User Manual

HRT Analyzer

Analytical Software

STAR ODDI

Logging Life Science

This user manual is compiled in August, 2023 and is made using v.1.2.0 of Star-Oddi HRT Analyzer

Older versions of loggers or Mercury might not support all features explained in this manual.

Contents

1   Introduction

The Star-Oddi HRT Analyzer is a tool intended to help users process their raw Electrocardiographic (ECG) data. The analyzer is built on top of an internal tool used by Star-Oddi engineers for several years to develop the Star-Oddi heart rate algorithm and quality index (QI) estimation for various animal models.

This guide will cover how to set up and use the analyzer, which uses the *.HAT and *.DAT files as input.

The ECG data is stored in the *.HAT file, and it is possible to process the data using the standard filter for the recorded ECG sampling frequency or to use a custom filter file received from Star-Oddi that in some cases can greatly improve the processing of the data.

The algorithm will calculate the HR, QI and estimate heart rate variability (HRV) using two different methods SDNN and RMSSD, where there is possible to calculate more than one R-R interval.

Manual annotation of the data is also possible where the user chooses the peak of the QRS wave.

Both the processed data and user annotated data can then be inputted to a *.DAT file with records that are missing ECG data to increase the quality of recordings.

Note that all files that are used as input or output in this analyzer are text files and can be opened using a text editor or any statistical software tool for further processing.

2   Program Installation

This chapter describes how to install the **HRT Analyzer** software on your personal computer. Currently the HRT Analyzer is only available for the Windows operating system.

Open the *analyzer* (.msi) file, a Setup Wizard opens up, guiding the user through the setup (see Figure 2.1).
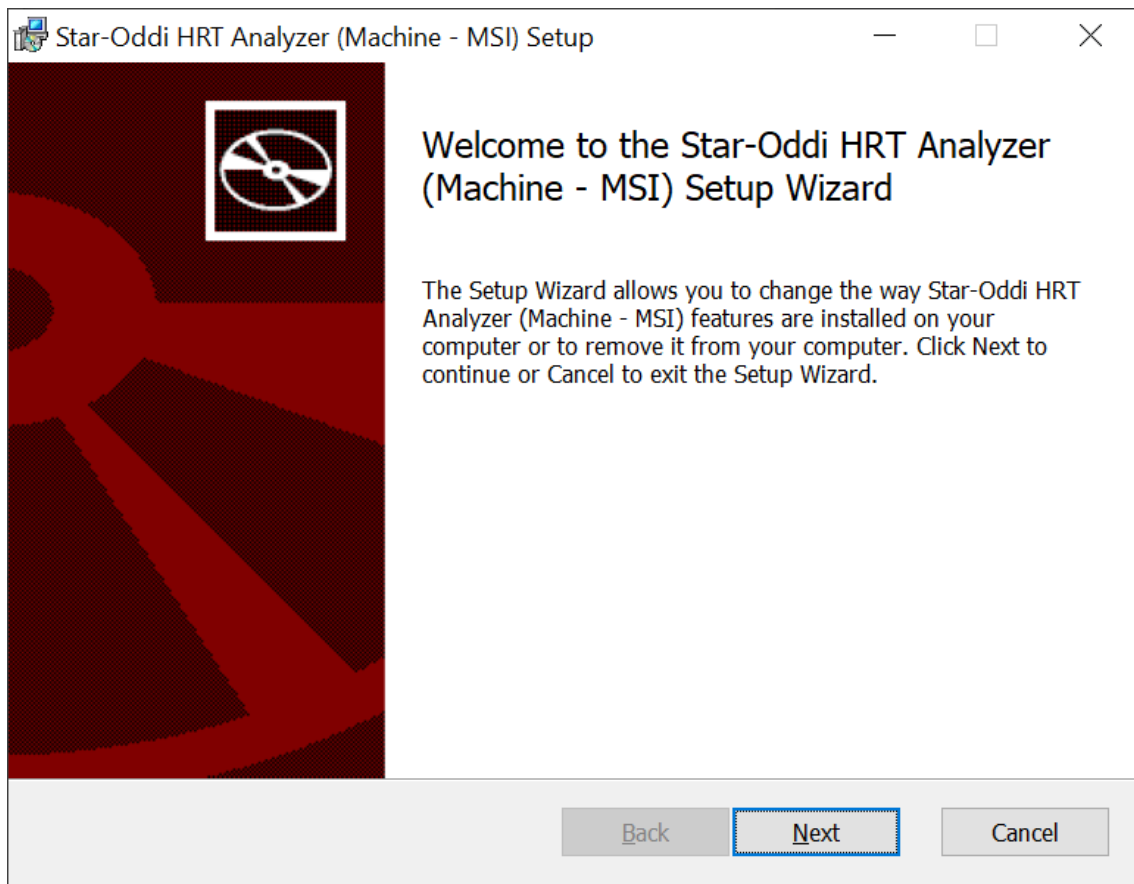
Figure 2.1: Star-Oddi HRT Analyzer Setup Wizard.

Click **Next**, and Custom Setup dialog box appears (see Figure 2.2).

Change install location by selecting the '**Browse**' button.

The installer chooses the drive that has the most free space. If you have previously installed other Star-Oddi software, i.e., Mercury, you can choose *C:\Software\Star-Oddi* as install location. If not, you can create a new folder within *C:\Software* and choose that folder as your installation folder.

Figure 2.2: Change install location.

When the installation folder has been selected, select **Next**, and installation will start. When completed, select **Finish**.

