	
Device Internal Temperature	Ambient temperature measured by a thermistor inside the BioHarness
Battery Voltage	Device Battery level in volts. ~4.2V = fully charged, ~3.6V = fully discharged
System Confidence	Currently identical to HR Confidence
Galvanic Skin Response	Not supported by BioHarness 3. Invalid value returned
Skin Conductivity Level	Indicative only for some BioHarness 2.0 versions. Not supported by the BioHarness 3
Link Quality	Bluetooth Link Quality. 0=Poor, 254=High, 255=Invalid
RSSI	Bluetooth Received Signal Strength Indication - -127 to +127 dB
TX Power	Bluetooth Transmit Power. -30 to +20 dBm

* Epoch is 1 / 2.5 / 5 seconds, dependent on ECHO network setting.

4.1.1 Time Data Graphs

- manually select 1 or 2 variables per subject
- HR/BR/Activity if any Fitness Test Selected
- HR/HRV/Activity/Posture if Readiness selected
- left axis - 1st variable selected
- right axis - 2nd variable selected
- a maximum of 16 subjects

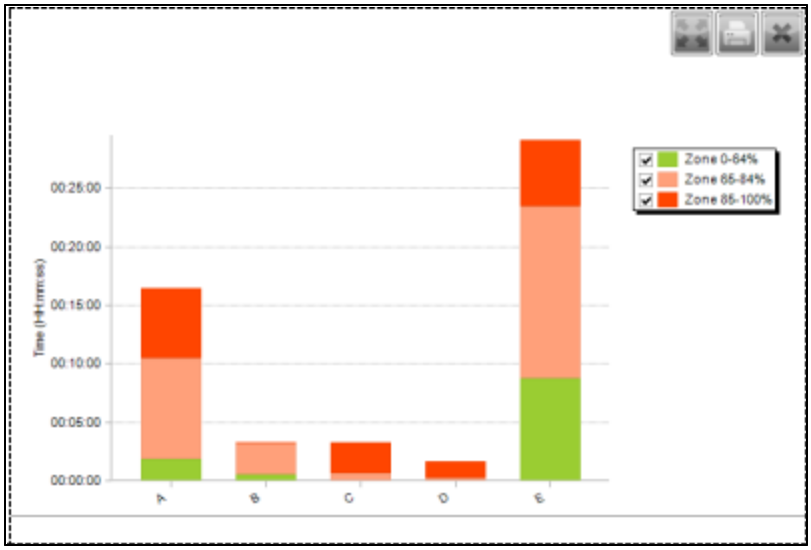


	Display the data values at the vertical cursor location. Upper timestamp is elapsed time. Lower timestamp is real time.
	Choose between: 1. None 2. ROG Status 3. Training Zone 4. Speed Zone (GPS data) 5. Positional Error (GPS data)
	Display the time axis as • Real Time - session data may not overlap • Elapsed Time - all sessions start at 00:00:00
	Delete all vertical markers from the session and subsessions
	Add a vertical marker at the vertical cursor location
	Create a subsession
	Toggle display of Google Map/Satellite view for GPS data

	Display full screen
	Display a Print dialogue
	Filter data displayed according to its own or other parameter values. The button text displays red if any filters are turned on. The will be applied to any session displayed on the graph, but are temporary, unless a filtered version of the session is saved.
	Export the graph data in a variety of formats

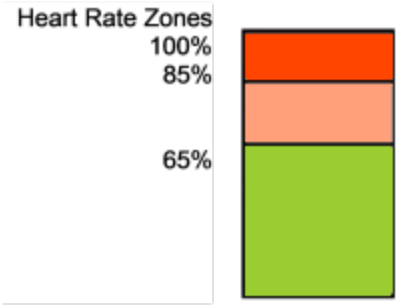
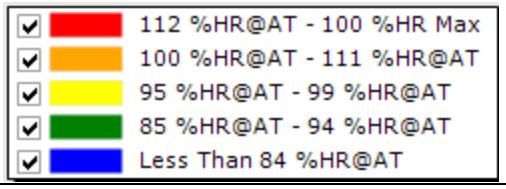
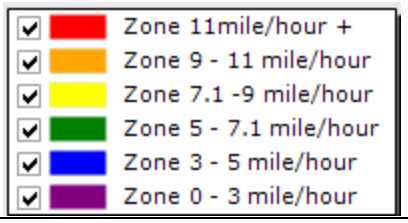
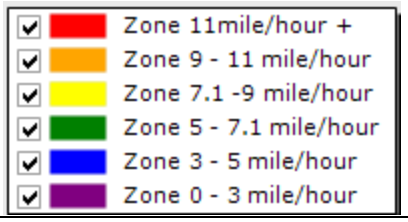
4.2 Summary Data Parameters

Summary data is in bar chart form. Each bar is typically a maximum, minimum or average value.



Raw Physiological	
Heart Rate	Beats per minute
Breathing Rate	Breaths per minute
Skin Temperature	Supported by BioHarness 2 only
Heart Rate Variability	No data for 1st 300 beats of session - updated per second
Dependent Physiological	
Estimated Core Temperature	Determined by HR data - independently researched algorithm. Not supported by BioHarness 2
Heart Rate Percent	HR displayed against background stratified at 65% and 85% of subject's HR max (illustrated)
Heart Rate at AT	Recorded when subject crosses their breathing rate anaerobic threshold
Heart Rate Recovery at 30sec	Recorded when HRR criteria are met
Heart Rate Recovery at	Recorded when HRR criteria are met

60sec	
Heart Rate Recovery at 120sec	Recorded when HRR criteria are met
Heart Rate Recovery at 180sec	Recorded when HRR criteria are met
Accelerometry	
Activity	VMU = 0.2~walking 0.8~jogging. At each 100Hz sampling point, the three axial accelerometer values are combined to give a single acceleration magnitude in g. VMU is the average value of this magnitude over a 1 second epoch
Posture	0°=vertical 90°=prone (lying face down) 180°=inverted -90°= supine (lying face up)
Peak Acceleration	The largest acceleration magnitude - 3 axes combined - in previous second, out of 100Hz samples. Max. dependent on hardware version. 3.3g on older hardware; currently 8g
Accelerometry g Force	Supported by PSM Direct Connect & Training 3.0 (ECHO) systems only. 3-axis data displayed
Average Rate Force Development	A measurement of explosive power, averaged over the previous 10 steps, measured in Newton/s
Average Step Impulse	A measure of the efficiency of steps, i.e. how much energy is expended during a step. Shorter (in duration) steps expend less energy. Measured in Newtons.
Average Step Period	Seconds - time duration of step
Flight Time	Milliseconds - time in the air for a detected jump event (crouch/pause/jump)
Peak Magnitude Phi	Degrees from vertical of force or impact during an epoch*
Peak Magnitude Theta	Degress from horizontal of force or impact during an epoch*
Impulse Load	A cumulative measure of mechanical load - the sum of the areas under the accelerometer magnitude curve for all impulses, measured in Newtons
Walk Step Count	Cumulative count of walking steps. Steps, bounds and jumps are distinguished by analysis of the direction of impulse, magnitude of the impulse, and time interval from the previous impulse.
Run Step Count	Cumulative count of running steps
Bound Count	Cumulative count of bounding steps
Jump Count	Cumulative count of detected jumps
Minor Impacts	Cumulative count of minor impacts (3 to 7g peak)
Major Impacts	Cumulative count of major impacts (> 7g peak)
Workout Summary	
Exercise Time	Total Time active for session
Time in HR Zones	Horizontal striping on bar. The following scale is used for the colors:

	
Time in Training Zone	Horizontal striping on bar. Zone thresholds are configurable in Preferences. 
Distance in speed zone	Horizontal striping on bar. Zone thresholds are configurable in Preferences. 
Time in speed zone	Horizontal striping on bar. Zone thresholds are configurable in Preferences. 
Calorie	Calories burned. ACSM formula.
Physiological Load	Cumulative index of effort based on heart rate
Physiological Intensity	Instantaneous index of effort based on heart rate
Mechanical Load	Cumulative index of effort based on acceleration
Mechanical Intensity	Instantaneous index of effort based on acceleration
Training Load	Average of the above two
Training Intensity	Average of the above two
AT	Heart Rate, breathing rate and time above AT threshold
Assessments	
40 Yard Peak Acceleration	Max/Min/Avg peak acceleration if a dash event is detected
Jump G Force	Max/Min/Avg jump g force if a jump event is detected
Jump Time in Air	Max/Min/Avg time in air (milliseconds) if a jump event is detected
Jump Height	Max/Min/Avg jump height if a jump event is detected

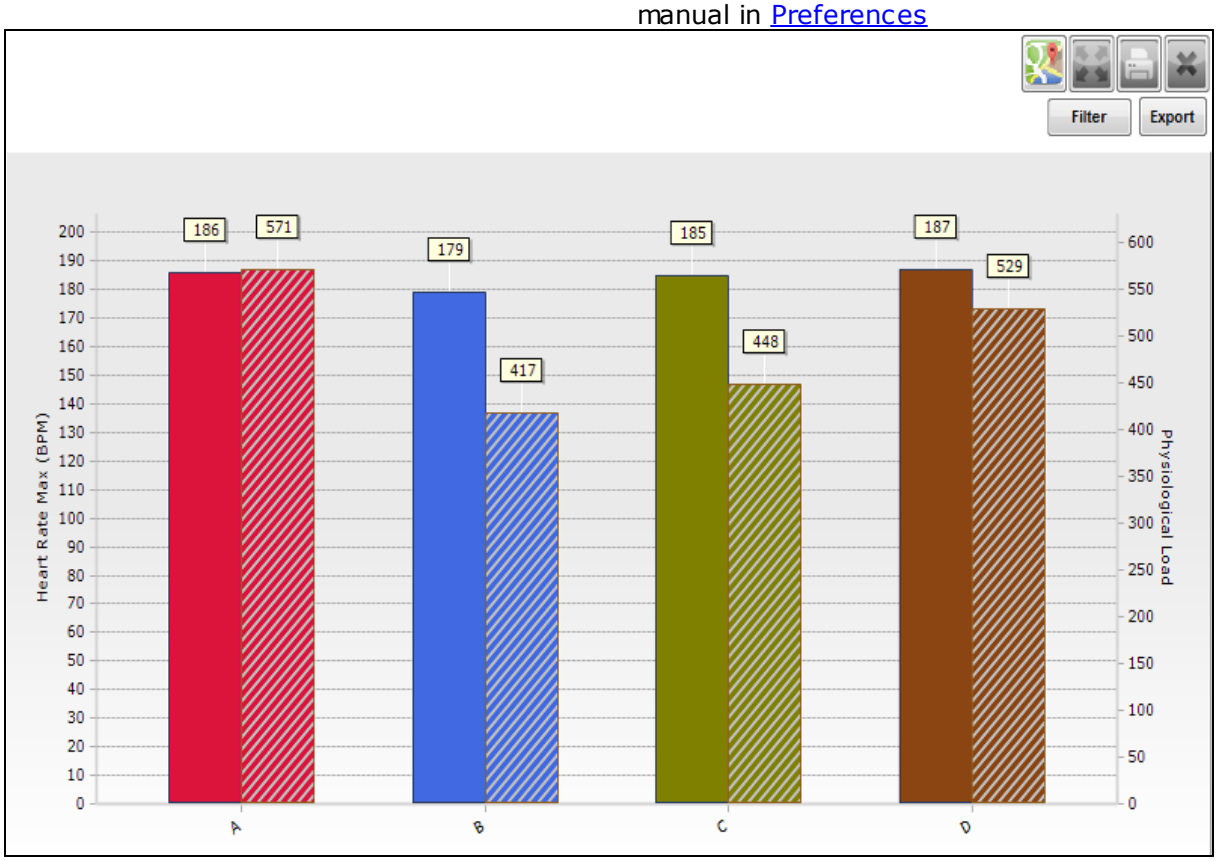
GPS/Accessory Input	
Total Distance Traveled	Total distance traveled
Speed	GPS data - speed
Elevation	GPS data - elevation
Pulse Oximeter Oxygen Saturation (%)	Supported by PSM Direct Connect & PSM Responder only, when a supported external SPO2 sensor has been assigned to the subject
Blood Pressure	Supported by PSM Direct Connect & PSM Responder only, when a supported external Blood Pressure sensor has been assigned to the subject
Aux ADC 1	Not used
Aux ADC 2	Not used
Aux ADC 3	Not used
Quality	
Heart Rate Confidence	Expressed as %. Dependent upon wear detection, ECG amplitude & ECG noise level
ECG Amplitude	Indicative only - represents an uncalibrated R-peak to S-peak. Measured in Volts
ECG Noise	Indicative only - represents an uncalibrated amplitude of noise between QRS complexes
Breathing Wave Amplitude	A metric extracted from the breathing detection algorithm - used for internal development only. A large initial value rapidly reduces. No inference on breathing depth can be made from this data
Breathing Wave Noise	N/a - 'Invalid' value always returned
Breathing Rate Confidence	N/a - 'Invalid' value always returned
Troubleshooting	
Device Internal Temperature	Ambient temperature measured by a thermistor inside the BioHarness
Battery Voltage	Device Battery level in volts. ~4.2V = fully charged, ~3.6V = fully discharged
System Confidence	Currently identical to HR Confidence
Galvanic Skin Response (GSR)	Not supported by BioHarness 3. Invalid value returned
Link Quality	Bluetooth Link Quality. 0=Poor, 254=High, 255=Invalid
RSSI	Bluetooth Received Signal Strength Indication - -127 to +127 dB
TX Power	Bluetooth Transmit Power. -30 to +20 dBm
Skin Conductance Level	Indicative only for some BioHarness 2.0 versions. Not supported by the BioHarness 3

4.2.1 Summary Data Graphs

- manually select 1 or 2 variables per
- a maximum of 16 subjects

subject

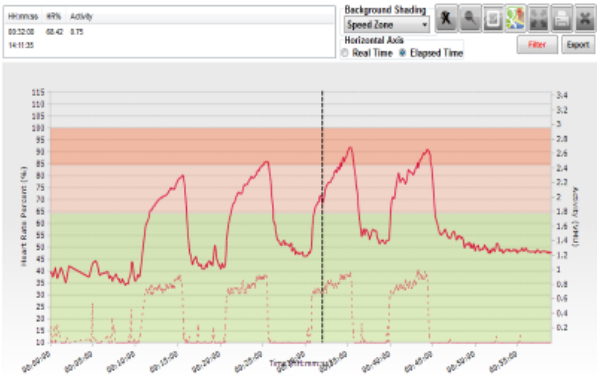
- left axis - 1st variable selected (or both if the units are the same e.g. Max & Average Heart Rate)
- right axis - 2nd variable selected
- sub sessions cannot be created from a summary graph
- vertical axis can be autoscaled or set to manual in Preferences



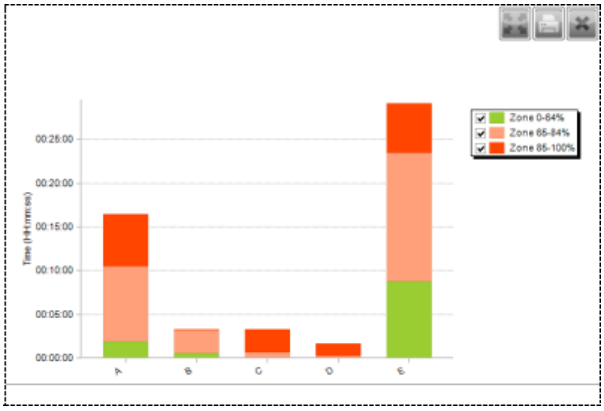
	Toggle display of Google Map/Satellite view for GPS data
	Display full screen
	Display a Print dialogue
	Filter data displayed according to its own or other parameter values. The button text displays red if any filters are turned on. The will be applied to any session displayed on the graph, but are temporary, unless a filtered version of the session is saved.
	Export the graph data in a variety of formats

Part 5

5 Graph Display



Time Data

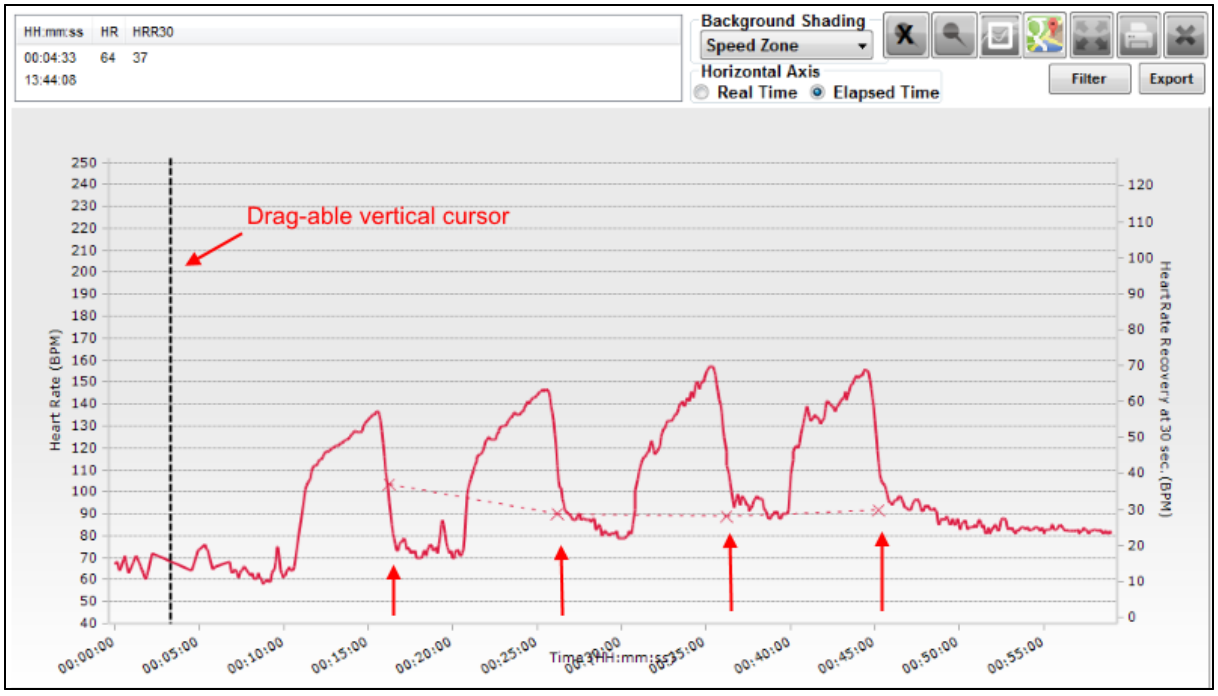


Summary Data

5.1 Cursor Values

- In Time graphs (but not Summary), a movable vertical cursor is located against the left hand axis.

- To move the cursor, hold down the left mouse button and drag to the required location.
- The data values for the *topmost* session in the legend will be displayed in the frame above the graph:



Note that the HRR30 field in the example above has no entry at the current cursor location. There is no applicable HRR value at that point. To display HRR values by cursor location, the HRR30 parameter should be selected *first* when populating the graph. They are indicated by the four vertical arrows.

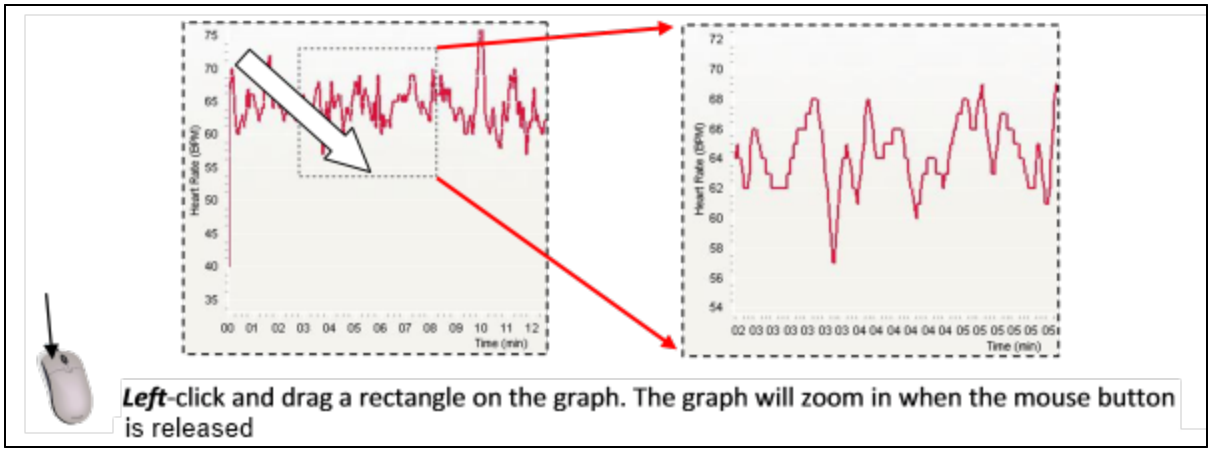
There are two time entries at the current cursor location:

- 00:04:33 - the *elapsed* time within the session - the session start is adjusted to 00:00:00
- 13:44:08 - the *real* time from the session

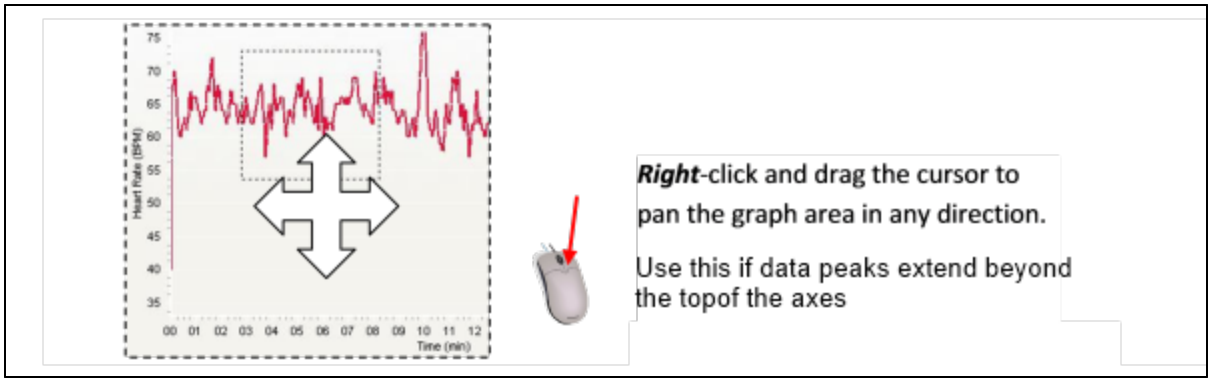
5.2 Zoom and Pan

There are three mouse functions to Zoom In, Pan and Reset the graphs. Both axes rescale automatically for each of these operations.

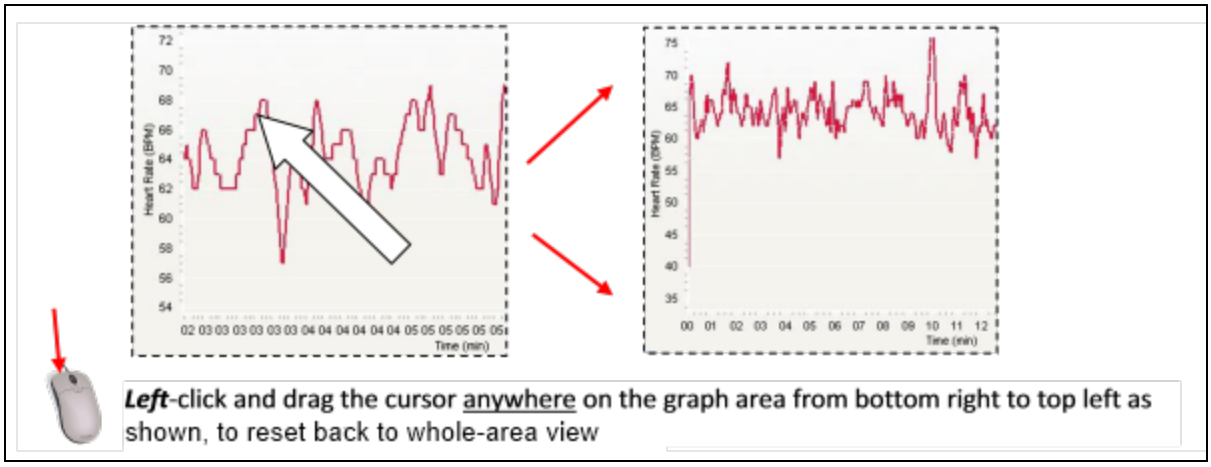
Zoom



Pan

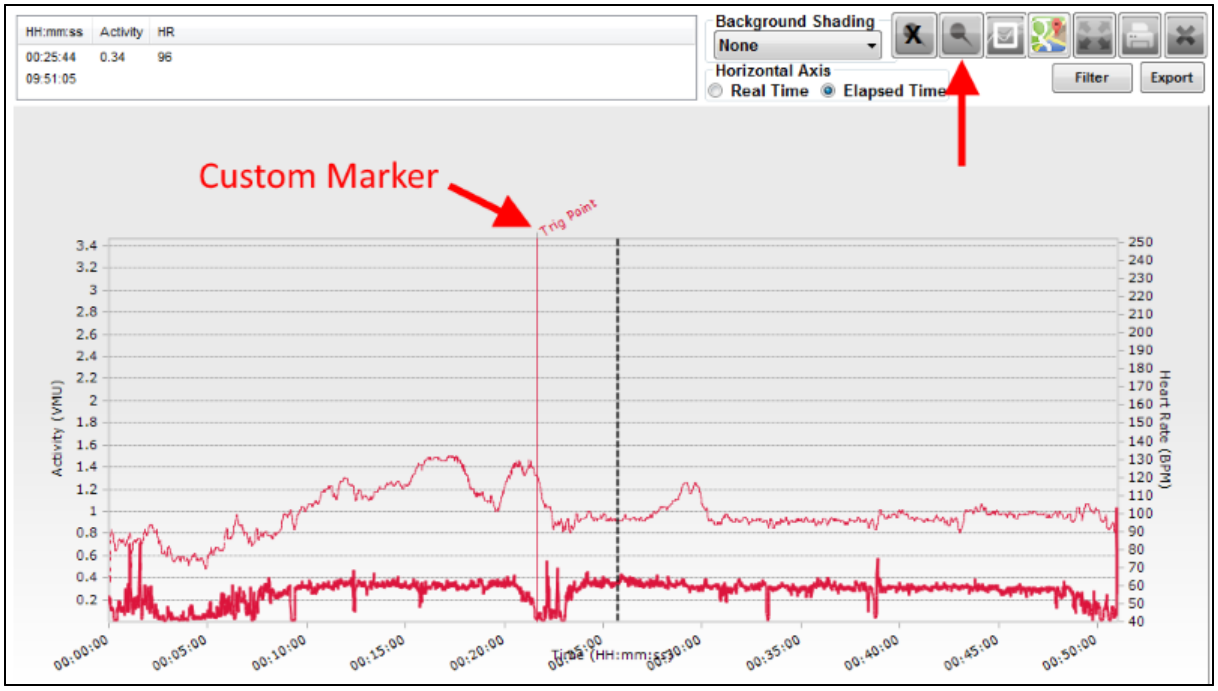


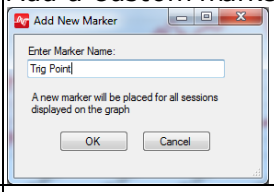
Reset



5.3 Add/Remove Markers

- Add markers to identify points of interest in data
- Markers remain when session is closed
- Markers are visible in graphic file exports, but not in data files such as .csv or .xls



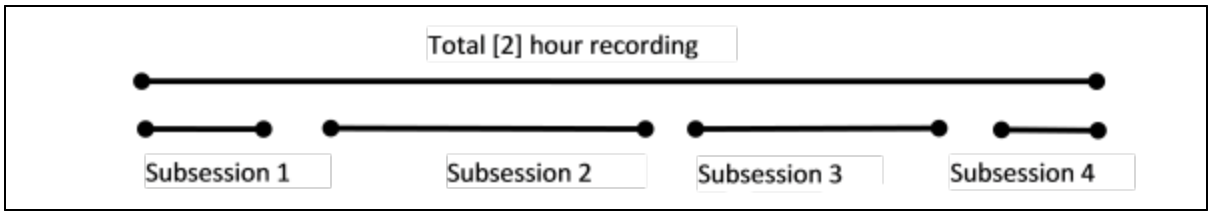
	Add a custom marker at the vertical graph cursor location 
	Delete <u>all</u> custom markers from the session

5.4 Subsessions

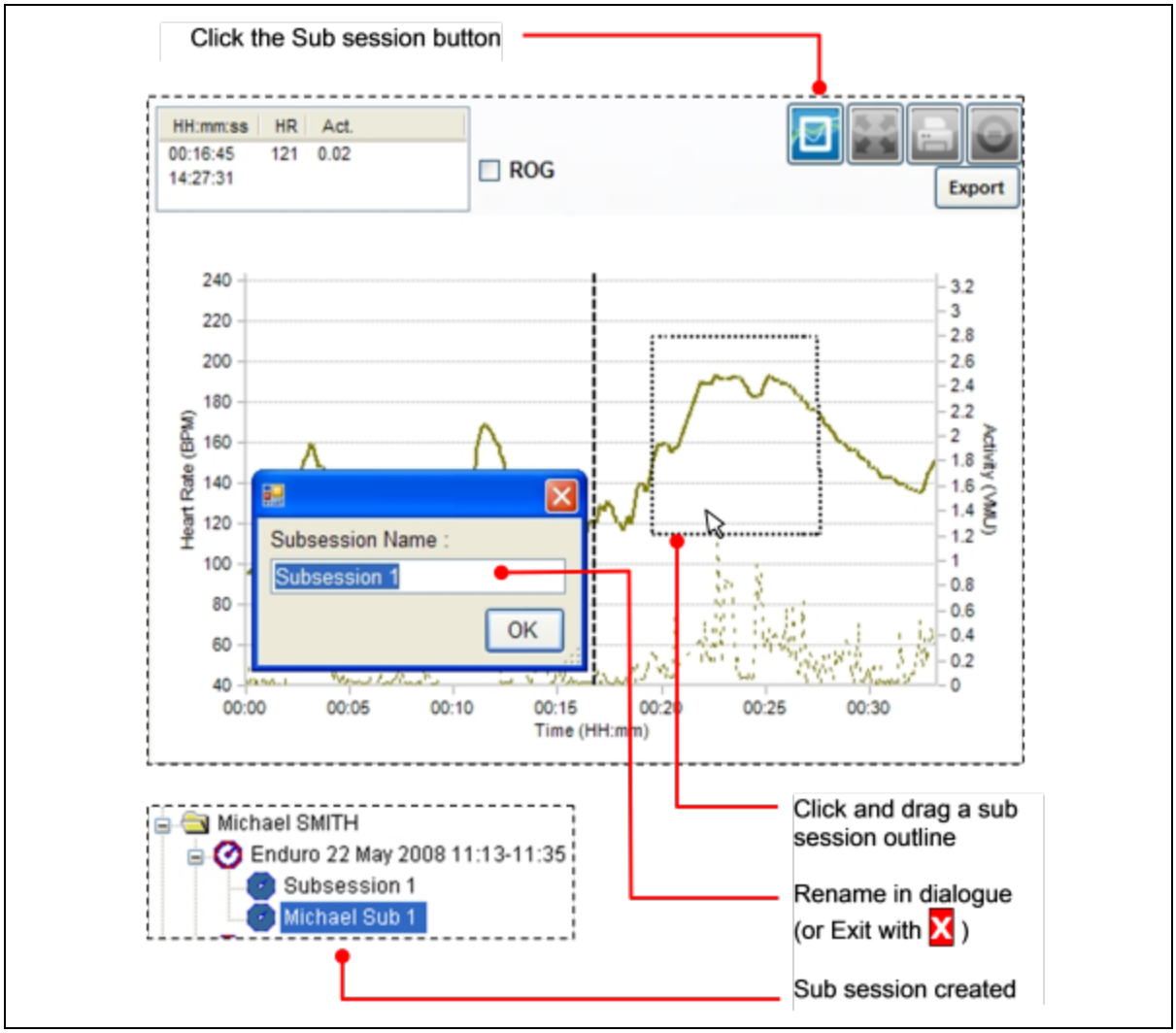
[Multiple Subsessions]
[Time-based Subsessions]

Single Subsessions

If a data recording consists of a number of distinct activities, each activity may be used a basis for a sub session:

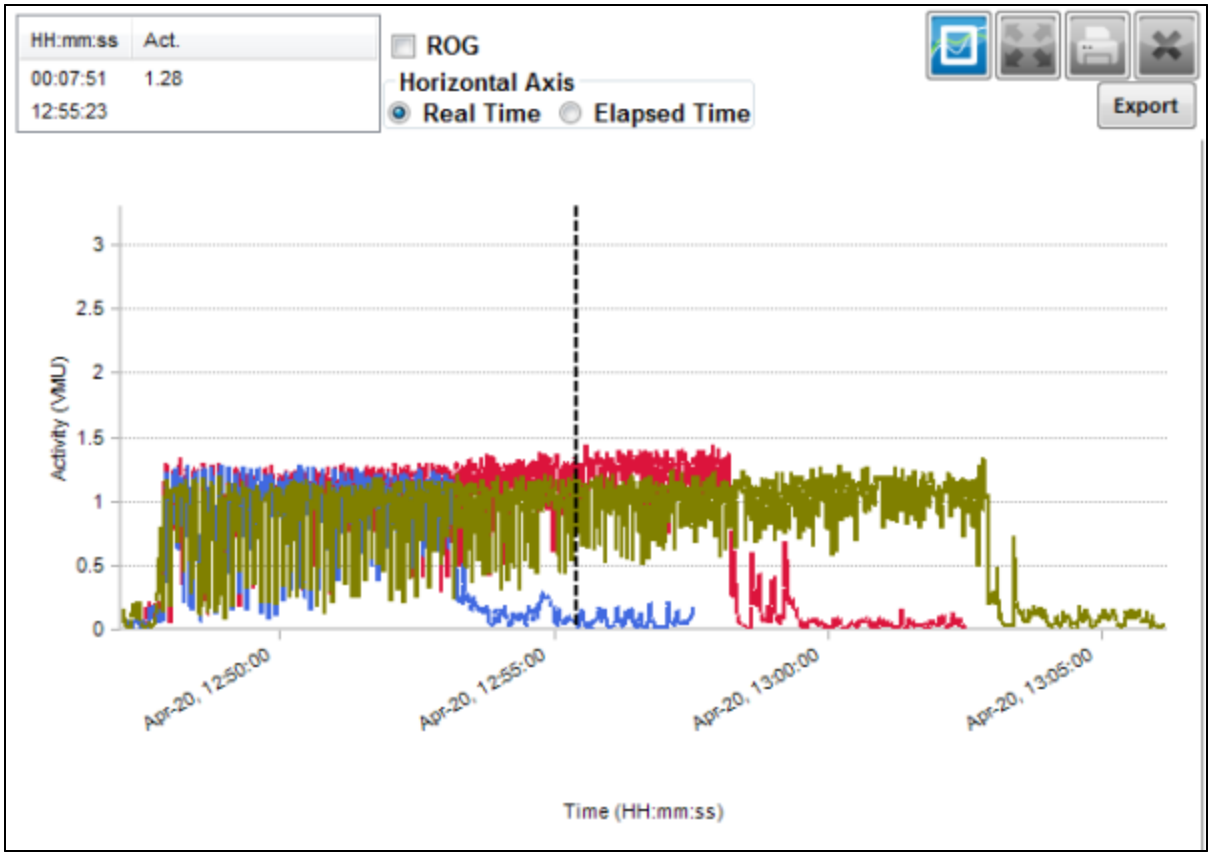


A separate data set is created each time a subset is created. They can be renamed, but are stored in the explorer panel as sub-nodes of the parent session.

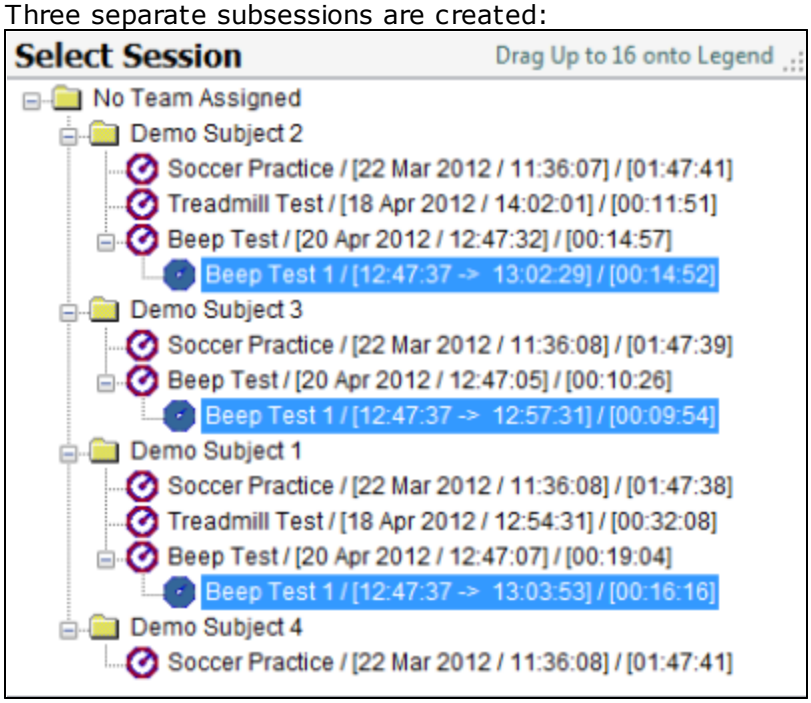


Multiple Subsessions

Subsessions can be created to remove extraneous data before and after comparative fitness tests, such as three subjects taking part in a Beep test. First, display the data and set the horizontal Axis to show real time.



Then make a subsession which excludes the before and after sections of the activity. Three separate subsessions are created:

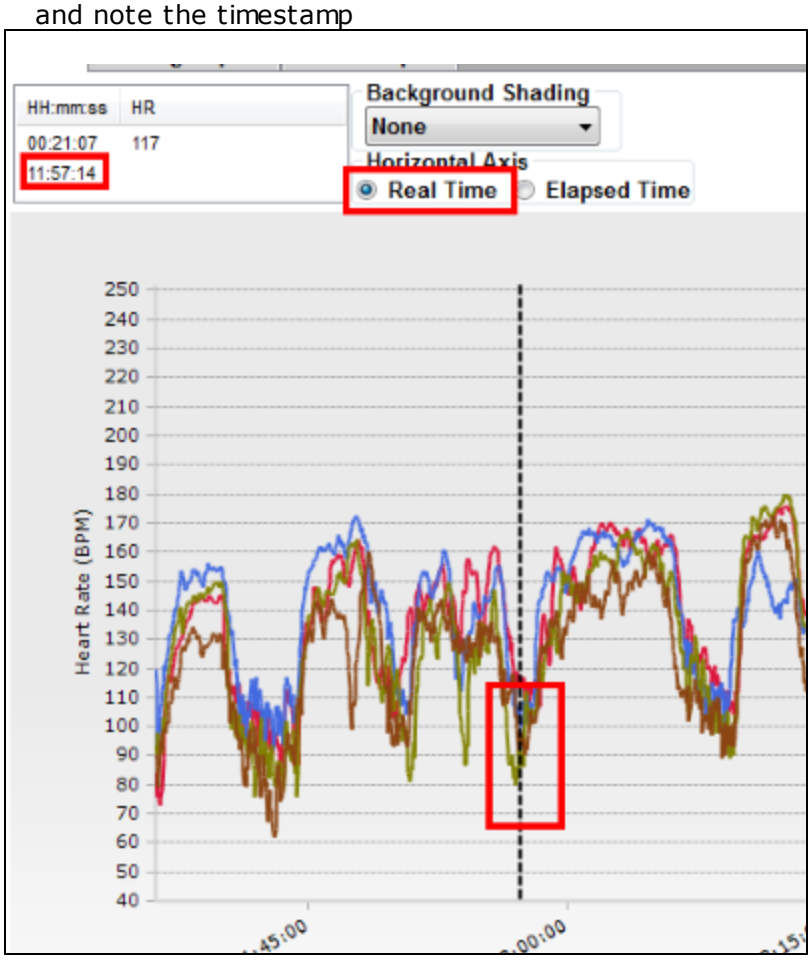


The three subsessions can then be used as data for a Group Report

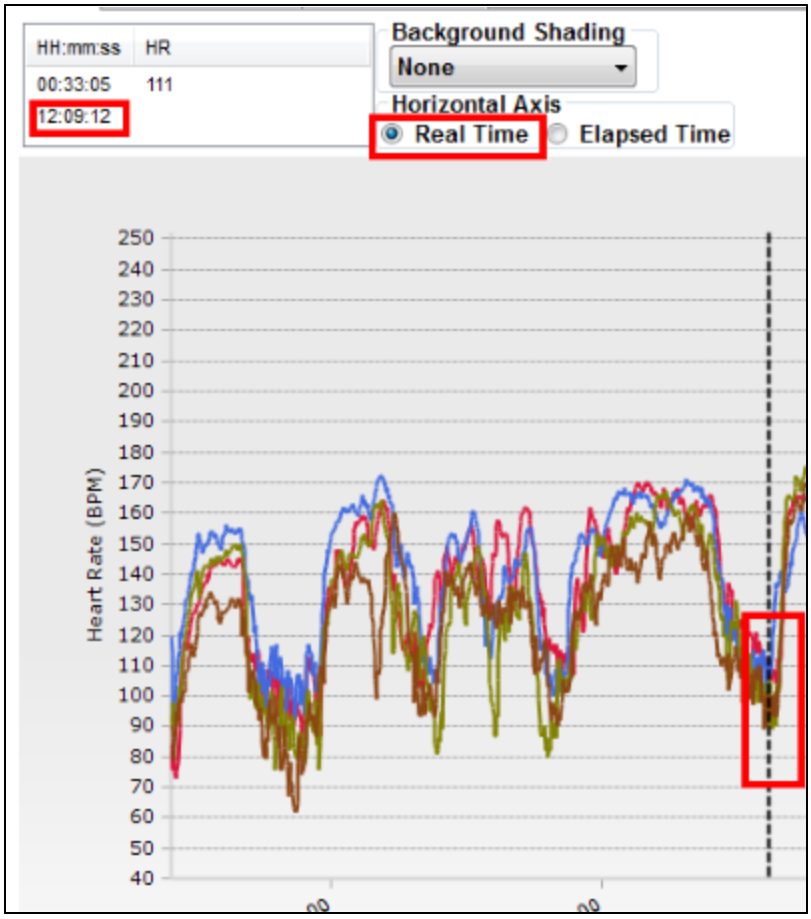
Time Based Subsessions

Subsessions can be created using time criteria.
Suggested workflow:

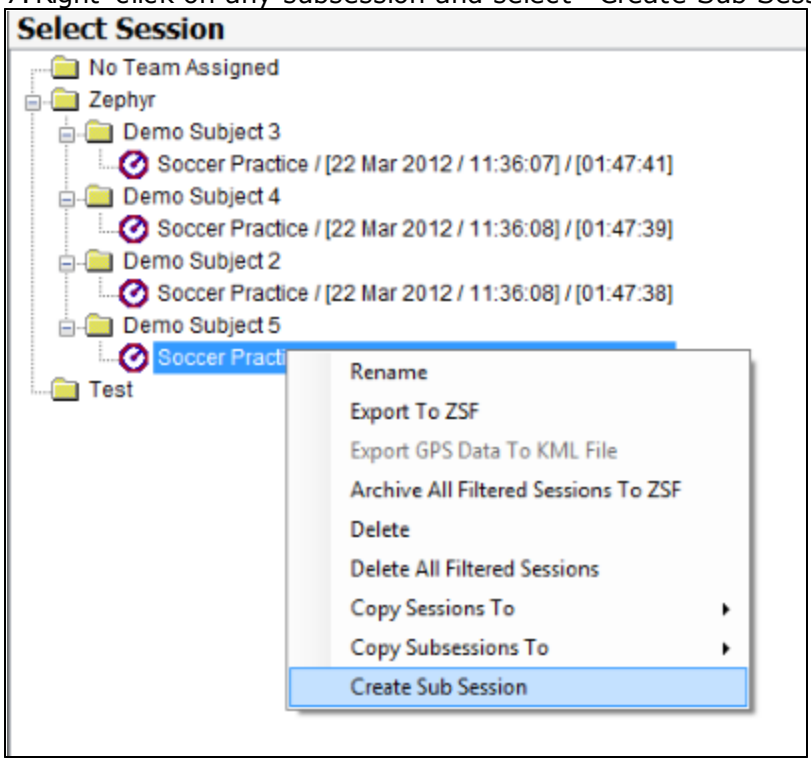
1. If desired, use the Filter Session pulldowns to select those parent sessions you intend to create subsessions from
2. Transfer the parent sessions to the graph legend by double-clicking them, or dragging on to the legend
3. Select those parameters (e.g. Activity) which will allow you to see the part of the parent session you intend to extract.
4. Select the Real Time radio button above the graph - this will match the parent sessions in real time
5. Drag the graph cursor to the start of the section you intend to create as a subsession and note the timestamp



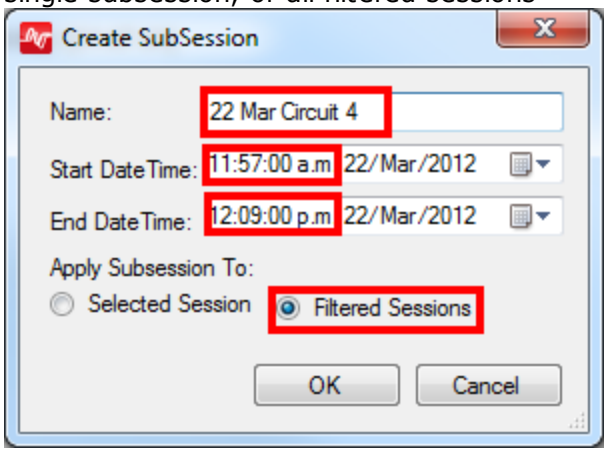
6. Drag the graph cursor to the end of the section you intend to create as a subsession and note the timestamp



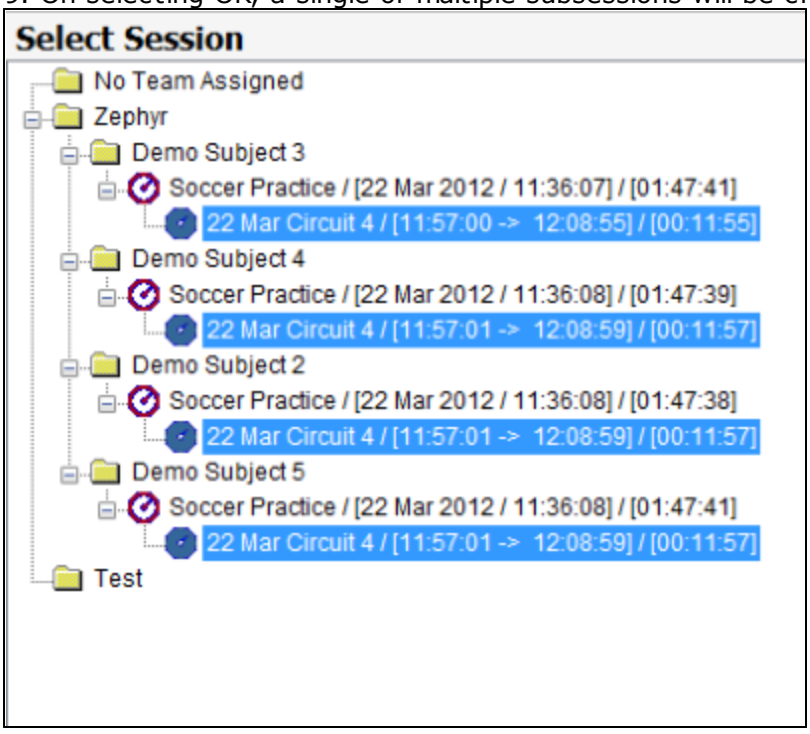
7. Right-click on any subsession and select 'Create Sub Session' from the context menu



8. In the dialogue, relabel the subsession name, enter the times you have noted as the start and end of the section you intend to extract as a subsession, and select whether a single subsession, or all filtered sessions



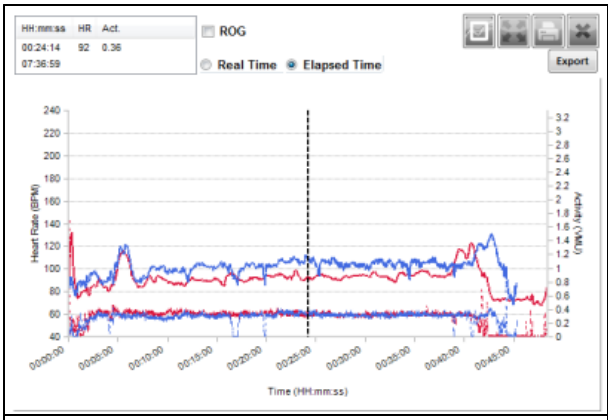
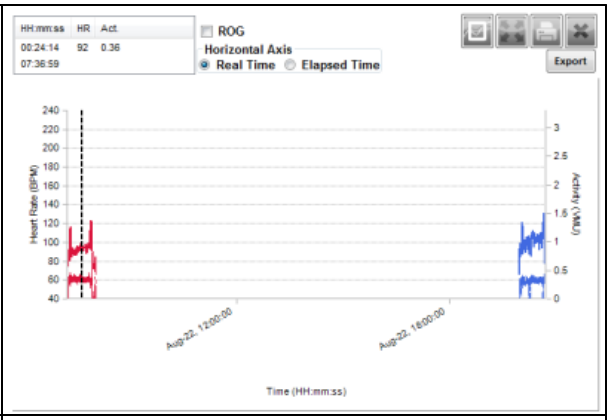
9. On selecting OK, a single or multiple subsessions will be created



5.5 Real/Elapsed Time

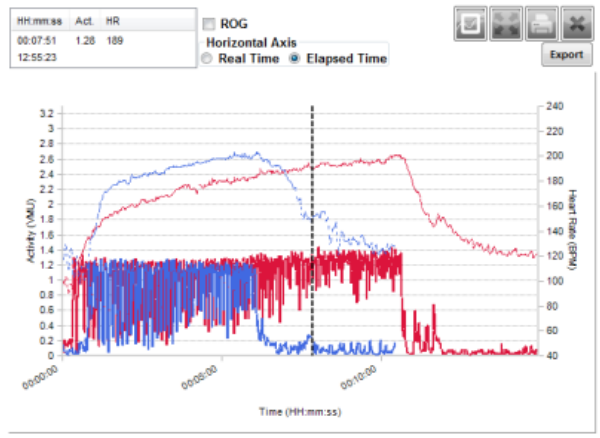
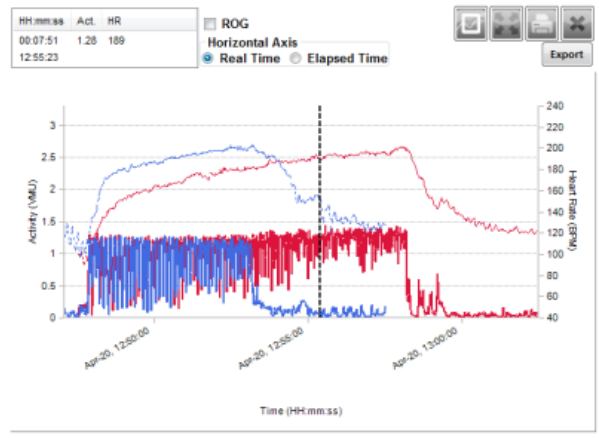
When displaying Time data on the graph, the default Time (horizontal) axis calibration is *Elapsed* time. This means all sessions start at 00:00:00, so they can be aligned with each other, regardless of which day or hour the sessions were actually recorded.

Elapsed Time	Real Time

	
Two identical activity sessions, recorded 12 hours apart, can be compared easily	The same two sessions displayed in real time do not overlap. A warning dialogue will display when this happens.

Real time should be used to compare sessions which occurred at the same time.

Below are two sessions from the same beep test where subject BioHarnesses were not started at the same time - an offset can be seen when they are displayed in Elapsed Time as the BioHarness modules were not started simultaneously.

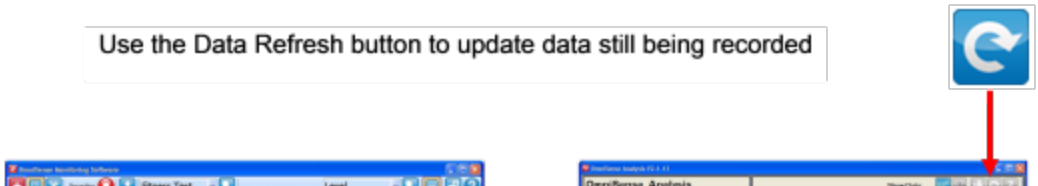
Elapsed Time	Real Time
	
An offset can be seen as the red data starts slightly before the blue	In real time, data is now synchronized exactly

When sessions are synchronized in real time, then multiple subsessions can easily be created which remove all extraneous data before and after the area of interest, allowing for more valid Group Fitness Reports

5.6 Using Live & Analysis Modules Simultaneously

The Analysis Module can be used at the same time as the Live module. Data which is currently being recorded in Live can also be displayed in Analysis. Use the Data Refresh button to update any graphs displaying data which is still being recorded.

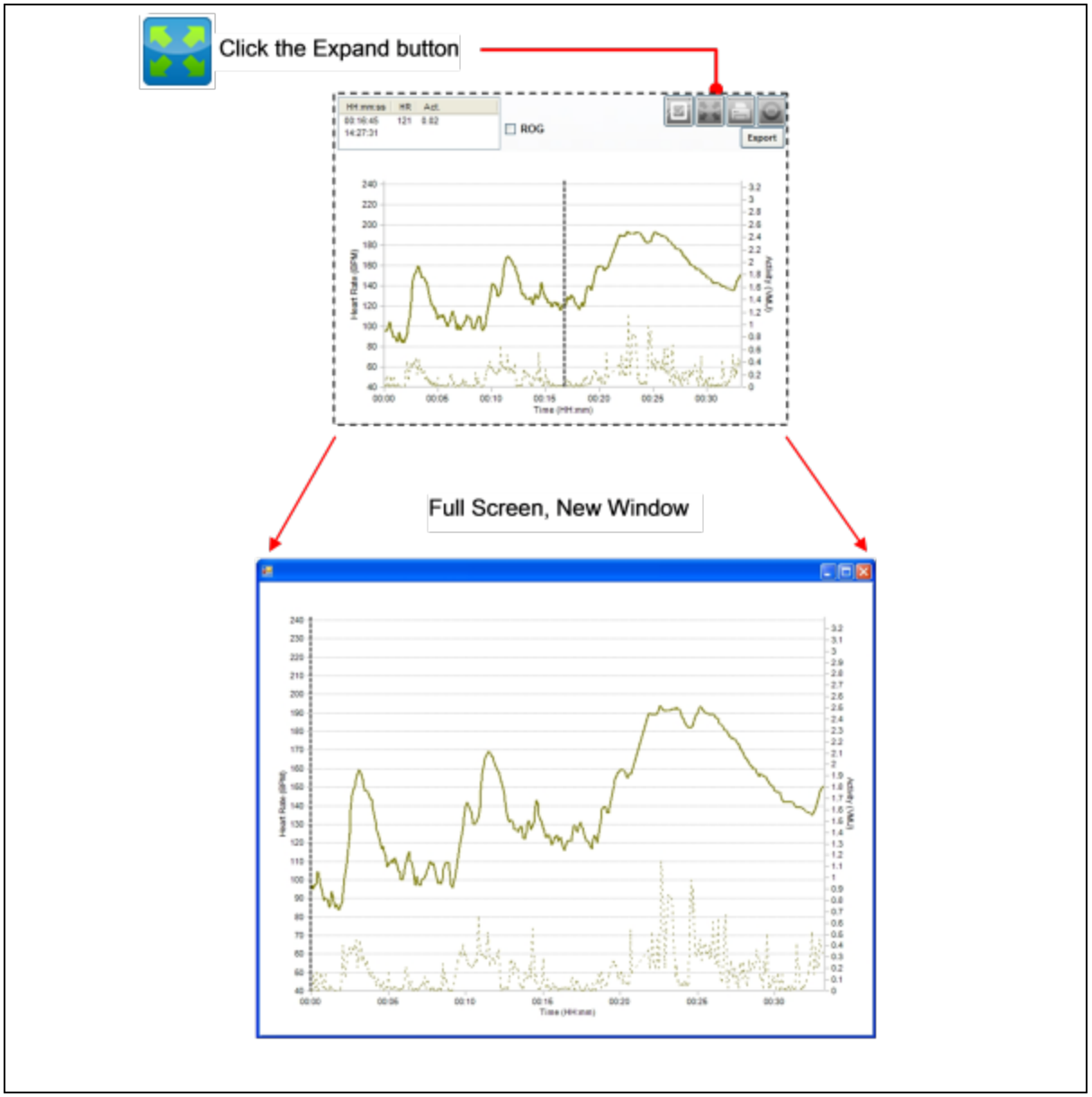
Use the Data Refresh button to update data still being recorded



Live Module

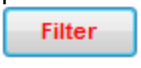
Analysis Module

5.7 Full Screen Display

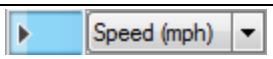


- Zoom and Pan will work on the new window
- No vertical cursor

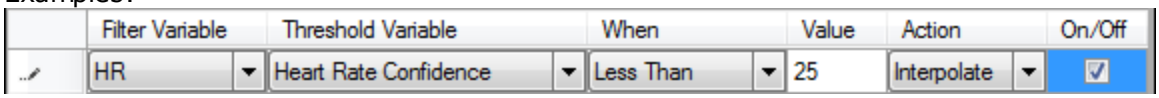
5.8 Filter Data

- Create filters to interpolate or make zero (null) sections of data according to their own value, or that for another parameter
- Use the filter data button 

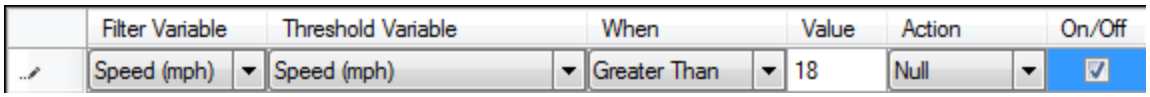
to display a dialogue to manage filters. The button text is red if any filter are active
- *Any* session displayed on the graph will have active filters applied
- Multiple filters can be applied to the same parameter

Filter Variable	Seven variables can be filtered: HR, BR, Posture, Activity, Peak Accel, HRV, Speed
Threshold Variable	The value of the threshold variable will control whether the filter is applied or not
When	Condition of threshold variable : Greater than, Less Than, Equal To, Not Equal To
Value	Value used with the 'When' condition. Units will be metric or imperial, as set in Preferences
Action	Should the filtered variable be interpolated, or made null? Which, depends on requirements.
On/Off	Turn the filter on or off. a filter set to ON applies to all sessions displayed on the graphs. if any filter is ON, the button text displays as red 
	To delete a filter, select on the left  and use the Delete key on your keyboad

Examples:

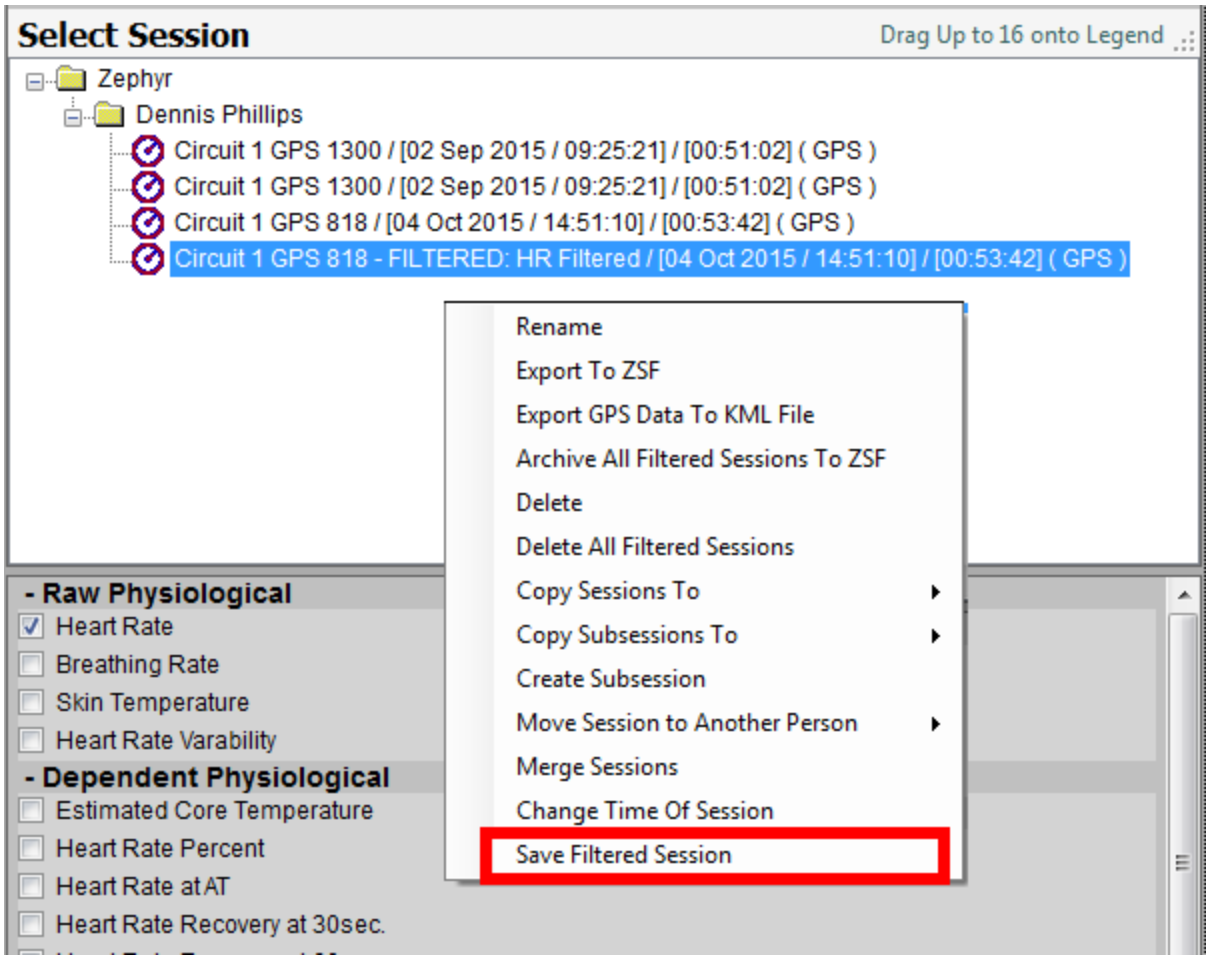


Use heart rate confidence to filter heart rate and remove high HR values caused by ECG noise, and interpolate - this will give more realistic values for calories burned, intensity and load calculations



Set realistic upper limits for speed and set to null any values greater than these, caused by poor GPS satellite reception.