3   Heart rate Measurements

3.1   ECG Sampling Frequency

The heart rate (HR) varies between and within species. Intraspecific variation might reflect actual differences in the resting HR given the genetics and characteristics of different animals, or it might also be affected by moment-to-moment variation of the state of the animal; stress, temperature, hibernation, activity, etc.
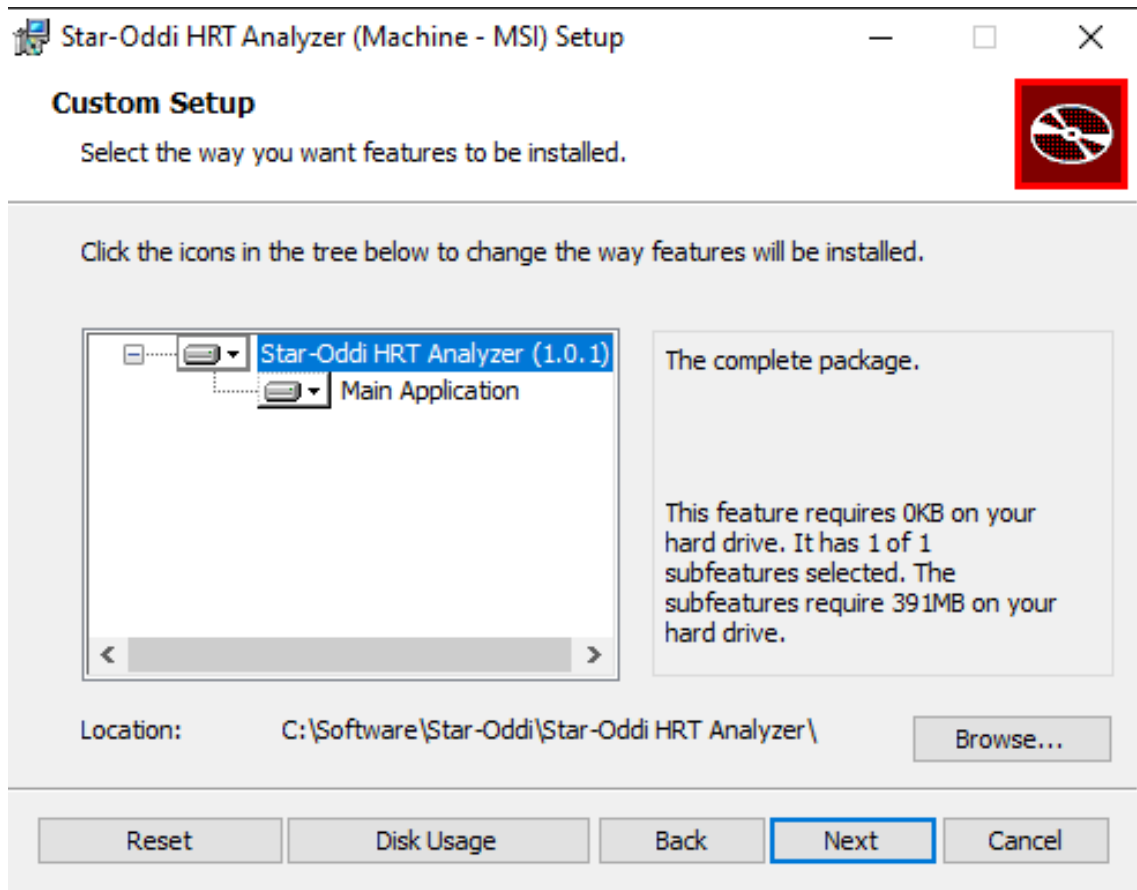The HR is dependant on body mass and cardiac output requirements for oxygen consumption, commonly with increasing resting HR for decreasing body mass. Figure 3.1 shows the broad relationship of HR with body mass.
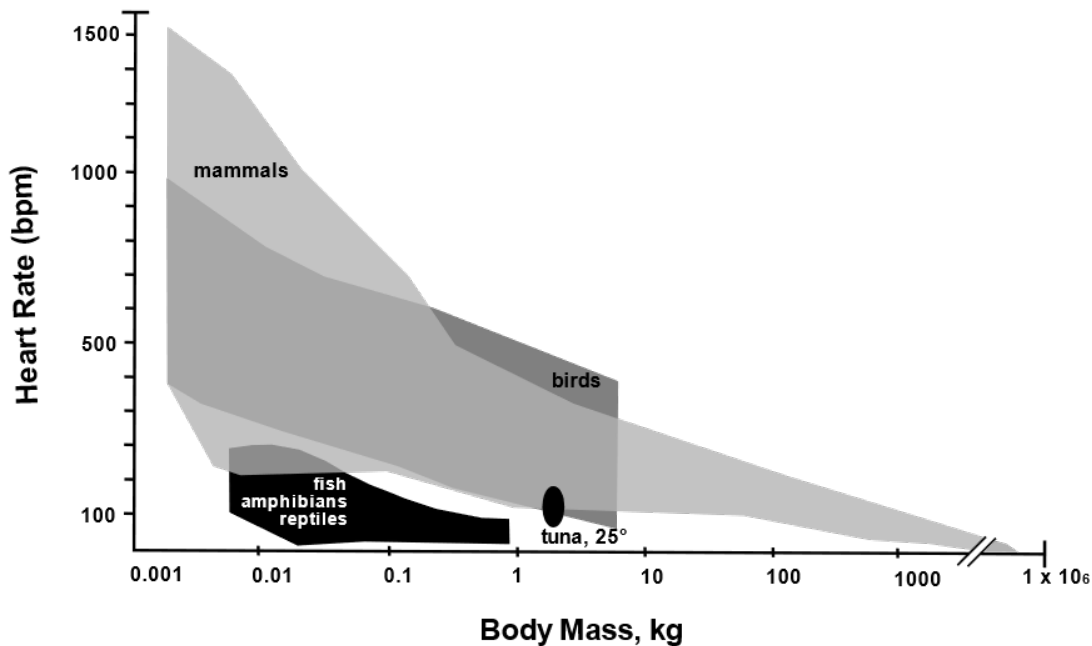
Figure 3.1: Relationship of heart rate in endothermic and ectothermic vertebrates by body mass. The envelopes include data for resting and maximal HRs recorded in selected species of vertebrates [3].

Different groups of animals have distinct heart structures. Mammals have two atrium and two ventricles and an average body temperature of 37℃ under normal conditions. Birds have similarly structured hearts as mammals, with two atrium and two ventricles. Still, the tissue inside the heart is more smooth, and the atrium structure is more simplistic than the mammalian heart, enabling a faster heart rate. The core body temperature is also higher (41-45℃), adding to a higher overall metabolic rate. Fish have only one atrium and one ventricle. The blood comes from the body low in oxygen through the atrium and ventricles. The bulbus arteriosus controls blood pumping to the gills where it is oxygenized, compared to the lungs that oxygenize the blood in birds and mammals.

Birds   Mammals   Fish
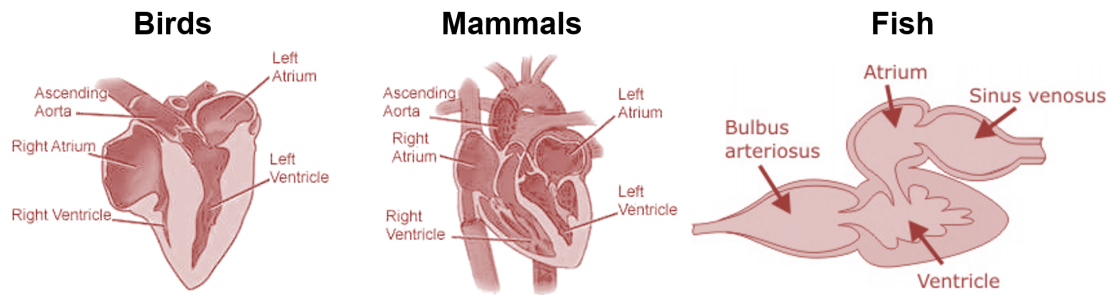
Figure 3.2: Heart structure comparison of mammals, birds, and fish.

Electrocardiography (ECG) is a graphical interpretation of the voltage difference versus time generated by the heart's electrical activity and recorded with at least one pair of electrodes. The ECG signal has three main components; the P wave, which represents the depolarization of the right and left atrium, the **QRS complex**, which represents the depolarization of the ventricles, and the T wave, which represents the repolarization of the ventricles. The QRS waveform is what we want to measure as accurately as possible during HR measurements. For example, in Figure 3.3 the waveform takes about 700 ms that you can calculate as HR of 85 bpm.

Figure 3.3: ECG action potential evolution during a heart beat, resulting in a QRS waveform. Different waveforms are generated by each of the specialized cells found in the heart.[4]

3.1.1   Different ECG sampling frequency for different animal models

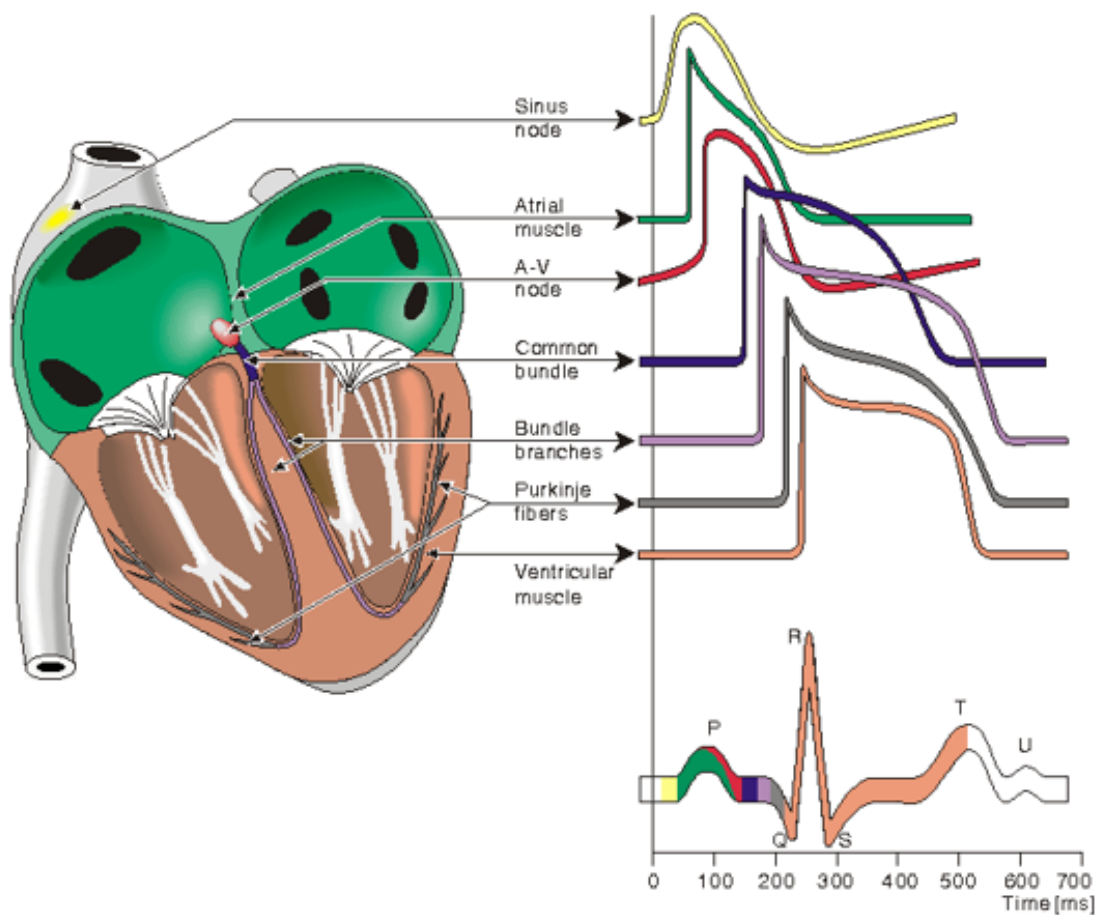We recommend using different sampling frequencies for different animal models. With higher HR, you need a higher sampling frequency to detect the QRS waveform accurately. Too low sampling frequency can cause *aliasing*, the signal can become indistinguishable, distorted and noise processing will be difficult with fewer sampling points on the ECG waveform