- Data is filtered in the graph, but the raw data remains unfiltered in the OmniSense database.
- To save the filtered data permanently as a separate session, right click the session in the Select Session panel and select the *Save Filtered Session* option.



5.9 GPS Distance & Speed

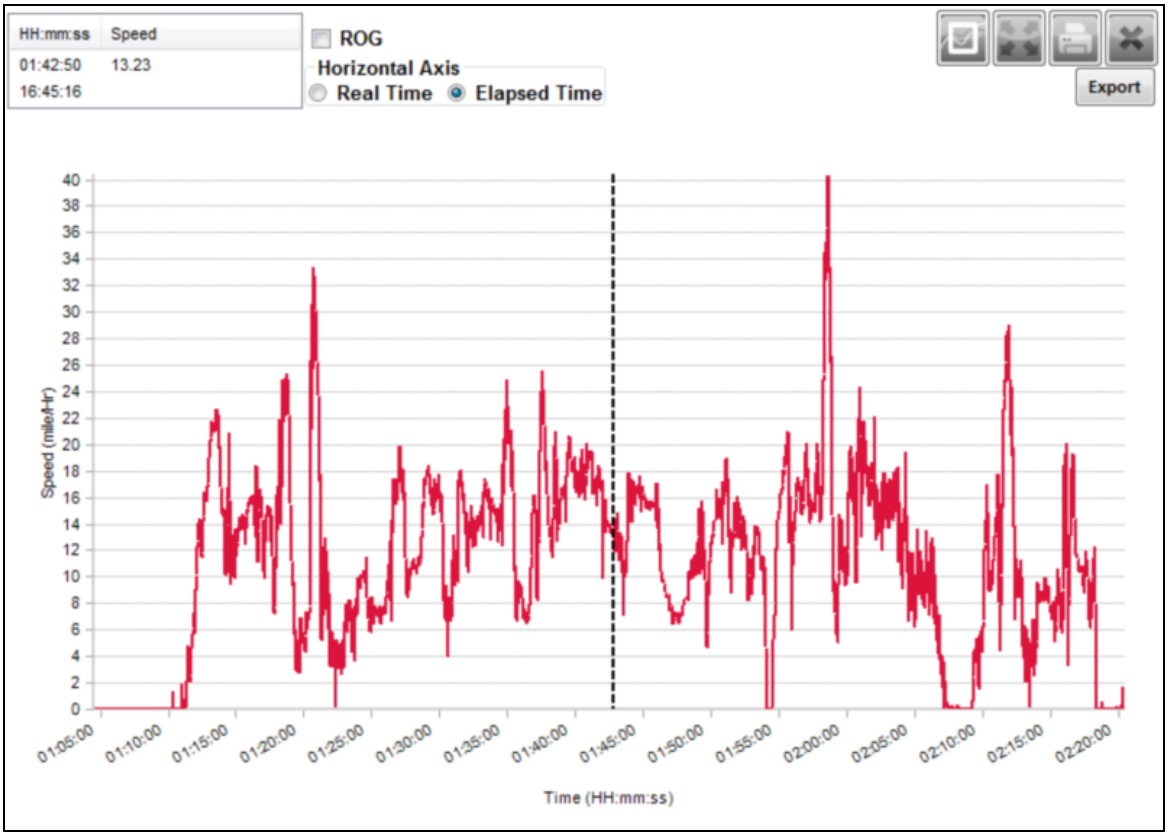
A BioHarness 3 may be manually configured to communicate with a supported Bluetooth GPS device. If this is done, and the device configured to Log in Summary & Waveform log format, then the GPS location and speed data can be accessed by importing the log data into Analysis. Instructions for configuration can be found in *OmniSense Live Help > GPS Support*.

Time Variables
Speed Over Time
Distance Over Time
Summary Variables
Speed Summary
Time in Speed Zone
Distance in Speed Zone
Total Distance Traveled

5.9.1 Speed Over Time

Speed Over Time is a Time Variable. It is only available from sessions created by importing log data from a BioHarness 3 which has been manually configured to communicate with a supported Bluetooth GPS device.

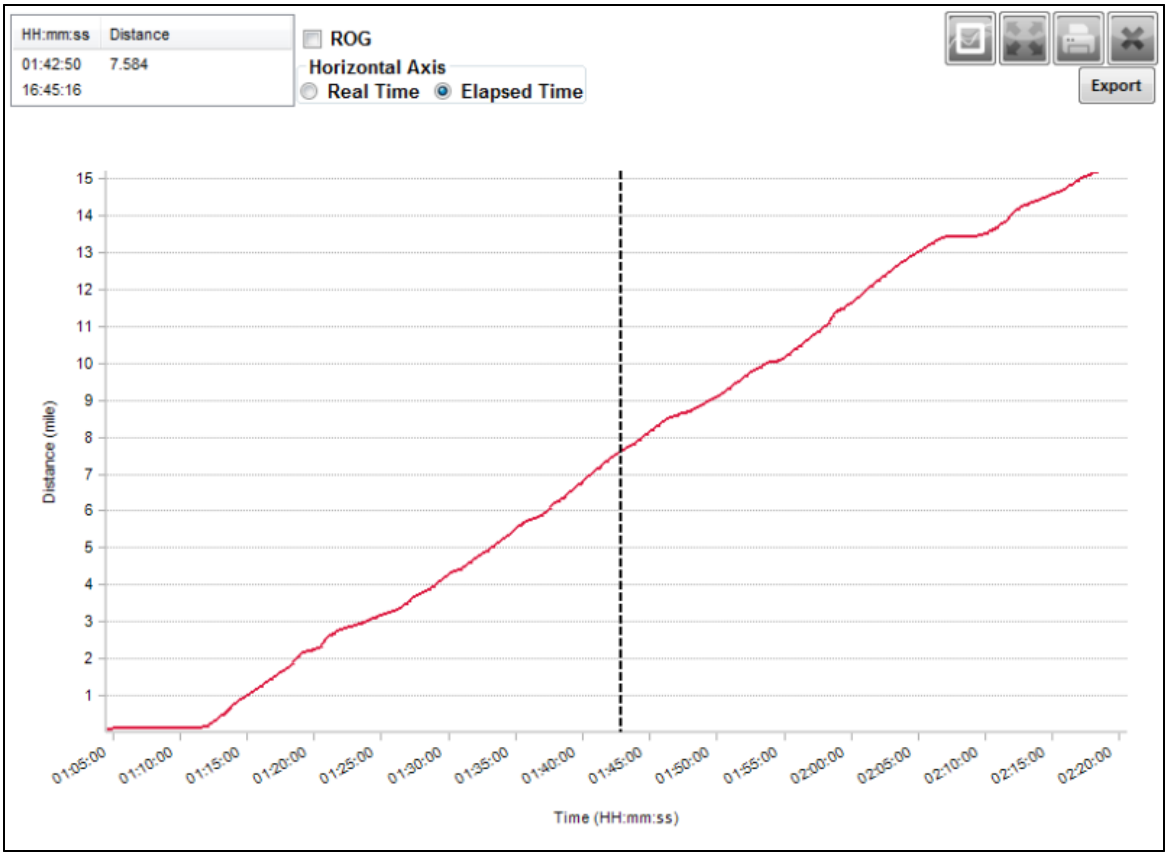
1. Select session from Session Tree, and populate the Legend
2. Check the *Speed Over Time* box in the Select Time Variables pane
3. A line graph will display, showing speed vs time



5.9.2 Distance Over Time

Distance Over Time is a Time Variable. It is only available from sessions created by importing log data from a BioHarness 3 which has been manually configured to communicate with a supported Bluetooth GPS device.

1. Select session from Session Tree, and populate the Legend
2. Check the *Speed Over Time* box in the Select Time Variables pane
3. A line graph will display, showing distance vs time, which will always accumulate



5.9.3 Speed Summary

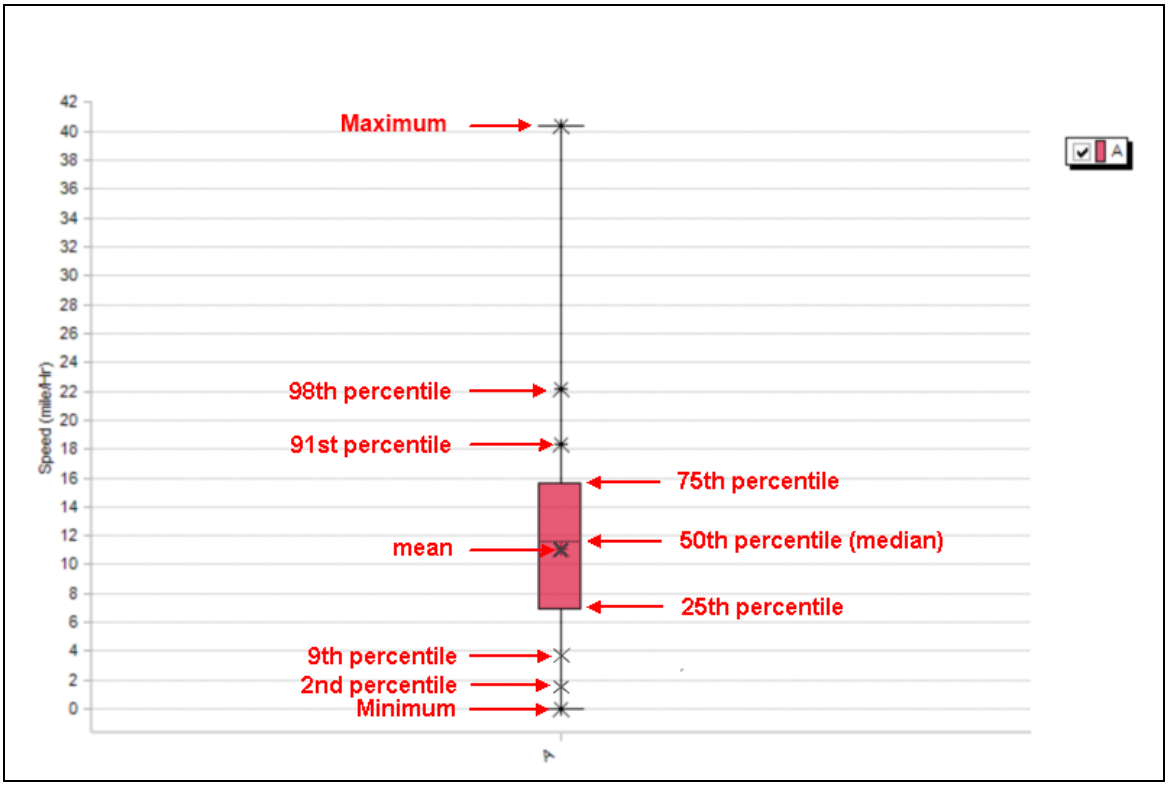
Distance Over Time is a Summary Variable. It is only available from sessions created by importing log data from a BioHarness 3 which has been manually configured to communicate with a supported Bluetooth GPS device.

Speed Summary is a box plot. An explanation can be found at http://en.wikipedia.org/wiki/Box_plot

1. Select session from Session Tree, and populate the Legend

2. Check the *Speed Over Time* box in the Select Summary Variables pane.

3. A line graph will display a box plot, as illustrated below.
   Note that some whisker points (the crosses at the mean and various percentiles) may be superimposed over each other if the speed distribution is compact enough.



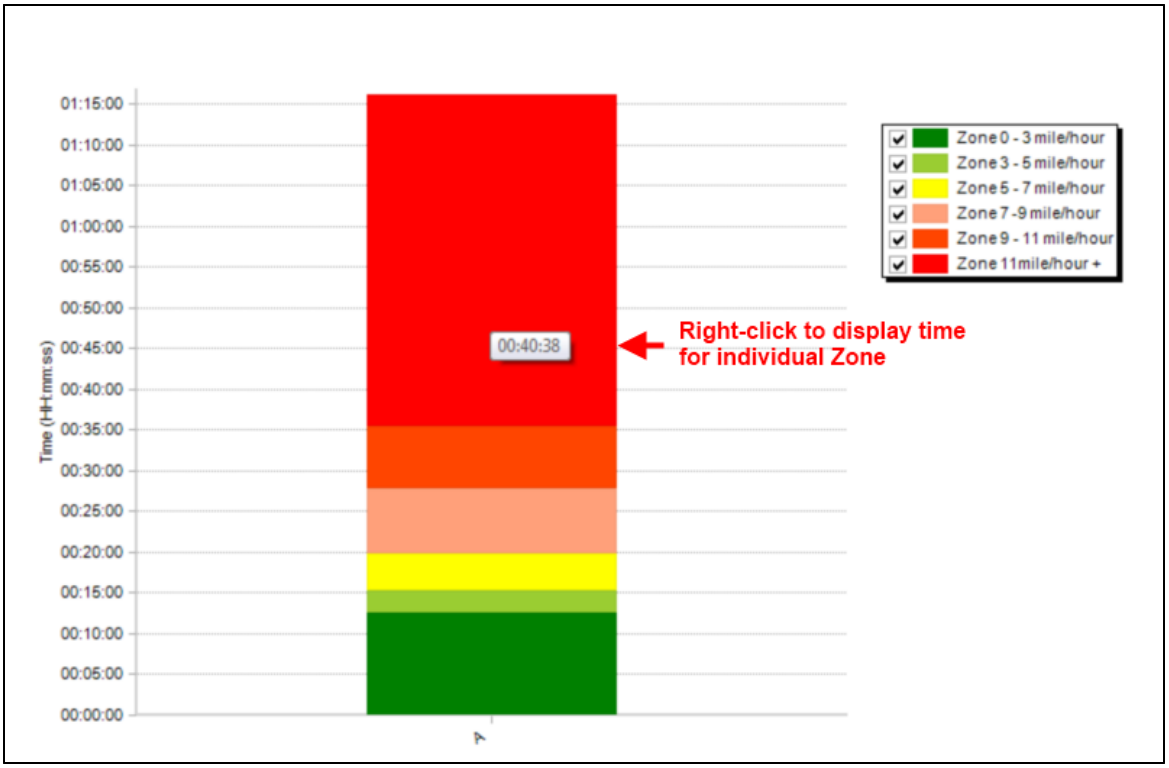
5.9.4 Time In Speed Zone

Time in Speed Zone is a Summary Variable. It is only available from sessions created by importing log data from a BioHarness 3 which has been manually configured to communicate with a supported Bluetooth GPS device.

1. Select session from Session Tree, and populate the Legend

2. Check the *Speed Over Time* box in the Select Summary Variables pane.

3. A histogram will display, as illustrated below.
   Right-click on an individual zone to display the duration in hh:mm:ss the subject has spent in any particular speed zone.



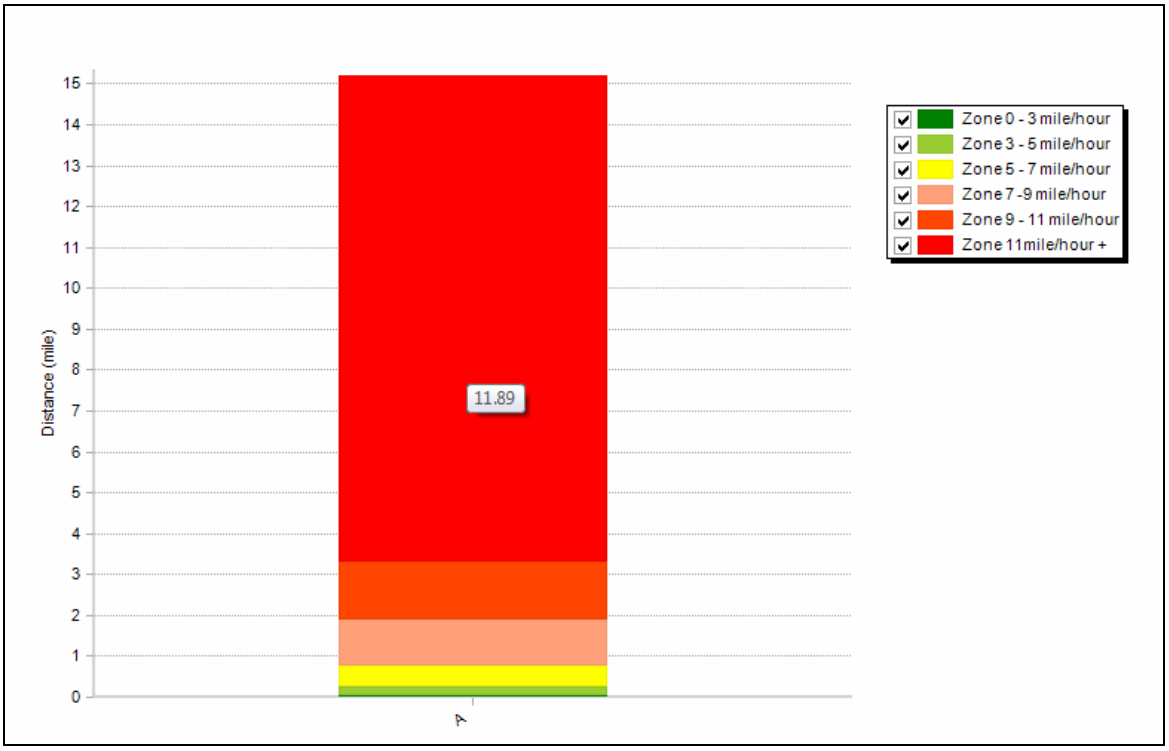
5.9.5 Distance In Speed Zone

Distance in Speed Zone is a Summary Variable. It is only available from sessions created by importing log data from a BioHarness 3 which has been manually configured to communicate with a supported Bluetooth GPS device.

1. Select session from Session Tree, and populate the Legend

2. Check the *Distance Over Time* box in the Select Summary Variables pane.

3. A histogram will display, as illustrated below.
   Right-click on an individual zone to display the distance in miles the subject has covered in any particular speed zone.



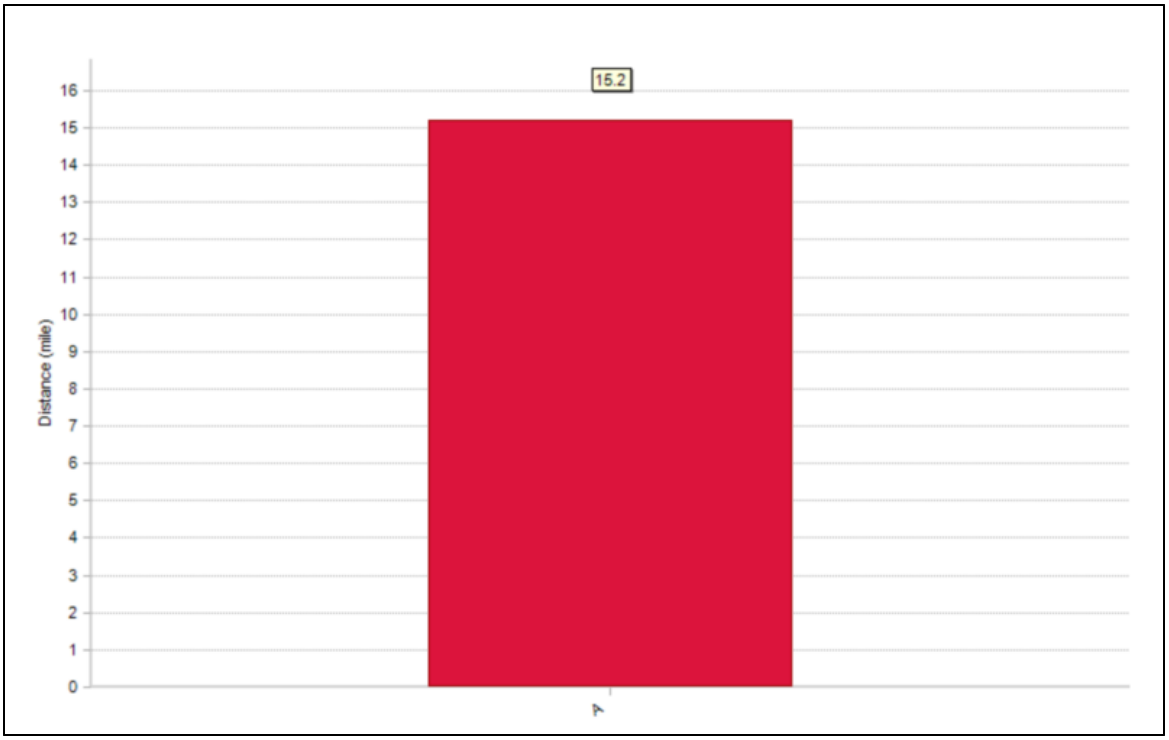
5.9.6 Total Distance Traveled

Total Distance Traveled is a Summary Variable. It is only available from sessions created by importing log data from a BioHarness 3 which has been manually configured to communicate with a supported Bluetooth GPS device.

1. Select session from Session Tree, and populate the Legend

2. Check the *Total Distance Traveled* box in the Select Summary Variables pane.

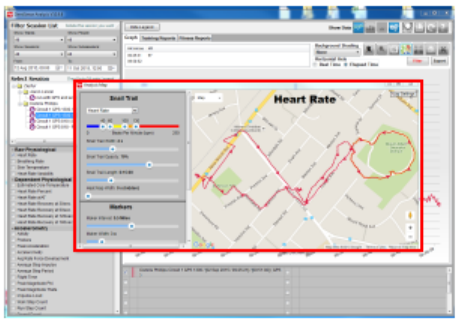
3. A histogram will display, as illustrated below.



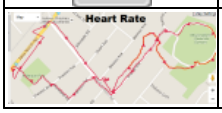
5.10 Map Display

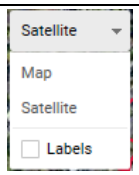
- Any data session containing location data provided by a supported GPS will now display automatically on an optional map/satellite view
- An internet connection is required for initial map display

Embedded map panel



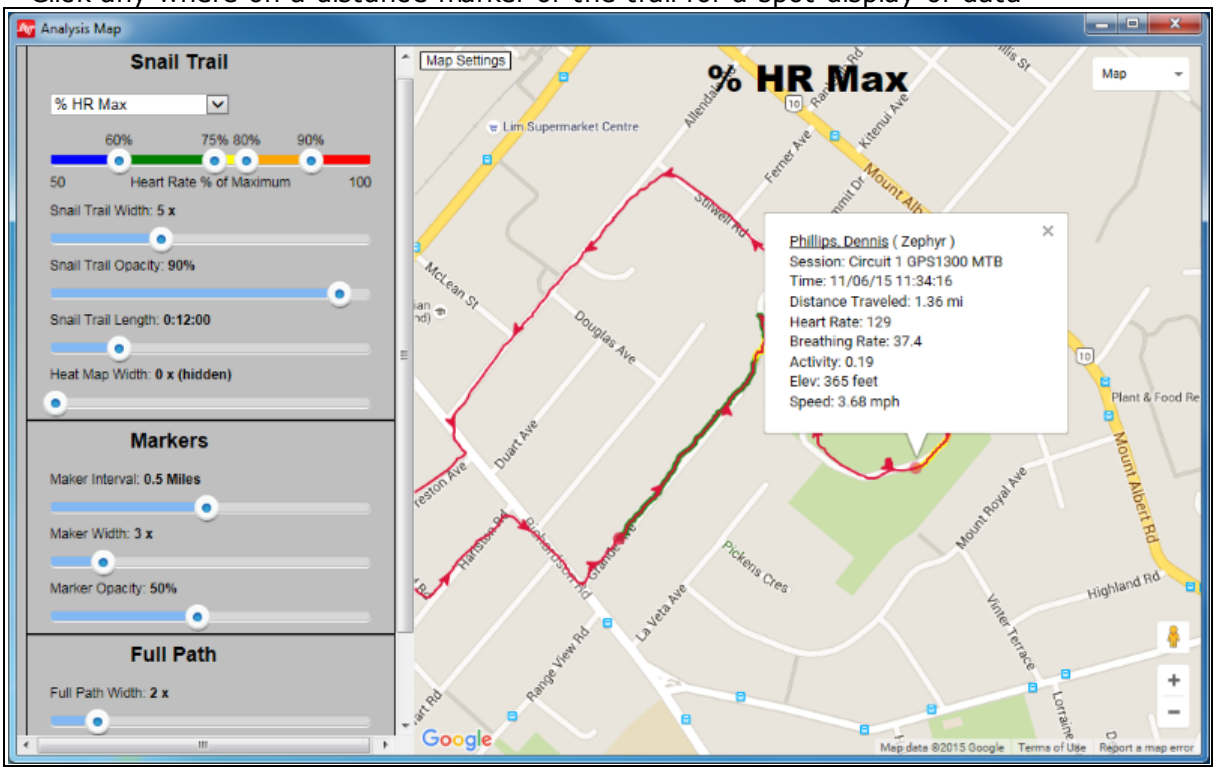
External window map

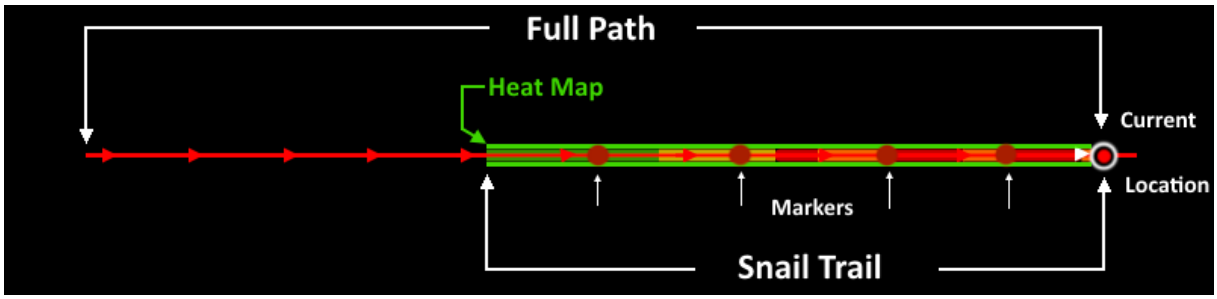
	The toolbar button toggles map display between an embedded panel, an external window, and hidden
	A map will display and scale automatically if the session contains valid GPS data

	Use the pulldown on the map  to switch between map and satellite view
Map Settings	Use the Map Settings button to show or hide the Snail Trail Panel
	Left-click and drag the map with the mouse cursor to reposition as needed
	Use the + / - button to zoom the map as needed
	Current location - the location on the map corresponding to the location of the vertical cursor on the graph panel in the main Analysis screen
	Full path - the full session path and direction traveled shown in color corresponding to the legend and data trace on the time graph or summary graph

5.10.1 Snail Trail

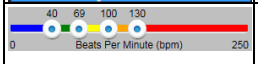
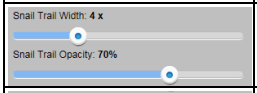
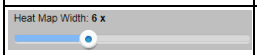
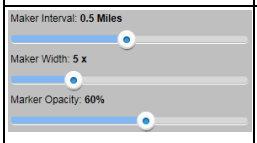
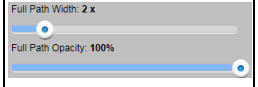
- The snail trail shows the immediate data history of a subject on the map or satellite view
- One of eight parameters can be color-indicated on the trail behind the current (vertical graph cursor) location on the map
- Click any where on a distance marker or the trail for a spot display of data





Snail against a black background for clarity

- Full track path is colored to match the assigned color in the legend (red in this example)
- Distance markers show on snail trail only
- Snail trail coloring changes according to thresholds set on Settings panel
- Snail trail length is set in settings, and show most recent selected data values for subject
- The heat map is an additional background to the snail trail. It changes from green (shown) to red as a subject reutrns to or stays in the same location. E.g. if the subject is stationary, their heat map will change to red if their location remains constant, or returns repeatedly to the same spot.

	The toolbar button toggles map display between an embedded panel, an external window, and hidden.
Map Settings	Use the Map Settings button to show or hide the snail trail settings panel.
Heart Rate % HR Max % HR@AT Physiological Intensity Mechanical Intensity Speed Zones Altitude Zones ROG Safety Path Only	Parameter available for display on the snail trail.
	Adjust thresholds for the chosen parameter to color snail trail according to parameter values.
	Snail trail width & opacity - adjust to suit required visibility of snail trail. Width at leftmost = snail trail hidden.
	Set snail trail duration - the time history of data prior to the current location. Current location can be varied by moving the vertical graph cursor on the time graph display
	The 'heat map' indicates persistence in a location. It is an additional background color surrounding the snail trail which changes from green to red as a location becomes more persistent.
	Distance markers will display (on the snail trail section only) as circles corresponding to the legend color scheme, as show in the diagram above.  Configure distance separation, width and opacity to suit.
	Full path width & opacity - adjust to suit required visibility. Width at leftmost = full path hidden.

	
Save Settings	Save the current map settings. They will be used each time a map is displayed.
Default Settings	Revert to default map settings.

Part 6

6 Readiness

- Readiness is a total indication of a subject's readiness for an activity within a training program.
- It is measured on a scale of 1 - 10.
- Access the Readiness components by using the  Readiness button in the toolbar.

1. Conduct an Orthostatic Test, and populate the legend with the data from the test.
2. Perform an automatic Orthostatic test analysis. This establishes the subject's resting heart rate, standing heart rate, and resting heart rate variability.
3. Complete a subjective survey and save the results. You can retain the subject's existing heart rate parameters, or update with those just measured.
4. Each component of the survey is given a weight factor and is used in the Readiness calculation.
5. Save the subject's new Readiness calculation.
6. Retrieve subject's Readiness history to monitor their progress and readiness status.

Orthostatic Test Analysis	Automatic Analysis of Orthostatic Test data to retrieve resting and standing heart rate, and resting HRV
Readiness Survey	Completion of subjective and objective factors to allow Zephyr's readiness algorithm to calculate a score.
Readiness History	Retrieval and display of a subject's readiness history from the database and external files

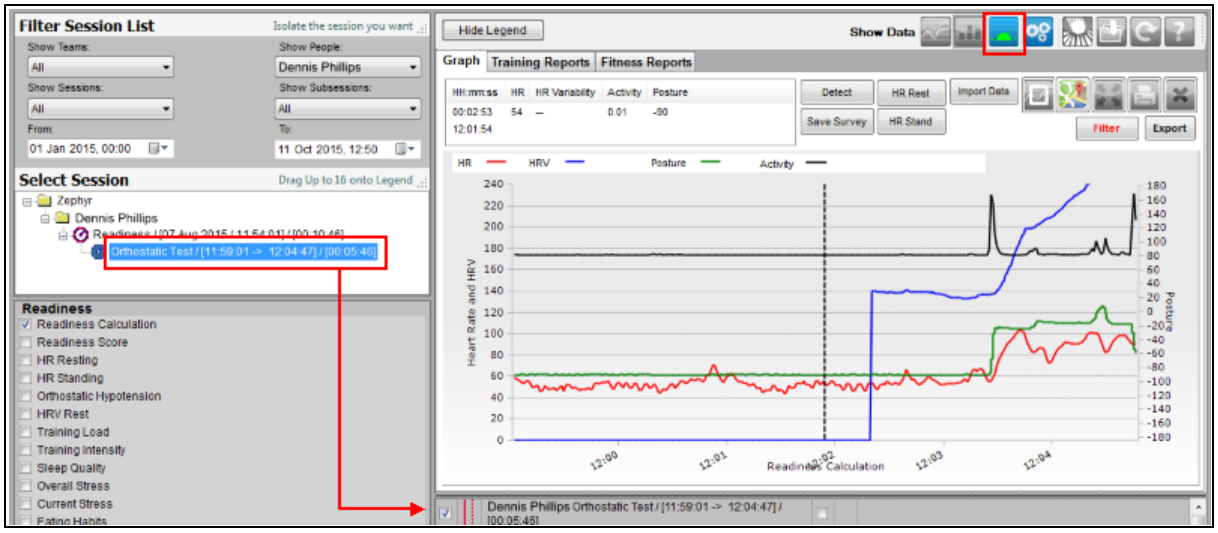
Remote Survey Using the Zephyr Readiness Phone application:

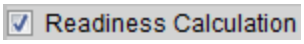
1. A subject will use Zephyr's Readiness application to conduct a Readiness test at home, and email the result to a chosen recipient.
2. The recipient will receive an email with a csv file attachment containing all information needed to complete a Readiness survey and update the subject's data.
3. Locate a session for the subject and populate the graph legend with it. *This need not be a Readiness session*. Any session for that subject is enough to ensure that the correct subject's Readiness History is updated.
4. Select the Readiness button on the toolbar.
5. Select the Survey button to display the survey dialogue.
6. Enter the survey data as received in the email attachment.
7. Save the survey results.

6.1 Orthostatic Test Analysis

Carry out an orthostatic hypotension test, using OmniSense Live to capture the data, or by logging data in the BioModule and importing into Analysis. A Zephyr Android application is under development which will allow a subject to carry out the test at home. The data will be analyzed and automatically emailed to a chosen recipient.

1. Locate the test data in the select session panel and load it into the legend.

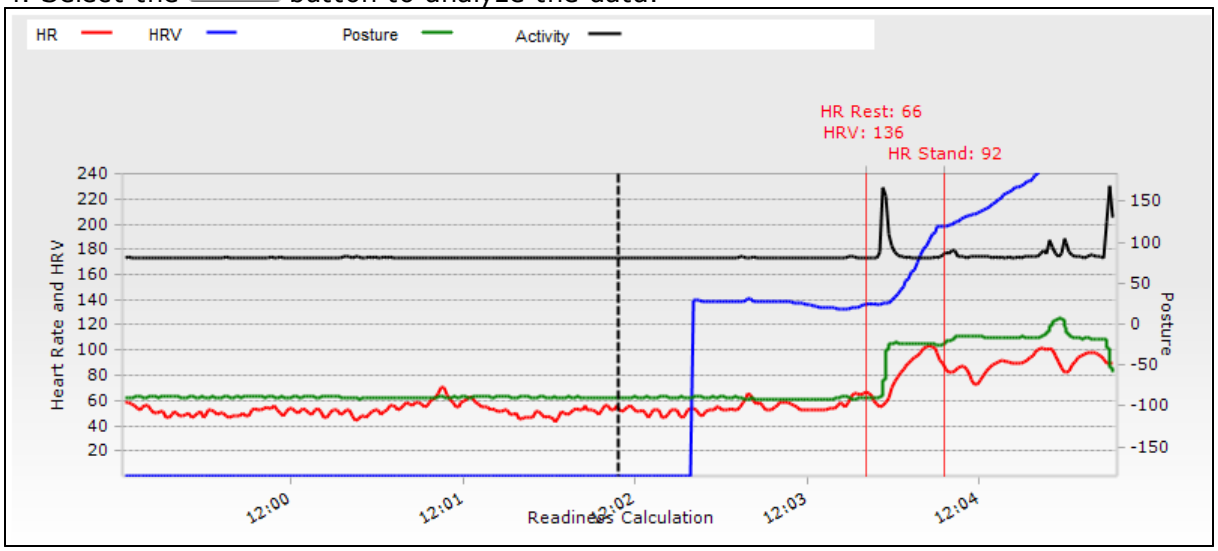


2. Select the  Readiness button from the toolbar and check the Readiness Calculation box  in the parameter list panel

3. Four parameters will display

Heart Rate	(Red) Will reach a settled value during the resting component. and increase when the subject stands
Heart Rate Variability	(Blue) Will be a zero value initially, as HRV takes 300 beats (~5 minutes) to be calculated
Activity	(Black) Will register a spike when the subject moves from the resting to standing positions
Posture	(Green) Will indicate the transition from resting to standing

4. Select the  button to analyze the data.



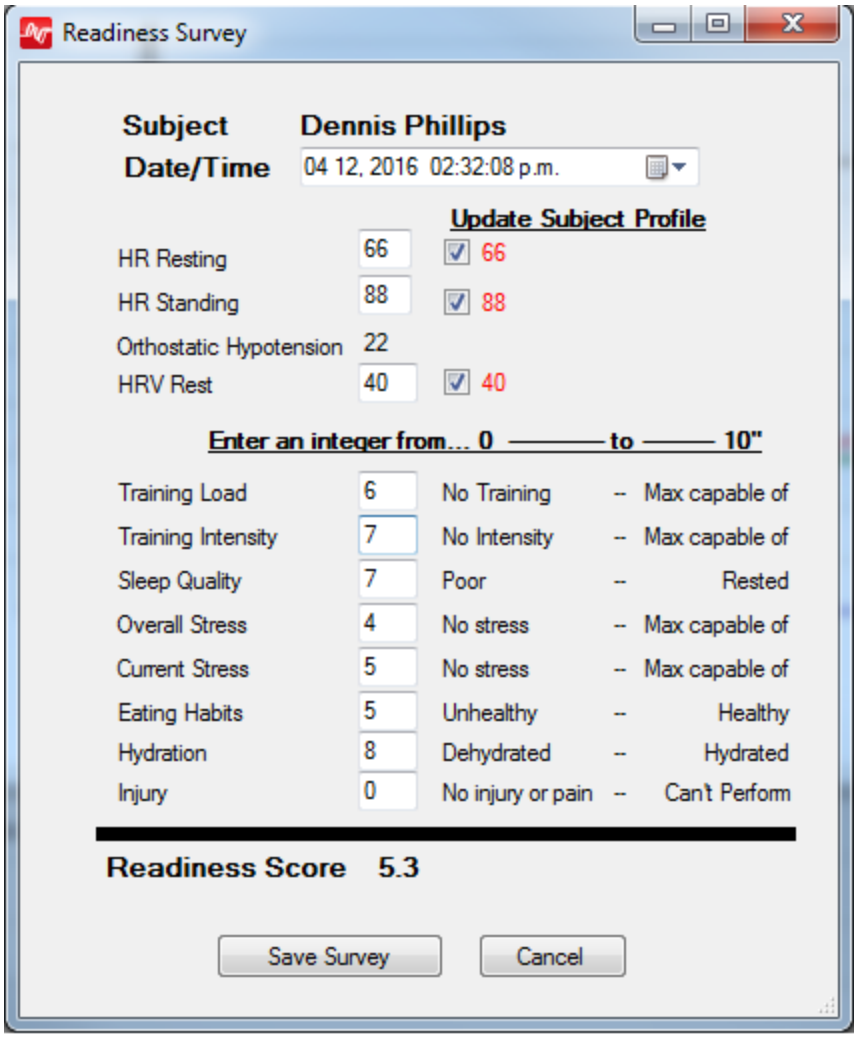
5. Markers will indicate Resting HR and Resting HRV at the end of the resting phase, and Standing HR approximately 15 seconds after the subject is standing.

6. The two markers can be adjusted manually by positioning the vertical graph cursor at the locations required and using the HR Rest and HR Stand buttons to update the acquired values.

7. Select the Save Survey button to display a dialogue containing the above values, and a survey of subjective questions for the subject to complete, to allow calculation of a Readiness value.

6.2 Readiness Survey

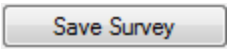
- Select the  toolbar button to display the Readiness panel, and then the Save Survey button to display the survey dialogue.



- The dialogue will be populated with the results of the current orthostatic hypotension test analysis, and the last saved value in the database.
- Use the checkboxes to update HR Resting & Standing, and HRV if needed. The new value will display in red.
- Values must be entered for the subject (shown blank above) for the rest of the survey, to calculate a more accurate Readiness metric.

Training Load	0 - 10 subjective estimate of average training load for previous 10 days
Training Intensity	0 - 10 subjective estimate of average training intensity for previous 10 days
Sleep Quality	0 - 10 subjective score for previous night only
Overall Stress	0 = No stress, 10 = Completely stressful
Current Stress	0 = No stress, 10 = Completely stressful
Eating Habits	0 = Poor, 10 = Optimal
Hydration	0 = dehydrated, 10 = hydrated
Injury	0 = injury free, 10 = unable to perform

- All of the above values will be used in the Readiness algorithm to arrive at a final calculation.
- The Readiness Score is updated as values are entered.
- Weighting of the components can be adjusted in the Preferences dialogue.

- Select  to save the final score to the database.

6.3 Readiness History

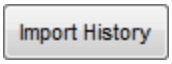
To display a history of Readiness metrics, including Orthostatic Test Analyses and Survey results:

1. Select the Readiness pane using the toolbar button

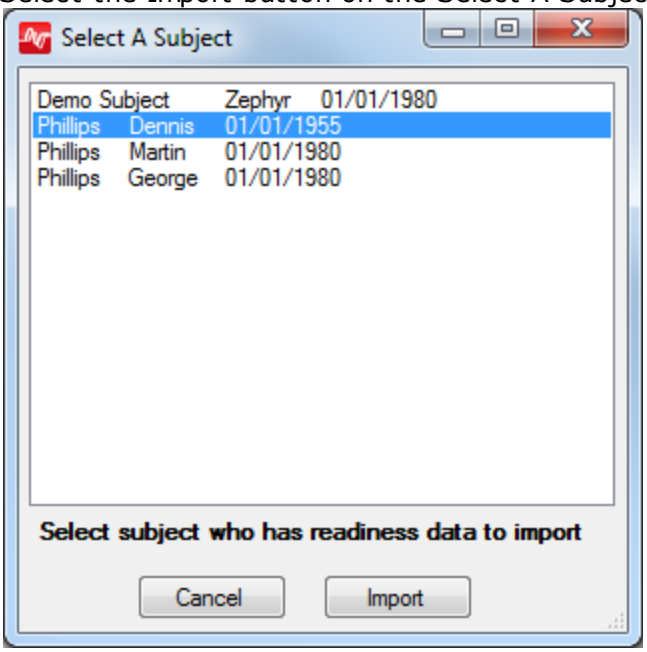
2. Set the From and To date range in the Filter Session panel to cover the desired history range

3. Select the Readiness Calculation checkbox in the Readiness parameter list

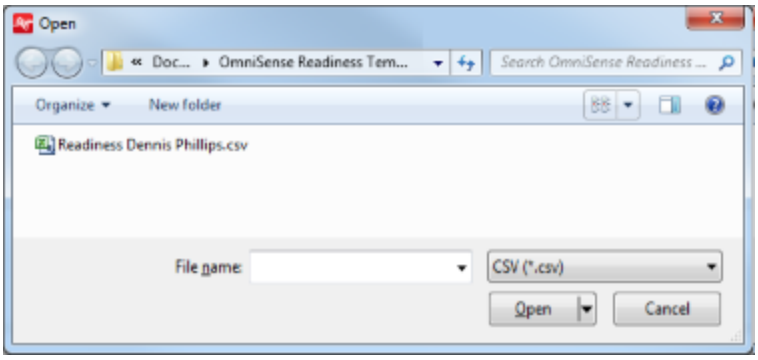
4. Select the Import History button (optional) to import Survey Results stored in an external file



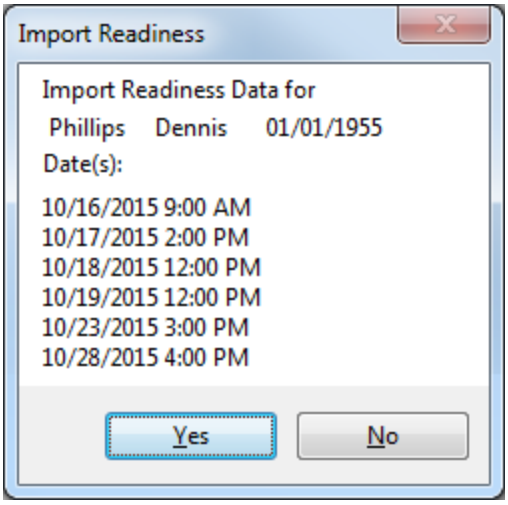
5. Select the Import button on the Select A Subject dialogue



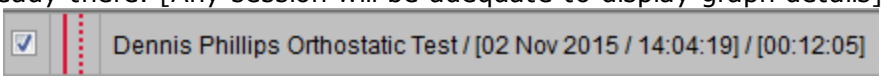
6. Browse to locate and select the required external survey file:



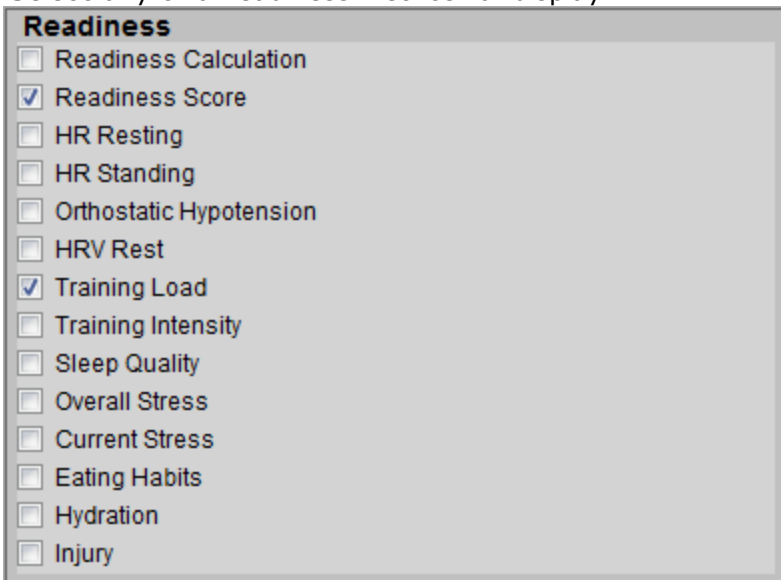
7. Confirm the selected data details



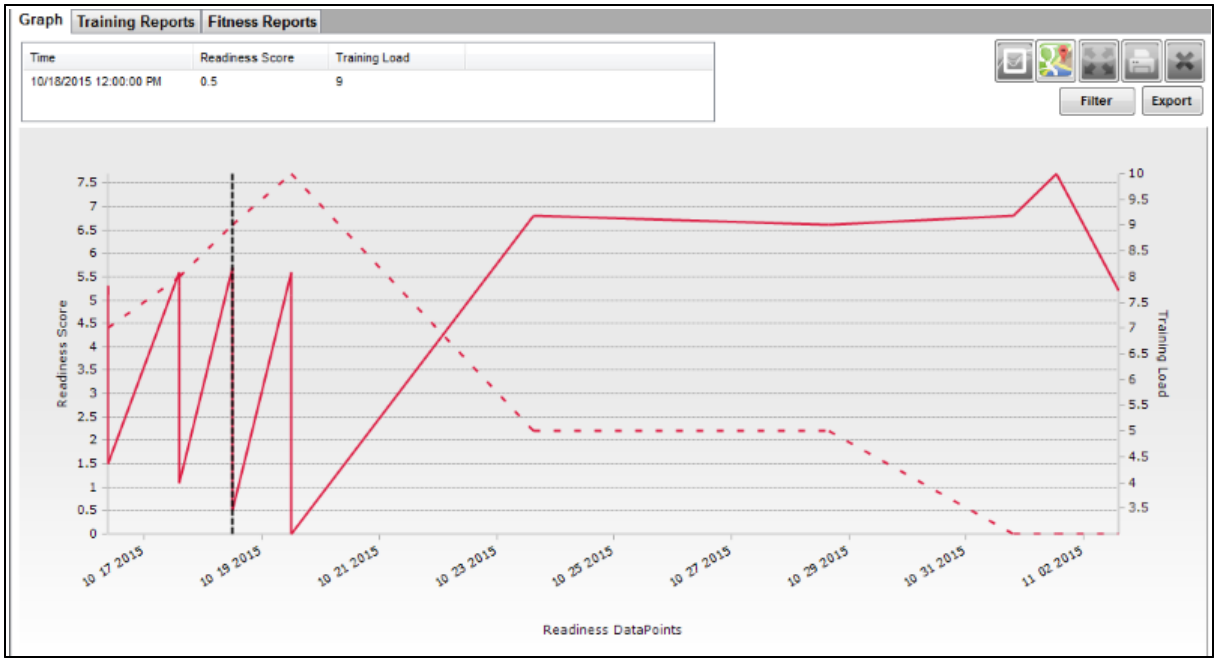
8. Populate the Legend with at least one session, if an orthostatic test session is not already there. [Any session will be adequate to display graph details]



9. Select any two Readiness metrics for display



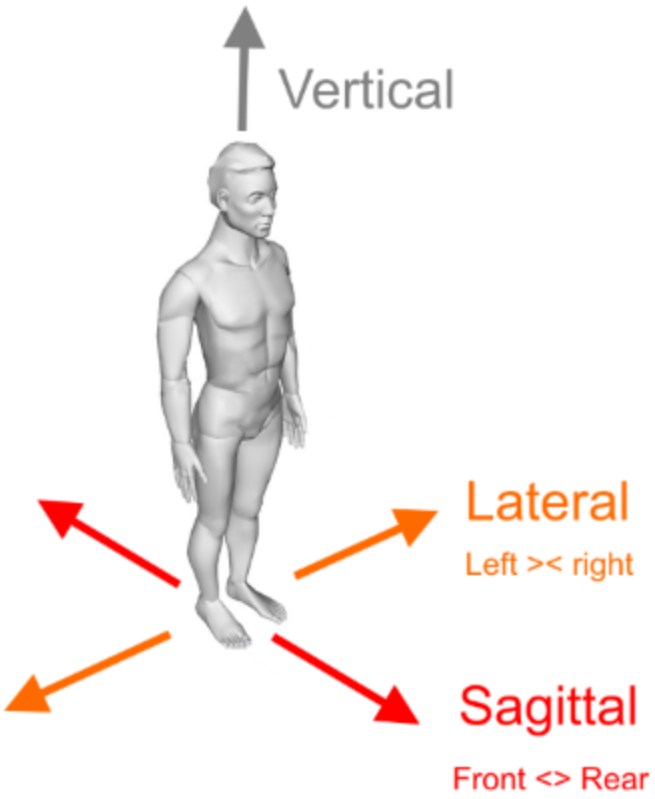
10. The graph will populate with the Readiness History. Adjust the From and To settings in the Filter Session list at any time.

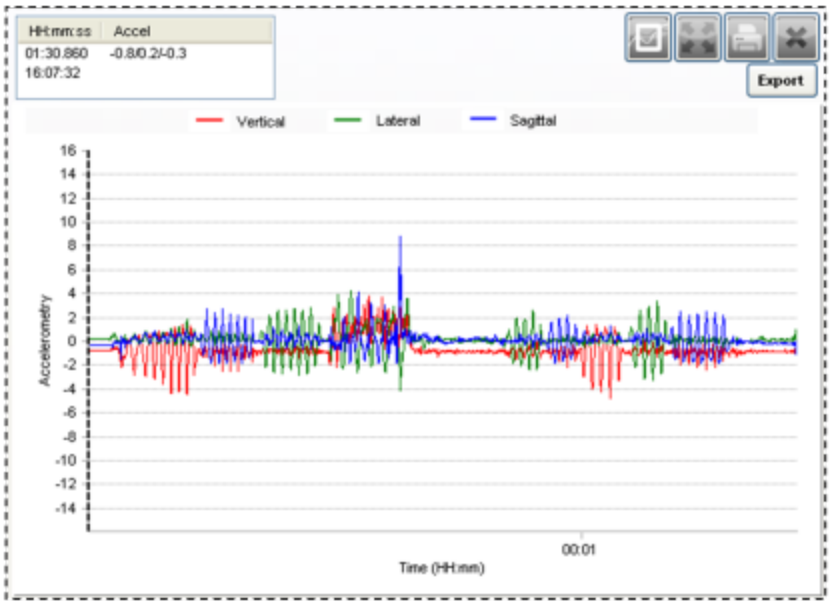


Part 7

7 Parameters

7.1 Acceleration

Acceleration	Lateral, Sagittal & vertical acceleration
OmniSense Live	Accel Side Panel
OmniSense Analysis	Time graphs
Log Data	Summary & Waveform, Enhanced Summary & Waveform recorded as raw bits
Units	g
Range	-8g - +8g
Reporting Frequency	100 Hz
Notes	• Available from data gather on Bluetooth & ECHO radio network systems  • Axis orientation - automatic if BioModule is configured for the correct garment type • Vertical data will show 1g gravitational offset



7.2 Activity Level

Activity Level	Measure of mechanical activity
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs, all Reports
Log Data	All Formats
Units	VMU (Velocity magnitude units, measured in g)
Range	0 - 16g
Reporting frequency	1Hz
Notes	• Walking equivalent activity > 0.2 VMU, running equivalent activity > 0.8 VMU
Formula	VMU = SQRT(x^2 + y^2 + z^2) where x, y & z are the averages of the three axial acceleration magnitudes over the previous 1 second epoch, sampled at 100Hz

7.3 Average Force Development Rate

Average Force Development Rate	Measure of explosive power.
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs, Pro Impact Report
Log Data	Enhanced log formats
Units	Newtons per second
Range	0 - 16g
Reporting Frequency	1Hz

Notes	• The gradient of the accelerometer magnitude (the steepness of the curve) during initiation of an impulse. • Averaged for the previous 10 steps, and zero if no steps detected for 5 seconds • Available OmniSense 4.0 and later

7.4 Average Step Period

Average Step Period	Time duration of a step
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs, Pro Impact Report
Log Data	Enhanced log formats
Units	Seconds
Range	0 - 1023
Reporting Frequency	1Hz
Notes	• Averaged for the previous 10 steps, and zero if no steps detected for 5 seconds • Available OmniSense 4.0 and later

7.5 Average Step Impulse

Average Step Impulse	Area under the accelerometer magnitude curve for a detected step
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs, Pro Impact Report
Log Data	Enhanced log formats
Units	Newton Seconds
Range	0 - 1023
Reporting Frequency	1Hz
Notes	• A measure of the efficiency of steps i.e. how much energy is expended during a step. Shorter (in duration) steps expend less energy. • Averaged for the previous 10 steps, and zero if no steps detected for 5 seconds • Available OmniSense 4.0 and later

7.6 Battery Level

Battery Level	Subject BioModule battery level
OmniSense Live	Battery icon in subject BioGauge
OmniSense Analysis	Time graphs
Log Data	All log formats
Units	Volts
Range	3.5 - 4.5
Reporting Frequency	1Hz
Notes	• Fully charged battery voltage ~4.2V • Fully discharged battery voltage ~3.6V • The BioModule processor powers off the device at ~3.6V to prevent chemical degradation to the battery

7.7 Blood Pressure

Blood Pressure	BP measured from a supported blood pressure cuff. Bluetooth Radio Network type only
OmniSense Live	Subject BioGauge, Sensors side tab
OmniSense Analysis	Time graphs
Log Data	Not logged in BioModule
Units	mmHg
Range	20 -280
Reporting Frequency	Default 5 minutes. Set in Live Preferences
Notes	• Sensor must be added by Bluetooth to the system • Pressure readings are relayed direct to the host PC by Bluetooth

7.8 Bound Count

Bound Count	Cumulative count of detected bounds
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary graphs, Pro Impact Report
Log Data	Enhanced log formats
Units	Count
Range	0 - 1023
Reporting Frequency	1Hz
Notes	• distinct from a step or a jump by the time in air between adjacent steps. • available from OmniSense 4.0 and later • reset when the BioModule is power cycled

7.9 Breathing Rate

Breathing Rate	Also respiration rate
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary graphs, reports
Log Data	All log formats
Units	Breaths per minute
Range	4 - 70
Reporting Frequency	1Hz
Notes	• breathing is detected by a pressure sensor in the strap which detects torso expansion and contraction due to breathing. • Several breaths cycles are necessary for initial breathing rate to stabilize (15 - 45 seconds) • spontaneous adjustment of strap tension or location, or abrupt changes in posture, talking, coughing etc may cause changes in the range of pressure detected by the strap which produce temporary artifacts (peaks or troughs) in breathing rate indication which should be anticipated and potentially ignored when analyzing data • BioHarness side strap rear showing location of the breathing pressure sensor • The strap should be located with the BioHarness device

	located under or slightly to the rear of the left armpit • This places the pressure sensor at the apex of rib curvature on the torso, allowing for optimal pressure variation as the subject breathes. • Regular manual palpitation of the breathing sensor can be used to check whether a sensor is functioning correctly. Use gentle pressure to simulate breathing cycles

7.10 Breathing Rate at Anaerobic Threshold

Breathing Rate at Anearobic Threshold (AT)	This is a fixed, saved value for any given subject
OmniSense Live	Saved in database, listed in Subject Details
OmniSense Analysis	Reports
Log Data	No
Units	Breaths per minute
Range	
Reporting Frequency	N/A
Notes	• Value can be manually entered in subject details screen • Value can be saved as a result of analysis of data from a Fitness Test

7.11 Calories Burned

Calories Burned	Cumulative estimation of calories burned during a session
OmniSense Live	Subject BioGauge
OmniSense Analysis	Summary Graphs, Reports
Log Data	No
Units	Calories
Range	
Reporting Frequency	1 Hz
Notes	• A heart rate based calculation $Calories = \sum_{e=1}^{n} Cal_e$ where Cal_e = Gender * (-55.0969 + (0.6309 * HR) + (0.1988 * wt) + (0.2017 * age)) + (1 - Gender) * (-20.4022 + (0.4472 * HR) - (0.1263 * wt) + (0.074 * age)) HR = average HR for epoch (1 second) wt = subject weight in Kg age = subject age in years Gender = 1 for male, 0 for female

7.12 Distance Traveled

Distance Traveled	GPS distance traveled since start of session
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary graphs, Reports
Log Data	Waveform or Development formats only
Units	Miles or Kilometers, configured in Preferences
Range	0 -
Reporting Frequency	1 Hz
Notes	• Data gathered by a supported GPS device, and relayed to BioModule • BioModule must be configured to log in Summary & Waveform or Enhanced Summary and Waveform format using Zephyr Config Tool

7.13 Elevation

Elevation	GPS elevation
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary graphs, Reports
Log Data	Waveform or Development formats only
Units	Feet or meters, configured in Preferences
Range	0 -
Reporting Frequency	1 Hz
Notes	• Data gathered by a supported GPS device, and relayed to BioModule • BioModule must be configured to log in standard or Enhanced Summary and Waveform or Summary and Development format using Zephyr Config Tool

7.14 Estimated Core Temperature

Estimated Core Temperature	Subject Core Temperature (estimation)
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary graphs, Reports
Log Data	Summary or Enhanced Summary formats
Units	Degrees Fahrenheit or Celsius, configured in Preferences
Range	33 - 41 Degrees C
Reporting Frequency	1 Hz
Notes	• A heart rate based calculation • Search for 'Estimation of Human Internal Temperature from Wearable Physiological Sensors' by Buller, Tharion, Hoyt & Jenkins to see a paper describing this work.