Figure 3.4 shows two different ECG recordings using Star-Oddi's DST-HRT recorders. The graph on the left shows HR of about 30bpm sampled at 100Hz. The graph on the right is recording a faster HR of about 360bpm, and the signal is sampled at a higher frequency 600Hz. The R-R interval is shown as the time elapsed between two successive R waves. While the number of samples at each R-wave is similar.
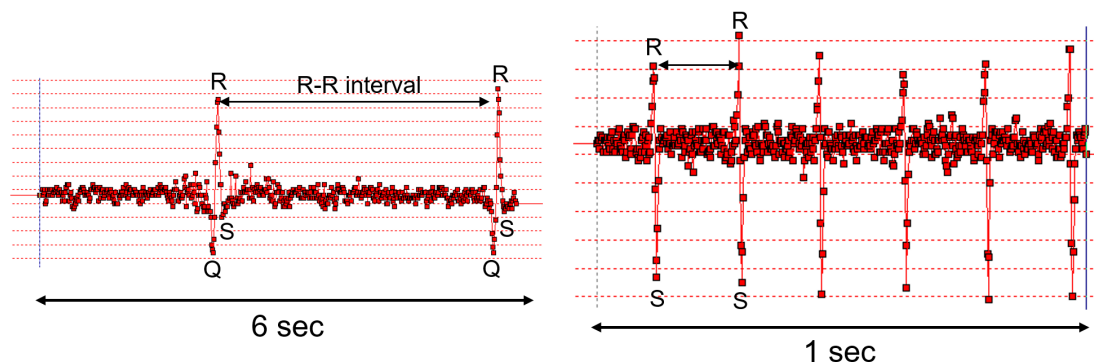

Figure 3.4: Two different ECG recordings. The left recording is sampled at 100 Hz, while the right recording is sampled at 600 Hz. Both recordings are 600 samples.

When setting up Star-Oddi's DST recorder in **Mercury**. The user can choose between different sampling frequencies. Each record is either 600 samples **normal** or 1500 samples **Long ECG**. The duration of the ECG measurement is proportional to the sampling frequency used, as seen in table 3.1.1. The user can **Save ECG data**, which enables you to record the raw ECG data behind the HR measurement. Those measurements will be stored in the *.HAT file, which is needed to further process the data using Star-Oddi tools or other ECG analytical methods.

ECG Sampling frequency	Animal model	Duration [Normal / Long ECG]
80 Hz	Fish	7.5s / 18.8s
100 Hz	Fish	6s / 15s
125 Hz	Fish	5s / 12s
150 Hz	Large animals	4s / 10s
200 Hz	Large animals	3s / 7.5s
300 Hz	Large animals	2s / 5s
400 Hz	Ferrets/Rabbits > 1kg	1.5s / 3.8s
500 Hz	Ferrets/Rabbits < 1kg	1.2s / 3s
600 Hz	Rodents > 500g	1s / 2.5s
700 Hz	Rodents > 300g	0.85s / 2.1s
800 Hz	Rodents < 300g	0.75s / 1.9s

Table 3.1: Mercury ECG sampling frequency options for HR recordings, the animal models are simply a recommended suggestion

The **Long ECG** option is especially useful when recording very low heart rates, see 3.2 for theoretical and guaranteed minimum heart rates based on sampling frequency.

3.2   ECG data and QI

In the current version of Star-Oddi's HR algorithm each HR measurement is graded with a certain **Quality Index (QI)**:

- **0:** Great

- **1:** Good

- **2:** Fair

- **3:** Poor

The algorithm defining the **QI** is a two-step; initially, it scans the recording for QRS waves and calculates each R-R interval. Suppose there is more than one R-R interval in the recording and less than a 20% variability between any R-R interval. In that case, the grade is set to QI_0 (great). If there is no R-R interval, the grade is QI_3, and HR is calculated as 2bpm. If HR is calculated above or below a certain defined threshold, the grade is QI_3 (see table 3.2). In most cases, HR graded QI_3 should be ignored since it cannot be considered reliable.

If there is exactly one R-R interval, there is a check to see if it is "appropriate" for the measurement window. Meaning if the R-R interval consumes approximately 45% of the sampling duration, the QI is set to QI_0 (great).

Anything that falls outside the aforementioned description goes on to step two of the algorithm. In this step, each potential R wave is given a grade that depends on various traits, for example, amplitude and "sharpness". Two levels are calculated based on the lowest and highest grade. We can call them lower-level threshold (LLT) and higher-level threshold (HLT). If the levels overlap (LLT $\geq$ HLT), that means all potential R waves are of similar grade. Then they are all used for the calculation of the BPM, and the QI is set to QI_1 (good). This is typical for good quality recordings that have an arrhythmia or more than 20% variation between any R-R interval inside a single ECG recording. Otherwise, only potential R-waves graded above the HLT are used for calculation. The QI is still set as QI_1 (good), except if one or more potential R-waves are graded between the LLT and HLT. Then the rating is considered somewhat ambiguous, and the QI is set to QI_2 (fair). Finally, if only a single R-wave is above the HLT, the QI is set as QI_3 (poor), and heart rate is calculated as 1bpm.

Fs $[Hz]$	Duration Normal $[s]$	Duration Long ECG $[s]$	Mercury QI_3 min $[bpm]$	Mercury QI_3 Long ECG min $[bpm]$	Mercury QI_3 max $[bpm]$
80	7.5	18.8	8	3	300
100	6	15	10	4	350
125	5	12.5	12	5	400
150	4	10	15	6	450
200	3	7.5	20	8	600
300	2	5.0	30	12	600
400	1.5	3.8	40	16	700
500	1.2	3.0	50	20	750
600	1	2.5	60	24	800
700	0.85	2.1	70	28	1022
800	0.75	1.9	80	32	1022

Table 3.2: Mercury limits (in use from 29.1.2019). Mercury V5.00 and later.

The ECG data can also be manually validated by saving the ECG data (HR buffer) and then analyzed in Star-Oddi **HRT Analyzer**, Pattern Finder or other 3rd party software. The ECG data can give valuable information in confirming the quality of measurements and how the QI is performing.

As of 2021 all Star-Oddi HRT products use the same version of the algorithm, micro-HRT from 2013-2020, milli-HRT from 2014-2017 and centi-HRT-ACT (2016-2020) used a slightly less accurate version of the algorithm. Further information can be found in [1].

3.3   Heart Rate Reconversion

After uploading the data from the sensor, it is possible to post-process and correct the heart rate data depending on the quality of the measurement in Mercury.