7.15 Explosiveness

Explosiveness	Peak g detected during a dash event
OmniSense Live	Subject BioGauge (displayed as 'Dash')
OmniSense Analysis	Time and Summary graphs, Reports
Log Data	N/A
Units	g
Range	~ 6 - 11g
Reporting Frequency	Per dash event
Notes	• Calculated automatically if a Dash Event is detected

7.16 Heart Rate

Heart Rate	Heart Rate
OmniSense Live	Subject BioGauge, details panel
OmniSense Analysis	Time and Summary graphs, reports
Log Data	All formats
Units	Beats per minute
Range	0 - 240
Reporting Frequency	1Hz
Notes	• Heart Rate is determined from analysis of 250Hz ECG data

7.17 Heart Rate @ Anaerobic Threshold (AT) %

Heart Rate @ AT %	Heart Rate as percentage point of HR at anaerobic threshold
OmniSense Live	Subject BioGauge, details panel
OmniSense Analysis	Time & Summary graphs, Reports
Log Data	N/A
Units	Beats per minute
Range	
Reporting Frequency	1Hz
Notes	• HR @ AT is a fixed saved value for each subject, in the OmniSense database • Can be entered manually is subject details screen in OmniSense Live • Can be saved automatically in OmniSense Analysis as a result of analysis of a Fitness Test • HR@AT is typically 80 - 85% of HRmax, and is used as a reference point in some training strategies.

Zephyr's interpretation of AT is the second ventilatory threshold, which is related to the anaerobic threshold. This is indicated by a marked increase in breathing rate under exertion, as a subject nears their maximum heart rate.

Each subject has a ***Breathing Rate*** at AT value stored against their details in the OmniSense database. It can be changed in two ways:

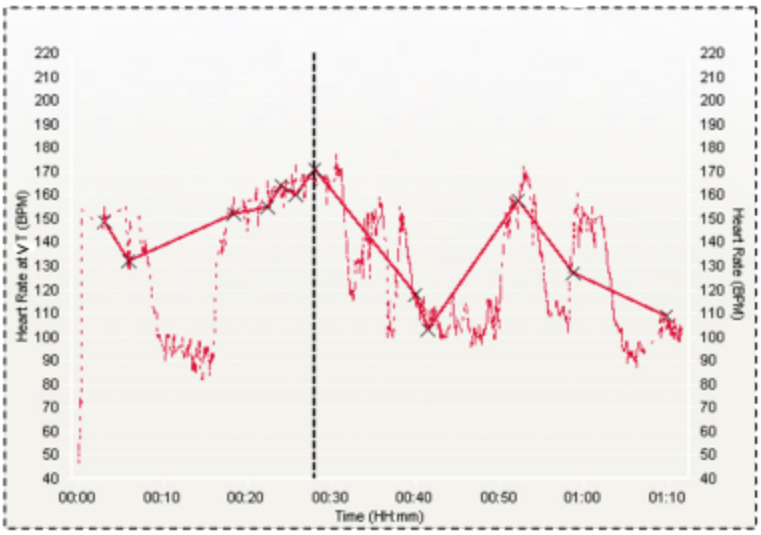
- Return to the Live Module, and edit the subject's details directly in the *Setup > Subject*

screen

First Name	Last Name	Age year	Sex M/F	Ht cm	Wt kg	Fitness Level	HR max BPM	BR@ AT BPM	HR Rest BPM	HR Stnd BPM
Carlo	Brena	1964	M	187	80	0	176	40		

- Conduct a Fitness Test and update the subject's details by analyzing the test data

During an active session, a subject's breathing rate may cross this threshold a number of times. The heart rate at AT value is updated on the display (top right corner) if the breathing rate stays above the AT threshold for more than 10 seconds, and this series of HR values can be displayed as a time graph

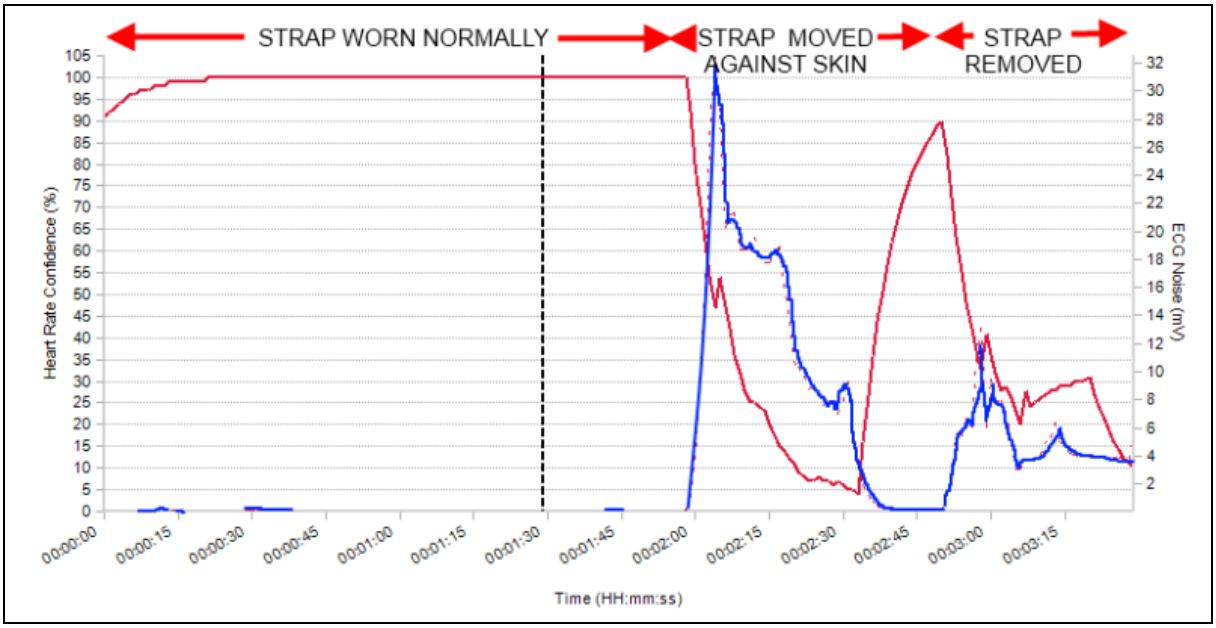


HR at AT (solid) graphed against HR

7.18 Heart Rate Confidence

Heart Rate Confidence	DEgree of validity of heart rate value, as a %
OmniSense Live	Subject BioGauge, details panel
OmniSense Analysis	Time & Summary graphs
Log Data	Summary and Enhanced Summary formats
Units	%
Range	0 - 100
Reporting Frequency	1Hz
Notes	An algorithm calculates the value, which takes into account: • ECG amplitude • ECG noise (and hence signal-to-noise-ratio, when combined with amplitude) • Worn detection. This is also dependent on ECG amplitude for the BioHarness 3, or impedance for the BioHarness 2 • 100% indicates full confidence in the indicated heart rate value. • Below ~ 25%, HR is not considered to be valid - the degree of noise in the signal will generate erroneous values - normally

	higher than expected

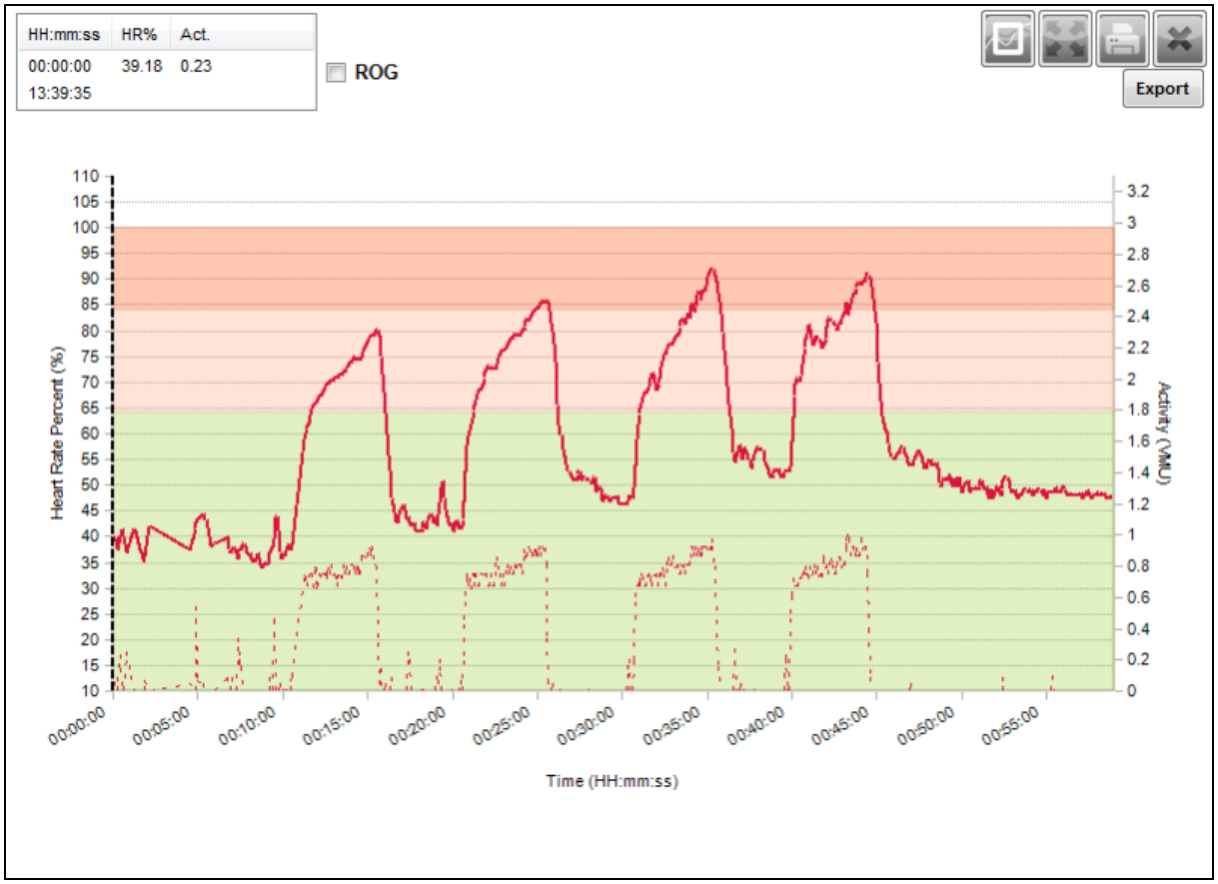


The above data show three scenarios:
- strap worn normally
- strap deliberately dragged against skin with dry ECG sensor pads. This creates excessive ECG signal noise
- strap removed completely

ECG noise is indicated by the blue trace. It is very evident that as ECG noise increases, then HR Confidence reduces, and vice versa.

7.19 Heart Rate Maximum (% of)

Heart Rate Maximum	Heart Rate displayed as a % of subject's maximum heart rate
OmniSense Live	Subject BioGauge, details panel
OmniSense Analysis	Time and Summary graphs, reports
Log Data	
Units	%
Range	0 - 100+
Reporting Frequency	1Hz
Notes	• Maximum heart rate is stored in the OmniSense database by editing the subject physiological parameters, or as part of analysis of ramped fitness test data using the OmniSense Analysis module. • A value greater than 100% is possible if the stored HR_{max} for a subject is inaccurate



Heart Rate is displayed over a stratified background indicating

- 0 - 64% HR_{max}
- 65 - 84% HR_{max}
- 85 - 100% HR_{max}

7.20 Heart Rate Maximum

Heart Rate Maximum	Subject's heart rate maximum, saved in OmniSense database
OmniSense Live	Subject Details
OmniSense Analysis	Reports (as Peak HR)
Log Data	N/A
Units	Beats per minute
Range	0 - 240
Reporting Frequency	N/A
Notes	A fixed value saved in the OmniSense database. • when a new subject is added it is auto-calculated but can be immediately edited • it is updated automatically when fitness test analysis data is saved in OmniSense Analysis • It governs the maximum value of the sweep scale in the subject BioGauge heart rate display • It is used to calculate HR as a percentage of maximum heart rate, when displayed in the subject BioGauge.

7.21 Heart Rate Recovery (HRR)

Heart Rate Recovery	Drop in heart rate following cessation of activity
OmniSense Live	Subject details
OmniSense Analysis	Readiness Report
Log Data	N/A
Units	Beats per minute over defined interval (30/60/120/180 sec)
Range	0 - 240
Reporting Frequency	Per Event
Notes	A fixed value saved in the OmniSense database. • when a new subject is added it can be entered manually • It will be calculated automatically in OmniSense Analysis from analysis of data from an Orthostatic Hypotension Test

Heart Rate recovery value can be used to give a measure of relative fitness.

It is commonly defined as the drop in heart rate following cessation of activity over a 30 sec interval, but this index can also be used over 60, 120 and 180 second intervals. OmniSense can provide all of these values automatically, if the subject maintains a low activity level (e.g. sitting or lying down) for the *entire* 180 seconds after ceasing activity.

The activity level above which activity must pass, and below which it must remain, to satisfy the criteria for the HRR algorithm to succeed, are configurable in the User Preferences dialogue of the OmniSense Live module.

Heart Rate recovery values are calculated in the BioModule and transmitted at each data request from the OmniSense Live application – they are saved to the OmniSense database and made available in the Analysis module.

The criteria for HRR recovery calculation are:

Active State

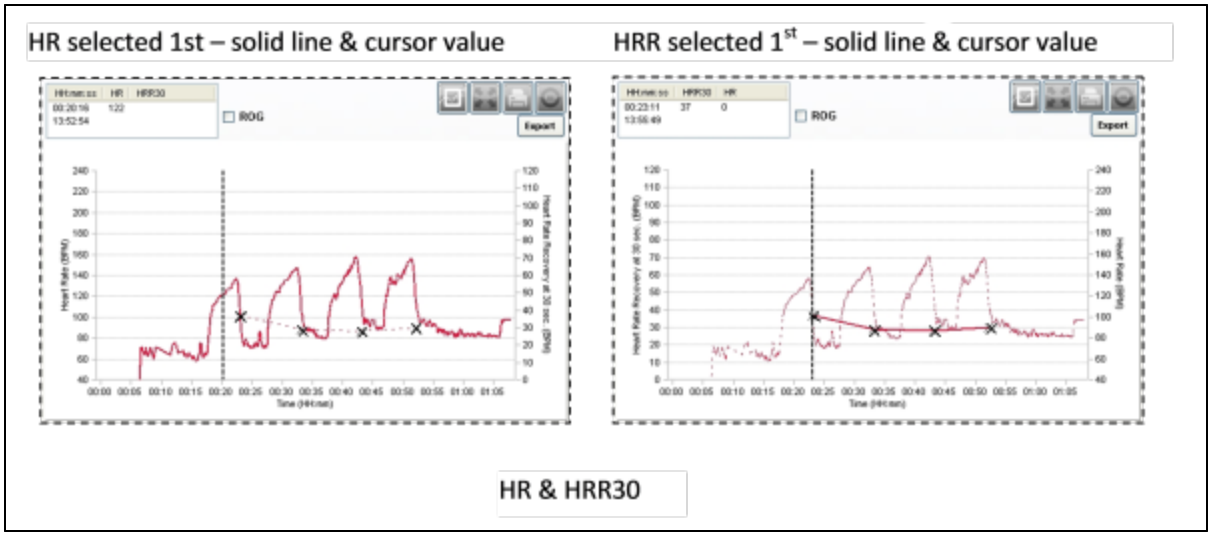
- A high rate of activity - VMU > 0.8 (configurable – see OmniSense Live User Guide)
- High heart rate - HR > 85% HR max

Resting State

- Low rate of activity - VMU < 0.2 (must be maintained for 30 - 180 seconds)

- If the subject causes an activity spike greater than 0.2 during the recovery phase, then the implication is that heart rate may increase momentarily, and render invalid the amount it has reduced during recovery. The HRR value will not be updated if such a spike is detected.

The following graphs are of a submaximal alternating run/rest test showing the various HRR options, graphed against Heart Rate:



Note that the order in which a pair of parameters is selected determines which is the easier to read on the graph. The moveable vertical cursor auto-positions to data points on the *first* parameter selected.

7.22 Heart Rate Resting

Heart Rate Resting	Subject's resting heart rate, saved in OmniSense database
OmniSense Live	Subject details
OmniSense Analysis	Readiness Report
Log Data	N/A
Units	Beats per minute
Range	0 - 240
Reporting Frequency	N/A
Notes	A fixed value saved in the OmniSense database. • when a new subject is added it can be entered manually • It will be calculated automatically in OmniSense Analysis from analysis of data from an Orthostatic Hypotension Test

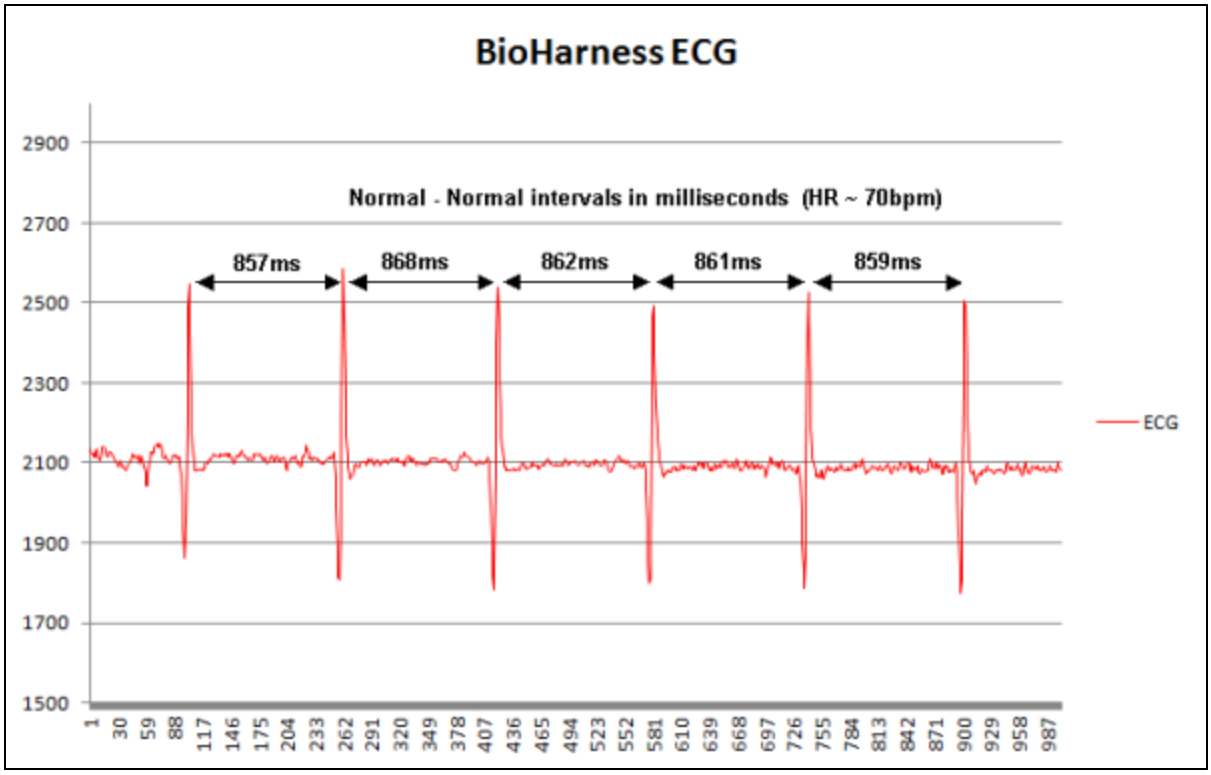
7.23 Heart Rate Standing

Heart Rate Standing	Subject's standing heart rate, saved in OmniSense database
OmniSense Live	Subject details
OmniSense Analysis	Readiness Report
Log Data	N/A
Units	Beats per minute
Range	0 - 240
Reporting Frequency	N/A
Notes	A fixed value saved in the OmniSense database. • when a new subject is added it can be entered manually • It will be calculated automatically in OmniSense Analysis from analysis of data from an Orthostatic Hypotension Test

7.24 Heart Rate Variability

Heart Rate Variability	A measure of the dynamic complexity of the ECG
OmniSense Live	Subject details
OmniSense Analysis	Reports
Log Data	Summary & Enhanced formats
Units	Milliseconds
Range	
Reporting Frequency	1Hz after first 300 beats (~5 minutes)
Notes	• A rolling 300 beat SDNN value (standard deviation of normal-normal intervals) • No data is available for ~ 5 minutes of BioModule power on

HRV is a measure of the small variations in R to R intervals



SDNN is the most representative parameter of HRV. Sometimes the term 'HRV' in medical papers indicates 'SDNN' among many papers of HRV analysis. Thus low SDNN is low HRV, which primarily indicates a reduction in dynamic complexity.

A healthy individual has a more irregular (higher) and complex HRV signal.

Age (Decade)	Mean SDNN	Notes
10s	55	> 50: High normal, Autonomic Nervous System's regulating function and stress coping ability good 35-50: Low-mid normal. The ANS's regulating function and stress coping

20s	47	ability good 20-35: Low. There's risk of developing stress induced disease. ANS function is weakened. < 20: Very low. There is a high risk of having chronic stress induced disease related to ANS dysfunction
30s	41	
40s	37	
50s	32	> 40: High normal 20-30: Low-mid normal 15-20: Low < 15: Very low
60s	27	

The clinical meaning of a decrease in SDNN is as follows:

- weakened autonomic nervous system's ability to keep homeostasis against the body's internal (e.g. core temperature) or external environmental changes
- lowered coping ability to various emotional or physical stressors
- general weakness of health

Diseases associated with lowered HRV

- Myocardial infarction
- Angina pectoralis
- Ventricular arrhythmia
- Sudden cardiac death
- Coronary artery disease
- Congestive heart failure
- Diabetes mellitus
- Diabetic autonomic neuropathy
- Brain injury
- Epilepsy
- Multiple sclerosis
- Fibromyalgia
- Obesity
- Chronic Fatigue syndrome
- Guillan-Barre syndrome
- Depression
- Anxiety disorder (Panic disorder)
- Autonomic dysrhythmias
- Stress induced diseases

7.25 Heart Rate Variability (Resting)

Heart Rate Variability Resting	Resting HRV
OmniSense Live	Subject Details
OmniSense Analysis	Readiness Report
Log Data	N/A
Units	Milliseconds
Range	
Reporting Frequency	N/A
Notes	• Saved from analysis of an Orthostatic Hypotension Test data in OmniSense Analysis

7.26 Height

Height	Subject Height
OmniSense Live	Subject details
OmniSense Analysis	N/A
Log Data	N/A

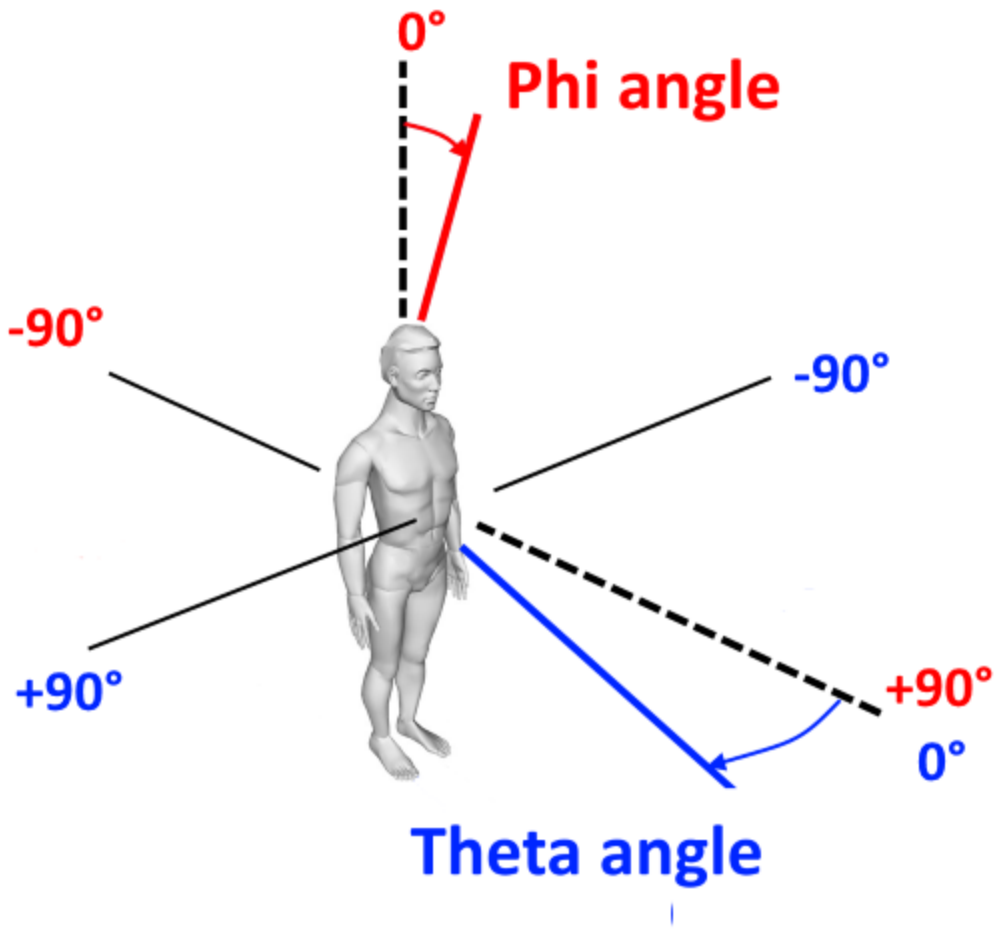
Units	Meters or inches
Range	
Reporting Frequency	N/A
Notes	• Entered manually in subject details. Used in BMI (Body Mass Index) calculations

7.27 Impact

Impact	Peak Acceleration in previous reporting period
OmniSense Live	Subject details
OmniSense Analysis	Time & Summary graphs
Log Data	All formats
Units	g
Range	0 - 16
Reporting Frequency	1 - 5 sec, dependent on ECHO setting
Notes	• Peak Acceleration Magnitude in the previous reporting epoch, using SQRT($x^2 + y^2 + z^2$) where x,y & z are the axial acceleration values sampled at 100Hz

7.28 Impact Peak Magnitude Phi & Theta

Impact Peak Magnitude Phi & Theta	Direction of angle of peak impact in the previous epoch
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs
Log Data	Enhanced Formats
Units	Degrees from vertical (phi), degrees from forward heading (theta)(see diagrams below)
Range	-180 - +180
Reporting Frequency	1 - 5 sec, dependent on ECHO setting
Notes	• direction of impact angle is determined by analysis of the three axial accelerometer streams



7.29 Impulse Load

Impulse Load	Accumulation of all impulses
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs
Log Data	Enhanced Formats
Units	Newtons
Range	0 -
Reporting Frequency	1 Hz
Notes	• the sum of the areas under the accelerometer magnitude curve for all impulses • reset when the BioModule is power cycled

7.30 Intensity and Load

In creating an exercise program it is important to ensure that mechanical load is gradually increased through the season as athletes become conditioned.

A high level repetitious mechanical load with unconditioned athletes can lead to stress fractures, shin splints, joint pain, or other "over use" injuries in short time. However, it is

important to get enough mechanical load in your training plan to ensure good musculoskeletal development. The key is in the adaptation.

These parameters are provided to enable the coach to more effectively monitor these early warning signs and create adaptive training plans that optimize performance.

The balance of mechanical to physiological indicators measured for multiple individuals performing the same activity can give an indication of efficiency and even "heart".

A high mechanical combined with a low physiological score relative to the others would indicate an individual is more efficient. Conversely, a high physiological and comparable mechanical output relative to others would indicate that an individual may be less efficient but have more mental stamina to compensate.

These concepts should only be considered under controlled activity circumstances and when individual subject profiles have all been calibrated using the baseline ramped effort fitness testing method.

Physiological Intensity & Load - a measure of a subject's cardiovascular workout

Mechanical Intensity & Load - a measure of a subject's musculoskeletal workout

Training Intensity & Load - the arithmetic average of the above

Physiological intensity measures a person’s cardiovascular output. A score of 0 is a resting level whereas a score of 10 is equivalent to the individual working at their maximal effort. This scale is based on the individual's customizable HRmax which can be measured and stored in their profile by performing a ramped effort baseline test (treadmill or beep test protocols outlined in OmniSense Analysis User Guide).

Physiological load provides a measure of the overall physiological output of a workout. By taking this value into account a coach can characterize workout’s difficulty (based on cardiovascular demand) on an individual or team basis.

Mechanical intensity is the measure of a person’s kinematic output. A mechanical intensity of 0 means that the subject is not putting any impact onto their musculoskeletal system whereas a score of 10 is equivalent to a sprinting level of impact and movement.

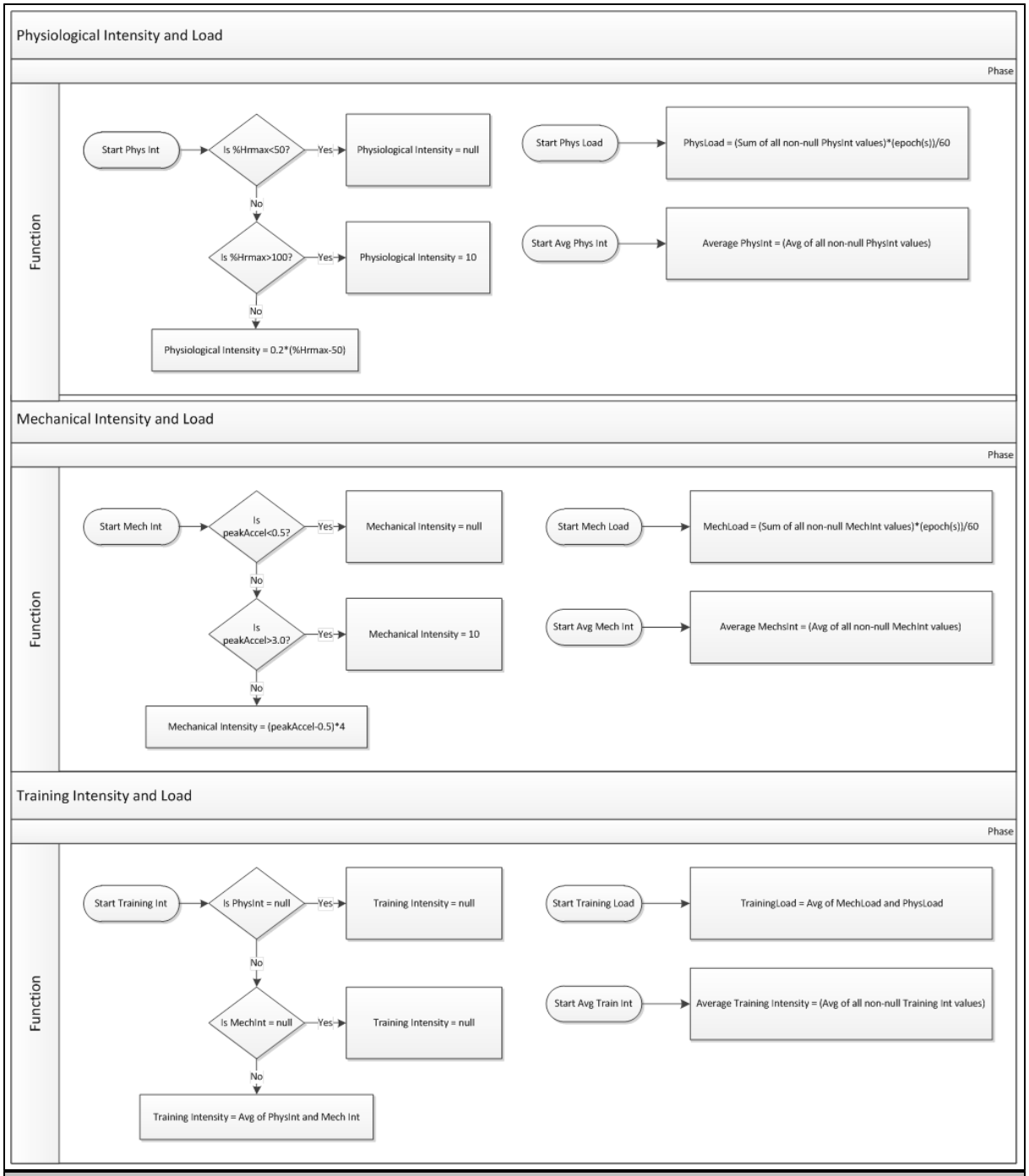
In creating an exercise program it is important to ensure that mechanical load is gradually increased through the season as athletes get conditioned. A high level repetitious mechanical load with unconditioned athletes can lead to stress fractures, shin splints, joint pain, or other "over use" injuries in short time. However, it is important to get enough mechanical load in your training plan to ensure good musculoskeletal development. The key is in the adaptation of the program through a well-devised periodization scheme that balances both mechanical and physiological demands and requirements. These parameters are provided to enable the coach to more effectively monitor these early warning signs and create adaptive training plans that optimize performance.

The balance of mechanical to physiological indicators measured for multiple individuals performing the same activity can give an indication of efficiency and even "heart". A high mechanical score combined with a low physiological score relative to the others would indicate an individual is more efficient. Conversely, a high physiological and comparable mechanical output relative to others would indicate that an individual may be less efficient

but have more mental stamina to compensate, they have "heart". These concepts should only be considered under controlled activity circumstances and when individual subject profiles have all been calibrated using the baseline ramped effort fitness testing method.

Also, by looking into the balance of mechanical and physiological load and intensity values for a player or team, day to day throughout the season, a coach can glean out of the "Periodization Report" which days the players are working more and less efficiently (when they are performing prescribed amounts of work), or even on what days a player or team are working most efficiently. By identifying the patterns associated with the workouts and games over a season, a coach can better optimize the periodization scheme of the team to make sure the players are performing at their best when it really matters. And conversely, when they are working hard enough ("putting money in the bank") to ensure that they are at their optimal conditioning level with impacting their performance in the key competitions.

These are the logic tables for how we calculate load and intensity in our software.



Bluetooth PSM systems report data at 1 second intervals. ECHO systems report at 2.5 second intervals. For this reason, load and intensity values should only be compared between sessions gathered on the same system, and of the same type e.g. both log sessions, or both transmitted sessions. Peak Acceleration values are always used in the calculations, and there is a greater likelihood that larger peak acceleration values will be found in the longer 2.5 second intervals. Valid comparisons can't be made between data sessions acquired on differing sessions.

7.31 Jump

Jump	Peak g during a jump event
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs
Log Data	N/A
Units	g
Range	0 - 16
Reporting Frequency	Per event
Notes	• the peak (upward) g detected during a jump event • jump criteria must be satisfied (crouch, pause, upward acceleration and time in the air)

7.32 Jump Count

Jump Count	Count of detected jump events
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs
Log Data	Enhanced Formats
Units	Count
Range	0 -
Reporting Frequency	1 Hz
Notes	• distinguished from a bound or a step by the time in the air • available from OmniSense 4.0 and later • reset when the BioModule is power cycled

7.33 Location

Location	Geographic location (supported GPS required)
OmniSense Live	Map side panel, Map window
OmniSense Analysis	Map Panel/Window
Log Data	Summary and Enhanced formats
Units	Latitude & Longitude
Range	
Reporting Frequency	1 Hz
Notes	• a supported GPS is required

7.34 Major Impact Count

Major Impact Count	Count of Major Impacts
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs, Impact reports
Log Data	Enhanced formats
Units	Cumulative Count
Range	0 -
Reporting Frequency	1 Hz

Notes	• Major impact has peak accelerometer magnitude during the event greater than 7g • detected angle of impact distinguishes impact from a step

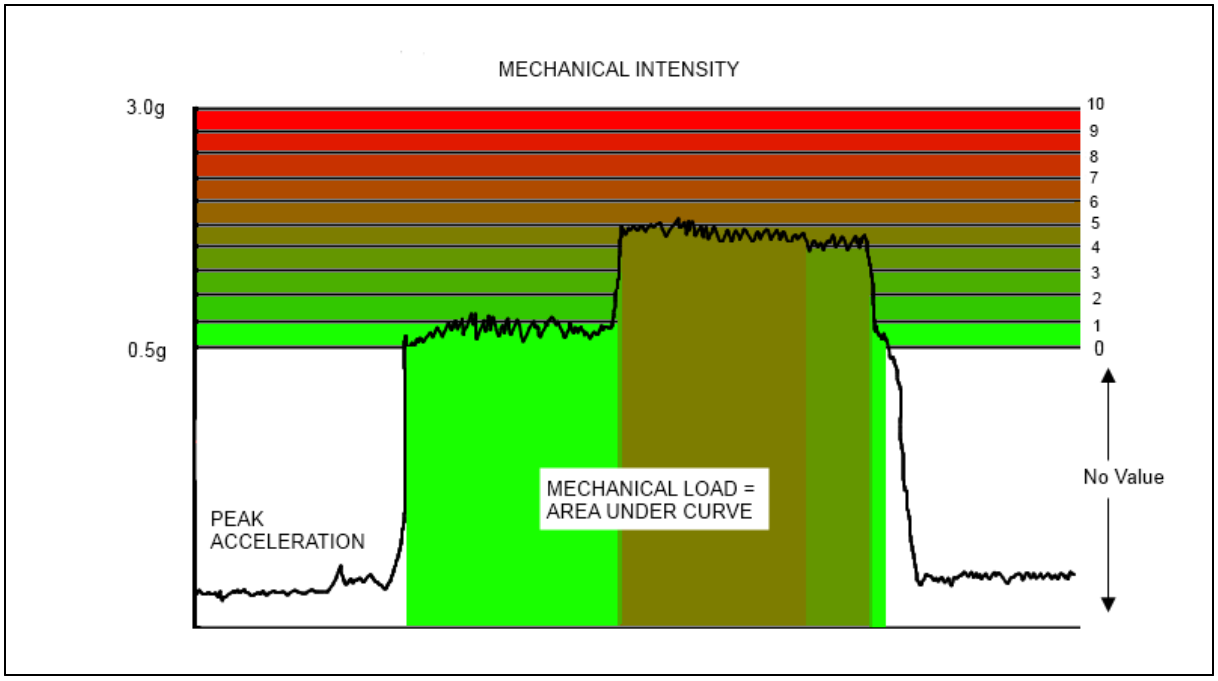
7.35 Mechanical Intensity

Mechanical Intensity	Index of kinetic output
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	N/A
Units	None
Range	0 - 10
Reporting Frequency	1 Hz
Notes	• Calculated within OmniSense • Peak Accelerometer Magnitude during epoch determines level of Intensity on 0 - 10 scale • Upper and lower peak g limits for the range are configurable in Live Preferences • An Intensity level of 10 is equivalent to a sprinting level of impact and movement • A subject whose peak acceleration values are less than 0.5g is considered to be resting. Mechanical Intensity = null. A null value will not bias any average intensity calculation if resting periods are included in a session. Walking will soon increase it above the 0.5g level. • Average mechanical intensity (per minute) = Mechanical load/ session duration in minutes

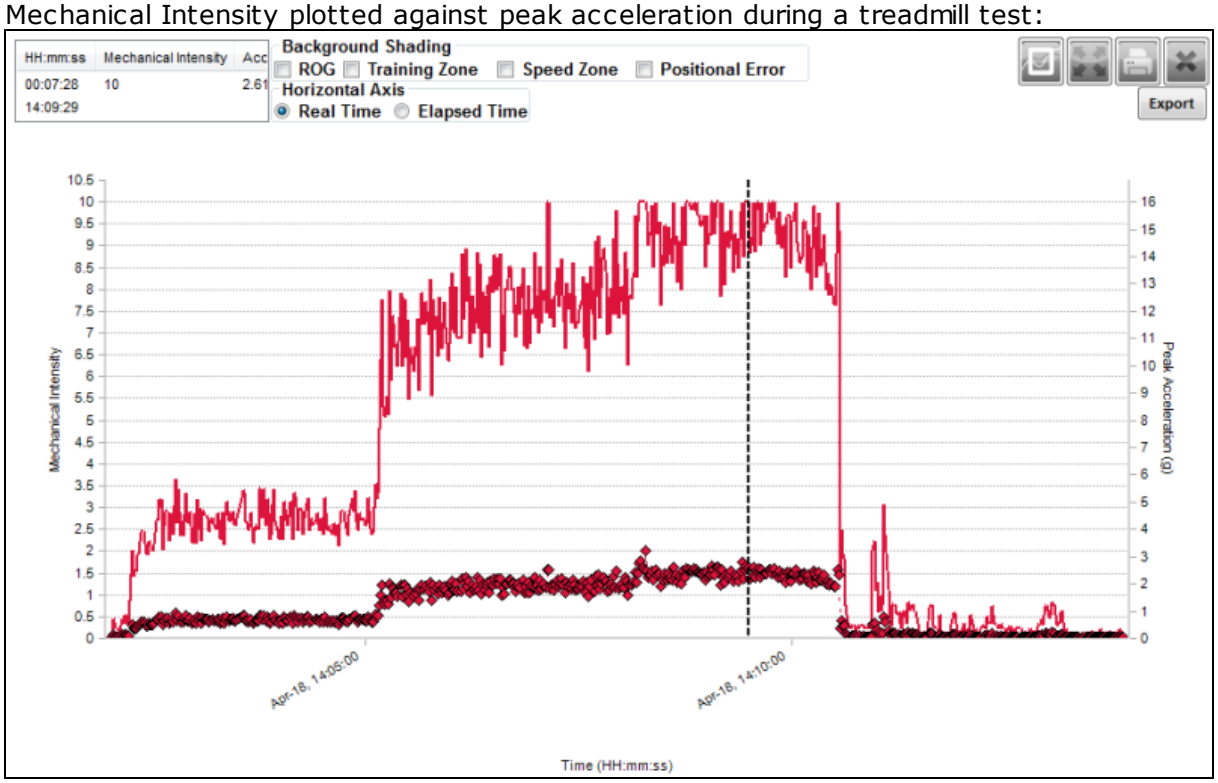
Mechanical Intensity is defined according to the range into which the Peak (in any axis) acceleration g value fits in any one second epoch, again stated as 1/60th minute. A value is assigned according to:

Intensity Level	Description
Null (no value)	Peak acceleration magnitude less than 0.5g (subject effectively resting)
1...9	Value scaled linearly between 0.5 (= 0) and 3.0g (= 10) e.g. 1.25g = Intensity of 5
10	Peak acceleration magnitude of 3.0g or greater

Thus a jogger who is running at a constant rate which generates (say) a peak g value of 2.0 for each epoch will have a constant Mechanical Intensity of 6

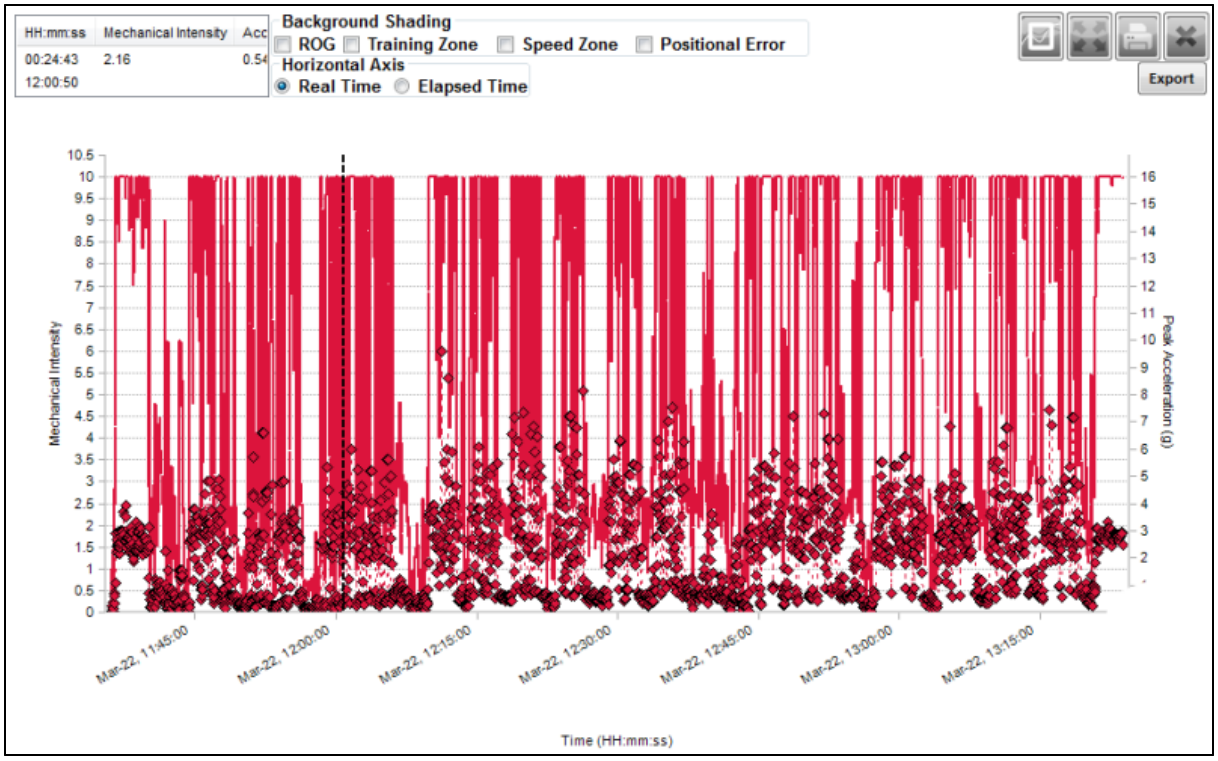


Mechanical Intensity plotted against peak acceleration during a treadmill test:

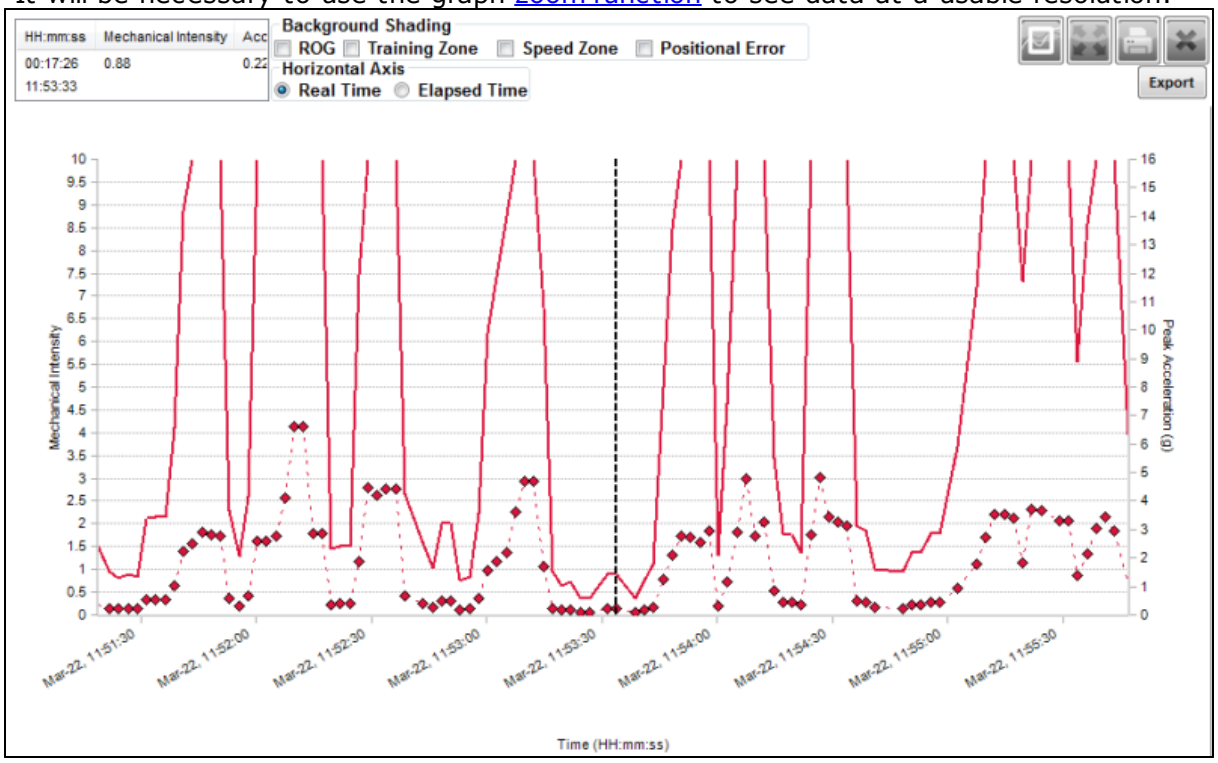


- Intensity increases as peak acceleration increases

Note: during activity sessions which involve much stop-start activity, Mechanical Intensity data may look chaotic, such as during soccer practice:

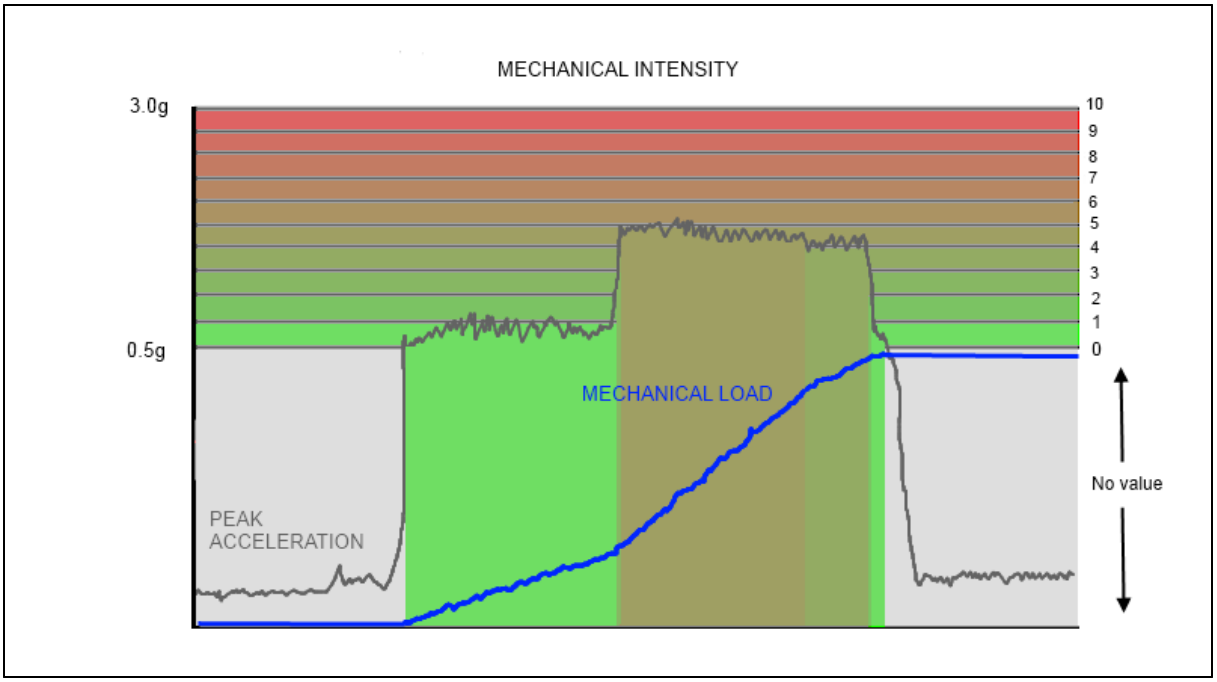


It will be necessary to use the graph zoom function to see data at a usable resolution:



7.36 Mechanical Load

Mechanical Load	Cumulative index of kinetic output, based on Mechanical Intensity
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	N/A
Units	None
Range	0 - 10
Reporting Frequency	1 Hz
Notes	• Mechanical Intensity values are accumulated • Mechanical load is a measure of total kinematic output and will give a good indication of an individual's overall level of effort compared to their historic data, or to a group, for a given training session.