This can be done at **Edit** > **Reconvert Definition** > **HR Definition** command, and the following dialog box appears:
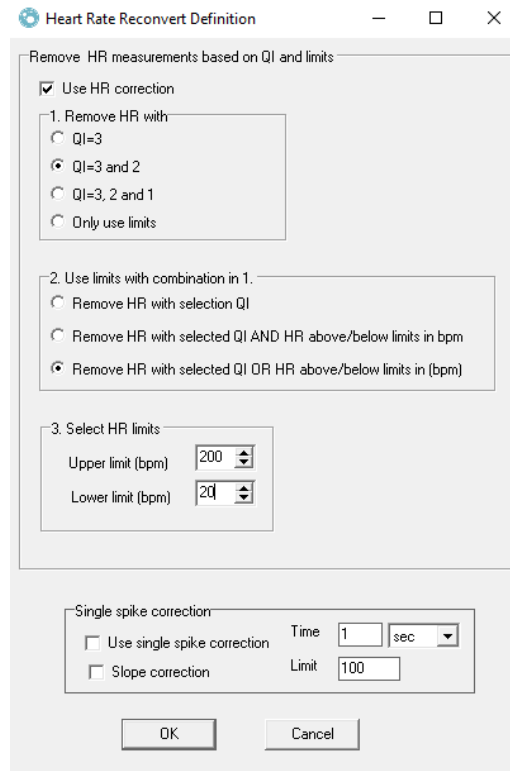

Figure 3.5: Heart Rate Reconversion Definition

[Remove HR with]:   It is possible to select to use the quality index (QI) to remove/filter the measurements or use the HR's upper or lower limit by selecting 'Only use limits'.

[Use limits with combination in 1]:   Selecting *QI=3* or *QI=3 and 2* in the first step, then selecting "Remove HR with selection QI" will remove all measurements that have the selected QI. Selecting AND the algorithm will process the measurement points that both have the QI and are outside the limits. By selecting OR statement, the records that either have the QI criteria or are outside of the limits will be removed.

[Select HR limits]:   The Upper limit sets the higher limit for the processing in bpm, meaning that all HR measurements above that value in bpm will be processed/removed. The lower limit sets the lower limit for the processing in bpm, meaning that all HR measurements below that value in bpm will be processed/removed. It is nice to find the high/max and low/min limits of HR by doing validation on the ECG data and to find values in literature.

4   Preparation

This chapter describes preparations that should be carried out before data can be analyzed.

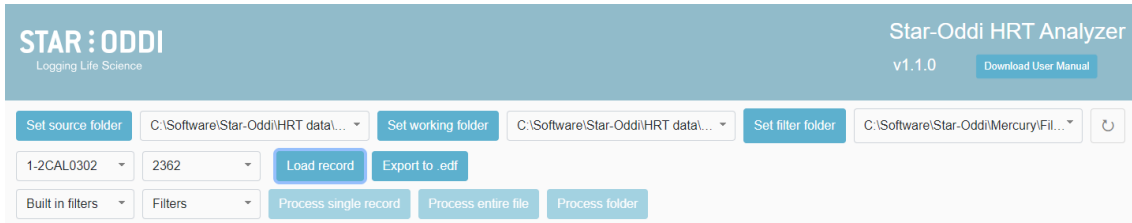Start the **HRT Analyzer**, and the following window appears:

Figure 4.1: HRT Analyzer Main Window

4.1   Set source folder

Select **Set source folder** to choose a folder in which *.HAT and *.DAT files are stored.

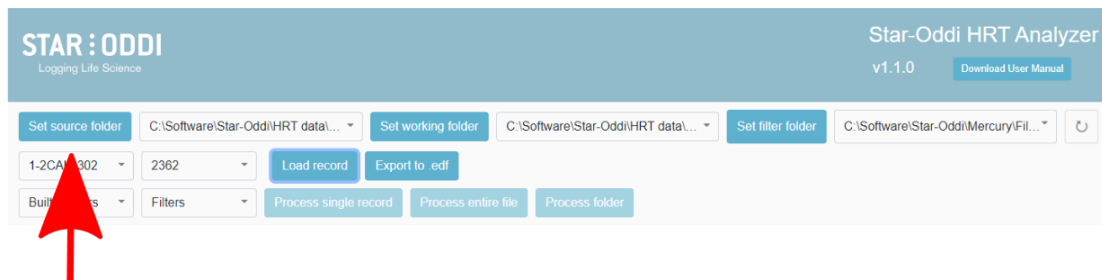Figure 4.2: Set source folder, marked by red arrow

4.2   Set working folder

Set working folder enables the user to select a folder in which files are saved. It is recommended to create a working folder for each logger.
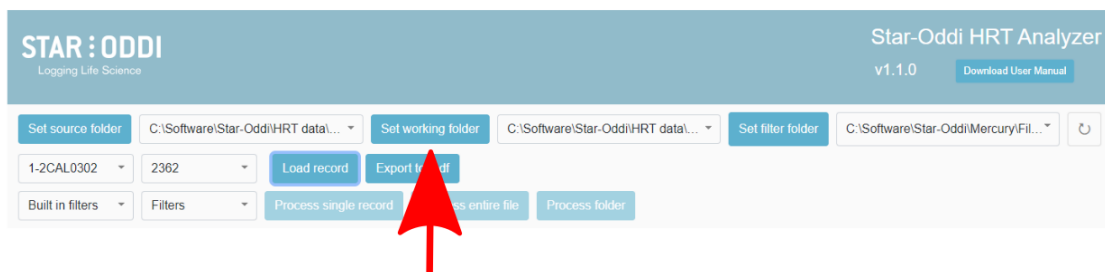

Figure 4.3: Set working folder, marked by red arrow

4.3   Set filter folder

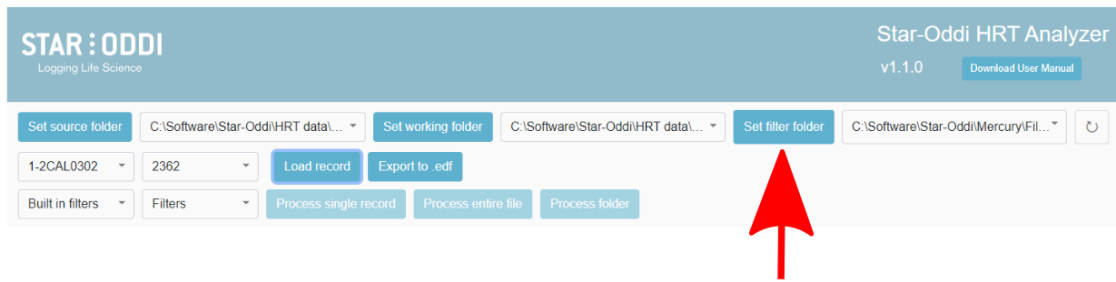Select **Set filter folder** to choose folder that contains custom filters, in .FLT file format.

Figure 4.4: Set filter folder, marked by red arrow

4.4   *.HAT file

The ECG data files analyzed in the **HRT Analyzer** are in *.HAT file format. The *.HAT file contains raw ECG data from an HR measurement buffer.

In Star-Oddi's **Mercury** software, when **Save ECG data** tick box is enabled, the raw ECG data behind the HR measurement is recorded. The duration of the ECG measurement is proportional to the sampling frequency used. With a normal duration, 600 samples are recorded.

By selecting **Long ECG**, a longer duration of each ECG will be recorded (1500 samples) for each HR measurement. This can be used to ensure that the HR does not surpass the lower limits of the detected HR.

The HR is an ECG-derived measurement where a recording of approx. 4-6 beats are recorded, and the HR is calculated from the R-R (of the QRS wave) interval of the ECG waveform. The ECG sampling frequency used for the study animal can be estimated from the average HR of the animal from scientific literature, which is usually highly correlated to the animal's weight, with some exceptions.

When **source folder** has been selected, the *.HAT file/s inside the set folder can be selected by pressing the **HAT file** button (as seen in Figure 4.5). A drop-down menu appears with all HAT files within the selected source folder.

When a *.HAT file has been selected, the **ID** or recording number within the *.HAT file can be selected. Press the **ID** button, and a drop-down menu appears with all ECG measurements within the set HAT file. Each HR measurement has a unique ID/measurement number, whether ECG data is stored or not.
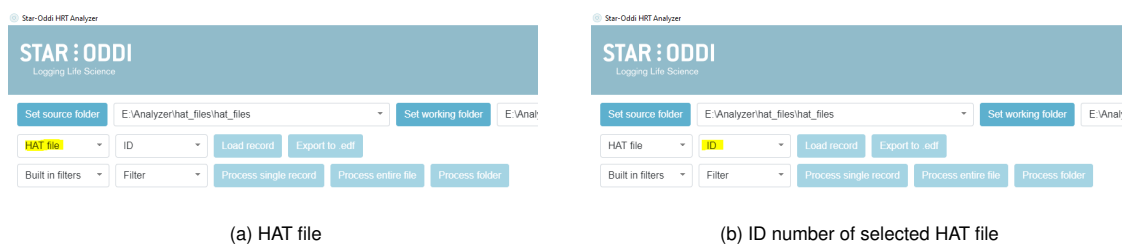
(a) HAT file

(b) ID number of selected HAT file

Figure 4.5: Select HAT file and ID.