The blue line represents mechanical load. It increases only when mechanical intensity > 0 (peak g > 0.5g or configured value)

Mechanical load is the accumulation of the Mechanical Intensity value over time.

$$\text{Mechanical Load} = \sum_{e=1}^{\infty} \text{Mech. Intensity}_e * \text{Epoch Duration}$$

The same jogger's Mechanical Load will increase by 6 each second, so their total Mechanical Load after 3 minutes will be

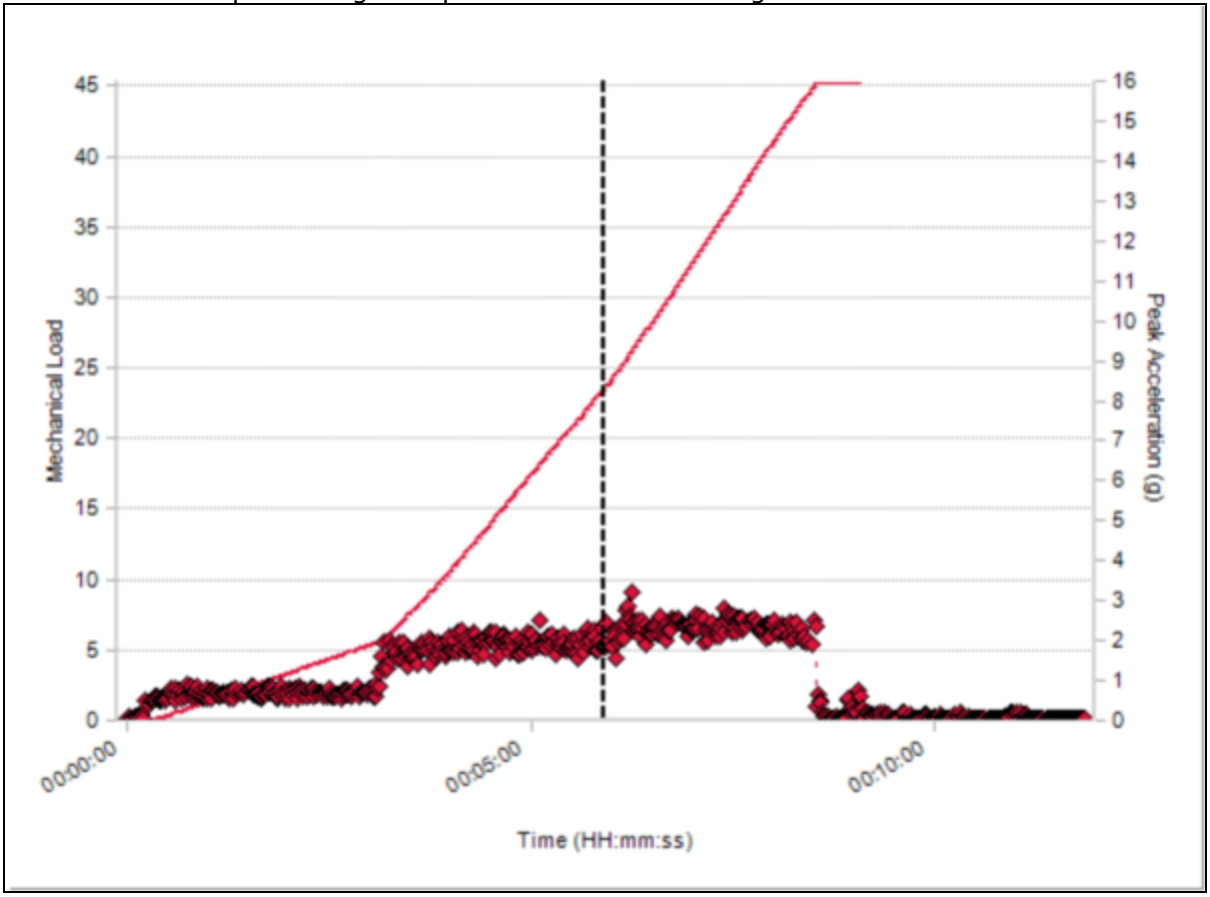
$$\text{Mechanical Load} = \sum_{e=1}^{180} \left(6 \times \frac{1}{60}\right)$$

$$= 18$$

AVERAGE MECHANICAL INTENSITY (per minute)
For the above example:

$$\text{Avg. Mech. Intensity} = \frac{\text{Mech.Load}}{\text{Session duration in Min.}}$$
$$= \frac{18}{3}$$
$$= 6$$

Example
Mechanical Load plotted against peak acceleration during a treadmill test:



- Load increases more gradually during warm up
- Load curve steepens during test as peak acceleration increases
- Load curve flattens when peak acceleration reduces

7.37 Minor Impact Count

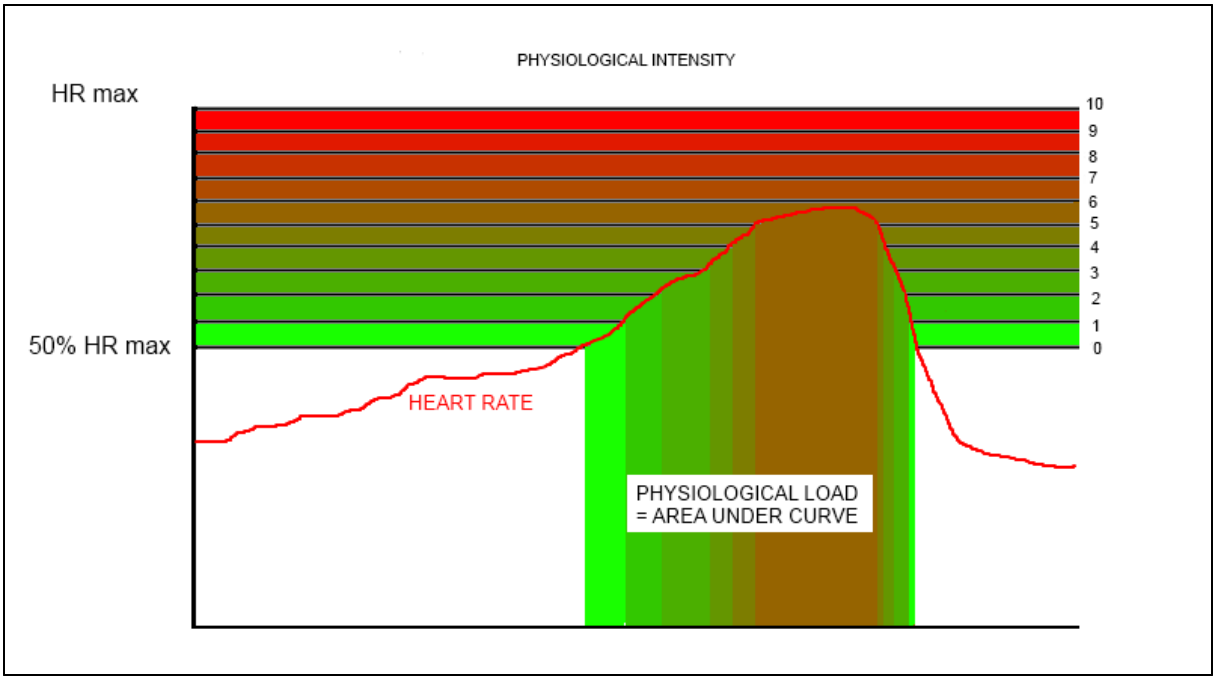
Major Impact Count	Count of Minor Impacts
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs, Impact reports
Log Data	Enhanced formats
Units	Cumulative Count
Range	0 -
Reporting Frequency	1 Hz

Notes	• Minor impact has peak accelerometer magnitude during the event between 3g and 7g • detected angle of impact distinguishes impact from a step

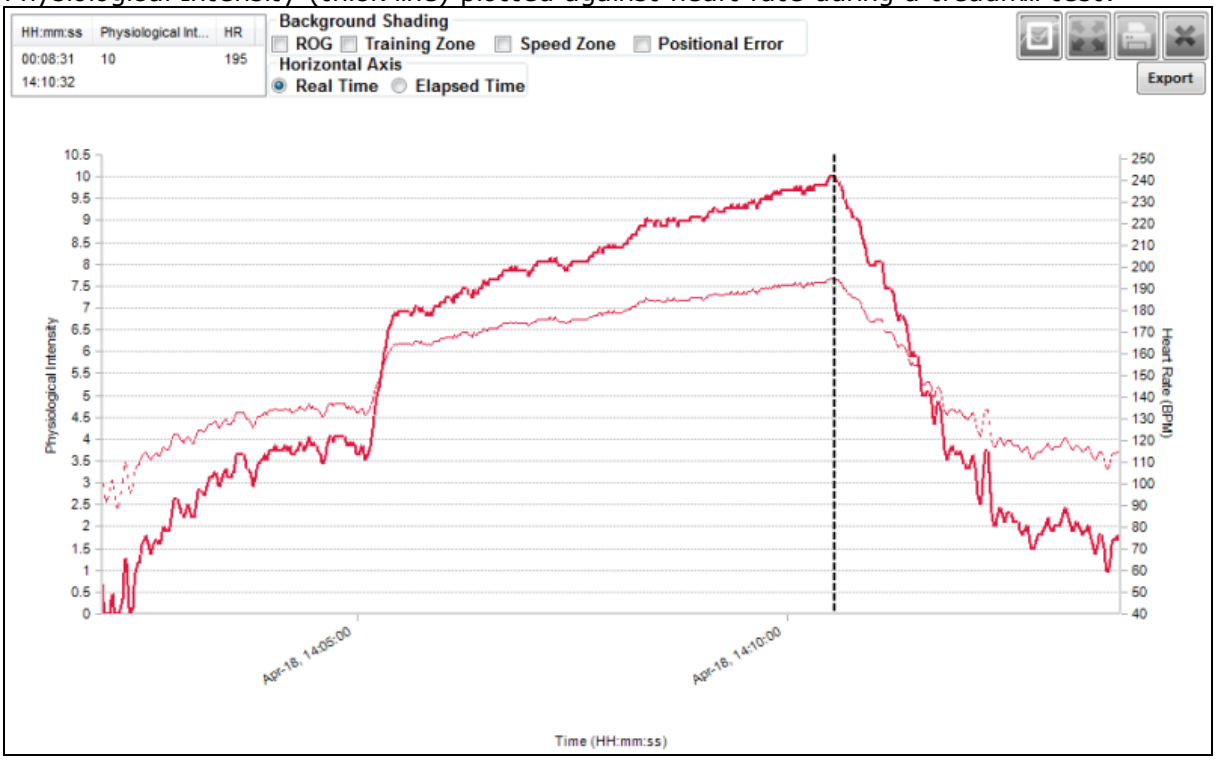
7.38 Physiological Intensity

Mechanical Intensity	Index of cardiac output
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	N/A
Units	None
Range	0 - 10
Reporting Frequency	1 Hz
Notes	• Calculated within OmniSense • Heart rate as a % of subject's stored HRmax determines Intensity on a 0 - 10 scale • Upper and lower %HR_{max} limits for the range are configurable in Live Preferences • An Intensity level of 10 is equivalent to 100% HR_{max} • A subject whose %HR_{max} value is less than 50% is considered to be resting. Physiological Intensity = null. A null value will not bias any average intensity calculation if resting periods are included in a session. Walking will soon increase it above the 50% level. • Maximum Heart Rate can be measured using a ramped maximal fitness test • Average physiological intensity (per minute) = Physiological load/session duration in minutes

Intensity Level	Description
Null (no value)	Less than 50% of subject's maximum heart rate.
...	Value scaled linearly between 50% (= 0) and 100% (= 10) e.g. 75% HR_{max} = Intensity of 5
10	100% of maximum heart rate or greater



Physiological Intensity (thick line) plotted against heart rate during a treadmill test:



- the maximum intensity level 10 is reached at maximum heart rate

AVERAGE PHYSIOLOGICAL INTENSITY (per minute)

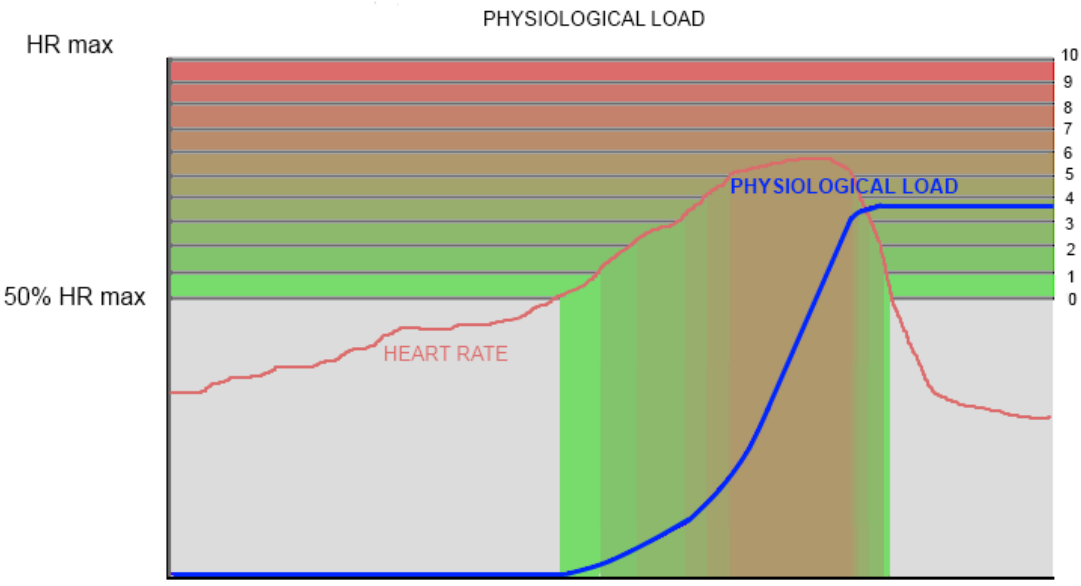
For the above example:

$$\text{Avg. Phys. Intensity} = \frac{\text{Phys.Load}}{\text{Session duration in Min.}} = \frac{12}{2}$$

= 6

7.39 Physiological Load

Mechanical Load	Cumulative index of cardiac output, based on Physiological Intensity
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	N/A
Units	None
Range	0 - 10
Reporting Frequency	1 Hz
Notes	• Physiological Intensity values are accumulated • Physiological load is a measure of total cardiovascular output and will give a good indication of an individual's overall level of effort compared to their historic data, or to a group, for a given training session.



The blue line represents physiological load. It increases only when physiological intensity > 0 (HR > 50%HR_{max} or configured value)

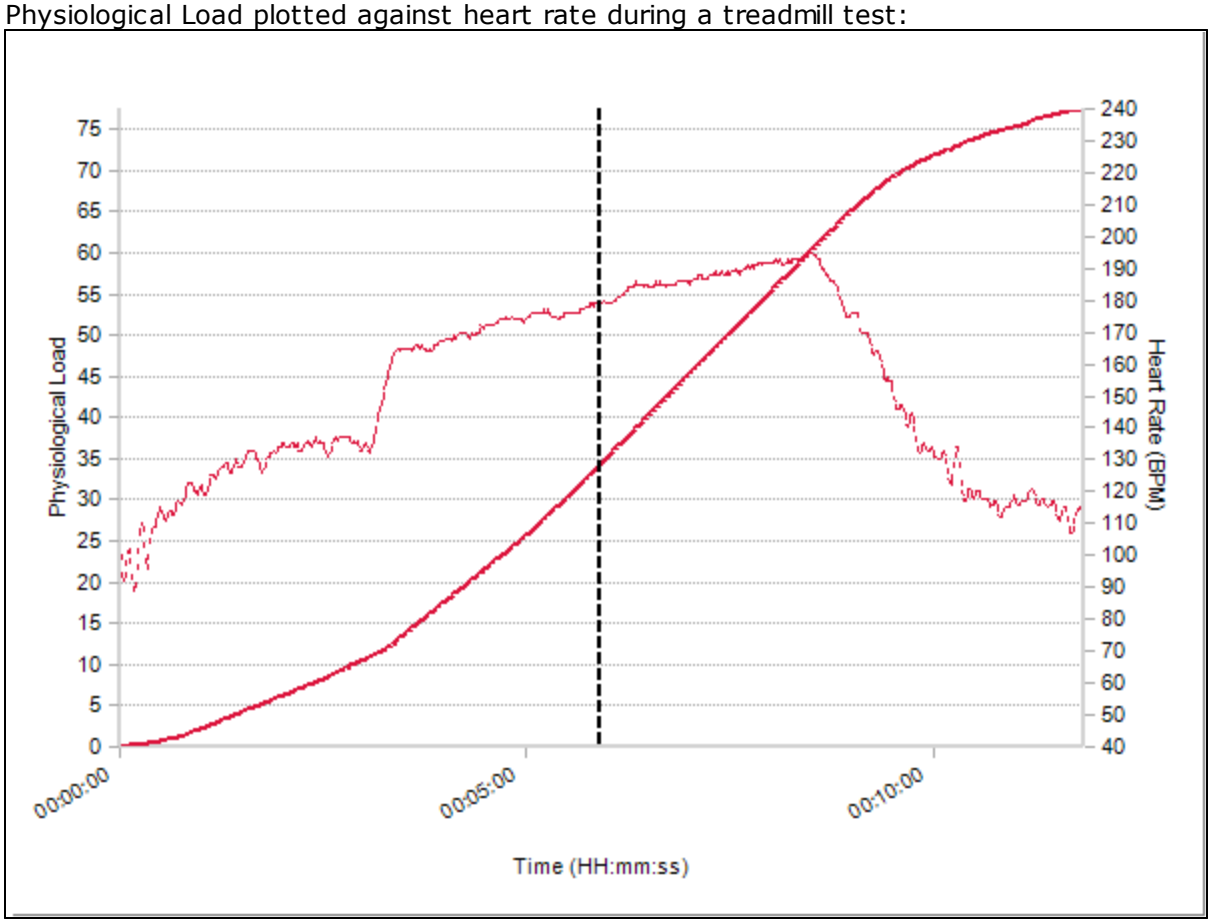
Physiological load is the accumulation of the Physiological Intensity over time.

$$\text{Physiological Load} = \sum_{e=1}^{\infty} \text{Phys. Intensity}_e * \text{Epoch Duration}$$

The same jogger's Physiological Load will increase by 6 each second, so their total Physiological Load after 2 minutes will be

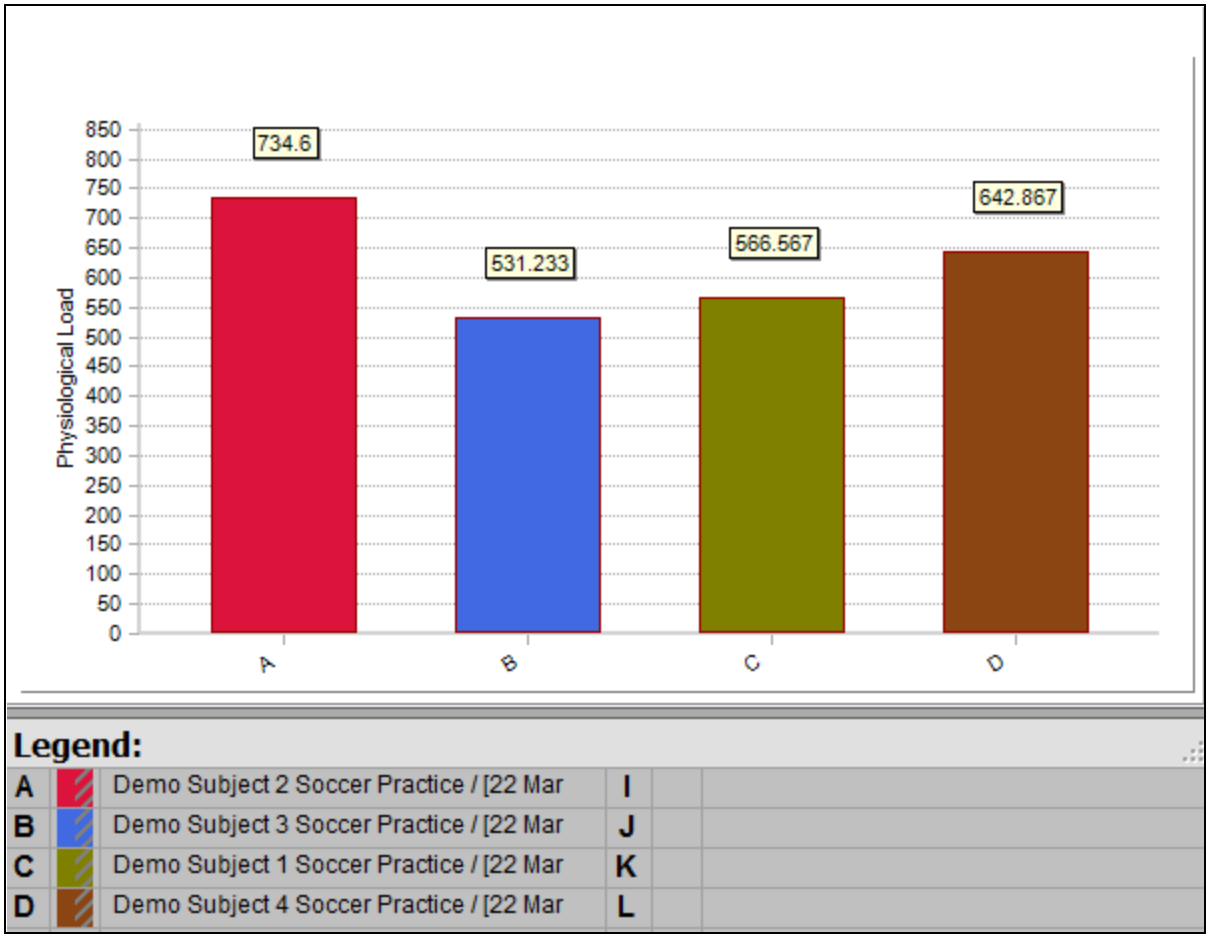
$$\text{Physiological Load} = \sum_{n=1}^{120} \left(6 * \frac{1}{60}\right)$$

Physiological Load plotted against heart rate during a treadmill test:



- Load increases more gradually during warm up
- Load curve steepens during test as heart rate increases
- Load curve increases less gradually when heart rate reduces

Load data is typically most useful viewed in Summary form:



This graph shows that less physiological load has been accumulated by Subject 3, in blue.

7.40 Posture

Posture	Orientation of subject
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	All formats
Units	Degrees from vertical
Range	-180 - +180
Reporting Frequency	1 Hz
Notes	• Subject vertical (sitting or standing) = 0 degrees • Subject inverted = ±180 degrees • Lateral (side to side) changes in posture are not detected - only lean forward/lean back. If posture indication is wrong, confirm that the garment type in subject setup is set correctly.

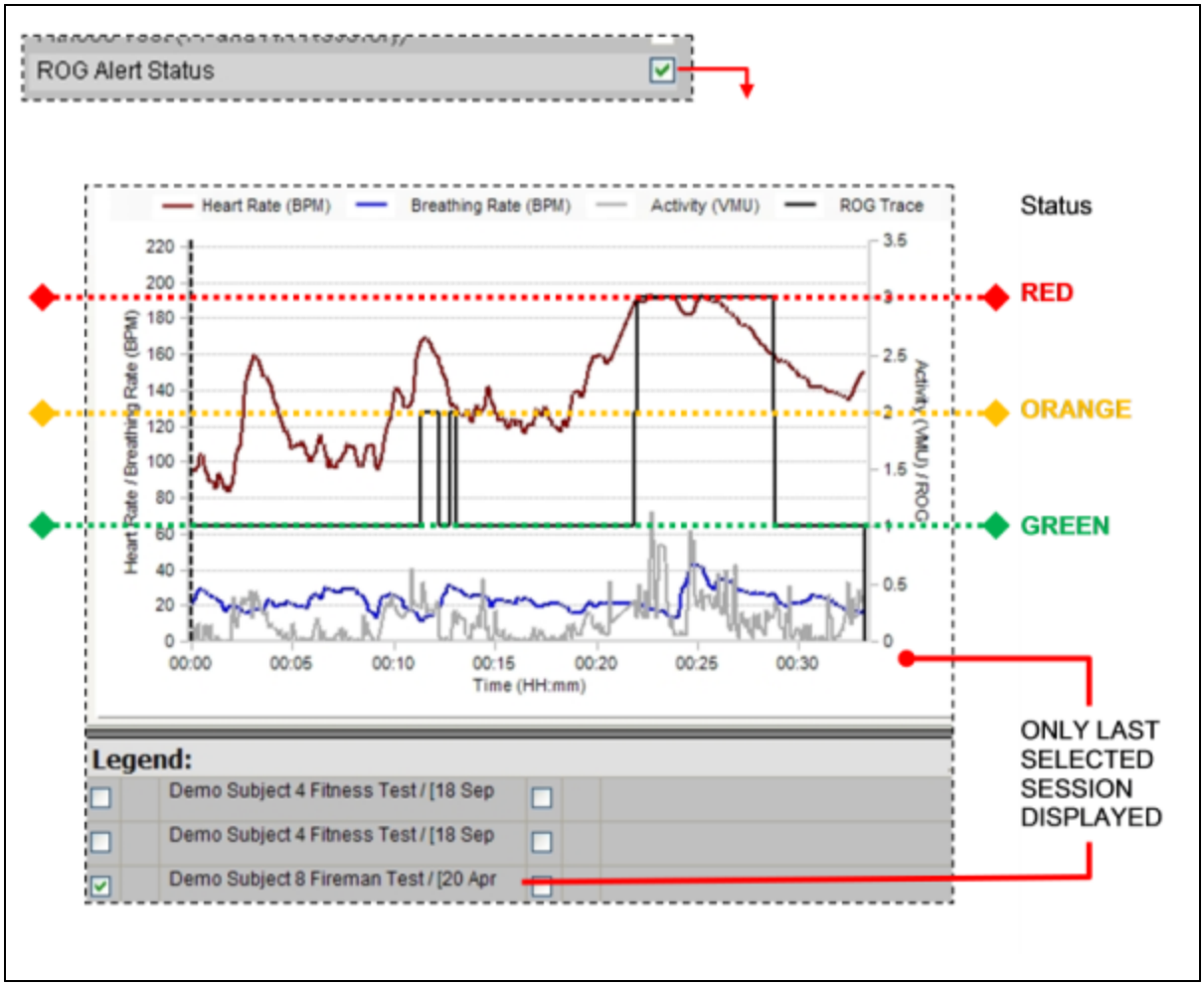
7.41 ROG Subject Status

ROG Subject Status	Color indication of subject physiological status in BioGauge
OmniSense Live	Subject Status
OmniSense Analysis	Time Graph
Log Data	Summary & Enhanced formats
Units	Red/Orange/Green
Range	N/A
Reporting Frequency	1 Hz
Notes	• The ROG algorithm combines activity level, Heart Rate, Breathing Rate and Estimated Core Temperature, and raises subject status to Orange and then to Red if thresholds, such as those indicated below are crossed. The time in a particular state is also taken into account.

Red-Orange-Green subject status is recorded in the database and can be displayed in two ways.

Line Graph

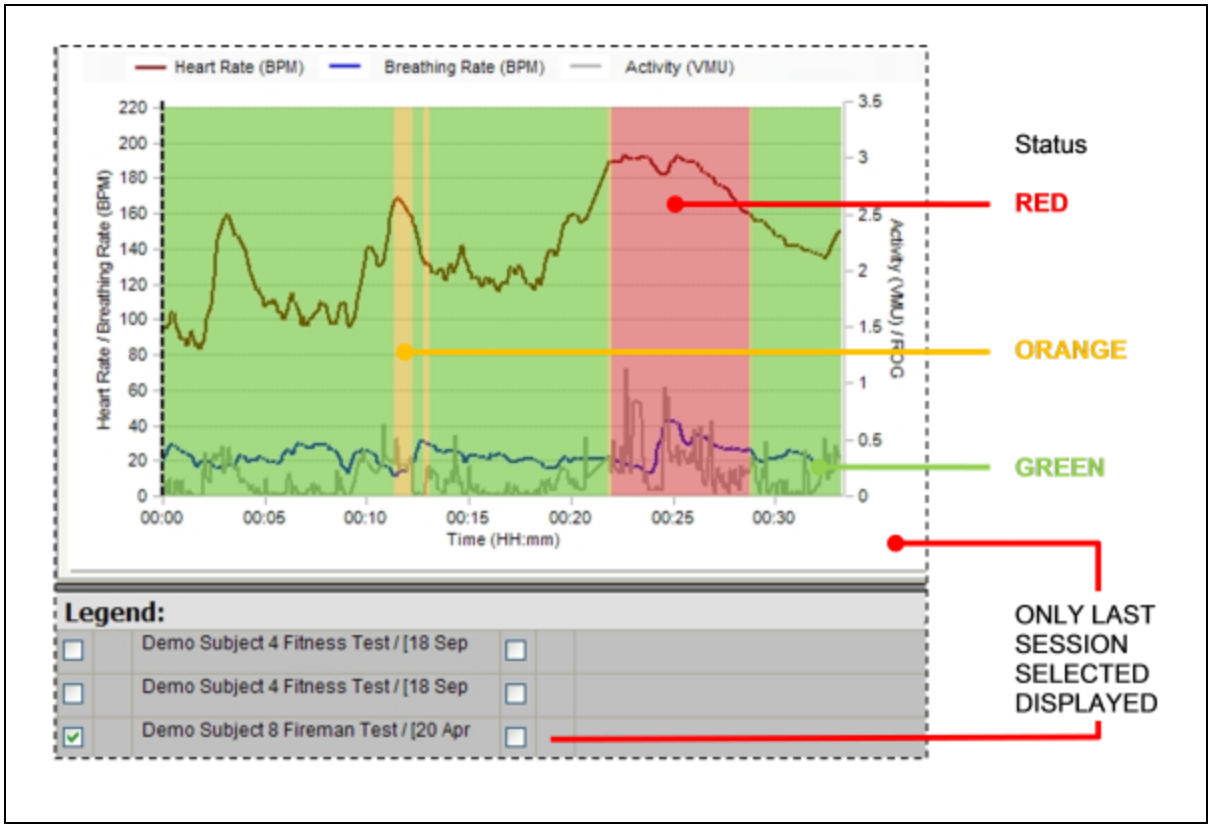
- select from Time Variables pane
- ROG status, heart rate & breathing rate are displayed. No other parameters can be selected.



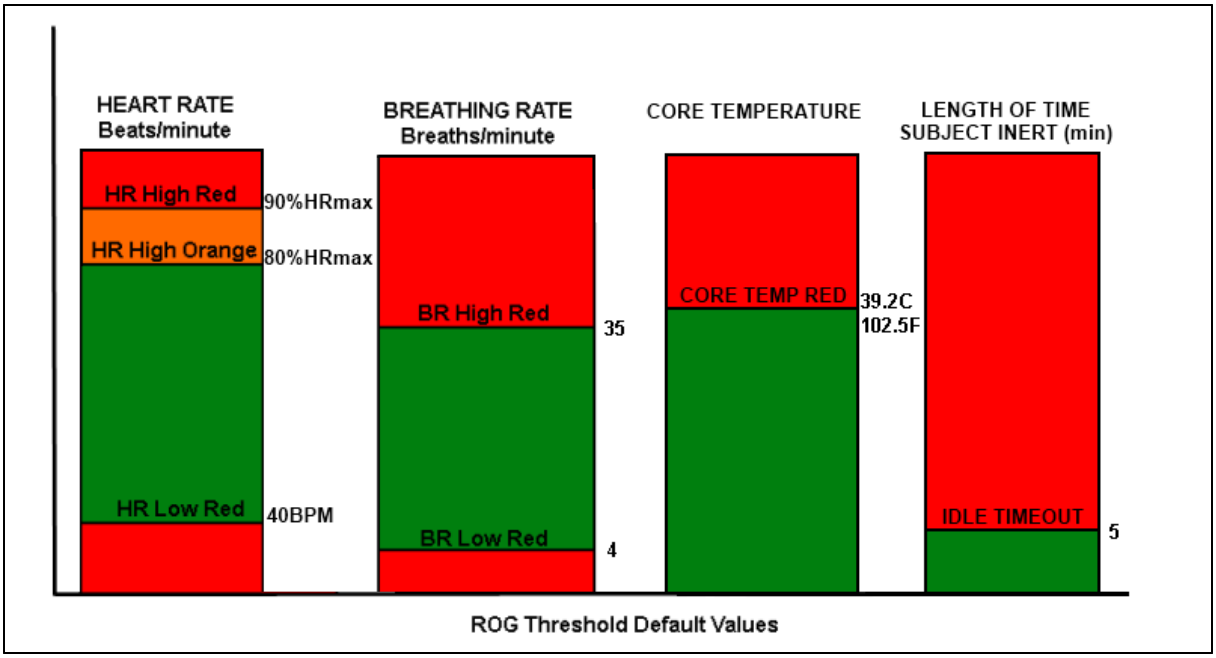
- N/W in the cursor values field for ROG indicates 'Not Worn'
- N/C in the cursor values field for ROG indicates 'Not Connected'

Background Color

- Allows ROG status to be superimposed on any two other physiological parameters
- Select ROG using the check box above the raw data graphs



Green = values inside expected limits for activity level
Orange = values have crossed inner threshold, subject should be monitored accordingly
Red = values have crossed outer thresholds, subject should be monitored more closely
Grey = low heart rate confidence, or device not worn
Blue = communications error
Thresholds can be configured in the OmniSense Live > Preferences > Safety Thresholds dialogue



- If either HR or BR move into the zones shown, the status will change accordingly.

7.42 Run Step Count

Run Step Count	Count of detected run steps
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs
Log Data	Enhanced Formats
Units	Count
Range	0 -
Reporting Frequency	1 Hz
Notes	• distinguished from a bound or a walking step by activity level • available from OmniSense 4.0 and later • reset when the BioModule is power cycled

7.43 Saturated Blood Oxygen Level

Saturated Blood Oxygen Level	Percentage saturated blood oxygen (external sensor needed)
OmniSense Live	Sensors side panel, details panel
OmniSense Analysis	Time & Summary graphs
Log Data	None
Units	%
Range	90 - 100
Reporting Frequency	Set in Live Preferences - default 60 seconds
Notes	• Supported by Bluetooth Radio Network type only • SpO_2 sensor must be added to system • The PC sends a request to the BioModule, which requests

	data from the SpO_2 sensor. The BioModule receives the data and sends it back to the PC. No data is logged in the BioModule.

7.44 Signal Strength

Signal Strength	Received signal strength from BioModule
OmniSense Live	Subject BioGauge (bar indication)
OmniSense Analysis	Time graphs
Log Data	Summary & Enhanced formats (Bluetooth RSSI)
Units	Bar indication on BioGauge
Range	1-5
Reporting Frequency	1 Hz
Notes	

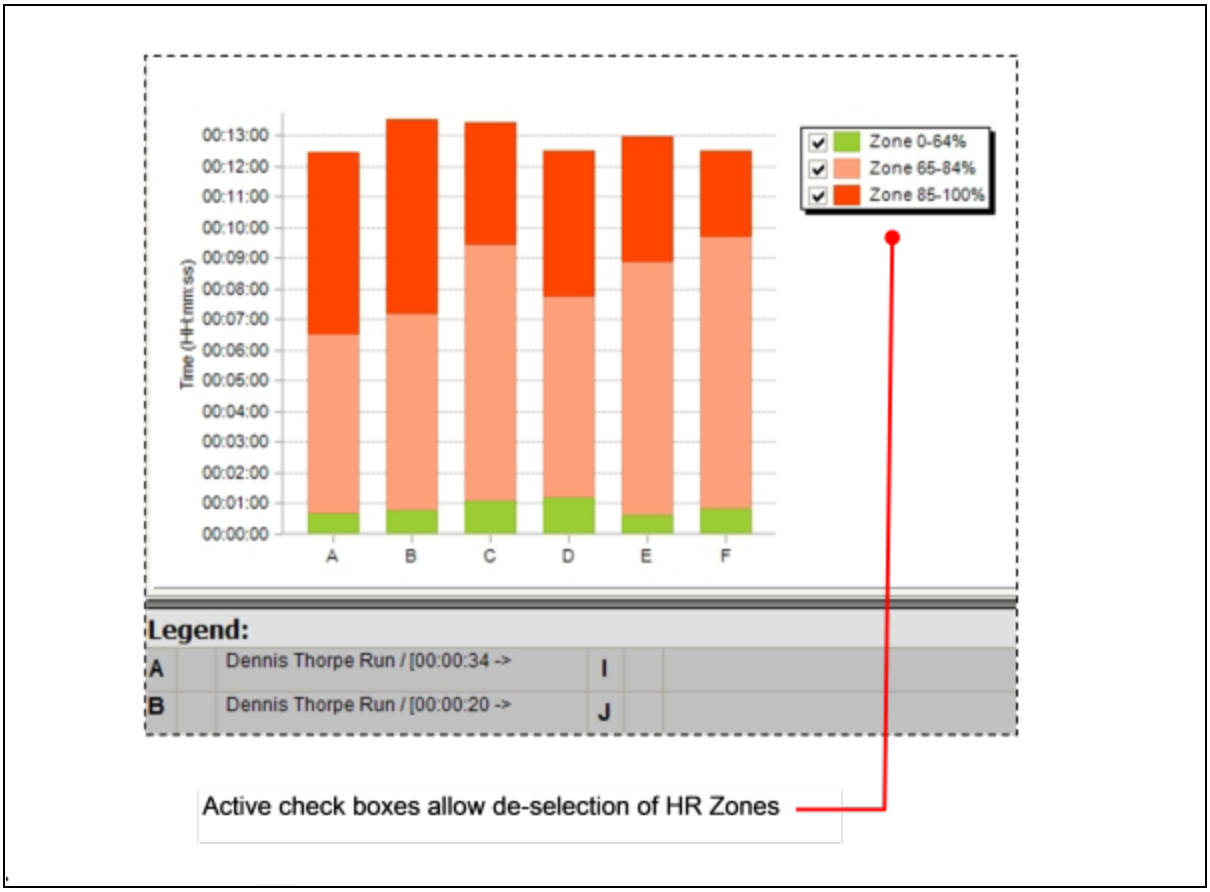
7.45 Speed

Distance Traveled	GPS speed
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary graphs, Reports
Log Data	Waveform or Development formats only
Units	Miles per hour or Kilometers per hour, configured in Preferences
Range	0 -
Reporting Frequency	1 Hz
Notes	• Data gathered by a supported GPS device, and relayed to BioModule • BioModule must be configured to log in Summary and Waveform or Enhanced Summary and Waveform using Zephyr Config Tool

7.46 Time in Heart Rate Zones

Time in Heart Rate Zones	Minutes spent in each Training Zone for a session
OmniSense Live	N/A
OmniSense Analysis	Summary Graphs
Log Data	N/A
Units	Minutes
Range	0 -
Reporting Frequency	N/A
Notes	• Available as a Summary variable. Displays as shown below • Training Zones are configurable in Preferences

Selection of this summary variable displays the graph below. This graph gives a very effective summary of relative performance for a number of subjects involved in the same activity.

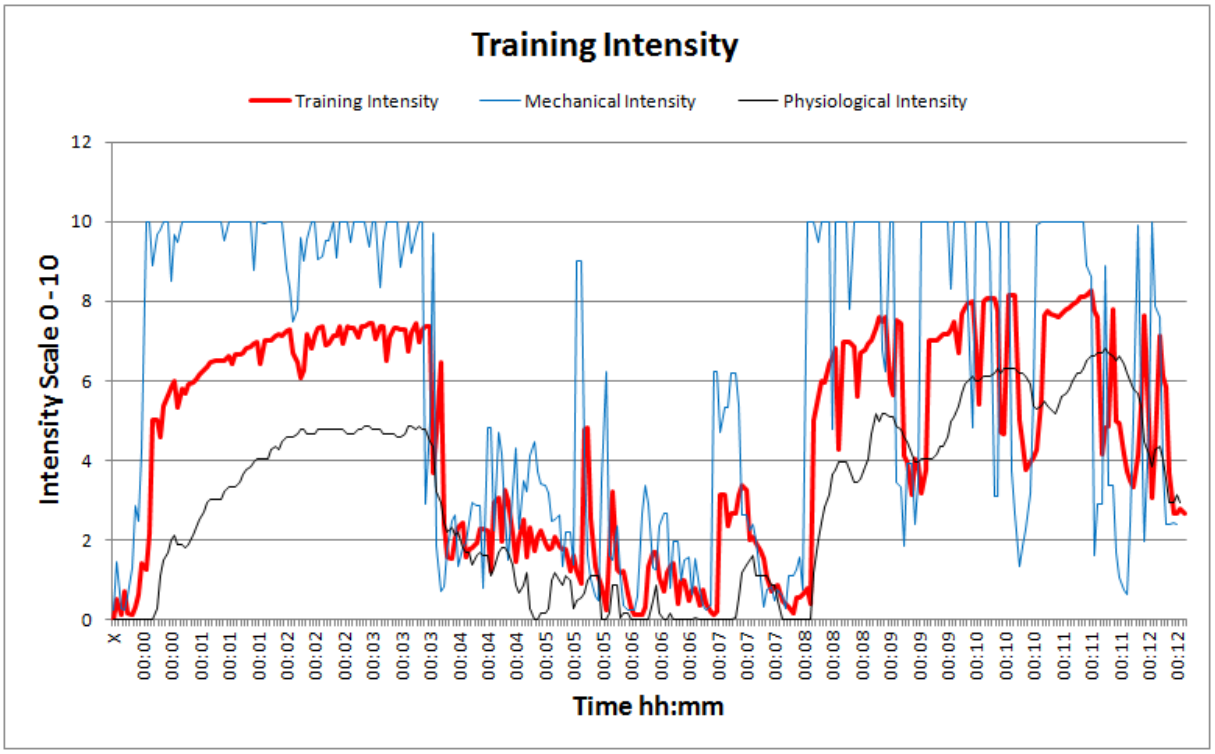


7.47 Training Intensity

Training Intensity	Index of total (cardiac + mechanical) output
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	N/A
Units	None
Range	0 - 10
Reporting Frequency	1 Hz
Notes	• The arithmetic average of Mechanical Intensity and Physiological Intensity

$$\text{Training Intensity} = \frac{(\text{Physiological Intensity} + \text{Mechanical Intensity})}{2}$$

The relationship is shown by this export of the 3 intensity metrics for one of the soccer practice sessions from 2012 :



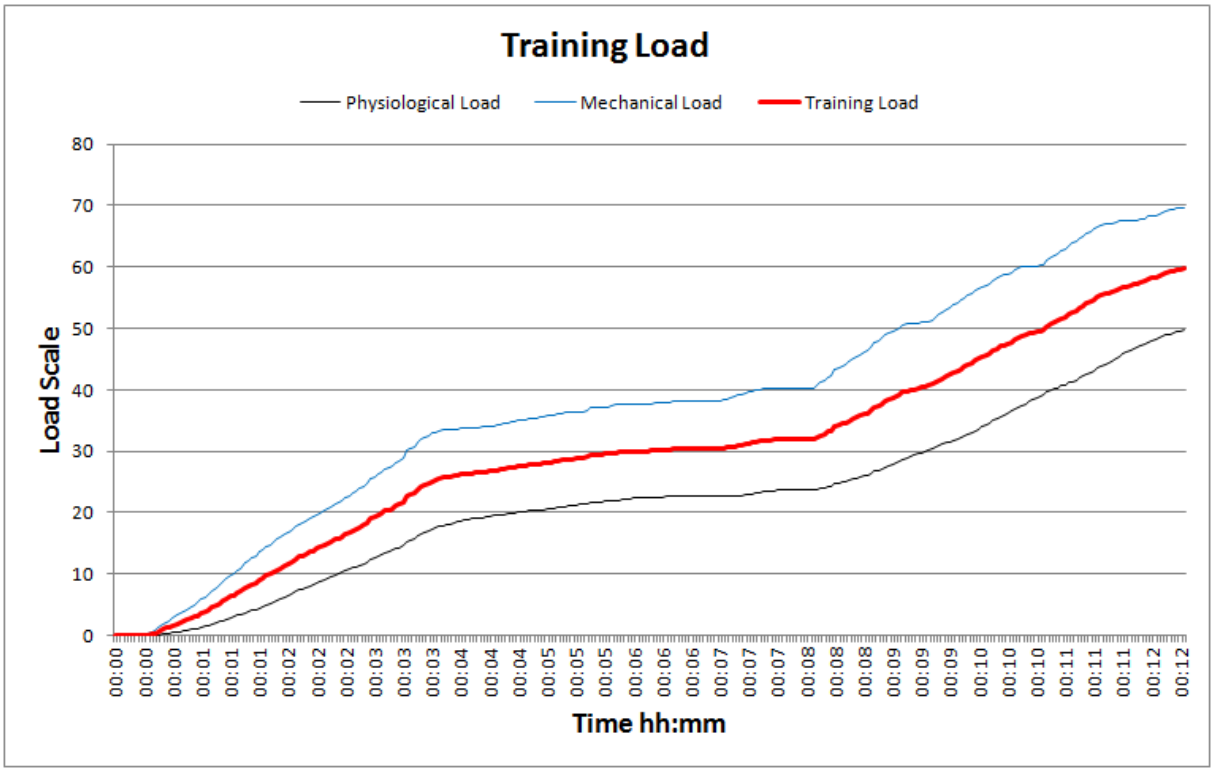
Note that any blue Mechanical Intensity peaks of greater than 3.0g register as the maximum 10 on the Intensity scale - hence the apparent 'clipping'. The maximum Physiological Intensity is 100% HR max. If this is exceeded then HR_{max} should be adjusted accordingly for that subject.

7.48 Training Load

Training Load	
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time and Summary Graphs
Log Data	N/A
Units	None
Range	0 - 10
Reporting Frequency	1 Hz
Notes	• Arithmetic average of Mechanical Load & Physiological Load

$$\text{Training Load} = \frac{(\text{Physiological Load} + \text{Mechanical Load})}{2}$$

Likewise, Training Load is the average of physiological and mechanical loads. For the same session as above:



Care should be taken when interpreting Training Intensity & Load, if the activity involved involves much physiological effort but no mechanical effort which would be detected by the BioHarness, such as weight lifting, or erg workouts. Training Intensity and Load may not reflect the true level of workout involved, since mechanical intensity will be determined as low

7.49 Walk Step Count

Walk Step Count	Count of detected walking steps
OmniSense Live	Subject BioGauge
OmniSense Analysis	Time & Summary graphs
Log Data	Enhanced Formats
Units	Count
Range	0 -
Reporting Frequency	1 Hz
Notes	• distinguished from a bound or a jump by activity level, time in the air • available from OmniSense 4.0 and later • reset when the BioModule is power cycled

7.50 Weight

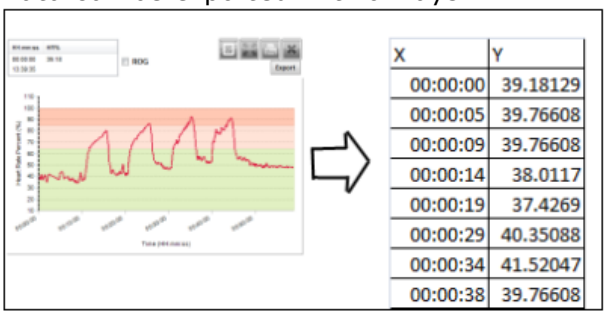
Weight	Subject Weight
OmniSense Live	Subject BioGauge
OmniSense Analysis	N/A

Log Data	N/A
Units	Kilograms or pounds
Range	
Reporting Frequency	N/A
Notes	• Entered manually in Subject Details in OmniSense Live. Used in BMI calculations

Part 8

8 Data Export & Import

Data can be exported in two ways:



X	Y
00:00:00	39.18129
00:00:05	39.76608
00:00:09	39.76608
00:00:14	38.0117
00:00:19	37.4269
00:00:29	40.35088
00:00:34	41.52047
00:00:38	39.76608

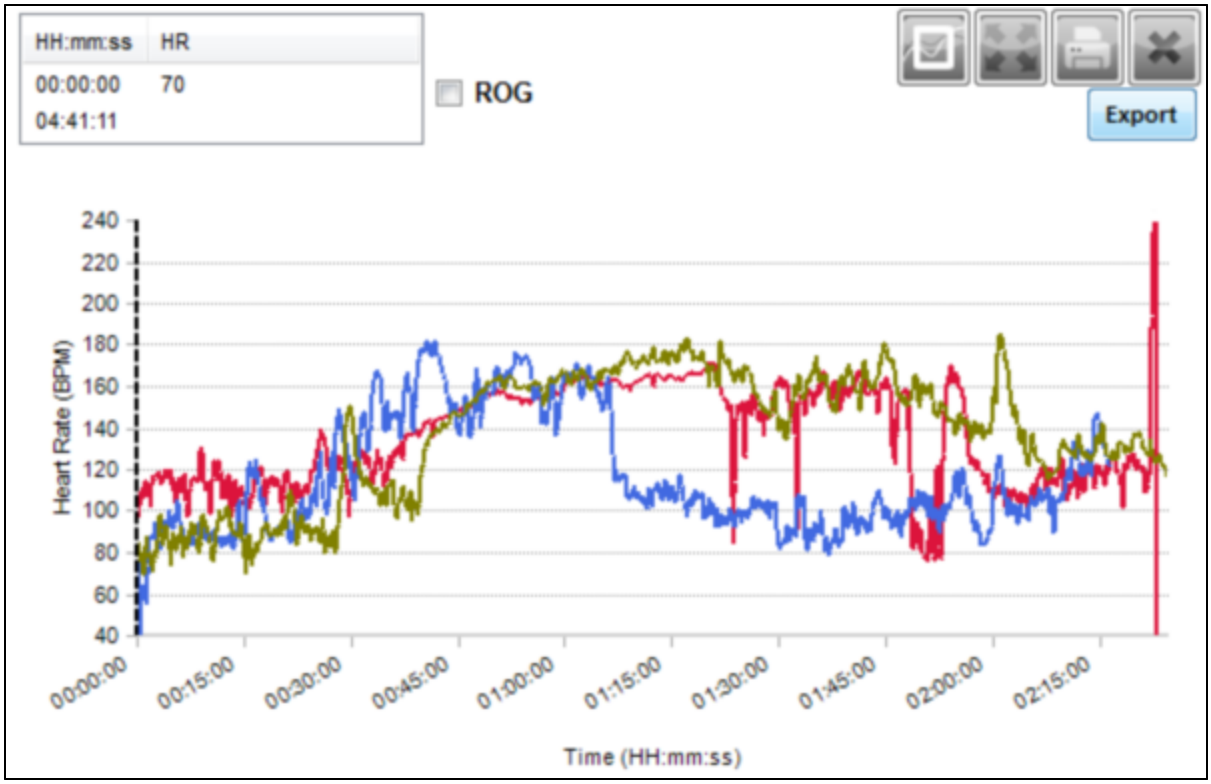
Displayed data as an external csv File
can be viewed in Excel or similar
cannot be imported into OmniSense

Individual Session as a .zsf file
can only be viewed using OmniSense
can be imported into another instance of OmniSense

8.1 Export Graph Data to External Files

In the graph pane there is an Export button which will export the contents of the graph (but no other data) one of several formats:

- .csv file, which opens by default in Excel®
- .JPEG, .GIF, .PNG, .Tiff or .SVG image files
- .PDF document file



CSV Files

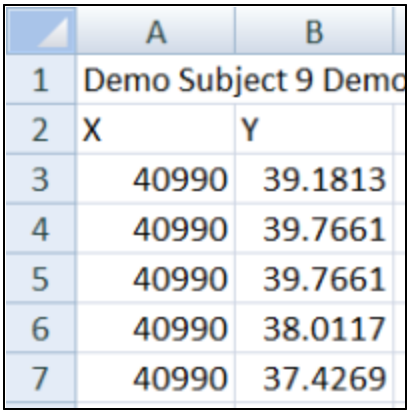
Export and save to a suitable location.

	A	B	C	D	E	F
1	Demo Subject 1 Trai		Demo Subject 2 Traini		Demo Subject 3 Training S	
2	X	Y	X	Y	X	Y
3	40995	70	40995	65	40995	74
4	40995.00001	75	40995.00001	65	40995.00001	79
5	40995.00002	80	40995.00002	67	40995.00002	82
6	40995.00003	84	40995.00003	68	40995.00003	86
7	40995.00005	88	40995.00005	70	40995.00005	88
8	40995.00006	91	40995.00006	71	40995.00006	88
9	40995.00007	94	40995.00007	72	40995.00007	87
10	40995.00008	96	40995.00008	73	40995.00008	86
11	40995.00009	97	40995.00009	74	40995.00009	85

When opened in Microsoft® Excel, the timestamp data will be in Excel Serial Date Format. It must be converted for readable results.

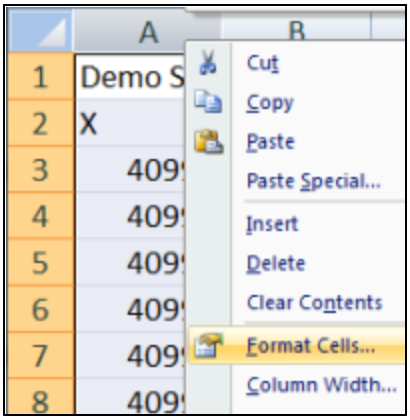
8.1.1 Change Excel Date Format

1. The default Excel date format, as seen in exported csv files, is an Excel *Serial Date Format*



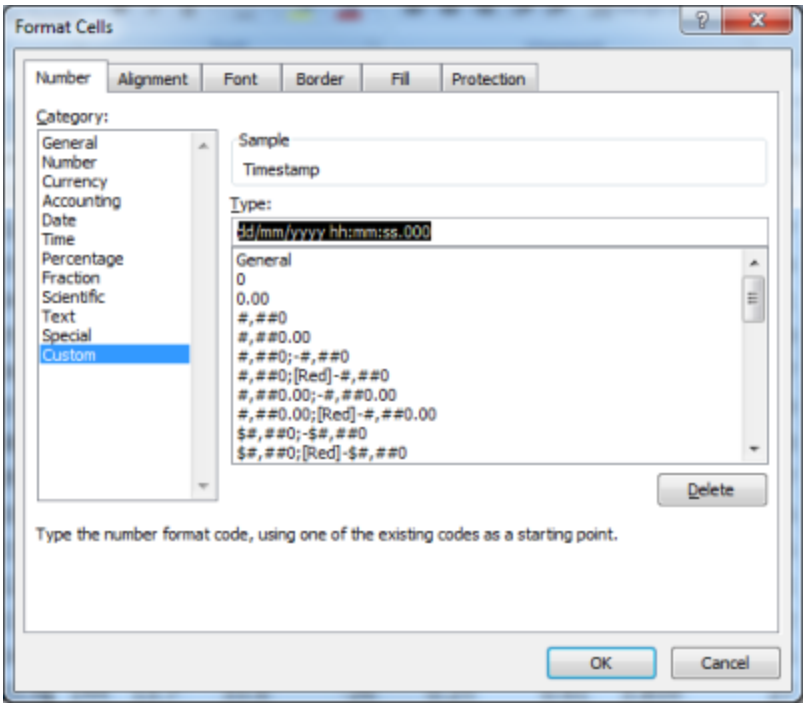
	A	B
1	Demo Subject 9 Demo	
2	X	Y
3	40990	39.1813
4	40990	39.7661
5	40990	39.7661
6	40990	38.0117
7	40990	37.4269

2. To change the date format to show full milliseconds, or any other date or time information:



Highlight the entire timestamp column, right-click, and select ***Format Cells*** from the context menu

3. Select ***Custom*** from the Category List, and enter dd/mm/yyyy hh:mm:ss.000 (or any combination of these special characters, and any other delimiting characters or symbols) in the ***Type*** field:



4. The timestamp column will be converted to the required format

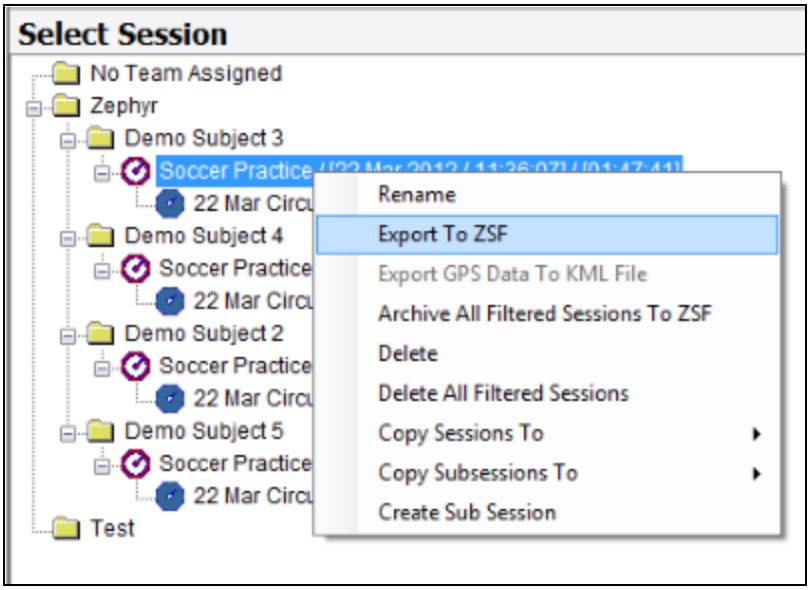
	A	B	C
1	Timestamp	HR	BR
2	01/07/2010 14:43:01.749	234	10.2
3	01/07/2010 14:43:02.757	233	10.2
4	01/07/2010 14:43:03.765	232	10.3
5	01/07/2010 14:43:04.773	229	10.3
6	01/07/2010 14:43:05.781	226	10.4
7	01/07/2010 14:43:06.789	222	10.4

Note that to preserve this formatting, the csv file must be saved as an ***.xlsx*** worksheet, and not as a ***.csv*** file.

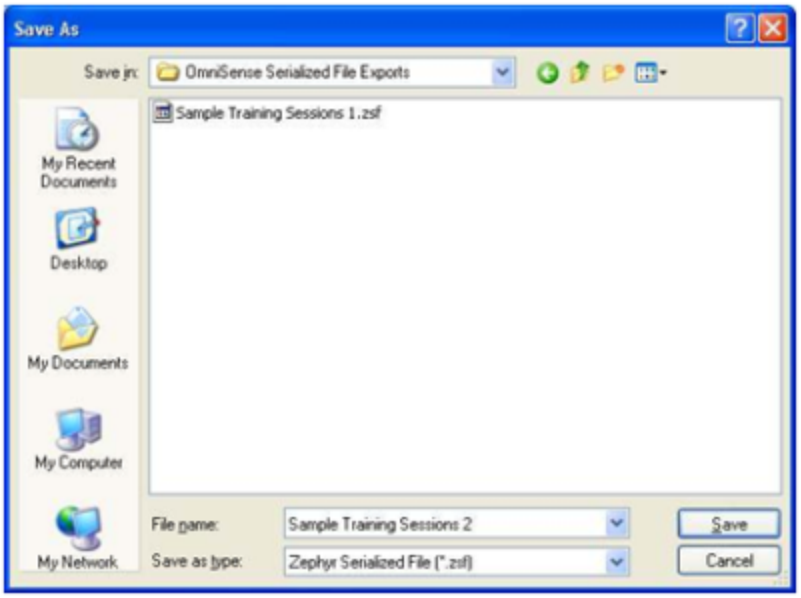
8.2 External zsf File

Individual sessions in the *Select Session* tree can be exported to an external *.zsf* (Zephyr Serial File) file. This allows their transfer between separate instances of OmniSense. The .zsf file can then be re-imported into another Analysis module.

1. Select a session (or sessions, using the Ctrl key while selecting) and right-click, selecting Export



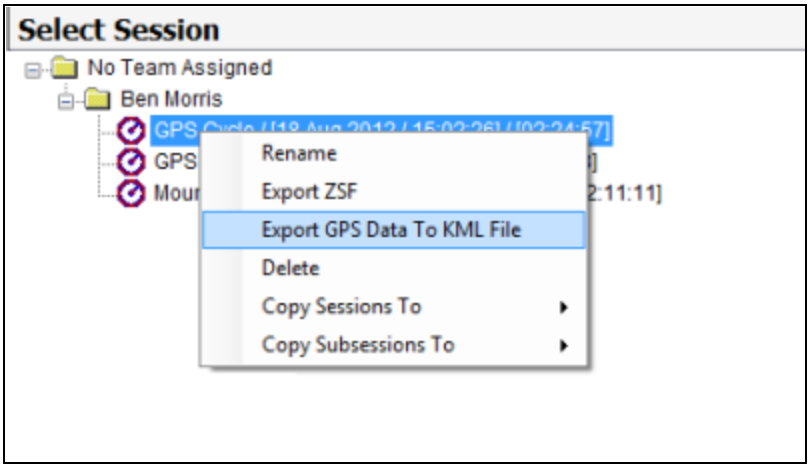
2. Browse and find a suitable location to save



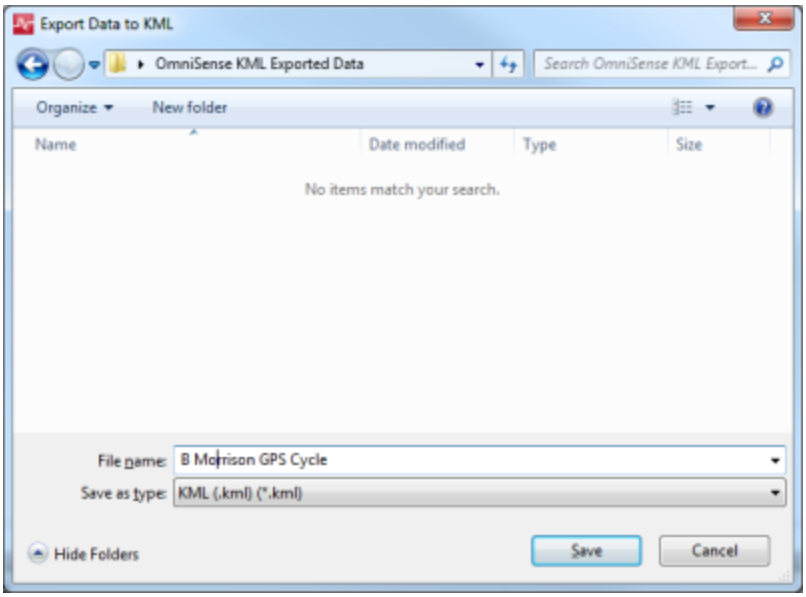
8.3 External KML File

Individual sessions in the *Select Session* tree can be exported to an external *.kml* (Keyhole Markup Language) file for import into Google Earth or Google Maps. This option only becomes active when the selected session contains actual GPS data.

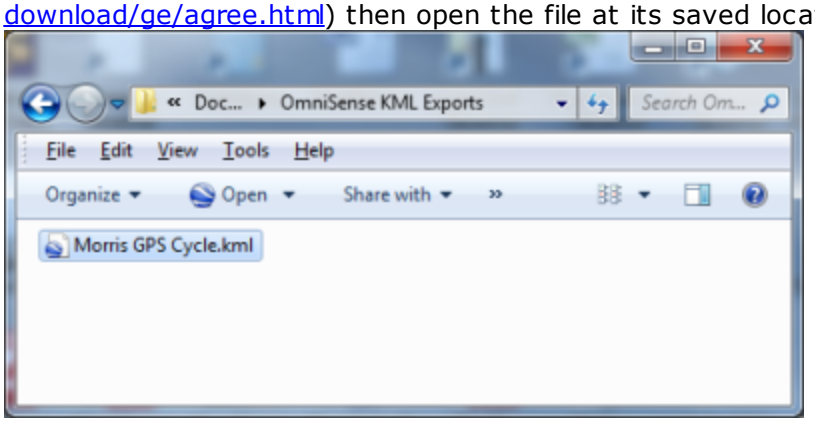
1. Select a session (or sessions, using the Ctrl key while selecting) and right-click, selecting Export



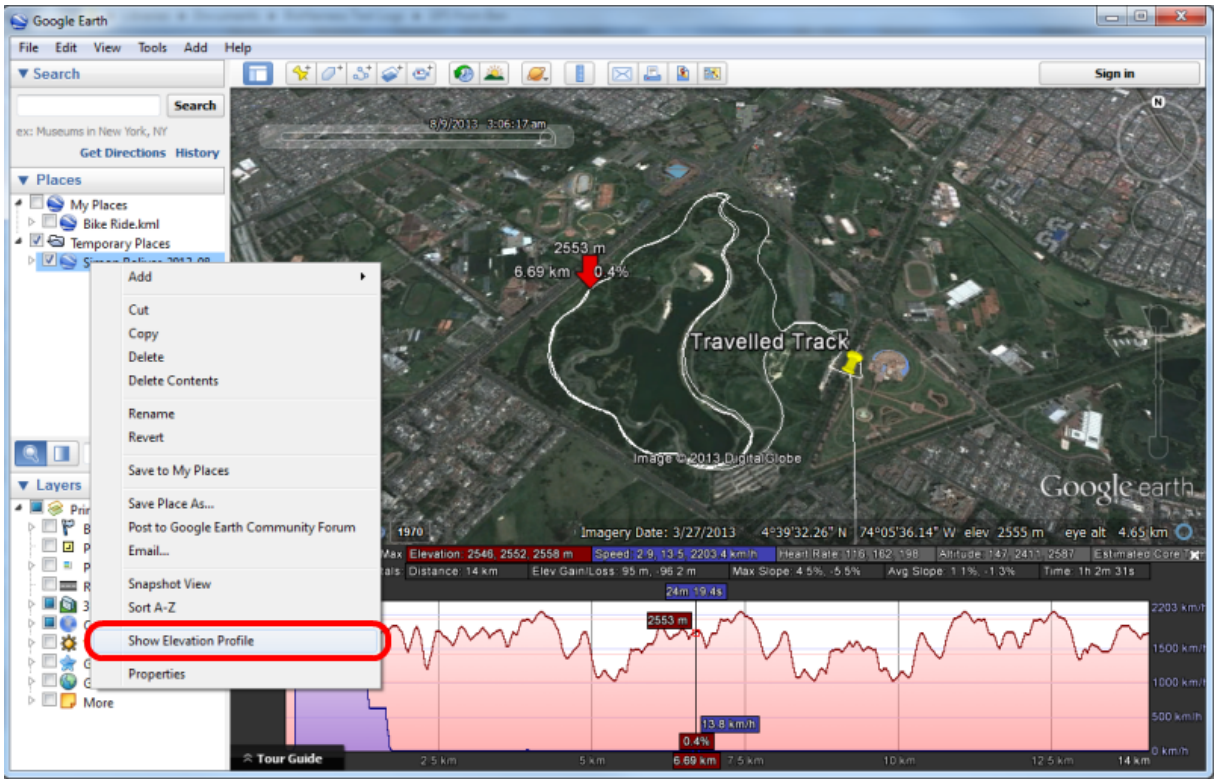
2. Browse and find a suitable location to save



3. If Google™ Earth has been installed (Download from http://www.google.com/earth/download/ge/agree.html) then open the file at its saved location:



4. The file will open Google Earth automatically if an internet connection is present, and scale to the map track, with a scrollbar to move the location pin around the track.



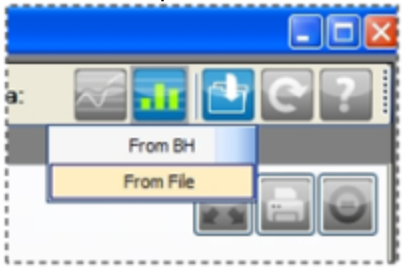
4. To display physiological data, right-click on the file in the *Places* navigation tree in Google Earth, and select *Show Elevation Profile* from the context menu as shown. A histogram will display. Above the histogram are a series of links which will allow display of:

- Elevation
- Speed
- Heart Rate
- Altitude
- Estimated Core Temperature
- Activity Level
- Peak Acceleration

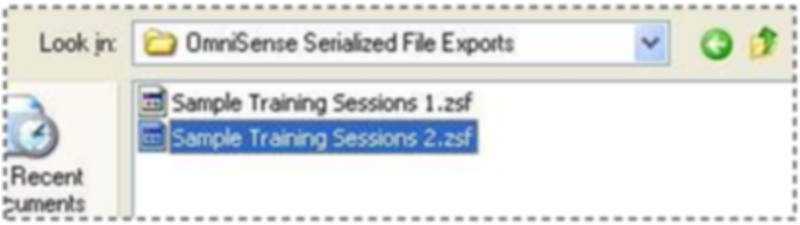
The selected values will be displayed beside a location beacon which moves around the GPS track as your PC cursor is floated over the histogram.

8.4 Importing an External zsf File

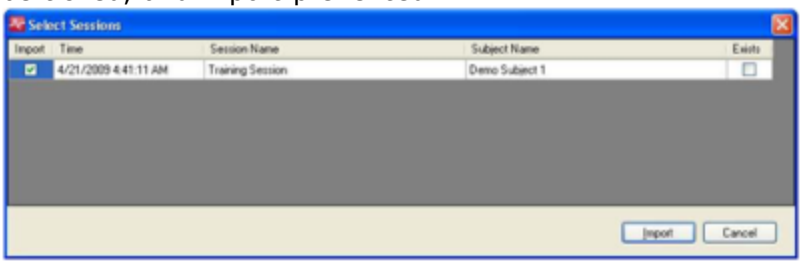
1. Click the Import  button and select *From File* from the drop-down menu



2. Select the .zsf file to import



3. A dialogue will display showing all sessions in the serialized file. If any session already exists in the target database (with the same name), then the checkbox on the right will be ticked, and import prevented.



Part 9

9 Log Data

A BioHarness Bluetooth (v2.0 or v3.0) is normally configured to log all data as well as transmit. [An ISM BioHarness can be set to Log mode using the button on the device. See your PSM system user manual for instructions.]

The Zephyr Downloader Utility has been optimized to download logs from up to 50 BioModules installed in a PSM Training System Case:

The Downloader utility will also work using Zephyr 5-device or single device charging/USB cradles. The utility will download from 6 devices over USB, and 6 devices over Bluetooth, simultaneously. Other detected BioModules will be queued and downloaded automatically.

Logs downloaded over Bluetooth will take longer than those downloaded over USB. Devices whose logs are downloaded over Bluetooth need not be connected to the host PC, but powered on and within Bluetooth range (typically 10 yards).

The Downloader will not download the same log from the same device twice.

Processing of logs will take longer if the user chooses to generate external csv files from the Downloader menu Options

Typical Download times (will vary according to PC specification and resource available):

Session Length	Download Path	Download Time (1 device)	Download Time (5 devices)	Download Time (10 devices)

1 hour	USB	25 sec	1 min 15 sec	2 min
1 hour	USB	1 min 45 sec	3 min 45 sec	6 min
1 hour	USB	4 min	6 min 30 sec	11 min

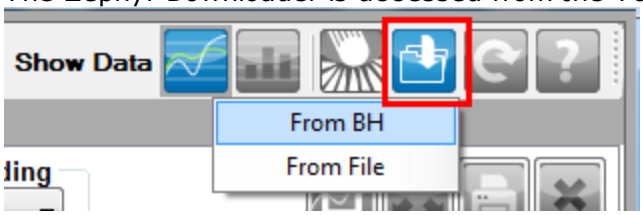
1 hour	USB	30 seconds	2 min	3 min 45 sec
1 hour	USB	2 min	6 min	7 min

1 hour	USB	4 min	7 min	13 min

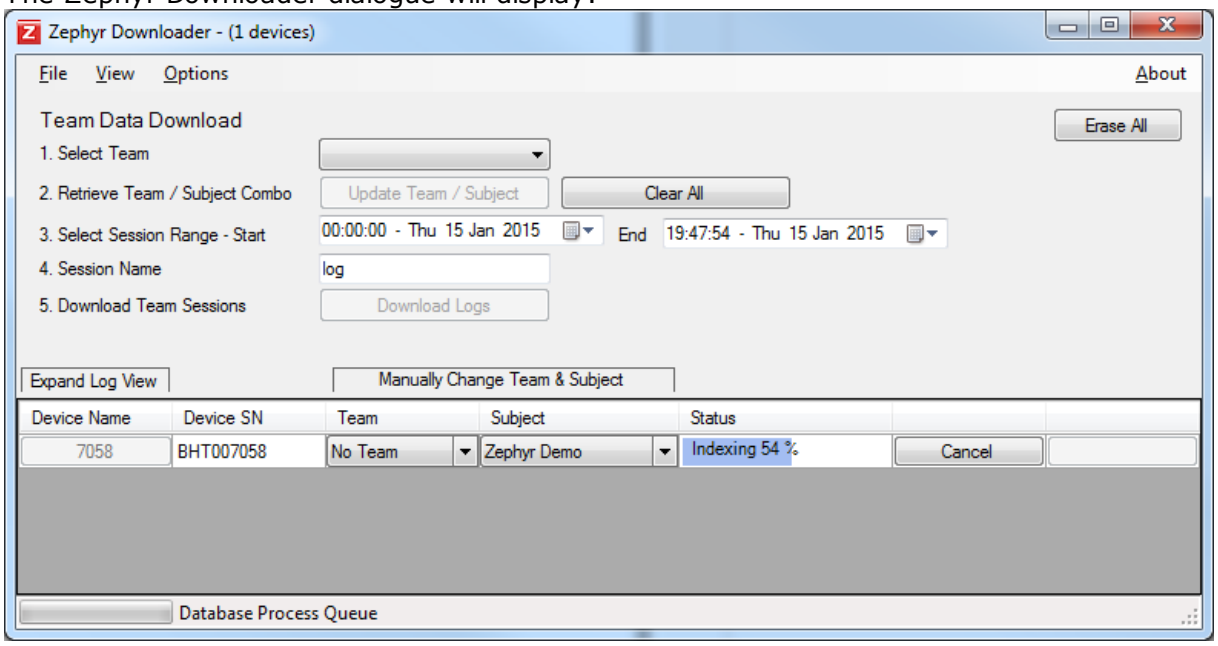
* Summary/Enhanced Summary and Waveform format is necessary to log speed and location data from a supported GPS unit, or for accelerometer data required for detailed impact analysis by the Impact Analysis Tool
** Enhanced Summary format is required for display of impact analysis parameters (impact type, magnitude, count, etc) which are calculated directly in the BioModule
*** Development log formats record ECG at 1KHz, and accelerometry data is reduced from 100Hz to 50 Hz to accomodate

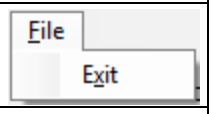
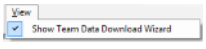
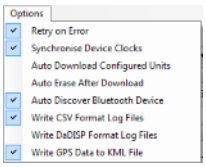
9.1 Zephyr Downloader

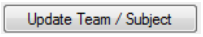
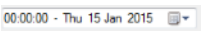
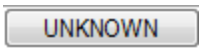
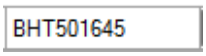
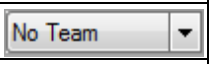
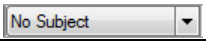
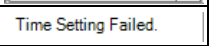
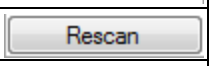
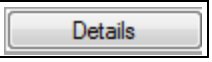
The Zephyr Downloader is accessed from the Toolbar - select the *From BH* option:



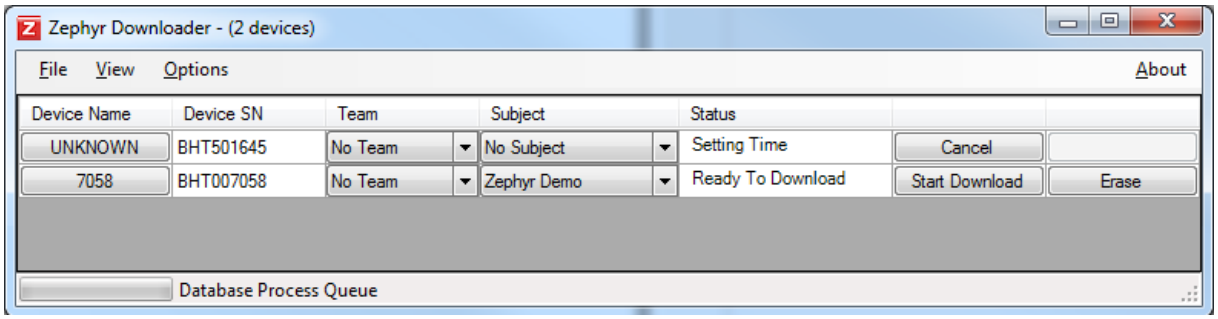
The Zephyr Downloader dialogue will display:



Menu	
File • **Exit** only	
View • **Unchecked** - basic view (see below) • **Checked** - Wizard view (as above)	
Options • **Retry on Error** - will continually retry to download logs. Abort manually • **Synchronize Device Clocks** - legacy option - all device clocks are synchronized to PC time over ECHO when Live is started. Leave checked as security. • **Auto Download Configured Units** - log download will start automatically, with data going to the Team/Subject combination as currently deplyoyed in the database. Unchecked by default. • **Auto Erase After Download** - erase logs on download. Logs are automatically overwritten (oldest first) when device memory is full. • **Auto Discover Bluetooth Device** - detect BioModule over Bluetooth, but	

do not download • **Write CSV Format Log Files** - write external .csv files to ...\My Documents\BioHarness Test Logs\...a folder is created with time and date stamp as part of file name • **Write DaDisp Format Log Files** - write external .hed/.dat files to the same location as csv for import into DaDISP application • **Write GPS data to KML File** - write kml files containing location & basic vital signs for display in Google Earth	
Wizard	
1. Select Team - a BioModule may be assigned to two subjects in different Teams, not deployed at the same time. Select the appropriate Team.	
2. Retrieve Team/Subject Combo - auto-populate Team/Subject Combinations	
3. Select Session Range - defaults to the previous 24 hours. No sessions will display if older than this - reset manually to display	
4. Session Name - change to a name which will make filtering easier in the Filter Session list [Show Sessions]	
5. Download Team Sessions - start download manually	
Columns	
Device Name Button - as named in the OmniSense database - this should be labeled on the front for identification. If 'Unknown' then the device has not been added to the system via OmniSense Live > Setup > Hardware. If pressed it will display the legacy Log Downloader Tool which can be used to view all Logs in the device, and download to external files if necessary.	
Device SN - serial number as detected by the system (USB or BT): *BHT######*	
Team - use the pulldown to edit manually if needed	
Subject - use the pulldown to edit manually if needed	
Status - various status messages displayed	
Button - action button (dependent on status)	
Button - action button (display messages)	

Zephyr Downloader Basic View - Team & subject must be selected manually, and *Start Download* button used for each device individually.



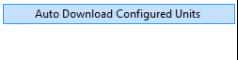
9.2 AutoDownload Workflow

The Zephyr Downloader has been designed to allow download of logs from 50 devices in the PSM system case (or multiple device cradles) with minimal user input, if the system is configured correctly.

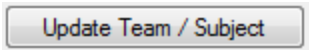
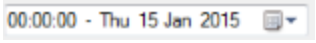
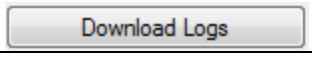
Pre-requisites:

- All BioModules must already be added into the system, via OmniSense Live > Setup > Hardware
- All BioModules must be assigned to members of the same team, and that team currently deployed in OmniSense Live
- Logs should be downloaded on the day they are recorded, otherwise the Select Session range values must be changed.
- Logs should not have been previously downloaded - otherwise 'No New Logs' will display for that device
- All BioModules must be in the PSM Training system case, or located in USB charging cradles which power them on

Workflow for Autodownload of same-day logs

Wizard		
1		Select Team (BioModules may be assigned to more than one team in the database)
4		Change the default 'log' session name to something more meaningful, which can be used when filtering sessions in the Filter Session panel to display logs as graphs or for creating reports.
		Select *Auto Download* from the options menu. Once this is checked, you can leave the Download Tool open, and add and remove BioModules as they become available.

Optional Manual adjustments

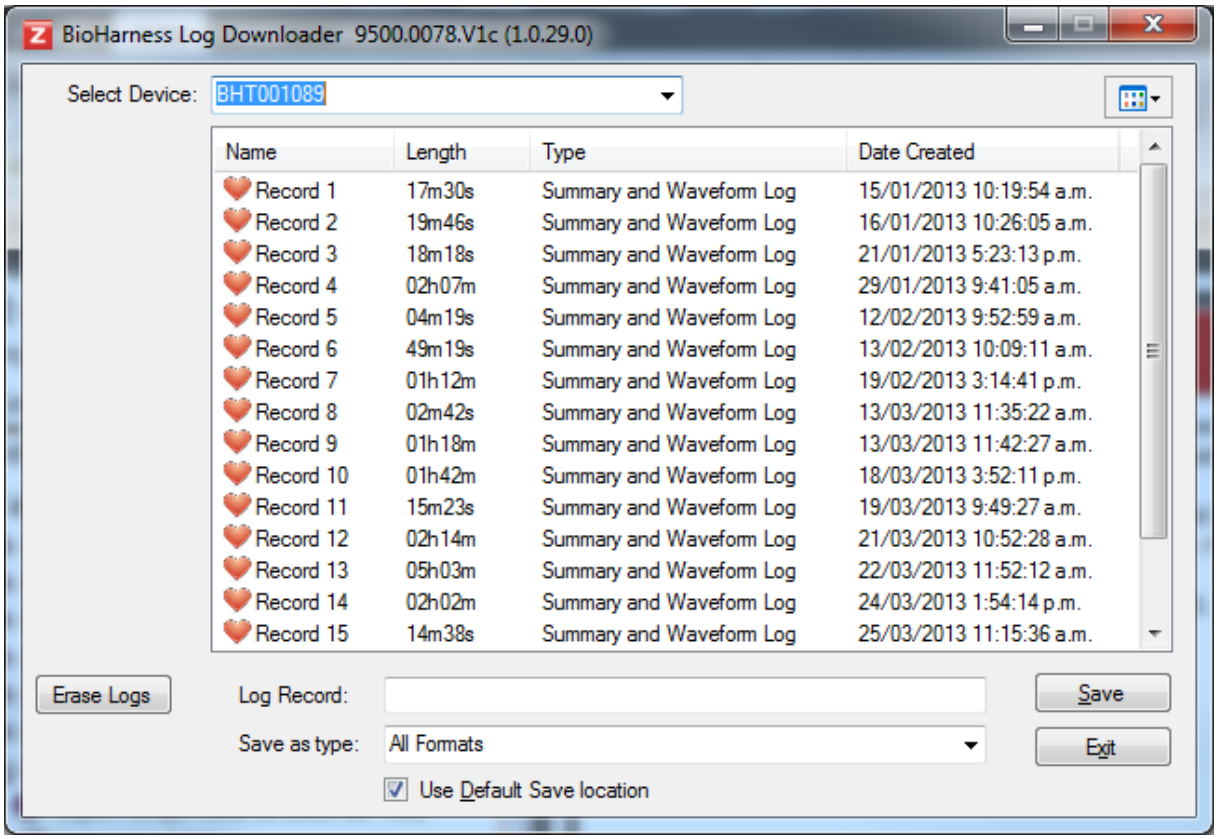
2		Use Update button to populate the Team & Subject button/fields in the dialogue. This is as they are stored in the database. If a device has been reassigned to another subject, change manually using the subject pulldown, otherwise data will go to the 'wrong' subject.
3		Set the start and end time & date to cover the logs to be downloaded. The default settings are the previous 24 hours and no logs will show if they pre-date this interval.
5		Manually initiate log download.

9.3 Log Downloader Legacy Tool

This can be accessed from the Zephyr Downloader (use the device name button), or at C:\Program Files (x86)\Zephyr\OmniSense\Tools there is a legacy tool BioHarness Log Downloader.exe. This can be used to check which logs are present on a device, regardless of how they are timestamped. If a BioHarness undergoes a complete reset and the clock is not resynchronized to current PC time by either:

- connecting to a PC and attempting to download logs into the Analysis modules using the toolbar button
- using the Zephyr Cfg Tool which is described in the Live Help file

..then files may be timestamped from Jan 1st 2000.



The Log Downloader will display all logs on the selected device. It will save logs as external csv and/or dat/hed files, located in My Documents\BioHarness Test Logs as default, or uncheck the *Use Default Save Location* box to save elsewhere.

9.4 Logging Formats

BioModules are configured to log data by default. Logging can be turned on or off and the logging format set, by using the Zephyr Config Tool.

There are a number of logging formats. Use the links below to see the parameters contained in each format.

Format	Description
General	Legacy format originated for BioModule 1.0 and 2.0. Still supported in 3.0
General and ECG	250Hz ECG waveform logged in addition to all General log parameters
General and Accelerometer	100Hz Accelerometer magnitude data logged in addition to general log parameters

Summary	General + Additional 1 Hz parameters
Summary and Waveform	Summary + 250Hz ECG, 100 Hz Accelerometer, 25 Hz Breathing waveforms. Separate RR and BB external files
Summary and Development	ECG increased to 1000Hz, Accelerometry reduced to 50Hz
Enhanced Summary	Additional Impact parameters, from OmniSense 4.0 onwards
Enhanced Summary and Waveform	As above for Summary
Enhanced Summary and Development	As above For Summary

- When log data is imported into OmniSense analysis, not all parameters are added to the OmniSense database for view in the Analysis graphs.
- In addition, data can be saved as external csv files by the Zephyr Downloader in OmniSense Analysis.
- Some data (principally waveforms)can *only* be saved as external .csv files and viewed using external 3rd party applications.

The total logging capacity of a BioModule varies according to the log format:

Format	Total Logging Capacity (Hours)	Approximate Download Time per hour of data (Single BioModule)
General	500	
General and ECG	140	
General and Accelerometer	280	
Summary	450	10 sec
Summary and Waveform	60	30 sec
Summary and Development	30	1 min 30 sec
Enhanced Summary	450	12 sec
Enhanced Summary and Waveform	60	45 sec
Enhanced Summary and Development	30	2 min

9.4.1 General

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
General	1 Hz	Heart Rate Breathing Rate Skin Temperature Posture Activity Acceleration Battery BR Amplitude ECG Amplitude	yyyy_mm_dd-hh_mm_ss_General	Yes

		ECG Noise X Acc Min X Acc Peak Y Acc Min Y Acc Peak Z Acc Min Z Acc Peak		
	18 Hz	Breathing Waveform Heart R-R	yyyy_mm_dd-hh_mm_ss_BR_RR	No
	Per Event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd- hh_mm_ss_Event_Data	No

9.4.2 General and ECG

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
General and ECG	1 Hz	Heart Rate Breathing Rate Skin Temperature Posture Activity Acceleration Battery BR Amplitude ECG Amplitude ECG Noise X Acc Min X Acc Peak Y Acc Min Y Acc Peak Z Acc Min Z Acc Peak	yyyy_mm_dd-hh_mm_ss_General	Yes
	18 Hz	Breathing Waveform Heart R-R	yyyy_mm_dd-hh_mm_ss_BR_RR	No
	Per Event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd- hh_mm_ss_Event_Data	No
	250 Hz	ECG waveform	yyyy_mm_dd-hh_mm_ss_ECG	No

9.4.3 General and Accelerometer

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense

General and Accelerometer	1 Hz	Heart Rate Breathing Rate Skin Temperature Posture Activity Acceleration Battery BR Amplitude ECG Amplitude ECG Noise X Acc Min X Acc Peak Y Acc Min Y Acc Peak Z Acc Min Z Acc Peak	yyyy_mm_dd-hh_mm_ss_General	Yes
	18 Hz	Breathing Waveform Heart R-R	yyyy_mm_dd-hh_mm_ss_BR_RR	No
	Per Event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd-hh_mm_ss_Event_Data	No
	100 Hz	Acc Magnitude	yyyy_mm_dd-hh_mm_ss_Accelmag	No

9.4.4 Summary

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
Summary	1 Hz	Heart Rate Breathing Rate Skin Temperature Posture Activity Peak Acceleration Battery Voltage Battery % BR Amplitude BR Noise BR Confidence ECG Amplitude ECG Noise HR Confidence HRV System Confidence GSR Status ROG Time ROG Vert Acc Min Vert Ac peak	yyyy_mm_dd-hh_mm_ss_Summary	Yes

		Lateral Acc Min Lateral Acc Peak Sagittal Acc Min Sagittal Acc Peak Device Temperature Status Info Link Quality RSSI Tx Power Core Temperature Aux ADC1/2/3		
	Per Event	Heart R-R	yyyy_mm_dd-hh_mm_ss_RR	No
	Per Event	Breathing B-B	yyyy_mm_dd-hh_mm_ss_BB	No
	Per Download	Subject Information Device Information Session Information	yyyy_mm_dd-hh_mm_ss_SessionInfo.txt	No
	Per event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd-hh_mm_ss_Event_Data	No

9.4.5 Summary and Waveform

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
Summary and Waveform	1 Hz	Heart Rate Breathing Rate Skin Temperature Posture Activity Peak Acceleration Battery Voltage Battery % BR Amplitude BR Noise BR Confidence ECG Amplitude ECG Noise HR Confidence HRV System Confidence GSR Status ROG Time ROG Vert Acc Min	yyyy_mm_dd-hh_mm_ss_Summary	Yes

		Vert Ac peak Lateral Acc Min Lateral Acc Peak Sagittal Acc Min Sagittal Acc Peak Device Temperature Status Info Link Quality RSSI Tx Power Core Temperature Aux ADC1/2/3		
	Per Event	Heart R-R	yyyy_mm_dd-hh_mm_ss_RR	No
	Per Event	Breathing B-B	yyyy_mm_dd-hh_mm_ss_BB	No
	Per Download	Subject Information Device Information Session Information	yyyy_mm_dd-hh_mm_ss_SessionInfo.txt	No
	Per event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd-hh_mm_ss_Event_Data	No
	100 Hz	Vertical Accn Lateral Accn Sagittal Accn	yyyy_mm_dd-hh_mm_ss_Accel	No
	25 Hz	Breathing Waveform	yyyy_mm_dd-hh_mm_ss_Breathing	No
	250 Hz	ECG Waveform	yyyy_mm_dd-hh_mm_ss_ECG	No
	1 Hz	Location (Lat/ Long) Altitude GPS fix Quality Speed Over Ground Track Angle HDOP	yyyy_mm_dd-hh_mm_ss_GPS * Supported GPS devicerequired	Yes (displayed on Google Maps in OmniSense 4.0)

9.4.6 Summary and Development

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
Summary and Development	1 Hz	Heart Rate Breathing Rate Skin Temperature Posture Activity Peak Acceleration	yyyy_mm_dd-hh_mm_ss_Summary	Yes

		Battery Voltage Battery % BR Amplitude BR Noise BR Confidence ECG Amplitude ECG Noise HR Confidence HRV System Confidence GSR Status ROG Time ROG Vert Acc Min Vert Ac peak Lateral Acc Min Lateral Acc Peak Sagittal Acc Min Sagittal Acc Peak Device Temperature Status Info Link Quality RSSI Tx Power Core Temperature Aux ADC1/2/3		
	Per Event	Heart R-R	yyyy_mm_dd-hh_mm_ss_RR	No
	Per Event	Breathing B-B	yyyy_mm_dd-hh_mm_ss_BB	No
	Per Download	Subject Information Device Information Session Information	yyyy_mm_dd-hh_mm_ss_SessionInfo.txt	No
	Per event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd-hh_mm_ss_Event_Data	No
	50 Hz	Vertical Accn Lateral Accn Sagittal Accn	yyyy_mm_dd-hh_mm_ss_Accel	No
	25 Hz	Breathing Waveform	yyyy_mm_dd-hh_mm_ss_Breathing	No
	1000 Hz	ECG Waveform	yyyy_mm_dd-hh_mm_ss_ECG	No

9.4.7 Enhanced Summary

Format	Reporting Frequenc	Parameter	External csv Filename	Imported Into OmniSense

	y			
Summary	1 Hz	Heart Rate Breathing Rate Posture Activity Peak Acceleration Battery % BR Amplitude BR Noise ECG Amplitude ECG Noise HR Confidence HRV ROG Device Temperature Status Info Link Quality RSSI Tx Power Core Temperature Aux ADC1/2/3 Impulse Load Walk Steps Run Steps Bounds Jumps Minor Impacts Major Impacts Average Rate Force Development Average Step Impulse Average Step Period Jump Flight Time Peak g Phi Angle Peak g Theta Angle	yyyy_mm_dd-hh_mm_ss_SummaryEnhanced	Yes
	Per Event	Heart R-R	yyyy_mm_dd-hh_mm_ss_RR	No
	Per Event	Breathing B-B	yyyy_mm_dd-hh_mm_ss_BB	No
	Per Download	Subject Information Device Information Session Information	yyyy_mm_dd-hh_mm_ss_SessionInfo.txt	No
	Per event	Event Code Event Type Source Event ID Event Specific	yyyy_mm_dd-hh_mm_ss_Event_Data	No

		Data		

9.4.8 Enhanced Summary and Waveform

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
Summary	1 Hz	Heart Rate Breathing Rate Posture Activity Peak Acceleration Battery % BR Amplitude BR Noise ECG Amplitude ECG Noise HR Confidence HRV ROG Device Temperature Status Info Link Quality RSSI Tx Power Core Temperature Aux ADC1/2/3 Impulse Load Walk Steps Run Steps Bounds Jumps Minor Impacts Major Impacts Average Rate Force Development Average Step Impulse Average Step Period Jump Flight Time Peak g Phi Angle Peak g Theta Angle	yyyy_mm_dd-hh_mm_ss_SummaryEnhanced	Yes
	Per Event	Heart R-R	yyyy_mm_dd-hh_mm_ss_RR	No
	Per Event	Breathing B-B	yyyy_mm_dd-hh_mm_ss_BB	No
	Per Download	Subject Information Device Information Session Information	yyyy_mm_dd-hh_mm_ss_SessionInfo.txt	No

	Per event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd-hh_mm_ss_Event_Data	No
	100 Hz	Vertical Accn Lateral Accn Sagittal Accn	yyyy_mm_dd-hh_mm_ss_Accel	No
	25 Hz	Breathing Waveform	yyyy_mm_dd-hh_mm_ss_Breathing	No
	250 Hz	ECG Waveform	yyyy_mm_dd-hh_mm_ss_ECG	No
	1 Hz	Location (Lat/Long) Altitude GPS fix Quality Speed Over Ground Track Angle HDOP	yyyy_mm_dd-hh_mm_ss_GPS * Supported GPS device required	Yes (displayed on Google Maps in OmniSense 4.0)

9.4.8.1 Enhanced Summary and Development

Format	Reporting Frequency	Parameter	External csv Filename	Imported Into OmniSense
Summary	1 Hz	Heart Rate Breathing Rate Posture Activity Peak Acceleration Battery % BR Amplitude BR Noise ECG Amplitude ECG Noise HR Confidence HRV ROG Device Temperature Status Info Link Quality RSSI Tx Power Core Temperature Aux ADC1/2/3 Impulse Load Walk Steps Run Steps Bounds Jumps Minor Impacts	yyyy_mm_dd-hh_mm_ss_SummaryEnhanced	Yes

		Major Impacts Average Rate Force - Development Average Step Impulse Average Step Period Jump Flight Time Peak g Phi Angle Peak g Theta Angle		
	Per Event	Heart R-R	yyyy_mm_dd-hh_mm_ss_RR	No
	Per Event	Breathing B-B	yyyy_mm_dd-hh_mm_ss_BB	No
	Per Download	Subject Information Device Information Session Information	yyyy_mm_dd-hh_mm_ss_SessionInfo.txt	No
	Per event	Event Code Event Type Source Event ID Event Specific Data	yyyy_mm_dd-hh_mm_ss_Event_Data	No
	50 Hz	Vertical Accn Lateral Accn Sagittal Accn	yyyy_mm_dd-hh_mm_ss_Accel	No
	25 Hz	Breathing Waveform	yyyy_mm_dd-hh_mm_ss_Breathing	No
	1000 Hz	ECG Waveform	yyyy_mm_dd-hh_mm_ss_ECG	No

Part 10

10 Baseline Fitness Testing

The OmniSense Analysis Module can be used to generate fitness parameters, if data is recorded during an appropriate treadmill or beep test.

- Treadmill Test
- Beep Test
- 40 Yard Dash Test
- Jump Test
- Orthostatic Hypotension Test (Resting & Standing Heart Rate)

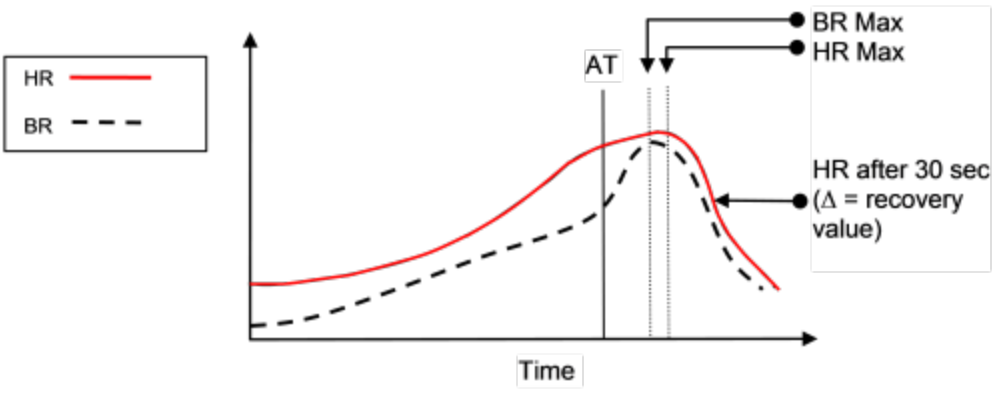
10.1 Treadmill Test

Zephyr recommends Fitness Test protocols be supervised under conditions such as those recommended by the American College of Sports Medicine (www.acsm.org)

The criteria for an effective treadmill test are:

- A constant, steady increase in workload required of the subject
- A gradual increase in both:
  - Heart Rate
  - Breathing rate
- As the Anaerobic Threshold (AT) is reached
  - An associated marked increase in breathing rate
  - The heart rate should be nearing its maximum value, so rate of increase of heart rate should be reducing.
- The subject continues with the test until they can no longer sustain the effort, at which point
  - Maximum Heart Rate and
  - Maximum Breathing Rate has been reached.
- Recording should continue for a minimum of 30 seconds after activity has ceased, to allow calculation of Heart Rate Recovery (HRR) values. The subject must remain inactive during this period, for any HRR evaluation to be valid.

An *idealized* graph of heart rate and breathing rate during the course of such a test would look like this:



To determine fitness parameters such as AT threshold from actual test data, refer to the sections on Fitness Parameter Detection

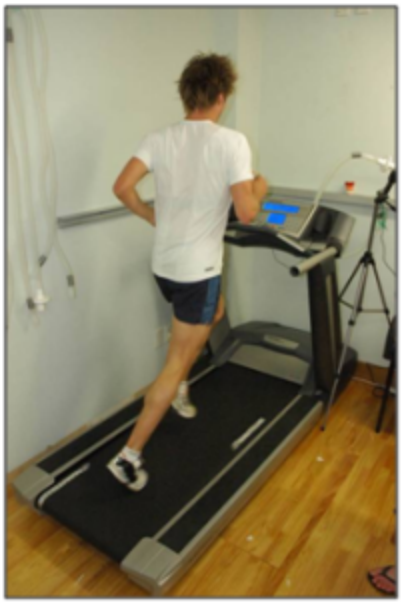
When using a PSM Responder system, better test results will be achieved by using data logged internally in the BioHarness module, due to latency in transmitting data over the radio network. Download data from the devices directly into OmniSense Analysis

10.1.1 Treadmill Test Protocol

To conduct an AT test using the PSM Training, use a treadmill:

The test should follow an incremental exercise test such as the ACSM ramp protocol, or a modified Conconi test, a treadmill version of which is described as follows:

1. 10 minute warm-up, including stretches..
2. Set the treadmill gradient at 5%.
3. Set the start speed at 6kph (3.7mph).
4. Every 3 minutes, increase the treadmill speed by 2kph (1.25mph)
5. To gain maximum benefit from the test, provide verbal encouragement to the athlete during the test.
6. The test finishes when the athlete can no longer continue.



The subject should reduce to walking or remain stationary for 30 seconds after the test to allow a Heart Rate Recovery measurement to be derived.

If this test is carried out using a PSM Responder system, better data will be captured by using the devices in logging mode, due to the latency of data transmitted over the radio network.

Download logged data directly into OmniSense Analysis.

Note: it is important that the above speed and timing criteria are observed, as the automatic VO_2max calculation is determined by the speed at which the subject stops running – specifically the duration they have been running for.

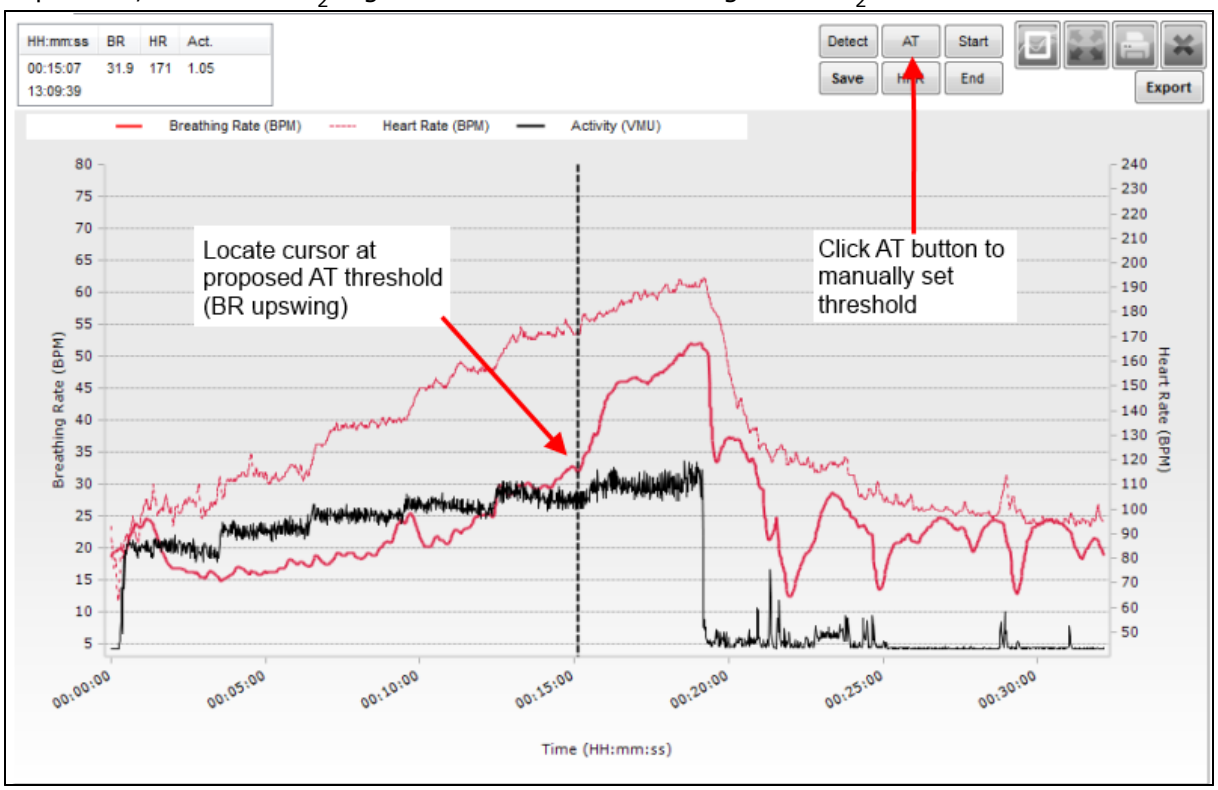
If different speed, gradient and timing criteria are used, the VO_2max calculation will be less accurate.

10.1.2 VO2Max Calculation

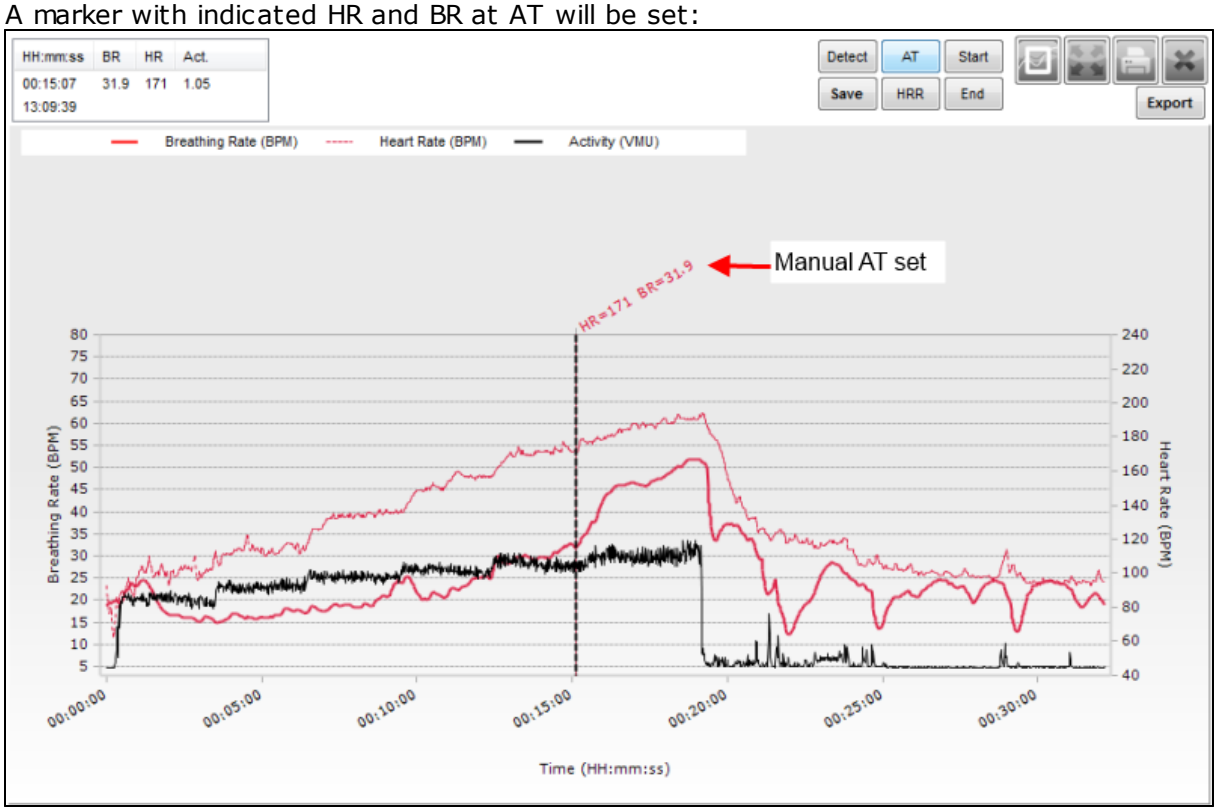
If the test protocol is *strictly* adhered to, then Analysis can calculate a VO_2Max value.

1. Detect anaerobic threshold, either automatically or manually. If an AT marker is already

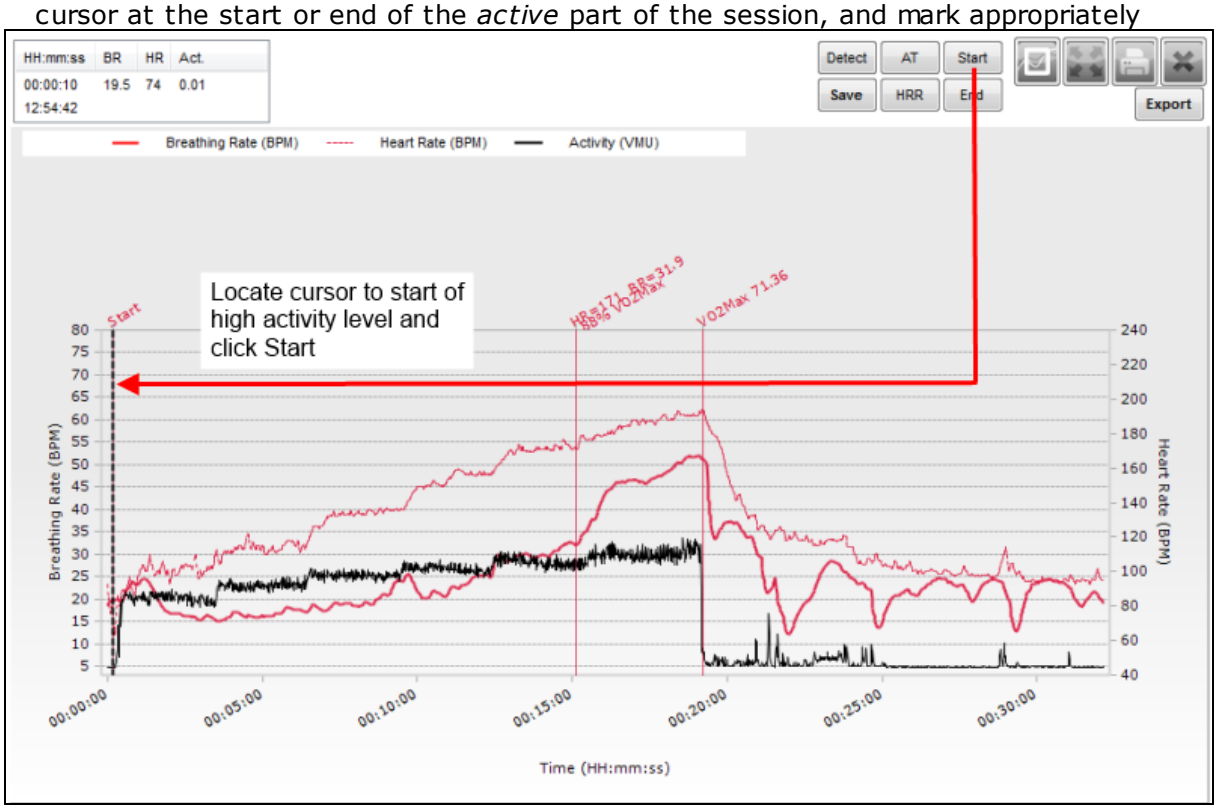
present, then the VO_2 algorithm calculation will assign a %VO_2Max value to it.

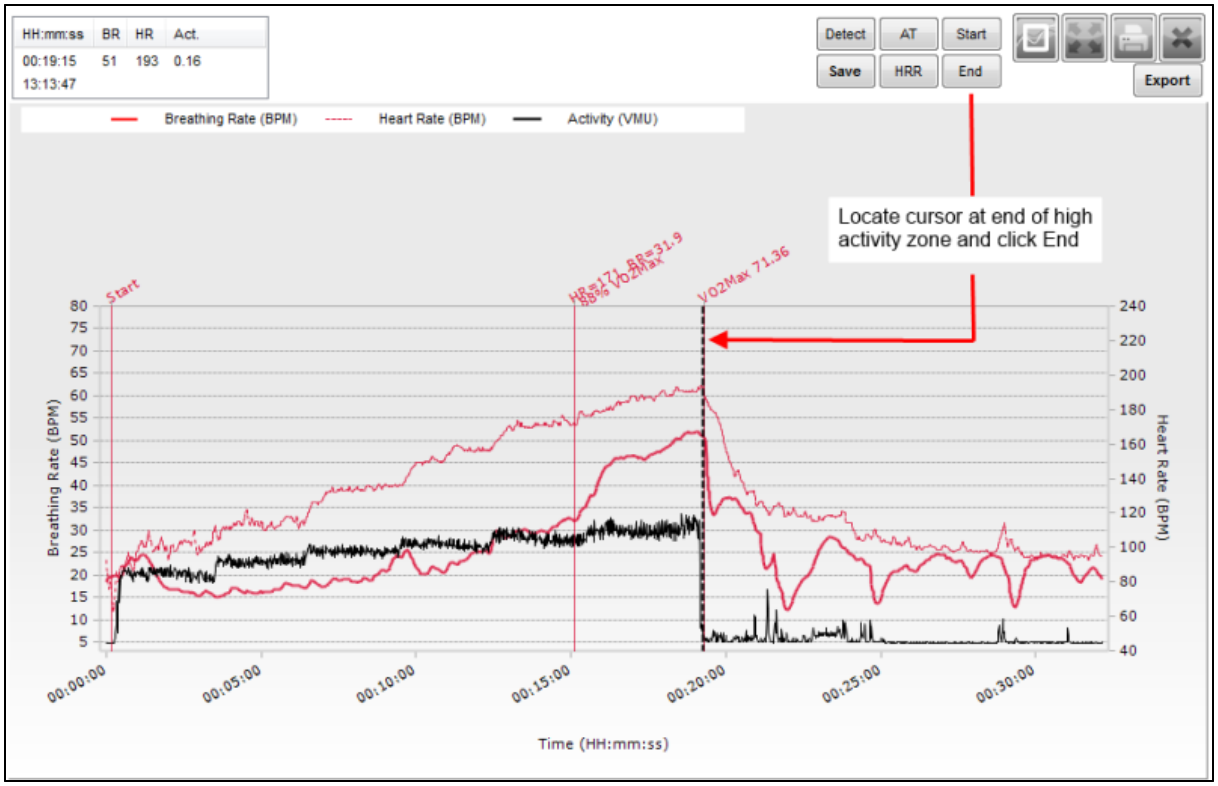


A marker with indicated HR and BR at AT will be set:



2. Set Start and End markers to the active section of the session - place the vertical cursor at the start or end of the *active* part of the session, and mark appropriately





3. VO_2Max will be displayed at the maximum breathing point. The %VO_2Max level will be displayed at the AT marker previously placed.
An ACSM-derived formula is used for this calculation.

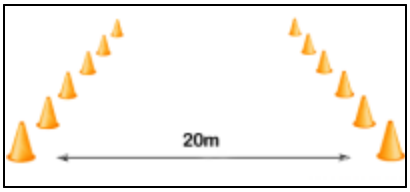
10.2 Beep Test

A beep test is another form of maximal performance test familiar to coaches and trainers. Subjects run back and forth between markers to an audio cue which gradually decreases the amount of time (and hence increases subject speed) allowed to reach the next marker.

Although the activity is different to a treadmill test, heart rate and breathing rate data should look broadly similar to that illustrated in for the treadmill test.

10.2.1 Beep Test Protocol

1. Place marks or cones 20 meters apart



2. Subjects should warm up and stretch for 10 minutes.
3. When ready, with all equipment operational, and OmniSense recording, start the audio recording to initiate the test. A sample of this recording can be found at: https://app.box.com/s/qnpds7wby5dq2g4yh2b5ay674uadpymq

The recording generates audio cues which are equivalent to the following running speeds between the markers:

Cycle Iteration	No. of shuttles at this level	Running Speed (kph)
1	7	8.0
2	8	9.0
3	8	9.5
4	9	10.0
5	9	10.5
6	10	11.0
7	10	11.5
8	11	12.0
9	11	12.5
10	11	13.0

Cycle Iteration	No. of shuttles at this level	Running Speed
11	12	13.5
12	12	14.0
13	13	14.5
14	13	15.0
15	13	15.5
16	14	16.0
17	14	16.5
18	15	17.0
19	15	17.5
20	16	18.0
21	16	18.5

Note: Beep Test protocols vary internationally, with markers being placed 20 yards or 20 meters apart. 20-meter spaced markers represent a 9.3% increase in distance over 20-yard spaced markers. Thus subjects using metric-spaced markers use 9.3% more effort for a given level in the test.

Likewise there are minor differences in the speed criteria for some audio recordings available, as different researchers have fine-tuned the test.

If different distance and timing increment criteria are used, the VO2max value will be less accurate.

10.3 40 Yard Dash Test

This test will populate a peak acceleration value Dg [Dash g-force] 'in the subject's BioGauge in the Live module, as well as record this value into the OmniSense database for access in the Analysis module.

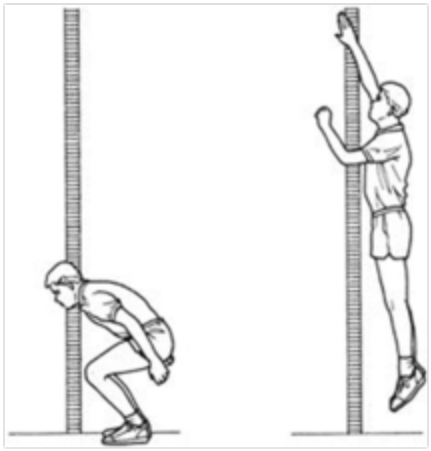
1. The subject must assume the half-crouch as shown above or full sprint crouch, and maintain for a minimum of one second. The posture value indicated when in the crouch position is required for the detection algorithm to initiate.

2. Start when directed and maintain sprint as required.

3. Note that other explosive activities or events which mimic the crouch posture , pause and explosive start may generate peak acceleration values which will populate or update the subject BioGauge Dg value, as well as record 'Dash' events in the database. Such activities should be avoided, or note made of exactly when a deliberate Dash event is attempted. Use the Marker facility in OmniSense Live if preferred.

10.4 Jump Test

This test will populate a peak acceleration value Jg [Jump g-force] 'in the subject's BioGauge in the Live module, as well as record this value and also Jump Height and Jump Time In The Air into the OmniSense database for access in the Analysis module.



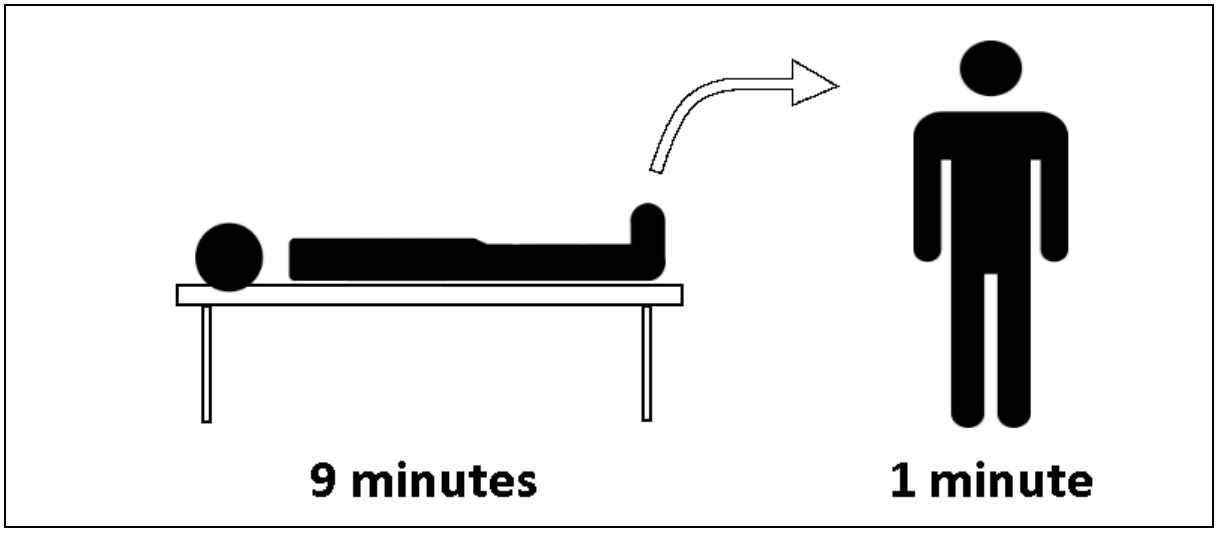
1. The subject should crouch, pause, and spring as high as they can. Note that the jump detection and calculation algorithm has been optimized for vertical jumping. It will also be triggered during a Broad Jump event, but the data for Jump Height and Time in the Air will be less valid.

2. The Jump Test is similar to the Dash Test in detection. Note that other explosive events which mimic the explosive start and vertical acceleration may generate peak vertical acceleration values which populate or update the subject BioGauge, and are also recorded into the OmniSense database. It is recommended that you use Markers when recording the data, to distinguish planned jump events from false detections.

10.5 Orthostatic Hypotension Test

This is a simple test to measure resting and standing heart rate, and resting HRV. These parameters are used in OmniSense Analysis to establish a Readiness Estimate for training athletes, when combined with other factors.

For repetition, create a Session Name in OmniSense Live labeled 'Orthostatic Test' or similar, and label the session accordingly. The test can also be carried out using a BioModule in logging mode, and the data imported into Analysis.



1. Pick a quiet location with a comfortable temperature.

2. Lie down on a comfortable surface such as a bed or couch, and remain still and quiet for 9 minutes.
   This will establish your resting heart rate and heart rate variability.

3. Stand up and hold a comfortable standing position for 1 minute.
   This will establish your standing heart rate.

Part 11

11 Fitness Test Analysis

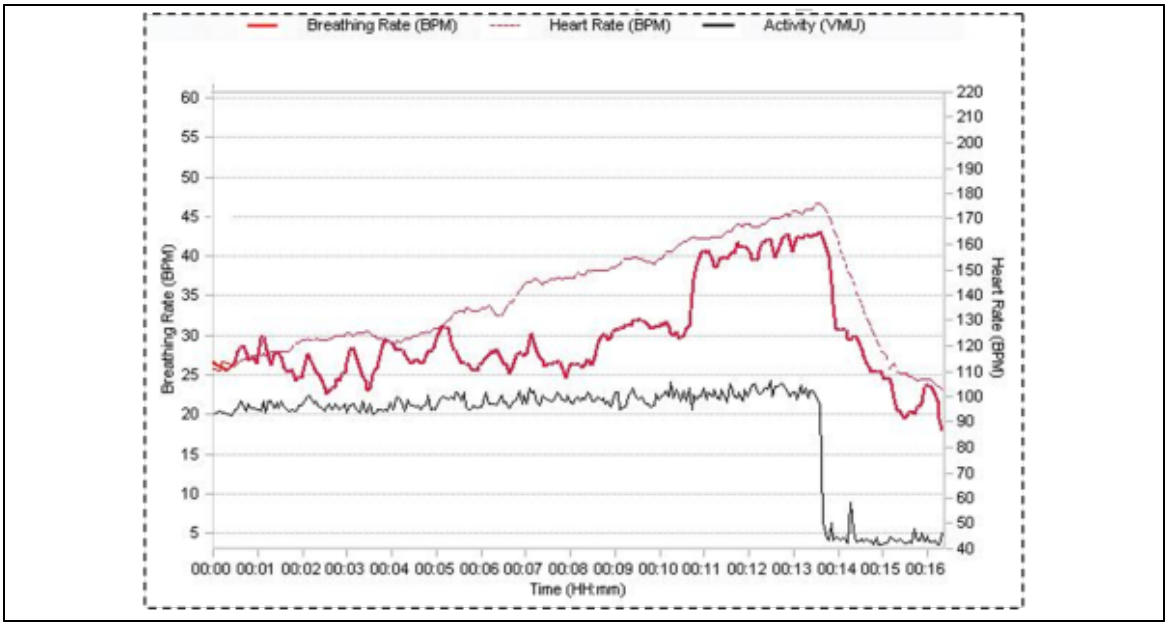
The Analysis module has integrated algorithms to determine Anaerobic Threshold (AT) and Heart Rate Recovery (HRR) values from suitable fitness test data.