When the HAT file and ID/measurement number have been selected, the **Load record** button can be pressed to load data from the selected file into the **HRT Analyzer** for further analysis.

5   Analyzing ECG data

This chapter guides users in analyzing ECG data in the **HRT Analyzer**.

When the HAT file and ID/measurement number have been selected (described in chapter 4.4), the **Load record** button can be pressed to load ECG data into the **HRT Analyzer**.

Figure 5.1: Record successfully loaded into HRT Analyzer

5.1   BPM (beats per minute)

Three values for each ECG measurement's BPM are presented in **HRT Analyzer**:

- **BPM (user)** Calculated from user's manual annotation.

- **BPM (logger)** Calculated by the DST recorder's on-board analyzer and stored in the *.DAT file.

- **BPM (computer)** Calculated by Star-Oddi **HRT Analyzer**.

5.1.1   BPM (user)

The BPM of each ECG measurement can be manually annotated by pressing data points on the ECG graph. When the user clicks on a data point, the point is marked with a red circle. The red circles represent the data points included in the **BPM (user)** calculation. At least two data points need to be selected to calculate the BPM.

Figure 5.2: BPM (user) manual annotation

5.1.2   BPM (logger)

The DST recorder calculated the **BPM** of the HR measurement with its on-board algorithm during the deployment. This data is stored in the *.DAT file and the BPM value is represented in the **HRT Analyzer** as **BPM (logger)**.

5.1.3   BPM (computer)

To access BPM as calculated by the **HRT Analyzer** software, the user needs to process the ECG record in view. This can be done by using the **Built-in filters**, named as listed in Table 3.1.1, with the number referring to the ECG sampling frequency of the record (Filters are explained in chapter 7). The recommended filter is highlighted in green see Figure 5.3 based on the tag type and firmware version.

Figure 5.3: The list of available sampling frequencies using the the built in filters. The recommended filter is highlighted in green.

Choose the correct filter based on the sampling frequency. The header of the graph shows what sampling frequency was used to record the ECG record. Then select **Process single record** to process the record in view, **Process entire file** to process all ECG records within selected HAT file, or choose **Process folder** to process all HAT files within the selected source folder.

Press one of these three options, and a new graph appears as shown in Figure 5.4

The green graph which appears when a record has been processed is the **HRT Analyzer** band-pass filtered graph. The Analyzer detects the peaks of the ECG recordings and calculates the BPM from the R-R interval. The detected peaks are shown on both the original raw data (blue) and the filtered graph (green) graph as green data points and user annotated values are shown as red. A new BPM value appears as **BPM (computer)**.

Figure 5.4: HRT Analyzer detected peaks are marked as green data points.

When the user has manually annotated the ECG peaks and has processed the record in the **HRT Analyzer**, three BPM values can be accessed and compared, i.e., **user**, **logger**, and **computer**.

Figure 5.5: The three BPM values (user, logger, and computer) can be seen in the red box on the bottom left.

5.2   HRV (Heart Rate Variability)

The **HRV** is a statistical analysis of the R-R intervals (beat to beat differences within each recording).

The **HRT Analyzer** calculates HRV as **SDNN** (standard deviation of normal to normal R-R intervals) and **RMSSD** (root mean square of successive differences between normal heartbeats)

From the user-derived BPM (manually annotated), the **HRV** is calculated from the red data points selected by the user. From **HRT Analyzer** derived BPM (computer), the **HRV** is calculated from the green data points detected by the software.

The HRV values are presented next to the BPM values as seen in figure 5.5.

Further information on the HRV file format is in section 8.2.

Examples of publications that have used HRV analysis using Star-Oddi HRT loggers include [5] and [2].

5.3   QI (Quality Index)

For each ECG record, three **QI** values can be accessed. The DST recorder's on-board algorithm calculates the QI as described in 3.2. This value is presented next to the BPM (logger) value.

The **HRT Analyzer** calculates a **QI** for each record in a similar manner when a set record is processed. This value is presented next to the BPM (computer) value.

The user then also has the option to define the **QI** (as seen in figure 5.6). The user can either use the arrows or type in the desired QI value.

	BPM	HRV (SDNN)	HRV (RMSSD)	QI
User	43	36.66 ms	61.04 ms	– 0 +
Computer	42	41.95 ms	69.54 ms	0
Logger	42			0

Figure 5.6: User defined QI.

With this option, the user can decide whether a particular record is included/excluded when all ECG data is further analyzed.

5.4   Amplitude Calculation

In version 1.2.0. an automatic amplitude calculations has been added that is stored in the *.HRV files. The amplitude is calculated from the median baseline value that is possible to showcase by ticking the box labelled "Show median baseline". See figure 5.7.
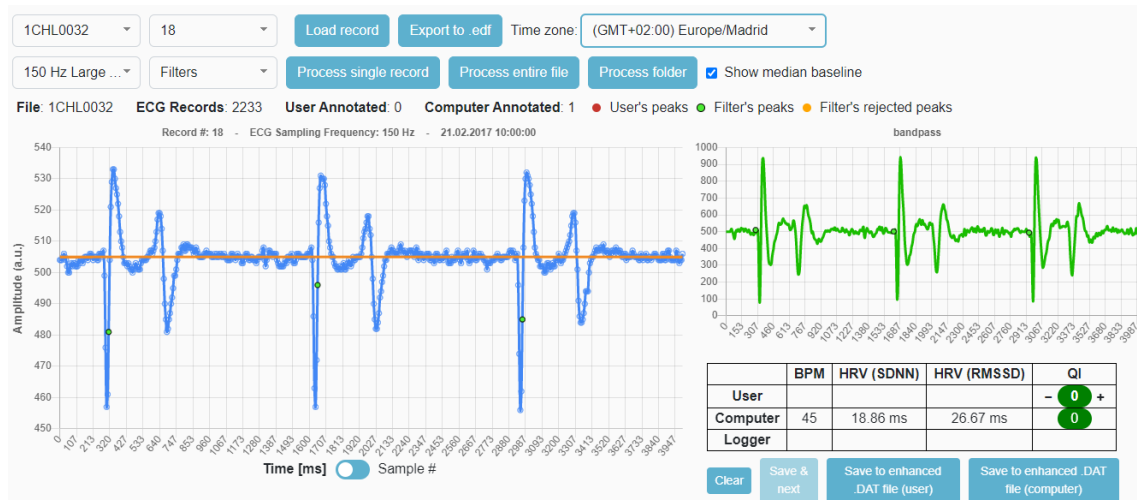
Figure 5.7: Show median baseline displayed

The data calculated are

- Mininum Amplitude within the ECG record

- Maximum Amplitude within the ECG record

- Average Amplitude within the ECG record

6   View Data

This chapter describes how data is viewed in Star-Oddi **HRT Analyzer**.

Load ECG data from HAT file as described in chapter 4 (Preparation). When a record has been loaded, a visual graph of the ECG data appears:
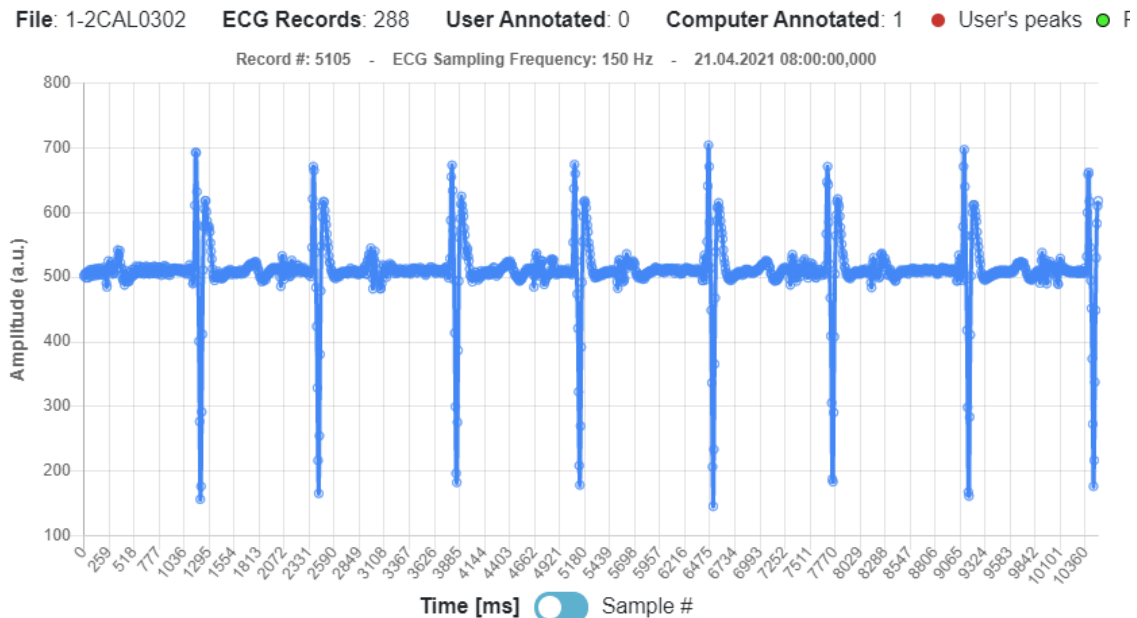

Figure 6.1: View of ECG data

6.1   Axes

The **x-axis** of the graph can be toggled between '**Time [ms]**' and '**Sample #**'. With 1-600 samples for normal ECG and 1-1500 samples for long ECG (see chapter 3).

The **y-axis** of the graph represents '**Amplitude**' (arbitrary unit) of the ECG signal. The value is a binary value of the recorder's A/D converter. Full scale being 2^{10}=1024 values.

6.2   Record information

Record information is presented above the graph, the following information is given:

File: Name of the current file from which ECG records are loaded.

ECG Records: Number of ECG records inside selected file.

User Annotated: Number of ECG records inside selected file that have been user annotated.

Computer Annotated: Number of ECG records inside selected file that have been computer annotated (processed).

Legend: The graph legend reflects the colour of data points displayed on the graph, user annotated and computer annotated.

6.3   Title

The graph title shows the **ECG sampling frequency** of particular record, and **date** (dd.mm.yyyy) and **time** (hh:mm:ss) of when ECG data was recorder. This information is derived from the loaded HAT file.

6.4   Using the Mouse

When the mouse pointer is pointed at a data point on the graph, the **Sample number** (upper number), and **Amplitude** (lower number) of a particular data point can be visualized.
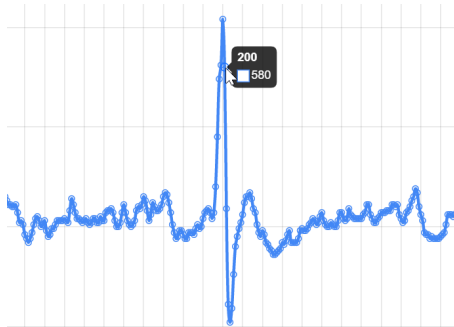

Figure 6.2: Using mouse pointer to analyze data points

6.5   Navigate Records

To navigate between records within selected HAT file, the user can select a new record from the **ID** button, when the button is pressed, a drop down menu appears:

Figure 6.3: Load new record

Select the desired ID from the drop-down menu and load the record by pressing the **Load record** button.

To navigate to next or previous record, the arrows below the graph can be used (see figure 6.4).
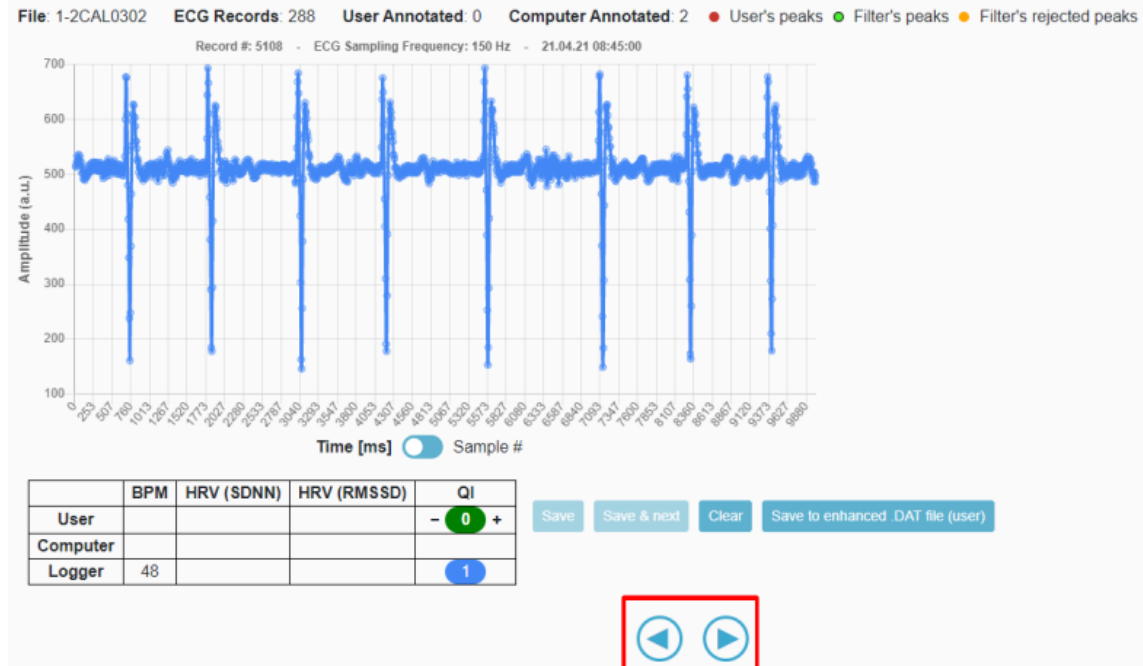
Figure 6.4: Navigate records by using arrows (red box).

6.5.1 Keyboard Shortcuts for Navigation

From version 1.2.0 keyboard shortcuts or Hotkeys have been added. Default keys are:

- S=Save record

- L=Load record

- A=Previous record

- D=Next record

- F=Save and next record

It is possible to press the question mark below Save Enhanced DAT file to change the assigned keys, see 6.5
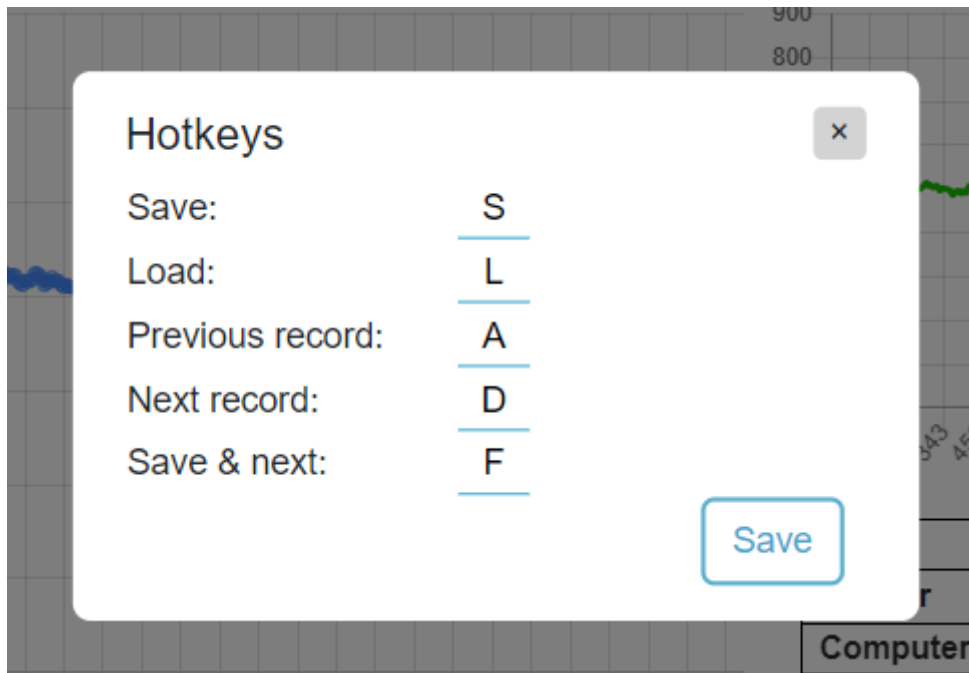
Figure 6.5: Keyboard Shortcuts "Hotkeys" information panel

6.6   Save Annotations

When ECG data has been manually annotated by the user and/or QI value set, the record with set annotation and QI value can be saved by pressing the **Save** button below the graph (see figure 6.6).