- Auto-detection of AT & HRR
- Manual detection & correction of AT & HRR
- VO2Max Calculation from a treadmill test
- Saving Fitness Parameters to the OmniSense database
- Display Parameters in a Fitness Report

11.1 Automatic Fitness Parameter Detection

1. SELECT DATA
   Populate the Legend with the session containing treadmill or beep test data (drag or double-click).
   The Sample Team contains real treadmill test data for Demo Subject 4.

2. SELECT TREADMILL OR BEEP TEST
   Select the Time Data button, and check the Treadmill Test or Beep Test box at the bottom of the *Select Time Variables* panel – this disables all the other check boxes:



The graph will automatically display three parameters:

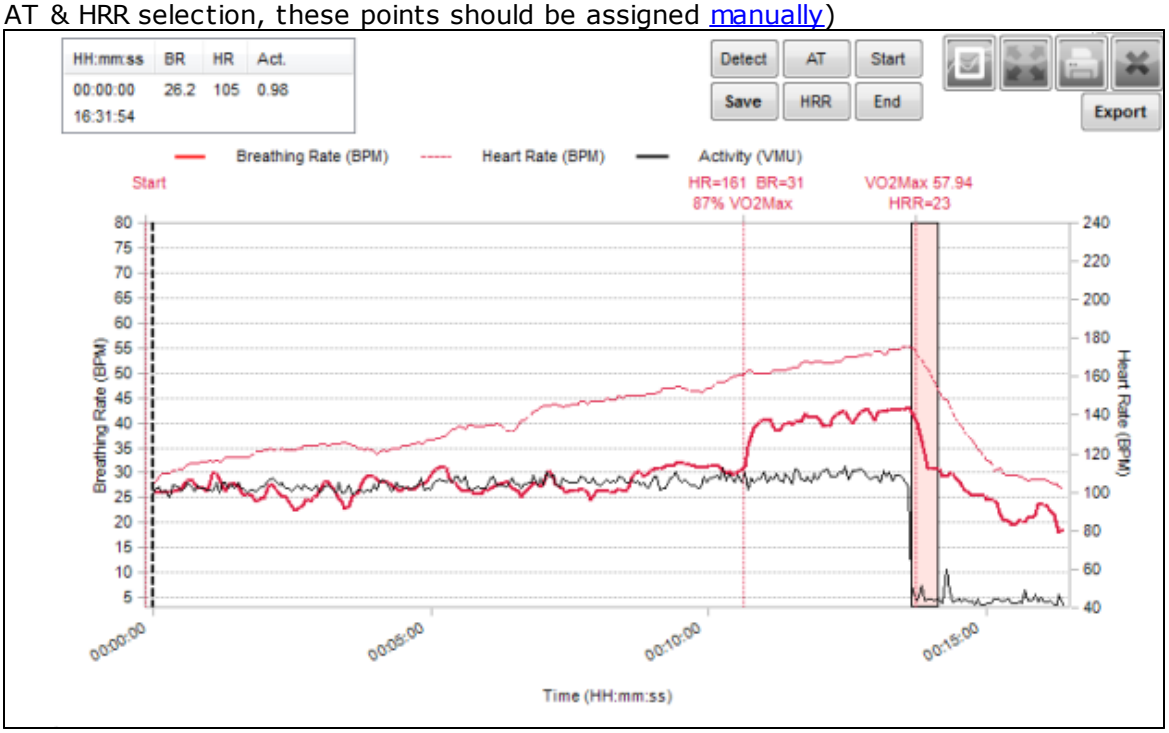
- Heart Rate
- Breathing Rate
- Activity Level

The values table also shows these values

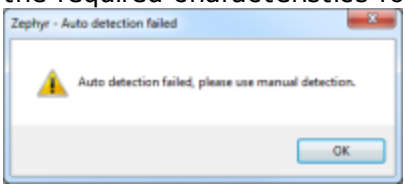
3. DETECT FITNESS PARAMETERS AUTOMATICALLY

A *Detect* button 

can be used to try and set the AT and HRR points in the data automatically (certain criteria in the data must be met - in the event of wrong or no AT & HRR selection, these points should be assigned manually)



The AT and HRR indicators will be placed automatically. If the data does not display the required characteristics for auto-detection, a dialogue will display:



AT and HRR points must be selected manually if this happens. The AT and HRR parameters can then be saved to the OmniSense database.

11.2 Manual Fitness Parameter Detection

If the data recorded during a treadmill or beep test does not clearly enough display the characteristics required to detect AT and HRR features, they may be selected manually.

Set Anaerobic Threshold

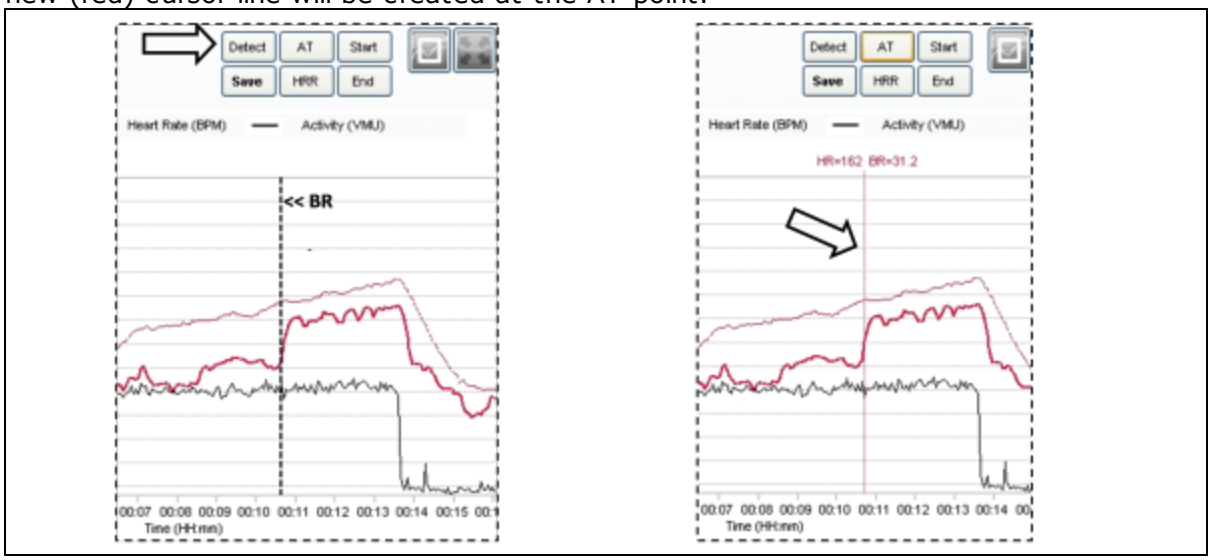
Identify the point where there is a marked increase in breathing rate (the second ventilatory threshold) during the latter part of the test.

Tip: Work backwards from the maximum Breathing Rate peak, and look for the first significant inflection point (upswing) where the breathing rate remains above 40 breaths/min. Be prepared to ignore or allow for major spikes or troughs in the breathing rate which may be artefacts caused by non-breathing related pressure changes on the sensor.

Drag the cursor to the point where this increase shows, and click the 

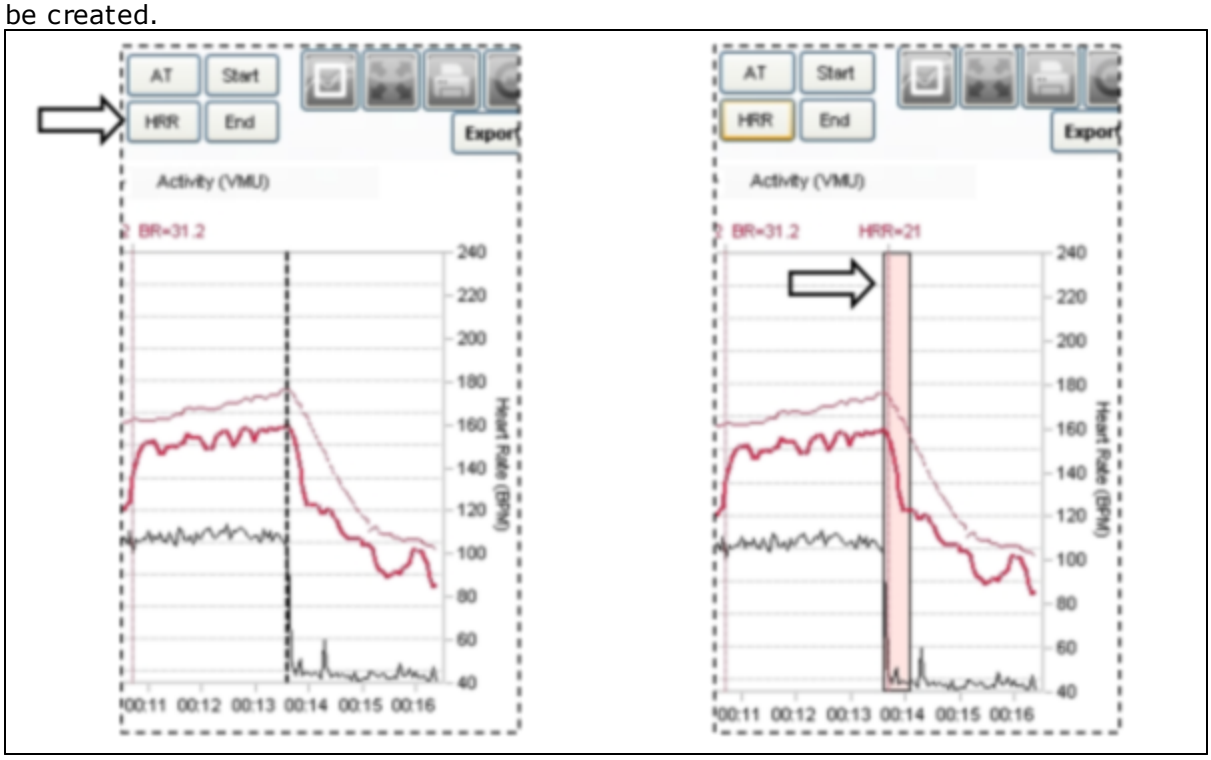
button. A

new (red) cursor line will be created at the AT point.



Set Heart Rate Recovery

Relocate the cursor to the point at the end of the test (probably where activity ceases) and the heart rate drops. Click the HRR button. A 30-second time interval outline will be created.

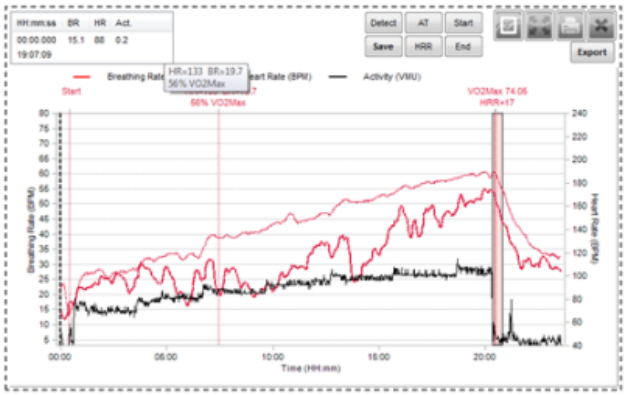


If desired, the selected parameters can be saved to the OmniSense database and used in subject fitness radar reports.

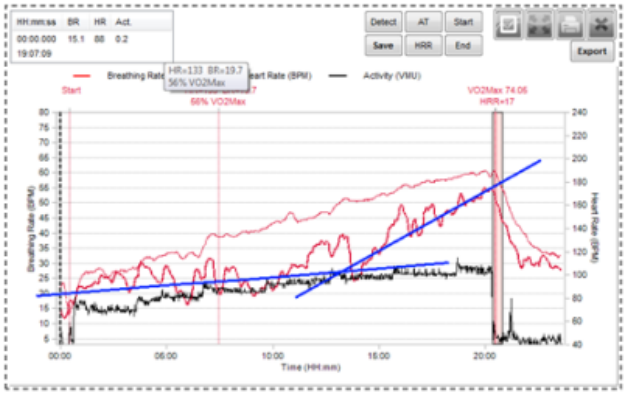
11.3 Correcting an Automatic Detection

The human brain has sophisticated pattern-recognition algorithm that can note subtleties in data that even sophisticated algorithms fail to detect. Developers continue to try and emulate the brain's potential.
A user should place the vertical cursor at manually selected points using the guidelines described below, and use the manual buttons AT and HRR to set the detections manually.

Here is an example of a data set where the automatic detection algorithm has - wrongly - placed the AT threshold at the 56% VO_2Max level:



However the human eye can see an underlying trend in the breathing data – a slowly increasing rate to around the 13:30 minute mark, followed by a more rapidly increasing rate.



These trends are marked with the blue lines.

They are masked by variations or artefacts in the data which have caused the algorithm to detect a false AT threshold, too early in the test.

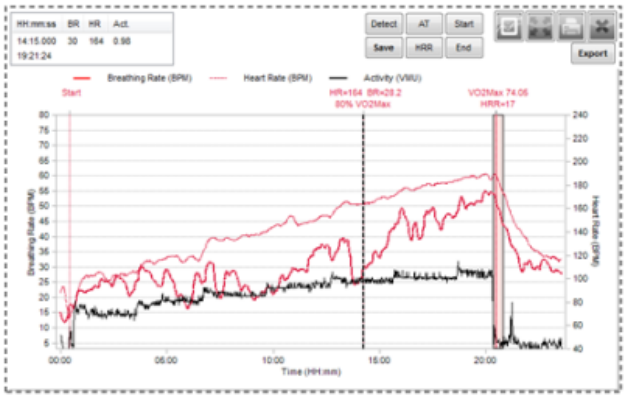
An alternative approach is too look for the major upswing in breathing rate which raises it above 40bpm and keeps it there, allowing for minor variations.

The 40 bpm level is indicated by the horizontal line.

The circle marks the major inflection in the breathing rate which pushes the breathing rate through the 40 bpm level.

The two fleeting drops below 40bpm above the inflection should be ignored.

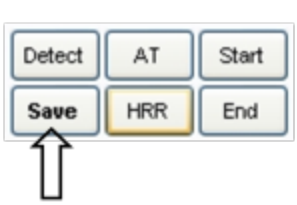
Both of the approaches above indicate that the automatically-detected AT threshold should be corrected. Drag the vertical cursor to the inflection point indicated by both the above methods, and click the AT button to manually correct the automatic detection.

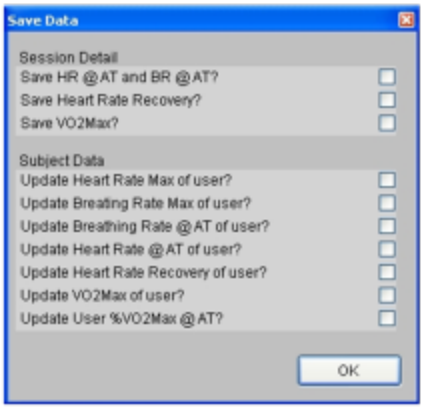


The new AT threshold is now at the 80% VO_2 Max level.

11.4 Save Fitness Parameters to Database

Click the Save button. A dialogue will display – select the check boxes according to requirements.





Session Detail

Values saved against that session, which will always be displayed on the graph

Save HR @ AT and BR @ AT: Saves the AT vertical marker created - the markers will always be visible on the graph for the selected session. Data is also available as a summary variable for that session

Save Heart Rate Recovery: Saves the HRR rectangle created - always visible on the graph. Data also available as a summary variable for that session

Save VO_2 Max: Saves the Start and End markers, along with VO_2 Max values

Subject Data

Values saved to the database, and updated in the subject's physiological parameters in the Live module. They can be displayed in Fitness Reports

Update HR Max of User:	Updates saved details for the subject - this changes the value which will give 100% deflection on the HR dial in the Live Module, and sets the levels when displaying Heart Rate Percent data
Update BR Max of User:	Updates saved details for the subject - this changes the value which will give 100% deflection on the BR dial in the Live Module
Update BR @ AT of User:	Updates saved details for the subject.
Update HR Recovery of User:	Updates saved details for the subject – this stores a reference HRR value for the user which is indicated on the HRR graph
Update VO_2 Max of User	Updates saved details for the subject.
Update User % VO_2 Max	Updates saved details for the subject.

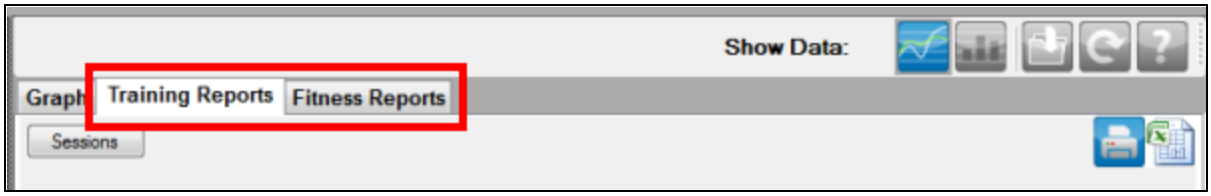
11.5 Orthostatic Hypotension Test

Carry out an orthostatic hypotenstion test, either using OmniSense Live, or using a BioModule in logging mode, and import the data.
See the Readiness topic.

Part 12

12 Reports

A number of fitness report options are now available. They are accessed from the tabs at the top of the graph panel:



Training Reports

- multiple subjects
- group summary statistics
- radar plots which compare each subject against the group average values

Fitness Reports

- multiple or single subjects
- summary statistics
- radar plots which compare each subject against the group average, or a selected population normal file, or a customized normal file created manually from historical group data

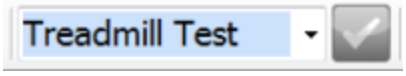
12.1 Report Generation Workflow

For efficiency in generating a report, and to minimize the work involved in selecting the correct sessions, the following steps are recommended:

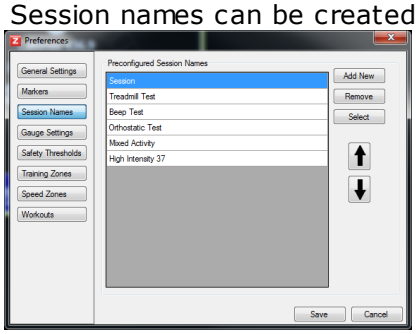
OmniSense Live

See also OmniSense Live *Help > OmniSense Application > User Preferences > Session Names*

1. Name the session in OmniSense Live



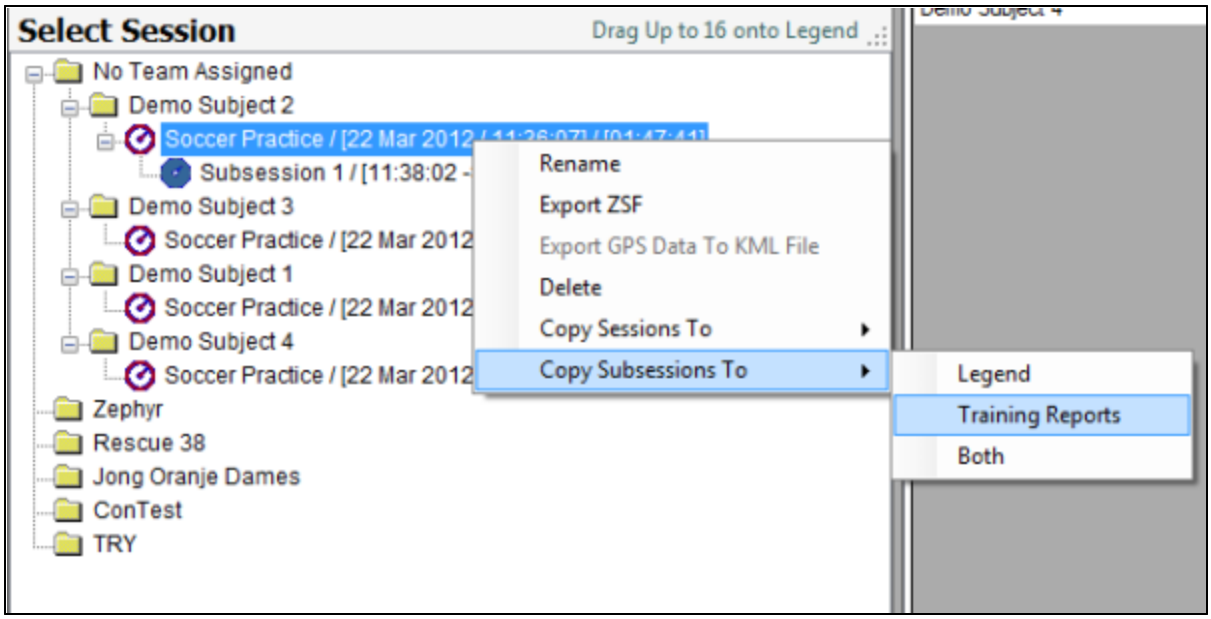
2. Session names can be created and edited in the Live > User Preferences dialogue.



Customized session names specific to a particular activity will greatly simplify selecting those sessions needed for a report.

OmniSense Analysis

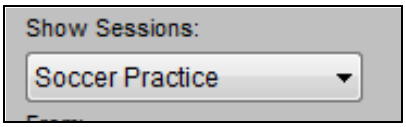
For rapid automatic population of Training Reports with larger groups, the best approach is to filter the sessions displayed in the Select Session tree to only the team, session, and subsessions within a certain timeframe desired to generate a report. Once this is done, a mouse right-click will display context menus which will auto-populate a report with only those sessions (or subsessions) which are displayed in open nodes in the Select Session tree. This may be the only practical way of creating a report with large numbers of subjects:



0

Using the above Demo Subject Soccer Practice sessions as an example, there are two ways of populating Select Session quickly.

1. Use the Session name



If the session name is unique, then this is all that needs to be set.

2. Use the Date Filter

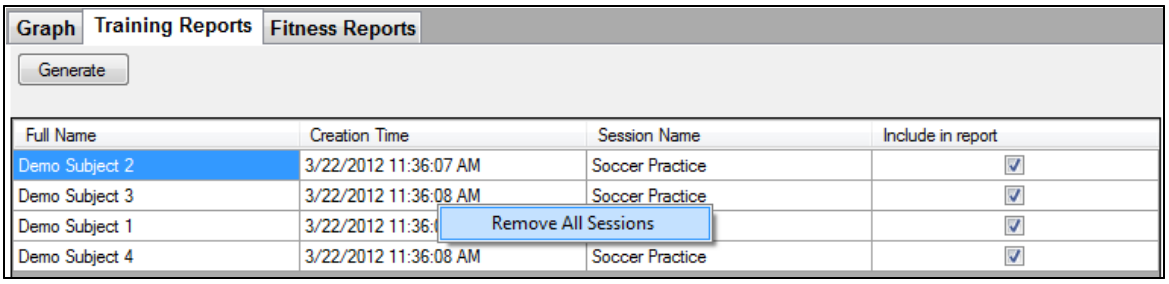
This particular session occurred 22 March 2012. Use the Date filters to select this day.

Use a combination of both of the above if necessary

3. When only those sessions wanted for the report are displayed in **Select Session**, then right-click any session and select the
desired option from the context menu displayed.

4. Alternatively, drag and drop those sessions wanted manually from the **Select Session** tree to the report pane.

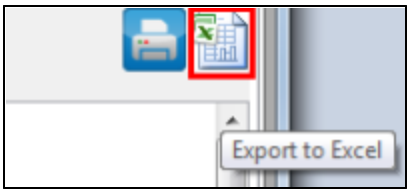
5. To remove sessions from a report, uncheck the *Include in report* checkbox for individual sessions, or right-click and select *Remove All Sessions*



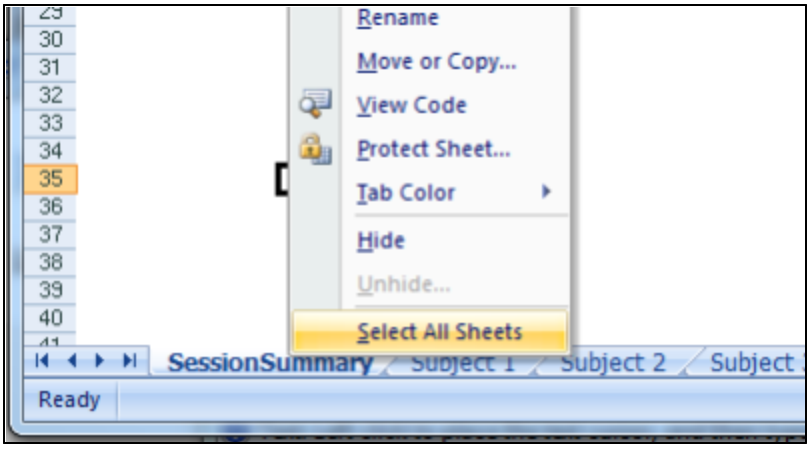
6. To generate the desired report, click the *Generate* button

12.2 Remove Unwanted Parameters

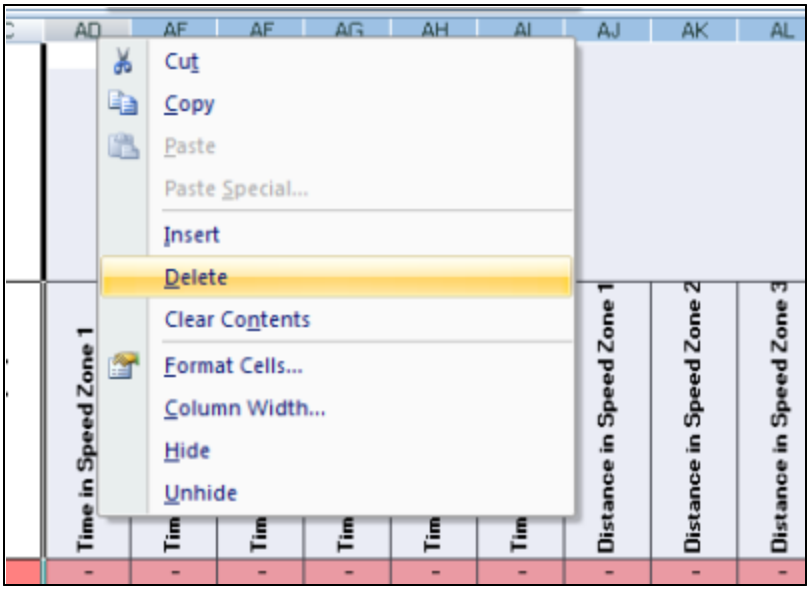
To remove unwanted parameters from a report (e.g GPS data when not needed) - both columns in the spreadsheet, and axes from the radar plots:
1. Export the report as an Excel® spreadsheet.



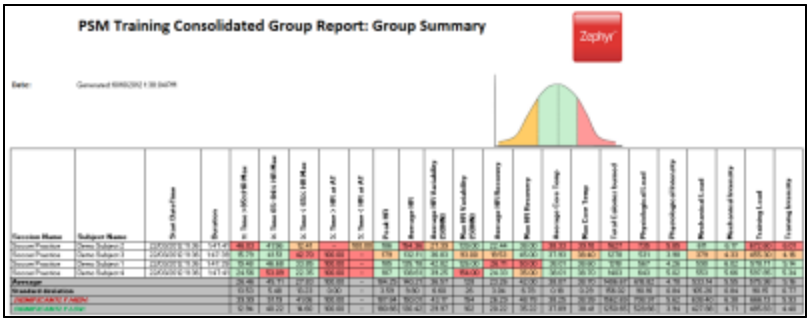
2. Open the spreadsheet at the *SessionSummary* tab. Right-click on the tab and select *Select All Sheets*. This will modify the radar plots also.



3. Select all the columns to delete (if the A|B|C|... column headings are not displayed, go to the View tab and check the *Headings* box) and delete them by right-clicking



4. The report and radar plots can be truncated to a more usable size

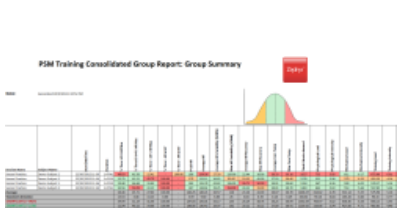
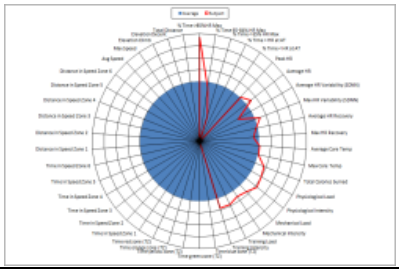
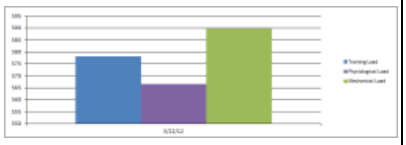


12.3 Error Values

Cells in the Report Spreadsheet may show the value #DIV/0!. This is an Excel-generated error indicating that a value cannot be calculated.

12.4 Training Reports

Training Reports are designed to provide analysis and display of data from groups of subjects pursing a training program. The data is typically presented in three ways:

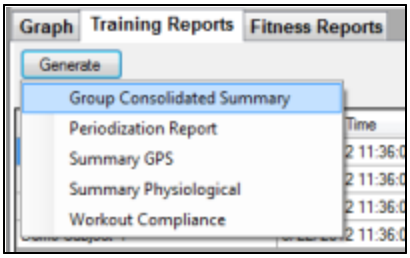
		
Summary spreadsheet of all	Radar plot to compare	Bar Charts of group and

parameters for group and individuals	individual vs. group performance	subject Intensity and Load values

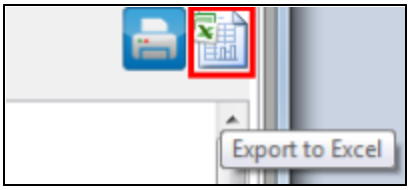
Group Consolidated Summary	A comprehensive set of parameters (42) available in group spreadsheet format, plus individual subject spreadsheets and radar plots for group comparison
Periodization Report	Group spreadsheet focussing on Physiological, Mechanical & Training Intensity and Load data. Group Load & Intensity bar charts, and the same for each subject
Summary GPS	Group spreadsheet showing time and distance by speed zone, average and max speed, elevation change & distance traveled. Subject radar plots of same for group comparison
Summary Physiological	Group spreadsheet of heart rate-related and core temperature parameters, plus individual radar plots for group comparison
Workout Compliance	Group spreadsheet focussing on intensity, load, and time in Workout Zones, defined in the OmniSense Live module preferences dialogue

Generate A Report

1. Populate the report pane with the required sessions according to the workflow recommendations
2. Click the *Generate* button and select report type from context menu

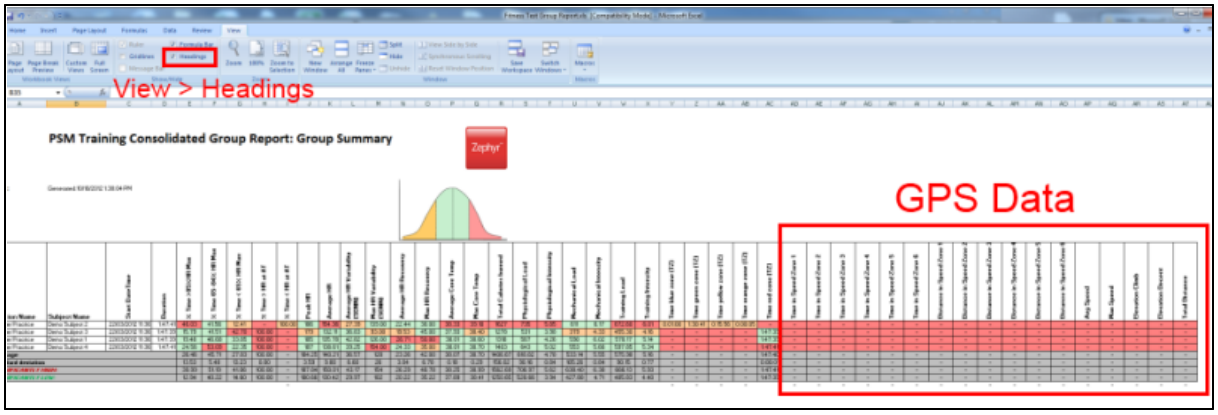


3. For detailed analysis, better display, and to remove unnecessary columns, export the report to an Excel .xlsx spreadsheet using the Export button
(Microsoft® Excel required)

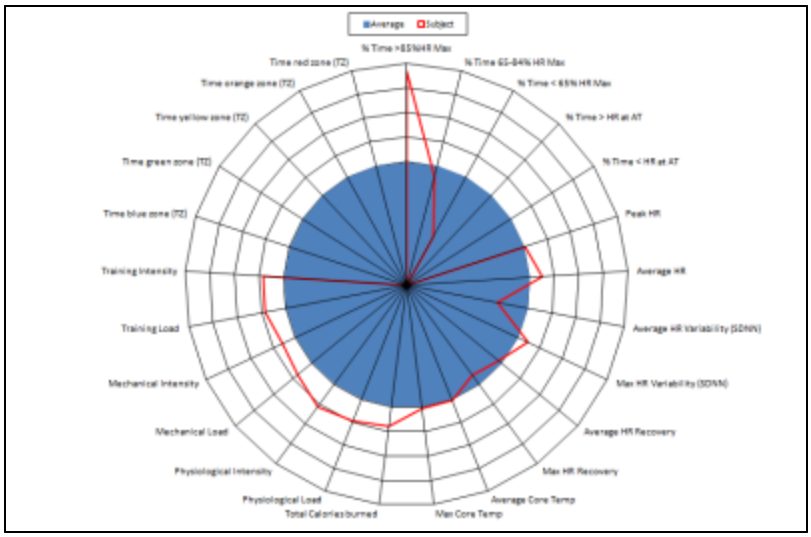


12.4.1 Group Consolidated Summary

The consolidated report is a comprehensive report containing all data for the group in spreadsheet form as well as individual subject spreadsheets and a radar plot:



Individual subject radar plot:



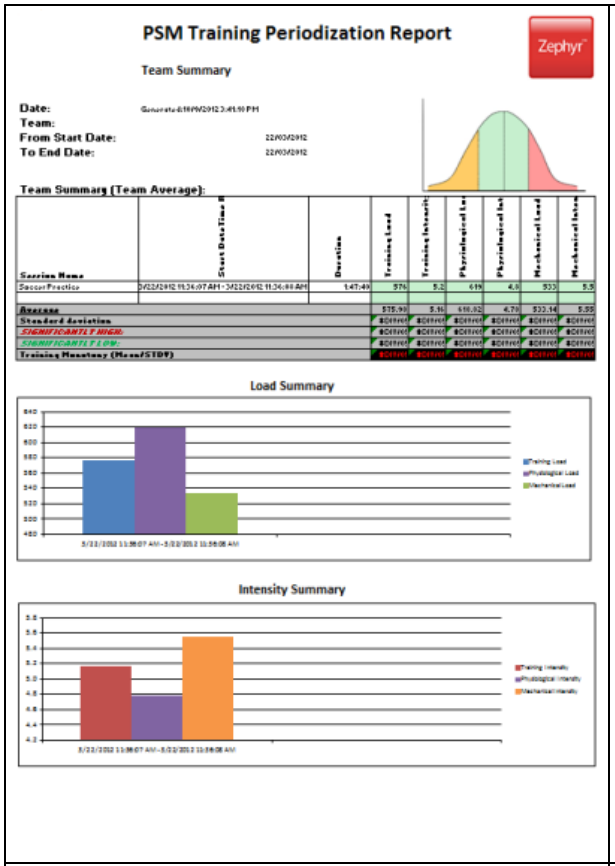
In many scenarios this report may present *too much* data. It should be exported as an Excel® spreadhseet and columns removed to suit. e.g GPS data columns can be removed, as well as the corresponding axes in the subject radar plots.

Parameter	Description	Also in
Session & Subject names, Start Date/Time, Duration		All reports
% Time > 85% HR_{max}		Summary Physiological Report
% Time 65 - 84% HR_{max}		Summary Physiological Report
% Time < 64% HR_{max}		Summary Physiological Report
% Time > HR@AT	% Time above anaerobic threshold	Summary Physiological Report
% Time < HR@AT	% Time below anaerobic threshold	Summary Physiological Report
Peak HR	Modify the subject's stored	Summary Physiological

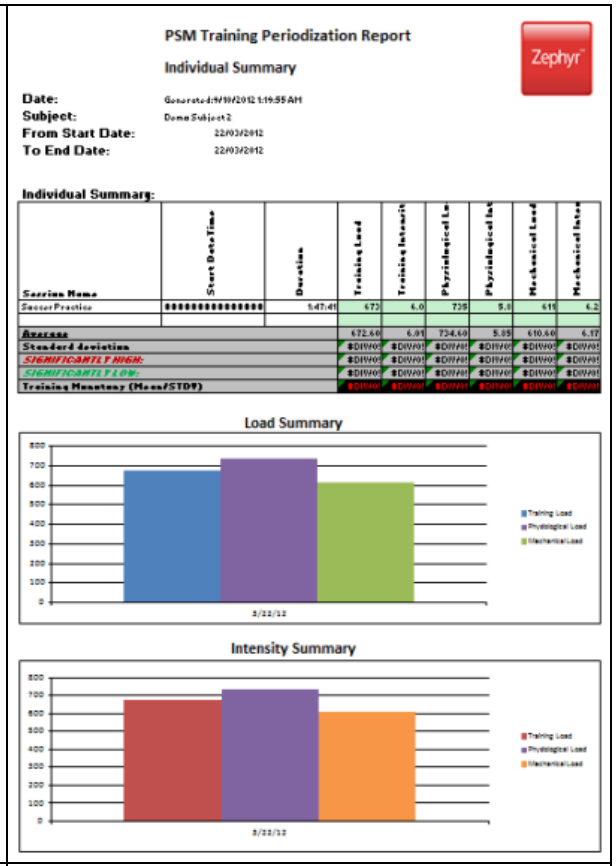
	HR_{max} if this value exceeds it	Report
Average HR		Summary Physiological Report
Average & Max HRV (SDNN)	Heart Rate Variability - Stress indicator	Summary Physiological Report
Average & Max HRR	Heart Rate Recovery - Fatigue indicator	Summary Physiological Report
Average Core Temperature		Summary Physiological Report
Maximum Core Temperature		Summary Physiological Report
Total Calories burned	Using ACSM formula	Summary Physiological Report
Physiological Intensity & Load	Heart Rate based indication of workout performance	Periodization Report Workout Compliance Report
Mechanical Intensity & Load	Acceleration based indication of workout performance	Periodization Report Workout Compliance Report
Training Intensity & Load	Average of the above two	Periodization Report Workout Compliance Report
Time in Blue/Green/Yellow/ Orange/Red Zones	HR based Training zones, configured in OmniSense Live > Preferences	Summary GPS Report Workout Compliance Report
Time in Speed Zone 1/2/3/4/5/6	GPS data - Speed zones configured in OmniSense Live > Preferences	Summary GPS Report
Distance in Speed Zone 1/2/3/4/5/6		Summary GPS Report
Average & Max Speed		Summary GPS Report
Elevation Climb & Descent		Summary GPS Report
Total Distance		Summary GPS Report

12.4.2 Periodization Report

This report focuses on the intensity and load parameters, and should be used as an overview to reveal any over-or under-training tendencies:
The parameters are listed in the table in the Group Consolidated Summary.

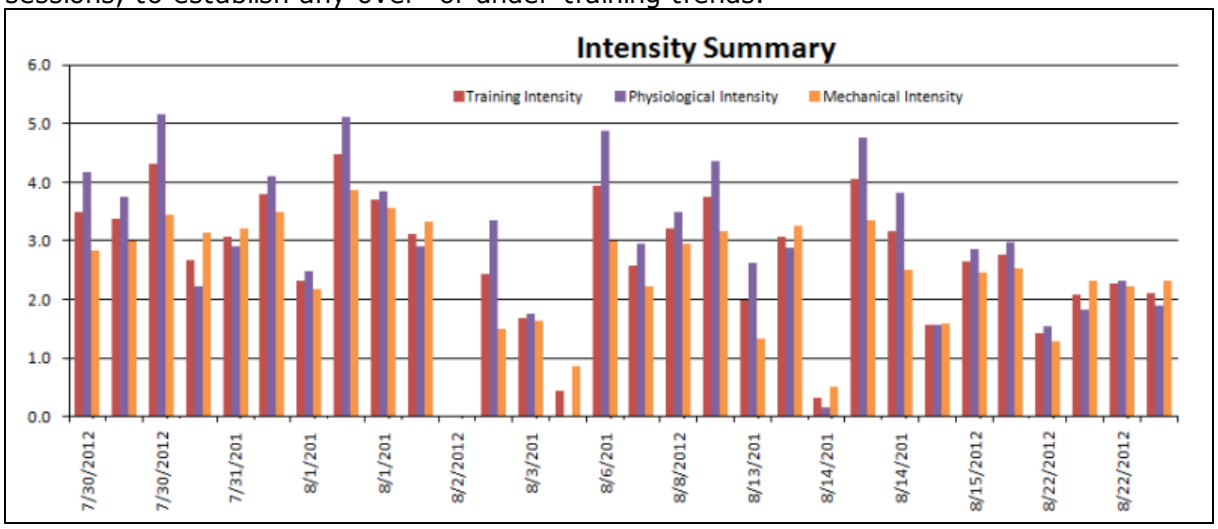


Group summary - data & stats in table format, plus bar chart (single session only displayed)



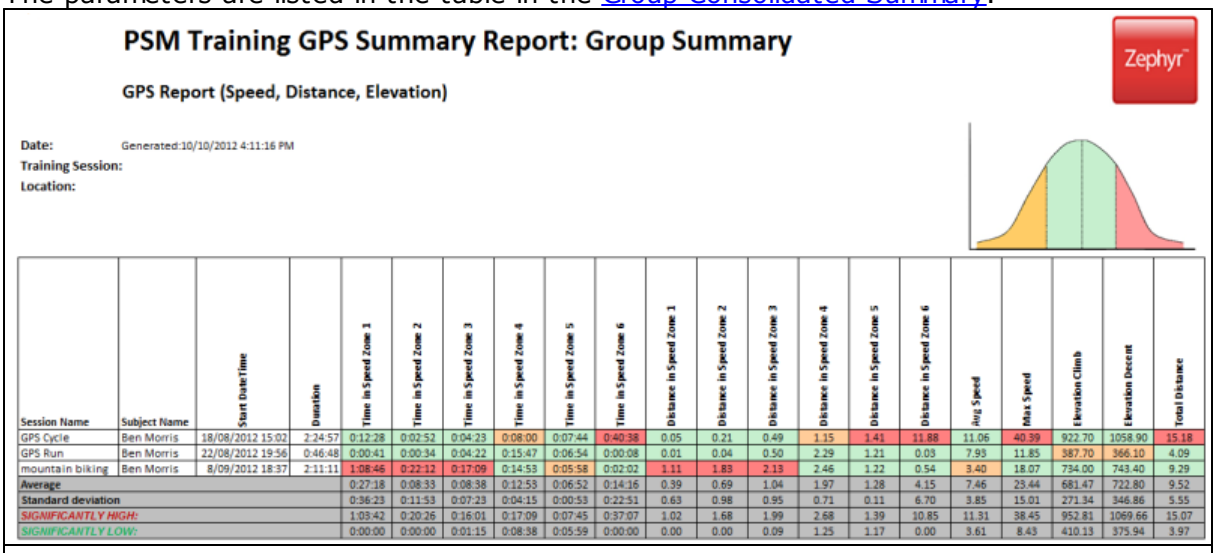
Individual subjects reports

This type of report is most useful in displaying long-term training data over multiple sessions, to establish any over- or under-training trends.



12.4.3 Summary GPS Report

This report focuses on the speed & distance parameters; the BioHarness must be accompanied by a supported Bluetooth GPS module, and configured to communicate with it. This process is described in the OmniSense Live Help > GPS > Support topic. No physiological parameters are included.
The parameters are listed in the table in the Group Consolidated Summary.



PSM Training GPS Summary Report: Group Summary

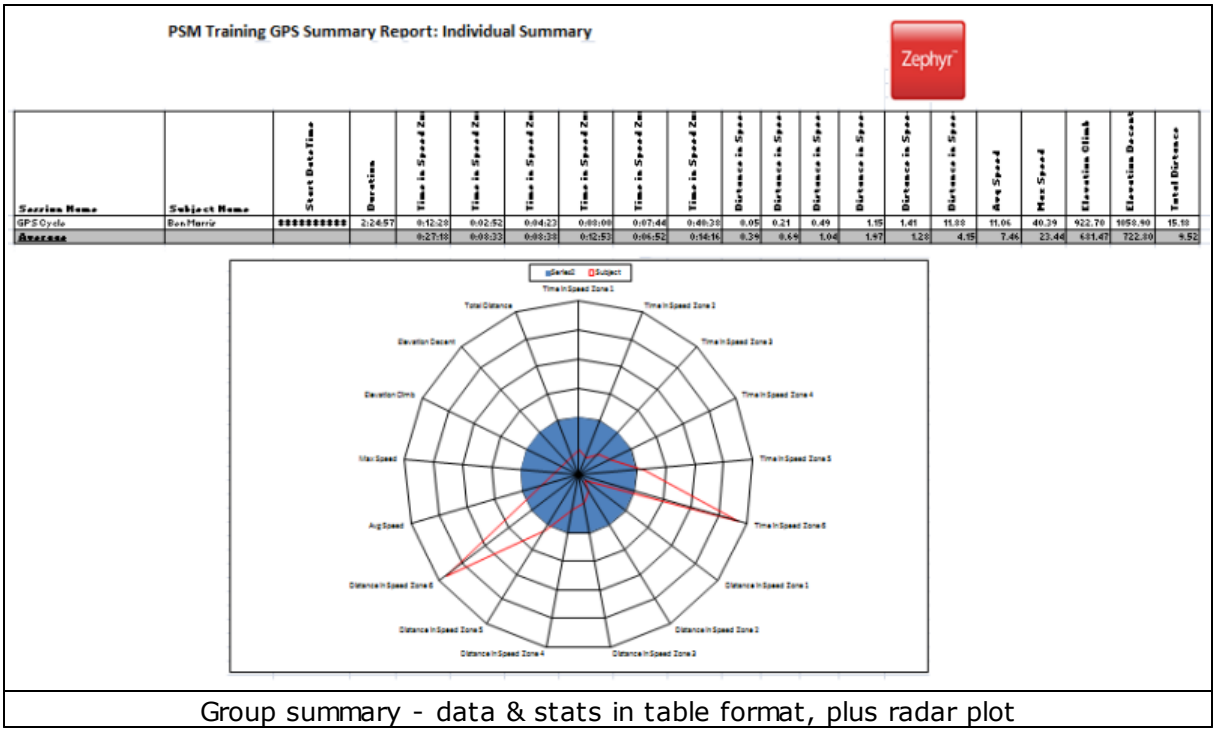
GPS Report (Speed, Distance, Elevation)

Zephyr™

Date: Generated:10/10/2012 4:11:16 PM
Training Session:
Location:

Session Name	Subject Name	Start Date Time	Duration	Time in Speed Zone 1	Time in Speed Zone 2	Time in Speed Zone 3	Time in Speed Zone 4	Time in Speed Zone 5	Time in Speed Zone 6	Distance in Speed Zone 1	Distance in Speed Zone 2	Distance in Speed Zone 3	Distance in Speed Zone 4	Distance in Speed Zone 5	Distance in Speed Zone 6	Avg Speed	Max Speed	Elevation Climb	Elevation Decent	Total Distance
GPS Cycle	Ben Morris	18/08/2012 15:02	2:24:57	0:12:28	0:02:52	0:04:23	0:08:00	0:07:44	0:40:38	0.05	0.21	0.49	1.15	1.41	11.88	11.06	40.39	922.70	1058.90	15.18
GPS Run	Ben Morris	22/08/2012 19:56	0:46:48	0:00:41	0:00:34	0:04:22	0:15:47	0:06:54	0:00:08	0.01	0.04	0.50	2.29	1.21	0.03	7.93	11.85	387.70	366.10	4.09
mountain biking	Ben Morris	8/09/2012 18:37	2:11:11	1:08:46	0:22:12	0:17:09	0:14:53	0:05:58	0:02:02	1.11	1.83	2.13	2.46	1.22	0.54	3.40	18.07	734.00	743.40	9.29
Average				0:27:18	0:08:33	0:08:38	0:12:53	0:06:52	0:14:16	0.39	0.69	1.04	1.97	1.28	4.15	7.46	23.44	681.47	722.80	9.52
Standard deviation				0:36:23	0:11:53	0:07:23	0:04:15	0:00:53	0:22:51	0.63	0.98	0.95	0.71	0.11	6.70	3.85	15.01	271.34	346.86	5.55
SIGNIFICANTLY HIGH:				1:03:42	0:20:26	0:16:01	0:17:09	0:07:45	0:37:07	1.02	1.68	1.99	2.68	1.39	10.85	11.31	38.45	952.81	1069.66	15.07
SIGNIFICANTLY LOW:				0:00:00	0:00:00	0:01:15	0:08:38	0:05:59	0:00:00	0.00	0.00	0.09	1.25	1.17	0.00	3.61	8.43	410.13	375.94	3.97

Group summary - data & stats in table format



PSM Training GPS Summary Report: Individual Summary

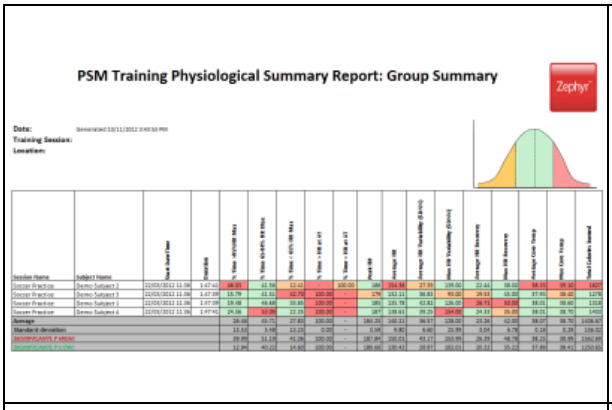
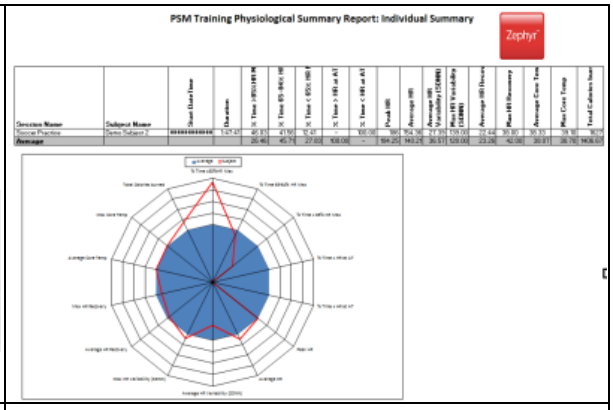
Zephyr™

Session Name	Subject Name	Start Date Time	Duration	Time in Speed Zone 1	Time in Speed Zone 2	Time in Speed Zone 3	Time in Speed Zone 4	Time in Speed Zone 5	Time in Speed Zone 6	Distance in Speed Zone 1	Distance in Speed Zone 2	Distance in Speed Zone 3	Distance in Speed Zone 4	Distance in Speed Zone 5	Distance in Speed Zone 6	Avg Speed	Max Speed	Elevation Climb	Elevation Decent	Total Distance
GPS Cycle	Ben Morris	##########	2:24:57	0:12:28	0:02:52	0:04:23	0:08:00	0:07:44	0:40:38	0.05	0.21	0.49	1.15	1.41	11.88	11.06	40.39	922.70	1058.90	15.18
Average				0:27:18	0:08:33	0:08:38	0:12:53	0:06:52	0:14:16	0.39	0.69	1.04	1.97	1.28	4.15	7.46	23.44	681.47	722.80	9.52

Group summary - data & stats in table format, plus radar plot

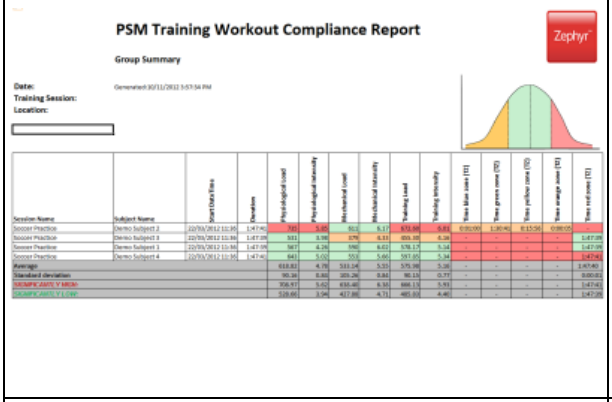
12.4.4 Summary Physiological Report

This report focuses on the physiological parameters only.
The parameters are listed in the table in the Group Consolidated Summary.

	
Group summary - data & stats in table format	Individual subject table with group averages, plus radar plot

12.4.5 Workout Compliance Report

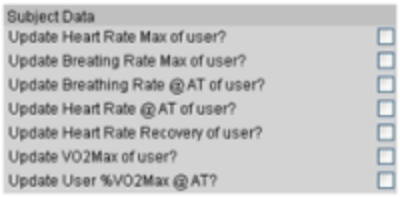
This report focuses on load, intensity, and the times in the Periodization workouts, if they have been activated during a session in the OmniSense Live module. Details are included in OmniSense Live Help > OmniSense Application > Live operation > Training % Workout Tabs The parameters are listed in the table in the Group Consolidated Summary.

	
Group summary - data & stats in table format	Individual subject table with group averages, plus radar plot

12.5 Fitness Reports

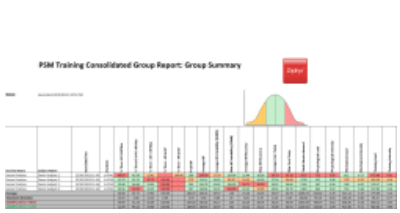
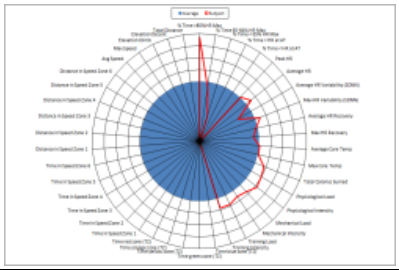
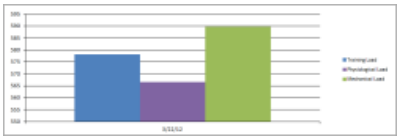
Fitness Reports are designed to provide analysis and display of data from groups of subjects pursuing a training program.
The data is gathered from three tests:

- Treadmill Test
  After Analysis of a Treadmill Test, the user is prompted in a dialogue whether fitness parameters are to be updated in the OmniSense database:



- Orthostatic Hypotension Test (Resting and Standing Heart Rate)
  Data is entered manually into the subject parameter table in OmniSense Live after the test has been performed.

It is typically presented in three ways:

		
Summary spreadsheet of all parameters for individual or a team	Radar plot to compare individual or team vs. normative performance	Bar Charts of team and individual Intensity and Load values

- Individual Fitness Report — Report of an individual subject chosen by name
- Team Fitness Report — Group fitness parameters, with outliers indicated, from a specific team selected by the user

3. For a Team Fitness report
   a. Select the team from the pulldown list
   b. Use *Select Team* to populate the table below
   c. Click the *Chart button*
   d. Export the data to an external Excel file for easier viewing

12.5.1 Individual Fitness Report

A individual Fitness Report contains parameters, and where they are sourced from:

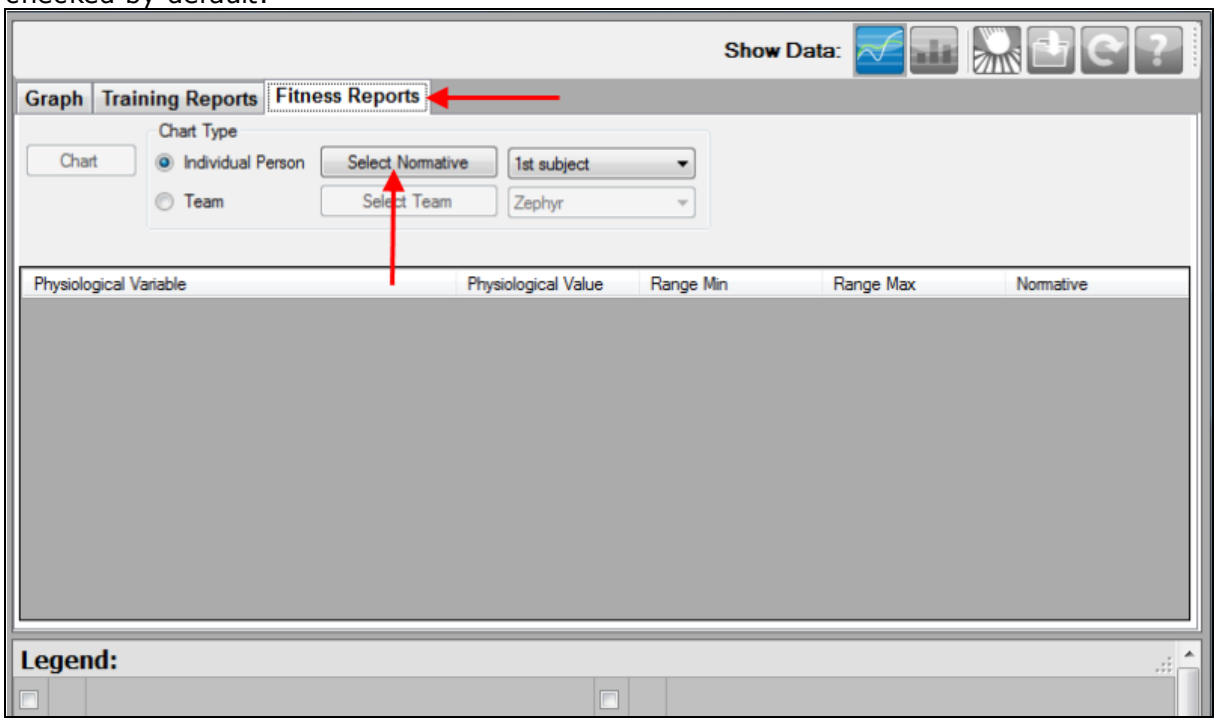
VO_2max	Saved from Analysis of a Treadmill Test
Percentage VO_2max at Anaerobic Threshold (AT)	Saved from Analysis of a Treadmill Test
Heart Rate Max	Saved from Analysis of a Treadmill Test Can be updated manually in OmniSense Live > Subject parameters
Heart Rate @ AT	Saved from Analysis of a Treadmill Test Can be updated manually in OmniSense Live > Subject parameters
HR @ AT as % of HRmax	Saved from Analysis of a Treadmill Test
Breathing Rate @ AT	Saved from Analysis of a Treadmill Test

	Can be updated manually in OmniSense Live > Subject parameters
Heart Rate Recovery	Saved from Analysis of a Treadmill Test
Min Heart Rate Standing	Entered manually in OmniSense Live > Subject parameters
Min Heart Rate Resting	Entered manually in OmniSense Live > Subject parameters

Analysis has the capacity to generate a radar plot of a variety of fitness parameters which can be derived from saved fitness test data:

Generate A Report

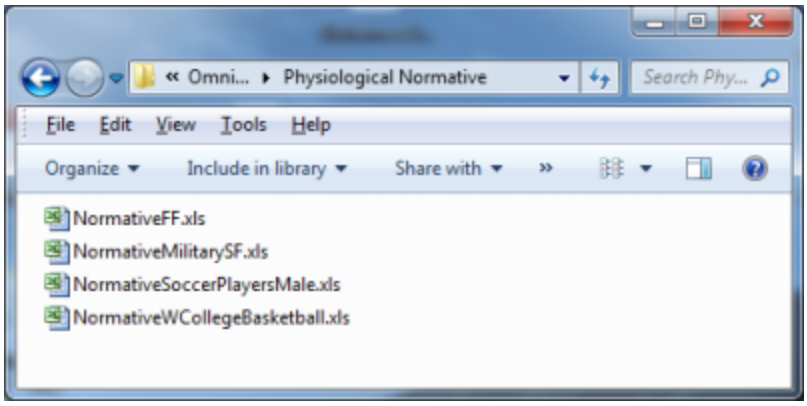
1. In the right-hand panel of Analysis, select the *Fitness Reports* tab. *Individual Person* is checked by default.