Figure 6.6: Save manual annotations (marked with red arrow).

To clear manual annotations and manually selected QI value, select the **Clear** button next to the Save button.

6.7   Processed Data

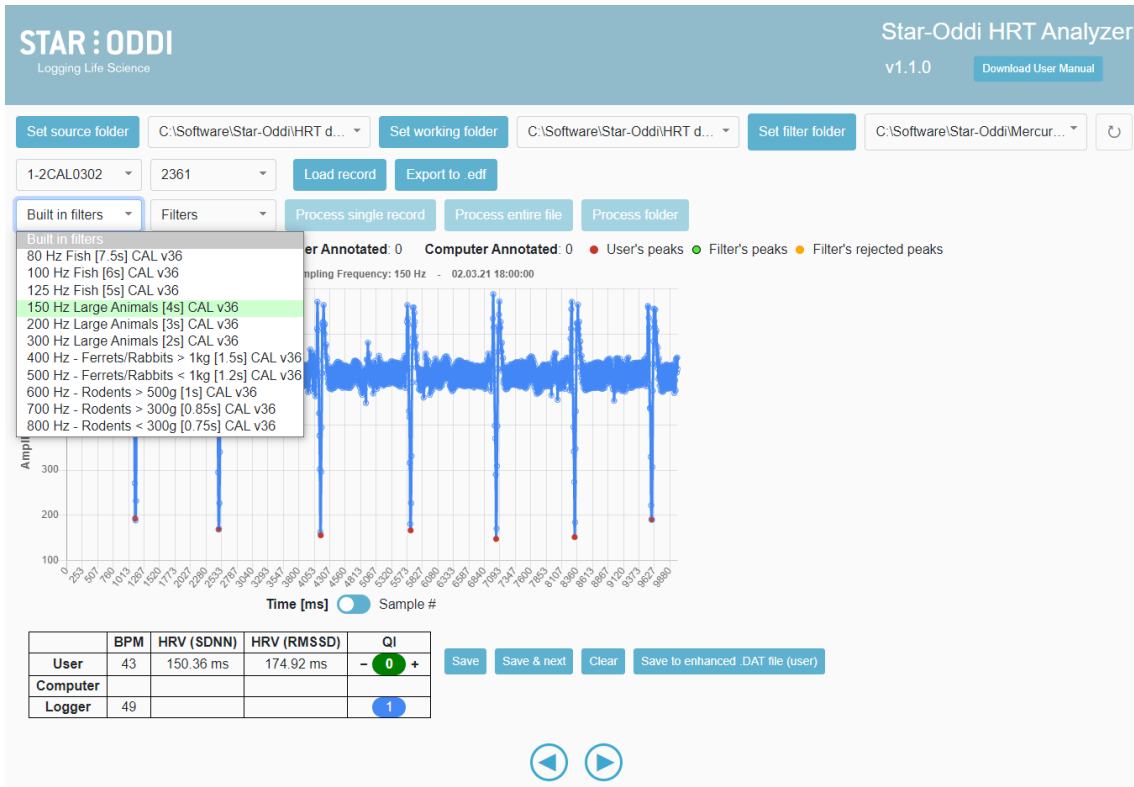When data has been processed, a new graph appears:

Figure 6.7: Processed ECG record graph in green (right) and original record in blue (left).

6.7.1 Toggle Between Graphs

It is possible to toggle between the processed (green) and original (blue) graphs by clicking on the smaller graph to the right. This can be helpful to visualize the processed graph better and access individual data points.

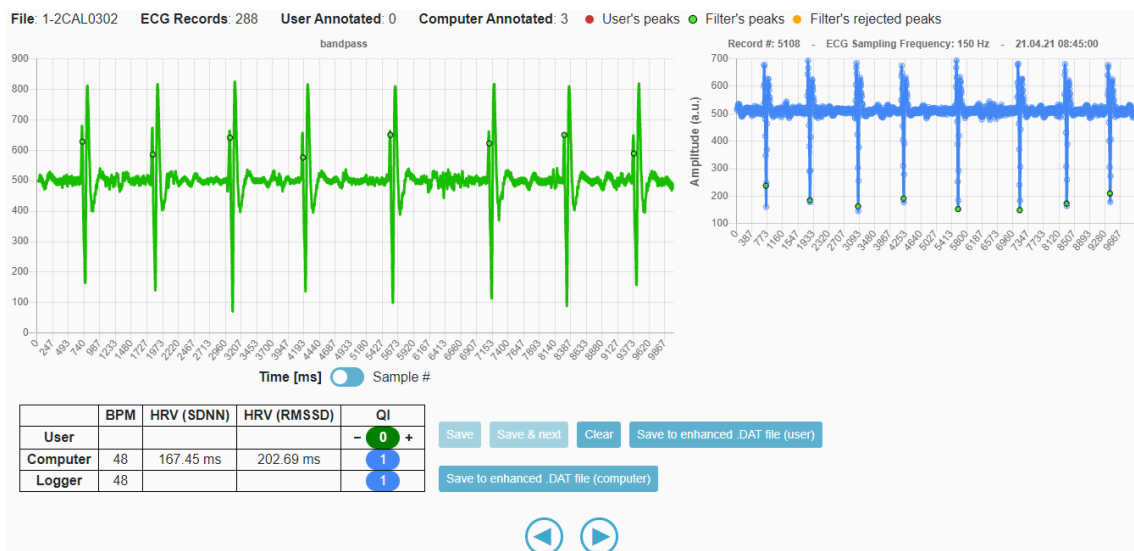It is also possible to annotate on the processed graph

Figure 6.8: Toggle between processed and original data graphs.

7   Filters

This chapter explains how to use built-in and custom filters to process the ECG records.

7.1   Built-in filters

HRT Analyzer's built-in filters can be accessed as seen in figure 7.1. The drop down menu produces the same list available in Mercury in Table 3.1.1, with the number referring to the ECG sampling frequency of the record. The recommended filter is highlighted in green see Figure 5.3 based on the tag type and firmware version.

When the **Built-in filters** tab is pressed, a drop-down menu appears:
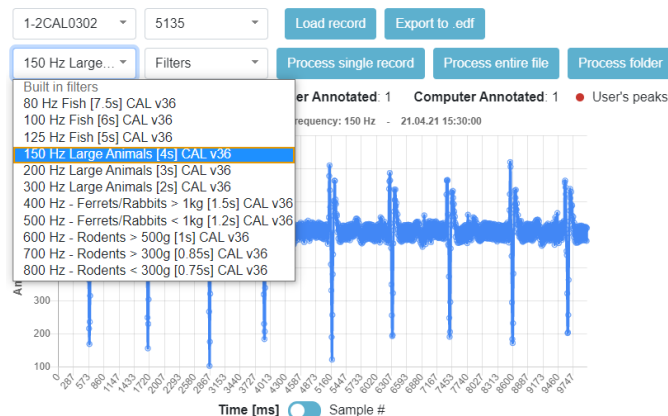
Figure 7.1: Built-in filters drop-down menu.

7.2   Custom filters

The **Filters** tab allows the user to import custom filters and adjust low-pass/high-pass filters for more control of the ECG data processing. The imported filters should be with file extension FLT and placed in the folder selected in the **Set filter folder** option.

When the **filter** tab is pressed, a drop-down menu appears with all filters (.FLT files) within set filter folder.
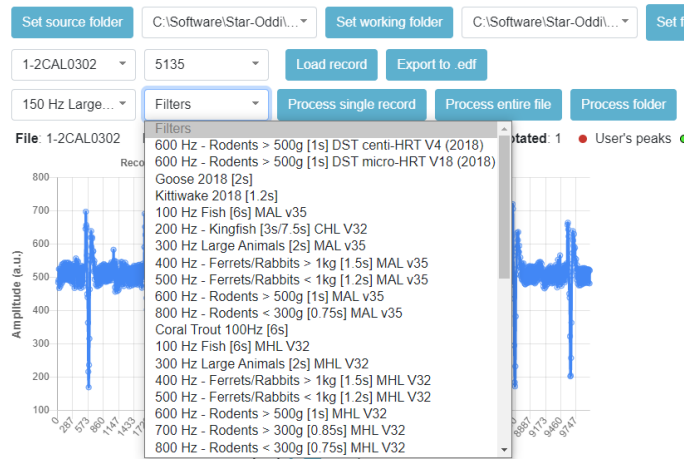
Figure 7.2: Filters drop-down menu.