2. Choose *Select Normative* - a normative file is a set of summary fitness parameters pertaining to a particular subject type, for for baseline fitness comparison. Zephyr provides sample data for:

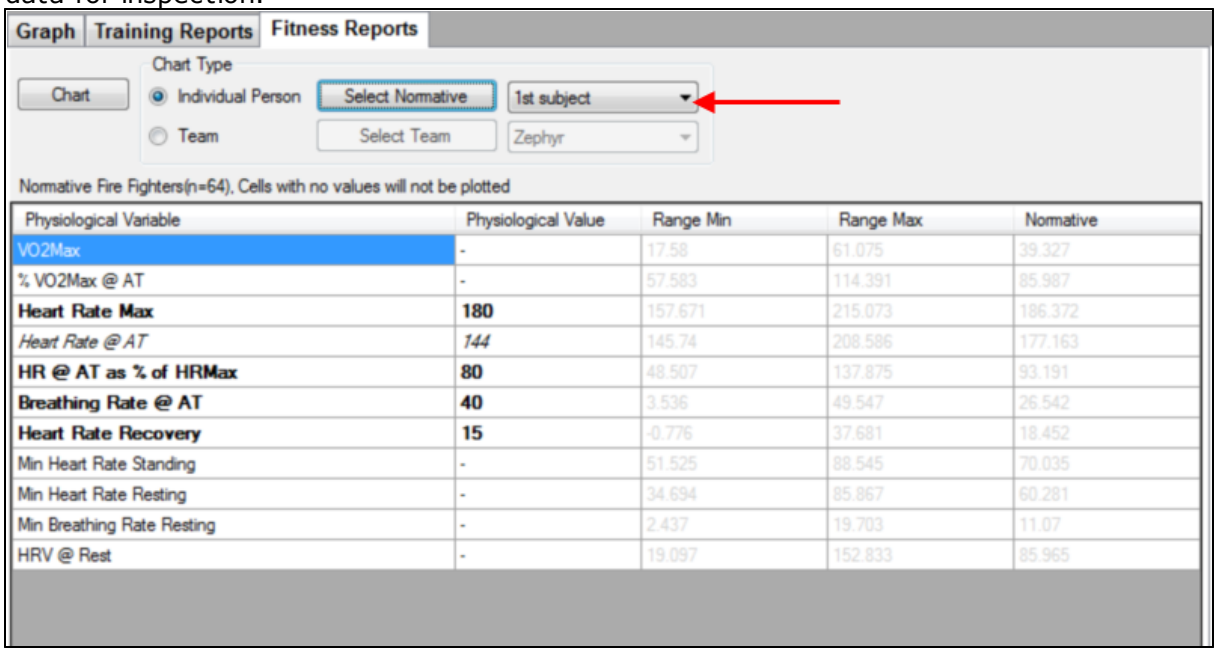
- Fire Fighters
- Military Special Forces
- Soccer players
- College basketball players

The files are located at My Documents\OmniSense\Physiological Normative.



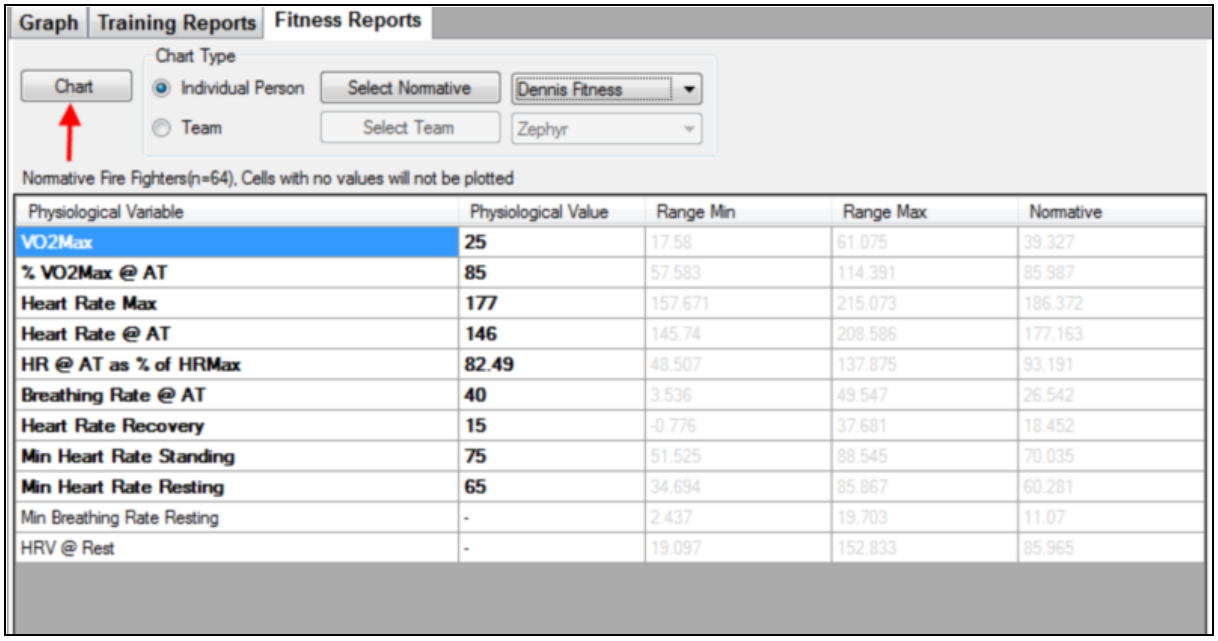
Any of these files can be cloned and customized with your own team data as a baseline.

3. When a normative file is selected, the report panel will populate with the normative data for inspection.



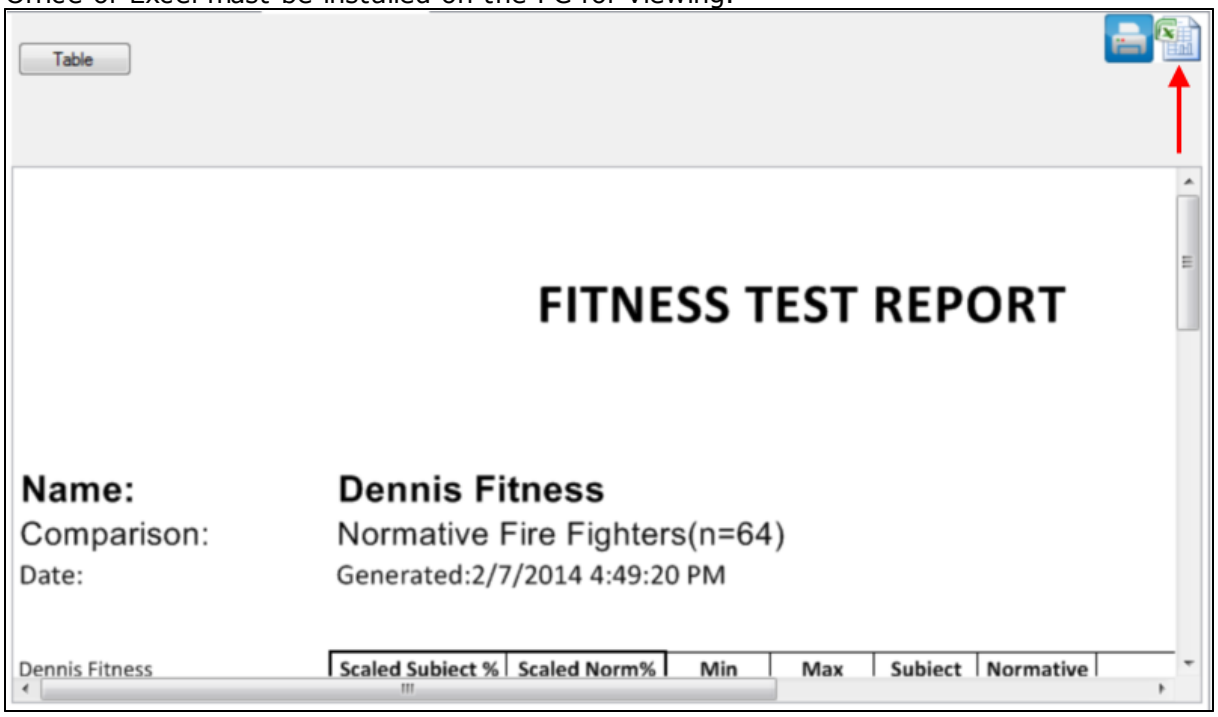
Select the desired subject from the Subject pulldown

4. The panel will repopulate with the selected subject's data



Then select the *Chart* button to display the report.

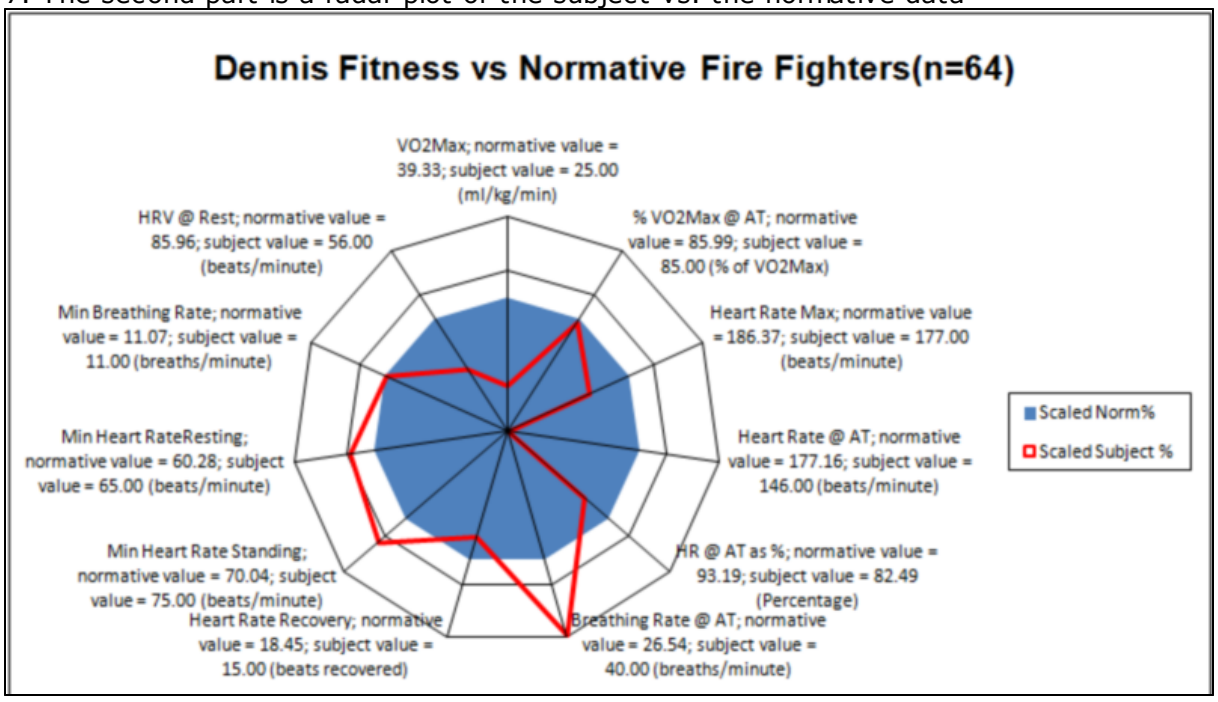
5. The full report can only be displayed in a very large screen. For easier viewing, click the *Export* button at top right to create an Excel® Spreadsheet of the Report. Microsoft Office or Excel must be installed on the PC for viewing.



6. The report comprises two parts - a table of summary data for the subject

Name:	Dennis Fitness						
Comparison:	Normative Fire Fighters(n=64)						
Date:	Generated:2/7/2014 4:49:20 PM						
Dennis Fitness	Scaled Subject %	Scaled Norm%	Min	Max	Subject	Normative	Description
VO2Max	0.17	0.50	17.58	61.07	25.00	39.33	VO2Max; normative value = 39.33; subject value = 25.00 (ml/kg/min)
% VO2Max @ AT	0.48	0.50	57.58	114.39	85.00	85.99	% VO2Max @ AT; normative value = 85.99; subject value = 85.00 (% of VO2Max)
Heart Rate Max	0.34	0.50	157.67	215.07	177.00	186.37	Heart Rate Max; normative value = 186.37; subject value = 177.00 (beats/minute)
Heart Rate @ AT	0.00	0.50	145.74	208.59	146.00	177.16	Heart Rate @ AT; normative value = 177.16; subject value = 146.00 (beats/minute)
HR @ AT as % of HRMax	0.38	0.50	48.51	137.87	82.49	93.19	HR @ AT as %; normative value = 93.19; subject value = 82.49 (Percentage)
Breathing Rate @ AT	0.79	0.50	3.54	49.55	40.00	26.54	Breathing Rate @ AT; normative value = 26.54; subject value = 40.00 (breaths/minute)
Heart Rate Recovery	0.41	0.50	-0.78	37.68	15.00	18.45	Heart Rate Recovery; normative value = 18.45; subject value = 15.00 (beats recovered)
Min Heart Rate Standing	0.63	0.50	51.52	88.55	75.00	70.04	Min Heart Rate Standing; normative value = 70.04; subject value = 75.00 (beats/minute)
Min Heart Rate Resting	0.59	0.50	34.69	85.87	65.00	60.28	Min Heart RateResting; normative value = 60.28; subject value = 65.00 (beats/minute)
Min Breathing Rate Resting	0.50	0.50	2.44	19.70	11.00	11.07	Min Breathing Rate; normative value = 11.07; subject value = 11.00 (breaths/minute)
HRV @ Rest	0.28	0.50	19.10	152.83	56.00	85.96	HRV @ Rest; normative value = 85.96; subject value = 56.00 (beats/minute)

7. The second part is a radar plot of the subject vs. the normative data

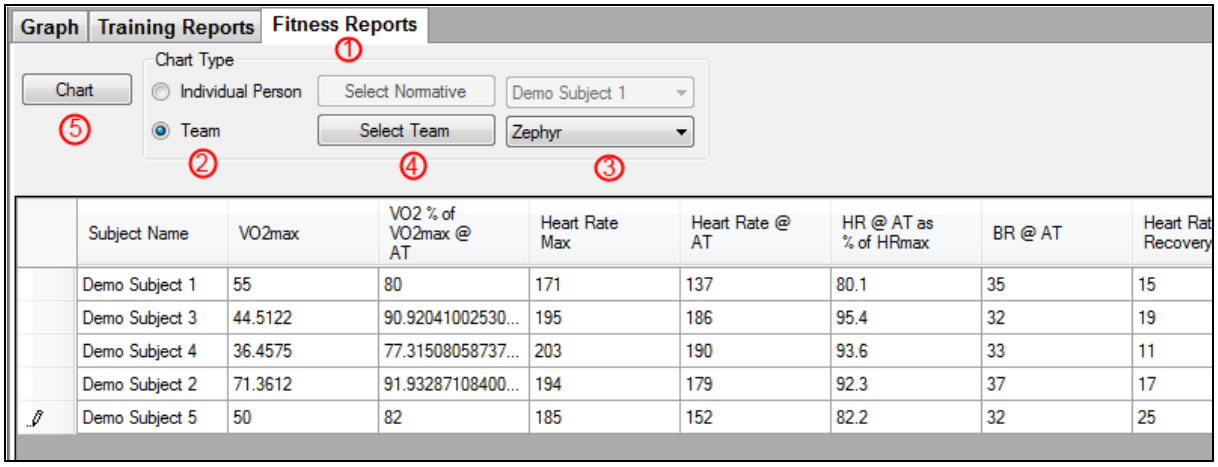


If a parameter is not available, or is not entered manually into the table which generates the plot, then the axis representing that parameter is omitted from the generated plot.

8. Each graph axis is scaled differently - it represents a bell curve of a theoretical group extrapolated from the normative file. The midpoint of each axis is the average of the normative data, indicated by the edge of the blue polygon. Inside and outside the polygon, the axes are three standard deviations in range. Thus the center point of the

plot does not represent zsero for any parameter, but the lowest expected value in a normal population sample.

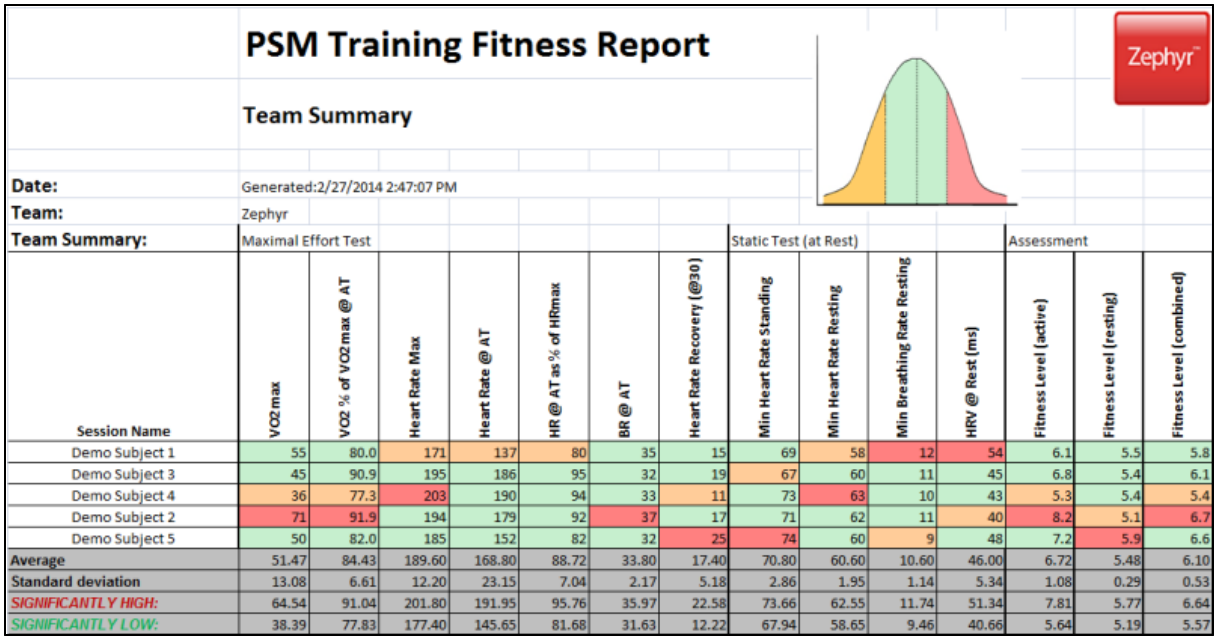
12.5.2 Team Fitness Report



	Subject Name	VO2max	VO2 % of VO2max @ AT	Heart Rate Max	Heart Rate @ AT	HR @ AT as % of HRmax	BR @ AT	Heart Rat Recovery
	Demo Subject 1	55	80	171	137	80.1	35	15
	Demo Subject 3	44.5122	90.92041002530...	195	186	95.4	32	19
	Demo Subject 4	36.4575	77.31508058737...	203	190	93.6	33	11
	Demo Subject 2	71.3612	91.93287108400...	194	179	92.3	37	17
	Demo Subject 5	50	82	185	152	82.2	32	25

1. Select Fitness Reports tab
2. Select Team button
3. Select Team
4. Click *Select Team* button
5. Click *Chart* to see chart

Group reports differ from Individual Fitness Reports which show individual subject fitness parameters.



PSM Training Fitness Report

Zephyr™

Team Summary

Date: Generated:2/27/2014 2:47:07 PM

Team: Zephyr

Team Summary:	Maximal Effort Test							Static Test (at Rest)				Assessment		
Session Name	**VO2max**	**VO2 % of VO2max @ AT**	**Heart Rate Max**	**Heart Rate @ AT**	**HR @ AT as % of HRmax**	**BR @ AT**	**Heart Rate Recovery (@30)**	**Min Heart Rate Standing**	**Min Heart Rate Resting**	**Min Breathing Rate Resting**	**HRV @ Rest (ms)**	**Fitness Level (active)**	**Fitness Level (resting)**	**Fitness Level (combined)**
Demo Subject 1	55	80.0	171	137	80	35	15	69	58	12	54	6.1	5.5	5.8
Demo Subject 3	45	90.9	195	186	95	32	19	67	60	11	45	6.8	5.4	6.1
Demo Subject 4	36	77.3	203	190	94	33	11	73	63	10	43	5.3	5.4	5.4
Demo Subject 2	71	91.9	194	179	92	37	17	71	62	11	40	8.2	5.1	6.7
Demo Subject 5	50	82.0	185	152	82	32	25	74	60	9	48	7.2	5.9	6.6
Average	51.47	84.43	189.60	168.80	88.72	33.80	17.40	70.80	60.60	10.60	46.00	6.72	5.48	6.10
Standard deviation	13.08	6.61	12.20	23.15	7.04	2.17	5.18	2.86	1.95	1.14	5.34	1.08	0.29	0.53
SIGNIFICANTLY HIGH:	64.54	91.04	201.80	191.95	95.76	35.97	22.58	73.66	62.55	11.74	51.34	7.81	5.77	6.64
SIGNIFICANTLY LOW:	38.39	77.83	177.40	145.65	81.68	31.63	12.22	67.94	58.65	9.46	40.66	5.64	5.19	5.57

Cells are color-coded:

Yellow more than one standard deviation below the group mean. This threshold value

for each parameter is the *'SIGNIFICANTLY LOW'* value

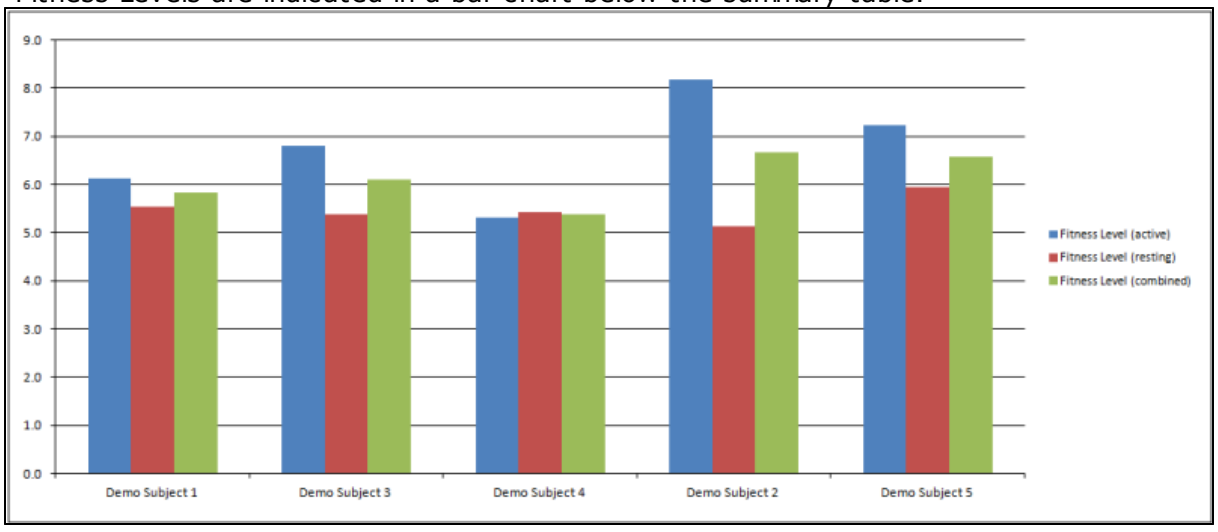
Green within one standard devia tion of the group mean

Red more than one standard deviation above the group mean. This threshold value is the *'SIGNIFICANTLY HIGH'* value

Report Data

VO_2max	Saved from Analysis of a Treadmill Test
VO_2max % VO_2max at AT	Saved from Analysis of a Treadmill Test
HRmax	Saved from Analysis of a Treadmill Test
HR at AT	Saved from Analysis of a Treadmill Test
HR at AT as %HRmax	Saved from Analysis of a Treadmill Test
BR at AT	Saved from Analysis of a Treadmill Test
Heart Rate Recovery (30 second)	Saved from Analysis of a Treadmill Test
Min Heart Rate Standing	Entered manually in OmniSense Live > Subject parameters
Min Heart Rate Resting	Entered manually in OmniSense Live > Subject parameters
Min Breathing Rate Resting	Entered manually in OmniSense Live > Subject parameters
HRV ar rest	Entered manually in OmniSense Live > Subject parameters
Fitness Level (Active)	
Fitness Level (Resting)	
Fitness Level (Combined)	Arithmetic Mean of the above two

Fitness Levels are indicated in a bar chart below the summary table.



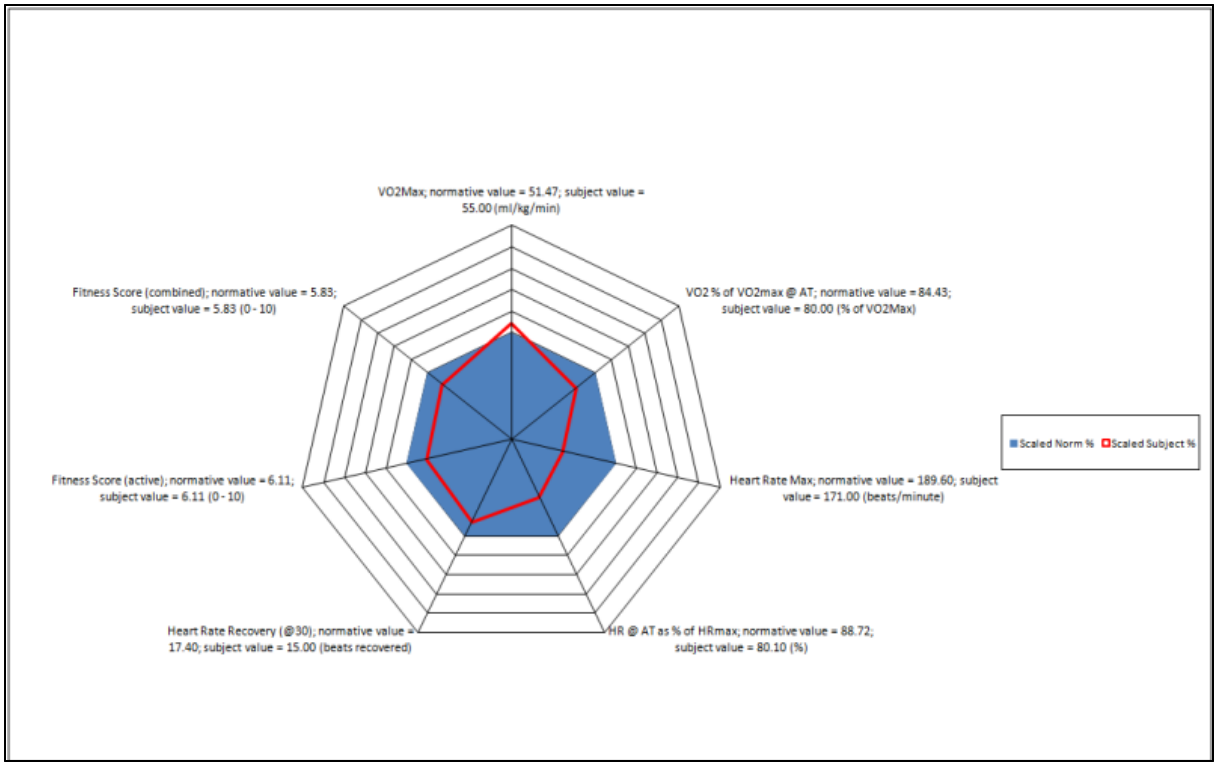
As separate tabs in the Excel worksheet, individual subject fitness reports are displayed

FITNESS TEST REPORT

Name: **Demo Subject 1**
Date: Generated:2/27/2014 2:47:07 PM

	Scaled Subject %	Scaled Norm %	Axis Min	Axis Max	Subject	Normative	Description
VO2Max	0.55	0.50	12.23	90.70	55.00	51.47	VO2Max; normative value = 51.47; subject value = 55.00 (ml/kg/min)
VO2 % of VO2max @ AT	0.39	0.50	64.61	104.25	80.00	84.43	VO2 % of VO2max @ AT; normative value = 84.43; subject value = 80.00 (% of VO2Max)
Heart Rate Max	0.25	0.50	153.00	226.20	171.00	189.60	Heart Rate Max; normative value = 189.60; subject value = 171.00 (beats/minute)
HR @ AT as % of HRmax	0.30	0.50	67.61	109.83	80.10	88.72	HR @ AT as % of HRmax; normative value = 88.72; subject value = 80.10 (%)
Heart Rate Recovery (@30)	0.42	0.50	1.87	32.93	15.00	17.40	Heart Rate Recovery (@30); normative value = 17.40; subject value = 15.00 (beats recovered)
Fitness Score (active)	0.41	0.50	3.47	9.98	6.11	6.72	Fitness Score (active); normative value = 6.11; subject value = 6.11 (0 - 10)
Fitness Score (combined)	0.41	0.50	4.50	7.71	5.83	6.10	Fitness Score (combined); normative value = 5.83; subject value = 5.83 (0 - 10)

As well as individual subject radar plots. The Blue polygon represents the team mean (normative) value for each fitness parameter. If a subject's red outline lies inside the polygon, then they have lower values than the group mean.



12.5.3 Customizing A Normative File

As individual team members perform fitness tests and baseline data is created for their fitness parameters, then this baseline data can be used to create a further normative file for subsequent comparisons against the team baseline.

1. Follow the steps to create a Team Fitness report using *any* of the Zephyr-supplied Normative fitness files.

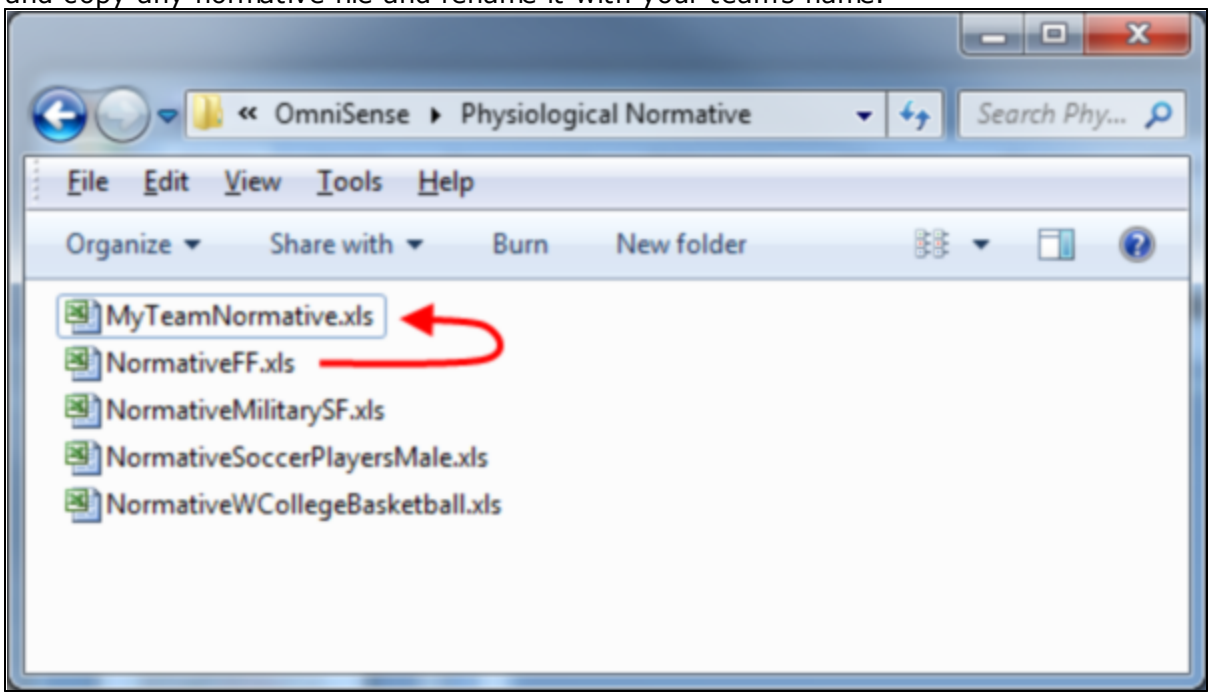
2. This will supply your team's average and standard deviation for all the fitness parameters.

Team Summary

Date: Generated:2/6/2014 12:36:41 PM
Team: Zephyr

Team Summary:	Maximal Effort Test							Static Test (at Rest)				Assessment		
Session Name	VO2max	VO2 % of VO2max @ AT	Heart Rate Max	Heart Rate @ AT	HR @ AT as % of HRmax	BR @ AT	Heart Rate Recovery (@30)	Min Heart Rate Standing	Min Heart Rate Resting	Min Breathing Rate Resting	HRV @ Rest (ms)	Fitness Level (active)	Fitness Level (resting)	Fitness Level (combined)
Brian Harrison	71	76.0	171	137	80	27	15	63	52	8	45	7.1	6.4	6.7
Wayne Debrett	43	88.0	183	146	80	40	15	58	53	8	65	5.4	7.0	6.2
Ben Morrison	48	78.0	183	146	80	40	15	67	63	6		5.7	4.9	5.3
John Smith	53	89.0	178	142	80	40	15	72	65	10	74	6.0	6.4	6.2
Aaron Coddel	37		160	140	88	40	15	77	60	7	-	5.6	8.1	6.9
Pete Nicholls	66		183	146	80	40	15	71	62	9	64	6.8	6.4	6.6
Paul Ryan	65		183	146	80	40	15	73	61	9		6.7	4.3	5.5
~~Dennis Owens~~	~~36~~		~~166~~	~~146~~	~~88~~	~~40~~	~~15~~	~~68~~	~~58~~	~~9~~		~~5.6~~	~~4.6~~	5.1
Average	52.38	82.75	175.88	143.63	81.83	38.38	15.00	68.63	59.25	8.13	62.00	6.10	6.01	6.05
Standard deviation	13.65	6.70	9.11	3.54	3.66	4.60	0.00	6.02	4.65	1.25	12.19	0.65	1.31	0.68
SIGNIFICANTLY HIGH:	66.02	89.45	184.98	147.17	85.49	42.97	15.00	74.65	63.90	9.37	74.19	6.74	7.32	6.73
SIGNIFICANTLY LOW:	38.73	76.05	166.77	140.08	78.16	33.78	15.00	62.60	54.60	6.88	49.81	5.45	4.70	5.37

3. Go to the location in .../My Documents/OmniSense/Physiological Normative directory, and copy any normative file and rename it with your team's name.



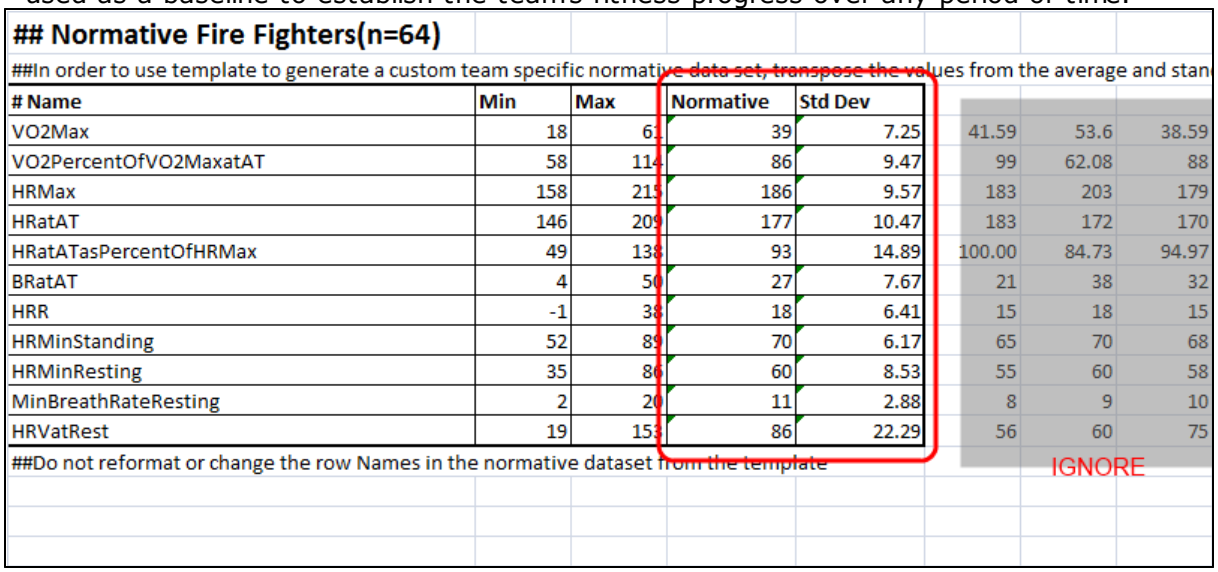
4. Open the new normative file, and replace the data in the *Normative* and *Standard Deviation data from your team's report.*

Thus the Normative = 39 and Standard Deviation = 7.25 in the top VO2max row of the diagram below should be replaced

with Average = 52.38 and Standard Deviation from the Team Summary report in the top diagram. Repeat this process for each fitness parameter.

In this manner the team's own normative file, which is a snapshot of their fitness levels

at the time the Team Fitness report was created, can be used as a baseline to establish the team's fitness progress over any period of time.



Normative Fire Fighters(n=64)

##In order to use template to generate a custom team specific normative data set, transpose the values from the average and stan

# Name	Min	Max	Normative	Std Dev			
VO2Max	18	61	39	7.25	41.59	53.6	38.59
VO2PercentOfVO2MaxatAT	58	114	86	9.47	99	62.08	88
HRMax	158	215	186	9.57	183	203	179
HRatAT	146	209	177	10.47	183	172	170
HRatATasPercentOfHRMax	49	138	93	14.89	100.00	84.73	94.97
BRatAT	4	50	27	7.67	21	38	32
HRR	-1	38	18	6.41	15	18	15
HRMinStanding	52	89	70	6.17	65	70	68
HRMinResting	35	86	60	8.53	55	60	58
MinBreathRateResting	2	20	11	2.88	8	9	10
HRVatRest	19	153	86	22.29	56	60	75

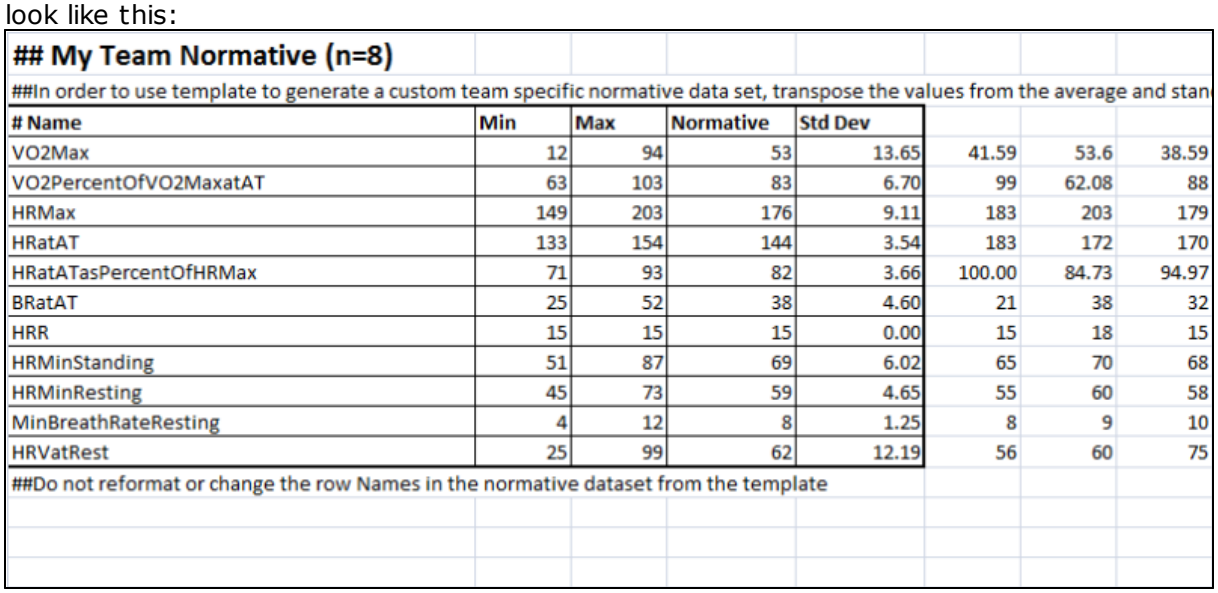
##Do not reformat or change the row Names in the normative dataset from the template

IGNORE

Do not change any other field in the Normative file - though the first cell is a comment - retain the '##' at the beginning and add a new description if desired.

Ignore the existing data in the Zephyr Normative file to the right of the Normative and Standard Deviation columns.

5. When the data from the Team Fitness Report is inserted into the Team Normative, it will look like this:



My Team Normative (n=8)

##In order to use template to generate a custom team specific normative data set, transpose the values from the average and stan

# Name	Min	Max	Normative	Std Dev			
VO2Max	12	94	53	13.65	41.59	53.6	38.59
VO2PercentOfVO2MaxatAT	63	103	83	6.70	99	62.08	88
HRMax	149	203	176	9.11	183	203	179
HRatAT	133	154	144	3.54	183	172	170
HRatATasPercentOfHRMax	71	93	82	3.66	100.00	84.73	94.97
BRatAT	25	52	38	4.60	21	38	32
HRR	15	15	15	0.00	15	18	15
HRMinStanding	51	87	69	6.02	65	70	68
HRMinResting	45	73	59	4.65	55	60	58
MinBreathRateResting	4	12	8	1.25	8	9	10
HRVatRest	25	99	62	12.19	56	60	75

##Do not reformat or change the row Names in the normative dataset from the template

This normative file can be used for all subsequent team fitness reports.

Part 13

13 Fitness Parameters

A number of Fitness Parameters are calculated in the BioHarness device, or in OmniSense itself:

- VMU - Vector Magnitude Units, measure of activity level
- Calories - a measure of energy expenditure
- VO2 Max - maximum oxygen uptake, a measure of physical capacity

EPOCH

A number of these parameters are calculated over an *epoch*. An epoch is an interval of time, rather than an instantaneous point. Data is sampled multiple times during the epoch, and the samples used to calculate the parameter.

For example, Peak Acceleration is sampled 100 times each second, but Peak Acceleration is reported once per epoch - the maximum value recorded.

VMU is a measure of activity calculated using all of the acceleration values recorded during an epoch.

13.1 VMU

Vector Magnitude Units (VMU) are used to indicate activity level. They are expressed in 'g' - units of gravity, 9.81m/s^2

- 0.2g - roughly equivalent to a walking level of activity
- 0.8g - roughly equivalent to a running level of activity

The BioHarness contains a 3-axis accelerometer which can record values of ±16g in the X (subject vertical), Y (subject lateral), or Z (subject sagittal) axes. The data is sampled at 100Hz, and these sets of samples used to calculate

$$\mathrm{VMU} = \frac{1}{n}\sum_{s=1}^{n}\sqrt{(x_s^2 + y_s^2 + z_s^2)}$$

Thus thus the VMU for the epoch is the average of $\sqrt{(x^2 + y^2 + z^2)}$ calculated for each sample point during the epoch.

13.2 Calories

A calorie is a measure of energy expenditure. The epoch for calorie calculations is 30 seconds.

$$\mathrm{Calories} = \sum_{e=1}^{n} \mathrm{Cal}\,e$$

Where Cal_e = Gender * (-55.0969 + 0.6309*HR + 0.1988*weight + 0.2017*age) + (1 - Gender) * (-20.4022 + 0.4472*HR – 0.1263*weight + 0.074*age)

HR = average heart rate for epoch
Weight = Subject weight in Kg

Age = Subject age in years
Gender = 1 for male, 0 for female

This formula is derived in the paper Keytel L.R, Goedecke J.H, Noakes T. D, Hiiloskorpi H, Laukkanen R, Van Der Merwe L and Lambert E.V. 2005, Prediction of energy expenditure from heart rate monitoring during submaximal exercise *Journal of Sports Sciences* 23(3) 289 – 297

13.3 VO2Max

VO2 Max is an estimate for maximal oxygen uptake. It can be calculated automatically in OmniSense from data obtained during a maximal fitness treadmill test. The test protocol must be strictly adhered to, including the gradient settings on the treadmill, as an ACSM-derived formula is used.

It is measure in milliliters per minute per kilogram.

$VO_2 max = 0.869 * (3.5 + (0.2 * v)) + (V * grade * 0.9) - 0.07$

V = velocity in meters per minute
Grade = Constant 5% (0.05)

For a 21 kph top speed, this formula would give 77.48 ml/min/kg

Part 14

14 Impact Processing

Accelerometry Overview - a summary of accelerometer data available in Analysis
Impact Overview - Introduction to Impact Analysis

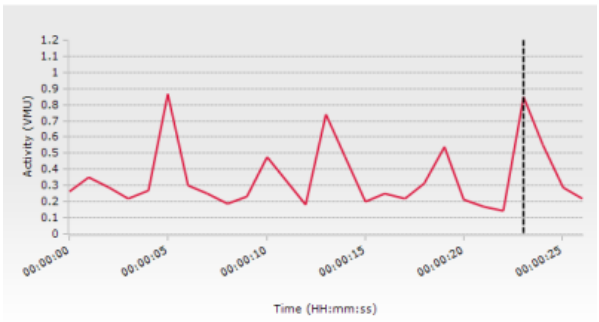
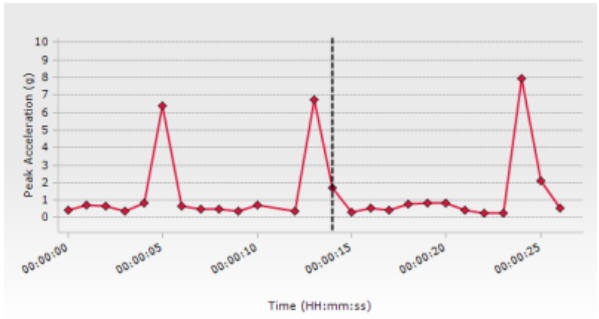
To collect impact data, the following tasks must be performed

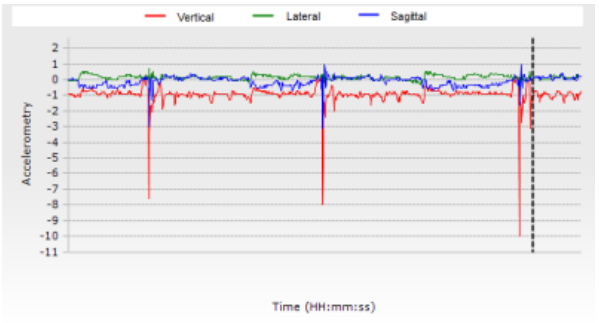
1. Configure the BioModule to Summary and Waveform logging format
2. Download logs from BioModule
3. Use Impact Processor Tool

Analyzing the data

14.1 Accelerometry Overview

The BioHarness module contains a 3-axis accelerometer which samples at 100Hz over the range ±16g. This data allows posture and activity data to be analysed. The graphs below show the data available for display in the Analysis module using a simple exercise - jumping from a 3 foot wall down to a hard surface on three occasions to show three clear (vertical) impact events.

ACTIVITY LEVEL This is measured in Vector Magnitude Units (VMU) and reported once per second. It uses the *average* acceleration in each axis, over the 100 samples, in the previous second. Maximum VMU is 0.85 in this example It is available in all PSM systems.	
PEAK ACCELERATION This is measured in g and reported once per second. It uses the *peak* acceleration in any one single axis, of the 100 samples, in the previous second. Peak Acceleration is 7.95 g in this example. The value is always positive. It is available in all PSM systems.	

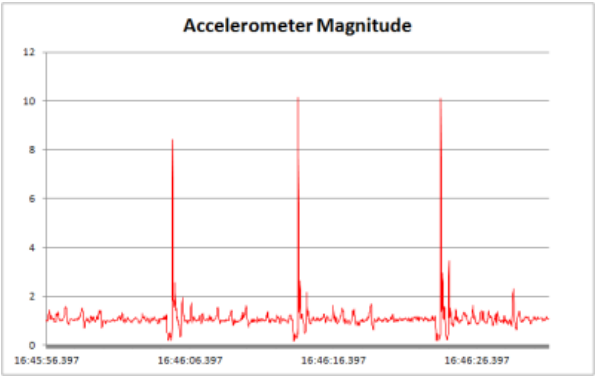
ACCELEROMETRY This is measured in g and reported at 50 Hz. Raw accelerometer data is shown - the effect of gravity is not filtered out. The minimum value is -10g in the vertical axis. This data is only available in PSM Training Systems using Bluetooth direct to the PC, or PSM Responder systems, for a single selected BioModule in use at any one time. It is not available in PSM Training ECHO systems.	

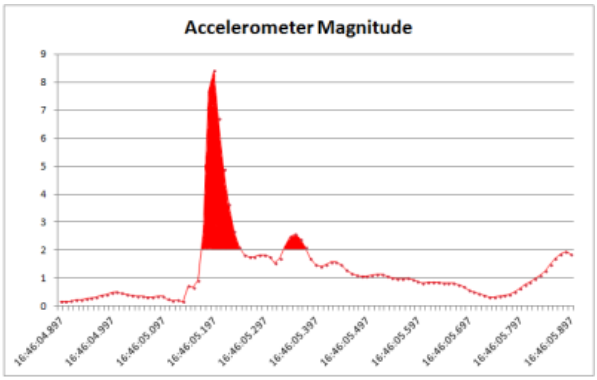
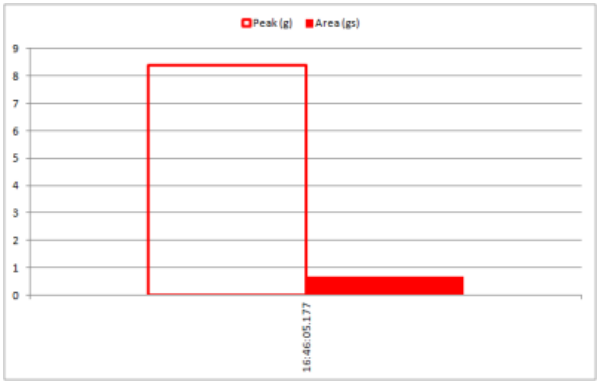
Although each of the three graphs above clearly show three major impacts, quantitative comparison of the impacts is not easy. Once meaningful data is collected in a session containing many large and small impacts, it becomes even harder to extract meaningful comparisons from this raw data.

For this reason Zephyr have embedded impact analysis functionality into OmniSense Analysis.

14.2 Impact Overview

The BioModule, if configured appropriately, can log the accelerometer data at 100Hz. The same three impacts illustrated in the overview, of jumping onto a horizontal surface are shown here.

ACCELEROMETER MAGNITUDE This is calculated using the formula $\sqrt{(V_g^2 + L_g^2 + S_g^2)}$ where V_g, L_g and S_g are three axis components of acceleration (Vertical, Lateral & Sagittal). This gives a single accelerometer parameter instead of a separate value for each axis. Data from the Accel file from the Summary and Waveform logging format is used. Two factors gauge how severe an impact is to the wearer: 1. The maximum value of accelerometer magnitude 2. How long the impact lasts (this will be milliseconds)	

To analyse an impact in detail, this graph shows only the first of the three impacts in an expanded view. The dots show individual samples at 100Hz. The maximum value of accelerometer magnitude is 8.4g To gain a metric which includes how long an impact lasts, we measure the shaded area under the curve. In this instance, we are measuring only the duration where the impacts exceeds 2g. This causes the impact to be split into two separate events - impact & rebound. The area under the graph is measured in gs (g-seconds)	
Zephyr's Impact processor tool automatically analyses the accelerometer magnitude data and produces a new data set, with two major values for each detected impact: • Peak g (red outline) • Area in g-seconds (solid red) The user must select the lower cut-off g value above which to measure area (this filters out 'noise' caused by foot impacts, etc. The tool also segregates the impacts into configurable zones of severity (e.g. above 2g, above 4g, above 6g etc) and counts the total number of impacts in each zone. This allows a coach or research to gauge how many impacts, and how severe, a wearer is subject to in any session.	

14.3 Gathering Impact Data

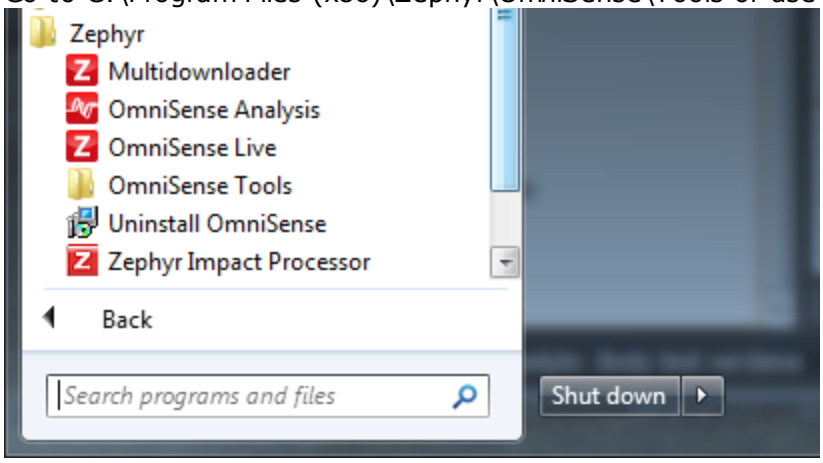
Configure the BioModule - set the required logging format using the Zephyr Cfg Tool
Download Logs - use the Zephyr Download Tool or Log Downloader to create the necessary external csv files needed for the Impact Processor
Impact Processing Tool - process the log files

14.3.1 Configure the BioModule

BioModules are normally configured to log data, in the default Summary Log format. This collects all major parameters at 1 second intervals. To analyse impact data, accelerometer data should be logged at 100Hz. This is done by reconfiguring the BioModule to log in

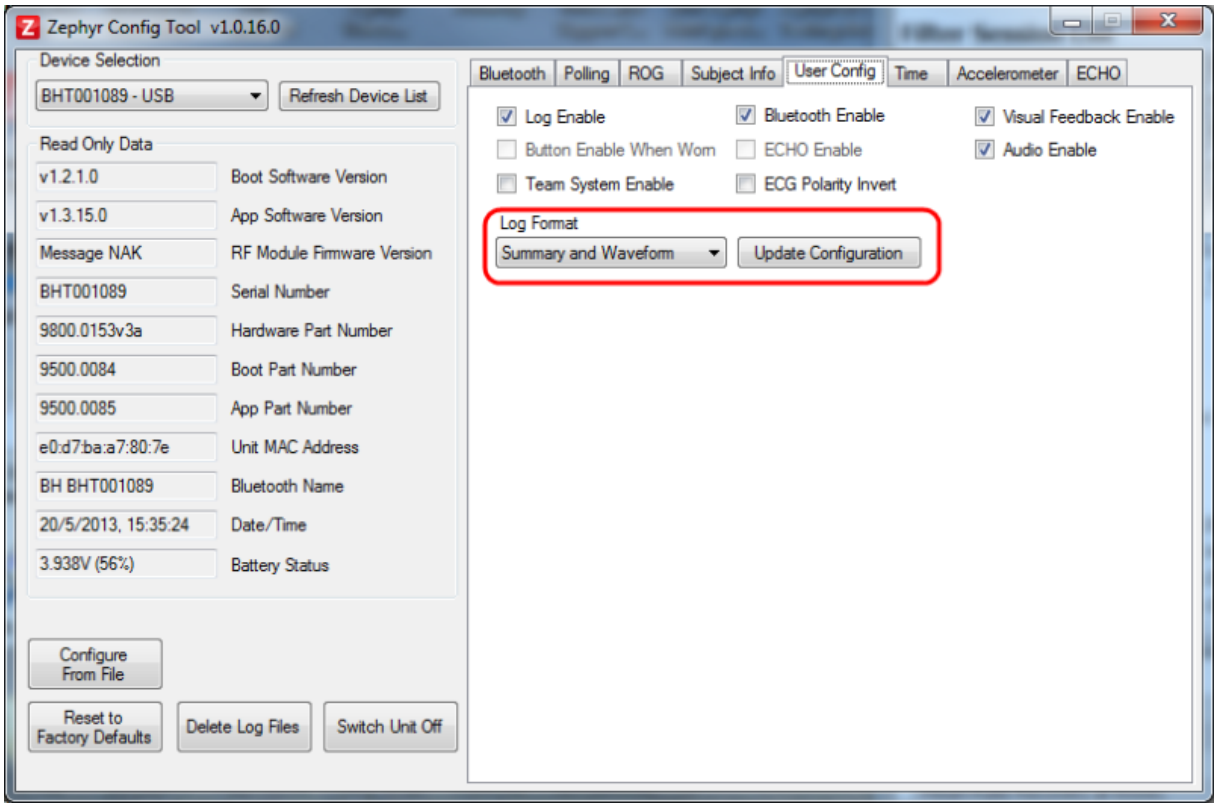
Summary and Waveform format, using the Zephyr Cfg Tool, which is installed automatically when OmniSense is installed.

1. Connect your BioModule to the PC in its charge cradle.
2. Go to C:\Program Files (x86)\Zephyr\OmniSense\Tools or use the Windows Start menu



3. Open the tools directory and locate the Zephyr Cfg Tool.exe. Click and start the tool.
4. Select your BioModule by its serial number from the *Device Selection* pull down.
5. Go to the User Config tab, and change the *Log Format* to *Summary and Waveform.*

Changing the Log format will erase all logs already existing in the device. Download any logs you do not wish to lose, using either the Zephyr Downloader Tool first to save data into the Analysis database, or the legacy Log Downloader tool to save data as external csv files (you will not be able to import this external data back into the OmniSense database afterwards)



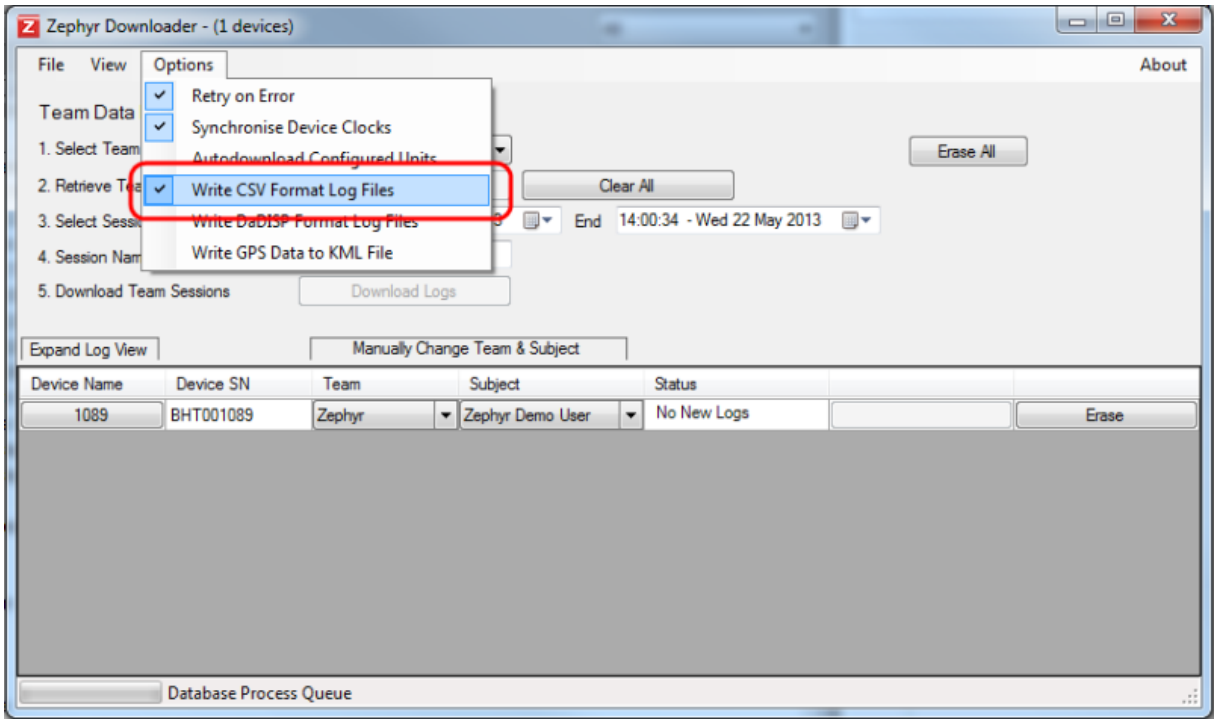
Note that changing log format to Summary and Waveform will greatly increase the size of any single log session. This will increase the time taken to download a log.

14.3.2 Download Logs

The 100Hz logged accelerometer data which is used for impact analysis is not stored in the OmniSense database.
It is stored in an external csv file located in a sub-directory in ...My Documents \BioHarness Test Logs.

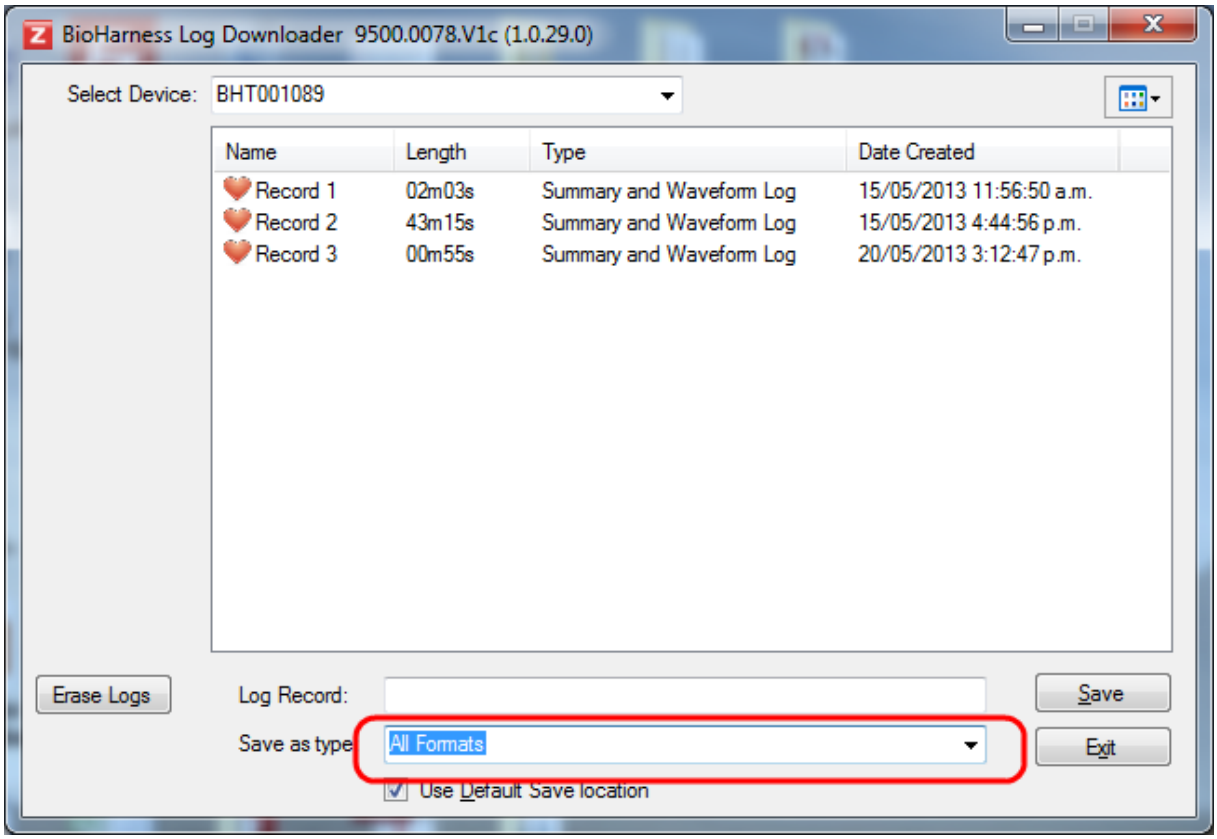
This file can be generated by either the Zephyr Downloader accessed from the Analysis toolbar, or the legacy BioHarness Log Downloader Tool located in C:\Program Files (x86) \Zephyr\OmniSense\Tools

When using the Zephyr Downloader accessed from Analysis, make sure that the *Write CSV Format Log Files* is checked in the Options menu.



This will ensure that the Accel file required for Impact Analysis is deposited in ..My Documents\BioHarness Test Logs.

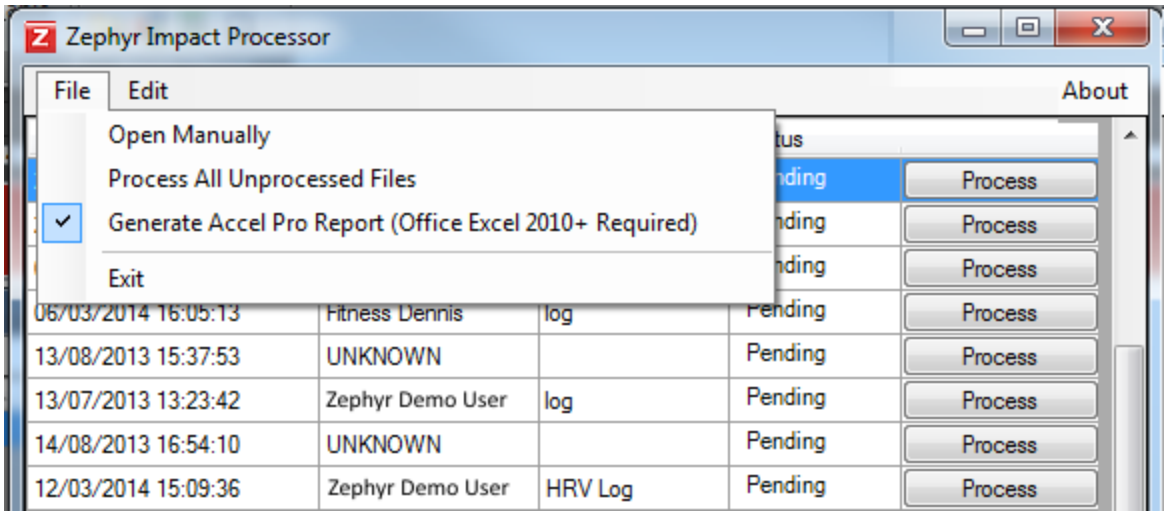
When using the Legacy BioHarness Log Downloader tool, ensure that logs are saved as *All Formats* or *CSV Format*.



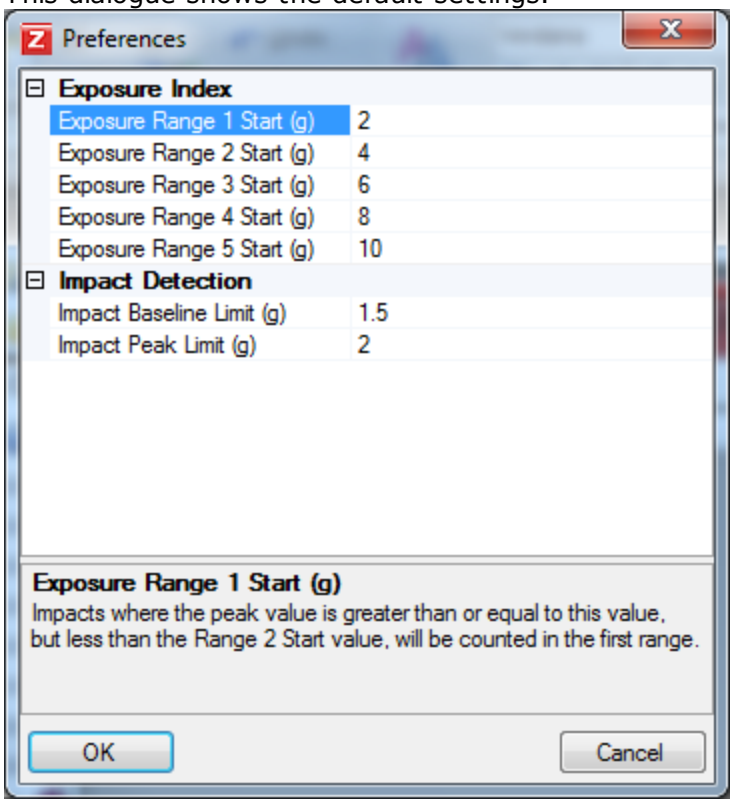
14.3.3 Impact Processing Tool

Start the Impact Processor tool using the  Impact Processor button in the Analysis toolbar.

- When the tool is started, it will automatically search the default ..My Documents \BioHarness Test Logs folder for any YYYY_MM_DD-hh_mm_ss_Accel.csv files which it has not previously processed, and display them as a list



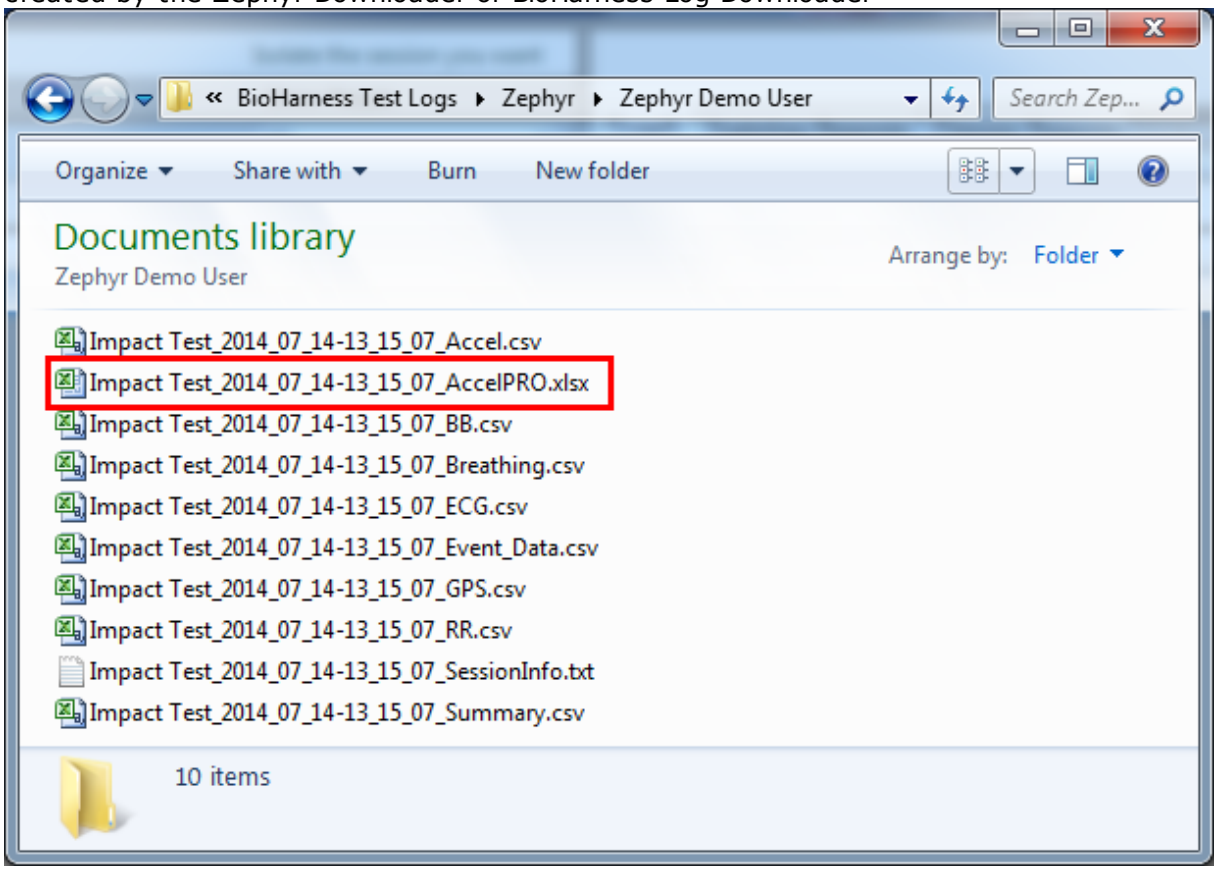
- Only files not previously processed will be displayed in the Impact Processor dialogue
- Choose the type of processing and output from the *File* menu option:
  - Open Manually - opens a dialogue to allow you to browse for a specific ...Accel file (say not in the default location) and open it
  - Process All Unprocessed Files - will automatically processed all files listed and generate default csv IMPACTS files
  - Generate Accel Pro Report - check to generate an Excel spreadsheet (Microsoft® Excel 2010 or later to be installed on PC) with color-coding and graphs
- Then set the configuration of the tool - the zones into which it will divide and counts impacts, according to peak g. Select *Edit* > *Preferences* from the tool's menu. This dialogue shows the default settings.



You can customize the Impact Exposure Range limits or leave the defaults initially to how your activity is represented using the default values.

- Click *Process* to process the raw acceleration data

The output csv file or Pro Report is deposited in the same directory as the other files created by the Zephyr Downloader or BioHarness Log Downloader



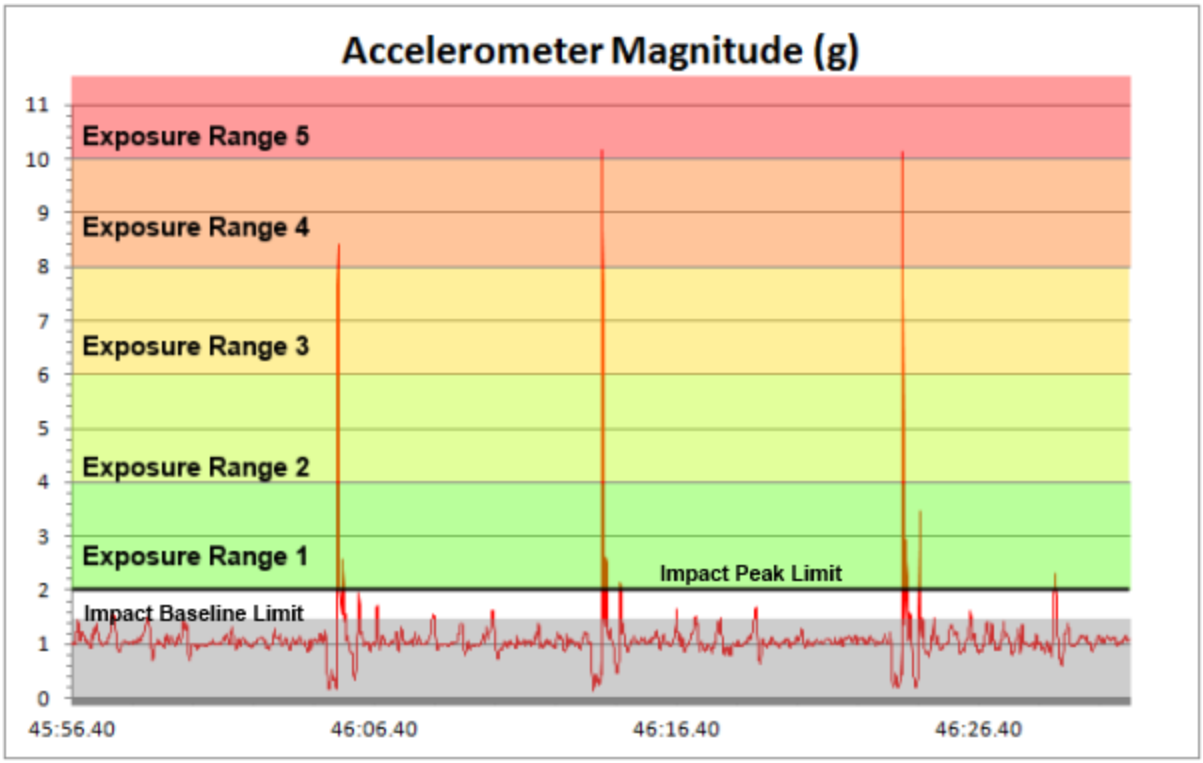
14.3.3.1 Impact Exposure Ranges

Configure the Tool using the *Edit* > *Preferences* menu option. The Impact Processor will categorize impacts by severity into five separate Exposure Ranges 1-2-3-4-5.

The settings are:

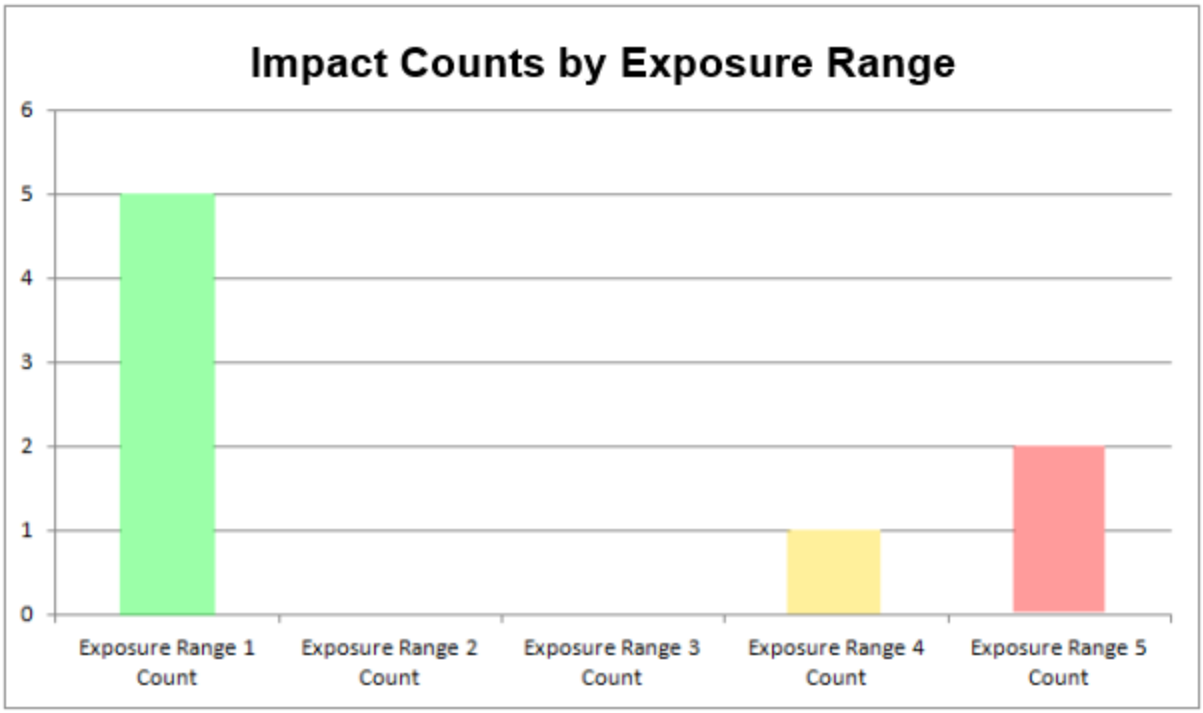
- Lower limit *Start* for each Exposure Range
- *Impact Baseline Limit* - ignore values below this absolute value when calculating impact parameters such as duration, rise time
- *Impact Peak Limit* - minimum g value for an impact to be counted

This graph explains the zones in context of the raw accelerometer magnitude data.



Every upper spike in the (red trace) raw accelerometer magnitude data could be categorized as an impact. The majority fall below the grey *Impact Baseline Limit* of 1.5 g.

This graph shows how they will be counted in the Impact Data output file.
- 5 impact rebounds in Exposure Range 1
- 1 major impact in Exposure Range 4
- 2 major impacts in Exposure Range 5



Users can fine-tune the Exposure Range limits to suit their data.

14.4 Analysing Impact Data

There are two processing options:

- Default csv file *Filetitle_yyyy_mm_dd_hh_mm_ss_IMPACTS.csv*
  - comma separated values format
  - itemizes impacts as categorized by the Impact Baseline Limit and Impact Peak Limit parameters set in the Preferences dialogue of the Impact Processor Tool
  - impact duration
  - count of impacts in each Exposure Range
  - direction of impact
  - count of up/down, left/right, forwards/backwards impacts
  - list of X/Y/Z accelerometer samples
- Pro Impact Report *Filetitle_yyyy_mm_dd_hh_mm_ss_AccelPro.xlsx*
  - Microsoft® Excel .xlsx format - PC must have Excel 2010 or later pre-installed
  - itemizes impacts as categorized by Impact Baseline Limit and Impact Peak limit parameters as above,

    Additional parameters:
    - left/right, front/back, above/below indication
    - Load/Impulse Load
    - Total Peak Load
    - Average Force Development
    - Average Peak g
    - Average Impulse
    - Average Period
    - Average Flight Time
    - Histogram display of X/Y/Z 100 Hz accelerometer stream
    - Angles of impact direction (Phi & Theta)

14.4.1 Default csv Impact File

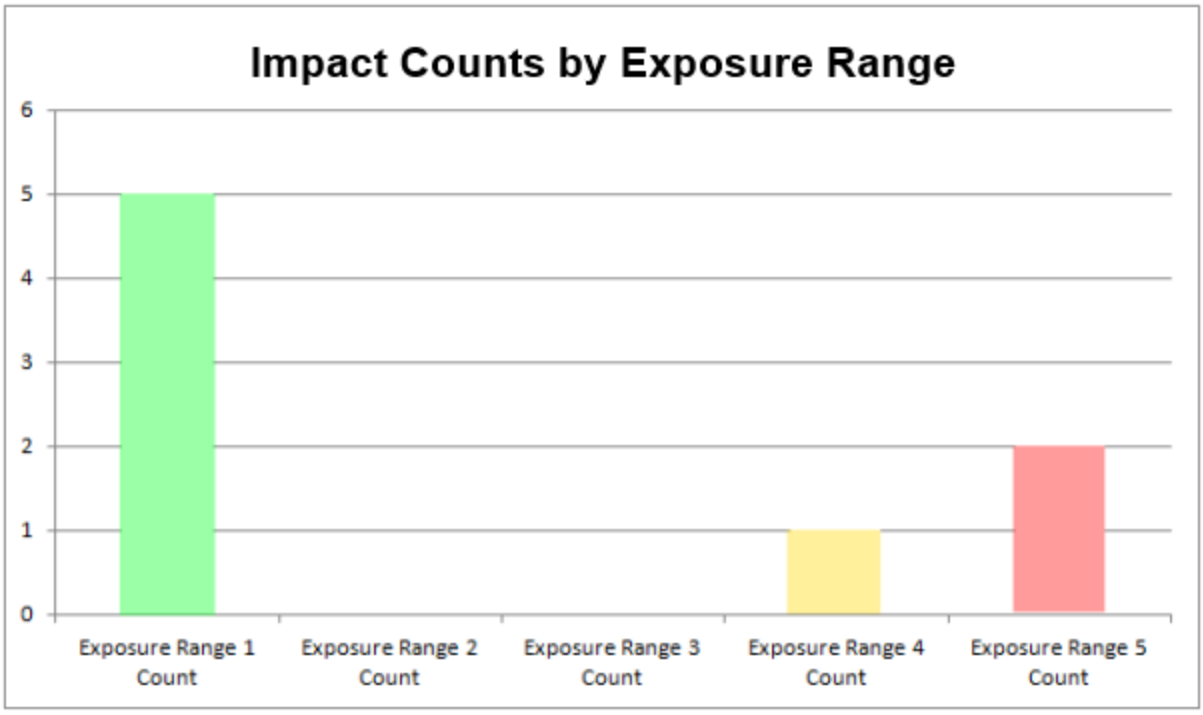
The Impact Processor outputs a .csv file labeled as with the following table of data. This file can be opened in Microsoft® Excel. The color has been added afterwards for clarity.

Timestamp	Impact Number	Rise Time(s)	Area (gs)	Peak (g)	Impact Length (s)	Exposure Range 1 Count	Exposure Range 2 Count	Exposure Range 3 Count	Exposure Range 4 Count	Exposure Range 5 Count
46:05.18	1	0.03	0.661450986	8.406151105	0.23	0	0	0	1	0
46:13.94	2	0.01	0.410536613	10.14861981	0.08	0	0	0	1	1
46:14.03	3	0.05	0.195700969	2.614096916	0.1	1	0	0	1	1
46:14.52	4	0.03	0.111909327	2.157602256	0.07	2	0	0	1	1
46:23.86	5	0.02	0.418535893	10.12995827	0.09	2	0	0	1	2
46:23.95	6	0.05	0.224865843	2.939709658	0.11	3	0	0	1	2
46:24.42	7	0.03	0.153382857	3.45262191	0.07	4	0	0	1	2
46:28.87	8	0.06	0.23794762	2.302718231	0.13	5	0	0	1	2
						Counts of Impact per Exposure Range				

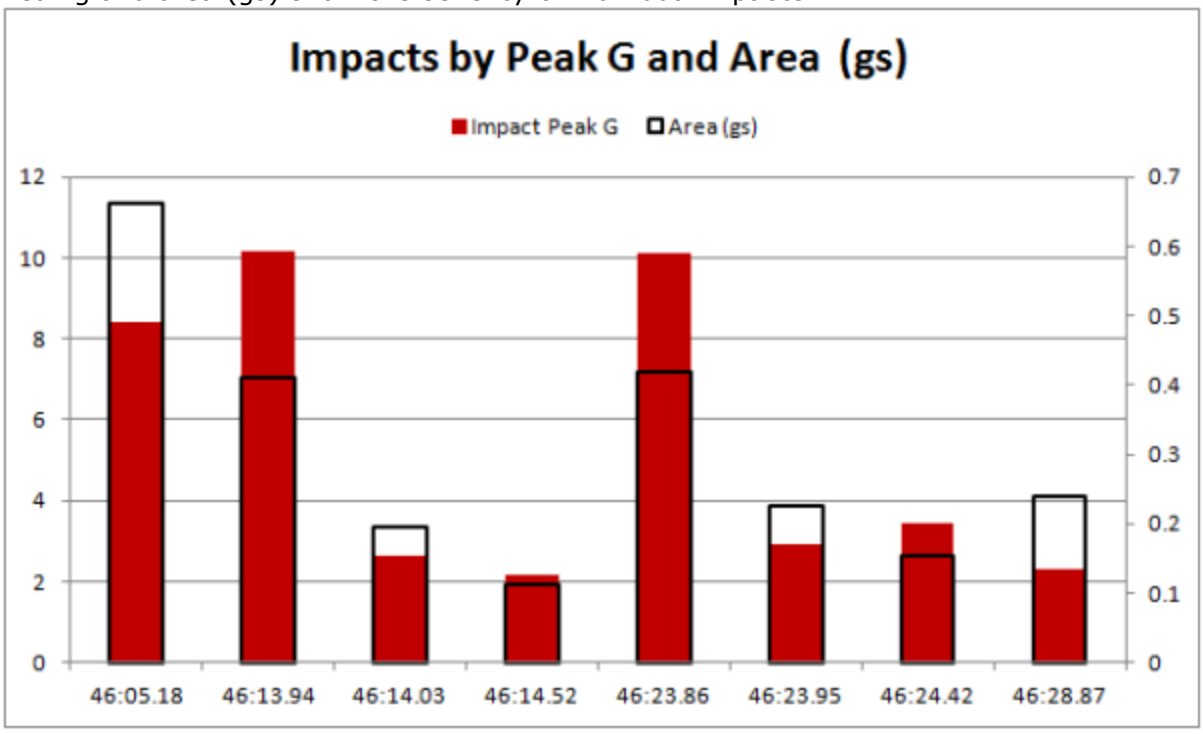
The parameters are:

Timestamp	resolution down to milliseconds. Configure using Excel
Impact Number	The bottom value shows the total impact count
Rise Time	How fast or slow the impact initiated
Area (gs)	Index of impact severity which integrates g over total impact duration. These metric is replaced by the Impulse Load which is measrued in SI units of Newton seconds in the Pro Impact Report
Peak g	Maximum deceleration occurring during impact
Impact Length	Duration of Impact above lower limit of Exposure Range lower value
Exposure Range Counts	Cumulative totals of impacts per Exposure range. The final totals are the bottom values in each column
Direction of Impact	Up/down, Left/Right, Forwards/Backwards - from the subject's point of view i.e. an 'Up' impact means the subject landing after a jump - the landing surface is 'hitting' the subject in an upwards direction
Positive/ Negative Vertical/ Lateral/Sagittal Counts	A cumulative total - the final totals are the bottom values in each column
Vertical Lateral/Sagittal Profiles	Lists of semi-colon separated values of the Accelerometer samples. These are not formatted for easy analysis - a better option is to have checked the Pro Impact Report which will show graphical analysis of the data

The cumulative counts of impact will characterize any particular session in terms of impact severity - this short sample data set contains only three major impacts.



Peak g and area (gs) show the severity of individual impacts.

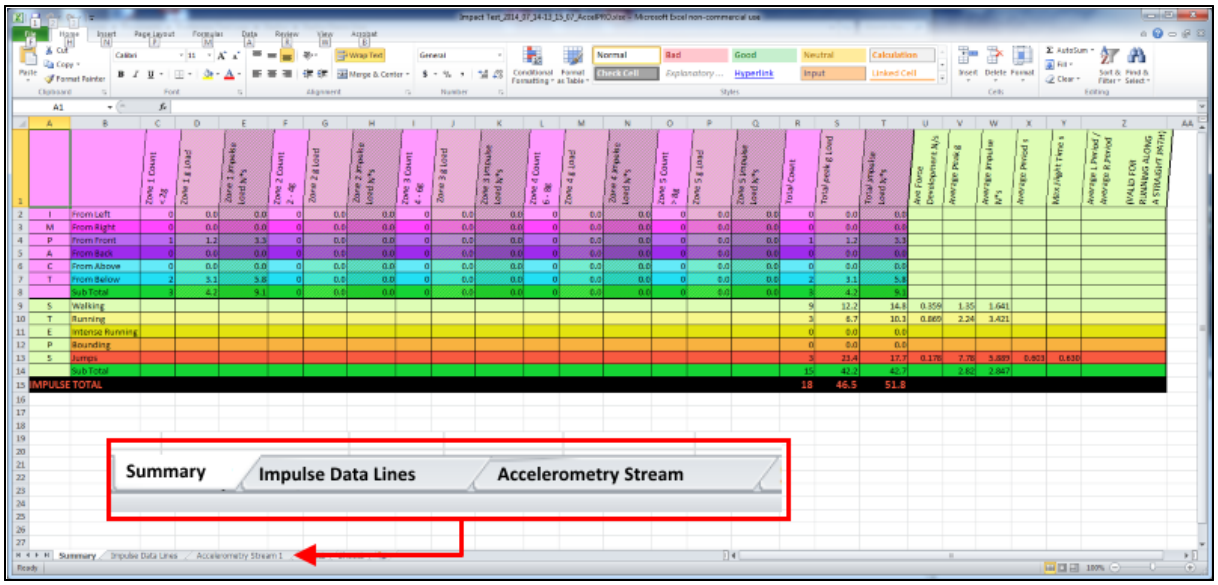


Combining the two shows that the initial major impact incurred a smaller peak g than the two following, but it lasted longer (The black outline showing Area)

14.4.2 Pro Impact Report

- To generate a Pro Impact report, the PC being used must have Microsoft Excel® 2010 or later installed.

- Check the Pro Accel Report option in the Impact Processor Tool menu options
- The generated Excel® spreadsheet will be saved into the *same directory* as the Accel csv file which was used as source, default C:\Users\...\Documents\BioHarness Test Logs \...



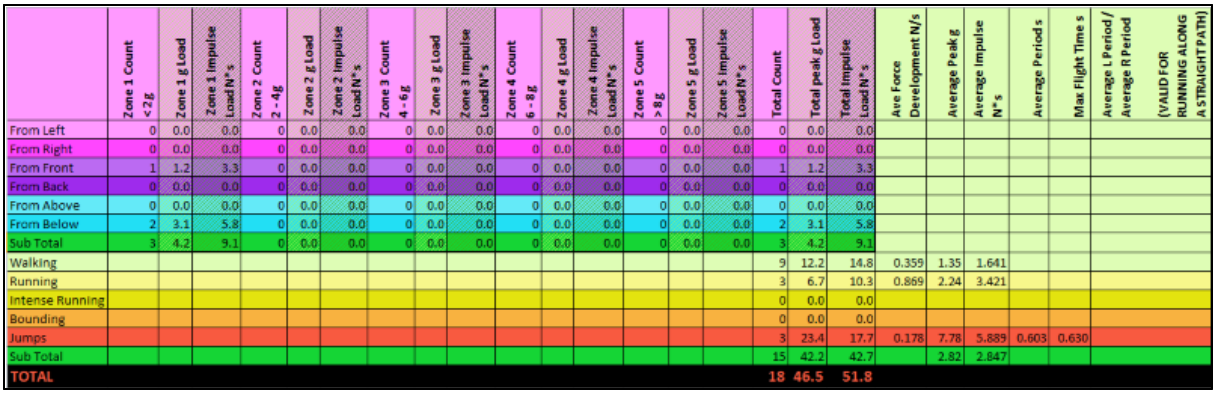
- The spreadsheet has three tabs:
  - Summary
  - Impulse Data Lines
  - Accelerometry stream

14.4.2.1 Summary

The Summary tab provides an overview of impact events, categorized by type. A type is either:

- an Impact - a change in momentum causing a detectable acceleration or deceleration of the BioModule
- a Step - a change in momentum caused by one of the step types below.
  - walking step
  - running step
  - bounding step
  - jump

Zephyr proprietary algorithms analyze the accelerometer samples and categorize changes in momentum as Impacts, or Steps of the various types. The data is analyzed for the direction, magnitude and regularity of the momentum changes. Rotational changes can infer whether a step is on the left or right side. The time period between steps can be used to determine step type - running steps are faster than walking, etc. Averages are determined over a number of steps of similar type. Jump flight times can be calculated once the takeoff/landing signature of the jump has been established.



	Zone 1 Count <2g	Zone 1 g Load	Zone 1 Impulse Load N*s	Zone 2 Count 2 - 4g	Zone 2 g Load	Zone 2 Impulse Load N*s	Zone 3 Count 4 - 6g	Zone 3 g Load	Zone 3 Impulse Load N*s	Zone 4 Count 6 - 8g	Zone 4 g Load	Zone 4 Impulse Load N*s	Zone 5 Count >8g	Zone 5 g Load	Zone 5 Impulse Load N*s	Total Count	Total peak g Load	Total Impulse Load N*s	Ave Force Development N/s	Average Peak g	Average Impulse N*s	Average Period s	Max Flight Time s	Average L Period / Average R Period (VALID FOR RUNNING ALONG A STRAIGHT PATH)
From Left	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0						
From Right	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0						
From Front	1	1.2	3.3	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1	1.2	3.3						
From Back	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0						
From Above	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0						
From Below	2	3.1	5.8	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	2	3.1	5.8						
Sub Total	3	4.2	9.1	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	3	4.2	9.1						
Walking																9	12.2	14.8	0.359	1.35	1.641			
Running																3	6.7	10.3	0.869	2.24	3.421			
Intense Running																0	0.0	0.0						
Bounding																0	0.0	0.0						
Jumps																3	23.4	17.7	0.178	7.78	5.889	0.603	0.630	
Sub Total																15	42.2	42.7		2.82	2.847			
TOTAL																18	46.5	51.8						

Impact Parameters

Categorized by Impact Zone

Parameter	Units	Description
Zone # Count	Number of impacts detected per Exposure Range (Zone)	The number of impacts in the 1/2/3/4/5 Impact Zones as configured in the Edit>Preferences menu option of the Impact Processor tool
Zone # g Load	g	The sum of the Peak g values for each impact in the given category
Zone # Impulse Load	Newton seconds	A summation of the accelerometer magnitude samples for the impulse expressed in SI units
Left/right, front/ back, above/ below		Direction *from* which the impact has come i.e. a landing after a jump is indicated as an impact from below
Total Count	Total number of impacts detected	The total number of impact events in each given category
Total Peak g load		The total Peak g Load of events categorized as above
Total Impulse Load	Newton seconds	The total Impulse Load of events categorized as above

Summary Parameters

Categorized by Impact Type

Parameter	Units	Description
Average Force Development	Newtons per second	Average of all events in each walking/running/ bounding/jumping type
Average Peak g	g	Average Peak g of all events categorized as above
Average Impulse	Newton seconds	
Average Period	Seconds	Average step time
Max Flight time	Seconds	Maximum time in the air of all jump events
Average L period/average R period	Seconds	Average L/R step time

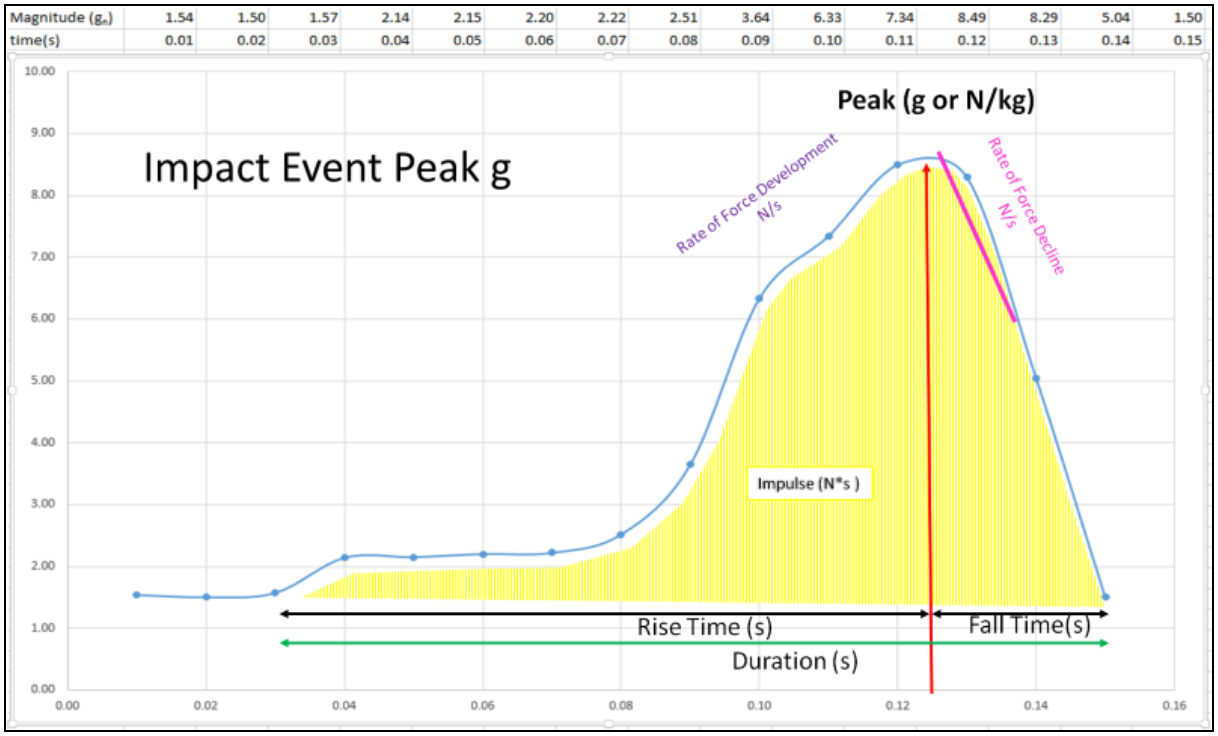
14.4.2.2 Impulse Data Lines

Each Impact Event contributing to the Total Count in the Summary tab is itemized as a data line in this tab.

Time of Peak	Magnitude g	Impulse N*s	Duration s	Rise Time s	Fall Time s	30 ms Rate of Force Development N/s	30 ms Rate of Force Decline N/s	Time since last Peak s	Phi Peak	Theta Peak	Classification	Type	Orientation
13:15:20.50	1.27	1.91	0.15	0.00	0.00	0.08	-0.06	13.08	2.72	0.31	Impact	Zone 1	From Below
13:15:28.85	1.81	3.90	0.26	0.00	0.00	0.33	-0.39	8.35	2.86	1.94	Impact	Zone 1	From Below
13:15:31.22	2.36	3.07	0.16	0.05	0.05	2.03	-1.06	2.37	3.10	1.57	Step	Run	
13:15:34.71	1.15	3.33	0.30	0.00	0.00	0.10	-0.03	3.49	2.32	0.19	Impact	Zone 1	From Front
13:15:36.52	1.15	4.26	0.38	0.00	0.00	0.03	-0.15	1.81	2.58	0.34	Step	Takeoff	
13:15:37.10	7.86	6.32	0.19	0.06	0.08	21.64	-16.94	0.58	2.61	-0.10	Step	Landing	
13:15:37.78	1.32	4.08	0.37	0.00	0.00	0.46	-0.26	0.68	2.78	0.51	Step	Walk	
13:15:43.52	1.57	3.45	0.25	0.00	0.00	0.34	-0.22	5.74	2.92	2.18	Step	Walk	
13:15:45.29	2.11	3.60	0.20	0.00	0.04	0.27	-1.82	1.77	3.09	0.95	Step	Run	
13:15:50.97	1.26	4.10	0.37	0.00	0.00	0.40	-0.23	5.68	2.73	0.29	Step	Takeoff	
13:15:51.57	8.04	5.77	0.17	0.06	0.08	24.70	-15.55	0.60	2.66	-0.27	Step	Landing	
13:15:58.19	1.37	3.26	0.26	0.00	0.00	0.35	-0.39	6.62	2.97	1.47	Step	Walk	

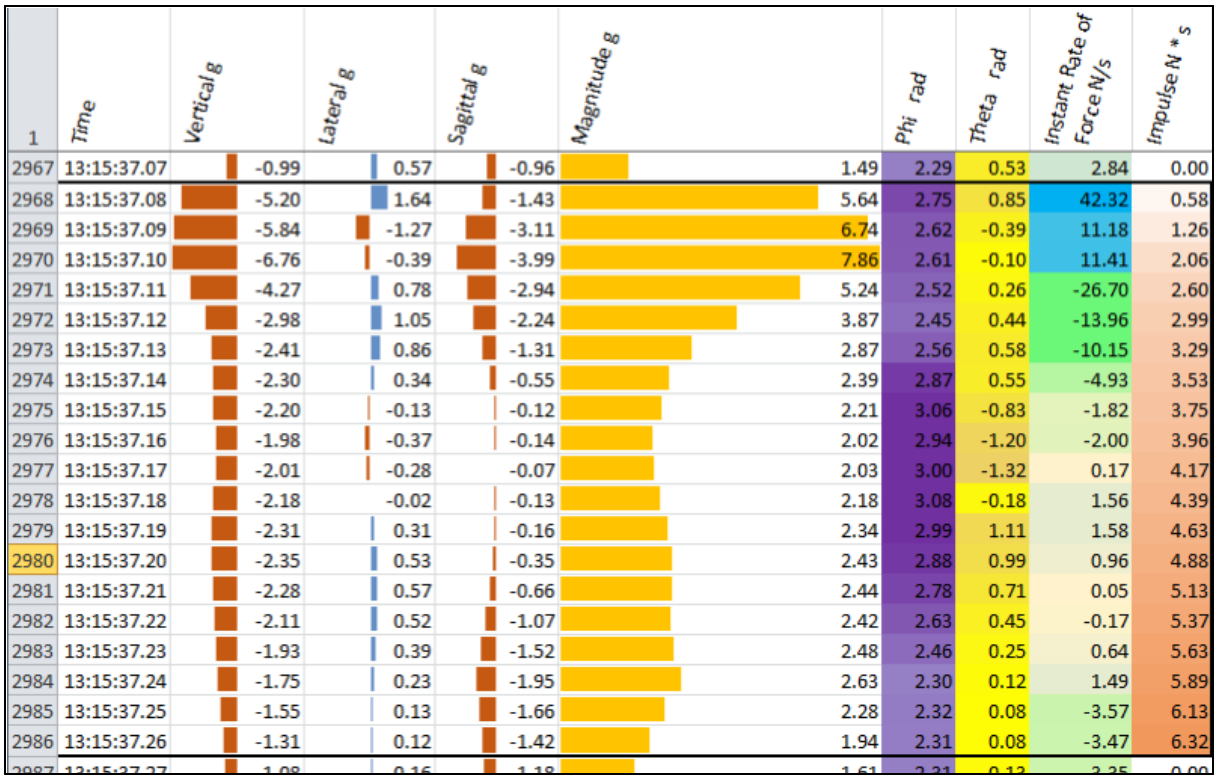
Time of Peak	Each entry is a hyperlink to the relevant lines in the Accelerometry Stream tab
Magnitude g	Peak g for that impulse event
Impulse Load	See diagram below
Duration	See diagram below. The duration of the impulse will dictate the number of lines selected from the Accelerometry Stream when following the hyperlink for that impulse
Rise Time	See diagram below
Fall Time	See diagram below
30ms Rate of Force Development	See diagram below
30ms Rate of Force Decline	See diagram below
Time Since Last Peak	Time duration since the peak of the last detected impact or step
Phi Peak	Angle in vertical plane of impact peak. See Impact Angle diagram
Theta Peak	Angle in horizontal plane of impact peak. See Impact Angle diagram
Classification	Step or Impact
Type	Impact Zone or type of step
Orientation	If an impact, the direction from which it came

The diagram below illustrates some terminology. All impacts are characterized by a rise, and then a fall in Peak g. Events occur above the configurable Impact Baseline Limit for peak g set in the Edit>Preferences menu option of the Impact Processor Tool, default 1.5g. At least one sample in the event must exceed the configurable Impact Peak Limit, default 2g



- Impact peak - location of maximum Peak g value, which can also be expressed in Newtons/Kilogram, using the subject's weight.
- Rise Time - duration of all samples above Impact Baseline Limit before impact peak
- Fall Time - duration of all samples above Impact Baseline Limit after impact peak
- Impulse Load - area (yellow) under the curve. This gives a measure of impact taking into account both the severity and duration of the impact
- Rate of Force Development - a measure of how rapidly the impact occurs - 'hard' or 'soft' it is
- Rate of Force Decline - a measure of how rapidly the impact forces decline

14.4.2.3 Accelerometry Stream



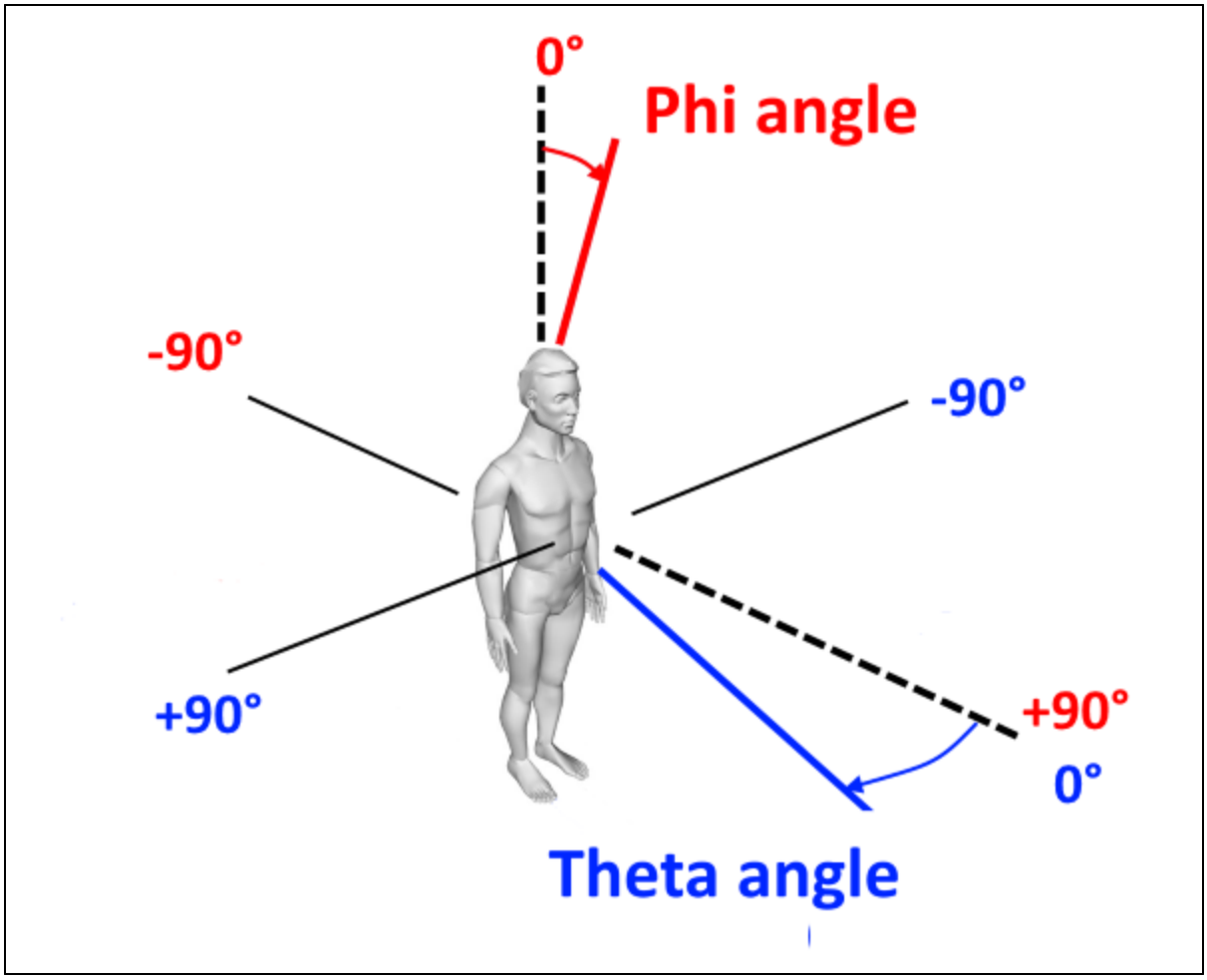
1	Time	Vertical g	Lateral g	Sagittal g	Magnitude g	Phi rad	Theta rad	Instant Rate of Force N/s	Impulse N * s
2967	13:15:37.07	-0.99	0.57	-0.96	1.49	2.29	0.53	2.84	0.00
2968	13:15:37.08	-5.20	1.64	-1.43	5.64	2.75	0.85	42.32	0.58
2969	13:15:37.09	-5.84	-1.27	-3.11	6.74	2.62	-0.39	11.18	1.26
2970	13:15:37.10	-6.76	-0.39	-3.99	7.86	2.61	-0.10	11.41	2.06
2971	13:15:37.11	-4.27	0.78	-2.94	5.24	2.52	0.26	-26.70	2.60
2972	13:15:37.12	-2.98	1.05	-2.24	3.87	2.45	0.44	-13.96	2.99
2973	13:15:37.13	-2.41	0.86	-1.31	2.87	2.56	0.58	-10.15	3.29
2974	13:15:37.14	-2.30	0.34	-0.55	2.39	2.87	0.55	-4.93	3.53
2975	13:15:37.15	-2.20	-0.13	-0.12	2.21	3.06	-0.83	-1.82	3.75
2976	13:15:37.16	-1.98	-0.37	-0.14	2.02	2.94	-1.20	-2.00	3.96
2977	13:15:37.17	-2.01	-0.28	-0.07	2.03	3.00	-1.32	0.17	4.17
2978	13:15:37.18	-2.18	-0.02	-0.13	2.18	3.08	-0.18	1.56	4.39
2979	13:15:37.19	-2.31	0.31	-0.16	2.34	2.99	1.11	1.58	4.63
2980	13:15:37.20	-2.35	0.53	-0.35	2.43	2.88	0.99	0.96	4.88
2981	13:15:37.21	-2.28	0.57	-0.66	2.44	2.78	0.71	0.05	5.13
2982	13:15:37.22	-2.11	0.52	-1.07	2.42	2.63	0.45	-0.17	5.37
2983	13:15:37.23	-1.93	0.39	-1.52	2.48	2.46	0.25	0.64	5.63
2984	13:15:37.24	-1.75	0.23	-1.95	2.63	2.30	0.12	1.49	5.89
2985	13:15:37.25	-1.55	0.13	-1.66	2.28	2.32	0.08	-3.57	6.13
2986	13:15:37.26	-1.31	0.12	-1.42	1.94	2.31	0.08	-3.47	6.32

Parameter	Units	Description
Time	hh:mm:ss.00	Timestamp of Hz accelerometer data sample
Vertical g	g	Vertical 3-axis g component
Lateral g	g	Lateral (subject side to side)
Sagittal g	g	Sagittal (subject front to rear)
Magnitude g	g	Square root(x^2 + y^2 +z^2)
Phi Rad	Degrees	See Impact Angle
Theta Rad	Degrees	See Impact Angle
Instant Rate of Force	Newtons per second	
Impulse	Newton seconds	

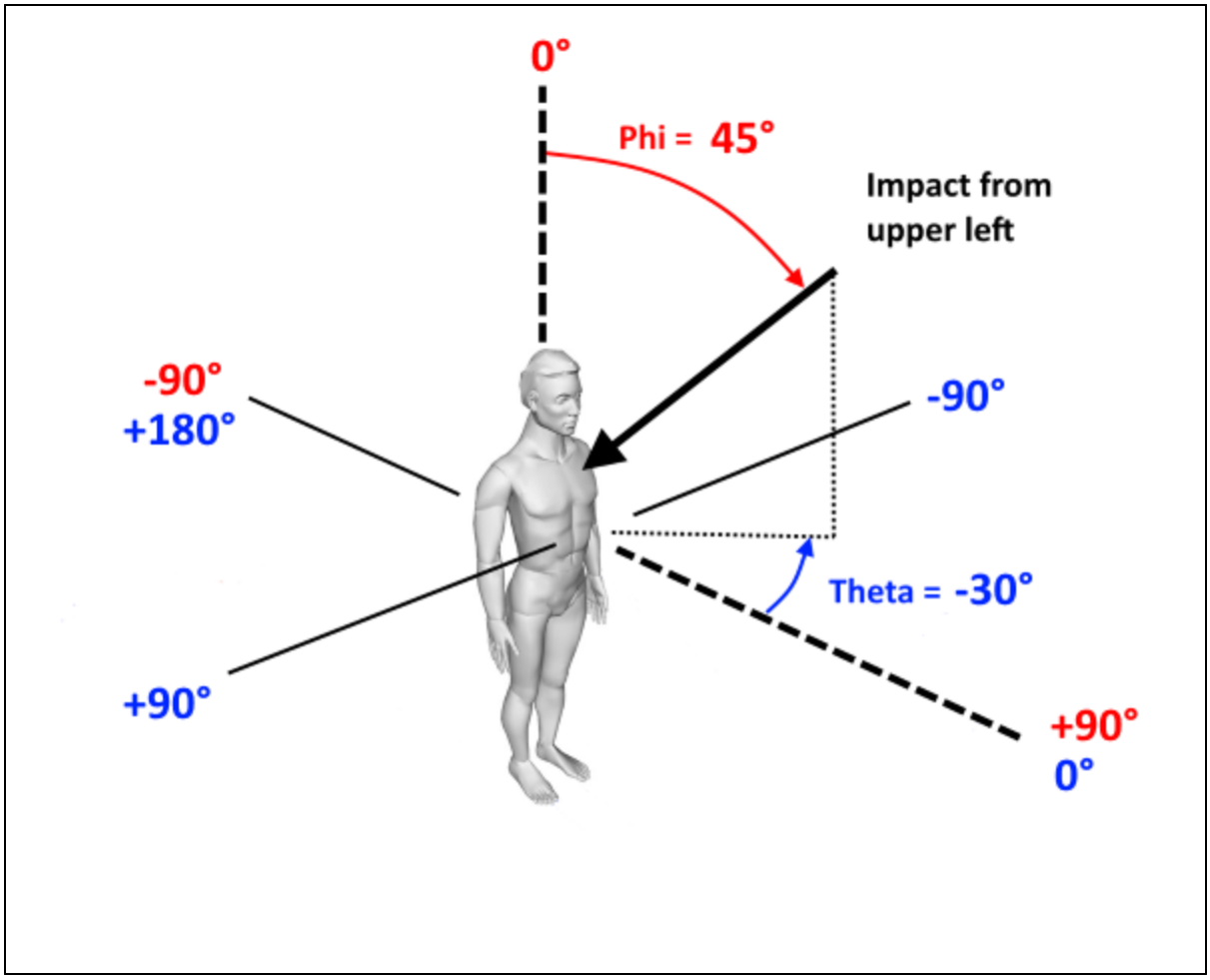
14.5 Impact Angle

Analysis of the X, Y & Z accelerometer components can determine the direction from which the impact event has come.
This is indicated by two angles, measured in degrees:

- Theta - angle in the horizontal plane. Subject's straight ahead = 0. From subject's right is a positive value, from subject's left is negative.
- Phi - angle in the vertical plane. Vertically upwards = 0. Impact angle from in front of subject is a positive value, impact angle from behind subject is negative.



This example shows an impact from the subject's 10 o'clock position, angled from above the horizontal plane.
Theta is negative (from subject's left), Phi is positive



15 Troubleshooting

This topic will be expanded as issues are reported.

Skin Temperature

• In a General log file, Skin Temp = -3276.8 Deg C

The BioHarness 3.0 does not support Skin Temperature in the General Log file, so the 'Invalid' value of -3276.8 is used. Configure the device using the Zephyr Config Tool - a description is included in the Live module Help file - to Log in Summary Format instead. Summary format includes an Estimated Core Temperature parameter, which the BioHarness 3.0 supports.

No Data appearing under a Team listing

If this is an ECHO system, check that the BioHarness internal clocks are synchronized to current time. Help for OmniSense Live describes the Zephyr Config Tool used to configure this. If a BioHarness does a hard reset, its internal clock will default to Jan 1 2010 - it may be useful to adjust the session filters to display any sessions with this timestamp.

No Logs Found on the BioHarness

To see all the logs on the BioModule, regardless of what dates they are timestamped with, use the legacy BioHarness Log Downloader.exe located at C:\Program Files(x86)\Zephyr \OmniSense\Tools

Markers placed during Live Session are not visible in Analysis

The BioModule clocks are out of synch with PC time. BioModule clocks will drift over time if not resynchronized regularly by using the Zephyr Config Tool (instructions in Live Help) or connecting them to a PC and opening the Zephyr Downloader from Analysis - this action will resynchronize the BioModule clocks with PC time automatically.

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