7.3 Selecting the wrong filter

If a wrong filter is selected either from the Built-in drop down list or from the custom Filters drop down list. An error message will appear stating that you are selecting a filter with different ECG sampling frequency which will cause erroneous calculations. See Figure 7.3.

Figure 7.3: If there is a mis-match between the used ECG frequency used to record the data and the selected filter. The following message appears.

7.4 Process records

When desired filter has been chosen, select;

Process record to process only the record in view,

Process entire file to process all ECG records within selected HAT file,

or **Process folder** to process all HAT files within the selected source folder.

8   Save Data

This chapter describes how files can be saved and exported. All files are text files and can be opened up with a text editor or imported to other statistical software such as R, Matlab, Python or Excel.

Files are saved in the **working folder**, (described in chapter 4.2).

8.1   Save to enhanced .DAT file

The **HRT Analyzer** offers the user two options to save .DAT files:

Save to enhanced .DAT file (user)

Save to enhanced .DAT file (computer)

8.1.1   User

This option will save DAT files with **BPM (user)**, as calculated from manual annotation, and **QI** values as set by the user.

The name of the DAT file will be the same as the original but with *_uenhanched*, at the back of it.

Example:
if the original DAT file is named: *0-5UHL1204.DAT*.
The "user enhanced" DAT file will be named: *0-5UHL1204_uenhanced.DAT*.

8.1.2   Computer

This option will save DAT file with **BPM (computer)**, and **QI** as calculated by the **HRT Analyzer** software when records are processed.

The name of the DAT file will be the same as the original but with *_cenhanched*, at the back of it.

Example:
if the original DAT file is named: *0-5UHL1204.DAT*.
The "computer enhanced" DAT file will be named: *0-5UHL1204_cenhanched.DAT*.

8.2   Save .HRV file

A .HRV file, containing HRV data, is automatically saved in the working folder. Three HRV files can be generated, 'user' from user annotation, 'computer' when records are processed by the **HRT Analyzer** software and a third file *.user-pc.HRV that consists first of all the computer annotated records and then as user annotated records are made they replace the computer annotated records, in the combined file

Both the **SDNN** and **rMSSD** HRV values are saved to the HRV files.

The HRV file will have format

- Rnr (Record number/ID)
- Time (Date and Time of record)
- Unix Time (Unix timestamp of record)
- HR
- QI
- HRV (SDNN)

- HRV (rMSSD)

- Min. Amplitude

- Avg. Amplitude

- Max. Amplitude

8.2.1   User

The user .HRV file contains HRV calculated from user annotations. The file is updated each time that annotations are saved. The name of the 'user' HRV file is the name of the recorder with '-*user*' at the end of it.

Example:
if the working HAT file is named: *0-5UHL1204.HAT*.
The 'user' .HRV file will be named: *0-5UHL1204-user.HRV*.

8.2.2   Computer

The computer .HRV file contains HRV data calculated from BPM (computer) values calculated when ECG records are processed. The file is updated each time records are processed. The name of the 'computer' HRV file is the name of the recorder with '-*pc*' at the end of it.

Example:
if the working HAT file is named: *0-5UHL1204.HAT*.
The 'computer' .HRV file will be named: *0-5UHL1204-pc.HRV*.

If a record is found to contain zero or one R-R intervals, then a heart rate variability can not be calculated. In this case the record is saved as having -1 HRV

8.2.3   Combined User and Computer HRV

The combined file contains as a baseline the HRV data from PC annotation but replaced by user annotated records if they exist. The HRV file will be named *.-user-pc.HRV

8.2.4   Unix Time - Timezone

In the time zone section, the user needs to select the time zone that the logger was set up in. Then the correct Unix Time is calculated in the HRV files.
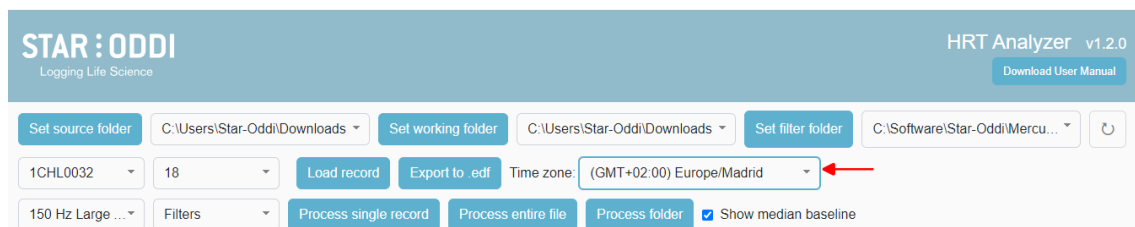See figure 8.1

Figure 8.1: Time Zone selection for correct Unix Time

8.3   Export to .edf

Files can be exported as **EDF** (European Data Format) files, with .edf extension.
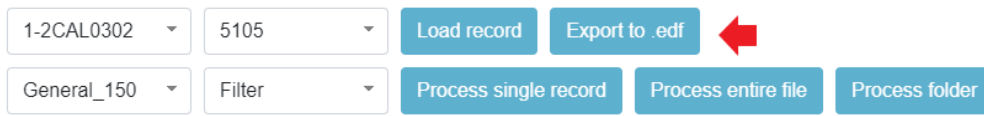
Figure 8.2: Export to .edf option.

9   Changelog

Star-Oddi HRT Analyzer changelog

v 1.2.0 - Feature release: Amplitude calculation and Hotkeys

- Overall improvements on calculation speed

- Amplify calculations added to user-pc.HRV file. max, min and average amplitude from baseline.

- Keyboard shortcuts ("Hotkeys") added to view and store records. A=previous record, S=store record, D=next record, F=store and next record and L=Load record.

- Added Time Zone of recorded data for correct Unix Timestamp calculation

v 1.1.0 - Feature release: Annotate processed graph and Combined HRV file

- Performance improvements

- User annotations are now visible on both the raw ECG and the bandpass processed graphs.

- User can annotate directly on the bandpass processed graph.

- A new HRV file that combines the PC processed records with those User processed records that exist.

- Records that contain zero or one R-R interval are now included in the HRV file, with HRV set as -1.

- An HRV file was not created if a HAT file used a dot as decimal separator for the seconds.

- Analyzer will now warn the user if they attempt to load a HAT file that is missing the sampling frequency definition.

v 1.0.5 - minor bugfixes

- Bug where user annotated data doesn't get written to the .HRV file is fixed

- Application generates a .CQI file for user annotated records in working folder when the 'save'-button is clicked

- The "Process single record"-button gets re-enabled if an error occurs in the filter process

1.0.4 - minor bugfixes

- Applcation uses the period (1/sampling frequency) from the most appropriate built-in filter to calculate the BPM and HRV (user) if the record has not been processed. If the record has been processed, the period from the used filter is used.

- The built-in filters dropdown shows only the appropriate filters for the currently loaded record i.e. HRT filters for HRT records and HRT-ACT filters for HRT-ACT records

- Application highlights the built-in filter in the built-in filters dropdown that has the same sampling frequency as the currently loaded record.

- Application shows a warning message if a filter is selected whose sampling frequency does not match the sampling frequency of the record.

- Application can read .HAT and .DAT files where the date and time are separated by a tab.

- Application works with a reconverted .DAT file where points have been removed.

- If an error occurs while reading a .DAT file, the Analyzer continues without the data from that .DAT file. An error message is displayed saying that a .DAT file was found but could not be interpreted

- ECG graph shows correct values when the x-axis is set to Time[ms].

- Analyzer shows a loading indicator and counter when record IDs are being read from the selected .HAT file and put into the ID dropdown. This process was also made faster.

- The "Data saved to enhanced .DAT in working folder" text when the "save to enhanced .DAT" buttons are clicked does not disappear until a new record is loaded.

- The "built in filters" dropdown shows only the filters appropriate for the logger type of the currently loaded record e.g. if a MHL record is loaded, the dropdown only contains MHL filters.

- The "built in filters" dropdown shows the names of the filters rather than their file names.

v 1.0.1 - minor bugfixes:

- Installer defaults to a directory that works.

- Better internal handling of ECG records.

- Application stops the user from selecting data folders inside the application folder (for it will be erased when uninstalling).

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